U.S. Department of Transportation
Federal Railroad Administration

ROLLER BEARING FAILURE MECHANISMS TEST AND WHEEL ANOMALY TEST REPORT

Office of Research and Development
Washington D.C. 20590

DOT/FRA/ORD-92/08

June 1992
Final Report

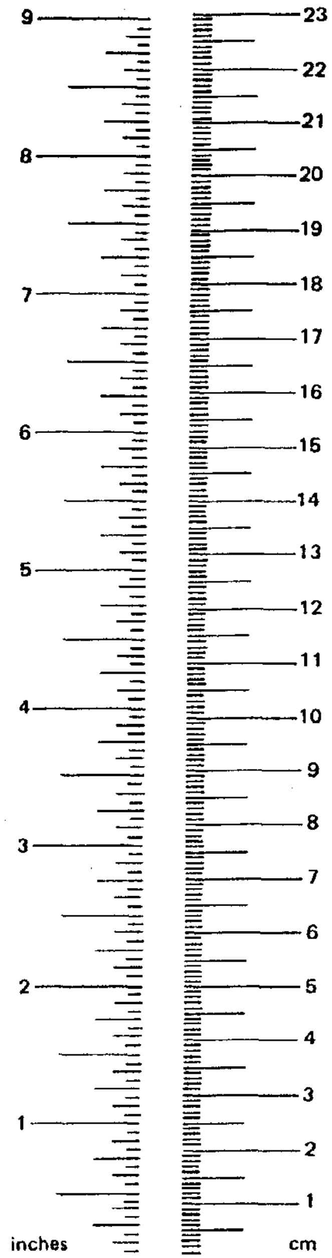
DISCLAIMER

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

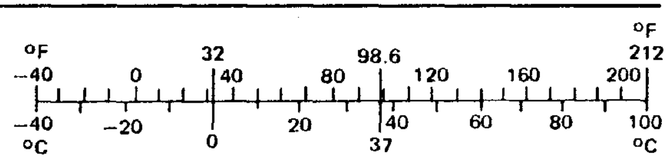
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in. = 2.54 cm (exactly). For other exact conversions and more detail tables see NBS Misc. Publ. 286. Units of Weight and Measures. Price $2.25 SD Catalog No. C13 10 286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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16. Abstract

A series of roller bearing performance tests were performed by the Association of American Railroads (AAR) as part of a Federal Railroad Administration (FRA) Task Order entitled "Freight Car Equipment Research." The objectives of these tests were to investigate the performance of degraded roller bearings, and quantify the effects of four common wheel tread anomalies on the dynamic load environment of the roller bearing.

Test results support the following conclusions:

- The grooved axle journal defects tested developed temperature gradients on the bearing cup which may be useful in identifying this defect type.
- A grooved axle condition developed on one of the test bearings and six other bearings showed evidence of cone slippage on the axle journal.
- Wayside detector alignment and scan location are critical factors in successful detection of an overheated bearing.
- The peak loads produced by the wheel defects at the speed ranges tested were significantly lower at the bearing adapter than at the rail. The peak loads were also significantly higher then the static loads at the wheel.

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EXECUTIVE SUMMARY

The mechanisms which cause roller bearing failure are not well understood and were the subject of a recent research program funded by the Federal Railroad Administration and conducted by the Association of American Railroads (AAR) at the Transportation Test Center (TTC), with assistance from the Volpe National Transportation Systems Center, and ENSCO Applied Technologies, Incorporated. Additional support for the program was provided by Brenco Incorporated, the Burlington Northern Railroad Company, Harmon Electronics Incorporated, the Atchison, Topeka & Santa Fe Railway Company, Servo Corporation of America, Timken Company, and the Union Pacific Railroad Company.

The objectives of the research program were to:

Solicit information from railroad and railroad supply industry experts to define the technical and operational safety procedures required to conduct roller bearing research at the TTC.

Investigate the effect of degraded bearing cone/axle journal interference fit and end clamp load conditions on short term bearing performance and reliability.

Determine the effects of degraded bearing cone/axle journal interference fit and end clamp load conditions on the long term performance and reliability of roller bearings operating in simulated revenue service conditions.

Determine the effect of initial run-in temperature and axle journal/cone interference fit on the rate and amount of bearing cone bore growth.

Develop growth rate data for AAR condemnable roller bearing raceway defects.

Document the dynamic load environment produced by four common wheel tread anomalies (Tread Flats, Out of Round Tread, Spalled Tread, and Tread Build-up) by measurements at the bearing/truck side frame interface.

A series of roller bearing performance tests were performed: Roller Bearing Failure Mechanism short- and long-term performance tests (RBFM I Test & RBFM II Test); Cone Bore Growth Test; Raceway Defect Growth Rate Test and Wheel Anomaly Test.

The short term (5,000 miles) performance of 24 AP Class F bearings with the axle journal/bearing cone interference fits ranging from a grooved axle journal condition to the maximum allowable interference fit (0.0045 inch), and end clamp loads ranging from zero to 30 ton was investigated in the first roller bearing failure mechanism test (RBFM I Test). Two of the 24 test bearings were modified to simulate a broken cage bar condition.

In addition, three AP Class F bearings equipped with experimental low friction seals, provided by Ernst Manufacturing Incorporated, were also included in the test to determine how well the seals would perform under simulated revenue service conditions, and if they would reduce the operating temperature of the bearing as measured by wayside Hot Bearing Detector (HBD) systems. The bearings were tested under fully loaded car conditions.

Onboard instrumentation included thermocouples attached to the cups of each test bearing, cone slippage measurement instrumentation installed on eight bearings, and acceleration sensors installed on four bearings. Data from five HBD systems were collected to monitor the operating temperature of the test bearings.

The results of the short term degraded bearing performance test showed that bearings with a grooved axle journal defect developed measurable temperature gradients across the cup surface, and that bearing cone slippage was detected on all bearings having less than 0.0015 inch interference fit between the axle journal and the bearing cones. It was also learned that wayside detector alignment and scan location are critical factors in successful detection of an overheated bearing. The short term performance of the experimental low friction seals evaluated during the test was acceptable.

The long term (19,000 miles) performance of 20 roller bearings that survived the short term test was investigated in the second roller bearing failure mechanisms test (RBFM II Test). Bearings considered as having a high risk of failure were equipped with thermocouples so that the operating temperature could be documented in the event of failure. Hot bearing detector bolts, manufactured by RASTECH, and the 3M Company, were installed in the end cap of each bearing to provide a visual indicator in the event of overheating. Bearings considered as having a low risk of failure were only equipped with the detector bolts. Two HBD systems and one Acoustic Bearing Detector/HBD system were also used in the tests.

While no over-temperature events occurred for any of the bearings evaluated in the long term degraded bearing performance test, cone slippage resulted in measurable loss of material on the axle journals and cones for eight of the test bearings, and a grooved axle condition developed on one of the bearings during the test. The operating temperature and the acoustic emissions of the bearing did not provide any indication that the axle was grooved. No mechanical failures occurred on the hot bearing detector bolts provided by RASTECH, Incorporated and the 3M Company.

In the Cone Bore Growth Test, 16 new bearings with pre-measured cone bores were provided by Brenco. The bearings were installed under two loaded 125-ton capacity open top hopper cars, equipped with thermocouples and two hot bearing detector bolts and operated for 7,000 miles. At the completion of the on-track test, the bearings were inspected for defects and the cone bore and axle journal dimensions were documented.

The results of the Cone Bore Growth Test showed that the bearings with a 0.005 inch interference fit and charged with 32 ounces of grease had higher operating temperatures and experimented more cone bore growth than bearings with 0.0025 inch interference fit and charged with 24 ounces of grease.

Four AP Class F bearings and four AP Class E bearings were evaluated in the Raceway Defect Growth Rate Test. The wheel sets were installed under fully loaded 100-ton and 70-ton capacity cars and the cars were operated as part of the Heavy Axle Load consist on the High Tonnage Loop (HTL). The AP Class F bearings accumulated 19,000 miles of operation, while the AP Class E bearings only accumulated 4,075 miles. The 70-ton capacity car was donated by a railroad late in the program and as a result low mileage was recorded on the AP Class E bearings.

The results of the Raceway Defect Growth Rate Test showed that after 19,000 miles of operation no measurable growth occurred on the Brinell and cone spall defects in the AP Class F bearings during the test. However, measurable growth did occur for the cup spall defect in the AP Class F bearing. No measurable growth occurred for any of the defects in the AP Class E bearings after 4,075 miles of operation.

In the Wheel Anomaly Test, wheels having slid flats were used to evaluate the effects of short wavelength anomalies (1 to 3 inch), while the effects of intermediate wavelength anomalies (3 to 5 inch) were investigated using wheels with tread spalls, and out of round wheels were used to determine the effects of long wavelength anomalies (5 to 15 inch). In order to limit the influence of the defect types upon each other, only one wheel set with defects was installed in the leading axle position of the leading truck of each car.

The results of the Wheel Anomaly Test showed that the tread defects did not produce significant accelerations in the body of the car for the speed range tested, and that the peak loads produced at the bearing adapter were significantly lower than the peak loads produced at the wheel/rail interface.

The cars were operated with one locomotive and an instrument/data acquisition car over a section of track having wooden ties and cut spike fasteners on the Transit Test Track (TTT) and over a section of track having concrete ties and elastic fasteners on the HTL at the Facility for Accelerated Service Testing.

The cars were equipped with instrumentation to measure vertical load, lateral and vertical acceleration. Strain gages were installed on the rails of the TTT at 10 locations to measure vertical force at the wheel/rail interface.

Table of Contents

Table of Figures

Tables

1.0 INTRODUCTION

The railroad industry suffers damages to equipment, wayside structures, and lading every year due to derailments caused by roller bearing failure. The mechanisms which cause roller bearing failure are not well understood and are the subject of a research program conducted by the Association of American Railroads (AAR), Transportation Test Center (TTC), Pueblo, Colorado, with assistance from the Volpe National Transportation Systems Center (VNTSC), Cambridge, Massachusetts, and ENSCO, Applied Technologies, Incorporated, Springfield, Virginia. The program was funded by the Federal Railroad Administration (FRA).

Additional support for the program was provided by Brenco Incorporated, the Burlington Northern Railroad Company (BN), Harmon Electronics Incorporated, the Atchison Topeka & Santa Fe Railway Company (AT&SF), the Servo Corporation of America, the Timken Company, and the Union Pacific Railroad (UP).

1.1 ROLLER BEARING DESIGN

The roller bearing was introduced into freight car use in the United States in 1954. The most common design found in service on today's U.S. railroads is the double row tapered configuration shown in Figure 1. The stationary raceways are located in the outer ring, which is commonly referred to as the cup. The rotating raceways are located in the roller assemblies, which are commonly referred to as the cones. The roller elements ride on the rotating raceways, and each roller element is separated from adjacent rollers by the cage assembly. The cone bore diameter is manufactured to be 0.0025 inch to 0.0045 inch smaller than the axle journal, which results in an interference fit between the cones and the journal when the bearing is mounted. The two cones are separated by a spacer ring which sets the amount of bearing end play. The function of the grease seals, which press into the cup and ride on the wear rings, is to retain the bearing lubricant and prevent lubricant contamination. The bearing is held in place on the axle journal by the bearing end cap assembly, which includes three cap screws.

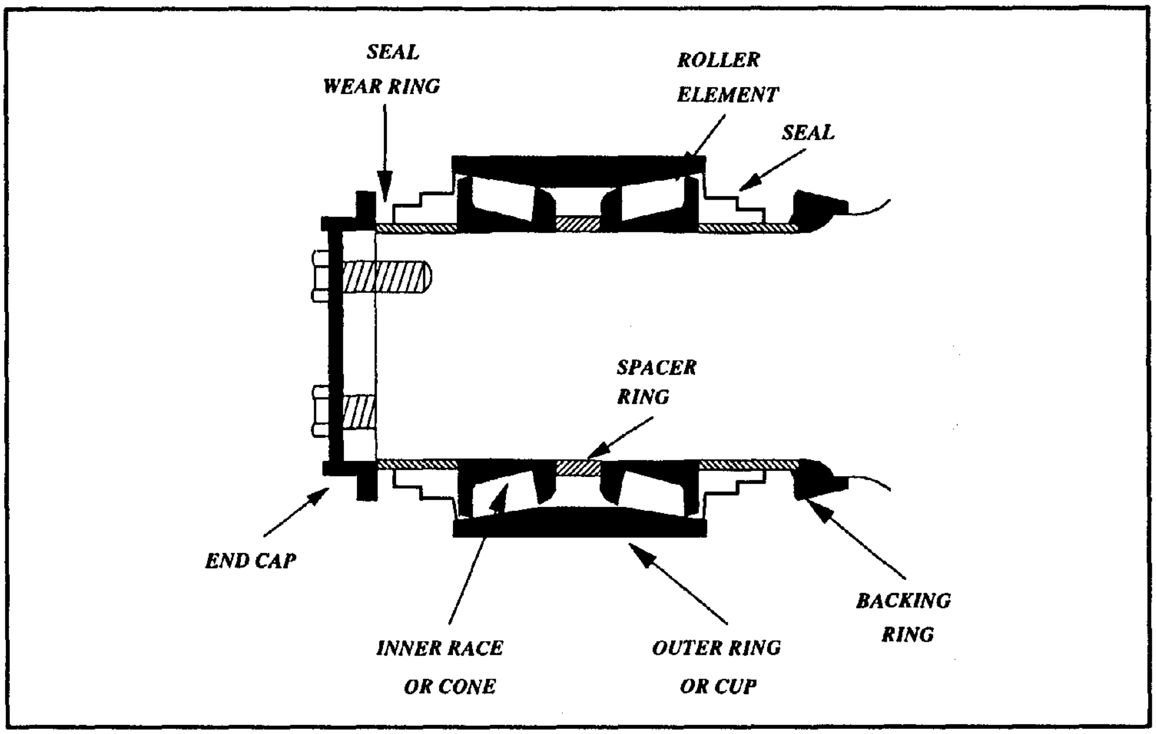


Figure 1. Cross section of a Tapered Roller Bearing (Schematic -- not to scale)

1.2 BEARING DEFECT CLASSIFICATION

Roller bearing inspection and reconditioning practices are subject to the requirements set forth in Volume H - Part II, "Roller Bearing Manual," of the AAR's *Manual of Standards and Recommended Practices.* Copies of the pertinent sections of the publication are provided in the appendix. A brief description of some of the types of bearing defects defined in the "Roller Bearing Manual" is provided below:

Brinelling

This defect consists of one or more indentations caused by the roller elements being forced into the surfaces of either raceway while the bearing was subjected to heavy impact loading. Figure 2 is an example of a Brinelling in a bearing cup raceway.

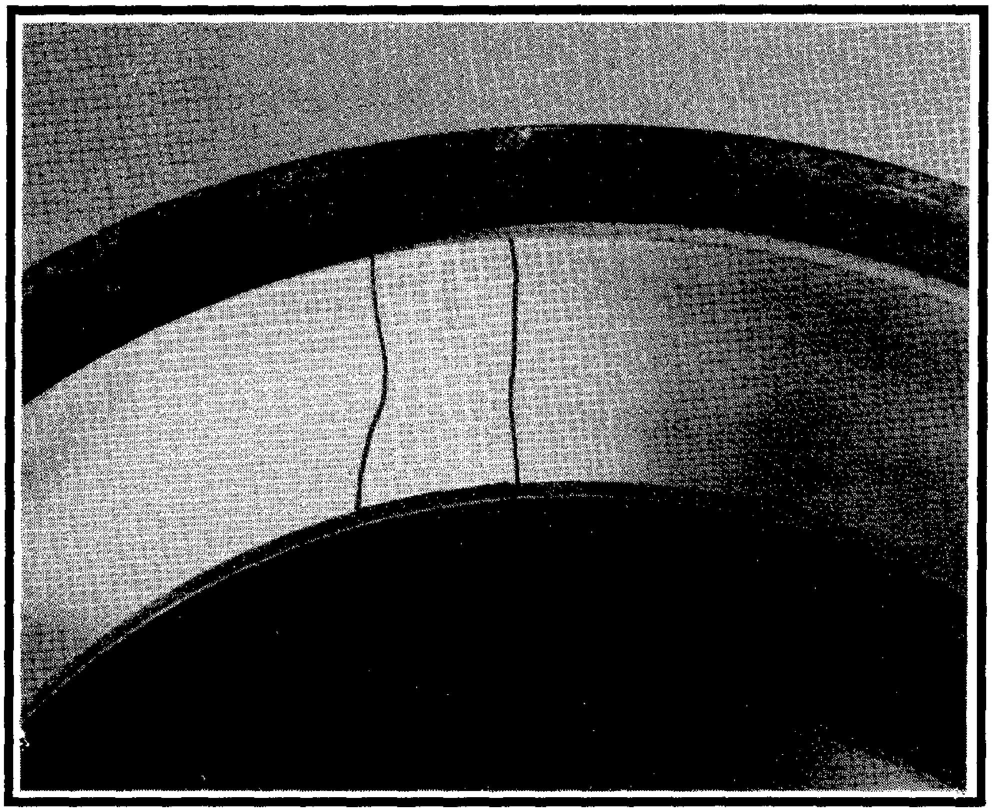


Figure 2. Brinelled Raceway Defect

Spalling

This defect originates as minute cracks which increase in size during cyclic loading and eventually cause metal break out. The defect occurs on the rolling contact surfaces of the raceways and roller elements. Figure 3 is an example of spalling on a bearing cup raceway.

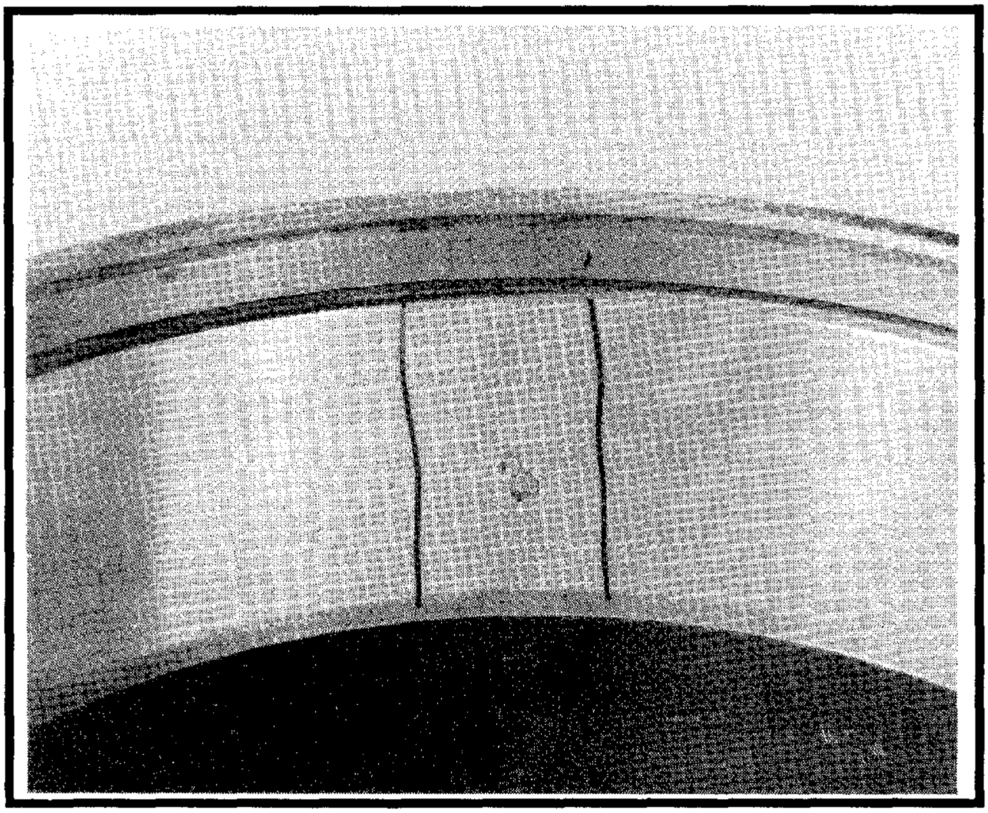


Figure 3. Spalled Raceway Defect

Pitting

Pitting occurs as the result of corrosion or electric arcing during welding. Pitting can occur on both rolling and non-rolling contact surfaces. Figure 4 is an example of pitted roller elements.

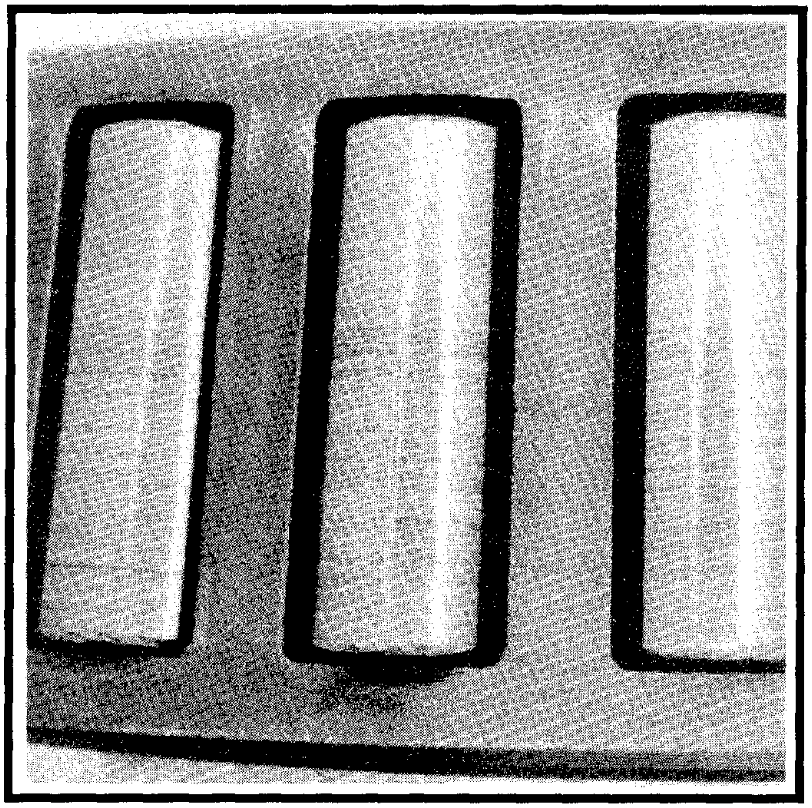


Figure 4. Pitted Roller Element Defect

1.3 ROLLER BEARING FAILURE

The two mechanisms believed to cause the majority of bearing failures are cone slippage and bearing seizure.

Cone slippage occurs when the interference fit between the cone bore and the axle journal becomes degraded due to a variety of factors. This condition is aggravated by the loss of end clamp load that is caused by the excessive bearing component wear which usually accompanies cone slippage. As the cone(s) slips on the axle, a groove is cut into the journal. As this mode of failure progresses, the depth of the groove in the journal increases resulting in improper loading of the bearing which can lead to heavy spalling on the rolling contact surfaces. In the final stages of this failure mode, the operating temperature of the bearing begins to increase rapidly, resulting in softening of the journal which yields under the load of the car. Figure 5 shows a grooved axle journal condition caused by cone slippage.

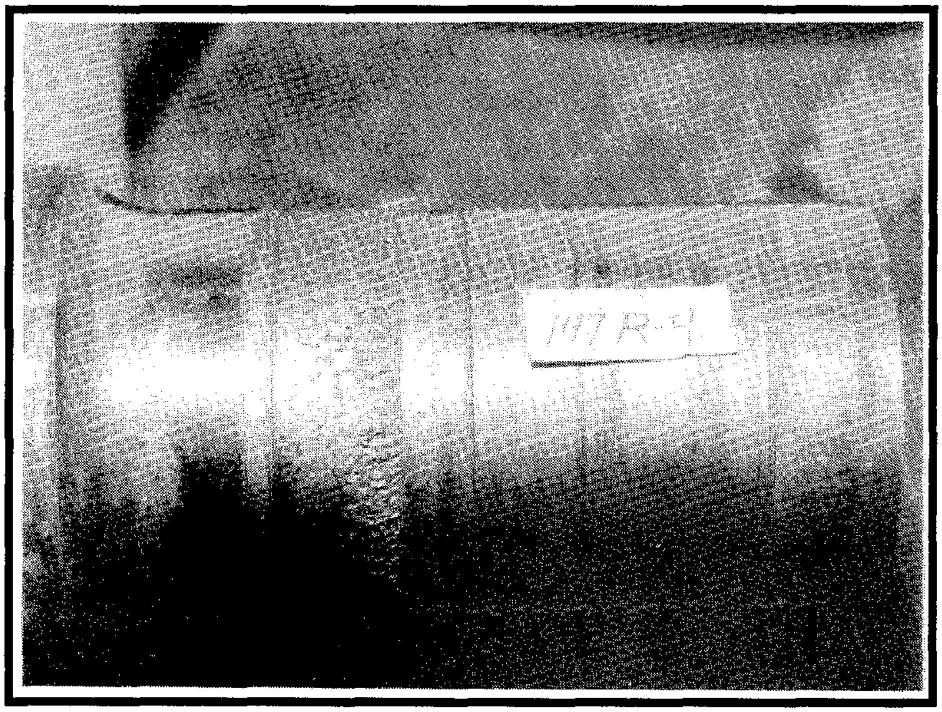


Figure 5. Grooved Axle Journal Defect

Bearing seizure occurs when the rotating and stationary raceways become locked together. This can occur in the final stages of the cone slippage failure mode, or it can occur suddenly and cause catastrophic bearing failure. Potential causes of sudden bearing seizure include fracture of the cage or roller element(s). Figure 6 shows a bearing cup that failed by seizure. The damage shown was caused by the bearing cup rotating under the bearing adapter after the bearing had seized.

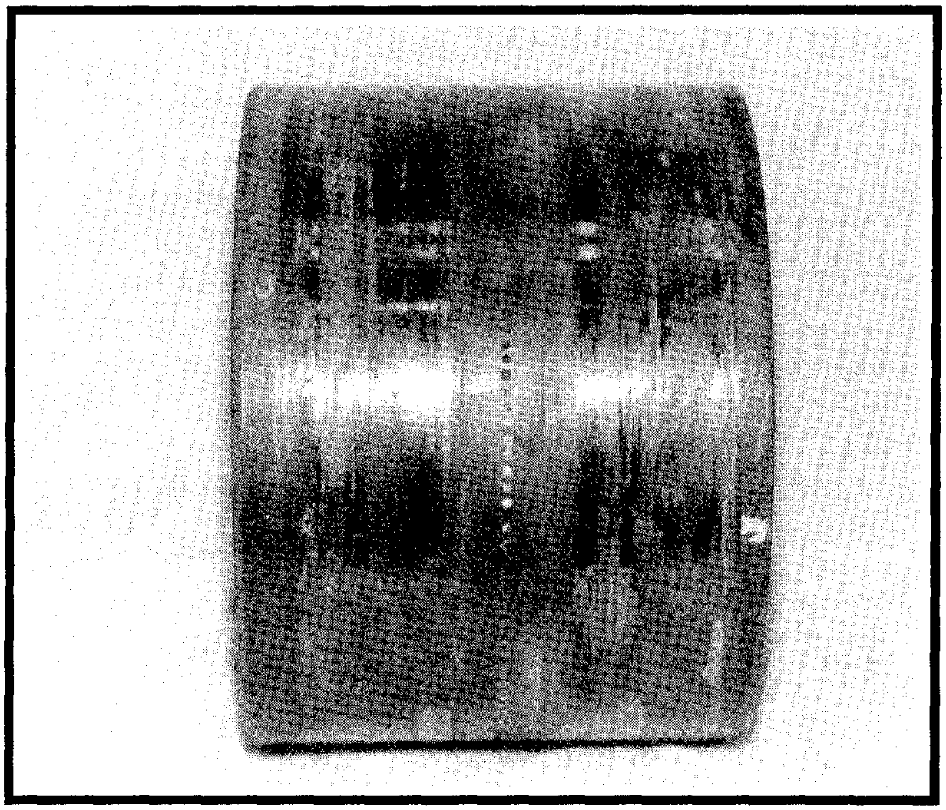


Figure 6. Bearing Seizure Failure

1.4 DEFECTIVE BEARING DETECTION

Several methods of identifying defective roller bearings are used to prevent train derailments.

HOT BOX DETECTORS

Hot Box Detectors (HBD's) are one method used to detect defective bearings. The HBD uses infrared transducers to monitor bearing temperature as the train passes by the detector. The HBD intercepts a portion of the infrared radiation from each bearing and, based on user programmable limits, issues an alarm if the bearing exceeds the preset limit. A typical installation showing the scanner heads is provided in Figure 7.

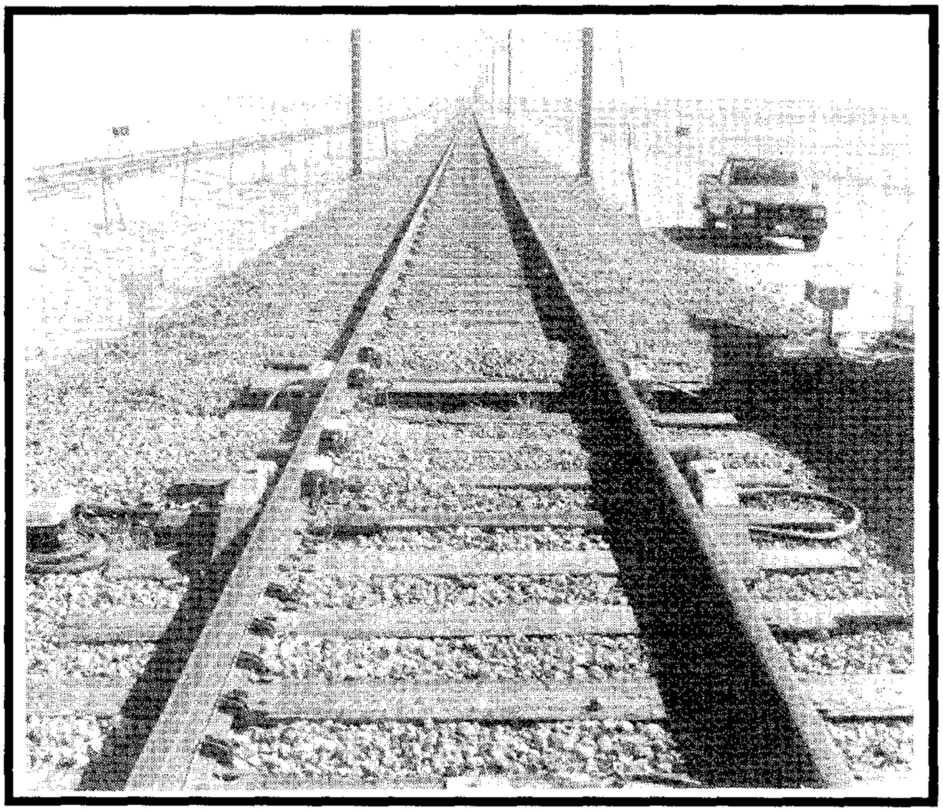


Figure 7. Scanner Heads of a Wayside HBD Installation

ACOUSTIC BEARING DETECTORS

Acoustic Bearing Detectors (ABD's) provide an additional method to detect defective bearings. Unlike the HBD's previously discussed, the ABD's are designed to detect bearing flaws before overheated operation occurs. These systems use wayside receivers to monitor acoustic emissions from the bearing as the train passes by the detector. The ABD analyzes the acoustic signal for each bearing and, based on user programmable limits, issues an alarm if a defect is detected. Figure 8 shows the wayside receivers of an ABD system.

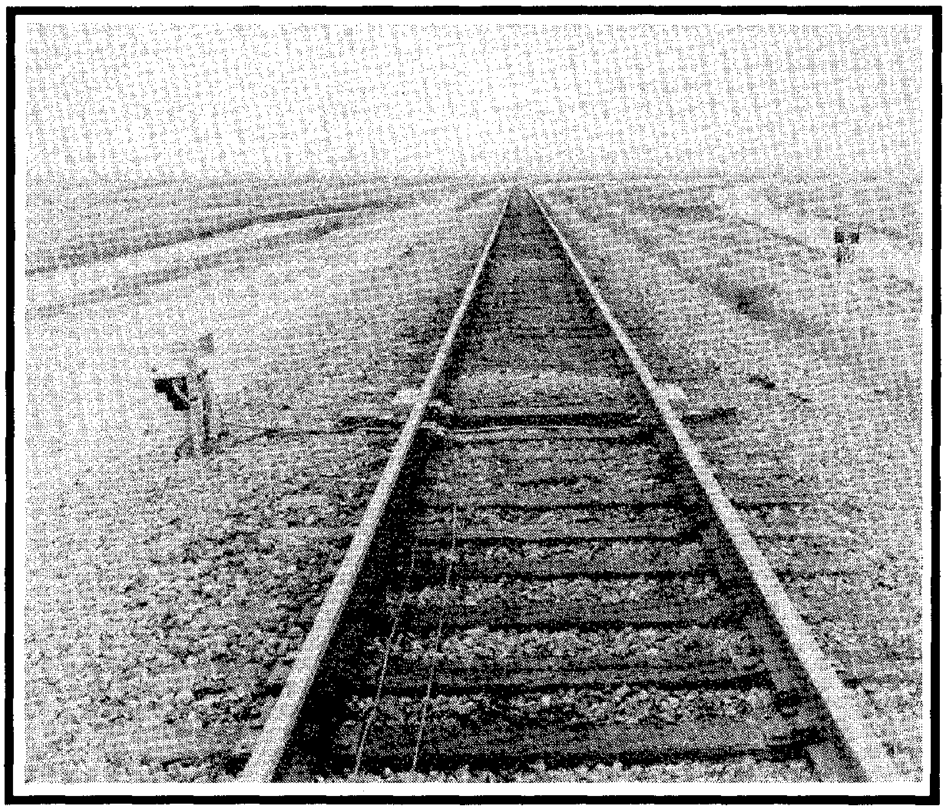


Figure 8. Acoustic Receivers of a Wayside ABD Installation

ONBOARD BEARING MONITORS

Trains carrying sensitive loads and/or passengers are sometimes equipped with Onboard Bearing Monitors (OBM's). OBM's provide protection from bearing failure by continuously monitoring the operating temperature of each bearing and issuing an alarm if any bearing exceeds a preset user programmable limit.

2.0 OBJECTIVES

The research program was divided into three major work efforts. Each work effort addressed specific program objectives. A description of the program objectives addressed by each work effort is provided below:

Work Effort No. 1 - Program Safety Assessment

> Solicit information from the railroad and railroad supply industry experts to define the technical and operational safety procedures required to conduct roller bearing research at the TTC.

Work Effort No. 2 - Short Term Tests

Roller Bearing Failure Mechanisms I (RBFM I)

> Investigate the effect of degraded bearing cone/axle journal interference fit and end clamp load conditions on short term (5,000 miles) bearing performance and reliability.

Wheel Anomaly Test

> Document the dynamic load environment produced by four common wheel tread anomalies (Tread Flats, Out of Round Tread, Spalled Tread, and Tread Build-up) by measurements at the bearing/truck side frame interface.

Work Effort No. 3 - Long Term Tests

Roller Bearing Failure Mechanisms II (RBFM II)

> Determine the effects of degraded bearing cone/axle journal interference fit and end clamp load conditions on the long term (20,000 mile) performance and reliability of roller bearings operating in simulated revenue service conditions.

Cone Bore Growth and Bearing Run-in Temperature Test (CBG)

> Determine the effect of initial run-in temperature on the rate of bearing cone bore growth.

Raceway Defect Growth Rate Test (RDGR)

Develop growth rate data for a variety of AAR condemnable roller bearing raceway defects.

3.0 PROCEDURES

The procedures developed for each test are described in the following subsections.

3.1 RBFM I TEST

Twenty-four AP Class F (6 1/2 X 12) bearings with the axle journal/bearing cone interference fit and end clamp loads detailed in Table 1 were evaluated in the test.

Table 1. RBFM I Test Bearing Fit and Clamp Load Summary

CLAMP	AXLE JOURNAL/CONE INTERFERENCE FIT					
	Grooved	Zero	0.00075"	0.0015"	0.002"	0.0045"
Zero	A,B		G,H	L,M		U,V
10-ton		C,D	I,J	N	O	
27-ton		E,F	K	P,Q	T	
27-ton				R,S		
27-ton				W*,X*		

*** Cut Cage Separator Bar**

Ten of the test bearings, provided by Brenco, were new bearings with no service miles. The Timken Company provided 10 reconditioned bearings, with no service miles for the test. The TTC provided two reconditioned Timken bearings (W & X) with no service, and bearings A and B were obtained from the AT&SF Railway. Table 2 describes the bearings used in the experiment.

Table 2. RBFM I Test Bearing Summary

BEARING ID	MFGR	DATE	SERIAL NUMBER	FIT (inches)	CLAMP (tons)	*LATERAL (inches)
A	Brenco	2-74	20825	Groove	Zero	0.030
B	Brenco	69N	27828	Groove	Zero	0.004
C	Timken	12-80	471222	Zero	10	0.009
D	Brenco	7-88	61113	Zero	10	0.018
E	Timken	9-81	197605	Zero	30	0.010
F	Brenco	7-88	61087	Zero	30	0.011
G	Timken	9-73	55529	0.00075	Zero	0.011
H	Brenco	7-88	61089	0.00075	Zero	0.015
I	Timken	3-77	418299	0.00075	10	0.010
J	Brenco	7-88	61062	0.00075	10	0.014
K	Timken	4-74	50066	0.00075	30	0.007
L	Timken	8-80	438393	0.0015	Zero	0.006
M	Brenco	7-88	61069	0.0015	Zero	0.008
N	Timken	1-73	303796	0.0015	10	0.009
O	Brenco	7-88	61078	0.0020	10	0.010
P	Timken	1-67	66180	0.0015	30	0.008
Q	Brenco	7-88	61094	0.0015	30	0.009
R	Brenco	7-88	61092	0.0015	30	0.011
S	Timken	1-87	1697	0.0015	30	0.008
T	Brenco	7-88	61093	0.0020	30	0.006
U	Timken	8-80	443064	0.0045	Zero	Zero
V	Brenco	7-88	61104	0.0045	Zero	Zero
W	Timken	6-80	294894	0.0015	30	0.003
X	Timken	8-85	13766	0.0015	30	0.010

* Mounted Lateral

Bearing A and bearing B, obtained from the AT&SF, had been removed from revenue service due to overheating. Figures 9-12 show the condition of the bearings before testing began.

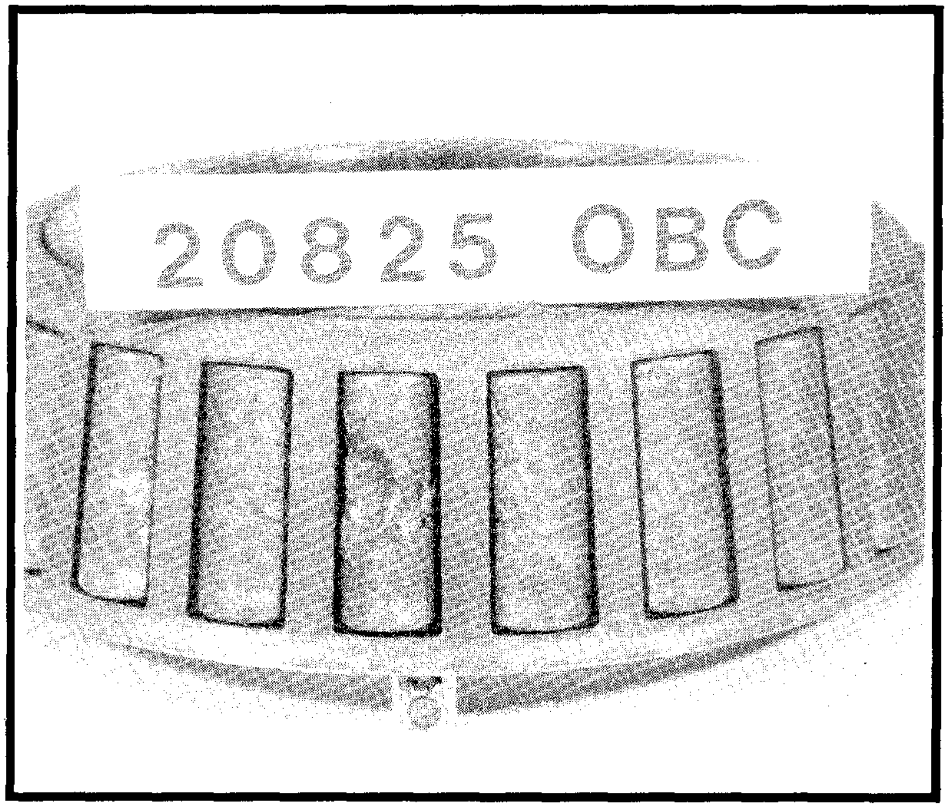


Figure 9. Pre-Test Spalled Roller Condition of Outboard Cone -- Bearing A

Figure 10. Pre-Test Spalled Condition of Outboard Cup Raceway -- Bearing A

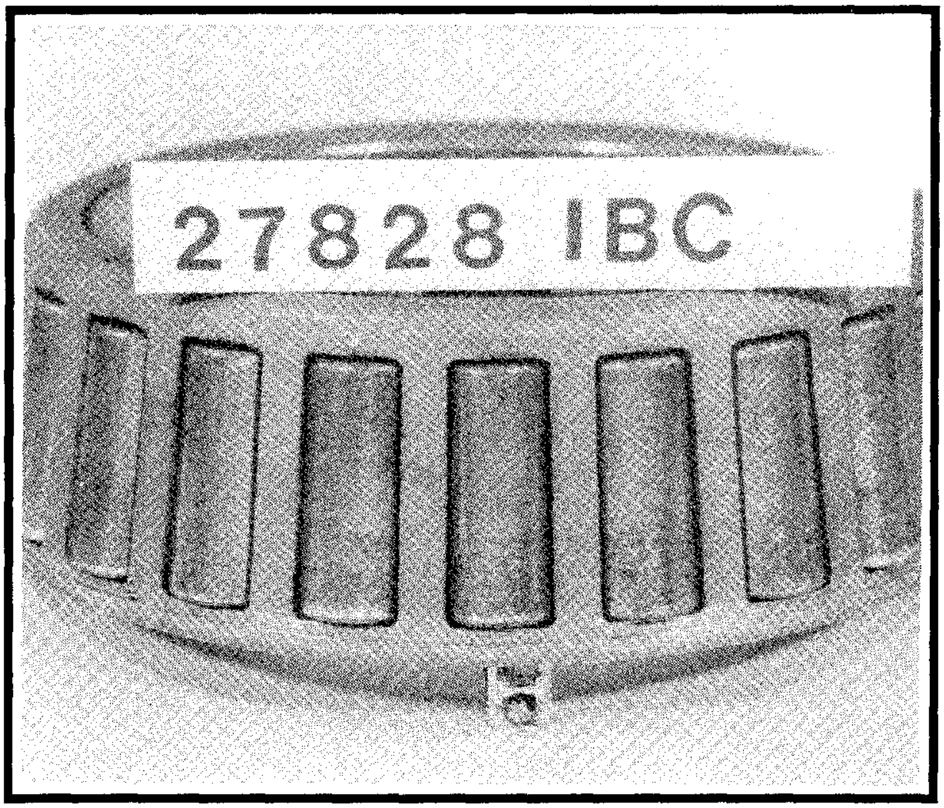


Figure 11. Pre-Test Condition of Inboard Cone -- Bearing B

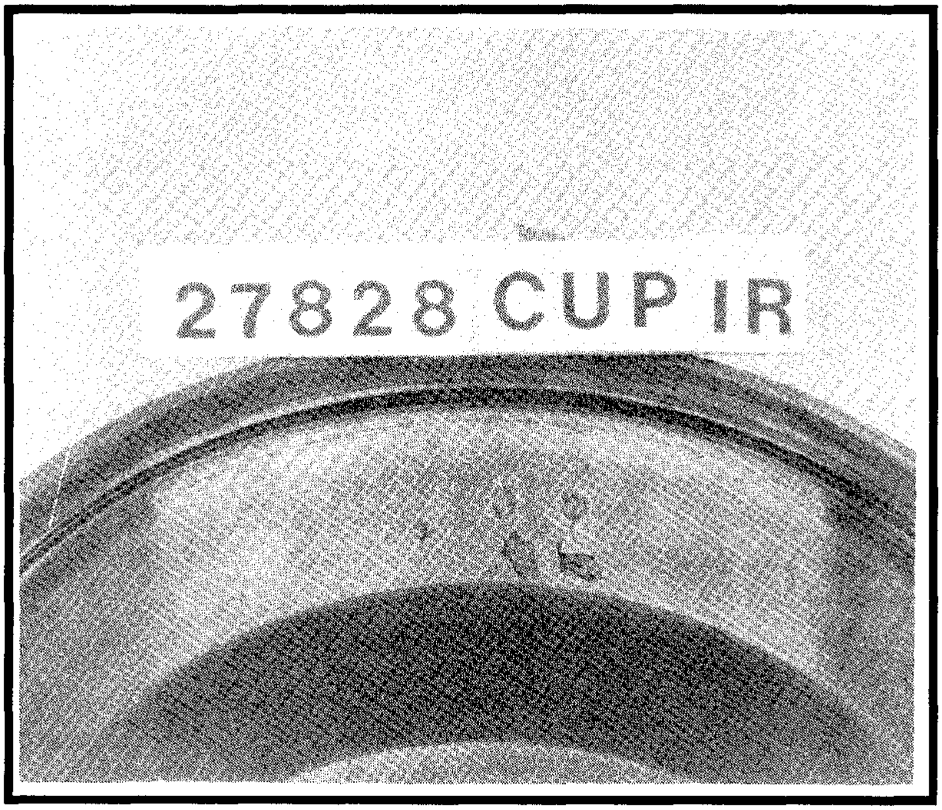


Figure 12. Pre-Test Condition of Inboard Cup Raceway -- Bearing B

Test bearings X and Y were modified by cutting one cage separator bar of the inboard cone to simulate a broken cage bar condition. The separator bar was placed between the two rollers when the bearing was assembled. Figure 13 shows the condition of one of the modified cones before on-track testing began.

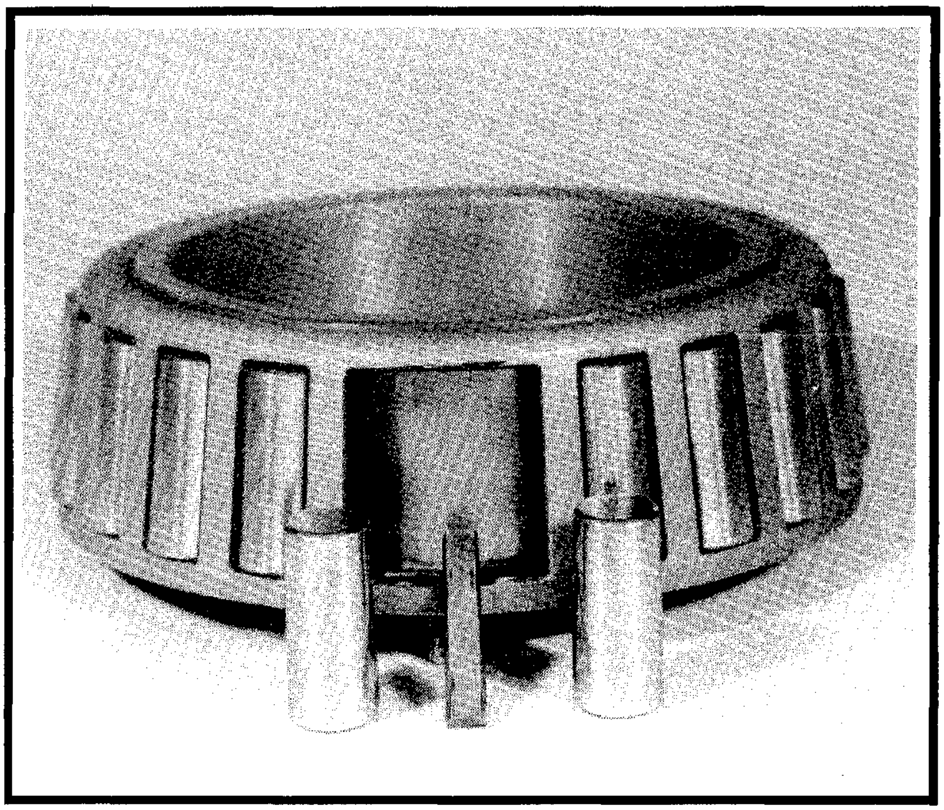


Figure 13. Broken Cage Simulation -- Bearing W and X

In addition to the 24 bearings described in Table 2, three bearings equipped with experimental low friction seals were included in the test. These were reconditioned bearings in nominal condition. The seals, provided by Ernst Manufacturing Incorporated, were included in the test to determine how well they would perform under simulated revenue service conditions, and if they would reduce the operating temperature of the bearing as measured by wayside HBD systems. These bearings were not considered as part of the RBFM I test matrix.

Before the bearings were applied, the journal diameter of each axle was measured using a snap gage. Table 3 summarizes the pre-test axle journal measurements.

Table 3. RBFM I Pre-Test Axle Journal Measurements

BEARING ID	OBWR (INCHES)	OBCS (INCHES)	IBCS (INCHES)	IBWR (INCHES)
A	6.1904	6.1870	6.0652	6.1904
B	6.1905	6.1893	6.1440	6.1902
C	6.1893	6.1893	6.1897	6.1895
D	6.1895	6.1894	6.1898	6.1897
E	6.1895	6.1895	6.1897	6.1898
F	6.1894	6.1894	6.1898	6.1899
G	6.1900	6.1901	6.1902	6.1903
H	6.1901	6.1901	6.1902	6.1902
I	6.1901	6.1901	6.1902	6.1903
J	6.1903	6.1902	6.1903	6.1903
K	6.1902	6.1902	6.1903	6.1904
L	6.1905	6.1904	6.1905	6.1905
M	6.1902	6.1902	6.1904	6.1905
N	6.1905	6.1904	6.1905	6.1905
O	6.1900	6.1900	6.1900	6.1901
P	6.1905	6.1905	6.1905	6.1905
Q	6.1905	6.1905	6.1905	6.1905
R	6.1908	6.1908	6.1907	6.1908
S	6.1905	6.1904	6.1904	6.1904
T	6.1900	6.1900	6.1900	6.1900
U	6.1915	6.1915	6.1915	6.1915
V	6.1914	6.1914	6.1915	6.1914
W	6.1905	6.1905	6.1905	6.1905
X	6.1905	6.1905	6.1905	6.1905

Note: OBWR - Outboard wear ring seat
OBCS - Outboard cone seat
IBCS - Inboard cone seat
IBWR - Inboard wear ring seat

Figure 14 shows the condition of the journal of the wheel set equipped with bearing A before on-track testing began; Figure 15 shows the condition for bearing B.

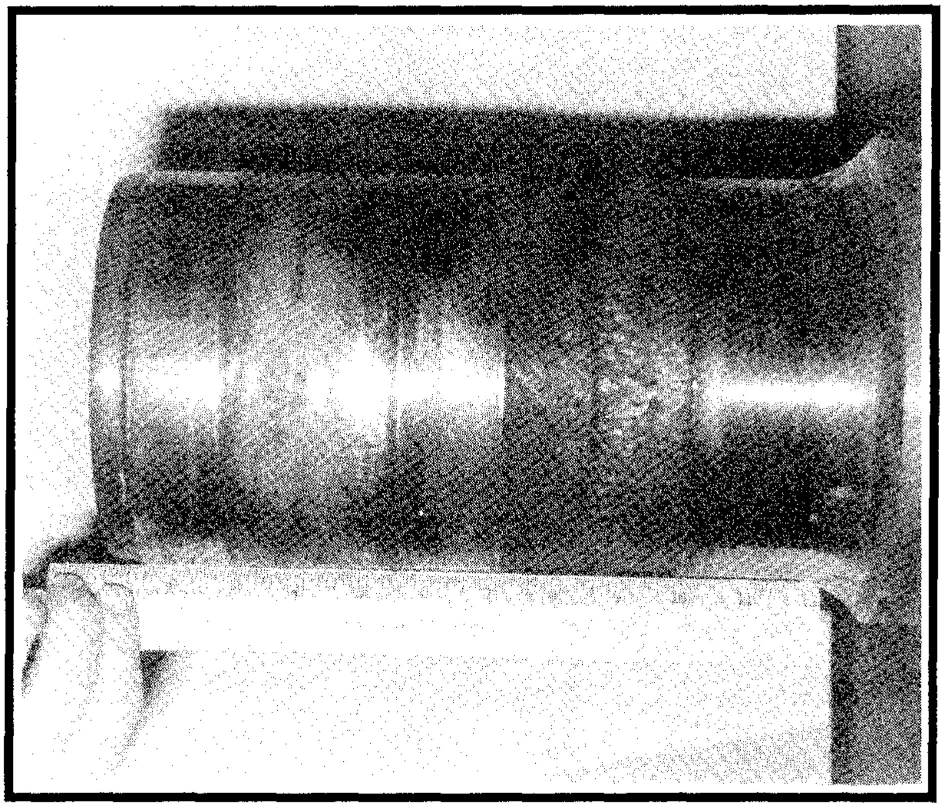


Figure 14. Pre-Test Axle Journal Condition -- Bearing A

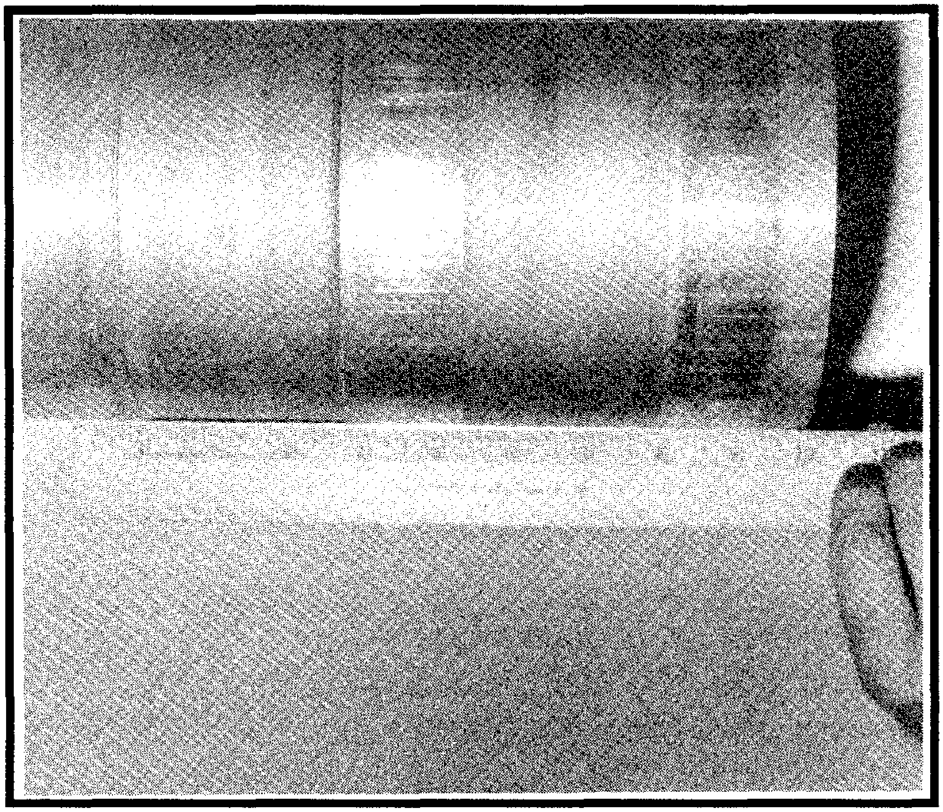


Figure 15. Pre-Test Axle Journal Condition -- Bearing B

3.1.1 Onboard Instrumentation

Two type K thermocouples were bonded to the surface of each bearing cup to monitor the operating temperature, as shown in Figure 16.

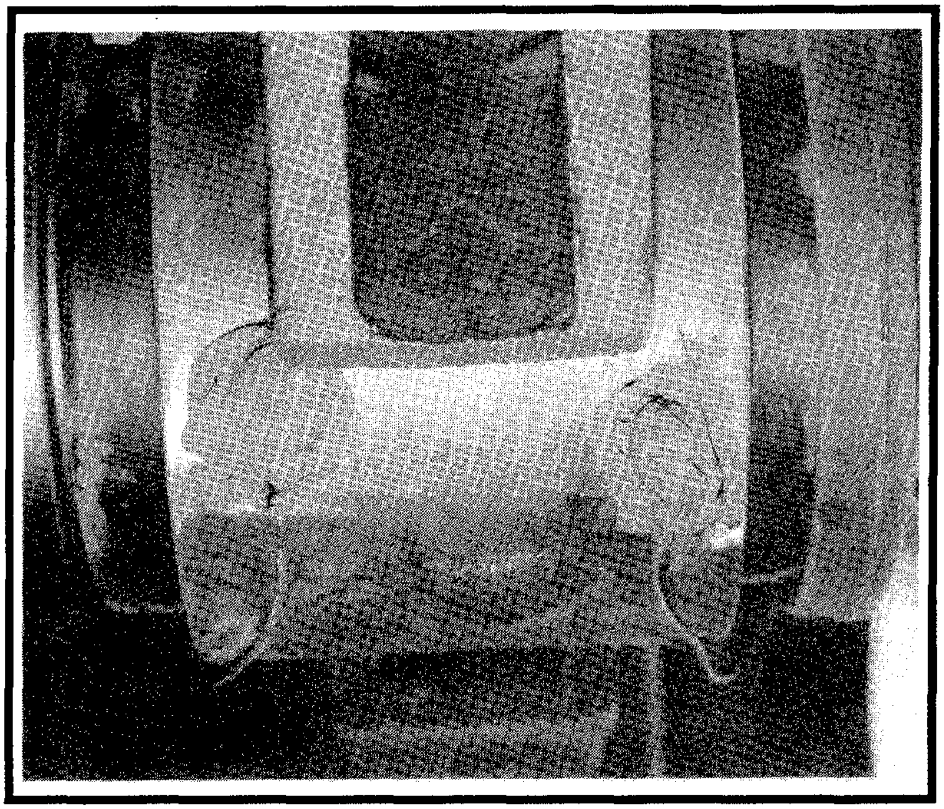


Figure 16. Typical Bearing Raceway Thermocouple Application

Each thermocouple signal was conditioned using individual electronic reference junctions and routed to an over-temperature alarm system installed on each car. The alarm system was provided by ENSCO and was used to alert the test controller if the operating temperature of any of the test bearings exceeded a preselected temperature threshold. The threshold temperature was set to 250°F. The thermocouple signal conditioning and the alarm system were housed in a junction box mounted on each of the test cars. Figure 17 shows a typical application of the onboard alarm system.

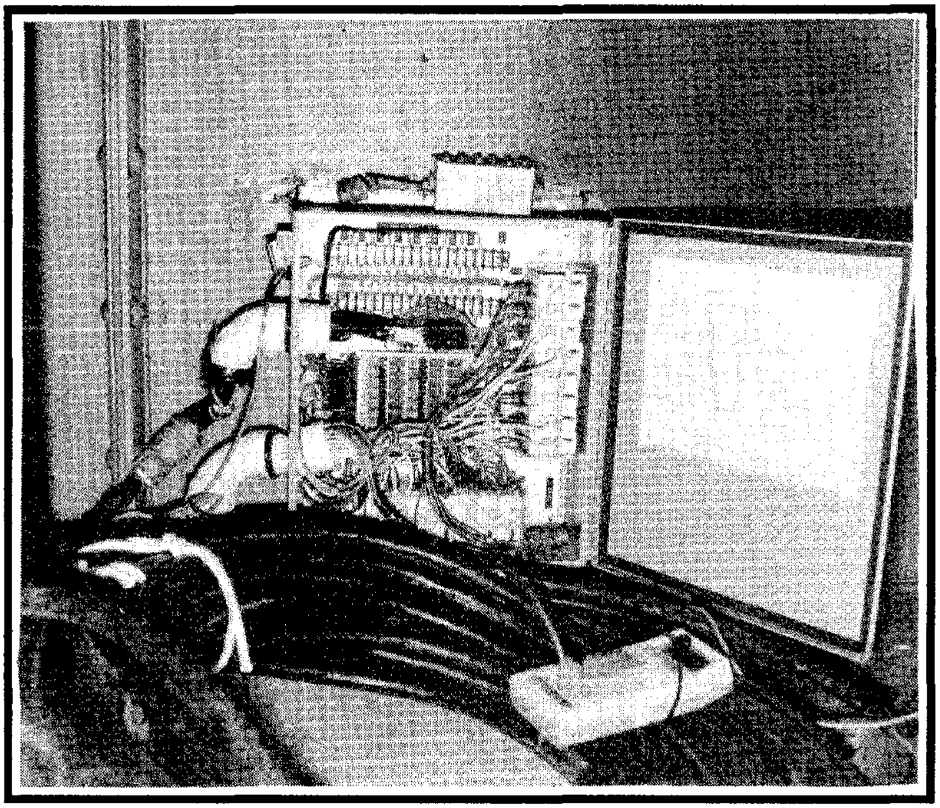


Figure 17. Typical Onboard Alarm System Application

Eight of the test bearings were equipped with special instrumentation, provided by ENSCO, to measure the movement or slip of the cone assemblies relative to the axle. The bearings equipped with the cone motion instrumentation were those expected to fail due to cone slippage and/or bearing seizure. A diagram of the cone slippage measurement system is given in Figure 18. For a more detailed description of the cone slippage measurement system please refer to the report entitled "Performance of Degraded Roller Bearings," report number DOT/FRA/ORD-90/12 prepared by ENSCO for the FRA.

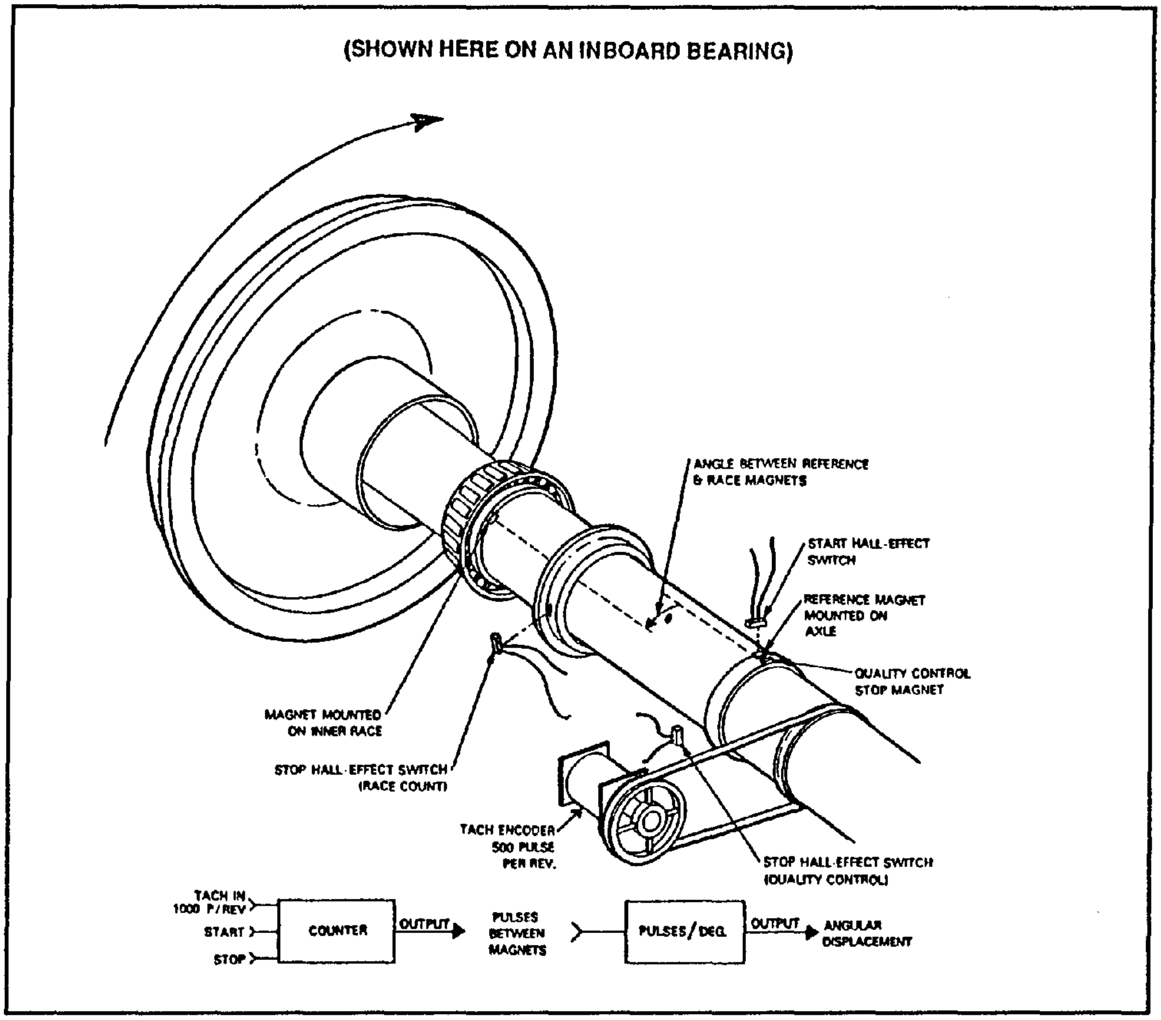


Figure 18. Cone Slippage Measurement System

Defects located on the rolling contact surfaces of a roller bearing create repetitive vibrations when the bearing rotates. Precise frequencies associated with defects located in specific bearing components can be calculated from a knowledge of the bearing geometry and rotational velocity. The equations required to calculate the bearing defect frequencies are provided below:

Cup Defect Frequency $$\left(\frac{N}{2}\right)\left(\frac{RPM}{60}\right)\left[1-\frac{Bd}{Pd}\text{COS}\,\phi\right]$$

Cone Defect Frequency $$\left(\frac{N}{2}\right)\left(\frac{RPM}{60}\right)\left[1+\frac{Bd}{Pd}\text{COS}\,\phi\right]$$

Roller Defect Frequency $$\left(\frac{1}{2}\right)\left(\frac{Pd}{Bd}\right)\left(\frac{RPM}{60}\right)\left[1-\left(\frac{Bd}{Pd}\right)^2\text{COS}^2\phi\right]$$

Where:

N = Number of rollers (balls)
RPM = Rotation rate
Pd = Mean roller pitch diameter
Bd = Mean roller (ball) diameter
φ = Contact Angle

Acceleration sensors were mounted on the bearing adapters of bearings A, B, W, and X during the test to monitor vibration. The output signal of each acceleration sensor was recorded on FM tape over a frequency ranging from direct current to 40 kHz. A vibration envelope detector and a spectrum analyzer were used to extract the bearing defect signatures and determine frequency content.

3.1.2 Wayside Instrumentation

The on-track tests were conducted on the Railroad Test Track (RTT) at the TTC. The RTT is a 14-mile loop capable of train speeds up to 125 mph. The RTT is also the site of the AAR's Wayside Detection Facility (WDF). Seven different types of wayside HBD systems are installed at the WDF, which is located in a tangent track section on the southeast side of the loop. During the on-track tests, data from four of the seven HBD systems were collected to monitor the operating temperature of the test bearings. Data from a prototype wayside HBD/ABD system, installed at the WDF specifically for the test by the SERVO Corporation of America, were also obtained. In addition, a standard HBD system provided by Harmon Electronics, Incorporated was installed in a tangent section of track on the northwest side of the RTT. Figure 19 diagrams the test tracks showing the location of the WDF and the additional Harmon HBD system.

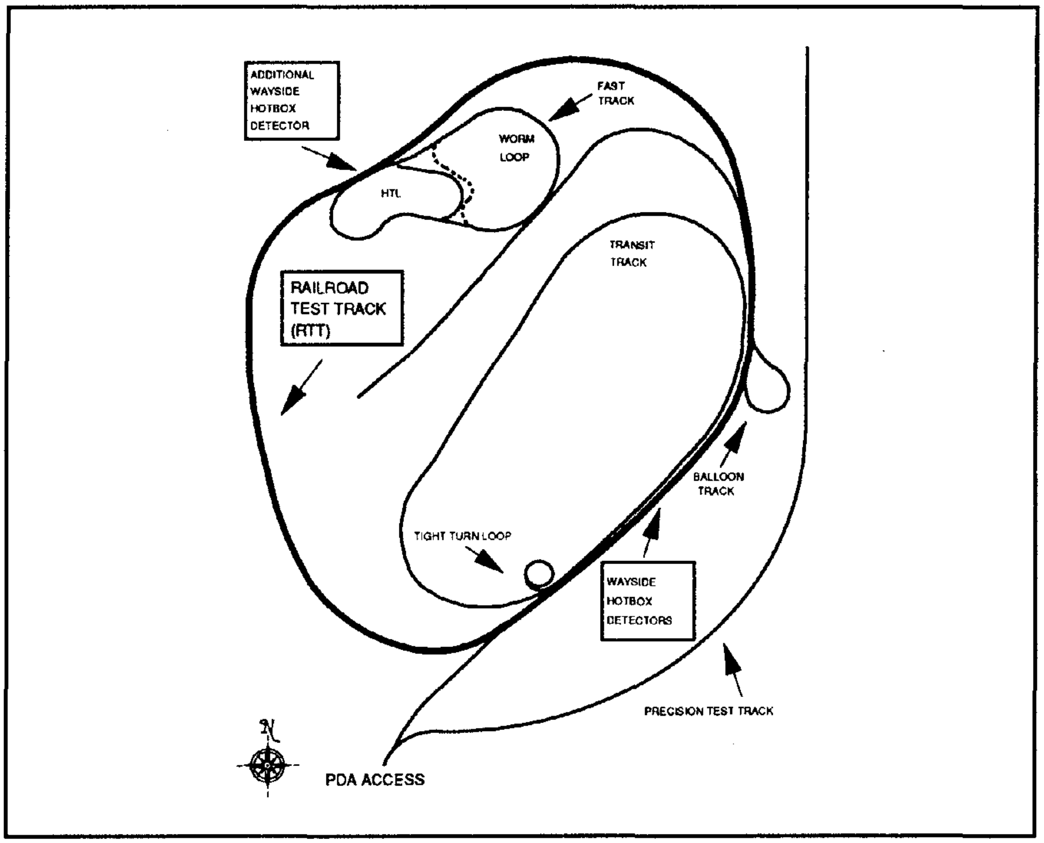


Figure 19. TTC Test Tracks and Wayside HBD Locations

3.1.3 Onboard Data Acquisition

The data acquisition scheme employed in the test included an IBM-AT personal computer (PC), used to record the cone slippage, train speed, and bearing operating temperatures measured at the outboard raceway and at the top of the cup between the raceways. An Omega thermocouple strip chart recorder also was used to record the bearing operating temperatures measured at the inboard raceway along with a Kyowa FM recorder to record bearing vertical acceleration. A schematic diagram of the data collection system is provided in Figure 20.

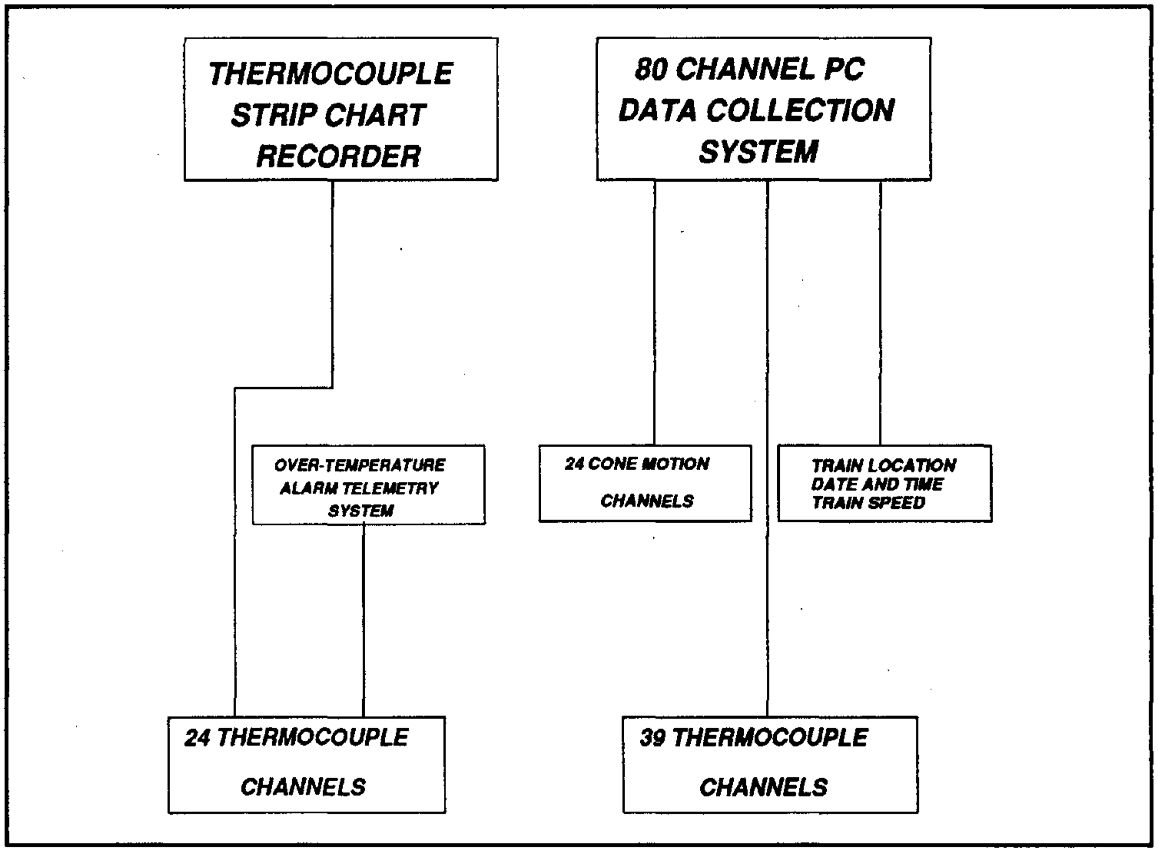


Figure 20. RBFM I Test Data Collection System

The PC and the Omega thermocouple strip chart recorder were provided by ENSCO.

3.1.4 Wayside Data Acquisition

Digital data were acquired at the WDF from five HBD systems using a Hewlett-Packard (HP) 9826 computer and AAR's general acquisition software. The digitized detector temperature data was reduced to peak temperature values using AAR's peak detector software. Figure 21 shows the WDF data collection system.

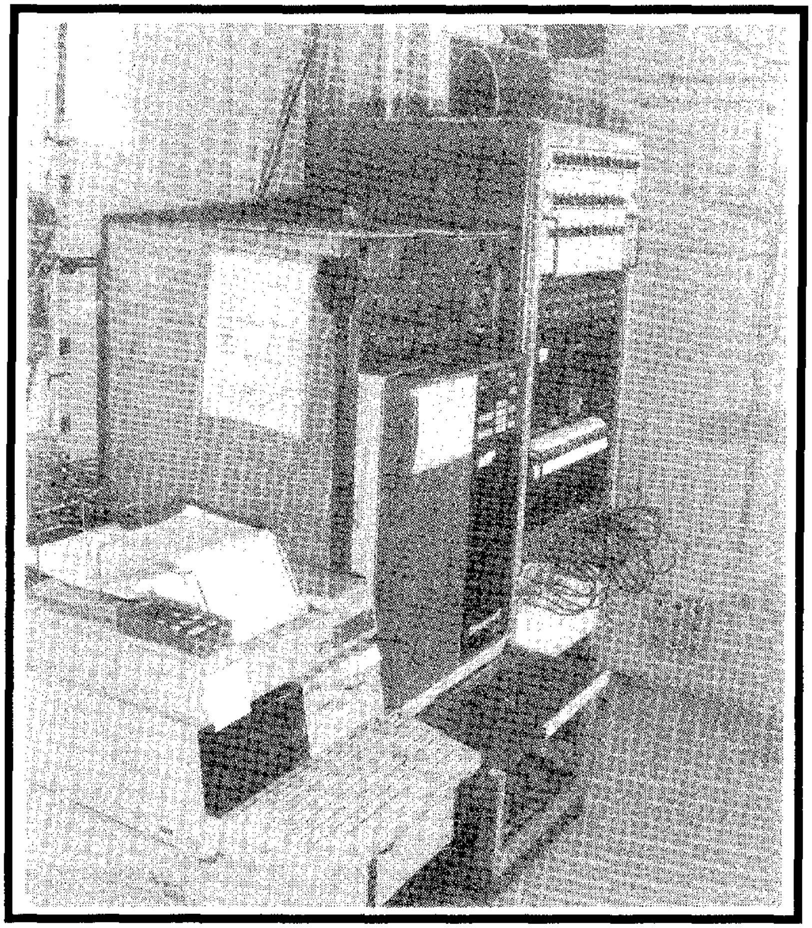


Figure 21. RBFM I Test Wayside Data Collection System

3.1.5 Test Consist

The test axles were installed under four fully loaded 100-ton capacity open top hopper cars. The cars, with one locomotive and an instrument/data acquisition car were operated as a consist for 5,016 miles on the RTT. A diagram showing the test consist, the location of the test bearings, the experimental seals, and the instrumentation is provided in Figure 22.

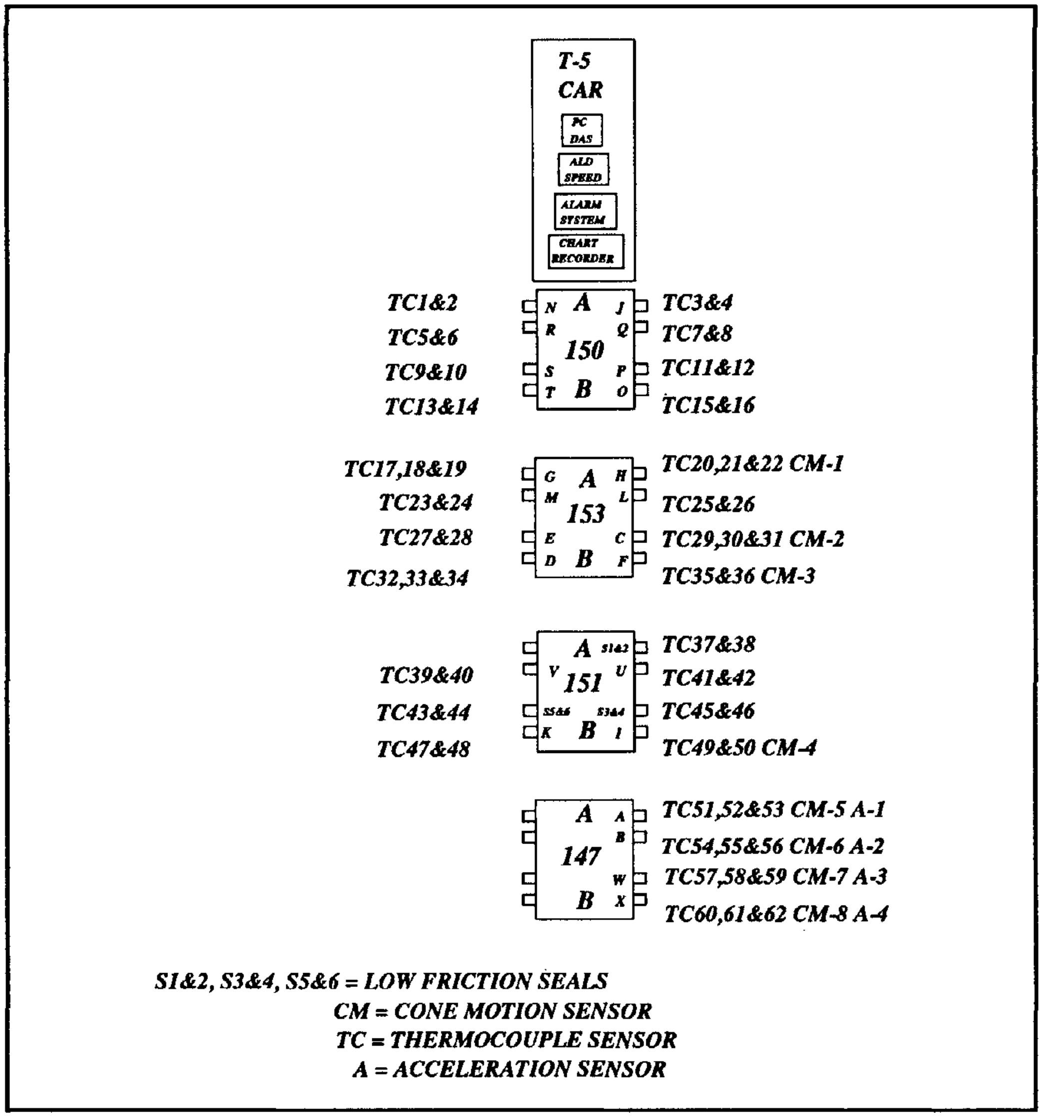


Figure 22. RBFM I Test Consist

The wheel sets equipped with bearings A and B were removed from car 147 and replaced with standard wheel sets after the behavior of the bearings was documented.

Car 147 was emptied after completing the 5,000 mile test, and the wheel set equipped with bearing A was re-installed so that additional tests could be conducted to document the performance of bearing A under empty car conditions. The test consist was operated for an additional 320 miles with car 147 in the empty condition. Car 147 was then loaded to a rail weight of 263,000 pounds and the test consist was operated for an additional 500 miles on the RTT bringing the total test mileage to 5,820.

3.2 WHEEL ANOMALY TEST

Wheels having slid flats were used to evaluate the effects of short wavelength anomalies (1 to 3 inch). The effects of intermediate wavelength anomalies (3 to 5 inch) were investigated using wheels with tread spalls, and out of round wheels were used to determine the effects of long wavelength anomalies (5 to 15 inch). Both 33- and 36-inch diameter wheels were evaluated in the test. The wheel sets used in the test were provided to the AAR by the CSX and UP Railroads.

Before testing began, the circumferential profile of each wheel was documented using a longitudinal wheel profilometer manufactured by Salient Systems. The profilometer system uses a special shoe to measure the radial runout as a function of angular position of both wheels of a wheel set simultaneously.

The AAR's Chicago Technical Center (CTC) provided an instrumented 70-ton capacity box car to evaluate the 33-inch diameter wheel sets. The 36-inch diameter wheel sets were evaluated using a loaded 100-ton capacity open top hopper car. To limit the influence of defect types upon each other, only one defected wheel set, installed in the leading axle position of the leading truck, was tested at a time. The cars were operated with one locomotive and an instrument/data acquisition car over a section of track having wooden ties and cut spike fasteners on the Transit Test Track (TTT) and over a section of track having concrete ties and elastic fasteners on the High Tonnage Loop (HTL) at the Facility for Accelerated Service Testing (FAST). A diagram of the Wheel Anomaly Test consist is provided in Figure 23.

Figure 23. Wheel Anomaly Test Consist

3.2.1 Onboard Instrumentation

The A-end of the 70-ton capacity car was equipped with instrumentation as summarized in Table 4.

Table 4. Instrumentation Summary for the A-end of 70-Ton Capacity Car

PARAMETER	LOCATION	QUANTITY
Vertical Load	Bearing Adapter	4
Vertical Load	Center Plate	1
Vertical Load	Truck Bolster	1
Vertical Load	Truck Side Bearing	2
Lateral Load	Truck Side Frame	1
Vertical Acceleration	Bearing Adapter	4
Vertical Acceleration	Car Center Sill	1
Lateral Acceleration	Truck Bolster	1
Lateral Acceleration	Car Center Sill	1
Vertical Displacement	Bolster to Side Frame	1

Table 5 summarizes the instrumentation used for the B-end of the 70-ton capacity car, and Table 6 summarizes the instrumentation used for the B-end of the 100 ton-capacity car.

Table 5. Instrumentation Summary for the B-end of 70-Ton Capacity Car

PARAMETER	LOCATION	QUANTITY
Vertical Acceleration	Car Center Sill	1
Lateral Acceleration	Car Center Sill	1

Table 6. Instrumentation Summary for the B-end of the 100-ton Capacity Car

PARAMETER	LOCATION	QUANTITY
Vertical Load	Bearing Adapter	2
Vertical Acceleration	Bearing Adapter	2
Vertical Acceleration	Car Center Sill	1

The A-end of the 100-ton capacity car was equipped with one acceleration sensor to measure vertical acceleration at the car center sill.

3.2.2 Wayside Instrumentation

Weldable strain gages, configured in full bridge shear circuits, were installed on the web of the rails of the TTT at 10 locations or cribs to measure vertical force at the wheel/rail interface. The wooden ties in the instrumented section of track were spaced at 22 inches.

3.2.3 Onboard Data Acquisition

The onboard data acquisition system included a HP model 9826 desk top computer and a HP model 6944 high speed multiprogrammer to record the train speed, acceleration, load, and displacement data at a sample rate of 1,024 samples/second.

3.2.4 Wayside Data Acquisition

The wayside data acquisition system included a HP model 9826 desk top computer and a HP model 6944 high speed multiprogrammer to record the wheel/rail vertical force data at a sample rate of 2,048 samples/second.

3.3 RBFM II TEST

Twenty roller bearings that survived the 5,000 mile test and the bearings equipped with the low friction seals were operated on the HTL as part of the FAST Heavy Axle Load (HAL) consist. Table 7 summarizes the bearings used in this test.

Table 7. RBFM II Test Bearing Summary

BEARING ID	MFGR	DATE	SERIAL NUMBER	FIT (INCHES)	CLAMP (tons)	LATERAL (inches)
C	Timken	12-80	471222	Zero	10	0.009
D	Brenco	07-88	61113	Zero	10	0.018
E	Timken	09-81	197605	Zero	30	0.010
F	Brenco	07-88	61087	Zero	30	0.011
G	Timken	09-73	55529	0.00075	Zero	0.011
H	Brenco	07-88	61089	0.00075	Zero	0.015
I	Timken	03-77	418299	0.00075	10	0.010
J	Brenco	07-88	61062	0.00075	10	0.014
K	Timken	04-74	50066	0.00075	30	0.007
L	Timken	08-80	438393	0.0015	Zero	0.006
M	Brenco	07-88	61069	0.0015	Zero	0.008
N	Timken	01-73	303796	0.0015	10	0.009
O	Brenco	07-88	61078	0.0020	10	0.010
P	Timken	01-67	66180	0.0015	30	0.008
Q	Brenco	07-88	61094	0.0015	30	0.009
R	Brenco	07-88	61092	0.0015	30	0.011
S	Timken	01-87	1697	0.0015	30	0.008
T	Brenco	07-88	61093	0.0020	30	0.006
U	Timken	08-80	443064	0.0045	Zero	Zero
V	Brenco	07-88	61104	0.0045	Zero	Zero

The wheel sets equipped with bearings L, M, U and V, and the low friction seals were remove from cars 151 and 147 and installed under two loaded 100-ton capacity cars (137 and 165) being used in the HAL program. The remaining wheel sets were operated under two of the loaded 100-ton capacity open top hopper cars (150 and 153) used in the 5,000 mile test on the RTT. Figure 24 is a diagram of the RBFM II test consist showing the position of the test bearings and seals.

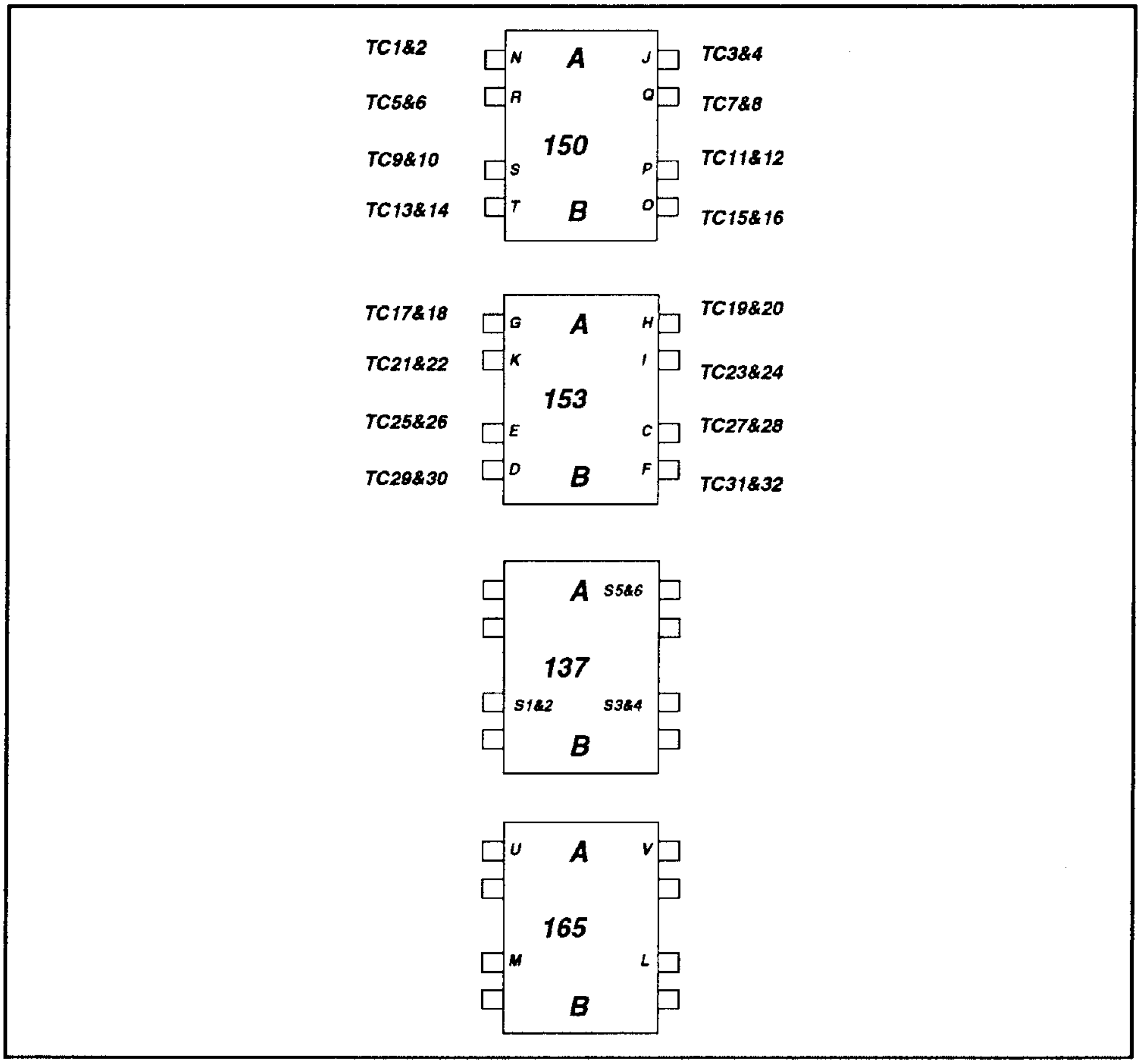


Figure 24. RBFM II Test Consist

3.3.1 Onboard Instrumentation

The bearings operated under car 150 and 153 were considered as having a high risk of failure; therefore, they were equipped with two type K thermocouples so that the operating temperature could be documented in the event of failure. The thermocouples were bonded to the bottom of the cup over each raceway. Hot bearing detector bolts provided by RASTECH Incorporated and the 3M Company were installed in the end cap of each bearing to provide a visual indicator in the event of overheating.

Bearings L, M, U, and V and those equipped with the low friction seals were considered as having a low risk of failure; therefore, they were equipped with the detector bolts only.

3.3.2 Wayside Instrumentation

Three HBD systems were used in the RBFM II tests. The HTL was already equipped with an inboard scanner HBD system located in Section 22. The prototype HBD/ABD system provided by the Servo Corporation of America was moved from the WDF and installed in Section 5 of the HTL. The HBD system provided by Harmon Electronics Incorporated was moved from the RTT and installed in Section 22 of the HTL. The scanner heads of this detector were modified to an outboard application. Figure 25 is a diagram showing the HTL and the location of the HBD systems.

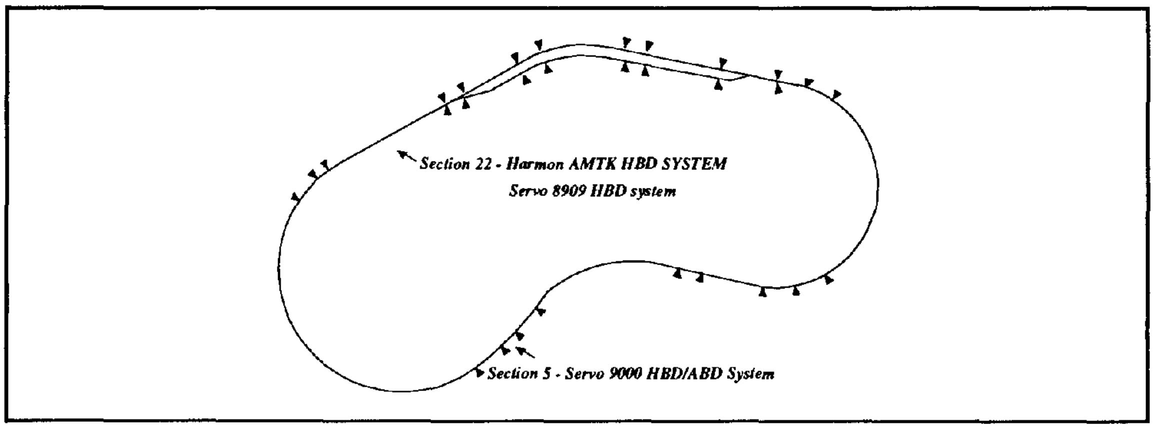


Figure 25. RBFM II Test Wayside Instrumentation Application on HTL

3.3.3 Onboard Data Acquisition

A datalogger, mounted on Car 150, was used to collect operating temperature data from each of the thermocouples on the test bearings.

3.3.4 Wayside Data Acquisition

Wayside data acquisition was limited to the standard strip chart recorders provided with the HBD systems.

3.4 CONE BORE GROWTH (CBG) TEST

Sixteen AP Class G (7 X 12) bearings with the axle journal/bearing cone interference fit and grease content combinations detailed in Table 8 were evaluated in the test. The new bearings were provided by Brenco.

Table 8. CBG Test Bearing Summary

BEARING ID	DATE	SERIAL NUMBER	FIT (inches)	GREASE (ounces)	*LATERAL (inches)
1A	12-80	11614	0.0025	32	0.009
1B	09-81	11838	0.0025	24	0.010
2A	07-88	11845	0.0025	32	0.011
2B	07-88	11586	0.0025	24	0.018
3A	07-88	11587	0.0025	32	0.009
3B	07-88	11850	0.0025	24	0.011
4A	07-88	11843	0.0025	32	0.010
4B	07-88	11872	0.0025	24	0.006
5A	08-80	11588	0.0050	32	0.006
5B	07-88	11869	0.0050	24	0.008
6A	01-87	11865	0.0050	32	0.008
6B	01-87	11866	0.0050	24	0.008
7A	07-88	11628	0.0050	32	0.014
7B	01-73	11585	0.0050	24	0.009
8A	07-88	11599	0.0050	32	0.015
8B	09-73	11605	0.0050	24	0.011

* Mounted lateral

Before starting the experiment, the journals of the test axles were measured at the outboard and inboard cone seats (OBCS and IBCS) by AAR personnel. A summary of the axle journal measurements is provided in Table 9.

Table 9. CBG Pre-Test Axle Journal Measurement Summary

BEARING ID	OBCS (inches)	IBCS (inches)
1A	7.0038	7.0041
1B	7.0035	7.0036
2A	7.0036	7.0040
2B	7.0038	7.0041
3A	7.0036	7.0037
3B	7.0033	7.0036
4A	7.0034	7.0037
4B	7.0037	7.0038
5A	7.0028	7.0028
5B	7.0028	7.0028
6A	7.0028	7.0029
6B	7.0028	7.0028
7A	7.0029	7.0032
7B	7.0028	7.0028
8A	7.0026	7.0028
8B	7.0028	7.0028

The test axle journal measurements and the desired interference fit were provided to Brenco by the AAR. The cone bore diameters were machined to the desired size by Brenco personnel and measured using Brenco's coordinate measurement machine before shipment to the TTC. A summary of the pre-test cone diameter measurements is provided in Table 10.

Table 10. CBG Pre-Test Cone Diameter Measurements

BEARING ID	OBC (inches)	IBC (inches)
1A	7.00160	7.00160
1B	7.00100	7.00110
2A	7.00110	7.00130
2B	7.00140	7.00150
3A	7.00110	7.00110
3B	7.00080	7.00090
4A	7.00140	7.00130
4B	7.00120	7.00120
5A	6.99785	6.99780
5B	6.99780	6.99790
6A	6.99780	6.99790
6B	6.99770	6.99790
7A	6.99800	6.99983
7B	6.99780	6.99800
8A	6.99760	6.99785
8B	6.99795	6.99790

The wheel sets were installed under two loaded 125-ton capacity open top hopper cars (Cars 306 and 309) and the cars were operated as part of the FAST/ HAL consist on the HTL. The bearings completed 7,000 miles of operation during the test.

At the completion of the on-track test, the bearings were removed from the axles, disassembled, and cleaned. The bearings were inspected for defects and then returned to Brenco for post test measurement of the cone bore diameters. The axle journals were measured by AAR personnel.

3.4.1 Onboard Instrumentation

Each bearing was equipped with two type K thermocouples. The thermocouples were bonded to the bottom of the cup over each raceway.

Hot bearing detector bolts provided by RASTECH and the 3M Company were installed in the end cap of each bearing to provide a visual indicator in the event of an over-temperature event.

3.4.2 Wayside Instrumentation

The wayside instrumentation for the experiment was the same as described in Section 3.3.2 of this report.

3.4.3 Onboard Data Acquisition

A datalogger, mounted on Car 306 was used to collect operating temperature data from each of the thermocouples on the test bearings.

3.4.4 Wayside Data Acquisition

Wayside data acquisition was limited to the standard strip chart recorders provided with the HBD systems.

3.5 RACEWAY DEFECT GROWTH RATE (RDGR) TEST

Four AP Class F (6 1/2 X 12) bearings and four AP Class E (6 X 11) bearings were evaluated in the RDGR test. The bearings and wheel sets were provided to the AAR by the BN railroad.

Before starting on-track tests, the roller bearings were removed from the axles, disassembled, and cleaned. The number, type, and size of raceway defects were documented for each test bearing. After inspection the bearings were reassembled and mounted on the axles.

The wheel sets were installed under loaded 100-ton and 70-ton capacity cars, and the cars were operated as part of the HAL consist on the HTL. The AP Class F bearings accumulated 19,000 miles of operation, while the AP Class E bearings only accumulated 4,075 miles. The 70-ton capacity cars were donated by a railroad late in the program and as a result low mileage was recorder on the AP Class E bearings.

At the end of on-track testing, the bearings were removed from the axles, disassembled, and cleaned. The number, type, and size of raceway defects were documented for each test bearing.

3.5.1 Onboard Instrumentation

Hot bearing detector bolts provided by RASTECH and 3M were installed in the end cap of each bearing to provide a visual indicator in the event of an over-temperature event.

3.5.2 Wayside Instrumentation

The wayside instrumentation for the experiment was the same as described in Section 3.3.2 of this report.

3.5.3 Onboard Data Acquisition

Onboard data acquisition was not provided.

3.5.4 Wayside Data Acquisition

Wayside data acquisition was limited to the standard strip chart recorders provided with the HBD systems.

4.0 TEST RESULTS

The results obtained in each of the experiments will be presented in the following subsections.

4.1 RBFM I TEST

The following summary of the results obtained in the RBFM I test was extracted from the report entitled "Performance of Degraded Roller Bearings," report number DOT/FRA/ORD-90/12 prepared by ENSCO for the FRA. For additional information, please refer to the ENSCO report.

THERMAL PERFORMANCE

Examples of bearing thermal performance data for selected bearings are provided below. The plots are displayed as temperatures above ambient in °F vs. sample number. **Sample number indicates cumulative test time at a sample rate of one sample every five seconds.** Examples of nominal bearing performance and bearing failure, axle differentials (left side vs. right side of same axle), cup raceway differentials (inboard raceway vs. outboard raceway of same cup), bearing heating in curved track vs. tangent track operation, operating temperature variation with measurement location (top of cup vs. bottom of cup) are discussed.

NOMINAL OPERATING TEMPERATURE RANGES

The operating temperatures for each of the bearings for the entire 5,000-mile test are plotted together in Figure 26. The cyclic pattern evident in the data is typical of heating and cooling of the bearing at the beginning and end of the test day. The range of operating temperatures for the entire test for all normal -- no thermal runaway -- operating bearings ranged between 65 F° and 140 F° (18 C° and 60 C°) above ambient during operation at 70 mph under loaded car conditions.

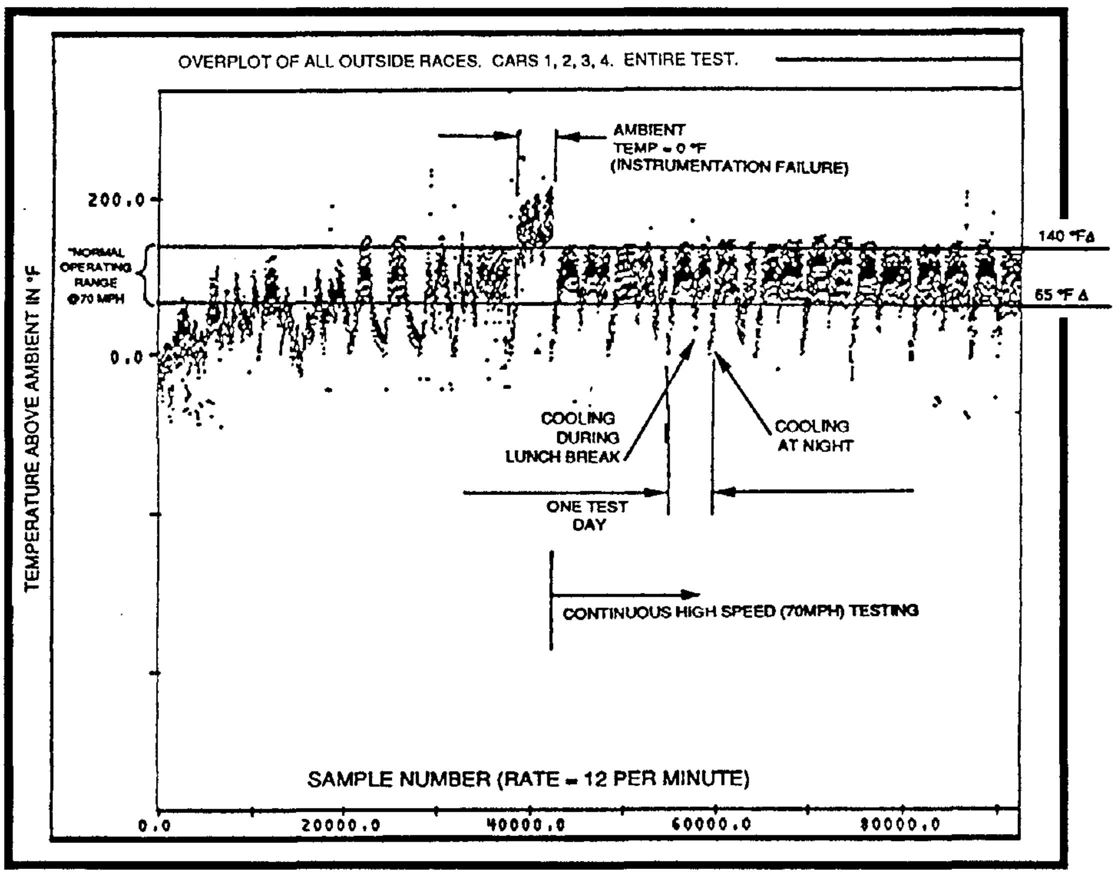


Figure 26. Operating Temperatures for Normal Bearings

LEFT SIDE VS. RIGHT SIDE OF SAME AXLE

Plots of the difference in temperature between right and left side outboard cup races of bearings mounted on the same axle are shown for bearings J and N in Figure 27 and bearings R and Q in Figure 28. The daily cyclic pattern evident in these plots is caused by the difference between temperatures for the bearing operating on the outside rail of the RTT loop (high rail) and the bearing operating on the inside rail of the RTT loop (low rail). The mean of the cyclic pattern is indicative of the nominal difference between the left-side and right-side bearings under these test conditions.

During testing from March 28 through May 1989 test speeds ran at nearly 70 mph continuously. For these days the results for both of these axles indicate a marked difference of 15 F° to 20 F° between high rail and low rail operation (half-peak to peak of cycle). The average temperature difference for bearings appears to be approximately -4 F° or -5 F°, indicating the left side bearing is running nominally 4 F° or 5 F° warmer than the right. The corresponding average for bearings appears to be nearer to -8 F° to -10 F°, indicating the left side bearing to be running 8 F° to 10 F° warmer than the right side.

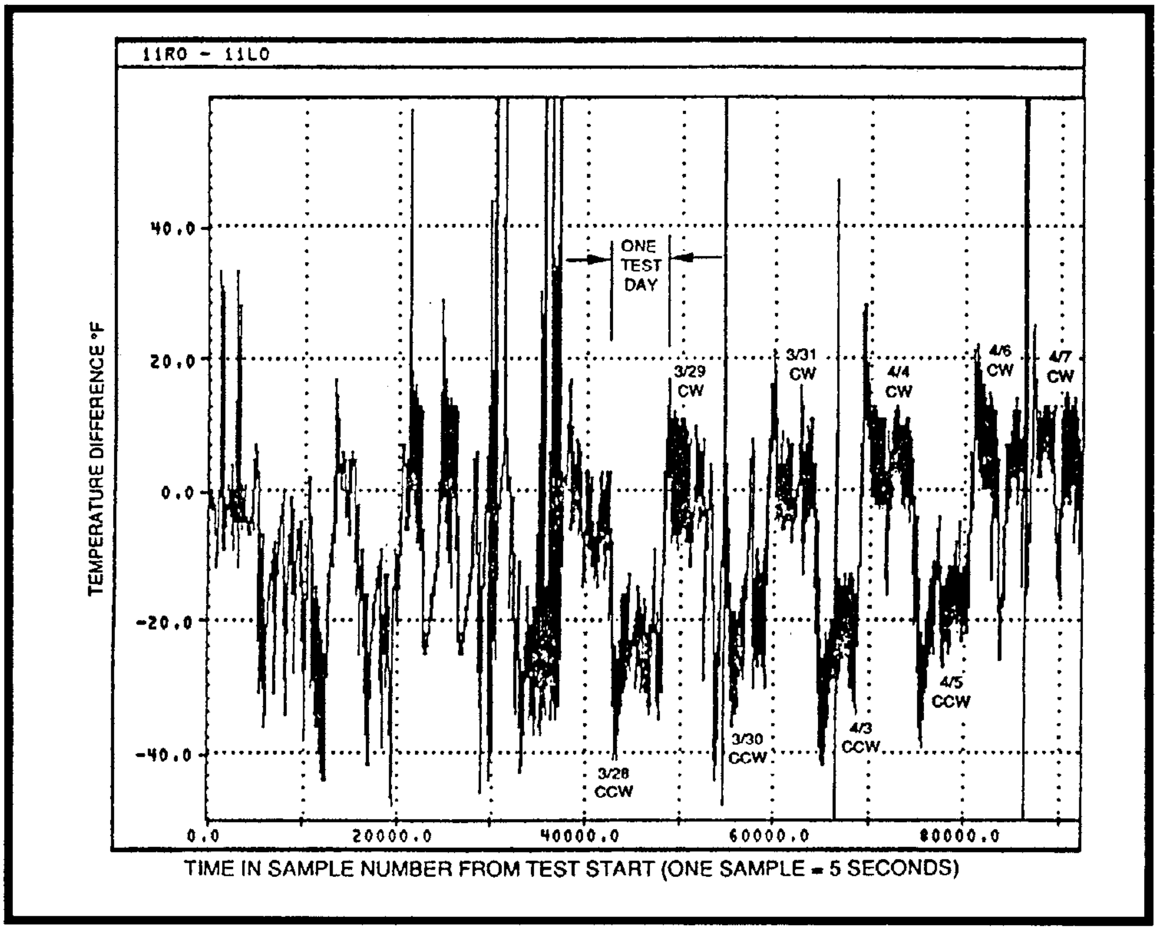


Figure 27. Temperature Difference -- Bearings N and J

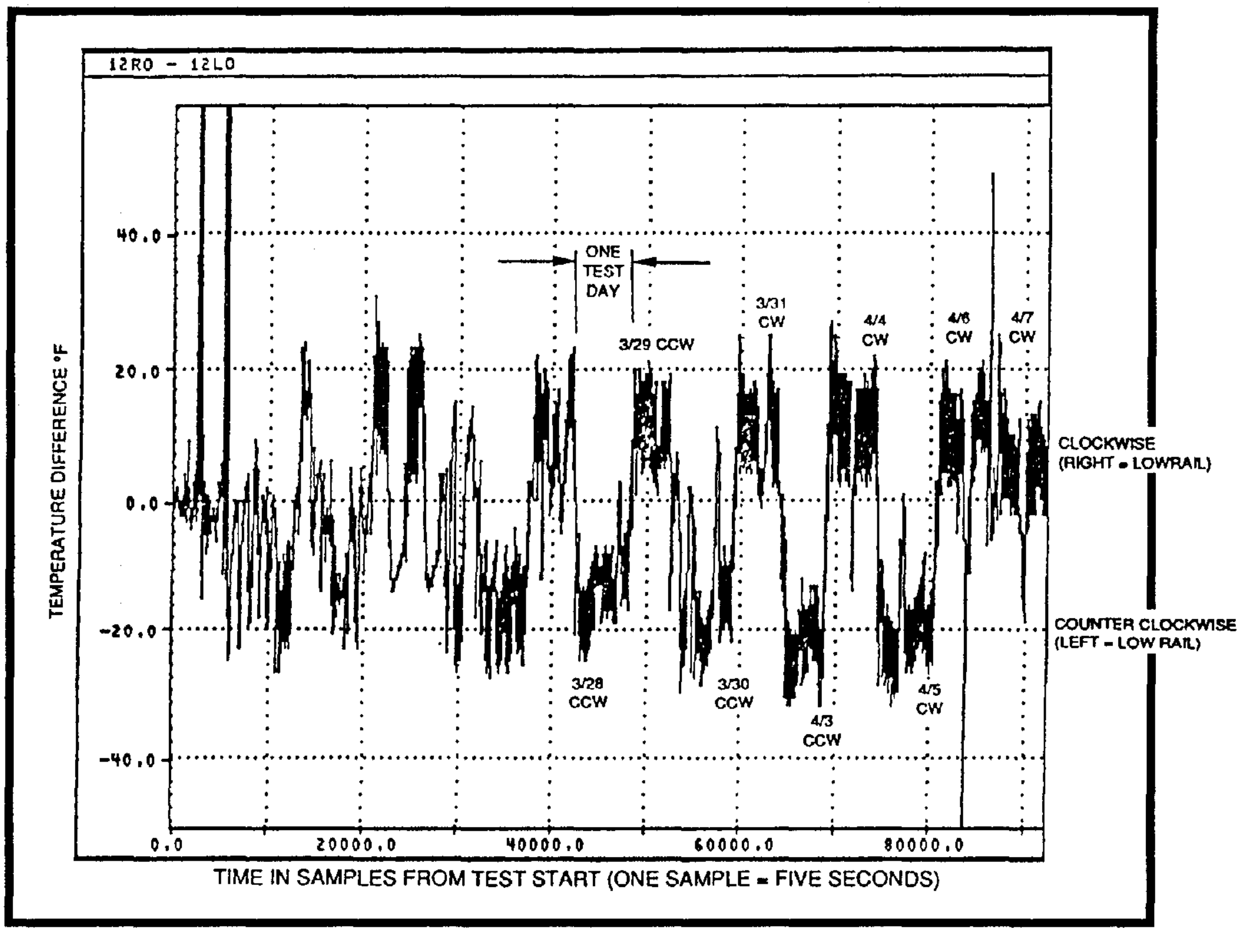


Figure 28. Temperature Difference -- Bearings R and Q

INBOARD RACEWAY VS. OUTBOARD RACEWAY FOR SAME BEARING

During the test, it was observed that on some occasions, when onboard bearing alarms sounded due to heating just over the alarm threshold, the wayside detector's alarm did not sound. Further investigation showed that significant temperature differences could exist between the inboard and outboard bearing cups on a single bearing.

For test bearing B, the outboard raceway temperature was approximately 50 F° higher than the inboard raceway during operation on March 15. This result was observed on other bearings, though not on all, indicating that significant thermal gradients can exist across one bearing. Figure 29 shows a time history of the temperatures above ambient for the inboard and outboard races and the difference between the two raceways of bearing B.

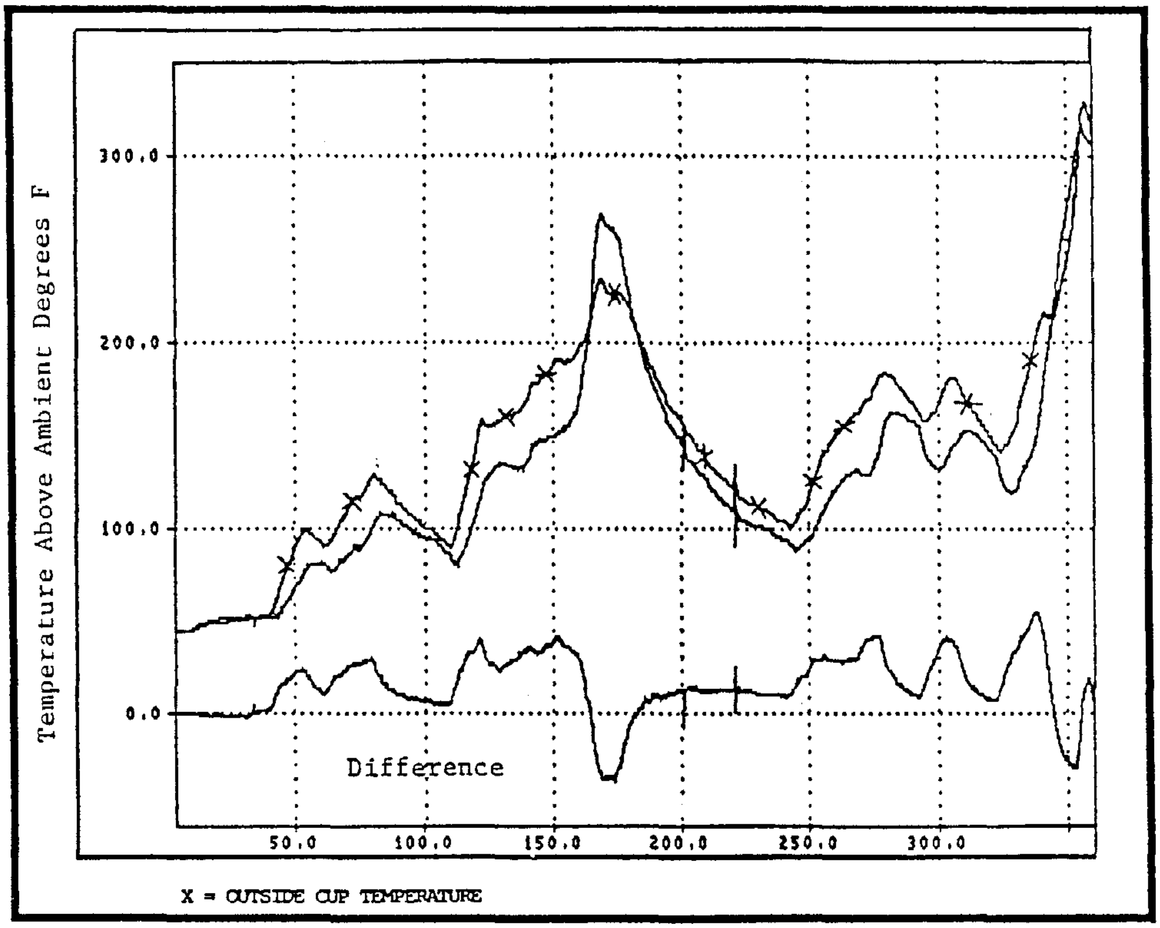


Figure 29. Raceway Temperature Gradient -- Bearing B

CURVED TRACK VS. TANGENT TRACK OPERATION

The variation in bearing temperature during one lap of the RTT is shown in Figure 30. The figure illustrates the effect negotiating curved track has on the operating temperature of tapered roller bearings. During curve negotiation, the inner and outer race of bearing M heats up by as much as 10 F° during one lap.

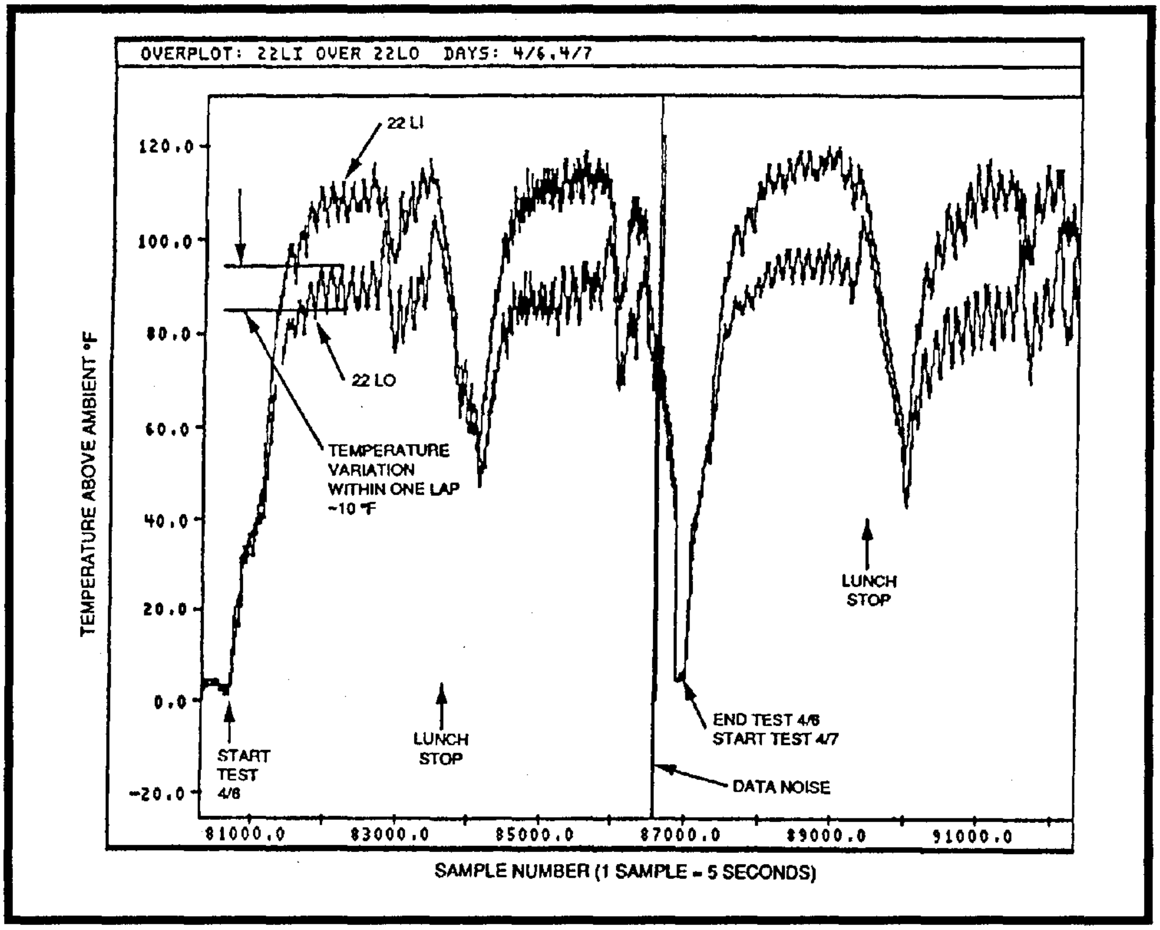


Figure 30. Temperature Variation with Track Curvature -- Bearing M

TOP OF CUP VS. SIDE OF CUP TEMPERATURE VARIATIONS ON SAME BEARING

Temperatures were measured on the top of the bearing between the bearing adapter and the bearing cup on six bearings. The temperature measurements from the top of cup location were approximately 10 F° higher than temperature measurements obtained from the side of the same cup. These data are significant in that wayside HBD systems determine bearing temperature by intercepting radiation from the bottom and side of the bearing cup whereas the heat in an overheating bearing is primarily generated in the load zone at the top of the cup. Figure 31 shows both top of cup and side of cup temperature measurements for bearing B during an overheating episode where the temperature difference is approximately 120 F°.

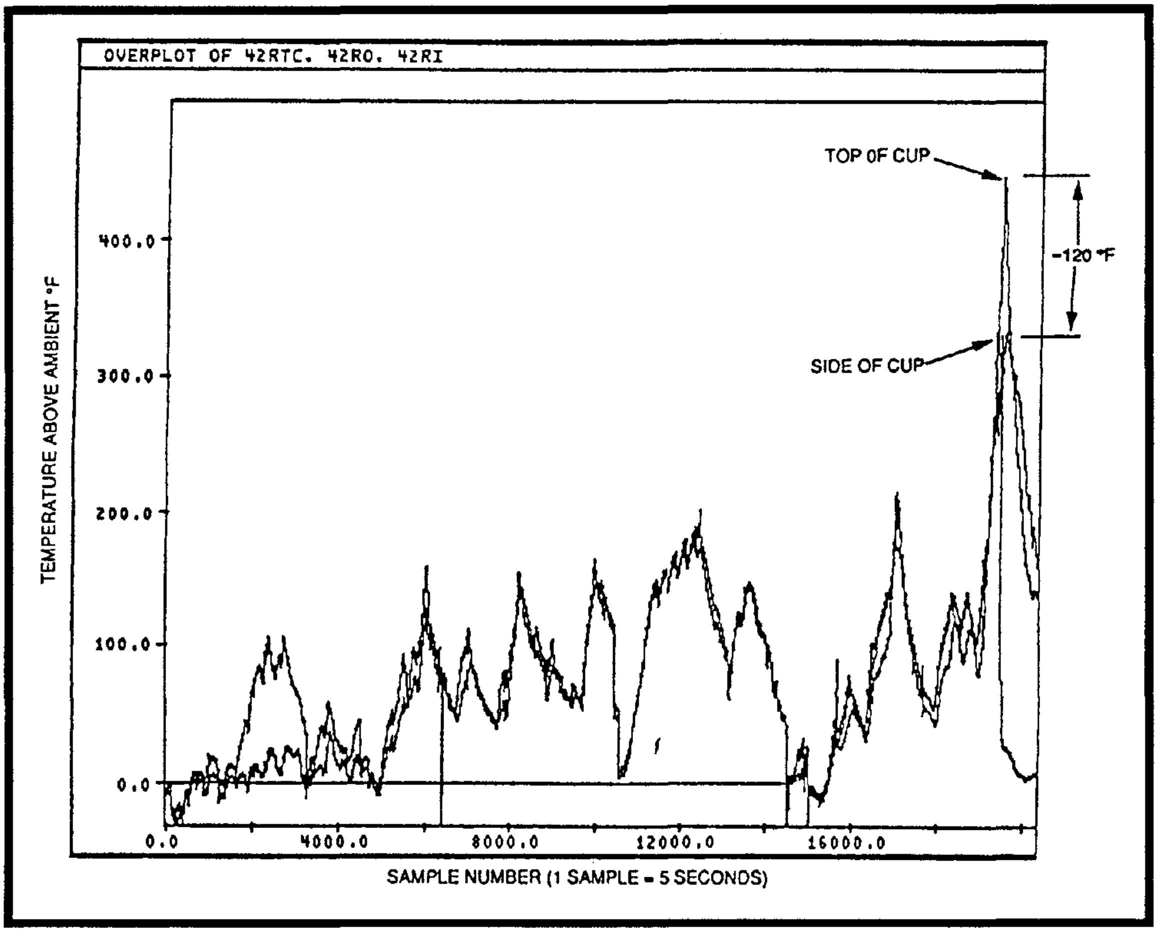


Figure 31. Top to Side Temperature Gradient -- Bearing B

SEAL TEMPERATURES

The data collected from the experimental seals showed that the temperature was nominally 50°F to 70°F above ambient temperature at operating speeds of 70 mph under loaded car conditions. This is significantly lower than the average 100°F to 110°F above ambient temperature measured on the cups of the other test bearings.

During the third day of testing, the operating temperature of one of the low friction seals rose to approximately 130 F° after approximately 30 miles of operation. Inspection of the bearing revealed that the outboard seal dust guard located in the bearing end cap was in rubbing contact with the seal case resulting in a high friction interface which caused the elevated operating temperature and some minor damage to the seal dust guard. Figure 32 shows the damaged dust guard.

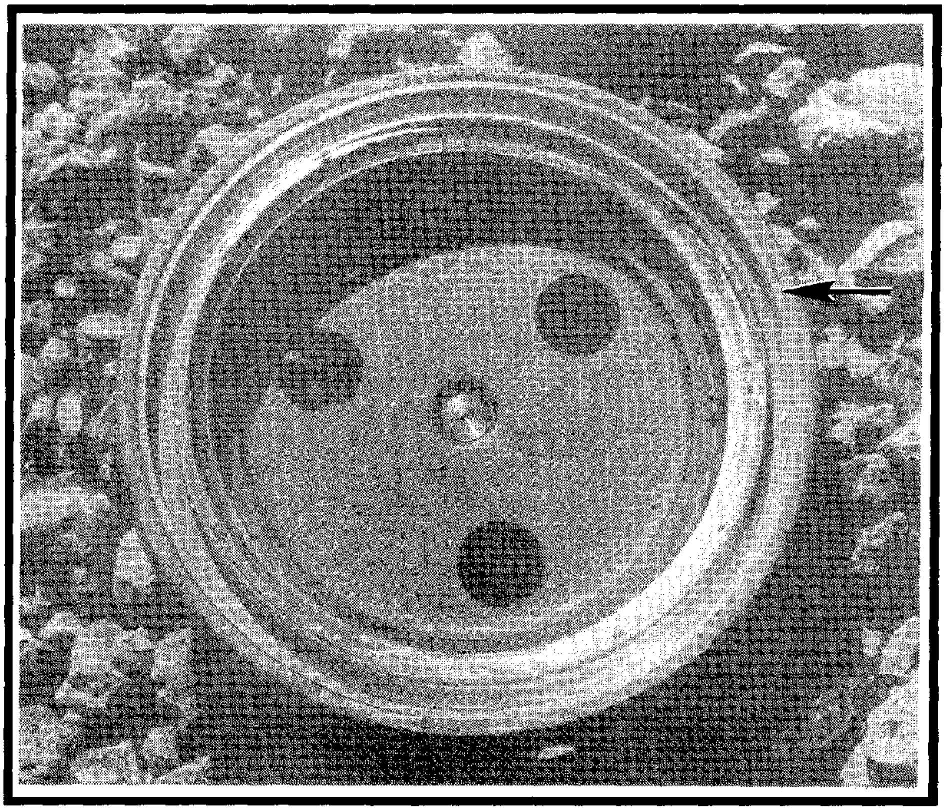


Figure 32. Damaged Low Friction Seal Components

The bearing end cap was removed and the dust guard was modified so that it no longer made contact with the seal case. The end cap was re-applied to the bearing, and testing was resumed. After this repair, the seal performance was acceptable for the remainder of the test.

The seals were given a limited inspection at the completion of the 5,000 mile test to document their condition. All of the seals showed some minimal grease seepage.

BEARINGS APPROACHING FAILURE

Bearings A and B experienced thermal failure during the test. At the beginning of the test, the inner race on both bearings was observed to be slipping, but not overheating. The behavior of each of these bearings is described in detail below.

BEHAVIOR OF BEARING B

Temperature time history plots for bearing B are shown for the entire test in Figures 33 and 34 for the top of cup and side of outboard cup raceway, respectively. On the first test day the consist was operated for approximately 40 minutes at 30 mph followed by 10 minutes of operation at 40 mph. The top of cup temperature reached just over 100 F° on two successive laps. The bearing completed a total of 40 miles of operation.

On the second test day, the bearing completed an additional 27 miles of operation at a maximum operating speed of 30 mph. During this limited testing, the bearing temperature on the top of the cup reached a maximum of approximately 60 F°.

On the third day of testing, a total of 175.5 miles of operation was completed with speeds up to 60 mph. During operation, the bearing temperature rose quickly to 130 F° each time 60 mph was attained, cooling rapidly upon stopping. On each subsequent period of operation at 60 mph the peak temperature above ambient increased slightly.

On the fourth test day, the bearing heated rapidly to approximately 130 F° while operating at 45 mph and continued to heat up as the operating speed was slowed to 30 mph. During this time, periods of warming during curve negotiation and cooling during tangent running were also observed.

On the fifth day of testing, the temperature of the bearing rose sharply to approximately 180 F° at the outboard cup raceway during operation at 50 mph.

The bearing cooled rapidly during several stops and heated just as rapidly when testing resumed. When the test ended the bearing temperature measured 370 and 371 F° on the inboard and outboard cup raceways of the bearing respectively. The top of the cup measured 486 F° or 116 F° hotter than the side of the cup at its peak.

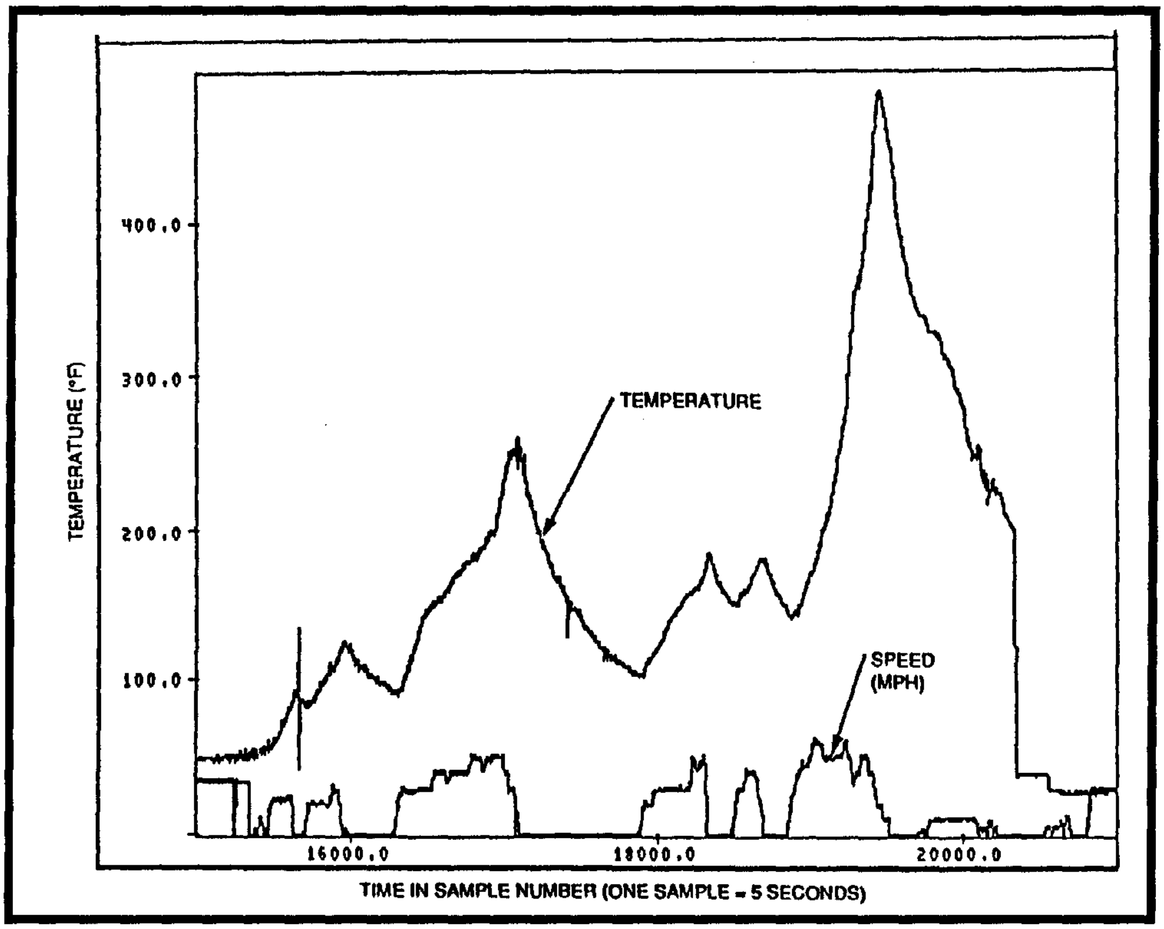


Figure 33. Top of Cup Temperature -- Bearing B

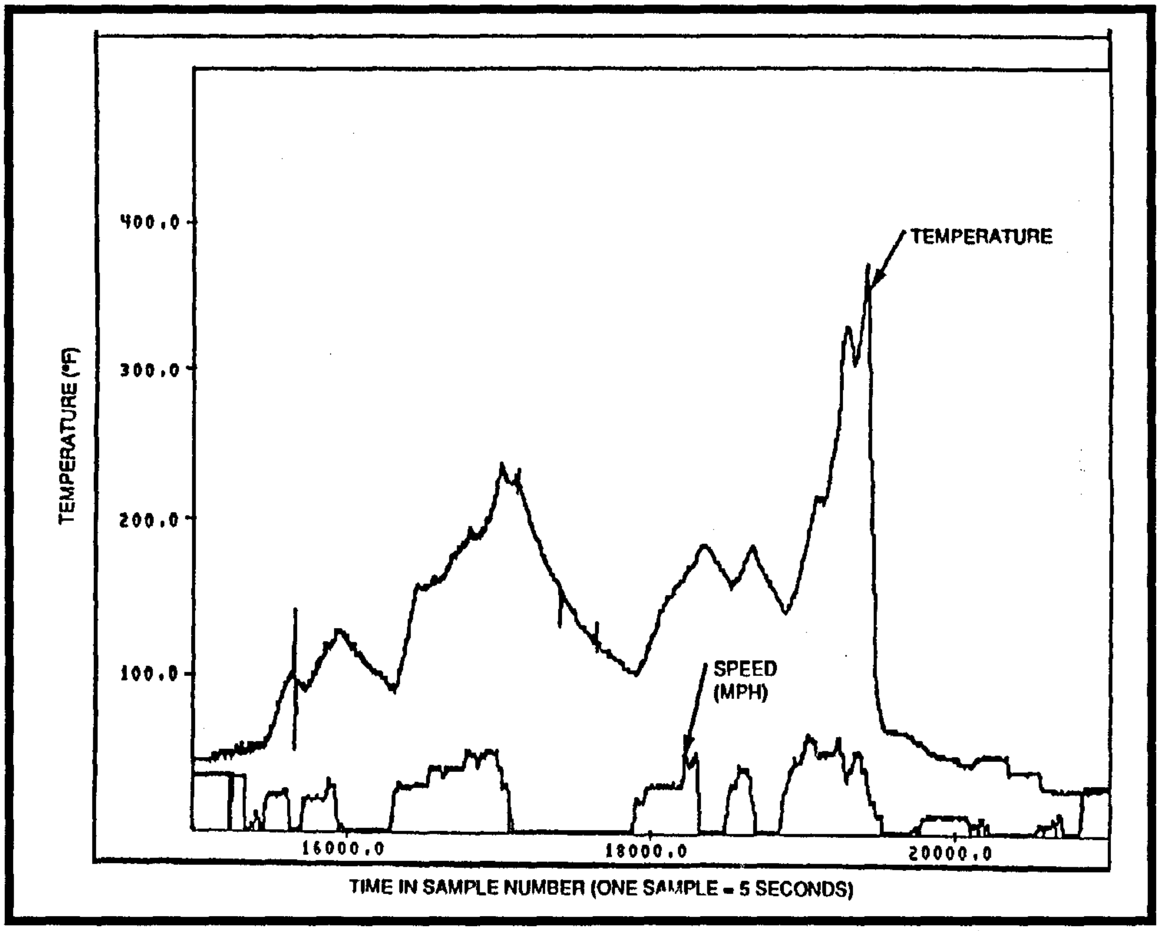


Figure 34. Side of Cup Temperature -- Bearing B

MAXIMUM BEARING HEATING AND COOLING RATES

The maximum heating rate observed was 12.8°F per minute. At this heating rate, at 60 mph, the bearing temperature could be expected to rise 256 F° in 20 miles.

The maximum cooling rate was 7.2°F per minute. At the above cooling rate, with a 250 F° alarm threshold, a train crew would have about 7 minutes between the time a hot bearing was detected (250 F°) and the bearing had cooled below 200 F°; the temperature at which a melt-stick will indicate a hot bearing (refer to Tables 11 and 12).

Table 11. Bearing B First Overheating Event 50-mph Peak Speed

Location	Max. Temperature (F°)	Heating Rate (F°/minute)	Cooling Rate (F°/minute)
Top of Cup	258	6.7	5.1
Outboard Race	234	5.2	3.7
Inboard Race	270	12.8	6.4

Table 12. Bearing B Second Overheating Event 60-mph Peak Speed

Location	Max. Temperature (F°)	Heating Rate (F°/minute)	Cooling Rate (F°/minute)
Top of Cup	486	10.1	7.2
Outboard Race	371	8.8	*
Inboard Race	370	10.3	5.0

*Thermocouple disbonded

The journal diameter at the inboard cone seat decreased from 6.1440 inches to 6.1436 inches during the test while the diameter at the outboard cone seat decreased from 6.1893 inches to 6.1890 inches.

BEHAVIOR OF BEARING A

Bearing A was the only other test bearing to overheat during the test. On the fourth test day, at operating speeds of 60 mph, the bearing reached nearly 260 F° for brief periods. On the following test day, the bearing reached nearly 280 F° briefly during 50 mph operation. The wheel set containing this bearing was removed from the test consist on March 15 to allow sustained high-speed running so that mileage could be accumulated on the other test bearings.

At the completion of the 5,000 mile test, the wheel set was installed under an empty car so that the behavior of bearing A under empty car conditions could be documented. Bearing A was operated for an additional 315 miles and the bearing temperature did not exceed 120 F°.

The car was then loaded to a rail weight of 263,000 pounds and operated for an addition 500 miles. Under loaded car conditions, bearing A reached a temperature of 250 F° within the initial 100 miles of operation.

At the completion of the on-track tests the bearing was removed from the axle and inspected. The condition of the bearing components did not change significantly during the on-track tests. The axle journal diameter at the inboard cone seat decreased from 6.0652 inches to 6.0650 inches during the tests, while the diameter at the outboard cone seat decreased from 6.1870 inches to 6.1865 inches.

WAYSIDE DETECTOR PERFORMANCE

During the third day of testing, the operating temperature of both bearings A and B exceeded the alarm threshold of 180 F° for the wayside HBD systems. However, inspection of the data collected from the HBD systems revealed that the HBD systems equipped with outboard scanners successfully detected bearing A but not bearing B, and those HBD systems equipped with inboard scanners successfully detected bearing B but not bearing A. Wayside HBD data for bearing A is provided in Table 13.

Table 13. Wayside HBD Measurement Summary for Bearing A

Wayside HBD Data for Bearing		
HBD Scanner Type	**Time**	**HBD Temperature (F°)**
Outboard	19:11	128
Outboard	19:11	160
Inboard	19:11	238
Inboard	19:11	144
Inboard	19:11	279
Inboard	19:11	277
Outboard	20:25	144
Outboard	20:25	178
Inboard	20:25	201
Inboard	20:25	130
Inboard	20:25	279
Inboard	20:25	277
Outboard	20:37	207
Outboard	20:37	225

Table 13. Wayside HBD Measurement Summary for Bearing A -- (Continued)

Wayside HBD Data for Bearing		
HBD Scanner Type	**Time**	**HBD Temperature (F°)**
Inboard	20:37	231
Inboard	20:37	157
Inboard	20:37	300
Inboard	20:37	277
Outboard	20:49	208
Outboard	20:49	227
Inboard	20:49	214
Inboard	20:49	145
Inboard	20:49	284
Inboard	20:49	276

Inspection of Table 13 reveals all but one of the HBD systems equipped with inboard scanners detected bearing A as over the alarm threshold initially, but that two additional laps of the RTT (28 miles of operation) were required before the HBD systems equipped with outboard scanners detected the bearing as over the alarm limit.

Similar results were observed with bearing B. However, in this case the HBD systems equipped with outboard scanners detected the bearing as over the alarm threshold initially, but additional laps were required before the HBD systems equipped with inboard scanners detected the bearing as over the alarm threshold.

It should be noted that one of the HBD systems equipped with an inboard scanner never detected either bearing as over the alarm threshold. This particular HBD was a prototype system, and the scanner heads were aligned such that the radiation the heads intercepted came from the bearing seals rather than the bearing cup. While this system is not in use in revenue service, it demonstrates the importance of proper alignment of the scanner heads for successful detection.

These results were unexpected and a review of the onboard temperature data confirmed that the temperature of the inboard and outboard raceways of the bearings were indeed different. **If such differences in temperature are typical for this type of failure mode, it could explain why some bearing failures occur just after passing a HBD system without setting off an alarm.**

CONE SLIPPAGE PERFORMANCE

The results of the cone slippage measurements for bearings A and B are presented as rate of slip, expressed in percent slip (slips/wheel revolution), in Table 14.

Table 14. Grooved Journal Cone Slippage Rate Summary

BEARING ID	CONE	SLIPPAGE RATE
A	Inboard	1.60%
A	Outboard	0.11%
B	Inboard	1.28%
B	Outboard	0.04%

Table 15 lists the results of the cone slippage measurements for the other six bearings, presented as the total number of revolutions of slippage that occurred during 5,000 miles of operation.

Table 15. Total Revolutions of Slippage During the 5,000 Mile Test

BEARING ID	INBOARD CONE	OUTBOARD CONE
H	3	3*
C	3 1/8	2 1/2
F	4 1/2*	7 1/2
I	1/2	SMALL
A	Continuous	Continuous
B	Continuous	Continuous
W	1/4*	1/4*
X	3 1/2	2 1/4

* Projected - some data missing

Table 16 provides a summary of the cup and cone raceway, and roller element defect frequencies (70 mph) calculated for bearings A, B, W, and X.

Table 16. Bearing Defect Frequency Summary

BEARING ID	ROLLER DEFECT FREQUENCY (Hz)	INNER RACE DEFECT FREQUENCY (Hz)	OUTER RACE DEFECT FREQUENCY (Hz)
A	88	97	118
B	92	99	121
W	91	100	122
X	92	99	121

Figure 35 is a graphic representation of the processed acceleration signature from bearing A. The frequencies corresponding to cup raceway and roller element defects are present in the signature.

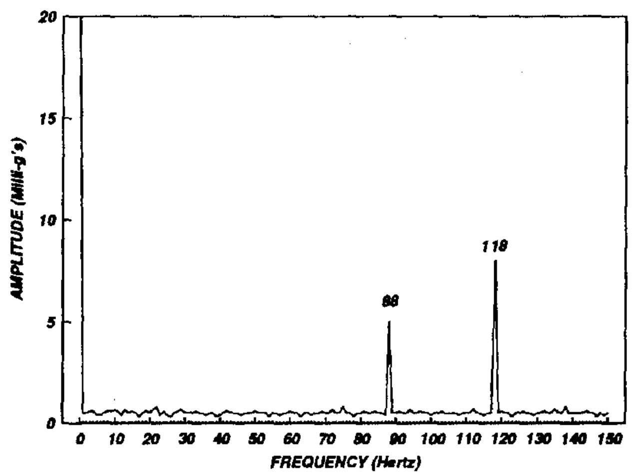


Figure 35. Processed Acceleration Signature -- Bearing A

The processed acceleration signature from bearing B is shown in Figure 36. Once again the frequencies corresponding to cup raceway and roller element defects are present in the signature.

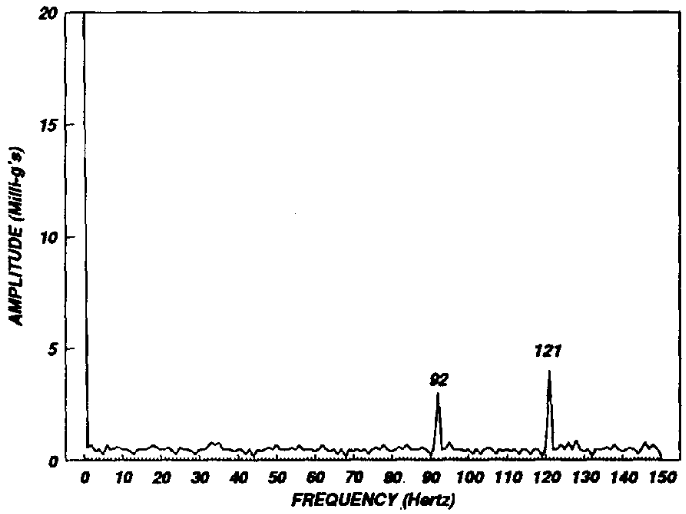


Figure 36. Processed Acceleration Signature -- Bearing B

Figure 37 is a graphic representation of the processed acceleration signatures from bearing W and X showing no defect frequencies present in the signatures.

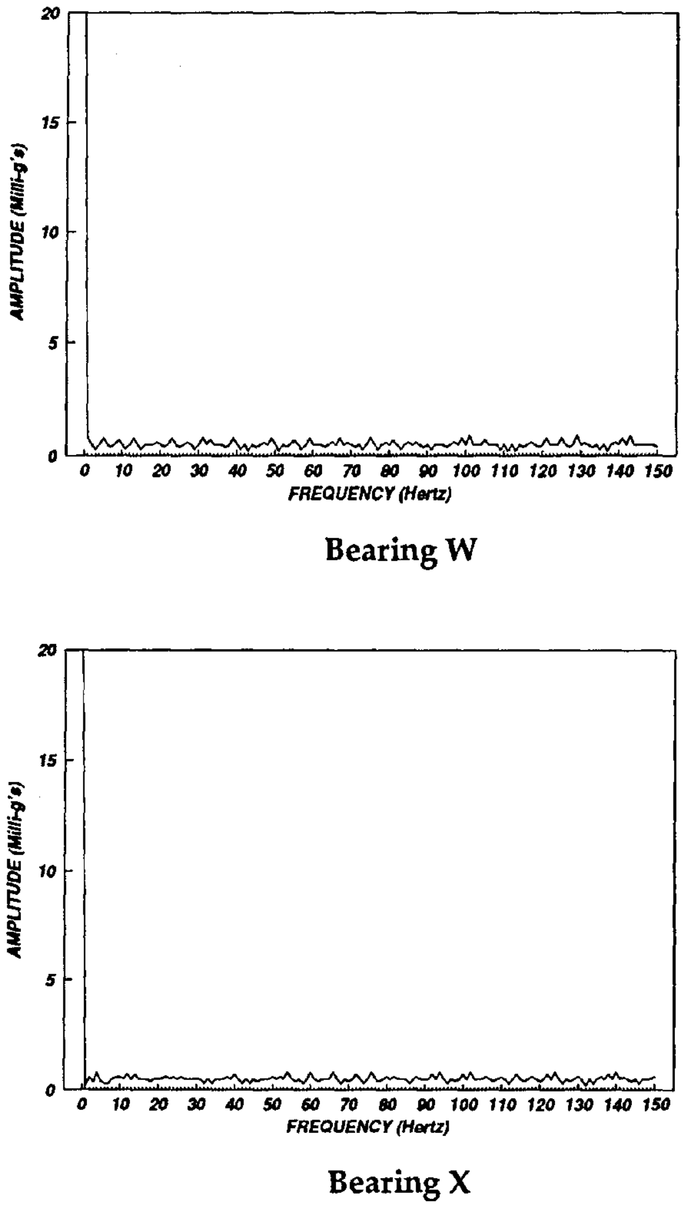


Figure 37. Processed Acceleration Signatures

4.2 WHEEL ANOMALY TEST

A summary of the results obtained for the tests conducted on the TTT are provided below. For additional information, refer to report entitled "Effects of Impact Loads on 70- and 100-ton Capacity Cars and Track" prepared by the AAR's Chicago Technical Center as part of the AAR's Vehicle Track Systems Research Program.

4.2.1 70-Ton Capacity Wheel Sets

SHELLED WHEEL TREAD DEFECT

Figure 38 shows the largest shell defect, 2.25 inches long and 1.00 inches wide, on the right wheel of the test wheel set.

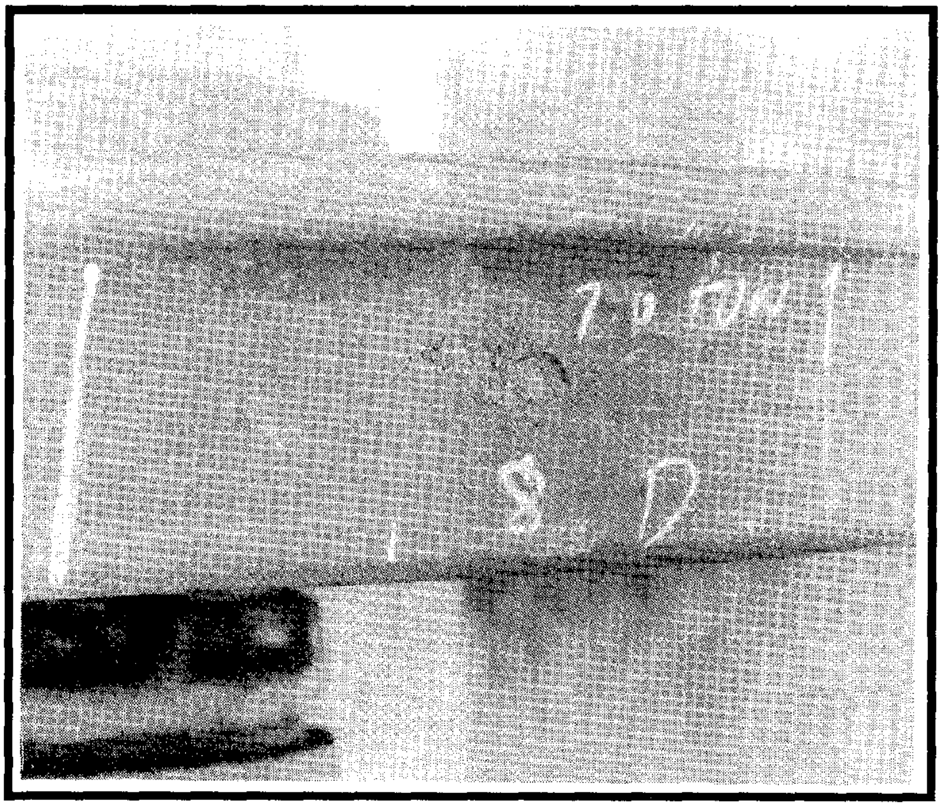


Figure 38. Shelled Wheel Tread Defect – Right Wheel

Figure 39 shows the largest shell defect, 6.00 inches long and 1.13 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 40.

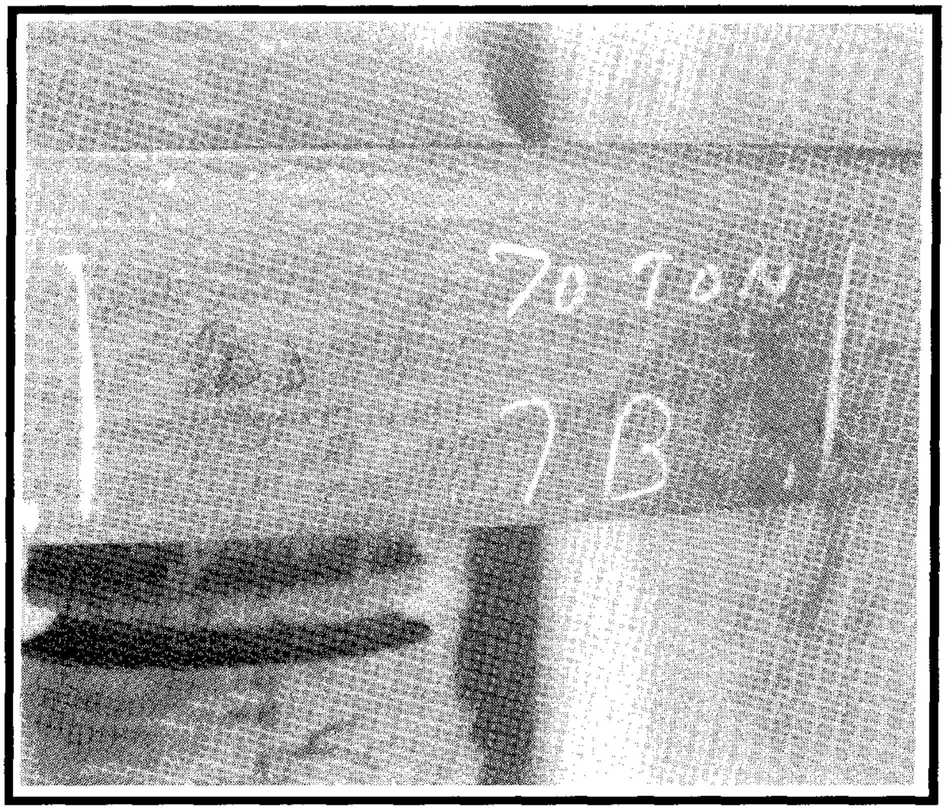


Figure 39. Shelled Wheel Tread Defect -- Left Wheel

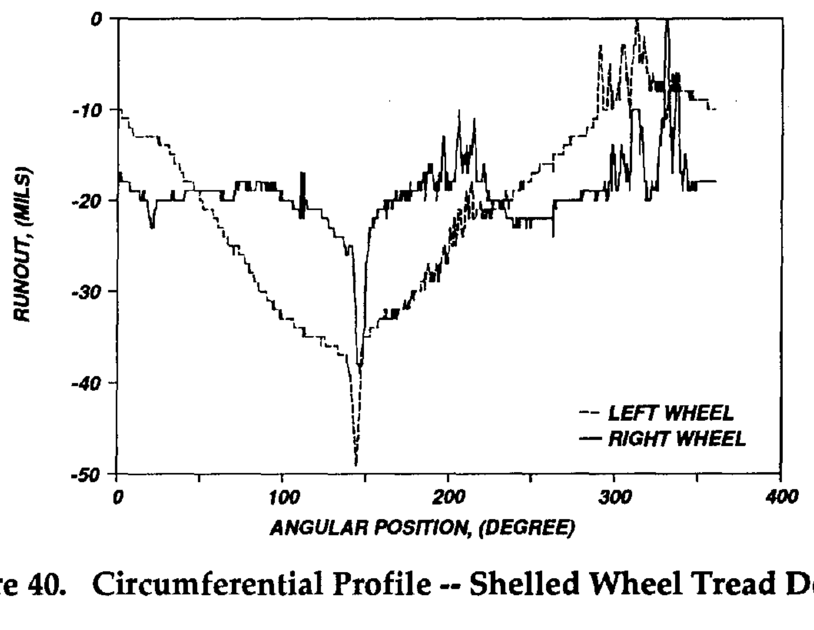
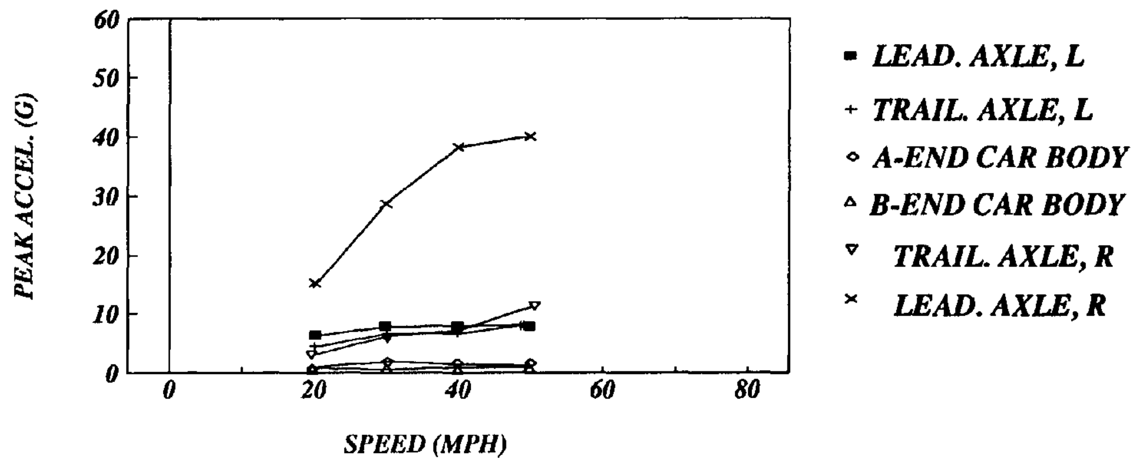


Figure 40. Circumferential Profile -- Shelled Wheel Tread Defect

The test results obtained for the shelled tread defect are provided in Figure 41. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs show that the defects on the right wheel produced higher accelerations at the bearing adapter than the defects on the left wheel. The defects did not produce high accelerations at the car body. The right wheel also produced the highest peak loads at the wheel/rail interface. The peak loads produced at the bearing adapter by the defects on the right wheel were also slightly higher than those produced by the defects on the left wheel. The peak loads produced by the defects did not vary significantly over the speed ranges tested for either wheel. **The defects produced peak loads at the bearing adapter approximately 1.5 times higher than the static wheel load at 50 mph, while the peak load produced at the wheel/rail interface by the defects on the right wheel was approximately 2.5 times higher than the static wheel load at 50 mph.**



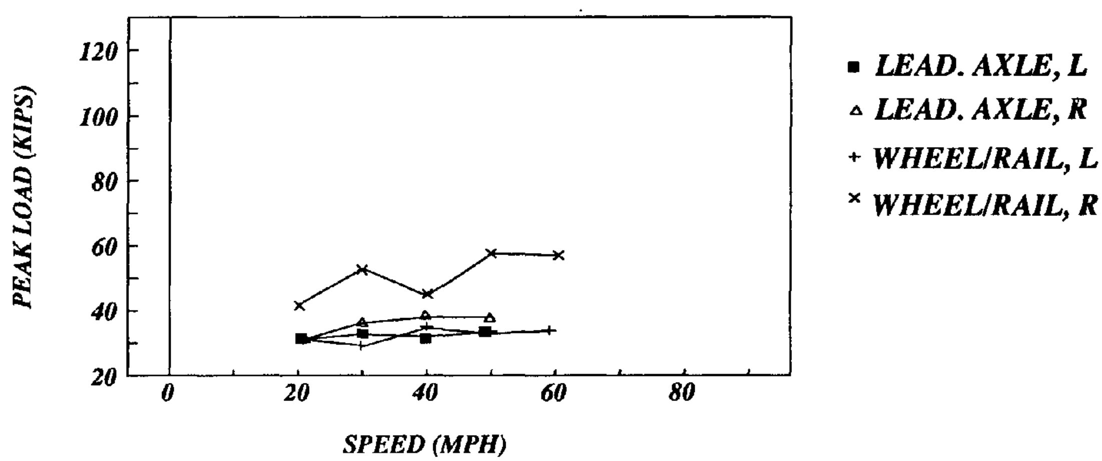


Figure 41. Peak Acceleration and Load vs Train Speed -- Shell Defect

SLID FLAT WHEEL TREAD DEFECT

Figure 42 shows the slid flat defect, 4.75 inches long and 3.00 inches wide, on the right wheel of the test wheel set.

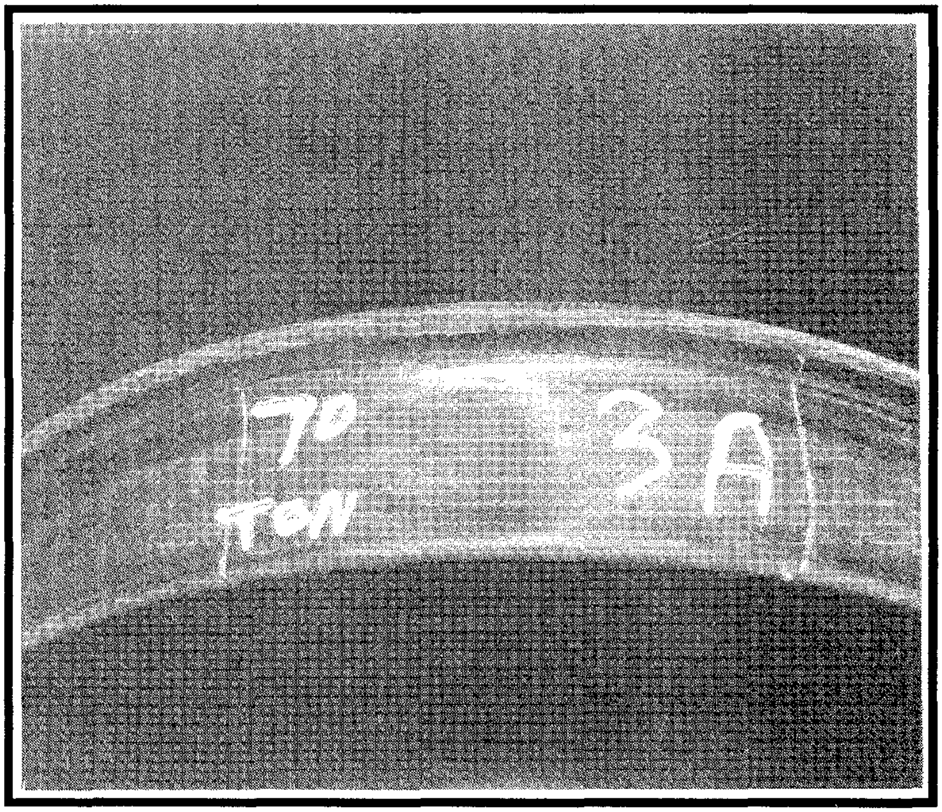


Figure 42. Slid Flat Wheel Tread Defect – Right Wheel

Figure 43 shows the slid flat defect, 4.75 inches long and 3.0 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 44.

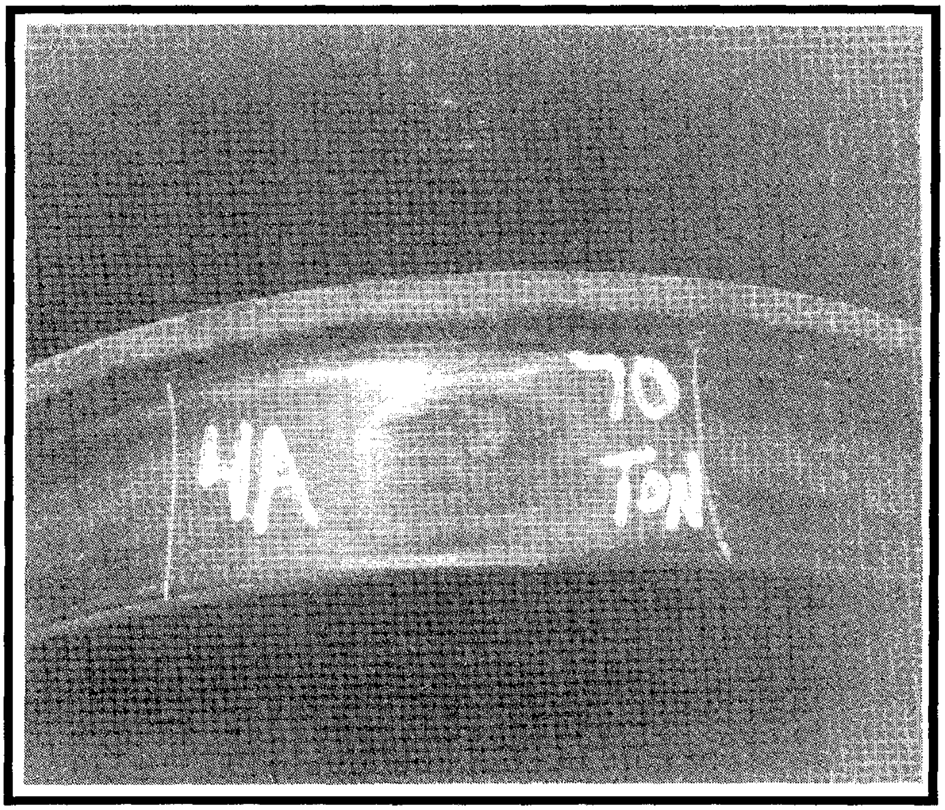


Figure 43. Slid Flat Wheel Tread Defect - Left Wheel

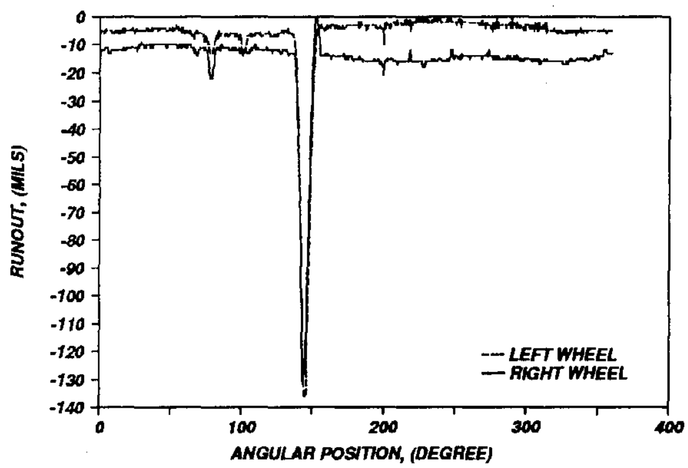
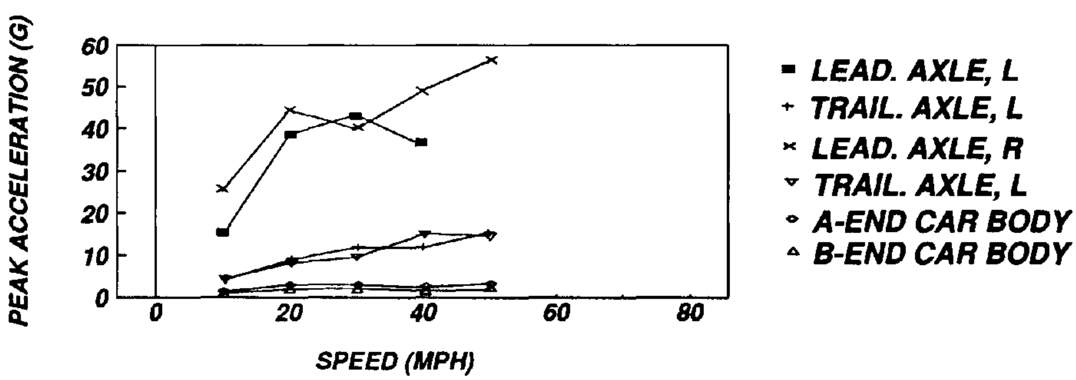


Figure 44. Circumferential Profile -- Slid Flat Wheel Tread Defect

The test results obtained for the slid flat defect are provided in Figure 45. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs shows the defects on the right wheel produced higher accelerations at the bearing adapter than the defects of the left wheel. The defects did not produce high accelerations at the car body. The right wheel also produced the highest peak loads at the wheel/rail interface. The peak loads produced at the bearing adapter by the defects on the right wheel were also slightly higher than those produced by the defects on the left wheel. The peak loads produced by the defects increased with train speed. **The defects produced peak loads at the bearing adapter approximately 1.5 times higher than the static wheel load at 50 mph, while the peak loads produced at the wheel/rail interface were approximately 3.5 times higher than the static wheel load at 50 mph.**



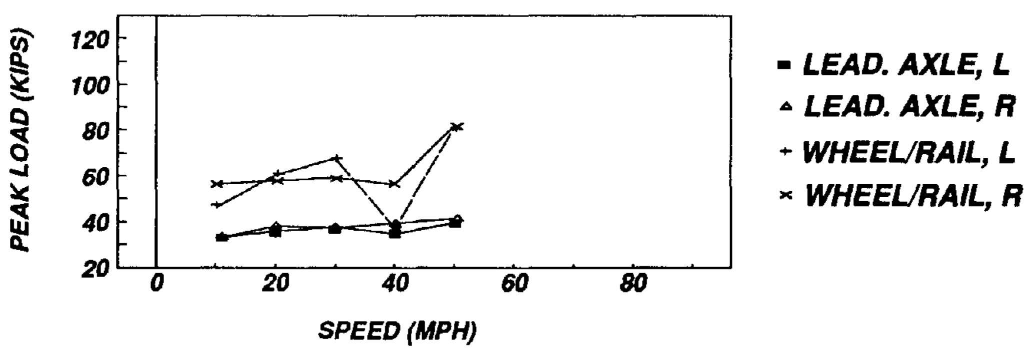


Figure 45. Peak Acceleration and Load vs Train Speed -- Flat Defect

OUT-OF-ROUND WHEEL DEFECT

Figure 46 shows the largest defect, 13.00 inches long and 1.50 inches wide, on the right wheel of the test wheel set.

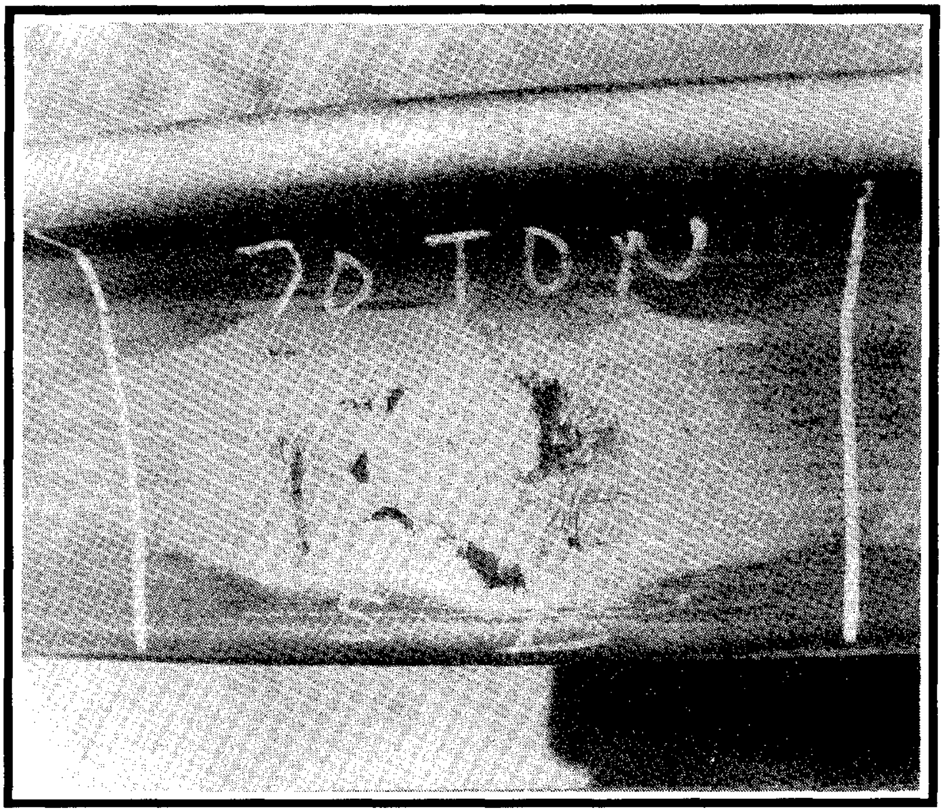


Figure 46. Out-of-Round Wheel Defect -- Right Wheel

Figure 47 shows the largest defect, 3.50 inches long and 2.00 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 48.

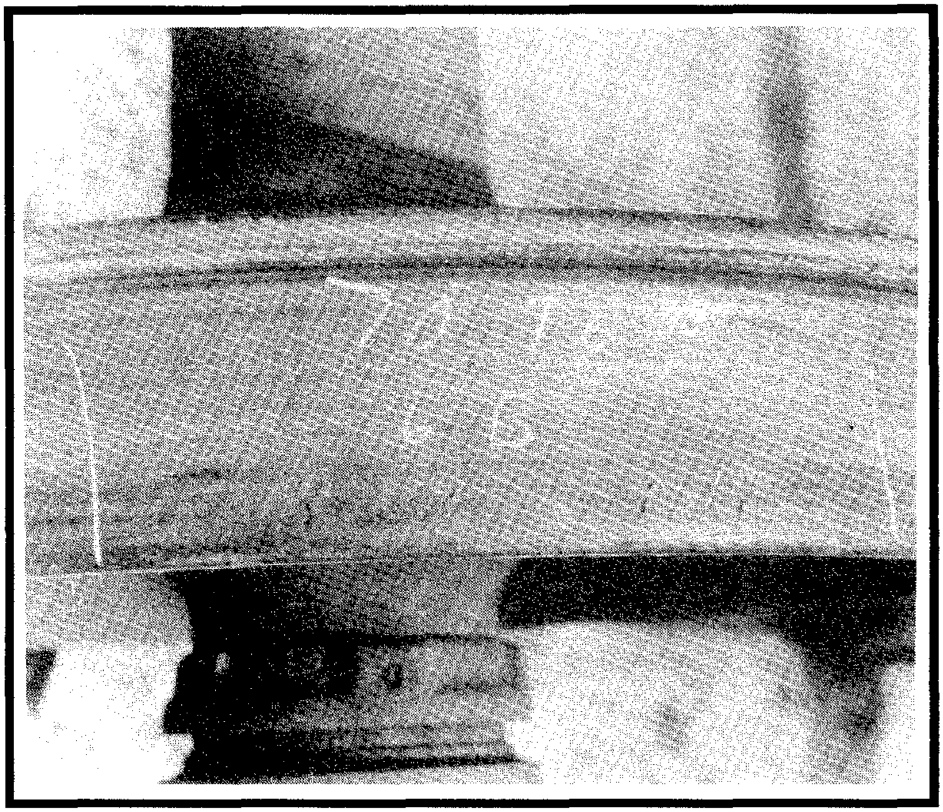


Figure 47. Out-of-Round Wheel Defect – Left Wheel

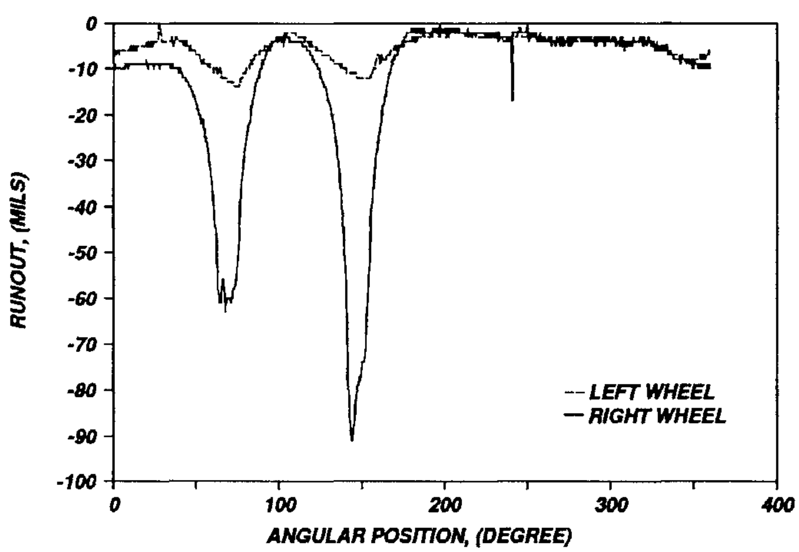
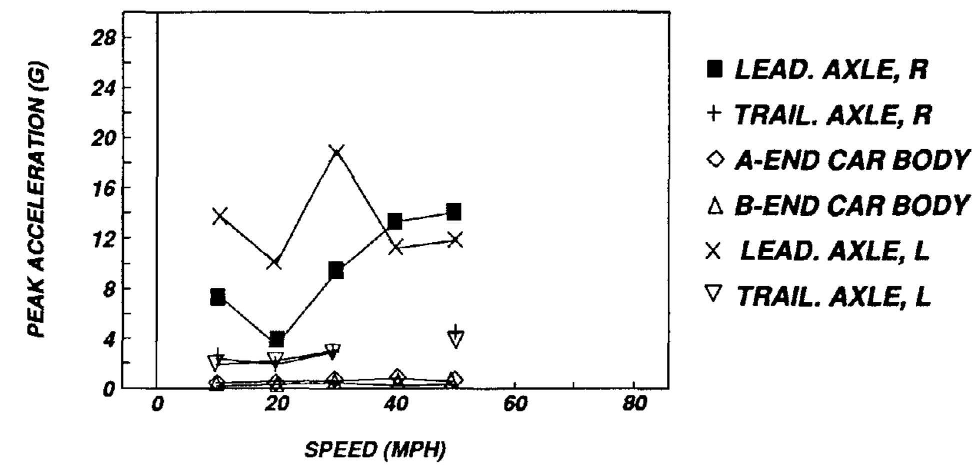


Figure 48. Circumferential Profile – Out-of-Round Wheel Defect

The test results obtained for the wheel set are provided in Figure 49. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs shows the defects on both wheels produced similar levels of acceleration at the bearing adapter and similar peak loads at the wheel/rail interface. The defects did not produce high accelerations at the car body. The peak loads produced by the defects did not vary significantly with train speed. **The defects produced peak loads at the bearing adapter and the wheel/rail interface approximately 1.3 times higher than the static wheel load at 50 mph.**



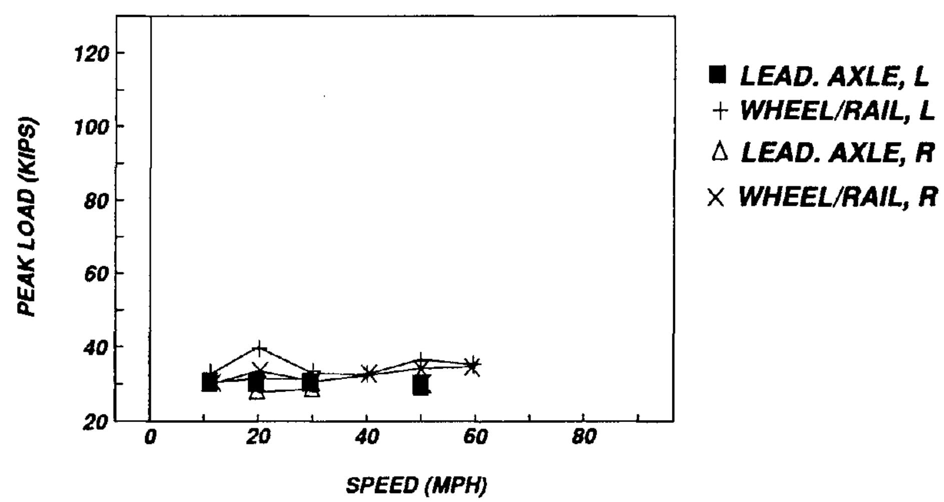


Figure 49. Peak Acceleration and Load vs Train Speed - Out-of-Round Defect

WHEEL TREAD BUILD-UP DEFECT

Figure 50 shows the largest tread build-up defect, 15.00 inches long and 2.50 inches wide, on the right wheel of the test wheel set.

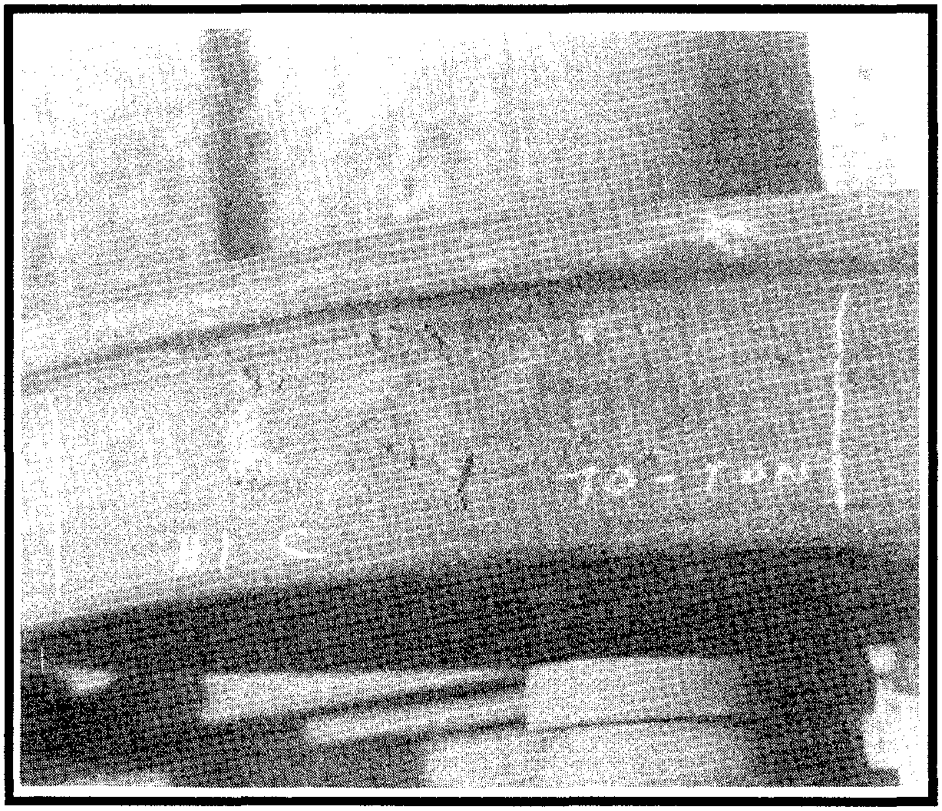


Figure 50. Wheel Tread Build-up Defect -- Right Wheel

Figure 51 shows the largest tread build-up defect, 14.50 inches long and 2.50 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 52.

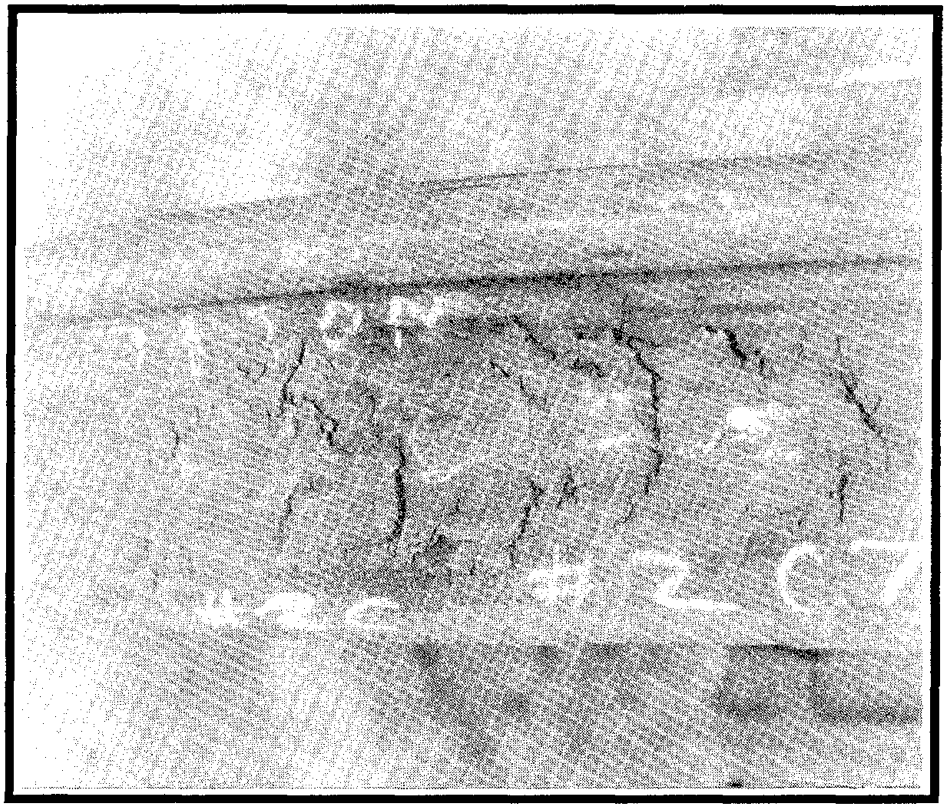


Figure 51. Wheel Tread Build-up Defect -- Left Wheel

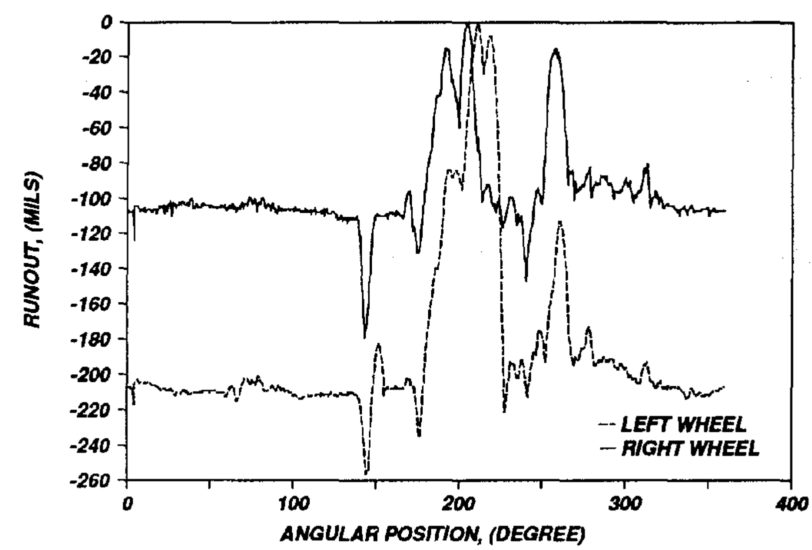
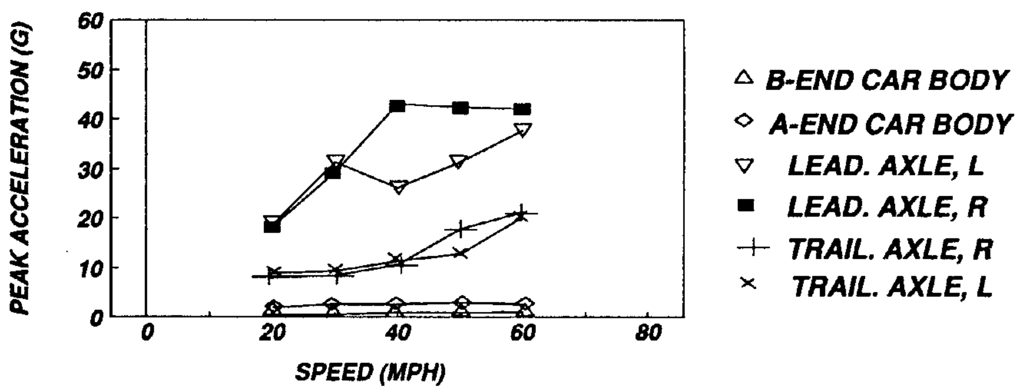


Figure 52. Circumferential Profile -- Wheel Tread Build-up Defect

The test results obtained for the wheel set are provided in Figure 53. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs shows that the defects on the right wheel produced higher accelerations at the bearing adapter than the defects of the left wheel. The defects did not produce high accelerations at the car body. The right wheel also produced the highest peak loads at the wheel/rail interface. The peak loads produced at the bearing adapter by the defects on the right wheel were also slightly higher than those produced by the defects on the left wheel. The peak loads produced by the defects increased with train speed. **The defects produced peak loads at the bearing adapter approximately 1.5 times higher than the static wheel load at 60 mph, while the peak loads produced at the wheel/rail interface were approximately 3.5 times higher than the static wheel load at 60 mph.**



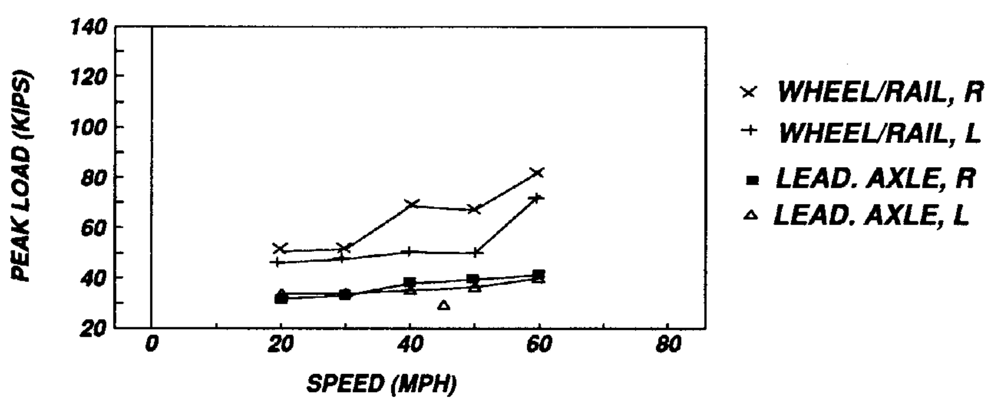


Figure 53. Peak Acceleration and Load vs Train Speed – Tread Build-up Defect

4.2.2 100-Ton Capacity Wheel Sets

SHELLED WHEEL TREAD DEFECT

Figure 54 shows the largest shell defect, 5.50 inches long and 1.00 inches wide, on the right wheel of the test wheel set.

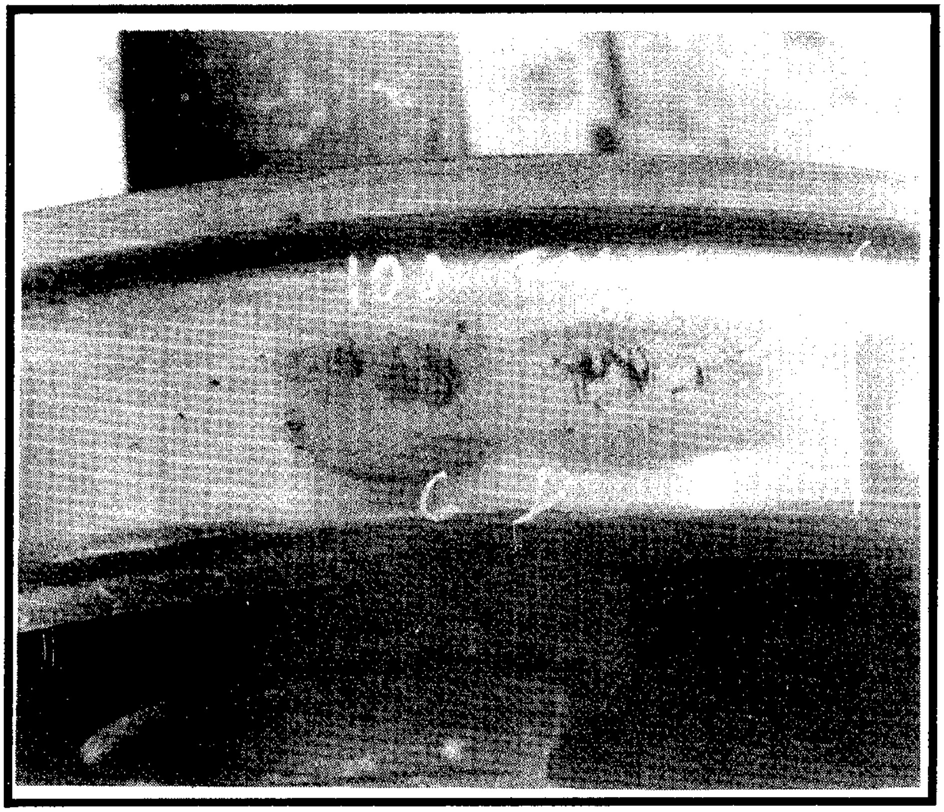


Figure 54. Shelled Wheel Tread Defect -- Right Wheel

Figure 55 shows the largest shell defect, 12.00 inches long and 1.50 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 56.

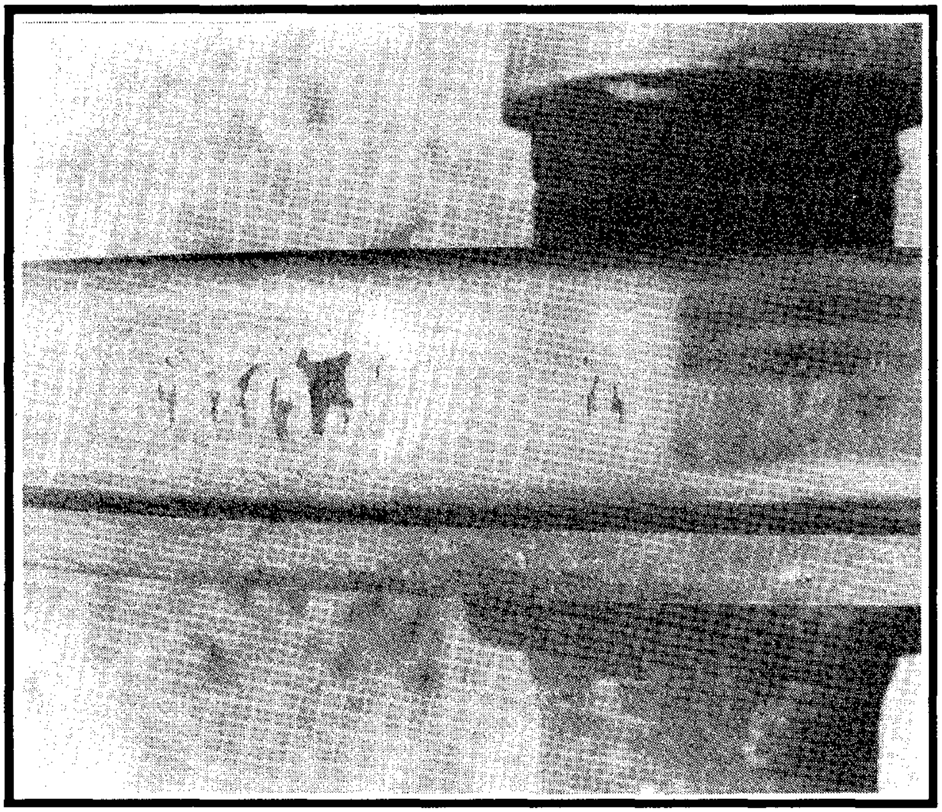


Figure 55. Shelled Wheel Tread Defect -- Left Wheel

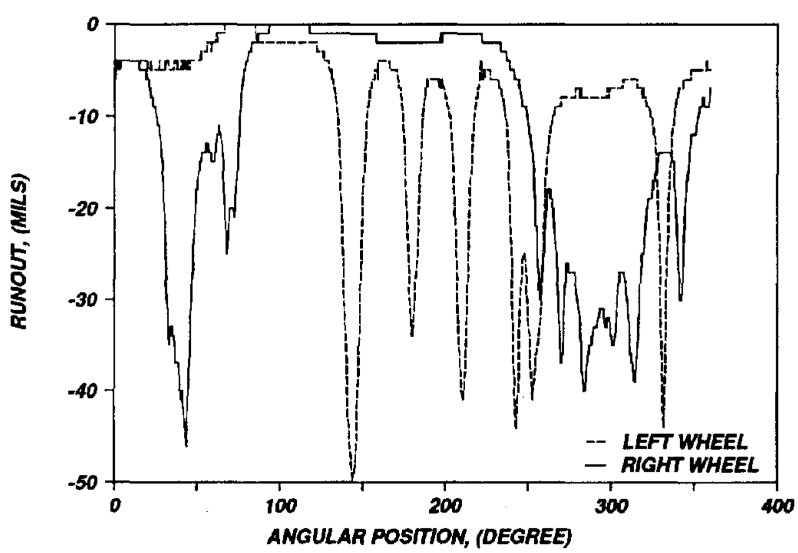


Figure 56. Circumferential Profile -- Shelled Wheel Tread Defect

The test results obtained for the wheel set are provided in Figure 57. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs shows the defects on the left wheel produced higher peak loads at the bearing adapter than the defects of the right wheel. The wheels produced similar peak loads at the wheel/rail interface. The peak loads produced by the defects did not vary significantly with train speed. The defects did not produce high accelerations at the car body. **The defects on the left wheel produced peak loads at the bearing adapter approximately 1.5 times higher than the static wheel load, while the peak loads produced at the wheel/rail interface were approximately 1.7 times higher than the static wheel load.**

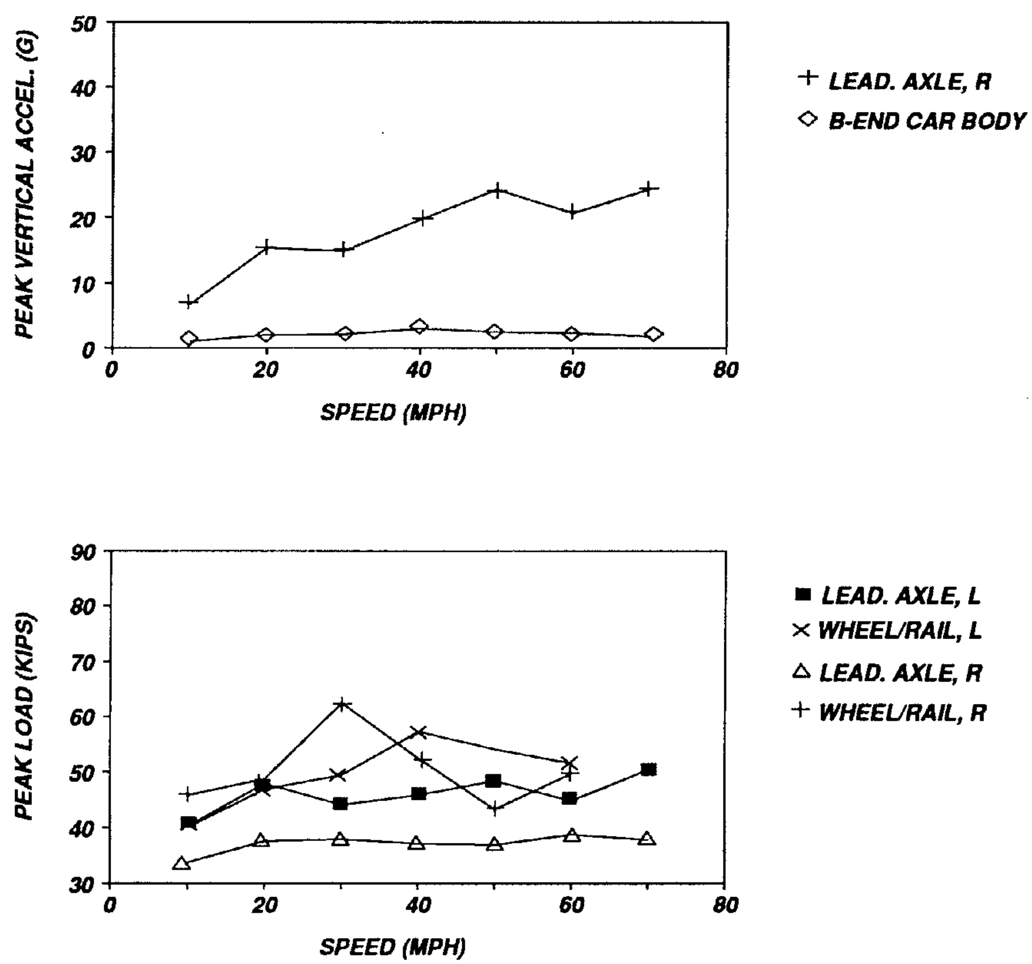


Figure 57. Peak Acceleration and Load vs. Train Speed -- Shell Defect

SLID FLAT WHEEL TREAD DEFECT

Figure 58 shows the largest slid flat defect, 2.50 inches long and 2.00 inches wide, on the right wheel of the test wheel set.

Figure 59 shows the largest slid flat defect, 2.50 inches long and 2.00 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 60.

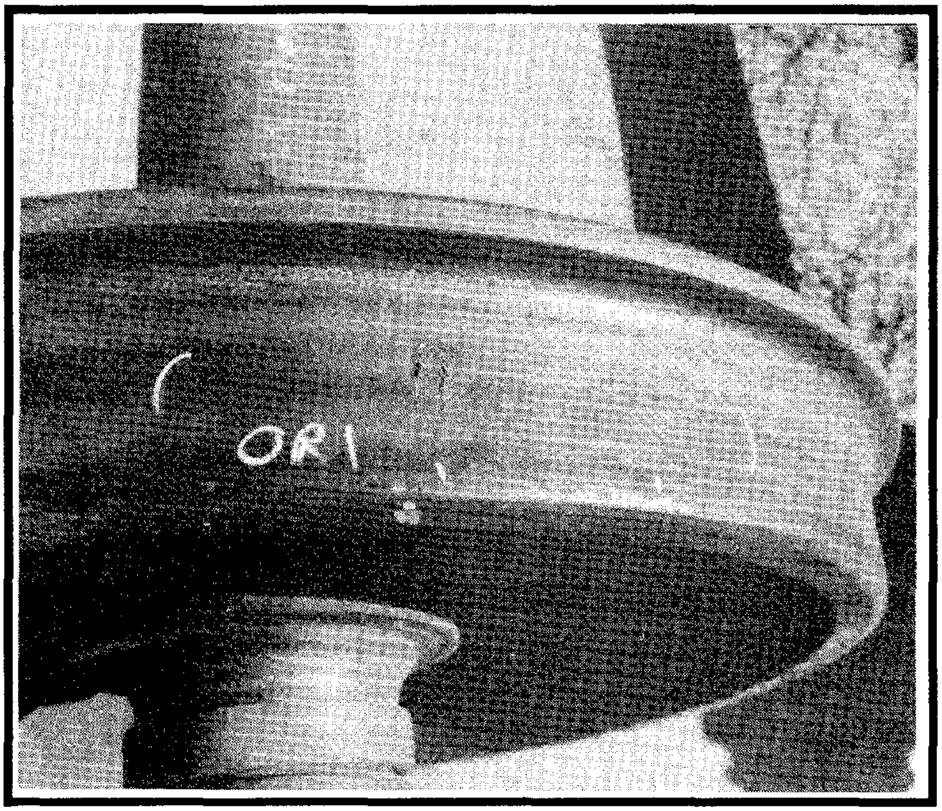


Figure 58. Slid Flat Wheel Tread Defect – Right Wheel

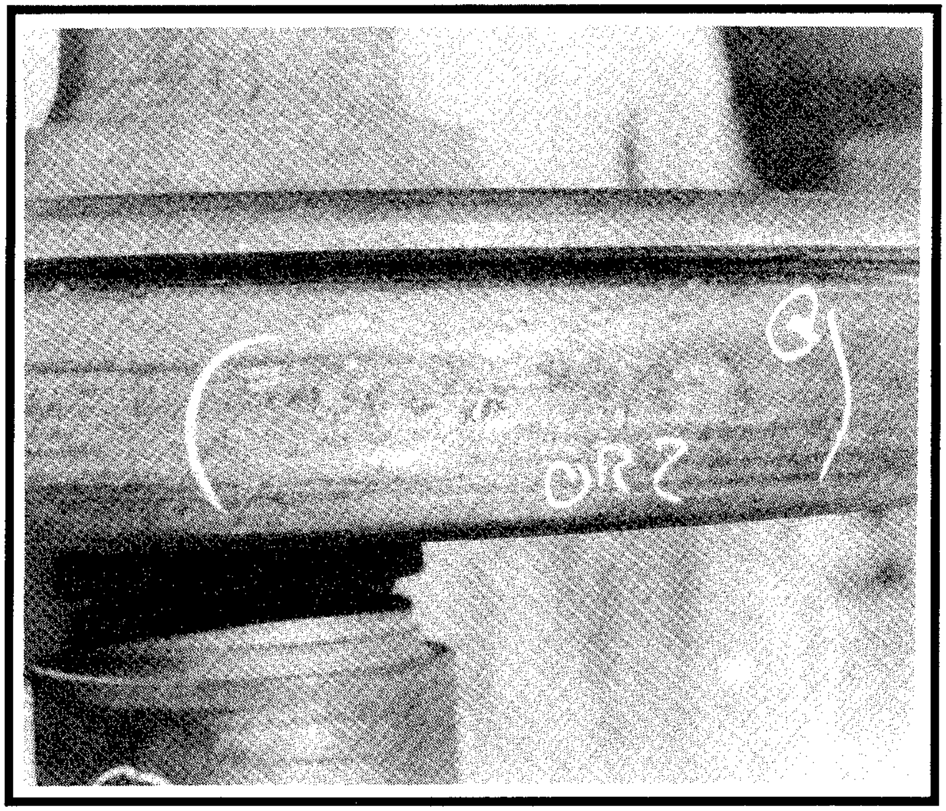


Figure 59. Slid Flat Wheel Tread Defect -- Left Wheel

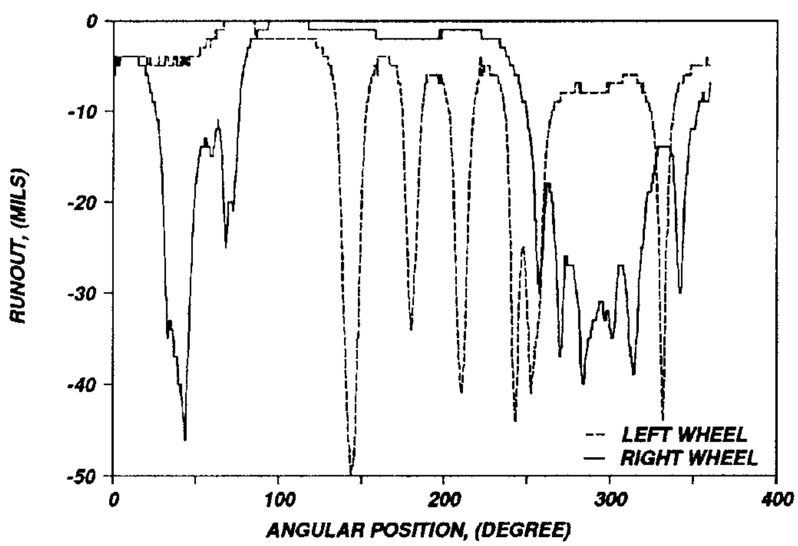
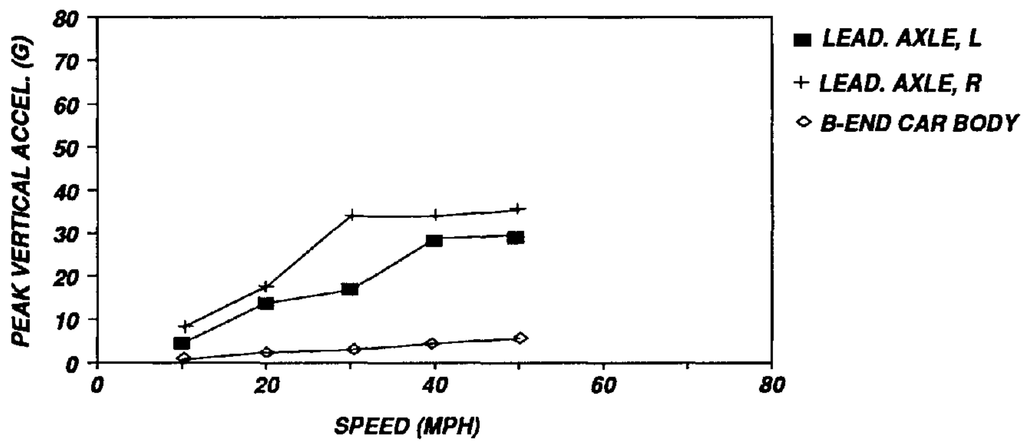


Figure 60. Circumferential Profile -- Slid Flat Wheel Tread Defect

The test results obtained for the wheel set are provided in Figure 61. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs show that the defects on both wheels produced similar peak accelerations at the bearing adapter. The defects did not produce high accelerations at the car body. The wheels also produced similar peak loads at the wheel/rail interface. The wheel/rail peak loads produced by the defects increased with train speed. **The defects on the right wheel produced peak loads at the bearing adapter approximately 1.3 times higher than the static wheel load at 50 mph, while the peak loads produced at the wheel/rail interface were approximately 2.3 times higher than the static wheel load at 60 mph.**



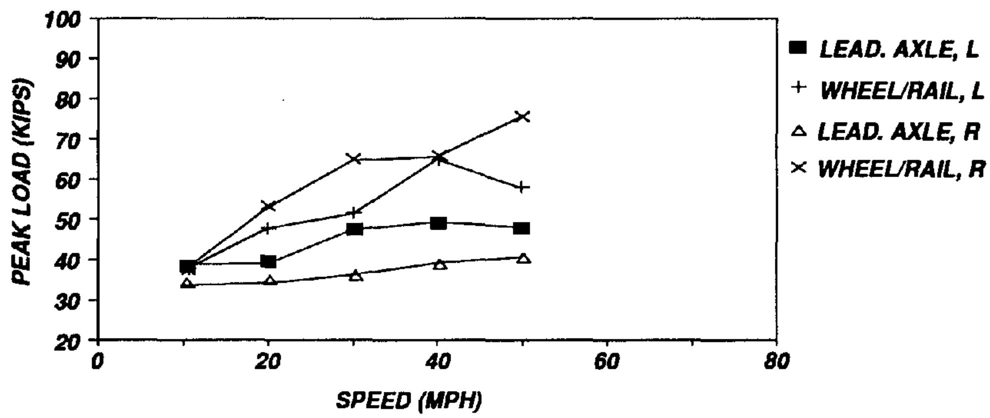


Figure 61. Peak Acceleration and Load vs. Train Speed -- Flat Defect

OUT-OF-ROUND WHEEL DEFECT

Figure 62 shows the largest defect, 4.00 inches long and 2.25 inches wide, on the right wheel of the test wheel set.

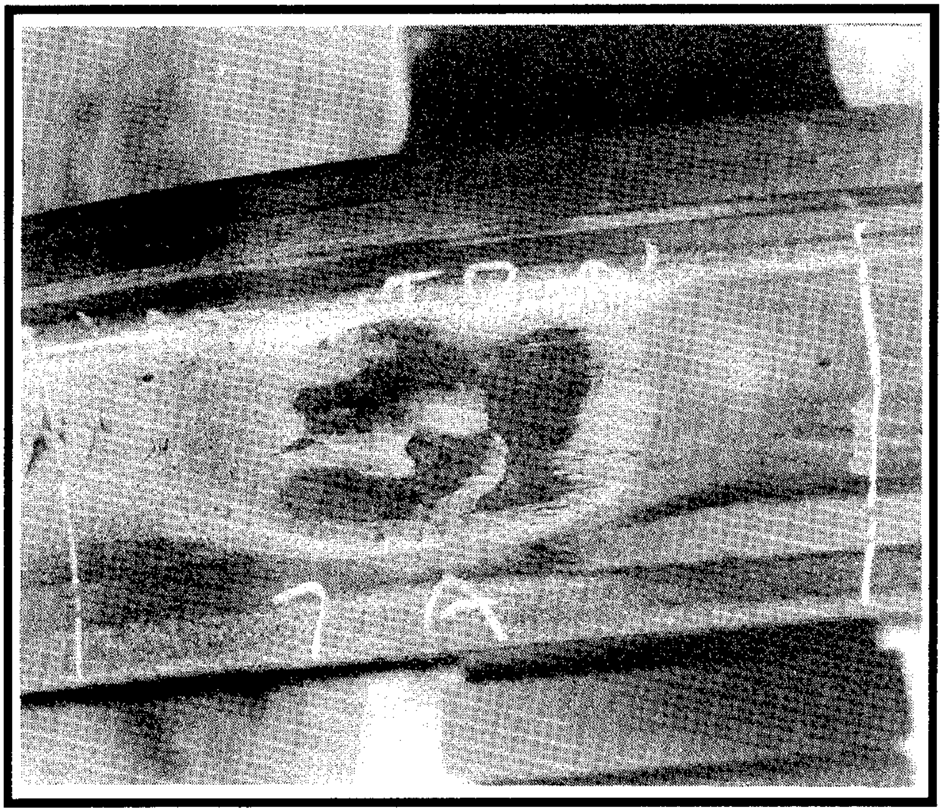


Figure 62. Out-of-Round Wheel Defect – Right Wheel

Figure 63 shows the largest defect, 4.00 inches long and 2.25 inches wide, on the right wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 64.

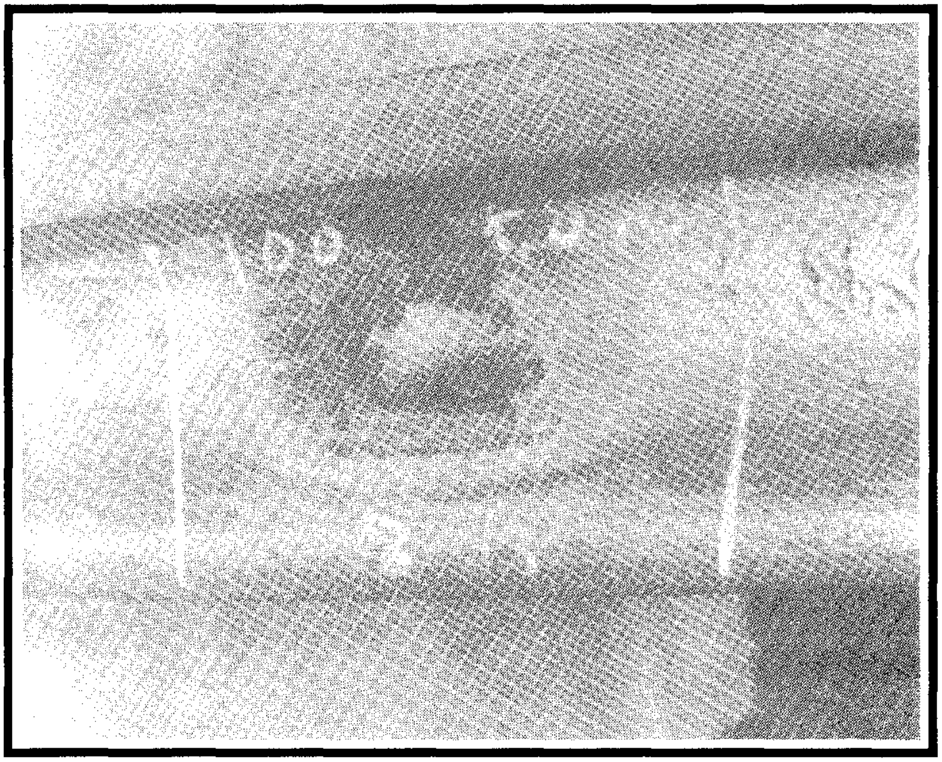


Figure 63. Out-of-Round Wheel Defect -- Left Wheel

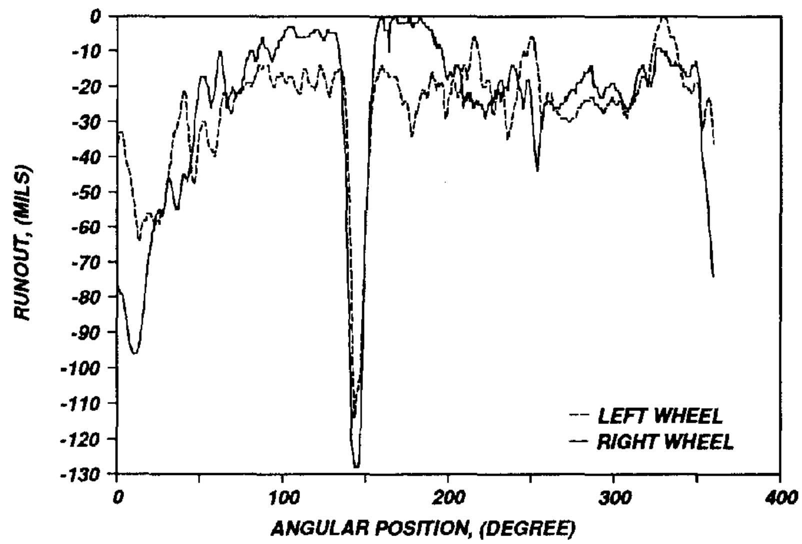


Figure 64. Circumferential Profile -- Out-of-Round Wheel Defect

The test results obtained for the wheel set are provided in Figure 65. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs show that the defects on the left wheel produced higher peak accelerations at the bearing adapter than the defects of the right wheel. The defects did not produce high accelerations at the car body. The defects on the left wheel produced higher peak loads at the wheel/rail interface than those on the right wheel. **The defects on both wheels produced peak loads at the bearing adapter approximately 1.5 times higher than the static wheel load, while the peak loads produced by the defects on the left wheel at the wheel/rail interface were approximately 5.8 times higher than the static wheel load at 35 mph.**

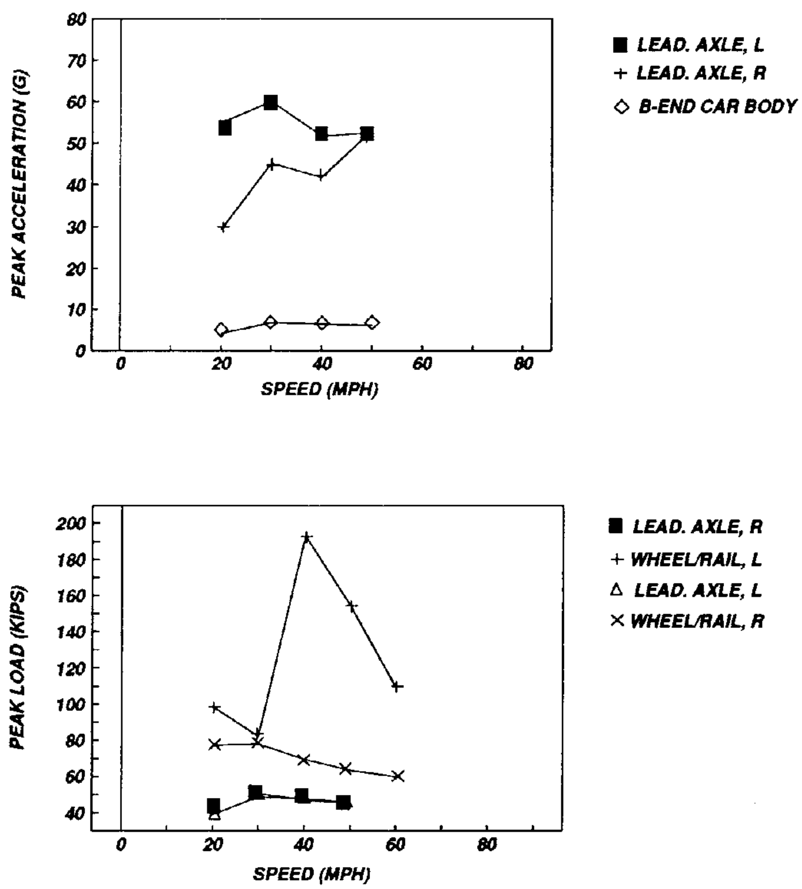


Figure 65. Peak Acceleration and Load vs. Train Speed -- Out-of-Round Defect

WHEEL TREAD BUILD-UP DEFECT

Figure 66 shows the largest tread build-up defect, 34.00 inches long and 1.75 inches wide, on the right wheel of the test wheel set.

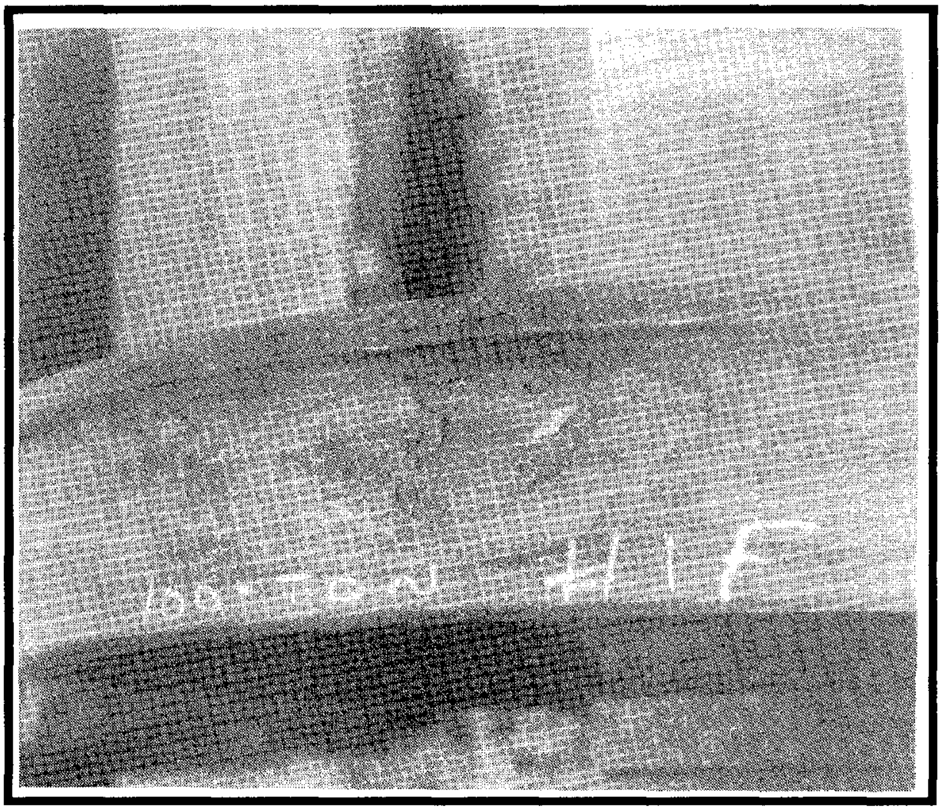


Figure 66. Wheel Tread Build-up Defect -- Right Wheel

Figure 67 shows the largest tread build-up defect, 13.25 inches long and 1.75 inches wide, on the left wheel of the test wheel set. The circumferential profile of the wheel set is shown in Figure 68.

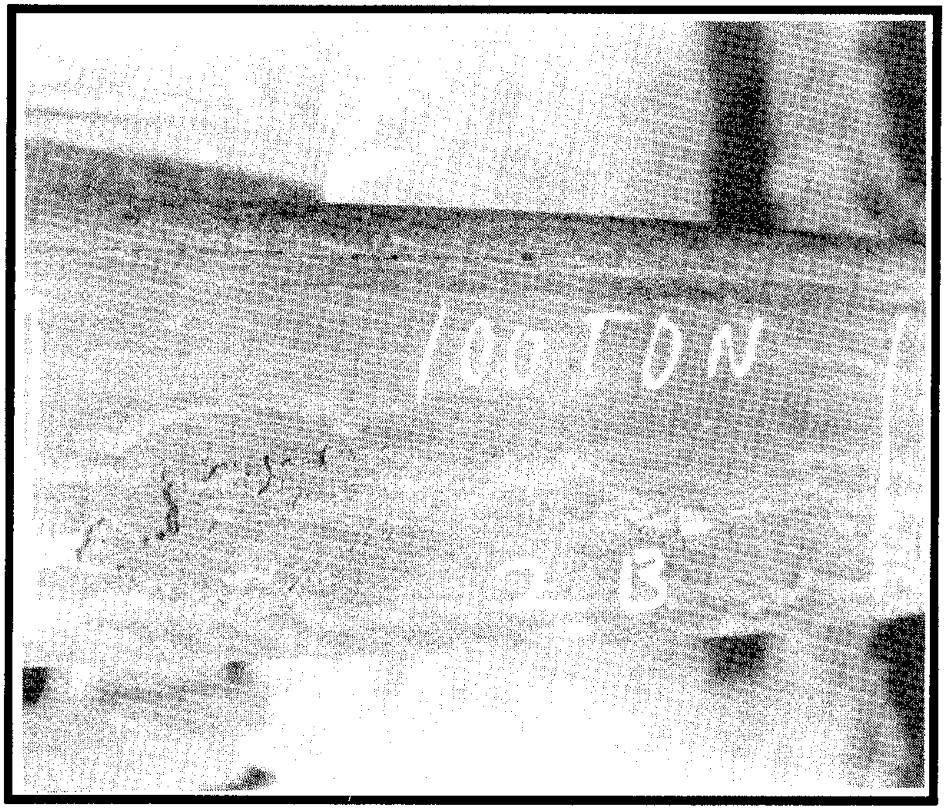


Figure 67. Wheel Tread Build-up Defect -- Left Wheel

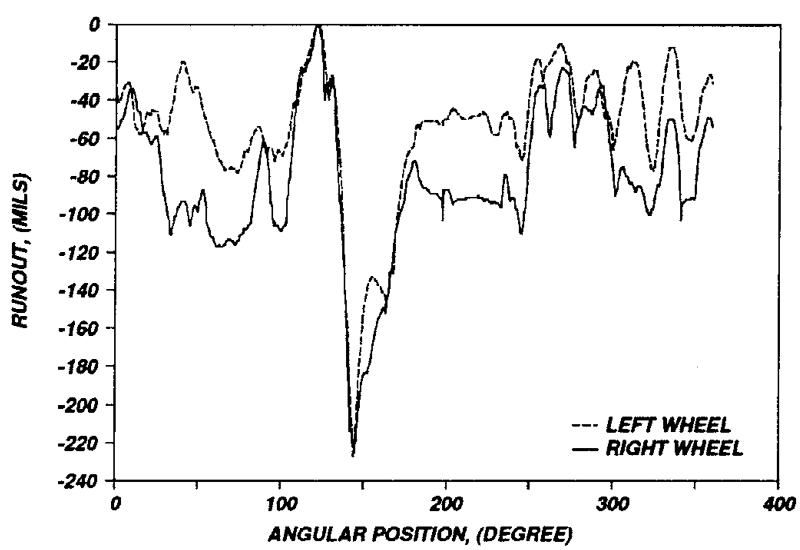


Figure 68. Circumferential Profile -- Wheel Tread Build-up Defect

Test results obtained for the wheel set are provided in Figure 69. The upper graph shows the peak acceleration measured at the axle and car body as a function of train speed. The lower graph shows the peak load measured at the wheel/rail and bearing adapter/side frame interfaces as a function of train speed.

Inspection of the graphs show that the defects on the right wheel produced higher accelerations at the bearing adapter than the defects of the left wheel. The defects did not produce high accelerations at the car body. The left wheel produced the highest peak loads at the wheel/rail interface. The peak loads produced at the bearing adapter were very similar for both wheel. The peak loads produced by the defects at the wheel/rail interface increased with train speed. **The defects produced peak loads at the bearing adapter approximately 1.4 times higher than the static wheel load. The peak loads produced at the wheel/rail interface by the left wheel were approximately 4 times higher than the static wheel load at 60 mph, while the right wheel produced peak loads approximately 3 times higher than the static wheel load at this speed.**

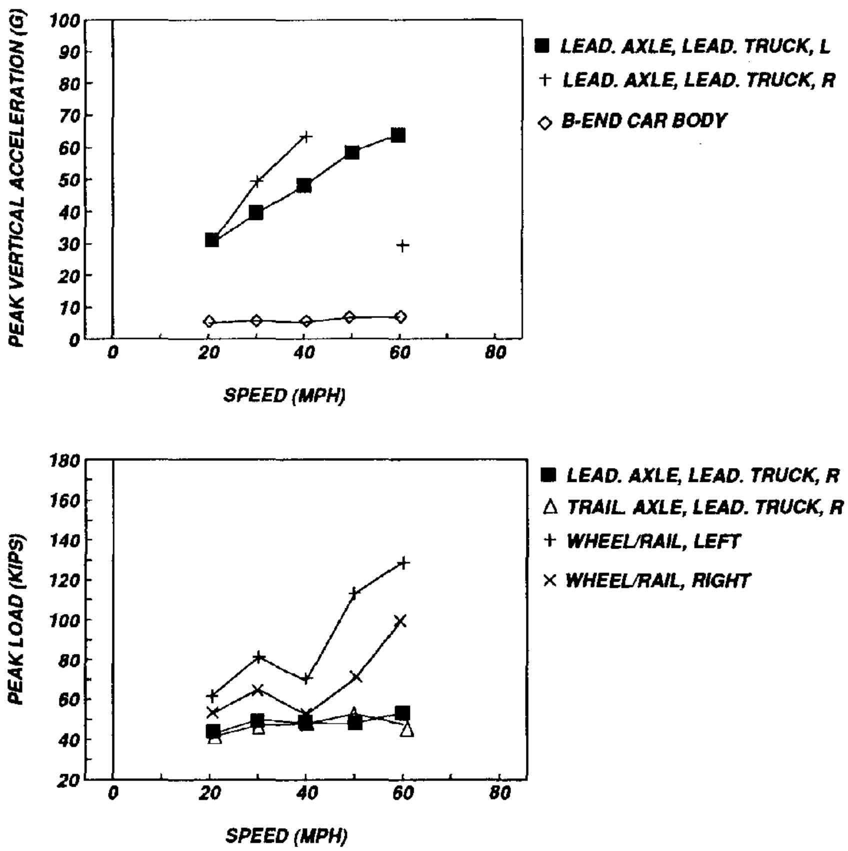


Figure 69. Peak Acceleration and Load vs. Train Speed -- Tread Build-up Defect

4.3 ROLLER BEARING FAILURE MECHANISMS II TEST

Bearings L, M, U, and V, and the low friction seals completed an additional 18,500 miles of operation on the HTL for a total test mileage of 24,320 miles. In order to operate Cars 150 and 151, which were equipped with the high risk bearings, as part of the HAL consist, both wayside HBD systems had to be functional. During the course of the test, the HBD system installed in Section 05 of the HTL sustained heavy damage during a lightning storm. Since this was a prototype detector, replacement components were not readily available, and the detector was out of service for 70 days. As a result, the roller bearings installed under Cars 150 and 151 completed only 11,500 addition miles of operation on the HTL for a total test mileage of 17,320 miles. No over-temperature events occurred on any of the test bearings during the on-track test.

At the completion of the tests on the HTL, Cars 150 and 151 were operated as a mini-consist on the RTT to document the cone slippage of the bearings equipped with cone slippage instrumentation and obtain some additional data from the HBD systems at the WDF.

The bearings and axles were inspected at the completion of the on-track tests.

Bearing C

Post test inspection of bearing C showed that the inboard cone bore diameter increased from 6.1897 inches to 6.1898 inches, while the outboard cone bore diameter increase from 6.1893 inches to 6.1895 inches due to rotation of the cones on the axle journal. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1897 inches to 6.1894 inches during the test, while the diameter at the outboard cone seat decreased from 6.1893 inches to 6.1890 inches. Figure 70 shows the condition of the axle journal at the completion of the test.

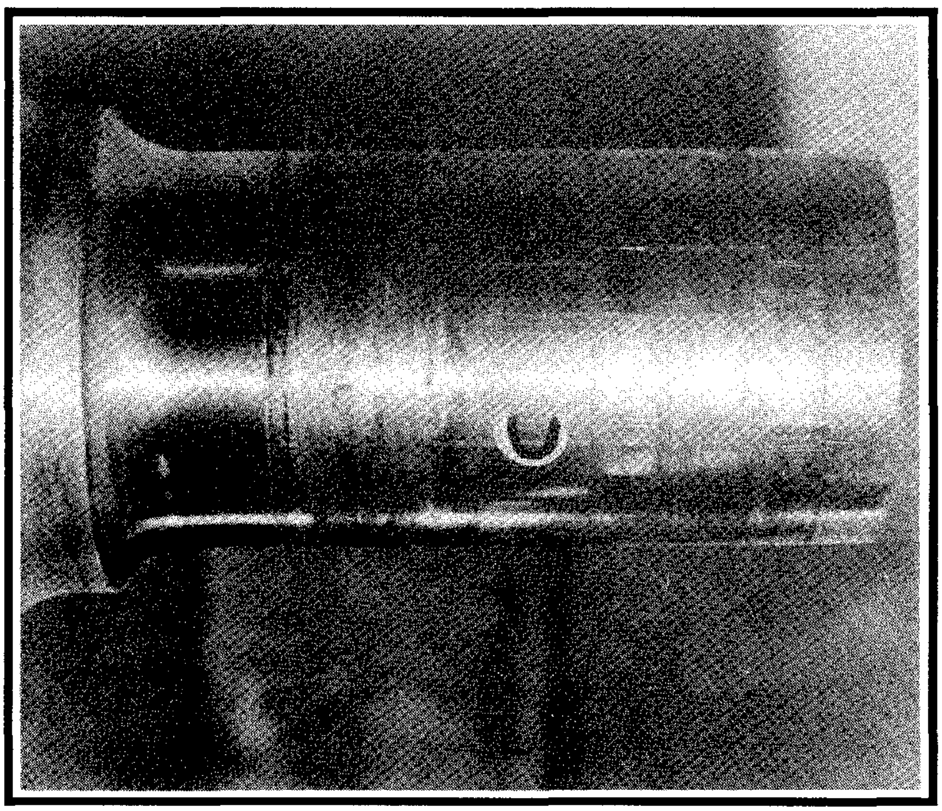


Figure 70. RBFMII Post Test Axle Journal Condition -- Bearing C

Bearing D

Post test inspection of bearing D showed that the inboard cone bore diameter increased significantly from 6.1898 inches to 6.2019 inches, while the outboard cone bore diameter increased from 6.1894 inches to 6.1896 inches due to rotation of the cones on the axle journal. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased significantly from 6.1898 inches to 6.1286 inches during the test, while the diameter at the outboard cone seat decreased from 6.1894 inches to 6.1890 inches. Figure 71 shows the condition of the axle journal at the completion of the test.

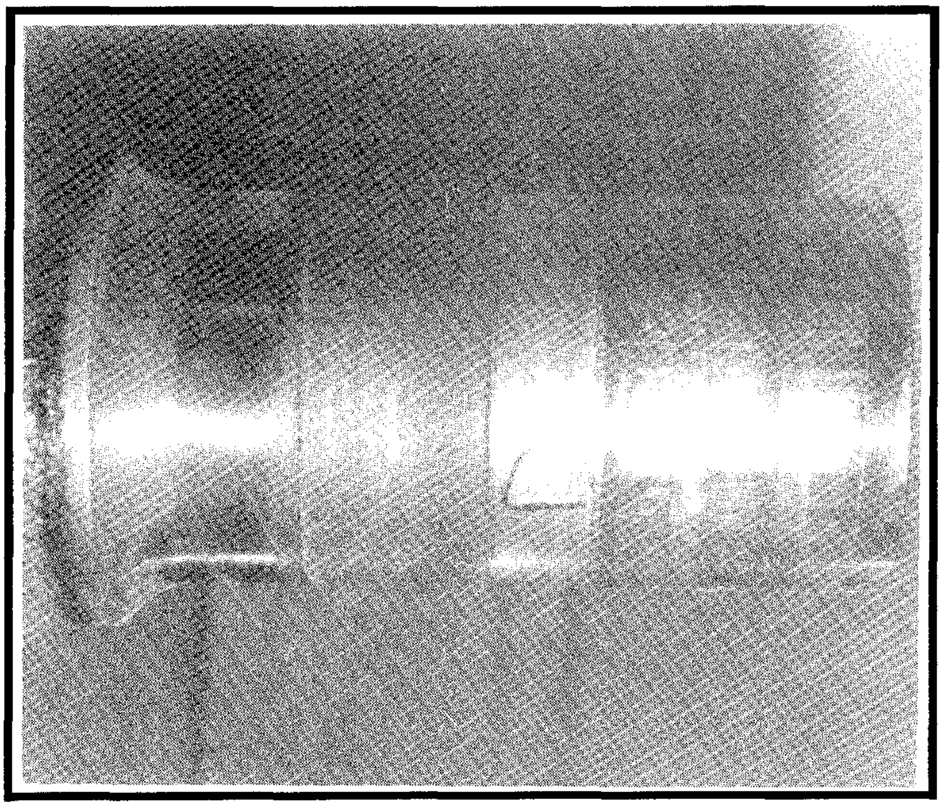


Figure 71. RBFM II Post Test Axle Journal Condition -- Bearing D

Bearing E

Post test inspection of bearing E showed that the inboard cone bore diameter increased from 6.1897 inches to 6.1899 inches, while the outboard cone bore diameter increase from 6.1895 inches to 6.1897 inches due to rotation of the cones on the axle journal. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1897 inches to 6.1894 inches during the test, while the diameter at the outboard cone seat decreased from 6.1895 inches to 6.1892 inches. Figure 72 shows the condition of the axle journal at the completion of the test.

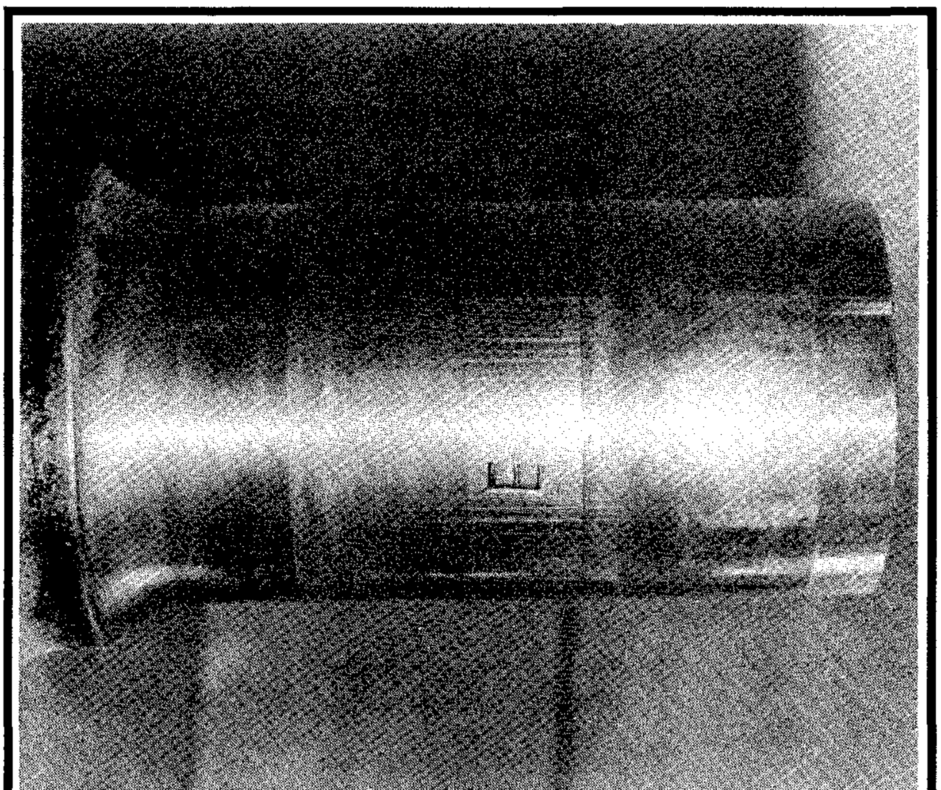


Figure 72. RBFM II Post Test Axle Journal Condition – Bearing E

Bearing F

Post test inspection of bearing F showed that the inboard cone bore diameter increased from 6.1898 inches to 6.1900 inches due to rotation of the cone on the axle journal, while the outboard cone bore diameter remained unchanged at 6.1894 inches. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1898 inches to 6.1895 inches during the test, while the diameter at the outboard cone seat remained unchanged at 6.1894 inches. Figure 73 shows the condition of the axle journal at the completion of the test.

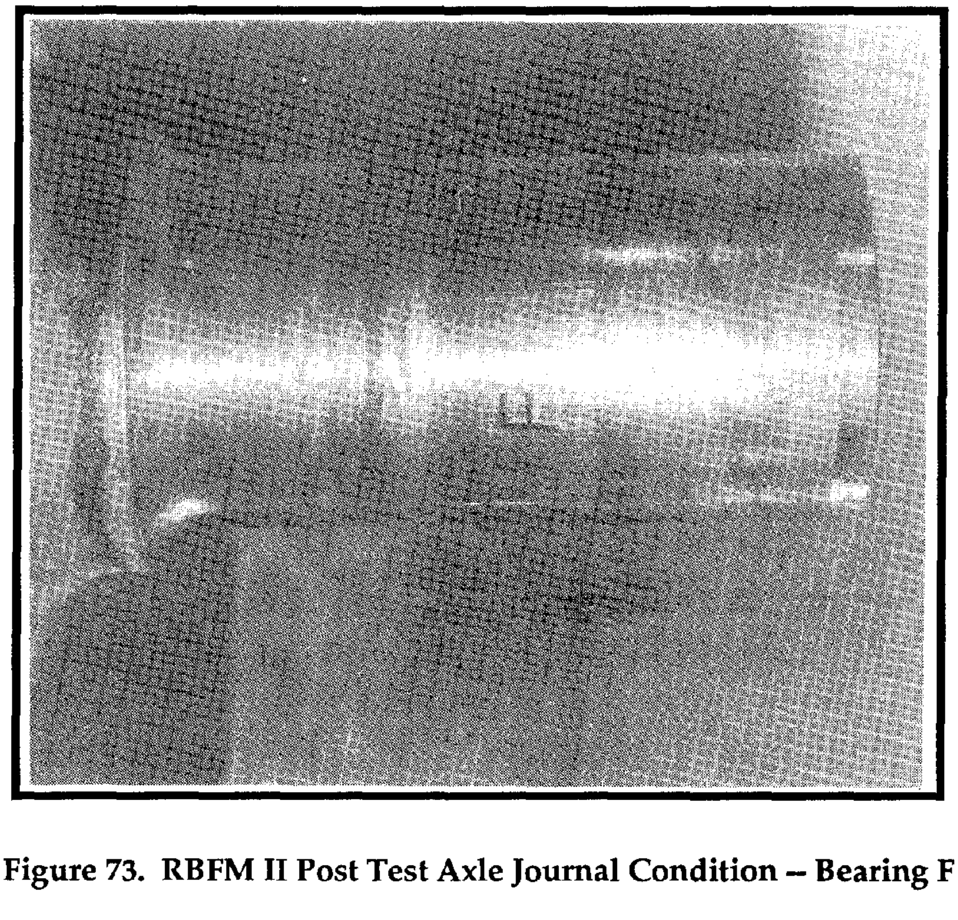


Figure 73. RBFM II Post Test Axle Journal Condition -- Bearing F

Bearing G

Post test inspection of bearing G showed that the bore diameter of the inboard and outboard cones remained unchanged at 6.1893 and 6.1894 inches respectively. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1902 inches to 6.1900 inches during the test, while the diameter at the outboard cone seat remained unchanged at 6.1901 inches. Figure 74 shows the condition of the axle journal at the completion of the test.

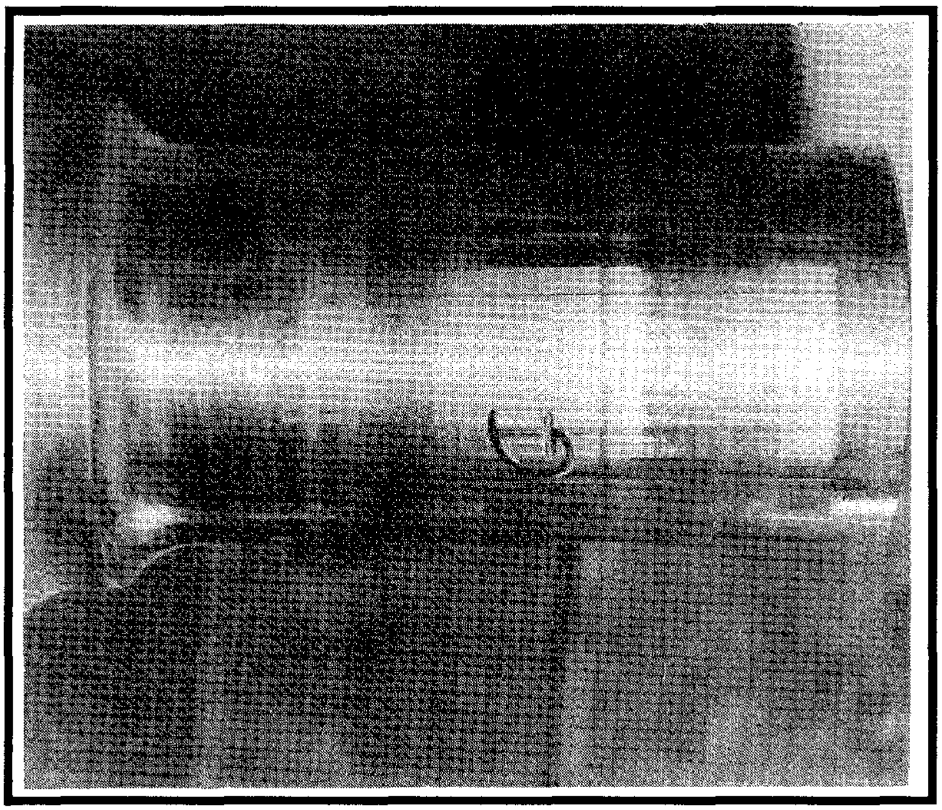


Figure 74. RBFM II Post Test Axle Journal Condition – Bearing G

Bearing H

Post test inspection of bearing H showed that the inboard cone bore diameter increased from 6.1894 inches to 6.1896 inches, while the outboard cone bore diameter increased from 6.1893 inches to 6.1895 inches due to rotation of the cones on the axle journal. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1902 inches to 6.1899 inches during the test, while the diameter at the outboard cone seat decreased from 6.1901 inches to 6.1898 inches. Figure 75 shows the condition of the axle journal at the completion of the test.

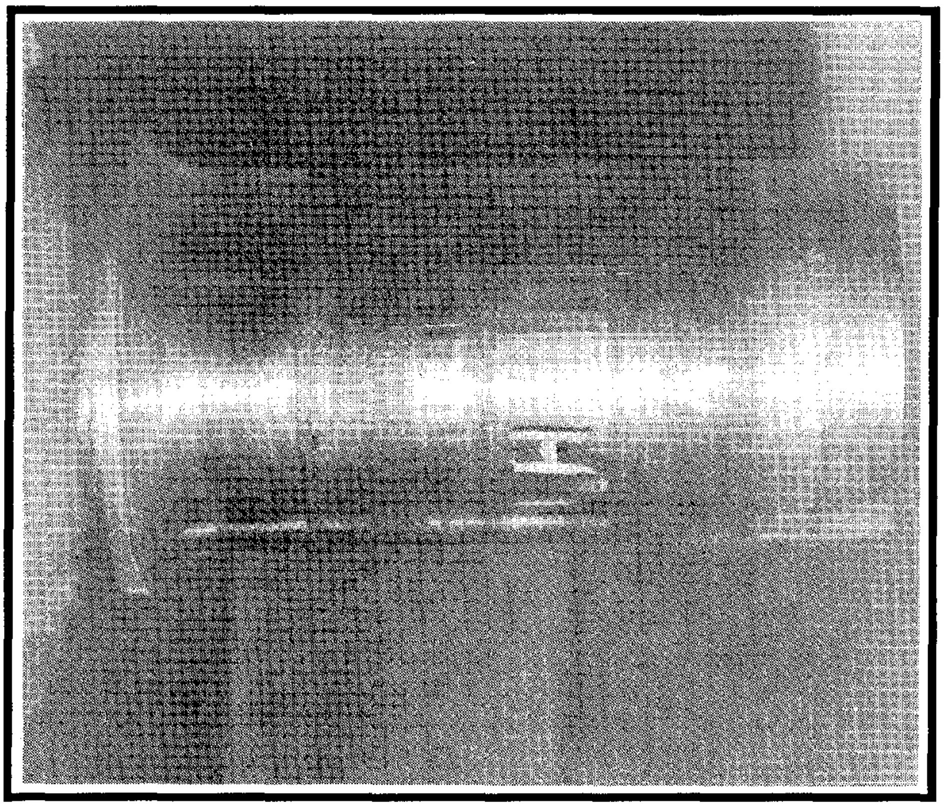


Figure 75. RBFM II Post Test Axle Journal Condition -- Bearing H

Bearing I

Post test inspection of bearing I showed that the bore diameter of the inboard and outboard cones at 6.1894 inches on both cones. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1902 inches to 6.1900 inches during the test, while the diameter at the outboard cone seat decreased from 6.1901 inches to 6.1898 inches. Figure 76 shows the condition of the axle journal at the completion of the test.

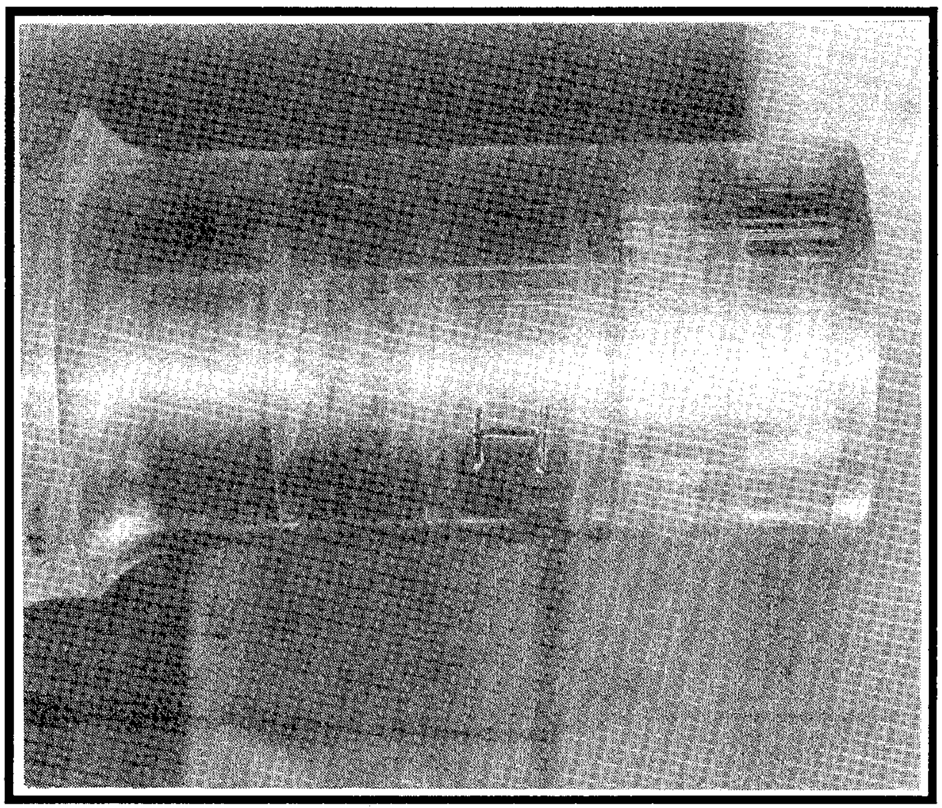


Figure 76. RBFM II Post Test Axle Journal Condition – Bearing I

Bearing J

Post test inspection of bearing J showed that the bore diameter of the inboard and outboard cones remained unchanged at 6.1894 inches and 6.1895 inches, respectively. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard and outboard cone seats remained unchanged at 6.1903 inches and 6.1902 inches, respectively. Figure 77 shows the condition of the axle journal at the completion of the test.

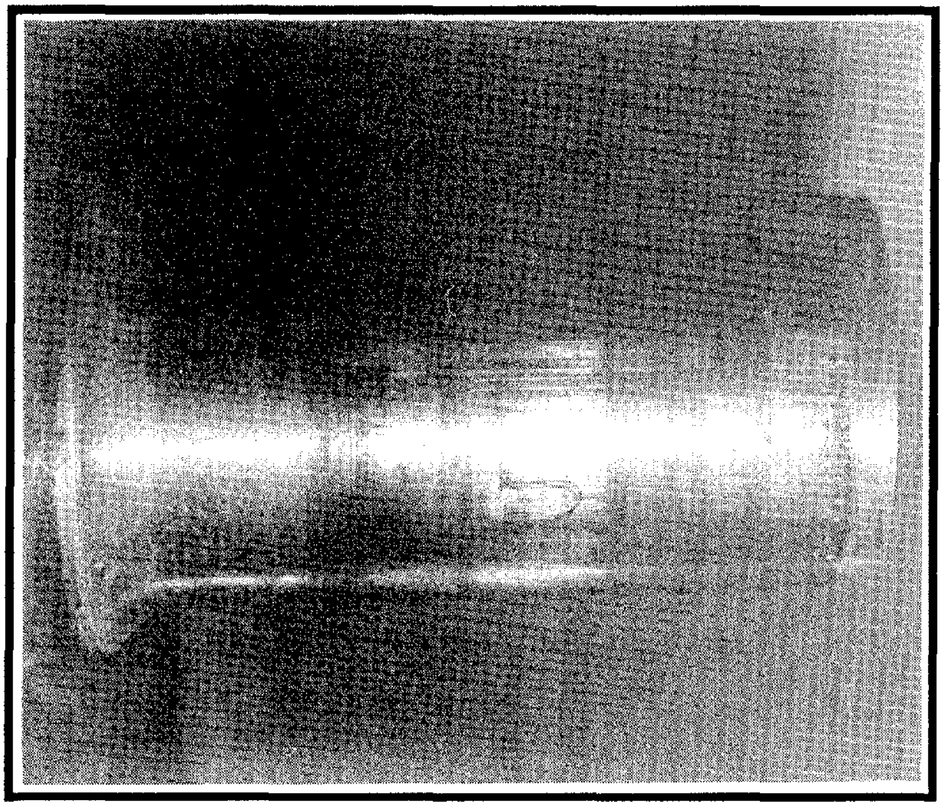


Figure 77. RBFM II Post Test Axle Journal Condition – Bearing J

Bearing K

Post test inspection of bearing K showed that the inboard cone bore diameter increased from 6.1895 inches to 6.1897 inches due to rotation of the cone on the axle journal, while the outboard cone bore diameter remained unchanged at 6.1894 inches. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard cone seat decreased from 6.1903 inches to 6.1900 inches during the test, while the diameter at the outboard cone seat remained unchanged at 6.1902 inches. Figure 78 shows the condition of the axle journal at the completion of the test.

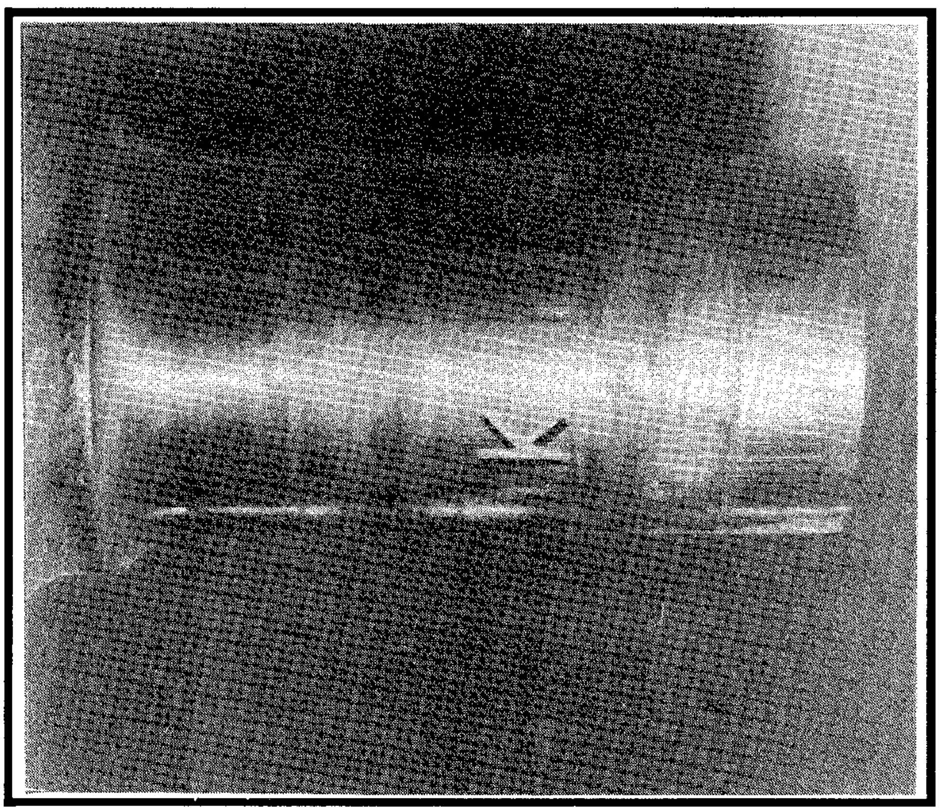


Figure 78. RBFM II Post Test Axle Journal Condition -- Bearing K

Bearing L

Post test inspection of bearing L showed that the bcre diameter of the inboard and outboard cones remained unchanged at 6.1890 inches and 6.1889 inches, respectively. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard and outboard cone seats remained unchanged at 6.1905 and 6.1904, respectively. Figure 79 shows the condition of the axle journal at the completion of the test.

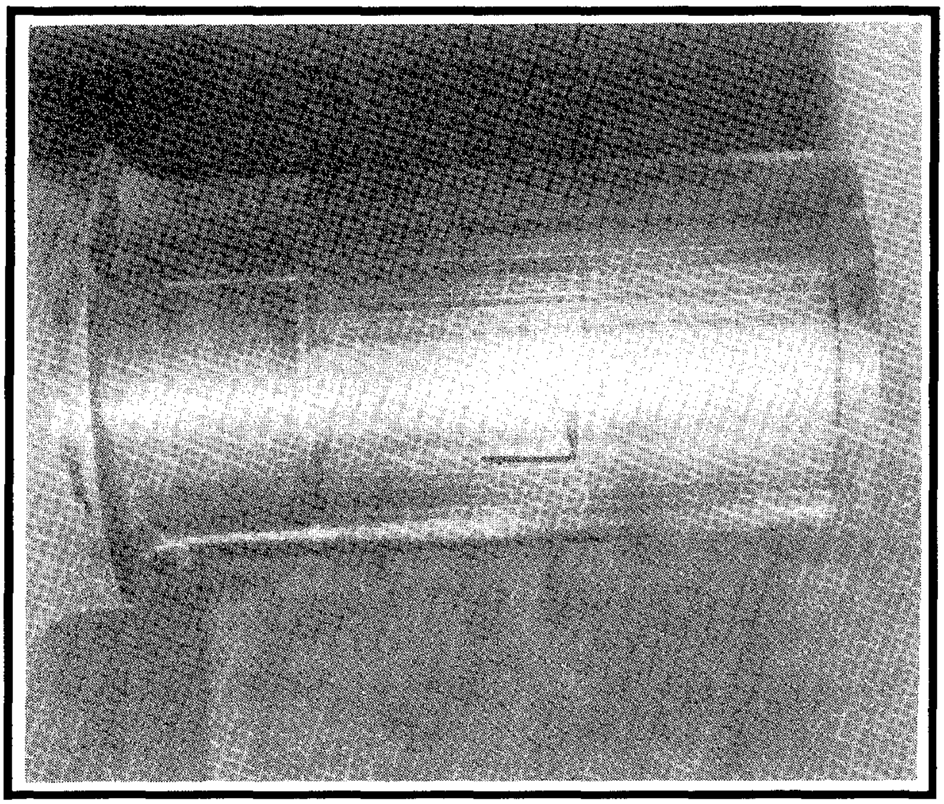


Figure 79. RBFM II Post Test Axle Journal Condition – Bearing L

Bearing M

Post test inspection of bearing M showed that the bore diameter of the inboard and outboard cones remained unchanged at 6.1889 inches and 6.1887 inches, respectively. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard and outboard cone seats remained unchanged at 6.1904 and 6.1902, respectively. Figure 80 shows the condition of the axle journal at the completion of the test.

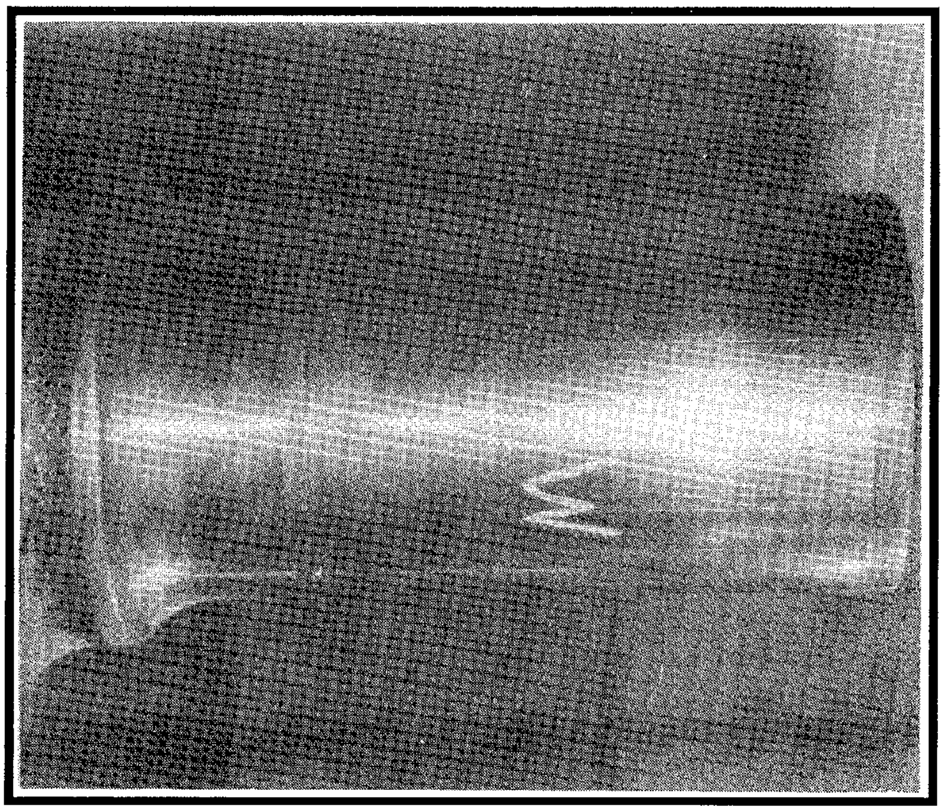


Figure 80. RBFM II Post Test Axle Journal Condition -- Bearing M

Bearing N

Post test inspection of bearing N showed that the bore diameter of the inboard and outboard cones remained unchanged at 6.1890 inches and 6.1889 inches, respectively. No defects developed on any of the other bearing components during the test.

The axle journal diameter at the inboard and outboard cone seats remained unchanged at 6.1905 inches and 6.1904 inches respectively. Figure 81 shows the condition of the axle journal at the completion of the test.

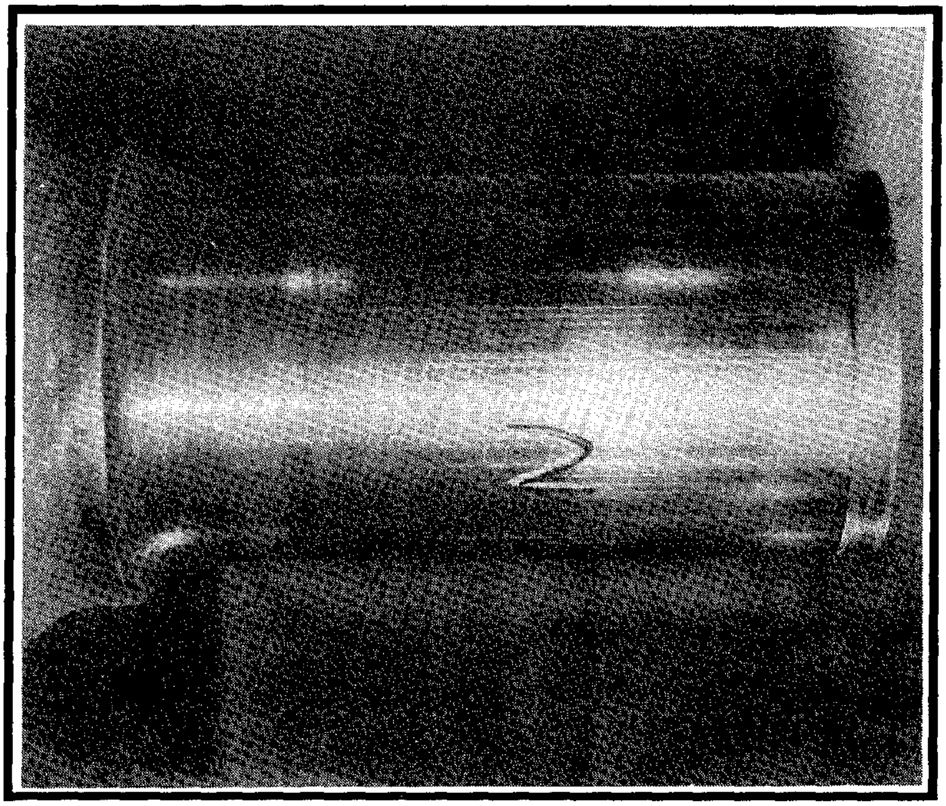


Figure 81. RBFM II Post Test Axle Journal Condition – Bearing N

Bearings O through V

Post test inspection of bearings O through V showed no increase in bore diameter of any of the cones nor did any defects develop on the other components of these bearings during the test.

A summary of the journal measurements for all of the axles is provided in Table 17.

Table 17. RBFM II Post Test Axle Journal Measurements

BEARING	OBWR	OBCS	IBCS	IBWR
C	6.1893	6.1890	6.1894	6.1895
D	6.1895	6.1890	6.1286	6.1897
E	6.1895	6.1892	6.1894	6.1898
F	6.1894	6.1894	6.1895	6.1898
G	6.1900	6.1898	6.1900	6.1903
H	6.1901	6.1898	6.1899	6.1902
I	6.1901	6.1898	6.1900	6.1903
J	6.1903	6.1902	6.1903	6.1903
K	6.1902	6.1902	6.1900	6.1904
L	6.1905	6.1904	6.1905	6.1905
M	6.1902	6.1902	6.1904	6.1905
N	6.1905	6.1901	6.1906	6.1905
O	6.1900	6.1900	6.1900	6.1901
P	6.1905	6.1905	6.1905	6.1905
Q	6.1905	6.1905	6.1905	6.1905
R	6.1908	6.1908	6.1907	6.1908
S	6.1905	6.1904	6.1903	6.1904
T	6.1900	6.1900	6.1900	6.1900
U	6.1915	6.1915	6.1915	6.1915
V	6.1914	6.1914	6.1914	6.1914

4.4 LOW FRICTION SEALS

At the completion of the on-track tests, the bearings equipped with the low friction seals were removed and inspected to document condition of the seal and bearing components and determine the quantity of grease remaining in the bearings.

There were no defects on any of the seals or bearing components. A summary of the grease content of each bearing and the amount of grease lost during the on-track tests is provided in Table 18.

Table 18. Low Friction Seal Grease Leakage Summary

BEARING	INITIAL GREASE CHARGE (ounces)	FINAL GREASE CHARGE (ounces)	LEAKAGE (ounces)
1	24	21.75	2.25
2	24	21.44	2.56
3*	24	18.25	5.76

***Bearing that sustained seal damage during 5,000 mile test on RTT**

4.5 CONE BORE GROWTH/RUN-IN TEMPERATURE TEST

The bearings were operated for 7,000 miles on the HTL during the test. Temperature data from each of the bearings was monitored on a daily basis. Figure 82 is a graphical representation illustrating the typical thermal behavior of the bearings. The average temperature of the bearings with similar interference fit and grease content are plotted as a function of elapsed time.

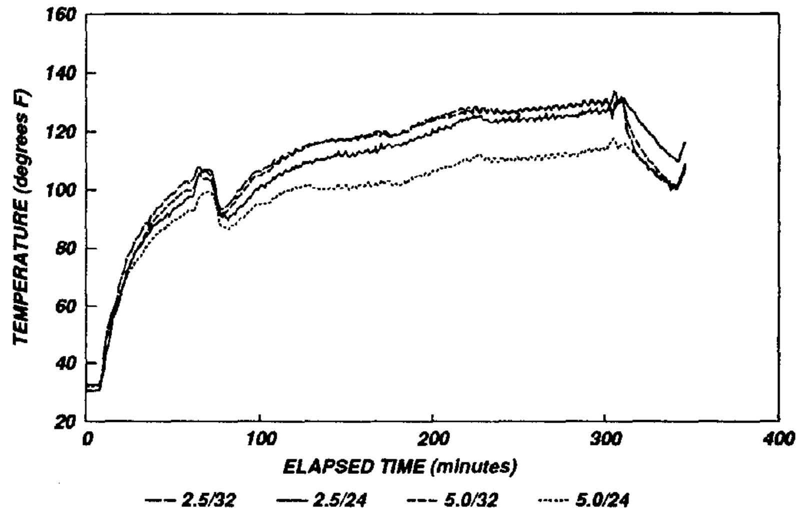


Figure 82. Thermal Behavior vs. Elapsed Time -- Initial 250 Miles of Operation

Inspection of Figure 82 shows that the bearings with a 0.005 inch interference fit charged with 32 ounces of grease had the highest operating temperature, while the operating temperature of the bearings with a 0.005 inch fit charged with 24 ounces of grease was approximately 20 F° lower.

At the completion of the on-track tests, the bearings and axles were inspected. A summary of the axle journal measurements obtained during the inspection are provided in Table 19.

Table 19. CBG Post Test Journal Measurement Summary

BEARING ID	OBCS (inches)	IBCS (inches)
1A	7.0038	7.0041
1B	7.0035	7.0036
2A	7.0036	7.0040
2B	7.0038	7.0041
3A	7.0036	7.0037
3B	7.0033	7.0036
4A	7.0034	7.0037
4B	7.0037	7.0038
6A	7.0028	7.0029
6B	7.0028	7.0028
7A	7.0029	7.0032
7B	7.0028	7.0028
5A	7.0028	7.0028
5B	7.0028	7.0028
8A	7.0026	7.0028
8B	7.0028	7.0028

The bearings were returned to Brenco where the cones were measured to determine bore growth. A summary of the cone diameter measurements and the growth that occurred during the test is provided in Table 20.

Table 20. CBG Post Test Cone Diameter Measurement Summary

BEARING ID	OBCS (inches)	GROWTH (inches)	IBCS (inches)	GROWTH (inches)
1A	7.00170	0.00010	7.00175	0.00015
1B	7.00150	0.00050	7.00115	0.00005
2A	7.00140	0.00030	7.00150	0.00020
2B	7.00175	0.00035	7.00165	0.00015
3A	7.00150	0.00040	7.00140	0.00030
3B	7.00090	0.00010	7.00100	0.00010
4A	7.00180	0.00040	7.00170	0.00040
4B	7.00130	0.00010	7.00135	0.00015
5A	6.99835	0.00060	6.99780	0.00050
5B	6.99865	0.00035	6.999790	0.00060
6A	6.99810	0.00030	6.99855	0.00025
6B	6.99830	0.00060	6.99870	0.00060
7A	6.99840	0.00040	6.99870	0.00040
7B	6.99805	0.00025	6.99850	0.00050
8A	6.99815	0.00065	6.99820	0.00035
8B	6.99870	0.00075	6.99845	0.00055

4.6 ROLLER BEARING DEFECT GROWTH RATE TEST

The 100-ton capacity bearings completed 19,000 miles of operation during the test. The bearings were inspected at the completion of the on-track tests to document the number and size of the raceway defects. A summary of the inspection results for each defect type is provided below:

CUP RACEWAY BRINELLING

The Brinelling defects in the bearing cup raceway did not increase in severity nor did any new Brinelling develop during the test.

CUP RACEWAY SPALL

The spall in the cup raceway increased from 0.06 sq-in to 0.11 sq-in. No additional spalls developed during the test.

CONE RACEWAY SPALL

The spall in the cone raceway did not increase from its initial size of 0.76 sq-in, nor did any additional spalls develop during the test.

Due to the unavailability of a suitable car until March 1990, the 70-ton capacity bearings only completed 4,000 miles of operation during the test. No measurable growth was observed on any of the defect types in these bearings.

5.0 CONCLUSIONS

The following subsections provide a summary of the conclusions for each test.

5.1 RBFM I TEST

- Bearings on grooved axle journals developed measurable temperature gradients across the cup surface which may be useful in identifying wheel sets with this defect type.
- Wayside detector alignment and scan location are critical factors in successful detection of an overheated bearing.
- Cone slippage was detected on all bearings having less than 0.0015 inch fit that were equipped with motion detection instrumentation.
- Bearing failure was not initiated by the removal of a cage spacer bar.
- The performance of the experimental low friction seals during the test was acceptable.
- Research using degraded roller bearings can be performed safely.

5.2 WHEEL ANOMALY TEST

- The wheel tread defects did not produce significant accelerations in the body of the car for the speed range tested.

- The peak loads produced at the bearing adapter were significantly lower than those produced at the wheel/rail interface for all of the wheel tread defects tested.
- The vertical acceleration measured at the bearing adapter increased with increasing train speed for most of the tread defects.

5.3 RBFM II TEST

- No over-temperature events occurred for any of the bearings during the test.
- Cone slippage resulted in measurable loss of material on the axle journals and cones for eight of the twenty test bearings.
- A grooved axle condition developed in bearing D during the test. The operating temperature and the acoustic emissions of the bearing did not provide any indication that the axle was grooved.
- No other defects developed on the components of any of the bearings used in the test.
- The experimental seals provided an acceptable level of performance under simulated revenue service conditions.
- No mechanical failures occurred on the hot bearing detector bolts provide by RASTECH, Incorporated and the 3M Company.

5.4 CONE BORE GROWTH TEST

- The bearings with a 0.005 inch interference fit charged with 32 ounces of grease had the highest operating temperature.
- The 0.0025 and 0.005 inch interference fit bearings charged with 24 ounces of grease had lower average operating temperatures than similar bearings charged with 32 ounces of grease. The effect of grease content on operating temperature was more pronounced for the bearings with a 0.005 inch interference fit.
- The bearings with higher operating temperatures experienced more cone bore growth than those with lower operating temperatures.

5.5 RACEWAY DEFECT GROWTH TEST

- No measurable growth occurred for any of the defects in the 70-ton capacity bearings during the test.
- No measurable growth occurred for the Brinell and cone spall defects in the 100-ton capacity bearings during the test.
- Measurable growth occurred for the cup spall defect in the 100-ton capacity bearings during the test.
- No overtemperature event occurred for any of the bearings used in the test.

6.0 RECOMMENDATIONS

The following recommendations are made based on the results obtained in this research program:

- Continue operating selected test bearings (C through N) under loaded car conditions as a part of the HAL consist during the 100-MGT extension of the HAL program to obtain additional information of the bearing failure process.
- Develop and test a prototype wayside detection system using infrared and acoustic techniques to identify defective bearings based on temperature gradient and acoustic emission data.
- Continue operating the 125-ton capacity bearings used in the CBG test under loaded car conditions as a part of the HAL consist during the 100-MGT extension of the HAL program to obtain additional data on the growth behavior of bearing cones.
- Continue operating the 100-ton capacity bearings used in the RDG test under loaded car conditions as a part of the HAL consist during the 100-MGT extension of the HAL program to obtain addition information on the growth behavior of raceway defects.

APPENDIX

MANUAL OF STANDARDS AND RECOMMENDED PRACTICES
SECTION H - PART II

Association of American Railroads

OPERATIONS AND MAINTENANCE DEPARTMENT

MECHANICAL DIVISION

MANUAL OF STANDARDS
AND
RECOMMENDED PRACTICES
SECTION H - PART II

ROLLER BEARING MANUAL

MANDATORY STANDARDS, RECOMMENDED PRACTICES AND GENERAL INFORMATION

Adopted, January 1, 1969

Ninth Edition

Revised 1985
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INTRODUCTION

Bearing maintenance is one of the most important functions performed by the Mechanical Department on American Railroads. The purchase of bearings and the labor to mount and maintain them requires very large annual expenditures. About one million new or reconditioned bearings are mounted each year. These expenditures justify special efforts to establish good workmanship and maintain the best practices which are currently available.

This Manual has been prepared for employees responsible for bearing work in shop and inspection on line. It is essential that they have a thorough understanding of their work and detailed study of this Manual will aid them very much. It is desirable for any employee having anything to do with bearing work to have a general knowledge of the subjects in this Manual even though his duties may not involve all phases of the subject.

It is also to be expected that each carbuilder, whether railroad or car manufacturing company, will provide itself with the necessary gages for its own protection and will make spot checks, and any additional checks, that may be deemed necessary to insure proper fit of all truck components.

The carbuilder, the railroad shops, contract shops or subcontractors, shall be responsible for:

a. Mounting of wheels
b. Mounting of bearings
c. Quality control program as to workmanship entering into the above steps.

The purpose of this Manual is to cover the best available practices in the field. There are methods of performing certain classes of work other than those described but the experience of many has been assembled and is here made available to all.

AAR requirements and recommended practices for wheel and axle and roller bearing mounting shops are covered in the Wheel and Axle Manual.

Revisions to the Roller Bearing Manual will be issued periodically. The Manual of Standards and Recommended Practices and the Interchange Rules are revised annually or more often, if necessary. Frequent reference should be made to both.

All approved Wheel and Axle Shops, Bearing Mounting Shops and Bearing Reconditioning Shops are listed in a quarterly publication which includes the identifying marks to be used in wheel and roller bearing mounting stamping and roller bearing marking. Each of these shops will be inspected periodically in accordance with the general procedures established by Section A. Rule 120, of the Field Manual of the A.A.R. Interchange Rules. Work done by shops which are not "APPROVED" is not acceptable in interchange service and is not considered as "correct repairs" for car repair billing.

Requests for approval of roller bearing reconditioning shops must be directed to the Secretary of the Mechanical Division, Association of American Railroads, 50 F Street, NW, Washington, DC 20001, and include the location of the facility, makes of bearings that will be reconditioned and the name of the railroad or company. This request should include a statement that the shop has been made ready for inspection and is capable of meeting the minimum AAR requirements in accordance with the Roller Bearing Manual.

All non-members must remit a check in the amount shown in Office Manual Rule 120, payable to the Association of American Railroads, prior to the inspection to defray the expenses for each inspection. Shops failing to qualify for certification will be charged an additional amount for each visit until approved. Approved shops shall be periodically inspected by the AAR Mechanical Inspection Department and failure to perform work in accordance with the Roller Bearing Manual would be justification for removal from the approved list, until specific conditions or violations are corrected.

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MANDATORY INSTRUCTIONS AND PRACTICES

RULE 1.1

All shops reconditioning roller bearings for interchange operations must meet the requirements of this manual in order to qualify and receive approval from the AAR Mechanical Division for interchange billing.

RULE 1.2

New roller bearings must conform to the latest revised AAR Specification M-934.

RULE 1.3

Where questions arise in connection with failures or other conditions, manufacturer's representative should be consulted with respect to his product.

RULE 1.4

When cars equipped with roller bearing units are involved in a fire, the heat may be sufficient to temper the bearings rings and/or destroy the lubricant and/or seals. Special examination is required in such instances. Similar damage may also occur in car thawing operations, particularly where open flames are employed. Wheel assemblies are to be inspected in accordance with Wheel and Axle Manual and roller bearings dismantled and examined for defects in accordance with Roller Bearing Manual with special attention being given to determine if excessive heat has affected any of the bearing parts.

RULE 1.5

When cleaning cars or trucks equipped with roller bearings, care should be exercised not to direct steam jet or water jet spray toward seal or vents of roller bearings.

RULE 1.6

Electrical current must never be passed through roller bearings as it may cause arcing within the bearing causing damage. All welding shall be done with ground cable attached so that the circuit formed shall not allow electrical current to flow through roller bearings.

RULE 1.7

Heating or cutting torch when used around roller bearings must never have heat directed on any portion of the roller bearing assembly. Care should be taken that cutting fragments are not directed toward the roller bearing assembly. Heating torch must never be used to heat lubricant fitting or plug for removal.

RULE 1.8

When bearing failure occurs due to overheating, a roller bearing failure report (AAR Form MD-11) must be completed for the "field inspection" part and forwarded to the AAR. The outer ring of overheated bearings must be properly identified. The complete roller bearing-wheel assembly may be forwarded to a point designated by the railroad removing the assembly for inspection to determine the cause of overheating. If this inspection is made, the "shop inspection" part of AAR form MD-11 should be completed and forwarded to the AAR.

RULE 1.9

Plating, metal spray, welding or any other method of building up bearing parts is prohibited, except plating is permissible by bearing manufacturers or their authorized representatives on all surfaces except raceway and roller surfaces and the seal wear ring outer diameter.

RULE 1.10

"Abrasive cleaning materials and processes (sand blasting and so forth) must never be used to clean inner rings, rollers or inner surfaces of outer rings. However, external surfaces of outer rings and other parts subject to corrosion and paint accumulation may be cleaned by use of abrasive material. All parts cleaned in this manner must have all abrasive matter removed and be thoroughly cleaned prior to reuse and must meet all finish requirements specified in this Manual. Parts, such as vents in backing rings, must be protected from damage by the cleaning process used."

RULE 1.11

Bearing parts of different roller bearing manufacturers must never be mixed nor interchanged in the same assembly, except as designated by the AAR in Section 7 of this Manual. This restriction also applies to bearings made by the same bearing manufacturer which have different AAR approval numbers (see manufacturer's specification sheet).

RULE 1.12

Waste must not be used to clean roller bearings. Clean towels free from lint must be used.

RULE 1.13

Roller bearing having AAR approval certificates are shown in Figure 3.4 of this manual. Approved roller bearing reconditioning shops are shown in Section 2, Figure 2.1 of this manual (up-dated quarterly by Mechanical Division Circular Letters).

RULE 1.14 TERMINOLOGY AND CLASSIFICATION OF BEARINGS AND PARTS

In order to correctly identify bearing designs and parts, the following will apply:

Roller bearings are of two general arrangements — Housing and Rotating End Cap. In a housing bearing, the end cap, if so equipped, is enclosed while in the rotating end cap bearings the end cap is exposed. (See Fig. 1.1.)

Roller Bearings are of two general designs—Tapered (Fig. 1.2 and 1.2A) and Cylindrical (Fig. 1.3A). Roller bearings can also be classified into "Field Lubrication" and "No Field Lubrication" (NFL) types. Figures 1.2, 1.2A and 1.3A show bearings which are not designed to be lubricated in the field and do not have a lubricant or grease fitting. NFL, "no field lubrication," bearings are those with no lubrication fitting hole or with the lubrication fitting removed and the hole plugged with a non-removable plug.

Terminology	**Description of Bearing Parts**
Outer Ring	Cup or Outer Race.
Inner Ring	Cone or Inner Race.
Raceways	Surfaces of Outer and Inner Ring on which Rollers operate.
Rollers	Cylindrical Rollers or Tapered Rollers.
Cage	Retainer; Separator.
Roller Assembly	Rollers with Inner Ring and Cage, separable or non-separable.
Spacer	Spacer, Spacer Ring; Cone Spacer.
Seal	Seal proper.
Seal Wear Ring	Ring on which seal rides or makes contact.
End Cap	Cap at end of journal; Axle end cap; Locking cup; End Cover.
Backing Ring	Collar between bearing and journal fillet; Axle Collar; Dust Guard Ring; Enclosure Collar.
Fitted Backing Ring	Backing ring with extension to provide press fit with suitable diameter axle dustguard seat.
Cap Screws	End cap fasteners.
Cap Screw Seal Ring	Elastomeric rings on cap screws between end cap and axle.
Locking Plate	Cap Screw Locking device.
Non-Removable Plug	Plug to replace grease fitting for bearings not requiring field lubrication.

RULE 1.15 TERMINOLOGY AND DESCRIPTION OF AND LIMITS FOR BEARING DAMAGE

Terminology	Description of and Limits for Bearing Damage.
Etching (1)	Gray or grayish black color, caused by water or acidity in the lubricant. Has little depth. Superficial water or acid etching, as shown in Fig. 1.4B is acceptable after surfaces have been polished. Slight pitting after polishing is acceptable.
Stain Discoloration (2)	Surface discoloration caused by moisture or acidity in the lubricant. Has no depth. Stains and discoloration having no depth, as shown in Fig. 1.4A, are not considered detrimental if they can be removed by polishing with a wire wheel or 180 grit abrasive cloth or wheel with similar abrasive qualities.
Corrosion Pitting & Rust (3)	Black corrosion lines or pit marks. Can have some depth. Rust is build up of iron oxide, sometimes due to finger prints and is a form of advanced etching. Corrosion pitting or rusting which has advanced to severe pitting, as shown in Fig. 1.4C, must be repaired by polishing the raceways and rollers with a wire wheel and polishing rouge or fine emery cloth before reuse, as shown in Fig. 1.4D. Slight pitting after polishing is acceptable. Parts which cannot be satisfactorily repaired by polishing must be rejected, except inner and outer rings which may be suitable for regrinding by the original manufacturer (see Section 6).
Heat Discoloration (4)	Color visible, from faint straw to dark blue may be an indication of overheating (heat discoloration should not be confused with lubricant stain or the dark coating used on certain parts by some manufacturers.) Parts should be rejected only if there is other evidence of overheating. Overheating from an internal source generally originates in the roller inner ring rib contact area and will usually be indicated by visible inner ring rib and/or roller end face wear. Overheating from an external source would usually show indications on both the outside and inside. In case of doubt, consult the manufacturers representative.
Fatigue Cracks (5)	Minute cracks in load carrying surfaces which are first indication of metal failure, should be ground out as in Figure 1.6 to preclude spalling.
Fatigue Spalling or Flaking (6)	Originates as minute fatigue cracks and eventually pieces of metal drop out. This occurs in roller path of inner and outer rings and in roller surface. Rollers with spalls must be rejected. However, pits, bruises and indentations due to lubricant contaminants are acceptable for further service. Incipient spalls on inner and outer ring raceways as shown in Figs. 1.6A and B may be repaired by grinding, as noted below, and returned to service. If a spall, as shown in Fig. 1.6C results in a repaired spall greater than 3/8″ on any side by 1/8″ deep, the part must be rejected and not returned to service. Maximum repaired spall size can be measured with gage shown in Fig. 1.5E.
	A small portable hand grinder, Fig. 1.6D, may be used to repair spalled areas as follows:

All loose material should be ground away and the edges of the ground area rounded with 320 grit abrasive cloth. The bottom of the spalled area need not be polished smooth. Not more than two spalls of maximum size 3/8″ on any side by 1/8″ deep after repair by grinding are permitted in a 2″ circumferential section of a raceway. Not more than four spalls 1/16″ by 1/16″ or less are to be repaired by grinding in a 2″ circumferential section of a raceway. A bridge, 3/16″ long minimum, must be left between two small spalls after grinding, except if spalls have run together, a final maximum dimension of 3/8″ in length x 1/8″ in depth is allowable. Fine abrasive grinding wheels, approximately 5/16″ or less in diameter with 1/8″ or 1/4″ diameter shanks, should be used repairing bearing spalls.

If the raceway of a bearing inner ring is spalled (where roller assembly is non-separable), this part is reuseable only if cage is removed and spall or spalls repaired as described above. A new cage must be used and reassembly must be done by the original manufacturer. Small spalls on the raceway, not more than 3/32″ by 3/32″ in size, are acceptable for further service. Inspection for spalls can be made with a probe as shown in Fig. 3.7 and with inspection stand shown in Fig. 3.8.

Fracture (7) — Crack extending across entire width of inner or outer ring or a roller is cause for scrapping.

Nicks (8) — Surface damage due to rough handling or other abuse should be stoned smooth if raised.

Peeling (9) — Condition caused by minute particles of metal peeling away from the original surface.

Bearing outer rings, inner rings and rollers having very shallow peeling (usually less than 0.001″ deep) on the raceway or roller diameter, as shown in Figures 1.7A and 1.7B may be returned to service.

Smearing (10) — Surface roughness caused by transfer of metal from one surface to another as a result of galling. This can be caused by rollers sliding on roller path because of adverse lubricating conditions.

Bearing outer rings and inner rings having very shallow smearing (usually less than .001″ build-up) on the raceway, as shown in Fig. 1.7C, may be returned to service after polishing. Inner rings having very shallow smearing (where roller assembly is non-separable) can be reused only if cage is removed and smearing is polished. A new cage must be used in the reassembly and must be done by the original manufacturer.

Where cages are removed, smeared rollers must be polished or scrapped. Roller must be maintained as a set.

Brinelling (11) — Surface indentations in raceways made by rollers under impact load. Parts from each bearing must be kept together during disassembly, cleaning and inspection to insure proper identification of the mating parts to enable adequate disposition for brinelling. Brinelling is caused by the rollers being forced into the surface of either raceway while the bearing was subjected to heavy impact loading beyond its capacity. Brinelling can only be repaired as indicated in Section 6.

Bearing Outer Ring — If the length of a brinell mark is less than half the width of the raceway, as shown in Figs. 1.5, A and B, and if its width, at the widest point, does not exceed 5/32″ as measured with the gage in Fig. 1.5E, the bearing outer ring is acceptable for further service. If the length of a brinell mark is more than half the width of the raceway, as shown in Fig 1.5C, and if its width, at the widest point, does not exceed 3/32″ (recommended gage in Fig. 1.5E), the Bearing Outer Ring is satisfactory for further service. Any number of brinell marks is permissible. If a brinell mark exceeds either of these limitations, the Bearing Outer Ring must be rejected. Fig. 1.5D shows a brinell mark which would exceed either limitation. Cracks associated with brinells as well as other cracks in raceways and counterbores not in conjunction with repairable fatigue are also cause for rejection.

Bearing Inner Ring (Roller assembly non-separable) — Bearing Inner Rings may be considered satisfactory for further service if the mating Bearing Outer Ring raceways are suitable for further service. However, if the mating Bearing Outer Ring raceway has been rejected because of brinell marks, the roller assembly must be rejected or cage may be removed so that roller path of Bearing Inner Ring can be thoroughly inspected or the Bearing Inner Ring may be inspected by other methods authorized by the AAR to determine suitability for reuse. If the length of a brinell mark is less than half the width of the raceway, as shown in Figs. 1.5, A and B, and if its width at the widest point, does not exceed 5/32″ as measured with the gage in Fig. 1.5E, the Bearing Inner Ring and Roller Sets are acceptable for further service. If the length of a brinell mark is more than half the width of the raceway, as shown in Fig. 1.5C, and if its width, at the widest point, does not exceed 3/32″ as measured with the gage in Fig. 1.5E, the Bearing Inner Ring is satisfactory for further service. Any number of brinell marks is permissible. If a brinell mark exceeds either of these limitations, the Bearing Inner Ring and Roller Sets must be rejected. Figure 1.5D shows a brinell mark which would exceed either limitation. Cracks associated with brinells as well as other cracks in raceway not in conjunction with repairable fatigue are also cause for rejection. Serviceable Bearing Inner Ring and Roller Sets can be reused only if a new cage is used in the reassembly and must be done by the original manufacturer.

Where cages are removed, the rollers must be maintained as a set.

Bearing Inner Ring (Roller assembly separable) — If the length of a brinell mark is less than half the width of the raceway, as shown in Figs. 1.5, A and B, and if its width, at the widest point, does not exceed 5/32″ as measured with the gage in Fig. 1.5E, the Bearing Inner Ring and rollers are acceptable for further service. If the length of a brinell mark is more than half the width of the raceway, as shown in Fig. 1.5C, and if its width, at the widest point, does not exceed 3/32″ as measured with the gage in Fig. 1.5E, the Bearing Inner Ring is satisfactory for further service. Any number of brinell marks is permissible. If a brinell mark exceeds either of these limitations, the bearing inner ring and rollers must be rejected.

Figure 1.5D shows a brinell mark which would exceed either limitation. Cracks associated with brinells as well as other cracks in raceway are also cause for rejection.

Indentations (12)

Visible recesses on surfaces of raceways or rollers, also called Fragment Indentations. Caused by foreign matter passing through bearing while loaded. Surface damages, as shown in Fig. 1.8, usually caused by contaminants in the lubricant, is not cause for rejecting bearing parts, unless the damage is such that roughness can be detected when the bearing is rotated by hand.

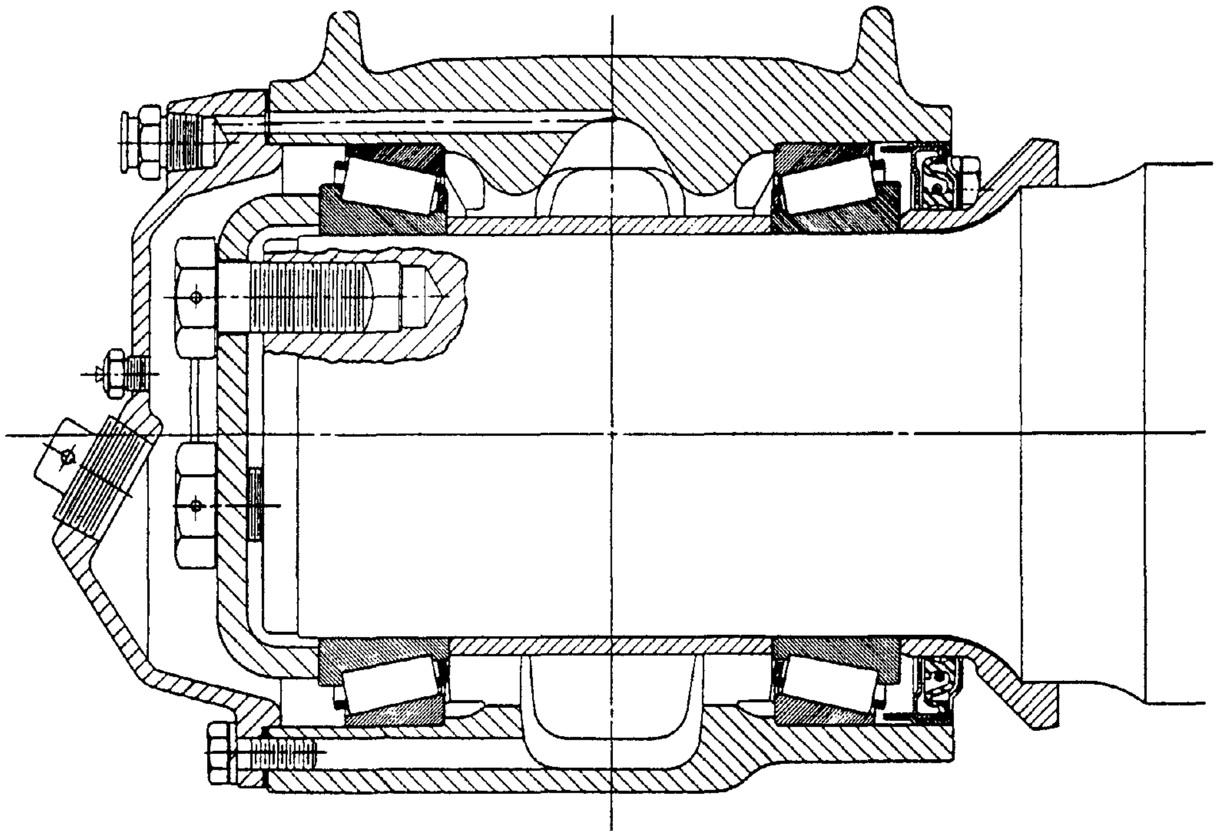
Electric Burns (13)

Surface damage from passage of electric current causing localized craters, pits, fluting or corrugations. Pitting, shown in Fig. 1.9A and B, is the result of electric current passing through the bearing, such as when the ground cable is clamped to the rail or wheel for arc-welding repairs on cars. Parts so affected must be rejected. Although only one pit is shown in the photographs, pitting may occur at several points simultaneously on any or all bearings on the car when arc-welding is used for repair work, if the ground cable is not clamped to or near the part being welded as recommended. **Welders must attach the ground cable so that the circuit formed will not allow current to flow through the roller bearings.**

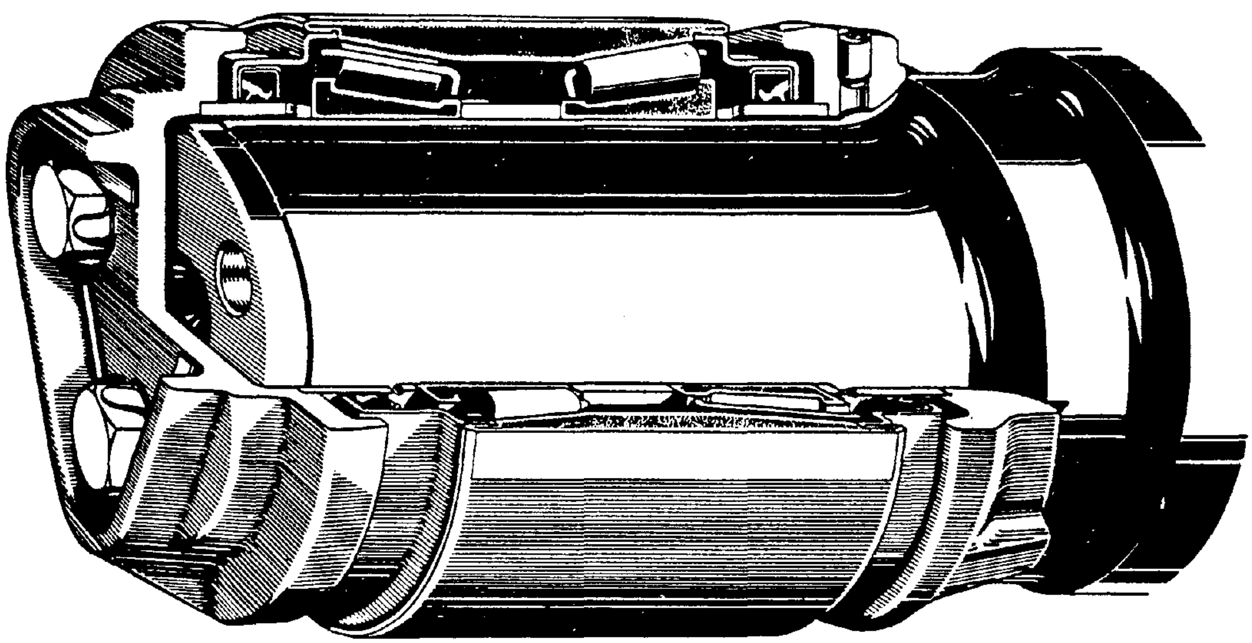
Fluting or corrugations, as shown in Fig. 1.10, result from electric current passing through the rotating bearing. The parts of bearings so affected must be rejected.

Scoring (14)

Parallel or concentric grooves which penetrate the original surface. They can be circumferential or axial. Scoring may be repaired in the same manner and under the same limitations as fatigue spalling.

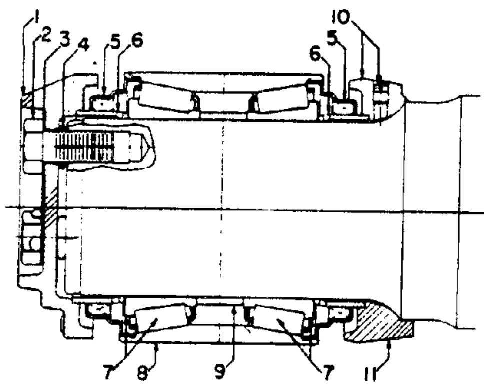


Housing type may have tapered or cylindrical rollers, tapered shown.

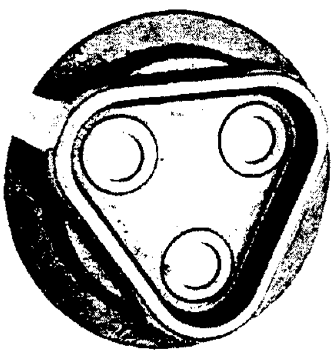


Rotating end cap type may have tapered or cylindrical rollers, tapered shown.

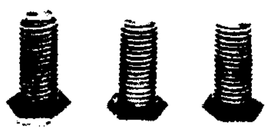
Fig. 1.1 General Arrangements of Roller Bearings



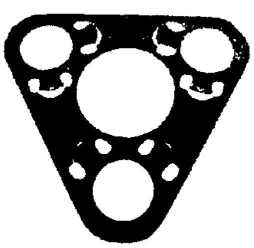
1. End Cap
2. Cap Screws
3. Locking Plate
4. Cap Screw Seal Rings
5. Seal
6. Seal Wear Ring
7. Roller Assembly (Includes Rollers, Cage, and Inner Ring.)
8. Outer Ring
9. Spacer
10. Backing Ring (With Vent Fitting.) Inboard seal wear ring and backing ring are one piece on bearings of some manufacturers.
11. Fitted Backing Ring - Extension press fitted over axle dust guard seat. Otherwise same as 10.



1. End Cap



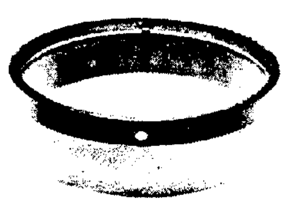
2. Cap Screws



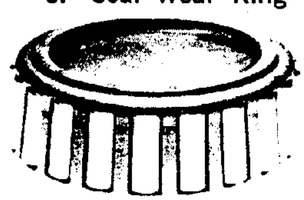
3. Locking Plate

4. Cap Screw Seal Rings

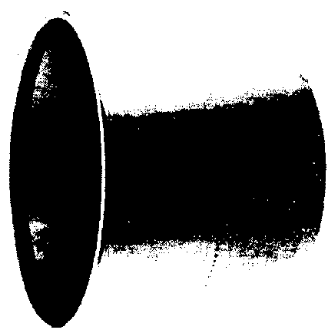
5. Seal



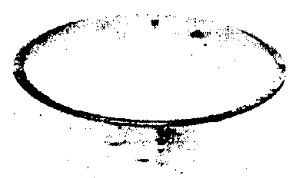
6. Seal Wear Ring



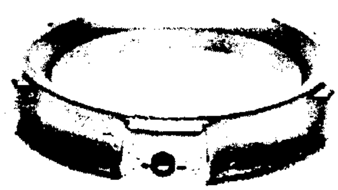
7. Roller Assembly



8. Outer Ring



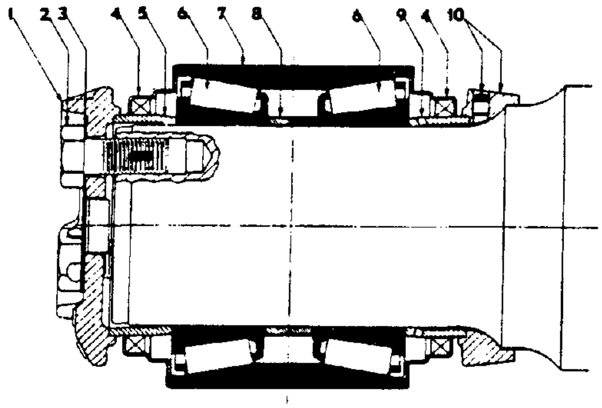
9. Spacer



10. Backing Ring - Nonfitted Type (With Vent Fitting.)

Fig. 1.2

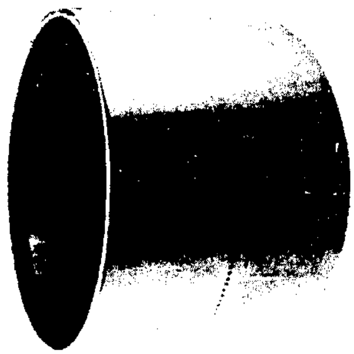
Identification - Journal Roller Bearing Parts of Tapered Roller Bearing with Rotating End Cap. (Roller Assembly & Inner Ring Non-separable.) - No Field Lubrication Provisions.



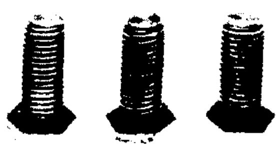
1. End Cap
2. Cap Screws
3. Locking Plate
4. Seal
5. Seal Wear Ring
6. Roller Assembly (Includes Rollers, Cage, and Inner Ring.)
7. Outer Ring
8. Spacer
9. Seal Wear Ring
10. Backing Ring

1. End Cap

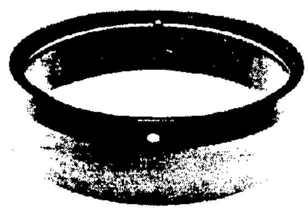
4. Seal



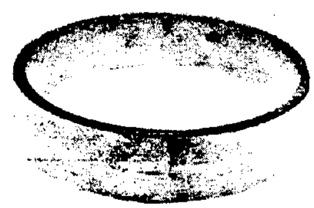
7. Outer Ring



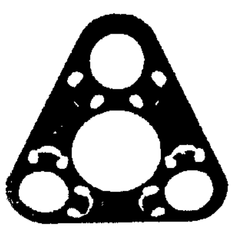
2. Cap Screws



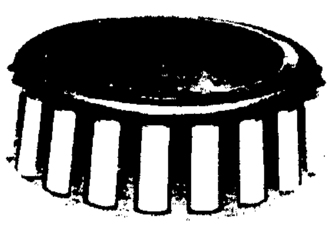
5 and 9. Seal Wear Ring



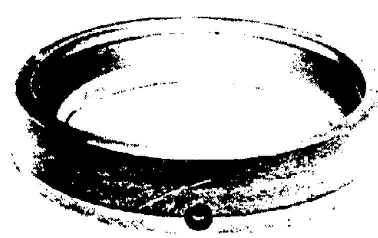
8. Spacer



3. Locking Plate



6. Roller Assembly

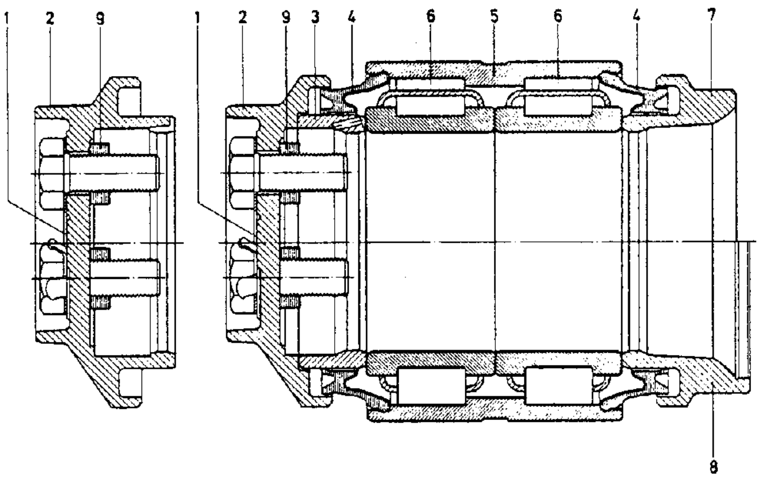


10. Backing Ring

Fig. 1.2A

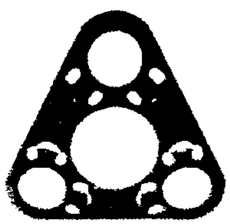
Identification Journal Roller Bearing Parts of Tapered Roller Bearing with Rotating End Cap (Roller Assembly and Inner Ring Non-separable — No Field Lubrication Provisions.) Refer to Manufacturer's Specification Sheets for Details.

(AAR Cert. Nos. 20, 21, 24 and 25)

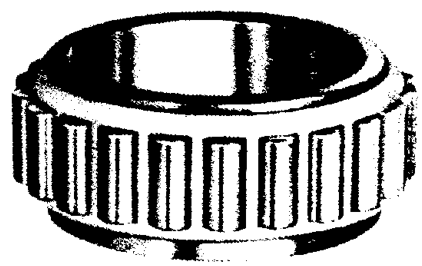


1. Locking Plate
2. End Cap (with integrated or separate seal wear ring)
3. Seal Wear Ring
4. Seal
5. Outer Ring
6. Roller Assembly (includes Rollers, Cage and Inner Ring)
7. Backing Ring
8. Backing Ring (fitted)
9. Cap Screw Seal Rings

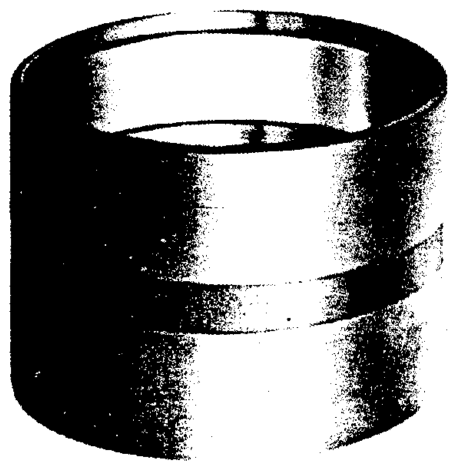
4. Seal

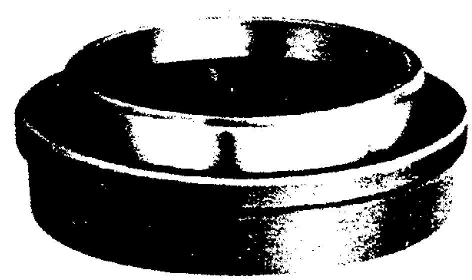


1. Locking Plate

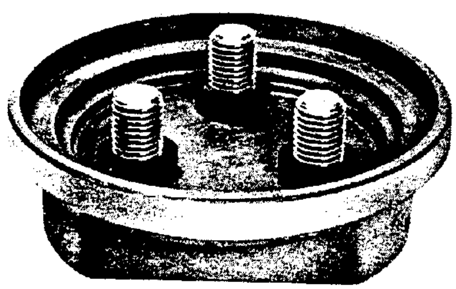


6. Roller Assembly





5. Outer Ring



2. End Cap
(With Cap Screws and
Cap Screw Seal Rings)

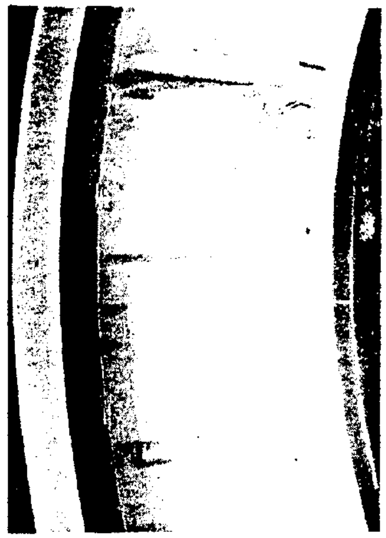
7. Backing Ring

Fig. 1.3A

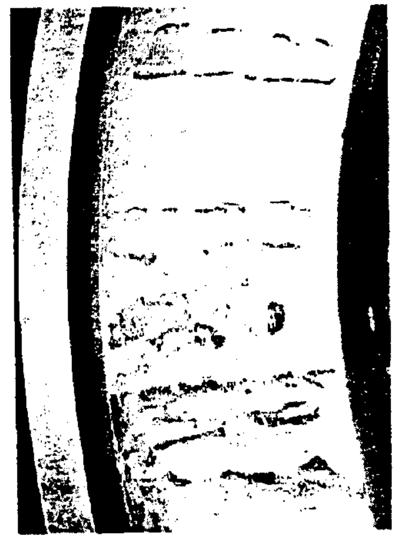
Identification Journal Roller Bearing Parts of Cylindrical Roller Bearing with Rotating End Cap. (Roller Assembly and Inner Ring Separable — No field lubrication provisions).

(AAR Cert. No. 3, 3A, 3B)

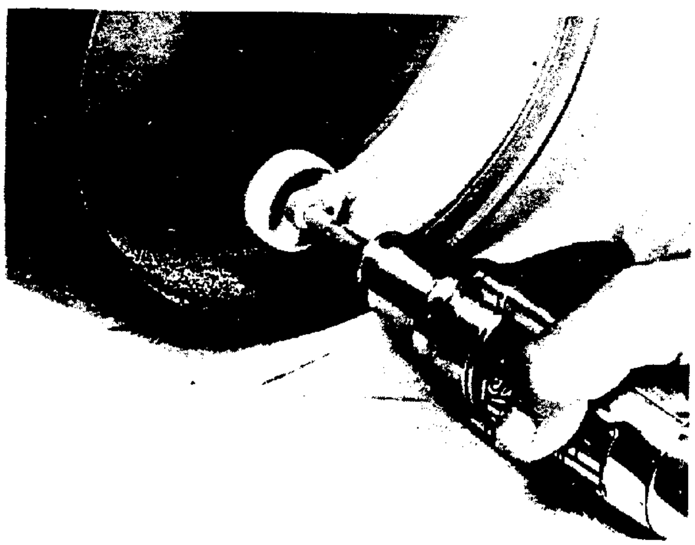
A



B



C



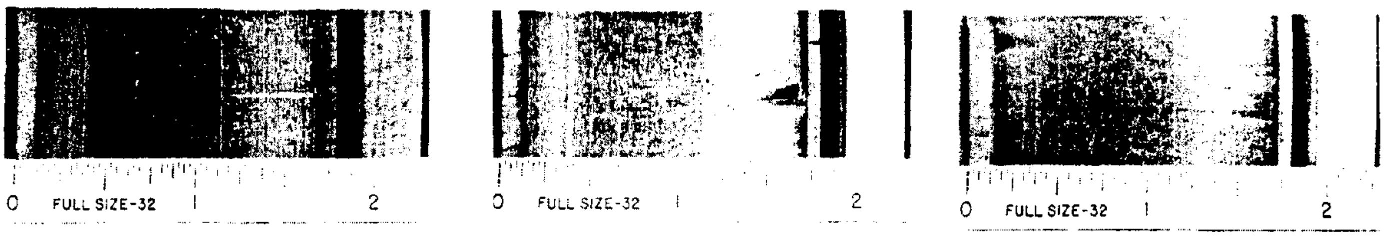
Polishing Outer Ring roller raceway using a wire wheel and polishing rouge.

Outer Ring raceway after polishing to remove stains or smearing.

D

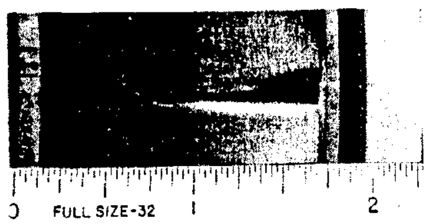
Fig. 1.4

Intensities of Corrosion and Repair



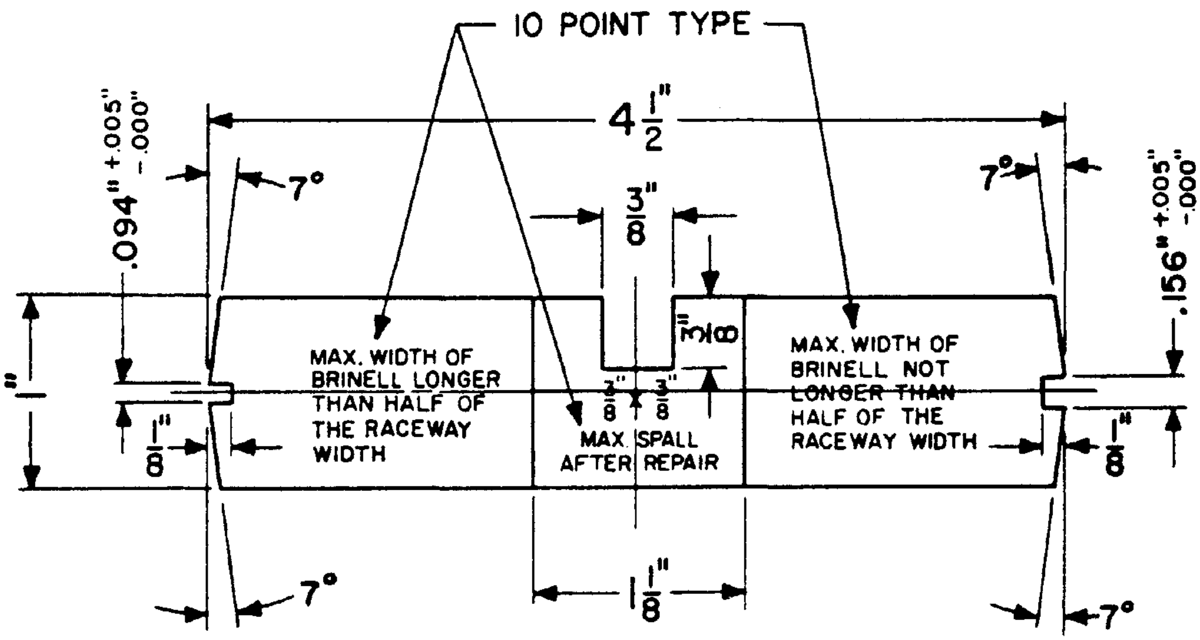
A B C

Acceptable Brinelling



D

Brinelling not satisfactory for further service.
(actual size photographs)



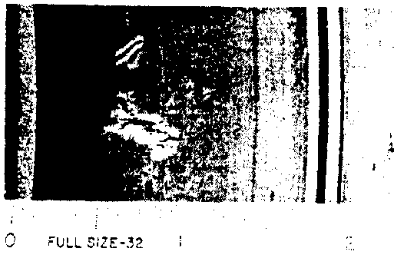
MATERIAL:
STAINLESS STEEL — 24 GAGE
BRASS SHIM STOCK — .020"
WHITE PLASTIC — .031"

E

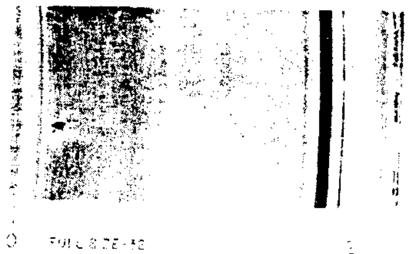
Brinell Width and Spall Limit Gage
(Recommended)

Fig. 1.5

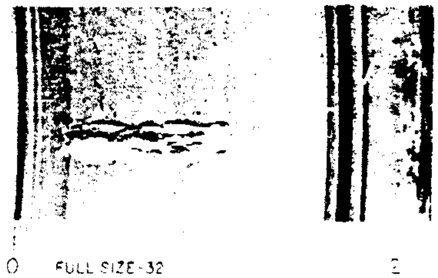
Brinelling



A

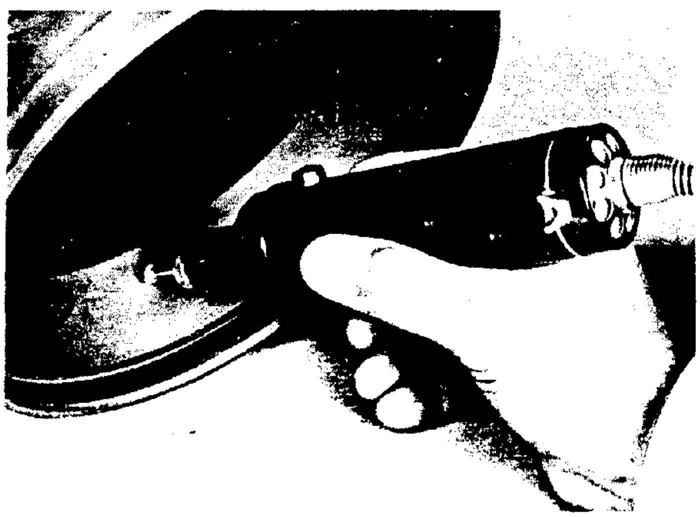


B



C

(actual size photographs)



Grinding Spall with Pencil Grinder

D

Fig. 1.6

Fatigue Spalling or Flaking and Method of Repair

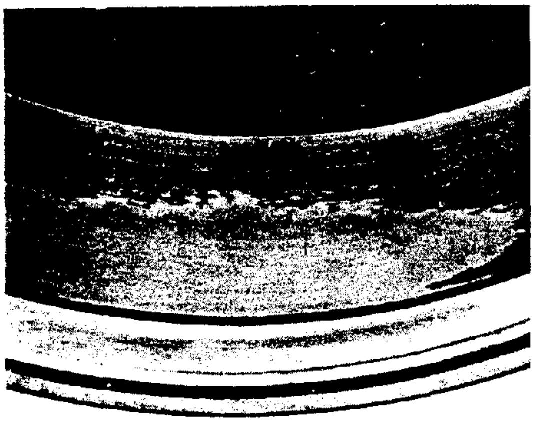


Fig. 1.7A

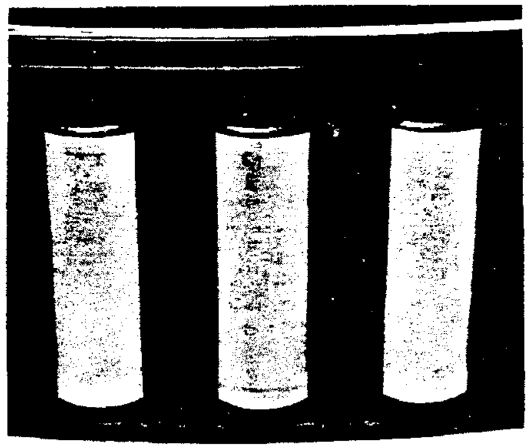


Fig. 1.7B

Fig. 1.7

Peeling

Acceptable for further service.

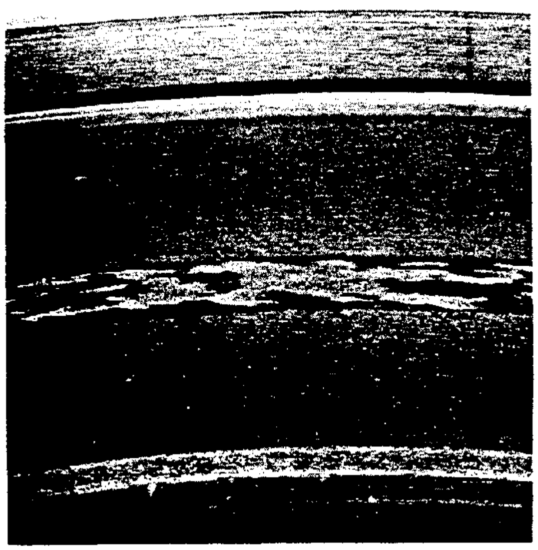
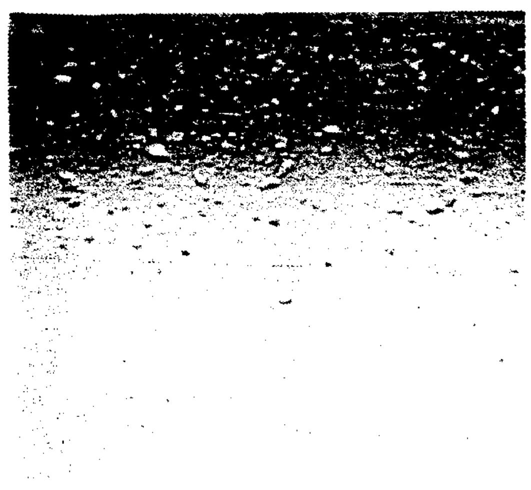


Fig. 1.7C

Smearing

Acceptable for further service after polishing.



(Full Scale)

Fig. 1.8

Fragment Indentations

Not considered condemnable unless excessive roughness or noise can be detected by rotating bearing by hand.

A B

Fig. 1.9

Pitting, resulting from electric current passing through bearing.

Bearing parts affected must be rejected.

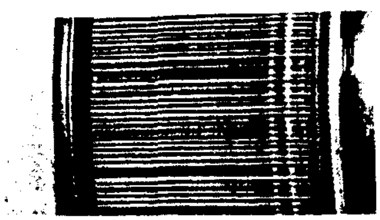


Fig. 1.10

Fluting or Corrugation, resulting from electric current passing through rotating bearing.

Bearing parts affected must be rejected.

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RULES COVERING REQUIREMENTS FOR APPROVAL OF ROLLER BEARING SHOPS TO RECONDITION ROLLER BEARINGS FOR INTERCHANGE SERVICE

(MANDATORY)

RULE 2.1

Compliance with A.A.R. minimum requirements covering servicing, shops, procedures and tool requirements is mandatory to recondition roller bearings for interchange use.

RULE 2.2

Any shop or repair facility that reconditions freight or Amtrak car roller bearing assemblies, or that engages in any operation which requires disassembly and assembly of such roller bearing units, must be approved by the AAR as qualified and authorized to perform such work. See Figure 2.1 for list covering Approved Bearing Reconditioning Shops. This list is revised quarterly by circular letter. No reconditioned bearings will be shipped until the facilities have been approved by the Mechanical Inspection Department as complying with the requirements of this Manual.

RULE 2.3

Roller bearing reconditioning shops shall be periodically inspected by an A.A.R. Mechanical Inspector, and failure to perform work in accordance with requirements of Roller Bearing Manual rules will be cause to stop reconditioning bearings for use in interchange service until specific conditions or violations are corrected. In order to recognize the difficulty in obtaining absolute repeatability of measurement and assessing the degree of importance of a given defect on satisfactory bearing operation, an additional tolerance is specified for use in audit inspections. Tolerances to be used when the work of bearing reconditioning shops is audit inspected by Mechanical Division inspectors or by customer representatives are listed below:

Outer Ring Counterbore Diameter—Max.	0.0002" over RBM Limit
Inner Ring Bore—Max.	0.0001" over RBM Limit
Fitted Backing Ring Back Face Flange I.D.—Max.	0.0002" over RBM Limit
Bearing Assembly Bench Lateral	0.001" over to 0.001" under RBM Limit
Grease Weight	± 2 ounces

RULE 2.4

Minimum requirements for shops reconditioning roller bearings for interchange service are listed in Section 3 complete. All rules under this section must be complied with to secure approval from the A.A.R. Mechanical Division.

STATUS CODES	RAILROAD OR COMPANY MARKS	SHOP CODE LETTERS	RAILROAD OR COMPANY	SHOP LOCATION
2B	AC	S	Algoma Central Rwy.	Sault Ste. Marie, Ont, Can.
2F	AL	A	Alaska Railroad	Anchorage, AK
2P	AM	BG	AMTRAK	Beech Grove, IN
2P	AM	W	AMTRAK	Wilmington, DE
2F	AT	T	Atchison, Topeka & Santa Fe	Topeka, KS
2F	BA	B	Bangor & Aroostook Railroad	Derby, ME
2F	BBS	L	Brenco Inc.	Louisville, KY
2F	BBS	LR	Brenco Inc.	Little Rock, AR
2F	BBS	P	Brenco Inc.	Petersburg, VA
2F	BBS	V	Brenco Inc.	Vandalia, IL
2F	BC	S	British Columbia Rwy.	Squamish, B.C., Can.
2F	BIX	K	Roller Bearing Industries, Inc.	Elizabethtown, KY
2F	BMX	MC	Brenco De Mexico	Mexico City, Mexico
2F	BN	DD	Burlington Northern Inc.	Havelock, NE
2F	BWC	H	Berwind Rwy. Service	Hollidaysburg, PA
2F	CAX	W	Canadian Bronze Co., Ltd	Winnipeg, Man., Can.
2B	CBX	D	Cooper Bearings Inc.	Dagsboro, DE
2F	CDX	M	Canada Allied Diesel Co. Ltd.	St. Laurent, Quebec, Can.
2F	CN	HQ	Canadian National Railways	Montreal, Que., Can.
2F	CN	PU	Canadian National Railways	Winnipeg, Man., Can.
2F	CO	R	Chesapeake & Ohio Rwy. Co.	Raceland, KY
2F	CP	W	CP Rail	Winnipeg, Man., Can.
2F	CR	H	Consolidated Rail Corp.	Hollidaysburg, PA
2F	CW	C	Chicago & North Western Trans. Comp.	Clinton, IA
2B	FSX	L	FSA Rebuilding Co.	Pico Rivera, CA
2F	GT	P	Grand Trunk Western Railroad Comp.	Port Huron, MI
2F	LI	R	Long Island Railroad	Richmond Hill, NY
2F	MC	W	Maine Central Railroad Comp.	Waterville, ME
2B	MNX	HN	Metro-North Commuter Rail Division	Harmon, NY
2F	MW	J	Milwaukee Road	Milwaukee, WI

Fig. 2.1
Approved Roller Bearing Reconditioning Shops

STATUS CODES	RAILROAD OR COMPANY MARKS	SHOP CODE LETTERS	RAILROAD OR COMPANY	SHOP LOCATION
2B	ON	N	Ontario Northland Railway	North Bay, Ont., Can.
2F	PFX	T	Pacific Fruit Express	Tucson, AZ
2F	PUC	B	Purdy Company	Burnham, IL
2F	RBX	S	Rail Bearing Service	Carlyle, IL
2B	RBX	K	Rail Bearing Service	Knoxville, TN
2F	RBX	L	Rail Bearing Service	North Little Rock, AR
2F	RBX	T	Rail Bearing Service	Corsicana, TX
2F	SD	H	Seaboard System Railroad	Hamlet, NC
2F	SO	M	Soo Line Railroad Comp.	Minneapolis, MN
2F	SP	H	Southern Pacific Transp. Comp.	Houston, TX
2B	SP	S	Southern Pacific Transp. Comp.	Sacramento, CA
2B	SPA	P	Southeast Penn. Trans. Auth.	Philadelphia, PA
2F	TJX	FW	Texas Rail Joint Co., Inc.	Fort Worth, TX
2F	UP	P	Union Pacific Railroad Comp.	Pocatello, ID

STATUS CODES EXPLANATION:

2B — Approved Roller Bearing Reconditioning Shop — Freight and Amtrak Passenger Car
2F — Approved Roller Bearing Reconditioning Shop — Freight Car
2P — Approved Roller Bearing Reconditioning Shop — Amtrak Passenger Car

NOTE: For a railroad or company having only one shop, it is not necessary to use "Shop Code Letters"; however, "Railroad or Company Marks", as shown above, must be used.

Fig. 2.1 (Continued)
Approved Roller Bearing Reconditioning Shops

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MINIMUM REQUIREMENTS FOR ROLLER BEARING RECONDITIONED SHOPS—PROCEDURES—TOOL REQUIREMENTS NECESSARY TO MAKE ROLLER BEARING REPAIRS FOR INTERCHANGE USE

(MANDATORY)

RULE 3.1

Railway roller bearing reconditioning is the disassembly, cleaning, inspection and repair if necessary, and reassembly of the roller bearing. Whenever a roller bearing unit that has been in service is removed from axle journal, it must be reconditioned before reapplication. Bearings must be modified to the NFL configuration (bearings not requiring field lubrication) before re-application.

RULE 3.2

Roller bearing reconditioning should preferably be confined to a separate shop or enclosure within a building. Tools, devices and cleaning facilities must be used which will rehabilitate roller bearings to serviceable standards. A typical small shop layout is shown in Fig. 3.1. A typical large shop layout is shown in Fig. 3.2. The designed floor plan can be modified to suit available space and number of bearings to be serviced.

RULE 3.3

Roller bearing shops shall be clean at all times; all work areas, benches and tools must be kept clean.

RULE 3.4

All roller bearing parts that are not used immediately must be protected from corrosion and dirt.

BEARING DISASSEMBLY

RULE 3.5

The bearing assembly, the backing ring and seal wear ring(s) are removed, excess grease removed and the bearing assembly is ready for disassembly bench work.

RULE 3.6

Remove the seal(s) from the outer ring and scrap. Care must be taken to prevent unnecessary damage to the bearing even though the seal must be scrapped.

RULE 3.7

Remove the roller assemblies and spacer, if so equipped.

CLEANING—General

RULE 3.8

With the bearing disassembled all parts are precleaned by removing as much residual grease as possible before wash-cleaning.

RULE 3.9

A suitable media is used to remove all lubricants and dirt. This may be accomplished through automatic cleaners, washers, agitators, or spray systems. The cleaning media must not be harmful to roller bearing parts. If a water soluble or evaporative-type cleaner is used, a water displacing media must be applied to prevent oxidizing deposits forming on clean parts. Backing rings with vents should not be cleaned in any solution which would be detrimental to the vents.

RULE 3.10

Should agitating type washer be used, outer rings, inner rings, rollers, cages, roller assemblies, spacers and seal wear rings may be washed together. End cap, backing ring, backing ring with seal wear ring, and housings may be cleaned in a separate wash.

RULE 3.11

Should the continuous spray-type washer be used, all parts may be cleaned through washer providing the media is filtered before re-use.

INSPECTION

RULE 3.12

The inspection area must be clean and well lighted. The manufacturer's specifications must be posted at the inspection area for each type of bearing being maintained (Figs. 3.4-1 to 3.4-25). The specification sheets shall show sizes and wear limits for all bearing assembly component parts.

RULE 3.13

Bearing parts should be pre-inspected at disassembly for obvious irreparable defects and, if such defects are found, must be rejected.

INSPECTION OF COMPONENT PARTS

RULE 3.14

Inspection procedures or devices, other than those listed elsewhere in this manual, may be used, if such procedures or devices can be verified as producing results which are equal to or better than those obtained with the procedures or devices and gages listed. At the beginning of each shift, procedure or device must be calibrated against standards.

RULE 3.15

End Cap: Inspect end cap for surface damage, cracks, breakage, wear or distortion. A condition that would affect proper seating of end cap and seal wear ring must be removed or corrected prior to bearing application. If end cap is equipped with lubricant fitting, remove fitting and replace with a non-removable plug (see Fig. 3.17).

RULE 3.16

Seal Wear Ring: Seal wear rings must be visually inspected for nicks, cracks, or scratches on the outside surface. The seal lip contact path must be smooth and free from any defect that might damage seal lip. The seal lip contact path must not be worn beyond manufacturer's tolerances. Light rusting on the seal wear ring outer diameter from a point ⅛″ outside of the inner lip wear path is acceptable. Seal wear ring inside diameter must be visually inspected. If there are circumferential grooves on the surface or any indication that the seal wear ring has turned on the axle journal, the ring should be scrapped.

RULE 3.17

Seals: All seals must be replaced with new seals. For Amtrak bearings with enclosure (non-rubbing) seals, see Rule 4.5.

RULE 3.18

Spacer: Spacers must be visually inspected for cracks, nicks, and burrs. Cracked spacers must be scrapped. Nicks and burrs on the end faces of all types of spacers must be stoned smooth. Secondhand spacers must meet dimension A of Figure 6.2.

RULE 3.19

Inspection of Inner and Outer Rings: Masters used in the calibration of gages for the measurement of inner ring inside diameters and outer ring counterbores should conform to American Gage Design Committee Standards and should be of, at least, Class X tolerance. It is recommended that masters be certified at least yearly by a qualified metrology laboratory against standards traceable to the Bureau of Standards and that up-to-date record of certification be maintained in each bearing repair facility. Masters, gages and the parts being gaged should be at approximately the same temperature. Pin type gages may be used to check diameter of outer ring counterbores and inner ring inside diameters providing dial bore gages and master gages are available for necessary rechecks.

RULE 3.20 Outer Ring:

a. Check seal fit counterbores for inside diameter (Figure 3.5). All bearings listed by certificate number in Figure 5.1 as having interchangeable seals shall have maximum counterbore diameters (by bearing size) as follows: 4¼ x 8 = 6.067", 5 x 9 = 7.192", 5½ x 10 = 7.755", 6 x 11 = 8.255", 6½ x 12 = 9.380" and 7 x 12 = 10.280". For all other bearings refer to the manufacturer's specifications. Not required for bearings of Fig. 1.3A.
b. When outer ring shows wear from adapters, check diameter using micrometer or suitable gage.
c. Inspect for bearing damage per Rule 1.15.

RULE 3.21

Inner Ring: Inner rings must be inspected for the same defects as outer rings (See Rule 3.20). The inner ring must be inspected as shown in Figures 3.7 and 3.8 or by any suitable method which will indicate condition of inner race. The inside diameters must be checked with dial bore gage (Figure 3.6) or other gages.

RULE 3.22

Rollers: The contact areas of each roller must be inspected for any damage or defects per Rule 1.15 of this manual. Separable rollers must remain in matched bearing sets. All Brenco inner rings which were manufactured during the years 1978, 1979 and 1980 must be equipped with new rollers (See Rules 6.14a.5., 6.15 and 6.16). Those inner rings marked as remanufactured by Brenco subsequent to May 1, 1985, need not be equipped with new rollers unless rollers with damage or defects are noted during inspection.

RULE 3.23

Cage: The roller bearing cage must be checked for proper clearance, cracks, or damage. Inner rings must be placed on back face (large diameter face) when checking clearance. If found defective, cages must be scrapped. (See Section 6 for cage removal).

RULE 3.24

Backing Ring: Check backing ring contact radius with a 1½″ radius gage at three points on the circumference to insure proper radius (See Figure 3.10). Check backing ring radius break out diameter (See Figure 3.9). Fitted backing rings having a backing ring radius break out diameter which exceeds the maximum allowable diameter per Figure 3.9, used as non-fitted backing ring column, must be scrapped. Non-fitted backing rings with break out diameter exceeding maximum allowable may be remanufactured per Section 6. Check seal wear ring counterbore diameter. The counterbore must provide a press fit for seal wear ring. Backing rings which do not provide a press fit for seal wear rings and are not more than .010″ oversize can have press fit restored by center punching the surface adjacent to the counterbore with or without seal wear rings in place. If the center punching is done with the seal wear ring removed, see Figures 3.11, 3.12 for recommended center punching tool and procedure. Counter bore oversize can be checked by use of seal wear ring and .010″ feeler gage. This salvage procedure may not be applied more than twice to the same backing ring and applies to tapered roller bearing backing rings only. Inspect for cracks, distortions, broken areas and pitting. All Timken cast backing rings having a flange which extends over the seal case and which do not have a date of manufacture and Brenco and Hyatt cast backing rings must be scrapped.

RULE 3.25

Vent Fitting: Check to be certain it is not clogged, hardened, or damaged. Should it be necessary to replace vent fitting, it must be renewed according to manufacturer's instruction. It must be properly protected during painting operations.

RULE 3.26

Cap Screw Seal Rings: All cap screw seal rings must be replaced with new seal rings.

RULE 3.27

Cap Screws: Check threads for damage and wear. Check cap screw body for stretching or elongation (this usually will show in the first 1″ length of cap screw under head, as an elongation of pitch, which can be compared to that of a new cap screw). Reject for burrs extending beyond the washer face on the underside of the cap screw head as these will damage the locking plate. If any defect is found in cap screw it must be rejected.

MARKING BEARINGS

RULE 3.28 Marking:

a. Bearings.

Bearings that have been reconditioned and outer rings that have been remanufactured must be permanently and legibly marked on the outer ring inner diameter on the straight portion in the center between the raceways. Caution must be used to avoid nicking or damaging the raceway surfaces. The marking must include the date (month and year), the reconditioning company's initials and shop code letters (Fig. 2.1). On bearings reassembled using inner and/or outer rings with reground races, the "remanufactured" symbol "R" is to be marked and encircled by the original manufacturer who has reground the races, see Fig. 3.16.

b. Remanufactured or Repaired Component Marking.

1. Outer rings with reground races must be marked as indicated in paragraph (a) above. See Fig. 3.16.
2. Inner rings which have been remanufactured (cage removed for inspection and/or operating surfaces reground) must be marked on the end face following manufacturer's identification in the manner illustrated in Fig. 3.16. (Note: Encircled R should be marked only when operating surfaces have been reground.)

3. Backing rings which have been remanufactured (radius remachined) must be marked on the vertical face above the seal wear ring fit area in the manner illustrated in Fig. 3.16.
4. Spacers which have end faces remachined must have the date (month and year) and the remachining company's initials and shop code letters marked on the outside diameter.

c. Prevoius markings must not be removed. A suitable marking tool must be used. Steel stamps are not acceptable.
d. Any shop certified to recondition bearings for interchange service must mark all bearings reconditioned in that shop as outlined above regardless of whether the end use of the bearing is for interchange service. Any bearings reconditioned in that shop which are destined for other than interchange service must be suitably marked on the outer cup, after assembly, to differentiate these from assembled bearings which are to be used in interchange service.
e. New bearings, with no service mileage, which are removed from axles for inspection for suspected damage must be marked per Rule 3.28a with additional marking of symbol "W" following the repairing shop markings. All new bearings inspected and marked per this Rule will be considered new bearings.

BEARING ASSEMBLY

RULE 3.29

Before reassembly, all parts must have been inspected. Any parts that had protective coatings of grease or oil must be free of dirt and grit before reassembly.

RULE 3.30

Reassemble bearings as follows:

a. For tapered roller bearings as shown in Figs. 1.2 and 1.2A, reassemble the outer ring, roller assemblies and spacer, if so equipped. Component parts of a manufacturer's bearing made under different AAR approval numbers must never be mixed or interchanged except where part numbers are the same as noted in the manufacturer's specification sheet (Fig. 3.4-1 to 25). For converting bearings per Fig. 1.2A to bearings per Fig. 1.2, see paragraph "d" below. Note: It is recommended that outer rings with reground races and inner rings with reground operating surfaces not be used in the same assembly. This avoids need for extremely short spacers which may not be available. These parts can be identified by the encircled R in the repair marking.
b. Component parts for cylindrical roller bearings as shown in Fig. 1.3A but made under different AAR Approval numbers must never be mixed and/or interchanged except as noted in manufacturer's specification sheet.
c. All bearings should be coated with light oil to protect them from corrosion in storage.
d. Bearings per Fig. 1.2A may be converted to bearings per Fig. 1.2 at reassembly under the conditions listed below.
   (1) AAR-20 Bearings.
   Replace outboard seal wear ring with AAR-1 or 1A seal wear ring per Fig. 3.4-1 (Note: AAR-20 roller assemblies and outer rings have different part numbers than AAR-1 and 1A roller assemblies and outer rings but are dimensionally interchangeable with the AAR-1 and 1A parts). When bearing is mounted on the axle, an AAR-1 or 1A axle end cap per Fig. 3.4-1 must be used. Also, cap screw seal rings must be used.

(2) AAR-24 Bearings.

Replace the outboard seal wear ring with an AAR-14 seal wear ring per Fig. 3.4-14. Replace AAR-24 seals (3 lip style) with interchangeable seals or AAR-14 (2 lip style) seals. (Note: AAR-24 roller assemblies, outer rings and backing rings have different part numbers than AAR-14 roller assemblies, outer rings and backing rings but are dimensionally interchangeable with the AAR-14 parts). When bearing is mounted on the axle, an AAR-14 axle end cap per Fig. 3.4-14 must be used. Also, cap screw seal rings must be used.

(3) AAR-25 Bearings.

Replace outboard seal wear ring with AAR-5 or 5A seal wear ring per Fig. 3.4-5 (Note: AAR-25 roller assemblies and outer rings have different part numbers than AAR-5 and 5A roller assemblies and outer rings but are dimensionally interchangeable with the AAR-5 and 5A parts.) When bearing is mounted on the axle, an AAR-5 or 5A axle end cap per Fig. 3.4-5 must be used. Also, cap screw seal rings must be used.

RULE 3.31

The bench lateral play (tapered roller bearings only) of the bearing assembly must be checked to make sure that the cone spacer has the required width.

RULE 3.32

Bench lateral for tapered roller bearings must be checked with power driven lateral checking equipment (where bearings are "run-in" under a light thrust load at both extremes of lateral movement) or by a dial indicator mounted to a cam actuated, hand operated device similar to Figure 3.13 or other suitable device for checking lateral movement. Bench lateral must not be checked when bearing is dry. For recommended bench lateral, see manufacturer's specifications.* Alternately, due to the various types of bench lateral checking equipment in use, a bearing reconditioning shop which is closely associated with a bearing mounting shop (both under the control of the same company) may establish bench lateral limits to provide satisfactory mounted bearing lateral.

BEARING LUBRICATION

RULE 3.33

An A.A.R. lubrication chart (Fig. 3.14) showing amounts of grease to be applied to bearing must be posted at lubrication area.

RULE 3.34

Only A.A.R. approved lubricants per specification M942, which are free from contamination by dirt or moisture, will be used. Lubricant must **not** be heated to facilitate application. See Section E, Field Manual Rule 26 for listing of Approved Lubricants.

*Until all manufacturers' specifications are revised the following chart will apply:

Bearing Size	Bench Lateral If Measured By:	
	Power Driven Equipment	Hand Operated Equipment
4¼ x 8, 5 x 9	.021" - .027"	.018" - .024"
5½ x 10, 6 x 11 6½ x 12, 7 x 12	.023" - .029"	.020" - .026"

RULE 3.35

Accurate lubrication metering systems must be used to apply correct amount, by weight, of lubricant and must be verified by measuring a sample weekly. Quantities of grease, larger than specified, should not be applied because excessive quantities may cause higher operating temperatures which might be sufficient to cause bearings to have high indications of heat on hot box detectors. Excessive quantities of grease may also result in purging at the seals and give false indications of seal wear or damage. All lubrication certification checks must be recorded and records kept on file for a period of two years.

RULE 3.36

A method of prelubricating inner ring assemblies is illustrated in Fig. 3.15. Alternatively, grease may be applied from both sides of the assembly. When greasing in this manner, apply one-half the total amount to each side. For method of lubricating cylindrical roller bearings shown in Fig. 1.3A, refer to manufacturer's specification sheet.

RULE 3.37

A lubrication fixture similar to that shown in Figure 3.15 or other suitable equipment may be used to prelubricate roller assemblies of tapered roller bearings.

RULE 3.38

Lubricate the lips of the contact type seals with roller bearing grease, if not prelubricated by supplier.

RULE 3.39

Apply new seals to outer ring (See Figure 3.3 for recommended installation tools). Seals must be installed with no damage to seal. Seal must be properly located and firmly seated. When seals are seated properly, the shoulder of the seal cases will be flush or below the bearing outer ring faces.

NOTE: For information on mounting of seals in bearings of Fig. 1.3A see manufacturer's specification sheet. Seals for AAR-20 bearings must be cemented in place. Contact bearing manufacturer for instructions.

RULE 3.40

Apply seal wear ring and backing ring, making sure seal wear rings are applied with the bevel and lubricating holes toward inside of bearing. Apply wear rings gradually so the lips of the seal will expand and not turn under. For bearings per Fig. 1.2A, inboard and outboard seal wear rings may be different. Refer to manufacturer's specification sheet for proper assembly.

RULE 3.41

For tapered roller bearings, apply cardboard tube or similar device, to hold spacer and seal wear rings in alignment and to prevent lubrication loss, except when bearings will be mounted in the same shop.

RULE 3.42

The bearing assembly is now ready for application to the axle or placed in stock.

RULE 3.43

If bearing assemblies are to be placed in stock, they must be stored in proper packaging, covered and stored in a dry area free from dirt and moisture.

IDENTIFICATION

RULE 3.44

For identification each roller bearing will be marked by a suitable means, sticker, stencil, etc., on the outer ring in 1½″ or larger letters the following:

N — New roller bearings.

R — Reconditioned roller bearings.

(NOTE: Not Applicable to Amtrak Passenger Car Bearings)

RULE 3.45

For identification, shops reconditioning bearings will mark the outer ring of a reconditioned bearing by a suitable means, sticker, stencil, etc., with the proper AAR Certificate Number and/or the bearing manufacturer.

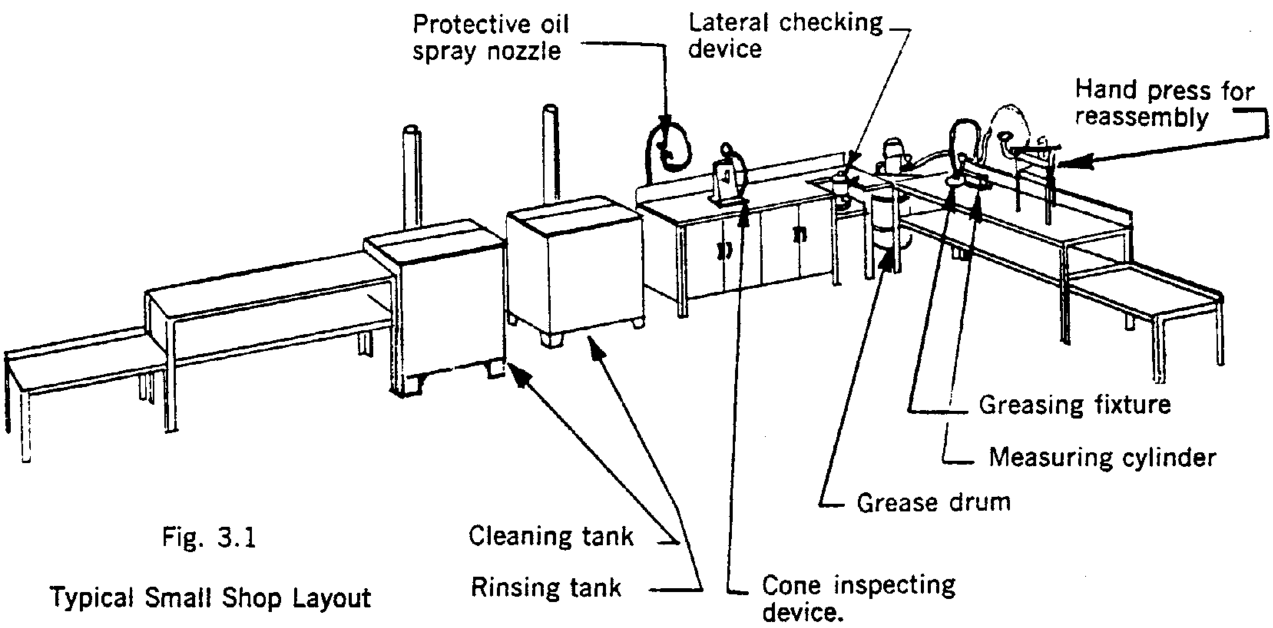


Fig. 3.1

Typical Small Shop Layout

(Recommended)

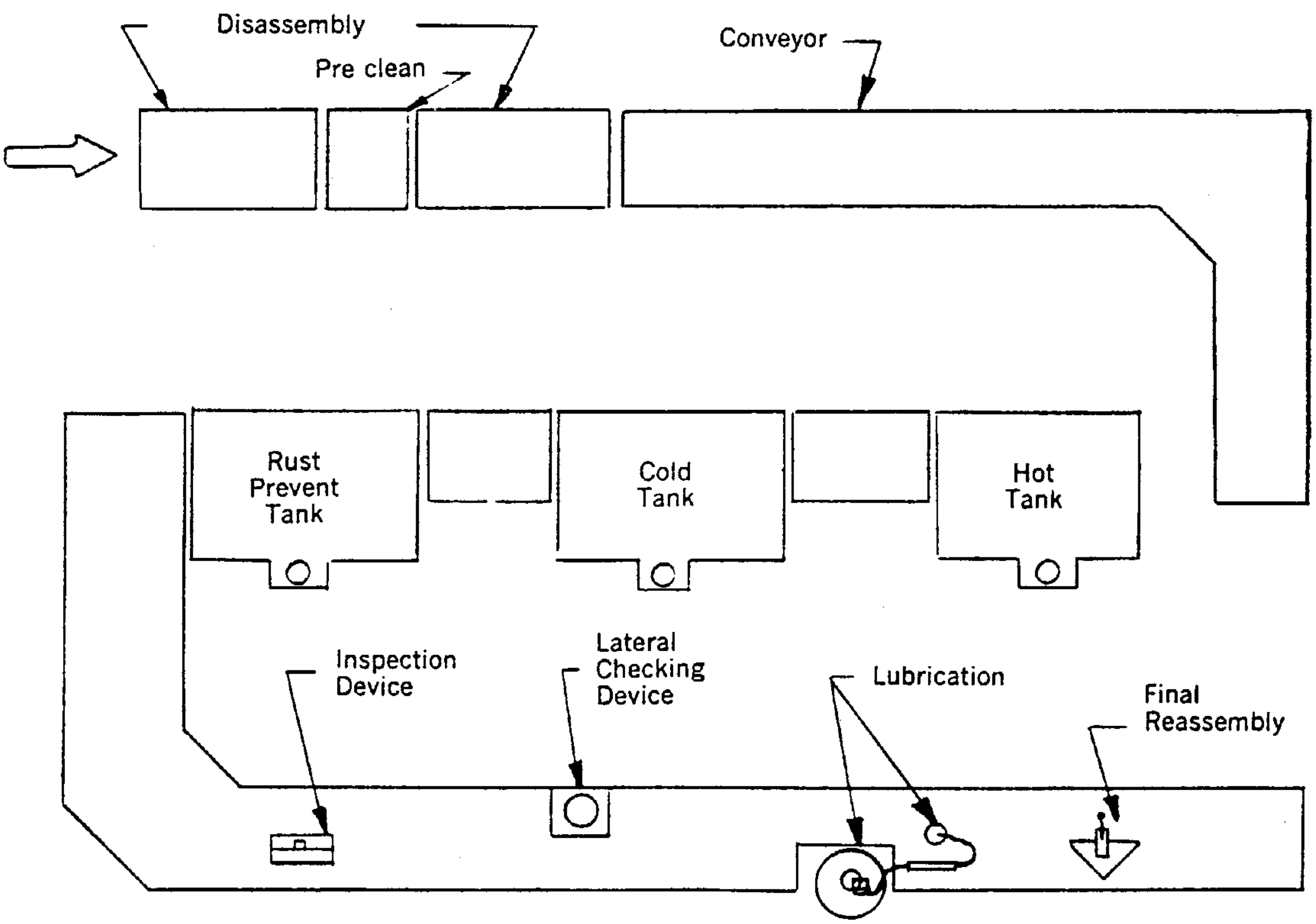
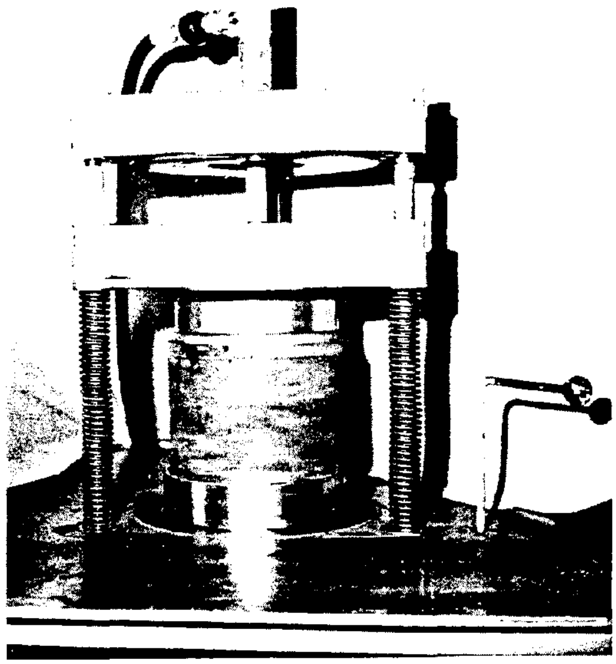


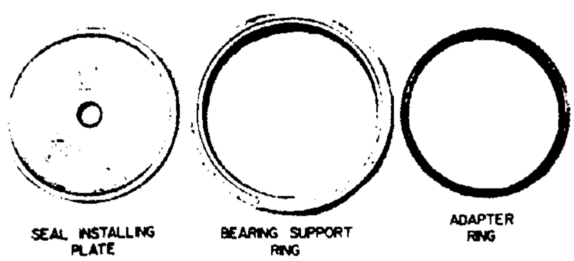
Fig. 3.2

Typical Large Shop Layout

(Recommended)



Installation of seals with platen press and adapter ring. Note first seal already applied; bearing is supported on bearing support ring while applying second seal with adapter ring.



Tools required for seal installation with platen press.

Fig. 3.3

Seal Installation Tools

(For Bearings to Fig. 1.3A, see manufacturers' specifications)

(Recommended Method)

BEARING PRODUCTION STATUS

Manufacturer	AAR Cert. Number	CLASS (SIZE)					
		B(4¼ x 8)	C(5 x 9)	D(5½ x 10)	E(6 x 11)	F(6½ x 12)	G(7 x 12)
TIMKEN	1	O	O	O	O	O	—
TIMKEN	1A	X	X	X	X	X	X
ND-HYATT	2	—	*	*	*	*	—
SKF, Sweden	3, 3A	—	O	O	O	O	—
SKF, Sweden	3B	O	O	O	O	O	O
SKF, US.	4, 4A, 4B	—	—	*	*	*	—
BRENCO	5	—	—	O	O	O	—
BRENCO	5A	X	X	X	X	X	X
ND-HYATT	6	—	—	O	O	O	—
ND-HYATT	6A	—	—	O	O	O	O
SKF, US.	7	—	—	—	*	—	—
BOWER	8	—	—	—	O	O	—
NTN	10	O	O	O	O	O	O
NSK	11	—	O	O	O	*	—
NSK	11A	—	X	X	X	X	—
NACHI	12	—	—	—	—	X	—
FAG	13	X	X	X	X	X	—
KOYO	14	X	X	X	X	X	X
MAGNUS	16	—	—	—	O	O	—
SKF, US.	17	—	—	—	O	O	—
SKF, Sweden	18	—	—	O	O	O	—
NTN	19(10A)	X	X	X	X	X	X
TIMKEN	20	—	—	—	—	X	—
ND-HYATT	21	—	—	—	—	O	—
NSK	22	X	X	X	X	X	X
SKF (Tapered)	23	X	X	X	X	X	—
KOYO	24	X	X	X	X	X	X
BRENCO	25	—	—	—	—	X	—

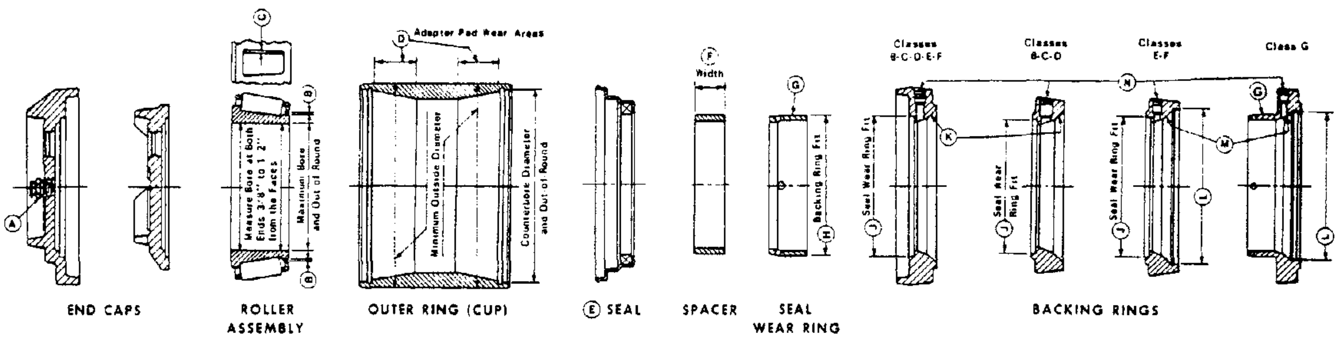
Note: X — In Production
O — Out of Production
— Not Produced or Not Available
* Obsolete

Fig. 3.4

TIMKEN "AP" ROLLER BEARINGS

SERVICE LIMITS

AAR APPROVAL NUMBERS 1 AND 1A
(NO FIELD LUBRICATION)



CLASS AND SIZE	DIAMETERS ARE AVERAGES							AMOUNT OF GREASE(OUNCES) +		
	ROLLER ASSEMBLY		OUTER RING				BACKING RING	Each Roller Assembly	Around Spacer	Total Quantity
	Maximum Bore	Out-of-Round	Minimum O.D.	Maximum C'bore	Minimum C'bore	Out-of-Round	Maximum C'bore			
B (4¼ x 8)	4.0015"	0.003"	6.4900"	6.0665"	6.0600"	0.005"	—	2	4	8
C (5 x 9)	4.6890"	0.003"	7.6775"	7.1915"	7.1850"	0.005"	—	3	6	12
D (5½ x 10)	5.1890"	0.003"	8.1775"	7.7540"	7.7450"	0.005"	—	4	8	16
E (6 x 11)	5.6890"	0.003"	8.6775"	8.2540"	8.2450"	0.005"	7.0300"	4	8	16
F (6½ x 12)	6.1890"	0.003"	9.9275"	9.3790"	9.3700"	0.005"	7.5300"	6	12	24
G (7 x 12)	7.0015"	0.003"	10.8650"	10.2790"	10.2700"	0.005"	7.9980"	8	16	32

+ NOTE: ONE HALF OF TOTAL AMOUNT OF GREASE MAY BE APPLIED TO EACH SIDE OF ASSEMBLED BEARING (BEFORE SEALS ARE APPLIED).

END CAP

(A) Inspect for cracks, breakage, wear, or distortion. If end cap is equipped with lubricant fitting, remove and replace with a nonremovable plug.

ROLLER ASSEMBLY - CAGE INSPECTION

Place roller assembly on back face (large diameter face) when checking clearances.

(B) Measure this clearance using two sets of feeler gages. Insert the feeler gages between the small rib and cage flange at two locations diametrically opposite. If the total of the two sets of feeler gages is 0.090" or more, the roller assembly should not be returned to service.

(C) If the roller pocket of the cage is worn to the extent that a 0.080" feeler gage can be inserted between the roller and the cage bridge, the roller assembly should not be returned to service.

OUTER RING (CUP)

(D) Minimum O.D. to be measured in adapter pad wear areas.

If the outer ring is distorted in the area of the counterbore a close visual inspection of the inside and outside surfaces is required. Outer rings that have hair line cracks must be scrapped.

(E) **SEAL** - SCRAP ALL USED SEALS

SPACER WIDTH - BENCH LATERAL

(F) A spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used:

	Power Operated	Hand Operated
Classes B-C	0.021" to 0.027"	0.018" to 0.024"
Classes D-E-F-G	0.023" to 0.029"	0.020" to 0.026"

Note:
Where close coordination is maintained between the bearing repair facility and the bearing mounting facility, the bearing bench lateral may be set to limits necessary to provide satisfactory mounted bearing lateral.

SEAL WEAR RING - OUTSIDE SURFACE

(G) If the outside surface of the seal wear ring is scratched or cracked or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring (or backing ring on Class G bearing size) must be scrapped.

SEAL WEAR RING - FIT IN BACKING RING

(H) The seal wear ring must have a tight fit in the backing ring counterbore.

BACKING RING - FIT ON THE SEAL WEAR RING

(J) The counterbore of the backing ring must have a tight fit on the seal wear ring. AAR Roller Bearing Manual permits salvage of backing rings with oversize counterbores. See A-24389 for suggested procedure.

BACKING RING - SIZE AND RADIUS (NONFITTED)

(K) Backing rings that are bent or distorted must be scrapped. Check the backing ring size and the bore radius for proper axle fillet contact and excessive corrosion with the AAR gage as shown in the Roller Bearing Manual.

BACKING RING - SIZE AND RADIUS (FITTED)

(L) Check major I.D.

(M) Check bore radius for excessive corrosion. Light pitting and rusting is acceptable.

VENT FITTING

(N) Check the vent fitting to see that it is not clogged, hardened or damaged. Hardened or damaged vent fittings should be replaced. (Part number K89716)

PART NUMBERS - BEARING COMPONENTS

CLASS AND SIZE	ROLLER ASSEMBLY	OUTER RING (CUP)	SPACER	SEAL	SEAL WEAR RING	OLD STYLE* BACKING RING	NEW STYLE* BACKING RING	OLD STYLE* END CAP	NEW STYLE* END CAP	NONREMOVABLE PLUG	CAP SCREW SEAL RINGS	LOCKING PLATE	CAP SCREWS
B (4¼ x 8)	HM120848	HM120817XD	HM120848XA	K86895	K86890	K86874	K127203	K86877	K523660	K523653	K523654	K84326	K53399
C (5 x 9)	HM124646	HM124618XD	HM124646XA	K85600	K86002	K85588	K127204	K86003	K523742	K523653	K523655	K84325	K44434
D (5½ x 10)	HM127446	HM127415XD	HM127446XA	K86860	K85507	K85525	K127205	K85521	K523744	K523652	K523655	K80511	K44434
E (6 x 11)	HM129848	HM129814XD	HM129848XA	K86861	K85508	K85095	K127206	K85510	K523746	K523652	K523656	K80596	K84354
F (6½ x 12)	HM133444	HM133416XD	HM133444XA	K85520	K85509	K85516	K125685	K85517	K523748	K523652	K523657	K84324	K84351
G (7 x 12)	HM136948	HM136916XD	HM136948XA	K96501	K95188	K83160	K83160	K95199	K523750	K523652	K523658	K84701	K84398

*END CAP AND BACKING RING INTERCHANGEABLE. REPLACEMENTS PER CURRENT PRODUCTION.

AAR Approval No. 1 And No. 1A Bearing Parts Are Interchangeable.

Do Not Use AAR Approval No. 20 Bearing Parts In AAR Approval No. 1 Or 1A Bearing Assemblies Except Where Part Numbers Are The Same Or As Permitted By AAR Roller Bearing Manual Rule 3.30d.

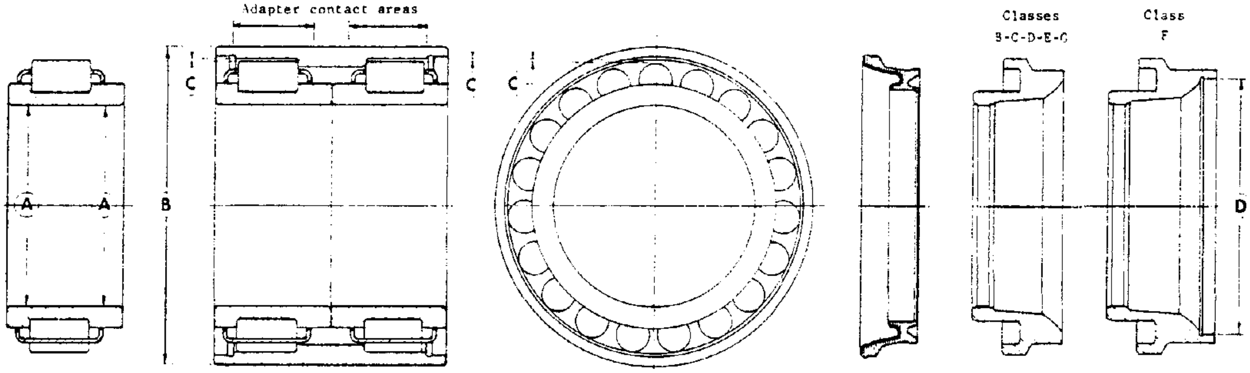
THE TIMKEN COMPANY
Canton, Ohio 44706 - Cable Address "TIMROSCO"

OCTOBER 20, 1980

Fig. 3.4-1

AAR-3,3A. AAR-3B.
CYLINDRICAL ROLLER BEARINGS RBU
MAINTENANCE SPECIFICATIONS

SKF



ROLLER ASSEMBLY   OUTER RING WITH TWO ROLLER ASSEMBLIES   SEAL   BACKING RINGS

CLASS (SIZE)	(A) MAXIMUM BORE OF ROLLER ASSEMBLY		(B) MIN. OUTSIDE DIA. OF OUTER RING		(C) INTERNAL RADIAL CLEARANCE MAXIMUM		(C) MINIMUM		(D) BACKING RING MAX. BORE		GREASE PER BEARING		COMPRESSION RING (E)	INSTALLING RING (F)
	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	ozs.	grams		
B(4.1/4x8)	4.0022	101.656	6.4900	164.846	0.012	0.30	0.004	0.11	-	-	7	200	1700885	1700891
C(5x9)	4.6897	119.118	7.6775	195.010	0.012	0.30	0.004	0.11	-	-	12	340	1700886	1700892
D(5.1/2x10)	5.1894	131.810	8.1775	207.710	0.014	0.35	0.004	0.11	-	-	14	400	1700887	1700893
E(6x11)	5.6894	144.510	8.6775	220.410	0.014	0.35	0.005	0.13	-	-	16	455	1700888	1700894
F(6.1/2x12)	6.1894	157.210	9.9275	252.160	0.014	0.35	0.005	0.13	7.5300	191.262	26	740	1700889	1700895
G(7x12)	7.0017	177.843	10.8650	275.970	0.016	0.40	0.006	0.15	-	-	32	910	1700890	1700896
ALL LIMITS ARE UNDERSTOOD TO BE THE AVERAGE OF 3 MEASUREMENTS, 60 DEGREES APART														

ROLLER ASSEMBLY
Measure bore "A" at both ends, 3/8" to 1/2" (9 to 13 mm) from faces of inner ring. Maximum out-of-round 0.003" (0.08 mm). - The cage does not have proper clearance and must be replaced if rollers fall out of cage pockets. - Each roller set is matched to an inner ring. Do not replace complete roller sets or individual rollers - scrap roller assembly if any rollers are missing.

OUTER RING
Measure diameter "B" in adapter contact areas. Max. out-of-round 0.005" (0.13 mm).

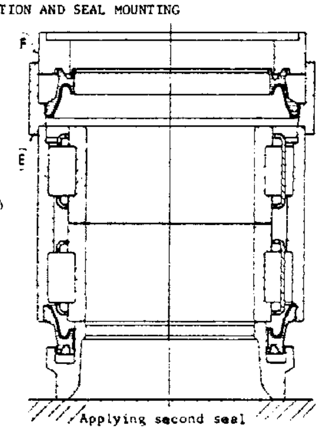
INTERNAL RADIAL CLEARANCE "C"
Any roller assembly may be used with any outer ring of same class and approval number. Maximum values of internal radial clearance shown above are higher than manufacturing limits. Check clearance if severe abrasive wear of raceways indicates possible excessive increase of clearance. Rest bearing on a flat surface and insert feeler gauges between top roller and outer raceway. Repeat twice, turning complete bearing 60° each time. Check average against tabulated limits. Repeat for other row of rollers. Maximum difference between the two rows 0.0025" (0.06 mm).

SEAL WEAR RING, END CAP (STYLE 1), BACKING RING
Replace component if seal lip contact path is worn 0.005" (0.13 mm) deep. Check major bore diameter "D" on backing rings, if so equipped.

INTERCHANGEABILITY
All AAR-3 and AAR-3A parts are interchangeable. AAR-3 and -3A parts are interchangeable with AAR-3B parts, except that outer rings and roller assemblies in one bearing must be either all AAR-3,3A or all AAR-3B. End caps AAR-3,3A must not be interchanged with AAR-3B (to avoid loss of identity of the mounted bearing).

LUBRICATION AND SEAL MOUNTING

Pregrease each roller assembly with 1/3 of full amount. Insert first assembly (wider flange down) into outer ring. Place compression ring "E" (small diameter of taper down) on outer ring. Place installing ring "F" on top of seal and (using Platen press) apply pressure until seal is properly located and firmly seated. Remove rings "E" & "F". Insert backing ring and invert bearing. Grease space between roller assemblies with remaining 1/3 of full amount. Then insert second roller assembly and mount seal.



(Preferred greasing method: Do not pregrease roller bearings. Using suitable fixture, force half the full amount into bearing from each side after placing each roller assembly into outer ring, but before mounting seal).

AAR-3,3A AND AAR-3B BEARINGS MUST BE MAINTAINED IN ACCORDANCE WITH THE ABOVE SPECIFICATIONS AND AAR REGULATIONS

REPLACEMENT COMPONENT PART NUMBERS													
CLASS (SIZE)	ROLLER ASSEMBLY		OUTER RING		SEAL	BACKING RING	* END CAP STYLE 1		* END CAP STYLE 2	** SEAL WEAR RING	CAP SCREW SEAL RING	LOCKING PLATE	CAP SCREW
	3,3A	3B	3,3A	3B	3,3A,3B	3,3A,3B	3,3A	3B	3B	3B	3,3A,3B	3,3A,3B	3,3A,3B
B(4.1/4x8)	-	R-238445	-	L-238445	715748A	722446	-	722447H	724058H	724059	729720-1	715730-1	722454
C(5x9)	R-234669	R-238450	L-234669	L-238450	715753A	722451	715752H	722452H	724051H	724052	729720-2	715730-2	722459
D(5.1/2x10)	R-234639	R-238455	L-234639	L-238455	715013A	715011A	715012H	715012AH	724056H	724057	729720 2	715730-3	722459
E(6x11)	R-234929A	R-238460	L-234929A	L-238460	715763A	715761A	715762H	715762AH	724061H	724062	729720-3	715730-4	722464
F(6.1/2x12)	R-234827	R-238465	L-234827	L-238465	715768A	715766F	715767H	715767AH	724066H	724067	729720-4	715730-5	722469
G(7x12)	-	R-238470	-	L-238470	722473	722471	-	722472H	724072H	724073	729720-5	715730-6	722474

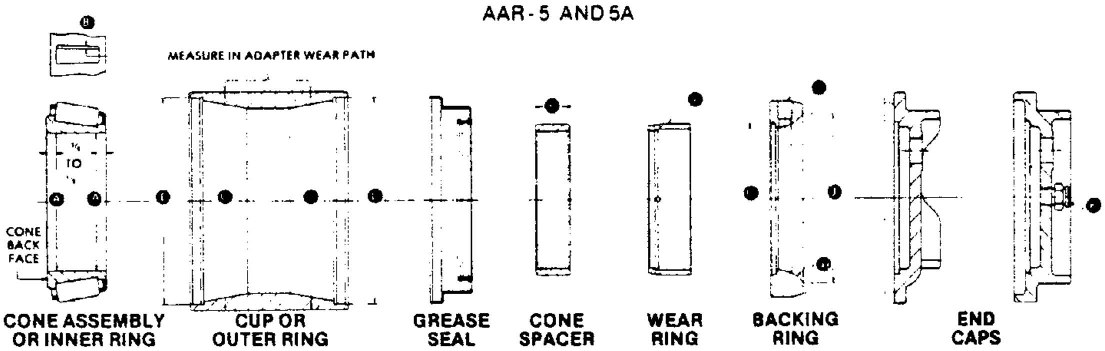
* SUFFIX H: NO GREASE FITTING HOLE (OR HOLE PERMANENTLY PLUGGED). ** USE ONLY WITH STYLE 2 END CAP (STYLE 1 END CAP INCORPORATES SEAL WEAR RING).

Fig. 3.4-3

Specifications for BRENCO Roller Bearing Maintenance

(NO FIELD LUBRICATION)

AAR-5 AND 5A



BEARING CLASS (SIZE)	B (4¼ x 8)	C (5 x 9)	D (5½ x 10)	E (6 x 11)	F (6½ x 12)	G (7 x 12)
CONE PART NO.	HM 120848	HM 124626	HM 127446	HM 129848	HM 133444	HM 136948
MAX. BORE OUT-OF-ROUND	.003" FOR ALL SIZES BUT AVERAGE MUST NOT EXCEED ● LIMIT.					
● AVG. I.D. NOT TO EXCEED	4.0015"	4.6890"	5.1890"	5.6890"	6.1890"	7.0015"

CAGE INSPECTION	PLACE CONE ASSEMBLY ON BACK FACE AND USE FEELER GAGES.
● POCKET SIDE CLEARANCE	LESS THAN .060" BETWEEN ROLLER AND CAGE BRIDGE.

CUP PART NO.	HM 120817XD	HM 124618XD	HM 127415XD	HM 129814XD	HM 133416XD	HM 136916XD
● MINIMUM O.D.	6.4900"	7.6775"	8.175"	8.675"	9.925"	10.863"
MAX. C'BORE OUT-OF-RND.	.005" FOR ALL SIZES BUT AVERAGE MUST MEET ● LIMITS.					
● C'BORE NOT TO EXCEED	6.0665"	7.1915"	7.754"	8.254"	9.379"	10.279"
● C'BORE MINIMUM	6.0600"	7.1850"	7.745"	8.245"	9.370"	10.270"

GREASE SEAL PART NO.	B0807	C0907	D1007	E1107	F1207	G71207
	REPLACE WITH NEW AAR APPROVED INTERCHANGE SEALS.					

CONE SPACER PART NO.	HM 120848XA	HM 124646XA	HM 127446XA	HM 129848	HM 133444XA	HM 136948XA
● WIDTH SELECTION MUST PROVIDE	.018" to .024" Hand Lateral or .021" to .027" Power Lateral		.020" to .026" Hand Lateral or .023" to .029" Power Lateral			

WEAR RING PART NO.	B0806	C0906	D1006	E1106	F1206	G71206
● WEAR LIMIT	SEAL LIP CONTACT PATH LESS THAN .005" DEEP.					

BACKING RING PART NO.	B0815	C0915	D1015	E1115	F1215	G71215
● COUNTERBORE	PROVIDE TIGHT FIT ON WEAR RING.					
● FILLET CONTACT	AREA NOT GALLED OR PITTED. USE RADIUS GAGE AS SPECIFIED IN RBM.					
● VENT FITTING	NOT CLOGGED, HARDENED, OR DAMAGED.					
● I.D. MAX. AVG. (FITTED)	N.A.	N.A.	N.A.	7.030"	7.530"	7.998"

END CAP PART NO.	B0811	C0911	D1011	E1111	F1211	G71211
INSPECTION	NO CRACKS, BREAKAGE, WEAR, OR DISTORTION.					
● LUBE FITTING	IF PRESENT, REPLACE WITH NON-REMOVABLE PLUG.					

GREASE WEIGHT OZ.	NOTE RBM FIG. 3.14 FOR FLOW THRU GREASING FROM BOTH SIDES.					
EACH CONE ASSEMBLY	2	3	4	4	6	8
SPACER	4	6	8	8	12	16
TOTAL ± 1 OUNCE	8	12	16	16	24	32

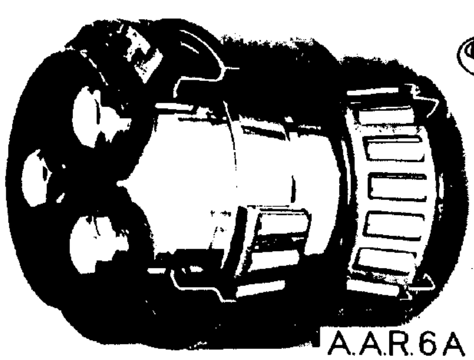
ALL PARTS OF BRENCO CROWN TAPERED ROLLER BEARINGS ARE TO BE MAINTAINED IN ACCORDANCE WITH ABOVE SPECIFICATIONS, ASSOCIATION OF AMERICAN RAILROADS (AAR) REQUIREMENTS IN AAR ROLLER BEARING MANUAL (RBM) AND AAR MANUAL OF STANDARDS AND RECOMMENDED PRACTICES.

BRENCO, INC. P. O. BOX 389, PETERSBURG, VIRGINIA 23804

ENGINEERING DWG. NO. - CP—200 040 REV. J., JULY 1985

Fig. 3.4-5

8/15/85

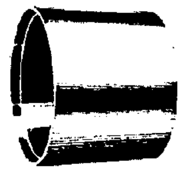
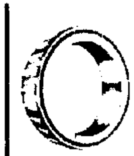


NEW DEPARTURE · HYATT BEARINGS

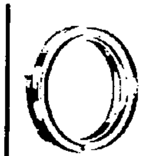
DIVISION OF GENERAL MOTORS CORPORATION · SANDUSKY, OHIO

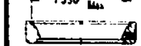
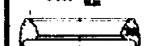
HY-ROLL TAPERED ROLLER BEARINGS 'NFL'

service notes and dimensions






Class and Size	Bearing Assembly and Mounting: Grease Weight (oz) Each Roller Assembly	Grease Weight (oz) Total per Bearing	Seating Pressure (Tons)	Cap Screw Size and Torque (FT-LBS)	Outer Ring Salvage Limits: Outside Diameter Min	Counterbore Diameter With New Seal	Roller Assembly: Bore Salvage Limits (Average Max)	Seal	Seal Wear Ring: Outside Diameter Wear Path Depth	Fit on Axle	Spacer: Code and Length	Backing Ring (Dust Guard or Enclosure Collar)	End Cap (Locking Cup)
D 5½ x 10	*(EA-100758-ZD) 8	16	40 To 50	¾" Dia. 140 150	(100758-ZD) 8 177	7.748 To 7 754	(A-100758) 5.189	(2-R-1053) Always use new seals	(3-R-1488) .005 Max.	Tight	(E-100758) A-2 1.255, A-1 1.260, A 1.265, B 1.270, C 1.275, D 1.280, E 1.285, F 1.290, G 1.295	Reject collar and/or seal ring if tight press fit is not obtained when seal wear ring is assembled in collar counterbore	(4-R-3810) No cracks, breakage wear or distortion. If equipped with lubricant fitting, replace with a nonremovable plug
E 6 x 11	*(EA-100808-ZD) 8	16	40 To 50	1" Dia. 250 270	(100808-ZD) 8 677	8.248 To 8 254	(A-100808) 5.689	(2-R-1048) Always use new seals	(2-R-1022) .005 Max.	Tight	(E-100808) A-1 1.510, A 1.515, B 1.520, C 1.525, D 1.530, E 1.535, F 1.540, G 1.545, H 1.550	VENT FITTING - Rule 5 25 Not clogged, hardened or damaged	(4-R-3811) Same as above
F 6½ x 12	*(EA-100916-ZD) 12	24	50 To 60	1⅛" Dia. 360 390	(100916-ZD) 9 927	9 373 To 9.379	(A-100916) 6.189	(2-R-1047) Always use new seals	(2-R-1056) .005 Max.	Tight	(E-100916) A-4 1.490, A-3 1.495, A-2 1.500, A-1 1.505, A 1.510, B 1.515, C 1.520, D 1.525, E 1.530	Same as above  7530 Dia Max FITTED STYLE	(4-R-3813) Same as above
G 7 x 12	*(EA-1001006-ZD) 18	36	40 To 70	1¼" Dia. 430 460	(1001006-ZD) 10.865	10.273 To 10 279	(A-1001006) 7.0015	(2-R-1096) Always use new seals	(3-R-1536) .005 Max.	Tight	(E-1001006) A-4 1.240, A-3 1.245, A-2 1.250, A-1 1.255, A 1.260, B 1.265, C 1.270, D 1.275, E 1.280	(RR-364) Same as above  8 000 Dia Max FITTED STYLE	(4-R-3888) Same as above

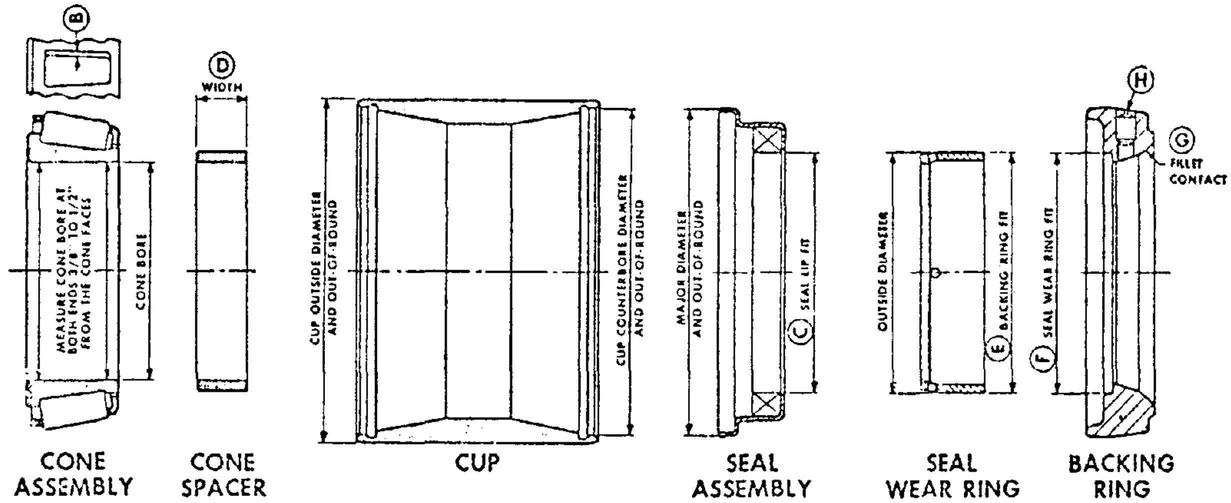
LATERAL ALL SIZES	CAP SCREW SEAL RINGS	OUT OF ROUND	OUT OF ROUND	OUT OF ROUND 003 max.	LOCKING PLATE - Rule 5 52	GENERAL
Bench: See Fig 5 22. Mounted: 001 017. Bearing must be serviced if mounted lateral is 030 or above	Always use new cap screw seal rings	All sizes 005 max	005 max Must average within limits	Cages - Reject if lip to rib clearance exceeds 090 or cage pocket to roller exceeds 080	D (5½ x 10) 3-R-1703; E (6 x 11) 3-R-1704; F (6½ x 12) 3-R-1705; G (7 x 12) 3-R-1706. Always use new locking plate	Any part should be rejected for breaks, cracks, deformities or other obvious defects. See Section 6 for remanufacture of bearing components.

* BEARING ONLY

Fig. 3.4-6

WEAR LIMITS AND SPECFICATIONS FOR BOWER ROLLER BEARINGS

AAR APPROVAL NO. 8



		BEARING					SEAL		AMOUNT OF GREASE (OUNCES)			
CLASS	SIZE	CONE NO.	CUP NO.	CONE BORE	CUP O.D. *	CUP † C'BORE	PART NO.	MAJOR O.D.	1 ST CONE	AROUND SPACER	2 ND CONE	TOTAL OUNCES
E	6 x 11	HM 129848	HM 129814XD	56890 5.6875	8.6925 8.6875	8.253 8.250	PD-105-C	8.263 8.258	4	8	4	16
F	6 1/2 x 12	HM133444	HM133416XD	6.1890 6.1875	9.9425 9.9375	9.378 9.375	PD-130-C	9.388 9.383	6	12	6	24

*** CUP**

New cup O.D. tolerance shown. Permissible wear of adapter cup seat pads into bearing cup .010" on diameter.

CUP OUT-OF-ROUND

0.005"

† COUNTERBORE OUT-OF-ROUND

0.005" but must average within tolerance shown. When using new seals, diameter of cup counterbore may be 0.001" larger than shown.

If cup exterior in vicinity of seal counterbore has been damaged causing a flat in excess of 2" the cup should be scrapped.

CONE BORE OUT-OF-ROUND

0.003"

SEAL OUT-OF-ROUND

0.015"
Based on .005" under minimum major O.D. to .005" above maximum major O.D.

CAGE INSPECTION

(B) If a cage pocket is so worn as to permit the insertion of a feeler in excess of .060" between the roll and the cage rib the cone assembly should be scrapped.

INTERFERENCE FIT OF SEAL AND SEAL WEAR RING

(C) To check, place a seal ring with a .010" undersize O.D. on a smooth and flat surface with chamfered end up, then apply the seal to be checked. If sufficient interference is not present to enable the seal to lift the undersize seal wear ring, the seal should be scrapped.

BENCH LATERAL

(D) If a bearing bench lateral is not within the .021" to .027" limits a new spacer should be selected so as to bring the bench lateral within these limits.

SEAL WEAR RING LIMITS OF WEAR

If the external surfaces of the seal wear ring are cracked, nicked or scratched or if the seal lip path has been worn into the seal wear ring to a depth of .010" on diameter the seal wear ring should be scrapped.

SEAL WEAR RING FIT IN BACKING RING

(E) The seal wear ring must fit tightly in the backing ring counterbore.

BACKING RING FIT ON SEAL WEAR RING

(F) The counterbore of the backing ring must have a tight fit on the seal wear ring.

BACKING RING AXLE FIT

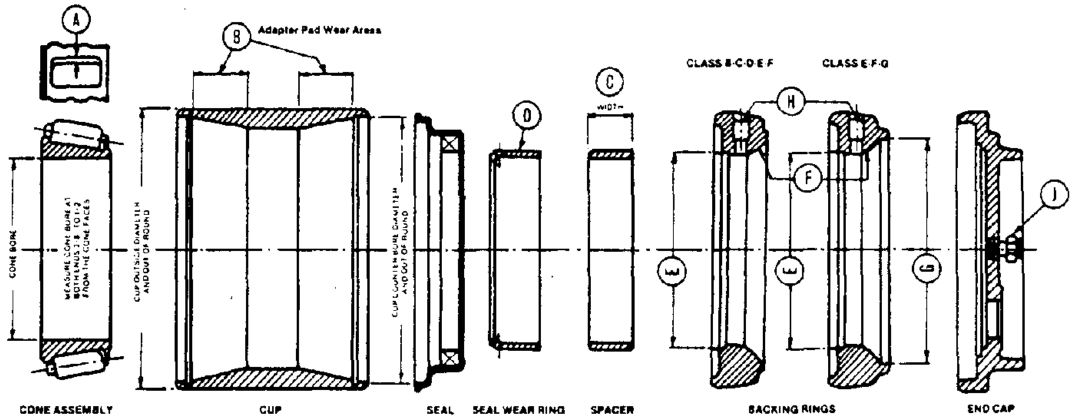
(G) Check bore radius for distortion, galling or fretting and corrosion.

VENT FITTING

(H) Check that fitting is operable, that is, not clogged, damaged, or hardened.

Fig. 3.4-8

WEAR LIMITS AND SPECIFICATIONS FOR AAR APPROVAL NO. 10 NTN



CLASS AND SIZE	DIAMETERS ARE AVERAGES (INCHES)							AMOUNT OF GREASE (OUNCES)		
	CONE		CUP				Backing Ring	Each Cone Assembly	Around Spacer	Total Qty.
	Maximum Bore	Out-of-Round	Minimum O.D.	Maximum C' bore	Minimum C' bore	Out-of-Round	Maximum C' bore			
B(4¼ x 8)	4.0015	0.003	6.500	6 144	6.141	0.005	——	2	4	8
C(5 x 9)	4.6890	0.003	7 6875	7 286	7 283	0.005	——	3	6	12
D(5½ x 10)	5.1890	0.003	8.1875	7 778	7 775	0.005	——	4	8	16
E(6 x 11)	5.6890	0.003	8.6875	8.270	8.267	0.005	7 030	4	8	16
F(6½ x 12)	6.1890	0.003	9.9375	9 471	9 468	0.005	7.530	6	12	24
G(7 x 12)	7 0015	0.003	10.8750	10.396	10.393	0.005	7.998	8	16	32

CAGE
(A) If the roller pocket of the cage is worn to the extent that an 0.060" feeler gage can be inserted between the roller and the cage bridge, the cone assembly should not be returned to service.

CUP
(B) Minimum O.D. to be measured in adapter pad wear areas.

SEAL
Scrap all used seals

SPACER WIDTH-BENCH LATERAL
(C) A Spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used.

	Power Operated	Hand Operated
Classes B C	0.021" to 0.027"	0.018" to 0.024"
Classes D E F G	0.023" to 0.029"	0.020" to 0.026"

SEAL WEAR RING — OUTSIDE SURFACE
(D) If the outside surface of the seal wear ring is cracked or scratched, or if the seal lip contact path has been worn to a depth of 0.005", the seal wear ring should be scrapped.

BACKING RING — FIT ON SEAL WEAR RING
(E) The counterbore of the backing ring must have a tight fit on the seal wear ring.

BACKING RING RADIUS
(F) Check bore radius for proper locating of contact with axle fillet and for fretting corrosion.

FITTED BACKING RING
(G) Check axle dust guard and backing ring counter-bore to ensure proper interference fit.

VENT FITTING
(H) Check the vent fitting to see that it is not clogged, hardened or damaged.

END CAP
(J) Inspect for cracks, breakage, wear or distortion. If end cap is equipped with lubricant fitting, remove and replace with a non-removable plug.

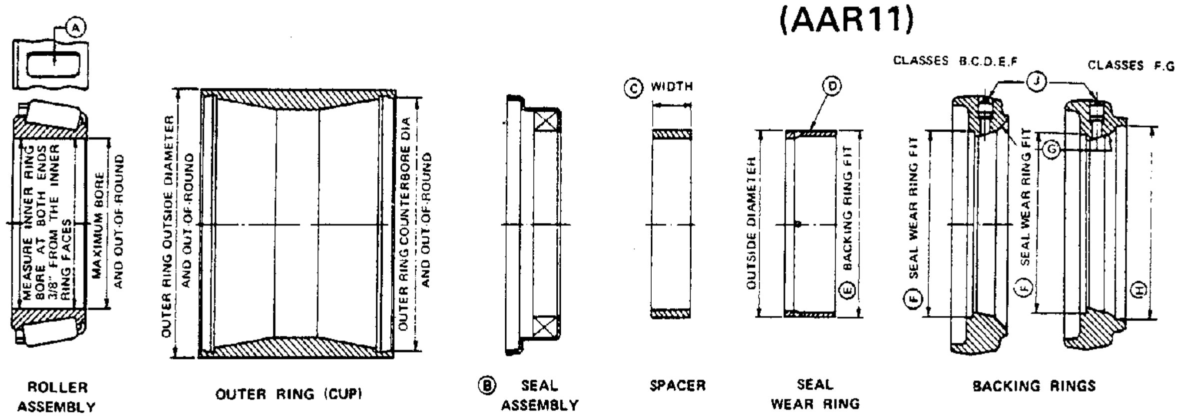
PART NUMBERS — BEARING COMPONENTS

Class and Size	Cone Assembly	Cup	Seal	Spacer	Seal Wear Ring	Backing Ring: Non Fitted	Backing Ring: Fitted	End Cap	Non Removable Plug	Cap Screw Seal Ring	Locking Plate	Cap Screw
B(4¼ x 8)	HM120848N	HM120817XDN	HM120817S2	HM120848XAN	RT40B10	RT30B10	——	RT20B10	RT22A21	RT52B11	RT51B12	RT50B11
C(5 x 9)	HM124646N	HM124618XDN	HM124618S2	HM124646XAN	RT40C10	RT30C10	——	RT20C10	RT22A21	RT52C11	RT51C12	RT50C11
D(5½ x 10)	HM127446N	HM127415XDN	HM127415S2	HM127446XAN	RT40D10	RT30D10	——	RT20D10	RT22A22	RT52C11	RT51D12	RT50C11
E(6 x 11)	HM129848N	HM129814XDN	HM129814S2	HM129848XAN	RT40E10	RT30E10	RT30E20	RT20E10	RT22A22	RT52E11	RT51E12	RT50E11
F(6½ x 12)	HM133444N	HM133416XDN	HM133416S2	HM133444XAN	RT40F10	RT30F10	RT30F20	RT20F10	RT22A22	RT52F11	RT51F12	RT50F11
G(7 x 12)	HM136948N	HM136916XDN	HM136916S2	HM136948XAN	RT40G10	—	RT30G20	RT20G10	RT22A22	RT52G11	RT51G12	RT50G11

DO NOT INTERCHANGE AAR APPROVAL NO. 10 BEARING PARTS WITH AAR APPROVAL NO. 19 OR 10A BEARING PARTS.

Fig. 3.4-10

WEAR LIMITS AND SPECIFICATIONS FOR NSK AAR11A (AAR11)



CLASS AND SIZE	DIAMETERS ARE AVERAGES						AMOUNT OF GREASE (OUNCES)		
	ROLLER ASSEMBLY		OUTER RING			BACKING RING			
	MAXIMUM BORE	OUT-OF-ROUND	MINIMUM O. D.	C'BORE	OUT-OF-ROUND	MAXIMUM C'BORE	EACH ROLLER ASSEMBLY	AROUND SPACER	TOTAL QUANTITY
B (4¼ x 8)	4.0016"	0.003"	6.5000"	6.1447" 6.1413"	0.005"	–	2	4	8
C (5 x 9)	4.6891"	0.003"	7.6875"	7.2864" 7.2831"	0.005"	–	3	6	12
D (5½ x 10)	5.1891"	0.003"	8.1875"	7.7785" 7.7752"	0.005"	–	4	8	16
E (6 x 11)	56891"	0.003"	8.6875"	8.2707" 8.2669"	0.005"	–	4	8	16
F (6½ x 12)	6.1891"	0.003"	9.9375"	9.4715" 9.4677"	0.005"	7.5300"	6	12	24
G (7 x 12)	7.0016"	0.003"	10.8750"	10.3967" 10.3929"	0.005"	7.9980"	8	16	32

OUTER RING O.D.

Minimum O.D. to be measured in adapter pad wear areas. If the outer ring is distorted in the area of the counterbore a close visual inspection of the inside and outside surfaces is required. Outer rings that have hair line cracks must be scrapped.

Ⓐ CAGE INSPECTION

If the roller pocket of the cage is worn to the extent that an 0.070" feeler gage can be inserted between the roller and the cage bridge, the inner ring and roller assembly should not be returned to service.

Ⓑ SEAL ASSEMBLY – SCRAP ALL SEALS

Ⓒ BENCH LATERAL

A spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used:

	Power Operated	Hand Operated
Classes B-C	0.021" to 0.027"	0.018" to 0.024"
Classes D-E-F-G	0.023" to 0.029"	0.020" to 0.026"

Ⓓ SEAL WEAR RING LIMIT

If the outside surface of the seal wear ring is cracked or scratched or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring should be scrapped.

Ⓔ SEAL WEAR RING FIT IN BACKING RING

The seal wear ring must have a tight fit in the backing ring counterbore.

Ⓕ BACKING RING FIT ON SEAL WEAR RING

The counterbore of the backing ring must have a tight fit on the seal wear ring.

Ⓖ BACKING RING SIZE AND RADIUS (NON FITTED)

Backing rings that are bent or distorted must be scrapped. Check the backing ring size and the bore radius for proper axle fillet contact and excessive corrosion with the AAR gage as shown in the Roller Bearing Manual.

Ⓗ BACKING RING – SIZE AND RADIUS (FITTED)

Check Major I.D.

Ⓙ VENT FITTING

Check the vent fitting to see that it is not clogged, hardened, or damaged. Hardened or damaged vent fittings should be replaced. (Part number JB8177A).

PART NUMBERS-BEARING COMPONENTS

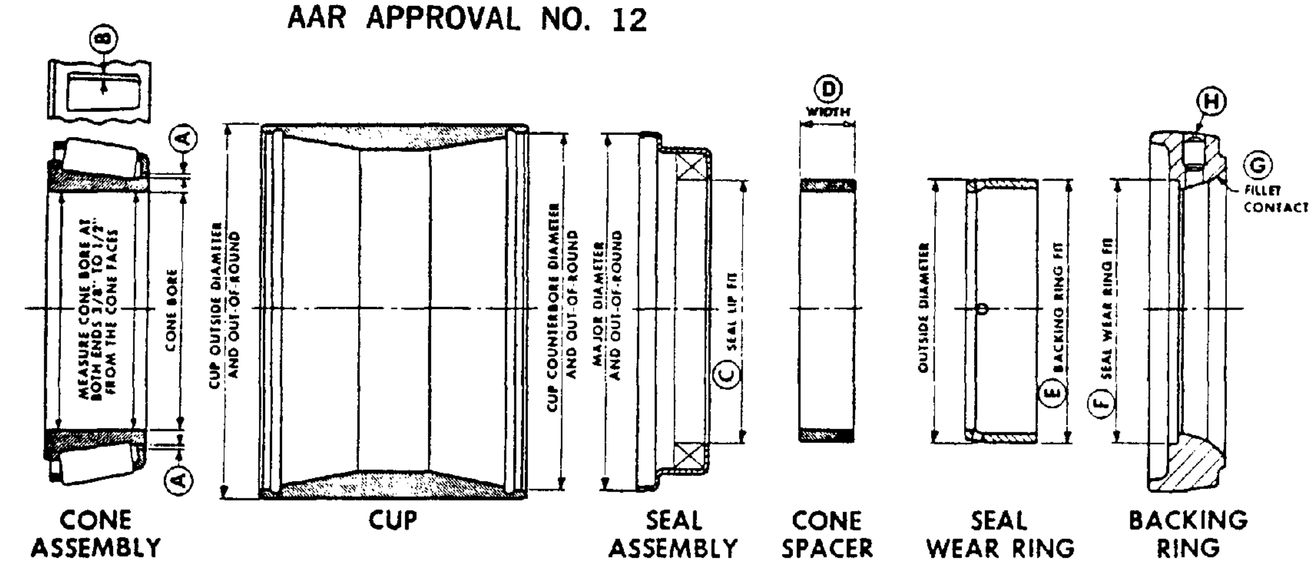
CLASS AND SIZE	ROLLER ASSEMBLY	OUTER RING (CUP)	SPACER	SEAL	SEAL WEAR RING	OLD STYLE BACKING RING	NEW STYLE BACKING RING	OLD STYLE END CAP	NEW STYLE END CAP	NONRE MOVABLE PLUG	CAP SCREW SEAL RINGS	LOCKING PLATE	CAP SCREWS
B (4¼ x 8)	HM120848N	HM120817XDNA	HM120848N L	HM120817XDNA S	J85597	J85598	—	J82665	J87802	J88392	J86194B	J88347B	J84541A
C (5 x 9)	HM124646N	HM124618XDNA	HM124646N L	HM124618XDNA S	J85590	J85589	—	J82661	J87803	J88392	J86194C	J88347C	J84531B
D (5½ x 10)	HM127446N	HM127415XDNA	HM127446N L	HM127415XDNA S	J85587	J85587A	—	J82665A	J82804	J88393	J86194D	J88347D	J84531B
E (6 x 11)	HM129848N	HM129814XDNA	HM129848N L	HM129814XDNA S	J85593	J85592	—	J82663	J87805	J88393	J86194E	J88347E	J84539A
F (6½ x 12)	HM133444NX	HM133416XDNA	HM133444N L	HM133416XDNA S	J85606	J85605	J85787	J82670	J82806	J88393	J86194F	J88347F	J84547A
G (7 x 12)	HM136948NX	HM136916XDNA	HM136948N L	HM136916XDNA S	J85623	J85622A	J85622A	J82680	J87807	J88393	J86194G	J88347G	J84561A

Do Not Interchange AAR Approval No. 11A or No. 11 Bearing Parts with AAR Approval No. 22 Bearing Parts.

Fig. 3.4-11

SPECIFICATION CHART: NACHI ROLLER BEARINGS

AAR APPROVAL NO. 12



CLASS AND SIZE	BEARING					SEAL		AMOUNT OF GREASE (OUNCES)			
	CONE		CUP				MAJOR	1ST CONE	AROUND CONE	2ND CONE	TOTAL
	PART NO.	BORE	PART NO.	O.D. *	C'BORE+		O.D.	ASSEMBLY	SPACER	ASSEMBLY	QUANTITY
B(4 1/4"×8")	HM120848	4.0015" 4.000"	HM120817XD	6.505" 6.500"	6.144" 6.141"		6.156" 6.150"	2	4	2	8
C(5"×9")	HM124646	4.689" 4.6875"	HM124618XD	7.6925" 7.6875"	7.286" 7.283"		7.297" 7.291"	3	6	3	12
D(5 1/2"×10")	HM127446	5.189" 5.1875"	HM127415XD	8.1925" 8.1875"	7.753" 7.750"		7.763" 7.757"	4	8	4	16
E(6"×11")	HM129848	5.689" 5.6875"	HM129814XD	8.6925" 8.6875"	8.253" 8.250"		8.263" 8.257"	4	8	4	16
F(6 1/2"×12")	HM133444	6.189" 6.1875"	HM133416XD	9.9425" 9.9375"	9.378" 9.375"		9.388" 9.382"	6	12	6	24
G(7"×12")	HM136948	7.0015" 7.000"	HM136916XD	10.880" 10.875"	10.278" 10.275"		10.288" 10.282"	8	16	8	32

*** CUP O.D.**

New cup O.D. tolerance shown in table. 0.005" (0.010" diameter) wear of adapter cup seat pads into bearing cup is permissible.

CUP OUT-OF-ROUND

0.005"

+ COUNTERBORE OUT-OF-ROUND

0.005" but must average within tolerance shown.

If new seals are used cup counterbore diameter may be 0.001" larger than shown in table.

If the cup has been struck causing a flat on the O.D. in the counterbore area, over a 2" or longer chord, the cup must be scrapped.

CONE BORE OUT-OF-ROUND

0.003"

SEAL OUT-OF-ROUND

–0.005" to +0.010" (0.015")

Based on major O.D. minimum plus 0.001" (new seal minimum).

CAGE INSPECTION

(A) Cages are considered to be worn excessively when the total clearance on diameter between the small rib of the cone and the cage flange is 0.090" or more.

Measure this clearance using two sets of feeler gages. Insert the feeler gages between the small rib of the cone and cage flange at two locations diametrically opposite. If the total of the two sets of feeler gages is 0.090" or more, the cone assembly should not be returned to service.

(B) If the roller pocket of the cage is worn to the extent that an 0.060" feeler gage can be inserted between the roller and the cage bridge, the cone and roller assembly should not be returned to service.

SEAL WEAR RING AND SEAL INTERFERENCE FIT

(C) To check the interference fit of the seal element and seal wear ring, place a 0.010" undersize seal wear ring on a smooth flat surface with the chamfered end of the wear ring at the top and apply the seal to be checked.

If the interference fit of the seal, on this undersize wear ring is not sufficient to lift the wear ring the seal should be scrapped.

BENCH LATERAL

(D) If the bearing bench lateral play is not within the limits of 0.021" to 0.027", the cone spacer should be ground or a new cone spacer selected to provide the specified bearing bench lateral play.

SEAL WEAR RING WEAR LIMIT

If the outside surface of the seal wear ring is cracked or scratched or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring should be scrapped.

SEAL WEAR RING FIT IN BACKING RING

(E) The seal wear ring must have a tight fit in the backing ring counterbore.

BACKING RING FIT ON SEAL WEAR RING

(F) The counterbore of the backing ring must have a tight fit on the seal wear ring.

CONE BACKING RING AXLE FILLET CONTACT

(G) Check the backing ring for distortion and the bore radius for proper location of contact with the axle fillet.

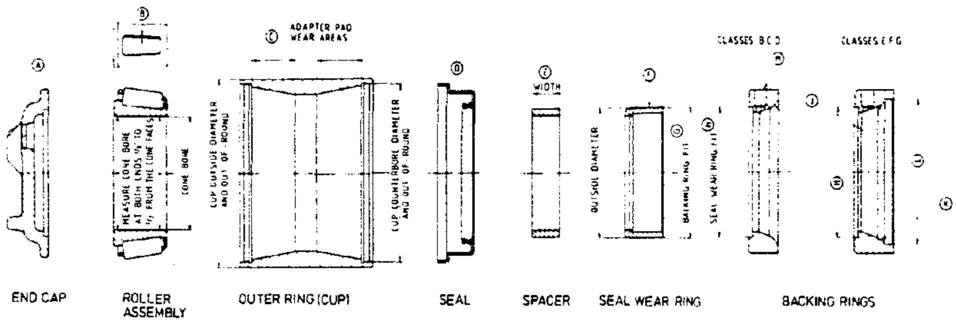
VENT FITTING

(H) Check the vent fitting to see that it is not clogged, hardened, or damaged.

Fig. 3.4-12

FAG

WEAR LIMITS AND SPECIFICATIONS FOR JOURNAL ROLLER BEARINGS AAR 13
(NO FIELD LUBRICATION)



CLASS AND SIZE	DIAMETERS ARE AVERAGES						AMOUNT OF GREASE (OUNCES)		
	ROLLER ASSEMBLY		OUTER RING			BACKING RING	Each Roller Assembly	Around Spacer	Total Quantity
	Maximum Bore	Out-of-Round	Minimum O.D.	Maximum C'bore	Out-of-Round	Maximum C'bore			
B ($4^1/_4$ x 8)	4.0015"	0.003"	6.4900"	6.0665"	0.005"	-	2	4	8
C (5 x 9)	4.6890"	0.003"	7.6775"	7.1915"	0.005"	-	3	6	12
D ($5^1/_2$ x 10)	5.1890"	0.003"	8.1775"	7.7540"	0.005"	-	4	8	16
E (6 x 11)	5.6890"	0.003"	8.6775"	8.2540"	0.005"	7.0300"	4	8	16
F ($6^1/_2$ x 12)	6.1890"	0.003"	9.9275"	9.3790"	0.005"	7.5300"	6	12	24
G (7 x 12)	7.0015"	0.003"	10.8650"	10.2790"	0.005"	7.9980"	8	16	32

Ⓐ **END CAP**

Inspect for cracks, breakage, wear or distortion. If end cap is equipped with lubricant fitting, remove and replace with a non-removable plug.

Ⓑ **CAGE**

If the roller pocket of the cage is worn to the extent that a 0.060" feeler gage can be inserted between the roller and the cage bridge, the roller assembly should not be returned to service.

Ⓒ **OUTER RING (CUP)**

Minimum O.D. to be measured in adapter wear areas. Maximum out-of-round 0.005".

Ⓓ **SEAL**

Scrap all used seals

Ⓔ **SPACER WITH - BENCH LATERAL**

	Power operated
Classes B-C	0.021" to 0.027"
Classes D-E-F-G	0.023" to 0.029"
	Hand operated
Classes B-C	0.018" to 0.024"
Classes D-E-F-G	0.020" to 0.026"

If the bearing bench lateral is not within the above limits, the cone spacer should be ground or a new cone spacer selected to provide the specified bearing bench lateral.

Ⓕ **SEAL WEAR RING LIMIT**

If the outside surface of the seal wear ring is cracked or scratched or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring should be scrapped.

Ⓖ **SEAL WEAR RING-FIT IN BACKING RING**

The seal wear ring must have a tight fit in the backing ring counterbore.

Ⓗ **BACKING RING-FIT ON THE SEAL WEAR RING**

The counterbore of the backing ring must have a tight fit on the seal wear ring.
Scrap backing rings which are bent or distored.

Ⓙ Check backing ring bore radius with AAR gauge to ensure proper axle fillet contact. Check for excessive corrosion.

Ⓚ Check bore radius for excessive corrosion. Light pitting and corrosion is acceptable.

Ⓛ Check major bore diameter of backing ring.

Ⓜ **VENT FITTING**

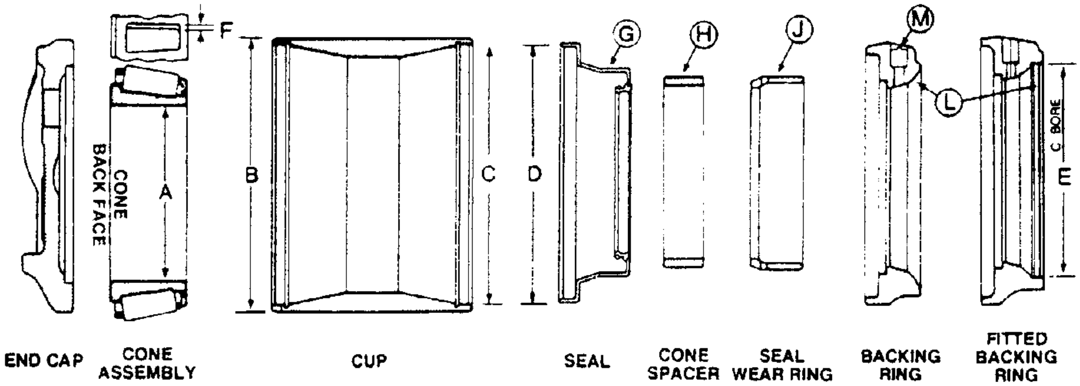
Check the vent fitting for clogging, hardening and damage.

PART NUMBERS - BEARING COMPONENTS

CLASS AND SIZE	ROLLER ASSEMBLY	OUTER RING (CUP)	SPACER	SEAL	SEAL WEAR RING	BACKING RING	END CAP	LUBE FITTING	LOCKING PLATE	CAP SCREWS
B $4^1/_4$ x 8	512927.2	512927.1	512927.3	120985/5	120985/4	120985/3	120985/2	128739/1	120985/6	126173/1
C 5 x 9	513149.2	513149.1	513149.3	120986/5	120986/4	120986/3	120985/2	128739/1	120986/6	126173/1
D $5^1/_2$ x 10	512952.2	512952.1	512952.3	120987/5	120987/4	120987/3	120987/2	128738/1	120987/6	126173/1
E 6 x 11	513150.2	513150.1	513150.3	120988/5	120988/4	120988/3	120988/7	128738/1	120988/6	126173/1
F $6^1/_2$ x 12	513151.2	513151.1	513151.3	120989/5	120989/4	120989/3	120989/7	128738/1	120989/6	126173/1
G 7 x 12	513976.2	513976.1	513976.3	120860/5	120860/4	120860/3	120860/7	128738/1	120860/6	126173/1

Fig. 3.4-13

Koyo AMERICAN KOYO CORPORATION AAR APPROVAL NO. 14



MAINTENANCE SPECIFICATIONS

CLASS AND SIZE	CONE		CUP				SEAL		FITTED BACKING RING		AMOUNT OF GREASE (OZ)		
	A		B		C		D		E				
	BORE DIA *	OUT OF ROUND T.I.R.	AVERAGE O.D.	OUT OF ROUND T.I.R.	AVERAGE C BORE DIA	OUT OF ROUND T.I.R.	AVERAGE O.D.	OUT OF ROUND T.I.R.	C BORE	OUT OF ROUND T.I.R.	CONE EA	AROUND SPACER	TOTAL
B (4¼ × 8)	4.0015	.003	6.5050 6.5000	.005	6.0655 6.0625	.005	6.074 6.068	.015	—	—	2	4	8
C (5 × 9)	4.6890	.003	7.6925 7.6875	.005	7.1905 7.1875	.005	7.200 7.194	.015	—	—	3	6	12
D (5½ × 10)	5.1890	.003	8.1925 8.1875	.005	7.7540 7.7510	.005	7.763 7.757	.015	—	—	4	8	16
E (6 × 11)	5.6890	003	8.6925 8.6875	.005	8.2530 8.2500	005	8.263 8.257	015	7.030	003	4	8	16
F (6½ × 12)	6.1890	003	9.9425 9.9375	.005	9.3780 9.3750	005	9.388 9.382	015	7.530	003	6	12	24
G (7 × 12)	7.0015	003	10.8800 10.8750	005	10.2780 10.2750	005	10.288 10.282	.015	8.000	003	8	16	32

* Average out-of-round reading $\left(\frac{D\ max \quad D\ min}{2}\right)$ must not exceed dimension shown. T.I.R. Total Indicator Reading

END CAP-Inspect for cracks, breakage, wear and distortion of machined surfaces. Lubricant fittings are to be replaced with non-removable plug.

F **CONE ASSEMBLY (CAGE WEAR)**—If an .080" thick feeler gage can be inserted between roller and cage bar, the assembly should be rejected. It is unsuitable for continued operation. (Lay cone on back face for gaging.)

G **SEALS**—Scrap used seals

H **BENCH LATERAL**—The cone spacer must be of such length as to obtain the following bench laterals

	Hand Oper.	Power Oper.
Class B.C	0.018" to 0.024"	0.021" to 0.027"
Class D.E.F.G	0.020" to 0.026"	0.023" to 0.029"

J **SEAL WEAR RING**—The wear ring should be scrapped if the outside surface is scratched, shows cracks, or if the seal has caused wear pattern (groove) of more than .005" deep

L **BACKING RING**—(Non-fitted type)—Scrap distorted, cracked, or heavily pitted rings. Check ring with service limited gage as outlined in roller bearing manual to insure proper axle fillet contact. (Fitted type)—check same as for non-fitted type and C bore for dimensions as shown above

M **VENT FITTING**—Check and replace if clogged, hardened, damaged or loose

COMPONENTS PARTS LIST

CLASS AND SIZE	BEARING ASSEMBLY	CUP	CONE	SPACER	AXLE END CAP	SEAL	SEAL WEAR RING	BACKING RING	LOCKING PLATE
B (4¼ × 8)	JB 1201	HM120817XD	HM120848	HM120848XA	701N60	701N50	701N40	701N20	701N80
C (5 × 9)	JB 1202	HM124618XD	HM124646	HM124646XA	702N60	702N50	702N40	702N20	702N80
D (5½ × 10)	JB 1203	HM127415XD	HM127446	HM127446XA	703N60	703N50	703N40	703N20	703N80
E (6 × 11)	JB 1204	HM129814XD	HM129848	HM129848XA	704N60	704N50	704N40	704N20	704N80
F (6½ × 12)	JB 1205	HM133416XD	HM133444	HM133444XA	705N60	705N50	705N40	705P20	705N80
G (7 × 12)	JB 1206	HM136916XD	HM136948	HM136948XA	706N60	706N50	706N40	706N20	706N80

MANUFACTURERS SERVICE LIMITS CHART
KOYO "ABU" ROLLER BEARINGS

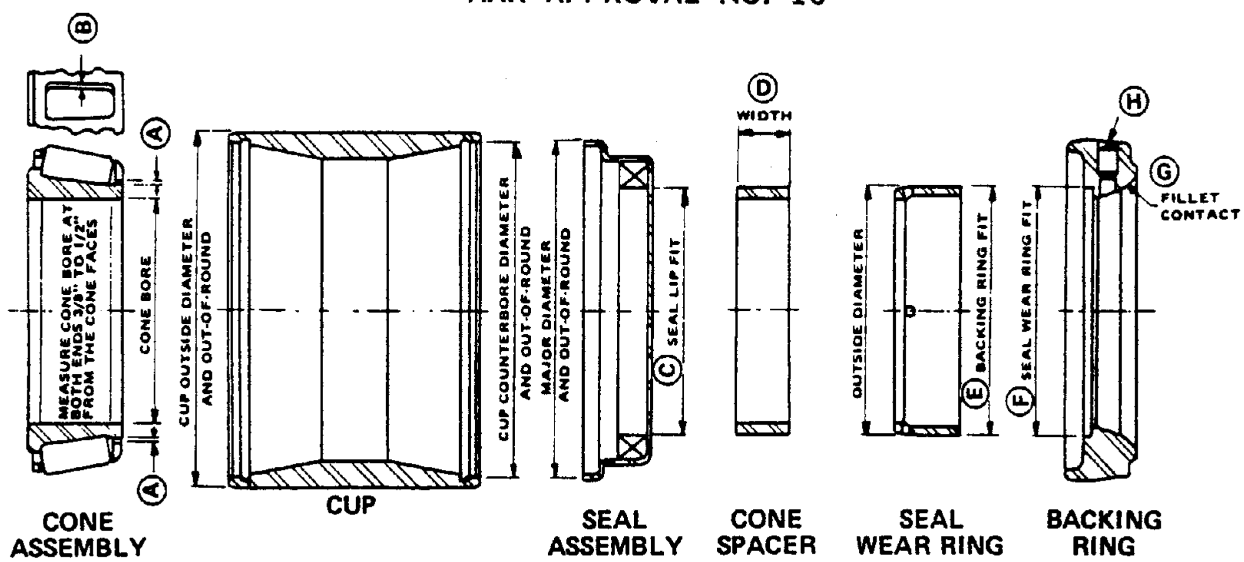
Do not interchange AAR approval No. 14 bearing parts with AAR approval No. 24 bearing parts.

American Koyo Corporation 12/80

Fig. 3.4-14

WEAR LIMITS AND SPECIFICATIONS FOR MAGNUS ROLLER BEARINGS

AAR APPROVAL NO. 16



CLASS AND SIZE	BEARING					SEAL		AMOUNT OF GREASE (OZS)			
	CONE ASSEMBLY		CUP								
	PART NO.	BORE	PART NO.	O.D.*	C'BRE†	PART NO.	MAJOR O.D.	1st CONE ASSEMBLY	AROUND SPACER	2nd CONE ASSEMBLY	TOTAL AMT.
E(6"x11")	E-1103	5.6890 5.6875	E-1102	8.692 8.687	8.253 8.250	E-1107	8.263 8.258	4	8	4	16
F(6½"x12")	F-1203	6.1890 6.1875	F-1202	9.942 9.937	9.378 9.375	F-1207	9.388 9.383	6	12	6	24

*CUP

New cup O.D. tolerance shown. Permissible wear of adapter cup seat pads into bearing cup .010" on diameter.

CUP OUT-OF-ROUND

0.005"

† COUNTERBORE OUT-OF-ROUND

0.005" but must average within tolerance shown. When using new seals, diameter of cup counterbore may be 0.001" larger than shown.

If cup exterior in vicinity of seal counterbore has been damaged causing a flat in excess of 2" the cup should be scrapped.

CONE BORE OUT-OF-ROUND

0.003"

SEAL OUT-OF-ROUND

0.015"
Based on .005" under minimum major O.D. to .005" above maximum major O.D.

CAGE INSPECTION

(A) Cages are worn excessively when the total clearance between the cone small flange and the cage flange exceeds .090". To measure, center cage flange around cone flange with two feeler gage sets. If the sum of the feelers needed exceeds .090" the cone assembly should be scrapped.

(B) If a cage pocket is so worn as to permit the insertion of a feeler in excess of .060" between the roll and the cage rib the cone assembly should be scrapped.

INTERFERENCE FIT OF SEAL AND SEAL WEAR RING

(C) To check, place a seal ring with a .010" undersize O.D. on a smooth and flat surface with chamfered end up, then apply the seal to be checked. If sufficient interference is not present to enable the seal to lift the undersize seal wear ring, the seal should be scrapped.

BENCH LATERAL

(D) If a bearing bench lateral is not within the .021" to .027" limits a new spacer should be selected so as to bring the bench lateral within these limits.

SEAL WEAR RING LIMITS OF WEAR

If the external surfaces of the seal wear ring are cracked, nicked or scratched or if the seal lip path has been worn into the seal wear ring to a depth of .010" on diameter the seal wear ring should be scrapped.

SEAL WEAR RING FIT IN BACKING RING

(E) The seal wear ring must fit tightly in the backing ring counterbore.

BACKING RING FIT ON SEAL WEAR RING

(F) The counterbore of the backing ring must have a tight fit on the seal wear ring.

BACKING RING AXLE FIT

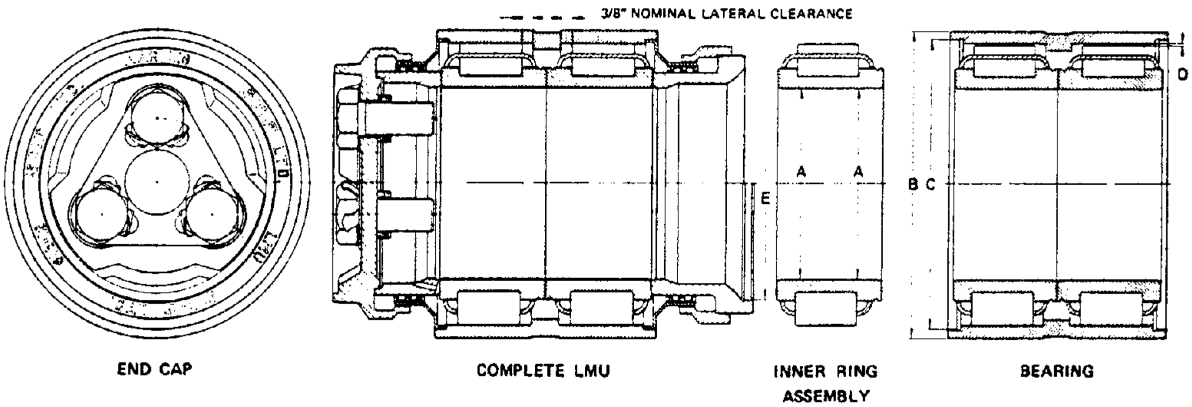
(G) Check bore radius for distortion, galling or fretting and corrosion.

VENT FITTING

(H) Check that fitting is operable, that is, not clogged, damaged, or hardened.

Fig. 3.4-16

SPECIFICATIONS FOR SKF (SWEDEN) LATERAL MOTION UNITS LMU
AAR APPROVAL L18



SIZE AND CLASS	INNER RING MAXIMUM BORE	OUTER RING MINIMUM OUTSIDE DIAMETER	OUTER RING MAXIMUM C'BORE	INTERNAL RADIAL CLEARANCE D		BACKING RING MAXIMUM C'BORE	TOTAL AMOUNT OF GREASE PER BEARING
	A	B	C	MAX.	MIN.	E	Ounces
5 1/2 x 10 (D)	5.1894	8.1775	7.7540	0.014	0.0045		11
6 x 11 (E)	5.6894	8.6775	8.2540	0.014	0.005		13
6 1/2 x 12 (F)	6.1894	9.9275	9.3790	0.014	0.005	7.529	21

Lateral clearance
By design, the LMU has 3/4" built-in lateral clearance.

Inner ring bore (A)
Measure in 2 places, 1/2" in from each face. Maximum out-of-round 0.003"

Outer ring outside diameter (B)
Maximum out-of-round 0.005".

Maximum outer ring counter bore diameter (C)
Maximum out-of-round 0.005".

Internal radial clearance (D)
With bearing resting on its OD on a flat surface, measure clearance by inserting feeler gauge between top roller of one row and outer ring track. (Caution: Do not allow rollers to roll over the blades of the feeler gauge). Repeat twice, turning complete bearing 120° between measurements. Average of the 3 measurements must be within values shown in tabulation. Repeat procedure for other row of rollers. The difference between the 2 average values must not exceed 0.0025".

Rollers
Rollers of each inner ring assembly form a set matched to that inner ring. Complete sets of rollers from one inner ring assembly must not be used with another inner ring. An individual roller must not be replaced. If an individual roller is damaged or lost, the entire inner ring assembly must be replaced.

Cage
If the rollers will not fall out of the cage pockets under the influence of their own weight and the cage has no other obvious defects, the cage is considered suitable for further service.

Wear of sealing surfaces on seal wear rings and backing rings
If the wear in the seal lip contact area exceeds 0.005" (0.010" on diameter), the part must be replaced. Sharp edges of all scratches and dents in this area must be removed. Note: The backing ring is made of 2 permanently assembled parts (to facilitate manufacture). The parts are not to be separated during removal and overhaul of the backing ring.

Seals
For removal and mounting of seals use same methods as used for tapered roller bearings. Do not use method applicable to RBU (AAR 3, 3A, 3B) shown in Fig. 3.4-3, as this may result in damage to cage.

Inner ring assemblies
When inner ring assemblies are inserted into outer rings, the wider flanges of the inner rings (identified by a circumferential witness groove in the flange OD) must face each other at the center of the bearing.

Lubrication
By using a suitable fixture, half the tabulated amount of grease can be applied to each side of the assembled bearing (before seals are mounted). Alternatively, slightly more than 30 % of the total amount may be applied to each inner ring assembly, and the remaining 35 % to 40 % to the area between the two inner ring assemblies and the outer ring center flange.

PARTS LIST

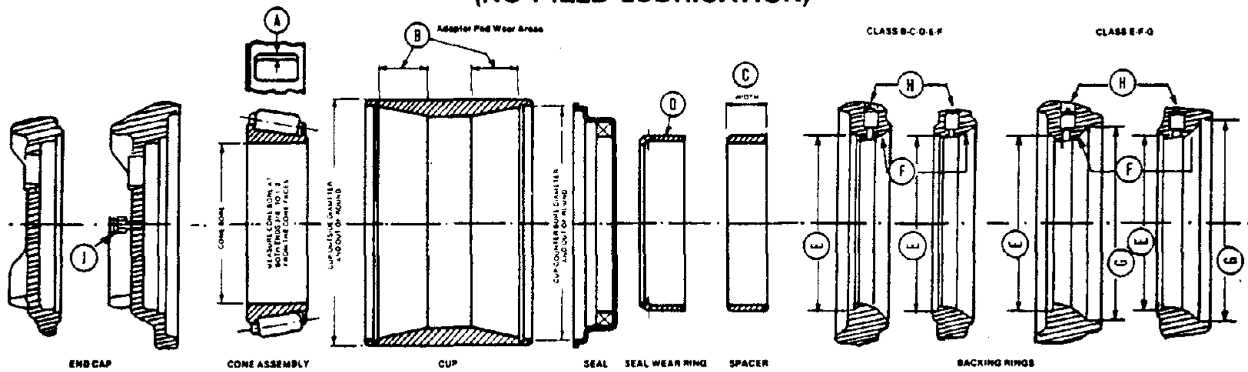
SIZE AND CLASS	COMPLETE LMU	** BEARING	SEAL	END CAP	SEAL WEAR RING	BACKING RING	LOCKING PLATE	CAP SCREW	CAP SCREW SEAL RING
5 1/2 x 10 (D)	725155	240355	240358	725157	725158	725156	715730-3	722459 (7/8")	729720-2
6 x 11 (E)	725160	240360	240363	725162	725163	725161	715730-4	722464 (1")	729720-3
6 1/2 x 12 (F)	725165	240365	240368	725167	725168	725166 F	715730-5	722469 (1 1/8")	729720-4

** Each bearing consists of one outer ring (designated with prefix L) and two inner ring assemblies (each with prefix R; example: R-240355).

Fig. 3.4-18

WEAR LIMITS AND SPECIFICATIONS FOR AAR APPROVAL NO. 19 NTN - TITAN®

(NO FIELD LUBRICATION)



CLASS AND SIZE	DIAMETERS ARE AVERAGES (INCHES)							AMOUNT OF GREASE (OUNCES)		
	CONE		CUP				Backing Ring			
	Maximum Bore	Out-of-Round	Minimum O.D.	Maximum C' bore	Minimum C' bore	Out-of-Round	Maximum C' bore	Each Cone Assembly	Around Spacer	Total Qty.
B(4½ x 8)	4.0015	0.003	6.500	6.065	6.061	0.005	—	2	4	8
C(5 x 9)	4.6890	0.003	7.6875	7.191	7.187	0.005	—	3	6	12
D(5½ x 10)	5.1890	0.003	8.1875	7.754	7.750	0.005	—	4	8	16
E(6 x 11)	5.6890	0.003	8.6875	8.254	8.250	0.005	7.030	4	8	16
F(6½ x 12)	6.1890	0.003	9.9375	9.379	9.375	0.005	7.530	6	12	24
G(7 x 12)	7.0015	0.003	10.8750	10.279	10.275	0.005	7.998	8	16	32

CAGE
(A) If the roller pocket of the cage is worn to the extent that an 0.060" feeler gage can be inserted between the roller and the cage bridge, the cone assembly should not be returned to service.

CUP
(B) Minimum O.D. to be measured in adapter pad wear areas.

SEAL
Scrap all used seals

SPACER WIDTH-BENCH LATERAL
(C) A Spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used.

	Power Operated	Hand Operated
Classes B C	0.021" to 0.027"	0.018" to 0.024"
Classes D E F G	0.023" to 0.029"	0.020" to 0.026"

SEAL WEAR RING — OUTSIDE SURFACE
(D) If the outside surface of the seal wear ring is cracked or scratched, or if the seal lip contact path has been worn to a depth of 0.005", the seal wear ring should be scrapped.

BACKING RING — FIT ON SEAL WEAR RING
(E) The counterbore of the backing ring must have a tight fit on the seal wear ring.

BACKING RING RADIUS
(F) Check bore radius for proper locating of contact with axle fillet and for fretting corrosion.

FITTED BACKING RING
(G) Check axle dust guard and backing ring counter-bore to ensure proper interference fit.

VENT FITTING
(H) Check the vent fitting to see that it is not clogged, hardened or damaged.

END CAP
(J) Inspect for cracks, breakage, wear or distortion. If end cap is equipped with lubricant fitting, remove and replace with a non-removable plug.

PART NUMBERS — BEARING COMPONENTS

Class and Size	Cone Assembly	Cup	Seal	Spacer	Seal Wear Ring	Old Type* Backing Ring: Non Fitted	Old Type* Backing Ring: Fitted	New Type* Backing Ring: Non Fitted	New Type* Backing Ring: Fitted	Old Type* End Cap	New Type* End Cap	Non Re-movable Plug	Cap Screw Seal Ring	Locking Plate	Cap Screw
B(4½ x 8)	HM120848	HM120817XD	HM120817S4	HM120848XA	RT40B11	RT30B11		RT30B31		RT20B11	RT20B31	RT22A21	RT52B11	RT51B12	RT50B11
C(5 x 9)	HM124646	HM124618XD	HM124618S4	HM124648XA	RT40C11	RT30C11		RT30C31		RT20C11	RT20C31	RT22A21	RT52C11	RT51C12	RT50C11
D(5½ x 10)	HM127446	HM127415XD	HM127415S4	HM127446XA	RT40D11	RT30D11		RT30D31		RT20D11	RT20D31	RT22A22	RT52C11	RT51D12	RT50C11
E(6 x 11)	HM129848	HM129814XD	HM129814S4	HM129848XA	RT40E11	RT30E11	RT30E21	RT30E31	RT30E41	RT20E11	RT20E31	RT22A22	RT52E11	RT51E12	RT50E11
F(6½ x 12)	HM133444	HM133416XD	HM133416S4	HM133444XA	RT40F11	RT30F11	RT30F21		RT30F41	RT20F11	RT20F31	RT22A22	RT52F11	RT51F12	RT50F11
G(7 x 12)	HM136948	HM136916XD	HM136916S4	HM136948XA	RT40G11		RT30G21		RT30G41	RT20G11	RT20G31	RT22A22	RT52G11	RT51G12	RT50G11

END CAP AND BACKING RING INTERCHANGEABLE. NEW TYPES ARE CURRENT PRODUCTION.

7/1/83

DO NOT INTERCHANGE AAR APPROVAL NO. 19 BEARING PARTS WITH AAR APPROVAL NO. 10 BEARING PARTS.

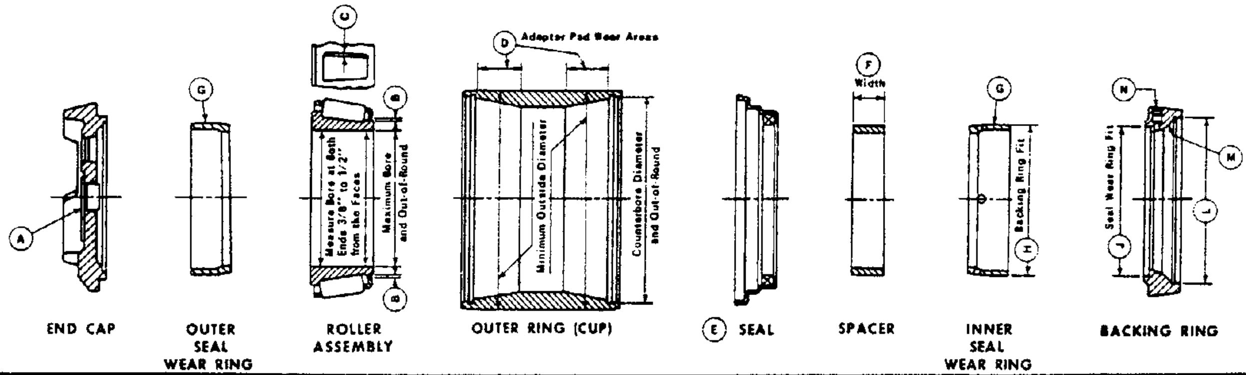
NTN BEARING CORP. OF AMERICA 31 E. Oakton Street, Des Plaines, Illinois 60018

Fig. 3.4-19

TIMKEN "XP" ROLLER BEARINGS

SERVICE LIMITS

AAR APPROVAL NUMBER 20



CLASS AND SIZE	DIAMETERS ARE AVERAGES							AMOUNT OF GREASE (OUNCES) +		
	ROLLER ASSEMBLY		OUTER RING				BACKING RING			
	Maximum Bore	Out-Of-Round	Minimum O.D.	Maximum C'bore	Minimum C'bore	Out-Of-Round	Maximum C'bore	Each Roller Assembly	Around Spacer	Total Quantity
F (6½ X 12)	6.1890"	0.003"	9.9275"	9.3790"	9.3700"	0.005"	7.5300"	6	12	24

+ NOTE: ONE HALF OF TOTAL AMOUNT OF GREASE MAY BE APPLIED TO EACH SIDE OF ASSEMBLED BEARING (BEFORE SEALS ARE APPLIED).

END CAP

(A) Inspect for cracks, breakage, wear, or distortion. Replace plastic plug if loose or damaged.

ROLLER ASSEMBLY - CAGE INSPECTION

Place roller assembly on back face (large diameter face) when checking clearances.

(B) Measure this clearance using two sets of feeler gages. Insert the feeler gages between the small rib and cage flange at two locations diametrically opposite. If the total of the two sets of feeler gages is 0.090" or more, the roller assembly should not be returned to service.

(C) If the roller pocket of the gage is worn to the extent that a 0.060" feeler gage can be inserted between the roller and the cage bridge, the roller assembly should not be returned to service.

OUTER RING (CUP)

(D) Minimum O.D. to be measured in adapter pad wear areas.

If the outer ring is distorted in the area of the counterbore a close visual inspection of the inside and outside surfaces is required. Outer rings that have hair line cracks must be scrapped.

(E) SEAL - SCRAP ALL USED SEALS

SPACER WIDTH - BENCH LATERAL

(F) A spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used:

Power Operated	Hand Operated
0.023" to 0.029"	0.020" to 0.026"

Note:
Where close coordination is maintained between the bearing repair facility and the bearing mounting facility, the bearing bench lateral may be set to limits necessary to provide satisfactory mounted bearing lateral.

SEAL WEAR RING - OUTSIDE SURFACE

(G) If the outside surface of the seal wear ring is scratched or cracked or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring must be scrapped.
Note:
Outer seal wear ring does not have vent holes.
When assembling Timken "XP" bearings make sure that the outer seal wear ring does not have vent holes and that the inner seal wear ring does have vent holes.

SEAL WEAR RING - FIT IN BACKING RING

(H) The inner seal wear ring must have a tight fit in the backing ring counterbore.

BACKING RING - FIT ON THE SEAL WEAR RING

(J) The counterbore of the backing ring must have a tight fit on the seal wear ring. AAR Roller Bearing Manual permits salvage of backing rings with oversize counterbores.
See A-24389 for suggested procedure

BACKING RING - SIZE AND RADIUS

(L) Check major I.D.

(M) Check bore radius for excessive corrosion. Light pitting and rusting is acceptable.

VENT FITTING

(N) Check the vent fitting to see that it is not clogged, hardened or damaged. Hardened or damaged vent fittings should be replaced. (Part number K89716)

PART NUMBERS - BEARING COMPONENTS

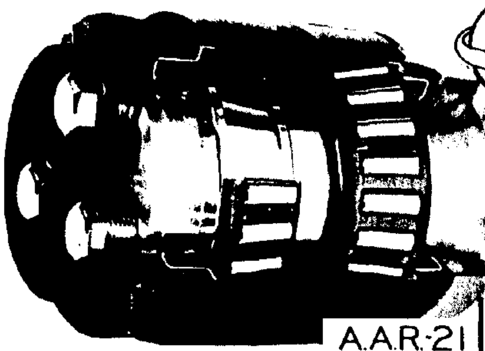
CLASS AND SIZE	ROLLER ASSEMBLY	OUTER RING (CUP)	SPACER	SEAL	OUTER SEAL WEAR RING	INNER SEAL WEAR RING	BACKING RING	END CAP	PLASTIC PLUG	LOCKING PLATE	CAP SCREWS
F (6½ X 12)	HM133443XP	HM133416XDXP	HM133444XA	K85520	K125679	K85509	K125685	K125681	K125684	K84324	K125683

Do Not Use AAR Approval No. 1 Or 1A Bearing Parts In AAR Approval No. 20 Bearing Assemblies Except Where Part Numbers Are The Same.

OCTOBER 20, 1980

THE TIMKEN COMPANY
Canton, Ohio 44706 - Cable Address "TIMROSCO"

Fig. 3.4-20



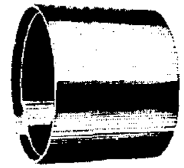
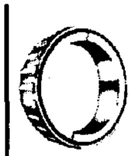
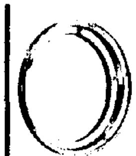
NEW DEPARTURE · HYATT BEARINGS

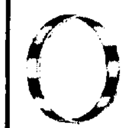
DIVISION OF GENERAL MOTORS CORPORATION · SANDUSKY, OHIO

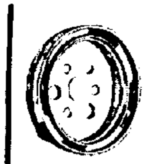
HY-ROLL TAPERED ROLLER BEARINGS

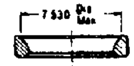
service notes and dimensions

A.A.R.-21





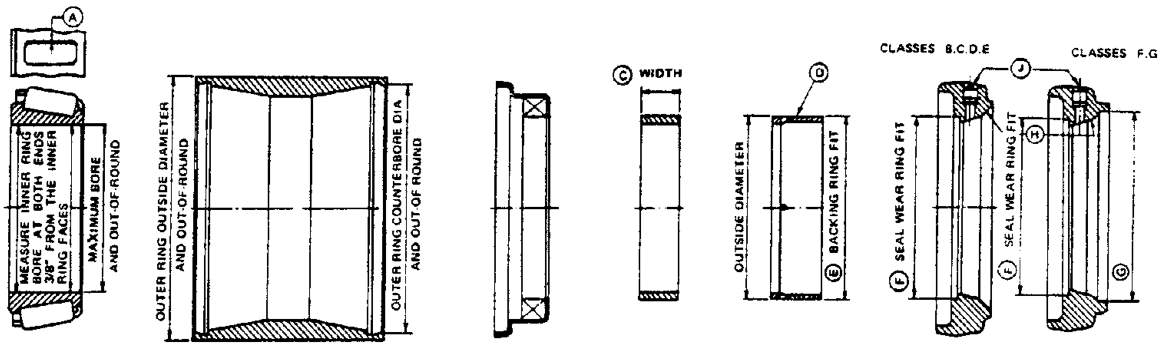
CLASS AND SIZE	BEARING ASSEMBLY AND MOUNTING				OUTER RING SALVAGE LIMITS		ROLLER ASSEMBLY	SEAL	SEAL WEAR RING		SPACER	BACKING RING (DUST GUARD OR ENCLOSURE COLLAR)	END CAP (LOCKING CUP)
	GREASE WEIGHT (oz)			CAP SCREW SIZE AND TORQUE (FT-LBS)	OUTSIDE DIAMETER	COUNTERBORE DIAMETER							
	EACH ROLLER ASSEMBLY	TOTAL PER BEARING (oz)	SEATING PRESSURE (TONS)		MIN.	WITH NEW SEAL	BORE SALVAGE LIMITS (AVERAGE MAX)		OUTSIDE DIAMETER WEAR PATH DEPTH	FIT ON AXLE	CODE AND LENGTH		
F 6½ x 12	12	24	50 To 60	1⅛" Dia. 360 390	9.927	9.373 To 9.379	6.189	Always use new seals	.005 Max.	Tight	A-4 1.490 A-3 1.495 A-2 1.500 A-1 1.505 A 1.510 B 1.515 C 1.520 D 1.525 E 1.530	Reject collar and/or seal ring if tight press fit is not obtained when seal wear ring is assembled in collar counterbore.  7.530 Dia. Max. FITTED STYLE	No cracks, breakage, wear or distortion.

NOTE-All parts, except Locking Cup, Backing Ring, Seal Wear Rings and Cap Screws are interchangeable with A.A.R.-6A.
Use grease conforming to A.A.R. Spec. M-942.

LATERAL	OUT OF ROUND	OUT OF ROUND	OUT OF ROUND .003 max.	LOCKING PLATE - Rule 5.52	GENERAL
Bench See Fig. 5.22 Mounted .004 .017 Bearing must be serviced if mounted lateral is .030 or above	All sizes .003 max.	.005 max. Must average within limits	Cages Reject if lip to rib clearance exceeds .090 or cage pocket to roller exceeds .000.	Always use new locking plate.	Any part should be rejected for breaks, cracks, deformities or other obvious defects. See Section 6 for remanufacture of bearing components.

Fig. 3.4-21

WEAR LIMITS AND SPECIFICATIONS FOR NSK AAR22



ROLLER ASSEMBLY | OUTER RING (CUP) | Ⓑ SEAL ASSEMBLY | SPACER | SEAL WEAR RING | BACKING RINGS

CLASS AND SIZE	DIAMETERS ARE AVERAGES						AMOUNT OF GREASE (OUNCES)		
	ROLLER ASSEMBLY		OUTER RING			BACKING RING			
	MAXIMUM BORE	OUT-OF-ROUND	MINIMUM O. D.	C'BORE	OUT-OF-ROUND	MAXIMUM C'BORE	EACH ROLLER ASSEMBLY	AROUND SPACER	TOTAL QUANTITY
B (4¼ x 8)	4.0015"	0.003"	6.4900"	6.0665" 6.0605"	0.005"	–	2	4	8
C (5 x 9)	4.6890"	0.003"	7.6775"	7.1915" 7.1855"	0.005"	–	3	6	12
D (5½ x 10)	5.1890"	0.003"	8.1775"	7.7540" 7.7480"	0.005"	–	4	8	16
E (6 x 11)	5.6890"	0.003"	8.6775"	8.2540" 8.2480"	0.005"	–	4	8	16
F (6½ x 12)	6.1890"	0.003"	9.9275"	9.3790" 9.3730"	0.005"	7.5300"	6	12	24
G (7 x 12)	7.0015"	0.003"	10.8650"	10.2790" 10.2730"	0.005"	7.9980"	8	16	32

OUTER RING O.D.

Minimum O.D. to be measured in adapter pad wear areas. If the outer ring is distorted in the area of the counterbore a close visual inspection of the inside and outside surfaces is required. Outer rings that have hair line cracks must be scrapped.

Ⓐ CAGE INSPECTION

If the roller pocket of the cage is worn to the extent that an 0.070" feeler gage can be inserted between the roller and the cage bridge, the inner ring and roller assembly should not be returned to service.

Ⓑ SEAL ASSEMBLY – SCRAP ALL SEALS

Ⓒ BENCH LATERAL

A spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used:

	Power Operated	Hand Operated
Classes B-C	0.021" to 0.027"	0.018" to 0.024"
Classes D-E-F-G	0.023" to 0.029"	0.020" to 0.026"

Ⓓ SEAL WEAR RING LIMIT

If the outside surface of the seal wear ring is cracked or scratched or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring should be scrapped.

Ⓔ SEAL WEAR RING FIT IN BACKING RING

The seal wear ring must have a tight fit in the backing ring counterbore.

Ⓕ BACKING RING FIT ON SEAL WEAR RING

The counterbore of the backing ring must have a tight fit on the seal wear ring.

Ⓖ BACKING RING – SIZE AND RADIUS (FITTED)

Check major I.D.

Ⓗ BACKING RING – SIZE AND RADIUS (NONFITTED)

Backing rings that are bent or distorted must be scrapped. Check the backing ring size and the bore radius for proper axle fillet contact and excessive corrosion with the AAR gage as shown in the Roller Bearing Manual.

Ⓙ VENT FITTING

Check the vent fitting to see that it is not clogged, hardened, or damaged. Hardened or damaged vent fittings should be replaced. (Part number IB8336)

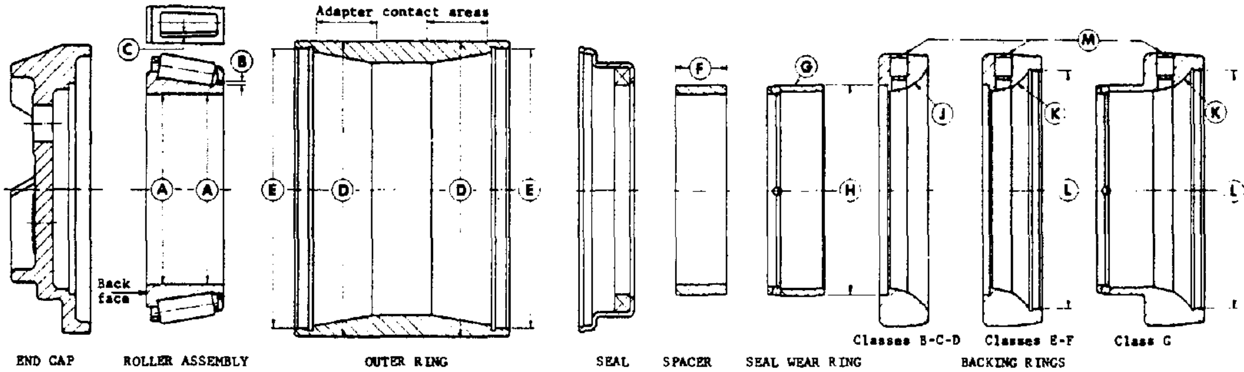
PART NUMBERS – BEARING COMPONENTS

CLASS AND SIZE	ROLLER ASSEMBLY	OUTER RING (CUP)	SPACER	SEAL	SEAL WEAR RING	BACKING RNIG	END CAP	CAP SCREW SEAL RINGS	LOCKING PLATE	CAP SCREWS
B (4¼ x 8)	HM120848R	HM120817XDR	HM120848R-L	HM120817XDR-S	J85723	J85722	J82772A	J86194B	J88347B	J84541A
C (5 x 9)	HM124646R	HM124618XDR	HM124646R-L	HM124618XDR-S	J85754	J85758	J82794A	J86194C	J88347C	J84531B
D(5½ x 10)	HM127446R	HM127415XDR	HM127446R-L	HM127415XDR-S	J85755	J85759	J82795	J86194D	J88347D	J84531B
E (6 x 11)	HM129848R	HM129814XDR	HM129848R-L	HM129814XDR-S	J85756	J85760	J82796	J86194E	J88347E	J84539A
F (6½ x 12)	HM133444R	HM133416XDR	HM133444R-L	HM133416XDR-S	J85707	J85752	J82755	J86194F	J88347F	J84542A
G (7 x 12)	HM136948R	HM136916XDR	HM136948R-L	HM136916XDR-S	J85757	J85761	J82797	J86194G	J88347G	J84561A

Do not Interchange AAR Approval No.22 Bearing Parts With AAR Approval No.11A or No.11 Bearing Parts.

Fig. 3.4-22

AAR-23 TAPERED ROLLER BEARINGS MAINTENANCE SPECIFICATIONS



CLASS (SIZE)	(A) MAXIMUM BORE OF ROLLER ASSEMBLY		OUTER RING (D) MINIMUM OUTSIDE DIAMETER		(E) COUNTERBORE MAXIMUM		(E) COUNTERBORE MINIMUM		(L) BACKING RING MAXIMUM MAJOR BORE		AMOUNT OF GREASE PER BEARING	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Ozs.	Grams
B (4.1/4x8)	4.0015	101.638	6.4900	164.846	6.0665	154.089	6.0600	153.924	-	-	8	225
C (5x9)	4.6890	119.100	7.6775	195.010	7.1915	182.664	7.1850	182.499	-	-	12	340
D (5.1/2x10)	5.1890	131.800	8.1775	207.710	7.7540	196.952	7.7450	196.723	-	-	16	455
E (6x11)	5.6890	144.500	8.6775	220.410	8.2540	209.652	8.2450	209.423	7.0300	178.562	16	455
F (6.1/2x12)	6.1890	157.200	9.9275	252.160	9.3790	238.227	9.3700	237.998	7.5300	191.262	24	680
G (7x12)	7.0015	177.838	10.8650	275.970	10.2790	261.087	10.2700	260.858	7.9980	203.149	32	910
ALL DIAMETERS ARE UNDERSTOOD TO BE THE AVERAGE OF 3 MEASUREMENTS, 60 DEGREES APART												

END CAP
Check for damage as well as for correct class (size) and "AAR-23" markings.

ROLLER ASSEMBLY
(A) Measure bore at both ends, 3/8" to 1/2" (9 to 13 mm) from faces of inner ring. Maximum out-of-round 0.003" (0.08 mm).
Place roller assembly (back face down) on horizontal support.
(B) Use two sets of feeler gauges. Insert feeler gauges between small rib of inner ring and bore of cage flange in two diametrically opposite locations. The total of the two sets of feeler gauges must not exceed 0.090" (2.3 mm).

(C) Insert feeler gauges between the roller and the cage bridge. Reject roller assembly if 0.060" (1.5 mm) feeler gauge can be inserted.

OUTER RING
(D) Measure outside diameter in areas of adapter contact. Maximum out-of-round 0.005" (0.13 mm).

(E) Measure both counterbores. Maximum out-of-round 0.005" (0.13 mm).

SPACER
(F) Spacer length is graduated and coded in increments of 0.003" (0.08 mm). (P6 means plus 0.006" from nominal; M18 means minus 0.018" from nominal). If spacer of a length to provide required lateral play is not available, a longer spacer may be ground to size. Faces must be parallel within 0.001" (0.025 mm).

SEALS
Replace all used seals with new seals.

SEAL WEAR RINGS AND BACKING RINGS
(G) Replace seal wear ring if lip contact path is worn 0.005" (0.13 mm) deep, or if outside surface has defects which might cause damage to seal lips.

(H) Seal wear ring outside diameter and backing ring counterbore must fit together with a tight fit.

Scrap backing rings which are bent or distorted.

(J) Check backing ring bore radius with AAR gauge to ensure proper axle fillet contact. Also check for excessive corrosion.

(K) Check bore radius for excessive corrosion. Only light pitting and corrosion is permissible.

(L) Check major bore diameter of backing ring.

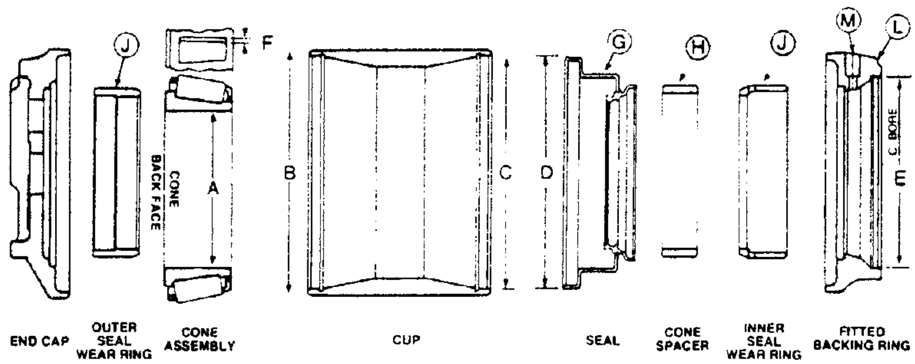
VENT FITTING (part number 1637504-18)
(M) Ensure vent fitting is not clogged. Replace any hardened or damaged vent fitting.

AAR-23 BEARINGS MUST BE MAINTAINED IN ACCORDANCE WITH THE ABOVE SPECIFICATIONS AND AAR REGULATIONS

COMPONENT PART NUMBERS												
CLASS (SIZE)	ROLLER ASSEMBLY	OUTER RING	SPACER	SEAL	SEAL WEAR RING	BACKING RING WITHOUT VENT	BACKING RING ASSEMBLED WITH VENT	BACKING RING ASSEMBLED WITH VENT AND S.W. RING	END CAP	CAP SCREW SEAL RING	LOCKING PLATE	CAP SCREW
B (4.1/4x8)	AJ-641138	OR-641138	RD-641138	729700	1637501-13	1637501-15	1637501-85	1637501-95	1637501-11	729720-1	715730-1	722454
C (5x9)	AJ-641135	OR-641135	RD-641135	729701	1637502-13	1637502-15	1637502-85	1637502-95	1637502-11	729720-2	715730-2	722459
D (5.1/2x10)	AJ-641130	OR-641130	RD-641130	729702	1637503-13	1637503-15	1637503-85	1637503-95	1637503-11	729720-2	715730-3	722459
E (6x11)	AJ-641125	OR-641125	RD-641125	729703	1637504-13	1637504-15	1637504-85	1637504-95	1637504-11	729720-3	715730-4	722464
F (6.1/2x12)	AJ-641134	OR-641134	RD-641134	729704	1637505-13	1637505-15	1637505-85	1637505-95	1637505-11	729720-4	715730-5	722469
G (7x12)	AJ-641139	OR-641139	RD-641139	729705	1637506-13	1637506-15	1637506-85		1637506-11	729720-5	715730-6	722474

Fig. 3.4-23

Koyo® AMERICAN KOYO CORPORATION AAR APPROVAL NO. 24



MAINTENANCE SPECIFICATIONS

CLASS AND SIZE	CONE		CUP				SEAL		FITTED BACKING RING		AMOUNT OF GREASE (OZ.)			WGT (LBS.)
	A		B		C		D		E					
	BORE DIA *	OUT OF ROUND T.I.R.	AVERAGE O.D.	OUT OF ROUND T.I.R.	AVERAGE C'BORE DIA.	OUT OF ROUND T.I.R.	AVERAGE O.D.	OUT OF ROUND T.I.R.	C'BORE	OUT OF ROUND T.I.R.	CONE EA	AROUND SPACER	TOTAL	
B (4¼ x 8)	4.0015	.003	6.5050 6.5000	.005	6.0655 6.0625	.005	6.074 6.068	.015	5.030	.003	2	4	8	34
C (5 x 9)	4.6890	.003	7.6925 7.6875	.005	7.1905 7.1875	.005	7.200 7.194	.015	5.905	.003	3	6	12	56
D (5½ x 10)	5.1890	.003	8.1925 8.1875	.005	7.7540 7.7510	.005	7.763 7.757	.015	6.405	.003	4	8	16	63
E (6 x 11)	5.6890	.003	8.6925 8.6875	.005	8.2530 8.2500	.005	8.263 8.257	.015	7.030	.003	4	8	16	74
F (6½ x 12)	6.1890	.003	9.9425 9.9375	.005	9.3780 9.3750	.005	9.388 9.382	.015	7.530	.003	6	12	24	111
G (7 x 12)	7.0015	.003	10.8800 10.8750	.005	10.2780 10.2750	.005	10.288 10.282	.015	8.000	.003	8	16	32	133

* Average out-of-round reading $\left(\frac{D\ max - D\ min}{2}\right)$ must not exceed dimension shown   T.I.R. — Total Indicator Reading

END CAP-Inspect for cracks, breakage, wear and distortion of machined surfaces. Inspect removable plug—replace if loose or damaged. Sealer may be used on threads.

F **CONE ASSEMBLY (CAGE WEAR)**—If an .080" thick feeler gage can be inserted between roller and cage bar the assembly should be rejected. It is unsuitable for continued operation. (Lay cone on back face for gaging.)

G **SEALS**—Scrap used seals.

H **BENCH LATERAL**—The cone spacer must be of such length as to obtain the following bench laterals.

	Hand Oper.	Power Oper.
Class B, C	0.018" to 0.024"	0.021" to 0.027"
Class D, E, F, G	0.020" to 0.026"	0.023" to 0.029"

J **SEAL WEAR RING**—The wear ring should be scrapped if the outside surface is scratched, shows cracks, or if the seal has caused wear pattern (groove) of more than .005" deep. Give special attention to outer ring end faces. Scrap if chipped, scratched, etc.

NOTE: Outer seal wear ring does not have vent holes. When assembling Koyo "MF" bearings, make sure the ring with vent holes is the "inner" seal wear ring.

L **BACKING RING**—(Fitted type)—Scrap distorted, cracked, or heavily pitted rings. Check ring with service limit gauge as outlined in roller bearing manual to insure proper axle fillet contact.

M **VENT FITTING**—Check and replace if clogged, hardened, damaged or loose.

COMPONENTS PARTS LIST

CLASS & SIZE	BEARING ASSEMBLY	CUP	CONE	SPACER	AXLE END CAP	SEAL	OUTER SEAL WEAR RING	INNER SEAL WEAR RING	BACKING RING	LOCKING PLATE
B (4¼ x 8)	JB901	HM120817XDMF	HM120848MF	HM120848XA	90160	90150	90140	701N40	90120	701N80
C (5 x 9)	JB902	HM124618XDMF	HM124646MF	HM124646XA	90260	90250	90240	702N40	90220	702N80
D (5½ x 10)	JB903	HM127415XDMF	HM127446MF	HM127446XA	90360	90350	90340	703N40	90320	703N80
E (6 x 11)	JB904	HM129814XDMF	HM129848MF	HM129848XA	90460	90450	90440	704N40	90420	704N80
F (6½ x 12)	JB905	HM133416XDMF	HM133444MF	HM133444XA	90560	90550	90540	705N40	90520	705N80
G (7 x 12)	JB906	HM136916XDMF	HM136948MF	HM136948XA	90660	90650	90640	706N40	90620	706N80

MANUFACTURERS SERVICE LIMITS CHART
KOYO "MAINTENANCE FREE" ROLLER BEARINGS

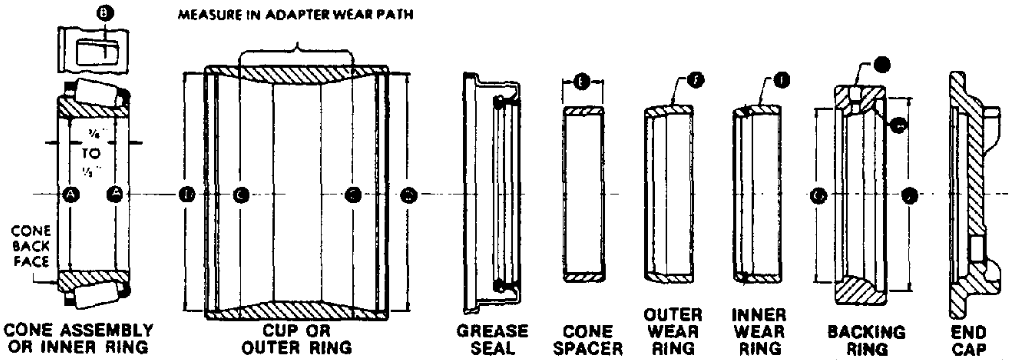
Do not interchange AAR approval No. 24 bearing parts with AAR approval No. 14 bearing parts.

American Koyo Corporation 12/80

Fig. 3.4-24

Specifications for BRENCO Roller Bearing Maintenance

EXTENDED LIFE BEARING——— AAR-25



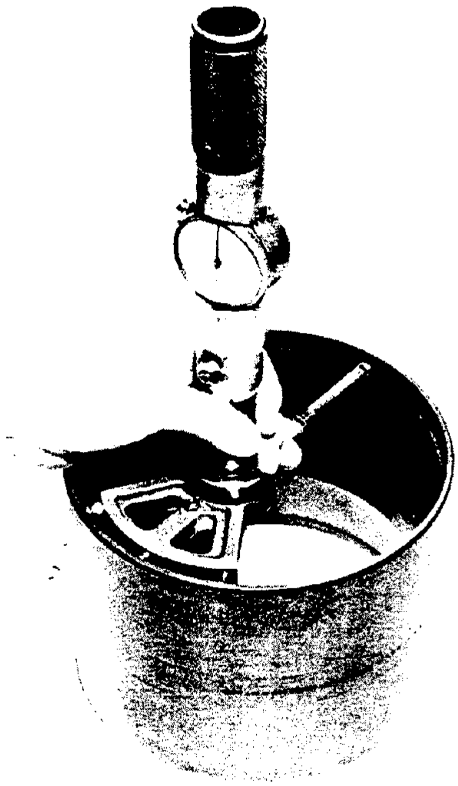
					RBM RULE NO.
BEARING CLASS (SIZE)			F (6½ x 12)		
CONE PART NO.			HM 133444XL		3.19 3.21 3.22
MAX. BORE OUT-OF-ROUND	.003", BUT AVERAGE MUST NOT EXCEED Ⓐ LIMIT.				
Ⓐ AVG. I.D. NOT TO EXCEED			6.1890"		
CAGE INSPECTION	PLACE CONE ASSEMBLY ON BACK FACE AND USE FEELER GAGES.				3.23
Ⓑ POCKET SIDE CLEARANCE	LESS THAN .060" BETWEEN ROLLER AND CAGE BRIDGE.				
CUP PART NO.			HM 133416XDXL		3.19 3.20
Ⓒ MINIMUM O.D.			9.925"		
MAX. C'BORE OUT-OF-RND.	.005", BUT AVERAGE MUST MEET Ⓓ LIMITS.				
Ⓓ C'BORE NOT TO EXCEED			9.379"		
Ⓓ C'BORE MINIMUM			9.370"		
GREASE SEAL PART NO.			F1207		3.17
	REPLACE WITH NEW AAR APPROVED INTERCHANGE SEALS.				
CONE SPACER PART NO.			HM 133444XA		3.18 3.30 3.31
Ⓔ WIDTH SELECTION	PROVIDE .020" TO .026" LATERAL FOR HAND LATERAL DEVICES OR .023" TO .029" FOR POWER DRIVEN LATERAL DEVICES.				
WEAR RING PART NO.			F1206 F1206XL		3.16
Ⓕ WEAR LIMIT	SEAL LIP CONTACT PATH LESS THAN .005" DEEP.				
	INNER WEAR RING HAS VENT HOLES - F1206 OUTER WEAR RING HAS NO HOLES - F1206XL				
BACKING RING PART NO.			F1215		3.24 3.25
Ⓖ COUNTERBORE	PROVIDE TIGHT FIT ON WEAR RING.				
Ⓗ FILLET CONTACT	AREA NOT GALLED OR PITTED.				
● VENT FITTING	NOT CLOGGED, HARDENED, OR DAMAGED.				
Ⓘ I.D. MAX. AVE. (FITTED)			7.530"		
END CAP PART NO.			F1211		3.15
INSPECTION	NO CRACKS, BREAKAGE, WEAR, OR DISTORTION.				
GREASE WEIGHT oz.	NOTE RBM FIG. 5.23 FOR FLOW THRU GREASING FROM BOTH SIDES.				3.33 3.34 3.35 3.36 3.37
EACH CONE ASSEMBLY			6		
SPACER			12		
TOTAL ±.1 OUNCE			24		

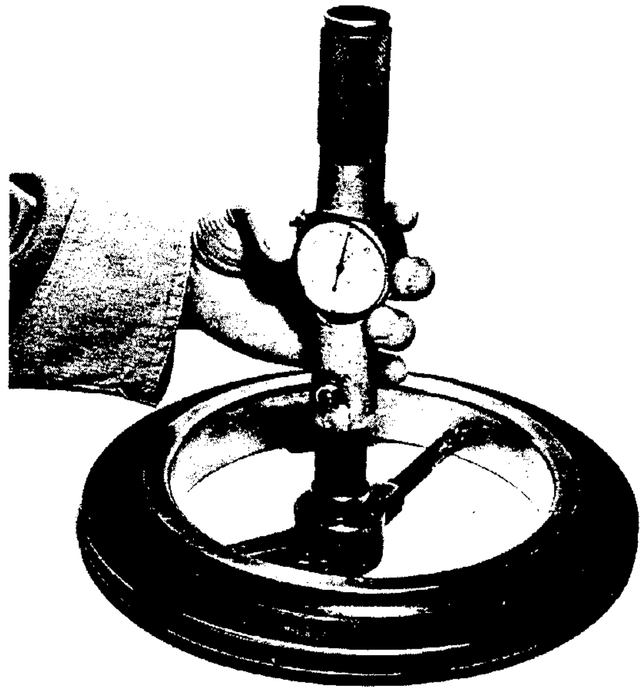
DO NOT USE AAR-5A INNER RINGS, OUTER RINGS, END CAPS, OR WEAR RINGS IN AAR-25 BEARINGS.

BRENCO INC., P. O. BOX 389, PETERSBURG, VIRGINIA 23803

JAN. 1979

Fig. 3.4-25





Master setting ring to set Dial Bore Gage.

Fig. 3.5

Checking Seal Fit Counter Bore with Dial Bore Gage.
(Recommended Method)

(Not required for bearings shown in Figure 1.3A)

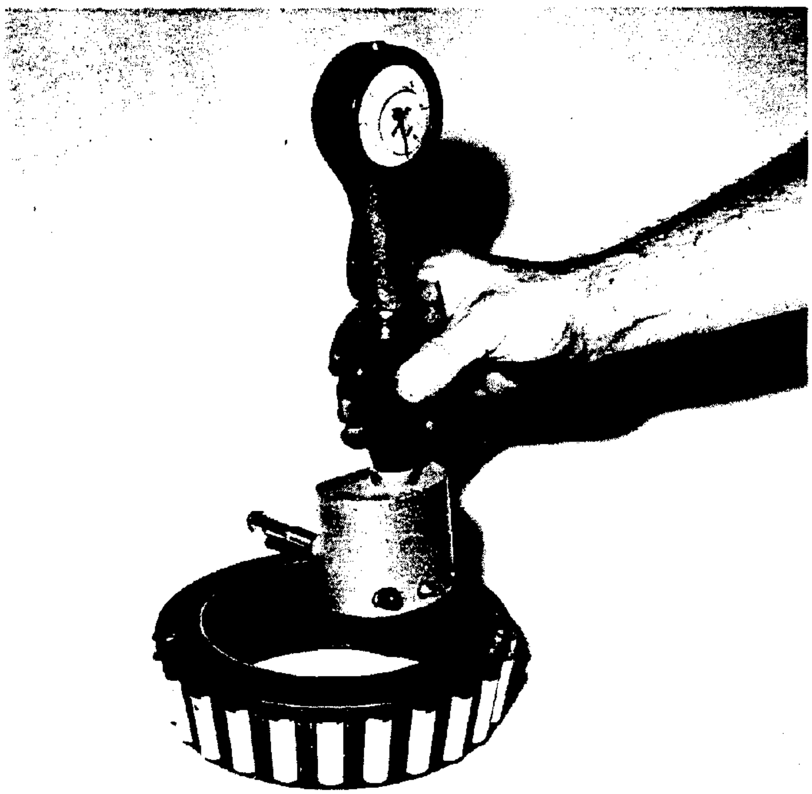


Fig. 3.6

Checking Inner Ring Bore with Dial Bore Gage

Note: See Manufacturer's specification charts for allowable bore size.

(Recommended Method)

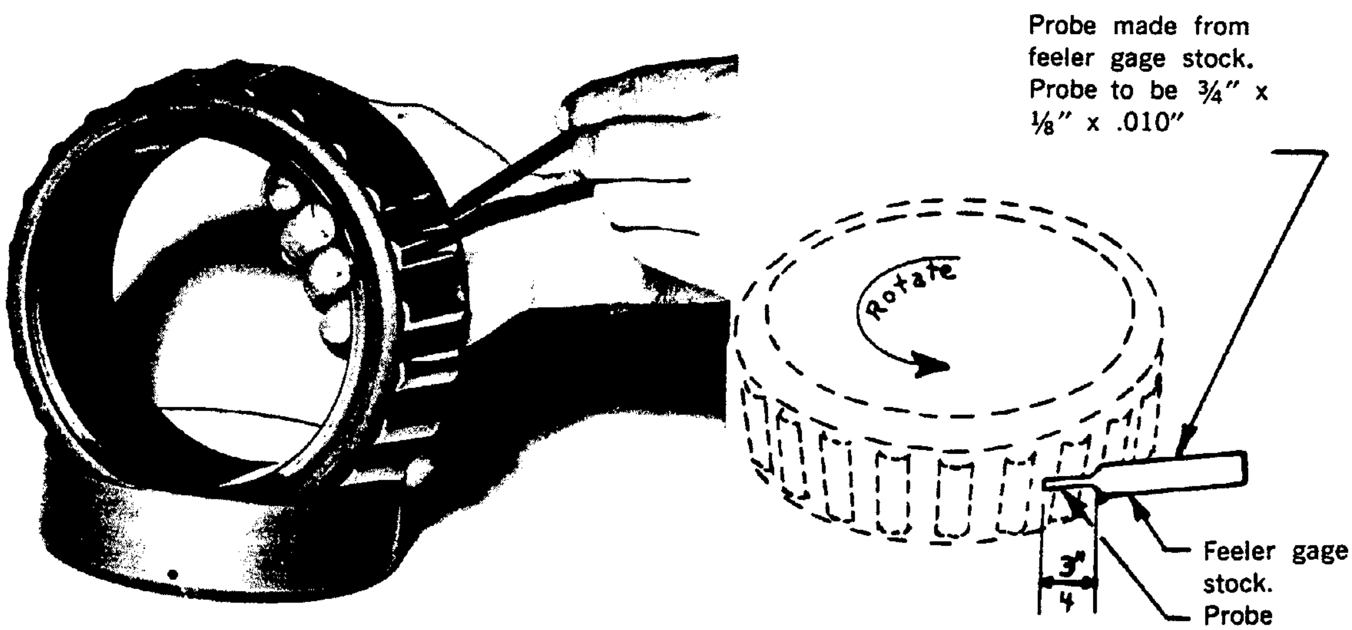


Fig. 3.7

Inspect Inner Ring for Defects

Place feeler of surface roughness tester between the roller and cage adjacent to both the large and small ribs, rotate inner ring. Any surface defects can be noted by roughness felt through the feeler gage.

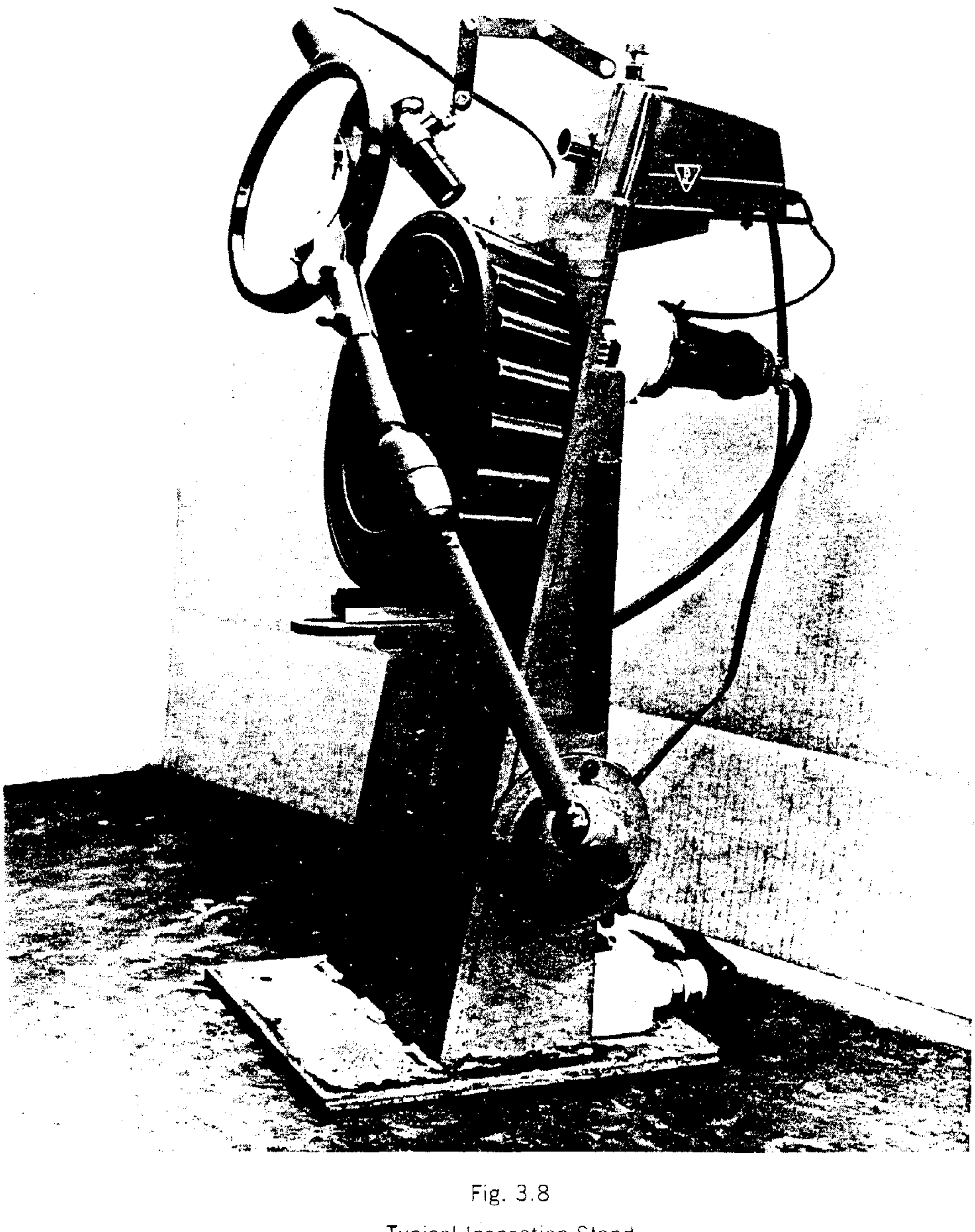
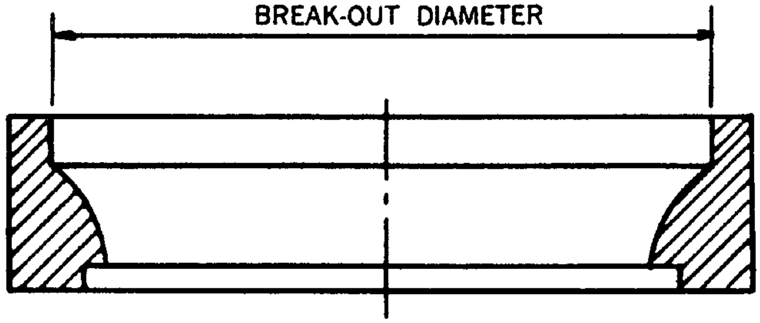


Fig. 3.8

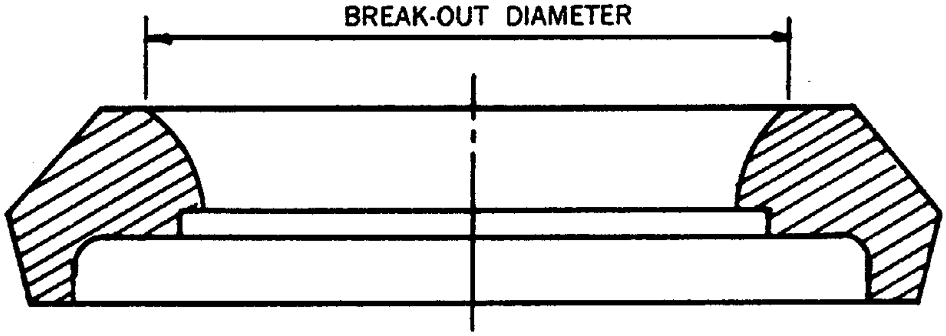
Typical Inspection Stand

By rotating inner ring and observing light area between rollers, inner race can be visually inspected. Additionally, while rotating inner ring feeler gage (as shown in Figure 3.7) can be used to inspect raceway adjacent to both the large and small thrust shoulders.



FITTED BACKING RING

Class and Size	Maximum Allowable Diameter	
	Used as Fitted Backing Ring	Used as Non-Ftted Backing Ring
E(6 x 11)	7.030"	7.060"
F(6½ x 12)	7.530"	7.560"
G(7 x 12)	7.998"	8.028"



NON-FITTED BACKING RING

Class and Size	Maximum Allowable Diameter
B(4¼ x 8)	5.035"
C(5 x 9)	5.910"
D(5½ x 10)	6.410"
E(6 x 11)	7.035"
F(6½ x 12)	7.535"

Fig. 3.9

Backing Ring Break-Out Diameter Limits.

CLASS AND SIZE	A	B	C	D
B(4¼" x 8")	5.035"	5½"	42°21'	1.002"
C(5" x 9")	5.910"	6⅜"	37°41'	.908"
D(5½" x 10")	6.410"	6⅞"	37°41'	.908"
E(6" x 11")	7.035"	7½"	34°49'	.845"
F(6½" x 12")	7.535"	8"	34°49'	.845"

MATERIAL: STEEL — HARDEN TO Rc 60-64.
TOLERANCES: ± 1/64" UNLESS OTHERWISE INDICATED.
BREAK SHARP CORNERS.
RUST PROOF FINISH.

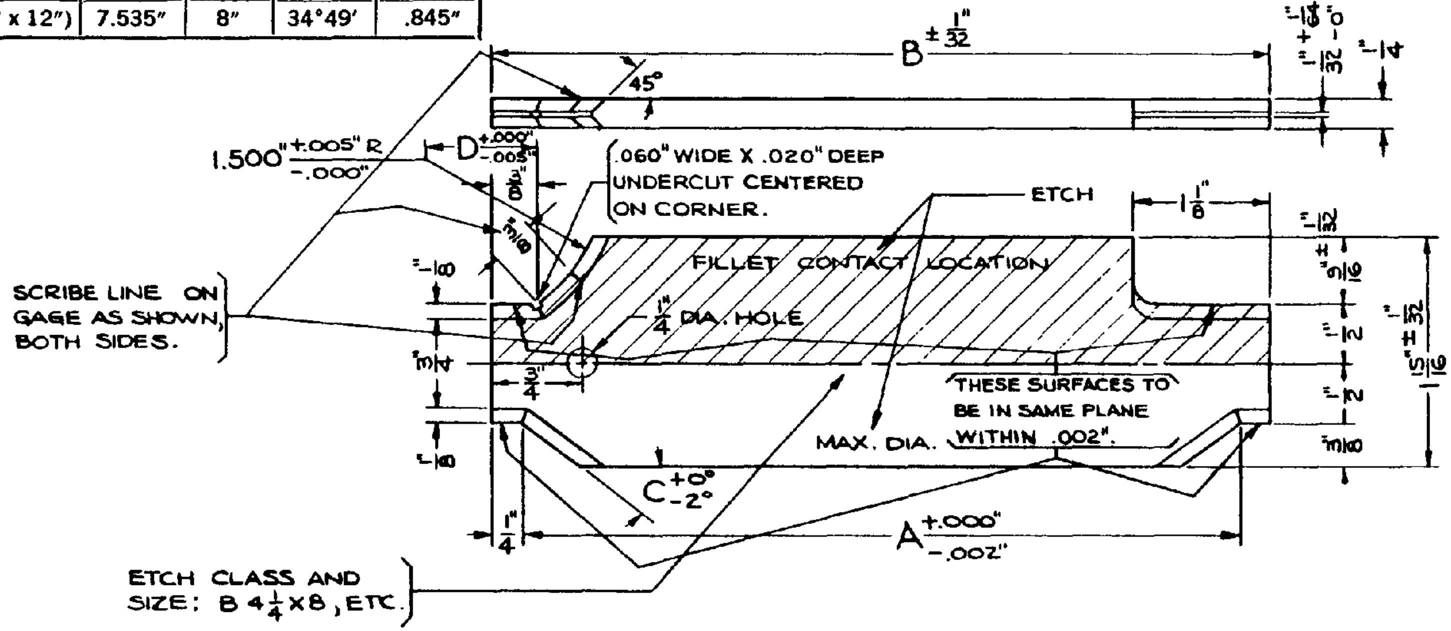
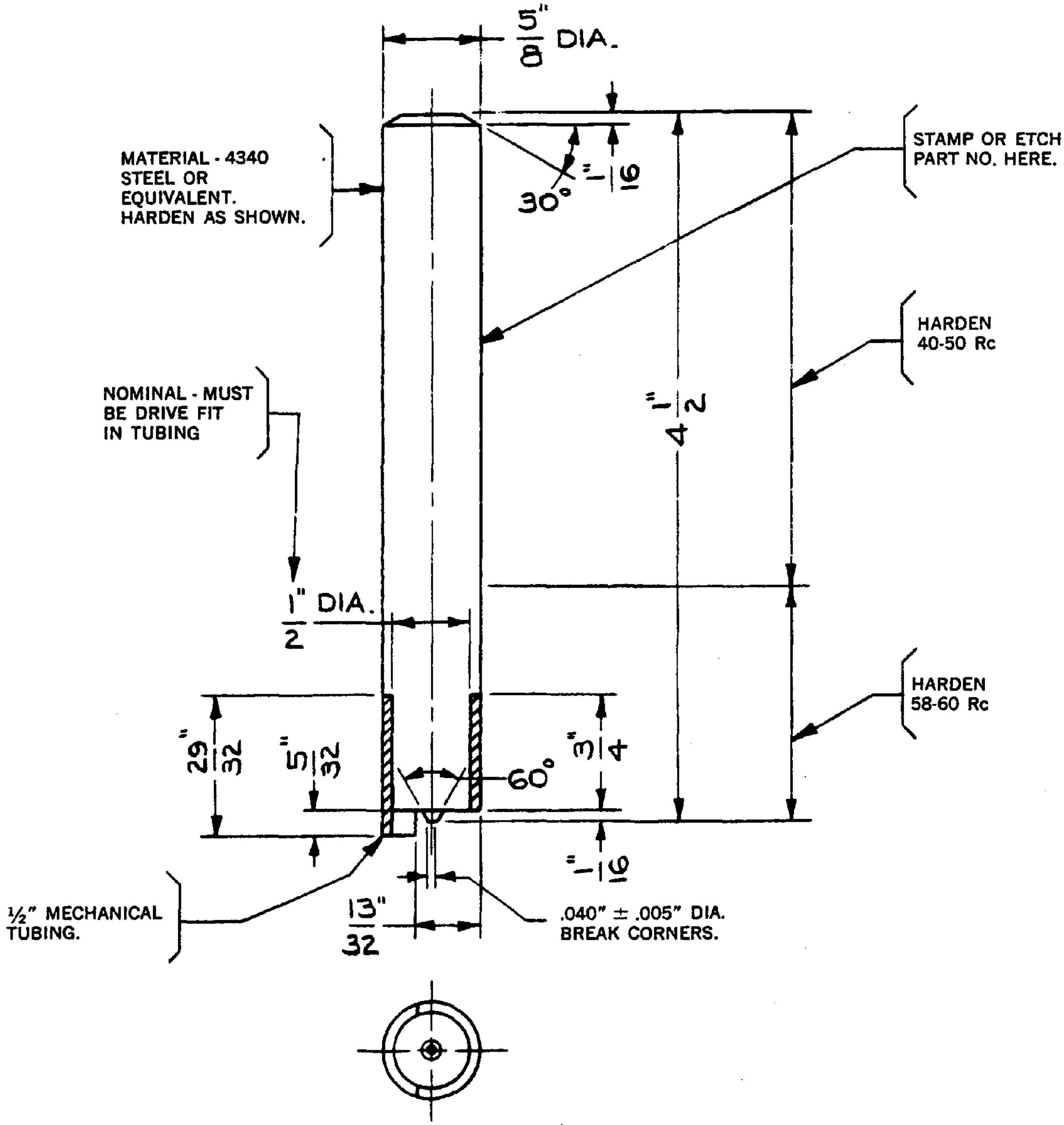


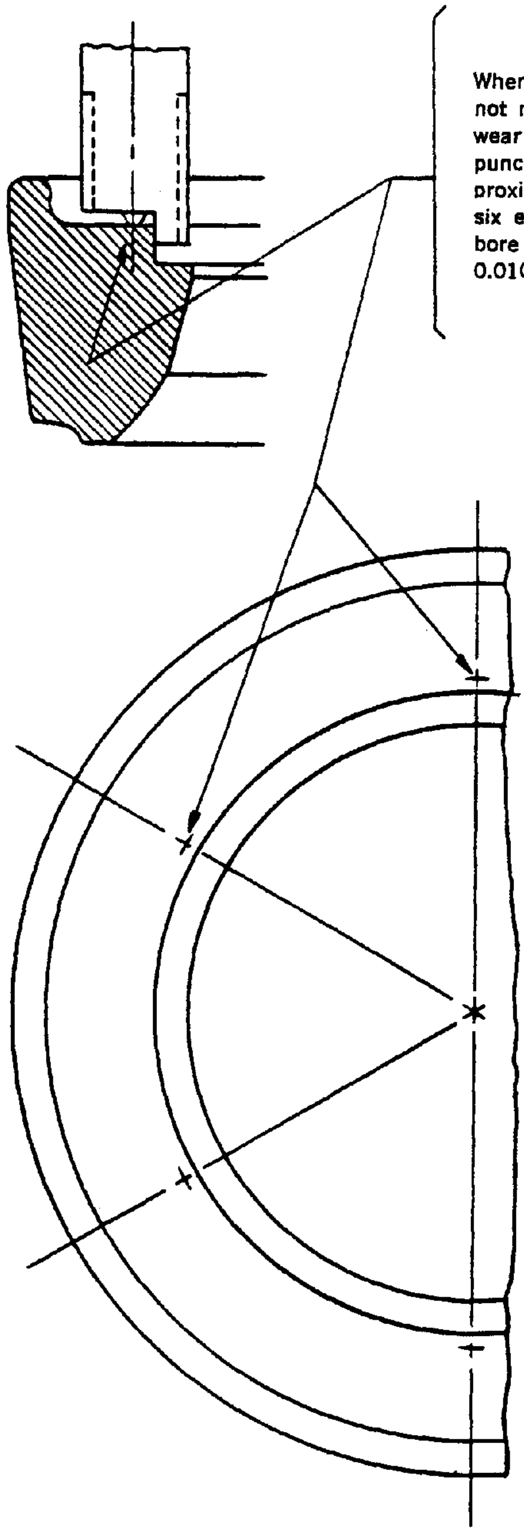
Fig. 3.10
Gage for Checking Non-Fitted Backing Rings.



CENTER PUNCHING TOOL

Fig. 3.11

Method of Restoring Backing Ring Press Fit on Seal Wear Ring



When backing ring counterbore is oversize by not more than 0.010", the press fit on seal wear ring may be restored by center punching face adjacent to counterbore approximately $\frac{1}{16}$" from edge of counterbore at six equally spaced locations. Check counterbore oversize by use of seal wear ring and 0.010" feeler gage.

Fig. 3.12

Method of Restoring Backing Ring Press Fit on Seal Wear Ring
(Recommended)

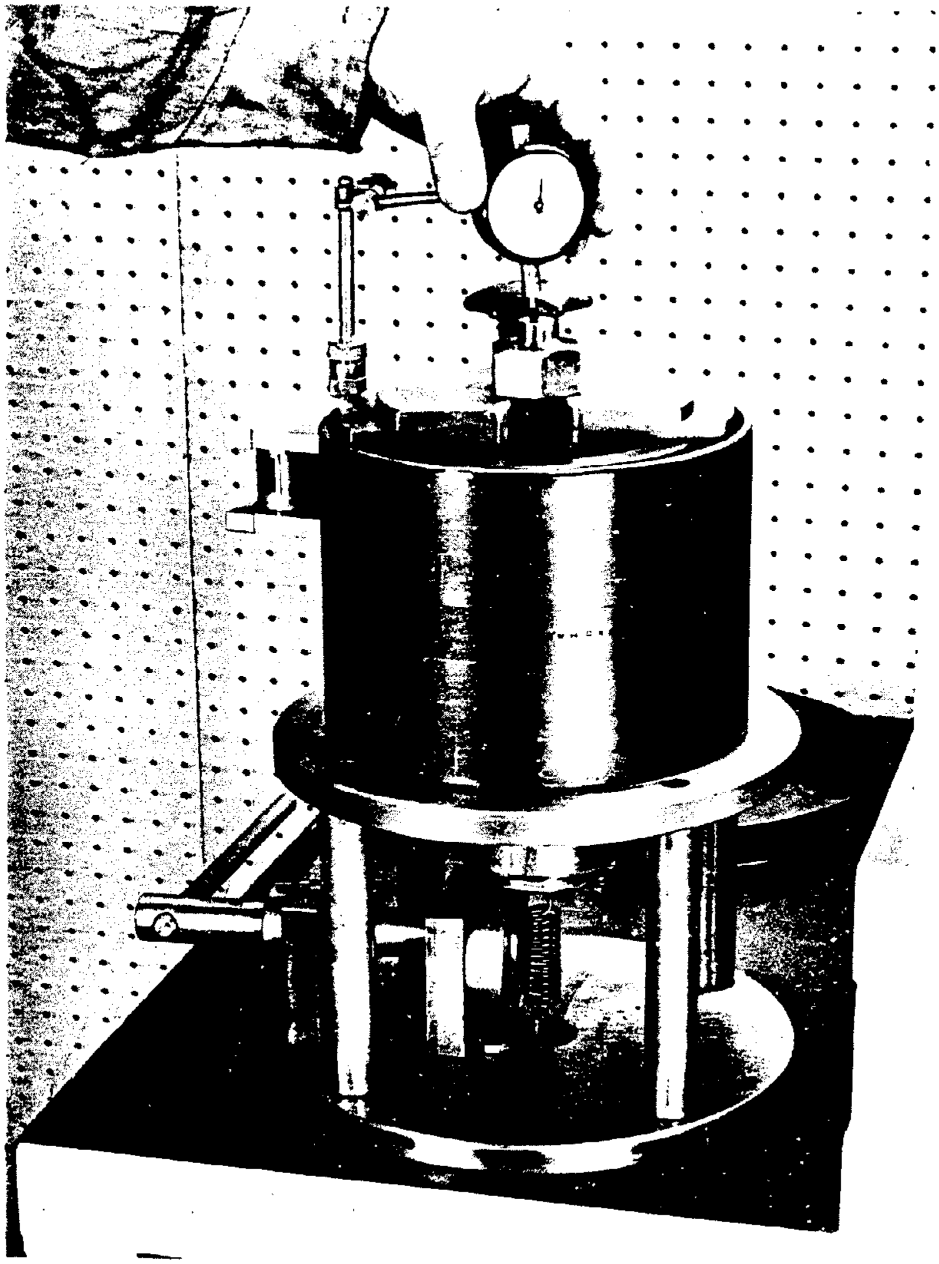


Fig. 3.13

Fixture for Checking Bench Lateral
(Recommended Method)

Manufacturer	AAR No.	Size	Grease Applied to Each Single Roller Assembly Ounces	Grease Applied Between Roller Assemblies Ounces	Total* Grease Applied To Bearing Assembly Ounces
Timken	1, 1A, 20				
NTN	10, 10A, 19				
Koyo	14, 24				
Nachi	12	4¼ x 8	2	4	8
FAG	13	5 x 9	3	6	12
Brenco	5, 5A, 25	5½ x 10	4	8	16
Bower	8	6 x 11	4	8	16
New Departure-		6½ x 12	6	12	24
Hyatt	6, 6A, 21	7 x 12	8	16	32
Magnus	16				
NSK	11, 11A, 22				
SKF (Tapered)	23				
SKF Sweden	3, 3A, 3B	4¼ x 8	2	3	7
		5 x 9	4	4	12
		5½ x 10	4.5	5	14
		6 x 11	5	6	16
		6½ x 12	8	10	26
		7 x 12	10	12	32

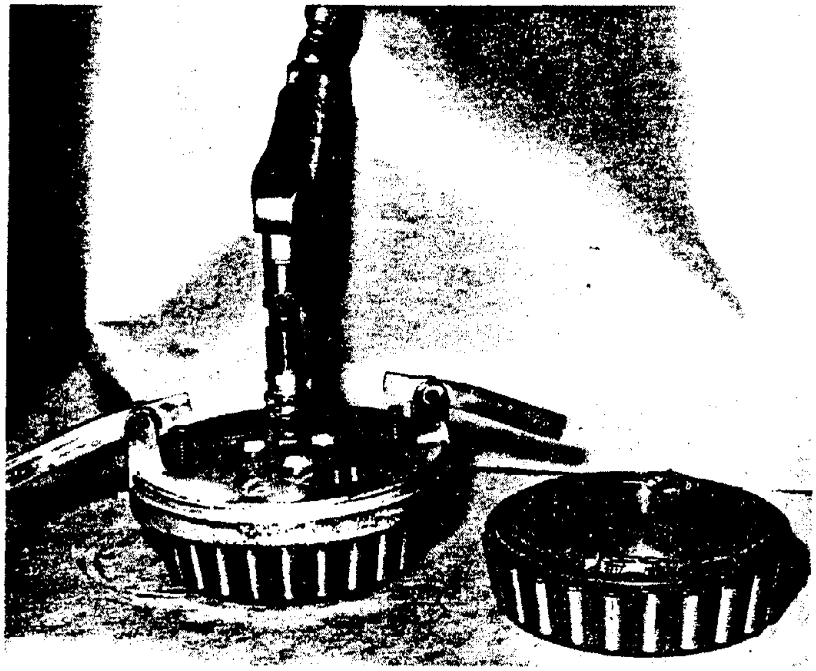
*Plus or minus 1 ounce, by weight.

Note 1. Grease may be applied from both sides of bearing assembly. When greasing in this manner apply one-half total amount through each side. Only M-942 greases will be used. See Section E, Rule 26 of the Field Manual for listing of approved lubricants.

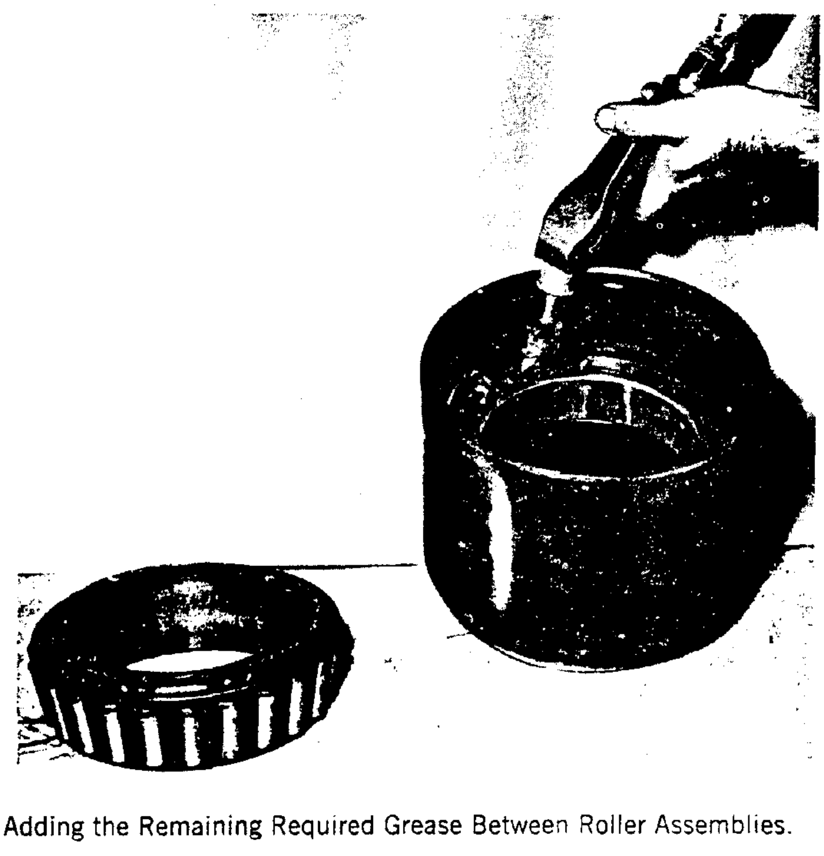
Note 2. Refer to Manufacturer's Specification Sheet (Fig. 4.6) for amount of grease to be applied to Amtrak Passenger Car Bearing.

Fig. 3.14

Lubrication Chart Amounts of Grease to be applied to Bearings to be Posted at Work Area.



Device for Pre-lubing Tapered Roller Bearings.

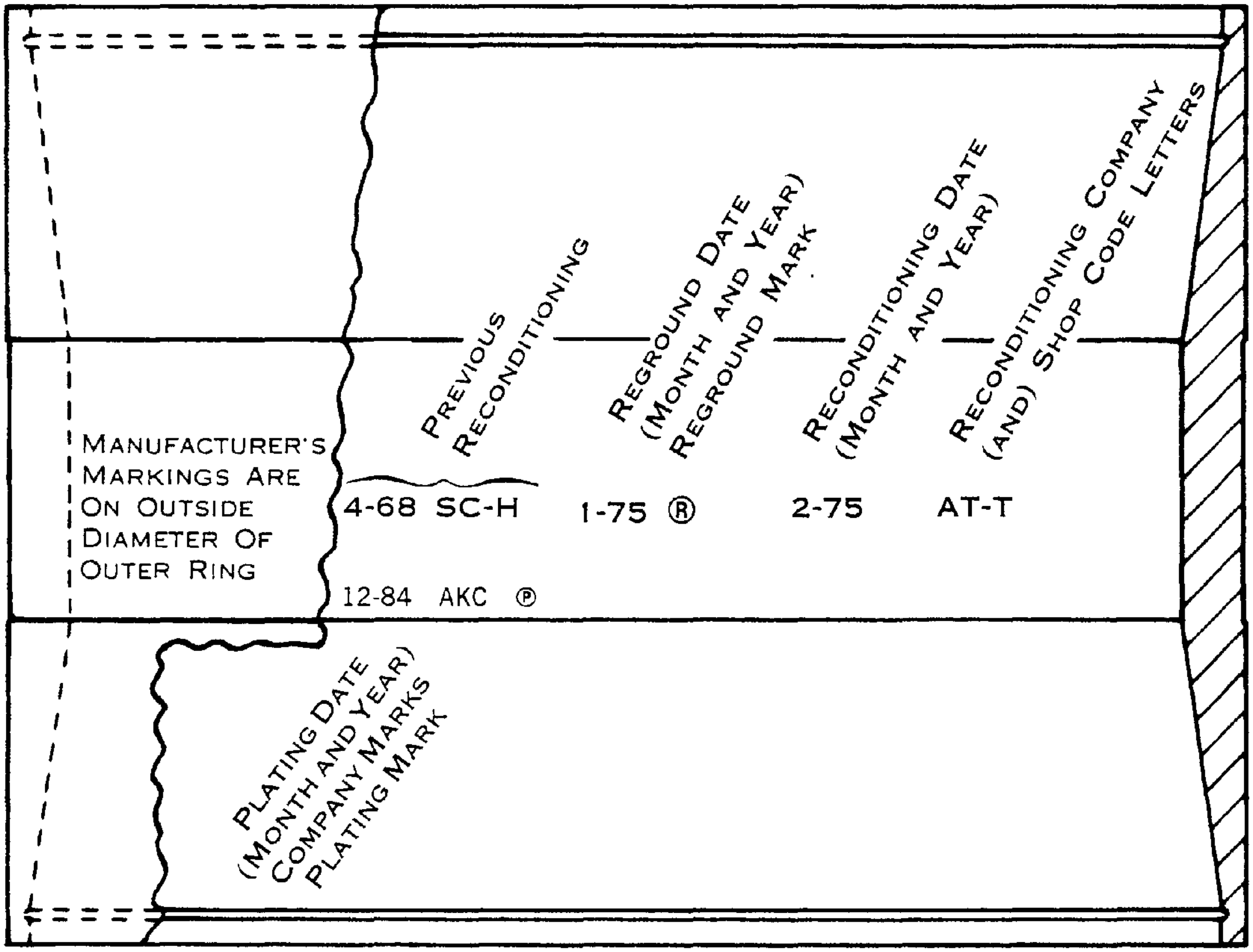


Adding the Remaining Required Grease Between Roller Assemblies.

Fig. 3.15

Method of Lubricating Roller Bearings.
(Recommended Method)

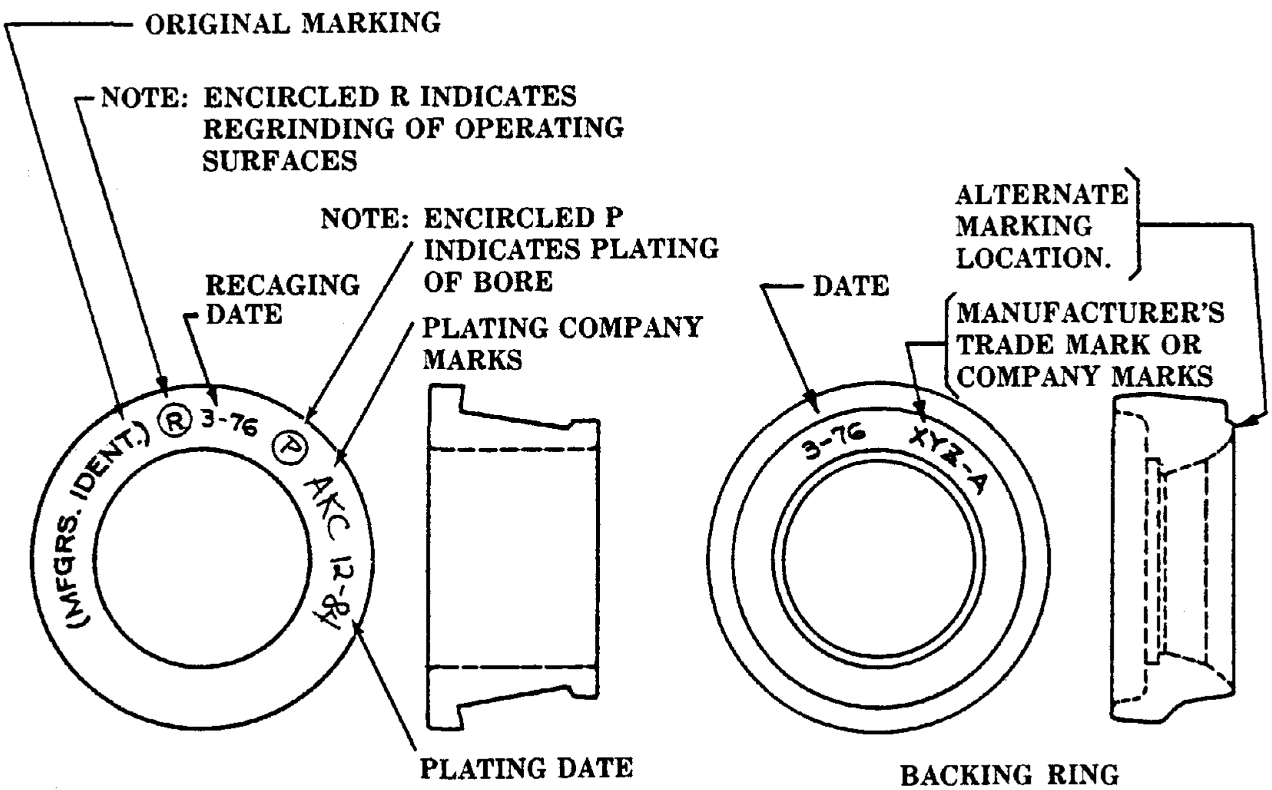
(For Bearings To Fig. 1.3A, See Manufacturer's Specifications)



OUTER RING MARKING

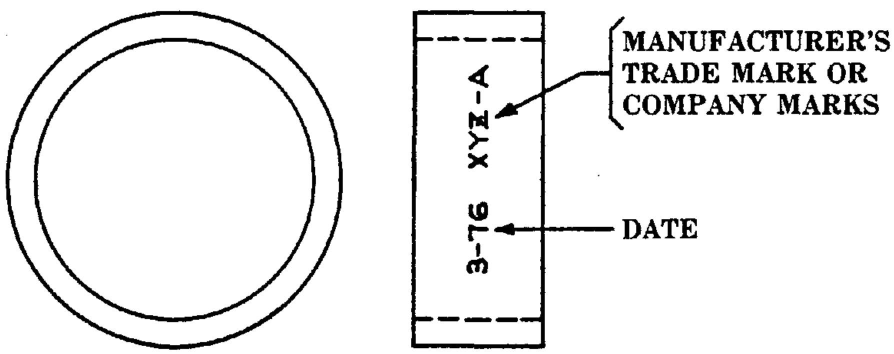
NOTE: Reconditioning and remanufacturing markings (encircled R for regrinding and encircled P for plating) must be on the inner diameter of the outer ring on the straight portion in the center between the raceways. Caution must be used to avoid nicking or damaging the raceway surfaces. Mark with a suitable scribing tool. Electric etching or steel stamping is not permitted.

Fig. 3.16
Method of Permanently Marking Reconditioned Roller Bearing Parts
(Mandatory)



INNER RING
(MARKING REQUIRED WHEN REMANUFACTURED)

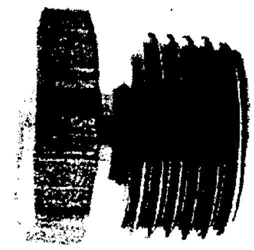
BACKING RING
(MARKING REQUIRED WHEN REMACHINED BY APPROVED SHOPS)



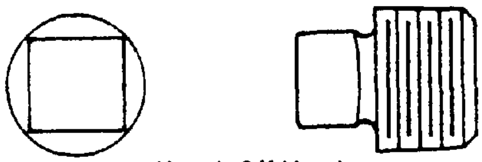
SPACER
(MARKING REQUIRED WHEN REMACHINED BY APPROVED SHOPS)

NOTE: FOR COMPANY MARKS, SEE FIGURE 2.1, COLUMN UNDER RAILROAD OR COMPANY MARKS.

Fig. 3.16 (Continued)



Twist-off Plug



Knock-Off Head

After Tightening to Specified Torque, Strike Head with Hammer to Break it Off.

One Way Turn — Recessed Head

One Way Turn — Raised Head

1. Class D ($5\frac{1}{2}$ x 10) through Class G (7 x 12) bearing sizes:
   Use $\frac{1}{2}$ - 14 NPT plug.
2. Class C (5 x 9) bearing size:
   Use $\frac{3}{8}''$ - 18 NPT plug. (Note: some end caps manufactured prior to 1969 will require use of a $\frac{1}{2}''$ - 14 NPT plug and others will require removal of a $\frac{1}{2}''$ x $\frac{1}{4}''$ face bushing before applying plug).
3. Class B ($4\frac{1}{4}$ x 8) bearing size:
   Use $\frac{3}{8}''$ - 18 NPT plug. (Note: Some end caps manufactured prior to 1969 will require removal of a $\frac{3}{8}''$ x $\frac{1}{4}''$ face bushing before applying plug).
4. Apply $\frac{3}{8}''$ - 18 NPT plug with 30-40 ft. lb. torque.
   Apply $\frac{1}{2}''$ - 14 NPT plug with 40-50 ft. lb. torque.
5. Head designs shown are typical. Other head designs may be used provided head is removable or designed for turning in tightening direction only and provided head design permits application of specified torque. For twist-off plugs, apply necessary torque to twist-off head. Torque should be within values in 4 above.

Fig. 3.17

Typical Nonremovable Plugs
for Plugging Lubricant Fitting Holes
in Axle End Caps for NFL Bearings

INFORMATION ON AMTRAK PASSENGER CAR BEARINGS

RULE 4.1

All sections of the Roller Bearing Manual are applicable to AMTRAK Passenger Car Bearing Reconditioning except as noted and as modified by the information contained in this section.

RULE 4.2

Identification and Terminology for AMTRAK bearings is shown in Figures 4.1 through 4.5.

RULE 4.3

Manufacturer's specifications are shown in Figure 4.6.

RULE 4.4

Standard Freight Car Class D, E and F Bearings are used on some passenger cars and applicable instructions in this Manual for these bearings must be followed.

RULE 4.5

Maintenance of enclosure seals (non-rubbing type) for Timken AP Bearings, Figures 4.2, 4.3 and 4.4.

a. **Removing the Enclosure**

To prevent unnecessary damage to the enclosure, the tools recommended for enclosure removal should be used. These tools are designed for use with a small press.

The enclosures are designed to protect the bearing against contamination from dirt, dust or water and to retain the lubricant.

The enclosure is retained in the bearing cup by a press fit and by a small bead which snaps into a groove located in the counterbore of the bearing cup.

Remove the lubricant fittings from the enclosure sleeves if so equipped.

Position a pair of seal element removal jaws between the front face of the cone and the cone spacer. Insert the forcing tube and apply the retainer nut (Figure 4.7). It may be necessary to reduce the length of the forcing tube to fit the press. (See Table 1 and Figure 4.7 for OTC* tool part numbers required for enclosure removal.)

* Owatonna Tool Company
Owatonna, Minnesota 55060

Class and Size	OTC Part Numbers			
	Jaws	Tube Plate	Retainer Nut	Support Ring
D (5½ x 10)	30477	21187	21118	40100
E (6 x 11)	30423	21187	21118	40100
F (6½ x 12)	30424	30470	30471	40109

TABLE 1. Tools Required for Removing Enclosures from the Bearing Cups. Also see Figure 4.7.

Place the bearing assembly in a bearing support ring and press the enclosure out of the bearing cup.

Remove the loose parts of the bearing assembly, invert the bearing cup and press the second enclosure and cone assembly out of the bearing cup.

The cast enclosure elements of the enclosure assemblies are not interchangeable from one outer pressed steel case to another and must not be removed from one outer pressed steel case and installed in another.

b. Cleaning: The enclosure seals should not be cleaned along with other bearing parts. Petroleum solvents such as kerosene or stoddard solvent should be used for cleaning enclosure seals either by hand or in agitating batch type cleaning tanks.

Cleaning solvents which are strong oxidizing agents, chlorinated, nitrated hydrocarbon, acetones or acetates should not be used.

c. Inspection:

1. Visual.

Inspect for damaged or bent cases, damaged and/or broken elastomeric part, and broken bonds with metal case.

2. Dimensional.

(a) The major outside diameter of the enclosure seal must be checked to the dimension shown in the following table using the gage shown in Figure 4.8. This gage is commercially available:

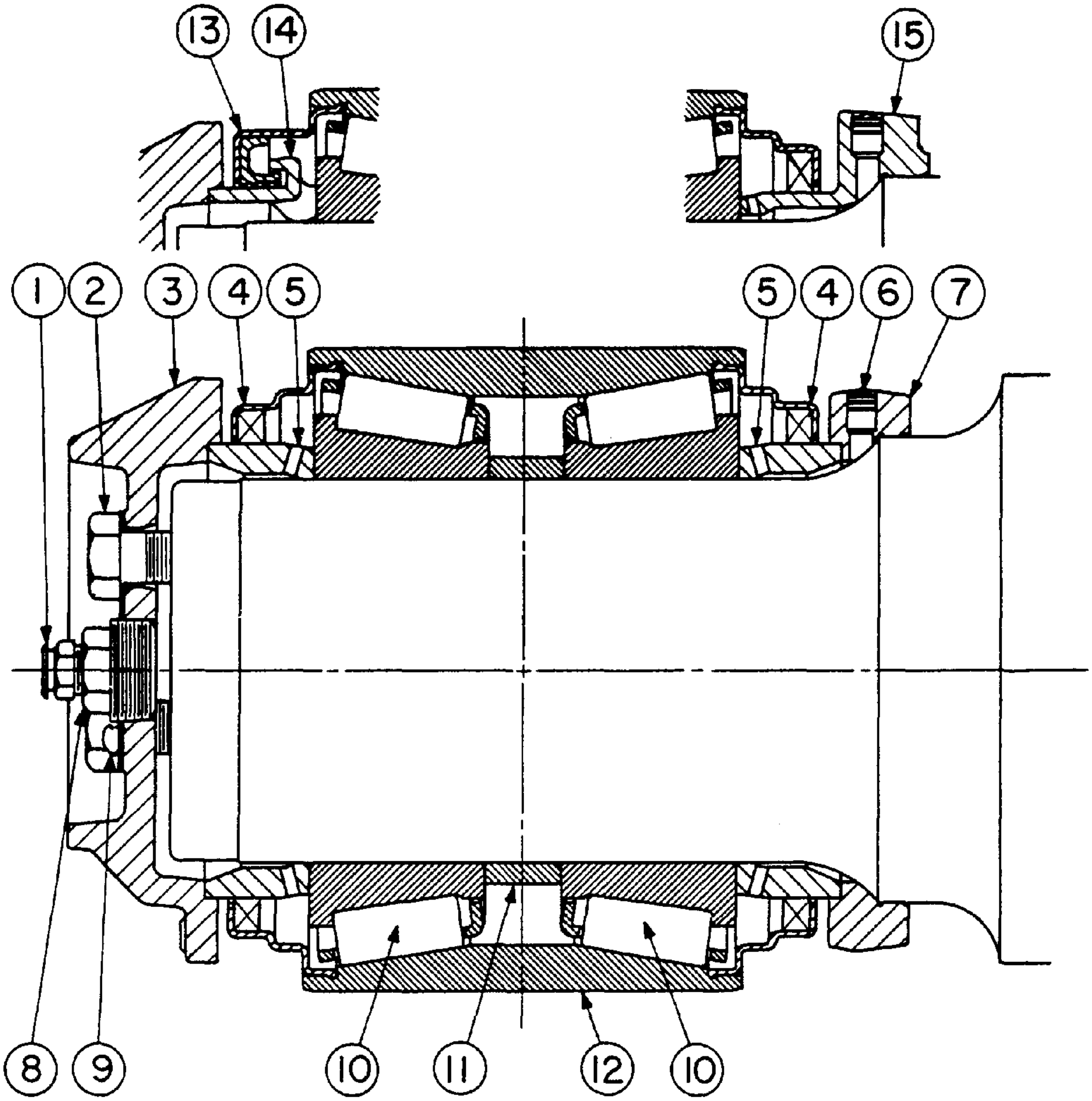
		Major O.D.	
Class	**Part Number**	**Maximum**	**Minimum**
D (5½ x 10)	K125688 K462062	7.763″	7.757″
E (6 x 11)	K504059	8.262″	8.257″
F (6½ x 12)	K125670	9.388″	9.382″
G (6½″ Axle)	K524454	10.288″	10.282″

Note: OUT-OF-ROUND -0.005″ to 0.010″ (0.015″) Based on major O.D. minimum plus 0.001″.

(b) In addition the entire circumference of the major O.D. should be checked with a square, as shown in Figure 4.9, to insure that the bead will be effective in retaining the enclosure in the cup counterbore. In Figure 4.9A the enclosure case O.D. is as it should be. In Figure 4.9B the enclosure case has been deformed and the locking bead would not be effective.

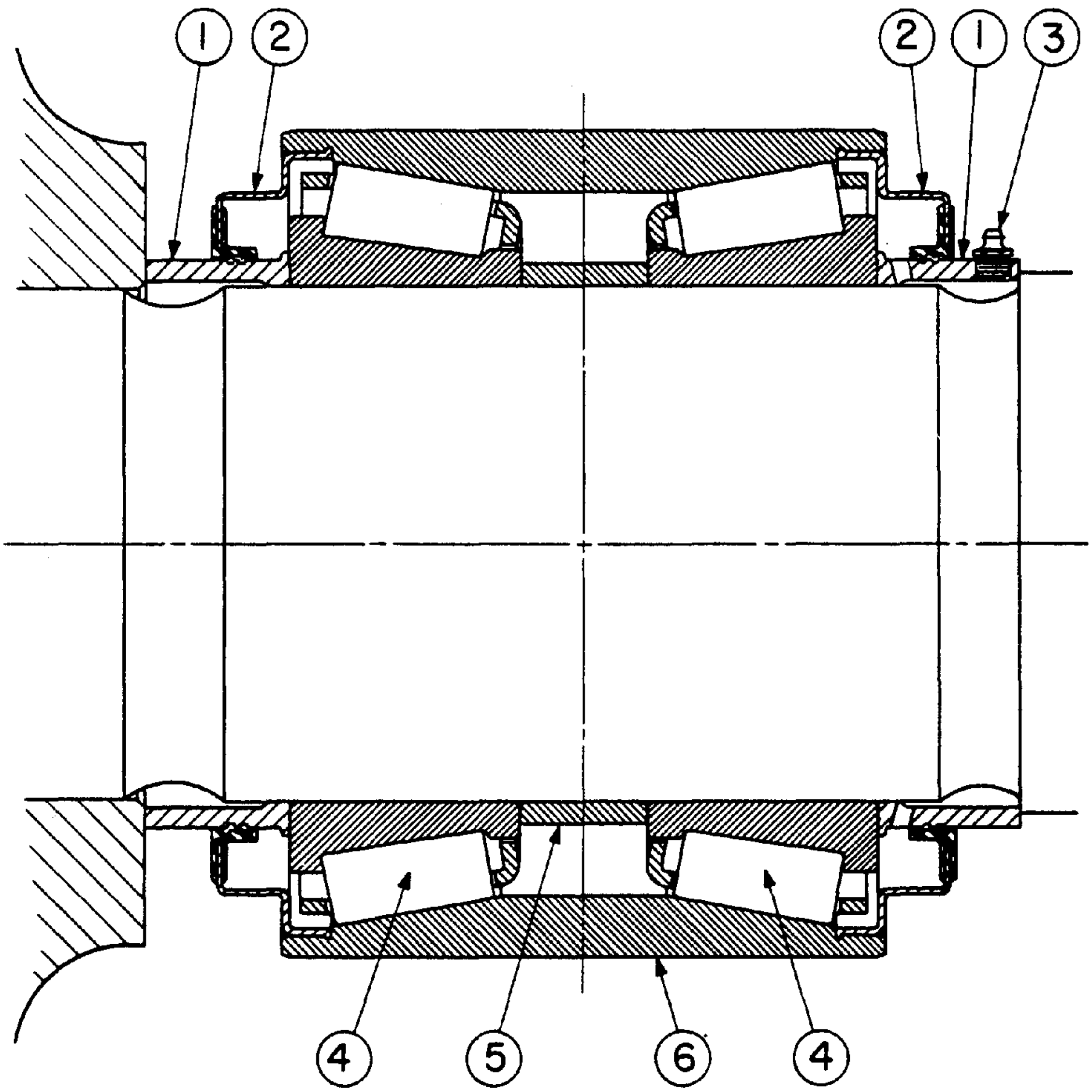
d. Lubrication:

Before installation of the enclosure seals, the enclosure I.D. must be lubricated with AAR approved roller bearing grease sufficient to continuously bridge the 0.030″ clearance with the O.D. of the enclosure sleeve around the entire circumference. It is not necessary to bridge the gap across the entire width of the I.D.



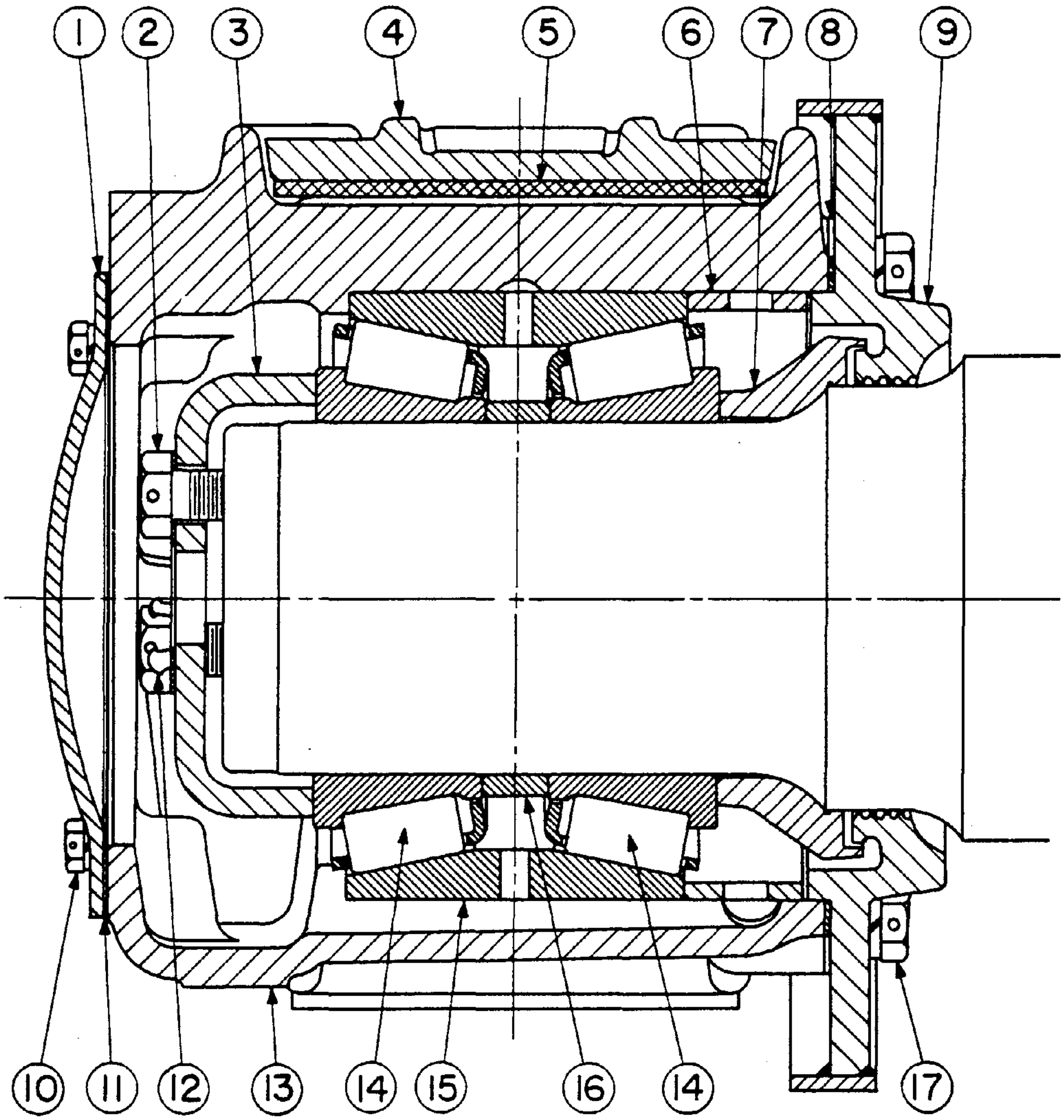
1. Lubricant Fitting	6. Vent Fitting	11. Spacer
2. Cap Screw	7. Backing Ring	12. Outer Ring
3. Axle End Cap	8. Reducing Bushing	13. Enclosure Assembly
4. Seal	9. Locking Plate	14. Flinger
5. Seal Wear Ring	10. Roller Assembly (includes Rollers, Cage, & Inner Ring)	15. Cone Backing Ring

Fig. 4.1
Identification—Outboard Journal Roller Bearing Parts of Tapered Roller Bearing with Rotating End Cap (Roller Assembly and Inner Ring Non-Separable).



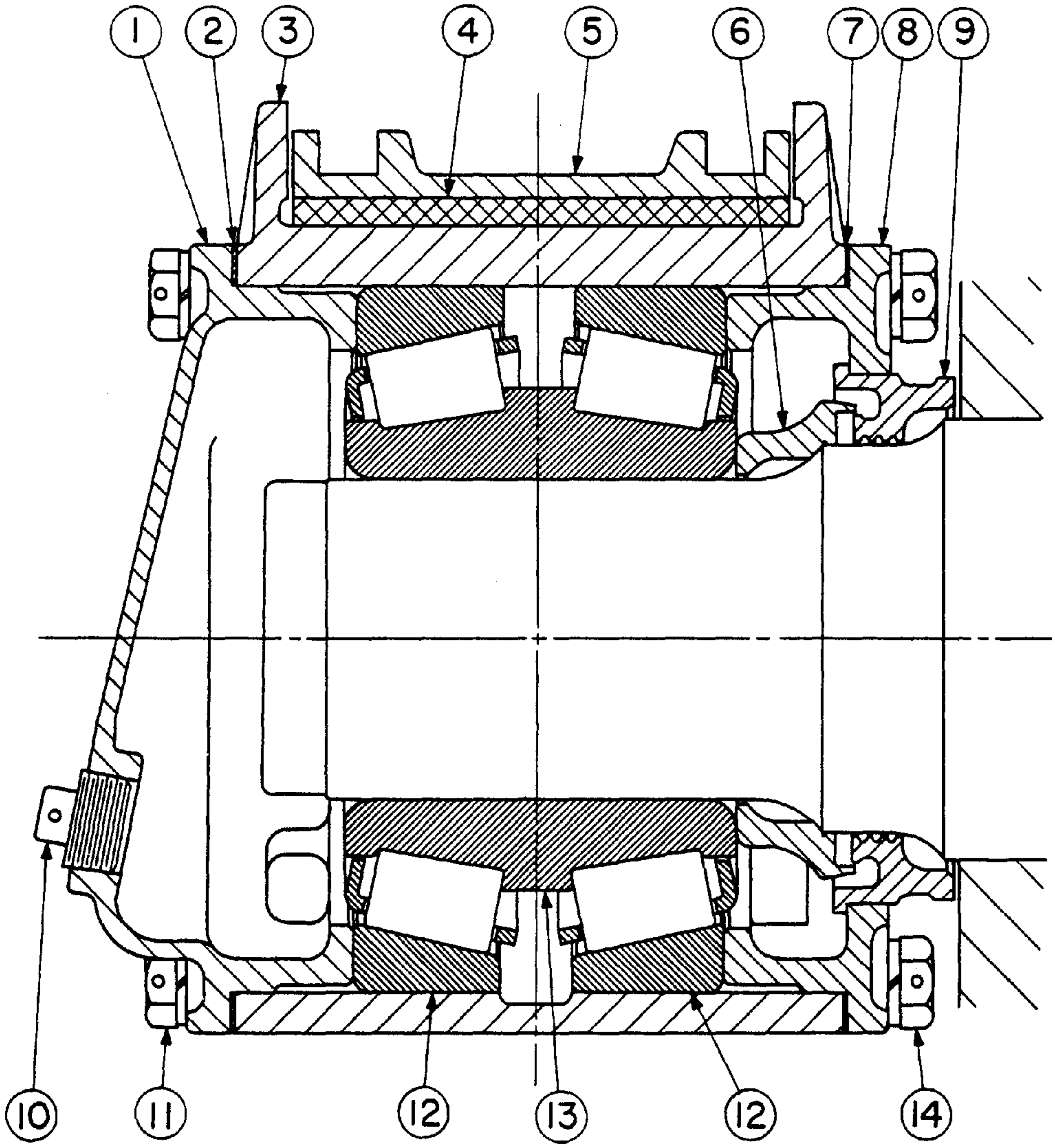
1. Enclosure Sleeve
2. Elastomeric Enclosure
3. Lubricant Fitting
4. Roller Assembly (Includes Rollers, Cage, & Inner Ring)
5. Spacer
6. Outer Ring

Fig. 4.2
Identification—Inboard Journal Roller Bearing Parts of Tapered Roller Bearing (Roller Assembly and Inner Ring Non-Separable).



1. Cover
2. Cap Screw
3. Axle End Cap
4. Equalizer Seat
5. Resilient Pad
6. Two-Piece Spacer
7. Flinger
8. Enclosure Gasket
9. Enclosure
10. Cover Cap Screw & Lockwasher
11. Cover Gasket
12. Locking Plate
13. Housing
14. Roller Assembly (Includes Rollers, Cage, & Inner Ring)
15. Outer Ring
16. Spacer
17. Enclosure Cap Screw & Lockwasher

Fig. 4.3
Identification—Double Cup Journal Roller Bearing Parts of Tapered Roller Bearing with Housing (Roller Assembly and Inner Ring Non-Separable).



1. Front Cover
2. Cover Gasket
3. Housing
4. Resilient Pad
5. Equalizer Seat
6. Flinger
7. Enclosure Gasket
8. Rear Cover
9. Enclosure
10. Plug
11. Cover Cap Screw & Lockwasher
12. Outer Ring
13. Roller Assembly (Includes Rollers, Cages, & Inner Ring)
14. Enclosure Cap Screw & Lockwasher

Fig. 4.4
Identification—Double Cone Journal Roller Bearing Parts of Tapered Roller Bearing with Housing (Roller Assembly and Inner Ring Non-Separable).

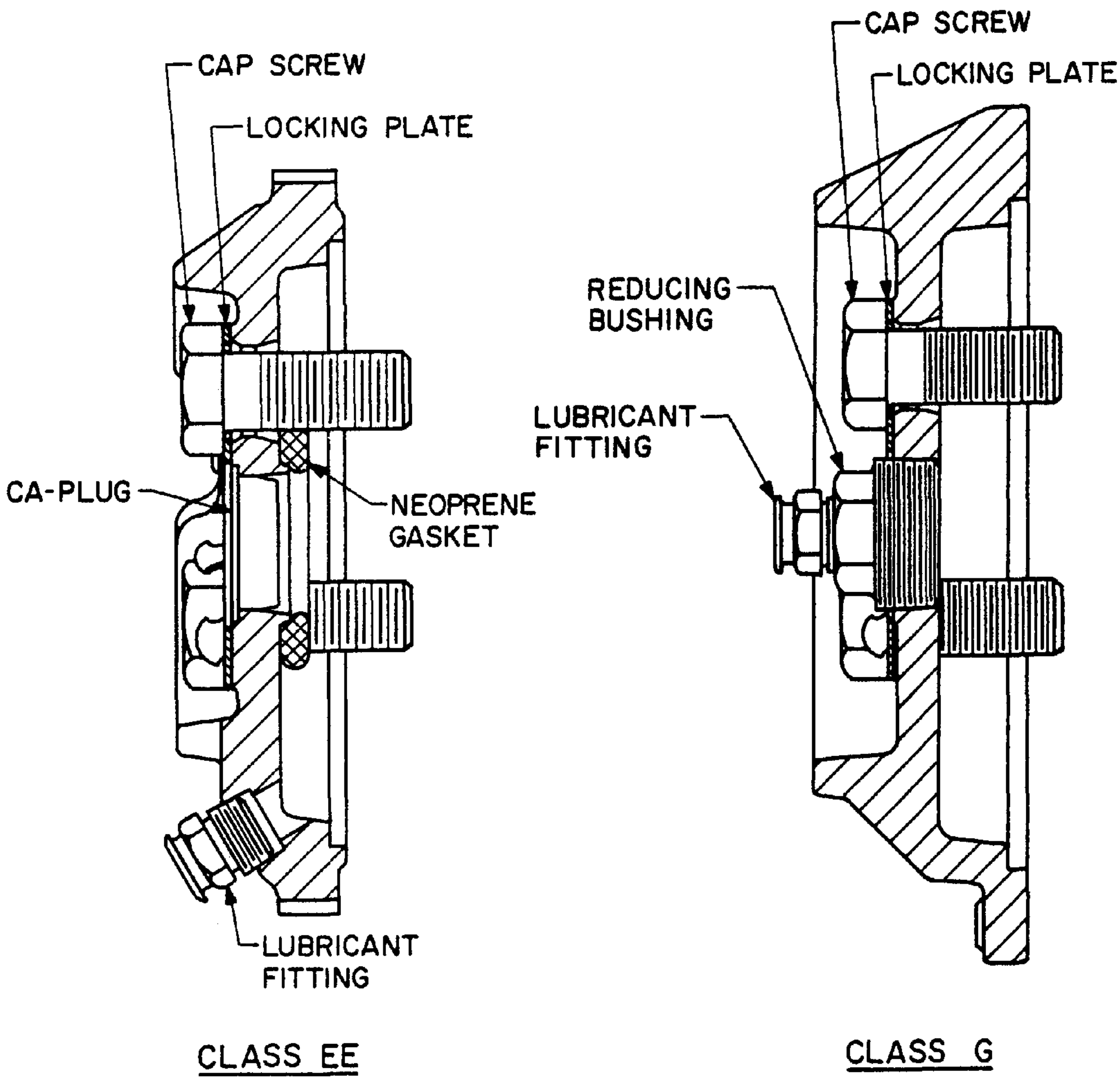


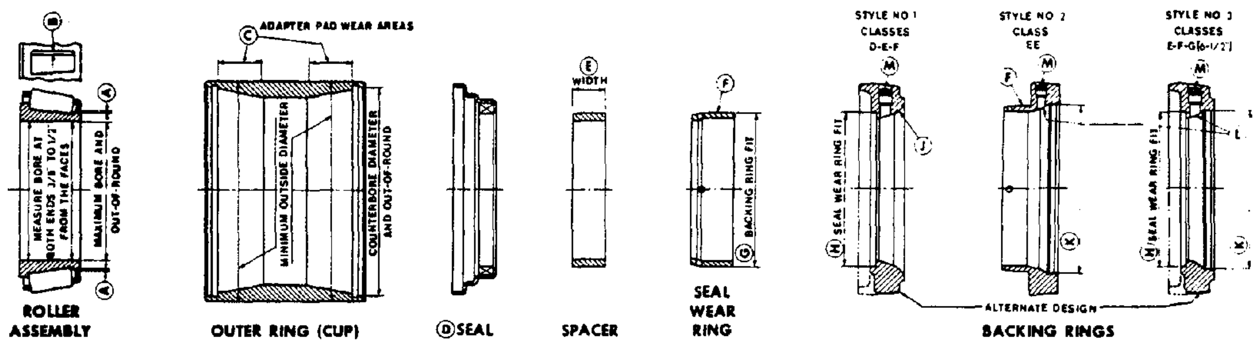
Fig. 4.5

Comparison of Axle End Cap Assemblies.

TIMKEN "AP" ROLLER BEARINGS

SERVICE LIMITS

PASSENGER CARS



CLASS AND SIZE	DIAMETERS ARE AVERAGES							AMOUNT OF GREASE (OUNCES) +		
	ROLLER ASSEMBLY		OUTER RING				BACKING RING	Each Roller Assembly	Around Spacer	Total Quantity
	Maximum Bore	Out-Of-Round	Minimum O. D.	Maximum C'bore	Minimum C'bore	Out-Of-Round	Maximum C'bore			
D (5½ X 10)	5.1890"	0.003"	8.1775"	7.7540"	7.7450"	0.005"	—	4	8	16
E (6 X 11)	5.6890"	0.003"	8.6775"	8.2540"	8.2450"	0.005"	7.0300"	4	8	16
F (6½ X 12)	6.1890"	0.003"	9.9275"	9.3790"	9.3700"	0.005"	7.5300"	6	12	24
G (6½)	6.5015"	0.003"	10.8650"	10.2790"	10.2700"	0.005"	7.9030"	9	9	27
EE (5½)	5.5015"	0.003"	10.8650"	10.2790"	10.2700"	0.005"	6.7000"	9	9	27
EE (6)	6.0015"	0.003"	10.8650"	10.2790"	10.2700"	0.005"	7.2470"	9	9	27

+ NOTE: ONE HALF OF TOTAL AMOUNT OF GREASE MAY BE APPLIED TO EACH SIDE OF ASSEMBLED BEARING (BEFORE SEALS ARE APPLIED).

ROLLER ASSEMBLY - CAGE INSPECTION

Place roller assembly on back face (large diameter face) when checking clearances.

(A) Measure this clearance using two sets of feeler gages. Insert the feeler gages between the small rib of the cone and cage flange at two locations diametrically opposite. If the total of the two sets of feeler gages is 0.090" or more, the roller assembly should not be returned to service.

(B) If the roller pocket of the cage is worn to the extent that a 0.060" feeler gage can be inserted between the roller and the cage bridge, the roller assembly should not be returned to service.

OUTER RING (CUP)

(C) Minimum O.D. to be measured in adapter pad wear areas.

If the outer ring is distorted in the area of the counterbore a close visual inspection of the inside and outside surface is required. Outer rings that have hair line cracks must be scrapped.

(D) **SEAL** - SCRAP ALL USED SEALS

SPACER WIDTH - BENCH LATERAL

(E) A spacer must be selected or the spacer may be ground to provide the bearing bench lateral play specified below for the type of lateral measuring equipment used:

	Power Operated	Hand Operated
Classes D-E	0.023" to 0.029"	0.020" to 0.026"
Classes F-G	0.027" to 0.031"	0.024" to 0.028"
Class EE	0.021" to 0.025"	0.018" to 0.022"

Where close coordination is maintained between the bearing repair facility and the bearing mounting facility, the bearing bench lateral may be set to limits necessary to provide satisfactory mounted bearing lateral.

SEAL WEAR RING - OUTSIDE SURFACE

(F) If the outside surface is cracked or scratched or if the lip contact path has worn to a depth of 0.005" (0.010" on diameter), the seal wear ring or backing ring style 2 must be scrapped.

SEAL WEAR RING - FIT IN BACKING RING

(G) The seal wear ring must have a tight fit in the backing ring counterbore (style no. 1 and 3).

BACKING RING - FIT ON THE SEAL WEAR RING

(H) The counterbore of the backing ring (styles 1 & 3) must have a tight fit on the seal wear ring. AAR Roller Bearing Manual permits salvage of backing rings with oversize counterbores. See A-24389 for suggested procedure.

BACKING RING - SIZE AND RADIUS (STYLE 1)

(J) Backing rings that are bent or distorted must be scrapped. Check the backing ring size and the bore radius for proper axle fillet contact and excessive corrosion with the AAR gage as shown in the Roller Bearing Manual.

BACKING RING - SIZE AND RADIUS (STYLES 2 & 3)

(K) Check major I.D.

(L) Check bore radius for excessive corrosion. Light pitting and rusting is acceptable.

VENT FITTING

(M) Check the vent fitting to see that it is not clogged, hardened, or damaged. Hardened or damaged vent fittings should be replaced. (Part No. K89716)

NOTE: Contact The Timken Company for information on bearing parts that are not shown.

PART NUMBERS - BEARING COMPONENTS

CLASS AND SIZE	ROLLER ASSEMBLY	OUTER RING (CUP)	SPACER	SEAL	SEAL WEAR RING	BACKING RING
D (5½ X 10)	HM127446	HM127415XD	HM127446XA	K86860	K85507	K85525
E (6 X 11)	HM129848	HM129814XD	HM129848XA	K86861	K85508	K85095
F (6½ X 12)	HM133444	HM133416XD	HM133444XA	K85520	K85509	K85516
G (6½)	HM136940	HM136916XD	HM136940XA	K96501	K96537	K96539
EE (5½)	H432640	H432614XD	H432640XA	K83082	K522358	K522359
EE (6)	H432649	H432614XD	H432649XA	K83082	K83081	K83088

OCTOBER 20, 1980

THE TIMKEN COMPANY

Canton, Ohio 44706 - Cable Address "TIMROSCO"

Fig. 4.6

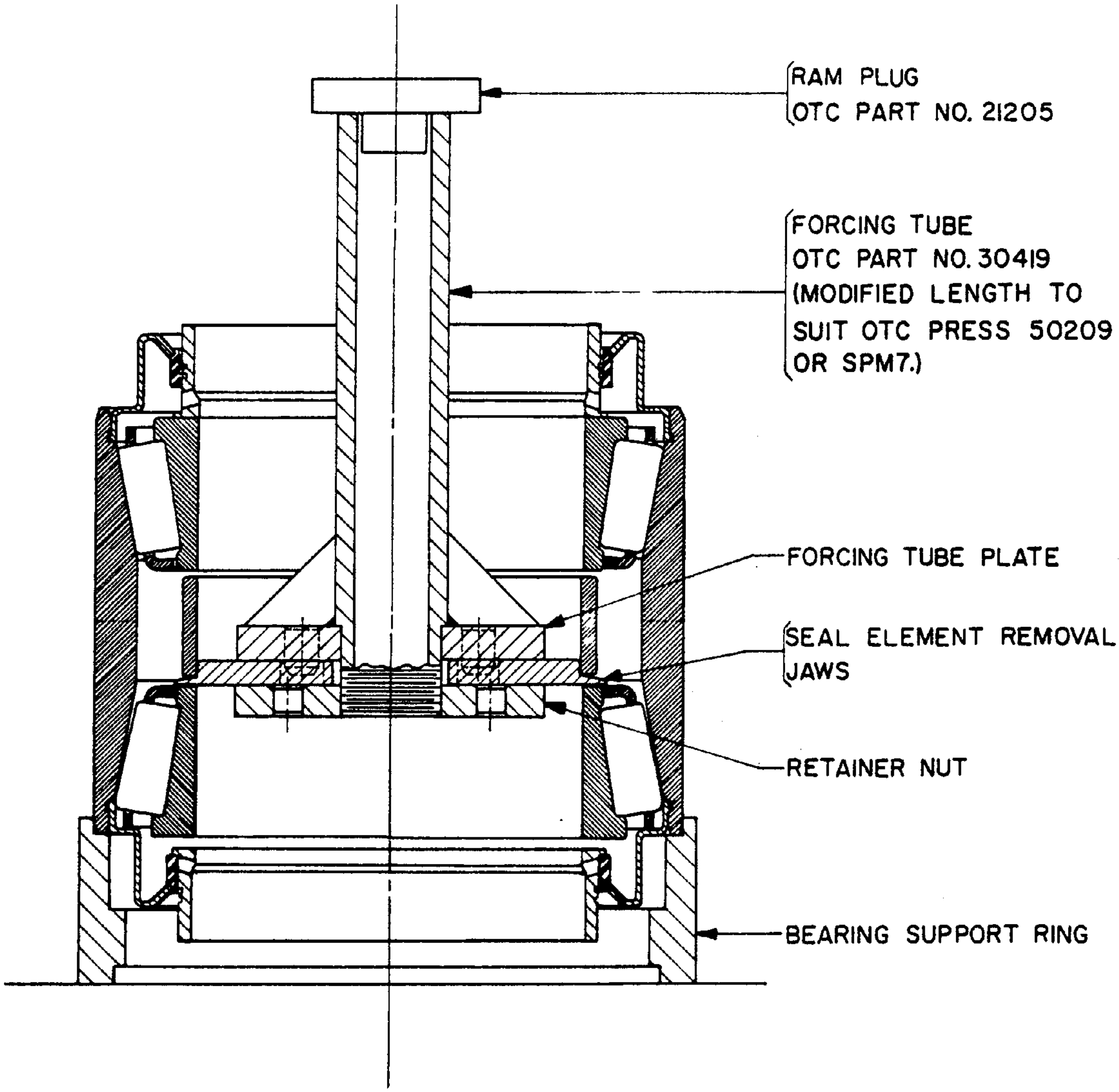


Figure 4.7 Removing the Enclosure from the Bearing Cup

Figure 4.8

Method of Checking Outside Diameter

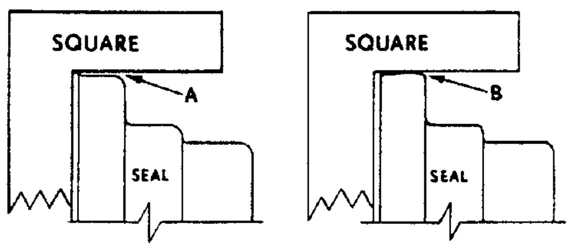


Fig. 4.9A Fig. 4.9B

Figure 4.9

Method of Checking Enclosure Case

RULES ON INTERCHANGEABLE ROLLER BEARING PARTS
(THIS SECTION NOT APPLICABLE TO AMTRAK PASSENGER CAR BEARINGS)

RULE 5.1

Interchangeable parts are listed in Figure 5.1 by part name and by certificate number of the bearings with which the part/s can be used. Part numbers are listed for backing rings and seal wear rings which can be interchanged.

RULE 5.2

Interchangeable parts must be procured from manufacturers who have qualified in accordance with the M-934. These are listed in Figure 5.2 by manufacturer and parts for which qualified.

RULE 5.3

Cap screws (except for AAR-20 bearings), cap screw seal rings (not required on AAR-20, AAR-24, and AAR-25 bearings), and cap screw locking plates are interchangeable on all bearings.

RULE 5.4

End caps for Classes D, E and F size bearings, with the part numbers listed in Figure 5.3 may be interchanged between Timken Nos. 1 and 1A bearings, Brenco No. 5 and 5A bearings, New Departure Hyatt Nos. 6 and 6A bearings, FAG No. 13 bearings, Koyo No. 14 bearings, NTN No. 19 and SKF No. 23 bearings, if necessary. If the end cap applied is not of the same manufacturer and approval number as the bearing to which applied, a distinctively colored locking plate will be used to identify the bearings. Orange colored locking plates will be used to identify Timken 1 and 1A bearings, Green for Brenco 5 and 5A bearings, Blue for ND Hyatt 6 and 6A bearings, Red for FAG 13 bearings, White for Koyo 14 bearings, Purple for NTN 19 bearings and Yellow for SKF 23 bearings. The locking plate coloring medium used must be distinctively orange, green, blue, red, yellow, purple or white, as the case may be, and of such permanence as to allow ready identification of the bearing during the time in service. If, for any reason, a colored locking plate is removed without also removing the bearing, it must be replaced with one of the same color to maintain bearing identity. Only Timken 1 and 1A, Brenco 5 and 5A, ND Hyatt 6 and 6A, FAG 13, Koyo 14, NTN 19 and SKF 23 end caps may be interchanged. Devices which are to be attached to standard locking plates and are intended to be used in place of colored locking plates for identification must be approved by the AAR Mechanical Division.

Bearing Cert. No.	Seals	Spacers	Interchangeable Parts: Fitted & Non-Fitted Backing Rings* 5½ x 10	6 x 11	6½ x 12	Seal Wear Rings* 5½ x 10	6 x 11	6½ x 12
1, 1A	X	X	K127205 K85525	K127206 K85095	K125685 K504082 K85516	K85507	K85508	K85509
5, 5A	X	X	D1015	E1115	F1215	D1006	E1106	F1206
6, 6A	X	X				3R-1488	2R-1022 3R-1129	2R-1056 3R-1493
8	X	X		PD-106-C	PD-131-D	PD-144-C	PD-104-C	PD-129-C
10		X						
11, 11A		X						
12						D-4A	E-4A	F-4
13	X	X	120 987/3	120 988/3	120 989/3 149 171/3	120 987/4	120 988/4	120 989/4
14	X	X	703N20 1203P20 120320	704N20 704P20 1204P20 120420	705N20 705P20 1205P20 120520	703N40	704N40	705N40
16	X	X		E1115	F1215		E-1106	F-1206
19	X	X	RT30D11	RT30E21 RT30E11	RT30F21 RT30F11	RT40D11	RT40E11	RT40F11
20		X						
21		X						
22	X	X	JB5759	JB5760	JB5752	JB5755	JB5756	JB5707
23	X	X	1637503-15	1637504-15	1637505-15	1637503-13	1637504-13	1637505-13
24		X						
25		X						

*SEAL WEAR RING AND BACKING RING PART NUMBERS NOT LISTED IN TABLE CANNOT BE INTERCHANGED.

Bearings Having Interchangeable Parts

Figure 5.1

Bearing Manufacturer	Interchangeable Parts Qualification: Seals
The Timken Company	X
Brenco Inc.	X
NTN Bearing Corp. of America	X
NSK Corporation	X
American Koyo Corporation	X
SKF Canada Limited (AKTIEBOLAGET SKF)	X
FAG Kugelfischer Georg Schafer & Co.	X

Manufacturer's Qualifying for Vending of Interchangeable Parts

Figure 5.2

Interchangeable End Cap Part Numbers			
Bearing Certificate No.	Class D 5½ X 10	Class E 6 X 11	Class F 6½ X 12
1, 1A	K85521 K523744	K85510 K523746	K85517 K523748
5, 5A	D1011	E1111	F1211
6, 6A	4-R-3810	4-R-3811	4-R-3813
13	120987/2	120988/7	120989/7
14	703N60	704N60	705N60
19	RT20D11 RT20D31	RT20E11 RT20E31	RT20F11 RT20F31
23	1637503-11	1637504-11	1637505-11

Interchangeable End Cap Part Numbers

Figure 5.3

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REMANUFACTURE OF BEARING COMPONENTS

GENERAL

Authorization has been given bearing manufacturers for certain salvage or remanufacturing operations on specified bearing components and associated parts under their responsibility. These remanufacturing operations are, in general, similar to certain steps in the original manufacturing process and require facilities and controls beyond the scope of this manual. These operations are the responsibility of manufacturers who have qualified in accordance with Specification M-934 and are currently producing railroad roller bearings or parts.

In some cases, the specified component must be returned to the original manufacturer for remanufacturing. The purpose of this section is to define components that may be remanufactured, selection criteria (in order to eliminate unnecessary handling, shipping and scrap costs) for salvage candidates, remanufacturing limits and marking requirements. It should be recognized that these remanufacturing procedures may not result in salvaging the component in every instance and some components returned for remanufacture may have to be scrapped. Bearing manufacturers should be contacted to determine if they are authorized and prepared to perform the remanufacturing procedures described before shipping components to them.

OUTER RINGS—REGRINDING RACES

RULE 6.1 DEFECT

Outer rings, or cups, of tapered roller bearings with certain raceway defects may qualify for salvage by regrinding raceways by the original manufacturer.

RULE 6.2 SELECTION CRITERIA

The selection criteria below are general and the original manufacturer may publish more specific criteria.

a. Outer ring defects which may be corrected by regrinding raceways are condemnable brinelling, water etching, corrosion, scoring, indentations, pitting, smearing and peeling described in Section 1.

b. There is no limit on the area of the raceway defect permitted; however, if the depth of the defect is greater than several thousandths the defect will generally not clean up.

c. Condemnable spalls are not suitable for remanufacturing. Outer rings with repairable spalls must be repaired before selection for regrinding.

d. Outer rings with cracks in any surface must be scrapped.

e. The outer ring should not be selected for regrinding if it is condemnable for defects other than those listed in (a) above.

f. Outer ring raceways can be reground only once and should not be returned if they have been reground previously. (See Rule 6.4 for marking.)

RULE 6.3 REMANUFACTURING LIMITS

a. Regrinding of raceways is the responsibility of the original bearing manufacturer.

b. Raceway grinding limits are determined by the original manufacturer.

c. After regrinding, the outer ring must meet requirements of Rule 3.20. Outer rings not meeting these requirements will be scrapped.

RULE 6.4 MARKING

Bearing reconditioning marking must not be marked on the salvage candidate outer rings before they are shipped for regrinding. The "remanufactured" symbol (an encircled "R") and the date, as shown in Fig. 3.16, are to be marked at the time of regrinding. The reconditioning marking, date and company initials and shop code letters, as shown in Fig. 3.16, are to be applied by the shop which reassembles the bearing.

BACKING RINGS—REMANUFACTURING RADIUS

RULE 6.5 DEFECT

Backing rings with a corroded, worn, or pitted radius may qualify for salvage by remachining the radius. Backing rings with other types of condemnable defects must be scrapped. Remachining of backing rings is the responsibility of a bearing manufacturer or a shop approved by the AAR. Bearing manufacturers or approved shops who contract for remachining of backing rings must apply their markings and will be responsible for the quality of the work done.

RULE 6.6 SELECTION CRITERIA

The selection criteria below are general, and individual bearing manufacturers may publish more specific criteria.

a. Backing ring defects which can be corrected by remachining the radius of a backing ring are corrosion or wear. Other types of defects cannot be corrected.

b. If backing ring does not pass inspection per Rule 3.24, use the "axle fillet contact location gage" (shaded portion of gage in Fig. 3.10) and attempt to insert a 25 gage (0.0204") diameter steel wire between the gage and the backing ring in top area of the radius. If the wire enters, the backing ring should be scrapped. Also, pits or gouges in the radius that are deeper than approximately .020" will not clean up and the backing ring must be scrapped.

c. Backing rings designed for a press fit on the axle dust guard diameter cannot be remanufactured.

d. Backing rings may be remachined more than once providing the remanufacturing limits are not exceeded, see Rule 6.7. See Rule 6.8 for marking.

e. Certain Timken and all Brenco and Hyatt cast backing rings must be scrapped per Rule 3.24.

RULE 6.7 REMANUFACTURING LIMITS

a. The table in Fig. 6.1 shows minimum length dimensions from the counterbore to the face of the backing ring after remachining (dimension A), based on a nominal breakout diameter equal to the axle dust guard diameter, (dimension B).

b. After remachining, the backing ring must meet the radius requirements of Rule 3.24 and Fig. 3.9. Backing rings not meeting these requirements must be scrapped.

RULE 6.8 MARKING

Backing rings must not be marked before being shipped for remanufacturing. The manufacturer or AAR approved shop must mark the remachined backing ring on the vertical face above the seal wear ring fit area or the machined back face as shown in Fig. 3.16.

INNER RINGS — STRESS RELIEF HEAT TREATMENT AND PLATING

RULE 6.9 DEFECT

Inner rings with bores that exceed the manufacturers' limits, because of growth on the bore, may qualify for remanufacturing by stress relief and/or plating.

RULE 6.10 SELECTION CRITERIA

The selection criteria below are general, and individual bearing manufacturers may publish more specific criteria.

a. If the bores are in excess of .002" beyond the manufacturer's condemning limit (see manufacturer's specification), or are .003" or more out-of-round, the inner rings should not be selected for remanufacturing. It should be understood that salvage rates will vary with the amount of oversize and other factors.
b. Inner rings which are scored as a result of having turned on the axle journal cannot be remanufactured.
c. Inner rings that have condemnable defects other than oversized bores must not be selected for remanufacturing by stress relief or stress relief and plating.

RULE 6.11 REWORK LIMITS

a. Stress relief and plating are the responsibility of a bearing manufacturer. Such work may also be performed by a bearing remanufacturer, only as authorized and certified by a bearing manufacturer.
b. The bearing manufacturer will make no inspection of inner rings received from the customer. After the inner rings are heat treated, these rings will be inspected and those not within the prescribed service limit may be subjected to specified plating procedures. After plating, the inner rings must be inspected for size prior to being returned to the customer. Inner rings not usable will be scrapped or returned to the customer upon request.

RULE 6.12 MARKING

No marking is required for stress relief heat treatment. The shop doing the plating must mark the inner ring with the plating symbol (an encircled "P"), the company marks and the date as shown in Fig. 3.16.

INNER RINGS — REMOVAL OF CAGES FOR INSPECTION AND RACEWAY REGRINDING

RULE 6.13 DEFECT

Inner rings, or cones, (roller assembly nonseparable) with certain raceway, roller, or cage defects may qualify for cage removal to permit adequate inspection and necessary correction of defects, including regrinding operating surfaces.

RULE 6.14 SELECTION CRITERIA

The selection criteria below are general and individual manufacturers may publish more specific criteria.

a. Inner rings with the following defects may be selected for rework by cage removal, inspection and repair within the criteria listed below:

1. Raceway spalls which exceed the reuse limits but which can be corrected within the limits covered in Section 1.
2. Light raceway smearing and peeling which can be corrected within acceptable limits by polishing as covered in Section 1. If the inner ring cannot be satisfactorily repaired by polishing, see (b) below.
3. Staining and light etching on raceway which can be removed within acceptable limits by polishing as covered in Section 1. Inner rings with significant depth of etching on the raceway which cannot be corrected by polishing may be reground on the operating surfaces by the original bearing manufacturer, see (b) below.
4. Inner rings removed from bearings where mating outer ring raceway has condemnable brinelling. If inner ring has condemnable brinelling, see (b) below.
5. Defective rollers per Rule 3.22
6. Cage with clearances beyond limits in manufacturers' specification sheets (Figs. 3.4-1 to 25) or otherwise defective per Rule 3.23.

b. Inner rings with the following defects may be remanufactured by regrinding operating surfaces within the criteria listed below:

1. Inner ring defects which can be corrected by regrinding operating surfaces are condemnable brinelling, water etching, corrosion, scoring, indentations, pitting, smearing, and peeling described in Section 1. (This would include inner rings with operating surface defects listed in (a) above which cannot be acceptably repaired by polishing.)
2. There is no limit on the area of the operating surface defect permitted; however, if the depth of the defect is greater than several thousandths, the defect will generally not clean up.
3. Inner rings can have operating surfaces reground only once and should not be returned for regrinding if they have been reground previously. (See Rule 6.16 for marking.)

c. Inner rings with cracks in any surface, unrepairable oversize bores, excessive out-of-round bores or unrepairable spalls should not be selected for salvage by cage removal and inspection or regrinding. In addition, inner rings with any other defects, other than those listed in (a) above, should not be selected for cage removal and inspection. Inner rings with any other defects, other than those listed in (b) above, should not be selected for regrinding operating surfaces.

RULE 6.15 REWORK LIMITS

a. Cage removal, inner ring inspection and/or correction are the responsibility of the original manufacturer. Regrinding operating surfaces and new cage reassembly must be done by the original manufacturer.

b. Salvage inspection and/or repair limits shall be according to Section 1.

c. Afer recaging, the inner ring must meet all requirements of Rules 3.21, 3.22, and 3.23. Inner rings not meeting these requirements will be scrapped.

RULE 6.16 MARKING

a. Inner rings selected for cage removal, inspection and repair should not be marked prior to shipment for remanufacturing.

b. The manufacturer who does the recaging will mark the inner ring on the back face as shown in Fig. 3.16 (NOTE: The encircled 'R' is marked only when the operating surfaces have been reground.)

OUTER RINGS — STRESS RELIEF HEAT TREATMENT AND PLATING

RULE 6.17 DEFECT

Outer rings with counterbores that exceed the manufacturers' limits, because of growth, may qualify for remanufacture by stress relief and/or plating.

RULE 6.18 SELECTION CRITERIA

The selection criteria below are general and individual manufacturers may publish more specific criteria.

a. If the counterbores are in excess of .0015" beyond the manufacturers' condemning limit (see manufacturers' specification), or more than .005" out-of-round, the outer rings should not be selected for remanufacturing. It should be understood that salvage rates will vary with the amount of oversize and other factors.

b. Outer rings that have condemnable defects other than oversized counterbores must not be selected for remanufacturing by stress relief or stress relief and plating.

c. Outer rings which show evidence of the seal turning in the counterbore, such as a shiny appearance on the counterbore I.D., are less likely to be restored within limits and should not be selected for remanufacturing.

RULE 6.19 REWORK LIMITS

a. Stress relief heat treatment and plating are the responsibility of a bearing manufacturer. Such work may also be performed by a bearing remanufacturer, only as authorized and certified by a bearing manufacturer.

b. The bearing manufacturer will make no inspection of outer rings received from the customer. After the outer rings are heat treated these rings will be inspected and those not within the prescribed service limit may be subjected to specified plating procedures. After plating, the outer ring counterbores must be inspected for size prior to being returned to the customer. Outer rings not usable will be scrapped or returned to the customer upon request.

RULE 6.20 MARKING

No marking is required for stress relief heat treatment. The shop doing the plating must mark the outer ring with the plating symbol (an encircled "P"), the company marks and the date as shown in Fig. 3.16.

SPACERS — REMACHINING END FACES

RULE 6.21 DEFECT

The spacer end face(s) can be remachined if a shorter length spacer is required or to remove nicks and burrs if such defects cannot be stoned smooth.

RULE 6.22 SELECTION CRITERIA

Spacer(s) selected for remachining must meet all requirements of specification M-934.

RULE 6.23 REMANUFACTURING LIMITS

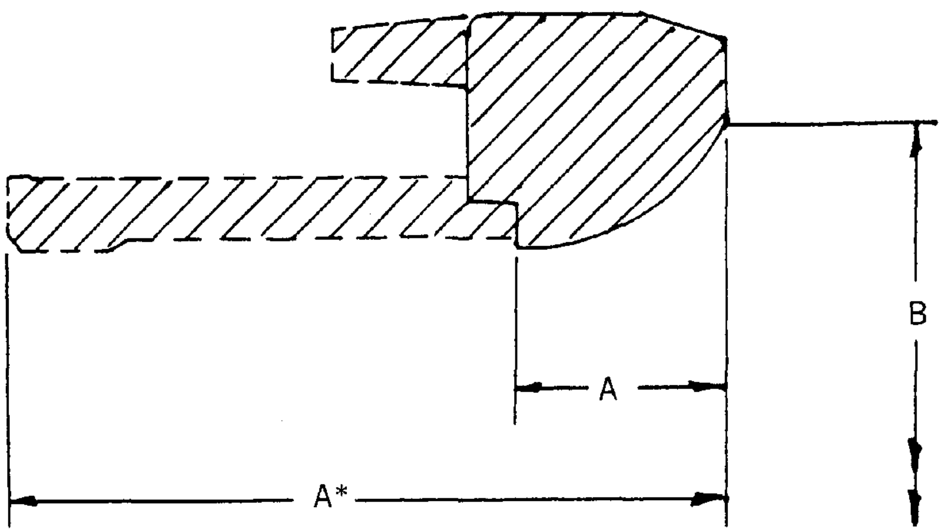
a. Remachining spacers is the responsibility of a bearing manufacturer or a shop certified by AAR.

b. Remachined spacers must meet all requirements of Rule 3.18 and Figure 6.2.

RULE 6.24 MARKING

Mark the spacer on the outside diameter as shown in Figure 3.16.

REMANUFACTURING LIMITS FOR BACKING RINGS



*for AAR 3, 3A, 3B, L18 Bearings only

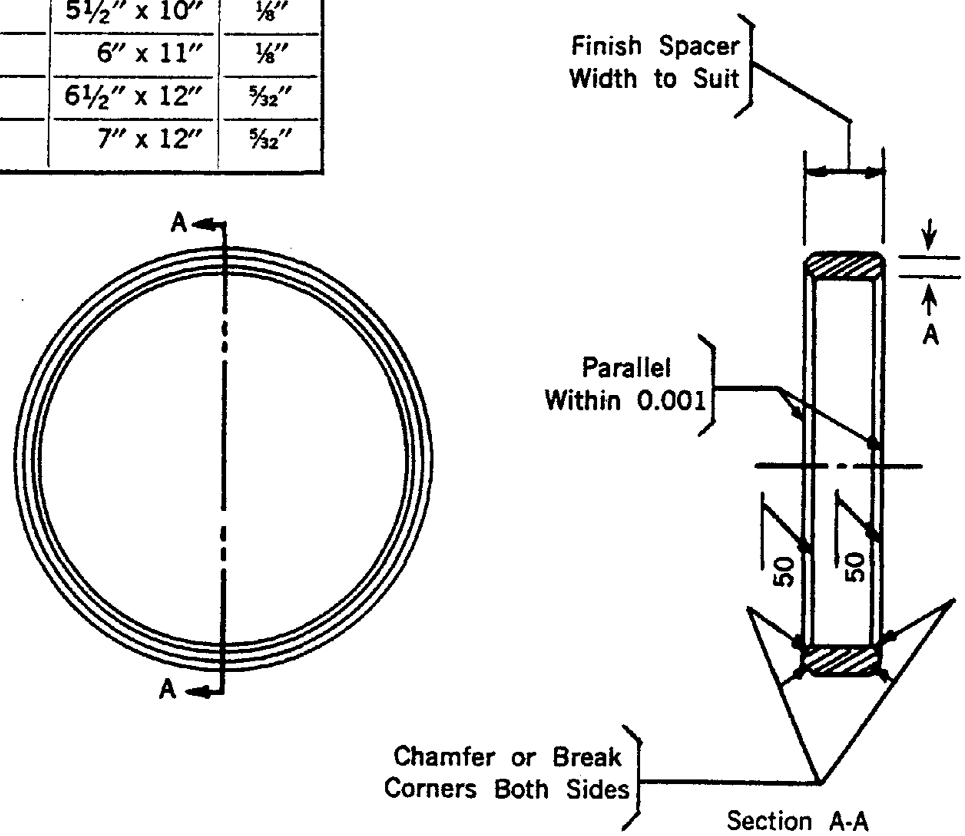
Backing Ring Radius Finish: 125 Microinches Maximum

MANUFACTURER	AAR APPROVAL NUMBER	A (Min. dimension after Remanufacturing)		
		5.½ x 10 B = 6.375″	6 x 11 B = 7.000″	6.½ x 12 B = 7.500″
Timken	1, 1A	1.001	1.157	1.033
SKF Sweden	3, 3A, 3B	2.464	2.663	2.770
Brenco	5, 5A	1.001	1.157	1.033
NDH	6, 6A	1.001	1.157	1.033
Bower	8	.....	1.157	.....
NTN	10	.990	1.143	1.143
NSK	11, 11A	.990	1.143	1.143
FAG	13	1.001	1.157	1.033
Koyo	14	.990	1.147	1.021
Magnus	16	1.001	1.157	1.033
SKF Sweden	L18	2.700	2.860	2.927
NTN	19	1.001	1.157	1.033
NSK	22	1.001	1.157	1.033
SKF (Tapered)	23	1.001	1.157	1.033

Fig. 6.1

These dimensions were selected to restrict the resulting shift in bearing center toward the wheel .030″ or less from the new minimum dimension.

CLASS	SIZE	A (MIN)
B	4¼" x 8"	¹⁄₁₆"
C	5" x 9"	⅛"
D	5½" x 10"	⅛"
E	6" x 11"	⅛"
F	6½" x 12"	⁵⁄₃₂"
G	7" x 12"	⁵⁄₃₂"



NOTE: Spacer Must Be Free of Nicks and Burrs.

Fig. 6.2
Remanufacturing Limits for Spacers.

Appendix of AAR Circular Letters

Circular letters forwarded between revisions of this section which affect Specifications, Standards, or Recommended Practices should be inserted here until the affected portion has been revised.

*U.S. G.P.O.:1993-343-273:80118