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# **GROUP 1 STRUCTURE AND OPERATION**

- **1. DRIVE AXLE UNIT**
- 1) STRUCTURE
  - (1) 10/13/15/18/20BR-9







- 1 Gear case cover
- Drive bracket 2
- 3 Gear box case
- 4 Cover
- Spiral pinion 5
- Spiral bevel gear 6
- 7 Steering gear
- 8 Idle gear
- 9 Gear
- 10 Bearing
- 11 Washer
- 12 Bearing lock nut
- 13 Taper roller bearing
- 14 Bearing lock nut
- 15 Bearing lock washer

- 16 Bearing
- Bearing 17
- 18 Bearing
- 19 Seal
- 20 Taper roller bearing
- 21 Bearing lock nut
- 22 Bearing lock washer
- 23 Gear spacer
- 24 Bearing
- 25 Sleeve
- 26 Pinion shaft
- 27 Idler gear shaft
- 28 Snap ring
- 29 Cover
- 30 Cover

- 31 Lock plate
- 32 Drive shaft nut
- 33 Taper plug
- 34 Bearing
- O-ring 35
- Drive wheel shaft 36
- 37 Taper plug
- 38 Gasket
- 39 Cover
- 40 Gasket
- 41 Plug
- 42 Breather
- 43 Oil seal
- Shim 44
- 45 Shim

- BR7DU100
- Shim
- Socket bolt 47
- 48

46

- 49 Hexagon bolt
- Spring washer 50
  - Hexagon bolt
- Hexagon bolt 52
- 53 Pinion
- Pinion gear 54
- Snap ring 55
- Snap ring 56
- 57 Spring washer
- 59 Snap ring
- Name plate 60

- Washer

- 51



Item	Unit	Spcification
Gear ratio	-	20.5
Oil quality	l	6.0

18BR9SS10

- 1 Drive unit assy
- 2 Steering gear
- 4 Undercarriage
- 5 Steering pinion
- 6 Roller bearing
- 7 Retaining ring (C)
- 8 Spring washer
- 9 Socket bolt
- 10 Socket bolt
- 11 Spring washer
- 12 Hex bolt
- 13 Socket bolt
- 14 Bracket

# ① Drive unit (1/4)



10BTR9DU01

- 1 Housing
- 2 Plug
- 3 Plug-w/magnet
- 2 Drive unit (2/4)
- 4 Ring-seal
- 7 Cover
- 8 O-ring

9 Circlip

1-12

 $\begin{array}{c} & & & & & & \\ & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & &$ 

10BTR9DU02

- 1-1 Pinion shaft
- 1-2 Bevel gear
- 1-3 Hexagon nut
- 1-4 Taper roller bearing
- 1-5 Taper roller bearing
- 1-6 Shim ring
- 1-7 Taper roller bearing
- 1-8 Taper roller bearing
- 1-9 Shim
- 1-10 Shaft sealing ring
- 1-11 Shim
- 1-12 Hexagon nut
- 2 Wheel shaft
- 3 Bolt-wheel
- 4 Protection cap

③ Drive unit (3/4)



10BTR9DU03

1-7 Sealing ring-shaft

- Spur gear 1-1
- 1-2 Input pinion
- 1-3 Plug
  - ④ Drive unit (4/4)
- 1-4 Ball bearing
- 1-5 Ball bearing
- 1-6 Retaining ring



10BTR9DU04

- Housing upper part 1
- Taper roller bearing 2 Cylindrical pin

Shim set

3

4

6 Connecting plate Bush 7

5

8 Cylindrical screw

O-ring

- Torx screw
- 10 Valve-breather

9

#### (3) 25/30BR-9 (25BR-9: #471~, 30BR-9: #070~)



- 1 Gear case
- 2 Steering housing
- 3 Gear case cover
- 4 Drive shaft
- 5 Input gear 23T
- 6 Driven gear 80T
- 7 Spiral bevel gear 42T
- 8 Spiral bevel pinion 7T
- 9 Drive sleeve
- 10 Sleeve, outer ring
- 11 Steering gear
- 12 Slewing bearing ass'y
- 13 Name plate

- 14 Serration blot
- 15 Wrench bolt
- 16 Wrench bolt
- 17 Wrench bolt
- 18 Wrench bolt
- 19 Hex bolt
- 20 Hex bolt
- 21 Spring washer
- 24 Grease nipple
- 25 Socket, H plug
- 26 Dowel pin
- 27 Lock nut
- 28 Lock nut

- 29 Snap ring
- 30 End cover, seal
- 31 Oil seal
- 32 End cover, seal
- 33 Air breather
- 34 O-ring
- 35,36,37 Taper roller bearing
  - 38 Ball bearing
  - 39 Ball bearing
  - 40 SHIM KIT1
  - 41 SHIM KIT2
  - 42 SHIM KIT3
  - 43 Gasket
  - 44 Magnet plug

# 2. SPECIFICATION

# 1) 10/13/15/18/20BR-9

ltem	Unit	Specification
Gear ratio	-	20.125
Oil quantity	l	1.6

# 2) 25/30BR-9 (25BR-9 :~#470, 30BR-9 : ~#069)

Item	Unit	Specification
Gear ratio	-	20.5
Oil quantity	l	6.0

# 3) 25/30BR-9 (25BR-9 :#471~, 30BR-9 : #070~)

ltem	Unit	Specification
Gear ratio	-	20.8
Oil quantity	l	4.0

# GROUP 2 TROUBLESHOOTING

Problem	Probable cause	Remedy
Continuous metallic groan		
1) During acceleration	<ul> <li>Worn out gears.</li> <li>Pinion and bevel gear meshed too deeply.</li> </ul>	- Adjust back-lash or replace gears.
2) During travelling at	Lack of gear oil.	- Refill
uniform speed	·Worn out gears.	- Replace
	·Loose or worn out bearing.	- Adjust preload or replace.
	·Loose bevel gear wheel	- Replace bolts and washers. Tighten new bolts and washer.
3) When turning corners.	·Worn out differential gear or thrust washer.	- Replace
Continuous knocking sound		
1) During travelling at	·Chipped gear teeth.	- Replace
uniform speed	·Foreign matter in axle case.	- Clean
	·Worn out spline of drive shaft.	- Replace
Oil leakage		
1) Differential housing	·Oil level too high	- Lower oil level
housing leaks.	·Broken oil seal	- Replace
2) Axle case leaks	·Mounting bolts for housing loose.	- Retighten
	·Damaged packing case cracked.	- Replace
	·Worn out hub grease seal.	- Replace
3) Hub, leaks	·Worn out oil seal.	- Replace
	·Worn out bearing or eccentric rotation due to damage.	- Replace
Power is not transmitted		
1) Drive shaft, gear	·Broken or slipped out drive shaft.	- Repair or replace
	·Gear teeth stripped or worn out.	- Replace
	·broken differential case parts.	- Replace
Oil leakage on wheel shaft	<ul> <li>Radial shaft seal wrongly installed or damaged.</li> <li>Race on wheel shaft damaged.</li> </ul>	<ul> <li>Remove wheel shaft and install a new radial shaft seal.</li> <li>Remove wheel shaft.</li> <li>Check wheel shaft race for reusability; if possible, rework.</li> </ul>
Oil leakage on housing cover	·Housing cover not sealed.	<ul> <li>Seal housing cover with LOCTITE No. 574.</li> </ul>
	·Housing cover or housing plane face uneven.	·Touch up plane faces with oil rubber.
	Bolts not tightened according to the	·Tighten bolts with the specified
	specified tightening torque.	tightening torque.

Problem	Probable cause	Remedy
Oil leakage on oil filler or oil	·Dirt between sealing ring and	·Cleaning required.
drain plug	housing.	11
	·Old sealing ring was used.	·Use new sealing ring
	the specified tightening torque.	tightening torque.
Oil leakage between hous-ing	·Seal faces not sealed or uneven.	·Apply LOCTITE 574 onto seal faces.
and top section	Duran en endiaden min	Touch up seal faces with oil rubber.
	·Burrs on cylinder pin.	·Use a new cylinder pin.
	the specified tightening torque.	tightening torque.
Oil leakage on top section	·Too much oil in transmission.	·Check oil level.
within helical gear stage / input	·O-ring on cover defective.	·Install new O-ring.
	·Breather valve defective.	·Replace breather valve.
Beating noise at helical gear	·Teeth on input pinion and/or helical	·Check tooth flanks for damage and
stage	gear damaged by false installation.	touch up damaged spots with oil
		rubber.
Ringing noise	·Helical gear stage running without	·Check oil level.
	oil.	Refill oil.
Grinding noise	·Bearing preload or backlash not	·Checking and new adjustment.
	correctly adjusted.	
Bearing damage on input	·No axial play.	·Install new bearing and adjust axial
pinion		play.
Pivoting bearing is difficult to	·Cover disc loosened and dirt enter-	·Replace pivoting bearing.
rotate or backlash recog-	ed into the bearing.	
nizable	·Cage segments are damaged.	·Replace pivoting bearing.
	·Plastic deformation of balls or ball	·Replace pivoting bearing.
	race.	
	Bearing not relubricated.	Relubricate pivoting bearing.
	·Grease not distributed.	Rotate pivoting bearing several times
		by hand.

# **GROUP 3 DISASSEMBLY AND ASSEMBLY**

# 1.10/13/15/18/20BR-9

# 1) DISASSEMBLY

- Before starting disassembly check the backlash and tooth contact for use as reference during assembly.
- Stabilize the drive unit assembly by using wooden block.



(2) Remove the plug and drain out the oil. Remove the gear case cover and drain out the oil.



- (3) Loosen the lock nut and remove the lock nut (12) and washer (11).
- (4) Remove drive unit bracket (2). Remove the outer race of bearing (10) and oil seal from bracket.
- (5) Remove bolts (48) and remove the steering gear (7).
- (6) Remove bolts (11 EA).
- (7) Remove the cover (1) of gear case with spiral bevel pinion (5).
- (8) Remove bearing nut (14) by straightening the locking part of the bearing washer (15), and remove the spiral bevel pinion (5) from the cover of gear case (1).



- (9) Remove the end cover (29, 30).
- (10) Remove the bearing (16, 20) installed on the side of spiral bevel gear (6) for pinion shaft (26).

Loose the nut for spiral bevel gear (6) by straightening the locking of the washer and remove the nut (21) and the washer (22).

When loosening the nut, lock the pinion shaft by puting capper for between the idle gear (8) and the pinion shaft (26).

- After removing the idle gear (8) remove the pinion shaft (26) and spiral bevel gear (6).
- (11) Support drive shaft (36) at drive wheel side not to rotate.

Remove the lock nut (32) of drive gear and pull out the drive shaft (36) to drive wheel side.

Remove the bearing (18) from drive shaft.

- (12) Remove the locking plate (31) for idle gear shaft and remove idle gear shaft (27).Pull out the idle gear from the side of
- drive gear (9).(13) After removing the snap ring (28), remove the bearing (17) for idle gear.
- (14) Pull out the pinion shaft (26) and the spiral bevel gear (6).



# 2) INSPECTION

- Inspect the gear case for cracks, bearing insertion parts for injuries, oil seals for damage and for other defects. Replace if found defective.
   Inspect for gear case cracks visually and by use of flaw penetrants.
- (2) Inspect the drive unit bracket for cracks, bearing insertion parts for injuries, bushings for damage, and other defects. Replace if found defective.
- (3) Inspect the gear case cover for cracks, bearing insertion parts for injuries and for other defects. Replace if found defective.
- (4) Inspect the spring adjuster and spring bracket for damage and spring for deterioration. Replace parts found defective.
- (5) Inspect the tooth part and spline part of steering pinion for damage and the bearing for damage, and replace the parts found defective.
- (6) Inspect the bearing and oil seal of steering part for damage, and replace the parts found defective.
- (7) Inspect the steering gear for damage, and replace parts found defective.
- (8) Inspect the spiral pinion shaft, counter gear shaft and idle gear shaft for tooth damage and shaft bend, and the bearings for damage. Replace the parts if found defective.
- (9) Inspect the spiral bevel pinion shaft for tooth damage and shaft bend, and the bearing holder and bearing for damage. Also inspect spiral bevel gear for damage. Replace the parts if found defective.
- (10)Inspect the drive wheel shaft for cracks, splines for wear and damage, and the bearings for damage. Replace the parts found defective.

# 3) ASSEMBLY

(1) Assemble the oil seal to the cover of gear case, assemble the bearing to spiral bevel pinion shaft. Assemble the spiral bevel pinion shaft bearing, washer and nut to the cover of gear case, and screw on the locking nut.

Tighten the locking nut while measuring starting torque required to start the bevel pinion turning. Bevel pinion starting torque.  $2.7 \sim 3.0 \text{ kgf} \cdot \text{cm} (0.2 \sim 0.22 \text{ lbf} \cdot \text{ft})$ 

- \* Apply loctite #271 white fastening lock nut (Item 12,14,21,32, Refer page 4-1).
- (2) Assemble the drive wheel shaft to the gear case, assemble the spur gear from opposite side and screw on the locking nut. Tighten the locking nut while measuring starting torque required to start the spur gear turning. Spur gear starting torque. 23.6~26.3 kgf·cm (1.7~1.9 lbf·ft)
- (3) Measure A1, A2 of the gear case and B of the gear case cover, and adjust C to be 69.00~69.10 by shim.

#### Shim thickness

3329022000	0.10 mm
3329022100	0.20 mm
3329022200	0.30 mm
3329022300	0.50 mm



(4) On the adjusting the tooth contact of spiral bevel gear, if changing the shim, idle of decrease the shim inserting between the cover of shaft both side and the gear case shim thickness.

ldle ge	ar side	Drive tire side		
No.	Shim thickness	No.	Shim thickness	
3329024400	0.10 mm	3329024000	0.10 mm	
3329024500	0.20 mm	3329024100	0.20 mm	
3329024600	0.30 mm	3329024200	0.30 mm	
3329024700	0.50 mm	3329024300	0.50 mm	

(5) Adjust the backlash between spiral bevel pinion and bevel gear.

Mount the dial gauge on gear case and read the backlash while rotating the drive wheel shaft. Backlash 0.15~0.20 mm

If the backlash is not within the specified range, readjust the bevel gear shims. Increase the shim thickness if the backlash is too large, and decrease if too small.

(6) Check the contact between the drive pinion and bevel gear tooth.

Clean the gear tooth and apply red lead of the surfaces of 8 or 9 bevel gear tooth.

Turn the bevel gear in both forward and reverse directions and determine by the patterns made on the tooth face whether the tooth is contacting properly.

### 4) INSTALLATION

Perform the removal in reverse order.

5) LUBRICATION PROCEDURES

Lubrication of drive unit gear case is performed as follows :

- ※ Cover the brakes and drive motor with waste to prevent the gear oil from splashing on these parts.
- (1) Fill in oil through the filler hole A.
- (2) After operating the vehicle for several hours, remove plug B and check the oil level. Replenish it now.



BR7DU107

# 2.25/30BR-9

# 1) STRUCTURE



Item	Unit	Spcification
Gear ratio	-	20.5
Oil quality	l	6.0

18BR9SS10

- 1 Drive unit assy
- 2 Steering gear
- 4 Undercarriage
- 5 Steering pinion
- 6 Roller bearing
- 7 Retaining ring (C)
- 8 Spring washer
- 9 Socket bolt
- 10 Socket bolt
- 11 Spring washer
- 12 Hex bolt
- 13 Socket bolt
- 14 Bracket

# (1) Drive unit (1/4)



10BTR9DU01

- 1 Housing
- 2 Plug
- 3 Plug-w/magnet
- (2) Drive unit (2/4)
- 4 Ring-seal
- 7 Cover
- 8 O-ring

9 Circlip



10BTR9DU02

- 1-1 Pinion shaft
- 1-2 Bevel gear
- 1-3 Hexagon nut
- 1-4 Taper roller bearing
- 1-5 Taper roller bearing
- 1-6 Shim ring
- 1-7 Taper roller bearing
- 1-8 Taper roller bearing
- 1-9 Shim
- 1-10 Shaft sealing ring
- 1-11 Shim
- 1-12 Hexagon nut
- 2 Wheel shaft
- 3 Bolt-wheel
- 4 Protection cap

(3) Drive unit (3/4)



10BTR9DU03

1-7 Sealing ring-shaft

- 1-1 Spur gear
  - Input pinion
- 1-2 1-3 Plug
- (4) Drive unit (4/4)
- 1-4 Ball bearing
- 1-5 Ball bearing
- 1-6 Retaining ring



10BTR9DU04

- Housing upper part 1
- 2 Taper roller bearing Cylindrical pin

Shim set

3

4

6 Connecting plate 7 Bush

5

8 Cylindrical screw

O-ring

- 9 Torx screw 10 Valve-breather

3-16

#### 2) CHECK AND INSPECTION

When repairing the drive unit, ensure utmost cleanliness and excellent workmanship.

Dismantle the drive unit only if any damaged parts must be replaced. After removing screws or nuts, loosen covers and housing parts which were installed with seals by slight blows with a plastic hammer. Use suitable pulling devices for removing parts being tightly installed on the shafts, such as bearings, bearing rings and similar.

Carry out disassembly and reassembly work on a clean working place. Use special tools which have been developed for this purpose. Prior to reinstallation of the parts, clean contact faces of housings and covers from residues of seals. Remove any burrs or similar irregularities with an oil stone. Clean housings and end covers, in particular corners and angles, with a suitable detergent. Damaged or heavily worn parts must be replaced, with an expert assessing whether parts subject to normal wear during operation, such as bearings, thrust washers etc. will be reinstalled.

Parts such as seal rings, lock plates, split pins etc. must generally be replaced. Radial seal rings with worn or broken sealing lip must also be replaced. In particular, ensure that no chips or other foreign bodies remain in the housing. Check the lube oil holes and grooves regarding unhindered passage.

Oil according to the relating List of Lubricants shall be applied to all bearings prior to their installation:

\* Only a heating furnace or an electric drier is permitted for heating parts such as bearings, housings, etc.

Parts fitted in heated state must be readjusted after cooling-down to ensure a perfect contact.

\* When assembling the unit, exactly observe the tightening torques and setting data indicated in the manual.

Tighten screws and nuts according to the enclosed standard table, unless otherwise specified.

When fitting snap rings and retaining rings, pay attention to an exact contact in the grooves.

Never wash disks having organic friction linings (e.g. paper disks) since this would have an adverse effect on lining adhesion.

Only dry-cleaning is permitted (leather cloth).

**A** When using detergents, observe the manufacturer's instructions regarding their handling.

# 3) DISASSEMBLY

Clamp the unit.

(S) Assembly truck(S) Clamping device

5870 350 000 AA00 852 804

\* The following figures show a different clamping device.



Loosen all screw plugs and drain the oil.

A Waste oil to be disposed of ecologically and according to the legal provisions.



# (1) Components and upper housing part

# Geared steering version

 Loosen the screw plug on top of the motor (arrow). Turn the eyebolt into the motor shaft behind and fix the lifting device.



② Loosen the cylindrical screws on the motor (see arrow) and remove the motor by means of the lifting device.



③ Loosen the cylindrical screws. Loosen the frame plate by means of slight hits with a plastic hammer and remove it.



- (4) If necessary, remove the cylindrical screws (steering stop).
- IDETR9DU006
- <sup>(5)</sup> Loosen countersunk screws (arrows 1) and lift off the steering stop (arrow 2).



# (2) Input and output

① Use lever to remove protective cap from the gear shaft.

2 Install locking device (S) on the gear shaft (see arrow) thus blocking the gear shaft against rotation. Loosen both hexagon nuts on the bevel gear shaft one after the other.

Remove disk.

- (S) Locking device 5870 240 002
- ③ If necessary, block gear shaft against rotation by means of the locking device (S) (see previous figure) and dismantle the wheel bolt with suitable pliers.
- \* It is possible to unscrew the wheel bolts with dismounted and mounted gear shaft.
- ④ Disengage snap ring from the annular groove on the housing.











(5) Lift off the cover on the cast brackets.



<sup>6</sup> Remove O-ring (see arrow).



- Install locking device (S) on the gear shaft (see arrow) thus blocking the gear shaft against rotation. Loosen both hexagon nuts on the gear shaft one after the other. Remove disk.
  - (S) Locking device 5870 240 002



- <sup>(8)</sup> Carefully remove the gear shaft from the crown wheel using a plastic hammer.
- \* Pay attention : gear shaft releases downwards.



- It is the bearing inner ring from the gear shaft.
  - (S) Cut-off device 5870 300 028



0 Remove the crown wheel from the housing.



(1) Remove the bearing inner ring out of the housing.



- Carefully remove the bevel gear shaft out of the spur gear using a plastic hammer (bearing inner ring below) and take out from the bottom.
- \* Pay attention : Bevel gear releases downwards.



<sup>(3)</sup> Support the bearing inner ring with a suitable sleeve and press it off the bevel gear shaft.



 $^{\textcircled{1}}$  Remove spur gear from the housing.



(5) Remove bearing inner ring from the housing.



- <sup>(1)</sup> Force bearing outer ring out of the housing and remove the adjusting washer behind.
- Pay attention so that the releasing adjusting washer does not drop. Mark installation position. Assembly aid.



1 Force out the opposite bearing outer ring.



- 18 Lift-off shaft seal.
- If the shaft seal is stuck, you can force it out from the opposite side.



Pay attention so that the releasing adjusting washer does not drop. Mark installation position. Assembly aid.

O Force out the opposite bearing outer ring.





# 4) REASSEMBLY

# (1) Input and output

If either crown wheel or bevel gear shaft is damaged, both parts must be jointly replaced.

Legend :

- 1 = Bevel gear shaft
- 2 = Crown wheel
- 3 = Adjusting washer of contact pattern
- 4 = Adjusting washer of backlash (circumferent. backlash)
- 5 = Taper roller bearing
- 6 = Taper roller bearing
- 7 = Gear shaft
- If a new taper roller bearing (fig. 048 item 5) is used, determine the bearing width and compare it with the previous bearing to match the adjusting washer (item 3).
- Determine thickness of the adjusting washer removed during disassembly. Determine bearing width of the new and the old taper roller bearing and calculate thickness of adjusting washer.

#### Calculation example A :

Bearing width (old bearing) e.g. . . 22.35 mm Adjusting washer (old) e.g. . . . . . + 0.30 mm Bearing width (new bearing) e.g. - 22.25 mm Adjusting washer (new) e.g. 0.40 mm

<sup>(2)</sup> Insert the adjusting washer into the bearing hole on the housing. Fit the bearing outer ring until contact is obtained.

(S) Driver tool AA00 607	184
--------------------------	-----

When installing the old taper roller bearing (fig. 048 item 5), use the adjusting washer removed during disassembly.







<sup>3</sup> Fit bearing outer ring into the bearing hole on the housing until contact is obtained.

(S) Driver tool

AA00 658 635



④ Press-on the bearing inner ring until contact with the bevel gear shaft is obtained.



<sup>(5)</sup> Insert bearing inner ring into the bearing outer ring.



<sup>(6)</sup> Wet inner gearing at the spur gear evenly with Loctite 270.



- O Place the spur gear on top of the housing.
- Observe the installation position. Convex side of spur gear to face upwards.

Mount the preassembled bevel gear shaft to the spur gear from below.

(8) Press against the bevel gear shaft from below. Use a suitable sleeve and a plastic hammer to bring the spur gear carefully to contact position.

Install the disk on the bevel gear shaft. Hand-tighten a hex. nut without using a wrench until contact is obtained.

- 10 Position the counter support (S). Tighten the second hexagon nut.
  - $\cdot$  Tightening torque : M<sub>A</sub> = 200 Nm
  - (S) Stop

AA00 321 773









- Check rolling torque of the bevel gear shaft bearing 0.7~1.3 Nm.
- \* Try to achieve the lower value.
- If rolling torque is incorrect, loosen both hexagon nuts and repeat the work steps shown in fig. 057~059. Use the lower hexagon nut for correction.
- ⑦ Drive in the bearing outer ring until contact is obtained.
  - (S) Driver tool AA00 603 011





3 Install shaft seal by means of driver tool (S).

(S) Driver tool AA00 603 138

\* Apply grease (Shell Alvania RL3) to the shaft seal inner side.



- When installing a new taper roller bearing (fig. 048 item 6), determine the bearing width and compare it with the previous bearing to match the adjusting washer (item 4).
- Determine bearing width of new and old taper roller bearing as well as thickness of adjusting washer.

Calculation example B :

Bearing width (old bearing) e.g. . . 32.10 mmAdjusting washer (old) e.g. . . . . . + 0.30 mmBearing width (new bearing) e.g. - 32.20 mmAdjusting washer (new) e.g.0.20 mm



<sup>(5)</sup> Insert adjusting washer into the bearing hole and force in bearing outer ring until contact is obtained.

(S) Driver tool AA00 658 776

- When installing the old taper roller bearing (fig. 048 item 6), use the adjusting washer removed during disassembly.
- <sup>(1)</sup> Insert the bearing inner ring into the bearing outer ring.









<sup>(1)</sup> Position the crown wheel at the bearing inner ring, as illustrated.



<sup>(1)</sup> Press on the bearing inner ring until contact with the gear shaft is obtained.



 Install the gear shaft on the crown wheel from below.
 Secure with hexagon nut.



② Support unit on the gear shaft. Use a press to bring crown wheel and suitable sleeve to contact position.



Hand-tighten a hexagon nut without using a wrench until contact is obtained.



Fix and support the locking device (S) on the gear shaft.

Position the counter support (S) and adjust contact position. Tighten the second hexagon nut.

 $\cdot$  Tightening torque : M<sub>A</sub> = 550 Nm

(S) Locking device	5870 240 002
(S) Counter support	AA00 857 163

- Check rolling torque of the gear shaft bearing 13~22 Nm.
- \* Try to achieve the lower value.
- If the rolling torque is incorrect, loosen both hexagon nuts and repeat work steps shown in fig. 070~072. Use the lower hexagon nut for correction.





- Place dial indicator at right angles to the tooth flank of the crown wheel and check backlash (0.10~0.18 mm).
- In case of any deviation from the required backlash correct the adjusting washer (fig. 063/fig. 048 item 4) according to the following specification :

Insufficient backlash-install thinner adjusting washer

Excessive backlash-install thicker adjusting washer

Then cover some drive and coast flanks on the crown wheel with marking ink and rotate crown wheel in both directions several times.

Compare the obtained contact pattern with the examples on page 3-39.

(S) Locking device 5870 240 002

If the contact pattern differs, use a suitable shim for correction (figure 050/fig. 048 item 3).



Grease the O-ring and install it into the annular groove on the cover (see arrow).



- Mount the preassembled cover into the housing until contact is obtained.
- \* Observe installation position. Bring recess for taper roller bearing into the correct position. See arrow.



Insert snap ring into the annular groove on the housing and fix the cover.



#### (2) Upper housing part and components

 If removed, or in case of a new part, flushmount the protection cap with the open side facing inwards.



- <sup>(2)</sup> Press ball bearing onto the input pinion until contact is obtained.
- \* Apply assembly force only on the bearing inner ring.



③ Install preassembled input pinion into the bushing as illustrated.



- ④ Press ball bearing onto the input pinion until contact is obtained.
- \* Observe installation position. Snap ring to show upwards/outwards.
- \* Apply assembly force only on the bearing inner ring.



<sup>(5)</sup> Fix ball bearing on the input pinion by means of a retaining ring.



<sup>(6)</sup> Press bearing inner ring onto the bushing as illustrated.



 $\widehat{\mathcal{O}}$  Insert both bearing outer rings onto the upper housing part until contact is obtained.



(8) Place upper housing part on the preassembled bushing, as illustrated. Place bearing inner ring as illustrated and carefully bring into contact position by means of a hand operated press.



9 Adjust rolling torque of the connection plate bearing (fig. 085~097).

Support the preassembled upper housing part on the bushing. Determine dimension I from front side of bearing inner ring to front side of bushing.

Dimension I e.g. ..... 9.90 mm

- \* Also see the following figure.

Calculate the adjusting washer thickness for rolling torque adjustment of connection plate.





Calculation example C :	
Dimension Le a	

Adjusting washer	0.15 mm
Bearing pre-load	0.10 mm
Dimension II e.g.	9.65 mm
Dimension re.y	

0.00 mm

Legend :

- 1 = Connection plate
- 2 = Shaft seal
- II = Dimension II (fig. 086)
- (1) If removed, or in case of a new part, install cylindrical pins (see arrows 1).

Wet mounting face (arrow 2) with Loctite 574.





<sup>12</sup> Use a plastic hammer to bring the upper housing part carefully into contact position with the housing.

- <sup>(3)</sup> Fix the upper housing part by means of cylindrical screws.
  - $\cdot$  Tightening torque (M8/10.9) : M<sub>A</sub> = 30 Nm





- If removed, or in case of a new part, install breather (S) on upper housing part by means of a driver tool.
  - (S) Press-fit mandrel AA00 852 929



<sup>(5)</sup> Place the adjusting washer determined in fig. 086 onto the bushing (e.g. s = 0.15 mm).

Grease the O-ring and place it into the annular groove on the upper housing part (see arrow).



- <sup>(1)</sup> Flush-mount the shaft-seal into the connection plate.
- \* Apply grease (Shell Alvania RL3) to the inner side of the shaft seal.
- \* Observe installation position. Also refer to fig. 087.

If removed, or in case of a new part, insert the cylindrical pin (see arrow) into the hole near the M12-threads, until contact is obtained.

- <sup>(1)</sup> Mount the connection plate on the input pinion/on the bushing.
- Ensure that the sealing lip on the shaft seal is not turned up.
- \* Observe installation position. Cylindrical pin (see arrow) to face the casting recess on the upper housing part (dashed line).
- <sup>(B)</sup> Use a plastic hammer to bring the connection plate carefully into contact position.







- <sup>(19</sup>) Fix the connection plate by means of Torx screws.
  - · Tightening torque :  $M_A = 79$  Nm
- \* Tighten screws crosswise.



- Check rolling torque of connection plate bearing 18~25 Nm.
  - (S) Assembly fixture AA00 630 183



Geared steering version

- (1) Mount steering stop as illustrated. Force in grooved pins in alignment with the steering stop. Fix steering stop by means of countersunk screws.
  - · Tightening torque (M6/10.9) :  $M_A = 14 \text{ Nm}$
- \* Secure countersunk screws with Loctite 243.



- ② If removed, or in case of a new part, install cylindrical screws.
  - · Tightening torque (M12/8.8) :  $M_A = 79 \text{ Nm}$
- \* Mount cylindrical screws with Loctite 243.



- <sup>③</sup> Place frame plate onto the connection plate and fix it by means of cylindrical screws.
  - · Tightening torque (M12/10.9) :  $M_A = 79Nm$
- \* Secure cylindrical screws with Loctite 243.



④ Wet inner gearing at the input pinion evenly with grease.



<sup>(5)</sup> Apply grease evenly on the shaft at the electric motor.



- <sup>(6)</sup> Place electric motor onto the connection plate and fix it by means of cylindrical screws.
  - $\cdot$  Tightening torque (M8/8.8) : M\_A = 23 Nm
- Observe installation position.
   See disassembly.



\* For tightening torque see motor manufacturer.





# CONTACT PATTERN EXAMPLES OF GLEASON TOOTH SYSTEM

Ideal contact pattern:



GEAR1

# Contact pattern setting:

The contact patterns are viewed on the crown wheel flanks.

The contact pattern must be tangent to the center of tooth flank (middle of tooth), otherwise it is too far on the tooth top or on the tooth root.

Flank glossary:

Convex flank = Drive side Concave flank = Coast side

Incorrect contact p	atterns:	Correct contact pattern setting by varying the installation position towards the arrow direction
Addendum tooth position:		
Addendum tooth position:		GEAR2

▲ If the contact pattern is incorrect, change the adjusting washer depending on the direction of arrow. Dismantle the unit for this purpose.

#### 3) 25/30BR-9 (25BR-9 : #471~, 30BR-9 : #070~)

#### (1) Structure



- 1 Gear case
- 2 Steering housing
- 3 Gear case cover
- 4 Drive shaft
- 5 Input gear 23T
- 6 Driven gear 80T
- 7 Spiral bevel gear 42T
- 8 Spiral bevel pinion 7T
- 9 Drive sleeve
- 10 Sleeve, outer ring
- 11 Steering gear
- 12 Slewing bearing ass'y
- 13 Name plate

- 14 Serration blot
- 15 Wrench bolt
- 16 Wrench bolt
- 17 Wrench bolt
- 18 Wrench bolt
- 19 Hex bolt
- 20 Hex bolt
- 21 Spring washer
- 24 Grease nipple
- 25 Socket, H plug
- 26 Dowel pin
- 27 Lock nut
- 28 Lock nut

- 29 Snap ring
- 30 End cover, seal
- 31 Oil seal
- 32 End cover, seal
- 33 Air breather
- 34 O-ring

# 35,36,37 Taper roller bearing

- 38 Ball bearing
- 39 Ball bearing
- 40 SHIM KIT1
- 41 SHIM KIT2
- 42 SHIM KIT3
- 43 Gasket
- 44 Magnet plug

# (2) Disassembly

Release the #44 MAGNET PLUG (D15A1440) and drain the gear oil from inside. (with 8mm L-wrench)



Release 3 pieces of the #19 HEX BOLT (D15A1190) with a 19mm socket or wrench.



Remove #10 SLEEVE, OUTER RING.



Release 12 pieces of the #15 WRENCH BOLT.



Remove #11 STEERING GEAR.



Release 16 pieces of the M8x25L WRENCH BOLT.



Remove #12 SLEWING BEARING ASSEMBLY. (If it does not come out well, using the part indicated in the attached photo to push up and remove.)



Remove #29 SNAP RING. (refer to the photo below).







(With an awl or small flat screw driver to remove the ring.)

Remove #9 DRIVE SLEEVE. (refer to the photo below).







Release #33 AIR BREATHER. (After that, remove the Teflon tape residue on the AIR BREATHER.)



Release #25 SOCKET, H PLUG (2 EA). (After Release, remove the Teflon tape residue on the SOCKET and G PLUG.)



Release 4 pieces of the #16 WRENCH BOLT.



Release 5 pieces of the #17 WRENCH BOLT.



Release 4 pieces of the #18 WRENCH BOLT.



Release 4 pieces of the #18 WRENCH BOLT.



Remove #2 STEERING HOUSING.



\* Be careful to prevent the gear tooth surface being nicked on removal.



Release #27 LOCK NUT. (Discard the released LOCK NUT because it should not be reused.)



With a puller, slightly lift the #6 DRIVEN GEAR 80T. (Carefully remove #5 INPUT GEAR at the same time as lifting #6 DRIVEN GEAR little at a time.)

Remove #5 INPUT GEAR 23T.



Remove #6 DRIVEN GEAR 80T completely.



Release 15 pieces of the #20 HEX BOLT. (Keep the #21 SPRING WASHERS with the bolts for reused.)



Remove #3 GEAR CASE COVER.



Remove #43 GASKET.

(When removing the cover, remove the gasket attached on the surface with a scraper Then also remove the liquid gasket with a thinner or alcohol.)

Liquid gasket used when assembling PERMATEX FORM-A-GASKET.





#### Release #28 LOCK NUT

(Be careful not to damage the thread of the Drlve Shaft when straighten the caulked spot.) (Discard the LOCK NUT, it should not be reused.)



Remove #4 DRIVE SHAFT.



Remove #7 BEVEL GEAR 42T.

Remove #31 OIL SEAL from the GEAR CASE. (On removal, put a flat screw driver in the gap between the Taper Roller bearing and the Oil seal then pull it out from the inside to the outside. When reinstalling, replace the oil seal with a new one.)

(When removing the OIL SEAL, Be careful not to drop the TAPER ROLLER BEARING inside the GEAR CASE. It is not fixed inside.)





Remove #37 TAPER ROLLER BEARING . (Be careful. It may drop and be damaged when removing the OIL SEAL.)

Remove #42 SHIM KIT3. (It may be reused, handle it carefully to avoid deformantion.)



Remove #42 SHIM KIT3. (It may be reused, handle it carefully to avoid deformantion.)



Remove #8 BEVEL PINION 7T (D15A1008) with a rubber mallet.

(By strike that point with a rubber mallet, remove as shown in the photo below.

Be careful to avoid the BEVEL PINION being nicked.)





# Remove #36 TAPER ROLLER BEARING.



Remove #35 TAPER ROLLER BEARING. (Remove by pushing it from the inside through the #36 BEARING mounting space.)



Remove #41 SHIM KIT2.

(Handle it while being careful to avoid deformation for reuse. If it is nicked or deformed, must replace it with a new one of the same specification.)

Remove #40 SHIM KIT1. (Handle it while being careful to avoid deformation for reuse.)





# (2) Reassembly

- 1. When tightening bolts, mark it with a marking pen and tighten it referring to the torque value.
- 2. Be careful to avoid damage to the bolts and the taps that engages the bolt. (Follow the tightening torque specified in the maintenance manual.)
- 3. Apply a small amount of LOCTITE to the threads of the bolt. (Apply on 2 to 3 threads from the end.)
- 4. Do not leave the bolt for over 5 minutes after applying the LOCTITE to it. (Could be cured before assembling.)
- 5. The lubricating grease replenishment cycle of the SLEWING BEARING ASSEMBLY shall be checked at every regular inspection and add it if necessary.
- 6. The cycle of GEAR OIL change is every 2000 hours. (It can be changed when parts are replaced due to leakage.)
- 1. Place INNER RING 1 and OUTER RING 2 on the Assembly Jig.
- 2. Install the BEARING Balls 3 and BEARING SPACERS 4. (Assemble 2 Bearing Balls for each 1 Bearing Spacer.)
- 3. Apply 50g of GREASE where the BEARING BALLS 3 and BEARING SPACER 4 are combined. (The BEARING Assembly must rotate smoothly.)
- \* GREASE: SHELL GADUS S2 V220 2
- 4. Assemble the Dust Cover for SLEWING BEARING 5 as shown in the example.(Example of assembling the dust cover with the slewing bearing)





Press SERRATION BOLT 2 into the DRIVE SHAFT 1. (Be careful of the  $\oint$  125.3 spot when pressing the BOLT in.)



1. Press BEARING 3 into INPUT SLEEVE 1.

2. Press BEARING 4 into INPUT SLEEVE 1.3. Install SEAL CAP 2 on INPUT SLEEVE 1.(When installing the SEAL CAP, make sure it does not protrude from the end of the INPUT SLEEVE.)

- 4. The BEARING must rotate smoothly after being mounted.
- 1. Press the TAPER ROLLER BEARING 2 into BEVEL GEAR 1.
- 2. Press the TAPER ROLLER BEARING 2 into BEVEL PINION 3.
- 3. The BEARING must rotate smoothly after being mounted.

1. Press OIL SEAL 2 into DRIVE SLEEVE 1. (Be careful to avoid damage to the OIL SEAL.)

2. Insert O-RING 3 into DRIVE SLEEVE 1.







- 1. Put SHIMS 2 & 4 in the GEAR CASE 1 and mount CUPS 3 & 5.
- 2. Put SHIMS 6 & 8 in the GEAR CASE 1 and mount CUPS 7 & 9.



 Put BEVEL PINION 2 and TAPER ROLLER BEARING 3 in GEAR CASE 1. (It must rotate smoothly after being assembled.)

- 1. Install TABER ROLLER BEARING 2 onto DRIVE SHAFT 1 and then BEVEL GEAR 3.
- Tighten LOCKNUT 5 using a torque wrench with a socket (56MM) (Tightening Torque: 160~170 Nm.)
- 3. After the assembly, measure the backlash and adjust it to be in the range of 0.17 to 0.25. (If it is not within this range, readjust using the SHIM.)
- 4. If there is no problem, caulk the LOCKNUT after the assembly.
  - \* Method of Adjusting the Backlash

If the BEVEL GEAR SET backlash (SPEC: 0.17 - 0.25) is not satisfied, adjust SHIM 6 and SHIM 4 followed by backlash value.

If the BEVEL GEAR or the PINION is nicked, or the backlash and contact cannot be adjusted, replace the SET and reassemble.









Caulking (Caulk at 2 locations)





Backlash measurement

\* Method of Adjusting the Contact



Reference Pattern of the Contact

If the contact is different from the reference pattern, adjust SHIM 6 and SHIM 4 to adjust the contact again.

When adjusting the contact, adjust SHIM 6 and SHIM 4. If SHIM 6 is added, remove SHIM 8 and if SHIM 6 is removed add SHIM 8.

(Adjust SHIM 2 in the same way as above to finish the assembly.)

The backlash and contact adjustment should be carried out in the same way. As shown

in the figure right side, for a positive tolerance, the SHIM should be removed, and for a negative tolerance, the SHIM should be added for the adjustment. (The backlash increases for a positive tolerance and decreases for a negative tolerance)





Place DRIVEN GEAR 2 in the BEVEL PINION SPLINE and assemble simultaneously by meshing the INPUT GEAR ASSEMBLY 4 with the DRIVEN GEAR.

Tighten LOCKNUT 3 with asocket (30MM) (Tightening Torque: 60~70 Nm.)

Measure the friction moment with a PUSH PULL GAUGE at a 100mm distance from the center of the INPUT GEAR (8-25 kg/cm).





- 1. Insert 2 DOWEL PINs in 8 of STEERING HOUSING 7 (with LOCTITE 648 applied).
- 2. Tighten 2 GREASE NIPPLES 6 on STEERING HOUSING 7(with tightening torque 5Nm).
- 3. Mount STEERING HOUSING 7 in GEAR CASE 1.
  (apply LOCTITE 5910 on the mounting surface).
  (Be careful to prevent the DRIVEN GEAR being nicked when mounting STEERING HOUSING 7).
- 4. Use SPRING WASHER 4 when tighten the 2 M8x60 WRENCH BOLTS 5 with NUTS.
- 5. Tighten 3 M8x35 WRENCH BOLTS 3 (Tightening torque 22Nm).
- 6. Tighten 8 M10x45 WRENCH BOLTS 2 (Tightening torque 44Nm).

Tighten 4 M8x35 WRENCH-BOLTS in GEAR CASE 1(Tightening torque 22Nm).



After applying liquid gasket PERMATEX FORM-A-GASKET #80017 on the assembly surfaces of GEAR CASE 1 and CASE COVER 6, fix GASKET 2 to match the bolt hole and Tighten the M6x20 HEX BOLT 5 with SPRING WASHER 4. (Tightening torque 10Nm).



Apply the oil using the pouring position marked. First, fill in 2000ml of oil. Use 2000ml of beaker. Add additional 2000ml of oil while checking the oil level to reach a total of 4000ml.

- OIL : (SHELL SPIRAX S2 G 80W-90)

Pour the oil while making sure it must not overflow to the inside of the #5 INPUT GEAR.

Tighten the SOCKET, H PLUGS 5 on the STEERING HOUSING 1. (After tightened one, check the oil level and then tighten the additional one tightening torque 35Nm.) Install DRIVE SLEEVE 3 on the STEERING HOUSING. (The INPUT GEAR BEARING will be assembled inside the DRIVE SLEEVE so use a rubber mallet to push it into the groove spot of the SNAP RING 4. Install SNAP RING 4.

Install AIR BREATHER 2 with a 10Nm torque. Match the Slewing Bearing assembly 2 with Tab Holes of Steering Housing 1 and tighten the 16 M8x30 Wrench Bolts 4. (Tightening torque 22Nm).

Match the Steering Gear 5 with Tab. Match the Steering Gear 5 with Tab Holes of Steering Housing 1 and tighten the12 M8x20 Wrench Bolts 6. (Tightening torque 22Nm).









Match the Sleeve, Outer Ring 1 with Tab Holes of Slewing Bearing assembly and tighten the 3M12x20 Hex Bolts 2. (Tightening torque 20-30 Nm).

