NASA CR 132622

STRESS RELAXATION AND MECHANICAL PROPERTIES OF RL-1973 AND PD-200-16 SILICONE RESIN SPONGE MATERIALS

Final Report
Contract No. NAS1-13342
Texas A&M Research Project - RF 3098

NASA-CR-132622) STRESS RELAXATION AND ECHANICAL PROPERTIES OF RL-1973 AND D-200-16 SILICONE RESIN SPONGE MATERIALS inal Report, 6 Jun. 1974 - 28 Apr. 1975 Texas A&M Research Foundation) 181 p HC G3/24

N75-21372

Unclas
18602

a report from the Texas A&M RESEARCH FOUNDATION
College Station, Texas

Prepared for
National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia 23665

by

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April 1975

STRESS RELAXATION AND MECHANICAL PROPERTIES

OF

RL-1973 AND PD-200-16

SILICONE RESIN SPONGE MATERIALS

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Final Technical Report

on

Contract No. NAS1-13342

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National Aeronautics and Space Administration

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FOREWORD

This final report was prepared by the Mechanics and Materials Research Center of Texas A&M University for the National Aeronautics and Space Administration, Langley Research Center under Contract NAS1-13342, "Stress Relaxation and Mechanical Properties of RL-1973 and PD-200-16 Silicone Resin Sponge Materials." Work reported herein was performed under the direction of Mr. A. Chapman who served as the Contracting Officer's technical monitor. Program duration was from 6 June 1974 to 28 April 1975.

The authors wish to acknowledge the contributions of the following individuals who were directly responsible for performing the program tasks and preparing this final report: Research Assistants; W. E. Conger and D. J. Fisher--Civil Engineering, N. Conrad--Aerospace Engineering. Laboratory assistance and data reduction was also provided by M. E. G. Fisher and K. Johnson.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES
(CONTINUED)

SYMBOLS

A	shear area, mm^2
G	modulus, N/m^2
h	sample thickness, mm
L	sample length, mm
P	load, N
T	temperature, degrees Kelvin (K)
t	time, seconds
W	sample width, mm
α	coefficient of thermal expansion, mm/mm/K
γ	shear strain, mm/mm or %
Δ	sample deformation, mm
τ	shear stress, N/m^2

Subscripts:

c	constant
g	glassy
i	initial
m	maximum or failure
o	reference
rel	relaxation
s	secant

1.0 INTRODUCTION AND SUMMARY

1.1 Purpose

The purpose of this study is to measure stress relaxation characteristics and other mechanical properties of two silicone resin sponge materials over a broad range of cold temperatures well below those anticipated during a space shuttle orbiter mission.

1.2 Scope and Objectives

The overall scope of the activity for this project was to furnish personnel, facilities, services, equipment and materials necessary to evaluate the stress relaxation and mechanical properties of two, government-furnished silicone resin sponge materials. Specific objectives included:

- Conduct shear stress relaxation tests at four (4) strain levels and nine (9) temperatures for each material.
- Determine failure properties at nine (9) temperatures and one (1) strain rate not to exceed 0.005 s^{-1}.
- Evaluate initial tangent modulus, ultimate secant modulus, ultimate strength and strain at failure.
- Determine glass transition temperature, T_g and coefficient of linear thermal expansion, α, for each material.
- Publish a final report of test results.
- Return tested samples to NASA-Langley upon completion of the work.

1.3 Background

The materials evaluated in this program represent candidates proposed for use as a strain-isolating layer by which the reusable surface insulation (RSI) for the space shuttle orbiter is attached to the shuttle primary structure. The brittle RSI is the baseline thermal protection system for the spacecraft and was developed to withstand severe thermal gradient of the order of 1400 K including temperatures in the cryogenic range.

Two silicone resins which have been processed into low-density sponges are under consideration for use as the strain-isolating bond material. At cryogenic temperatures the materials undergo a transition and become relatively stiff. Since the bondline temperature may remain in the cryogenic range during reentry when the orbiter is being heated, the possibility exists that the strain isolation pad may not perform its required function. To overcome this problem it may become necessary to place a sheet of high modulus material between the silicone sponge layer and the RSI to further minimize excessive induced strain. The addition of this strain arresting plate would increase the weight of the thermal protection system and hence add an additional weight penalty to the entire orbiter and its mission.

Recent work (ref. 1) involving the characterization of the mechanical behavior of silicone elastomers has shown that strain at failure may increase at certain low temperatures. It was also suggested that stiffness values might decrease as the temperature became colder. These behavioral characteristics are contrary to those normally expected in which strain capabilities decrease and moduli increase to relatively constant glassy values. However, if these behavior characteristics can be substantiated it may be possible to eliminate the strain arresting plate and its attendant weight. The tests and results discussed in this report were designed to provide a resolution of this question.

Supportive tests to establish the linear coefficient of thermal expansion, α, and glass transition temperature, T_g, were also conducted on each material to assist in the analysis of experimental results.

2.0 TECHNICAL PROGRAM

2.1 General

Stress relaxation tests were conducted by loading specimens in double-lap shear to a preselected strain level and monitoring the decay of stress with time. Before performing the test, the specimen temperature was allowed to stabilize. Time to achieve thermal equilibrium was determined by monitoring the output of a thermocouple embedded within a control specimen in the environmental chamber. The selected strain level was applied at a strain rate of 0.002 s^{-1} and was maintained for at least one hour while the specimen stress level was recorded. The specimen was then loaded to failure at 0.002 s^{-1}. Initial tangent modulus, secant modulus at failure (i.e., at maximum stress), ultimate stress and corresponding strain were determined for each test.

A total of 72 tests on each material were performed as described above; generally, two replicate tests for each condition. Each material was subjected to at least 36 test conditions including the temperatures and strain levels listed below:

Strain levels (4): 1, 3, 5 and 10 percent

Temperatures (9): 100, 125, 150, 175, 200, 225, 250, 275 and 300 K.

2.2 Materials

The two foams studied in this work were silicone based formulations which the manufacturers considered to be proprietary. The General Electric material, PD-200-16, is an open-cell RTV-560 with no other additives but filler and blowing agent. The major constituent is poly(methylphenylsiloxane). The Raybestos Manhattan material, RL-1973, is a closed-cell foam and was also indicated to be a poly(methylphenylsiloxane) with vinyl groups crosslinked with an organic peroxide crosslinking agent. The GE material also contained crosslinking sites and a crosslinking agent which were not specified. Thus, it was impossible to distinguish between these two materials from the chemical descriptions made available (ref. 2). The above information was obtained by telephone conversations with representatives of both GE and Raybestos.

2.3 Experimental Program

2.3.1 Sample Preparation

The double-lap shear specimen consists of identical pieces of the silicone sponge material (12.7 x 25.4 x 127.0 mm) sandwiched between three aluminum platens (4.8 x 25.4 x 177.8 mm) as shown in Figure 1. The PD-200-16 and RL-1973 samples were bonded in blocks of seven or eight as needed in order to preclude the possibility of a bonding irregularity permeating the entire sample group. Before bonding, the aluminum bars were roughened by sandblasting and degreased with acetone. The bars were coated with SS-400 Primer and allowed to dry for one hour or longer. The RTV-560 adhesive was prepared in accordance with General Electric specifications (ref. 3) using dibutyl tin dilurate as a catalyst.

The aluminum bars were separated with glass slides on a clean paper sheet, and coated with a thin layer of the prepared RTV compound. Initially, dry sheets of the silicone resin foam were attached to this wet

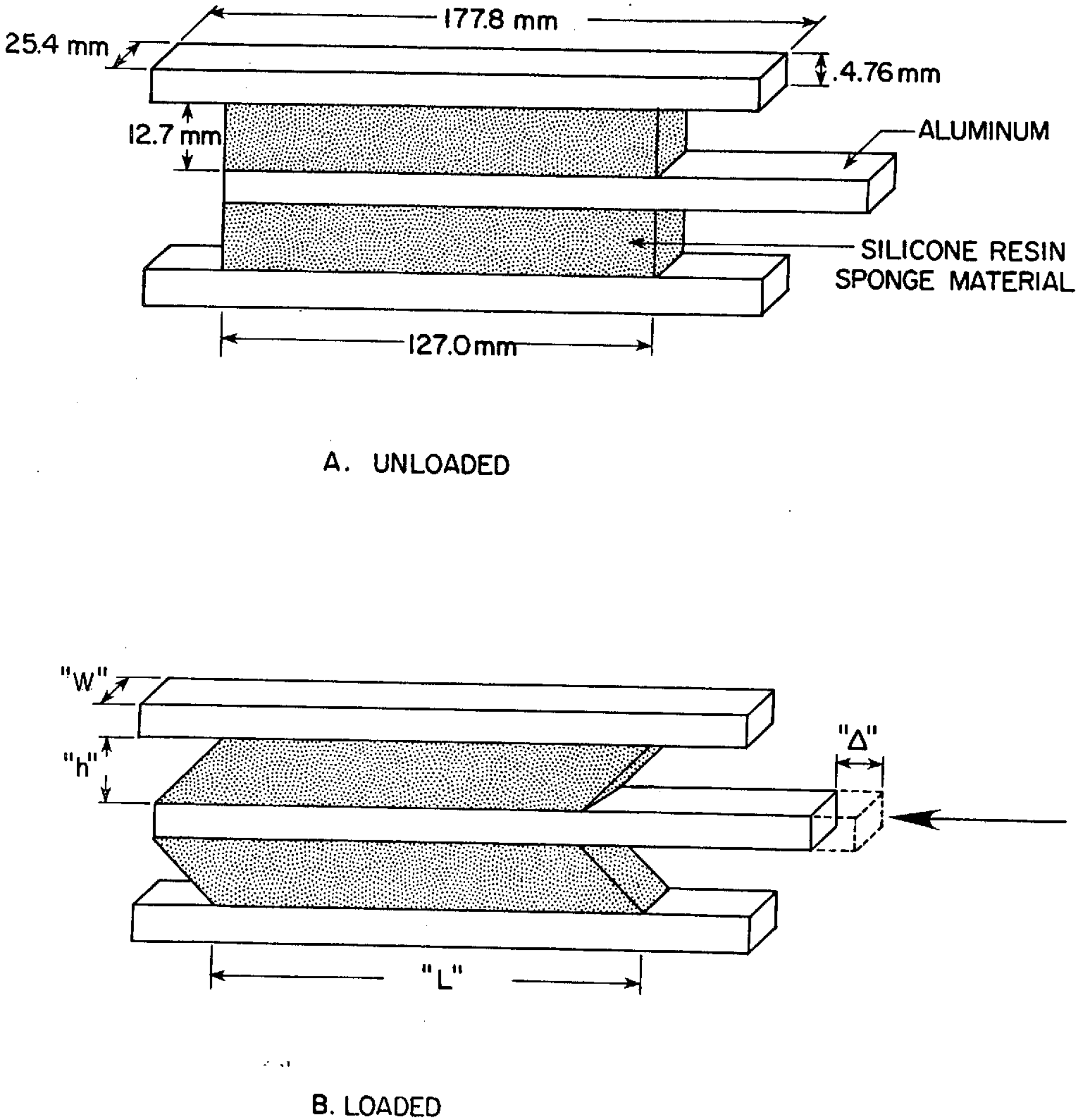

Figure 1. Double lap shear specimen.

layer and set aside to dry. It was found that the PD-200-16 material bonded well in this manner because of its great porosity. In contrast, the RL-1973 material frequently failed to become thoroughly wetted and, consequently, formed poor bonds. It became necessary to add RTV 560 to both the RL-1973 sponge and the aluminum platen to achieve a secure bond.

After the bars and material were properly positioned and aligned, they were taped to the table to avoid slippage during curing of the adhesive. In accordance with General Electric specifications for the RTV bonding material, the samples were allowed to set for 48 hours at room temperature. They were then taken to an environmental chamber and kept at a constant temperature of 333 K and 25% R.H. for at least 72 hours to ensure complete curing of the bond. The blocks of sample were removed from the environmental chamber and the protruding RTV and silicone foam trimmed from the sides of each sample with razor blades. After the samples had cooled to room temperature, those that were to be tested at temperatures less than 275 K were individually wrapped in dessicated plastic bags to avoid moisture and placed in a freezer at 258 K. Samples used for the warmer temperatures were kept at 296 K and 55% R.H.

2.3.2 Apparatus

The primary piece of equipment used to perform the relaxation and failure tests was the Instron Universal Testing Machine. Forces encountered ranged from less than 4.0 N at the warmer test temperatures to more than 20 x 10^3 N at the colder temperatures. At the warmer temperatures, two load cells with maximum ranges 0 to 900 N and 0 to

450 N respectively were used, while at the temperatures below the glassy transition, a 9 MN maximum load cell with a 0 to 225 N full scale maximum sensitivity was used. All loads were recorded on the 254 mm wide motor driven chart of the Instron console.

Linear variable differential transformers (LVDT's) were the primary instruments used to measure sample deformation. The LVDT's employed had a 5 mm total travel with a sensitivity of 1.27 x 10^{-3} mm per microvolt (μv). The LVDT's were calibrated such that 0.127 mm of deformation (1% strain) produced 1000 μv of output. The output of the LVDT's was fed into a signal conditioner and was converted to a digital readout and printed on paper tape. When low temperature conditions caused the LVDT's to malfunction, displacement dials (with total travel of 5 mm) were substituted in their place. The deformations readings were then taken manually.

Thermocouples. All temperatures were determined and monitored by the use of copper-constantan thermocouples. The range of measurable temperatures with this type of thermocouple far exceed the 100 K to 300 K range of this testing program. By coupling the thermocouples into the same signal conditioner mentioned above, it was possible to measure a change in temperature of 0.5 K. Inherent asymmetries in the thermocouple wire allowed an absolute calibration only as close as ±3 K.

Cold Chamber. To provide a stable thermal environment necessary to test the properties of the silicone sponge material, a low temperature cryostat was constructed (see Figure 2). The side walls of the chamber were constructed of polystyrene foam and phenolic plates formed

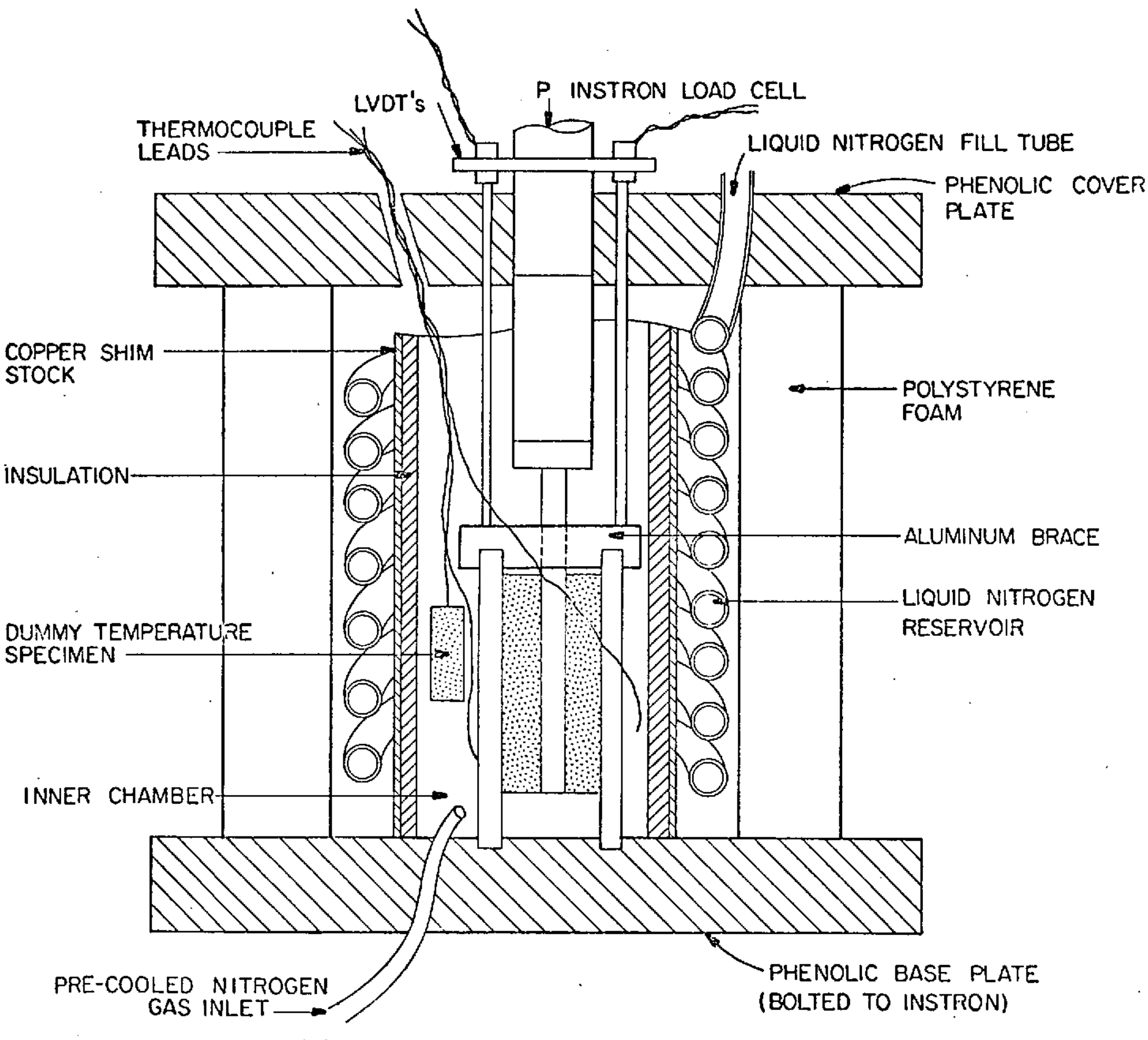

Figure 2. Cross-section of low temperature cryostat.

the base and cover. The inner chamber was constructed using thin sheets of copper shimstock which served three purposes: (1) to add high thermal conductivity in the vertical direction, (2) to avoid the formation of thermal layers within the chamber and (3) to form a reservoir surrounding the sample for the addition of liquid nitrogen into the chamber. In order to precondition the chamber, nitrogen gas, which had been pre-cooled in a liquid nitrogen bath, was introduced into the inner chamber surrounding the sample. The vapor pressure of this cool, dry gas prevented moisture from entering the apparatus and contaminating the specimen. The gas flow rate was kept low enough so as not to disturb the sample, but yet adequate to maintain a continuous circulation. To bring the chamber down to the desired test temperatures, liquid nitrogen was added as needed through a fill tube through the phenolic cover plate. To provide greater stability to the cooling process, a 4 m length of TYGON tubing, through which the liquid nitrogen was fed, was attached to the fill tube and fitted into a coil within the annular space between the chamber wall and the shimstock. Since both open ends of the tube extended outside the chamber, the liquid nitrogen did not come in contact with either the copper or the sample. The low thermal conductivity of the TYGON tubing provided a slow, stable temperature control within the cryostat.

Special walk-in environmental chambers located in the laboratory building were used to perform tests at temperatures of 250 K, 275 K and 300 K. These rooms were large enough to hold the entire test setup and their controlled temperature and humidity made the use of the cryostat described above unnecessary.

2.3.3 Test Methods

Before testing, all load cells, LVDT's and thermocouples were calibrated. Liquid nitrogen was poured into the thermal chamber to prepare it for the sample. An aluminum brace was affixed to the top of the sample while in the freezer in its plastic bag. After a wait of 20 to 30 minutes to allow the chamber to cool, the sample was removed from the freezer and transported to the testing apparatus. It was quickly removed from its plastic cover and set into the chamber. Three thermocouples were then inserted into the chamber, two in the space around the sample and one in a dummy sample of the material to be tested. The chamber lid was quickly set in place and the flow of nitrogen gas was initiated. The Instron crosshead was lowered until the load cell push-rod was just touching the center platen of the sample. The apparatus so assembled was allowed to sit for one to two hours to reach the testing temperature and stabilize. Liquid nitrogen was then added to the chamber reservoir as needed to lower the temperature. After approximately 40 minutes, the three thermocouples showed a stable test environment, but at least 20 minutes additional soak time was allowed for each sample. At the end of this waiting period, the LVDT's or displacement dials were attached and zeroed and the crosshead was brought down slightly to cause a slight preload on the sample (no more than one or two percent of the testing load).

To start the test, the crosshead was set in downward motion at a rate of 0.02 mm/s and halted when the desired strain level as indicated by the LVDT's was reached. Deformation, temperature and time were printed out at two minute intervals during the test while loads on the sample were recorded continuously. One of the two thermocouples hanging free in the chamber was chosen as the reference. The use of the thermocouple in the dummy specimen was discontinued early in the program because it responded too slowly to temperature transients to permit adequate control to be maintained. Liquid nitrogen was added to the reservoir and/or the gas flow to the inner chamber adjusted as necessary to maintain a constant temperature within the chamber throughout the test.

At the end of 60 minutes of test time, the load scale on the Instron was changed and once again the crosshead was set in downward motion at a rate of 0.02 mm/s until the sample failed. Simulated Instron readouts showing typical traces of the relaxation and constant strain rate-to-failure tests are shown in Figures 3 and 4, respectively.

2.3.4 Data Reduction Procedures

The calculations of shear stress, τ, shear strain, γ, and shear relaxation modulus, $G_{rel}(t)$, for the test specimen shown in Figure 1 were based on the following relationships:

$$\tau = \frac{P}{A} \tag{1}$$

$$\gamma_c = \frac{\Delta}{h} \tag{2}$$

where:

P = applied force, N
A = shear area = W x L
= 1/2 (25.4 mm x 127.0 mm)
= 1.6×10^3 mm^2
Δ = sample deformation, mm
h = thickness of silicone resin sponge material,
= 12.7 mm

$$G_{rel}(t) = \frac{\tau(t)}{\gamma_c}$$

In addition to the shear relaxation modulus, $G_{rel}(t)$, mechanical behavior parameters evaluated for each test included (1) initial tangent

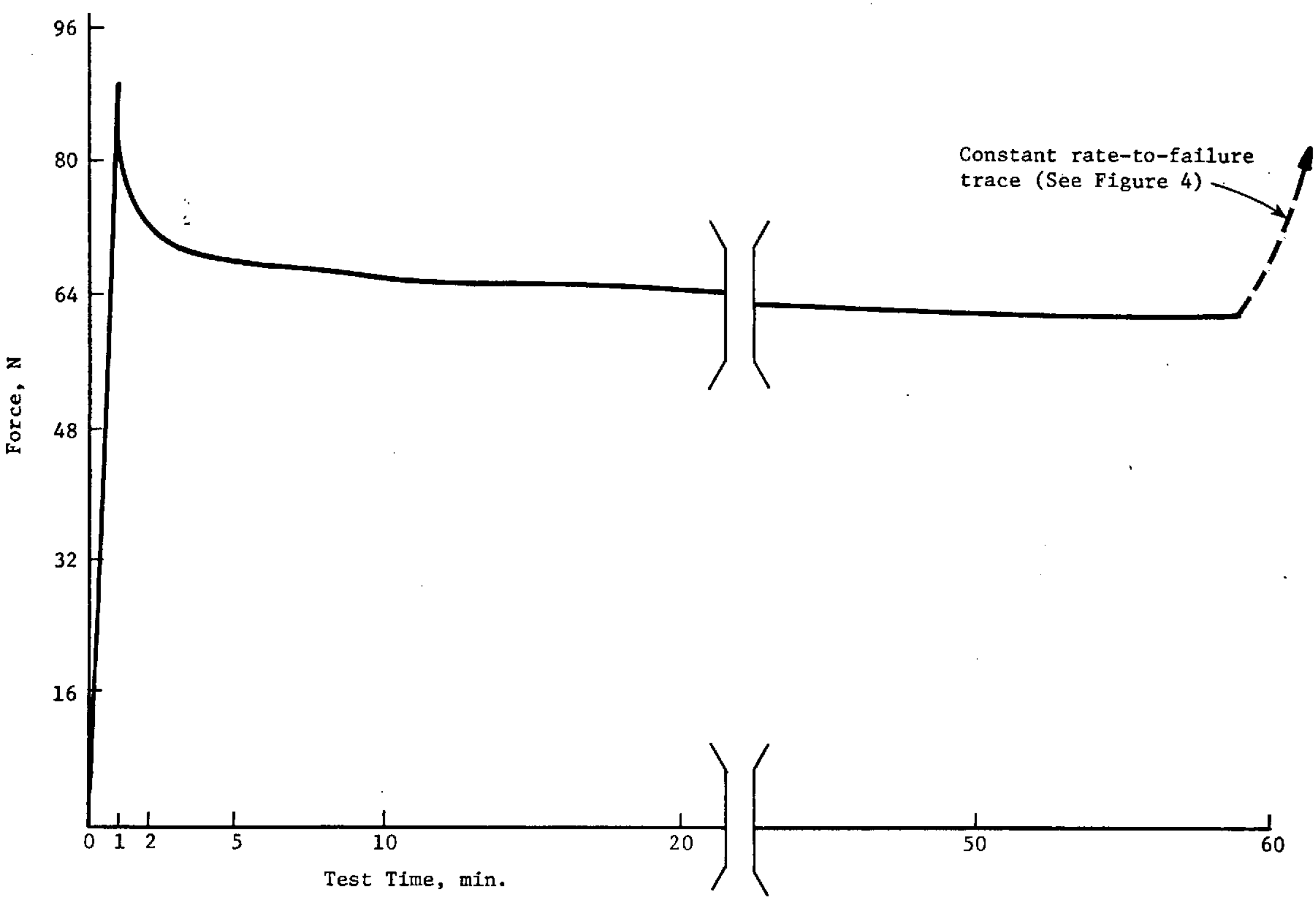

Figure 3. Typical stress relaxation trace.

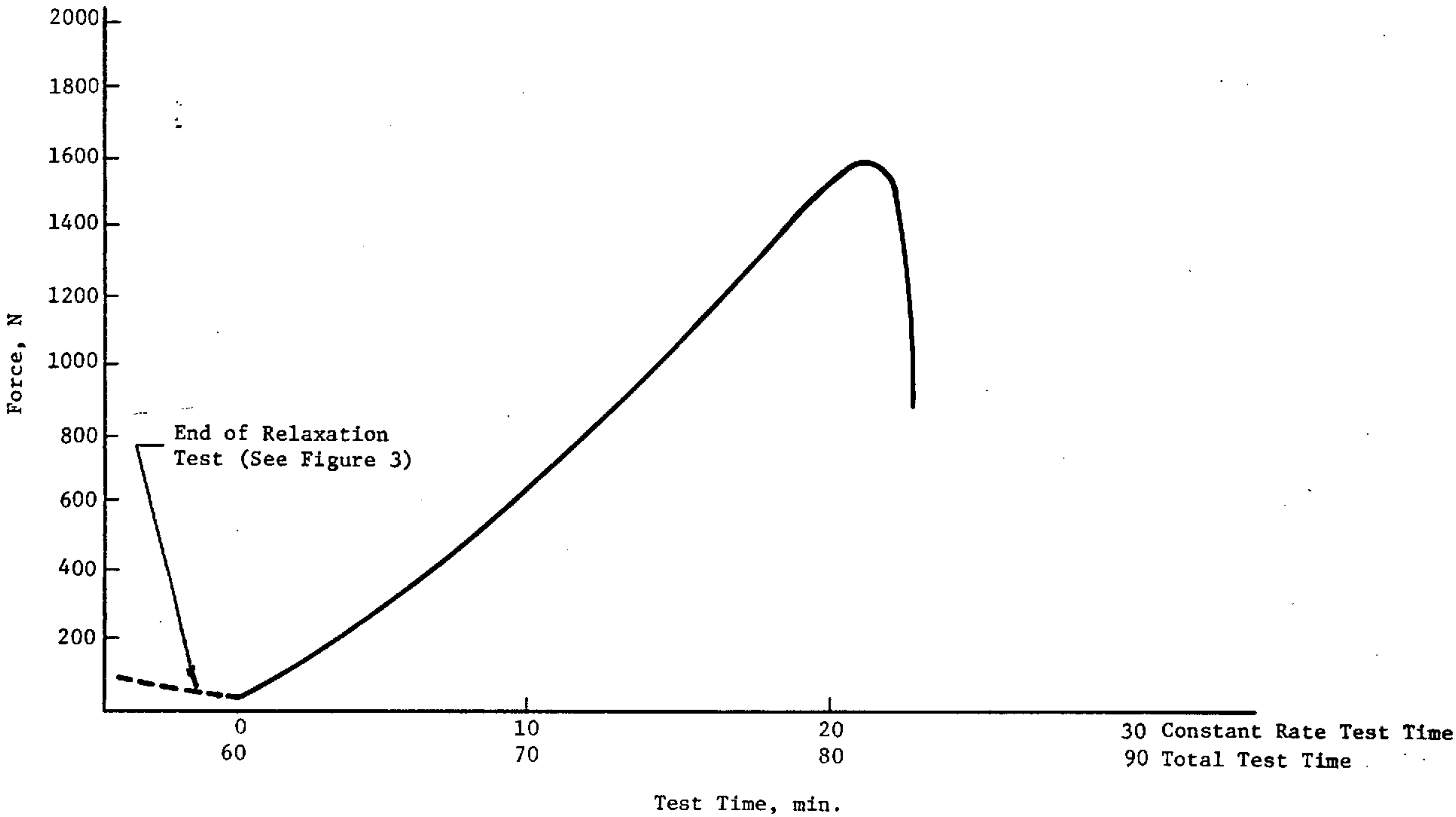

Figure 4. Typical constant rate-to-failure trace.

modulus, G_i; (2) stress at failure, τ_m; (3) strain at failure, γ_m and (4) secant modulus at failure, G_s. The location of these parameters on a typical test curve is shown in Figure 5.

A computer program was generated to calculate these parameters. The format is given in Appendix A and tabulated values are shown in Appendix B. This program also used the Compudyne plotter which generated the stress-strain curves for each test also given in Appendix B. At least 15 points were used to generate each of these curves.

The initial tangent modulus reported herein is the average slope exhibited by the stress-strain curve prior to relaxation (as indicated by the vertical off-set in Figure 5). This was used to minimize any inconsistencies which would have been introduced by employing the slope of the stress-strain curve through the origin because of the frequent existence of a toe or positive curvature in the initial portion of the traces.

As shown in Figure 5, failure for the calculation of τ_m, γ_m and G_s was assumed to occur at the point of maximum load. The rupture point was not used because there was no way of determining how or exactly when the sample first began to tear while it was in the test chamber. To calculate the secant modulus, G_s, the final loading trace (i.e., after relaxation) was extrapolated to the strain axis with a curve drawn parallel to the original trace as shown in Figure 5. The maximum stresses and strains were then measured from that point. This procedure would not be expected to effect the failure properties since the strain levels at failure were usually large compared to those imposed during relaxation.

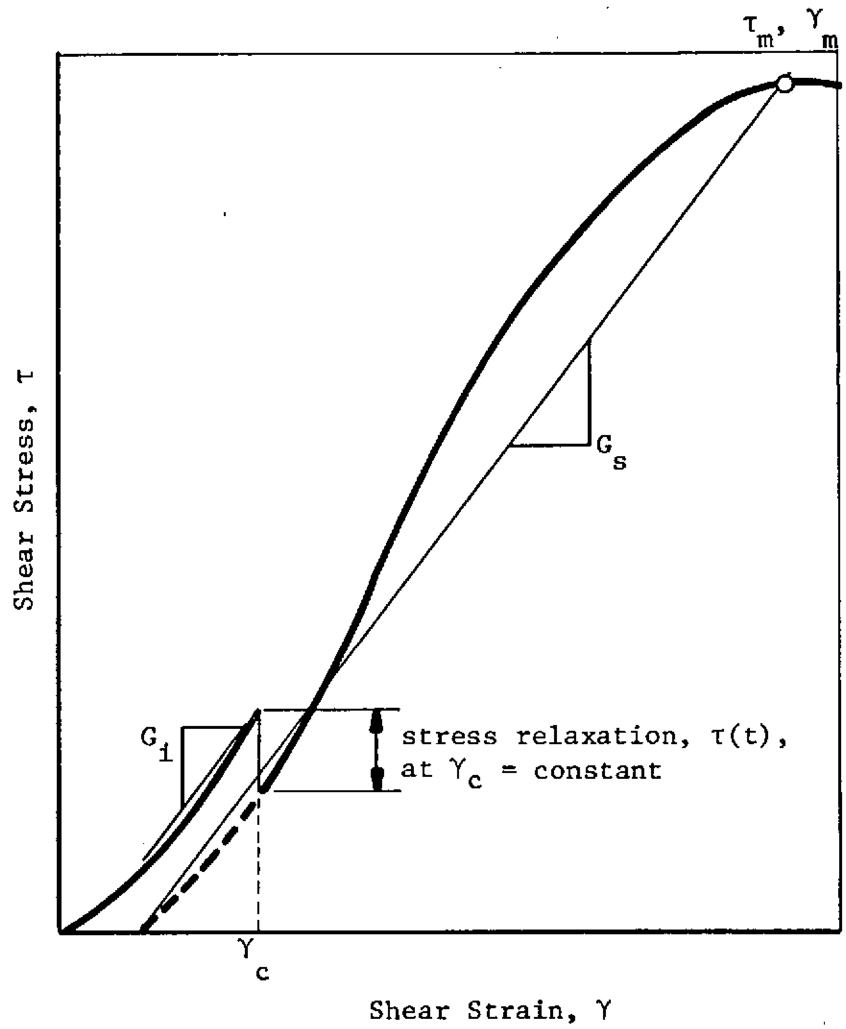

Figure 5. Typical stress-strain curve identifying major parameters.

In keeping with kinetic theory for rubbers (ref. 4) the stress and stiffness values are presented in their temperature reduced form, e.g. $G_{rel}(T_o/T)$, where T_o and T are the absolute values of the reference and test temperatures, respectively. This correction becomes more significant the greater the difference between T_o and T. The reference temperature, T_o, used for this correction was 300 K.

3.0 DISCUSSION OF RESULTS

For discussion purposes the test data for each of the two materials, PD-200-16 and RL-1973, were divided into four convenient categories: (1) tangent and secant moduli, (2) relaxation moduli, (3) thermal properties and (4) failure properties.

3.1 Tangent and Secant Moduli

The values measured for the tangent modulus, G_i, and the secant modulus, G_s, are shown in Tables I and II for the PD-200-16 and RL-1973 materials, respectively. The values shown at each temperature represent the arithmetic average of the three to eight tests run at that temperature. As stated earlier, the initial tangent modulus represents the average slope exhibited by a given stress-strain curve prior to the relaxation test.

The data points plotted in the graphs of Figures 6 and 7 represent the individual test values of the tangent moduli. The tangent modulus values shown in Tables I and II, which as stated above, are averages of the measured values, served as guides for drawing the broken lines shown on the graphs. Both the tables and the figures illustrate a phenomenon that was demonstrated by nearly all the data for both materials. As the samples were cooled below room temperature they tended to remain quite more compliant (indeed PD-200-16 became more compliant). The modulus of the PD-200-16 material decreased somewhat below the room temperature values as the temperature decreased to about 175 K. With further decrease in temperature the modulus rapidly increased about two orders of magnitude.

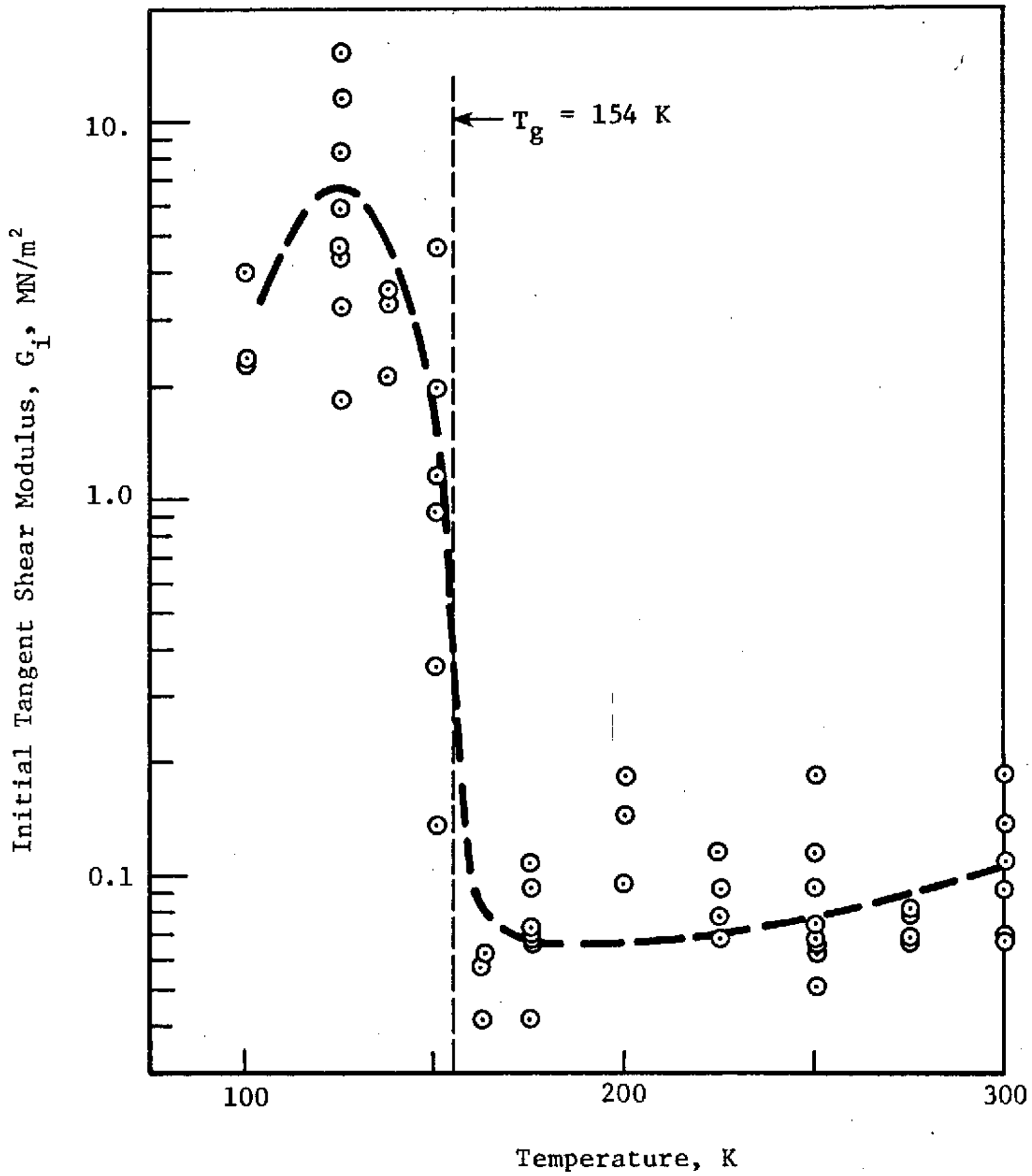

Figure 6. Initial tangent moduli observed for the PD-200-16 foam. The crosshead displacement rate was 0.05 in/min, (0.127 cm/min).

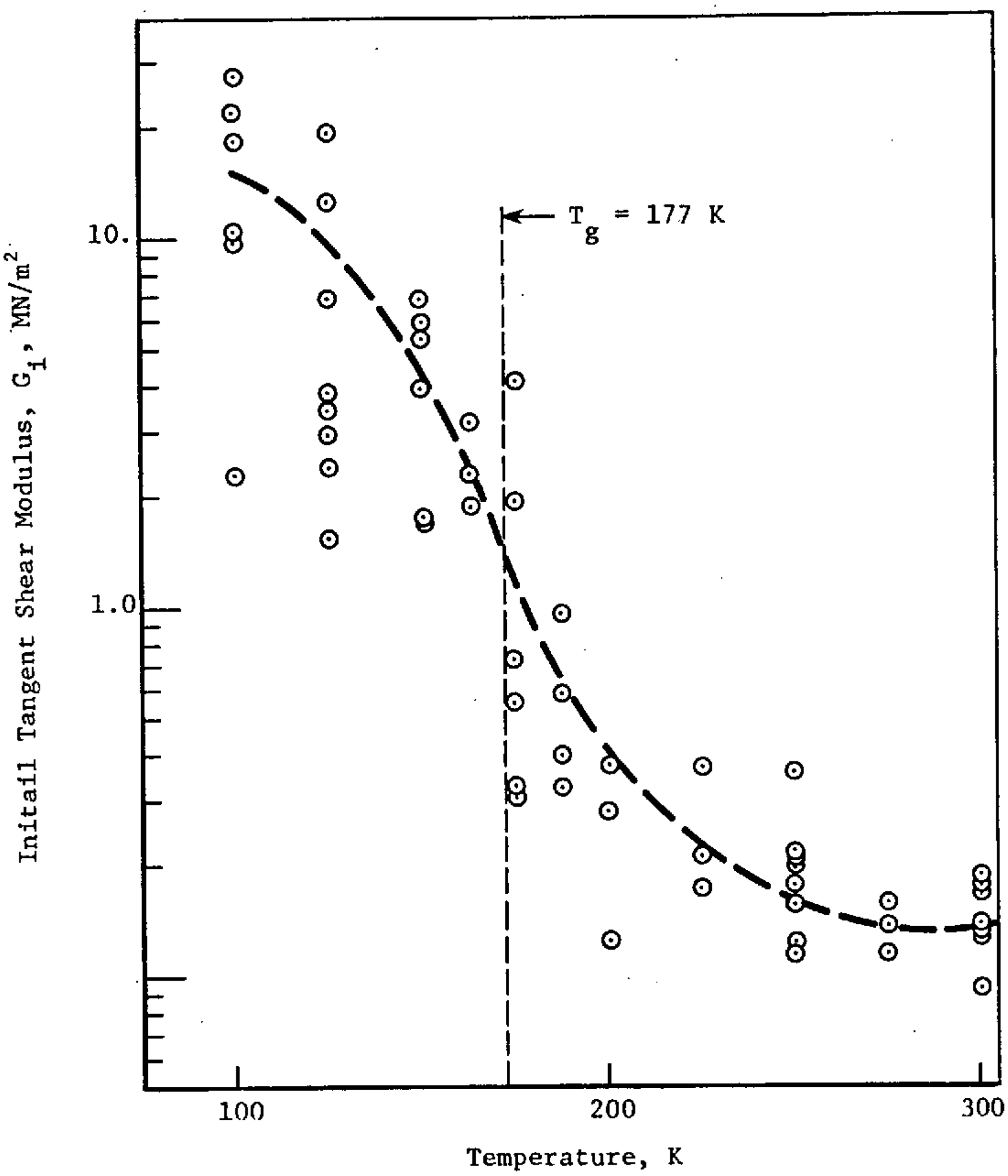

Figure 7. Initial tangent moduli observed for the RL-1973 foam. The crosshead displacement rate was 0.05 in/min, (0.127 cm/min).

TABLE I. Tangent and Secant Shear Moduli for PD-200-16 Foam. These Moduli Represent the Averages for All Tests Run at the Specified Temperature.

Test Temperature (K)	Tangent Modulus G_i (N/m^2)	Secant Modulus G_s (N/m^2)
300	110,000	209,000
275	74,000	120,000
250	89,000	203,000
225	88,000	138,000
200*	141,000	175,000
175	74,000	242,000
163*	54,000	1,840,000
150	1,520,000	3,630,000
138*	3,000,000	10,600,000
125	7,350,000	12,900,000
100*	2,860,000	11,500,000

*The average of three tests only.

TABLE II. Tangent and Secant Shear Moduli for RL-1973 Foam. These Moduli Represent the Averages for All Tests Run at the Specified Temperature.

Test Temperature (K)	Tangent Modulus G_i (N/m^2)	Secant Modulus G_s (N/m^2)
300	141,000	209,000
275*	137,000	111,000
250	192,000	227,000
225	280,000	190,000
200*	256,000	418,000
188	570,000	918,000
175	1,300,000	1,910,000
163*	2,460,000	1,310,000
150	4,240,000	11,300,000
125	6,640,000	18,200,000
100	15,000,000	18,200,000

*The average of three tests only.

At temperatures lower than 125, the stiffness of PD-200-16 decreased with further decrease in temperature as shown in Figure 6 by the curve representing the best fit of the data. The modulus of RL-1973, in contrast changed only slightly at temperatures as low as 250 K. But below 250 K the stiffness increased gradually with decreasing temperature until it reached values as high as PD-200-16.

3.2 Relaxation Moduli

Shear relaxation modulus is plotten versus time in Figures 8 through 11 for PD-200-16 and in Figures 12 through 15 for RL-1973. Each figure represents one imposed strain level so that four graphs are shown for each material, one for 1, 3, 5 and 10% strain. Data for at least nine temperatures ranging from 100 to 300 K are shown in each figure. In most instances two intermediate temperatures in the neighborhood of the transition temperature are also included.

As can be seen, both materials are very compliant in shear. Here as in all test the PD-200-16 could be characterized as having about half the stiffness of the RL-1973 at most temperatures. Both materials show only slight relaxation through the 60 min. test duration at both the cold and warm extremes. Only at the intermediate temperatures is there an indication of a greater slope to the log-log relaxation curve. These intermediate temperatures, interestingly enough, are near the transition temperatures identified by thermal expansion tests as described in Section 3.3 below.

No correlation between the strain level of the relaxation test and the measured relaxation modulus was observed.

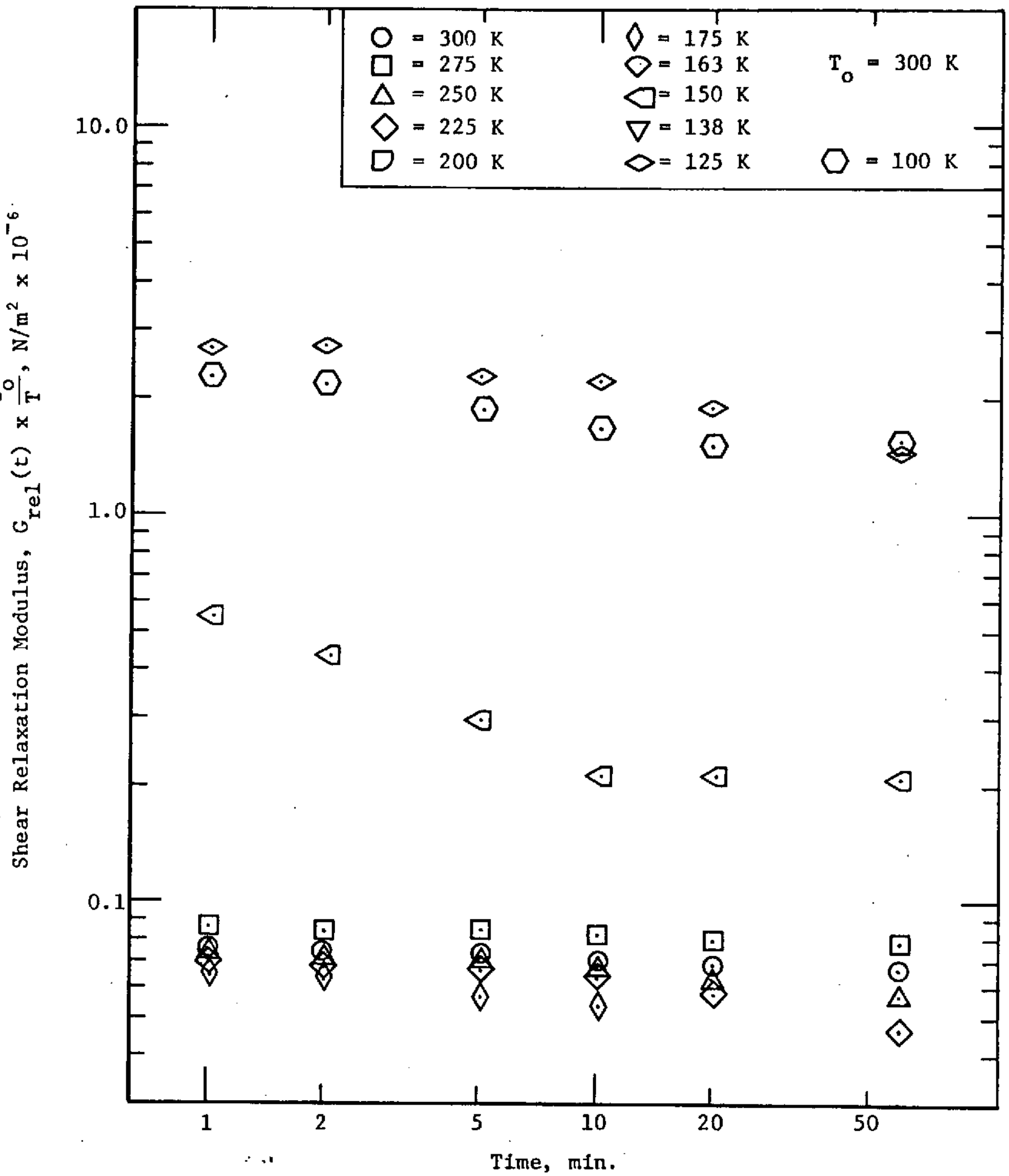

Figure 8. Relaxation moduli measured for the PD-200-16 foam. The imposed strain was 1%.

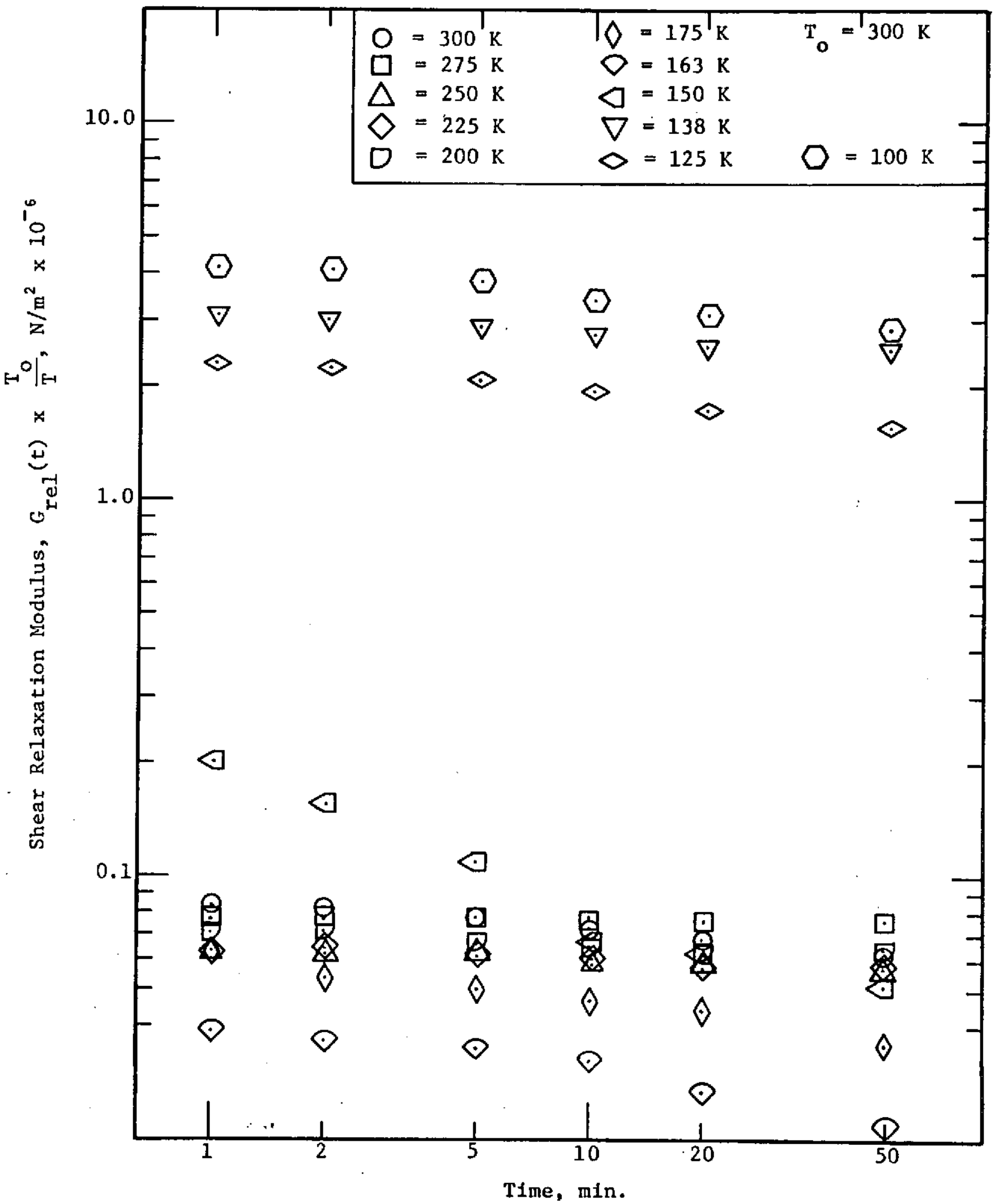

Figure 9. Relaxation moduli measured for the PD-200-16 foam. The imposed strain was 3%.

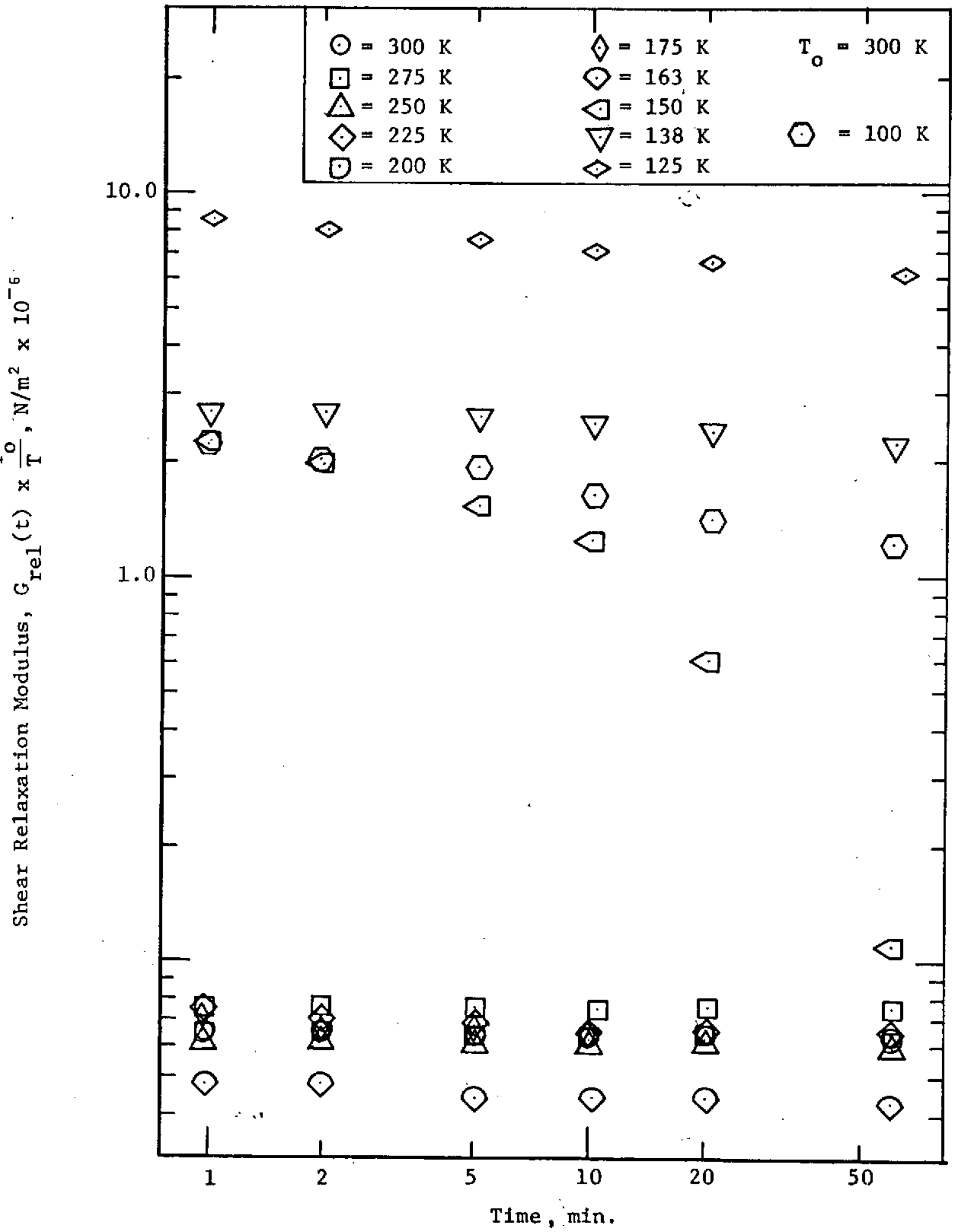

Figure 10. Relaxation moduli measured for the PD-200-16 foam. The imposed strain was 5%.

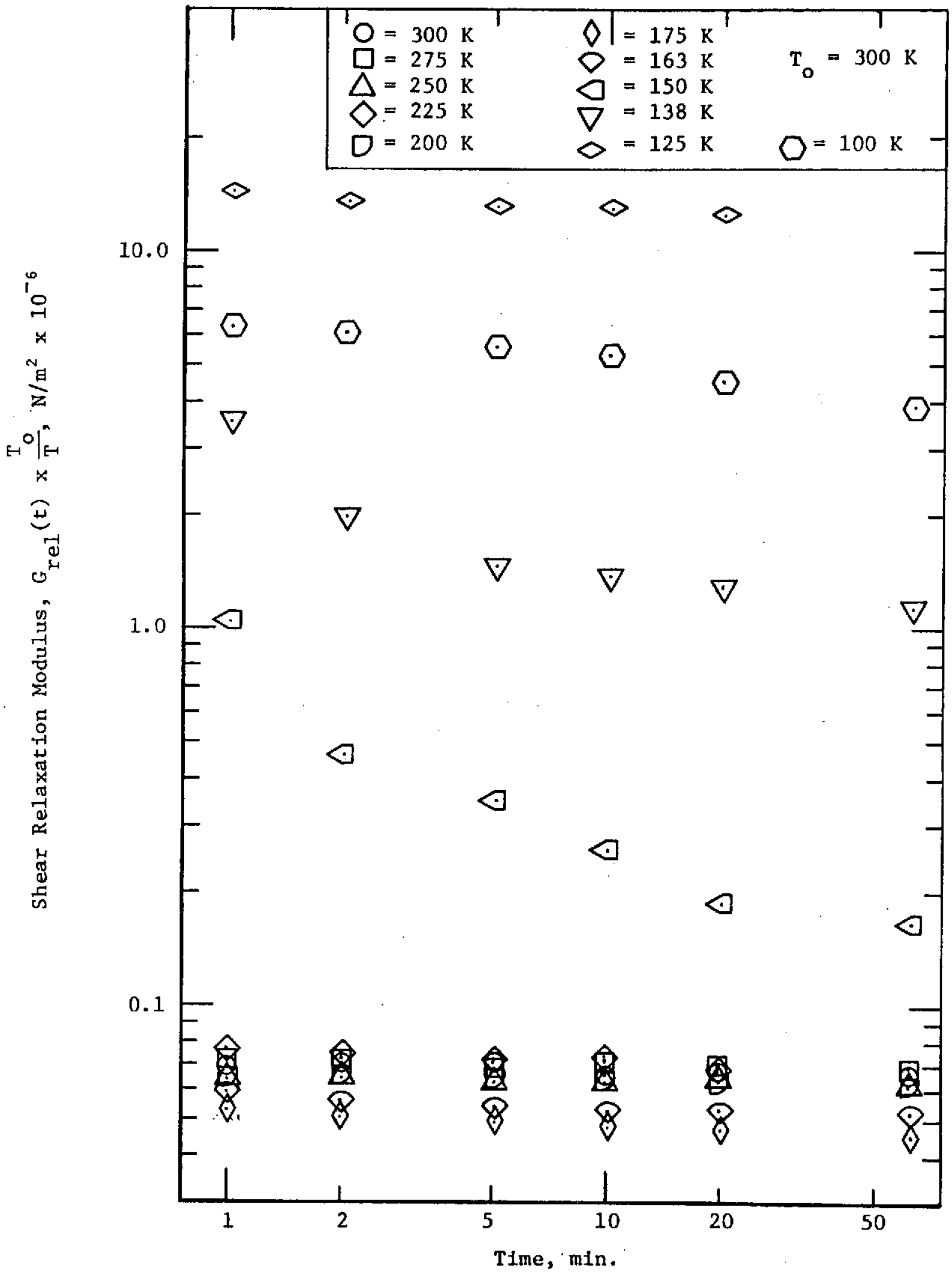

Figure 11. Relaxation moduli measured for the PD-200-16 foam. The imposed strain was 10%.

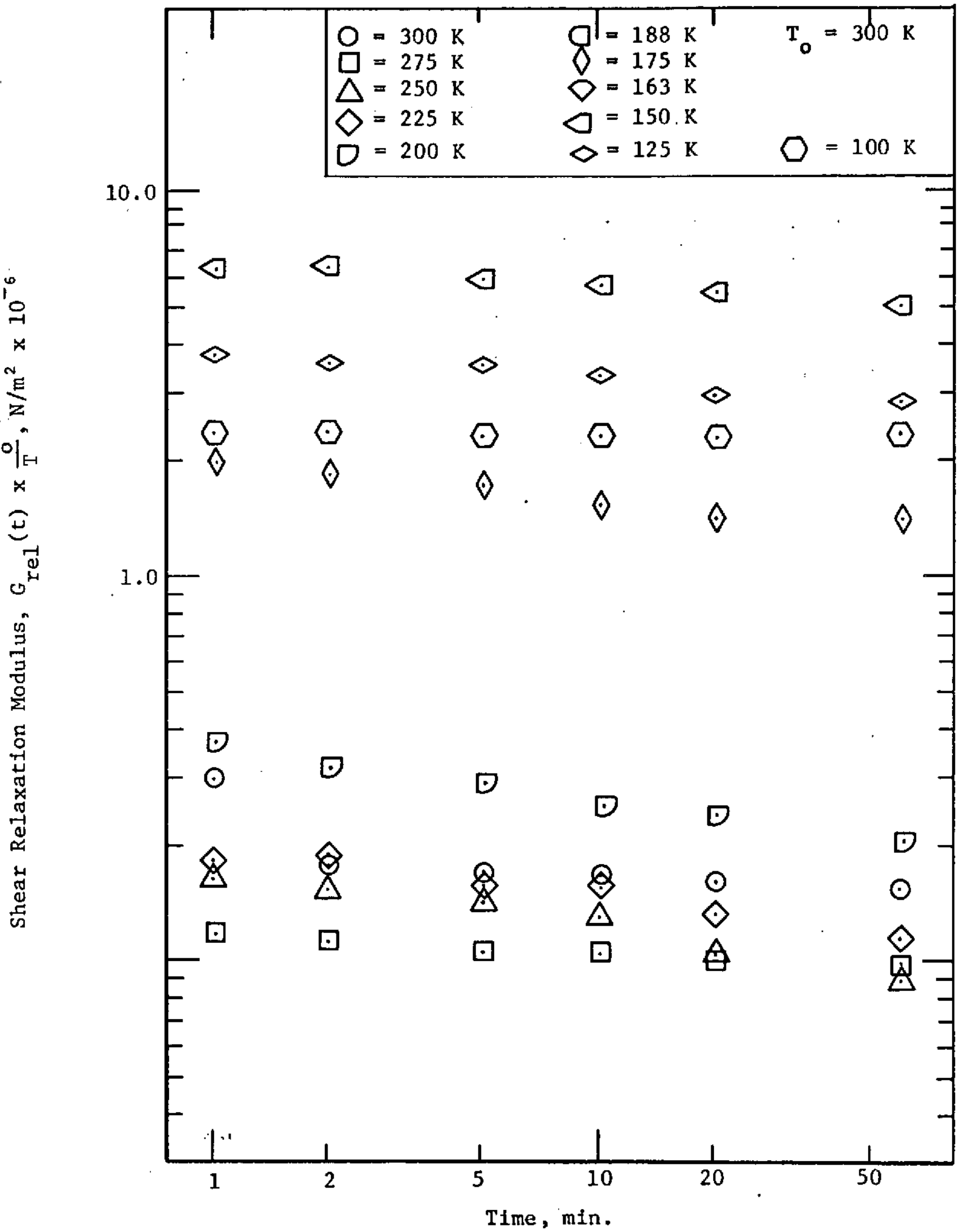

Figure 12. Relaxation Moduli measured for the RL-1973 foam. The imposed strain was 1%.

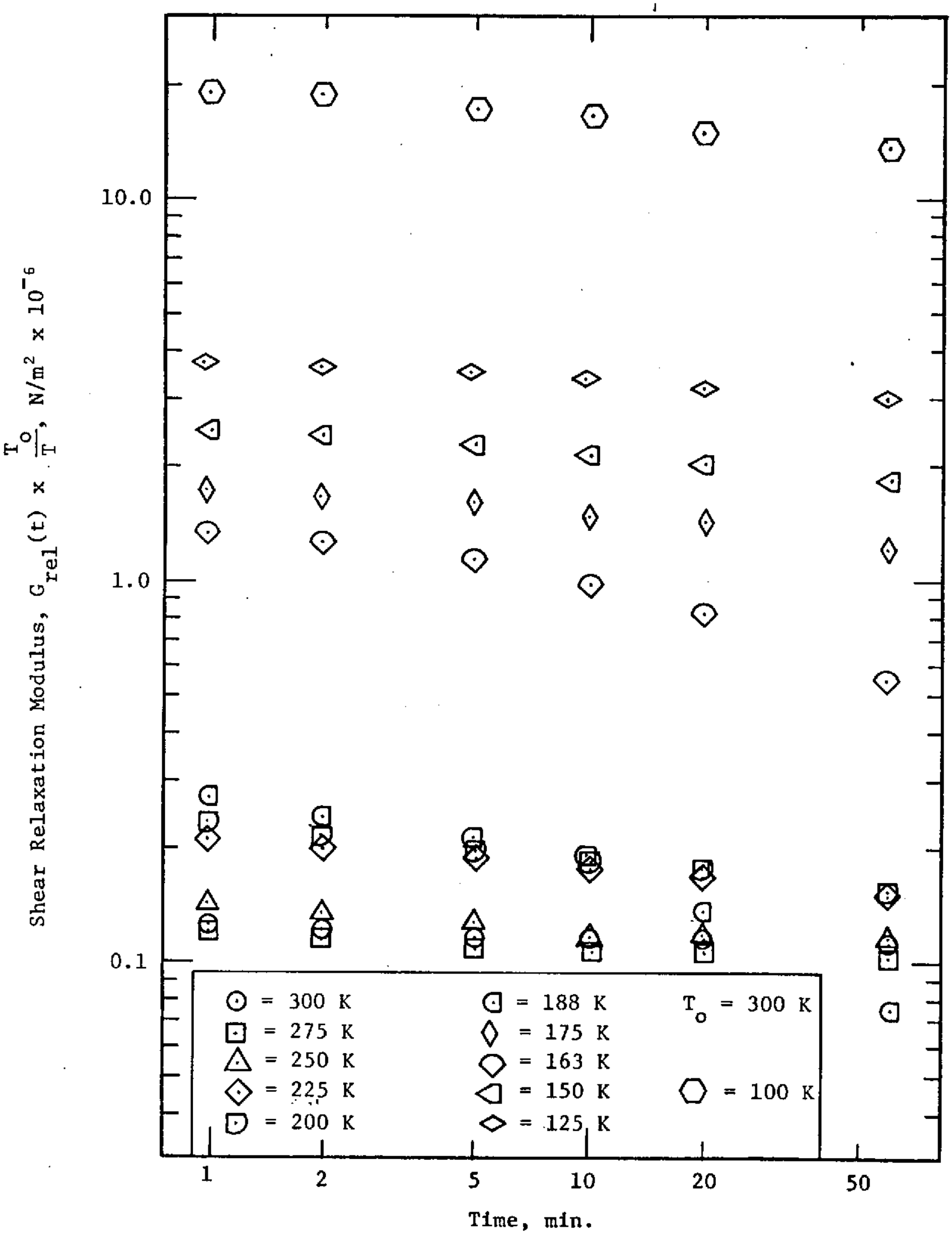

Figure 13. Relaxation moduli measured for the RL-1973 foam. The imposed strain was 3%.

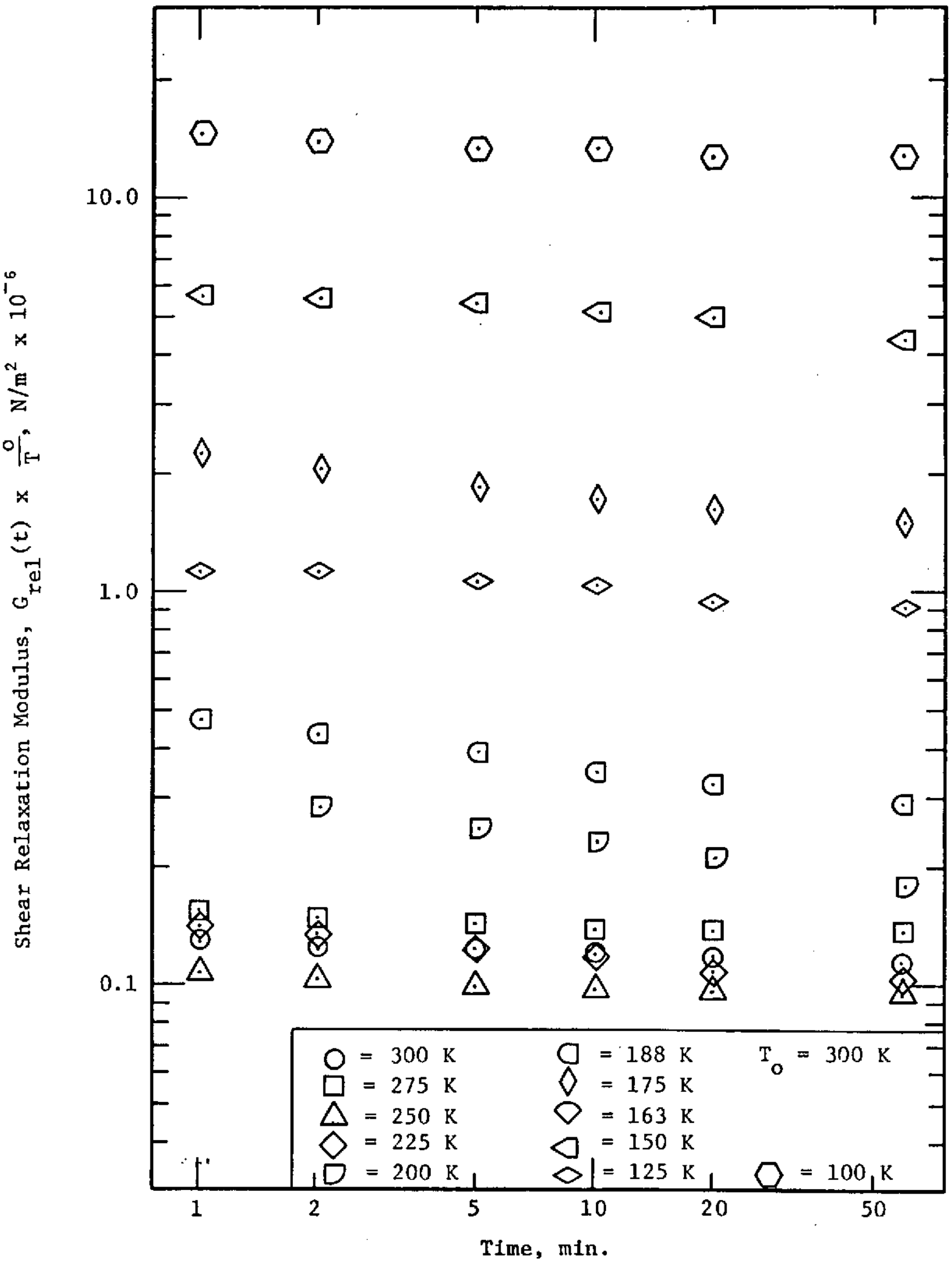

Figure 14. Relaxation moduli measured for the RL-1973 foam. The imposed strain was 5%.

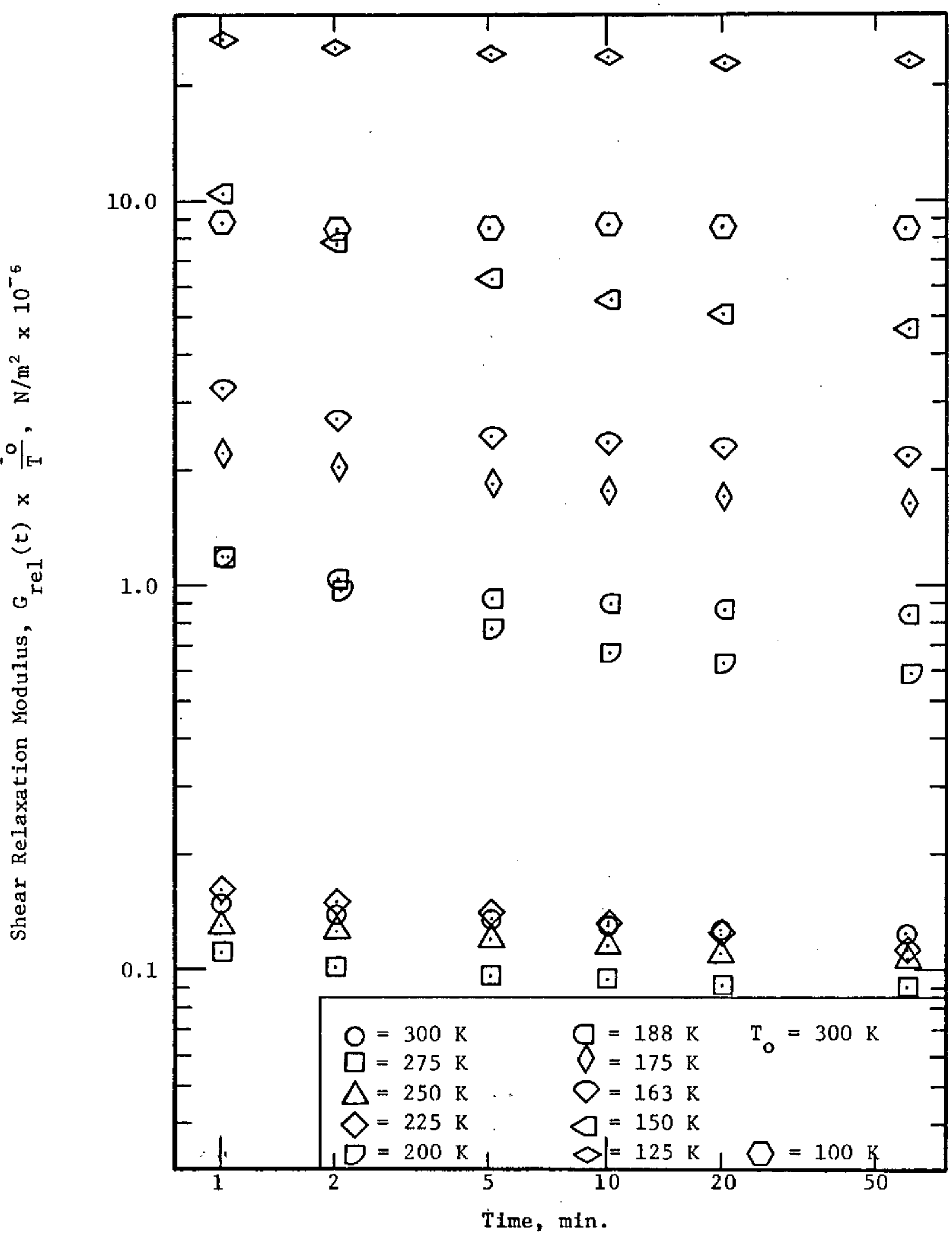

Figure 15. Relaxation moduli measured for the RL-1973 foam. The imposed strain was 10%.

The trends of the shear relaxation moduli with temperature appear to correlate exactly with those indicated by the initial tangent moduli as discussed in Section 3.1 above. Initial tangent and relaxation modulus data for the PD-200-16 exhibit the same decreasing stiffness with decreasing temperature to well below 200 K. Similarly the RL-1973 shows only a slight tendency to stiffen as temperature decreases to about 225 K.

Further, three out of four strain levels give an indication that the PD-200-16 stiffness might be decreasing at the lowest temperature (100 K). However, the great scatter inherent in the data continues to cloud this conclusion. It might be noted that two of the four figures indicate the same phenomena for the RL-1973.

3.3 Measurement of Glassy Transition Temperature

To measure the linear coefficients of thermal expansion, α, and the glassy transition temperature, T_g, a dilatometer quite similar to that described in ASTM D 696-44 was constructed. (See Figure 16.) The apparatus is very nearly identical to that described in the JANNAF Solid Propellant Mechanical Behavior Manual (ref. 5).

The device consists of a large styrofoam solid with an oversized cavity into which a 6×10^{-3} m^3 stainless steel beaker is placed. The space surrounding the beaker serves as a liquid nitrogen bath which is used to cool the beaker and its contents. The beaker contains a massive

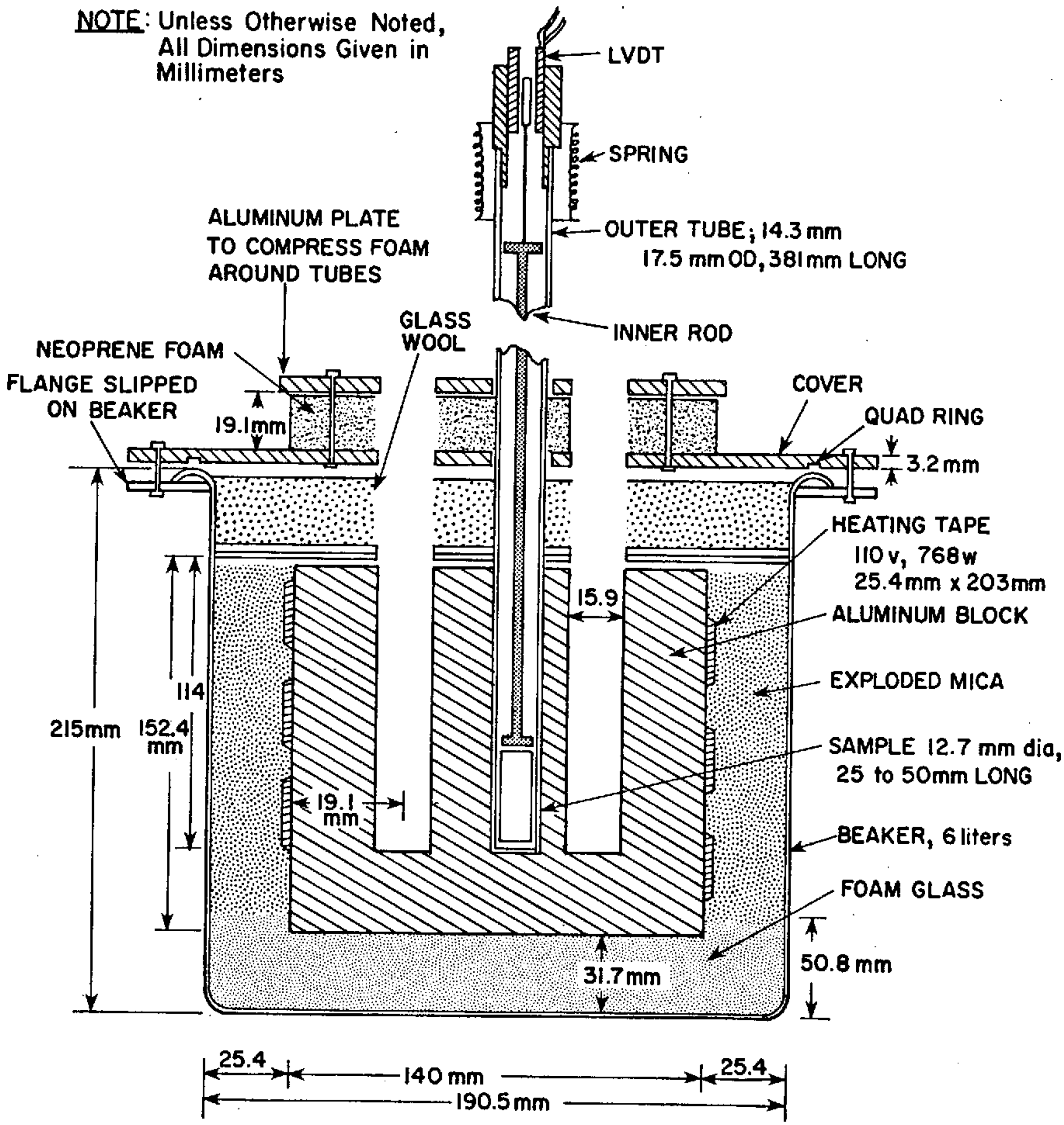

Figure 16. Schematic drawing of dilatometer.

aluminum block heavily insulated from the beaker, thus isolating the block from rapid or erratic temperature fluctuations caused by the nitrogen. To prevent nitrogen vapor from spilling over the top of the beaker and disturbing the even temperature distributions in the core, a cover plate, sealed with a Quad-ring, was used. Three holes were drilled through the lid, through the insulation and well into the aluminum core. Quartz tubes containing the test samples were inserted into these cavities. A Neoprene foam sheet was laid on top of the beaker cover with undersized holes for the quartz tubes to form a seal against the ambient air. A center hole provided the cavity for the thermocouples required to control and monitor the temperature.

Specimens of the material to be tested were machined to 13 mm x 13 mm x 51 mm long and placed in the bottom of the quartz tubes. Then small, light quartz rods with flat bakelite feet were inserted in the tubes over the specimen as indicated in Figure 16. The vertical movement of these rods, reflecting the expansion and contraction of the specimen, were measured with small linear variable differential transformers mounted at the top of the tube.

Once the apparatus was assembled and readied, a test cycle was performed to determine whether or not the cooling and heating rates would be satisfactory (<1 K/min). Further, one of the quartz rods was positioned against the bottom of a quartz tube without a sample in place. The resulting output gave a system error characteristic of the device for which a correction could subsequently be made when reducing data.

A plot of temperatures versus time for this trial run is shown in Figure 17. The device inherently cools at a faster rate than it warms, but in both instances the rates were well below 1 K/min. The lowest temperature recorded during the trial run was 160 K while the test plans were to go as low as 123 K. Therefore, the cooling portion of the cycle was continued for a longer duration to extend the lower excursion.

The conduct of the actual tests were performed with two specimens, one of each material. Two such tests were conducted. The outputs of both the thermocouples and LVDT's were sensed and recorded on paper tape at 900 second intervals.

Figures 18 and 19 indicate the results of the tests for the RL-1973, and Figures 20 and 21 for the PD-200-16 silicone resin sponges. The thermal strains, defined as the change in length divided by the original length, are plotted versus temperature. The data were collected both during the cooling and warming portion of tests so hysteresis accounts for a significant portion of the apparent scatter.

Two straight lines were drawn through the data points for each material and their slopes were calculated to give the linear (as opposed to volumetric) coefficients of thermal expansions. It is evident that the straight lines fit the test data for the PD-200-16 sponge better than for the RL-1973. The intersection of the two lines on each graph indicates the value of the glassy transition temperature. These results are summarized in Table III.

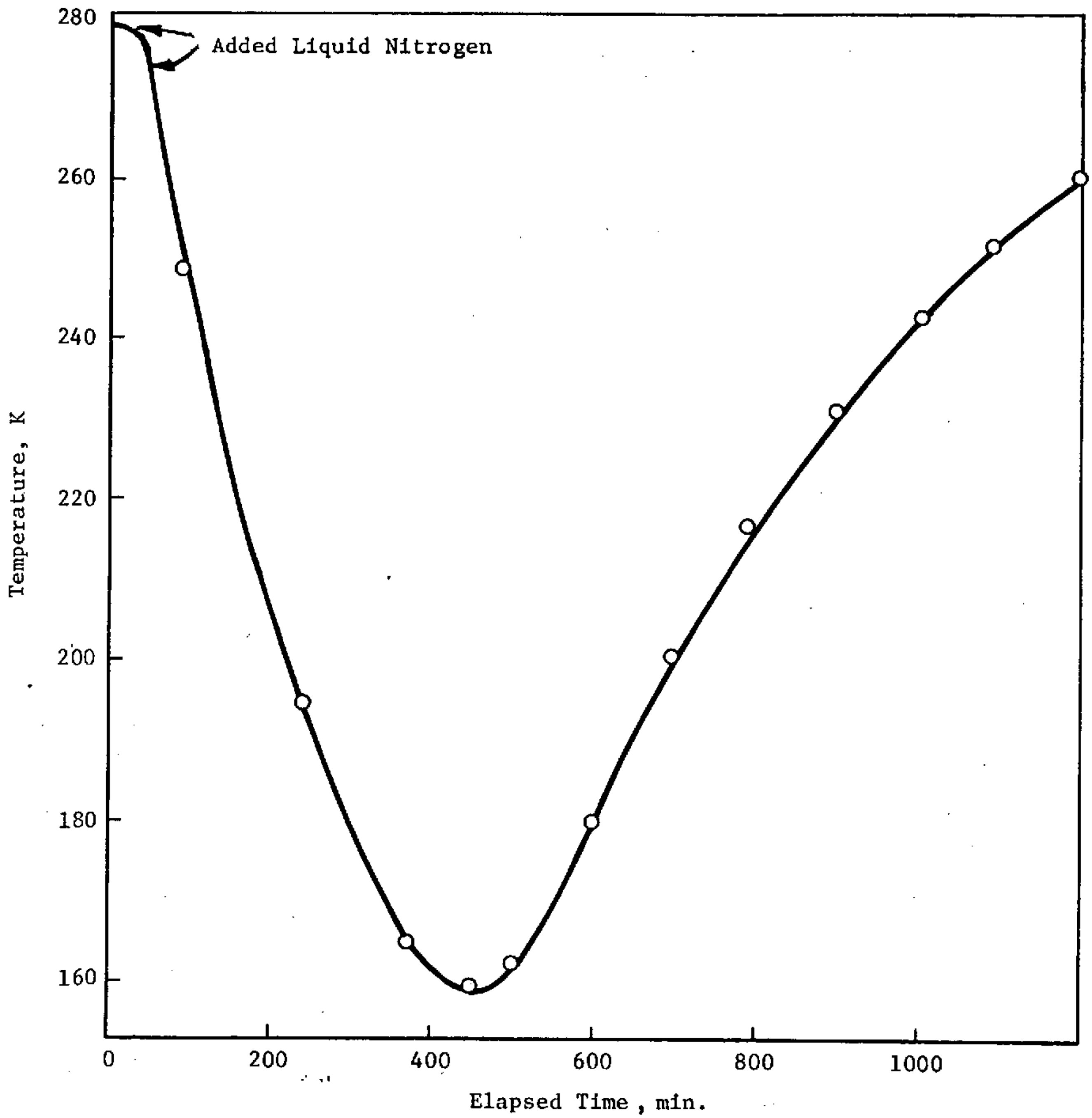

Figure 17. Curve showing the temperature measured in the dilatometer during a trial test cycle.

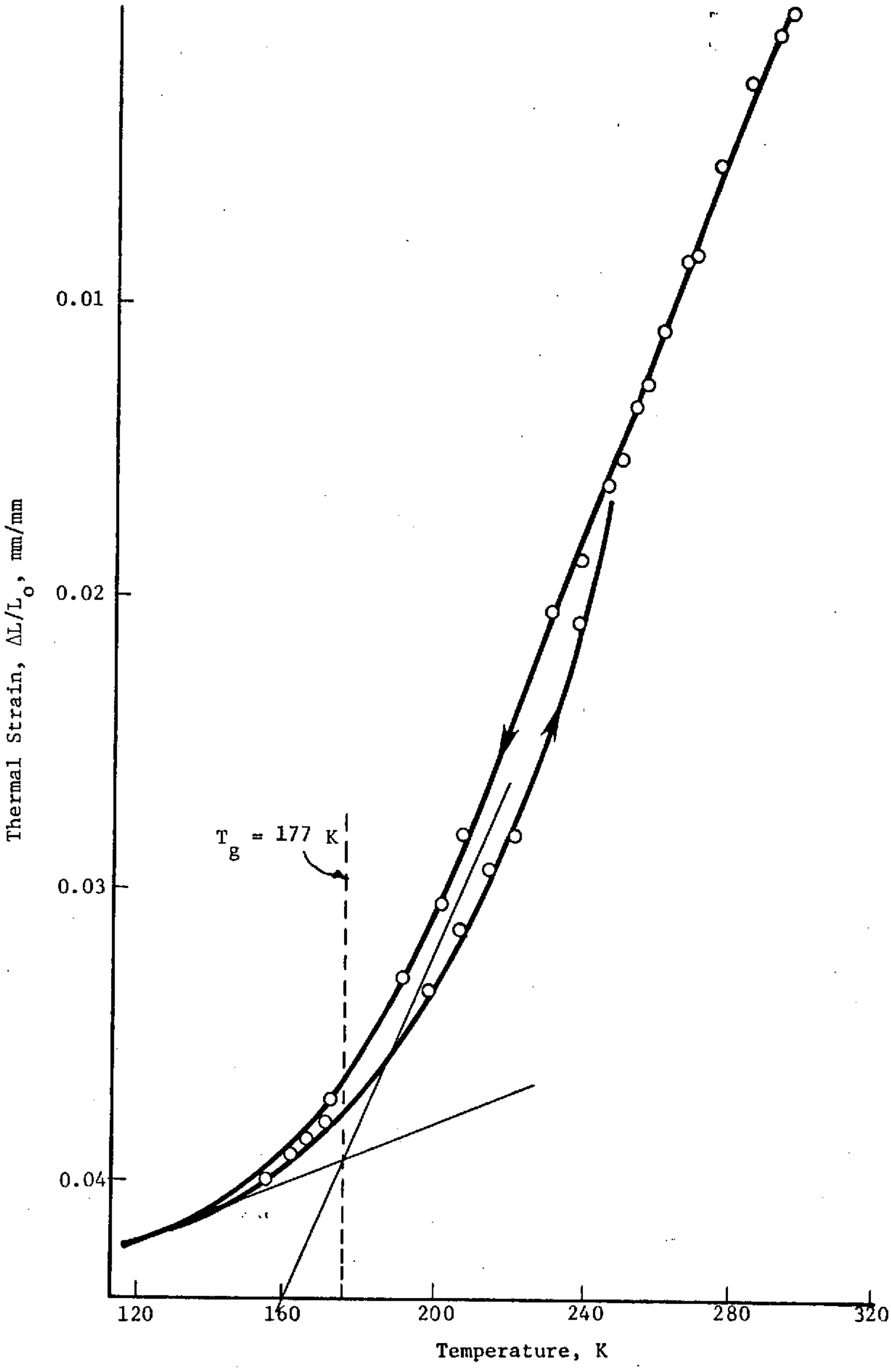

Figure 18. Curve showing the thermal strains as a function of temperature for the RL-1973, Sample 1.

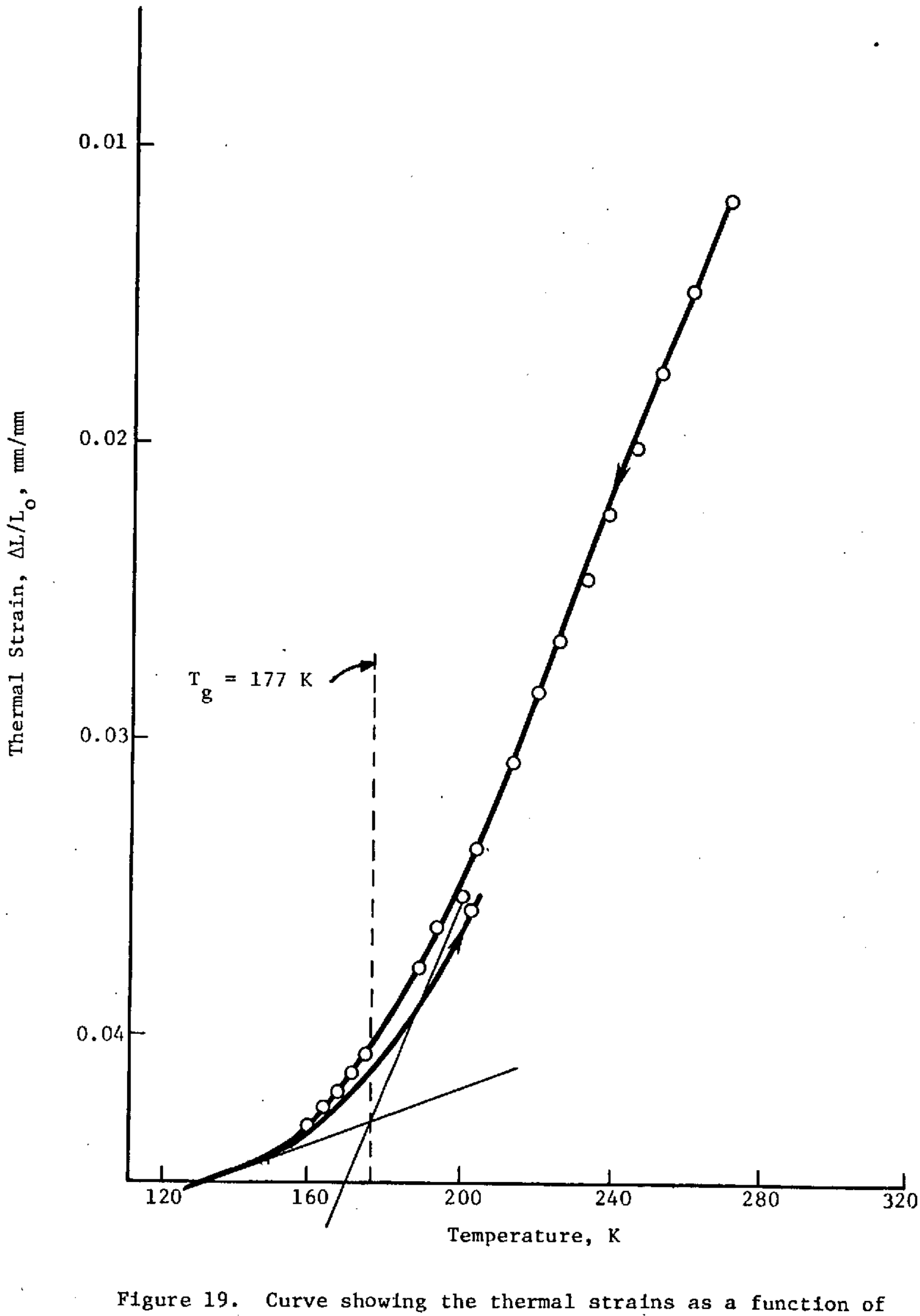

Figure 19. Curve showing the thermal strains as a function of temperature for the RL-1973, Sample 2.

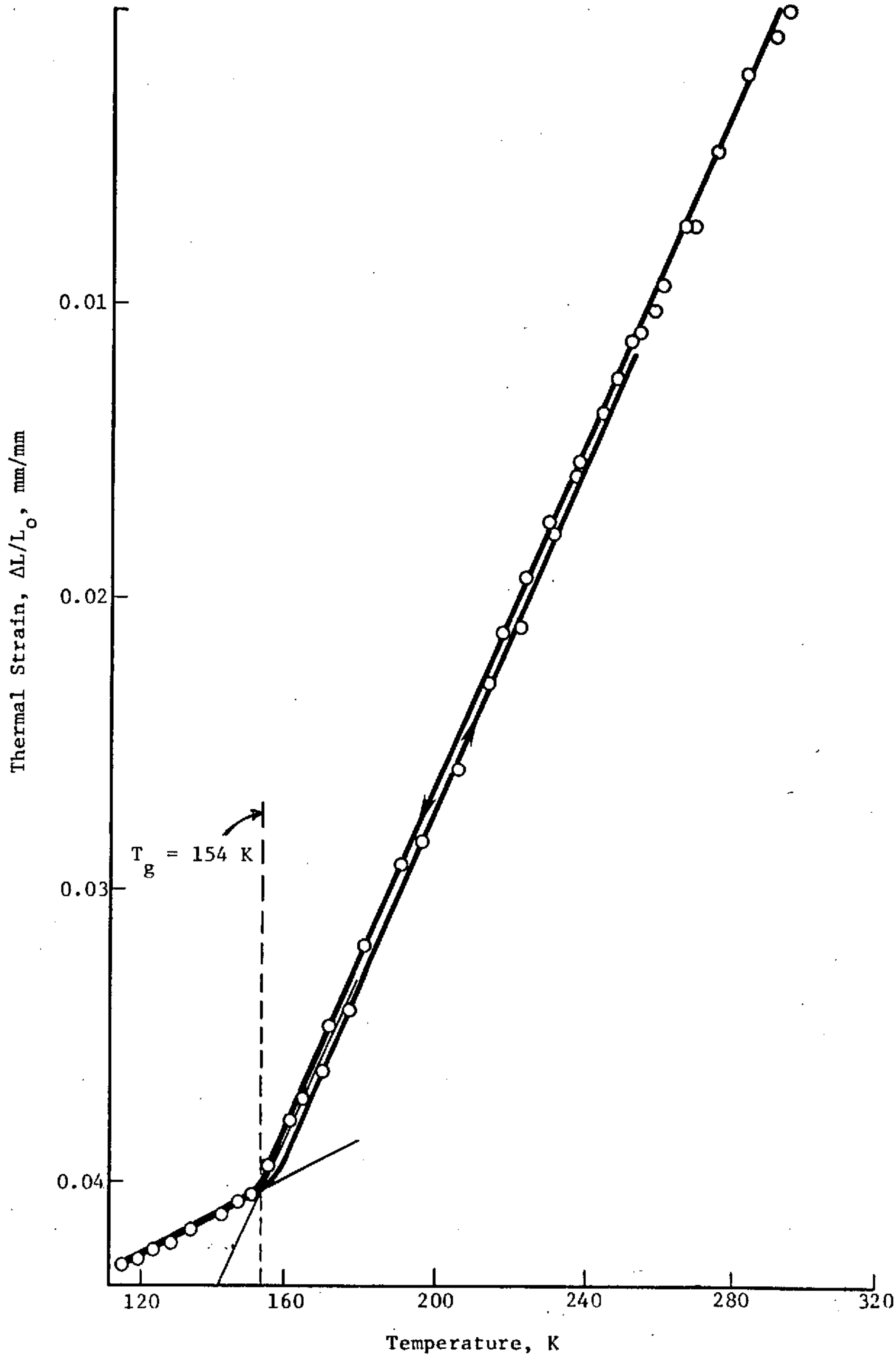

Figure 20. Curve showing the thermal strains as a function of temperature for the PD-200-16, Sample 1.

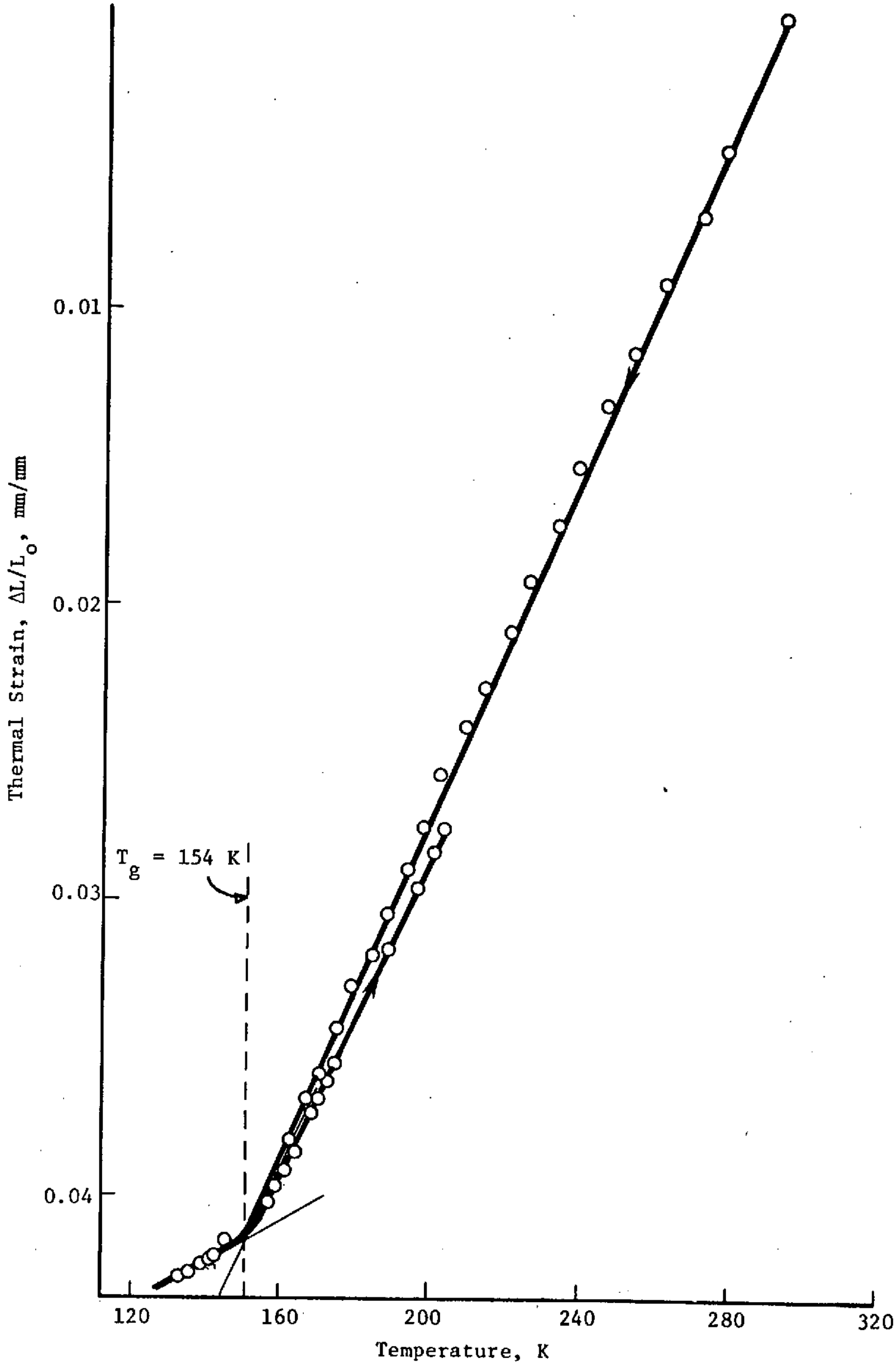

Figure 21. Curve showing the thermal strains as a function of temperature for the PD-200-16, Sample 2.

TABLE III. Measured Thermal Properties of the Silicone Resin Sponge (SRS) Materials

	PD-200-16	RL-1973
Glassy Transition Temperature, T_g (K)	154	174
Average Linear Coefficient of Thermal Expansion above T_g (mm/mm/K)	28×10^{-5}	33×10^{-5}
Average Linear Coefficient of Thermal Expansion below T_g (mm/mm/K)	6.1×10^{-5}	4.8×10^{-5}

The experimentally determined glass transition temperatures given above are consistent with those for silicone rubbers as found in the literature (ref. 1). On the other hand, the results reflected in Figures 6 and 7 would indicate a significant amount of stiffening at temperatures well below these glassy temperatures. This characteristic, often observed for silicones, is not consistent with that experienced with other organic polymers which typically exhibit a maximum stiffness at the T_g. The reasons for this behavior have not yet been established.

One possible explanation for this behavior is that the temperature related property changes may lag, in time, the actual temperature change in the sample. Such delays have been observed by measuring volumetric changes in a material while undergoing temperature excursions. In carefully controlled tests significant volumetric shrinkage will continue well after a steady-state lower temperature has been reached. If such phenomena are also characteristic of stiffnesses and other properties (e.g. Poisson's ratio) then a ready explanation is available for the observations described above.

This hypothesis can be verified by conducting an additional series of selective stress relaxation tests utilizing a number of different conditioning times at temperatures below T_g. The time at which the modulus ceases to change with storage time will be the recommended conditioning time.

3.4 Failure Data

Following the relaxation tests the specimens were strained to failure at a constant-rate strain of 0.002 s^{-1}.

Failure was defined simply as the point of maximum force (See Figure 5). It was noted during the 300 K (room temperature) tests that specimen tearing or other signs of failure were always present prior to reaching maximum load. However, since the majority of the tests were performed with the specimen concealed within a conditioning chamber it was not always possible to observe and record these earlier indications of failure. In order to be consistent the point of failure was taken to be where the load attained its largest value.

Figures 22 and 23 show the maximum stresses and the corresponding strains for the PD-200-16 and RL-1973, respectively. These stresses and strains are plotted in their unreduced form; i.e., without the T_o/T correction factor.

Note should be taken of the fact that the constant displacement rate tests were interrupted at various strain levels (1, 3, 5 or 10%) to perform the relaxation tests. These strain levels are low compared to subsequent strains at failure. Therefore, it seems reasonable to assume that the failure data was not significantly influenced by the intervening relaxation.

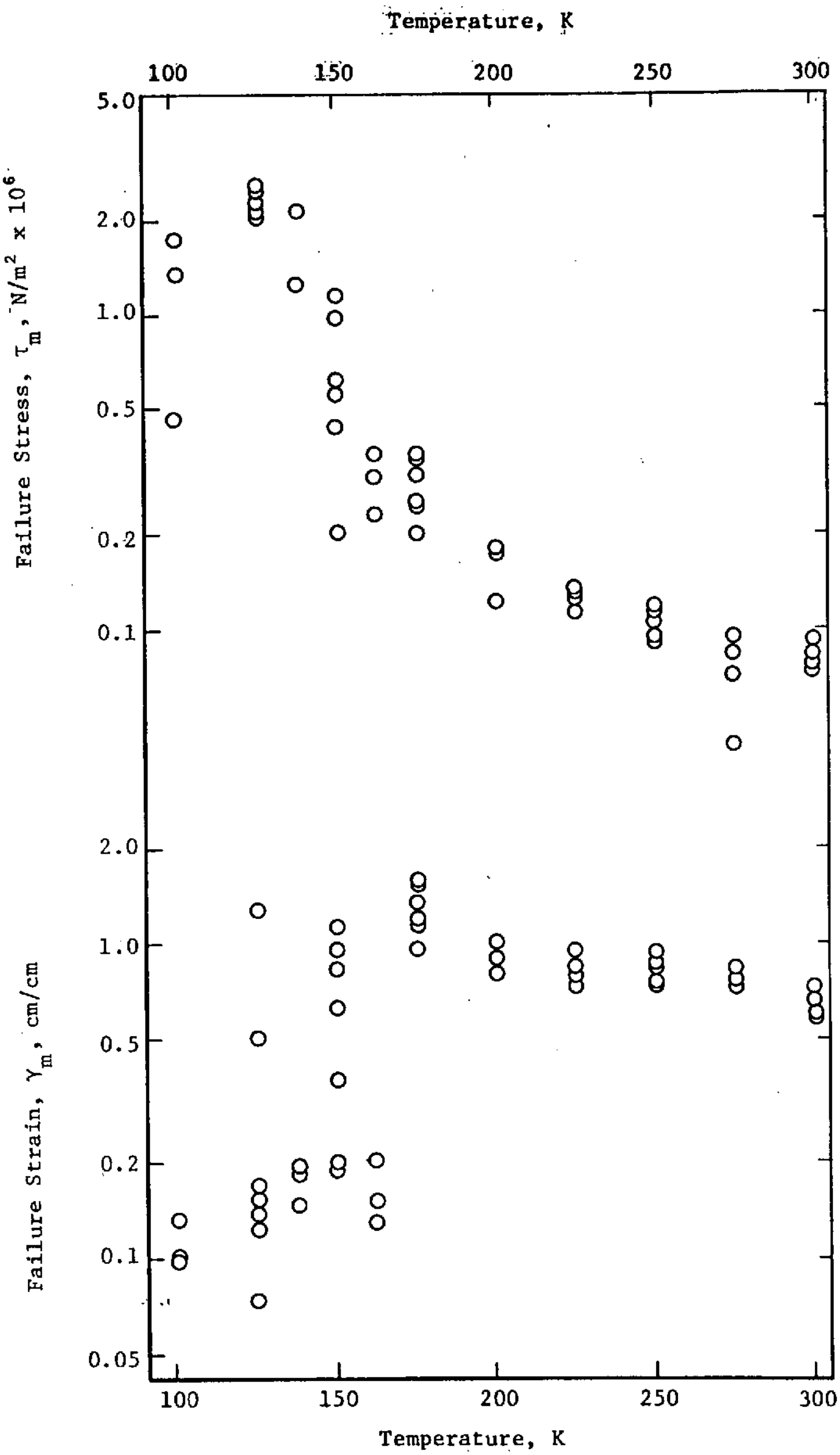

Figure 22. Failure shear stresses and corresponding strains observed for the PD-200-16 at the various test temperatures.

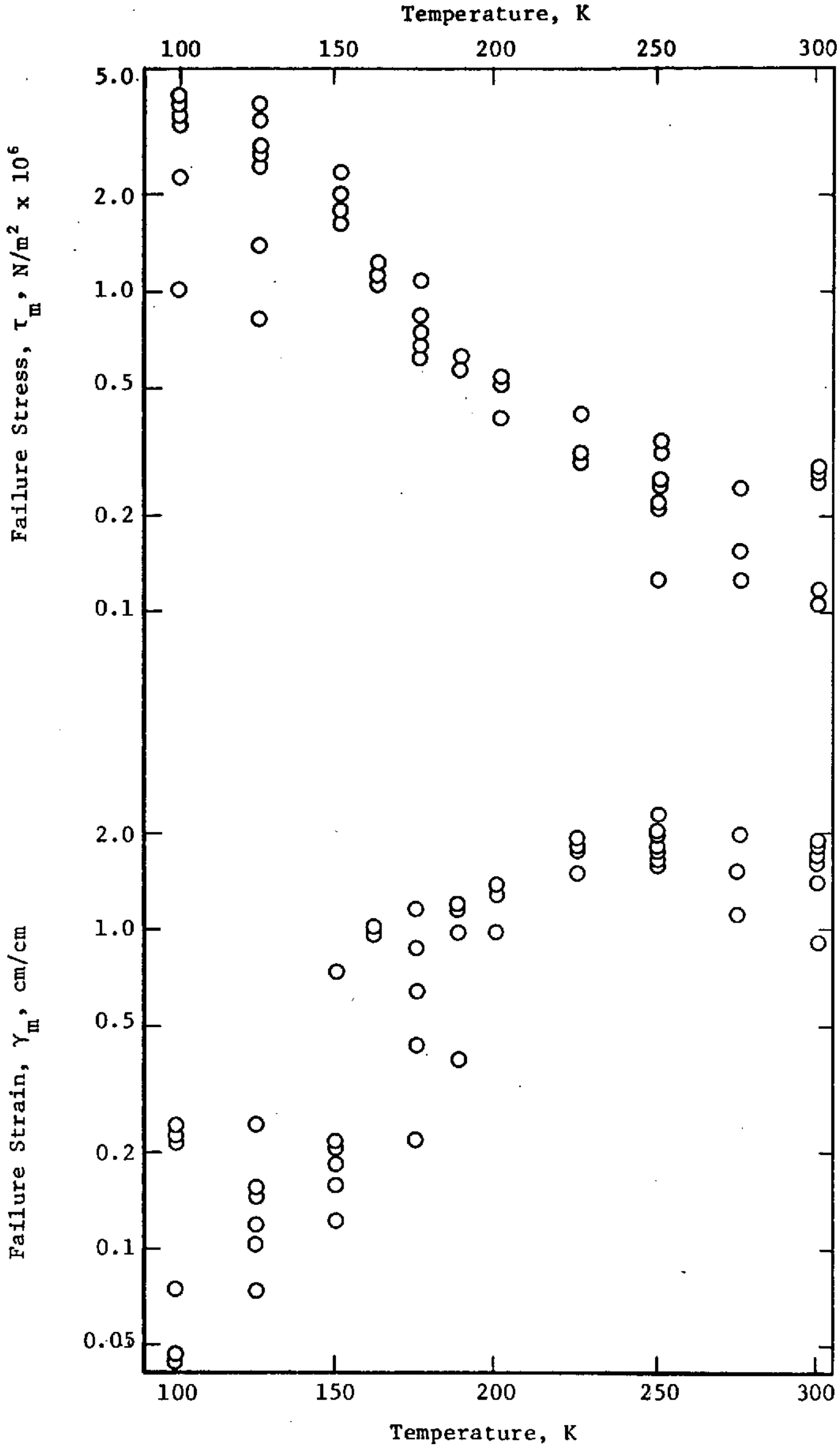

Figure 23. Failure shear stresses and corresponding strains observed for the RL-1973 at the various test temperatures.

Finally, Figures 24 and 25 show the maximum stresses plotted against the maximum strains. Such plots are often used to show failure data obtained from uniaxial tests and are referred to as failure envelopes (ref. 6). Such curves imply that failure is independent of the loading history, often a convenient but also often an invalid assumption.

The stresses used in these plots were adjusted by the factor T_o/T where T_o was arbitrarily selected to be 300 K. Therefore, the failure stresses at the lower temperatures were considerably magnified.

Several points are shown plotted with a diagonal arrow pointing upward and to the right. For one reason or another these failures were believed to be invalid and premature. For example, a specimen which failed by debonding the adhesive from the aluminum bar would be so labeled. As a result, such points were considered to give, at best, only a lower limit for the true failure stress and strain.

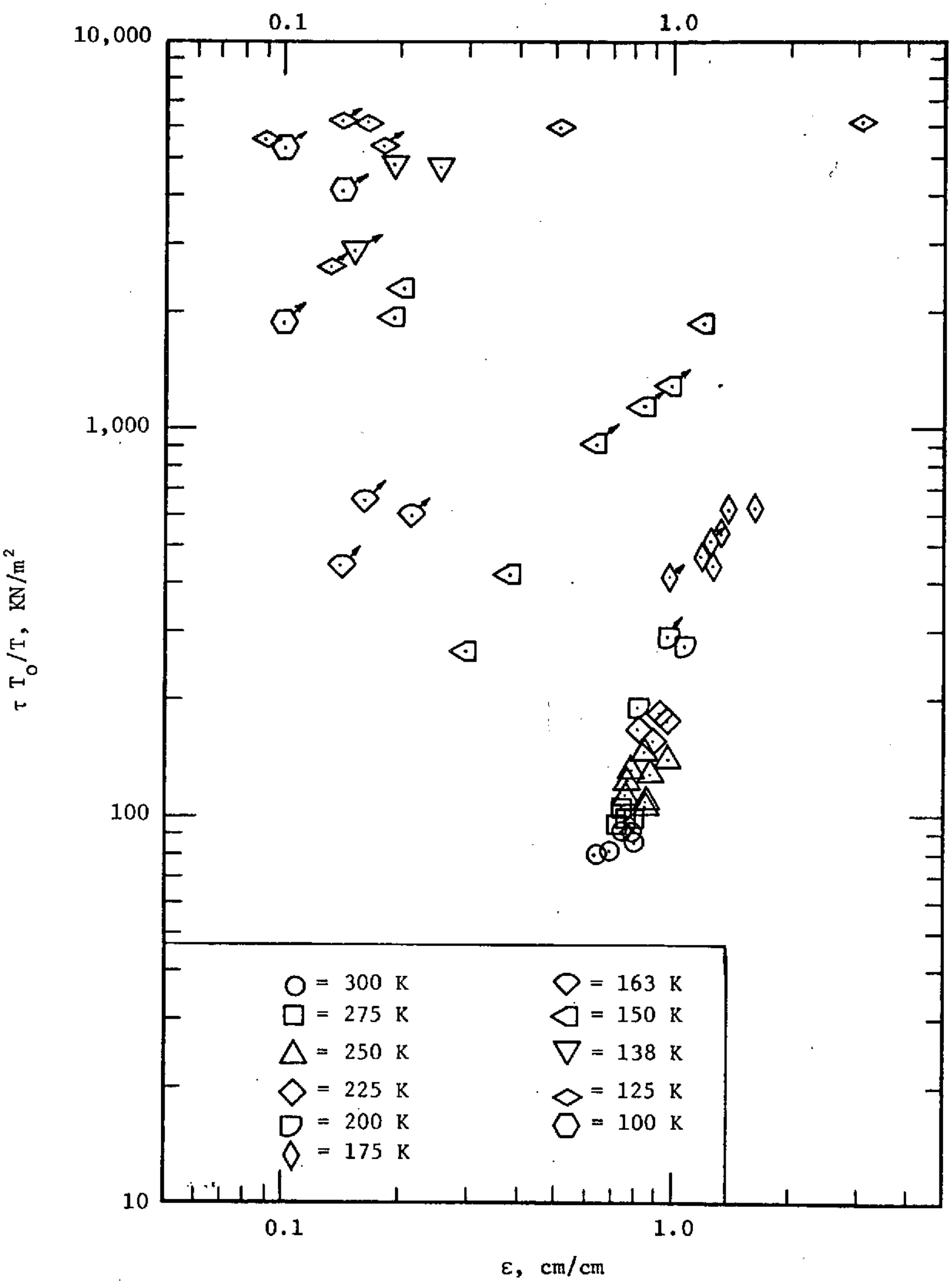

Figure 24. The stresses at maximum load plotted against the corresponding strains for the PD-200-16.

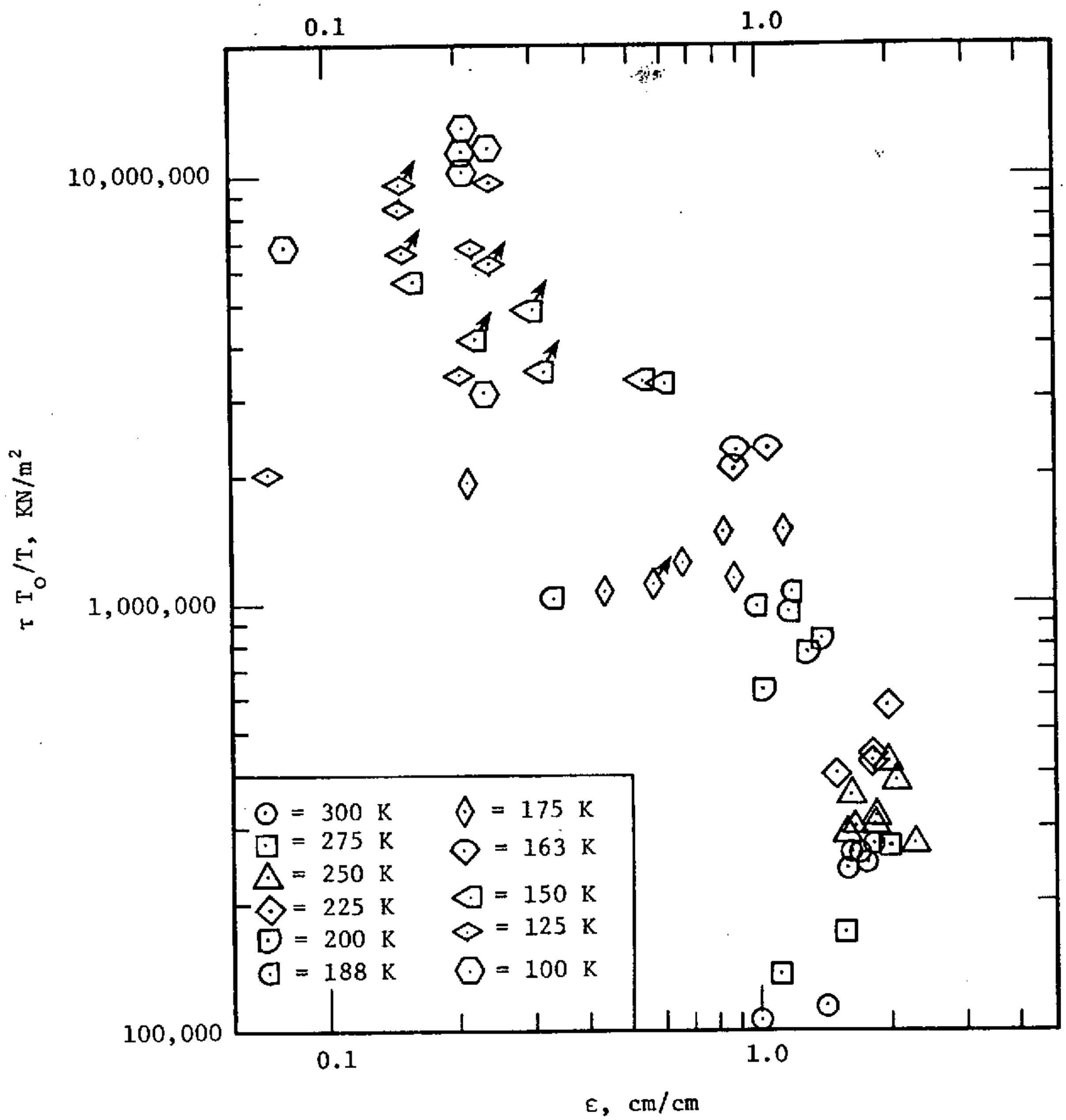

Figure 25. The stresses at maximum load plotted against the corresponding strains for the RL-1973.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The stress relaxation response characteristics of PD-200-16 and RL-1973 silicone resin foams were measured over a temperature range of 100 to 300 K and four strain levels (1, 3, 5 and 10%). Initial tangent, secant moduli and failure properties were also determined for each material at these test conditions. The following represent the conclusions reached:

1. The two silicone foams studied, PD-200-16 and RL-1973, were both extremely compliant at room temperature (i.e., respectively less than 100 and 200 N/m^2) over a range of temperatures from 300 K down to near their respective transition temperatures. Almost inevitably the PD stiffness was 100 N/m^2 or below and the RL was 200 N/m^2 or below over this range.

2. Only a slight amount of stress relaxation was observed in both materials during the 60 minute test periods except at intermediate temperatures. The slope of the log-log relaxation curve never exceeded 0.1 except in this locale.

3. The experimentally determined transition temperatures of 154 K for the PD and 177 K for the RL were consistent with those found in the literature (ref. 1) for similar chemically structured materials. It should be noted that these transitions while reflecting a change in the rate of thermal expansion did not fit the classical definition of glassy transition because the shear modulus at this temperature (and below) was in no sense "glassy" or elastic. However, the transition temperature

did indicate the onset, with cooling, of an extremely rapid increase in the stiffness.

4. The stiffness increased approximately two orders of magnitude over the range of temperatures of the tests.

5. The data were extremely scattered. This scatter can possible be explained by an apparent change of the properties as a function of the duration of the thermal conditioning time. The possibility of this phenomenon, suggested by I. K. Spiker of NASA's Johnson Space Center led to several exploratory side tests which seemed to indicate its validity.

6. No decisive evidence was found relating the measured stiffness values to the test strain levels.

7. Both stress and strain values measured at failure may be unconservative for design purposes because of the inability to observe specimen behavior in the cryostat.

4.2 Recommendations for Future Work

Figures 6 and 7 indicate that both PD-200-16 and RL-1973 experience the greatest degree of viscoelasticity at temperatures below their respective glass transition temperatures. This is contrary to that normally expected in rate dependent materials. If this represents the true characteristic of silicone rubbers such behavior would be unique. If it is not, any modelling of this behavior and consequently any analysis which incorporates this model would be suspect.

One possible reason for this behavior can be attributed to insufficient sample conditioning. If a test were run prematurely the results produced would tend to be shifted to the shorter times (i.e., to the left) as shown in Figures 6 and 7. As the test temperature assumes lower values the conditioning times required to reach thermal equilibrium increases. It is therefore recommended that a more in-depth study of the transition zones of the two materials be undertaken, with initial consideration being devoted toward establishing the necessary pre-test conditioning time to achieve thermal equilibrium in the samples.

This can be accomplished by extending the one hour conditioning time used throughout this program and rerunning selective relaxation tests. In addition to temperature, volumetric contraction during conditioning should also be monitored. The time required for the thermal contractions to cease will establish the desired conditioning time. Stress relaxation tests at this conditioning time should verify or refute the existence of the high degree of viscoelasticity in the two materials below their T_g. These results would also be extremely beneficial to future characterizations of polymers for use at cryogenic temperatures.

REFERENCES

1. Owen, H. T.; and Carroll, M. T.: Development of Design Allowable Data for Adhesives for Attaching Reusable Surface Insulation, Final Technical Report for Contract No. NAS9-12392, General Dynamics, Convair Aerospace Division, October 1972.

2. Telephone conversation with Dr. A. Hiltz of General Electric, Valley Forge Space Center, Box 8555, Philadelphia, Pa. 19101 and Mr. J. Owens of Raybestos-Manhattan, Garco and Oher Ave., North Charleston, S. C. 29406.

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STRESS RELAXATION AND MECHANICAL PROPERTIES

OF

RL-1973 AND PD-200-16

SILICONE RESIN SPONGE MATERIALS

by

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J. S. Noel
J. S. Ham
R. McCoy

APPENDIX A

COMPUTER PROGRAM FORMAT

Mechanics and Materials Research Center
Texas A&M University
College Station, Texas 77843

Final Technical Report

on

Contract No. NAS1-13342

1 March 1975

National Aeronautics and Space Administration

Langley Research Center

Hampton, Virginia 23665

Best available copy

APPENDIX A

This appendix contains a listing of the FORTRAN Code used to reduce the test data to the format shown in Appendix B.

LISTING OF PROGRAM USED TO REDUCE DATA

```
      IMPLICIT REAL * 8 (A-H, Ø-Z)
      DIMENSIØN STRESS(100), STRAIN(100), ET(100), ES(100)
  100 CØNTINUE
C     READ IN DATA
      STRANØ= 0.0
      STRESØ= 0.0
      READ(5,10) SAM1, SAM2, SAM3, SAM4, SAM5, SAM6, SAM7
   10 FØRMAT(7A8)
      READ(5,20) PØINTS,STØP
   20 FØRMAT(2F10.5)
      N = PØINTS
      DØ 30 I = 1,N
   30 READ(5,40) STRESS(I), STRAIN(I)
   40 FØRMAT (2F10.5)
C     CALIBRATE DATA
      DØ 50 I = 1,N
      STRESS(I) = STRESS(I) * 6895.
      STRAIN(I) = STRAIN(I) * 100.
      IF(STRAIN(I).EQ.0.0) GØ TØ 110
      ADD = STRESS(5) - STRESS(6)
      IF(I.GT.5) STRESS(I) = STRESS(I) + ADD
      ES(I) = STRESS(I) / STRAIN(I) * 100.
      ET(I) =(STRESS(I) - STRESØ) / (STRAIN(I) - STRANØ) * 100.
  110 CØNTINUE
      STRESØ = STRESS(I)
      STRANØ = STRAIN(I)
      IF(I.GT.5) STRESS(I) = STRESS(I) - ADD
   50 CØNTINUE
C     WRITE ØUT DATA
      WRITE(6,60) SAM1, SAM2, SAM3, SAM4, SAM5, SAM6, SAM7
   60 FØRMAT('1', ////, 10X, 7A8)
      WRITE(6, 70)
   70 FØRMAT(///, 13X, ' STRESS ',12X ' STRAIN ',14X, ' GT MØDULUS ',
     *10X,'GS MØDULUS')
      DØ 80 I = 1,N
   80 WRITE(6,90) STRESS(I), STRAIN(I), ET(I), ES(I)
   90 FØRMAT( 10X, F10.1, 10X, F10.4, 10X, F12.0, 10X, F12.0)
C     DRAW THE STRESS-STRAIN CURVE
      CALL CURVE(STRESS, STRAIN, SAM1, SAM2, SAM3, SAM4, SAM5, SAM6, SAM
     *7, N)
      IF(STØP.EQ.0.) GØ TØ 100
      CALL LINE4
      WRITE(6,120)
  120 FØRMAT('1')
      STØP
      END
```

(CONTINUED)

```
      SUBRØUTINE CURVE(STRESS, STRAIN, SAM1, SAM2, SAM3, SAM4, SAM5, SAM
     *6, SAM7, N)
      REAL*8 STRESS(100), STRAIN(100), SAM1, SAM2, SAM3, SAM4, SAM5,
     C SAM6, SAM7
      DIMENSIØN STRES(100), STRAN(100)
      S1 = 500000.
      S2 = 1000000.
      S3 = 2000000.
      S4 = 4000000.
      E1 = 50.
      E2 = 200.
      S1DX=S1/10.
      S2DX = S2/10.
      S3DX=S3/10.
      S4DX=S4/10.
      E1DX=E1/10.
      E2DX=E2/10.
      DØ 10 I = 1,N
      STRES(I) = STRESS(I)
10    STRAN(I) = STRAIN(I)
      IF(STRESS(N).LE.S1) CALL AXIS1(0.0,0.0,' STRESS (N/MS)',
     C 14, 10., 90., 0.0, S1DX, 20.)
      IF(STRESS(N).LE.S1) GØ TØ 20
      IF(STRESS(N).LE.S2) CALL AXIS1(0.0, 0.0, ' STRESS (N/MS)',
     C14, 10., 90., 0.0, S2DX, 20.)
      IF(STRESS(N).LE.S2) GØ TØ 20
      IF(STRESS(N).LE.S3) CALL AXIS1(0.0, 0.0, ' STRESS (N/MS)',
     C 14, 10., 90., 0.0, S3DX, 20.)
      IF(STRESS(N).LE.S3) GØ TØ 20
      CALL AXIS1(0.0, 0.0, ' STRESS (N/MS)',
     C 14, 10., 90., 0.0, S4DX, 20.)
20    CØNTINUE
      IF(STRAIN(N).LE.E1) CALL AXIS1(0.0,0.0, 'STRAIN (PERCENT)',-16,
     C10., 0.0, 0.0, E1DX, 20.)
      IF (STRAIN(N).LE.E1) GØ TØ 40
      CALL AXIS1( 0.0, 0.0, 'STRAIN (PERCENT)',-16, 10., 0.0, 0.0,E2DX,
     C20.)
40    CØNTINUE
      IF(STRESS(N).GT.S1) GØ TØ 30
      IF(STRAIN(N).GT.E1) GØ TØ 35
      CALL LINE1(E1, 0.0, S1, 0.0,E1DX,S1DX)
      GØ TØ 75
35    CALL LINE1(E2, 0.0, S1, 0.0,E2DX,S1DX)
      GØ TØ 75
30    IF(STRESS(N).GT.S2) GØ TØ 50
      IF(STRAIN(N).GT.E1) GØ TØ 55
      CALL LINE1(E1, 0.0, S2, 0.0, E1DX,S2DX)
      GØ TØ 75
55    CALL LINE1(E2, 0.0, S2, 0.0, E2DX,S2DX)
      GØ TØ 75
50    IF (STRESS(N).GT.S3) GØ TØ 60
      IF(STRAIN(N).GT.E1) GØ TØ 65
      CALL LINE1(E1, 0.0, S3, 0.0, E1DX,S3DX)
      GØ TØ 75
```

(CONTINUED)

```
65      CALL LINE1(E2, 0.0, S3, 0.0, E2DX,S3DX)
        GØ TØ 75
60      IF(STRAIN(N).GT.E1) GØ TØ 70
        CALL LINE1(E1, 0.0, S4, 0.0, E1DX,S4DX)
        GØ TØ 75
70      CALL LINE1(E2, 0.0, S4, 0.0, E2DX,S4DX)
75      CØNTINUE
        CALL SYMBØL(1., 10.,.2, SAM1, 0.0, 8)
        CALL SYMBØL(2.4,10.,.2, SAM2, 0.0, 8)
        CALL SYMBØL(3.7,10.,.2, SAM3, 0.0, 8)
        CALL SYMBØL(4.95, 10., .2, SAM4, 0.0, 8)
        CALL SYMBØL(6.35, 10., .2, SAM5, 0.0, 8)
        CALL SYMBØL(7.75,10.,.2,SAM6,0.0,8)
        CALL SYMBØL(9.15,10.,.2,SAM7,0.0,8)
        CALL LINE2(STRAN, STRES, N, 2,1,1)
        CALL LINE3(15.)
        RETURN
        END
```

(END)

STRESS RELAXATION AND MECHANICAL PROPERTIES

OF

RL-1973 AND PD-200-16

SILICONE RESIN SPONGE MATERIALS

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APPENDIX B

COMPUTER PRINTOUT

Mechanics and Materials Research Center
Texas A&M University
College Station, Texas 77843

Final Technical Report

on

Contract No. NAS1-13342

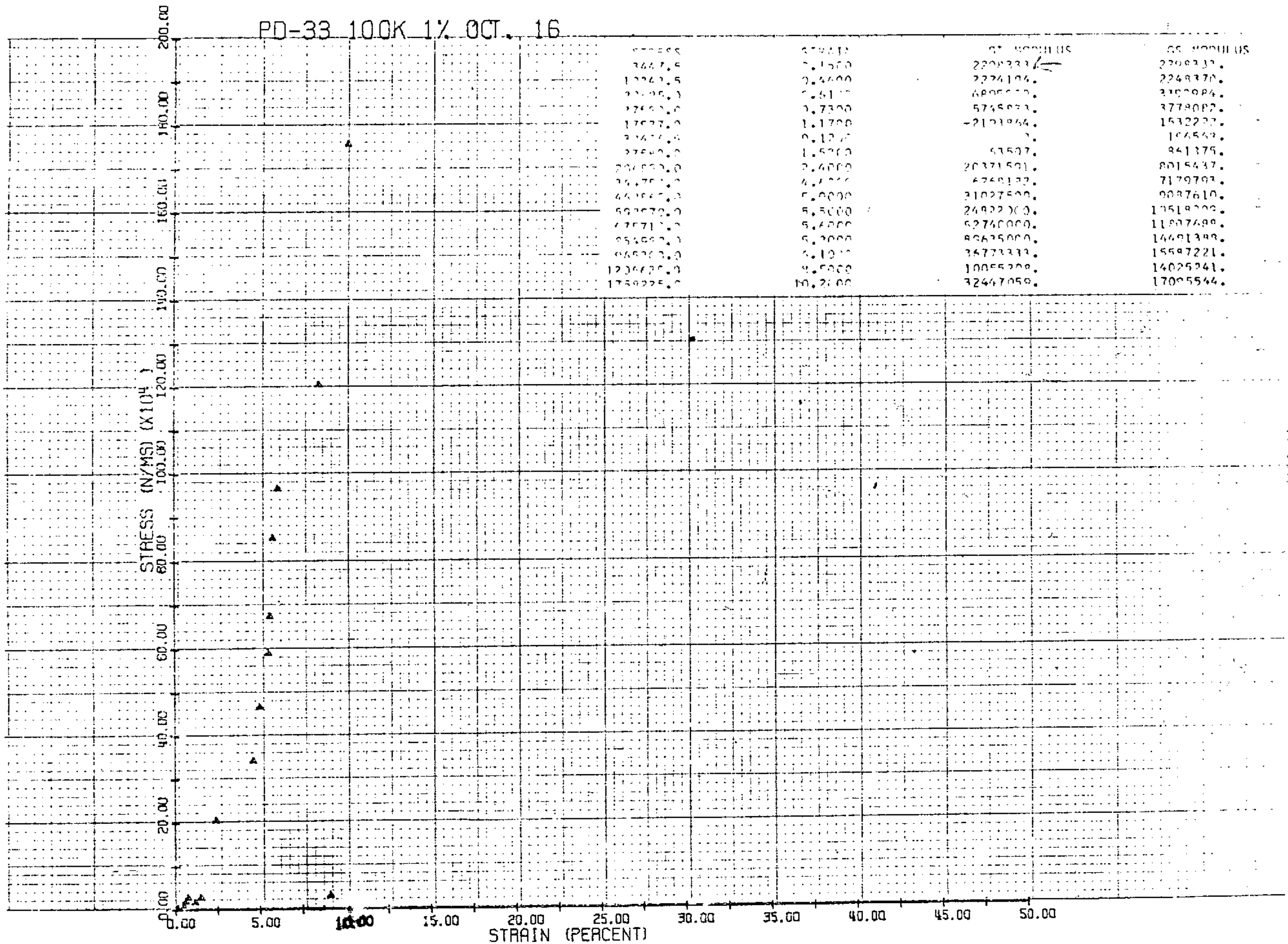
1 March 1975

National Aeronautics and Space Administration

Langley Research Center

Hampton, Virginia 23665

PD-33 100K 1% OCT. 16



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10342.5	0.4600	2224194.	2248370.
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[illegible]	0.7300	5745833.	3778082.
17927.0	1.1700	-2121964.	1532222.
[illegible]	0.1200	0.	156563.
27580.0	1.5200	53597.	941375.
[illegible]	2.4000	20371591.	8015437.
[illegible]	4.4000	6749122.	7179793.
[illegible]	5.0000	31027500.	9087610.
[illegible]	5.5000	24922000.	13518???
[illegible]	5.6000	52740000.	11807688.
[illegible]	5.?000	89635000.	14491388.
[illegible]	?.1000	36773333.	15597221.
1206620.0	9.5000	10055208.	14025241.
1758225.0	10.2000	32447059.	17095544.

7A

PD-35 100K 5% OCT. 15

STRESS	STRAIN	[illegible] MODULUS	[illegible] MODULUS
13795.0	0.9000	1533333.	1533333.
33470.0	1.5000	2299333.	1915278.
55140.	2.7000	2209333.	2042953.
90625.0	3.4000	3820557.	2441961.
137600.0	[illegible]	4826500.	2597924.
82600.0	5.7700	0.	2026528.
137600.0	6.1000	-8235744.	3176221.
[illegible]	[illegible]	11822000.	4016022.
374320.0	7.4000	10061250.	5633941.
551600.0	9.1000	11051323.	6675269.
690550.0	10.2000	12526364.	7307348.
837400.0	11.2000	12700000.	7986156.
965300.0	11.4000	68950000.	8957452.
1103220.0	11.7000	45966667.	9026406.
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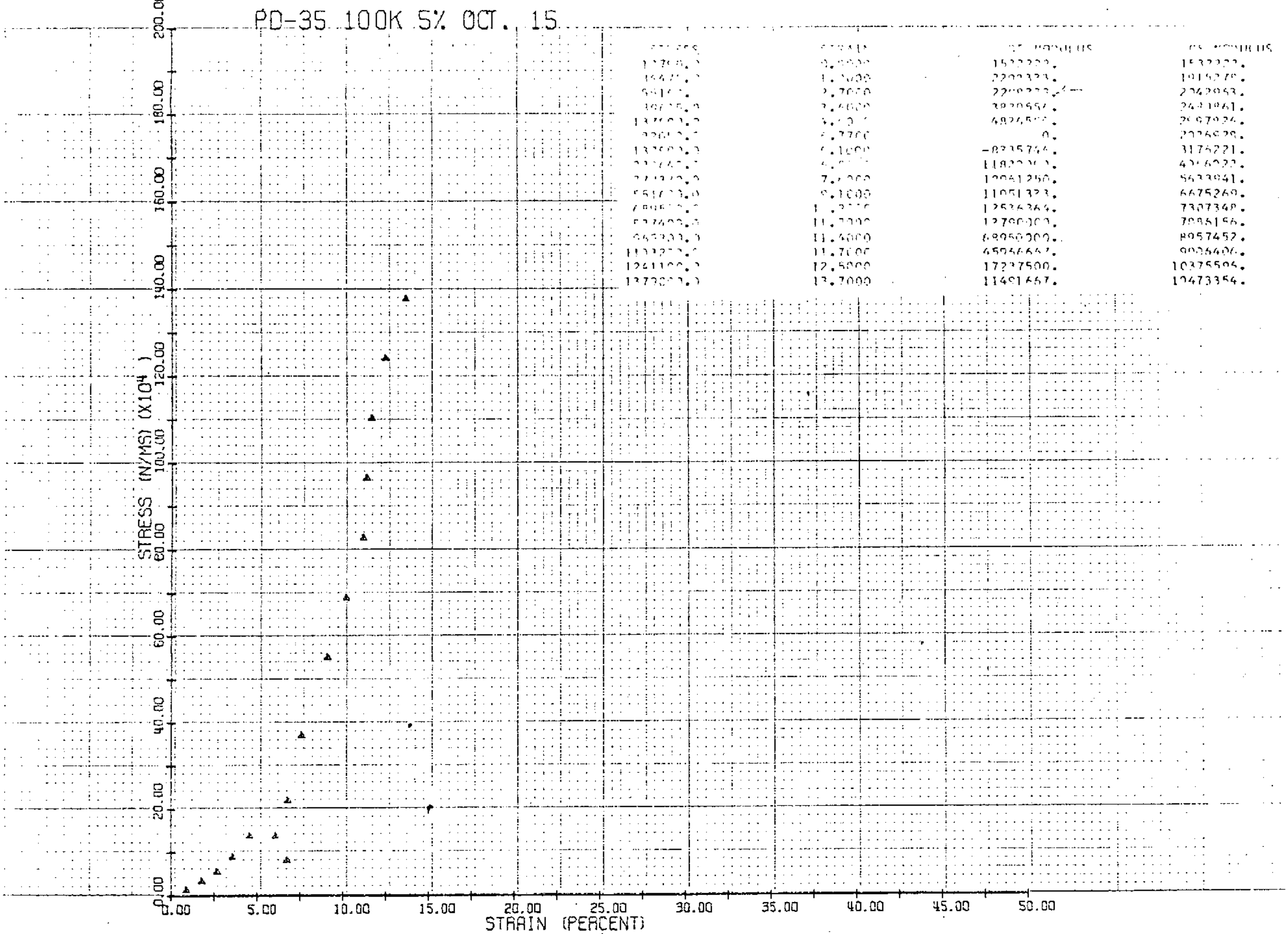
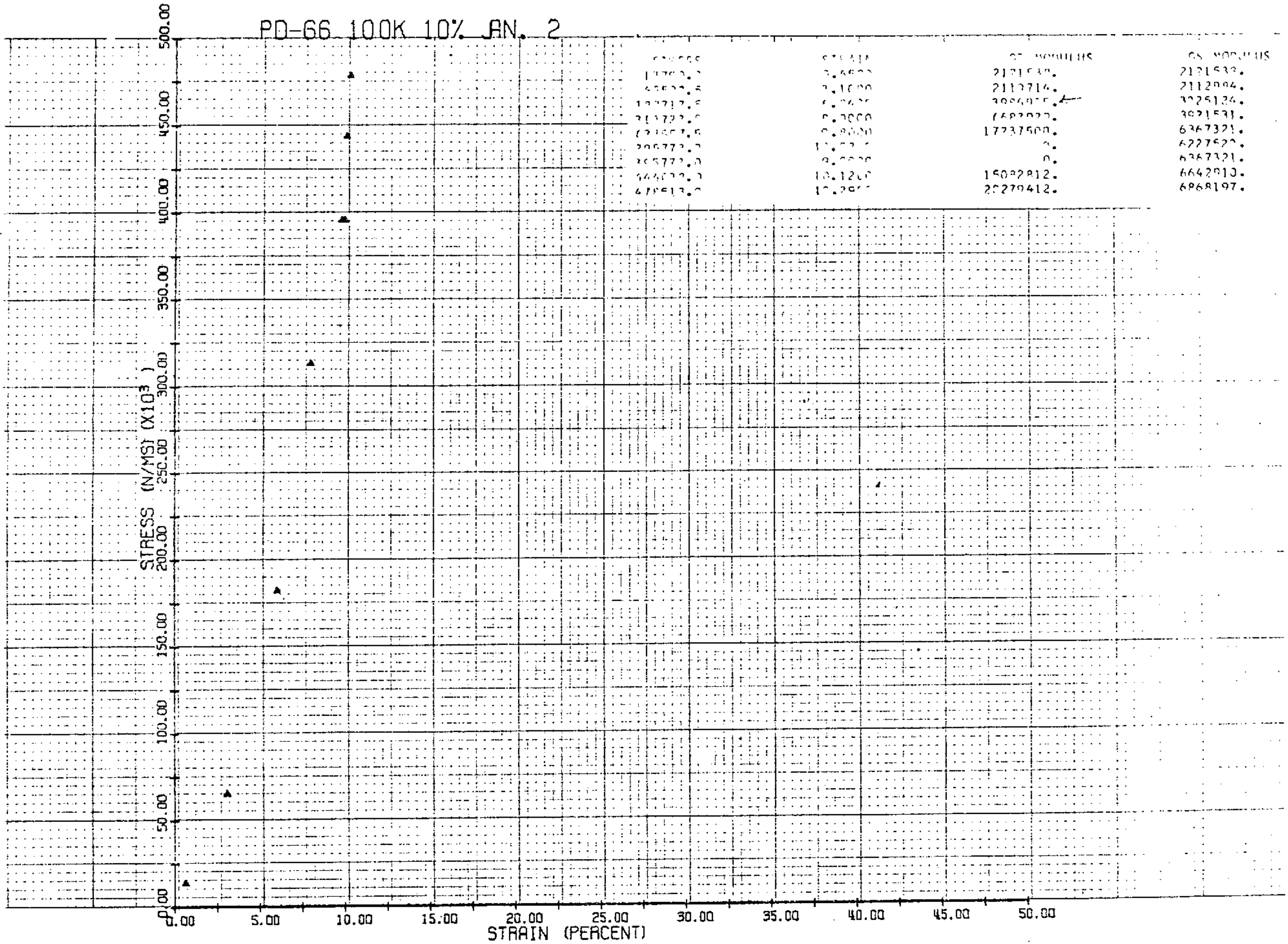


84

#6



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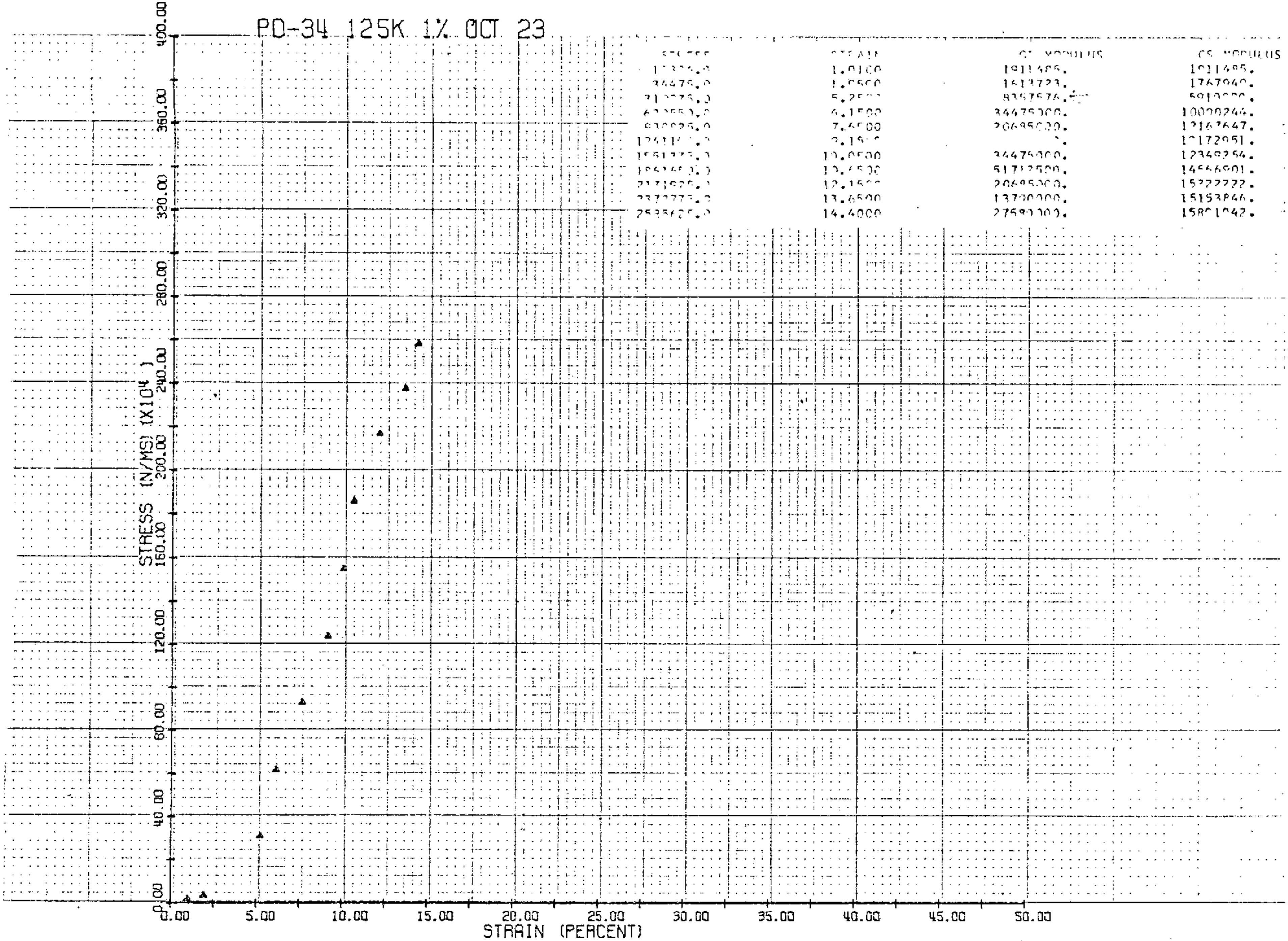
65633.5	[illegible].1000	2112714.	2112994.
183717.5	[illegible]	3986055. ←	3925126.
313722.0	[illegible].3000	6827022.	3921531.
[illegible]	[illegible].8000	17237500.	6367321.
396772.[illegible]	10.[illegible]	0.	6227529.
355772.0	9.[illegible]	0.	6367321.
444022.[illegible]	10.1200	15022812.	6642910.
478513.[illegible]	10.2800	20279412.	6868197.

PD-34 125K 1% OCT 23



STRESS	STRAIN	CT MODULUS	CS MODULUS
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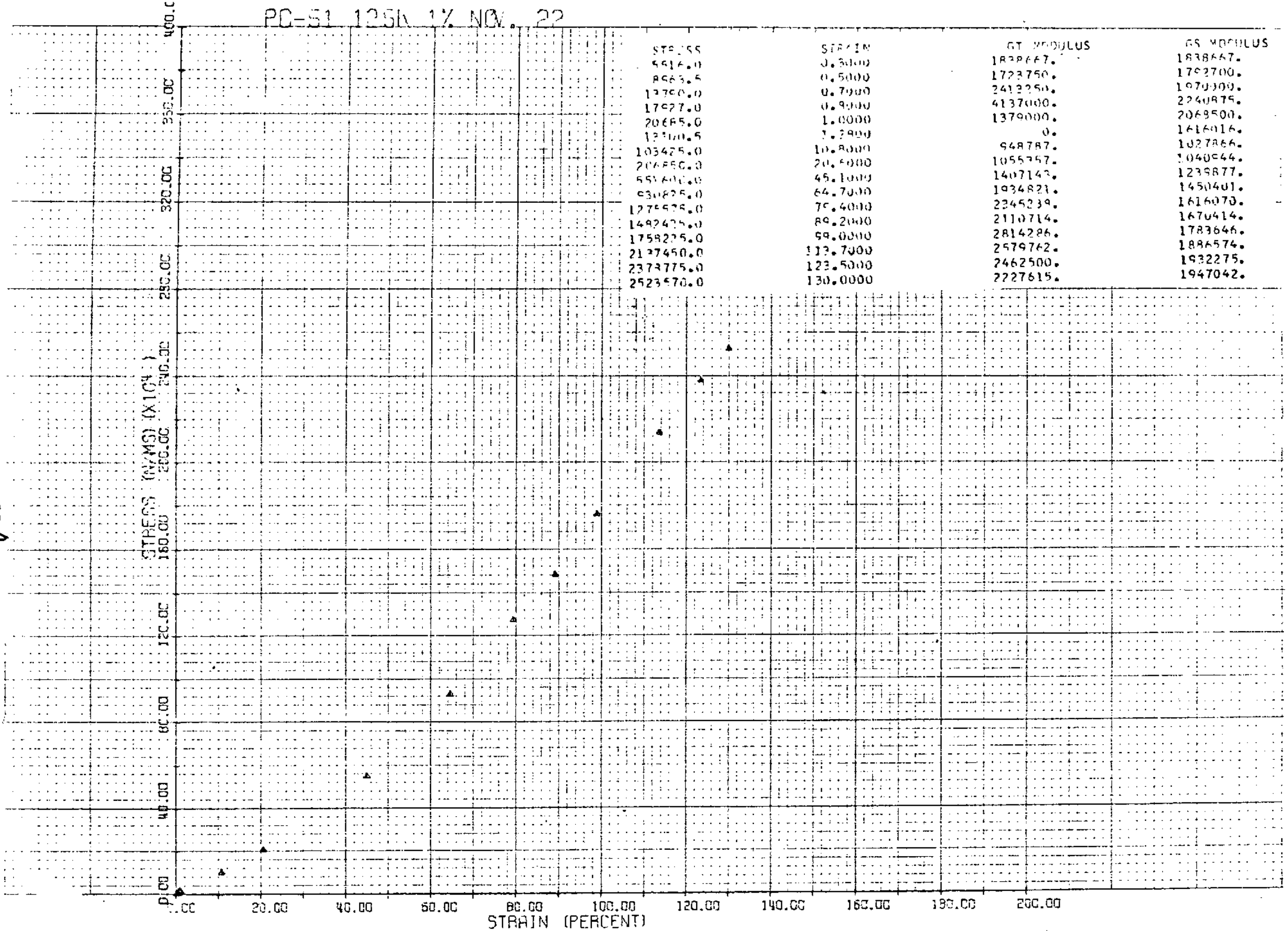
34475.0	1.9500	1613723.	1767949.
31[illegible]75.0	5.2500	8357576.	5910000.
62[illegible]550.0	6.1500	34475000.	10090244.
930925.0	7.6500	20685000.	12167647.
12411[illegible].0	9.15[illegible]	[illegible].	12172951.
1551375.0	10.0500	34475000.	12349254.
1861650.0	10.6500	51712500.	14556901.
2171925.0	12.1500	20685000.	15222222.
2372775.0	13.6500	13790000.	15153846.
2535625.0	14.4000	27580000.	15801042.

#11



STRESS	STRAIN	GT MODULUS	GS MODULUS
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8963.5	0.5000	1723750.	1792700.
13790.0	0.7000	2413250.	1970000.
17927.0	0.9000	4137000.	2240875.
20685.0	1.0000	1379000.	2068500.
[illegible]	1.2900	0.	1616016.
103425.0	10.8000	948787.	1027866.
206850.0	20.6000	1055357.	1040944.
551600.0	45.1000	1407143.	1239877.
930825.0	64.7000	1934821.	1450401.
1275575.0	79.4000	2245239.	1616070.
1482425.0	89.2000	2110714.	1670414.
1758225.0	99.0000	2814286.	1783646.
2137450.0	113.7000	2579762.	1886574.
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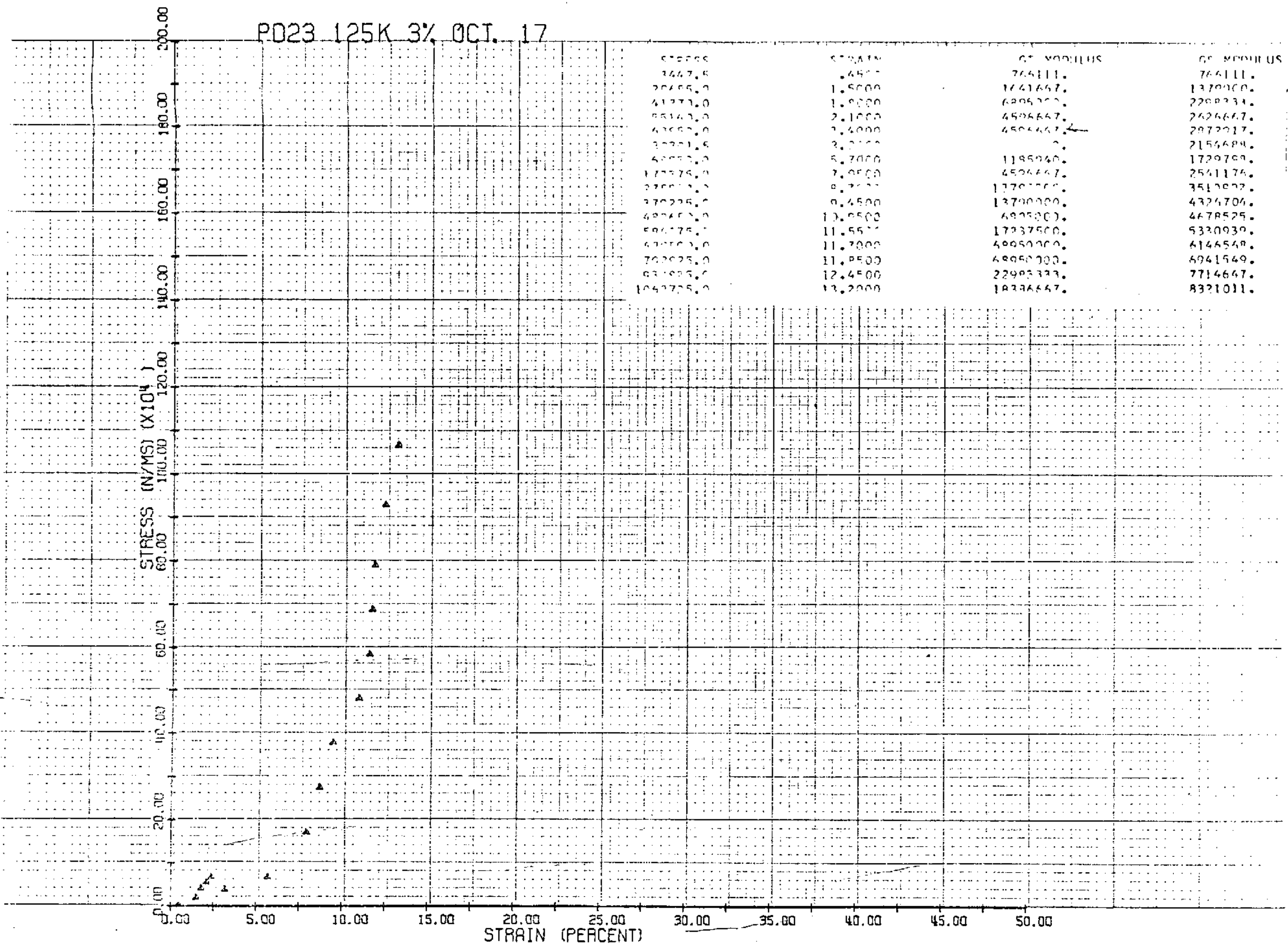
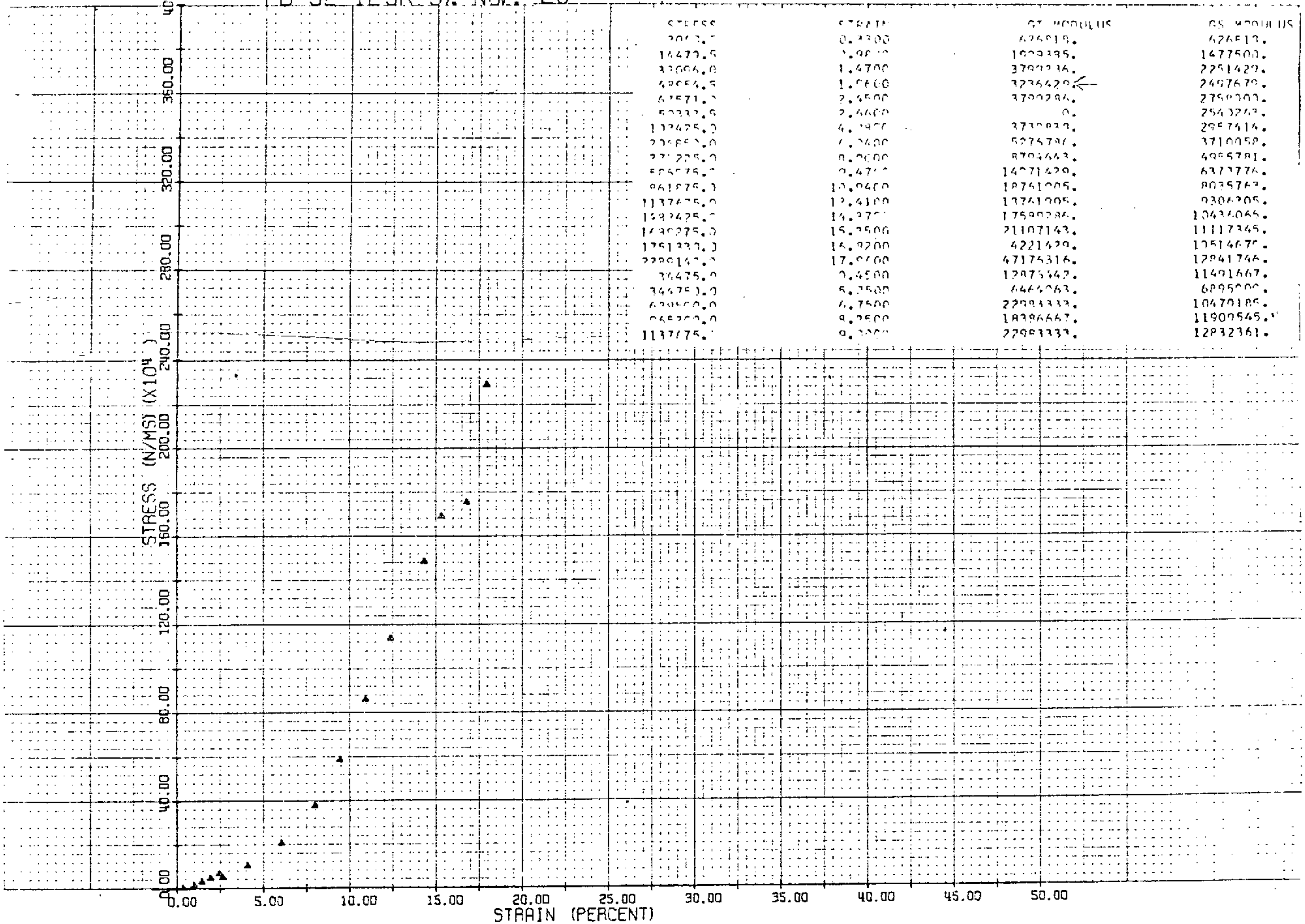


STRESS	STRAIN	CT MODULUS	CS MODULUS
3447.5	.45[illegible]	766111.	766111.
20685.0	1.5000	1641667.	1379000.
41370.0	1.8000	6895[illegible].	2298331.
55160.0	2.1000	4596667.	2626667.
6[illegible]5[illegible].0	[illegible].4000	4596667.	2872917.
[illegible]1.5	3.[illegible]	[illegible].	2156689.
[illegible].0	5.7000	1185940.	1729799.
1[illegible]7375.0	7.9500	4596667.	2541176.
[illegible].0	8.[illegible]	1379[illegible].	351[illegible]27.
370225.0	9.4500	13790000.	4324704.
4[illegible]6[illegible].0	10.[illegible]500	6895000.	4678525.
59[illegible]75.[illegible]	11.55[illegible]	17237500.	5330939.
6[illegible]0.0	11.7000	68950000.	6146548.
792925.0	11.8500	68950000.	6941549.
93[illegible]925.0	12.4500	22983333.	7714667.
1063725.0	13.2000	18386667.	8321011.

12 #

PD-52 125K 3% NOV. 20



STRESS	STRAIN	GT MODULUS	GS MODULUS
2063.7	0.3300	626919.	626913.
14473.5	0.9800	1029385.	1477500.
33096.0	1.4700	3799236.	2251429.
49954.5	1.9600	3236429. ←	2497679.
63571.0	2.4500	3799286.	2759303.
53333.5	2.4600	0.	2540243.
113475.0	4.3900	3730933.	2957414.
235850.0	6.3400	5275796.	3710058.
371275.0	8.9000	8704663.	4955781.
584575.0	9.4700	14071429.	6373776.
961575.0	10.9400	18761905.	8035763.
1137475.0	12.4100	13761905.	9306205.
1583475.0	14.3700	17599286.	10434065.
1639275.0	15.3500	21107143.	11117345.
1751333.0	16.9200	4221429.	10514670.
2299143.0	17.9400	47175316.	12841746.
36475.0	0.4500	12975342.	11491667.
344750.0	5.7500	6464063.	6895000.
639550.0	6.7500	22993333.	10470185.
955300.0	9.2500	18396667.	11909545.
1137475.0	[illegible]	22993333.	12832361.

134

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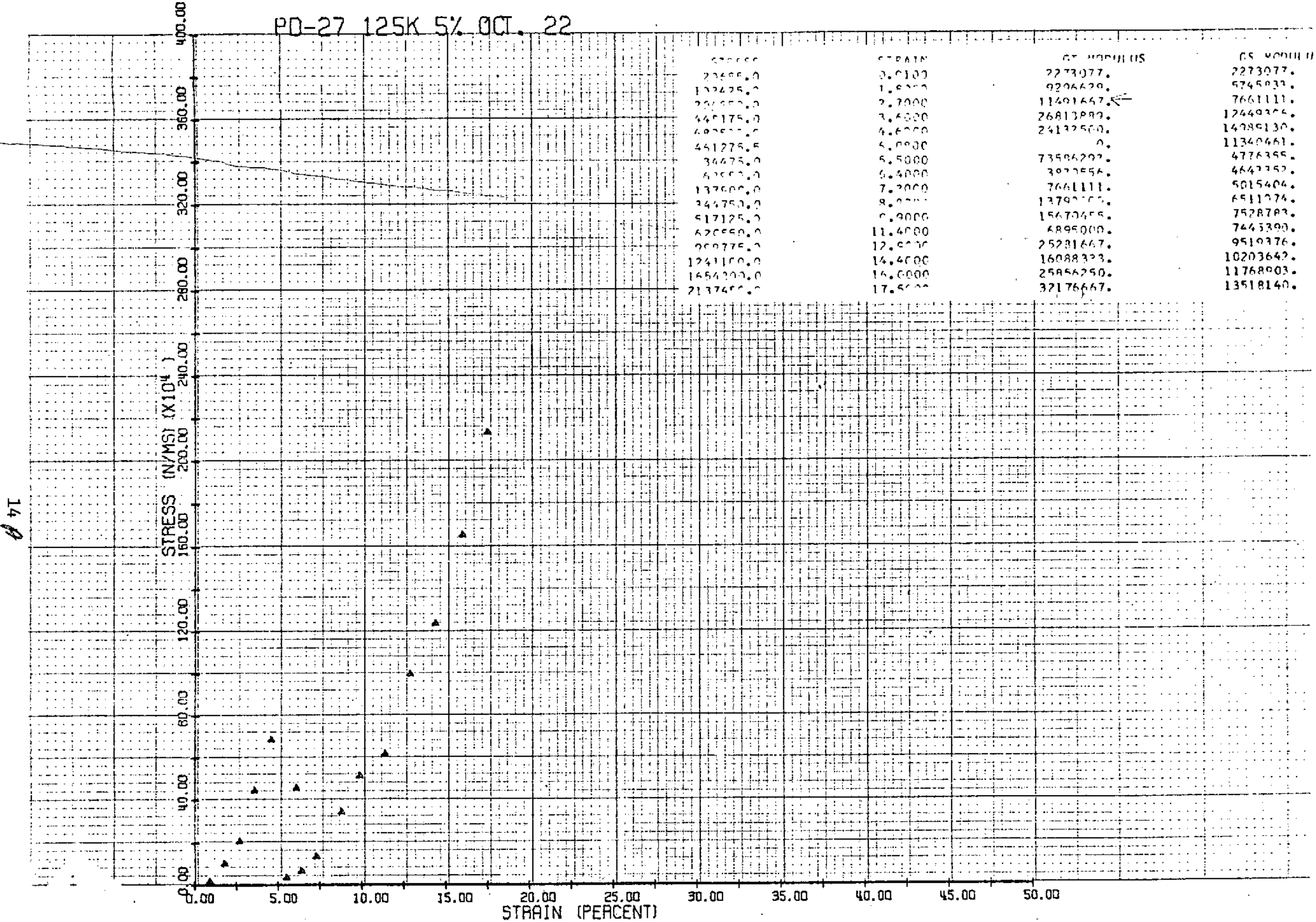
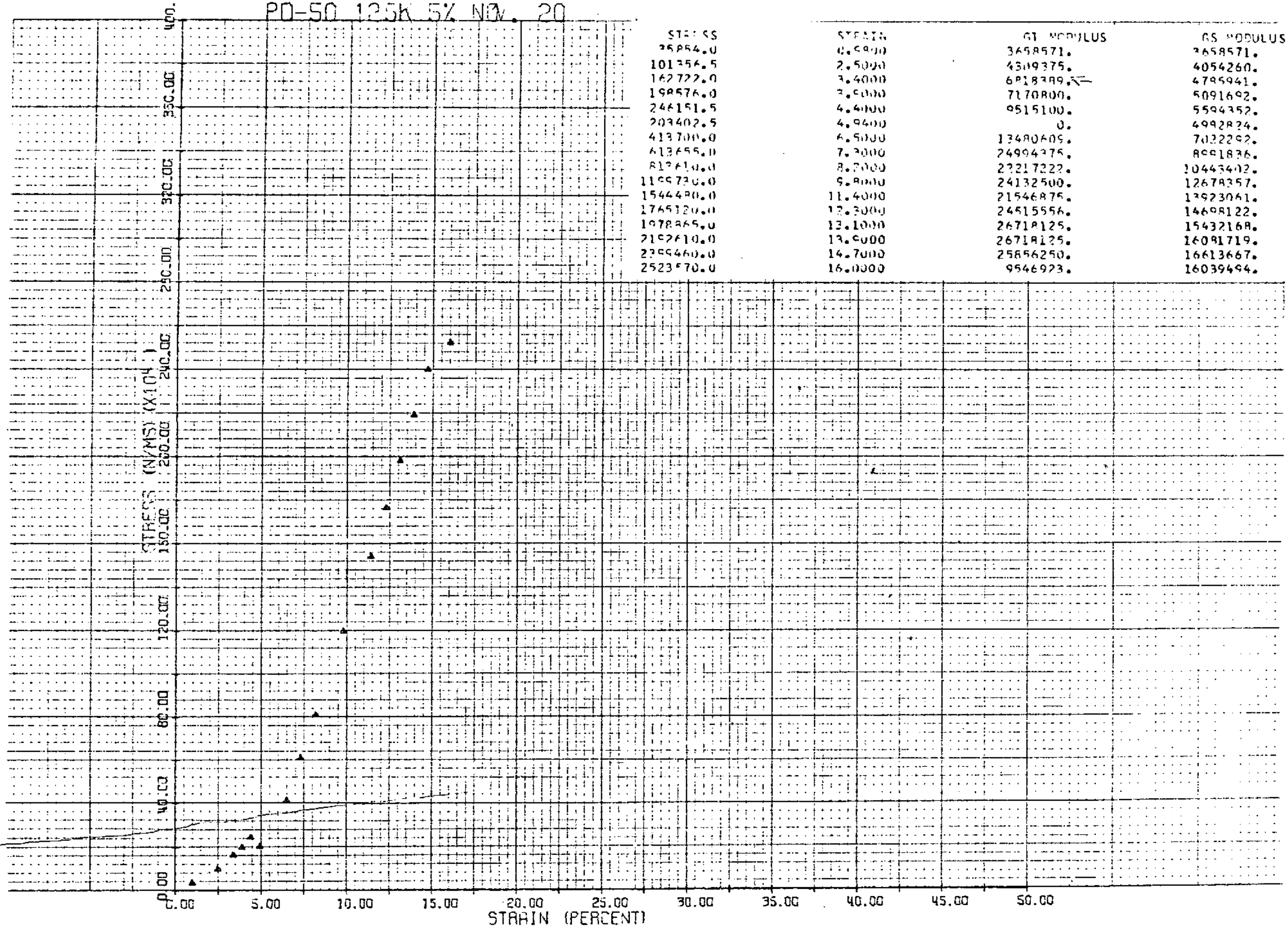


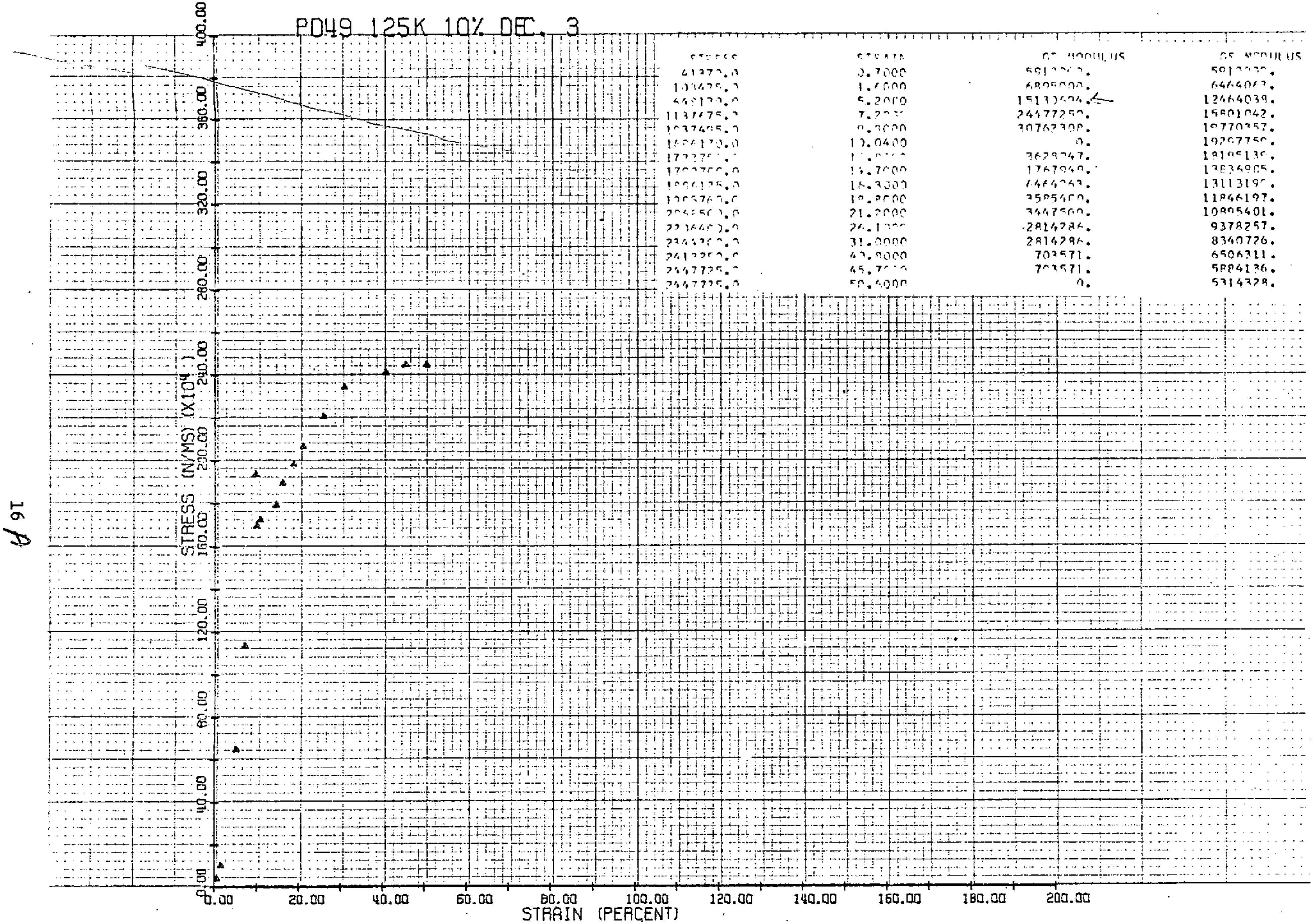
STRESS	STRAIN	GT MODULUS	GS MODULU
22655.0	0.0100	2273077.	2273077.
132425.0	1.6000	9296629.	5745833.
206550.0	2.7000	11491667. ←	7661111.
445175.0	3.6000	26813889.	12449366.
482550.0	4.6000	24132500.	14289130.
461275.5	5.0000	0.	11340461.
34475.0	5.5000	73586292.	4776355.
62550.0	6.4000	3877556.	4643352.
137900.0	7.2000	7661111.	5015404.
344750.0	8.0000	13790000.	6511974.
517125.0	9.9000	15670455.	7528783.
620550.0	11.4000	6895000.	7443390.
959775.0	12.9000	25281667.	9519376.
1241100.0	14.4000	16088323.	10203642.
1654200.0	16.0000	25856250.	11768903.
2137450.0	17.5000	32176667.	13518140.



STRESS	STRAIN	GT MODULUS	GS MODULUS
35854.0	0.5900	3658571.	3658571.
101356.5	2.5000	4309375.	4054260.
162722.0	3.4000	6818389.	4795941.
198576.0	3.5000	7170800.	5091692.
246151.5	4.4000	9515100.	5594352.
203402.5	4.9400	0.	4992824.
413700.0	6.5000	13480609.	7022292.
613655.0	7.3000	24994375.	8991836.
817610.0	8.7000	23217222.	10443402.
1155730.0	9.8000	24132500.	12678357.
1544480.0	11.4000	21546875.	13923061.
1765120.0	12.3000	24515556.	14698122.
1978865.0	13.1000	26718125.	15432168.
2152610.0	13.9000	26718125.	16081719.
2355460.0	14.7000	25856250.	16613667.
2523570.0	16.0000	9546923.	16039494.

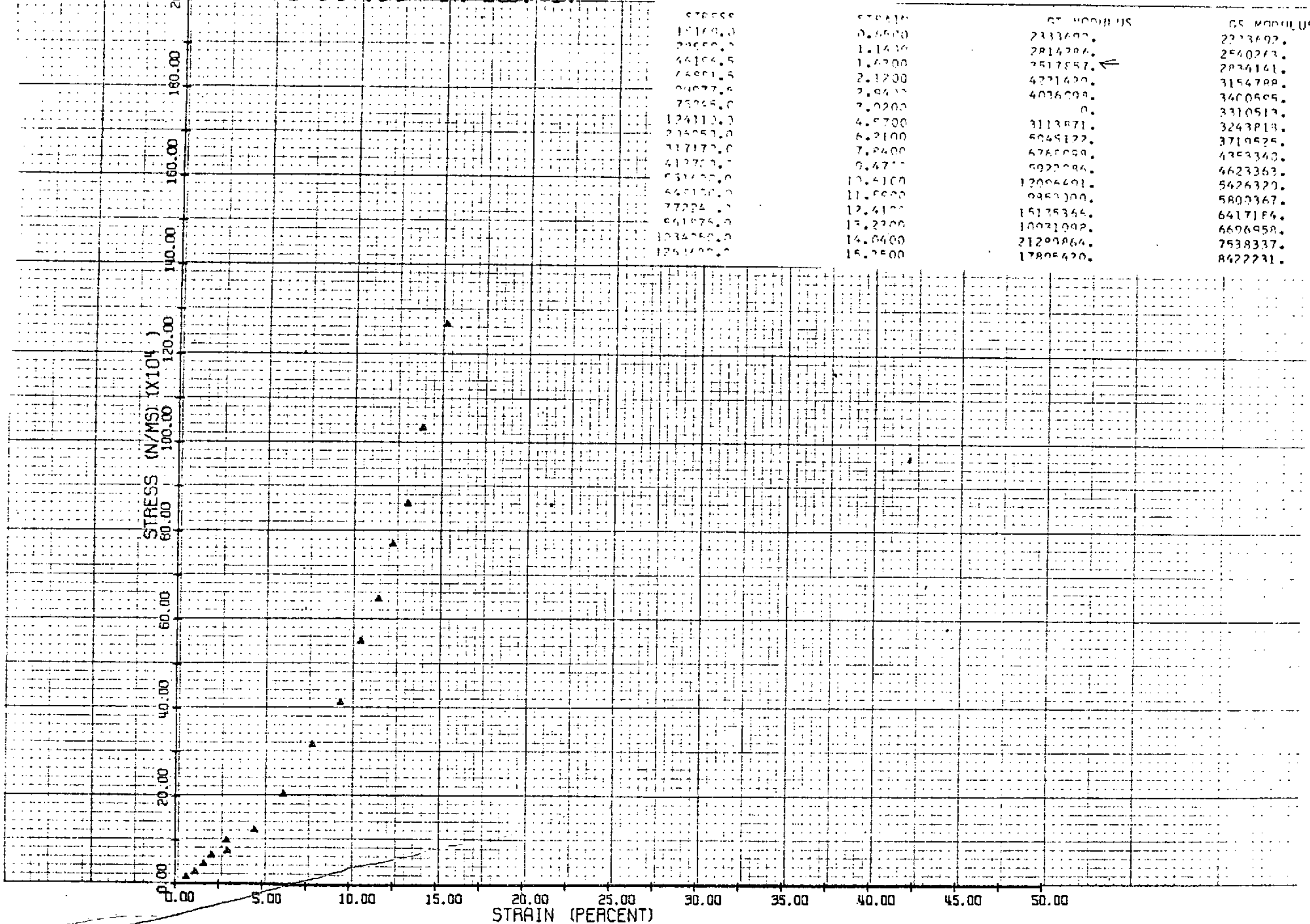
15 A

D



STRESS	STRAIN	CT MODULUS	CS MODULUS
41370.0	0.7000	5910000.	5910000.
103425.0	1.6000	6895000.	6464063.
448170.0	5.2000	15130694.	12464039.
1137675.0	7.2000	24477250.	15801042.
1637495.0	9.8000	30762308.	19770357.
1674170.0	10.0400	0.	19297759.
[illegible]	[illegible]	3628747.	18195139.
1793700.0	15.7000	1767940.	13836905.
1996175.0	16.3000	6464063.	13113190.
2055760.0	19.8000	3585400.	11846197.
2068500.0	21.2000	3447500.	10895401.
2216400.0	26.1000	-2814286.	9378257.
2344260.0	31.0000	2814286.	8340726.
2412250.0	40.9000	703571.	6506311.
2447725.0	45.7000	703571.	5884136.
2447725.0	50.6000	0.	5314328.

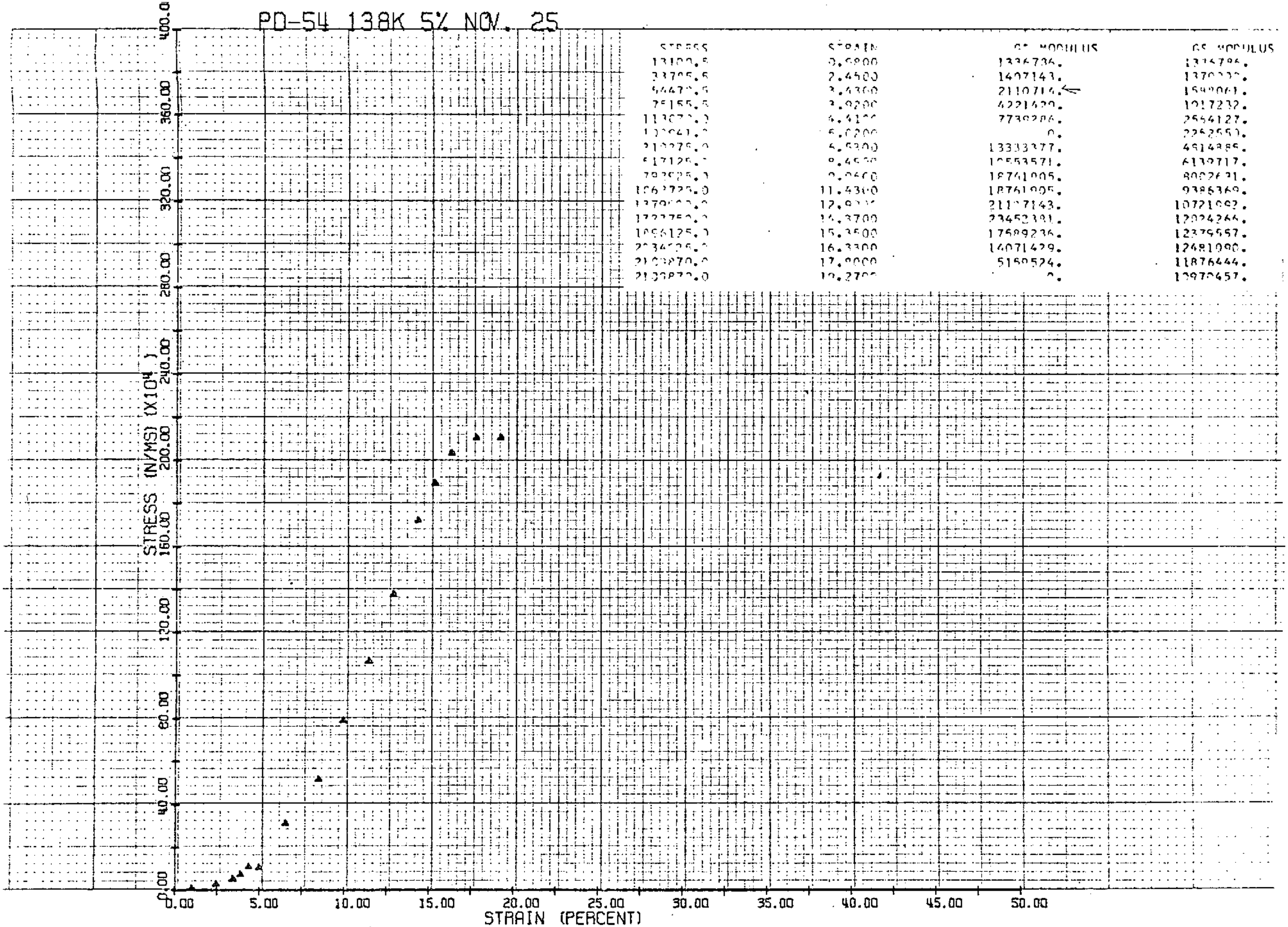
PU-64 138K 3% DEC. 17



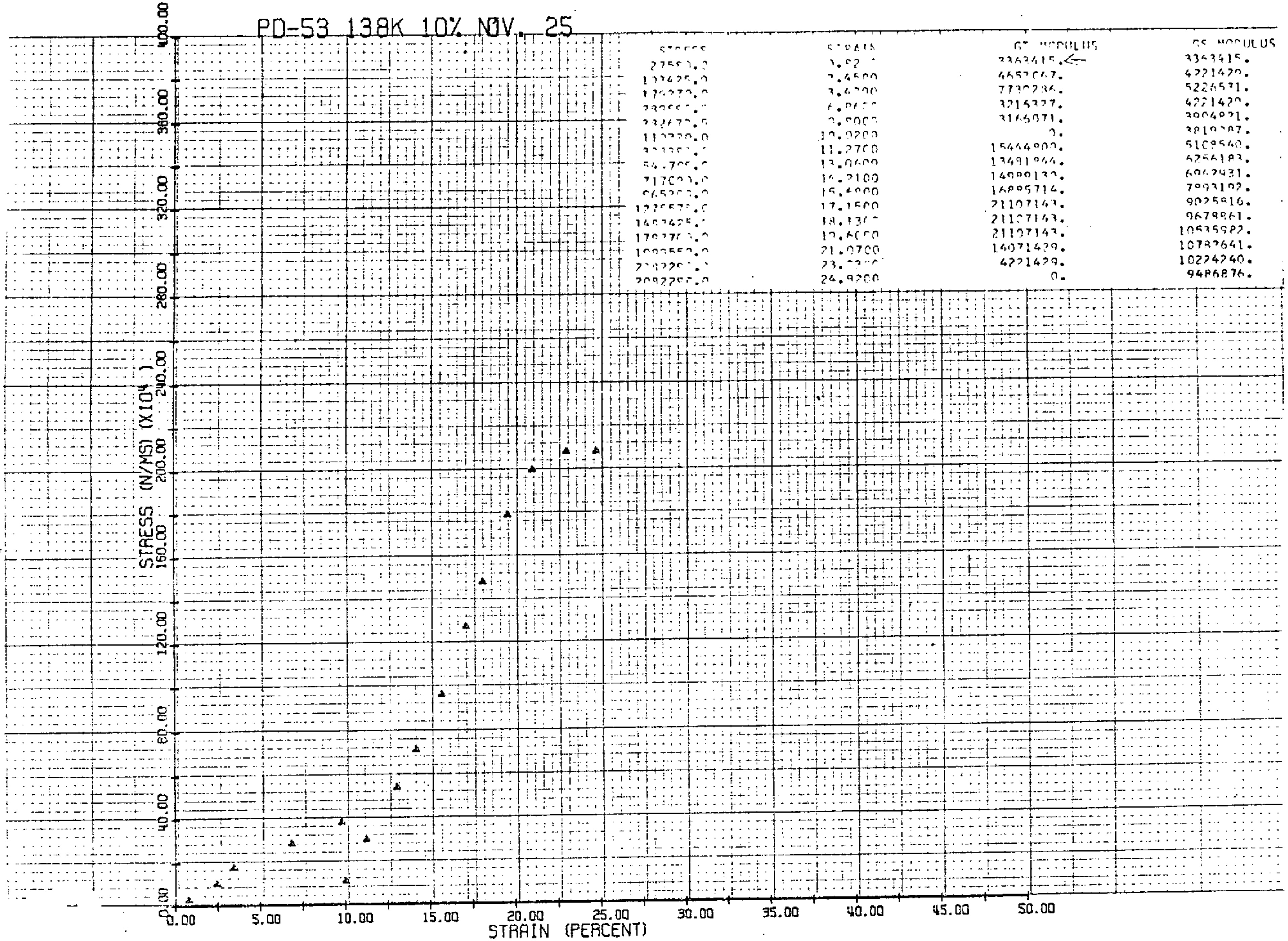
STRESS	STRAIN	GT MODULUS	CS MODULUS
15169.0	0.6500	2333692.	2333692.
29550.0	1.1430	2814286.	2540273.
46164.5	1.6200	3517557. ←	2834141.
66881.5	2.1200	4221620.	3154788.
99977.6	2.9400	4036098.	3400595.
75945.0	3.0200	0.	3310513.
124113.0	4.5700	3113871.	3243813.
230653.0	6.2100	5045122.	3719525.
317172.0	7.2400	6765659.	4353340.
412723.0	9.4700	5922986.	4623363.
531472.0	10.6100	12096491.	5426320.
645130.0	11.5500	9953000.	5800367.
77224[illegible].0	12.4100	15135344.	6417184.
861875.0	13.2200	10031092.	6696958.
1034050.0	14.0400	21209864.	7538337.
1261400.0	15.2500	17805420.	8422231.

PD-54 138K 5% NOV. 25

STRESS	STRAIN	CS MODULUS	GS MODULUS
13100.5	0.9800	1336736.	1336786.
33705.5	2.4500	1407143.	1375735.
54470.5	3.4300	2110714.	1588061.
75155.5	3.9200	4221429.	1917232.
113078.0	4.4100	7739286.	2564127.
113541.0	5.0200	0.	2262550.
320975.0	6.5300	13333377.	4914885.
517125.0	8.4500	10553571.	6119717.
793525.0	9.9600	18761905.	8002631.
1062725.0	11.4300	18761905.	9386369.
1379000.0	12.9300	21107143.	10721992.
1727750.0	14.3700	23452381.	12024266.
1900125.0	15.3500	17589236.	12379557.
2034525.0	16.3300	14071429.	12481090.
2103870.0	17.9000	5159524.	11876444.
2103870.0	19.2700	0.	10970457.

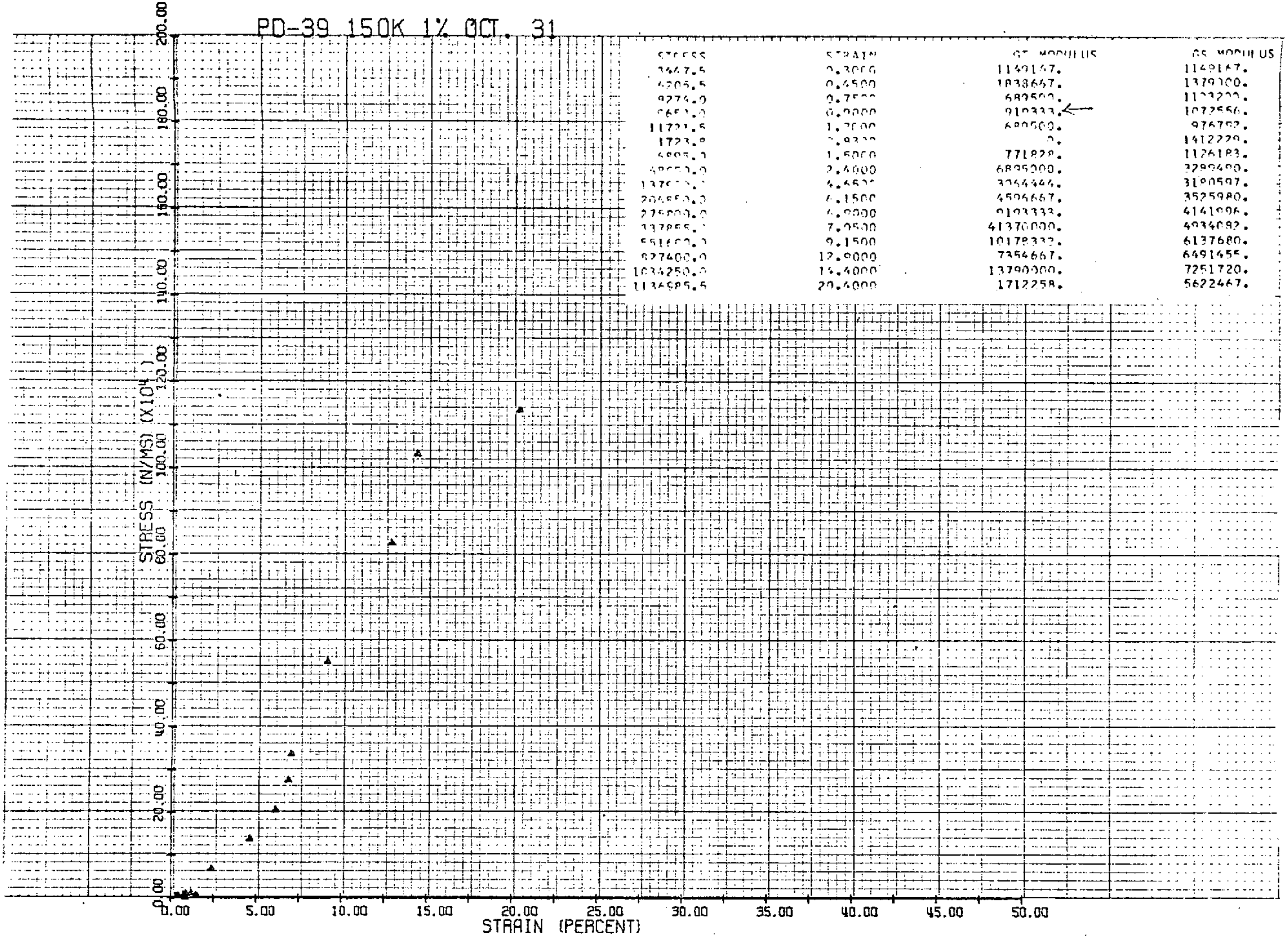


18

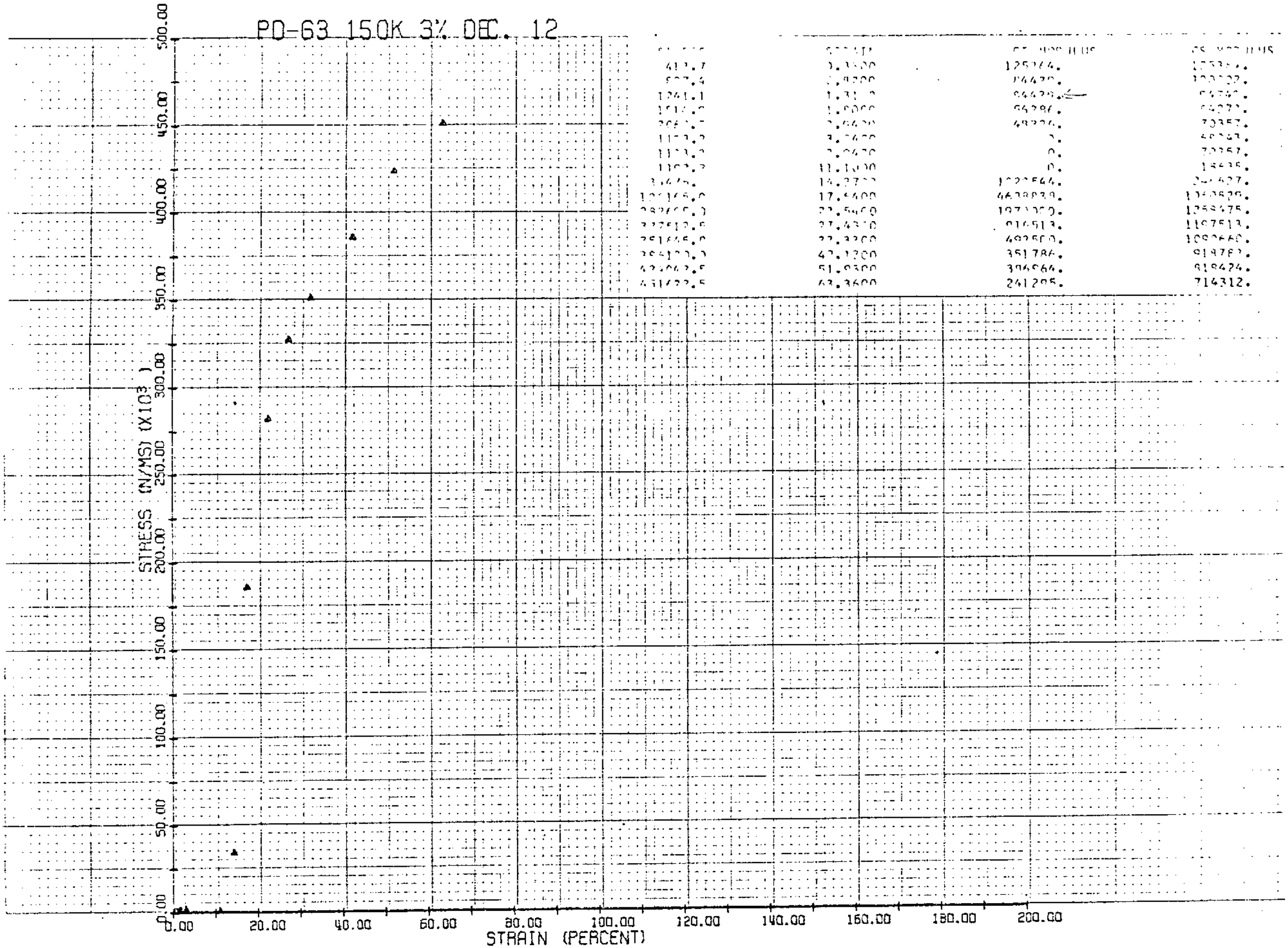


STRESS	STRAIN	GT MODULUS	GS MODULUS
27551.3	0.92 [illegible]	3363415. ←	3363415.
137425.0	2.4500	4657067.	4221429.
179279.0	3.4200	7739236.	5226531.
239551.[illegible]	6.8[illegible]	3214327.	4221429.
232672.5	8.9000	3166071.	3904821.
113339.0	10.9200	0.	3819087.
[illegible]	11.2700	15444909.	5109540.
54.705.0	13.0600	13491944.	6256183.
717093.0	14.2100	14989139.	6962931.
965303.0	15.4900	16885714.	7993192.
1235575.0	17.1500	21107143.	9025916.
1463425.[illegible]	18.13[illegible]	21107143.	9678861.
1792763.0	19.6000	21107143.	10535982.
1993559.0	21.0700	14071429.	10782641.
2092297.[illegible]	23.[illegible]	4221429.	10224240.
2092297.0	24.9200	0.	9486876.

194



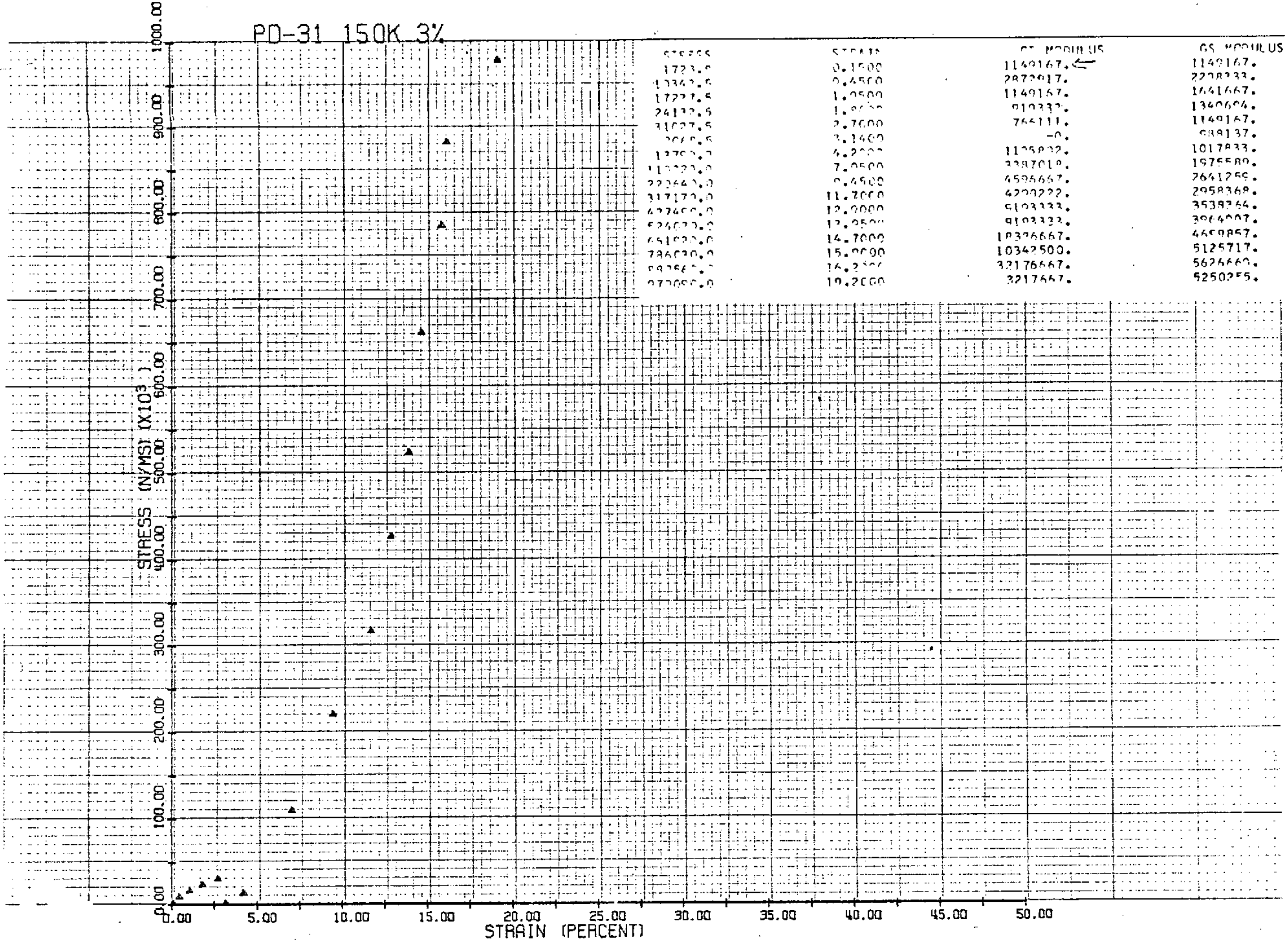
STRESS	STRAIN	GT MODULUS	GS MODULUS
3447.5	0.3000	1149167.	1149167.
6205.5	0.4500	1838667.	1379100.
9274.0	0.7500	689500.	1123200.
8651.0	0.9000	919333. ←	1072556.
11721.5	1.2000	689500.	976792.
1723.8	0.9333	0.	1412229.
6895.0	1.5000	771828.	1126183.
[illegible]	2.4000	6895000.	3299490.
[illegible]	4.6500	3064444.	3190597.
204850.0	6.1500	4596667.	3525980.
275800.0	6.9000	9193333.	4141996.
337855.0	7.0500	41370000.	4934082.
551600.0	9.1500	10178333.	6137680.
827400.0	12.9000	7354667.	6491455.
1034250.0	14.4000	13790000.	7251720.
1134585.5	20.4000	1712258.	5622467.



[illegible]	[illegible]	[illegible]	[illegible]
413.7	[illegible]	125764.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
1261.1	[illegible]	[illegible] ←	[illegible]
[illegible]	1.6000	56296.	[illegible]
[illegible]	[illegible]	48226.	70357.
[illegible]	[illegible]	0.	[illegible]
[illegible]	[illegible]	0.	70357.
[illegible]	11.1000	0.	18435.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	17.5400	[illegible]	[illegible]
[illegible]	22.5400	[illegible]	[illegible]
[illegible]	27.4310	[illegible]	1107513.
[illegible]	[illegible]	492500.	[illegible]
[illegible]	42.1200	351786.	919782.
[illegible]	51.9300	396564.	919424.
431622.5	63.3600	241295.	714312.

21

PD-31 150K 3%



STRESS	STRAIN	CT MODULUS	GS MODULUS
1723.5	0.1500	1149167. ←	1149167.
10342.5	0.4500	2872917.	2298333.
17237.5	1.0500	1149167.	1641667.
24132.5	1.8000	919333.	1340694.
31027.5	2.7000	766111.	1149167.
31027.5	3.1400	-0.	988137.
13790.0	4.2000	1125832.	1017833.
110322.0	7.0500	3387010.	1975580.
222640.0	9.4500	4595667.	2641259.
317170.0	11.7000	4229222.	2958368.
427460.0	12.9000	9193333.	3538364.
524070.0	13.9500	9193333.	3964007.
651920.0	14.7000	10376667.	4659857.
786030.0	15.7000	10342500.	5125717.
893560.0	16.2000	32176667.	5626669.
972090.0	19.2000	3217667.	5250255.

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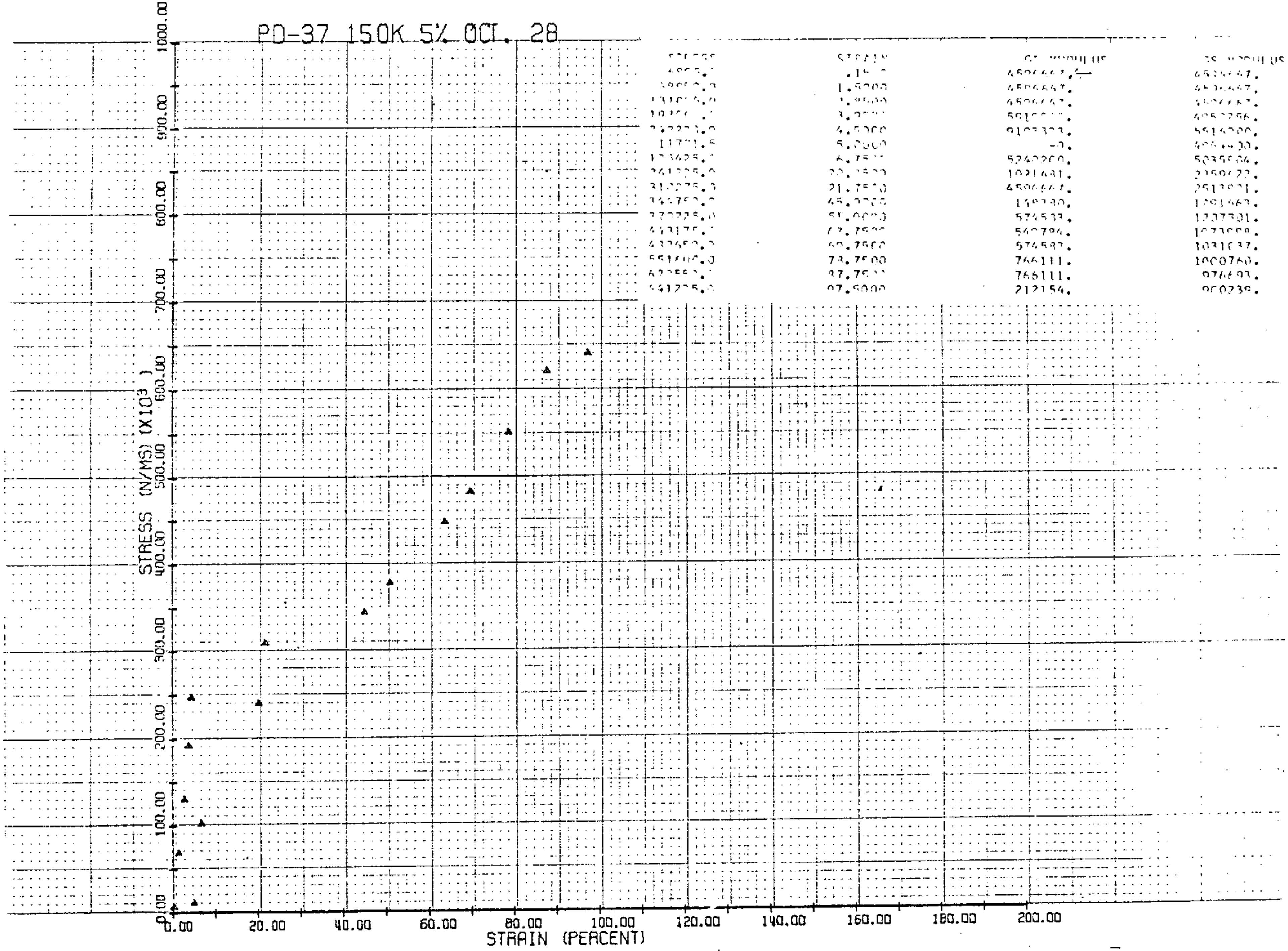
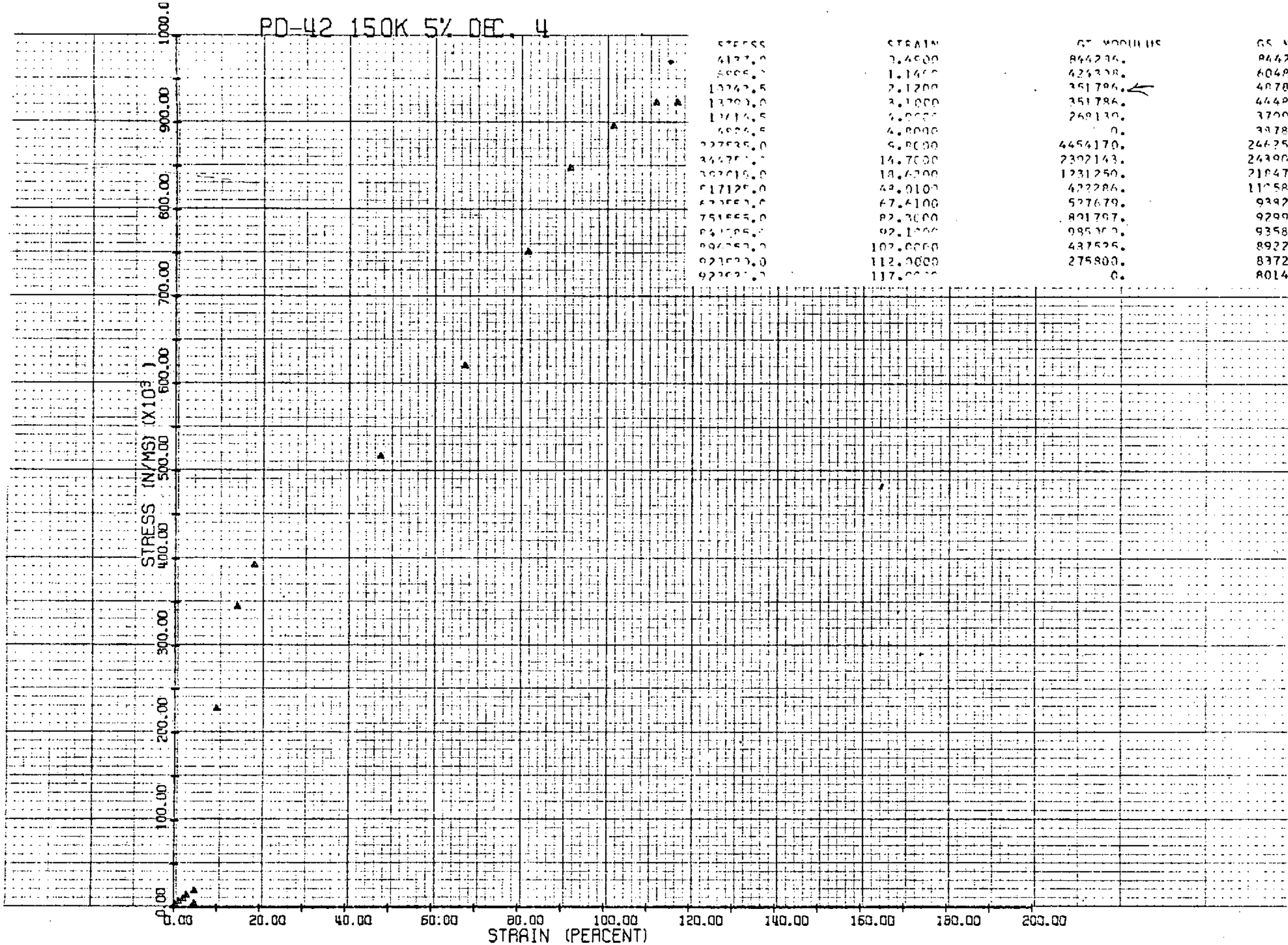
22

23 A



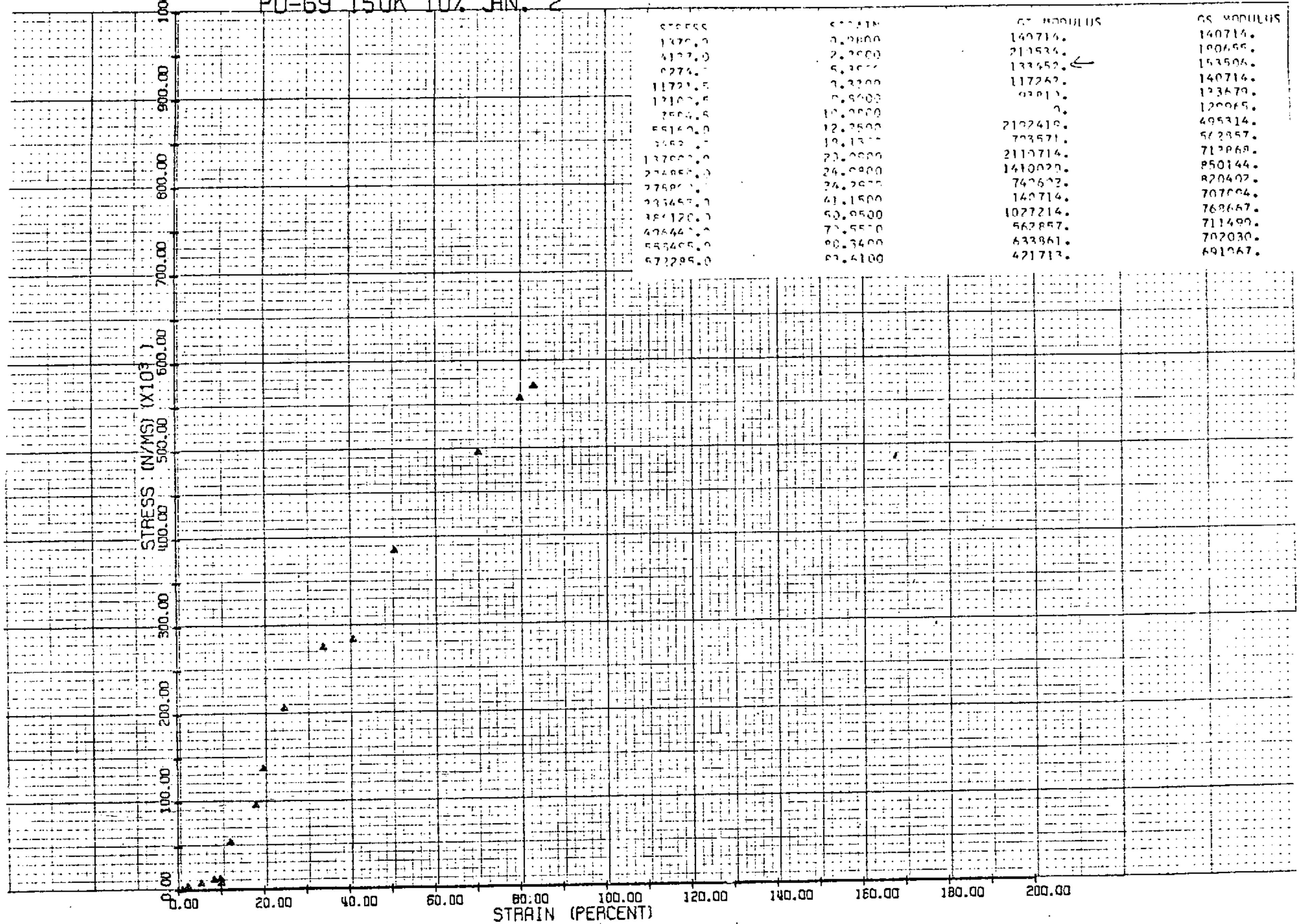
STRESS	STRAIN	CT MODULUS	SS MODULUS
4995.0	.1500	4596667.	4596667.
59990.0	1.5000	4596667.	4596667.
131015.0	1.9500	4596667.	4596667.
19366.0	3.9000	5910000.	4052256.
242223.0	4.5000	9107373.	5516200.
11771.5	5.0000	-0.	4054430.
123425.0	6.7500	5242200.	5035504.
241225.0	20.2500	1021631.	2150622.
310275.0	21.7500	4596667.	2512991.
344750.0	45.0000	149730.	1291463.
372225.0	51.0000	574533.	1237301.
443175.0	63.7500	560794.	1073998.
433650.0	69.7500	574583.	1031037.
551600.0	73.7500	766111.	1000760.
622552.0	87.7500	766111.	976693.
641275.0	97.5000	212154.	960239.

PD-42 150K 5% DEC. 4



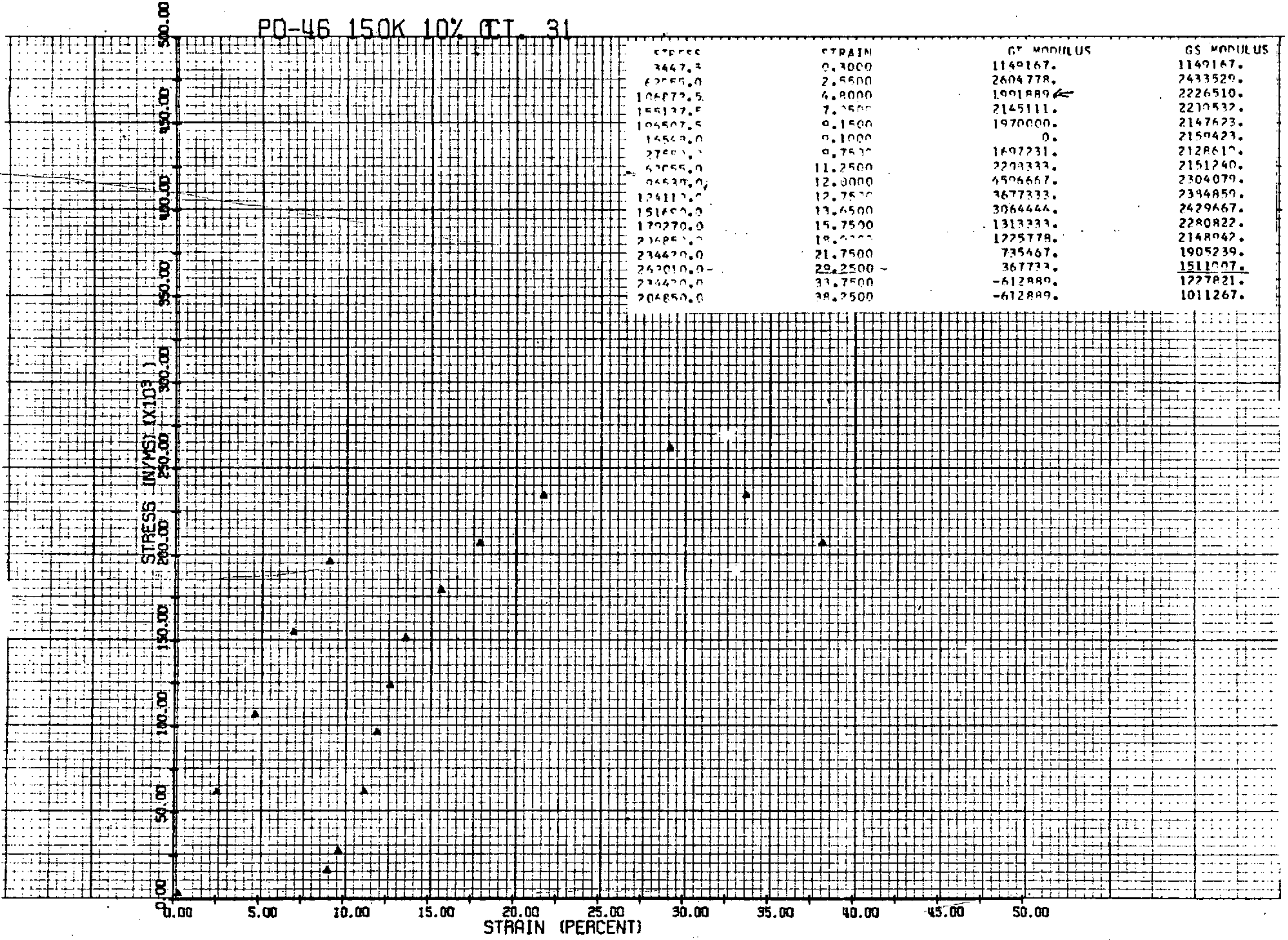
STRESS	STRAIN	GT MODULUS	GS MODL
4127.0	0.4500	844286.	844286.
[illegible]	1.1400	426328.	604825.
13242.5	2.1200	351786.	487854.
13790.0	3.1000	351786.	444830.
13714.5	4.0000	268130.	370029.
6896.5	4.8000	0.	337844.
227535.0	5.8000	4454170.	2462500.
344750.0	14.7000	2392143.	2439048.
392019.0	18.6200	1231250.	2104774.
517125.0	48.0100	422286.	1105843.
673553.0	67.6100	527679.	939234.
751555.0	82.3000	891797.	929945
843505.0	92.1000	985362.	935863
896353.0	102.0000	437525.	892294
923593.0	112.0000	275800.	837250
923627.0	117.0000	0.	801470

PD-69 150K 10% JAN. 2

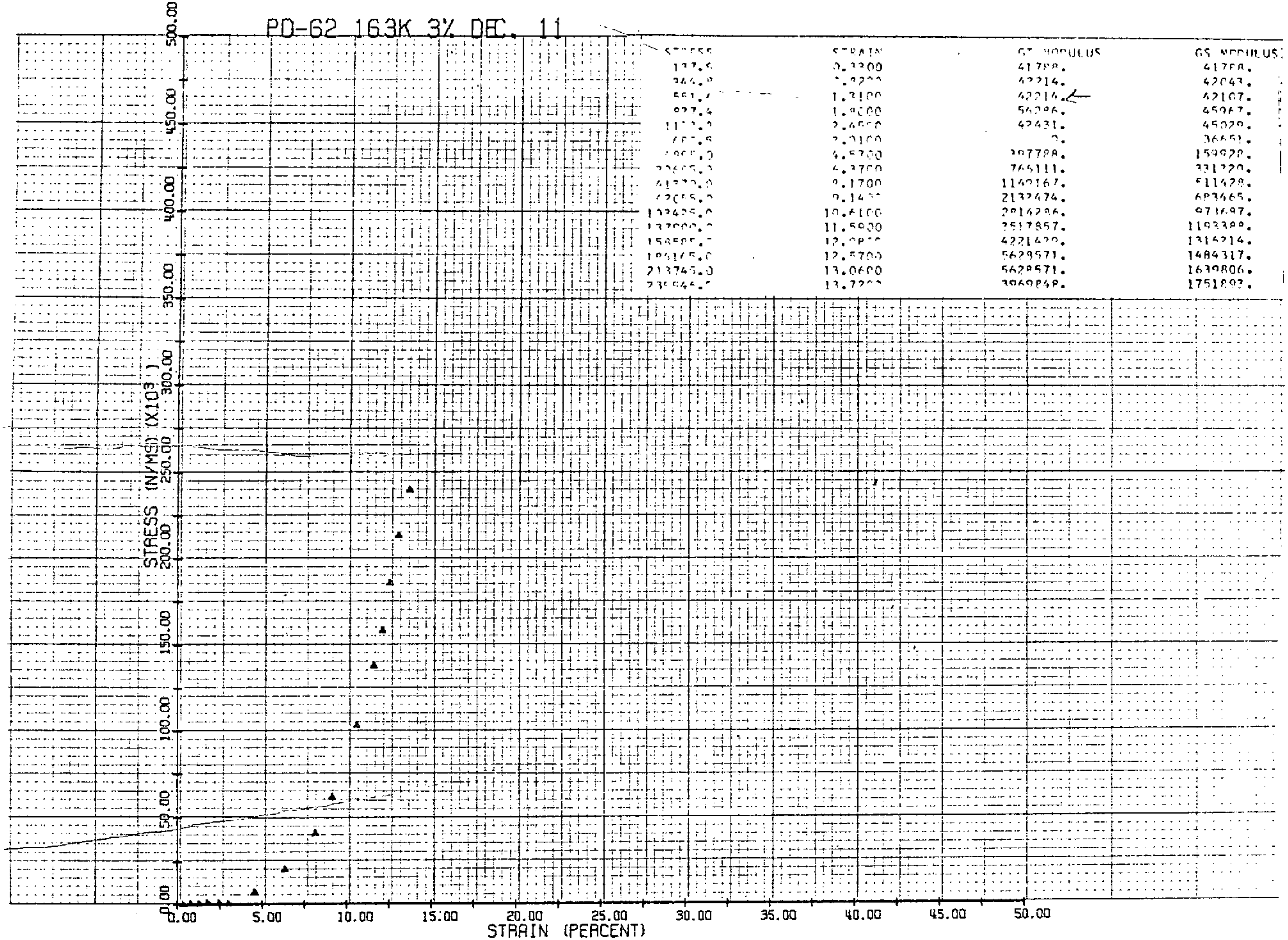


STRESS	STRAIN	GT MODULUS	GS MODULUS
1379.0	0.9800	140714.	140714.
4137.0	2.2900	211536.	180655.
8274.[illegible]	5.3[illegible]	133552. ←	153506.
11721.5	8.3300	117262.	140714.
13100.5	9.5800	93811.	133679.
[illegible]	10.2800	0.	129965.
55160.0	12.2500	2102419.	495314.
[illegible]	19.13[illegible]	703571.	562357.
137900.0	20.0000	2110714.	712868.
[illegible]	24.0900	1410029.	850144.
[illegible]	34.2975	742603.	820407.
[illegible]	41.1500	140714.	707094.
386120.0	50.9500	1027214.	768667.
496442.0	70.5500	562857.	711499.
555495.0	80.3400	633861.	702030.
572285.0	83.6100	421713.	691967.

25Ø

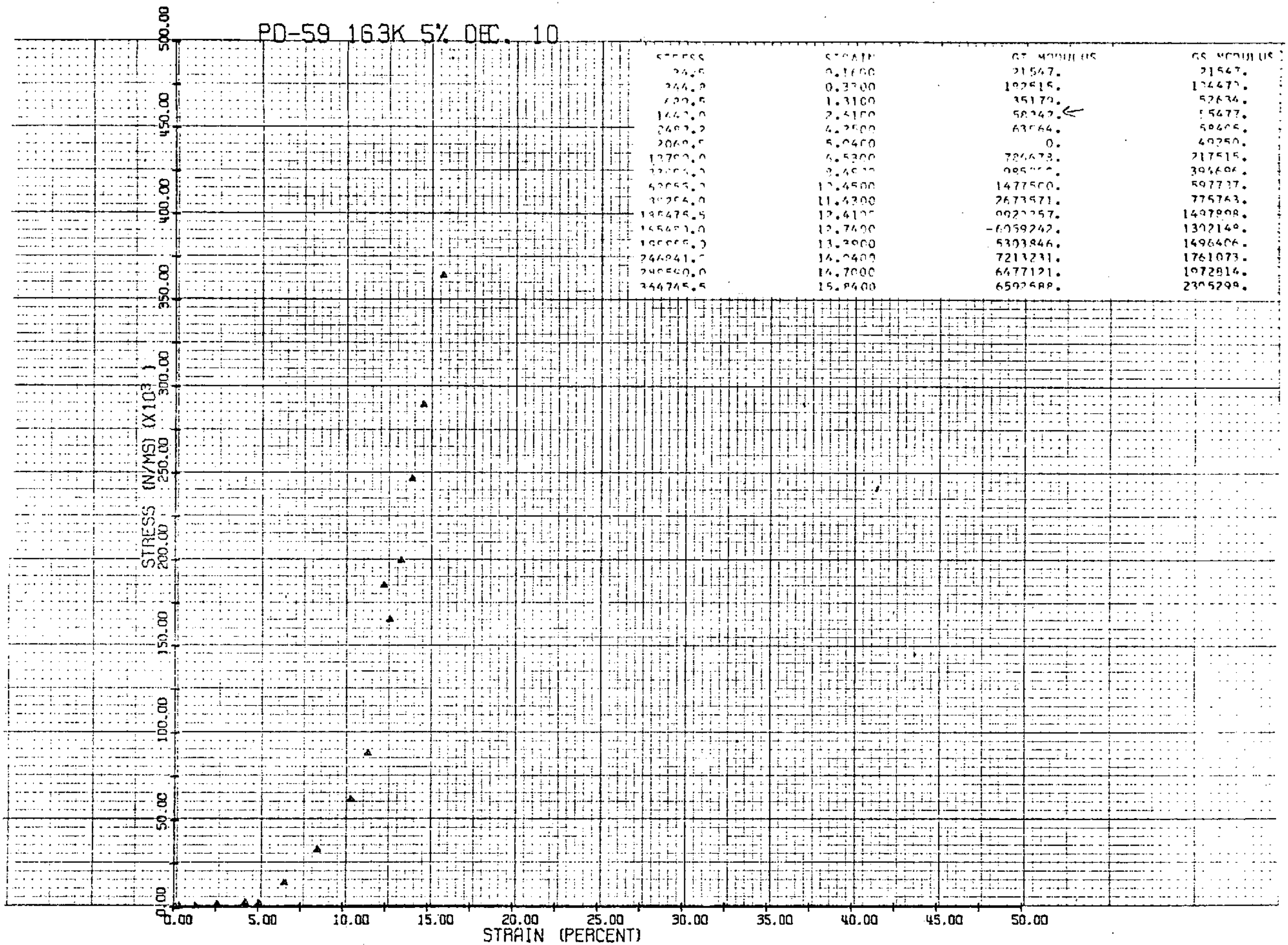


STRESS	STRAIN	GT MODULUS	GS MODULUS
3447.3	0.3000	1149167.	1149167.
62055.0	2.5500	2604778.	2433529.
106872.5	4.8000	1991889 ←	2226510.
155137.5	7.2500	2145111.	2219532.
196507.5	9.1500	1970000.	2147623.
1554[illegible].0	9.1000	0.	2159423.
27[illegible]	9.7500	1697231.	2128619.
62055.0	11.2500	2293333.	2151240.
96530.0	12.0000	4596667.	2304079.
124112.[illegible]	12.7500	3677333.	2394859.
151690.0	13.6500	3064444.	2429667.
179270.0	15.7500	1313333.	2280822.
2168[illegible]	18.[illegible]	1225778.	2148942.
234420.0	21.7500	735467.	1905239.
262010.0 –	29.2500 ~	367733.	1511007.
234420.0	33.7500	-612889.	1227821.
206850.0	38.2500	-612889.	1011267.

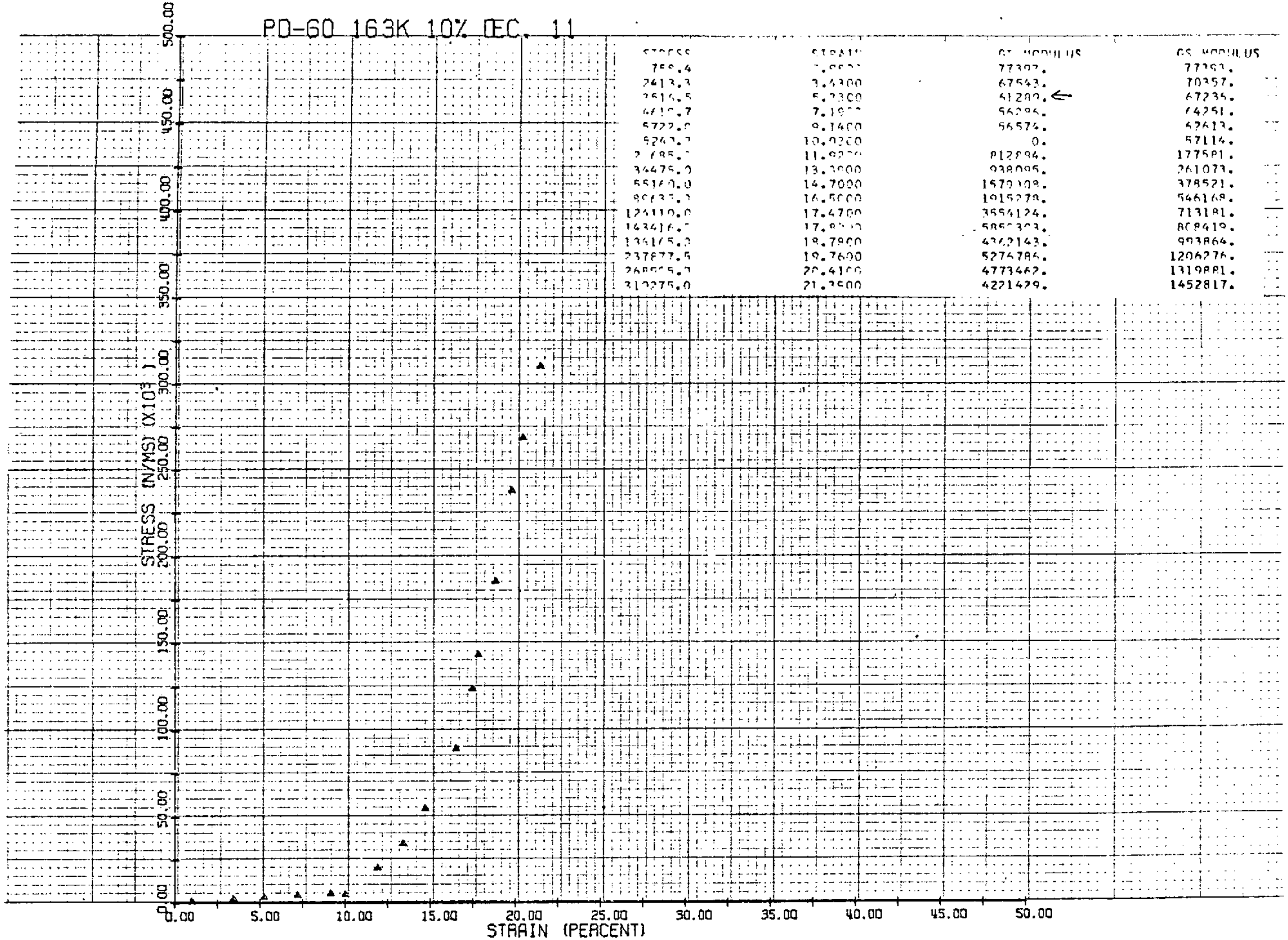


STRESS	STRAIN	GT MODULUS	GS MODULUS
137.5	0.3300	41788.	41788.
344.8	0.8200	42214.	42043.
551.4	1.3100	42214.	42107.
827.4	1.9000	56296.	45967.
1103.2	2.4500	42431.	45029.
[illegible]	[illegible]	0.	36651.
[illegible]	4.5700	397788.	159928.
22665.3	6.3700	765111.	331220.
41372.0	8.1700	1142167.	511428.
62055.8	9.1400	2132474.	683465.
103425.0	10.6100	2814286.	971697.
137900.0	11.5900	3517857.	1193388.
158585.7	12.0800	4221429.	1316214.
186165.0	12.5700	5628571.	1484317.
213745.0	13.0600	5628571.	1639806.
235944.5	13.7200	3969848.	1751893.

PD-59 163K 5% DEC. 10



STRESS	STRAIN	GT MODULUS	GS MODULUS
24.5	0.1600	21547.	21547.
244.9	0.3700	192515.	134470.
429.5	1.3100	35179.	52634.
1442.0	2.5100	58347. ←	55477.
2493.2	4.2500	63564.	59405.
2069.5	5.0400	0.	49250.
13790.0	6.5300	726673.	217515.
33966.0	8.4500	985000.	394696.
62055.0	10.4500	1477500.	597737.
89254.0	11.4300	2673571.	775763.
135475.5	12.4100	9922257.	1497998.
165491.0	12.7400	-6059242.	1302149.
199955.0	13.3900	5303846.	1496406.
246941.0	14.0400	7213231.	1761073.
289560.0	14.7000	6477121.	1972814.
344745.5	15.8400	6592588.	2305299.

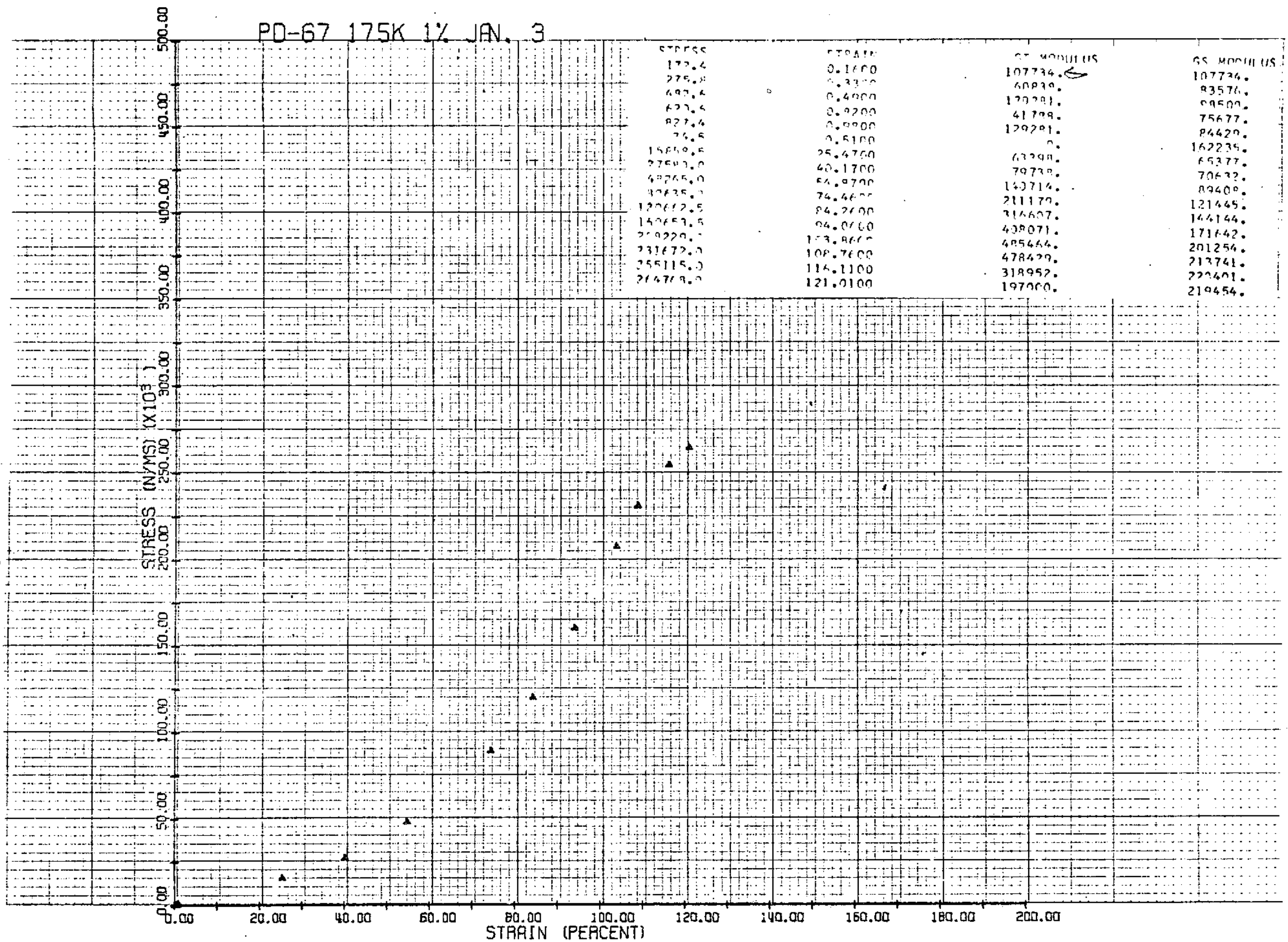


STRESS	STRAIN	GT MODULUS	GS MODULUS
755.4	[illegible]	77392.	77393.
2413.3	3.4300	67543.	70357.
3516.5	5.2300	61289. ←	67235.
4610.7	7.1900	56296.	64251.
5722.0	9.1400	56574.	62613.
6243.7	10.9300	0.	57114.
[illegible]	11.9200	812894.	177581.
34475.0	13.3900	938095.	261073.
55160.0	14.7000	1579108.	378521.
90637.3	16.5000	1915278.	546168.
124110.0	17.4700	3554124.	713181.
143416.[illegible]	17.9[illegible]	585[illegible]303.	808419.
186165.3	18.7900	4362143.	993864.
237877.5	19.7600	5274786.	1206276.
268565.3	20.4100	4773462.	1319881.
310275.0	21.3500	4221429.	1452817.

29A

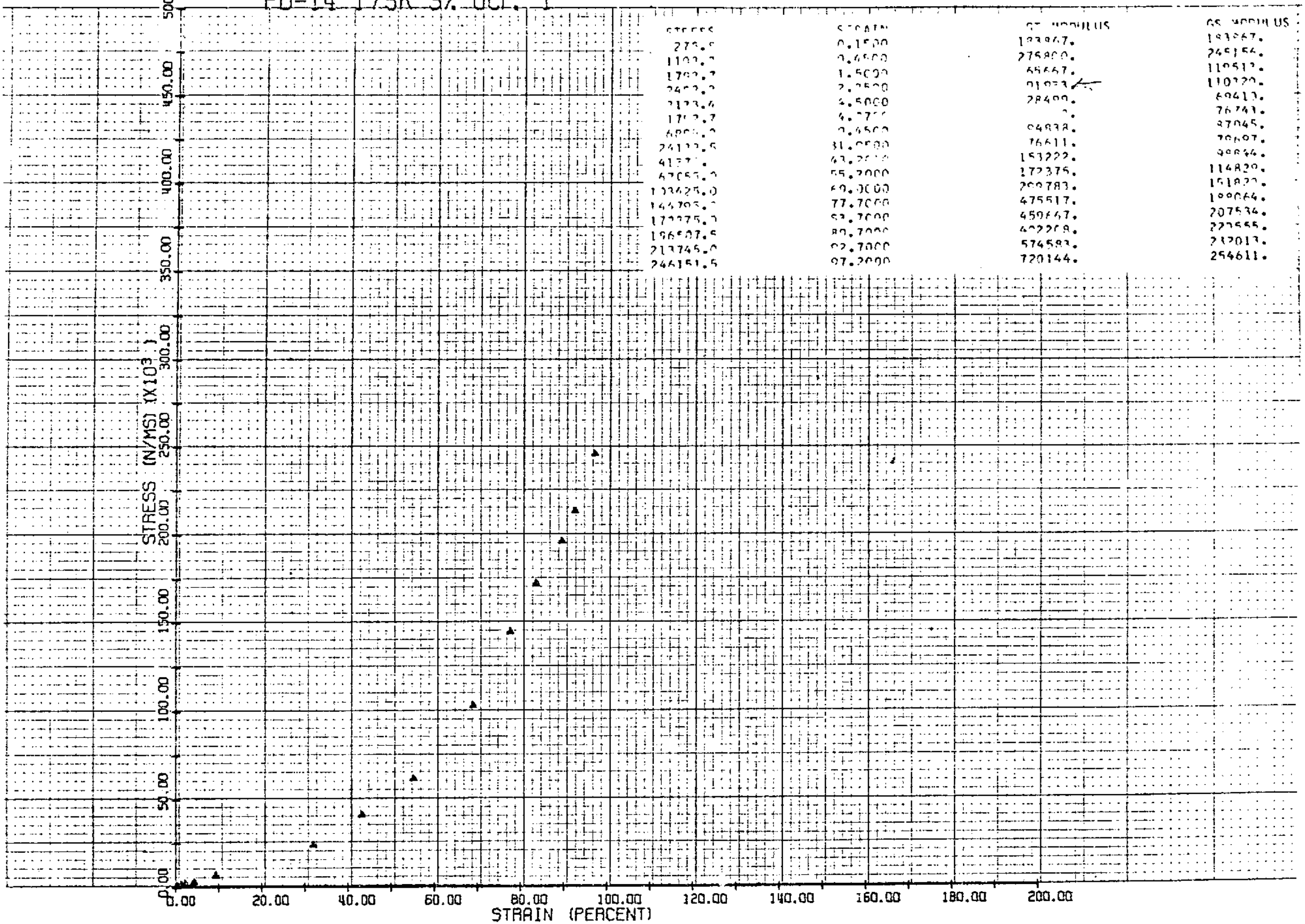
30 A

PD-67 175K 1% JAN. 3



STRESS	STRAIN	ST MODULUS	GS MODULUS
172.4	0.1600	107734.	107734.
275.8	0.3300	60839.	83576.
697.6	0.4000	179281.	99509.
623.5	0.9200	41798.	75677.
827.4	0.9900	129281.	84429.
76.5	0.5100	0.	162235.
15659.5	25.4700	63298.	65377.
27583.0	40.1700	79738.	70632.
48765.0	54.9700	140714.	89408.
87635.0	74.4600	211179.	121445.
120612.5	84.2600	316607.	144144.
150653.5	94.0600	408071.	171642.
209229.0	103.8600	485464.	201254.
231672.0	108.7600	478429.	213741.
255115.0	116.1100	318952.	222401.
264768.0	121.0100	197000.	219454.

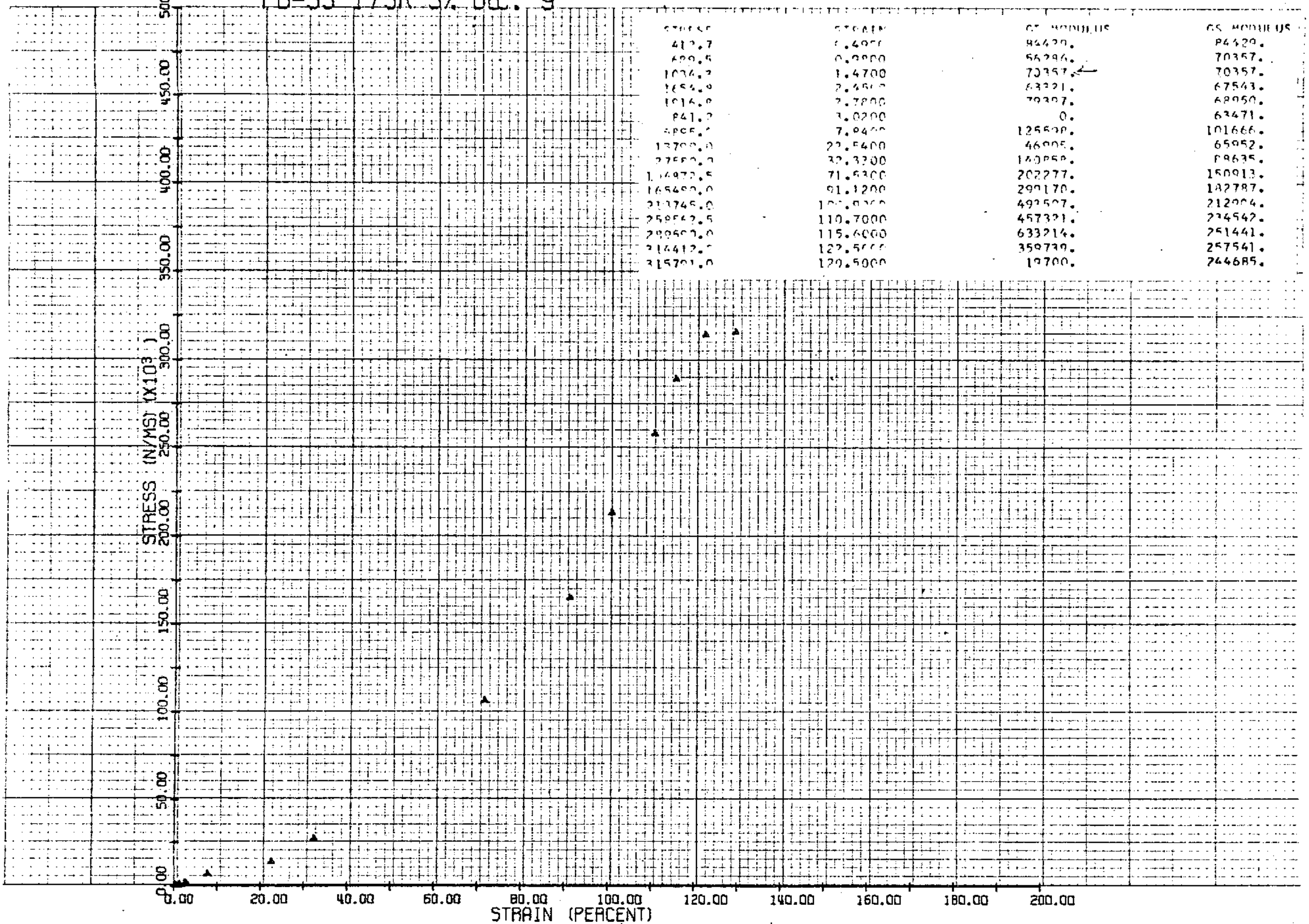
PD-14 175K 3% OCT. 1



STRESS	STRAIN	GT MODULUS	GS MODULUS
275.5	0.1500	183967.	183967.
1103.7	0.4500	275800.	245154.
1793.7	1.5000	65667.	119512.
2482.7	2.2500	91933.	110320.
3173.4	4.5000	28499.	69413.
1752.7	4.7500	0.	76741.
6805.0	9.4500	94838.	87045.
24133.5	31.0500	76611.	79697.
41377.	43.2000	153222.	99844.
67055.0	55.2000	172375.	114829.
103425.0	69.0000	299783.	151833.
144795.0	77.7000	475517.	189064.
177375.0	83.7000	459667.	207534.
196507.5	89.7000	402208.	223555.
213745.0	92.7000	574583.	232013.
246151.5	97.2000	720144.	254611.

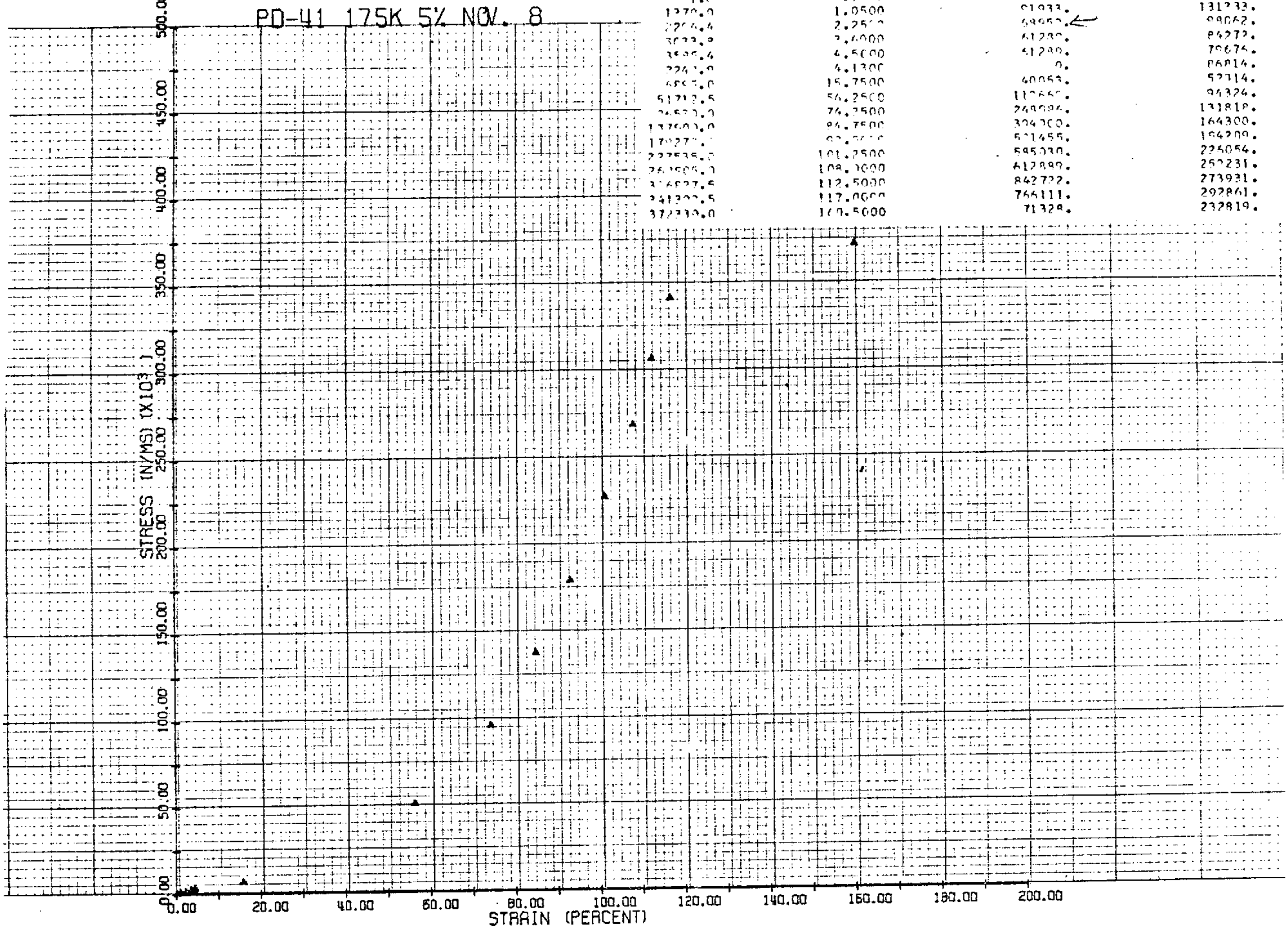
31 A

PD-55 175K 3% DEC. 9

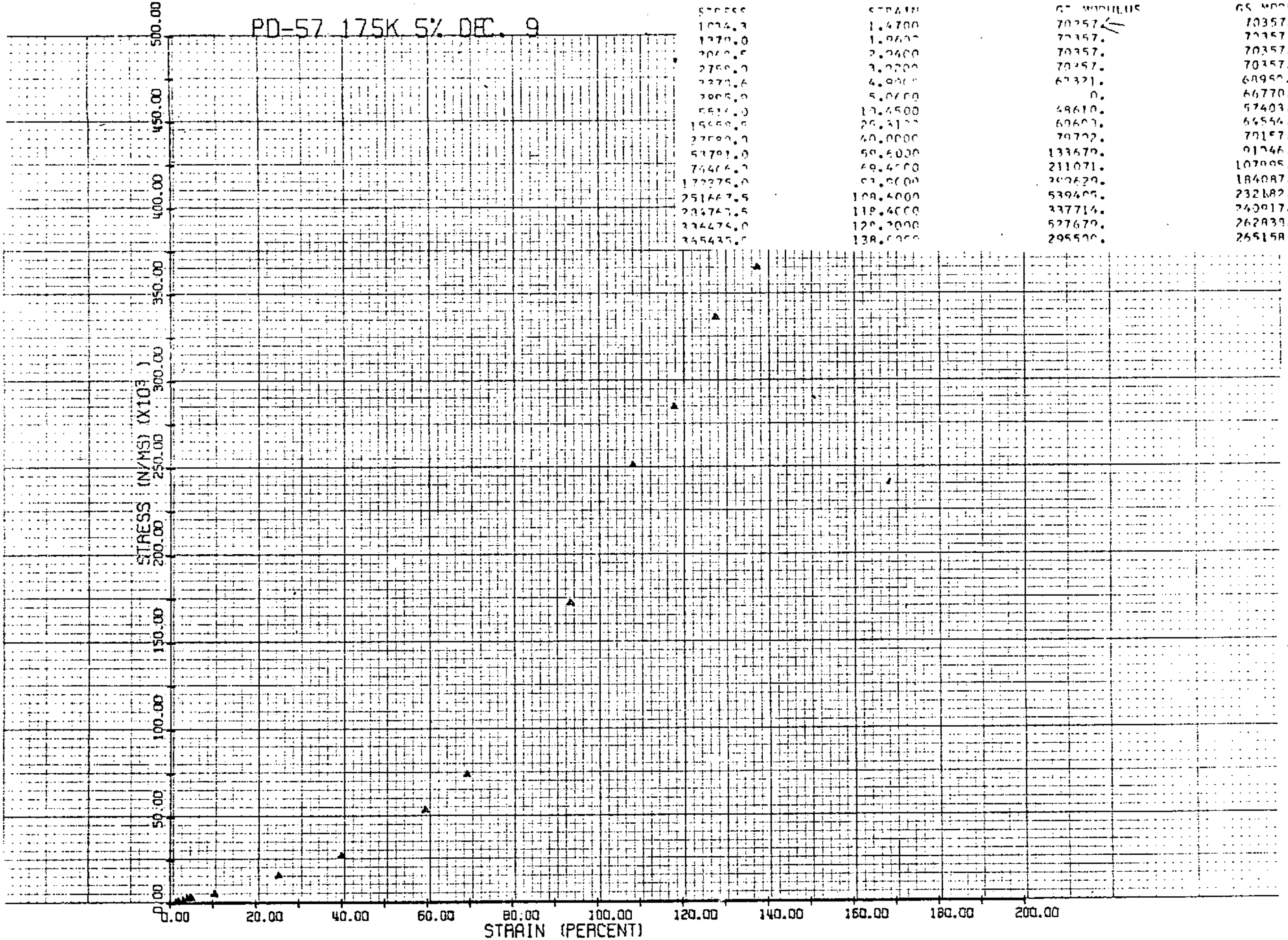


STRESS	STRAIN	CT MODULUS	CS MODULUS
412.7	0.4900	84429.	84429.
699.5	0.9900	56296.	70357.
1034.2	1.4700	70357. ←	70357.
1654.9	2.4500	63321.	67543.
1916.8	2.7800	79397.	68950.
841.2	3.0200	0.	63471.
8085.?	7.9400	125590.	101666.
13790.0	22.5400	46905.	65952.
27550.0	32.3300	140858.	88635.
104972.5	71.5300	202277.	150913.
165480.0	91.1200	299170.	182787.
213745.0	[illegible]	493597.	212904.
259562.5	110.7000	457321.	234542.
299590.0	115.6000	633214.	251441.
314412.?	122.5000	359739.	257541.
315791.0	129.5000	19700.	244685.

STRESS	STRAIN	GT MODULUS	GS MODULUS
551.6	0.1500	367733.	367733.
1379.0	1.0500	91933.	131333.
2206.4	2.2500	6895[illegible]. ←	98062.
3033.9	3.6000	6128[illegible].	84272.
3585.4	4.5000	61289.	79676.
224[illegible].9	4.1300	0.	86814.
6895.0	15.7500	40053.	52314.
51712.5	56.2500	112660.	94324.
[illegible]4522.0	74.2500	249096.	131818.
137900.0	84.7500	394300.	164300.
179275.[illegible]	[illegible]	521455.	194209.
227535.0	101.2500	595030.	225054.
26[illegible]505.0	108.0000	612899.	252231.
316827.5	112.5000	842722.	273931.
341322.5	117.0000	766111.	292861.
37231[illegible].0	160.5000	71328.	232819.

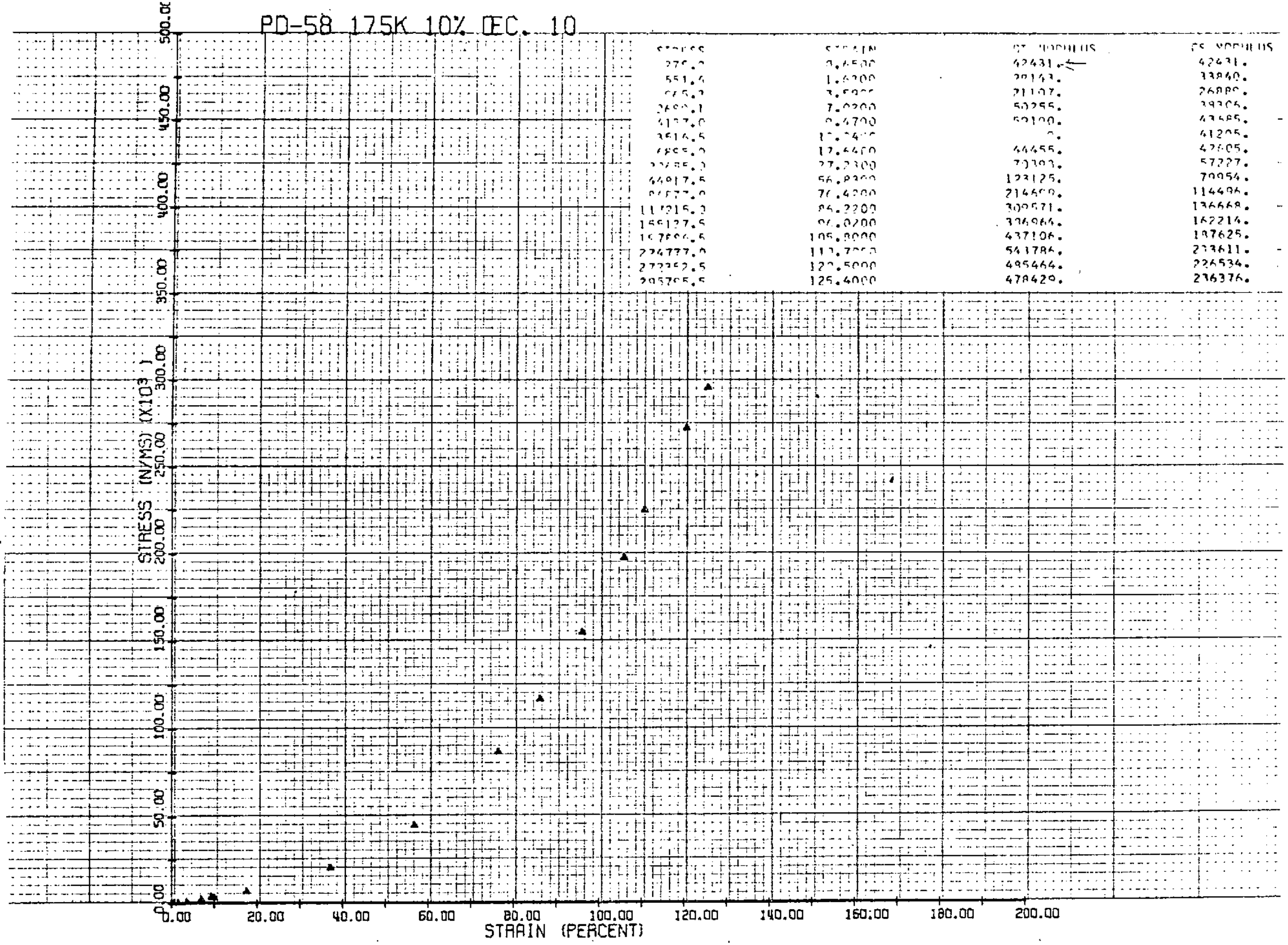


33 A



STRESS	STRAIN	GT MODULUS	GS MODULUS
1034.3	1.4700	70357.	70357.
1379.0	1.9600	70357.	70357.
2068.5	2.9400	70357.	70357.
2758.0	3.9200	70357.	70357.
3378.6	4.9000	62321.	68950.
[illegible]	5.0600	0.	66770.
5516.0	10.4500	48610.	57403.
15558.5	25.3100	60603.	64544.
27580.0	40.0000	79792.	70157.
53781.0	59.6000	133679.	91246.
74466.0	69.4000	211071.	107095.
172375.0	93.6000	392629.	184087.
251667.5	108.6000	539405.	232682.
284763.5	118.4000	337714.	240917.
334475.0	128.2000	527679.	262839.
345435.0	138.0000	295590.	265158.

PD-58 175K 10% DEC. 10



STRESS	STRAIN	ST MODULUS	CS MODULUS
275.0	0.6500	42431. ←	42431.
551.4	1.6200	29143.	33840.
965.3	3.5900	21107.	26889.
2699.1	7.0200	50255.	38306.
4137.0	9.4700	59100.	43685.
3516.5	[illegible]	0.	41205.
6895.0	14.4800	44455.	47605.
15585.0	27.2300	70393.	57227.
44817.5	56.8300	123125.	79954.
87577.0	76.4200	214699.	114496.
117835.0	86.2200	309571.	136668.
155127.5	96.0200	336966.	162214.
198506.5	105.8000	437106.	187625.
224777.0	113.7000	541786.	233611.
272352.5	120.5000	495464.	226534.
295795.5	125.4000	478429.	236376.

35 A

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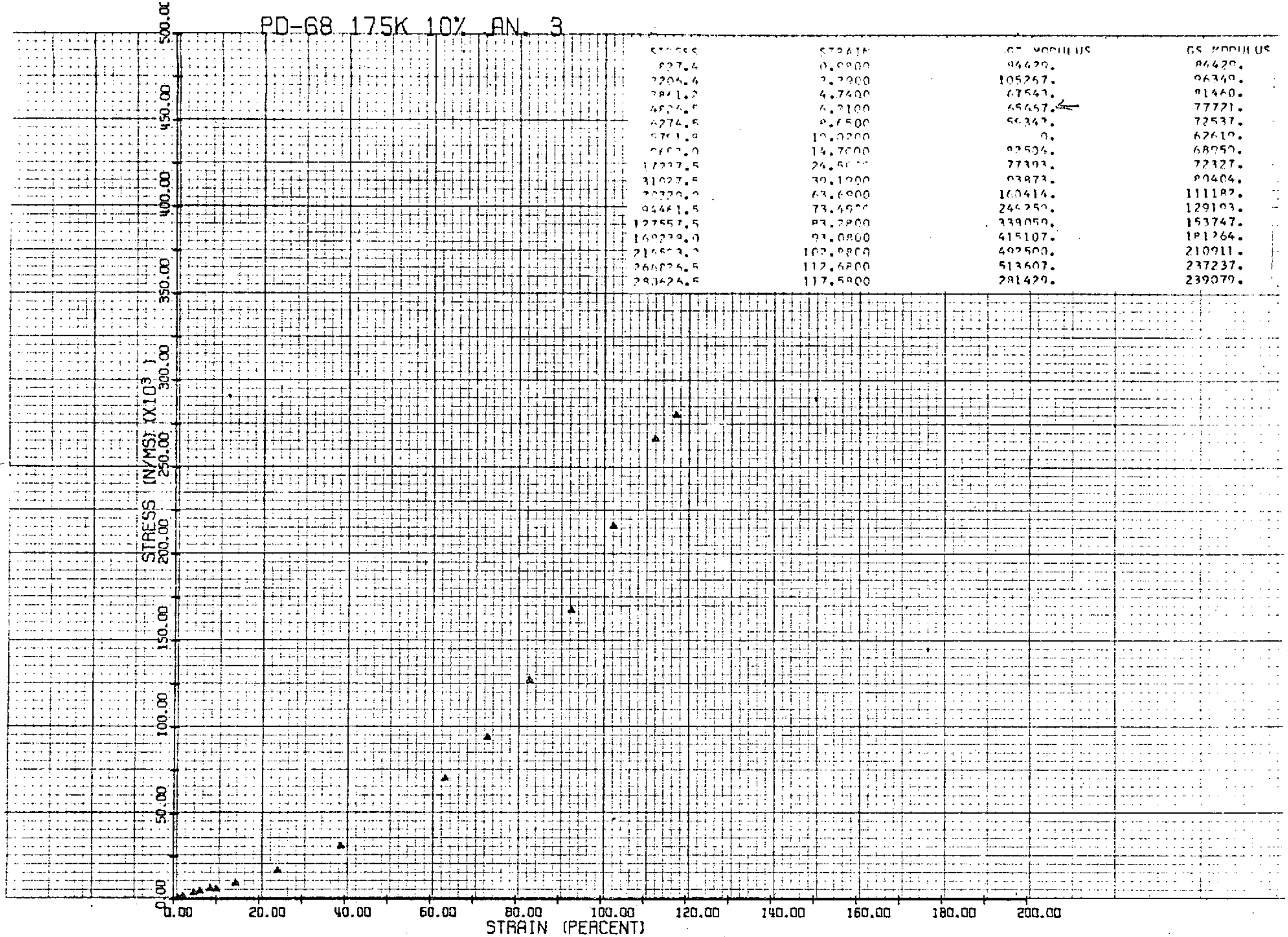
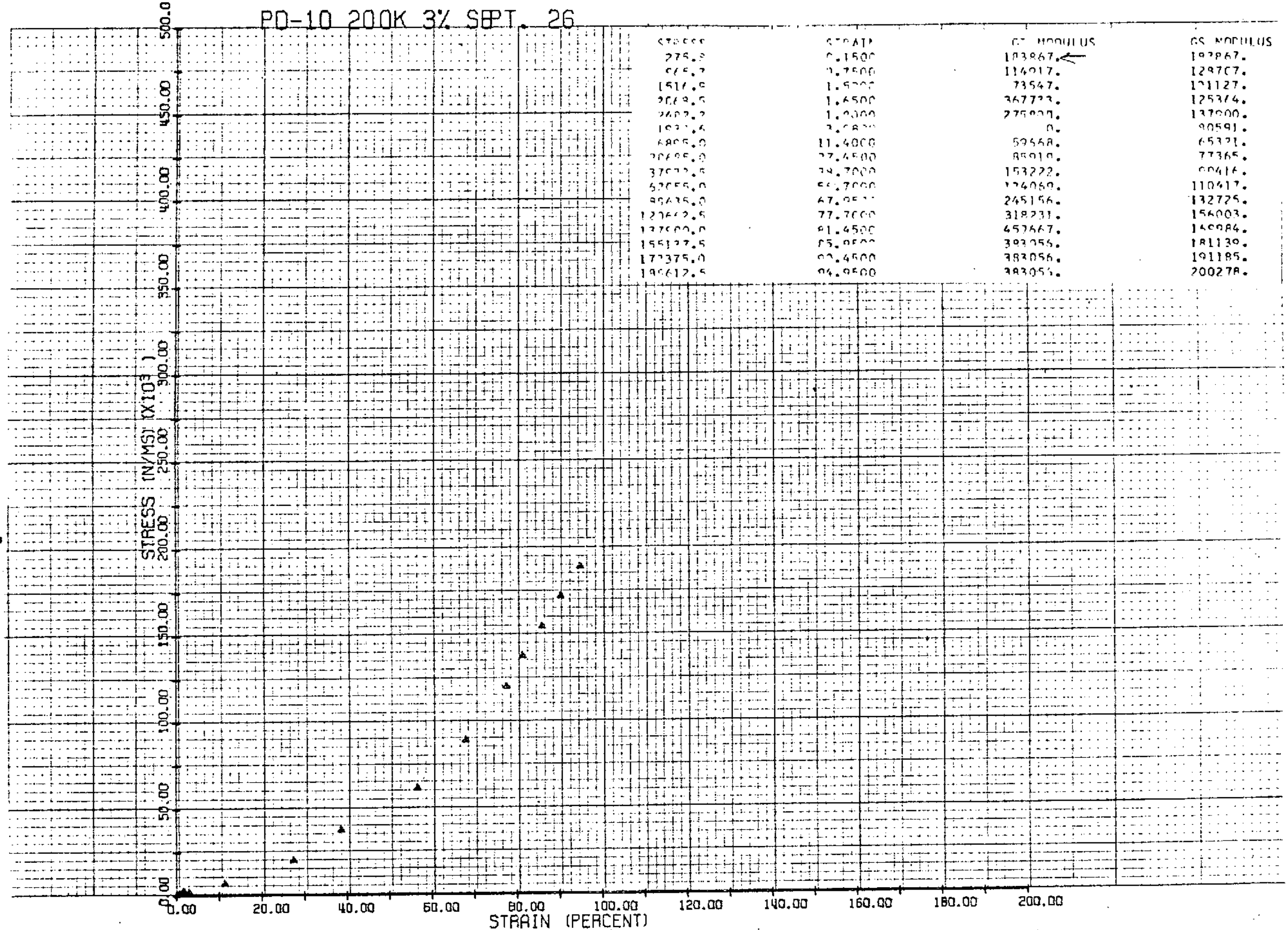


STRESS	STRAIN	GT MODULUS	GS MODULUS
827.4	0.9800	86429.	86429.
2206.4	2.2900	105267.	96349.
3861.2	4.7400	67543.	81460.
4826.5	6.2100	65657. ←	77721.
6274.6	8.6500	59347.	72537.
6761.9	10.0200	0.	67619.
9652.0	14.7600	82504.	68259.
17727.5	24.5600	77393.	72327.
31027.5	39.1900	93873.	80404.
70779.9	63.6900	160414.	111182.
94461.5	73.4900	246259.	129193.
127557.5	83.2800	339059.	153747.
169738.0	93.0800	415107.	181264.
216603.2	102.8800	492500.	210911.
266825.5	112.6800	513607.	237237.
280626.5	117.5800	281429.	239079.

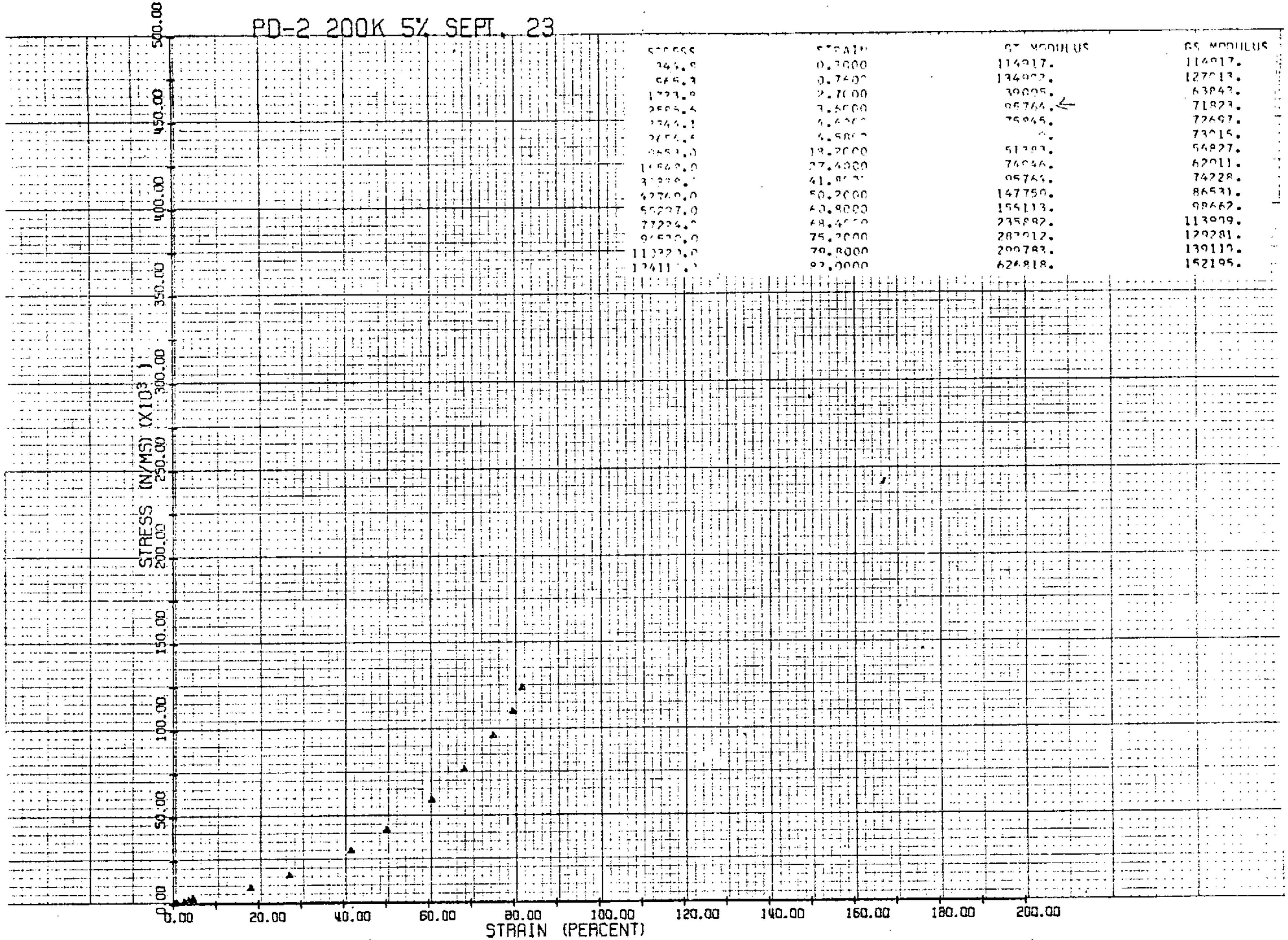
36 #

PD-10 200K 3% SEPT. 26



STRESS	STRAIN	CT MODULUS	GS MODULUS
275.8	0.1500	183867. ←	183867.
575.7	0.7500	114917.	129707.
1516.9	1.5000	73547.	101127.
2069.5	1.6500	367723.	125424.
2482.2	1.8000	275133.	137900.
1933.6	[illegible]	0.	90591.
6805.0	11.4000	59568.	65371.
20695.0	27.4500	85919.	77365.
37572.5	38.7000	153222.	90416.
62055.0	56.7000	124060.	110417.
90635.0	67.9500	245156.	132725.
120662.5	77.7000	318231.	156003.
137500.0	81.4500	457667.	169984.
155127.5	85.9500	393055.	181139.
177375.0	92.4500	383056.	191185.
195612.5	94.9500	383055.	200278.

37 A

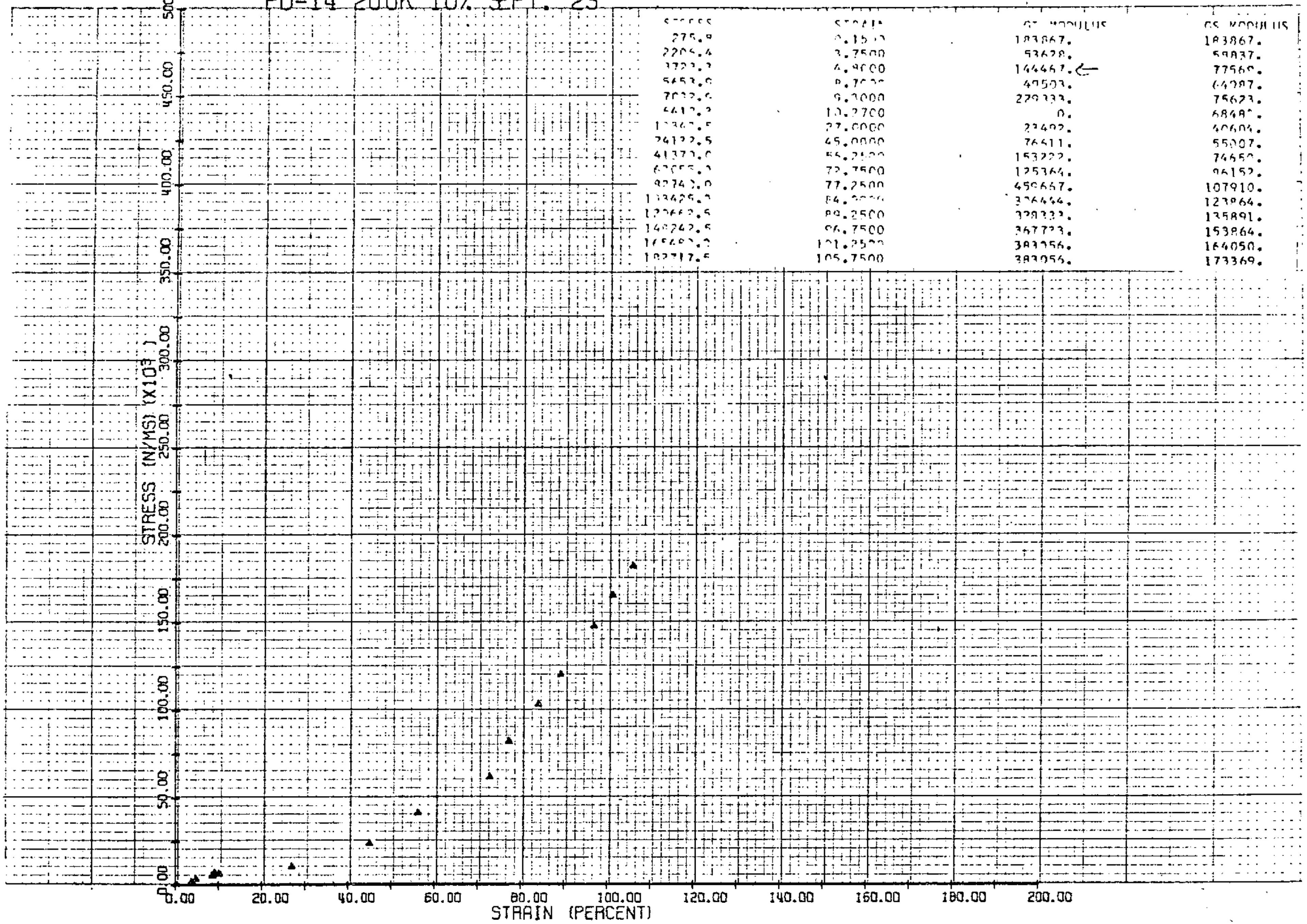


STRESS	STRAIN	GT MODULUS	GS MODULUS
344.9	0.3000	114917.	114917.
969.3	0.7600	134902.	127913.
1773.9	2.7000	39095.	63843.
2555.4	3.6000	95764. ←	71823.
3344.1	4.6000	75945.	72697.
[illegible]	6.5000	[illegible]	73015.
[illegible]	18.2000	51783.	54827.
[illegible]	27.4000	74946.	62011.
[illegible]	41.8000	95764.	74228.
42760.0	50.2000	147750.	86531.
55227.0	60.9000	155113.	98662.
77224.0	68.4000	235892.	113979.
96520.0	75.2000	282912.	129281.
113223.0	79.8000	299783.	139119.
[illegible]	82.0000	626818.	152195.

38

PD-14 200K 10% SEPT. 23

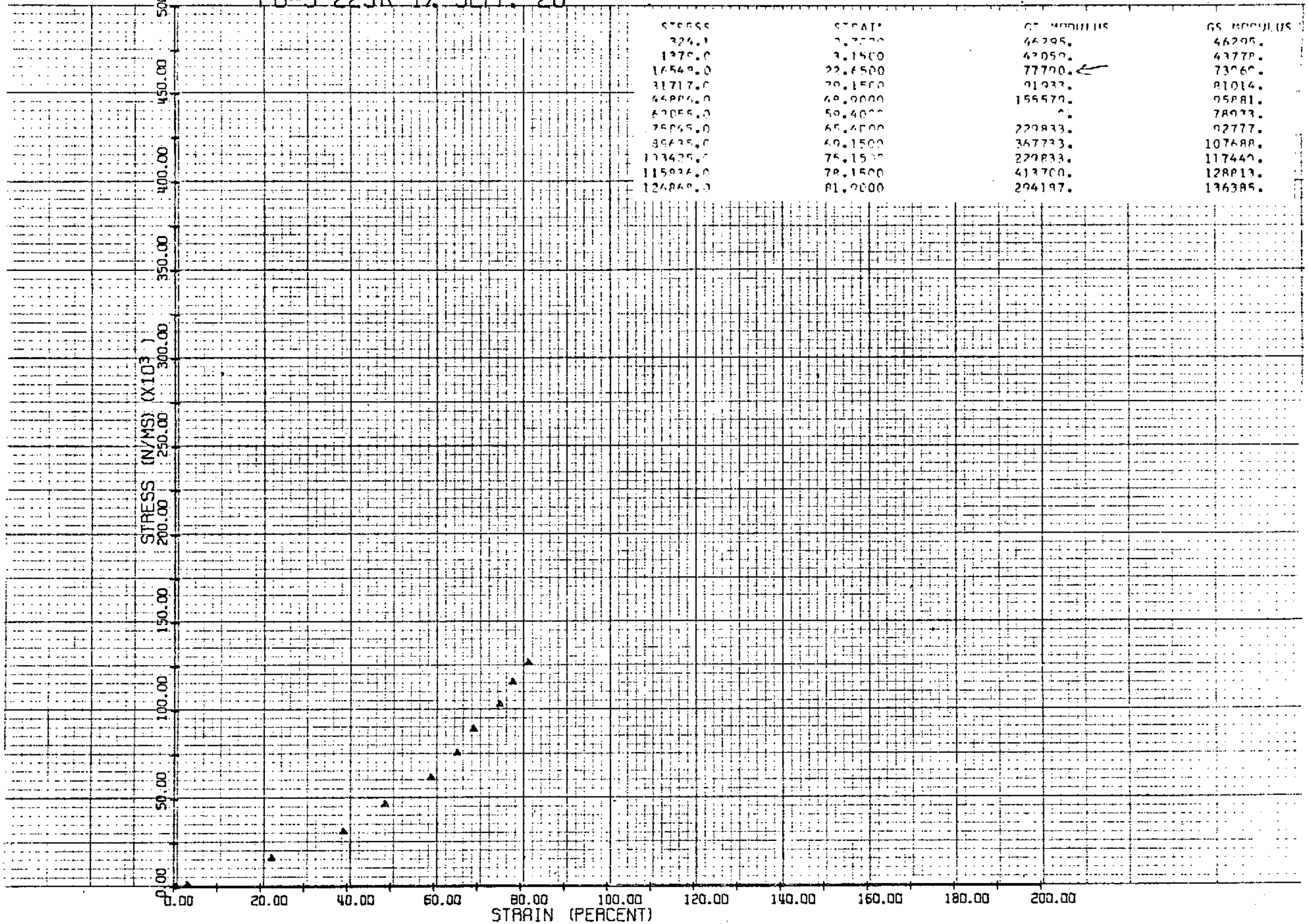
STRESS	STRAIN	GT MODULUS	GS MODULUS
275.8	0.1500	183867.	183867.
2206.4	3.7500	53628.	59837.
3723.3	4.9000	144467. ←	77569.
5653.9	8.7000	47503.	64987.
7032.6	9.3000	229333.	75623.
6412.3	10.2700	0.	68489.
10342.5	27.0000	23492.	40604.
24132.5	45.0000	76611.	55007.
41372.0	55.2500	153222.	74659.
62055.0	72.7500	125364.	96152.
82740.0	77.2500	459667.	107910.
103425.0	84.0000	306444.	123864.
120662.5	89.2500	328333.	135891.
148242.5	96.7500	367733.	153864.
165482.0	101.2500	383056.	164050.
182717.5	105.7500	383056.	173369.



39 A

C-2

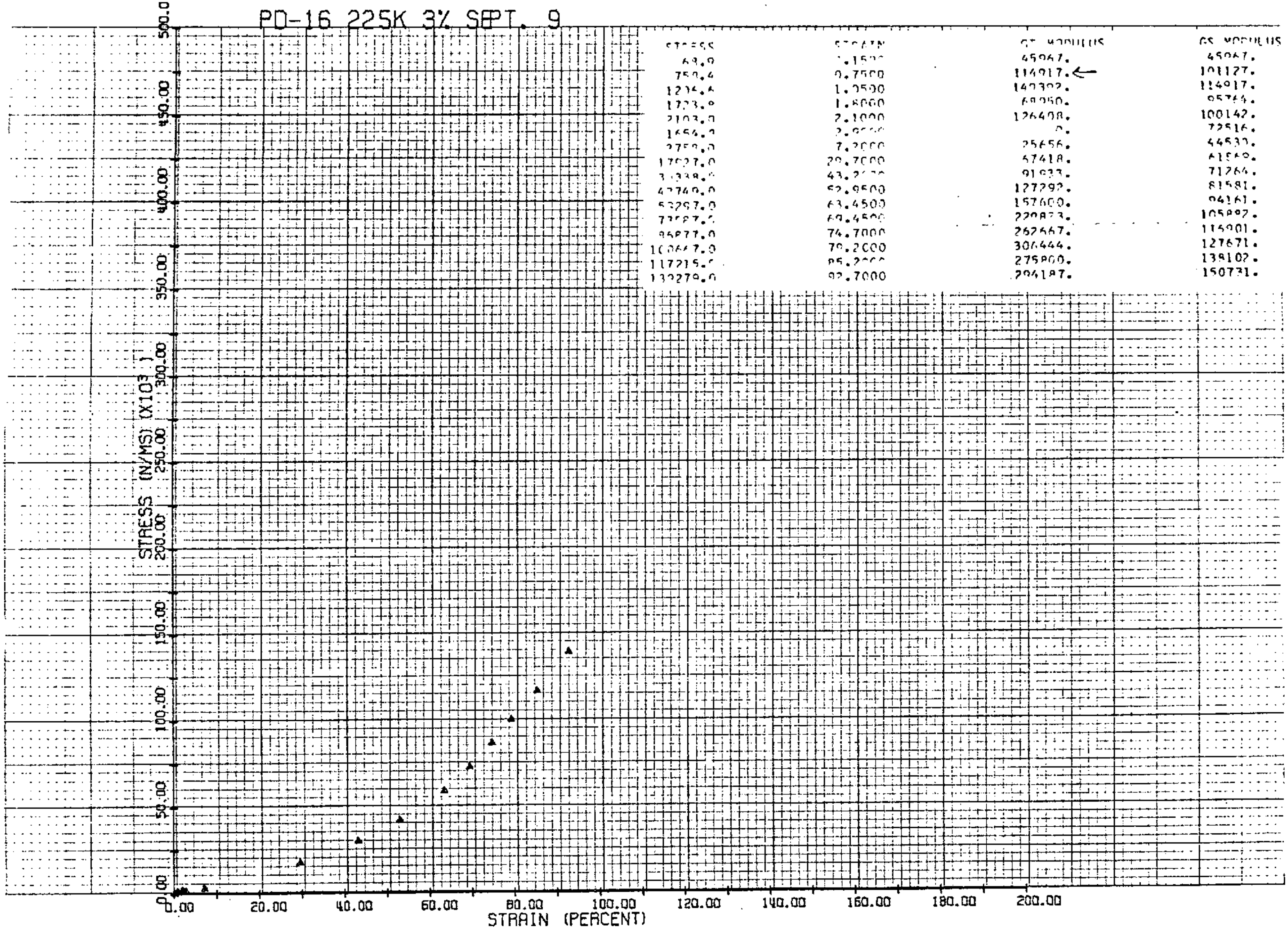
PD-9 225K 1% SEPT. 20



STRESS	STRAIN	CT MODULUS	GS MODULUS
324.1	0.7000	46295.	46295.
1379.0	3.1500	43059.	43778.
16549.0	22.6500	77790. ←	73960.
31717.0	39.1500	91933.	81014.
46886.0	48.9000	155579.	95881.
62055.0	59.4000	0.	78933.
75865.0	65.4000	229833.	92777.
89635.0	69.1500	367733.	107688.
103425.0	75.1500	229833.	117449.
115936.0	78.1500	413700.	128813.
124869.0	81.9000	294197.	136385.

40

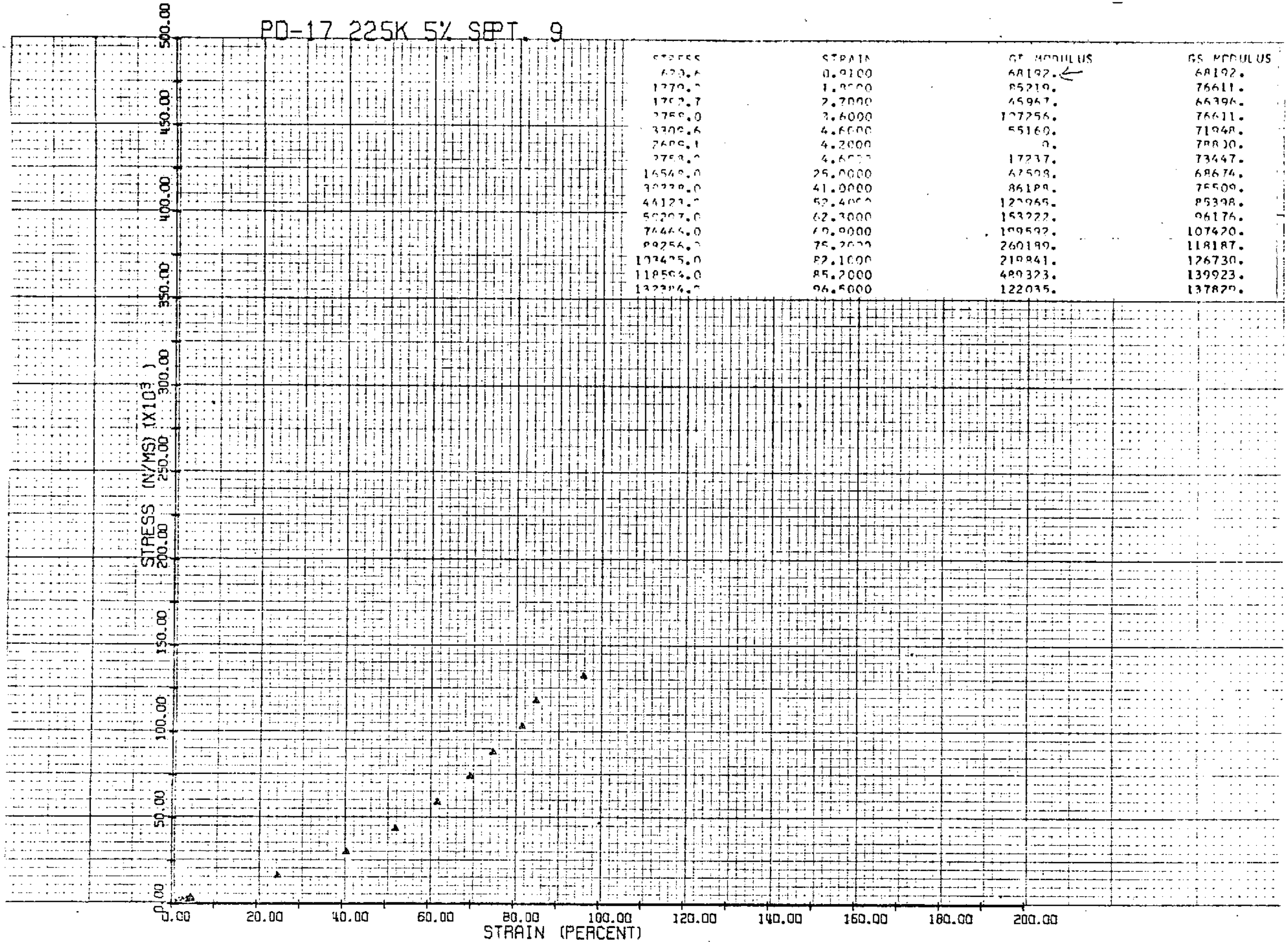
PD-16 225K 3% SEPT. 9



STRESS	STRAIN	GT MODULUS	GS MODULUS
69.0	0.1500	45967.	45967.
759.4	0.7500	114917. ←	101127.
1206.6	1.0500	142392.	114917.
1723.8	1.8000	68950.	95764.
2103.0	2.1000	126408.	100142.
1654.0	2.9000	0.	72516.
2758.0	7.2000	25656.	44533.
17027.0	29.7000	67418.	61569.
31338.0	43.2000	91933.	71264.
47749.0	52.9500	127292.	81581.
53297.0	63.4500	157600.	94161.
77587.0	69.4500	220873.	105897.
95877.0	74.7000	262667.	115901.
100647.0	79.2000	306444.	127671.
117215.0	85.2000	275800.	138102.
132279.0	92.7000	294187.	150731.

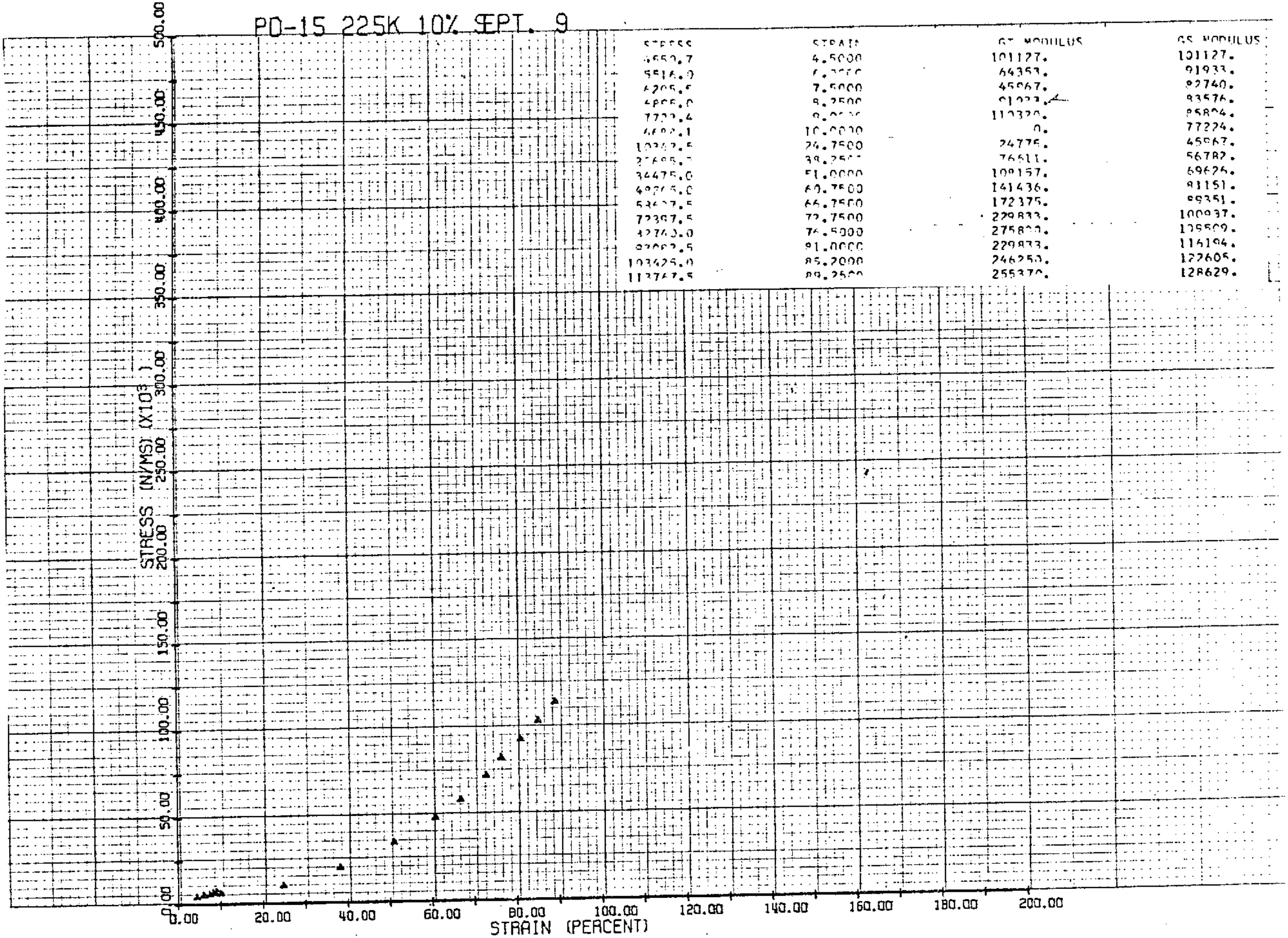
PD-17 225K 5% SEPT. 9

STRESS	STRAIN	GT MODULUS	GS MODULUS
620.6	0.9100	68192. ←	68192.
1279.0	1.8500	85219.	76611.
1762.7	2.7000	45967.	66396.
2758.0	3.6000	107256.	76611.
3309.6	4.6000	55160.	71948.
7605.1	4.2000	0.	78830.
3758.0	4.6000	17237.	73447.
16549.0	25.0000	67598.	68674.
30228.0	41.0000	86189.	75509.
44123.0	52.4000	123965.	85398.
59297.0	62.3000	153222.	96176.
74465.0	69.9000	199592.	107420.
88256.0	75.2000	260199.	118187.
103425.0	82.1000	219841.	126730.
118594.0	85.2000	489323.	139923.
133284.0	96.5000	122035.	137829.



42

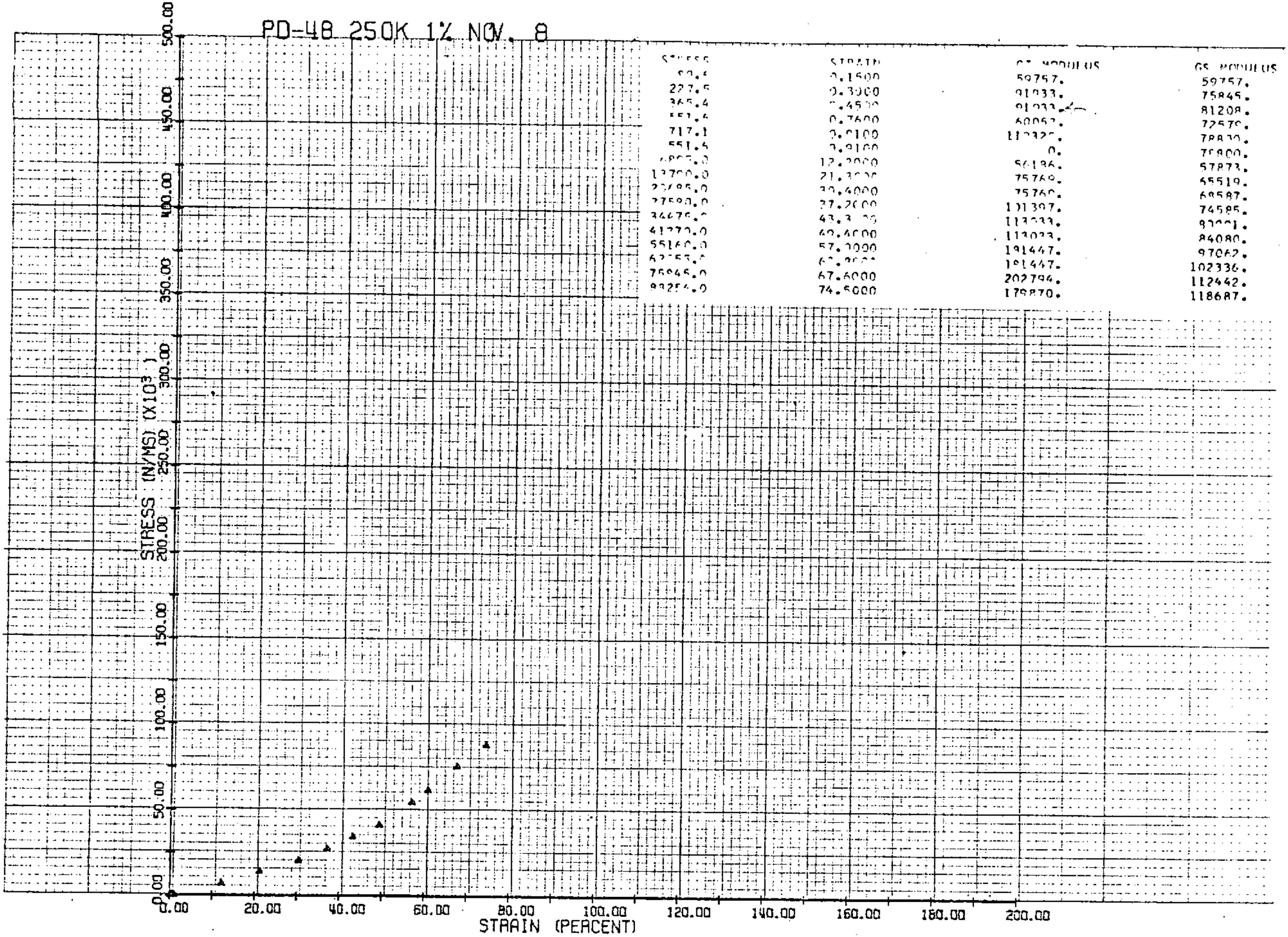
PD-15 225K 10% SEPT. 9



STRESS	STRAIN	GT MODULUS	GS MODULUS
4550.7	4.5000	101127.	101127.
5516.0	6.0000	64353.	91933.
6205.5	7.5000	45967.	82740.
6895.0	8.2500	91933.	83576.
7722.4	9.0000	110320.	85804.
6682.1	10.0000	0.	77224.
10342.5	24.7500	24775.	45967.
21685.7	38.2500	76611.	56782.
34475.0	51.0000	109157.	69626.
49265.0	60.7500	141436.	81151.
59642.5	66.7500	172375.	89351.
73397.5	72.7500	229833.	100937.
82740.0	76.5000	275800.	105509.
93062.5	81.0000	229833.	116194.
103425.0	85.2000	246250.	122605.
113767.5	89.2500	255370.	128629.

43

PD-48 250K 1% NOV. 8



STRESS	STRAIN	CT MODULUS	GS MODULUS
89.6	0.1500	59757.	59757.
227.5	0.3000	91033.	75845.
365.4	0.4500	91033.	81208.
551.6	0.7600	60052.	72579.
717.1	0.9100	110325.	78830.
551.5	0.9100	0.	75800.
6895.0	12.2000	56196.	57873.
13790.0	21.3000	75769.	65519.
20685.0	30.4000	75769.	68587.
27580.0	37.2000	101397.	74585.
34475.0	43.3000	113033.	83001.
41370.0	49.4000	113033.	84080.
55160.0	57.3000	191447.	97062.
62055.0	60.6000	191447.	102336.
75845.0	67.6000	202794.	112442.
83254.0	74.5000	179870.	118687.

44 A

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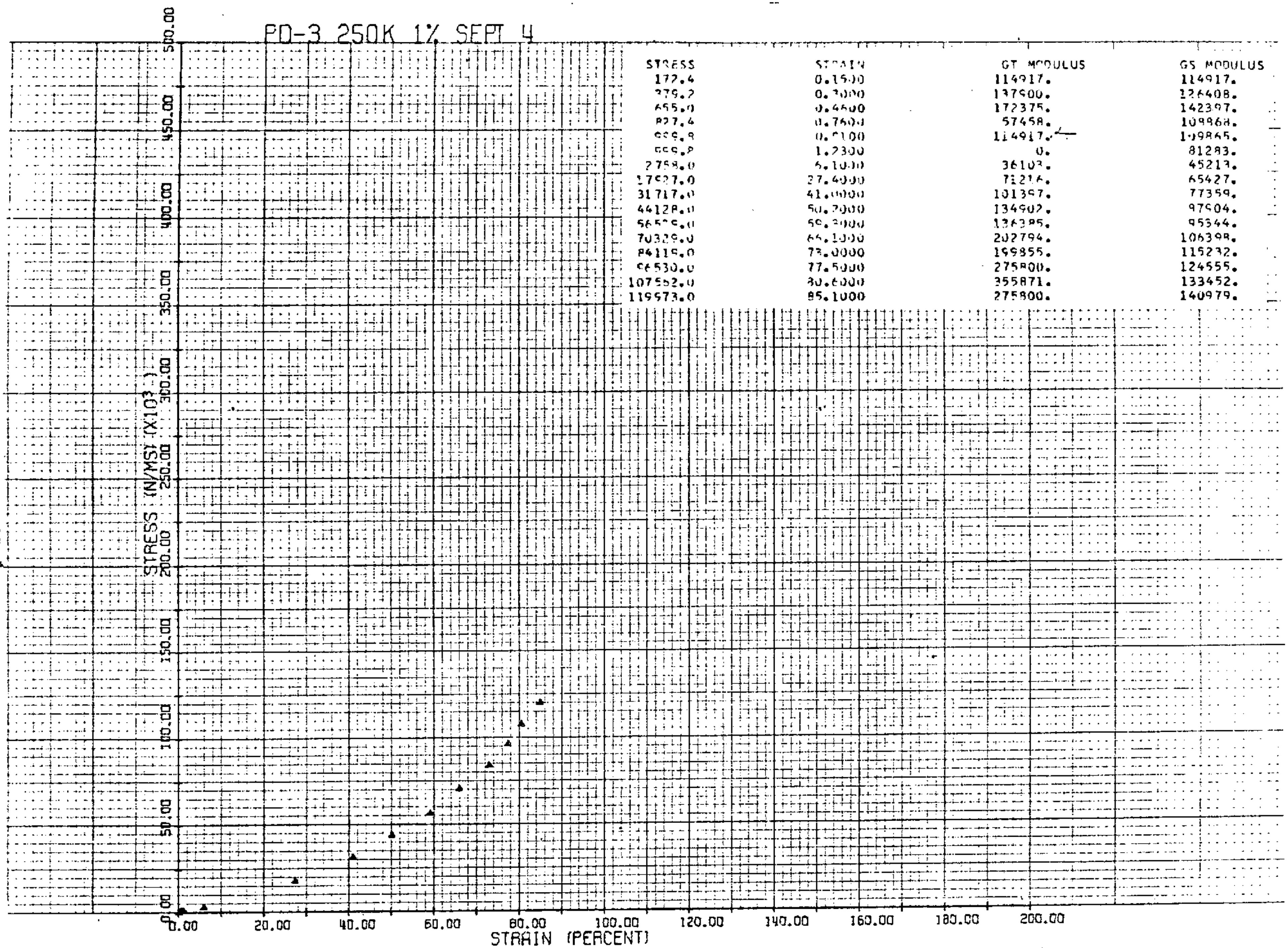
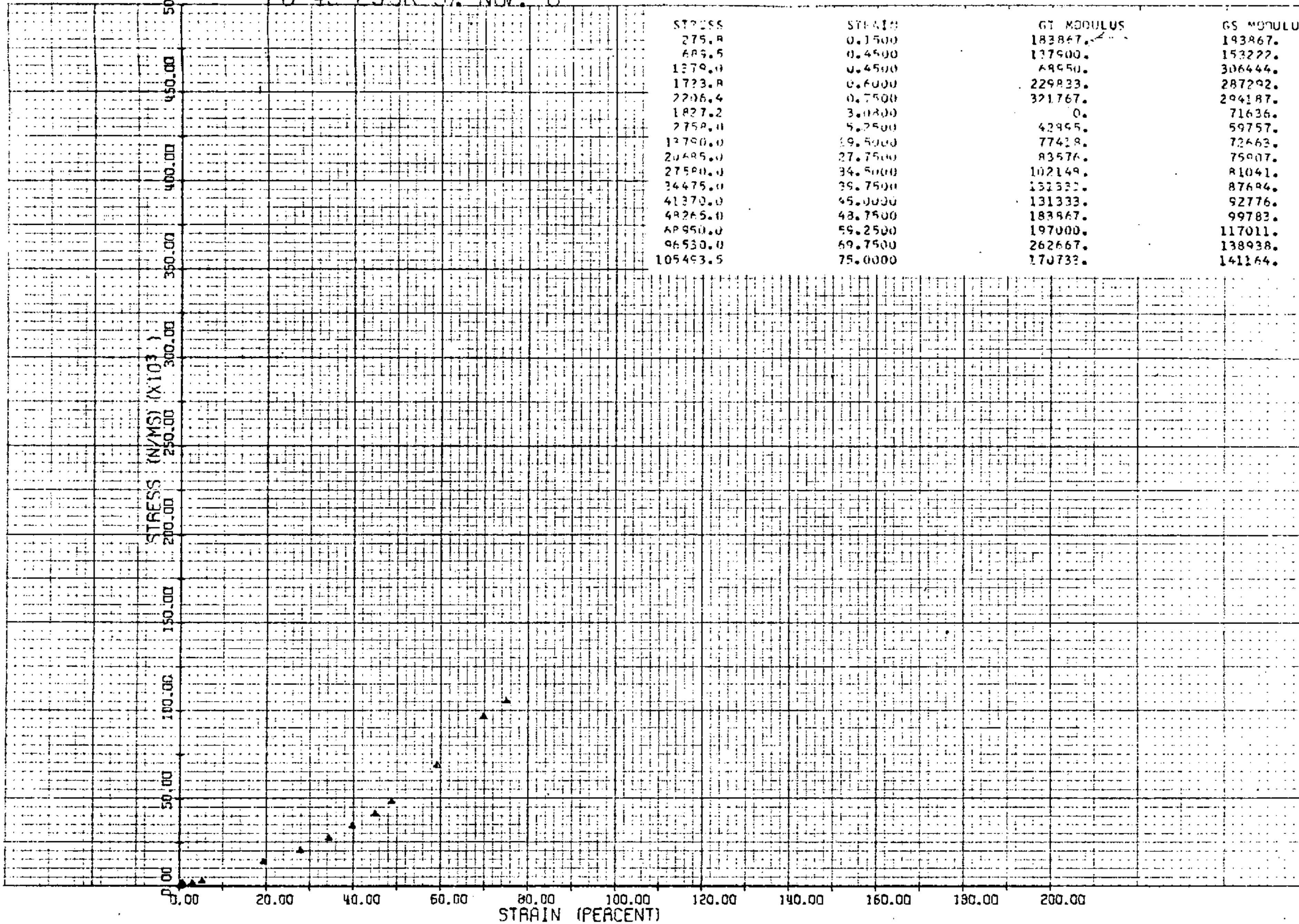
45 #

PD-3 250K 1% SEPT 4



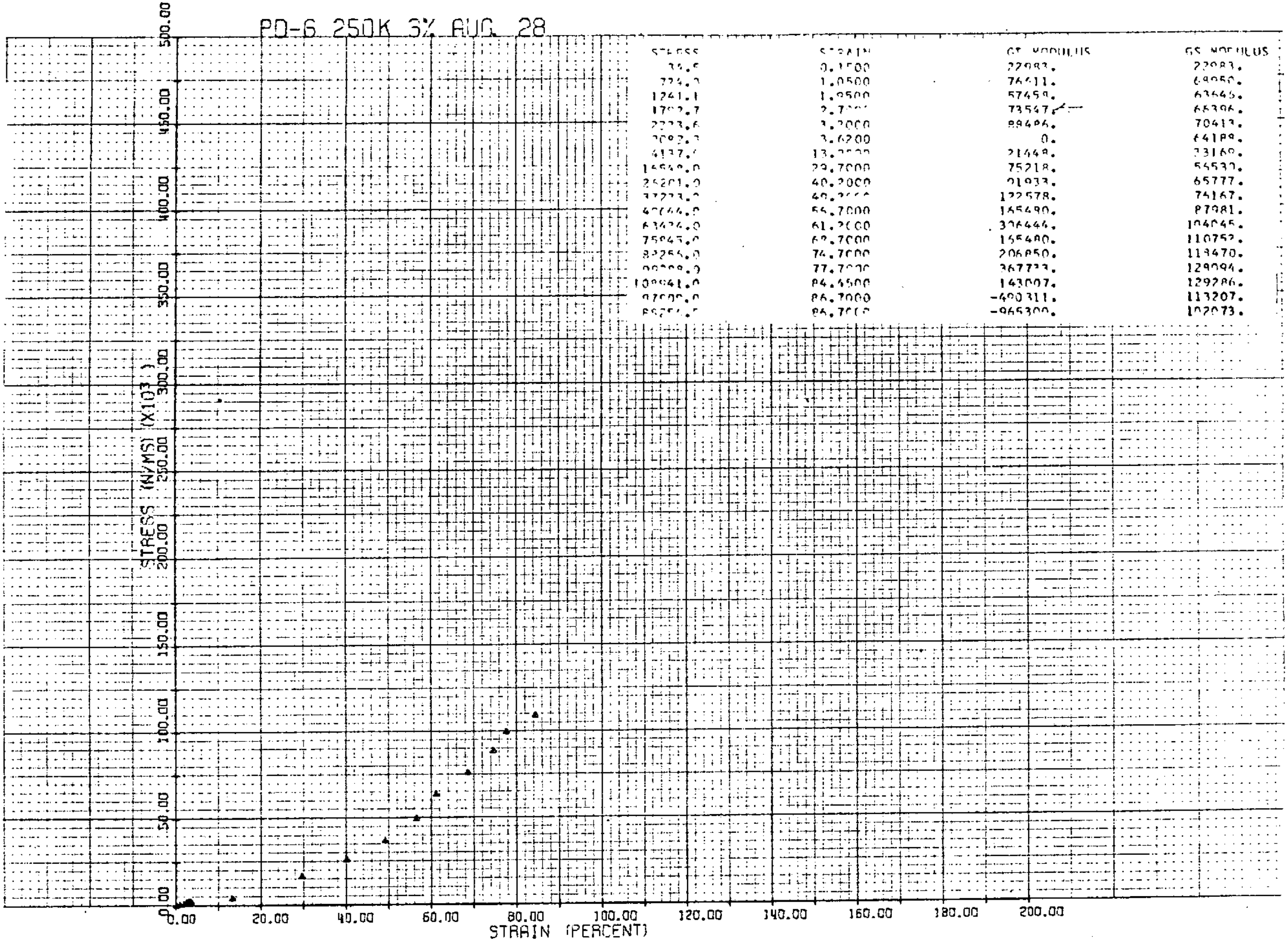
STRESS	STRAIN	GT MODULUS	GS MODULUS
172.4	0.1500	114917.	114917.
379.2	0.3000	137900.	126408.
655.0	0.4600	172375.	142397.
827.4	0.7600	57458.	109968.
999.8	0.9100	114917. ←	109865.
999.8	1.2300	0.	81283.
2758.0	6.1000	36103.	45213.
17927.0	27.4000	71216.	65427.
31717.0	41.0000	101397.	77359.
44128.0	50.2000	134902.	97904.
56539.0	59.3000	136385.	95344.
70329.0	66.1000	202794.	106398.
84115.0	73.0000	199855.	115232.
96530.0	77.5000	275800.	124555.
107562.0	80.6000	355871.	133452.
119973.0	85.1000	275800.	140979.

PD-43 250K 3% NOV. 8



STRESS	STRAIN	GT MODULUS	GS MODULUS
275.8	0.1500	183867.	183867.
689.5	0.4500	137900.	153222.
1379.0	0.4500	68950.	306444.
1723.8	0.6000	229833.	287292.
2206.4	0.7500	321767.	294187.
1827.2	3.0800	0.	71636.
2758.0	5.2500	42955.	59757.
13790.0	19.5000	77418.	72663.
20685.0	27.7500	83576.	75907.
27580.0	34.5000	102149.	81041.
34475.0	39.7500	131333.	87694.
41370.0	45.0000	131333.	92776.
48265.0	48.7500	183867.	99783.
68950.0	59.2500	197000.	117011.
96530.0	69.7500	262667.	138938.
105493.5	75.0000	170733.	141164.

PD-6 250K 3% AUG. 28



STRESS	STRAIN	GT MODULUS	GS MODULUS
34.5	0.1500	22983.	22983.
774.0	1.0500	76411.	69950.
1241.1	1.9500	57459.	63645.
1792.7	2.7000	73547. ✓	66396.
2223.6	3.2000	88486.	70413.
3092.3	3.6200	0.	64189.
4137.[illegible]	13.2000	21448.	33169.
15549.0	29.7000	75218.	55532.
25201.0	40.2000	91933.	65777.
37223.0	49.2000	122578.	74167.
49066.0	55.7000	165490.	87981.
63474.0	61.2000	396444.	104045.
75943.0	69.7000	165480.	110752.
83255.0	74.7000	206850.	113470.
99998.0	77.7000	367723.	129094.
109941.0	84.4500	143007.	129286.
97909.0	86.7000	-490311.	113207.
85754.0	86.7000	-965300.	102073.

47

ESSER CO. PRINTED IN U.S.A.

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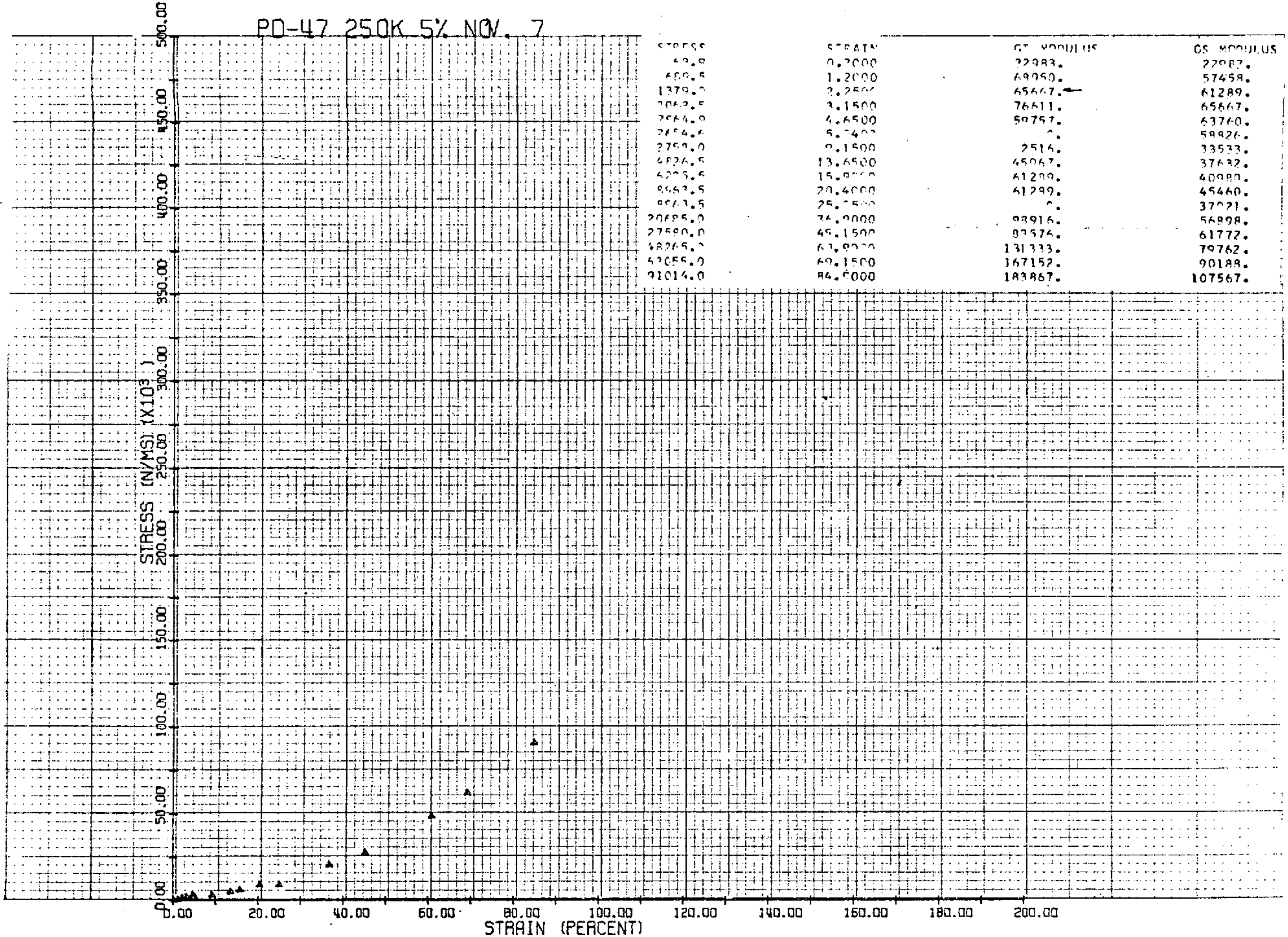
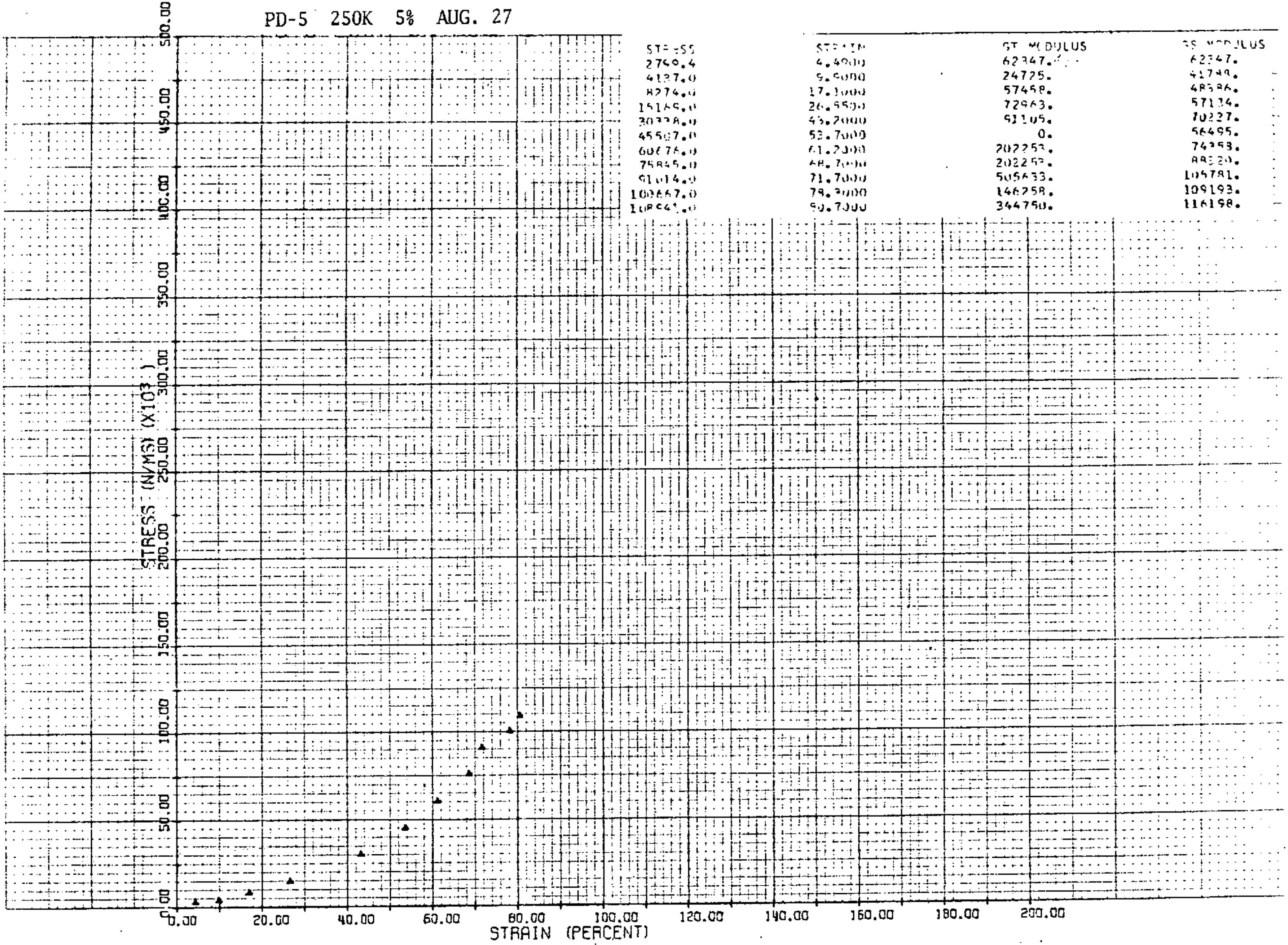


STRESS	STRAIN	GT MODULUS	GS MODULUS
45.9	0.2000	22983.	22987.
689.5	1.2000	68950.	57458.
1379.0	2.2500	65667. ←	61289.
2068.5	3.1500	76611.	65667.
2964.9	4.6500	59757.	63760.
2654.6	5.5400	0.	59926.
2759.0	8.1500	2516.	33533.
4826.5	13.6500	45067.	37632.
6205.5	15.9500	61299.	40980.
9653.5	20.4000	61299.	45460.
9563.5	25.7500	0.	37021.
20685.0	36.9000	93916.	56898.
27580.0	45.1500	83576.	61772.
48265.0	61.9000	131333.	79762.
62055.0	69.1500	167152.	90188.
91014.0	84.6000	183867.	107567.

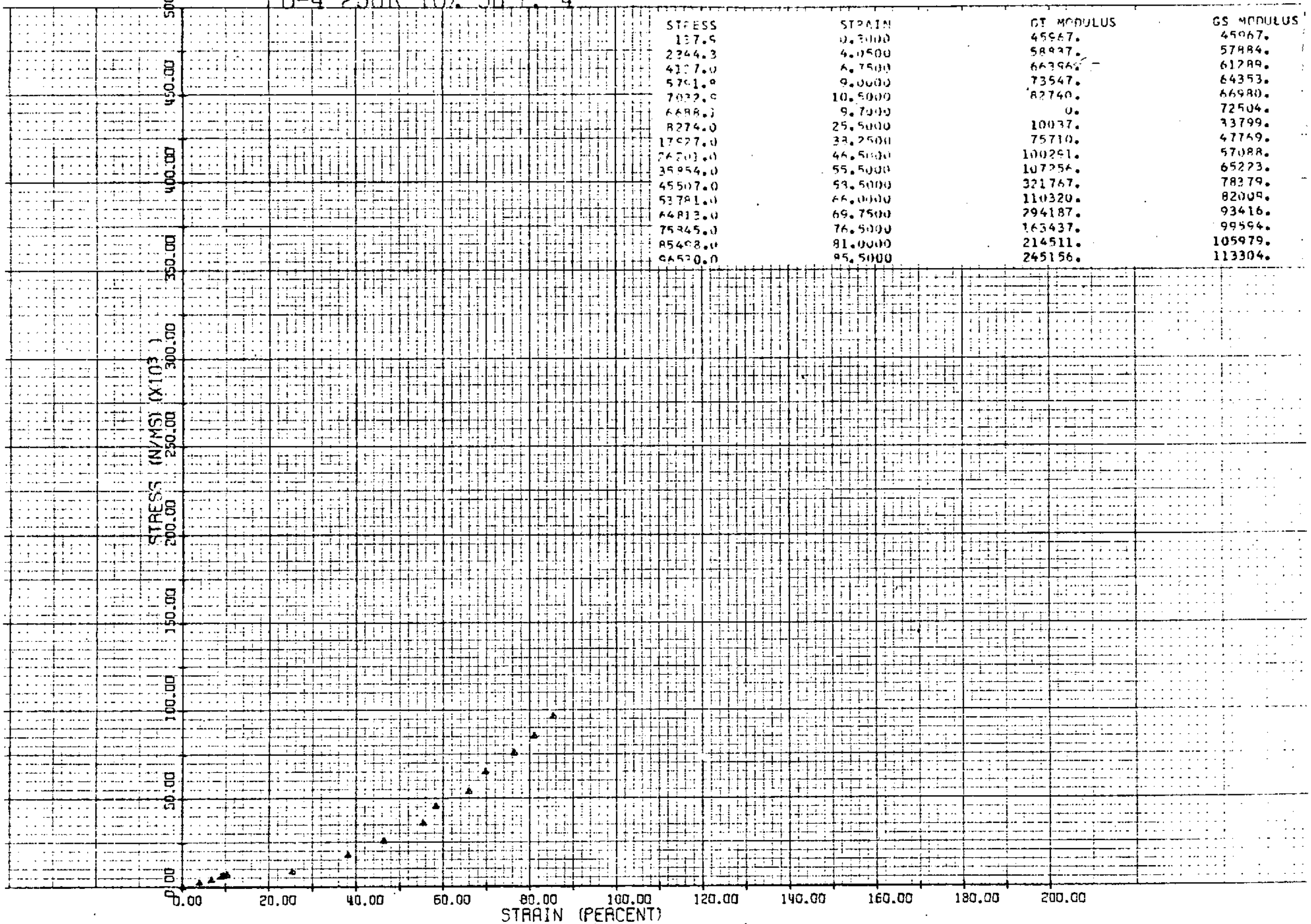
PD-5 250K 5% AUG. 27

STRESS	STRAIN	ST MODULUS	SS MODULUS
2759.4	4.4900	62347.	62347.
4137.0	9.9000	24725.	41749.
8274.0	17.3000	57458.	48386.
15169.0	26.5500	72963.	57134.
30338.0	43.2000	91105.	70227.
45507.0	53.7000	0.	56495.
60676.0	61.2000	202253.	74353.
75845.0	68.7000	202253.	88320.
91014.0	71.7000	505633.	105781.
100667.0	79.3000	146258.	109193.
108541.0	90.7000	344750.	116198.



49 A

PD-4 250K 10% SEPT. 4



STRESS	STRAIN	GT MODULUS	GS MODULUS
137.5	0.3000	45967.	45967.
2344.3	4.0500	58937.	57884.
4137.0	6.7500	66396.	61289.
5791.9	9.0000	73547.	64353.
7032.9	10.5000	82740.	66980.
6688.1	9.7000	0.	72504.
8274.0	25.5000	10037.	33799.
17927.0	33.2500	75710.	47769.
26701.0	46.5000	100291.	57088.
35954.0	55.5000	107256.	65223.
45507.0	58.5000	321767.	78279.
53781.0	66.0000	110320.	82009.
64813.0	69.7500	794187.	93416.
75345.0	76.5000	163437.	99594.
85498.0	81.0000	214511.	105979.
96520.0	85.5000	245156.	113304.

50 #

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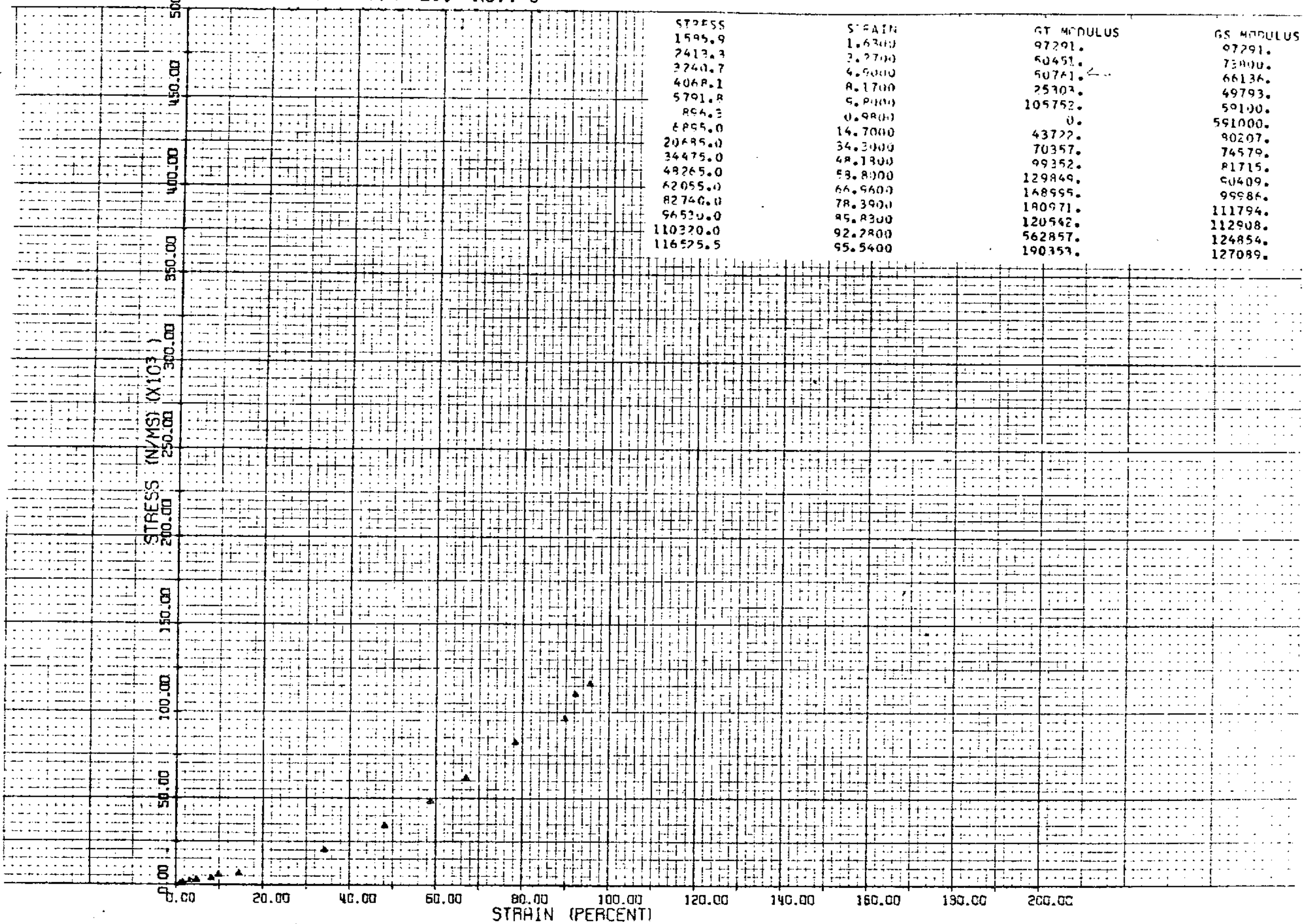
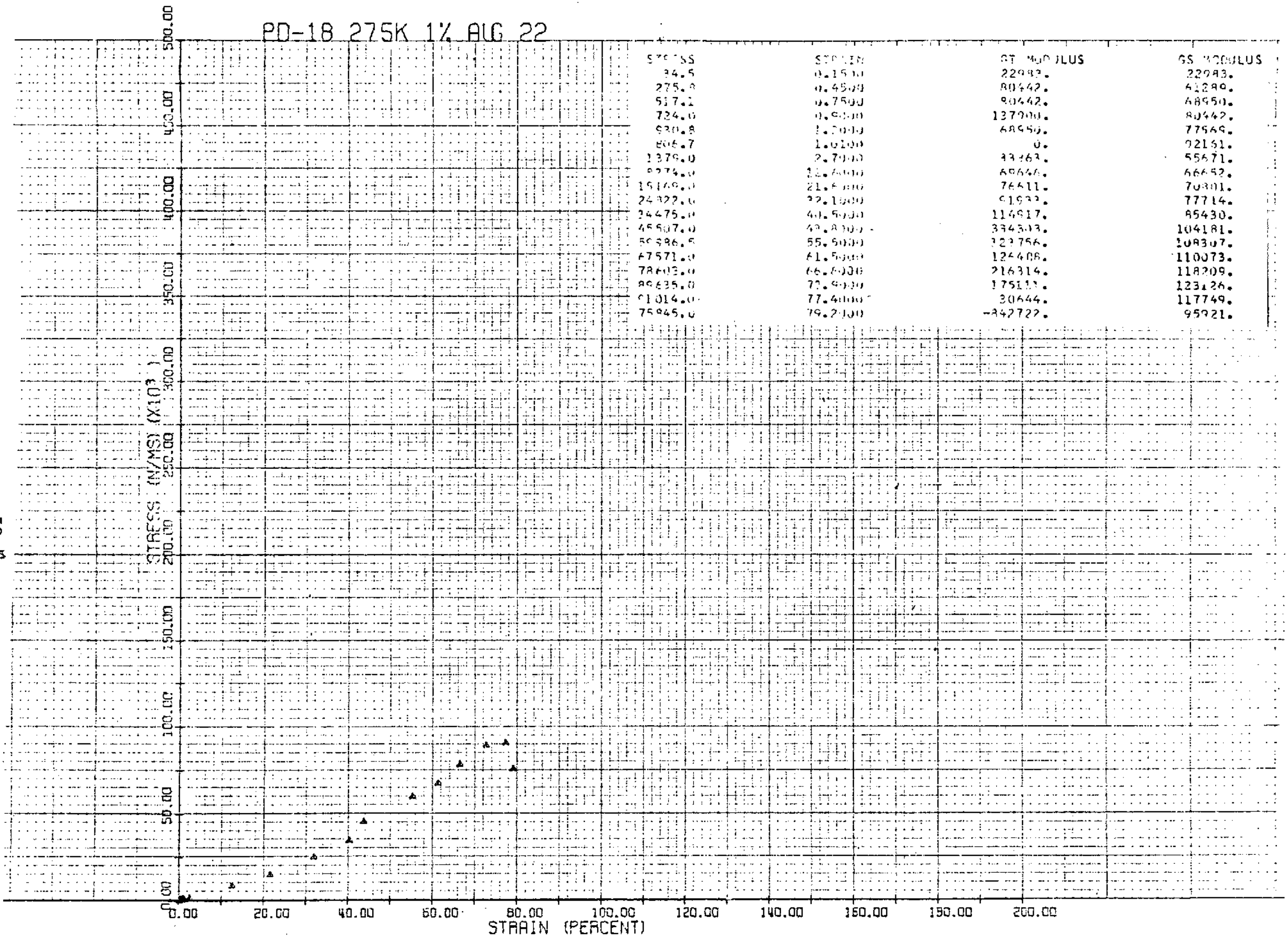
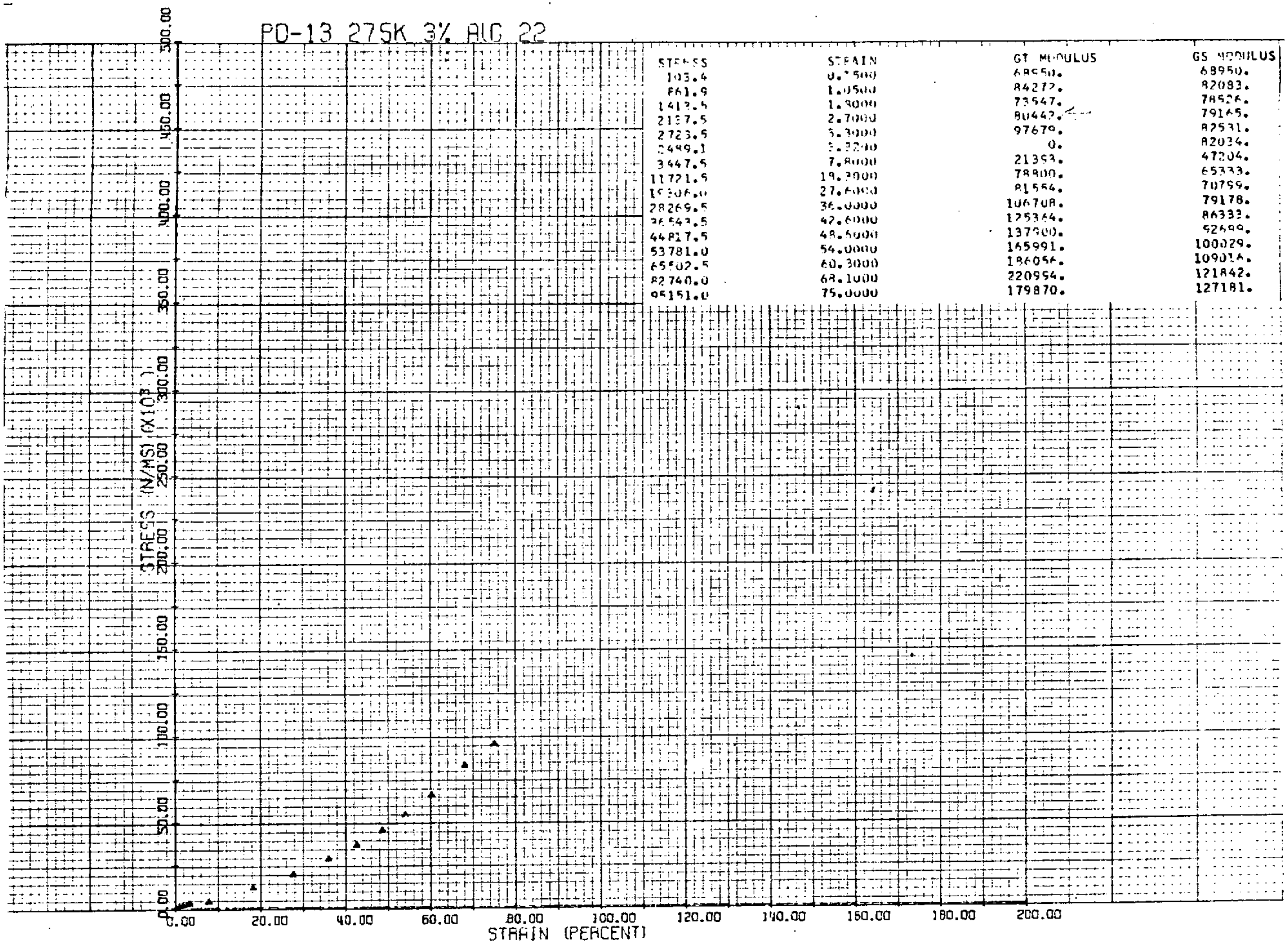
PD-44 250K 10% NOV. 6



STRESS	STRAIN	GT MODULUS	GS MODULUS
1595.9	1.6300	97291.	97291.
2413.3	3.2700	50451.	73800.
3240.7	4.9000	50761. ←	66136.
4068.1	8.1700	25303.	49793.
5791.8	9.8000	105752.	59100.
896.3	0.9800	0.	591000.
6895.0	14.7000	43722.	80207.
20685.0	34.3000	70357.	74579.
34475.0	48.1300	99352.	81715.
48265.0	58.8000	129849.	90409.
62055.0	66.9600	168995.	99986.
82740.0	78.3900	180971.	111794.
96530.0	85.8300	120542.	112908.
110320.0	92.2800	562857.	124854.
116525.5	95.5400	190353.	127089.



STRESS	STRAIN	ST MODULUS	GS MODULUS
34.5	0.1500	22983.	22983.
275.8	0.4500	80442.	61289.
517.1	0.7500	80442.	68950.
724.0	0.9000	137900.	80442.
930.8	1.2000	68950.	77569.
806.7	1.0100	0.	92161.
1379.0	2.7000	33463.	55671.
8274.0	12.6000	69646.	66652.
15169.0	21.6000	76611.	70301.
24822.0	32.1000	91933.	77714.
34475.0	40.5000	114917.	85430.
45507.0	43.8000	334303.	104181.
59986.5	55.5000	123756.	108307.
67571.0	61.5000	126408.	110073.
78603.0	66.6000	216314.	118209.
89635.0	72.9000	175133.	123126.
91014.0	77.4000	30644.	117749.
75845.0	79.2000	-842722.	95921.

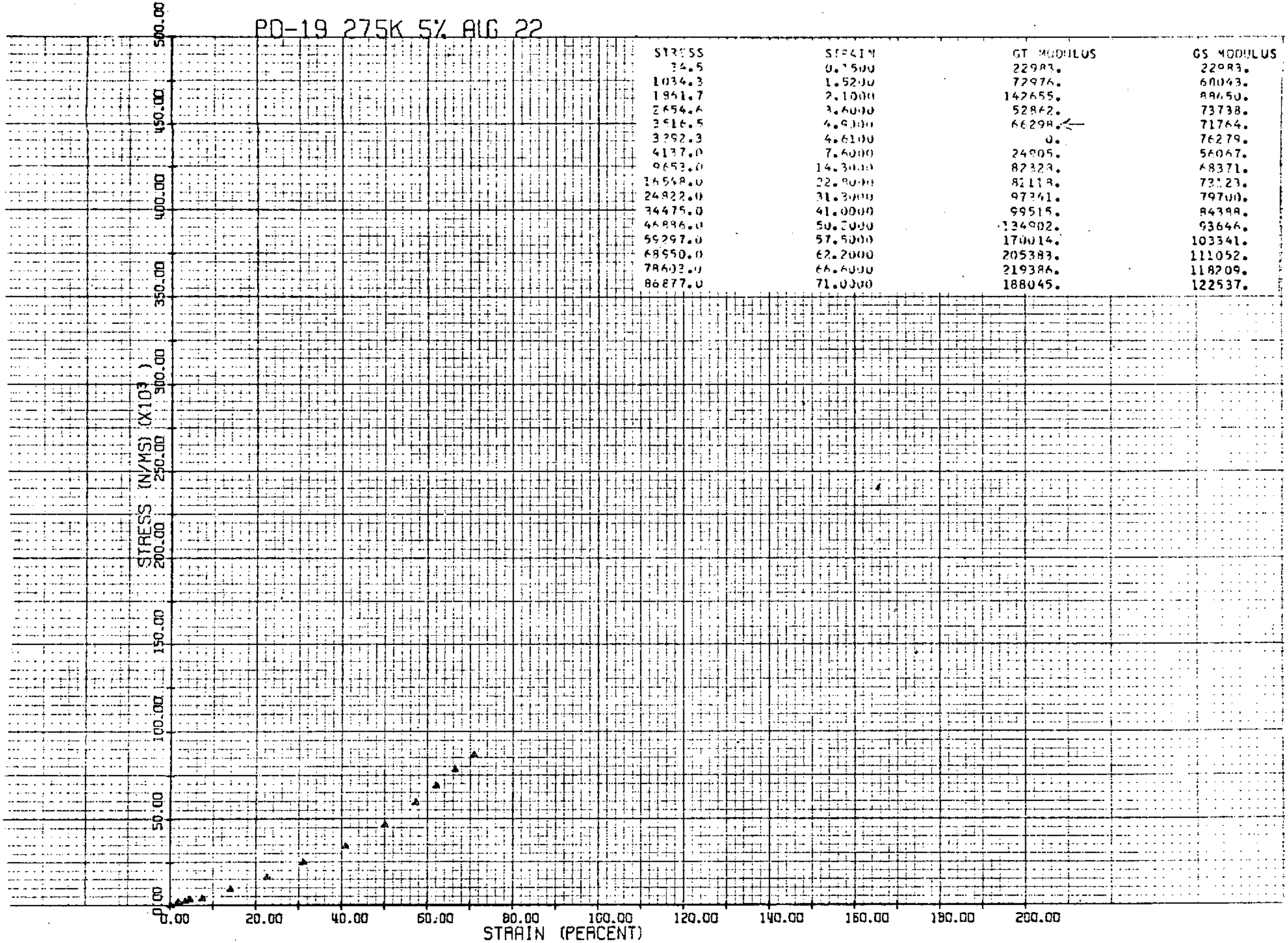


STRESS	STRAIN	GT MODULUS	GS MODULUS
103.4	0.7500	68550.	68950.
861.9	1.0500	84272.	82083.
1413.5	1.8000	73547.	78526.
2137.5	2.7000	80442.	79165.
2723.5	3.3000	97679.	82531.
2449.1	5.2200	0.	82034.
3447.5	7.8000	21393.	47204.
11721.5	19.2000	78900.	65333.
15306.0	27.6000	81554.	70759.
28269.5	36.0000	106708.	79178.
36543.5	42.6000	125364.	86333.
44817.5	48.5000	137900.	92699.
53781.0	54.0000	165991.	100029.
65502.5	60.3000	186056.	109016.
82740.0	68.1000	220954.	121842.
95151.0	75.0000	179870.	127181.

53 A

K+E KEUFFEL &

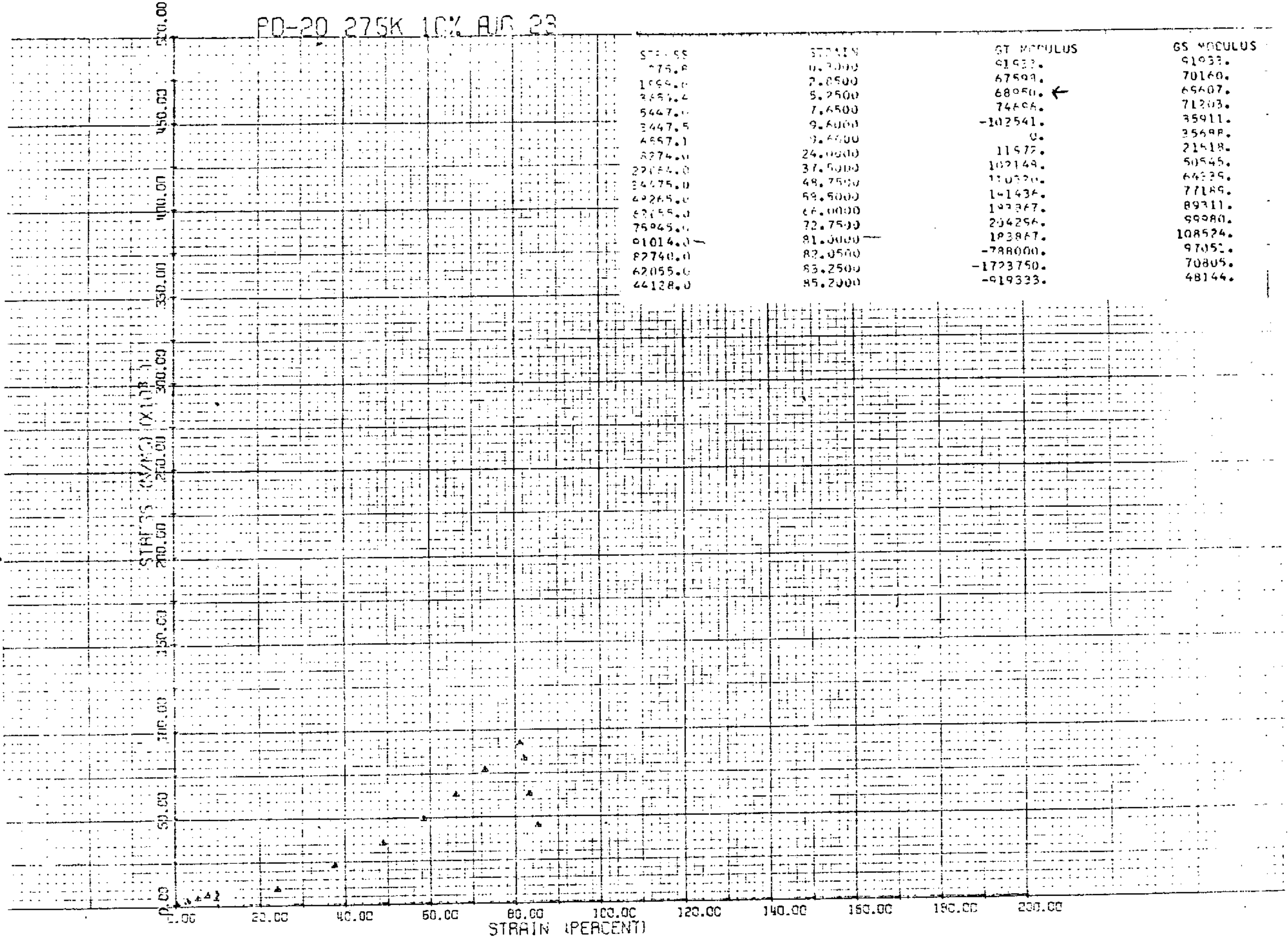
PD-19 275K 5% AUG 22



STRESS	STRAIN	GT MODULUS	GS MODULUS
34.5	0.1500	22983.	22983.
1034.3	1.5200	72976.	60043.
1961.7	2.1000	142655.	88650.
2654.6	3.6000	52862.	73738.
3516.5	4.9000	66298. ←	71764.
3292.3	4.6100	0.	76279.
4137.0	7.6000	24905.	56067.
9653.0	14.3000	82323.	68371.
16548.0	22.9000	82118.	73123.
24822.0	31.3000	97341.	79700.
34475.0	41.0000	99515.	84398.
46886.0	50.2000	134902.	93646.
59297.0	57.5000	170014.	103341.
68950.0	62.2000	205383.	111052.
78603.0	66.6000	219386.	118209.
86877.0	71.0000	188045.	122537.

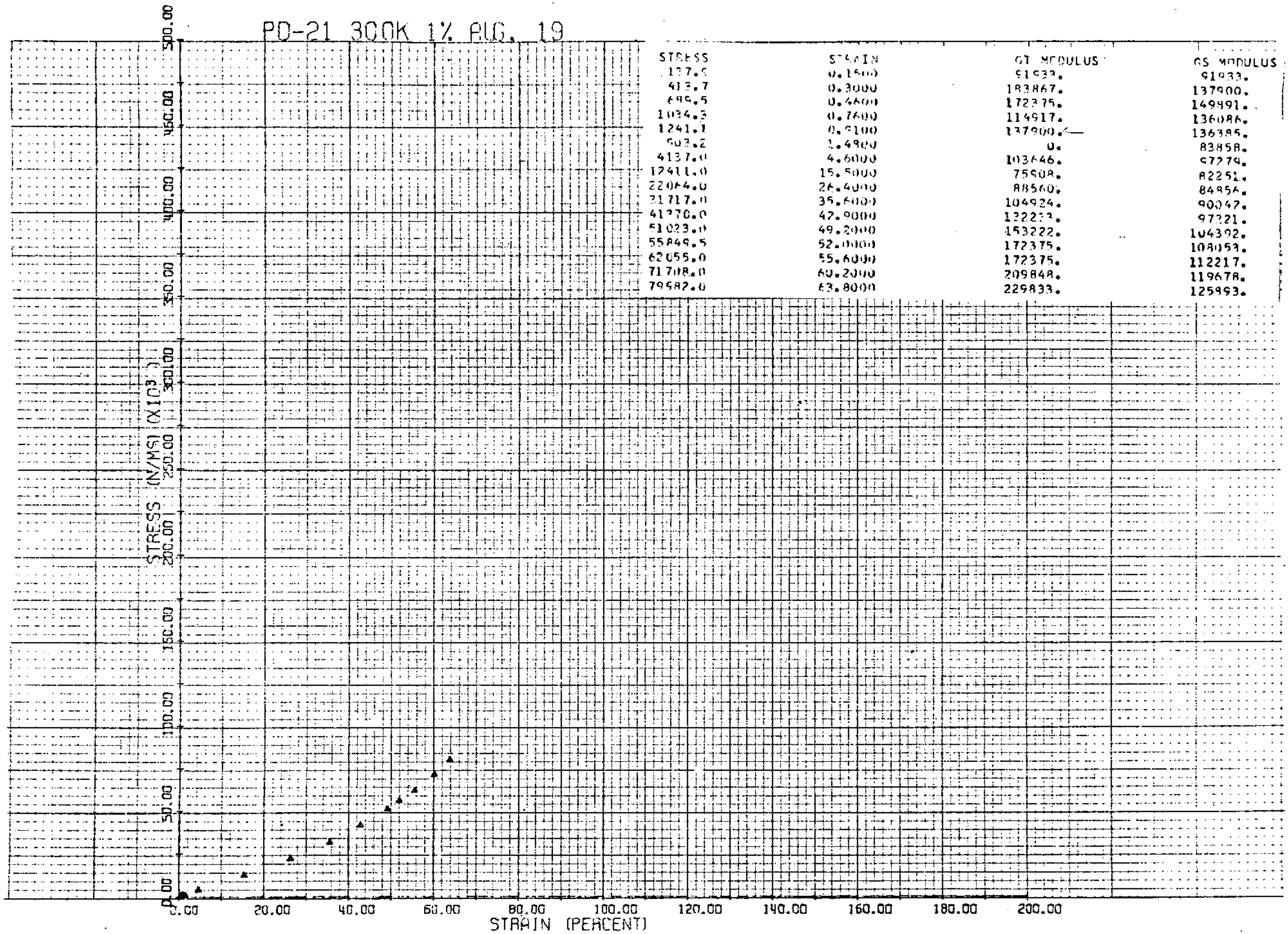
55 A

PD-20 275K 10% AUG 23

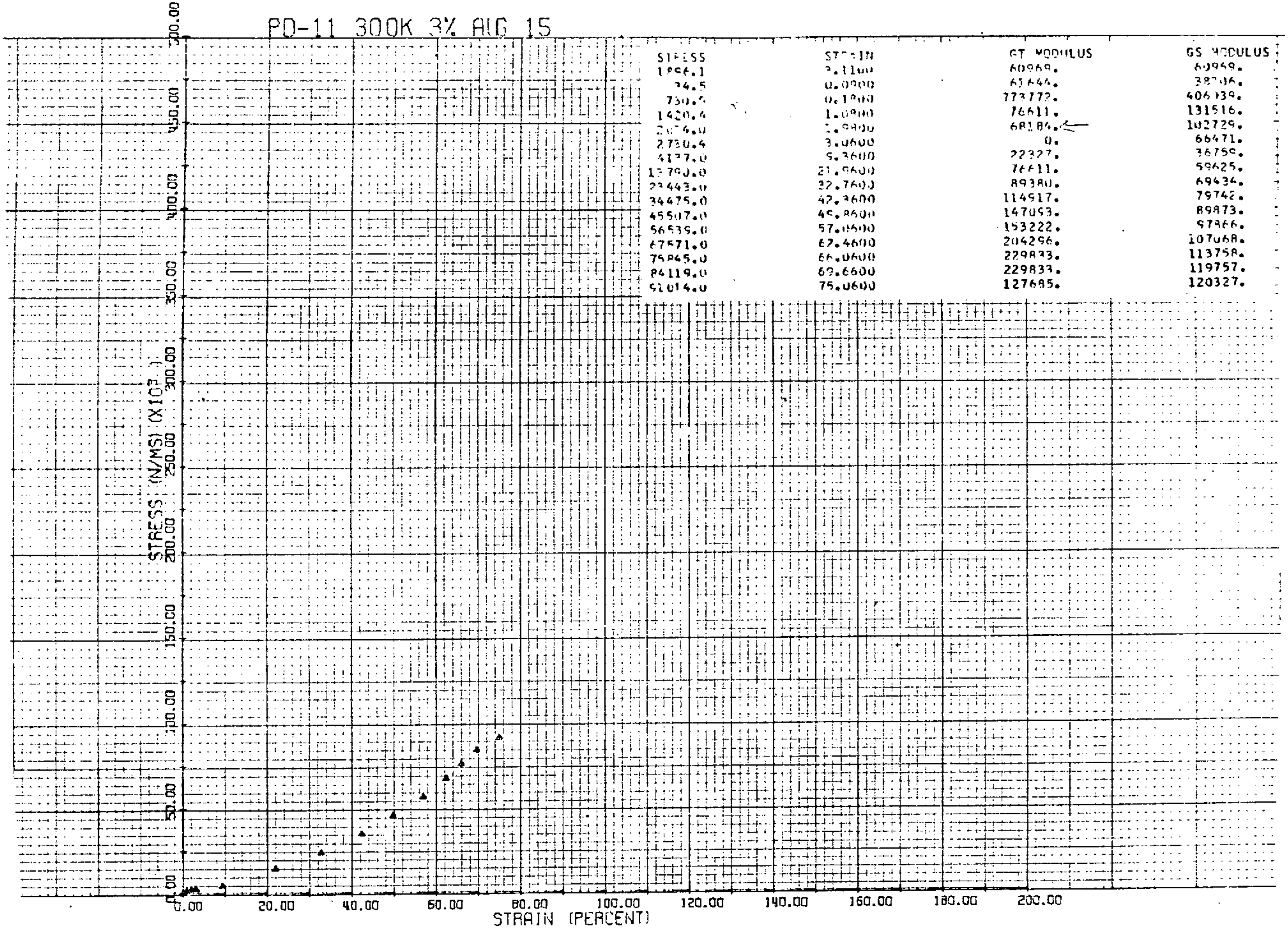


STRESS	STRAIN	GT MODULUS	GS MODULUS
275.8	0.3000	91933.	91933.
1599.0	2.0500	67593.	70160.
3654.4	5.2500	68950. ←	69607.
5447.0	7.6500	74696.	71203.
3447.5	9.6000	-102541.	35911.
6557.1	9.6000	0.	35698.
8274.0	24.0000	11577.	21518.
22684.0	37.5000	102149.	50545.
34475.0	48.7500	110320.	64339.
49265.0	59.5000	141436.	77189.
63155.0	66.0000	193367.	89311.
75945.0	72.7500	204296.	99980.
91014.0 —	81.0000 —	183867.	108524.
82740.0	82.0500	-788000.	97052.
62055.0	83.2500	-1723750.	70805.
44128.0	85.2000	-919333.	48144.

PD-21 300K 1% AUG. 19



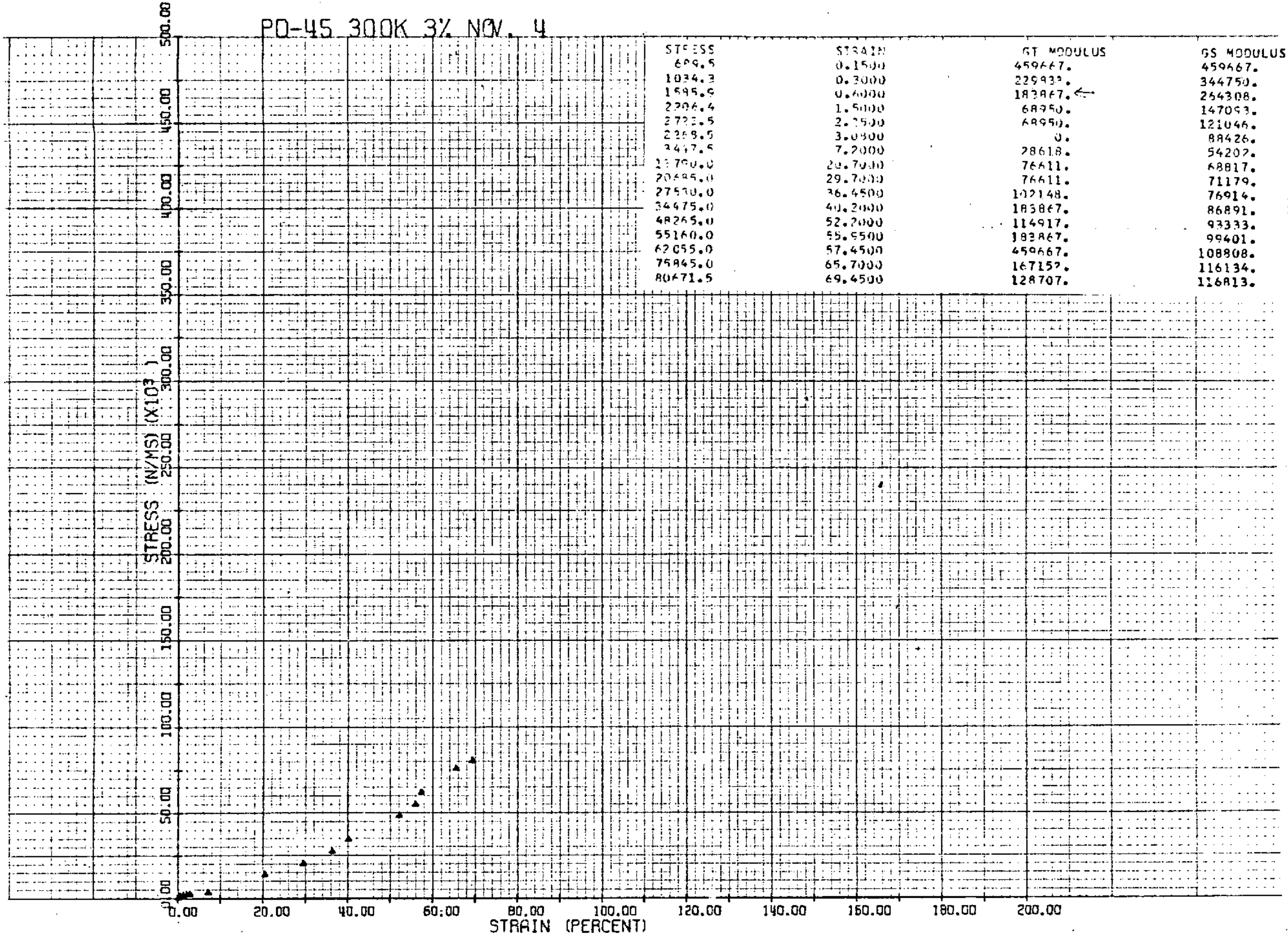
STRESS	STRAIN	GT MODULUS	GS MODULUS
137.9	0.1500	91933.	91933.
413.7	0.3000	183867.	137900.
689.5	0.4600	172375.	149891.
1034.3	0.7600	114917.	136086.
1241.1	0.9100	137900. ←	136385.
503.2	1.4900	0.	83858.
4137.0	4.6000	103646.	97279.
12411.0	15.5000	75908.	82251.
22064.0	26.4000	88560.	84856.
31717.0	35.6000	104924.	90047.
41370.0	42.9000	132233.	97221.
51023.0	49.2000	153222.	104392.
55849.5	52.0000	172375.	108053.
62055.0	55.6000	172375.	112217.
71708.0	60.2000	209848.	119678.
79582.0	63.8000	229833.	125993.



STRESS	STRAIN	GT MODULUS	GS MODULUS
1896.1	3.1100	60969.	60969.
34.5	0.0900	61644.	38706.
730.6	0.1900	773772.	406139.
1420.4	1.0900	76611.	131516.
2074.0	1.9900	68184. ←	102729.
2730.4	3.0600	0.	66471.
4137.0	5.3600	22327.	36759.
13790.0	21.9600	76611.	59625.
23443.0	32.7600	89380.	69434.
34475.0	42.3600	114917.	79742.
45507.0	49.8600	147093.	89873.
56539.0	57.0600	153222.	97966.
67571.0	62.4600	204296.	107068.
75845.0	66.0600	229833.	113758.
84119.0	69.6600	229833.	119757.
91014.0	75.0600	127685.	120327.

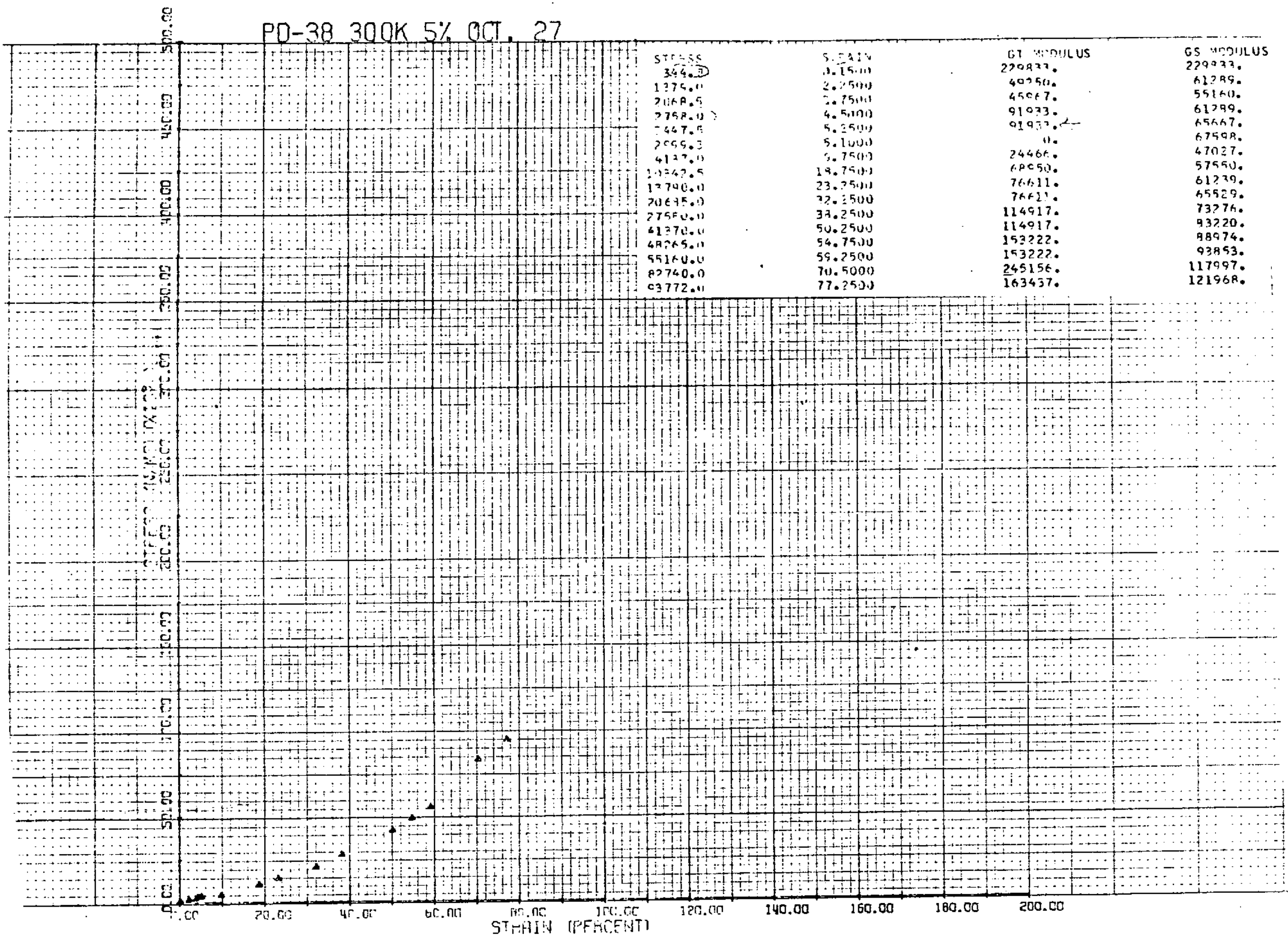
PD-45 300K 3% NOV. 4

STRESS	STRAIN	GT MODULUS	GS MODULUS
689.5	0.1500	459667.	459667.
1034.3	0.3000	229933.	344750.
1595.9	0.6000	183867. ←	264308.
2206.4	1.5000	68950.	147093.
2723.5	2.2500	68950.	121046.
2758.5	3.0300	0.	88426.
3447.5	7.2000	28618.	54207.
13790.0	20.7000	76611.	68817.
20685.0	29.7000	76611.	71179.
27580.0	36.4500	102148.	76914.
34475.0	40.2000	183867.	86891.
48265.0	52.2000	114917.	93333.
55160.0	55.5500	183867.	99401.
62055.0	57.4500	459667.	108808.
75845.0	65.7000	167152.	116134.
80671.5	69.4500	128707.	116813.



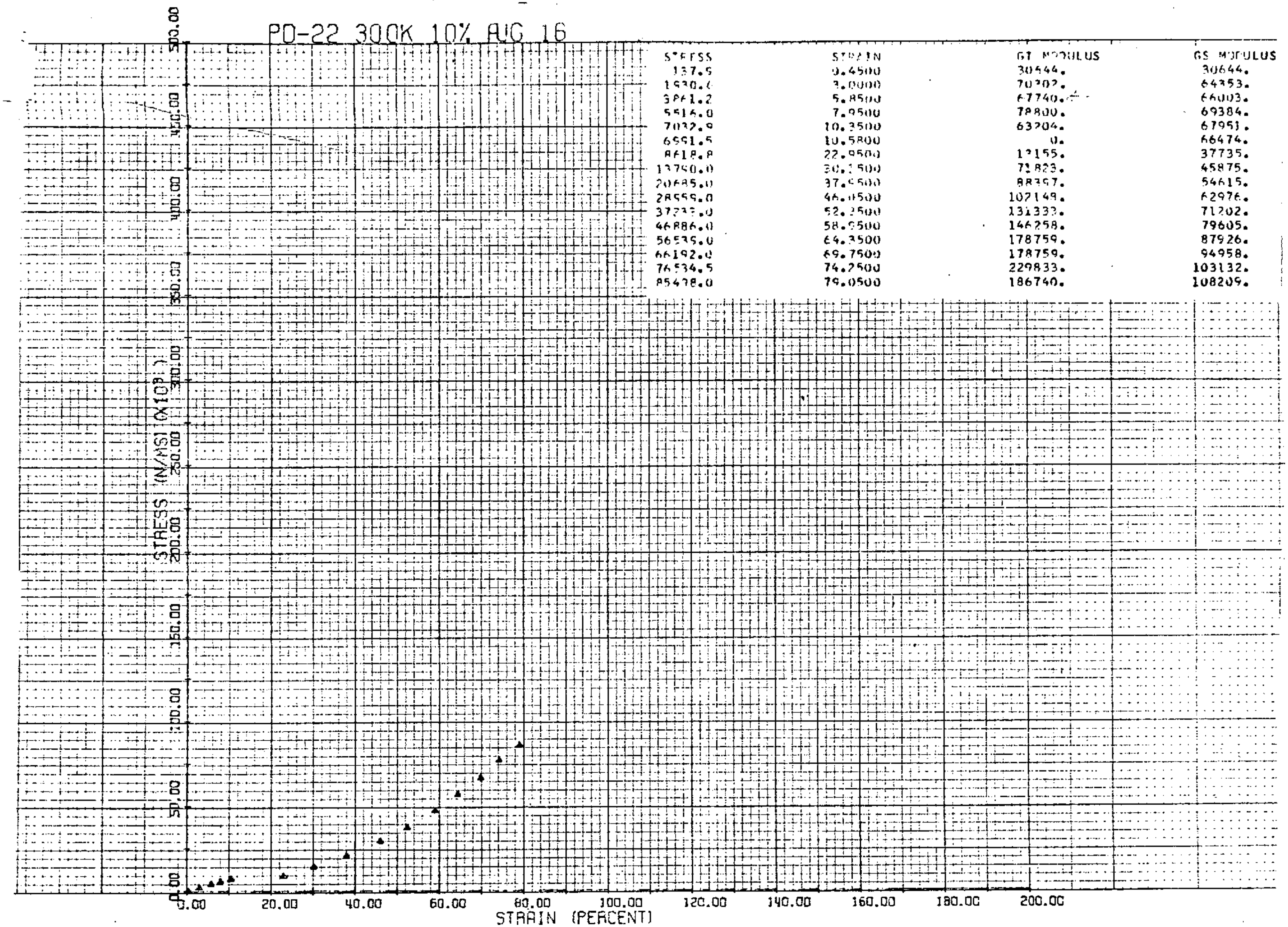
58

PD-38 300K 5% OCT. 27



STRESS	STRAIN	GT MODULUS	GS MODULUS
344.7	0.1500	229833.	229833.
1379.0	2.2500	49250.	61289.
2068.5	3.7500	45967.	55160.
2758.0	4.5000	91933.	61289.
3447.5	5.2500	91933.	65667.
2999.3	5.1000	0.	67598.
4137.0	8.7500	24466.	47027.
10342.5	18.7500	68950.	57550.
13790.0	23.2500	76611.	61239.
20685.0	32.2500	76611.	65529.
27580.0	38.2500	114917.	73276.
41370.0	50.2500	114917.	93220.
48265.0	54.7500	153222.	88974.
55160.0	59.2500	153222.	93853.
82740.0	70.5000	245156.	117997.
93772.0	77.2500	163437.	121968.

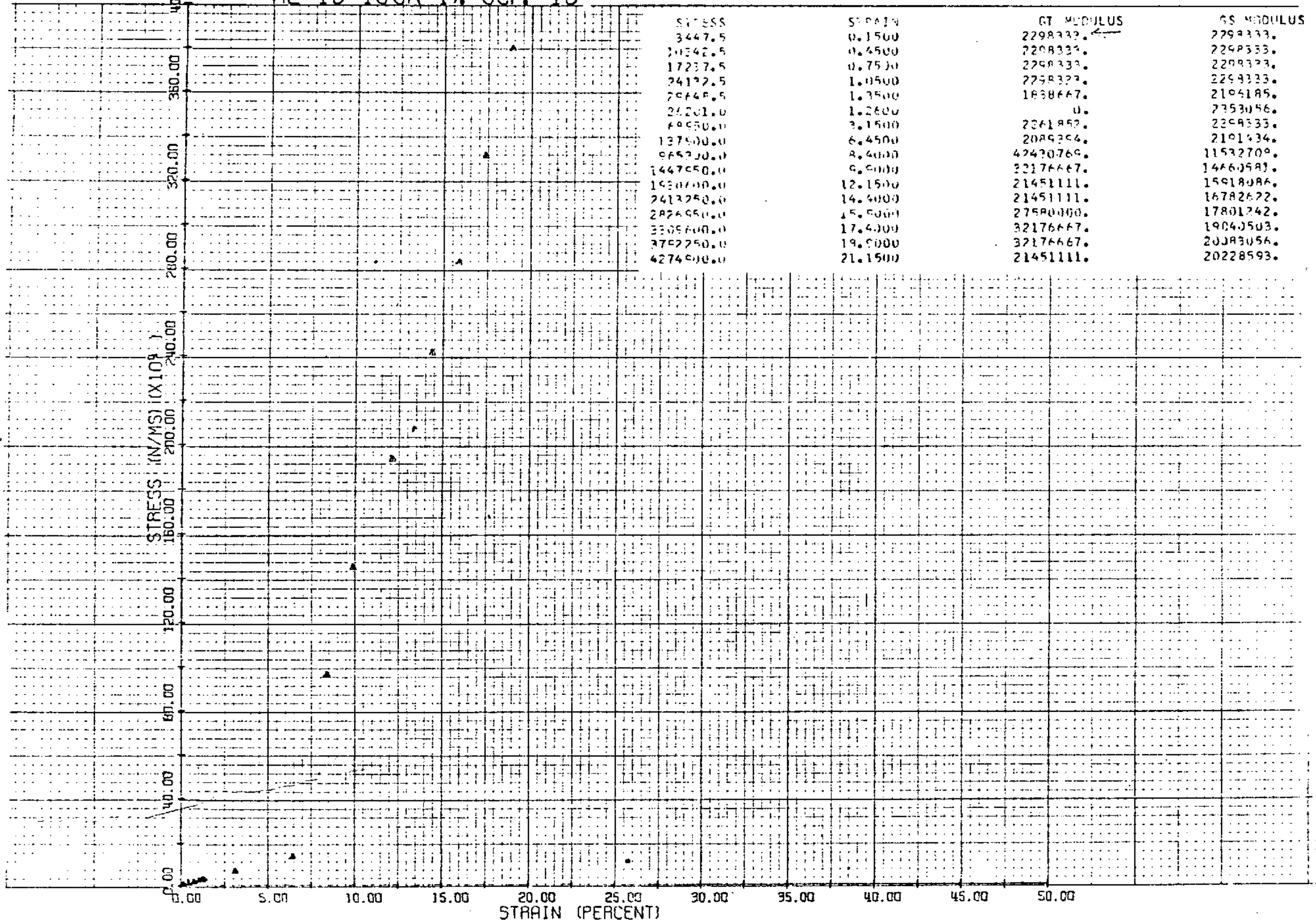
59 A



STRESS	STRAIN	GT MODULUS	GS MODULUS
137.5	0.4500	30644.	30644.
1930.6	3.0000	70302.	64353.
3861.2	5.8500	67740.	66003.
5516.0	7.9500	78800.	69384.
7032.9	10.3500	63204.	67951.
6991.5	10.5800	0.	66474.
8618.8	22.9500	12155.	37735.
13790.0	30.1500	71823.	45875.
20685.0	37.9500	88357.	54615.
28555.0	46.0500	107149.	62976.
37233.0	52.2500	131333.	71202.
46886.0	58.9500	146258.	79605.
56535.0	64.3500	178759.	87926.
66192.0	69.7500	178759.	94958.
76534.5	74.2500	229833.	103132.
85478.0	79.0500	186740.	108209.

60

RL-13 100K 1% OCT. 16

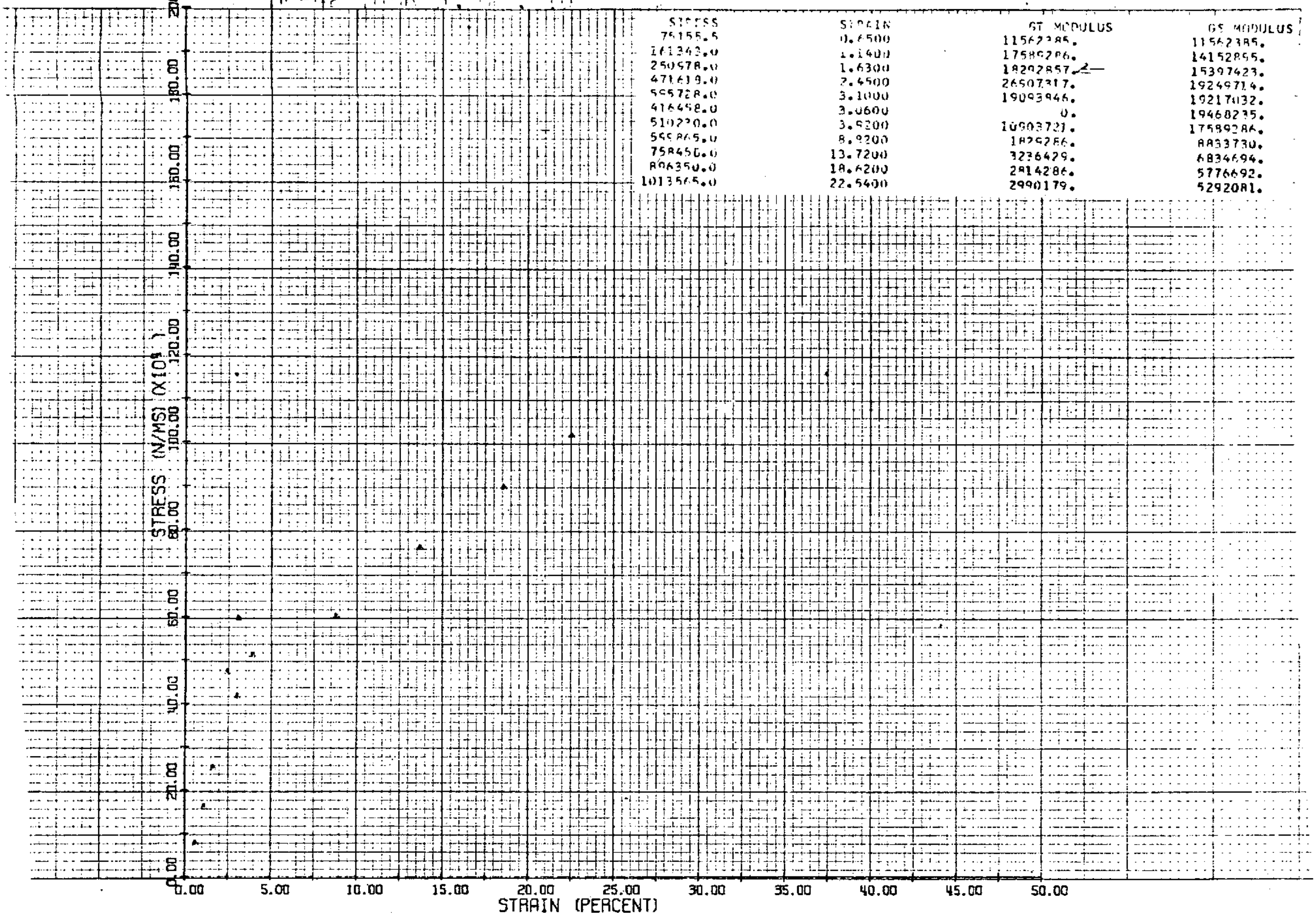


STRESS	STRAIN	GT MODULUS	SS MODULUS
3447.5	0.1500	2298333. ←	2298333.
10342.5	0.4500	2298333.	2298333.
17237.5	0.7500	2298333.	2298333.
24132.5	1.0500	2298333.	2298333.
29648.5	1.3500	1838667.	2196185.
24201.0	1.2600	0.	2353056.
68950.0	3.1500	2261852.	2298333.
137900.0	6.4500	2089394.	2191434.
965300.0	8.4000	42430769.	11532709.
1447950.0	9.9000	32176667.	14660581.
1930600.0	12.1500	21451111.	15918086.
2413250.0	14.4000	21451111.	16782622.
2876950.0	15.5000	27580000.	17801242.
3309600.0	17.4000	32176667.	19040503.
3752250.0	19.9000	32176667.	20083056.
4274900.0	21.1500	21451111.	20228593.

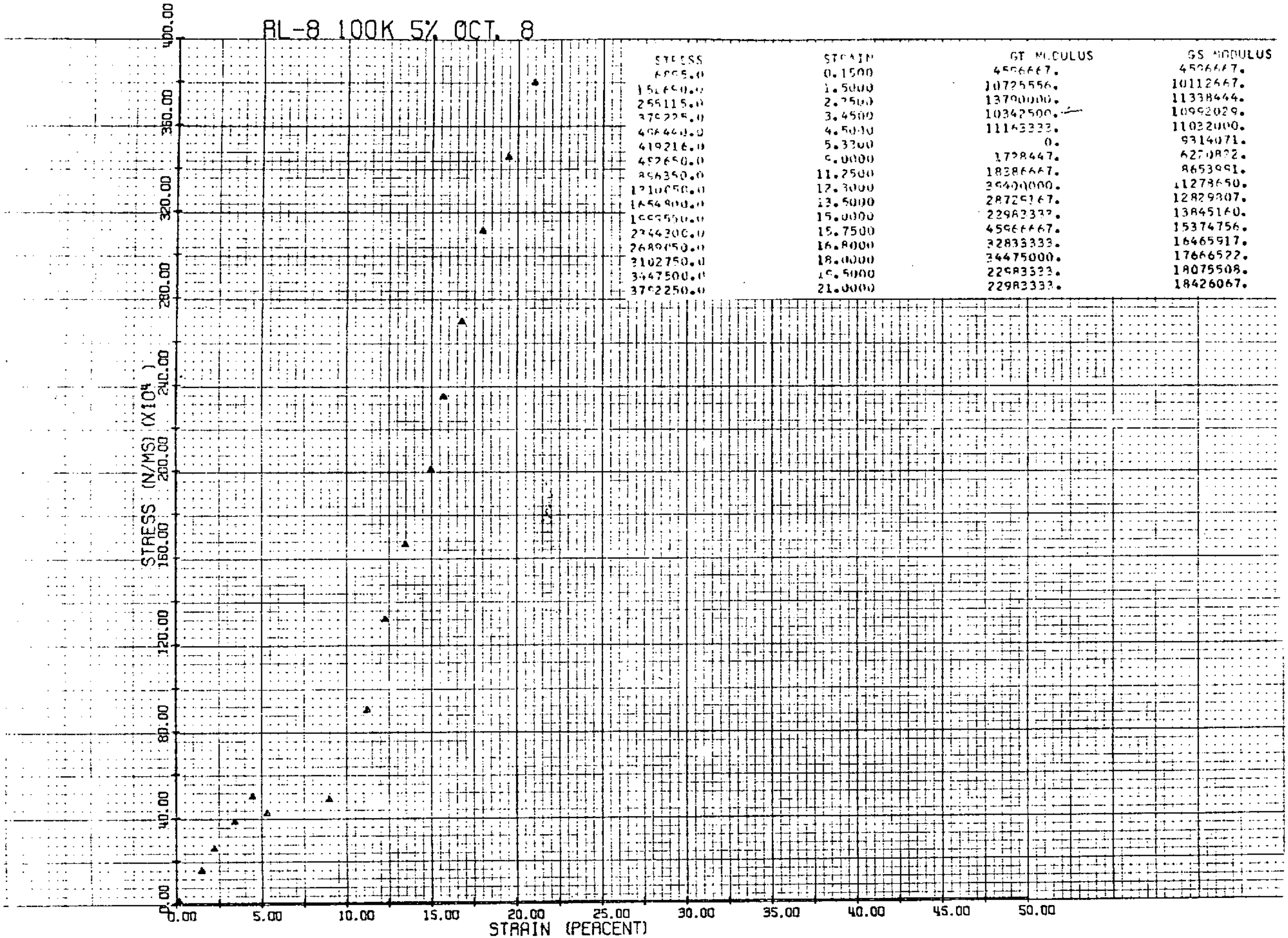
61 A

RI-42 100K 3Y SP. 18

STRESS	STRAIN	GT MODULUS	GS MODULUS
75155.5	0.6500	11562385.	11562385.
161343.0	1.1400	17589286.	14152855.
250978.0	1.6300	18292857.	15397423.
471619.0	2.4500	26507317.	19249714.
595728.0	3.1000	19093946.	19217032.
416458.0	3.0600	0.	19468235.
510220.0	3.9200	10903721.	17589286.
555865.0	8.9200	1829286.	8833730.
758450.0	13.7200	3236429.	6834694.
806350.0	18.6200	2814286.	5776692.
1013565.0	22.5400	2990179.	5292081.



62

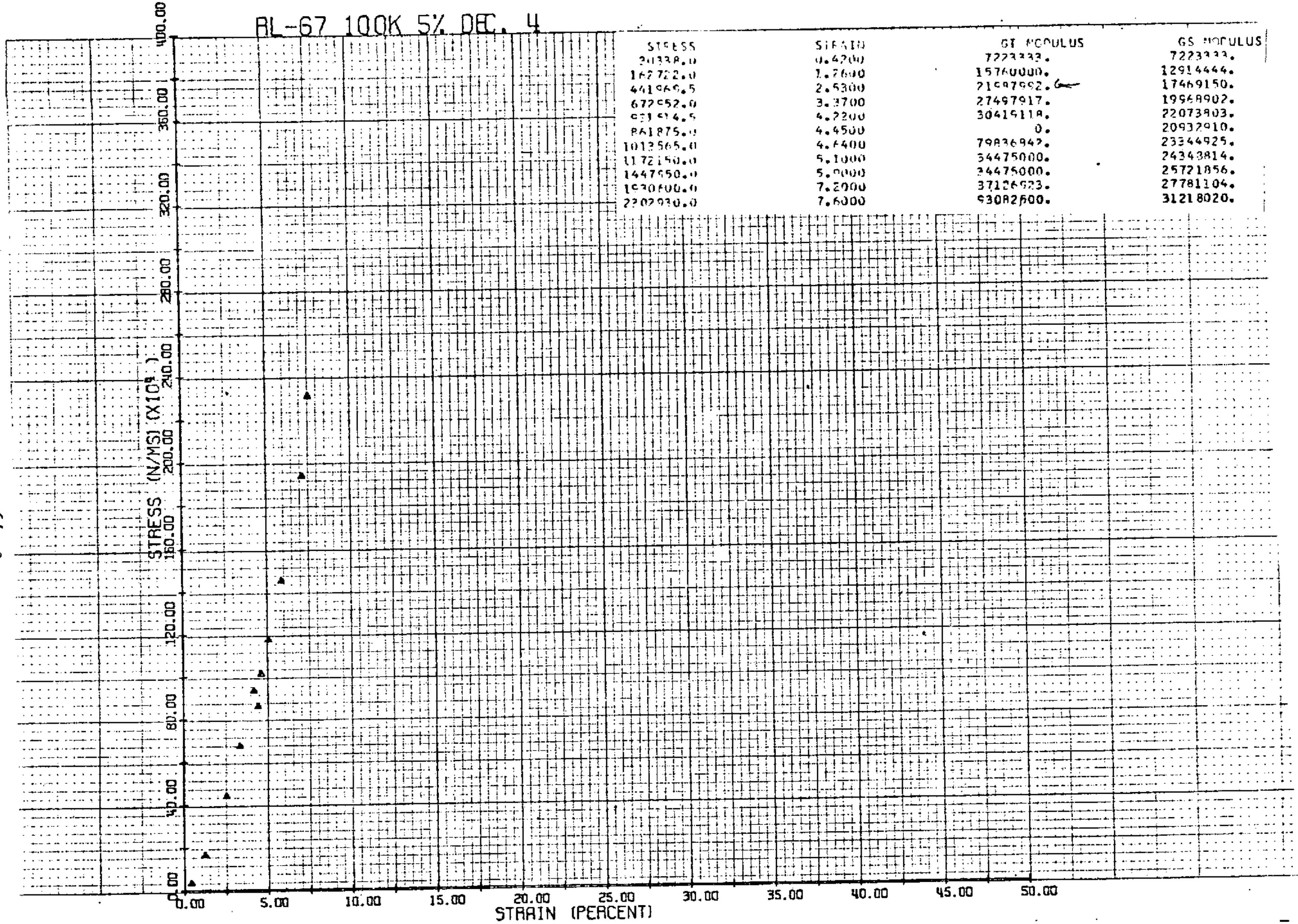


STRESS	STRAIN	GT MODULUS	GS MODULUS
6895.0	0.1500	4596667.	4596667.
151690.0	1.5000	10725556.	10112667.
255115.0	2.2500	13790000.	11338444.
379225.0	3.4500	10342500.	10992029.
496440.0	4.5000	11163333.	11032000.
419216.0	5.3300	0.	9314071.
452650.0	9.0000	1728447.	6270822.
896350.0	11.2500	18386667.	8653991.
1210950.0	12.3000	39400000.	11278650.
1654900.0	13.5000	28729167.	12829307.
1995550.0	15.0000	22983332.	13845160.
2344300.0	15.7500	45966667.	15374756.
2689050.0	16.8000	32833333.	16465917.
3102750.0	18.0000	34475000.	17666522.
3447500.0	19.5000	22983333.	18075508.
3792250.0	21.0000	22983333.	18426067.

63

RL-67 100K 5% DEC. 4

STRESS	STRAIN	GT MODULUS	GS MODULUS
30338.0	0.4200	7223333.	7223333.
162722.0	1.7600	15760000.	12914444.
441969.5	2.5300	21597992. ←	17469150.
672952.0	3.3700	27497917.	19968902.
931514.5	4.2200	30419118.	22073903.
861875.0	4.4500	0.	20932910.
1013565.0	4.6400	79836942.	23344925.
1172150.0	5.1000	54475000.	24343814.
1447950.0	5.9000	34475000.	25721856.
1930600.0	7.2000	37126923.	27781104.
2202930.0	7.6000	93082600.	31218020.



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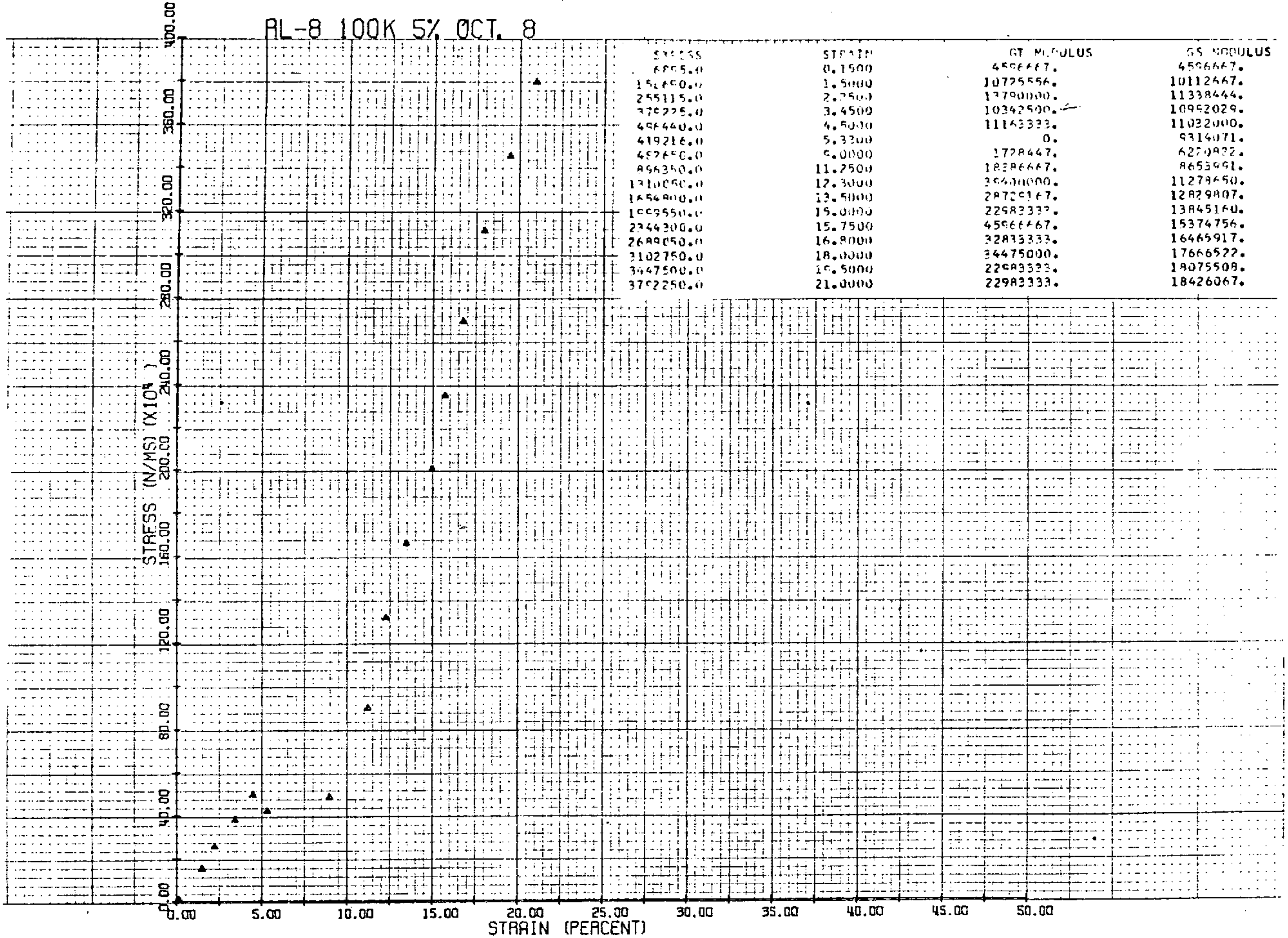
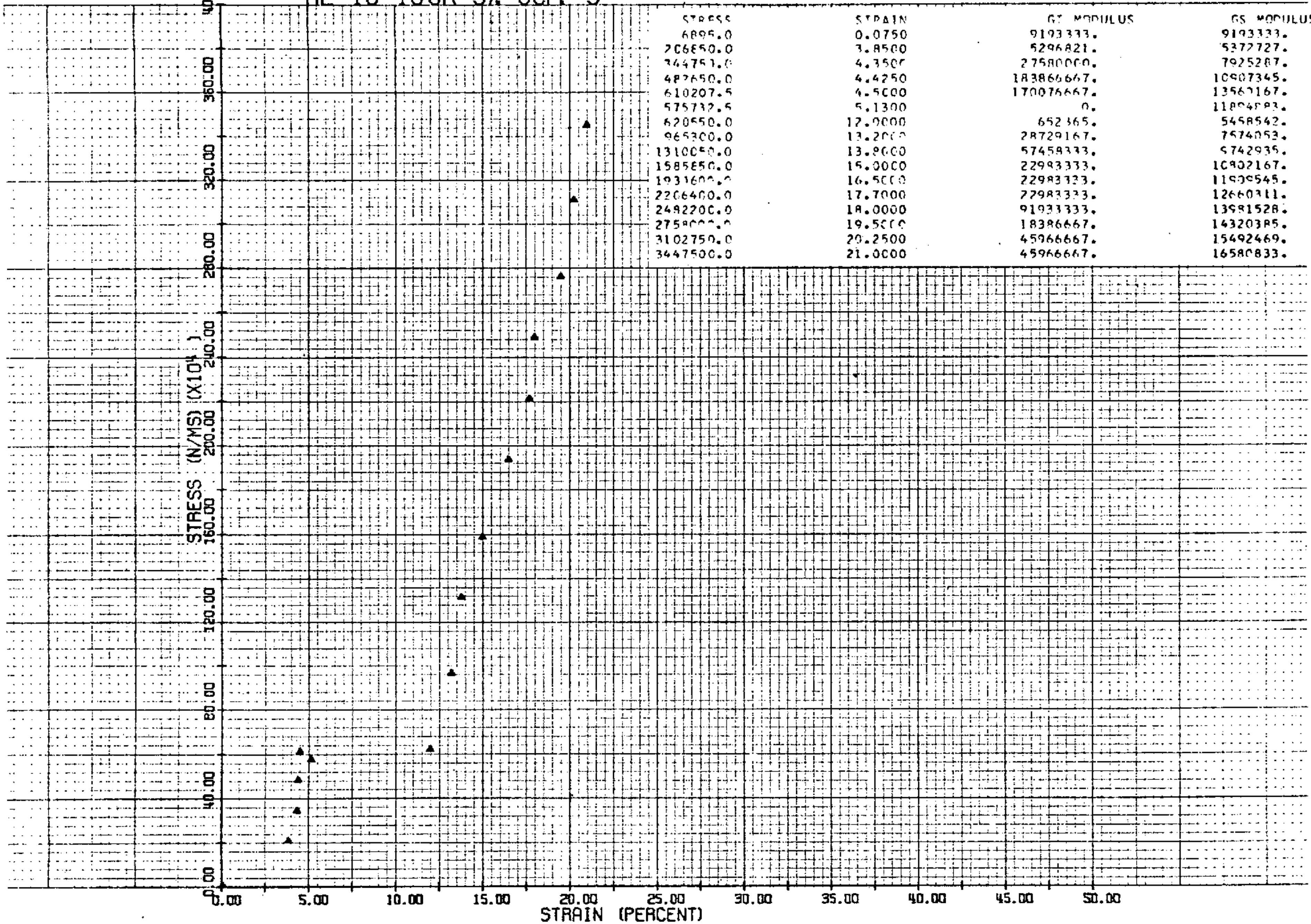
AL-8 100K 5% OCT. 8



STRESS	STRAIN	GT MODULUS	GS MODULUS
6895.0	0.1500	4596667.	4596667.
151690.0	1.5000	10725556.	10112667.
255115.0	2.2500	13790000.	11338444.
379225.0	3.4500	10342500.	10992029.
496440.0	4.5000	11163333.	11032000.
419216.0	5.3300	0.	9314071.
452650.0	9.0000	1728447.	6270822.
896350.0	11.2500	18386667.	8653991.
1310050.0	12.3000	35400000.	11278650.
1654800.0	13.5000	28729167.	12829807.
1999550.0	15.0000	22983333.	13845160.
2344300.0	15.7500	45966667.	15374756.
2689050.0	16.8000	32833333.	16465917.
3102750.0	18.0000	34475000.	17666522.
3447500.0	19.5000	22983333.	18075508.
3792250.0	21.0000	22983333.	18426067.

65 A

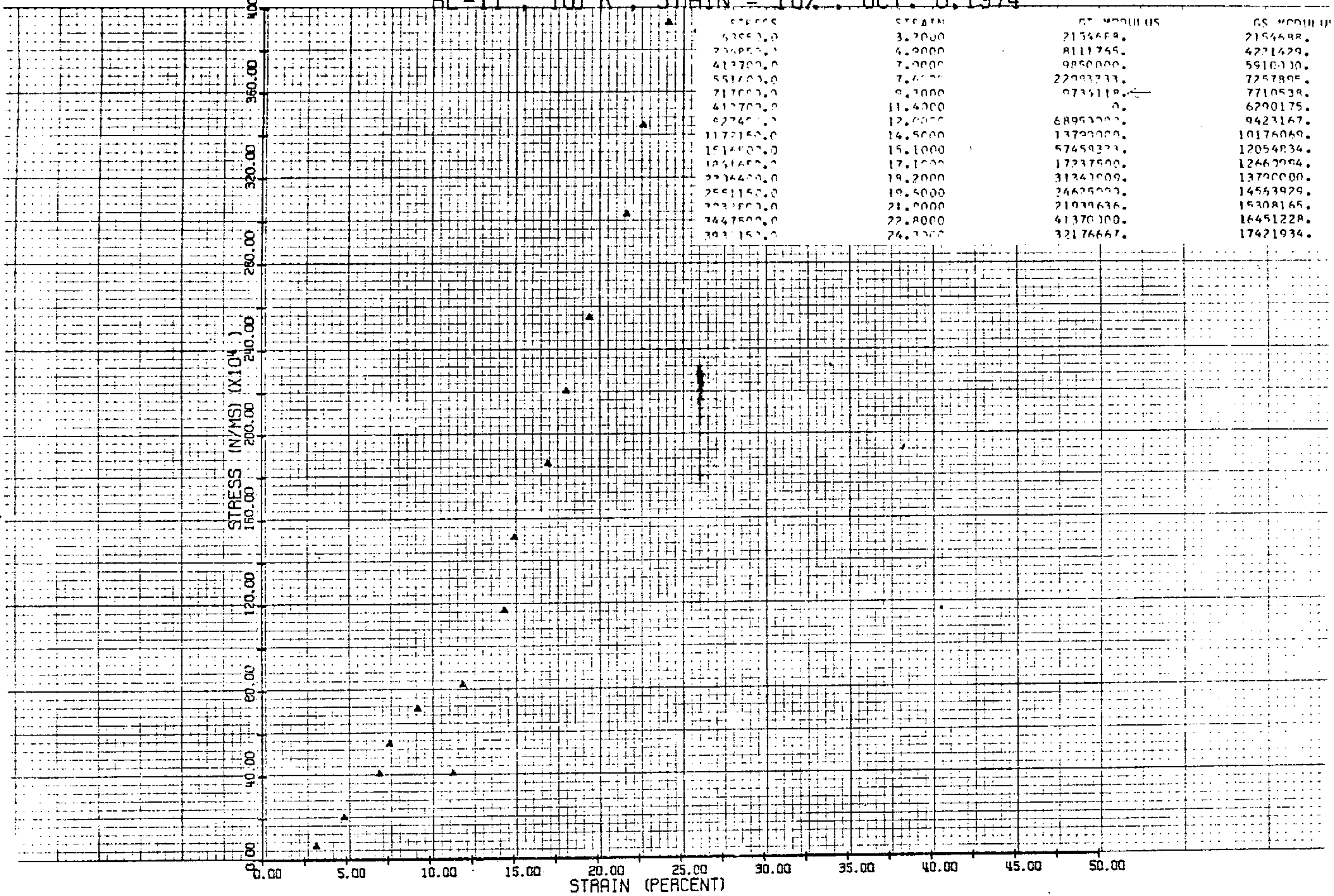
RL-16 100K 5% OCT. 9



STRESS	STRAIN	GT MODULUS	GS MODULUS
6895.0	0.0750	9193333.	9193333.
206850.0	3.8500	5296821.	5372727.
344751.0	4.3500	27580000.	7925287.
482650.0	4.4250	183866667.	10907345.
610207.5	4.5000	170076667.	13560167.
575732.5	5.1300	0.	11804883.
620550.0	12.0000	652365.	5458542.
965300.0	13.2000	28729167.	7574053.
1310050.0	13.8000	57458333.	5742935.
1585850.0	15.0000	22983333.	10902167.
1931600.0	16.5000	22983323.	11909545.
2206400.0	17.7000	22983323.	12660311.
2482200.0	18.0000	91933333.	13981528.
2758000.0	19.5000	18386667.	14320385.
3102750.0	20.2500	45966667.	15492469.
3447500.0	21.0000	45966667.	16580833.

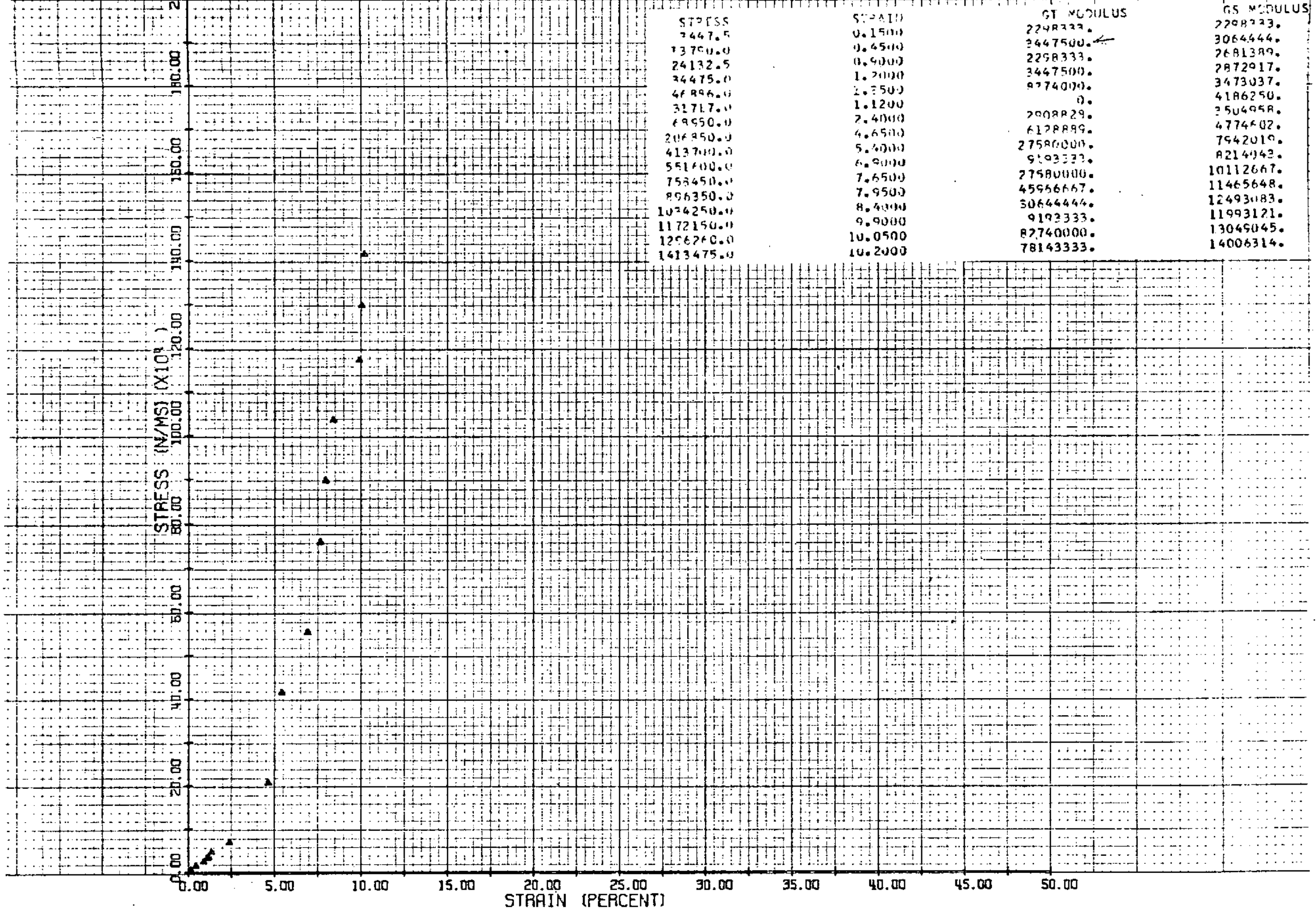
99

BL-11, 100 K, STRAIN = 10%, OCT. 8,1974



STRESS	STRAIN	GT MODULUS	GS MODULUS
63553.0	3.2000	2154688.	2154688.
206850.0	4.9000	8111765.	4221429.
413700.0	7.0000	9850000.	5910000.
551600.0	7.6000	22983333.	7257895.
717080.0	9.3000	9733118.	7710538.
413700.0	11.4000	0.	6290175.
827400.0	12.0000	68953000.	9423167.
1172150.0	14.5000	13790000.	10176069.
1516900.0	15.1000	57459333.	12054834.
1861650.0	17.1000	17237500.	12662994.
2206400.0	19.2000	31341909.	13790000.
2551150.0	19.5000	24625000.	14563929.
3033500.0	21.0000	21939636.	15308165.
3447500.0	22.8000	41370000.	16451228.
3930150.0	24.3000	32176667.	17421934.

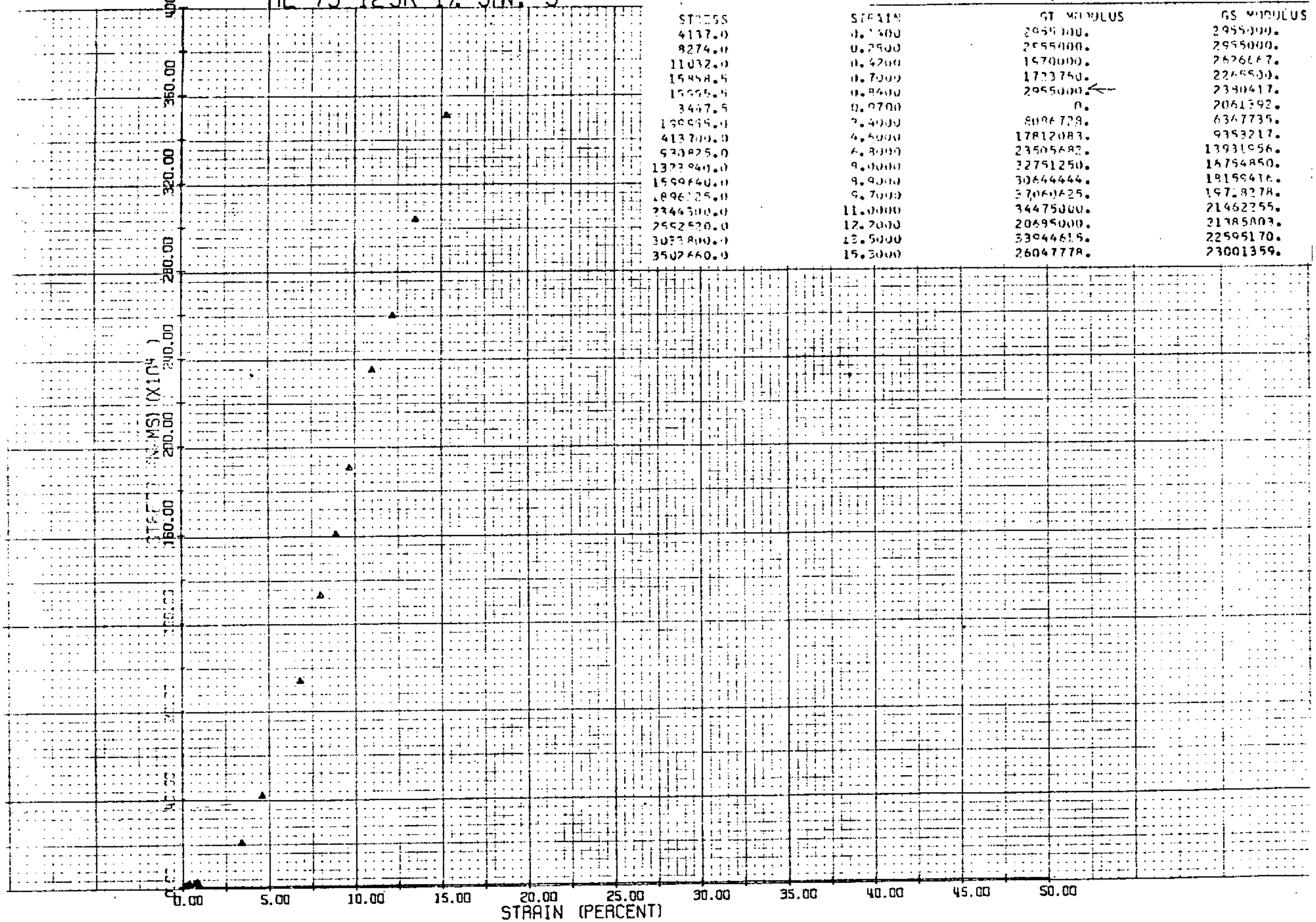
AL-26 125K 1% OCT. 23



STRESS	STRAIN	GT MODULUS	GS MODULUS
3447.5	0.1500	2298333.	2298333.
13790.0	0.4500	3447500. ←	3064444.
24132.5	0.9000	2298333.	2681389.
34475.0	1.2000	3447500.	2872917.
46896.0	1.3500	9274000.	3473037.
31717.0	1.1200	0.	4186250.
69950.0	2.4000	2908829.	3504958.
206850.0	4.6500	6128889.	4774602.
413700.0	5.4000	27580000.	7942019.
551600.0	6.9000	9193333.	8214043.
758450.0	7.6500	27580000.	10112667.
896350.0	7.9500	45966667.	11465648.
1034250.0	8.4000	30644444.	12493083.
1172150.0	9.9000	9193333.	11993121.
1296260.0	10.0500	82740000.	13049045.
1413475.0	10.2000	78143333.	14006314.

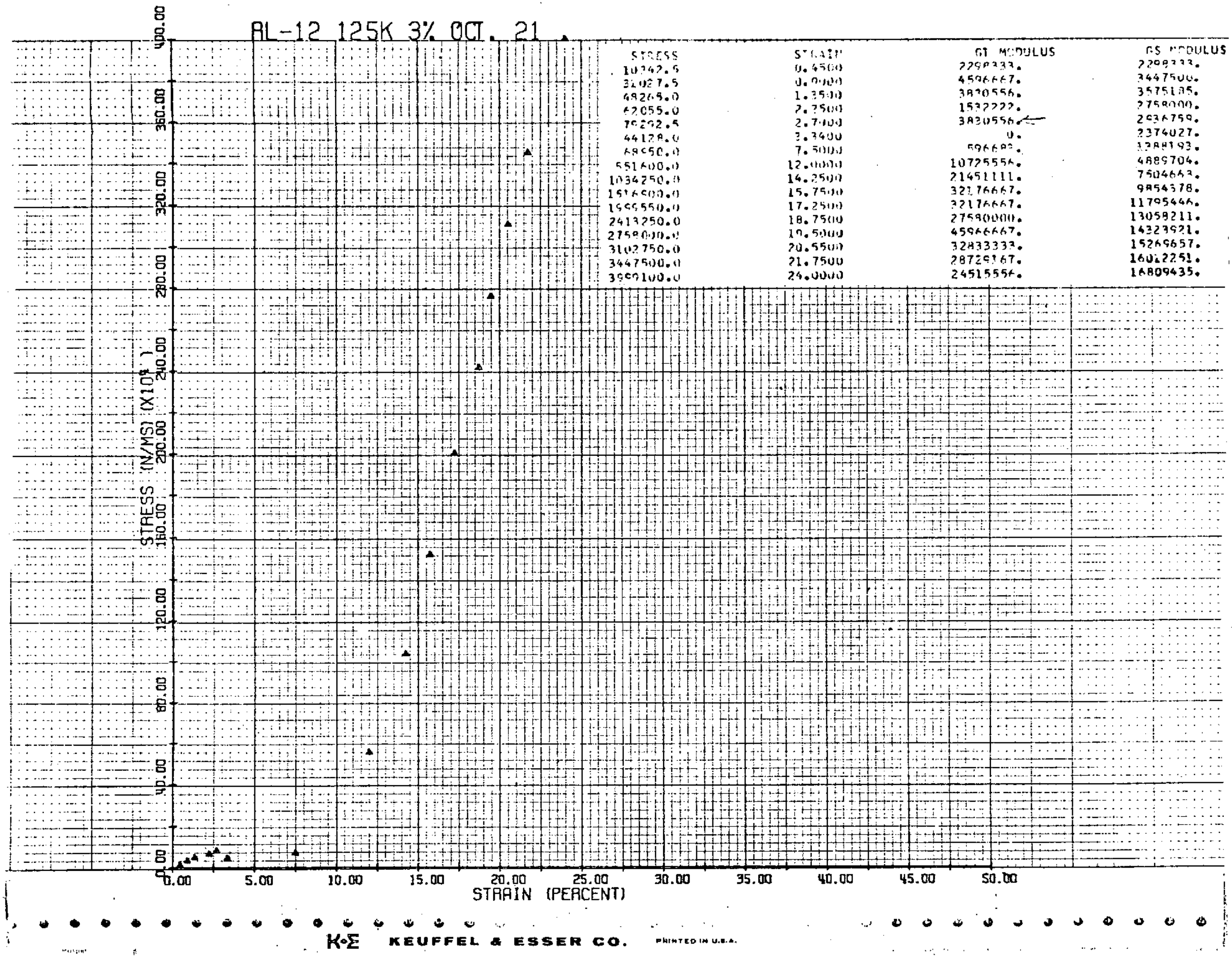
89

RL-79 125K 1% JAN. 5

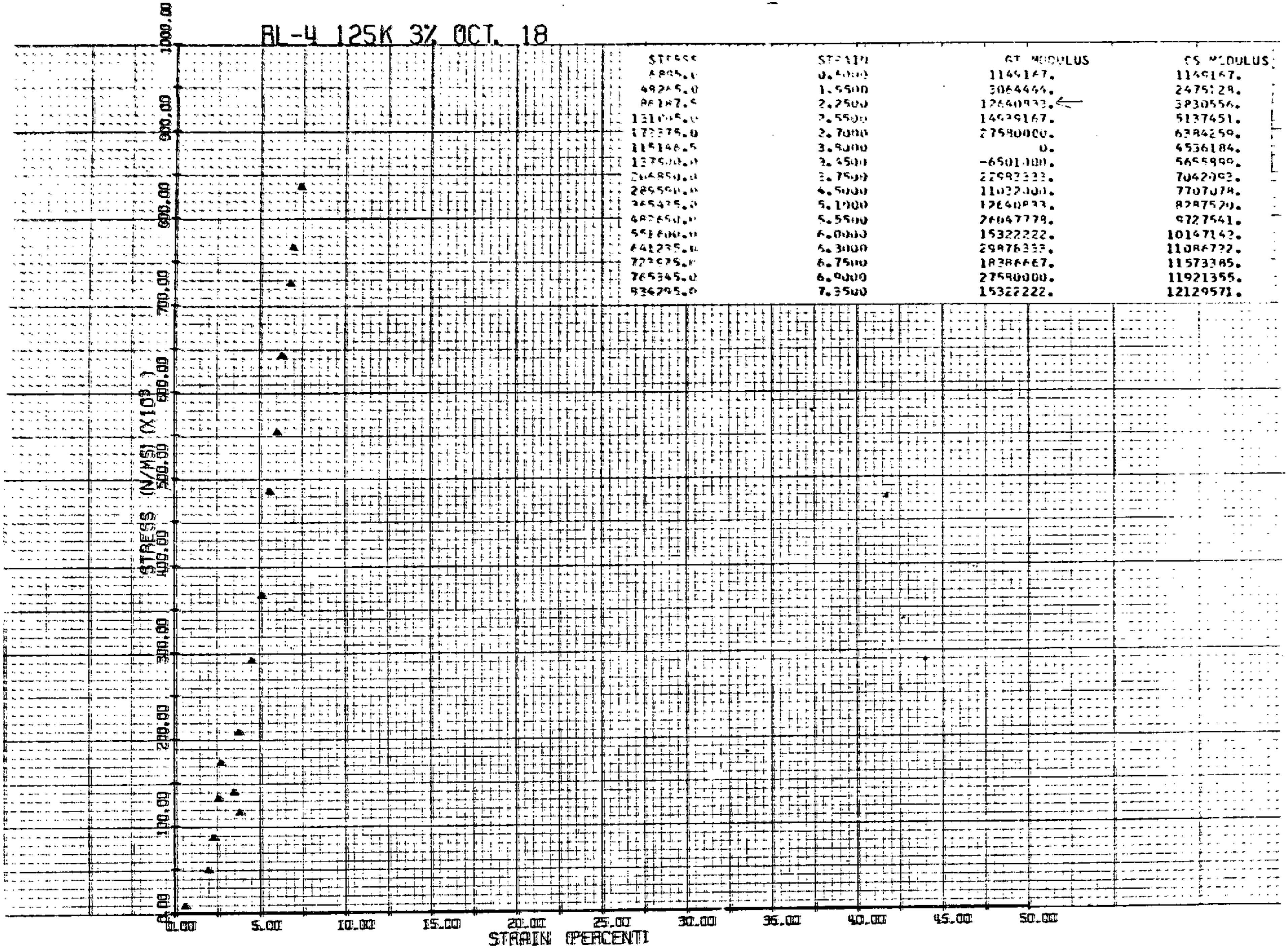


STRESS	STRAIN	GT MODULUS	GS MODULUS
4137.0	0.1400	2955000.	2955000.
8274.0	0.2900	2555000.	2955000.
11032.0	0.4200	1570000.	2626667.
15858.5	0.7000	1723750.	2265500.
15555.5	0.8400	2955000. ←	2390417.
3447.5	0.9700	0.	2061392.
199995.0	2.4000	8096728.	6367735.
413700.0	4.6000	17812083.	9353217.
930825.0	6.8000	23505682.	13931956.
1323940.0	9.0000	32751250.	16754850.
1599640.0	9.9000	30644444.	18159416.
1896125.0	9.7000	37060625.	19718278.
2344300.0	11.0000	34475000.	21462255.
2552520.0	12.7000	20695000.	21385803.
3033800.0	13.5000	33944615.	22595170.
3502660.0	15.3000	26047778.	23001359.

#69

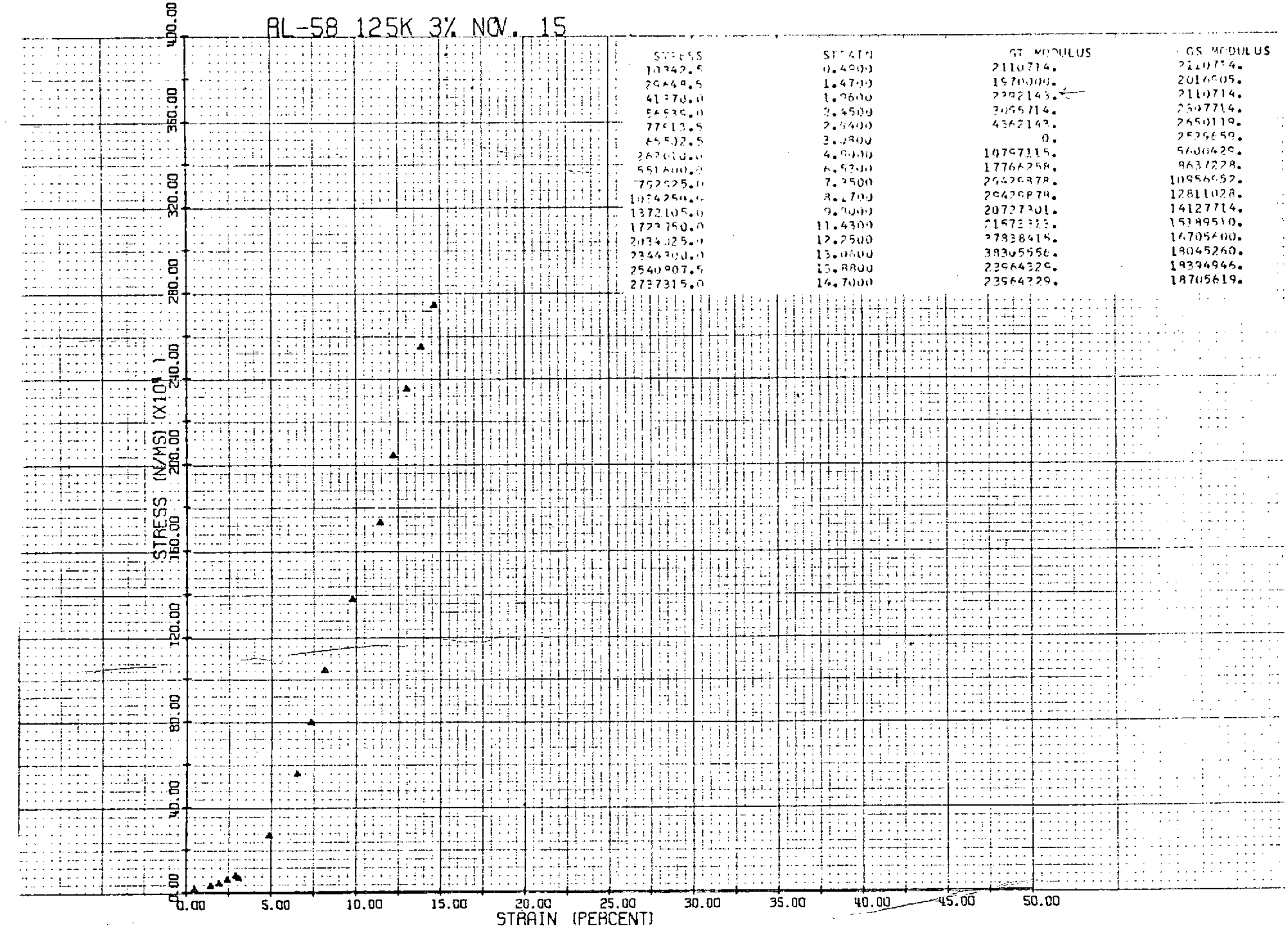


STRESS	STRAIN	GT MODULUS	GS MODULUS
10342.5	0.4500	2298333.	2298333.
31027.5	0.9000	4596667.	3447500.
48265.0	1.3500	3830556.	3575185.
62055.0	2.2500	1532222.	2758000.
79292.5	2.7000	3830556. ←	2936759.
44128.0	3.3400	0.	2374027.
68950.0	7.5000	596689.	3288193.
551600.0	12.0000	10725556.	4889704.
1034250.0	14.2500	21451111.	7504663.
1516500.0	15.7500	32176667.	9854378.
1999550.0	17.2500	32176667.	11795446.
2413250.0	18.7500	27580000.	13058211.
2758000.0	19.5000	45966667.	14323921.
3102750.0	20.5500	32833333.	15269657.
3447500.0	21.7500	28729167.	16012251.
3999100.0	24.0000	24515556.	16809435.



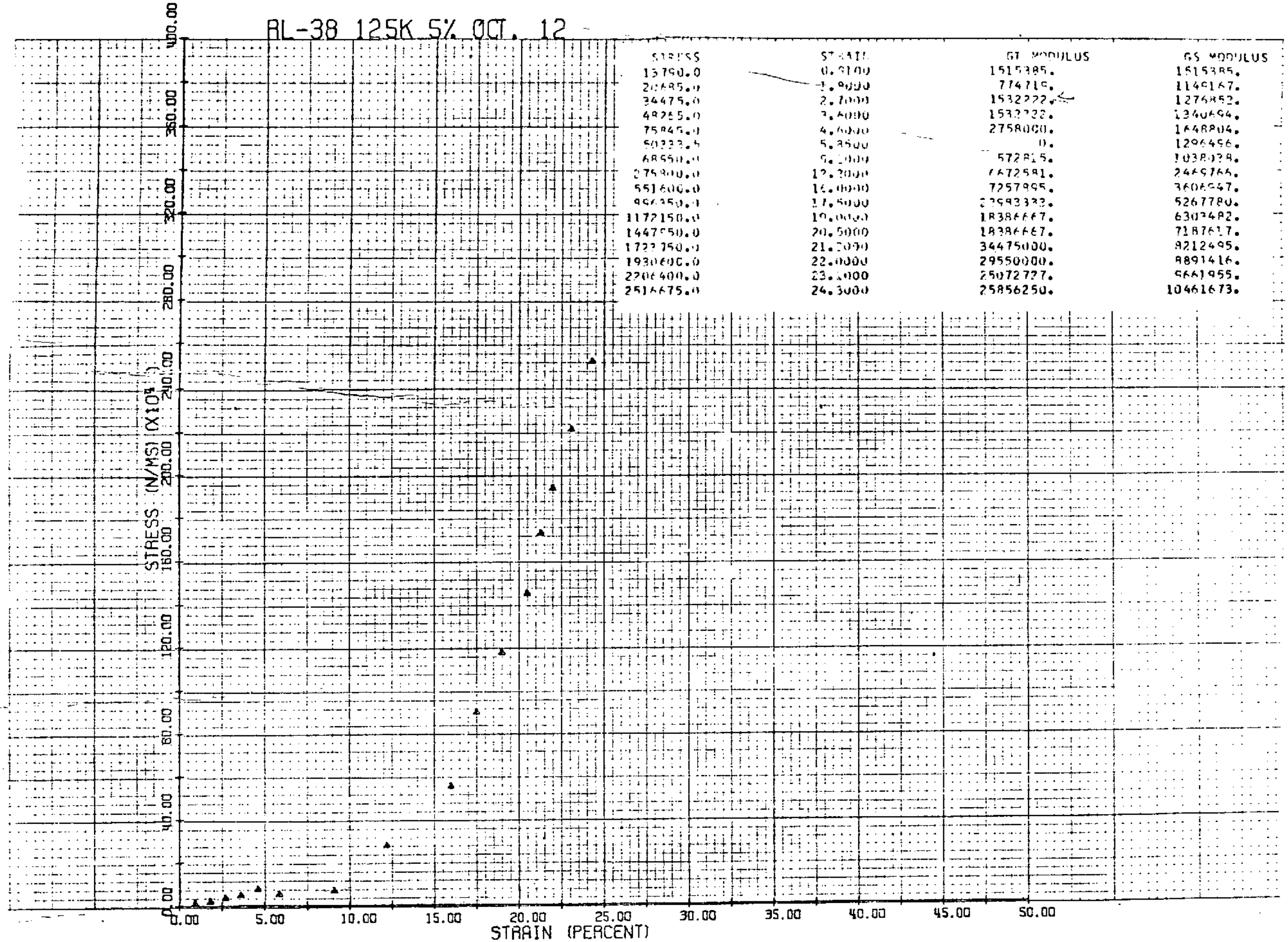
STRESS	STRAIN	GT MODULUS	CS MODULUS
6895.0	0.6000	1149167.	1149167.
49265.0	1.5500	3064444.	2475129.
86187.5	2.2500	12640833. ←	3830556.
131005.0	2.5500	14939167.	5137451.
172375.0	2.7000	27580000.	6384259.
115146.5	3.9000	0.	4536184.
137500.0	3.4500	-6501000.	5655999.
264850.0	3.7500	22983333.	7042093.
285590.0	4.5000	11032000.	7707078.
365425.0	5.1000	12640833.	8287520.
482650.0	5.5500	26047778.	9727541.
551600.0	6.0000	15322222.	10147142.
641235.0	6.3000	29876333.	11086722.
723975.0	6.7500	18386667.	11573385.
765345.0	6.9000	27580000.	11921355.
834295.0	7.3500	15322222.	12129571.

AL-58 125K 3% NOV. 15



STRESS	STRAIN	GT MODULUS	GS MODULUS
10342.5	0.4900	2110714.	2110714.
29649.5	1.4700	1970000.	2016505.
41370.0	1.9600	2292143.	2110714.
54635.0	2.4500	2095714.	2507714.
77513.5	2.9400	4362143.	2650119.
65502.5	3.4300	0.	2525659.
262080.0	4.9000	10797115.	5600429.
551600.0	6.5300	17766258.	8637228.
752525.0	7.3500	29429878.	10956652.
1074250.0	8.1700	29429878.	12811028.
1372105.0	9.0000	20727301.	14127714.
1723750.0	11.4300	21573333.	15189510.
2034025.0	12.2500	27838415.	16705600.
2344300.0	13.0600	38305556.	18045260.
2540907.5	13.8800	23964329.	19394946.
2737315.0	14.7000	23964329.	18705619.

72



STRESS	STRAIN	GT MODULUS	GS MODULUS
13790.0	0.9100	1515385.	1515385.
20685.0	1.9000	774715.	1149167.
34475.0	2.7000	1532222.	1276852.
48255.0	3.6000	1532222.	1340694.
75845.0	4.6000	2758000.	1648804.
50333.5	5.8500	0.	1296496.
68550.0	9.1000	572815.	1038028.
275800.0	12.2000	6672581.	2469766.
551600.0	16.0000	7257895.	3606947.
956350.0	17.5000	27593333.	5267780.
1172150.0	19.0000	18386667.	6303482.
1447950.0	20.5000	18386667.	7187617.
1723750.0	21.3000	34475000.	8212495.
1930600.0	22.0000	29550000.	8891416.
2206400.0	23.1000	25072727.	9661955.
2516675.0	24.3000	25856250.	10461673.

73A

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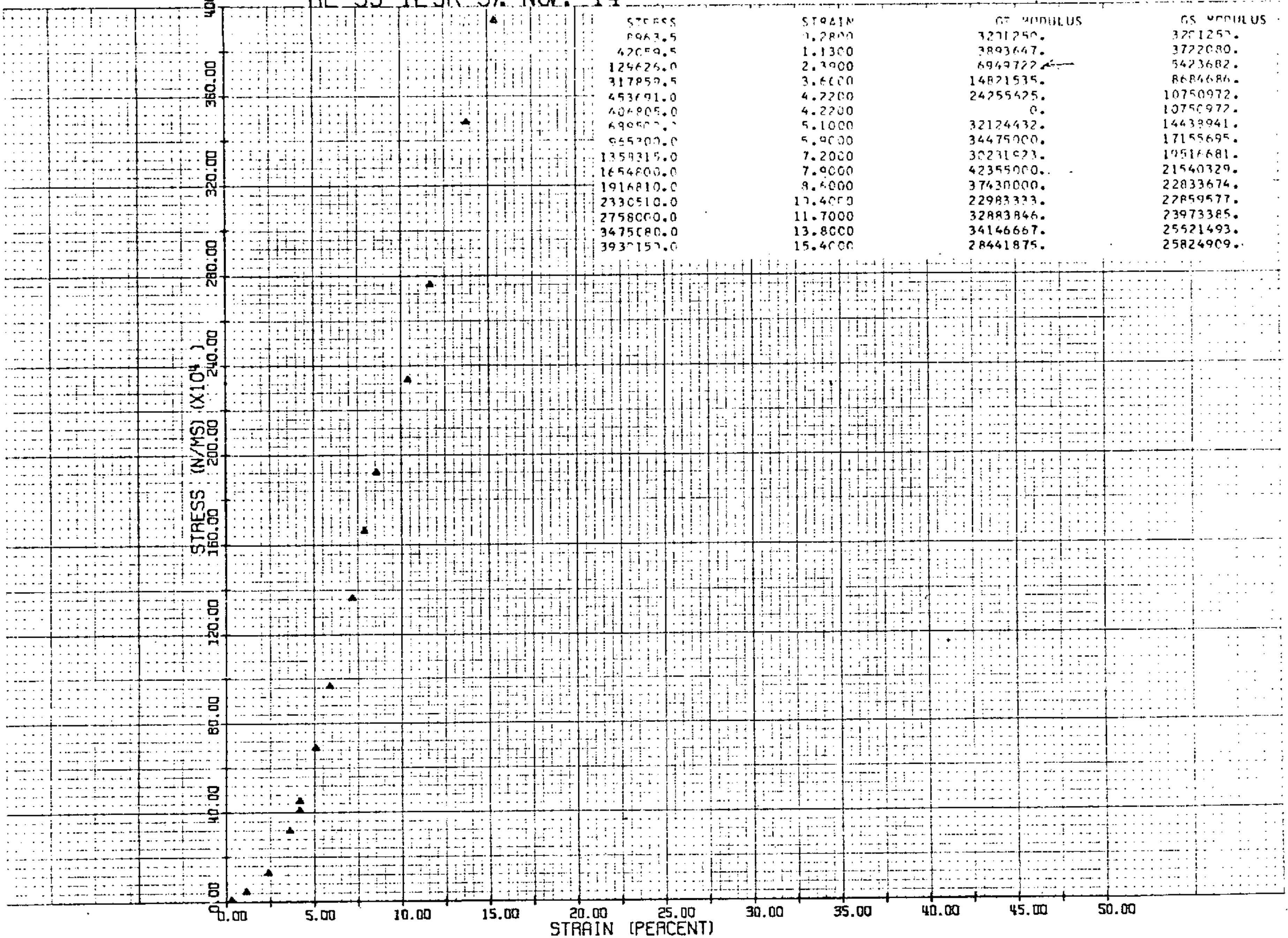
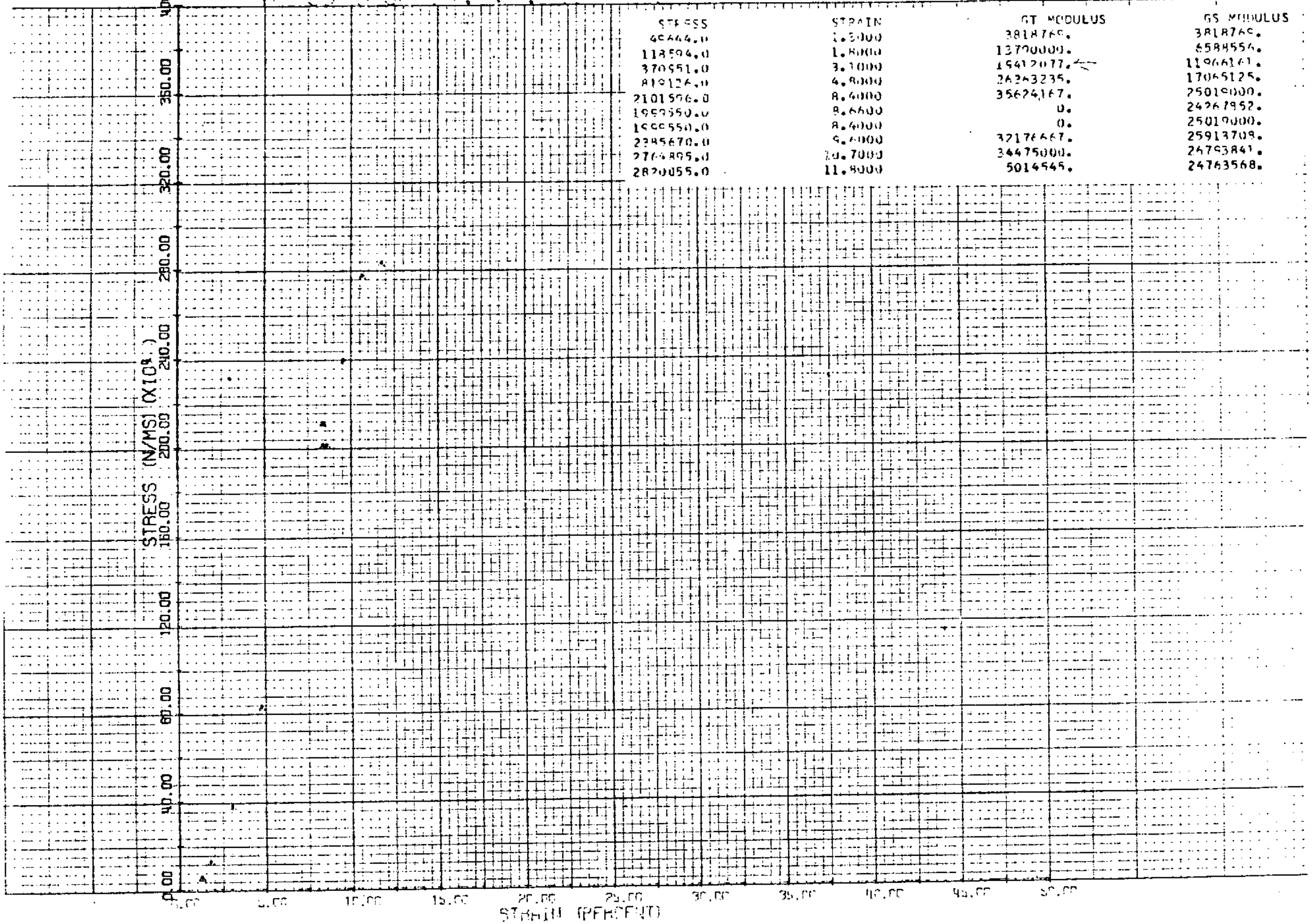
BL-59 125K 5% NOV. 14



STRESS	STRAIN	GT MODULUS	GS MODULUS
8963.5	0.2800	3201250.	3201250.
42059.5	1.1300	3893647.	3722080.
129626.0	2.3900	6949722. ←	5423682.
317859.5	3.6000	14821535.	8684686.
453691.0	4.2200	24255625.	10750972.
406805.0	4.2200	0.	10750972.
698500.0	5.1000	32124432.	14438941.
955200.0	5.9000	34475000.	17155695.
1358315.0	7.2000	30231923.	19516681.
1654800.0	7.9000	42355000.	21540329.
1916810.0	8.6000	37430000.	22833674.
2330510.0	10.4000	22983333.	22859577.
2758000.0	11.7000	32883846.	23973385.
3475080.0	13.8000	34146667.	25521493.
3930150.0	15.4000	28441875.	25824909.

STRESS	STRAIN	GT MODULUS	GS MODULUS
45644.0	1.2000	3818769.	3818769.
118594.0	1.8000	13790000.	6588556.
370951.0	3.1000	19412077.	11966161.
819126.0	4.8000	26363235.	17065125.
2101596.0	8.4000	35624167.	25019000.
1959550.0	8.6600	0.	24267952.
1999550.0	8.4000	0.	25019000.
2385670.0	9.6000	32176667.	25913709.
2764895.0	10.7000	34475000.	26793841.
2820055.0	11.8000	5014545.	24763568.



75 A

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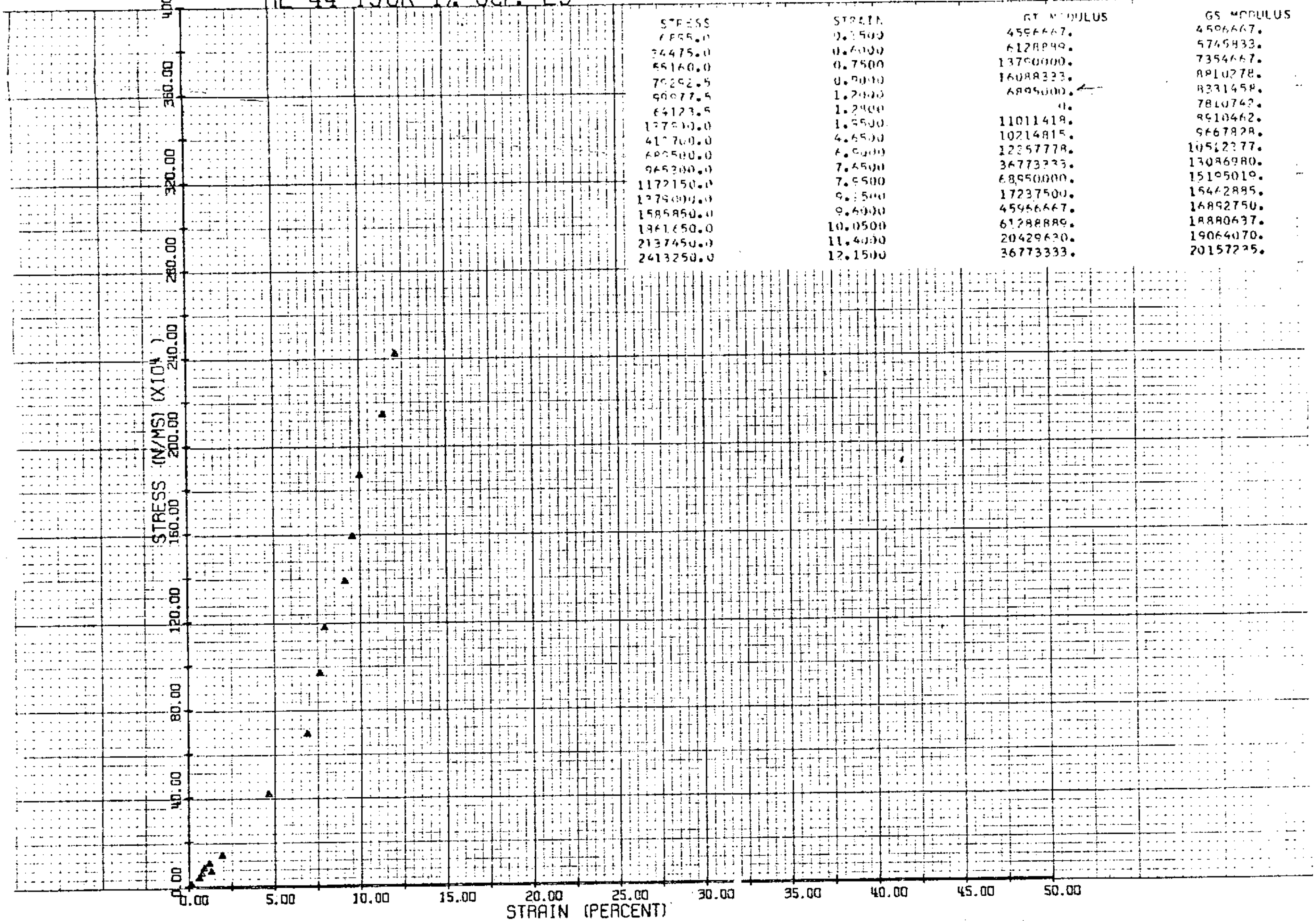
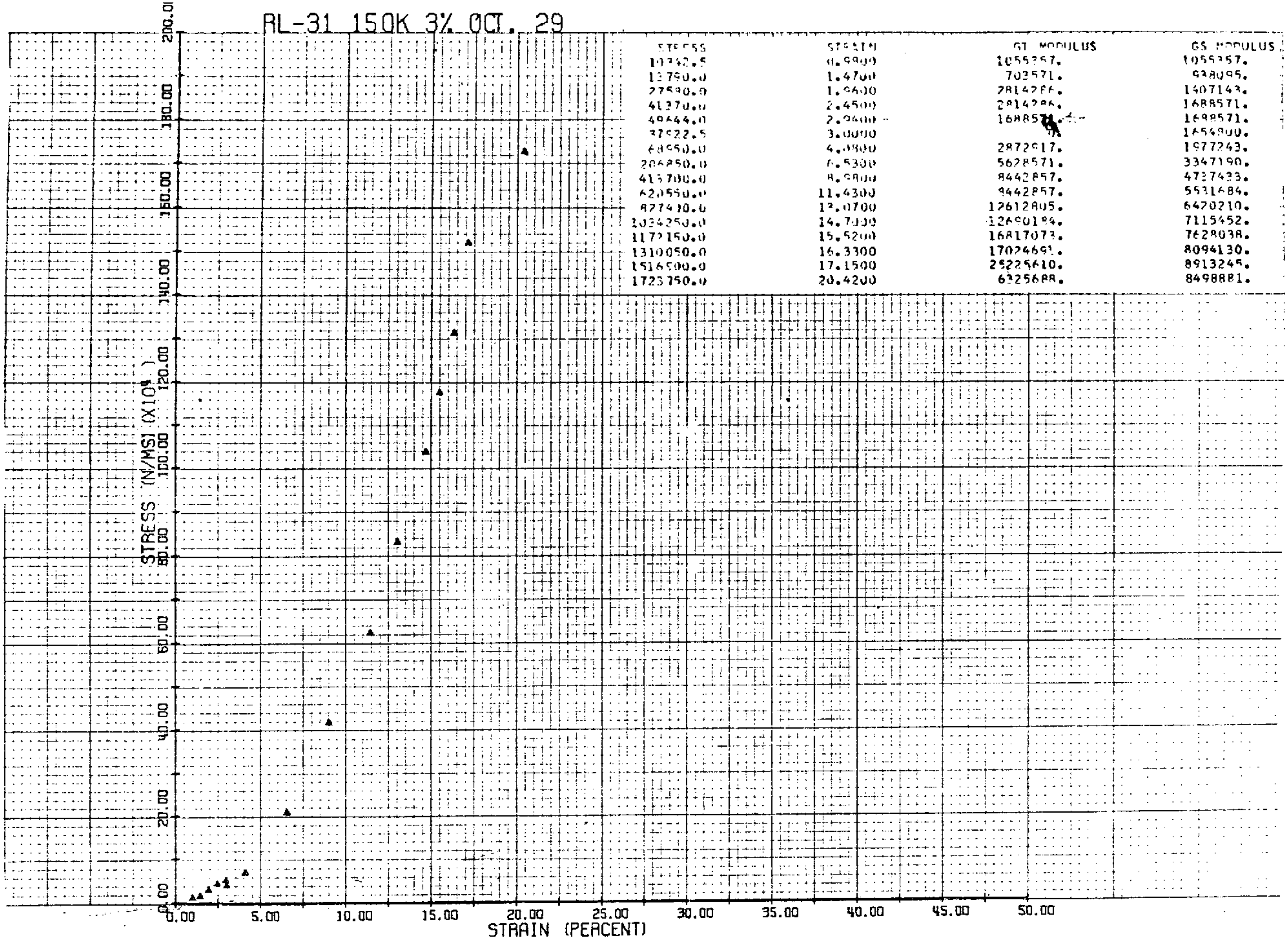
KE KEUFFEL &

AL-44 150K 1% OCT. 29



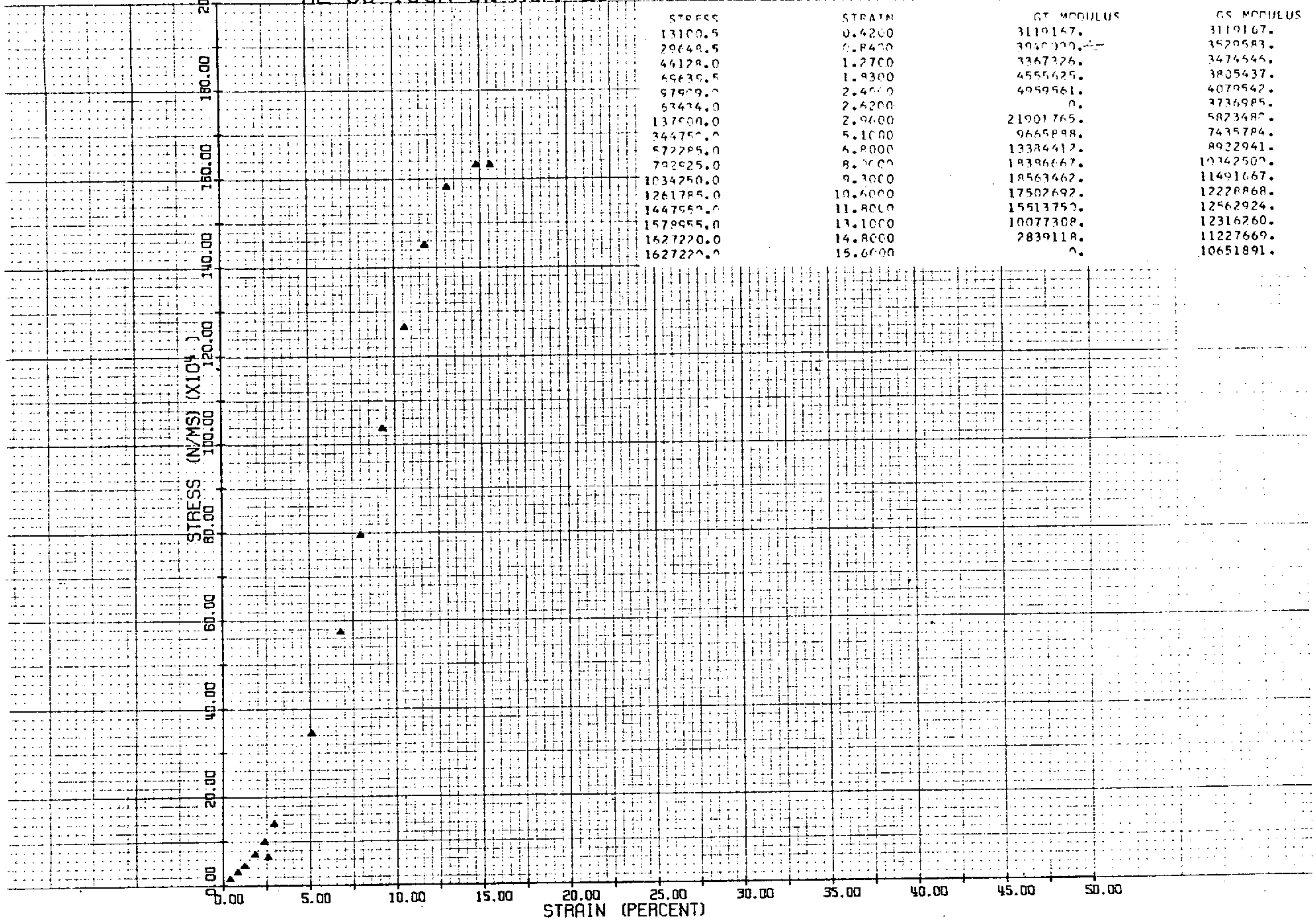
STRESS	STRAIN	GT MODULUS	GS MODULUS
6895.0	0.1500	4596667.	4596667.
34475.0	0.6000	6128889.	5745833.
55160.0	0.7500	13790000.	7354667.
79292.5	0.9000	16088333.	8810278.
99977.5	1.2000	6895000. ←	8331458.
64123.5	1.2900	0.	7810742.
137900.0	1.5500	11011419.	8910462.
417200.0	4.6500	10214815.	9667828.
689500.0	6.5000	12257778.	10512377.
965300.0	7.6500	36773333.	13086980.
1172150.0	7.9500	68950000.	15195019.
1379000.0	9.1500	17237500.	15442885.
1585850.0	9.6000	45966667.	16892750.
1861650.0	10.0500	61288889.	18880637.
2137450.0	11.4000	20429630.	19064070.
2413250.0	12.1500	36773333.	20157225.

RL-31 150K 3% OCT. 29

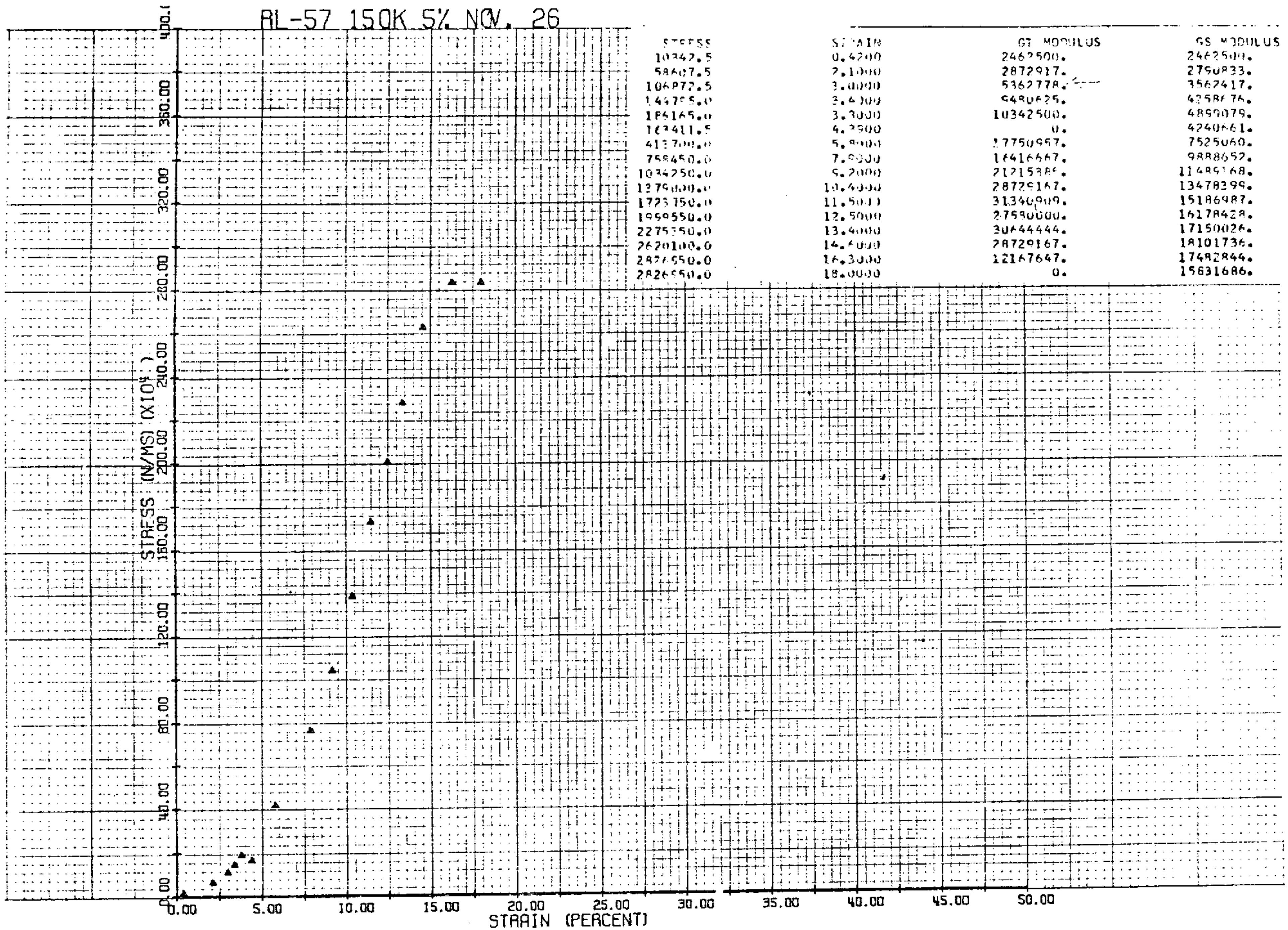


STRESS	STRAIN	GT MODULUS	GS MODULUS
10342.5	0.9800	1055357.	1055357.
13790.0	1.4700	703571.	938095.
27580.0	1.9600	2814286.	1407143.
41370.0	2.4500	2814286.	1688571.
49644.0	2.9400	1688571.	1688571.
37922.5	3.0000		1654900.
68950.0	4.0800	2872917.	1977243.
206850.0	6.5300	5628571.	3347190.
413700.0	8.9800	8442857.	4737433.
620550.0	11.4300	9442857.	5531684.
827400.0	13.0700	12612805.	6470210.
1034250.0	14.7000	12690184.	7115452.
1172150.0	15.5200	16817073.	7628038.
1310050.0	16.3300	17024691.	8094130.
1516500.0	17.1500	25225610.	8913245.
1723750.0	20.4200	6325688.	8498881.

BL-60 150K 3% NOV. 26



STRESS	STRAIN	GT MODULUS	GS MODULUS
13100.5	0.4200	3119167.	3119167.
29649.5	0.8400	3940000.	3529583.
44128.0	1.2700	3367326.	3474546.
69639.5	1.9300	4555625.	3805437.
97909.0	2.4600	4959561.	4079542.
63434.0	2.6200	0.	3736985.
137900.0	2.9600	21901765.	5823480.
344750.0	5.1000	9665888.	7435784.
572285.0	6.8000	13384412.	8922941.
792925.0	8.3000	18396667.	10342500.
1034250.0	9.3000	18563462.	11491667.
1261785.0	10.6000	17502692.	12228868.
1447959.0	11.8000	15513752.	12562924.
1579955.0	13.1000	10077308.	12316260.
1627220.0	14.8000	2839118.	11227669.
1627220.0	15.6000	0.	10651891.



STRESS	STRAIN	GT MODULUS	GS MODULUS
10342.5	0.4200	2462500.	2462500.
58607.5	2.1000	2872917.	2790833.
106872.5	3.0000	5362778.	3562417.
144795.0	3.4000	9480625.	4258676.
186165.0	3.3000	10342500.	4899079.
183411.5	4.3900	0.	4240661.
413700.0	5.9000	17750957.	7525060.
758450.0	7.9300	16416667.	9888652.
1034250.0	9.2000	21215385.	11489168.
1379000.0	10.4000	28729167.	13478399.
1723750.0	11.5000	31340909.	15186987.
1999550.0	12.5000	27590000.	16178428.
2275350.0	13.4000	30644444.	17150026.
2620100.0	14.6000	28729167.	18101736.
2826550.0	16.3000	12167647.	17482844.
2826550.0	18.0000	0.	15631686.

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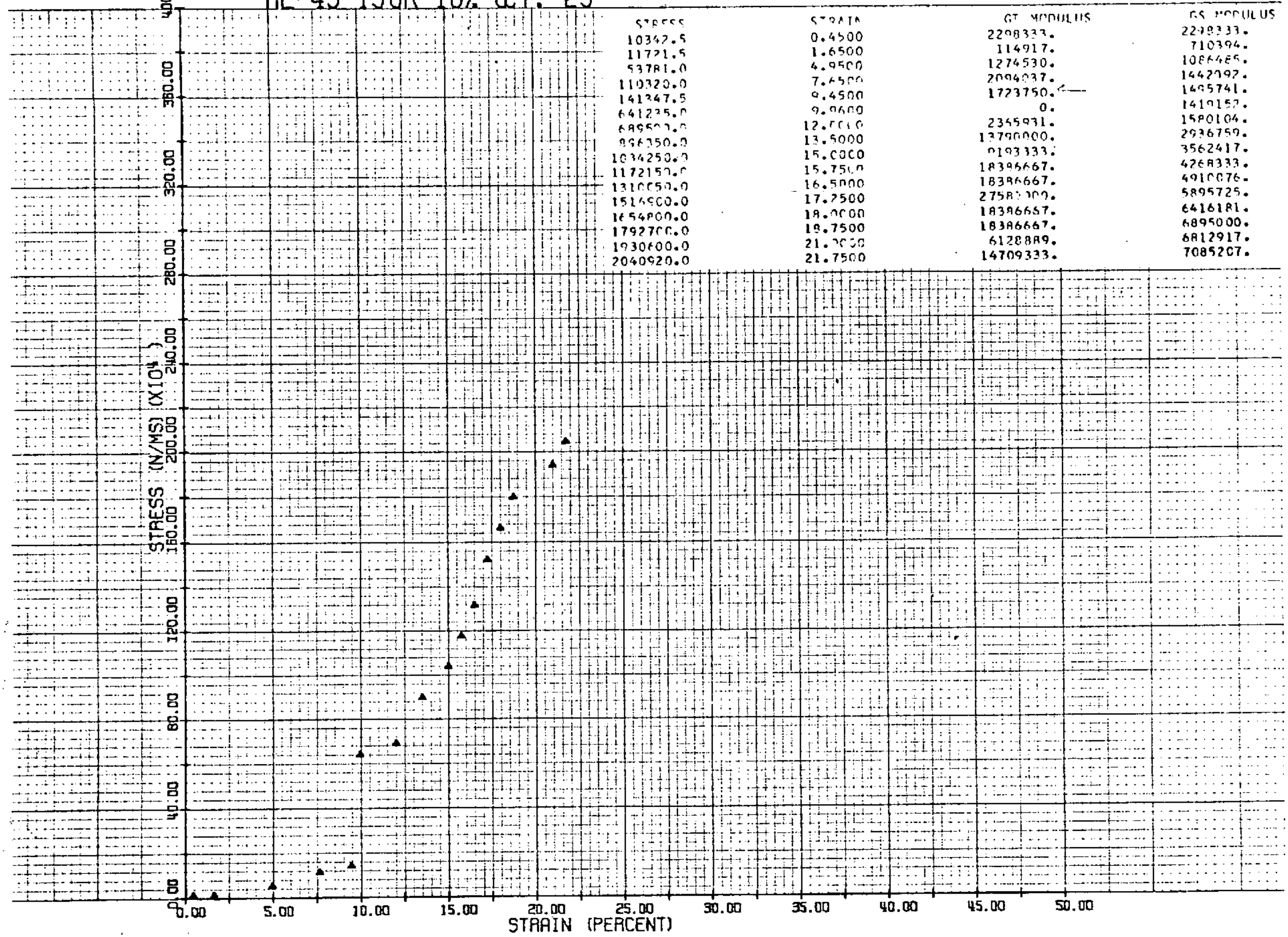
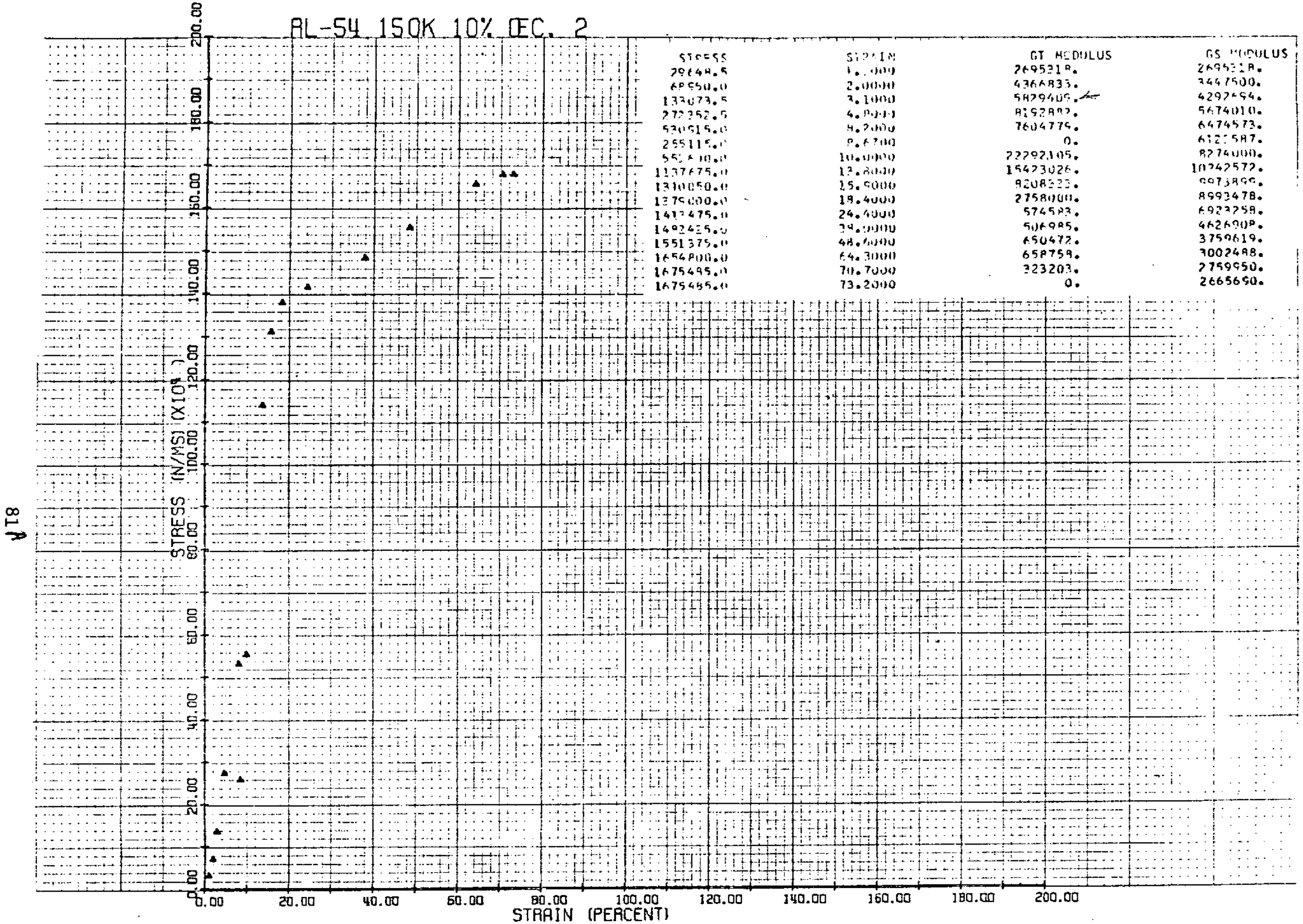
K+E KEUFFEL &

BL-45 150K 10% OCT. 29

STRESS	STRAIN	GT MODULUS	GS MODULUS
10342.5	0.4500	2298333.	2298333.
11721.5	1.6500	114917.	710394.
53781.0	4.9500	1274530.	1086485.
110320.0	7.6500	2094037.	1442092.
141347.5	9.4500	1723750. ←	1495741.
641235.0	9.9600	0.	1419157.
689500.0	12.0000	2345931.	1580104.
896350.0	13.5000	13790000.	2936759.
1034250.0	15.0000	9193333.	3562417.
1172150.0	15.7500	18386667.	4268333.
1310050.0	16.5000	18386667.	4910076.
1516900.0	17.7500	27580000.	5895725.
1654800.0	18.0000	18386667.	6416181.
1792700.0	18.7500	18386667.	6895000.
1930600.0	21.0000	6128889.	6812917.
2040920.0	21.7500	14709333.	7085207.

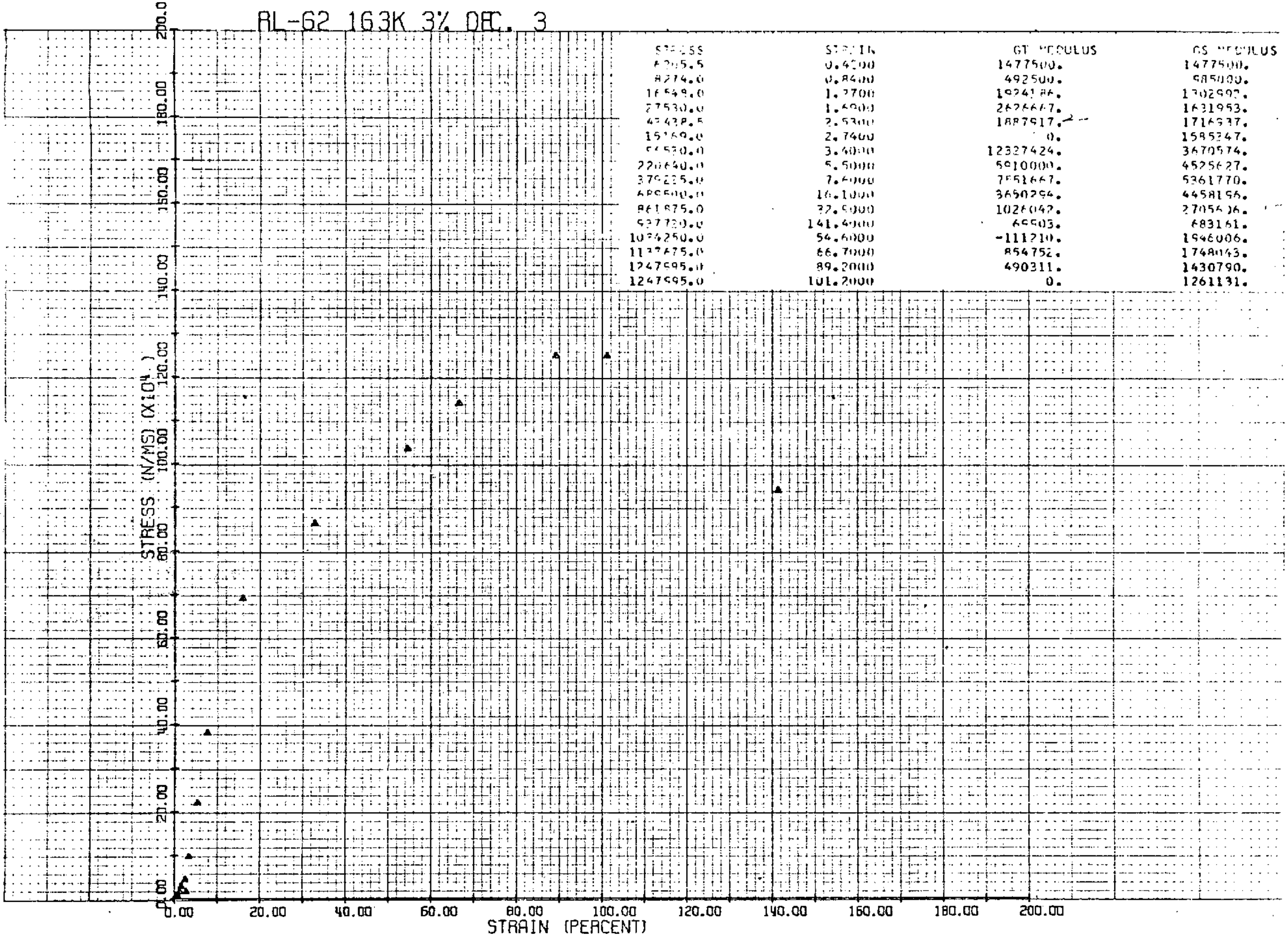


80



STRESS	STRAIN	GT MODULUS	GS MODULUS
29648.5	1.1000	2695218.	2695218.
68950.0	2.0000	4366833.	3447500.
133073.5	3.1000	5829409.	4292694.
272252.5	4.8000	8192892.	5674010.
530515.0	8.2000	7604779.	6474573.
255115.0	8.6700	0.	6121587.
551610.0	10.0000	22292105.	8274000.
1137675.0	13.8000	15423026.	10242572.
1310050.0	15.9000	9208333.	9973899.
1379000.0	19.4000	2758000.	8993478.
1417475.0	24.4000	574583.	6923258.
1492425.0	39.0000	506985.	4626908.
1551375.0	48.6000	650472.	3759619.
1654800.0	64.3000	658758.	3002488.
1675495.0	70.7000	323203.	2759950.
1675485.0	73.2000	0.	2665690.

RL-62 163K 3% DEC. 3



STRESS	STRAIN	GT MODULUS	GS MODULUS
6205.5	0.4200	1477500.	1477500.
8274.0	0.8400	492500.	985000.
16549.0	1.2700	1924186.	1302992.
27530.0	1.6900	2626667.	1631953.
43438.5	2.5300	1887917.	1716937.
15169.0	2.7400	0.	1585347.
55530.0	3.4000	12327424.	3670574.
220640.0	5.5000	5910000.	4525627.
379225.0	7.6000	7551667.	5361770.
685500.0	16.1000	3650294.	4458196.
861875.0	32.5000	1026042.	2705606.
937720.0	141.4000	69503.	683161.
1074250.0	54.6000	-111210.	1946006.
1137675.0	66.7000	854752.	1748043.
1247595.0	89.2000	490311.	1430790.
1247595.0	101.2000	0.	1261131.

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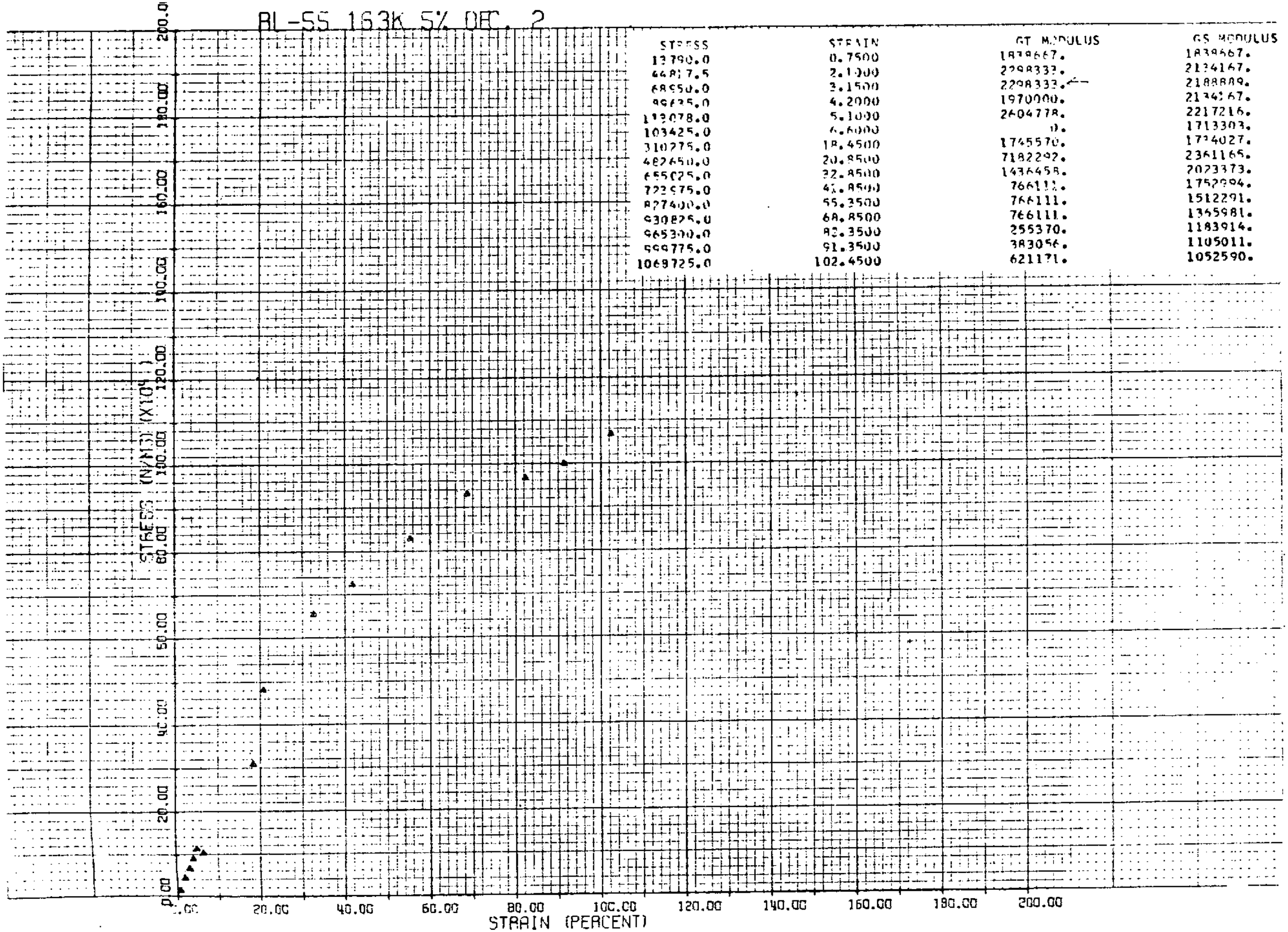
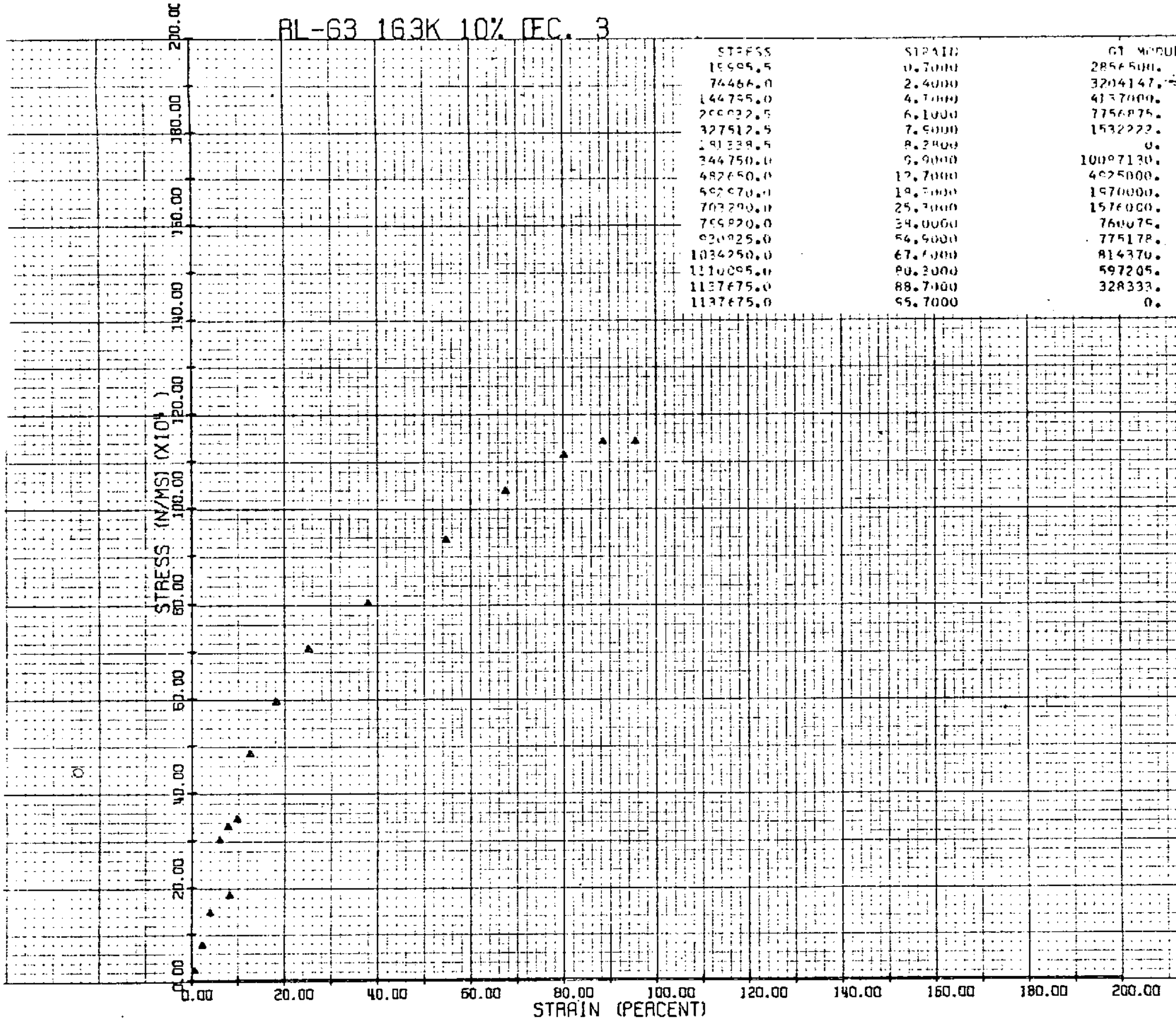


STRESS	STRAIN	GT MODULUS	GS MODULUS
13790.0	0.7500	1838667.	1838667.
44817.5	2.1000	2298333.	2134167.
68950.0	3.1500	2298333. ←	2188889.
89635.0	4.2000	1970000.	2134167.
113078.0	5.1000	2604778.	2217216.
103425.0	6.6000	0.	1713303.
310275.0	18.4500	1745570.	1724027.
482650.0	20.8500	7182292.	2361165.
655025.0	32.8500	1436458.	2023373.
723975.0	41.8500	766111.	1752994.
827400.0	55.3500	766111.	1512291.
930825.0	68.8500	766111.	1365981.
965300.0	83.3500	255370.	1183914.
999775.0	91.3500	383056.	1105011.
1069725.0	102.4500	621171.	1052590.

RL-63 163K 10% ŒC. 3

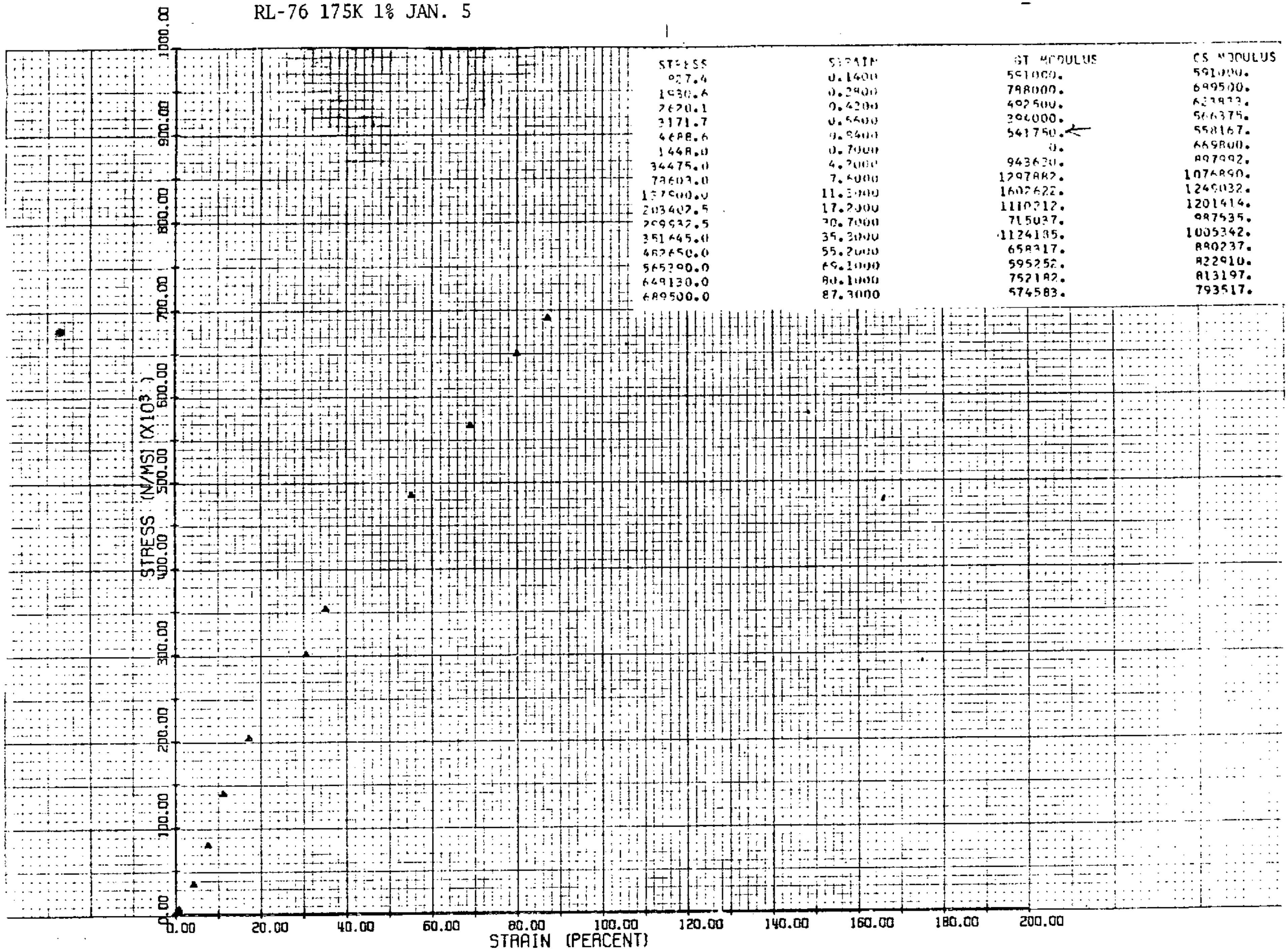


STRESS	STRAIN	GT MODULUS	GS MODULUS
15995.5	0.7000	2856500.	2856500.
74466.0	2.4000	3204147.	3102750.
144795.0	4.7000	4137000.	3531535.
299932.5	6.1000	7756875.	4916926.
327512.5	7.9000	1532222.	4145728.
191339.5	8.2800	0.	3955465.
344750.0	9.9000	10097130.	4958828.
482650.0	12.7000	4925000.	4951370.
592970.0	19.7000	1970000.	4039038.
703290.0	25.7000	1576000.	3357565.
759920.0	34.0000	760075.	2499458.
930925.0	54.9000	775178.	1961747.
1034250.0	67.6000	814370.	1746189.
1110095.0	80.3000	597205.	1564469.
1137675.0	88.7000	328333.	1447406.
1137675.0	95.7000	0.	1341535.

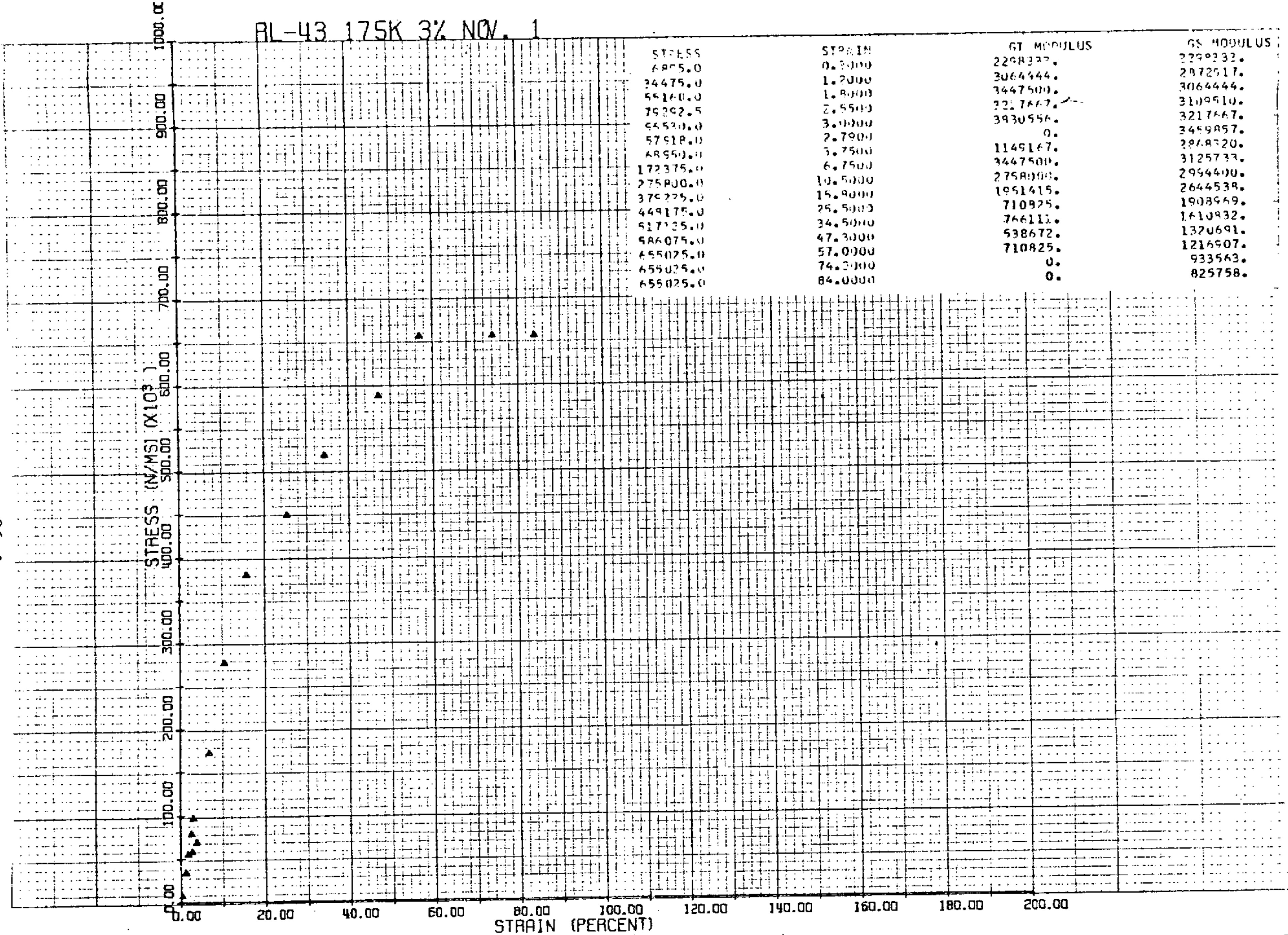
84

RL-76 175K 1% JAN. 5

STRESS	STRAIN	GT MODULUS	CS MODULUS
927.4	0.1400	591000.	591000.
1930.6	0.2900	798000.	699500.
2620.1	0.4200	492500.	623833.
3171.7	0.5600	394000.	566375.
4688.6	0.8400	541750.	558167.
1448.0	0.7000	0.	669800.
34475.0	4.2000	943630.	897992.
78603.0	7.6000	1297882.	1076890.
137500.0	11.3000	1602622.	1249032.
203402.5	17.2000	1110212.	1201414.
299532.5	30.7000	715037.	987535.
351645.0	35.3000	1124135.	1005342.
462650.0	55.2000	658317.	890237.
565390.0	69.1000	595252.	822910.
649130.0	80.1000	752182.	813197.
689500.0	87.3000	574583.	793517.

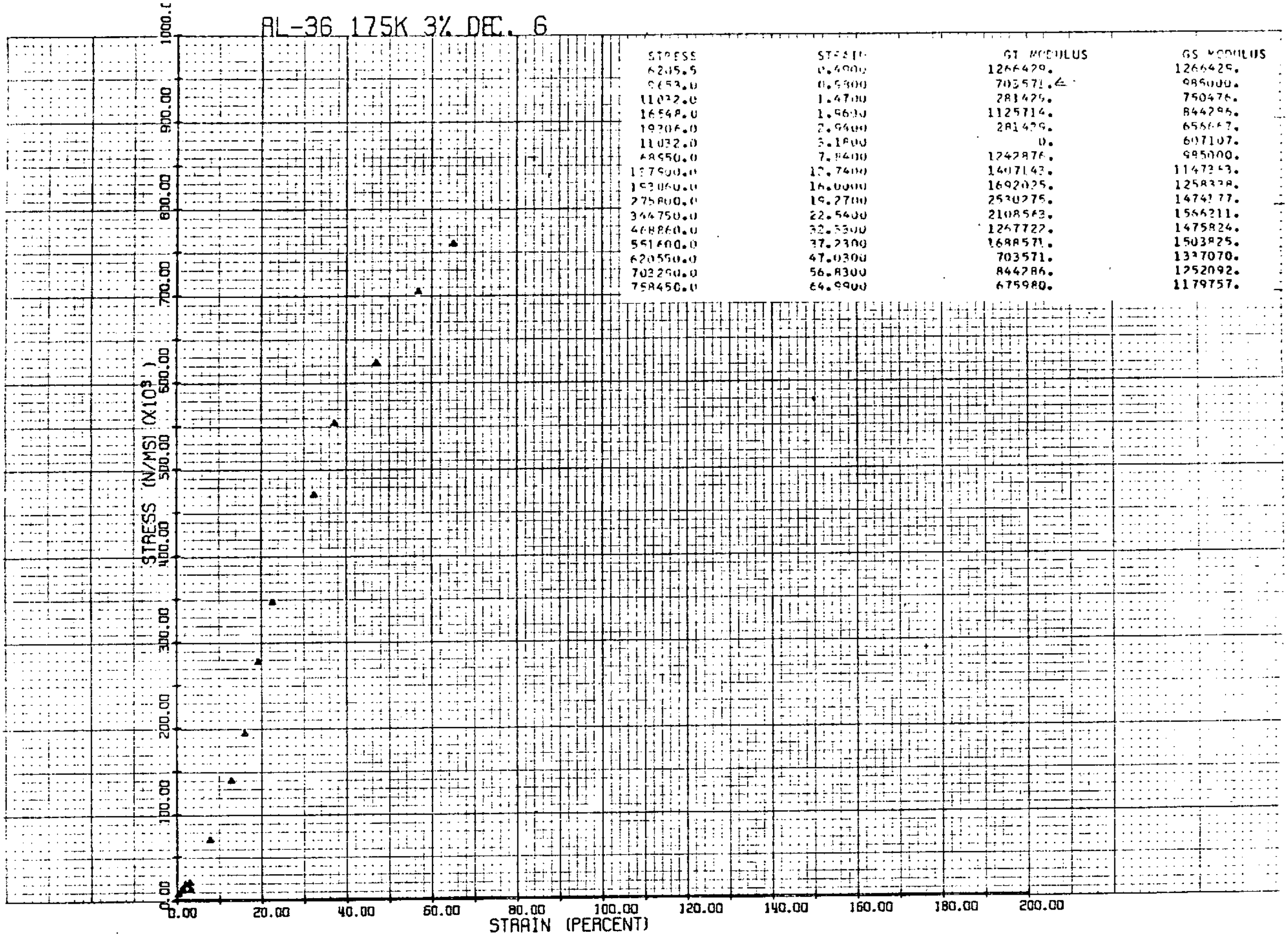


98



STRESS	STRAIN	GT MODULUS	GS MODULUS
6895.0	0.3000	2298333.	2298333.
34475.0	1.2000	3064444.	2872517.
55160.0	1.8000	3447500.	3064444.
75292.5	2.5500	3217667.	3109510.
65530.0	3.0000	3930556.	3217667.
57918.0	2.7900	0.	3459857.
68950.0	3.7500	1149167.	2968320.
172375.0	6.7500	3447500.	3125733.
275800.0	10.5000	2758000.	2954400.
379225.0	15.9000	1951415.	2644538.
448175.0	25.5000	710925.	1908969.
517125.0	34.5000	766111.	1610832.
586075.0	47.3000	538672.	1320691.
655025.0	57.0000	710825.	1216907.
655025.0	74.3000	0.	933563.
655025.0	84.0000	0.	825758.

RL-36 175K 3% DEC. 6



STRESS	STRAIN	GT MODULUS	GS MODULUS
6205.5	0.4900	1266429.	1266429.
9653.0	0.9300	703571. ←	985000.
11032.0	1.4700	281429.	750476.
16548.0	1.9600	1125714.	844295.
19306.0	2.9400	281429.	656667.
11032.0	3.1800	0.	607107.
68950.0	7.8400	1242876.	985000.
137900.0	12.7400	1407143.	1147353.
193060.0	16.0000	1692025.	1258338.
275800.0	19.2700	2530275.	1474177.
344750.0	22.5400	2108563.	1566211.
468860.0	32.5300	1267722.	1475824.
551600.0	37.2300	1688571.	1503825.
620550.0	47.0300	703571.	1337070.
703290.0	56.8300	844286.	1252092.
758450.0	64.9900	675980.	1179757.

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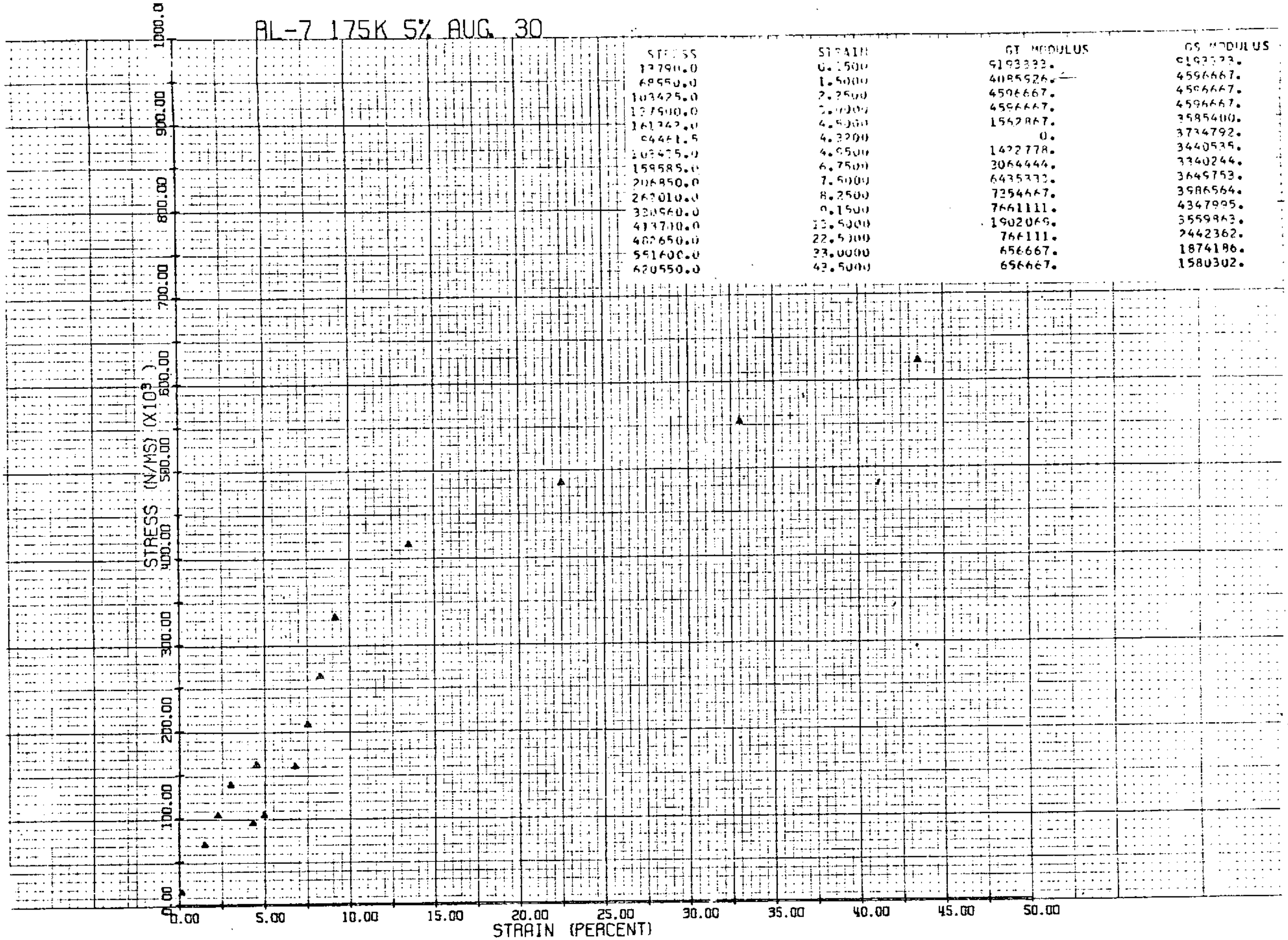
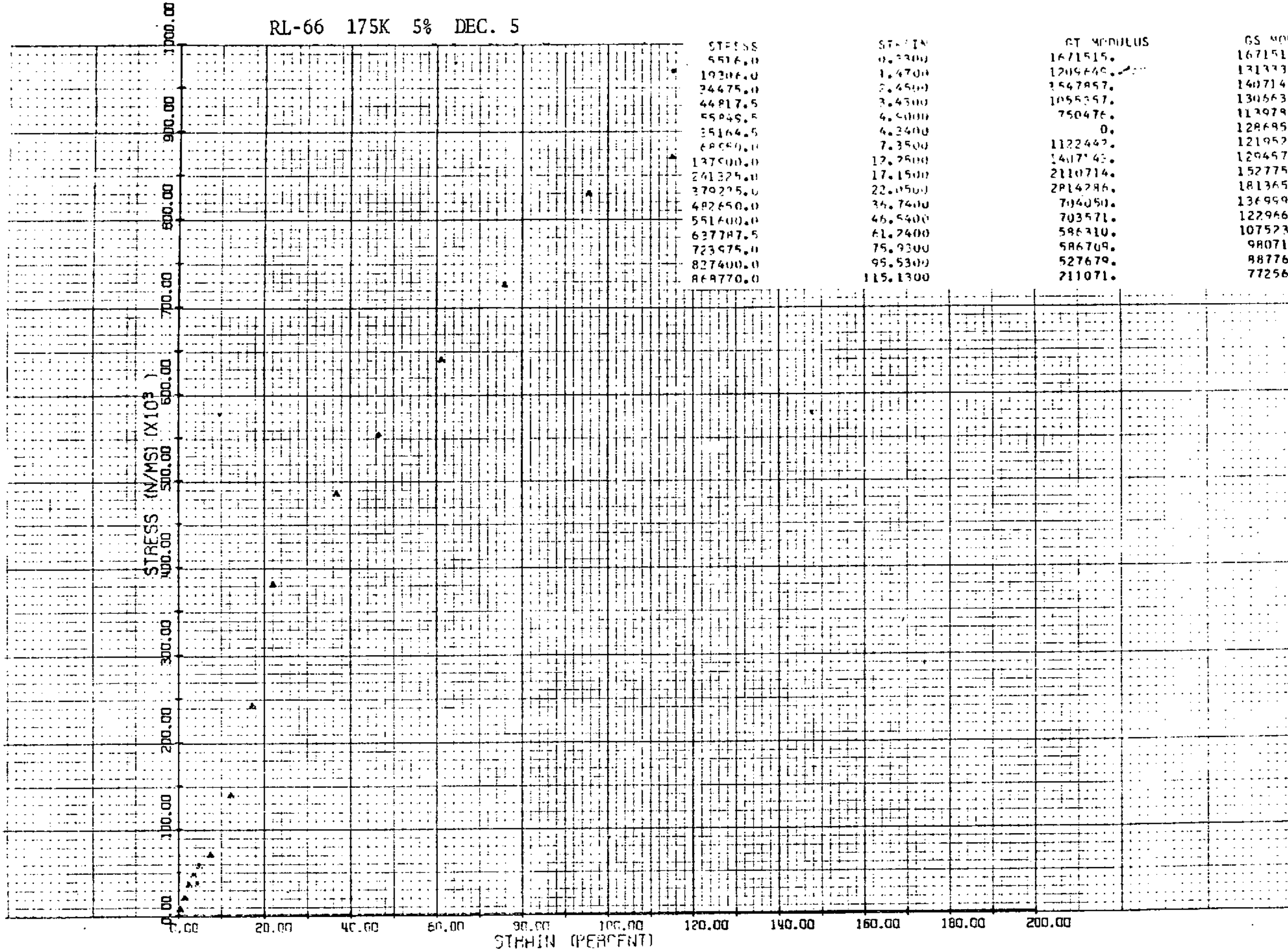
AL-7 175K 5% AUG. 30



STRESS	STRAIN	GT MODULUS	GS MODULUS
13790.0	0.1500	9193333.	9193333.
68950.0	1.5000	4085526.	4596667.
103425.0	2.2500	4596667.	4596667.
137900.0	3.0000	4596667.	4596667.
161343.0	4.5000	1562867.	3585400.
94461.5	4.3200	0.	3734792.
103425.0	4.9500	1422778.	3440535.
159585.0	6.7500	3064444.	3340244.
206850.0	7.5000	6435333.	3649753.
262010.0	8.2500	7254667.	3986564.
330960.0	9.1500	7661111.	4347995.
413700.0	13.5000	1902069.	3559863.
482650.0	22.5000	766111.	2442362.
551600.0	33.0000	656667.	1874186.
620550.0	43.5000	656667.	1580302.

RL-66 175K 5% DEC. 5

STRESS	STRAIN	GT MODULUS	GS MODULUS
5516.0	0.3300	1671515.	1671515.
19306.0	1.4700	1209649.	1313333.
34475.0	2.4500	1547857.	1407143.
44817.5	3.4300	1055357.	1306633.
55849.5	4.9000	750476.	1139796.
55164.5	4.3400	0.	1286855.
68950.0	7.3500	1122442.	1219524.
137500.0	12.2500	1407143.	1294571.
241325.0	17.1500	2110714.	1527755.
379225.0	22.0500	2814286.	1813651.
482650.0	36.7400	704050.	1369992.
551600.0	46.5400	703571.	1229663.
637787.5	61.2400	586310.	1075233.
723975.0	75.9300	586709.	980719.
827400.0	95.5300	527679.	887768.
869770.0	115.1300	211071.	772566.



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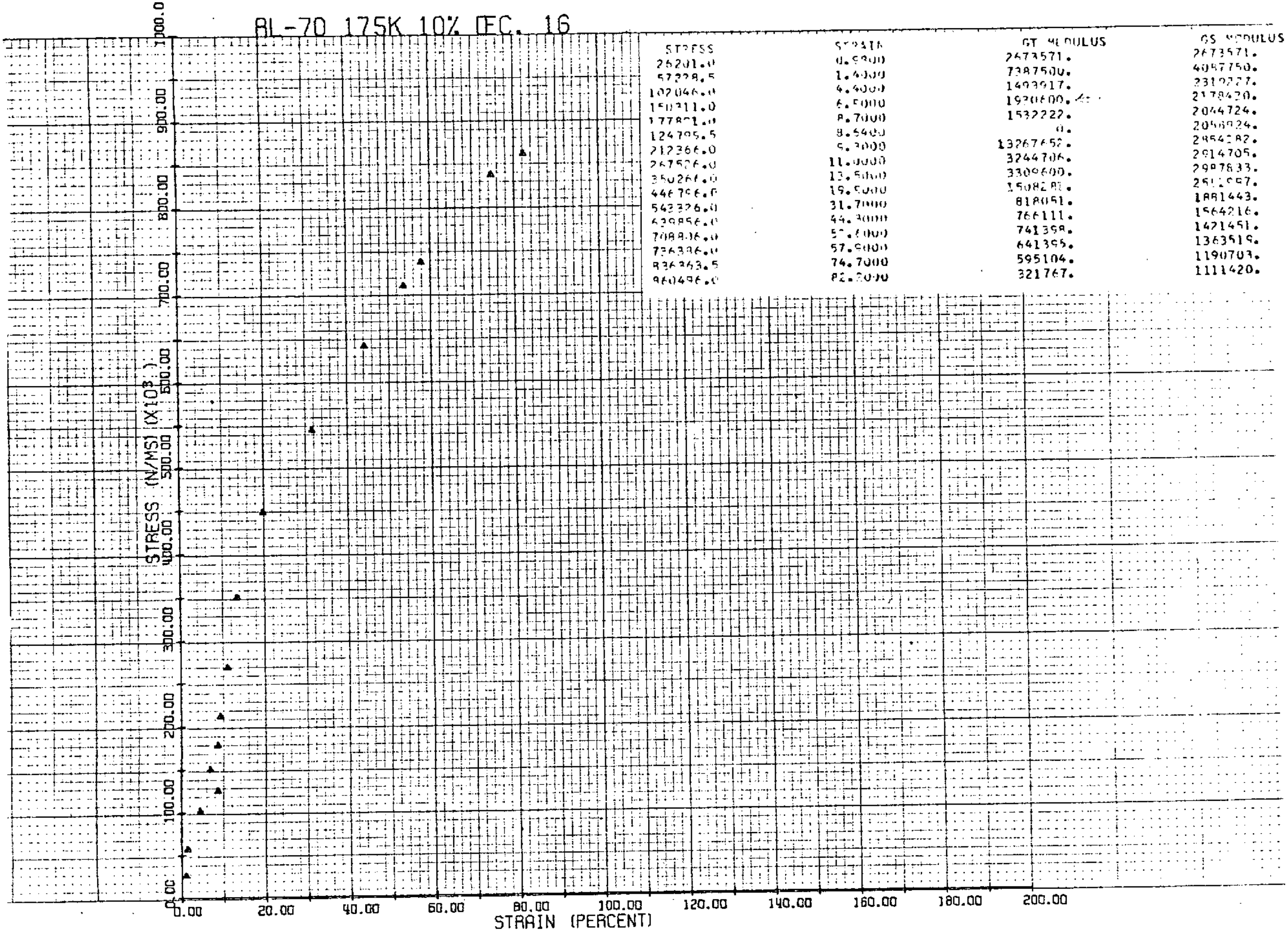
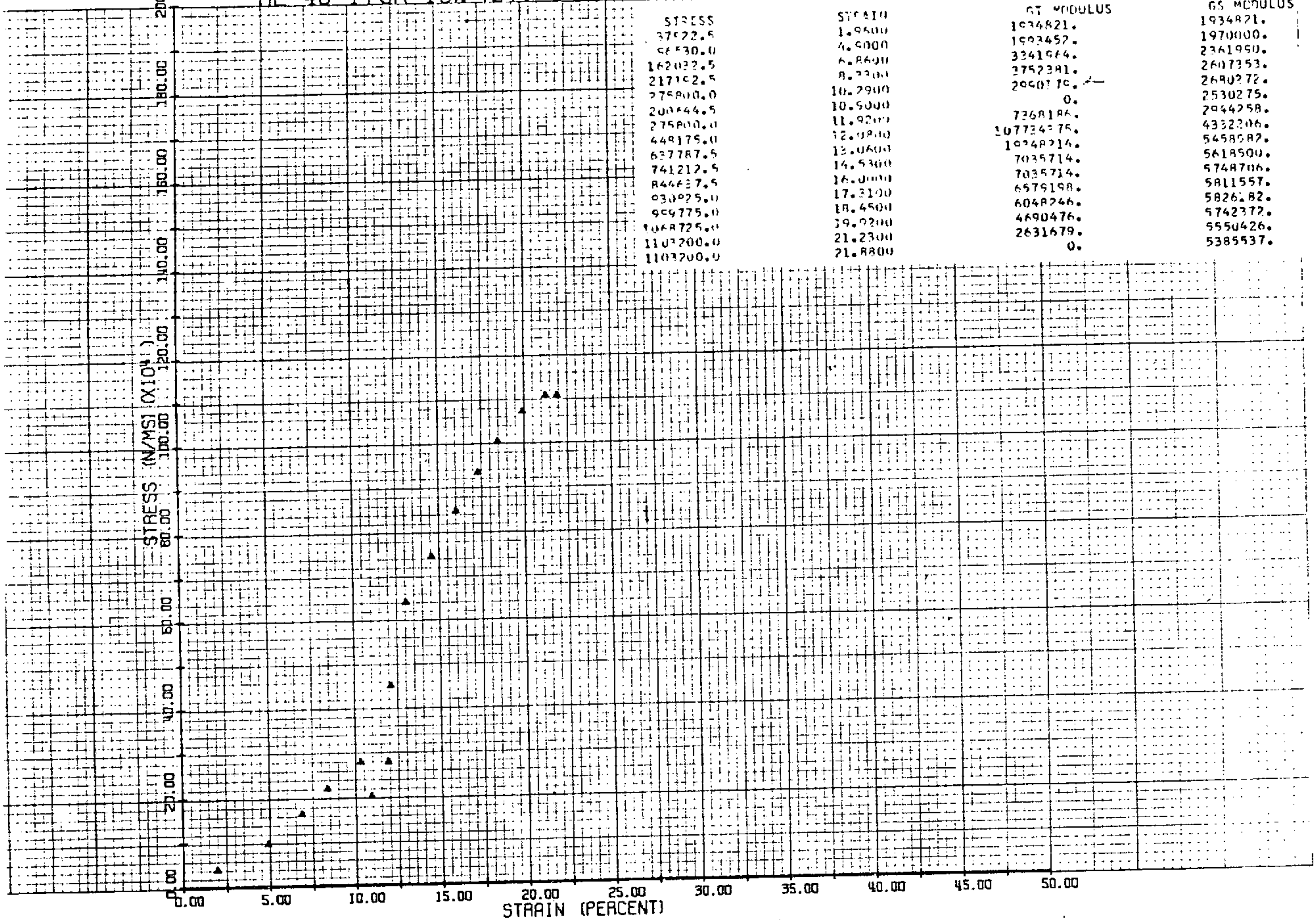


STRESS	STRAIN	GT MODULUS	GS MODULUS
26201.0	0.9800	2673571.	2673571.
57228.5	1.4000	7387500.	4087750.
102046.0	4.4000	1493917.	2319227.
150311.0	6.5000	1920600.	2178420.
177891.0	8.7000	1532222.	2044724.
124795.5	8.5400	0.	2056924.
212366.0	5.3000	13267652.	2854182.
267526.0	11.0000	3244706.	2914705.
350264.0	13.5000	3309600.	2987833.
446796.0	19.5000	1508281.	2511997.
543326.0	31.7000	818051.	1881443.
639856.0	44.3000	766111.	1564216.
708806.0	52.6000	741398.	1421451.
736396.0	57.9000	641395.	1363519.
836363.5	74.7000	595104.	1190703.
960496.0	82.2000	321767.	1111420.

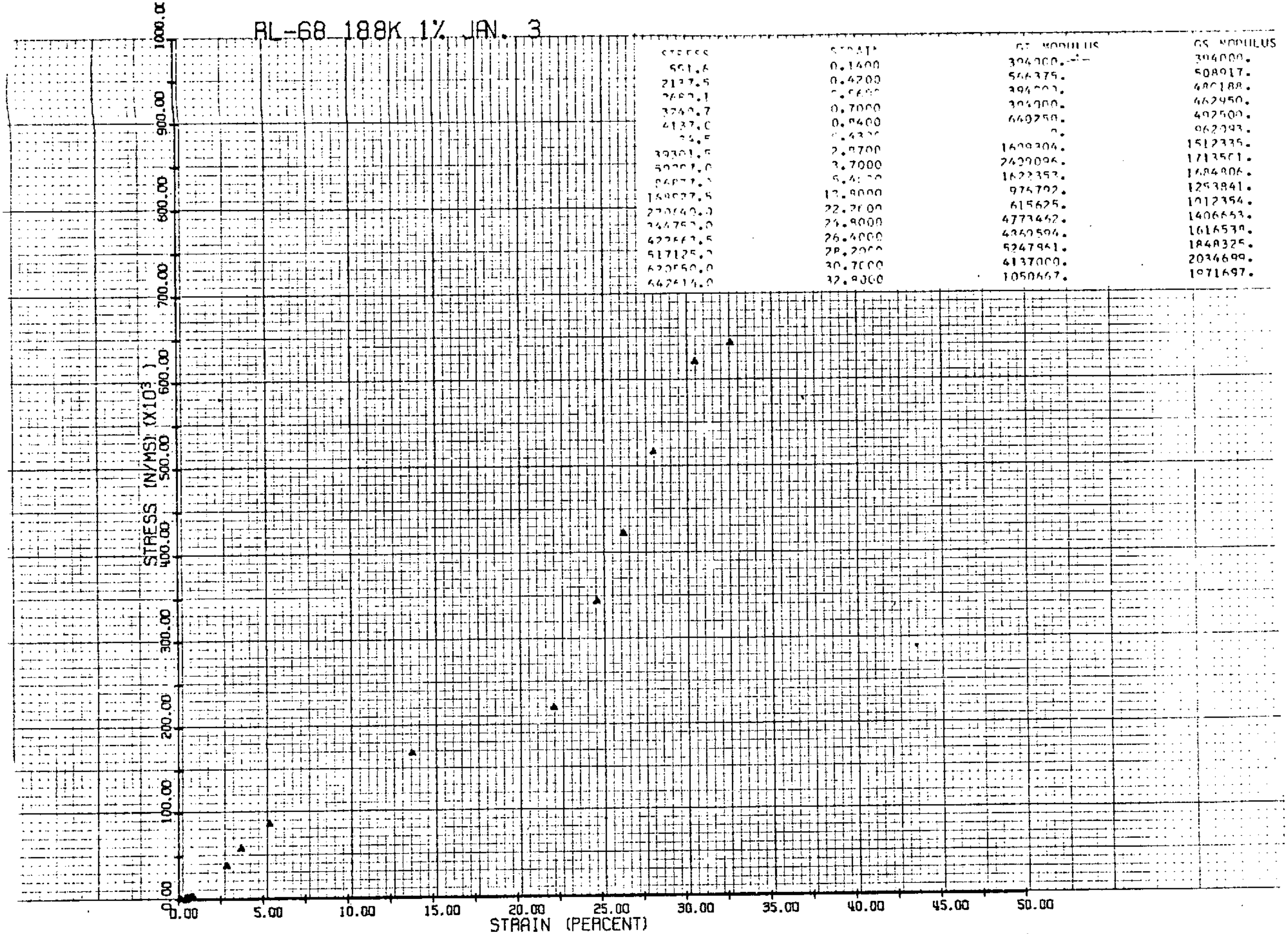
AL-48 175K 10% NOV. 8

STRESS	STRAIN	GT MODULUS	GS MODULUS
37522.5	1.9600	1934821.	1934821.
96530.0	4.9000	1993457.	1970000.
162032.5	6.8600	3341964.	2361950.
217192.5	8.2300	3752381.	2607353.
275800.0	10.2900	2960179.	2680272.
200644.5	10.5000	0.	2530275.
275800.0	11.9200	7368186.	2944258.
448175.0	12.0800	107734375.	4332206.
637787.5	13.0600	19348214.	5458982.
741212.5	14.5300	7035714.	5618500.
844637.5	16.0000	7035714.	5748706.
930925.0	17.3100	6579198.	5811557.
959775.0	18.4500	6048246.	5826182.
1068725.0	19.9200	4690476.	5742372.
1103200.0	21.2300	2631679.	5550426.
1103200.0	21.8800	0.	5385537.



91 A

RL-68 188K 1% JAN. 3

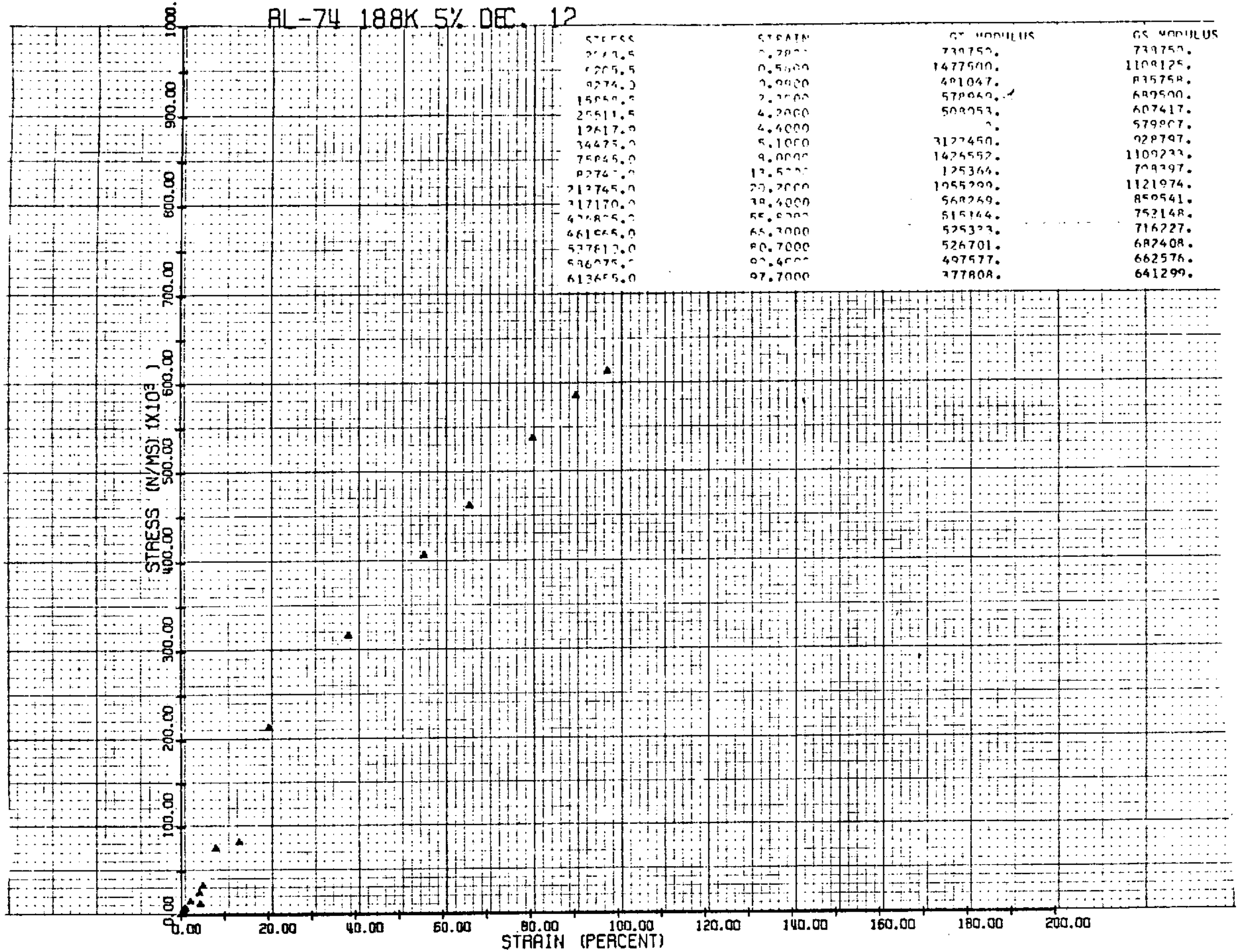


STRESS	STRAIN	GT MODULUS	GS MODULUS
551.6	0.1400	394000.	394000.
2137.5	0.4700	566375.	508917.
2662.1	0.5600	394000.	480188.
3249.7	0.7000	394000.	462950.
4137.0	0.8400	640250.	492500.
[illegible]	[illegible]	0.	962093.
39301.5	2.9700	1609304.	1512335.
59287.0	3.7000	2429096.	1713561.
84877.5	5.4100	1622353.	1684806.
158927.5	13.9000	976792.	1253841.
220640.0	22.2600	615625.	1012354.
344752.0	24.9000	4773462.	1406653.
422667.5	26.4000	4360594.	1616538.
517125.0	28.2000	5247961.	1848325.
620550.0	30.7000	4137000.	2034699.
642614.0	32.9000	1050667.	1971697.

#92

K·E KEUFFEL

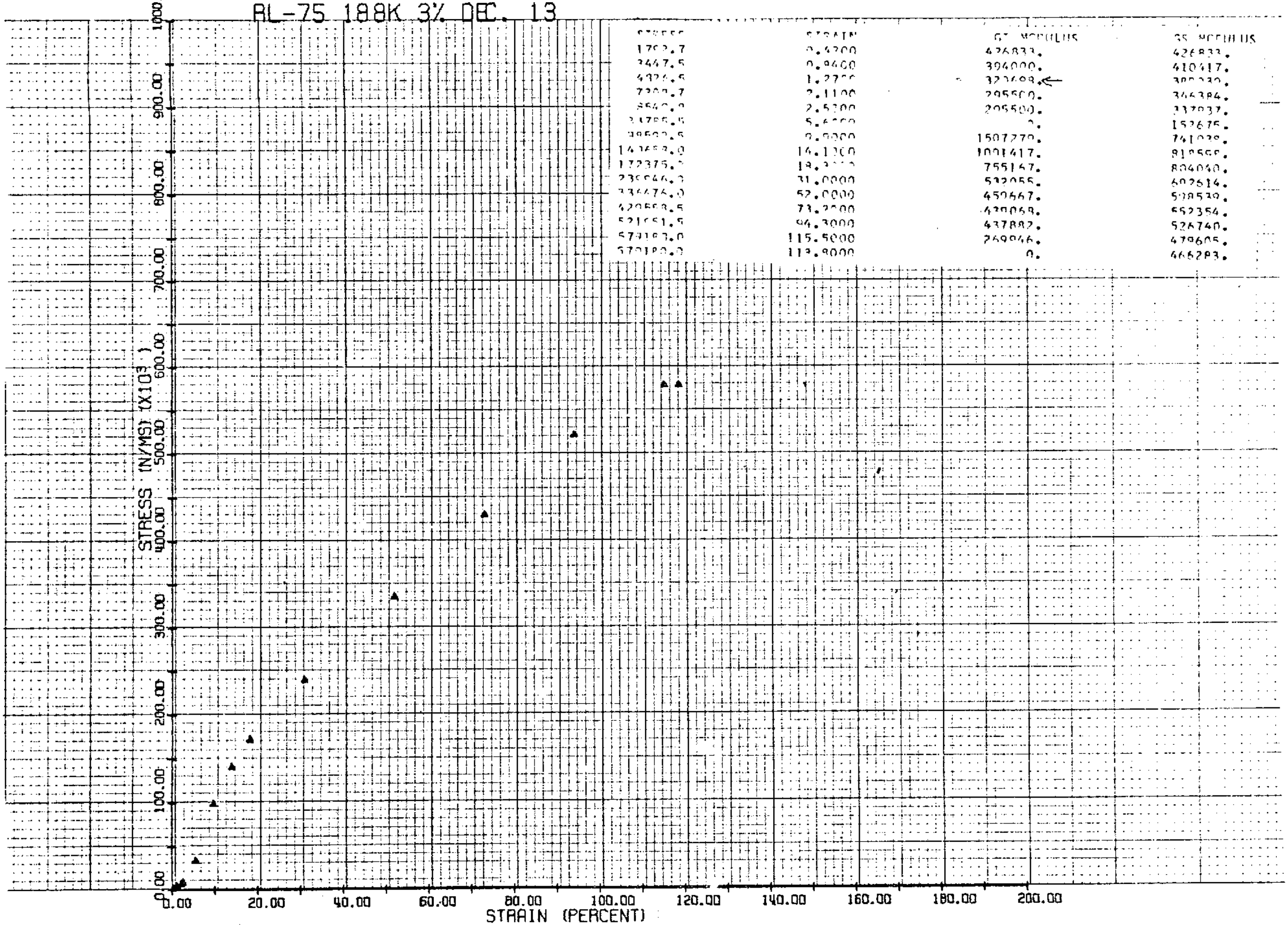
AL-74 188K 5% DEC. 12



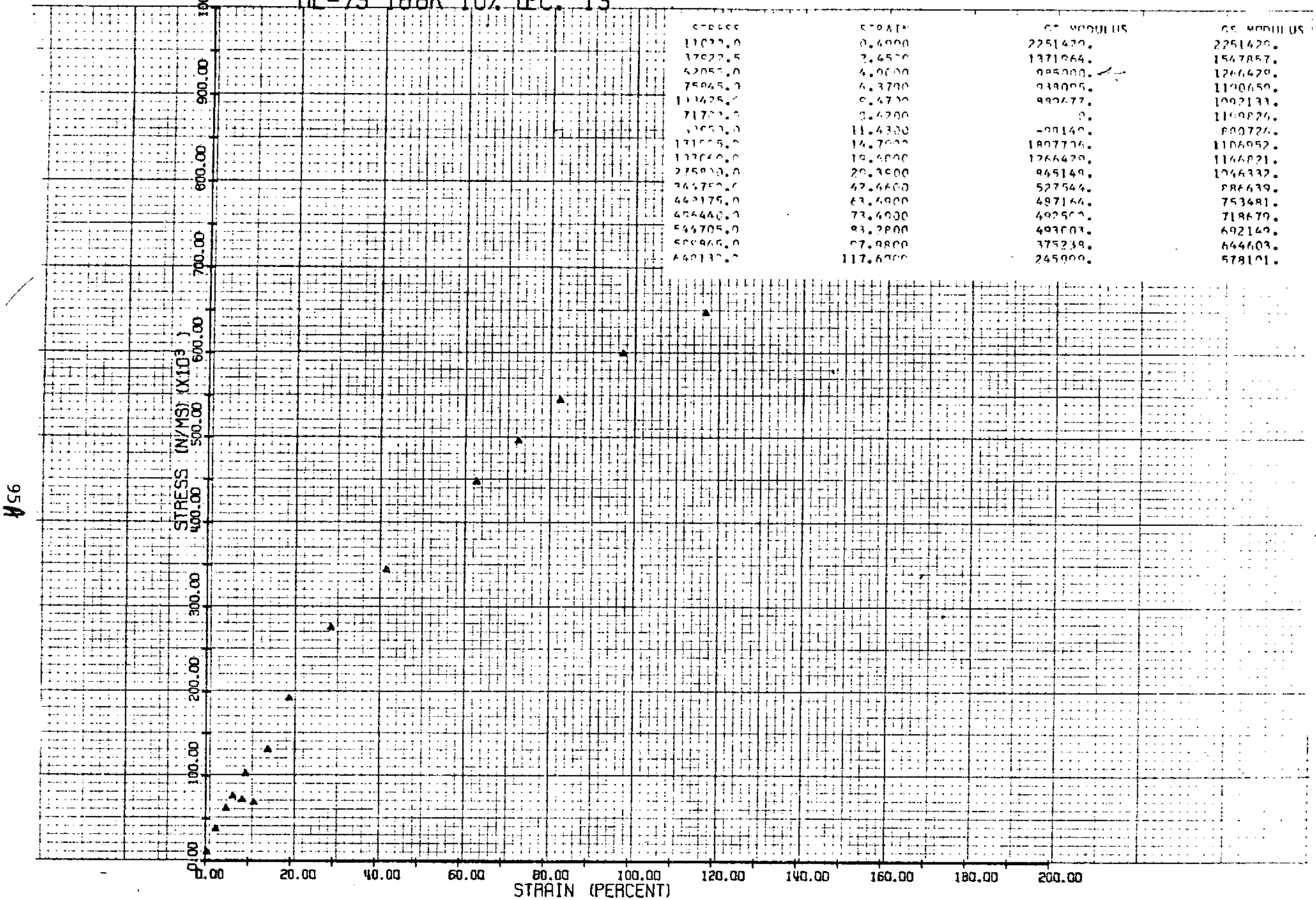
STRESS	STRAIN	GT MODULUS	GS MODULUS
[illegible]	0.2000	739750.	739750.
5205.5	0.5000	1477500.	1108125.
9274.0	0.9900	491047.	835758.
15859.5	2.3000	578960.	689500.
25511.5	4.2000	508053.	607417.
12617.9	4.4000	0.	579807.
34475.0	5.1000	3127450.	928797.
75845.0	9.0000	1426552.	1109233.
82747.0	13.5000	125364.	709397.
213745.0	20.2000	1955299.	1121974.
317170.0	38.4000	568269.	859541.
4[illegible]5.0	55.8000	515144.	752148.
461565.0	65.3000	525323.	716227.
537812.0	80.7000	526701.	682408.
586075.0	90.4000	497577.	662576.
613655.0	97.7000	377808.	641299.

BL-75 188K 3% DEC. 13

STRESS	STRAIN	GT MODULUS	SS MODULUS
1792.7	0.4200	426833.	426833.
3447.5	0.8400	394000.	410417.
4326.5	1.2700	323698.	[illegible]
7308.7	2.1100	295500.	346384.
8540.9	2.5300	295500.	337937.
[illegible]	5.6000	0.	152675.
98502.5	9.9000	1507279.	741039.
143658.0	14.1300	1001417.	819555.
172375.7	18.3[illegible]	755167.	804040.
235546.3	31.0000	532055.	602614.
336476.0	52.0000	459667.	598539.
429558.5	73.2000	439069.	552354.
521551.5	94.3000	437882.	526740.
579193.0	115.5000	269946.	479605.
579180.0	113.9000	0.	466283.



RL-73 188K 10% DEC. 13



STRESS	STRAIN	CT MODULUS	CS MODULUS
11022.0	0.6900	2251429.	2251429.
37927.5	2.4500	1371964.	1547857.
62055.0	4.9000	985000.	1266429.
75945.0	6.3700	939095.	1190659.
103425.0	9.4700	992677.	1092131.
71700.0	9.6200	0.	1199826.
69053.0	11.4300	-99149.	890726.
131665.0	14.7000	1897736.	1106952.
193060.0	19.6000	1266429.	1146821.
275830.0	29.3500	945149.	1046332.
344750.0	42.4600	527544.	886639.
442175.0	63.6900	497164.	753481.
496440.0	73.4900	492500.	718679.
544705.0	83.2800	493003.	692149.
599965.0	97.9800	375239.	644603.
649132.0	117.6900	245000.	578101.

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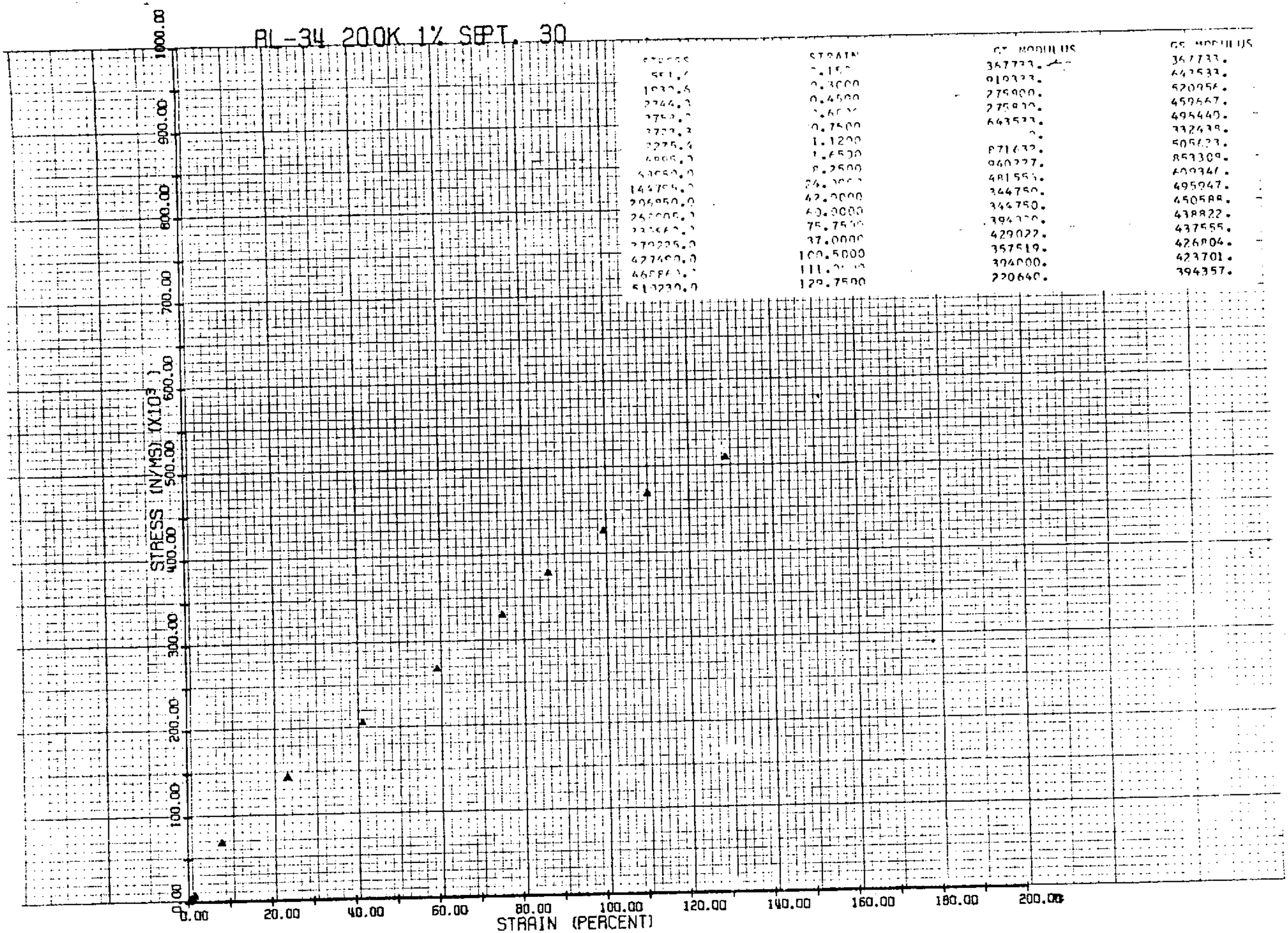

STRESS	STRAIN	GT MODULUS	GS MODULUS
551.[illegible]	[illegible].15[illegible]	367733.	367733.
1032.6	0.3000	919333.	643533.
2244.3	0.4500	275900.	520956.
2752.[illegible]	[illegible].60[illegible]	275830.	459667.
3722.3	0.7500	643533.	495440.
2275.4	1.1200	0.	332438.
4995.0	1.6500	871632.	505623.
53050.0	8.2500	940277.	853309.
144755.[illegible]	24.[illegible]	481555.	609346.
206950.0	42.0000	344750.	495947.
252005.[illegible]	60.0000	344750.	450588.
333562.[illegible]	75.75[illegible]	394[illegible].	438822.
379225.0	37.0000	429022.	437555.
427490.0	100.5000	357519.	426804.
468860.[illegible]	111.[illegible]	394000.	423701.
513230.0	129.7500	220640.	394357.

#96

[illegible] ESSER CO. PRINTED IN U.S.A.

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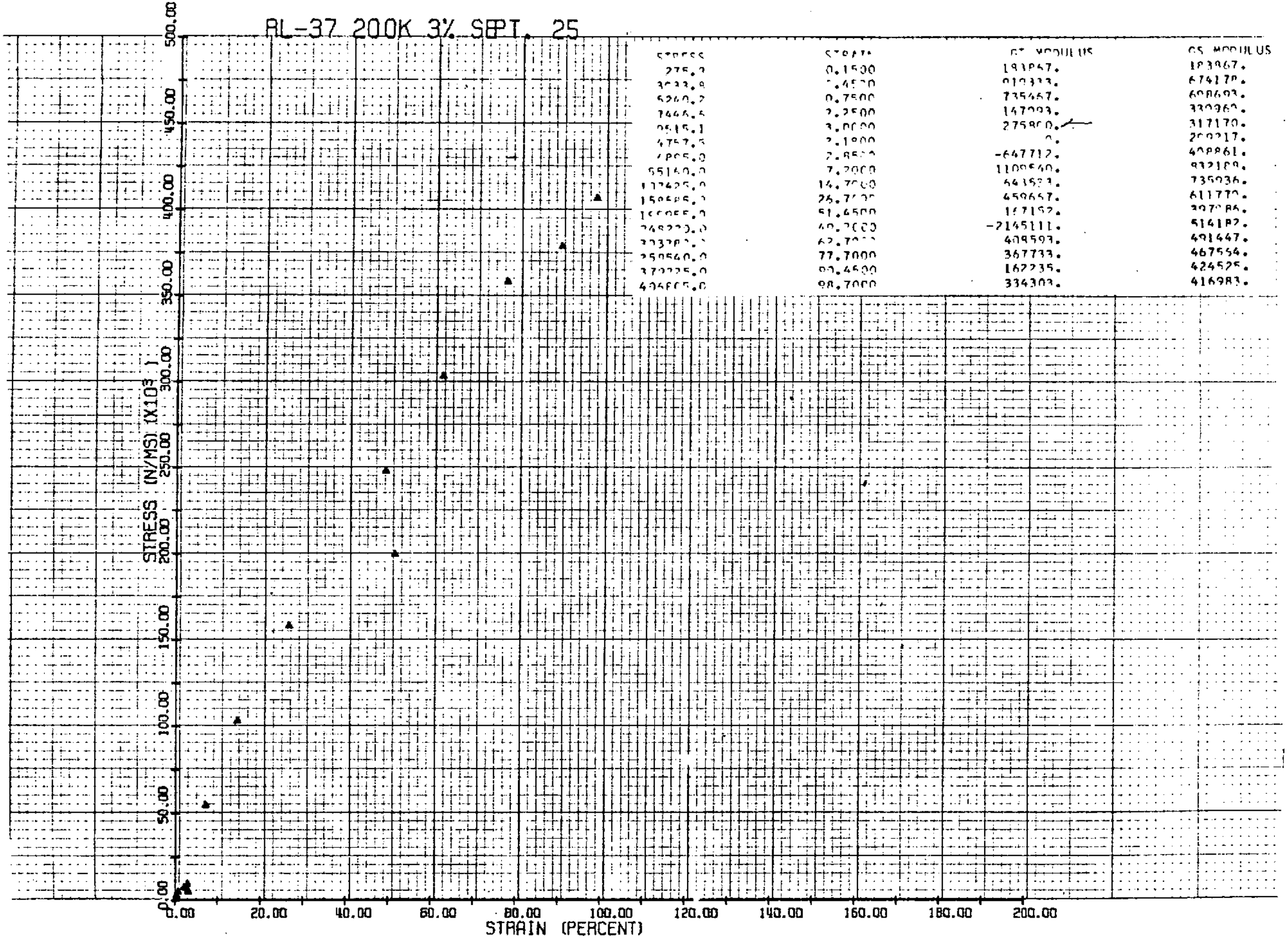
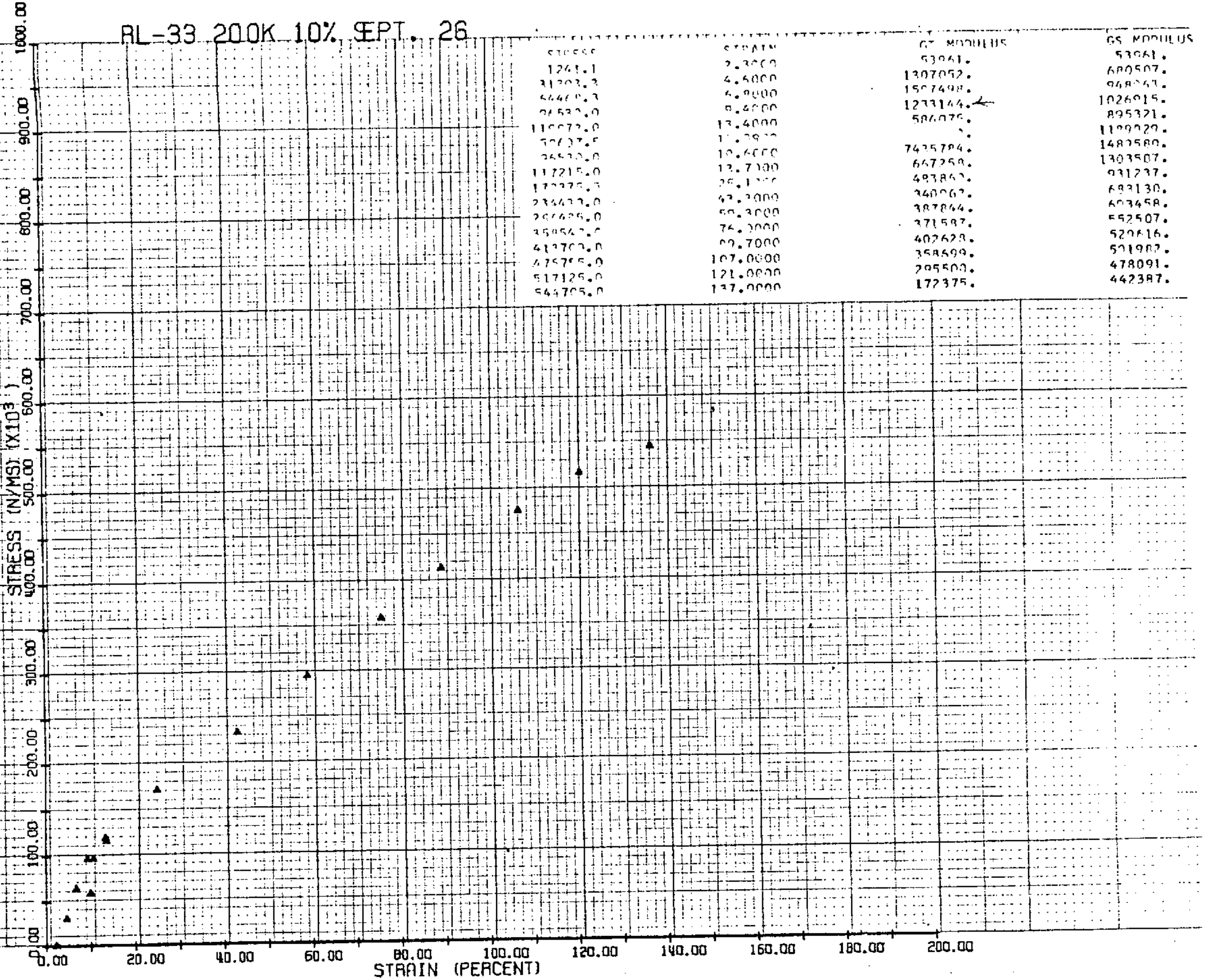


STRESS	STRAIN	GT MODULUS	GS MODULUS
275.9	0.1500	193847.	183967.
3033.9	0.4500	919333.	674178.
5260.2	0.7500	735467.	698693.
7446.5	2.2500	147993.	330960.
9515.1	3.0000	275800.	317170.
4757.5	2.1900	0.	200217.
4805.0	2.8500	-647712.	408861.
55160.0	7.2000	1109540.	932109.
117425.0	14.7000	643523.	735936.
159585.0	26.7000	459657.	611770.
155055.0	51.4500	167152.	307086.
248220.0	49.2000	-2145111.	514182.
303780.0	62.7000	409593.	491447.
359540.0	77.7000	367733.	467554.
372225.0	90.4500	162235.	424525.
406605.0	98.7000	334303.	416983.

97

RL-33 200K 10% SEPT. 26



STRESS	STRAIN	GT MODULUS	GS MODULUS
1241.1	2.3000	53961.	53961.
31703.3	4.6000	1307052.	680507.
64460.3	6.9000	1567498.	948263.
96532.0	9.4000	1233144. ←	1026915.
119972.0	13.4000	584075.	895321.
59637.5	1[illegible].3900	[illegible].	1199929.
96533.0	10.6000	7425784.	1482580.
117215.0	13.7100	667259.	1303507.
172375.3	25.1000	493863.	931237.
234433.0	43.3000	340967.	693130.
296625.0	59.3000	387844.	603458.
350542.0	76.2000	371597.	552507.
413703.0	92.7000	402623.	529616.
475755.0	107.0000	358699.	521987.
517125.0	121.0000	295509.	478091.
544705.0	137.0000	172375.	442387.

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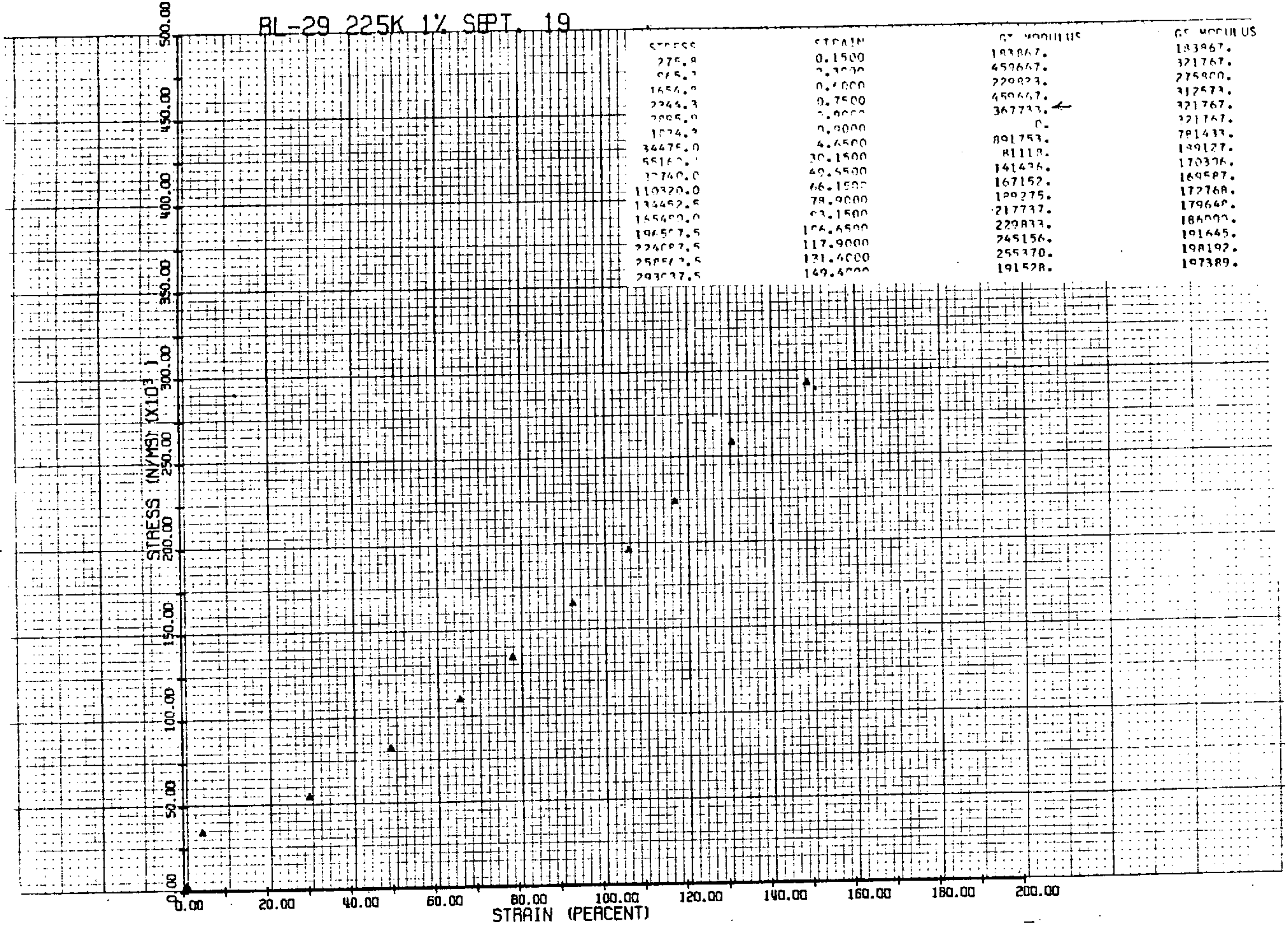
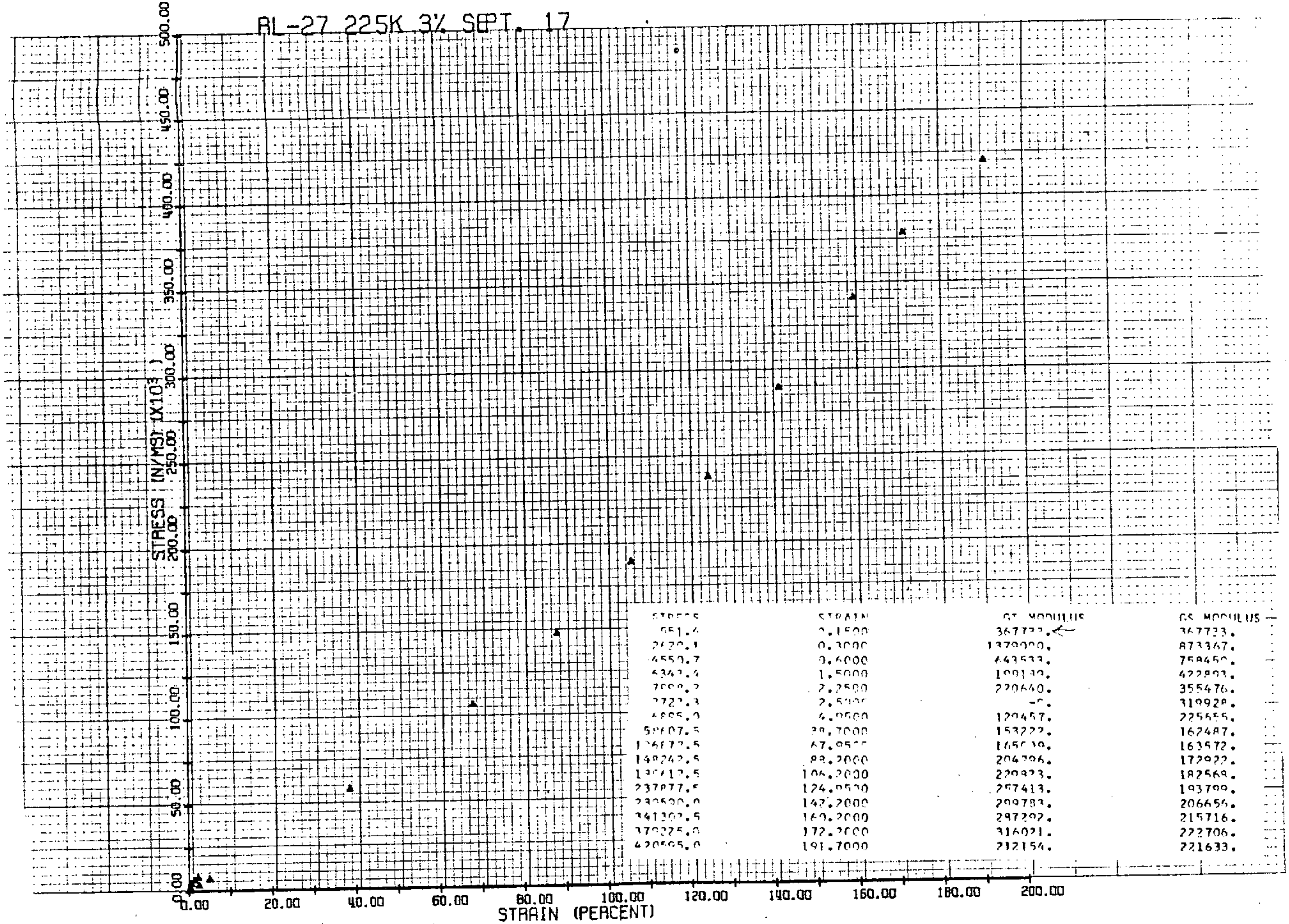
K•E KEUFFEL &

BL-29 225K 1% SEPT. 19

STRESS	STRAIN	GT MODULUS	GT MODULUS
275.8	0.1500	183867.	183967.
965.3	0.3000	459667.	321767.
1654.8	0.6000	229823.	275900.
2344.3	0.7500	459667.	312573.
2895.0	0.9000	367733. ←	321767.
1034.2	0.9000	0.	321767.
34475.0	4.6500	891753.	781433.
55160.[illegible]	30.1500	81118.	139127.
82740.0	49.6500	141436.	170376.
110320.0	66.1500	167152.	169587.
134452.5	79.9000	189275.	172768.
165480.0	93.1500	217737.	179648.
196507.5	106.6500	229833.	186093.
224087.5	117.9000	245156.	191645.
258562.5	131.4000	255370.	198192.
293037.5	149.4000	191528.	197389.





STRESS	STRAIN	GT MODULUS	GS MODULUS
551.4	0.1500	367723. ←	367723.
2620.1	0.3000	1379000.	873367.
4550.7	0.6000	643533.	758450.
6342.4	1.5000	199139.	422893.
7999.2	2.2500	220640.	355476.
7722.3	2.5000	-0.	319928.
4885.0	4.0500	129457.	225655.
58607.5	28.7000	153222.	162487.
106877.5	67.9500	165039.	163572.
148242.5	88.2000	204796.	172922.
193612.5	106.2000	229823.	182569.
237877.5	124.8500	257413.	193799.
293500.0	142.2000	299783.	206656.
341302.5	160.2000	297292.	215716.
379225.0	172.2000	316021.	222706.
420595.0	191.7000	212154.	221633.

100 A

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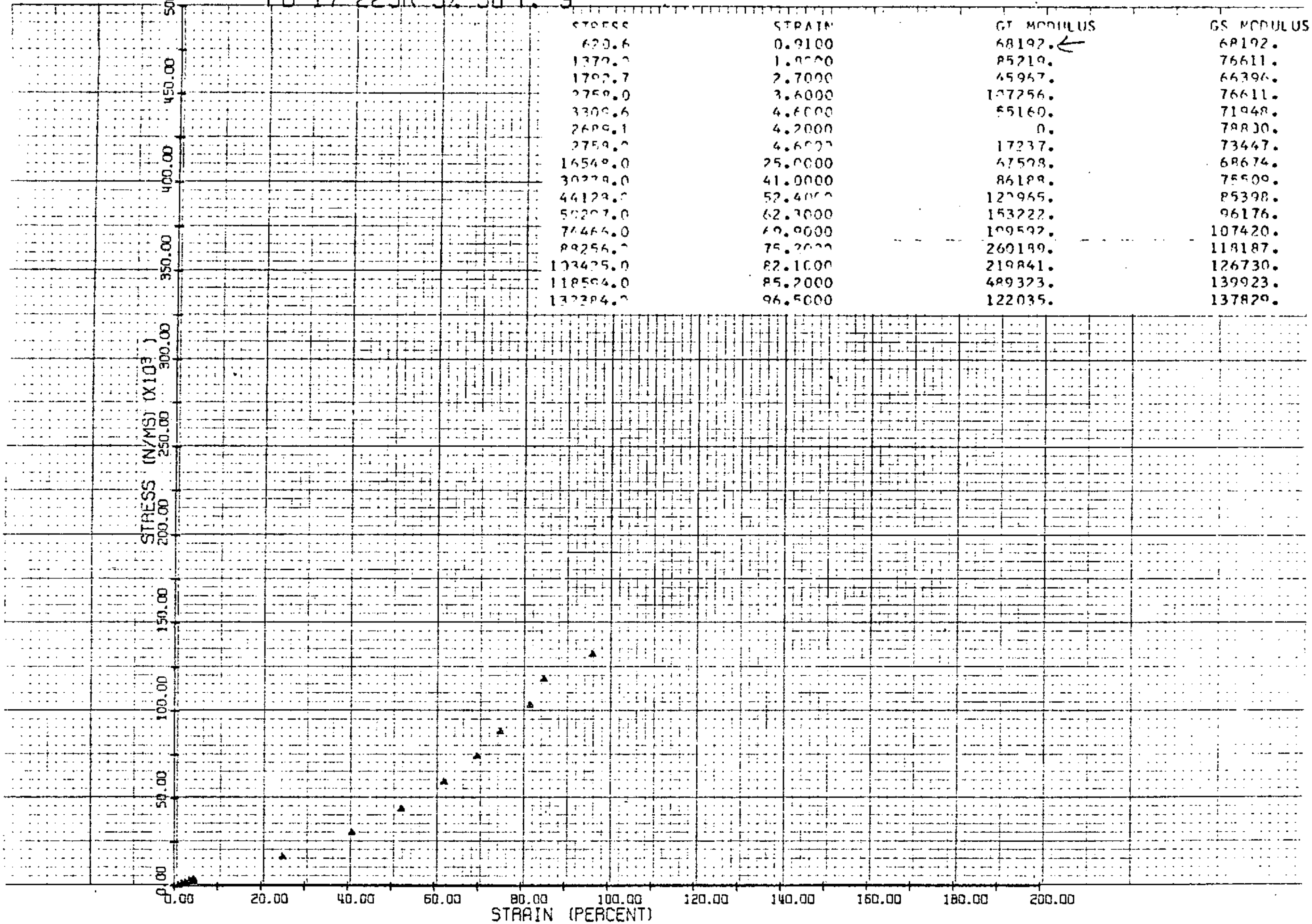
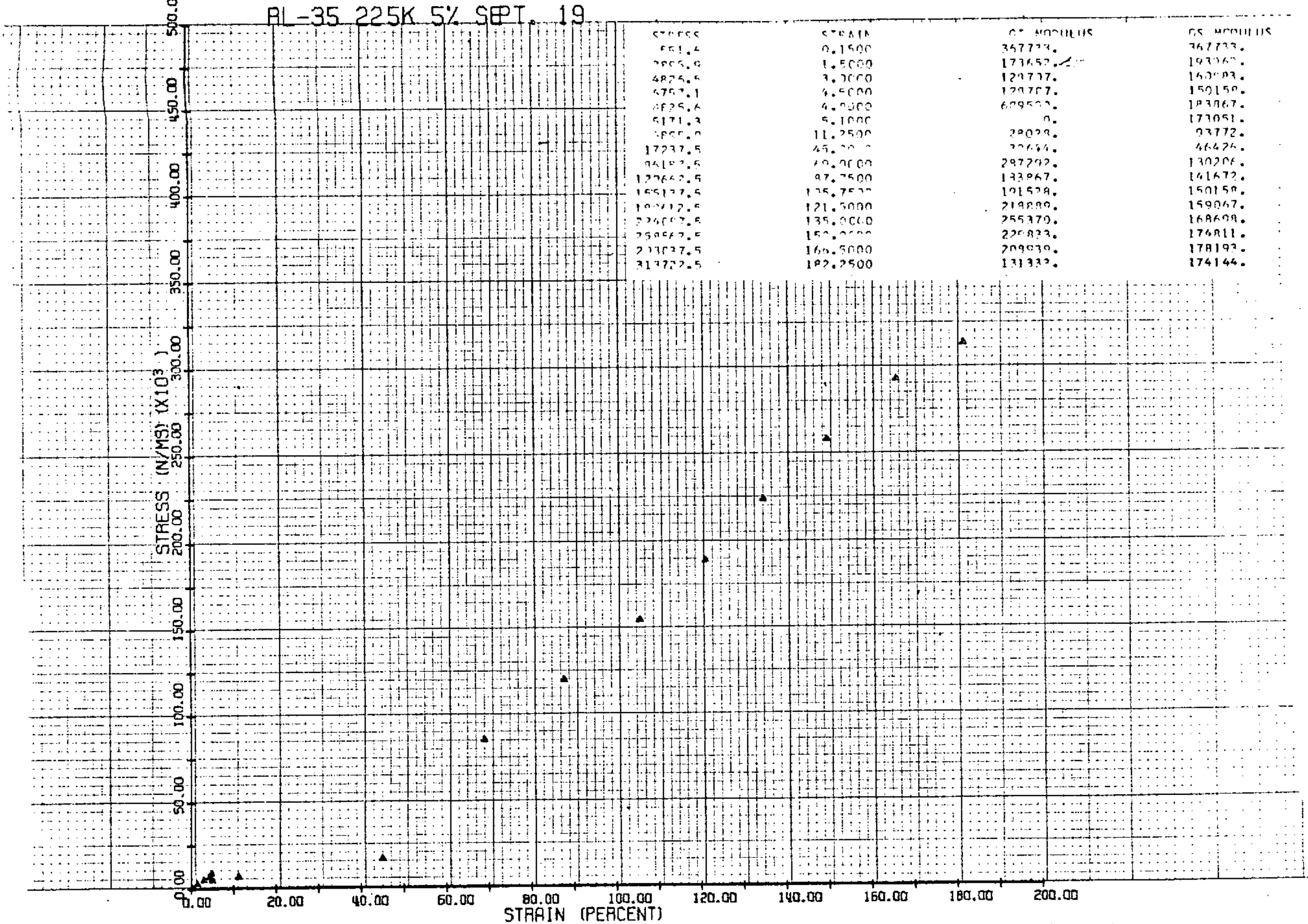
PD-17 225K 5% SEPT. 9

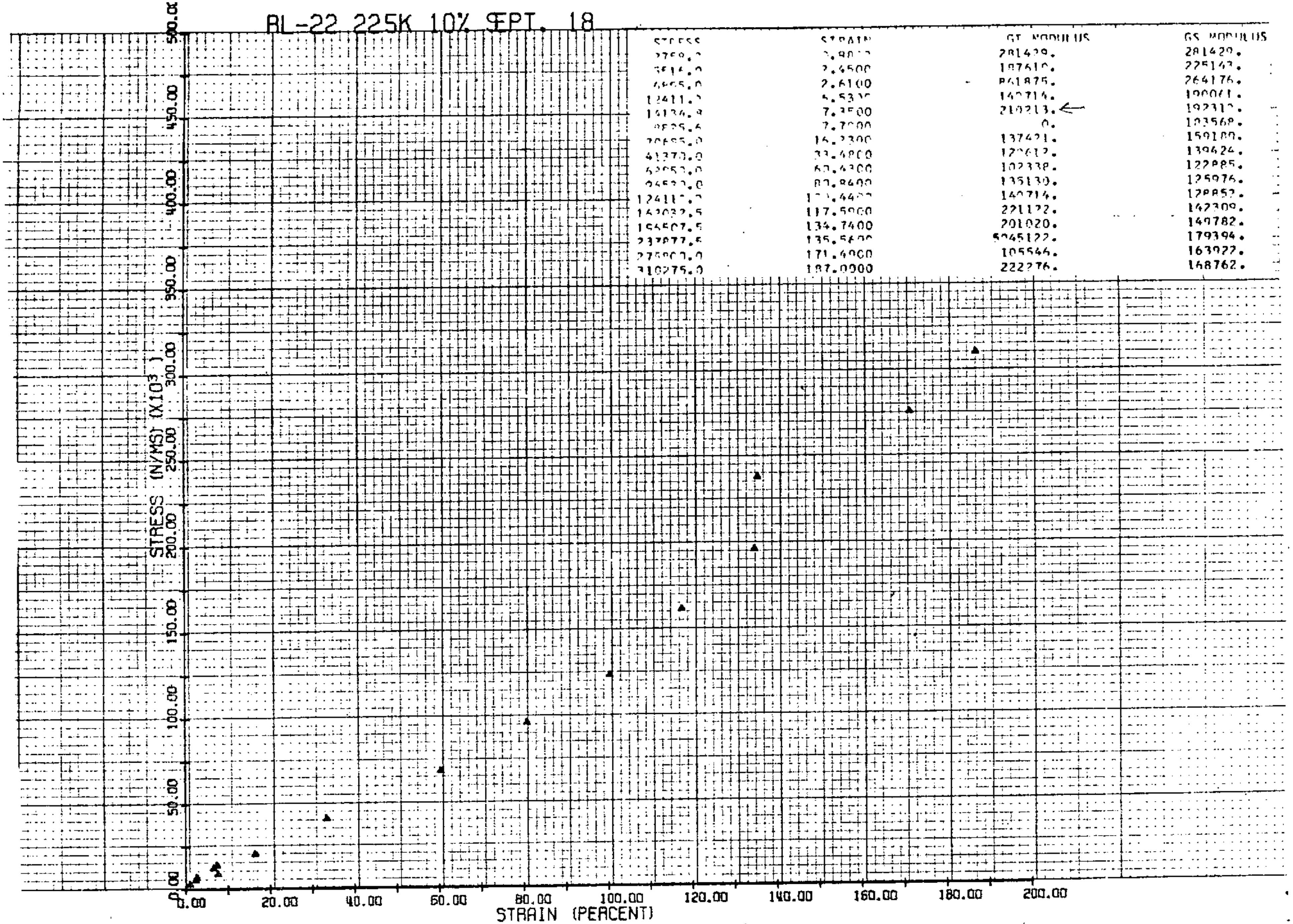


STRESS	STRAIN	GT MODULUS	GS MODULUS
620.6	0.9100	68192. ←	68192.
1379.0	1.8000	85219.	76611.
1792.7	2.7000	45967.	66396.
2758.0	3.6000	107256.	76611.
3309.6	4.6000	55160.	71948.
2689.1	4.2000	0.	78830.
2758.0	4.6000	17237.	73447.
16548.0	25.0000	67598.	68674.
30338.0	41.0000	86188.	75509.
44123.0	52.4000	120965.	85398.
59297.0	62.3000	153222.	96176.
74466.0	69.9000	199592.	107420.
88256.0	75.2000	260189.	118187.
103425.0	82.1000	219841.	126730.
118594.0	85.2000	489323.	139923.
132384.0	96.5000	122035.	137829.

101

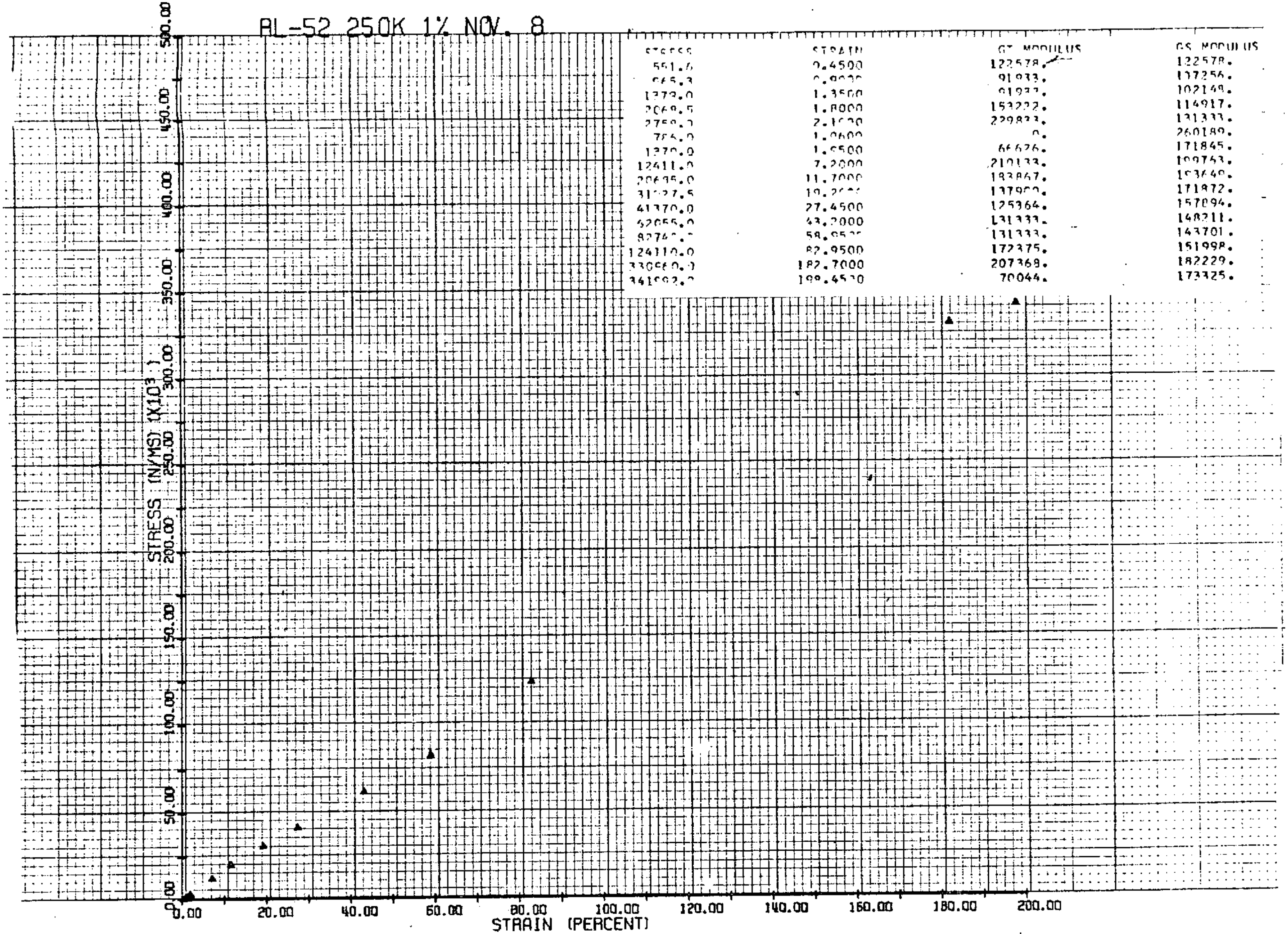


STRESS	STRAIN	CT MODULUS	CS MODULUS
551.4	0.1500	367733.	367733.
[illegible]5.9	1.5000	173652.	193067.
4875.5	3.0000	129737.	160[illegible]83.
6757.1	4.5000	129707.	150158.
8825.6	4.8000	689533.	183867.
5171.3	5.1000	0.	173051.
[illegible]	11.2500	28028.	93772.
17237.5	45.[illegible]	[illegible]	46426.
96187.5	69.0000	297292.	130206.
129662.5	97.7500	133867.	141672.
155177.5	105.75[illegible]	191528.	150158.
1[illegible]12.5	121.5000	219889.	159067.
[illegible]4087.5	135.0000	255370.	168698.
259562.5	15[illegible]	220833.	176811.
293037.5	166.5000	209939.	178193.
31[illegible]722.5	182.2500	131333.	174144.

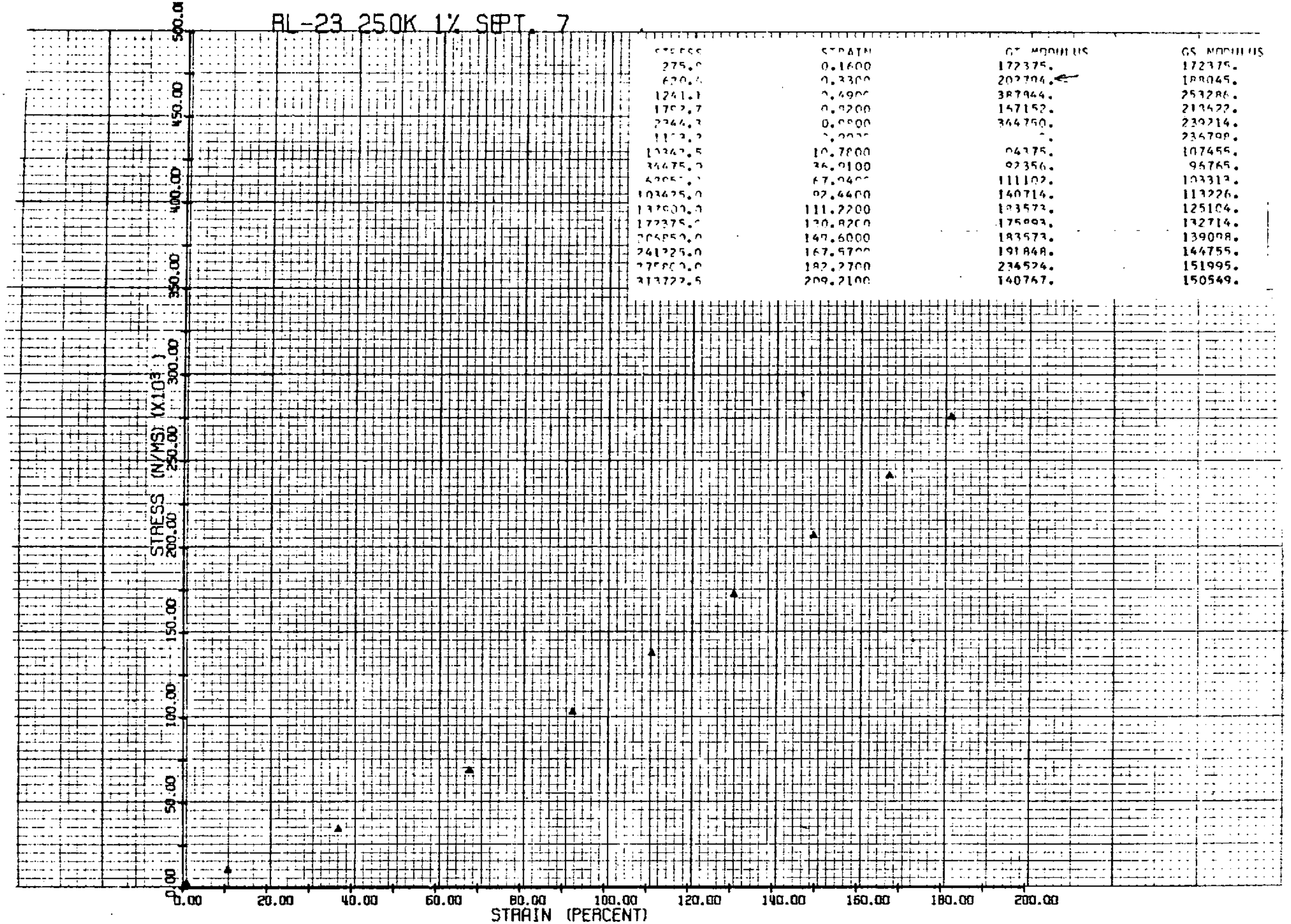


STRESS	STRAIN	GT MODULUS	GS MODULUS
2759.[illegible]	[illegible].90[illegible]	281429.	281429.
3514.0	2.4500	197610.	225143.
6895.0	2.6100	861875.	264176.
12411.[illegible]	6.5300	140714.	190061.
14134.9	7.3500	210213. ←	192312.
9825.6	7.7000	0.	123568.
20685.0	16.2300	137421.	159189.
41370.0	33.4800	120612.	139624.
62053.0	60.4300	102338.	122885.
945[illegible].0	83.8400	135130.	125976.
124110.[illegible]	[illegible].4400	140714.	128852.
162032.5	117.5900	221172.	142309.
194507.5	134.7400	201020.	149782.
237877.5	135.5600	5045122.	179394.
275803.0	171.4900	105546.	163922.
310275.0	187.0900	222276.	168762.

AL-52 250K 1% NOV. 8



STRESS	STRAIN	GT MODULUS	GS MODULUS
551.6	0.4500	122578.	122578.
965.3	0.9000	91933.	107256.
1379.0	1.3500	91933.	102149.
2068.5	1.8000	153222.	114917.
2758.0	2.1000	229833.	131333.
765.0	1.0600	0.	260189.
1379.0	1.9500	66676.	171845.
12411.0	7.2000	219133.	199763.
20685.0	11.7000	183867.	193649.
31027.5	19.2000	137900.	171872.
41370.0	27.4500	125364.	157094.
62055.0	43.2000	131333.	148211.
82740.0	58.9500	131333.	143701.
124110.0	82.9500	172375.	151998.
330960.0	182.7000	207369.	182229.
341992.0	199.4500	70044.	173325.

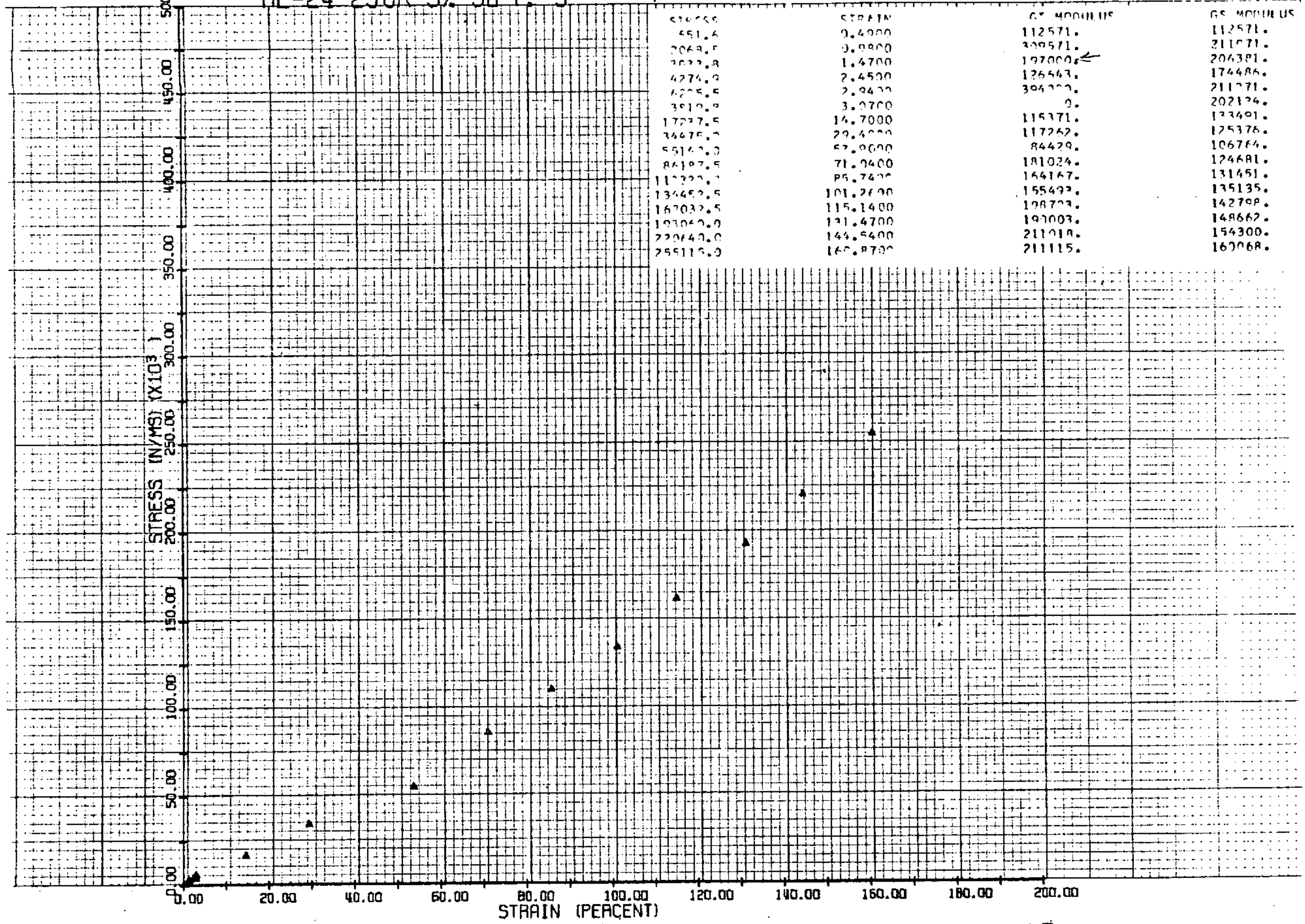


STRESS	STRAIN	GT MODULUS	GS MODULUS
275.0	0.1600	172375.	172375.
620.4	0.3300	207704.	188045.
1241.1	0.4900	387944.	253286.
1752.7	0.8200	157152.	213422.
2344.3	0.9800	364750.	239214.
[illegible]	[illegible]	[illegible]	236798.
13342.5	10.7800	94375.	107455.
34475.0	36.0100	92356.	95765.
[illegible]	67.9400	111102.	103313.
103425.0	92.4400	140714.	113226.
137900.0	111.2200	183573.	125104.
172375.0	130.8200	175893.	132714.
206850.0	147.6000	183573.	139098.
241325.0	167.5700	191848.	144755.
275800.0	182.2700	234524.	151995.
313722.5	209.2100	140767.	150549.

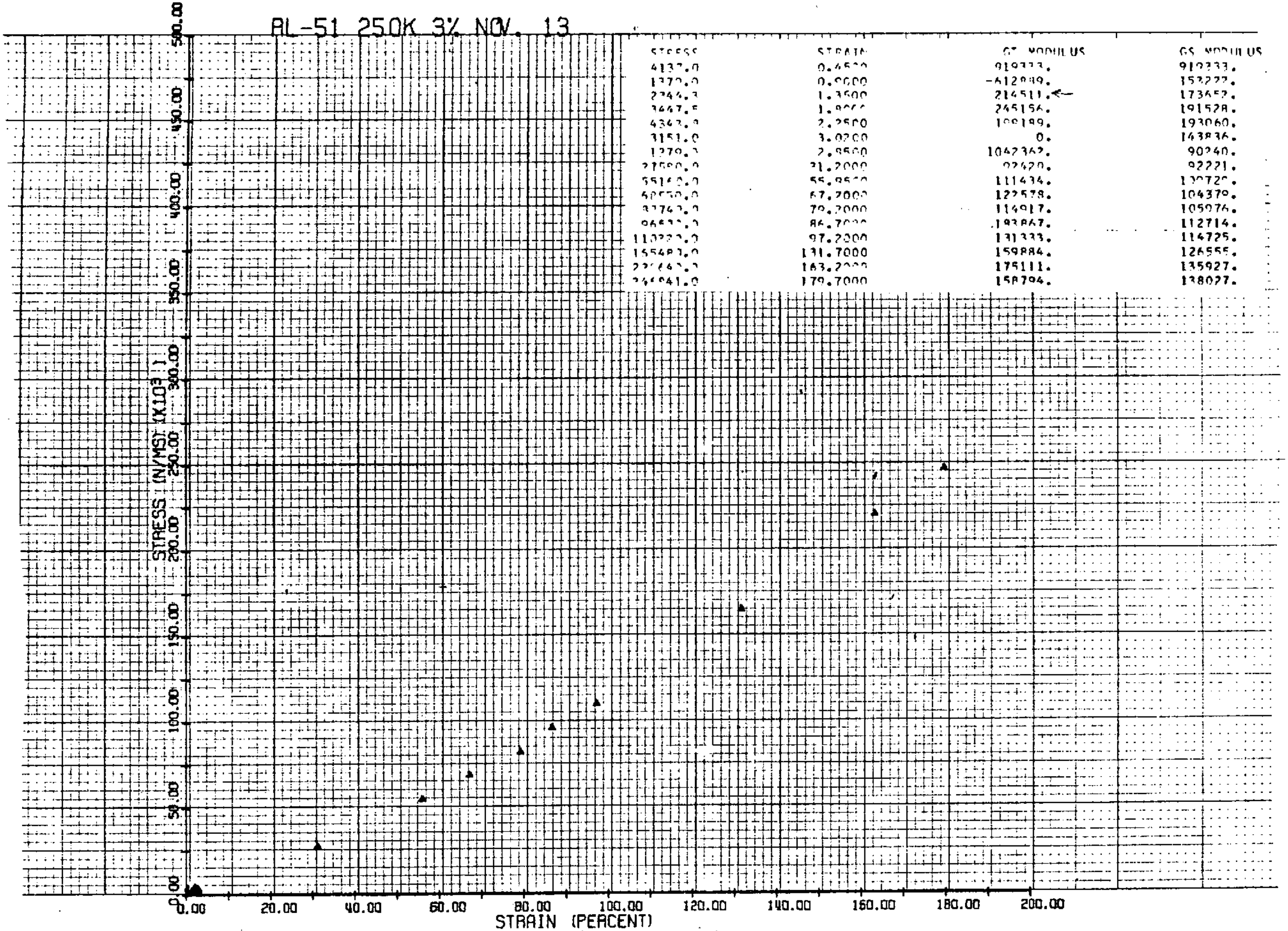
105

1064

BL-24 250K 3% SEPT. 5

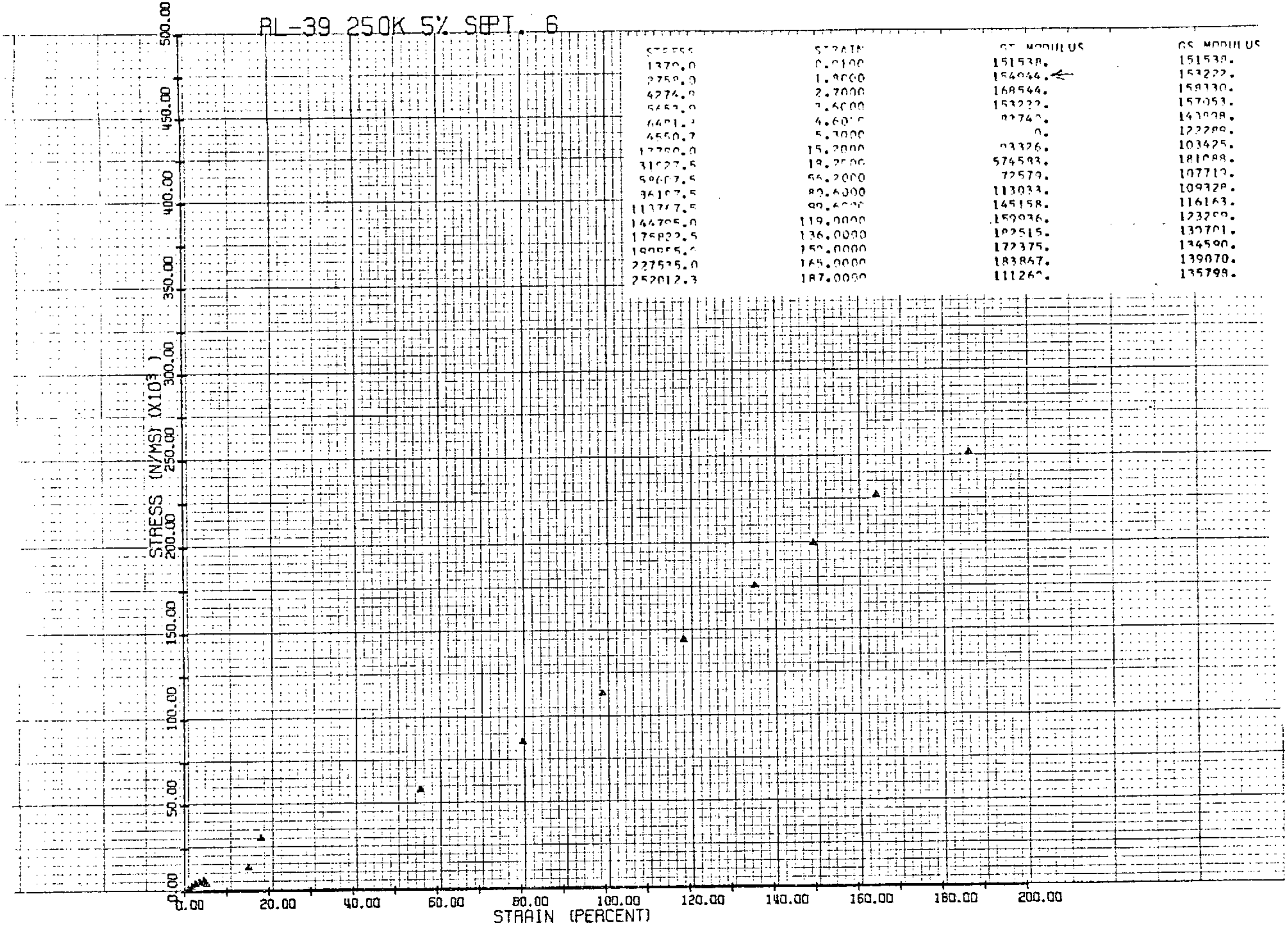


STRESS	STRAIN	GT MODULUS	GS MODULUS
551.6	0.4900	112571.	112571.
2068.5	0.9800	309571.	211071.
2922.8	1.4700	197000. ←	206381.
4274.9	2.4500	126563.	174486.
6205.5	2.9400	394000.	211071.
3919.8	3.9700	0.	202134.
17237.5	14.7000	115371.	133491.
34475.0	29.4000	117262.	125376.
55162.0	52.9000	84429.	106764.
86187.5	71.9400	181024.	124681.
112322.5	85.7400	164167.	131451.
134452.5	101.2600	155493.	135135.
162032.5	115.1400	198793.	142798.
193060.0	131.4700	190003.	148662.
220640.0	144.5400	211018.	154300.
255115.0	160.8700	211115.	160068.



STRESS	STRAIN	GT MODULUS	GS MODULUS
4137.0	0.4500	919333.	919333.
1379.0	0.9000	-612889.	153222.
2344.3	1.3500	214511. ←	173652.
3447.5	1.8000	245156.	191528.
4343.9	2.2500	199199.	193060.
3151.0	3.0200	0.	143836.
1379.3	2.9500	1042362.	90240.
27580.0	31.2000	92420.	92221.
55160.0	55.9500	111434.	100720.
68950.0	67.2000	122578.	104379.
83742.9	79.2000	114917.	105976.
96532.9	86.7000	193867.	112714.
110322.9	97.2000	131333.	114725.
155483.0	131.7000	159884.	126555.
221663.3	163.2000	175111.	135927.
248041.0	179.7000	158794.	138027.

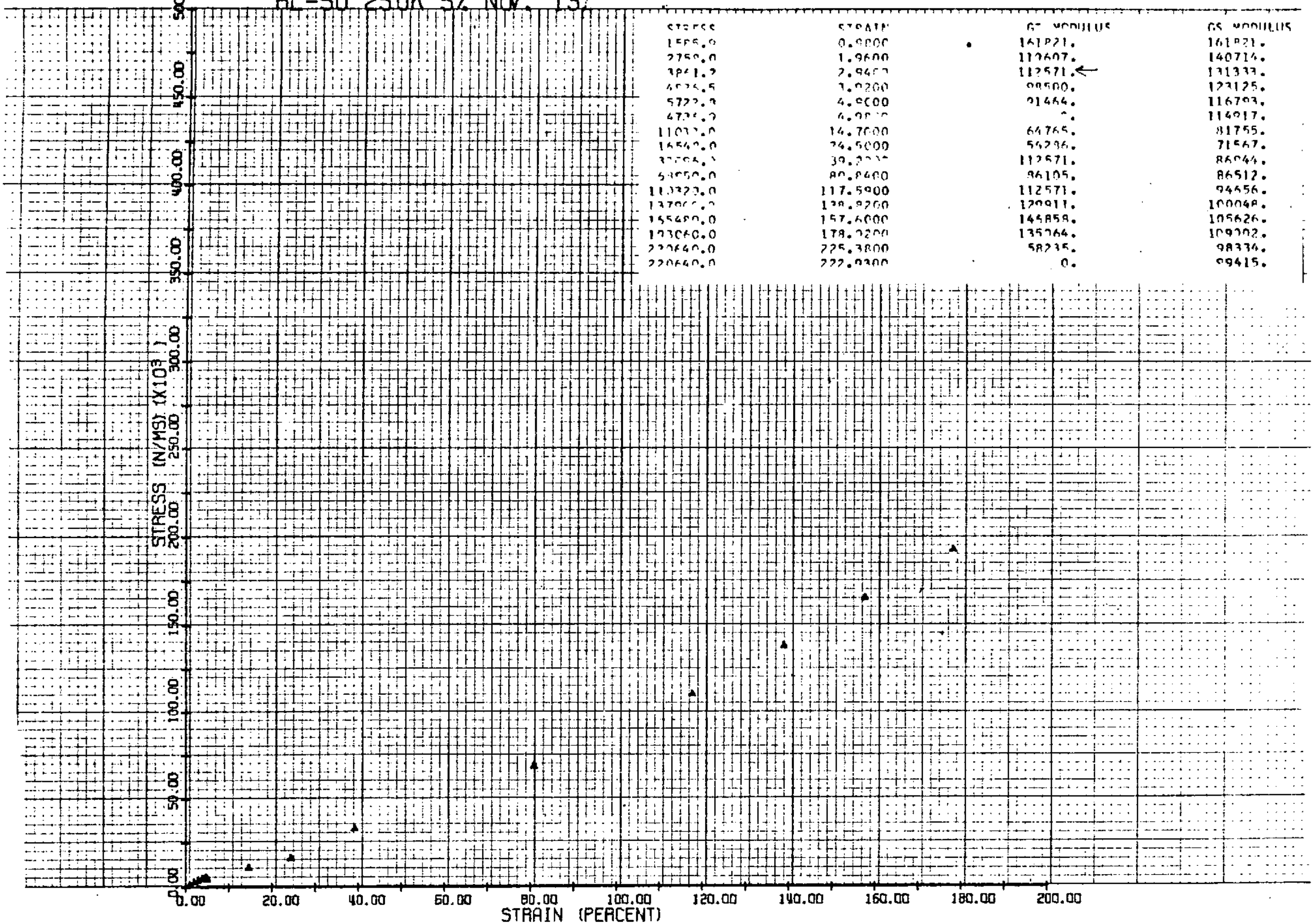
K+E KEUFFEL & ESSER CO. PRINTED IN U.S.A.

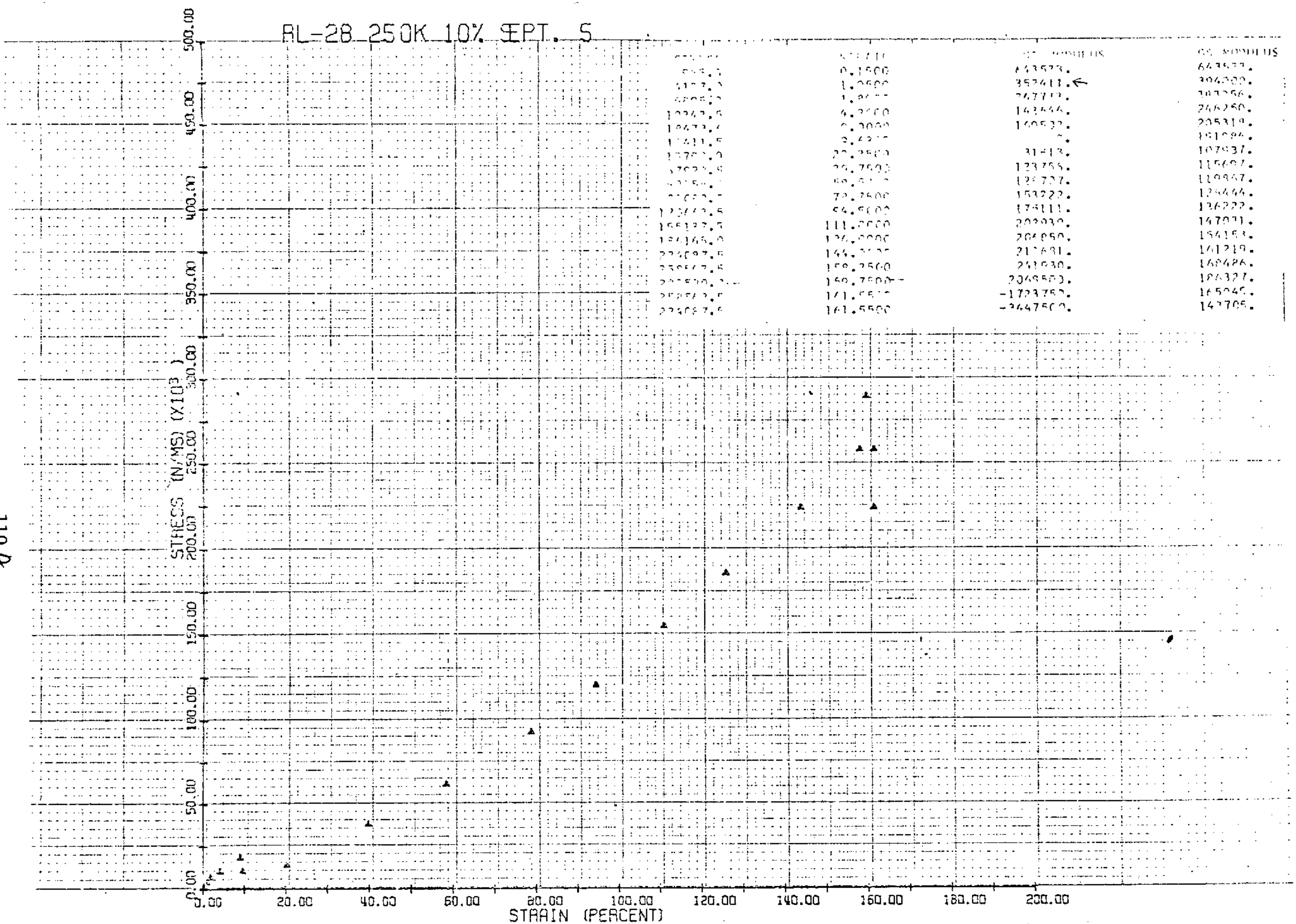


STRESS	STRAIN	GT MODULUS	GS MODULUS
1379.0	0.9100	151538.	151538.
2758.0	1.8000	154944. ←	153222.
4274.9	2.7000	168544.	158330.
5653.9	3.6000	153222.	157053.
6621.3	4.6015	92742.	143998.
4550.7	5.3000	0.	122289.
13790.0	15.2000	93326.	103425.
31027.5	18.2500	574593.	181088.
59607.5	55.2000	72579.	107712.
86197.5	80.6000	113033.	109328.
113747.5	99.6000	145158.	116163.
144795.0	119.0000	159936.	123259.
175822.5	136.0000	182515.	130701.
199955.0	150.0000	172375.	134590.
227535.0	165.0000	183867.	139070.
252012.3	187.0000	111269.	135798.

AL-50 250K 5% NOV. 13

STRESS	STRAIN	GT MODULUS	GS MODULUS
1585.0	0.9800	161821.	161821.
2759.0	1.9600	112607.	140714.
3861.2	2.9400	112571. ←	131333.
4825.5	3.9200	98500.	123125.
5722.8	4.9000	91464.	116793.
4735.2	[illegible]	0.	114917.
11032.0	14.7000	64765.	81755.
16540.0	24.5000	56296.	71567.
[illegible]	[illegible]	112571.	86044.
53850.0	80.8400	96105.	86512.
110323.0	117.5900	112571.	94656.
137966.0	138.9200	129911.	100048.
155480.0	157.6000	145858.	105626.
193060.0	178.3200	135364.	109302.
220640.0	225.3800	58235.	98334.
220640.0	222.9300	0.	99415.





STRESS	STRAIN	[illegible] MODULUS	CS MODULUS
[illegible]	0.1500	643573.	643577.
4127.[illegible]	1.0500	357411. ←	394000.
6605.[illegible]	1.9[illegible]	247713.	303256.
10242.5	4.2600	143666.	246250.
19673.4	[illegible].3000	160532.	205319.
1[illegible]411.5	[illegible].4[illegible]	0.	191094.
1[illegible]70[illegible].0	2[illegible].2500	31413.	107937.
[illegible]702[illegible].5	[illegible].7500	123755.	115697.
[illegible]	[illegible]	125737.	119967.
[illegible]	72.7500	153222.	126444.
12[illegible].5	54.5000	175111.	136222.
155122.5	111.0000	202030.	147071.
184165.0	126.0000	206950.	154153.
224097.5	144.[illegible]	217691.	161219.
259567.5	159.2500	251930.	168486.
[illegible]	160.7500	2049553.	186327.
[illegible]	161.[illegible]	-1723752.	165045.
224087.5	161.5500	-2447500.	143705.

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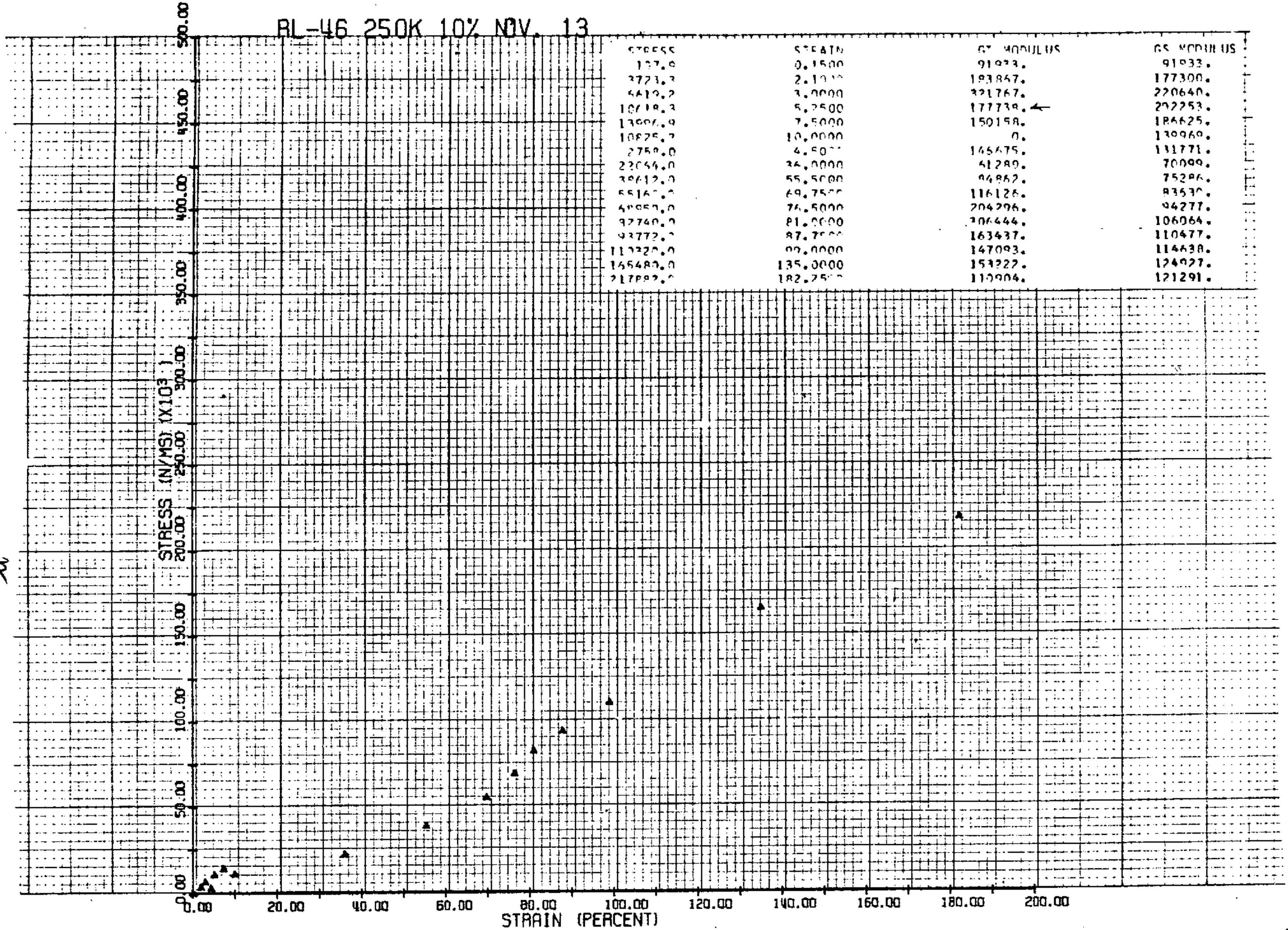
KEUFFEL &

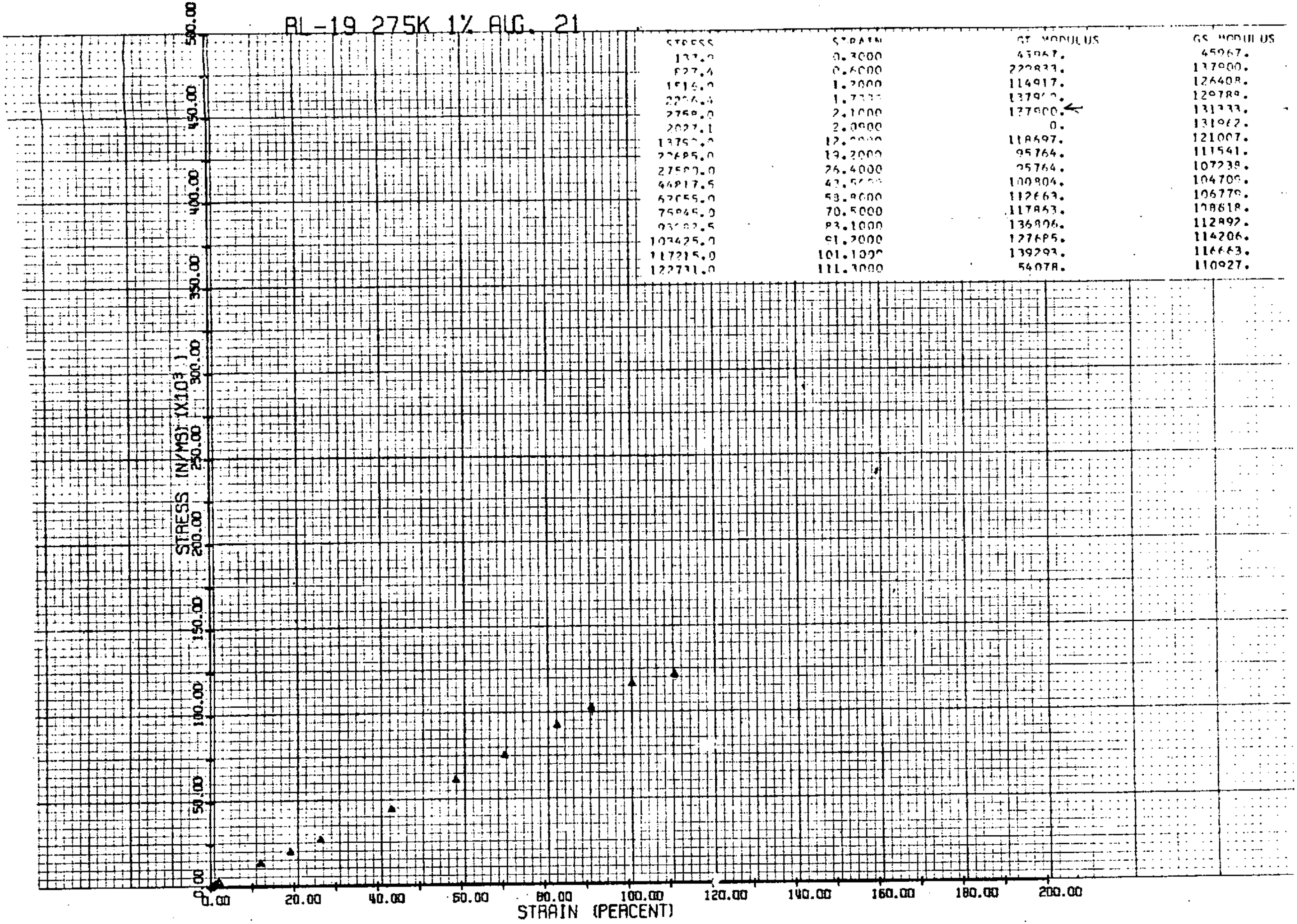
RL-46 250K 10% NOV. 13



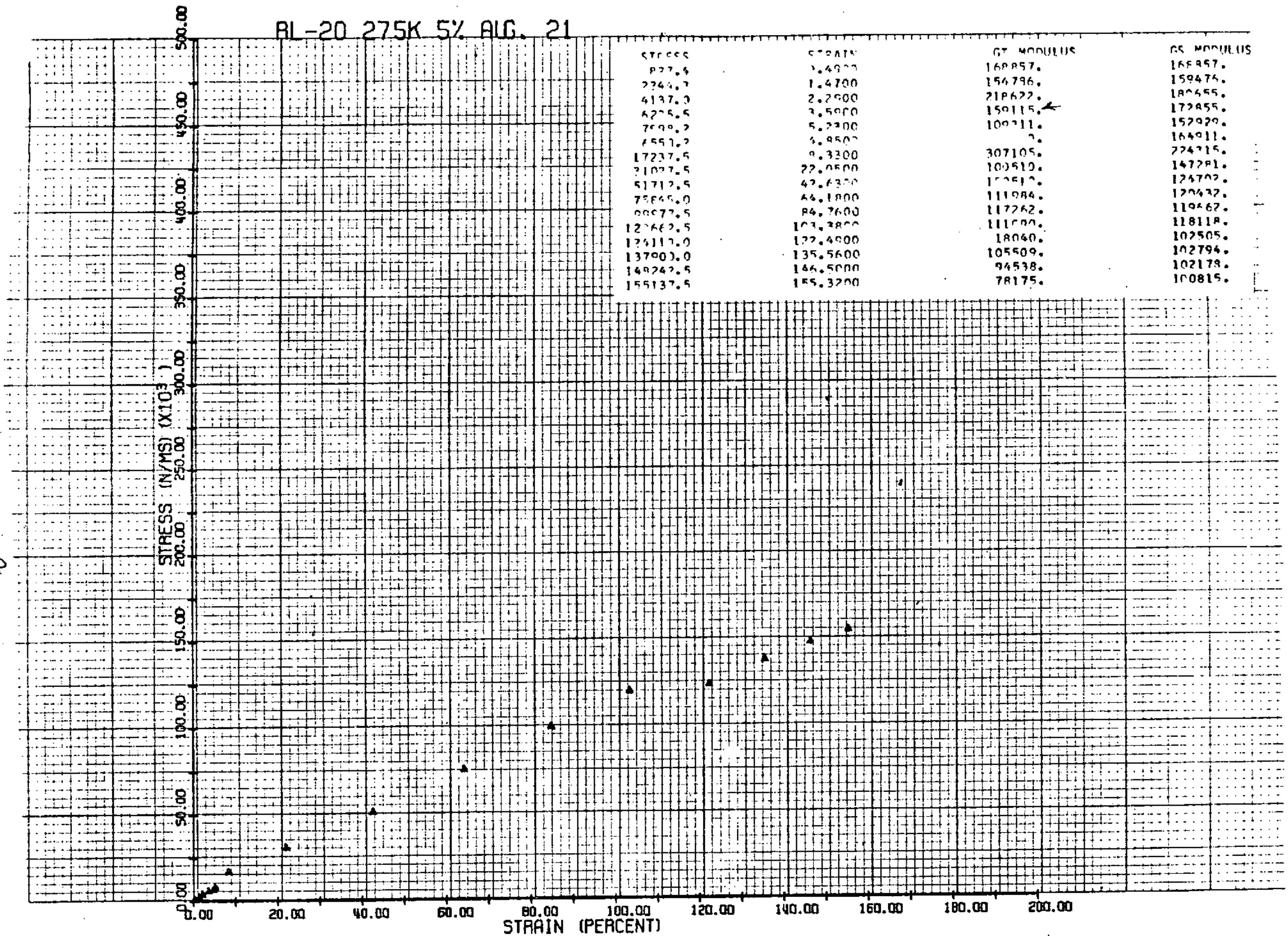
STRESS	STRAIN	GT MODULUS	GS MODULUS
137.9	0.1500	91933.	91933.
3723.3	2.1000	193867.	177300.
6619.2	3.0000	321767.	220640.
10618.3	5.2500	177739. ←	202253.
13996.9	7.5000	150158.	186625.
10875.7	10.0000	0.	139969.
2758.0	4.5000	145675.	131771.
22054.0	36.0000	61289.	70099.
39612.0	55.5000	94862.	75286.
55160.0	69.7500	116126.	83530.
68953.0	76.5000	204296.	94277.
92740.0	81.0000	306444.	106064.
93772.0	87.7500	163437.	110477.
113320.0	99.0000	147093.	114638.
165480.0	135.0000	153222.	124927.
217882.0	182.2500	110904.	121291.

AL-19 275K 1% AUG. 21

STRESS	STRAIN	GT MODULUS	GS MODULUS
137.9	0.3000	45967.	45967.
827.4	0.6000	229833.	137900.
1516.9	1.2000	114917.	126408.
2206.4	1.7333	137900.	129789.
2758.0	2.1000	137900. ←	131333.
2027.1	2.0900	0.	131962.
13790.0	12.0000	118697.	121007.
22685.0	19.2000	95764.	111541.
27580.0	26.4000	95764.	107238.
44817.5	42.5000	100804.	104709.
62055.0	58.8000	112663.	106779.
75845.0	70.5000	117863.	108618.
93082.5	83.1000	136806.	112892.
103425.0	91.2000	127685.	114206.
117215.0	101.1000	139293.	116663.
122731.0	111.3000	54078.	110927.



112 A

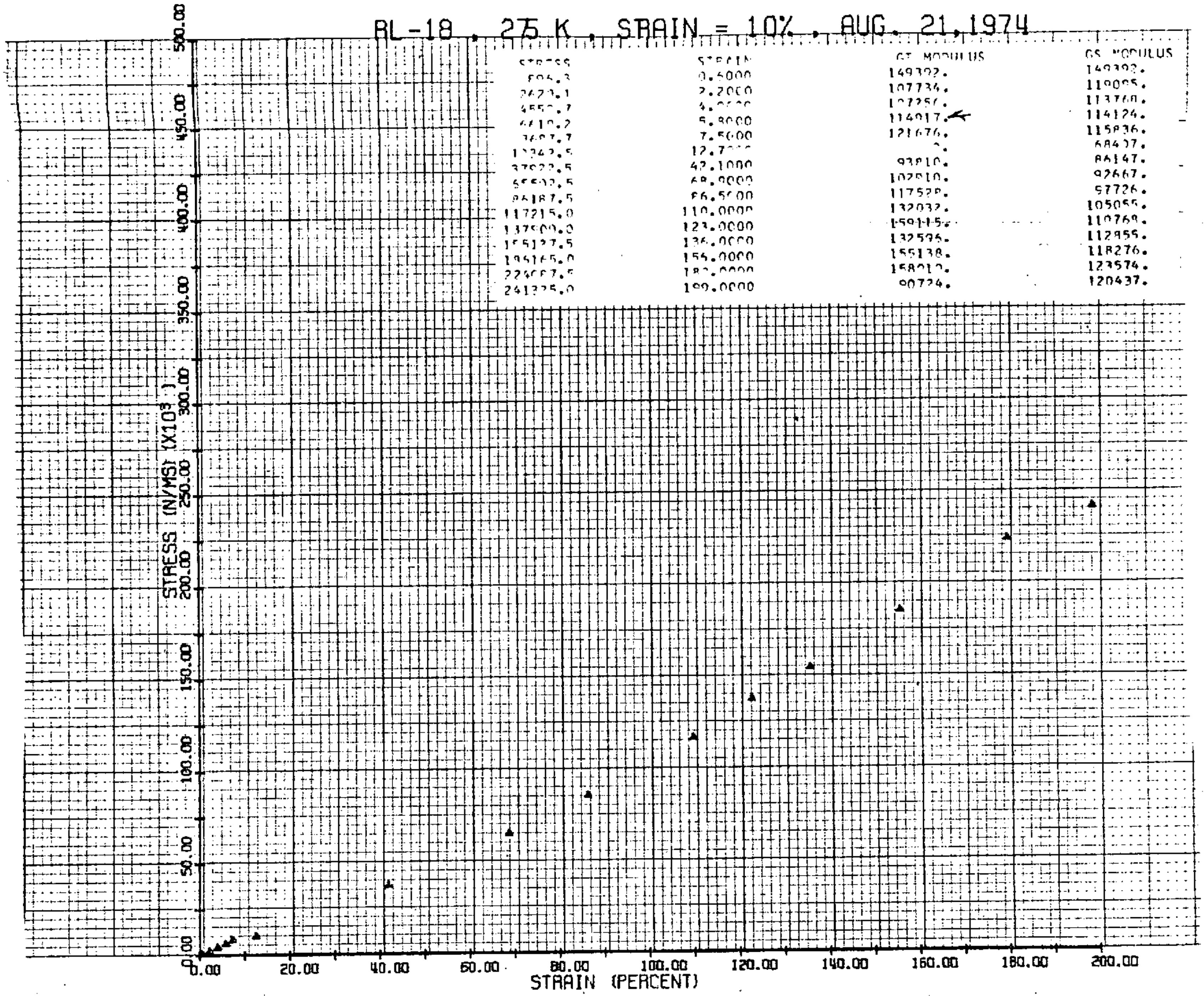


STRESS	STRAIN	GT MODULUS	GS MODULUS
827.5	0.4900	168857.	168857.
2244.7	1.4700	154796.	159476.
4137.0	2.2900	218622.	180655.
6205.5	3.5900	159115. ←	172855.
7599.2	5.2300	109911.	152929.
6551.2	6.9500	0.	164911.
17237.5	9.3300	307105.	224315.
31027.5	22.0500	100510.	147281.
51712.5	42.6300	100510.	124702.
75845.0	64.1800	111984.	120432.
99972.5	84.7600	117262.	119662.
120662.5	103.3800	111600.	118118.
134117.0	122.4900	18040.	102505.
137900.0	135.5600	105509.	102794.
148242.5	146.5000	94538.	102178.
155137.5	155.3200	78175.	100815.

113Ø

K•E KEUFFEL & ESSER CO. PRINTED IN U.S.A.

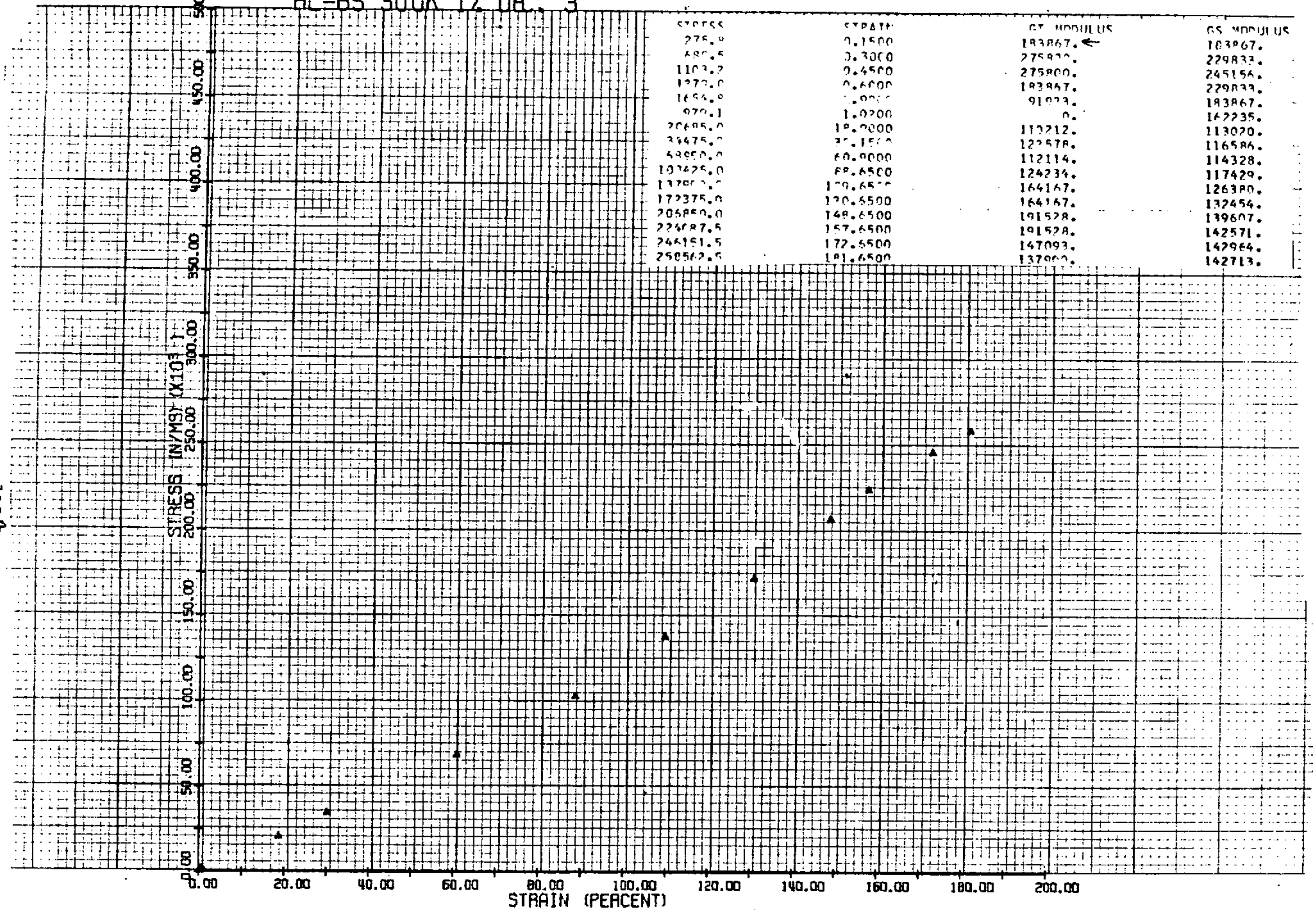
RL-18 , 275 K , STRAIN = 10% , AUG. 21,1974



STRESS	STRAIN	GT MODULUS	GS MODULUS
604.3	0.5000	149392.	149392.
2623.1	2.2000	107734.	119095.
4550.7	4.0000	107256.	113760.
6619.2	5.8000	114917.	114124.
8687.7	7.5000	121676.	115836.
10342.5	12.7000	0.	68407.
37922.5	42.1000	93810.	86147.
65502.5	68.9000	102810.	92667.
86187.5	86.5000	117528.	97726.
117215.0	110.0000	132032.	105055.
137900.0	123.0000	159115.	110769.
155127.5	136.0000	132596.	112955.
195165.0	154.0000	155138.	118276.
224087.5	182.0000	158912.	123574.
241325.0	199.0000	90724.	120437.

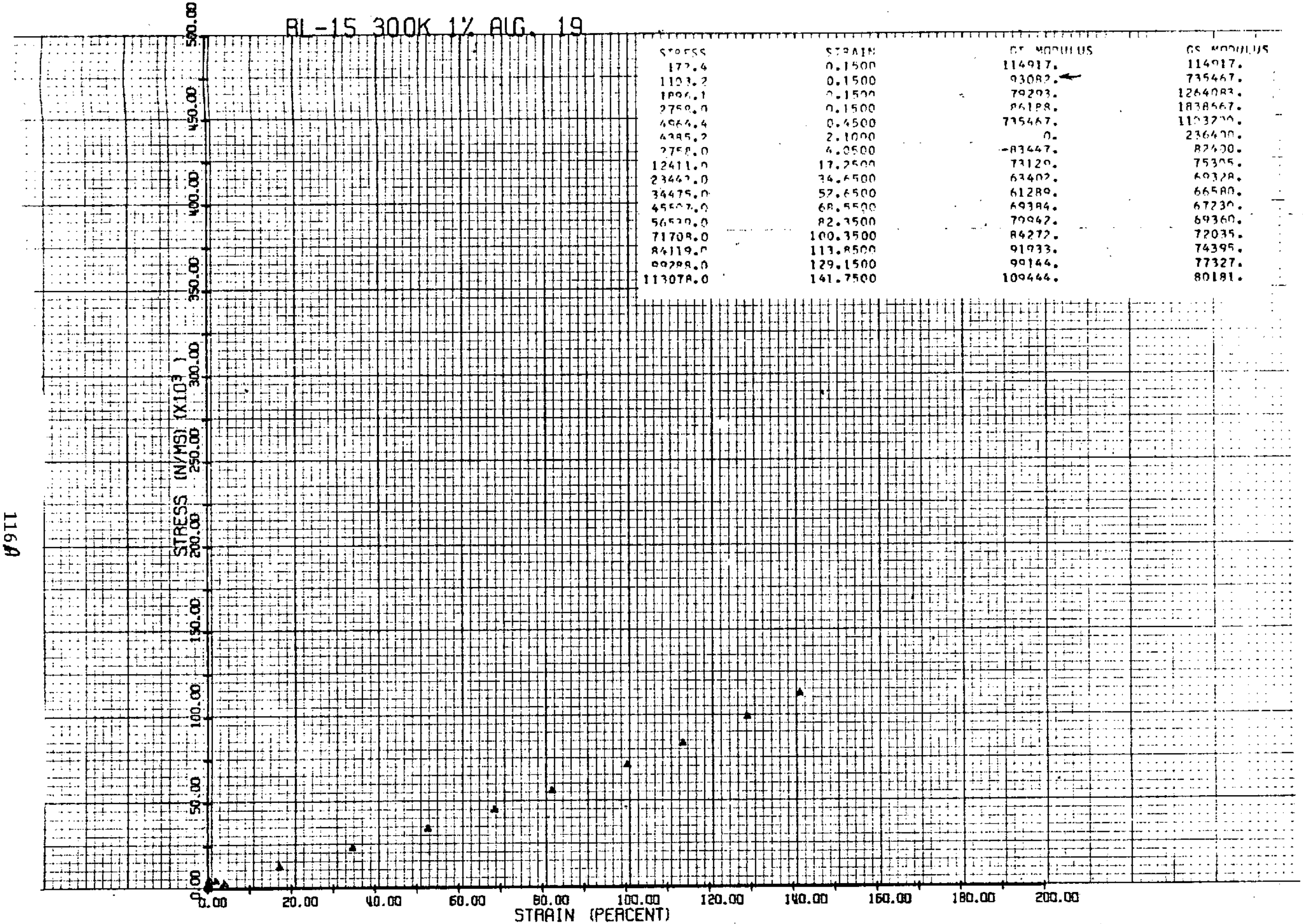
114

BL-65 300K 1% DEC. 3



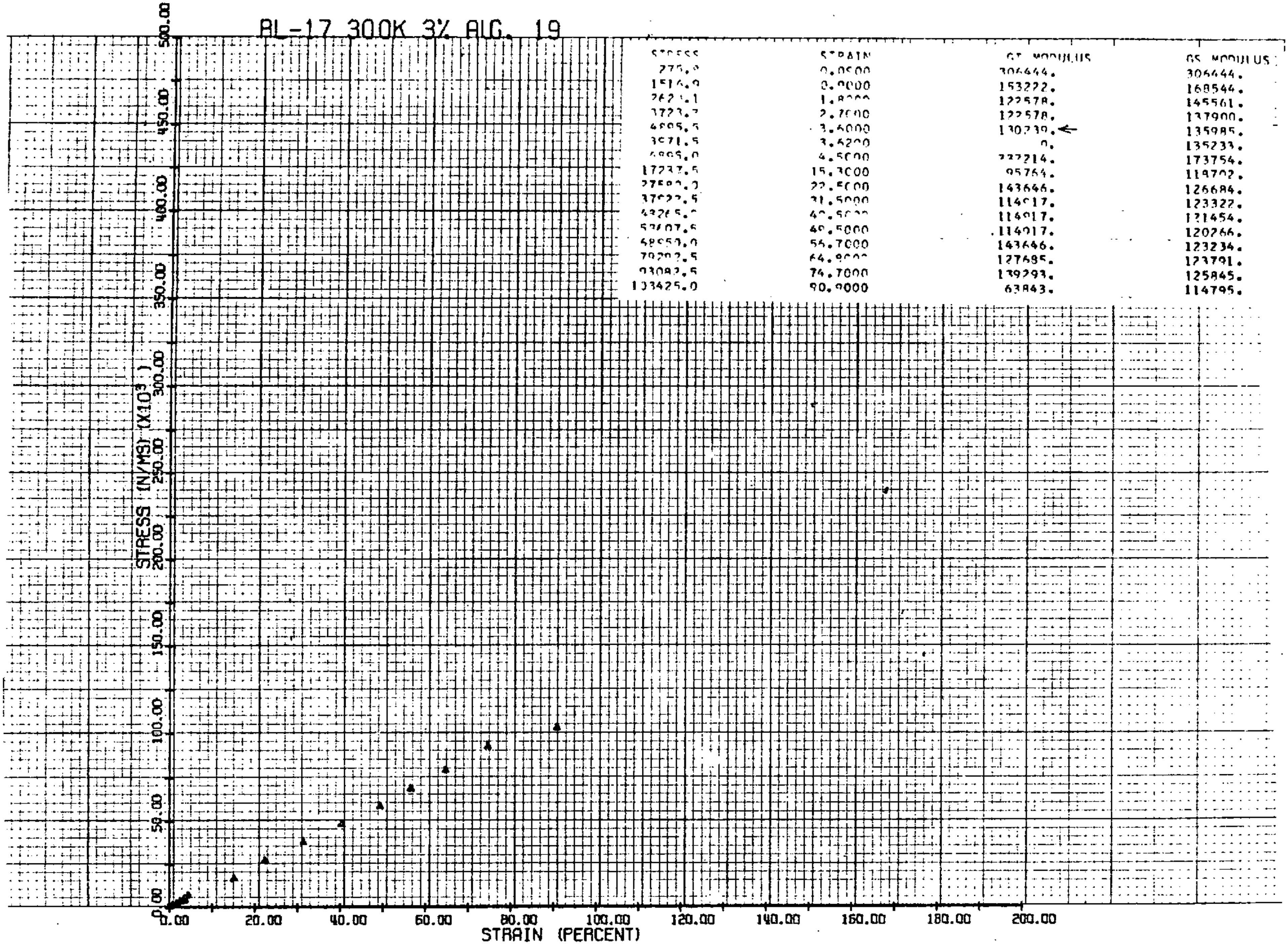
STRESS	STRAIN	GT MODULUS	GS MODULUS
275.8	0.1500	183867. ←	183867.
689.5	0.3000	275933.	229833.
1103.2	0.4500	275800.	245156.
1379.0	0.6000	183867.	229833.
1654.8	0.9000	91933.	183867.
970.1	1.0200	0.	162235.
20685.0	18.0000	113212.	113020.
34475.0	30.1500	122578.	116586.
68950.0	60.9000	112114.	114328.
103425.0	88.6500	124234.	117429.
137900.0	109.6500	164167.	126380.
172375.0	130.6500	164167.	132454.
205850.0	148.6500	191528.	139607.
224087.5	157.6500	191528.	142571.
246151.5	172.6500	147093.	142964.
258562.5	181.6500	137900.	142713.

1154



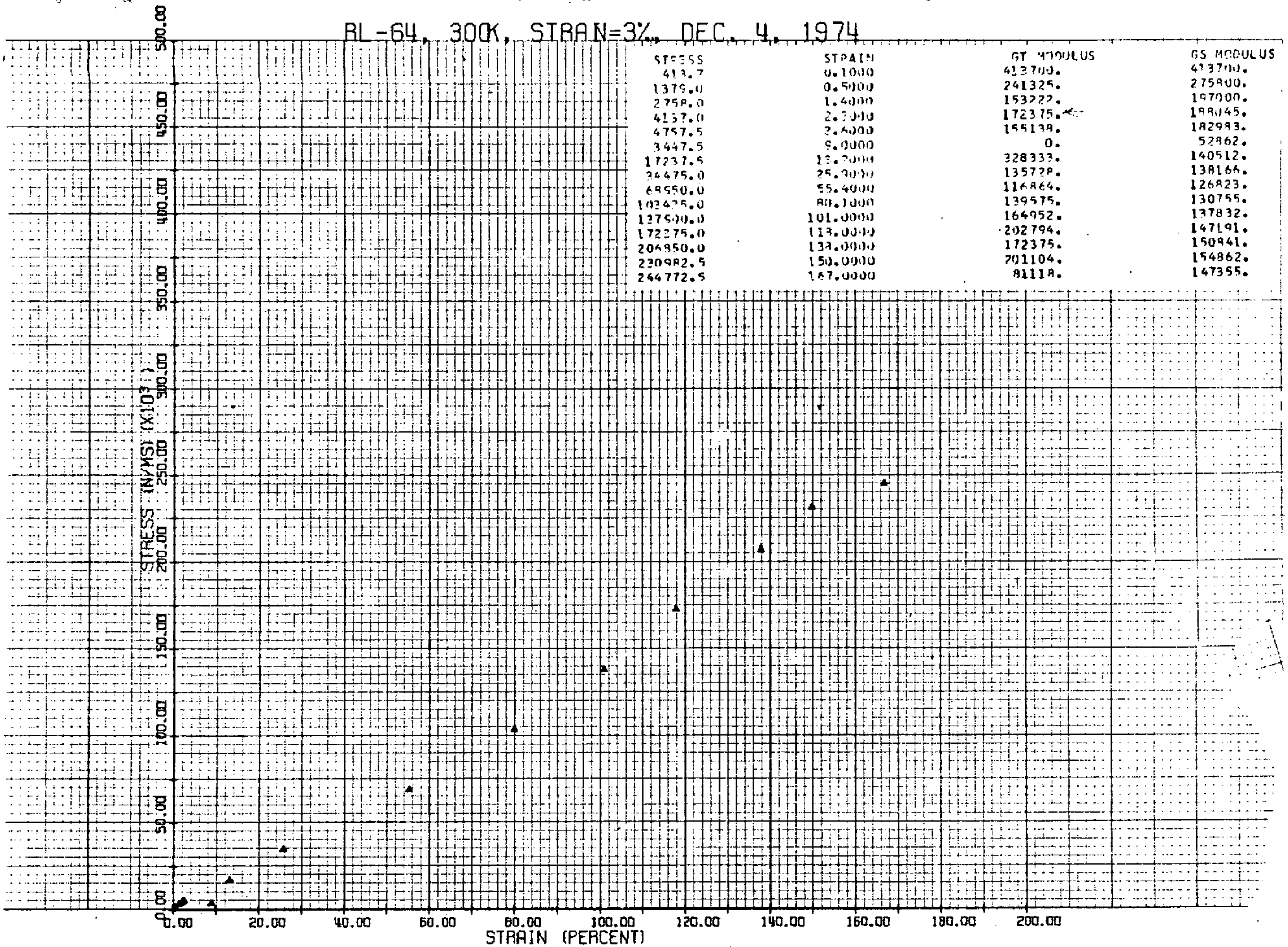
STRESS	STRAIN	CT MODULUS	GS MODULUS
172.4	0.1500	114917.	114917.
1103.2	0.1500	93082. ←	735467.
1896.1	0.1500	79293.	1264083.
2758.0	0.1500	86188.	1838667.
4964.4	0.4500	735467.	1103200.
4385.2	2.1000	0.	236400.
2758.0	4.0500	-83447.	82400.
12411.0	17.2500	73129.	75305.
23442.0	34.6500	63402.	69328.
34475.0	57.6500	61289.	66580.
45507.0	68.5500	69384.	67230.
56539.0	82.3500	79942.	69360.
71708.0	100.3500	84272.	72035.
84119.0	113.8500	91933.	74395.
99288.0	129.1500	99144.	77327.
113078.0	141.7500	109444.	80181.

117



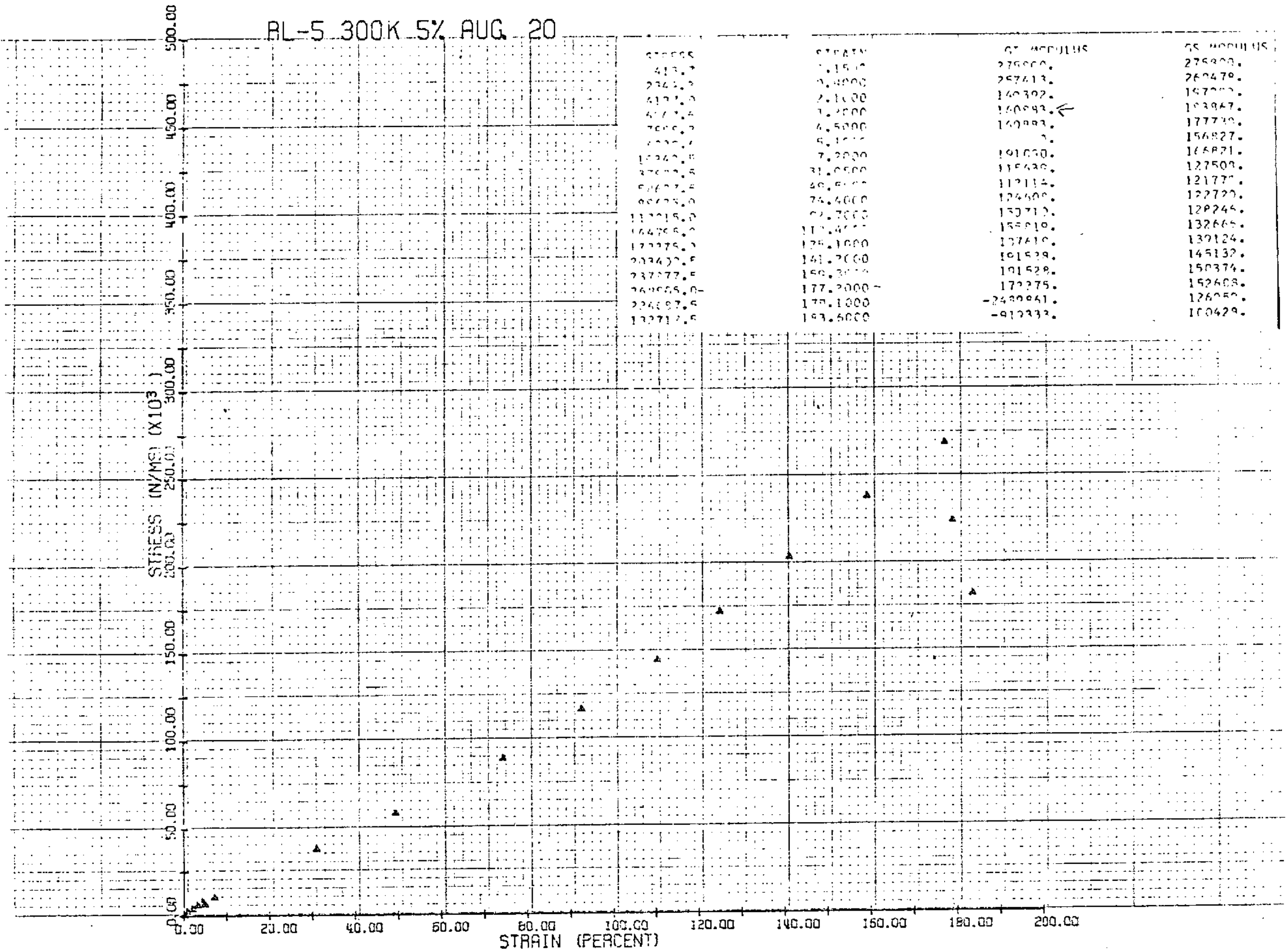
STRESS	STRAIN	GT MODULUS	GS MODULUS
275.9	0.0500	306444.	306444.
1516.9	0.9000	153222.	168544.
2623.1	1.8000	122578.	145561.
3723.7	2.7000	122578.	137900.
4895.5	3.6000	130239. ←	135985.
3571.5	3.6200	0.	135233.
6905.0	4.5000	337214.	173754.
17237.5	15.3000	95764.	119702.
27590.0	22.5000	143646.	126684.
37922.5	31.5000	114917.	123322.
49265.0	40.5000	114917.	121454.
59607.5	49.5000	114917.	120266.
68959.0	56.7000	143646.	123234.
79292.5	64.9000	127685.	123791.
93082.5	74.7000	139293.	125845.
103425.0	90.9000	63843.	114795.

RL-64, 300K, STRAIN=3%, DEC. 4, 1974



STRESS	STRAIN	GT MODULUS	GS MODULUS
413.7	0.1000	413700.	413700.
1379.0	0.5000	241325.	275800.
2758.0	1.4000	153222.	197000.
4137.0	2.3000	172375. ←	198045.
4757.5	2.6000	155138.	182983.
3447.5	9.0000	0.	52862.
17237.5	13.2000	328333.	140512.
34475.0	25.3000	135728.	138166.
68950.0	55.4000	116864.	126823.
103425.0	80.1000	139575.	130755.
137500.0	101.0000	164952.	137832.
172275.0	113.0000	202794.	147191.
206850.0	138.0000	172375.	150941.
230982.5	150.0000	201104.	154862.
244772.5	167.0000	81118.	147355.

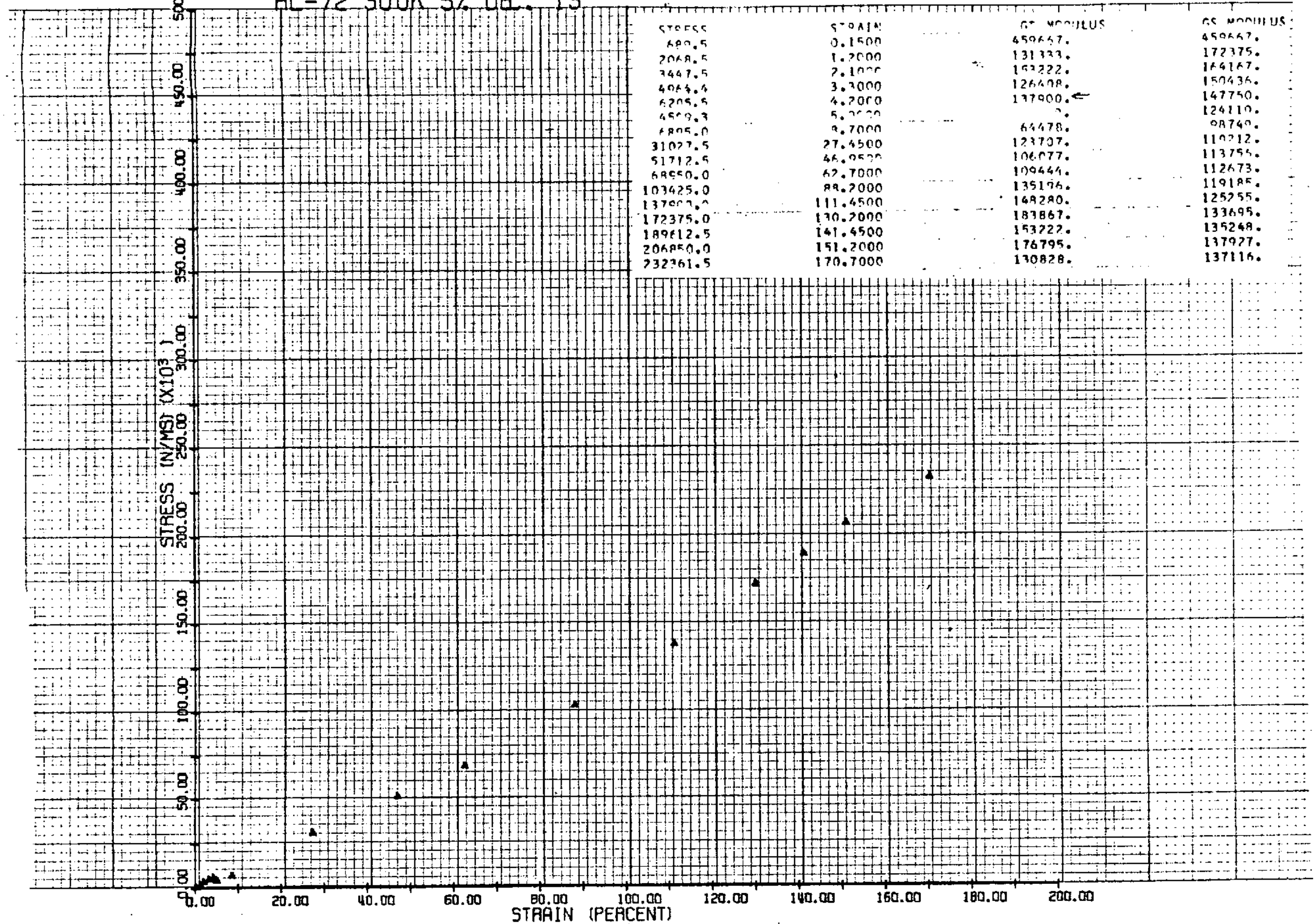
AL-5 300K 5% AUG. 20

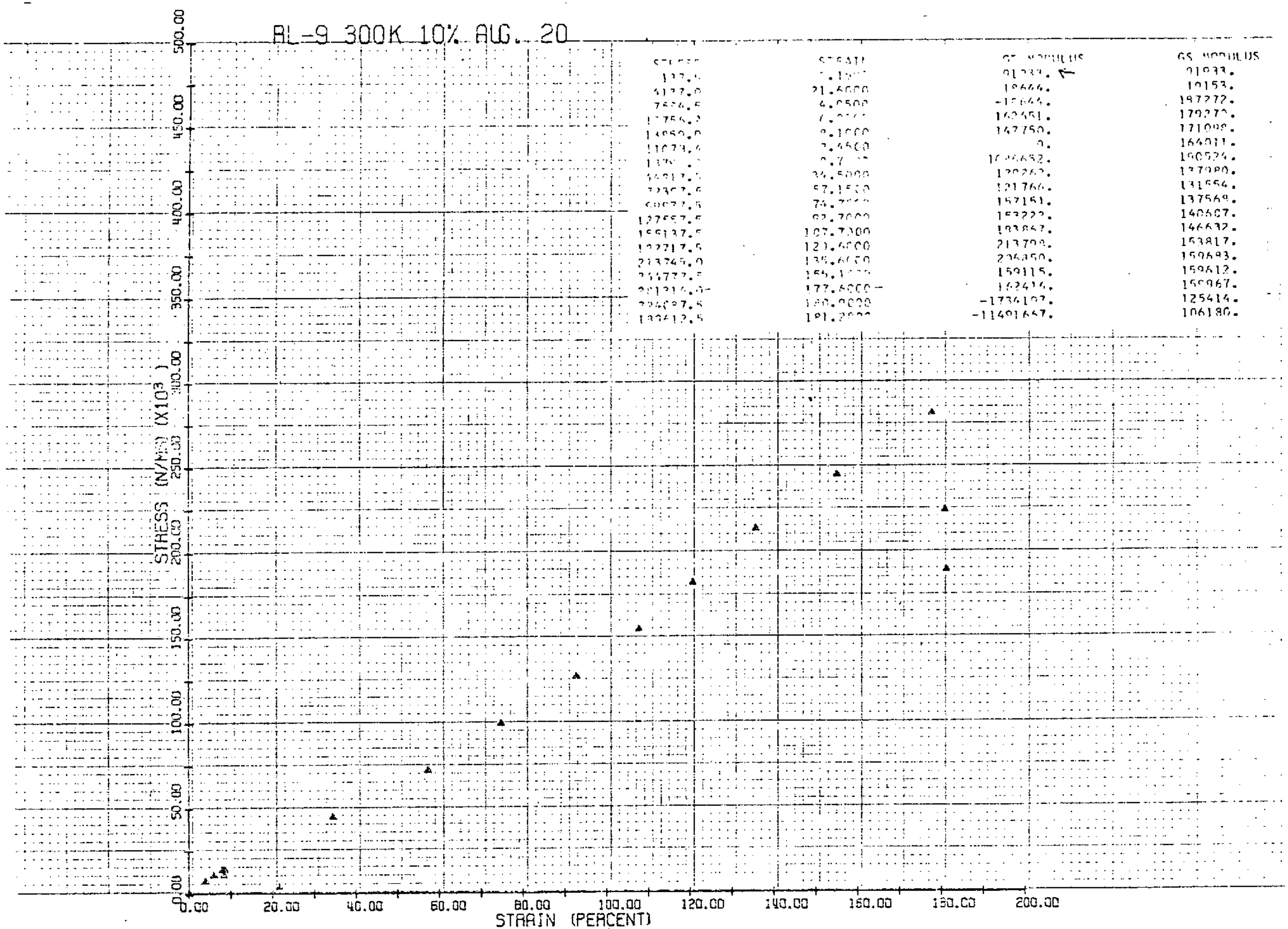


STRESS	STRAIN	GT MODULUS	GS MODULUS
413.7	0.1500	275800.	275800.
2342.3	0.9000	257413.	260478.
4137.0	2.1000	149392.	197000.
6377.4	3.2000	160893. ←	193967.
7999.2	4.5000	160893.	177739.
8999.4	5.1000	0.	156827.
12340.5	7.2000	191030.	166871.
37999.5	31.0500	115630.	127509.
56637.5	46.5000	112114.	121777.
95423.0	74.4000	124609.	122729.
119215.0	92.7000	130712.	128245.
164755.0	112.4000	155910.	132665.
177275.0	125.1000	137610.	139124.
203432.5	141.7000	191529.	145132.
237877.5	159.3000	191528.	150374.
269665.0-	177.2000-	172275.	152608.
224697.5	179.1000	-2439961.	126059.
132717.5	193.6000	-912333.	100429.

BL-72 300K 5% DEC. 13

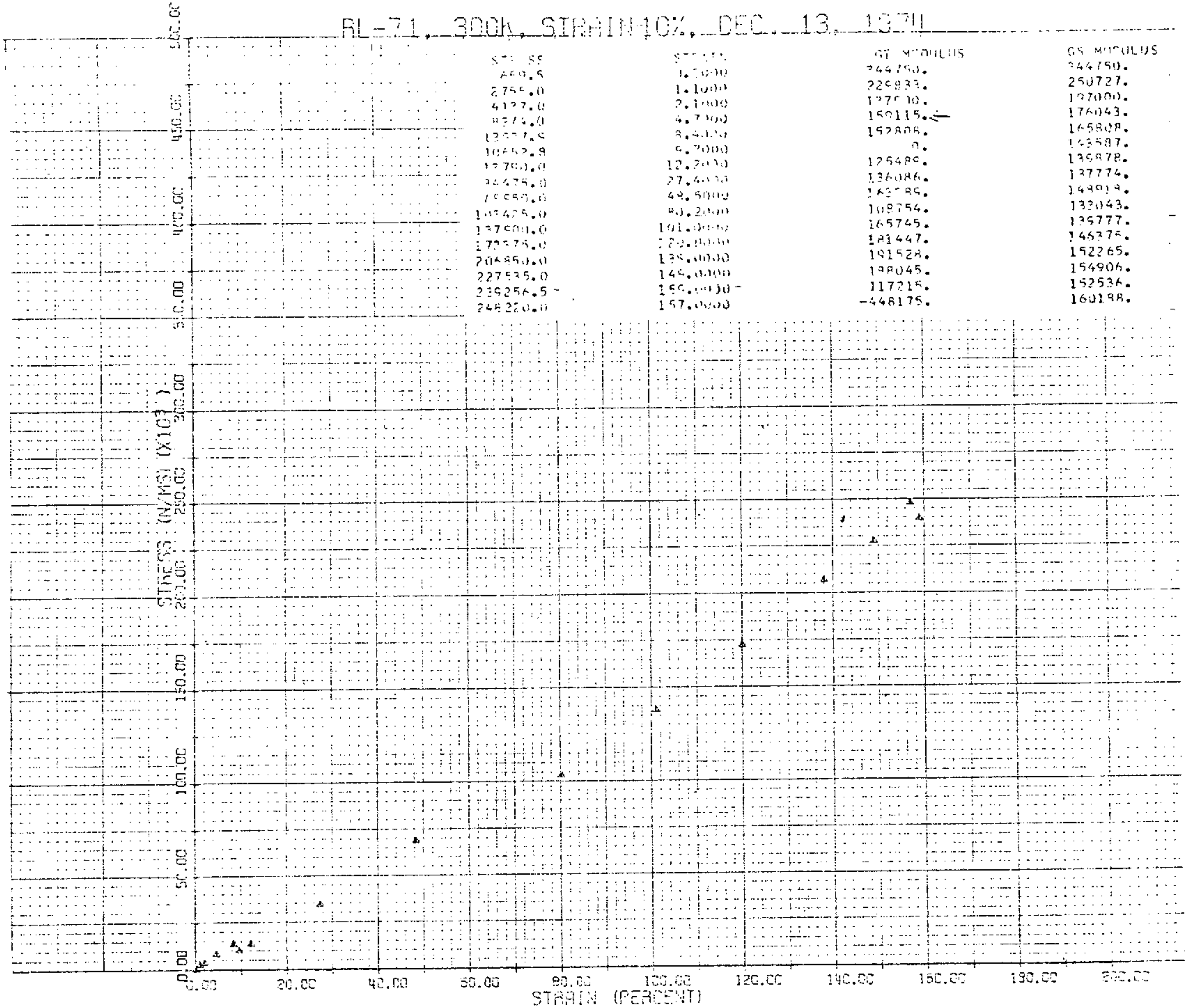
STRESS	STRAIN	GT MODULUS	GS MODULUS
689.5	0.1500	459667.	459667.
2068.5	1.2000	131333.	172375.
3447.5	2.1000	153222.	164167.
4964.4	3.3000	126408.	150436.
6205.5	4.2000	137900. ←	147750.
4569.3	5.2000	0.	124110.
6895.0	9.7000	64478.	98740.
31027.5	27.4500	123707.	110212.
51712.5	46.9500	106077.	113755.
68950.0	62.7000	109444.	112673.
103425.0	88.2000	135196.	119185.
137900.0	111.4500	148280.	125255.
172375.0	130.2000	183867.	133695.
189612.5	141.4500	153222.	135248.
206850.0	151.2000	176795.	137927.
232361.5	170.7000	130828.	137116.





STRESS	STRAIN	ST MODULUS	GS MODULUS
117.5	[illegible]	91733.	91933.
6177.0	21.6000	19666.	19153.
7626.5	4.0500	-15644.	197272.
12756.2	7.6500	162451.	179272.
14859.0	9.1000	147750.	171098.
11073.4	7.4500	0.	164011.
[illegible]	9.7000	[illegible]	190524.
44917.5	34.5000	120262.	137980.
72367.6	57.1500	121766.	131554.
90077.5	74.[illegible]	157151.	137569.
127557.5	92.7000	153222.	140607.
155137.5	107.7300	193867.	146632.
182717.5	121.6000	213798.	153817.
213745.0	135.6650	296850.	159693.
244777.5	155.1[illegible]	159115.	159612.
281214.0	177.6000	162416.	155967.
224097.5	180.9000	-1736197.	125414.
193612.5	191.2000	-11491667.	106180.

RL-71, 300K, STRAIN 10%, DEC. 13, 1974



STRESS	STRAIN	GT MODULUS	GS MODULUS
689.5	1.0000	244750.	244750.
2755.0	1.1000	229833.	250727.
4137.0	2.1000	127000.	197000.
8274.0	4.7000	159115. ←	176043.
13577.5	8.4000	152808.	165808.
10652.9	9.2000	0.	143587.
17790.0	12.2000	125489.	139878.
34475.0	27.4000	136086.	137774.
75850.0	49.5000	163185.	149919.
103425.0	80.2000	108754.	132043.
137900.0	101.0000	165745.	135777.
172375.0	120.0000	181447.	146375.
206850.0	135.0000	191528.	152265.
227535.0	149.0000	198045.	154906.
239256.5	155.0000	117215.	152536.
248220.0	157.0000	-448175.	160198.

122 ∅