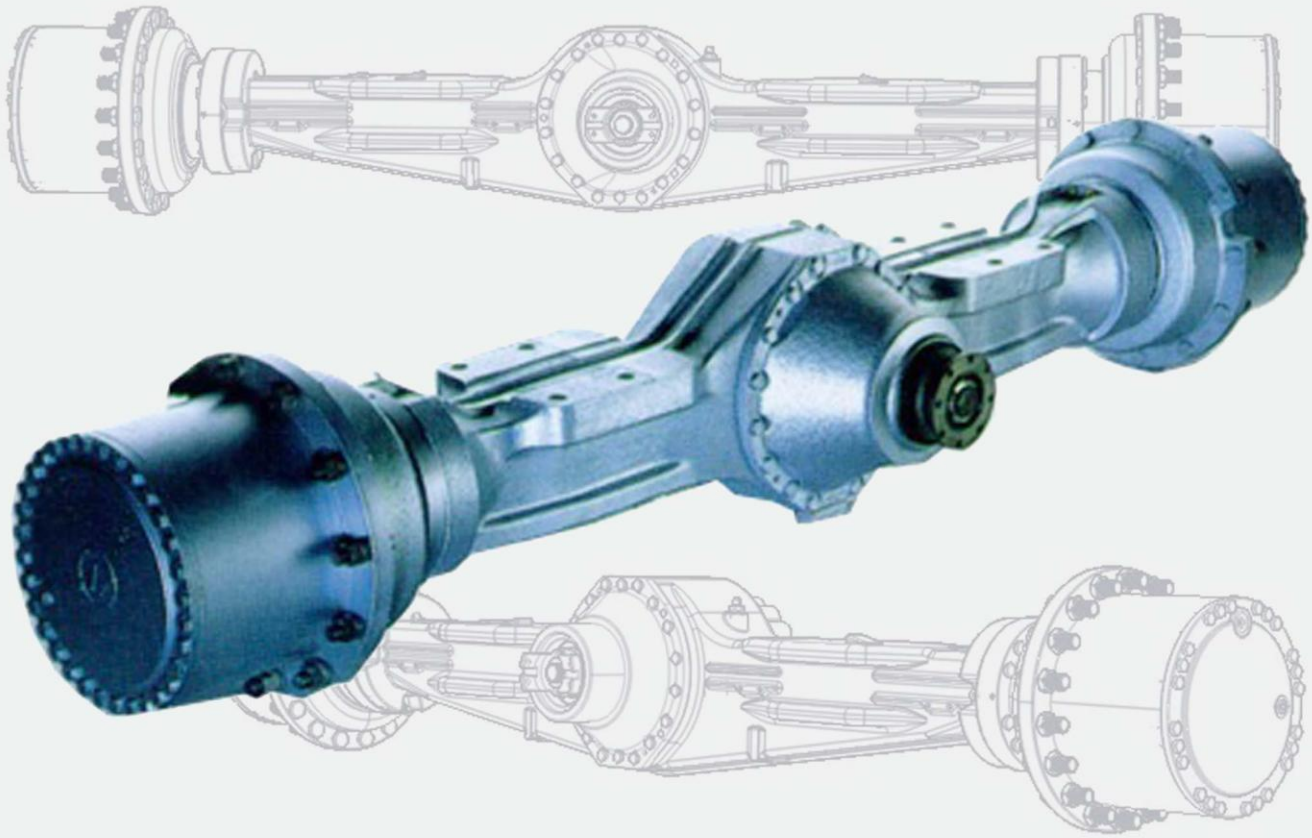
ZFAP-410/DK 驱动桥维修手册

ZFAP-410/DK Axle Service Manual



SDLG 山东临工

Contents

Foreword

Taking ZF AP-410/DK rear axle (now LZZF replaces AP411 with AP412 front axle and AP409 with AP410 rear axle) as an example, this manual specifies the assembling and disassembling process of ZF driving axle and its operating principle and includes the maintenance technology and relevant standard requirements of driving axle, in order to help service technician to further understand the assembling and disassembling method of driving axle and provide them with a basis for correct fault judgment and elimination.

The front axle ZFAP-411/HK is structurally same with rear axle, so it can be subject to repair according to this service manual.

This manual mainly includes:

Chapter 1 Introduction

This chapter mainly specifies the repair precautions of driving axle, meanings of each symbol in this manual and tightening torque of ordinary thread.

Chapter 2 Structure and principle of ZF driving axle system

This chapter mainly specifies the structure and operating principle of ZF axle.

Chapter 3 Disassembling and assembling of driving axle

This chapter specifies how to correctly disassemble and reassemble each part and component and the precautions during disassembling and reassembling.

Chapter 4 Fault diagnosis and maintenance

This chapter specifies the fault diagnosis and maintenance of ZF driving axle.

CAUTION

The specification of part and component in this manual may vary with product improvement without prior notice. Please contact or ask SDLG for latest data.

1 Introduction

1.1 Safety precautions

⚠ Important safety precautions

It is very important for safe operation of vehicle to conduct maintenance and repair. This manual describes the technology in relation to how to disassemble and reassemble the driving axle assembly correctly.

In order to avoid the occurrence of personal injury, ⚠ is used as safety mark in this manual. The precautions with such mark shall be done carefully without any neglect. If the danger occurs, it is necessary to firstly consider the personal safety and then take necessary measure.

During disassembling and reassembling, the wrong operating method will cause damage, shortened service life and weakened performance of part and component as well as result in occurrence of unsafe factor. Therefore, please read this manual carefully before disassembling and reassembling.

1. The parameter, graph and content included in this manual are applicable to standard product. For the product with variation, please contact SDLG or refer to relevant data.

2. In repair shop, it is necessary to arrange for a separate or special area for disassembling and reassembling purpose and storage of disassembled parts and place the relevant tool and part in appropriate area. Additionally, the operating area shall be clean without any oil stain and pollutant. Smoking is allowed only at specified area. During operation, no smoking will be allowed and relevant fire extinguisher shall be provided.

3. The welding operation (if any) shall be undertaken by such person that has been trained and has some welding experiences. During welding, it is necessary to wear welding gloves, baffle, safety goggles, helmet and appropriate protective clothes.

4. Before the transmission and torque converter assembly is disassembled, the pollutant on the assembly surface shall be cleaned off to prevent polluting part and component during disassembling.

5. It is necessary to wear safety shoes and safety helmet during operation. It is not allowed to wear the working clothes that are not as required. It is necessary to do up the buttons of working clothes.

It is necessary to wear goggles when knocking at the part and component with cooper bar.

6. It is allowed to use the gasoline, coal oil and water-based cleanser to clean the disassembled part and component.

7. It is necessary to firstly check the relevant sling for damage when travelling crane or other hoisting equipment is used. It is necessary to use the hoisting equipment with adequate hoisting capacity. During hoisting operation, it is necessary to slowly hoist any part at specified hoisting position to avoid collision between parts. Never work under the hoisted part and component.

8. For the operation to be done by two persons or more at the same time, the operating procedure to be followed jointly shall be agreed in advance to avoid the occurrence of accident due to inconsistent step.

9. It is necessary to properly keep all the tools and know well their operating method.

10. Do not insert your finger into hole when aligning with two holes. For the part and component to be directly assembled by hand, a special attention shall be paid to the hand gripping position to avoid the occurrence of injury.

11. The disassembled part must be subject to detection. The part and component with performance affected shall be replaced with a new one.

12. Any interference is not allowed after each part and component is reassembled.

13. When the oil seal and seal ring are assembled, they shall be protected with relevant measures to avoid the damage of oil seal and seal ring, if they pass through key groove, screw hole and step.

14. When the part and component are assembled, the tool adopted shall be matchable with screw thread fastener to avoid the damage of screw thread fastener.

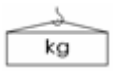
15. Do not use the pneumatic wrench or other tightening tools to tighten the joint and screw plug. It is necessary to tighten them to an extent by hand and then tighten them to the specified torque with a torque wrench.

16. To drain oil from driving axle, be sure to slowly screw off oil drain plug to avoid ejection of oil. The drained oil shall be contained in special vessel to avoid polluting environment.

1.2 Description on mark and symbol

In order to give a full play of this manual, the following marks shall be used in respect of important safety and quality requirements.

Table 1-1 Description on mark and symbol

Mark	Item	Remarks
	Safety	The operation is in process and a special attention shall be paid to safety.
		A special attention shall be paid to internal pressure during operation.
	Caution	Much attention shall be paid to technical requirement during operation to ensure the operating quality is up to standard.
	Weight	Weight of part or device and disassembling and reassembling method.
		Much attention shall be paid to sling selection and posture during operation.
	Tightening torque	Much attention shall be paid to tightening torque of subassembly during assembling.
	Coating	The position where the adhesive and grease shall be applied.
	Oil and water	Add a certain amount of engine oil, water or fuel oil.
	Drainage	The position where the oil or water shall be drained, and drainage capacity.

1.3 Table for tightening torque of ordinary bolt thread

Table 1-2 Table for tightening torque

Strength grade of bolt	Yield strength N/mm^2	Nominal diameter of bolt				
		6	8	10	12	14
		Tightening torque N•m				
4.6	240	4~5	10~12	20~25	36~45	55~70
5.6	300	5~7	12~15	25~32	45~55	70~90
6.8	480	7~9	17~23	33~45	58~78	93~124
8.8	640	9~12	22~30	45~59	78~104	124~165
10.9	900	13~16	30~36	65~78	110~130	180~210
12.9	1080	16~21	38~51	75~100	131~175	209~278
Strength grade of bolt	Yield strength N/mm^2	Nominal diameter of bolt				
		16	18	20	22	24
		Tightening torque N•m				
4.6	240	90~110	120~150	170~210	230~290	300~377
5.6	300	110~140	150~190	210~270	290~350	370~450
6.8	480	145~193	199~264	282~376	384~512	488~650
8.8	640	193~257	264~354	376~502	521~683	651~868
10.9	900	280~330	380~450	540~650	740~880	940~1120
12.9	1080	326~434	448~597	635~847	864~1152	1098~1464
Strength grade of bolt	Yield strength N/mm^2	Nominal diameter of bolt				
		27	30	33	36	39
		Tightening torque N•m				
4.6	240	450~530	540~680	670~880	900~1100	928~1237
5.6	300	550~700	680~850	825~1100	1120~1400	1160~1546
6.8	480	714~952	969~1293	1319~1759	1694~2259	1559~2079
8.8	640	952~1269	1293~1723	1759~2345	2259~3012	2923~3898

10.9	900	1400~1650	1700~2000	2473~3298	2800~3350	4111~5481
12.9	1080	1606~2142	2181~2908	2968~3958	3812~5082	4933~6577

1.4 Table for bolt tightening torque and adjusting clearance of ZF driving axle

Table 1-3 Table for bolt tightening torque and adjusting clearance of ZF driving axle

No.	Part	Mounting position	Part specification	Torque (N•m)	Adjusting clearance (mm)
1	Rear axle	Bracket locking nut		700	
2	Rear axle	Bracket connecting bolt	M14×1.5×40, 12.9	265	
3	Rear axle	Wheel locking nut		800-1000	
4	Rear axle	Wheel supporting axle bolt	M18×60, 10.9	390	
5	Rear axle	Planet wheel carrier connecting bolt	M14×40, 10.9	180	
6	Rear axle	Adjusting clearance of wheel friction plate			2.4~2.8
7	Rear axle	Adjusting clearance of sun gear shaft			0.3~0.6

2 Structure and principle of ZF driving axle

2.1 General description on driving axle

The driving axle is located at the end of loader power train, as shown in Fig.2-1. It is mainly composed of final drive, differential, axle shaft, wheel reducer and axle housing. Its function is to: (1) transmit the torque from drive shaft to driving wheel to reduce the speed and increase the torque; (2) change the transfer direction of torque via bevel gear pair of final drive; (3) realize the differential function of wheels at two sides to ensure the inner and outer wheels can rotate at different speed.

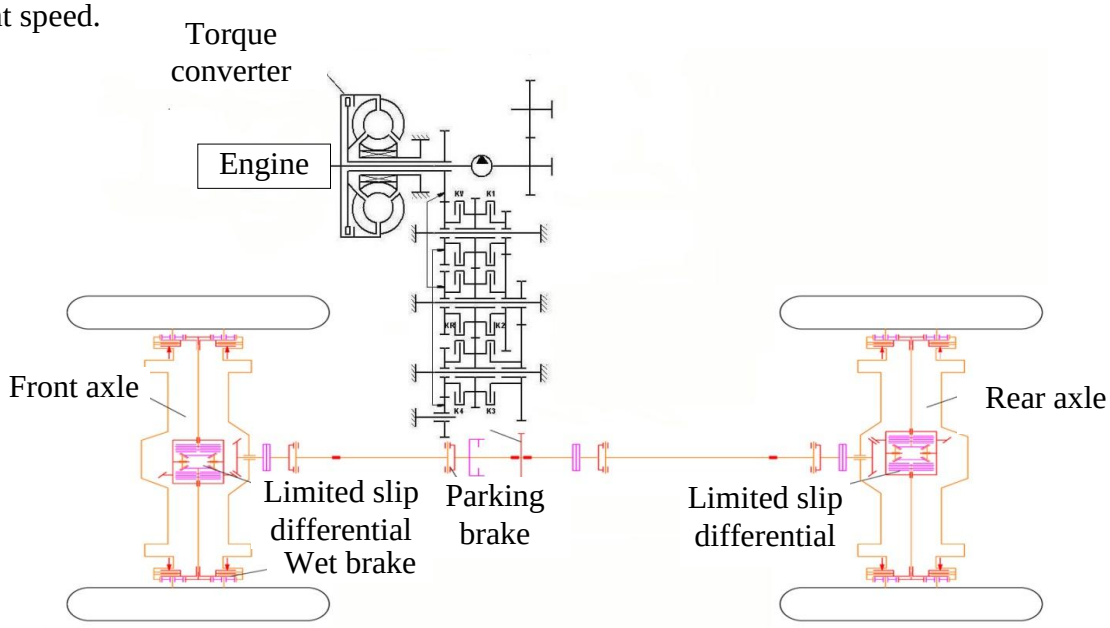


Fig.2-1 Position drawing of driving axle

2.2 Structure and performance parameter of ZF axle

ZF (ZF Friedrichshafen) AP-400 series driving axles have many advantages. Firstly, it benefits from limited slip differential to play an outstanding role in helping vehicle out of difficulty, reducing tire abrasion and improving working efficiency. Additionally, it is not larger than the conventional differential. It can be installed as required and needs no special maintenance. Secondly, with wet brake, it is characterized by easy maintenance, long service life and high ground clearance. Because of such advantages, ZF axle has been widely applied to non-road machinery.

2.2.1 Structure and performance parameter of assembly

Each assembly of ZF axle is as shown in Fig.2-2 and its performance is as shown in Table 2-1.

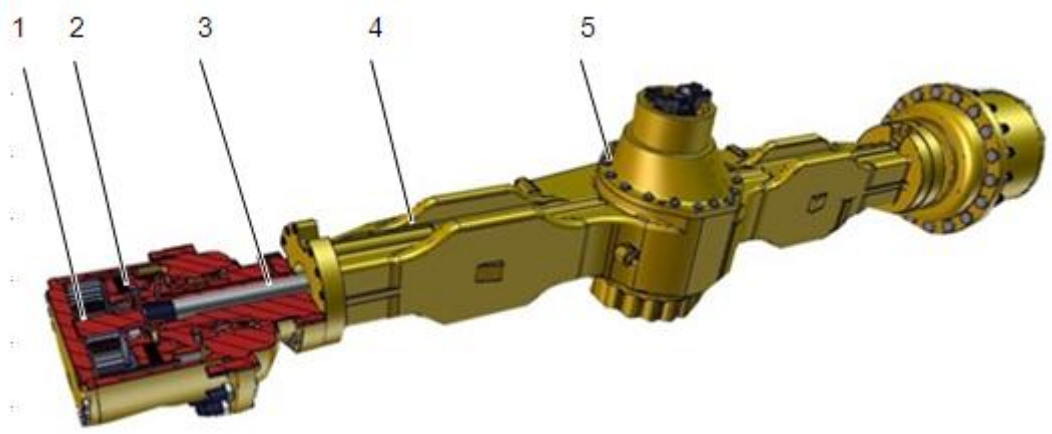


Fig.2-2 ZF driving axle assembly

1—Wheel reducer 2—Wet brake 3—Axle shaft 4—Axle housing 5—Main actuator

Table 2-1 Performance parameter of ZF axle

	AP410/DK	AP410/HK
Load:		
Maximum static load (t)	21.8	25.0
Maximum dynamic load (t)	13.3	15.3
Output torque		
Normal (N•m)	81030	101140
Peak (N•m)	145850	182050
Brake torque (N•m)	39548 (3 discs)	52732 (4 discs)
Tire	20.5-25	23.5-25
Wheel speed reduction ratio	6.353	6.353

2.3 Operating principle of ZF axle

Firstly, the following is the differential principle and torque distribution of ordinary driving axle.

2.3.1 Differential principle

The kinematic relation--differential speed principle of each component in ordinary symmetrical bevel gear differential can be shown by Fig.2-3. The symmetrical bevel gear differential is a planet

gear mechanism. The differential housing 3 is connected with the cross axle 5 to form planet carrier. Because it is fixed together with the driven spiral bevel gear 6, the differential housing, cross axle and driven spiral bevel gear enjoy a same rotary speed. The differential is driving part and its angular speed is assumed as ω_0 while the axle shaft gears 1 and 2 are driven parts with their angular speed as ω_l and ω_2 respectively. A and B are the engagement points of the planet gear 4 and the axle shaft gears 1 and 2. The planet gear center is C and the distance from the points A, B and C to the differential rotating axis is r.

When the planet gear only revolves with planet carrier around differential rotating axis, obviously, those points A, B and C at same radius r enjoy a same peripheral speed, which is equal to $\omega_0 r$. Then, $\omega_0=\omega_l=\omega_2$. This shows the differential doesn't play any differential role and the axle shaft angular speed is equal to the angular speed of differential housing 3.

When the planet gear 4 revolves on its own axis 5 at the angular speed ω_4 in addition to revolution, the peripheral speed of engagement point A will be $\omega_1 r=\omega_0 r+\omega_4 r_4$ (assume the radius of planet gear as r_4) and that of engagement point B will be $\omega_2 r=\omega_0 r-\omega_4 r_4$. Then,

$$\omega_1 r+\omega_2 r=(\omega_0 r+\omega_4 r_4)+(\omega_0 r-\omega_4 r_4)$$

namely,

$$\omega_1+\omega_2=2\omega_0$$

The above equation shows the motion characteristic equation of symmetrical bevel gear differential. This shows the sum of rotating speed of left and right axle shaft gears is twice than the rotating speed of differential housing at all times, irrespective of the rotating speed of planet gear. Therefore, when the loader turns or operates in other modes, the planet gear can revolve on its axis at the same rotating speed to make the driving wheels at two sides roll on ground at different speed without slip. Additionally, the above equation also shows:

(1) When the rotating speed of axle shaft gear at any side is equal to zero, the rotating speed of axle shaft gear at the other side will be twice than that of differential housing;

(2) When the rotating speed of differential housing is equal to zero, the axle shaft gear at one side will reversely rotate at the same rotating speed if the axle shaft gear at the other side is driven to rotate by other external torque.

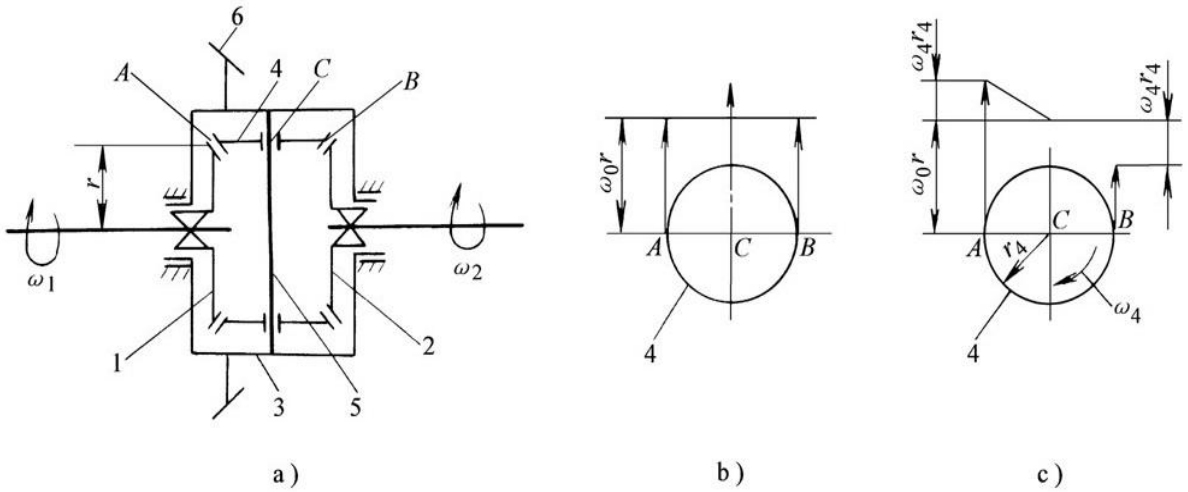


Fig.2-3 Differential speed principle of differential

1, 2—Axle shaft gear 3—Differential housing 4—Planet gear 5—Cross axle 6—Driven spiral bevel gear

2.3.2 Torque distribution

The torque distribution of ordinary symmetrical bevel gear differential has following relation. When the torque from final drive is taken as M_0, the torque M_0 is always evenly distributed onto left and right axle shaft gears if the planet gear doesn't revolve on its own axis, namely, $M_1= M_2= M_0/2$.

When the two axle shaft gears rotate at different speed along same direction, namely, at differential speed, the planet gear will revolve on the cross axle along the arrow n_4 direction in Fig.2-4, if the left axle shaft rotating speed n_1 is larger than the right axle shaft rotating speed n_2. On this account, there is friction between planet gear hole and cross axle journal and between gear back and differential housing. The direction of friction torque M_r on planet gear is reverse to that of its rotating speed n_4. This friction torque respectively generates two peripheral forces F_1 and F_2 which are same quantitatively but reverse directionally on left and right axle shaft gears. F_1 reduces the torque M_1 transferred on the left axle shaft rotating at a higher speed while F_2 increases the torque M_2 transferred on the right axle shaft rotating at a lower speed. Therefore, when the left and right driving wheels have speed difference, $M_1=(M_0-M_r)/2$, $M_2=(M_0+M_r)/2$. The torque difference of left and right wheels is equal to the internal friction torque M_r of differential.

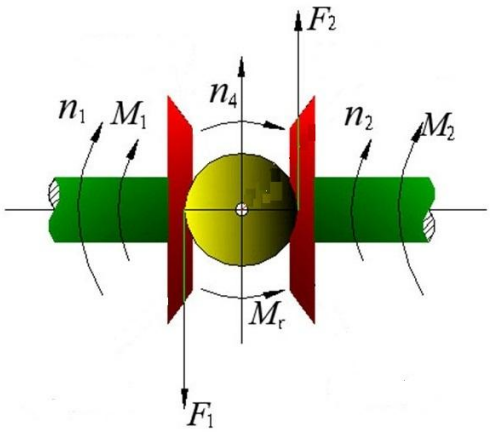


Fig.2-4 Torque distribution of differential

The popular symmetrical bevel gear differential has relatively small internal friction torque, so it can be said to some extent that the torque is evenly distributed whether the rotating speed of left and right driving wheels is the same. This is known as the force transfer characteristics of "differential speed with same force" of ordinary differential. Such distribution proportion is reasonable for straight driving on good road. However, the trafficability will be severely affected if the vehicle runs on bad road. For instance, when the driving wheel at one side touches the muddy or snowy road, the wheel at muddy road will slip on the spot while the wheel at good road will maintain immobile. This is because the adhesion between the wheel at muddy road and the road surface is so small that the road surface applies only very small reactive torque on axle shaft. Though the adhesion between the wheel at other side and the good road surface is relatively large, the evenly-distributed torque of symmetrical bevel gear differential makes the torque distributed onto this wheel is equal to the small torque transferred on the driving wheel in slippage. On this account, the total driving force is not enough to conquer the running resistance, so the wheel cannot run forward. However, the limited slip differential on ZF axle can improve this situation.

2.3.3 Operating principle of limited slip differential

The limited slip differential develops from the symmetrical bevel gear differential and its structure is as shown in Fig.2-5. The cross axle assembly consists of two slotted shafts 1 and the four planet gears are applied onto the slotted shaft to engage with the axle shaft gear 2. At two sides of axle shaft gear, there is one thrust pressure plate 3 respectively. In the thrust pressure plate, there are four V-grooves mounted on the shaft journal of slotted shaft. At each side of thrust pressure plate, there

are driving and driven friction plates 5 and 4

respectively. The six semicircular key grooves at edge of driving friction plate can wedge the driving friction plate 5, thrust pressure plate 3 and differential housing 7 together via cylindrical force transfer pin 6. This structure enables these parts revolve around axle shaft as a whole and the thrust pressure plate and friction plate slightly move along axle shaft. The driven friction plate has many grooves on its surface to increase friction and the spline on its inner edge to match with the outer spline of axle shaft gear. The axle shaft gear is mounted on the outer spline of axle shaft via the inner spline. The differential assembly is as shown in Fig.2-6.

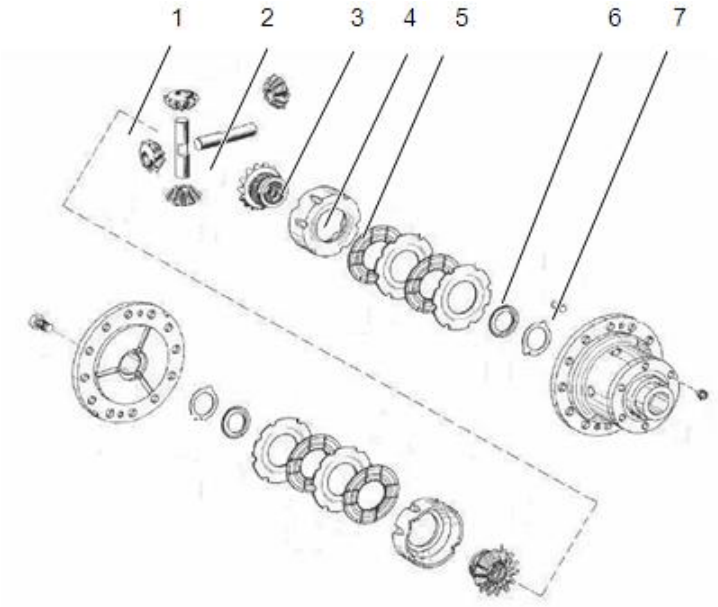
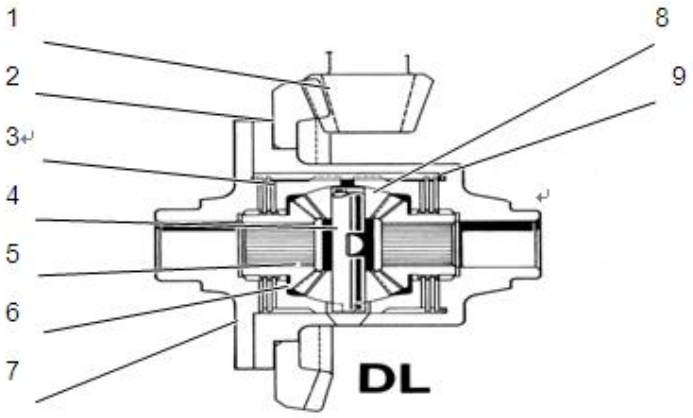


Fig.2-5 Structure of limited slip differential

1—Slotted shaft 2—Axle shaft gear 3—Thrust pressure plate 4—Driven friction plate

5—Driving friction plate 6—Force transfer pin 7—Differential housing



2-6 Limited slip differential

1—Driving spiral bevel gear 2—Driven spiral bevel gear 3—Driving and driven friction plates
4—Slotted shaft 5—Axle shaft gear 6—Thrust pressure plate
7—Differential housing 8—Planet gear 9—Force transfer pin

When the differential operates, its power transmission route is as follows: the driving spiral bevel gear drives the driven spiral bevel gear to rotate. Because the latter is fixed with the differential housing, the differential housing is also driven to rotate. The differential housing drives the thrust pressure plate and driving friction plate via force transfer pin while the thrust pressure plate V-groove drives the cross axle to rotate. When the planet gear on cross axle drives the axle shaft gear to rotate, the power output occurs.

When the thrust pressure plate drives the cross axle to rotate as per the direction shown in the drawing, the stress analysis is as shown in Fig.2-7. V-groove applies a force F that is vertical to the inclined plane to cross axle. This force can be divided into forces F_1 and F_2, of which, F1 drives the cross axle assembly to rotate to transfer power outwards while F_2 combines the thrust pressure plate at other side to balance the force on the other slotted shaft. Additionally, F_2 generates a reacting force F3 (namely, the reacting force of cross axle on thrust pressure plate) to drive the thrust pressure plate to move outwards so as to press against the driving and driven friction plates. After they are pressed, the driving friction plate can drive the driven friction plate to realize the power output.

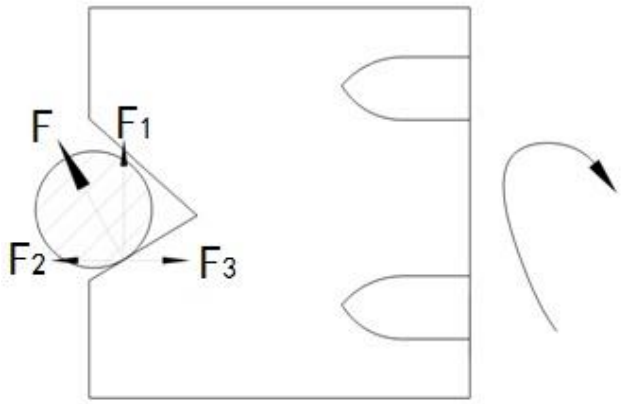


Fig.2-7 Stress analysis chart

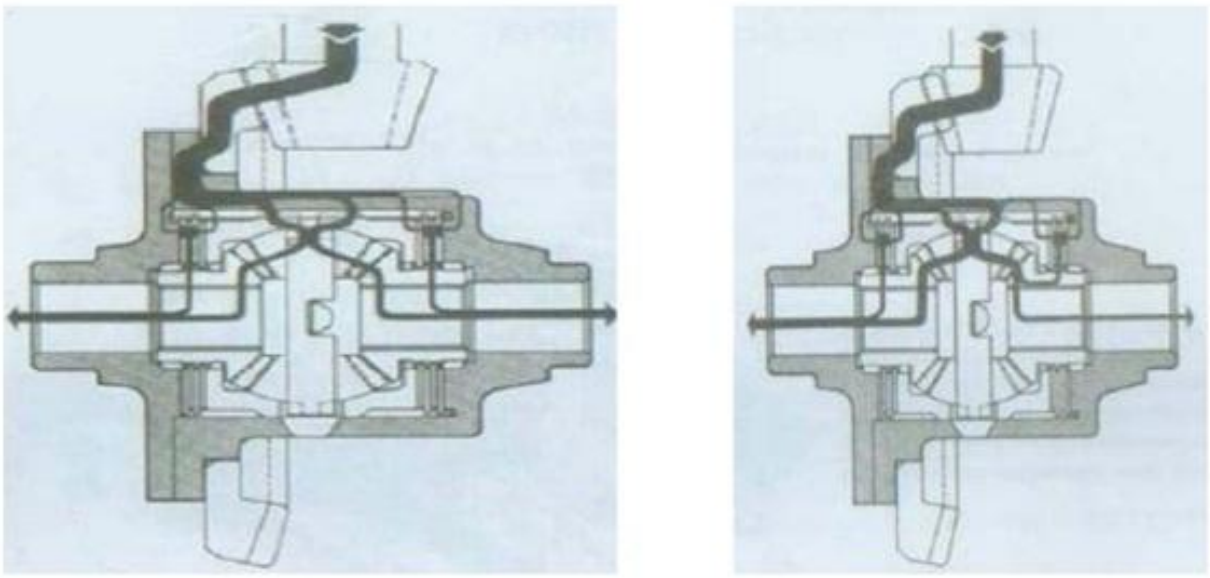
(1) When driving in a straight line, the two axle shafts have no differential rotating speed and the torque is evenly distributed to two axle shafts. There is no relative slippage between friction plates

if no differential speed. Due to the pressing force F_3, the two thrust pressure plates press against their respective driving and driven friction plates at outer end. At this time, the torque is transited to axle shaft via two routes: one is to transmit the most torque to axle shaft via cross axle, planet gear and axle shaft gear and the other one is to transmit to axle shaft via differential housing, force transfer pin and driving and driven friction plates. The torque flow is as shown in Fig.2-8 (a).

(2) When the wheel at one side slips on road surface, take the rotating speed of differential housing as ω_0, the rotating speed of left side axle shaft gear as ω_1 and the rotating speed of right side axle shaft gear as ω_2. Because the driving friction plate and differential housing are wedged together by force transfer pin, the rotating speed of driving friction plates at two sides are the same, namely ω_0. However, the driven friction plate is assembled together with axle shaft gear, so the rotating speed of driven friction plate on the left is ω_1 and that on the right is ω_2. It is assumed that the wheel on the right slips and the differential plays a differential role. Though the thrust pressure plate generates a pressing force on friction plate, the external resistance is so small that the driving torque transmitted by thrust pressure plate is relatively small. As a result, the pressing force on friction plate is also small (F_3 is positively correlated with F). Additionally, the torque (torque on driving friction plate) transmitted from drive shaft is largely different from the torque (torque on driven friction plate) of axle shaft from outside, so the driving and driven friction plates conquer the friction force between them to slip oppositely. The relationship among them can be shown as $\omega_1<\omega_0<\omega_2$. It can be concluded that the rotating speed of driven friction plate on the right is higher than that of driving friction plate. When the driving friction plate applies a resistance torque to the driven friction plate, therefore, it is equivalent to an additional reacting torque from the ground to the axle shaft at slippage side. This can help wheels at two sides to obtain driving torque so as to get out of trouble. However, the left side is just the opposite. The rotating speed of driving friction plate is greater than that of driven friction plate, so a driving torque will be generated on driven friction plate to drive the driven friction plate to rotate. On this account, the wheel that runs at a low speed can obtain additional power to get out of trouble. If the adhesion condition at two ends is different, the torque flow is as shown in Fig.2-8 (b).

The turning mode is similar to the mode of slippage at one side. When turning, the outer wheels are

of high rotating speed and small resistance torque while the inner wheels are of low rotating speed and large resistance torque. However, the limited slip differential can increase the driving torque of inner wheels but reduce that of outer wheels. Moreover, the driving and driven friction plates slip each other, producing no influence on differential function. When turning, the torque flow is as shown in Fig.2-8 (b).



Torque flow under the same adhesion condition when driving in a straight line

(a)

Torque flow when turning left or under different adhesion conditions at two ends

(b)

Fig.2-8 Torque flow under different modes

2.3.4 Principle of wet brake

The structure of wheel reducer and wet brake is as shown in Fig.2-9. The friction plate bracket 5 has the inner spline applied on the spline of axle shaft 1. The driving friction plate 3 is applied onto the outer side of friction plate bracket via the inner spline and rotates with the friction plate bracket while the driven friction plate 4 outer spline is fixed on inner gear ring 6. The sun gear shaft 7 has outer spline at one end to match with the inner spline of friction plate bracket, so the axle shaft, friction plate bracket and sun gear shaft are connected together via inner spline to realize synchronous rotation. The sun gear shaft is engaged with four planet gears 8 and the four planet gear shafts integrate into the hub. During operation, the planet gear revolves around its own axis

and the sun gear shaft. When revolving around sun gear shaft, the planet gear will drive the hub to transfer power to tires.

When the brake pedal is stepped, the high-pressure brake oil will enter the internal oil duct 10 through brake oil pipe to drive the piston 2 to firmly press the driving and driven friction plates together. Because the driven friction plate is immobile, a resistance torque is generated on the driving friction plate to arrest the rotation of friction plate bracket and sun gear shaft so as to realize the wet brake.

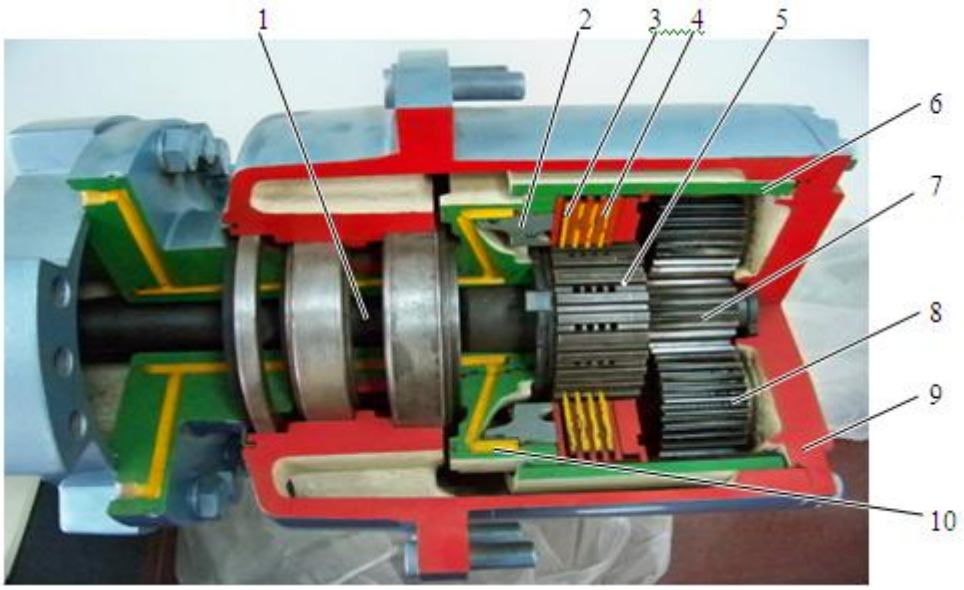


Fig.2-9 Wet brake and wheel reducer

1-Axle shaft 2-Piston 3-Driving friction plate 4-Driven friction plate 5-Friction plate bracket 6-Inner gear ring 7-Sun gear 8-Planet gear 9-Hub 10-Oil pipe

3 Disassembling and reassembling of ZF driving axle

3.1 Disassembling of ZF driving axle

3.1.1 Disassembling of axle accessories

1. Remove the hollow bolt and seal gasket from grease pipe on front swinging bracket.

1 2

Fig. 3-001 Tool: Wrench 17
1 Hollow bolt, 1 piece
2 Copper gasket, 2 pieces

2. Remove the hollow bolt and seal gasket from grease pipe on rear swinging bracket.

1 2

Fig.3-002 Tool: Wrench 17
1 Hollow bolt, 1 piece
2 Copper gasket, 2 pieces

Fig.3-003 Tool: Screwdriver
1 Pipe clip, 2 pieces
2 Washer, 4 pieces
3 Screw, 4 pieces

3. Use a screwdriver to remove screw, washer and pipe clip from grease pipe and take off the grease pipe.

Fig.3-004 Tool: Wrench 22
1 Brake oil pipe

4. Take apart the brake oil pipe joint and place an oil container under it.

Drain the brake fluid

★CAUTION

It is necessary to use the iron-made oil container other than plastic container to prevent polluting the oil. The disassembled joint shall be protected appropriately.

Fig.3-005 Tool: Wrench 10
1 Pipe clip, 1 piece
2 Bolt, 1 piece

5. Remove the pipe clip and other oil pipe fasteners.

Fig.3-006 Tool: Wrench 22
1 Brake oil pipe

6. Place an oil container under the oil pipe joint and remove the brake oil pipe. Be sure to protect the oil pipe.

Drain the brake fluid

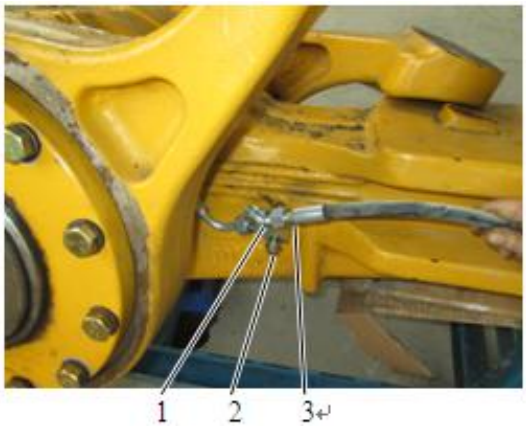


Fig.3-007 Tool: Wrench 10
1 T-joint, 1 piece
2 Bolt, 1 piece
3 Cushion block, 1 piece

7. Remove the bolt and cushion block and take down the tee union and brake oil pipe.

Fig.3-008 Tool: Wrench
1 Bolt, 4 pieces

8. Remove the bolt on the transmission shaft flange plate and disconnect its connection with the gearbox.

Fig.3-009 Tool: Wrench
1 Bolt, 4 pieces

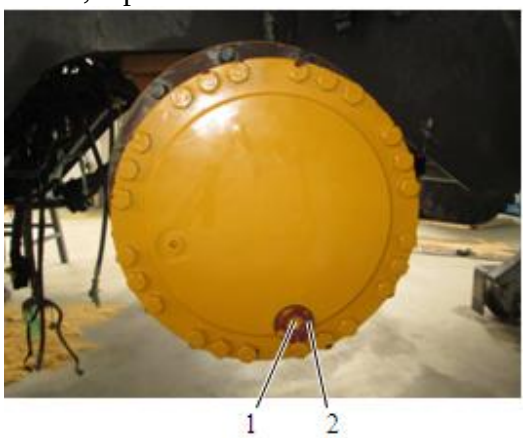


Fig.3-010 Tool: Allen wrench
1 Screw plug, 1 piece
2 O-ring, 1 piece

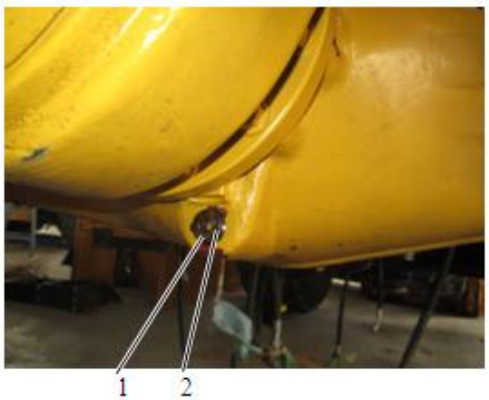


Fig.3-011
1 Screw plug, 1 piece Tool: Allen wrench
2 O-ring, 1 piece

9. Remove the bolt, disconnect the connection between the transmission shaft and rear axle, and remove the transmission shaft.

3.1.2 Oil drainage

1. Rotate the left and right hubs till the screw plug is at the lowest point, place a iron-made oil container under it and then use a Allen wrench to remove the screw plug to drain oil from hub.

Drain gear oil from hub

★CAUTION

The screw plug has O-ring and shall be protected.

⚠CAUTION

The oil shall be drained after vehicle runs for a period of time. It is necessary to slowly screw off screw plug to prevent the hot oil splashing.

2. Place an oil container under screw plug and then use an Allen wrench to remove the screw plug to drain oil. The O-ring on screw plug shall be protected.

Drain the gear oil from axle housing

3.1.3 Disassembling of driving axle assembly

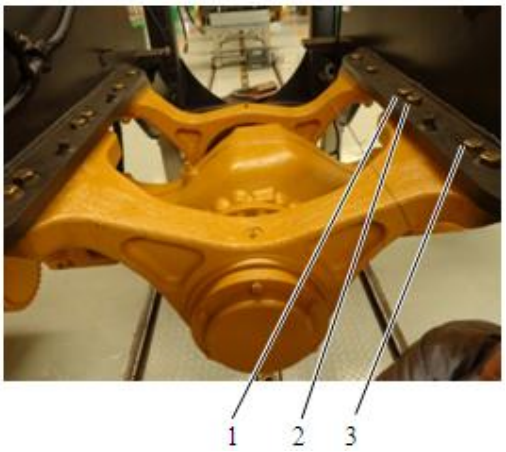


Fig.3-012
1 Bolt, 12 pieces
2 Washer, 12 pieces
3 Nut, 12 pieces

1. Uphold two ends of the driving axle and place a cart under it, use a pneumatic wrench to remove the fixing bolts from front and rear swinging brackets and place the driving axle on the cart.

kg **Rear axle assembly**

Fig.3-013

2. Push out the cart and place the driving axle on appropriate bracket.

⚠CAUTION

The front swinging bracket has no axial positioning and shall be protected from hurting the operator.

Fig.3-014
1 Front swinging bracket

3. The front swinging bracket has no axial positioning and can be removed directly.

kg **Front swinging bracket**

Fig.3-005 Tool: Wrench 18
1 Bolt, 6 pieces

4. Remove the rear end cover fixing bolt.

Fig.3-016
1 End cap, 1 piece
2 Shim, 1 piece

5. Remove the end cover and gasket.

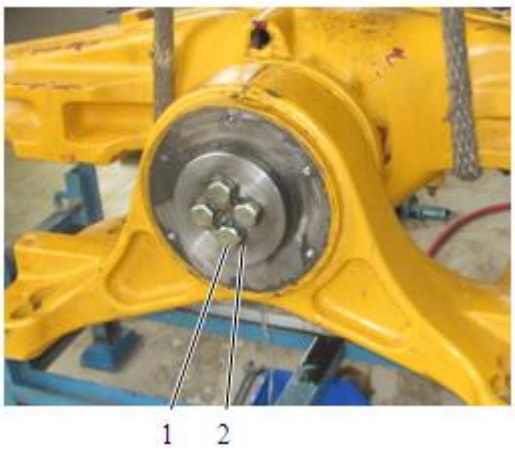


Fig.3-007 Tool: Wrench 30
1 Bolt, 4 pieces
2 Gasket, 4 pieces

6. Clean up the grease and remove the bolt and gasket with wrench.

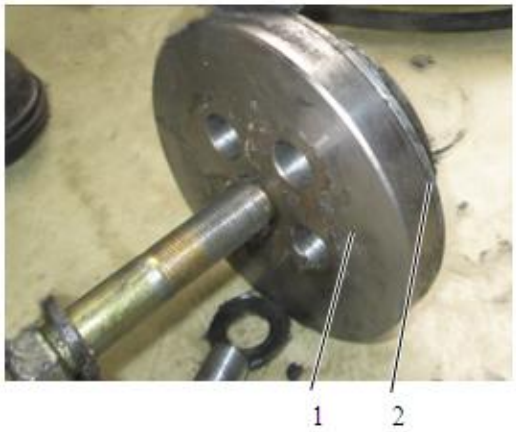


Fig.3-018
1 Cushion block, 1 piece
2 Gasket, 1 piece

7. Remove the cushion block and gasket.

CAUTION

After the cushion block and gasket are removed, the rear swinging bracket has no axial positioning and shall be protected from hurting the operator.

Fig.3-019
1 Rear swinging bracket, 1 piece
2 Gasket, 1 piece

8. Remove the rear swinging bracket and gasket from its inner hole.

kg **Rear swinging bracket**

3.1.4 Disassembling of wheel reducer

Fig.3-020 Tool: Wrench 24
1 Bolt, 24 pieces

1. Remove the fixing bolt from planet carrier.

Fig.3-021
1 Planet carrier, 1 piece

2. Insert the crow bar into the groove at hub edge to slowly pry out the planet carrier.

⚠CAUTION

Appropriate protection shall be done to prevent the internal sun gear and friction plate bruising operator.

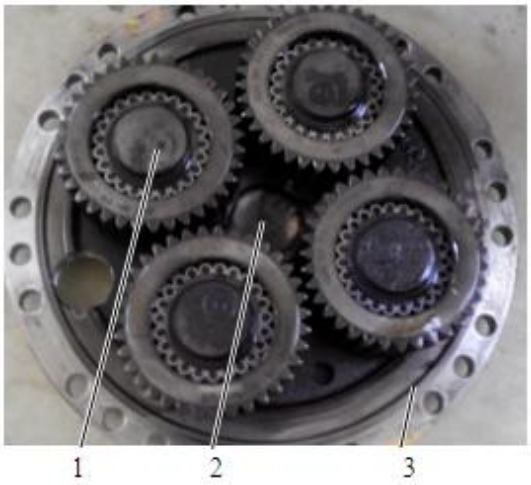


Fig.3-022
1 Planet carrier, 1 piece

3. Remove the planet carrier and planet gear from axle, remove the lock washer and then protect the O-ring.

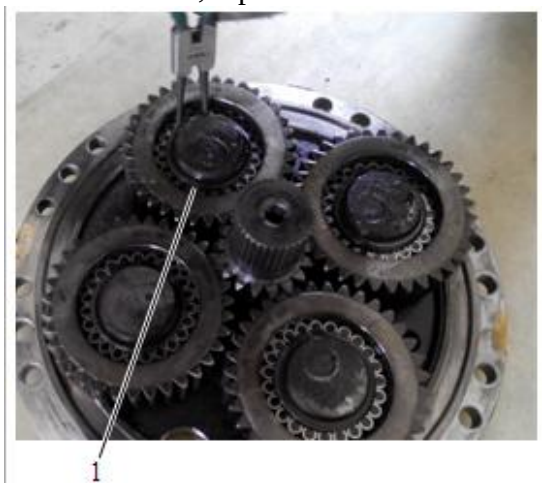


Fig.3-023 Tool: Snap ring pliers
1 Snap ring, 4 pieces

4. Remove the snap ring.

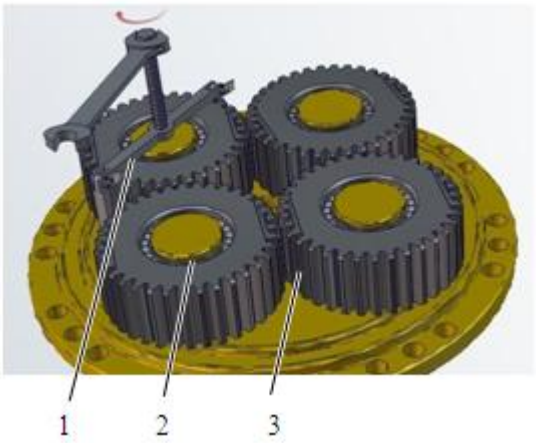


Fig.3-024
1 Puller
2 Bearing, 4 pieces
3 Planet gear, 4 pieces

5. Remove the planet gear and bearing with puller

3.1.5 Disassembling of wet brake

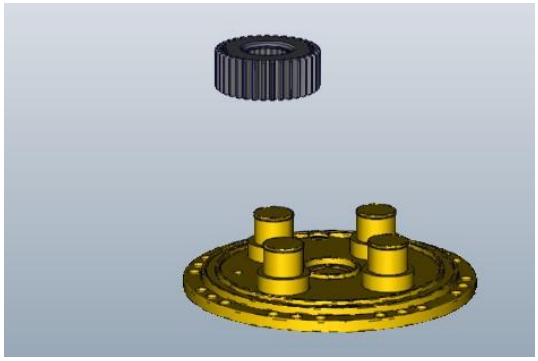


Fig.3-025

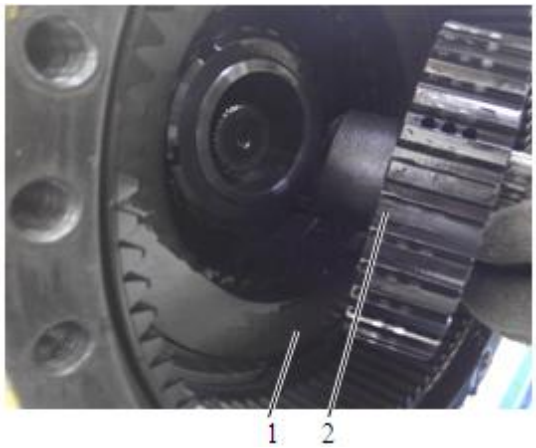


Fig.3-026
1 Friction plate bracket, 1 piece
2 Sun gear shaft, 1 piece

1. Remove the friction plate bracket and sun gear shaft.

Fig.3-027
1 Lock washer, 1 piece

2. Take off the lock washer

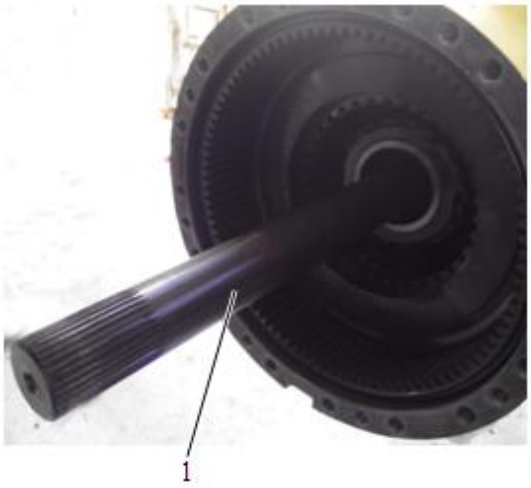


Fig.3-028
1 Axle shaft, 1 piece

3. Take out the axle shaft.

★CAUTION

Because the spline end matchable with axle shaft and friction plate bracket has different length from that matchable with axle shaft gear, it is necessary to keep in mind the inner side and outer side of axle shaft spline to avoid incorrect installation during reassembling

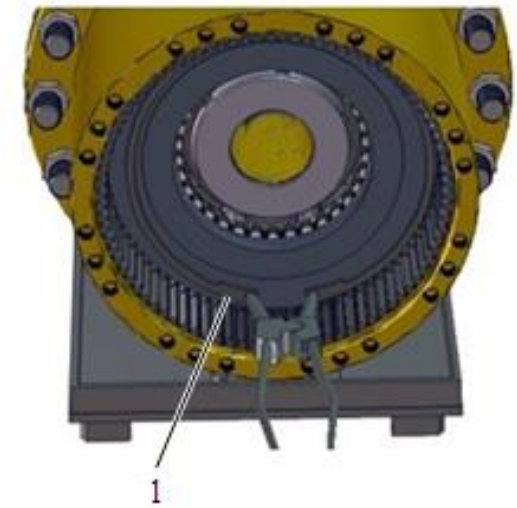


Fig.3-029 Tool: Snap ring pliers
1 Snap ring, 1 piece

4. Use a snap ring pliers to remove the snap ring

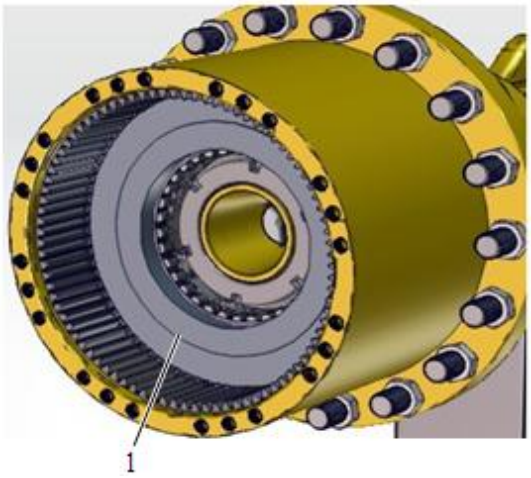


Fig.3-030
1 End gasket, 1 piece

5. Take off the end gasket.

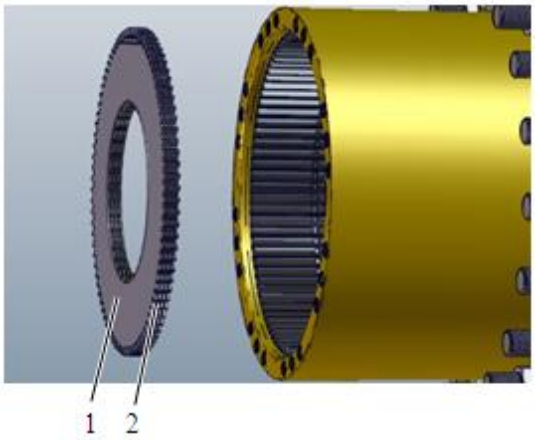


Fig.3-031
1 Driven friction plate, 3 pieces
2 Driving friction plate, 3 pieces

6. Take off the driving and driven friction plates.

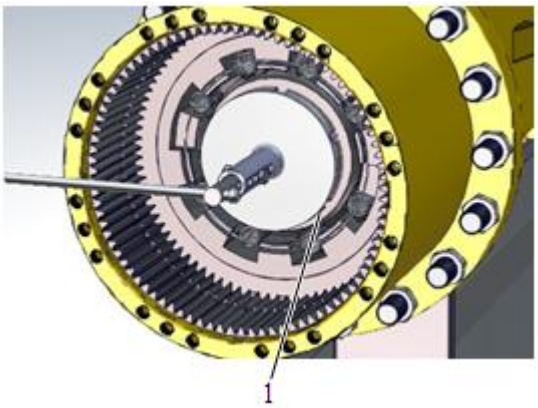


Fig.3-032
1 Slotted nut, 1 piece

7. Use a special tool to remove the slotted nut.

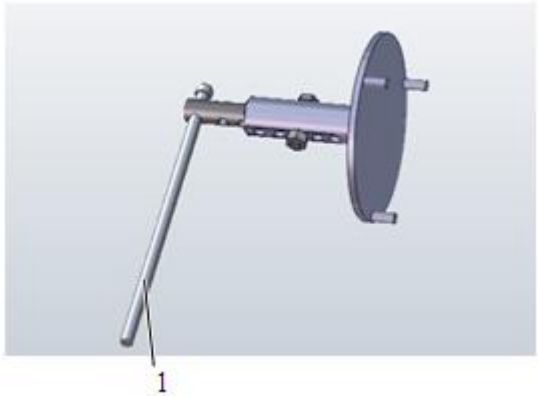


Fig.3-033
1 Special tool

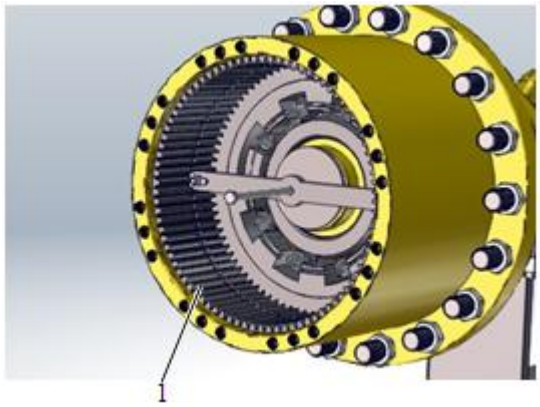


Fig. 3-034
1 Gear ring assembly, 1 piece

8. Use an inner gear ring puller to pull out the gear ring assembly.

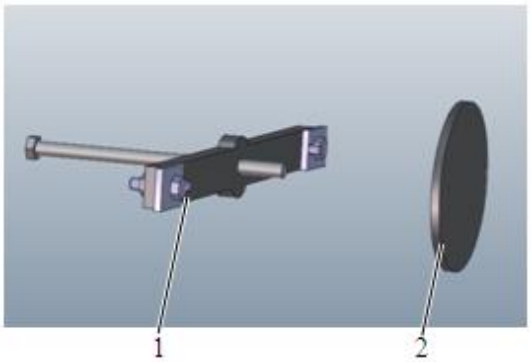


Fig.3-035
1 Inner gear ring puller (6399006949)
2 Iron gasket

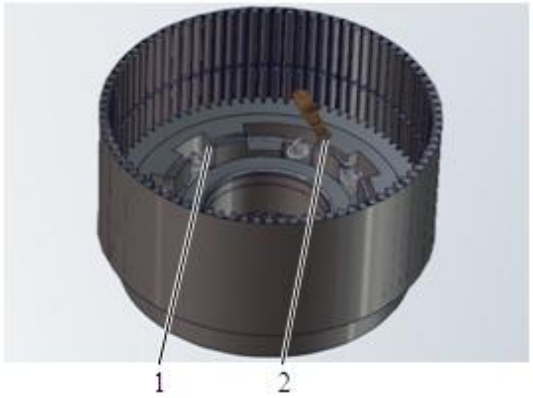


Fig. 3-036
1 Slotted ring, 1 piece
2 Iron hook, 1 piece

9. Remove the tension spring with iron hook and take off the slotted ring.

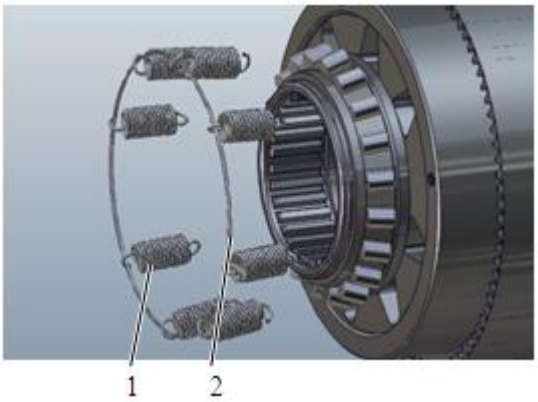


Fig. 3-037
1 Tension ring, 8 pieces
2 Ring groove, 1 piece

10. Take off the tension spring and the slotted ring at other side

Fig. 3-038
1 Special tool
2 Bearing, 1 piece

11. Knock at the special tool to pack out the bearing.

Fig. 3-039
1 Piston, 1 piece
2 Rear-mounted seal ring, 2 pieces
3 Piston guide ring, 2 pieces

12. Take off the piston, rear-mounted seal ring and piston guide ring.

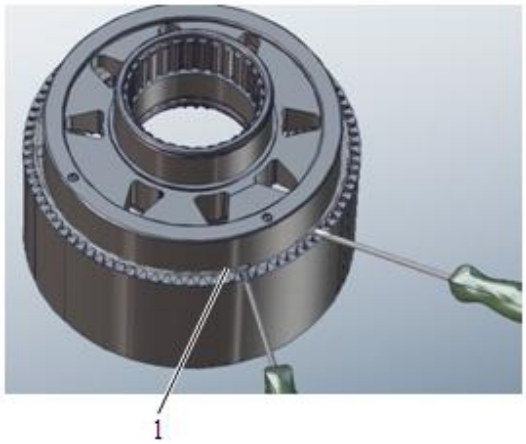


Fig.3-040 Tool: Screwdriver
1 Elastic retainer ring, 1 piece

13. Pry out the elastic retainer ring

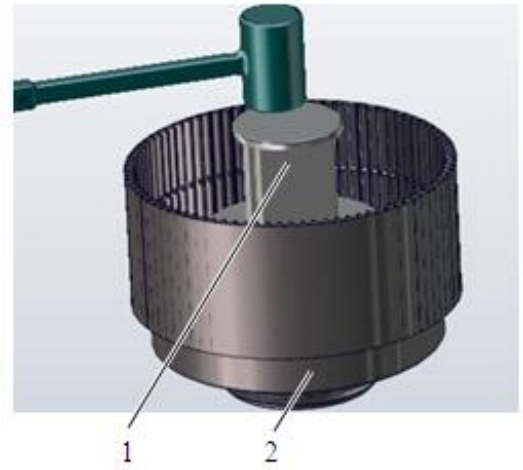


Fig. 3-041
1 Tooling
2 Spline hub, 1 piece

14. Knock at the tooling to pack out the spline hub.

15. Knock at the hub to remove the hub.

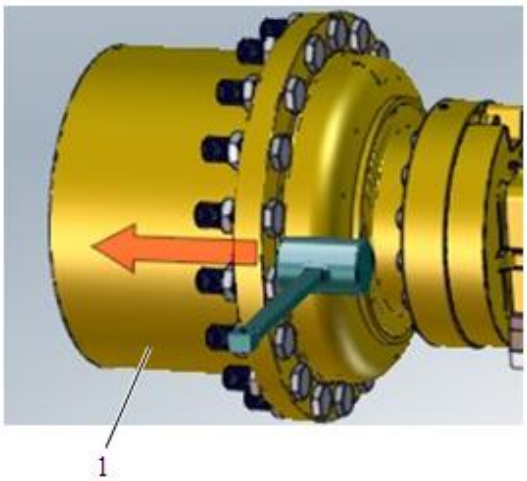


Fig. 3-042
1 Hub, 1 piece

16. Take off the bearing outer ring

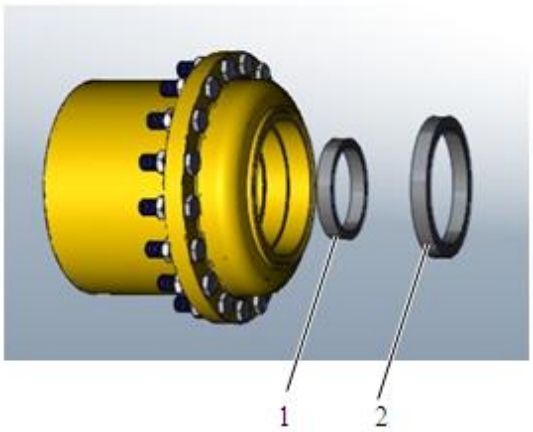


Fig. 3-044
1 Bearing outer ring, 1 piece
2 Bearing outer ring, 1 piece

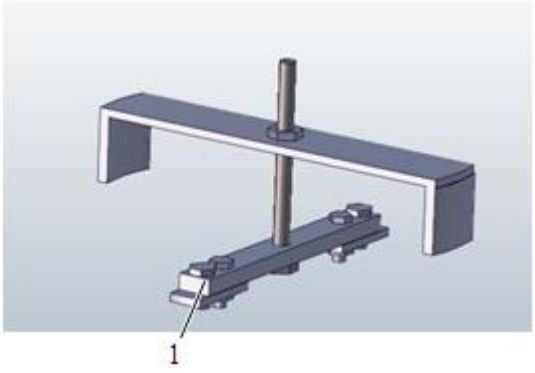


Fig.3-043
1 Bearing outer ring puller (6399006951)

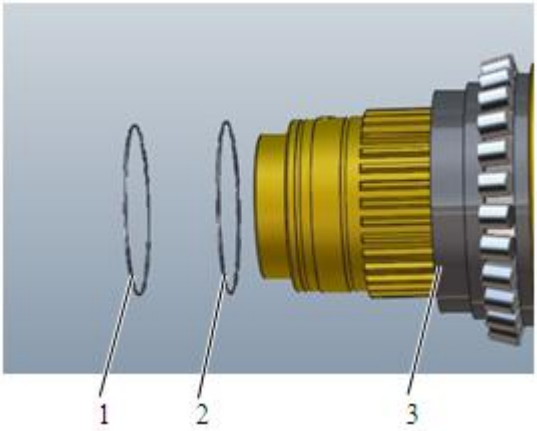


Fig. 3-045
1 O-ring, 1 piece
2 O-ring, 1 piece
3 Adjusting gasket, 1 piece

17. Take off the O-ring and adjusting gasket.

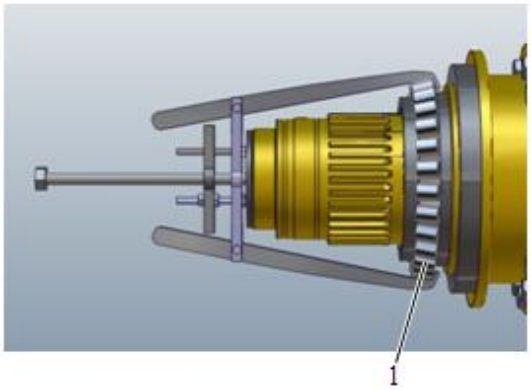


Fig. 3-046
1 Bearing inner ring, 1 piece

18. Use the bearing inner ring puller to remove the bearing inner ring

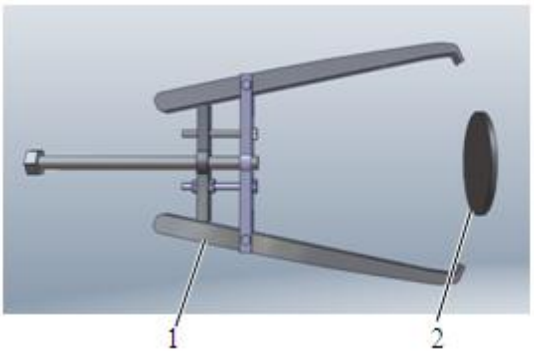


Fig.3-047
1 Bearing inner ring puller (6399006950)
2 Iron gasket

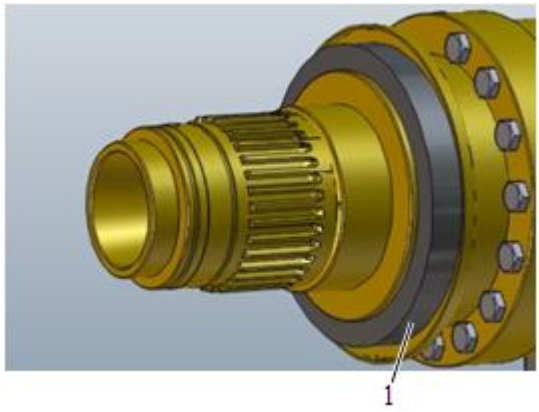


Fig.3-048
1 Seal ring, 1 piece

19. Remove the seal ring.

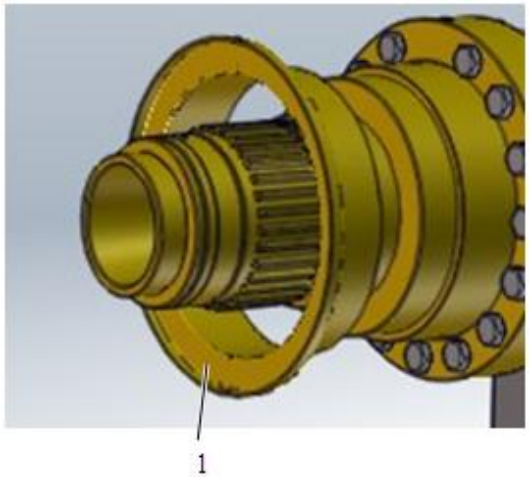


Fig. 3-049
1 Dust cover, 1 piece

20. Remove the dust cover.

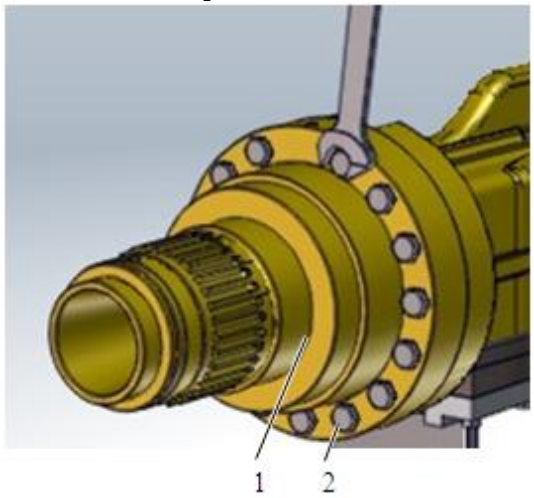


Fig.3-050 Tool: Wrench 27
1 Wheel supporting axle, 1 piece
2 Bolt, 14 pieces

21. Remove the bolt and wheel supporting axle.

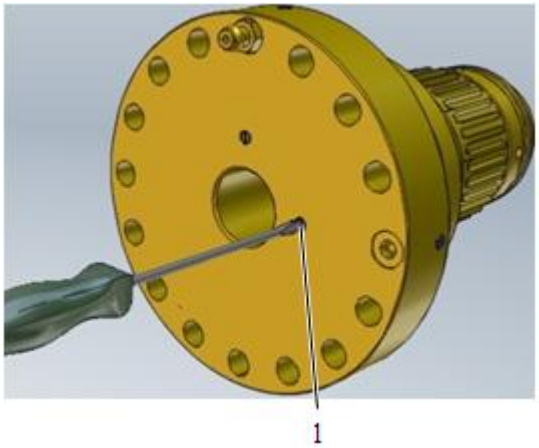


Fig.3-051 Tool: Screwdriver
1 Screw, 4 pieces

22. Remove the screw.

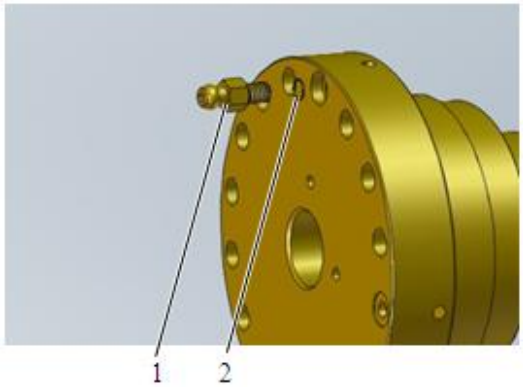


Fig.3-052 Tool: Wrench
1 Exhaust valve, 1 piece
2 O-ring, 1 piece

23. Remove the exhaust valve and O-ring.

Fig.3-053 Tool: Wrench 21
1 Bolt, 18 pieces

3.1.6 Disassembling of main actuator

1. Remove the fixing bolts from main actuator.

Fig. 3-054
1 Bolt, 2 pieces

2. Screw two M14 bolts in top thread hole and then use the wrench to tighten it downwards to push out the main actuator.

Fig. 3-055
1 Main actuator, 1 piece

3. Loosen the main actuator with crow bar to raise it out.

kg **Main actuator**

Fig. 3-056

4. Place the main actuator at clean cushion protected properly.

Fig.3-057 Tool: Wrench 24
1 Bolt, 4 pieces
2 Gasket, 4 pieces

5. Use a wrench to remove fixing bolt and gasket.

Fig. 3-058
1 Upper bearing seat, 2 pieces

6. Remove the upper bearing seat.

★**CAUTION**

Mark shall be made during disassembling to prevent mixing the bearing seats at two sides.

Fig. 3-059
1 Adjusting nut, 2 pieces

7. Remove the adjusting nut

Fig. 3-060
1 Bearing outer ring, 2 pieces

8. Remove the bearing outer ring.

Fig. 3-061
1 Differential, 1 piece

9. Take off the differential.

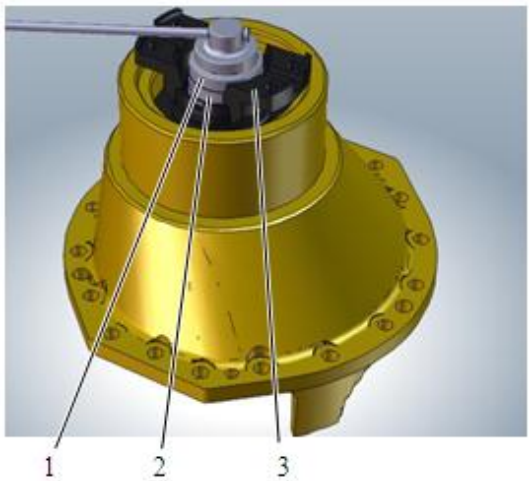


Fig. 3-062
1 Nut, 1 piece
2 Washer, 1 piece
3 Input flange, 1 piece

10. Remove the nut and take off the washer and input flange

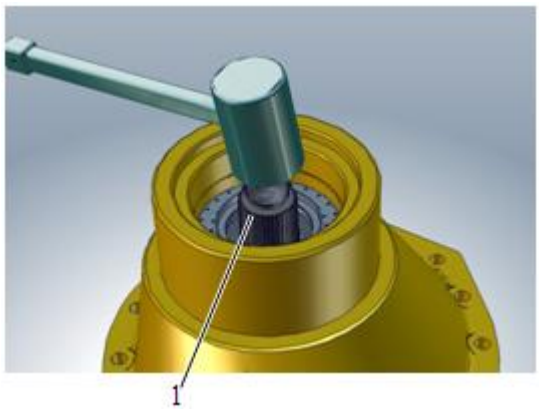


Fig. 3-063
1 Driving spiral bevel gear shaft, 1 piece

11. Knock at and remove the driving spiral bevel gear shaft.

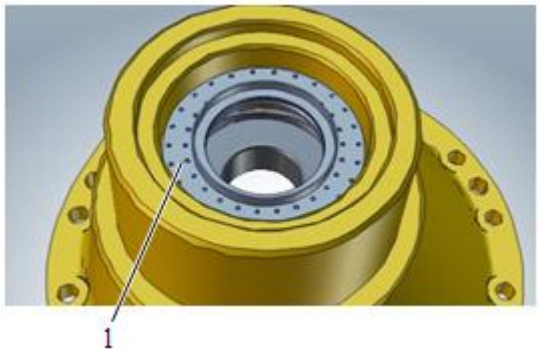


Fig. 3-064
1 Framework oil seal, 1 piece

12. Take off the framework oil seal.

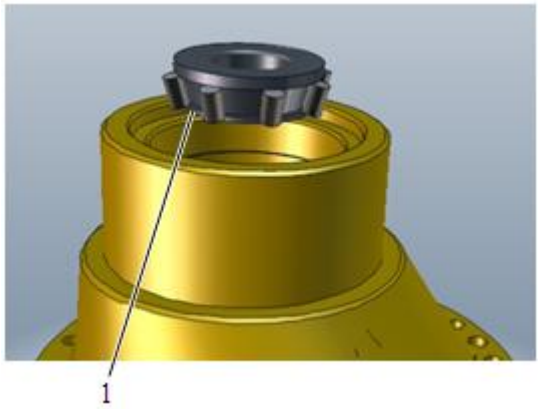


Fig. 3-065
1 Bearing inner ring, 1 piece

13. Take off the bearing inner ring.

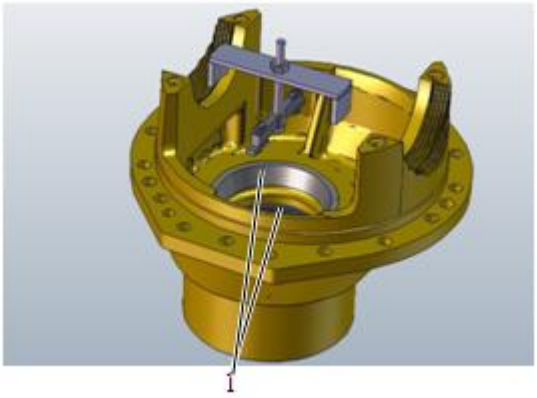


Fig. 3-066
1 Bearing outer ring, 2 pieces

14. Use the puller to remove the bearing outer ring.

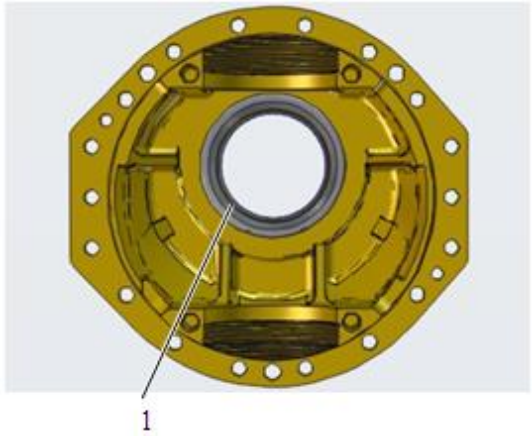


Fig. 3-067
1 Adjusting gasket, 1 piece

15. Take off the adjusting gasket.

Fig. 3-068
1 Bearing inner ring, 1 piece

16. Use the bearing inner ring puller to remove the bearing inner ring.

Fig.3-069 Tool: Wrench 21
1 Bolt, 12 pieces

3.1.7 Disassembling of differential

1. Remove the fixing bolt.

Fig. 3-070
1 Differential cover, 1 piece

2. Use a screwdriver to pry up the differential cover.

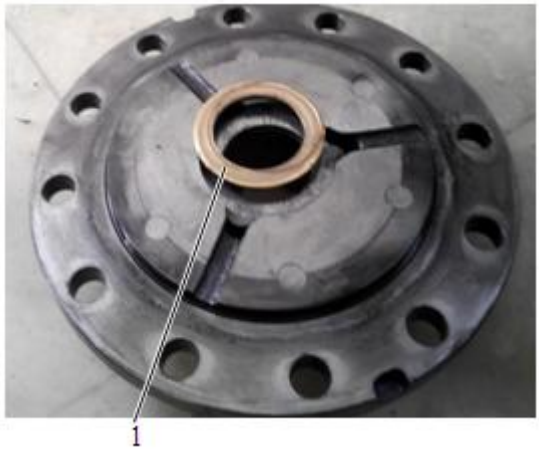


Fig. 3-071
1 Gasket, 1 piece

3. Take off the gasket.

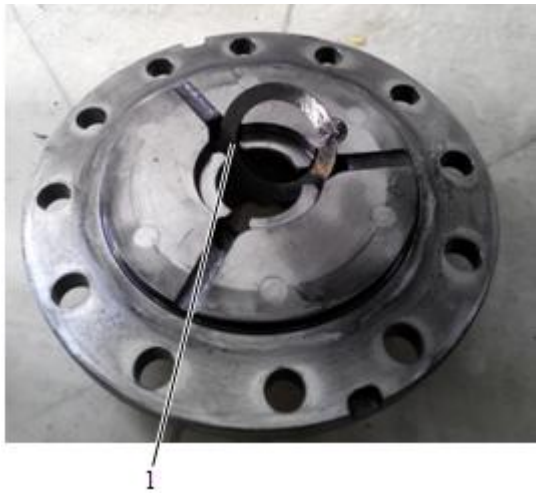


Fig. 3-072
1 Gasket, 1 piece

4. Take off the gasket.

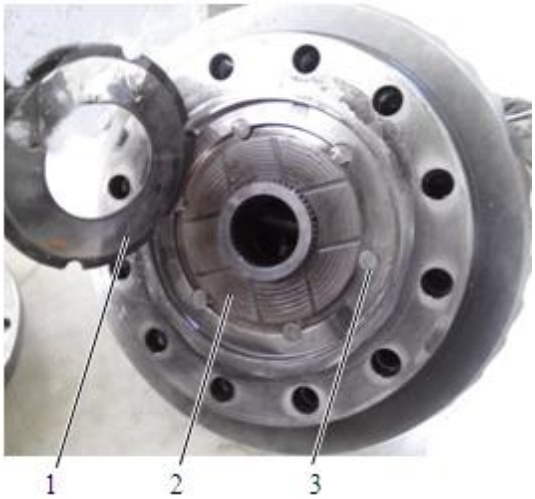


Fig. 3-073
1 Driving friction plate, 2 pieces
2 Driven friction plate, 2 pieces

5. Take off the driving and driven friction plates and force transfer pin.

Fig. 3-074
1 Thrust pressure plate, 1 piece

6. Take out the thrust pressure plate.

Fig. 3-075
1 Axle shaft gear, 1 piece

7. Take off the axle shaft gear.

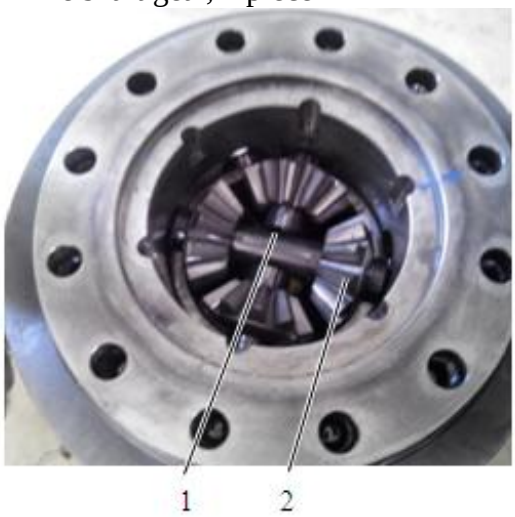


Fig. 3-076
1 Slotted shaft, 2 pieces
2 Planet gear, 4 pieces

8. Take off the planet gear and two slotted shafts.

Fig. 3-077
1 Axle shaft gear, 1 piece
2 Thrust pressure plate, 1 piece

9. Take off the axle shaft gear and thrust pressure plate at the other side.

Fig. 3-078

1 Driven friction plate, 2 pieces
2 Driving friction plate, 2 pieces
3 Gasket, 1 piece
4 Gasket, 1 piece
5 Force transfer pin, 6 pieces

Fig. 3-079

10. Take off the driving and driven friction plate, lubricating gasket and friction gasket at the other side.

3.2 Reassembling of ZF axle

3.2.1 Cleaning

1. Clean the disassembled parts and components with brush and wipe them with lint-free paper.

★CAUTION

It is allowed to use the ordinary gasoline for cleaning. It is allowed to use the diesel oil drained from oil tank for cleaning if repair in field.

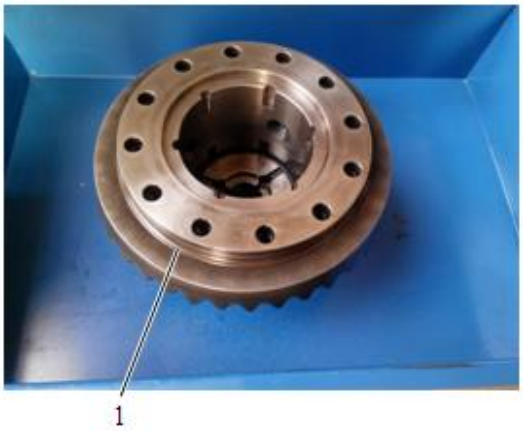


Fig. 3-080
1 Differential housing, 1 piece

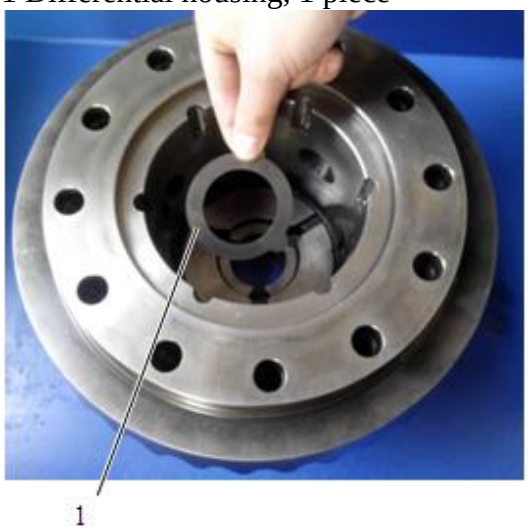


Fig. 3-081
1 Gasket, 1 piece

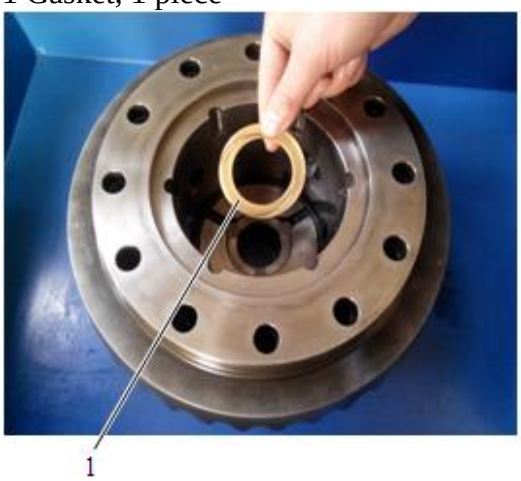


Fig. 3-082
1 Gasket, 1 piece

3.2.2 Reassembling of differential

1. Take the differential housing in a clean environment.

★CAUTION

Do not wear gloves during reassembling to prevent any sundries entering the reassembled body.

2. Mount the gasket. The raised part of gasket shall match with the oil groove to prevent the gasket rotating

3. Mount the cooper gasket with oil groove.

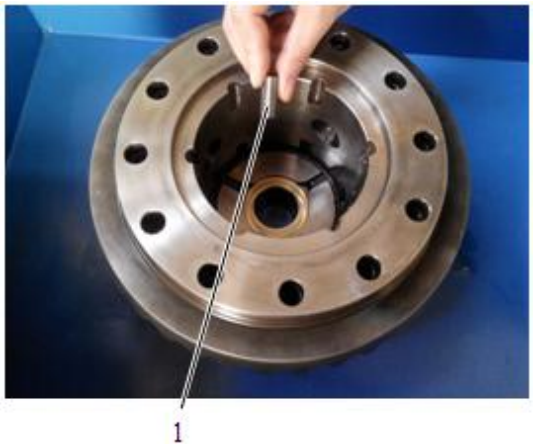


Fig. 3-083
1 Force transfer pin, 6 pieces

4. Insert the force transfer pin into the groove of differential housing.

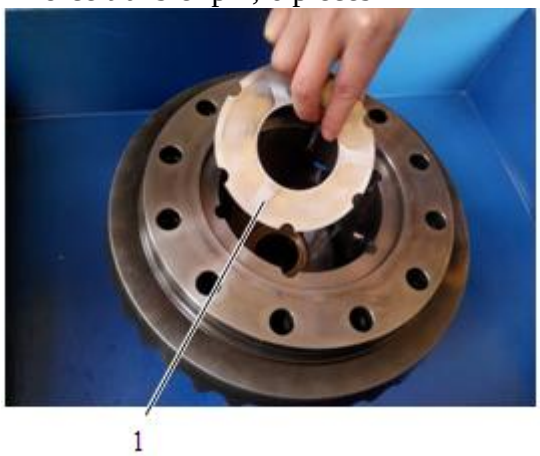


Fig. 3-084
1 Driving friction plate, 2 pieces

5. Place a driving friction plate to ensure its key groove at outer edge can match with the force transfer pin.

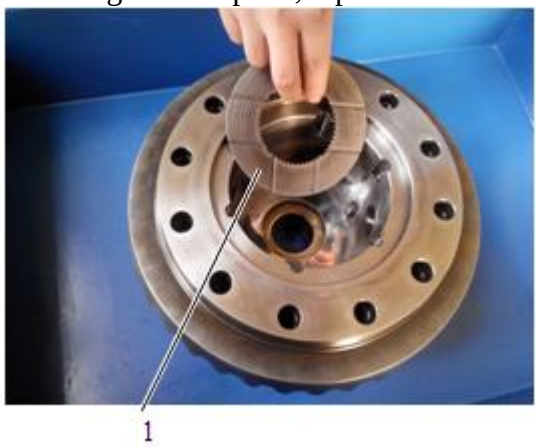


Fig. 3-085
1 Driven friction plate, 2 pieces

6. Place a driven friction plate. Alternatively place the driving friction plate and driven friction plate till there are two driving friction plates and two driven friction plates.

Fig. 3-086
1 Thrust pressure plate, 1 piece

7. Mount the thrust pressure plate to ensure its key groove can match with the force transfer pin.

Fig. 3-087
1 Axle shaft gear, 1 piece

8. Mount the axle shaft gear to ensure its outer spline can match with the inner spline of driven friction plate.

Fig. 3-088
1 Slotted shaft, 2 pieces
2 Planet gear, 4 pieces

9. Assemble two slotted shafts together with their grooves opposite. Mount the planet gear on slotted shaft with the small end of former inward.

Fig. 3-089

10. Mount the shaft journal of slotted shaft on V-groove of thrust pressure plate to ensure the planet gear can engage with axle shaft gear.

Fig. 3-090
1 Axle shaft gear, 1 piece

11. Mount the planet gear at other side to ensure it can engage with planet gear.

Fig. 3-091
1 Thrust pressure plate, 1 piece

12. Mount the thrust pressure plate at other side to ensure the V-groove can match with the shaft journal of slotted shaft and the key groove can be opposite to that on differential housing.

Fig. 3-092
1 Force transfer pin, 6 pieces

13. Insert the force transfer pin to the hole between differential housing and thrust pressure plate.

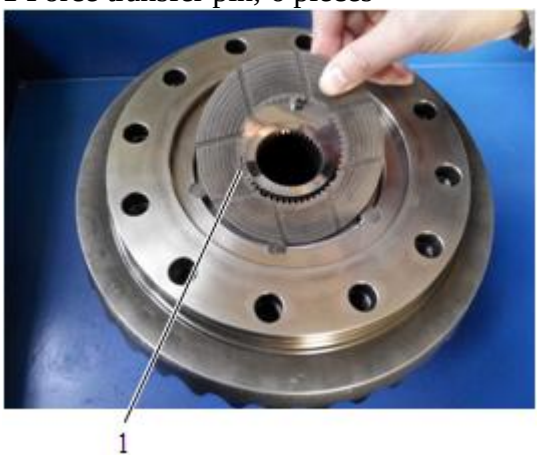


Fig. 3-093
1 Driven friction plate, 2 pieces

14. Mount a driven friction plate

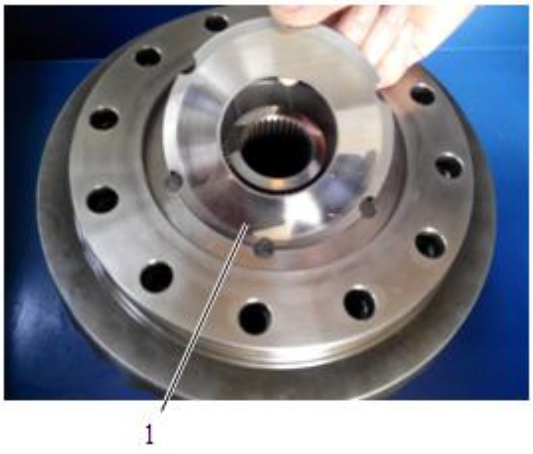


Fig. 3-094
1 Driving friction plate, 2 pieces

15. Mount a driving friction plate to ensure its key groove at outer edge can match with force transfer pin. Alternatively place the driving friction plate and driven friction plate till there are two driving friction plates and two driven friction plates.

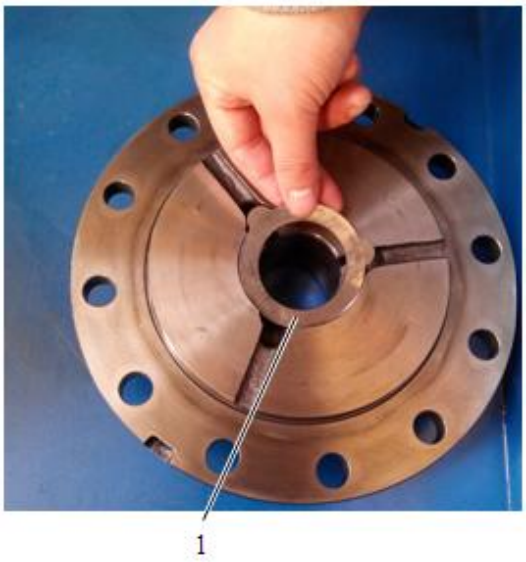


Fig. 3-095
1 Gasket, 1 piece

16. Mount the gasket on differential cover. The raised part of gasket shall match with the groove on differential cover to prevent the gasket rotating

Fig. 3-096
1 Gasket, 1 piece

17. Mount the copper gasket with oil groove on differential cover.

1 Differential cover, 1 piece

18. Mount the differential cover on differential housing.

Fig.3-098 Tool: Wrench 21
1 Bolt, 12 pieces

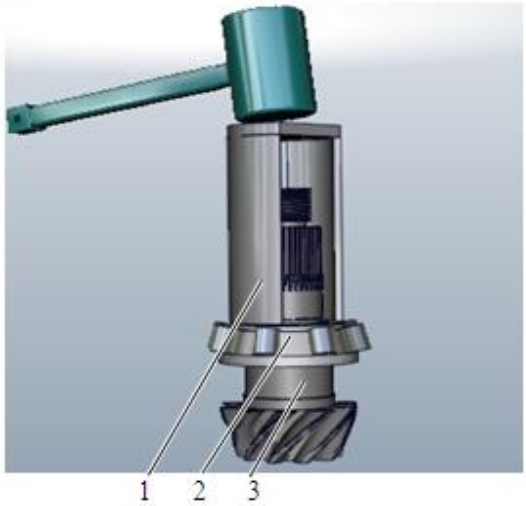


Fig. 3-099
1 Special tool
2 Bearing inner ring, 1 piece
3 Driving spiral bevel gear shaft, 1 piece

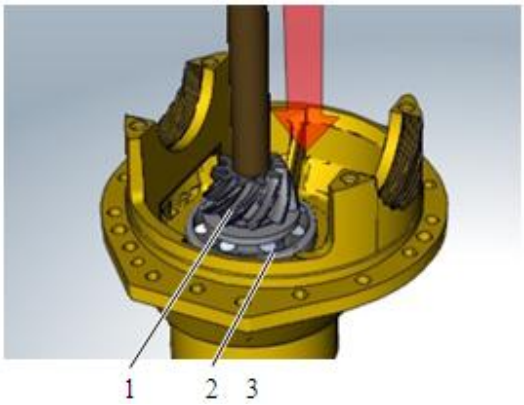


Fig.3-100
1 Driving spiral bevel gear shaft, 1 piece
2 Bearing outer ring, 1 piece
3 Adjusting gasket, 1 piece

19. Mount and tighten the bolt.

Screw thread sealant: 1262

Tightening torque: 209~278 N•m

3.2.3 Reassembling of main actuator

1. Knock at the special tool to mount the bearing inner ring into gear shaft.

★CAUTION

Do not inversely mount the bearing inner ring. The force shall be even during knocking. It is not allowed knock at one position of bearing inner ring only.

2. Place the appropriate adjusting gasket on bearing seat and use a copper bar to knock at and mount the gear shaft and bearing outer ring.

★CAUTION

The force shall be even during knocking. It is not allowed knock at one position of gear shaft only.

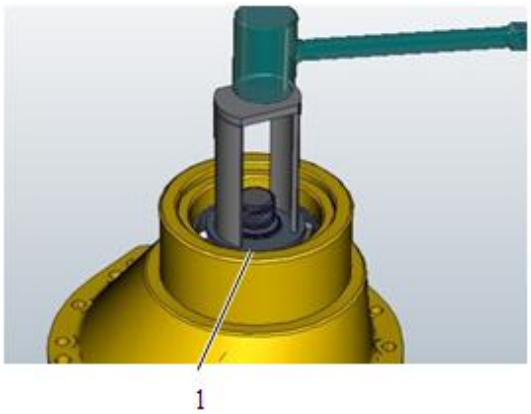


Fig.3-101
1 Bearing, 1 piece

3. Knock at the special tool to mount the bearing at the other side.

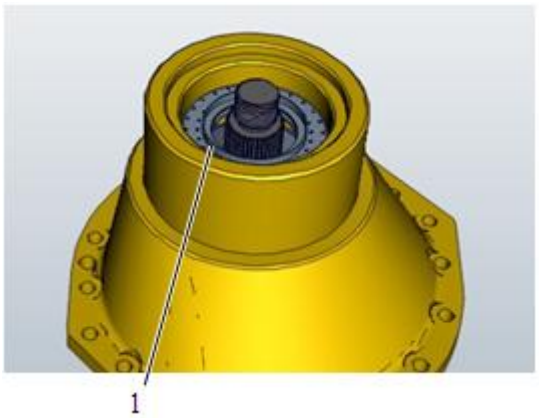


Fig.3-102
1 Framework oil seal, 1 piece

4. Mount the framework oil seal.

★CAUTION

Because the sealing performance of original framework oil seal is damaged during disassembling, a new framework oil seal shall be adopted.

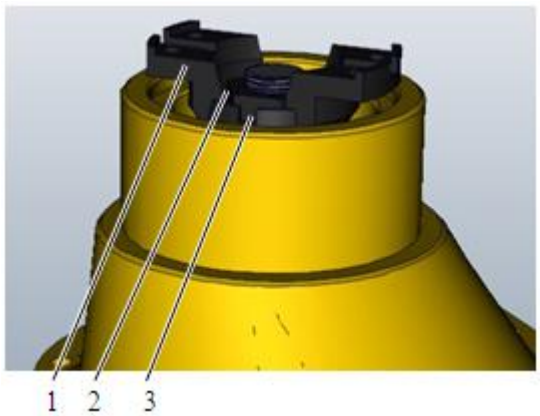


Fig.3-103
1 Flange, 1 piece
2 Nut, 1 piece
3 Gasket, 1 piece

5. Mount the flange, gasket and nut and tighten the nut.

Screw thread sealant: 1262

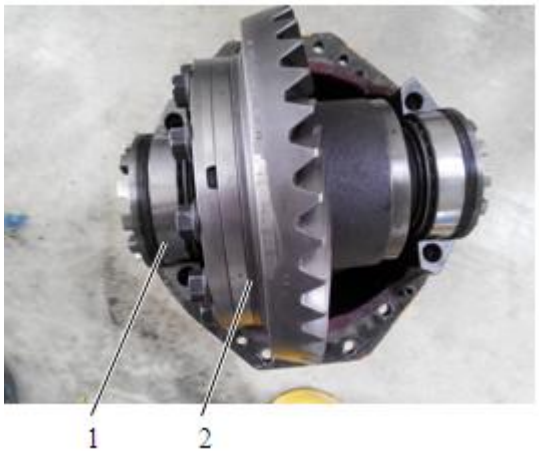


Fig. 3-104
1 Bearing outer ring 2 Differential

6. Mount the bearing outer ring on the two ends of differential and then mount the differential on driving axle box body.

Fig. 3-105
1 Bolt, 4 pieces 2 Gasket, 4 pieces
3 Bearing upper cover 4 Tension pin

7. Firstly jack the tension pin out of bearing upper cover to prevent it affecting the next procedure and then mount the bearing upper cover, bolt and gasket on box body.

★CAUTION

Much attention shall be paid to the previous mark to prevent disordering the bearing upper covers at two sides.

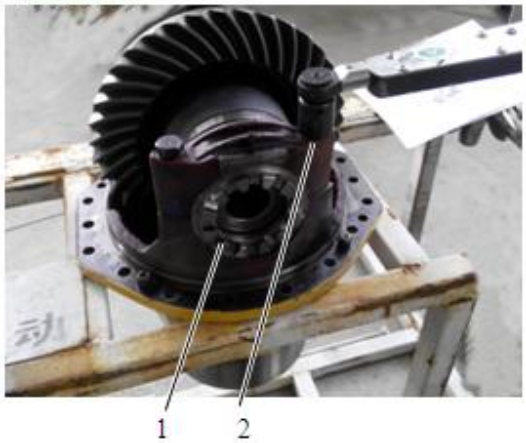


Fig.3-106 Tool: Torque wrench 24
1 Adjusting nut, 2 pieces
2 Bolt, 4 pieces

8. Slightly tighten the fixing bolt of bearing cover and then tighten the adjusting nut. It is necessary to screw in the adjusting nuts at two sides toward the center.

★CAUTION

The torque used to tighten the adjusting nuts at two sides shall not be large excessively. It should be noted that the bearing outer ring cannot be extruded, because this will cause the abrasion of roller during operation and thus reduce the service life of bearing

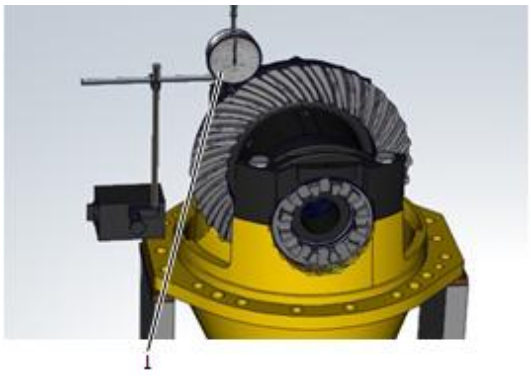


Fig. 3-107
1 Dial indicator

Fig. 3-108
1 Dial indicator

Fig. 3-109
1 Tension pin, 1 piece
2 Adjusting nut, 1 piece

9. The dial indicator shall be so mounted that its contact is vertical to the tooth face of driven spiral bevel gear and is pressed at the outer edge. The magnetic base of dial indicator shall be fixed on driving axle box body and keep relative rest with the box body to eliminate the error.

10. Slightly shake left and right the driven spiral bevel gear and then use the dial indicator to measure the backlash of driving and driven spiral bevel gears. Generally, three points shall be measured and the measured value shall be 0.20~0.35 mm.

★CAUTION

When shaking the driven spiral bevel gear, it is necessary to maintain the driving spiral bevel gear immobile to avoid the occurrence of error.

11. If the measured value is less than the specified value, rotate the adjusting nuts at two sides to make the driven spiral bevel gear leave from the driving spiral bevel gear. Contrarily, make the former approach to the latter.

★CAUTION

In order to maintain the adjusted pretension of bearing, the screwing-in turns of adjusting nut at one end shall be equal to the screwing-out turns at the other side.

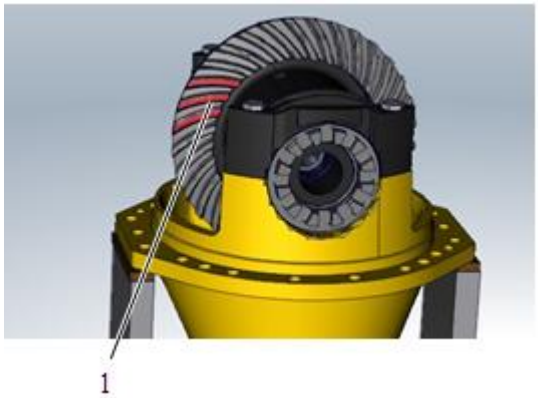


Fig. 3-110
1 Red lead powder

12. Apply the red lead powder onto the driven spiral bevel gear (generally three teeth) and rotate the gear to make it engage with the driving spiral bevel gear repeatedly, and then check the engagement mark. Ensure the contact area is not less than 60% along tooth length and tooth height and the center along tooth height is slightly nearer to the small end while that along tooth length is also slightly nearer to the small end. If the above requirements cannot be met, the following adjustment must be done:

(a) when the engagement mark is nearer to the large end of driven spiral bevel gear, rotate the adjusting nut to make the driven spiral bevel gear approach to the driving spiral bevel gear. After such adjustment, measure the backlash. If the backlash is too small (less than 0.20 mm), it is allowed to reduce the adjusting gasket of driving spiral bevel gear to make the driving spiral bevel gear away from the driven spiral bevel gear so as to obtain a reasonable backlash; when the engagement mark is nearer to the small end of driven spiral bevel gear, the opposite adjustment shall be done.

Fig. 3-111

(b) When the engagement mark is nearer to the tooth top, increase the adjusting gasket of driving spiral bevel gear to make it approach to the driven spiral bevel gear. Then, measure the

backlash. If the backlash is too small, rotate the adjusting nut to make the driven spiral bevel gear away from the driving gear; when the engagement mark is nearer to the tooth root, the opposite adjustment shall be done. After above adjustment is completed, smash tension pin to make it insert the groove of adjusting nut, and tighten the bolt.

Screw thread sealant: 1262

Tightening torque of bolt: 280~330 N•m

CAUTION

The adjustment of backlash and engagement area is very important for operating performance and service life, so it shall be completed carefully. Remove the red lead powder after adjustment.

13. Apply a coat of sealant to junction plane, mount main actuator in axle housing and align bolt hole with pin hole.

Main actuator

Plane sealant: 1596

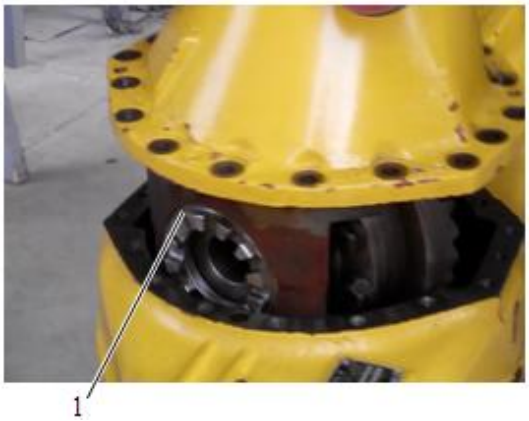


Fig. 3-112
1 Main actuator, 1 piece

Fig. 3-113
1 Bolt, 18 pieces
2 Screw thread sealant

14. Apply a turn of screw thread sealant at thread head.

Screw thread sealant: 1262

Fig.3-114 Tool: Wrench 21
1 Bolt, 18 pieces

15. Tighten bolt diagonally and gradually.

Torque requirement: 180~210 N•m

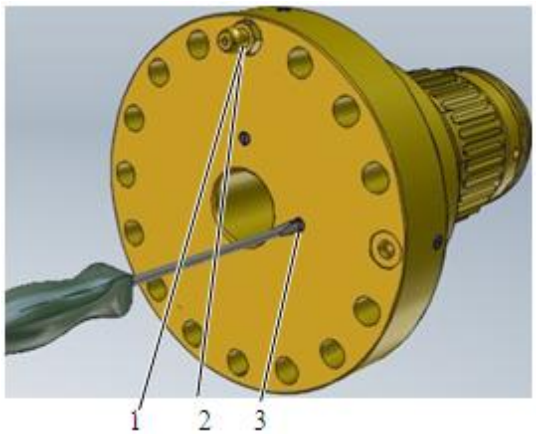


Fig.3-115 Tool: Screwdriver
1 Exhaust valve, 1 piece
2 O-ring, 1 piece
3 Screw, 4 pieces

3.2.4 Reassembling of wet brake

1. Mount exhaust valve and screw.

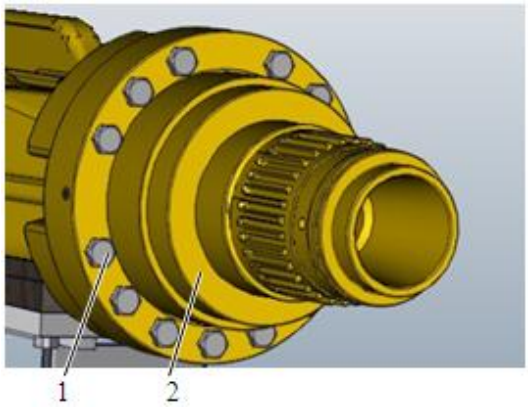


Fig.3-116 Tool: Wrench 27
1 Bolt, 14 pieces
2 Wheel supporting axle, 1 piece

2. Tighten bolt and mount supporting axle.

Screw thread sealant: 1277

Tightening torque: 380~450 N•m

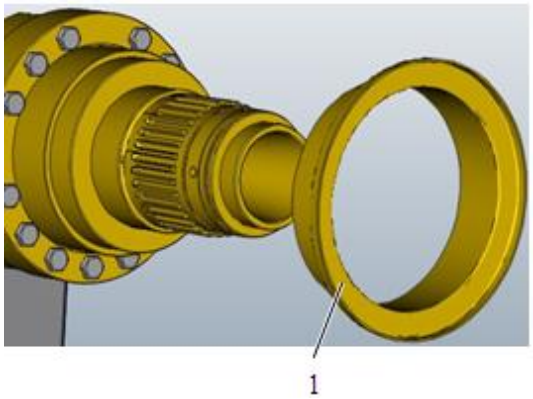


Fig. 3-117
1 Dust cover, 1 piece

3. Apply appropriate amount of sealant on wheel supporting axle and then mount dust cover.

Sealant: 1680

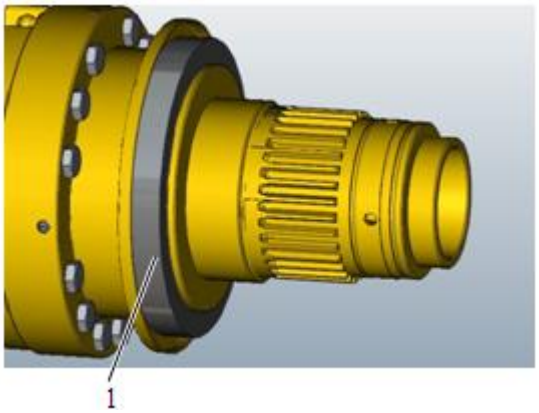


Fig. 3-118
1 Seal ring, 1 piece

4. Mount the seal ring.

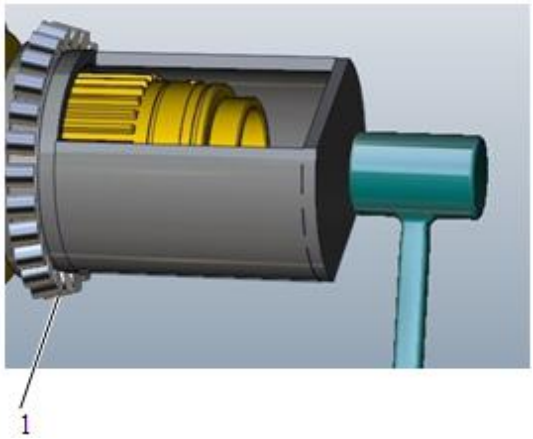


Fig. 3-119
1 Bearing inner ring, 1 piece

5. Knock at the tooling and mount the bearing inner ring.

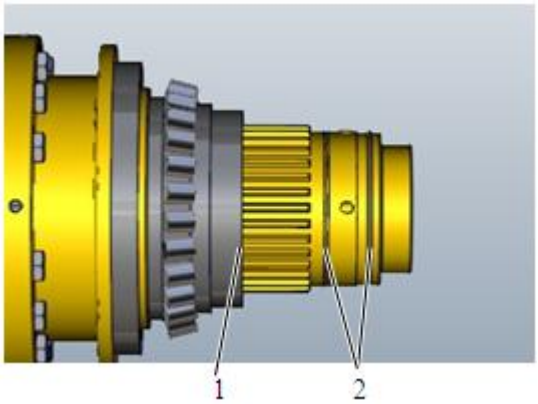


Fig. 3-120
1 Seal ring, 1 piece
2 O-ring, 2 piece

6. Mount the seal ring and O-ring

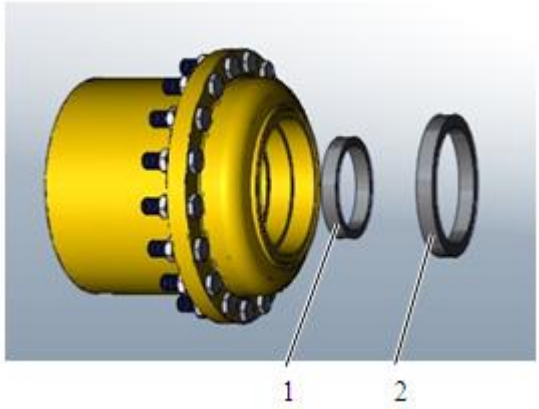


Fig.3-121
1 Bearing outer ring, 1 piece
2 Bearing outer ring, 1 piece

7. Mount the outer ring of wheel bearing and spline hub bearing on hub.

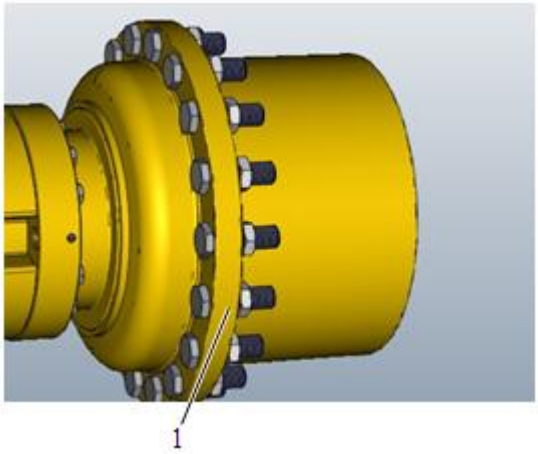


Fig. 3-122
1 Hub, 1 piece

8. Mount the hub

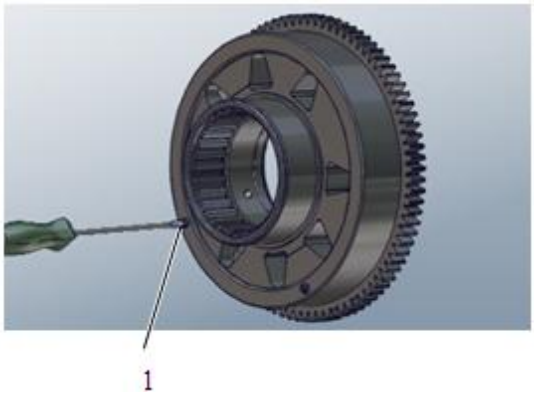


Fig.3-123 Tool: Screwdriver
1 Screw, 2 pieces

9. Mount the screw.

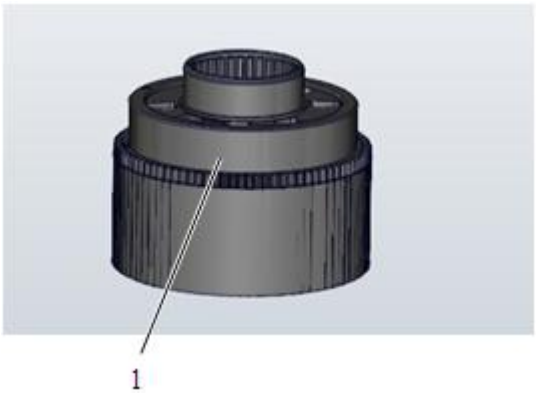


Fig. 3-124
1 Spline hub, 1 piece

10. Mount the spline hub

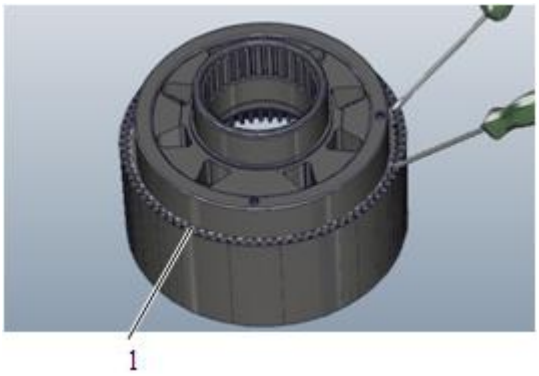


Fig.3-125 Tool: Screwdriver
1 Retainer ring, 1 piece

11. Mount the retainer ring.

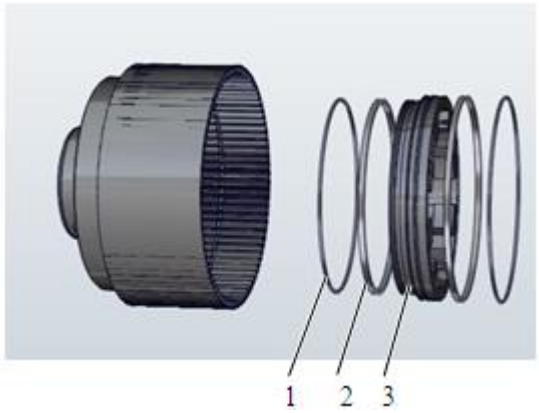


Fig. 3-126
1 Piston guide rod, 2 pieces
2 Rear-mounted seal ring, 2 pieces
3 Piston, 1 piece

12. Mount the piston guide ring, rear-mounted seal ring and piston

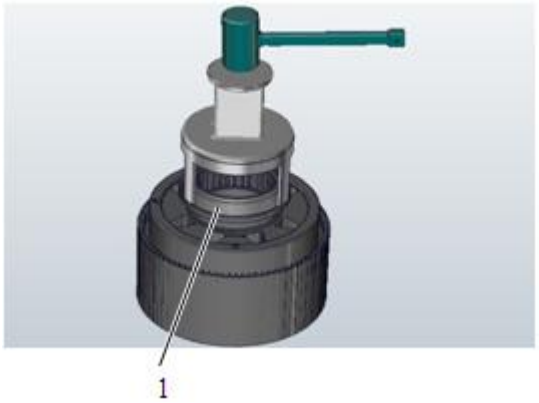


Fig. 3-127
1 Bearing inner ring, 1 piece

13. Mount the bearing inner ring.

Fig. 3-128
1 Tension ring, 8 pieces
2 Slotted ring, 1 piece

14. Mount the tension spring and slotted ring.

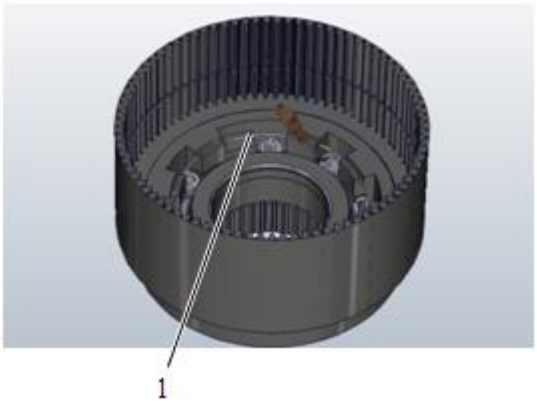


Fig. 3-129
1 Slotted ring, 1 piece

15. Mount the slotted ring and use the hook to mount the tension spring.

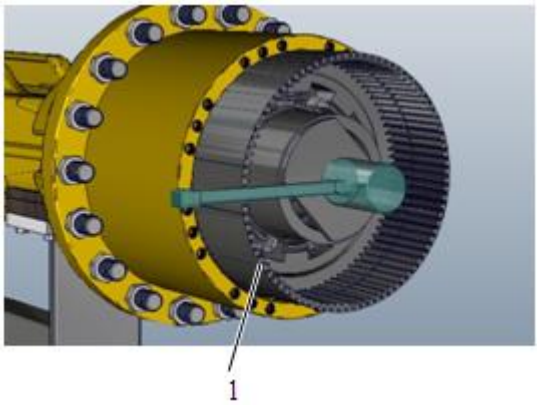


Fig. 3-130
1 Gear ring assembly, 1 piece

16. Knock at the special tool to mount the gear ring assembly on wheel supporting axle.

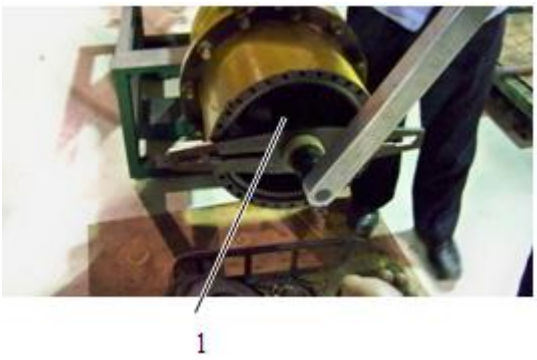


Fig. 3-131
1 Slotted nut, 1 piece

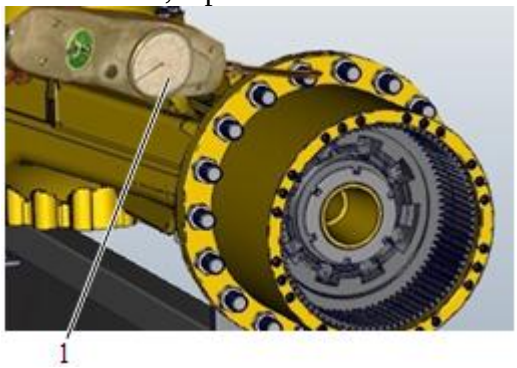


Fig. 3-132
1 Tension meter

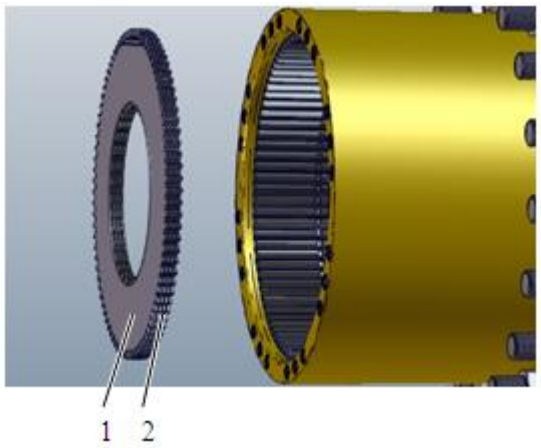


Fig. 3-133
1 Driven friction plate, 3 pieces
2 Driving friction plate, 3 pieces

17. Tighten the slotted nut when rotating the hub.

kgm **Tightening torque:**

800~1000 N•m for AP-407/409/410

1300~1500 N•m for AP-411/412/415

2000~2200 N•m for AP-417/420

18. Measure the rolling resistance torque at wheel side.

★CAUTION

11~18 N•m for AP-407/409/410/411/412/415

14~20 N•m for AP-417/420

If the resistance torque is inappropriate, it is necessary to select the thickness of adjusting gasket again.

19. Alternatively mount the driving and driven friction plates.

★CAUTION

It is necessary to align inner splines of driving friction plate for mounting the friction plate bracket

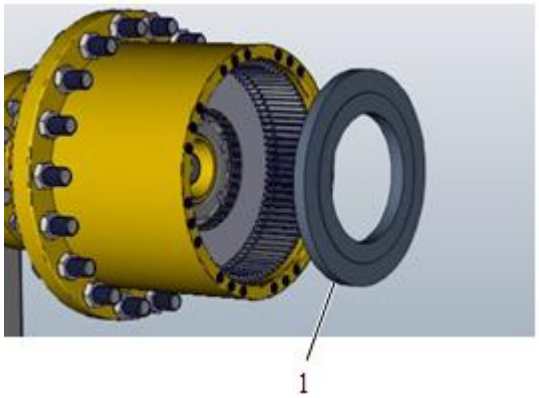


Fig. 3-134
1 End gasket, 1 piece

20. Mount the end gasket.

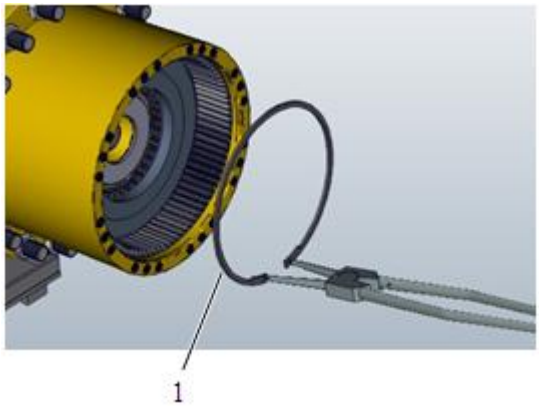


Fig.3-135 Tool: Snap ring pliers
1 Snap ring, 1 piece

21. Mount the snap ring at groove of inner gear ring with snap ring pliers.

Fig. 3-136
1 Axle shaft, 1 piece

22. Insert the axle shaft. The spline at axle shaft head shall match with the axle shaft spline in differential and the spline of driven friction plate.

★CAUTION

The left and right axle shafts are of different length and cannot be mounted incorrectly. The splines at two ends of each axle shaft are of different length and cannot be mounted inversely.

Fig. 3-137
1 Lock washer, 1 piece

23. Mount the lock washer on the slotted nut. The raised part of lock washer shall be clamped in the groove of slotted nut

Fig. 3-138
1 Sun gear shaft, 1 piece
2 Friction plate bracket, 1 piece

24. Firstly align the inner splines of driving friction plate and then mount the friction plate bracket and sun gear shaft.

★CAUTION

Because the friction plate bracket must match with both the driving friction plate and the axle shaft spline, the small assembling space increases the assembling difficulty. To mount the sun gear shaft in friction, shake the sun gear shaft.

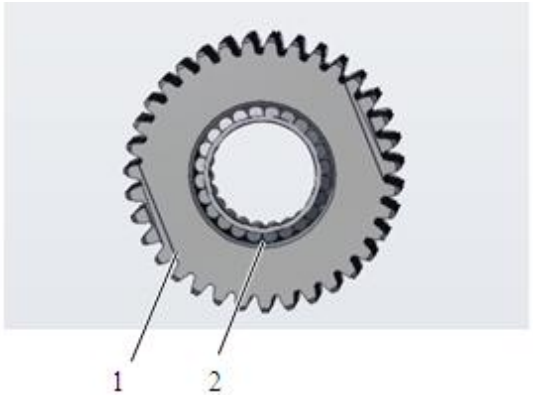


Fig. 3-139
1 Planet gear, 4 pieces
2 Bearing, 4 pieces

3.2.5 Reassembling of wheel reducer

1. Take the planet gear and bearing assembly.

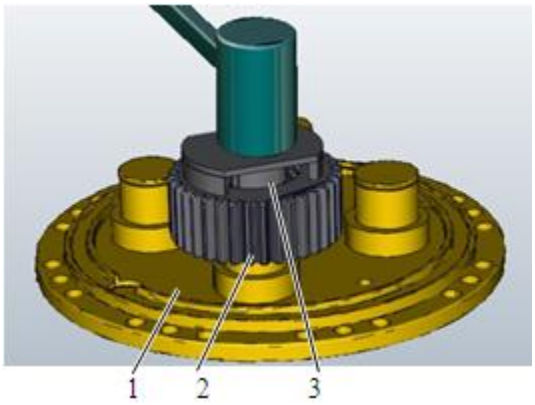


Fig. 3-140
1 Planet carrier, 1 piece
2 Planet gear, 4 pieces
3 Bearing, 4 pieces

2. Mount the planet gear and bearing assembly on planet carrier.

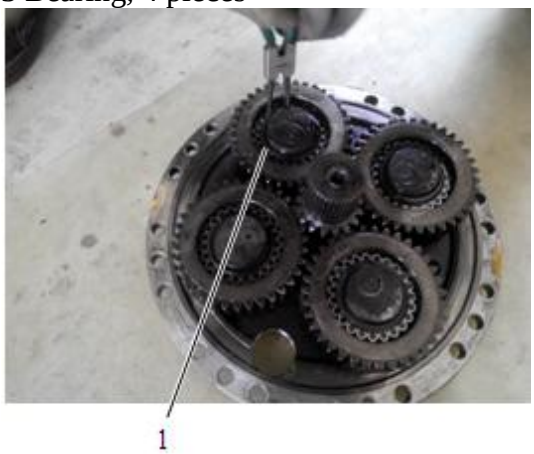


Fig.3-141 Tool: Snap ring pliers
1 Snap ring, 4 pieces

3. Use the snap ring pliers to mount the snap ring.

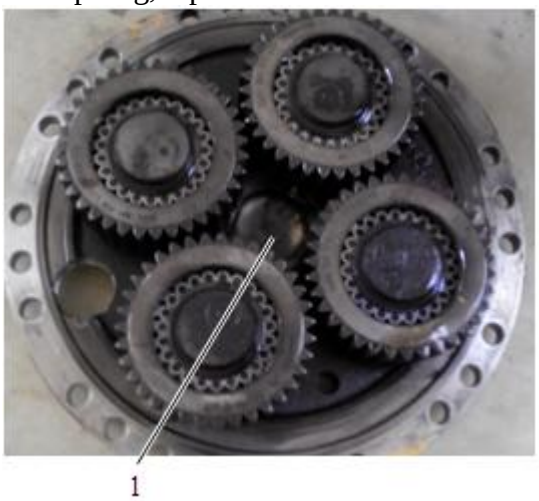


Fig. 3-142
1 Lock washer, 1 piece

4. Mount the lock washer.

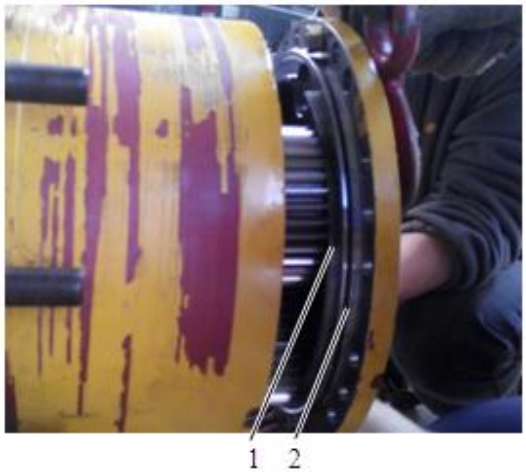


Fig. 3-143
1 Planet carrier, 1 piece
2 O-ring, 1 piece

5. Mount the planet carrier. Be careful not to damage the O-ring at planet carrier edge.

Planet carrier

Fig.3-144 Tool: Wrench 24
1 Bolt, 18 pieces

6. Tighten bolt diagonally and gradually.

Screw thread sealant: 1262

Tightening torque: 193~257 N•m

Fig. 3-145
1 Gasket, 1 piece
2 Rear swinging bracket, 1 piece

3.2.6 Reassembling of front and rear swinging brackets

1. Mount the gasket in rear swinging bracket.

Fig. 3-146
1 Rear swinging bracket, 1 piece

2. Mount the rear swinging bracket on axle housing.

kg **Rear swinging bracket**

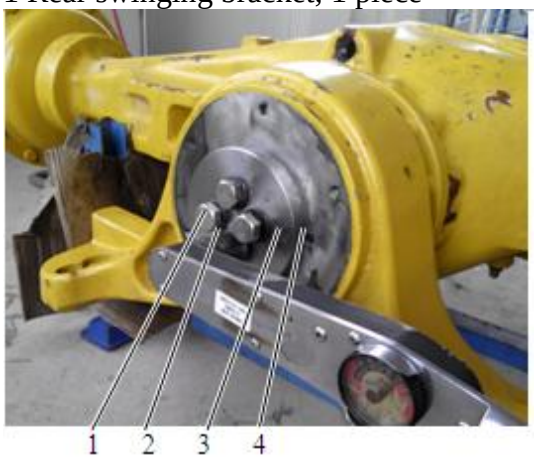


Fig.3-147 Tool: Wrench 30
1 Bolt, 4 pieces
2 Washer, 4 pieces
3 Cushion block, 1 piece
4 Gasket, 1 piece

3. Mount the gasket, cushion block, washer and bolt and tighten the bolt.

kgm **Tightening torque: 376~502 N•m**

Fig. 3-148
1 End cap, 1 piece
2 Gasket, 1 piece

4. Clean the end cover, apply little grease on paper gasket and align it with bolt hole and stick it on end cover.

Fig.3-149 Tool: Wrench 18
1 Bolt, 6 pieces

5. Mount the end cover on rear swinging bracket and tighten the bolt.

kgm **Tightening torque: 78~104 N•m**

Fig. 3-150
1 Front swinging bracket, 1 piece

6. Mount the front swinging bracket.

kg **Front swinging bracket**

★CAUTION

The front swinging bracket has no axial positioning and shall be protected from hurting the operator

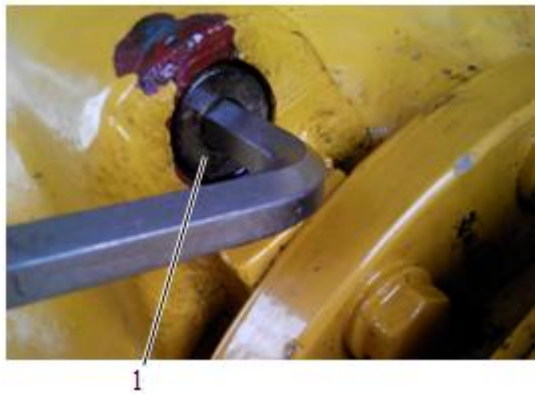


Fig.3-151 Tool: Allen wrench
1 Screw plug, 1 piece

3.2.7 Refilling of gear oil

1. Tighten the oil drain plug under axle. Be careful not to damage O-ring.

Fig. 3-152

2. Horizontally place the axle, rotate the hub or main actuator till the line of OIL LEVEL on hub is at horizontal position, and refill the gear oil till it overflows from screw plug hole.

Refill the special lubricating oil for ZF axle. This oil contains LS limited slip additive, known as API GL-5 SAE90+LS.

★CAUTION

After refilling, it is necessary to refill oil till the specified oil level is maintained if the oil level lowers after several minutes. Add about 7 L to left and right hubs respectively.

3. Tighten the screw plug. Be careful not to damage O-ring at edge.

kgm **Tightening torque: 50 N•m**

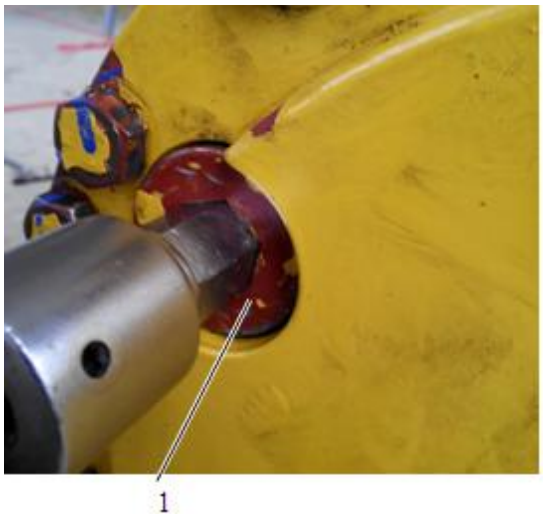
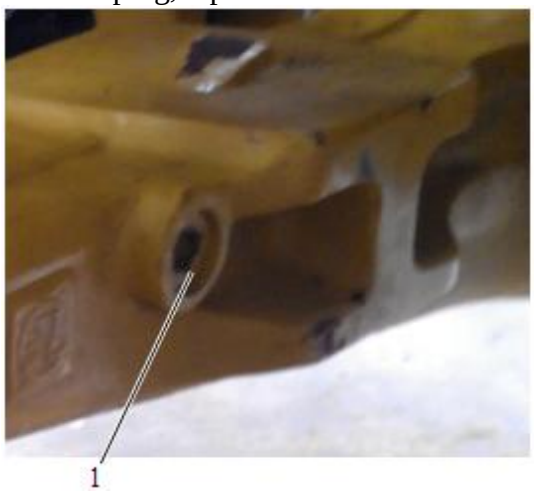


Fig.3-153 Tool: Allen wrench
1 Screw plug, 1 piece



4. Horizontally place the axle, screw off the oil filler plug in the middle of axle, refill the gear oil till the oil overflows from the screw plug hole. After refilling, tighten the screw plug.

Refill the special lubricating oil for ZF axle. This oil contains LS limited slip additive, known as API GL-5 SAE90+LS.

Fig.3-154 Tool: Allen wrench
1 Screw plug, 1 piece

Fig.3-155 Tool: Wrench 22
1 Brake oil pipe, 1 piece

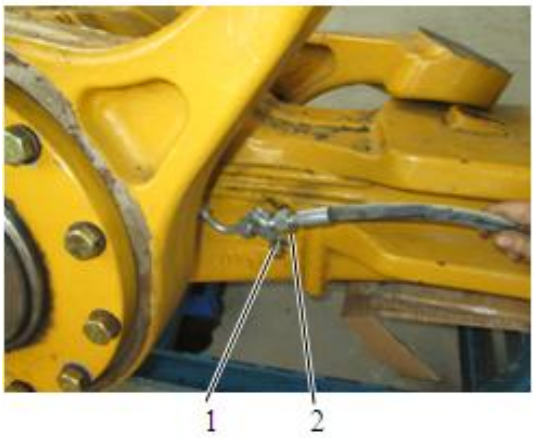


Fig.3-156 Tool: Wrench 10
1 Bolt, 1 piece
2 Cushion block, 1 piece

★CAUTION

After refilling, it is necessary to refill oil till the specified oil level is maintained if the oil level lowers after several minutes. Add about 20 L to axle housing

3.2.8 Reassembling of axle assembly and other components

1. Clean the joint with cleanser and then tighten the brake oil pipe.

kgm **Tightening torque: 30~40 N•m**

2. Tighten the fixing bolt and other fasteners of T-joint.

kgm **Tightening torque: 22~30 N•m**

Fig. 3-157

3. Hoist and place the axle on cart, push the cart to the position below frame, hoist the axle and align the bolt hole on swinging bracket with that on frame.

kg **Rear axle assembly**

Fig. 3-158
1 Bolt, 12 pieces
2 Gasket, 12 pieces
3 Nut, 12 pieces

4. Mount and tighten the bolt, nut and gasket.

kgm **Tightening torque: 540~650 N•m**

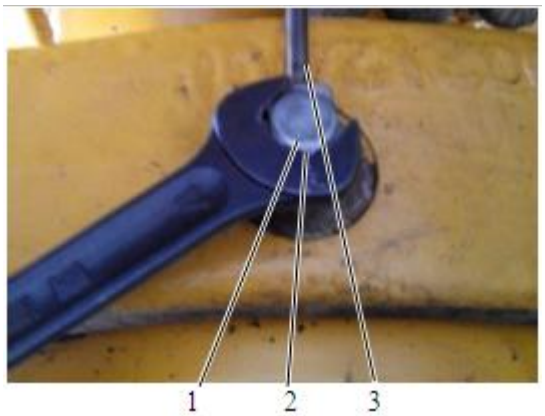


Fig.3-159 Tool: Wrench 17×19
1 Hollow bolt, 1 piece
2 Copper gasket, 2 pieces
3 Grease pipe, 1 piece

5. Fix the grease pipe on front and rear swinging brackets.

kgm **Tightening torque: 25~35 N•m**

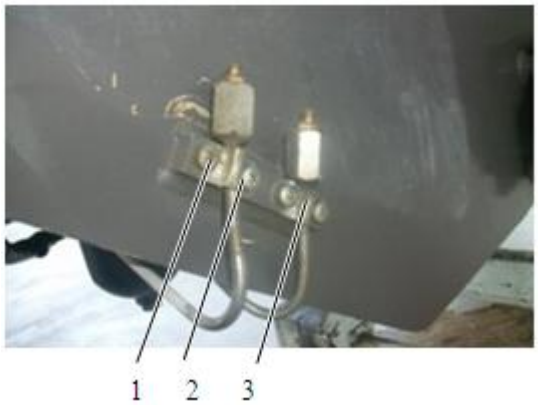


Fig.3-160 Tool: Screwdriver
1 Screw, 4 pieces
2 Gasket, 4 pieces
3 Pipe clip, 2 pieces

6. Tighten the screw and fix the grease pipe on frame.

Fig.3-161 Tool: Wrench 22
1 Oil pipe, 1 piece

7. Clean the brake pipe joint with cleanser and mount it on T-joint.

kgm **Tightening torque: 30~40 N•m**

Fig. 3-162
1 Bolt, 8 pieces

8. Mount the drive shaft on the flange of main actuator and transmission.

kgm **Tightening torque: 75~105 N•m**

★CAUTION

Be sure to align the balance positioning arrows of two drive shafts.

4 Frequent fault diagnosis and maintenance of driving axle

4.1 Fault diagnosis and troubleshooting of driving axle

4.1.1 Abnormal sound of driving axle

(1) Symptom and danger

The abnormal sound of driving axle includes continuous sound or intermittent or occurs when vehicle speed changes, during normal running or when going uphill or downhill. Some sounds are toneless and some are ringing.

The sound of driving axle is mainly from main actuator and differential. Some occurs at wheel reducer. The abnormal sound of driving axle reflects the abnormal technical condition among parts and components of driving axle. It is necessary to find out and eliminate the reason immediately. Otherwise, the severe fault or accident may be caused.

(2) Reason and troubleshooting of abnormal sound of driving axle

The abnormal sound of driving axle is often caused by some components in axle (including wheel reducer) due to collision or interference.

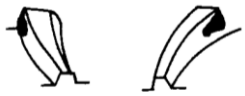
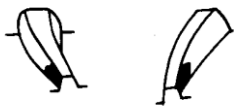
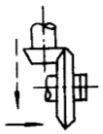
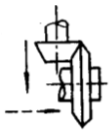
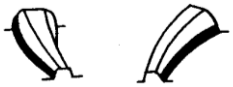
The sound caused by different components is of different strength and nature under different conditions, so the sound source and reason can be determined upon the condition and position of abnormal sound.

Based on the reason of abnormal sound, the abnormal sound can be classified into as follows: one is the abnormal sound generated between components due to loose connection or component damage. This abnormal sound is often due to the abnormal friction and collision between components, so the sound is relatively clear. The other is the sound due to abnormal fit of bearing or abnormal engagement of gear.

The abnormal engagement of gear includes too small or large backlash, incorrect engagement position and insufficient engagement area. This will often cause continuous and clear sound and the sound volume will become large when the rotating speed rises. The abnormal fit of bearing covers two small or large bearing clearance. When the bearing clearance is too large, the continuous sound will be caused and the sound volume will increase when the vehicle speed rises.

If there is abnormal sound at axle housing, it is necessary to check whether any component is loose and whether the engagement area and backlash of bevel gear pair of main actuator are reasonable. If the engagement area and backlash are not as required, the following adjustment must be done.

Table 4-1 Adjustment of engagement area and backlash

Tooth face contact area of driven bevel gear	Adjusting method	Travel direction of gear
	Move the driven gear toward the driving gear. If the backlash is too large, move the driving gear outwards.	
	Move the driven gear away from the driving gear. If the backlash is too large, move the driving gear inwards.	
	Move the driving gear toward the driven gear. If the backlash is too large, move the driven gear outwards.	
	Move the driving gear away from the driven gear. If the backlash is too large, move the driving gear inwards.	

The engagement area can often be adjusted by increasing or reducing adjusting gasket and rotating adjusting nut. The adjustment of contact area is very important for operating performance and service life, so it shall be completed carefully.

4.1.2 Heating of driving axle

(1) Symptom and danger

The heating of driving axle means that the temperature of driving axle exceeds the allowable range after it operates for a period of time, that is to say, you will burn your hand if touching it by hand. The heating of driving axle often occurs at axle housing of driving axle (beyond main actuator and differential) and wheel reducer.

The heating of driving axle also shows the components of driving axle are abnormal in terms of technical condition, fit relation or lubrication. Such abnormality shall be eliminated immediately to avoid the damage of relevant components.

(2) Reason and troubleshooting of heating of driving axle

The reason why the driving axle heats can be considered from two aspects: firstly, the excessive heat is generated; secondly, the heat generated cannot give out immediately.

The main heat source of driving axle is the friction heat generated due to too small fit clearance between relative motion parts. The fitting piece of driving axle includes bearing and gear, so the basic heating reason of driving axle is too small bearing fit clearance or small gear backlash.

The main reason why the heat of driving axle (and wheel reducer) cannot give out is short of oil or bad oil quality. On this account, not only will the friction heat generated from driving axle not give out but also the friction heat of relative motion parts will largely increase due to dry friction.

We can determine the heating reason based on heating position. For instance, if the bearing heats, we can determine that it may be caused by too small fit clearance; if the whole driving axle housing heats, this may be caused by abnormal gear engagement or shortage of oil. At this time, the gear oil as required shall be refilled.

4.1.3 Oil leakage of driving axle

(1) Symptom and danger

The oil leakage of driving axle occurs at axle housing and wheel reducer and the oil mainly leaks from sealing junction plane. The oil leakage can not only cause the heating of driving axle and affect the performance but also result in the pollution on environment.

(2) Reason and troubleshooting of oil leakage of driving axle

The oil leakage of driving axle is mainly caused by damaged sealing element or seal gasket.

In any oil leakage, it is necessary to check the oil seal for aging, crack or damage. Do not extend the oil seal forcibly to avoid the occurrence of plastic deformation. The oil seal is advisable to be dipped in the liquid with temperature equal to operating temperature before installed. When installation, the special tool and process shall be used.

4.2 Maintenance of ZF driving axle

4.2.1 Inspection on oil level

Park the vehicle horizontally and clean all the oil filler holes before inspection. Drain oil after the vehicle runs for a period of time. When opening the screw plug to drain oil, much attentional shall be paid to the splashing hot oil.

Wheel oil level: to check the oil level in wheel reducer, rotate the hub till the words of "OIL LEVEL" are at horizontal position. The oil level shall reach the position where the oil overflows from screw plug.

Axle body oil level: the oil level shall reach the position where the oil overflows from the middle oil filler hole or screw plug hole.

Inspection: after refilling, it is necessary to refill oil till the specified oil level is maintained if the oil level lowers after several minutes. Check the oil level once a month.

4.2.2 Replacement of oil

For a new vehicle, the driving axle oil shall be replaced firstly after running for 500 h. The subsequent oil replacement cycle shall follow Table 4-2. The oil shall be replaced at least once a year.

Table 4-2 Oil replacement cycle

Load grade		Interval of oil replacement
General load	Wheel loader, land leveler	1000 h or one year at least
Heavy load	Loader in bad operation or brake condition	500 h or half a year at least
Heavy load	Ambient temperature of vehicle: >40 ℃	500 h or half a year at least

4.2.3 Measurement of wear extent of friction plate

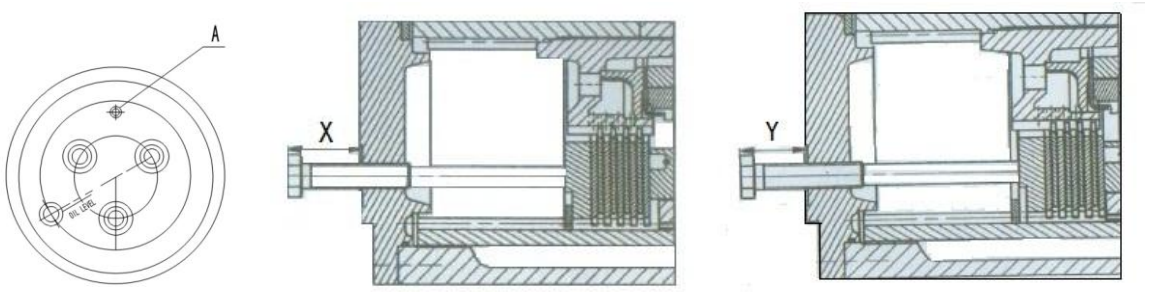
We can determine whether the wear extent of friction plate is as required, requiring no removal of

hub. The measuring tool adopted is only a bolt. The specification of bolt selected for each model is as shown in the table below:

Table 4-3 Selection of measuring tooling

	
Bolt specification	Applicable model
M16×1.5×170	AP-411-420
M16×1.5×120	AP-407/409

The detailed measuring method is as follows: rotate the plug A on hub to its highest position, as shown in Fig.4-1(a), use Allen wrench to remove the plug, step down the brake (oil pressure of 80~120 bar), screw on the measuring tooling with tightening torque of 25 N•m and then measure the distance X from hexagon head to planet carrier surface, as shown in Fig.4-1(b). Release the brake, retighten the measuring tooling with same torque (25 N•m) and then measure the distance Y from hexagon head to planet carrier surface, as shown in Fig.4-1(c). Obviously, the piston stroke is equal to X-Y.



(a) (b) (c)

Fig.4-1 Measurement of wear extent of friction plate

The maximum piston stroke is as shown in Table 4-4. If this range is exceeded, this shows the friction plate has been worn out and shall be replaced.

Table 4-4 Maximum piston stroke (X-Y)

Model of ZF axle	Number of driving (driven) friction plates	Piston stroke (mm)
AP-407	2	5.0
AP-410	3	5.0

AP-412	3	7.7
AP-412	4	7.7
AP-415	5	7.7
AP-417	3	6.4
AP-420	4	6.4

4.2.4 Inspection on sealing performance of brake hydraulic system

It should be noted that the brake shall exhaust before the sealing performance of brake hydraulic system is inspected. Apply the brake for 10 times, conduct exhaust operation and then do the following pressure tests:

1. Use a hydraulic pump to produce the pressure of 120 bar, tighten the switch. After the pressure is maintained for 5 min, the pressure cannot be lower than 117 bar.

2. When producing the pressure of 5 bar and maintaining the pressure for 5 min, any pressure drop cannot be allowed.

4.2.5 Operating temperature

The operating temperature of axle shall not exceed 90 ℃ after continuous operation. If its operating temperature exceeds 130 ℃, it is necessary to stop machine to check the brake system and driving axle.

4.2.6 Lubricating grease

It is necessary to select the multipurpose lubricating grease, such as lithium grease characterized by dropping point of 170 ℃, class NLGI2 and good corrosion and water resistance and extrusion stability. Apply the grease on grease nozzle once a week.

4.2.7 Inspection on tightening torque

It is necessary to check the tightening torque of connecting bolts between the driving axle and the frame, drive shaft and wheel rim regularly. The first inspection shall be done after 50 h of operation.

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