



MAINTENANCE INSTRUCTION

WHEELS, AXLES, AXLE GEARS AND PINIONS

GENERAL

Wheels and axles should be inspected for visible defects each trip. In the United States this is part of the inspection required by the Federal Locomotive Inspection Laws. Wheels are periodically checked for wear, sharp flanges, shelling, cracks, and flat spots to see that they are within the limits prescribed by the Federal Railroad Administration, Department of Transportation.

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.

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.

For convenience some of the most common wheel defects are illustrated in Figs. 2 through 16.

Axle defects may also require removal of wheel sets. Some of the most common are illustrated in Figs. 17 through 21.

REMOVAL OF WHEEL SETS

Wheel sets may be removed while a truck is under the locomotive or the truck itself may be removed and taken to a truck overhaul section of the shop where wheel sets are removed for maintenance.

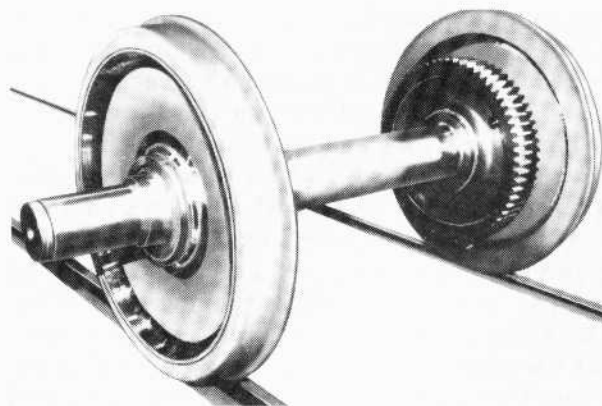
The weight of the locomotive should be supported on the locomotive jacking pads before dropping wheel sets. If this is not done, serious damage may result.

CAUTION

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

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 and remove the journal box roller bearing inner races (where used) for inspection and servicing.



20904

Fig.1 - Wheel, Gear And Axle Assembly

*This bulletin is revised and supersedes previous issues of this number.



20701

Fig.2 - Burnt Rim

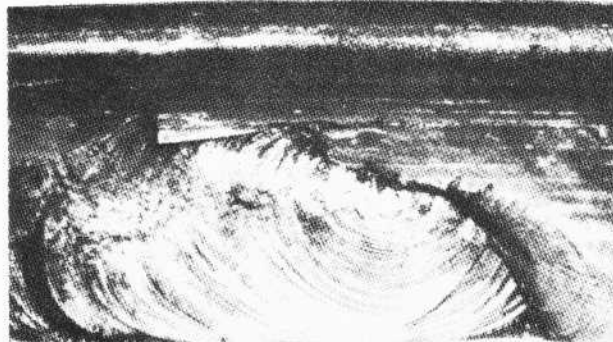
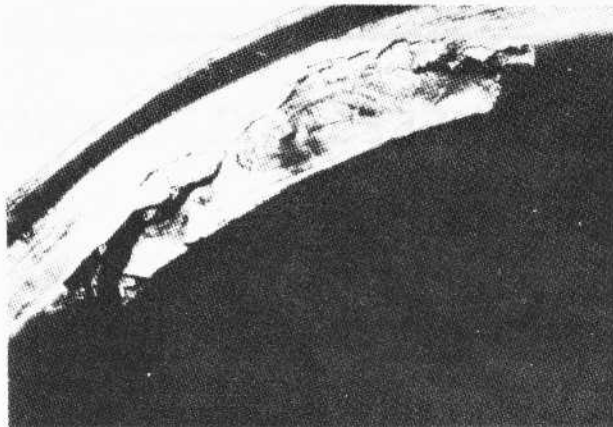
When the wheels are pressed off, be careful to apply the pressure uniformly over the end of the axle to avoid upsetting it. Always use a pressure block between the end of the axle and the ram of the press. An upset condition of the axle end will cause the journal to swell locally at the outer end, which 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 box 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 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

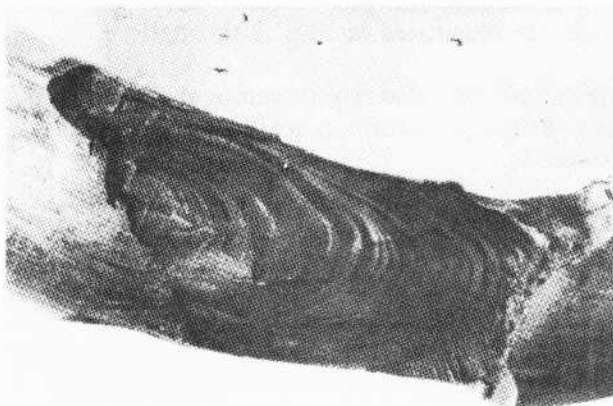
the other wheel. An analysis of this condition is given in the AAR Wheel and Axle Manual, Paragraph 288.

If the axles are not magnafluxed, all wheel work may be done without disturbing the inner races. They should, however, be protected against damage by applying sheet copper or brass sleeves over them while the wheel work is in process.



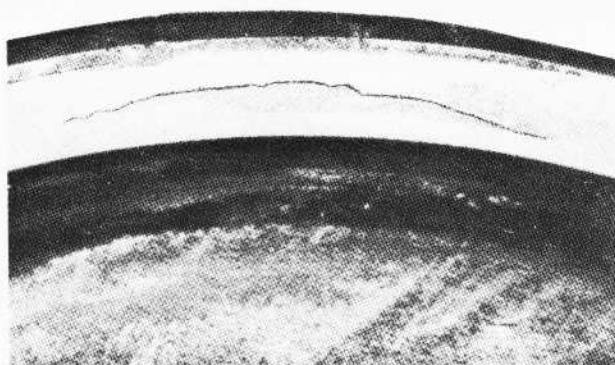
20702

Fig.3 - Shattered Rim



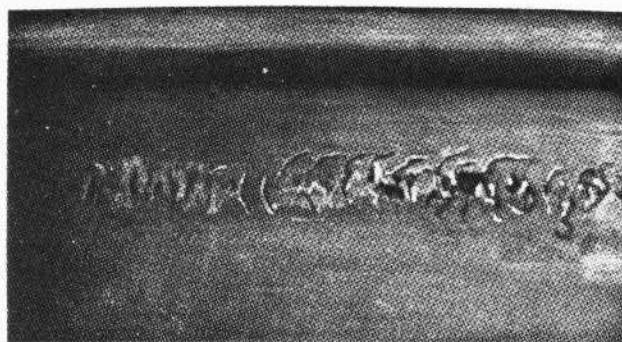
20703

Fig.4 - Shattered Rim



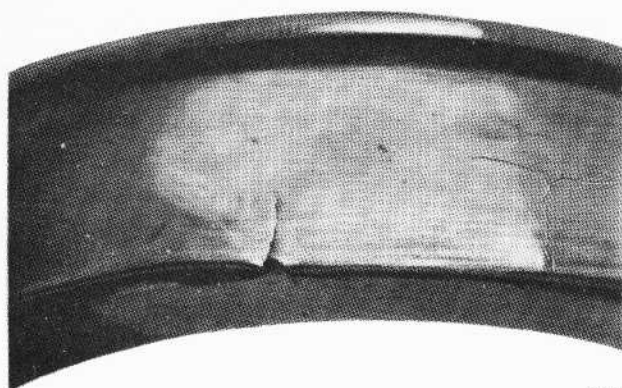
20704

Fig. 5 - Shattered Wheel Revealed By Crack



20707

Fig. 8 - Shelled Tread



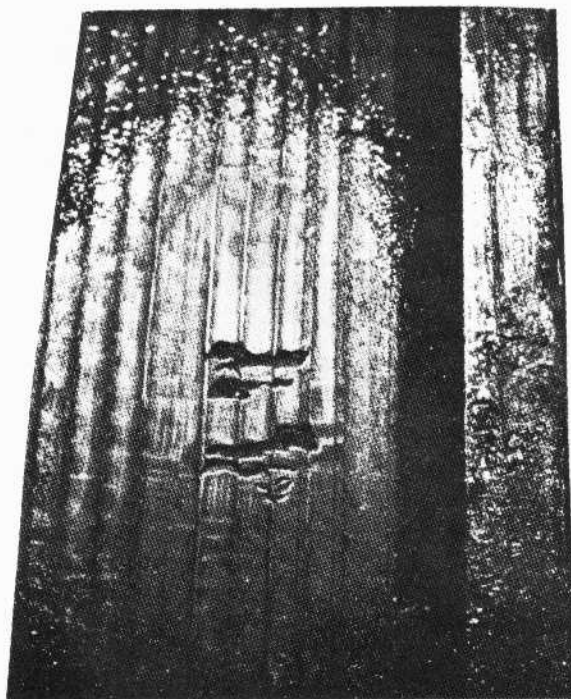
20705

Fig. 6 - Spread Rim



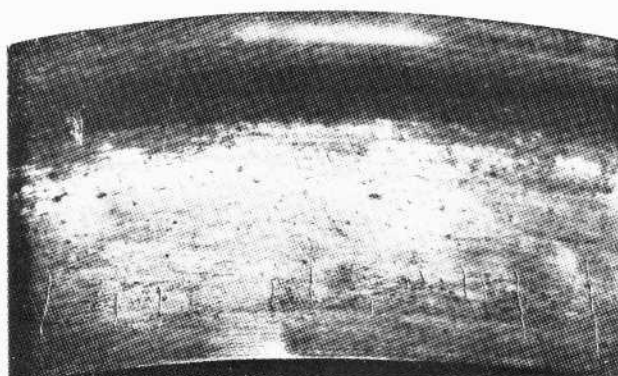
20708

Fig. 9 - Shelled Tread



20706

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



20709

Fig. 10 - Thermal Cracks

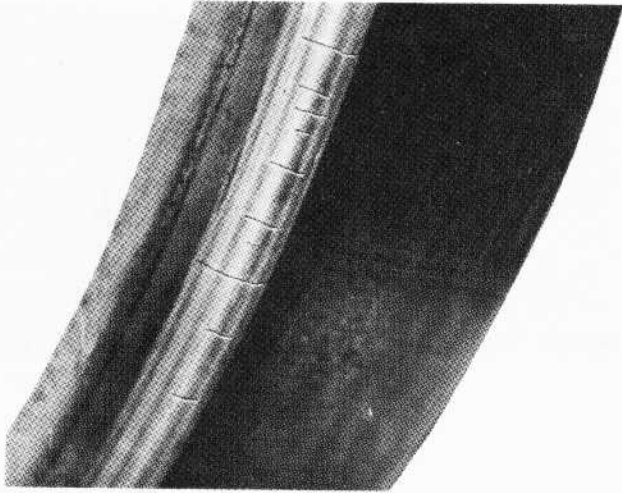
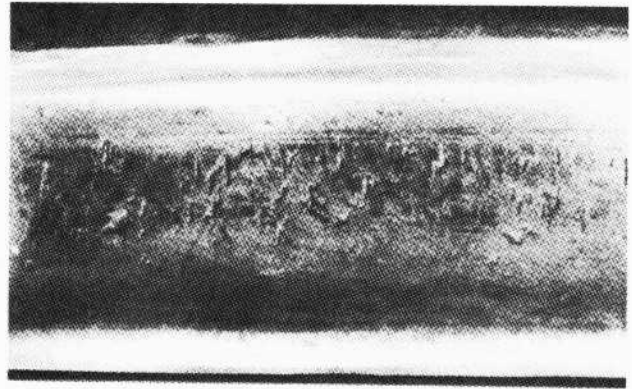


Fig.11 - Thermal Cracks

20710



20713

Fig.14 - Spalling Out Of Metal Between Fine Thermal Cracks (Top) Compared With True Shelling (Bottom)

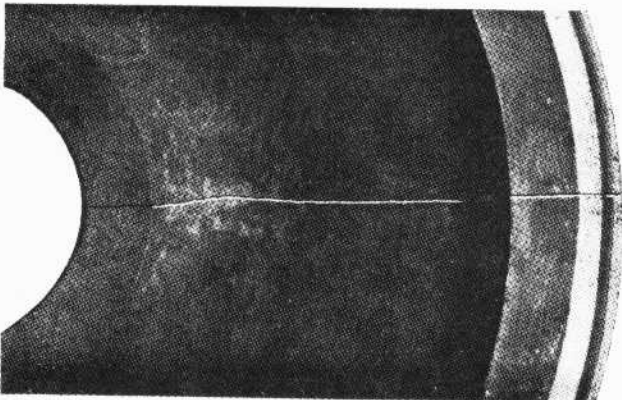


Fig.12 - Thermal Cracks

20711

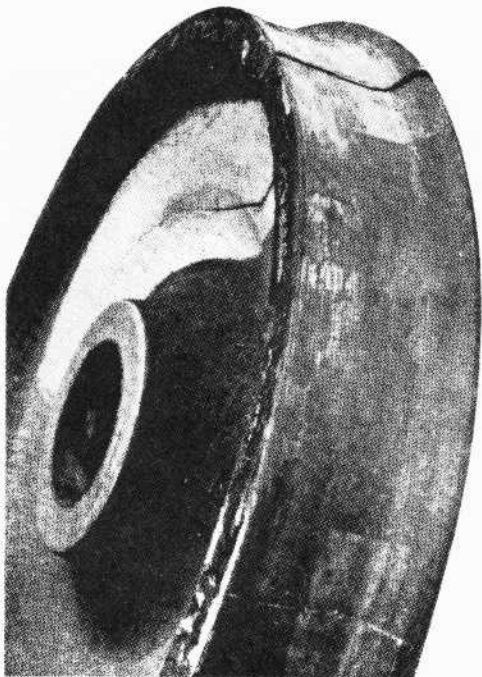


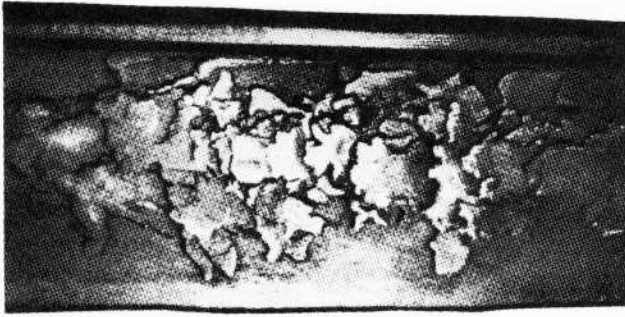
Fig.13 - Thermal Cracks

20712



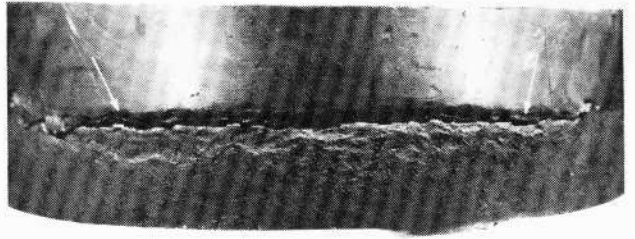
20714

Fig.15 - Built-Up Tread And Slid Flat



20715

Fig.16 - Built-Up Tread



20716

Fig.17 - Corrosion Fatigue

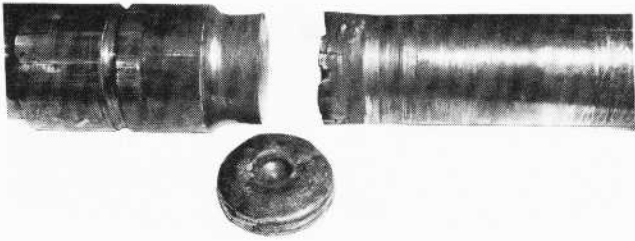


20717

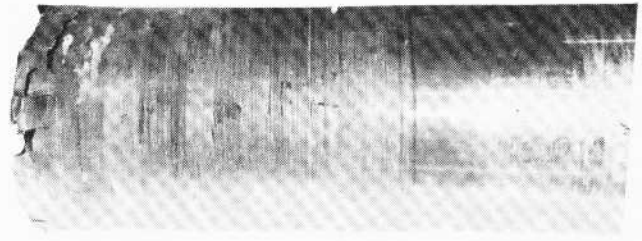


20718

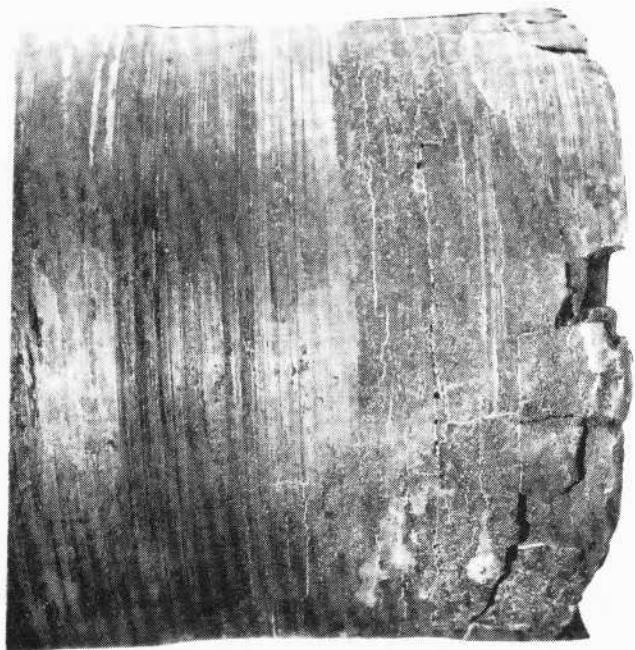
Fig.18 - Support Bearing Failure Due To Lack Of Lubrication



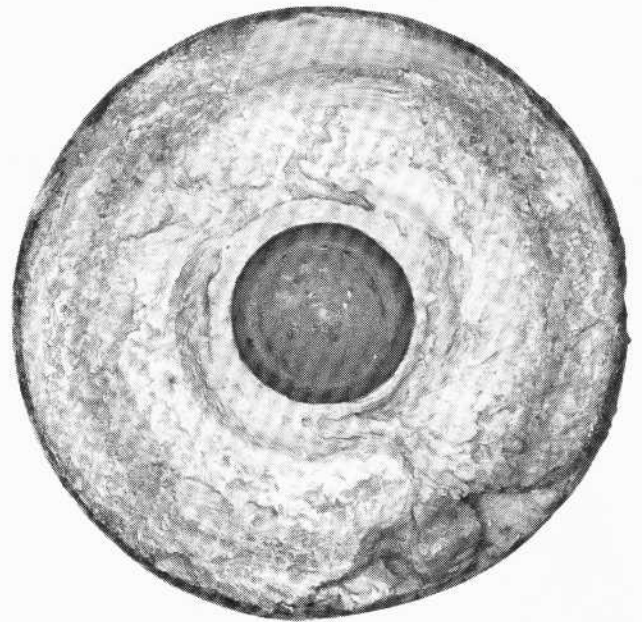
20719



20720

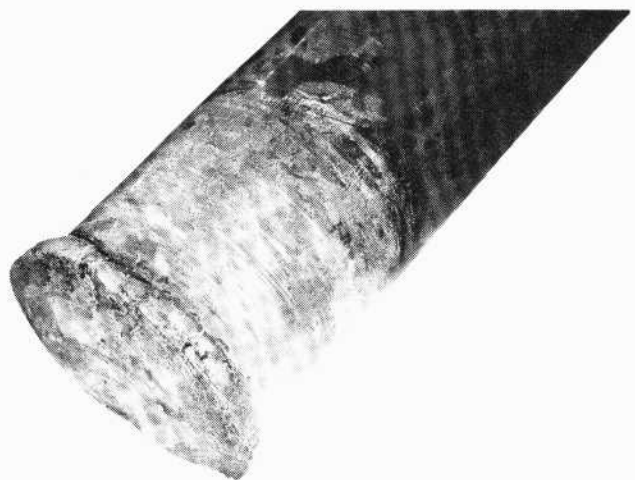


20721

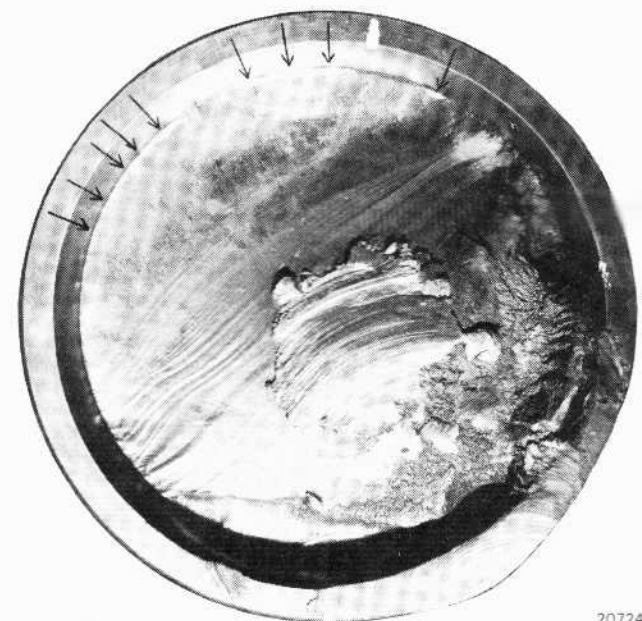


20722

Fig.19 – Support Bearing Failure Due To Lack Of Lubrication



20723



20724

Fig.20 – Support Bearing Failure Resulting From Repeated Heating And Cooling Cycle – Lack Of Lubrication

Fig.21 – Corrosion Fretting Between The Radius Of Journal Bearing Inner Race And Axle Journal

WHEELS

Wheels are made in three nominal diameters, 914 mm (36"), 1 016 mm (40"), and 1 067 mm (42"). The 914 mm (36") wheels are used on six-wheel passenger locomotive swinghanger trucks with an idler axle. The 1 016 mm (40") wheels are basic on all other applications. The 1 067 mm (42") wheels are available on all SD (HT-C) and GP trucks built since January of 1972.

Three types of wheel treads 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 having maximum speeds of 113 kph (70 mph) or less. Cylindrical or 1:40 taper wheels are recommended for use on locomotives having maximum permissible speeds of over 113 kph (70 mph).

An optional wheel design is available for use on locomotives operating under conditions where wheels are normally condemned for flange wear (thin flanges). This is the wide flange Uni-Point contour wheel with a 4.0 mm (5/32") wider flange which increases the rim width by 1.6 mm (1/16"). This contour provides a single point contact which distributes the wear more evenly over the tread flange area, work hardens the entire area at the same time, and confines the wear to that which results from microslip during stable operation. With these wheels the nominal back-to-back wheel spacing is 1 352.6 mm (53-1/4"), Fig. 34.

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 - (1) Service with light braking conditions and high wheel loads.
(2) Service with heavier braking conditions where off-tread brakes are employed. (Does not apply to locomotives.)

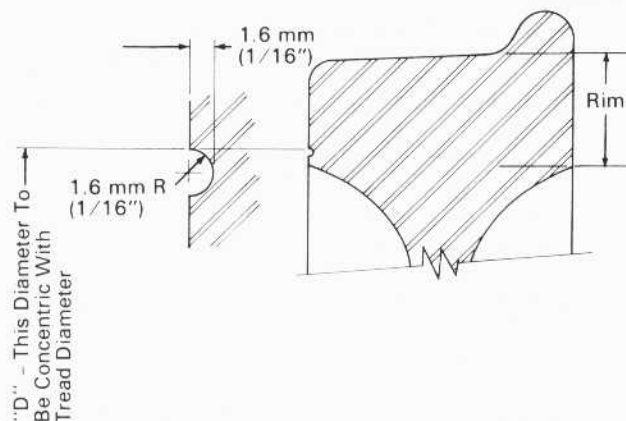
The hardness for the various classes is given in the Service Data. The most commonly used class in locomotive service is the Class B wheel and unless the customer specified otherwise, Electro-Motive will supply wheels on new locomotives which are in the high Class B range (302-341 Brinell preferred).

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. 22, 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") |
| 1 016 mm (40") | 914 mm (36") | 457 mm (18") |
| 1 067 mm (42") With 89 mm (3-1/2") Rim | 914 mm (36") | 457 mm (18") |
| 1 067 mm (42") With 64 mm (2-1/2") Rim | 965 mm (38") | 482 mm (19") |

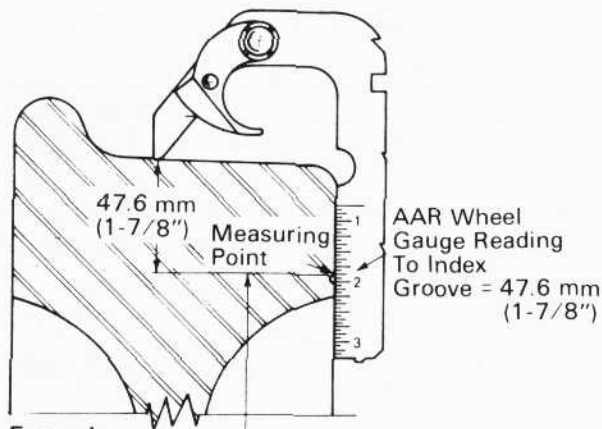
25276

Fig.22 - 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. 23. The gauge measurement is added to the index groove radius to obtain the wheel radius. If wheels are worn beyond limits shown in the Service Data see "Compensating For Wheel Variations" near the end of this bulletin.

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. 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.



Example:

Measuring Wheel Radius Of 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")

Total Wheel Radius = 457 mm + 47.6 = 504.6 mm
(18" + 1-7/8" = 19-7/8")

25277

Fig.23 – Measuring Wheel Radius

When applying all 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 the 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 approximately 1.6 mm (1/16") on the radius (3 tapes) and between axles in different trucks is approximately 6.4 mm (1/4") on the radius (14 tapes).

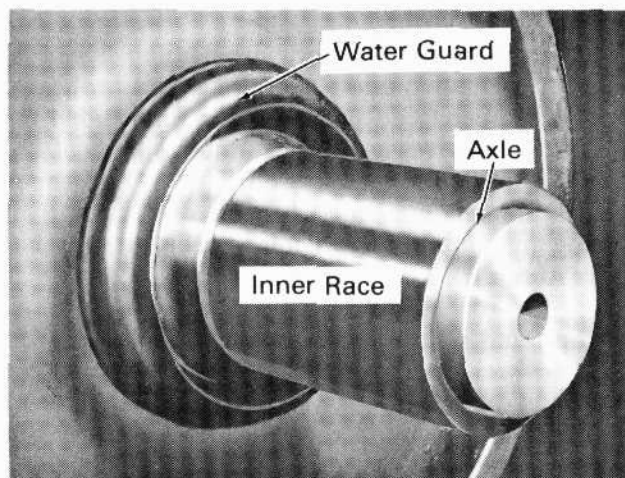
The wheel seat should be checked for taper and machined to AAR specifications if the wheel seat taper exceeds 0.17 mm per metre (.002" per foot) on diameter.

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 micro-inch finish should be held to 5.08 ± 1.90 microns (200 ± 75 micro-inches).

WATER GUARD

The water guard, Fig. 24, remains in place for the life of the wheel. Remove the water guard from the wheel hub after the wheel has been removed from the axle. The guard may then be used on a new wheel.



4277

Fig.24 – Water Guard

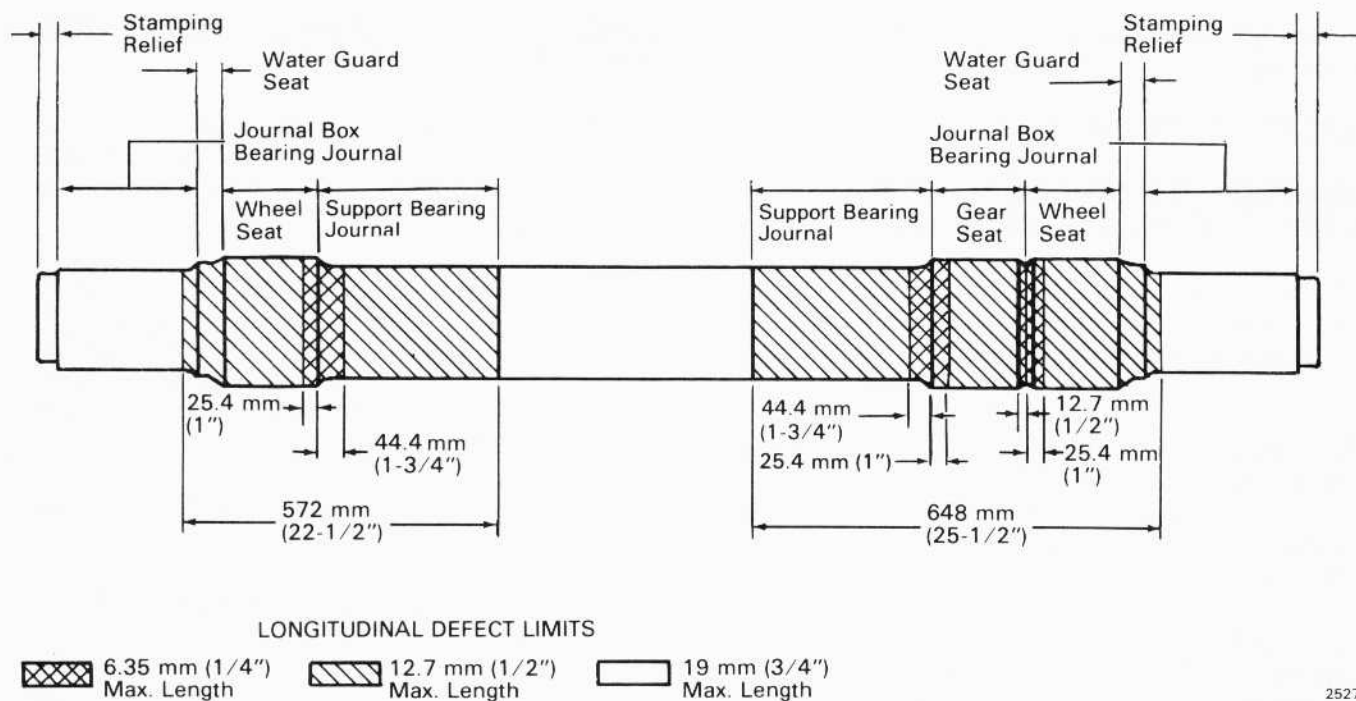
To remove the guard, heat is sufficiently to release the shrink fit, then pry it off. To apply the guard heat it uniformly to 176° C (350° F) and shrink in place on the wheel hub. Ensure water guard is pressed tightly against the wheel.

AXLES

Current domestic road locomotives are equipped with axles which have a cold rolled relief groove between the wheel and gear seat and a 174.62 mm (6-7/8") journal box bearing diameter rather than a 165.10 mm (6-1/2") diameter. This improvement makes possible increased axle loading.

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

Inspected axles that are not within the longitudinal defect limits of Fig. 25, or have circumferential defects on or below the surface, should be scrapped. Axles with friction-type bearing journal boxes should be scrapped if journals show evidence of



25278

Fig.25 - Longitudinal Axle Defect Limits

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 box bearing at zero. If the axle has over 0.13 mm (.005") total runout, it should be reworked.

On locomotives equipped with roller bearing journal box, the axle journal box bearing surface taper must not exceed 0.08 mm per metre (.001" per foot). Bearing surface out-of-round must not exceed 0.03 mm (.001"). Support bearing surface finish should be maintained at a maximum of 0.18 microns (7 micro-inches). If taper exceeds 0.12 mm per metre (.0015" per ft.), journal should be reworked.

Refer to Service Data for service dimensions of roller bearing journals.

On switcher locomotives equipped with friction bearing journal boxes, the axle bearing surface taper must not exceed 0.8 mm (1/32") for the length of the journal. If taper exceeds 0.8 mm (1/32"), the journal should be reworked. Refer to Service Data for service dimension of friction bearing journals. Bearing surface finish should be maintained at a maximum of 0.38 microns (15 micro-inches).

Axles and axle 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 wear limits.

In order to ensure accurate axle measurements, the micrometers used should be checked against a known standard.

NOTE

Axles and micrometers used for measuring 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 axle ends. If it is necessary to machine 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, cracked or have rounded edges.

If the wheel set has been removed from a truck involved in a wreck, the inner races should be removed and the journals of the axles should be

fluorescent magnetic particle or magnetic particle inspected.

AXLE JOURNALS

JOURNAL BOX OIL LUBRICATED STRAIGHT ROLLER BEARING

The minimum journal box bearing axle journal diameter is governed by the interference fit between the axle journal and 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 (6.8765") 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") to the inner race.

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. 26. However, the interference fit should be 0.08 mm (.003") to 0.13 mm (.005").

JOURNAL BOX TAPERED CARTRIDGE TYPE ROLLER BEARING

The minimum journal box bearing 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 and 177.90 mm to 177.88 mm (7.004" to 7.003") for the Class G bearing. This provides 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.

JOURNAL BOX FRICTION BEARING

Friction bearing journal box bearing axle journals that have been worn mechanically may be reduced to not less than 158.75 mm (6.250") diameter and a 19 mm (3/4") minimum fillet radius must be maintained. All tool marks must be polished from the fillet. If an axle journal has worn to 157.86 mm (6.215") diameter, the axle should be scrapped.

MOTOR SUPPORT BEARING AREA

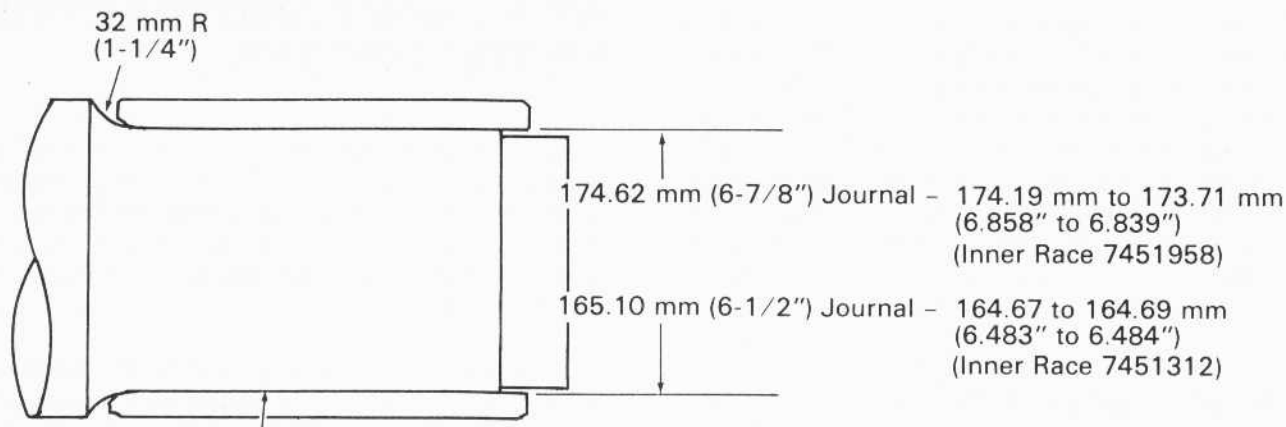
Generally, the maximum axle diameter reduction at the support bearings should not exceed 1.6 mm (1/16"), due to axle loading on some locomotives. However, for 2 axle trucks not subjected to speeds over 113 kph (70 mph) operation, undersize axles up to 3.2 (1/8") can be used. Support bearings are available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

Wheel seat should be checked for taper and reworked if taper exceeds 0.17 mm per meter (.002" per foot) on diameter.

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



Do not finish this surface with roller or burnisher. This diameter to be measured when axle is cold. 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.

25279

Fig.26 – Journal Box Bearing Axle Journal For
0.51 mm (.020") Undersize Inner Race

4.0 mm (5/32") maximum. The increased wheel seat length is to ensure that an undersize wheel bore does not contact the shoulder.

JOURNAL BEARING INNER RACE

OIL LUBRICATED STRAIGHT ROLLER BEARING

An induction heater is recommended to remove and install the journal box bearing inner race. Refer to Service Data for induction heater part number.

If an induction heater is not available, the bearing inner race may be pressed off the wheel using a filler ring, outer ring, split ring, and pressure block as shown in Fig. 27. Refer to Service Data for tool part numbers.

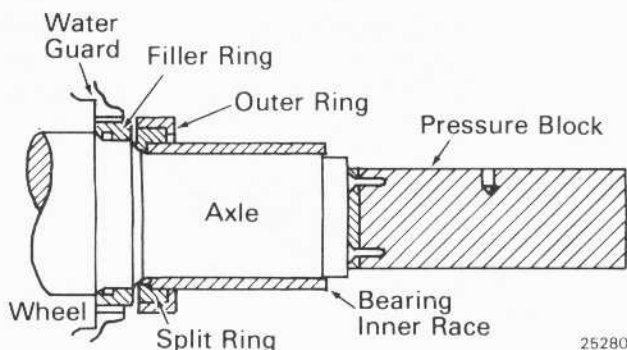


Fig.27 – Journal Box Bearing Inner Race Removal

1. Inspect the inside diameter surface for fretting. If fretting is evident on more than 20% of the total surface the race should be discarded. If the journal shows fretting not over 25.4 mm (1") wide and outside diameter of the axle measures the minimum diameter where fretting exists, either a new race, or a race that has been removed from another axle should be applied. When applying a used 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 race for further use.
3. Measure the inside diameter of the bearing inner race with a micrometer.

On current 174.62 mm (6-7/8") journal box bearing axles, the inside diameter of the bearing 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").

On 165.10 mm (6-1/2") journal box bearing axles, the inside diameter of the bearing 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").

- Inspect for hardness with a scleroscope or hardness tester similar to an Ernst tester. Measure the bearing inner race 76 mm to 102 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 Scleroscope (Rockwell "C" 56).

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 asbestos gloves is recommended for handling the hot race. A split collar, shown in Fig. 28, clamped around the journal will space the race the proper distance from the journal fillet. Refer to Service Data for journal box bearing 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. 28, for dimension of inner race to fillet.

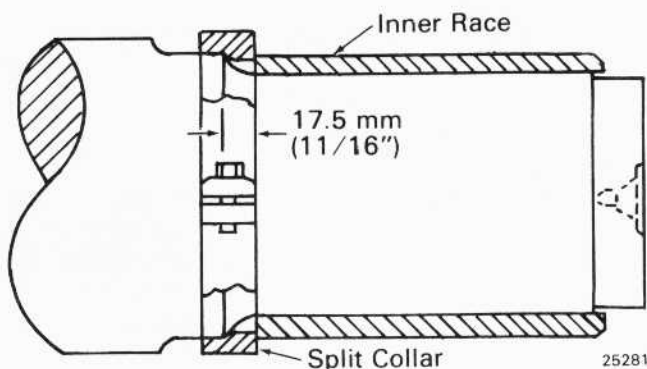


Fig.28 - Locating Journal Box Bearing Inner Race

AXLE GEARS AND TRACTION MOTOR PINIONS

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.

The new series of gauges is identified by the letter "A" following the gauge part number. The letter indicates the gauge is manufactured to the theoretical tooth contour. Some of the new gauges are applicable to gears and pinions for which no gauge existed previously; however, all of the gauges will have the suffix letter "A" after their part number.

- 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.
- 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, pitted, or there is evidence of shelling. Slight pitting or scratches are permitted on the entire working surface.
- 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.
- Inspect the bore in the axle gear for scoring. The bore surface must be 90% intact and have a 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.

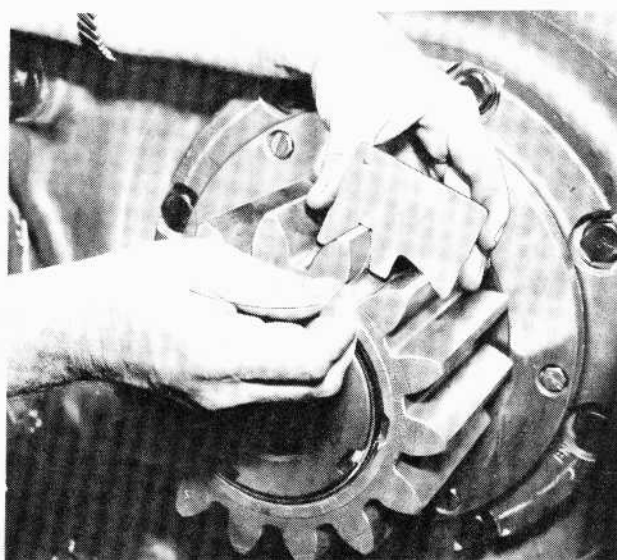
Fatigue cracks on axle gears and traction motor pinions usually start in the fillet at the root of the teeth on the motor side, approximately 13 mm (1/2") from the end, and progress to the side. Fatigue cracks in the axle gear or pinion at the root of the teeth are dangerous and the axle gear or pinion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

TRACTION MOTOR PINION TOOTH PROFILE 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. 29. If a feeler gauge is used, width of the gauge should not exceed 3 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.29 – 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. 30. 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.
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.

| <u>No. Of Teeth</u> | <u>Min. Tip Thickness</u> |
|---------------------|---------------------------|
| 12 – 13 – 14 | 0.8 mm (1/32") |
| 15 – 16 – 17 – 18 | 3.1 mm (1/8") |
| 19 (9332202) | 4.0 mm (5/32") |
| 19 (all others) | 3.1 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 and those not meeting requirements should be scrapped.

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

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. 31. If a feeler gauge is used, width of the gauge should not exceed 3 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.

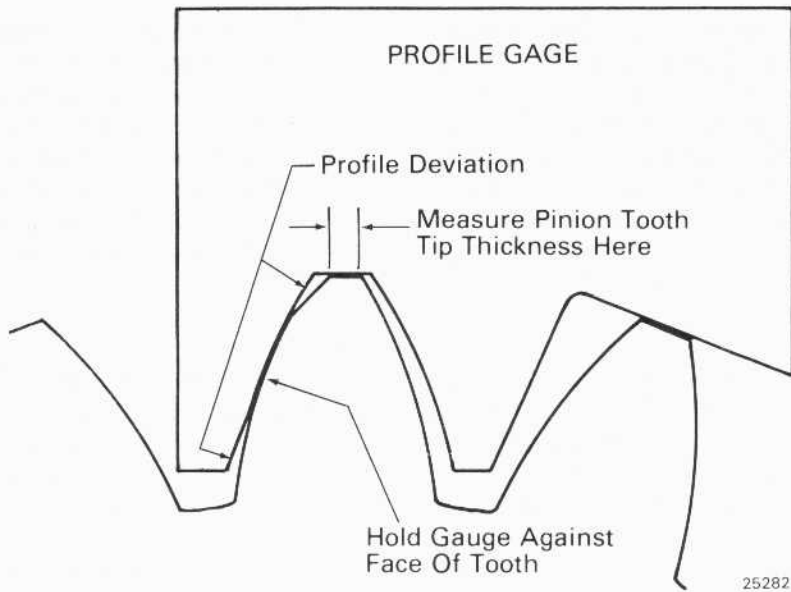


Fig.30 – Measuring Profile Deviation And Wear Of Traction Motor Pinion

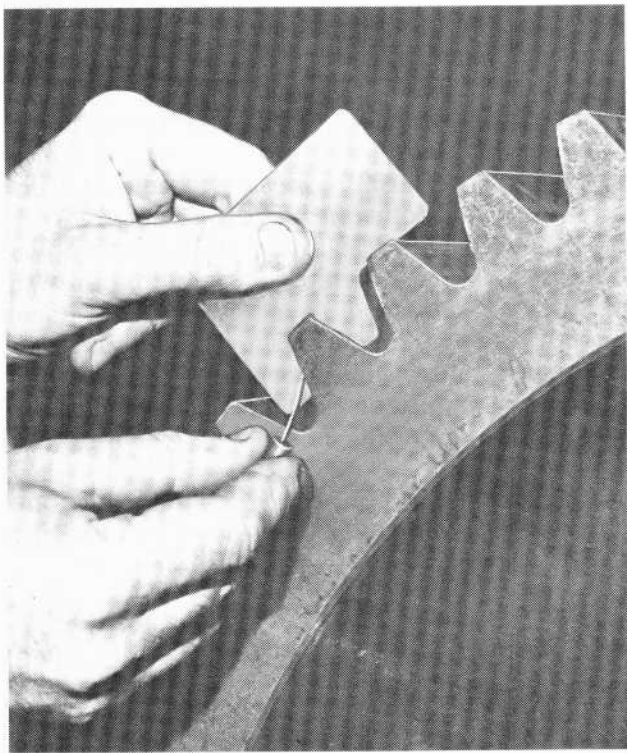


Fig.31 – Axle Gear Tooth Contour Gauge

1. Place the tooth contour gauge against one flank of the axle gear tooth as shown in Fig. 32. 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. 33, 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. 33. 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.

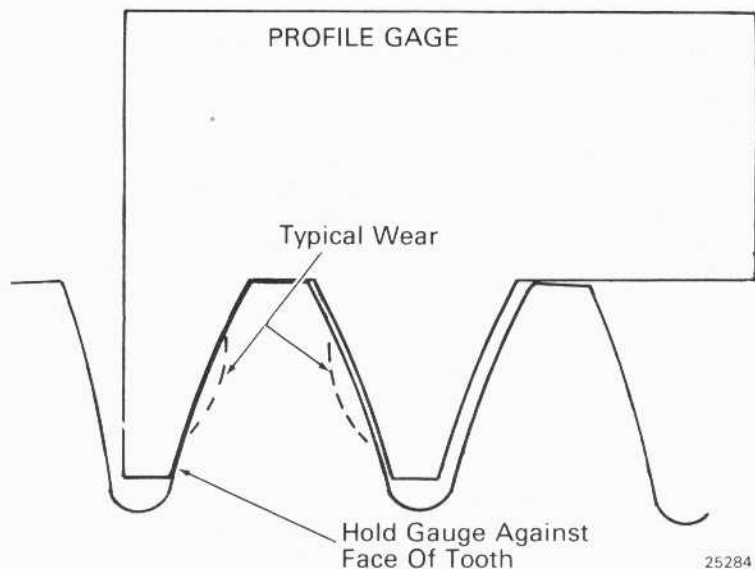
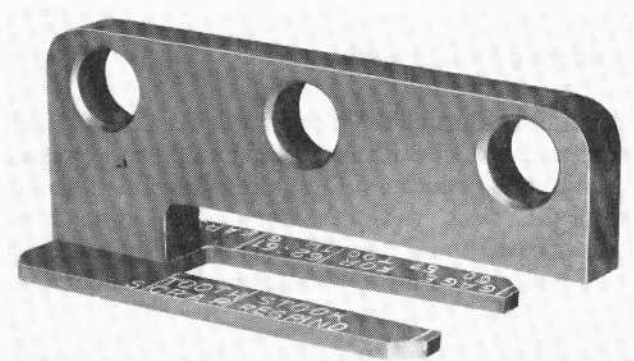
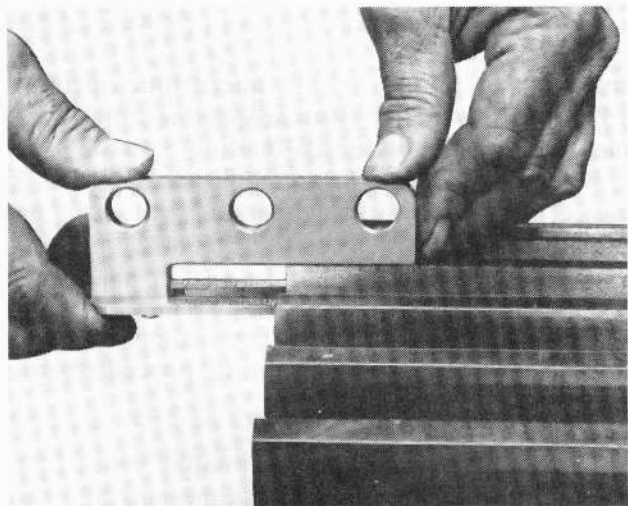


Fig.32 – Measuring Profile Deviation And Wear Of Axle Gear



24230



24231

Fig.33 – Axle Gear Wear Gauge

The interference between the wheel bore and the wheel seat should be between 0.241 mm (.0095") 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 metre (.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").

Referring to Fig. 34 for mounting dimensions, assemble wheel set as follows:

NOTE

A lubricant such as mounting compound must be used when mounting wheels and axle gears.

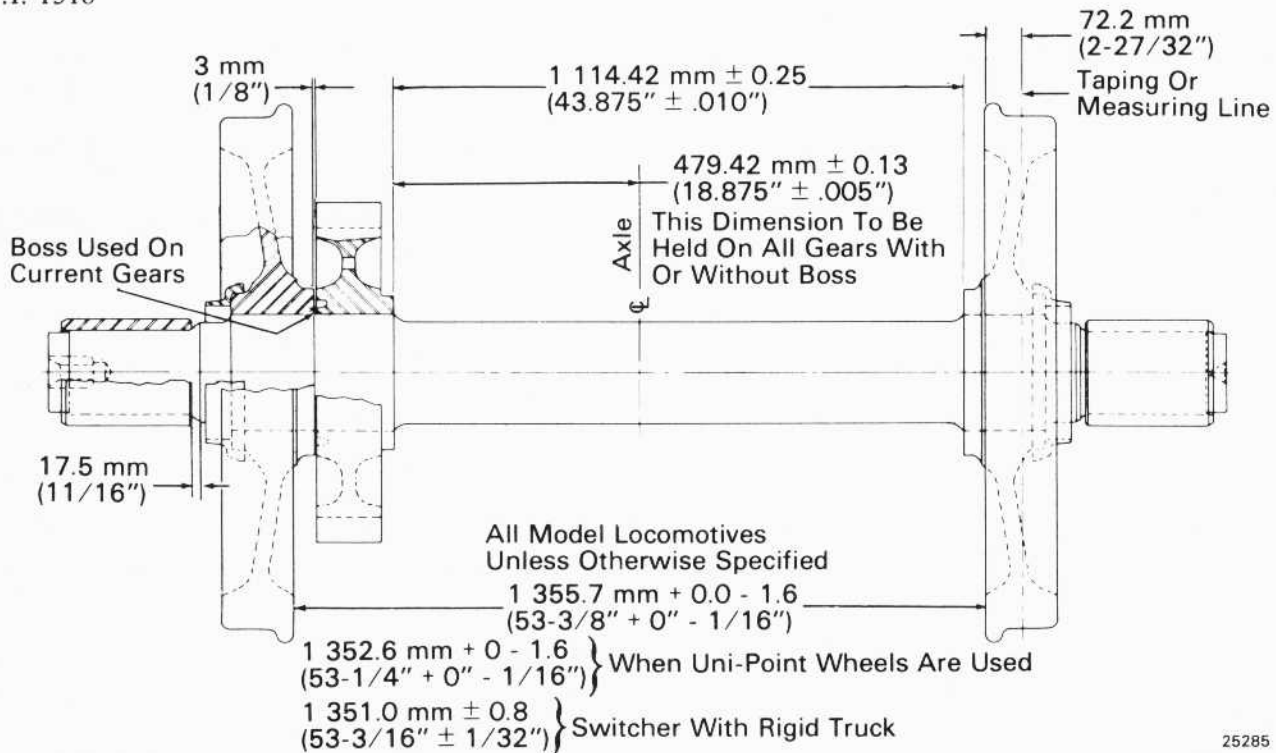


Fig.34 - Dimensions For Assembling Wheel Sets

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.
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).
5. Press on the wheel next to the gear.

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. 35. 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. Load equalization can be accomplished by shimming between the journal spring seat and the journal box 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 boxes on the same axle. There should be no shims added to the largest pair when

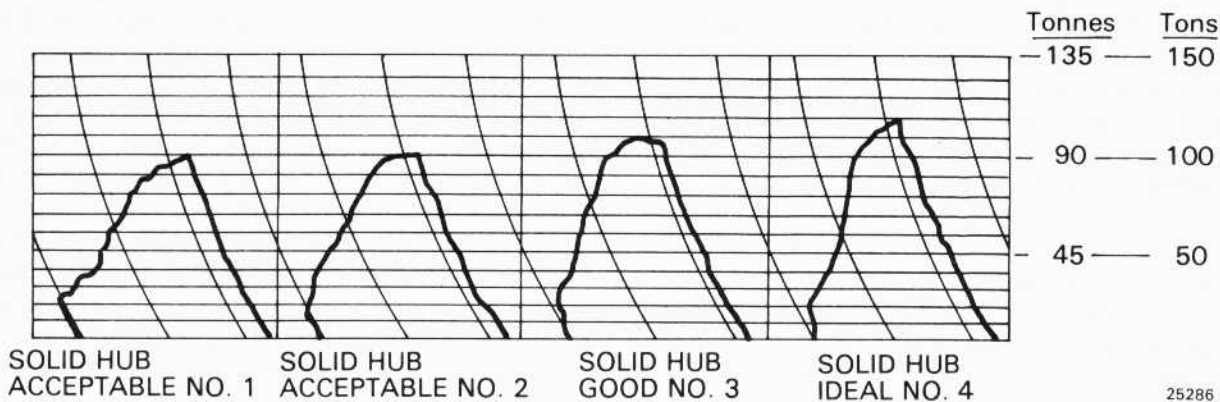


Fig.35 – Typical Wheel Mounting Pressure Graph

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 boxes.

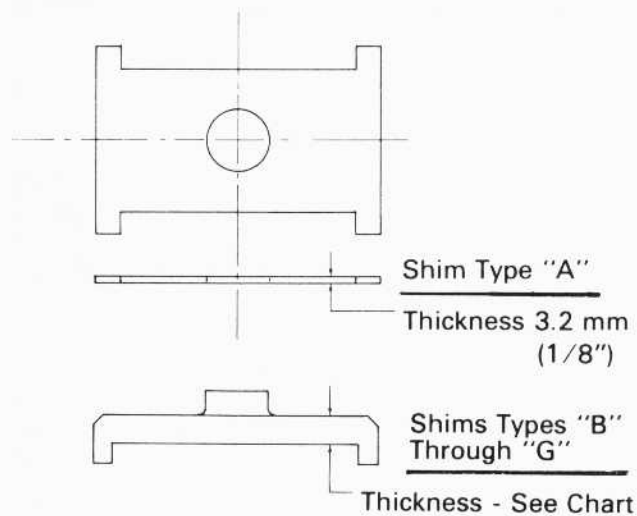
APPLICATION OF SHIMS

The shims shown in Fig. 36 are designed for application between the journal box and the journal

spring seat. In order to apply the required shims at each journal box location, each axle requiring shimming should be moved over a single axle drop table. Suitable U-shaped steel bars should be placed between the truck frame pedestals and the spring seat as shown in Fig. 37. 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 box.

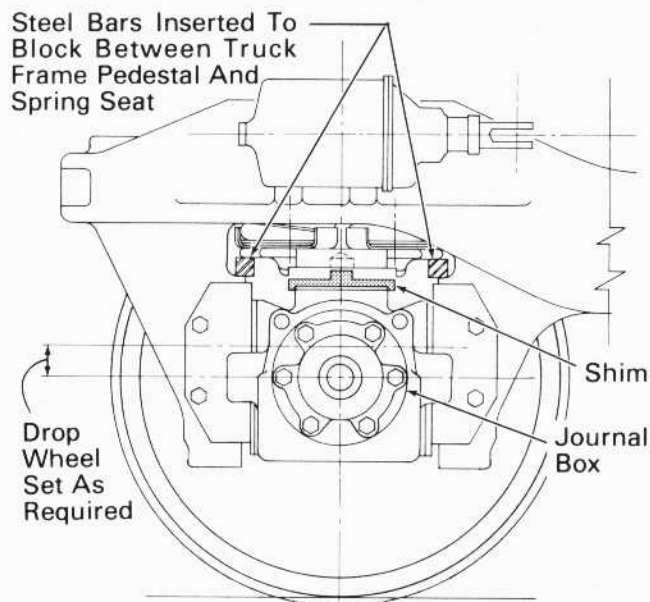
WARNING

Care should be exercised in securely blocking the spring seat due to the heavy spring forces involved. Blocking must be placed between the truck frame casting and the spring seat and not against the pedestal liners. This will prevent



17055

Fig.36 – Wheel Size Compensating Shims



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

17056

Fig.37 – Application Of Shims

possible cracking of the pedestal liners as well as "cold flowing" of "Nylatron" pedestal liners which will result in short life. Special care should be taken when applying the bars to make sure they cannot "pop" out when the assembly is lowered causing possible injury.

Referring to Fig. 36, shim type "A" is designed to fit either directly on top of the journal box or on top of shim types "B" through "G." However, the number of shims type "A" applied directly on top of the journal box should be limited to a maximum of two and the number applied on top of shims "B" through "G" should be limited to one.

After the shims are in place, the drop table is then raised to engage the journal box, shim and spring seat. The bars used to block the spring seat can then be removed. Journal boxes on the same axle must be shimmed equally.

Shims "B" through "G" are designed to fit directly on top of the journal box. Therefore, any "A" type shims that may have been previously applied on top of the journal box should be removed before applying shims "B" through "G."

SERVICE DATA

REFERENCE

| | |
|--|-----------|
| New Departure - Hyatt Journal Boxes With Resilient Rubber Thrust Units | M.I. 1552 |
| Grease Lubricated Cartridge - Type Journal Bearings | M.I. 1553 |

SPECIFICATIONS

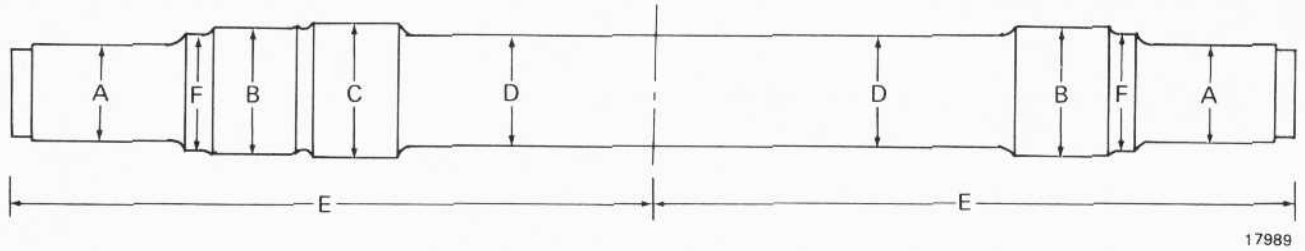
RECOMMENDED WHEEL SIZE LIMITS (Tapes)

| | <u>NEW</u> | <u>MAX. VARIATION</u> |
|---------------------------|------------|----------------------------|
| Wheels on same axle | | |
| 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



17989

| REBUILD AXLE LIMITS DIMENSION A | | | | | |
|---------------------------------|--------------------------|----------------------------------|----------------------------------|-------------------------|-----------------------|
| | Friction Bearing Journal | Straight Roller Bearing | | Tapered Bearing | |
| | | 165.10 mm (6-1/2") Journal | 174.62 mm (6-7/8") Journal | Class F | Class G |
| New | 165.10 mm (6.500") | 165.20 mm (6.504") | 174.73 mm (6.879") | 157.264 mm (6.1915") | 177.90 mm (7.004") |
| | 164.97 mm (6.495") | 165.18 mm (6.503") | 174.70 mm (6.878") | 157.239 mm (6.1905") | 177.88 mm (7.003") |
| Maximum | 165.10 mm (6.500") | 165.20 mm (6.504") | 174.73 mm (6.879") | 157.264 mm (6.1915") | 177.90 mm (7.004") |
| Minimum | 158.75 mm (6.250") | 165.164 mm (6.5025") | 174.688 mm (6.8775") | 157.239 mm (6.1905") | 177.88 mm (7.003") |
| Max. Taper/Ft. | 0.8 mm (1/32") | 0.03 mm (.001") | 0.03 mm (.001") | 0.03 mm (.001") | 0.03 mm (.001") |
| Max. Out-Of-Round | 0.13 mm (.005") | 0.03 mm (.001") | 0.03 mm (.001") | 0.03 mm (.001") | 0.03 mm (.001") |

| 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 (.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") | 201.62 mm (7.938") |
| Taper Per Ft. Maximum | 0.05 mm (.002") | 0.05 mm (.002") | 0.05 mm (.002") | 0.05 mm (.002") | 0.13 mm (.005") | 0.13 mm (.005") |
| 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 Friction Bearings | SW Tapered Roller Bearings | Pass. | F GP SD MP |
| New | 1 177.9 mm ± 0.8 | 1 133.5 mm ± 0.4 | 1 143 mm ± 0.4 | 1 155.7 mm ± 0.4 |
| | (46-3/8" ± 1/32) | (44-5/8" ± 1/64) | (45" ± 1/64) | (45-1/2" ± 1/64) |
| Maximum | 1 178.7 mm (46-13/32") | 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 | 1 171.6 mm (46-1/8") | 1 133.1 mm (44-39/64") | 1 136.6 mm (44-3/4") | 1 149.4 mm (45-1/4") |

| REBUILD AXLE LIMITS DIMENSION F | | | | |
|---------------------------------|--------------------------|---|-------------------------|-------------------------|
| | Friction Bearing Journal | 165.10 mm, 174.62 mm (6-1/2", 6-7/8") Roller Brg. Journal | Tapered Class F Bearing | Tapered Class G Bearing |
| New | 196.98 mm (7.755") | 200.02 mm (7.875") | 190.55 mm (7.502") | 203.25 mm (8.002") |
| | 196.72 mm (7.745") | 199.90 mm (7.870") | 190.50 mm (7.500") | 203.20 mm (8.000") |
| Maximum | 196.98 mm (7.755") | 200.02 mm (7.875") | 190.55 mm (7.502") | 203.25 mm (8.002") |
| Minimum | 196.09 mm (7.720") | 199.64 mm (7.860") | 190.50 mm (7.500") | 203.20 mm (8.000") |

EQUIPMENT LIST

| | |
|---|---------|
| Gauge, Journal Box Bearing 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 |
| Journal Box Bearing Inner Race Removal Tools | |
| Outer Ring | 8048301 |
| Split Ring | 8048302 |
| Filler Ring | 8048303 |
| Pressure Block | 8107834 |
| Journal Box Bearing Inner Race Induction Heater | 8254202 |

TOOTH CONTOUR GAUGES**TRACTION MOTOR PINIONS**

| <u>Number Of Teeth</u> | <u>Pinion Part No.</u> | <u>Gauge Part No.</u> | <u>Series</u> |
|----------------------------|---|---------------------------|---------------|
| 12 | 8168517 & 8452310 (Integral with shaft) | 8362636 | A |
| 13 | 8428702 | 9098509 | A |
| 14 | 8179135, 8326123 & 8452311 | 8361636 | A |
| 15 | 8452312, 9096751, 8459295 & 8458508 | 8344485 | A |
| 16 | 8452313, 8210792 & 8341961 | 8347119 | A |
| 17 | 8452314 & 8206504 | 8347120 | A |
| 17 | 9315722 | 9526379 | A |
| 18 | 8452315 | 8375380 | A |
| 18 | 9332201 | 8526378 | A |
| 19 | 9326333 | 8370612 | A |
| 19 | 9332202 | 9526377 | A |
| 20 | 9326334 | 8485575 | A |
| 20 | 9332203 | 9526376 | A |
| 21 | 9326335 | 8485576 | A |
| 22 | 9326336 | 8485577 | A |
| 25 | 9326337 | 8485578 | A |

AXLE GEARS

| <u>Number Of Teeth</u> | <u>Gear Part No.</u> | <u>Gauge Part No.</u> | <u>Series</u> |
|----------------------------|----------------------------|---------------------------|---------------|
| 70 | 9315723 & 9520045 | 9526383 | A |
| 69 | 9332207 & 9520044 | 9526382 | A |
| 67 | 9332206 & 9520043 | 9526381 | A |
| 66 | 9332205 & 9520042 | 9526380 | A |
| 65 | 8178812 | 8362635 | A |
| 64 | 8428701 | 9098508 | A |
| 63 | 8200600, 8326122 & 9081796 | 8361635 | A |
| 62 | 8109579, 8459296 & 9318170 | 9523997 | A |
| 61 | 8184341, 8210783 & 8453042 | 9523996 | A |
| 60 | 8179295 & 8206505 | 9523995 | A |
| 59 | 8184333 | 8375379 | A |
| 58 | 8184378 | 8370613 | A |
| 57 | 8184325 | 9321569 | A |
| 57 | 8341962, 8368989 & 8491290 | 8491552 | A |

Axle gears within the regrinding limits may be returned to Electro-Motive, La Grange for regrinding.

Figures 2 through 16 courtesy of The Association of American Railroads.

• • • • **A Service Department Publication** • • • •

Electro-Motive Division Of General Motors La Grange, Illinois 60525