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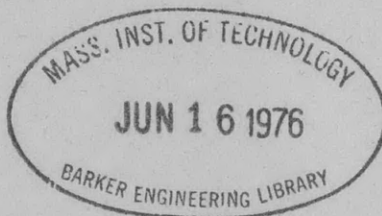
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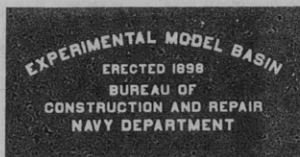
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UNITED STATES EXPERIMENTAL MODEL BASIN

NAVY YARD, WASHINGTON, D.C.



TESTS TO DETERMINE MODULUS OF ELASTICITY
OF STEEL SPECIMENS FROM U.S.S. PRESTON



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TESTS TO DETERMINE MODULUS OF ELASTICITY OF STEEL SPECIMENS
FROM U.S.S. PRESTON

Introduction:

During the tests on the U.S.S. PRESTON, a great number of strain readings were taken at designated stations throughout the ship. To determine the true stress developed in the metal at these strain gage stations, it is necessary to know the true modulus of elasticity of the metal under strain. For this reason sample pieces were taken from the ship and tests were conducted for the purpose of determining this modulus of elasticity.

In addition, one of the purposes for which tests on the PRESTON were made was that of determining the modulus of elasticity of the complete ship structure. Since Sir John Biles' notable experiment on the WOLF, there has been much discussion as to the reasons for the difference between the ship modulus and that determined for a tensile test specimen. In this case the true modulus of elasticity of the tensile test specimen can be used as a basis of comparison to that determined for the ship structure as a whole.

Nine specimens were taken from the ship, the majority of which were of high tensile steel. Tensile test specimens were made from these and numbered from one to nine. There are two number sevens, 7_1 and 7_2 . In the remainder of this report specimens will be referred to by these numbers.

Description of the location on the ship from which numbered specimens were taken follows:

<u>Specimen Number</u>	<u>Location</u>
1	Web plate, intermediate deck girder, port.
2	Sheer strake, port.
3	Sheer strake, starboard.
4	Web plate, first longitudinal, port.
5	Web plate, first longitudinal, starboard.
6	Intermediate deck girder, starboard.
$7_1, 7_2$	Deck stringer plate, port.
8	Deck stringer plate, starboard.
9	Top bar, vertical keel.

Testing of Specimens:

From each piece of material were cut tensile test specimens of the same proportions as prescribed in Appendix II of the "General Specifications for

Inspection of Material," dated 1 March 1930.

The length of parallel section for all test pieces was 14" except that specimens Nos. 2 and 9 were 8" and specimen No. 7₁ was 3½" long. The thickness and width of each section were carefully measured and cross section areas calculated:

TABLE I

Specimen No.	Width Inches	Thickness, Inches	Cross Section Area, Sq.ins.	Length of Parallel Section, Inches	TEST RESULTS	
					Proportional Limit, lbs.per.sq.in.	"E" Lbs.per sq.in. x 10 ⁶
1	1.500	.300	.450	14	23000	29.0
2	1.500	.392	.588	8	27000	27.4
3	1.500	.410	.615	14	17000	28.7
4	1.500	.395	.592	14	21000	29.0
5	1.500	.389	.583	14	21000	29.1
6	1.500	.320	.480	14	18000	29.5
7 ₁	1.498	.375	.562	3.5	21000	27.0
7 ₂	1.500	.461	.691	14	25000	29.5
8	1.500	.458	.687	14	18000	28.8
9	1.500	.259	.388	8	20000	32.7
AVERAGE					21100	29.07

To obtain strain readings three types of strain gages were used; there were no extensometers available for gage lengths of 8 inches or more which would give as accurate readings as the strain gages. Experimental Model Basin 10-inch gages were used on specimens Nos. 1, 3, 4, 5, 6, 7₂ and 8. Huggenberger 1-inch tensometers were used on specimens No. 2 and 7₁, and a Berry 8-inch gage was used on specimen No. 9. The methods of attachment and the number of gages used are indicated on the stress-strain diagrams for the individual specimens. In the cases where more than one strain gage was used on a specimen, the readings were averaged. Where more than one gage was used strain readings were taken on both sides of the specimen.

A Riehl 100,000 lb. machine was used for testing the pieces. From the data obtained, stress-strain diagrams were plotted for each specimen, from which the modulus of elasticity and proportional limit was determined in the usual manner. The values are given in Table I.

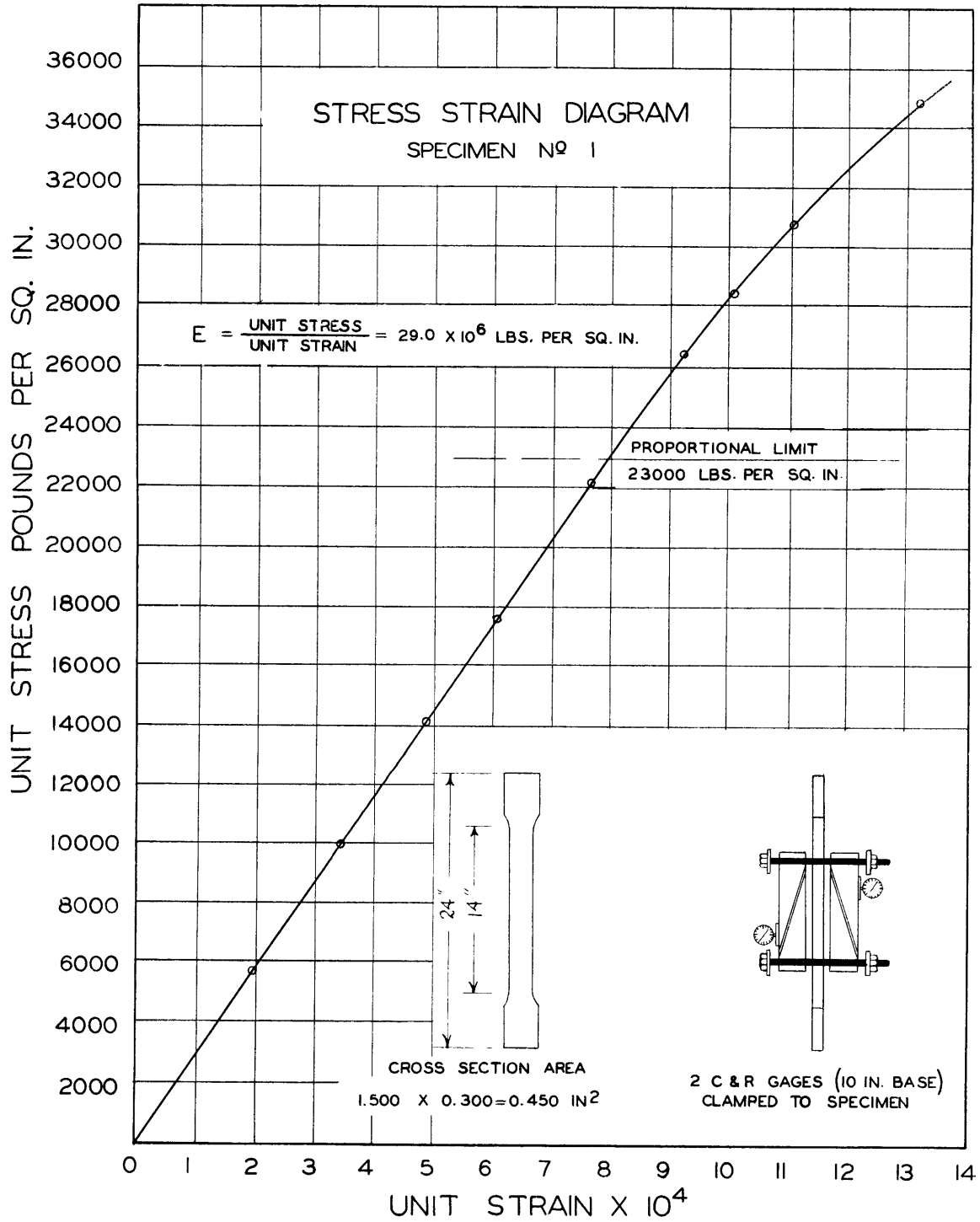
Discussion:

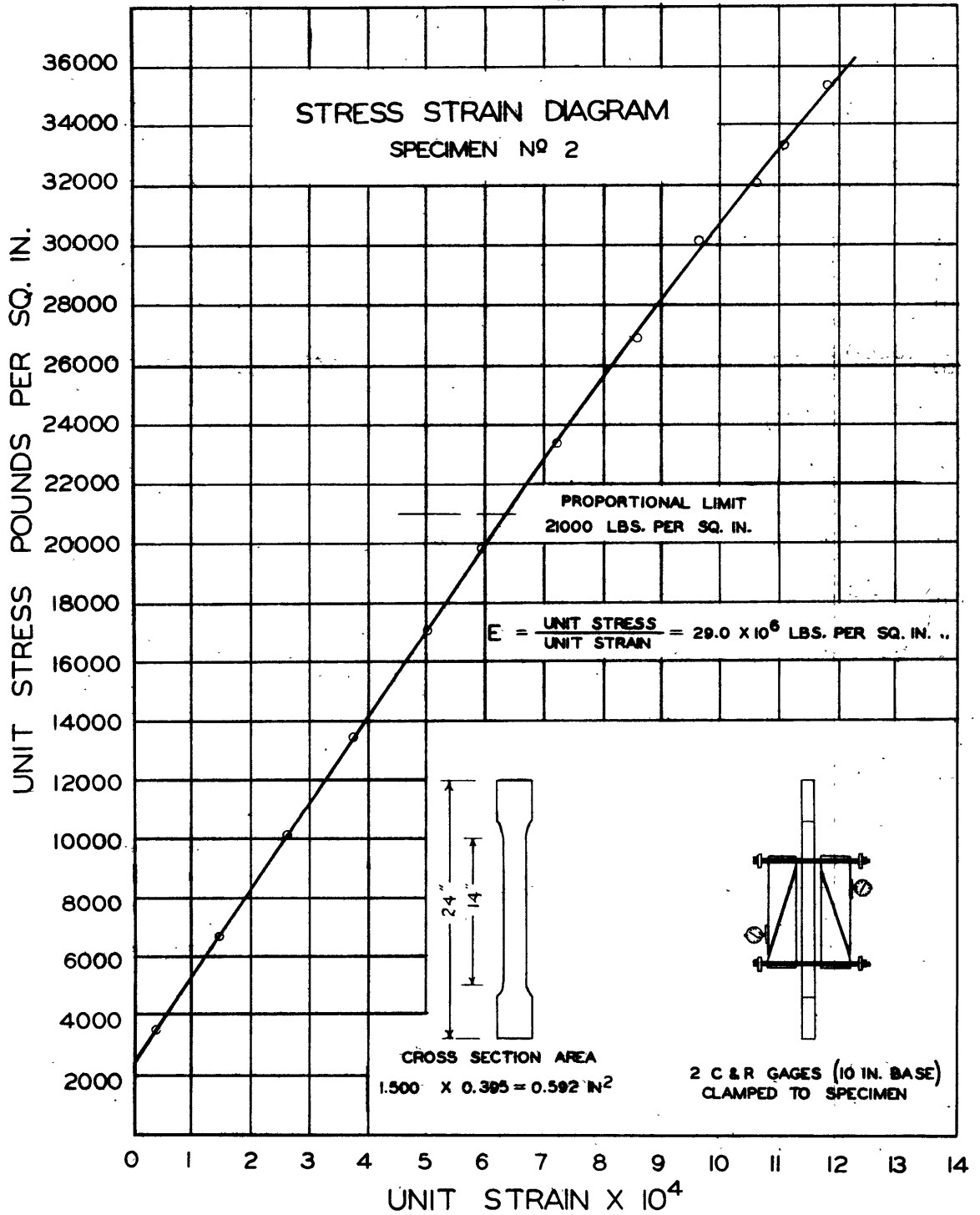
The average E was found to be 29,070,000 as compared with the usually assumed modulus of elasticity for steel of 30,000,000. Results obtained from the long test pieces were consistent but the E values obtained for the shorter specimens were quite low in two cases and quite high in the third case. By coincidence the average value for these three pieces is the same as that for the total. The probable reason that results obtained from short specimens are so erratic, is that the Huggenberger gages used in two cases have a base length of only 1", and hence their accuracy is not as great as the E.M.B. gage with a 10" base length. In the third case only one Berry gage was used, hence readings were taken on only one side of this test specimen.

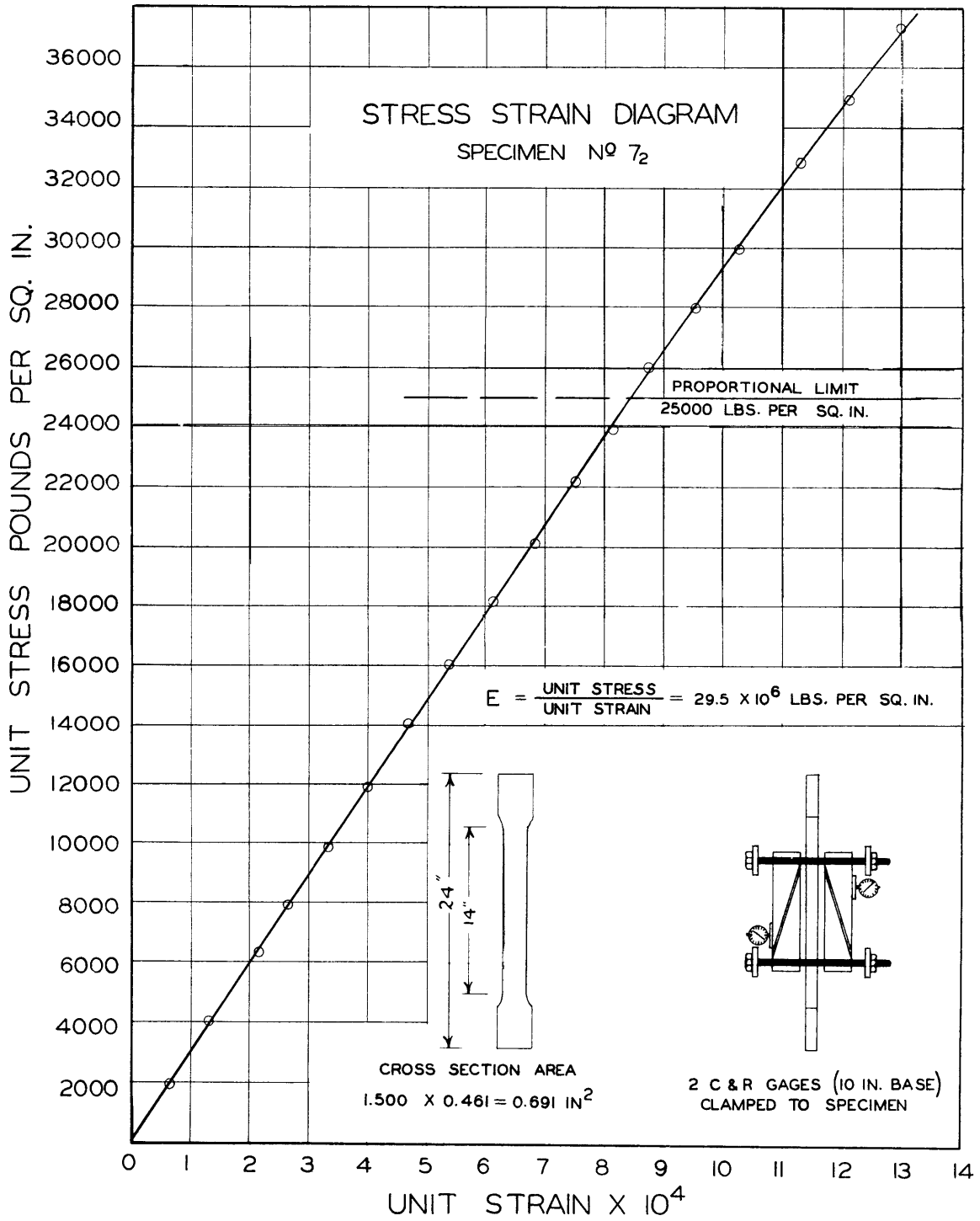
The length of the parallel section of the specimen to which the 8" Berry gage was applied was only slightly longer than the distance between gage holes. In other words, the distance "E" on a Type 2 specimen described in the "General Specifications for Inspection of Material" was only about 1/8 inch instead of 1/2 inch. This may, or may not, be the reason for the high value of modulus of elasticity on this specimen. The distance "E" on all remaining specimens was at least four times the required amount. It is recommended that on all future work where accuracy is desired, the distance "E" be made ample.

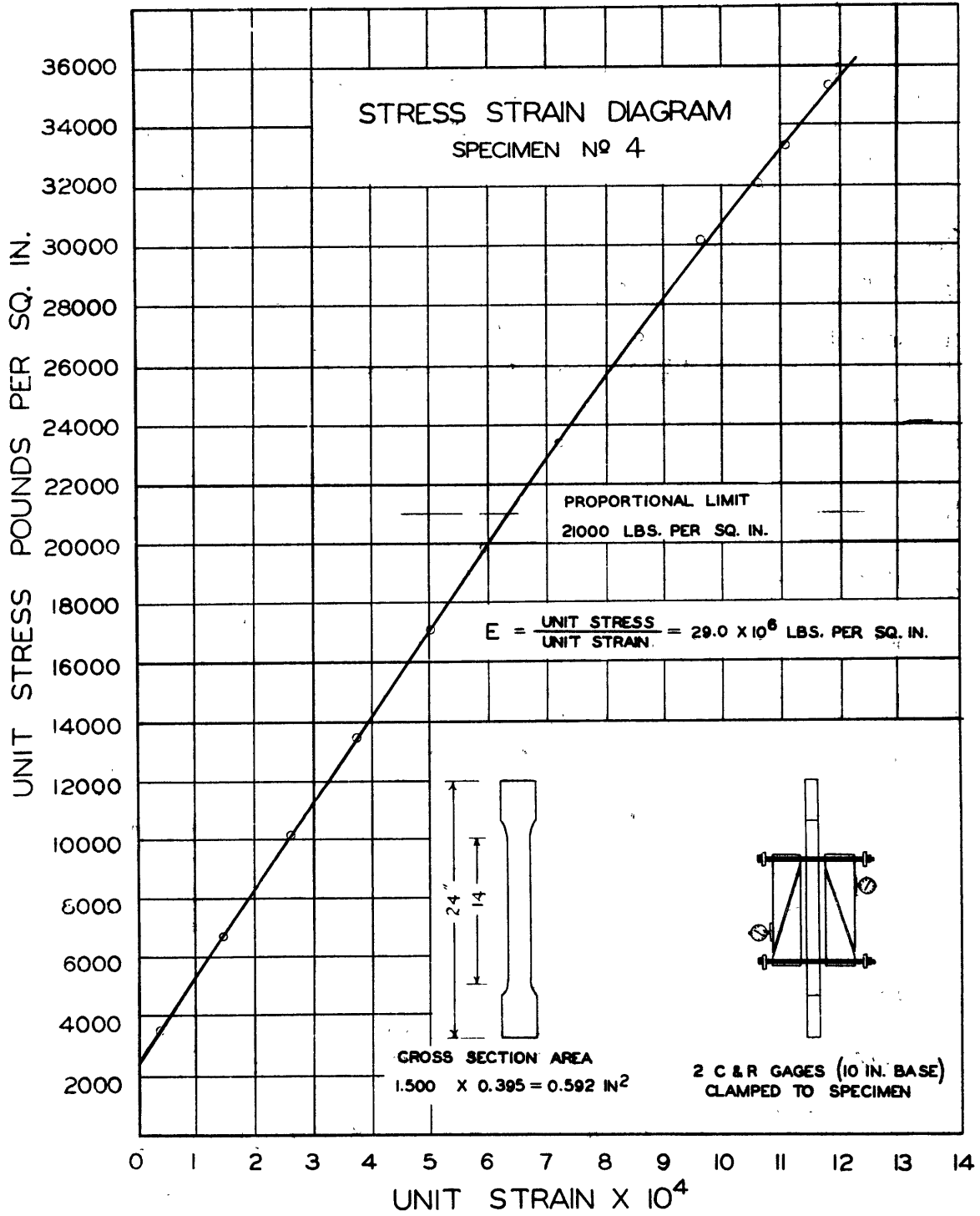
It can be concluded that it is more desirable to have test specimens with long lengths of parallel middle section. Then gages with a long base length can be used and more accurate and consistent results obtained.

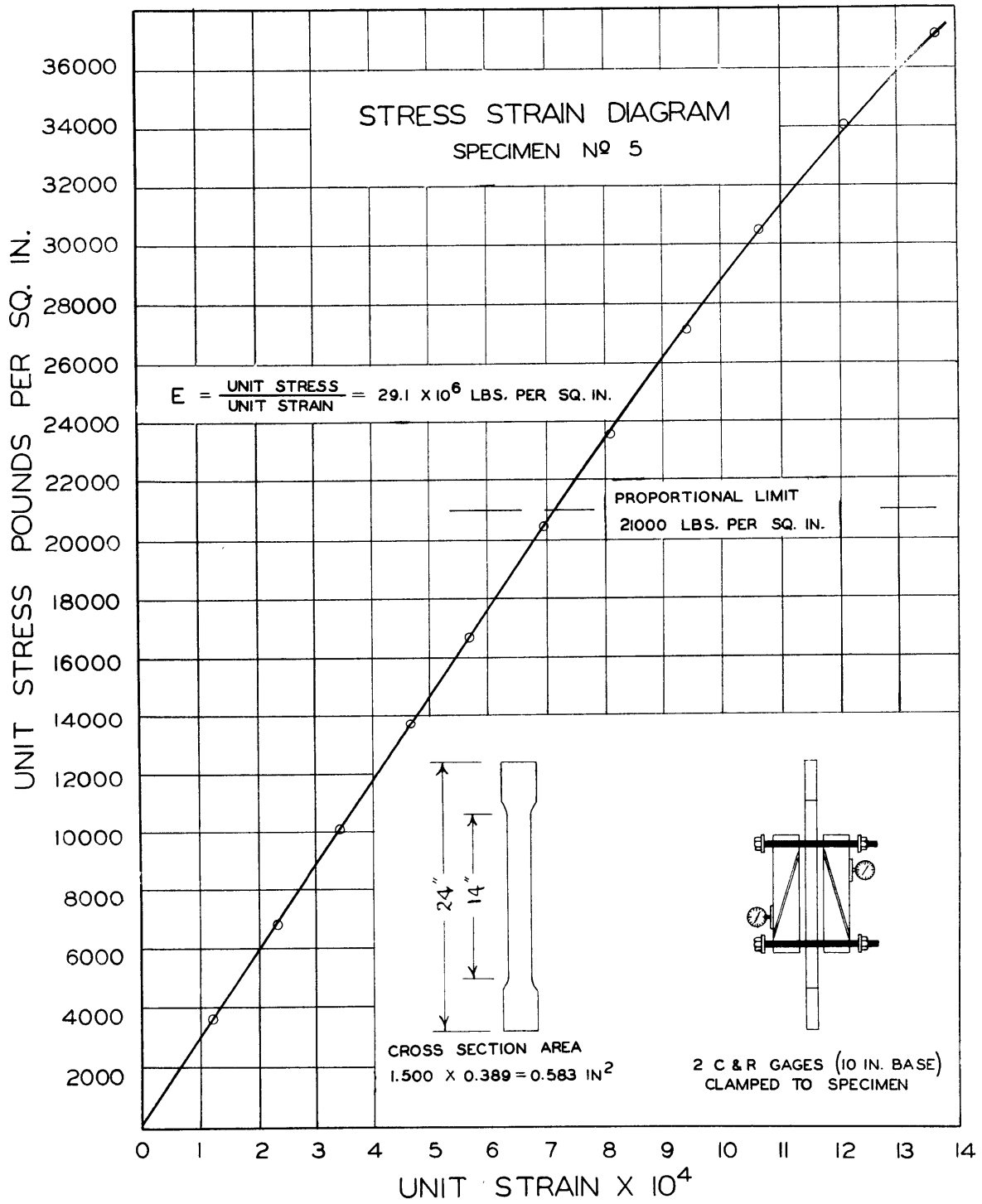
Determination of proportional limit was not called for, but was made as a matter of interest. The values for the proportional limit, as determined by inspection from the appended curves, varied from 17,000 to 27,000 lbs. per sq. in. These are appreciably lower, for high tensile steel specimens, than the values of 30,000 to 35,000 lbs. per sq. in. frequently quoted for mild steel, but it must be remembered that the limit of proportionality for the latter is usually defined as that load which will produce a permanent elongation of 0.0004 inches (approximately) in a length of 8 inches. The fact that a permanent set is produced almost necessarily involves an extension of the load well above the limits marked on the enclosed diagrams.

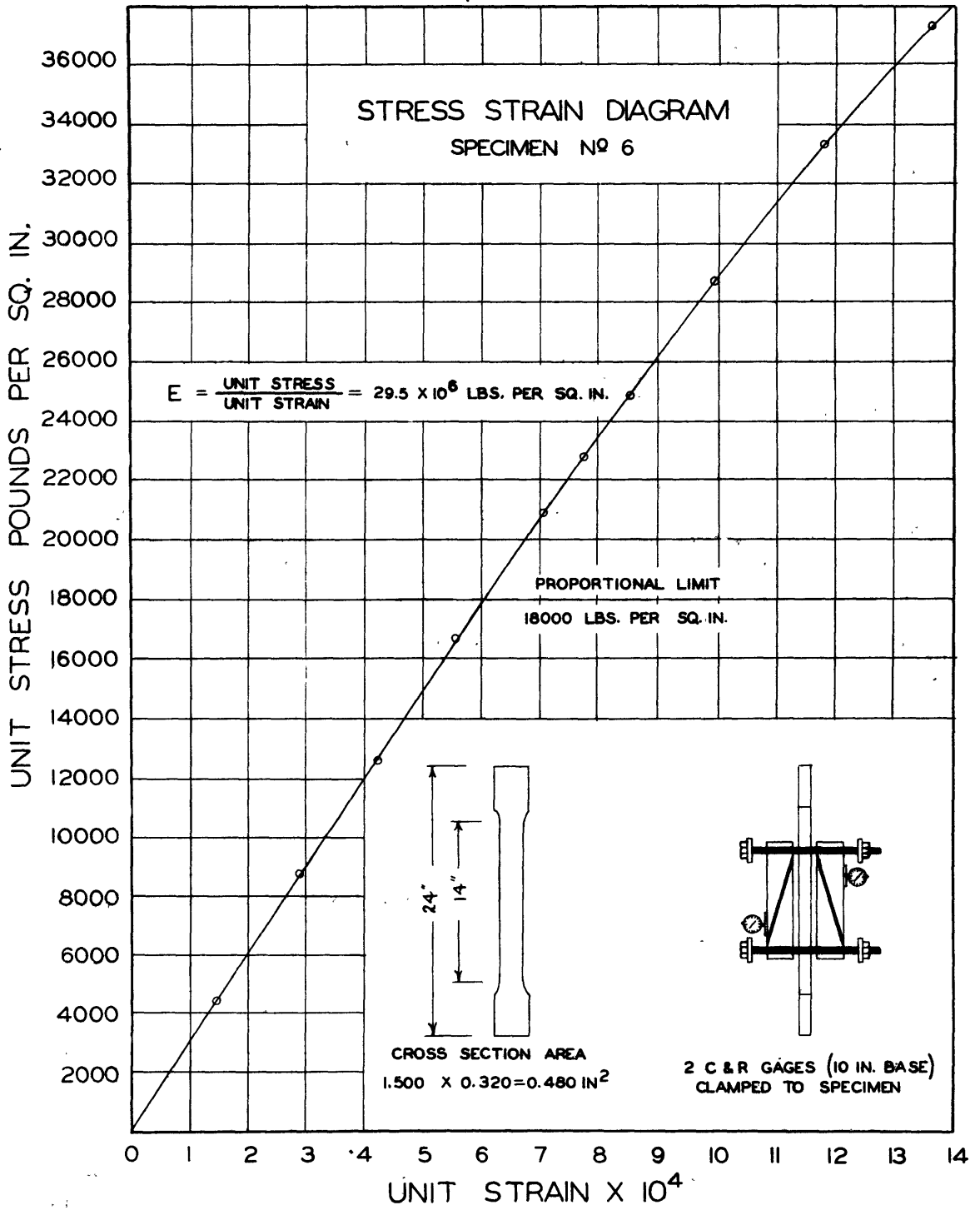


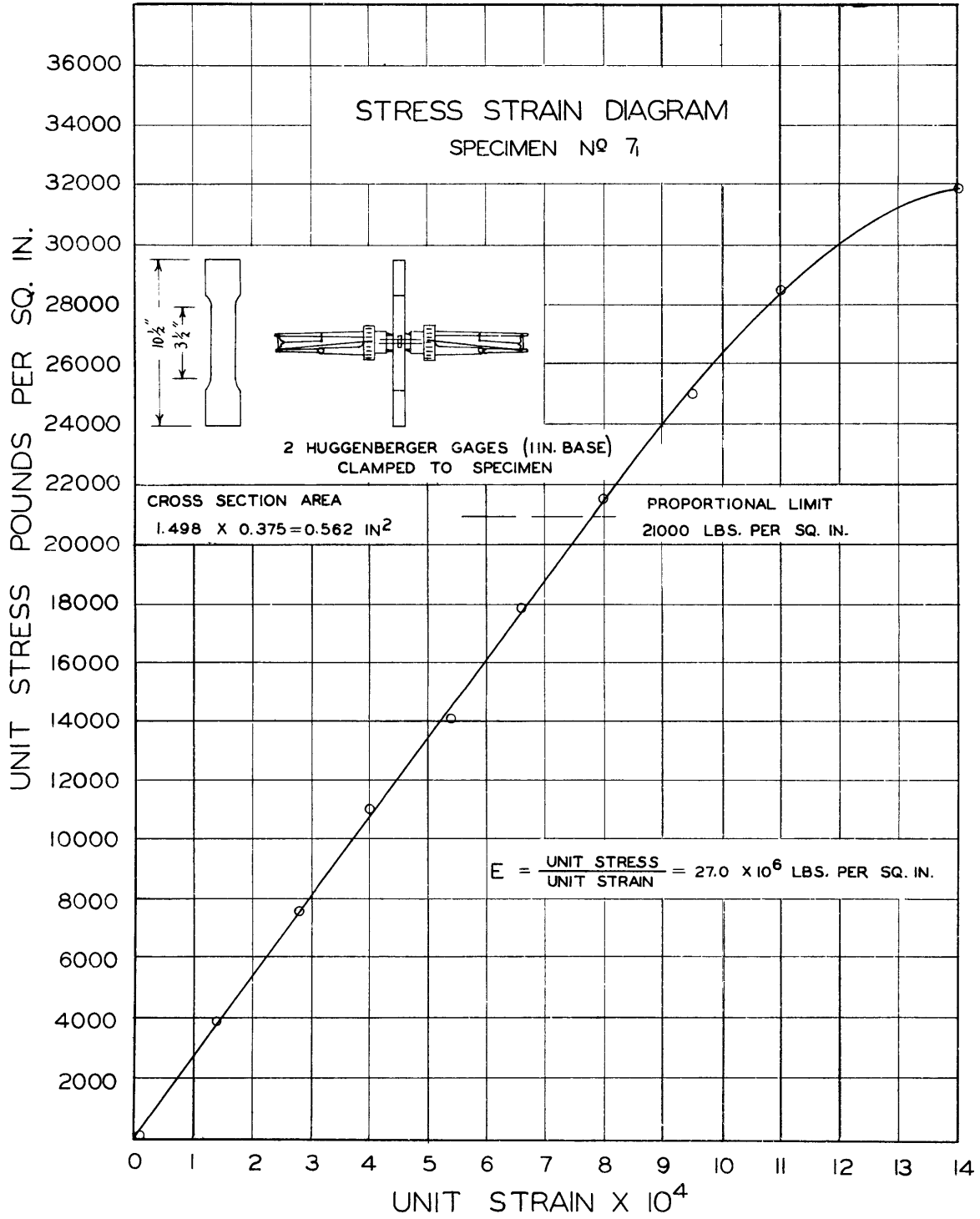


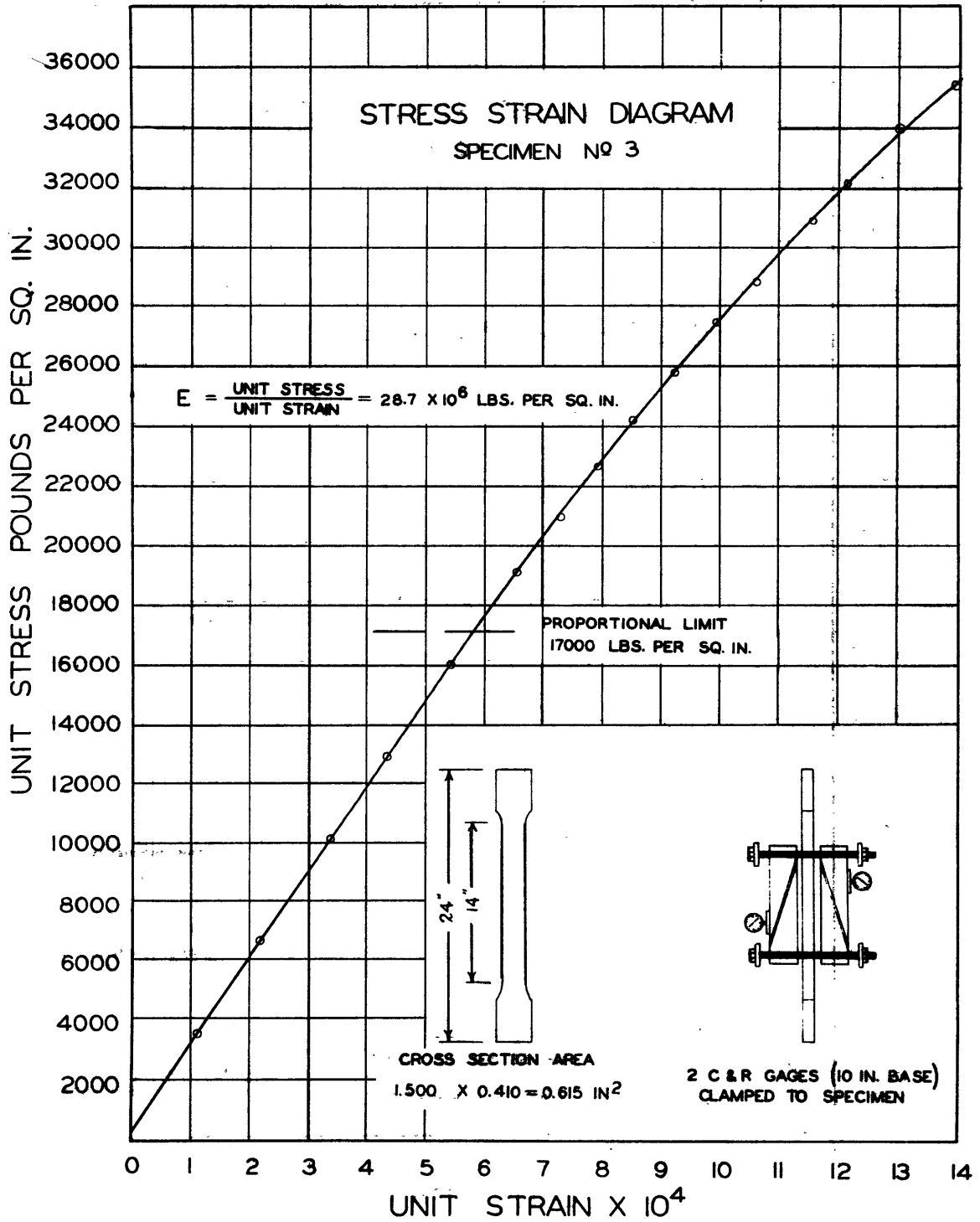


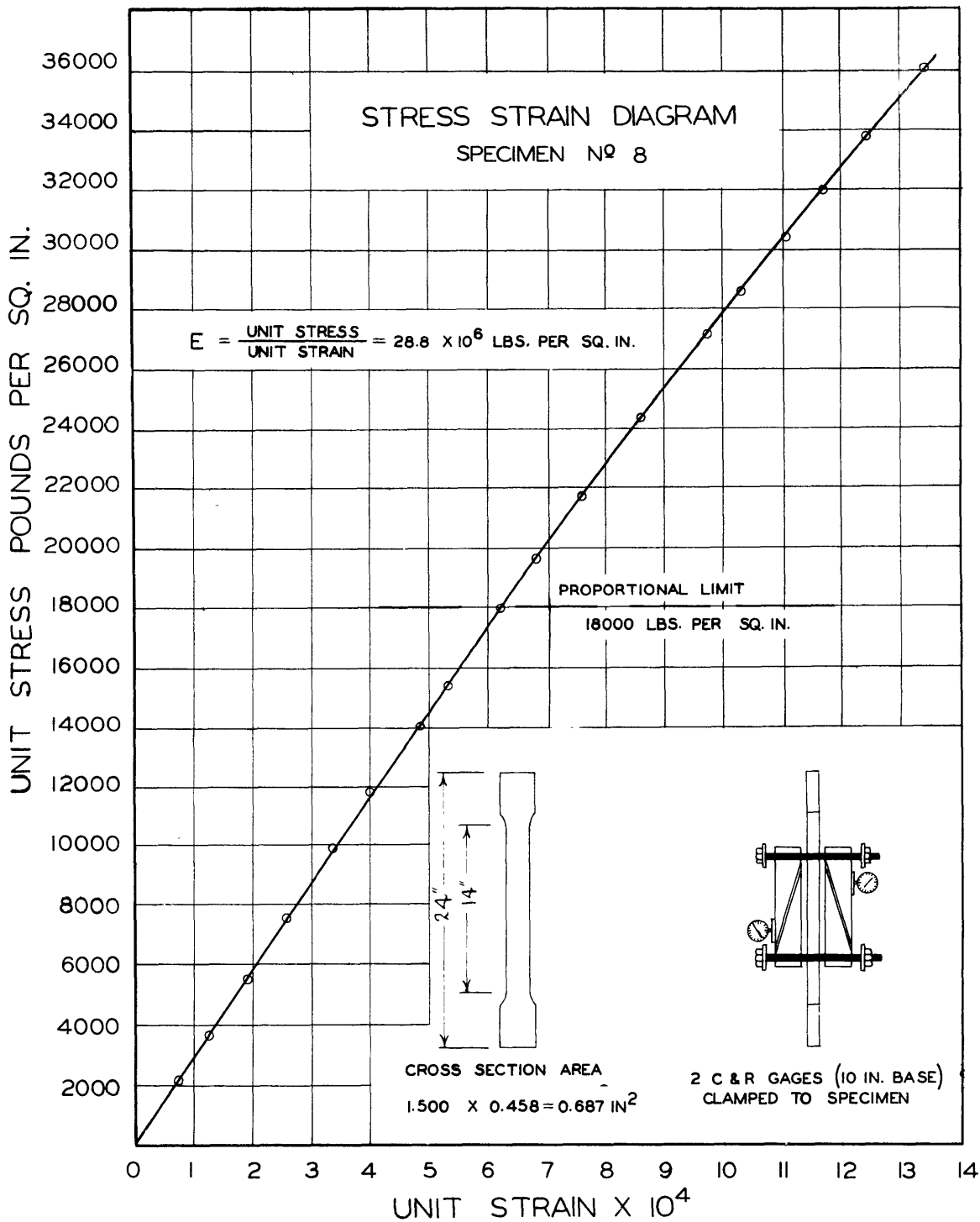


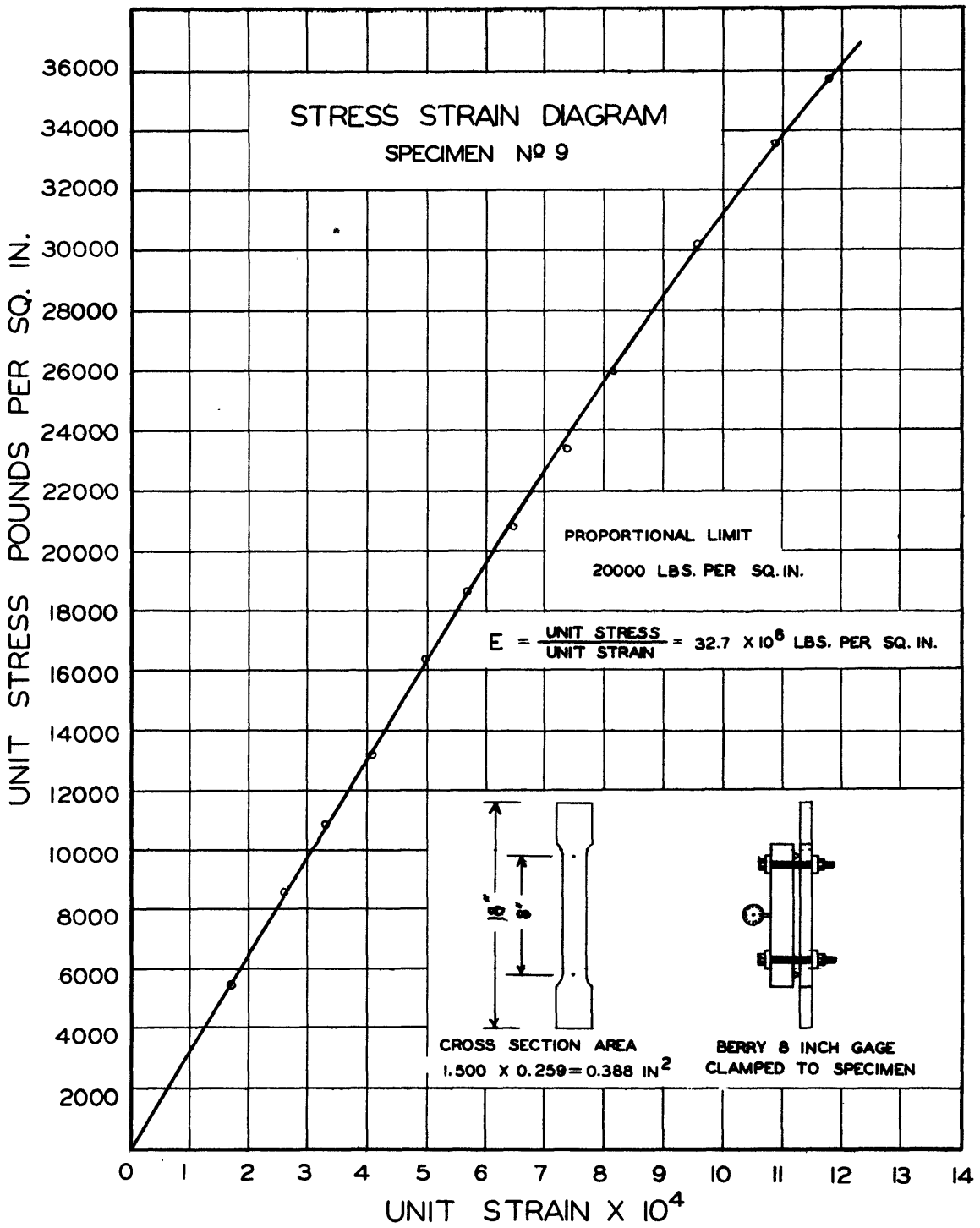












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