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O T T A W A   March 25, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2015.

(Subsequent to Investigation)
(Reports Nos. 1991, 2002 and)
(2014, Jan.-March, 1946.   )

Research on Optimum Thread Form for Proposed Anglo-American-Canadian Screw Thread.

PART IV. - Investigation of Axiality of Loading of a Short Threaded Specimen Loaded in Type II Adaptors (With Spherical Seats) in a 20-Ton Avery-Schenck Pulsator.

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(This research is performed in collaboration with the National Bureau of Standards, Washington, U. S. A., the National Physical Laboratory, Teddington, England, and the National Research Council, Ottawa, Canada.)

(Copy No. II.)

Abstract

In order to determine whether the load imposed on a screw-thread specimen by Type II Adaptors[*] (with spherical seats) in the 20-ton Avery-Schenck fatigue testing machine is axial, four resistance wire SR-4 strain gauges, type A-7, were placed on the middle of a $\frac{3}{4}$-inch stud[**] which was then placed in the adaptors and loaded.

During loading and unloading, readings were taken on each gauge with a Baldwin SR-4 strain indicator.

Similar tests had been done with Type I adaptors.

It was shown that while satisfactory alignment is not obtained with Type I adaptors (see Investigation Report No. 2014), Type II adaptors, with spherical seats graphite lubricated, align themselves enough during the first 100,000 cycles to give substantially axial loading.

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[*] Type II adaptors were made in accordance with Physical Metallurgy Research Laboratories (Ottawa) drawings designed in connection with the research on optimum thread form for proposed A.B.C. thread (see Figure 2).

[**] The threaded stud was made in accordance with National Physical Laboratory Drwg. C103/202 (see Figure 1 in Investigation Report No. 2014).

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

OTTAWA March 25, 1946.

REPORT

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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2015.

(Subsequent to Investigation)
(Reports Nos. 1991, 2002 and)
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Research on Optimum Thread Form for Proposed Anglo-American-Canadian Screw Thread.

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Origin and Purpose of Investigation:

Axiality of loading is important in the screw-thread specimens used for the Research on Optimum Thread Form.

It was decided to investigate, on the P. M. R. L. pulsator, how far the loading departs from axiality when using adaptors with spherical seats as described in P. M. R. L. reports.

Procedure:

A stud made from high tensile steel and of thread form No. 3 was used, together with cylindrical nuts of the same thread form. The specimen used had a ground thread.[⊕]

Four SR-4 strain gauges, type A-7, were attached to the stud. The manner of attaching terminal strips and rings to protect the gauges while placing the specimen in the machine is shown in Figure 1.

After placing the specimen in the machine with Type II adaptors, load was applied in steps of about 3,000 pounds until a load of about 18,000 pounds was reached, the loads being measured by simultaneously taking readings on two previously calibrated A-3 gauges placed on both sides of the loop dynamometer. An SR-4, 20-point switching unit was used to transfer the SR-4 strain indicator from gauge to gauge. The results obtained in this way, using Type II adaptors, are shown in Figure 3.

Type II adaptors have been adopted with the idea that they would align themselves during operation of the machine, if lubricated with graphite grease. The machine was reloaded to 5,000 pounds static preload and was run 10 minutes under dynamic load and standard test conditions and load range, stopped and readings taken, this being continued for one hour. The results of a static test on the spherical adaptors are illustrated in Figure 3. The behaviour while it was running is shown in Figure 4.

⊕ Details are given in P.M.R.L. Investigation Report No. 2014, dated March 16, 1946.

Discussion of Results:

Inequality of the strains measured on the gauges placed opposite each other on the stud indicates the presence of a bending moment about an axis perpendicular to the plane passing through the centroids of the two gauges. This bending moment is directly proportional to the difference in strains measured on two opposite gauges.

Results of a static test taken with spherical seat adaptors (Type II) are given in Figure 3. They show more misalignment during unloading than during loading. However, the maximum of the differences of the deflections of the gauges concerned is 100 micro inches per inch, as contrasted with 283 obtained with Type I adaptors (see Investigation Report No. 2014). Further, the difference at 18,000 pounds load is about 30 micro inches per inch for vertical plane and 10 micro inch per inch for horizontal plane, corresponding to load inequalities of 900 and 300 p.s.i. respectively, or about 2.2 per cent and 0.73 per cent respectively.

Figure 4 shows that with these spherical grips, generously lubricated with graphite grease, running the machine caused inequality of load to smoothen out, i.e. the grips adjust themselves. This is attributed to the use of a graphite grease, which could allow angular yielding of the faces.

After one hour of running the strain gauge deflection differences had, for Gauges 2 and 4, on vertical plane, decreased from 73 micro inches per inch to 12 micro inches per inch, while for Gauges 1 and 3, horizontal plane, they had decreased from 12 micro inches to zero.

(Continued on next page)

(Discussion of Results, cont'd) -

To further test the behaviour of these grips, a Baldwin-Southwark SR-4 two-channel dynamic tester was connected to the gauges. This instrument applies 5,000 cycles voltage to two strain gauge bridges mounted on a part subject to dynamic stress. The out-of-balance voltage of each bridge is amplified and rectified in a separate amplifier-demodulator unit and measured on a cathode ray oscillograph through an electronic switch. Gains can be so adjusted by comparing the trace with that obtained from a calibrating circuit, that strain can be directly read. This instrument indicates for Gauges 1 and 3, horizontal plane, a dynamic bending strain of 10 micro inches per inch, and for Gauges 2 and 4, vertical plane, 5 micro inches per inch. The maximum load during the cycle was 20,000 pounds, e.g. 45,300 p.s.i. for 0.442 sq. in. section. The dynamic variation of dynamic bending effect over the sample was $\pm \sqrt{5^2 + 10^2} \times 30 = 336$ p.s.i., or 0.74 per cent.

Conclusion:

The results of this investigation show that in the 20-ton Avery-Schenck fatigue testing machine of the Physical Metallurgy Research Laboratories, Ottawa, an acceptable approximation of axial loading can be secured within an hour's run with Type II spherical seat adaptors. After a run of 20 megacycles there was no perceptible wear on the spherical surfaces, even tool marks being unaffected.

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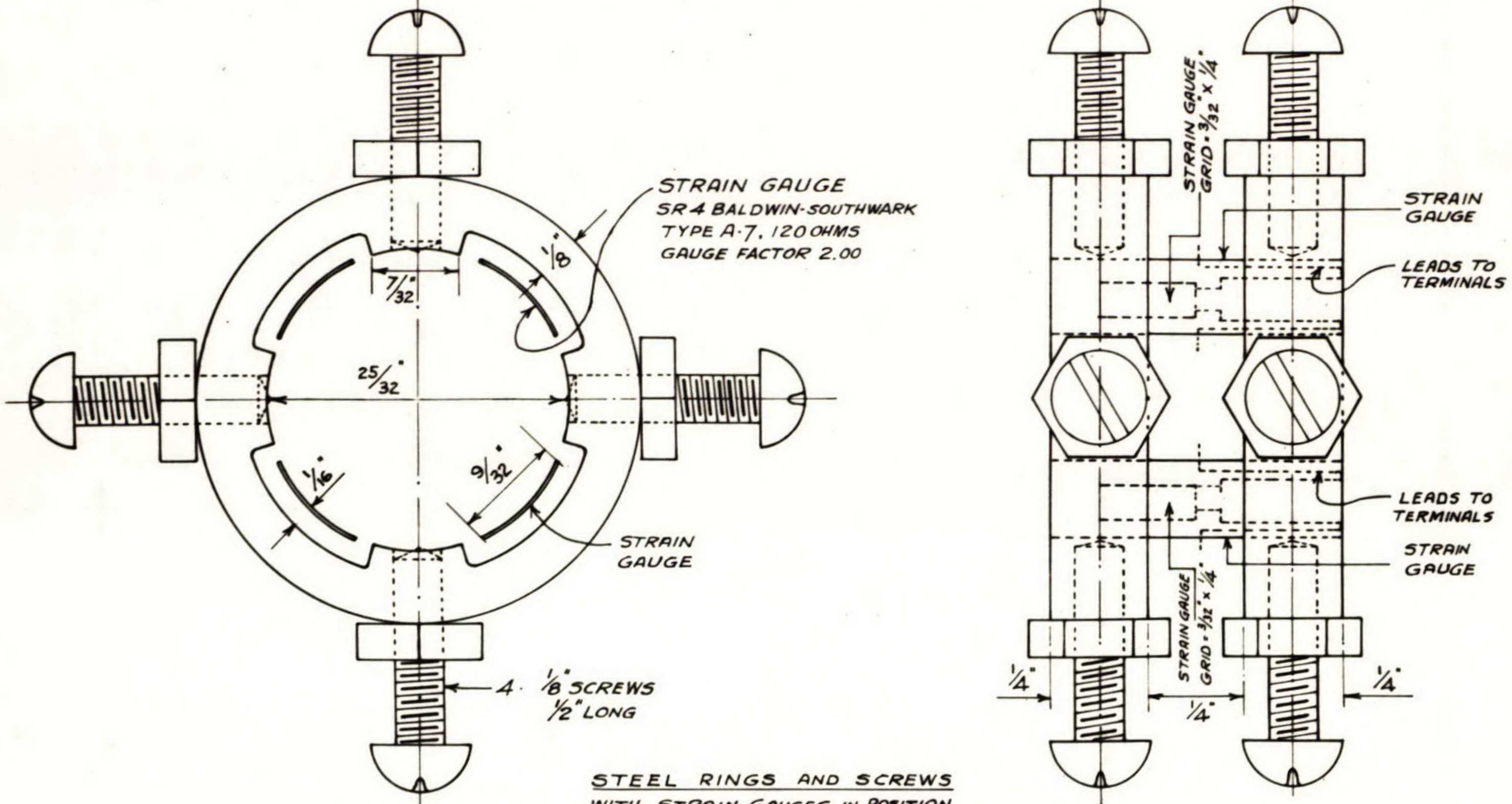
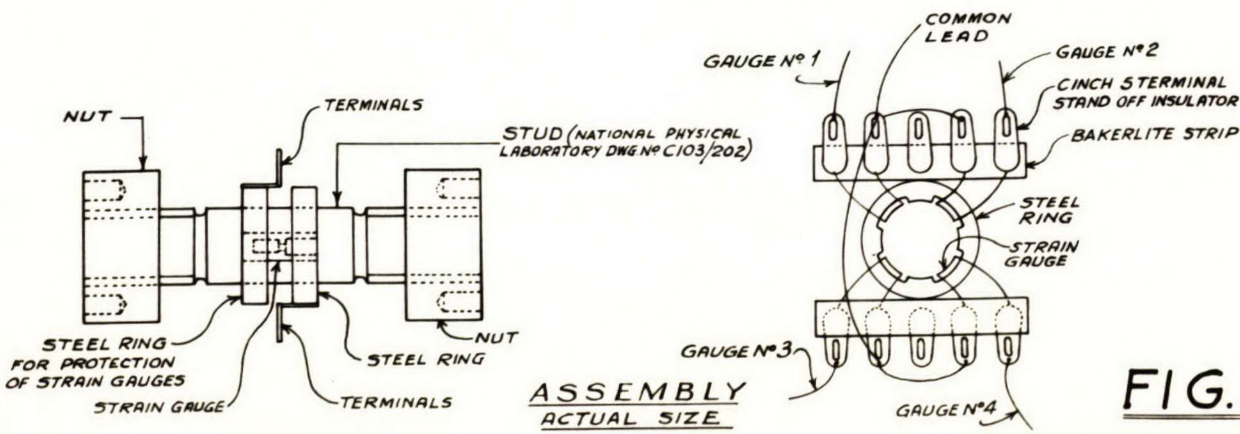
TWW:JW:PES.

(Figures 1 to 4 follow,)
(on Pages 5 to 8.)



STEEL RINGS AND SCREWS
WITH STRAIN GAUGES IN POSITION
4 TIMES ACTUAL SIZE



ASSEMBLY
ACTUAL SIZE

REMARK:
THE SPACES BETWEEN STUDS AND RINGS & BETWEEN RINGS ARE FILLED WITH WAX

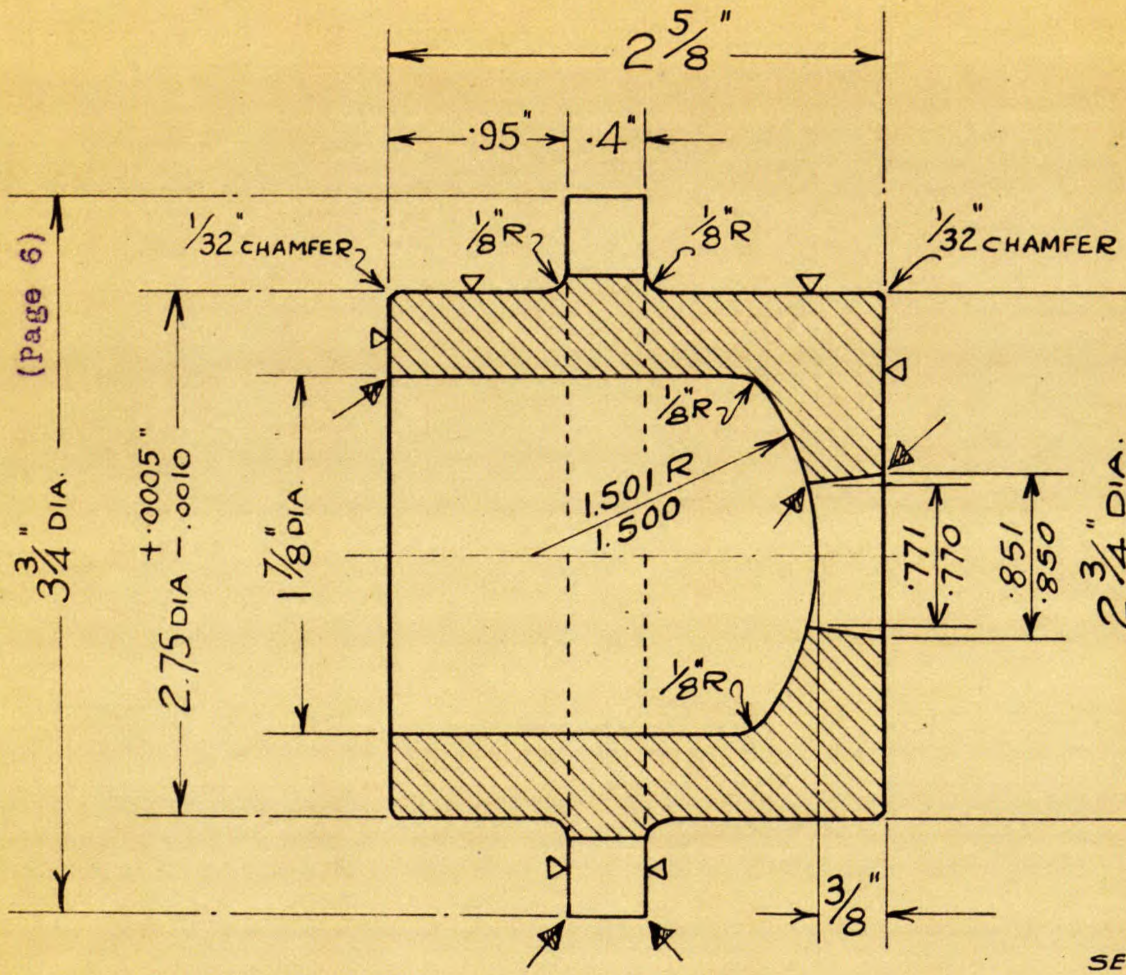
ARRANGEMENT OF ELECTRICAL STRAIN GAUGES FOR MEASUREMENT OF THE STRAIN AND THE AXIALITY OF LOADING ON FATIGUE SAMPLE

FIG. 1

PHYSICAL METALLURGY RESEARCH LABORATORIES BOOTH ST. OTTAWA		
DEPARTMENT OF MINES & RESOURCES		
TITLE AS ABOVE		
DESIGNED J.W. T.W.W.	DRAWN W.A.E.	TRACED W.A.E.
SCALE AS SHOWN DATE 2-10 45	APPROVED	CHECKED T.W.W.

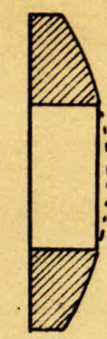
NOTE: FACES MARKED Δ MUST BE SQUARE AND CONCENTRIC.

EDGES MARKED ➔ MUST BE SLIGHTLY ROUNDED.



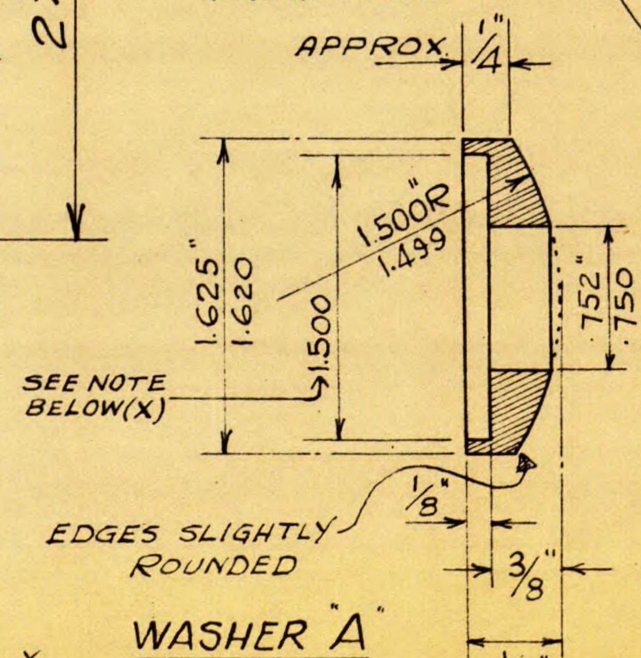
ADAPTOR · TYPE 2

(2 REQUIRED, 1 MARKED B AND 1 MARKED M.)



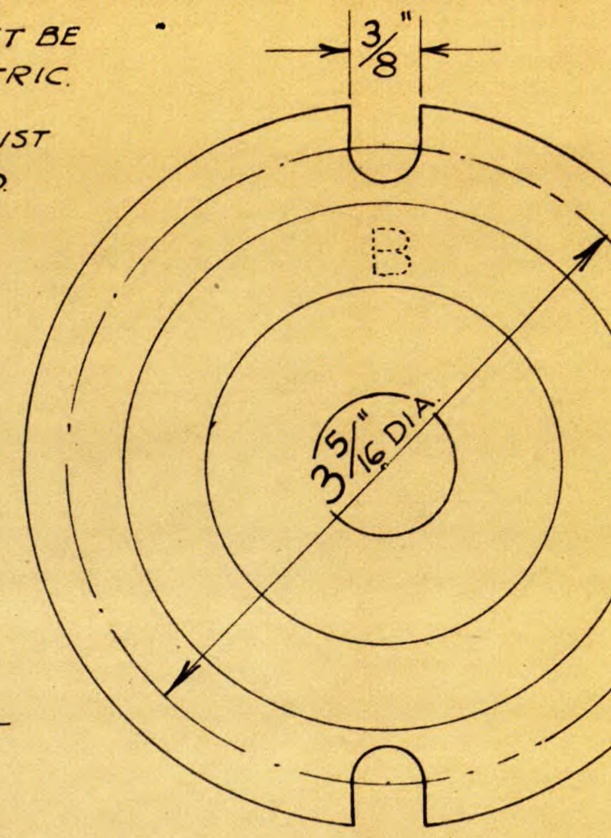
WASHER "B"

DIMENSIONS SAME AS IN WASHER "A". 1 REQUIRED



WASHER "A"

X SEVERAL NEEDED TO SUIT DIMENSIONS OF NUT.



ADAPTOR END VIEW

NOTE: ALL PARTS MADE FROM STEEL S.A.E 4340. QUENCHED 1500°F IN OIL DRAWN 700°F. ROCKWELL C50.

N.B. ALLOW 14/1000" ON DIAMS. FOR GRINDING

FIG. 2

PHYSICAL METALLURGY RESEARCH LABORATORIES BOOTH ST. OTTAWA		
DEPARTMENT OF MINES & RESOURCES		
ADAPTOR · TYPE II & WASHERS AVERY PULSATOR		
DESIGNED T.W.W. J.W.	DRAWN W.A.E	TRACED W.A.E
SCALE FULL SIZE DATE 15·9·45	APPROVED	CHECKED

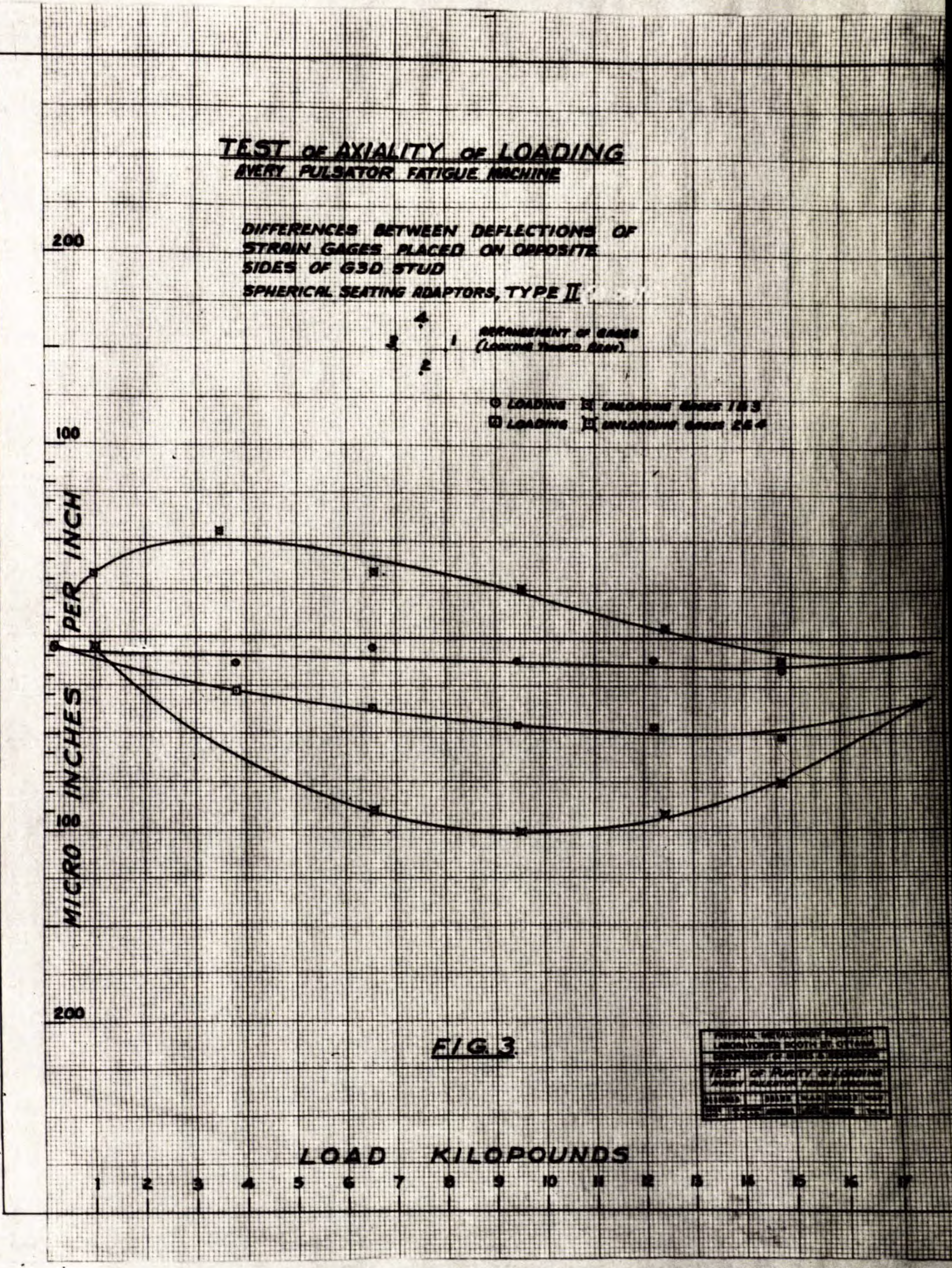

TEST OF AXIALITY OF LOADING
AVERY PULSATOR FATIGUE MACHINE
DIFFERENCES BETWEEN DEFLECTIONS OF
STRAIN GAGES PLACED ON OPPOSITE
SIDES OF G3D STUD
SPHERICAL SEATING ADAPTORS, TYPE II
4
3
1
2
ARRANGEMENT OF GAGES
(LOOKING TOWARD BEAM)
LOADING
UNLOADING GAGES 1 & 3
LOADING
UNLOADING GAGES 2 & 4
200
100
100
200
MICRO INCHES PER INCH
LOAD KILOPOUNDS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
LABORATORIES BOOTH ST. OTTAWA

FIG. 3

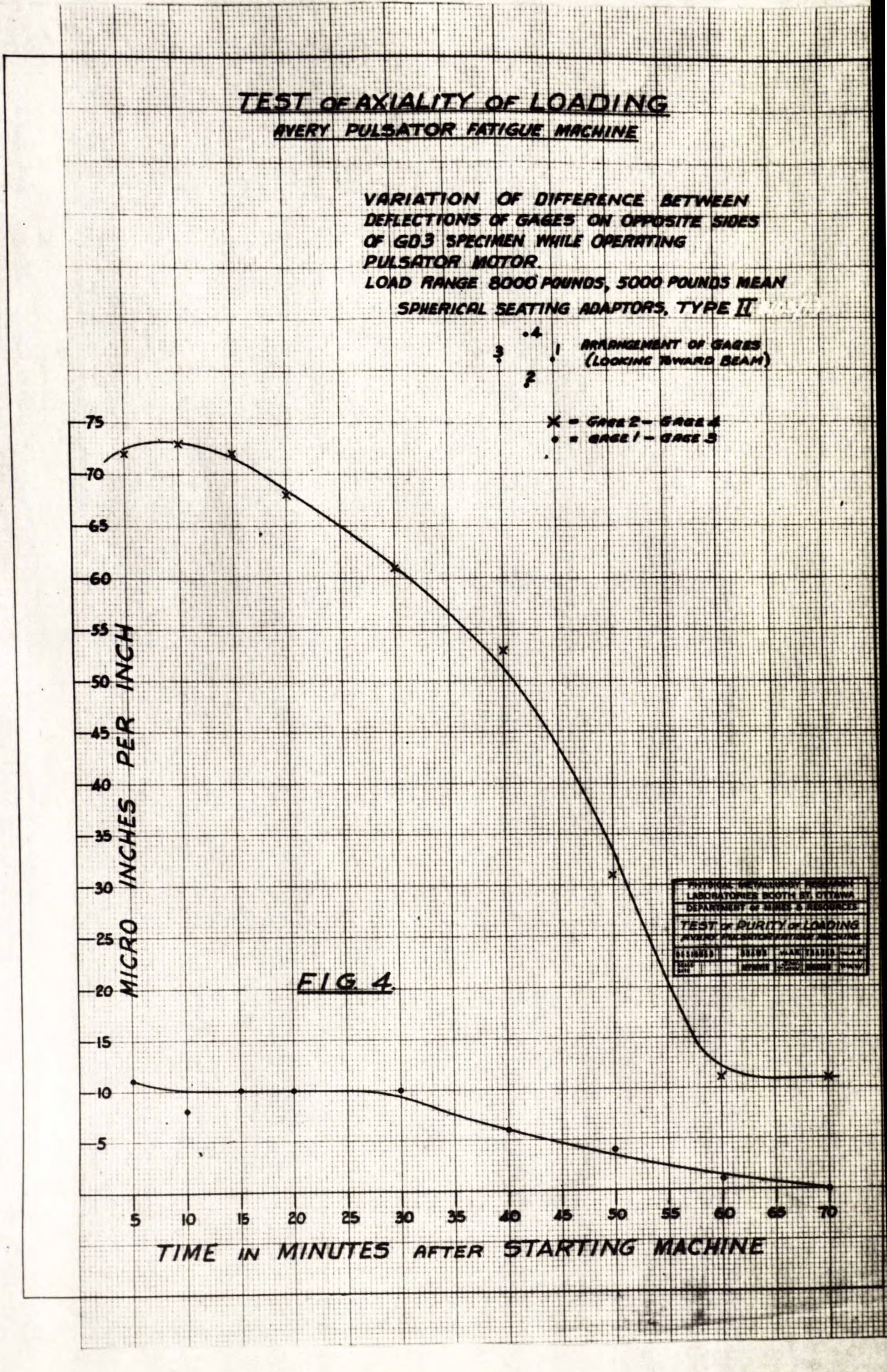

TEST OF AXIALITY OF LOADING
AVERY PULSATOR FATIGUE MACHINE
VARIATION OF DIFFERENCE BETWEEN
DEFLECTIONS OF GAGES ON OPPOSITE SIDES
OF GD3 SPECIMEN WHILE OPERATING
PULSATOR MOTOR.
LOAD RANGE 8000 POUNDS, 5000 POUNDS MEAN
SPHERICAL SEATING ADAPTORS, TYPE II
4
3
1
2
ARRANGEMENT OF GAGES
(LOOKING TOWARD BEAM)
X = GAGE 2 – GAGE 4
• = GAGE 1 – GAGE 3
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
MICRO INCHES PER INCH
5
10
15
20
25
30
35
40
45
50
55
60
65
70
TIME IN MINUTES AFTER STARTING MACHINE
LABORATORIES BOOTH ST. OTTAWA
DEPARTMENT OF MINES & RESOURCES
TEST OF PURITY OF LOADING

FIG. 4.