NATIONAL BUREAU OF STANDARDS REPORT

9060

Progress Report
on
Some Flow Characteristics at 37°C of Ternary Wax Mixtures That May Have Possible Dental Uses

U.S. DEPARTMENT OF COMMERCE
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Progress Report on Some Flow Characteristics at 37°C of Ternary Wax Mixtures That May Have Possible Dental Uses

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Some Flow Characteristics at 37°C of Ternary Wax Mixtures That May Have Possible Dental Uses

Abstract

One hundred and eighty two ternary diagrams of the flow at 37°C of mixtures of commercial waxes indicate some of these mixtures may have dental use.

1. Introduction

This report is part of an eight-year investigation dealing with the physical and clinical characterization of selected materials used in the construction of complete dentures. Specifically, the report presents flow data at 37°C on 182 ternary combinations of commercial waxes and gums which may have appropriate flow characteristics for a variety of dental uses. These wax mixtures may have use as wash impression materials for recording the mucosal tissues at rest or during function. It is believed also that some of the wax mixtures may be used as temporary relining materials for dentures and for almost all other dental application of waxes.

The accurate recording of the surface detail and contour of edentulous jaw tissues is an important function of a dental impression material. This is so because the degree of the apposition of the mucosa and the tissue bearing surface of the denture is significant in the retention and stability of the dentures and in the condition of the oral tissues that support them. The higher the degree of proximity at the mucosa-denture interface the better, supposedly, is the fit and functioning of the denture. However, the proximity of the interface varies. The tissues are at rest when the jaws are separated - which is most of the time - and are in function only during clenching, swallowing or chewing - generally a small fraction of the time the denture is being worn. It is not definitely known if it is more desirable to obtain an impression of the tissues when at rest or during functioning of the denture.

2. Materials and Methods

In Table 1 are shown the various commercial waxes and gums, their source and type, which were used in constructing binary diagrams of flow characteristics at 37°C. The binary mixtures tested are listed in Table 2.

The flow was measured by subjecting wax cylinders, six millimeters high and ten millimeters in diameter, to a 2000 gram load at 25°C, 30°C, 37°C 40°C and 45°C, by the method given in American Dental Association Specification No. 4 for Dental Inlay Casting Wax.[1]

The 182 ternary diagrams of the percentage of flow at 37°C of the various wax mixtures which follow were constructed mostly from appropriate binary systems as listed in Table 2. Where insufficient data were obtainable from binary mixtures to construct certain areas of some of the ternary diagrams the flow characteristics of ternary mixtures were determined.

3. The Ternary Flow Diagrams

As previously stated the principal reason for the study of the flow characteristics of the wax and gum mixtures was the development of dental wash impression waxes. Therefore, binary mixtures which in general would give a high percentage of flow at body temperature were selected for the base.

At the angles of the diagrams are given the pure waxes of each ternary system with the percentage of flow of the pure wax at 37°C. Thus, in Figure 1 pure Japan wax which has a flow 0.6% at 37°C is at "C" angle, pure Microcrystalline #1365 is at "B" angle with a flow of 78.0% and pure Cornelius paraffin 124 with a flow of 91.2%, is at "A" angle. The line A-B, therefore, represents all compositions of the binary system of Cornelius paraffin 124 and Microcrystalline #1365. This is true for Figures 1 through 14. The uncommon component in these figures is at the "C" angle of the ternary diagram.

Thus, in Figure 1 the B-C direction gives the composition of all mixtures of Japan wax and Microcrystalline #1365. The A-C direction gives the compositions of Cornelius paraffin 124 and Japan wax.

The oblique lines running toward the right in Figure 1 were derived from the data in the three binary diagrams represented by wax systems A-B, and B-C and C-A. The figures on these lines are the average of two determinations and indicate the percentage of flow at 37°C for any ternary composition which the lines cross. These lines were constructed as follows:

Since the flow of 100% Cornelius paraffin 124 is 91.2% at 37°C and the flow of 100% Microcrystalline #1365 is 78.0% it is apparent that the points with flow values between 91.2 and 78.0% will fall on line A-B. Consider line A-C. At A-100% Cornelius paraffin 124 has a flow of 91.2% and at C 100% Japan wax has a flow of 0.6% at 37°C. So on line A-C the flow points cannot be greater than 91.2% or less than 0.6%, and any mixture of Cornelius paraffin 124 and Japan wax that has a flow of 78% or more can be equated with similar flow values on line A-B. For example, the straight line on the graph labeled 78 was constructed by drawing a line from B angle where 100% Microcrystalline #1365 had a flow of 78% to a point on line A-C where the composition of Cornelius paraffin 124 and Japan wax had a flow of 78% at 37°C. This composition is, thus, seen to be 52 1/2% Cornelius paraffin 124 and 47 1/2% Japan wax. Similarily all of the lines with values more than 78% flow were constructed from the composition of the waxes on lines A-C and A-B that gave the flow percentages as given by the numbers on the constructed lines of the graph. Similarily the lines on Figure 1 labeled 10, 65, 70 and 75 were constructed from points on lines A-C and C-B where the compositions gave the foregoing flow values. This construction of the ternary graphs is possible because the waxes are true mixtures and no new phases are formed in the binary or ternary systems. To check this, it is necessary to construct identical diagrams, one based upon data from the three binary systems, and the other with data based upon the flow of ternary compositions or at least at key composition points. It is necessary to determine the flow of appropriate ternary mixtures when the flow values on one of the binary base lines are not within the range of values on the other two base lines. This was done in the 50 instances in Figures 1-182 where the lines showing flow do not extend continuously straight across the diagrams. Figure 2 is one example of such a ternary diagram in which the lines showing the flow do not go continuously straight across from one side of the diagram to the other so it was necessary to determine the appropriate flow on ternary mixtures. Fifty-five of the diagrams have dotted areas showing when the waxes were not soluble in each other in the solid state. When the wax mixtures were soluble in the solid state the cylinders would flow uniformly so that the resultant wax disk would be symmetrical. When the waxes were not soluble in the solid state flat plates with irregular edges would be formed when the wax cylinders flowed under the load. Table 2, ternary mixtures containing Stevenson Spermaceti, Japan wax or Durowax usually showed some compositions which were not soluble in the solid state. This is specially noticeable in Figures 162-169. Segregation in the solid state could often be observed when the flow specimens such as were used in the determinations were sectioned.

Many ternary diagrams showing continuous straight lines for flow of the wax mixtures at 25°, 30°, 40° and 45°C could be constructed on the flow data that was obtained on the binary wax mixtures listed in Table 2. The data on available but ternary diagrams have not been constructed.

Flow graphs of the binary systems listed in Table 2 have been roughly drawn with percentage of flow plotted on the abscissa axis and temperature on the ordinate axis with the compositions given on the curves. Similar graphs have been roughly constructed with the percentage of flow given on the abscissa and composition on the ordinate with the temperature given on the curves. The data are available but are not shown in this report.

4. Waxes for Clinical Tests

Some ternary wax mixtures were formulated for clinical trials. These mixtures and their flow data are given in Table 4. Clinical testing of these waxes has not yet been done.

5. Bibliography

1. Guide to Dental Materials. Third Edition, American Dental Association, Chicago, Illinois, 1966.

Table 1

Waxes and Compounds in Ternary Mixtures

	Name of Materials	Batch No.	Source	Type or Origin
1	AA-1063-D wax		Allied Asphalt and Mineral Corp.	Synthetic
2	Aldo 33		Glyco Chemical, Inc.	Synthetic
3	Beeswax (U.S.P. white)		Stevenson Bro. and Co.	Animal
4	Be Square 190/195 amber		Bareco Wax Co.	Mineral
5	C-905		Allied Asphalt and Mineral Corp.	Synthetic
6	Candelilla wax		Stevenson Bro. and Co.	Vegetable
7	Carnauba wax		Stevenson Bro. and Co.	Vegetable
8	Ceresine wax #1573/1		Frank B. Ross Co.	Mineral
9	Durawax #1032		Cornelius Wax Refining Corp.	Synthetic
10	Flexowax C light		Glyco Chemical, Inc.	Synthetic
11	Japan wax		Frank B. Ross Co.	Vegetable
12	Microcrystalline #1365		Cornelius Wax Refining Corp.	Mineral
13	Ozokerite #870		Cornelius Wax Refining Corp.	Mineral
14	Ozokerite #871		Cornelius Wax Refining Corp.	Mineral
15	Paraffin wax 124		Cornelius Wax Refining Corp.	Mineral
16	Paraffin wax 128/130		Frank B. Ross Co.	Mineral
17	Paraffin wax 138/141		Stevenson Bro. and Co.	Mineral
18	Paraffin wax 160/165		Stevenson Bro. and Co.	Mineral
19	Rosin N. F.	714236	Fisher Scientific Co.	Vegetable
20	Singapore Gum		Morningstar-Paisley, Inc.	Vegetable
21	Spermaceti wax		Stevenson Bro. and Co.	Animal
22	Ultraflex amber wax	V-3260	Bareco Wax Co.	Mineral

Table 2

Binary Wax Mixtures Tested*

	Melting Point	Stevenson Spermaceti	Cornelius Paraffin 124	Ceresine #1573/1	Stevenson Beeswax	Microcrystalline #1365	Ultraflex	Flexowax C light	C-905	Rosin N. F.
	°C	°C	°C	°C	°C	°C Approx.	°C	°C	ø	ø
		47.4	51.0	53.5	61.8	62.0	63.0	63.1		
Japan wax	41.2		‡			†	‡	‡	‡	
AA-1063-D	42.9		†			†	†	†	†	
Cornelius Spermaceti	45.2		†							‡
Stevenson Spermaceti	47.4		‡	‡		†	†	‡	‡	
Ross Paraffin 128/130	52.8	‡		†						†
Ceresine #1573/1	53.5	‡	†			†	†	†	†	†
Stevenson Paraffin 138/141	57.4	†	†			†	†	†	†	
Aldo 33	58.1 54.0	†	†							
Stevenson Beeswax	61.8	‡	†							†
Microcrystalline #1365	Approx. 62.0	†	†	†			†	†	†	†
Ultraflex	63.0	†	†	†		†		†		†
Flexowax C light	63.1	‡	†	†		†				†
Stevenson Candelilla	68.4 63.4		†		†	†	†	†	†	
Albacer	71.6		**			**	**	**	**	
Stevenson Paraffin 160/165	72.0 65.6		†			†	†	†	†	
Ozokerite #870	76.8		†		†	†	†	†	†	
Stevenson Carnauba	80.5		†		†	†	†	‡	†	
Durawax #1032	81.2		†			†	‡	‡	‡	
Ozokerite #871	85.5		†			†	†	†	†	
Be Square 190/195	85.5		†			†	†	†	†	
C-905 wax	ø	‡	†	†		†	†	†		†
Rosin N. F.	ø	‡	†	†	†	†	†	†	†	
Singapore gum	ø		†			†	†	†	†	

ø No hold or arrest point on temperature-rate cooling curve.
† Satisfactory flow specimen (symmetrical disk) when tested at 37°C.
‡ Some flow specimens at certain proportions at 37°C are unsatisfactory (unsymmetrical).
** Does not mix
* Blanks indicate binary systems that were not investigated.

Table 3

List of Ternary Flow Diagrams

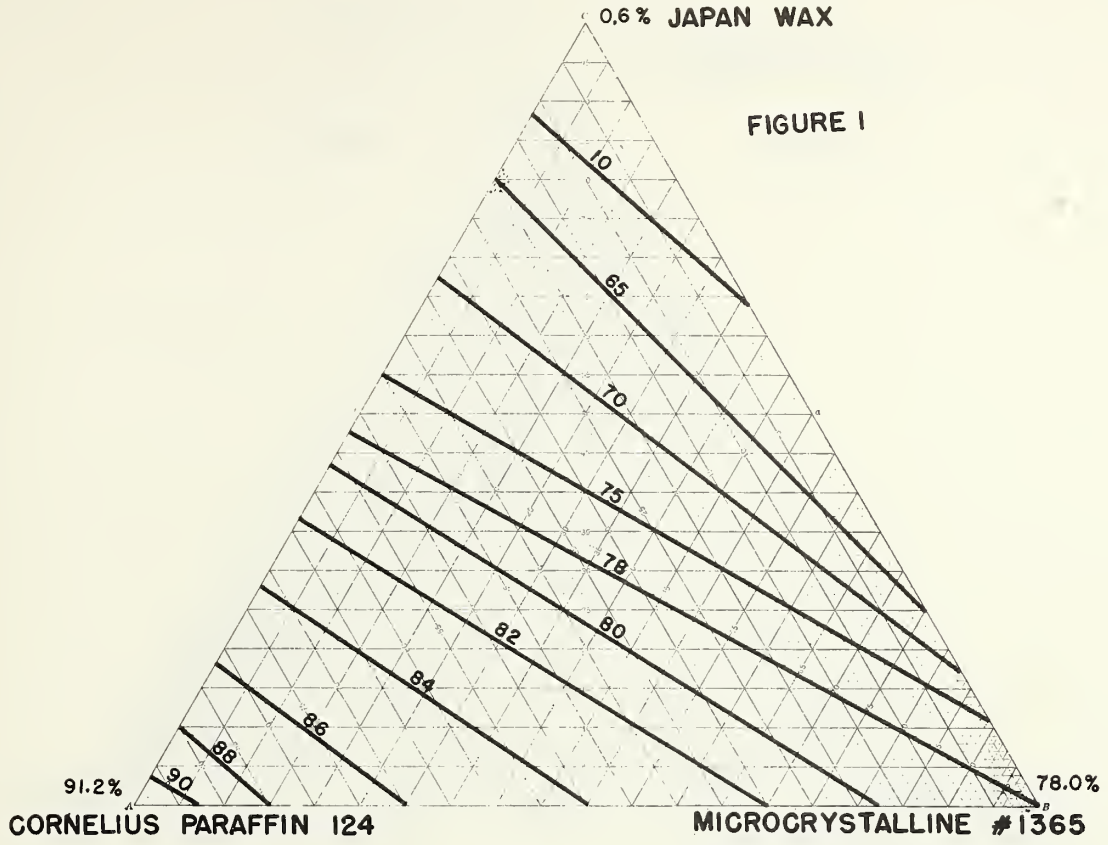
Figure Numbers	Common Base Binary Mixtures	Direction of Common Base
1-14	Cornelius Paraffin 124 - Microcrystalline #1365	
15-19	Cornelius Paraffin 124 - Stevenson Beeswax	
20-37	Cornelius Paraffin 124 - Flexowax C Light	
38-53	Cornelius Paraffin 124 - Ultraflex	
54-68	Cornelius Paraffin 124 - C-905	A-B
69-82	Flexowax C Light - Microcrystalline #1365	
83-97	Flexowax C Light - C-905	
98-113	Flexowax C Light - Ultraflex	
114-128	Ultraflex - C-905	
129-142	Ultraflex - Microcrystalline #1365	
143-156	C-905 - Microcrystalline #1365	
157-161	Stevenson Paraffin 138/141 - Stevenson Spermaceti	
162-169	Stevenson Spermaceti - Rosin	B-C
170-172	Ceresine #1573/1 - Rosin	A-C
173-175	Ceresine #1573/1 - Rosin	B-C
176-178	Ceresine #1573/1 - Stevenson Spermaceti	A-C
179-181	Ceresine #1573/1 - Stevenson Spermaceti	B-C
182	Cornelius Paraffin 124 - Aldo 33	A-B

Table 4

Composition, Melting and Flow Characteristics of Ternary Wax Mixtures Selected for Clinical Trial as Wash Impression Materials or as Temporary Reliners for Dentures

Composition		Melting Point	Flow at			
Wax	Proportions by Weight		30°C	37°C	40°C	45°C
	%	°C	%	%	%	%
Cornelius Paraffin 124	60					
Stevenson Spermaceti	20	45.7	81.5	93.4	96.6	98.4
Flexowax C Light	20					
Cornelius Paraffin 124	60					
Stevenson Spermaceti	20	48.0	78.1	92.8	96.2	98.2
Ultraflex	20					
Cornelius Paraffin 124	60					
Stevenson Spermaceti	20	48.5	82.5	93.2	96.2	97.8
C-905	20					
Cornelius Paraffin 124	60					
Stevenson Spermaceti	20	48.5	77.2	9 .8	96.0	98.2
Microcrystalline #1365	20					
Cornelius Paraffin 124	60					
Stevenson Spermaceti	30	48.0	84.0	93.2	96.8	98.0
Ceresine #1573/1	10					
	10					
	30	49.5	60.9	91.4	95.6	97.3
	60					
Ceresine #1573/1	60					
Stevenson Spermaceti	20	50.0	66.1	92.1	95.4	98.0
Flexowax C Light	20					
Ceresine #1573/1	60					
Stevenson Spermaceti	20	50.5	57.2	90.5	94.0	98.0
Ultraflex	20					
Ceresine #1573/1	60					
Stevenson Spermaceti	20	51.0	65.0	91.8	94.4	97.6
C-905	20					
Ceresine #1573/1	60					
Stevenson Spermaceti	20	51.5	51.2	88.9	92.1	97.7
Microcrystalline #1365	20					
Oxygenated Cornelius Paraffin[1]	60					
Stevenson Spermaceti	20	48.5	78.6	95.4	96.9	97.6
Ceresine #1573/1	20					

[1] Compounded as closely as possible as described by DIRKSEN, LYNN C. composition and properties of a wax for lower impressions, J.A.D.A. 26:273 Feb. 1939. (This is sometimes referred to as the Iowa impression wax).



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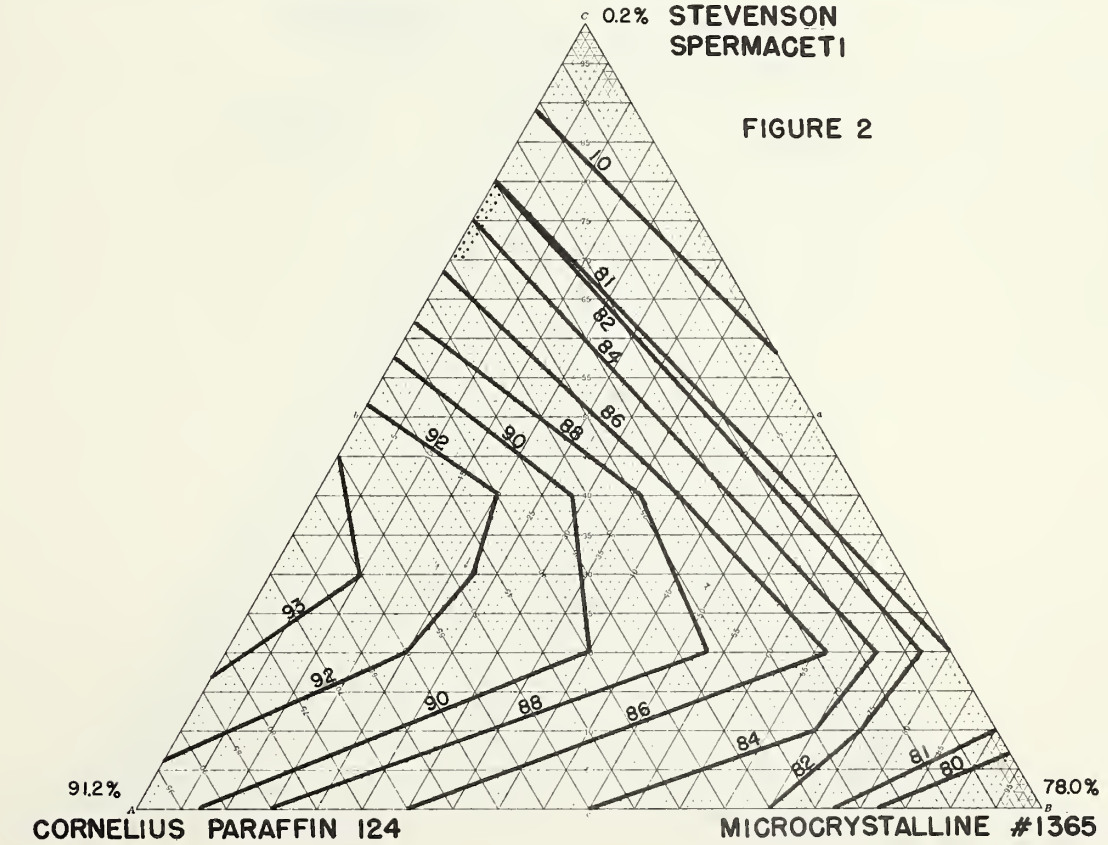

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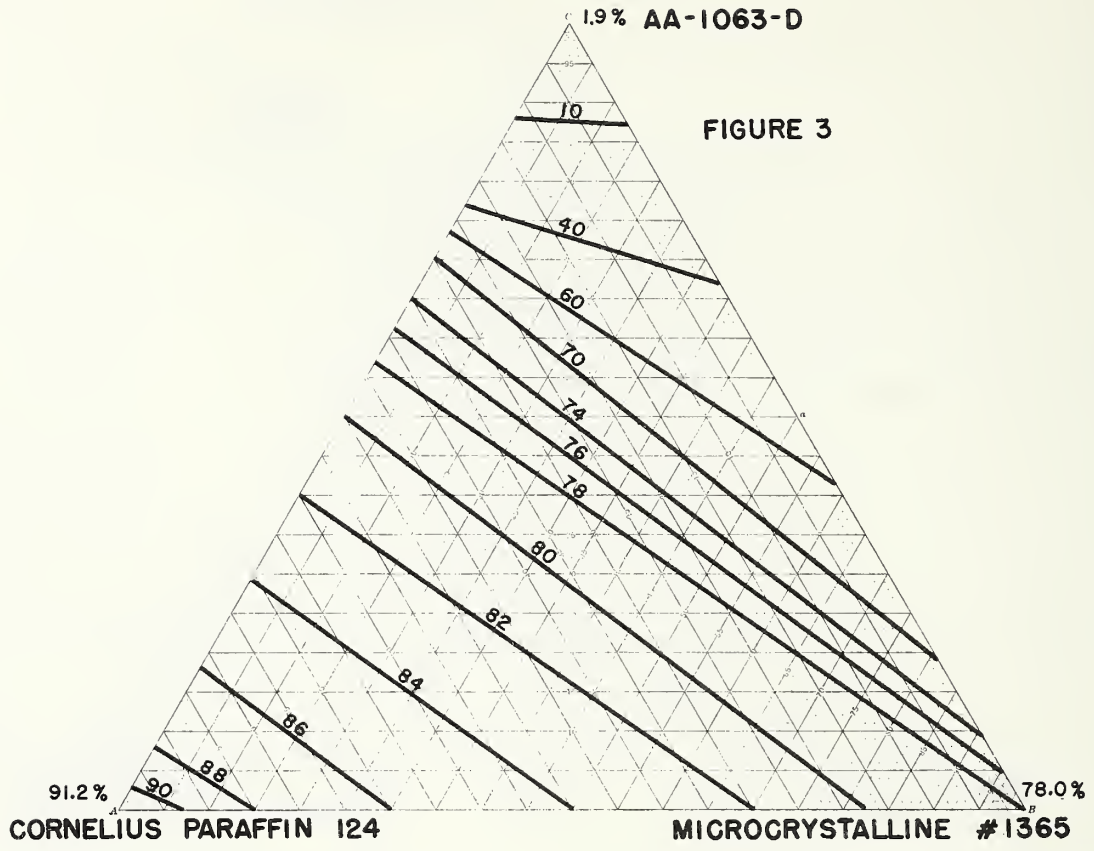

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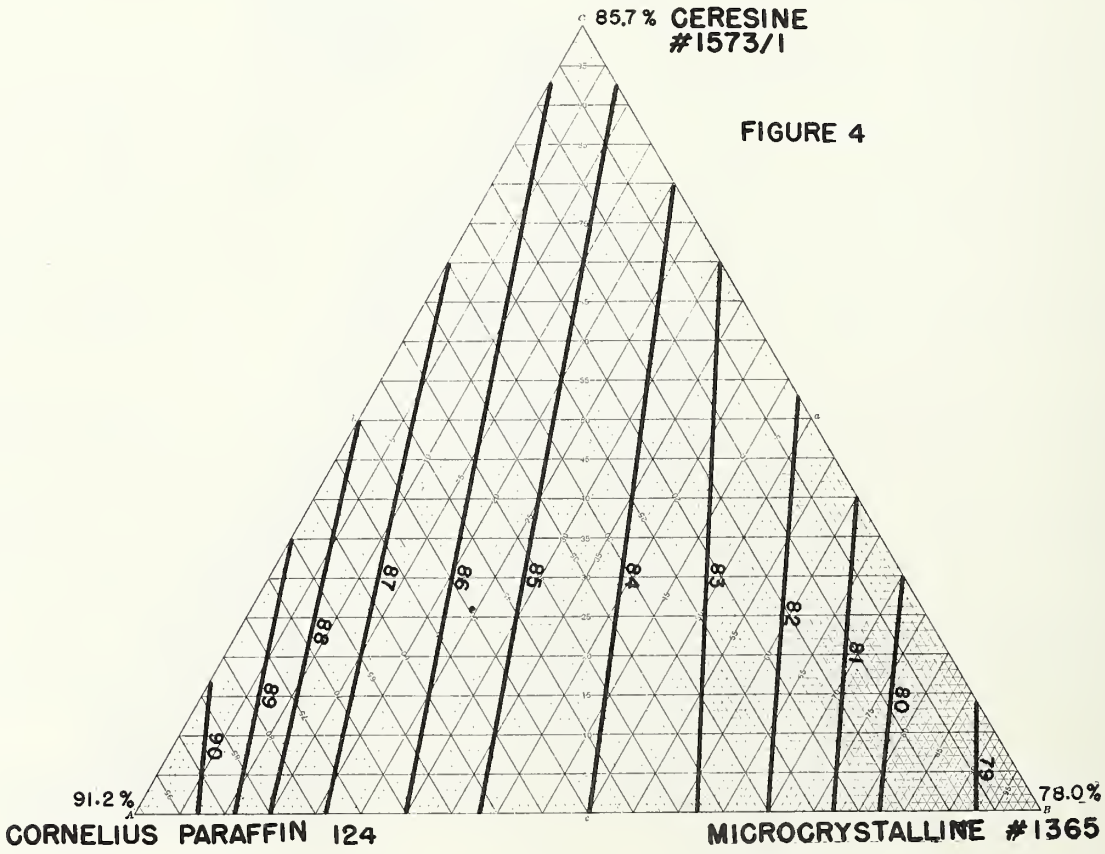

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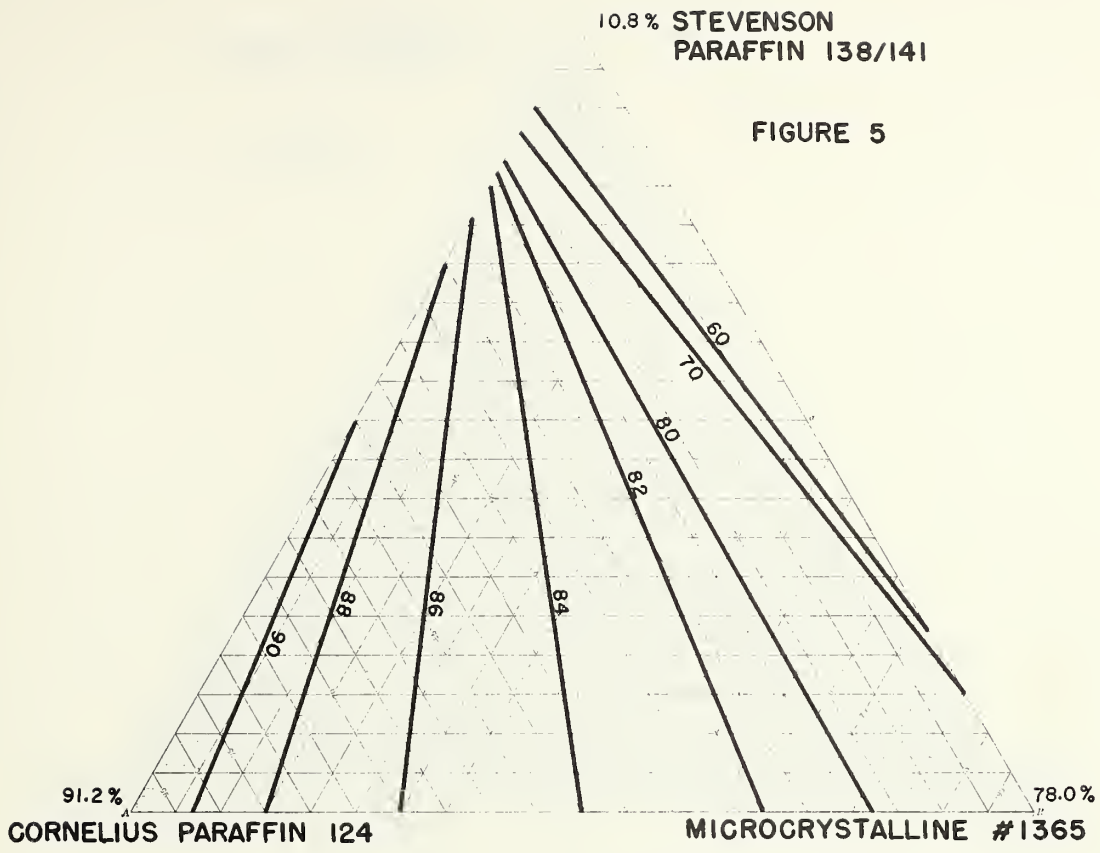

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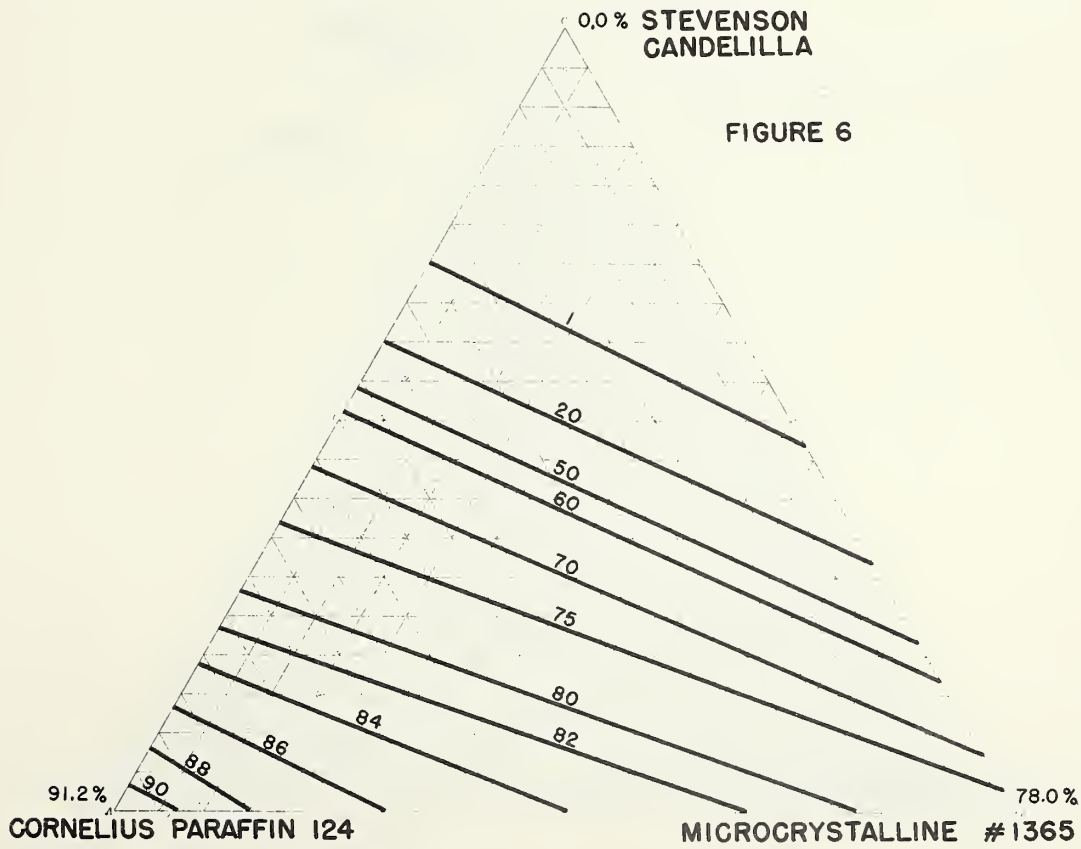

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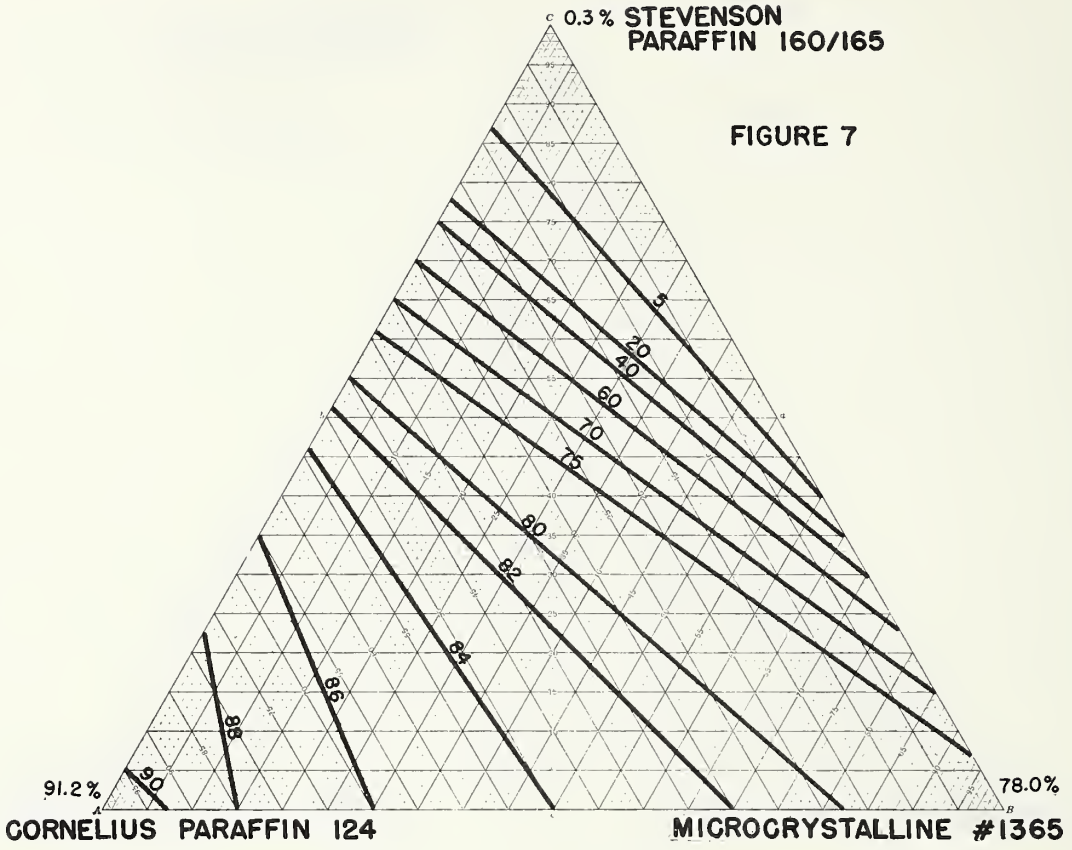

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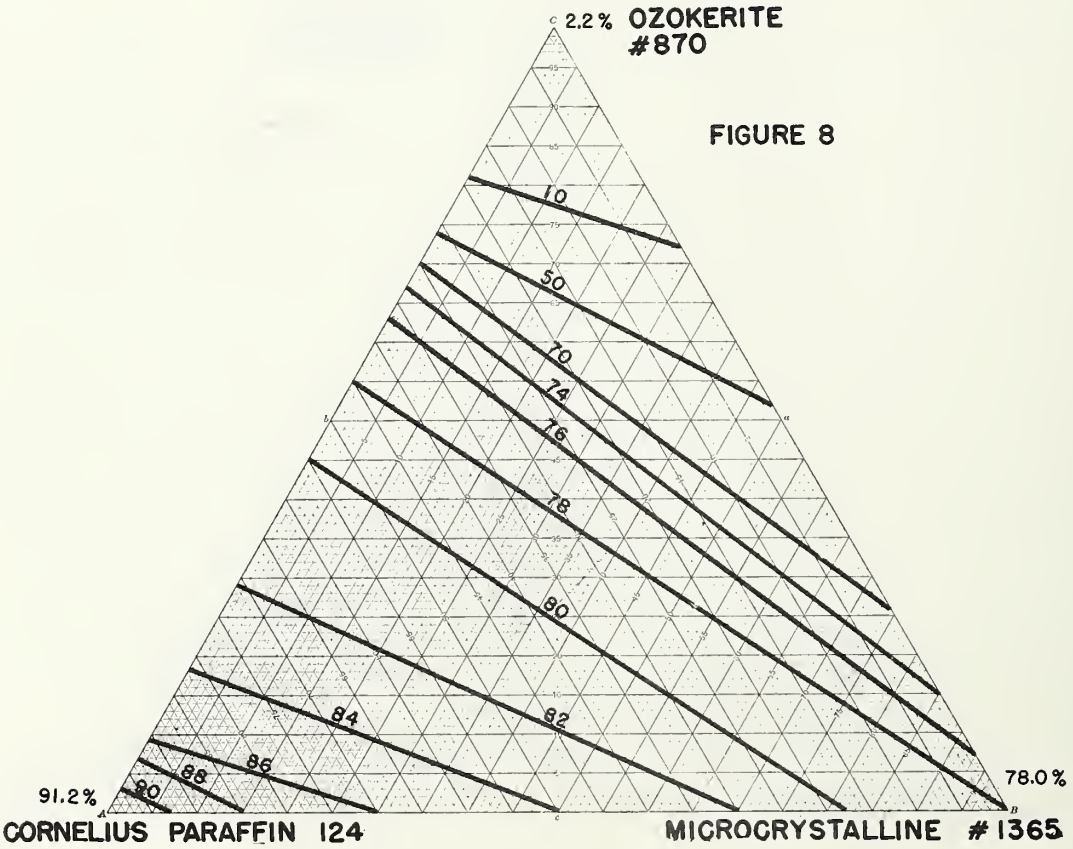

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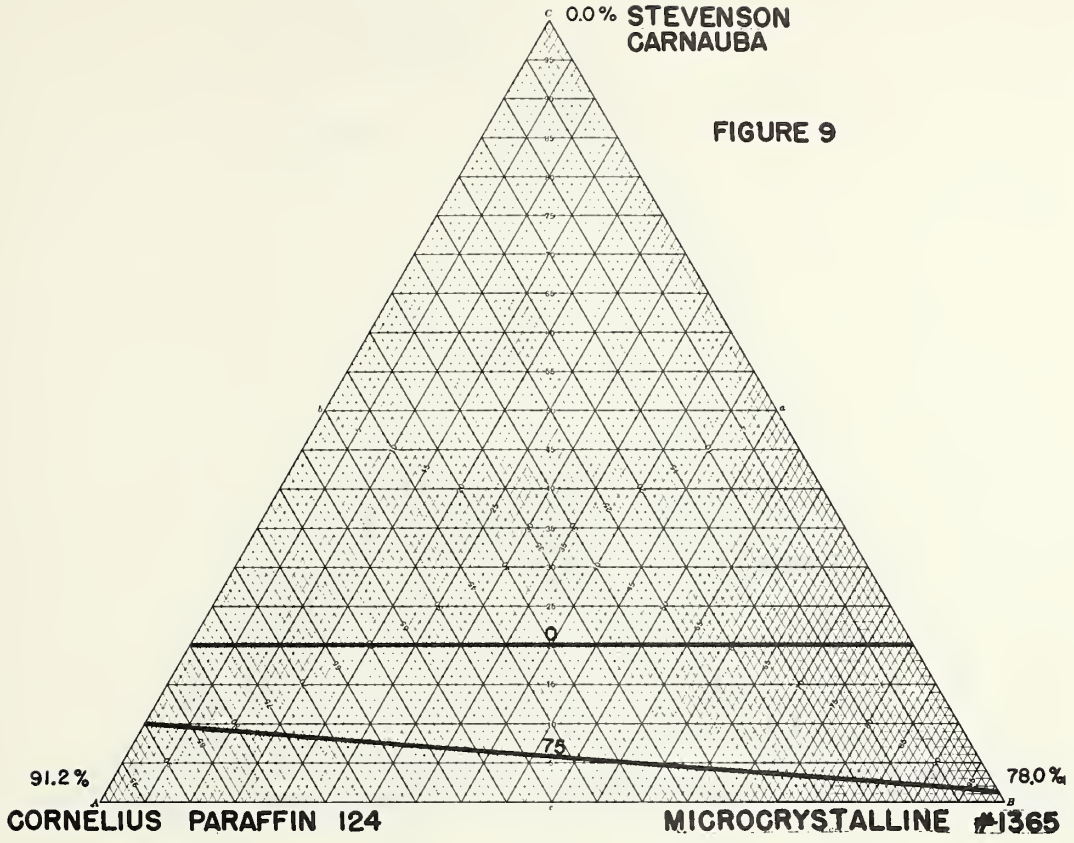

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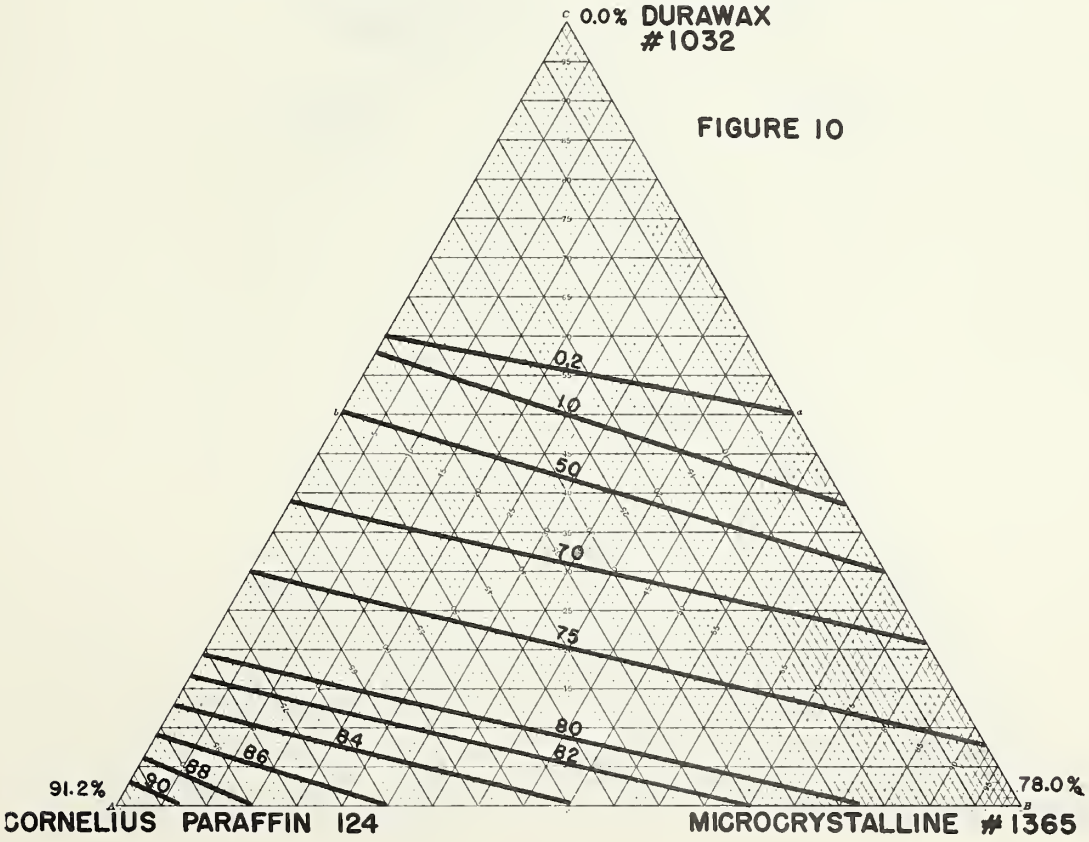

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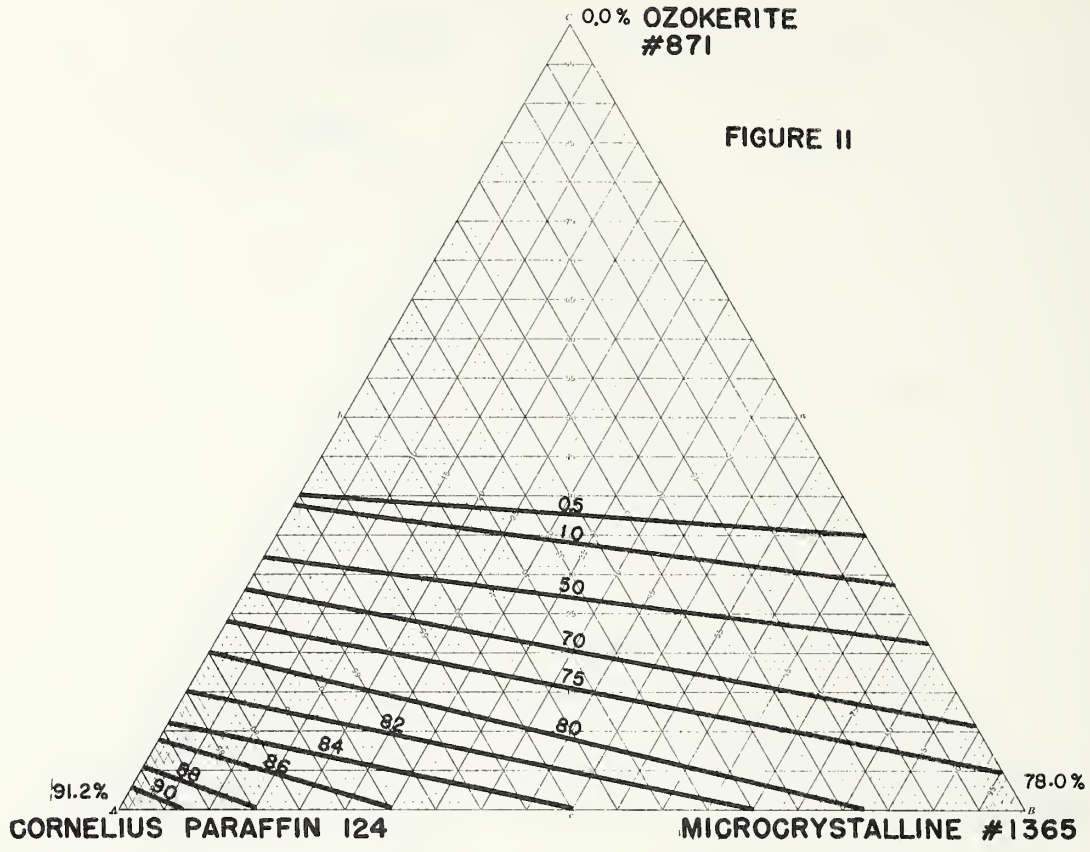

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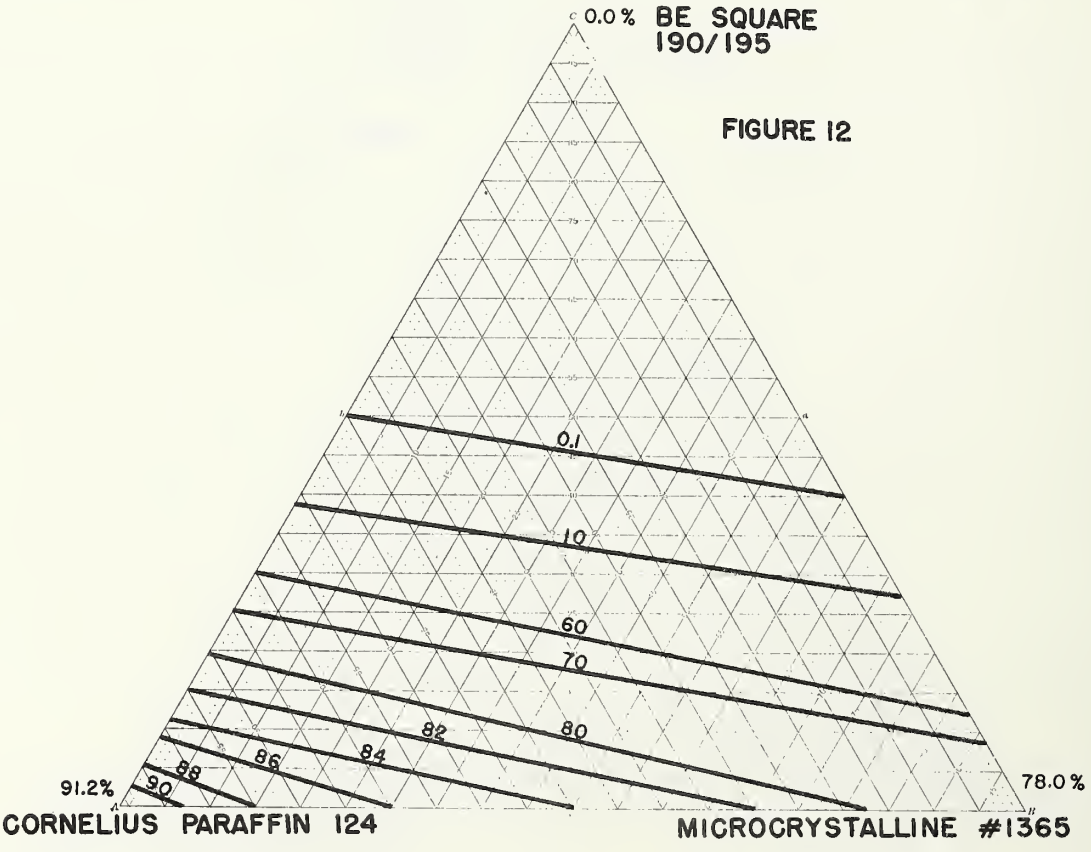

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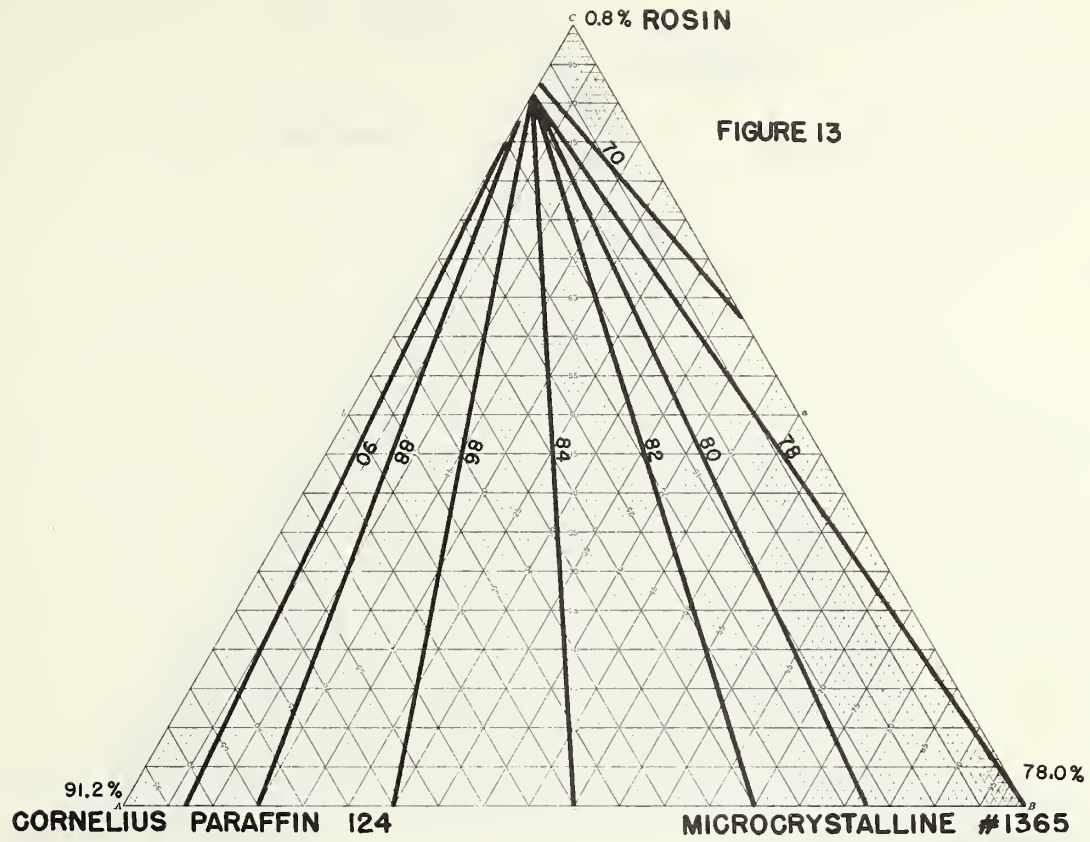

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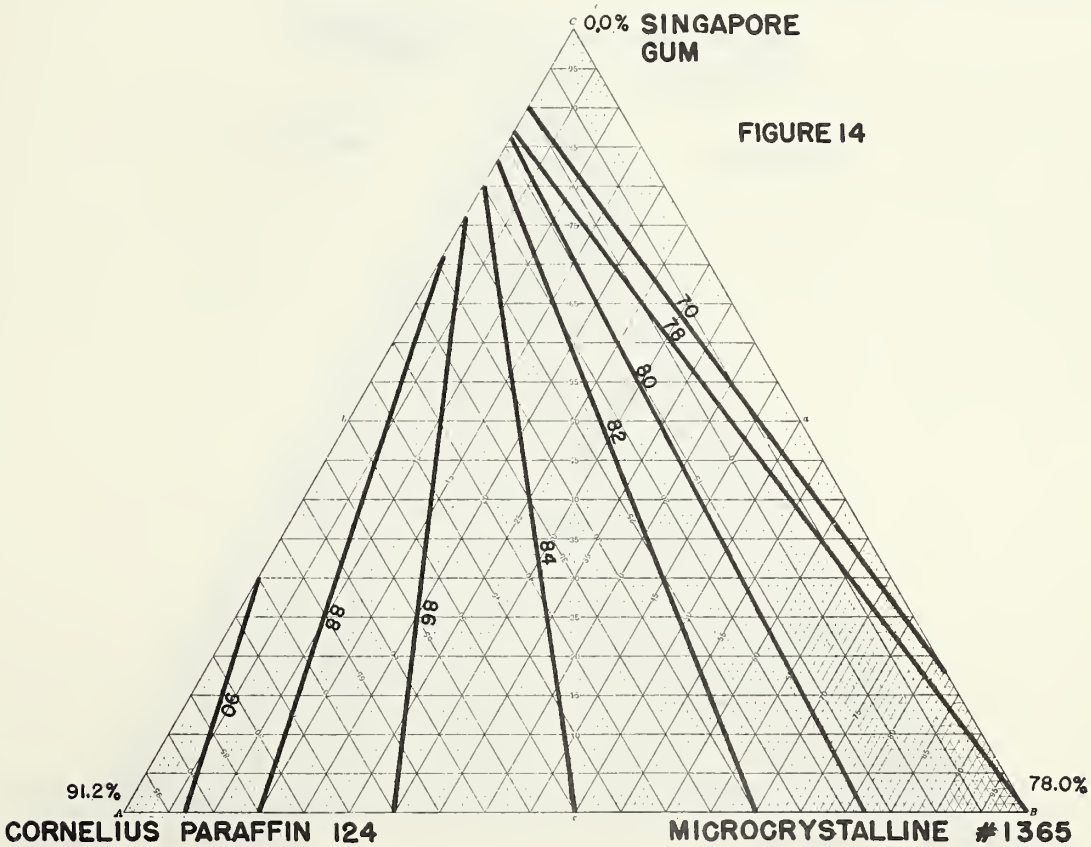

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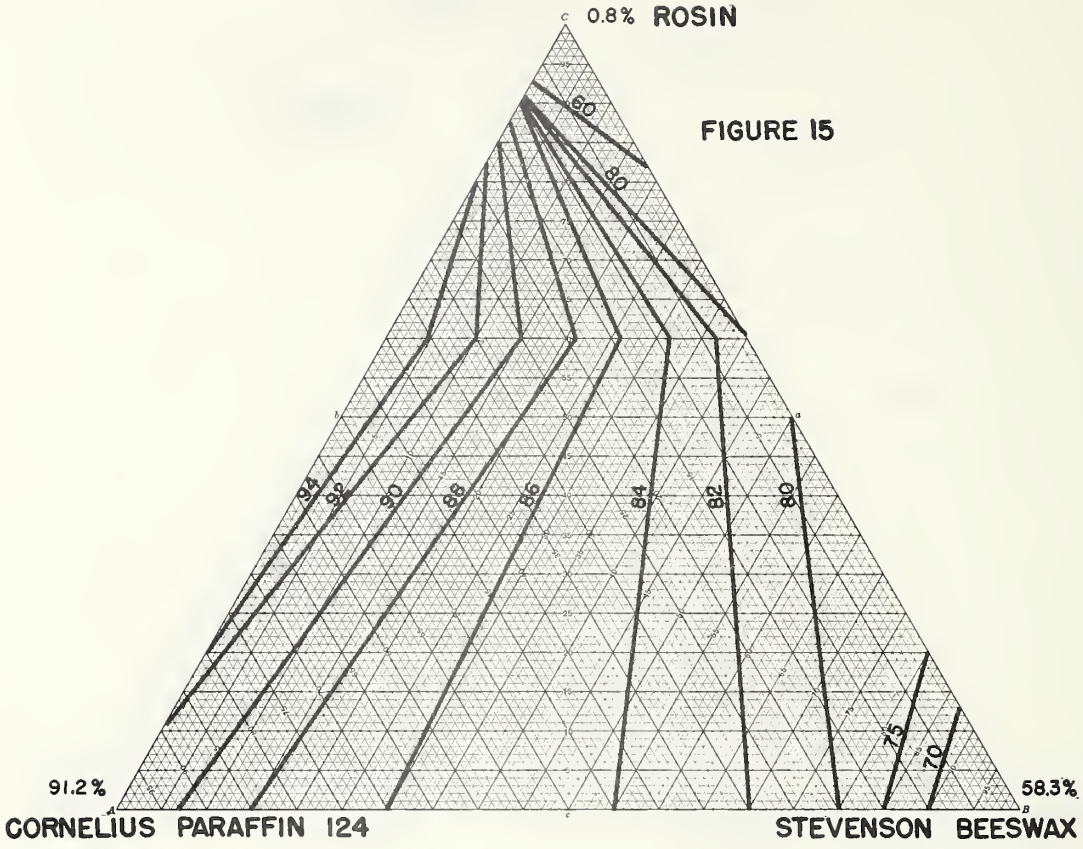

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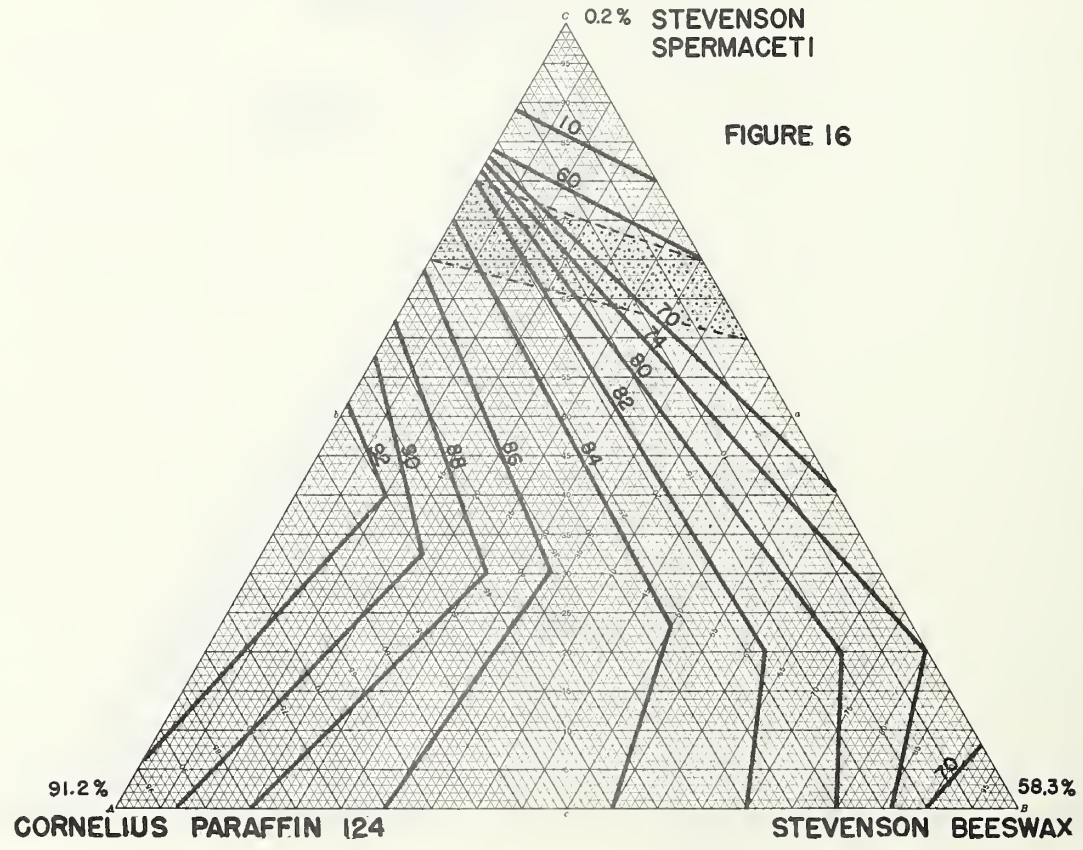

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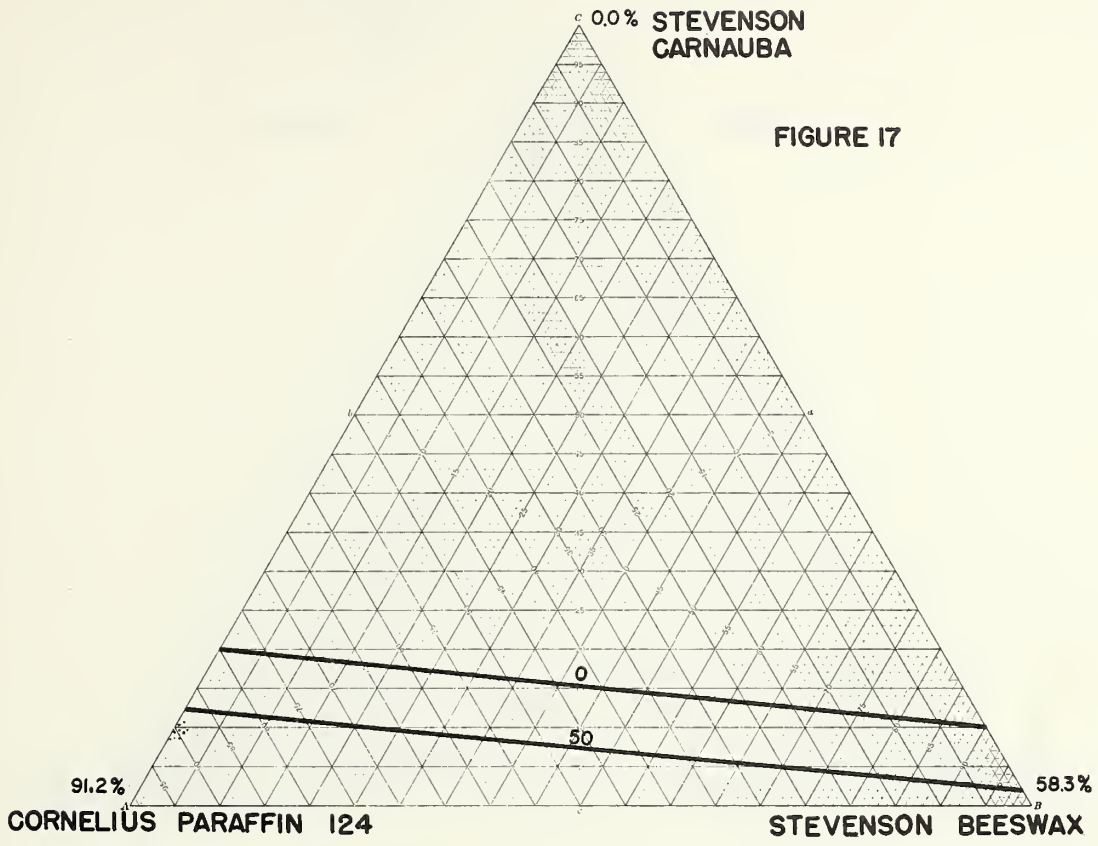

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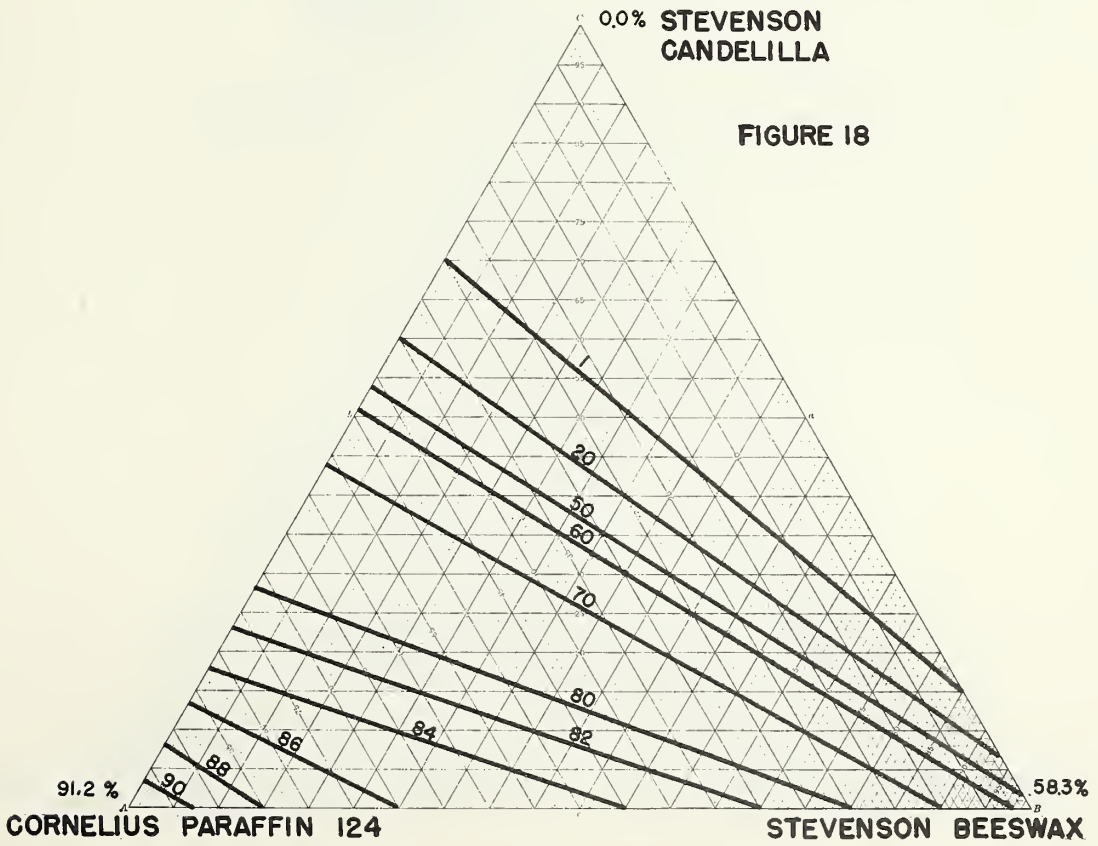

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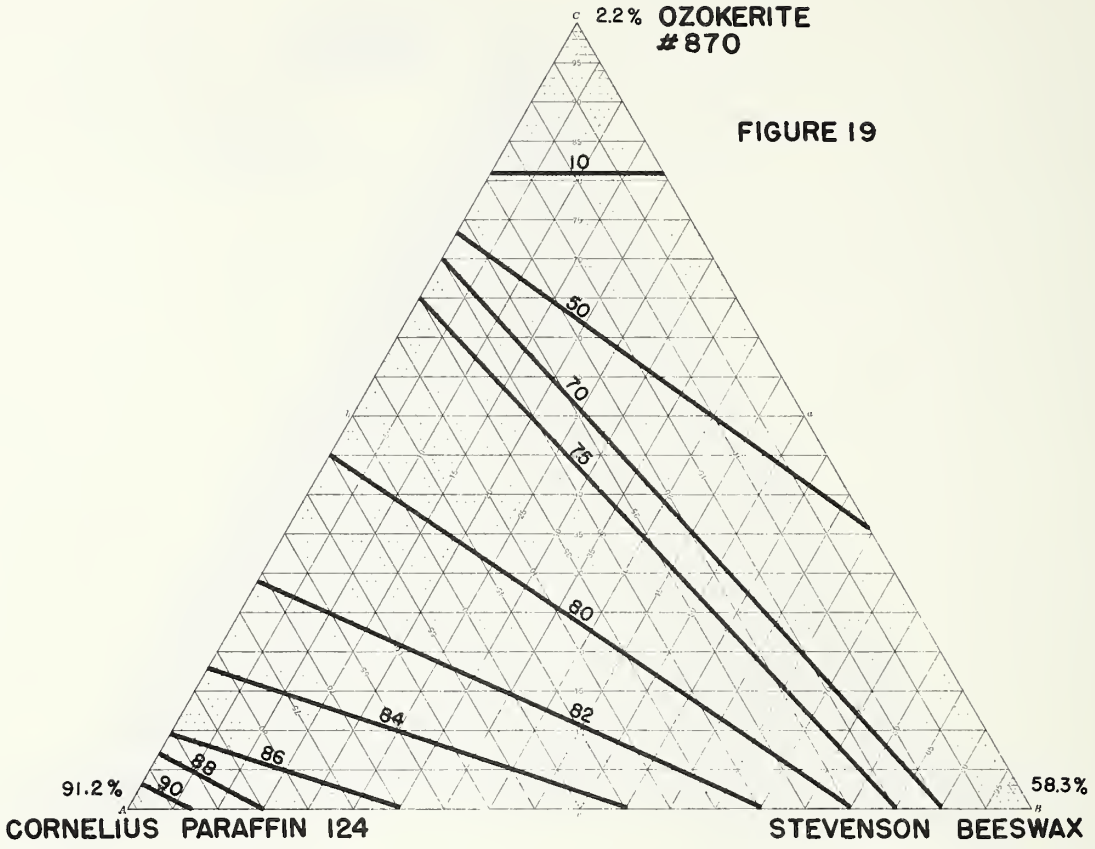

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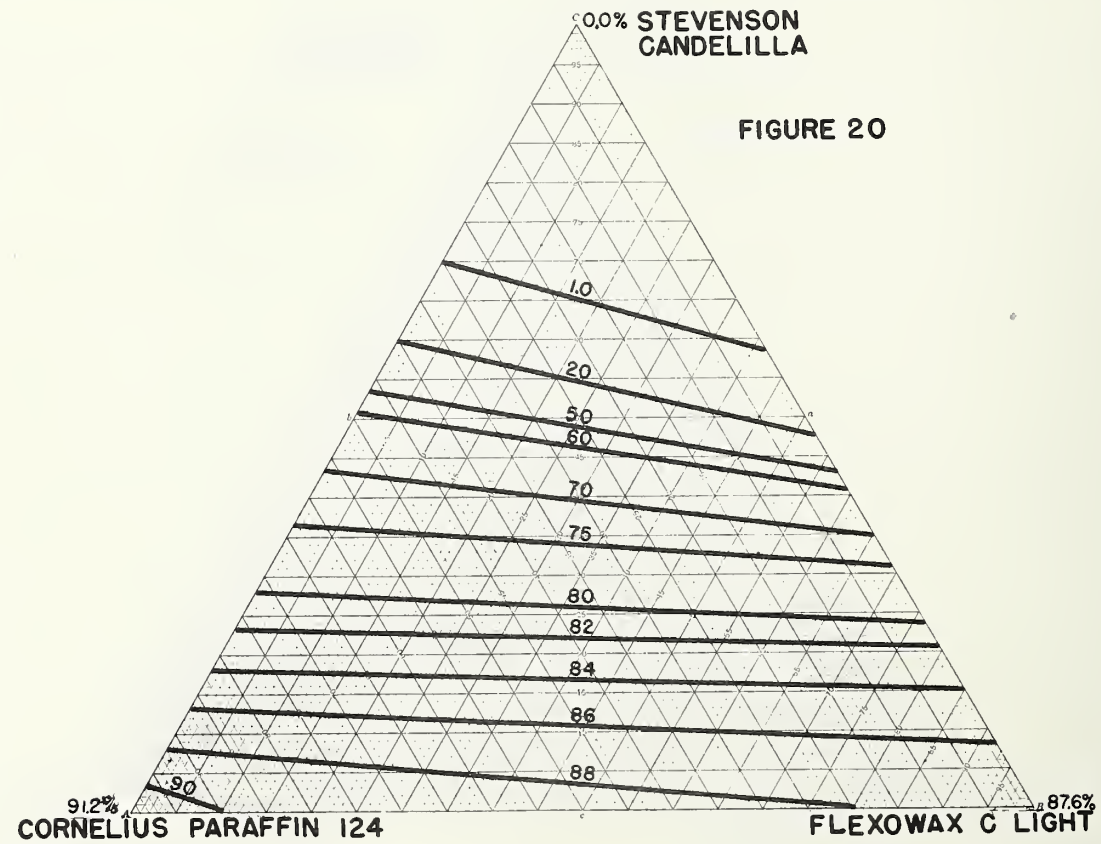

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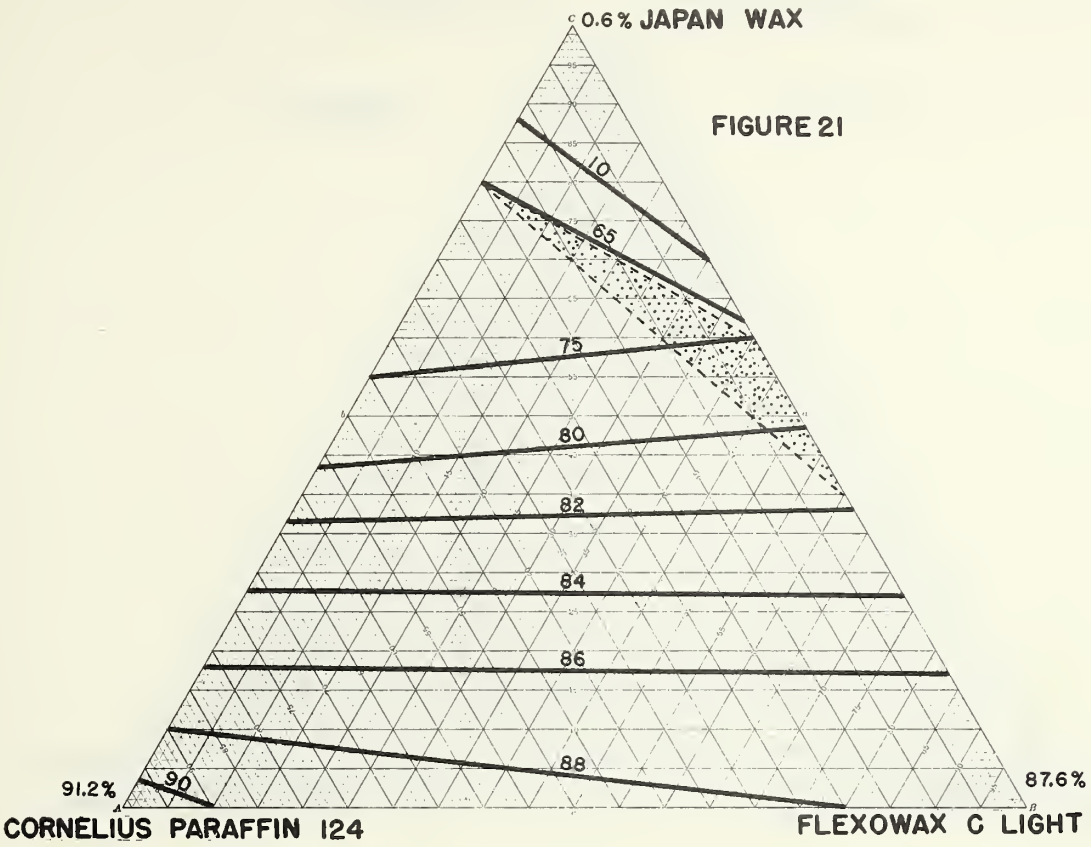

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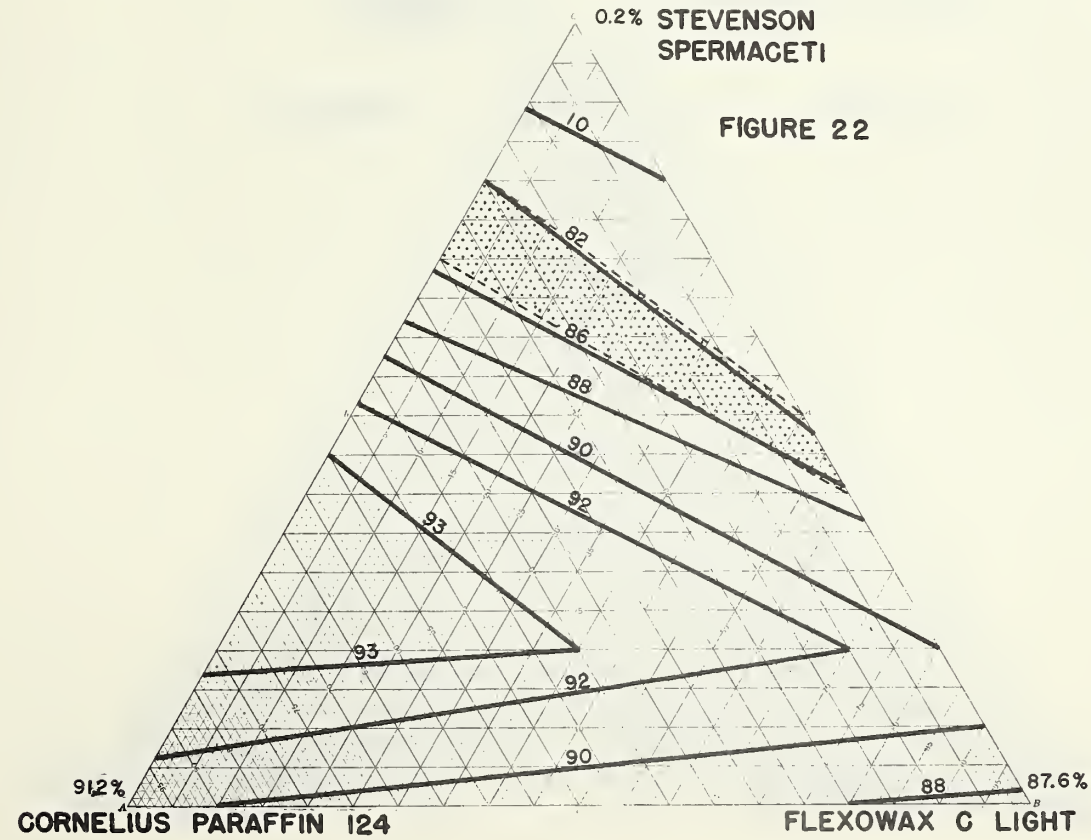

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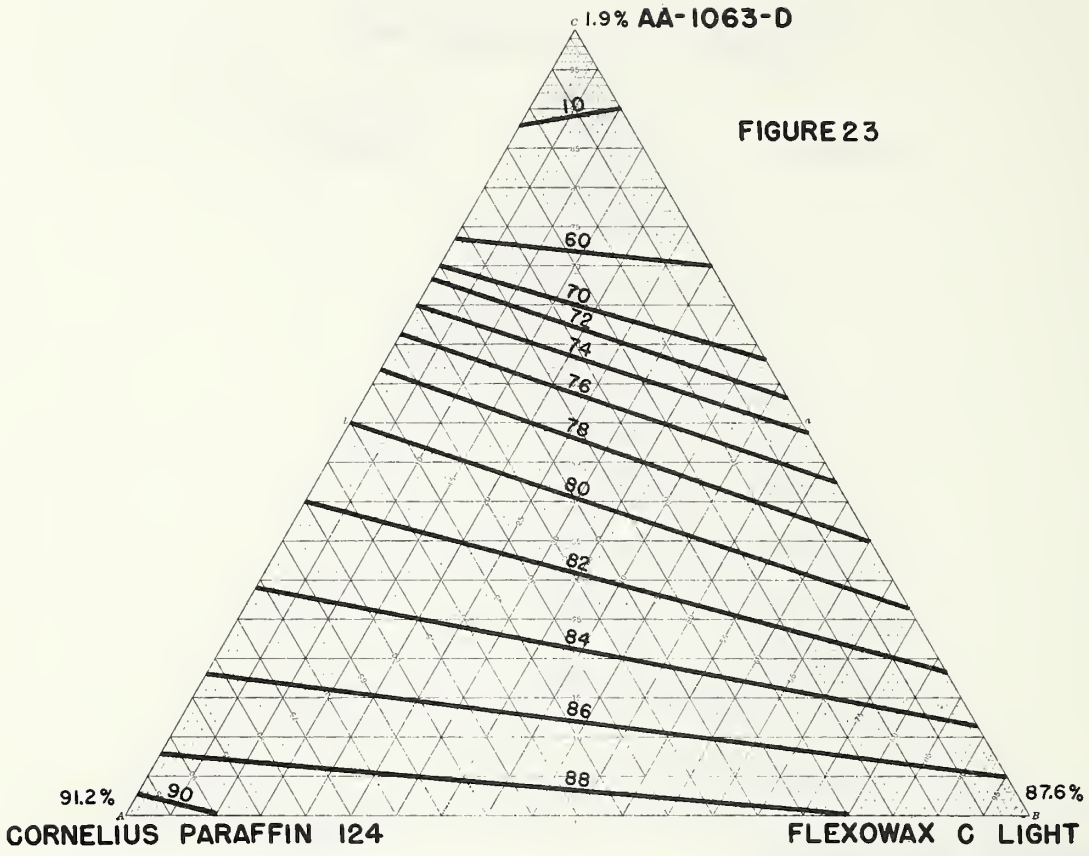

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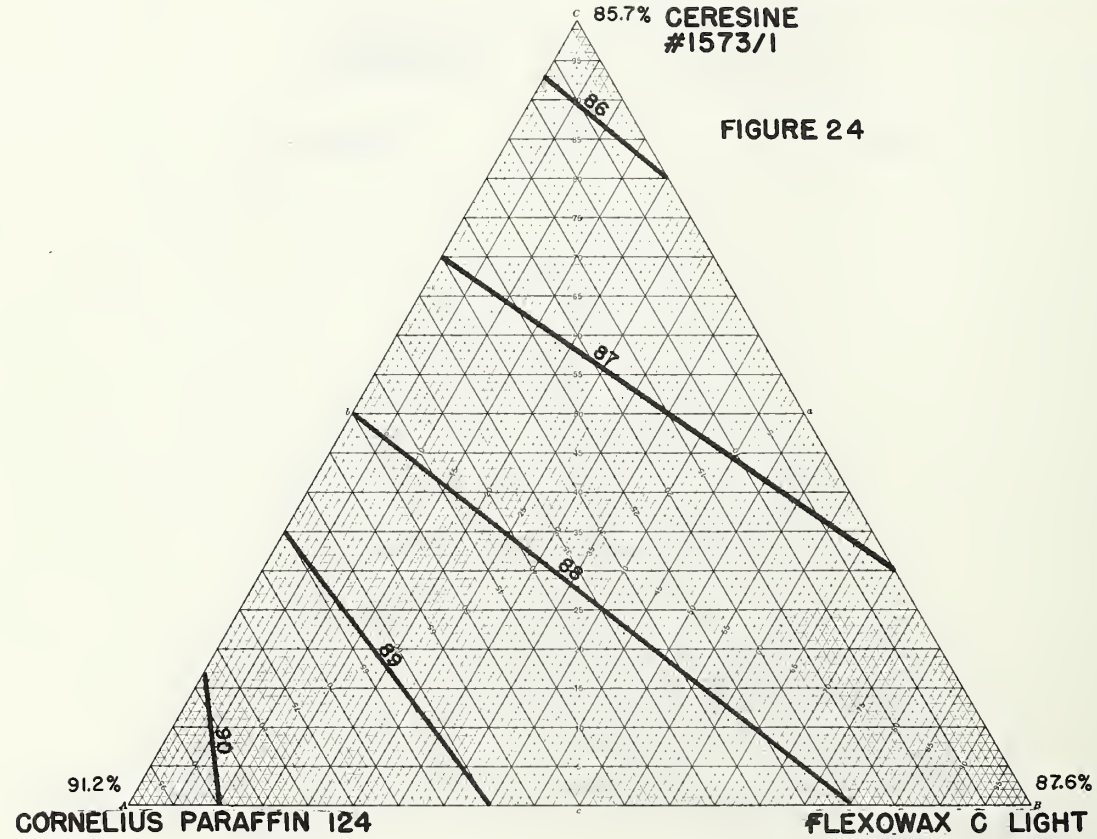

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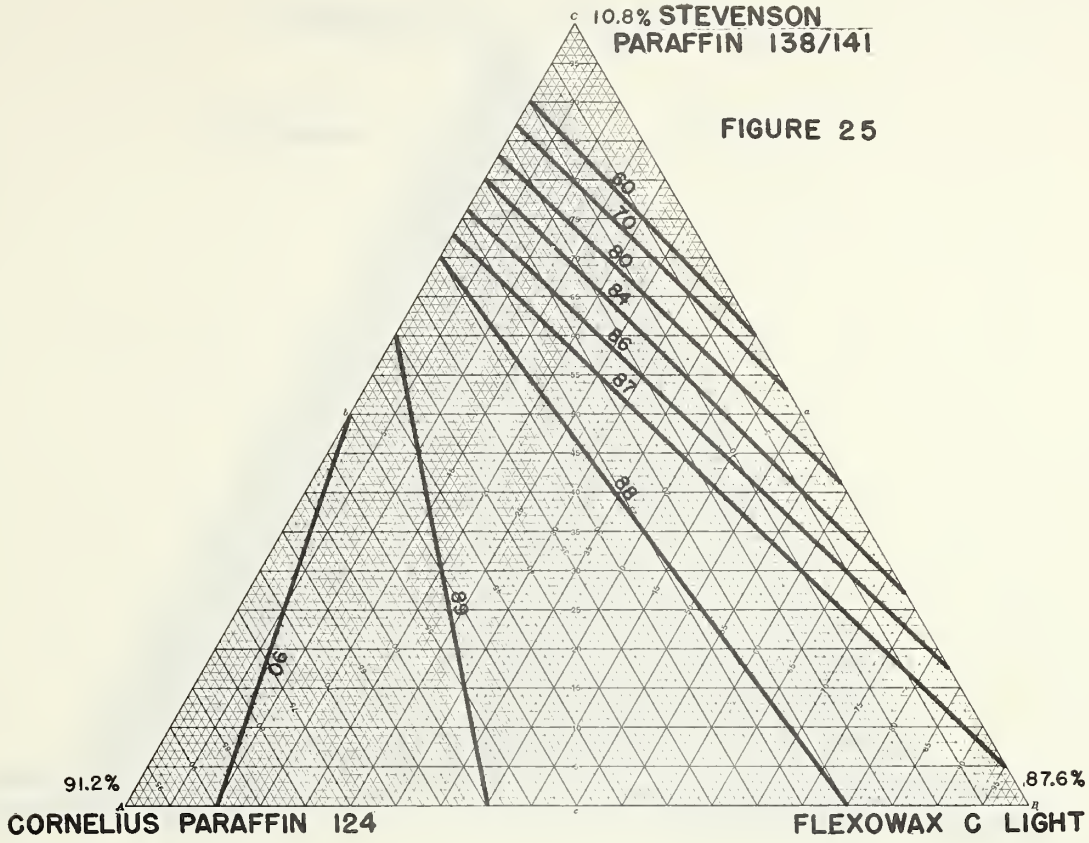

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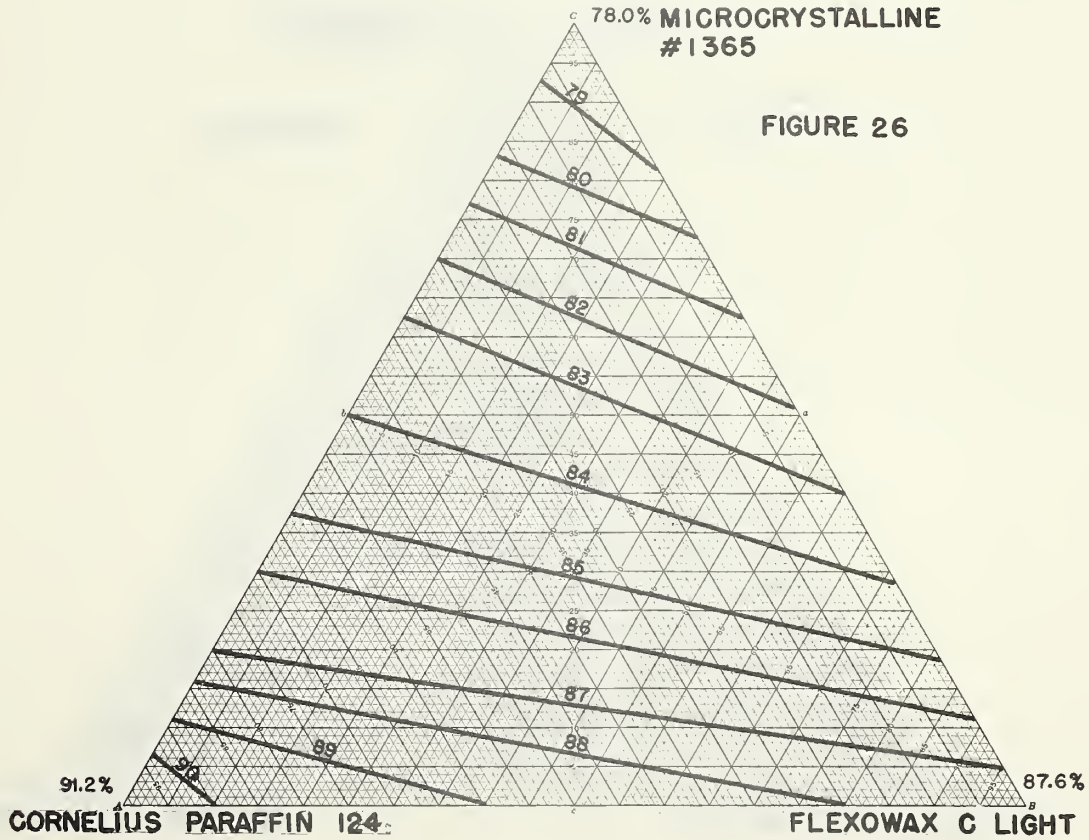

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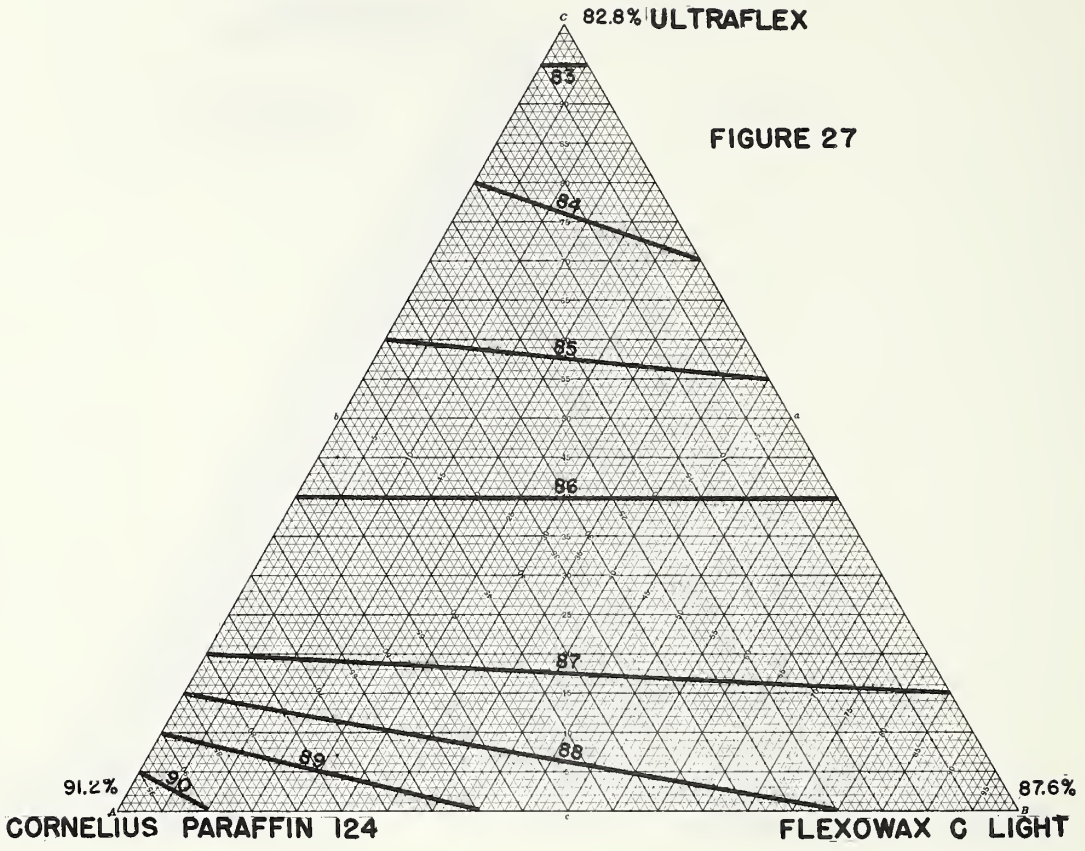

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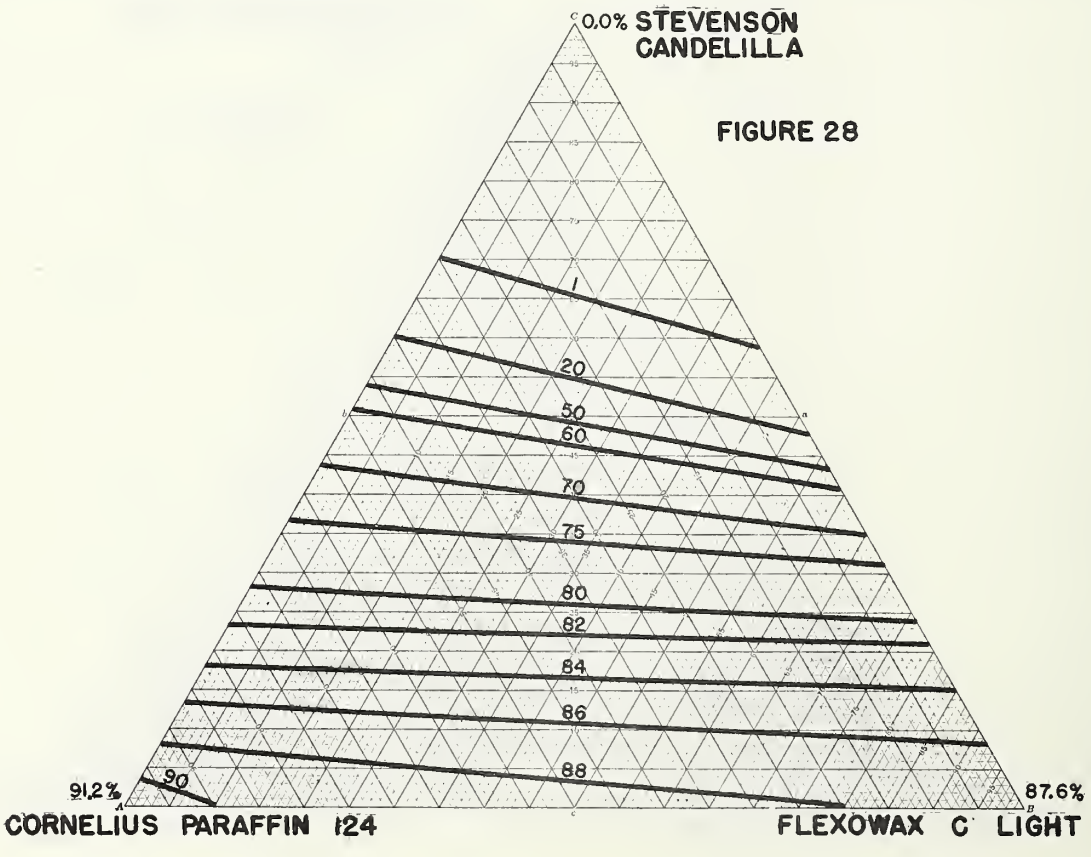

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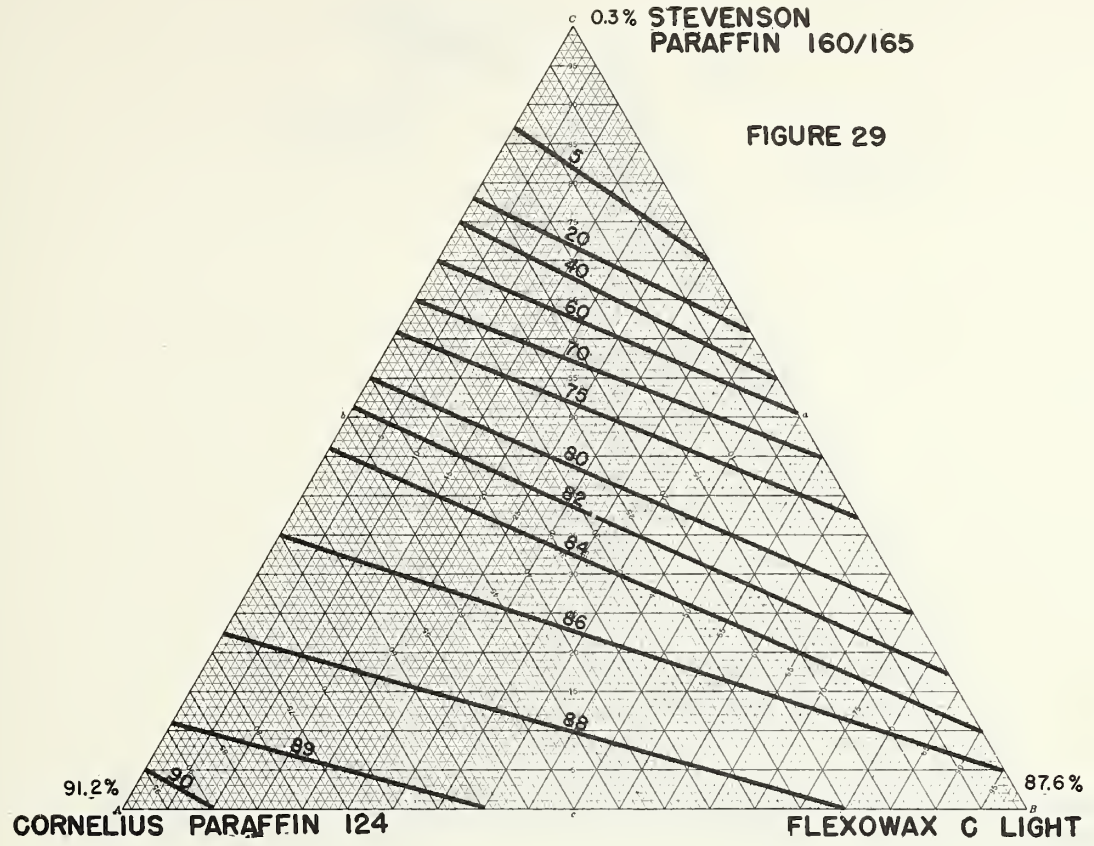

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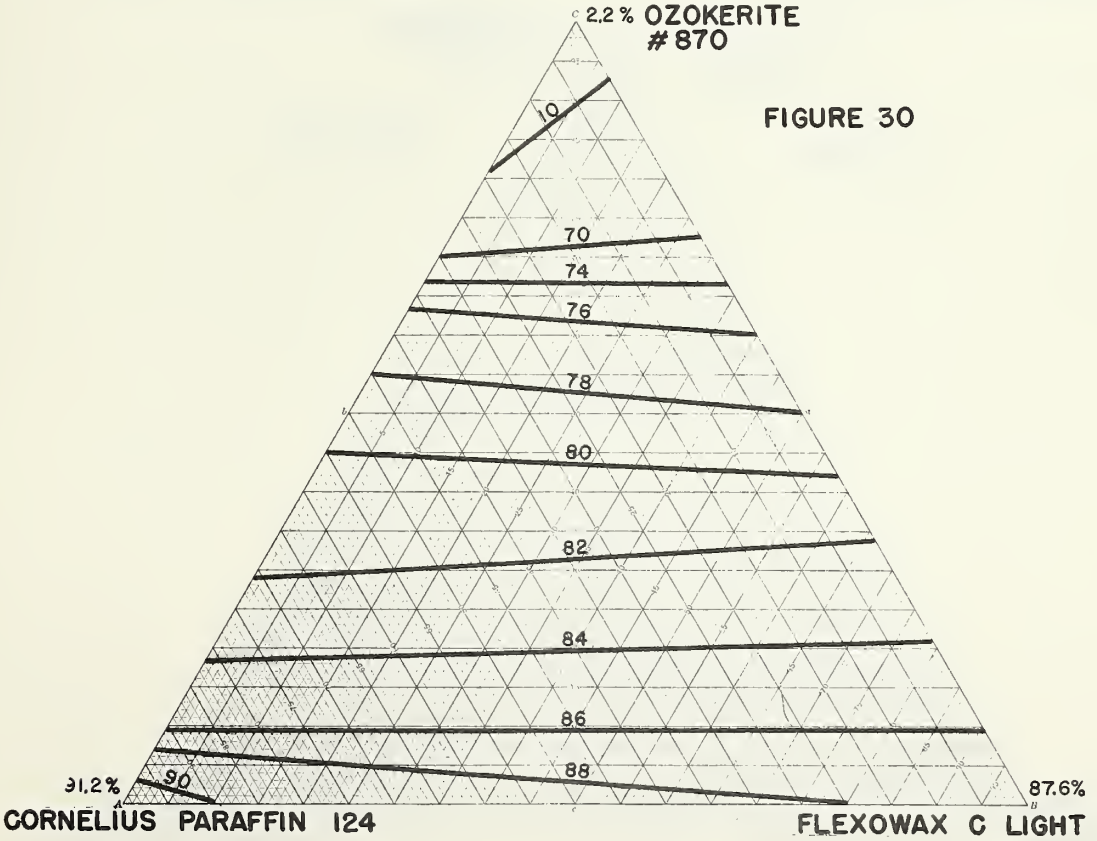

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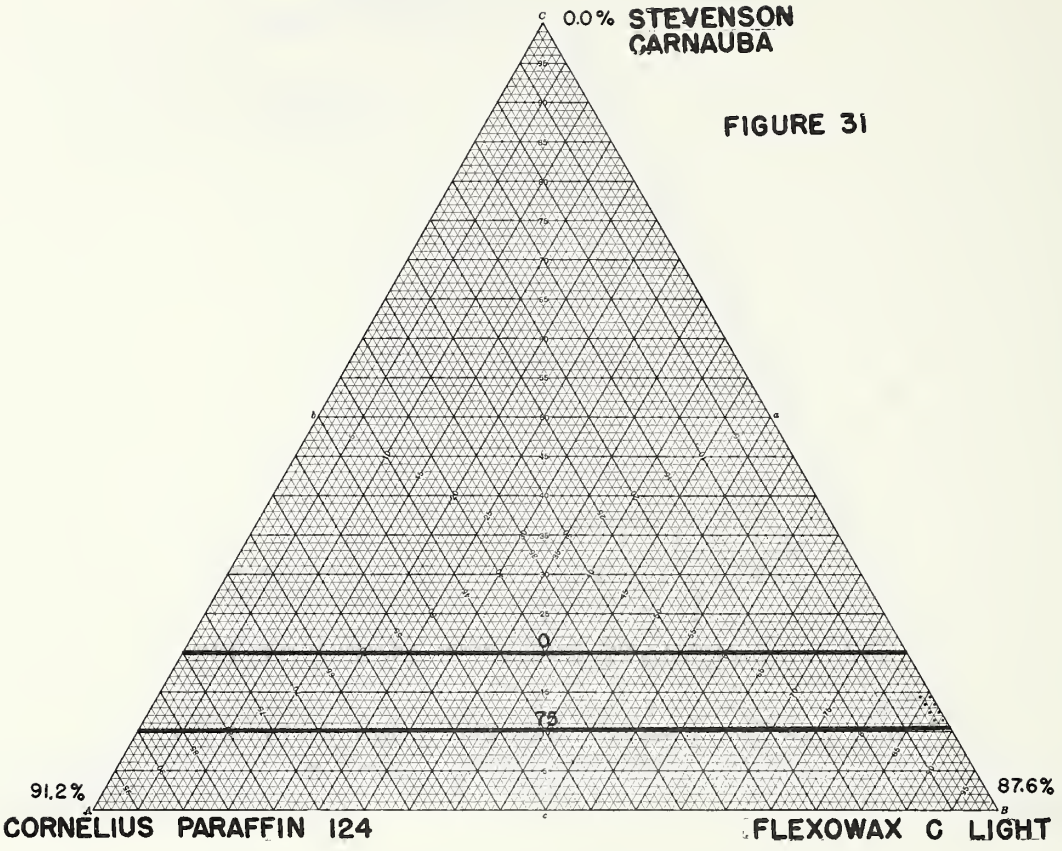

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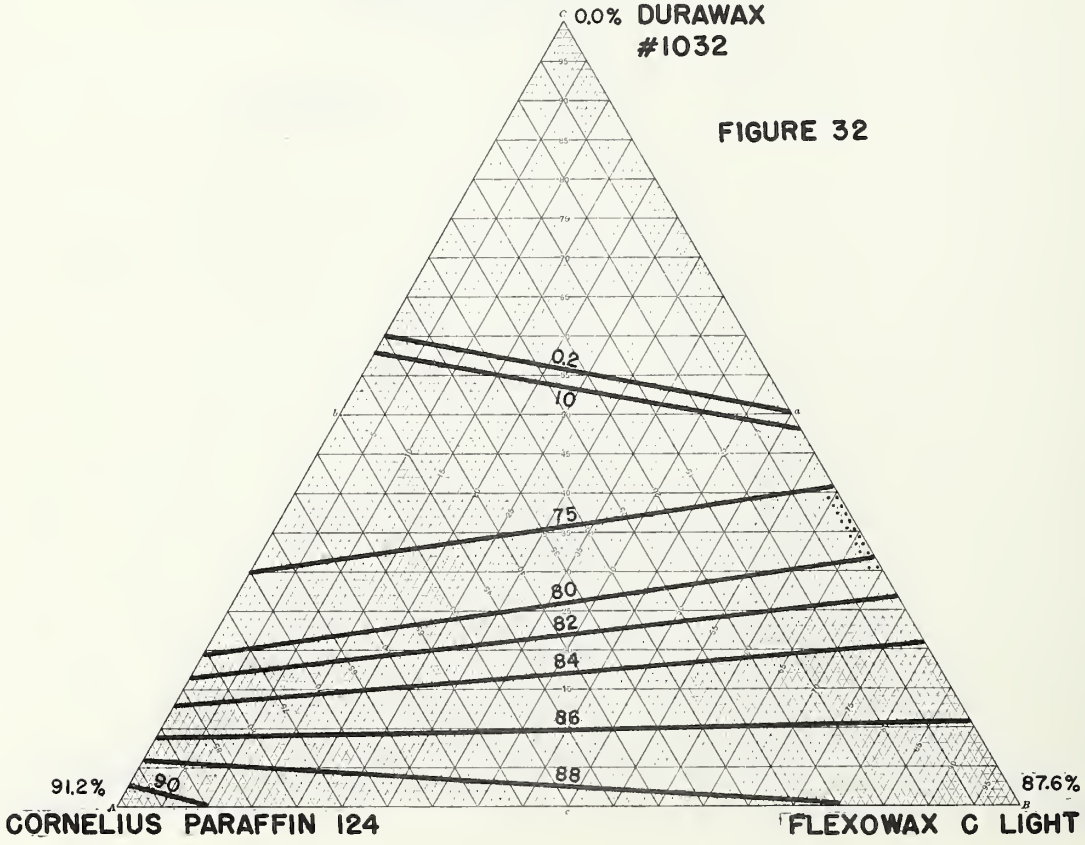

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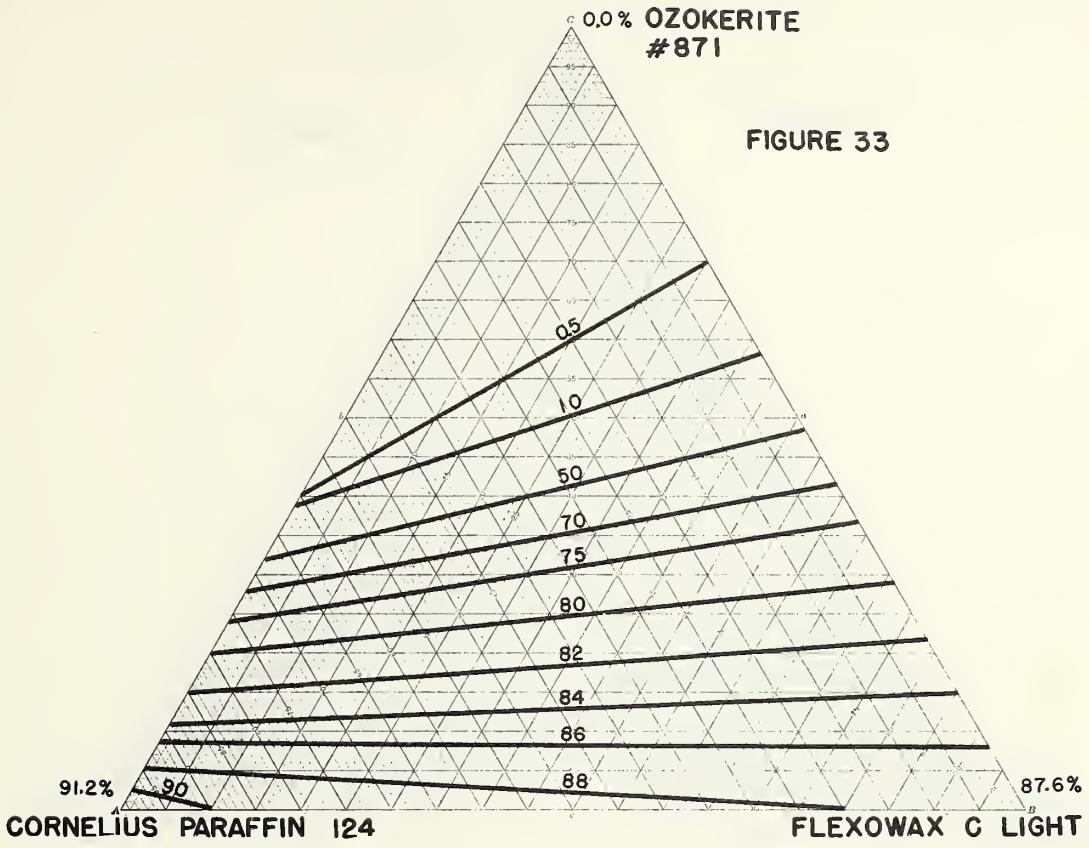

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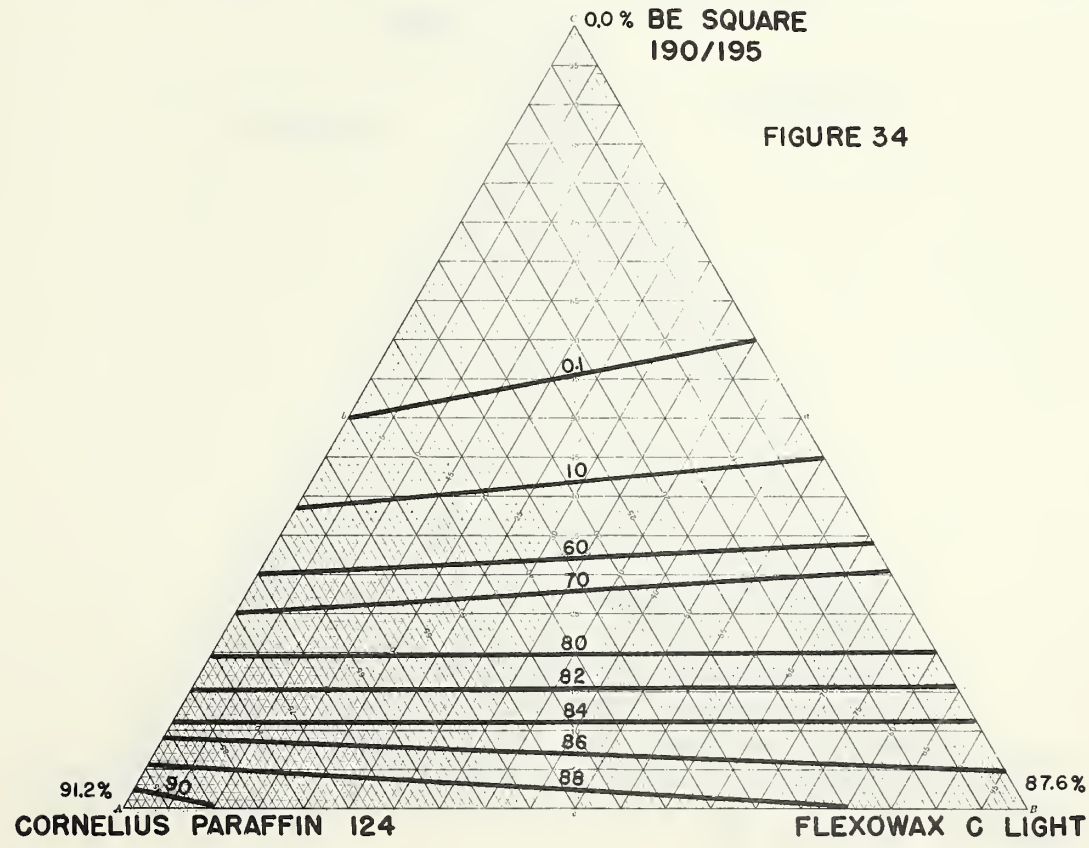

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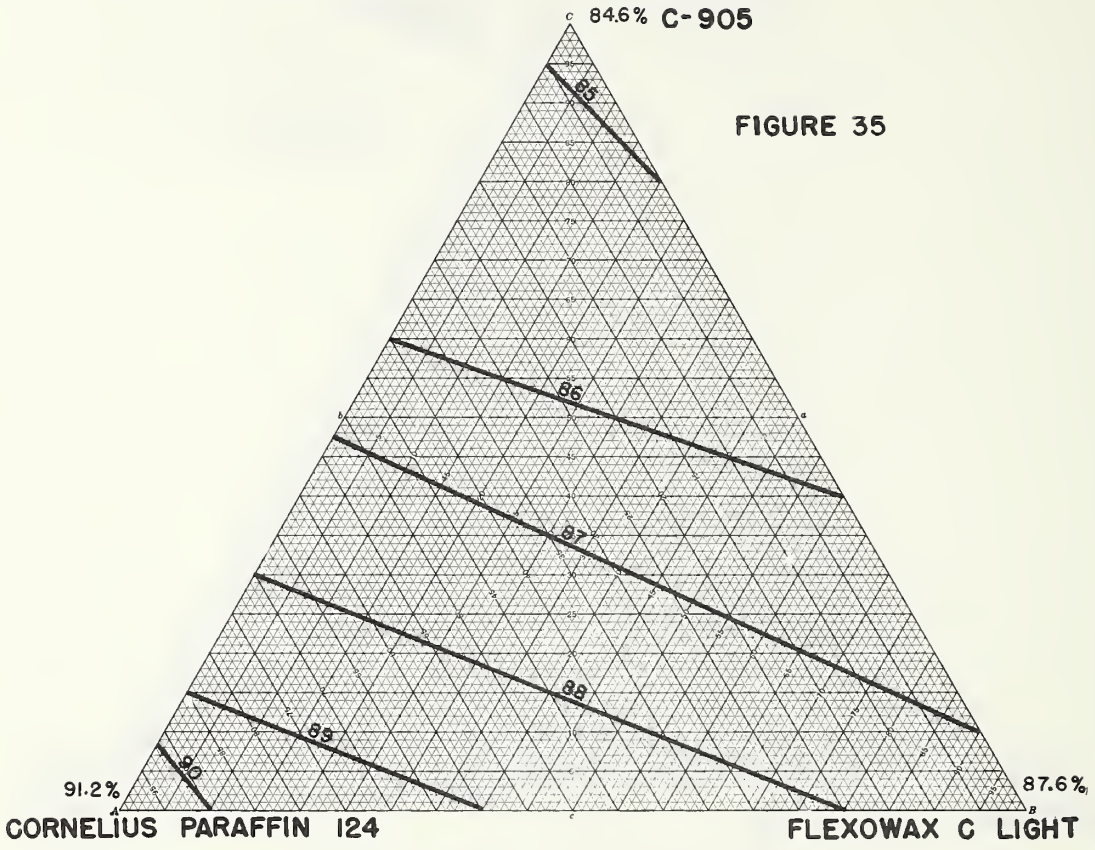

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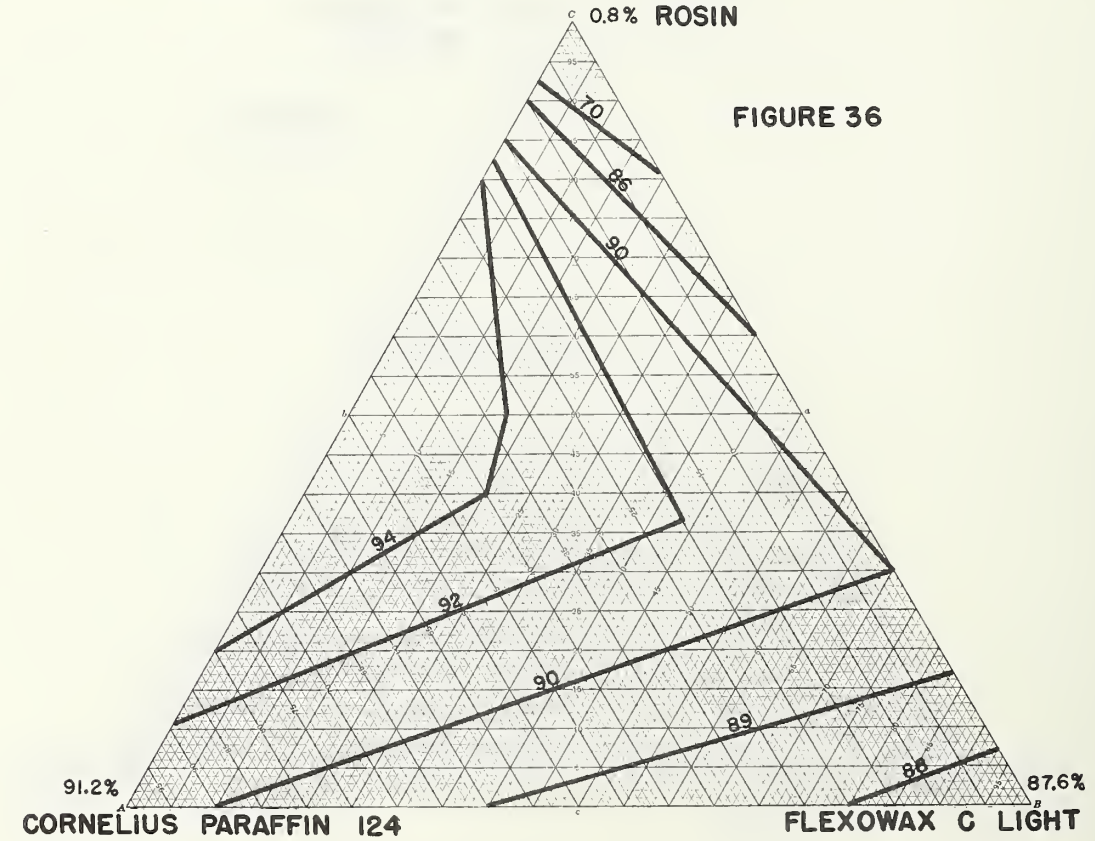

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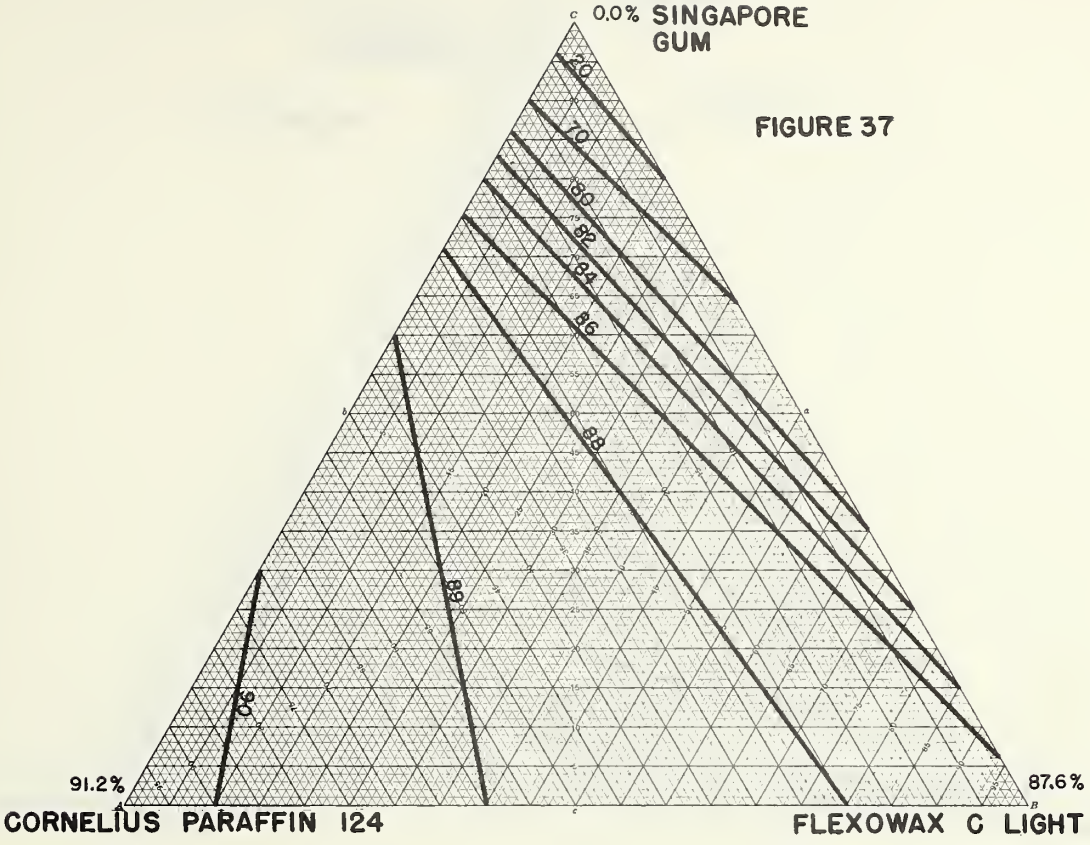

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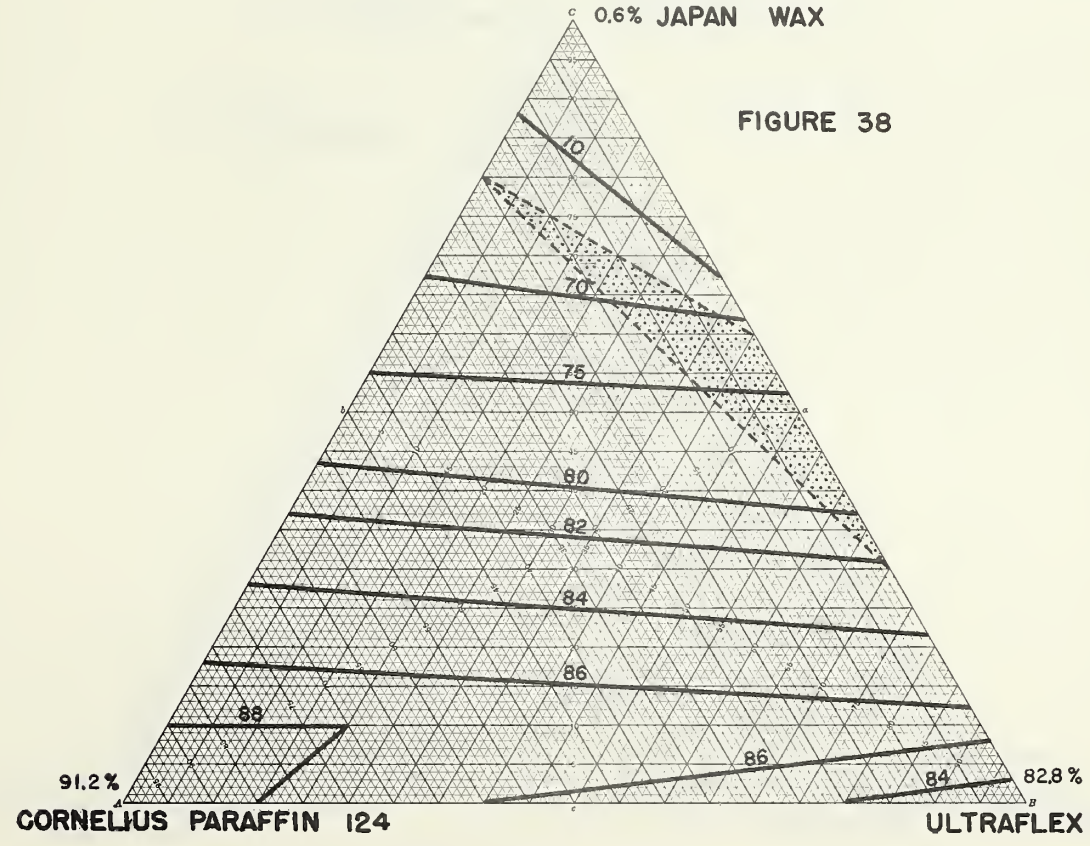

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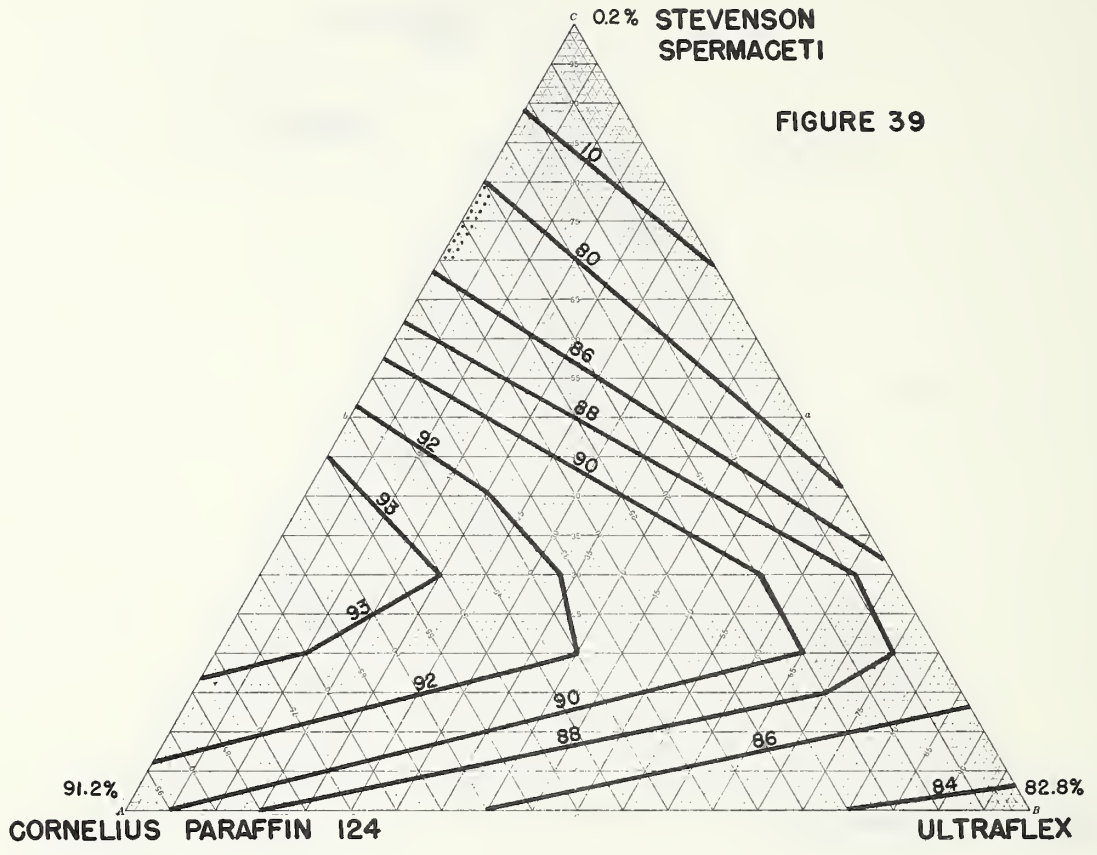

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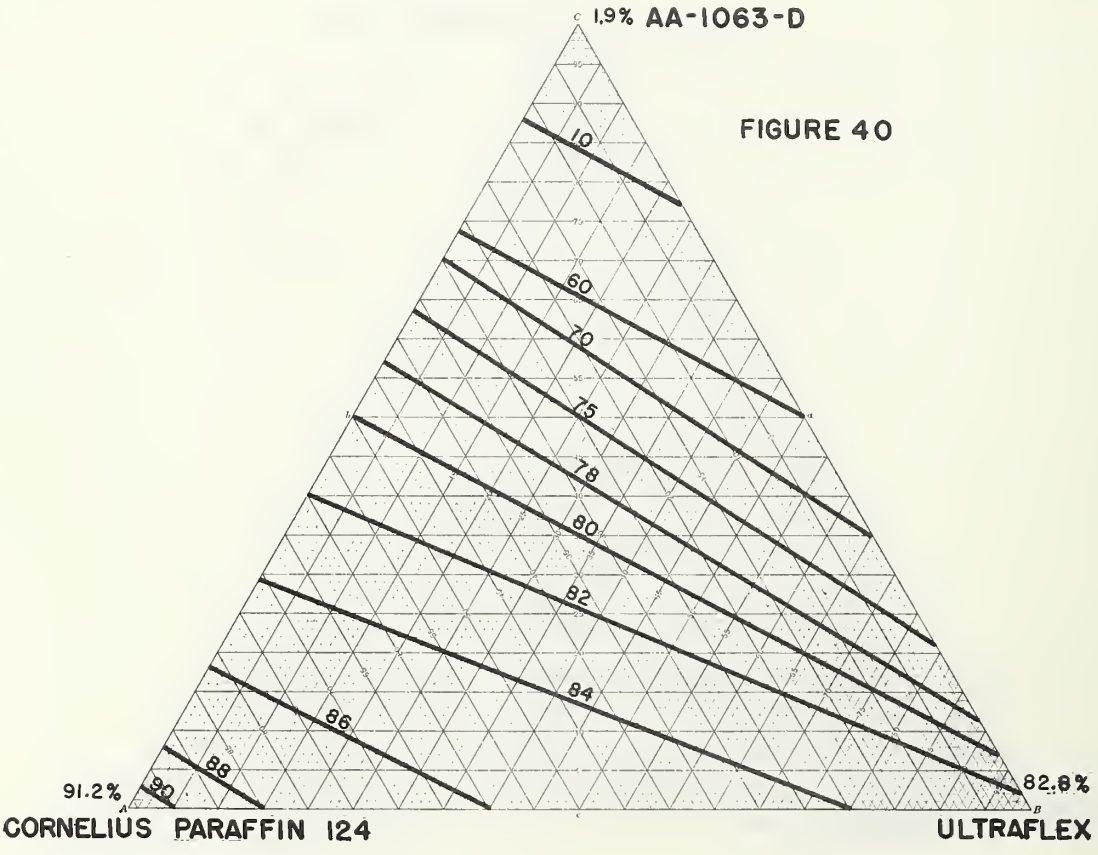

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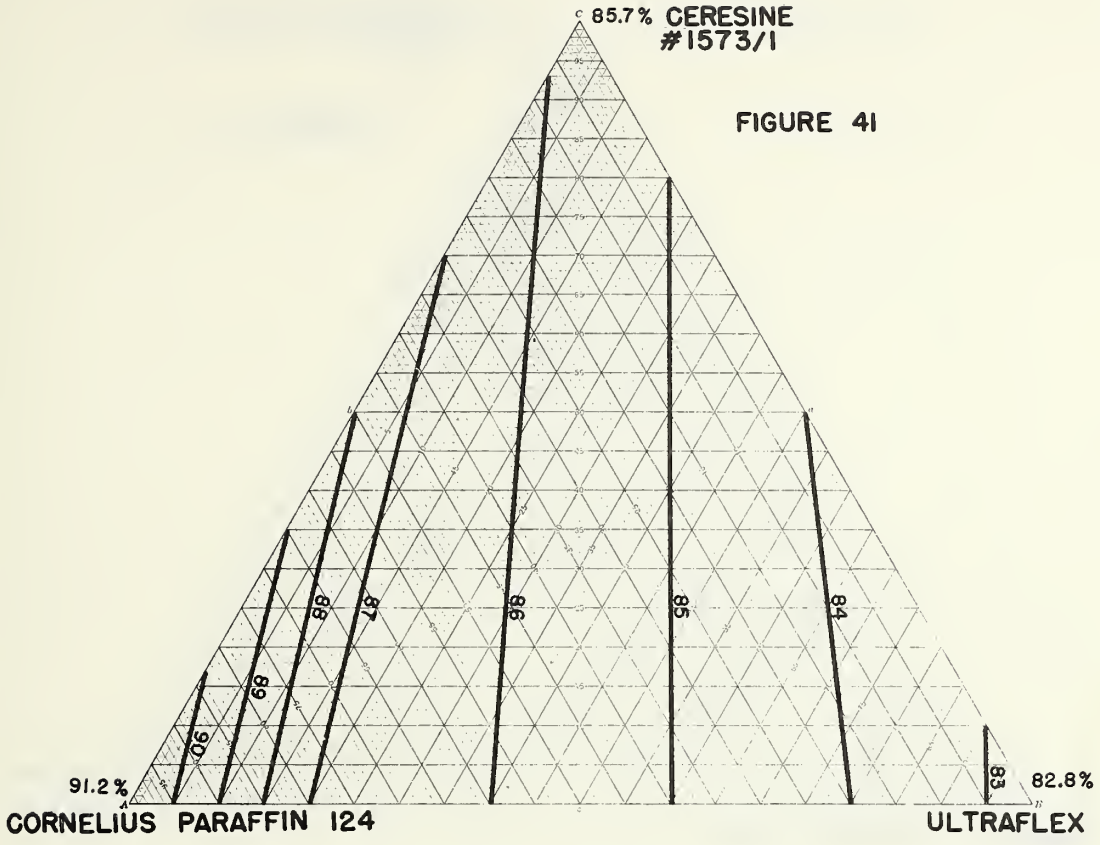

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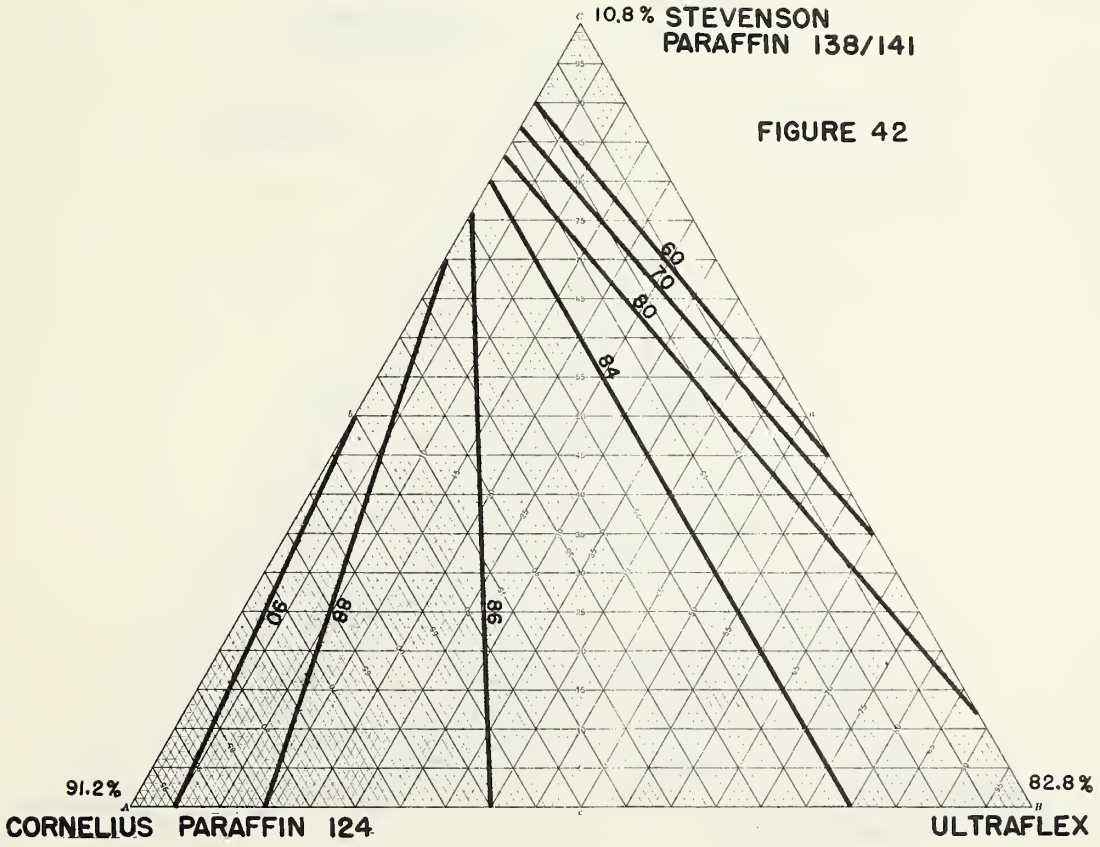

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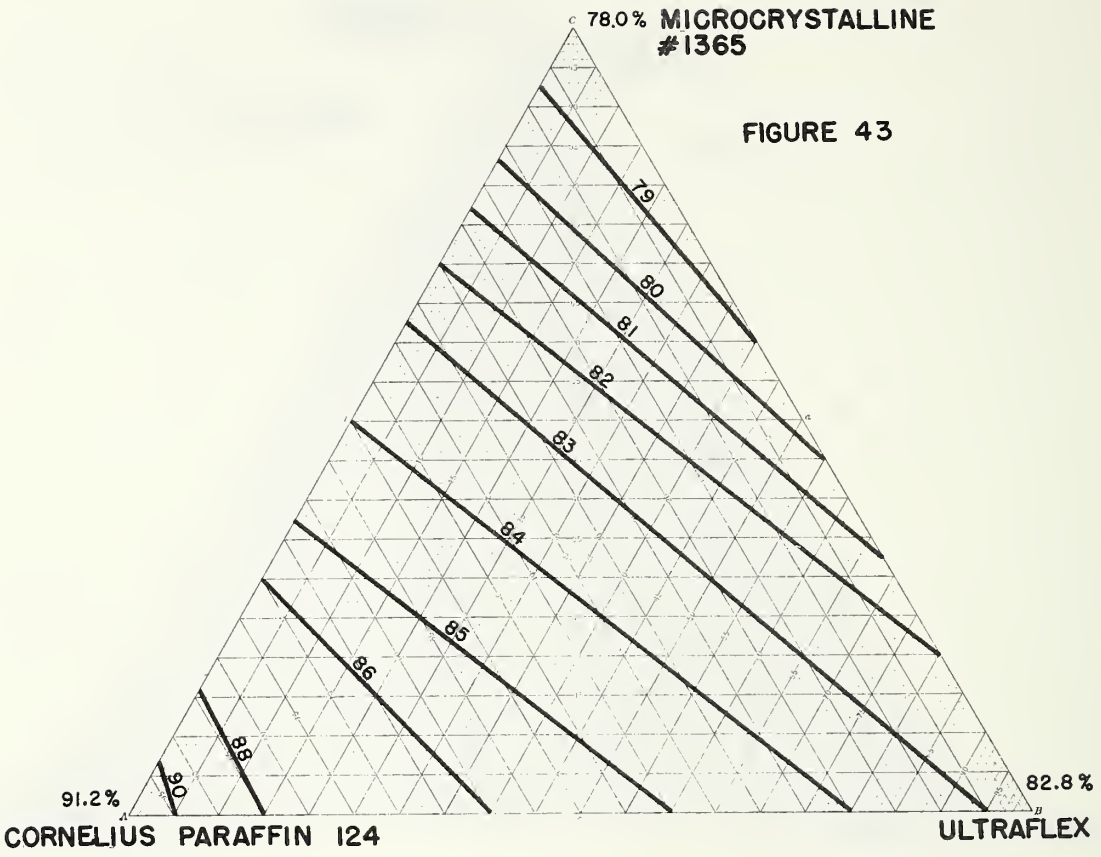

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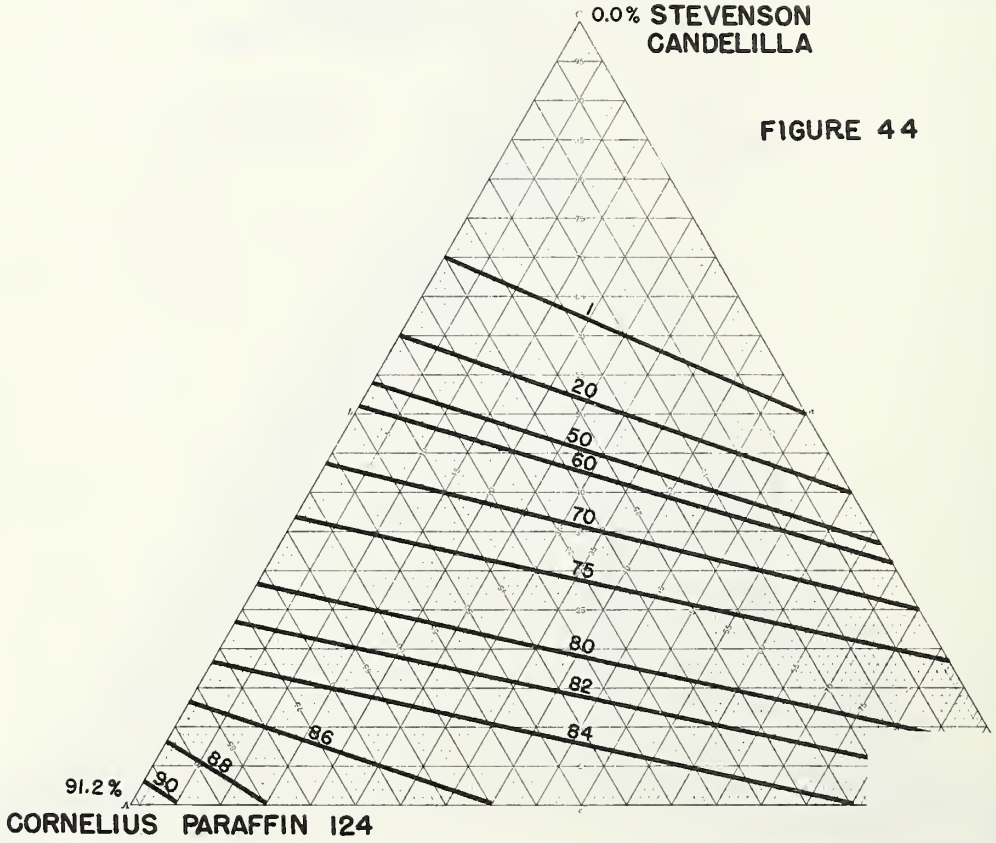

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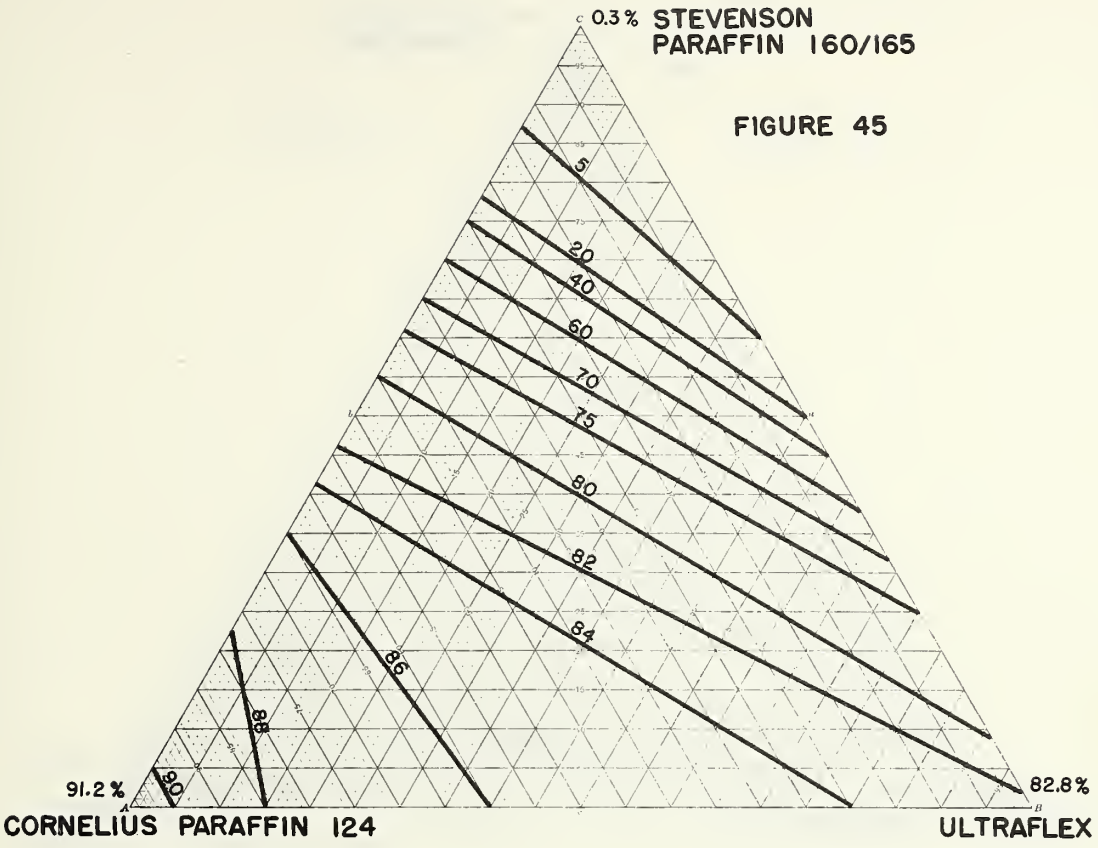

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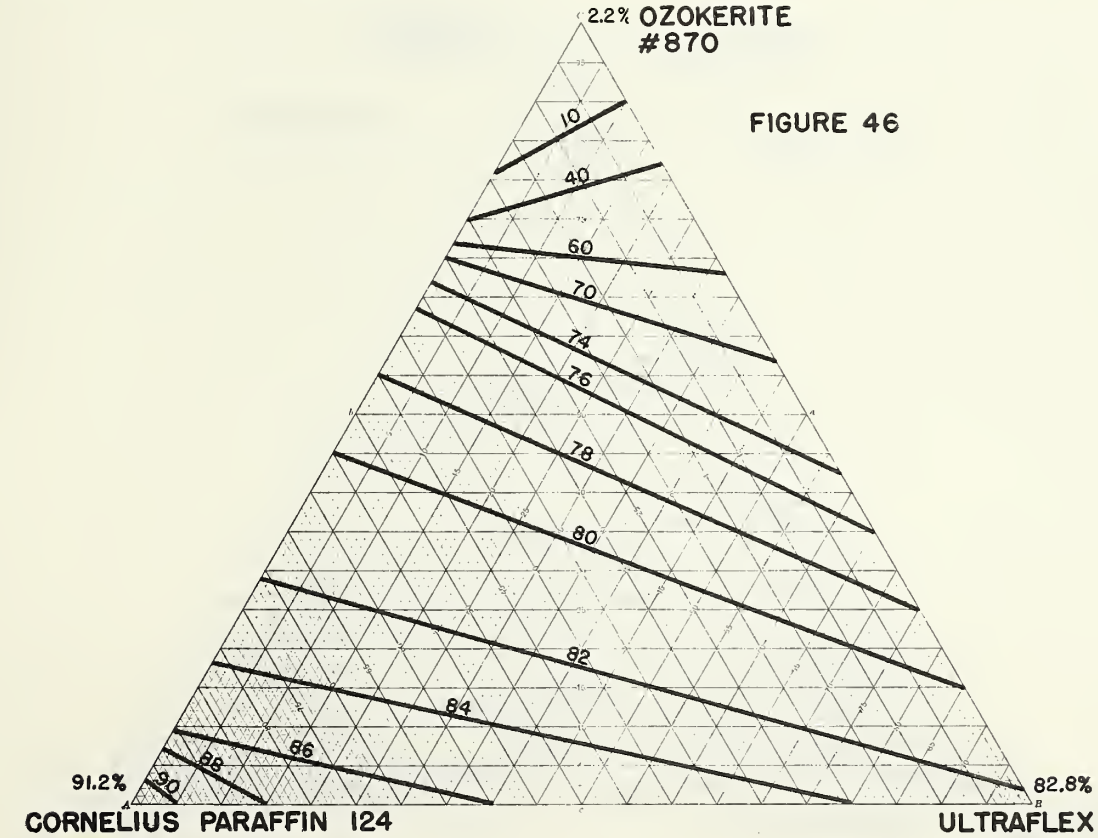

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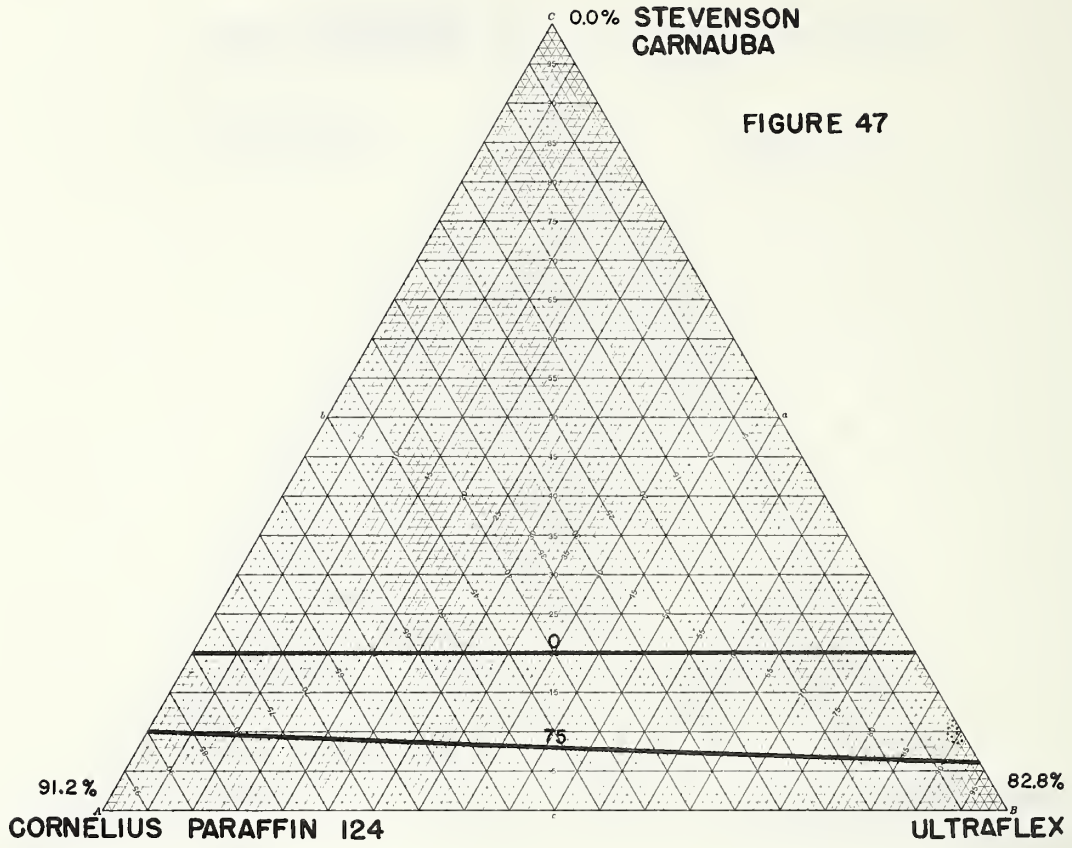

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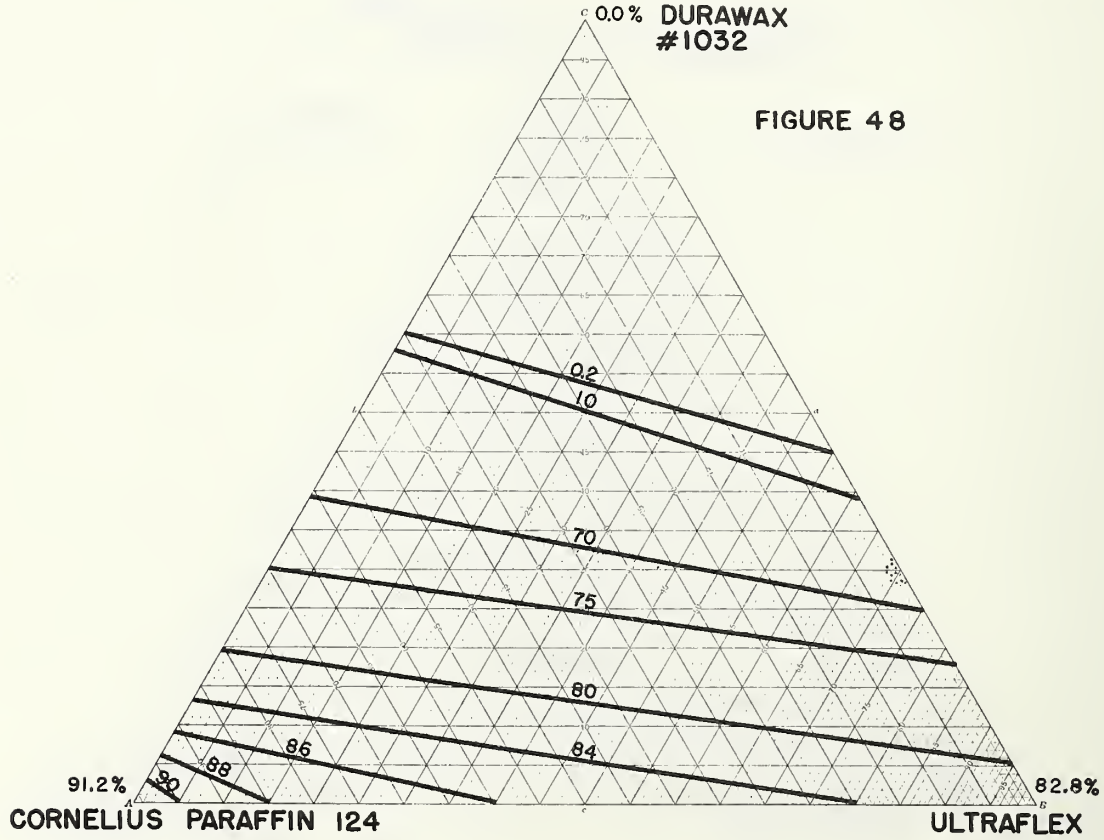

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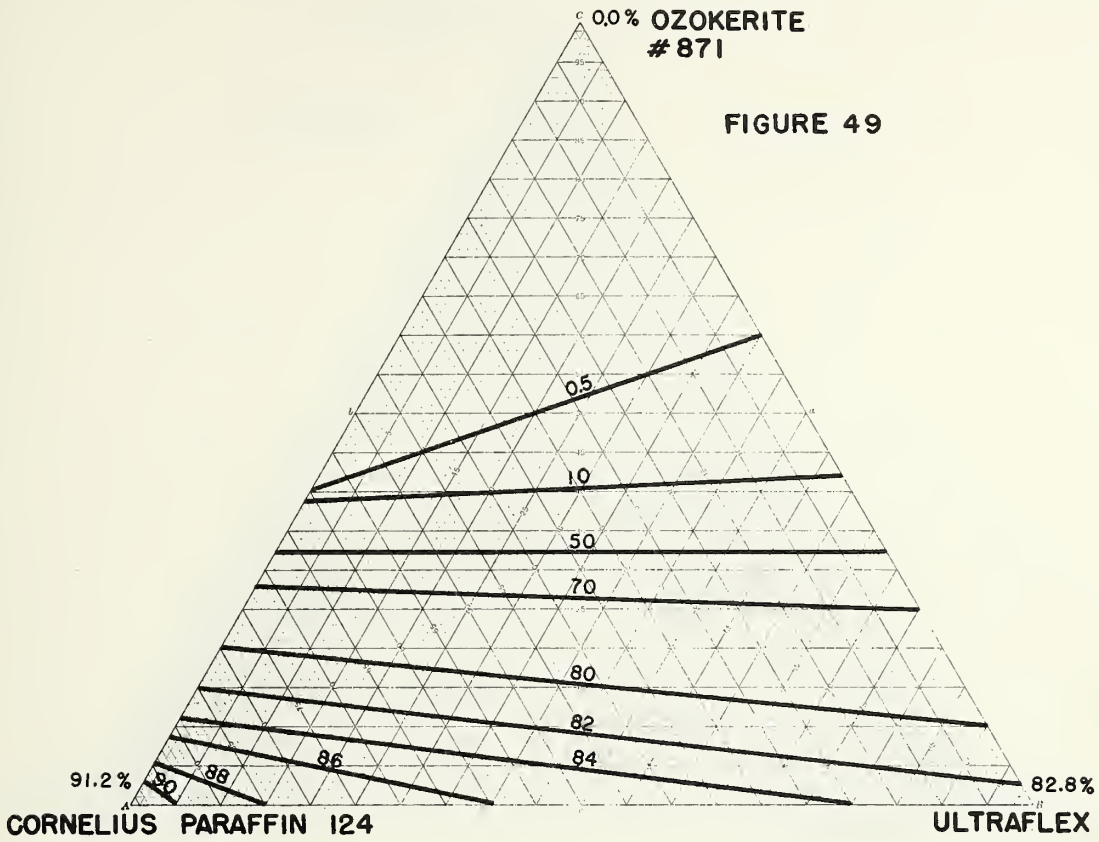

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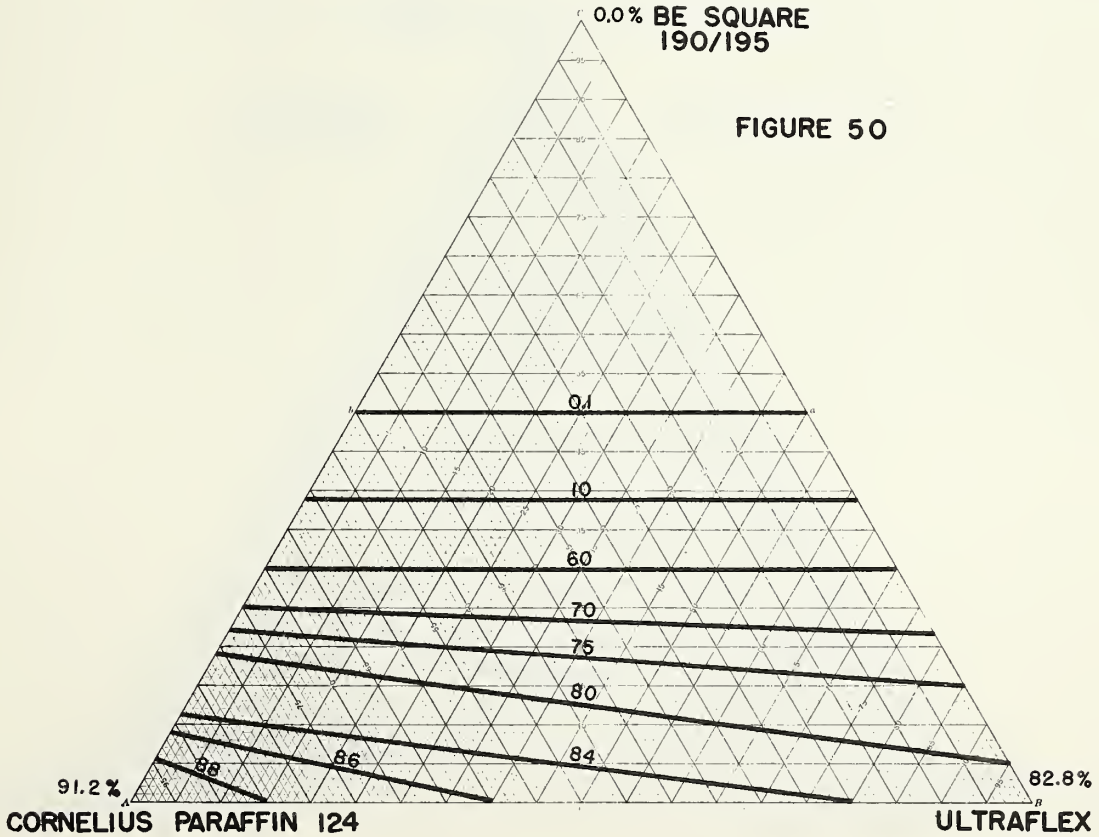

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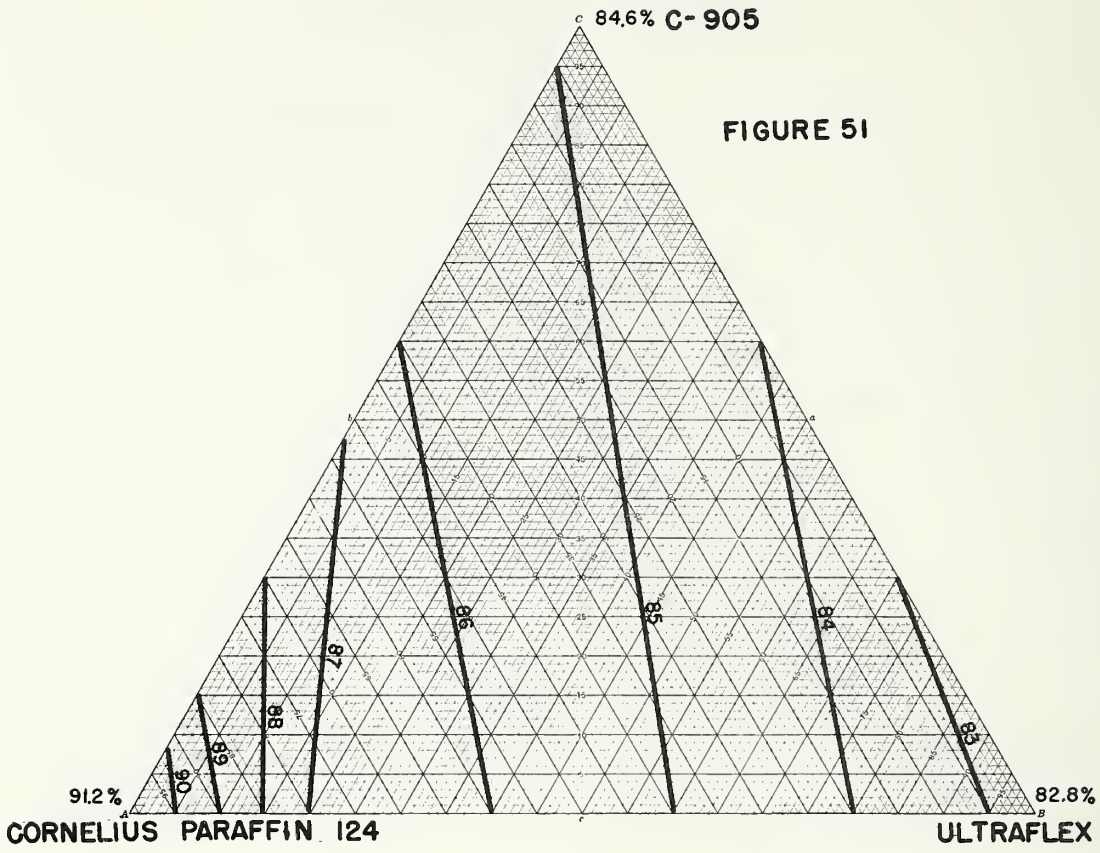

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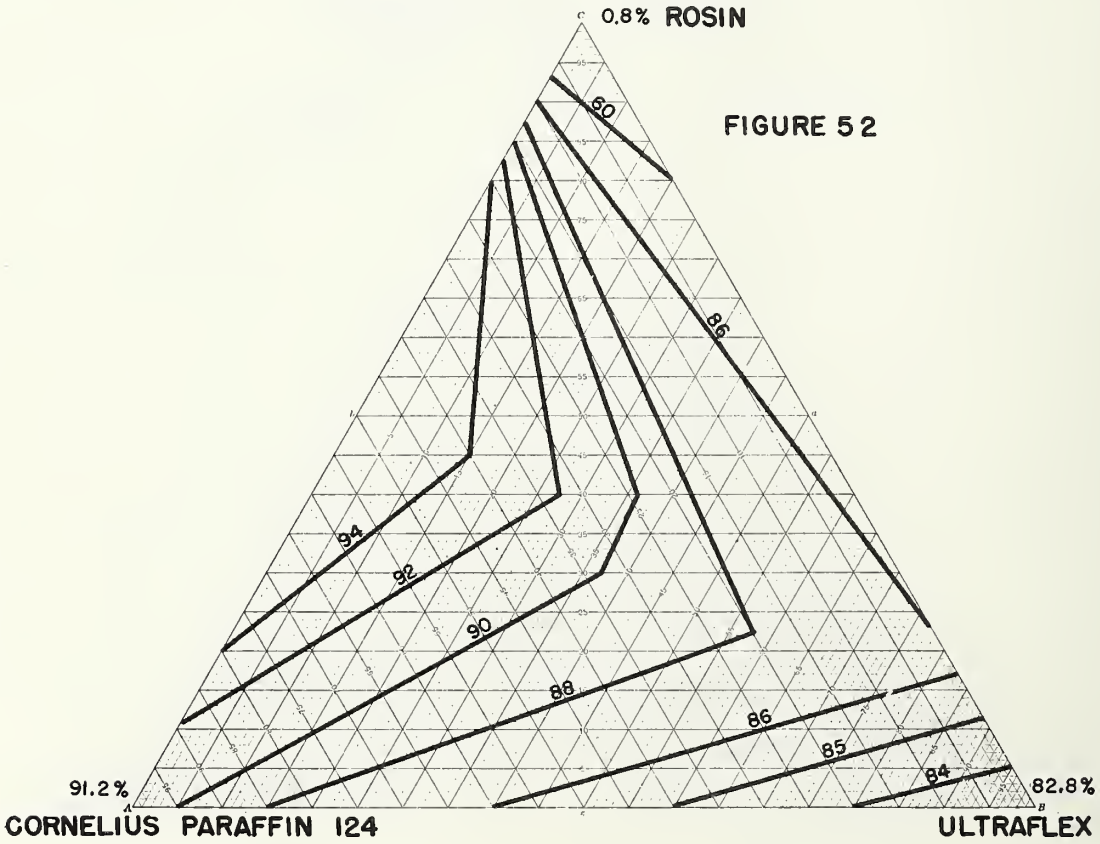

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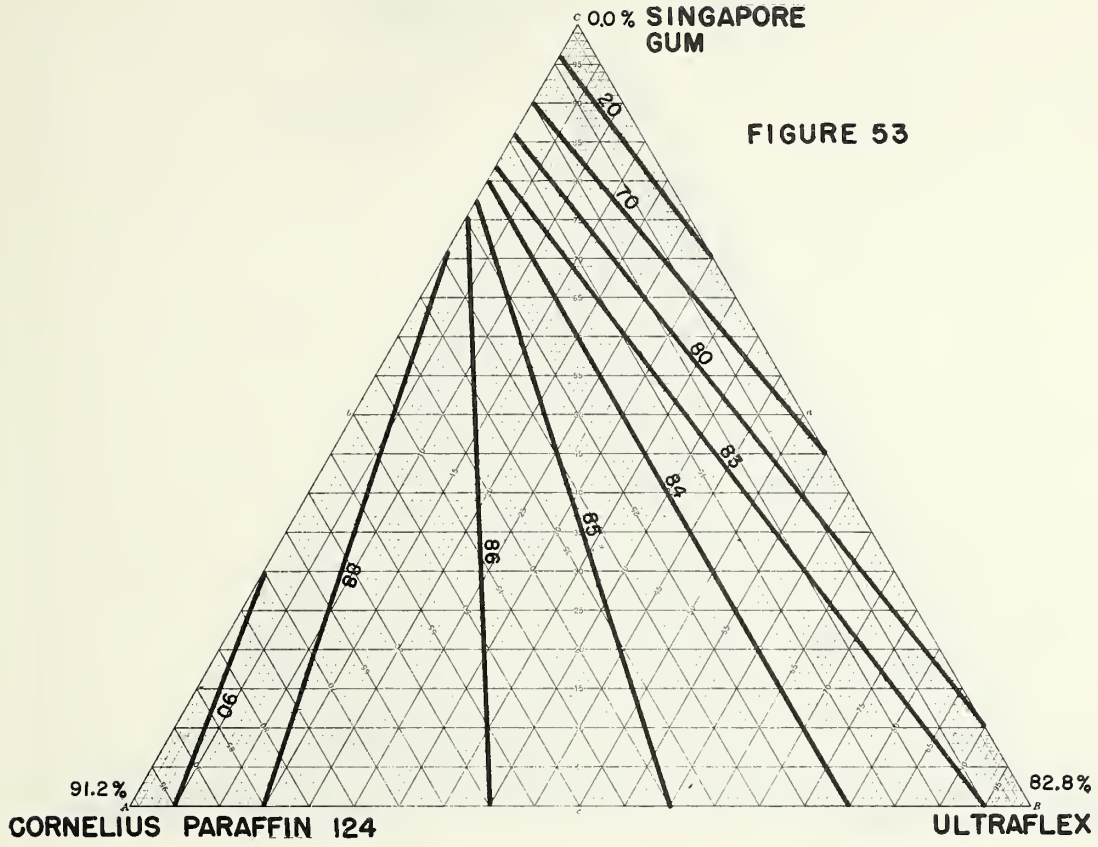

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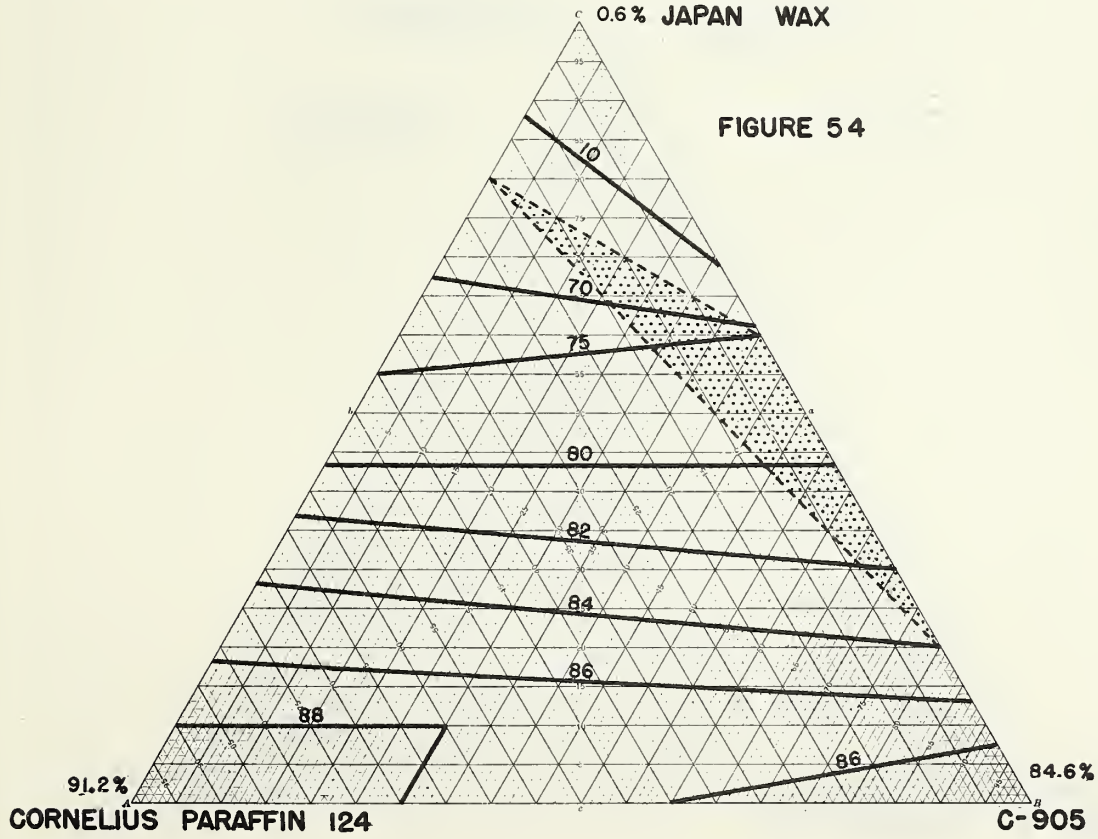

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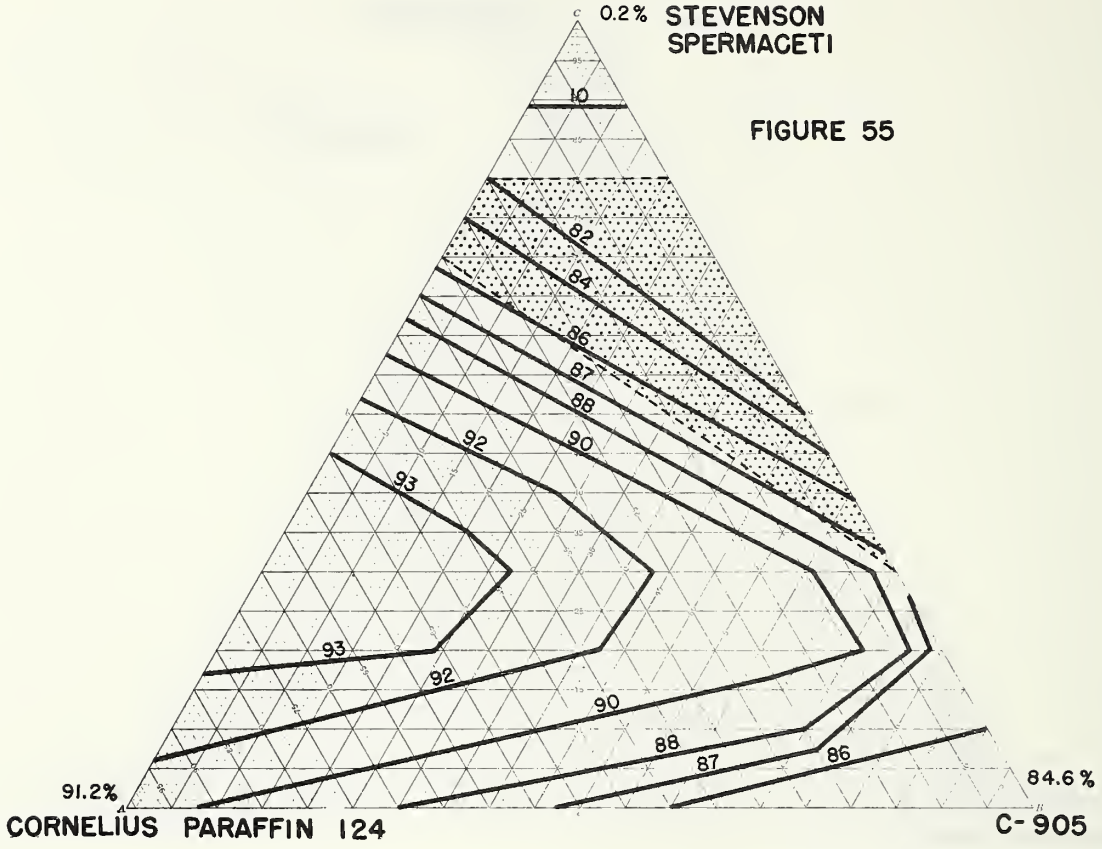

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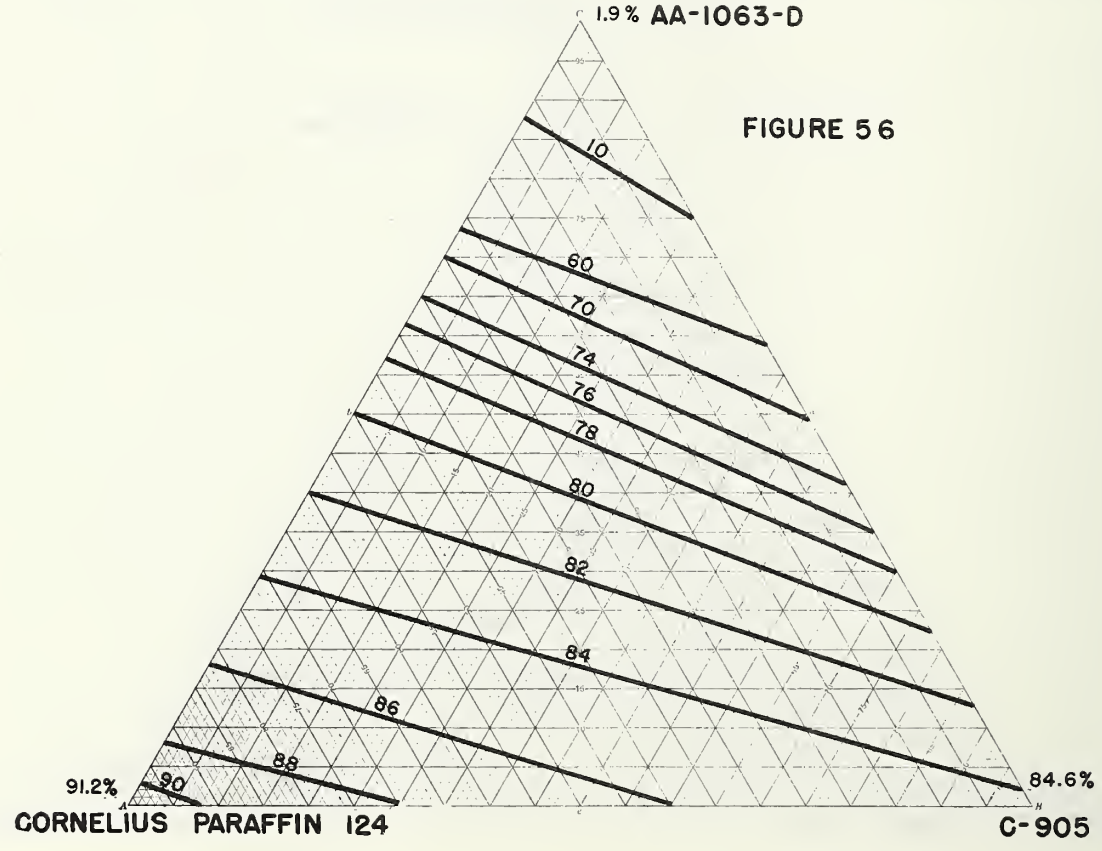

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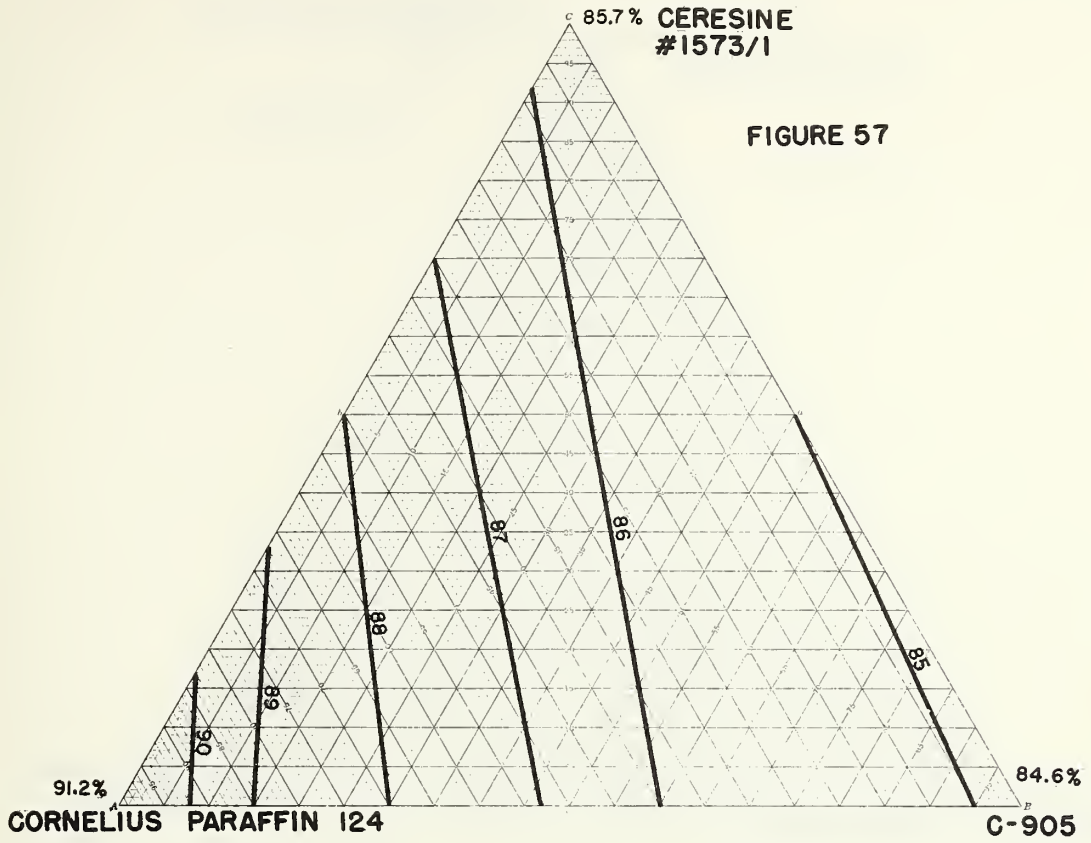

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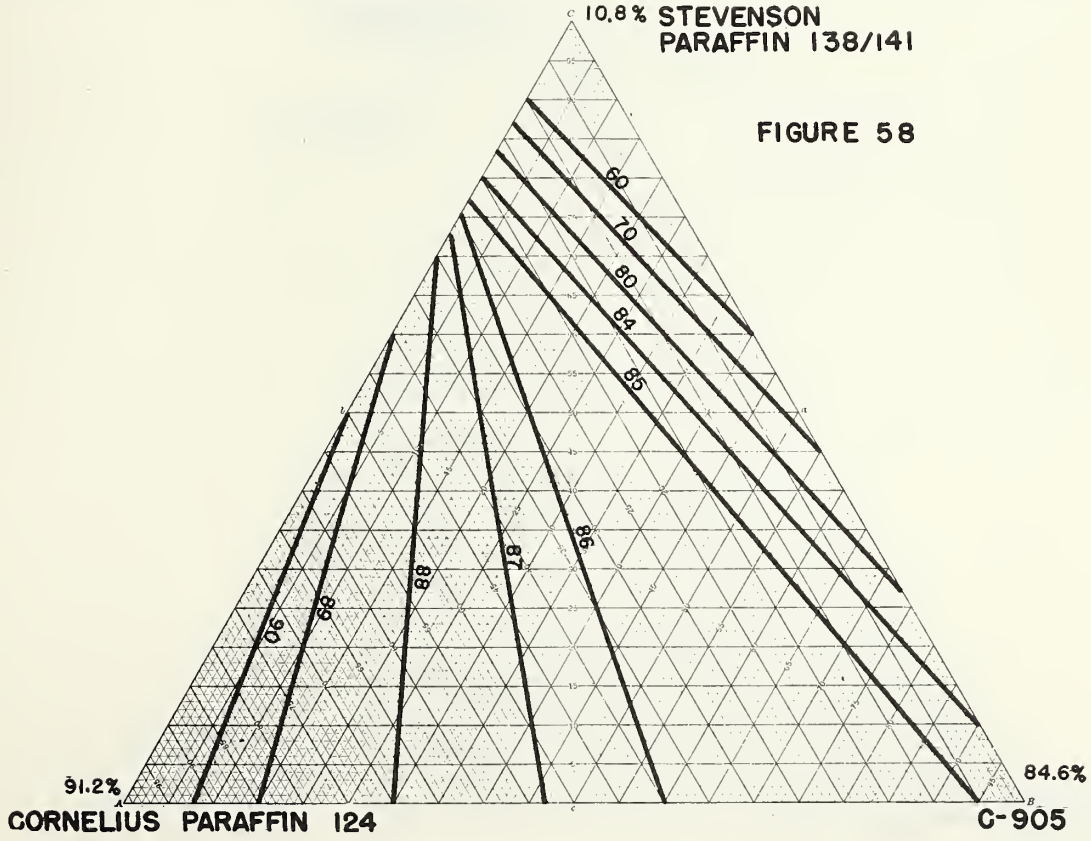

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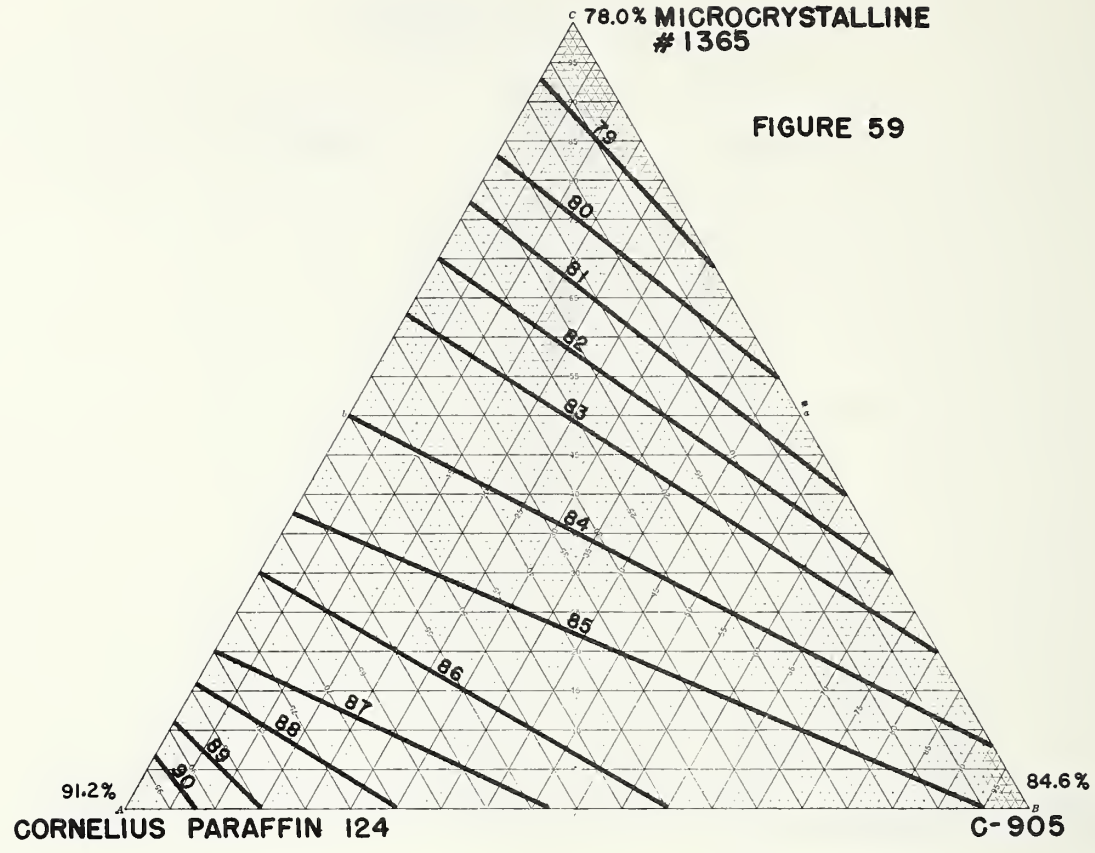

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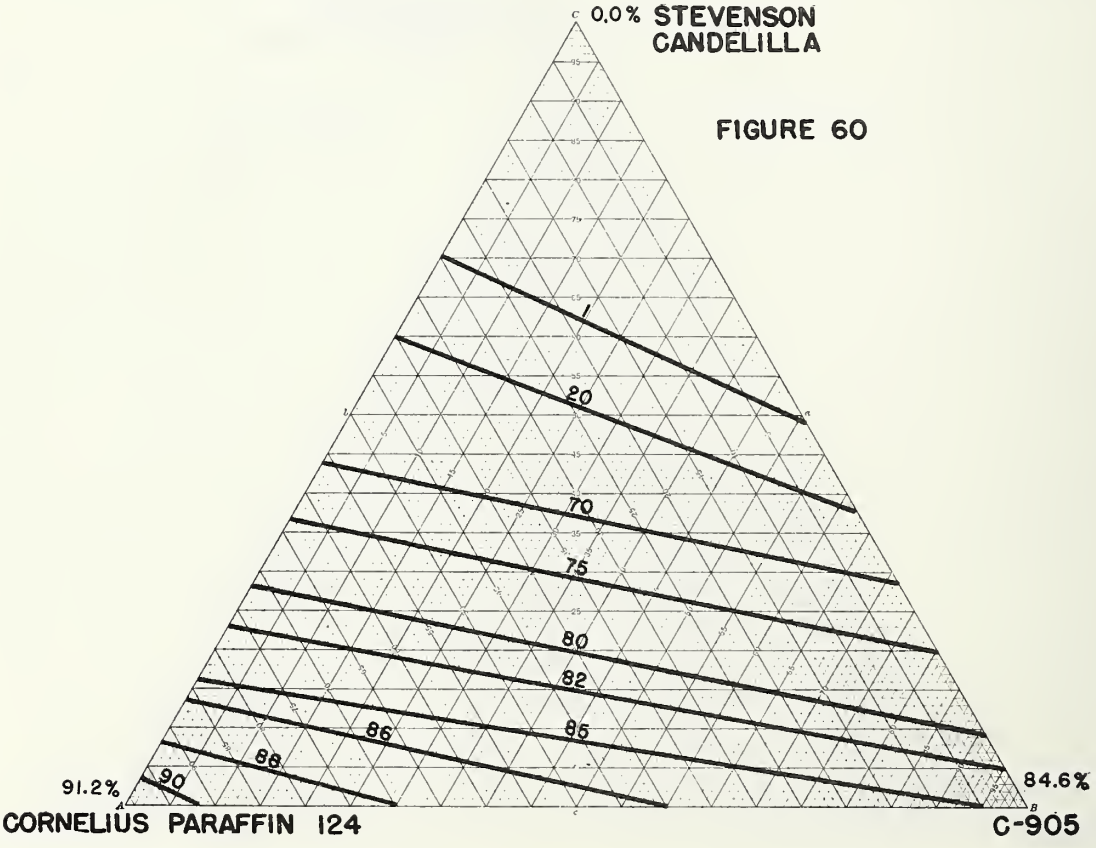

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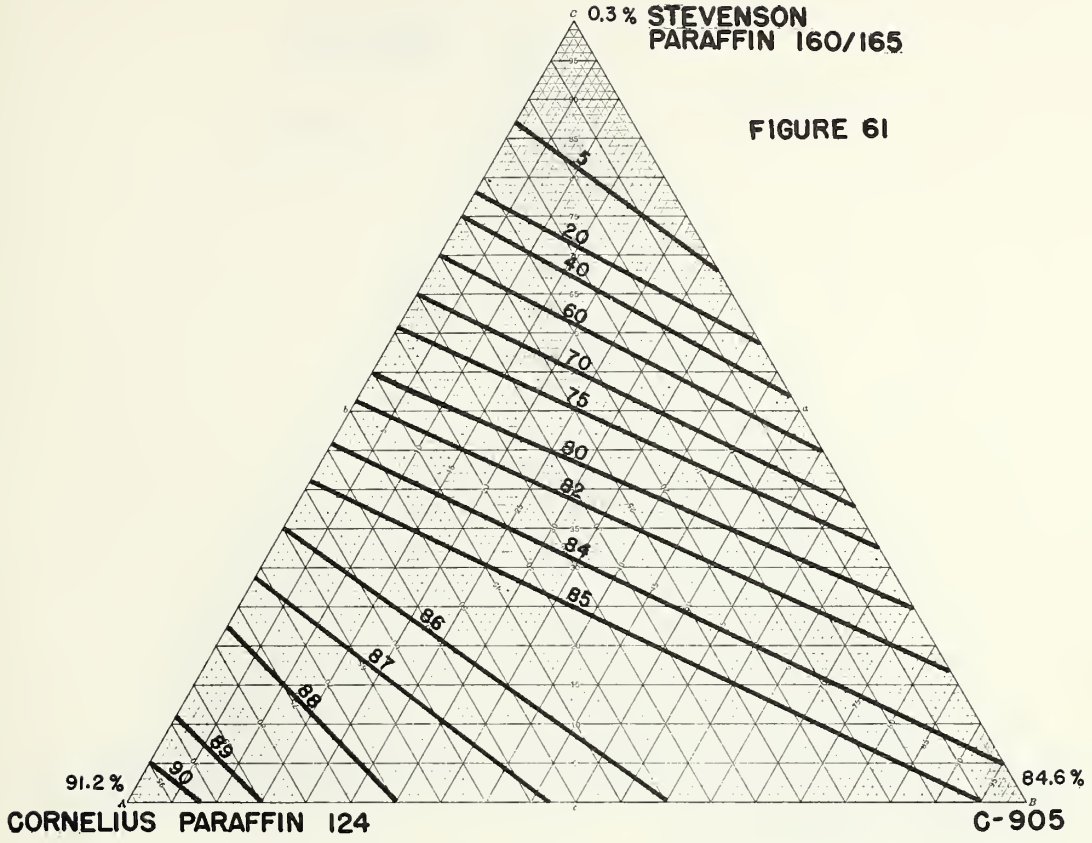

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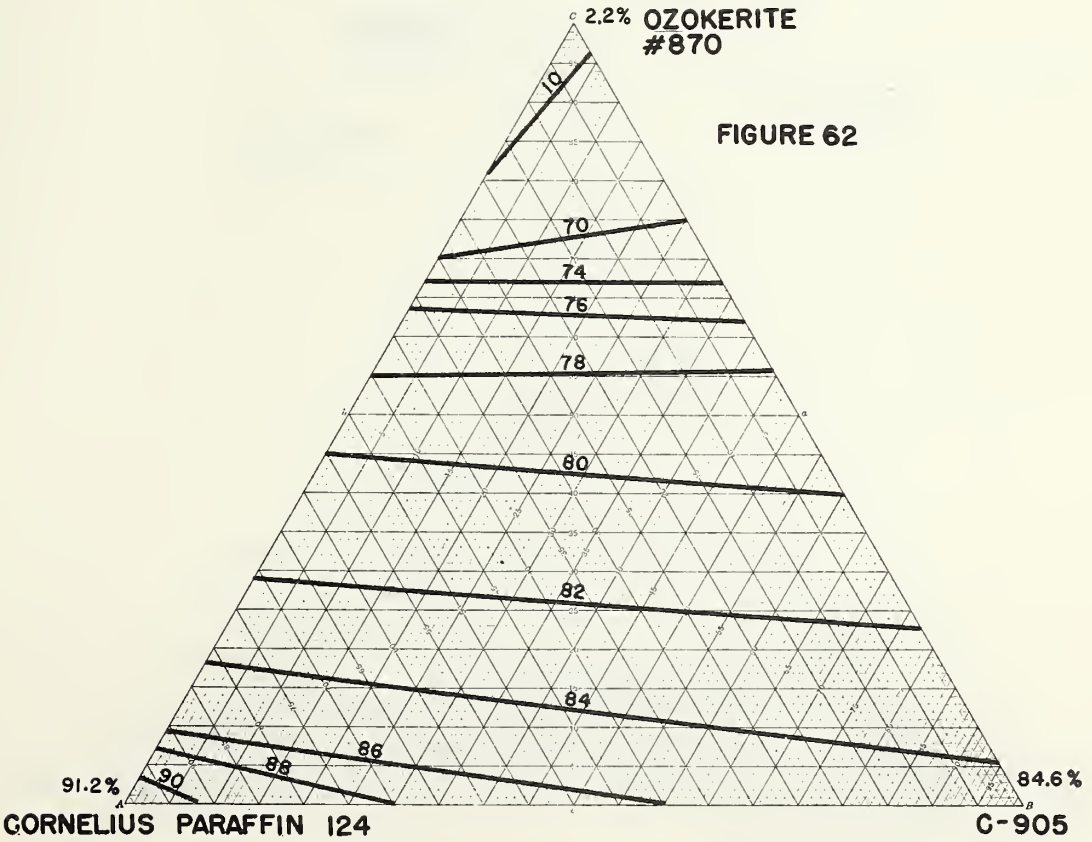

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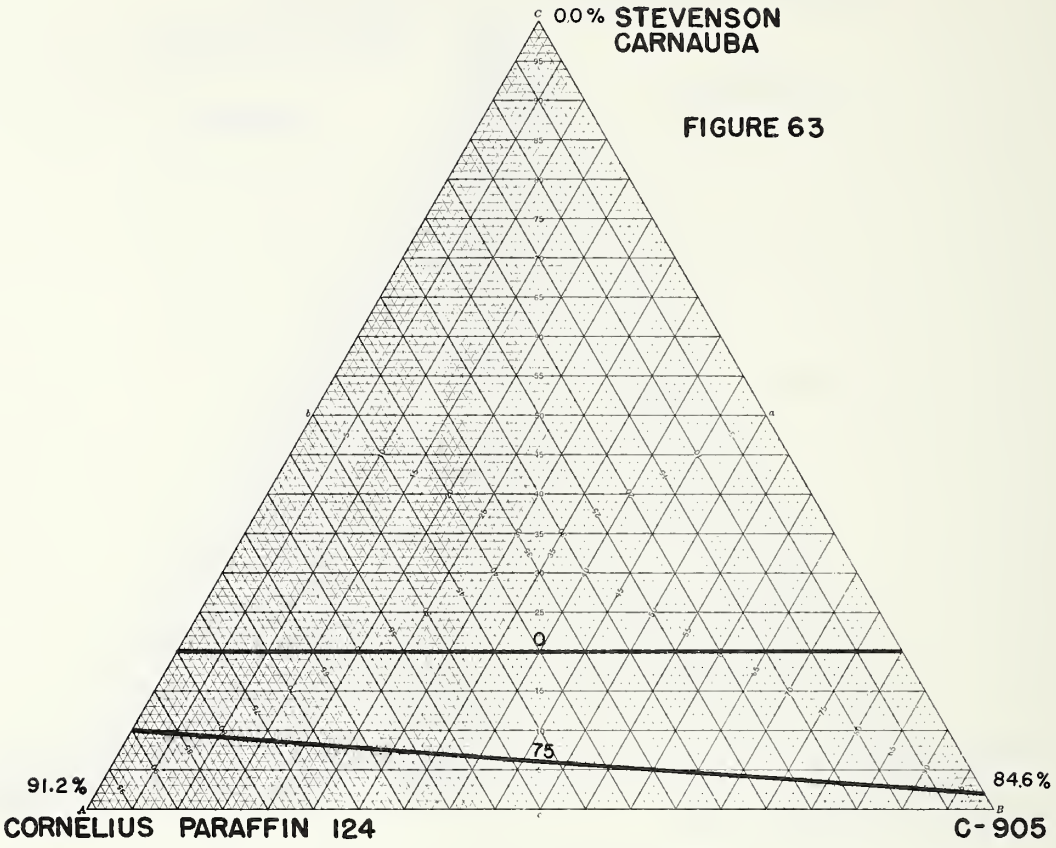

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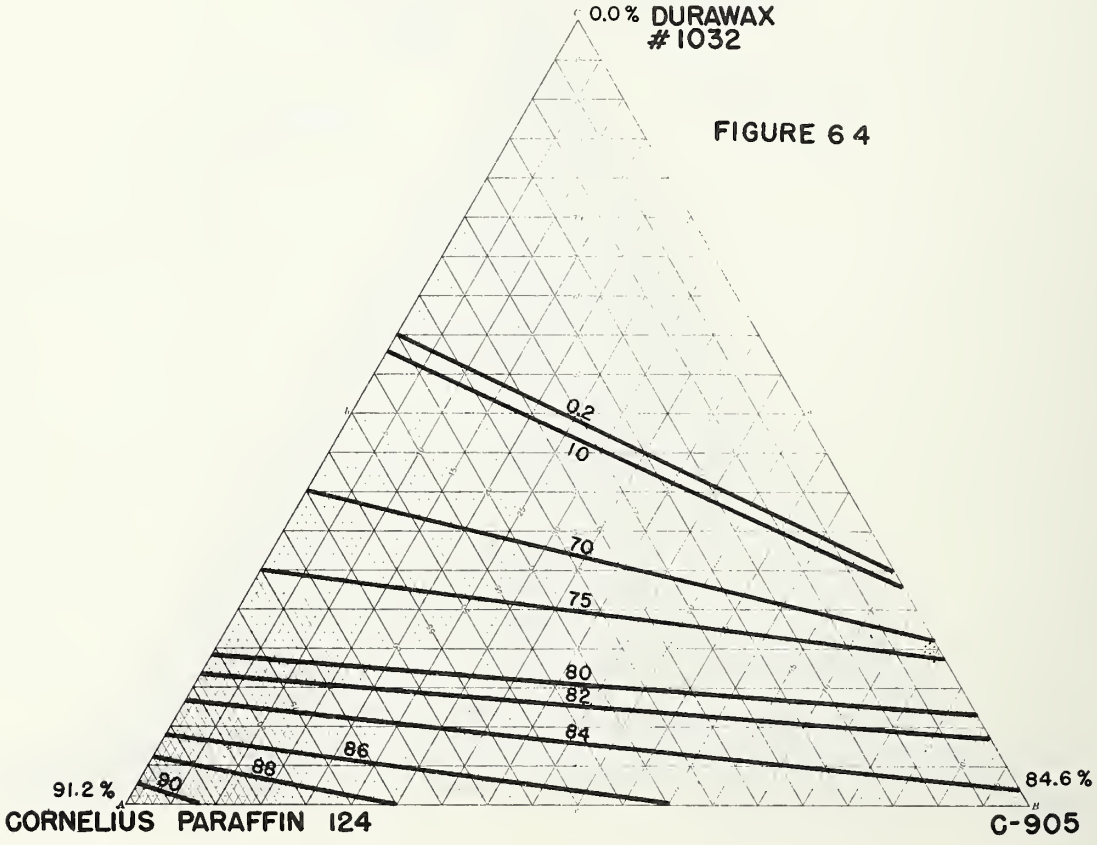

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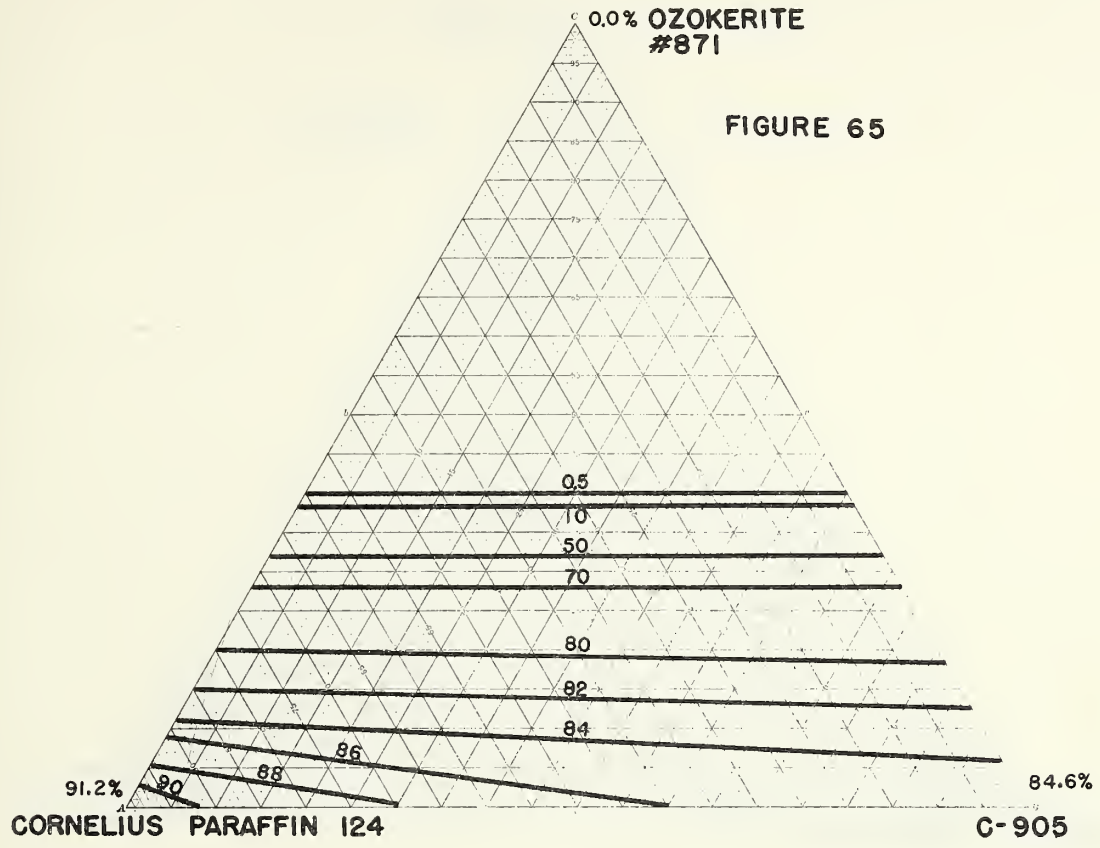

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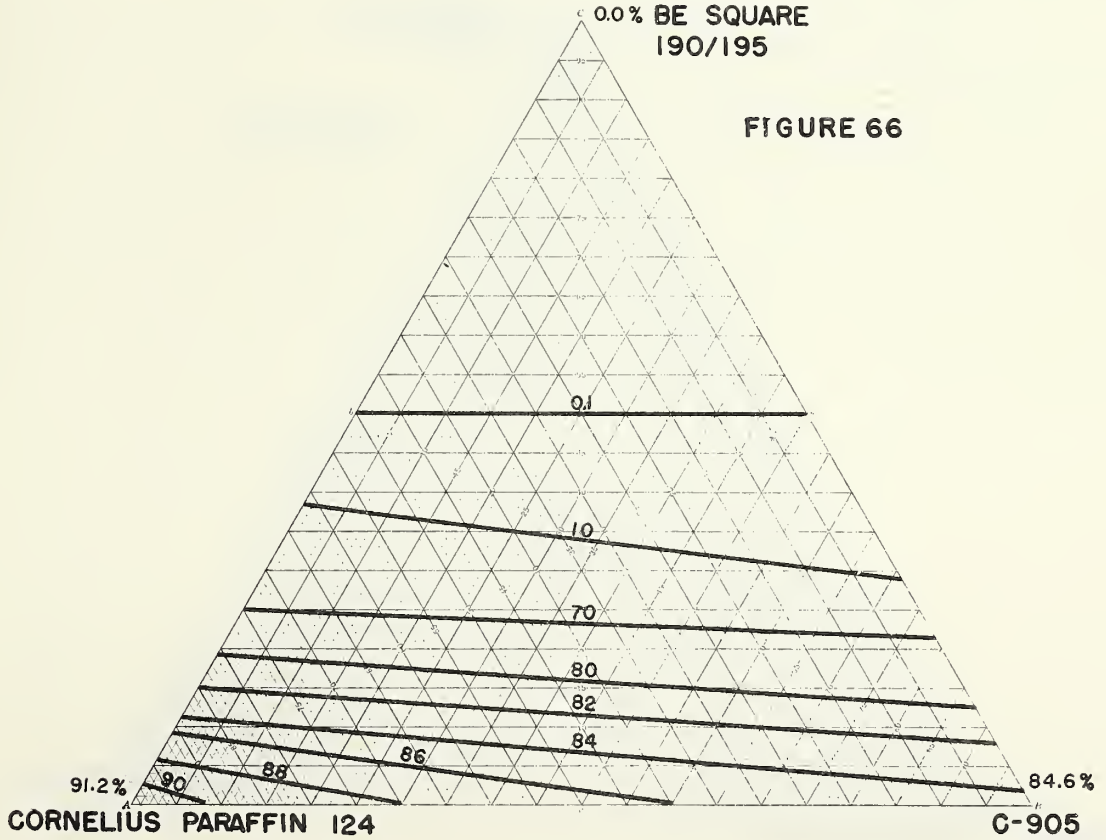

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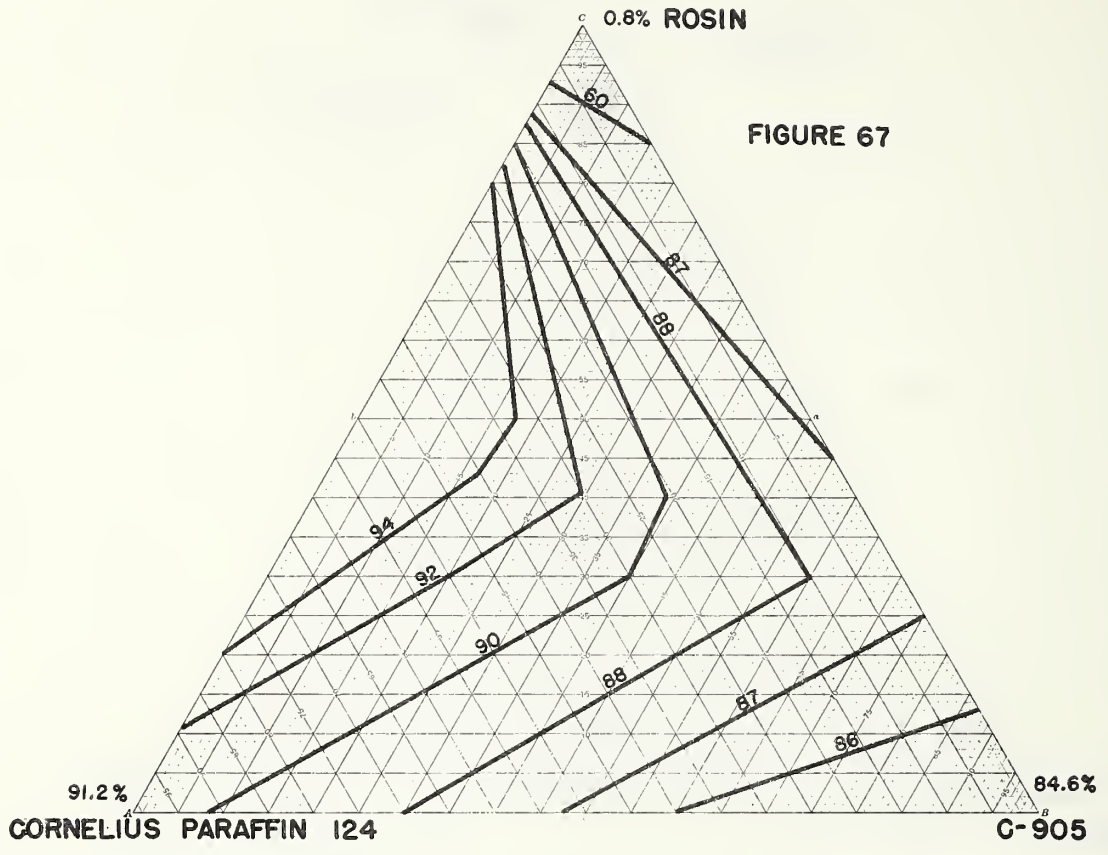

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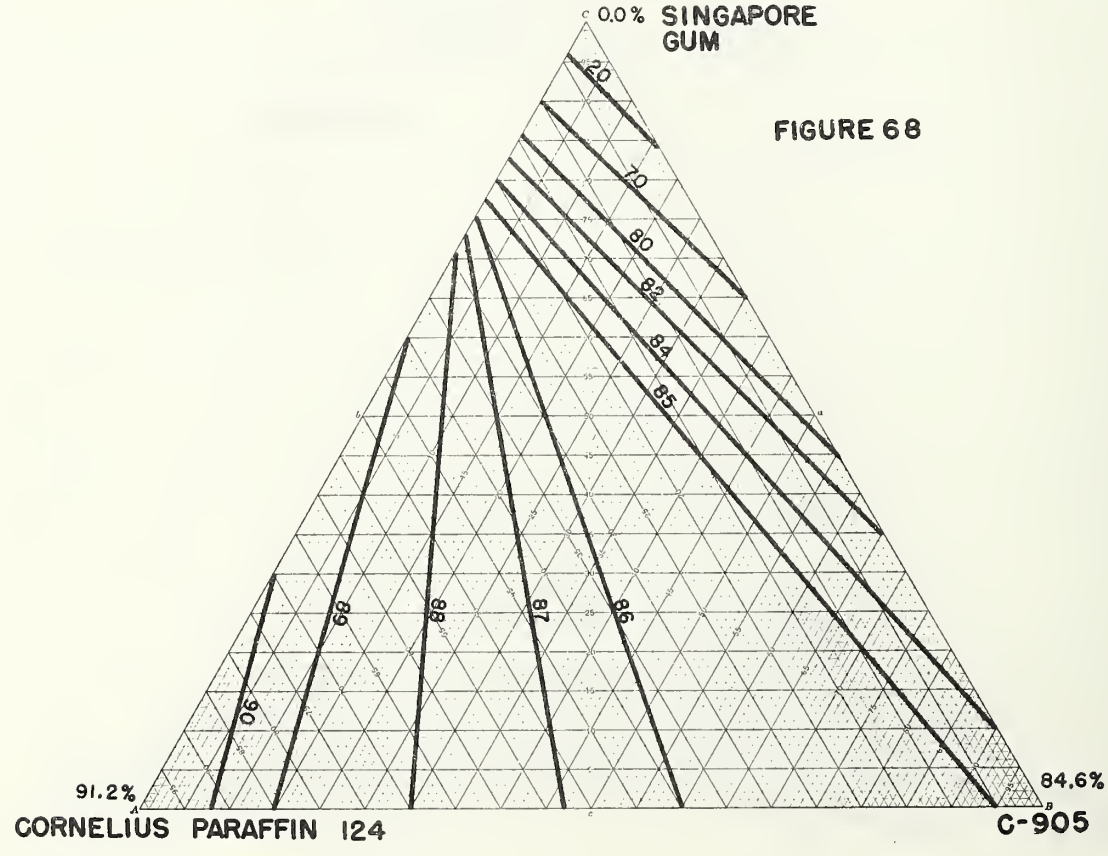

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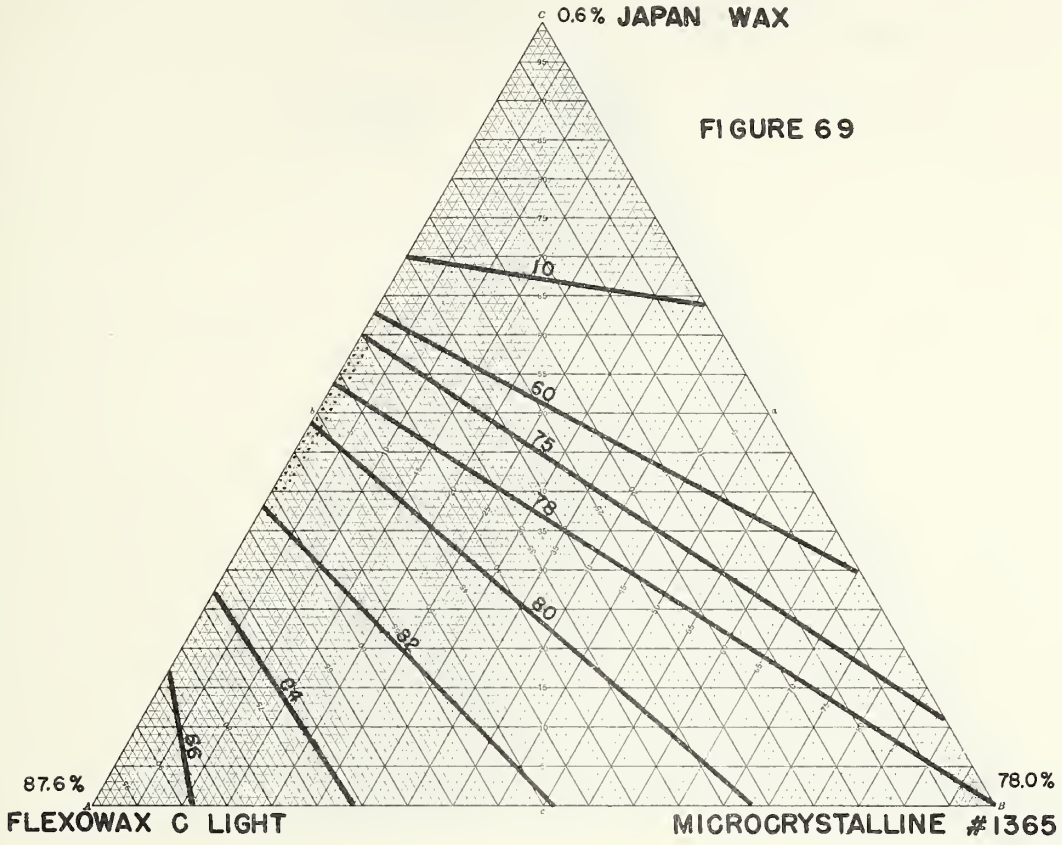

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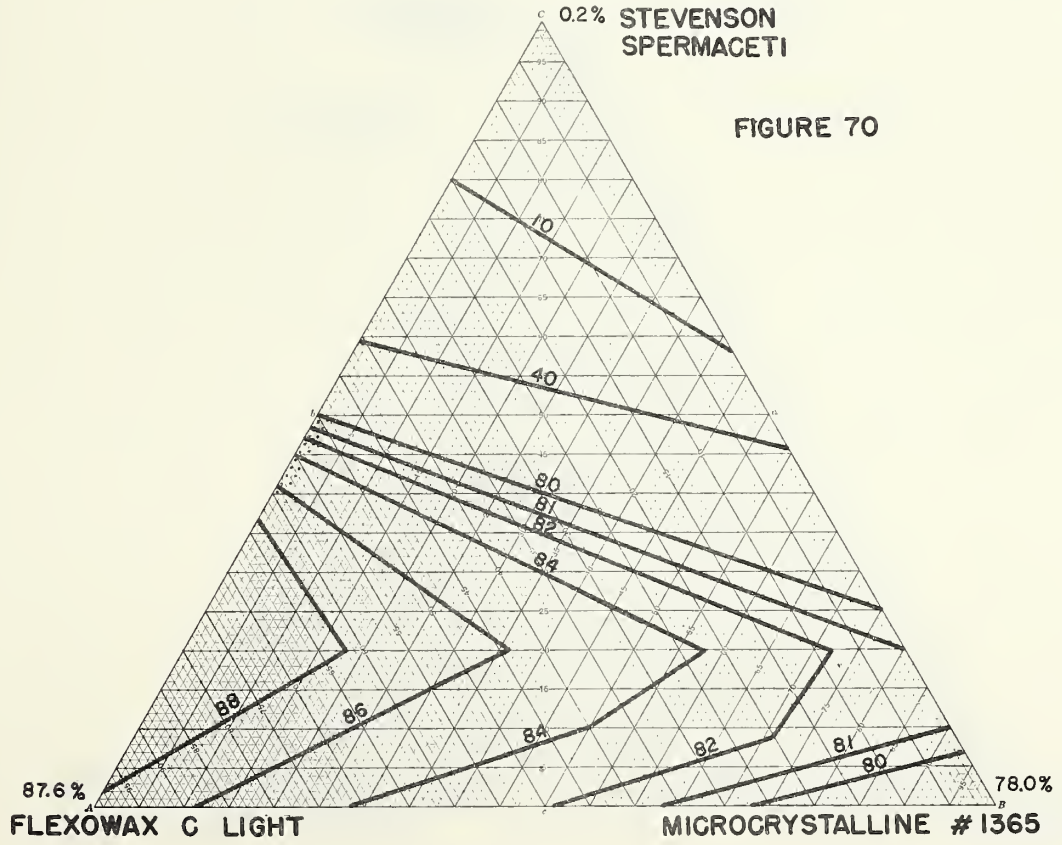

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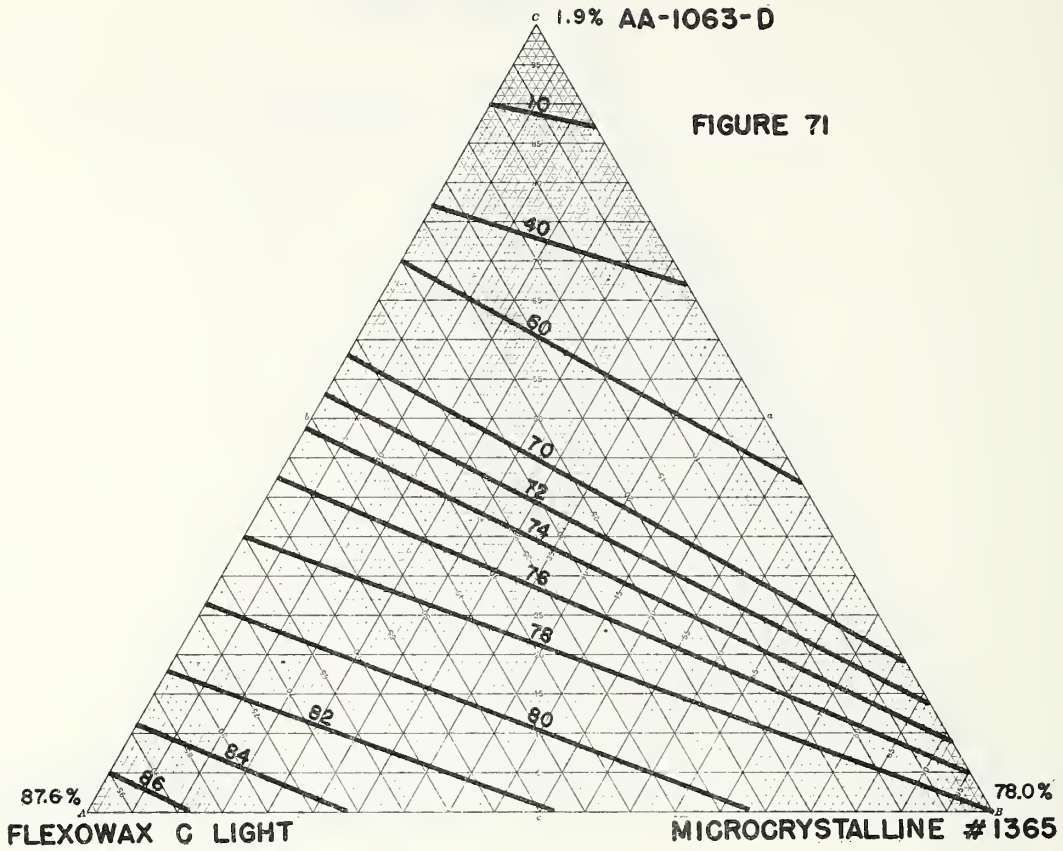

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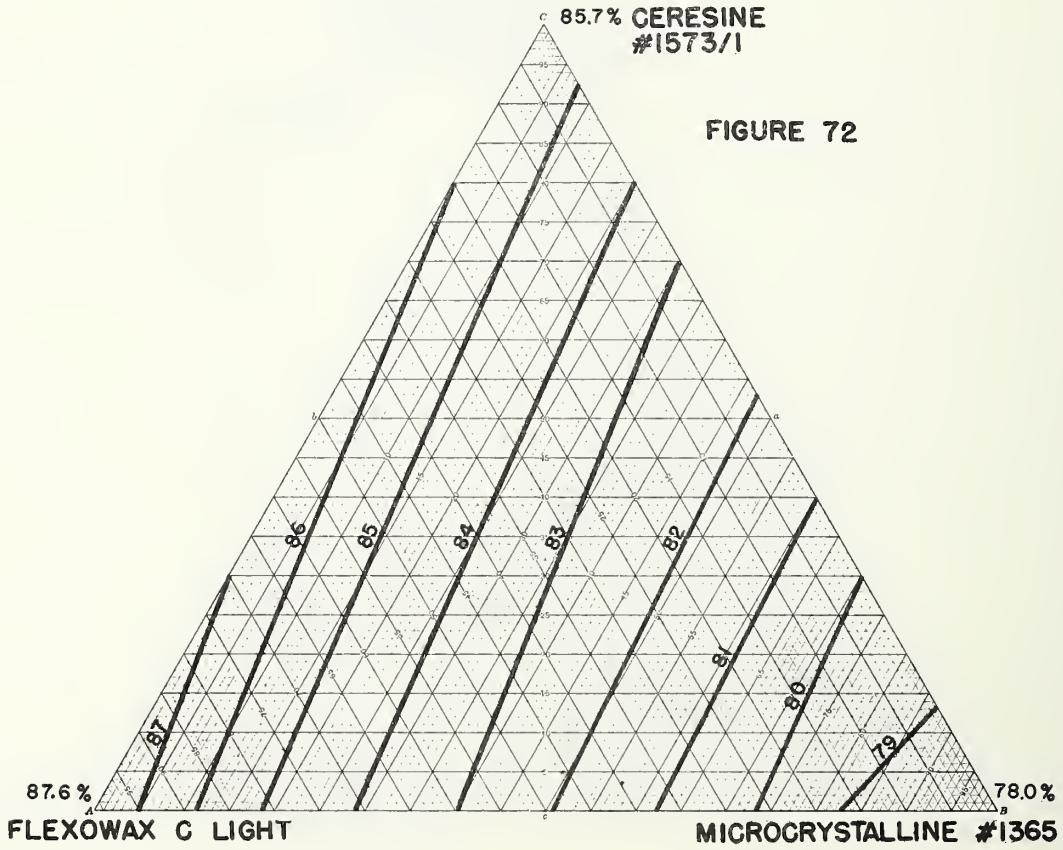

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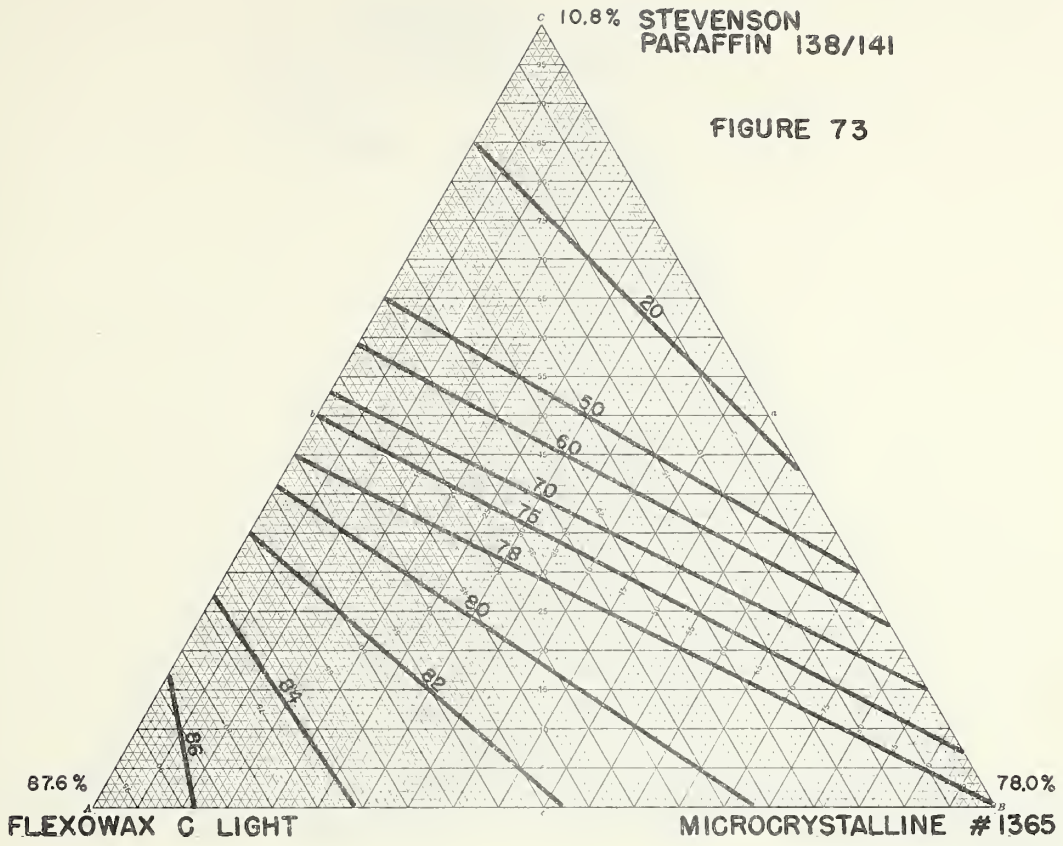

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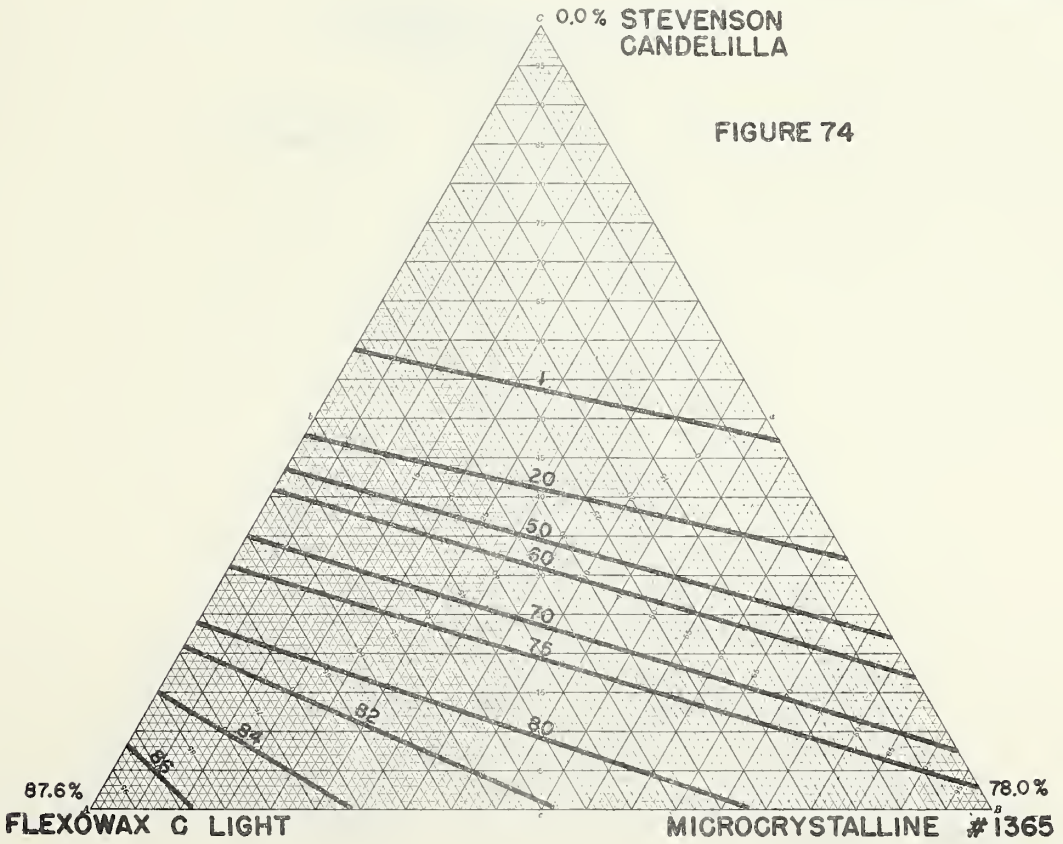

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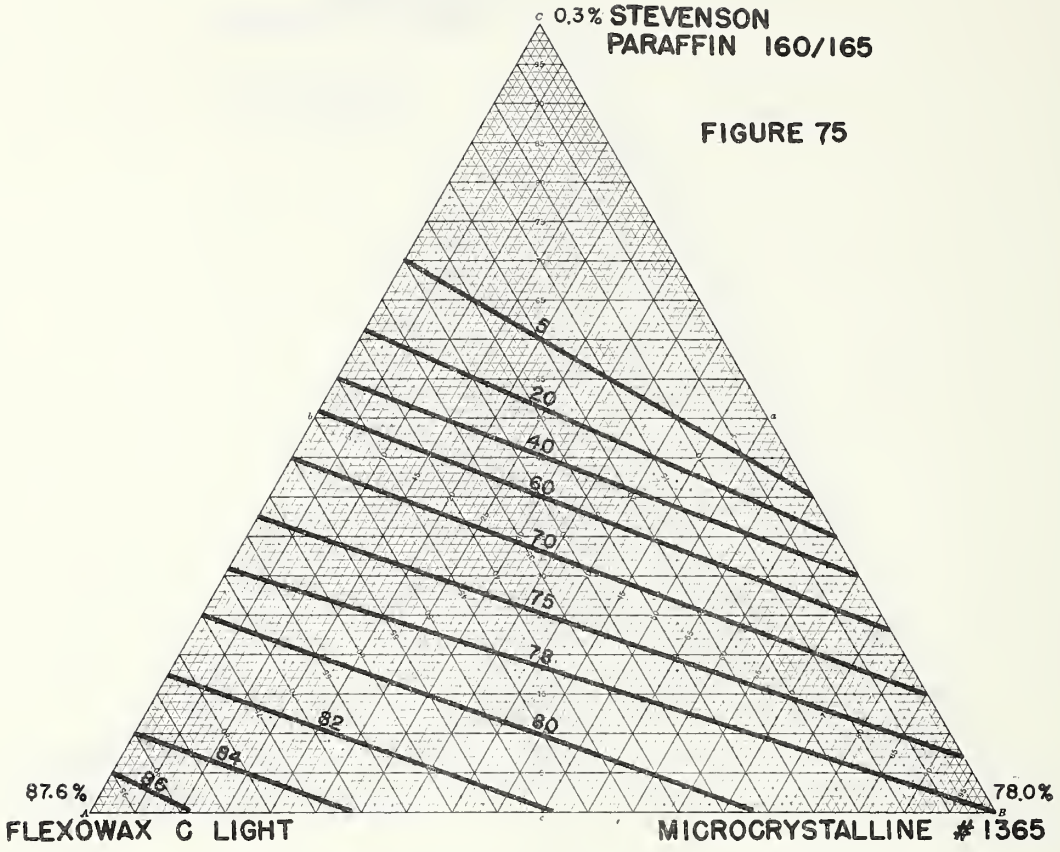

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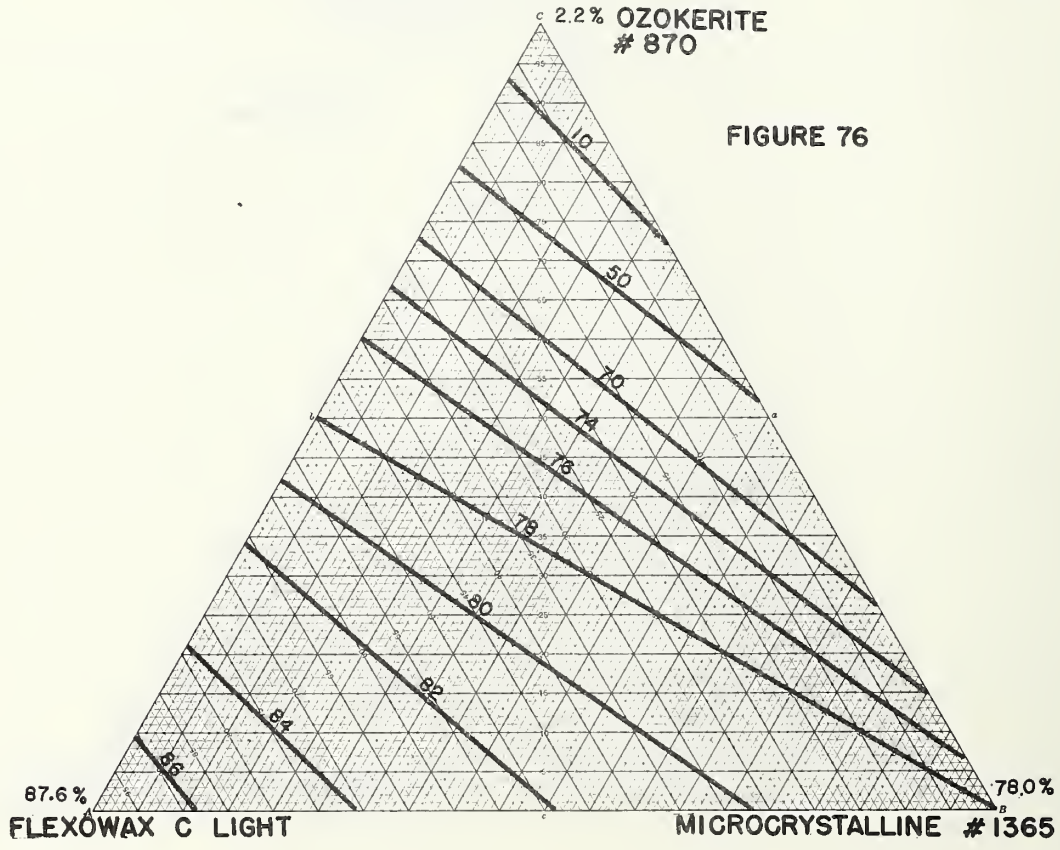

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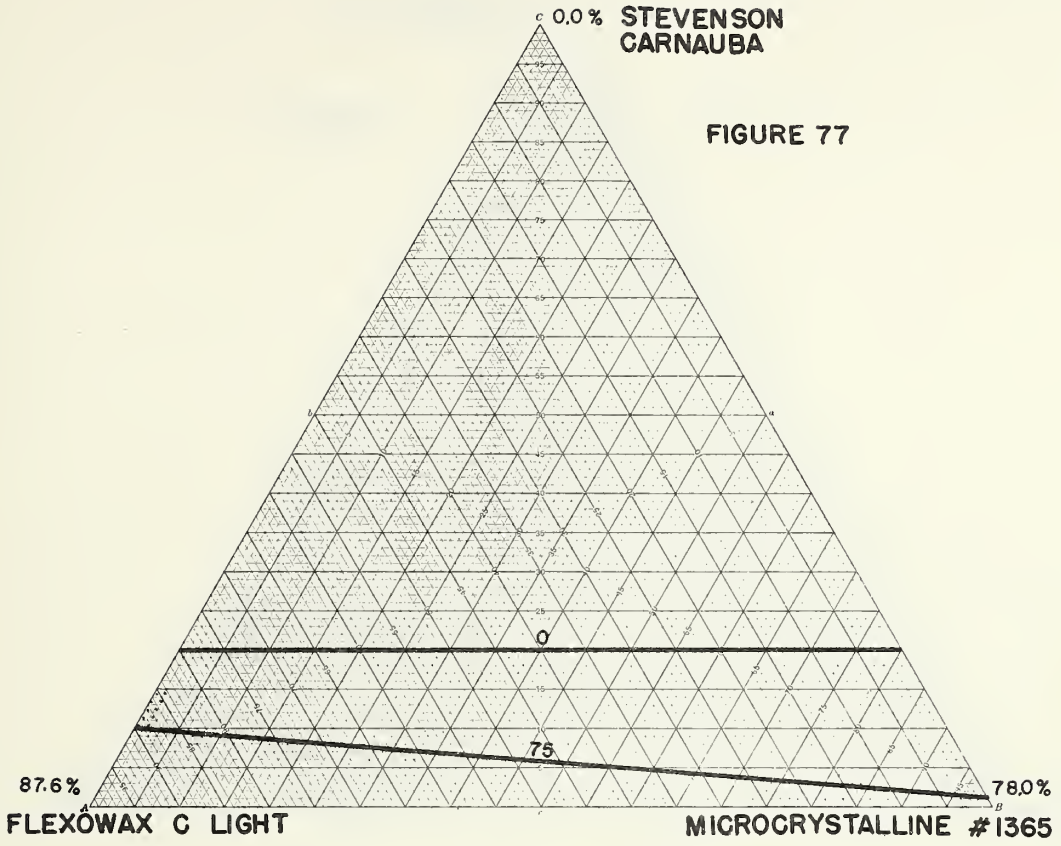

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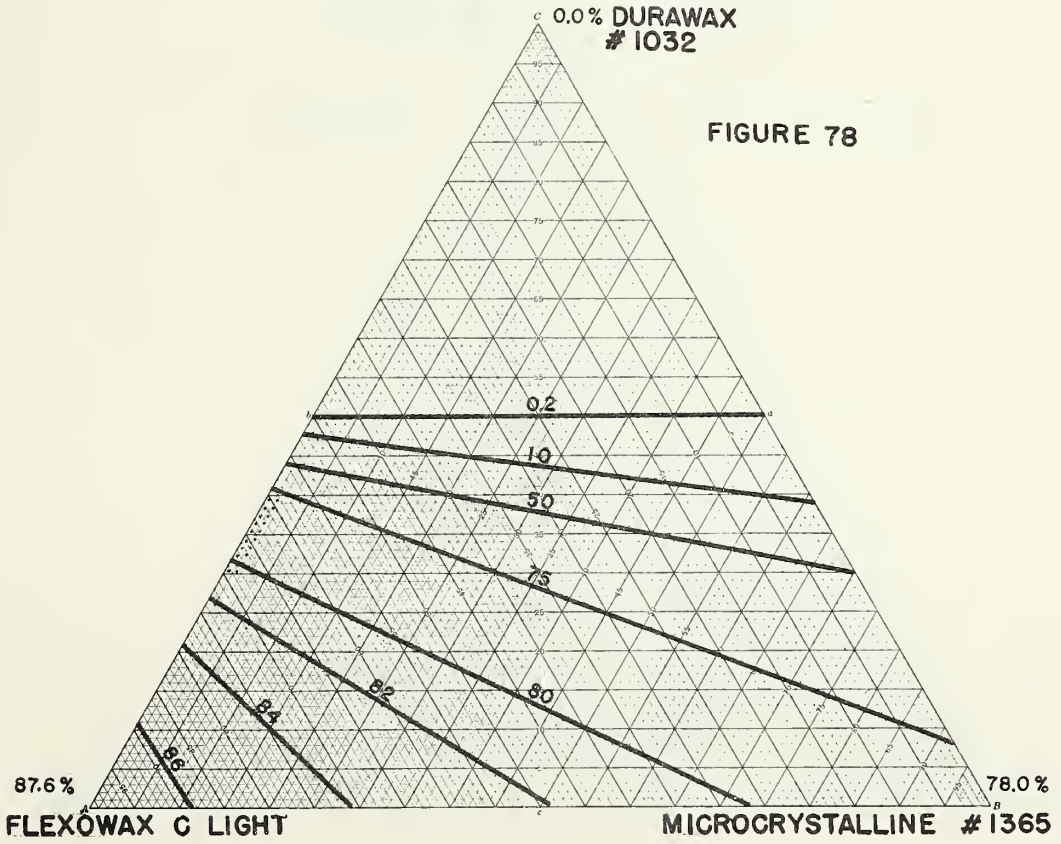

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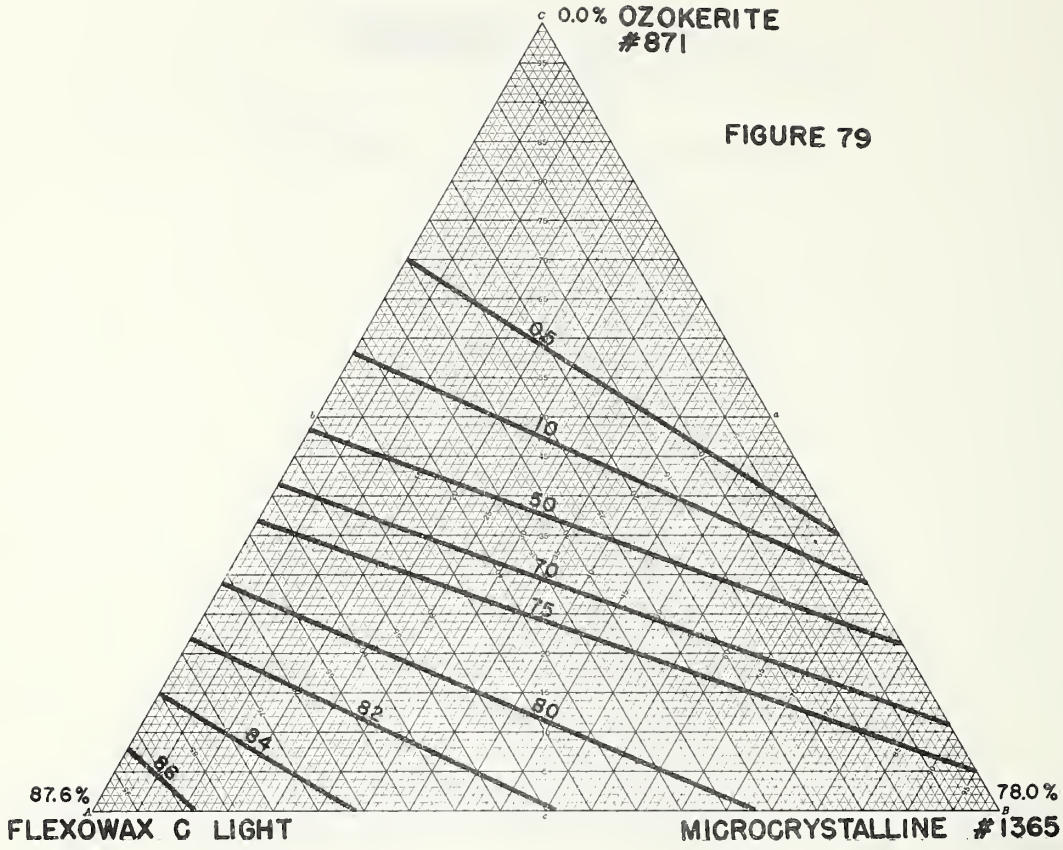

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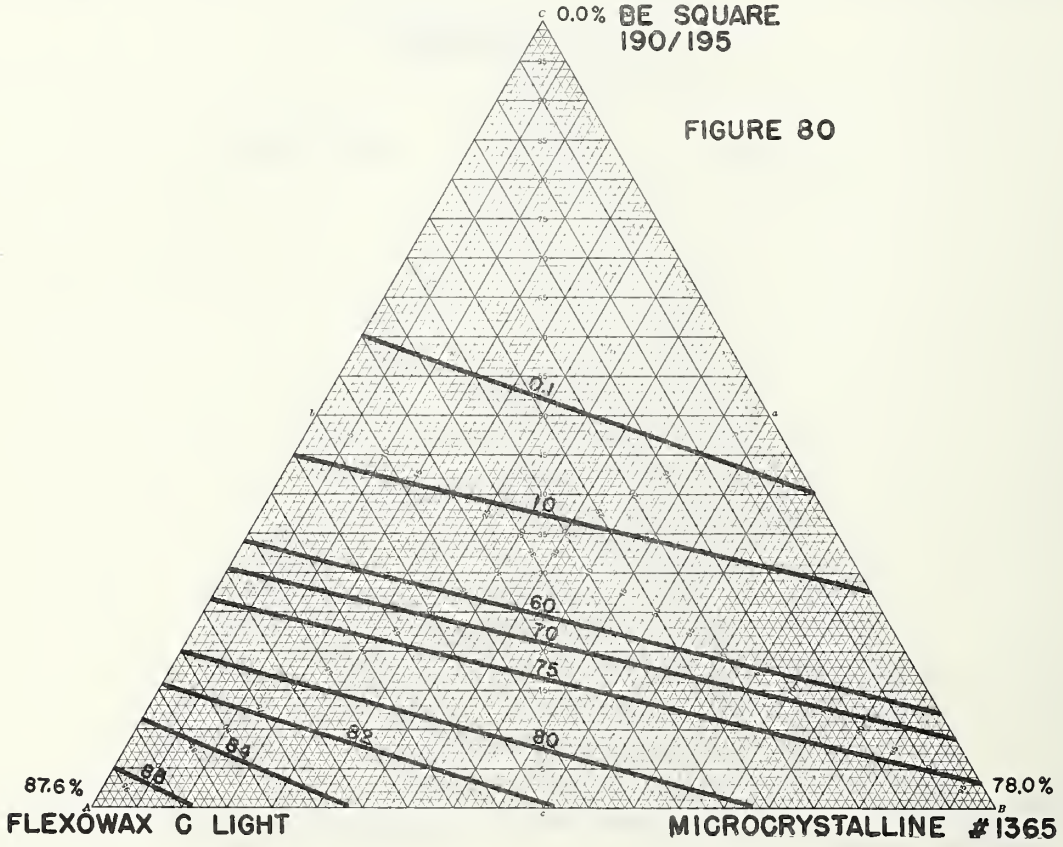
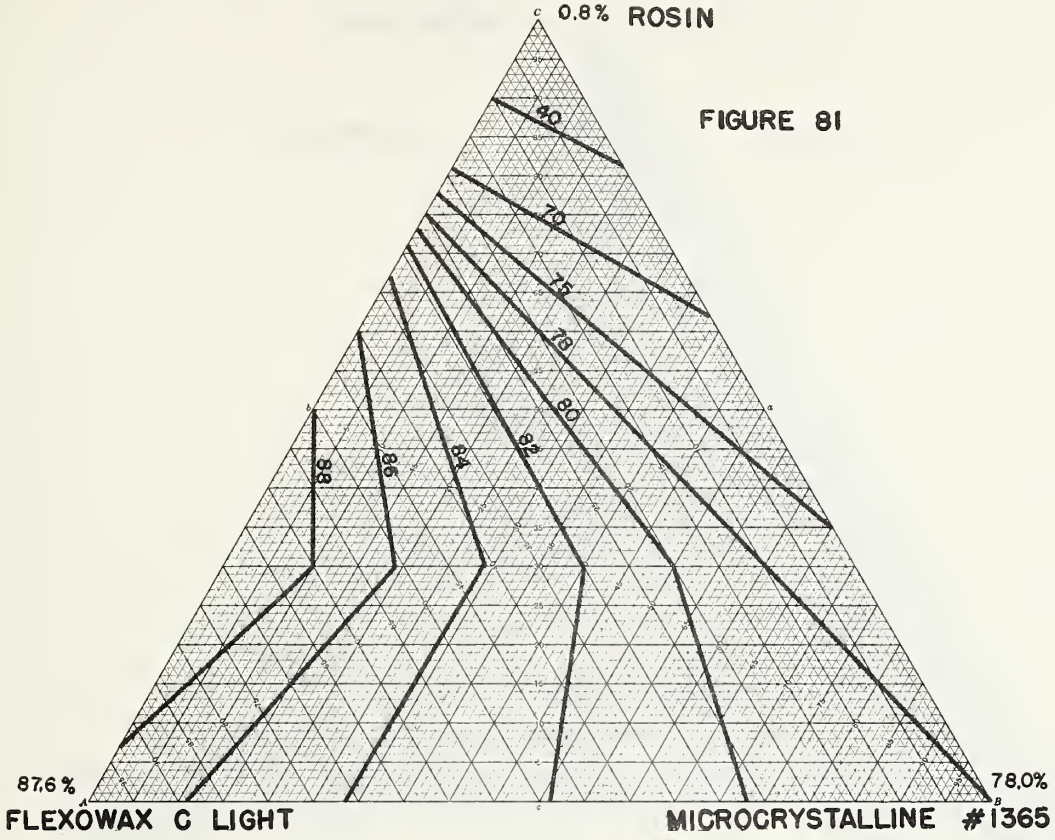


FIGURE 80



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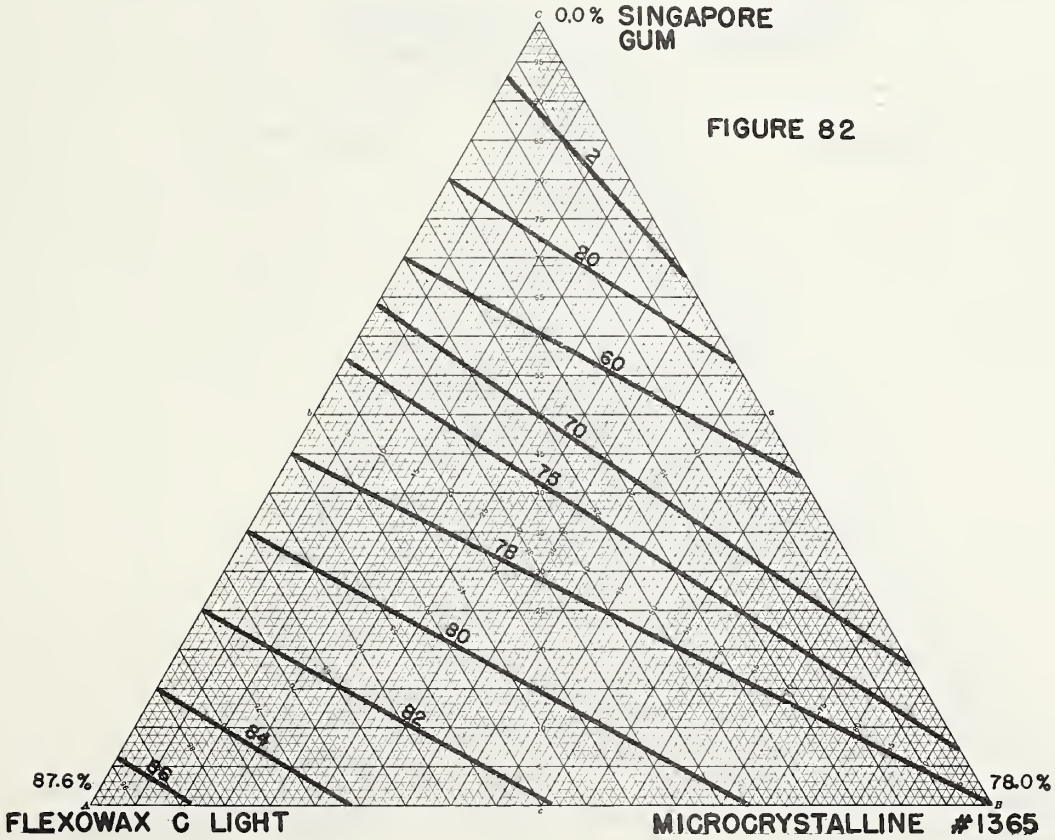

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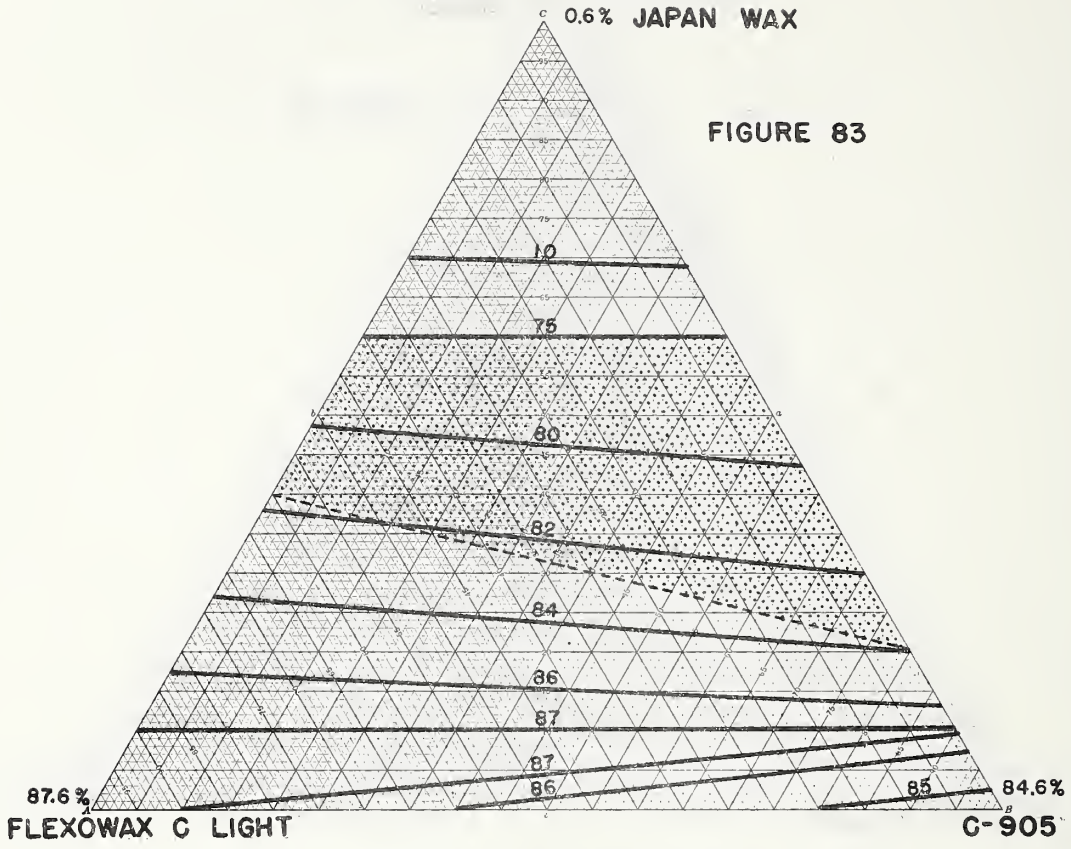

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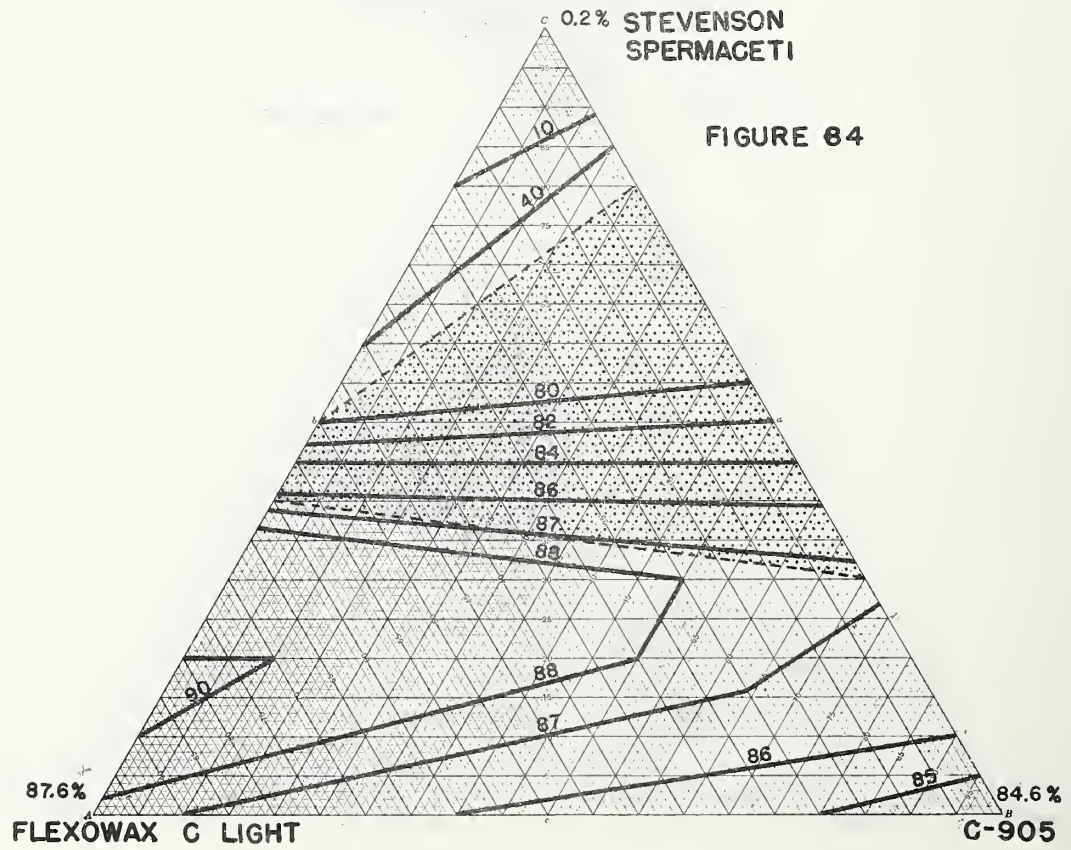

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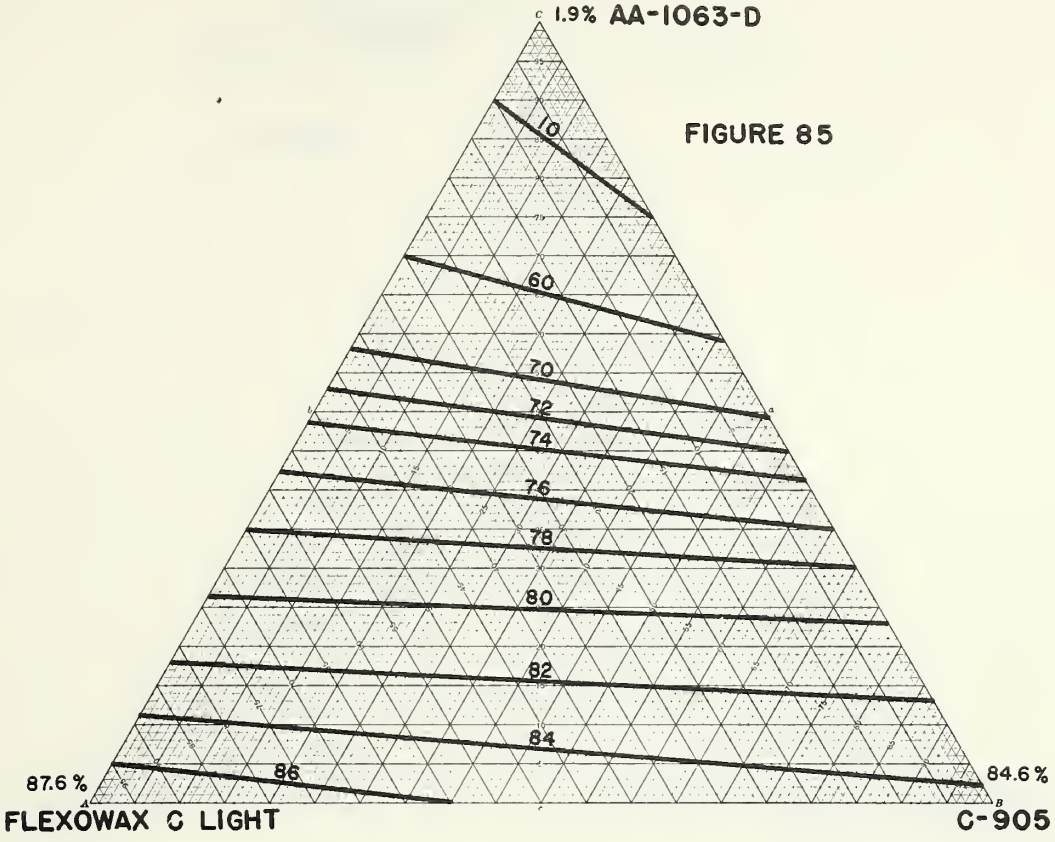

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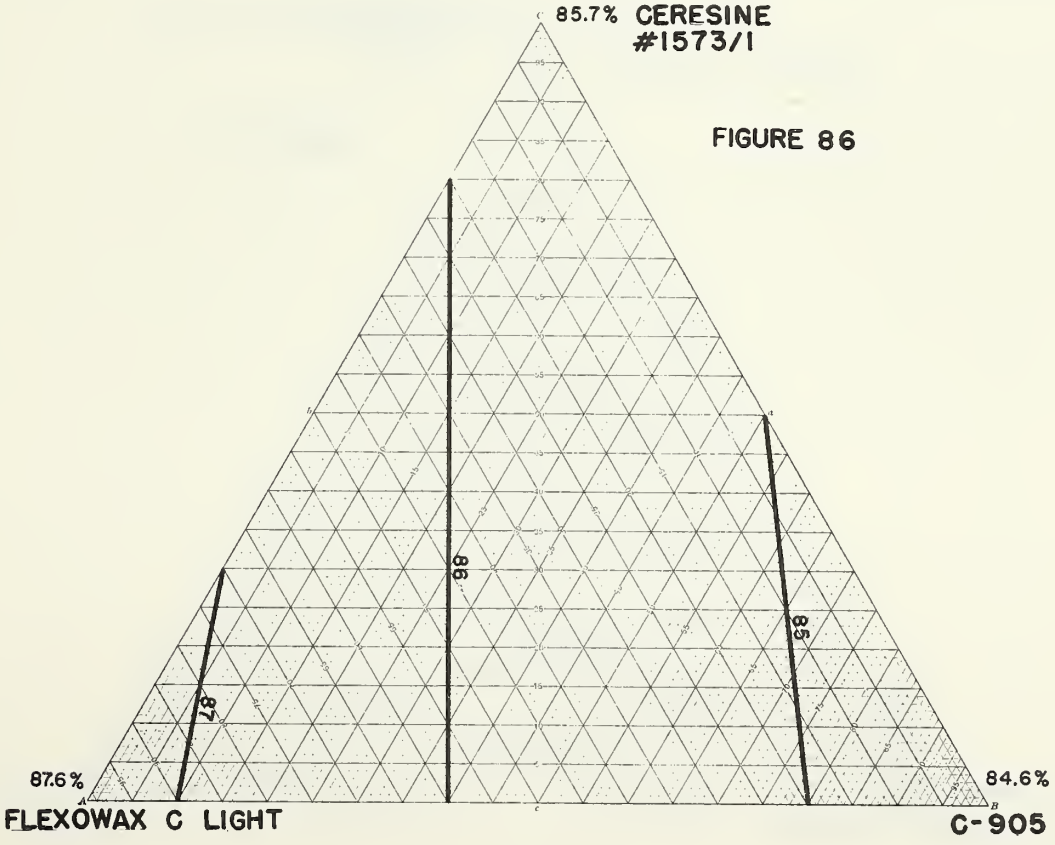

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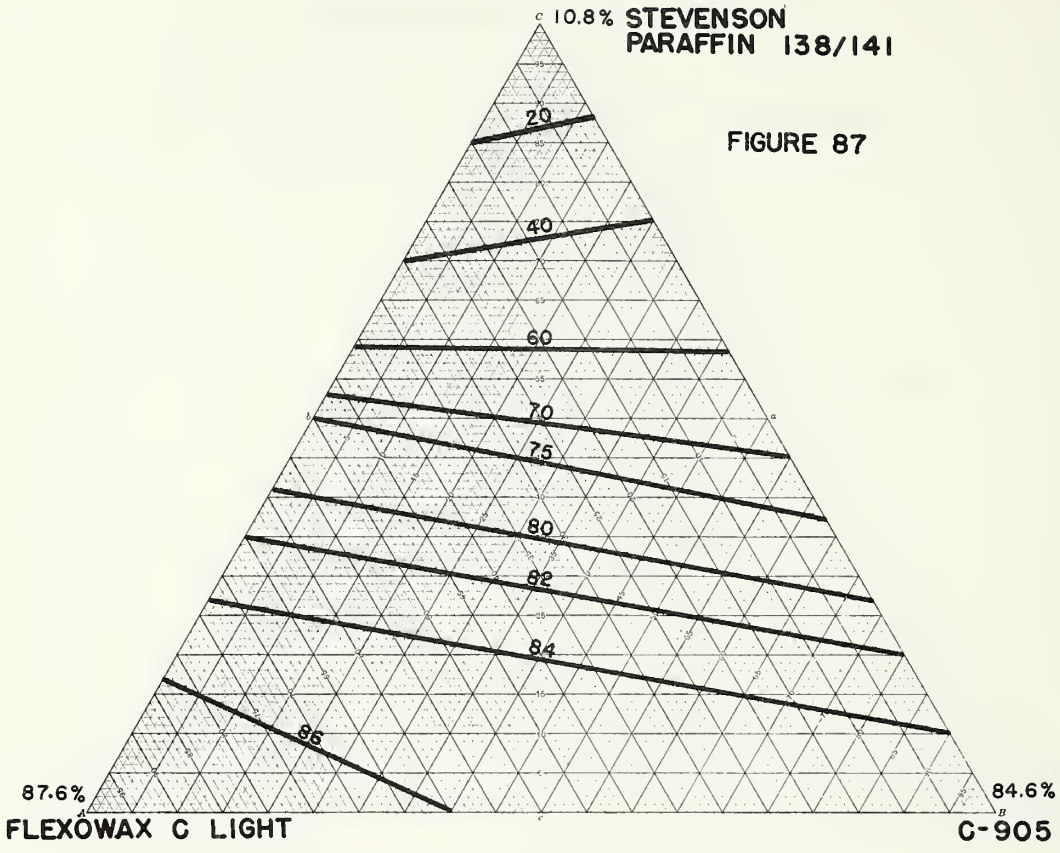

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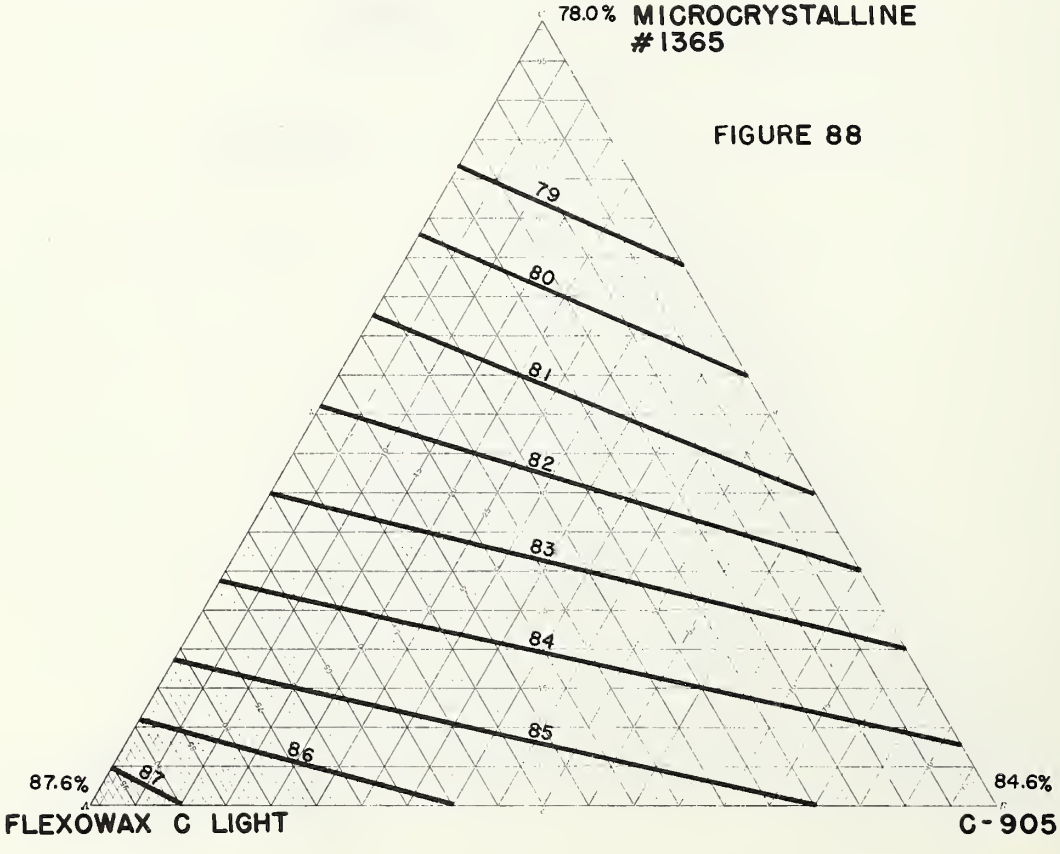

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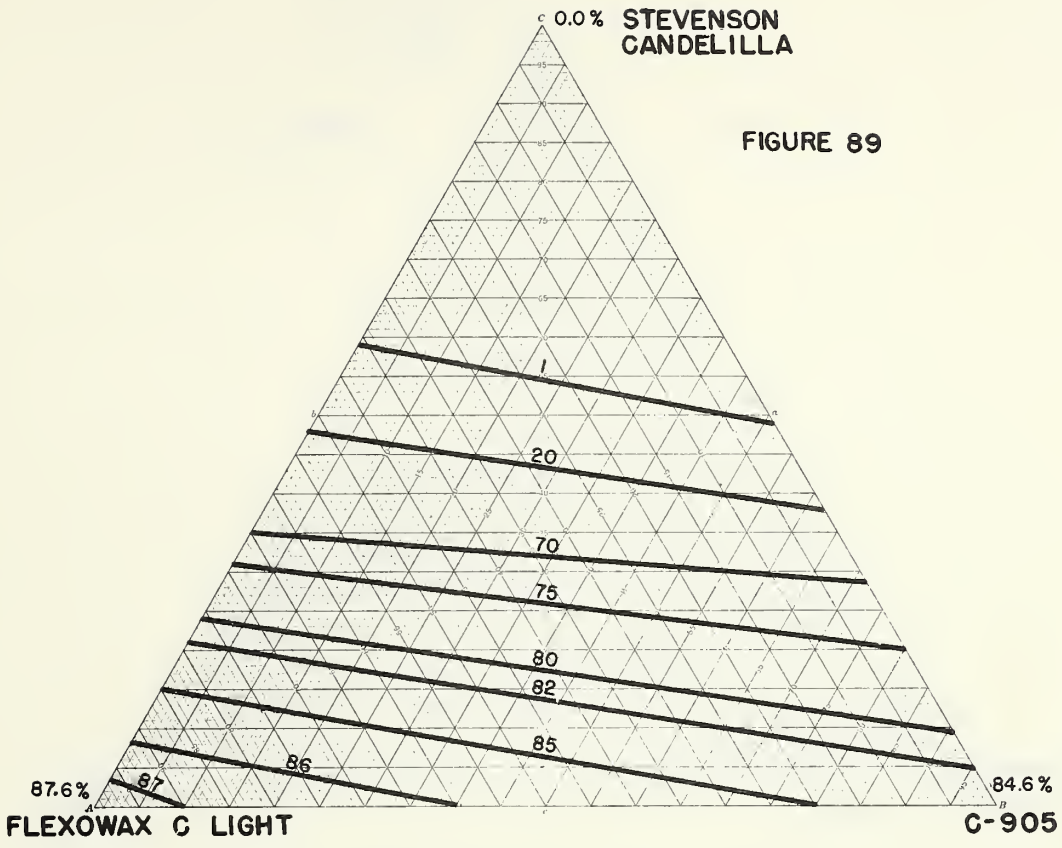

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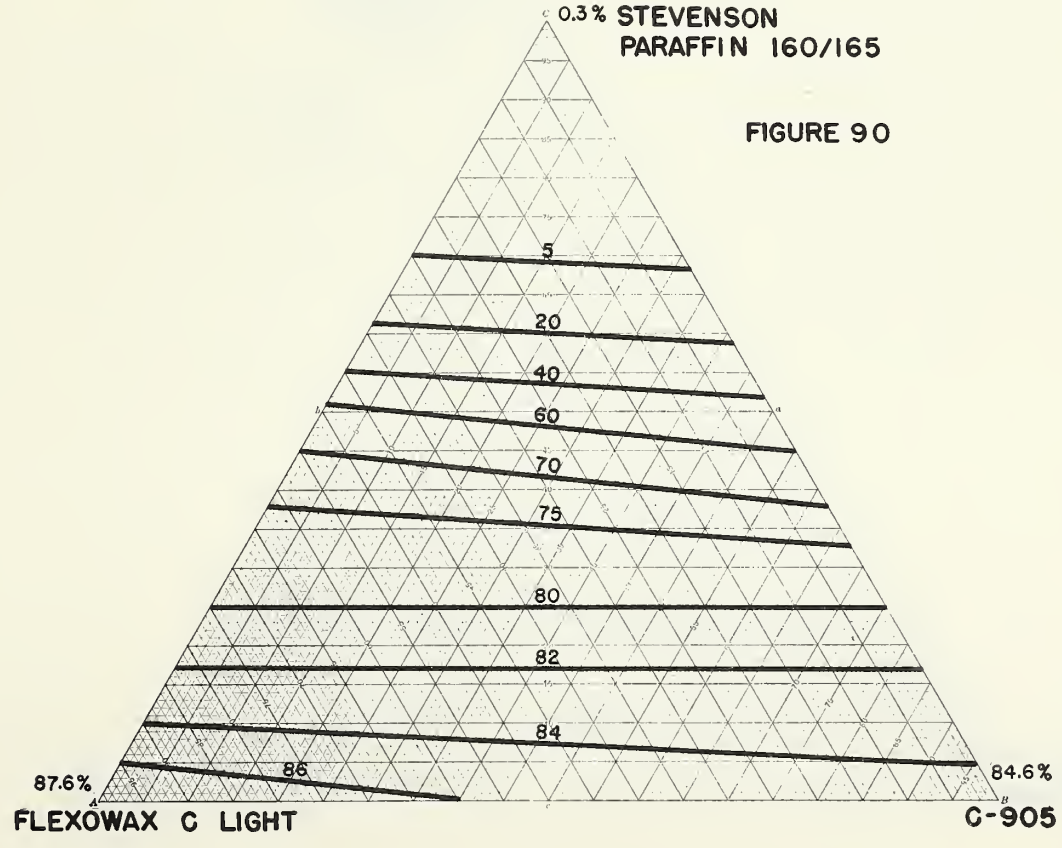

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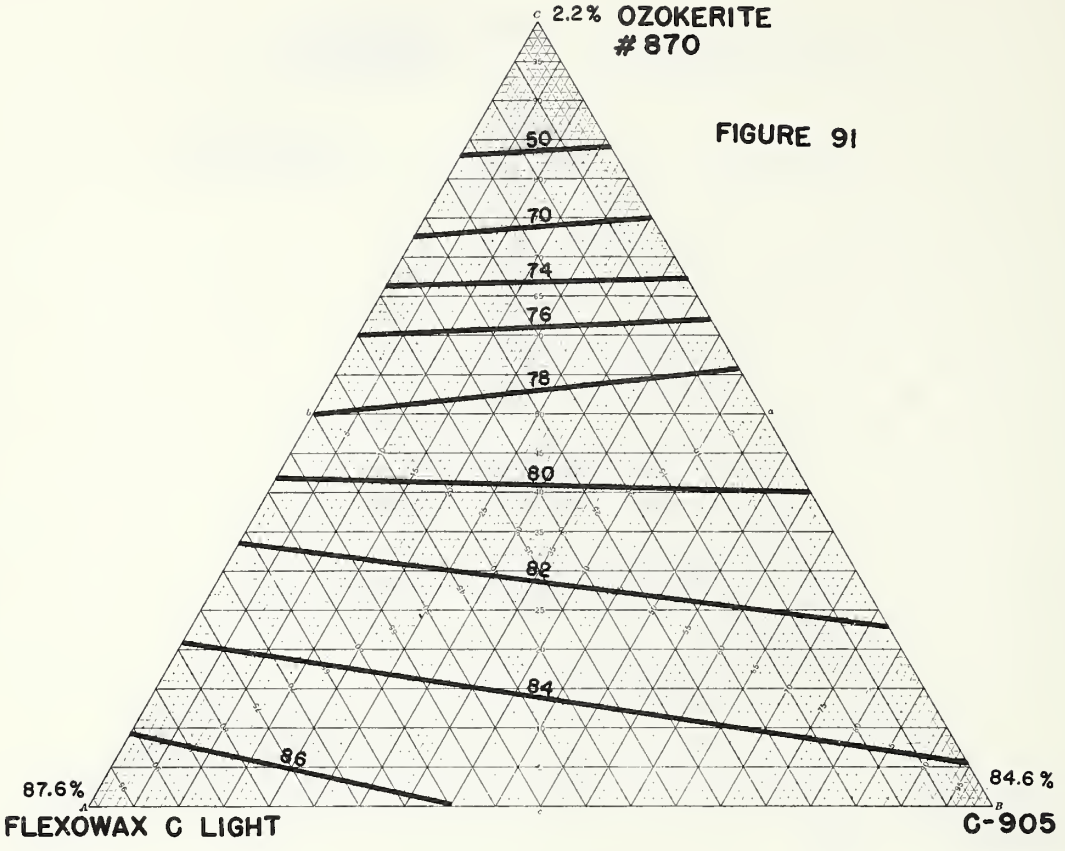

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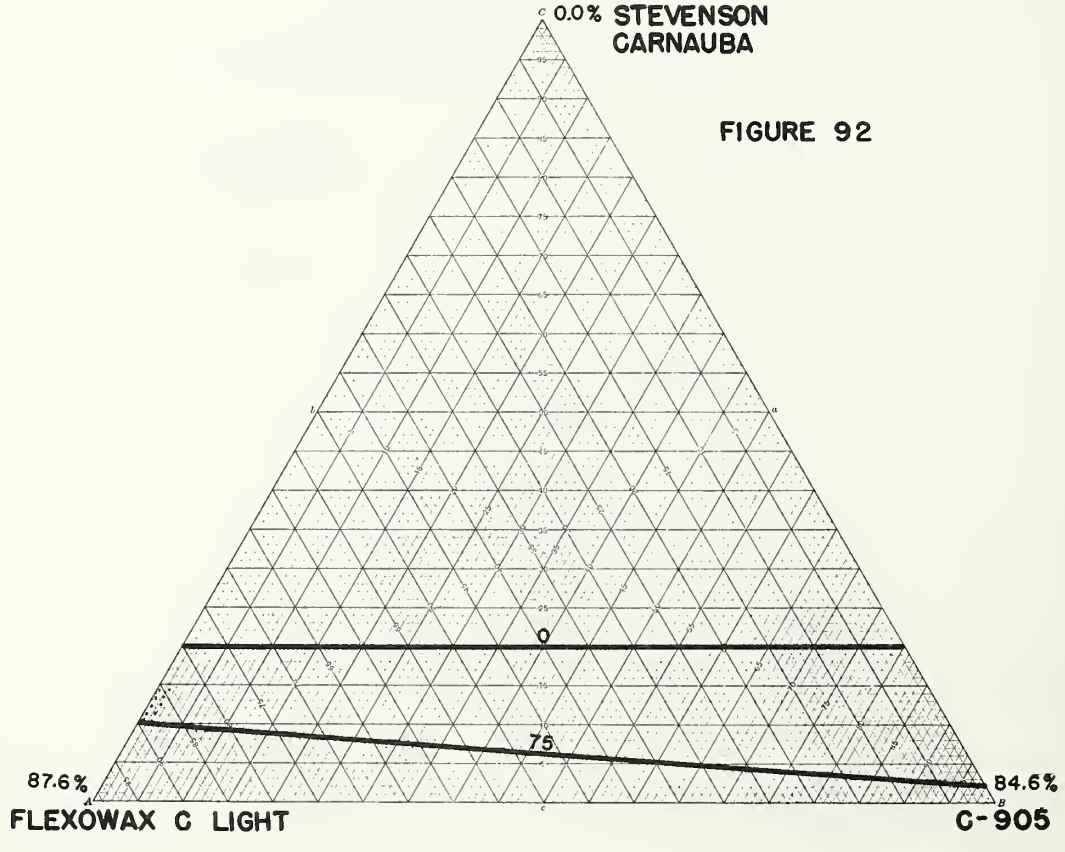

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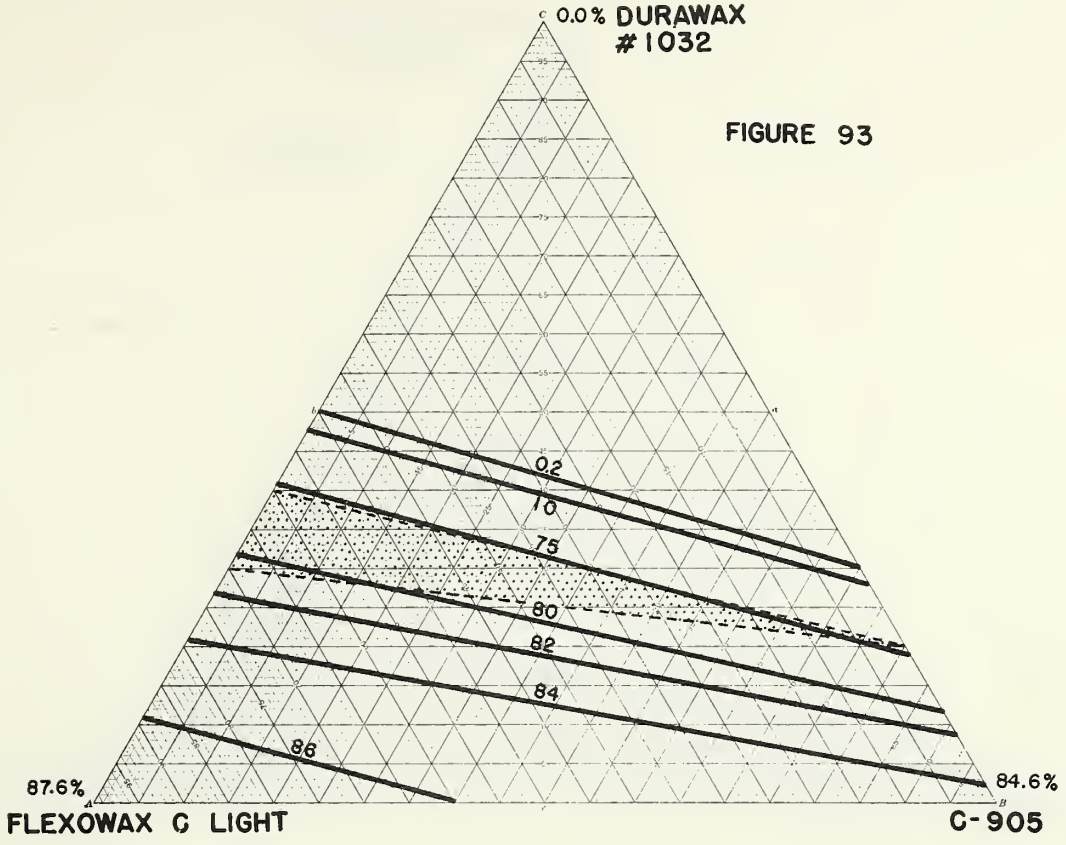

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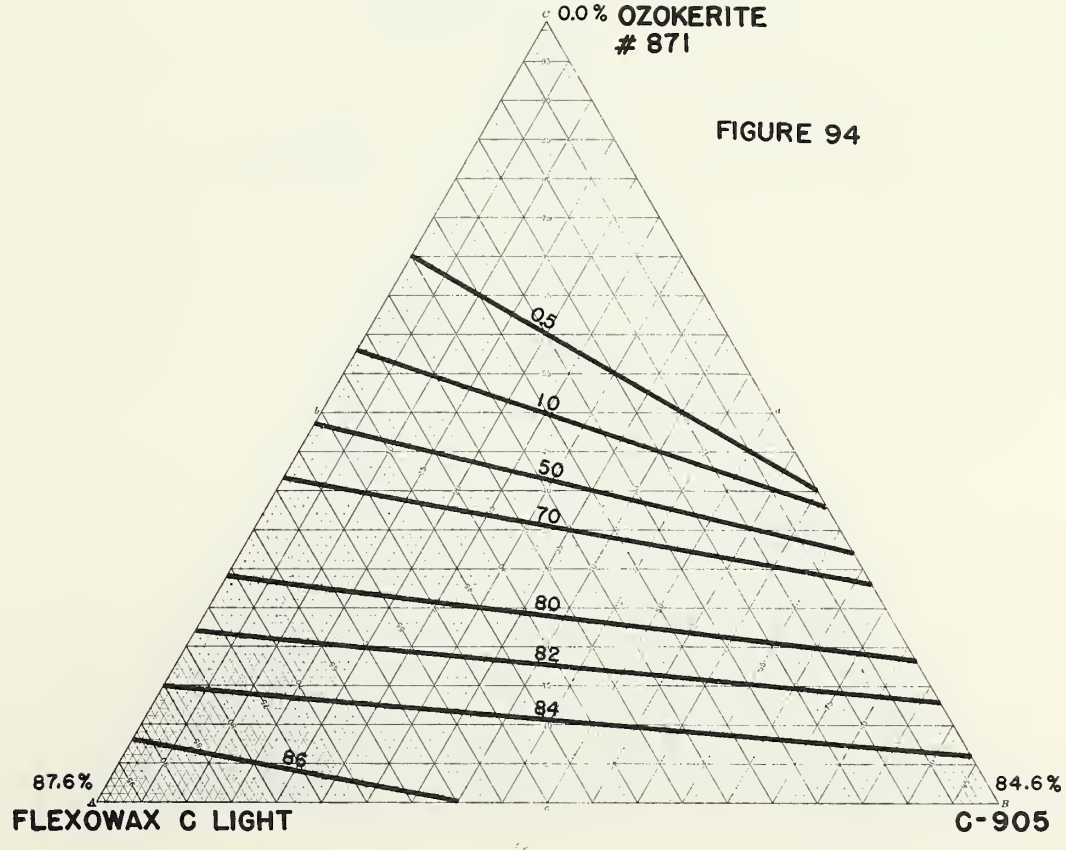

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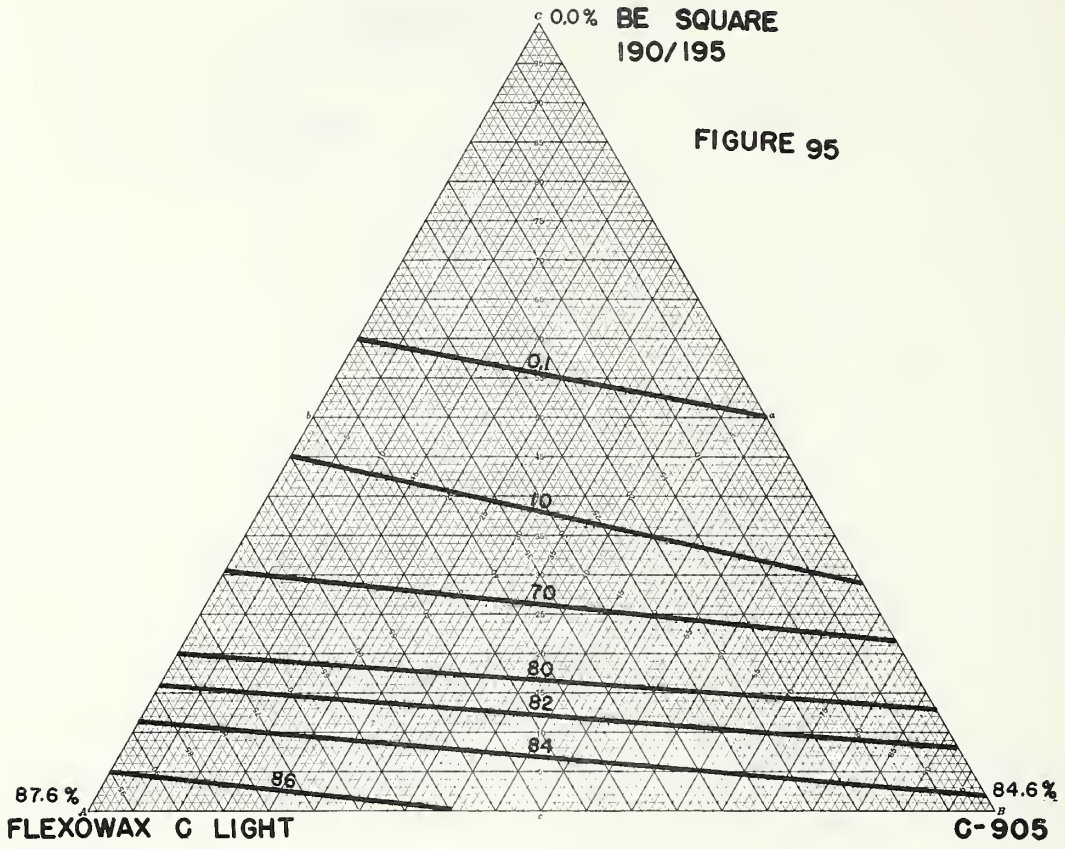

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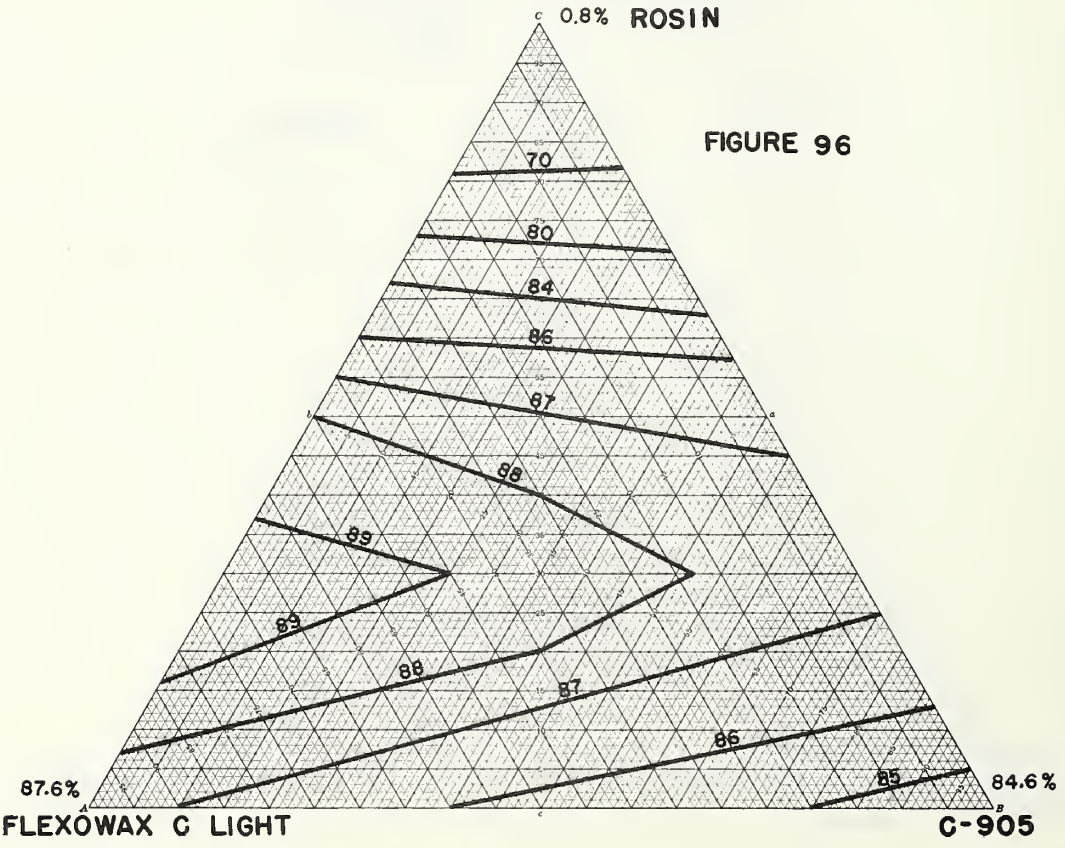

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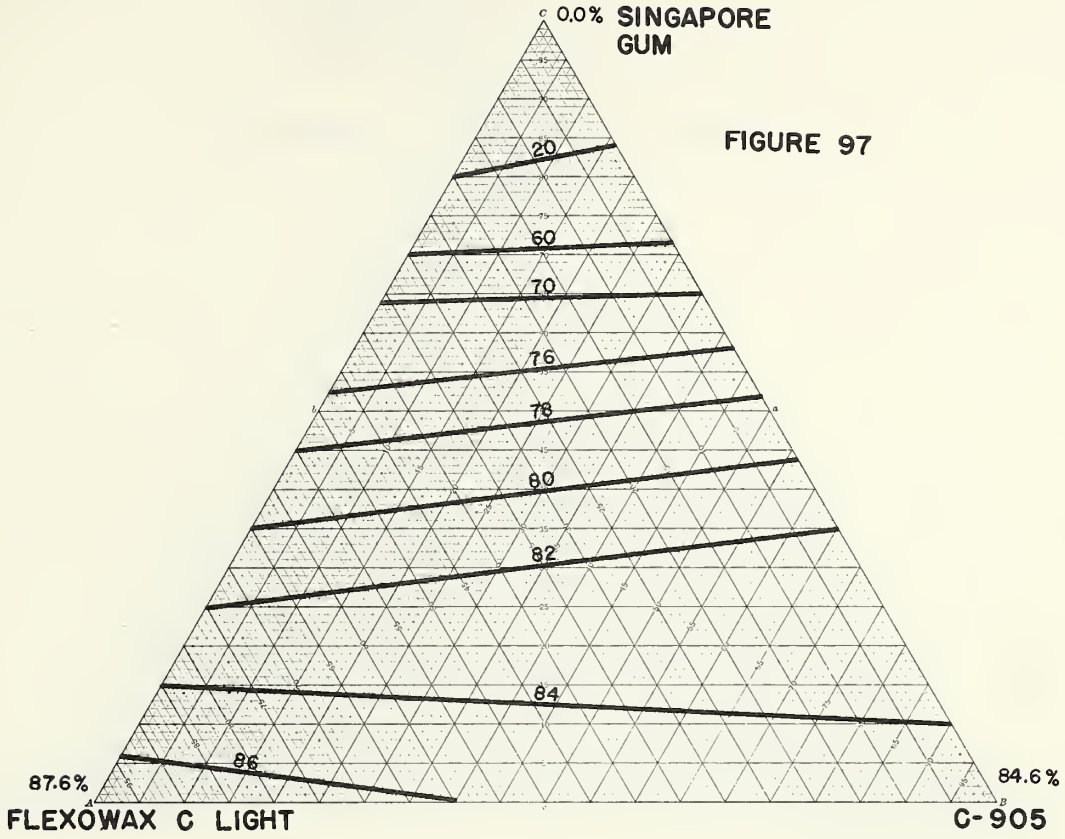

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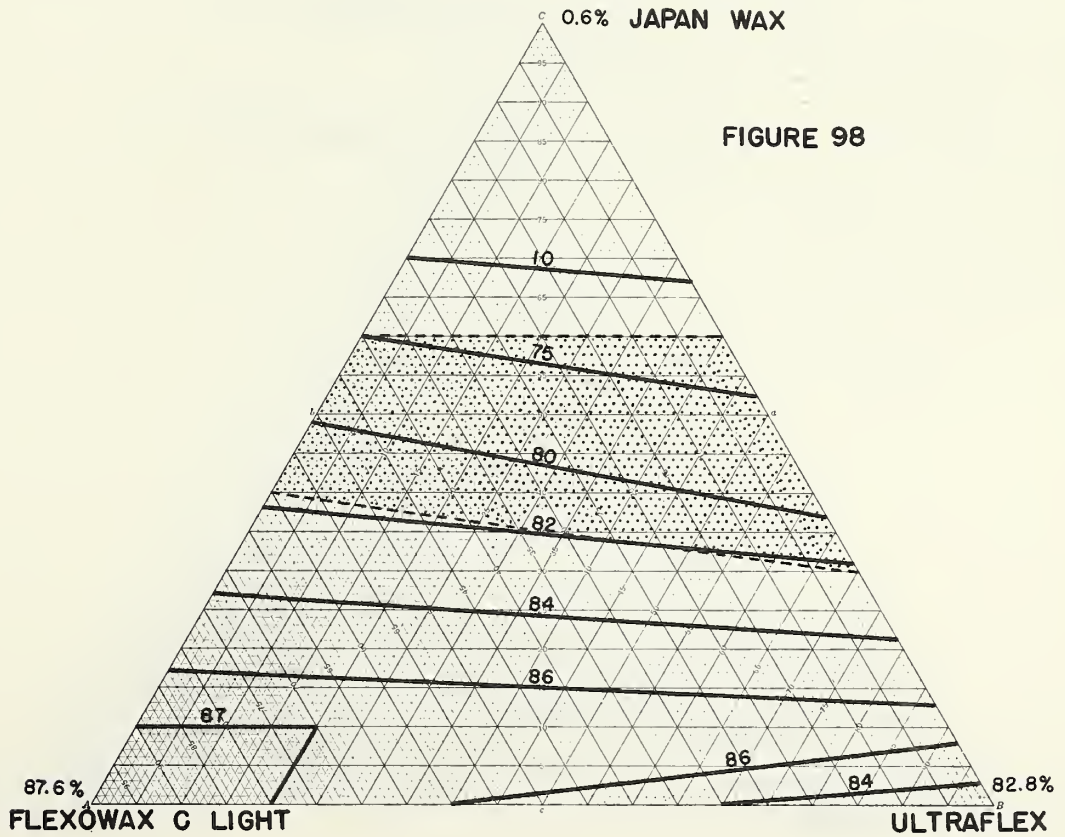

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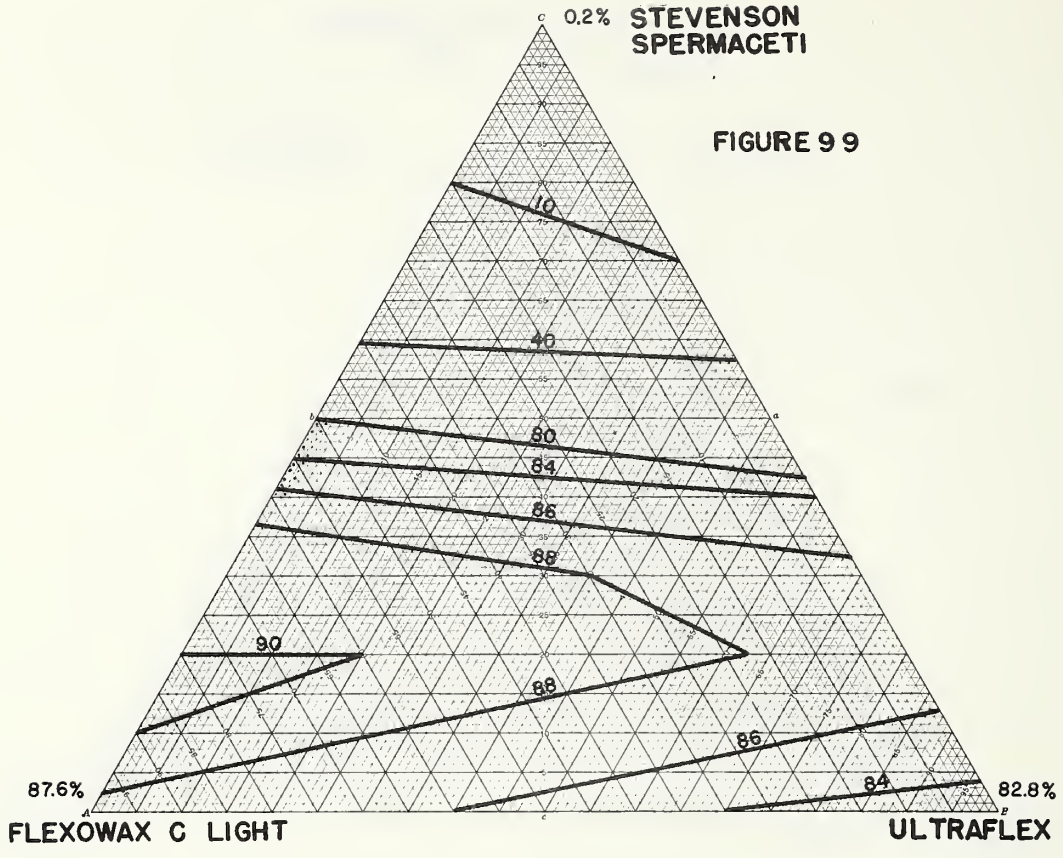

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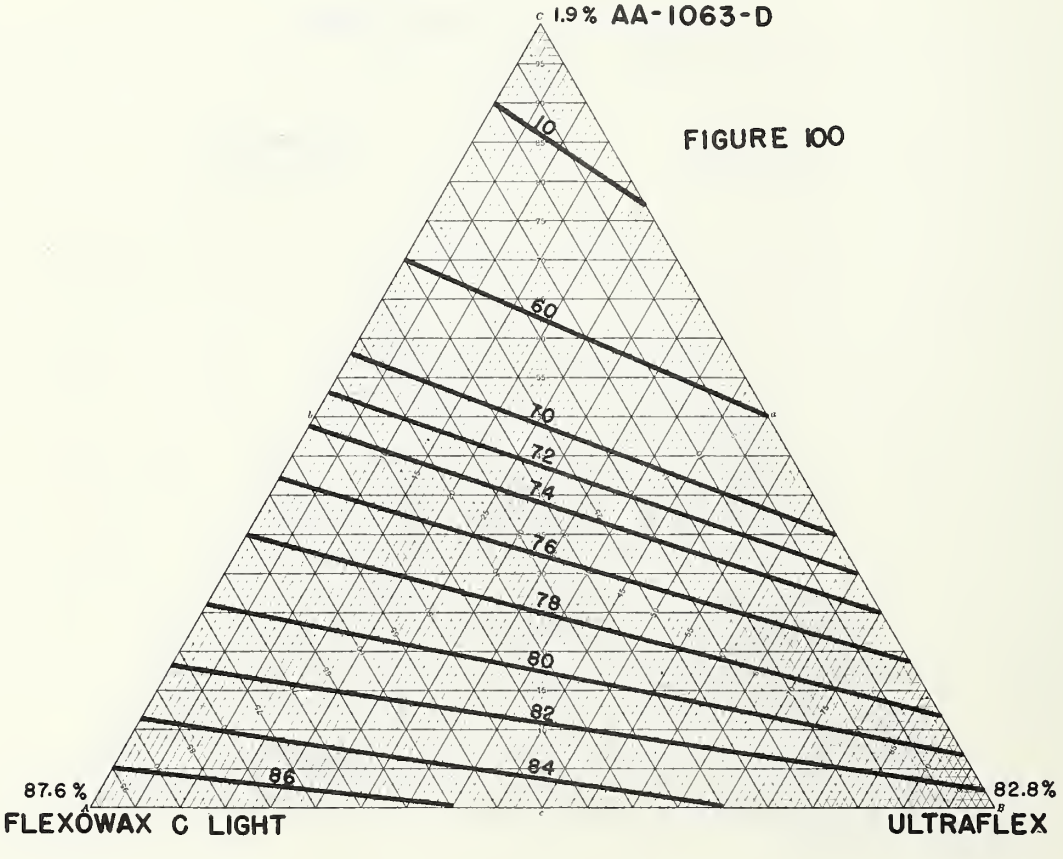

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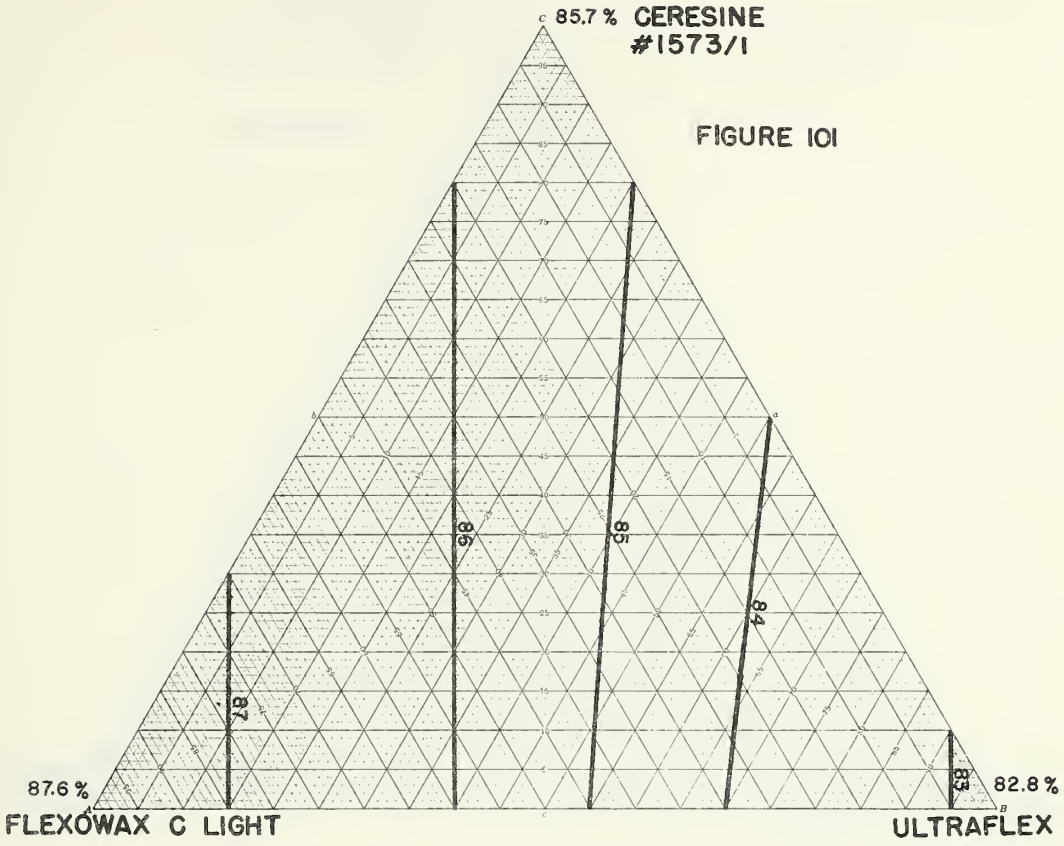

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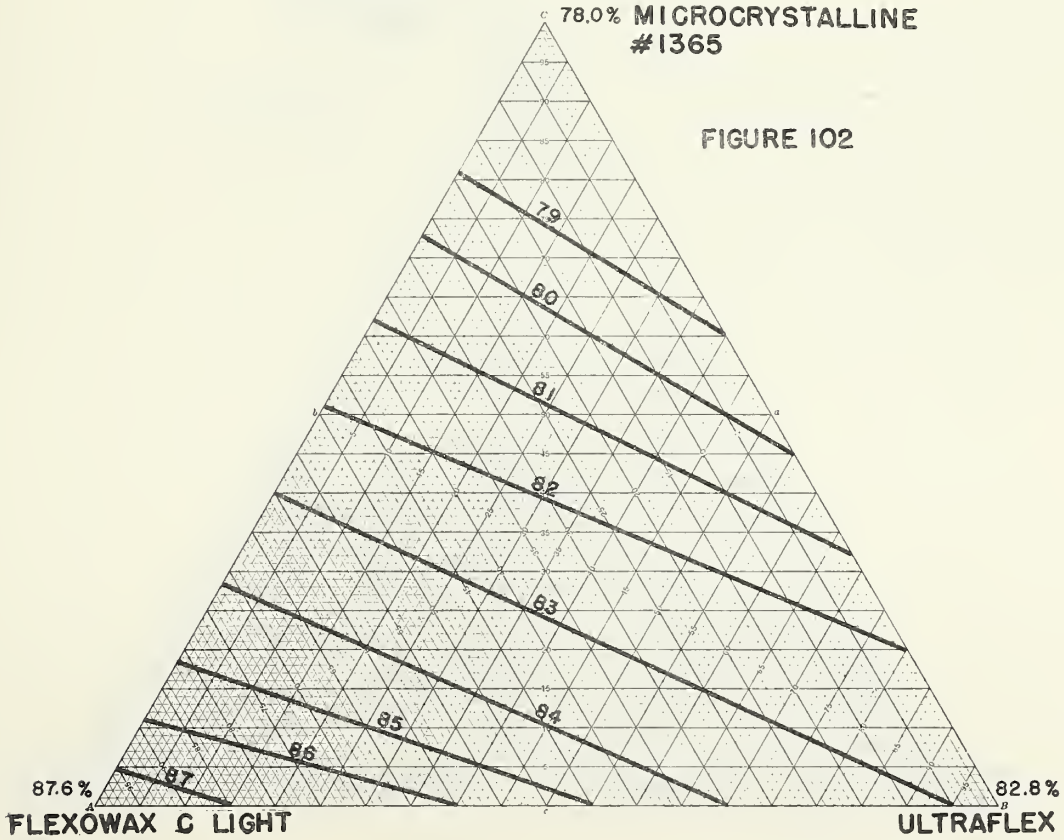

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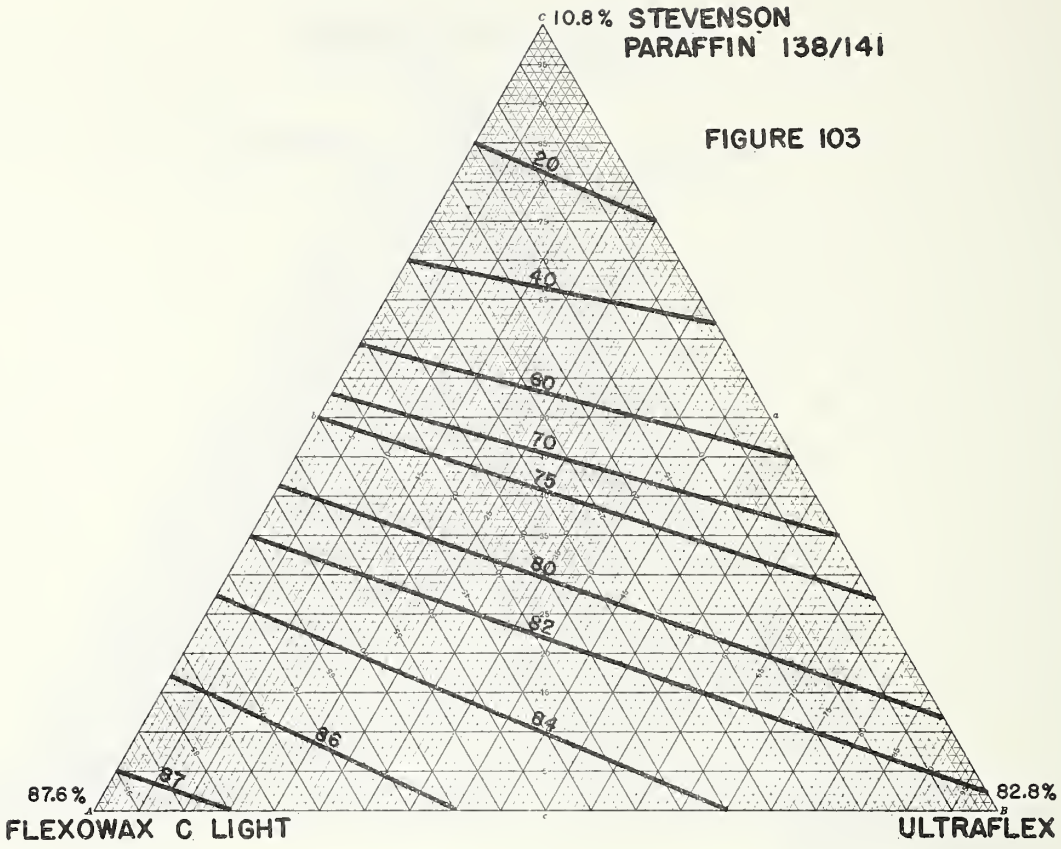

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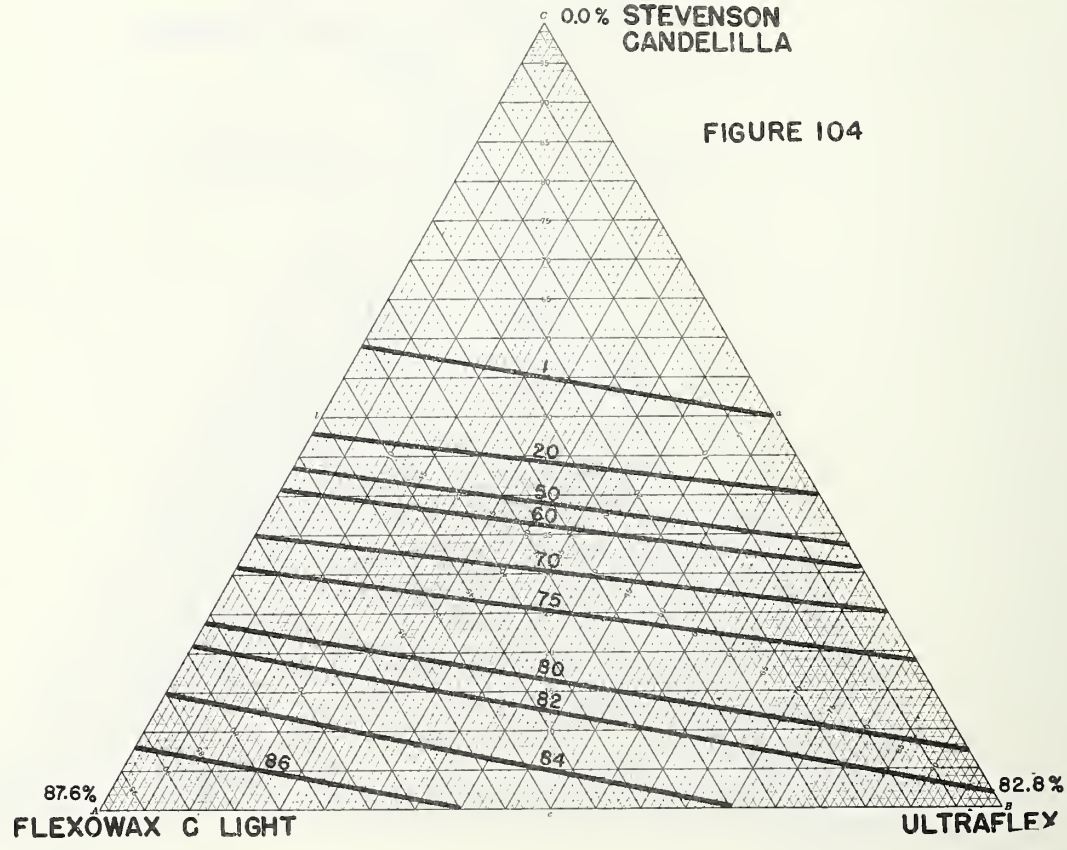

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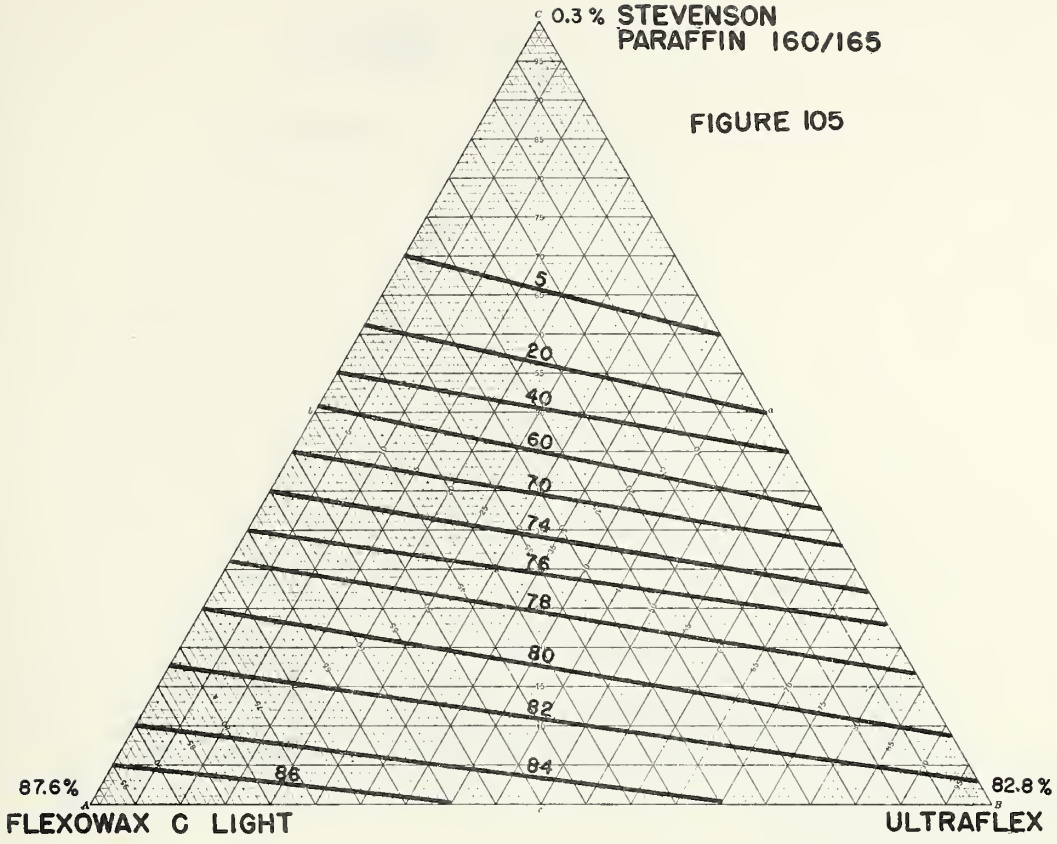

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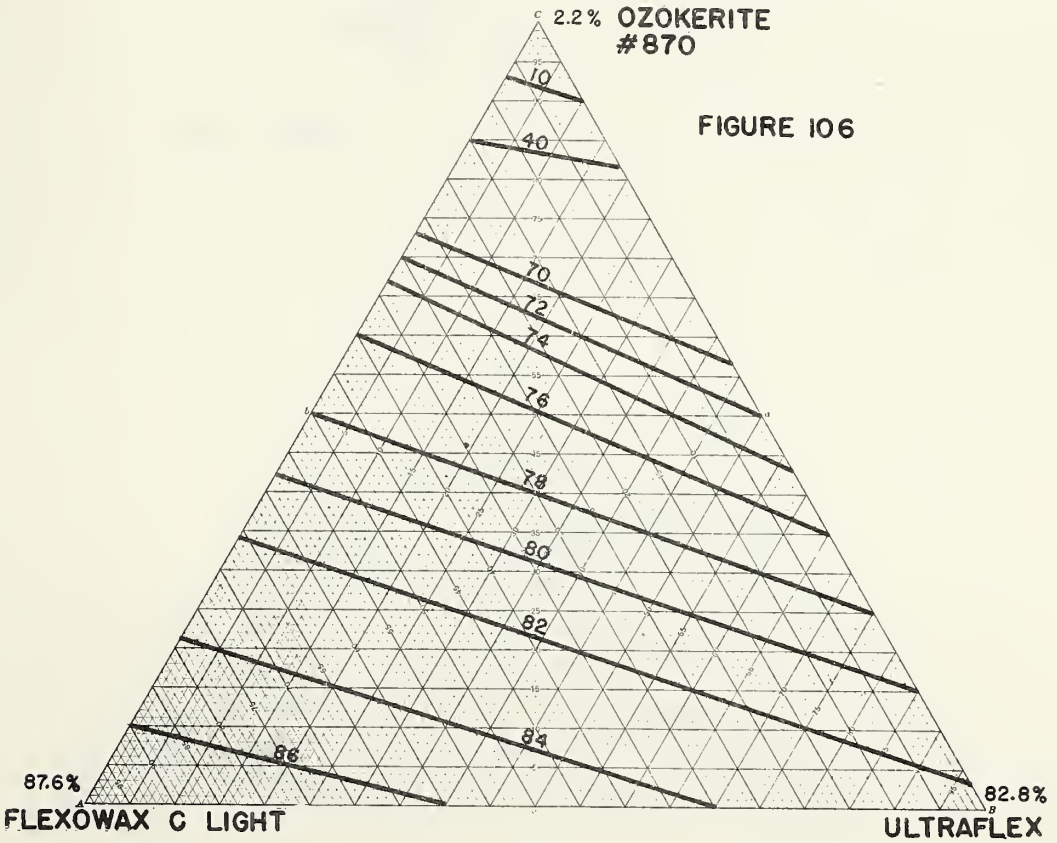

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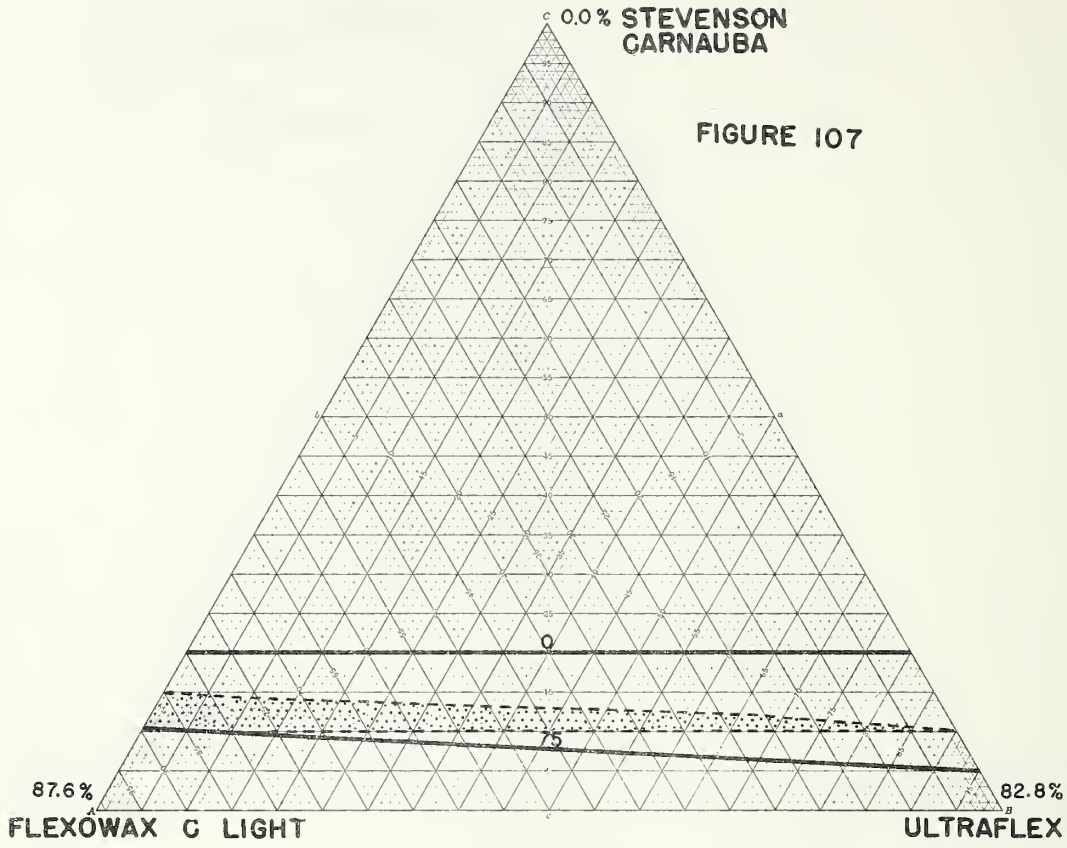

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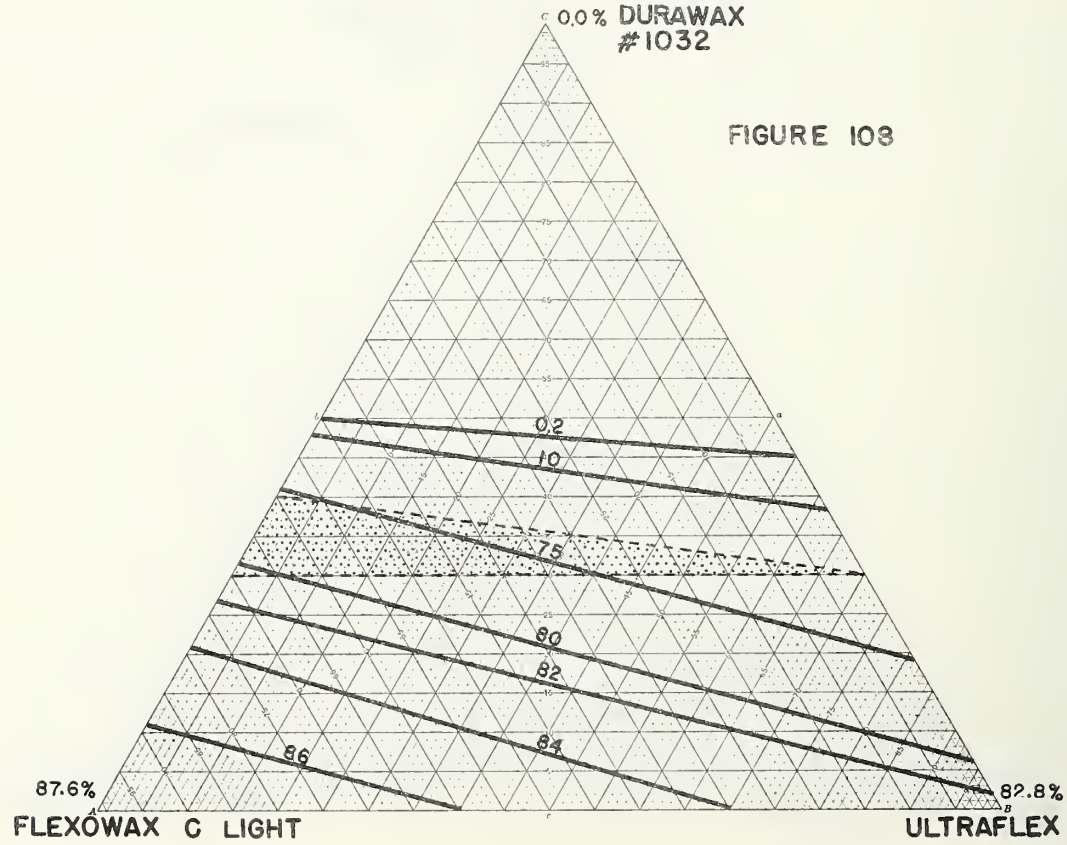

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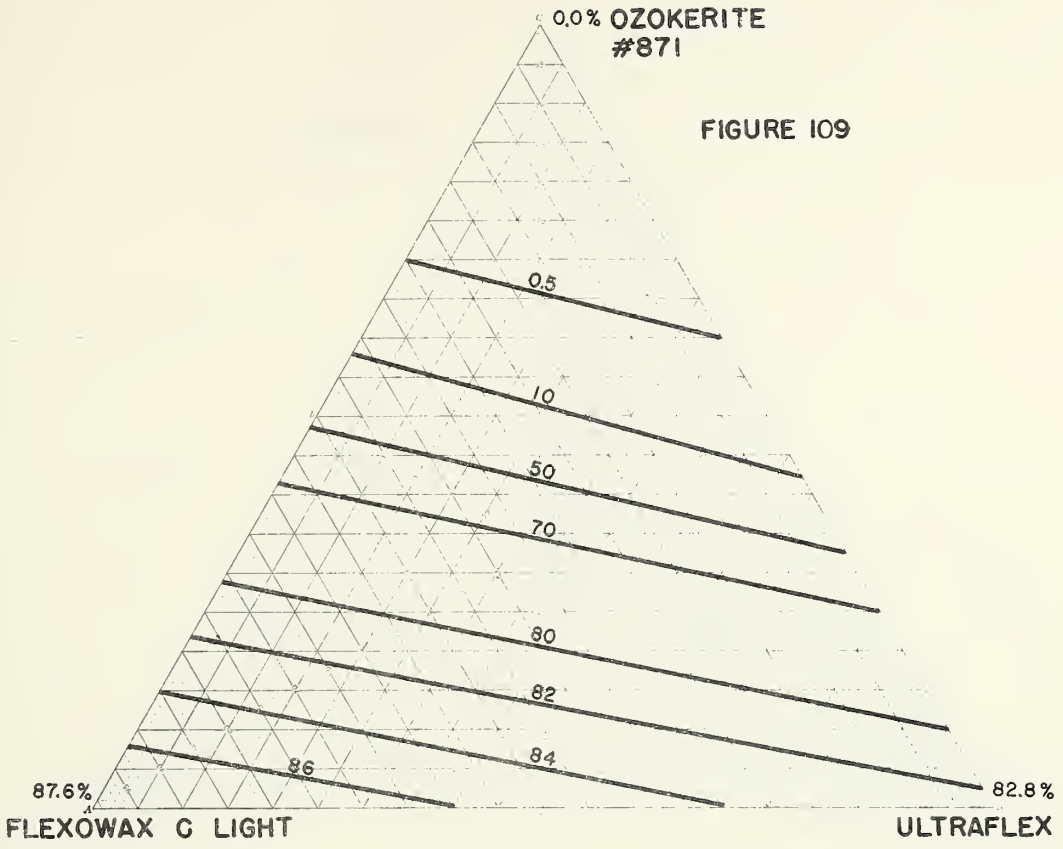

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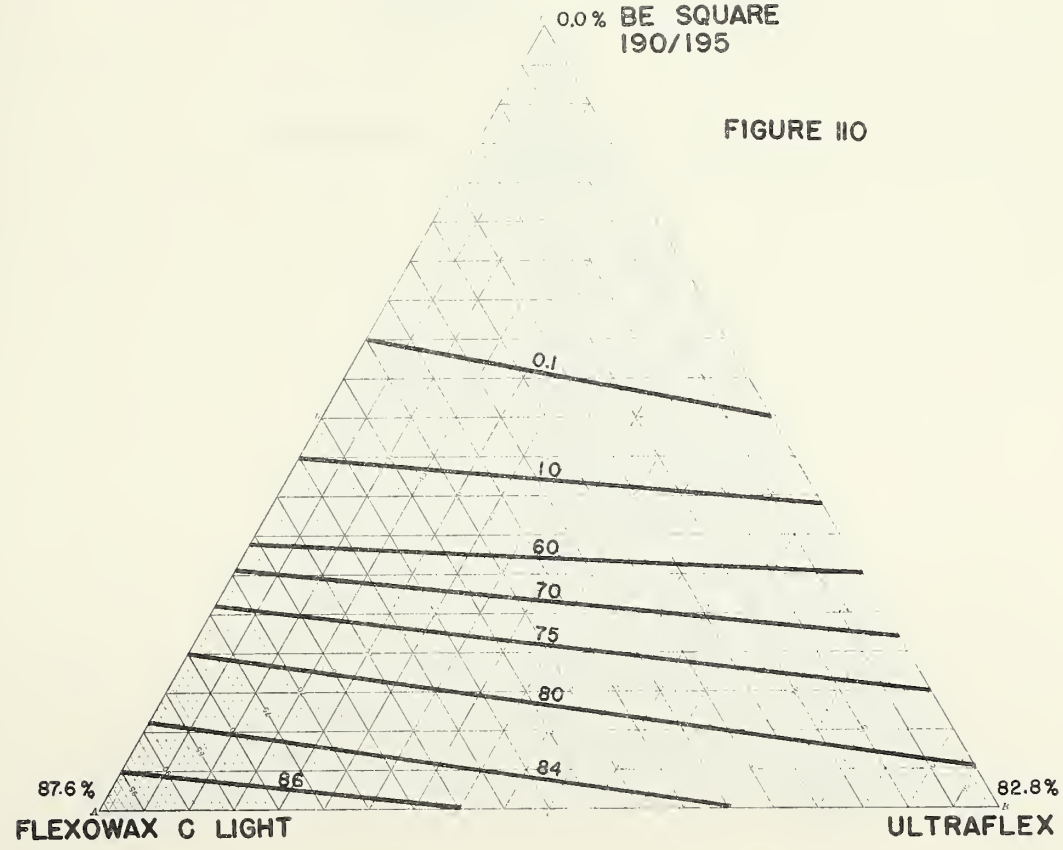

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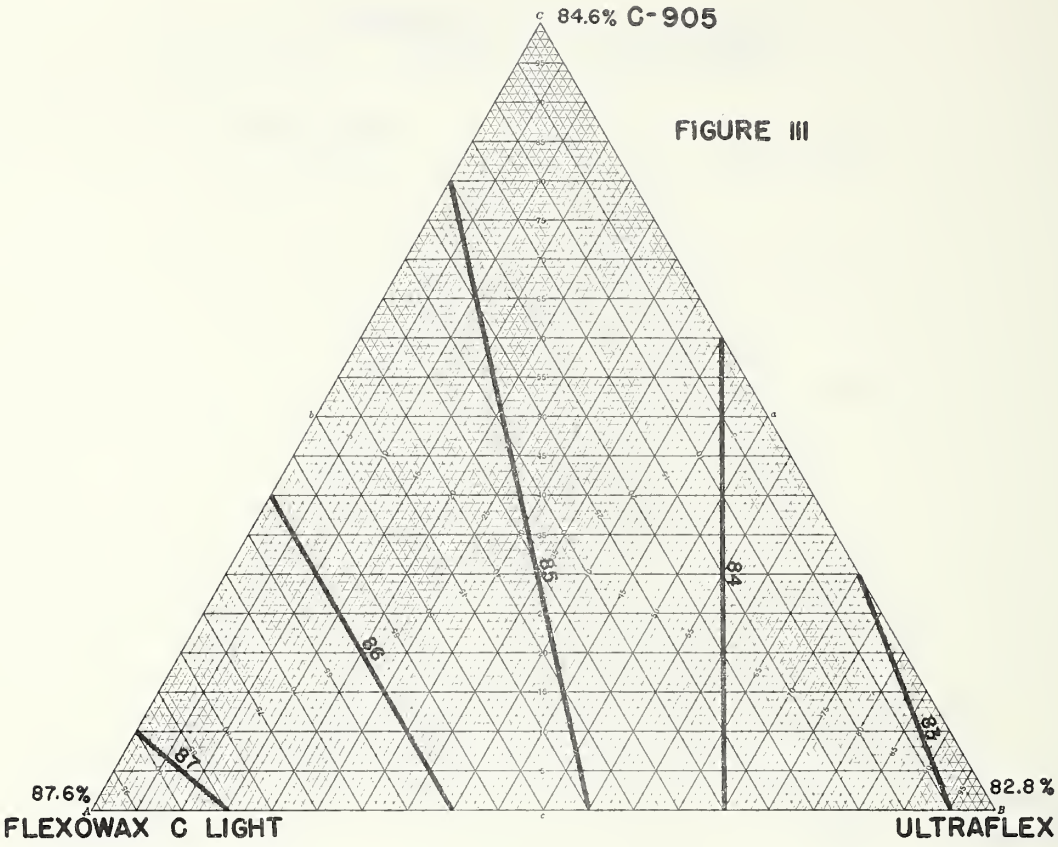

FIGURE III

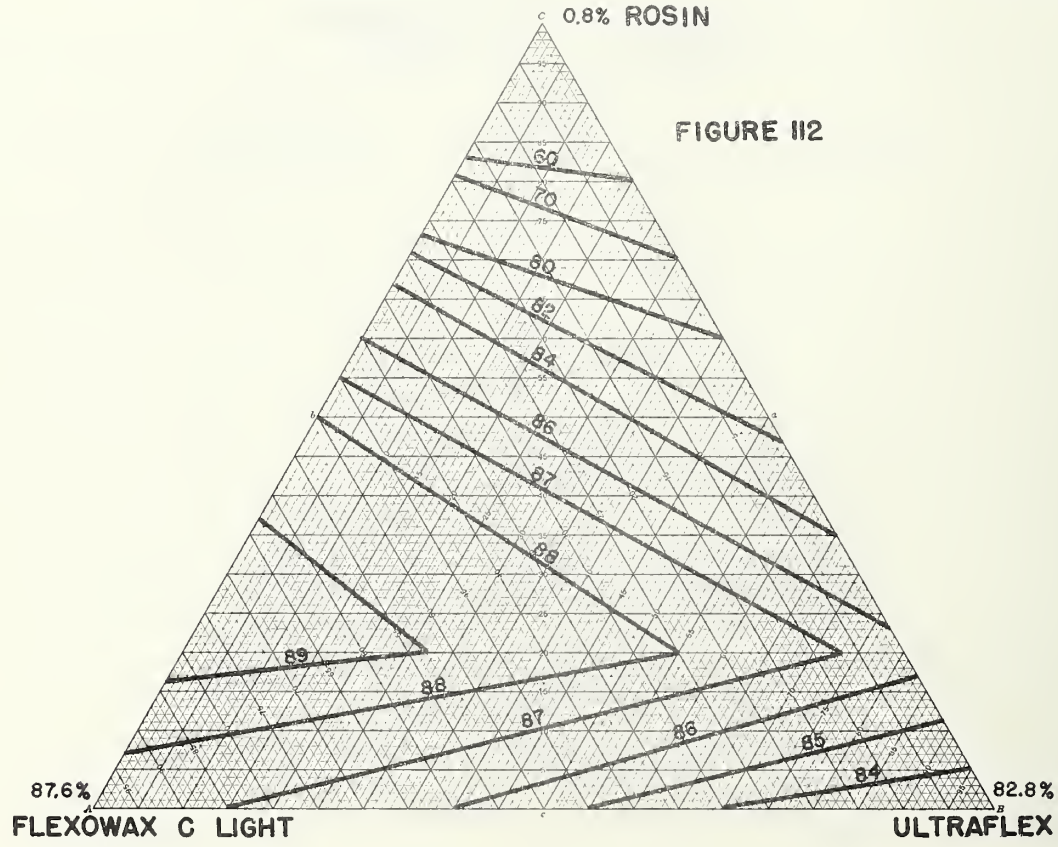

FIGURE 112

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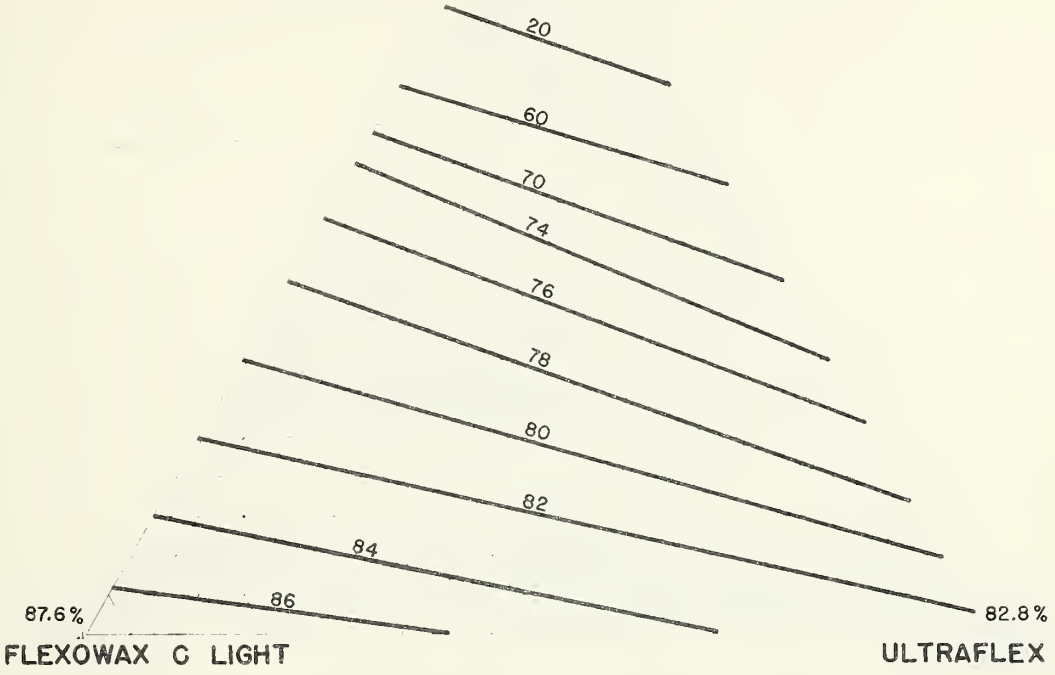
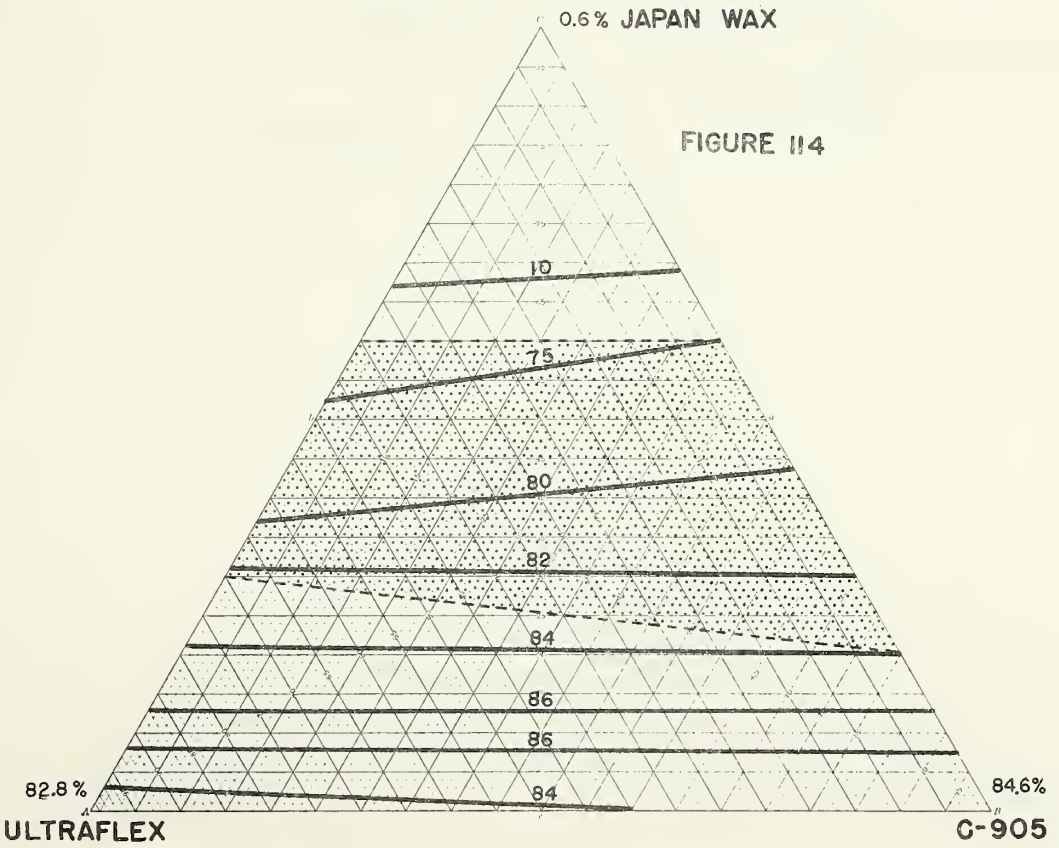
FIGURE 113





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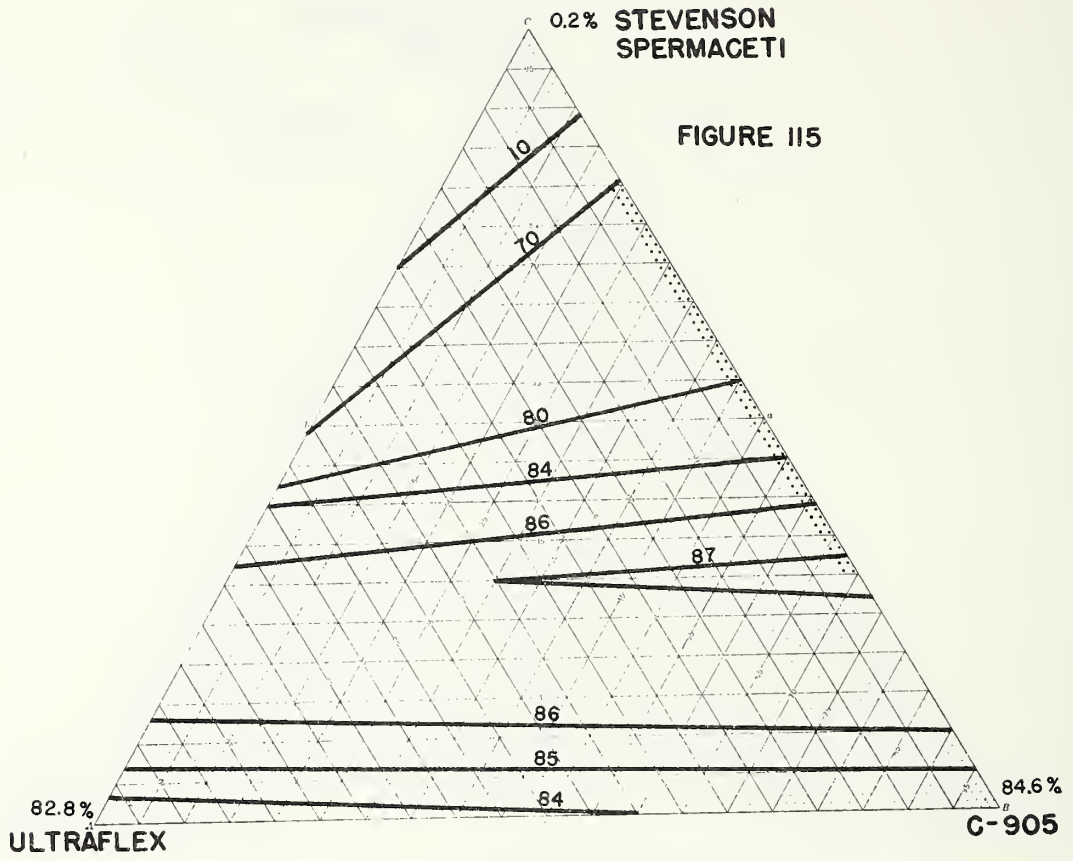

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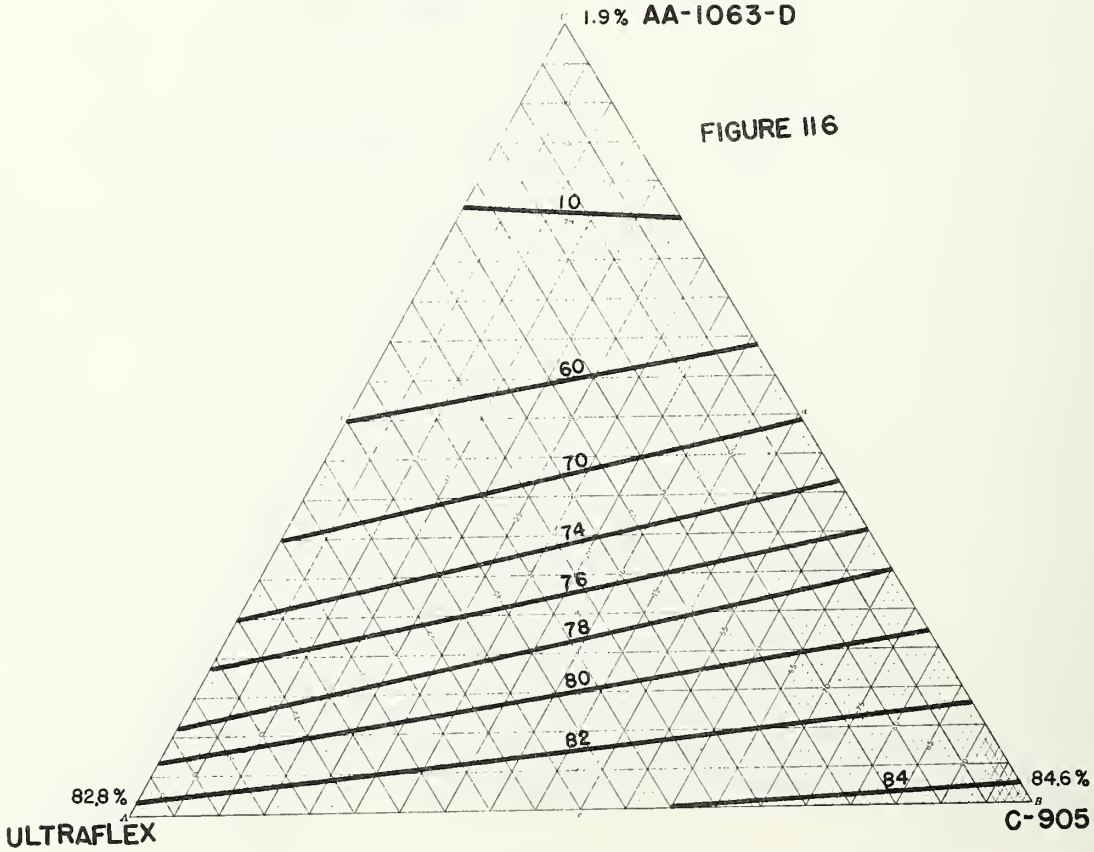

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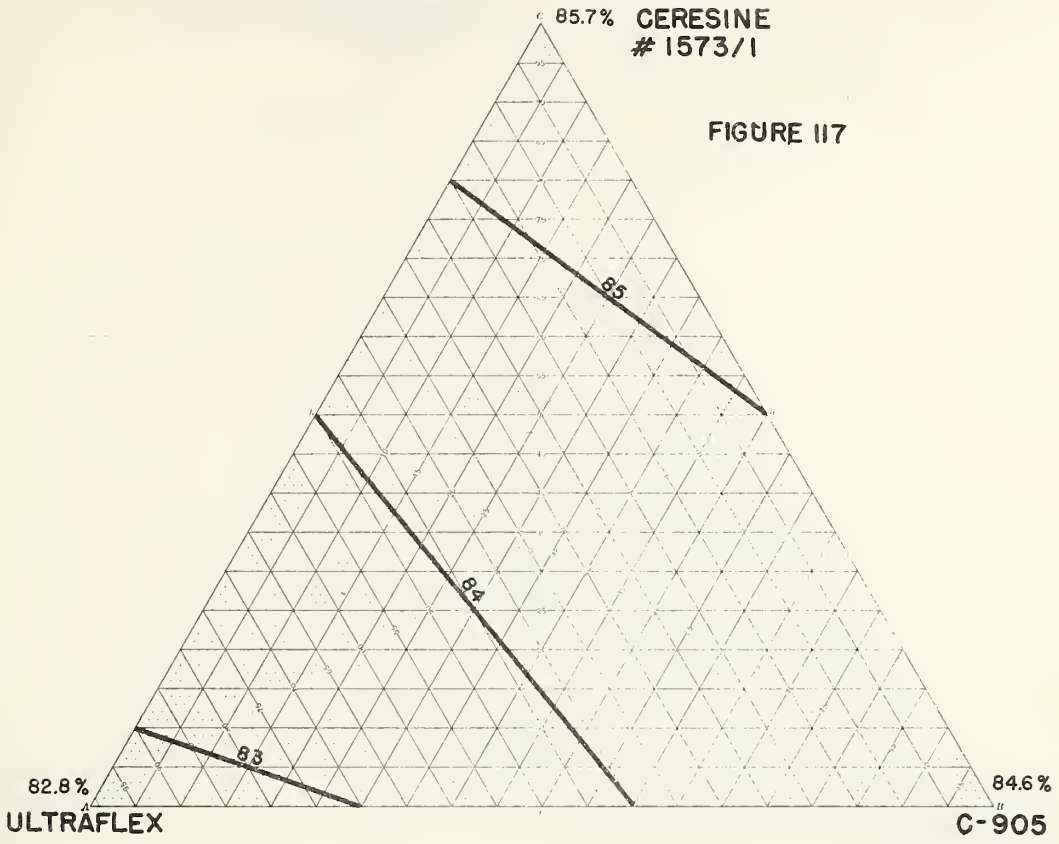

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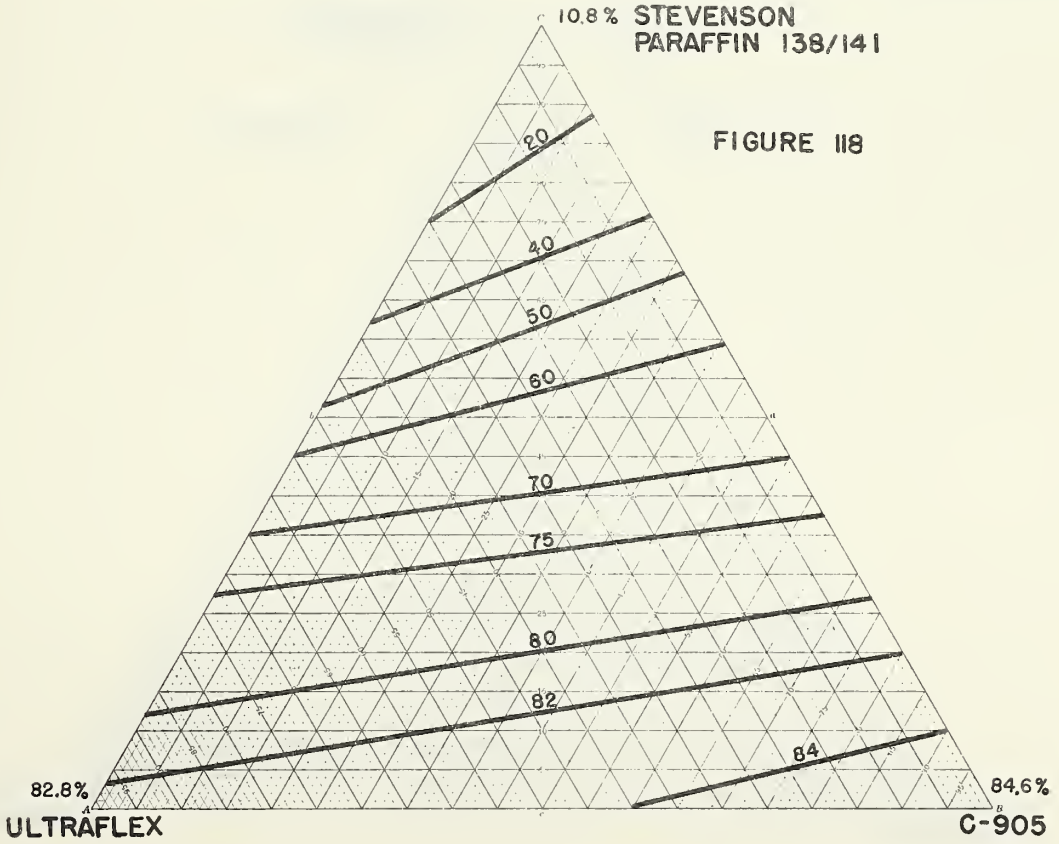

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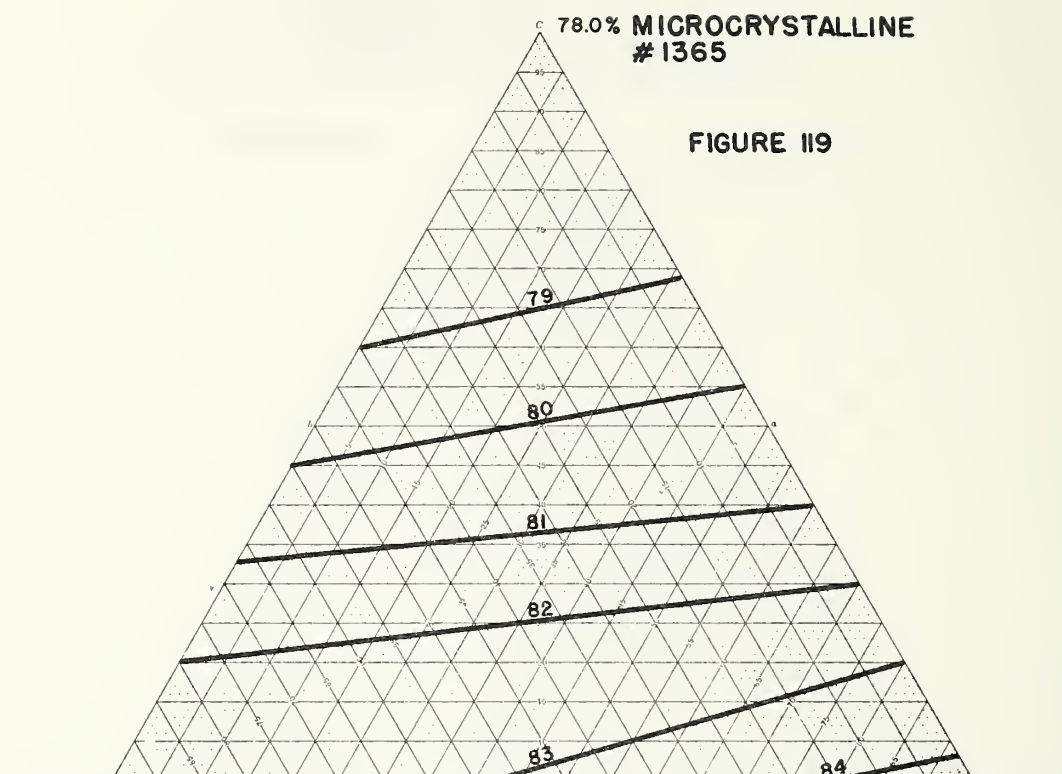

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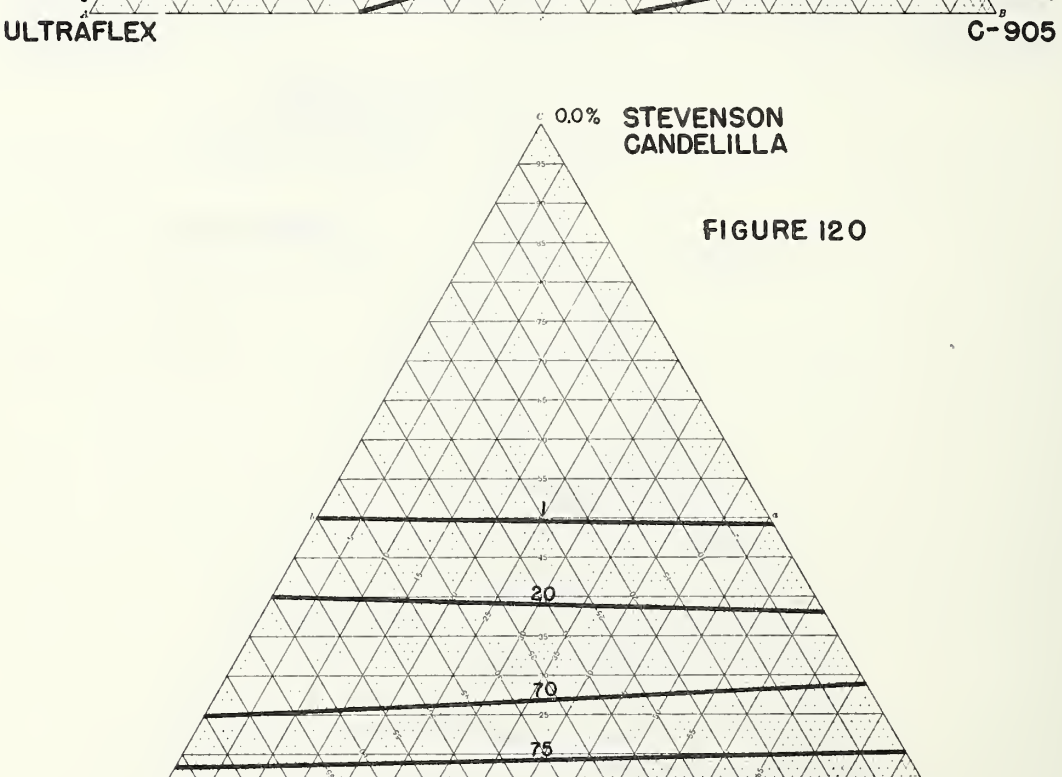

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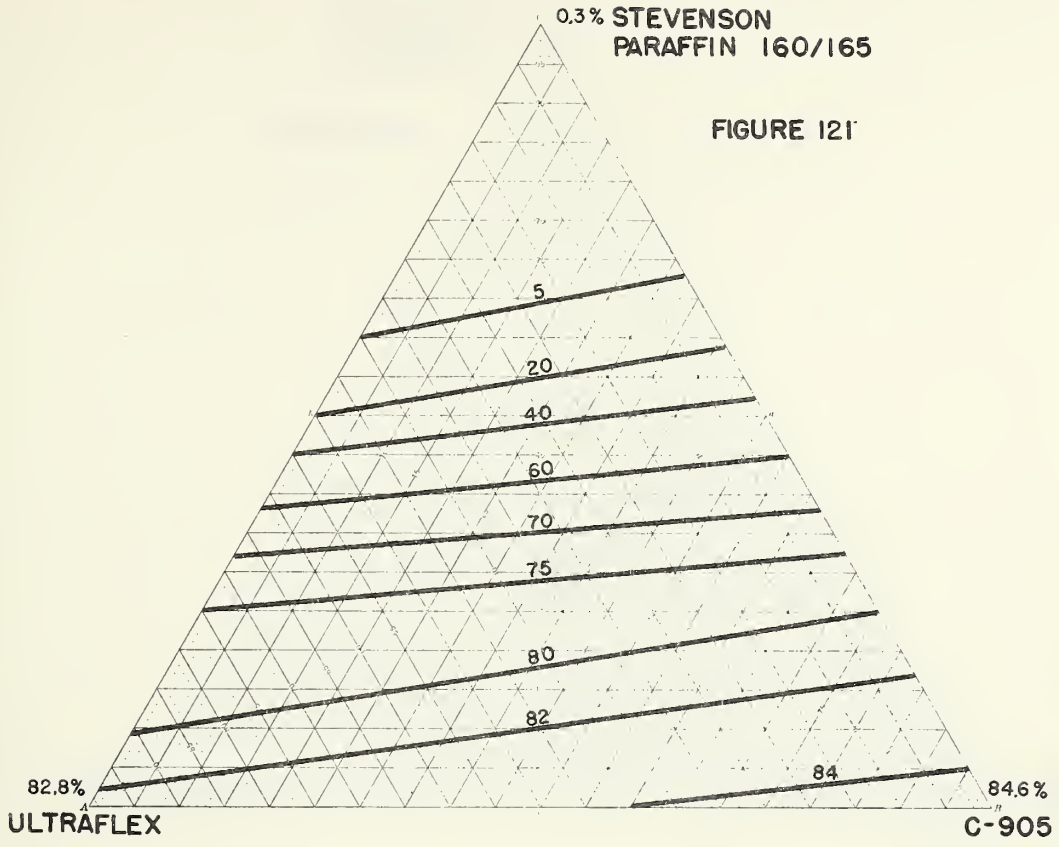

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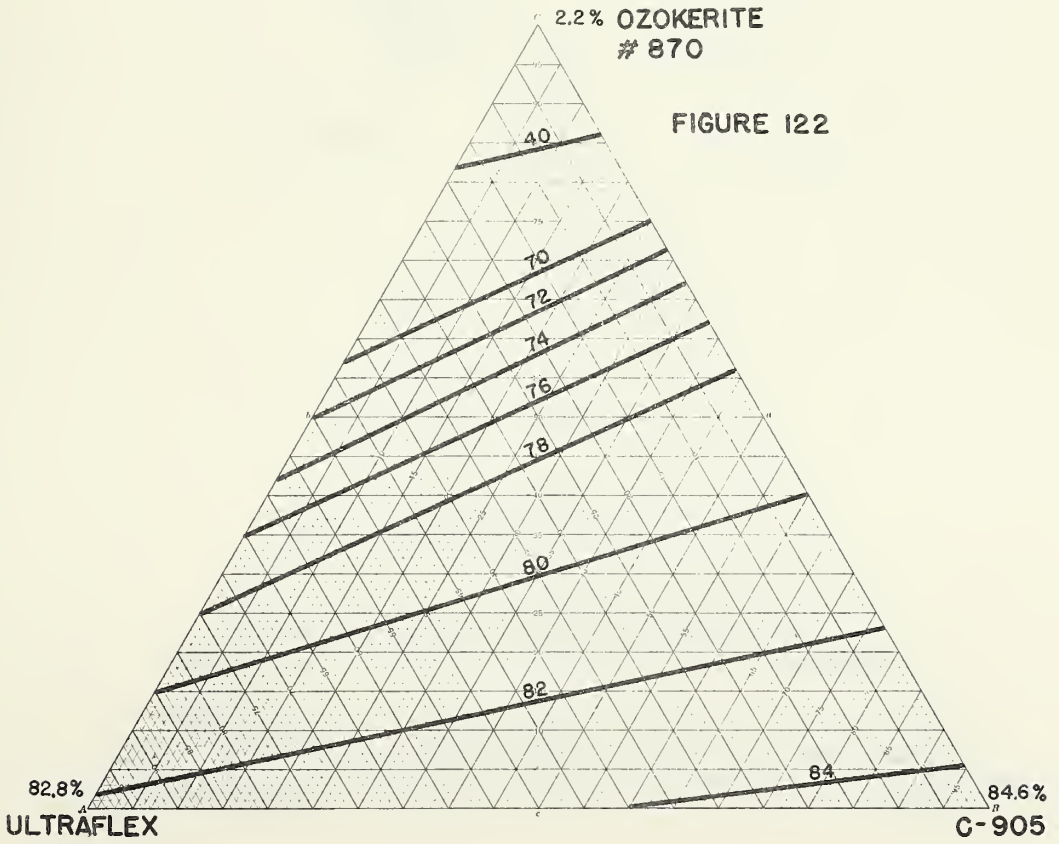

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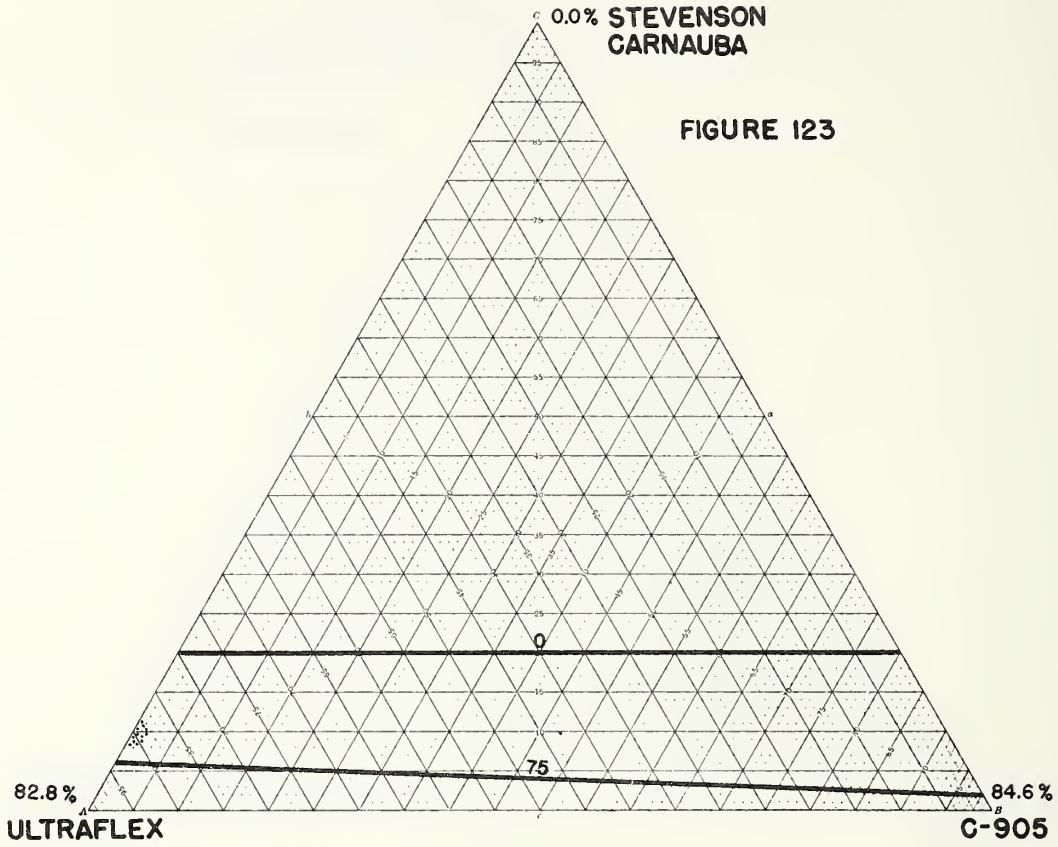

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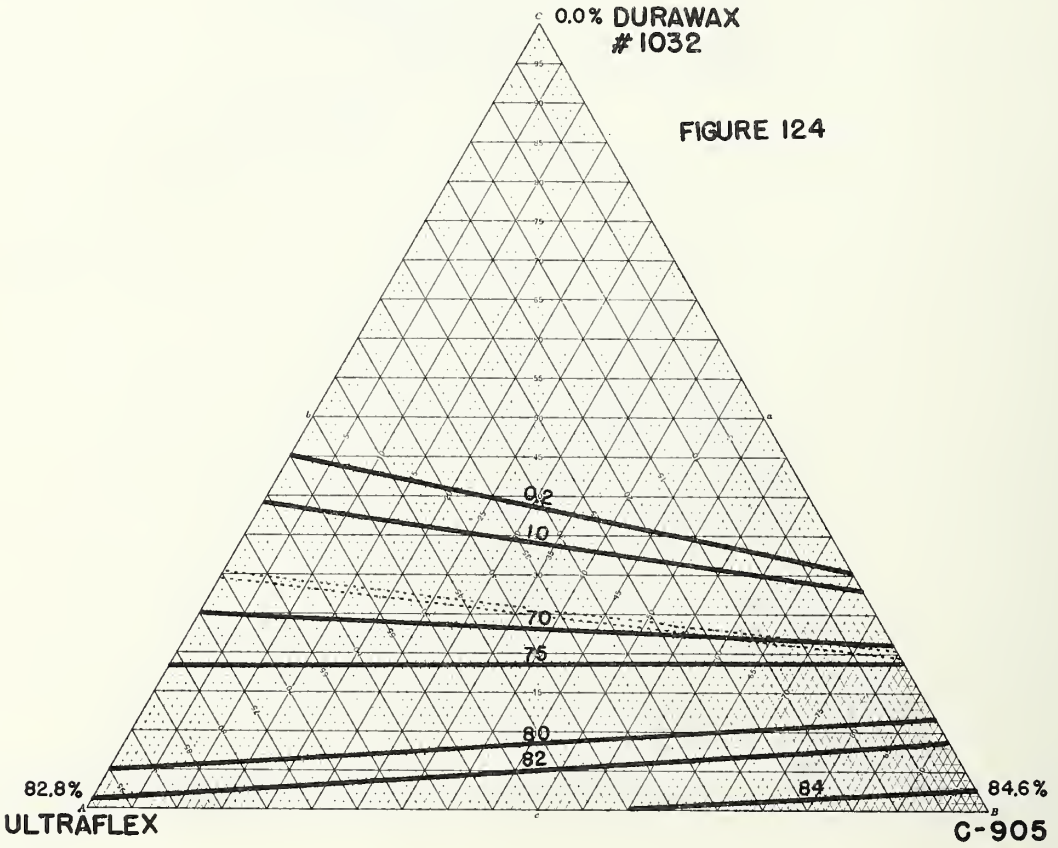

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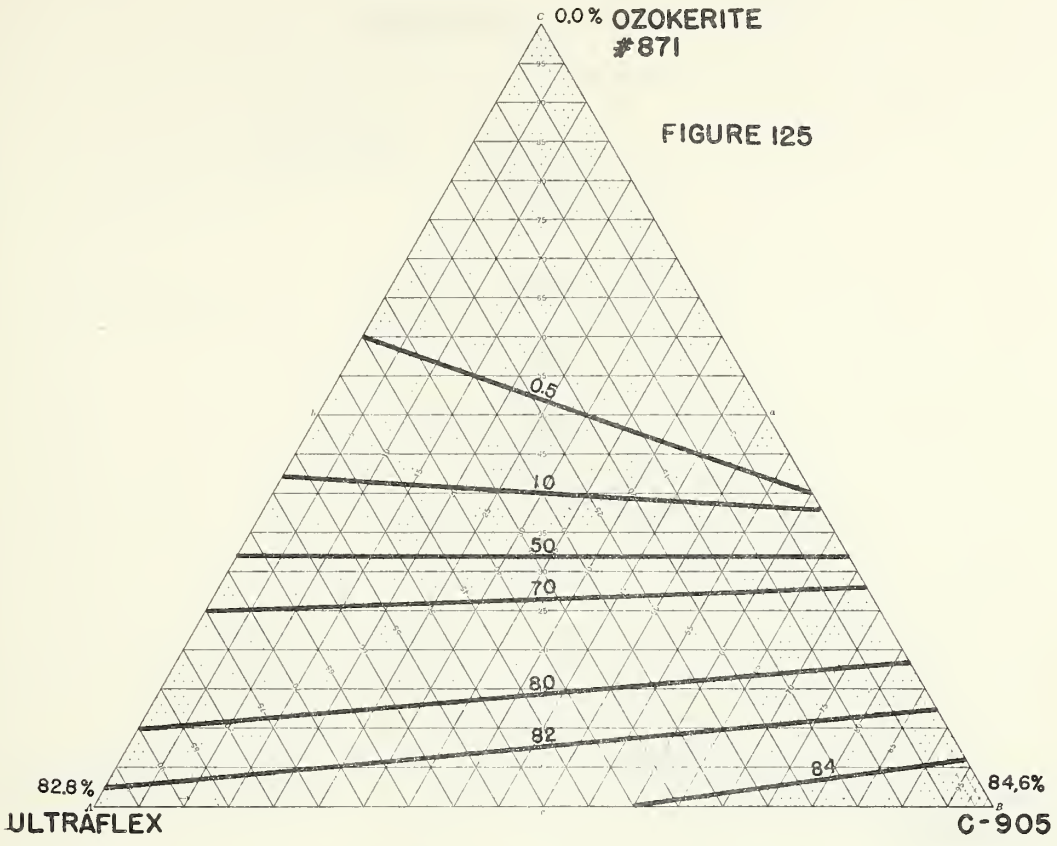

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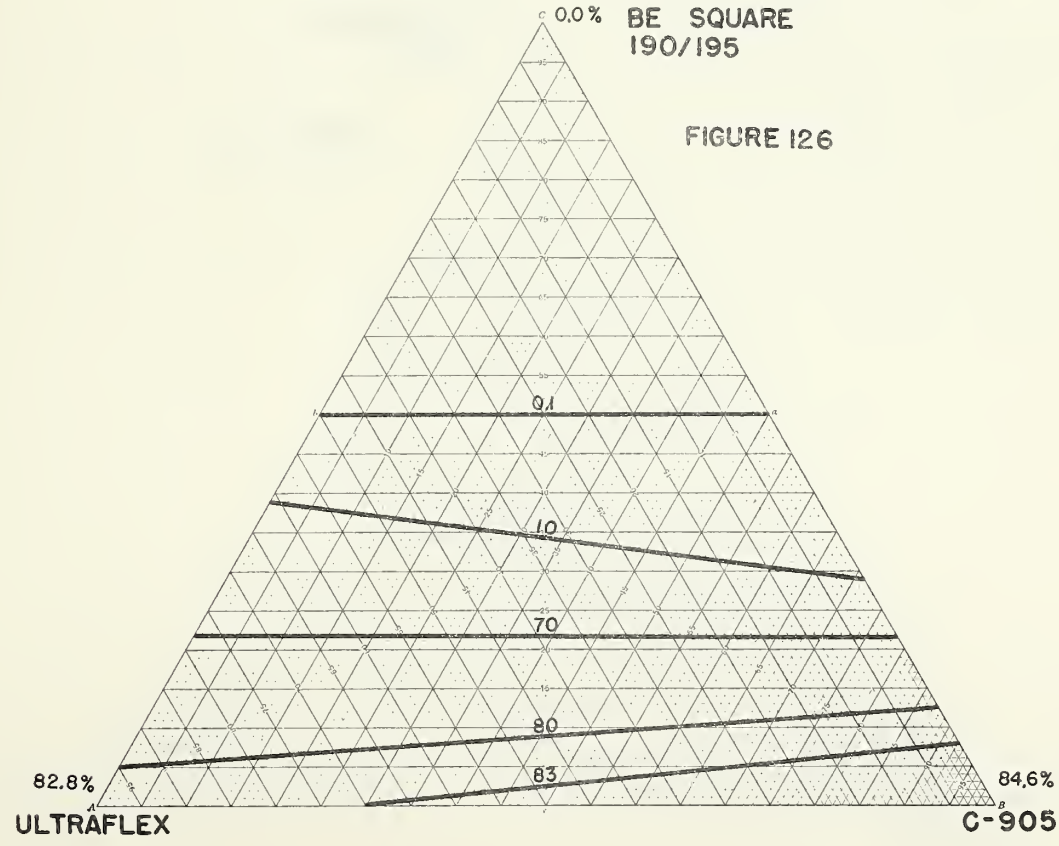

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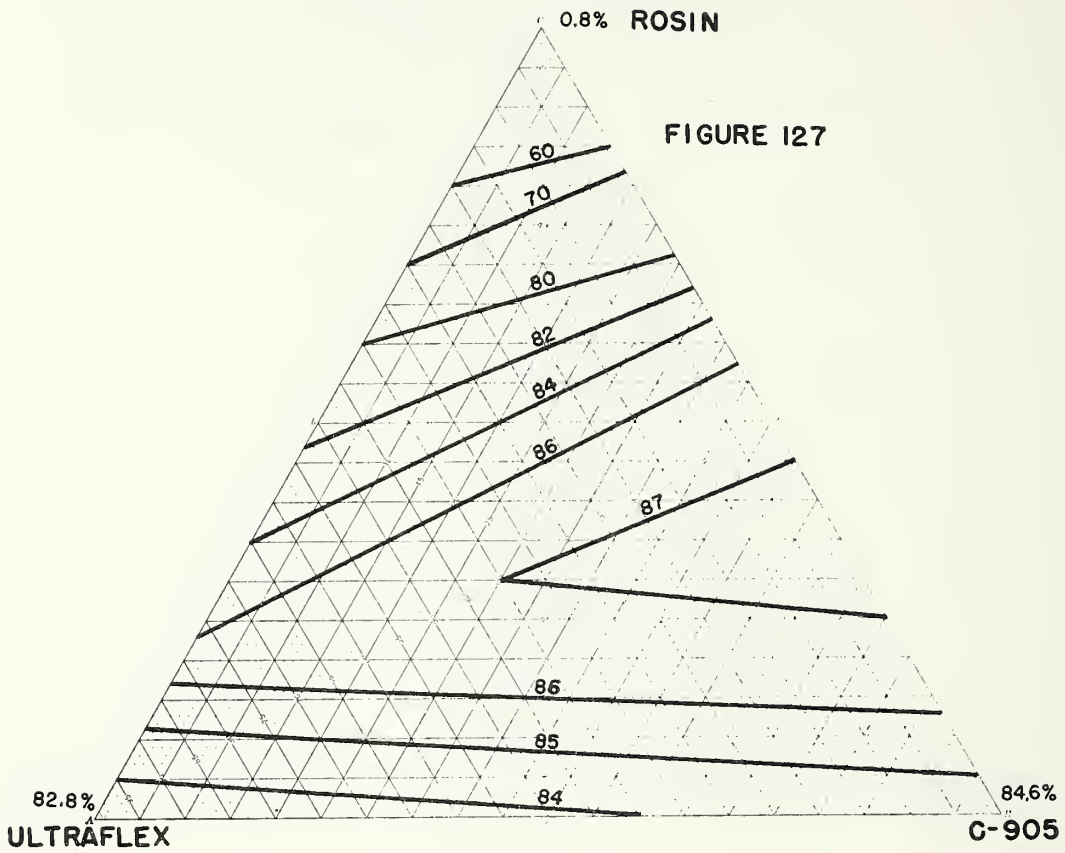

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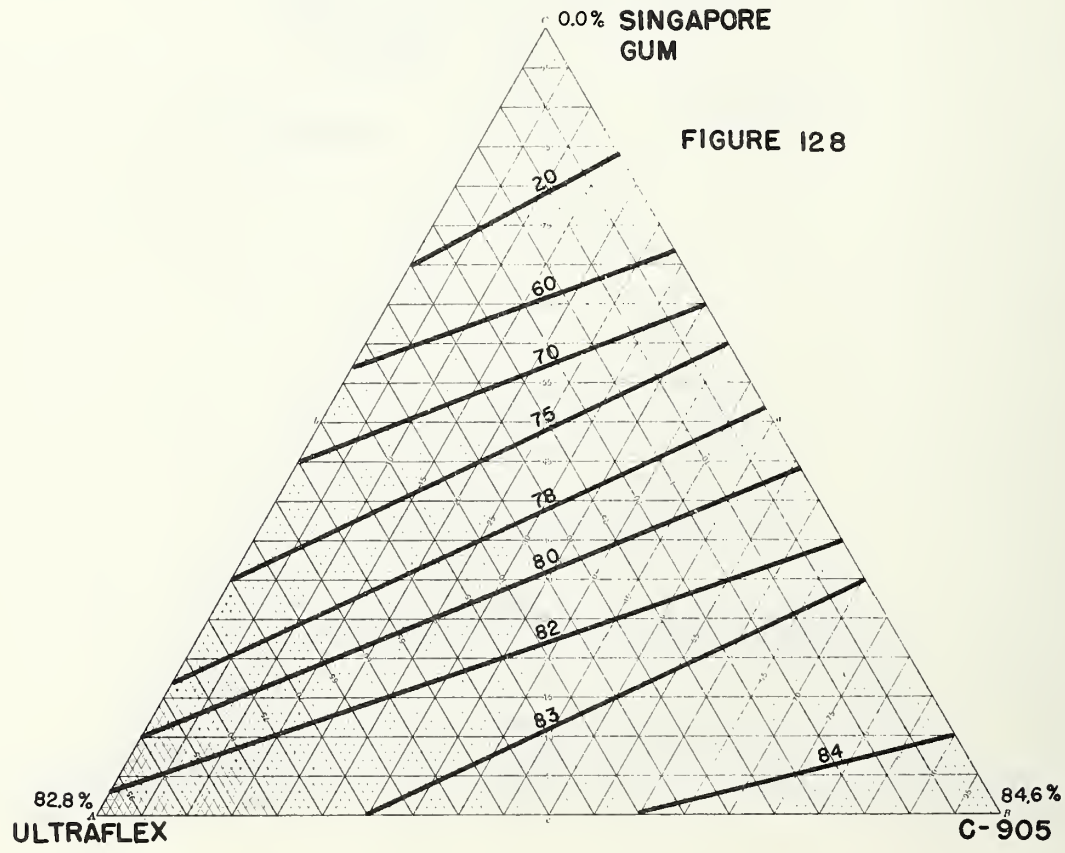

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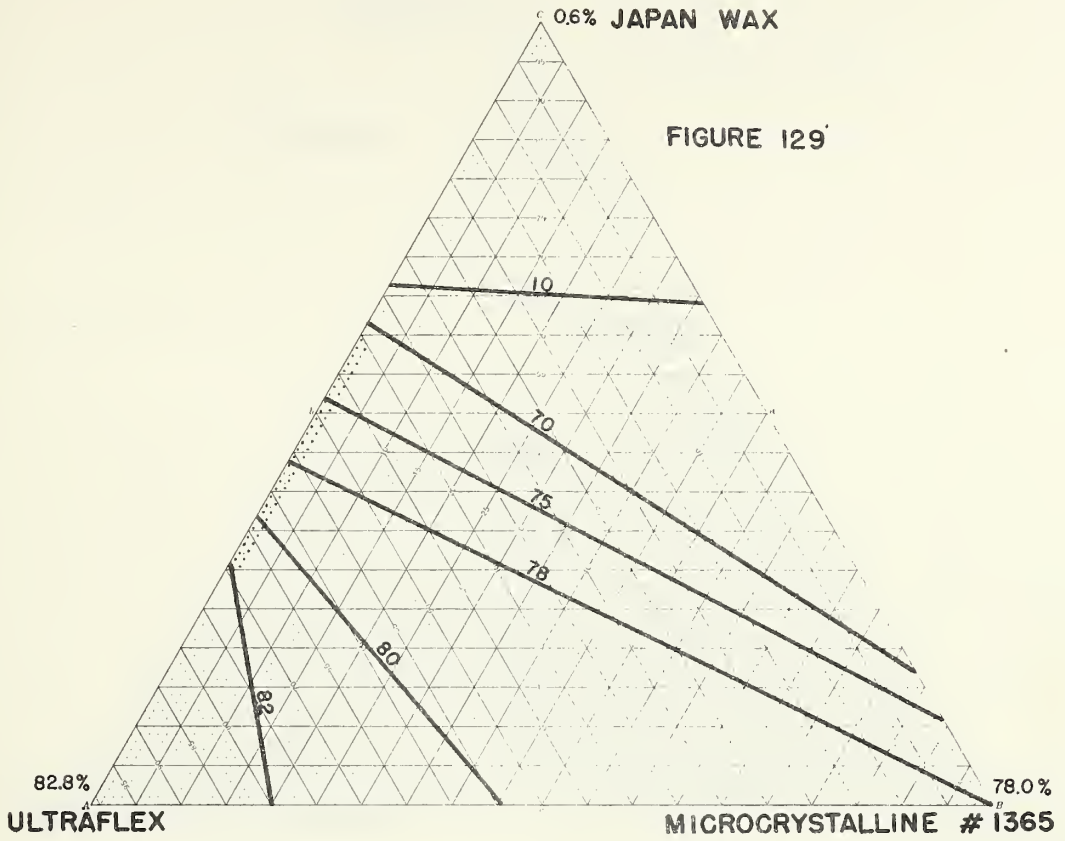

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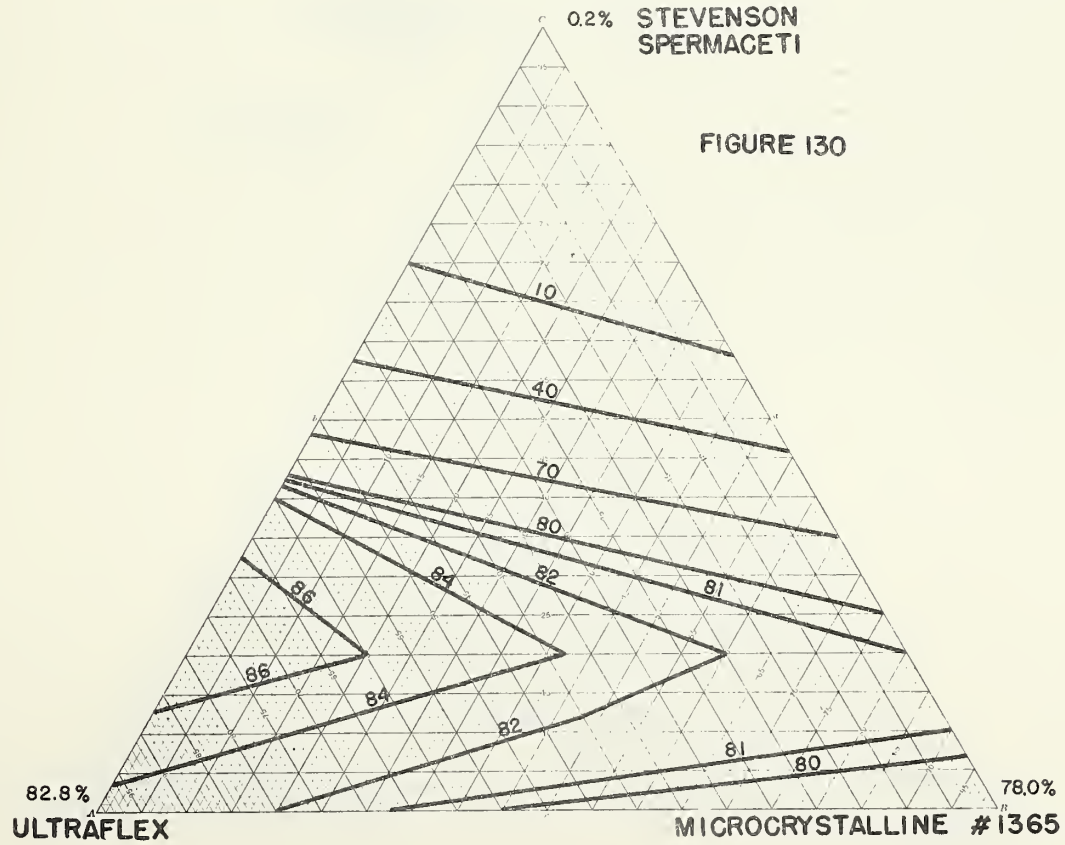

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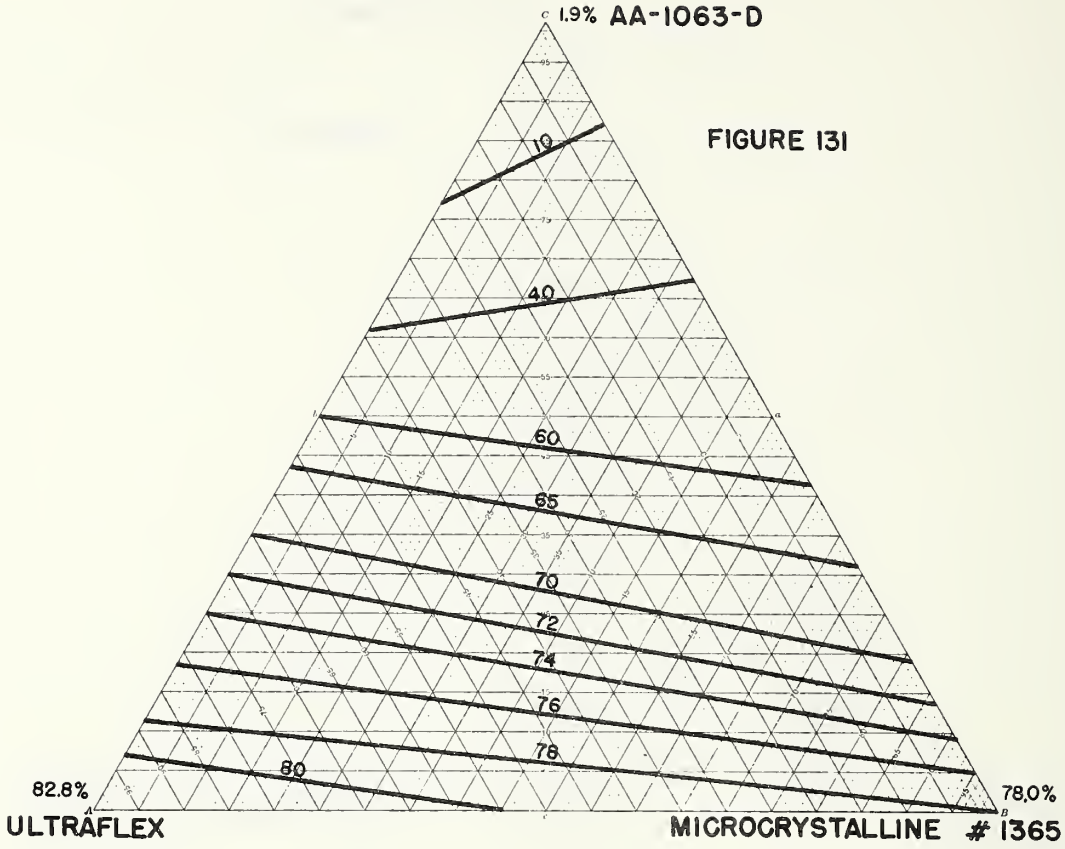

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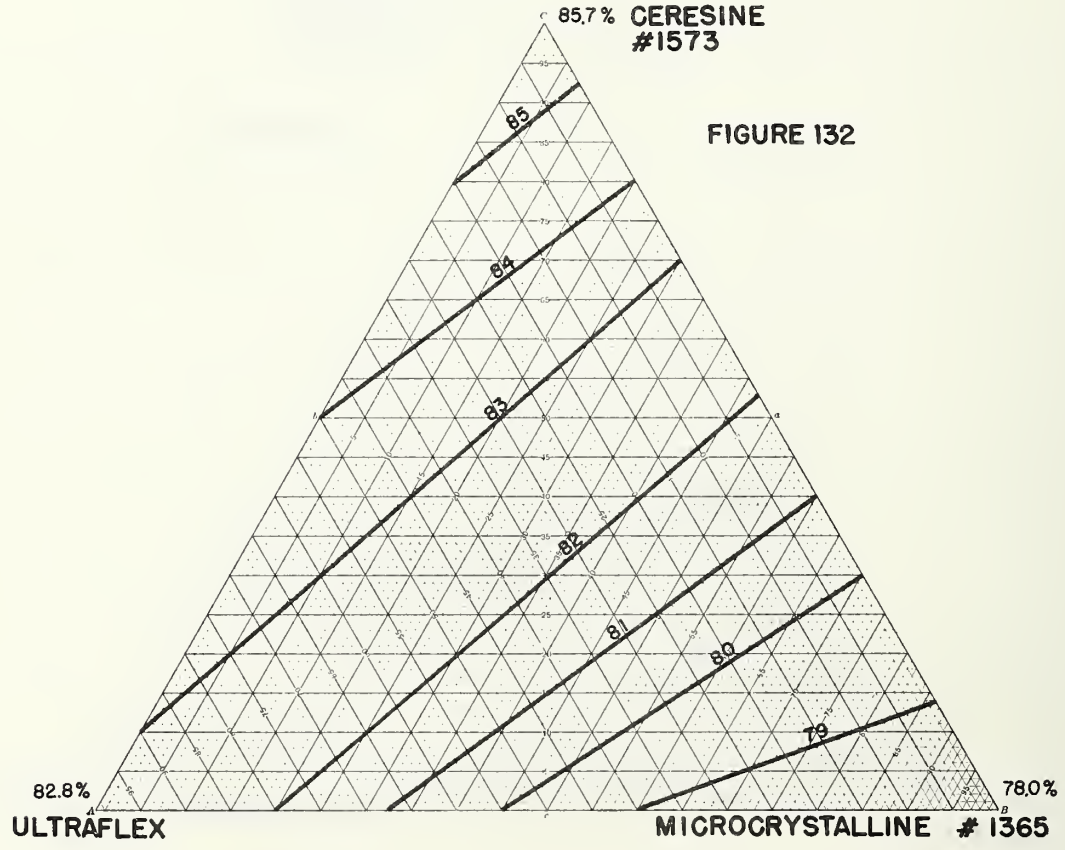

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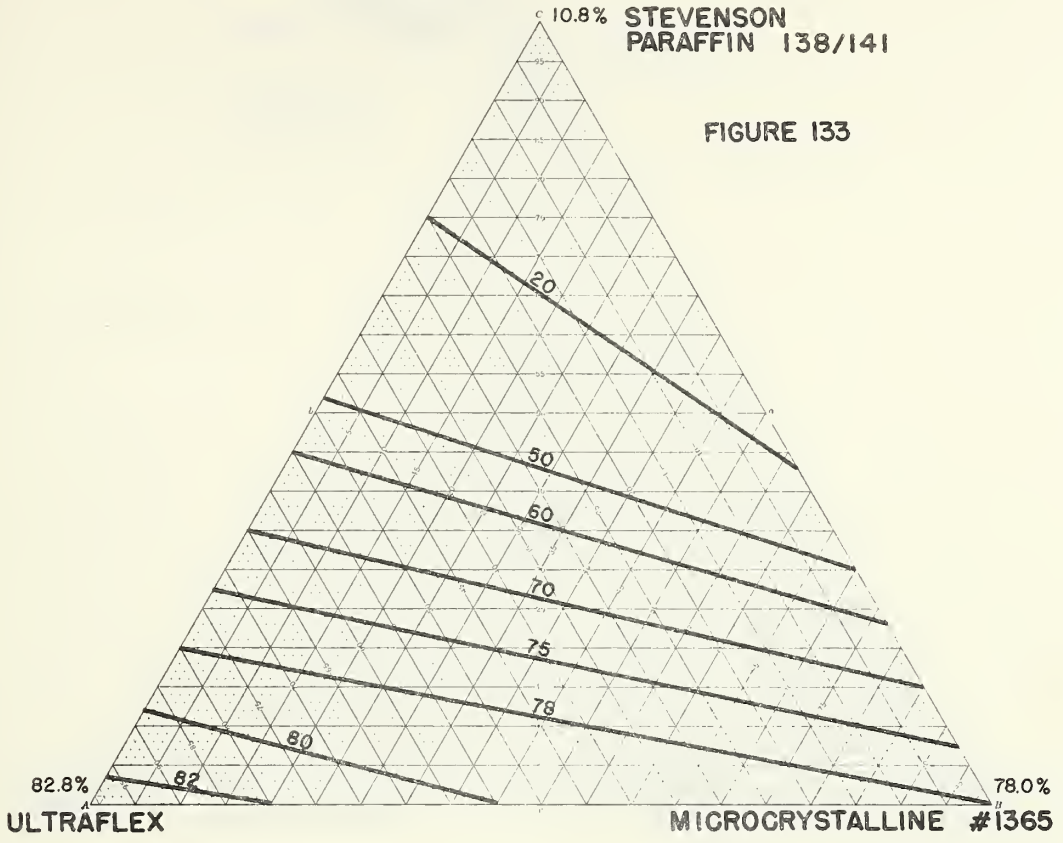

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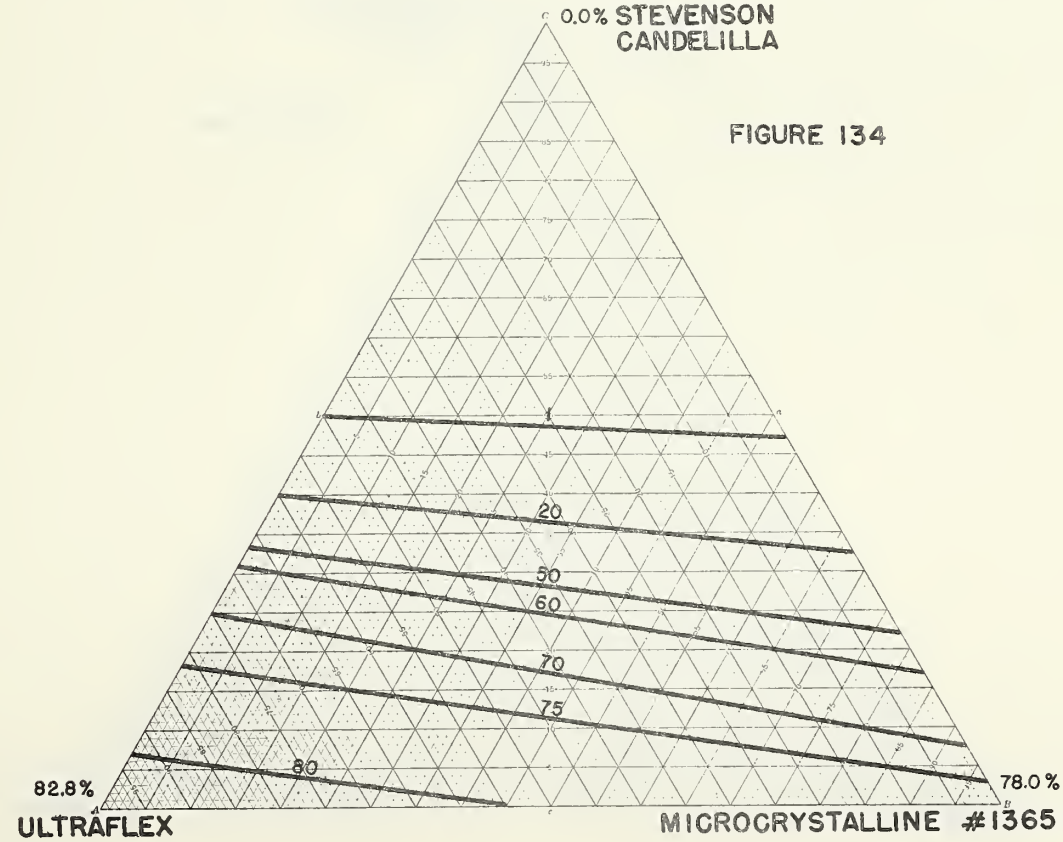

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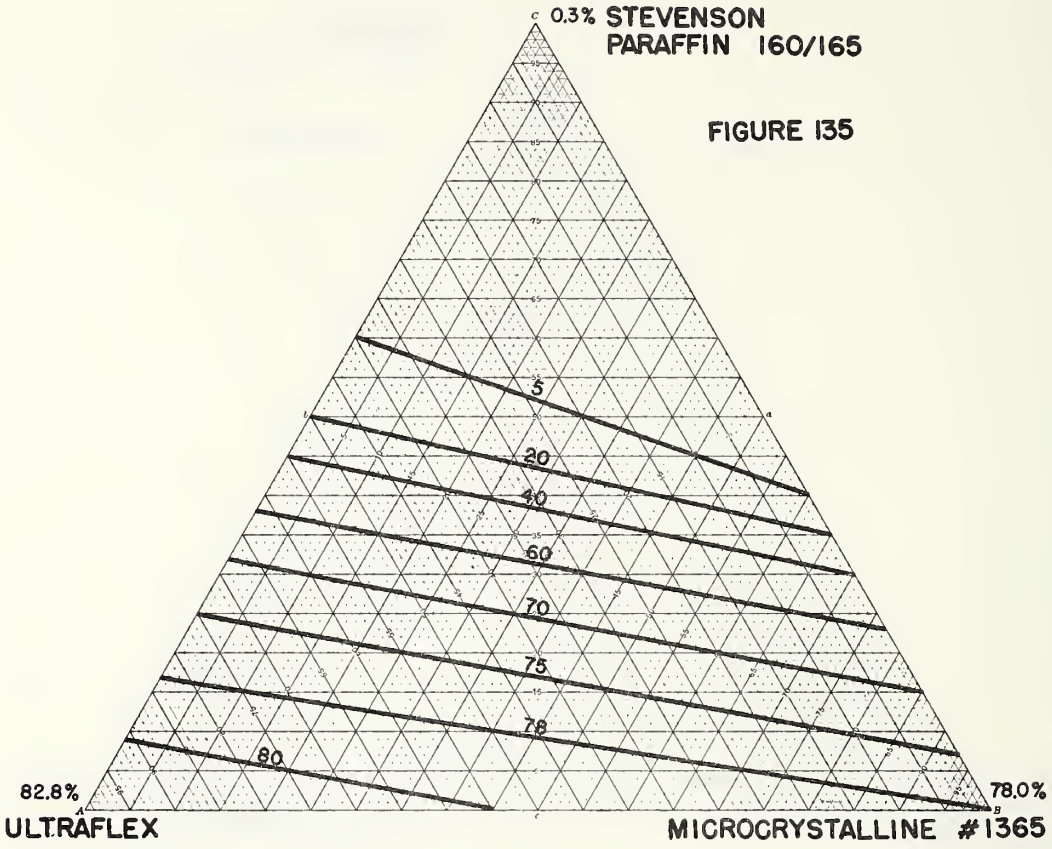

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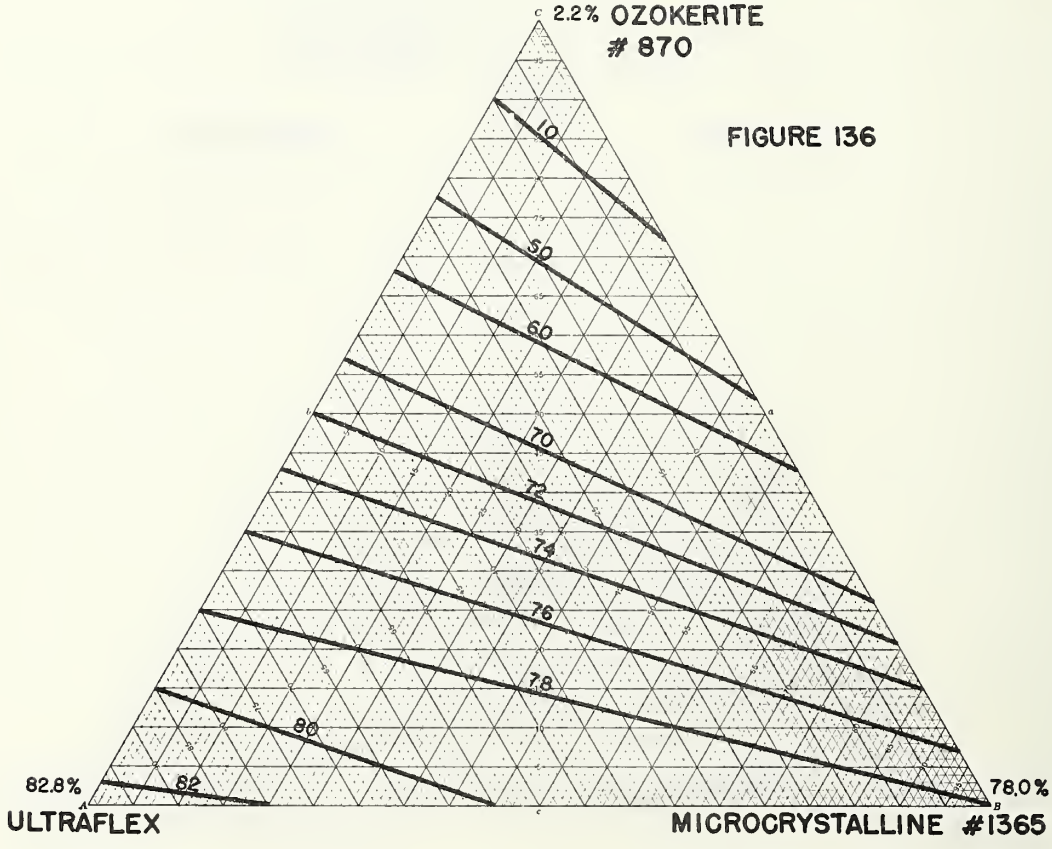

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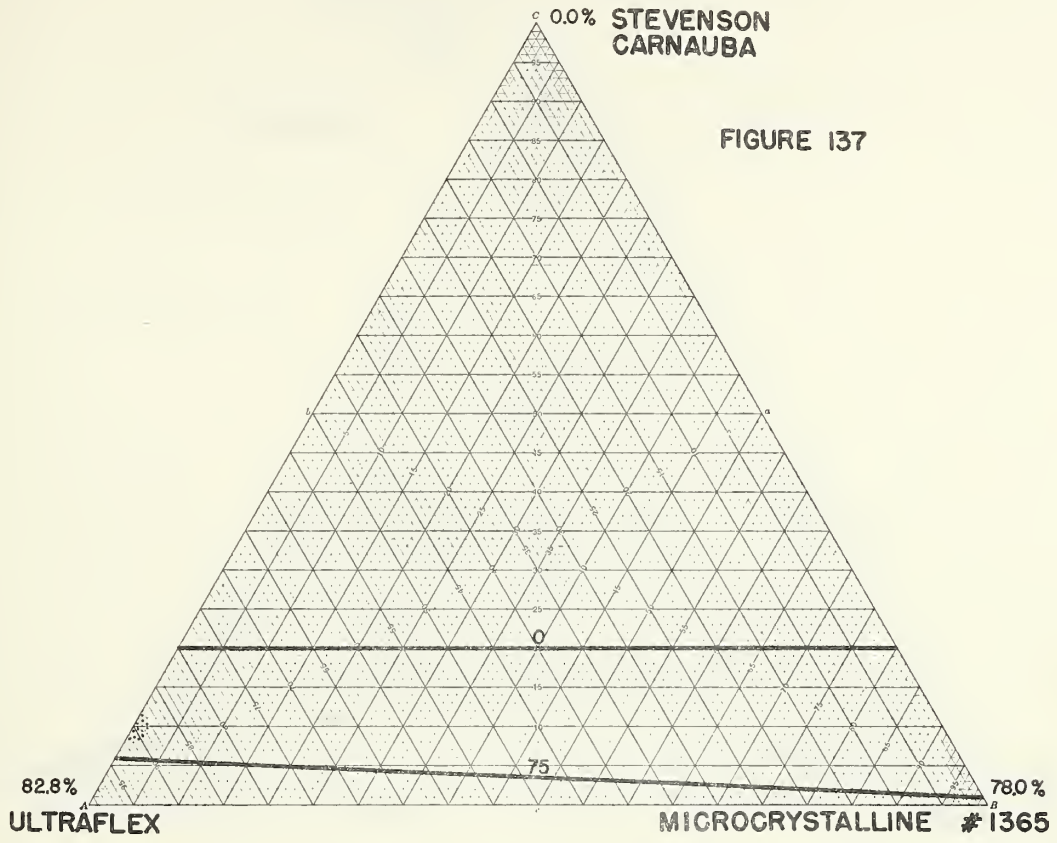

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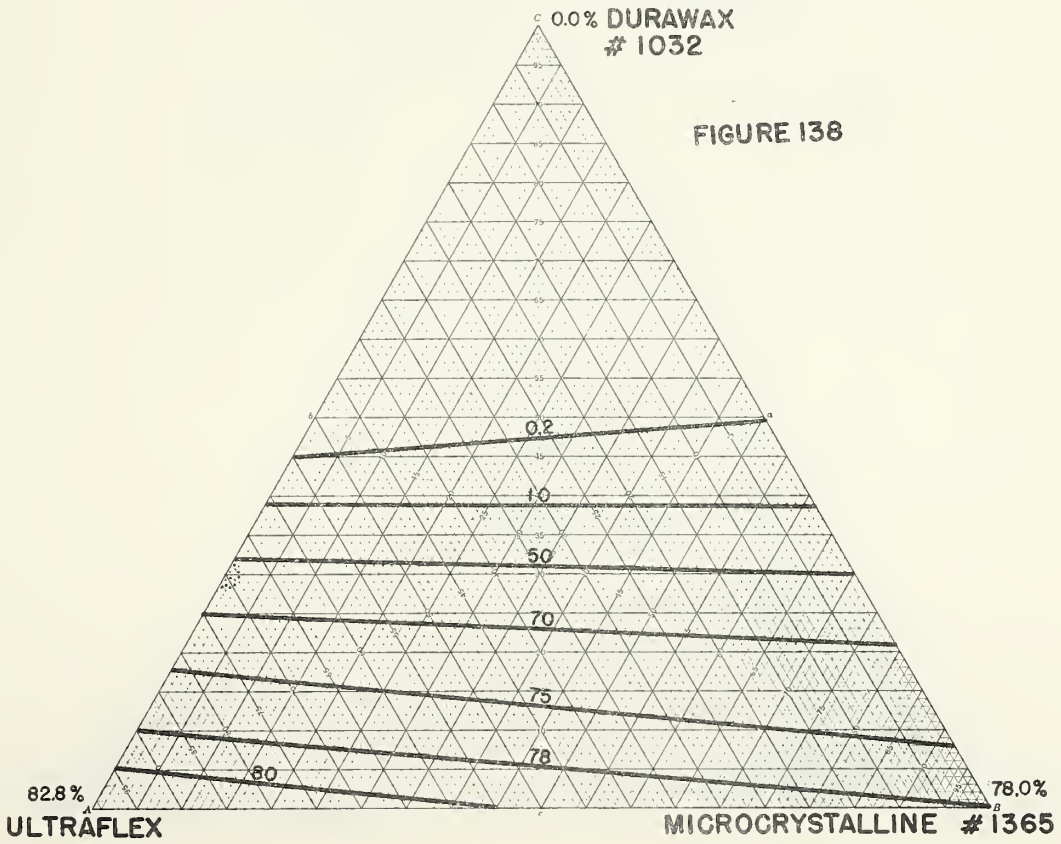


FIGURE 138

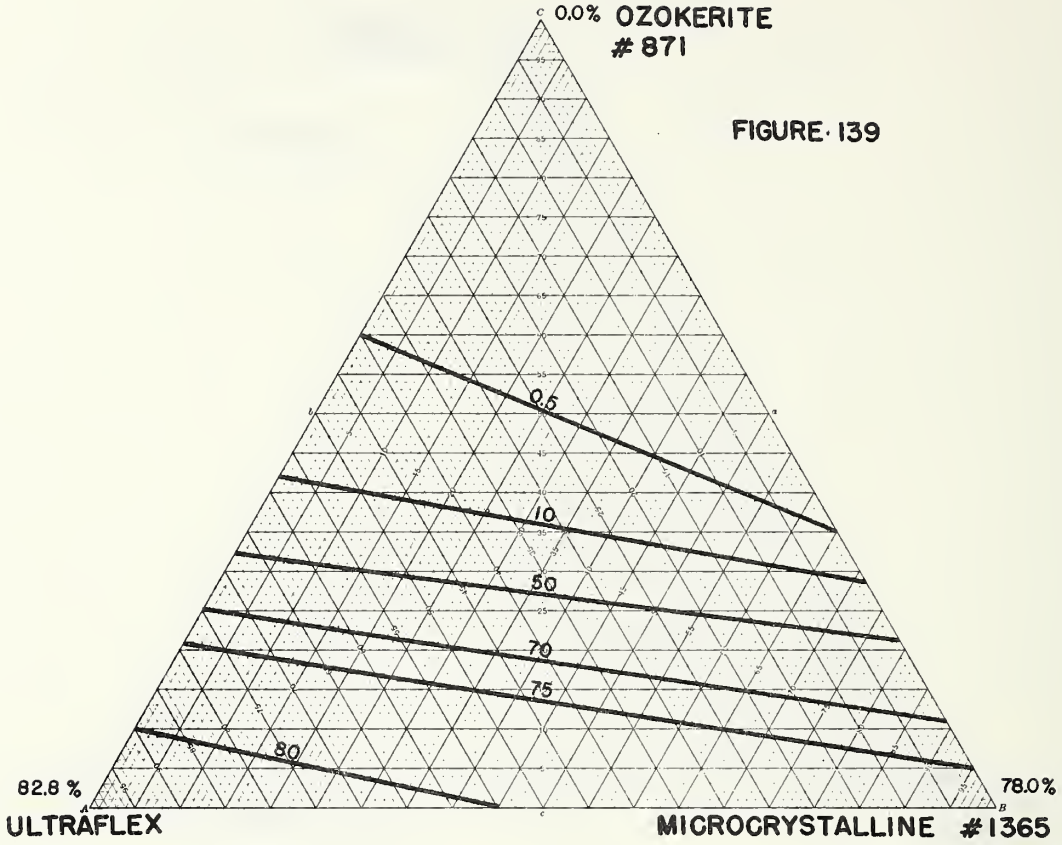
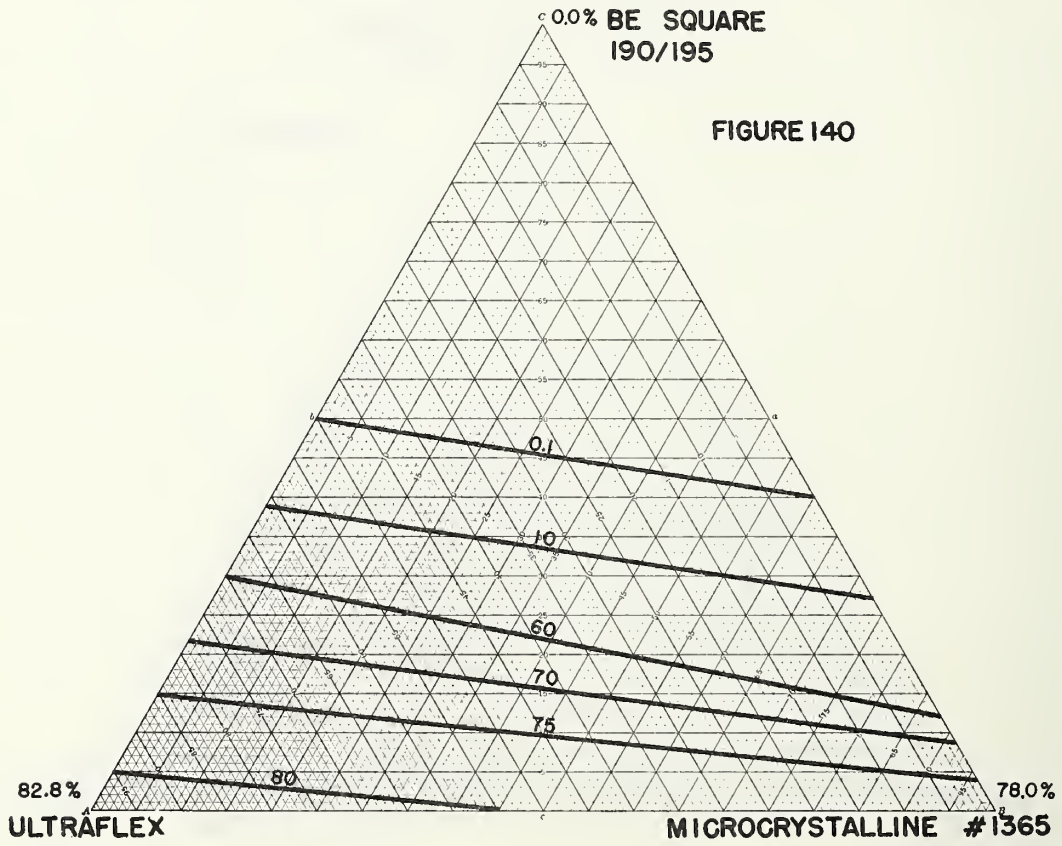


FIGURE 139



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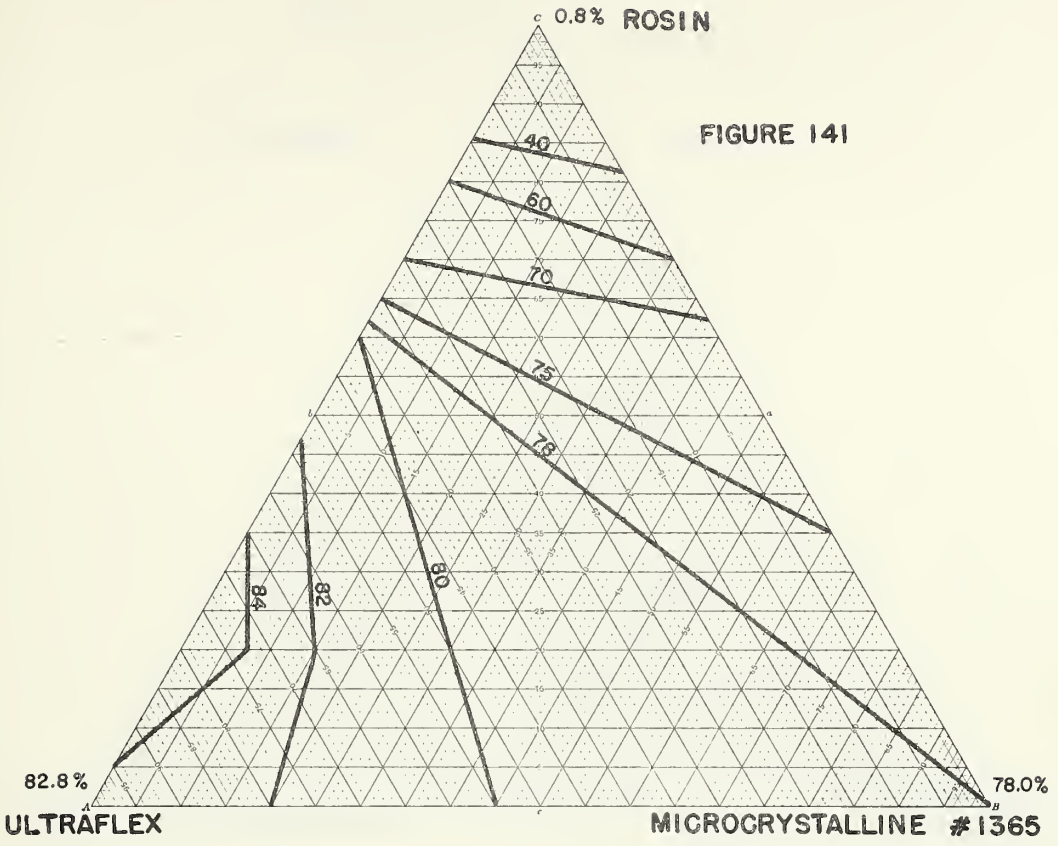

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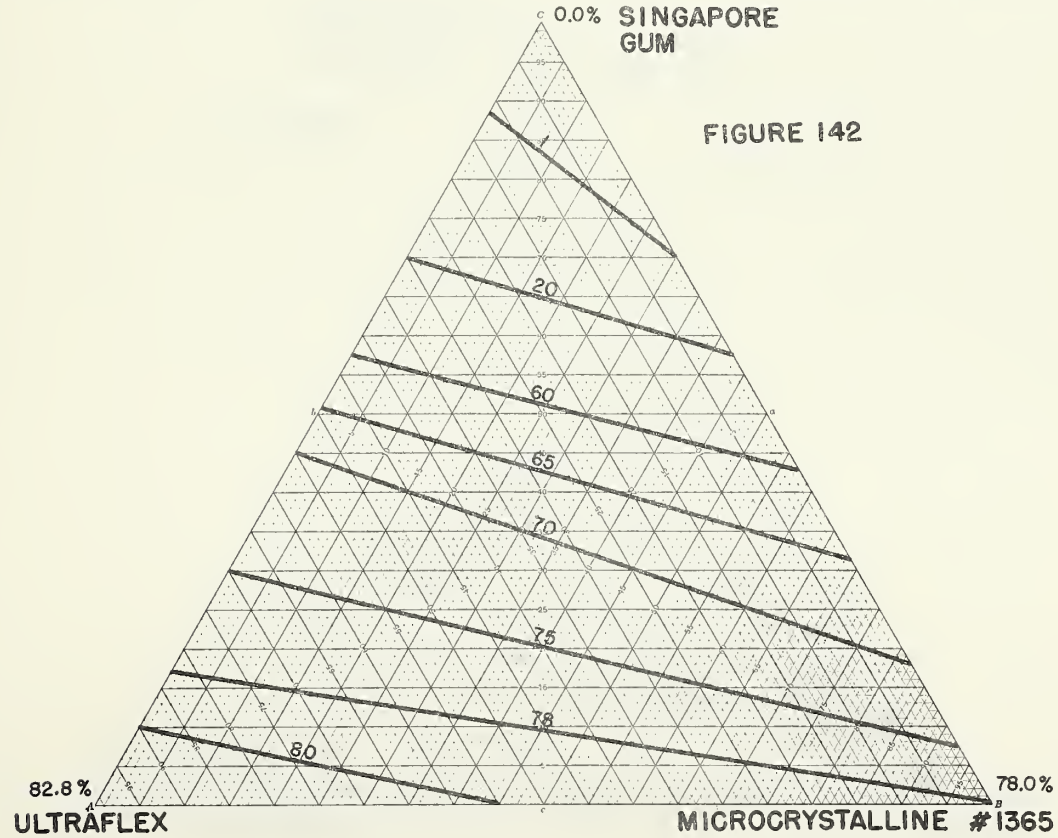


FIGURE 142

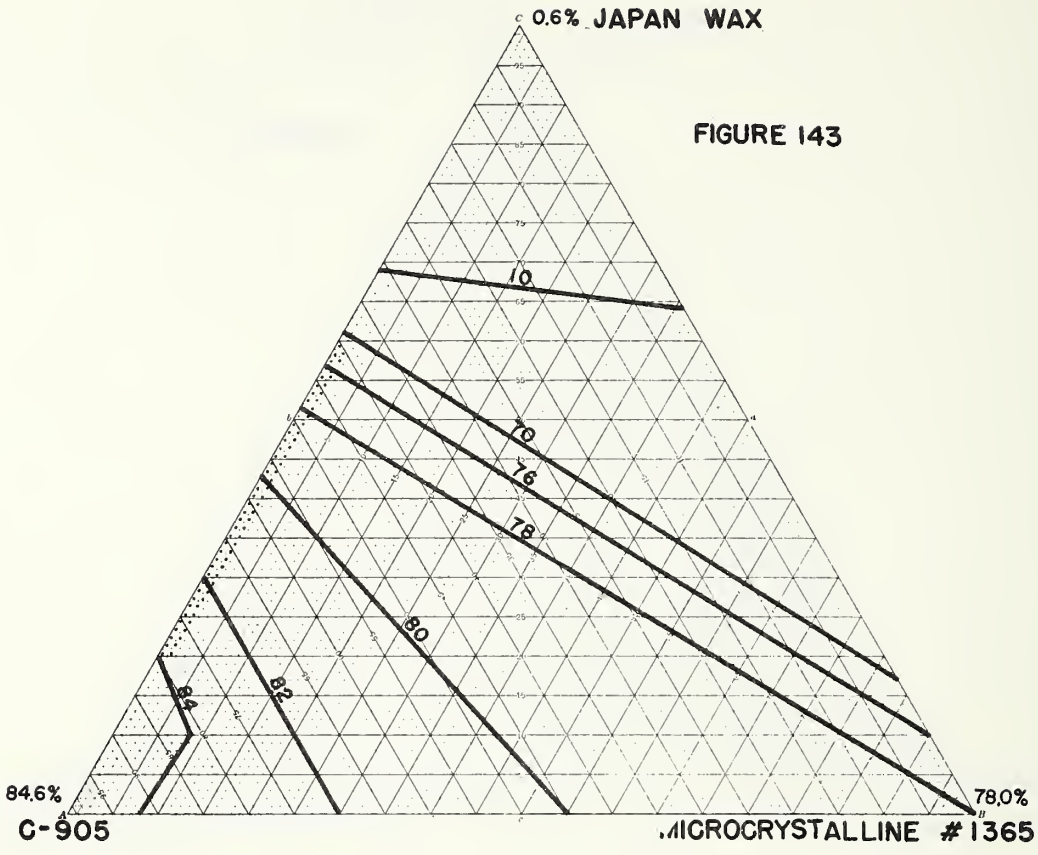
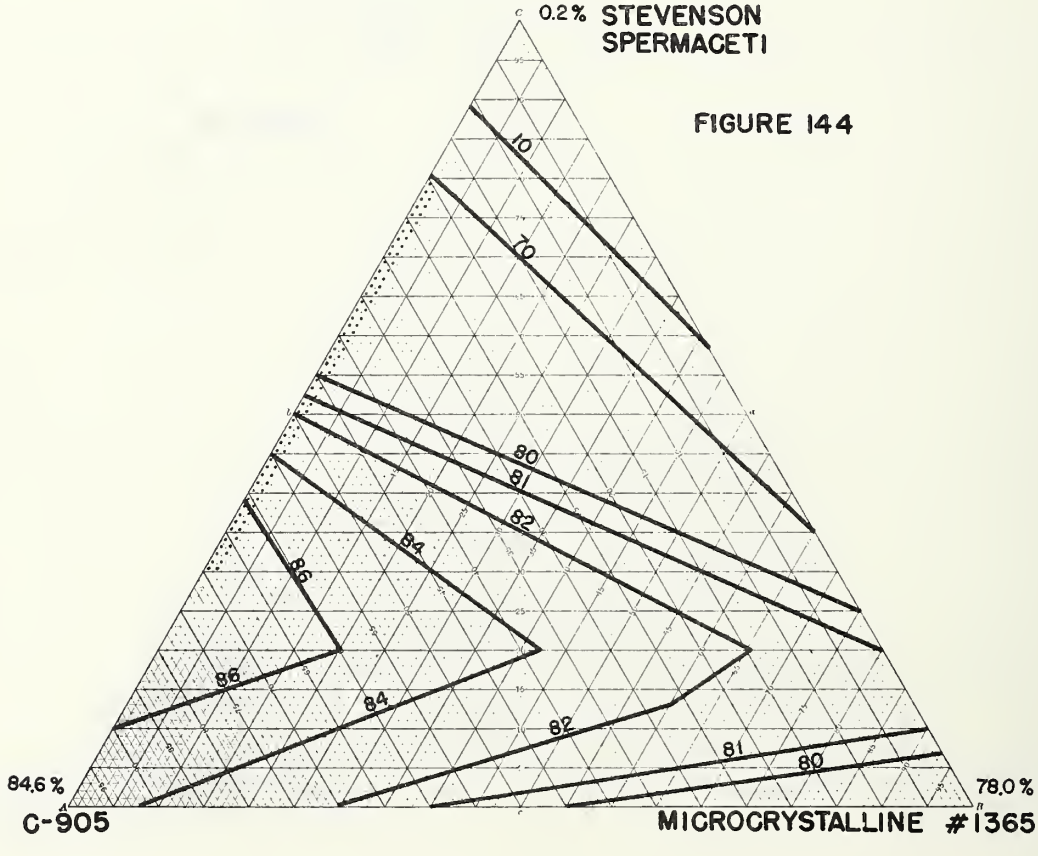


FIGURE 143



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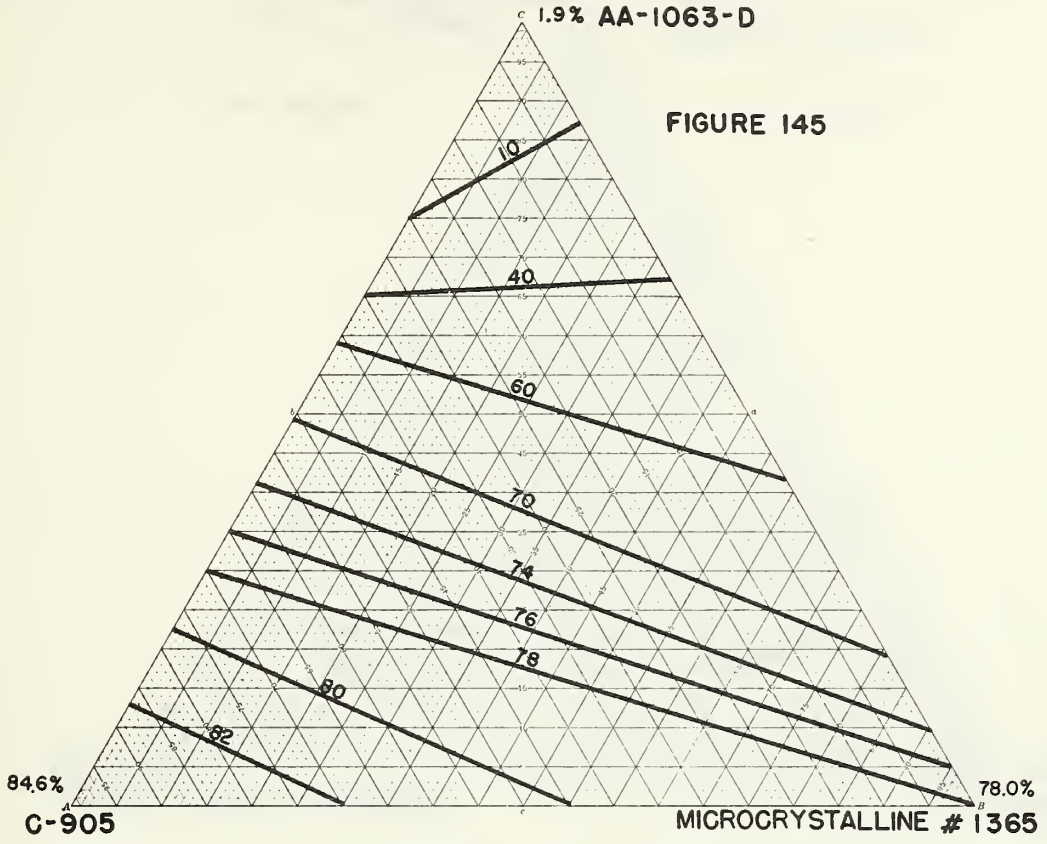

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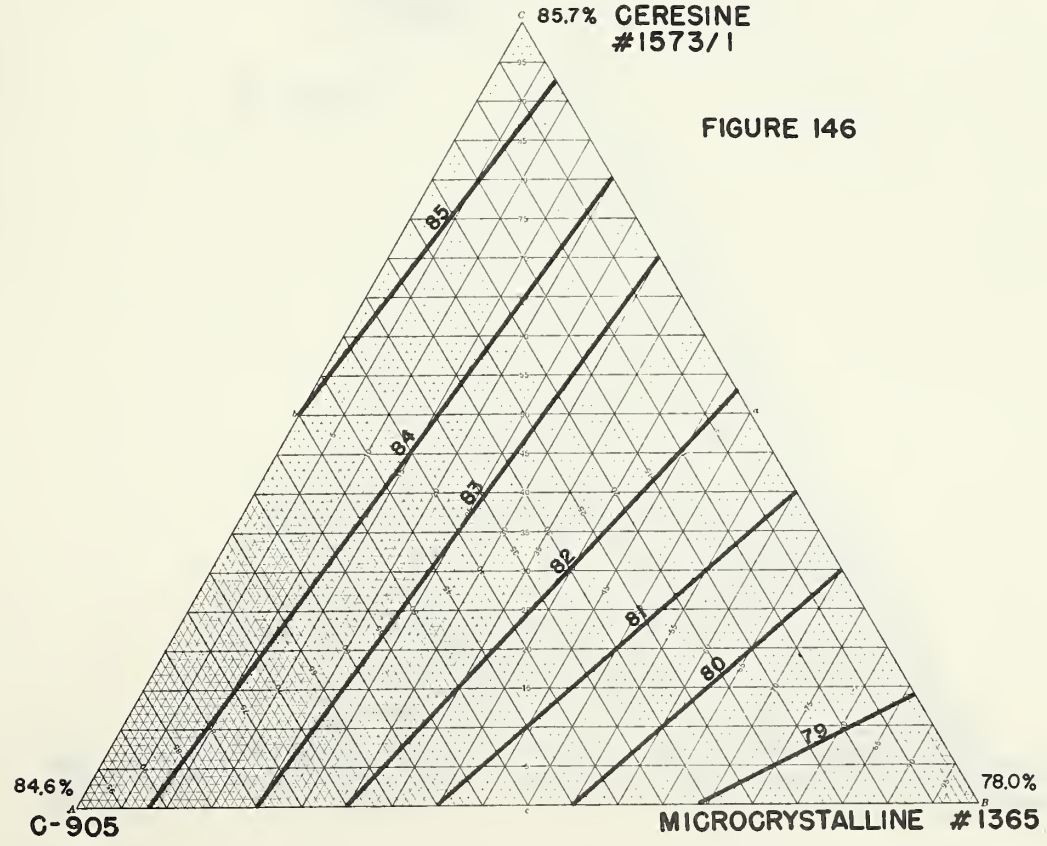

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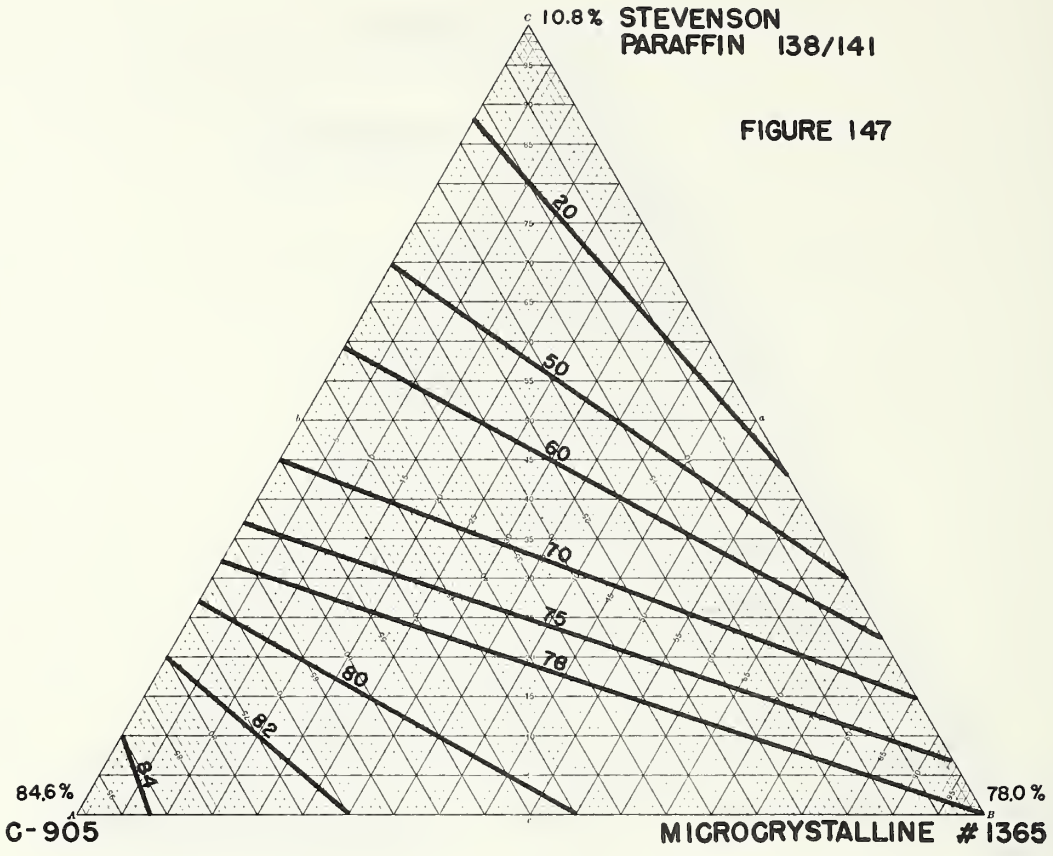


FIGURE 147

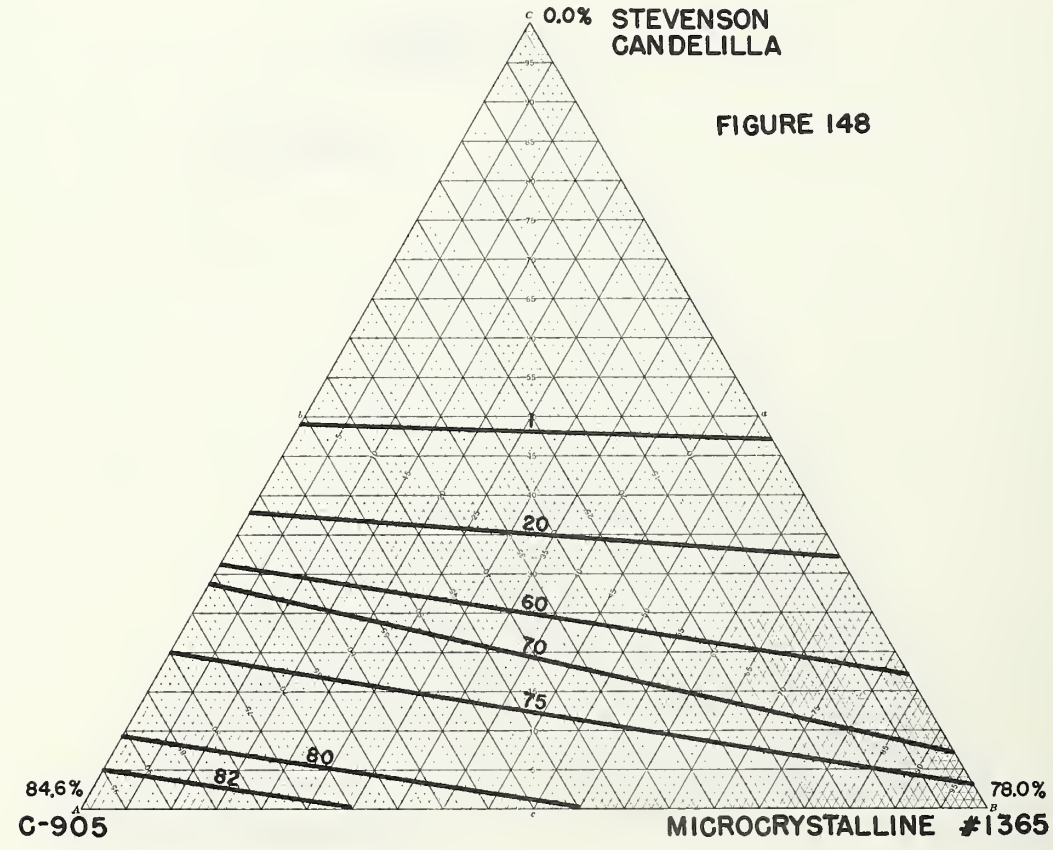


FIGURE 148

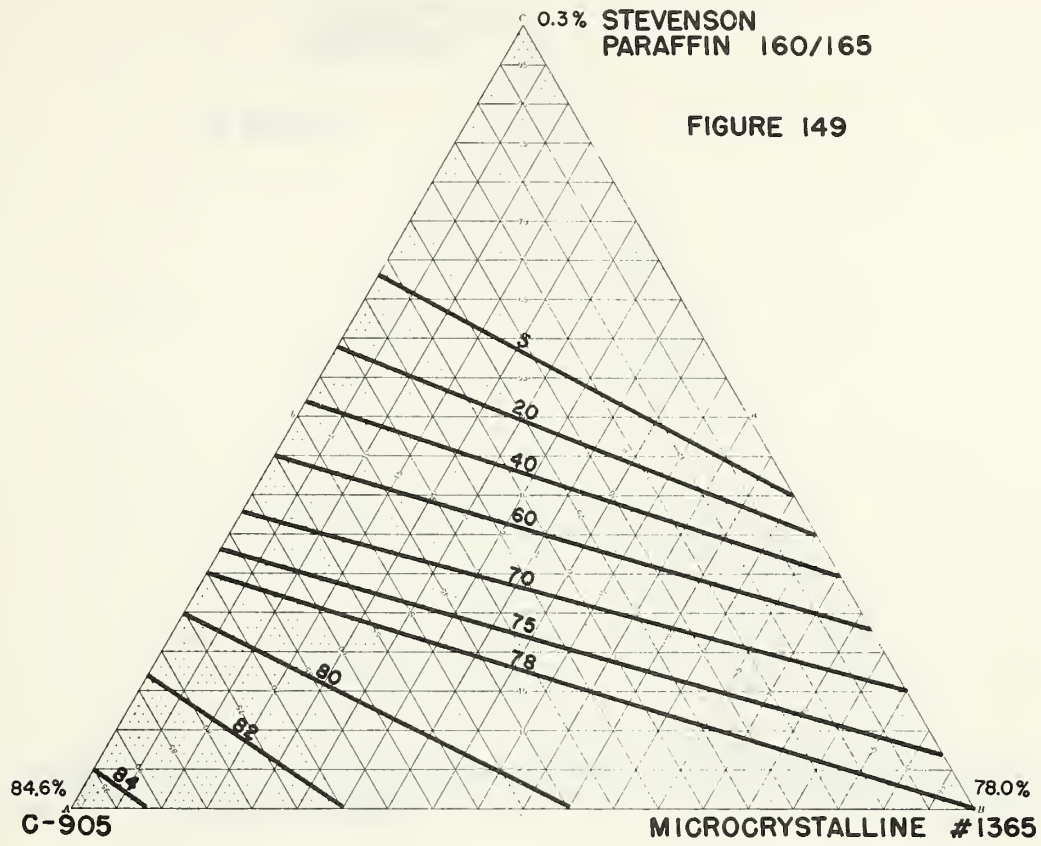
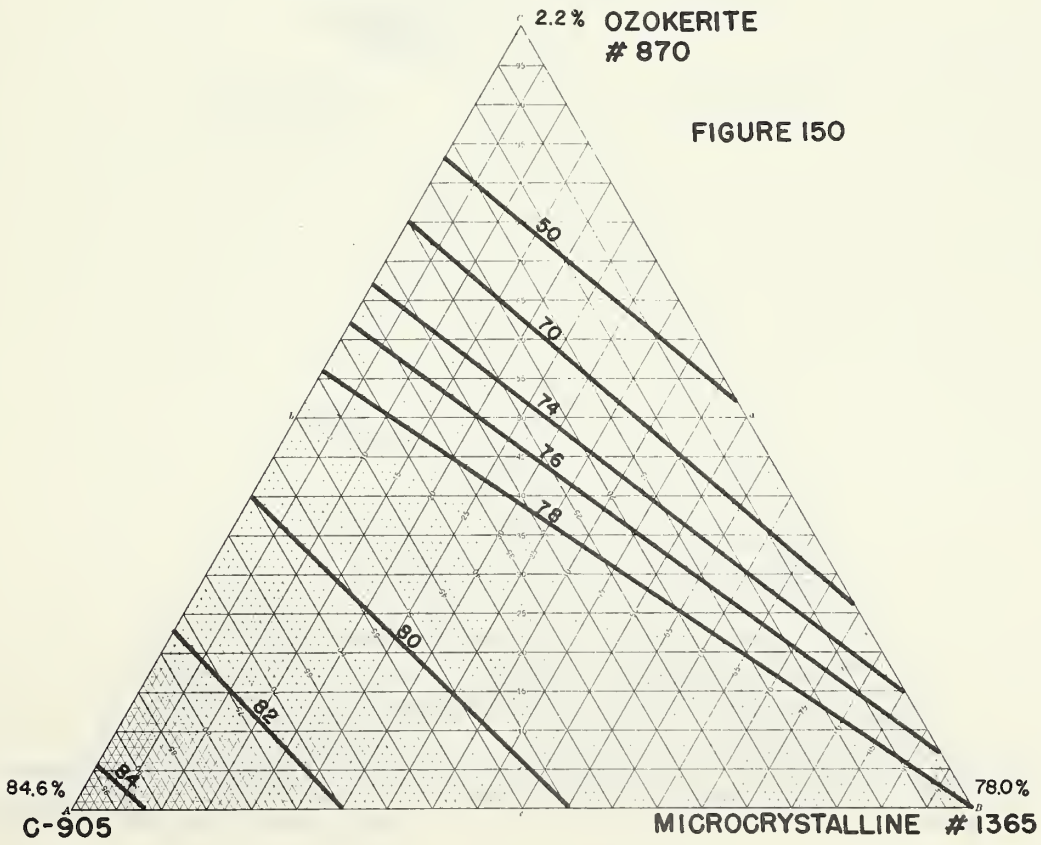


FIGURE 149



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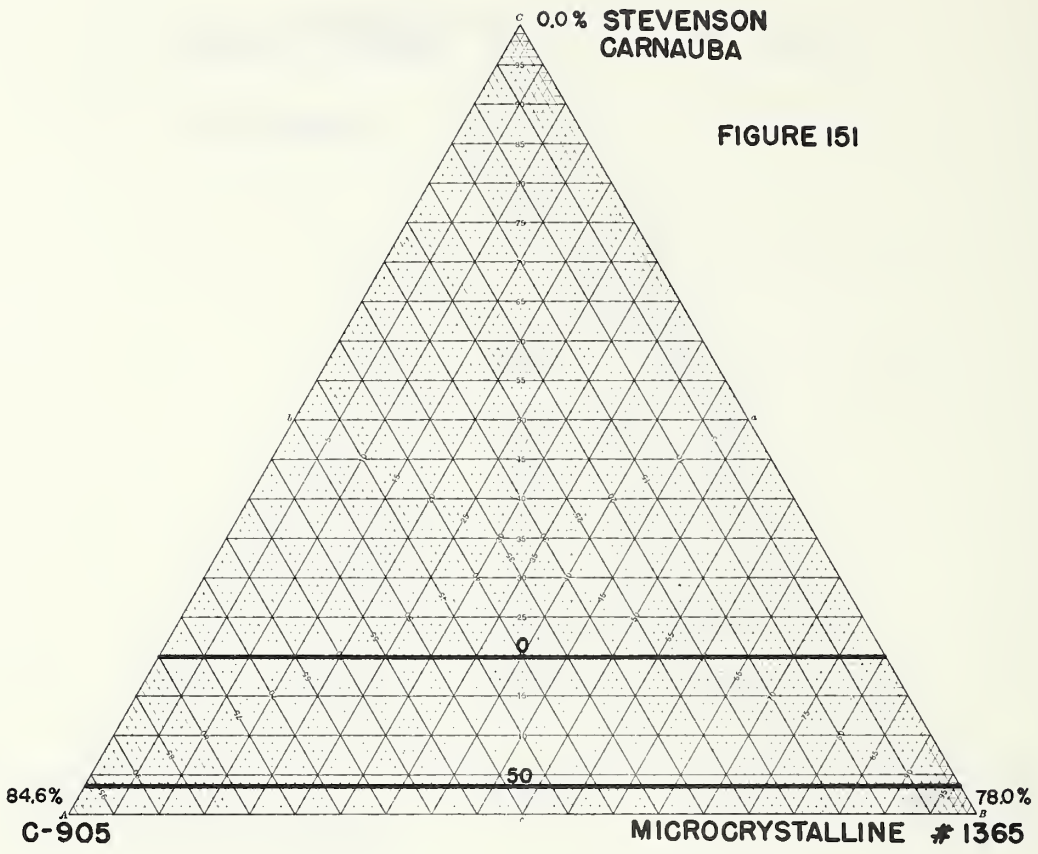
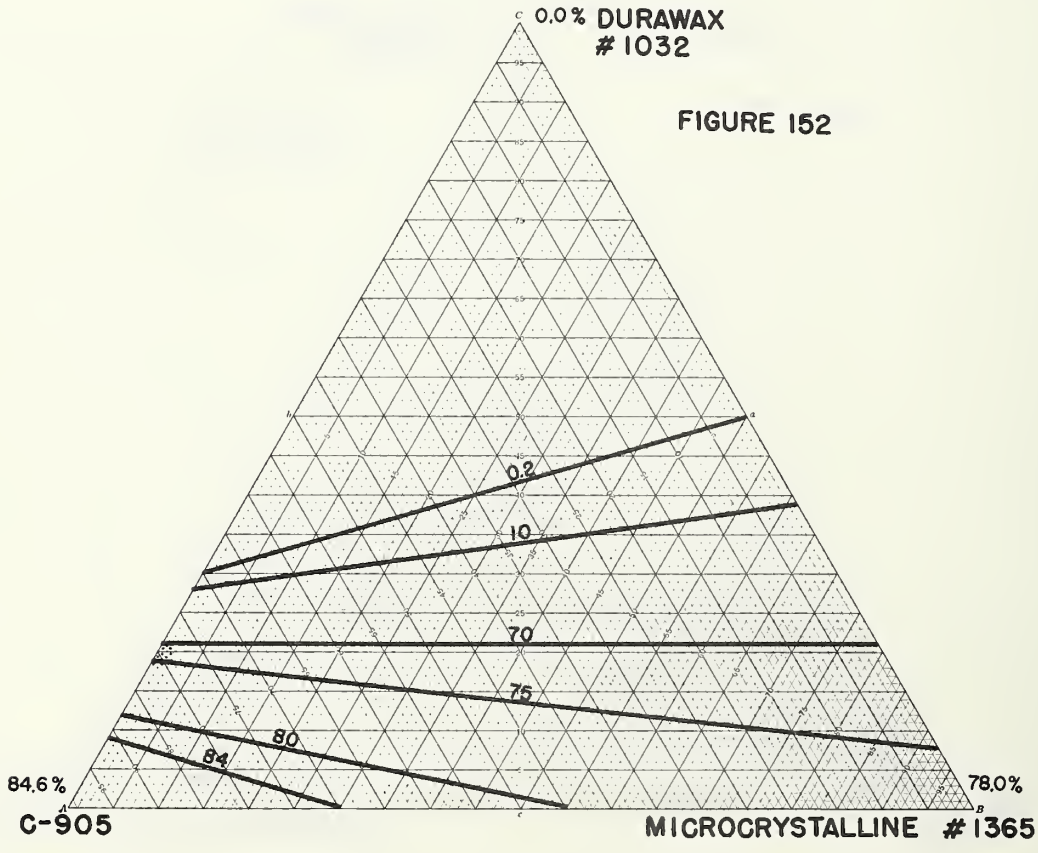


FIGURE 151



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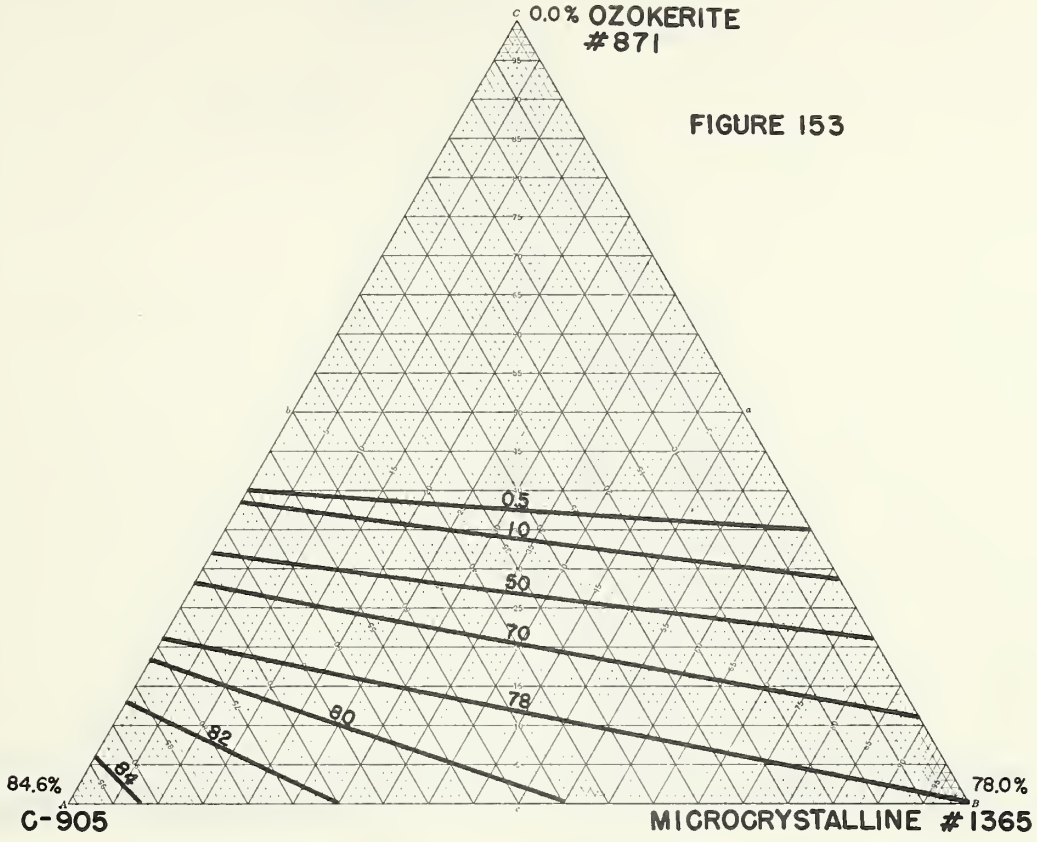

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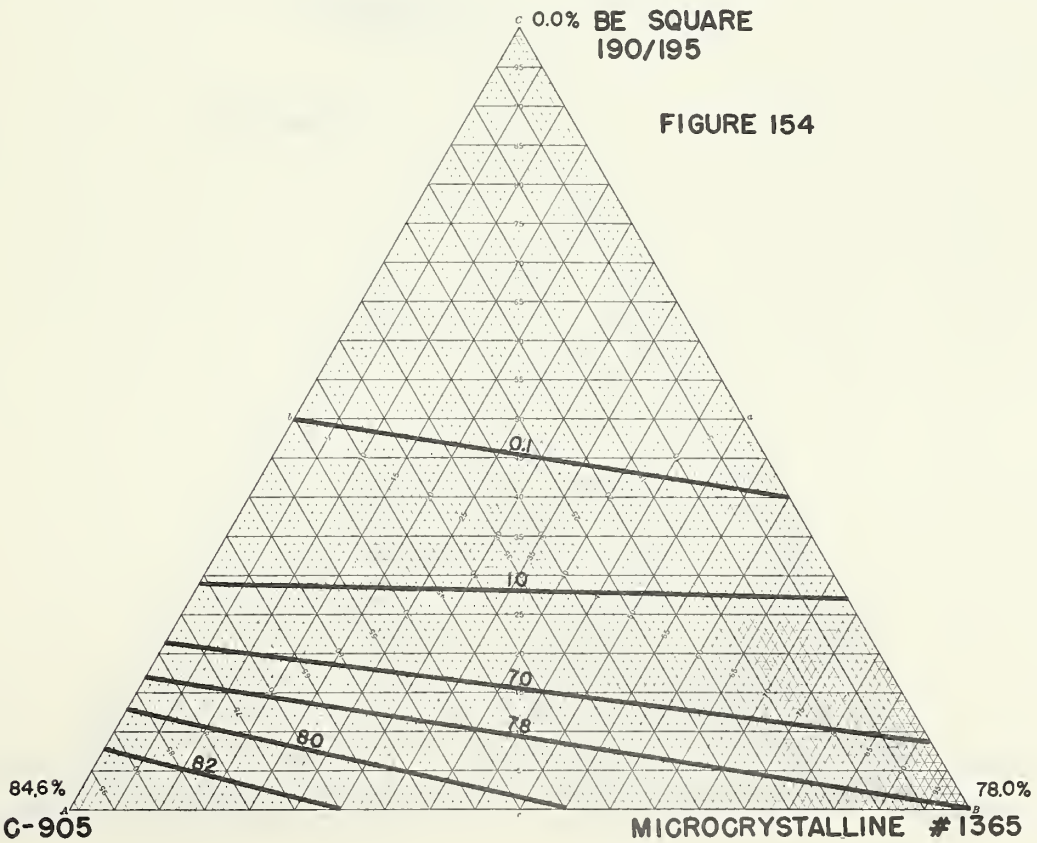

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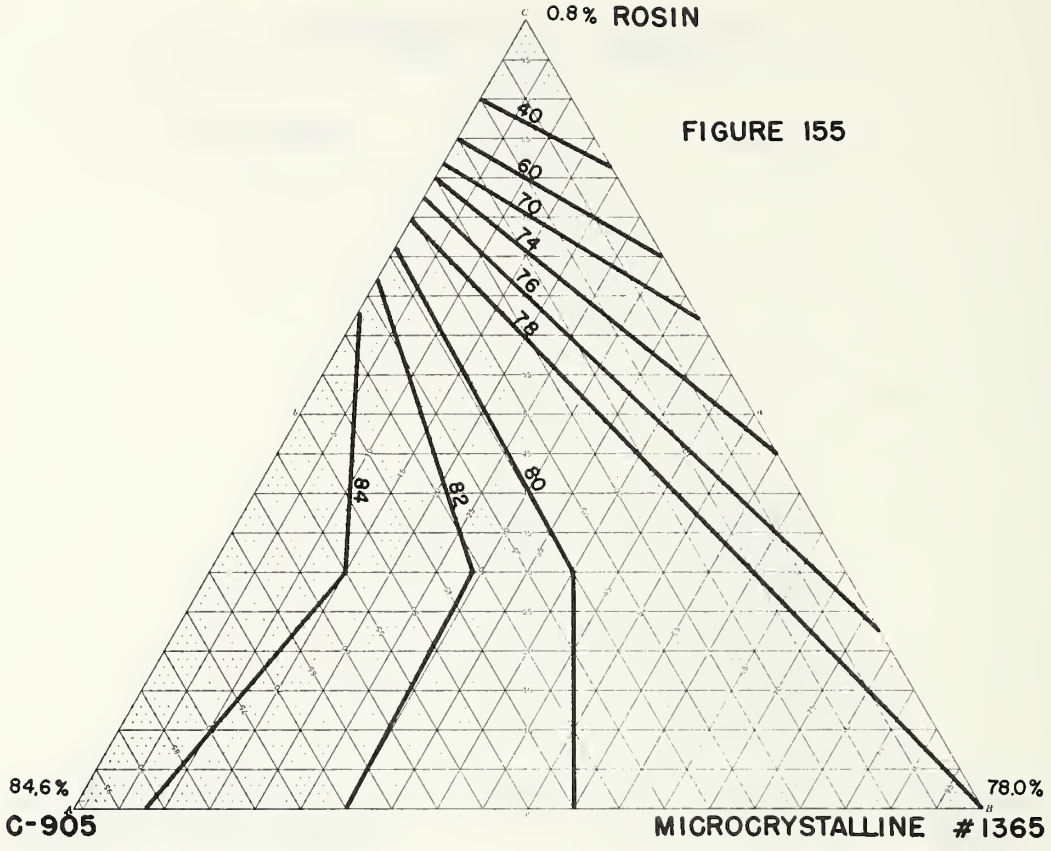

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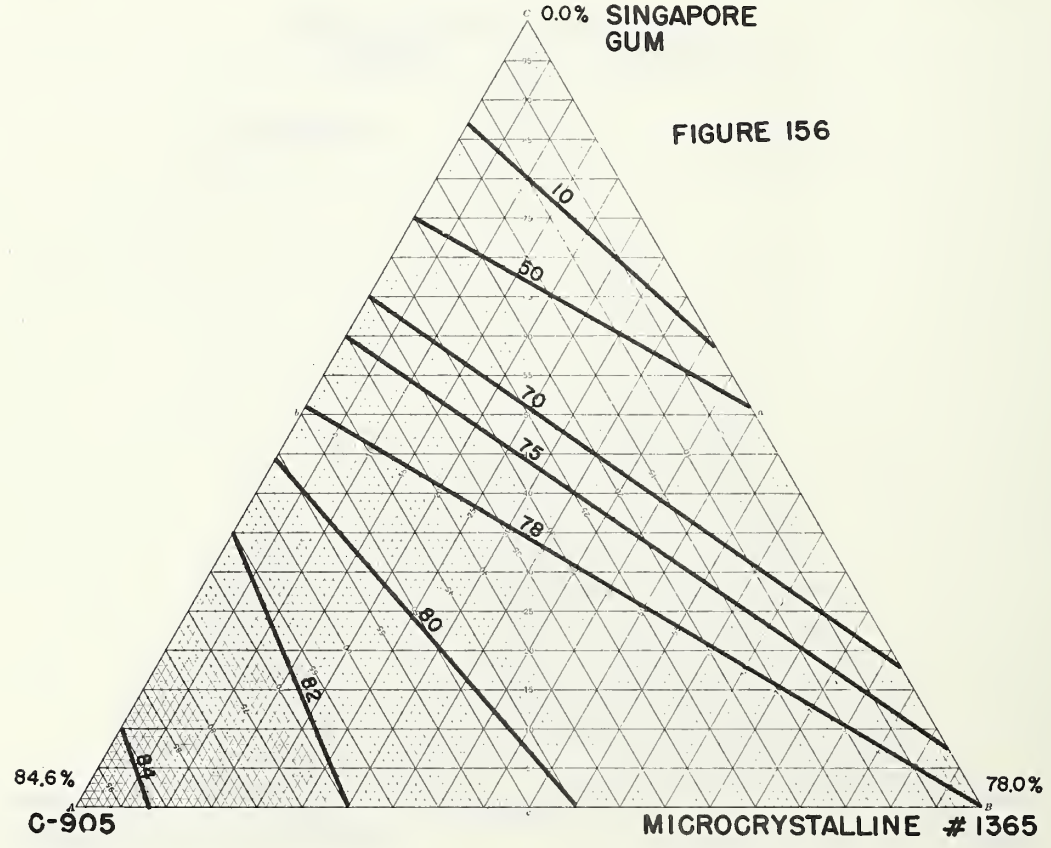

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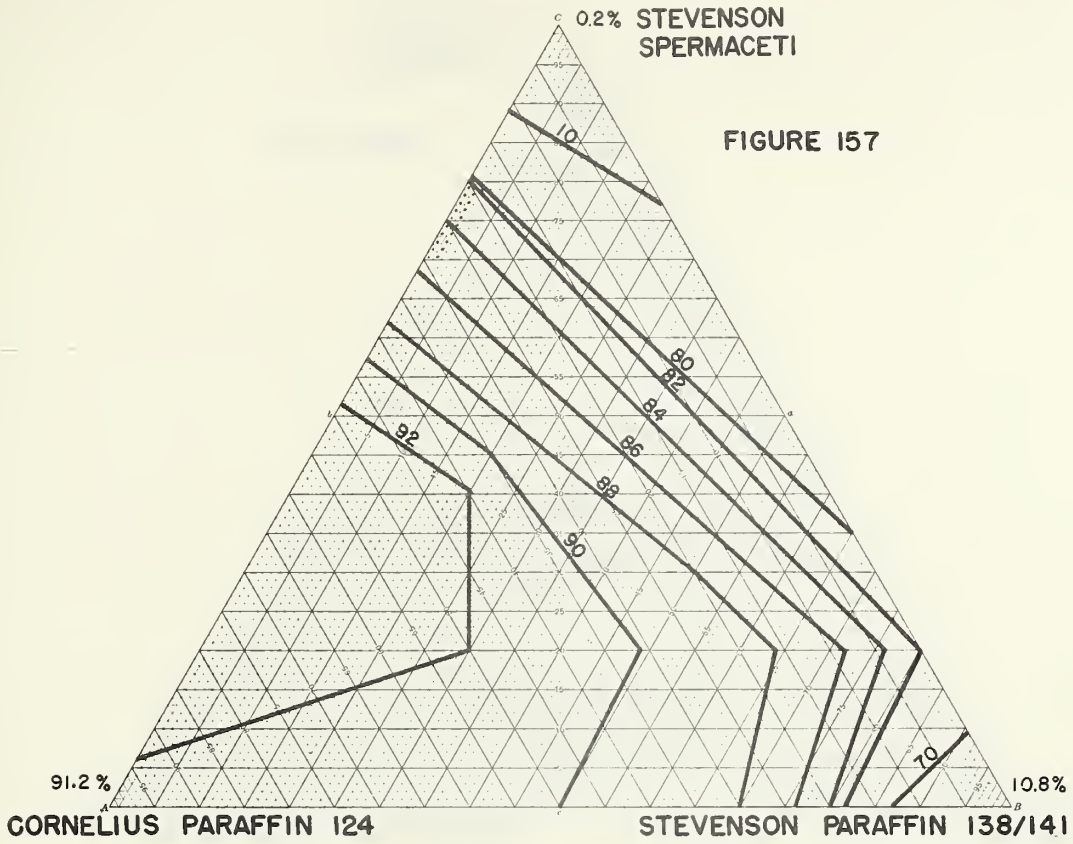

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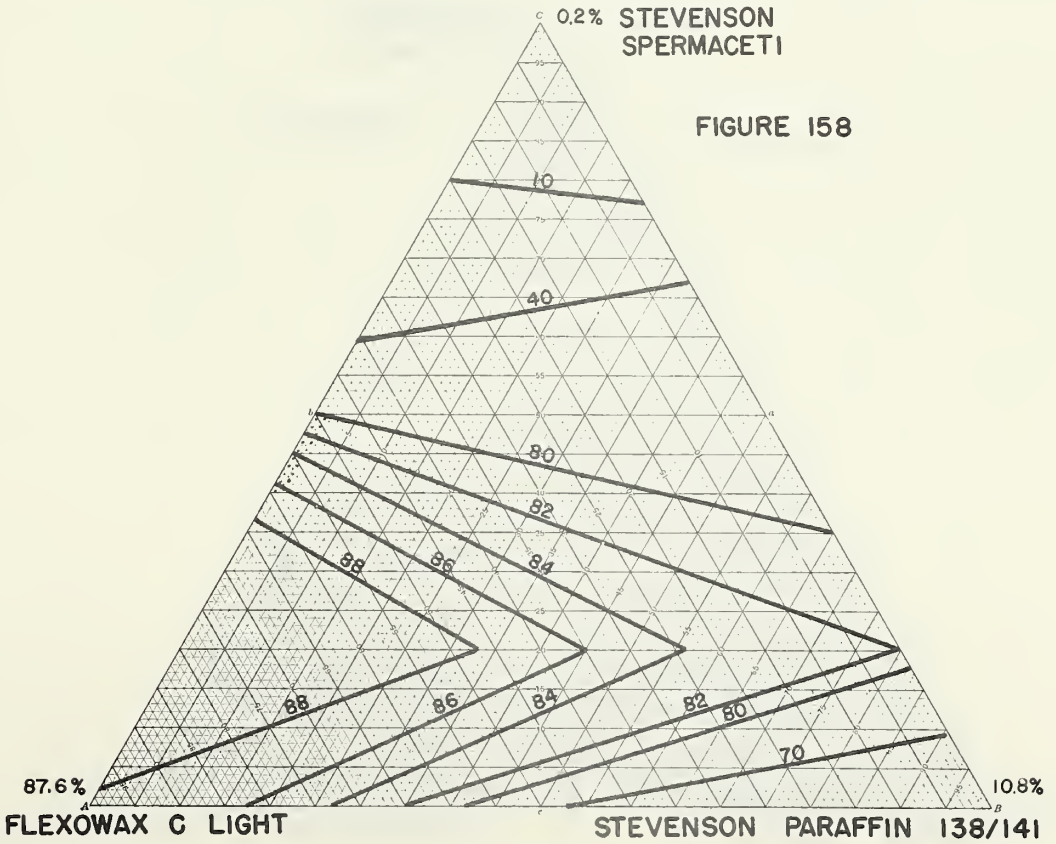


FIGURE 158

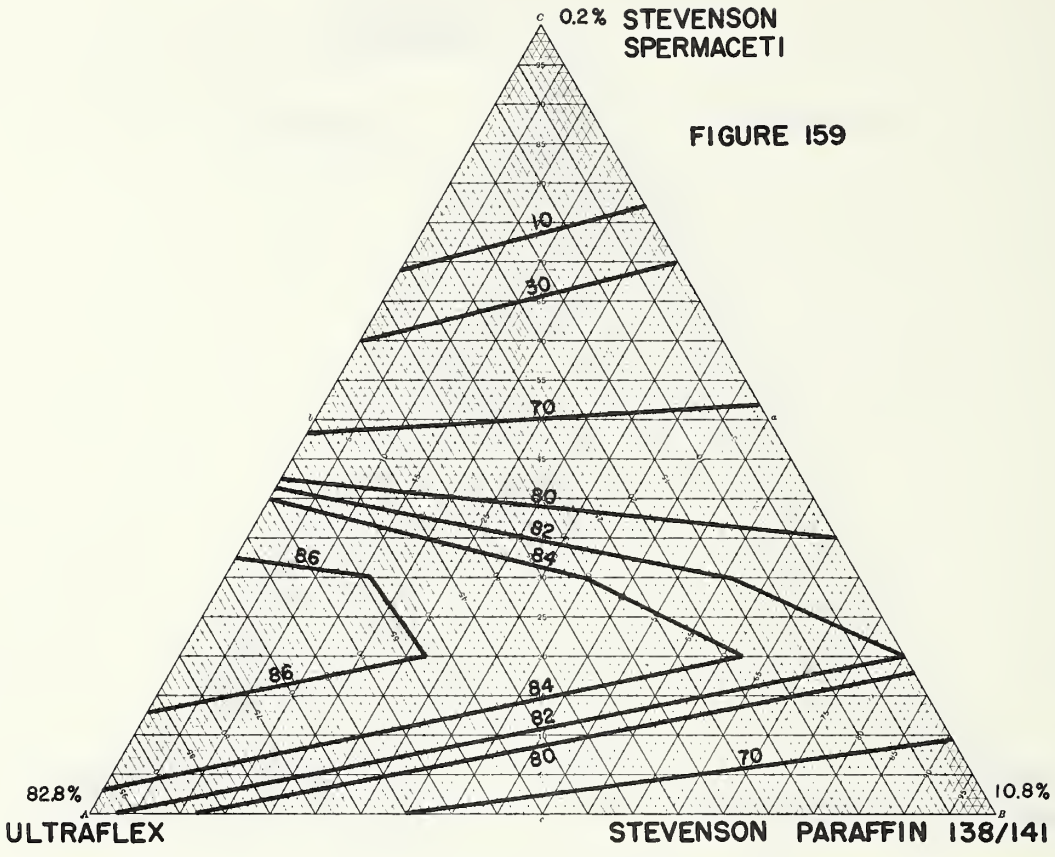


FIGURE 159

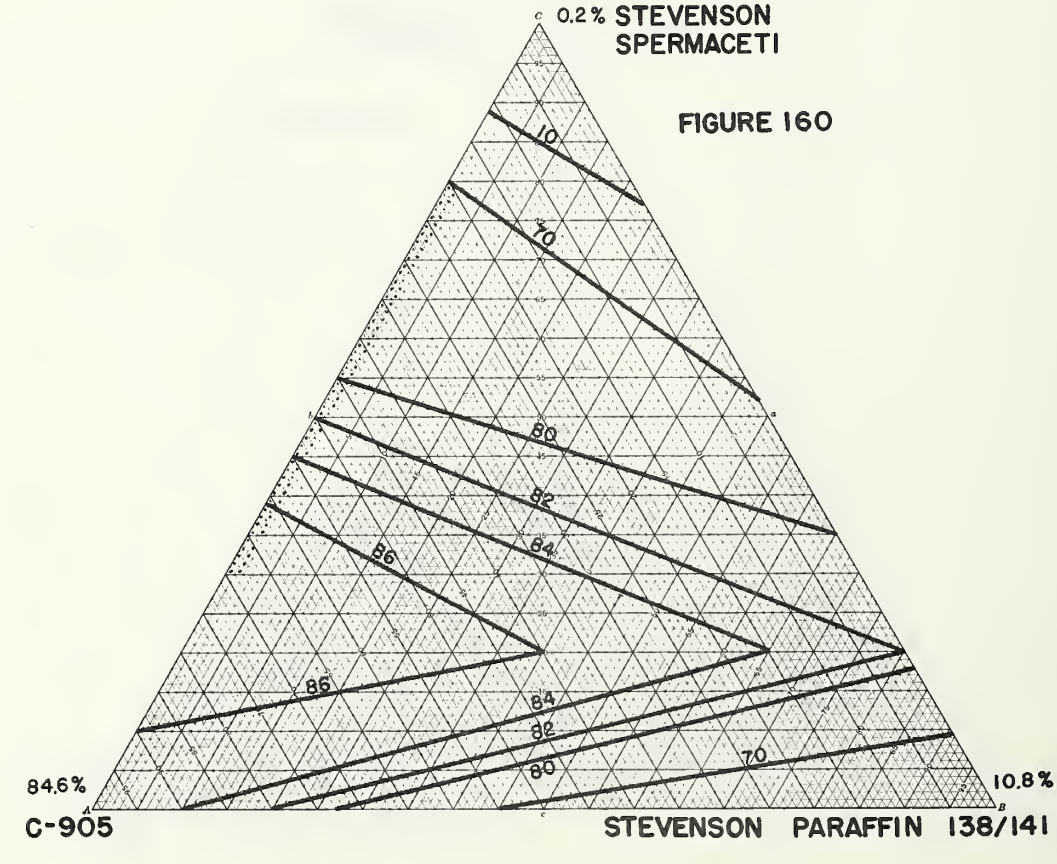
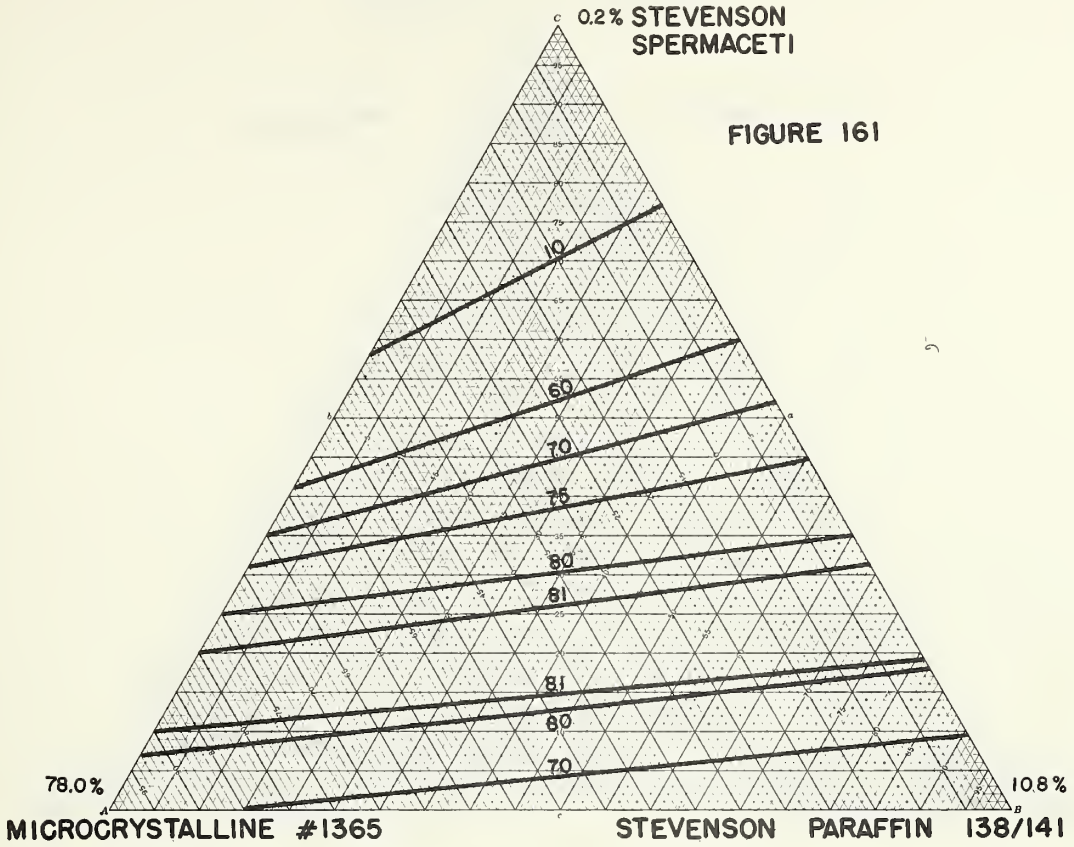


FIGURE 160



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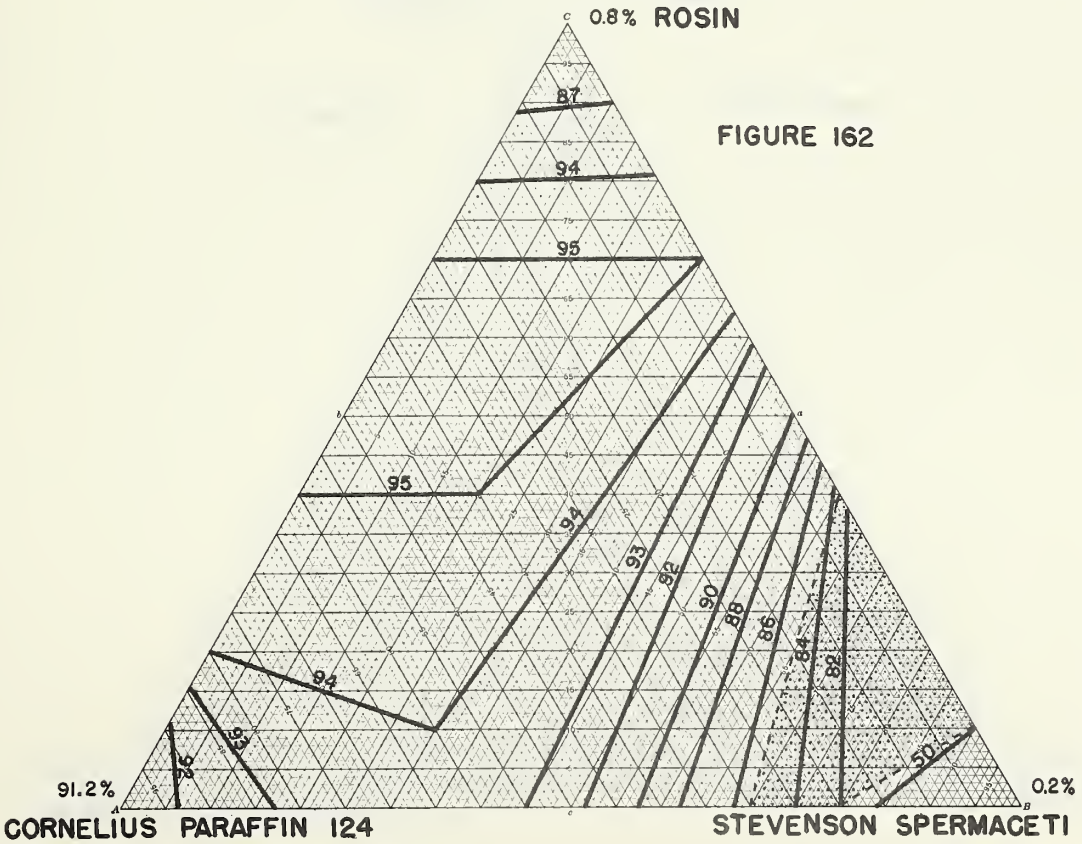


FIGURE 162

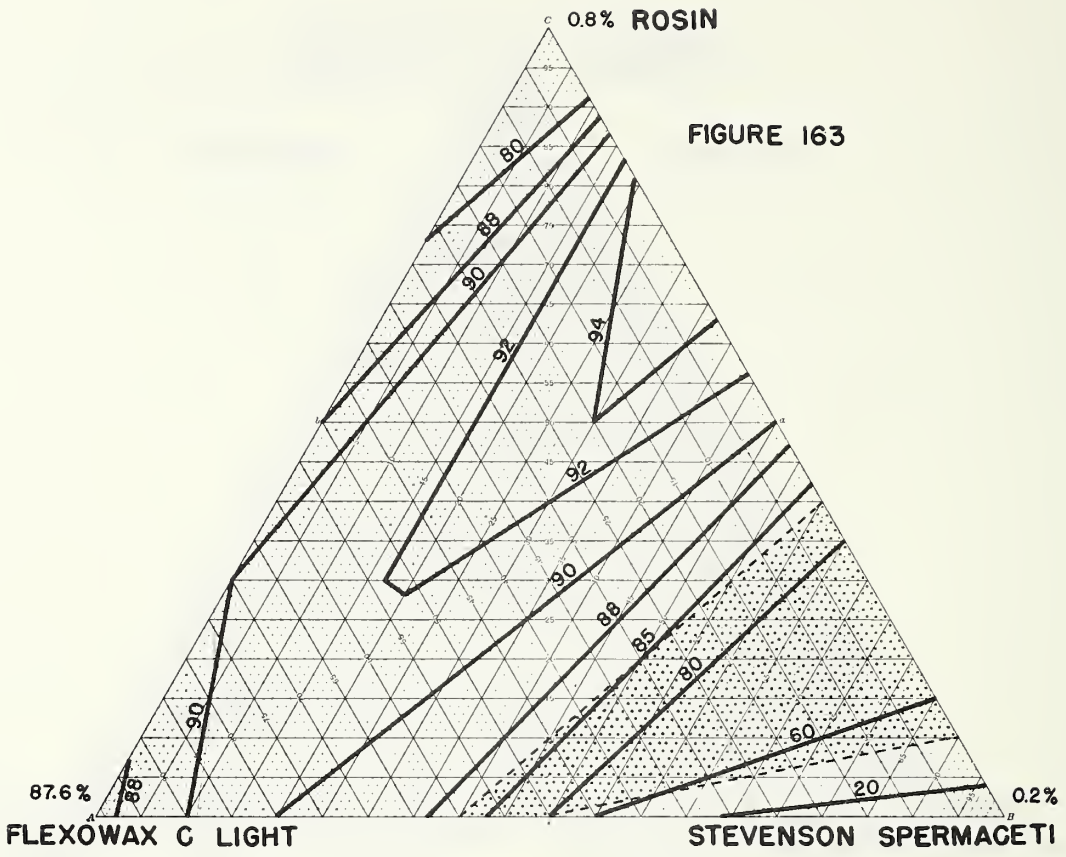


FIGURE 163

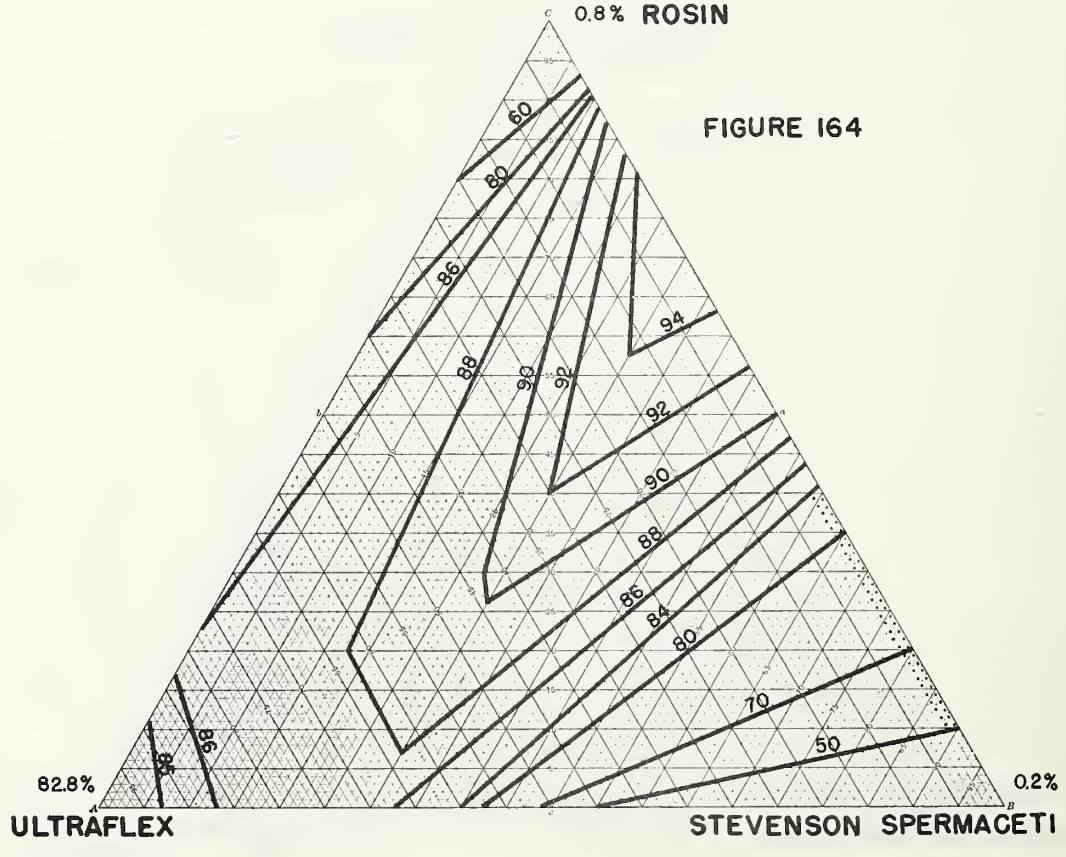


FIGURE 164

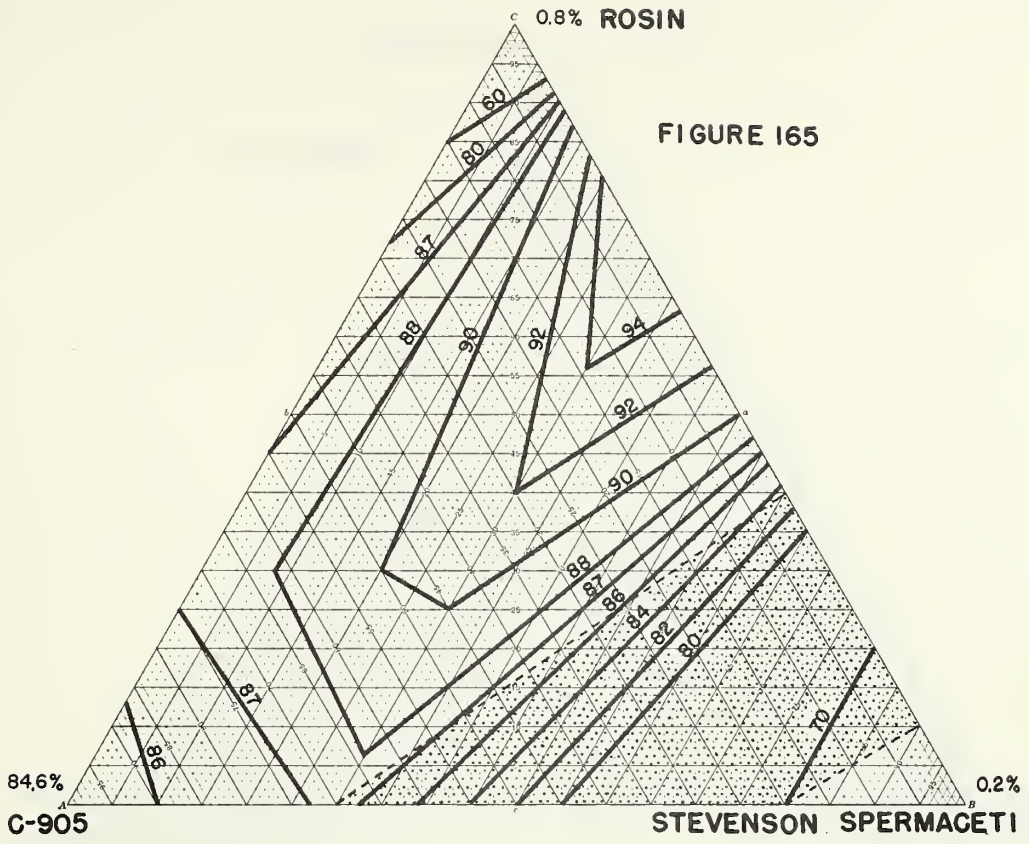
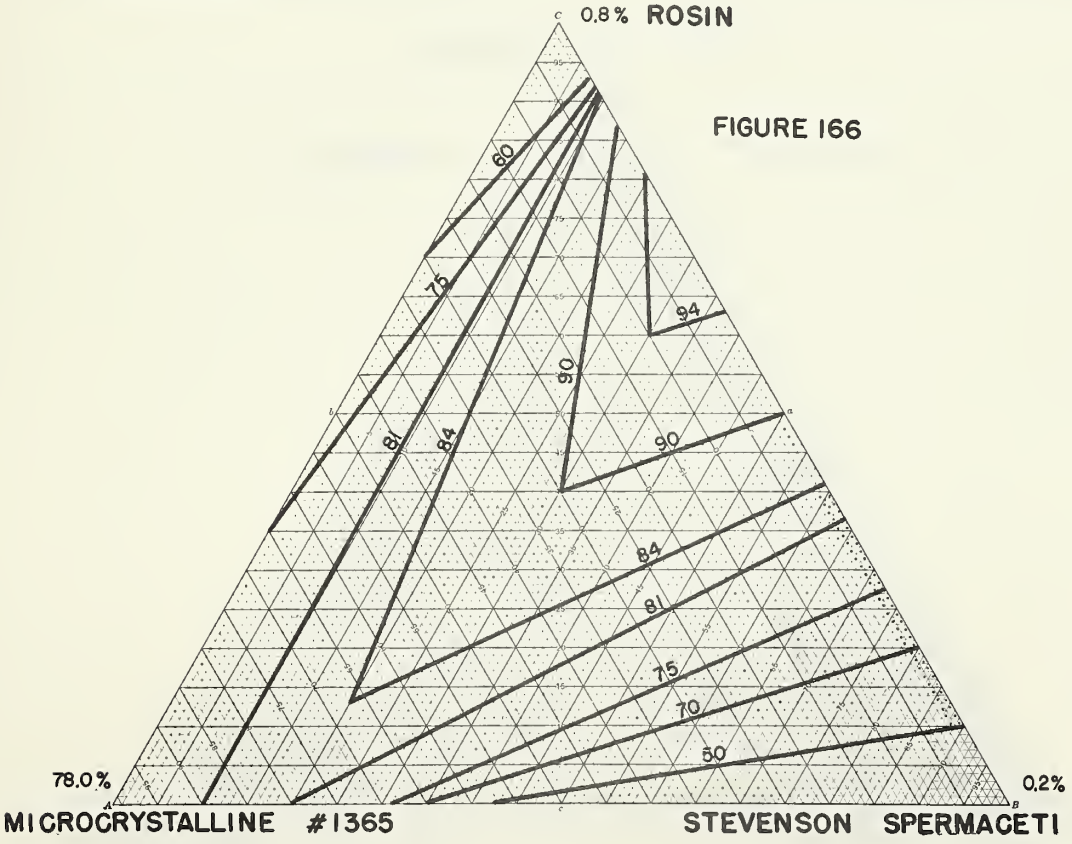


FIGURE 165



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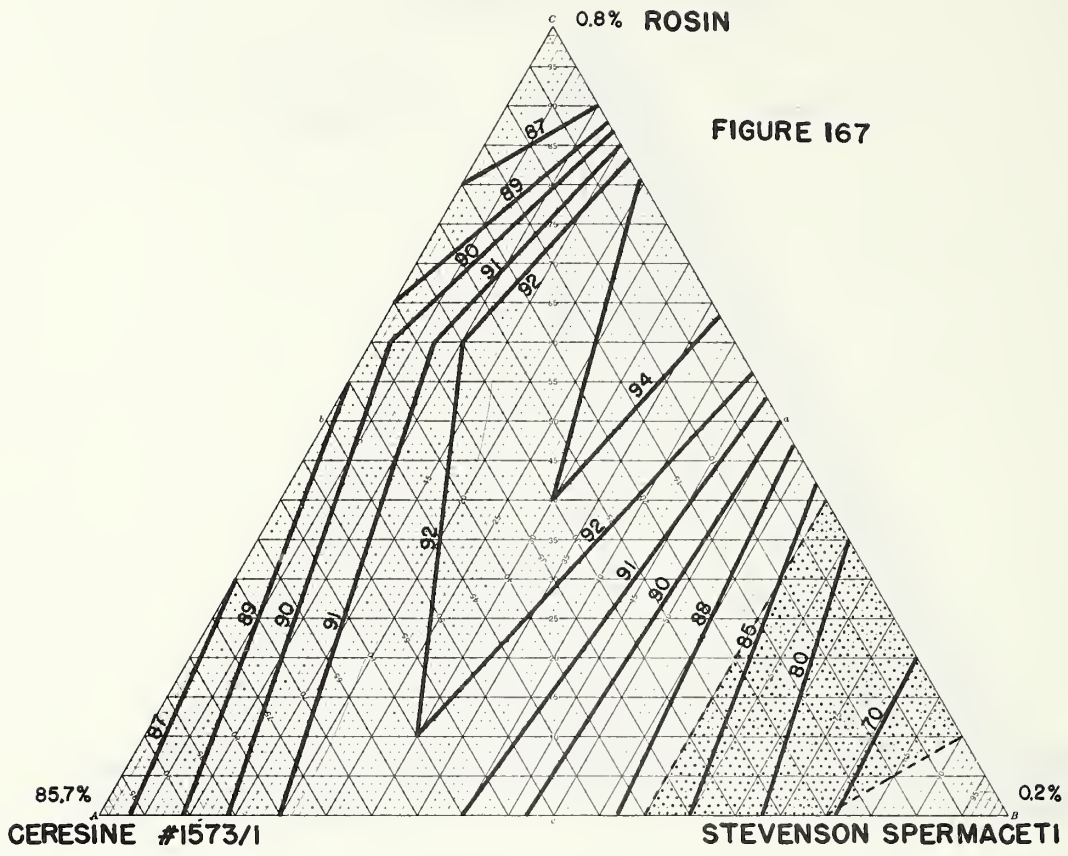

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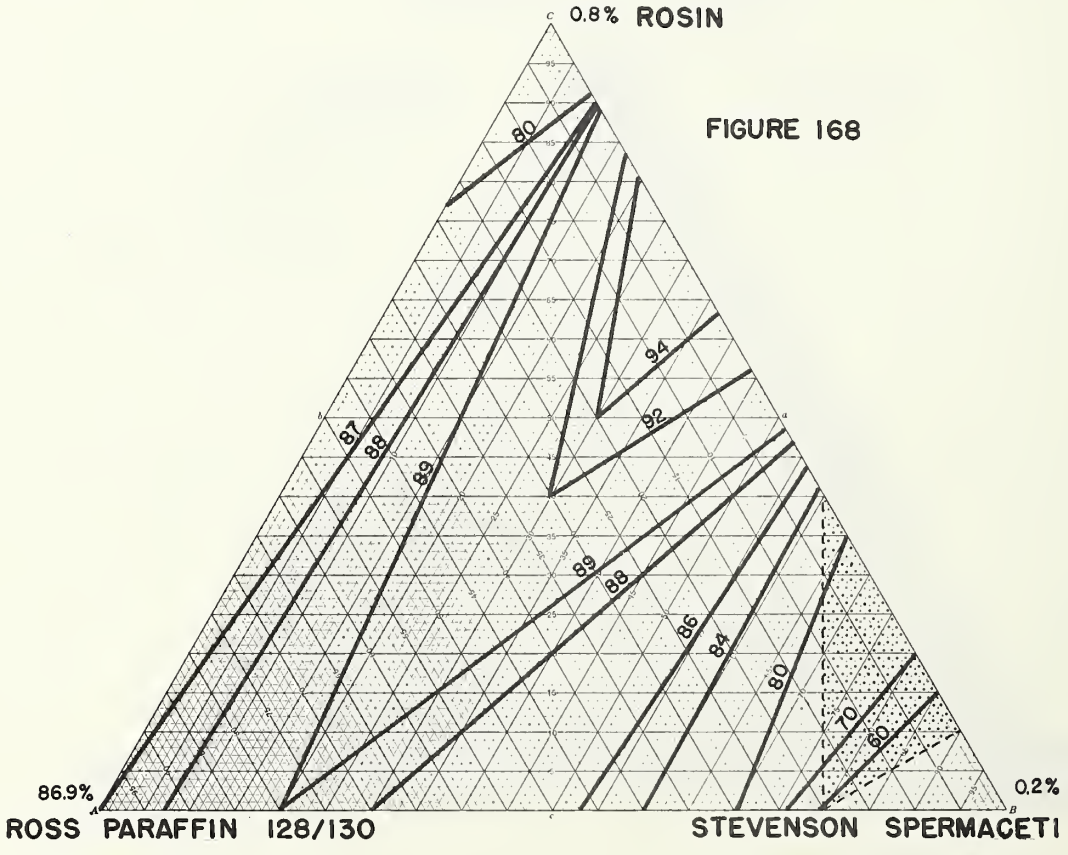


FIGURE 168

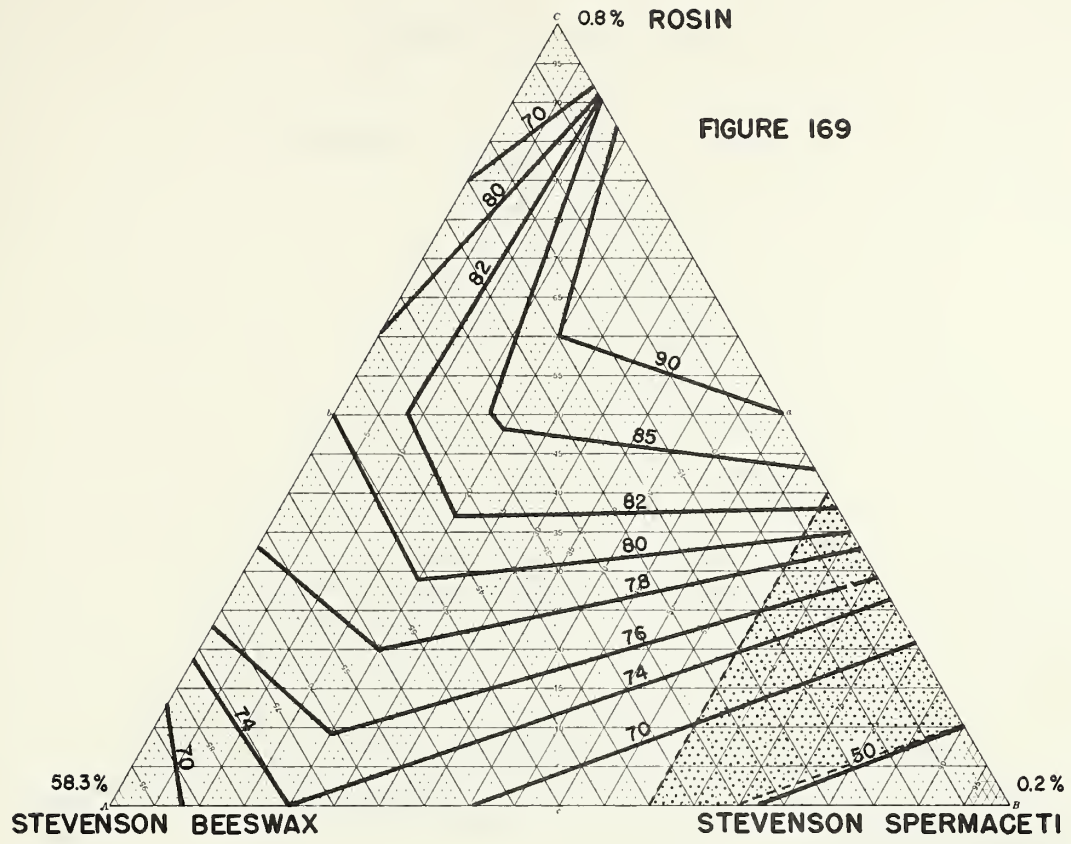
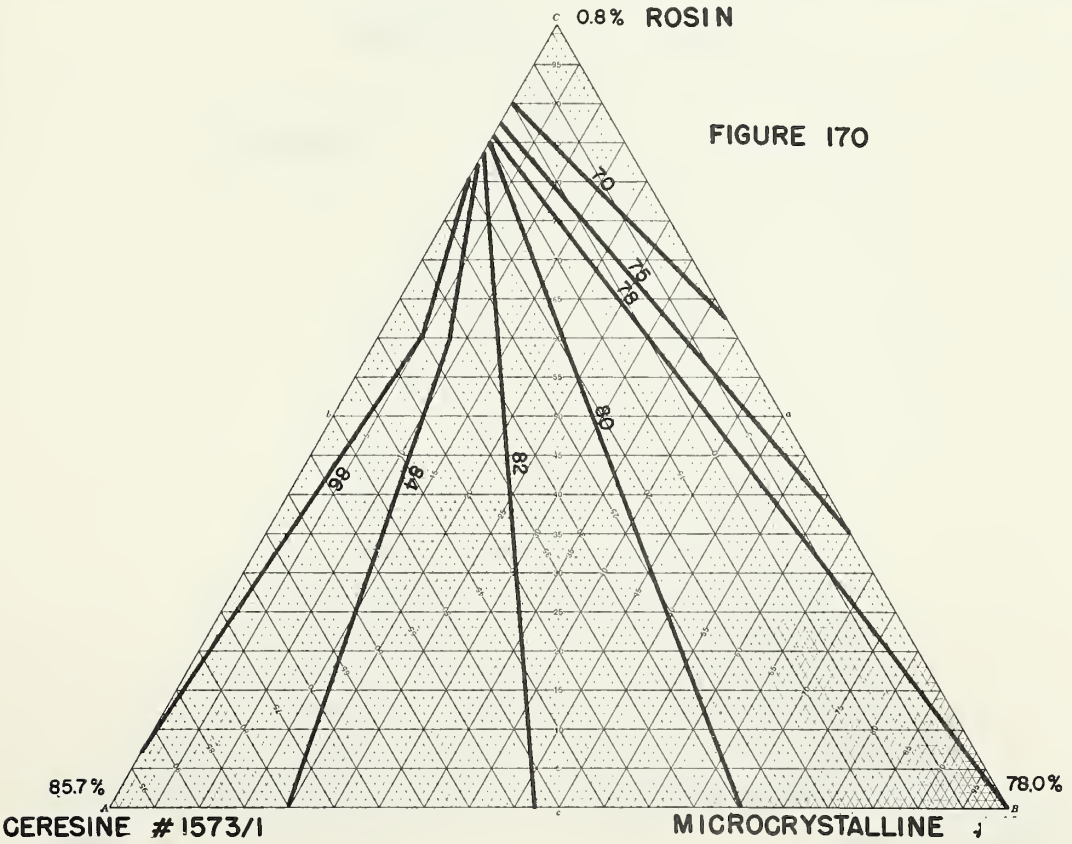


FIGURE 169



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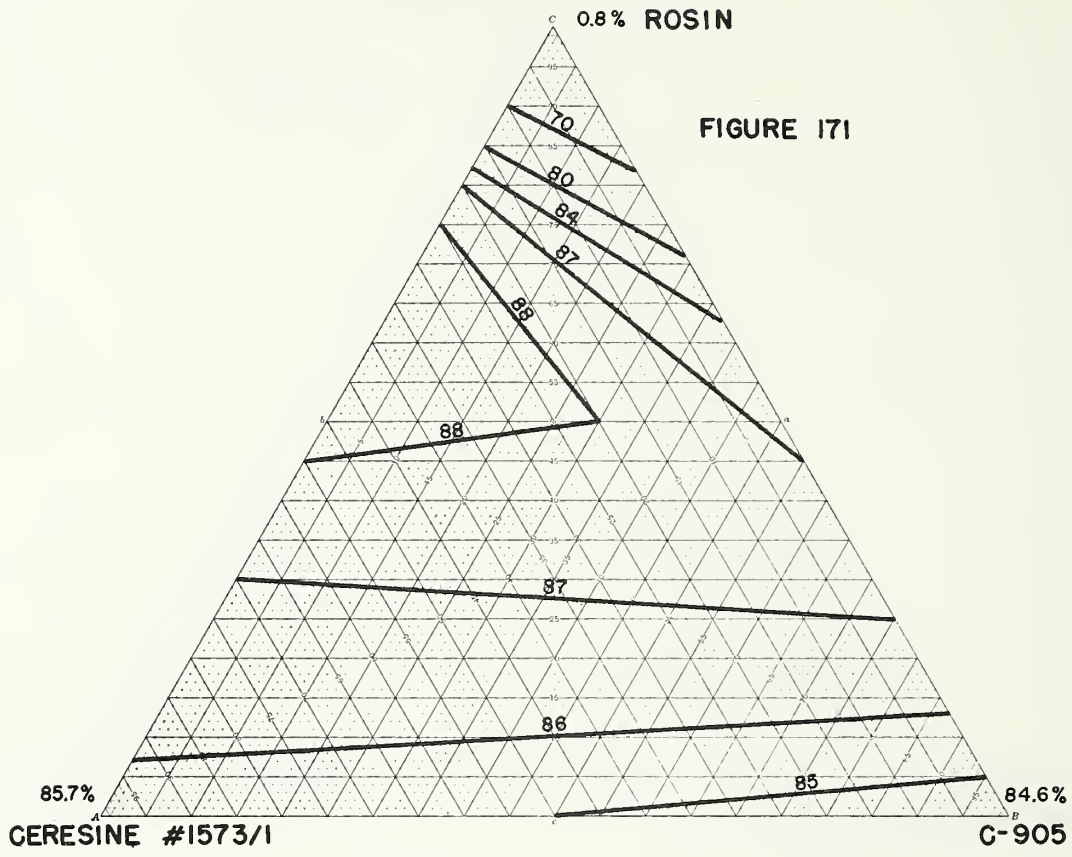


FIGURE 171

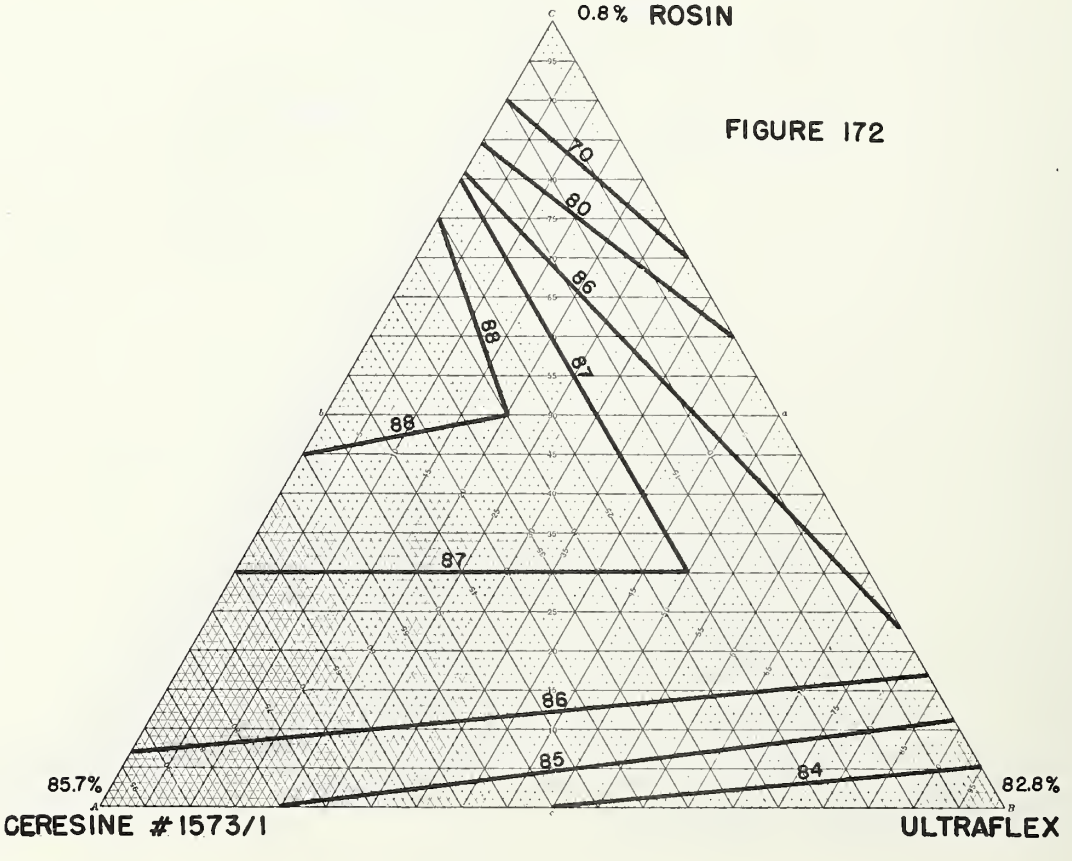
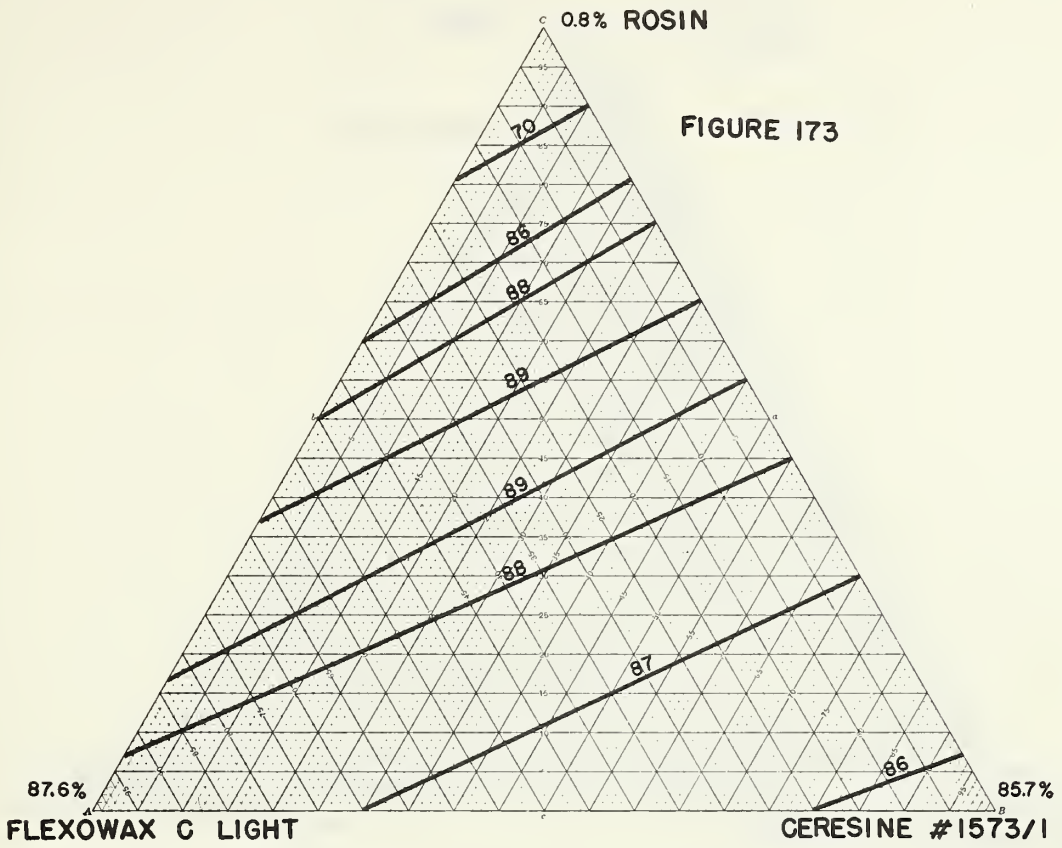


FIGURE 172



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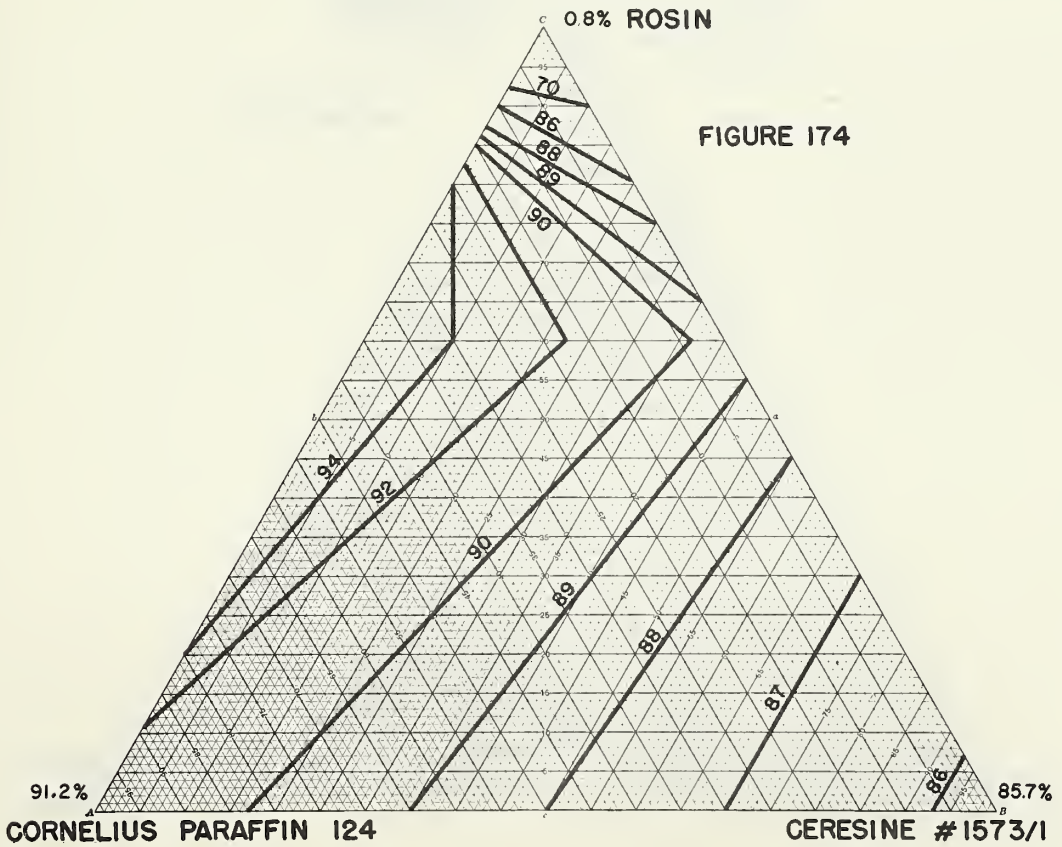

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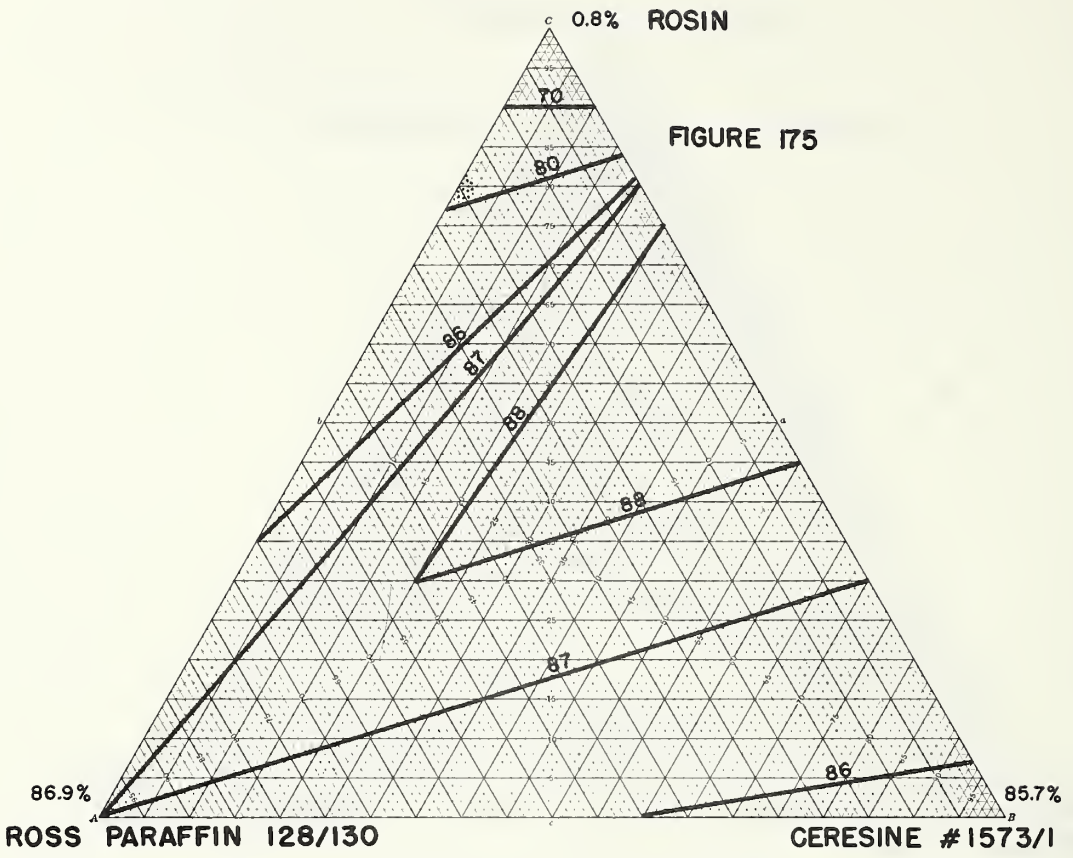

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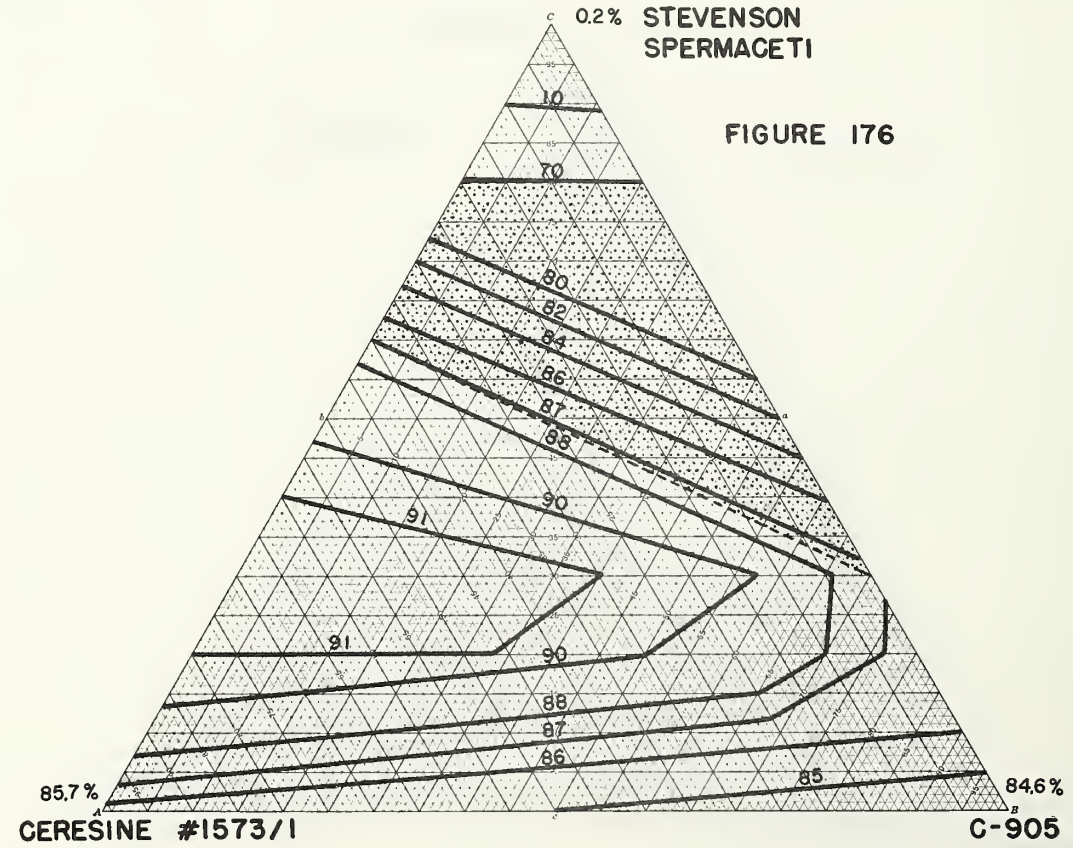

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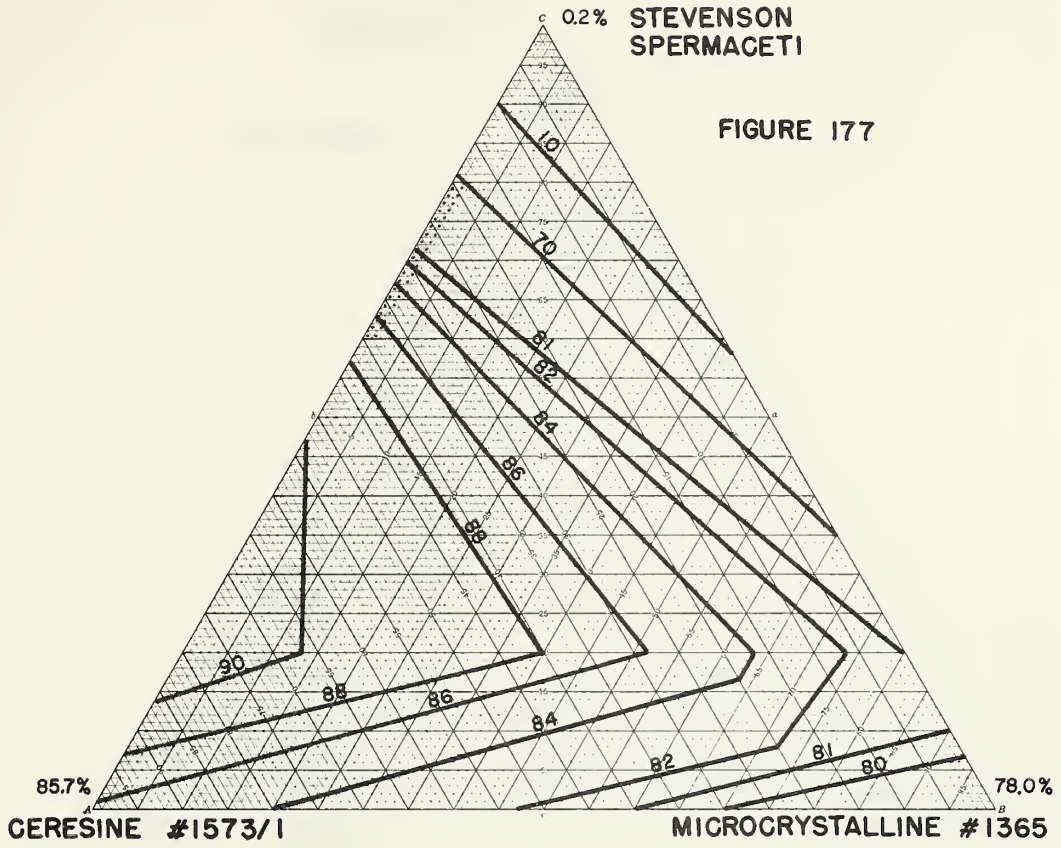

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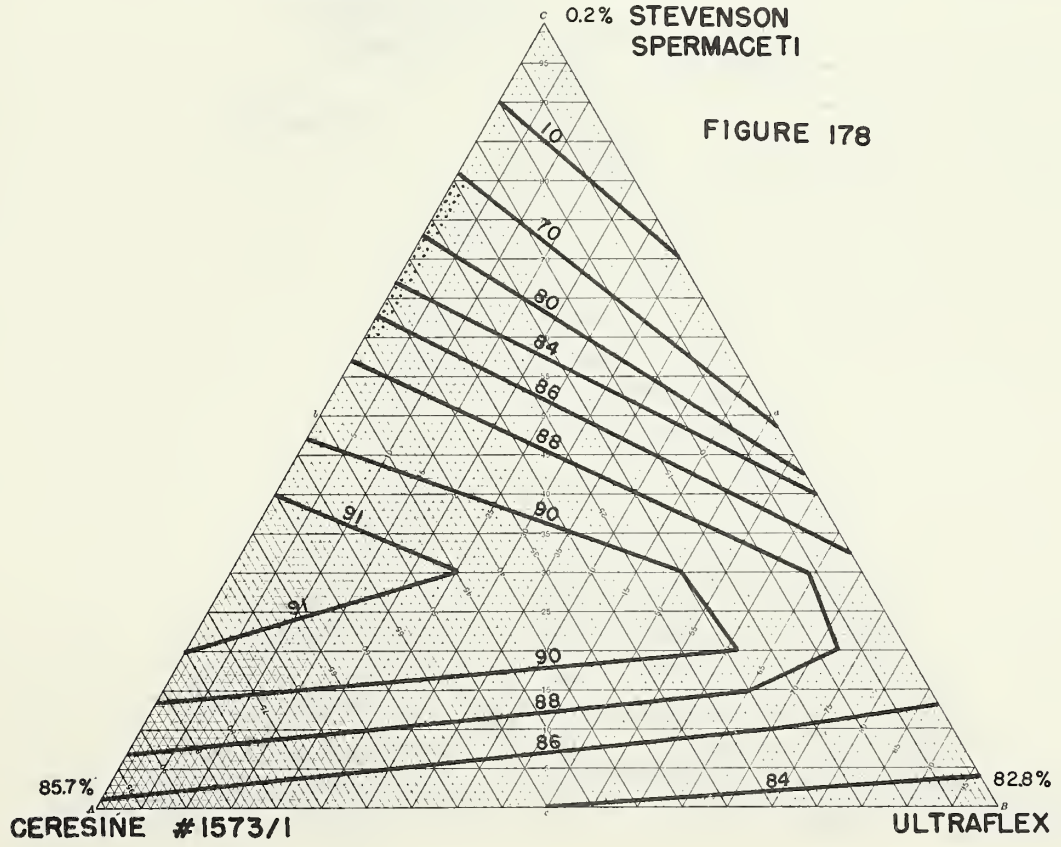


FIGURE 178

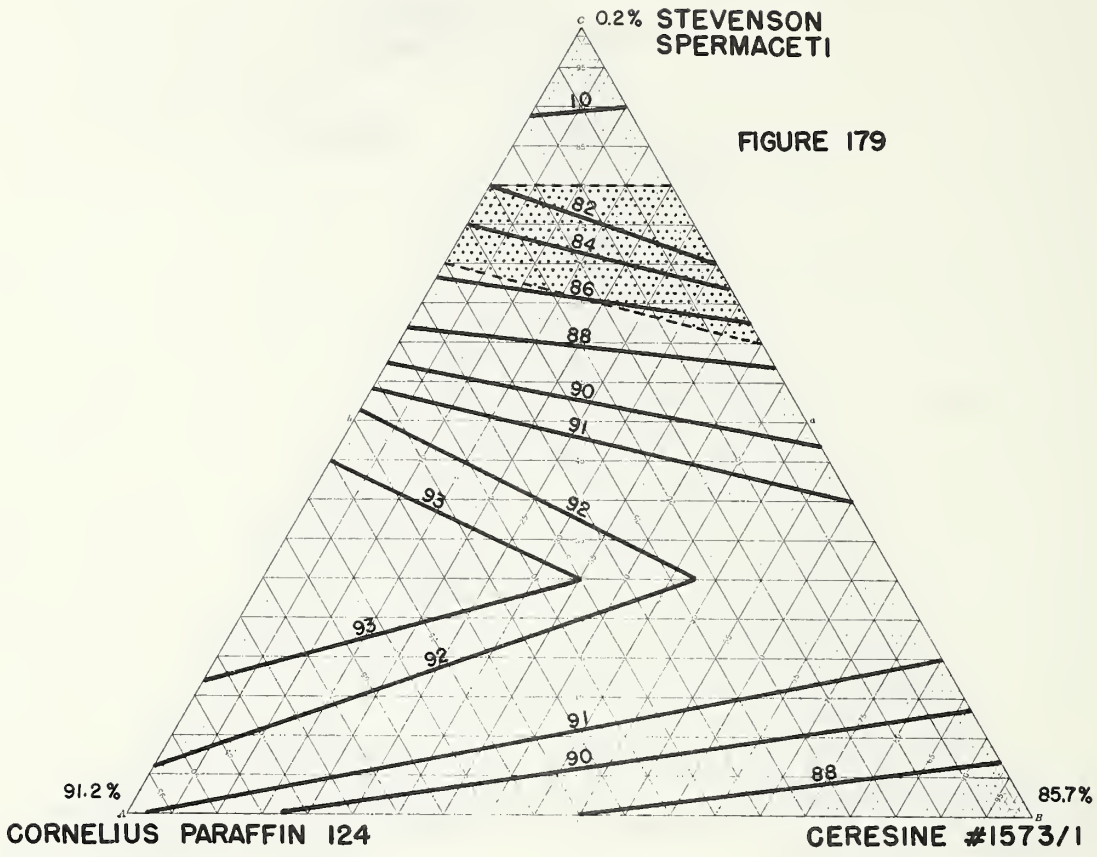
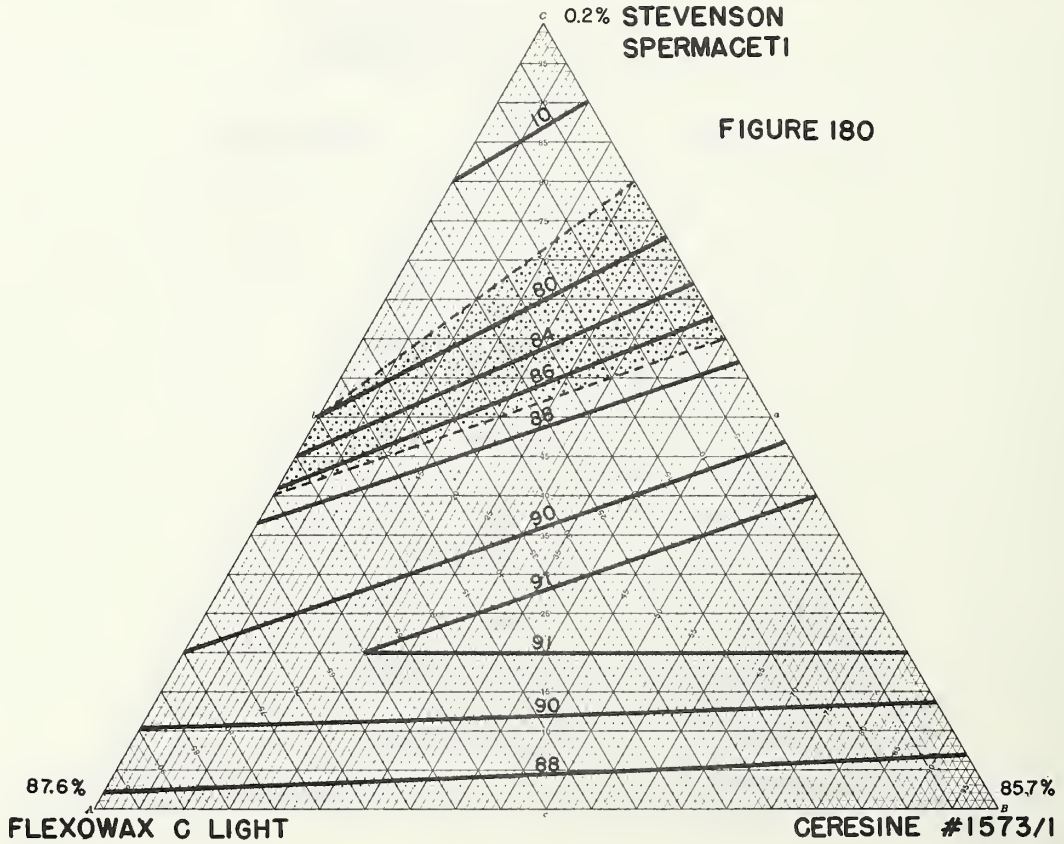


FIGURE 179



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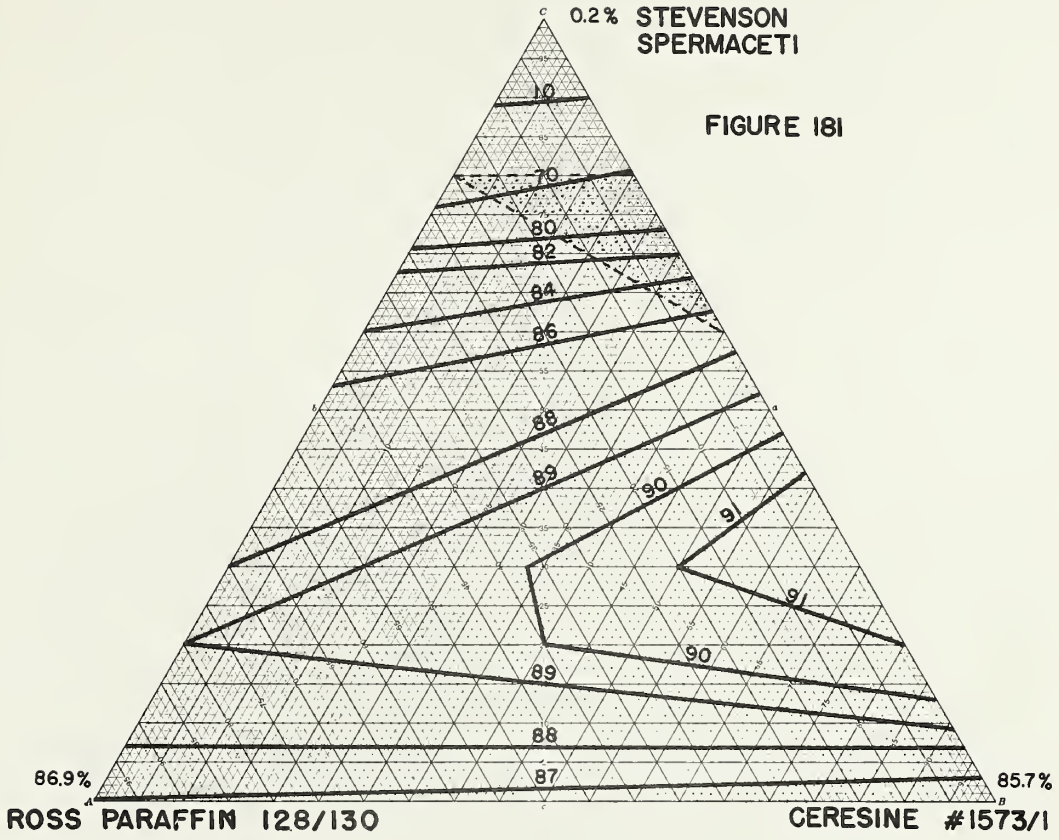

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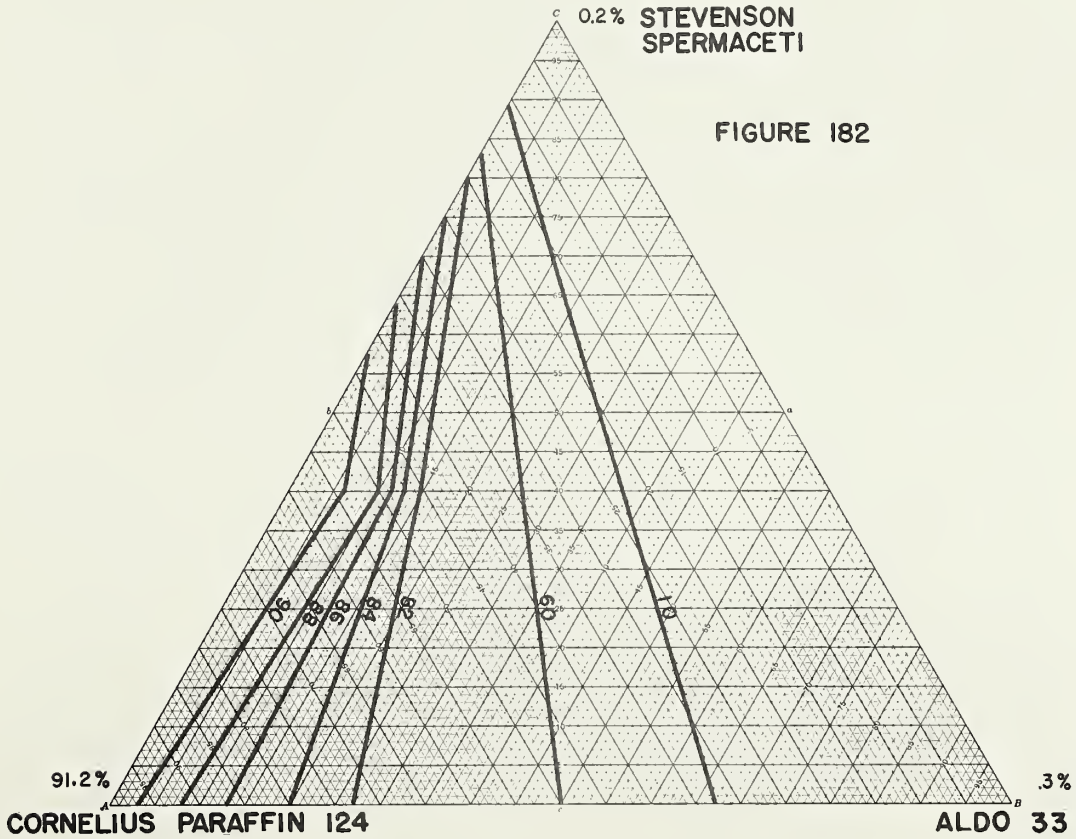

FIGURE 182


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