

MAINTENANCE INSTRUCTION

WHEELS, AXLES, AXLE GEARS AND PINIONS

GENERAL DESCRIPTION

An assembly of two wheels on an axle is generally considered a "wheel set," Fig. 1, in railroad parlance. For Diesel locomotives, an axle gear is also mounted on the axle except in "idler" wheel sets used in six wheel trucks under passenger locomotives. In this Maintenance Instruction a "wheel set" will be considered to include an axle gear unless otherwise stated.

Wheels

The wheels used in EMD locomotives are classed according to two nominal diameters, 36" and 40". 36" wheels are used in six wheel passenger trucks with an idler axle and 40" wheels are used in four wheel and six wheel trucks having all power axles. All wheels on six wheel "E" type trucks have taper treads. Two types of wheel treads are recommended for 40" wheels, depending on maximum permissible speed of locomotive operation. All switching locomotives have taper wheel treads.

1. Taper treads on the wheels of all F, BL and GP locomotives having maximum permissible speeds of 70 MPH or less (61:16 gear ratio or lower).
2. Cylindrical treads on the wheels of all F, BL and GP locomotives having maximum permissible speeds of 75 MPH or over (60:17 gear ratio or higher).

Axles

The axles for freight and passenger locomotives are the same general type E-12 with modifications. The power axles used for 36" and 40" wheels differ in some dimensions although the diameters

of wheel seats and journals are the same on both types as are the axle gear seat diameters, see Fig. 2. Axles used in switcher locomotives are designated as E-12X. The diameters of wheel and axle gear seats are the same as those on freight and passenger locomotive axles.

Axle Gears

The same design is used for the axle gears of all locomotives, the gears differing only in pitch diameter and number of teeth.

ROUTINE MAINTENANCE

Inspection

Wheels and axles are inspected for visible defects each trip, as part of the inspection required by Federal Locomotive Inspection Law. Wheels are also periodically checked for wear, sharp flanges, shelling, cracks, and flat spots to see that they are within the limits prescribed by the Interstate Commerce Commission, Bureau of Locomotive Inspection. Usually, the railroads will set up wear limits which are well within the maximum allowed by ICC rules.

Defects Requiring Removal Of Wheel Sets

Wheel and axle defects which require the removal of any particular wheel set are listed in the Wheel and Axle Manual, published by the Association of American Railroads, 59 East Van Buren Street, Chicago, Illinois. They are also published in the "Interstate Commerce Commission, Bureau of Locomotive Inspection - Laws, Rules and Instructions for Testing of Locomotives Other Than Steam." The latter publication is

THIS ISSUE COMPLETELY REVISED AND SUPERSEDES ALL *
PREVIOUS ISSUES.

April, 1956

obtainable from the Superintendent of Documents, Government Printing Office, Washington, D.C. In addition to the defects listed, we recommend that wheels in service should have a variation no greater than 2 tapes (1/4" in circumference, or .080" in diameter) between wheels on the same axle.

NOTE: For complete information and for use of gauges used for checking wear and defects, see AAR Wheel and Axle Manual. The AAR gauge and the wheel defect gauge may be purchased from Pratt & Whitney Company.

Defects in axle gears may also require removal of wheel sets. Such defects usually are in the form of a gear failure or damage to the gear due to breakage of the motor pinion.

Removal of Wheel Sets

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

Jacking pads are provided on the body of the locomotive for the purpose of removing the weight of the locomotive from the truck prior to dropping any one of the wheel sets. Under no circumstances should any of the wheel sets be dropped from the truck without first supporting the weight of the locomotive on these jacking pads. If these instructions are not closely followed, serious damage may result.

IMPORTANT: Ends of axles are bearing surfaces and should be protected when journal box is removed.

MAINTENANCE OVERHAUL

Removal Of Wheels And Axle Gears

After the wheel set has been removed from the locomotive, it may be necessary to press off the wheels and axle gear as well as to remove the roller bearing inner races. This will permit thorough inspection of all parts both visually and by magnaflux or mag-naglow.

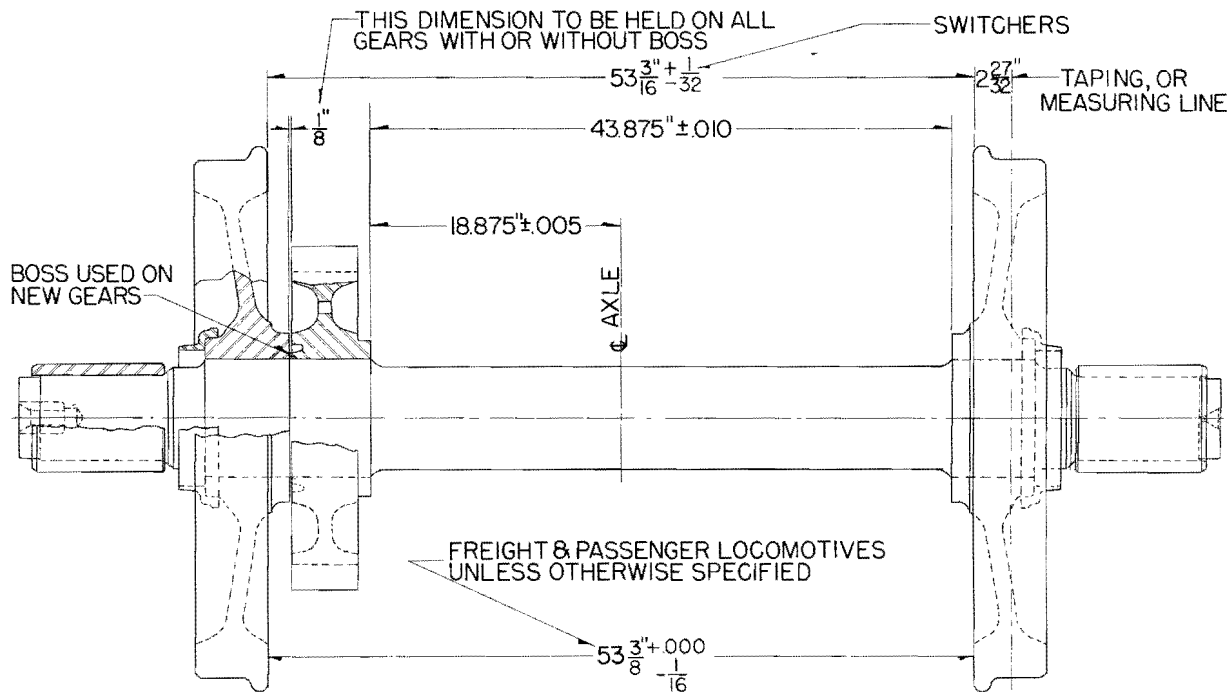


Fig. 1 - Axle Gear And Wheel Assembly

In some instances, it may be economical to dismount one or both wheels of a pair. This condition arises when inspection shows that a considerable reduction in diameter will be required to remedy a defect in one wheel only. If both wheels are turned to the required diameter, a considerable loss of service metal will result in the other wheel. See AAR Wheel and Axle Manual, paragraph 288, for analysis of this condition.

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 wheel set should be pressed off by removing the gear with it. The same wheel press yoke used in removing individual wheels may be used against the gear. If the wheel press capacity is not sufficient to remove wheel and gear simultaneously, it may be necessary to remove the wheel 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. The blocks are removed and pressure is applied to the gear hub. Break the gear loose and push both wheel and gear off.

After the 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.

Visual Inspection

The wheels, axle and axle gear of each wheel set must be given a thorough visible check for any defects not visible on previous inspections.

The wheels and axles should be inspected as outlined in the Wheel and Axle Manual. Because of possible dangers resulting from axle cracks, it is our

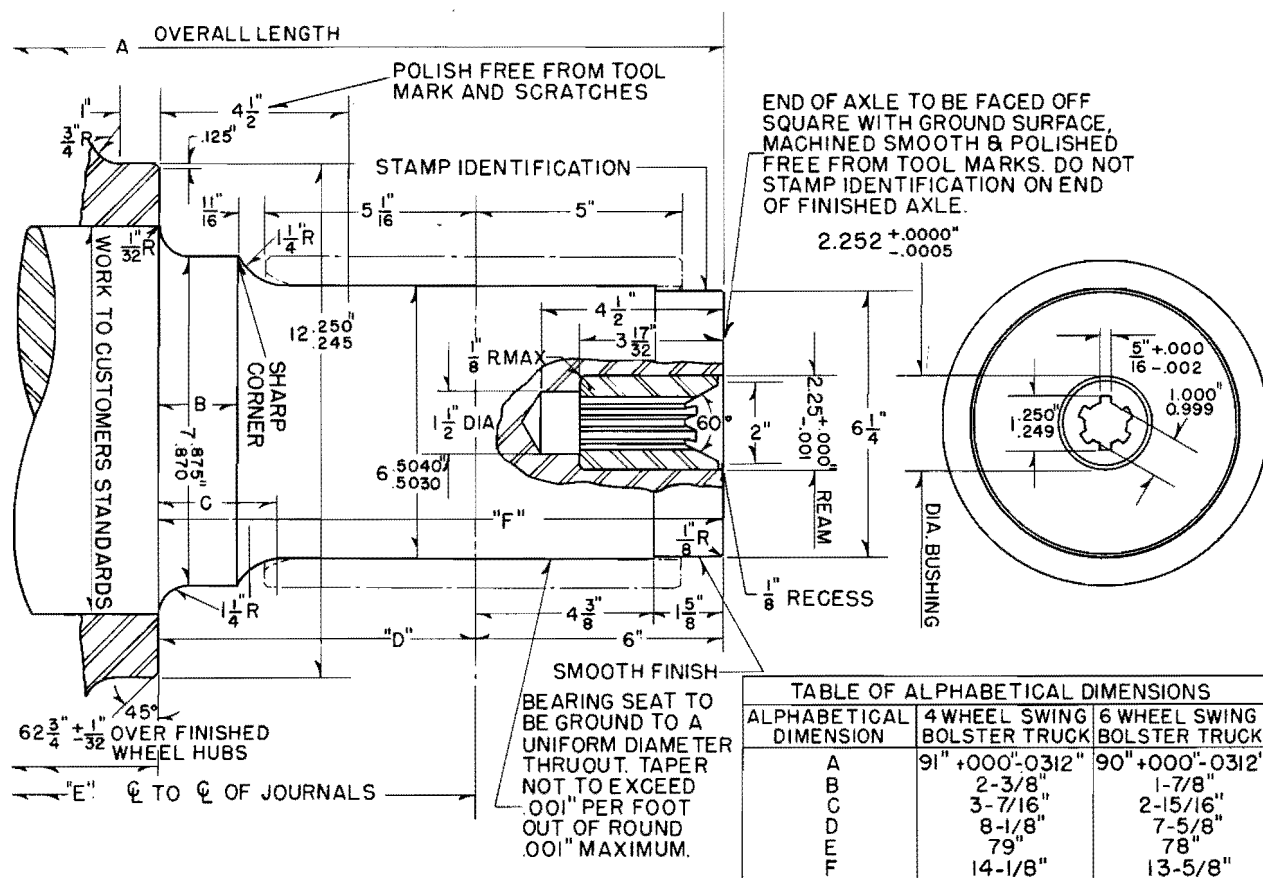


Fig. 2 - Combination Type Axle Dimensioned - Four And Six Wheel Trucks

recommendation that axles be given a magnaglo or magnaflux test whenever a wheel is removed. This should be done each time a wheel is changed, regardless of length of service. When a wheel is removed from an axle for any reason, it is imperative that the roller bearing inner race also be removed so the ends of the axle under the bearing race can be visually inspected for fretting and magnaflux tested along with wheel seat.

Fretting, which shows up on the I.D. of the inner race and the O.D. of the axle journal at high service mileage, reduces the solid contact between the journal and the inner race, causing the race to loosen.

This condition cannot be observed unless the race is removed from the axle.

If fretting is evident on more than 20% of the I.D. of the race, it should be discarded. If the journal shows fretting not over an inch wide and the O.D. of the axle measures the present minimum diameter of 6.503" 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.

Whenever the inner race is removed, it is recommended that induction heater 8131924 be used. If the heater is not available, the race can be removed with the split collar as shown in Fig. 3.

When both wheels are removed from an axle because of wear to their condemning limits, it is imperative that both bearing inner races be removed for the magnaflux test.

Danger of axle fatigue can be determined by a deposit of red metal dust on wheel seat, which indicates the wheel has worn loose. Moisture has entered and rusted the metal.

Each time a wheel set is removed from a truck for any reason, the gear should be thoroughly inspected. Railroad condemning limits for gears and pinions are given in the inspection procedure below:

1. Visually inspect for broken, chipped, spalled or pitted teeth. Pinions and axle gears should be condemned when more than 20% of the total working

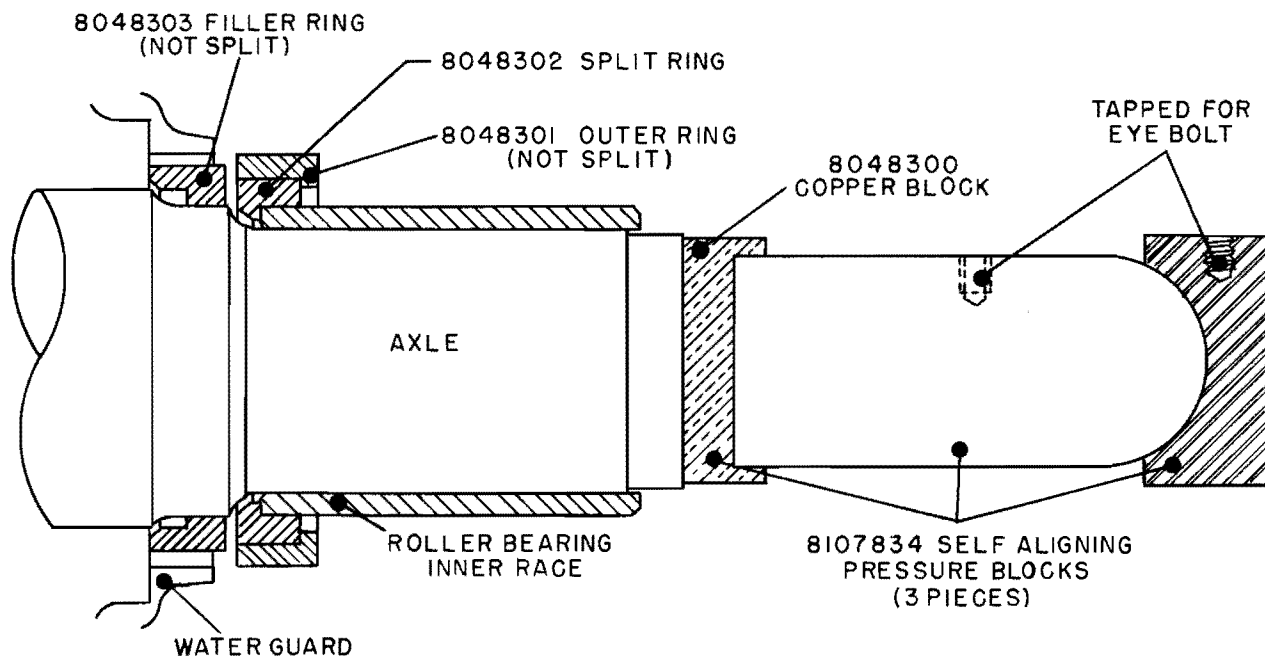


Fig. 3 - Inner Race Removal

surface of tooth is spalled or pitted. Axle gears should be scrapped when either one of the working surfaces is worn to the point where a step 1/32" deep exists in the root of the gear tooth where contact with the pinion ends.

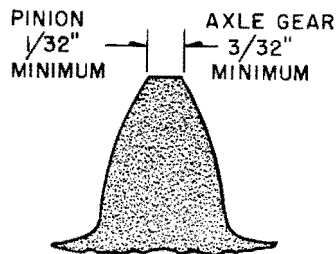


Fig. 4 - Pinion and Axle Gear Wear Limit

2. Check for wear limits, determined by dimension across the tip of the tooth. The minimum allowable dimension at this point is 3/32" for axle gears and 1/32" minimum for pinions, see Fig. 4.
3. Inspect for cracks by magnaglo or magnafluxing.

Magnaflux Inspection

The Magnaflux Corporation should be contacted for suitable equipment and technical aid.

The magnaflux or magnaglo method of inspection is very searching, and indiscriminate scrapping of parts showing magnaflux or magnaglo indications without regard to their effect to part function may be very costly to the railroad. If doubt exists concerning the significance of a specific magnaflux or magnaglo indication, the railroad's Engineer of Tests should be consulted.

If the number of axles, axle gears and pinions to be inspected does not warrant magnaglo equipment, magnaflux can be used. Wet magnaflux would be best, but requires similar equipment to magnaglo. Operator technique is important when using magnaflux powder in that crack indications can be masked by too

much powder, or overlooked if too little or an uneven application of powder is made. A bulb type applicator will give satisfactory results if used properly.

Any supply of current can be used if it is in the range necessary for magnetizing the part. (See following chart for recommended amperage.)

Part	Magnetization	Current
Axle	Four turn coil - *Continuous	500-600
Axle Gear	Three turn coil - *Continuous	200-300
	Hair-pin coil - **Residual	150-200
Pinions	Three turn coil - *Continuous	200-300
	Hair-pin coil - **Residual	150-200
	Mounted on brass bar - Continuous	2000-3000

* Inspection medium applied while part is being magnetized.

** Inspection medium applied after part is magnetized.

The inspection mediums in order of sensitivity are magnaglo bath, wet magnaflux bath and dry powder method. All are applicable to the above methods and the choice will depend on facilities and conditions under which the inspection is to be made.

Crack indications on an axle in the transverse plane are dangerous and the axle should not be returned to service. The axle must be scrapped, unless individual railroad specifications permit reworking to entirely remove the crack.

Plain bearing journals or suspension bearing journals may have small thermal cracks which are not circumferential, but which are equally dangerous. The axle should be scrapped if suspension

bearing journals or the journals of the axles for friction type boxes show evidence of bearing seizure accompanied by thermal cracks.

If an axle has been run hot, either a motor support bearing, or a plain brass bearing, as used on a switcher, there is a very great possibility of copper penetration in the axle steel, making the steel very brittle and likely to break.

It is suggested this axle first be checked for a bent condition. If the axle has over .030" total runout, it should be discarded, but under no condition should this axle be reused until inspected for copper penetration by the Railroad Engineer of Tests, and he gives approval to use this axle.

Fatigue cracks on axle gears and pinions usually start in the fillet at the root of the teeth on motor side approximately 1/2" from the end and progress onto the side face of the gear. Any such 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.

Service Life Of Axles and Axle Gears

The service life of axles and axle gears will vary with the type of locomotive service.

Axles and axle gears should be subjected to a very close magnaflux or magnaglo inspection (magnaglo preferred) each time wheels are removed. After the second pair of wheels are worn to their condemning limit and the axle and axle gear are free from cracks or defects and the gear is not to the condemning limits, the railroad may, at their discretion, apply new wheels, using the axle and axle gear as long as no defects show up.

If axles are not magnafluxed at each wheel removal, it is recommended that the axle be scrapped after two pair of

wheels have been worn to their condemning limit.

The axle gear, if not subjected to magnaflux or magnaglo, should not be used beyond the life of two axles.

Wheel Work

When a pair of new wheels are to be mounted on an axle, they must be carefully mated with a maximum variation of 1/2 tape (1/16" in circumference, or .020" in diameter). If new wheels are not available within these limits or variation, or if old wheels are to be used, they should be matched as closely as possible, turned and ground after mounting.

For the operation of modern high speed trains the concentricity of wheels is extremely important. This requires particular vigilance if the wheels are turned in an ordinary wheel lathe, especially if the wheel lathe has seen long service.

The wheels should be mounted so that they are evenly spaced with regard to the **AXLE CENTER LINE**. When wheels are pressed on or off, particularly the latter, be careful to apply the pressure uniformly over the end of the axle to avoid upsetting it. Always use a self-aligning pressure block, Fig. 3, 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 outside of the inner race as a high spot on the operating surface. This would not only invite early failure of the race, but might even interfere with the assembly of the box over the journal.

If the axles are not to be 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.

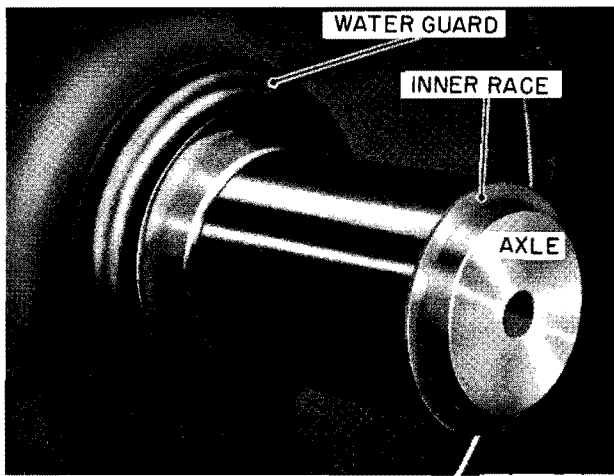


Fig. 5 - Inner Race And Water Guard

The water guard, Fig. 5, remains in place for the life of the wheel. When new wheels are applied the water guards can be pried off after being heated sufficiently with a torch to release the shrink fit. The same water guards can be re-used on the new wheels. Remove the water guard from the wheel hub after the wheel has been removed from the axle. To apply the water guards, heat them in an open flame or by torch to a black heat at 500° F. to 700° F. and shrink them in place on the wheel hub. They should be pushed tightly against end of wheel hub.

Be sure to use the proper water guard. Water guard 8102844 should be

applied to 36" wheels used on all E class passenger locomotives.

Water guard 8102908 should be applied to 40" wheels used on all 4 wheel freight type trucks and SD six wheel trucks.

Switcher locomotives with friction bearings do not use a water guard.

Water guards are not used where the roller journal bearings are grease lubricated.

Axle Work

In order to insure accurate axle measurements, the micrometers used should be checked against a known standard. Axles should always be measured when they are cold, never when they are warm from machining. All the fillets and axle ends must be polished free from 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 assure that the axle is centered in the truck after assembly.

Present experience indicates that axles which have developed run-outs to a maximum of .030" total indicator reading

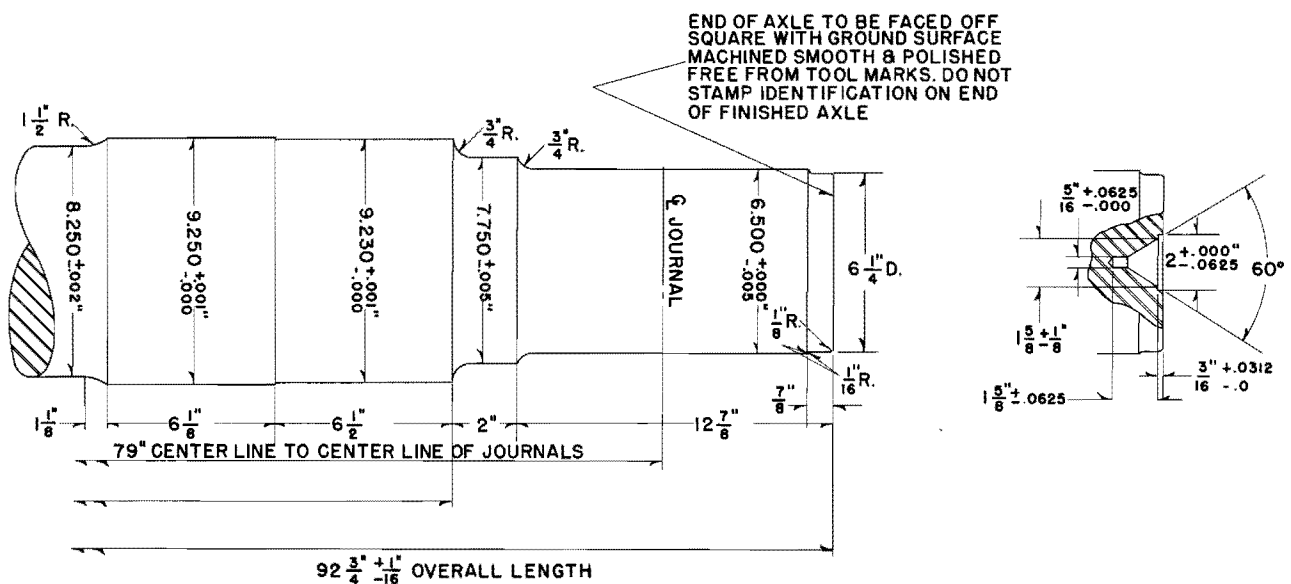


Fig. 6 - Dimension For Switcher Axles

with journals at zero, may be continued in service with no detrimental effect on suspension or journal bearings provided that a thorough magnaflux inspection of the axle has shown that no defects exist.

All dimensions and directions shown in Fig. 2 are self-explanatory, but it should be noted that there is an inch (1") difference in the length of axles used in the four wheel swing bolster truck and the six wheel passenger truck. Table of Alphabetical Dimensions shows that B, C and D are the dimensions that are different on the two axles. The dimensions for the switcher axle are shown in Fig. 6. For other dimensions, see Specification Table.

Axle Journal Condemning Limits

The minimum axle journal diameter is to be governed by the fit between the axle journal and the inner race. IT IS IMPERATIVE that the interference fit be not less than .003". This is to insure the inner race is tight, and under normal conditions, should not work loose on the axle.

The absolute minimum diameter of an axle journal should not be less than 6.502", and the I.D. of the race applied to this axle should not be greater than 6.499".

If an axle journal with friction bearings has been cut because of a hot bearing, this axle journal should NOT be cut

down and the axle reused until the Railroad Engineer of Tests has given his approval of its use. This precaution should be followed.

Axle journals that have been worn MECHANICALLY may be reduced to not less than 6.250" diameter. At least a 3/4" fillet radius must be maintained. All tool marks MUST be polished out of the fillet. If an axle journal has worn to 6.125" diameter, this axle must be removed from service and condemned.

Mounting Of Wheels On Axle

See AAR Wheel and Axle Manual, Section XV for detailed information on mounting procedure.

The allowable pressure range for wheel application, using new or old wheels or axles is 80 tons low limit and 130 tons high limit.

For these pressures the permanent Record of Pressure Graph should be the shape illustrated in Fig. 7. The pressure rise indicated on the graph must be gradual as shown. The four graphs show from ideal to acceptable. The pressures shown on these graphs are actual pressures for steel wheels.

Mounting Of Axle Gears On Axle

The same press equipment can be used in this operation and similar permanent record of pressure graph obtained. For old or new axle gears, the pressure

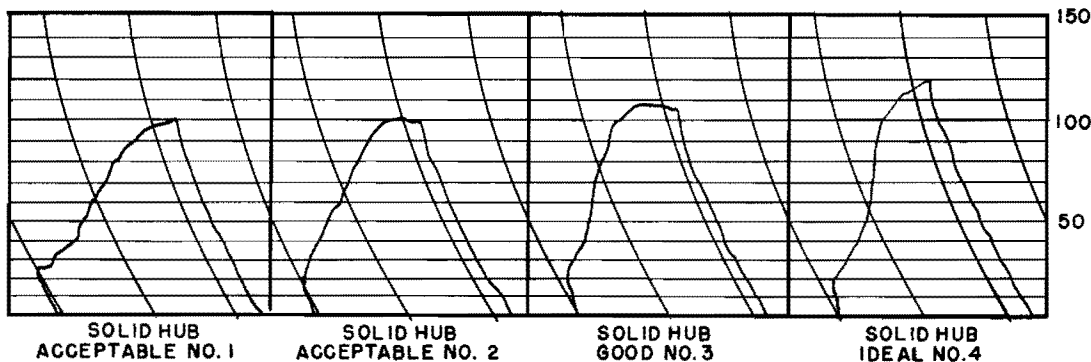


Fig. 7 - Typical Pressure Graph

required should be between 55 tons low limit and 125 tons high limit. When old axle or gears are involved, the surfaces must be in good condition and not scored.

White lead may be used as a lubricant when mounting wheels or axle gears.

A standard spacing has been set up for mounting axle gears and wheels onto an axle. These dimensions are very close, and care should be used when mounting axle gears and wheels to maintain these dimensions.

Before an axle gear is mounted onto an axle, the exact center of the axle, from end to end should be determined. The axle gear is then pressed onto the axle. Measurements are taken from the gear hub to the axle center line to determine how far the gear goes on. This measurement is held to a tolerance of plus or minus .005", as shown in Fig. 1. The wheel at opposite end of axle is pressed on next. Measurements are taken from the hub of this wheel to the gear hub. This measurement has a tolerance of plus or minus .010". The wheel next to the gear is pressed on last.

All axle gears manufactured since late in 1946 have a boss on the spider, just above the axle bore. This boss protrudes 1/8" beyond the face of the gear hub. With the use of this new gear, it is no longer necessary to check the 1/8" clearance between the axle gear and the wheel, as the wheel is being pressed solid against this boss, this clearance will be attained automatically. On all axle gears of previous manufacture, it is necessary that this 1/8" clearance between wheel hub and gear hub be maintained.

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

Removing And Mounting Inner Race

The recommended method of removing the inner race from the axle journal is by using induction heater 8131924. If an induction heater is not available,

the inner race may be pressed off with the wheel by interposing split ring 8048302 between the race and the wheel hub, see Fig. 3.

NOTE: When removing an inner race by pressing it off with the wheel, a careful examination of the inner race should be made to determine whether or not it is in suitable condition to be re-applied.

After removing an inner race always inspect the journal for defects, size, etc., before applying a new race. The new race is applied by heating it in induction heater 8131924 and shrinking it in place. If an induction heater is not available, heat in oil to a maximum of 300° F. and shrink in place. Wipe the oil from the inside of the race before it is reappplied. When heated, the race can be slid into place, taking care not to get it cocked and stuck fast out of the proper position. The use of asbestos gloves is recommended for handling the hot race. A split collar, 8164608, shown in Fig. 8, clamped around the journal will space the race the proper distance from the journal fillet. Due to slight variations in the 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 of the race encroach upon the journal fillet. See Fig. 2 for the dimension of inner race to fillet.

Split collar 8164608 cannot be used for locating the inner race when applied to an axle with a seal ring, used for grease lubricated roller bearings only.

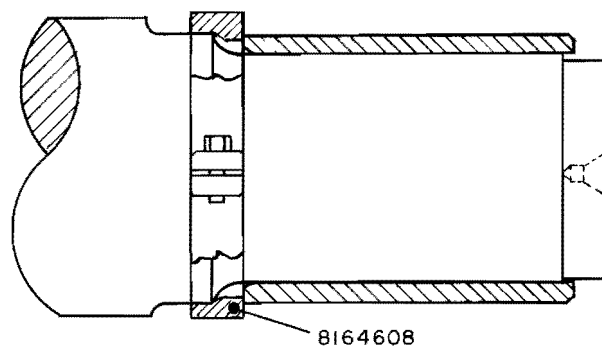


Fig. 8 - Locating Inner Race

The inner edge of the inner race is spaced 1/32" from the edge of the seal ring. This can be gauged by using 1/32" thick strips or a 1/32" thick collar against the seal ring.

Matching Of Wheel Sets In Trucks Or Locomotive Units.

On locomotives with 4-wheel trucks, wheel sizes between different axles may vary up to 3/4" in diameter in any individual locomotive unit. This same rule applies to switchers.

On locomotives having 6-wheel trucks, wheel sizes between different power axles in any truck may vary up to 3/4" in diameter. The variation between the size of either pair of power wheels and the idler wheels must not exceed 1". On new trucks, the variation between power axle wheels should not exceed 3 tapes (3/8" in circumference or .120" in diameter), and a variation between power and idler wheels should not exceed 14 tapes (1-3/4" in circumference, or 9/16" in diameter). New wheels may vary from normal size to 14 tapes oversize.

AXLE DIMENSIONS
(All Dimensions Shown In Inches)

Application	All Types F, BL, GP, SD	Power Axle - All "E" types	Idler Axle - All "E" types	Switcher Axle
Axle Part No.	8054494	8049628	8051302	8068674
Length Overall	91 + .000 - 1/32	90 + .000 - 1/32	90 + .000 - 1/32	92-3/4 + 1/16
Axle Journal Diameter	6.5040 + .000 - .001	6.5040 + .000 - .001	6.5040 + .000 - .001	6.500 + .000 - .005
Condemning Limits	Less than 6.502"	Less than 6.502"	Less than 6.502"	6.125"
Wheel Seat Diameter	9.230 + .001 - .000	9.230 + .001 - .000	9.230 + .001 - .000	9.230 + .001 - .000
Condemning Limit	9.125	9.000	9.000	9.000
Gear Seat Diameter	9.250 + .001 - .000	9.250 + .001 - .000	None	9.250 + .001 - .000
Condemning Limit	9.145	9.020	None	9.020
Support Bearing Diameter	8.000 ± .002 Max. reduction 1/16	8.000 ± .002 Max. reduction 1/16	None	8.250 ± .002 Max. reduction 1/16
Axle Diameter ϕ	8.000	8.000	8.000	8.250
Journal Bearing ϕ to ϕ	79	78	78	79
Wheel Hub Water Guard	8102908	8102844	8102844	None

Due to the axle loading on some of our locomotives, it is not our general recommendation to go below the 1/16" maximum axle diameter reduction at the support bearing. Our Parts Department does stock motor support bearings 3/32" and 1/8" undersize, to serve a few railroads that insisted on an undersize bearing below our recommended minimum.