NATIONAL BUREAU OF STANDARDS REPORT

4086

RESULTS OF STATIC LOADING TESTS OF
ELFACA GRATINGS BY AIRCRAFT TIRES

by

L. K. Irwin

Report to
Equipment Laboratory
Wright Air Development Center
Department of the Air Force

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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L. K. Irwin
Engineering Mechanics Section
Mechanics Division

To

Equipment Laboratory
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NBS Lab. No. 6.4/2-85-2

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1. INTRODUCTION

The need for illumination without obstructions on or very near to runways and deceleration areas of airports led to the design of a system of recessed lights with steel grids or gratings to protect the lights from aircraft tires. Limited use has been made of gratings with the trade name "Elfaca" at overseas installations. The performance of these gratings has not been determined and evaluated for the large variety of tire sizes and landing and deceleration loads that can be expected in civil and military aircraft.

At the request of the Equipment Laboratory, Wright Air Development Center, tests with static loads were undertaken to study the effects of Elfaca gratings upon two sizes of aircraft tires.

2. TEST SAMPLES AND APPARATUS

The aircraft tires were sizes 20x4.4, 10-ply rating and 26x6.6, 12-ply rating. Two Elfaca gratings, designated types 0200-SB and 3130-E, were used. Compressive loads were applied to the tires and gratings with a testing machine of 10,000,000-lb capacity. An auxiliary load measuring system was placed in series with the reaction head and the loading fixture to indicate the loads applied by the machine with increased sensitivity. The test fixture, a 20x4.4 tire, a type 0200-SB grating and the load sensing devices are shown in figure 1. The load was applied by means of a test fixture of rolled steel sections and 1 1/4-inch steel plate to a steel shaft through the wheel. Precautions were taken to prevent motion of the test fixture parallel to the axis of the wheel. Deflection measurements were made during these tests with dial gages.

3. TEST PROCEDURES

The tires and gratings were set up in a compression testing machine so that the tires could be loaded by the gratings with various orientations of the bars relative to the tires. Also each tire was loaded on a flat steel plate to provide a base for comparing the load-deflection relations of the tire on the gratings. The test positions of each tire and grating combination are given in table 1.

Continuously increasing compressive loads were applied and values of load and deflection were determined simultaneously. The vertical deflections of the axis of the wheel relative to the top of the grating or flat plat were measured for all tests. Also the deflections of the tops of the bars parallel to the axis of the wheel were measured during tests 4 and 5 of the 26x6.6 tire.

The position of no load and zero deflection was taken to be that position in which the tire and one or more bars of the grating had made sufficient contact to prevent easy rotation of the wheel by hand. The air pressure in the tires with no load was measured periodically to be 155 lb/in.^{2} in the 20x4.4 and 165 lb/in.^{2} in the 26x6.6 tire.

4. RESULTS

4.1 Size 20x4.4 Tire

The tire was photographed for each test position while sustaining the rated static load, 3750 lb, and the maximum load applied. These load conditions are shown in figures 2 to 11, inclusive. Load-deflection curves for the 20x4.4 tire in the various test positions are shown in figure 12. The deflections for opposite sides of the tire were averaged for each load. The tests were stopped when it appeared that the wheel flange was bearing directly on double thicknesses of the casing and tube, or the deflections were large enough to cause the lower edge of the flange to be below the tops of the bars, see figure 11.

The deflections at the rated static load, 3750 lb, and the loads required to cause 2-inch deflection for the various test positions are listed in table 2.

4.2 Size 26x6.6 Tire

Photographs of the 26x6.6 tire in each test position while sustaining the rated static load, 8,000 lb, and the maximum load applied are shown in figures 13 to 22, inclusive. Load-deflection curves for this tire in each test position are given in figure 23. The deflection values are the average of measurements made on opposite sides of the tire. The tests were stopped at 20,000-lb load with the tire on a flat plate and at 18,000-lb load in the other test positions to avoid possible damage to the tire which might influence the results of subsequent tests.

The deflections measured at the rated static load, 8,000 lb, and the loads required to cause 3-in. deflection are given in table 2. The lateral deflections of the top of the bars as measured during tests 4 and 5 of the 26x6.6 tire, figures 19 through 22, ranged from 0.02 to 0.07 in. at the maximum test loads. Visual examination of the bars and gratings after the tests did not reveal any damage.

5. DISCUSSION

The load-deflection curves for the tests of the 20x4.4 tire on two Elfaca gratings indicate that when the tire is supported by one bar of the gratings and the load sustained by the tire and grating exceeds the rated static load, the deflections of the tire are sufficiently large that the flange of the wheel lies below the top of the grating as shown in figure 11. It seems likely that relatively large forces might result from operating conditions under which the wheel is required to climb out of the grating while sustaining maximum service loads. The magnitude and effects of these forces on the tire and aircraft should be determined analytically or experimentally.

The tests of the 26x6.6 tire on two Elfaca gratings indicate that the tire probably would traverse the two types of gratings considered without serious damage to either tire or grating.

Several factors which cannot be evaluated adequately from the static tests reported include

(a) the tendency of rolling wheels to "track", that is, to travel parallel to the axes of bars while the main body of the aircraft travels skew to the axes of the bars.

(b) the cutting action of the bars on the tread of skidding tires.

(c) the forces developed in the undercarriage when tire is required to climb out of the grating.

(d) the structural strength and stability of the bars which make up the grating when loads are applied skew to the axis of the maximum principal moment of inertia of the bars.

The effects of these factors should be determined analytically or experimentally.

For the Director,

B L Wilson

B. L. Wilson, Chief,
Engineering Mechanics Section,
Division of Mechanics.

Washington, D. C.

Table 1. Test Positions of 20x4.4 and 26x6.6 Tires On Elfaca Gratings

Test	Type of grating	No. of bars supporting tire	Average distance between bars under ℄ of wheel	Figure Nos.
			in.	
		20x4.4 Tire		
1	(a)	(a)	--	2, 3
2	0200-SB	2	2.51	4, 5
3	0200-SB	3	1.22	6, 7
4	3130-E	(b)	3.18	8, 9
5	3130-E	1	2.30	10, 11
		26x6.6 Tire		
1	(a)	(a)	--	13, 14
2	3130-E	2	2.30	15, 16
3	3130-E	(b)	3.18	17, 18
4	3130-E	3	2.30	19, 20
5	0200-SB	5	1.22	21, 22

(a) Tire supported on flat plate

(b) Axis of tire at 45° to long dimension of bars

Table 2. Results of Static Load Tests of 20x4.4 and 26x6.6 Tires on Elfaca Gratings

Test	Deflection at rated static load	Load at 2 inches deflection	Load at 3 inches deflection	Maximum test load
	in.	lb	lb	lb
		20x4.4 Tire		
1	0.98	10,900	--	11,500
2	0.97	10,900(a)	--	10,000
3	1.12	8,100	--	11,000
4	1.29	6,600	--	9,000
5	1.93	3,900	--	5,800
		26x6.6 Tire		
1	1.58	--	18,100	20,000
2	1.70	--	13,950	18,000
3	1.74	--	16,600	18,000
4	1.70	--	17,400	18,000
5	1.68	--	16,400	18,000

(a) Load-deflection curve extrapolated to obtain this value.

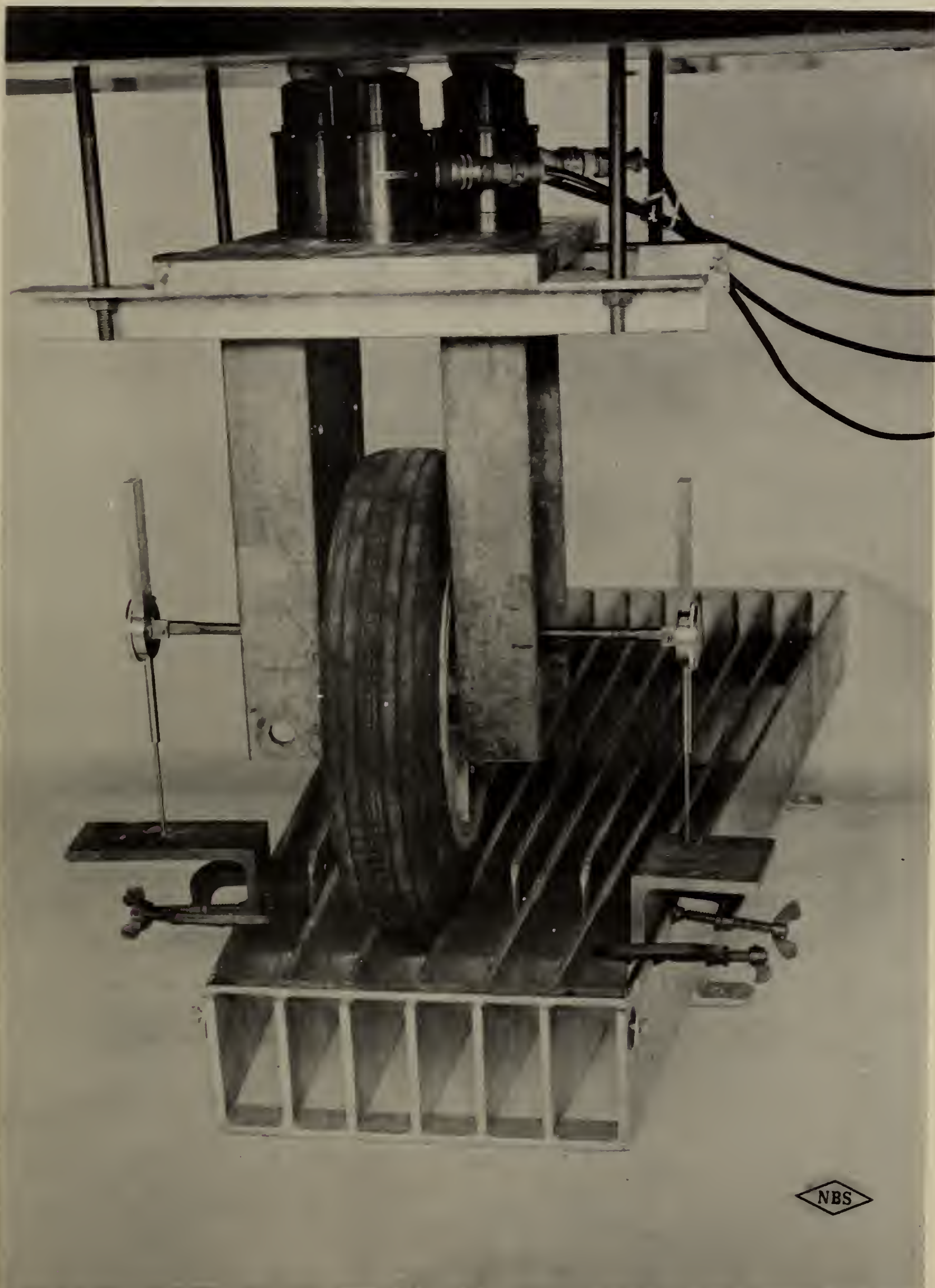

Figure 1. Test set-up of a 20x4.4 aircraft tire and a type ~~3130-E~~ 0200-5B "Elfaca" grating.

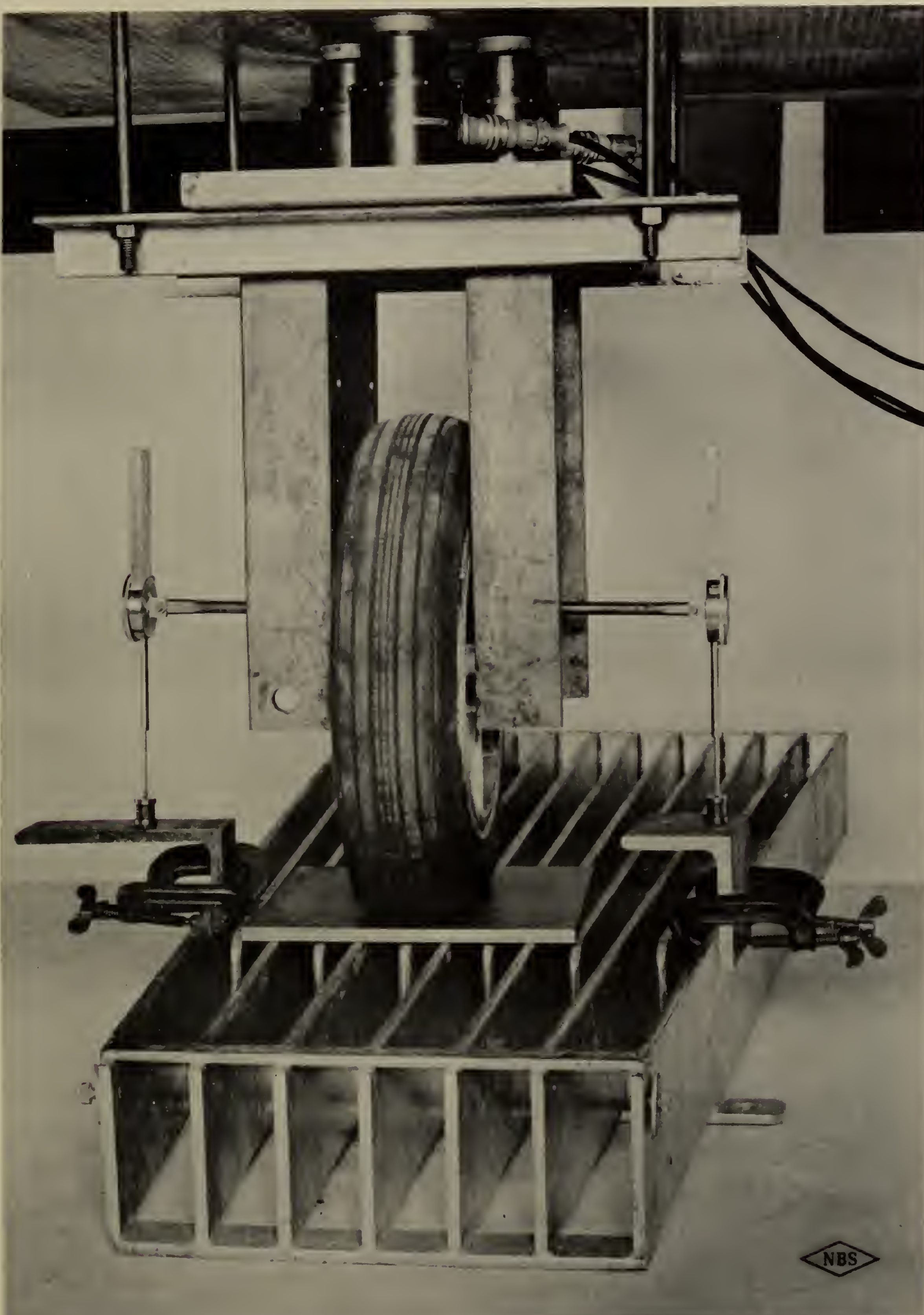

Figure 2. A 20x4.4 aircraft tire on a flat steel plate. Load = 3,750 lb.

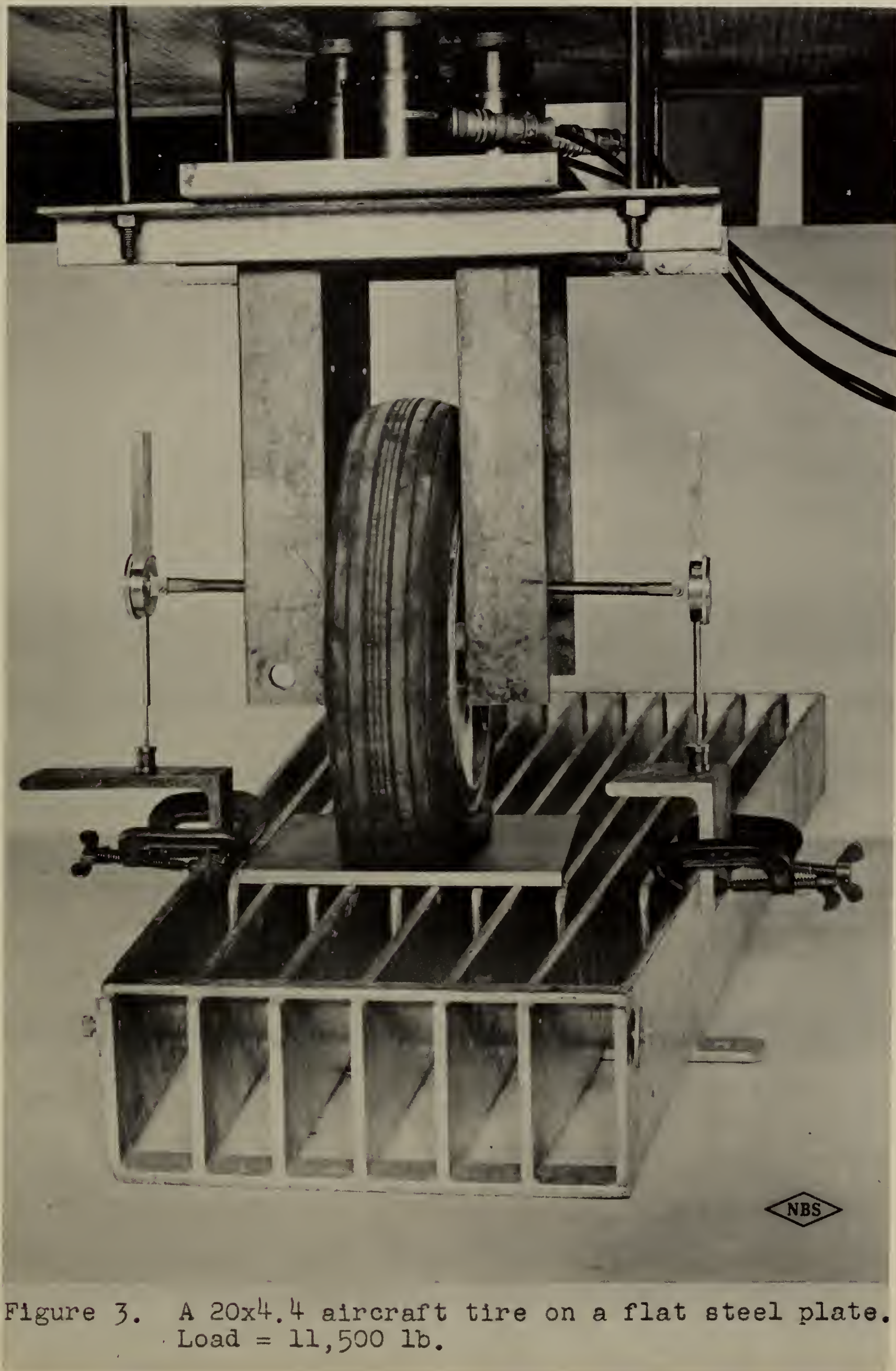

Figure 3. A 20x4.4 aircraft tire on a flat steel plate. Load = 11,500 lb.

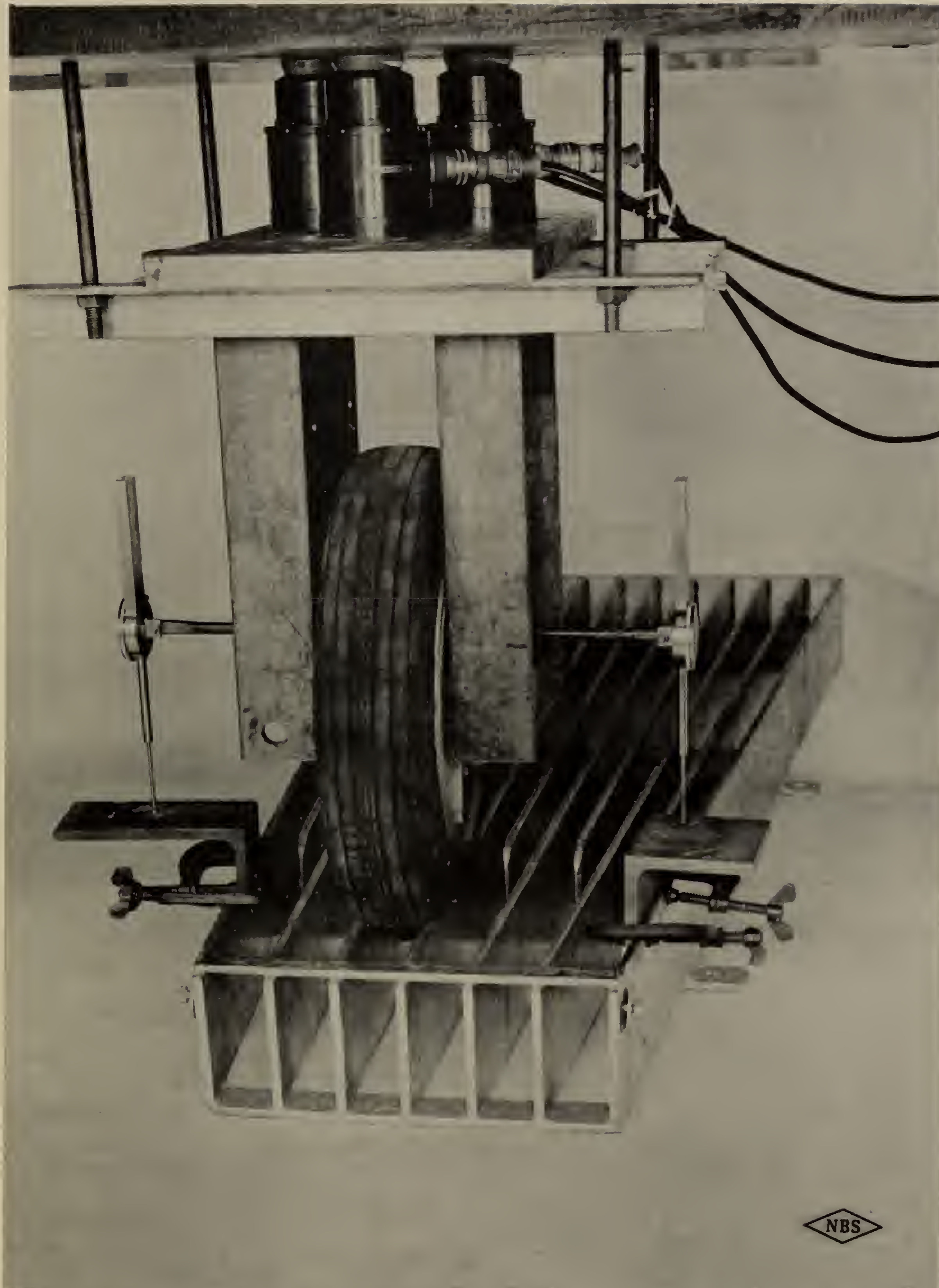

Figure 4. A 20x4.4 aircraft tire on two bars of a type 0200-SB "Elfaca" grating. Load = 3,750 lb.

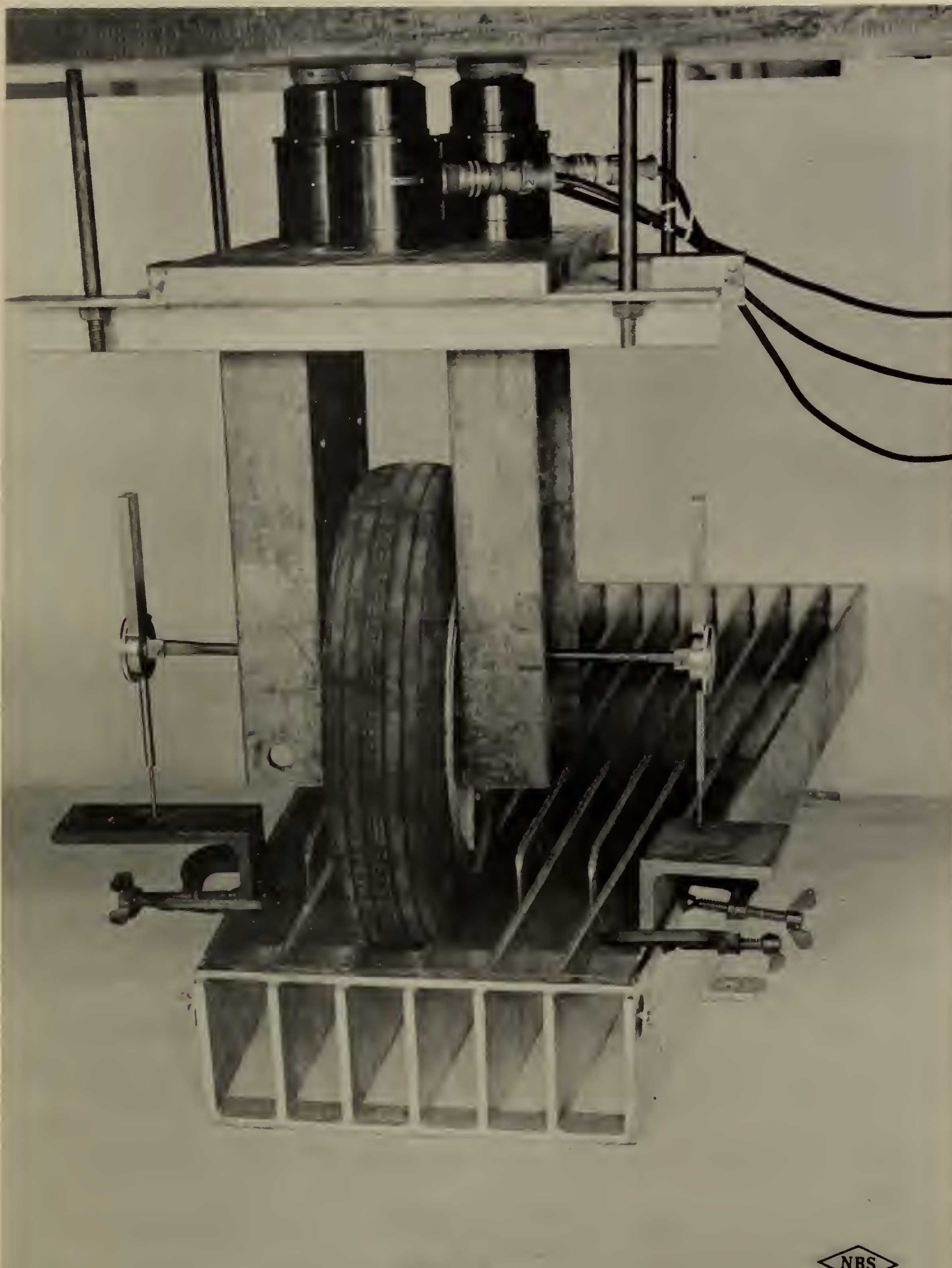

Figure 5. A 20x4.4 aircraft tire on two bars of a type 0200-SB "Elfaca" grating. Load = 10,000 lb.

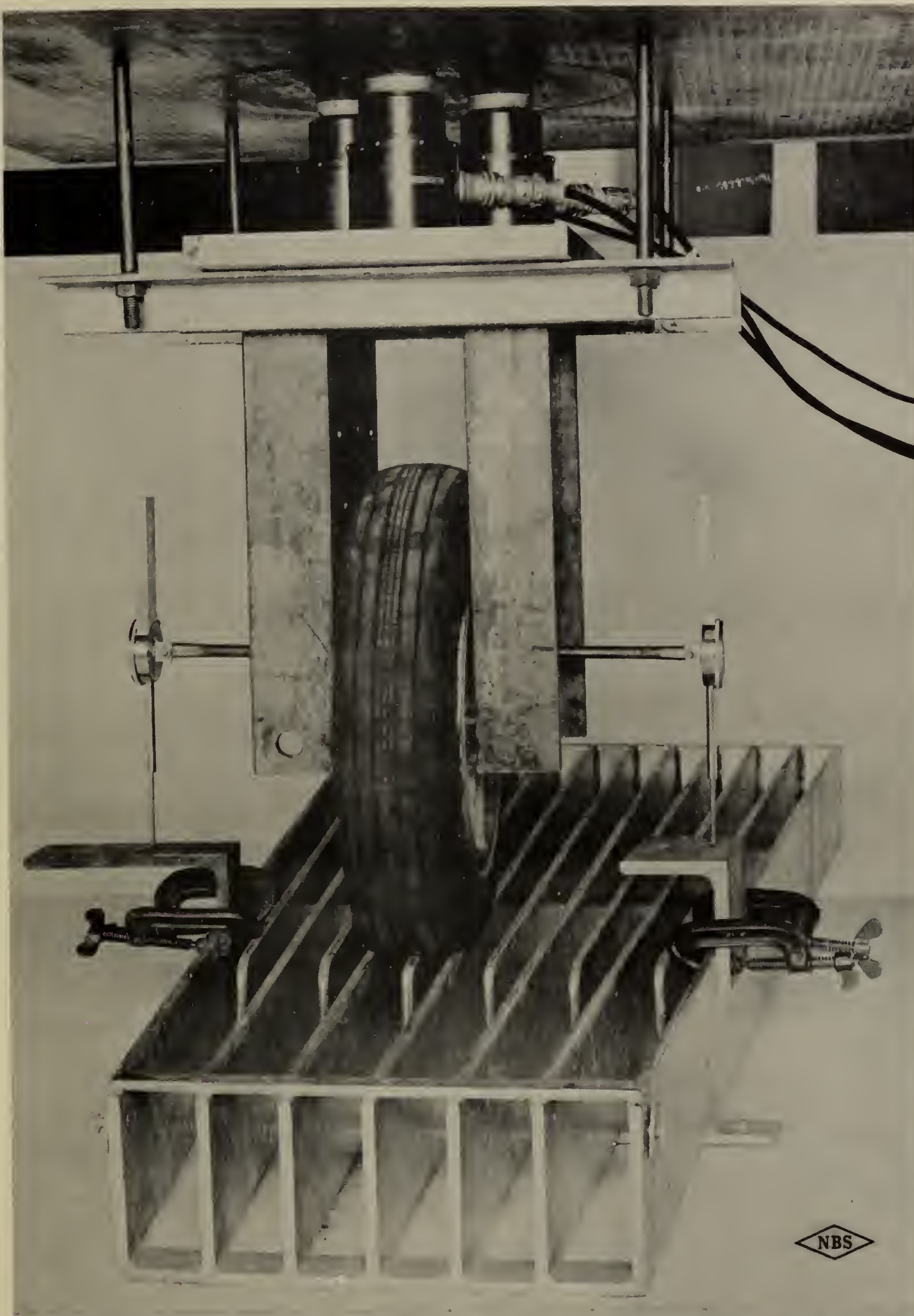

Figure 6. A 20x4.4 aircraft tire on three bars of a type 0200-SB "Elfaca" grating. Load = 3,750 lb.

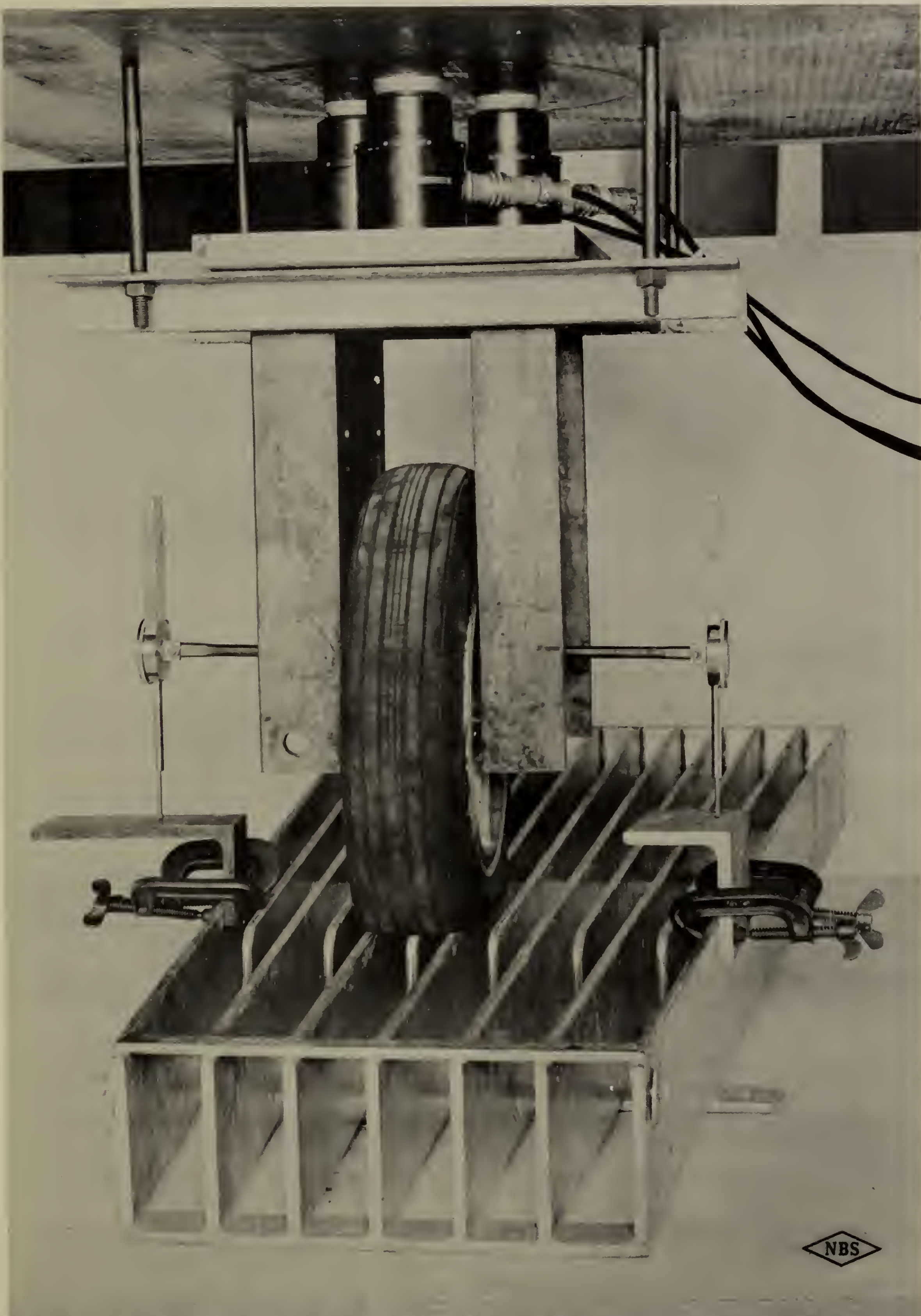

Figure 7. A 20x4.4 aircraft tire on three bars of a type 0200-SB "Elfaca" grating. Load = 11,000 lb.

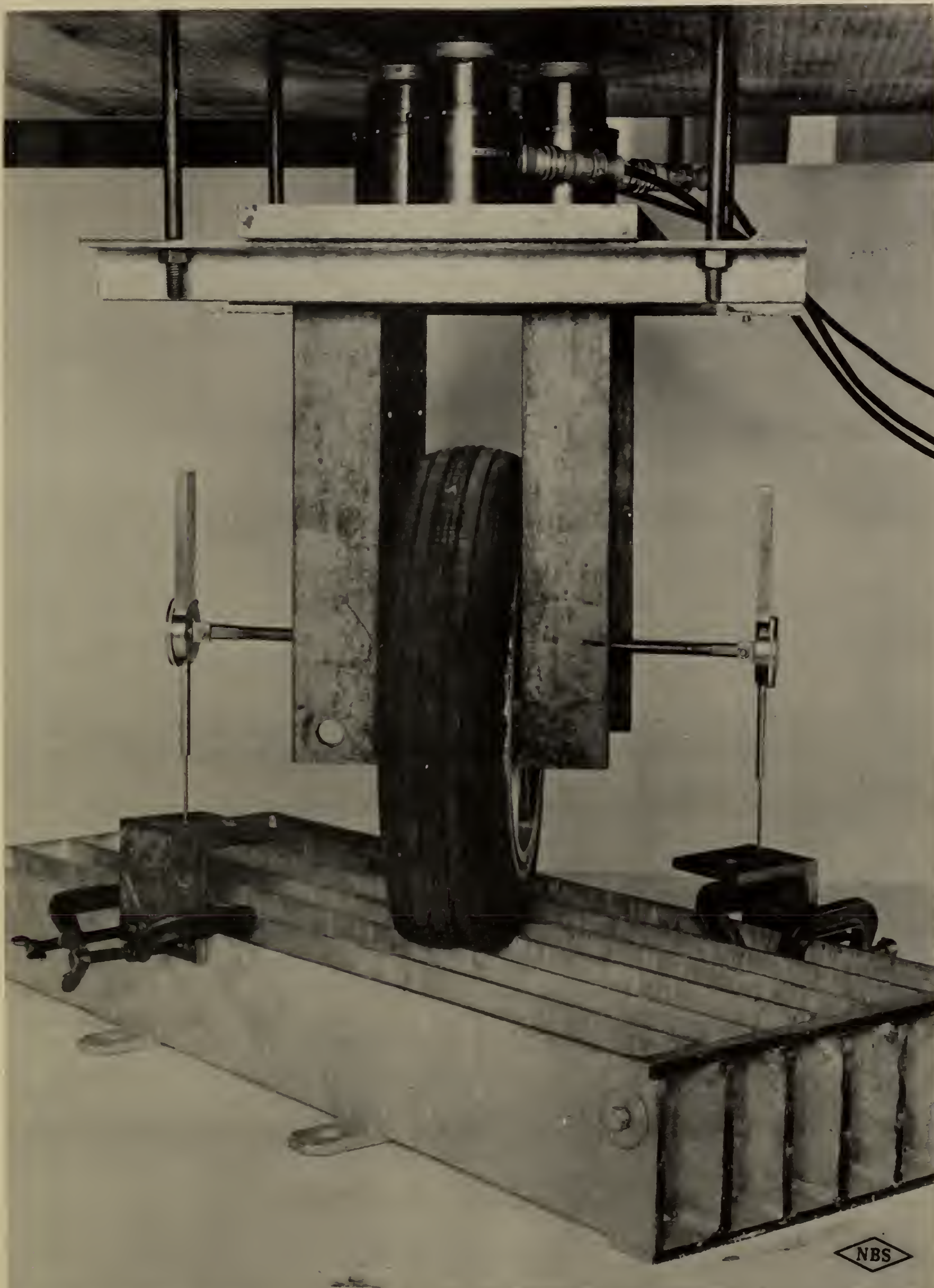

Figure 8. A 20x4.4 aircraft tire at 45° to the bars of a type 3130-E "Elfaca" grating.
Load = 3,750 lb.

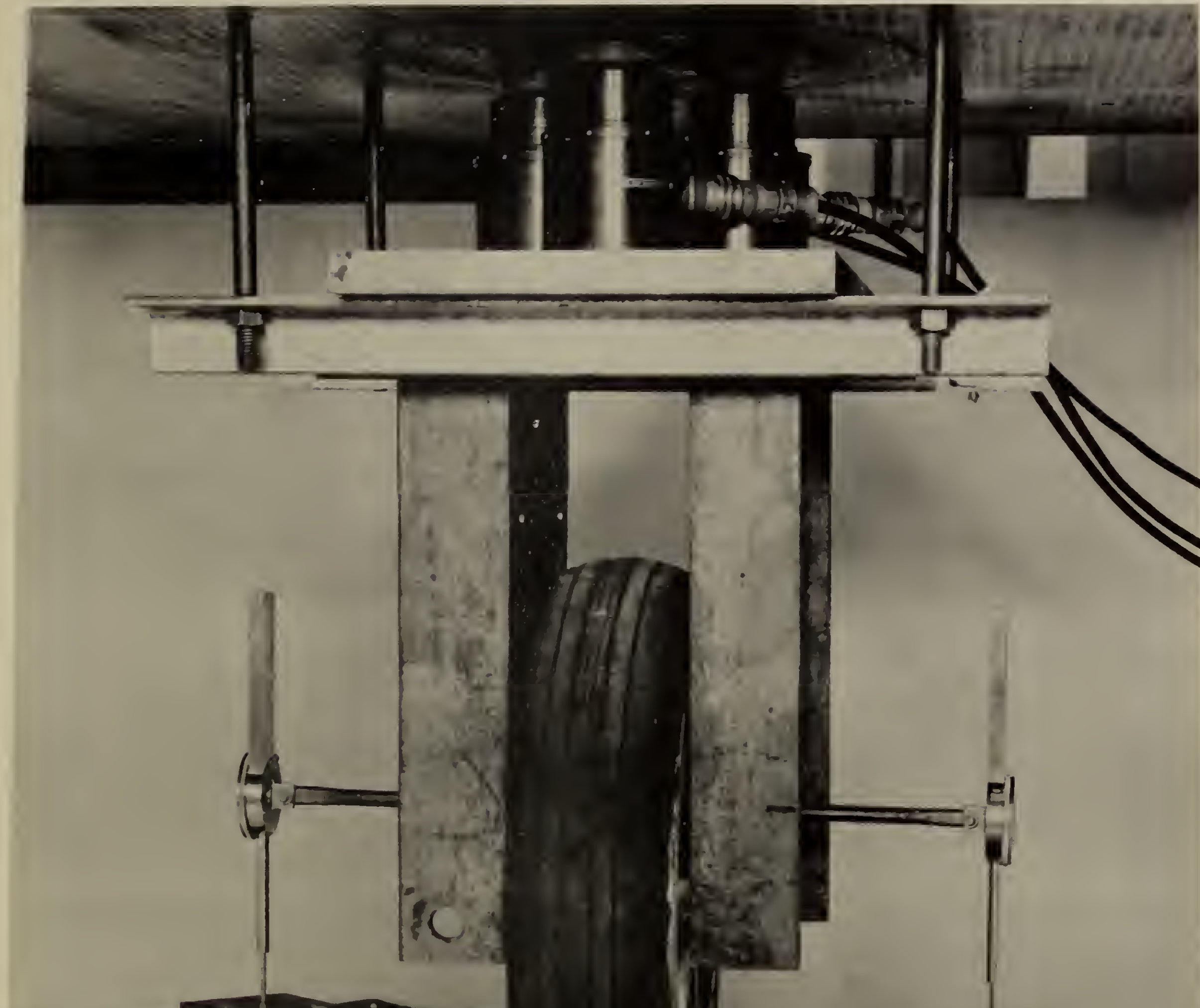

Figure 9. A 20x4.4 aircraft tire at 45° to the bars of a type 3130-E "Elfaca" grating.
Load = 9,000 lb.

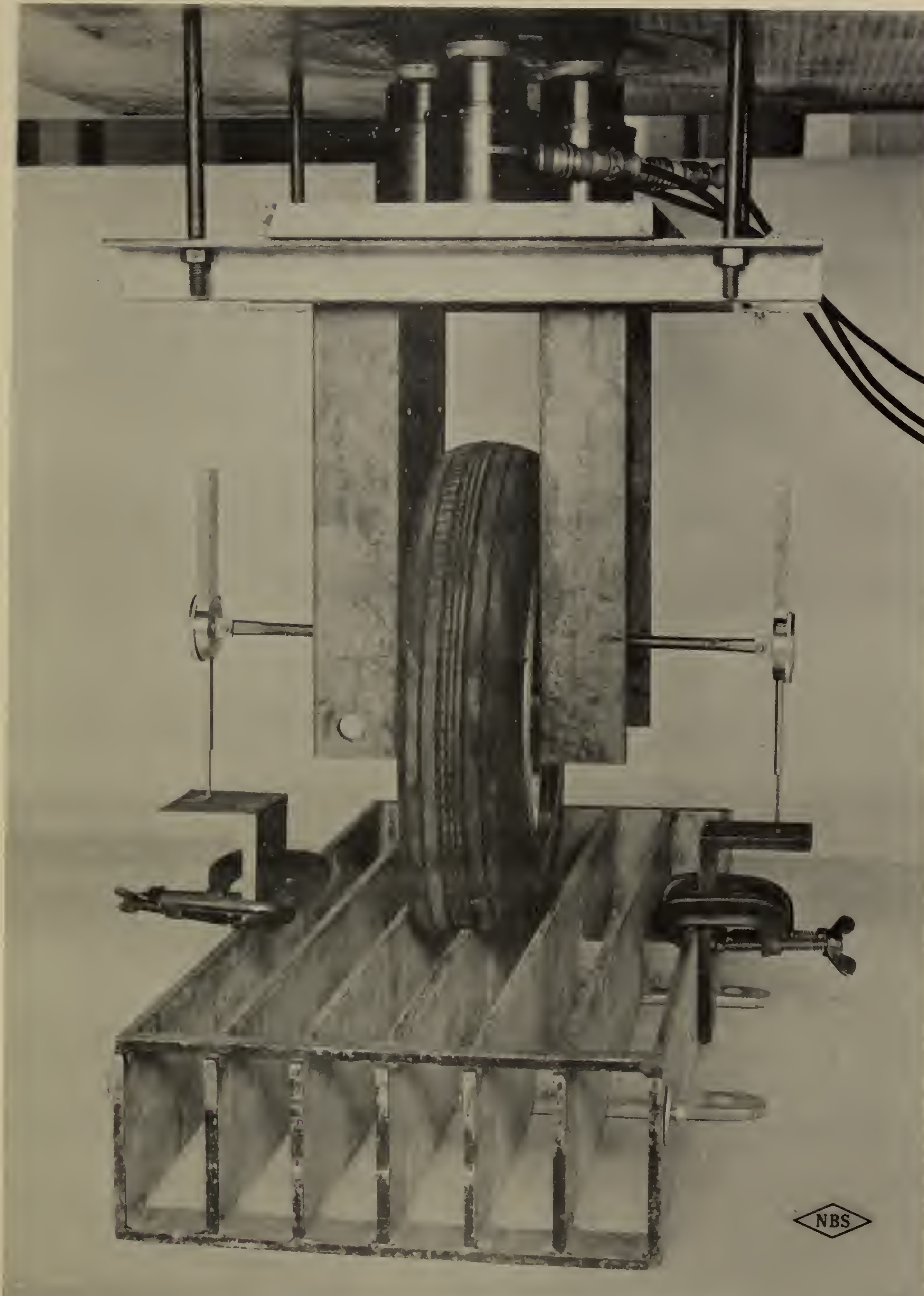

Figure 10. A 20x4.4 aircraft tire on one bar of a type 3130-E "Elfaca" grating. Load = 3,750 lb.

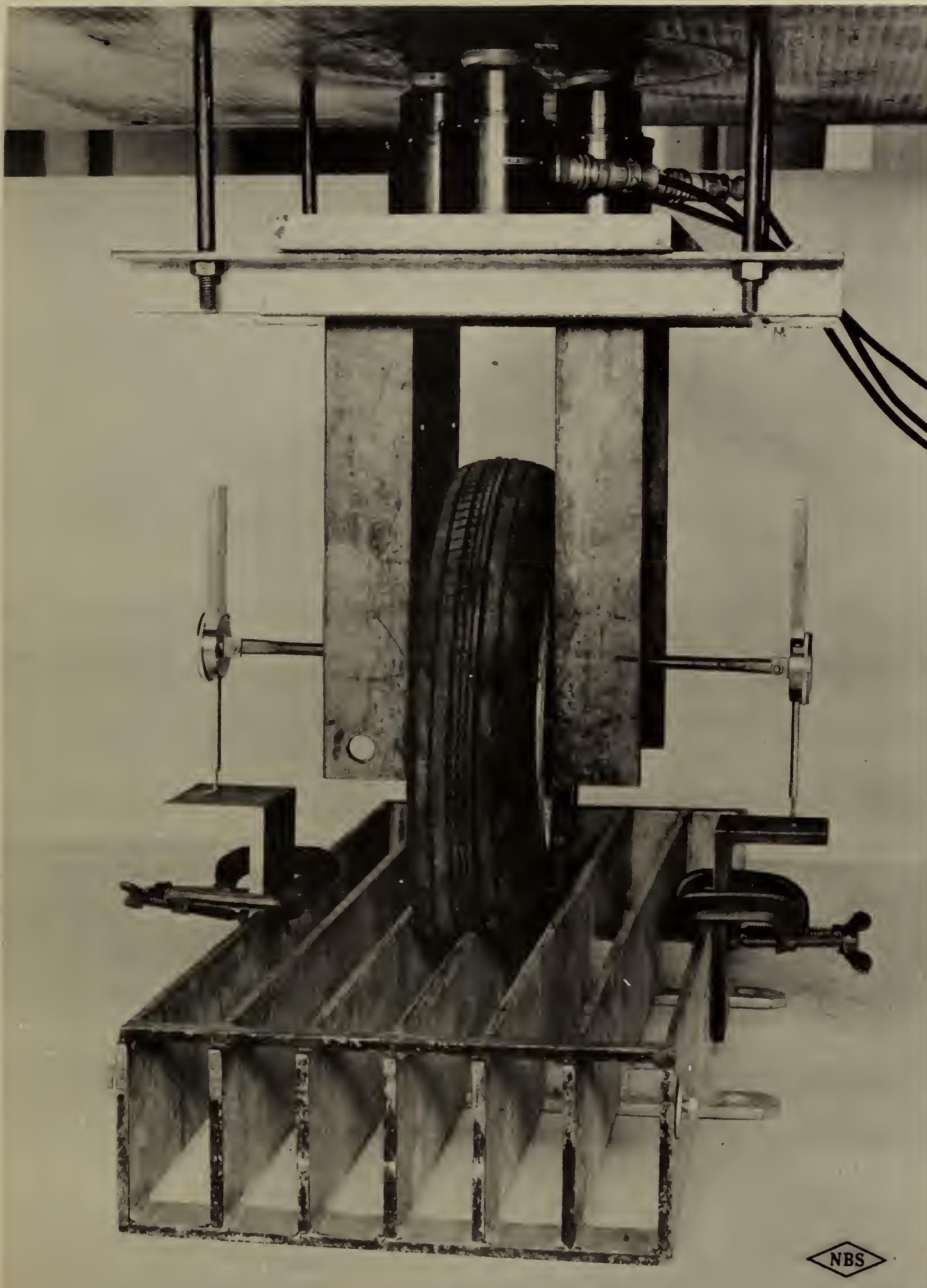

Figure 11. A 20x4.4 aircraft tire on one bar of a type 3130-E "Elfaca" grating. Load = 5,800 lb.

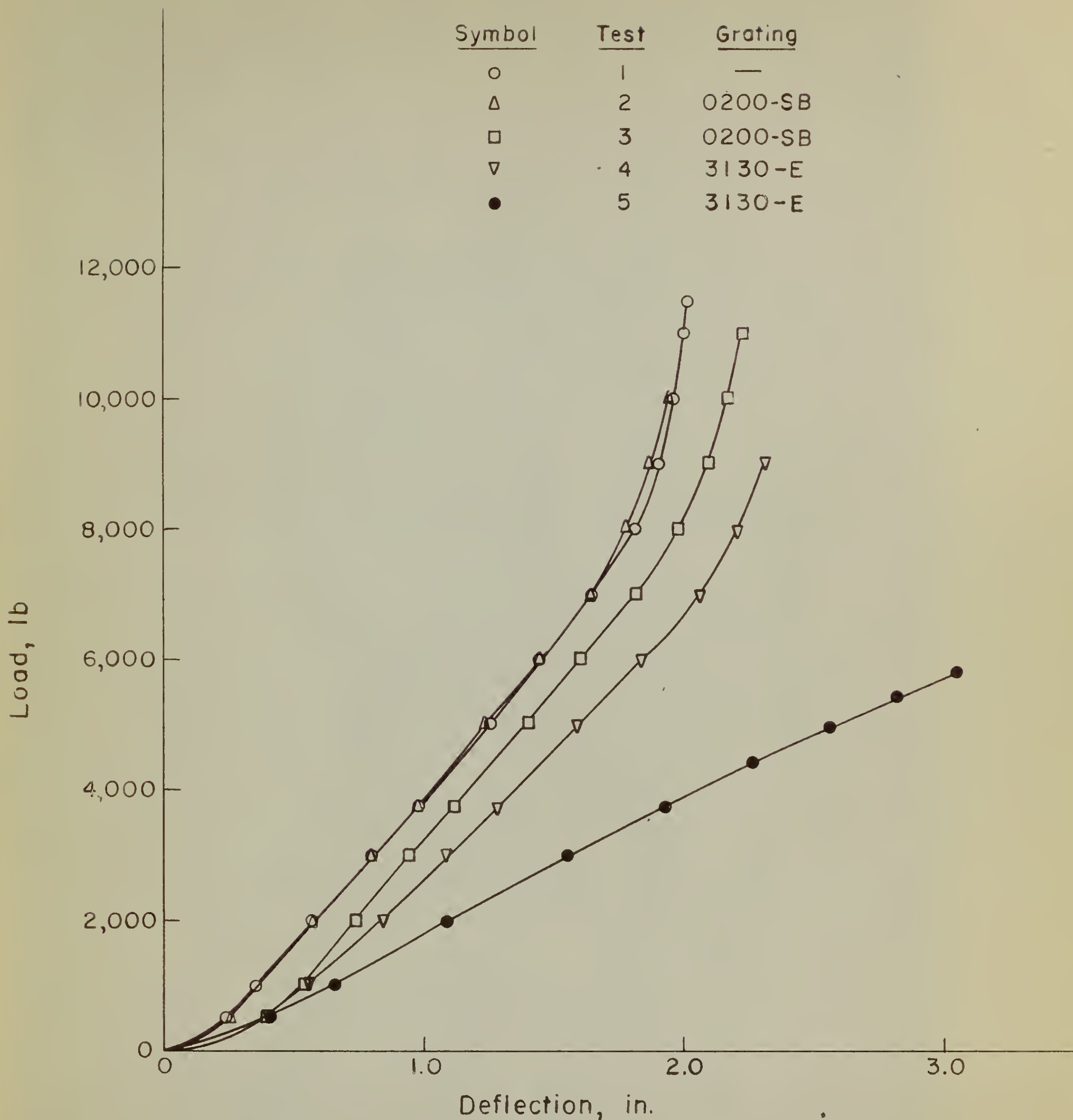

Fig. 12 Load-deflection relations for a 20 x 4.4 aircraft tire on "Elfaca" grating.

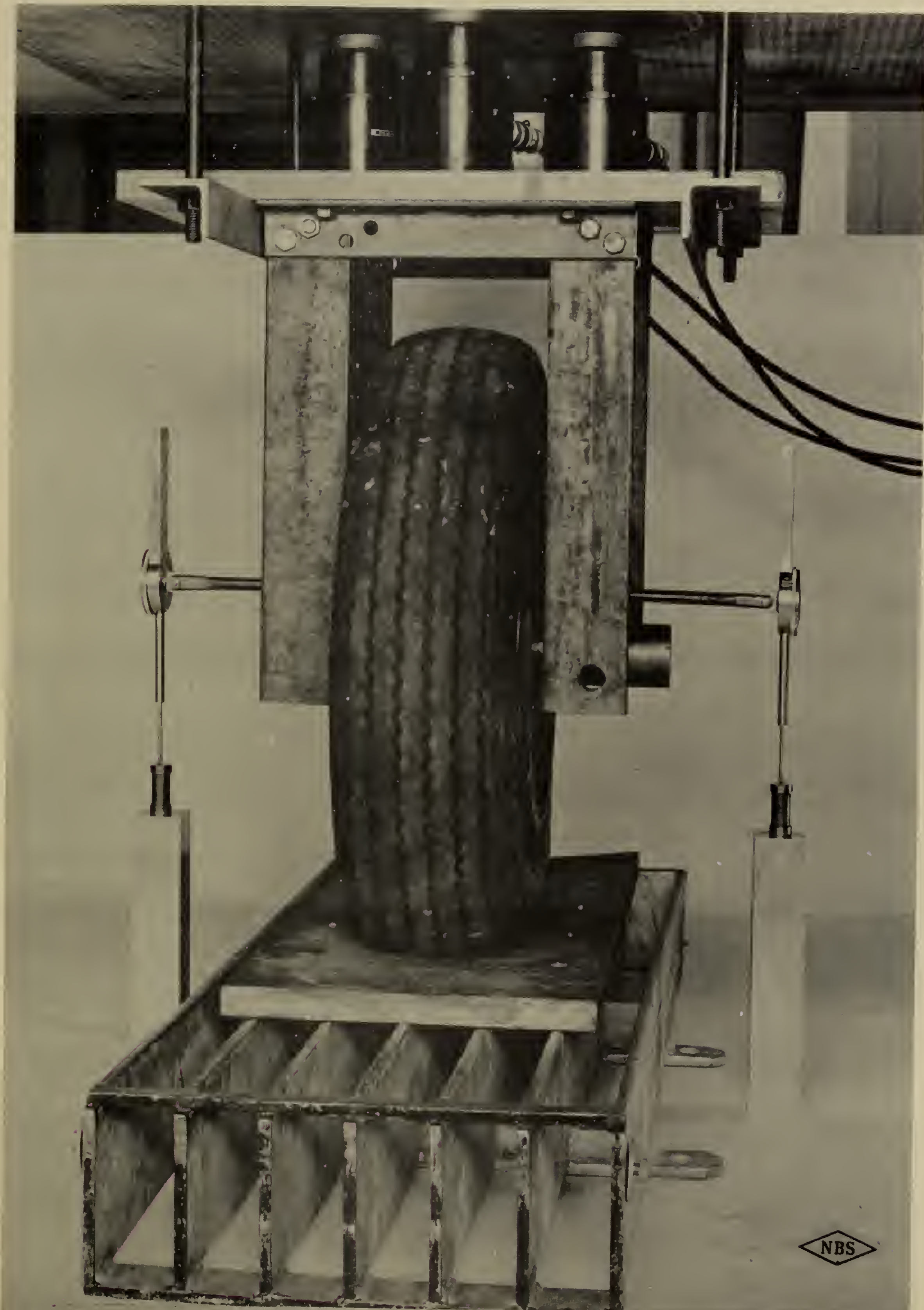

Figure 13. A 26x6.6 aircraft tire on a flat steel plate.
Load = 8,000 lb.

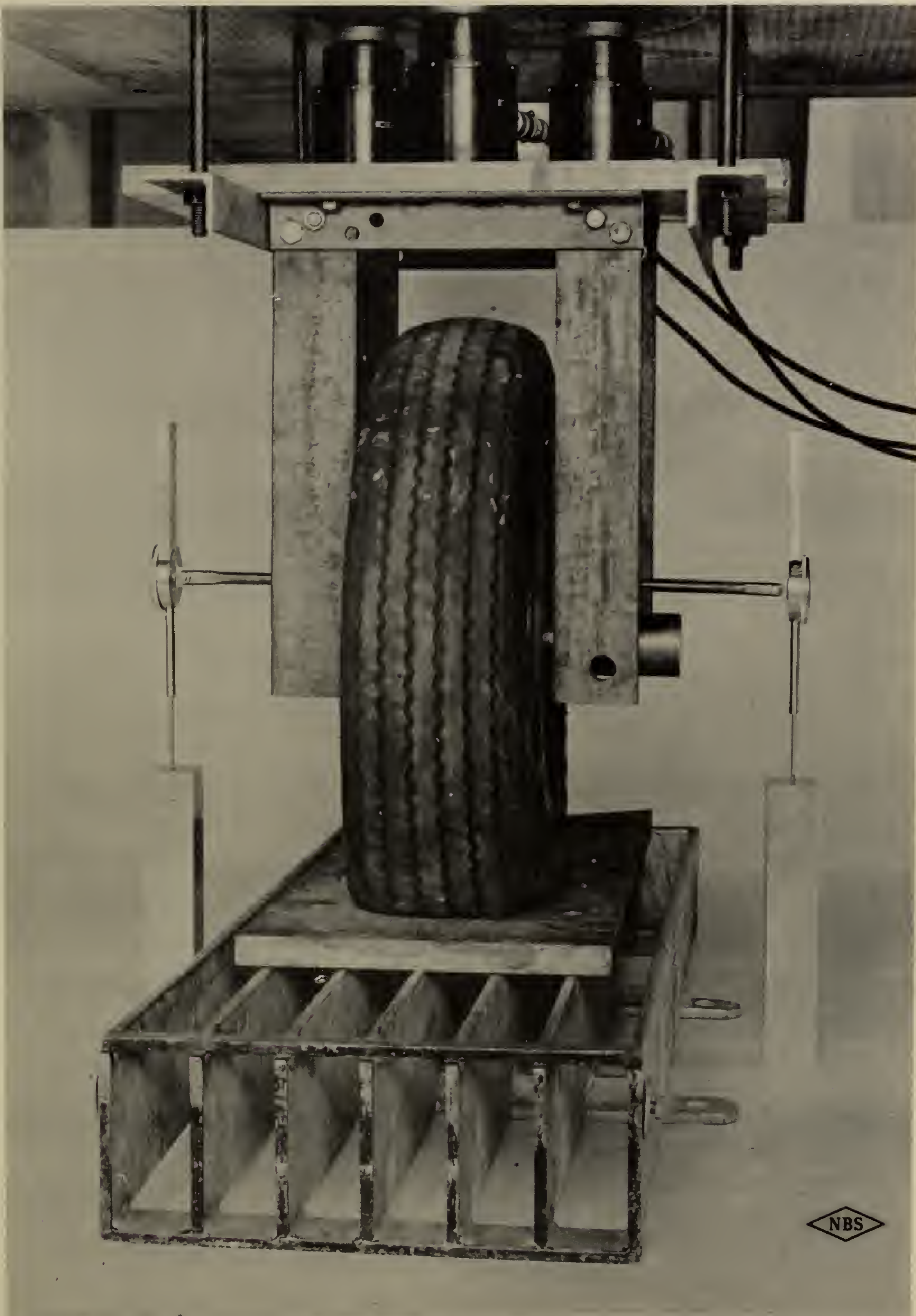

Figure 14. A 26x6.6 aircraft tire on a flat steel plate
Load = 20,000 lb.

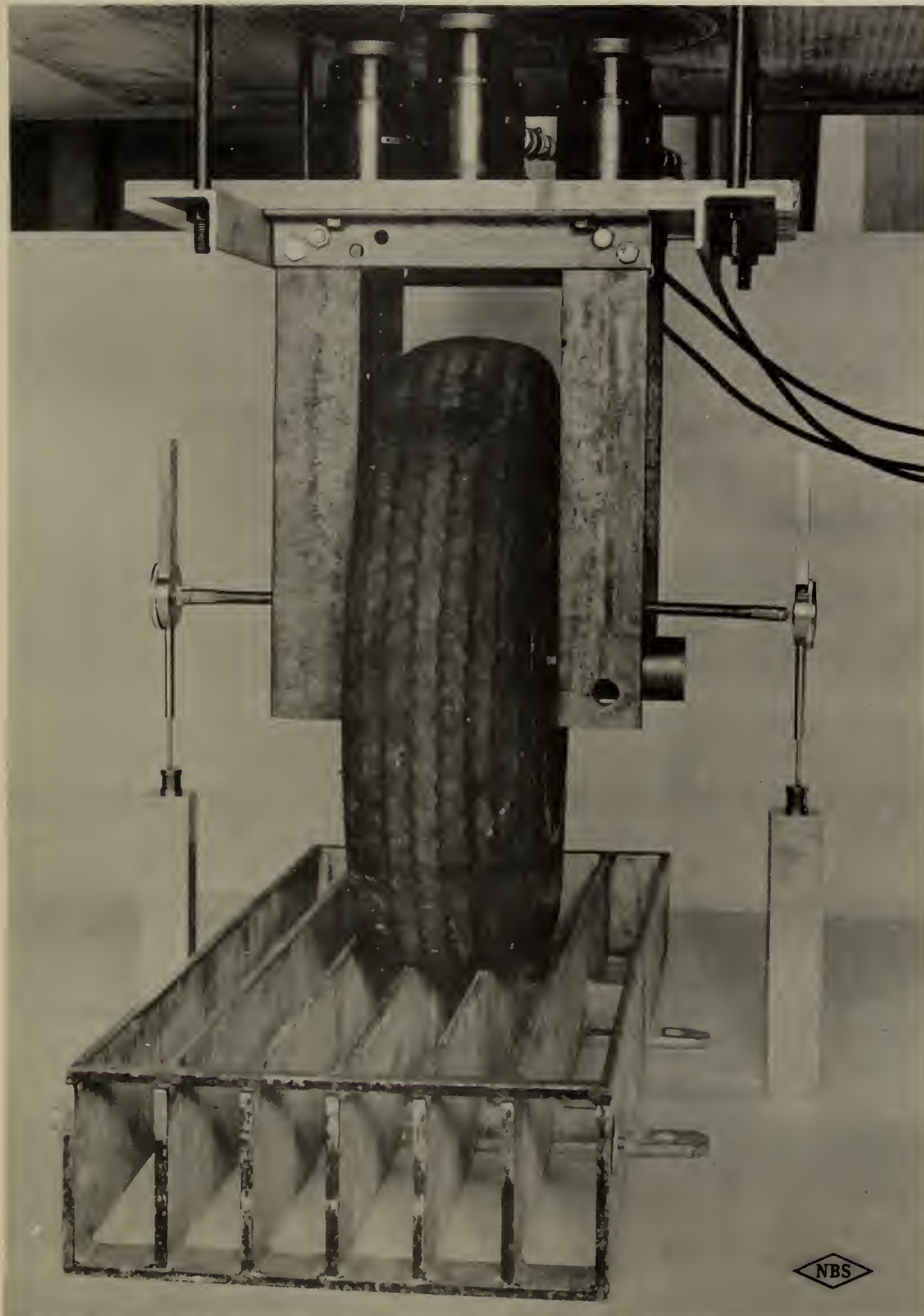

Figure 15. A 26x6.6 aircraft tire on two bars of a type 3130-E "Elfaca" grating. Load = 8,000 lb.

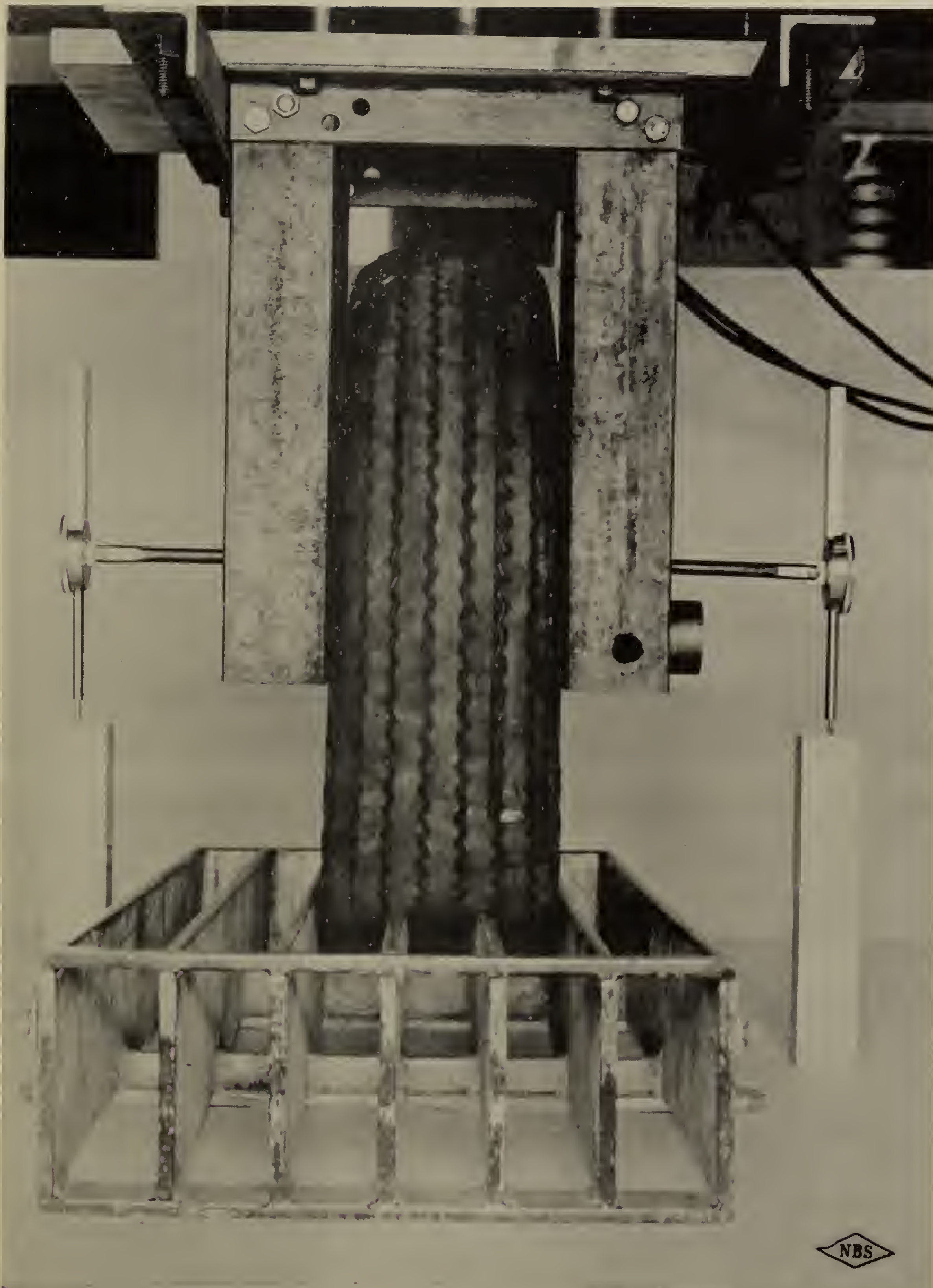

Figure 16. A 26x6.6 aircraft tire on two bars of a type 3130-E "Elfaca" grating. Load = 18,000 lb.

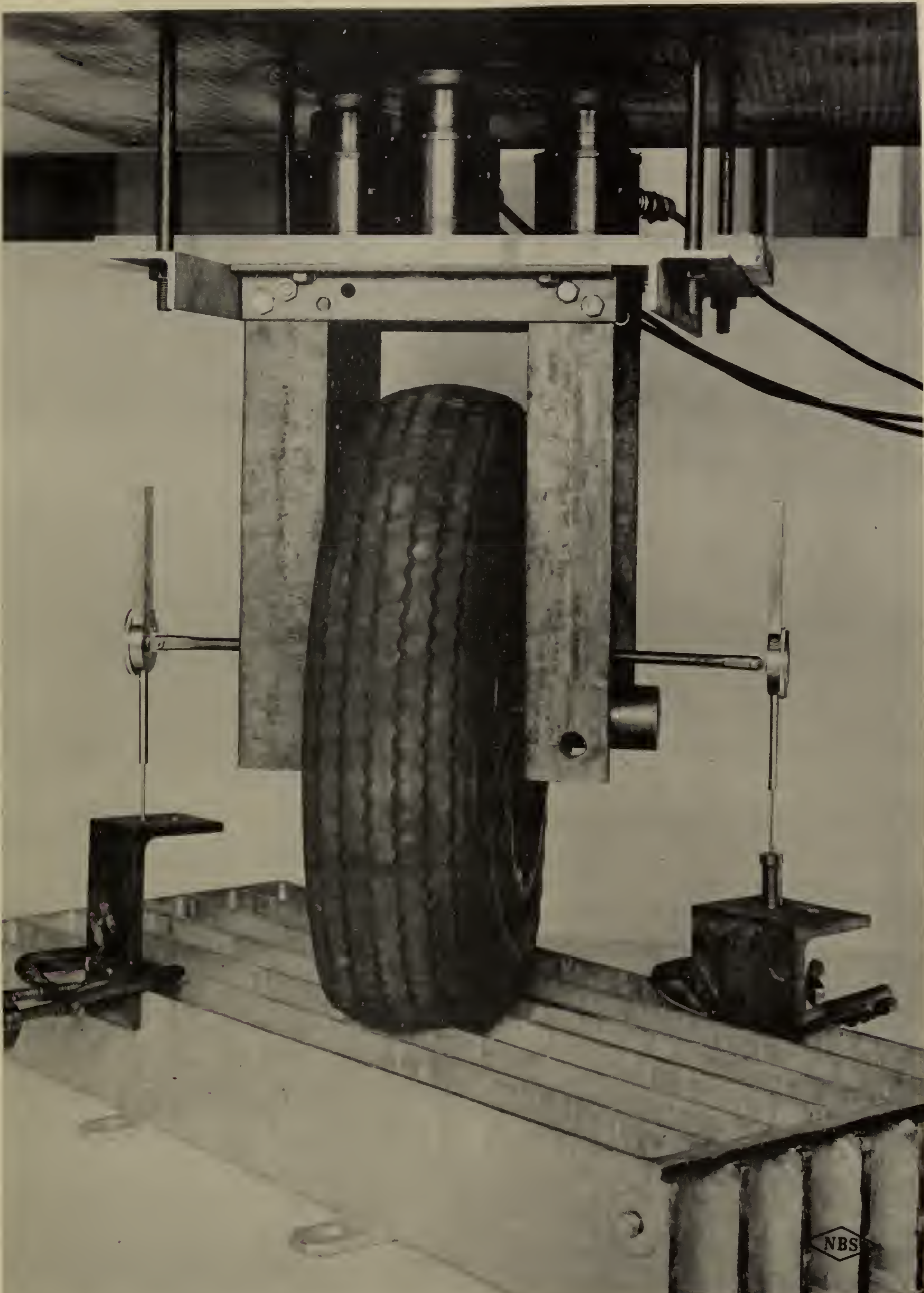

Figure 17. A 26x6.6 aircraft tire at 45° to the bars of a type 3130-E "Elfaca" grating. Load = 8,000 lb.

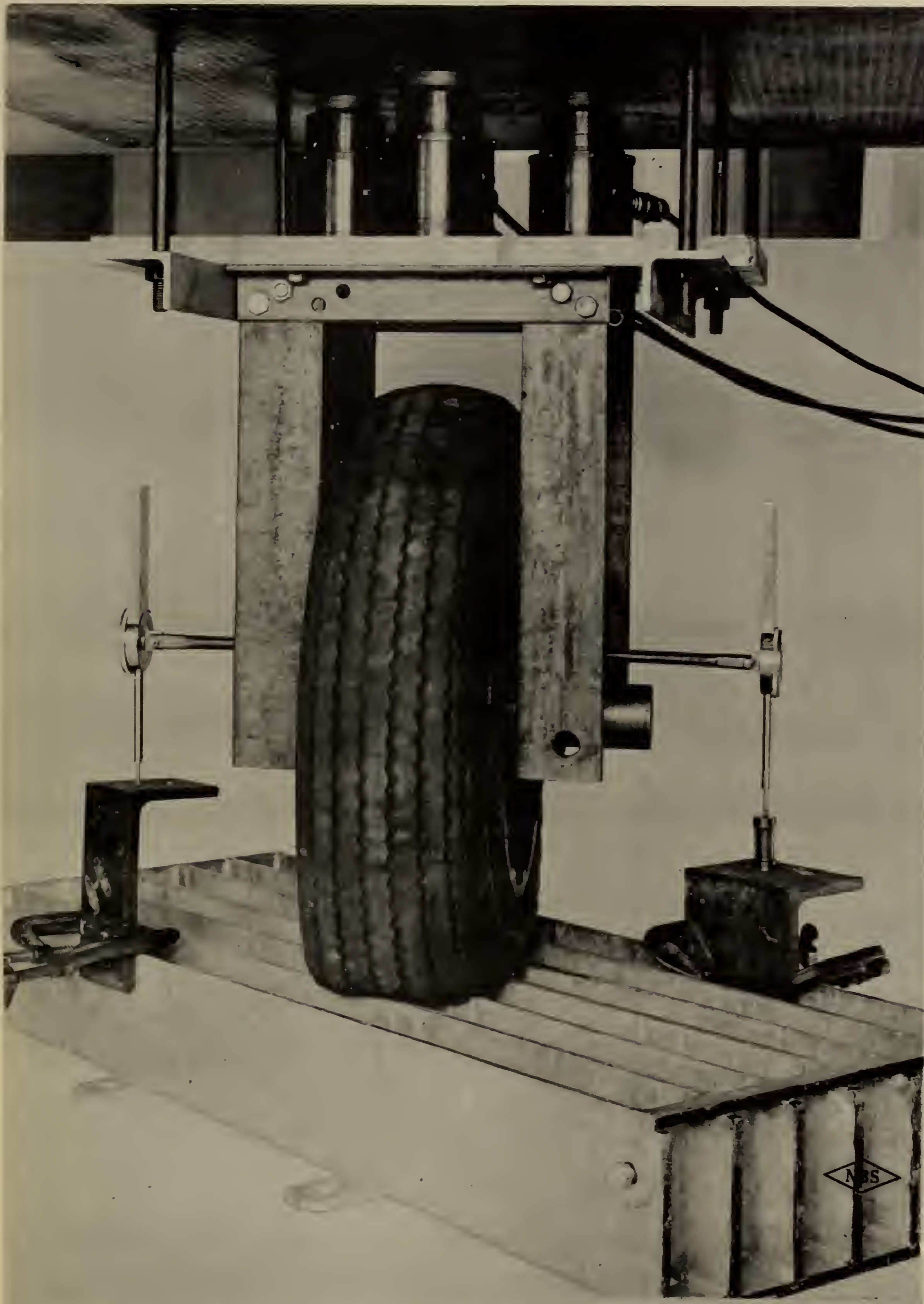

Figure 18. A 26x6.6 aircraft tire at 45° to the bars of a type 3130-E "Elfaca" grating.
Load = 18,000 lb.

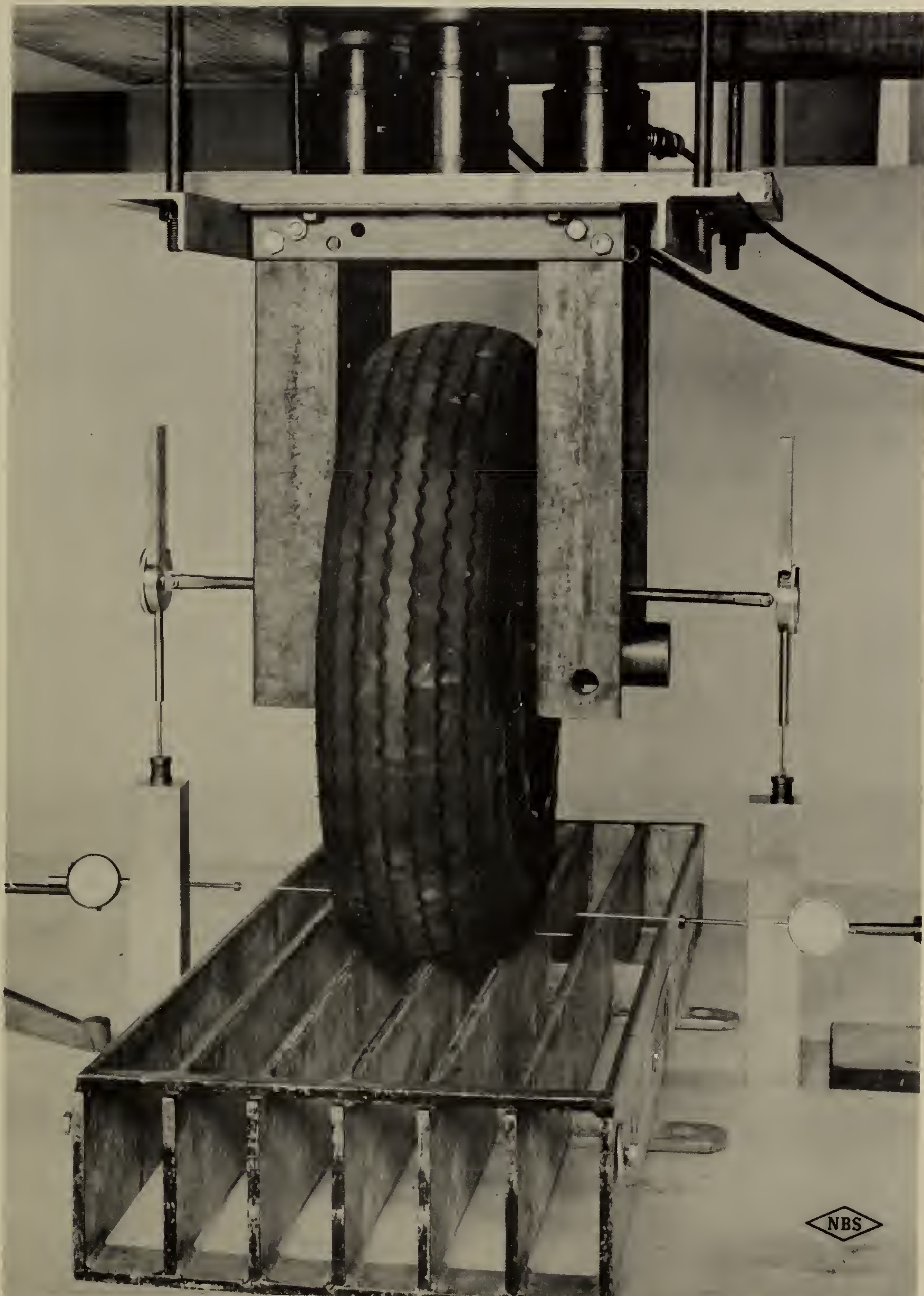

Figure 19. A 26x6.6 aircraft tire on three bars of a type 3130-E "Elfaca" grating.
Load = 8,000 lb.

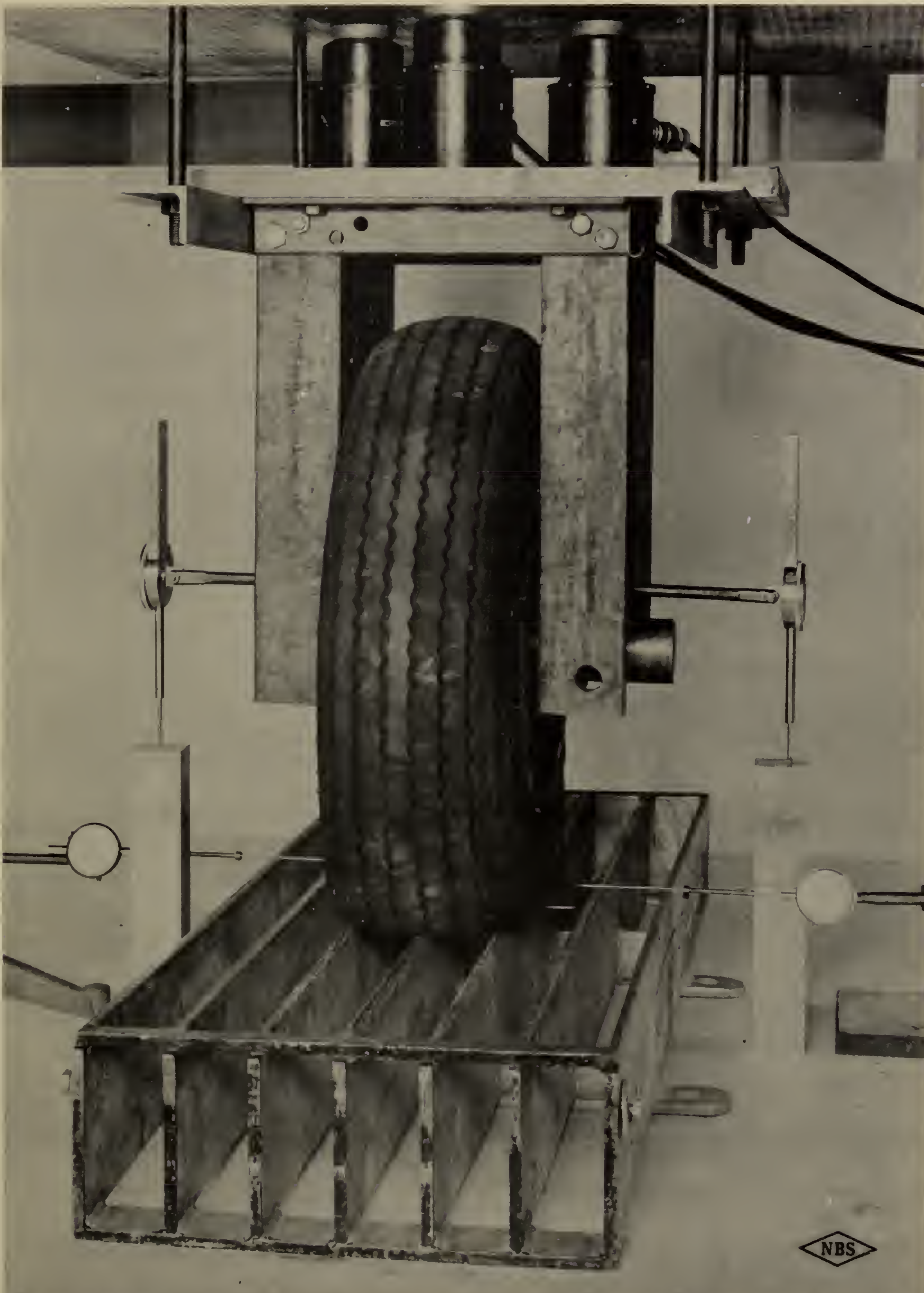

Figure 20. A 26x6.6 aircraft tire on three bars of a type 3130-E "Elfaca" grating.
Load = 18,000 lb.

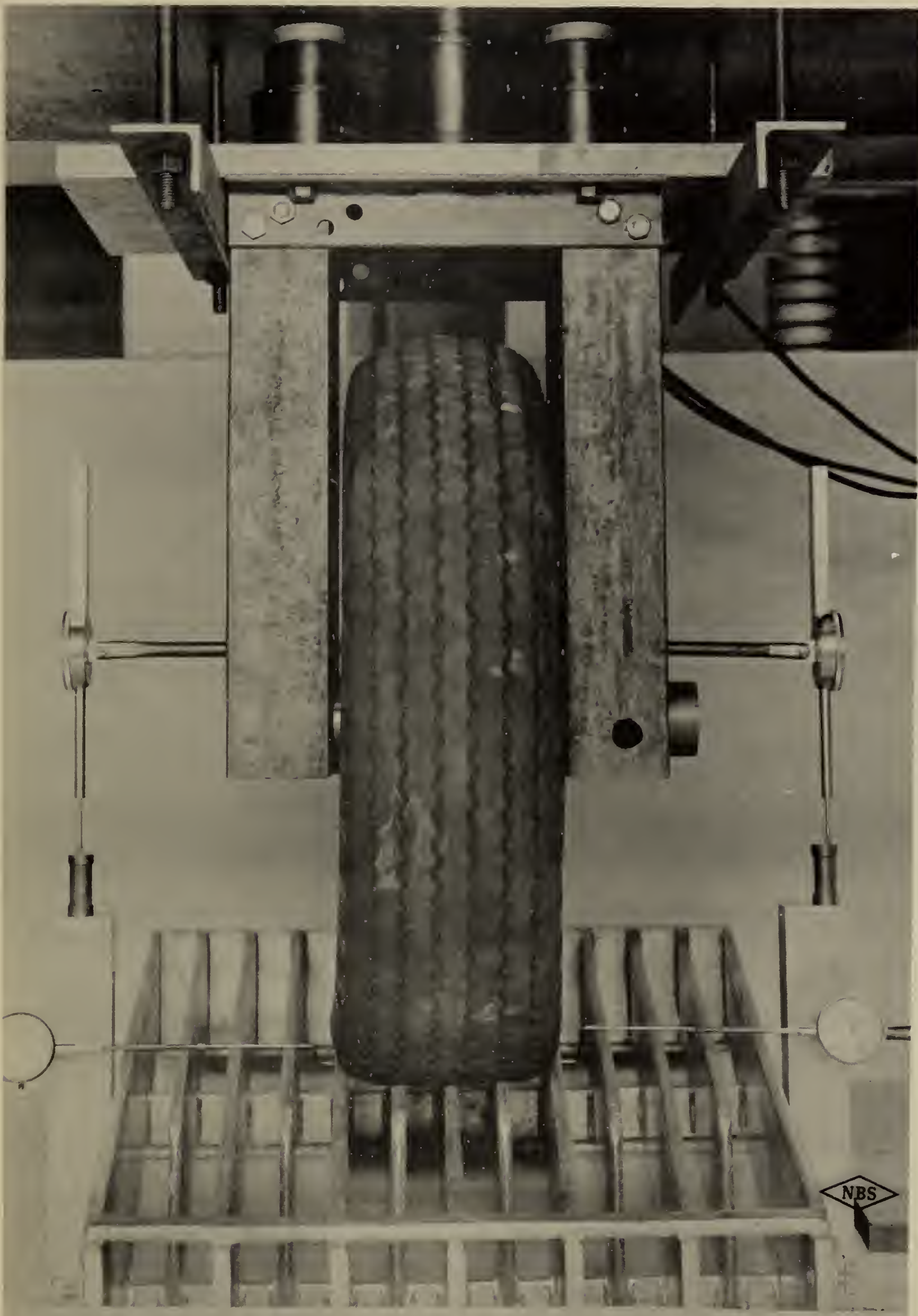

Figure 21. A 26x6.6 aircraft tire on five bars of a type 0200-SB "Elfaca" grating.
Load = 8,000 lb.

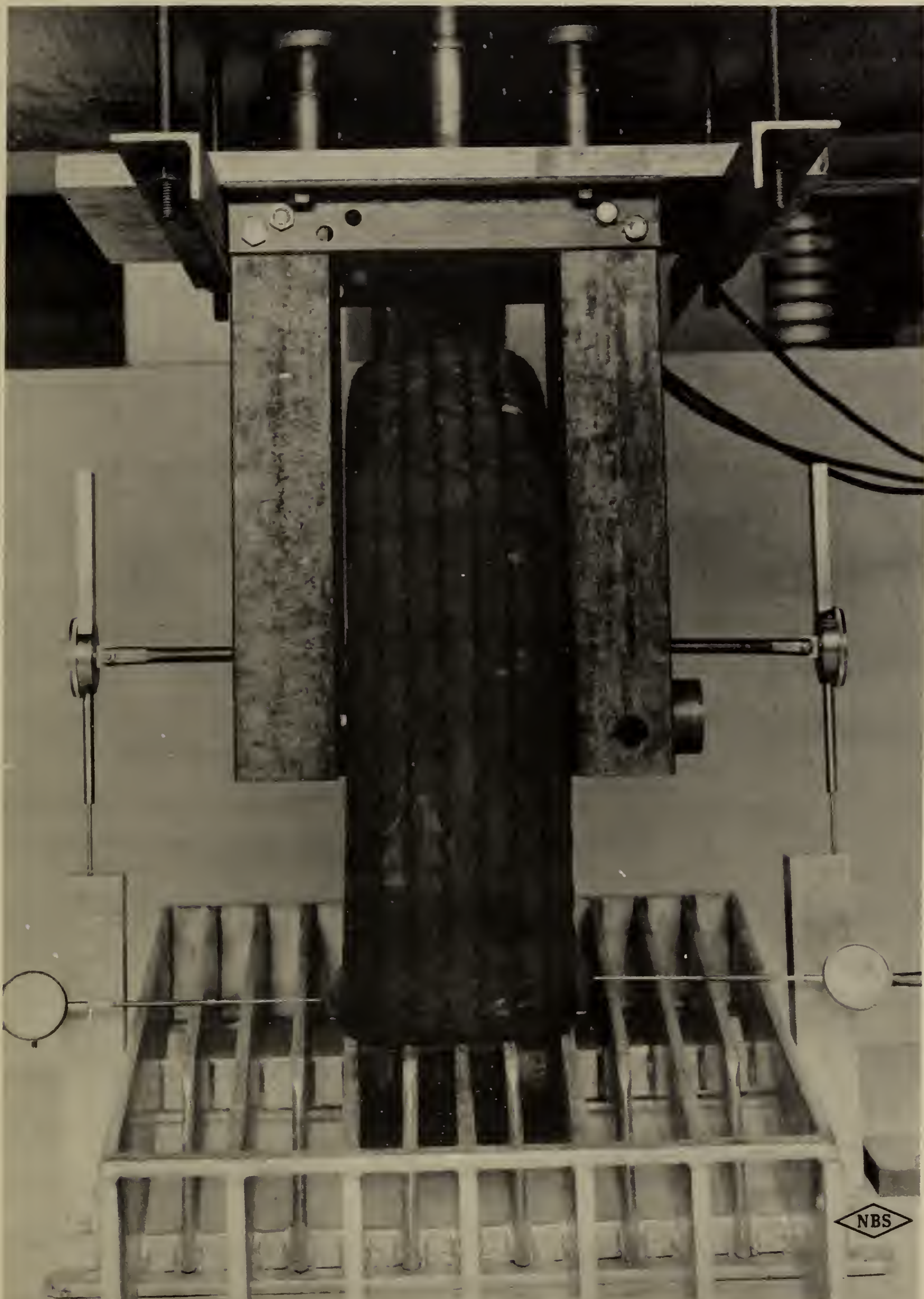

Figure 22. A 26x6.6 aircraft tire on five bars of a type 0200-SB "Elfaca" grating.
Load = 18,000 lb.

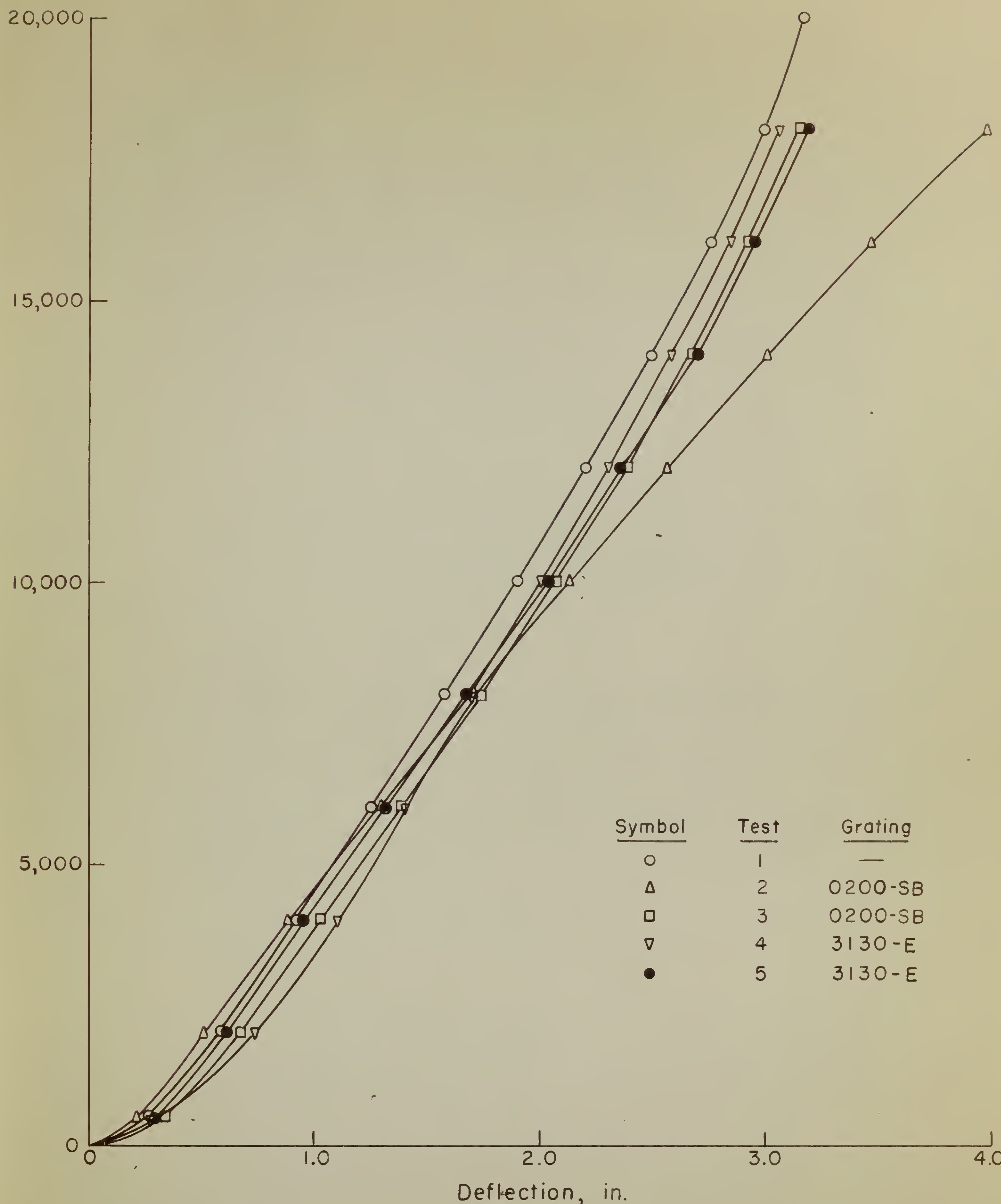

Fig. 23 Load-deflection relations for a 26 x 6.6 aircraft tire on "Elfaca" gratings.

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