

# Maintenance Instruction



Technical Publications

## WHEELS, AXLES, AXLE GEARS AND PINIONS

### GENERAL

Wheel and axle assemblies should be inspected for visible defects each trip. This is part of the inspection required by Federal Locomotive Inspection Laws.

Wheels are periodically inspected for wear, sharp flanges, spalling, cracks and flat spots to ensure they are within the limits prescribed by the Federal Railroad Administration, Department of Transportation.

Axles should also be periodically checked for 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 East Van Buren Street, Chicago, Illinois 60605.

#### 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 gauges may be purchased from the Pratt and Whitney Company.

### REMOVAL OF TRACTION MOTOR, WHEEL, GEAR, AND AXLE ASSEMBLIES

Traction motor, wheel, gear, and axle assemblies 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 GEAR

After the traction motor and journal bearings have been removed from the wheel, gear, and axle assembly, Fig. 1, it may be necessary to press off the wheels and gear from the axle for inspection and, if required, replacement.

#### CAUTION

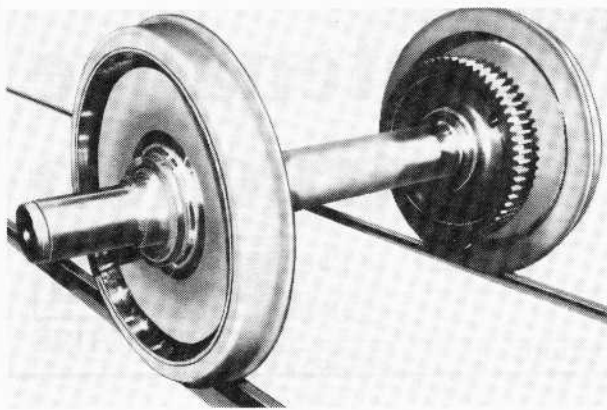
Axle journal bearing surfaces should be protected when the journal bearings are removed.

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These instructions do not purport to cover all details of maintenance, procedures, or variations in equipment. Due to variations in manufacturing equipment, installation, operation, or maintenance of users, unforeseen situations may arise which have not been covered herein. Should additional information be desired, or situations encountered which are not covered herein, please contact your local EMD Service Representative.

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



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Fig.1 – Wheel, Gear And Axle Assembly  
(Wheel Set)

While the wheels are being pressed off, be careful to apply the pressure uniformly over the end of the axle to avoid damaging 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, which could be transferred to the inner race as a high spot on the operating surface. This might interfere with the application of the journal bearing to the axle journal and could cause early failure of the race.

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 could be pressed off by removing the gear with it, using a press yoke against the gear. If the wheel 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 DEFECTS AND AXLE FAILURE

Refer to Fig. 2 for an illustration of common wheel defects. Refer to Fig. 3 for an illustration of a failed axle associated with improper maintenance such as:

- Lack of lubrication
- Improper axle surface finish
- Improperly applied wick lubricator
- Defective wick lubricator
- Contaminants introduced during assembly or in lubricant
- Improperly applied components

## WHEELS

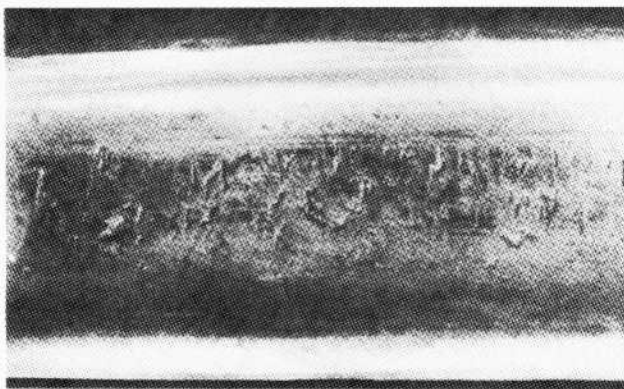
Wheels are made in two nominal diameters, 1 016 mm (40") and 1 067 mm (42"). The 1 016 mm (40") wheel is the standard diameter for most applications. The 1 067 mm (42") diameter wheel is available for use on all HT-C and GP trucks built since January of 1972.

Three types of wheel tread tapers are available: a 1:20 taper, a 1:40 taper, and a cylindrical tread contour. The 1:20 taper tread wheels are recommended for use on locomotives operating at speeds up to 113 kph (70 MPH). A 1:40 taper tread wheel is recommended for use on locomotives operating at speeds over 113 kph (70 MPH). The cylindrical tread contour wheel can be used on GP trucks, but is not recommended for speeds above 161 kph (100 MPH).

An optional Unipoint wheel is also available. This is a wide flange wheel profile with a 1:20 taper tread, designed to provide single point contact with the rail, improving flange wear life. The Unipoint wheel has a 4.0 mm (5/32") wider flange which increases the rim width by 1.6 mm (1/16").

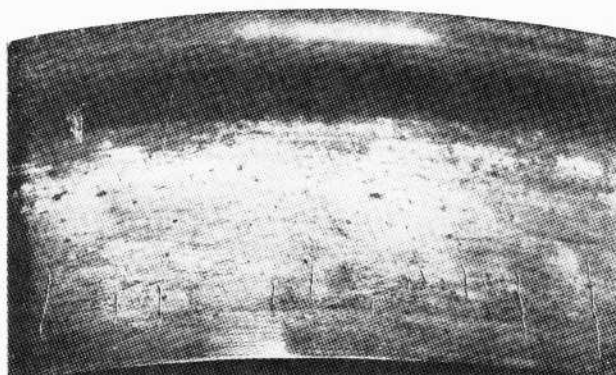
### CAUTION

The Unipoint wheel contour is not recommended for speeds above ~~69~~<sup>100</sup> kph (65 MPH). The higher effective taper of the Unipoint wheel profile reduces the speed at which hunting occurs. At speeds above ~~69~~<sup>100</sup> kph (65 MPH) sufficient hunting can occur to purge oil lubrication from the cylindrical journal bearings.



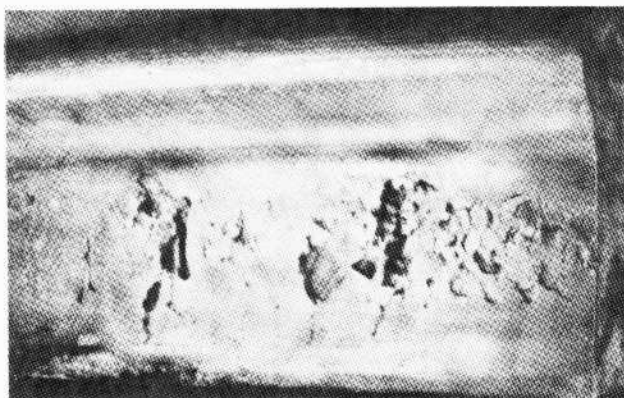
Spalling Out Of Metal  
Between Fine Thermal Cracks

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Thermal Cracks

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Shelling

#### NOTE

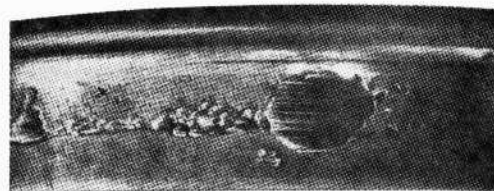
The term "shelling" is frequently misused and in most cases should be called "spalling."

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 wheels rotate. 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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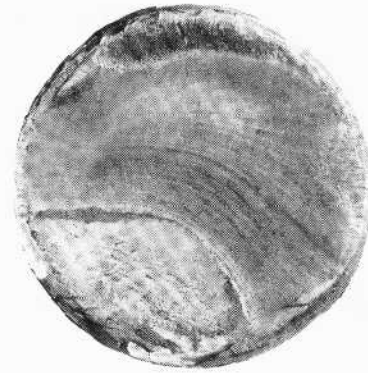
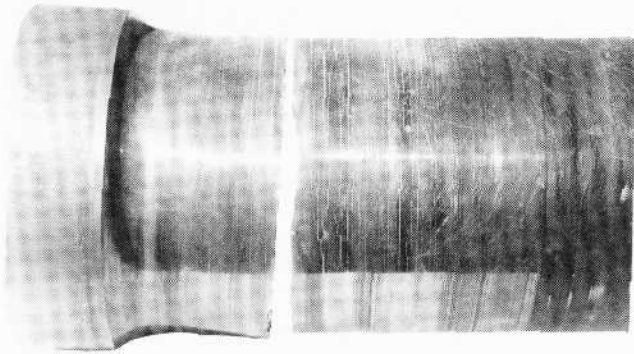


Built-Up Tread And Slid Flat

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(Photos courtesy of the  
Association of American Railroads)

Fig.2 - Common Wheel Defects



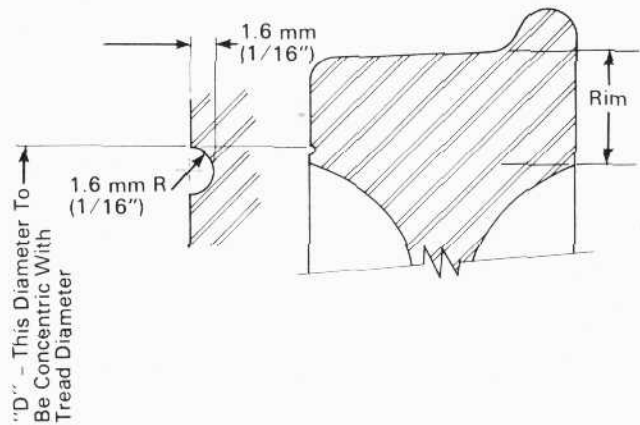
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Fig.3 - Axle Failure

Both cast and wrought steel wheels are available and may be procured in three different classes of hardness range as described in AAR Specifications M-107 and M-208. These are:

- Class A - High speed service with severe braking conditions, but moderate wheel load.
- Class B - High speed service with moderate braking conditions and heavier wheel loads.
- Class C - Service with light braking conditions and high wheel loads.

The hardness for the various classes is given in the Service Data. The most commonly used class in locomotive service is the Class B wheel and unless the customer specifies otherwise, Electro-Motive will supply wheels on new locomotives which are in the upper Class B range (302-341 Brinell preferred).



Wheel Diameter	"D"	Radius
1 016 mm (40")	914 mm (36")	457 mm (18")
1 067 mm (42")	914 mm (36")	457 mm (18")

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Fig.4 - Index Groove To Determine Wheel Size

## WHEEL SIZE MATCHING LIMITS

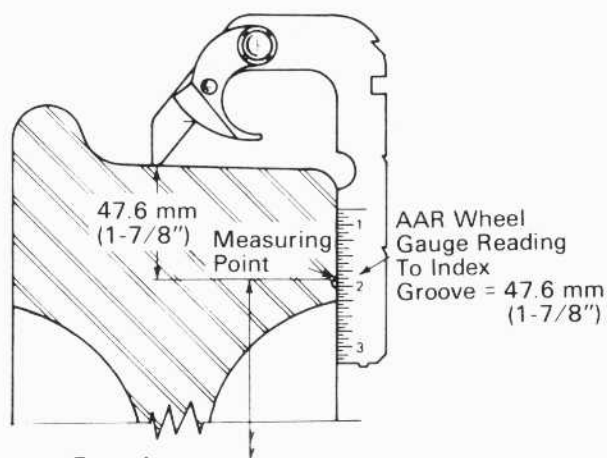
Wheel size limits are listed in the Service Data. When determining wheel size, any conventional method may be used. However, EMD recommends the "diameter index groove" method, where a groove of known diameter is machined in the outer rim of the wheel, Fig. 4.

Wheel matching is important to lengthen the life of the wheel and rail. If the wheel-size mismatch is on the same axle the smaller wheel will run against the rail and cause excessive wear on the wheel flange and excessive wear on the gage face of the rail.

Diameters of wheels with index grooves can easily be determined by measuring to the outer radius edge of the index groove with an AAR wheel gauge, Fig. 5. The gauge measurement is added to the index groove radius to obtain the wheel radius. If the wheel size variation exceeds the limits between axles or trucks listed in the Service Data, refer to Compensating For Wheel Size Variations near the end of this bulletin. The AAR gauge may be purchased from the 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

**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")

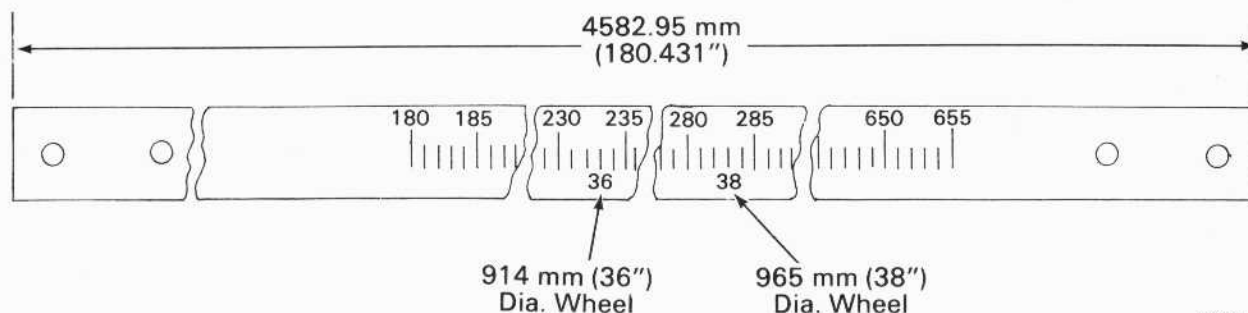
Total Wear = 6.4 mm (1/4")

30032

Fig.5 - Wheel Measurement Method

wheel matching. It should not be used for measuring rim thickness. The official measurement and evaluation of the rim thickness as specified by the Federal Railroad Administration can be accomplished only by measuring the rim thickness at the back face.

A wheel circumference gauge (tape), Fig. 6, can be used to match wheels. Each graduation between the stamped numbers on the gauge is referred to as "1 tape."



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Fig.6 - Wheel Circumference Gauge (Tape)

When applying new wheels to a truck, the following limits apply. Refer to Service Data.

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).

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).

2. 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).

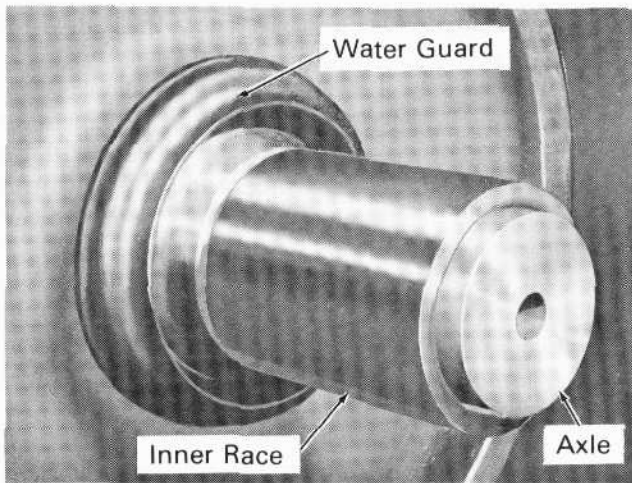
The wheel bore surface finish should be maintained at 5 microns  $\pm$ 2 (200 micro-inches  $\pm$ 75).

## WATER GUARD

### NOTE

Axles using cartridge-type (tapered) roller bearings do not use water guards.

Axles equipped with cylindrical roller journal bearings have a water guard, Fig. 7. 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.7 – 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

Currently there are two configurations of the domestic locomotive axle. The axle configuration depends upon the type of journal bearing used.

The axle utilizing the 175 mm (6-7/8") tapered GG cartridge-type bearing requires three holes drilled in the axle ends to accommodate a bearing end cap. The ends of the axle require a surface finish of 3.2 microns (125 micro-inches) maximum.

The axle utilizing the 165 mm x 305 mm (6-1/2" x 12") cylindrical roller bearing requires a surface finish of 0.38 microns (15 micro-inches) maximum on the ends of the axles for a satisfactory service life of the interacting bronze thrust block.

To measure surface finish, an instrument such as a "Talysurf" manufactured by Rank, Taylor, Hobson can be used. The Talysurf is an instrument with a diamond-tipped stylus used to transverse the surface. The movement of the stylus caused by variations in the surface, produce current changes in a pickup unit.

The Talysurf can also be used in the wave index procedure which follows.

## NOTE

The axles and micrometers used for measurement should be allowed to stabilize at room temperature prior to measuring. Micrometers used should be checked against a known standard prior to use.

Refer to Service Data for axle dimensions. Axles should also be checked for runout. Axle runout should not exceed 0.13 mm (.005") total indicator reading with the bearing journal at zero. If axle exceeds the maximum limits listed in Service Data, the axle should be reworked.

The axle surfaces should also be checked for taper. If the indicator indicates a taper which exceeds the limits listed in Service Data, the axle should be reworked.

## AXLE SURFACE FINISH

The surface finish of the axle is very important especially in the support bearing area. It is recommended that all surfaces of the axle meet the micro-finish requirements and the support bearing area also be checked to meet the waviness (wave index) requirement.

The wave index is the peak-to-valley (P-V) wave height in micro-inches divided by the peak-to-peak (P-P) wave length in inches as obtained from a high magnification trace of the journal axial surface. The trace must show only rounded surface irregularities and may have occasional valleys, but should be free of sharp projections above the journal surface. The wave index requirement applies to surface irregularities which typically have a pronounced harmonic character.

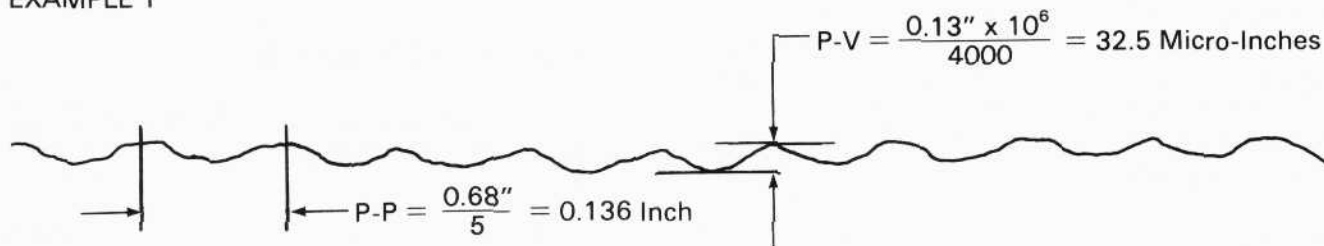
A representative section of the trace should be selected for wave index evaluation. Average wave height and average wave length within this representative section may be used in determining the wave index.

The calculated maximum wave index should not exceed 100 micro-inch/inch. If the wave index value exceeds 100 micro-inch/inch, the probability of failure is increased.

Examples using simulated axle journal traces are shown in Fig. 8.

Simulated Axle Traces – Scales: Vertical 4000 X  
Horizontal 5 X

## EXAMPLE 1



$$\text{WAVE INDEX} = \frac{32.5}{0.136} = 240 \text{ Micro-Inch/Inch}$$

AXLE NOT ACCEPTABLE – Wave Index Greater Than 100 Micro-Inch/Inch

## EXAMPLE 2



NO SIGNIFICANT WAVES

AXLE ACCEPTABLE – If Axle Meets Other Requirements

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Fig.8 – Wave Index Determination

The support bearing journals are to be finished by the following sequence of operations to achieve the necessary surface requirements.

1. Rough turn the axle in the support bearing journal area to a maximum of 125 micro-inch finish.
2. Grind the support bearing journal area to a finish of 25-50 micro-inches. Grinding this area prior to rolling, eliminates the peaks left by lathe turning and presents a flatter surface for the final surface finishing. Grinding should also reduce the machine marks in the fillets which could result in areas of high stress concentration.
3. Roller burnish the support bearing journals in a single pass.

The support bearing journal must have a surface finish when measured in the axial direction as follows:

Surface Finish  $R_A = 7$  micro-inches maximum

Surface Waviness (Wave Index) = 100 micro-inch/inch maximum

The surface finish of other areas of the axle are as follows:

- a. CENTER PORTION OF AXLE between support bearing journals – 125 micro-inches maximum
- b. END JOURNALS, 50 micro-inches maximum
- c. WHEEL SEATS and GEAR SEAT (after rough turning), should be ground to 50 micro-inches maximum

d. ALL FILLETS, must be free of tool marks

Because of possible dangers resulting from axle cracks, it is recommended that axles be given a magnetic particle or fluorescent magnetic particle inspection whenever the wheels are removed, regardless of length of service. The journal bearing inner race (if applicable) should be removed so that the axle under the race is exposed for a thorough visual examination.

Inspected axles that are not within the longitudinal defect limits of Fig. 9 or have circumferential defects on or below the surface, should be scrapped.

**NOTE**

Acceptance or rejection of axles is based on the visible length of the indication(s) in question using normal shop lighting (white light).

If the wheel set has been removed from a truck involved in a wreck, the inner races (if applicable) should be removed and the journals of the axles should be magnetic particle inspected.

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

If axles are not magnetic particle inspected at each wheel removal, it is recommended that the axle be scrapped after two pair of wheels have been worn to maximum limits.

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

**AXLE JOURNALS**

**OIL LUBRICATED, CYLINDRICAL ROLLER BEARING**

The minimum axle journal diameter is governed by the interference fit of the bearing inner race.

On current 174.62 mm (6-7/8") journal box bearing axle journal diameters, a new axle journal diameter is 174.70 mm to 174.73 mm (6.878" to 6.879"). This provides a minimum interference fit of 0.076 mm (.003") to the inner race.

A service limit of 174.663 mm (6.8763") minimum axle journal diameter provides an interchangeable interference fit of 0.038 mm (.0015"). If it is desired to use a selective fit, an axle journal diameter of 174.638 mm (6.8755") can be used with an inner race having a minimum inside diameter of 174.600 mm (6.8740") to obtain the 0.038 mm (.0015").

On 165.10 mm (6-1/2") journal bearing diameters, a new axle journal diameter is 165.18 mm to 165.20 mm (6.503" to 6.504"). This provides a minimum interference fit of 0.076 mm (.003") when using a 165.10 mm (6-1/2") inner race.

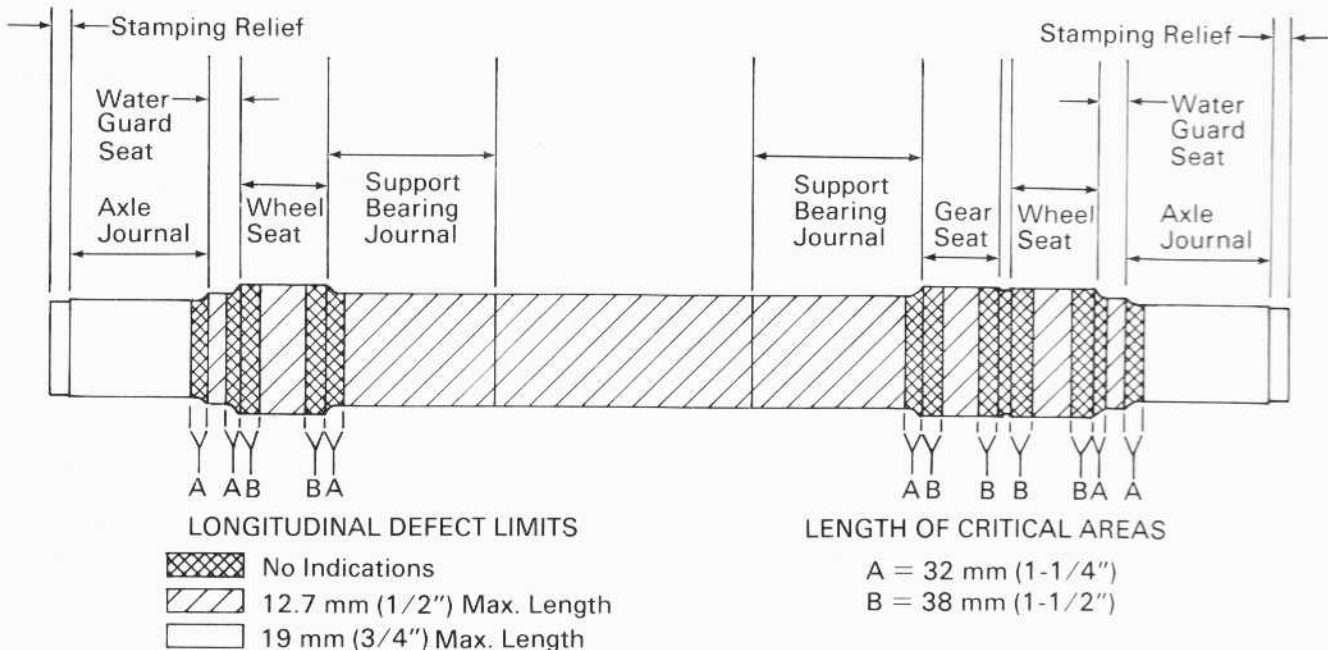


Fig.9 - Longitudinal Axle Defect Limits

A service limit of 165.138 mm (6.5015") minimum axle journal diameter provides an interchangeable interference fit of 0.038 mm (.0015"). If it is desired to use a selective fit, an axle journal diameter of 165.113 mm (6.5005") can be used with an inner race having a minimum inside diameter of 165.075 mm (6.499") to obtain the 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 inside diameter surface.
2. Axle journal surface does not show fretting in excess of 25.4 mm (1") wide or 10% of the total surface.

If the 0.038 mm (.0015") interference fit cannot be obtained with a standard inner race, the axle journal can be machined to the undersize dimensions shown in Fig. 10. 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.

A new axle journal diameter is 157.264 mm to 157.239 mm (6.1915" to 6.1905") for the Class F bearing, 177.90 mm to 177.88 mm (7.004" to 7.003") for the Class G bearing, and 174.73 mm to

174.70 mm (6.879" to 6.878") for the Class GG bearing. This provides an interference fit of 0.114 mm (.0045") maximum to 0.064 mm (.0025") minimum.

All bearings with previous service require an interference fit with the axle of not less than 0.038 mm (.0015").

## MOTOR SUPPORT BEARING AREA

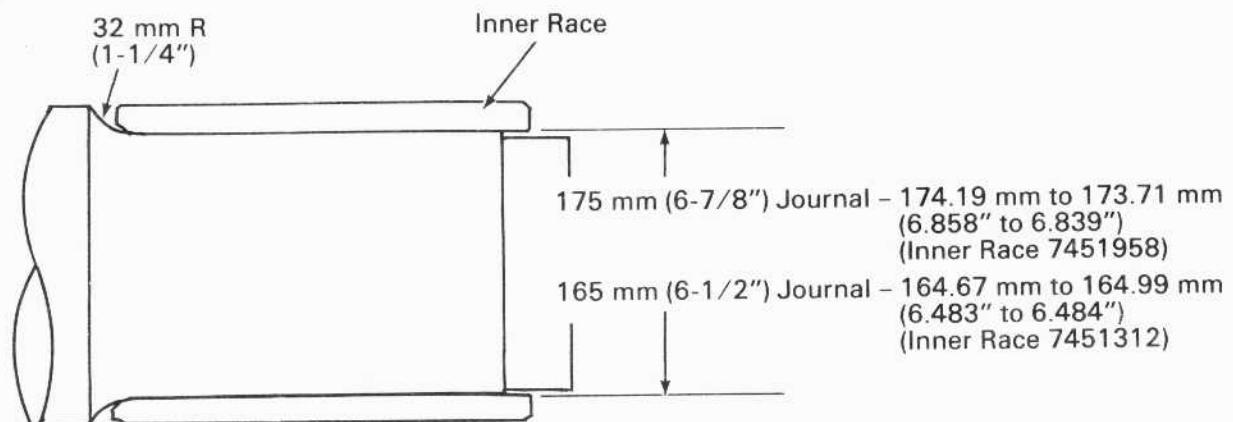
Generally, the maximum axle diameter reduction at the support bearings should not exceed 1.6 mm (1/16") due to axle loading on some locomotives. However, for 2 axle trucks not subjected to speeds over 113 kph (70 MPH) operation, undersize axles up to 3.2 mm (1/8") can be used. Support bearings are available with 0.8 mm (1/32"), 1.6 mm (1/16"), 2.4 mm (3/32"), and 3.2 mm (1/8") undersize bores, as well as 0.8 mm (1/32") and 1.6 mm (1/16") oversize flanges.

Ensure the surface finish of the support bearing journals conform to the limits listed in the Axle section of this Maintenance Instruction.

## WHEEL SEAT AREA

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

Wheel seats may be ground undersize to the limits listed in the Service Data.



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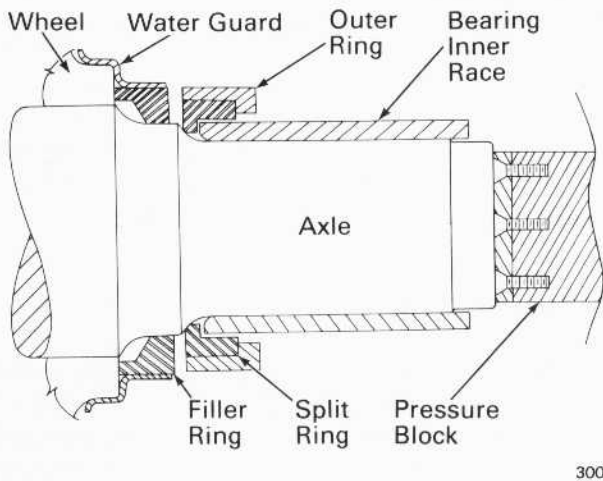
Fig.10 - Axle Journal For Undersize Inner Race

# 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.

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. 11. Refer to Service Data for tool part numbers.



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Fig.11 - 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 (6.500"). The maximum out-of-round limit is 0.03 mm (.001").

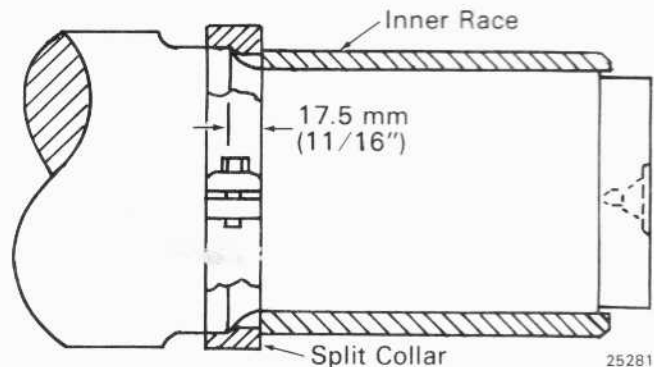
4. Inspect for hardness with a scleroscope or hardness tester similar to an Ernst tester. Measure the bearing inner race 75 mm to 100 mm (3" to 4") from each end of the race (the approximate center). If a hardness tester is used which leaves an indentation larger than a Rockwell 15 N impression, the 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. 12, 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. 12 for dimension of inner race to fillet.



25281

Fig.12 - 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.

Accurate gauges are available to assist in inspection and qualification of axle gears and pinions. Refer to Service Data for gauge part numbers and corresponding pinion and gear part numbers.

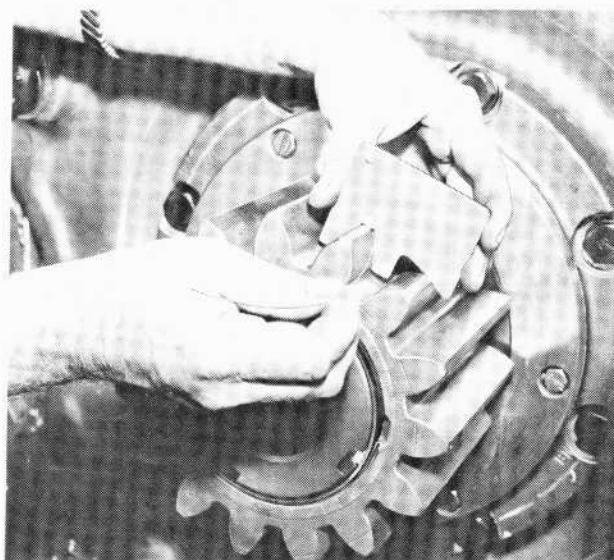
1. After the axle gear has been removed, examine the inner face of the gear hub and polish off any marks that may have been made while removing gear.
2. Visually inspect for broken, chipped, spalled, shelled, or pitted teeth. Traction motor pinion and axle gears should be rejected when more than 20% 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 3.2 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

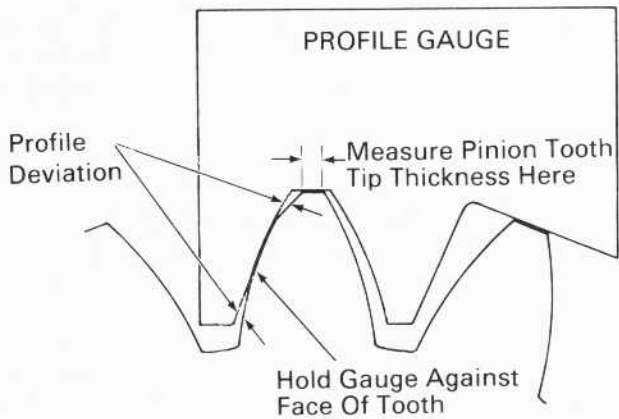
The traction motor pinion tooth involute profile is checked with a tooth contour gauge and a 0.25 mm (.010") wire gauge or narrow feeler gauge as shown in Fig. 13. If a feeler gauge is used, width of the gauge should not exceed 3.2 mm (1/8").



12650

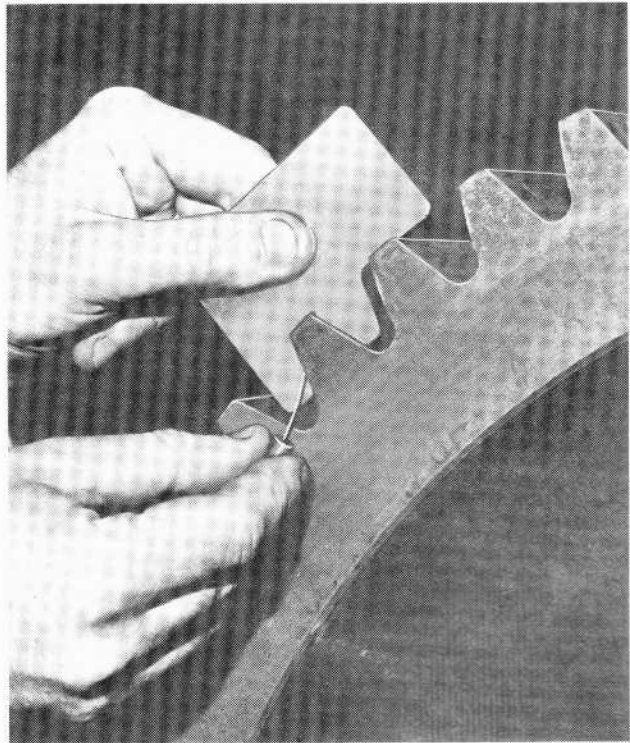
Fig.13 – Traction Motor Pinion Tooth Contour Gauge

1. Place the tooth contour gauge against one flank of the traction motor pinion tooth as shown in Fig. 14. 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.
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.



30278

Fig.14 – Measuring Profile Deviation And Wear Of Traction Motor Pinion



25283

Fig.15 – Axle Gear Tooth Contour Gauge

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")

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

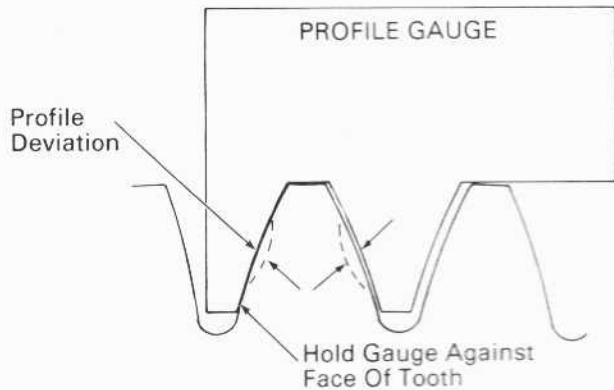
**NOTE**

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

**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. 15. If a feeler gauge is used, width of the gauge should not exceed 3.2 mm (1/8").

1. Place the tooth contour gauge against one flank of the axle gear tooth as shown in Fig. 16. 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.



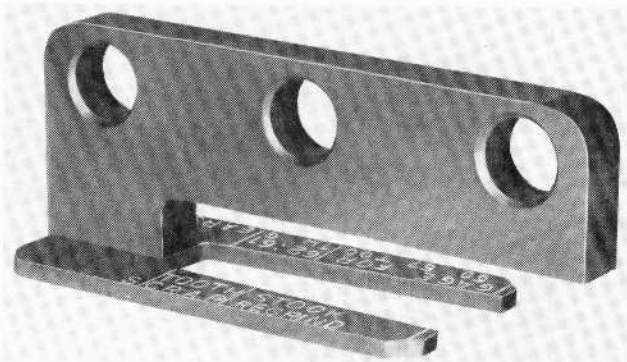
30277

Fig.16 – Measuring Profile Deviation Of Axle Gear

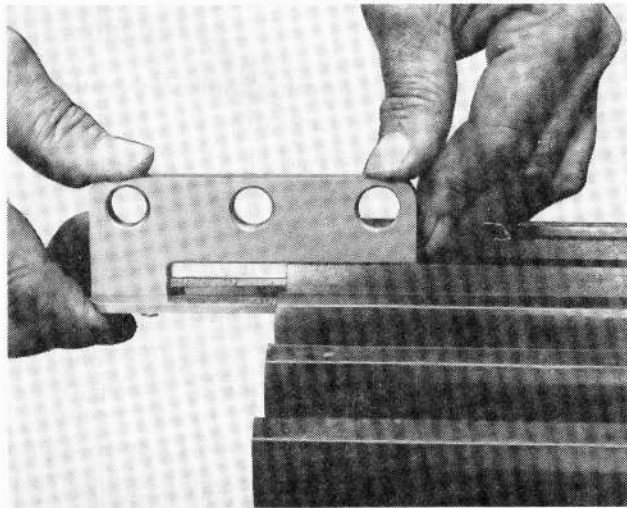
2. Shift the tooth contour gauge until the gauge contacts the opposite tooth flank. At this flank, measure and record the maximum amount of deviation from tooth profile.
3. When deviation from original tooth profile is 0.25 mm (.010") or less, the gear may be reused. If profile error exceeds 0.25 mm (.010"), the gear should be reground if there is sufficient stock. A wear gauge, Fig. 17, is available to

determine if the gear can be reground. Refer to Service Data for axle gear wear gauge part number.

- Place wear gauge on the axle gear tooth as shown in Fig. 17. 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.



24230



24231

Fig.17 - Axle Gear Wear Gauge

## MOUNTING OF WHEELS AND AXLE GEARS ON AXLE

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 3.2 to 7 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 minimum 3.2 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 1:20 wheel 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 Fig. 18 for typical wheel contour mounting dimensions. Other wheel contours may require different mounting dimensions. Consult EMD Service Representative for recommended spacing.

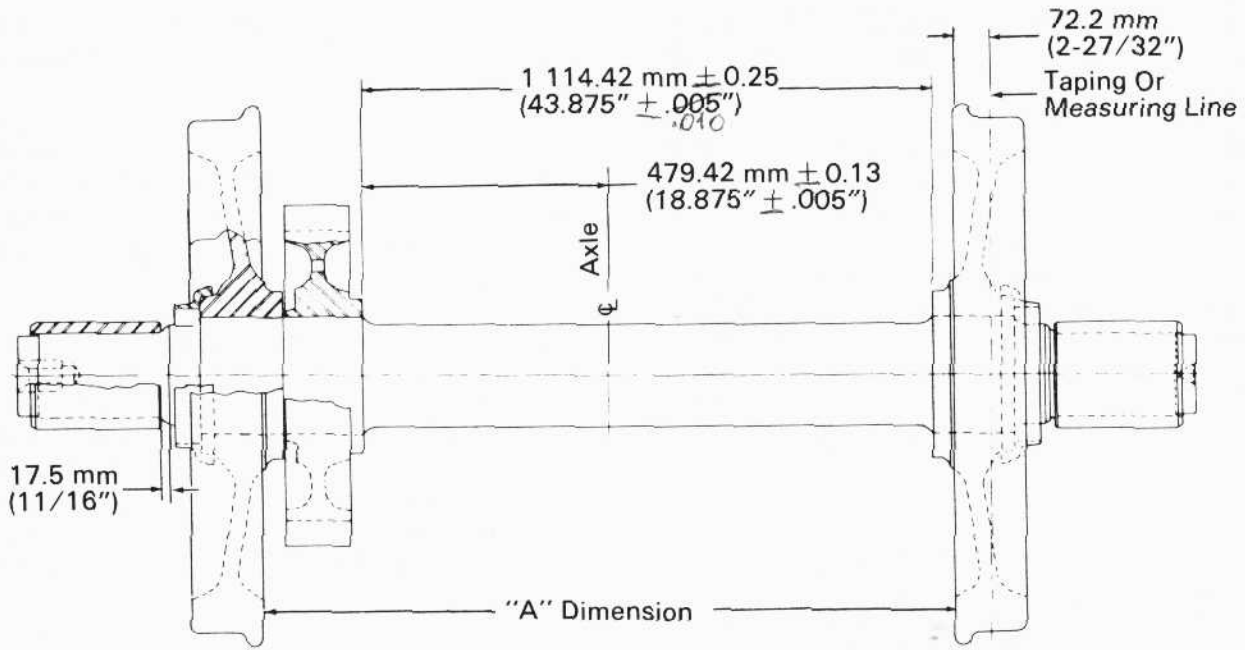
Mount wheels and axle gear as follows:

- 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 surface 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.

- Press axle gear onto the axle with a pressure of between 50 and 114 tonnes (55 and 125 tons). Locate the gear hub 479.43 mm (18.875") from the center of the axle.
- Next, press on the wheel opposite the gear end. The dimension between the wheel hub and gear hub must be 1 114.42 mm ± 0.13 (43.875" ± .005).



**"A" DIMENSION**

Standard AAR Wheels	.....	1 355.7 mm +0.0, -1.6
(All Model Locomotives,		(53-3/8" +0, -1/16)
Unless Otherwise Specified)		
Unipoint Wheels	.....	1 352.6 mm +0.0, -1.6
		(53-1/4" +0, -1/16)
Switcher With Rigid Truck	.....	1 351.0 mm ± 0.8
		(53-3/16" ± 1/32)

30276

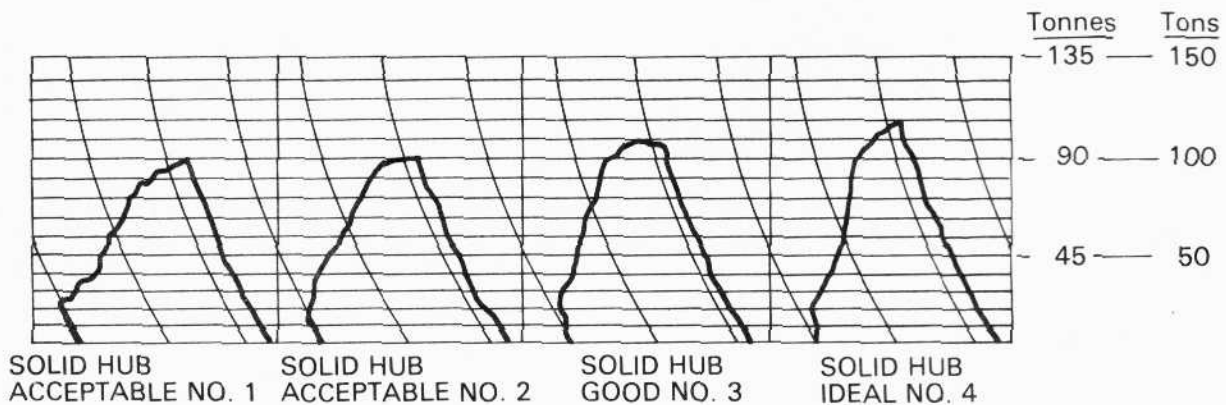
Fig.18 - Dimensions For Assembling Typical Wheel Sets

4. Finally, press on the wheel next to the gear to "A" dimension of Fig. 18. For new or used wheels on a new axle, the press-on tonnage required should be between 86 and 132 tonnes (95 and 145 tons).

rise indicated on the graph should be gradual as shown in Fig. 19. The four graphs illustrate tonnage curves ranging from ideal to acceptable.

A permanent Record Of Tonnage Graph should be made for every mounting operation. The tonnage

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



25286

Fig.19 - Typical Wheel Mounting Tonnage Graph

## 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.

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.

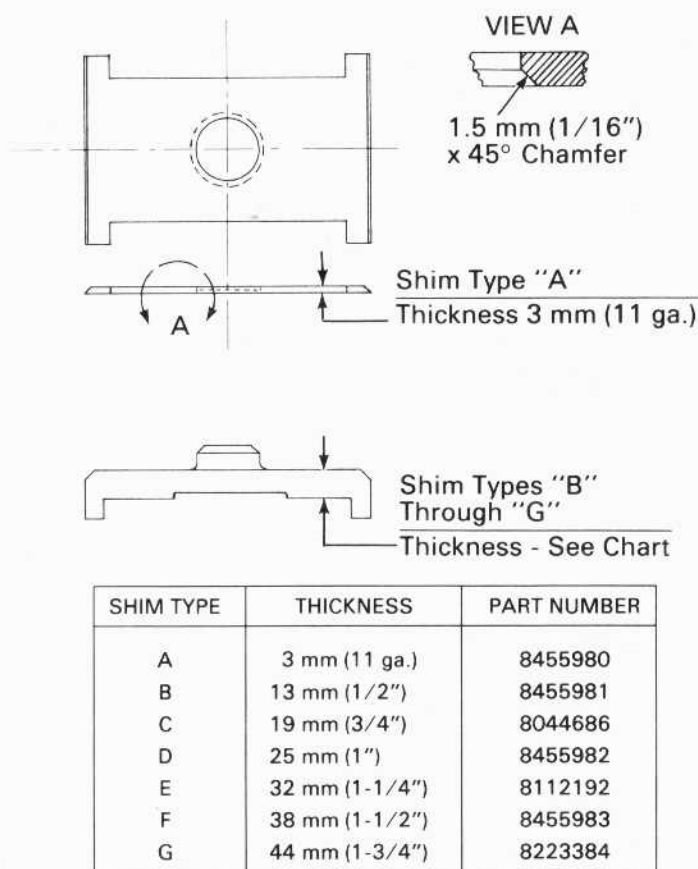
## APPLICATION OF SHIMS

### 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.

The shims shown in Fig. 20 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 bar or fixture should be placed between the truck frame and the spring seat as shown in Fig. 21. After removing the pedestal tie bars, the wheel 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.

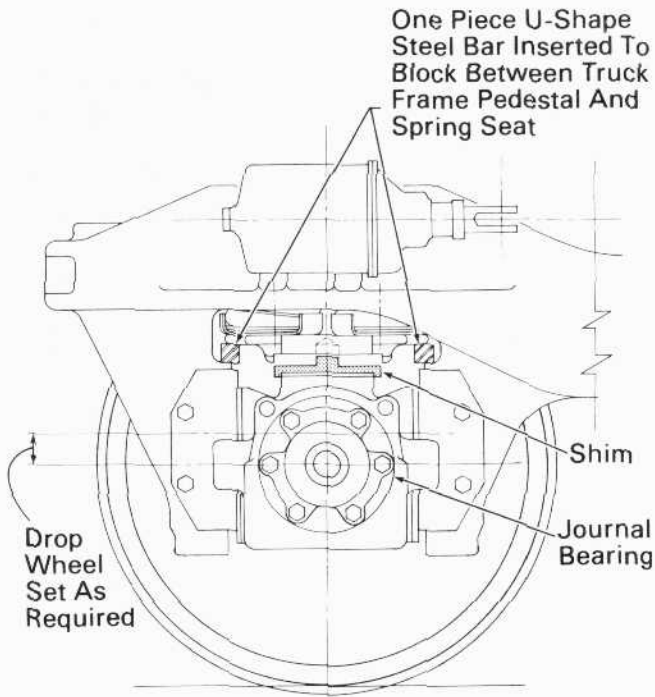


30038

Fig.20 - Wheel Size Compensating 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 bearings, shim and spring seat. The fixture or bar used to block the spring seat can then be removed.



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

30039

Fig.21 - Application Of Shims

Referring to Fig. 20, 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

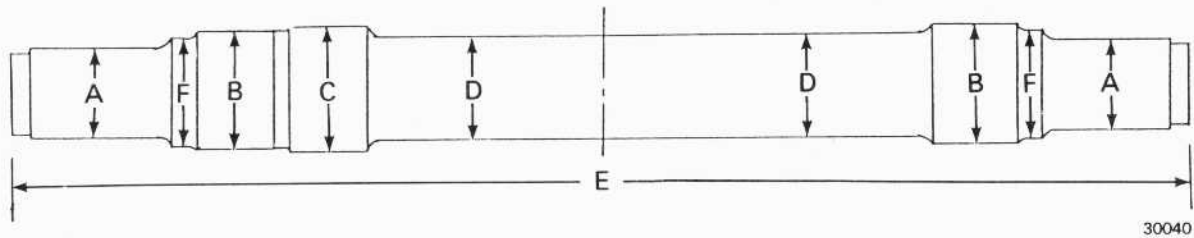
#### RECOMMENDED WHEEL SIZE LIMITS (Tapes)

	<u>NEW</u>	<u>MAX. VARIATION</u>
Wheel on same axle		
GP, SD, DD, E, F, MP	1/2	2
SW	1	2
Wheels on same truck		
GP, SW, F, MP	3	20 (9.5 mm [3/8"] radius)
SD, DD, E	3	14 (6.3 mm [1/4"] radius)
Wheels on same locomotive		
GP, SD, SW, E, F, MP	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					
	Cylindrical Roller Bearing		Tapered Roller Bearing		
	165.10 mm (6-1/2") Journal	174.62 mm (6-7/8") Journal	Class F	Class G	Class GG
New	165.20 mm (6.504")	174.73 mm (6.879")	157.264 mm (6.1915")	177.90 mm (7.004")	174.73 mm (6.879")
	165.18 mm (6.503")	174.70 mm (6.878")	157.239 mm (6.1905")	177.88 mm (7.003")	174.70 mm (6.878")
Maximum	165.20 mm (6.504")	174.73 mm (6.879")	157.264 mm (6.1915")	177.90 mm (7.004")	174.73 mm (6.879")
Minimum	165.164 mm (6.5025")	174.688 mm (6.8775")	157.239 mm (6.1905")	177.88 mm (7.003")	174.69 mm (6.8775")
*Max. Taper/Ft.	0.03 mm (.001")	0.03 mm (.001")	0.03 mm (.001")	0.03 mm (.001")	0.03 mm (.001")
Max. Out-Of-Round	0.03 mm (.001")	0.03 mm (.001")	0.03 mm (.001")	0.03 mm (.001")	0.03 mm (.001")

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

**REBUILD AXLE LIMITS DIMENSION**

	B		C		D	
	SW (E Units)	F GP SD MP	SW (E Units)	F GP SD MP	SW	F GP SD MP
New	234.47 mm (9.231")	234.47 mm (9.231")	234.97 mm (9.251")	234.97 mm (9.251")	209.60 mm (8.252")	203.25 mm (8.002")
	234.42 mm (9.229")	234.42 mm (9.229")	234.95 mm (9.250")	234.95 mm (9.250")	209.45 mm (8.246")	203.10 mm (7.996")
Maximum	234.47 mm (9.231")	234.47 mm (9.231")	234.97 mm (9.251")	234.97 mm (9.251")	209.60 mm (8.252")	203.25 mm (8.002")
Minimum	228.60 mm (9.000")	231.78 mm (9.125")	222.11 mm (9.020")	234.95 mm (9.250")	206.38 mm (8.125")	200.02 mm (7.875")
Taper Per Ft. Maximum	0.05 mm (.002")	0.05 mm (.002")	0.05 mm (.002")	0.05 mm (.002")	0.13 mm (.005")	0.04 mm (.0015")
Out-Of-Round Maximum	0.05 mm (.002")	0.05 mm (.002")	0.05 mm (.002")	0.05 mm (.002")	0.13 mm (.005")	0.13 mm (.005")

**REBUILD AXLE LIMITS DIMENSION E**

	SW Tapered Roller Bearings	Pass.	F GP SD MP
New	1 133.5 mm ± 0.4 (44-5/8" ± 1/64)	1 143 mm ± 0.4 (45" ± 1/64)	1 155.7 mm ± 0.4 (45-1/2" ± 1/64)
Maximum	1 133.9 mm (44-41/64")	1 143 mm + 0.4 (45" + 1/64)	1 155.7 mm + 0.4 (45-1/2" + 1/64)
Minimum	1 133.1 mm (44-39/64")	1 136.6 mm (44-3/4")	1 149.4 mm (45-1/4")

<b>REBUILD AXLE LIMITS DIMENSION F</b>				
	165.10 mm 174.62 mm (6-1/2", 6-7/8") Cylindrical Bearing	Tapered Class F Bearing	Tapered Class G Bearing	Tapered Class GG Bearing 174.62 mm (6-7/8")
New	200.02 mm (7.875")	190.55 mm (7.502")	203.55 mm (8.002")	200.02 mm (7.875")
	199.90 mm (7.870")	190.50 mm (7.500")	203.20 mm (8.000")	199.90 mm (7.870")
Maximum	200.02 mm (7.875")	190.55 mm (7.502")	203.25 mm (8.002")	200.02 mm (7.875")
Minimum	199.64 mm (7.860")	190.50 mm (7.500")	203.20 mm (8.000")	199.90 mm (7.870")

## EQUIPMENT LIST

Gauge, Inner Race Split Locating Collar		
165.10 mm (6-1/2") Axle Journal Diameter	.....	8164608
174.60 mm (6-7/8") Axle Journal Diameter	.....	8391625
Gauge, Axle Gear Wear	.....	9512412
Remover Set, Inner Race	.....	8048299
Outer Ring	.....	8048301
Split Ring	.....	8048302
Filler Ring	.....	8048303
Pressure Block	.....	8107834
Induction Heater, Inner Race	.....	8254202
Wheelset Shimming Fixture		
GP Trucks	.....	*File No. 936
HT-C and SD	.....	*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 numbers represent facility drawings that are available (at no charge) from EMD Service Department. These drawings include construction details of tooling that can be manufactured.

## TOOTH CONTOUR GAUGES

Axle Gears	Teeth	Gauge
8184342	55	9566768
9534520 8184325	57	9321569
8184378 8486278	58	8370613
8184333	59	8375379
8179295	60	9523995
8184341	61	9523996
8109579 9318170	62	9523997
8402408	63	8361635
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
8452311 9556207	14	8361636
8452312 9096751	15	8344485
8452313 9556208	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	20	8485575
9332203	20	9526376
9326335 9556213	21	8485576
9326336 9556214	22	8485577
9326337 9556215	25	8485578