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DEPARTMENT OF MINES AND RESOURCES

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Ottawa, June 15, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2062.

Dynamic Calibration in Compression of 20,000-pound SF-20-U Sonntag Universal Fatigue Testing Machine.

(Copy No. 9 .)

(Investigation)
(Report No. 2062.)

Abstract.

This report gives the results obtained from a dynamic calibration in compression of the 20,000-pound Universal Fatigue Testing Machine, developed and built by the Sonntag Scientific Corporation and supplied by Baldwin Southwark Division, that has been installed in the Physical Metallurgy Research Laboratories, Ottawa. The calibration covered a load range from 1,000 to 18,000 pounds compression, and was carried out using a 50,000-pound Morehouse proving ring loaned by the Sonntag Scientific Corporation. The ring was equipped with a special indicating device in which the vibrating reed was replaced by an insulated spring-loaded plunger, used as an electrical contact in a circuit composed of a battery and a neon lamp.

It is shown that the true applied load range is lower than the value indicated on the control panel, the error in the maximum load being less than 1 per cent.

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA

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OF
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Mines and Geology Branch

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1. Origin and Purpose of Investigation:

The machine was purchased from the Baldwin Southwark Division of the Baldwin Locomotive Works, Philadelphia, Pa., for a special research project and to form part of the general fatigue testing equipment of the Laboratories. As a preliminary to using the machine for these purposes, and in accordance with the policy of the Laboratories, a check calibration of the machine was carried out under dynamic compressive loading. Representatives of the Sonntag Scientific Corporation collaborated in this investigation.

2. Description of the Machine:

Preload capacity = 0 to 10,000 pounds tension or compression.
Dynamic load range = $\pm$500 to $\pm$10,000 pounds.
Maximum dynamic load = 20,000 pounds tension or compression.

The machine is essentially a resonance machine, designed to carry out fatigue tests under direct or bending stresses, subject to the above limitations. A photograph of the machine with a test-piece in position is shown in Figure 1. At one end of the machine is the mechanical vibrating system, made up of sixteen helical compression springs, initially stressed between two plates by means of tie rods. One of these plates is the reciprocating platen. A centrifugal force oscillator unit is mounted centrally between eight of these springs, while the other eight springs, which apply the preload, are attached to the frame of the machine. At the other end of the machine is the hydraulic preload assembly. A schematic diagram is shown in Figure 2.

The mechanical oscillator with a fixed eccentricity is driven by an electronically controlled thyratron motor. The speed of rotation is slightly below the first resonance frequency of the system, thus small changes in motor speed produce relatively large changes in the magnitude of the applied dynamic load. The speed of testing also depends on the specimen stiffness, and varies from 1200 to 1900 r.p.m.

The load is transmitted through the specimen to the frame through a so-called "SR-4 dynamometer," which consists of a thin steel tube on the surface of which are attached SR-4 wire resistance strain gauges. The electrical output of these gauges is proportional to the alternating load applied and is used to measure and to control the load range. A load dial and multiplier mounted on the electrical control panel (shown in Figure 3) are used to set the

(Description of the Machine, cont'd) -

required load range.

The static preload is applied hydraulically through a double acting cylinder, and is measured by the deflection of the preload springs. This is done by means of a sensitive dial indicator, which can be mounted between a U-shaped member attached to the frame and a stud rigidly connected to the reciprocating platen. After the preload is applied to the specimen, the locking nut is tightened against the appropriate surface for tension or compression.

3. Calibration Procedure and Results:

The calibration was carried out in compression using a specially-adapted 50,000-pound Morehouse proving ring loaned by the Sonntag Scientific Corporation. In order to facilitate the dynamic calibration, the vibrating reed of the instrument had been removed and replaced by a spring-loaded plunger, which was electrically insulated from the supporting boss. The plunger was electrically connected to the ring through a 110-volt battery and a neon glow lamp ($\frac{1}{4}$ watt). This circuit was completed when the face of the micrometer screw was brought into contact with the lower end of the plunger.

The procedure used in the calibration was first to mount the ring in the machine in an axial position and then to apply the desired compressive preload. This gave a check on the static calibration of the preload springs. The thyratron motor was switched on and the speed increased to give the required dynamic load range. When the automatic control was in operation, the proving ring reading was taken. It will be clear from the previous description that only the maximum of the load range, and not the minimum, can be

(Calibration Procedure and Results, cont'd) -

observed under these conditions. The motor was then switched off and a further proving ring reading taken of the static load. This process was repeated for several values of the load range and subsequently for two more values of the static preload, care being taken that the load on the ring was always compressive. The total range of load covered in this investigation was from 1,000 pounds to 18,000 pounds compression, and in all cases the dynamic load was set by maintaining the load dial reading at 2,000 pounds and varying the position of the multiplier. The results of the calibration are given in Table I, and are shown plotted in Figure 4.

TABLE I. - Results of Dynamic Calibration (Compression).

Preload, pounds	Dynamic Load Setting: Load dial	Dynamic Load Setting: Multiplier	Dynamic Load from Proving Ring, pounds	Nominal Load Range, pounds	Error in Max. Load*: Pounds	Error in Max. Load*: Per Cent
10,000 nominal	2,000	2	1,920	8,000-12,000	80	0.7
9,930 actual		4	3,985	6,000-14,000	15	0.1
		6	5,940	4,000-16,000	60	0.4
		8	7,970	2,000-18,000	30	0.2
8,000 nominal	2,000	2	1,995	6,000-10,000	5	<0.1
7,935 actual		4	4,005	4,000-12,000	-5	<-0.1
		6	5,960	2,000-14,000	40	0.3
6,000 nominal	2,000	1	995	5,000- 7,000	5	<0.1
5,865 actual		2	1,995	4,000- 8,000	5	<0.1
		3	2,990	3,000- 9,000	10	0.1
		4	3,985	2,000-10,000	15	0.2
		5	4,945	1,000-11,000	55	0.5

* The values given for the error in the maximum load do not include the initial errors in the static preload.

4. Accuracy of Calibration:

The proving ring used in this investigation was calibrated by the National Bureau of Standards, Washington, with dead-weight loading and its accuracy, under static conditions, is of the order of 0.1 per cent. Under dynamic loading the accuracy of the ring is limited by the precision with which the readings can be taken; with the specially-adapted ring

(Accuracy of Calibration, cont'd) -

used for these experiments, the accuracy of the reading was about ±20 pounds.

As previously stated, the readings in this calibration were taken while the dynamic load was under automatic control. The load dial was marked with 100 divisions and it was observed that the degree of control was about ±1 division. Thus the dynamic load may vary by approximately ±1 per cent.

5. Conclusion:

A preliminary dynamic calibration of the 20,000-pound Sonntag fatigue machine has been carried out at the P.M.R.L., using a 50,000-pound Morehouse proving ring under compressive loading. The results, plotted in Figure 4, indicate that the load range setting is higher than the true load range with one exception, the error in the maximum applied load being less than 1 per cent.

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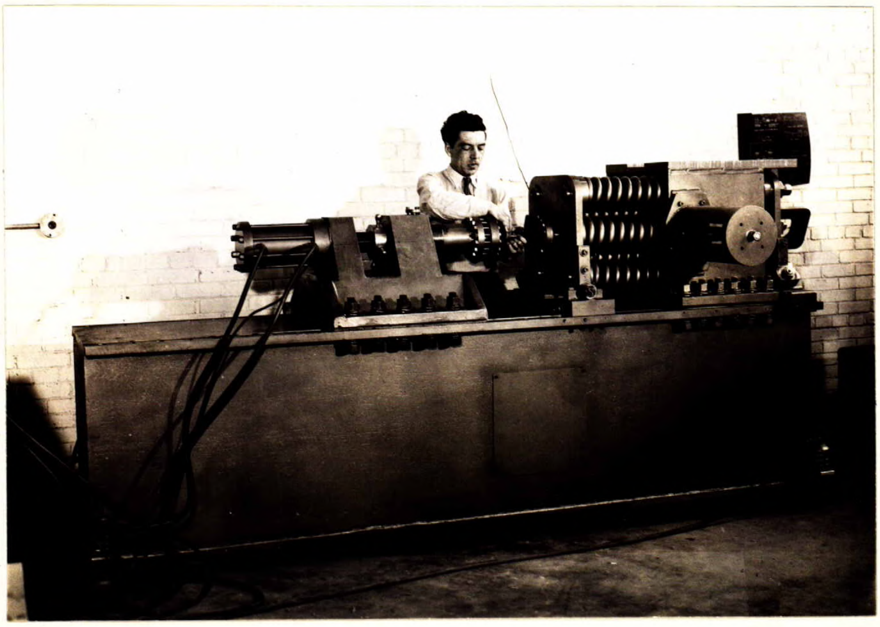
TWW:RT:LB.

(Figures 1 to 4 follow,)
(on Pages 6 to 8.)

Figure 1.



THE MACHINE WITH TEST PIECE IN POSITION.

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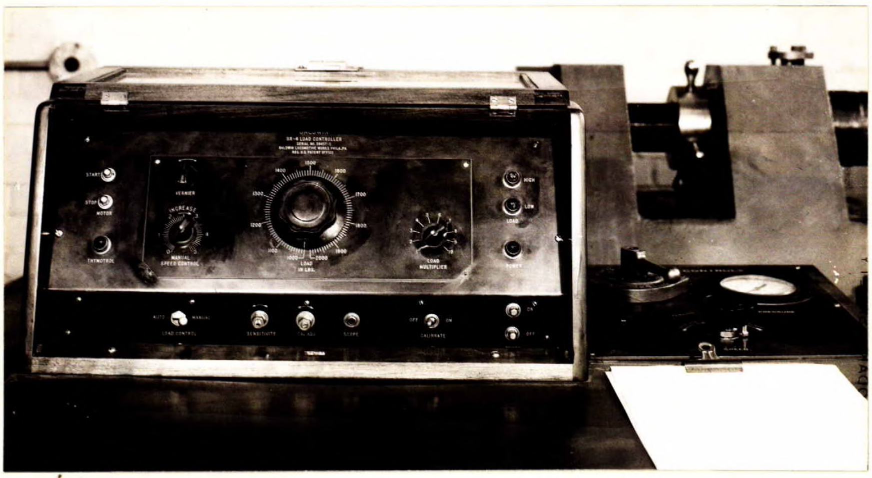
Figure 3.



CONTROL PANEL.

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(Figures 2 and 4 comprise)
(Pages 7 and 8 respectively.)

TWW;RT:LB.

SONNTAG UNIVERSAL FATIGUE TESTING MACHINE SF-IOU

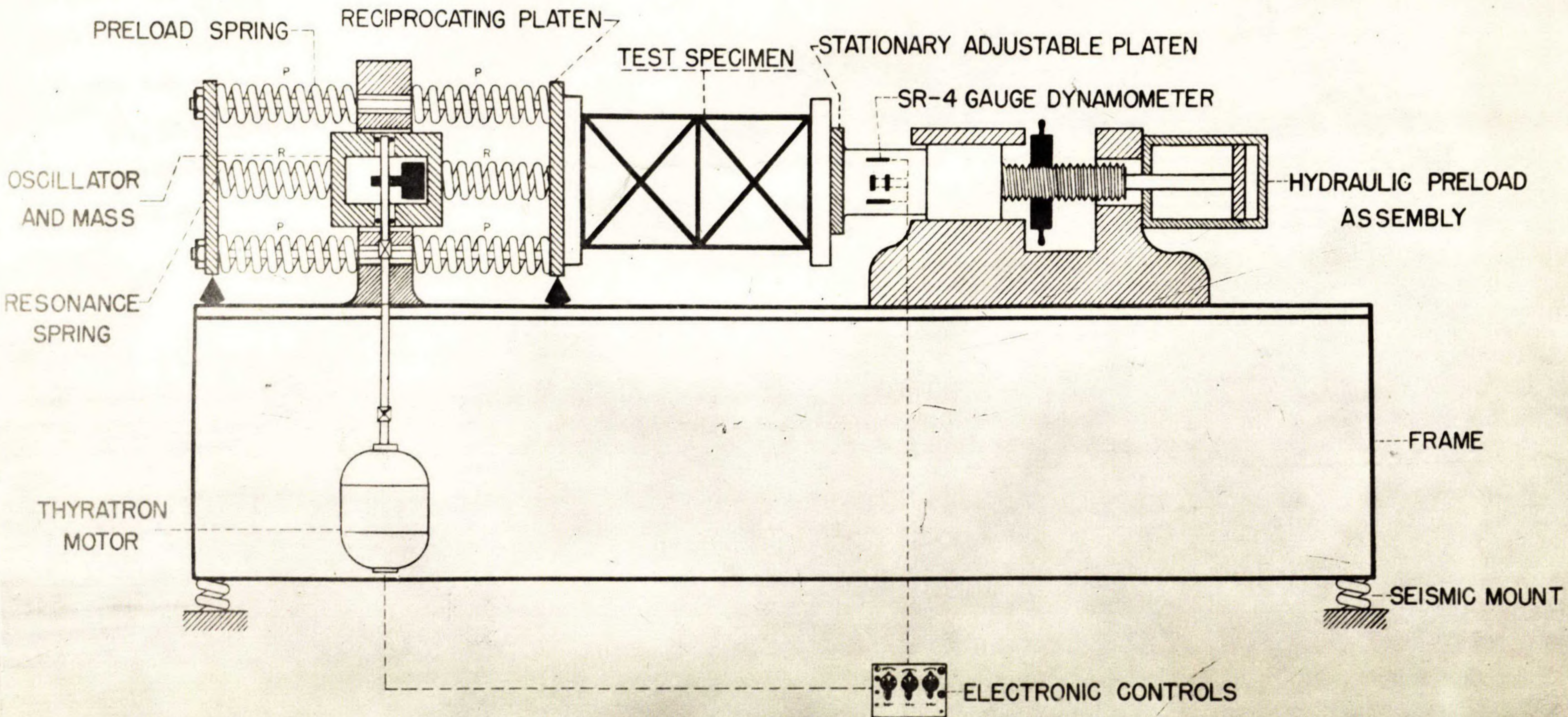
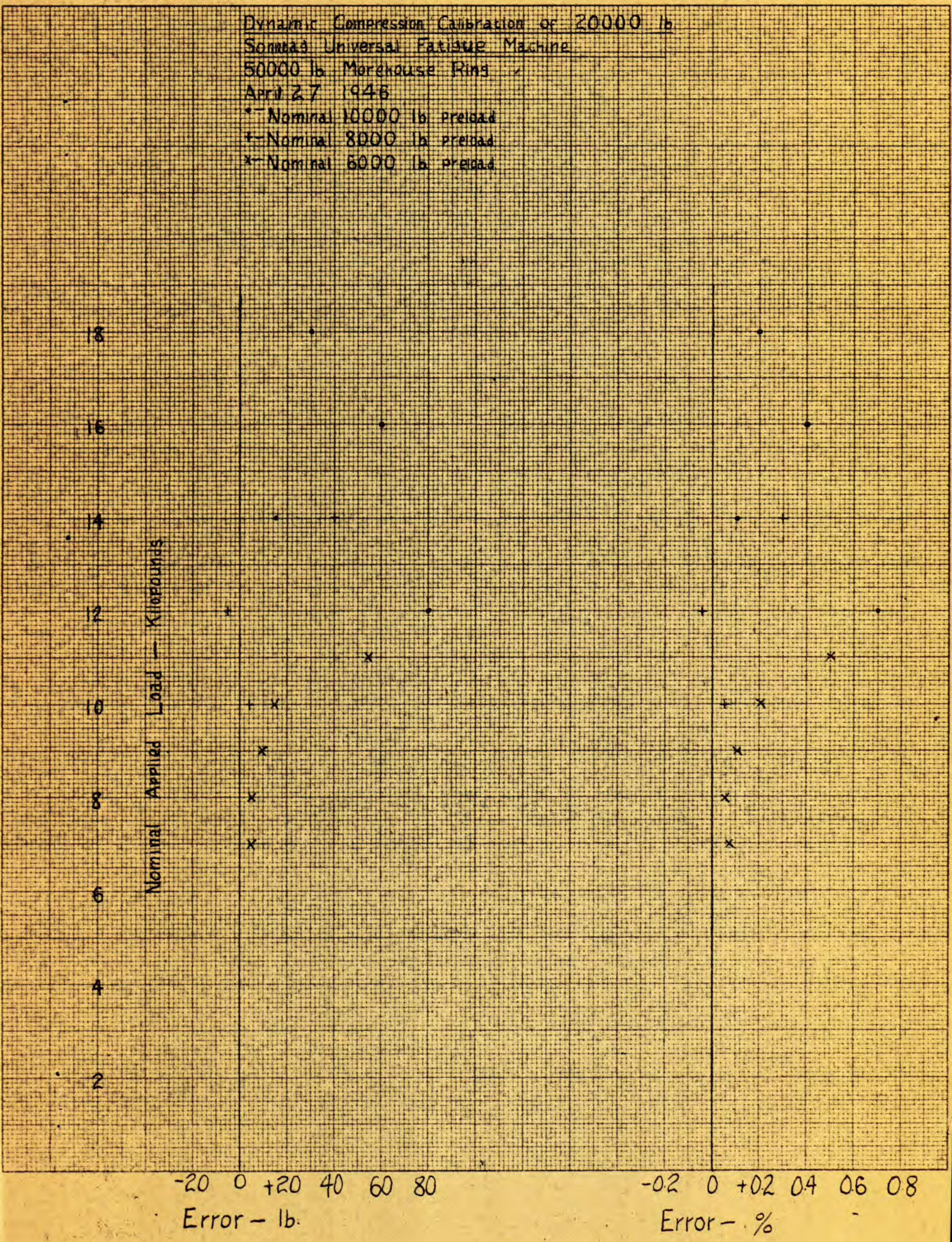


FIG. 2

Figure 4.


Dynamic Compression Calibration of 20000 lb
Sonntag Universal Fatigue Machine
50000 lb Morehouse Ring
April 27 1946
•- Nominal 10000 lb preload
+- Nominal 8000 lb preload
×- Nominal 6000 lb preload
Nominal Applied Load — Kilopounds
2
4
6
8
10
12
14
16
18
-20 0 +20 40 60 80
Error — lb.
-0.2 0 +0.2 0.4 0.6 0.8
Error — %