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PRELIMINARY TEST REPORT ON THE A 1 TESTS

(Title Unclassified)

DISCLAIMER

ABSTRACT

Tests conducted by the Engineering Mechancis Laboratory personnel on thirty-two production grade unfueled and uncoated Westinghouse Cheswick elements (WANL Drawing No. 909 E 324) received to date (6-30-63) have yielded the following average values of mechanical properties.

Static Flexural Strength (Ambient Temperature)	5,460 psi
Static Compressive Strength (Ambient Temperature)	12,800 psi
Young's Modulus (Ambient Temperature)	
At strains corresponding to 250 psi	2.58×10^6 psi
At strains corresponding to 1000 psi	2.0×10^6 psi
At strains corresponding to 4000 psi	1.35×10^6 psi
Fatigue Strength (1×10^6 cycles, ambient temperature)	3,000 psi

Tests at other than ambient temperature will be run in the future.

The A 1 series of tests as defined in Westinghouse document WANL-TNR-095 is to determine the standard properties of fuel elements. The elements to be tested are manufactured in various configurations and may be coated and/or fuel bearing in varying percentages. The first group of elements available form the Cheswick plant have been tested to experimentally determine values of the dynamic Young's Modulus, compressive, and flexural strengths. As a corollary to determining these values, the experimental methods have been checked out by comparison of initial results with published values.

As of June 30, thirty-two fuel elements had been made available for testing. These were divided among the various tests involved which were A 1-1, A 1-2, A 1-5 and A 1-7. Results have been averaged and published for preliminary information purposes. These first elements were unfueled and uncoated, and have been tested at room temperature only. Other variations will be tested and reported on as they become available.

No specific conclusions may be drawn from this first series of tests except to point out that the values reported are slightly higher than published values of similar tests. Additionally, similar values from Oak Ridge manufactured elements are lower than those of Cheswick manufacture. The test methods and equipment have proved satisfactory and a good backlog to results has been accumulated to base further test efforts.

The tests were carried out as in WANL-TNR-095 with no major modification of method. Calculations were according to the formula illustrated in that document. For the A 1-1 test sixteen fuel elements were used and the following values obtained after averaging the individual results:

Length	52.00 inches
Moment of Inertia	0.01398 inches^4
Weight	1.211 lbs
Resonant Frequency	32.17 cps
Dynamic Modulus	2.58×10^6 psi
Amplitude at Resonant Frequency	0.09 inches
Stress at Resonance	250 psi

The test equipment and instrumentation are shown in Figures 1 and 2.

The A 1-2 test was designed to determine the dynamic modulus of the fuel elements but by compressive instead of flexural vibration. Sixteen additional elements were tested in this manner with the following results (averages of inidvidual values):

Length	52.00 inches
Area	0.35 inches^2
Resonant Frequency (Compression)	1133.7 cps
Weight	1.211 lbs
Dynamic Modulus	2.42×10^6 psi

The 6% difference in measured results between the dynamic Young's Modulus determined from flexure and compression can be ascribed to test methods and measurements.

Test equipment is shown in Figure 3. Instrumentation is equal to A 1-1 test instrumentation.

The A 1-5 test covers the compressive and tensile strengths of the fuel elements. These tests are performed on shorter specimens prepared for the range of the testing machine. Three of the fuel elements were used to obtain fifteen two inch samples for compressive testing. No tensile testing is being reported at this time due to test discrepancies ascribed to the holding fixture.

Specimens were compressed to failure and data was recorded showing stress vs strain. The average value of stress at fracture for fifteen specimens tested was determined to be 12,800 $\pm$ 1100 psi. A typical strain at failure was 10,000 μ in/in at a stress of 13,200 psi; this corresponds to a Young's Modulus at fracture of 1.3×10^6 psi. A second series of tests is planned utilizing strain gaged specimens in order to more accurately determine this value. Hysteresis curves were measured for the enclosed area and the energy absorption calculated. The results of this study will be reported later.

The test equipment is shown in Figure 4.

The A 1-7 test was run on specimens which were cut from six of the Cheswick elements. This test covers the fatigue strength of the elements when stressed as a cantilever with alternating loads, and static failure with increasing loads, as described in WANL-TNR-095. For the preliminary area, nine inch specimens were used at a 25 cps vibration rate.

For six specimens tested static values of failure stress averaged 5460 psi. For sixteen specimens tested in flexure to 10^6 total cycles an average of 3000 psi was obtained. A graph is attached showing a straight line relationship based on preliminary data which bunches the points at each end of the line. Further tests are to be run to confirm other areas of the curve and supply the requirements of the 095 Test Program.

The test equipment is shown in Figure 5 and preliminary data curves in Figures 6 and 7.

SUMMARY

The activities presented in this preliminary report cover the A 1 tests performed by the Engineering Mechanics Laboratory on an initial quantity of thirty-two production Cheswick fuel elements (unfueled, uncoated 19 holes). Only those tests in which there has been significant testing activity have been discussed. As additional data is obtained, periodic reports will be issued.

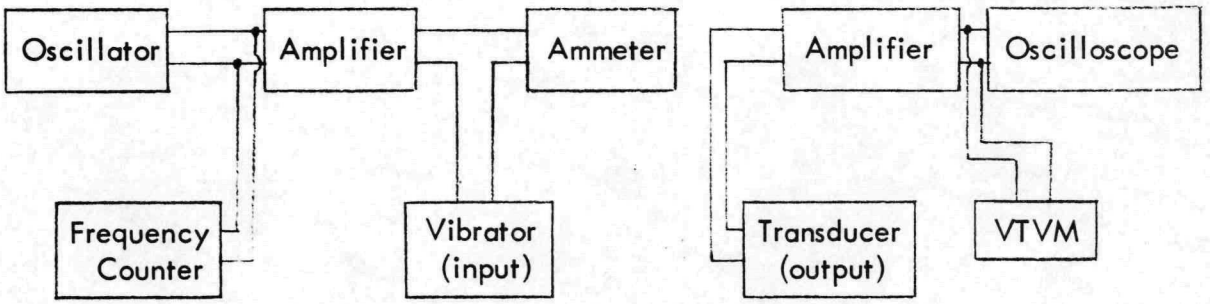

FIGURE 1

DYNAMIC MODULUS OF FUEL ELEMENT INSTRUMENTATION

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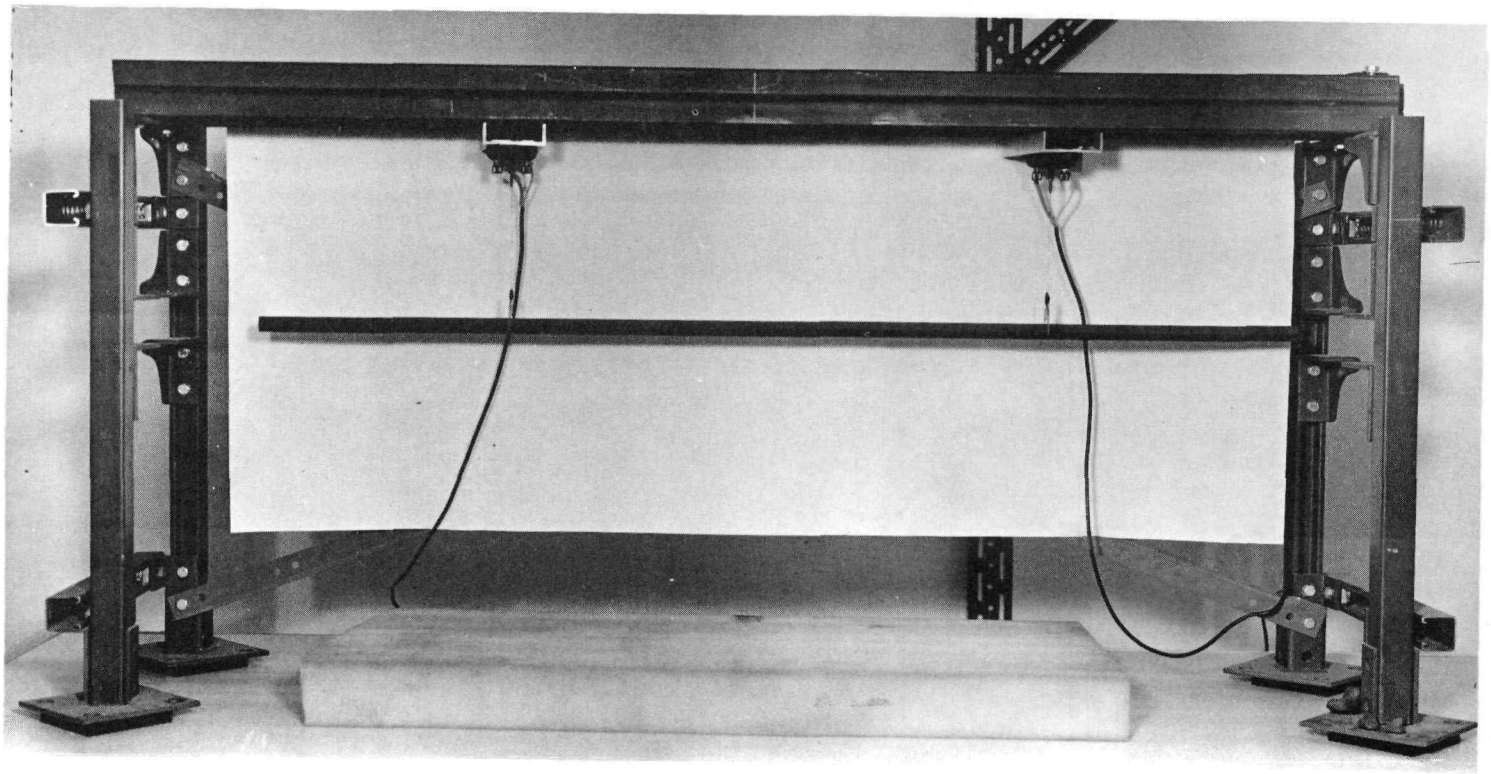

FIGURE 2

A 1-1 Dynamic Modulus Test Fixture

The test cables leading from the electro-mechanical shakers are attached to an oscillator, amplifier, and frequency counter on the input, and an oscilloscope and VTVM, on the output. Either shaker may be used as the input.

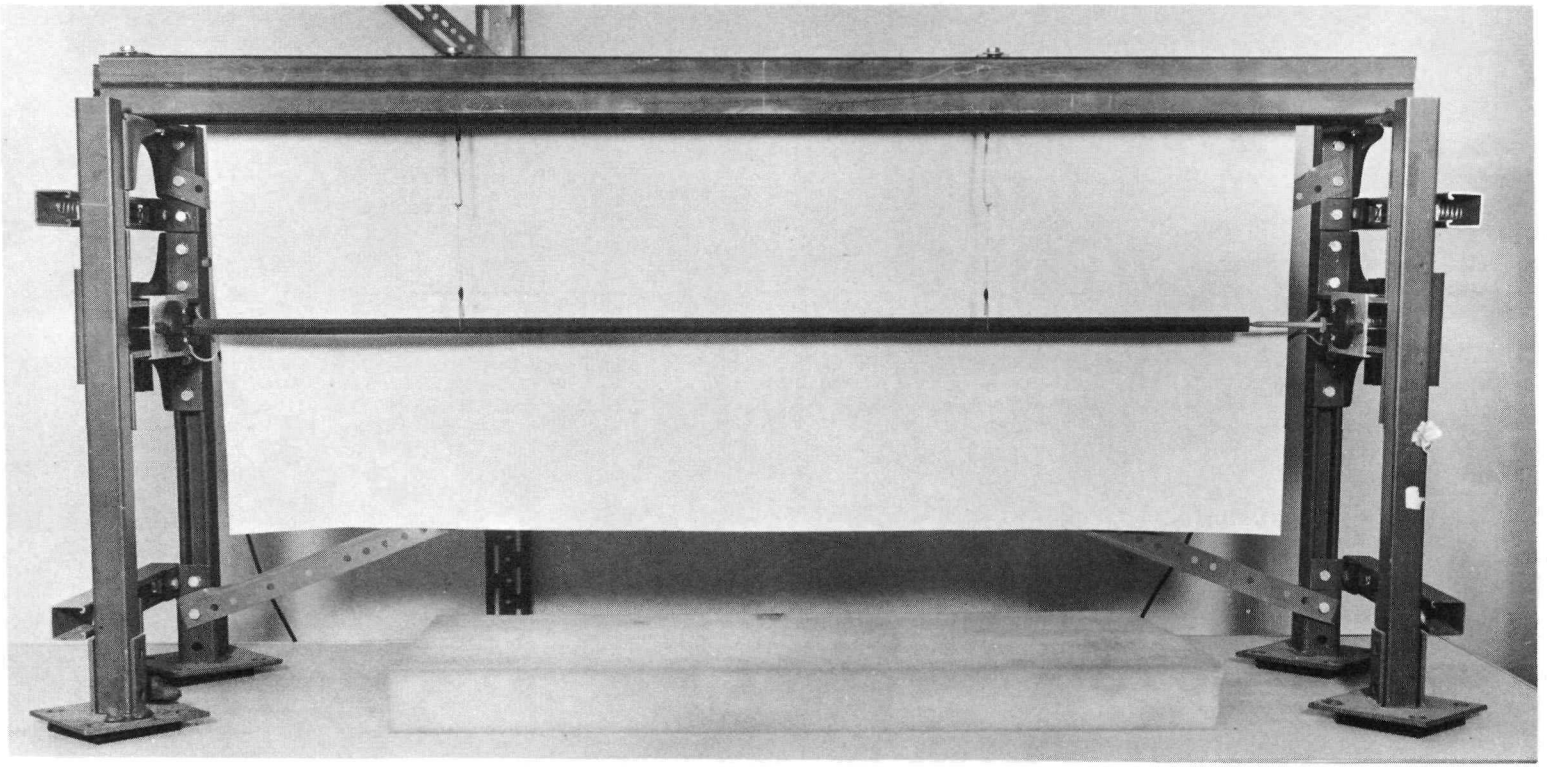

FIGURE 3

A 1-2 Elastic Modulus Test Fixture

The test cables leading from the electro-mechanical shakers are attached to an oscillator, amplifier, and frequency counter on the input, and an oscilloscope and VTVM, on the output. The shaker on the right, with the dowel pin attached, is used as the pickup.

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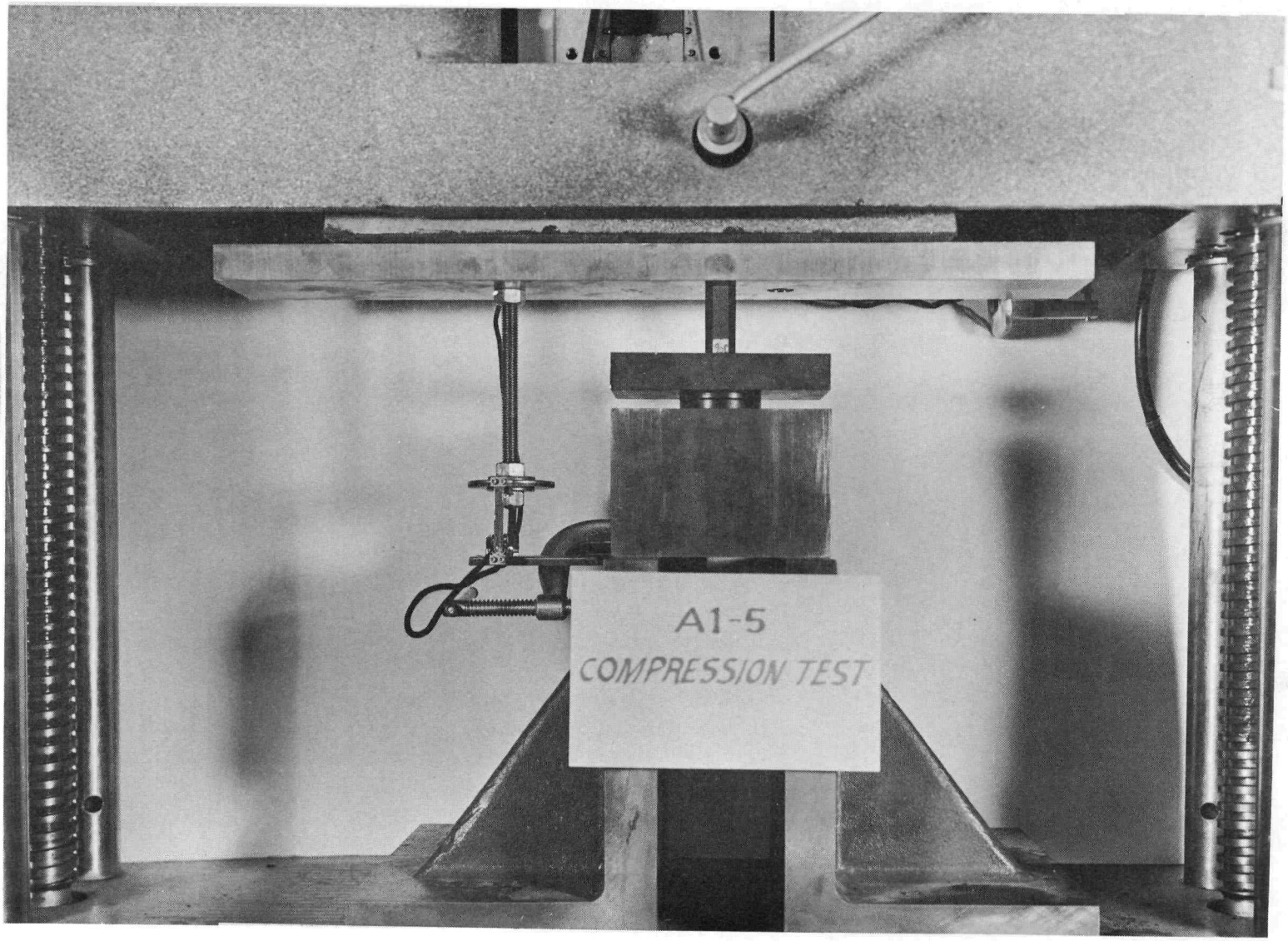

FIGURE 4

A 1-5 Compression Test Setup

The two inch specimen is placed on a flat plate balanced on spherical washers to eliminate bending. On the left side is the Wiedeman-Baldwin strain gage recorder pickup.

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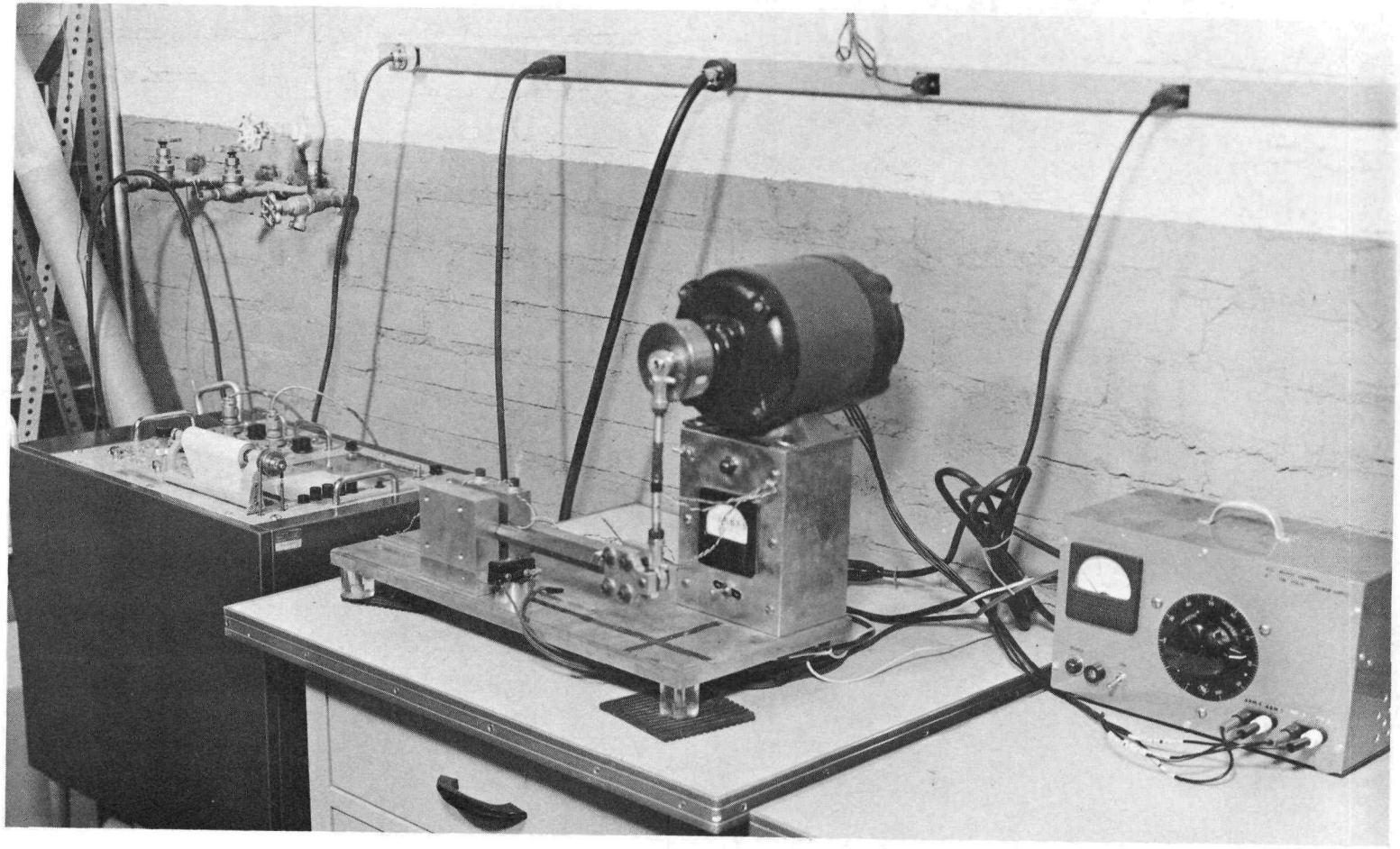

FIGURE 5

A 1-7 Fatigue Strength Test Fixture and Instrumentation

From left to right are pictured the Sanborn two channel recorder (for the load cell output and the specimen-mounted strain gage output), the eccentric motor drive and test specimen mount, and the variable DC power supply.

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FIGURE 6

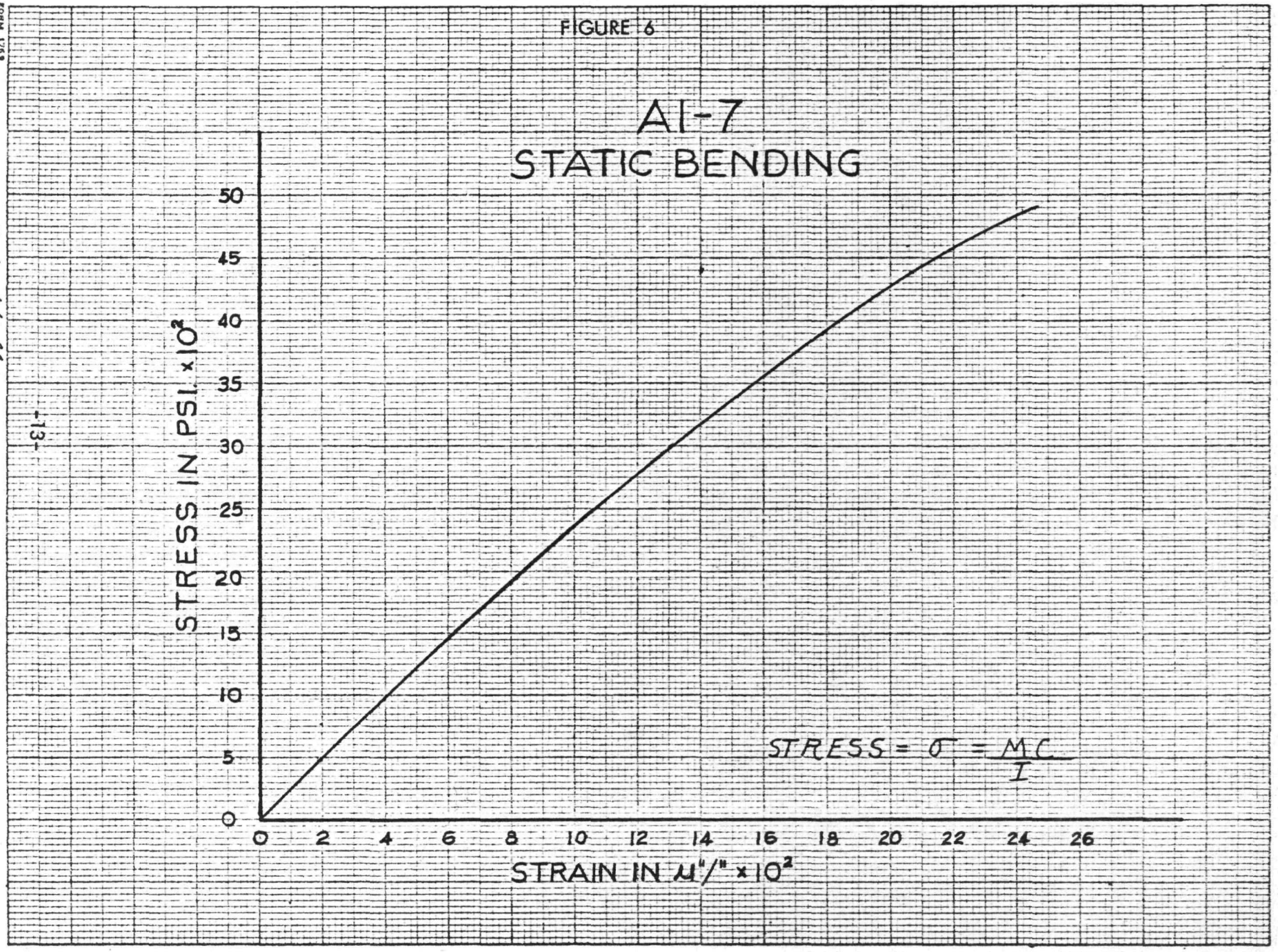

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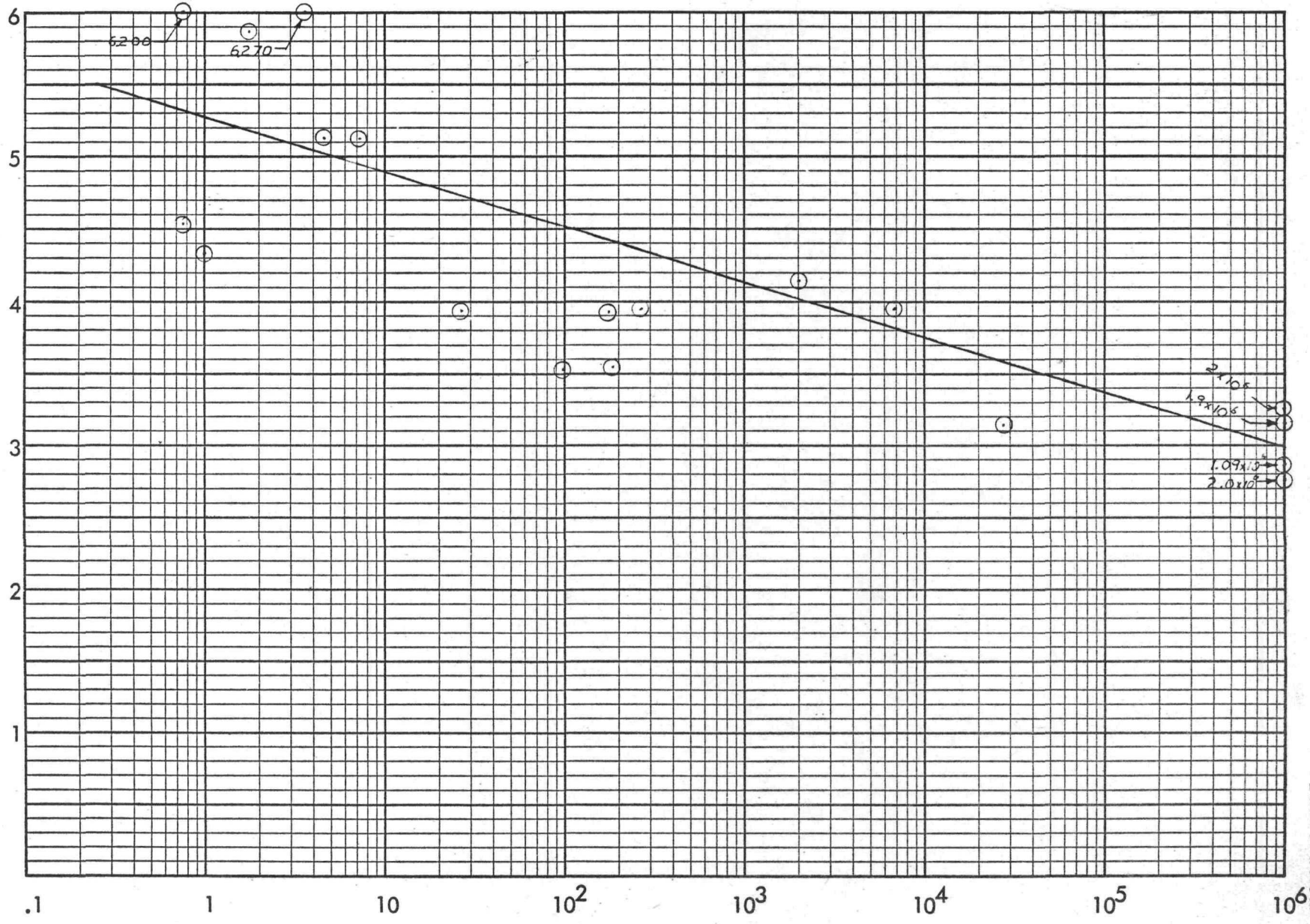
FIGURE 7

A 1-7 FATIGUE TEST



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