

# Maintenance Instruction



ELECTRO-MOTIVE

Technical Publications

## WHEELS, AXLES, AXLE GEARS AND PINIONS - EXPORT

### GENERAL

Wheel, gear, and axle assemblies suitable for eight different track gauges are covered in this instruction. These are : 1.676 m (5' 6"), 1.600 m (5' 3"), 1.524 m (5' 0"), 1.435 m (4' 8-1/2"), 1.067 m (3' 6"), meter gauge - 1.000 m (39-3/8"), 0.991 m (3' 3"), and 0.914 m (3' 0").

Wheels should be inspected for visible defects each trip. Wheels should be checked for wear, sharp flanges, shelling, cracks, and flat spots.

Axles should also be periodically checked for defects.

Refer to Wheel And Axle Defects paragraphs for defects which require removal of a wheel set.

### REMOVAL OF WHEEL SETS

Wheel sets may be removed from the locomotive by using an overhead crane or jacks to raise the locomotive, or by use of a drop table.

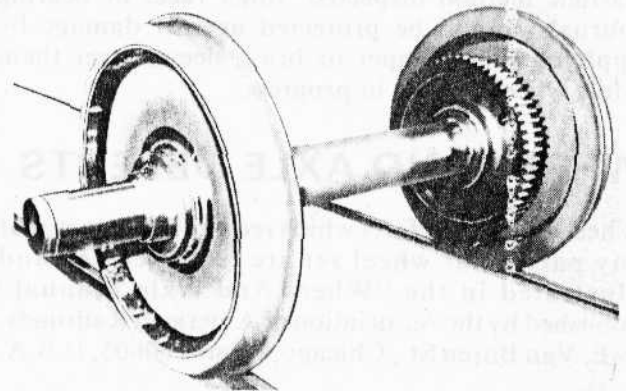
When jacks are used to raise the locomotive, ensure all jacks are raised equal amounts. Unequal jacking may cause the carbody to be sprung out of shape. The locomotive should be supported on blocking located under the center sills near the jacking pads.

### REMOVAL OF WHEELS AND AXLE GEARS

After the wheel, gear, and axle assembly, Fig. 1, has been removed from the locomotive, it may be necessary to press off the wheels and axle gear for inspection and servicing.

### CAUTION

Axle journal bearing surfaces should be protected when the journal boxes are removed.



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Fig. 1 - Wheel, Gear And Axle Assembly

While the wheels are being pressed off, be careful to apply the pressure uniformly over the end of the axle to avoid upsetting it. Always use a pressure block between the end of the axle and the ram of the press. An upset condition of the axle end will cause the journal to swell at the outer end, which would be transferred to the inner race as a high spot on the operating surface. This would cause early failure of the race, and might interfere with the application of the journal bearing to the journal.

The amount of pressure required for wheel and gear removal is disregarded when wheels and gears are removed from axles. The wheel at the gear end of the axle should be pressed off by removing the gear with it, using a press yoke against the gear. If the wheel

\*This bulletin is revised and retyped and supersedes previous issue of this number.

Figs. 2 through 19 courtesy of the Association of American Railroads.

press capacity is not sufficient to remove the wheel and gear simultaneously, the wheel may be removed first by use of blocks against the top and bottom of the wheel rim. The wheel should be rotated so the stampings on the wheel rim are under the blocks, lessening the possibility of cracking the wheel. Break the wheel loose. Remove the blocks and apply pressure to the gear hub. Break the gear loose and remove the wheel and gear separately.

When inspection shows that a considerable reduction in one wheel diameter will be required to remedy a defect, it is economical to dismount just one wheel. If both wheels are turned to the required diameter, a considerable loss of service metal will be incurred by the other wheel.

If axle is equipped with a cylindrical roller bearing, all wheel work can be done without disturbing the bearing inner race if axle is not to be magnetic particle method inspected. Inner races or bearing journals should be protected against damage by applying sheet copper or brass sleeves over them while wheel work is in progress.

## WHEEL AND AXLE DEFECTS

Wheel and axle defects which require the removal of any particular wheel set are fully defined and illustrated in the "Wheel And Axle Manual" published by the Association of American Railroads, 59 E. Van Buren St., Chicago, Illinois 60605, U.S.A.

### NOTE

See AAR Wheel And Axle Manual for complete information, including use of gauges for checking wear and defects. The AAR gauge and the wheel defect gauge may be purchased from the Pratt & Whitney Company.

Some of the most common wheel defects are illustrated in Figs. 2 through 14.

Some of the most common axle defects are illustrated in Figs. 15 through 19.

## WHEELS

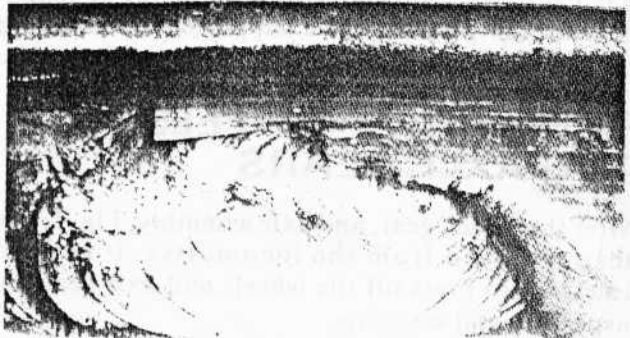
Three sizes of wheels are used on locomotives manufactured by Electro-Motive Division for export service. Nominal diameters of these wheels are 1016 mm (40"), 965 mm (38"), and 914 mm (36").

Various types of wheel tread profiles are used throughout the world, and it is beyond the scope of this publication to describe them.



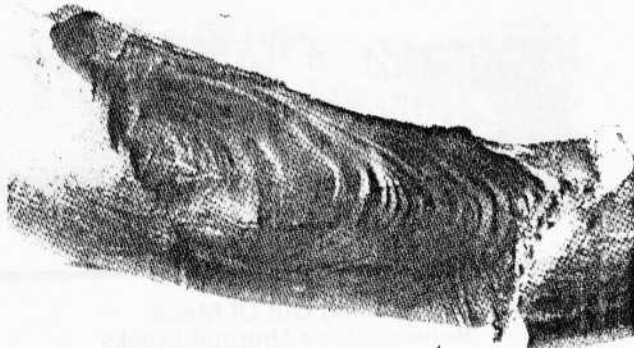
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Fig.2 - Burnt Rim



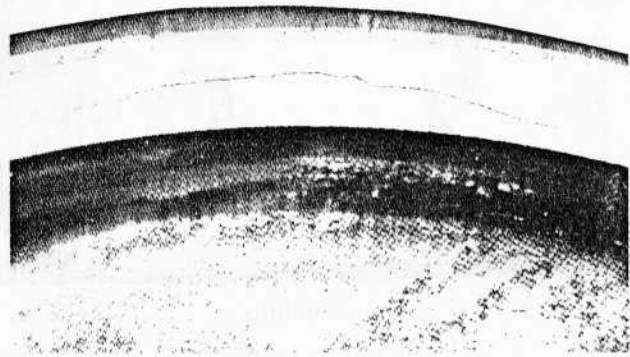
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Fig.3 - Shattered Rim



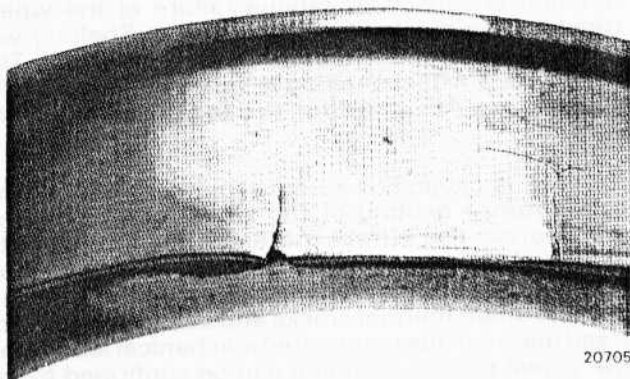
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Fig. 4 - Shattered Rim



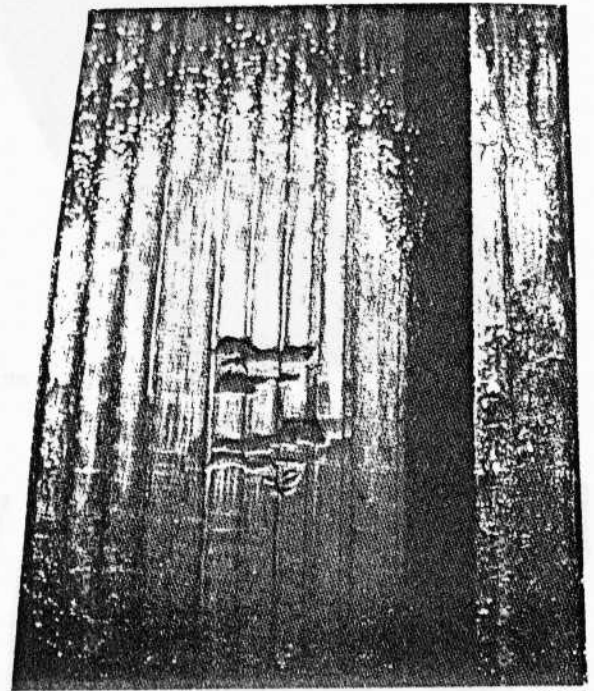
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Fig. 5 - Shattered Wheel Revealed By Crack



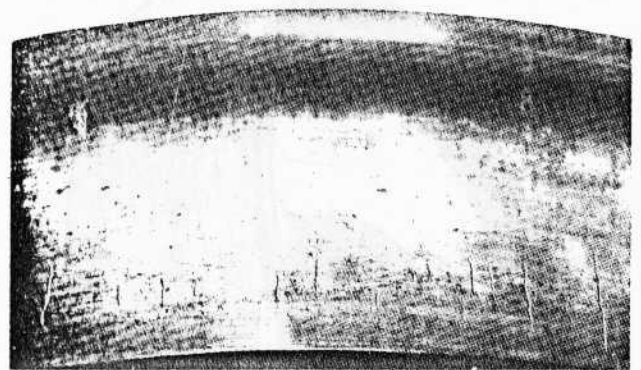
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Fig. 6 - Spread Rim



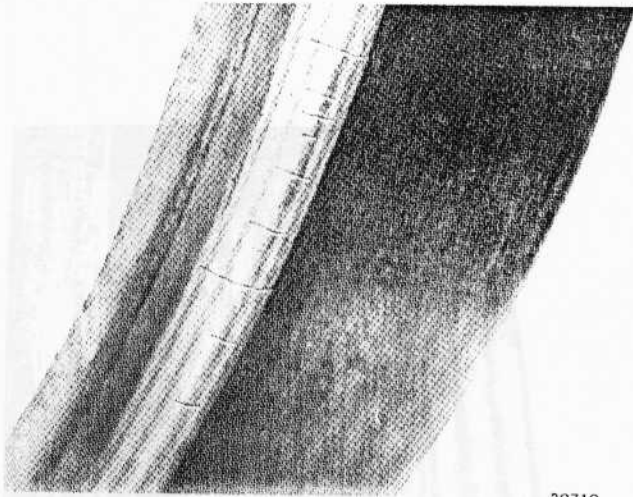
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Fig. 7 - Sub-Surface Defect, Found When Turning Wheel



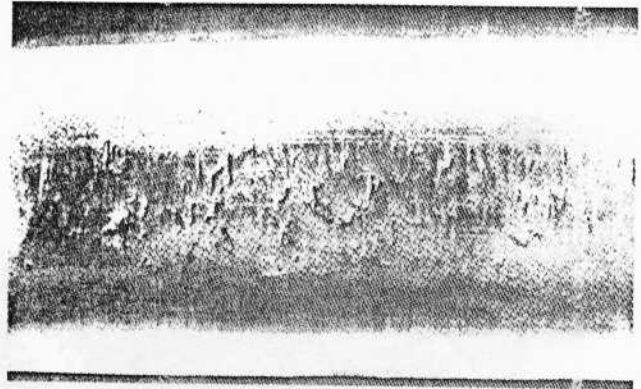
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Fig. 8 - Thermal Cracks

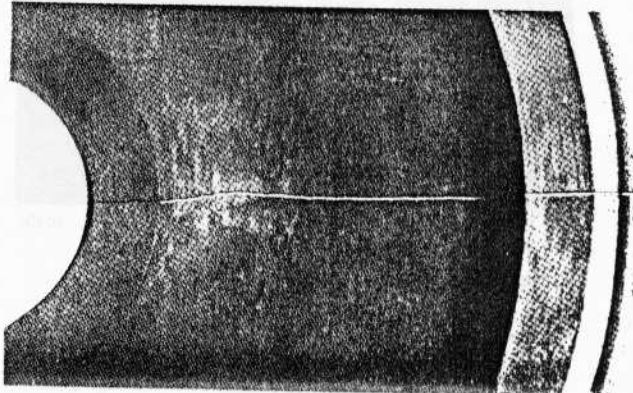


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Fig.9 - Thermal Cracks



Spalling Out Of Metal  
Between Fine Thermal Cracks



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Fig.10 - Thermal Cracks



Shelling

**NOTE**

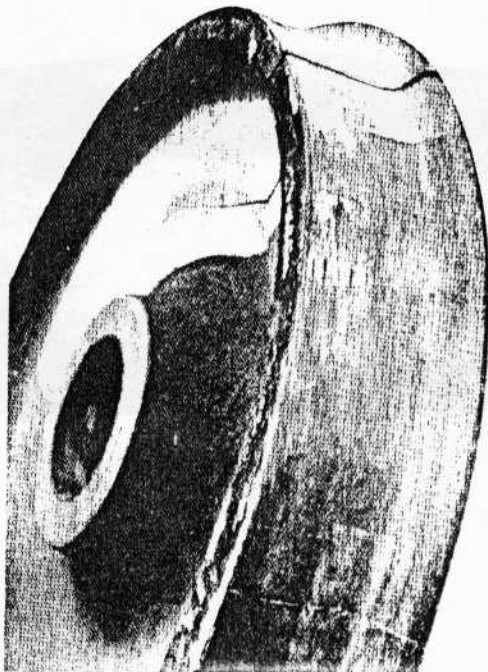
The term "shelling" is frequently misused by railroads and in most cases should be called "spalling."

Shelling is caused by fatigue failure of the wheel tread due to mechanical overloading. Shelling will not show as a positive sign in an etching test. The chance of a wheel shelling is very remote since the wheels are designed for the locomotive weight range.

Spalling is caused by wheel slipping or sliding and brief intense heating of the wheel tread. Spalling transforms the wheel material from pearlite to austenite. When the wheel is quenched against the rail, the wheel material becomes martensite which leads to small thermal cracks and subsequent loss of tread material due to repeated mechanical loading as the wheel rotates. Spalling can be confirmed by an etching test.

Spalling and mild shelling may look very similar, but the key distinction is the heat input involved in spalling.

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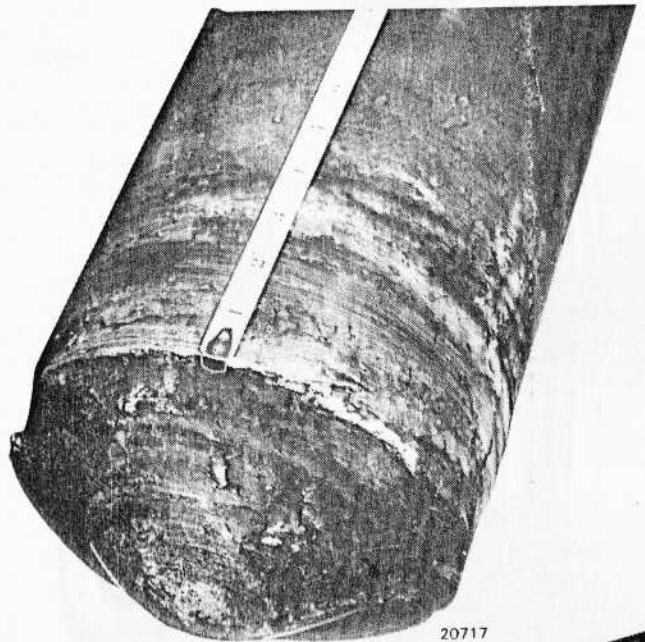
Fig.11 - Thermal Cracks

Fig.12 - Spalling And True Shelling

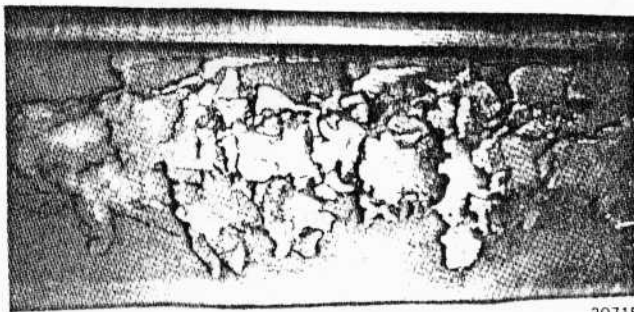


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Fig.13 - Built-Up Tread And Slid Flat

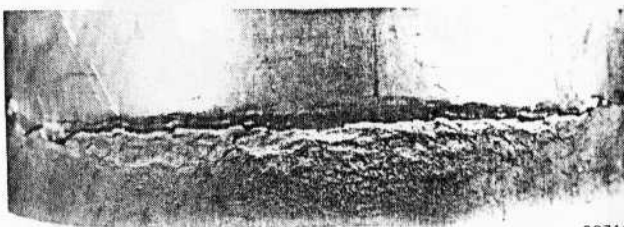


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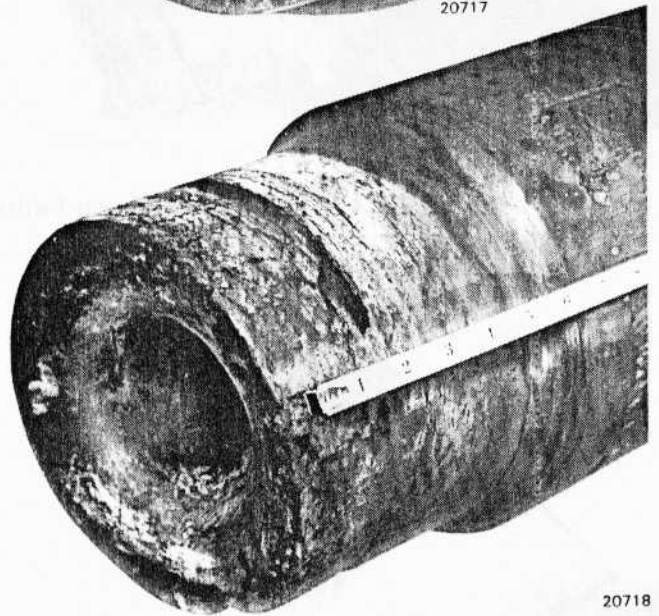
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Fig.14 - Built-Up Tread



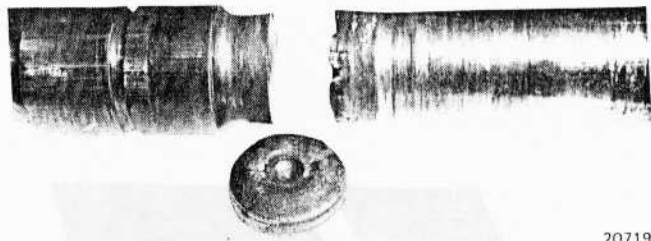
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Fig.15 - Corrosion Fatigue



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Fig.16 - Support Bearing Failure Due To Lack Of Lubrication



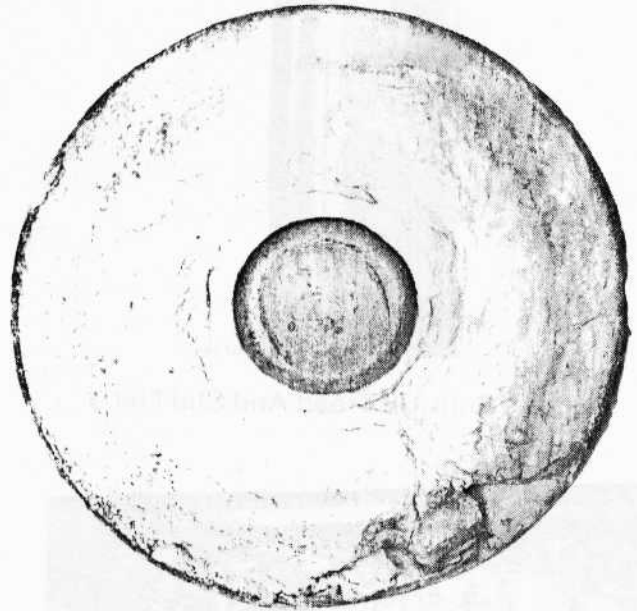
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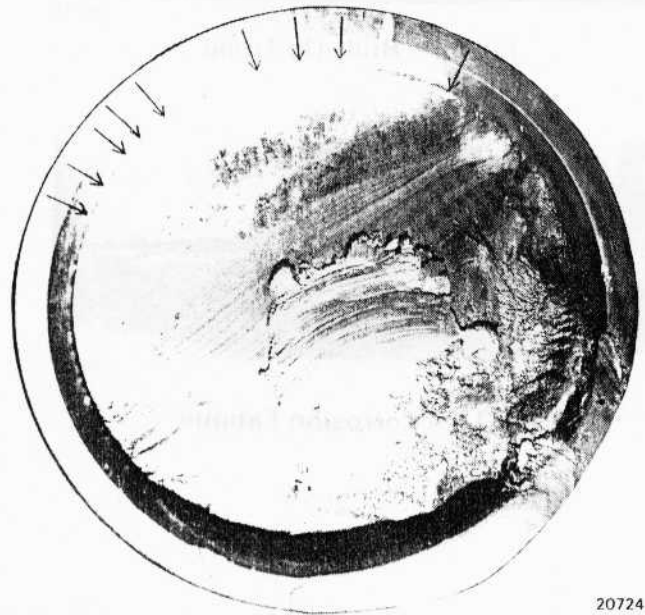


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Fig.17 - Support Bearing Failure Due To Lack Of Lubrication



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Fig.18 - Support Bearing Failure Resulting From Repeated Heat And Cooling Cycle - Lack Of Lubrication

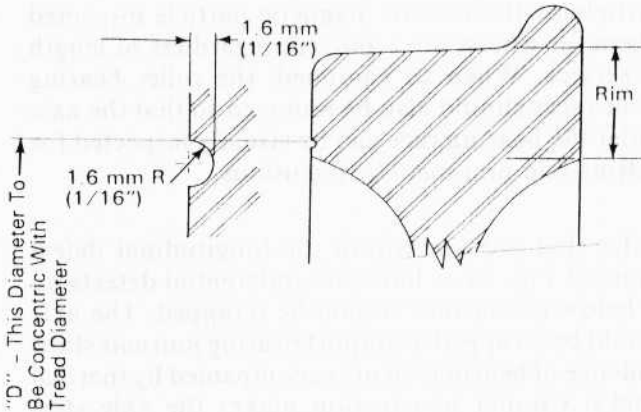
Fig.19 - Corrosion Fretting Between The Radius Of Journal Bearing Inner Race And Axle Journal

# WHEEL WEAR LIMITS

Wheel wear limits are given in the Service Data. When determining wheel size, any accurate conventional method may be used. However, EMD recommends the "diameter-radius index groove" method, where a groove of known diameter is machined into the outer rim of the wheel, Fig. 20, prior to wheel mounting.

**NOTE**

The index groove is machined in all new EMD wheels.



Wheel Diameter	"D"	Radius
914 mm (36")	813 mm (32")	406 mm (16")
965 mm (38")	864 mm (34")	432 mm (17")
1 016 mm (40")	914 mm (36")	457 mm (18")

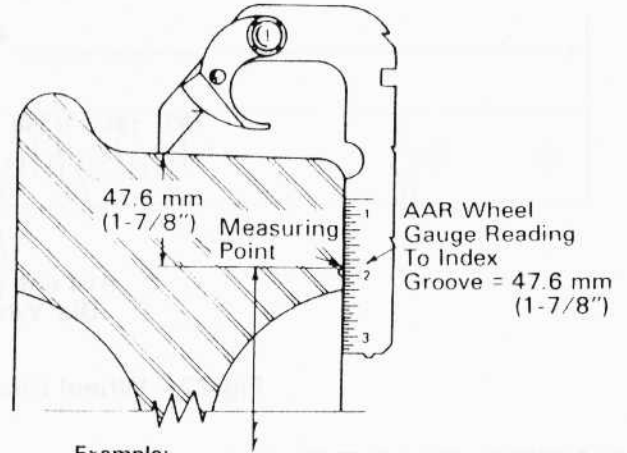
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Fig.20 - Index Groove To Determine Wheel Size

Wear on wheels with index grooves can easily be determined by measuring the radius of the groove and then using an AAR wheel gauge to measure to the index groove, Fig. 21. The gauge measurement is added to the index groove radius to obtain the wheel diameter. If wheels are worn beyond limits shown in the Service Data see "Compensating For Wheel Variations" near the end of this bulletin. The AAR gauge may be purchased from Pratt and Whitney Company.

**NOTE**

The only purpose of the diameter index groove is to provide a reference to easily measure the wheel diameter in order to simplify proper wheel matching. It should not be used for measuring rim thickness to determine wheel life. Accurate measurement and evaluation of the rim thickness can be accomplished only by measuring the rim thickness at the back face.



Example:

Measuring 1 016 mm (40") Diameter Wheel After Wear Has Occurred:  
 1 016 mm (40") Diameter Wheel  
 Index Groove "D" Diameter 914 mm (36") - Radius 457 mm (18")  
 AAR Wheel Gauge Reading To Index Groove = 47.6 mm (1-7/8")  
 Wheel Radius = 457 mm + 47.6 = 504.6 mm (18" + 1-7/8" = 19-7/8")  
 Wheel Diameter = 504.8 mm x 2 = 1009.7 mm (19-7/8" x 2 = 39-3/4")  
 Total Wear = 6.4 mm (1/4")

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Fig.21 - Wheel Measurement Method

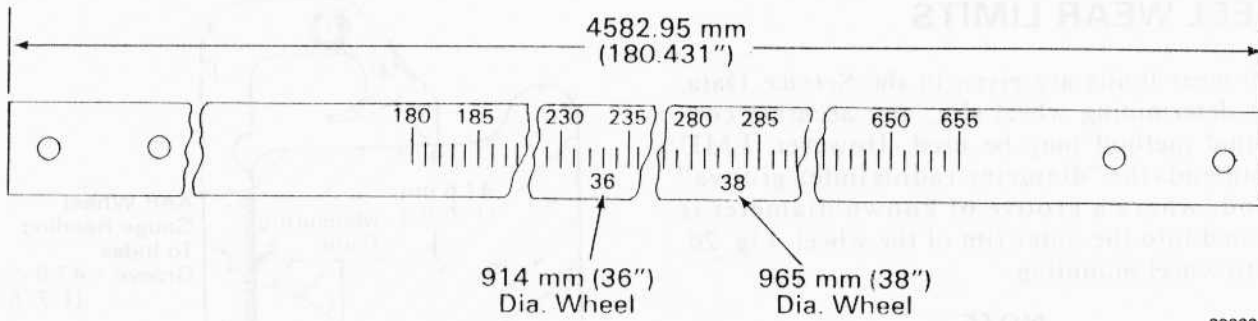
A wheel circumference gauge (tape), Fig. 22, can be used to match wheels. Each graduation between the stamped numbers on the gauge is referred to as "1 tape."

When applying new wheels to a truck, the following limits apply:

1. New wheels that are mounted on the same axle of locomotives in road service should be matched to the same wheel tape size within a maximum variation of 0.25 mm (.010") on the radius (1/2 tape).
2. On switcher locomotives equipped with rigid trucks, maximum variation for new wheels on the same axle is 0.51 mm (.020") on the radius (1 tape).
3. The maximum recommended new wheel variation between power axles in the same truck is 1.6 mm (1/16") on radius (3 tapes) and between axles in different trucks is 6.4 mm (1/4") on radius (14 tapes).

The micro-inch finish on the outside diameter of the hub on the flange side of the wheel and the micro-inch finish of the thrust face must not be more than 0.38 microns (15 micro-inches).

The wheel bore surface finish should be maintained at 5 microns ±2 (200 micro-inches ±75).

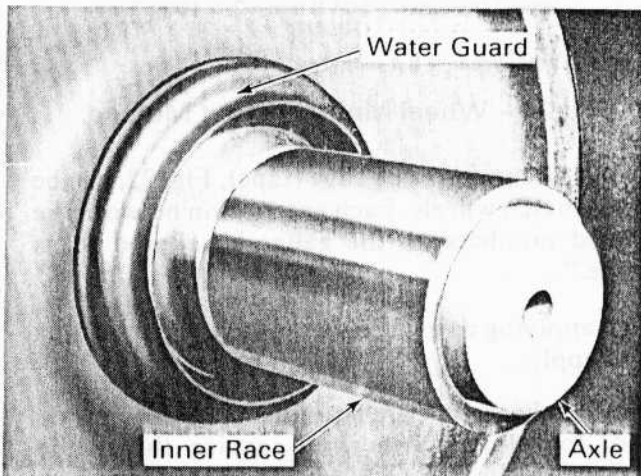


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Fig.22 – Wheel Circumference Gauge (Tape)

## WATER GUARD

Axles equipped with cylindrical roller journal bearings have a water guard, Fig. 23. The water guard remains in place for the life of the wheel. The water guard is removed from the wheel hub when the wheel is removed from the axle. The water guard may be reused.



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Fig.23 – Cylindrical Roller Bearing Water Guard And Inner Race

To remove the guard, heat sufficiently to release the shrink fit, then pry it off. To apply the guard, heat it uniformly to 176° C (350° F) and shrink in place on the wheel hub. Ensure water guard is pressed tightly against the wheel.

## AXLES

Some export locomotives are equipped with axles which have a rolled relief groove between the wheel and gear seats.

Because of possible dangers resulting from axle cracks, it is recommended that axles be magnetic

particle or fluorescent magnetic particle inspected whenever wheels are removed, regardless of length of service. When so equipped, the roller bearing inner races should also be removed so that the axle under the bearing race can be visually inspected for fretting and non-metallic inclusions.

Axles that are not within the longitudinal defect limits of Fig. 24 or have circumferential defects on or below the surface should be scrapped. The axle should be scrapped if support bearing journals show evidence of bearing seizure accompanied by thermal cracks. Copper penetration makes the axle steel very brittle and subject to breakage. A distressed axle should never be reused until inspected for copper penetration and approved for use by the proper railroad authorities.

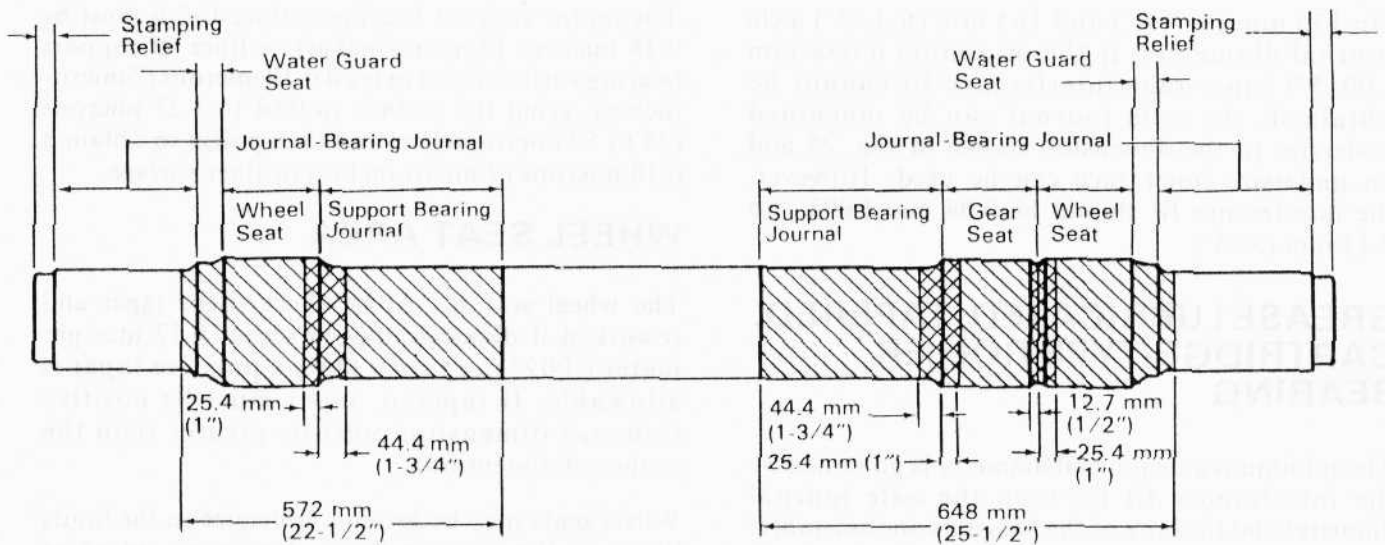
Axles should be checked for runout which should not exceed 0.13 mm (.005") total indicator reading with journal bearing indication at zero. If the axle has over 0.13 mm (.005") total runout, it should be reworked.

### NOTE




Only a positive taper is allowed on the axle journal bearing surface. The dimension at the inboard end of the journal must be greater than the dimension at the outboard end.

On locomotives equipped with cylindrical roller journal bearings, the axle journal bearing surface taper must not exceed 0.08 mm per meter (.001" per foot). Axle journal bearing surface out-of-round must not exceed 0.03 mm (.001"). Refer to Service Data for service dimensions of the roller bearing journals. The journal bearing surface finish should be maintained at a maximum of 1.25 microns (50 micro-inches).

Check traction motor support bearing journal taper. If taper exceeds 0.12 mm per meter (.0015" per foot), support bearing journal should be



## LONGITUDINAL DEFECT LIMITS

 6.35 mm (1/4") Max. Length	 12.7 mm (1/2") Max. Length	 19 mm (3/4") Max. Length
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Fig.24 – Longitudinal Axle Defect Limits

reworked. Support bearing surface finish should be maintained at a maximum of 0.18 microns (7 micro-inches).

Axles and axle gears may be used until worn to maximum wear limits, if magnetic particle method inspection reveals no defects.

If axles are not magnetic particle method inspected when wheels are removed, it is recommended that the axle be scrapped after two pairs of wheels have been worn to maximum wear limits.

To ensure accurate axle measurements, the micrometers used should be checked against a known standard. Axles and micrometers should be allowed to stabilize at room temperature before measuring.

All fillets and axle ends must be polished free of tool marks and each time wheels are turned, all burrs or other irregularities should be polished off the axle ends. If it is necessary to machine the axle ends, the same amount should be removed from each end to ensure that the axle is centered in the truck after assembly.

If the axle has a spline for a speed governor drive, the spline should be visually inspected and replaced if any of the teeth are found broken, chipped, or cracked or have rounded edges.

If a wheel set has been removed from the truck involved in a wreck, the journals of the axles should be fluorescent magnetic particle or magnetic particle inspected. If the axle is equipped with a journal bearing inner race, the inner race should be removed before inspection.

## AXLE JOURNALS

### OIL LUBRICATED, CYLINDRICAL ROLLER BEARING

The minimum axle journal diameter is governed by the interference fit between the axle journal and the bearing inner race. On new axles the interference fit is 0.08 mm (.003") minimum to 0.13 mm (.005") maximum. The service limit on interference fit is 0.038 mm (.0015").

The minimum interference fit of 0.038 mm (.0015") for any axle, is only permitted providing that:

1. Inner race does not show fretting in excess of 20% of total I.D. surface.
2. Axle journal surface does not show fretting in excess of 25.4 mm (1") wide or 10% of the total surface.

On 175 mm (6-7/8") and 165 mm (6-1/2") axle journal diameters, if the minimum 0.038 mm (.0015") inner race interference fit cannot be obtained, the axle journal can be machined undersize to the dimension shown in Fig. 25 and an undersize inner race can be used. However, the interference fit should be 0.08 mm (.003") to 0.13 mm (.005").

### GREASE LUBRICATED, TAPERED, CARTRIDGE-TYPE ROLLER BEARING

The minimum axle journal diameter is governed by the interference fit between the axle journal diameter and the bore of the bearing cone assembly.

The journal diameter of a new axle provides for an interference fit of 0.10 mm (.004") maximum to 0.05 mm (.002") minimum.

A minimum interference fit of 0.038 mm (.0015") is the service limit.

### MOTOR SUPPORT BEARING AREA

Generally, the maximum axle diameter reduction at the support bearings should not exceed 1.6 mm (1/16"), due to axle loading on some locomotives. However, for 2 axle trucks not subjected to speeds over 113 km/h (70 MPH) operation, undersize axles up to 3.2 (1/8") can be used. Support bearings are available at 2.4 mm (3/32") and 3.2 mm (1/8") undersize.

The motor support bearing surface finish must be 0.18 microns (7 micro-inches) or finer. If support bearing surface is not at least 0.18 microns (7 micro-inches), grind the surface to 0.64 to 1.27 microns (25 to 50 micro-inches) and then polish to obtain a 0.18 microns (7 micro-inches) or finer surface.

### WHEEL SEAT AREA

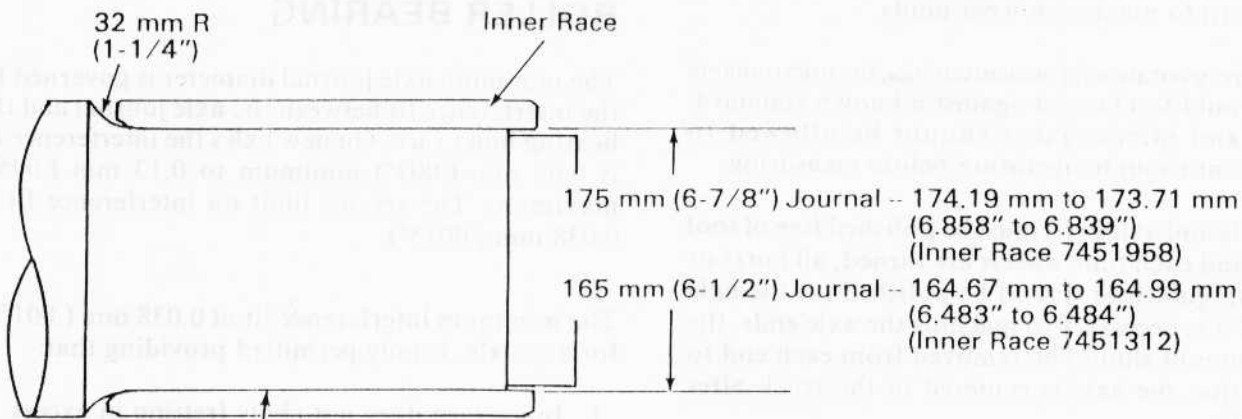
The wheel seat should be checked for taper and reworked if diameter taper exceeds 0.17 mm per meter (.002" per foot). Only a positive taper is allowable. If tapered, taper must be positive (inboard dimension must be greater than the outboard dimension).

Wheel seats may be ground undersize to the limits listed in the Service Data. However, on axles without rolled relief groove between the gear seat and wheel seat, the transition between the seats must be a smooth radius and the wheel seat length should be increased from 1.6 mm (1/16") minimum to 4.0 mm (5/32") maximum. The increased wheel seat length is to ensure that an undersize wheel bore does not contact the shoulder.

### INNER RACE REMOVAL, INSPECTION, AND APPLICATION

#### REMOVAL

An induction heater is recommended to remove and install the bearing inner race of an oil lubricated, cylindrical roller bearing. Refer to Service Data for induction heater part number.



Do not finish this surface with roller or burnisher. Axle out-of-round not to exceed 0.025 mm (.001"). Taper not to exceed 0.08 mm per metre (.001" per foot) on diameter. If tapered, taper must be positive (inboard dimension must be greater than the outboard dimension).

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Fig.25 - Axle Journal For Undersize Inner Race

If an induction heater is not available, the inner race may be pressed off the axle using a filler ring, outer ring, split ring, and pressure block as shown in Fig. 26. Refer to Service Data for tool part numbers.

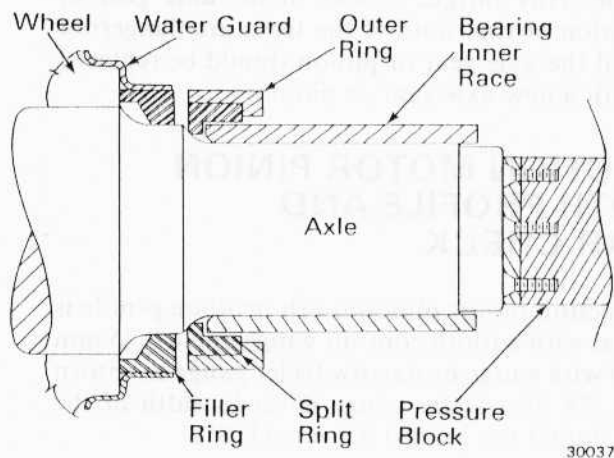


Fig.26 - Inner Race Removal

## INSPECTION

1. Inspect the inside diameter surface of the bearing inner race for fretting. If fretting is evident on more than 20% of the total surface, the race should be discarded. When applying a used inner race to a used axle, it is preferable to use a race with little or no signs of fretting.
2. Inspect for indenting, scoring, or pitting on the outside diameter surface. If any imperfections are found on the roller paths, reject the inner race.
3. Measure the inside diameter of the inner race with a micrometer.

For current 175 mm (6-7/8") axles, the inside diameter of the inner race should be a minimum of 174.600 mm (6.8740") and a maximum of 174.625 mm (6.8750"). The maximum out-of-round limit is 0.03 mm (.001").

For 165 mm (6-1/2") axles, the inside diameter of the inner race should be a minimum of 165.075 mm (6.4990") and a maximum of 165.100 mm (6.5000"). The maximum out-of-round limit is 0.03 mm (.001").

For 152 mm (6") axles, the inside diameter of the inner race should be a minimum of 152.37 mm (5.999") and a maximum of 152.40 mm (6"). The maximum out-of-round limit is 0.03 mm (.001").

For 140 mm (5-1/2") axles, the inside diameter of the inner race should be a minimum of 139.675 mm (5.499") and a maximum of 139.700 mm (5.500"). The maximum out-of-round limit is 0.03 mm (.001").

4. Inspect for hardness with a scleroscope or hardness tester similar to an Ernst tester. Measure the bearing inner race 75 mm to 100 mm (3" to 4") from each end of the race (the approximate center). If a hardness tester is used which leaves an indentation larger than a Rockwell 15 N impression, the indentation must be stoned flat with a smooth stone. Hardness should not be below 75 Shore or Rockwell "C" 56 hardness scale.

## APPLICATION

### CAUTION

Do not exceed 176° C (350° F) when heating the bearing inner race. Heating inner race beyond 176° C (350° F) will affect the hardness of the race.

The bearing inner race is applied by heating it in an electric oven or induction heater and shrinking it to the axle. If an oven or induction heater is not available, heat inner race in oil to a maximum of 149° C (300° F) and shrink to the axle. Wipe the oil from the inside of the race before it is reapplied. When heated, the race can be easily slid into place. Take care to properly position the race before it cools and seats on the axle. The use of insulated gloves is recommended for handling the hot race. A split collar, shown in Fig. 27, clamped around the journal will space the inner race the proper distance from the journal fillet. Refer to Service Data for inner race locating collar and induction heater part numbers. Due to slight variations in axle length, it is preferable to locate the race from the fillet rather than from the end of the axle. Under no conditions should the shrink fit encroach upon the journal fillet. See Fig. 27 for dimension of inner race to fillet.

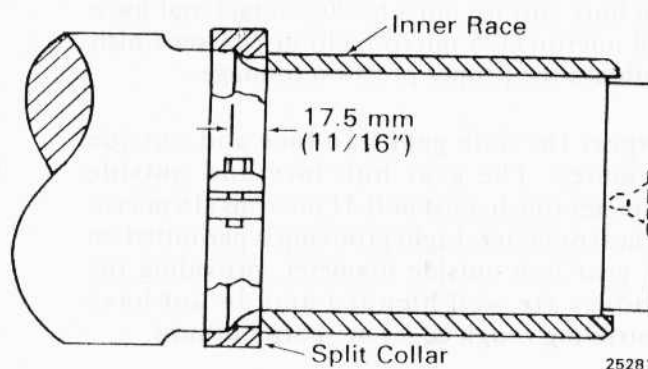


Fig.27 - Locating Inner Race

# AXLE GEARS AND TRACTION MOTOR PINIONS

## INSPECTION

Inspection and qualification of traction motor pinion and axle gear teeth for wear, and for tooth involute profile at time of motor or wheel change is essential, since operation with gearing worn beyond recommended limits is harmful to traction motors and related equipment.

New highly accurate gauges have been developed to assist in inspection and qualification. The new gear tooth gauges are manufactured by a process that results in gauges having a much higher degree of accuracy in the critical areas. For example, formerly there was a single gauge used for 60, 61, and 62 tooth axle gears. Now, with the new method of manufacture, three are required. The differences between the theoretical tooth contours of these three gears are sufficient to require individual gauges for each gear.

1. After the axle gear has been removed, examine the inner face of the gear hub and polish off any marks that may have been made while removing gear.
2. Visually inspect for broken, chipped, spalled, shelled, or pitted teeth. Traction motor pinion and axle gears should be rejected when more than 20% of the total working surface of the tooth is spalled or pitted, or there is evidence of shelling. Slight pitting or scratches are permitted on the entire working surface.
3. Remove all burrs from the edges of the teeth where the tooth wear surface and the tip of each tooth meet. All burrs must be removed before checking tooth involute profile.
4. Inspect the bore in the axle gear for scoring. The bore surface must be 90% intact and have 3.18 micron (125 micro-inch) or coarser finish to obtain the proper press-on tonnage.
5. Inspect the axle gear hub face and outside diameter. The gear hub face and outside diameter finish must be 0.41 microns (16 micro-inches) or better. Light grooving is permitted on the gear hub outside diameter, providing the grooves are well blended and do not have protruding rough edges or sharp bottoms.
6. Inspect for cracks using magnetic particle or fluorescent particle inspection.

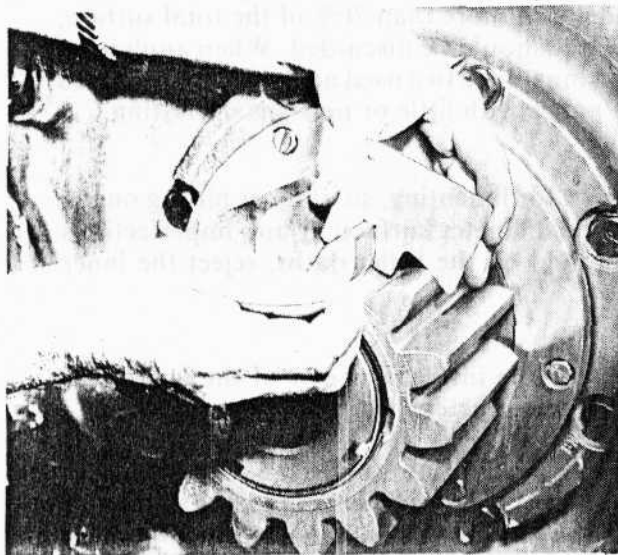
Fatigue cracks on axle gears and traction motor pinions usually start in the fillet at the root of the teeth on the motor side, approximately 13 mm (1/2") from the end, and progress to the side. Any fatigue cracks in the axle gear or pinion at the roots of the teeth are dangerous and the axle gear or pinion should be replaced with a new axle gear or pinion.

## TRACTION MOTOR PINION TOOTH PROFILE AND WEAR CHECK

The traction motor pinion tooth involute profile is checked with a tooth contour gauge and a 0.25 mm (.010") wire gauge or narrow feeler gauge as shown in Fig. 28. If a feeler gauge is used, width of the gauge should not exceed 3.2 mm (1/8").

### NOTE

A new series of highly accurate traction motor pinion tooth contour gauges is available from EMD. Refer to Service Data for traction motor pinion tooth contour gauge part numbers.



12650

Fig.28 - Traction Motor Pinion Tooth Contour Gauge

1. Place the tooth contour gauge against one flank of the traction motor pinion tooth as shown in Fig. 29. The gauge will normally contact tooth flank near the pitch diameter, which is the area of least wear. At this flank, measure the maximum amount of deviation from tooth profile. If the deviation exceeds 0.25 mm (.010") of original contour, replace pinion with a new pinion.

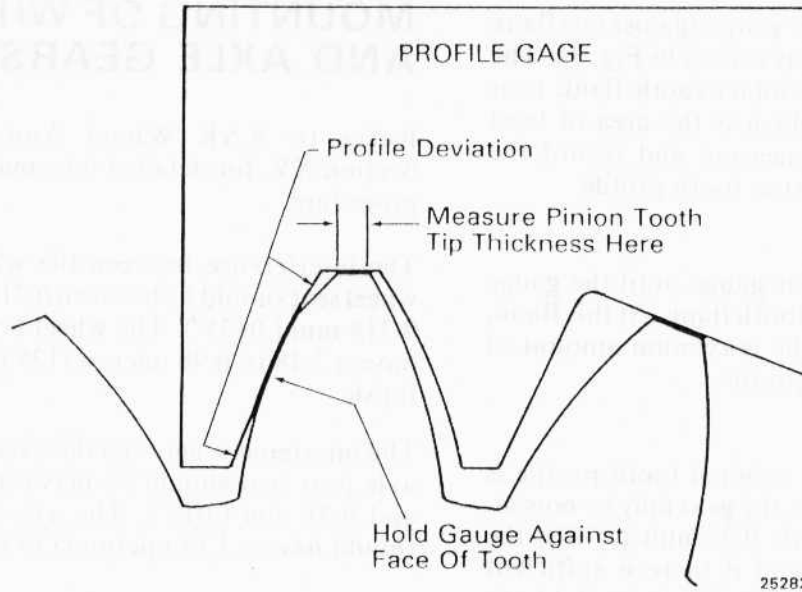


Fig.29 – Measuring Profile Deviation And Wear Of Traction Motor Pinion

2. Shift the tooth contour gauge until the gauge contacts the opposite tooth flank. At this flank, measure the maximum amount of deviation from tooth profile. If the deviation exceeds 0.25 mm (.010") of original contour, replace pinion with a new pinion.
3. If the deviation from tooth profile is within 0.25 mm (.010") of original contour –
  - a. Reuse pinion if tooth tip thickness is greater than the following minimum values.

No. Of Teeth	Min. Tip Thickness
12 – 13 – 14	0.8 mm (1/32")
15 – 16 – 17 – 18	3.2 mm (1/8")
19 (9332202)	4.0 mm (5/32")
19 (all others)	3.2 mm (1/8")
20 – 21 – 22	4.0 mm (5/32")
25	4.8 mm (3/16")

**NOTE**

Traction motor pinions cannot be reground economically; those not meeting requirements should be scrapped.

- b. Replace pinion with a new pinion if tooth tip thickness is less than the minimum value.

**AXLE GEAR TOOTH PROFILE AND WEAR CHECK**

The axle gear tooth involute profile is checked with a tooth contour gauge and a 0.25 mm (.010") wire

gauge or narrow feeler gauge as shown in Fig. 30. If a feeler gauge is used, width of the gauge should not exceed 3.2 mm (1/8").

**NOTE**

A new series of highly accurate axle gear tooth contour gauges is available from EMD. Refer to Service Data for axle gear tooth contour gauge part numbers.

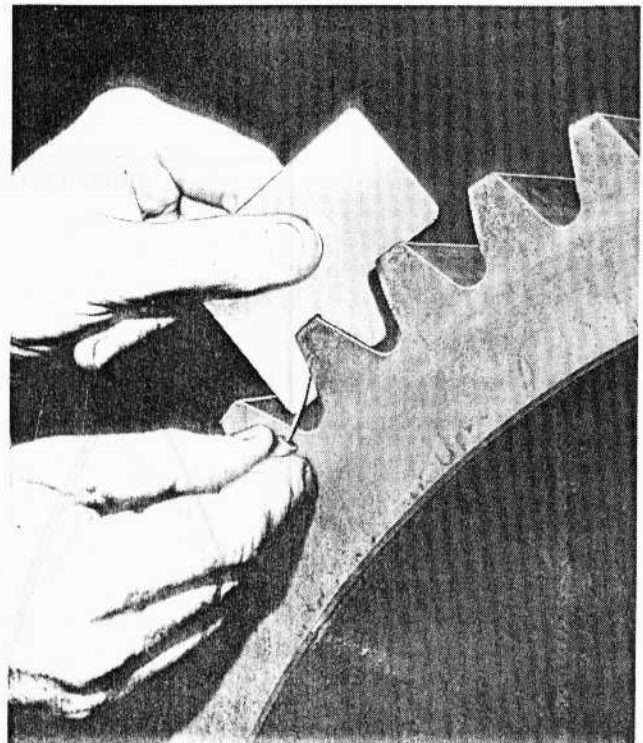


Fig.30 – Axle Gear Tooth Contour Gauge

1. Place the tooth contour gauge against one flank of the axle gear tooth as shown in Fig. 31. The gauge will normally contact tooth flank near the pitch diameter, which is the area of least wear. At this flank, measure and record the amount of deviation from tooth profile.
2. Shift the tooth contour gauge until the gauge contacts the opposite tooth flank. At this flank, measure and record the maximum amount of deviation from tooth profile.
3. When deviation from original tooth profile is 0.25 mm (.010") or less, the gear may be reused. If profile error exceeds 0.25 mm (.010"), the gear should be reground if there is sufficient stock. A wear gauge, Fig. 32, is available to determine if the gear can be reground. Refer to Service Data for axle gear wear gauge part number.
4. Place wear gauge on the axle gear tooth as shown in Fig. 32. Press firmly and slide gauge along gear tooth until the tapered jaws contact the sides of the tooth. If the gauge comes to a stop in the area of the gauge marked "Stock Regrind," there should be sufficient stock for reprofiling the gear teeth. If the gauge moves beyond the scribed line into the area of the gauge marked "Tooth Scrap," there is insufficient stock for reprofiling the gear teeth and the gear should be scrapped.

## MOUNTING OF WHEELS AND AXLE GEARS ON AXLE

Refer to AAR Wheel And Axle Manual, Section XV, for detailed information on mounting procedure.

The interference between the wheel bore and the wheel seat should be between 0.216 mm (.0085") and 0.318 mm (.0125"). The wheel bore surface should have a 3.18 to 6.98 micron (125 to 275 micro-inch) finish.

The interference between the axle gear bore and the axle gear seat should be between 0.25 mm (.010") and 0.31 mm (.012"). The axle gear bore surface should have a 3.18 micron (125 micro-inch) finish.

New wheel bore diameter should be 234.200 mm + 0.00 mm - 0.05 mm (9.2205" + .000" - .002") and should be held square with the back face of the wheel rim within 0.50 mm per meter (.006" per foot). Taper on the wheel bore should be held to a minimum and limited to a forward taper of 0.038 mm (.0015") or a reverse taper of 0.008 mm (.0003") as measured 12.7 mm (1/2") from the edge of the hub.

For a standard AAR profile, the wheel hub offset from the back rim face should be held to 42.85 mm + .00 mm - 0.51 mm (1.687" + .000" - .020").

Refer to Service Data for mounting dimensions and assemble wheel set as follows:

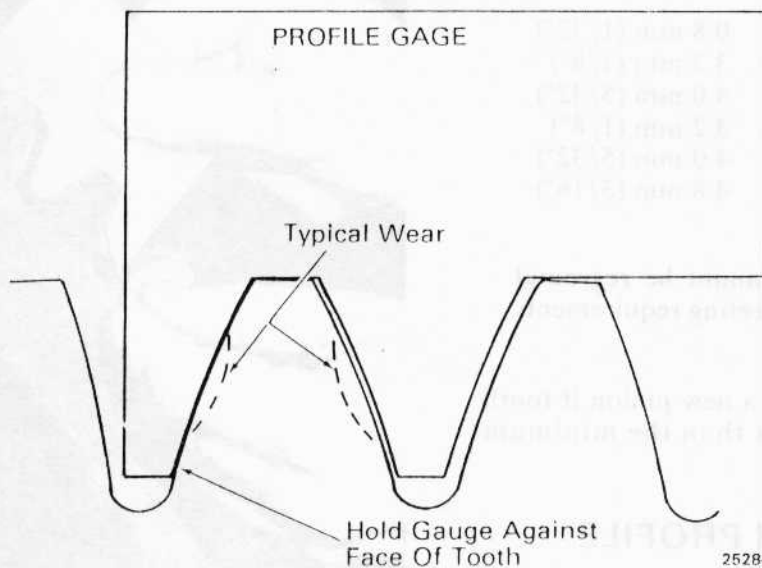


Fig.31 - Measuring Profile Deviation And Wear Of Axle Gear

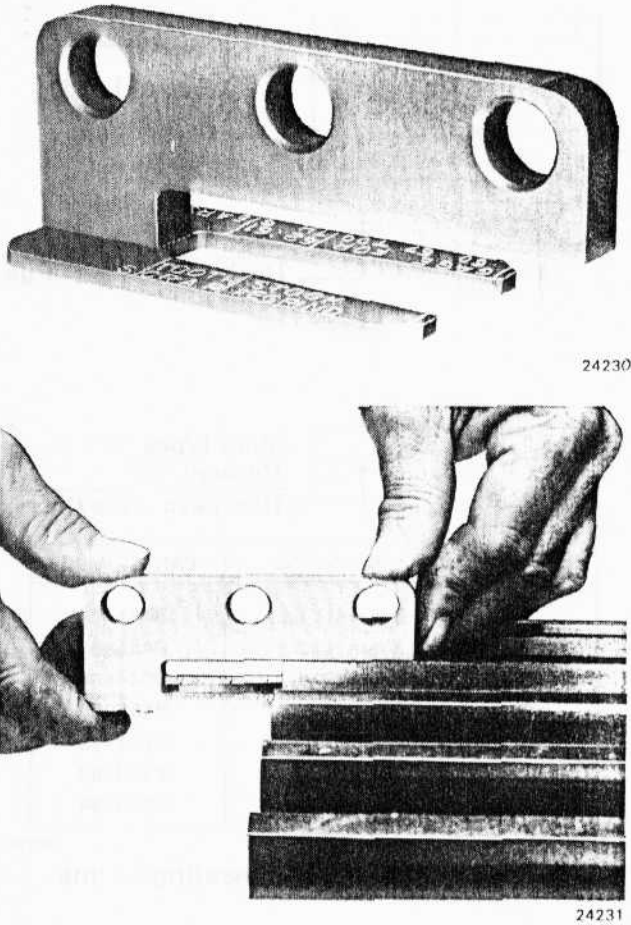


Fig.32 – Axle Gear Wear Gauge

1. To locate the center of the axle, mark the axle with chalk, and measuring from the ends of the axle, scribe the chalk with a blunt instrument. The center of the axle will be half the distance between the two marks. The metal of the axle must not be permanently marked in any way such as prick punching or scribing with a sharp instrument.

**NOTE**

Wheel mounting compound may be used as a lubricant when mounting wheels and axle gears.

2. Press axle gear onto the axle with a pressure of between 50 and 114 tonnes (55 and 125 tons). When reused axles or gears are assembled, the mating surface must not be scored.
3. Press on the wheel opposite the gear end.
4. Press on the wheel next to the gear. For new or used wheels on a new axle with the wheel seat reground the pressure required should be 86 to 132 tonnes (95 to 145 tons).

A permanent Record Of Pressure Graph should be made for every mounting operation. The pressure rise indicated on the graph should be gradual as shown in Fig. 33. The four graphs illustrate pressure curves ranging from ideal to acceptable.

All current axle gears have a boss on the spider, just above the axle bore. The boss protrudes 3 mm (1/8") beyond the face of the axle gear hub which maintains a 3 mm (1/8") clearance between the axle gear and the wheel hub when the wheel is pressed solid against the boss. On axle gears which do not have this boss, it is necessary that 3 mm (1/8") clearance is maintained.

Wheels on idler axles are mounted according to standard wheel practice.

**COMPENSATING FOR WHEEL SIZE VARIATIONS**

In order to maintain safe operation, optimum adhesion and tractive effort levels, it is important to maintain reasonably equal loading between axles.

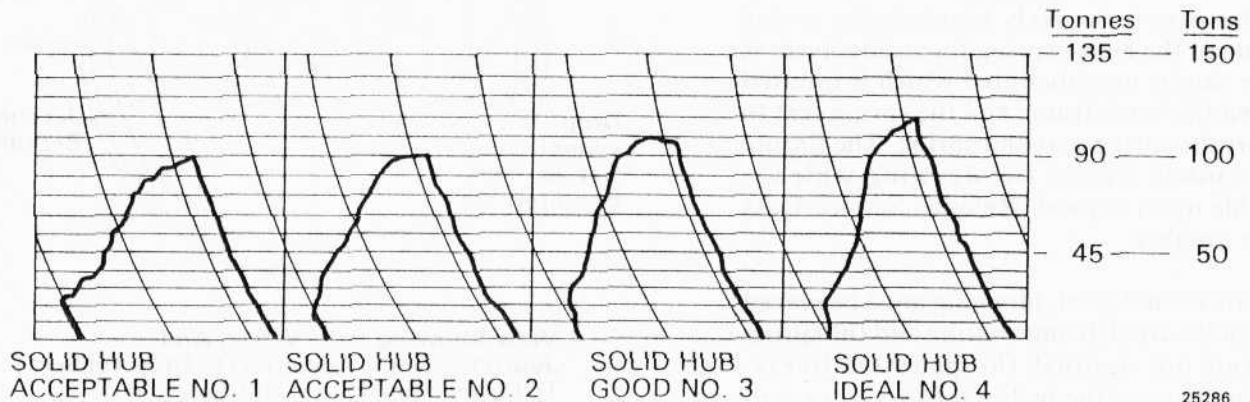


Fig.33 – Typical Wheel Mounting Pressure Graph

Load equalization can be accomplished by shimming between the journal spring seat and the journal bearing to compensate for wheel size difference.

**NOTE**

Correct and properly qualified springs must be used or the entire shimming procedure is useless.

In order to determine the proper amount of shimming it will be necessary to measure all of the wheels on the truck. The average radius for each pair should be used. The radial difference between the largest pair of wheels and each other pair will indicate the amount of shimming required at each axle. An equal amount of shimming must be applied to both journal bearings on the same axle. There should be no shims added to the largest pair when shimming only to compensate for wheel size mismatch.

**NOTE**

If additional shimming is desirable for coupler, footboard and/or pilot height, an equal thickness of shims, should be added to all journal bearings.

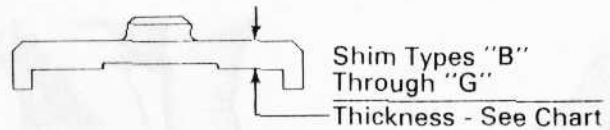
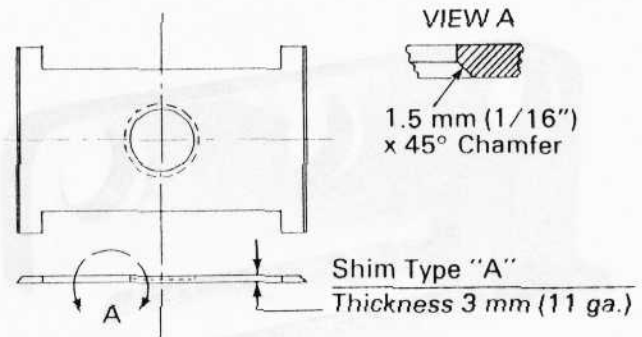
**APPLICATION OF SHIMS**

The shims shown in Fig. 34 are designed for application between the journal bearing and the journal spring seat. In order to apply the required shims at each journal bearing location, each axle requiring shimming should be moved over a single axle drop table. Suitable one piece U-shaped steel bars should be placed between the truck frame pedestals and the spring seat as shown in Fig. 35. After removing the pedestal tie bars, the assembly can be lowered sufficiently to disengage each journal seat and permit the proper shim to be applied to the top of the journal bearing.

**WARNING**

Exercise care in securely blocking the spring seat due to the heavy spring forces involved. A fixture can be manufactured which is inserted between the truck frame and the spring seat to support the spring seat and spring. The fixture can be made from a file drawing which is available upon request. Refer to Service Data for file number.

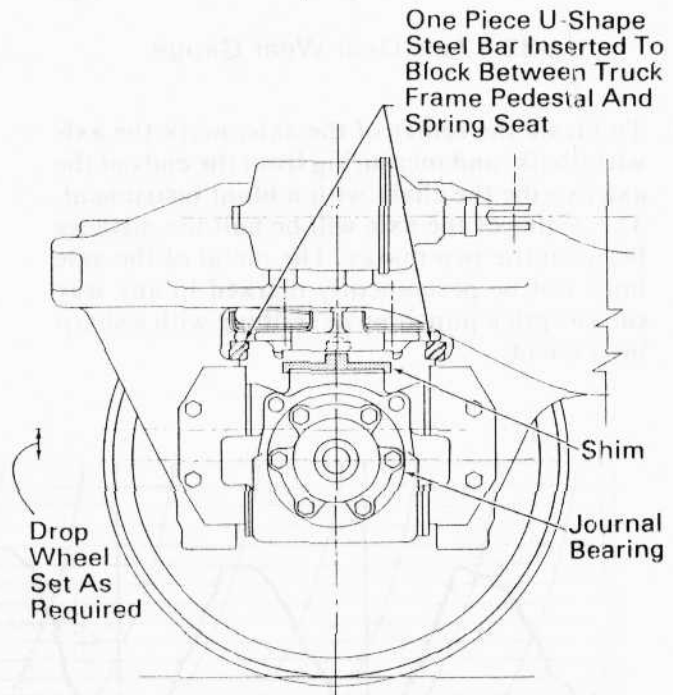
If a fixture is not used, blocking must be placed between the truck frame casting and the spring seat and not against the pedestal liners. Blocking against the pedestal liners can result in cracking the liners as well as "cold flowing" of the Nylatron.



SHIM TYPE	THICKNESS	PART NUMBER
A	3 mm (11 ga.)	8455980
B	13 mm (1/2")	8455981
C	19 mm (3/4")	8044686
D	25 mm (1")	8455982
E	32 mm (1-1/4")	8112192
F	38 mm (1-1/2")	8455983
G	44 mm (1-3/4")	8223384

30038

Fig.34 - Wheel Size Compensating Shims



View Showing Axle, Wheel And Journal Bearing Lowered On Drop Table To Permit Application Of Shim

30039

Fig.35 - Application Of Shims

Ensure journal bearings on the same axle are shimmed equally.

After the shims are in place, the drop table is then raised to engage the journal bearing, shim and spring seat. The bars used to block the spring seat can then be removed.

Referring to Fig. 34, shim type "A" is designed to fit either directly on top of the journal bearing or on

top of shim types "B" through "G." However, the number of shims type "A" applied directly on top of the journal bearing should be limited to a maximum of two and the number applied on top of shims "B" through "G" should be limited to one.

Shims "B" through "G" are designed to fit directly on top of the journal bearing and cannot be stacked. Ensure any "A" type shims that may have been previously applied on top of the journal bearing are removed before applying shims "B" through "G."

## SERVICE DATA

### REFERENCE

Cylindrical Roller, Oil Lubricated Journal Bearings	.....	M.I. 1552
Grease Lubricated, Cartridge-Type Journal Bearings	.....	M.I. 1553

### SPECIFICATIONS

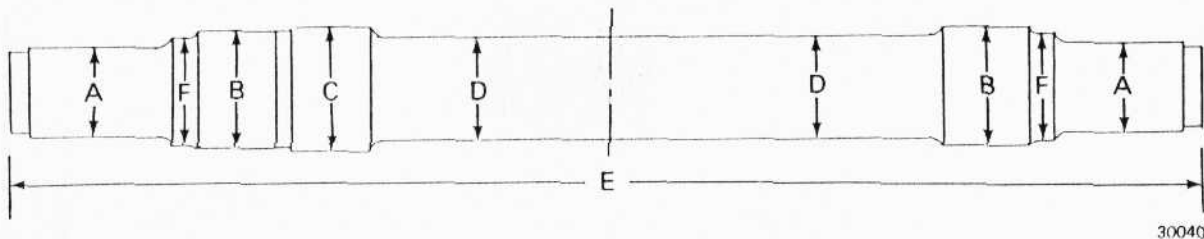
#### RECOMMENDED WHEEL SIZE LIMITS (Tapes)

	<u>NEW</u>	<u>MAX. VARIATION</u>
Wheels on same axle		
All flexible trucks	1/2	2
Rigid switcher trucks	1	2
Wheels on same truck		
All two axle trucks	3	20 (9.5 mm [3/8"] radius)
All three axle trucks	3	14 (6.4 mm [1/4"] radius)
Wheels on same locomotive		
All trucks	14	32 (15.9 mm [5/8"] radius)

#### WHEEL HARDNESS LIMITS

CLASS	RANGE (BRINELL)
A	255-321
B	277-341
C	321-363

### REBUILD AXLE LIMITS



**REBUILD AXLE LIMITS DIMENSION A**

Journal Bearing	CYLINDRICAL ROLLER BEARINGS							
	140 mm x 254 mm (5-1/2" x 10")		152 mm x 279 mm (6" x 11")		165 mm x 305 mm (6-1/2" x 12")		175 mm x 305 mm (6-7/8" x 12")	
	mm	Inches	mm	Inches	mm	Inches	mm	Inches
New	139.80	5.504	152.48	6.003	165.20	6.504	174.73	6.879
	139.78	5.503	152.45	6.002	165.18	6.503	174.70	6.878
Max.	139.80	5.504	152.48	6.003	165.20	6.504	174.73	6.879
Min.	139.738	5.5015	152.413	6.0005	165.138	6.5015	174.663	6.8765
*Max. Taper/Ft.	0.03	0.001	0.03	0.001	0.03	0.001	0.03	0.001
Max. Out-Of-Round	0.03	0.001	0.03	0.001	0.03	0.001	0.03	0.001

\*Positive taper only. Inboard dimension must be greater than outboard dimension.

**REBUILD AXLE LIMITS DIMENSION A**

Journal Bearing	TAPERED ROLLER BEARINGS							
	152 mm x 279 mm (6" x 11")		165 mm x 305 mm (6-1/2" x 12")		175 mm (6-7/8")		178 mm x 305 mm (7" x 12")	
	mm	Inches	mm	Inches	mm	Inches	mm	Inches
New	144.564	5.6915	157.264	6.1915	174.73	6.879	177.90	7.004
	144.539	5.6905	157.239	6.1905	174.70	6.878	177.88	7.003
Max.	144.564	5.6915	157.264	6.1915	174.73	6.879	177.90	7.004
Min.	144.539	5.6905	157.239	6.1905	174.70	6.878	177.88	7.003
*Max. Taper/Ft.	0.03	0.001	0.03	0.001	0.03	0.001	0.03	0.001
Max. Out-Of-Round	0.03	0.001	0.03	0.001	0.03	0.001	0.03	0.001

\*Positive taper only. Inboard dimension must be greater than outboard dimension.

REBUILD AXLE LIMITS DIMENSION B								
Journal Bearing	CYLINDRICAL ROLLER BEARINGS							
	Idler 140 mm x 254 mm (5-1/2" x 10")		Driver 140 mm x 254 mm (5-1/2" x 10")		Driver 152 mm x 279 mm (6" x 11")		Driver 165 mm x 305 mm (6-1/2" x 12")	
	mm	Inches	mm	Inches	mm	Inches	mm	Inches
New	192.13	§7.564	234.47	9.231	234.47	9.231	234.47	9.231
	192.08	§7.562	234.42	9.229	234.42	9.229	234.42	9.229
Max.	192.13	7.564	234.47	9.231	234.47	9.231	234.47	9.231
Min.	189.91	7.477	231.78	9.125	231.78	9.125	231.78	9.125
*Max. Taper/Ft.	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002
Max. Out-Of-Round	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002

§Narrow gauge idler axles with wheels less than 1016 mm (40") may have 192.10 mm (7.563") wheel seat diameter, otherwise same diameter as driver axle.

\*Positive taper only. Inboard dimension must be greater than outboard dimension.

REBUILD AXLE LIMITS DIMENSION B										
Journal Bearing	TAPERED ROLLER BEARINGS									
	Idler and Driver 152 mm x 279 mm (6" x 11")		Idler 165 mm x 305 mm (6-1/2" x 12")		Driver 165 mm x 305 mm (6-1/2" x 12")		Driver 175 mm (6-7/8")		Driver 178 mm x 305 mm (7" x 12")	
	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches
New	196.62	7.741	192.13	7.564	234.47	9.231	234.47	9.231	234.47	9.231
	196.57	7.739	192.08	7.562	234.42	9.229	234.42	9.229	234.42	9.229
Max.	196.62	7.741	192.13	7.564	234.47	9.231	234.47	9.231	234.47	9.231
Min.	194.36	7.652	189.92	7.477	231.78	9.125	231.78	9.125	231.78	9.125
*Max. Taper/Ft.	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002
Max. Out-Of-Round	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002

\*Positive taper only. Inboard dimension must be greater than outboard dimension.

REBUILD AXLE LIMITS DIMENSION C						
Journal Bearing	CYLINDRICAL ROLLER BEARINGS					
	140 mm x 254 mm (5-1/2" x 10")		152 mm x 279 mm (6" x 11")		165 mm x 305 mm (6-1/2" x 12")	
	<u>mm</u>	<u>Inches</u>	<u>mm</u>	<u>Inches</u>	<u>mm</u>	<u>Inches</u>
New	234.98	9.251	234.98	9.251	234.98	9.251
	234.95	9.250	234.95	9.250	234.95	9.250
Max.	234.98	9.251	234.98	9.251	234.98	9.251
Min.	234.95	9.250	234.95	9.250	234.95	9.250
*Max. Taper/Ft.	0.05	0.002	0.05	0.002	0.05	0.002
Max. Out-Of-Round	0.05	0.002	0.05	0.002	0.05	0.002

\*Positive taper only. Inboard dimension must be greater than outboard dimension.

REBUILD AXLE LIMITS DIMENSION C								
Journal Bearing	TAPERED ROLLER BEARINGS							
	152 mm x 279 mm (6" x 11")		165 mm x 305 mm (6-1/2" x 12")		175 mm (6-7/8")		178 mm x 305 mm (7" x 12")	
	<u>mm</u>	<u>Inches</u>	<u>mm</u>	<u>Inches</u>	<u>mm</u>	<u>Inches</u>	<u>mm</u>	<u>Inches</u>
New	197.13	7.761	234.98	9.251	234.98	9.251	234.98	9.251
	197.10	7.760	234.95	9.250	234.95	9.250	234.95	9.250
Max.	197.13	7.761	234.98	9.251	234.98	9.251	234.98	9.251
Min.	197.10	7.760	234.95	9.250	234.95	9.250	234.95	9.250
*Max. Taper/Ft.	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002
Max. Out-Of-Round	0.05	0.002	0.05	0.002	0.05	0.002	0.05	0.002

\*Positive taper only. Inboard dimension must be greater than outboard dimension.

REBUILD AXLE LIMITS DIMENSION D				
Traction Motor Type	Nominal Dimension		Undersize Dimension	
	<u>mm</u>	<u>Inches</u>	<u>mm</u>	<u>Inches</u>
D29CC	165.1	6.5"	0.79	1/32"
			1.59	1/16"
D29CC7	177.8	7.0"	---	---
D29, D31, D43	203.2	8.0"	0.79	1/32"
			1.59	1/16"
D77, D87	203.2	8.0"	0.79	1/32"
			1.59	1/16"
			2.38	3/32"
			3.18	1/8"
			0.79	1/32"
	209.55	8.25"	1.59	1/16"
			2.38	3/32"
			3.18	1/8"
			0.79	1/32"

**NOTE**

Minimum obtainable dimensions are dependent upon weight of the locomotive.

REBUILD AXLE LIMITS DIMENSION E				
AXLE LENGTH RANGES (Regardless Of Bearing)				
Gauge	Drivers		Idlers	
	Meters	Standard	Metres	Standard
Meter	1.854 m through 1.899 m	6' 1" through 6' 2-3/4"	1.854 m through 1.953 m	6' 1" through 6' 4-7/8"
1.067 m (3' 6")	1.854 m through 1.953 m	6' 1" through 6' 4-7/8"	1.854 m through 1.953 m	6' 1" through 6' 4-7/8"
Std.	2.197 m through 2.311 m	7' 2-1/2" through 7' 7"	2.188 m through 2.248 m	7' 2-1/8" through 7' 4-1/2"
Wide	2.438 m through 2.489 m	8' 0" through 8' 2"	2.464 m through 2.537 m	8' 1" through 8' 3-7/8"

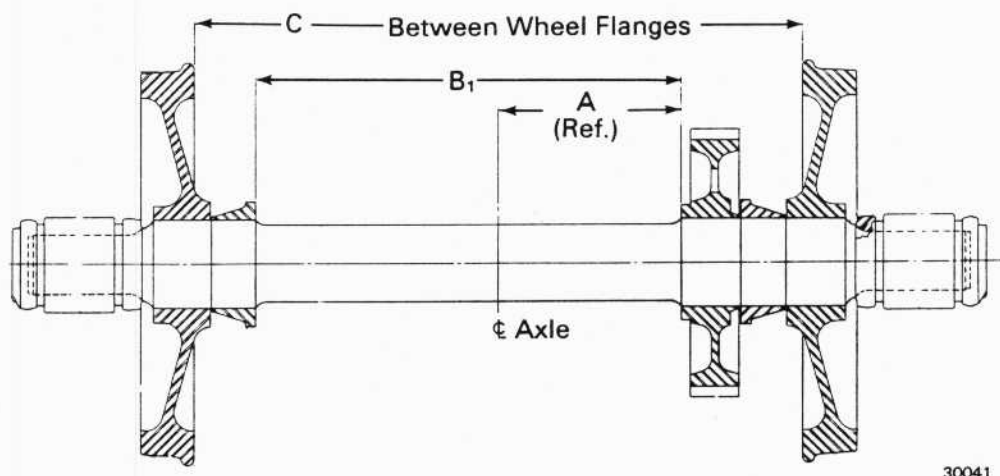
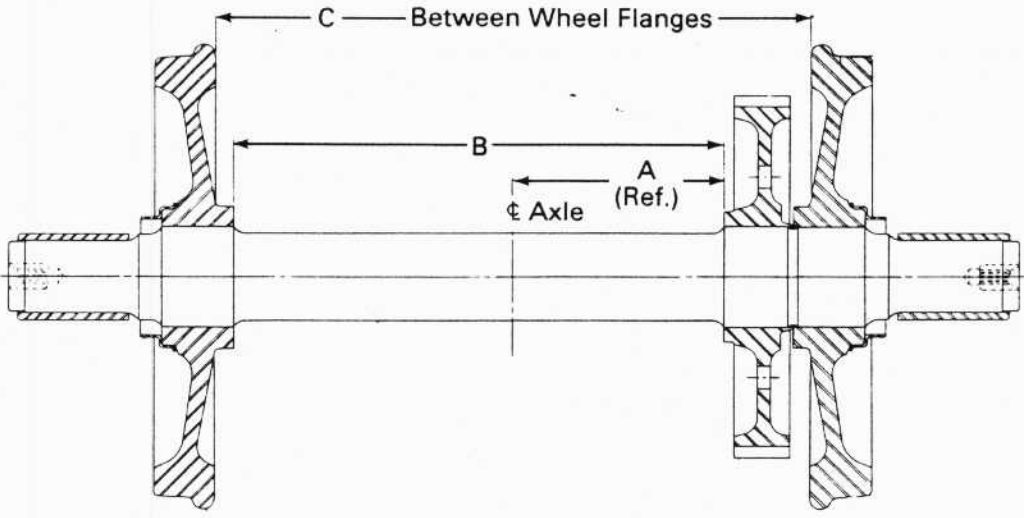
**NOTE**  
 Tapered roller bearings allow no deviation from new length. Cylindrical rollers can be shortened as follows:

140 mm x 254 mm (5-1/2" x 10") - 3.2 mm (1/8") total length

165 mm x 304.8 mm (6-1/2" x 12") - 4.8 mm (3/16") total length

REBUILD AXLE LIMITS DIMENSION F						
Journal Bearing	CYLINDRICAL ROLLER BEARINGS					
	140 mm x 254 mm (5-1/2" x 10")		152 mm x 279 mm (6" x 11")		165 mm x 305 mm (6-1/2" x 12")	
	mm	Inches	mm	Inches	mm	Inches
New	170.26	6.703	184.15	7.250	200.02	7.875
	170.21	6.701	184.02	7.245	199.90	7.870
Max.	170.26	6.703	184.15	7.250	200.02	7.875
Min.	170.21	6.701	184.02	7.245	199.90	7.870

REBUILD AXLE LIMITS DIMENSION F								
Journal Bearing	TAPERED ROLLER BEARINGS							
	152 mm x 279 mm (6" x 11")		165 mm x 305 mm (6-1/2" x 12")		175 mm (6-7/8")		178 mm x 305 mm (7" x 12")	
	mm	Inches	mm	Inches	mm	Inches	mm	Inches
New	177.93	7.005	190.55	7.502	200.02	7.875	203.25	8.002
	177.67	6.995	190.50	7.500	199.90	7.870	203.20	8.000
Max.	177.93	7.005	190.55	7.502	200.02	7.875	203.25	8.002
Min.	177.67	6.995	190.50	7.500	199.90	7.870	203.20	8.000



30041

Wheel And Gear Mounting Dimensions

# SERVICE DATA (CONT'D)

## WHEEL AND GEAR MOUNTING DIMENSIONS

Dimensions	Gauge		
	Meters (Ft/Inches)	Meters (Ft/Inches)	Meters (Ft/Inches)
	0.914 (3' 0")	*1.000 (39-3/8")	1.067 (3' 6")
A (Ref.)	0.305 (12.000")	0.322 (12.687")	0.322 (12.687")
B $\pm 0.25$ mm (.010")	0.705 (27.750")	0.765 (30.125")	0.765 (30.125")
**C	0.840 (33-1/16")	0.926 (36-7/17")	0.987 (38-7/8")
Traction Motor	D36	D29, D29CC D31, D43	D29, D29CC D31, D43

Dimensions	GAUGE				
	Meters (Ft/Inches)	Meters (Ft/Inches)	Meters (Ft/Inches)	Meters (Ft/Inches)	
	1.435 (4' 8-1/2")	1.524 (5')	1.600 (5' 3")	1.676 (5' 6")	
A (Ref.)	0.479 (18.875")	0.479 (18.875")	0.479 (18.875")	0.479 (18.875")	
B <sub>1</sub> $\pm 0.25$ mm (.010")	1.114 (43.875")	1.114 (43.875")	1.114 (43.875")	1.114 (43.875")	
**C	1.356 (53-3/8")	1.445 (56-7/8")	1.521 (59-7/8")	1.597 (62-7/8")	
Traction Motor	D77 D87	D77 D87	D77 D87	D77 D87	
Optional Motors	A	0.322 (12.687")	0.322 (12.687")	0.322 (12.687")	0.322 (12.687")
	B <sub>1</sub> $\pm 0.25$ mm (.010")	0.765 (30.125")	0.765 (30.125")	0.765 (30.125")	0.765 (30.125")
	Traction Motor	D29, D29CC D31, D43	D29, D29CC D31, D43	D29, D29CC D31, D43	D29, D29CC D31, D43

\*2.38 mm (3/32") machined off inside wheel rim (flange side).

\*\*The "C" dimension is suggested as standard which is derived by maintaining a similar wheel flange to rail clearance with the same wheel profile (AAR).

## TOOTH CONTOUR GAUGES

Axle Gears				Teeth	Gauge
8184342				55	9566768
8341962	8368989	8491290		57	8491552
9534520	8184325			57	9321569
8184378	8486278			58	8370613
8184333				59	8375379
8179295	8206505			60	9523995
8184341	8210783	8453042		61	9523996
8109579	9318170	8459296		62	9523997
8402408 9081796	8200600 9504211	8326122	8452886	63	8361635
8428701				64	9098508
8178812				65	8362635
9520042	9332205			66	9526380
9520043	9332206			67	9526381
9520044	9332207			69	9526382
9520045	9315723			70	9526383
Traction Motor Pinions				Teeth	Gauge
8168517	8452310			12	8362636
8428702				13	9098509
8179135	8326123	8452311	9556207	14	8361636
8452312	9096751	8459295	8458508	15	8344485
8210792	8452313	9556208	8341961	16	8347119
8452314	9556209	8206504		17	8347120
9315722				17	9526379
8452315	9556210			18	8375380
9332201				18	9526378
9326333	9556211			19	8370612
9332202				19	9526377
9326334	9556212	9534521		20	8485575
9332203				20	9526376
9326335	9556213			21	8485576
9326336	9556214			22	8485577
9326337	9556215			25	8485578

## SERVICE DATA (CONT'D)

### EQUIPMENT LIST

Gauge, Inner Race Split Locating Collar	
140 mm (5-1/2") Axle Journal Diameter	8232368
152 mm (6") Axle Journal Diameter	8258486
165 mm (6-1/2") Axle Journal Diameter	8164608
175 mm (6-7/8") Axle Journal Diameter	8391625
Remover Set, Inner Race, 140 mm x 254 mm (5-1/2" x 10")	8219258
Split Ring	8219259
Outer Ring	8219260
Filler Ring	8219261
Pressure Block	8219262
Filler Ring	8219263
Remover Set, Inner Race, 165 mm x 305 mm (6-1/2 x 12)	8048299
Outer Ring	8048301
Split Ring	8048302
Filler Ring	8048303
Pressure Block	8107834
Induction Heater, Inner Race, 140 mm x 254 mm (5-1/2" x 10")	8254200
Induction Heater, Inner Race, 165 mm x 305 mm (6-1/2" x 12")	8254202
Gauge, Axle Gear Wear	9512412
Wheelset Shimming Fixture	
GP Trucks	*File No. 936
HT-C Trucks	*File No. 935

#### NOTE

The width between pedestal liners can vary on a model truck other than those listed, but the fixture concept can be utilized with dimensions modified to suit a specific truck.

\*File number represents facility drawings that are available (at no charge) from EMD Service Department. These drawings include construction details of tooling that can be manufactured.