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LIMITATION CHANGES
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AUTHORITY
CSS memo dtd 22 Mar 2013

Report No. 12234
Author: Joseph Mikaila

Mechanical Components Sub-Function
Mechanical & Electrical Components
Development Function
Date of Report: 12 January 1977

Project Title: M151 Bonded vs. Riveted Brake Lining Test

Abstract:

1. Purpose: Determine the percent of increase in usable life for the bonded brake lining (.375 inch thick) when compared to the original equipment (OE) M151 riveted brake lining (.250 inch thick).

2. Method: One set each of the riveted and the bonded brake lining were subjected to laboratory tests on an inertia brake dynamometer. After an initial 200 burnish stops, a 115 stop cycle consisting of wear stops and fade stops was conducted until linings were worn out.

3. Results: The bonded brake lining showed a 97% increase in usable lining life.

4. Recommendations: It is recommended that the thicker bonded brake lining be used in place of the OE riveted lining.

U.S. Army
Tank-Automotive Command
Warren, MI 48090

SECURITY CLASSIFICATION: UNCLASSIFIED

TANK AUTOMOTIVE RESEARCH AND DEVELOPMENT LABORATORY
ARMOR AND COMPONENTS DIVISION
MECHANICAL AND ELECTRICAL COMPONENTS DEVELOPMENT FUNCTION
MECHANICAL COMPONENTS SUB-FUNCTION

TITLE OF REPORT: M151 Bonded vs. Riveted Brake Lining Test

WRITTEN BY: Joseph Mikaila

REVIEWED BY: Jimmie B. Harvin

DATE OF REPORT: 12 January 1977

REPORT NO: 12234

CRN: RS20017G

SECURITY CLASSIFICATION: UNCLASSIFIED

(1) For ease of starting and operation of the heater, remove the heater to the warmer environment until such time that it is required for engine preheating of the cold soaked vehicle.

(2) Start the heater periodically and operate in a stand-by engine heating mode.

TANK AUTOMOTIVE RESEARCH AND DEVELOPMENT LABORATORY
ARMOR AND COMPONENTS DIVISION
MECHANICAL AND ELECTRICAL COMPONENTS DEVELOPMENT FUNCTION
MECHANICAL COMPONENTS SUB-FUNCTION

Report No. 12234 (F)
Date: 12 January 1977

TITLE OF REPORT: M151 Bonded vs. Riveted Brake Lining Wear Test

1. Object:

a. Determine the increase in usable life of the bonded brake lining when compared to the Original Equipment (OE) riveted brake lining.

b. Determine whether the bonding will adhere fully to the shoe through the complete test.

2. Conclusion:

a. The bonded brake lining had 97% longer brake lining life than the riveted brake lining.

b. The bonded brake lining adhered fully to the brake shoe through out the complete test.

3. Test Material and Equipment:

a. Two Original Equipment riveted brake shoe assemblies Ordnance Part No. 11660466 (See Figures 1 and 2).

b. Two bonded brake shoe assemblies Ordnance Part No. 11669180 (See Figures 1 and 2). The brake lining was of the same formulation for both the bonded and the riveted linings.

c. Two front brake assemblies for the M151 vehicle.

d. Inertia brake dynamometer - The brake assemblies were tested on an inertia brake dynamometer (See Figure 3). The dynamometer consists of a drive motor, a rotating inertia section, a tail stock assembly, and

a control console. In operation, the drive motor rotates the inertia section and the brake, mounted on the tail shock stops the rotating inertia section. A load cell and lever arm are used in the tail stock to measure the resulting torque. The speed of drive motor and the mass of the inertia section are sized to correspond to the speed and inertia of the vehicle being tested. A hydraulic servo is used to vary the hydraulic pressure to provide constant torque. This insures that the brakes perform work at a constant rate. Controls are provided to use either time or a programed brake drum temperature to initiate stops. A blower and ducting system provides cooling air across the brake assembly to simulate the cooling effect that the brake would see in actual vehicle operation.

4. Test Procedure:

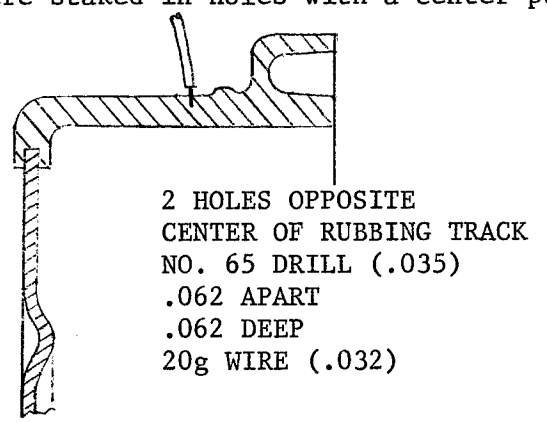
a. Test preparation

(1) New drums were used for each test.

(2) Friction material - The linings were visually inspected for workmanship and defects.

(3) Thermocouple installation - The method described below was used for installation thermocouples.

(4) Holes were drilled in the brake drum in the locations shown below. Thermocouple wires were staked in holes with a center punch.



LOCATING SKETCH

(5) Brake adjustment - Brake lining clearance was adjusted according to vehicle maintenance specification and was checked daily and readjusted as necessary.

(6) Dynamometer flywheel inertia - The total amount of inertia of the rotating components of the dynamometer was 50 slug ft^2.

(7) Test rpm required to simulate the specified vehicle speeds was calculated as follows:

$$RPM = \frac{14.02 \times mph}{R} \qquad R = 1.18 \text{ ft.}$$

Where: R = Tire rolling radius

For this test the following values were used:

MPH	RPM
30	356
40	475
50	594
55	643
60	711

(8) Test deceleration - All brake stops during the procedure maintained a constant brake torque output which resulted in a constant deceleration. All specified decelerations were the rate of change in velocity (slope of velocity/time curve) measured from the time brake reaches the preset torque to the time where the rpm was equivalent to 5 mph. The follwoing is the relationship between deceleration and torque for the M151:

Deceleration Ft/Sec^2	Ft/Lbs Troque
10	411
12	492
15	617

(9) The following is the relationship between speed, deceleration and time to stop for the M151:

	$10Ft/Sec^2$	$12Ft/Sec^2$	$15Ft/Sec^2$
40 MPH	5.86 sec.	4.88 sec.	3.91 sec.
50 MPH	7.34	6.14	4.91
55 MPH	8.07	6.72	5.37
60 MPH	8.80	7.32	5.87

(10) Cooling air velocity was 20 MPH.

(11) The lining and shoe assemblies were indexed with a 1/4 inch drill bit as shown in Figure 4 in six locations on each shoe.

(12) Lining and shoe thickness measurements were taken at each indexing mark with a micrometer and a ball anvil attachment as shown in Figure 5.

b. Test Execution

(1) Burnish

a. Stop speed - 40 MPH
b. Stop deceleration - 12 ft/second^2
c. Stops required - 200
d. Stop cycle - as required to maintain an initial brake temperature of 250^{o}F.

(2) Wear Test

a. Wear - The wear test consisted of cycles of 100 wear stops and 15 fade stops. The wear stops were performed as follows:

1. 25 stops from 40 MPH at 10 ft/sec^2 deceleration
2. 25 stops from 40 MPH at 12 ft/sec^2 deceleration
3. 25 stops from 55 MPH at 10 ft/sec^2 deceleration
4. 25 stops from 55 MPH at 12 ft/sec^2 deceleration

b. The initial brake drum temperatures were 375^{o}F for the 40 MPH stops and 425^{o}F for the 55 MPH stops.

c. The fade test consisted of 15 stops from 60 MPH at 44 second intervals and was performed after each set of 100 wear stops. Deceleration was 15 ft/sec^2. Drum temperature was 150^{o}F prior to first stop. Cooling speed in between stops was 30 MPH.

d. The burnish stops were performed at the start of the test. The wear and fade stops were performed until the linings wore out. Wear out was defined as the point where the pressure required to produce the programed decelerations exceeded 2000 PSI, or until metal to metal contact occurred between the brake drum and brake shoe.

(3) Wear Measurements

Thickness measurements of the brake shoe were taken at the six indexing marks provided as follows:

a. Before burnish
b. After burnish
c. Every two days of operation or as directed.

RESULTS & DISCUSSION

1. The test procedure does not represent any particular vehicle test course. It is a very severe duty cycle which was developed for this test to prevent the test from being too lengthy. The wear data does not correlate to any particular vehicle mileage, but rather it is a ratio of relative wear between the two brake shoe configurations.

2. The wear data for the bonded brake lining is presented in TABLES I and II. The bonded brake lining had not worn through after 7,245 stops. However, when checked at 7,590 stops, the drum and shoe were making metal to metal contact as shown in Figure 6. For wear rate calculations, the life of the bonded brake lining shall be considered to be 7,245 stops.

3. The wear data for the riveted brake lining is presented in TABLES III and IV. The riveted brake lining wear test was stopped for examination due to a scraping sound after 3,680 stops. Tear down of the brake assembly revealed that the secondary shoe was making contact at the rivet, closest to the #5 wear measurement position. The brake was reassembled and was tested an additional 1,156 stops for a total of 4,836. The lining was cracked and 9 of the 14 rivets were making contact with the drum, see Figure 6. For wear data calculations, the life of the riveted brake lining shall be considered to be 3,680 stops since this is the point at which the brake lining would have been changed on the vehicle.

4. The bonded brake lining had a 97% longer life than the riveted lining. This is based on the bonded lining life of 7,245 stops and the riveted lining life of 3,680 stops.

5. The relative wear rates are presented in Figure 7. The wear curves shown are the total wear of measurement points, 6 points on the primary, and 6 points on the secondary shoe.

WRITTEN BY: Joseph J. Mikaila
JOSEPH J. MIKAILA

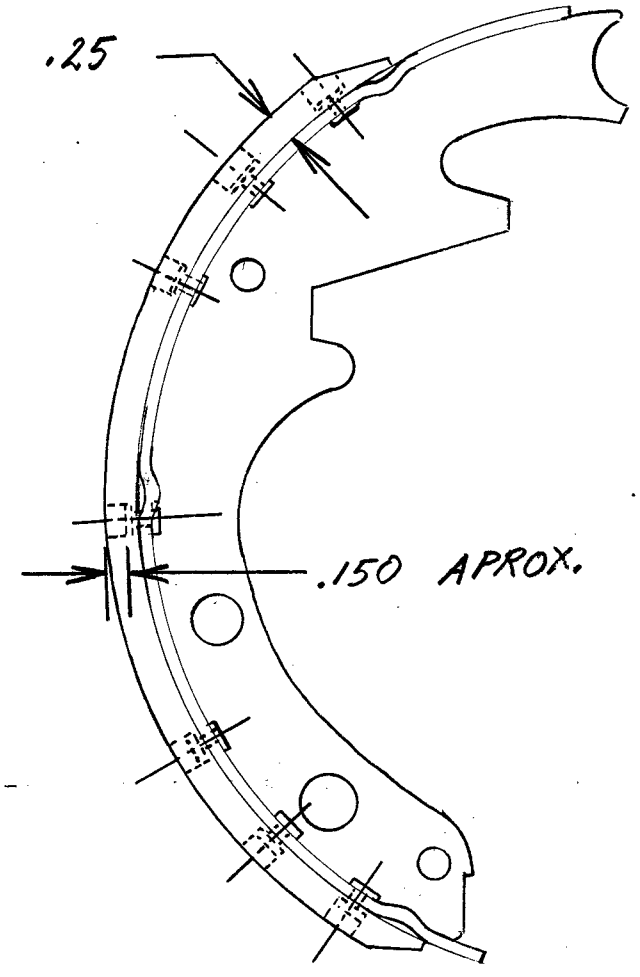
REVIEWED BY: James B. Harvin
JIMMIE B. HARVIN

APPROVED BY: R. G. Carion
ROBERT G. CARION

New, Riveted (top) and Bonded (bottom) Brake Shoes

FIGURE 1

Riveted Lining & Shoe Assembly



Bonded Lining & Shoe Assembly

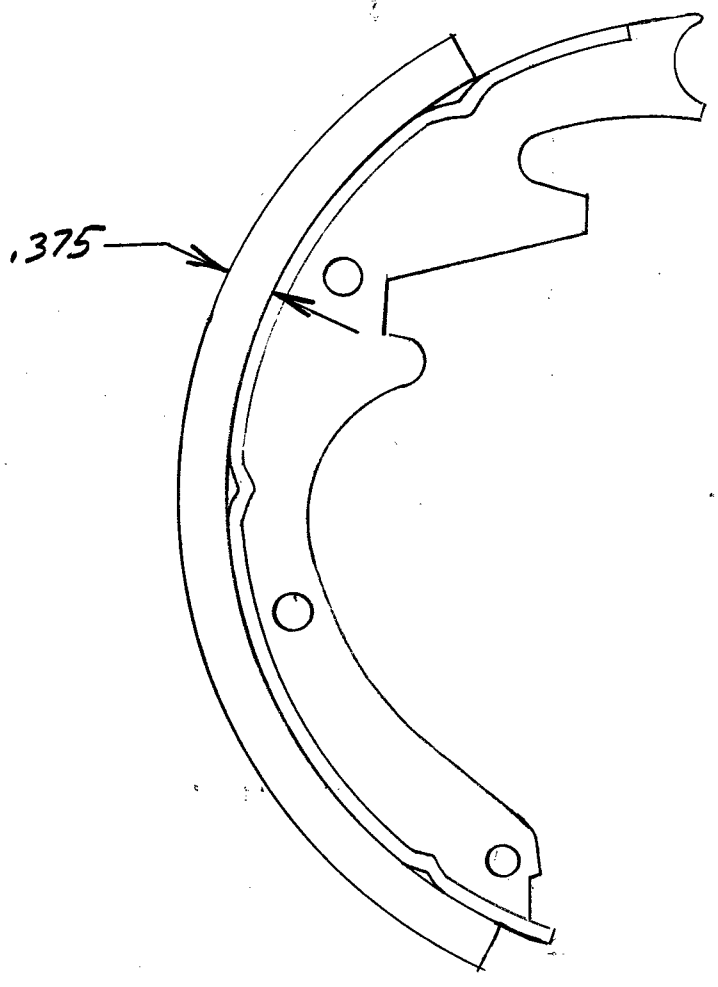
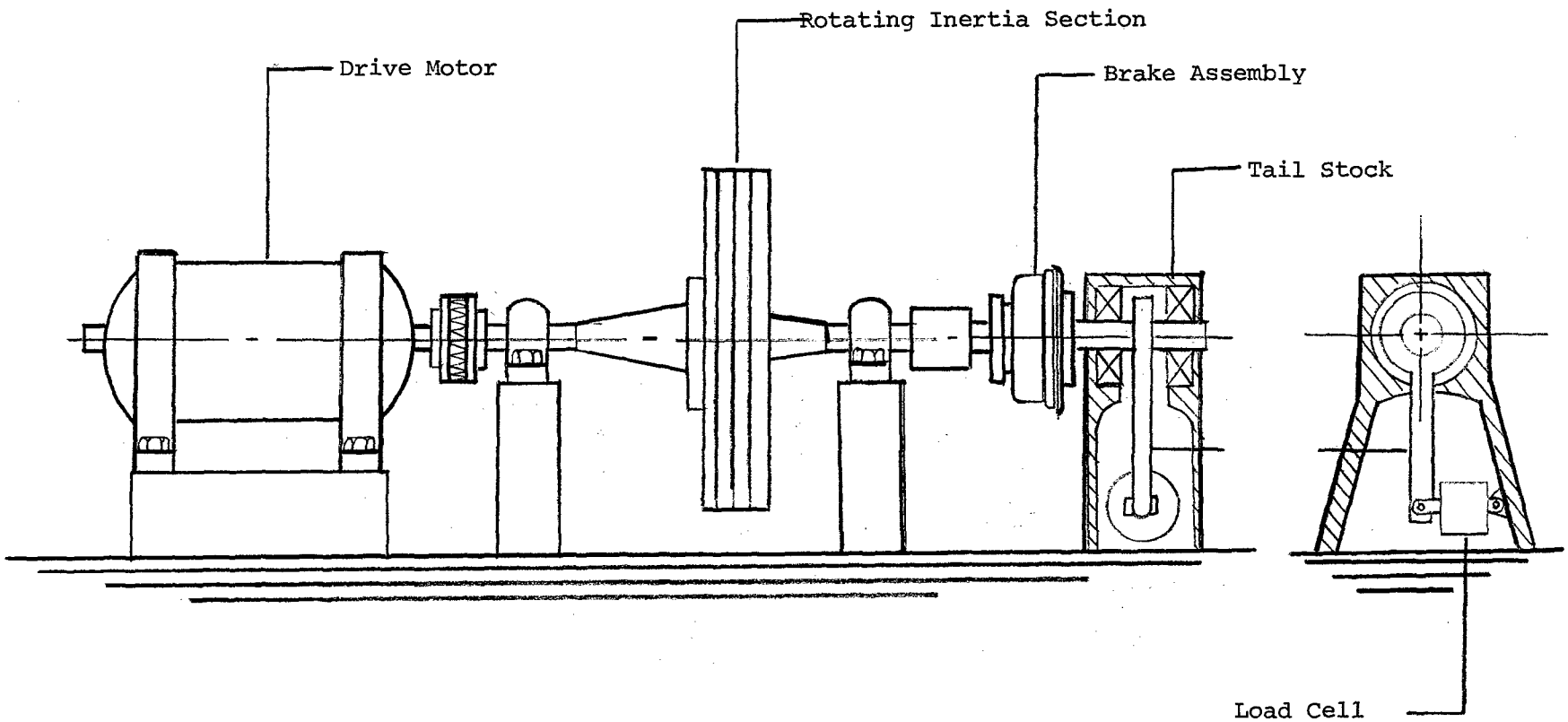
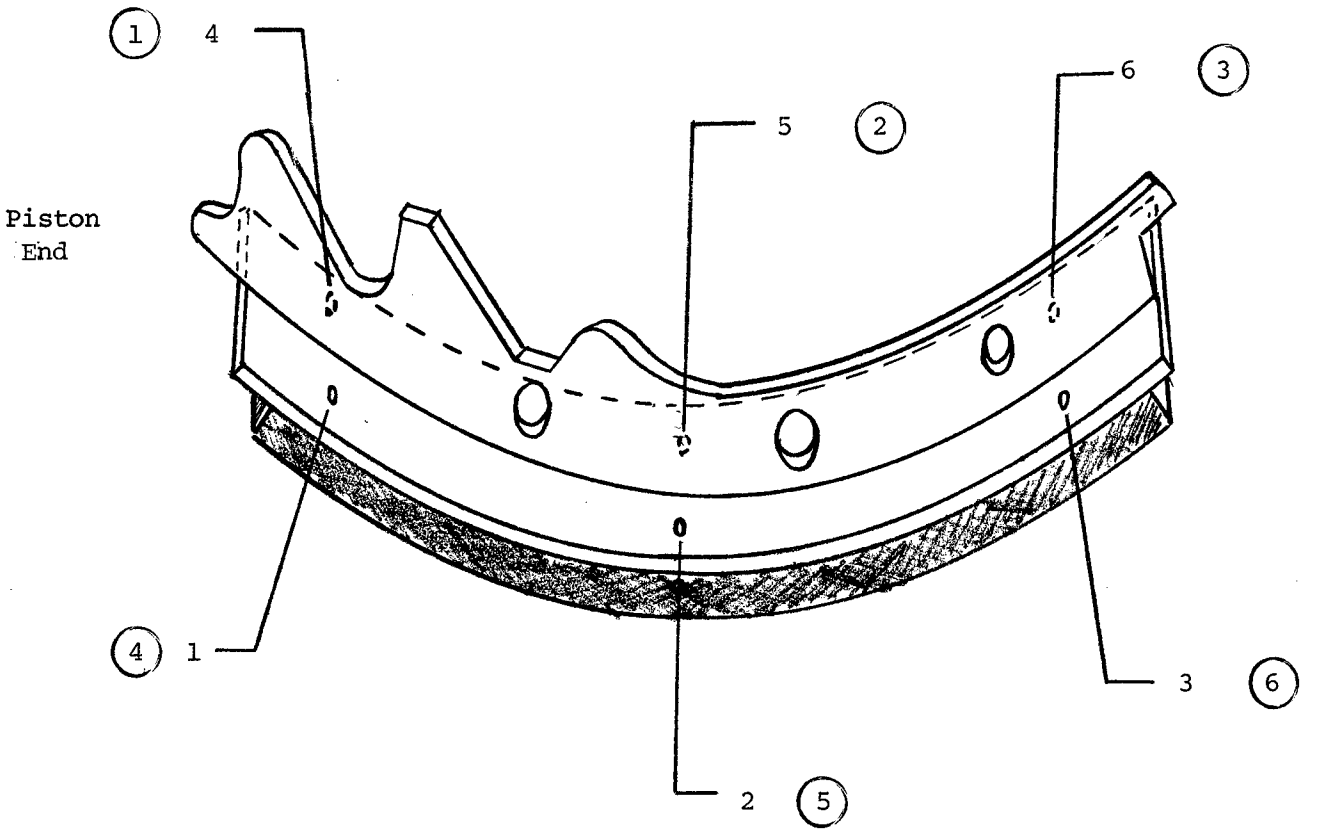


FIGURE 2



Inertia Brake Dynamometer

FIGURE 3

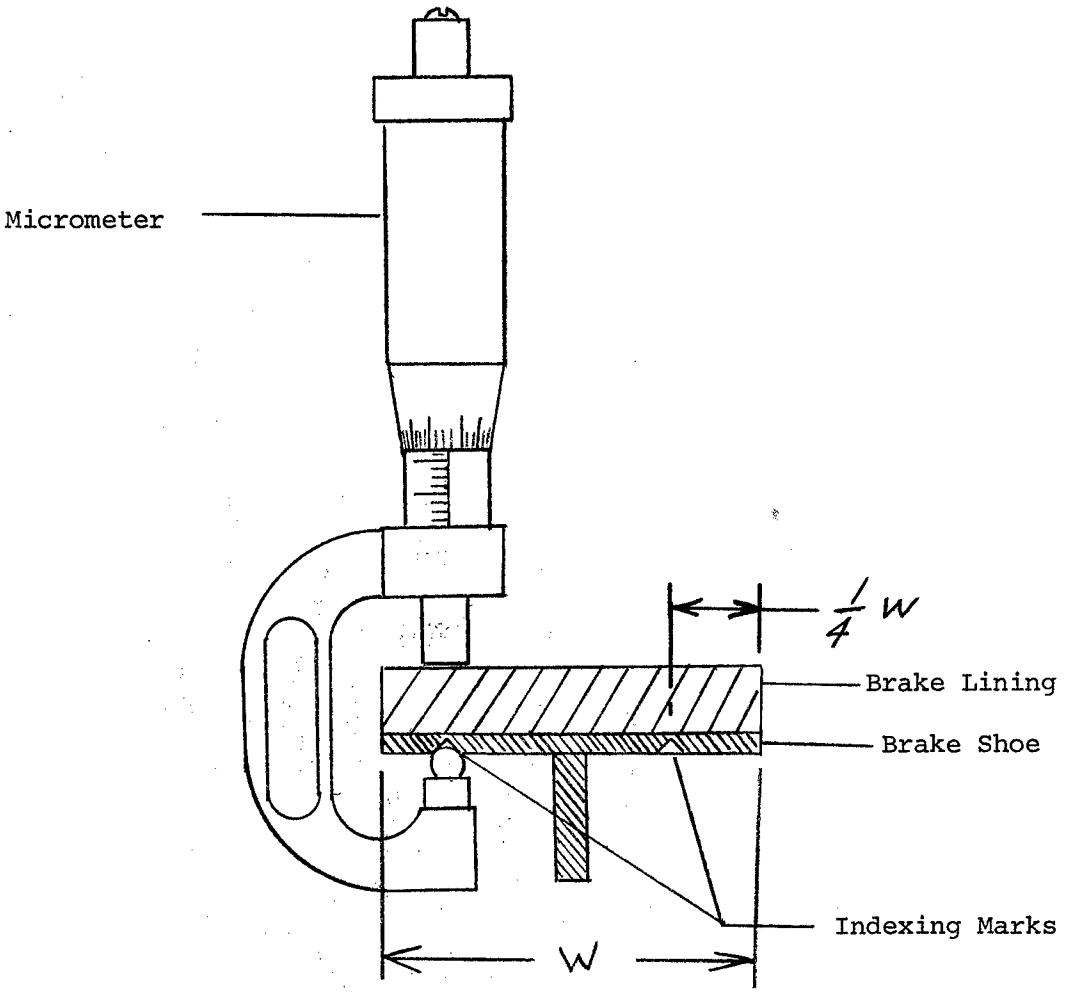


Primary Shoe - Uncircled numbers

Secondary Shoe - Circled numbers

Positioning of Indexing Marks

FIGURE 4

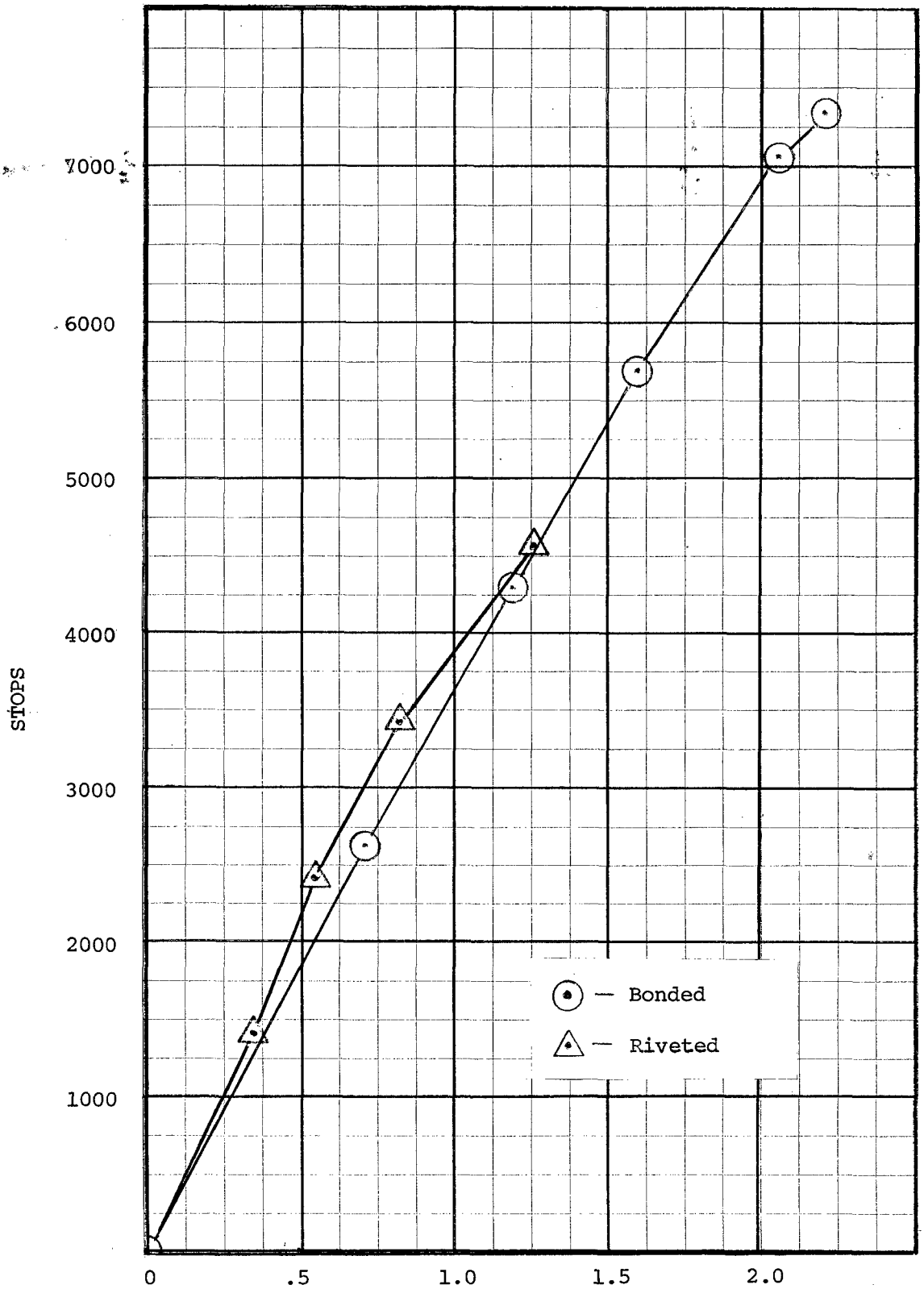


Brake Lining Thickness Measurement

FIGURE 5

Riveted Lining after 4836 Stops and
Bonded Lining after 7590 Stops

FIGURE 6



Wear, Inches Secondary and Primary Shoe

(Total of 12 Measurement Points)

Wear vs. Stops

FIGURE 7

POSITION

Number of Stops	1	2	3	4	5	6
200	.001	-.001*	0	.003	-.001	0
2875	.083	.107	.102	.102	.121	.048
4480	.049	.071	.052	.052	.074	.044
5944	.045	.063	.048	.048	.068	.044
7245	.053	.064	.059	.059	.075	.042
7590	.010	.020	.024	.024	.022	.019
TOTAL WEAR	.240	.325	.285	.285	.360	.197

Bonded Lining Wear, Inches, Secondary Shoe

TABLE I

POSITION

Number of Stops	1	2	3	4	5	6
200	-.006	-.003	0	-.003	.003	-.001
2875	.014	.023	.034	.018	.038	.041
4480	.013	.033	.028	.012	.029	.028
5944	.013	.023	.023	.013	.027	.019
7244	.012	.027	.022	.011	.029	.026
7590	0	.001	.002	.004	.009	.007
TOTAL WEAR	.052	.107	.109	.058	.132	.121

Bonded Lining Wear, Inches, Secondary Shoe

TABLE II

*Negative reading indicates lining thickness growth.

POSITION

Number of Stops	1	2	3	4	5	6
200	.006	.010	.004	.006	.010	.003
1676	.027	.043	.019	.034	.052	.026
2645	.028	.037	.022	.031	.041	.023
3680	.029	.040	.023	.028	.041	.024
TOTAL	.084	.120	.064	.093	.134	.073
4836*	.057	.079	.043	.054	.066	.030

Riveted Lining Wear, Inches, Secondary Shoe

TABLE III

POSITION

Number of Stops	1	2	3	4	5	6
200	0	0	.003	.001	.008	.005
1676	.012	.019	.012	.012	.021	.012
2645	.003	.010	.010	.003	.011	.009
3680	.004	.012	.010	.004	.011	.011
TOTAL	.109	.041	.032	.019	.043	.032

Riveted Lining Wear, Inches, Secondary Shoe

TABLE IV

*The 4836 shop wear figure is provided for information only. Lining rivet making contact after 3680 stops.

DEPARTMENT OF THE ARMY
PROGRAM EXECUTIVE OFFICE
COMBAT SUPPORT & COMBAT SERVICE SUPPORT
6501 EAST 11 MILE ROAD
WARREN, MICHIGAN 48397-5000

REPLY TO
ATTENTION OF

SFAE-CSS

22 MAR 2013

MEMORANDUM FOR Defense Technical Information Center (DTIC-OQ), 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218

SUBJECT: Change of Classification Level to 4M151 Truck Documents

1. Reference Defense Technical Information Center (DTIC) Infosec "RE: M151A2 Documents retrieval and review" direction email of 14 December 2012.

2. In accordance with the above reference, please change the classification and distribution level for the following documents:

a. Document.

(1) The DTIC AD#: ADB271644

(2) Title: M151 Transmission Clutch Hub Insert – P/N 7059129

(3) Date of Document: 29 February 1972

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for Operations Security (OPSEC) and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

b. Document 2.

(1) The DTIC AD#: AD0474825

(2) Title: ENGINEER DESIGN TEST OF TRUCK, UTILITY, 1/4–TON, 4X4, M151 (RIDE AND HANDLING CHARACTERISTICS)

(3) Date of Document: 15 December 1965

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

c. Document 3.

(1) The DTIC AD#: AD0857240

(2) Title: Product Improvement Test of Truck, Utility, 1/4–TON, 4X4, M151 Series with Modified Independent Rear Suspension System

(3) Date of Document: 27 June 1969

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

d. Document 4.

(1) The DTIC AD#: ADB273320

(2) Title: Bonded vs. Riveted Brake Lining Test

(3) Date of Document: 12 January 1977

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

e. Document 5.

(1) The DTIC AD#: AD0810372

(2) Title: Product Improvement Test of Truck, Utility, 1/4–TON, 4X4, M151 Modified with Solid Rear Axle

(3) Date of Document: March 1967

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

f. Document 6.

(1) The DTIC AD#: ADB271624

(2) Title: Transmission Cluster Gear (M151 Vehicle)

(3) Date of Document: 06 March 1972

(4) New Distribution/Classification: Distribution A. Approved for public release; distribution is unlimited.

(5) Reason for Change: This document has been reviewed for OPSEC and has been deemed to contain no OPSEC concerns. The documents are for the M151 Truck that has not been in the military inventory since the early 1980s; the vehicle and associated documents are obsolete.

(6) Date of Change: Immediately

3. The Point of Contact for this action is Robert Anick, Sr, email: robert.d.anick.civ@mail.mil or COM (586) 282-8448.

Kevin M. Fahey
Program Executive Officer,
Combat Support & Combat Service Support