AM Gears
Shift gear, together MASIERO

GENERAL SPECIFICATIONS FOR INSTALLING AND ADJUSTING BEVEL GEAR AND PINION SETS



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1 - MAINTENANCE

PROPER MAINTENANCE IS ESSENTIAL TO ENSURE MAXIMUM AXLE LIFE.
ONE OF THE MOST IMPORTANT ASPECTS OF MAINTENANCE IS CERTAINLY LUBRICATION, AS INCORRECT OR INSUFFICIENT LUBRICATION CAN CAUSE SERIOUS DAMAGE TO THE AXLE.
IT IS RECOMMENDED TO USE A SUITABLE OIL, TO KEEP ITS LEVEL CONSTANT AND TO CHANGE IT AT REGULAR INTERVALS OF TIME.

1a **Choice of the lubricant:** The quietness and good functioning of the axle components over time are closely related to the quality and correct quantity of the lubricant used.
If you have the specific repair manual for the model under maintenance, please follow the instructions given in it, otherwise we recommend using a lubricant type API GL5 with the correct viscosity for the application.

1b **Periodic check of the lubricant level:** Pay close attention to the level of oil in the axle, as insufficient lubrication can lead to serious consequences and dramatically reduces the life of the axle.
If the oil level in the differential is low or close to the minimum allowed, immediately restore the correct level using the same type and viscosity of lubricant originally used, never mix oils of different types and viscosities.

1c **Change of lubricant:** Changing the oil at regular intervals is essential to keep the axle efficient at all times. During the regular operation of the axle, the oil gets dirty and deteriorates, losing its lubricating capacity, resulting in an increase in the operating temperature of the components and their rapid deterioration and breakage. Refer to your vehicle's owner's manual for the recommended oil change interval.

1d **Disposal of used oil:** Dispose of used oil at an authorized collection point.

2 - OVERHAUL

CLEANING, CAREFUL ANALYSIS OF ALL COMPONENTS AND CORRECT ASSEMBLY ARE ESSENTIAL FOR GOOD OVERHAUL AND TO ENSURE MAXIMUM AXLE LIFE.

2a **Cleaning:** Use commercially available solvents suitable for use on metals to wash all axle components.
WARNING! Be careful when using washing solvents. For safe use of the solvent, follow the instructions provided by the solvent manufacturer.
To prevent corrosion, DO NOT clean components with water, steam, or alkaline solutions.
Remove any residual gaskets from the surfaces of the components to be reused, taking care not to damage them.
Immediately dry washed parts with clean paper or rags.
The bearings can be dried with compressed air, taking great care not to damage them. Never spin a bearing with compressed air!
Refer to bearing manuals for a proper maintenance.
Apply a thin layer of lubricant to all those components that will be reassembled in the axle.

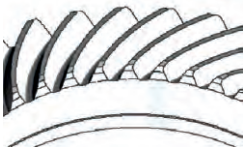
2b **Inspection of the components** It is very important to check that all components are suitable for assembly before the axle is re-assembled. Carefully check that the components are not worn or damaged and replace them if necessary.
Replacing worn and damaged components will prevent premature axle failure.
In general, check that no grooves, cavities, seizures, deformation or colouring anomalies are visible in the components, which could be due to incorrect or insufficient lubrication during the operating period prior to overhaul. To get the most out of an overhaul, we recommend replacing all low-cost parts, such as thrust washers, gaskets and bushings, as well as all worn or damaged parts.
It is recommended to replace all bearings and all fasteners such as ring nuts, bolts and nuts.
Check the axle housing for damage and for signs of breakage or leaks that could cause lubricant leaks. Any structural and alignment damage to the axle housing requires its replacement.
We strongly advise against repairing the axle housing by welding or trying to realign the deformed parts.

2c **Installation:** We recommend that you follow the assembly procedures described in the original manufacturer's repair manual corresponding to the specific model being repaired.
Always follow the bearing preload adjustment procedures very carefully. The procedure for adjusting the bearing preload varies depending on the model and make of axle, therefore it is recommended to refer to the original manufacturer's service manual.
Some components, such as bearings, may require the use of presses or induction heaters for both assembly and disassembly. Avoid using direct flames on surfaces as they could permanently alter the structure of the piece material causing sudden failure during operation.
Components that require interference fit should not be mounted using steel hammers or differential fixings such as screws and ring nuts. In the first case, the strong and repeated blows of the hammer could damage the components to be assembled. In the second case, you could permanently damage the threads and compromise the specific locking function of the components.
The helical bevel gears are machined in such a way that the components, pinion and helical bevel gear, are matched together and sold as a bevel gear set.
When a pinion or helical bevel gear in the axle have to be replaced, both components must be replaced with the new bevel gear set. Never replace the single damaged component with a new one.

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3 - NOMENCLATURE

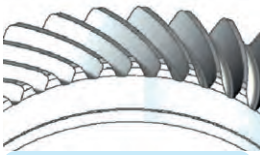
hand of spiral



Right hand ring gear



Left hand pinion

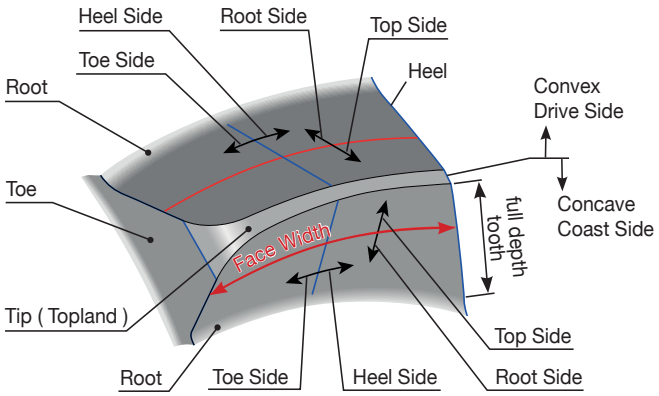


Left hand ring gear



Right hand pinion

Example of right hand ring gear tooth



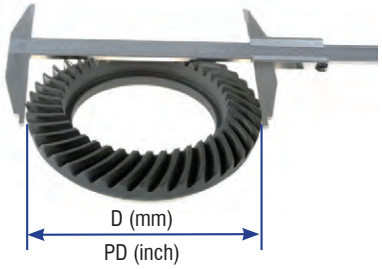
4 - RECOMMENDED BACKLASH

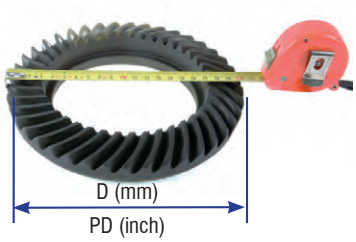
THE BACKLASH IS THE GAP THAT SHOULD BE LEFT BETWEEN THE PINION AND RING GEAR TEETH, TABLE 4E and - IMAGE 1.
THIS PARAMETER IS EXTREMELY IMPORTANT, AS TOO LOW VALUE CAN GIVE RISE TO A SEIZURE, WHILE TOO HIGH VALUE GENERATES NOISE AND CAN LEAD TO THE NEXT GEAR BREAKAGE.
BEFORE YOU BEGIN ANY ASSEMBLY ACTIVITY YOU SHOULD KNOW THE RECOMMENDED BACKLASH THAT IS USUALLY FOUND IN THE AXLE SERVICE MANUAL.
IF YOU HAVE THIS INFORMATION, GO DIRECTLY TO STEP 5, MEASURE AND RECORD THE BACKLASH.
IF YOU DO NOT HAVE THIS INFORMATION, PROCEED AS FOLLOWS:

4a **Measure the outside diameter of the ring gear (D or PD)**

• D if the unit of measure is the millimetre • PD if the unit of measure is the inch

Use a slide gauge or alternatively a tape measure and write down the value in the box below paying attention to the unit of measurement used.





Diameter = D …….. mm

Pitch diameter = PD = ……inches

4b **Count the number of teeth (Z) of the ring gear and enter the value in the box below.**



Number of teeth = Z =……

4c **Enter the values D, PD, Z in the formula below and solve the operation:**

Module = M = (mm)		Diametral Pitch = P = (inches)	
M = D : Z = …… : ……. =	M =……	P = Z : PD = …… : …… =	P = ……
Example: D = 310 mm - Z = 39 M = D : Z = 310: 39 = 7.948		Example: PD = 12.205 inches - Z = 39 P = Z : PD = 39 : 12,205 = 3,195	

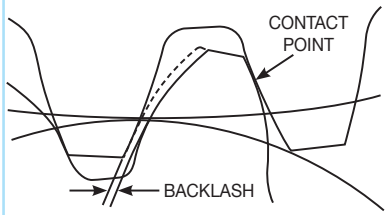
4d **Using the value M or P calculated, obtain the backlash recommended in table 4.e**
Enter the value in the space below.

backlash (mm)	backlash (inches)
……	……
Example: M = 7.948 Clearance 0.203 – 0.279 mm.	Example: P = 3.195 0.008 – 0.011 inches.

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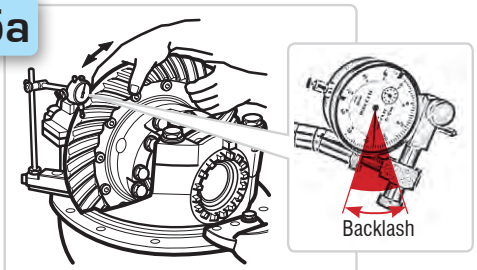
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4e Recommended backlash

Backlash **Image 1**	Module **M**	Backlash **Millimetres min. - max.**	Diametral Pitch **P**	Backlash **Inches min. - max.**
	☐ From 2.54 to 3.18	☐ 0.076 – 0.127	☐ 8.00 – 10.00	☐ 0.003 – 0.005
	☐ From 3.18 to 4.23	☐ 0.102 – 0.152	☐ 6.00 – 8.00	☐ 0.004 – 0.006
	☐ From 4.23 to 5.08	☐ 0.127 – 0.178	☐ 5.00 – 6.00	☐ 0.005 – 0.007
	☐ From 5.08 to 6.35	☐ 0.152 – 0.203	☐ 4.00 – 5.00	☐ 0.006 – 0.008
	☐ From 6.35 to 7.26	☐ 0.178 – 0.229	☐ 3.50 – 4.00	☐ 0.007 – 0.009
	☐ From 7.26 to 8.47	☐ 0.203 – 0.279	☐ 3.00 – 3.50	☐ 0.008 – 0.011
	☐ From 8.47 to 10.16	☐ 0.254 – 0.330	☐ 2.50 – 3.00	☐ 0.010 – 0.013
	☐ From 10.16 to 12.7	☐ 0.305 – 0.406	☐ 2.00 – 2.50	☐ 0.012 – 0.016
	☐ From 12.7 to 14.51	☐ 0.356 – 0.457	☐ 1.75 – 2.00	☐ 0.014 – 0.018
	☐ From 14.51 to 16.93	☐ 0.406 – 0.559	☐ 1.50 – 1.75	☐ 0.016 – 0.022
	☐ From 16.93 to 20.32	☐ 0.457 – 0.660	☐ 1.25 – 1.50	☐ 0.018 – 0.026
	☐ From 20.32 to 25.4	☐ 0.508 – 0.762	☐ 1.00 – 1.25	☐ 0.020 – 0.030

5 - MEASURING AND RECORDING THE BACKLASH

5a



5b Increase the clearance: remove the ring gear from the pinion



5c Decrease the clearance: move the ring gear closer to the pinion



To measure the clearance, place a dial gauge with the tip perpendicular to a ring gear tooth near the heel (the largest part of the tooth), as shown in **Figure 5a.**
Holding the pinion locked, rock the ring gear slightly backward and foreward: the travel of the dial gauge needle represents the actual value of the backlash.
Adjust the backlash by means of the special rings or shims until the value recommended by the axle service manual or the value calculated in **point 4** is reached.
Only move the ring gear to adjust the backlash. Do not move the bevel pinion
Figures 5b and **5c** show in which direction to move the ring gear to increase or decrease the backlash.
We recommend setting the backlash of the bevel gear using the average value of the range recommended in **table 4e**
E.g. backlash *0.203 – 0.279 mm => average* backlash *to use in setup= (0.203+0.279):2 = 0.241 mm*
E.g. backlash *0.008 – 0.011 inches => average* backlash *to use in setup= (0.008+0.011):2 = 0.0095 inches*

6 - ADJUSTMENT OF THE CONTACT PATTERN BETWEEN TEETH

The position of the contact can be adjusted by varying the distance between the pinion and the centre of the ring gear. This position is controlled by the pack of tapered roller bearing adjustment shims. Please note that there is no general rule at this stage, as some axles are designed in such a way that by adding adjustment shims the pinion approaches the centre of the ring gear, and by removing shims it moves away, while for other types of axles the exact opposite occurs.
For this reason, it is advisable to follow the instructions in the original manufacturer's service manual for the model being repaired and to use the specific tooling required in it.
To get a clear contact pattern, apply a thin layer of yellow or white paint to 8-10 teeth of the ring gear with a brush.
Use specific gear marking compounds that contain lubricating grease and coloured pigments.
Then turn the pinion in both directions while holding the ring gear in place.
The contact pattern obtained in the examples in **point 7** is the result of real tests on specific testers at high speed of rotation of the gears and with mechanical brake applied.
In practice, the more load you are able to apply to brake the ring gear, the wider and visible the contact pattern will be. However, you may not be able to match the size of the contact on the new bevel gear to be installed.
In order to ensure maximum quietness and durability of the bevel gear, the contact pattern should be centred on the surface of the teeth as shown in **step 7b.** The contact pattern must not in any way touch the outer edges of the surface of the teeth. Preference should be given to the position of the contact on the convex side of the ring gear, i.e. the most stressed one.
In **points 7a** and **7c** you will find some practical information on how to correct an incorrect position of the contact by changing the pack of shims.
It is important to remember that after each variation of the axial position of the pinion it is always necessary to restore the value of the backlash following the procedure in **point 5.**

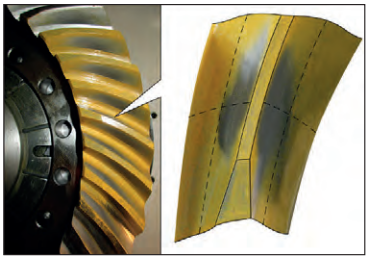
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7 - BEVEL GEAR SETTING SIMULATION

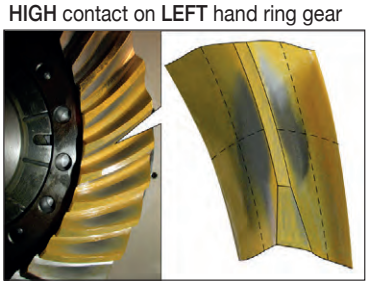
7a

Backlash:	CORRECT
Position of the pinion	INCORRECT
Contact pattern	INCORRECT - HIGH CONTACT
Effects on transmission	NOISE AND PREMATURE FAILURE

HIGH contact on **RIGHT** hand ring gear



HIGH contact on **LEFT** hand ring gear



- The contact pattern is located almost entirely in the HIGH part of the tooth with contact points on the upper edge of the tooth.

CORRECTION OF THE ERROR



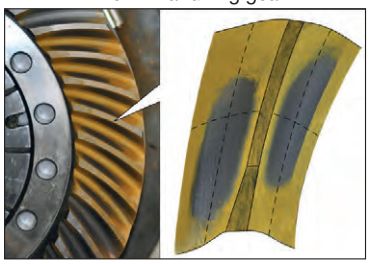
A. Move the pinion towards the centre of the ring gear in the direction of the arrow A.

B. Move the ring gear away from the pinion axis in the direction of arrow B to restore the recommended backlash and check it again following the procedure already described in point 5.

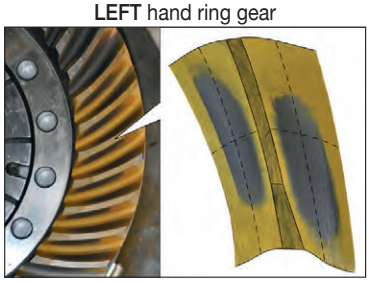
7b

Backlash:	CORRECT
Position of the pinion	CORRECT
Contact pattern	CORRECT

RIGHT hand ring gear



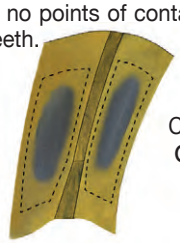
LEFT hand ring gear



- The contact pattern is centred on the height of the tooth and the face width with slight advancement towards the toe on the convex side, on the drive side.
- There are no points of contact between the contact pattern and the upper edges of the tooth, nor at the ends of the face width, toe and heel.
- The width of the contact pattern is proportional to the brake load used in the tester.
- Decreasing the brake, the extension of the contact pattern decreases as shown in the adjacent picture. By increasing the brake, the contact pattern increases in extension.

By convention, the contact pattern is always evaluated on the tooth of the ring gear.
The optimal contact pattern is centred on both the full depth tooth and the face width.
The dotted line delimits the area within which the contact pattern may be placed.
There must be no points of contact with the edges of the teeth.

Convex **DRIVE** side



Concave **COAST** side

All bevel pairs produced by Euroricambi S.p.A. are 100% checked on special testers.
When registering the contact pattern, we recommend that priority is given to the position on the convex side, i.e. the most stressed side.

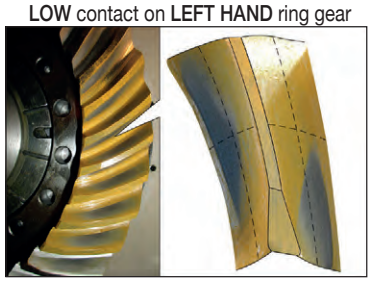
7c

Backlash:	CORRECT
Position of the pinion	INCORRECT
Contact pattern	INCORRECT - LOW CONTACT
Effects on transmission	NOISE AND PREMATURE FAILURE

LOW contact on **RIGHT HAND** ring gear



LOW contact on **LEFT HAND** ring gear



- The contact pattern is almost fully located in the LOW part of the tooth.
- In this specific case, the contact pattern may be strongly concentrated on the upper edges of the pinion tooth.

CORRECTION OF THE ERROR



A. Move the pinion away from the centre of the ring gear in the direction of the arrow A.

B. Approach the ring gear to the pinion axis in the direction of arrow B to restore the recommended backlash and check it again following the procedure already described in point 5.

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