NATIONAL BUREAU OF STANDARDS REPORT

7046

STATIC TESTS OF MODEL L-809
(MODIFIED) AIRPORT MARKER LIGHT BASE
AND MULTI-ELECTRIC CLASS BB LIGHT

by

L. J. Davis and A. F. Kirstein

Technical Report
to
Ship Aeronautics Division
Bureau of Naval Weapons

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS PROJECT | **NBS REPORT**

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Engineering Mechanics Section
Mechanics Division

Technical Report
to
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NBS Lab. No. 6.4/295-7

NBS

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1. INTRODUCTION

Data were needed to determine whether the model L-809 (modified) airport marker light base is structurally adequate for use with runway marker lights. Also, data were needed on the load deflection relations of aircraft tires on the Multi-Electric class BB runway light and on the behavior of the light base assembled with this light or a cover plate.

Static load tests were made on an assembled light and light base with 20x4.4 and 32x8.8 tires. Tests were made on light bases assembled with cast iron or with steel cover plates, applying the loads through the aircraft tires or through a steel strut.

The results of these tests are given in this report.

2. TEST APPARATUS AND INSTRUMENTATION

2.1 Airport Marker Light Bases

The marker light base shown in figure 1 is a model L-809 (modified), the type used in the tests. In an attempt to simulate a runway installation, the base was encased in a 24-1/2 by 24-1/2 by 21 inch block of concrete having an ultimate strength in excess of 5,000 lb/in^2. The base was cast in the inverted position in order to insure intimate contact between the base and the concrete.

During static load tests the flange of a base was damaged, therefore another base was required to complete the tests. The second base was encased in concrete in the same manner and with the same dimensions as the first, except that reinforcing steel was placed in the concrete to minimize cracks.

During the test of the base, the load was applied through a 5-1/4 inch diameter steel strut. The strut was centered over the base on a 1 inch thick, 12 inch diameter steel plate. This simulated the installation of a cover plate and is shown in figure 2. Rubber gaskets

1/8 inch thick were used between the steel plate and the base assembly, and also between the steel plate and strut.

Strains in the base assembly were measured with twelve A5-1 wire resistance strain gages. The orientation and location of the strain gages are shown in figure 3.

2.2 Runway Light

An adjustable adapter ring was used to attach the Multi-Electric Class BB light to the base assembly as shown in figure 4. Six bolts, 3/8 inch in diameter, were used to connect the adapter ring to the base assembly and an additional six 3/8-inch diameter bolts were used to attach the light to the adapter ring. A rubber gasket 1/8 inch thick was used between the adapter ring and the base and a 1/16 inch thick gasket was used between the adapter ring and the light.

Deflection measurements of the tires on the light were made with two dial gages having a least count of 0.001 inch. These were mounted as shown in figures 5 and 6.

The air pressure in the tires with no load was measured before each test to be 155 lb/in^2 in the 20x4.4 tire and 280 lb/in^2 in the 32x8.8 tire.

The laboratory setup for the 20x4.4 tire on the light, under a load of 10,000 lb, is shown in figure 5. The 32x8.8 tire and the light, under a load of 80,000 lb, are shown in figure 6.

3. TEST PROCEDURES

The marker light base encased in concrete was placed on the movable platen of a 10,000,000 lb capacity hydraulic testing machine. The tires were mounted on the fixed head of this machine with a steel fixture. The tires were centered directly over the base and oriented with respect to the light in the approximate direction of traffic on a runway. Load was then applied to the light through the tire.

The position of no load and zero deflection was taken to be that position where there was sufficient contact between the tire and loading surface to prevent easy rotation of the wheel by hand.

Compressive loads were applied to each test assembly and values of load, strain, and deflection were recorded at each increment.

The 20x4.4 tire on the flat plate and on the light was loaded to 10,000 lb in 1,000 lb increments. The 32x8.8 tire on the flat plate and on the light was loaded to 80,000 lb in 10,000 lb increments. The light base was loaded through the steel strut to 200,000 lb; strain gage readings were taken at 20,000 lb increments.

4. RESULTS

The brittle failure of a cast iron cover plate during one of the static load tests damaged the flange of the first base, and cracked the concrete. Therefore, it was necessary to use a second base to complete the tests. Photographs of the cast iron plate after failure are shown in figures 7 and 8.

The load deflection relations of the 20x4.4 tire on the Multi-Electric light and on a flat steel plate are shown in figure 9. The values of deflection at each load are the average of two gages located on opposite sides of the tire. Similar load deflection relations with the 32x8.8 tire on the Multi-Electric light and on a flat plate are shown in figure 10.

An examination of the components after the tests revealed no visible damage. However, strain measurements on the second base after having been loaded with the 32x8.8 tire indicated a small amount of inelastic action as evidenced by the permanent set shown in figures 11, 12 and 13. The intersection of the dashed line representing unloading and the strain axis shows the permanent set for each gage position. Strains measured on the base when loaded with the 20x4.4 tire did not exceed 340×10^{-6} and indicated no permanent set. Therefore, these data are not presented herein.

The second base covered with a steel plate was subjected to load in 20,000 lb increments through the 5-1/4 inch diameter steel strut to 200,000 lb. The load strain readings are shown in figures 14, 15 and 16. During the loading of this base assembly, the flange of the base yielded until it became conical in shape as shown in figure 17. Further increase in the load caused the steel plate to yield and become hemispherical in shape as shown in figure 18. With the movable steel plate bearing on the fixed flange of the base, a wedging action occurred which forced the top of the base assembly outward. As the diameter of the base assembly was increased, a force was exerted on the surrounding concrete producing minor radial cracks. These cracks were noticed on close examination after removal of the load.

6. DISCUSSION

The load deflection relations for the 20x4.4 and 32x8.8 tires on the Multi-Electric light should be of assistance in determining whether tires would be damaged significantly by rolling over the light. There was no appreciable structural damage to the light or tires during the static tests with the tires.

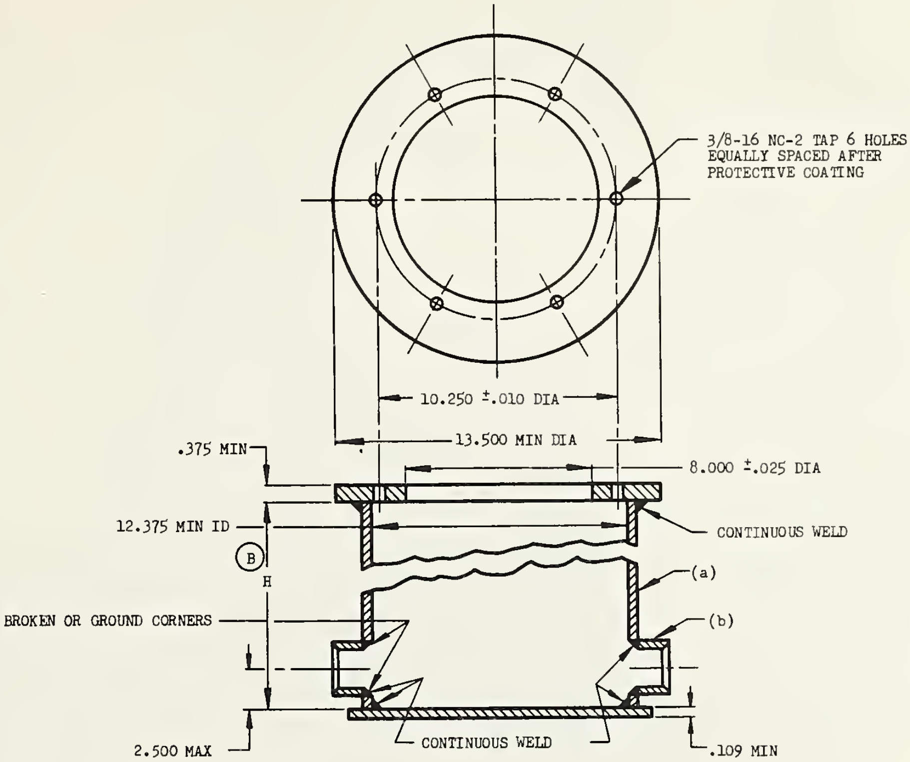
Since the measured strains in the light base shown in figures 11, 12 and 13 indicate permanent set after unloading, it was evident that some portion of the material in the light base yielded under the load exerted by the 32x8.8 tire. If it is assumed that the light base was made of hot rolled steel, comparable to ASTM A-7 steel, an uniaxial strain of approximately 1200×10^{-6} would define the yield strength. Upon examination of figures 12 and 13 it was apparent that the material at the juncture of the flange and side wall of the light base reached the uniaxial yield strain between 70,000 and 80,000 lb.

When the steel strut was used to load the light base well beyond the yield strength of the material, the strains on the underside of the flange changed from compressive to tensile as shown in figure 15. This was no doubt a result of the rapid increase in membrane strain due to the large deflection of the flange and the decrease in flexural strain due to the plastic hinge effect at the juncture of the flange and side wall of the light base.

The main purpose for grossly overloading the light base was to visually demonstrate the yield mode of failure exhibited by the light base in figure 17. The yield mode of failure is usually considered a conservative design criterion, and in general a structure designed to fail by yielding under static load will support much larger momentary dynamic loads.

Washington, D. C.
December 1960

FED. SUP CLASS
6210



B

DASH NO.	FIIN	HEIGHT (H) ±.250
-1		16.000
-2		20.500

(a) CYLINDER TO BE FORMED OF STANDARD SHEET STEEL, SEAM TO BE CONTINUOUSLY WELDED. THE SHEET STEEL UTILIZED FOR CYLINDER AND BOTTOM SHALL HAVE A MINIMUM THICKNESS OF .109 INCH. THE TOP FLANGE SHALL BE FABRICATED FROM 3/8 INCH MINIMUM THICKNESS STANDARD STEEL PLATE.

(b) 2 INCH PIPE COUPLING OR EQUIVALENT, TWO REQUIRED, 180° ±10° APART, RANDOM LOCATION. THE LENGTH OF THE ENTRANCE HUBS PROJECTING BEYOND THE BODY OF THE BASE SHALL NOT EXCEED 2.5 INCHES. ENTRANCE HUBS SHALL BE PROVIDED WITH STANDARD BLACK FINISH 2-INCH PIPE PLUGS.

DIMENSIONS IN INCHES.

~~MINIMUM~~ MARKING: MS PART NO. AND MANUFACTURERS NAME, ABBREVIATION, OR TRADE MARK.
BASE ASSEMBLY SHALL BE WATERTIGHT.
B ENTIRE UNIT SHALL BE CORROSION PROTECTED BY HOT DIP GALVANIZING OR EQUAL. THREADS SHALL BE PROTECTED BY ANTISEIZE COMPOUND. COVER FLANGE TO BE WIPED SMOOTH TO FLATNESS OF ±.010 INCH
13.5 INCH DIAMETER BY 3/4 INCH PLYWOOD COVER SHALL BE BOLTED ON FOR PROTECTION DURING SHIPMENT AND INSTALLATION. A PAPER GASKET SHALL BE UTILIZED BETWEEN THE BASE AND PLYWOOD COVER.
SIX HEX HEAD, STEEL, CADMIUM PLATED BOLTS, 1-1/4 INCHES LONG, SHALL BE PROVIDED.

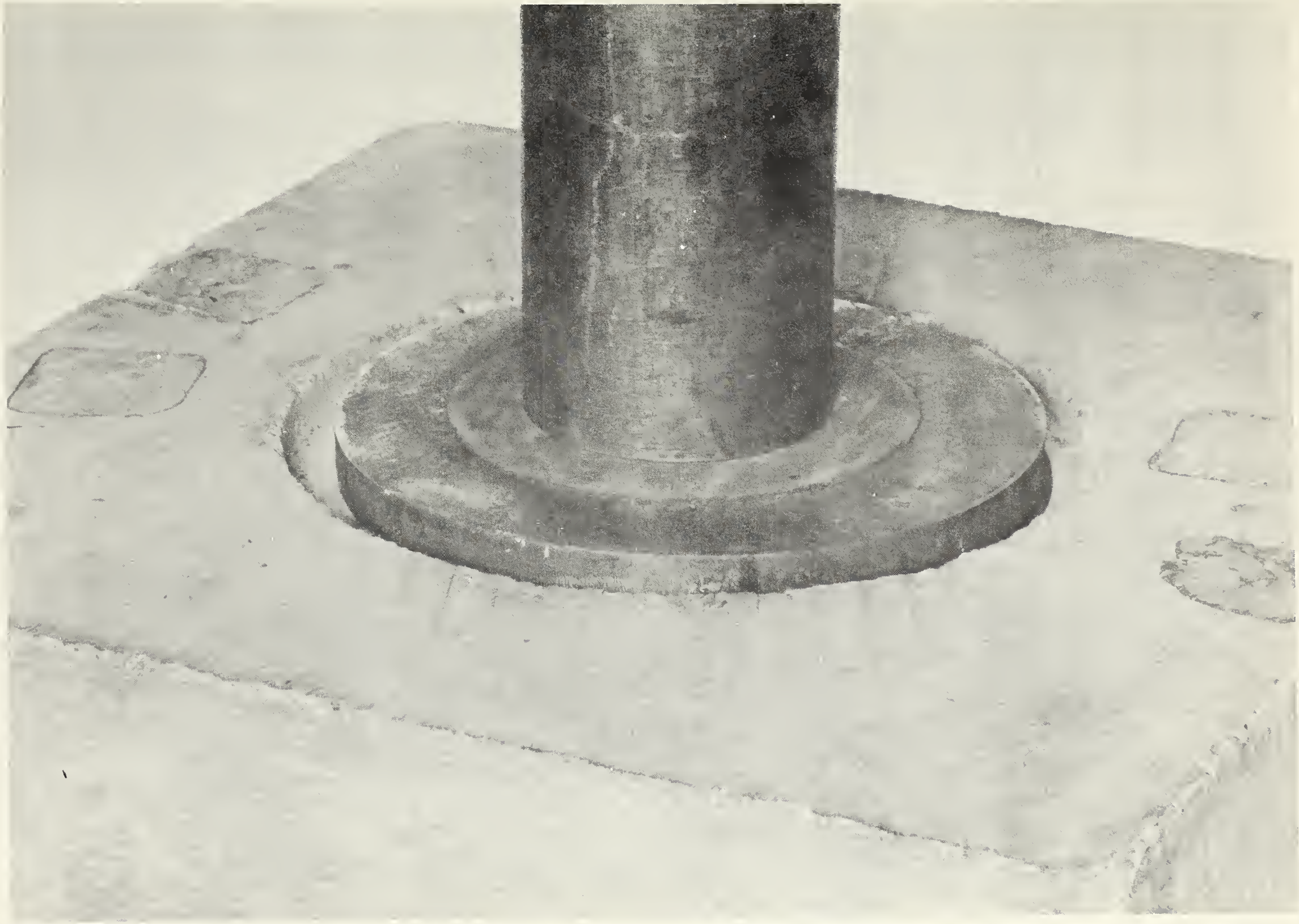
STANDARD MS24526 CONVERTED FROM (USAF) TO (ASG) STATUS.

THIS STANDARD TAKES PRECEDENCE OVER DOCUMENTS REFERENCED HEREIN.
REFERENCED DOCUMENTS SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATIONS FOR BID.

APPROVED 31 Jul 58 REVISED A 15 May 59 B 12 Aug 59

Base, Airport Marker Light

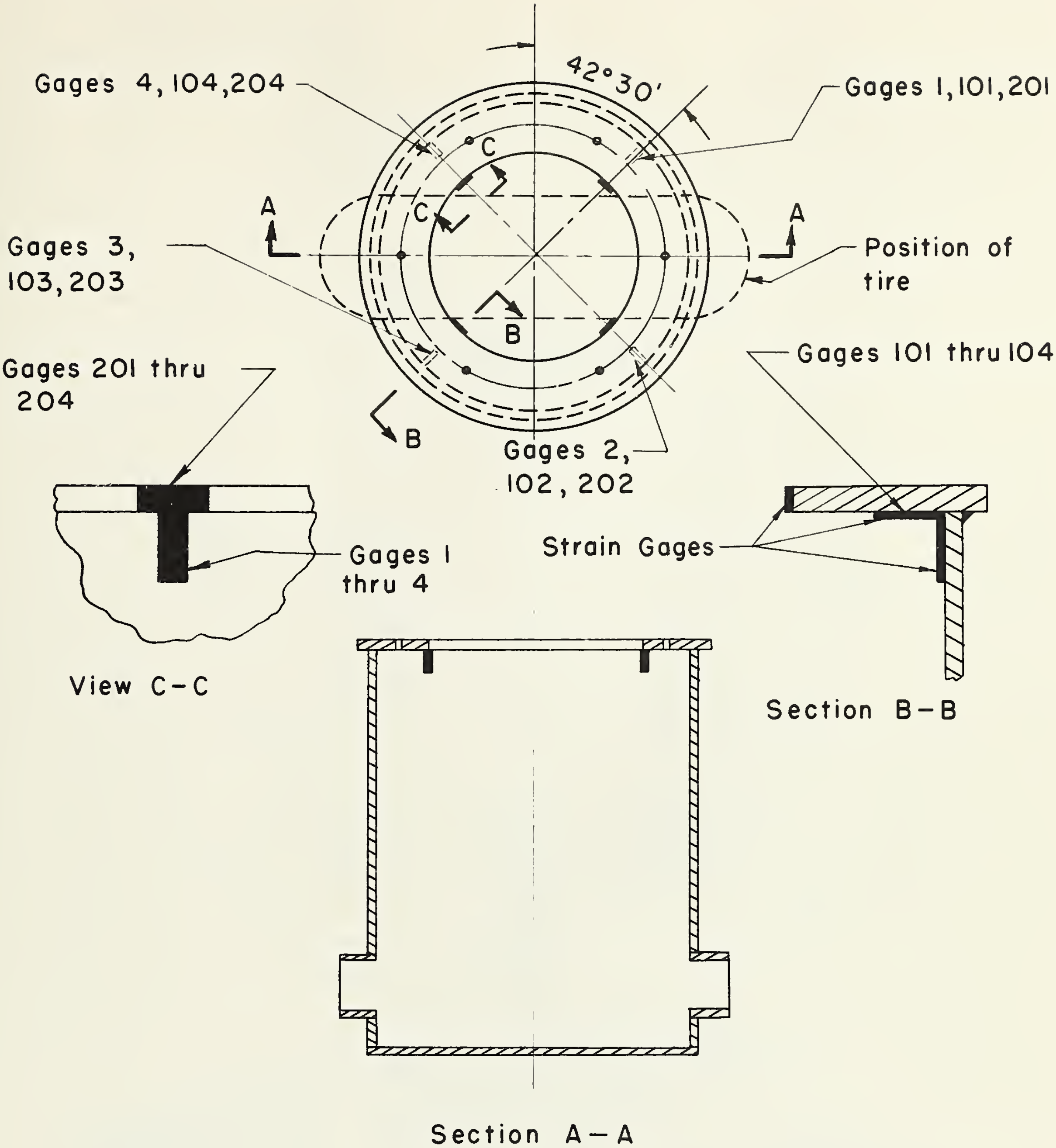
Figure 1



Steel Strut on Light Base Covered With 1" Thick Steel Plate

6.4/295-7

Figure 2



Location of 12-A-5 Strain Gages on Base

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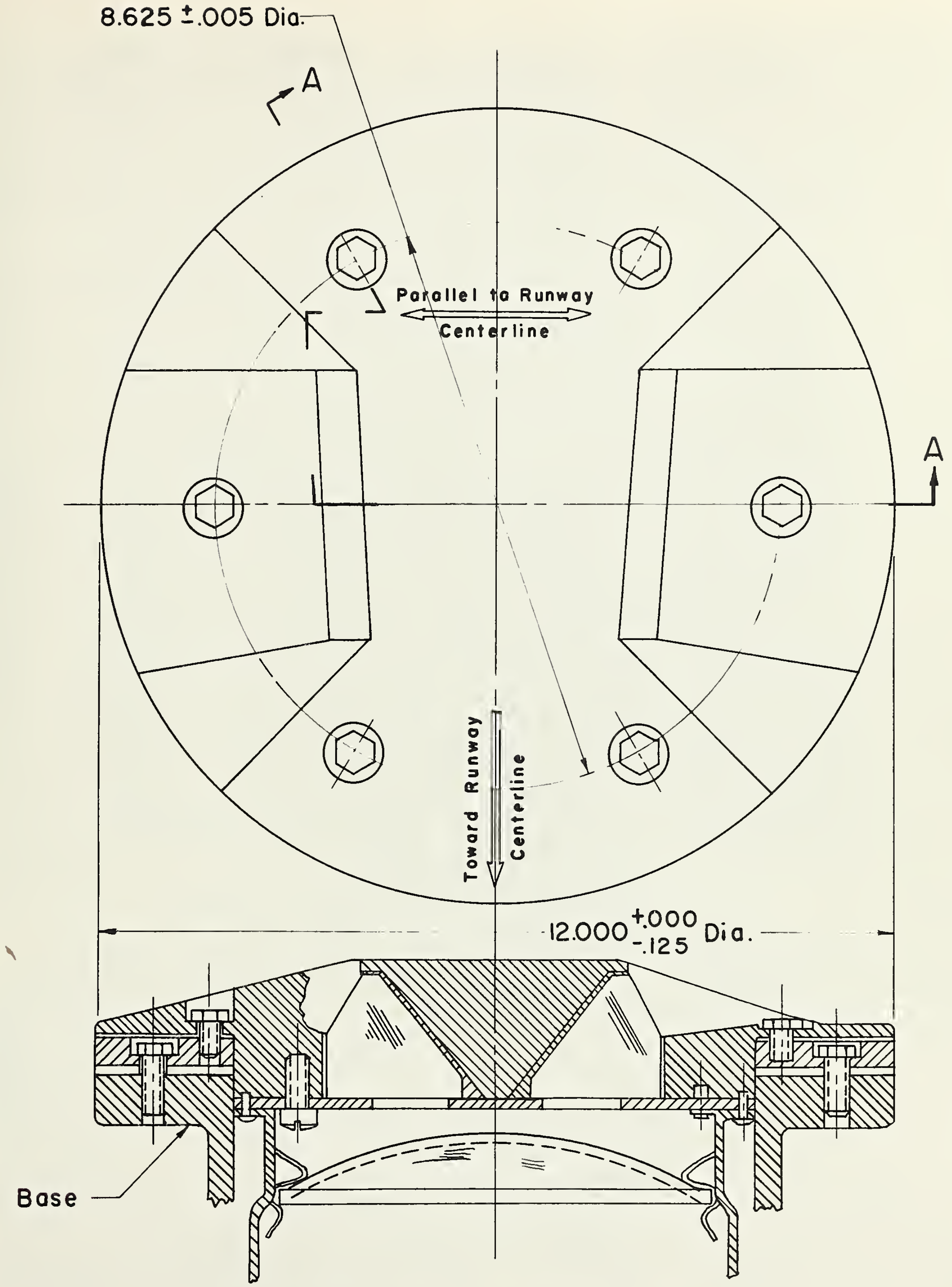
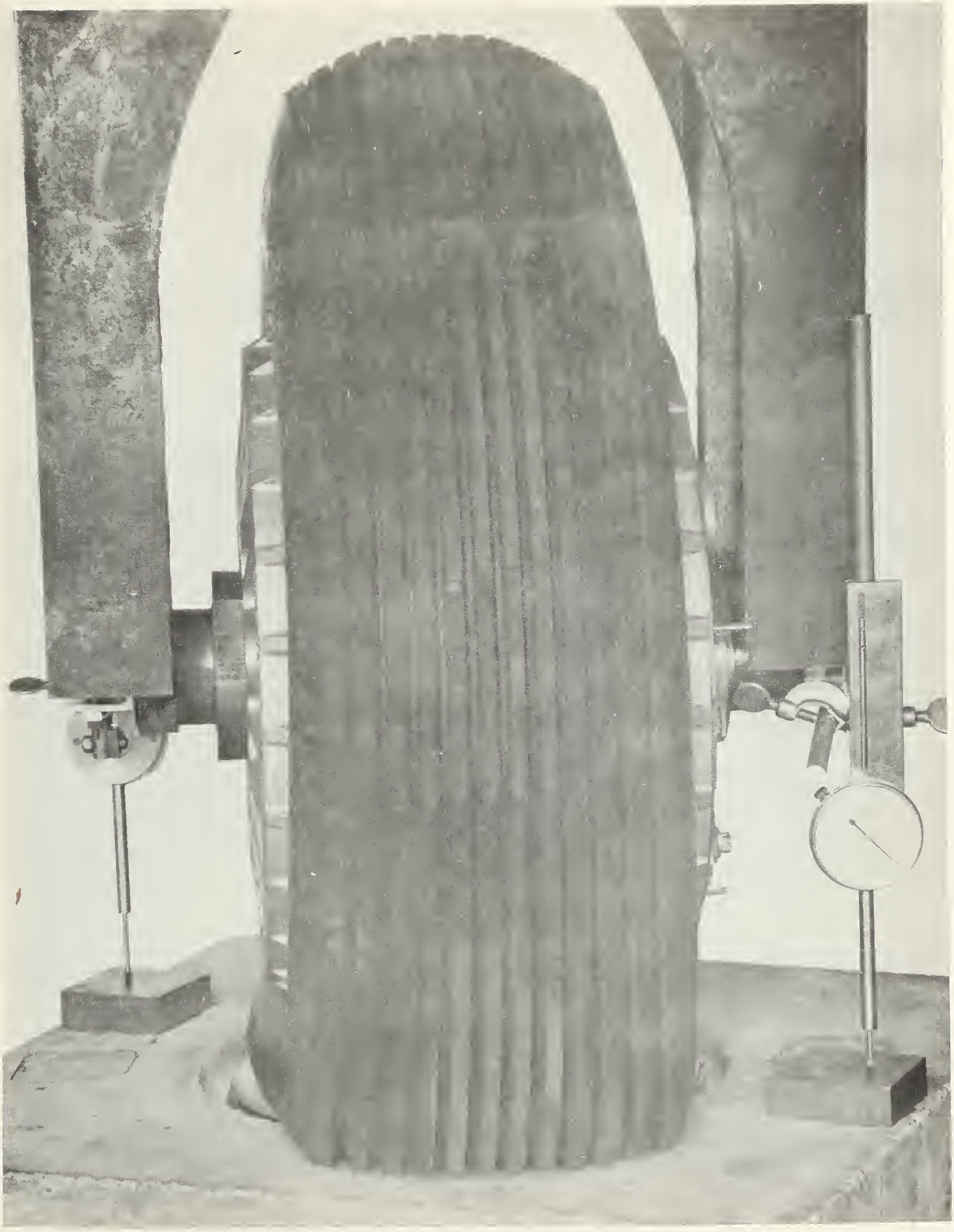
Figure 3

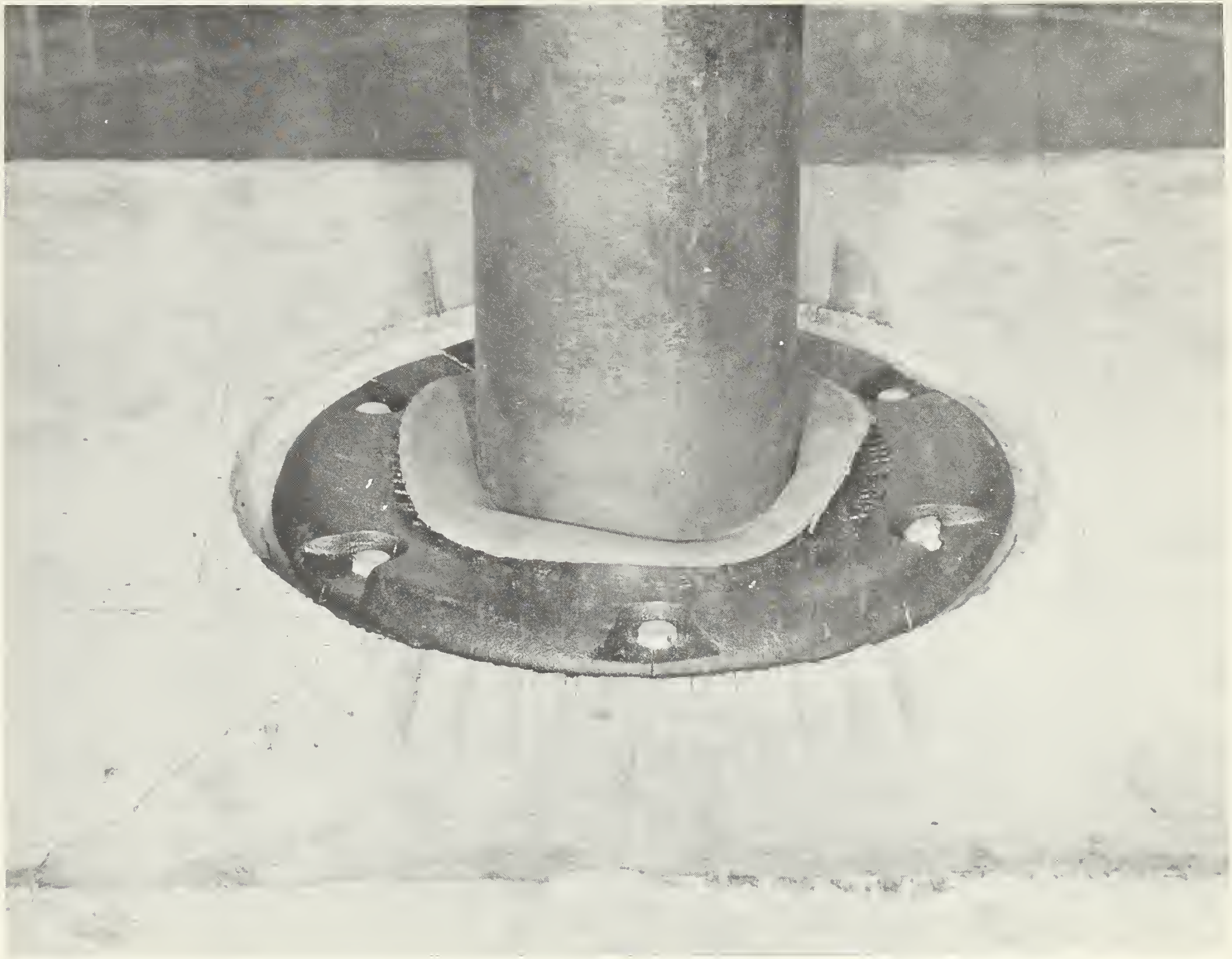


Multi-Electric Class BB Light

20 X 4.4 Tire on Multi-Electric Light, load = 10,000 lb
6.4/295-7 Figure 5

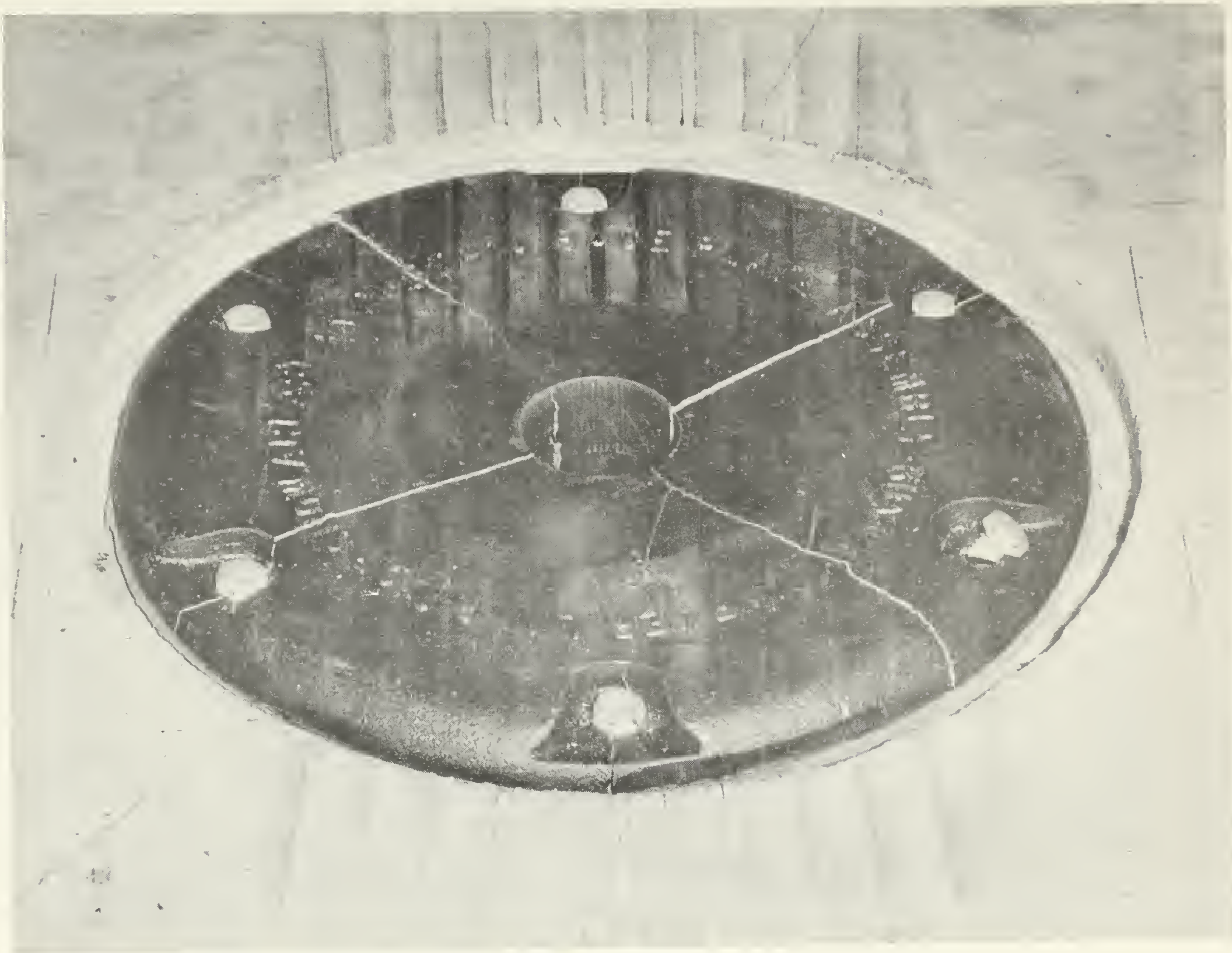


32 X 8.8 Tire on Multi-Electric Light, load = 80,000 lb
6.4/295-7 Figure 6



Steel Strut on Cracked Cast Iron Cover Plate , load = 23,000 lb
6.4/295-7

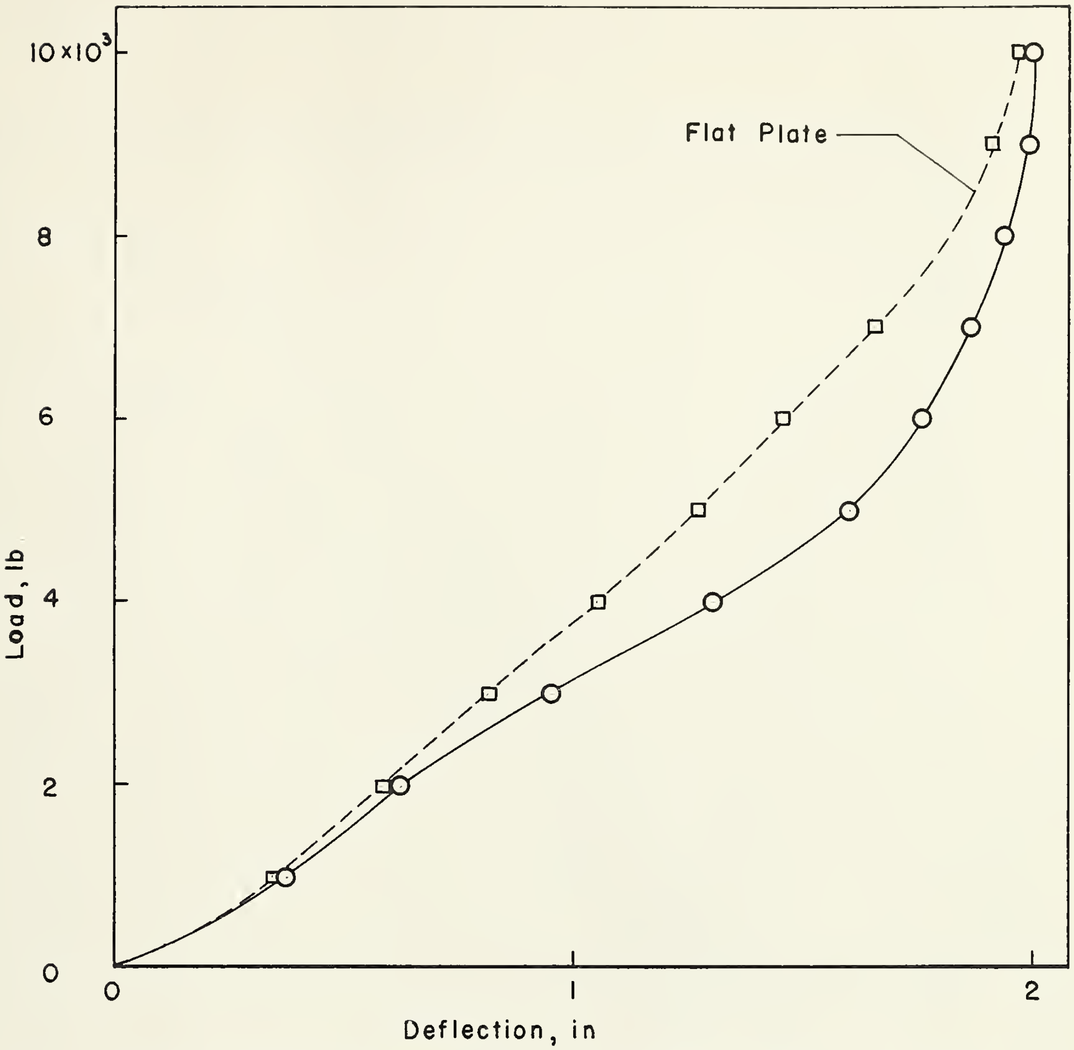
Figure 7



Cracked Cast Iron Cover Plate

6.4/295-7

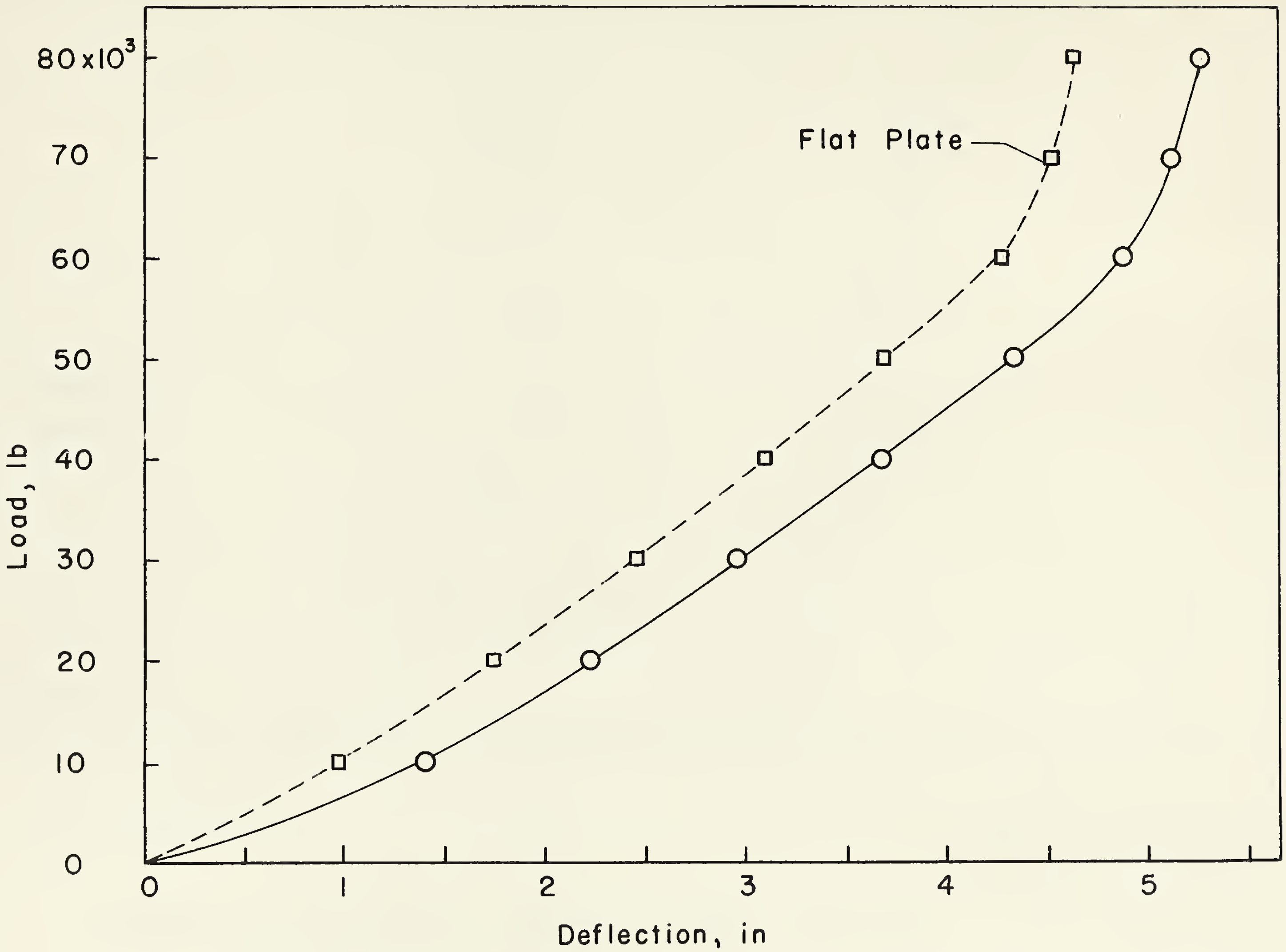
Figure 8



Load Deflection Relations for 20×4.4 Tire on Light and Flat Plate

6.4/295-7

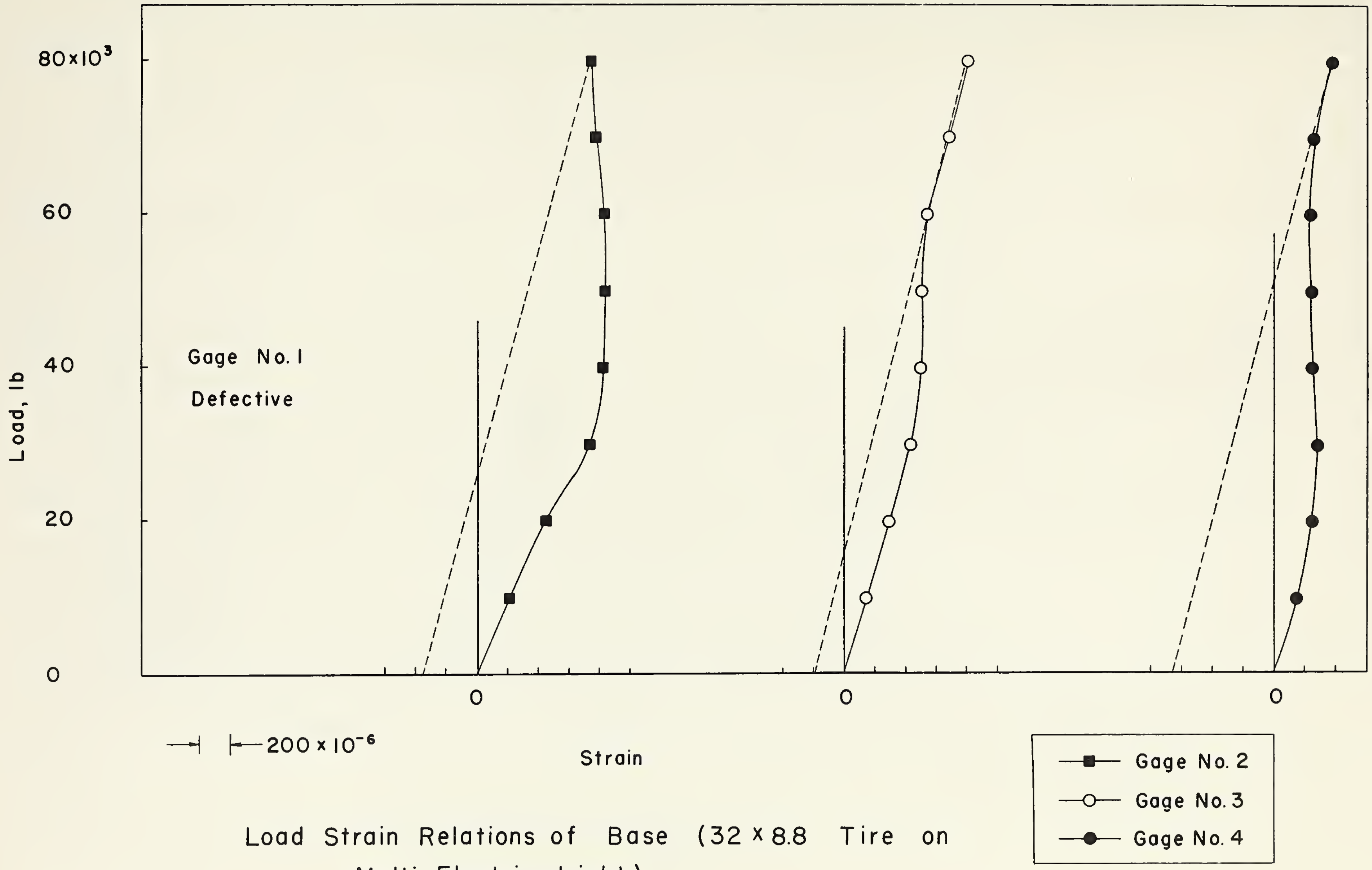
Figure 9



Load Deflection Relations for 32 x 8.8 Tire on Light and Flat Plate

6.4/295-7

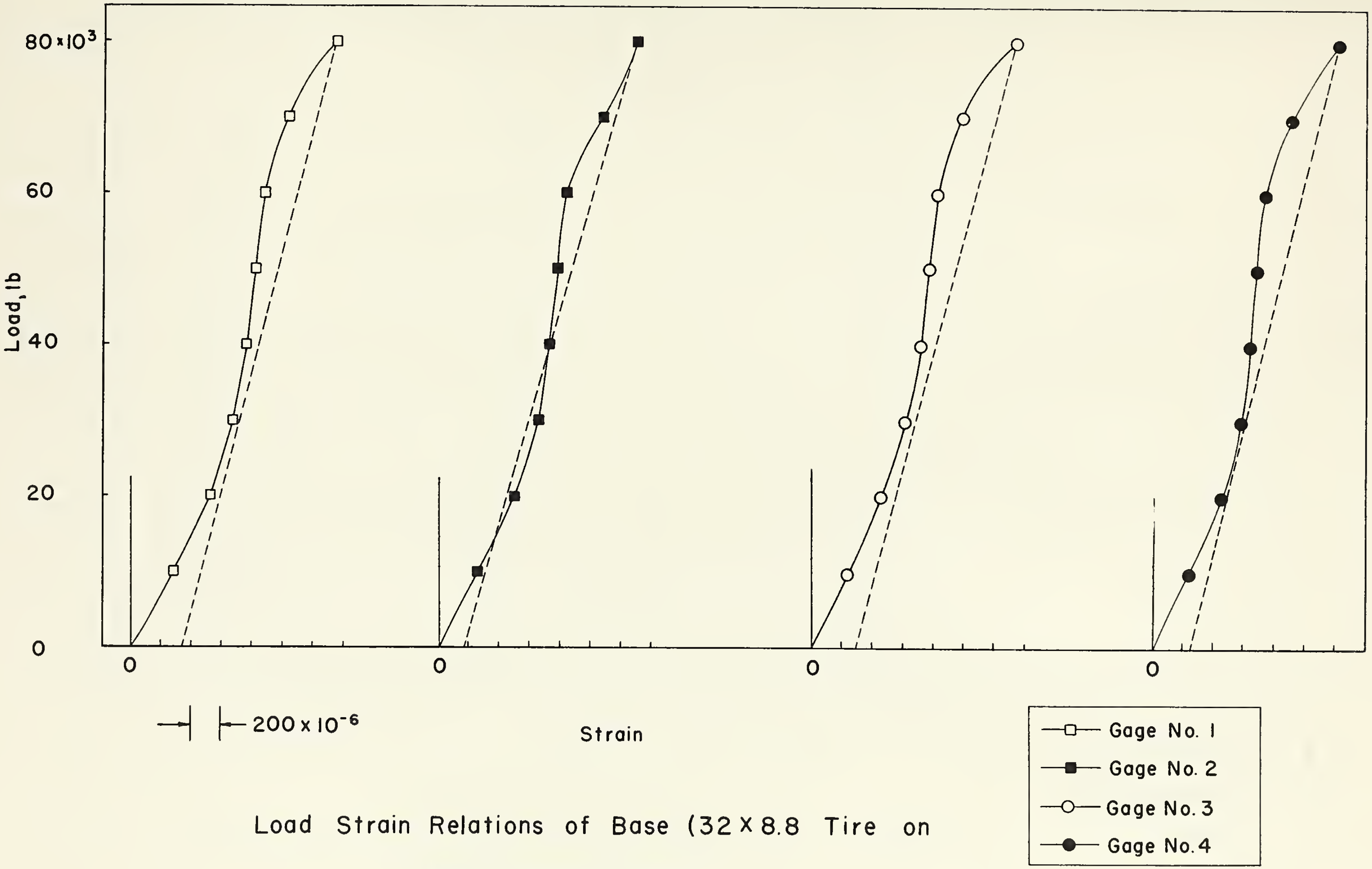
Figure 10



Load Strain Relations of Base (32 x 8.8 Tire on Multi-Electric Light)

6.4/295-7

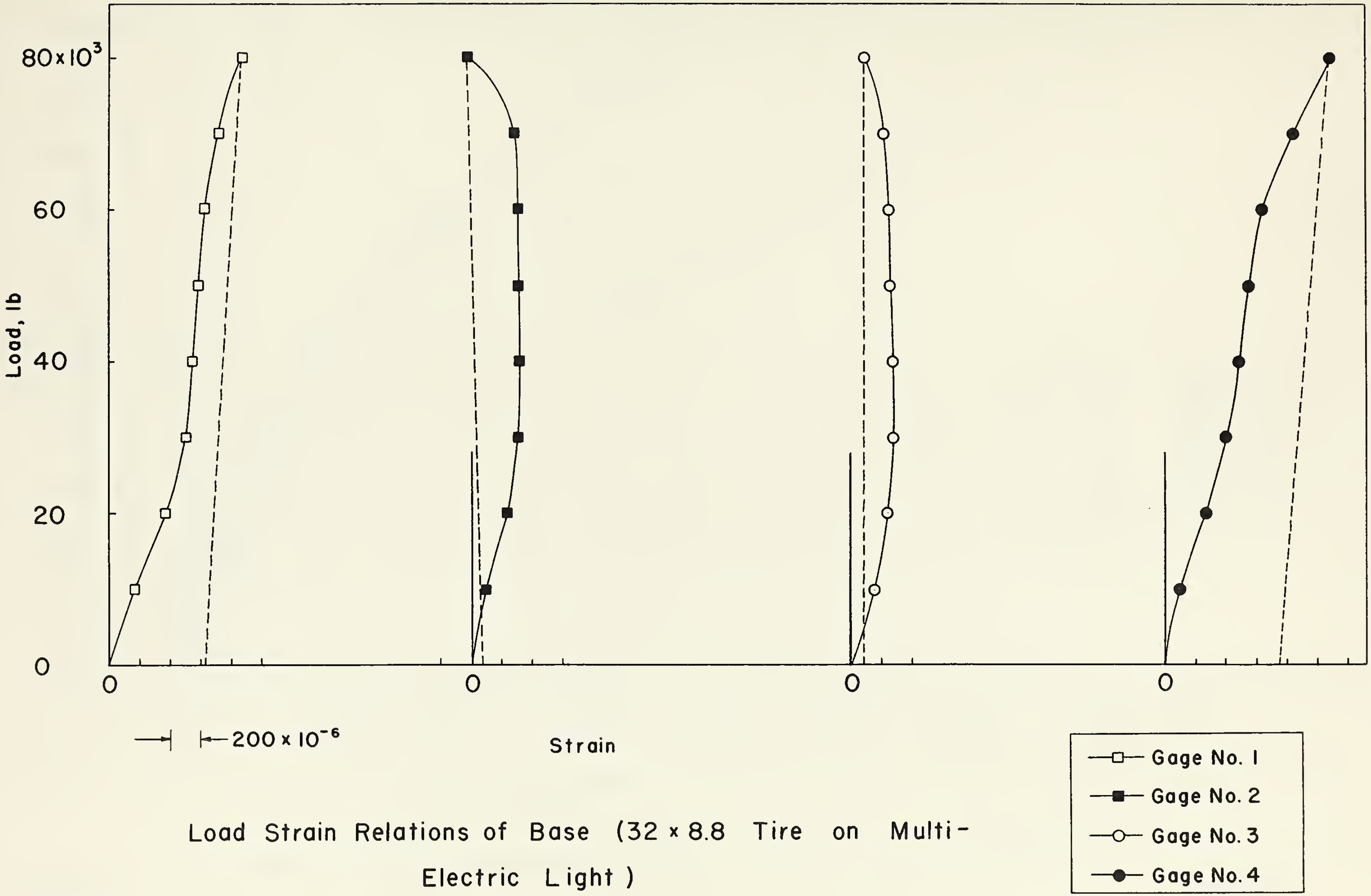
Figure 11



Load Strain Relations of Base (32 X 8.8 Tire on Multi-Electric Light)

6.4/295-7

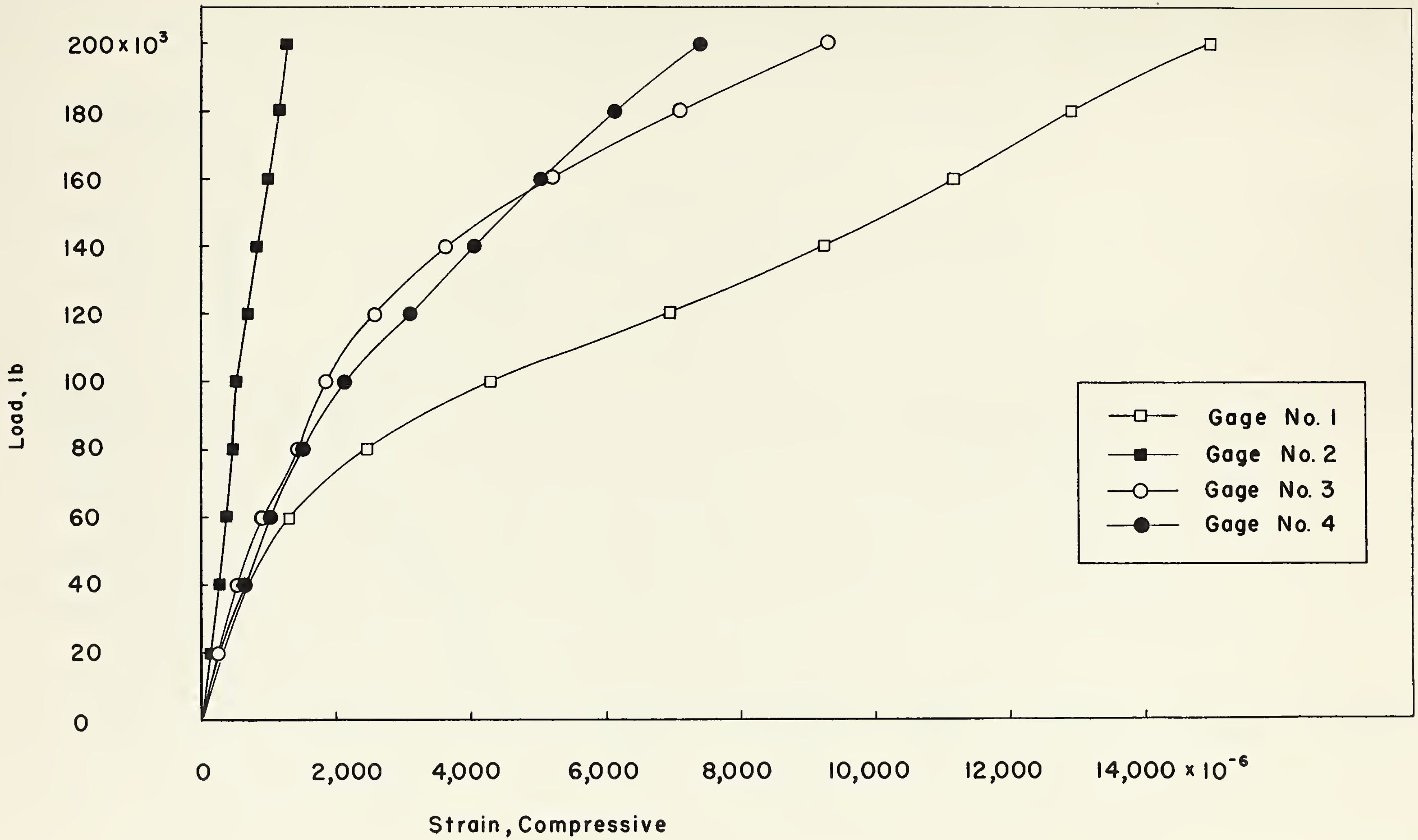
Figure 12



Load Strain Relations of Base (32 x 8.8 Tire on Multi-Electric Light)

6.4/295-7

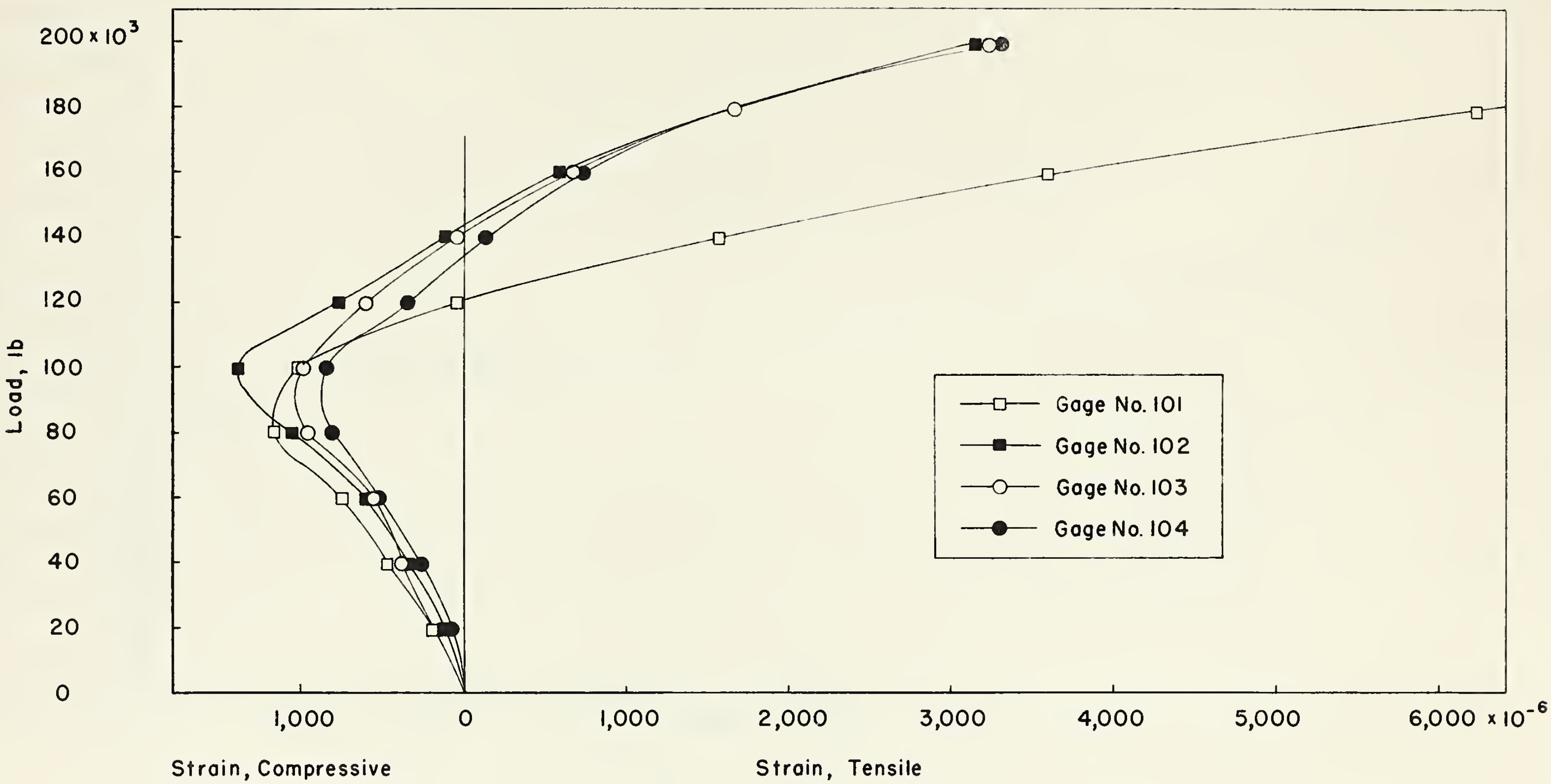
Figure 13



Load Strain Relations of Base (Strut on Flat Plate)

6.4/295-7

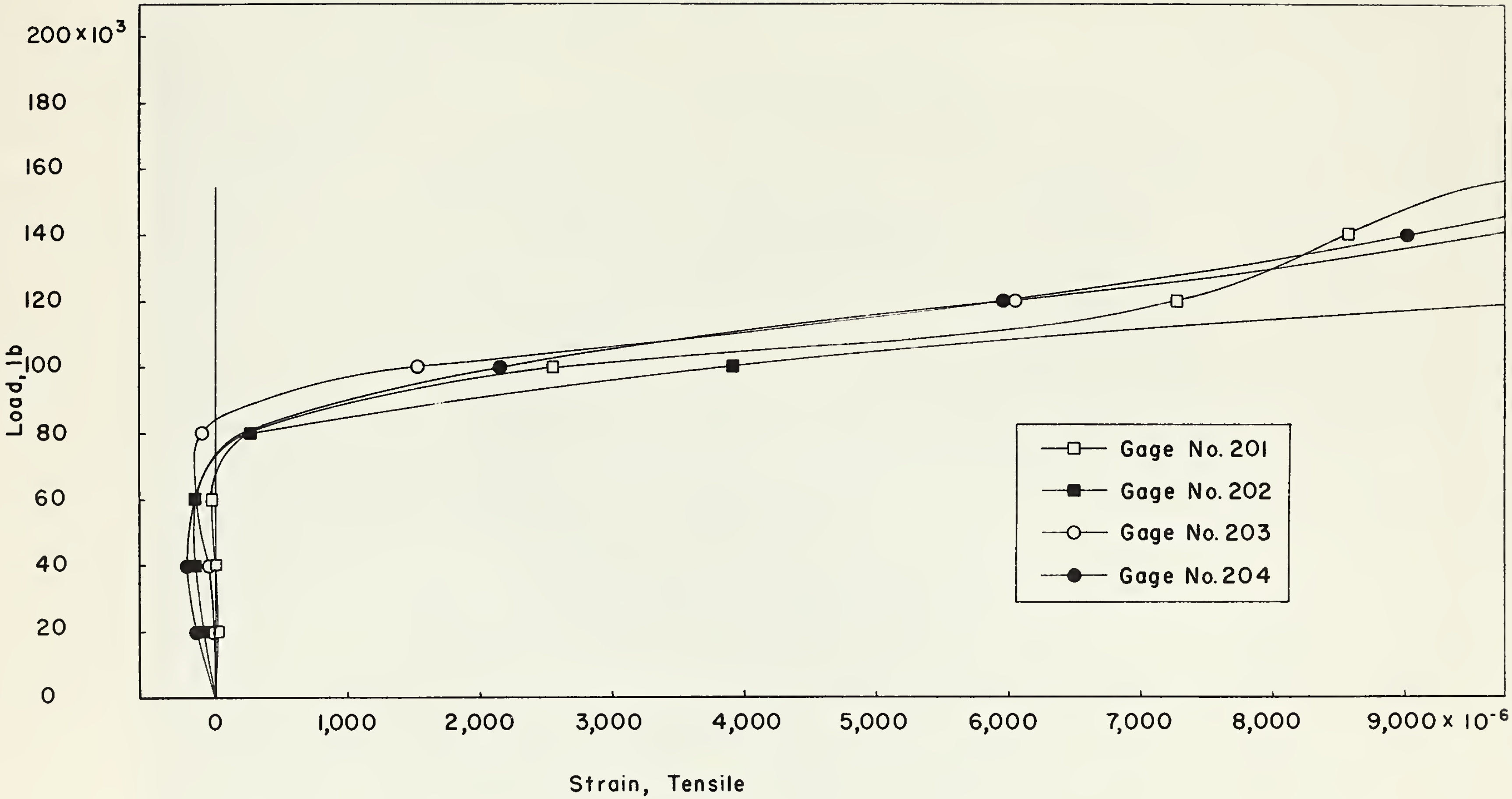
Figure 14



Load Strain Relations of Base (Strut on Flat Plate)

6.4/295-7

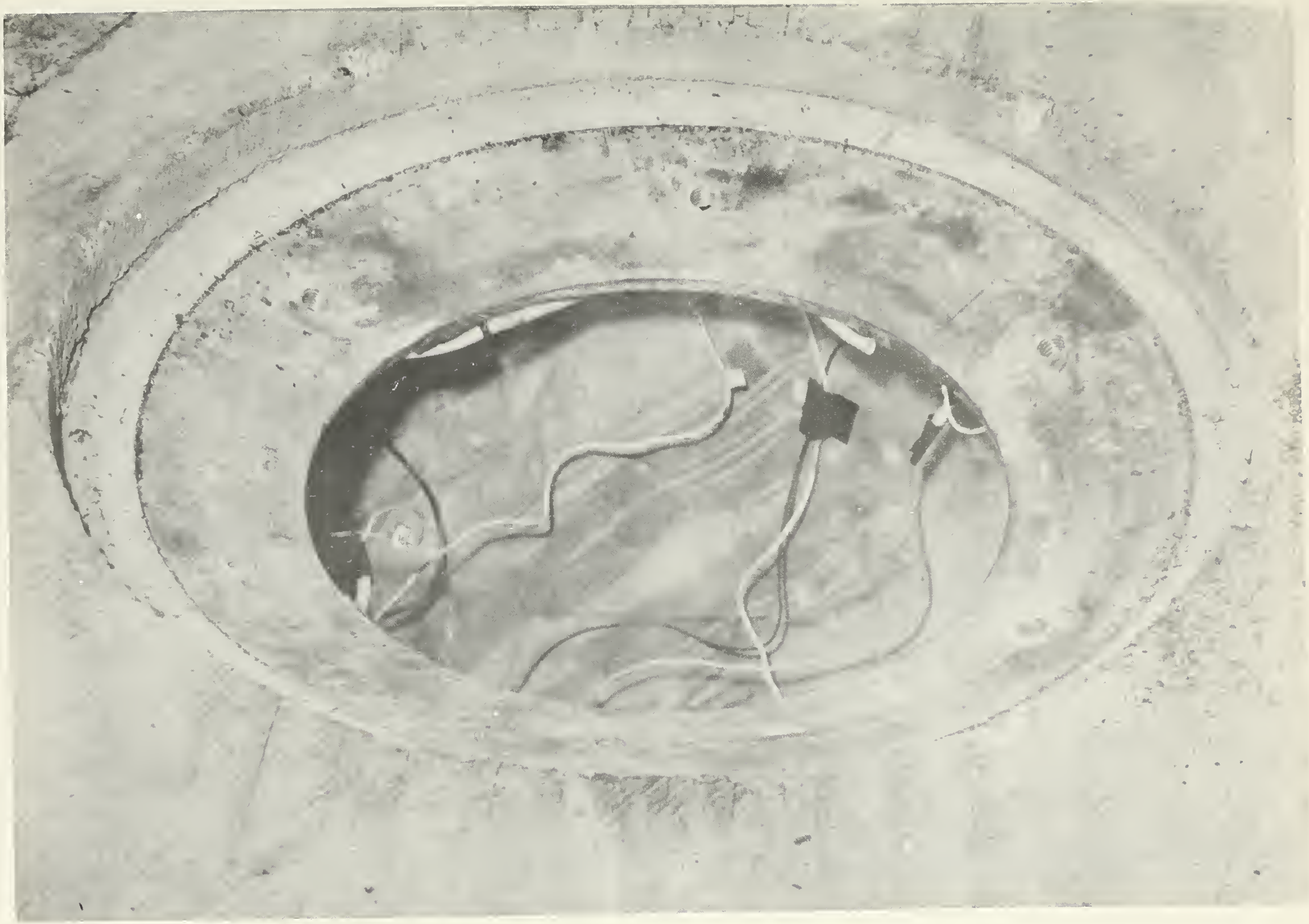
Figure 15



Load Strain Relations of Base (Strut on Flat Plate)

6.4 /295-7

Figure 16



Conical Shaped Flange of Base

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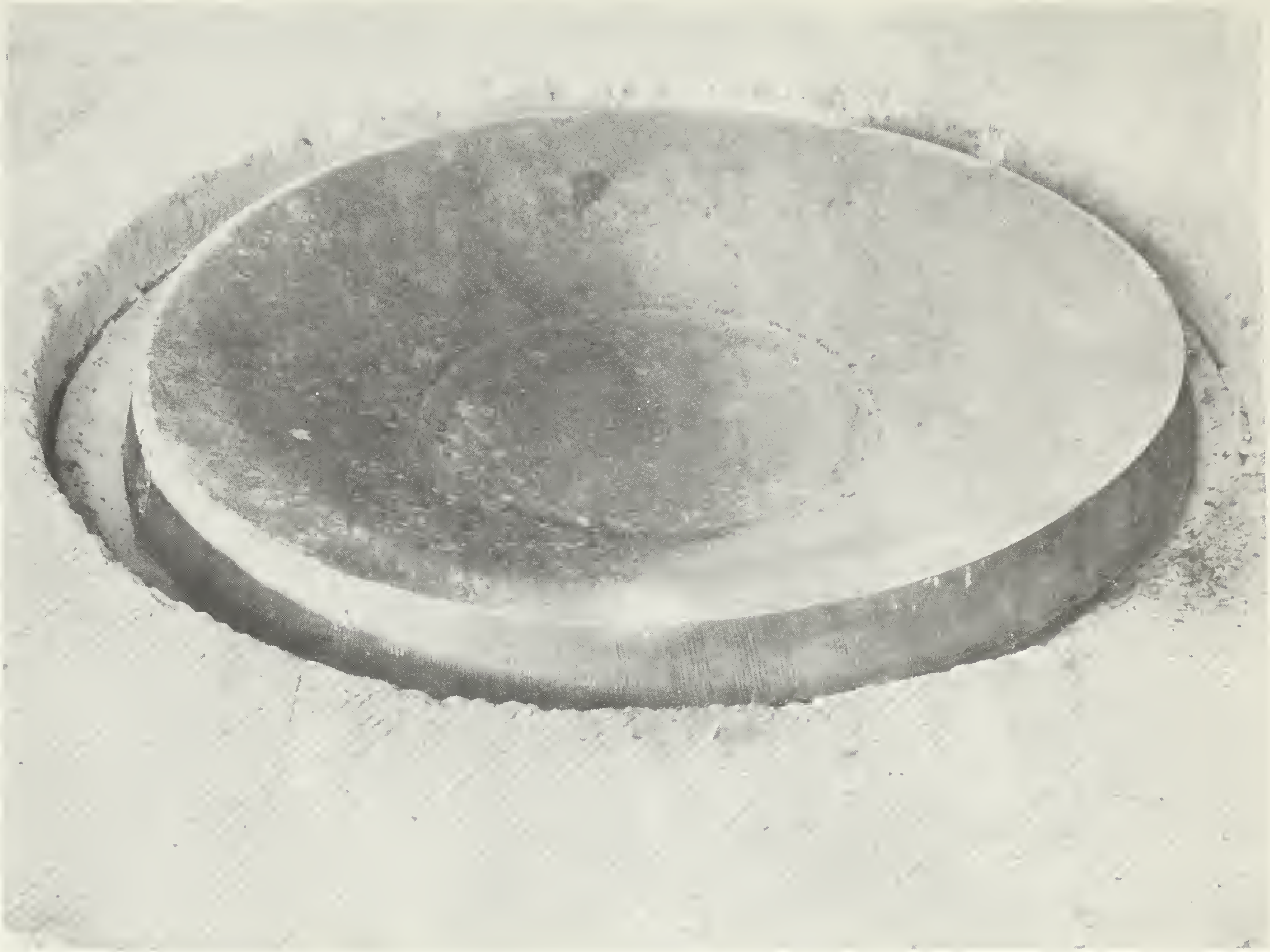
Figure 17



Hemi-Spherical Shaped Steel Plate

6.4/295-7

Figure 18

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Frederick H. Mueller, *Secretary*

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A. V. Astin, *Director*

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ELECTRICITY. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

METROLOGY. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

HEAT. Temperature Physics. Heat Measurements. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research. Equation of State. Statistical Physics. Molecular Spectroscopy.

RADIATION PHYSICS. X-Ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

CHEMISTRY. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

MECHANICS. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Combustion Controls.

ORGANIC AND FIBROUS MATERIALS. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

METALLURGY. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

MINERAL PRODUCTS. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

BUILDING RESEARCH. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

APPLIED MATHEMATICS. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

DATA PROCESSING SYSTEMS. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

ATOMIC PHYSICS. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics.

INSTRUMENTATION. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

IONOSPHERE RESEARCH AND PROPAGATION. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

RADIO PROPAGATION ENGINEERING. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

RADIO STANDARDS. High frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

RADIO SYSTEMS. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Space Telecommunications.

UPPER ATMOSPHERE AND SPACE PHYSICS. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

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