

福田轻型载货汽车
使用与维修手册
FOTON LIGHT-DUTY TRUCK
USE AND SERVICE MANUAL

北汽福田汽车股份有限公司
BEIQI FOTON MOTOR CO., LTD.



内 容 简 介

INTRODUCTION

本《福田轻型载货汽车使用与维修手册》主要介绍了福田轻型载货汽车技术维护；BJ493ZQ、BJ493ZLQ、CY4102ZLQ、YZ4105ZLQ、Phaser110Ti、Phaser135Ti 等柴油发动机构造、使用、维护、故障排除；福田轻型载货汽车底盘维护及故障排除；部分汽车的主要技术参数等内容，供车辆使用与维修时参考。

This manual mainly introduces the technical services for FOTON light-duty truck; construction, operation, service and troubleshooting for BJ493ZQ, BJ493ZLQ, CY4102ZLQ, YZ4105ZLQ and Phaser110Ti / Phaser135Ti model engines. The manual also includes main technical parameters for some vehicles that can be used during vehicle operation and service.

北汽福田汽车股份有限公司
BEIQI FOTON MOTOR CO. LTD.

福田轻型载货汽车使用与维修手册
FOTON LIGHT-DUTY TRUCK USE AND SERVICE MANUAL

Book size: 889mm×1194mm1/16 page required: 13.3 Words total: 59.387
June 2006 Beijing first edition June 2006 First publishing
No. of copies: 0~1000



TABLE OF CONTENTS	
目 录	
Chapter 1 Vehicle main data and specifications.....	1
第一章 汽车数据与规格	
1.1 Vehicle main data and specifications.....	1
1.1 汽车主要数据与规格	
1.2 BJ493ZLQ diesel engine technical specifications.....	12
1.2 BJ493ZLQ 柴油机技术资料	
1.3 PHASER 110Ti diesel engine technical specifications.....	22
1.3 珀金斯 Phaser110Ti 柴油机技术资料	
1.4 YZ4102ZLQ diesel engine technical specifications.....	25
1.4 YZ4102ZLQ 柴油机技术资料	
1.5 YZ4105ZLQ diesel engine technical specifications.....	31
1.5 YZ4105ZLQ 柴油机技术资料	
1.6 PHASER135Ti diesel engine technical specifications.....	34
1.6 珀金斯 Phaser110Ti 柴油机技术资料	
Chapter 2 Vehicle technical service.....	46
第二章 汽车技术维护	
2.1 Vehicle daily maintenance.....	46
2.1 汽车日常维护	
2.2 Vehicle 1 st level maintenance.....	47
2.2 汽车一级维护	
2.3 Vehicle 2 nd level maintenance.....	49
2.3 汽车二级维护	
2.4 Vehicle maintenance during break-in period.....	54
2.4 汽车走合期维护	
2.5 Vehicle seasonal maintenance.....	55
2.5 汽车换季维护	
2.6 Vehicle lubrication.....	56
2.6 汽车全车润滑	
Chapter 3 BJ493ZLQ series diesel engine construction and service/adjustment.....	58
第三章 BJ493ZLQ 系列柴油机构造与维修调整	
3.1 Notes to diesel engine maintenance and adjustment.....	58
3.1 柴油机维护调整须知	
3.2 Cylinder block parts.....	58
3.2 气缸体部件	
3.3 Cylinder head parts.....	60
3.3 气缸盖部件	
3.4 Piston/crank mechanism.....	63
3.4 活塞曲柄连杆机构	
3.5 Valve train.....	69



3.5	配气机构	
3.6	Lubrication system	75
3.6	润滑系统	
3.7	Crankcase ventilation devices	78
3.7	曲轴箱通风装置	
3.8	Cooling system	78
3.8	冷却系统	
3.9	Fuel system	82
3.9	供油系统	
3.10	Air intake and exhaust system	88
3.10	进排气系统	
3.11	Supercharging system	88
3.11	增压系统	
3.12	Electrical system	92
3.12	电气系统	
3.13	Electric control EGR system	92
3.13	电控 EGR 系统	
3.14	Clutch	93
3.14	离合器	
Chapter 4 BJ493ZLQ diesel engine operation		95
第四章 BJ493ZLQ 柴油机的使用		
4.1	The rules of safe operation	95
4.1	安全操作规定	
4.2	Fuel/oil and cooling fluids	95
4.2	油料和冷却液	
4.3	Preparations before start up	97
4.3	起动前准备	
4.4	Diesel engine start-up procedures	100
4.4	起动步骤	
4.5	Check during engine running	101
4.5	运转期间的检查	
4.6	Shutdown	101
4.6	停车	
4.7	Keys points to engine operation	101
4.7	使用要点	
4.8	The rules to engine operation	102
4.8	使用注意事项	
4.9	Use diesel engine in winter	103
4.9	冬季使用	
4.10	Diesel engine and environment	104
4.10	柴油机对环境的影响	
4.11	Transportation, installation and storing	104
4.11	搬运.安装和存封	
4.12	Decide an overhaul	104



4.12	大修期的判定	
Chapter 5	Technical maintenance for BJ493ZLQ diesel engine	105
第五章	BJ493ZLQ 柴油机的技术保养	
5.1	Daily maintenance	105
5.1	日常技术维护内容	
5.2	1 st level technical maintenance	106
5.2	一级技术维护	
5.3	2 nd level technical maintenance	106
5.3	二级技术维护	
5.4	Technical maintenance of air filter	107
5.4	空气滤清器的技术保养	
5.5	Technical maintenance of fuel supply system	108
5.5	供油系统的技术保养	
5.6	Technical maintenance of lubrication system	111
5.6	润滑系统的技术保养	
5.7	Technical maintenance of cooling system	114
5.7	冷却系统的技术保养	
Chapter 6	Diesel engine faults and solutions	115
第六章	柴油机故障与排除方法	
6.1	Hard start-up	115
6.1	柴油机起动困难	
6.2	Hard start-up at low temperature	116
6.2	柴油机低温起动困难	
6.3	Insufficient power	116
6.3	柴油机功率不足	
6.4	Abnormal noise during operation	117
6.4	柴油机运转时有异常杂音	
6.5	Abnormal exhaust gas color	118
6.5	柴油机排气烟色不正常	
6.6	Low oil pressure	118
6.6	柴油机机油压力不足	
6.7	Abnormal coolant temperature or insufficient coolant	119
6.7	柴油机冷却系统冷却液温度失常.缺液	
6.8	Supercharging system fault	120
6.8	柴油机增压系统故障	
6.9	Starter does not run, weak start up or noise	121
6.9	起动机不运转.起动无力.发出噪声	
6.10	Alternator does not work, lower or higher charging current	121
6.10	发电机不发电.充电电流小或充电电流过大	
6.11	Lower battery volume, higher self-discharging	122
6.11	蓄电池容量不足.自放电过大	
6.12	Failure cold-start preheating system	122
6.12	冷起动预热系统故障	
6.13	Water pump electro-magnetic fan clutch faults	123



Chapter 7 Chassis construction and service	126
第七章 底盘构造与修理	
7.1 Clutch	126
7.1 离合器	
7.2 Transmission	135
7.2 变速器	
7.3 Propeller shaft	149
7.3 传动轴	
7.4 Rear axle	154
7.4 后桥	
7.5 Front axle	164
7.5 前桥	
7.6 Steering mechanism	174
7.6 转向机构	
7.7 Suspension	180
7.7 悬架	
7.8 Brake system	186
7.8 制动系统	
7.9 Frame	200
7.9 车架	
7.10 Wheel	204
7.10 车轮	
Appendix 1: BJ1049V9JD6-C Electrical diagram	
附录 1: BJ1049V9JD6-C 电器原理图	
Appendix 2: BJ1049V9JE6-A and BJ1043V8JE6-D Electrical diagrams	
附录 2: BJ1049V9JE6-A 和 BJ1043V8JE6-D 电器原理图	
Appendix 3: BJ1099VEPED Electrical diagram	
附录 3: BJ1099VEPED 电器原理图	
Appendix 4: BJ1069VCJEA-A Electrical diagram	
附录 4: BJ1069VCJEA-A 电器原理图	
Appendix 5: BJ1069VCJFA-A Electrical diagram	
附录 5: BJ1069VCJFA-A 电器原理图	
Appendix 6: BJ1039V4JD3-A Electrical diagram	
附录 6: BJ1039V4JD3-A 电器原理图	



Chapter 1

Vehicle main data and specifications

1.1 Vehicle main data and specifications

Table 1-1 Main data and specifications

Model			BJ1049V9JD6-C	BJ1049V9JE6-A	BJ1043V8JE6-D
Description					
Engine mounted			BJ493ZLQ	Phaser110Ti	YZ4102ZLQ
Main size parameters (m m)	Overall size (L×W×H) (mm)		5875×1840×2210	5975×1915×2240	5995×2000×2320
	Inner cargo (L×W×H) (mm)		4230×1810×380	4230×1900×380	4230×1900×400
	Wheel base (mm)		3360	3360	3360
	Wheel track (mm)	FR wheel	1530	1530	1530
		RR wheel	1425	1485	1485
Mass parameters	Curb weight (kg)		2095	2150	2160
	Rated payload (kg)		2360	2345	1620
	Rated passenger (person)		3	3	2
	Max. total mass (kg)		4455	4495	3780
Main performance parameters	Max speed (km/h)		≥95	≥95	≥95
	Max slope of climbing (%)		≥30	≥25	≥20
Fuel tank volume (L)			80	80	80

Table 1-2 Engine main data

Engine	Model	BJ493ZLQ	Phaser110Ti	YZ4102ZLQ
	Engine type	Four-in-line, water cooled, inter-cooled diesel engine		
	Overall size (L×W×h) (mm)	775×633×708	892.5×650×794.8	825×714×740
	Rated power/rpm (kw/rpm)	68/3600	81/2600	81/2900
	Max torque (N·m)	202≤2200	360/1400-1600	310/≤1800
	Total displacement volume (L)	2.771	3.99	3.432
	Compression ratio	17.2: 1	17.5:1	17: 1
	Net mass (kg)	280	457	330
	Idle (rpm)	750±40	750±30	750±50
	Engine oil volume (L)	4.5	8.5	8



Table 1-3 Main data and specifications

Model		BJ1049V9JD6-C	BJ1049V9JE6-A	BJ1043V8JE6-D
Engine mounted		BJ493ZLQ	Phaser110Ti	YZ4102ZLQ
Allowed axle load (kg)	Front axle	2400	2400	2400
	Rear axle	4000	5000	5000
Clutch	Diameter (mm)	φ 250× φ 160	φ 325× φ 200	φ 300× φ 190
	Type	Single disc, dry type, diaphragm spring		
	Pedal free travel (mm)	20~30		
Transmission	Model	MSB-5M	5T108	LC5T30
	Type	Mechanical, five forward gears, one reverse gear, with synchronizer		
	Operation	Distant operating with cable		
	Gear ratio	i1: :5.594 i2: 2.814 i3: 1.660 i4: 1.000 i5: 0.794 IR: 5.23	i1: 4.754 i2: 2.733 i3: 1.680 i4: 1.000 i5: 0.751 IR: 5.084	i1: 4.766 i2: 2.496 i3: 1.429 i4: 1.000 i5: 0.728 IR: 4.774
Rear axle	Type	Integrated banjo type, press axle housing		
	Drive ratio	5.857	4.875	5.375
	Lubricant volume (L)	2.5	3.5	2.5
Steering mechanism	Steering gear type	Mechanical re-circulation ball		
	Steering wheel free travel (°)	± 10°	± 10°	± 10°
	Steering fluid volume (L)	0.5	0.5	0.5

Table 1-4 Main data and specifications

Model		BJ1049V9JD6-C	BJ1049V9JE6-A	BJ1043V8JE6-D
Engine mounted		BJ493ZLQ	Phaser110Ti	YZ4102ZLQ
Electrical devices	Type	12V electrical system, negative ground	24V electrical system, negative ground	24V electrical system, negative ground
	Battery (V/A-h)	95D31Re	24/100	6-QA-105or 6Q-105
	Starter (V/k w)	12/2.8	24/4.5	24/4.0
	Alternator (V/W)	12/600	28/1500	28/2000



Table 1-5 Technical specifications					
Model		BJ1039V 4JD3-A	BJ1069VCJEA-A BJ1069VCPEA-A	BJ1099VEPED	BJ1069 VCJFA-A
Parameters					
Engine type		BJ493ZQ、	Phaser135Ti	Phaser135Ti	YZ4105ZLQ
General data (mm)	Over all dimensions (L×W×H) (mm)	4955×1870×2240	6995×2250×2350 6725×2100×2280	7520×2240×2530	6995×2250×2350
	Inner dimensions of the cargo body (L×W×H) (mm)	3200×1760×380	5150×2050×550 4750×2050×550	5800×2130×550	5150×2050×550
	Wheel base (mm)	2600	3800	4500	3800
	Wheel track (mm)	Front	1530	1665、1685	1830
		Rear	1380	1600	1700
Mass data	Curb weight (kg)	2035	3325	4850	3325
	Rated payload (kg)	1250	2300	3941	2300
	Rated passenger (person)	3	3	3	3
	Max. total mass (kg)	3480	5820	8986	5820
Apply data	Max speed (km/h)	≥95	≥95	≥95	≥95
	Max slope of climb (%)	≥30	≥23	≥20	≥23
Furl tank (L)		60	80	120	80

Table 1-6 Technical specifications					
Vehicle Model		BJ1039 V4JD3-A	BJ1069VCJEA-A BJ1069VCPEA-A	BJ1099 VEPED	BJ1069 VCJFA-A
Engine mounted		BJ493ZQ	Phaser135Ti	Phaser135Ti	YZ4105ZLQ
Clutch	Diameter (mm)	φ 250× φ 160	φ 330× φ 200	φ 330× φ 200	φ 330× φ 200
	Type	Single disk dry diaphragm spring			
	Free travel of clutch pedal (mm)	20~30			
Gearbox	Model	MSB-5S	LC6T46	QLD6T53	LC6T46
	Type	Mechanical 5+1,with synchronizers			
	Operation	Distant operating with cable			
	Gearbox speed ratio	i1: 5.016	i1: 6.314	i1: 6.515	i1: 6.314
		i2: 2.672	i2: 3.913	i2: 3.917	i2: 3.913
		i3: 1.585	i3: 2.262	i3: 2.346	i3: 2.262
		i4: 1.000	i4: 1.393	i4: 1.429	i4: 1.393
		i5: 0.77	i5: 1.000	i5: 1.000	i5: 1.000
		I R: 4.783	i6: 0.788 I R: 5.874	i6: 0.814 I R: 6.061	i6: 0.788 I R: 5.874



Vehicle Model		BJ1039 V4JD3-A	BJ1069VCJEA-A BJ1069VCPEA-A	BJ1099 VEPED	BJ1069 VCJFA-A
Rear axle	Type	Whole banjo type pressing axle house			
	Final drive ratio	5.571	4.33/4.875 5.714	4.875	4.33/4.875 5.714
	Rear axle（L）	2.5	3.5	4.0	2.5
Steering gear	Type	Mechanical circular ball type		Mechanical recirculating ball type （Power assisting steering rear）	Mechanical recirculating ball type
	Free angle of steering wheel（°）	±10°	±10°	±10°	±10°
	Steering gear（L）	0.5	0.5	3(Power assisting steering gear)\ 1.02,(Mechanical)	0.5
Front Wheel alignment data	Toe-in（mm）	4~6(for bias ply tyre);1~3(For radial tyre)	4~6	1~3	4~6
	Camber	1° 30′	1°	1°	1°
	Caster	3°	3°	2° 30′	3°
	King pin inclination	7° 15′	8°	8°	8°
Brake system	Driving brake	Hydraulic vacuum boosting ,dual circuits , drum brake,		Air pressure dual circuits drum Wheel edge brake	Hydraulic vacuum boosting ,dual circuits drum brake,
	Parking brake type	Central drum brake	Central drum brake	Central drum brake or spring accumulator	Central drum brake
Suspension system	Front	Longitudinal elliptical leaf spring non-independent suspension hydraulic dual acting telescopic shock absorber			
	Leaf spring	7	9	9	9
	Rear	Longitudinal elliptical leaf spring non-independent suspension With auxiliary ; leaf spring , hydraulic dual acting telescopic shock absorber			
	Leaf spring	7+4	11+7/12	11+7	11+7/12
Wheel	Wheel	Two front wheels Four rear wheels , one spare tire			
	Front wheel	6.00-15LT[10] XZ6.5-R15LT[10]	7.50-16/8.25—16/8.5R17.5	8.25-16 or8.25-18	7.50-16/8.25—16/8.5R17.5
	Rear wheel	6.00-15LT[10] XZ6.5-R15LT[10]	7.50-16/8.25—16/8.5R17.5	8.25-16 or8.25-18	7.50-16/8.25—16/8.5R17.5



Table 1-7 Electric device Technical specifications

Model		BJ1036V4JD3-A	BJ1069VCJEA-A BJ1069VCPEA-A	BJ1099VEPED	BJ1069VCJFA-A
Engine		BJ493ZLQ	Phaser135Ti	Phaser135Ti	YZ4105ZLQ
Electrical Devices	Rated voltage	Negative ground 12V	Negative ground 24V	Negative ground 24V	Negative ground 24V
	Battery (V/A-h)	95D31Re	95D31Re	12/100-2	24/100
	Starter (V/k w)	12/2.8	24/4.5	24/4.5	24/4.0
	Alternator (V/W)	12/600	24/1500	24/1500	24/2000

Table1-8 Engine Technical specifications

	Description	BJ493ZQ	Phaser135Ti	YZ4105ZLQ
Engine	Engine type	Four-cylinder in-line, water cooling , DI supercharging diesel engine	Four-cylinder in-line, water cooling, DI supercharging inter cooling diesel engine	Four-cylinder in-line, water cooling, DI supercharging inter cooling) diesel engine
	Bore ×stroke(mm)	93×102	100×127	105×118
	Compression	17.2: 1	17.5:1	17: 1
	Displacement (L)	2.771	3.99	4.087
	Engine rated power (k w /rpm)	68/3600	101/2600	105/2800
	Engine rated torque (N-m)	202/≤2200	445/1600	420/≤1600
	Idling speed (rpm)	750±40	750±30	750±50
	Engine lubricating system (L)	4.5	8.5	11
	Net weight (kg)	280	457	350
	Overall dimensions (L×W×H) (mm)	775×633×708	892.5×650×794.8	823×654×813

Table1-9 Engine Technical specifications

	Description	LL480Q、Y480Q、YD480、CZ480QB、LL480QB、QC480Q (DI)
Engine	Engine type	Four-cylinder , in-line, water cooling , four -stroke diesel engine
	Bore×stroke (mm)	80×90
	Compression	22.5:1or 18:1
	Displacement (L)	1.809



	Engine Rated power (k w /rpm)	29/3000
	Engine Rated torque (N-m)	104/2100
	Injection pump (environmental protection vehicle)	BH4Q60R8 or BH4Q60R7 or 4IW209
	Injector (environmental protection vehicle)	00P21-15N or P21- II or 00P21-5N
	Net weight (kg)	≤195
	Overall dimensions (L×W×H) (mm)	687×494×623

Table1-10 Engine Technical specifications

	Description	BJ483Q1	BJ483QB	BJ483ZQB
Engine	Engine type	Four-cylinder in-line, water cooling , four -stroke DI diesel engine		Four-cylinder in-line , water cooling , DI supercharging diesel engine
	Bore×stroke(mm)	83×100		
	Compression ratio	20.8:1		17.5:1
	Displacement (L)	2.164		2.164
	Engine rated power (k w /rpm)	38/3300		46/3300
	Engine rated torque (N-m)	120/2300		150/200-2300
	Idling speed (rpm)	650±30		750~850
	Engine lubricating system (L)	4.5		4.5
	Injection pump (environmental protection vehicle)			IW255
	Injector (environmental protection vehicle)			Multi hole S series,CKBEL87S069or ZP22
	Net weight (kg)	≤210		≤215
	Overall dimensions (L×W×H) (mm)	841×555×663		838×605×663



Table1-11 Engine Technical specifications

	Description	N485QA	YSD490Q、490Q(DI)、QC490Q(DI)
Engine	Engine type	Four-cylinder in-line, water cooling , four-stroke diesel engine	
	Bore × stroke (mm)	85×95	90×95
	Compression ratio	18:1	18:1
	Displacement (L)	2.156	2.54
	Engine rated power (k w /rpm)	34.5/3000	45.6/3200
	Engine rated torque (N·m)	124.3/2100	157/2240
	Idling speed (rpm)	750±50	750±50
	Engine lubricating system (L)	7.5	7.5
	Net weight (kg)	≤230	≤230
	Overall dimensions (L×W×H) (mm)	692×492×675	716×530×700

Table1-12 Engine Technical specifications

	Description	BJ493Q	BJ493ZQ1	BJ493ZLQ1
Engine	Engine type	Four-cylinder in-line, water cooling , DI diesel engine	Four-cylinder in-line, water cooling, DI supercharging diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine
	Bore ×stroke (mm)	93×102	93×102	93×102
	Compression ratio	18.2: 1	17.2: 1	17.2:1
	Displacement (L)	2.771	2.771	2.771
	Engine rated power (k w /rpm)	57/3600	68/3600	80/3600
	Engine rated torque (N·m)	272/≤2300	230/2300	245/≤2300
	Idling speed (rpm)	750±40	830	750±40
	Engine lubricating system (L)	4.5	4.5	4.5
	Net weight (kg)	230	241	280
	Overall dimensions (L×W×H) (mm)	775×615×713	775×635×705	775×633×715



Table1-13 Engine Technical specifications

	Description	4100Q、Y4100Q	YZ4102ZLQ	YZ4DB3
Engine	Engine type	Four-cylinder in-line, water cooling , DI diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine
	Bore ×stroke (mm)	100×105	102×105	98×105
	Compression ratio	17.5: 1	17.5: 1	17:1
	Displacement (L)	3.298	3.432	4.087
	Engine rated power (k w /rpm)	58.8/3200	70/2900	75/3200
	Engine rated torque (N-m)	200/2000	265/1800	260/2200
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	9	8	13
	Net weight (kg)	≤300	330	350
	Overall dimensions (L×W×H) (mm)	877×650×716	825×714×740	814×600×731

Table1-14 Engine Technical specifications

	Description	CY4100ZQ	CY4100ZLQ	YZ4102Q1
Engine	Engine type	Four-cylinder in-line , water cooling , DI supercharging diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine	Four-cylinder in-line, water cooling , DI diesel engine
	Cylinder bore (mm)	100	100	102×105
	Compression ratio	17.5: 1	17.5: 1	17:1
	Displacement (L)	3.707	3.707	3.432
	Engine rated power (k w /rpm)	66/2900	70/3200	63/3300
	Engine rated torque (N-m)	230/1800-2000	235/≤1800-2000	210.9/2200
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	8.4	8.4	8
	Overall dimensions (L×W×H) (mm)	791× 705 ×756	791×705×756	903×600×708



Table1-15 Engine Technical specifications

	Description	CY4102BZQ	CY4102BZLQ	CA4100/125Z
Engine	Engine type	Four-cylinder in-line , water cooling , DI supercharging diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine
	Cylinder bore (mm)	102	102	100
	Compression ratio	17:1	17:1	17:1
	Displacement (L)	3.865	3.856	4.752
	Engine rated power (k w /rpm)	70.6/3200	88/2800	100/2700
	Engine rated torque (N-m)	245/≤2200	434/1400-1800	392/≤1800
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	8.4	8.4	8
	Net weight (kg)	350	350	450
	Overall dimensions (L×W×H) (mm)	878×776×773	878×776×773	939×707×793

Table1-16 Engine Technical specifications

	Description	4100QB	4100QBZ	4100QBZL
Engine	Engine type	Four-cylinder in-line, water cooling , DI diesel engine	Four-cylinder in-line, water cooling , DI supercharging diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine
	Cylinder bore (mm)	100	100	100
	Compression ratio	17.5: 1	17.5: 1	17.5: 1
	Displacement (L)	3.298	3.298	3.298
	Engine rated power (k w /rpm)	58.8/3200	62.5/3200	70/3200
	Engine rated torque (N-m)	200/2000	202/2200	245/2200
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	9	9	9
	Net weight (kg)	300	330	330
	Overall dimensions (L×W×H) (mm)	877×650×716	825×560×729	825×560×729



Table1-17 Engine Technical specifications

	Description	CY4100Q	CA498	YZ4102QF
Engine	Engine type	Four-cylinder in-line, water cooling , DI diesel engine	Four-cylinder in-line, water cooling , DI diesel engine	Four-cylinder in-line, water cooling , DI diesel engine
	Bore × stroke (mm)	100×118	98×105	102×118
	Compression ratio	17.5: 1	17.5: 1	17.5: 1
	Displacement (L)	3.298	3.168	3.875
	Engine rated power (k w /rpm)	58.8/3200	62.5/3600	70.6/3200
	Engine rated torque (N-m)	200/2000	196/1900-2100	245/2200
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	9	9	9
	Net weight (kg)	300	245	330
	Overall dimensions (L×W×H) (mm)	879×662×765	764×603×722	820×635×762

Table1-18 Engine Technical specifications

	Description	BJ491EQ2	YC4D120-21	YZ485ZLQ
Engine	Engine type	Vertical , in-line, water cooling, Four cylinders , four strokes, electronic control multi-point injection gasoline engine	Four-cylinder in-line , water cooling , DI diesel engine	Four-cylinder in-line, water cooling , DI supercharging inter cooling diesel engine
	Bore × stroke (mm)	91×86	108×115	85×92
	Compression ratio	8.8:1	17: 1	17: 1
	Displacement (L)	2.237	4.214	2.088
	Engine rated power (k w /rpm)	70/4000	90/2800	46/3200
	Engine rated torque (N-m)	193/2000-2600	350/1600-1900	165/2000
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	4.5		7.5
	Net weight (kg)	≤150		230
	Overall dimensions (L×W×H) (mm)	743×588×620	870×670×780	820×605×679



Table1-19 Engine Technical specifications

	Description	N490ZLQ	4100QB-1A	4100QB-2
Engine	Engine type	Four-cylinder in-line, water cooling , DI Supercharging inter cooling diesel engine	Four-cylinder in-line, water cooling diesel engine	Four-cylinder in-line, water cooling diesel engine
	Bore × stroke (mm)	90×100	100×105	100×115
	Compression ratio	18:1	17.5:1	17.5:1
	Displacement (L)	2.54	3.298	3.612
	Engine rated power (k w /rpm)	60/3200	62.5/3400	66.2/3200
	Engine rated torque (N-m)	210/2000	201/2380	230/2000-2200
	Idling speed (rpm)	750±50	750±50	750±50
	Engine lubricating system (L)	7.5	11	11
	Net weight (kg)	≤150	≤310	≤330
	Overall dimensions (L×W×H) (mm)	861×606×679	877×650×716	877×650×716

Table1-20 Engine Technical specifications

	Description	YZ4105QF	BJ486ZQ
Engine	Engine type	Four-cylinder in-line, water cooling diesel engine	Four-cylinder in-line, water cooling , DI supercharging diesel engine
	Bore × stroke (mm)	105×118	86×100
	Compression ratio	17.5:1	18
	Displacement (L)	4.087	2.324
	Engine rated power (k w /rpm)	75/3200	52/3300
	Engine rated torque (N-m)	260/2200	175/1900~2300
	Idling speed (rpm)	750±50	800~850
	Engine lubricating system (L)	8	8
	Net weight (kg)	≤330	≤215
	Overall dimensions (L×W×H) (mm)	820×720×761	754×592×671



1.2 BJ493ZLQ Diesel engine technical specifications

1.2.1 BJ493Q Diesel engine diagram

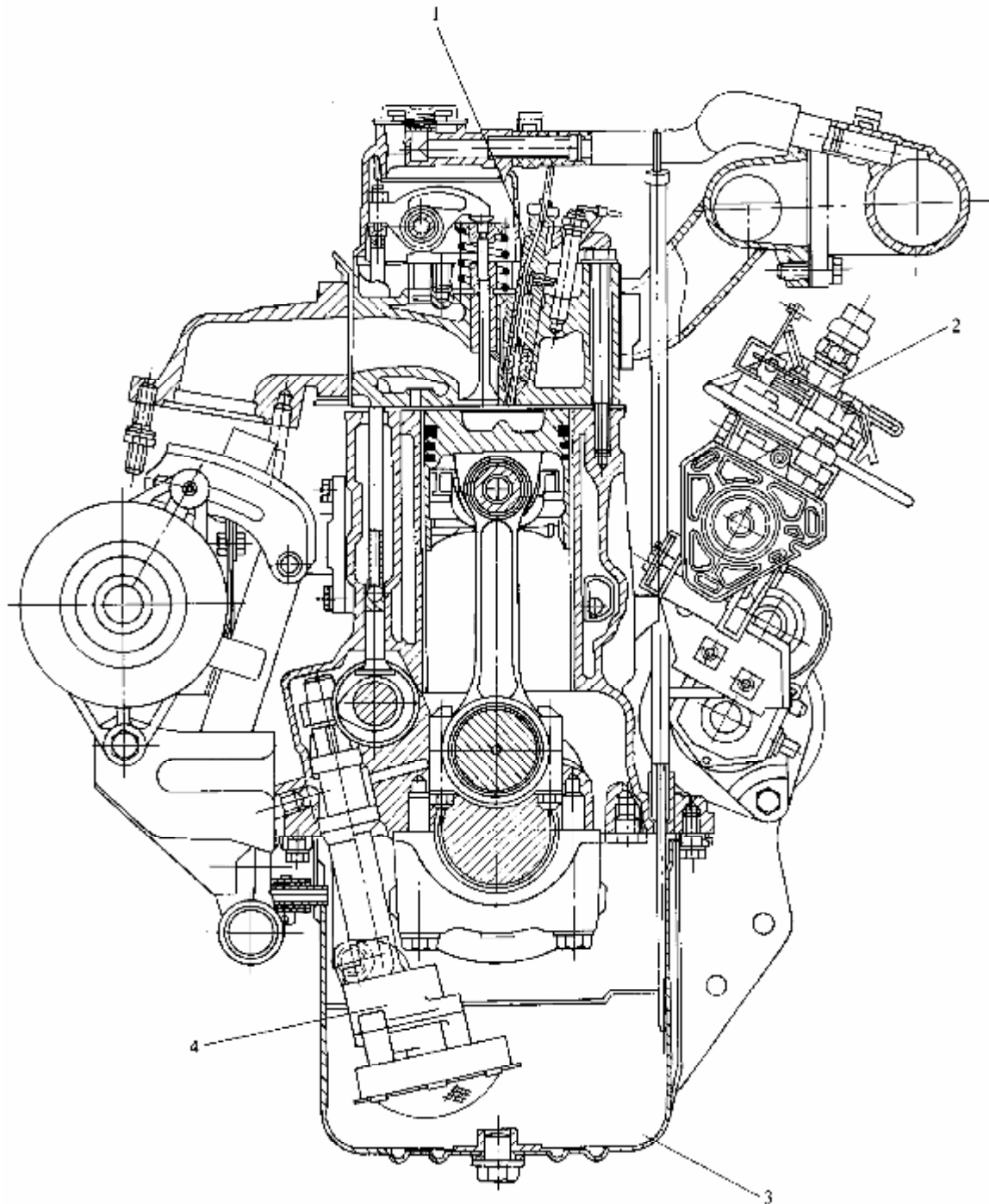


Figure 1-1 BJ493Q Diesel engine assembly diagram

1-Injector assembly; 2-Ve-fuel pump; 3-Oil pan assembly; 4-Oil pump assembly

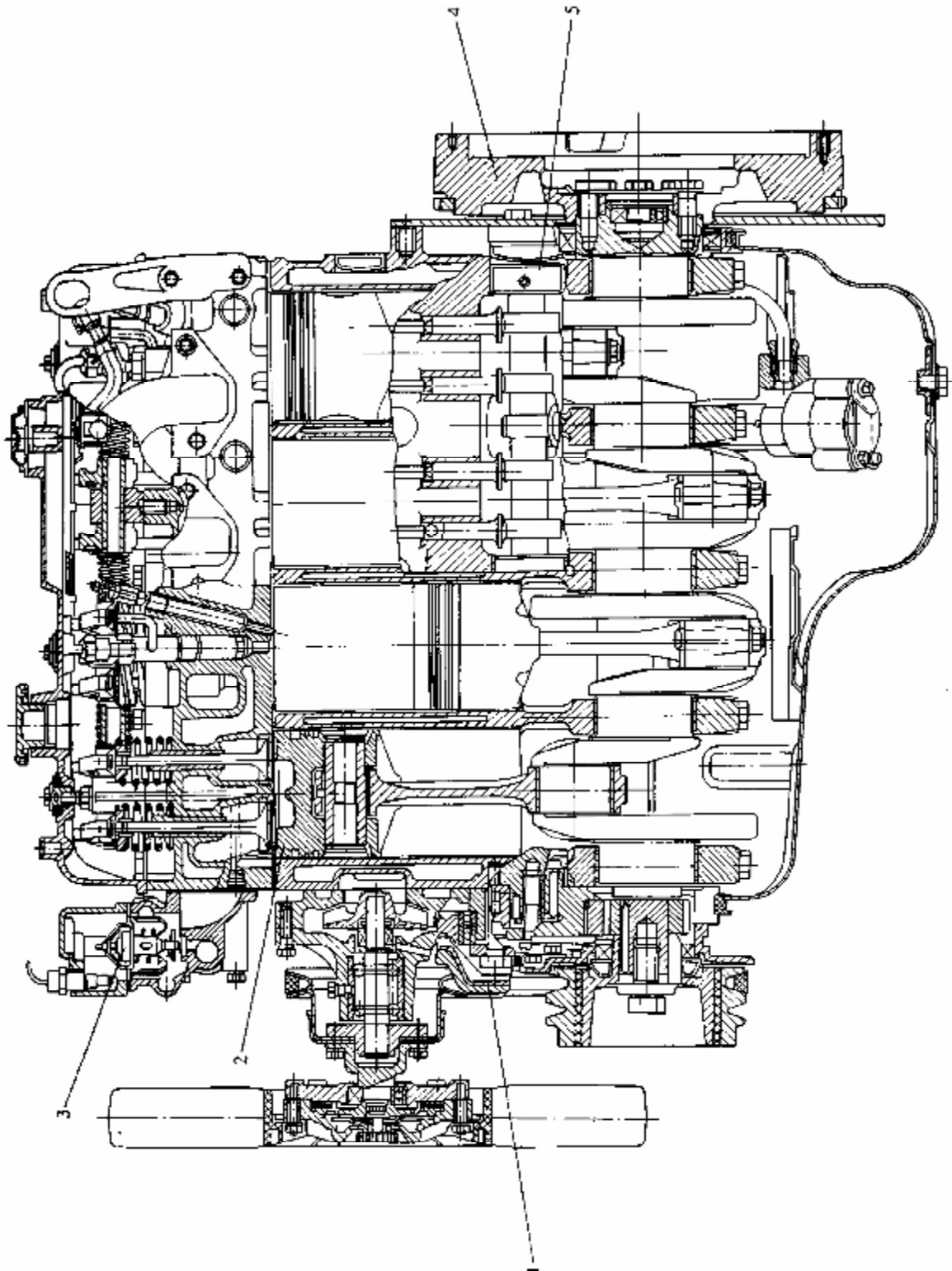


Figure 1-2 BJ493Q Diesel engine assembly diagram

1-timing gear chamber; 2-piston connecting rod assembly; 3-thermostat assembly;
4-crankshaft flywheel assembly; 5- camshaft assembly

1.2. 2 Model BJ493ZLQ inter-cooled diesel engine

Model BJ493ZLQ inter-cooled diesel engine assembly diaphragm see figure 1-3、1-4、1-5、1-6、1-7。

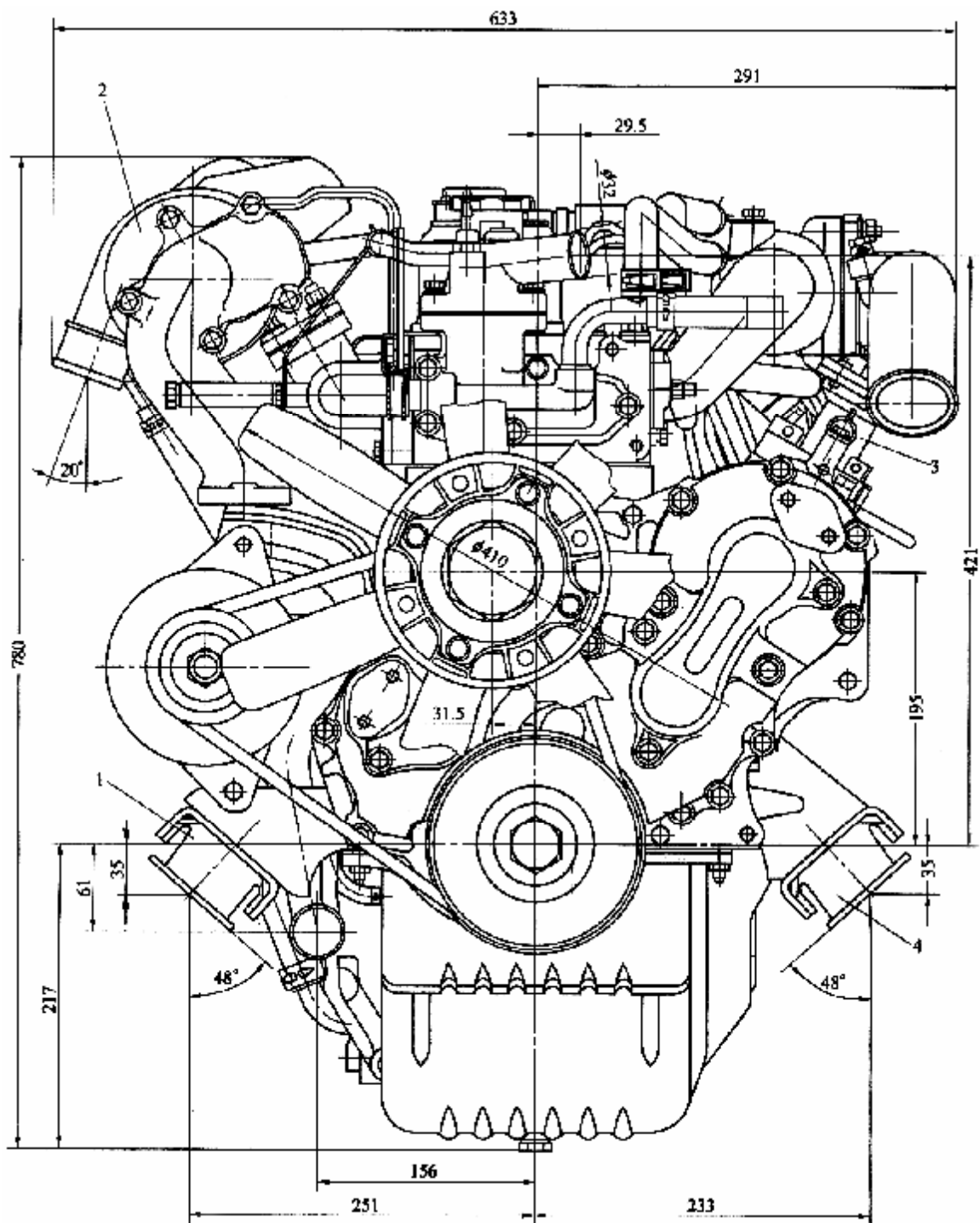


Figure 1-3 Model BJ493ZLQ inter-cooled diesel engine assembly front view

1-LH weld bracket and rubber pad; 2-supercharger assembly;

3-VE- fuel injection pump assembly; 4- RH weld bracket and rubber pad

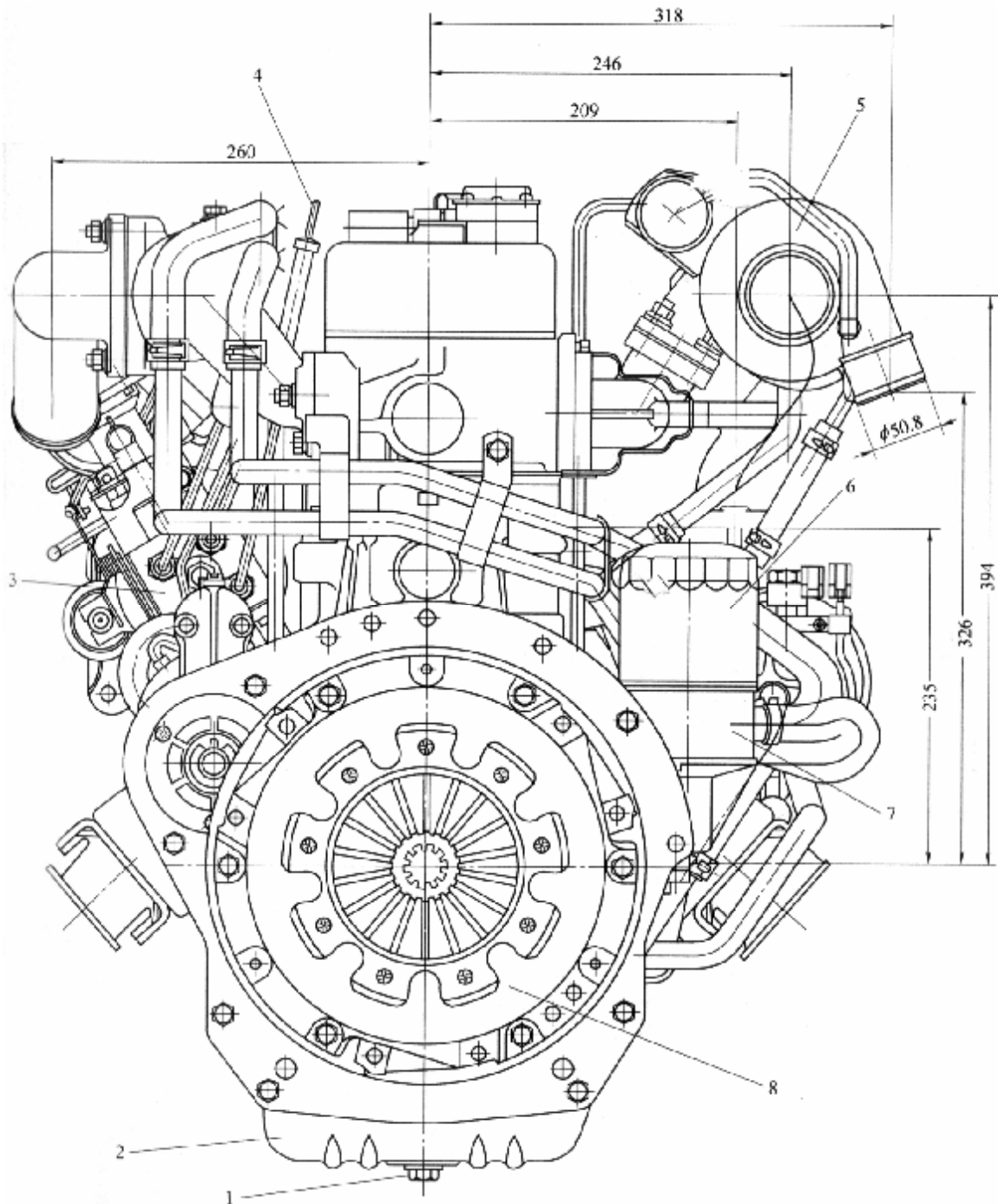


Figure 1-4 Model BJ493ZLQ inter-cooled diesel assembly rear view

1-oil pan drain plug; 2-oil pan; 3-VE fuel injection pump; 4-dipstick;

5-supercharger assembly; 6-oil filter; 7-oil cooler; 8-clutch assembly

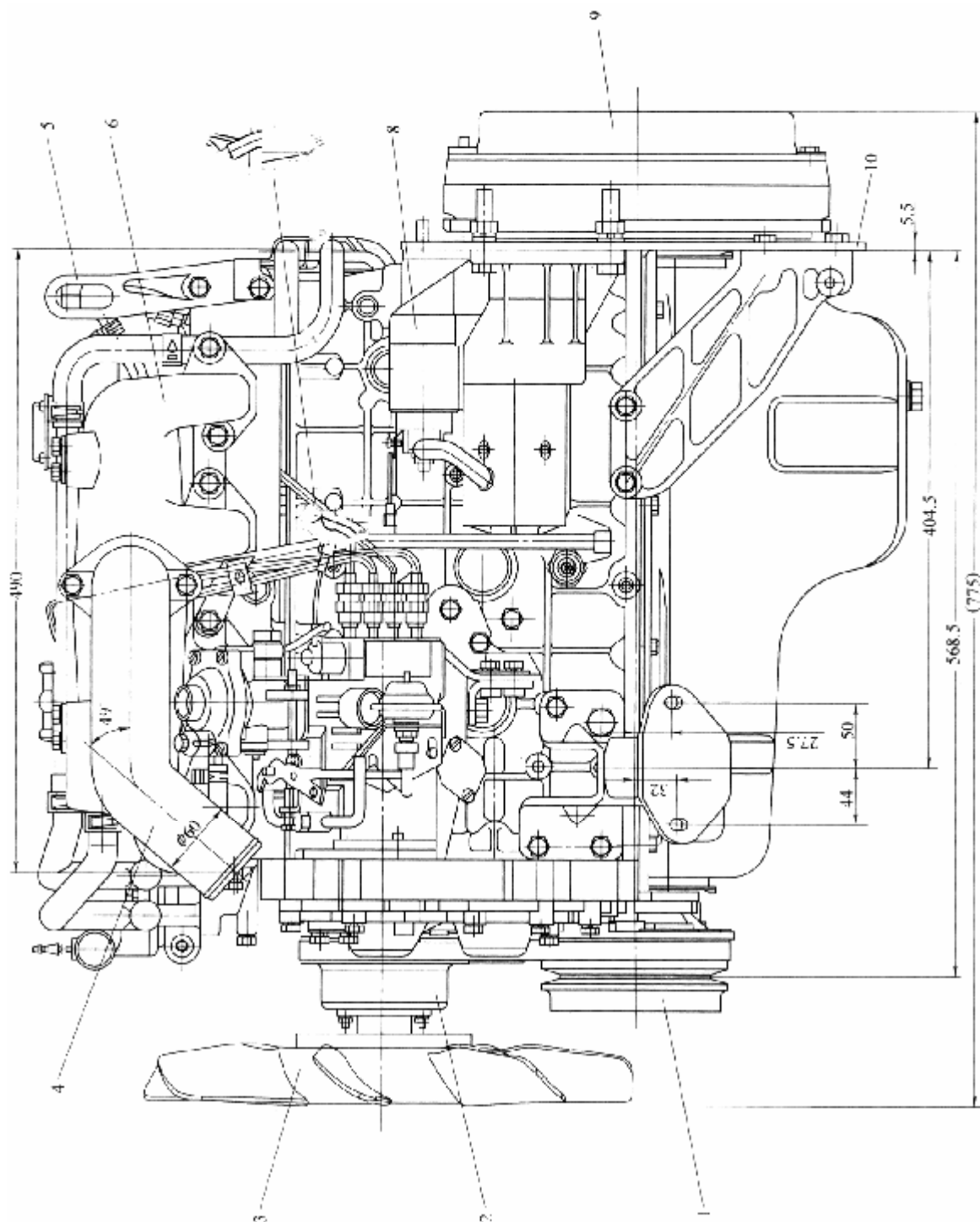


Figure 1-5 Model BJ493ZLQ inter-cooled diesel engine assembly LH view

1-crankshaft pulley; 2-water pump; 3-fan; 4-air inlet pipe; 5-engine rear lug;

6-intake manifold; 7-high pressure oil pipe; 8-starter; 9-clutch; 10-body rear cover plate

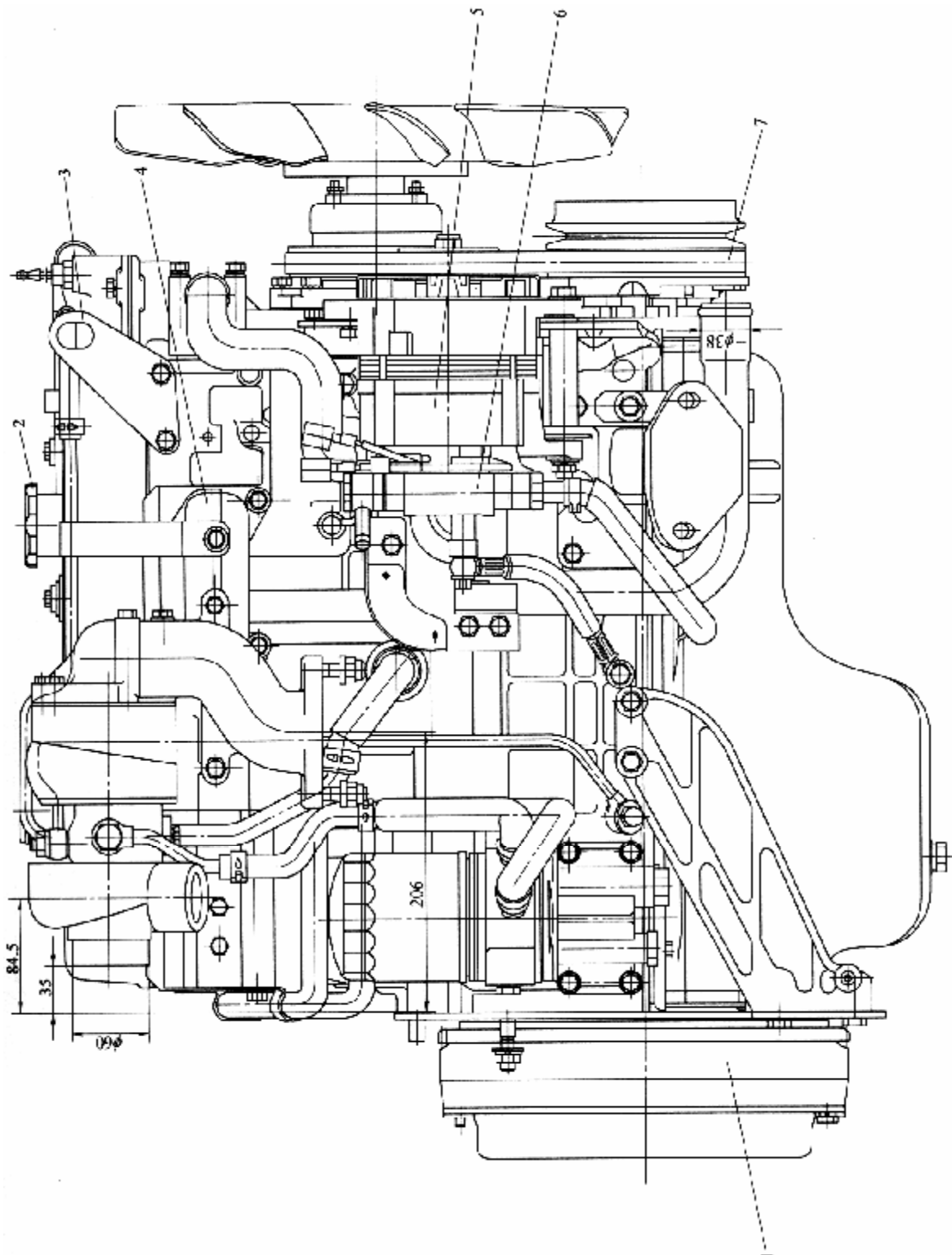


Figure 1-6 Model BJ493ZLQ inter-cooled diesel engine assembly RH view

1-flywheel assembly; 2-oil tank cover; 3-engine front lug; 4-exhaust tube;
5-alternator; 6-vacuum pump; 7-fan belt

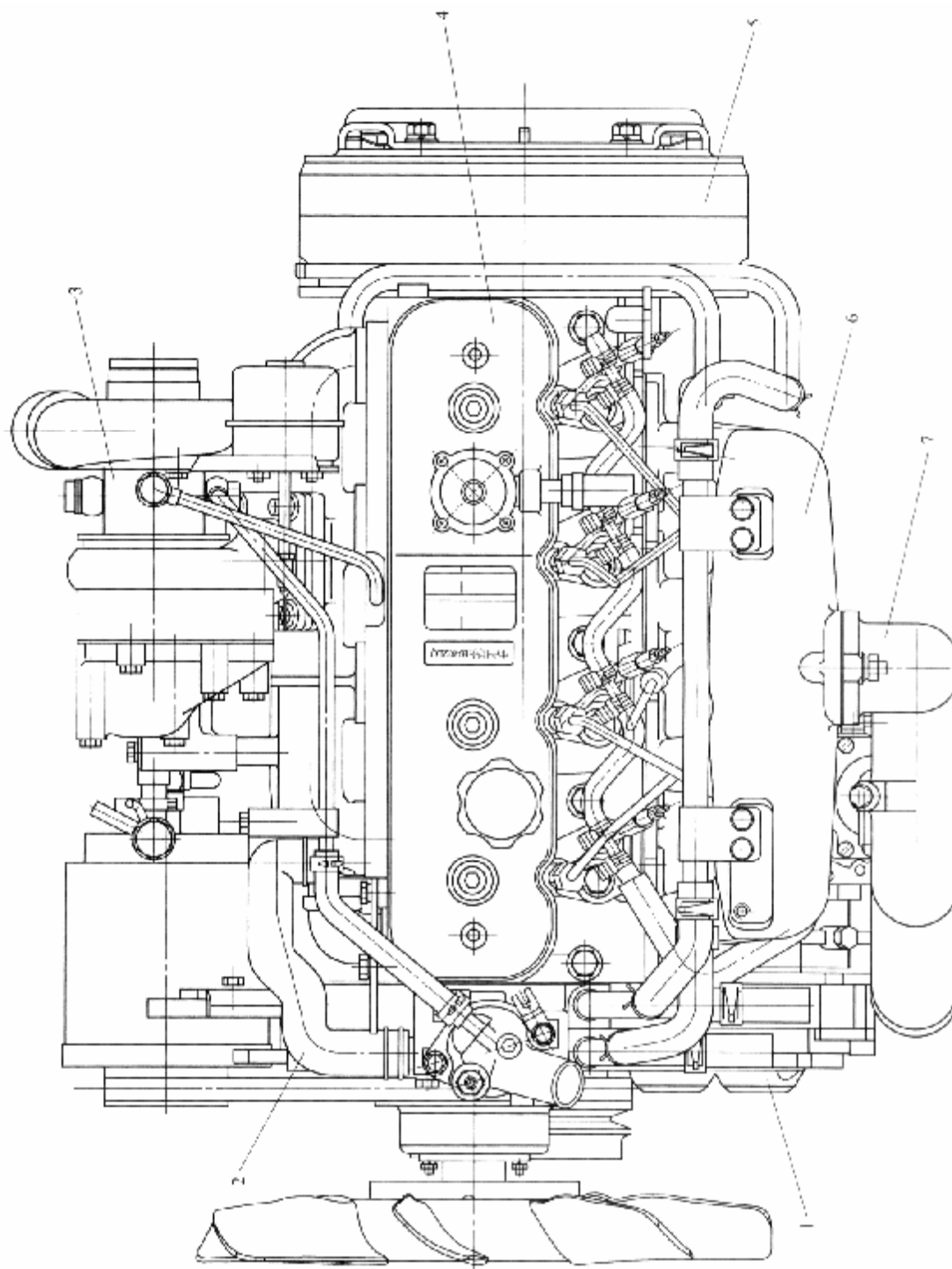


Figure 1-7 Model BJ493ZLQ inter-cooled diesel engine assembly over view

1-gear box cover; 2-small circulation water pipe; 3-supercharger;
4-valve cover; 5-flywheel assembly; 6-intake manifold; 7-air inlet pipe

1.2.3 Model BJ493ZLQ diesel engine main technical parameters

Model BJ493ZQ（ZLQ）series diesel engine main technical parameters

Description	Unit	Technical parameters
Model		BJ493ZLQ1
Type		In-line, vertical, forced water-cooled, four strokes
Combustion chamber		DI circular ω shape with restriction
Cylinder No.	Cylinder	4
Bore	mm	93
Stroke	mm	102
Compression ratio		17.2: 1
Displacement	L	2.771
Operation sequence		1—3—4—2
Rated power/Rpm	K W/r/min	80/3600
Max torque /Rpm	N. m/min	245/≤2300
Min.fuel consumption	g/kW • h	≤210
Idle Rpm	Rpm/min	750±40
Crankshaft rotation direction (facing flywheel)		Anti-clockwise
Lubrication		Pressure and splash combination
Net mass	K g	241
Overall size	mm	775×633×715

1.2.4 Main parts technical parameters-Model BJ493ZQ series diesel engine electrical system

Model BJ493ZQ series diesel engine-electrical system main parts technical parameter

Description		Units	Technical parameters
Alternator	Nominal voltage	V	12
	Rate current	A	80
	Power	W	960
	Rate Rpm	Rpm /min	5000
	Operation Rpm	Rpm /min	900~11000
	Rotating direction		Clockwise (from FR to RR)
	Polarity		Ground
	Operation		Continuity on rated condition
	Regulator type		IC regulator
	Regulated voltage by regulator	V	14.5±0.15



Description		Units	Technical parameters
Vacuum pump	Operation		Continuity on rated condition
	Operation Rpm	Rpm/min	10000
	Max. vacuum	KP a	90.7
	Vacuum arriving time	s	66.7kPa arriving time <18（1000r/min）
	Sealing		Stop when vacuum drops to 53.3kPa, vacuum F drop value after 15s≤2.67kPa
Starter	Voltage	V	12
	Output power	kW	2.8
	Rotating direction		Clockwise (viewing from small gear)
Battery	Rated voltage	V	12

1.2.5 Tightening torque-Model BJ493ZQ diesel engine fittings

Tightening torque for model BJ493ZQ series diesel engine main fittings.

Tightening torque-model BJ493ZQ series diesel engine main fittings.

Fittings	Tightening torque (N • m)	Fittings	Tightening torque (N • m)
Camshaft gear, upper idler bolt	80~90	Cylinder head bolt	98~108
Main bearing cap bolt	160~180	Crankshaft pulley bolt	260~300
Connecting rod bolt	80~90	Flywheel bolt	113~123

1.2.6 Main adjusting specifications

- 1、valve mechanism
- Intake valve opening advance angle: 24.5° before TDC（crankshaft turning angle）;
- Intake valve closing delay angle: 55.5° after BDC（crankshaft turning angle）;
- Exhaust valve opening advance angle: 54° before BDC（crankshaft turning angle）;
- Exhaust valve close delay angle: 26° after TDC（crankshaft turning angle）
- 2、Valve clearance
- Intake valve clearance (cold): 0.4mm±0.05mm;
- Exhaust valve clearance（cold）: 0.4mm±0.05mm。
- 3、Single spring pintle fuel injector opening pressure: 27MPa; dual spring pintle fuel injector primary opening pressure: 22Mpa.
- 4、Engine static fuel supply advance angle: 14° ±1° (crankshaft turning angle) before TDC for model BJ493ZQ1 diesel engine; 13° ±1° (crankshaft turning angle) before TDC for model BJ493ZLQ1 diesel engine.

1.2.7 Temperature and pressure ranges -- Model BJ493ZQ diesel engine

Model BJ493ZQ series diesel engine temperature and pressure ranges



Model BJ493ZQ series diesel engine temperature and pressure ranges

Description	Temperature range (℃)	Description	Pressure range (MPa)
Cooling system outlet temperature ①	80℃ ±5	Oil pressure at idle	≥0.1
Lubrication system main oil duct oil temperature	≤110	Oil pressure at rated Rpm	0.35~0.55

Note: ① may reach 105℃ for closed pressurized radiator

1.2.8 Specifications-Model BJ493ZQ diesel engine main accessories

Main accessories specifications for model BJ493ZQ series diesel engine.

Main accessories specifications for model BJ493ZQ series diesel engine.

Description		Specification	Description		Specification
Lubrication system	Oil pump	Gear type	Cooling system	Water pump	Centrifugal
	Oil filter	Screw-in		Water pump pressure head	5m
Fuel supply system	Fuel filter	Screw-in		Thermostat	Wax thermostat
	Fuel pump	Vane		Fan	Suction, silicone oil clutch, plastic fan
	Injection pump	VE distributor type	Glow plug system	Glow plug voltage	12V
	Injector	P type multi-hole (5 holes)		Glow plug system ECU	DKK1503
Air intake system	Supercharger	Model CT2, JP60T type	Electrical controlled EGR system	EGR system ECU	SMS (BJ493Q-14pe、BJ493Q-15pe) SMS-TC (BJ493ZQ-3fe)

1.2.9 Fitting clearance – Model BJ493ZQ diesel engine main parts

Fitting clearance for model BJ493ZQ series diesel engine main parts

Fitting clearance for model BJ493ZQ series diesel engine main parts

No.	Fitting sets	Fitting nature	Clearance or interference (mm)	Wear limit (mm)
1	Valve guide inner hole inlet valve stem	Clearance	0.039~0.071	0.20
2	Valve guide inner hole Exhaust valve stem	Clearance	0.064~0.096	0.25
3	Rocker arm hole rocker arm outer dia.	Clearance	0.01~0.05	0.20
4	Cylinder sleeve inner dia. Piston skirt	Clearance	0.042~0.060	
5	Tappet hole diameter. Tappet outer diameter.	Clearance	0.010~0.041	0.10



No.	Fitting sets	Fitting nature	Clearance or interference (mm)		Wear limit (mm)
6	$\frac{\text{Top ring groove height}}{\text{Top ring height}}$	Clearance	0.078~0.137		0.20
7	$\frac{\text{second ring groove height}}{\text{second ring height}}$	Clearance	0.045~0.090		0.15
8	$\frac{\text{Oil ring groove height}}{\text{Oil ring height}}$	Clearance	0.03~0.07		0.15
9	Piston ring open clearance (put in gauge of ϕ 93mm)	Clearance	I	0.2~0.4	1.5
			II	0.6~0.85	1.5
			III	0.35~0.65	1.5
10	$\frac{\text{connecting rod bush}}{\text{Piston pin}}$	Clearance	0.008~0.020		0.05
11	$\frac{\text{piston pin hole}}{\text{piston pin}}$	Clearance	0.002~0.015		0.03
12	$\frac{\text{crank pin}}{\text{connecting rod big end}}$	Axial clearance	0.175~0.290		0.35
13	$\frac{\text{camshaft busing hole}}{\text{camshaft journal}}$	Clearance	0.015~0.085		0.12
14	$\frac{\text{bearing dia. of connecting rod big end}}{\text{crank pin diameter.}}$	Clearance	0.029~0.075		0.10
15	$\frac{\text{main bearing hole dia.}}{\text{crankshaft main shaft diameter.}}$	Clearance	0.033~0.079		0.11
16	Crankshaft thrust clearance	Axial clearance	0.05~0.20		0.30
17	Gears meshing clearance	Clearance	0.10~0.17		0.30

1.3 Perkins Phaser110Ti diesel engine technical specifications

1.3.1 Perkins Phaser110Ti diesel engine main technical parameters

No.	Description	Unit	Parameter
1	Engine ID model		Phaser110Ti
2	Engine type		Vertical, in-line, water cooled, four strokes, inter-cooled (supercharged)
3	Combustion chamber type		DI
4	Cylinder No.-bore × travel	mm	4-100×127
5	Displacement	(L)	3.99
6	Rated power (Rpm)	kW (r/min)	101(2600)
7	Max. torque (Rpm)	N-m (r/min)	445(1600)
8	Min. fuel consumption	g/ k w. h	210



No.	Description	Unit	Parameter
9	Oil consumption	g/k w. h	≤0.3
10	Max. Rpm at no-load	r/min	≤2964
11	Rpm at idle	r/min	750±30
12	Starting		Starting up easily at above -15℃
13	Emission		As per GB17691-2001 (II)
14	Seeable pollutant at free acceleration	m-1	As per GB3847-2005
15	Noise	L w dB (A)	≤98
16	Net mass	K g	457
17	Fuel supply advanced angle	℃A	TDC 10 ⁰ ±2 ⁰
18	Fuel injecting pump model and manufacturer		BH49120
19	Fuel injector model and manufacturer		KBEL—P033 (BOSCH)
20	Supercharger model and manufacturer		GT25 (Nivel turbo-charging system (Shanghai Co. Ltd)
21	Fan diameter		Φ470 above crankshaft center 230, fan speed ratio 1.25: 1
22	Throttle cable bracket		Injecting pump with bracket plate, fuel supply from rear
23	Front supporting rubber damping pad		T66001008A
24	Flywheel casing		Depth 135
25	Clutch pressure plate and housing assembly	mm	With φ330 diaphragm clutch pressure plate
26	Clutch driven plate	mm	With φ330 diaphragm clutch driven plate (10 teeth rectangle spline)
27	Input-shaft bearing		6205 (φ25 inner diameter)
28	Transmission	mm	5T108
29	Diesel pipeline		Fuel return pipe connector M12×1.25, outer screw connector, with fuel supply bolt M14×1.5

1.3.2 Starter technical parameter

	Rated voltage (V)	Power (KW)	Controlled terminal current A	Positive post	Control terminal post
PHASER 110Ti	24	4.5	19	M10	M4

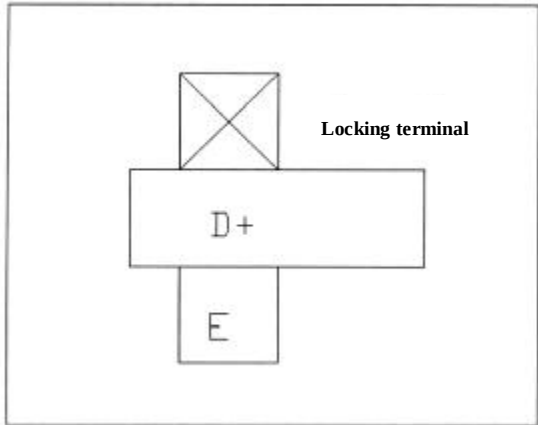


1.3.3 Alternator technical parameter

	Rated voltage (V)	Current (A)	B+ Terminal	D+ Terminal	E Terminal	Pole pairs
PHASER110Ti	28	55	M8	DJ7021-6.3-10		6

▲ D+ terminal load power $\geq 5W$, D+ and E terminals are plugs from engine, plug types are DJ7021-6.3-10. Plug is fixed on engine.

D+ and E arrangement see following figure.



1.3.4 Meters and sensors

1. Coolant temperature sensor (FOTON figure No. 1B22037600090)

① Sensor connector is 6.3×0.8 plug blade type,

② detail parameter:

Temperature (°C)	40	80	97 (alarm point)	100	120
resistor (Ω)	287.4 ± 30	69.1 ± 5	44.3	38.5 ± 4	22.7 ± 3

2. Pressure alarm

① Single lead screw press connecting M4

② Alarm pressure : $0.08 \pm 0.01MPa$ 。

3. Glow plug device

① Engine equips with cold start heater. Plug blade connector: 9.5×1.2 (SAE standard)

② Voltage: 24V

4. Engine Rpm sensor

① Operating voltage: 10V-30V (DC)

② Sensor output signal: square wave

③ Sensor plug type: DJ7031-1.8-10; retaining clip: 0436602HB

④ Test clearance (sensor probe and flywheel gear ring): 1 ± 0.2

1.4 YZ4102ZLQ diesel engine technical specifications

1.4.1 Main engine technical specifications

No.	Description		Unit	YZ4102ZLQ
1	Type			In-line, water cooled, four strokes, DI, inter-cooler
2	Cylinder No.			4
3	Bore		mm	102
4	Travel		mm	105
5	Cylinder jacket			干式
6	Combustion chamber			Circular ω shape with restriction
7	Compression ratio			17: 1
8	Displacement		L	3.432
9	Rated power / Rpm		KW/r/min	81/2900
10	Max Rpm at no-load		r/min	≤3220
11	Min. stable Rpm at no-load		r/min	690±10
12	Max. Torque /Rpm		N-m/r/min	285/2200
13	Min. fuel consumption		g/ kW h	210
14	Oil/fuel consumption ratio		%	≤0.5
15	Cylinder working sequence			1-3-4-2
16	Crankshaft rotating direction (viewing from flywheel end)			Anti-clockwise
17	Cooling			Water cooled
18	Lubrication			Pressure and splash combination
19	Starting			Electrical start-up
20	Exhaust temperature		℃	≤680
21	Coolant outlet temperature		℃	75~95
22	Oil temperature		℃	≤95
23	Oil pressure	Normal	MPa	0.3~0.5
		Idle	MPa	≥0.08
24	Port timing	Intake valve opening point		18° before TDC
		Intake valve closing point		54° after BDC
		Exhaust valve opening point		62° before BDC
		Exhaust valve closing point		18° after TDC
25	Compression clearance		m m	0.9~1.1



No.	Description		Unit	YZ4102ZLQ
26	Valve clearance	Intake (cold)	mm	0.35~0.40
		Exhaust (cold)	mm	0.40~0.45
27	Injector operating pressure		MPa	19~19.5
28	Fuel pump advanced angle, before TDC as per crankshaft turning angle		(°)	13±1
29	Overall size	L	mm	814
		W	mm	665
		H	mm	738
30	Net mass		K g	330

1.4.2 Main technical specifications for diesel engine accessories

Diesel engine model		YZ4102ZLQ
Fuel injection pump	Type	A - pump
	Code	4PM103
Governor	Type	Mechanical centrifugal two-pole or half-adjustable speed governor
	Model	RFD、RLD、R801
Injector	Injector coupler model	
	Injector coupler type	S type
	Injector type	DLLA155S054
Fuel injecting pressure MPa		21~23
Fuel supply auto advanced angle		Mechanical centrifugal, built-in JQ319
Diesel filter	Type	Paper element
	Model	C0708、C0810B、CX0710T3
Oil filter	Type	Paper element
	Model	J0814A
Oil pump	Type	Gear
	Rpm (r/min)	1400
	Flow (L/min)	40
Coolant pump	Type	Centrifugal
	Rpm (r/min)	3040
	Flow (L/min)	200
Starter (11 teeth)	Model	QD2636A、QD267、QD2636C
	Voltage (V)	24



Diesel engine model		YZ4102ZLQ
	Power （k w）	4.5
Alternator	Model	JFWB25C、JFWB25-NJC; JFWB25
	Voltage （V）	28
	power（k w）	500; 1000; 2000
Glow plug	Model	10-24-105（or other code）、1F5
	Voltage（V）	24
	Power (k w)	100
	Continuous operating time（S）	<30
Thermostat	Type	Wax type
	Model	145B、1039-76K
Oil cooler	Type	Warped plate
	Model	28Z2、28Z3
Vacuum pump		Vane

1.4.3 Fitting clearance and wear limit-YZ4102ZLQ diesel engine main parts

NO.	Description	Standard （mm）	Fitting nature	Newly mounted fitting standard（mm）	Limit（reference）（mm）
1	Crankshaft main journal vs. Main bearing hole	Shaft $\Phi 80h6\left(\begin{smallmatrix} 0 \\ -0.019 \end{smallmatrix}\right)$ Hole $\Phi 80\begin{smallmatrix} +0.116 \\ +0.07 \end{smallmatrix}$	Clearance	0.070~0.135	0.23
2	Crankshaft thrust plate vs. Crankshaft		Axial clearance	0.07~0.25	0.40
3	Crankshaft connecting rod journal vs. rod bearing hole	Shaft $\Phi 66h6\left(\begin{smallmatrix} 0 \\ -0.019 \end{smallmatrix}\right)$ Hole $\Phi \begin{smallmatrix} +0.089 \\ +0.046 \end{smallmatrix}$	Clearance	0.046~0.018	0.20
4	Connecting rod big end vs. rod journal	Shaft $40\begin{smallmatrix} -0.15 \\ -0.25 \end{smallmatrix}$ Hole $40\begin{smallmatrix} +0.10 \\ 0 \end{smallmatrix}$	Clearance	0.15~0.35	0.06
5	Connecting rod small end bush vs. small end hole	Shaft $\Phi 40S7\left(\begin{smallmatrix} +0.068 \\ +0.043 \end{smallmatrix}\right)$ Hole $\Phi 40H7\left(\begin{smallmatrix} +0.025 \\ 0 \end{smallmatrix}\right)$	Interference	-0.018~0.068	
6	Piston pin vs. small end bush hole	Shaft $\Phi 38\begin{smallmatrix} 0 \\ -0.005 \end{smallmatrix}$ Hole $\Phi 38\begin{smallmatrix} +0.037 \\ +0.022 \end{smallmatrix}$	Clearance	0.022~0.042	
7	Piston pin vs. pin hole	Shaft $\Phi 38\begin{smallmatrix} 0 \\ -0.005 \end{smallmatrix}$ Hole $\Phi 38\begin{smallmatrix} +0.009 \\ +0.001 \end{smallmatrix}$	Clearance	0.001~0.014	
8	Piston skirt vs. cylinder sleeve hole	Shaft A sets: $\Phi 101.85\sim \Phi 101.86$ Hole A sets: $\Phi 102.005\sim \Phi 102.015$	Clearance 0.115~0.135		



NO.	Description	Standard (mm)	Fitting nature	Newly mounted fitting standard (mm)	Limit (reference) (mm)
9	Piston skirt vs. cylinder sleeve hole	Shaft B sets: Φ 101.86~Φ 101.87 Hole B sets: Φ 102.015~Φ 102.025			
10	Piston skirt vs. cylinder sleeve hole	Shaft C sets: Φ 101.87~Φ 101.88 Hole C sets: Φ 102.025~Φ 102.035			
11	Top piston ring groove	$2.6^{0}_{-0.025}$ $2.605^{+0.10}_{+0.08}$	End clearance	0.085~0.13	0.20
12	Second piston ring groove	$2.35^{+0.010}_{-0.030}$ $2.425^{+0.01}_{-0.01}$	End clearance	0.075~0.115	0.17
13	Piston Oil ring groove	$4^{+0.06}_{+0.04}$ $4^{-0.010}_{-0.025}$	End clearance	0.05~0.085	0.17
14	Top ring open clearance, measure in Φ 102.03 gauge	0.40 ~ 0.65	Clearance	0.40~0.65	2.5
15	Top ring open clearance, measure in Φ 102.03 gauge	0.6 ~ 0.8	Clearance	0.6~0.8	2.5
16	Oil ring open clearance, measure in Φ 102.03 gauge	0.35 ~ 0.60	Clearance	0.35~0.60	2.5
17	Flywheel vs. gear ring	Shaft Φ 346v8($^{+0.564}_{+0.475}$) Hole Φ 346h8($^{+0.089}_{0}$)	Interference	-0.386~-0.564	
18	Intake valve stem vs. valve guide	Shaft Φ 9e8($^{+0.025}_{-0.047}$) Hole Φ 9H8($^{+0.022}_{0}$)	Clearance	0.025~0.069	0.23
19	Exhaust valve stem vs. valve guide	Shaft Φ 9($^{+0.05}_{-0.07}$) Hole Φ 9H8($^{+0.022}_{0}$)	Clearance	0.050~0.092	0.24
20	Valve guide vs. guide hole in cylinder head	Shaft Φ 14u7($^{+0.051}_{+0.033}$) Hole Φ 14H8($^{+0.018}_{0}$)	Interference	-0.015 ~ -0.051	
21	Intake valve seat vs. cylinder head	Shaft Φ 47y7($^{+0.139}_{+0.114}$) Hole Φ 47H7($^{+0.025}_{0}$)	Interference	-0.89 ~ -0.139	
22	Exhaust valve seat vs. cylinder head	Shaft Φ 39y7($^{+0.119}_{+0.094}$) Hole Φ 39H7($^{+0.025}_{0}$)	Interference	-0.069 ~ -0.119	
23	Injector bronze bush vs. injector hole in cylinder head	Shaft Φ 13r8($^{+0.050}_{+0.023}$) Hole Φ 13H7($^{+0.018}_{0}$)	Interference	-0.005 ~ -0.05	
24	Rocker arm bush vs. valve rocker arm hole	Shaft Φ 24s7($^{+0.056}_{+0.035}$) Hole Φ 24H7($^{+0.021}_{0}$)	Interference	-0.014 ~ -0.056	



NO.	Description	Standard (mm)	Fitting nature	Newly mounted fitting standard (mm)	Limit (reference) (mm)
25	Rocker arm shaft vs. rocker arm bush hole	Shaft $\Phi 20h7(0_{-0.021}^0)$ Hole $\Phi 20F8(+0.053_{+0.020})$	Clearance	0.020 ~ 0.074	0.20
26	Camshaft bush outer circle vs. hole in cylinder body hole	Shaft $\Phi 62^{+0.094}_{+0.072}$ Hole $\Phi 62H7(+0.03_0)$	Interference	-0.042 ~ -0.094	
27	Camshaft journal vs. camshaft sleeve hole	Shaft $\Phi 57h6(0_{-0.019})$ Hole $\Phi 57(+0.08_{+0.05})$	Clearance	0.05 ~ 0.099	0.20
28	Tappet vs cylinder body	Shaft $\Phi 28g6(+0.007_{-0.020})$ Hole $\Phi 28F7(+0.041_{+0.020})$	Clearance	0.027 ~ 0.061	0.15
29	Camshaft thrust plate vs. camshaft	6c11 $(-0.070_{-0.145})$ 6H11 $(+0.075_0)$	Axial Clearance	0.07 ~ 0.22	
30	Cylinder sleeve outer circle vs. inner hole in cylinder body	A set: shaft $\Phi 107.995\sim 108.005$ A set : hole $\Phi 108.000\sim 108.010$	Interference	Average -0.005 ~ +0.015	
31	Cylinder sleeve outer circle vs. inner hole in cylinder body	B set : shaft $\Phi 108.006\sim 108.015$ B set : hole $\Phi 108.011\sim 108.020$			
32	Cylinder sleeve outer circle vs. inner hole in cylinder body	C set: shaft $\Phi 108.016\sim 108.025$ C set: hole $\Phi 108.021\sim 108.030$			
33	Cylinder sleeve step height (above cylinder body)	$10^{+0.07}_{+0.04}$ cylinder sleeve $10^{+0.07}_{-0.05}$ body	Height difference	0.040 ~ 0.089	Difference in one cylinder is less than 0.05
34	Idler shaft vs. idler shaft sleeve	shaft $\Phi 55h6(0_{-0.019})$ hole $\Phi 55F6(+0.049_{+0.030})$	Clearance	0.030 ~ 0.068	
35	Drive gear shaft vs. oil pump bearing cap	shaft $\Phi 16^{+0.09}_{-0.11}$ hole $\Phi 16H7(+0.018_0)$	Clearance	0.09 ~ 0.128	
36	Oil pump drive gear shaft sleeve vs. cylinder body sleeve hole	shaft $\Phi 32s7(+0.068_{+0.043})$ hole $\Phi 32(+0.025_0)$	Interference	-0.018 ~ -0.068	0.23
37	Drive gear shaft vs. oil pump drive gear shaft sleeve	shaft $\Phi 16f7(-0.016_{-0.034})$ hole $\Phi 16H7(+0.018_0)$	Clearance	0.09~0.128	0.24
38	End gap--Oil pump gear to casing	0.065 ~ 0.125	Clearance	0.065 ~ 0.125	



NO.	Description	Standard （mm）	Fitting nature	Newly mounted fitting standard（mm）	Limit (reference)（mm）
39	Side gap – oil pump gear to casing	0.090 ~ 0.170	Clearance	0.090 ~ 0.170	
40	Oil pump drive shaft vs. oil pump cover	shaft $\Phi 16h6^{(0)}_{(-0.011)}$ hole $\Phi 16E8^{(+0.059)}_{(+0.032)}$	Clearance	0.032 ~ 0.070	
41	Oil pump driven shaft vs. oil pump body	shaft $\Phi 16h6^{(0)}_{(-0.011)}$ hole $\Phi 16X7^{(-0.038)}_{(-0.056)}$	Interference	-0.027 ~ -0.056	
42	Oil pump driven shaft vs oil pump driven gear	shaft $\Phi 16h6^{(0)}_{(-0.011)}$ hole $\Phi 16F8^{(+0.043)}_{(+0.016)}$	Clearance	0.016 ~ 0.054	
43	Oil pump drive shaft vs oil pump driven gear	shaft $\Phi 16h6^{(0)}_{(-0.011)}$ hole $\Phi 16U7^{(-0.026)}_{(-0.044)}$	Interference	-0.015 ~ -0.044	
44	Oil pump cover vs. pump body	shaft $\Phi 25g6^{(-0.007)}_{(-0.020)}$ hole $\Phi 25U7^{(+0.021)}_{(0)}$	Clearance	0.007 ~ 0.041	
45	End gap – water pump vane to casing	0.1 ~ 0.3	Clearance (adjust with washer)	0.1 ~ 0.3	

1.4.4 Engine main bolt tightening torque

No.	Description		Torque (N-m)
1	Cylinder head bolt		120~140
2	Main bearing bolt		180~200
3	Connecting rod bolt		100~120
4	Flywheel bolt		130~150
5	Camshaft gear pressure plate bolt		60~80
6	Crankshaft pulley nut / bolt		M16-140~170; M20-280~320
7	Rocker arm seat bolt		60~70
9	Other screw fittings	M6	6~11
10		M8	20~25
11		M10	41~51
12		M12	73~89
13		M14	100~110
14		M16	140~170



1.5 Technical specifications for Model YZ4105ZLQ diesel engine

Model YZ4105ZLQ diesel engine is a new renovation based on batch-produced model YZ4105QF diesel engine. Its appearance and mounting / fitting dimensions are basically the same as that of YZ4105QF diesel engine. Parts in these two models are interchangeable, and can exchange to mount in-assembly on chassis. This manual introduces only its deviated technical parameters of major parts and accessories, and requirements to its assembling and maintenance.

1.5.1 Model YZ4105ZLQ diesel engine construction

1 Cylinder head

Cylinder head, cylinder head cover, rocker arm and rocker arm shaft are basically the same as that in model YZ4105QF, except following differences:

▲Material code for cylinder head is HT300 (breeding treatment). Model YZ4105ZLQ has changed its interior chamber structure, reinforce rib arrangement and water flowing direction by taking account of possible heat-load increases due to boosted pressure. It has been verified that the engine meets application requirements. To meet EURO II standard, the engine adopts P type fuel injector that has higher injecting pressure and low inertia. And injectors mounting location and angle are also changed to improve their performance.

2 Cylinder block

① Material (HT300 breeding cast iron) used to make YZ4105ZLQ diesel engine is better than that used for YZ4105QF engine, and it has been specially treated to reduce internal stress. Through superior design, block stiffness and flexibility have been greatly improved. By using the casting technique recommended by Japanese Casting Institute, even block thickness with higher hardness have been available. As crankshaft main shaft journal is enlarged, main bearing holes on block also get enlarged accordingly.

② Cylinder sleeve wall thickness is 2mm, made of boron-copper alloy cast iron. Use special caution when transporting or press-to-mount a block, avoid cylinder sleeve from being distorted or damaged due to pressure and collision.

③ YZ4105ZLQ diesel engine corporate with 13" diaphragm clutch and uses special flywheel case; flywheel case that matches YZ4110QA engine is also acceptable, in this case, a 12" diaphragm clutch is adopted. Select flywheel according to clutch specification. Flywheel gear ring has total 128 teeth, it has two more teeth than flywheel that is used in YZ4105QF engine.

④ YZ4105ZLQ engine equips with angular mounted oil pump. Oil pool in oil pan is set in the front for easy mounting on chassis.

3 Piston and piston ring

① YZ4105ZLQ engine uses aluminum piston that has inner oil passage used to cool down piston head. As piston head temperature has been decreased, the clearance between piston and cylinder wall is reduced accordingly to lower oil consumption. Combustion chamber volume is changed, its compression ratio has been adjusted to 17:1. Piston top hard film is positive oxidized, piston skirt is graphite coated. The combustion chamber shape is circular “ ω ” with restriction. First ring groove is of austenite cast iron ring insert, with a double trapezoid shape. The shape of second ring groove is rectangular. The third ring (oil ring) groove has no radial oil return hole. The diameter of piston pin is $\Phi 38\text{mm}$, and its length is 86mm.

② Piston rings used in YZ4015ZLQ engine are the same as those used on YZ4015ZQ engine: First ring is made of chroming spheroidal graphite iron (double trapezoid barrel face); second ring is chroming cone face twist ring, made of multi-alloy; the third ring is spiral expansion spring ring (oil ring).

4 Crank connecting rod mechanism

YZ4105ZLQ engine use special crankshaft and connecting rod. Main shaft journal diameter and circular



angle are enlarged, and crank overlap is increased. Crank and connecting rod are made of high hardness spheroidal graphite cast iron, is cast from metal mold (sand pattern) and have undergone anneal and ion-nitrified treated. They have very high fatigue and wear-proof capability.

Strengthened YZ4015ZQ engine connecting rods are uses in YZ4105ZLQ engine. Their small ends adopts steel back copper alloy, and bearings are made of copper-lead alloy.

5 Supercharged air intake / exhaust system and supercharger / intercooler

YZ4105ZLQ diesel engine has a supercharger mounted on outlet flange of exhaust manifold. The engine adopts Mitsubishi TD04 supercharger that uses exhaust gas energy to drive air compressor, increasing amount of air entering cylinder. Compressor operating flow is $590\text{m}^3/\text{h}$. User is suggested to select air filter whose flow is larger than $600\text{m}^3/\text{h}$. An intercooling system is added to supercharger to cool down intake air to around 40°C , that improves efficiently air intake and ensures lower emission and better engine performance.

6 Cooling system

YZ4105ZLQ engine is an uprated engine, the capacity of its cooling system has been enhanced accordingly. The engine adopts Z140 (20m^2) radiator and model 28Z₃ oil cooler fins (3 pieces), and speeds up water pump to increase cooling water flow in pump. This design improves heat radiation and keeps engine running in proper temperature.

The engine can drive at the same time the high power dependent A/C compressor, independent vacuum pump or water-cooling air pump and steering pump. It has two driving methods: crankshaft pulley, water pump pulley (double grooves) and alternator pulley share a belt, i.e. crankshaft pulley drives directly other pulleys; and water pump pulley (that is driven by crankshaft) drives air pump.

Nozzles inside engine block chamber spray oil to cool down piston inner chamber.

7 Fuel system

Model YZ4105ZLQ engine fuel system uses PM injection pump and R801 regulator with boost compensator. Auto injection advancer is of mechanical centrifugal type and dual-eccentric structured. Injector set is among P-series product line. Injector is mounted in place with a press bolt and a press plate. Top of injector set extends $3.2\pm 0.20\text{mm}$ above cylinder head base plane.

8 Electrical system

The operation voltage of YZ4105ZLQ engine electrical system is 24V. Starter has nine teeth, its power is 4.5kW with larger starting torque.

9 Lubrication system

YZ4105ZLQ engine uses angular mounted oil pump in its lubrication system. Oil pan is enlarged (sectional welding), oil pool is set in its rear. In order to mount engine on chassis of varied model vehicles, there is another front-mounted oil pump whose oil pool is in the front of oil pan. Type of oil filter is J1012H it is vertical mounted.

1.5.2 Diesel engine break-in

New or overhauled engine must break in before use. Break-in brings contacting faces among moving sets into ideal fitting states to avoid abnormal wears and damages afterwards. Experience tells that break-in before use determines in great extent diesel engine's service life, reliability and economy. User should strictly abide by break-in regulations.

1 Preparations before break-in

- ① Remove external dust and dirt;
- ② Check and tighten external bolts and nuts;
- ③ Apply grease at water pump bearing;
- ④ Add diesel engine oil into oil pan according to specified level;
- ⑤ Fill up fuel tank and radiator (must use soft water for radiator);



- ⑥ Check electric circuit connections;

Proceed to break in according to following specifications after preparations have been made.

2 Break-in specification

- ① Diesel engine break-in mileage should not be less than 2500km.

② Carry out initial 200km unladen break-in. During the process, observe closely how diesel engine is operating at different rpm : check for any leakages of fuel, oil and cooling water; any abnormal noise; any smoke emitting and if reading of each meter is correct. Pinpoint any fault cause and remove fault immediately. Break-in with load can start only after engine has been confirmed to be normal.

③ Within 800km driving distance, vehicle load should not exceed 70% of its rated load, and engine Rpm should not be 75% higher than rated Rpm.

④ Within 1500km driving distance, vehicle load should not exceed 80% of its rated load, and engine Rpm should not be 80% higher than rated Rpm.

⑤ Within 1500-2500km driving distance, vehicle load should not exceed 90% of its rated load, and vehicle speed should not exceed rated highest speed. Change oil in oil pan after vehicle has driven 2000-2500km.

3 Check after break-in

Change all oil after break-in as oil then has great amount of metal particle inside. Take necessary cleaning, otherwise parts may wear out quickly.

① Shut down engine, drain oil from oil pan while engine is hot. At this moment, impurities can be removed easily as they were suspending in oil. Use diesel to wash oil pan and strainer.

- ② Clean or replace oil filter element.

- ③ Check and adjust valve clearance.

④ Check and tighten all external bolts and nuts. Check wears on main bearing and connecting rod bearing. Check fastening or fittings and operation of each part. Tighten cylinder head bolts/nuts according to requirement.

- ⑤ Check out and remove other abnormal symptoms.

- ⑥ Perform lubrication maintenance (such as applying grease) on concerning lubrication spots.

1.5.3 Diesel engine application

1 Fuel, oil and cooling water

Fuel: Fuel used should be GB252 specified light diesel (rate 0, 10, -20 and -30). Select fuel as indicated in chart below according to season and ambient temperature. Select to use fuel whose freezing point is 3~5°C lower than ambient temperature. Diesel can be put into use only after it has been laid to settle down for 48 hours and screened with thick cloth.

Oil: Oil should be GB11122 specified diesel engine oil. Select oil as indicated in chart below according to season and ambient temperature.

Ambient temperature	Light diesel rate		Ambient temperature	Diesel oil rate
Above 5° C	0		Above -10° C	CD 15W/40
5° C~-5° C	-10		-10° C~-25° C	CD 10W/30
-5° C~-15° C	-20		Below -25° C	CD 5W/30
Below -15° C	-35			

Cooling water: Cooling water for diesel engine must be clean natural soft water such as rain, snow or river water. Hard water (well or spring water) must be softened in following two ways before use:



- (1) Boiling;
- (2) Make solution by adding 20g caustic soda into 30L water.

2 Preparation before starting up an engine

① Check if diesel engine parts are normal before start-up, and if connections are reliable. Check if oil, cooling water and fuel levels are normal, if there is any leakage. Adding fuel and cooling water in winter should follow maintenance requirements. Check if electrical circuit connections are reliable, and if battery gets enough charging; check if driving parts are detached.

② Check if there is air in fuel passage. Loosen vent screws on fuel injection pump and fuel filter to bleed fuel passage. Retighten vent screws after bleeding.

③ If diesel engine has laid for longer time or its oil or filter element have been changed or replaced, all its lubrication system should be filled up with oil. Start-up can proceed only after above mentioned problems have been solved.

3 Start up an engine

① Step down gas pedal, turn ignition key to connect power supply. Observe if electrical devices and meters work normally. Turn ignition key to “START” to start up engine then release key.

② Usually, diesel engine can start up after one cranking when ambient temperature is over 5°C. When ambient temperature is below 5°C, engine can use its pre-heating start-up device to preheat. Preheating lasts 45 seconds.

Use following methods to facilitate preheating startup when an engine cannot start up in cold weather:

(1) Use hot water to warm up engine. Repeat filling / draining hot water into and from engine cooling system till engine gets warmed up. Be sure to tighten up drain plug after these.

(2) Warm up oil to 80~90° before filling it into oil pan.

4 Run a diesel engine

① After engine has started up, check oil pressure and cooling water temperature. Run engine at medium Rpm for 5-10 minutes. Do not drive vehicle until cooling water temperature reaches over 60°C. Do not depress gas pedal abruptly to accelerate speed.

② Keep watching meters reading during driving to check if engine operates normally. Stop engine to remove faults if any.

5 Diesel engine shutdown

① Unload diesel engine gradually before shutting it down. Shutdown an engine only after having run it at idle for 3~5 minutes at around 1000 Rpm till cooling water temperature drops below 70°C.

② Emergent shutdown. Pull stop control to cut off fuel supply. If engine fails to stop and abnormal situations like over-speeding happen, the operator must take following measures: (1) loosen nuts on hi-pressure fuel pipe; and (2) block up air intake tube.

③ In winter, engine block, water pump and radiator should be protected from being frozen to get damaged. After an engine has stopped, the operator should remove block/radiator drain plugs to discharge cooling water. Remove radiator cap during the process to drain cooling water completely.

1.5.4 Diesel engine construction

1 Cylinder head

Cylinder head is integrated structured, made of HT300 high hardness (breeding treated) cast iron. It consists of following parts: cylinder head mechanical sets, injector, glow plug, valve mechanism, intake/exhaust manifolds, FR/RR cover plates, thermostat and water temperature sensor plug.

Sealing circle face between intake/exhaust valves and valve seats should be tightly sealed, its width is 1.8~2.2mm. Use special cutter to repair if width is out of specification (figure 1). Cylinder number is stamped on valve



do not exchange to mount a valve. Grind valve whose sealing face has burnt-out dent spot and wear that cause air leaking. After grinding, clean all parts and fill kerosene into intake/exhaust tubes, hold it for 2 minutes while check if there is any leak at valves. Also check valve top recessing (valve big end drops lower than cylinder head plane). The recess should be 0.6~0.7mm. Mount valve spring with its small pitch end approaching to cylinder head.

Injector tip protrusion under cylinder head plane should be in specified range (figure 2). Use adjusting shim to adjust protrusion.

The protrusion for glow plug is 4~6mm. Use adjusting shim to adjust protrusion. Tighten (in three steps) cylinder bolts (18 pieces) counter-clockwise starting with center bolts (figure 3). Last tightening torque is 120~140N.m. Dismantle cylinder head in reverse sequence of assembling to avoid air leak due to distortion.

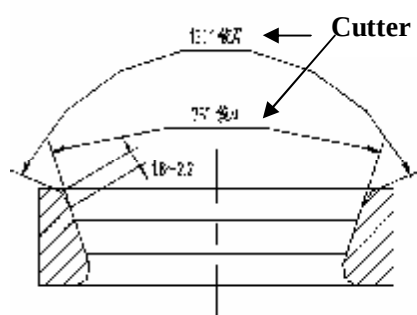


Figure 1

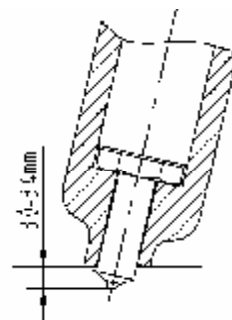


Figure 2

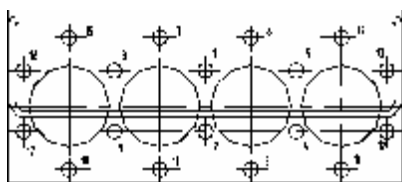


Figure 3

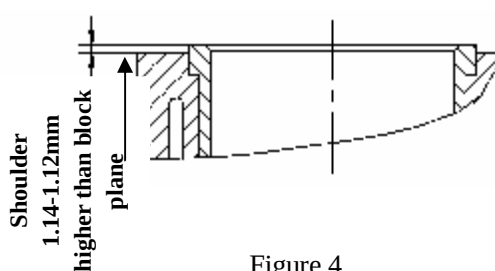


Figure 4

2 Cylinder block

Material used to make cylinder block is HT300 breeding treated high hardness cast iron. Crankshaft is fully supported and gets reinforcement on its certain part. Main bearing cap is made of QT450-10 spheroidal graphite cast iron. On right side of block are fuel injection pump, oil filter and oil cooler; on the left are silicon rectified alternator, brake air pump or AC compressor, starter, ram chamber cover and water drain switch. Cooling water pump, fan, gear case / cover are mounted on block front; and on the rear of block are oil seal / cover, flywheel case or clutch housing.

There are two peeping holes on gear case cover that is used to check fuel supply timing mark during dismantling/mounting a fuel injection pump. When dismantling an injection pump, operator should remove peeping hole cover, rotate crankshaft (less than two turns) till arrows on two holes align respectively with spot mark on camshaft gear and short slash mark on fuel supply advancer. Remove injection pump then. The operator does not have to turn crankshaft when he remounts an injection pump, align marks correctly will ensure correct fuel supply timing.

Cylinder sleeve is of dry type, its shoulder is 0.04~12mm higher than block plane (figure 4). Height difference on a same block is not more than 0.05mm. Select other sleeves to adjust if height difference exceeds specification.

Gasket is used to seal engine block and head. Operator should mount a gasket by aligning holes on gasket with relating locating hole, water hole and oil hole. Set O-ring ($\phi 16 \times 1.9\text{mm}$) on oil hole. After gasket has been replaced, operator should measure piston top gap (specification is 0.9-1.1mm).

Engine uses either No. 20 high tin-aluminum alloy camshaft bushing or bimetal bushing. Press bushing into block, be sure to align oil hole on bushing with oil hole on block.

Main bearing cap and cylinder block are bored in pair. Five main bearing caps on a same engine are stamped with matching codes that avoid interchanging. There are arrow marks on main bearing cover. When assembling a main bearing cap, the arrow mark should point to fan. Convexes of diamond pin's two arcs on fifth bearing should be in line with main bearing hole axis. Tighten main bearing bolts starting with center one, then tighten bolts on two sides alternatively. Gradually increase tightening torque in two steps, and the final tightening torque is 180~200N.m. Main bearing upper bearing has oil groove and hole, which is different from lower bearing. Thrust plate is mounted on last main bearing, used limit crankshaft axial clearance to 0.07~0.25mm. Thrust plate has abrasive-reducing alloy on one side on which there is oil groove. During mounting, operator should ensure oil groove could contact shoulder section on crankshaft.

There are four small platforms under main oil passage inside crankcase. Four screw holes are processed on them that connect to main oil passage. These four holes are used to mount nozzle assembly that cools down piston.

3 Valve mechanism

Valve mechanism consists of camshaft gear, camshaft, tappet, push rod and valve sets.

The engine adopts overhead valves and under slung camshaft. It uses the same camshaft that is used in model YZ4102Q1 engine.

Camshaft is made of spheroidal graphite cast iron that has undergone normalization. Camshaft axial clearance is 0.07~.22mm, clearance could be adjusted by thrust plate. Too smaller clearance will lead to parts damage while larger clearance will harm port timing and produce more noise.

Crankshaft gear drives camshaft gear and injection pump gear via idler. Each gear has “•” mark on it. Mark alignment is crucial to ensure correct port timing and fuel supply timing.

Camshaft gear drives camshaft, pushing tappet and push rod to open and close intake/exhaust valves according to specified porting timing.

Tightening torque of (camshaft gear) pressure plate bolts is 60~70N-m.

4 Crank connecting rod mechanism

Crank connecting rod mechanism includes piston / connecting rod sets and flywheel sets.

Piston / connecting rod sets consist of pistons, compression rings, oil ring, piston rings and connecting rod / bearings / bolts.

Crankshaft flywheel sets consist of crankshaft, flywheel, crankshaft timing gear and pulley. For an engine equipped with AC compressor, it has six M8 screw holes on the front end of crankshaft pulley, that are used to mount AC compressor pulley.

Each piston has two compression rings and an oil ring. The first compression ring is of chroming double trapezoid (barrel face) ring; second ring is chroming cone face twist rectangular ring. Mount piston rings with each opening is 120° away from others, and direction of oil ring opening should be vertical to piston pin hole center line. Second ring has “TOP” mark on one side of its opening, and this side should be facing up. To measure piston ring open clearance, operator should put ring into cylinder sleeve and measure with a feeler blade. Too small clearance could be repaired with a fine file. Replace ring if clearance exceeds specification.

During mounting procedures, piston, piston pin and connecting rod should face matching numbers on connecting rod. At this moment, intake valve recess on top of piston should be on the left of exhaust valve recess.



Connecting rod and caps are processed in pair and stamped with matching numbers, which are not interchangeable. In a same engine, weight difference among connecting rod assemblies should not be more than 20g. Coat piston/connecting rod with clean oil before mounting them into cylinder sleeve. Intake valve recess on piston should point to front of engine block.

Connecting rod uses copper-lead alloy bearing. Upper and lower bearings are the same. Tightening torque of connecting rod bolt is 100~120N.m. Tighten bolt gradually and evenly in 2-3 steps during assembling. Connecting rod small end bushing is made of copper alloy with steel back.

Crankshaft is made of spheroidal graphite cast iron and has undergone anneal and nitrogen treatment. It is solid structured with four counter weights. There are oil passage connecting two neighboring crankshaft journals to lubricate connecting rod shaft journal.

When to mount a flywheel, tighten in 2-3 steps flywheel bolts according to sequence indicated in figure 5. Final tightening torque is 130~150N.m.

Crankshaft pulley edge and end face have TDC marks and fuel supply advance angle of this cylinder (figure 6). The marks are used for check and adjustment.

Tightening torque of crankshaft pulley bolts is 280~320N.m, and 350~400N-m for nuts.

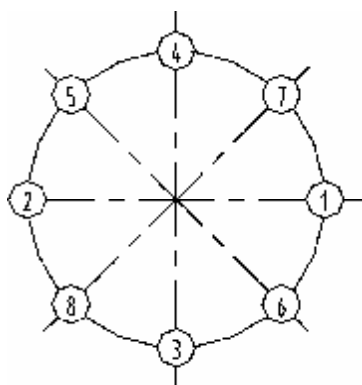


Figure 5

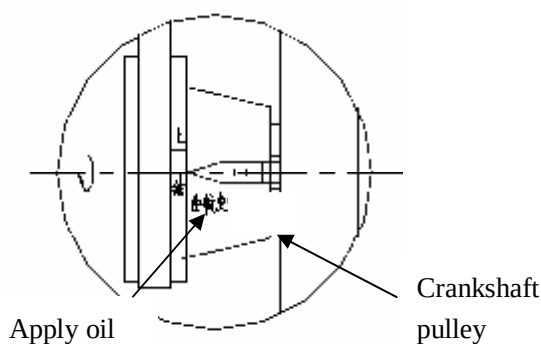


Figure 6

5 Supply systems

Diesel engine supply system includes fuel supply system and air intake system. Fuel supply system consists of fuel filter, fuel pump, injection pump/regulator, fuel supply auto advancer, injector and fuel pipe; air intake system includes air intake manifold and air filter.

Fuel pump sucks fuel from fuel tank. Fuel goes through strainer then fuel filter to remove larger and tiny impurities before entering low pressure chamber in injection pump. Injection pump plunger pressurizes fuel and sends it to injector via high pressure fuel pipe. When fuel pressure becomes higher than the opening pressure of injector needle valve, fuel is injected into cylinder. Minor fuel leak from injector inner clearance goes via fuel return pipe to mix with extra fuel in fuel pump low pressure chamber. They together return to fuel tank through fuel return pipe.

Diesel filter adopts paper element. Clean or replace filter element according to maintenance specification. This will remove effectively harmful impurities in diesel and prolong service life of parts in fuel supply system. When to remount an element, operator should put on filter rubber sealing rings correctly, especially be aware of these sealing rings on element two ends.

Fuel pump is of single acting / piston type, mounted on injection pump side and driven by an eccentric gear in camshaft. A hand pump in fuel pump is used to discharge air in fuel passage. Screw to tighten hand pump after use.

Injection pump is a PM pump. Injection pump plunger and outlet valve are pair sets that are not

interchangeable. Injection pump uses pressure lubrication, and its lubrication oil is from engine main oil duct.

Fuel injection pump assembly includes injection pump, fuel pump, regulator, fuel supply auto advancer, manifold pressure compensator, injection pump gear and mounting plates. Injection pump is mounted on gear case by connecting plate with 7 screws, it has a rear supplementary support. To ensure fuel supply advance angle will not be changed during reassembling, there are marks on gear case cover, gear and auto advancer driven plate. When to dismantle an injection pump assembly, operator should first open inspection hole cover on gear case side, turn crankshaft to align mark line on auto advancer driven plate with arrow inside inspection hole cover. Without turning crankshaft, fuel supply timing could also remain unchanged after reassembling as long as marks align correctly. Otherwise, operator will have to remove gear case cover and reassemble parts according to marks on gear.

Injection pump has been set in factory, and each limiting screw has been lead-sealed, user is not allowed to unseal it. Anyway, if an adjustment has become necessary, it has to be done by a professional technician on test stand according to pump instruction manual. Injection fuel supply cycle is adjusted according to technical data indicated in engine application manual.

Type P injector used in the engine has 5 injecting holes. Injectors are mounted on cylinder head, which need maintenance according to specification. Needle sets in injector are processed (ground) in pair, it is not allowed to exchange needle valve and its body at random.

Max load limiting screw and high speed limiting screw on injection pump regulator have been set in factory, it is not allowed to alter unless it has to. Use manufacturer instruction to make adjustment.

Fuel supply auto advancer is of mechanical centrifugal built-in type. Its advance angle is $3^{+0.5}_{-0}$ degree (850 rpm to rate rpm).

Air filter uses double stage paper element composed by cyclone rough filter and paper fine filter. When to perform maintenance on filter, operator should first clear dust inside the disc, take element out and knock slightly on two ends to get rid of dust. He can also use soft hair brush to wipe out outside dust or use compressed air (less than 300Kpa) to blow element from inside. Never use brush to wash element in fuel or water. Replace broken or de-gummed element immediately. Cover element two ends to shelf store an element to keep away dust. When to install an element, operator should notice location of rubber sealing ring to ensure reliable sealing at two ends and inside tube. This will guarantee dust cannot enter cylinder to wear out cylinder sleeve and piston/ring early.

Air filter has automatic dust discharging device. When to mount an air filter case, the opening of its dust bag should not against wind or it will hamper dust removing.

6 Lubrication system

Diesel engine lubrication combines pressure and splash methods. Main moving sets that use pressure lubrication are: crankshaft main bearing, connecting rod bearing, camshaft bearing, idler bearing and rocker arm bearing; and sets that use splash lubrication are: cylinder sleeve / piston, piston / connecting rod small end bushing / piston pin seat, valve, valve guide and gear. Apply grease on water pump bearing and motor bearing regularly.



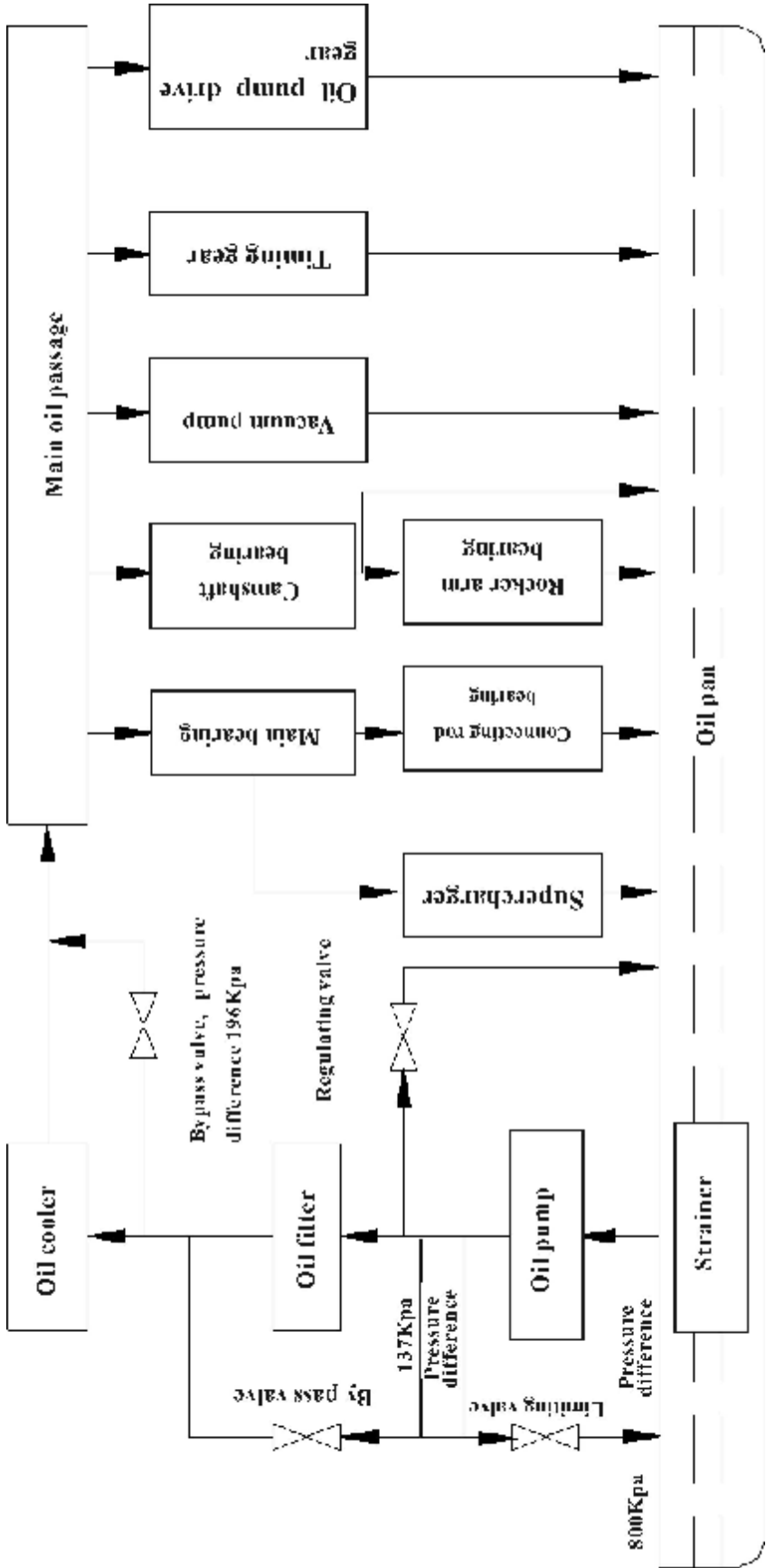


Figure 7

Oil pump is an outer meshing gear pump, driven by gear on camshaft.

Oil pump presses oil into oil filter. Oil filter is of full flow type, using paper element. It is required to ensure that rubber sealing ring could seal well without weeping and short circuit at assembling. This filter has pressure regulating valve and relief bypass valve. Pressure regulating valve adjusts oil pressure. It takes excess oil back to oil pan when pressure becomes higher, and mains pressure in specified range. Relief bypass valve protects lubrication system. When element gets choked severely, this valve would open at 137Kpa pressure difference to avoid parts from being damaged due to oil short. At the moment, unfiltered oil goes directly into cooler and flows into main oil passage. It is not necessary to remove relief bypass valve during maintenance, as its open pressure has been set on special equipment. In the event the oil cooler is choked severely, its bypass valve opens at 196Kpa pressure difference, and oil that has not been cooled flows directly into main oil passage.

7 Cooling system

Close forced water-cooling cycle is used on engine cooling system. The system consists of radiator, fan, water pump and thermostat.

Water pump is of centrifugal type, composed by pump body, impeller, shaft, pulley and water seals. Water pump pulley has two types-- single and dual groove. Dual groove pulley is used on rear engine vehicle. A hose connector is press-mounted on pump body inlet, used to connect water return pipe of heating fan devices.

Water pump ball bearing (60304) has deep race with a dust boot on one side. Dust boot should face outward during mounting (not being pressed on end face of bearing spacer).

There is grease nozzle on water pump. Use grease gun to fill regularly lithium grease to lubricate bearing.

Fan has two types — 7 blades axial flow and 6 blades axial flow. Water pump inlet is set either on right or left, so as to meet requirements to different assemblies.

A single thermostat is set at cylinder head water outlet. Its type is 145B.

The piston nozzle assembly inside crankcase injects oil from main oil passage directly into cooling oil duct inside piston to cool down piston.

8 Electrical system

Electrical system includes starter, alternator and glow plug. Starter is a silicon rectified alternator with negative ground. Never misconnect cable.

9 Vacuum pump

A vacuum pump is mounted on engine rear that provides vacuum to vehicle's vacuum-assisting brake system.

While vacuum pump is working, oil from main oil passage enters the pump via oil inlet pipe and oil-inlet screw to lubricate each moving part (it also facilitate sealing). Oil then after having mixed with incoming air is discharged to gear case and return to crankcase finally.

10 Supercharger

(1) Supercharger mainly consists of following parts: air compressor impeller and turbine impeller (they mount on same shaft), air compressor case, turbine case, countershaft bearing race and bearing. Supercharger operates in following way: As turbine case connects to exhaust pipe, the exhaust gas with certain energy enters turbine case at high speed to drive turbine to rotate at high Rpm, it also drives air compressor impeller that mounts in same shaft. Air from air filter gets pressurized after flowing through air compressor impeller, this increases air amount entering cylinder, thus improves engine power.

Rules to use supercharger and maintenance requirements:

① Rules to use a supercharger

Start-up

▲ After engine has started, operator should run it idly for 5 minutes till oil pressure and temperature go up to normal operation range. Run engine with load after that, otherwise supercharge may be injured due to oil short.



Note: Do not accelerate suddenly, and do not speed up engine Rpm rapidly during driving either.

▲ For engine whose oil / oil filter has been changed or cleaned, or engine has been laid for long (over 1 week), operator should loosen supercharger oil inlet connector to fill in clean oil, ensuring supercharger bearing is full of oil inside. **Note: Rotate turbine rotor (impeller) for several turns during filling to lubricate rotating parts fully.**

Running

Should keep supercharger input oil pressure at 190~390Kpa during running.

▲ Watch out for any abnormal noise and vibration during running. Pinpoint and remove faults timely if any.

Shutdown

When vehicle has to be stopped at higher speed or under full load, driver should reduce speed gradually, cannot stop vehicle abruptly. Run engine idly for several minutes before complete shutdown to protect supercharger from being damaged by heat due to oil short.

Note: During emergent braking at high speed and under heavy load (such as heavy trailer, driving uphill at high speed), driver should not shutdown engine immediately. Stop engine after it has run at idle for at least half minute.

② Maintenance

Must perform maintenance on supercharger to ensure normal engine operation.

Daily maintenance

Remove oil and air leakages;

▲ Clean away dust and oil stain on supercharger;

▲ Check if supercharger connects to engine firmly. Fasten if connection is loose.

Regular check

▲ Check fittings and moving parts after vehicle has driven for 125 hours or 1500-2000km.

▲ Check impeller rotor for play after vehicle has driven 500 hours or 6000-15000km.

③ Descriptions checked

▲ Check fittings;

▲ Check if bolts on turbocharger and its connections with intake / exhaust pipes are loose; tighten loose bolts and nuts or replace sealing plate to remove any air leak.

▲ Check supercharger oil inlet / return pipe for leakage; tighten loose bolts and nuts or replace sealing plate to remove any oil leak.

Note: Only professional technician can dismantle or assemble a supercharger.

(3) Supercharger fault diagnosis and solutions

Fault mode		Causes	Solutions
NO.	Symptoms		
1	Poor acceleration performance decreased, power and higher fuel consumption	Air intake system is restricted	Check air intake system and perform necessary repair and replacement
		Leak in air intake system	Check and perform necessary repair or replacement
		Exhaust system is restricted	Check and perform necessary repair or replacement
		Leak in exhaust system	Check and perform necessary repair or replacement
		Unstable supercharger operation	Check air compressor impeller rotation. Replace supercharger with unstable impeller rotation; check shaft axial clearance, replace supercharger whose clearance exceeds 0.13mm.



Fault mode		Causes	Solutions
NO.	Symptoms		
2	Abnormal noise	Leak or loose air intake / exhaust pipe	Check air intake / exhaust pipes for distortion, and bolts for loosening and washer damage. Repair or replace if necessary.
		Impeller is caught or damaged by foreign matters	Replace supercharger
		Unstable supercharger operation	Replace supercharger
3	Higher oil consumption and white smoke	Leaks at supercharger oil inlet / return pipe	Check supercharger oil inlet / return pipe for connection and sealing. Repair or replace if necessary.
		Failure supercharger sealing parts	Check sealing parts. Repair or replace.
		Oil cross-leak in engine	Check and repair.

1.5.5 Diesel engine check and adjustment

1 Adjust valve clearance

Valve clearance adjustment is very important. As clearance is too small, valve will expand (due to heating) and can not close during engine operation, which could lead to air leak and engine power decreasing; while larger valve clearance will shorten intake / exhaust valves opening time, which could lead to insufficient air intake and incomplete exhausting. This will also reduce engine power and put intake / exhaust valves, rocker arm and camshaft under heavy impact. Readjust valve clearance once an engine has been dismantled. Moreover, valve clearance could change during engine operation due to loose adjusting screw and wears on valve mechanism, Therefore, after a vehicle has driven 500 hours or 8000km under load, its valve clearance has to be adjusted.

Adjust valve clearance while engine is cold. When to adjust a valve clearance, operator should first remove cylinder head cover, turn crankshaft till 1st cylinder TDC mark on crankshaft pulley aligns with the point on gear case (figure 6). When 1st cylinder piston reaches TDC of compression stroke, intake / exhaust valves in this cylinder are all closed. Then operator uses a feeler to measure clearances of intake / exhaust valves in first cylinder, intake valve in second cylinder and exhaust valve in third cylinder, i.e. 1st, 2nd, 3rd and 6th valve clearances from front to rear. Intake valve clearance should be 0.35~0.40mm and exhaust valve clearance should be 0.4~0.45mm. If clearance is incorrect, operator could loosen and fix locking nut with a wrench., then turn adjusting screw with a screw driver till feeler could perfectly insert into between rocker arm big end and valve head, when feeler will not feel over-tight or loose. Retighten locking nut and recheck clearance until it is qualified.

After above valve clearances have been adjusted, rotate crankshaft a full turn. At the moment, 4th cylinder piston reaches TDC of compression stroke. Check clearances at 4th, 5th, 7th and 8th valves. Adjust and recheck valve clearances as per above procedures. So far, all valve clearances have been adjusted.

2 Adjust fuel supply advance angle

In order to maintain lower fuel consumption and better operation performance, fuel advance should be checked and adjusted after an engine has been dismantled/reassembled, or has run 1000 hours or 18000km under load.

When to adjust advance angle, operator could remove hi-pressure fuel pipe in 1st cylinder, and connect a piece of hi-pressure pipe with transparent section to fuel injection pump outlet valve seat (for 1st cylinder). Set injection pump regulator handle to max and bleed completely fuel system with hand pump. Turn crankshaft till there is no air bubble in fuel discharged from transparent pipe. Turn crankshaft slowly and watch closely (through



transparent pipe) fuel level change at injection pump outlet valve seat (for 1st cylinder). Stop turning crankshaft at the right moment fuel level begins to raise (start supplying fuel to 1st cylinder). Observe the relating position between Chinese character mark line (crankshaft turning angle 10° before TDC) and the point on gear case cover (figure 6). Operator could loosen bolts connecting injection pump and gear case, turn injection pump to change advance angle. The angle is enlarged when upper injection pump turns toward engine block and reduced when upper pump turns away from block.

3 Adjust fuel injection pressure

Remove injectors from cylinder head and put them on test stand to check and adjust. Press hand pump up and down, read injecting pressure from pressure meter. The readings should fall in the range indicated in engine’s main technical data. Fuel mist should be even, sound should be short and crisp. If pressure is incorrect, operator should remove injector and select to use pressure-adjusting shim to adjust pressure into specification.

4 Adjust fan pulley tension

Fan pulley tension has much to do with water pump and alternator operation. It also affects directly engine operation and has to be adjusted frequently. Adjusting procedures are as follows: while engine is not running, press belt with thumb (30~40N.m), the tension is normal if belt drops 10~15mm. Operator could also change tension by loosening the bracket retaining bolts on engine side to change alternator position. Tension should be snug, over-tight belt will cause early wear-out at alternator and water pump due to overload on their bearing, and belt service life would be shorten due to over-stress too; while loose belt will cause slip, which could not offer enough cooling to engine, and belt may get damaged easily due to surface wear

5 Adjust oil pressure

Always watch carefully oil pressure during diesel engine operation. Normal oil pressure is 200~500Kpa. Oil pressure adjustment should be made while engine is hot (oil temperature is around 80°C). Procedures are as follows: remove oil screw cap on side of oil filter, loosen retaining nut. Unscrew adjusting screw to reduce oil pressure while tighten the screw to increase pressure. After adjustment, operator should put on washer and tighten nuts, and then tighten oil screw cap finally.

1.6 Phaser135Ti Diesel engine technical specifications

1.6.1 Phaser135Ti Diesel engine main technical parameters

No.	Description	Unit	Parameter
1	Model in engine ID plate		Phaser135Ti
2	Engine type		Vertical, in-line, water cooled, four strokes, supercharged, inter-cooled
3	Combustion chamber type		DI
4	Cylinder no. – bore × travel	mm	4-100×127
5	Displacement	(L)	3.99
6	Rated power (Rpm)	kW (r/min)	101 (2600)
7	Power in ID plate (Rpm)	kW (r/min)	101 (2600)
8	Max. torque (Rpm)	N-m (r/min)	445(1600)
9	Full load characteristic min. fuel consumption	g/k W .h	200
10	Oil / fuel consumption rate	g/k w .h	≤0.4
11	Max. idling speed	Rpm/min	≤2964



No.	Description	Unit	Parameter
12	Idle speed	Rpm/min	750±30
13	Startability		Start up freely at above -30℃
14	Emission pollutant		Meet requirements in GB17691-2001 (II)
15	Invisible pollutant at free acceleration	m-1	As per requirement in GB3847-1999
	Smoke intensity at free acceleration	R b (BOSCH)	≤2.5
16	Invisible pollutant in emission at full load	m-1	As per requirements in GB3847-1999
	Max. smoke intensity at full load	(FSN)	≤3.5
17	Noise	L w [dB (A)]	≤98
18	Net mass	K g	330
19	Overall dimension(L×W×H)	mm	
20	Fuel supply advance angle	°CA	TDC 10 ⁰ ±2 ⁰
21	Fuel injection pump model and manufacturer		VE4/12F1300 (BOSCH)
22	Fuel injector model and manufacturer		KBEL—P033 (BOSCH)
23	Supercharger model and manufacturer		TB25 Turbocharger system NEVEL (Shanghai) Co. Ltd
24	Fan diameter		Φ 508 above crankshaft center 230, Fan speed ratio 1:1
25	Exhaust pipe open gasket, bolts and nuts		Flange M10 (3 holes); divide circle Φ 100; with 3-M10 stud (protrude 50 above flange end face, thread length 25) and 6-M10 copper nuts; with sealing gasket and heat baffle.
26	KSB switch		Blade plug 6.3×0.8
27	Throttle cable bracket		Injection pump with supporting plate; fill pump from behind
28	Water temperature switch		Blade plug 6.3×0.8 (2)
29	Front support rubber damping pad		T0550053, T2635116
30	Flywheel case		Depth 135
31	Clutch pressure plate and housing assembly	mm	With Φ 330 diaphragm clutch pressure plate
32	Clutch driven plate	m m	With Φ 330 diaphragm clutch driven plate (10 teeth rectangular spline)
33	Input shaft bearing		6205 (Φ 25 inner diameter.)



No.	Description	Unit	Parameter
34	Matching transmission	mm	17D45, input shaft protruding length229; clutch case thickness110
35	Air compressor		Water cooled, volume 225CC , working pressure 0.8Mpa, with feather valve; air outlet M22×1.5; female screw connector; air inlet with vertical elbow, outside diameter ϕ18
36	Diesel pipeline		Fuel return pipe connector size M12×1.25, male screw connector, with fuel inlet bolt M16×1.5

1.6.2 Starter technical parameters

	Rated voltage (V)	Power (KW)	Control end current A	Positive terminal	Control end terminal
PHASER 135Ti	24	5		M10	M4

1.6.3 Alternator parameters

	Rated voltage V	Power A	Terminal B+	Terminal E	Terminal D+	Terminal W	Tachometer terminal W drive ratio	No. OF polarity pair
PHASER 135Ti	28	55	M8	M5	6.3×0.8 blade plug		200/82.5	6

- ▲ Terminal D+ load power≥5W
- ▲ Terminal W output signal should be unified, no interfering signal

1.6.4 Other technical specifications:

1. Water temperature sensor, its terminal is 6.3×0.8 blade plug. Parameters see chart below:

Temperature (℃)	40	80	97 (alarm)	100	120
Resistor (Ω)	287.4±30	69.1±5	44.3	38.5±4	22.7±3

- 2. Oil pressure sensor: single lead screw press connection (connection screw M4); alarm pressure 0.08±0.01Mpa
- 3. A/C and heater: include AC compressor bracket and its retaining / adjusting bolts, compressor tensioning mechanism, compressor belt (A belt 1260mm); heater water inlet / outlet are on engine upper left; thermostat seat with heater water outlet pipe, all heater connector outer diameter is ϕ16mm, with heater water valve.
- 4. Power control stalling mechanism: with fuel cut-off solenoid, blade plug 6.3.
- 5. Breather is set on engine side; oil filler is on upper rear of valve cover.
- 6. Fuel filter is set on fuel pump side, whose top is lower than valve cover upper plane.
- 7. Dynamic unbalance (crankshaft + flywheel + clutch assembly) ≤100g-cm.



Chapter 2

Vehicle Technical Maintenance

With the improvement of vehicle technology and quality, vehicle maintenance becomes more important. Vehicle maintenance should be performed regularly based on preventive and forcible principles.

Vehicle maintenance procedures are arranged according to gradual changes of vehicle technical conditions, and they should be preformed before these conditions become deteriorated. Therefore, vehicle maintenance is of preventive nature. To perform compulsory maintenance according to maintenance interval and technical requirements will keep vehicle clean and tidy, timely pinpoint and remove potential faults so as to prolong vehicle service life.

2.1、Daily Maintenance

Vehicle parts tend to become loose, worn-out and damaged during vehicle’s operation, which harm vehicle’s performance. Daily maintenance carried out by driver will reverse these effects and keep vehicle in a proper working condition. Driver keeps watching vehicle’s technical conditions by means of daily maintenance is very important to drive safely and avoid accident.

2.1.1、Daily Maintenance procedures for vehicle

- a. Before, within and after using vehicle, check safety mechanism and fittings for fastening;
- b. Keep oil, air, fuel filters and battery surface clean;
- c. Avoid fuel, water, air and electricity from leaking.

These steps will keep vehicle in a clean look and good working condition. For same purpose, it is required to perform following daily maintenance procedures on vehicle:

Category	Procedures
External	1. Check and clean mirrors outside driver cab, windshield and window glasses; 2. Check vehicle appearance, paint and corrosion on body; 3. Check and adjust tyre pressure and fasten wheel lugs. 4. Check and adjust windshield wiper; 5. Check and lubricate door hinges and engine hood; 6. Check and adjust battery fluid level or check battery fluid density
Interior	7. Check vehicle for any leaks; 8. Check and adjust vehicle lights and signals; 9. Check and adjust horn; 10. Check wiper and windshield washer; 11. Check windshield defroster; 12. Check and adjust rear view mirrors and sun-visor, 13. Check steering wheel free travel and its operation. 14. Check gas pedal performance; 15. Check clutch/brake pedals free travels and their travel smoothness at depressing and releasing; 16. Check brake performance; 17. Check parking brake performance.



Category	Procedures
Engine compartment	18. Check and add engine oil; 19. Check and add engine coolant; 20. Check and add windshield washer fluid; 21. Check and add fluid to brake master cylinder and clutch master cylinder. 22. Check and clean air filter element. 23. Check engine intake / exhaust systems for fastening.

2.1.2、Procedures for daily vehicle maintenance

Before, within and after using vehicle, it is suggested to perform daily maintenance procedures indicated with following flow chart (figure 2-1):

Figure 2-1 Vehicle daily maintenance procedures

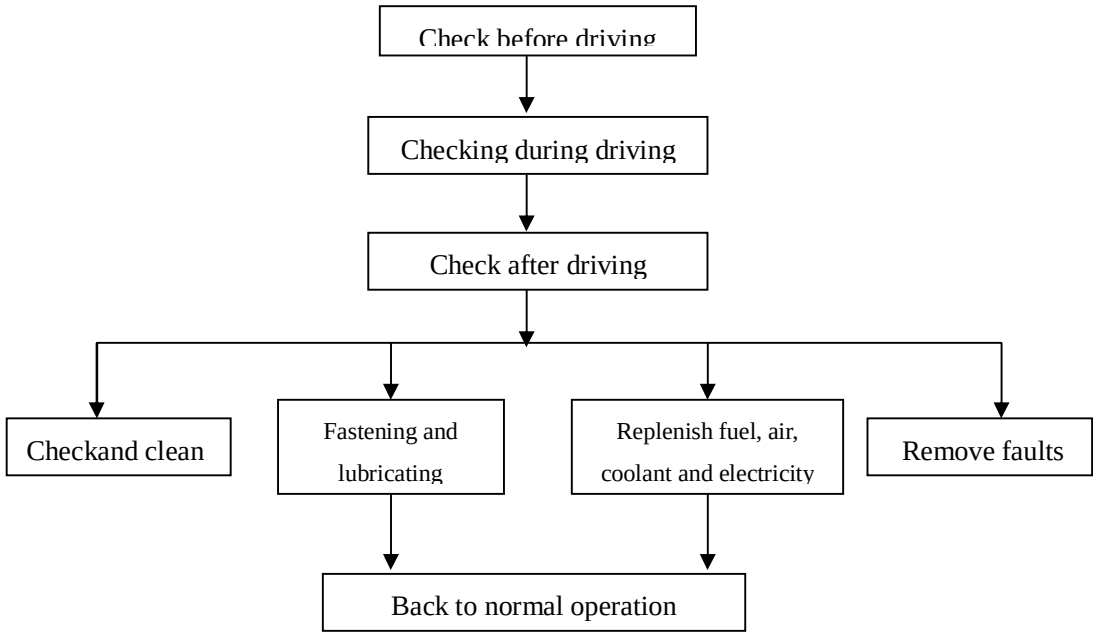


Figure 2-1 Flow chart of daily maintenance

2.2、First level maintenance

For 1st level maintenance, the interval or mileage are 6 months or 7500km—15000km respectively, whoever comes first will override. First maintenance is carried out by service technician, it focuses on cleaning, fastening and lubricating procedures beside these have made in daily maintenance procedures, and also includes checks on safety-related devices such as brake and operating mechanisms.

2.2.1、Procedures for 1st level maintenance (see chart 2-2)

Chart 2-2 Procedures for 1st level maintenance

Engine	1. Check lubricating, cooling, exhaust and fuel systems for leakage or damage; 2. Replace engine oil and oil filter element; 3. Check coolant level and its frozen-proof capability, add coolant or adjust coolant concentration if necessary; 4. Clean air filter, replace filter element if necessary. 5. Check drive belt condition and tension, adjust belt tension or replace belt if necessary.
--------	---



Chassis	6. Check clutch pedal travel; 7. Check transmission for leakage or damage; 8. Check UJ boot for damage; 9. Check tie rod ball joint for fastening and clearances, and check if boot is damaged; 10. Check brake system for leakage or damage; 11. Check brake fluid level, add fluid if necessary; 12. Check brake pad lining's thickness; 13. Check and adjust manual brake devices; 14. Check tyre for pressure, wear or damage; 15. Check wheel lugs torque; 16. Check tyre tread depth.
Driver cab and	17. Check door hinges and limit arms; 18. Check for any crack and loosening,
Electrical system	19. Check performances of headlights, alarm lights, turning lights and horn; 20. Check and adjust headlight beams; 21. Check windshield wiper and washer, add fluid if necessary; 22. Check battery fluid level, add distilled water if necessary;
Road test	23. Check and test vehicle technical performance.

2.2.2、Requirements to First Level Maintenance

1. All exposed nuts and bolts at following units are complete, fastened and crack-free: engine FR/RR suspensions, intake/exhaust manifolds, assisted exhaust brake system, heating and A/C systems, engine radiator, tyres, propeller shaft, vehicle body, accessory brackets;
2. Steering arm, steering tie rod and brake controls operate well with complete fittings; no free plays on tie rod ball joints, steering cross bearings and propeller shaft cross bearings;
3. Fluid levels of steering gear, transmission, transaxle should be 0-15mm under inspection doors (check when engine is cold), vent hole should not be blocked; and flange nuts on transmission, final drive are fastened.
4. Lubricating fluid nozzles are complete and on their right mounting positions; all lubricating spots are fed without being ignored,
5. Air filter element is clean and effective,
6. Tyre pressure is up to standard, no stone or other hard objects embedded in tyre.
7. Free travel of clutch and brake pedals comply with technical standards.
8. Lights, meters, horn and signals are complete and work well.
9. Battery fluid level is 10-15mm higher than plates, and battery vent hole unclogged and connectors fastened.
10. No free play on wheel hub bearings,
11. Test run vehicle to check maintenance result. During test, there should be no abnormal noise on engine and chassis, each control mechanism should meet technical demands; steering and braking system are sensitive and reliable, and no loosening on fittings. After test run, check engine and chassis for oil, fluid, air and electricity leakages.



2.2.3、Flow chart of 1st level maintenance

Flow chart of 1st level maintenance is indicated as follow:

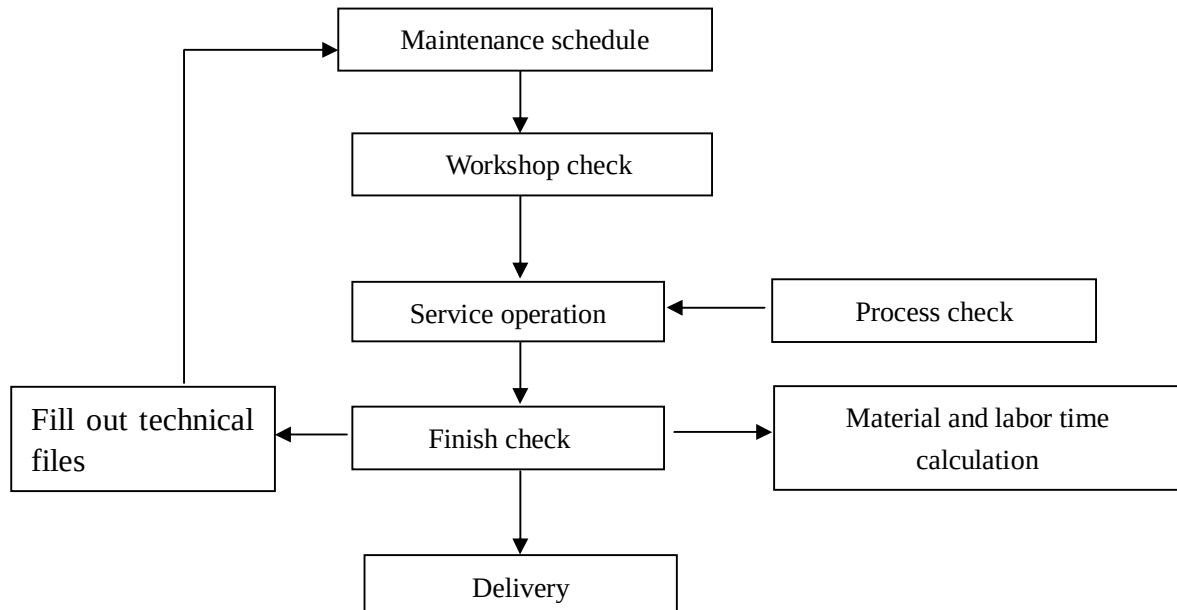


Chart 2-2 Flow chart of 1st level maintenance

2.3、Second level maintenance

After being used for a longer period of time or mileage (30000km or 12 months), vehicle should be checked and adjusted thoroughly to retrieval its safety, power and fuel economy. For these purpose, vehicle is required to be serviced completely with Second Level maintenance. Second level maintenance mainly focuses on checks and adjustments besides these have made during first level maintenance, it also dismantles tyres to check and rotate. To avoid vehicle's early damage, vehicle will be diagnosed and analyzed technically before starting this maintenance, and additional services or repairs based on diagnosed results may be added to maintenance procedures. Professional service technician performs 2nd level maintenance.

2.3.1、Vehicle technical judgment before 2nd level maintenance

Before 2nd level maintenance, there should be checks both with instruments and manually. These checks will diagnose possible faults and judge vehicle's technical condition, so as to determine additional procedures to 2nd maintenance's basic procedures.

Basic methods to judge vehicle's technical condition:

1. To know how the vehicle is driving. Service technician will ask driver how the vehicle is running (includes engine power, abnormal noise, steering and braking performance, and oil consumption).
2. Review vehicle's technical records that include records on driving, maintenance, check/test, assembly repair and minor repairs during maintenance cycles.
3. Analyze results from instrumental check/test and manual check to pinpoint faults.

2.3.2、Diagnosing procedures before 2nd level maintenance

1. Engine check and test: performances at acceleration and deceleration, and possible engine's smoke emission and leakage;
2. Power-train check and test: clutch performance, transmission internal coordination, sealing conditions of transmission and final drive. And also check transmission and final drive's working temperature, and check for

any abnormal noise in the system.

3. Brake system: performances of main brake system, parking brake system, exhaust assisted brake system. And check systems for any leakage.

4. Steering system check/test: steering wheel free travel, system performance, and check for any leakage.

5. Drive line system check/test: abnormal tyre wear, suspension bushes wear, and check bolts on body for any loosening, rust and distort, also check body surface for corrosion and paint peel-offs.

6. Electrical devices check/test: dashboard gauges’ indication, oil pressure, coolant temperature, alternator charging indication, A/C, and heating device’s operation.

Checking methods: with check/test equipment, vehicle tester and by experience.

2.3.3、Technical performance judgment and additional service before 2nd level maintenance

Basis for additional service Description to 2nd level maintenance, details see chart 2-3.

Chart 2-3. Basis for additional service procedures to 2nd level maintenance

Category	Location	Check results	Faults	Additional services
Instrumental check	Engine	1. Engine’s power is 75% lower than rated value;	Poor valve seal	Adjust valve clearance, grind valve
		2. Cylinder pressure is 80% lower than rated value.	Piston ring wear, top and side gap increase, piston ring breakage;	Replace piston ring
		3. Uneven power outputs among cylinders;	Cylinder worn, large clearance between pistons and cylinder walls;	Check and measure cylinder, select piston, bore cylinder if necessary
		4. Excessive crankshaft case gas leakage >40L/min（1000r/min） >70L/min（2000r/min）	Piston ring stuck, ring bank broken	Replace ring and piston, check cylinder
		5. Vacuum value is low and unstable;	Piston head burnt, bore scratched	Replace piston (adjust advance angle of injection), Check cooling system.
		6. Higher cylinder leakage, air pressure drops up to 0.25 MPa;	Larger fitting clearance between crankshaft/connecting rod bearing, abnormal sound	Remove to check, adjust clearance, check crankshaft journal wear, measure its roundness and cylindrical. Cut if necessary.
		7. Oil consumption increases (>0.3L/100km);	Worn-out camshaft and its timing gear	Remove to check camshaft and timing gear
		8. Low oil pressure;	Larger fitting clearance and abnormal sound --piston, piston pin and connecting rod cooper bush	Remove to check clearances among them, replace if necessary
		9. Piston top burnt, cylinder scratched;	Low oil pressure, abnormal sound due to larger crankshaft bearing clearance	Remove to check, repair if necessary
		10. Crankshaft bearing whining;	Larger valve clearance, worn valve train	Adjust valve clearance, check valve train, repair or replace if necessary
		11. Piston pin whining;		
		12. Cylinder knock;		
		13. Valve noise.		



Category	Location	Check results	Faults	Additional services
Manual check	Engine	Abnormal sound — valve train	Valve spring broken	Replace valve spring
			Noise--camshaft bearing	Remove to check camshaft bearing
			Worn timing gear	Replace timing gear
		Larger crankshaft axial clearance	Worn crankshaft thrust washer	Replace thrust washer
		Oil leak at crankshaft oil seal	Oil seal failure	Replace oil seal
		Abnormal sound-- water pump	Water pump shaft bearing damaged or shaft broken	Remove to check water pump, replace bearing or water pump
		Engine over heated	Radiator pipe restricted	Remove to check, remove pipe restrictions.
	Clutch	Clutch failure	Clutch skipping, worn friction plate, incomplete release, unstable engagement	Remove to check clutch, replace friction plate or return spring
	Transmission	Abnormal sound—clutch release bearing	Bearing damaged	Replace release bearing
		Abnormal sound or frequent repair--transmission	Worn or broken shaft, gear, bush	Remove to check transmission
	Axle	Enlarged meshing clearance or abnormal sound—final drive's drive/driven gears	Worn gear face or larger meshing clearance	Adjust meshing clearance, check gear fitting.
		abnormal sound—differential, final drive, axle case temperature > 60℃ (frequent minor repair)	Incorrect gear meshing or tooth broken	Remove to check final drive and differential
	Steering gear	steering wheel free travel > 10° , stuck or heavy	Larger meshing clearance, worn-out gear, ball groove worn —out to stick	Adjust steering wheel free travel, remove to check steering gear
	Others	Abnormal and free play-propeller shaft counter bearing	Radial play or bearing worn to stick	Remove to check counter bearing
		Brake failure (adjustment does not work)	Worn-out brake pad	Remove to check or replace pad / shoe
		Body deformed, serious paint peel-off	Metal crack, rust	Repair, weld and paint
		Tyre side wear	Front axle distorted, steering knuckle kingpin play, axle parts distorted	Perform front wheel alignment, remove to check or replace kingpin or bush, correct or replace distorted parts
		Serious leakage at oil seals on transmission, steering gear, axle case.	Aged oil seal, poor sealing	Replace oil seal
General comments	Engine or vehicle	Engine power and reliability decreased, fuel and oil consumption increased. Chassis and body conditions turn to worse		Engine passably service or overhaul vehicle



2.3.4、 Basic service procedures during 2nd level maintenance

Professional technician performs the 2nd level maintenance that includes these services in 1st level maintenance mainly focuses on check and adjustment, and also on tyres rotation. The basic service items see chart 2-4.

Chart 2-4 Basic service procedures of 2nd level maintenance

Category	Description
Engine and clutch	1. Check lubrication, fuel and cooling systems for leakage
	2. Check exhaust system for leakage or damage
	3. Replace engine oil or oil filter
	4. Check coolant level and coolant performance, add coolant or adjust concentration if necessary
	5. Check belt tension and condition, adjust tension or replace it if damaged
	6. Clean air filter, replace element if necessary
	7. Replace fuel filter
	8. Check clutch pedal free travel, adjust if necessary
	9. Check and clean fuel injector
	10. Check advanced angle of injection, adjust if necessary
Drive system	11. Check transmission for leakage
	12. Check propeller shaft and UJ
Steering system	13. Check tie rod ball joint for fastening and clearance, adjust if necessary
Brake system and wheel	14. Check brake system for leakage or damage
	15. Check pad lining thickness, replace pad if necessary
	16. Check and adjust parking brake unit
	17. Check assisted exhaust brake system performance
	18. Check tyre pressure
	19. Check tyre for tread depth and wear
	20. Check wheel lug torque
Electrical system	21. Check performances of headlights, alarm light, turning lights and horn
	22. Check performances of windshield wiper and washer devices
	23. Check windshield fluid level, add if necessary
	24. Check battery fluid level, add distilled water if necessary
	25. Check air filter
A/C system	26 check A/C’s performance and refrigerant amount
Heating unit	27. Check heating fan performance, and any leaks at pipeline and connectors
Road test	28. Check performances of speedometer, brake, shift mechanism and steering mechanism.



2.3.5 Flow chart of 2nd level maintenance

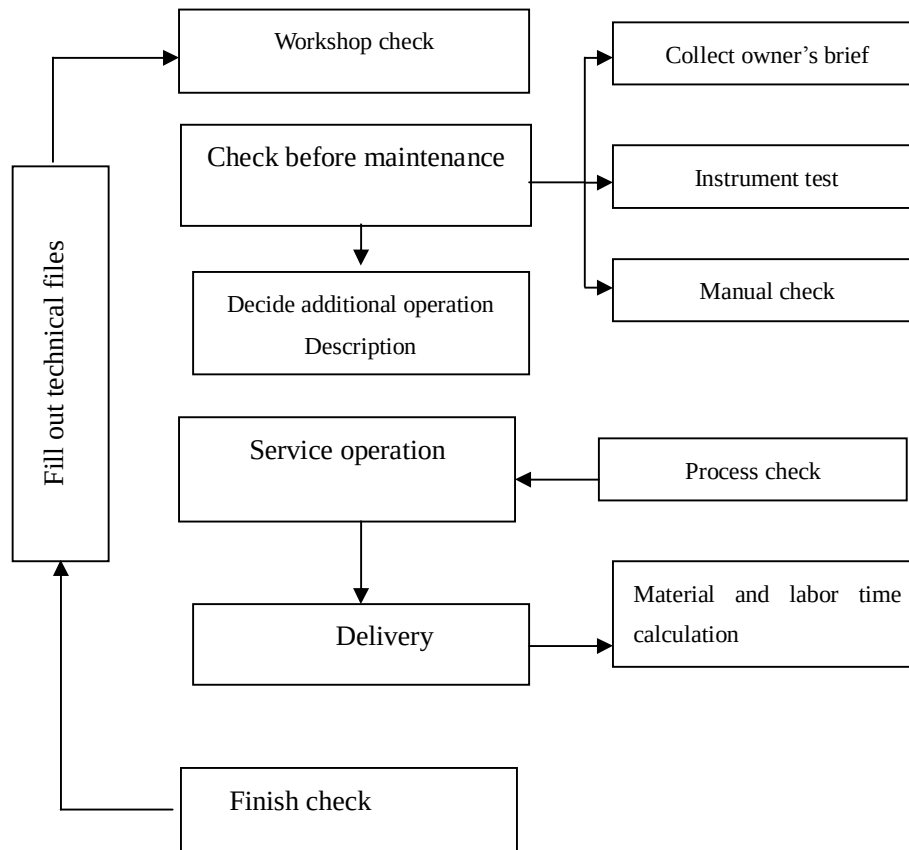


Figure 2-3 Flow chart of 2nd level maintenance

2.3.6、 Requirements to 2nd maintenance

1. Engine's three filters (air, fuel and oil) are clean, engine starts easily and runs smoothly, exhausts normally, temperature and oil pressure are within normal range; engine is sensitive to rpm changes without abnormal noise; all drive belts are complete with proper tension and without abnormal wear.

2. Clutch pedal free travel is up to standard; clutch operates easily and releases completely, engages smoothly and reliable; no leakages at pipelines on hydraulic operating systems; there is proper amount of fluid in reservoir and fluid is clean and clear.

3. Parts in transmission, axle and UJ drive unit are lubricated and connected well, no abnormal noise and overheating; no jump-gear and shift difficulties; their exterior surfaces are clean and no sign of fluid leaks.

4. Steering wheel free travel and wheel toe-in are up to standards, steering maneuver is light, flexible and reliable; front wheels do not dive or incline to one side.

5. Brake pedal free travel and brake clearance are up to standards; brake, parking brake and assisted exhaust brake all work well without lagging and misalignment; no air leak in brake systems; inertia proportional valve works well.

6. Tyres are mounted correctly with right pressure; shock absorber system is clean and well, fixed tightly; wheel hub bearing with right torque and gets well lubricated.

7. Battery is clean and works well, fixed tightly; battery fluid level, density and load voltage are up to standards.

8. Alternator, starter, gauges, lights, signals, switch/button and all other accessories are complete and work well; all circuit is complete and well and fastened tightly.

9. Vehicle is clean, vehicle body’s pose is sound with well paint; no oil, water, air and electricity leaks. All lubricating spots are well fed and all connections are tight and reliable.
10. A/C/heating fan work well, their connecting pipelines have no water or fluid leakages.

2.3.7、Required check and diagnosing Description before 2nd level maintenance

Required check and diagnosing Description before 2nd level maintenance see following chart 2-5.

Chart 2-5 Required check and diagnosing Description before 2nd level maintenance

Category	No.	Test description	Check items
Parts tested	1	Engine power	No load power, power output balance among cylinders
	2	Parameters of starting system	Starting current and voltage
	3	Cylinder sealing	Cylinder pressure, crankshaft case leak, cylinder leak and vacuum
	4	Port timing	Open and close angles of inlet/exhaust valves
	5	Engine noise	Crankshaft bearing, rod bearing, pistons, piston pins and valve train
	6	Cylinder surface condition	Cylinder scratch, piston head burnt, coke and piston side wear
	7	Engine oil lab test	Contaminated index, water content, flash point, PH value and motional viscosity
Parts checked	1	Engine	Seals on engine (oil/water), FR/RR crankshaft, radiator, water pump, water jacket; crankshaft axial play and abnormal sound
	2	Steering system	Steering wheel free travel, steering gear performance and sealing; road test steering stability (if necessary)
	3	Transmission system	Clutch performance, transmission, final drive housing surface conditions and their oil seals; road test; abnormal sounds from transmission, differential, final drive, bearing on propeller shaft; case temperatures on transmission and final drive.
	4	Drive line	Tyre side wear, leaf spring bracket, pin and bush
	5	Meters and signals	Correct indication
	6	Others	

2.4、Break-in maintenance

2.4.1、Vehicle during break-in period

To prolong vehicle’s operating year, it is required to let vehicle “break in “ when it is first put into use. Only after break- in period can a vehicle be put into normal use.

Requirements during break-in period:

1. Break-in mileage: 1500-2000 km;
2. Select better road to drive vehicle with moderate speed, and vehicle’s load and speed should be less than rated values.



- 3. Driver should comply with operation rules, keep engine in normal working temperature;
- 4. Keep vehicle’s daily maintenance checks and fasten outside bolts/nuts regularly; watch closely temperature changes of each assembly and their sound; and make proper adjustment timely.
- 5. When break-in period is finished, vehicle should be sent vehicle for break-in service.

2.4.2、Maintenance services during break-in period

Newly purchased or overhauled vehicle must have break-in period. To keep vehicle’s reliable operation and prolong its operation year, there must be a compulsory service. The “Maintenance Manual “ enlists detailed requirements to maintenance.

A compulsory maintenance is to find and remove faults after break-in period, which includes complete checks, fastening and lubricating is crucial to drive vehicle safely.

Vehicle break-in period maintenance includes following cleaning, checks, fastening and lubricating services:

- ① Change engine oil, transmission and rear axle fluids;
- ② Change oil filter and fuel filter elements;
- ③ Check transmission, rear axle, steering gear and engine for leakages, fasten half shaft bolts, steering drop arm nuts, tie rod ball joint nuts;
- ④ Check engine coolant and windshield washer fluid levels;
- ⑤ Check propeller shaft and FR-RR suspension systems, fasten propeller shaft bolts and suspension U-bolts.
- ⑥ Check tyre for pressure and technical conditions, fasten wheel lugs;
- ⑦ Check brake system performance, add brake fluid, check and adjust brake pad clearance;
- ⑧ Check and adjust engine valve clearance.

Note: Detailed content please see “Maintenance Manual”

2.5、Seasonal Maintenance

Weather conditions affect vehicle’s operation. In the area where lowest temperature drops under 0℃ in a year, there must be seasonal maintenance before summer and winter. In-using vehicle’s seasonal maintenance is usually performed by driver, and can also be sent to service workshop for help. Main services for seasonal maintenance include oil, coolant (according to seasonal temperature requirements) changes, and adjustment on fuel supply system & power supply system.

1. Change lubrication oil

Engine& chassis use multi-level oil that can be applied both in summer and winter. This makes oil change easy at seasonal maintenance by just selecting relevant oil with same viscosity and by following changing interval requirement.

Chart 2-6 Viscosity and ambient temperature

Engine oil viscosity rate	Lowest operation temp. (℃)	Gear fluid viscosity rate	Lowest operation temp. (℃)
5W、5W/30	-32	70W	-55
10W、10W/40	-23	75W	-40
20W、20W/50	-12	80W	-26
		85W	-12
		90、140、250	above 0℃



Chassis gear fluid is mainly used on transmission and final drive assemblies. To change lubrication oil, one can only adjust its viscosity, and obey all quality and rate requirements in owner’s manual. No alteration is allowed.

2. Change engine coolant

One can formulate coolant by him or buy it with relevant brand/specification from market. Ethylene glycol/water coolant is commonly seen. It is rated by icing point as -18℃、-35℃and -45℃. One should select coolant with rated temperature is 5℃ lower that actual environment temperature.

3. Clean fuel system and select diesel of right rate

Before winter, fuel system should be cleaned thoroughly. Clean all filtering grids, clean and change filter element and turn to use right-rated diesel. According to their quality, vehicle diesel is rated into three levels as premium, 1st class and qualified, and classified into 6 rates as 10、0、-10、-20、-35、-50 according to their icing points. One should select diesel whose rated temperature is 5℃ lower than actual environment temperature to keep diesel from freezing (paraffin seeping out).

4. Battery maintenance

Before winter, one should clean battery, add distilled water or adjust battery fluid density. Right gravities according to local temperature are as follows:

Below 0℃: 1.24 above -20℃: 1.27 above -30℃: 1.28 above -40℃: 1.29 below -40℃: 1.31

Use battery fluid with a density of 1.853 (15℃) and clean distilled water to adjust a battery density

If battery capacity becomes low due to longer operation, it should be recharged as follows:

Constant current charging: Current: 0.1C20 (C20: 20 hours capacity). When end voltage reaches 14.4V, go on charging for 5 hours.

Constant voltage charging: Voltage: 14.4±0.1V, allowed max. current 0.5 C20, keep charging for 16 hours.

Perform these operations could be difficult in cold winter, it is suggested to do some of those works before winter, which include adjustments, fastening and cleaning on various locations. A thoroughly maintenance may let a vehicle pass through winter safely.

2.6、Vehicle lubrication

▲ Follow these rules to lubricate assemblies and parts:

- 1. Clean and remove dirt on oil cap, plug and nozzle to avoid them from entering parts.
- 2. Use grease gun to inject grease till parts interior is full and grease overflow at seam is seen.
- 3. Use standard grease that can be used year round.

Assemblies& parts lubrication mileage and requirements see chart 2-7

Chart 2-7 Assemblies& parts lubrication mileage and requirements

No.	Lubricant. location	Lubricant rate	Break-in maintenance (1500~ 2000km)	1st level maintenance (7500~ 15000km or 6 month)	2 nd level maintenance (30000km or 12 month)
1	Engine oil	Select as per engine manual and local temperature	Change	Change	Change
2	Transmission	Select as per engine manual and local temperature	Change	Add	Change
3	Rear leaf spring pin	No.2 lithium grease		Add	Change



No.	Lubricant. location	Lubricant rate	Break-in maintenance (1500~ 2000km)	1st level maintenance (7500~ 15000km or 6 month)	2 nd level maintenance (30000km or 12 month)
4	Between FR/RR leaf springs	Lithium grease (molybdenum disulfide)		Add	Change
5	Propeller shaft UJ	No.2 lithium grease		Add	Change
6	Propeller shaft spline	No.2 lithium grease		Add	Change
7	Mid propeller shaft bricking bearing	No.2 lithium grease		Add	Change
8	Battery terminals	Industrial Vaseline			
9	Steering knuckle pin	General lithium grease		Add	Change
10	Alternator bearing	General lithium grease		Add	Change
11	Drag link ball joint	General lithium grease		Add	Change
12	Tie rod ball joint	General lithium grease		Add	Change
13	Steering gear	Select as per engine manual and local temperature (same as that of transmission)		Add	Change
14	FR leaf spring pin	No.2 lithium grease		Add	Change
15	Front wheel hub bearing	General lithium grease			Change
16	Rear wheel hub bearing	General lithium grease			Change
17	Water pump bearing	General lithium grease		Add	Add
18	Transmission input shaft FR bearing	General lithium grease			
19	Oil filter (element)		Replace	Replace	Replace
20	Rear axle	Select as per engine manual or local temperature	Change	Add	Change
21	Door hinges	Engine oil			add 3~4 drops
22	Wiper motor and driving rod pin	Engine oil			add 3~4 drops



Chapter 3

BJ493ZLQ Series Diesel Engine

Construction and Service / Adjustment

3.1 Notes to diesel engine maintenance and adjustment

3.1.1 Non-professional personnel never try to dismantle to repair a diesel engine. Customer should send vehicle that needs to be repaired to service station.

3.1.2 Operator should get to know diesel engine construction, technical parameters, parts mounting location and dismantling skills, and also dismantling and reassembling methods and right operation measures with service tools. Customer who does not have necessary technical skills and conditions is suggested to contact the service stations authorized by FOTON Overseas Enterprises.

3.1.3 Dismantling sequence proceeds from outside to inside, and from assembly to part. Mark the part at dismantling to ensure correct assembling to increase efficiency. One should clean dismantled parts and check them carefully. Parts that can be used continuously should put according to their assembly catalogue, and precision parts should be separated from ordinary parts and put into clean container.

3.1.4 Assembly sequence proceeds from inside to outside, and starts with part to assembly. Watch out their mounting dimension, location, fitting clearance, fastening torque to avoid miss or wrong mounting, scratch on mating surface and foreign object falling into. Use proper wrench and fastening torque on bolts and nuts. Use fittings correctly according to regulations, including cotter pins, spring washer, retaining washer etc. Besides, during assembly, one should cross check parts codes with assembling marks to ensure right locations and motional relations among parts.

3.1.5 Always keep diesel engine clean and complete. One should clean parts before dismantling and assembling to ensure assembling quality. Complicated adjustment and service should be performed indoor to avoid contaminating diesel engine.

3.1.6 Watch out personal injury due to moving parts or wrongly use of tools during dismantling or service.

3.2 Cylinder block parts

BJ493ZLQ series diesel engine cylinder block is made of cast iron HT250. It is center equi-spaced among cylinders and equi-split construction to minimize height and length. This design reduces block wall thickness to make cylinder block compact and light in weight. And the reinforced ribs that radiate from crankshaft main journal rotating center make the body a construction with good stiffness to damper vibration and noise.

There are main oil duct and ducts that go to main bearing and camshaft hole in cylinder block. Lubrication oil goes through oil holes on body to reach cylinder head to lubricate valve rocker arms. Cylinder water jacket core is integrated type, tappet cover is omitted. This requires less sealing.

BJ493ZLQ series diesel engine (EURO II) uses steel sleeve of dry thin wall type. It is chromalized. Its inner surface is specially treated to retain oil to enhance wear-proof capability. Sleeve is set into body. With cylinder sleeve, one can only replace sleeve during service, not necessarily discard the whole block.

There are 5 main bearings in cylinder block. Bearing caps are made of cast iron. Each main bearing cap is fixed on body by 2 M14 bolts with a fastening torque of 160~180 N-m. Cap is fastened by 3 steps (40~50 N-m, 90~100 N-m and 160~180 N-m), the sequences see figure 3-1. Main bearing cap is finely processed together



with cylinder block, therefore, caps are not interchangeable or mounted reversibly. To avoid this from happening, each cap is tapped with number “1, 2” with arrow toward engine front as indicated in figure 3-1.

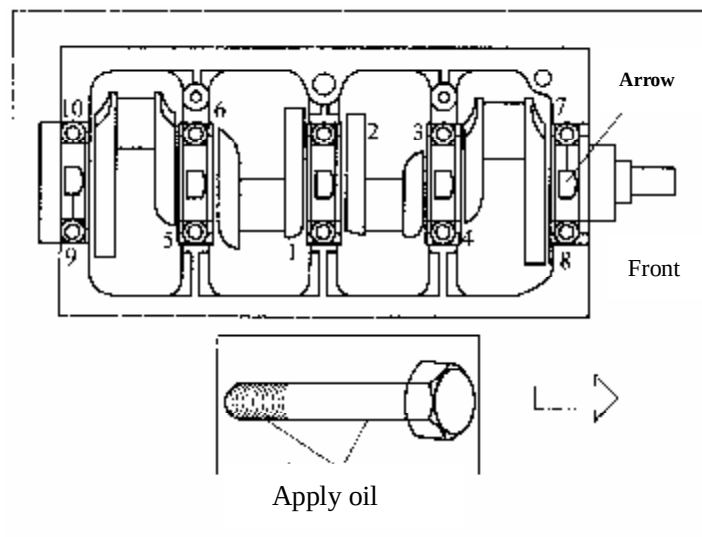


Figure 3-1 Fastening sequence – main bearing bolts

The 3rd bearing under axial load from crankshaft is locked by two half-circle thrust bearings on two sides. Thrust bearing is made of aluminum alloy with steel back. When thrust bearing is mounted, its oil duct should direct to rotating face of crankshaft. See figure 3-2.

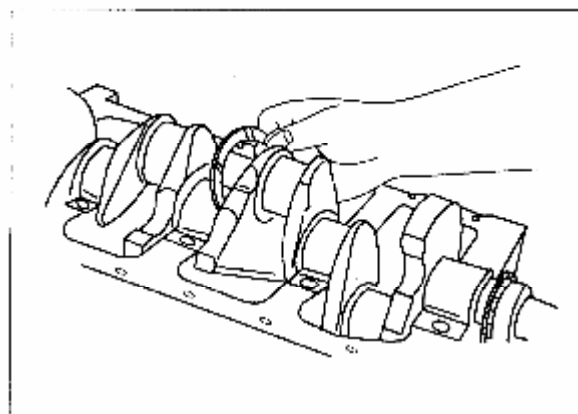


Figure 3-2 Mount crankshaft thrust bearing

The axial clearance of crankshaft is 0.05-0.20 mm.

There are aluminum alloy materials on the steel back. During mounting, be sure oil ducts and holes are seen on all bearing, see figure 3-3.

Crankshaft upper bearings are mounted on cylinder block, and lower bearing on main bearing cap.

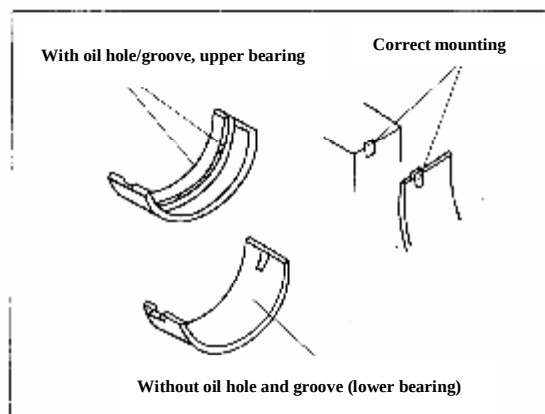


Figure 3-3 Mount crankshaft upper and lower bearings

There are 3 camshaft holes located on the upper right of main bearing. And a sleeve is pressed into each shaft hole. When mounting the sleeve, one should make sure its oil hole is aligned with oil duct on cylinder block.

Oil pump and starter locate on the left side (viewing from flywheel end); alternator and oil filter on the right side. And a coolant drain plug is on the right side of diesel engine block.

The upper part of the block is sealed by cylinder head, and a cylinder gasket is set between cylinder block and head.

3.3 Cylinder head parts

The cylinder head in BJ493ZLQ series diesel engine is made of cast iron HT250 intake and exhaust ducts are put on different sides separately. The ducts are cross-arranged. The shape of intake duct is determined by analyzing combustion conditions. A spiral intake duct is applied to ensure proper swirl ratio. See figure 3-4.

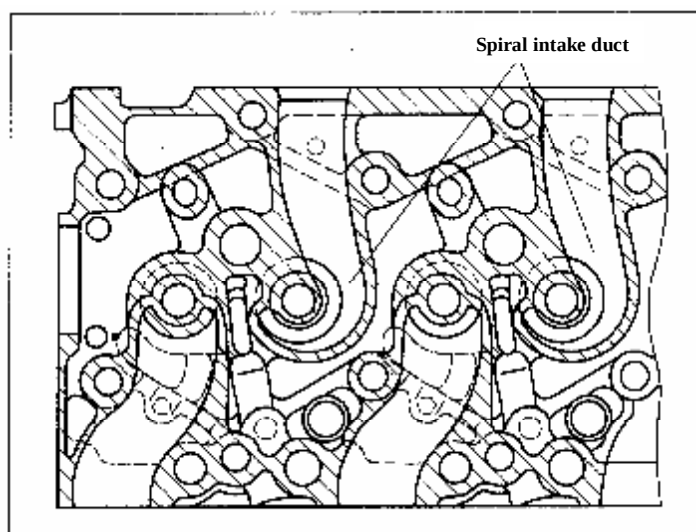


Figure 3-4 Air duct construction

Cylinder head is fixed on cylinder block by 18 pieces of M11 bolts. Before mounting the head, one should lubricate bolts with diesel engine oil, then proceed to fasten the bolts in 3 steps according to the sequence indicated in figure 4-5: first step: fasten with 50 N·m, loosen it completely; second step: fasten with 30-35 N·m;

third step: fasten with 160-180 N-m.

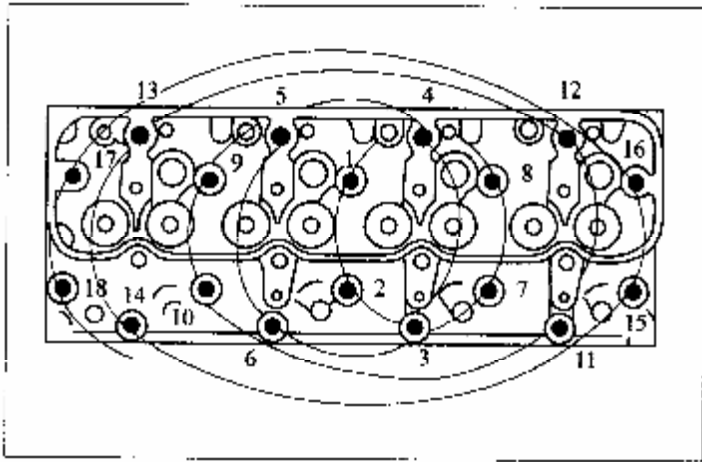


Figure 3-5 Fastening sequence – cylinder head bolts

Valve guide that is pressed into cylinder head is made of iron base powdered alloy or cast iron alloy. It has higher wear resistance but can not take higher side force. When dismantling a guide, one should avoid it from being squeezed or pressed.

Valve seat is made of special heat-resistant alloy. It is set on valve port on cylinder head with a relatively larger interference. The inner diameter of exhaust valve seat is smaller than that of intake valve seat. Beside, there are coolant passages among intake and exhaust valve seats for cooling purpose.

A compact fuel injector is set at the center of combustion chamber, which facilitates a fully combustion. Besides, the glow plug is mounted at the best location to ensure engine’s proper starting performance in cold operation condition. See figure 3-6.

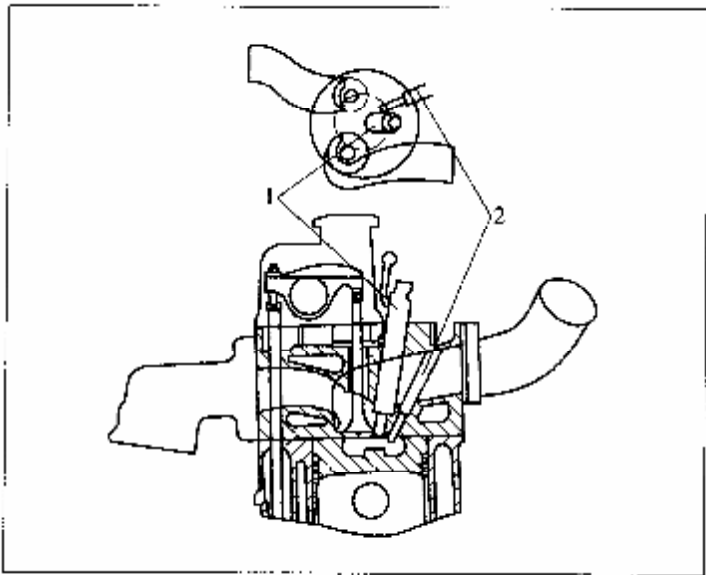


Figure 3-6 Cylinder mounting
1. fuel injector 2. glow plug

Cylinder gasket is made of 5 layers of steel. Its edge is wrapped with sheet tin. Metal wire rings are embedded into the gasket, push rod hole and water holes are coated with special material that is to reinforce sealing. See figure 3-7.

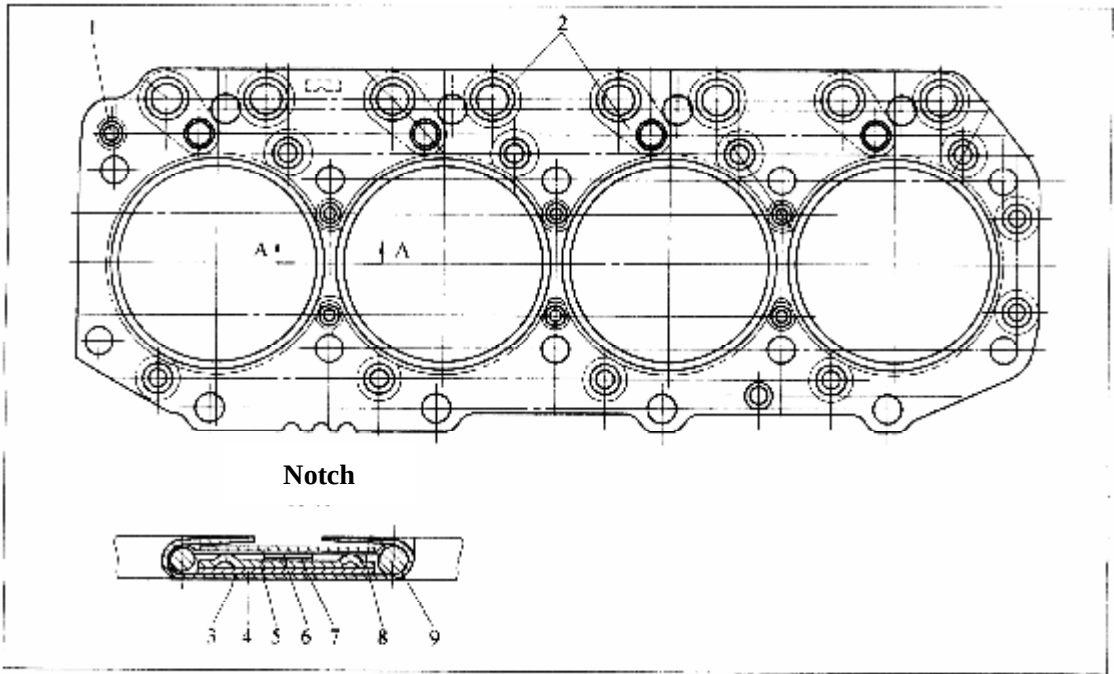


Figure 3-7 Cylinder gasket assembly

1. Oil hole 2. Coating 3.Base plate 4. Bracket plate 6. Space plate
7. Upper plate 8. Assisting plate 4. Metal wire ring

Chart 3-1 BJ493Q series diesel engine cylinder gasket thickness

Gasket notch mark	Piston top projection （mm）	Gasket free thickness （mm）
Ⓐ	0.700～0.800	1.60
Ⓑ	0.801～0.900	1.65
Ⓒ	0.901～1.000	1.70

When cylinder head has to be removed for coke-cleaning or piston dismantling, one should first drain coolant in cooling system and remove fittings with cylinder head (excl. intake and exhaust manifolds), then remove head’s 18 bolts. Remove head carefully to avoid it or 2 faces of cylinder block from getting injured. Check at the same time cylinder head for crack or distort, or gasket for damage, corrosion, oil leaking, air leak or water seeping.

Measure projection of piston top

- (1)Clean to remove carbon or gasket dirt on piston top or cylinder block top;
- (2)Use dial indicator to measure projection at measuring points ①, ③ on piston top and ② ,④ on cylinder block (see figure 3-8, 3-9). Must measure every cylinder.
- (3)Note the highest value measured, it will decide the thickness of gasket. The larger the value, the thicker the gasket will be.

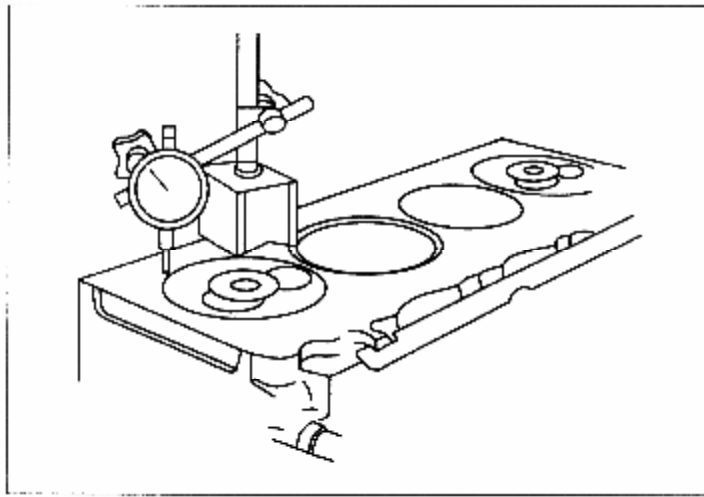


Figure 3-8 Measure piston top projection

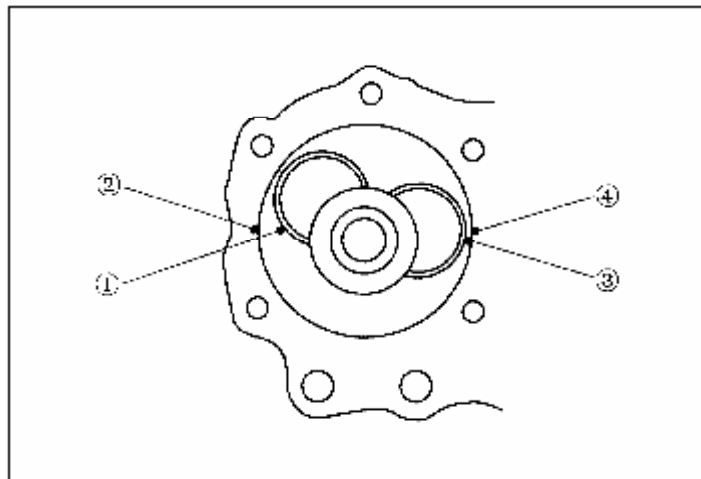


Figure 3-9 Measuring points on piston top

● **Note:** Piston top projection should be within 0.07~1.00mm.

3.4 Piston crank mechanism

3.4.1 Piston

Piston goes forward and backward in cylinder. It takes air pressure and transmits the pressure via piston pin to connecting rod. Piston is divided by top section, sealing section and skirt (guide part).

Piston top together with cylinder head constitute combustion chamber. On piston sealing section there are 2 compression ring grooves and 1 oil ring groove. Embedded ring seat is used in first compression ring groove to facilitate anti-wear and reliability. Skirt section performs guiding function and takes side pressure. A piston pin seat is on this section, it connects with connection rod via piston pin.

Piston is made of silicon aluminum alloy with tin coat that used to improve anti-abrasive capability. To control heat expansion on skirt, a steel bracket is cast into piston. Piston pin offsetting is 0.7mm to reduce colliding noise between piston and cylinder sleeve. See figure 3-10.

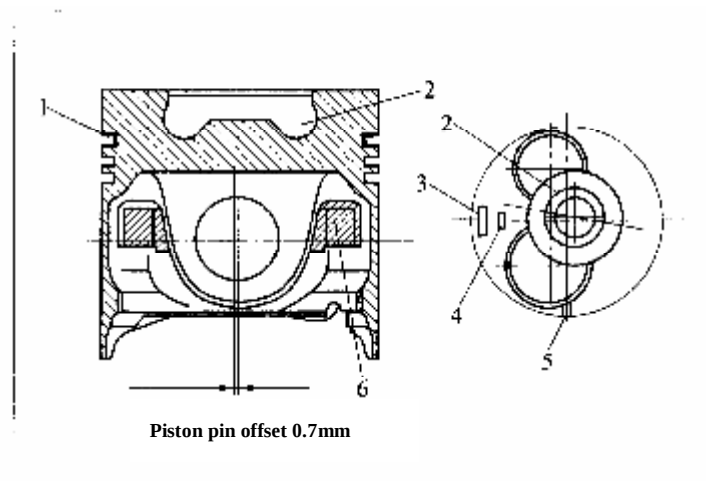


Figure 3-10 Piston ring

1-embedded ring 2-direct injection ω shape combustion chamber with restriction 3-outer diameter group mark
 4-quality mark 5-forward mark 6-steel bracket

Piston top is carved with forward mark that is supposed to point engine front at mounting. Beside, there is outer diameter group mark on piston (see figure 3-11), which indicates piston's matching cylinder sleeve.

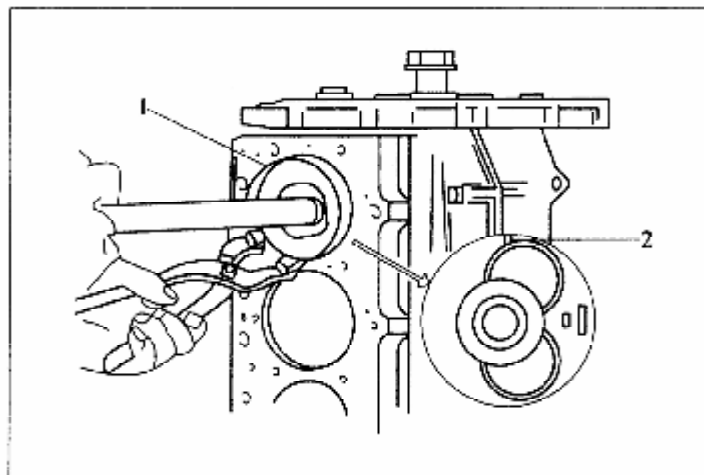


Figure 3-11 Mount piston with piston ring compressor

1.Piston ring compressor 2 Forward mark on piston

- **Note:** When mounting a piston, forward mark should point to engine front. See figure 3-11. Measure piston for any wears during service. Replace piston when wear on it exceeds limit.
- **Note:** Replace piston ring at the same time a piston is replaced.

3.4.2 Combustion chamber

Diesel engine combustible mixture is formed and combusted in combustion chamber.

BJ493ZLQ series diesel engine (ERU II) adopts direct injection round ω shape combustion chamber with restriction, a construction of higher combustion efficiency. The shape of combustion chamber indicated in figure 3-10.

The restriction designed in combustion chamber can get stronger squish swirl and micro swirl to facilitate fuel to mix with air. As thinner part of incomplete-mixed mixture produces black smoke. The restriction will

reduce these black smokes. See figure 3-12.

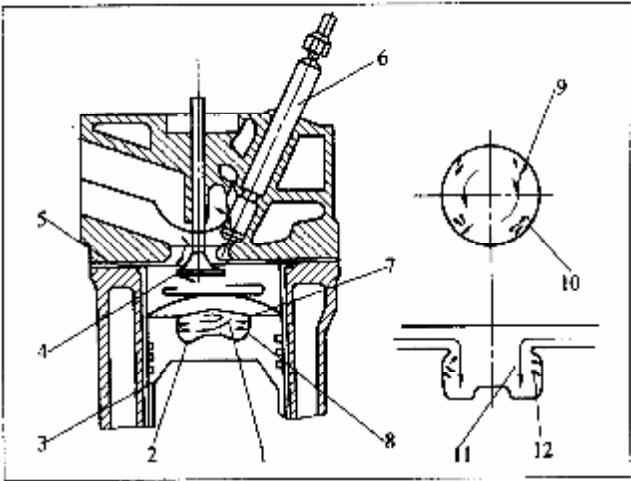


Figure 3-12 Air circulation inside cylinder

- 1.Intake swirl 2.Combustion chamber 3. Piston 4.Intake valve 5 gasket 6.fuel injector
7. restriction 8. micro swirl 9. main swirl 10. micro swirl 11. squish swirl 12. micro swirl

3.4.3 Piston ring

There are compression rings and oil ring on a piston. First compression ring is of trapezoidal shape, second compression ring is a twist ring and third ring is a pushing out (spiral spring) oil ring. See figure 3-13.

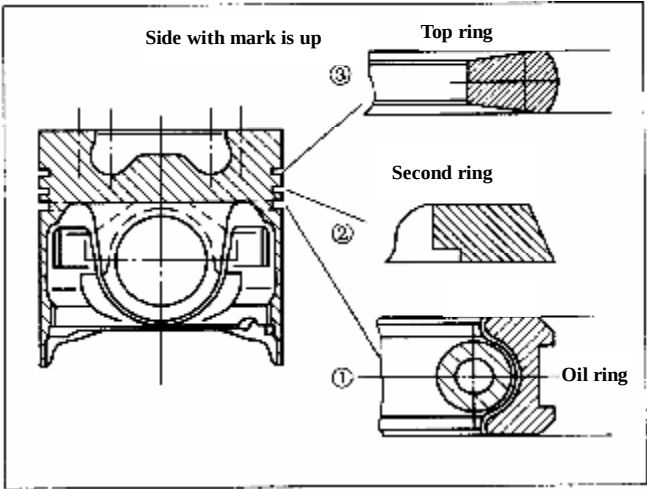


Figure 3-13 Piston ring

Piston rings were set into cylinder sleeve under normal temperature. There should be proper gap at their opens —so called “open gap”. Proper gap can help to avoid sticking due to heat expansion, and reduce leakage through gap to preserve energy and keep crankcase clean. The standard clearance values are as follows: first compression ring 0.20-0.40mm; second compression ring 0.60-0.85; oil ring 0.36-0.65mm.

Use a feeler to measure open gap after a piston has been put into a standard cylinder sleeve.

Wear on outer circle of a piston ring would enlarge open gap. air leakage would increase too, Replace ring sets when gap exceeds limit.

The height clearance between ring and ring groove is called side clearance. Proper upper limit of side clearance ensures ring could move in groove freely without sticking; and proper lower limit could help ring to

reduce oil pumping amount and restrain ring from moving up and down. Side clearance affects oil consumption. Side clearance values are as follows: first compression ring 0.078~0.137mm; second compression ring 0.045~0.090mm; oil ring 0.030~0.070mm.

Use a feeler to measure side clearance while a piston ring has been put into its relating groove.

One should comply with the requirements to side and open clearances when mounting a piston ring. Otherwise ring could stick to groove to lose its sealing or even lead to faults such as oil leak and knock.

Use piston ring tools to install 3 rings according to number sequence indicated in diagram. Put the side with “TOP” marks upward, and arrange directions of three ring’s open as indicated in figure 3-13, 3.14.

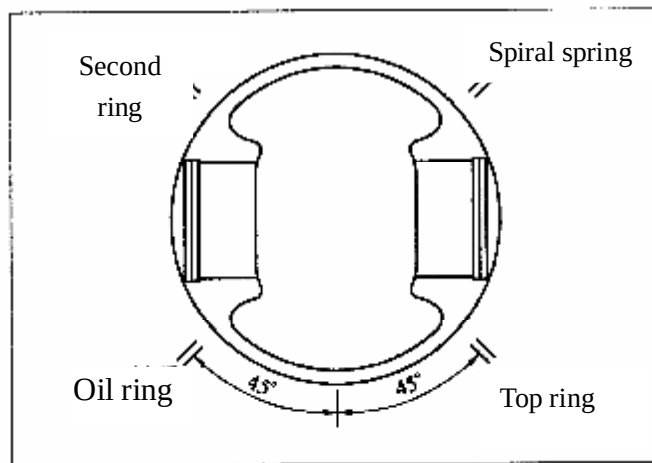


Figure 3-14 Piston ring mounting location

3.4.4 Piston pin

Piston pin is made of alloy steel. It adopts floating type. Piston pin is located with spring locating ring. There is notch at piston pinhole. Operator can simply use nose pliers to remove a spring locating ring from groove, no special tool is needed. See figure 3.15.

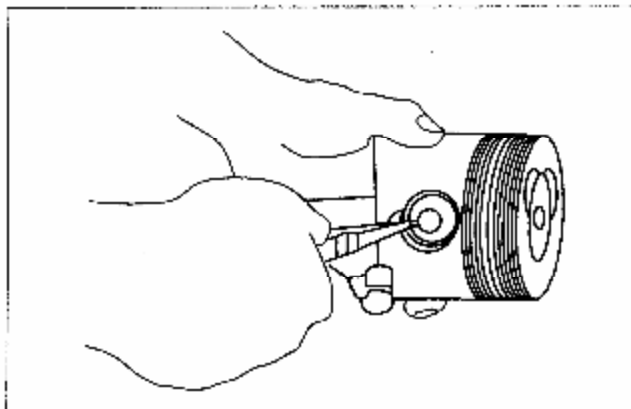


Figure 3-15 Remove spring locating ring with nose pliers

Heat piston to 70-80°C before mounting piston pin into piston.

When installing piston pin locating ring, check locating ring surface for any damage. Ring open should not align with mounting notch on piston.

3.4.5 Connecting rod and bolt

Connecting rod is used to connect piston and crankshaft. It has three sections as big end, stem and small end. Connecting rod transmits force from piston to crankshaft, and turns piston lineal movement into crankshaft rotation movement.

Connecting rod is made of alloy steel. There is steel-backed bronze alloy bush inside small end, and a small oil duct is set on the bush for piston pin lubrication. An aluminum alloy (steel-backed) bearing is mounted inside big end hole. Big end is processed together with connecting rod stem and cap in the factory, thus 4 caps are not interchangeable or reversely mounted. To avoid this, marks are carved on the right sides of cap and stem. Beside, there are projection marks on middle stem and cap. Marks should point engine front during assembling. See figure 3-16.

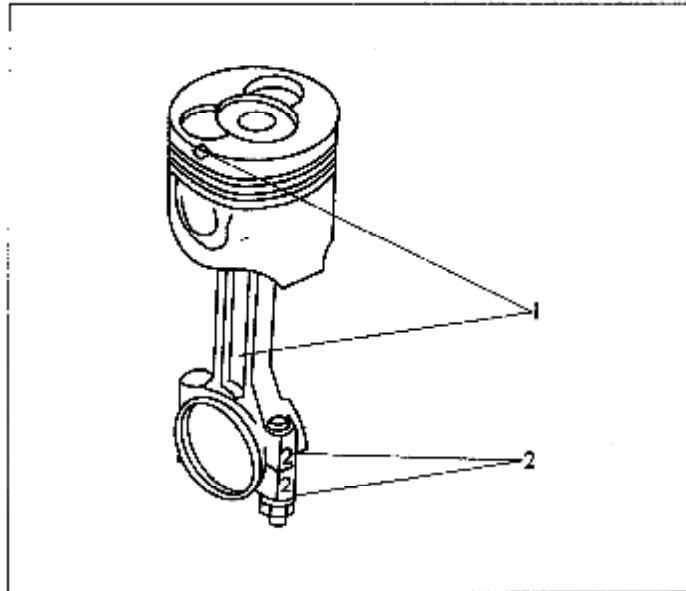


Figure 3-16 Connecting rod marks

● **Note:** Do not reverse the direction of connecting cap during assembling.

Connecting rod bolts and nuts are made of high-grade steel alloy. Before assembling, coat fitting faces of bolts/nuts with oil. Torque for bolt is 80-90N.m. Fasten bolt in two steps: first step 40-50-N.m, second step 80-90N.m. See figure 3-17.

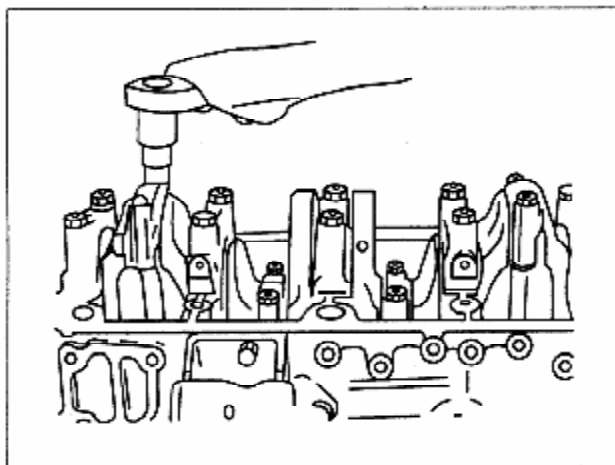


Figure 3-17 Tighten connecting rod bolt

3.4.6 Crankshaft

Crankshaft turns air pressure from connecting rod into torque, and transmits torque to transmission devices.

Crankshaft is of fully supporting type. It has been nitrified to enhance its strength to make it anti-abrasive when it is first put into use. The widths of main shaft journal and connecting rod journal are narrow to reduce friction loss. Each connecting rod journal gets oil independently to maintain an even lubrication and proper load distribution. The dynamic unbalance of crankshaft should not exceed 30g. cm.

3.4.7 Flywheel

Flywheel is a cast iron disk with larger mass, mounted at the end of crankshaft. It is used to store energy during piston explosion stroke, and release energy during other strokes to overcome resistance, letting crankshaft rotate evenly.

Flywheel gear ring is mounted on the outer rim of flywheel, used for starter to crank engine.

Flywheel is mounted on the rear end of crankshaft with 8 bolts.

● **Notes:**

(1)When mounting crankshaft pulley with connecting bolt, be sure to coat bolt thread with oil and fasten it with indicated torque (260-300 N·m)

(2)When mounting flywheel bolt, be sure to coat bolt thread and fitting face with oil. Fasten bolt diagonally with a torque of 123N.m.

Crankshaft sealing employs frame seals with thread groove (have better sealing performance). Its construction and location see figure 3-18.

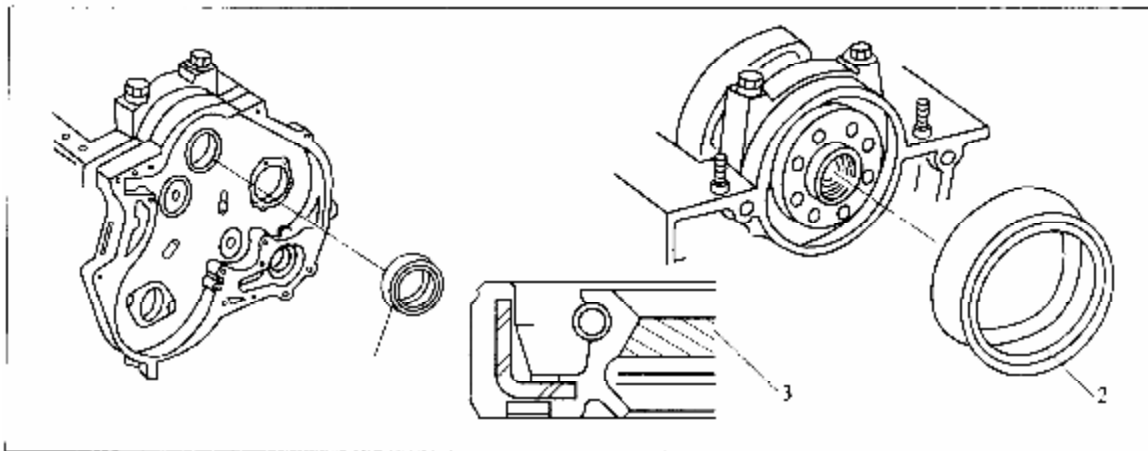


Figure 3-18 - Crankshaft construction

Crankshaft pulley adopts shock-absorber type, which is to press a rubber ring into pulley and its hub. This reduces crankshaft turning vibration and noise.

Marks at TDC and at 6° 、 8° 、 10° 、 12° 、 14° 、 16° before TDC are stamped on the circumference of a pulley. By referring them to projections on gear case cover, piston's TDC position and fuel supply advance angle are determined. See figure 3-19.

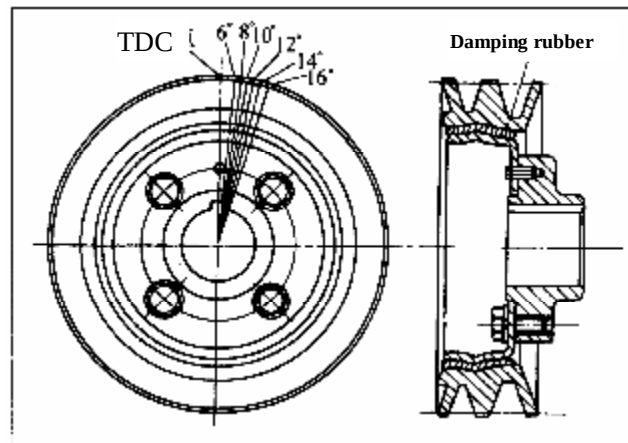


Figure 3-19 - Crankshaft pulley

3.5 Valve train

3.5.1 Intake and exhaust valve

Valves are used to control the open and close of intake / exhaust ducts.

Intake / exhaust valves are arranged vertically on cylinder head. Camshaft rotates to push tappet, push rod and rocker arm, helping valves to overcome spring force to open, and close valves again with spring force. For more air intake, intake valve disc diameter is larger than that of exhaust valve.

The fitting face between valve and seat is cone-shaped and has been grinded to avoid air leaking.

Wedge locking pins are set into the grooves at valve ends. they are used to retain spring cap and valve spring (see figure 3-20).

There are oil seals at valve guides to avoid oil from entering cylinder,

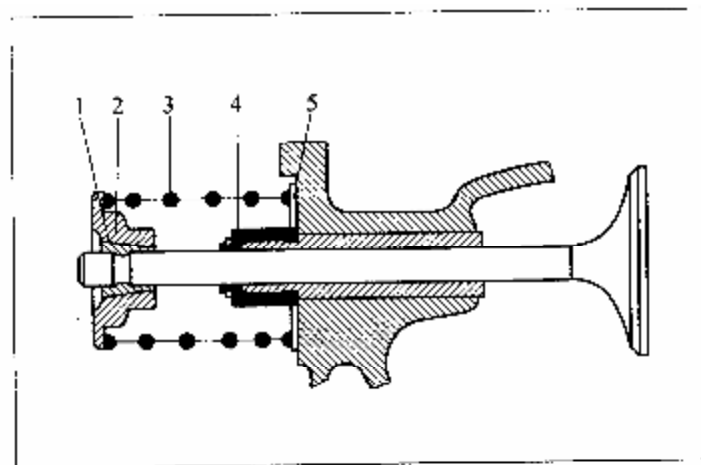


Figure 3-20 Valve mounting

1-valve locking pin 2. upper cap-valve spring 3. valve spring 4. oil seal-valve guide 5- lower cap-valve spring

3.5.2 Valve spring

Valve spring is made of cold drawn spring wire, it has been grid blasted with better anti-fatigue strength. To minimize spring vibration, valve spring pitch is varied. Press small pitch (white painted) end to cylinder head when mounting a spring.

● Warning:

Install valve spring locking pins correctly into spring seat. Otherwise, pins may detach to fall into cylinder.

3.5.3 Valve rocker arm

Rocker arm is a dual arm lever. It changes amount and direction of the force coming from push rod, then transmit the force to the valve to make it open.

To avoid rocker arm from playing axially during working, a rocker arm spring is installed on shaft between two arms.

Rocker arm head is made of sintered alloy, and its body is made of cast aluminum. Screws and adjusting nuts on rocker arm are used to adjust valve clearance.

3.5.4 Adjust valve clearance

When a diesel engine is cold, the clearance of its intake/exhaust valves is $0.4\text{mm} \pm 0.05\text{mm}$. Larger clearance will lead to serious knock, and smaller clearance will not close valve, that may burn out the valve.

Incorrect valve clearance can be adjusted according to following procedures and methods:

(1) Turn crankshaft till 1st cylinder piston reaches TDC of compression stroke (see figure 3-21), saying pulley TDC mark aligns the point on gear cover, and intake/exhaust valves in 1st cylinder are both closed. Perform adjustment on 1,2,3,6 valves (see figure 3-22).

(2) Insert a feeler into rocker arm and valve, and loosen concerning rocker arm locking nut, turn adjust screw with screwdriver till feeler becomes snug. Then retighten nut (see figure 3-23).

(3) After adjustment is done, turn crankshaft 360 degree. At the moment, 4th piston is at its TDC of compression stroke. Perform same adjustments on remaining 4,5,7,8 valves. (See figure 3-24)

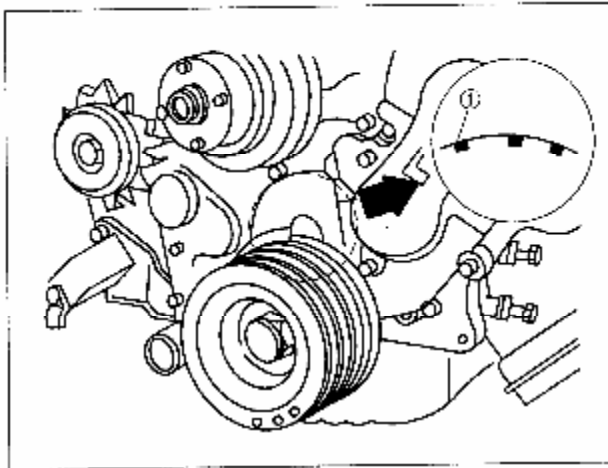


Figure 3-21 Turn crankshaft till piston reaches TDC of compression stroke

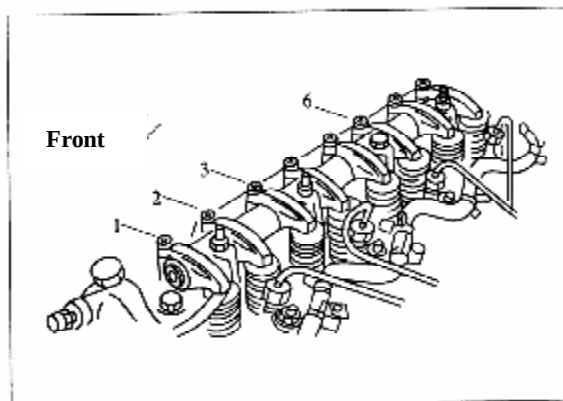


Figure 3-22 Valve clearance adjustment, valve 1,2,3,6

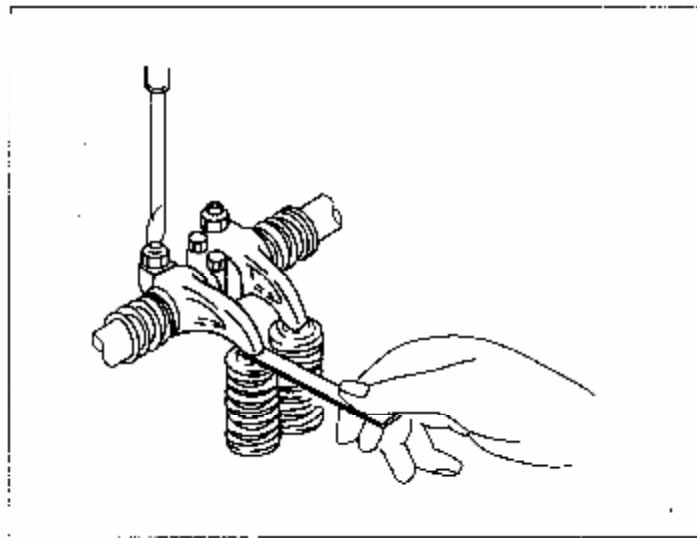


Figure 3-23 Check valve clearance with feeler blades

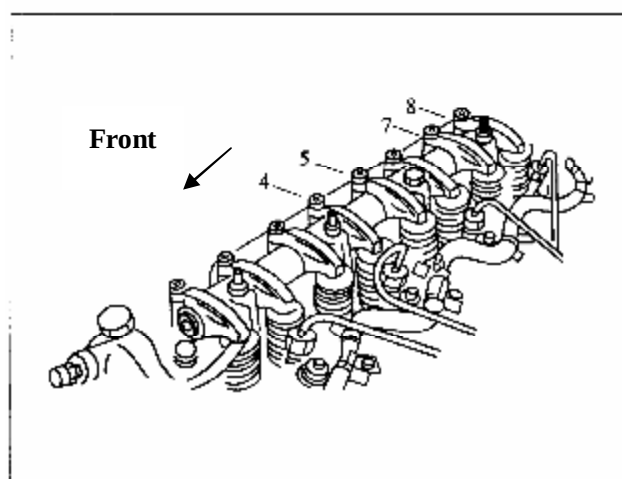


Figure 3-24 Valve clearance adjustment, valve 4,5,7,8

3.5.5 Grind valve and check valve sealing

Check valves together with valve seats after a diesel engine had worked 600 hours. Worn-out or burnt-out valves have to be grinded to restore its sealing. Check valve earlier than 600 hours in following cases: a engine has worked longer time under heavy load; fuel system does not work well; air filter is damaged or engine has taken too much dust.

(1) Grind valve

When wear is minor on valve and valve seat, they can be corrected by manual grinding. Here are the procedures:

Remove carbon at valve and valve seat guide, and coat a thin layer of valve sand on valve cone face. Suck to fix the valve with rubber cup (with wood handle), slap and turn to grind valve. Each turn should be less than 90 degree. Grind valve till a layer of even and unglazed band (width 1.5-2mm) is seen at valve cone. Larger band will lead to poor sealing while narrower one restrains heat radiation. There are two types of valve sand (thick and thin), select right type according to actual wear and burning conditions. Usually use thick sand for preliminary first or second grinding, and thin sand after that. After grinding operation, clean valve, seat guide with diesel. Any sand

leftover is not allowed. And check valve sealing finally.

(2) Check valve sealing

Mark with pencil 8-12 lines (see figure 3-24) along the circumference of valve head cone. Put valve back and slap valve seat gently many times (do not turn valve). If pencil lines cut off in the middle of band, it indicates sealing is well. Another method is to remount valves and springs, pour kerosene into intake and exhaust ducts. If no leakage is seen in 2-3 minutes, it indicates the sealing is well.

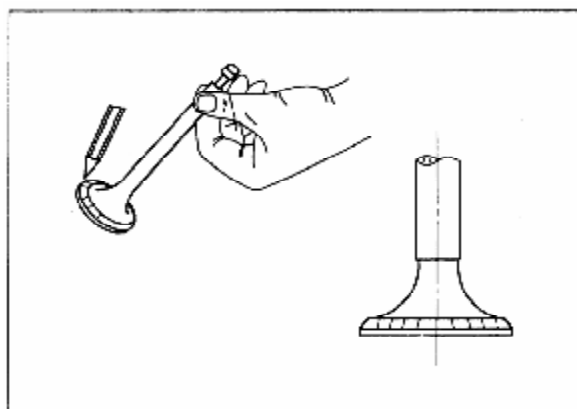


Figure 3-25 Check valve clearance for sealing

3.5.6 Rocker arm shaft

The turning face of rocker arm has been hi-frequency quenched to enhance surface hardness to improve abrasive resistance.

● **Note:** Install rocker arm with oil hole end directing to front.

Valve system lubrication oil goes from 1st journal of camshaft to oil hole on cylinder head, and then goes into rocker arm shaft via 1st bracket to each rocker arm. See figure 3-26.

When assembling a rocker arm shaft, one should tighten shaft bolts at the same time as per the sequence indicated in figure 3-27. Tightening torque is 49-59 N·m.

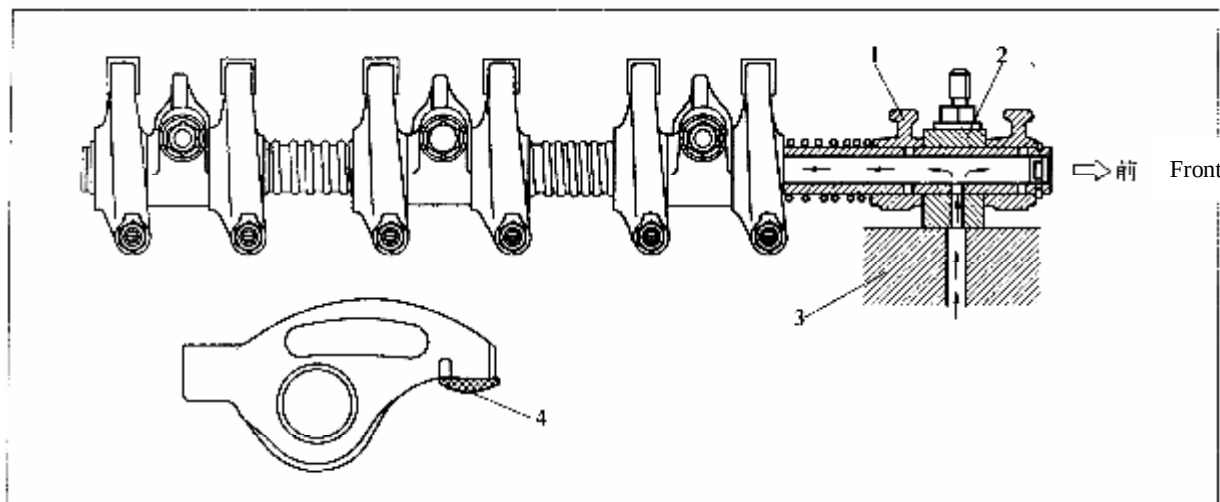


Figure 3-26 Rocker arm and lubrication

1-rocker arm 2-rocker arm bracket 3-cylinder head 4-sintered alloy

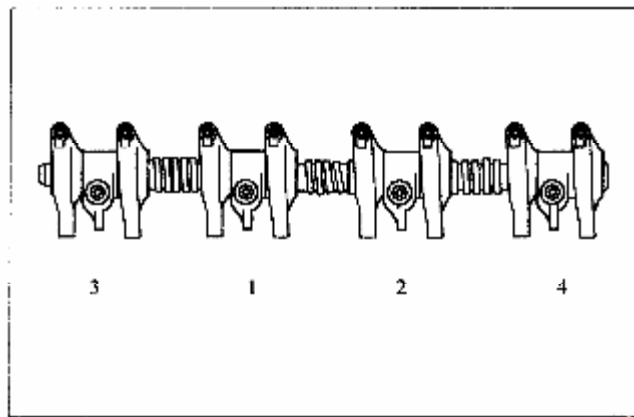


Figure 3-27 Tighten rocker arm bolts according to sequence

3.5.7 Push rod

Push rod transmits force from cam and tappet to rocker arm.

Push rod stem is of hollow type, push rod head and ball welded on both sides.

3.5.8 Tappet

Tappet transmits pushing force from camshaft to push rod, and takes side forces created by turning cam.

Tappet is made of alloy-chilled cast iron with a shape of mushroom to reduce inertia force. Its fitting face with flywheel has been hi-frequency quenched to enhance surface hardness to improve wearability.

3.5.9 Camshaft

Camshaft is the driving shaft for valve system. Camshaft has intake/exhaust cams on it, each cam controls open/close timing and open height of each valve.

Camshaft has 3 supporting journals. Shapes of intake and exhaust cam are the same. Cam's base circle diameter is 35.5mm, its max. lift is 6.511mm.

Fitting clearance between camshaft journal and sleeve is 0.15-0.085mm. Camshaft axial clearance is determined by thickness difference between thrust plate and thrust flange, the axial clearance is 0.05-0.14mm. See figure 3-28.

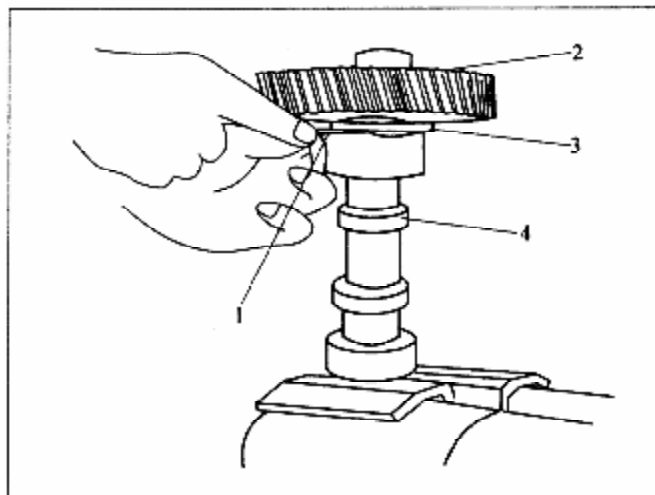


Figure 3-28 Measure camshaft axial clearance

1-feeler 2-camshaft gear 3-upper thrust plate 4-camshaft

3.5.10 Gear case

Gear case is made of ZL104. There are 5 gears inside: crankshaft gear, camshaft gear, and injector pump gear, upper and lower idlers. There are “x, Y, z V” marks on gears (see figure 3-29). Align marks during assembling to guarantee correct valve distribution and fuel supply. During operation, crankshaft gear drives lower idler (mounting mark is “x”); lower idler drives camshaft and upper idler (marks are “Y” and “z”); upper idler drives fuel pump gear (mark is “V”).

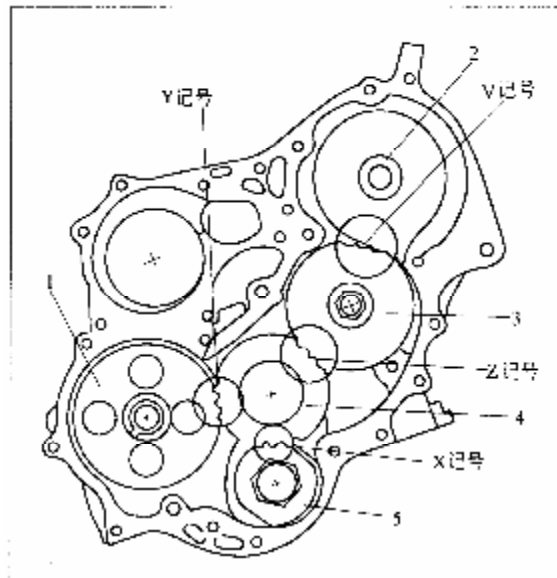


Figure 3-29 Gear driving and marks

1-camshaft gear 2-injecting pump gear 3-upper idler 4-lower idler 5-crankshaft gear

● **Warning:**

(1) Be sure to align marks during assembling. Otherwise diesel engine may not start up or its power decreases and fuel consumption goes up, or valve mechanism parts get damaged. In the case marks are blurred or gears are worn-out, whole gear mechanism should be replaced.

(2) Oil hole in lower idler should be turned to upper side during assembling. See figure 3-30.

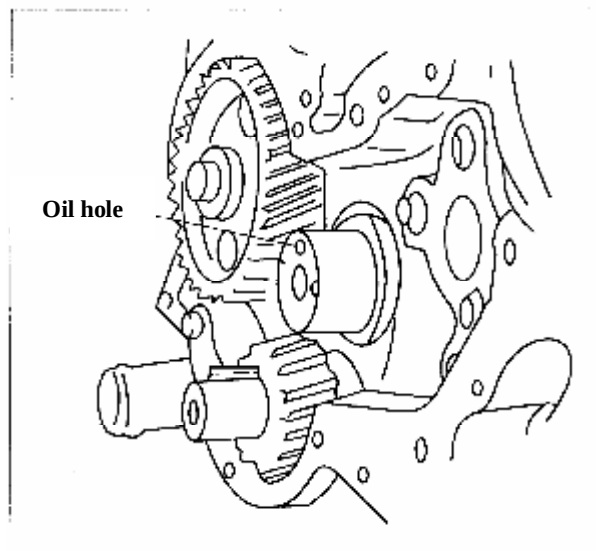


Figure 3-30 Assembling of lower idler shaft

3.5.11 Gear case cover

Gear case cover is made of ZL104. To minimize transmitting noise inside timing gear case, a noise damping cover is added onto gear case cover.

3.6 Lubrication system

3.6.1 Lubrication system construction

BJ493ZLQ series diesel engine combines to use pressure and splash type lubrications.

BJ493ZLQ series diesel engine lubrication system (see figure 4-31) includes oil pan, oil strainer, oil pump, oil filter, oil cooler, cylinder block main oil duct, oil pressure sensor and oil pressure gauge etc.

Parts using pressure lubrication are supercharger, main bearing, connecting rod bearing, camshaft bearing, rocker arm shaft, rocker arm, valve regulating screw, injector pump gear, upper/lower idlers gear faces, crankshaft upper thrust bearing and lower idler shaft bearing.

Supercharger uses pressure lubrication. This way will ensure rotor and bearing can get sufficient lubrication and cooling under normal operation. The lubrication duct route goes as follow: oil flows through cylinder block main oil duct to enter supercharger via oil inlet tube, and flows back to oil pan via oil return pipe.

To avoid supercharger from leaking oil, its oil passage must be clear all the time. Oil return pipe’s section dimension and shape should not be changed.

Parts using splash lubrication are piston, piston ring, piston pin, cylinder sleeve, camshaft, oil pump gear etc. (see figure 3-32).

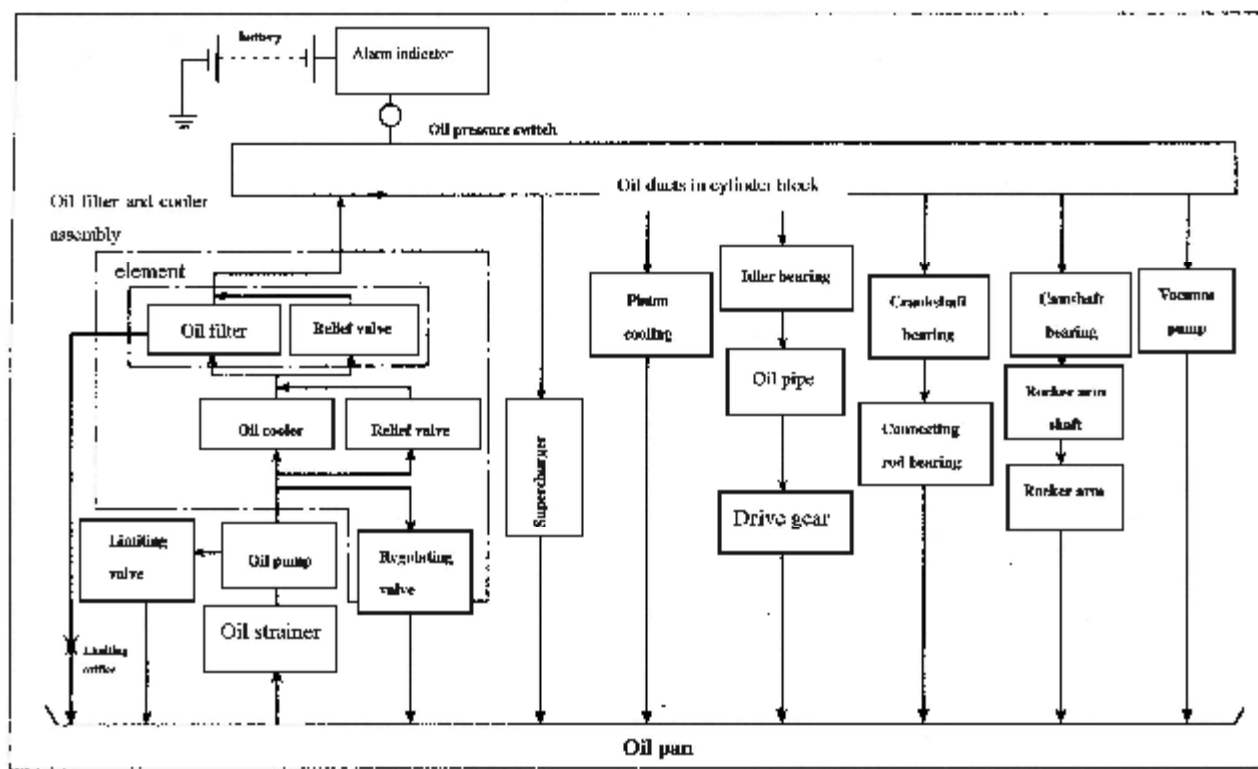


Figure 3-31 Diesel engine lubrication system

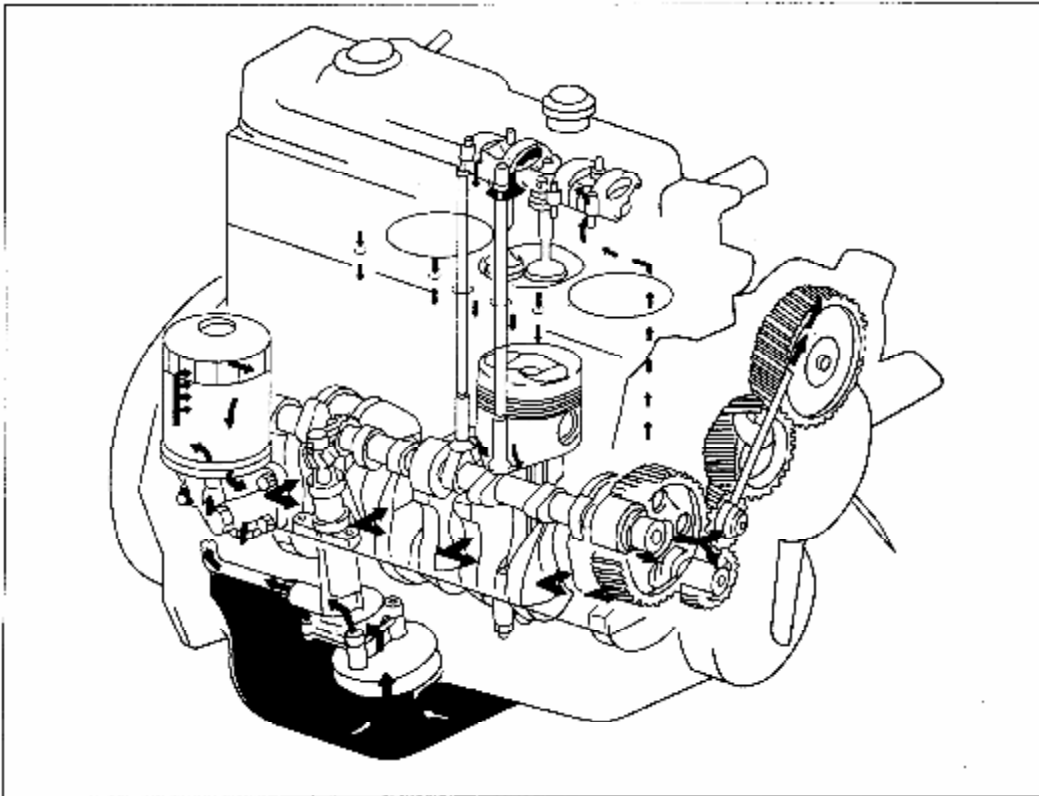


Figure 3-32 Diesel engine lubrication system oil circuit

3.6.2 Oil filter

Oil filter is used to filter out metal, dirt and oxidized paste from oil.

Oil filter consists of filter base sets, cooler, element and sealing ring (See figure 3-33). Inside the filter are a relief valve and a limiting valve that takes excess oil back to oil pan.

The working range of oil filter limiting valve is $0.45\text{Mpa} \pm 0.02\text{Mpa}$. It has been adjusted in the factory do not carry out work on it in normal condition. When oil filter is removed or mounted, one should install rubber-sealing ring correctly to avoid oil leaking.

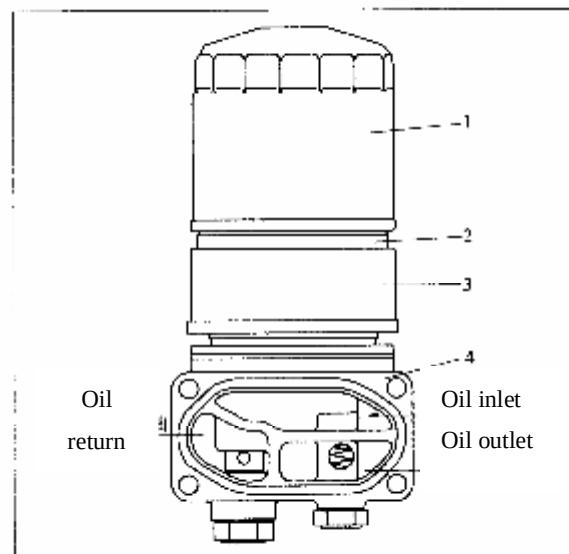


Figure 3-33 Oil filter

Note: There should be no oil leaking on the mating face between filter case and seat, and no part gets damaged.

3.6.3 Oil pump

Oil pump is used to push oil to cycle in the system.

Oil pump is a gear pump, fixed in cylinder block. Spiral gears both in camshaft and oil pump drive it. Oil strainer is installed under oil pump to suck relatively clean oil (see figure 3-34).

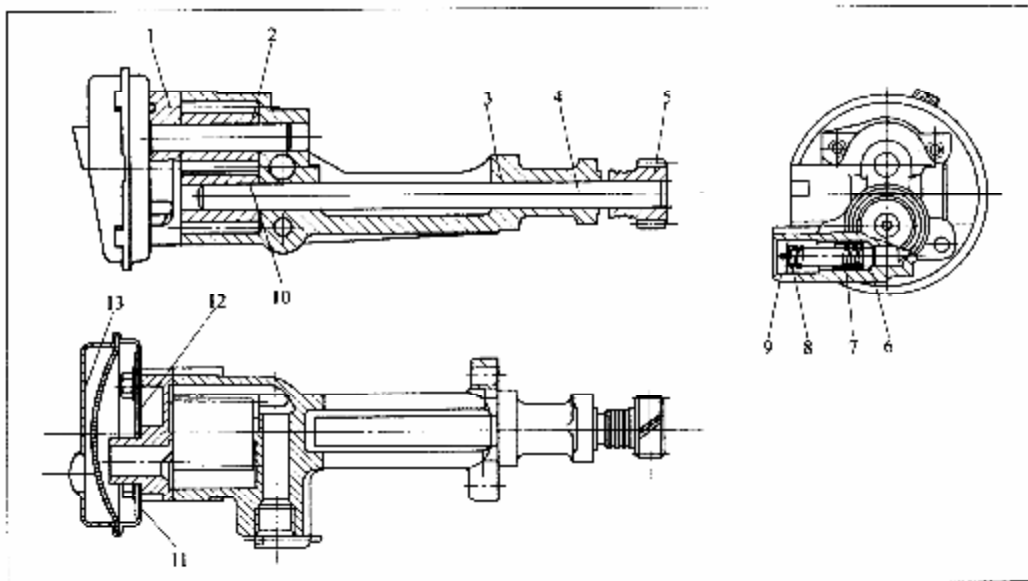


Figure 3-34 Oil pump

1-oil pump cover 2-oil pump sets 3-oil pump body 4-drive shaft 5-transmitting gear-oil pump

6-plunger-limiting valve 7-limiting valve spring 8-spring cap 9-cotter pin 10-oil pump gear

11-oil pump cover bolt 12-filter screen case sets 13-filter screen cover sets

Technical requirements to oil pump installation:

- (1) Installed oil pump should turn freely and smoothly.
- (2) There should be no oil seeping on fitting face between pump body and cover.
- (3) Open pressure of limiting valve is 0.61-0.76Mpa.
- (4) Open pressure can be adjusted by adding adjusting shim into the plunger.
- (5) Fastening torque for 4 bolts on oil pump cover is 20N.m+-5N.m.

● **Note:**

(1) Oil pressure lower than specified value indicates there is fault in the system. Check and service are needed.

(2) Oil pressure meter is the one deserves to be watched much carefully. Failure meter should be replaced timely to ensure accurate and reliable readings.

3.6.4 Oil pan

Oil pan is used to seal crankcase, collect and restore lubrication oil.

Check installed oil pan for any leakage. Check should be performed while diesel engine is hot. Tighten bolts and nuts at concerning location where leakage happens. In the event leakage cannot be removed after bolts have been tightened, one should dismantle parts to check or replace rubber washer.

3.6.5 Oil dipstick

Oil dipstick is used to check lubrication oil level in the system.

There are two round holes in dipstick that are used to check oil level.

3.6.7 Oil pipe sets used to cool piston

These pipes are consisted of injecting pipe and limiting valve, they help to cool piston to let piston work well under high temperature and high load.

Use torque wrench to fix oil pipes, tightening torque is (60+5) N-m.

3.7 Crankcase ventilation devices

BJ493ZLQ series diesel engine uses natural ventilation. Crankcase should be sealed to prevent gas in the casing from escaping to air. When pressure in crankcase increases, gas enters intake pipe via vent diaphragm valve on valve cover. In order to reduce oil fog escaped from vent hole, an oil deflector is installed at vent hole (see figure 3-35).

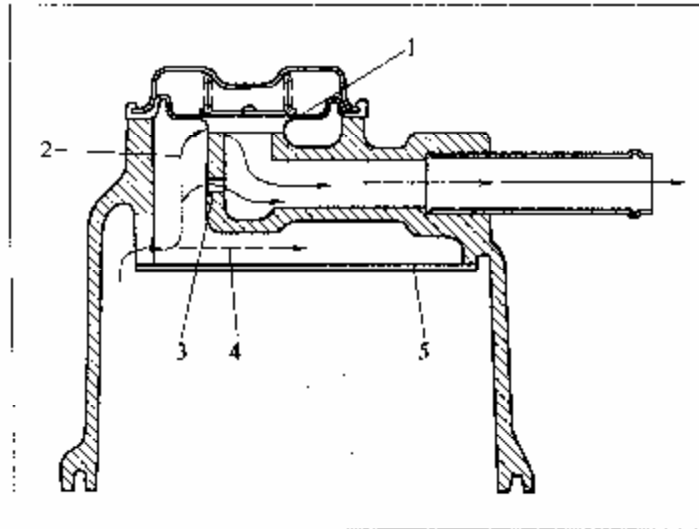


Figure 3-35 Crankcase ventilation devices

1.diaphragm 2.air/fuel gas 3.bypass orifice 4.oil 5.oil baffle

● **Note:** Check crankcase ventilation devices regularly to maintain its performance.

3.8 Cooling system

3.8.1 Cooling system construction and application

BJ493ZLQ series diesel engine cooling system is of closed water-cooling type (circulation under pressure). Its operation process see figure 3-36.

Following parts composes the system: water jacket in cylinder block and head, centrifugal water pump, radiator fan, thermostat, drain plug and radiator.

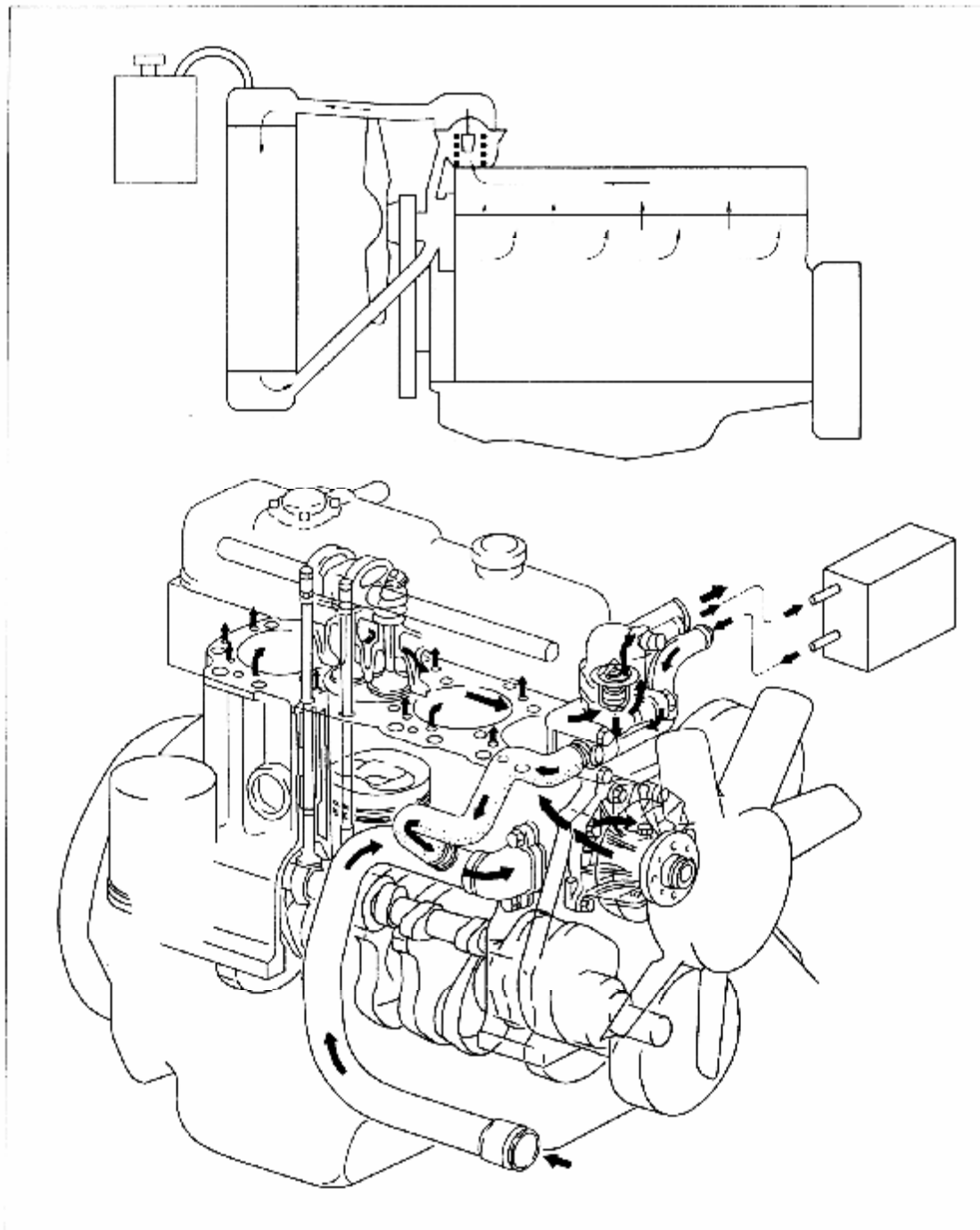


Figure 3-36 Diesel engine cooling system

When coolant temperature is under 82°C , thermostat valve keeps closed. Water flows into water pump via bypass passage to perform small circulation (does not flow through radiator). When coolant temperature goes up over 82°C , thermostat valve opens. Water cycles to flow inside radiator, while the bypass valve under thermostat cuts off bypass passage. All cooling water flows to radiator to perform larger circulation.

● **Warning:** In cold season, if a diesel engine that does not use antifreeze needs to be stalled for longer time, one should drain all cooling water inside diesel engine and radiator. Ice may hurt cylinder block or radiator.

3.8.2 Water pump

Water pump drives coolant to circulate to cool down engine, ensuring reliable diesel engine cooling.

Water pump is of centrifugal type composed by impeller, case, shaft/ bearing and water sealing. Its construction see figure 3-37. Impeller diameter is 76mm with 6 blades. Pump body is aluminum casting. O-rings are installed at pump's mounting location for better sealing.

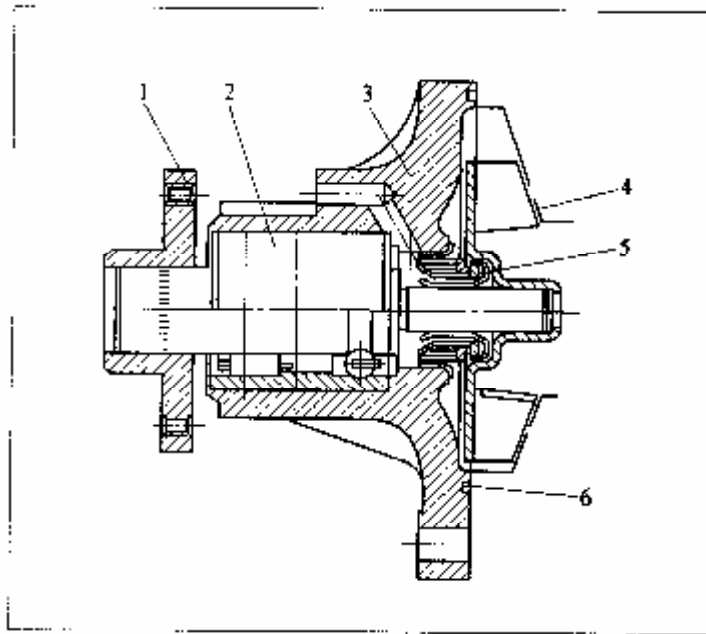


Figure 3-37 Water pump construction

1-flange disc of water pump pulley 2-shaft/bearing

3-water pump body 4-propeller 5-water sealing 6-O-ring

Never run water pump dry to avoid water sealing from damaged early by heat. When water sealing is faulty, cooling water flows out from an overflow hole under pump case, so overflow hole should be cleared all the time to prevent leaking water from damaging the bearing.

When water pump works at 3000r/min with flow of 100L/min, its pressure head should be larger than 5m.

3.8.3 Thermostat

Thermostat automatically changes radiator flow according to engine temperature to maintain engine in a proper operation temperature.

Thermostat is of wax type. It is mounted in cylinder head outlet pipe. A bypass valve under thermostat closes when thermostat valve opens, coolant then flows into radiator to improve cooling (see figure 3-38).

Thermostat primary open temperature is $82^{\circ}\text{C} \pm 2^{\circ}\text{C}$, full open temperature is 95°C . Full open travel is no less than 8mm.

Test thermostat: remove thermostat, put it into a container with water to warm it up gradually. Observe temperature with a thermometer. While water temperature is changing, check if valve closes or opens as required (see figure 3-39), otherwise replace thermostat.

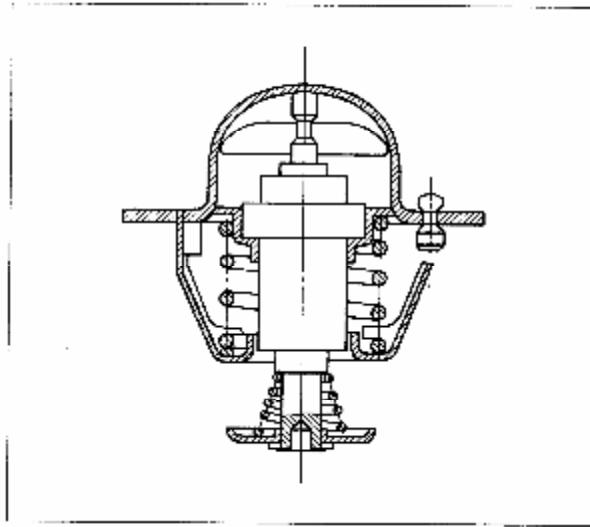


Figure 3-38 Thermostat

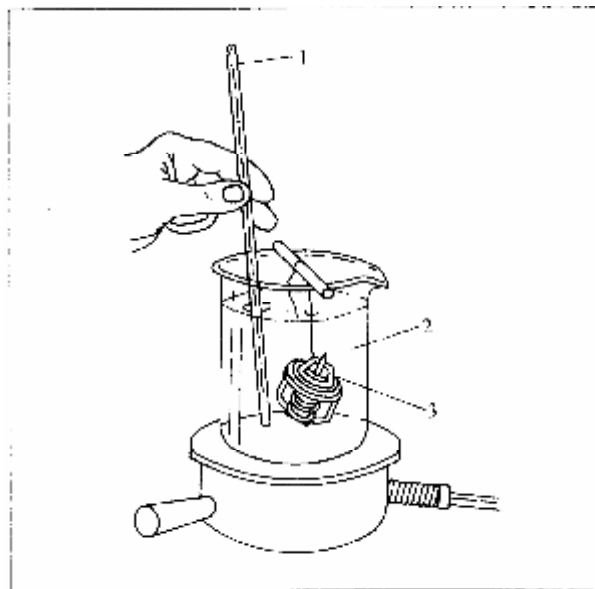


Figure 3-39 Check thermostat

1-thermometer 2-water under heating 3-thermostat

3.8.4 Radiator fan and fan clutch

Radiator fan blows air quickly across radiator fin, helping to cool down coolant.

Fan is installed on front end of water pump and shares a shaft with water pump. It is driven by crankshaft pulley with a belt.

Fan belt tension should be snug. Loose belt will lead to slippery between belt and pulley, which may decrease heat radiation in cooling system and accelerate belt wear; too tight belt may lead to early wear on fan bearing and belt, and increase power consumption. Check belt tension regularly.

To install fan belt, first put belt into alternator and water pump pulley grooves, then into crankshaft pulley grooves. Pry engine with pry bar to tighten belt, then fasten locking bolts.

Check and adjust fan belt tension: under pressure of 68.6-98N.m, the deflection of new belt is 5-7mm, and old belt is 7-8mm.

- **Warning:** Stop the engine before checking, adjusting or adjusting fan belt.

3.8.5 Radiator

Radiator is a pressure water tank, it radiates coolant temperature to air. Radiator mainly includes upper and lower water tanks and radiator fin. Inlet pipe of upper water tank connects to cylinder head outlet pipe, and outlet pipe of lower tank connects to water inlet pipe (see figure 3-36).

Coolant (hot water) enters radiator from cylinder head. Heat in coolant is radiated to air via radiator.

Auto manufacturer assembles radiator. Its construction and maintenance see “Vehicle use and maintenance manual”.

3.8.6 Remove scale in cooling system

After diesel engine has operated for a period of time, there will be scale formation in its cooling system if no special anti-freeze and rust proof coolant has been used. Scale accumulation decreases cooling and should be removed.

Use solvent (150g caustic soda with 1 L water) to remove scale from the system

Cleaning procedures and methods as follows:

- (1) Drain coolant completely before cleaning. Remove thermostat and add detergent into radiator.
- (2) Run engine at moderate Rpm for 5-10 min, and shut it off to wait for 12 min.
- (3) Restart engine and vary its Rpm with speed regulating handle. This is to flush scale or sediment. At the moment water temperature reaches 70°C ~ 80°C, stop engine and drain detergent.
- (4) Cool down engine for a while. Add clean water from radiator cap. Start up to run at idle to circulate water. Check drained water till it is clean. Tighten water drain plug, shut off engine. Re-mount thermostat and add coolant.

3.9 Fuel supply system

3.9.1 Fuel supply system parts

Diesel engine fuel supply system consists of fuel tank, pipe, oil-water separator, fuel filter, hi-pressure fuel pipe and injector (see figure 3-40).

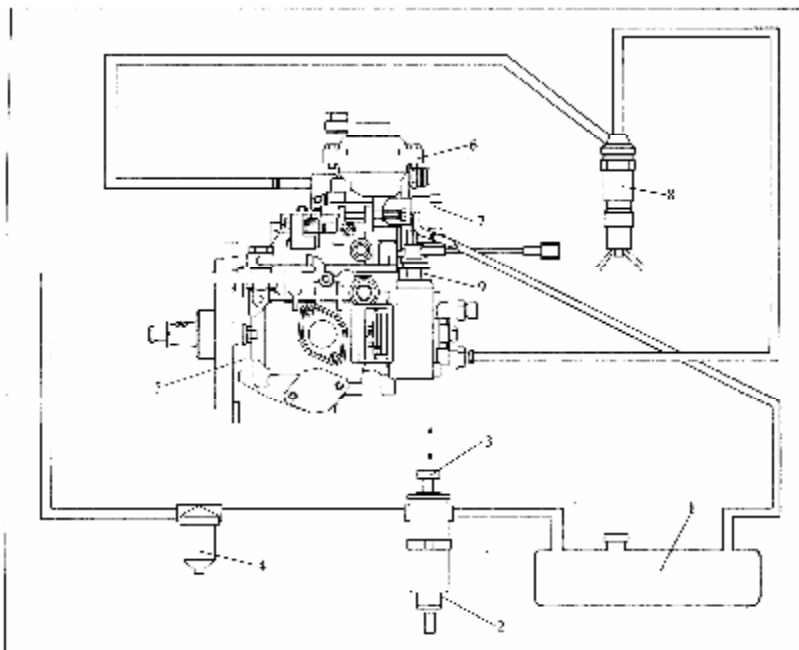


Figure 3-40 Diesel engine fuel system

1-fuel tank; 2-oil-water separator; 3-hand pump handle of oil water-separator; 4-fuel filter; 5-VE fuel injection pump; 6- boost compensator; 7-oil return plug; 8-fuel injector; 9-fuel shutoff solenoid

3.9.2 Fuel tank

A fuel tank is a diesel container. It is generally made of sheet steel by press-welding process.

Fuel tank was equipped in auto plant. A fuel level sensor is installed inside the tank to indicate timely fuel amount to driver during driving. Its indicator is mounted on instrument panel in driver cab.

3.9.3 Fuel filter

Fuel flows into the filter, and then is pressed into filter element to remove foreign particles and water. Fuel from filter enters fuel injection pump through fuel outlet connector. The fuel filters used in BJ493ZLQ series of diesel engine adopt paper element or spin-on canned elements for easy replacement.

● **Notes:** Please strictly abide by the technical maintenance requirements, performing regular maintenance on fuel filter to ensure fuel clean.

3.9.4 Fuel injection pump

Fuel injection pump is to increase fuel pressure and feed fuel to combustion chamber at rated time, amount and pressure according to demands in working process.

BJ493ZLQ series diesel engine adopts VE distribution-type fuel injection pump. Its plunger/bushing, delivery valve / valve base are precision couplers which are not interchangeable.

Diesel engine immobilizer is controlled by a solenoid on fuel injection pump. It cuts off fuel supply.

VE fuel injection pump adopts self-lubricating method; it lubricates itself with diesel in pump body. Meanwhile diesel also helps to cool down heating locations.

VE distribution-type fuel injection pump has a hydraulic mechanism that adjusts fuel supply advanced angle. The fuel pressure in the pump, while diesel engine is working, will vary with rotating speed of the driving shaft. Fuel supply advance angle can be adjusted automatically by changing piston travel of hydraulic advance device.

● **Note:** The adjusting screws in fuel injection pump have been set in the factory; they should not be dismantled or adjusted at will. You are supposed to go for professional help when something is wrong with fuel injection pump. A tune-up test can, if necessary, be done on a special testing stand.

3.9.5 Oil-water separator

Oil-water separator is a canned fuel filter with oil /water separating parts (see figure 3-41). It is mounted on engine frame near the fuel tank (see figure 3-40).

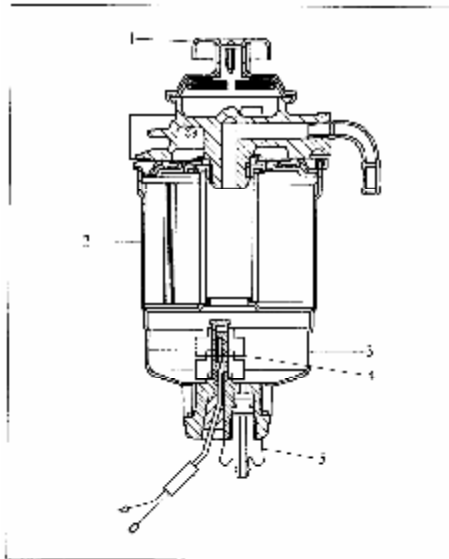


Figure 3-41 Oil-water Separator

1-hand pump; 2- filter can; 3-water level alarm; 4-reed contact switch; 5-drain plug

Oil-water separator, taking advantage of the specific density difference of water and diesel, separates water from oil in water pool under filter can. There is a water-alarming device in water pool, it triggers alarm indicator on instrument panel when water volume reaches 80cc. Water drainage alarm device consists of a reed contact switch and a float with a magnet inside. The float sinks usually at the bottom as its specific density is designed smaller than that of water but bigger than that of diesel. It goes up with water rising in the pool to connect reed contact switch. (See figure 3-41)

● **Notes:** When indicator light is turned on, loosen drain plug under filter to drain water immediately.

3.9.6 Fuel injector

Fuel injector is used to atomize fuel into mist and distribute them in the combustion chamber to mix with air, so as to form good combustible mixture.

BJ493ZLQ series diesel engine adopts P-series 5-orifice fuel injector. After having taken full account of the layout of intake/exhaust valves and characteristics of a circular combustion chamber, the injector is set at the location that faces combustion center. At this location, oil mist can be jetted via the nozzle at a specific angle into the furthest end in combustion chamber. The injection pressure differences among injectors on a same engine are not more than 0.5Mpa. The pressure can be adjusted by replacing the adjusting washer. Fuel injector has a structure featuring small in size and light in weight. The pressure adjusting spring is designed as small as possible, and injector push rod as short as possible. By minimized motion parts' mass and inertia, fuel injection operation could be complete, and secondary injection therefore is prevented. These help to improve emission and reduce fuel consumption.(see figure 3-42)

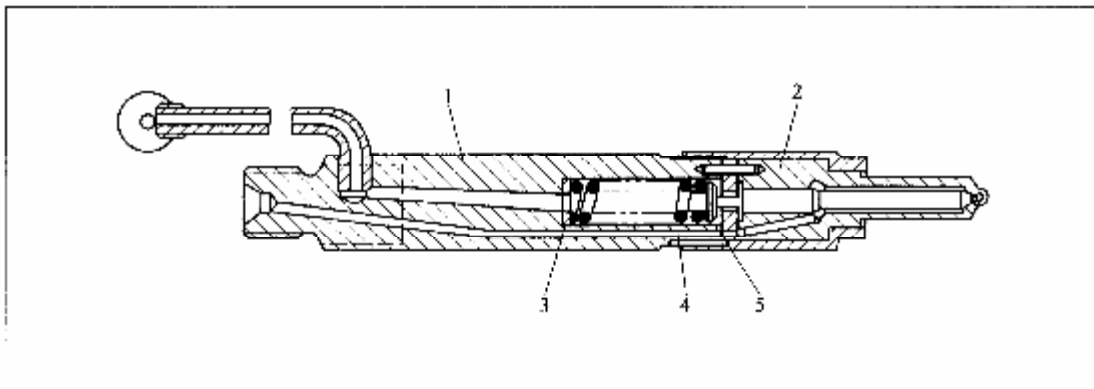


Figure 3-42 fuel injector

1-injector body ; 2-injector top; 3-injection pressure adjusting washer; 4-spring; 5-injector push rod

Malfunction of a fuel injector will lead to uneven engine Rpm and black smoke emitting. In order to find which injector is faulty, you should set throttle on a position where engine Rpm is most irregular, unscrew high pressure pipe joint nuts on fuel injection pump top to shut off fuel supply to relevant cylinder. If the engine Rpm does not change much at a cylinder whose fuel has been cut off while engine emits less smoke, injector in this cylinder must be faulty and should be removed.

3.9.6.1 Check injecting quality. Put a fuel injector on test stand to observe its spraying quality (see figure 3-43). Clean, adjust and even replace injector in the events of poorly atomization, fuel spills, leakage and strange injecting sound.

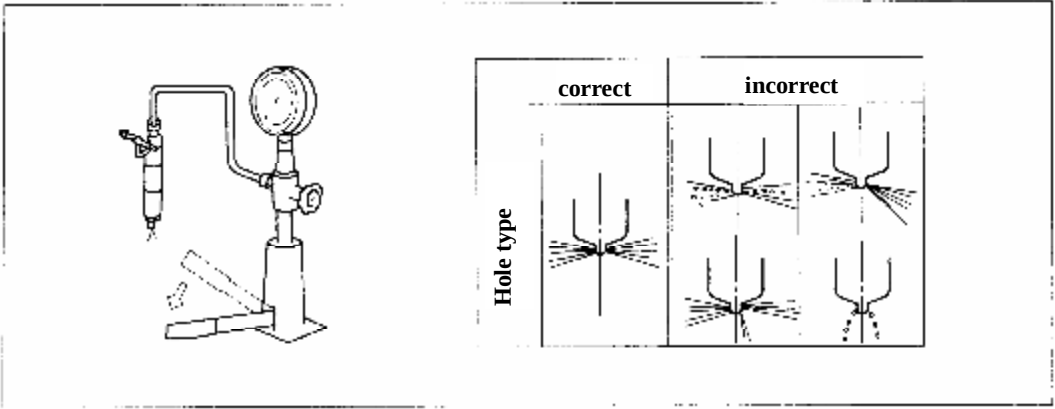


Figure 3-43 Check injecting quality of a fuel injector

A normal injecting quality is identified with following conditions: fine fuel mist; a certain cone angle (between 4-12, see figure 3-43); clear sound of “pop, pop...” clear and quick fuel shutoff; no dipping or leaking after injecting. Moisture at injector tip is allowed.

3.9.6.2 Check and adjust fuel supply advance angle. Correct injection timing determines if a diesel engine can operate well and reliable. Even a minor error will increase fuel consumption and decrease engine power. So, fuel supply advance angle should be adjusted carefully and precisely.

Procedures to adjust fuel supply advance angle:

(1)Check if the cutting line on fuel injection pump flange aligns with center of the U-hole under pump body (see figure 3-44).

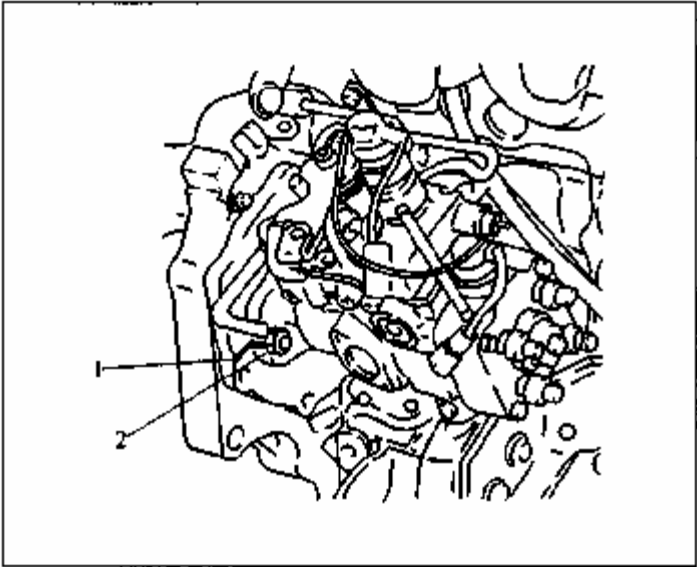


Figure 3-44 Check if the cutting line on pump flange aligns with pump body and flange cutting line
1-cutting line; 2-retaining nut

(2)Rotate crankshaft till first cylinder piston reaches to TDC of compression stroke, and TDC mark line on crankshaft pulley ① aligns with timing mark ② (see figure 3-45).

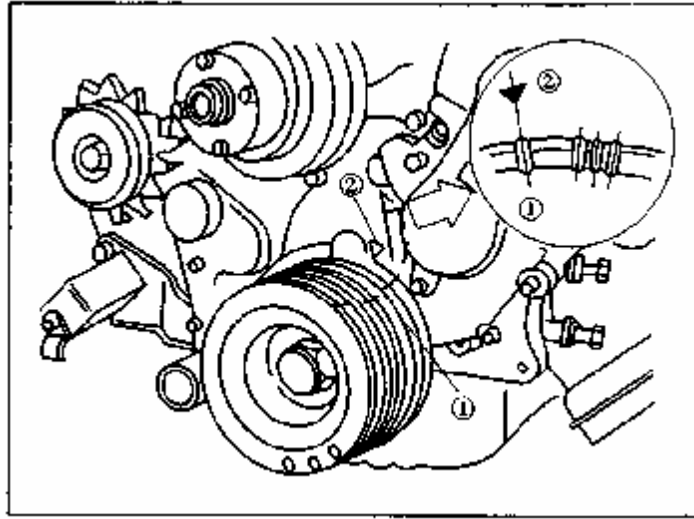


Figure 3-45 Nut to confirm first cylinder piston has reached TDC of compression stroke

● **Note:** Check idle travel of intake/exhaust valves push rod in first cylinder. If intake valve and push rod has idle travel, first cylinder piston is at TDC of compression stroke.

(1) Unscrew and remove tapered screw plunger from fuel injection pump.

(2) Install a dial indicator to measure fuel supply advance angle③ (see figure 3-46). Indicator probe should be push down inwardly by approximate 1mm.

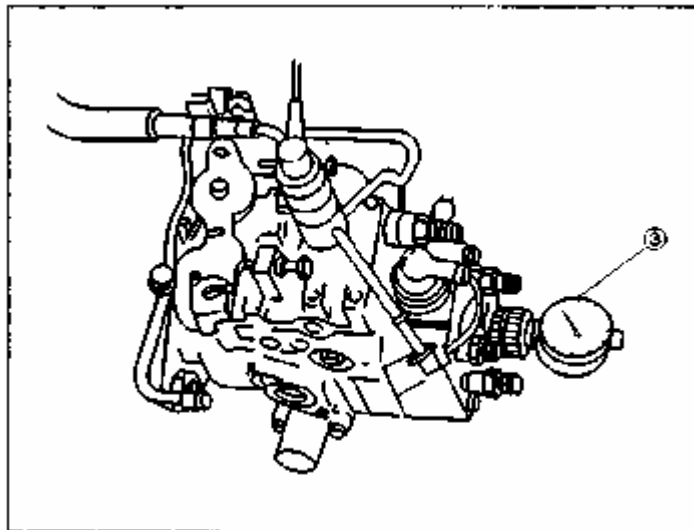


Figure 3-46 Install a dial indicator

(3) Rotate crankshaft till first cylinder piston reaches to the position $30^{\circ} \sim 40^{\circ}$ before TDC. Set dial indicator to zero. Lightly rotate crankshaft pulley both ways then check indicator reading.

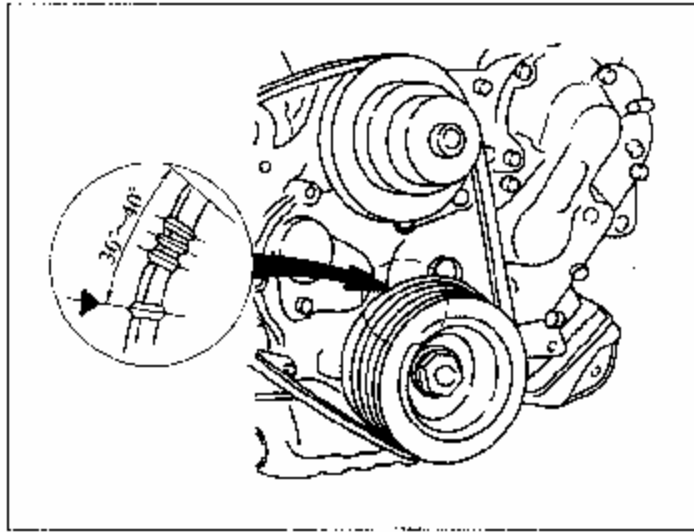


Figure 3-47 Set first cylinder piston to the position $30^{\circ} \sim 40^{\circ}$ before TDC

(4) Rotate crankshaft clockwise. Dial indicator reading should be 0.5mm at the time pulley TDC mark aligns timing mark on gear case cover.

Go on following steps if fuel supply timing is still not correct:

(5) Unscrew fuel injection pump retaining nut and pedestal bolt.

(6) Adjust fuel supply advance angle:

A—to delay, rotate fuel injection pump toward engine (see figure 3-48). Direction A.

B—to advance, rotate fuel injection pump away from engine (see figure 3-48). Direction B.

If advance angle deviates from the normal range, unscrew injection pump retaining nut and pedestal bolt, then adjust fuel supply timing by changing fuel injection pump set angle.

—When the angle is larger than standard value: rotate fuel injection pump away from engine till dial indicator reading lands in standard range (see figure 3-48).

—When the angle is lower than standard value: rotate fuel injection pump toward engine till dial indicator reading lands in standard range (see figure 3-48).

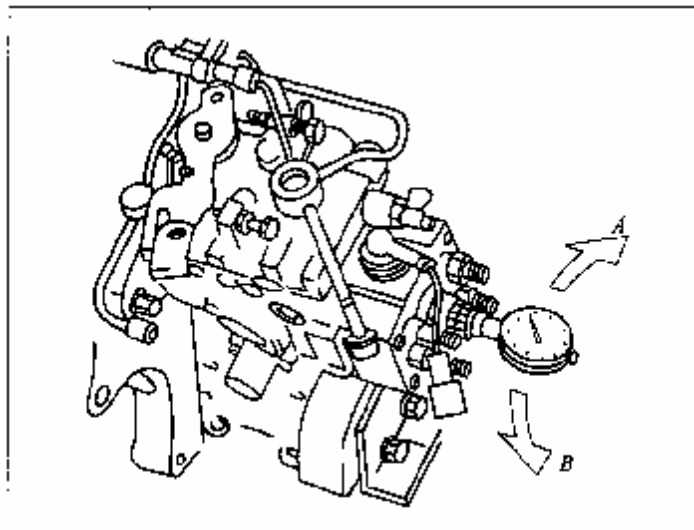


Figure 3-48 Adjust fuel supply timing of fuel injection pump

3.10 Intake and exhaust system

Intake / exhaust system consists of intake manifold, exhaust manifold, inlet pipe and air filter.

3.10.1 Intake and exhaust manifolds

Intake manifold delivers air to each cylinder; and exhaust manifold takes waste gas from each cylinder and discharge it via muffler.

When a vehicle has driven up to 4000-5000km, you should check intake / exhaust manifolds as follows:

(1) Check for loose nuts. The force used to tighten intake/exhaust manifolds should be even, otherwise air leakage may happen.

(2) Check intake/exhaust manifolds for cracks or cavities, and gasket for damage or corrosion.

Use intake manifold gasket only once. Replace timely damaged gasket for better air sealing.

3.10.2 Air filter

When entering the diesel engine dust in air could accelerate wear of cylinder sleeve, piston ring, piston, valve and bearing. Air filter is used to filter out dust in air that enters diesel engine.

Keep regular maintenance for air filter according to technical requirements so as to keep higher air cleaning efficiency. Keep regular check air intake system sealing; prevent unfiltered air from entering cylinder.

● **Notes:**

(1) Cleanliness of intake air affects much the life expectancy of a diesel engine. It is strictly prohibited to have a diesel engine worked without air filter or with a failure filter. .

(2) A clogged air filter may lead to oil weeping on air compressor end in supercharger. Keep regular maintenance or replacement of element.

3.11 Supercharging system

Supercharging system of BJ493ZLQ series inter-cooled diesel engine consists of intake/exhaust systems and exhaust gas turbine supercharger.

3.11.1 Turbocharger construction

Generally, a turbocharger consists of turbine, center housing and air compressor.

Exhaust gas turbocharger has an exhaust valve that is used to improve accelerating and climbing ability of turbocharged diesel engine while maintaining enough power to provide to relating assemblies.

A turbocharger includes turbine, radial-flow air compressor, center housing, rotor assembly and bypass valve (see figure 3-49 and figure 3-50). The turbine and compressor are installed at two ends of shaft. Each has a cast housing. Shaft is installed in center housing.



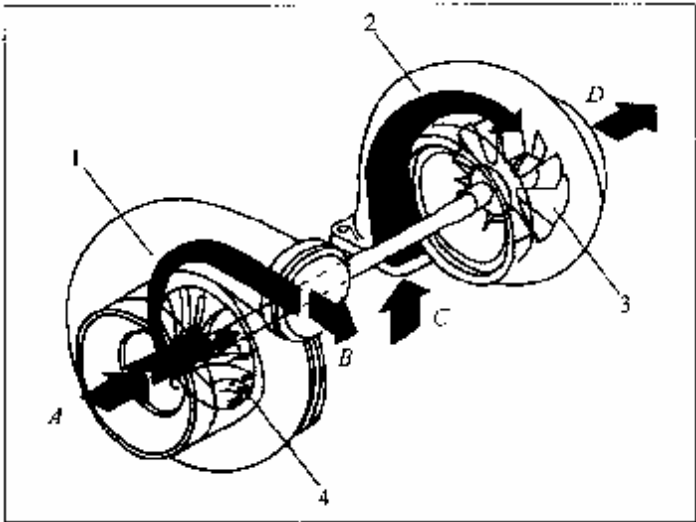


Figure 3-49 Air compressor and turbine

1-air compressor housing; 2-turbine housing; 3-turbine impeller; 4-compressor impeller;
A- ambient air inlet; B-air outlet; C-turbine exhaust-gas inlet; D-turbine exhaust-gas outlet

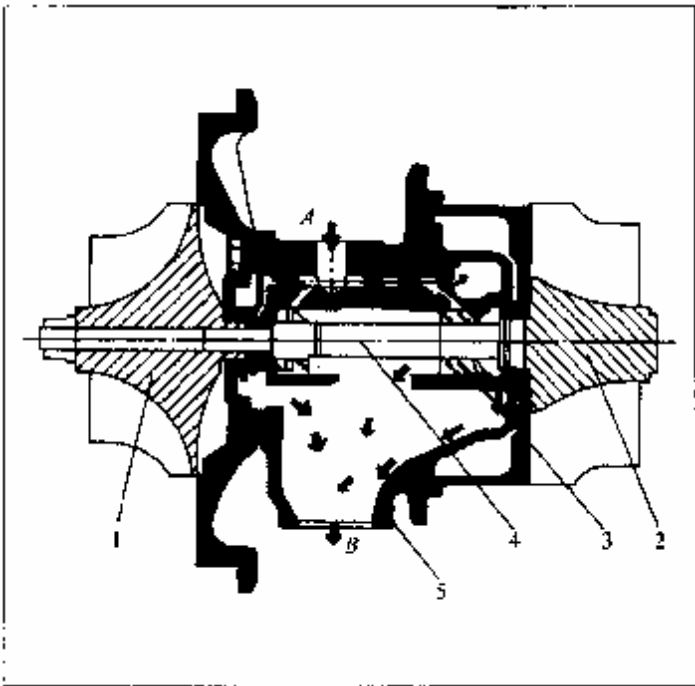


Figure 3-50 Supercharger center housing and rotor assembly

1-air compressor impeller; 2-turbine impeller; 3-floating shaft bearing; 4-rotor assembly; 5-center housing;
A- oil inlet; B-oil outlet

3.11.1.1 Turbine

The turbine essentially includes turbine housing and single-stage radial-flow turbine. They are energy converters. Exhaust gas from diesel engine is sprayed at certain angle onto impeller by a nozzle in turbine housing, converting exhaust gas heat energy into kinetic energy to push turbine to rotate at a high speed.

3.11.1.2 Center Housing



Center housing is an intermediate supporting body that holds rotor assembly and fixes turbine housing and air compressor housing. It is also an oil tank that holds oil to lubricate and cool floating bearing rotor.

3.11.1.3 Air compressor

Air compressor mainly includes single-stage centrifugal compressor impeller, diffuser and compressor housing. Air is sucked in at high speed via air filter by compressor impeller; its flowing speed and pressure are increased. Then diffuser and compressor housing turn airflow's kinetic energy into pressure energy. Further compressed air enters cylinder via air intake pipe, increasing air density in cylinder.

Turbine shaft and turbine are friction-welded together, and compressor impeller is installed on turbine shaft and is pressed tightly with self-locking nut. Rotor assembly has undergone precise dynamic balance to ensure normal operation at high speed.

Rotor assembly uses an internal supporter, i.e. two full floating bearings are arranged on center housing between two impellers. A thrust bearing fixed on center housing takes rotor axial forces.

3.11.1.4 Air outlet Valve

Turbocharger uses an air outlet valve to ensure diesel engine could match turbocharger within low-medium speed ranges, so that engine could get enough air to serve increasing fuel supply. This will increase low-speed torque and improve fuel consumption. By discharging air at high speed (exhaust gas goes directly to exhaust pipe without being through turbine), turbocharger rotor will not run over-speed and its pressure will not go up too higher. Otherwise it may lead to much higher combustion pressure in cylinder to add extra mechanical load on engine. That is to say, turbocharger uses air outlet valve to improve low-speed torque of engine, while maintaining engine's performance and reliability at high-speed operation. The construction of the turbocharger with air outlet valve see figure 3-51.

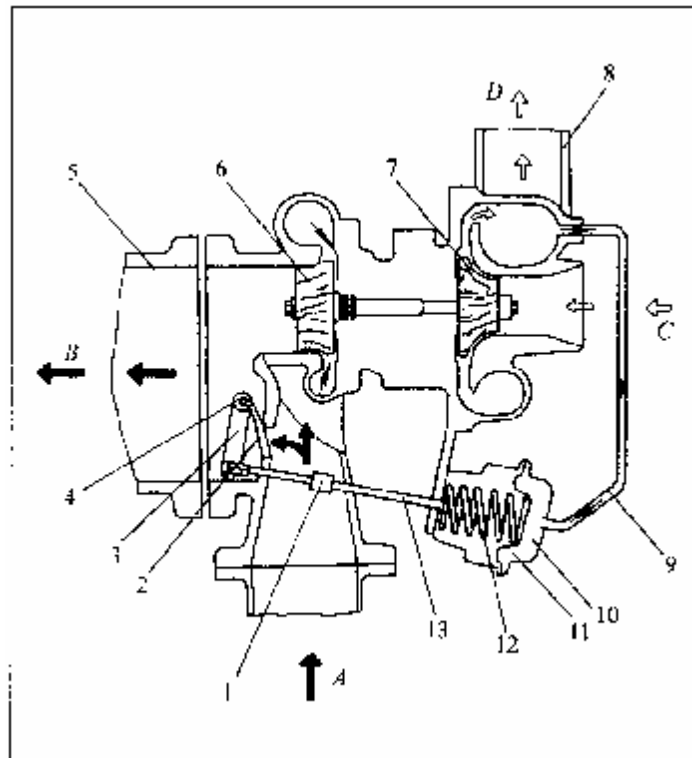


Figure 3-51 Turbocharger construction

1-adjusting nut; 2-air outlet valve; 3-rocker arm; 4-axis pin; 5-exhaust pipe; 6-turbine; 7-compressor impeller; 8-intake tube; 9-air-guiding pipe; 10-enclosed pressure chamber; 11-diaphragm; 12-spring; 13-interlink pushrod; A-exhaust gas inlet; B-exhaust gas outlet; C-fresh air; D-pressurized air

Boosted pressure controls automatically opening and closing of air outlet valve. When boost pressure reaches or exceeds set value, the diaphragm will overcome spring on the left and move leftward together with interlink pushrod, pushing rocker arm to rotate around axis pin and open air outlet valve. This discharges air via bypass duct and restrains supercharger speed from going up.

● **Notes:**

(1) Auto manufacturer has set the opening pressure value for air outlet valve. User should not make any adjustment on it, i.e. adjusting nut on interlink pushrod should not be tightened, otherwise diesel engine's power, economy and reliability will be hurt badly.

(2) Interlink pushrod should in no circumstance be used as a handle or a step.

(3) If during the operation, faults like air guiding pipe leak or stuck interlink pushrod are found, one should stop vehicle to remove the faults.

(4) Air outlet valve and enclosed pressure chamber are not repairable. Replace whole turbine case assembly if fault is found.

3.11.2 Supercharger maintenance

In order to keep boosted diesel engine working efficiently and reliably, beside using and operating engine correctly, one should keep regular maintenance on supercharger. But it should be noted that turbocharger is a precision machine that rotates at a high speed (its maximum Rpm is 130000r/min or even higher, usual Rpm is at least 10 to 200 thousands r/min). So supercharger should not be disassembled unless it has to. When supercharger rotor does not rotate smoothly due to dirt and carbon deposits, or engine performance becomes poor, one can do following simple cleaning-up works without dismantling supercharger.

(1) Remove dust and oil dirt on supercharger surface.

(2) Remove supercharger from diesel engine. Be sure not to use interlink pushrod as handle to lift supercharger.

(3) Remove air-guiding pipe, remove adjusting device for air outlet valve.

(4) Remove compressor case, turbine housing and fittings of oil supply /return pipe and coolant pipe.

(5) Clean surface of compressor case, turbine housing and two impellers.

(6) Pour cleaning agent into oil-inlet while rotate impeller with hand until impeller could rotate smoothly.

(7) Assemble the supercharger and install it on diesel engine. During the process, all sealing connected to supercharger should be replaced. And add clean oil into supercharger oil inlet for pre-lubrication purpose.

● **Cautions:** Never collide impeller blade when disassembling and cleaning the supercharger. Do not use distort impeller by just simple repairing. Kerosene, gasoline and quality diesel can be used to clean supercharger.

3.11.3 Check Supercharger

(1) Check rotor radial clearance: Press radially compressor impeller blade with hand and measure minimum clearance between impeller blade and compressor case with a feeler gauge. The value should not be lower than 0.10 mm, otherwise floating bearing should be replaced.

(2) Check rotor axial clearance: Fix dial indicator magnetic base onto flange on turbine shell outlet, contact dial indicator to rotor shaft end face, push or pull rotor axially. The difference measured is axial clearance. A new supercharger axial clearance should be $\leq 0.10\text{mm}$, the limit should be $\leq 0.25\text{mm}$. When a supercharger rotor axial clearance exceeds the limit, supercharger should be disassemble to replace worn-out parts.

Do not replace a faulty supercharger rashly before its damaging cause has been identified.



3.12、Electrical System

3.12.1 Battery, alternator and starter

Engine electrical system mainly includes battery, alternator and starter. Battery rated voltage is 12V. The alternator is a 1C adjuster (built-in type) with a vacuum pump, and the starter is a reduction motor.

3.12.2 Glow plug

Combining glow plug with a direct injection diesel engine can acquire a good starting performance (see figure 3-52).

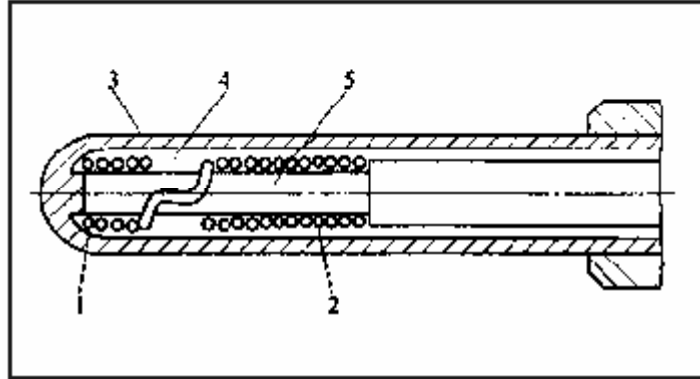


Figure 3-52 Glow plug

1-flash coil; 2-brake coil; 3-protective bush; 4-iron oxide; 5-alumina

The heat-saturating characteristic of glow plug is achieved by way of connecting in series two coils with different temperature resistance coefficient. One coil is called flash coil while another brake coil. Flash and brake coils are installed in the front and rear part of protective bush respectively.

At the beginning of preheating process, the flash coil becomes red-hot to get quick pre-heating. Quick pre-heating goes on till temperature rises to a set point where coil current will cut off automatically. At this moment, resistance value of brake coil (that has higher temperature resistance coefficient) will rise correspondingly, lowering power supply current to restrain temperature rising and keep saturation temperature at a set level. Meanwhile, the protective bush gets red-hot all the way down from front to rear, it finally becomes red-hot wholly after it has reached saturated state.

3.13 Electric Control EGR System for Recycled Exhaust Gas

The EGR System, also called Recycled Exhaust Gas System, is used to recycle part of gas in exhaust pipe by taking them back into intake manifold, where it mixes with fresh air and goes to the combustion chamber. The process decreases combustion temperature and reduces nitrogen oxides production and pollution to air.

3.13.1 Composition of EGR System

For BJ493Q (Euro II) diesel engine with electric control EGR system, its EGR system mainly consists of ECU, vacuum regulator, EGR valve and valve position sensor, coolant temperature sensor, Rpm sensor, throttle position sensor, pressure maintaining valve, recycled exhaust gas pipeline and vacuum connecting pipeline (see figure 3-53).

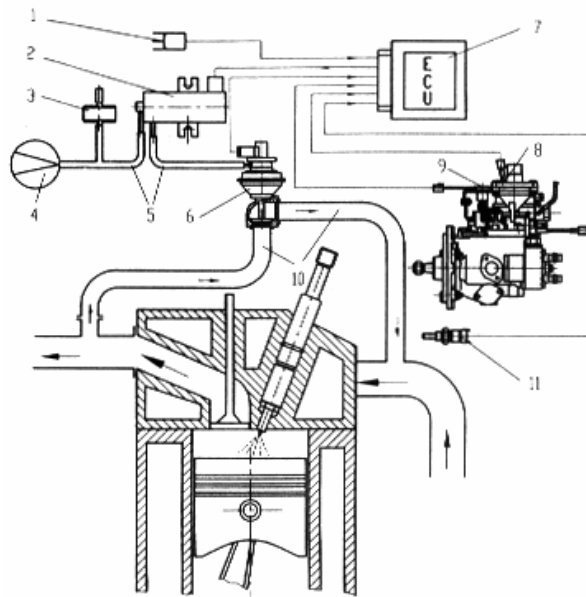


Figure 3-53 Electric control EGR system

1-diagnostic tool connector; 2-vacuum regulator; 3- pressure maintaining valve; 4-vacuum pump; 5-vacuum connecting pipe; 6-EGR valve and valve position sensor; 7-ECU; 8-Rpm sensor; 9- throttle position sensor; 10- recycled exhaust gas pipe; 11- coolant temperature sensor

3.13.2 Electric Control Unit (ECU)

ECU is a control center of whole EGR system. It identifies current engine state with input signals and regulate vacuum through vacuum regulator according to the pre-stored data in ECU, obtaining an optimum EGR valve opening.

ECU consists of electronic elements enclosed in a plastic case. ECU should be protected from moisture and wet. The ECU of EGR system in BJ493Q series diesel engine (Euro II) is generally installed in driver cab.

● **Cautions:** Use special diagnostic instrument and software to diagnose ECU. Otherwise the ECU may be damaged.

3.13.3 Vacuum Regulator

The vacuum regulator is controlled by ECU signals, which regulates vacuum that acts on EGR valve diaphragm to a required value.

● **Cautions:** A faulty vacuum regulator may make engine emitting black smoke.

3.14 GR Valve and Valve Position Sensor

EGR valve controls valve opening by regulating vacuum so as to control exhaust gas flow. Valve opening signal is detected by valve position sensor and sent back to ECU.

● **Caution:** A severe stuck EGR valve may make engine emitting black smoke.

3.14.1 Throttle position sensor and Rpm sensor

For BJ493Q (Euro II) series diesel engine with electric control EGR system, the throttle position sensor is installed on regulating lever in fuel injection pump. Lever position and transient speed reflect directly the quantity of injected fuel, and its signal is transmitted to ECU. This signal decides the rate of recycled exhaust gas. Rpm sensor is installed on fuel injection pump, which measures rotational speed of fuel injection pump camshaft. Engine Rpm is also available by converting camshaft Rpm signal.

The coolant temperature sensor is installed on thermostat case. Only through getting temperature signal, can the exhaust gas recycling rate adapts constantly to working temperature changes during operation period.

In every 4000-5000km, exhaust gas connecting pipes should be checked as follows:

(1) Check if there are loose nuts.

(2) Check exhaust gas connection pipe for crack or hole, gasket for damage or erosion.



Chapter 4

BJ493ZLQ Diesel Engine Operation

4.1 The rules of safe operation

- 4.1.1** The operator should know the structure of a diesel engine and master the skills for its use and maintenance. Those who don't know the operation techniques are not allowed to start up a diesel engine.
- 4.1.2** The operator should wear working clothes that meet the safety and work protection requirements. Women operators should wear safety helmet to avoid personal injuries.
- 4.1.3** When a diesel engine is running don't stand in rotation range of a fan. Don't put hand near pulley, belt or fan. Don't wear loose clothes.
- 4.1.4** When a diesel engine is running, the operator is not allowed to approach any of its rotating parts. It is strictly prohibited to dismantle parts while diesel engine is running. It needs special care during the necessary check and adjustment.
- 4.1.5** Avoid being scalded while filling coolant, draining oil /coolant or approaching high-temperature locations on diesel engine Keep away from exhaust pipe / muffler hot surface while service or repair is in progress to avoid scalding.
- 4.1.6** Try to avoid skin from contacting petrol-oil products while managing fuel/oil to prevent skin from irritated or getting poisoned. Never suck fuel with mouth.
- 4.1.7** Battery electrolyte is erosive. Never let it splash into eyes, on skin or cloth. Wash it immediately with clean water if that happens.
- 4.1.8** Operator should never try to go on working when he feels bad, tired or sluggish.
- 4.1.9** The supercharger can be checked only after diesel engine has been shutoff and cooled down completely. Don't run diesel engine during the check to prevent personal injury.

4.2 Fuel/oil and Cooling fluids

4.2.1 Fuel

BJ493ZLQ series diesel engine should use specified light diesel. In the area where environmental protection is required, diesel that meets environmental protection regulations must be used. Select and use right diesel according to season and local temperature, see chart 4-1. .

Chart 4-1 Fuel for BJ493ZLQ series Diesel Engine

Ambient temp.	Diesel rate	Ambient temp.	Diesel rate
Over 5℃	0 light diesel	Over -10℃	-20 light diesel
Over -5℃	-10 light diesel	Over -25℃	-35 light diesel

- **Note:** When a diesel engine runs in lower ambient temperature, paraffin wax in diesel will separate out, blocking or choking fuel pipeline. When temperature is below 0℃, winter diesel should be used.
- In order to avoid fault and prolong diesel engine's service life, engine must use clean fuel. It is required to fill clean diesel that meets specification in qualified gas station. For self-filling, fuel container must be clean and for diesel only; keep sealing during filling fuel; sit diesel in container (for sediment purpose) for at least 48 hours,



then take upper (clean) part to fill. Always keep in mind the cleanness and contamination-free during whole fuel transportation, filling and use.

● **Warning:**

- (1)Never use inferior diesel. There should be no impurities and moisture in fuel.
- (2)Disqualified diesel will lead to difficult engine start-up.

● **Notice:** Never fill fuel tank while diesel engine is running. Do not fill up fuel tank in hot weather. Otherwise fuel may overflows due to expansion. Clean any overflowed fuel immediately.

4.2.2 Lubricant (oil)

BJ493Q series diesel engine uses specified CD grade or higher-grade diesel engine oil. BJ493ZLQ series diesel engine uses CF-4 grade or higher-grade diesel engine oil specified by Great Wall Oil Company. Select to use oil according to environmental temperatures (figure 4-2).

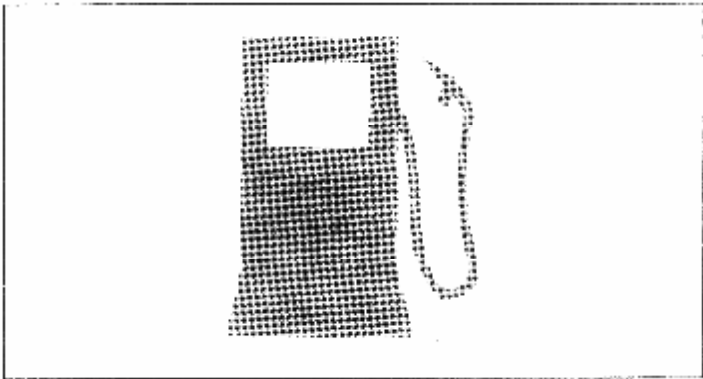


Figure 4-1 Fill clean diesel that is up to national standard

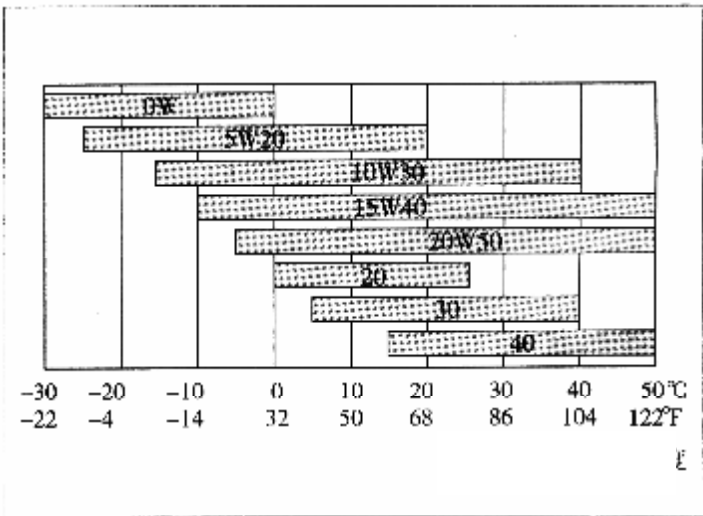


Figure 4-2 Select oil according to environment temperature

● **Warning:**

- (1)After diesel engine has been boosted by turbocharger, its mechanical load and heat load are greatly increased. The supercharger is a precise high speed operating mechanism under high-temperature, it sets a higher demand for oil quality. Therefore, clean rated engine oil rather than ordinary oil must be used to prevent possible cylinder scratch, stuck bearing and supercharger damages.
- (2)Engine oil filled should be impurities and moisture free.



(3) Never mix to use oils of different rates or different manufactures. Never mix to use new and used oil during technical maintenance.

4.2.3 Lubricating grease

Alternator, starter bearing, water pump shaft and cooling fan grease cup should use specified general auto lithium-base grease.

- **Note:** Clean grease cup before applying grease. Apply grease with grease gun.

4.2.4 Coolant

Coolant used in the BJ493ZLQ series diesel engine must be anti-frozen, corrosion proof, anti-fouling and with higher boiling point.

- **Warning:**

Coolant is poisonous and must be stored in its original container.

If a diesel engine uses hard water (containing more minerals), high temperature will facilitate minerals to separate out, forming scale in pipeline and high temperature parts. Scale blocks pipeline and restrains heat radiation, which could overheat diesel engine and lead to faults.

- **Notes:**

- (1) Never replenish coolant with untidy water it could deteriorate coolant performance.
- (2) If coolant is short due to leakage in cooling system, be sure to add coolant of same rate after fault has been removed. Add coolant after engine has cooled down.
- (3) Never use inferior coolant or mix to use different coolants. Otherwise corrosion and scale may happen, that shorten engine service life.

4.3 Preparations before Start-up

- **Note:** Before starting up a diesel engine, operator should carefully read this manual and operate strictly according to instructions.

The following items should be checked before starting up a diesel engine:

4.3.1 Carefully check each part of diesel engine for their connecting, fastening and operation.

4.3.2 Check coolant level in the radiator, and check fastening of coolant pipe connectors and fan belt tension.

- **Notes:**

- (1) Correct coolant level is very important to efficient operation of engine cooling system.
- (2) Check coolant level only when engine has been shut off.

4.3.3 Use dipstick to check if oil amount meets requirements. And check if oil has been aged or deteriorated. Change oil timely in following events: oil is deteriorated; its color has been turned; it becomes thinner and it has moisture inside.

- **Note:** Lower hole in dipstick is the alarming level, not operation level. Add oil timely as per specification to avoid severe accident.

4.3.4 Open fuel tank switch to check fuel amount inside tank, and check if pipe connectors in fuel supply system are fastened tightly. Remove any leaks and bleed the pipelines.

4.3.5 Check electrolyte level in battery.

4.3.6 Check the fastening of electrical connectors on battery, alternator, starter etc.

4.3.7 For newly bought turbocharger engine, engines that has been stopped for long (over 1 week) and whose oil, oil filter have been changed, one should unscrew oil inlet connector on supercharger, add certain amount of oil (whose rate should be same as these in oil pan). Turn supercharger rotor to offer enough preliminary lubrication to



supercharger.

4.3.8 Once air enters fuel system, it must be discharged before diesel engine starts up.

Air enters fuel system in following occasions and conditions:

- When draining oil from fuel tank;
- Low pressure fuel pipe cuts off;
- Part of the low pressure fuel pipe leaks;
- Use diesel that does not match environmental temperature.

Bleeding methods:

(1) Open fuel tank switch;

(2) Bleed low pressure pipe (fuel tank to fuel pump): Loosen oil return connector bolt on fuel pump (see fig.4-3), pump fuel (40 times a minutes) with the hand pump on oil-water separator (see fig.4-4). Go on pumping till there is no air bubble in overflowed fuel. Retighten bolts on hand pump and oil return connector.

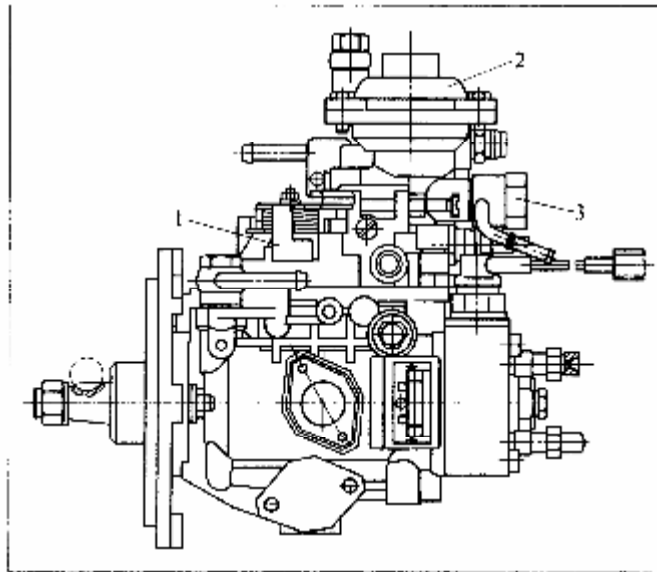


Fig.4-3 Fuel Injection Pump Assembly

1. throttle operating handle; 2. boost compensator; 3.oil return bolt.

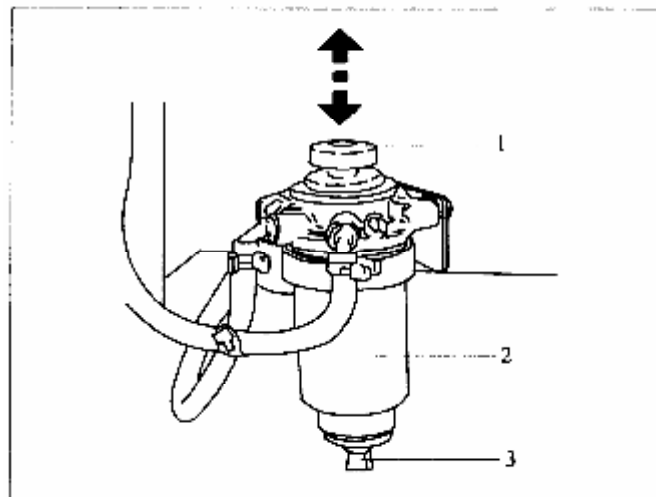


Fig.4-4 Bleeding with oil-water separator

1.hand pump; 2.oil-water separator; 3.drain plug

(1)Bleed a fuel filter: loosen vent valve on filter (see fig.4-5), pump fuel with hand pump on oil-water separator till there is no bubble in drained fuel. Retighten vent screw.

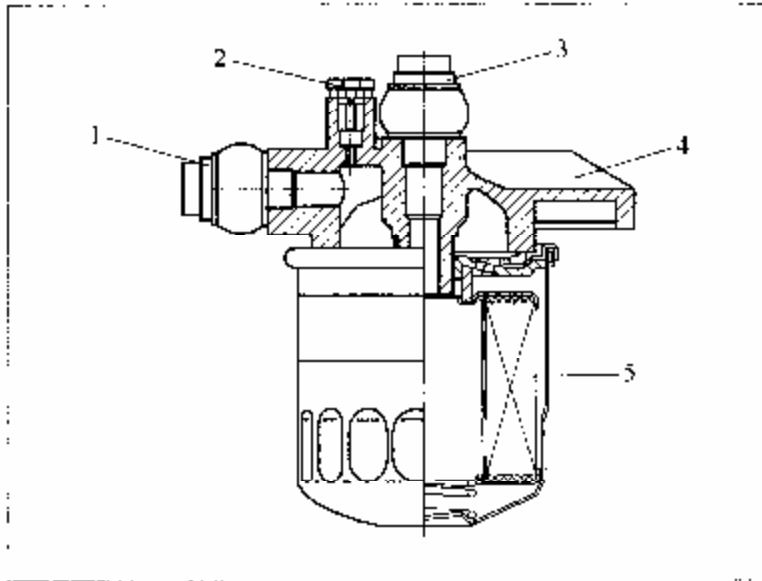


Fig.4-5 Fuel filter assembly

1.fuel inlet screw; 2. vent valve 3 drain screw 4 fuel filter seat 5.filter element

(2)Bleed high-pressure fuel pipe (fuel injection pump to oil injection pipe): loosen pipe nut on injector end (Fig.4-6). Crank with starter the crankshaft till there is no bubble in drained fuel. Retighten pipe nut.

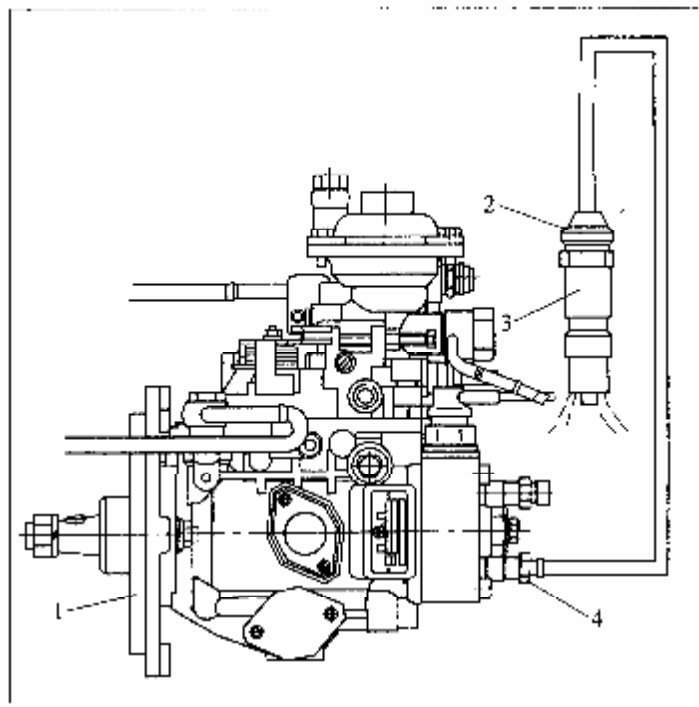


Fig.4-6 Bleed high-pressure fuel pipe

1.injection pump 2.injector end pipe nut 3.fuel injector 4.injection pump end pipe nut

● **Note:**

- (1) Don't forget to retighten all loose screws, nuts and hand pump in oil-water separator after bleeding.
- (2) Do not let fuel to contaminate diesel engine compartment. Put a collecting pan under engine during bleeding. Dispose used oil according to local laws.

4.4 Diesel engine start-up procedures

4.4.1 Start-up when environment temperature is over -5°C

● **Note:** Never crank an engine without proper pre-starting preparations. Before starting-up, check if there are any objects around that hamper engine operation.

4.4.1.1 Set transmission to N gear.

4.4.1.2 Depress clutch pedal to reduce load on engine during cranking.

4.4.1.3 Turn ignition switch to "START", quickly press down start button to start up engine. If starter gear cannot mesh with flywheel gear ring, driver should release start button. Re-crank engine after starter has stopped.

● **Note:** Each cranking should not last more than 30 seconds. This is to protect starter and battery. There should be at least 2 minutes interval between a fail start-up to second cranking. If 3 attempts cannot start up engine, one has to turn to find the cause before next cranking.

4.4.1.4 After engine has started up, keep it running at idle while check oil pressure (should not be less than 0.1Mpa), and check any abnormal noise and vibration on supercharger. For supercharged or inter-cooled engine, idle running should not last more than 5 minutes.

4.4.1.5 Start-up engine when environment temperature is lower than -5°C

(1) Turn ignition switch to "ON", pause at least 2~3 seconds, check meters indications in instrument panel.

(2) While coolant temperature is above 5°C, the pre-heating indicator on instrument panel does not lit. In this case, crank engine as per methods used when temperature is over -5°C.

(3) While coolant temperature is below 5°C, pre-heating indicator keeps on. This indicates the system operates well and glow plug is connected. When glow plug has pre-heated for starting up, pre-heating indicator flickers at 1.2 time /second to remind driver to start up engine. If driver doesn't crank engine within 10 seconds, the indicator will go out and pre-heating system will stop automatically. A new pre-heating operation can be done only when ignition switch has been cut off for 3 seconds.

(4) When glow plug finishes pre-heating and indicator blinks at 1.2 times / second. Step down clutch pedal, turn ignition switch to "START" to start engine.

(5) If starter gear cannot mesh with flywheel gear ring, driver should release start button. Crank the engine after starter has stopped.

(6) After engine has started up, ignition switch quickly from "START" to "ON". At the moment, pre-heating system enters post-heating stage. Pre-heating indicator keeps blinking to indicate glow plug is in post-heating that lasts for 40 seconds. After post-heating, indicator goes out and pre-heating system shut off automatically.

(7) After engine has started up, keep it running at idle while check oil pressure (should not be less than 0.1Mpa), and check any abnormal noise and vibration on supercharger. For supercharged or inter-cooled engine, idle running should not last more than 5 minutes.

4.4.3 Pre-heat diesel engine

When it is difficult to start up engine at a temperature lower than -25 °C, drain coolant and warm up diesel engine with boiled water. Fill hot water higher than 90°C into radiator; drain it after it has turned cold through water jacket. Repeat the procedure to warm up engine, and then add coolant. Moreover, after engine has been started up and during preheating period, thermostat valve is closed, coolant circulation is not through radiator. Hence in order to avoid icing inside radiator, one should always use hot water and add a windshield before



radiator.

4.4.4 After diesel engine has started up, run engine at low-mid Rpm for minutes to “warm up” engine. In order to raise coolant temperature as quick as possible, don’t turn on heating fan during engine “warming-up”. Turn on heating fan only when coolant and oil temperature reach at least 50°C. At this moment, it is allowed to accelerate engine to max Rpm for full load operation.

4.5 Check during engine running

4.5.1 Check for knocking, loosening or other abnormal sound;

4.5.2 Check electrical parts for burnt smell due to over heating.

4.5.3 Check fuel, cooling and lubricating systems for leakages.

4.5.4 Check meters of oil pressure, coolant temperature, current and oil level for correct readings.

● **Warning:**

(1)The operator must not stand in the rotation plane of fan when the diesel engine is running. Don’t put your hand near belt pulley, belt or fan. Don’t approach its rotating parts.

(2)Don’t remove radiator cap while cooling system is hot with pressure. Otherwise serious scalding may happen.

(3)Never dismantle parts while diesel engine is running. Use special care when performing check and adjustments.

● **Notes:** Listen to any abnormal sound that may come out from a running engine. Check regularly fuel and coolant passages for leakage. Remove any leakage immediately to avoid major accident.

4.6 Shutdown

If the diesel engine needs to be shut down under heavy load running, operator should first lower its Rpm and reduce running load till coolant and oil temperature drop to lower than 75°C. This is to cool diesel engine gradually and evenly to avoid parts distortion due to sharp cooling. This is especially important to a supercharged diesel engine, as supercharger rotor is running at higher speed, sudden shutdown may lead to burnt damage due to poor cooling caused by oil-short in rotor bearing.

4.7 Important points to engine operation

The supercharged diesel engine uses exhaust gas pulse energy to push the runoff turbine inside supercharger, and drive impeller in centrifugal compressor (that is coaxial to the turbine) to rotate at high speed. This increases intake pressure and fuel supply so as to enhance engine power. The following measures should be taken while using a turbocharger engine, as it works under the conditions of high temperature (>650°C) and high rotation speed (100000~180000r/min):

4.7.1 The supercharger floating bearing demands highly for lubrication -- specified CF-4 lubricating oil is required. Clean regularly oil filter and change oil. Otherwise bearing may be worn-out and performances of supercharger and diesel engine may be deteriorated.

4.7.2 Release gas pedal slightly right after engine has started, run engine at low Rpm. Acceleration can be made only after oil pressure has gone up. Otherwise supercharger floating bearing may be worn-out early due to poor lubrication, even get stuck.

4.7.3 Never abruptly shut down a high-speed running engine. Lower Rpm and running load gradually, let engine run at idle for minutes before shutdown. Or supercharger may be damaged due to overheating and poor lubrication.

4.7.4 When starting firstly an engine in the following circumstances, operator should tighten supercharger fuel



inlet connector; turn off fuel injection pump switch. Crank engine with starter for seconds (<10s). Retighten connector after oil overflowing has been seen on it. Or restart engine after adding 60~100 ml. oil.

- New or overhauled diesel engine;
- Diesel engine that has not worked for over one week;
- Supercharger has been cleared or replaced;
- After changing oil and cleaning the oil filter.

4.7.5 Regularly check air sealing on air intake / exhaust pipes to avoid air leak. Air leaks in pipeline from air filter to air compressor will let unfiltered air enter air compressor and engine, causing parts early worn-out. And leaks in pipelines from air compressor to cylinder, from cylinder to supercharger turbine will decrease engine power, and increase engine's exhausting fume.

4.7.6 Notice any abnormal sound from supercharger during diesel engine operation. Listen at instantaneous moment right after engine has shutdown to any rubbing sound between supercharger impeller and the case. Check and remove rubbing sound if any.

4.7.7 In the events of unstable engine Rpm, sharp vibration on supercharger and intake pipe roaming, the air filter element and intake pipe should be cleared.

4.8 Rules to engine operation

4.8.1 According to these use and maintenance procedures in this manual to operate a diesel engine.

4.8.2 Use specified light diesel.

4.8.3 A new or overhauled diesel engine should have break-in period. It is not allowed to run it at high speed or under heavy load in the first place. In the first 50 hours, a diesel engine should be used at reduced power and its load should not exceed 75%. Better break-in will prolong its service life.

4.8.4 Warm up engine at low-mid Rpm after an engine has started. Usually, one cannot run engine under load until oil and coolant temperatures reach 40°C.

4.8.5 Normal coolant temperature during engine operation is $80^{\circ}\text{C} \pm 5^{\circ}\text{C}$ (105°C is allowed when using a pressurized radiator).

4.8.6 Diesel engine is not allowed to run at idle for longer time, or run it for longer time when it is emitting black smoke.

4.8.7. Watch fan belt conditions Adjust belt tension as required.

4.8.8 Watch sealing conditions on oil, coolant and air passages. Remove any leakage. Keep a clean operating environment for diesel engine.

4.8.9 It is not allowed to operate a diesel engine that has fault in it. Stop to check and remove faults in the cases of low or no oil pressure, too high coolant temperature or abnormal sound from engine.

4.8.10 Fireproof. No lit fire is allowed to approach engine. Vehicles should equip with fire extinguisher.

● Warning

(1)No full throttle operation on cold engine either at N gear or any other gears. Full throttle operation applies only on warmed engine.

(2)Shifting timely into higher gears during driving will help to save fuel and reduce noise.

(3)Shift to lower gears timely when a diesel engine cannot run smoothly to avoid overload.

(4)Never use “accelerate—stall—coast at N gear—clutch shift to crank” process. Sudden stalling at high speed and temperature stops oil pump and water pump, oil and coolant cannot take away heat on parts. Especially for a supercharger, oil inside lubricates and cools down parts as well. Moreover, cranking by clutch shift harms engine seriously, i.g. shifting in this way at 40km/h is actually cranking to start an engine at 1300r/min.



4.9 Use diesel engine in winter

In winter (when temperature is below 5°C), it is very difficult to start up an engine due to cold engine body, high oil viscosity and motion resistance. Lubricants in power-train and running system too will increase their viscosities and resistances. Without “warming up” after starting, parts that work under full load will get damaged easily. An overall technical maintenance before winter should be conducted. Following points should be observed:

4.9.1 Must use Coolant with anti-freezing and corrosion proof functions.

4.9.2 Change to use winter oil before winter for better starting up performance.

It is suggested that users select oil that can be used in wide temperature range according to local temperatures in four seasons. This will reduce the cost from seasonal oil change. .

4.9.3 Use higher rate light diesel according to environment temperature in winter. In low temperature, diesel viscosity and surface tension increases, these reduce engine-cranking Rpm. In this case, oil pressure becomes lower, and fuel atomizing quality gets poorer, which prolong ignition delay thus make engine start-up difficult. Prevent rain, snow or dirt from entering fuel system during filling. When fuel tank has water inside, it should be drained completely to add new diesel to avoid icing to block fuel pipeline.

4.9.4 Release main clutch for easier engine start-up.

4.9.5 Battery volume drops sharply as temperature drops and discharging current increases. In cold temperature, its total output and high power discharging duration are also decreased.

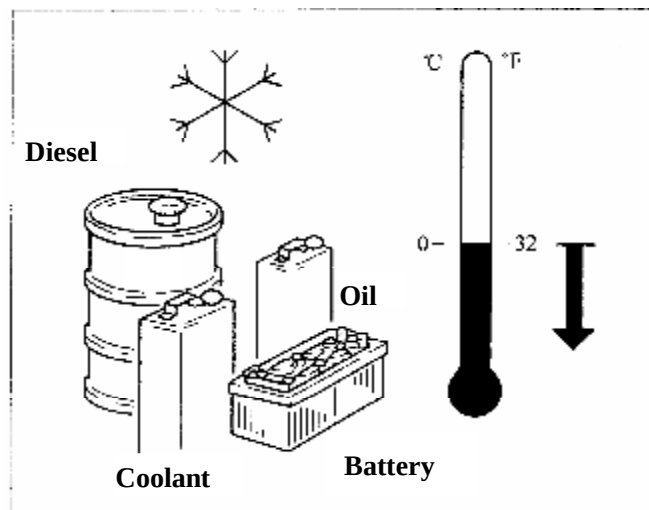


Figure 4-7 Use a diesel engine in winter

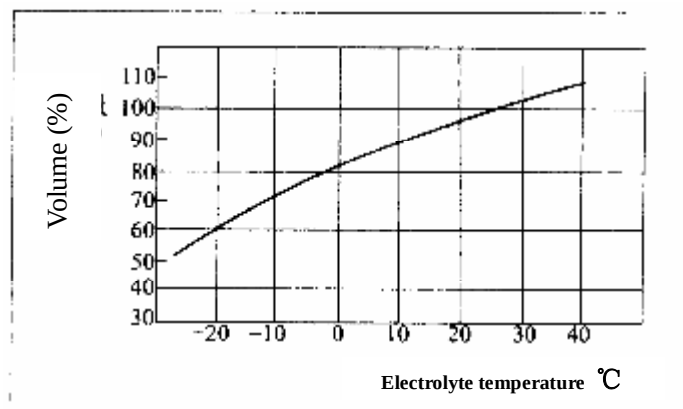


Figure 4-8 Battery volume vs. electrolyte temperature

Chart 4-2 Battery volume and electrolyte temperature vs. discharging rate

Temp. °C	27	15	4	-7	-18	-29	-40	-51
20h discharging rate	100	90	77	63	49	35	21	9
20min discharging rate	46	39	31	24	16	9	1	

Generally there are two ways to raise battery output at low temperature: to use low-temperature battery that has good low temperature performance; and to keep battery warm.

Experiment in cold area shows that using low temperature battery, low freezing point diesel, low temperature oil will facilitate engine start-up.

It is suggested to go to authorized service station to check battery before winter. Replace battery if necessary. These will not only make the diesel engine start more quick and reliable, but also help to prolong service life of a battery.

4.10 Diesel engine and environment

Diesel engine will emit exhaust gas and fume containing CO_{2, effective} ventilation is needed when it is used in limited space. Meanwhile as diesel engine makes noise during working, user has to consider its influences on environment, human and property with its exhausted gas, fume and noise. The operator should care about labor protection.

4.11 Transportation, installation and storing

BJ493Q series diesel engine (Europe II) has been constructed compactly. Use lugs on FR/RR ends of cylinder head to safely lift it during transportation. Watch out not to injure (by colliding) supercharger, fuel pipe, accessories and other exposed parts.

The new diesel engine has been sealed and packed in the factory, it must be checked carefully to accept: wipe up dust on exposed parts and rust-proof grease, check whether the accessories included are complete and fittings are tightened.

● **Notice:** Oil in oil pan has been drained before transportation for safety. User needs to add oil into engine according to requirement before using an engine. Check for any abnormal grabbing and colliding before starting a diesel engine. Only after engine’s condition has been confirmed can it be started as per technical requirement.

4.12 Decide an overhaul

An overhaul refers to a periodic and thorough service on engine in order to restore its technical state and economic value. An overhaul usually includes disassembling, checking, repairing on most parts / assembly, or replacing worn-out parts.

The methods to decide an overhaul are as follows:

4.12.1 Oil consumption: set new engine oil consumption as 100% (kilometers or hours / liter). When it falls to 50%, engine needs an overhaul.

4.12.2 In the events fuel consumption raises, engine power is insufficient while these have nothing to do with faults in fuel system. Engine needs an overhaul.

4.12.3 Internal abnormal sound due to excessive wear, overheating, improper use and maintenance indicate an engine needs to be overhauled.

● **Note:** Overhaul requires higher technical skill. It is suggested to send vehicle to professional repair shop. Use genius parts for replacement.



Chapter 5

Technical Maintenance for BJ493ZLQ Diesel Engine

During its operation, diesel engine technical conditions tend to become deteriorated due to part wear, loose fittings, clearance change fluid deterioration, leading to various abnormal phenomenon such as hard start-up, decreased power output and increased fluid consumption, even to a dead engine. It is very import to carry out regular technical services on engine such as cleaning, check, lubricating, adjusting/replacing according to engine technical conditions and operation time or mileage. Maintenance on diesel engine should go with these maintenances on vehicle. Here are maintenance procedures on some systems.

5.1 Daily maintenance

(1) Clear dust and acid splashes on battery cover and clear vent hole. Battery hardly needs any maintenance under normal working condition. Regularly check fluid level (see fig5-1) under high temperature. Right fluid level should be between MIN/MAX lines on battery side. Add distilled water when fluid level is low.

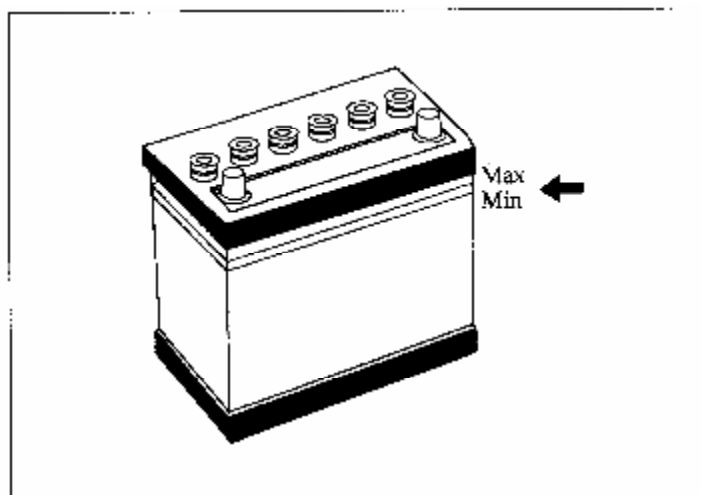


Figure 5-1 Check battery fluid level

● **Caution:**

Never fill unnecessary fluid or unclean water into battery, or it will cause undercharging. Go to service station if fluid level drops rapidly.

● **Warning:**

(1) Battery acid is corrosive, avoid it from splashing into eye or on skin/cloth. Wash it immediately with clean water if these happen.

(2) After engine has started, check it for fuel, coolant, air and electricity leakages. Remove if any.

(3) Check the fastening of each accessory.

(4) Listen if engine running is normal after started. Check meter indications. Timely repair and replace failure meters.

(5) Keep engine clean and tidy, electrical devices are not allowed to be oil contaminated. There should be no dirt on radiator. When washing out diesel engine, one should avoid water from entering diesel engine from oil

filler, dipstick tube and air intake pipe.

(6) Check and fasten connections between supercharger and engine, remove fluid and air leakages, keep supercharger exterior clean.

● **Warning:**

If the diesel engine works under dusty environment, one should disassemble and clean air filter everyday.

5.2 First level technical maintenance

Following maintenance procedures should be done after vehicle has run 7500~15000km

(1) Check fuel injector operating condition, correct injecting pressure, observe spraying mist. Clean and adjust if necessary.

(2) Check the fuel injection pump according to the working condition, conduct a shakedown test when necessary.

(3) Change oil in oil pan.

(4) Replace spin-on fuel and oil filter elements

(5) Check valve clearance, and adjust it when necessary.

(6) Check water dripping at water jump overflow hole. Replace water pump if dripping becomes serious.

(7) Check electrical devices, and check electrical connector for tightness. Replace burnt parts.

(8) Clear scale in cooling system pipe.

(9) Clean crankcase ventilation system.

(10) Check operation of supercharger rotor if necessary. Dismount connecting pipe between air compressor and air filter and turn rotor. Rotor is fine if it can rotate smoothly over one revolution, otherwise dismantle to check it. Note that dismantling position and around should be absolutely clean. There should be no foreign matters dropping into supercharging system during reassembling. Otherwise serious consequences may occur.

Moreover, under the normal circumstances, disassembling and assembling supercharger assembly need special equipment and tool. Only manufacturer and service station point have these. Never try to disassemble and assemble a supercharger assembly unless it has to.

(11) If necessary, disassemble air compressor case to check if there is oil leak on its end. In the meantime clean out case interior and impeller surface on air compressor. Be careful not to damage vane during cleaning.

5.3 Second level technical maintenance

The second level maintenance should be made on engine when vehicle has run 30000 km. It focuses on assembly dismantling, cleaning, and dismantling to check, adjustment and eliminating hidden faults.

(1) Dismantle and clean a diesel engine, remove carbon deposit, oil stain and scale. Clean all lubricant pipes and ducts.

(2) Check wears on contacting faces among valves, push rod and rocker arm. Repair or replace if necessary.

(3) Check wears on piston ring, cylinder sleeve, connecting rod small end bush and connecting rod bearing. Replace when necessarily.

(4) Check wears on main bearing and thrust plate.

(5) Check wears on driving mechanism and meshing face of driving gears. Measure meshing clearance. Repair or replace if necessary.

(6) Check wears on intake/exhaust valves and valve seats. Conduct restoration, grinding and leak test. Replace if necessary.

(7) Check injector mist-spraying. Repair or replace injector if necessary.

(8) Check oil pump. Dismantle and measure wear on parts and make necessary adjustment.



(9) Check cylinder gasket and intake/exhaust pipe gaskets. Replace if necessary.

(10) Check alternator and starter. Clean each part and bearing. Apply new grease after they have dried up. Check gear wear on starter and if its driving mechanism is flexible.

(11) Dismantle to check supercharger assembly if necessary. Replace any failure parts.

——Clean air intake connecting pipe, air compressor impeller, compressor case. Remove carbon deposit on impeller and inside turbine case.

——Check supercharger moving parts. Turn the rotor with finger. If it can rotate a few rounds by inertia, it is ok. Adjust or repair it if it is stuck or there are jamming and bumping sound.

——Check axial movement of rotor shaft if movement exceeds 0.3mm, the thrust bearing is worn excessively and should be replaced.

——Check the radial clearance between compressor impeller and case. Press down the impeller along the radial direction with finger, then min clearance between impeller and case is no less than 0.1mm. If it is less than this value, the floating bearing of supercharger should be replaced.

5.4 Technical Maintenance of Air Filter

Air filter is used to filter out dust and other impurities in air to prevent cylinder sleeve, piston ring, valve and valve seat from being worn due to grinding. It is therefore required that the air filter have high filtration efficiency. An engine without air filter is absolutely not allowed to work.

It is important to give air filter maintenance in time. If not, the air filter will be blocked by dust and resistance of air inlet will also increase. This will lead to symptoms like smoking, power down and early worn. The user needs to regularly maintain the air filter strictly according to the instruction for using vehicles.

5.4.1 The Maintenance of oil bath type air filter with inertial steel wire element

Generally, clean filter at every 4000km. The interval could be varying according to dust situation in environment. During the cleaning, take out steel wire and wash it in gasoline then dry it up with compressed air. Meanwhile clean filter oil pool, then add moderate new engine oil.

5.4.2 The maintenance of air filter with paper element

Generally, clear dust inside filter case and clean element at every 4000km.

(1) Clear air filter case and cover: when conducting a technical maintenance or changing element, wipe up dust inside or outside an air filter case, cover and gasket surface (see fig.5-2).

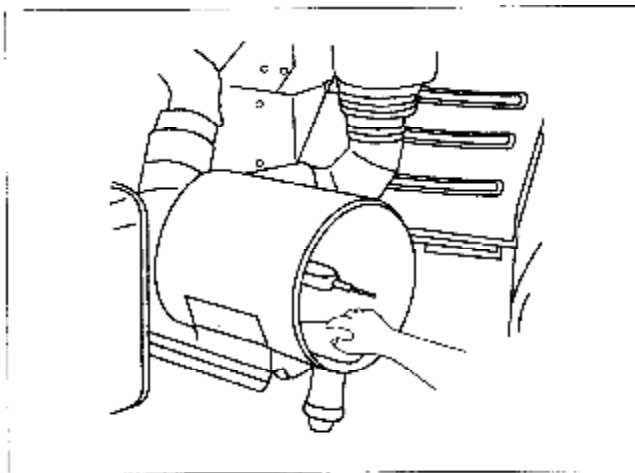


Figure 5-2 Air filter maintenance

(2) Clear an element: while a dust-contaminated element is dry, use compressed air to blow to clear it. Rotate element with hands while blow off the dust from its inside with compressed air. The pressure of compressed air should be less than 490kPa.



Figure 5-3 Clear air filter element

● **Warning:**

Don't clear element from outside, otherwise dust will enter interior of the element (cleaning surface).

Replace element when the following circumstances occur.

- Element is contaminated by carbon deposit and grease.
- Element is contaminated seriously, and dirt on it is not easy to be removed.
- Element is distort and damaged.

● **Warning:**

(1) Never clean paper element with fuel or water, or it will be dust-contaminated and blocked easily, causing insufficient air inlet, which leads to faults such as reduced power output and black smoke.

(2) Check regularly air sealing at connection between air intake pipe and air filter. Repair any leakage by replacing gasket and tightening fittings to avoid engine from being worn out.

5.5 Technical maintenance of fuel supply system

5.5.1 Fuel filter technical maintenance

Fuel filter is mounted on the low-pressure fuel pipe. Diesel enters filter and then being pressed into element to filter out impurities. Filtered diesel enters injection pump through outlet pipe.

BJ493ZLQ series diesel engine uses spin-on filter. Replace fuel filter after vehicle has driven 12000km.

Procedures to replace a fuel filter:

- (1) Thoroughly clean outer surface of a fuel filter pack. Fix fuel inlet pipe tightly.
- (2) Loosen element with wrench or appropriate tools. Remove element (see fig.5-4).

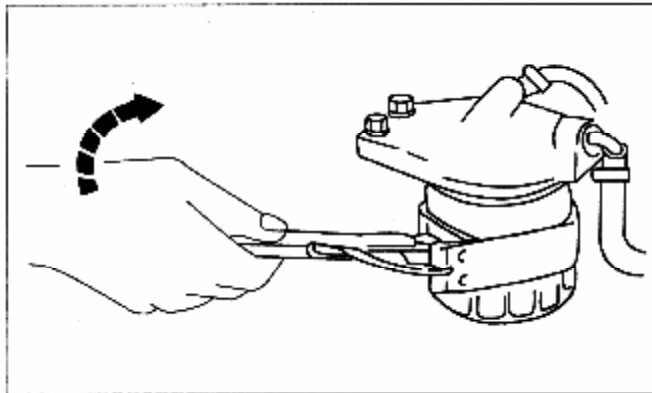


Figure 5-4 Remove fuel filter element

- (1) Ensure screw connector is fixed tightly on filter base, also ensure base interior is clean.
- (2) Lubricate slightly element sealing ring in a new filter with clean fuel (figure 5-5). Screw filter can onto filter base till resistance is felt.

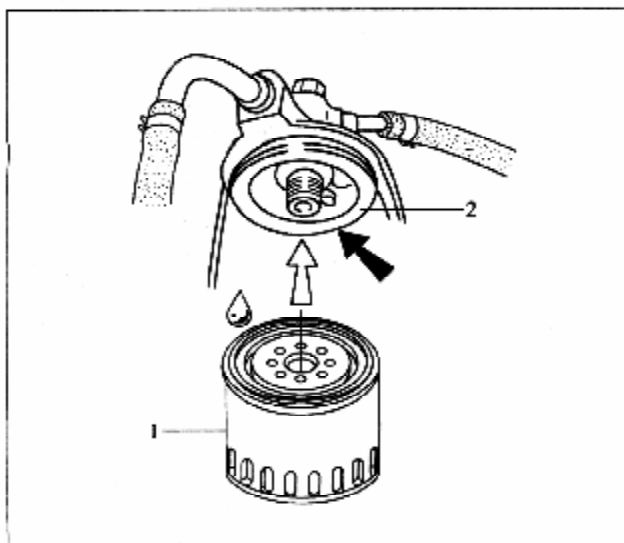


Fig.5-5 Installing fuel filter element

1-element of spin-on filter 2-fuel filter base

- (1) Tighten element with a wrench connect fuel pipe to check for leakage.
- (2) Discharge air from fuel filter.

5.5.2 Injection pump technical maintenance

Fuel injection pump is the heart of a diesel engine, composed by many precise parts. Correct technical maintenance on injection pump can ensure normal operation of a diesel engine and prolong injection pump service life.

- (1) BJ493ZLQ series diesel engine adopts VE distributor type injection pump, using diesel to lubricate (must use specified light diesel). Never use diesel that contains water. Diesel with moisture will lead to injection pump parts damage due to poor lubrication. Diesel must be held for depositing for over 48 hours, and carefully filtered before it could put into use. Use clean container and tools to fill diesel to prevent dust and dirt from entering.

(2) After 2500km breaking-in driving, a new diesel engine should replace its spin-on fuel filter element. From then on replace element at every 12000km.

(3) Regularly check fuel pipe sealing in fuel system. Watch closely for overheating at any location or listen carefully for any abnormal sound..

(4) At every 200 hours operation, check if fastening screws on fuel injection pump are loose.

(5) Injection pump has been set as per engine technical requirements, and lead-sealed on relevant positions. It is not allowed to unseal lead seal during using. Without testing and regulating capability, anyone is not allowed to disassemble or regulate an injection pump assembly.

(6) In the event a diesel engine is expected to lie for long time, one should drain diesel from injection pump and fill with rust proofing fuel.

5.5.3 Discharge water from fuel System

Take a vehicle diesel engine for instance:

When water level inside oil-water separator reaches alarm level, water indicator in separator is lit. (See fig5-6).

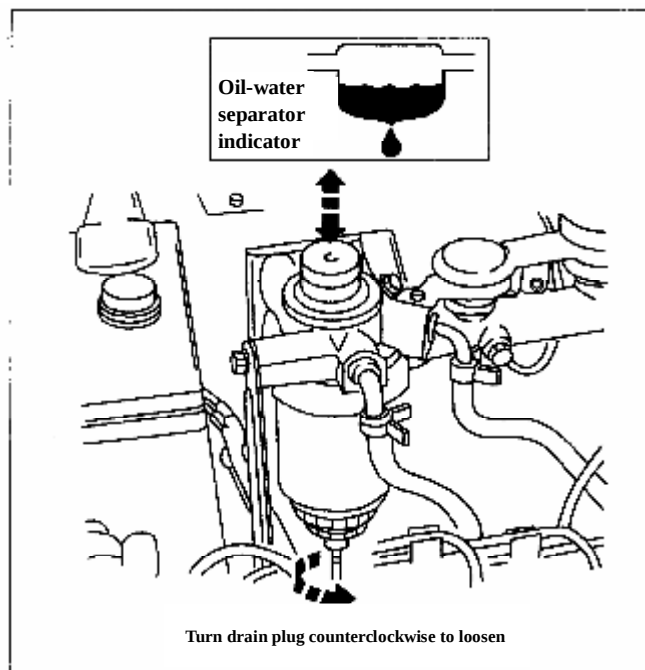


Figure 5-6 Drain water with oil-water separator

●Note:

Oil-water separator indicator keeps on when engine is running. This indicates there is water inside that needs to be drained.

Draining procedures:

- (1) Park vehicle in a safe and plane place.
- (2) Open engine hood, put a container (about 0.2L) at vinyl hose top below drain plug of oil-water separator.
- (3) Loosen drain plug counter-clockwise (about 5 turns, see fig.5-6). Operate hand pump in oil-water separator for about 10 times (See fig. 5-6) to drain water till oil-water separator is filled up with fuel.
- (4) After water has been drained, tighten drain plug clockwise, then press hand pump up and down several times (see fig.5-7).

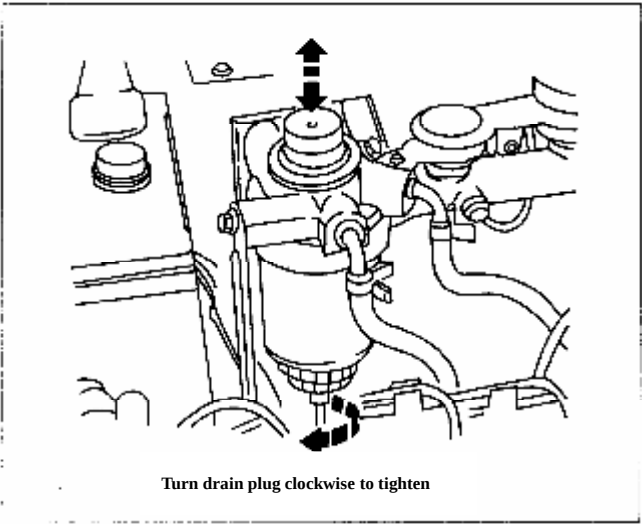


Figure 5-7 Check after draining

(1) Start engine to confirm no fuel leakage. Check if indicator in oil-water separator has gone out.

● **Note:**

If frequent water draining is demanded, fuel must be disqualified and there is water in fuel tank. Send engine to service station.

5.6 Lubrication system technical maintenance

5.6.1 Select oil for diesel engine lubrication system according to environment temperature.

● **Warning:** Do not mix to use oils of different rates.

5.6.2 Measure engine oil level

The engine oil level inside oil pan is measured by a dipstick mounted on the left side of the engine (see fig.5-8). Measure oil level when vehicle parks at plane place while engine has stopped. Draw out dipstick when oil level is not in motion. Wipe up oil on dipstick with clean cotton cloth and insert it back all the way into oil pan. Draw out dipstick again to see oil level.

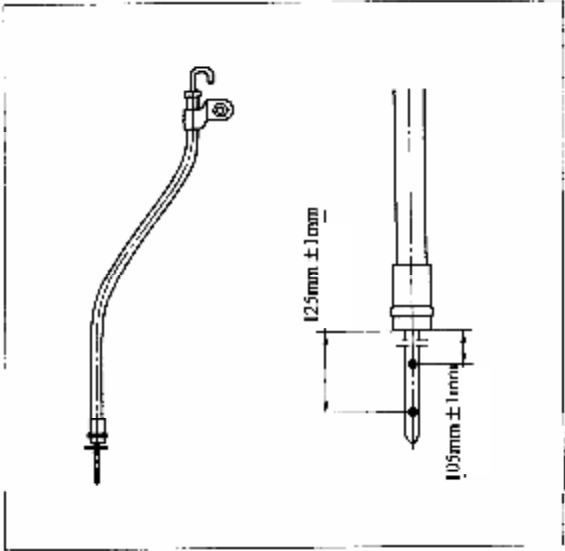


Figure 5-8 Check oil level with dipstick

There are two holes in dipstick used to check oil level (see fig 5-8). Oil level should not be lower than bottom round hole, as in this case, oil pump cannot suck up engine oil. Oil level higher than upper round hole is also inappropriate, as crank of crankshaft will sweep over engine oil surface, making excessive oil mist and oil splashes inside crankcase, thus leading to severe carbon deposit on piston top and in combustion chamber wall.

Moreover, piston ring will be stuck by coke to create problems like smoke, leak at oil seal and higher oil consumption. Therefore, in addition to watching closely oil pressure all the time, one has to check oil level before driving and at each 300~500Km.

● **Note:** Check oil level before driving in addition to watching closely oil pressure all the time.

5.6.3 Change with new oil

There will be impurities, dust and dirt in oil that has been used for longer time. Some un-burnt fuel may mix into and dilute oil. Moreover, blowing-by exhaust gas brings in acid anhydride that deteriorates oil to erode parts. So engine oil should be drained completely and fill in new oil after a period of using time (for example at each 12000km).

Procedures to change oil:

- (1) Put diesel engine or park vehicle on plane place.
- (2) Run engine till oil temperature reaches 80°C, then stop engine.
- (3) Put a pan (or a barrel) under engine, unscrew to remove oil drain plug to give out oil. Lay engine for at least 10 minutes after oil draining, and then screw up oil drain plug.

● **Warning:**

Be careful to avoid to be scalded by hot oil. Dispose used oil properly to protect environment.

- (1) Mount new gasket, screw on oil drain plug and tighten as per required torque. Fill in new oil and measure oil level with dipstick.

When a new diesel engine is in break-in period, if there are large amount of impurities deposited in oil pan, one should clean lubricating system with rate 5 or 7 machine oil (light spindle oil), but never use gasoline or kerosene.

When cleaning a diesel engine interior, fill rate 5 or 7 machine oil into oil pan till oil level reaches middle of the two round holes in dipstick. Remove all fuel injectors and rotate crankshaft for 2~3 minutes, then drain the cleaning oil quickly.

Each time after changing oil, run engine under no-load for a while to ensure lubrication system and locations that need to be lubricated get enough oil.

When filling oil from oil filler on valve cover, one should clear oil filler to prevent impurities and dust from entering. Put on cap tightly after filling.

● **Note:** Before filled oil reaches oil pan, it has to go through push rod hole on cylinder head and hole on tappet side in cylinder block. Therefore, check oil level only at the time 5 minutes after filling.

5.6.4 Oil filter technical maintenance

After a new vehicle has run 2500km in its break-in period, its spin-on oil filter element has to be replaced. From then on change oil together with filter at every 12000km.

Rules and procedures to change oil filter:

- (1) Set a container under the filter to receive overflowed oil.
- (2) Rotate filter counter-clockwise with a special spanner to remove (see fig.5-9)
- (3) Check and clean filter base to ensure new filter can be fitted well.
- (4) Apply a thin layer of oil on O-ring (fig.5-10). Screw new filter onto filter base with hand till resistance is felt. Then rotate filter clockwise (3/4 turn) with a special spanner.



- (5) Don't start engine before ensuring there is enough oil in oil pan.
- (6) Start engine to check whether there is oil leak in filter. Shut down engine and check oil level with dipstick, replenish when necessary.

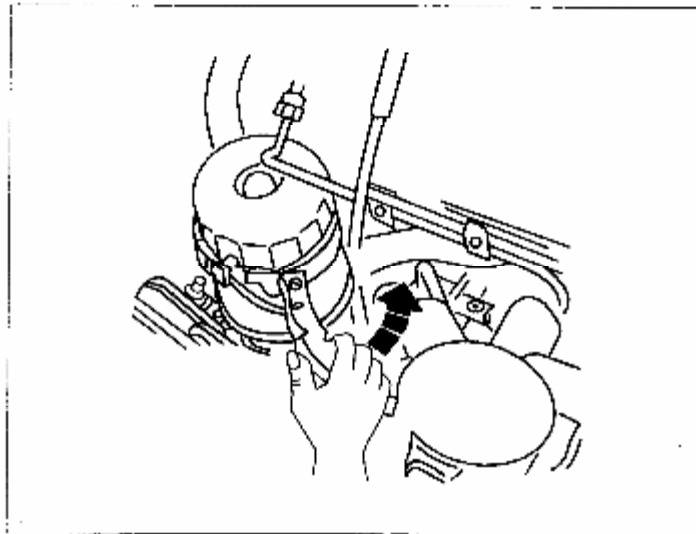


Figure 5-9 Replace oil filter

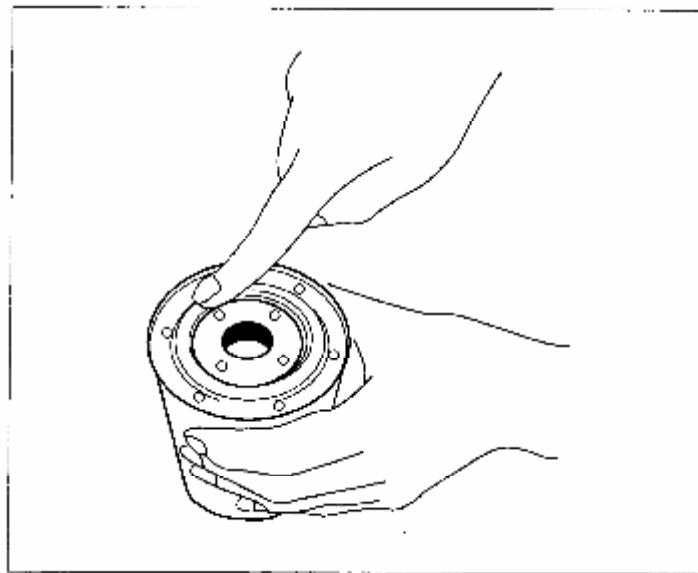


Figure 5-10 Replace oil filter

● **Warning:**

- (1) The spin-on filter is use-only-once part.
- (2) Replace oil filter regularly as per technical maintenance requirements.

The oil pressure range limited by pressure regulating valve on oil filter is $0.45\text{MPa} \pm 0.02\text{Mpa}$. The value was set in manufacturer. It is not suggested to make any adjustment in normal conditions.

Be careful not to damage rubber-sealing ring to avoid leakage during oil filter changing process.

Replace sealing ring if it has been damaged.

5.7 Cooling System technical maintenance

5.7.1 When a diesel engine is running, there ought to be enough antifreeze and antirust fluid (coolant) within the cooling system to ensure normal engine operation. Check coolant before each driving and add when necessary.

5.7.2 Long life coolant can be used for 1~2 year. During coolant changing, in addition to adding coolant as per specification, one has to run engine for 5 minutes to fill up cooling system with coolant, then shutdown engine to check coolant level. Replenish if necessary.

● **Note:**

- (1) Never use untreated hard water such as tap water or mineral water for coolant.
- (2) Never use inferior coolant or mix to use coolants of different rates to avoid parts damage.
- (3) Check coolant concentration to find the cause of coolant abnormal consumption.
 - ① If coolant concentration has not increased, leakage may be the cause. Remove leakage and add coolant of same rate.
 - ② If concentration goes down, one should add concentrated coolant of same brand.
 - ③ If concentration has increased, water evaporation from coolant may be the cause. Add distilled water.

After having filled in distilled water or concentrated coolant, stir them evenly and check coolant concentration again till the value reaches its corresponding icing point. If the user is not able to perform these checks, he should go to service station for help.

5.7.3 Check fan belt tension. Press down with thumb (70~80N) the belt at the point between water pump and alternator (see fig.5-11). Its correct deflection is 7~8mm.

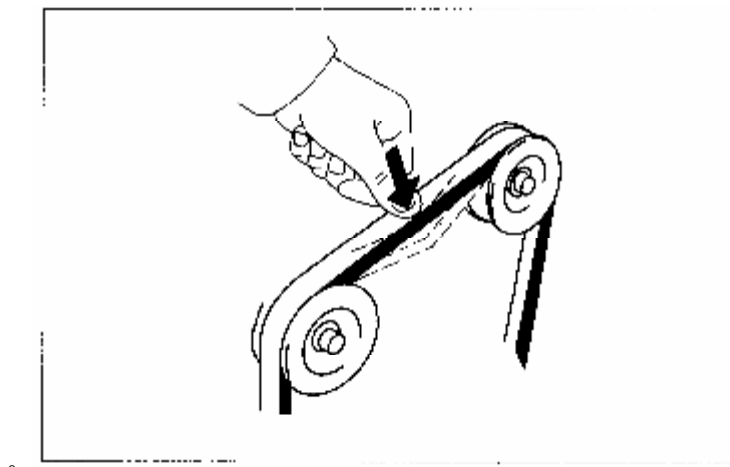


Figure 5-11 Check and adjust fan belt tension

Chapter 6

Diesel engine faults and solutions

During diesel engine operation, technical state of the parts could deteriorate gradually due to wearing, distorting and improper maintenance. When some technical indices exceed the limits, the engine is faulty. The common faults on a diesel engine are: hard start-up, rough operation, lack of power, abnormal sound during operation, abnormal exhaust gas color, lower oil pressure and higher coolant temperature, etc.

Remove any engine faults whenever they happen. Engine operates with faults would reduce its power and economy and deteriorate its operating performance. Moreover, it would accelerate parts wear or lead to accidental damages.

● **Notes:**

- (1) Diagnose an engine according to symptoms and by referring to diesel engine’s construction /operation theories. Avoid missing a fault or dismantling blindly.
 - (2) Much complicated diagnosis or fault-removing procedures may need to use instrument or special equipment, and be performed by technician.
- The diesel engine faults and removing procedures in this chapter are for reference only.

6.1 Hard start-up

Symptoms and causes		Removing procedures
Electrical system	Wrong circuit connection or poor contact	Check if connections are tight and reliable.
	Weak battery	Charge battery
	Poor contact between start brush And commuter	Repair or replace brush. Polishing commuter surface with wooden sandpaper and blow it clean
	Stuck or failure starter solenoid	Adjust solenoid and replace if necessary
	Failure pre-heating system	Replace glow plug
Fuel system	Air in fuel system	Check if fuel supply connector is loose. Loosen vent screws on injection pump and fuel filter, press hand pump till no bubble in overflowed fuel. Retighten vent screws and hand pump.
	Choked fuel pipe	Check if fuel pipe is clear.
	Blocked fuel filter	Clean fuel filter or replace element.
	Fuel pump failure or inconsistent supply	Check fuel inlet pipe for air leaking and if screen net is blocked. If there is no fuel supply after removing faults, check fuel inlet pipe and fuel pump.
	Less injection from injector. No injection or non atomization	Check injector for its atomizing state, check to see if injector plunger and oil outlet valve is worn-out or stuck, check and adjust the injection pressure to specified range.
	No fuel supply from injection pump	Check and repair.



Symptoms and causes		Removing procedures
Mechanical system	Worn-out piston compression ring	Replace piston ring. And replace cylinder sleeve as per its wear situation.
	Leaked valve	Check valve and valve seat for air sealing. Repair or grind if necessary.

6.2 Hard start-up at low temperature

Symptoms and causes		Removing procedures
Fuel	In winter or cold area, diesel becomes turbid and frozen due to selection of wrong fuel.	Use low-freezing diesel according to local ambient temperature
Oil	In winter or cold area, selecting wrong oil. Oil becomes too viscous, which increase interior friction and the resistance to start-up.	Use low-viscosity oil according to local temperature of the diesel engine in order to decrease the starting power.
Battery	Select to use battery whose volume is less than 100Ah in cold area or in winter	Select to use low-temperature battery whose volume is larger than 100Ah according to local temperature

6.3 Insufficient power

Insufficient diesel engine power means engine power does not reach the designed requirements. Engine is “weak” and tends to stalling under heavy load or climbing a hill. The lack of power usually comes with hard start up. They are related to each other, cross-reference diagnosing can be made thereupon.

Symptoms and causes		Removing procedures
Power and Rpm do not increase after depressing gas pedal	(1) air in fuel pipe and fuel filter, or they are blocked.	Bleed the system or replace fuel filter element, flush oil pipes.
	(2) insufficient fuel supply from injection pump.	Check, repair or replace plunger sets.
	Fuel injector atomization is poor or injecting pressure is low and some fuel injectors are stuck.	Check fuel injector atomization or adjust injecting pressure. Check, repair or replace injector parts.
Bad exhaust gas color with higher temperature	Blocked air filter	Remove dust on air filter element. Replace if necessary.
	Exhaust pipe has longer connector or connecting pipes, small turning radius or too many elbows.	Remove carbon deposit inside the exhaust pipe, re-install exhaust connecting pipes, use less than 3 elbows with enough exhausting section.
Poor performance at each gear	Fuel supply advance angle and valve timing are changed.	Check and adjust the static fuel supply advance angle and valve timing.
	Valve clearance is changed.	Check and adjust the valve clearance.
Diesel engine overheating	Coolant temperature is too high.	Check cooling system, remove water scale; check belt tension and adjust it if necessary; check thermostat.
	Oil temperature is too high.	Check oil volume and add if necessary; if bearing and any motion parts get hot, find out the cause and remove
	Exhaust gas temperature is too high.	Check and correct static fuel supply advance angle and fuel injector injecting pressure



Symptoms and causes		Removing procedures
Lack of power, performance deteriorates, leakage, black smoke and abnormal slapping.	Leakage at contacting face between cylinder head and block. Cylinder-head bolt is loose or the cylinder-head gasket is damaged.	Tighten cylinder head as per specified torques, or replace cylinder-head gasket.
	Leakage at intake/exhaust valves	Disassemble and check intake/exhaust valves, grind contacting face between valve and valve seat. Replace parts if necessary.
	Valve clearance is not correct.	Adjust valve clearance to standard.
	Leakage at injector hole, or copper washer is damaged	Remove to check injector. Clean injector hole and replace damaged parts.

6.4 Abnormal noise during operation

First of all, one should recognize what a abnormal sound is like: either a knock due to an abnormal breaking-out or clashing noise due to parts’ abnormal motion. Diagnose to locate sound source according to its acoustic feature together with parts construction theory.

● **Cautions:** It is strictly prohibited to keep a diesel engine operating with abnormal noise. Once hearing an abnormal noise, you should stop vehicle immediately to check and remove the fault to avoid accident.

Symptoms and causes	Removing procedures
Early injecting or fuel injector is stuck, there is clear metal-beating noise in the cylinder.	Adjust static fuel supply advance angle, and check fuel injector for injecting.
Excessive clearance between piston pin and connecting rod small end bushing hole, which makes light and sharp noise. The noise is clearer during idle running, and turns sharper when throttle is opened wider suddenly.	Replace connecting rod small end bushing to make its clearance reaching the standards
Excessive clearance between piston and cylinder sleeve, and clashing noise can be heard from engine outside. The noise gets louder with rising of engine Rpm.	Replace piston, piston ring. Or replace cylinder sleeve depending on its wear.
Excessive clearance between connecting rod bearing and main bearing due to wear. Clashing noise among engine parts can be heard at crankcase during operation. And heavy and strong knocking can be heard when engine Rpm is slowed down suddenly.	Disassemble to check bearing. Replace it if necessary. And keep specified fitting clearance.
Valve knocks piston. Heavy, even and rhythmical beating noise can be heard at cylinder head.	Find out knocking cause, check valve timing, and adjust valve clearance.
Drive gear is worn-out or with excessive clearance. Abnormal noise comes out from gear chamber. And knocking noise can be heard at sudden deceleration.	Check driving gear clearance and replace gear if necessary.
Excessive clearance at intake/exhaust valves. Louder and rhythmical sound can be heard at cylinder head.	Re-adjust valve clearance.



6.5 Abnormal exhaust gas color

The color of exhaust gas under normal load is light gray, and deep gray for the most under short heavy load. Blue, white or black gas indicates faults are occurring. Blue indicates oil burning; white indicates that atomized diesel have not burnt in cylinder or there is water in the fuel; and black indicates the injected fuel is excessive, which has not burnt completely.

Symptoms and causes		Removing procedures
Black exhaust gas	Diesel operates under overload.	Reduce diesel engine load to specified range.
	Uneven fuel supply among cylinders	Adjust fuel supply to each cylinder from injection pump.
	Incorrect valve clearance, poor valve sealing (exhaust valve is leaking)	Adjust valve clearance and check sealing cone.
	Smaller fuel injecting angle, injecting delay causes part fuel burning in exhaust pipe.	Adjust static fuel supply advance angle.
	Insufficient air intake, air filter or intake pipe is blocked.	Remove dust and dirt, and replace air filter element if necessary.
	Worn-out cylinder sleeve and piston ring.	Replace parts.
	Damaged EGR system solenoid (for diesel engine with EGR system only)	Disconnect the hose (from solenoid) from EGR valve end, if black smoke stops, it shows solenoid has damaged and needs to be replaced.
White exhaust gas	There is water in cylinder or in diesel.	Locate the cause and remove.
	Engine is too cold at cranking, no combustion in certain cylinder (especially in winter).	Increase moderately engine Rpm and load and let it run longer.
Blue exhaust gas	Piston ring is stuck or worn-out, and its elasticity becomes poor. Oil enters combustion chamber as second piston ring has been mounted on wrong side.	Disassemble and check piston ring, or replace it if necessary.
	Engine operates on low load for a long period, clearance between piston and cylinder sleeve becomes larger, oil enters combustion chamber.	Increase moderately engine load or disassemble to check or replace piston ring, piston and cylinder sleeve.
	Excessive oil in oil pan.	Drain excess oil by referring to dipstick hole.

6.6 Low oil pressure

Each diesel engine’s high-speed moving sets should get enough lubricant to reduce wearing and taking heat away. This will help to avoid parts from stuck and early worn-out. Moreover, lubricating oil can fill up the tiny clearance in parts (e.g. the one between piston and inner wall of cylinder sleeve), which will improve sealing and prevent high-pressure air leak, making start-up easy and keeping engine’s original power. Therefore, lubricating oil should have certain pressure and flow, and should be clean as well.



● **Cautions:** Engine oil pressure lower than specified value indicates there is fault in lubricating system. Never run diesel engine without oil pressure or under lower oil pressure. In those cases, one should shut off engine to check and remove faults.

Symptoms and causes	Removing procedures
Oil pressure meter indication does not match sensor output.	Replace them in pair with mated ones from same manufacturer.
Oil amount in oil pan is not enough.	Add oil to specified level.
Oil strainer or filter is blocked, or filter pressure adjusting valve is failure.	Clean oil strainer, replace oil filter element, and adjust or replace pressure-adjusting valve.
Oil pump pressure limiting valve is failure.	Adjust or replace oil pump pressure limiting valve.
Fitting clearances at connecting rod bearing, crankshaft bearing and camshaft bearing are excessive.	Replace with new bearing.
Oil pump is worn-out severely or there is other fault inside.	Check, adjust or replace relevant parts.
Oil viscosity is much low.	Change with specified oil.

6.7 Abnormal coolant temperature or coolant short

Symptoms and causes		Removing procedures
Diesel engine overheating	(1) Coolant level is too low	(1) Replenish coolant, check for leak, repair if necessary
	(2) Fan belt is loose or broken	(2) Adjust fan belt tension or replace fan belt
	(3) Thermostat main valve stuck	(3) Replace thermostat assembly
	(4) Faulty water pump and fan clutch	(4) Replace water pump and fan clutch
	(5) Incorrect fuel supply timing	(5) Correct fuel supply timing
	(6) Chocked radiator core	(6) Clean radiator
Diesel engine is too cold	(1) Thermostat valve is ajar (2) Coolant temperature meter is failure	(1) Replace thermostat (2) Measure coolant temperature, replace coolant temperature meter
Short coolant often	(1) Radiator is leaking (2) Radiator hose connector is loose or hose is damaged (3) Water pump is leaking	(1) Repair or replace radiator (2) Tighten clamp or replace hose (3) Replace water pump assembly

- **Notes:**
- (1) Once a diesel engine gets overheated, it is not allowed to shut down engine or add coolant immediately. Run engine under no-load at mid-large throttle till coolant temperature drops. Then stop engine to perform checks.
 - (2) Do not remove radiator cap while engine is still hot to avoid scalding. Use caution when adding coolant.
 - (3) In the event the cause of overheating cannot be found, contact service station or repairing garage immediately to prevent other parts from damaged.



6.8 Supercharging system faults

Symptoms and causes		Removing procedures
Lack of power	(1)Impurity deposits at sealing location on turbine side (2)Higher oil temperature, insufficient fuel supply and floating bearing is burnt (3)Oil leaks from turbine and compressor shaft end due to blocked or distort oil return pipe. (4)Supercharger sealing ring is failure due to damage (5)Turbine rotor lost balance (6)Turbine and compressor impellers are worn-out and damaged. (7)Air filter is blocked (dirty). (8)Boost compensator breaks air pipe (9)Dirty intake/exhaust pipes or connectors are leaking. (10)Supercharger cannot operate well or is damaged.	(1) Change oil and service supercharger. (2) Check fuel supply system, service supercharger. (3) Service and replace fuel return pipe. (4) Replace sealing ring. (5) Repair and replace turbine shaft rotor (6) Check and service. (7) Service air filter and replace element (8) Check or replace air-conducting pipe. (9) Clean, check, repair or replace air intake/exhaust pipes (10) Check, repair or replace supercharger
Higher fuel consumption	(1) Dirty intake/exhaust pipes or air leak at connections. (2) Poor supercharger performance	(1) Check or replace part. (2) Clean, adjust or replace.
Higher oil consumption	(1) Supercharger sealing ring is worn out. (2) Oil leakage at compressor impeller end. (3) Screws at joints of oil intake / return pipe are loose washers are damaged. (4) Oil is of poor quality.	(1) Replace sealing ring. (2) Check and repair. (3) Check, repair or replace washers. (4)Change oil according to requirements.
Abnormal noise	(1) There is too much oil dirt in gas passage on turbine end, which narrows the passage. (2) There is too much oil dirt in gas passage on compressor end, which narrows passage. (3) Excessive wear on floating bearing, rubbing between turbine/compressor impeller and case.	(1) Clean or replace. (2) Clean or replace. (3) Replace floating bearing.
Vibration due to rubbing between turbine, air compressor impeller	(1) Foreign matter enters. (2) Floating bearing is excessively worn out. (3) Poor turbine shaft dynamic balance.	(1) Clean or replace. (2) Replace floating bearing. (3) Check, repair or replace.

- **Cautions:**
- (1) Be ware of any foreign matters entering intake/exhaust system during fault removing and assembling / disassembling a diesel engine. Supercharger rotor rotates at a very high speed, its clearance to case is narrow, any foreign matters either big /small or soft / hard would adversely affect rotor performance and damage its impellers.



The supercharger may subject to abnormal vibration and noise once the impellers are damaged. Shut off engine immediately when this happens, perform check and repair on supercharger.

(2) Oil leak on supercharger does not warrant that it must be replaced as long as impeller does not rub case and impeller shaft can rotate freely. Supercharge in this case can be used after oil leak has been removed.

6.9 Starter does not run, weak startup and noise

Symptoms and causes		Removing procedures
Starter motor does not run	(1) Starter switch and other control circuit are disconnected.	(1) Check circuit, make connections reliable.
	(2) Poor contact between brush and commutator	(2) Adjust brush spring pressure, clean the commutator.
	(3) Starter motor internal disconnected	(3) Check and repair starter.
Weak starter, cannot startup diesel engine	(1) Lower battery volume	(1)Charge battery according to specifications.
	(2) Poor lead contacting	(2)Tighten lead connections.
	(3) Burnt damage or oil dirt on commutator surface.	(3)Polish the commutator surface or remove the oil filth.
	(4) Worn-out brush or weak brush spring leads to poor brush contacting with commutator	(4)Replace carbon brush or adjust carbon brush spring.
	(5) Poor contacting due to burnt electro-magnetic switch main contacts,	(5)Polish with grade “0” non-metallic sandpaper.
	(6) Worn-out bearing, armature rubs case	(6)Replace bearing.
Engine started up, while starter goes on running with sharp noise	(1) Bronze contact disk sticks to two contacts inside starter clutch	(1)Cut off power immediately, check circuit and repair contacts.
	(2) Starter motor armature shaft is bent.	(2)Cut off power immediately, replace starter
	(3) Tooth face is scratched to be stuck.	(3)Cut off power immediately, repair tooth face.
	(4) Starter overriding clutch is damaged.	(4)Cut off power immediately, repair or replace clutch.

6.10 Alternator does not work, lower/higher charging current

Symptoms and causes		Removing procedures
Alternator does not work	(1)Wrong circuit connection, disconnected circuit or poor contacting.	(1)Check and repair circuit.
	(2)Rotor coil is disconnected.	(2)Check repair or replace alternator assembly
	(3)Commutator diode is damaged.	(3)Replace commutator diode.
	(4)Poor contacting on carbon brush.	(4)Remove dirt on brush or replace brush.
	(5)Regulator is damaged.	(5)Repair or replace regulator.
Lower charging current	(1)Driving belt is loose.	(1)Adjust belt tension.
	(2)Regulated voltage is too low.	(2)Replace regulator.
	(3)Battery fluid is insufficient or the battery plates are severely sulphurized.	(3)Add battery fluid to specified level. Replace battery with severely sulphurized plates.

Symptoms and causes		Removing procedures
Higher charging current, burn out bulb often	(1) Regulated voltage is too high. (2) Regulator magnetic coil is de-welded to lose regulation.	(1)Adjust voltage to specification. (2)Check and repair coil and re-weld.

6.11 Lower battery volume, higher self-discharging

Symptoms and causes		Removing procedures
Hard engine startup due to lower battery volume	(1) Lower battery fluid level. (2) Short circuit among battery plates. (3) Plates are sulphurized. (4) Poor contacting at circuit connections,too much oxide on terminals. Insufficient charging.	(1) Fill in distilled water or diluted sulfuric acid (concentration 1.1) as specified. (2) Remove sediments or change battery fluid. (3) Repeatedly recharge to remove sulphurization. (4) Make the connection firm, remove oxide and apply Vaseline on terminals.
Larger battery self-discharging	(1) Impurities in battery fluid. (2) Short circuit on battery outside lead. (3) Fluid overflowing from battery, connect positive / negative poles to short circuit. (4) Heavy shedding, damaged separator plates and warped plates make short circuit.	(1) Add battery fluid formulated with pure sulfuric acid and distilled water as specified. (2) Locate short circuit and remove. (3) Clean battery surface and terminals with soda water or warm water, be sure no water is entering battery. (4) Repair or replace battery.

- Cautions:
- (1) The gas released from battery is easy to be ignited by sparks, so there should be no lighted fire presenting during battery’s check and service. Do not let battery fluid contact skin and cloth. Wear goggles while servicing a battery.

(2) Never short circuit two battery terminals, or it may lead to battery overheating even explosion.

(3) While dismounting or mounting electrical equipments, remove first the negative (ground) cable from terminal. But for replacing light bulbs, cutting off relating switch would be ok.

(4) When removing a battery, remove negative cable first then positive cable. Untie battery bracket to life out battery. Operate in reverse sequence to mount a battery.

6.12 Failure cold-start preheating system

Symptoms and causes	Removing procedures
Turn ignition key to “START”, engine stalls after flash indicator has blinked 30 seconds at a frequency of 4 times per second. The cause may be burnt fuse or short circuit on glow plug “P” (normal glow plug resistance is about 2 Ω), or solenoid “D” fuse is burnt. Fuse damage or loose wire connection may also be the causes.	Check circuit of cold start device or replace damaged parts.



Symptoms and causes		Removing procedures
Turn ignition key to “START”, engine stalls after flash indicator has blinked 60 seconds at a frequency of 4 times per second. This may be caused by relay contacts inside controller that control FGK output haves not closed due to damaged controller or lower battery voltage (lower than 9V).		Replace controller or charge battery to specification.
Glow plug does not ignite during normal preheating. The cause may be blocked fuel pipe / plug fuel feeder or damaged solenoid parts.		Check fuel pipe, replace damaged parts.
After whole preheating process has completed (ignition key on “START”): (1) Indicator goes off after it has blinked (quickly) for 60 seconds at a frequency of 4 times per second. This may be caused by stuck MV output relay contacts. (2) Indicator keeps blinking at a frequency of 4 times per second This may be caused by stuck FCK output relay contacts. (3) Indicator goes off after it has blinked (quickly) for 30 seconds at a frequency of 4 times per second. Coolant temperature sensor RT is disconnected or poor contacting of RT harness may cause this.		(1) Cut off power and replace controller. (2) Replace controller. (3) Replace controller.
When coolant temperature is below 15℃, turn ignition switch to “START” will not lit indicator. Damaged indicator clip or controller, or poor harness contacting may cause this.		Check harness first, if indicator keeps off, replace indicator. Replace controller if replaced indicator still does not lit.

6.13 Water pump electro-magnetic fan clutch faults

No.	Symptoms and causes		Removing procedures
1	Fan does not work, higher engine coolant temperature	Power lead is disconnected or voltage is too low	Check power lead (from alternator terminal B to clutch) for continuity and ground. Check the plug connecting temperature control switch and clutch for tightness; check battery voltage, and if alternator operates well.
		Control switch is failure.	Unplug clutch lead from switch, connect clutch lead to alternator terminal “B” with a wire (can not keep connection for long). Listen to any clutching sound from clutch. If clutch is fine and no other faults are found after above checks, the cause must be temperature control switch. Replace switch.



No.	Symptoms and causes		Removing procedures
		Excessive clutch clutching clearance	If there is no clutching sound from clutch, measure with a feeler the clearance between clutch suction disc and the pulley, adjust clearance to 0.5~0.8mm.
		Clutch is failure	In the events clutch still does not work after clutching clearance, power supply connection and switch all have been checked and adjusted, remove water pump belt, turn with hand the pulley and fan to see if there are grabbing. If things are normal, make adjustment with the 3 bolts on front end of clutch fan retaining plate, pressing suction firmly on pulley. This will make fan and water pump synchronizing.
		Coolant temperature is too low.	Measure coolant with a water thermometer to see whether coolant reaches the working temperature $85\pm 2^{\circ}\text{C}$.
2	Fan clutch works intermittently	Power lead has not connected firmly.	Tighten the connection.
		Coolant short in radiator	Check level in radiator timely and add coolant or antifreeze.
3	Water pump leaks	Gasket leaks.	If coolant leakage is seen at connecting section between water pump and engine, damaged water pump gasket is the cause. Replace water pump gasket.
		Coolant sealing leaks.	Check leaking spot. If coolant comes from water pump overflow hole under pulley, damaged water seal is the cause. Replace water pump (but slow dripping from overflow hole is normal).
4	Abnormal sound from assemblies	Clutch noise	(1) Check if clearance between suction plate pulleys is too small. Adjust to specification. (2) Voltage is too low, clutching torque is insufficient. (3) Loosen belt and turn pulley and fan to check if there are grabbing, swinging and rubbing. Replace assembly if any
		Water pump noise	
5	Fan is activated only after the hand of coolant temperature meter reaches red zone	Coolant temperature sensor is failure.	Measure coolant temperature in radiator with a water thermometer. If it works only when coolant temperature is over 90°C , either temperature control switch or sensor is failure.
		Clutch temperature control switch is too hot.	

No.	Symptoms and causes	Removing procedures
● Notes: 1. Fault- removing procedures and requirements to replacement and mounting-- temperature control switch: (1) Remove temperature control switch, connect its two leads to a voltmeter. Put switch in water under heating. Switch is well if voltmeter indicates continuity at $83\pm2^{\circ}\text{C}$. (As thermometer error is concerned, switch is considered well even at $80\sim87^{\circ}\text{C}$. (2) Temperature control switch case is thin, dismounting/mounting torque should not exceed 20N.m. Otherwise it might get distort, cannot work properly. 2. In the event engine is overheated and clutch is failure while no spare parts at hand, you can set clutching clearance to zero and fix it via 3 adjusting bolts on fan retaining plate. Let fan run synchronizing with pulley. Bring the problem to service station quickly.		



Chapter 7

Chassis construction and service

7.1 Clutch

7.1.1 Clutch-main technical parameters

Clutch-- main technical parameters

No.	Description		Data		
1	Model vehicle		BJ1043V8JE6-D	BJ1049V9JD6-C	BJ1049V9JE6-A
2	Engine model		YZ4102ZLQ	493ZLQ	Phaser110Ti
3	Type		Single plate, dry type, diaphragm spring clutch, with shock absorber		
4	clutch plate size (mm)	Inner diameter.	φ 190	φ 160	φ 200
		Outer diameter.	φ 300	φ 250	φ 330
5	Shock absorber		Corrugated spring plus damping spring		
6	Pressure plate pressing force (N)		8000	6276	6786
7	Max driving torque (N·m)		502.2	353	392
8	Clutch assembly outer diameter. (mm)		φ 370	φ 297	φ 314
9	Clutch assembly thickness (free state) (mm)		63	45.5	54.8
10	Operating mechanism type		Hydraulic		
11	Release master cylinder×travel (mm)		φ 19×35		
12	Clutch slave cylinder inner diameter.× travel (mm)		φ 22×24		

BJ493ZLQ series diesel engine uses single plate, dry type, diaphragm spring clutch (See figure 7-1-1).Though diaphragm spring is very complicated during fabrication, it has non-linear characteristic. Its spring force is stable through friction plate’s normal wear range, this could save depressing force on pedal needed to release clutch. All these make operating easy and stable, which is advantageous to high speed driving. Beside, diaphragm performs as a release lever, no extra adjusting mechanism is needed. The whole construction is simple and compact.



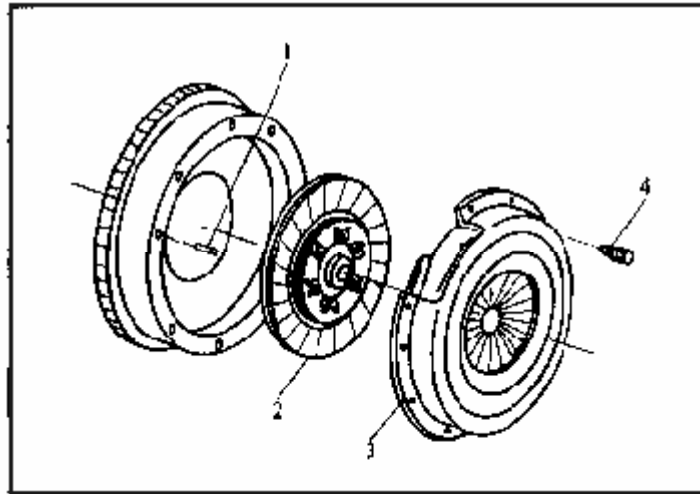


Figure 7-1-1 Clutch

1-column pin 2-clutch plate assembly 3-clutch pressure plate and case assembly
4-bolt, spring washer, flat washer

7.1.2 Briefs on construction

Clutch connects engine and transmission, it transmits and cuts off power connection between these two. It is mainly used to start up vehicle, help gear-shifting and avoid overload on transmission line. BJ1049, BJ1043 vehicle adopt type 300, 250 and 330 diaphragm spring clutch. This clutch is of friction type it transmits engine power through frictions at drive and driven parts, and cuts off power with release mechanism. The clutch is operated by clutch operating mechanism. The operation mechanism used in these two vehicles are hydraulic type it has the characteristics of low friction resistance, high transmitting efficiency and smooth-clutching. The clutch mainly consists of clutch pedal, master cylinder, slave cylinder, booster and oil pipe.

1. Diaphragm spring clutch construction (figure 7-1-2)

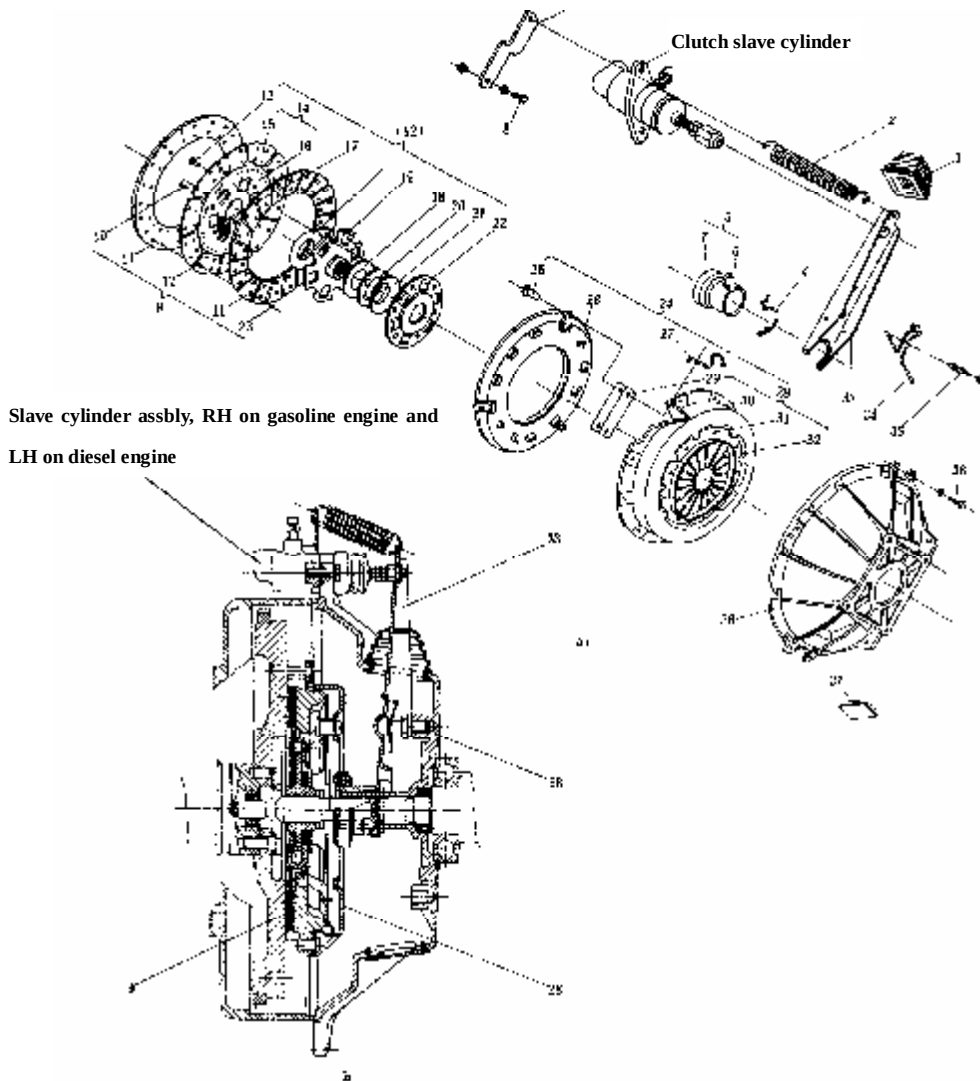


Figure 7-1-2 Diaphragm spring clutch

1.hook plate- release fork return spring 2-return spring 3-hood 4-return spring 5-release bearing socket assembly 6-release socket 7-release bearing 8-bolt 9-clutch driven plate assembly 10- corrugated spring leaf rivet 11-friction plate 12-FR/RR damping disc with case assembly 13-driven plate assembly rivet 14- corrugated leaf/FR damping disc assembly 15-corrugated spring leaf 16-FR damping disc 17-large/small damping spring 18-damping plate 19-clutch disc case 20-damping spring washer 21-damping spring washer 22-RR damping disc 23-hollow rivet 24-clutch pressure plate and cover assembly 25-flat rivet 26-clutch rear disc 27-rear disc connecting plate 28-clutch cover and diaphragm spring assembly 29-pressure plate transmitting plate 30-clutch cover 31-diaphragm spring rivet 32- diaphragm spring 33-clutch release fork 34-bracket spring 35-circular bracket 36-bolt 37-dust boot 38-clutch housing

Diaphragm spring clutch is a kind of advanced clutch, composed by pressure plate and cover assembly (24), driven plate assembly (9) and release mechanism. By using a disc diaphragm spring (32), clutch rear disc and cover assembly is mounted on clutch cover (30) by attaching its big end with nine rivets (31). (Its small end contacts release bearing). A 2-step torsion damper and an auto compensative damper are mounted on driven plate. A corrugated spring leaf (15) is mounted on front damping disc (16), two friction plates (11) is riveted on both sides of corrugated spring leaf. Clutch disc hub (19) (with involutes spline) mounts on transmission input shaft. The clutch driven disc assembly that slides on input shaft spline is pressed in between flywheel and clutch

pressure disc (26). The friction force made by pressure disc transmits engine power to transmission via FR/RR damping discs (16, 22) and through damping spring (17) / clutch disc hub.

Clutch pressure disc assembly releases away from driven plate assembly by means of releasing mechanism. When clutch pedal is depressed, the force presses onto small end of diaphragm spring via release fork (8) through release bearing assembly (5), thus detaches the clutch; while pedal is released, pressure disc assembly, by using the returning force of diaphragm spring, presses on driven plate assembly to attach the clutch. See figure 7-1-3.

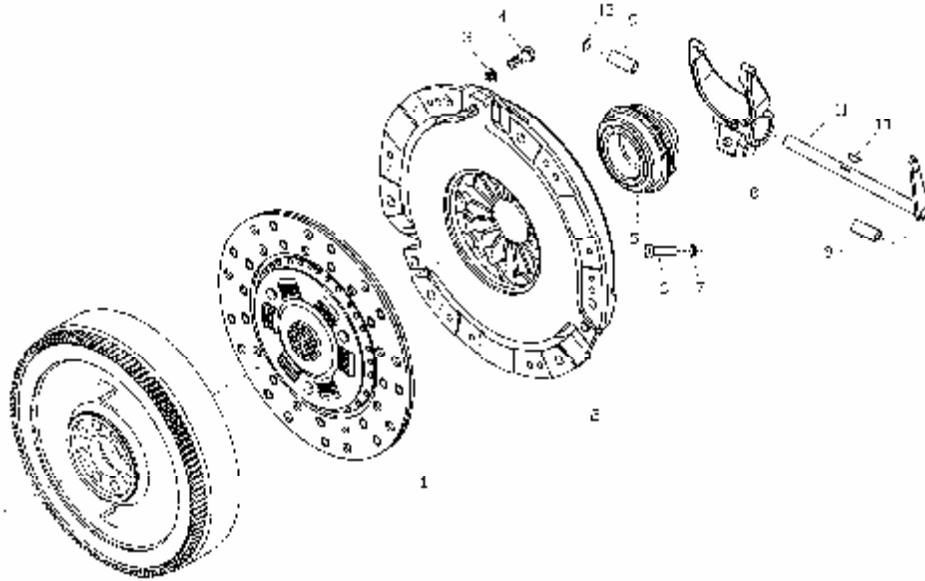


Figure 7-1-3 Clutch

1-clutch driven plate assembly 2-clutch pressure plate
3-spring washer 4-hex bolt 5-release bearing assembly

2.Clutch operating mechanism

The mechanism is of hydraulic type, composed by clutch pipe system and pedal mechanism. The pipe system consists of clutch master cylinder, slave cylinder, booster and oil pipes.

(1) Clutch master cylinder

The master cylinder is of single piston design. It consists of following parts: cylinder block, piston, main cylinder cup, return spring, push rod, boot and push rod fork assembly. The master cylinder is mounted on clutch pedal bracket inside the driver cab. A screw pipe on top of master cylinder is connects to fluid reservoir via rubber hose, and its outlet connector is connected to slave cylinder on clutch housing via clutch pipe system.

(2) Clutch slave cylinder

The slave cylinder is of single piston design. It consists of slave cylinder block, piston, cup, boot, push rod and vent screw. Push rod fork on slave cylinder end connects to clutch release fork. See figure 7-1-4.

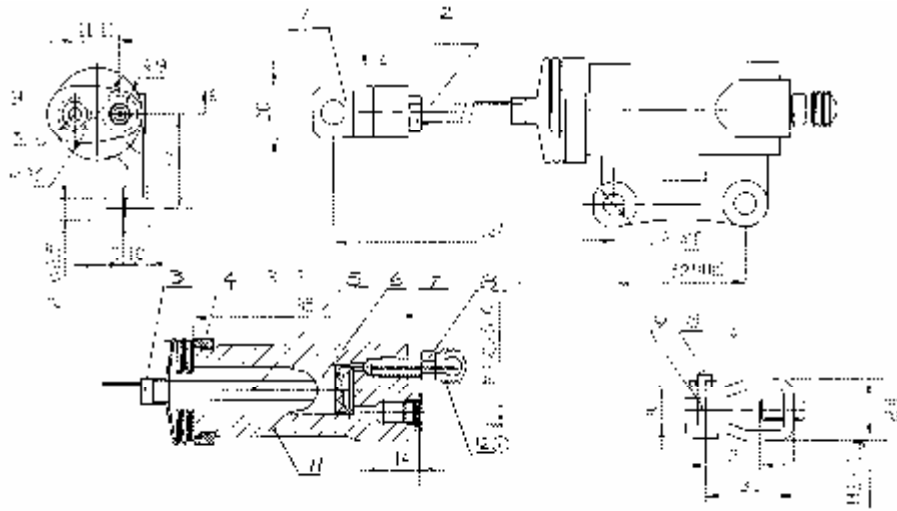


Figure 7-1-4 Clutch slave cylinder

1-push rod fork 2-locking nut 3-vent screw cap 4-dust boot 5-push rod 6-piston 7-cup 8-vent screw 9-column pin 10-cotter pin
11-cylinder tube

(3) Clutch booster

The booster (figure 7-1-5) is a vacuum booster. Its construction is basically the same as that of the booster in brake system. The booster indicated in figure 7-1-6 is a pneumatic booster. Its operation travel is 38mm and diameter is 70mm. The booster consists of cylinder tube, piston, sealing ring and controller. The oil pressure from master cylinder via slave cylinder drives booster control valve to push booster piston to move; booster piston rod then pushes piston in slave cylinder. Slave cylinder push rod pushes release fork shaft to turn, shifting release socket to move. At the moment, clutch pressure plate moves backward to loosen clutch driven plate to release the clutch finally. Clutch booster can help clutch to operate lightly.

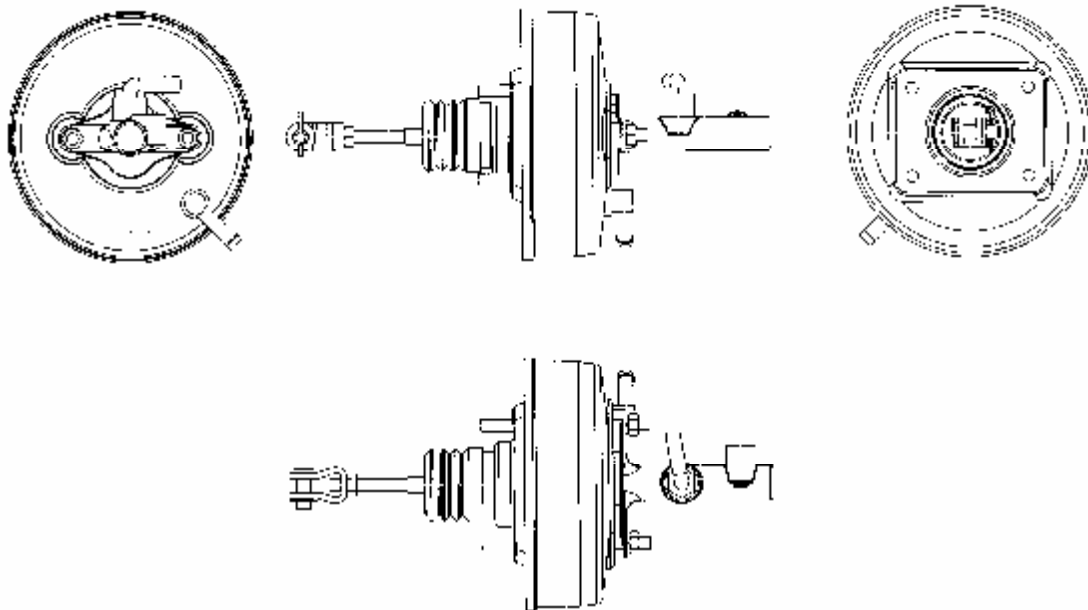


Figure 7-1-5 Clutch vacuum booster

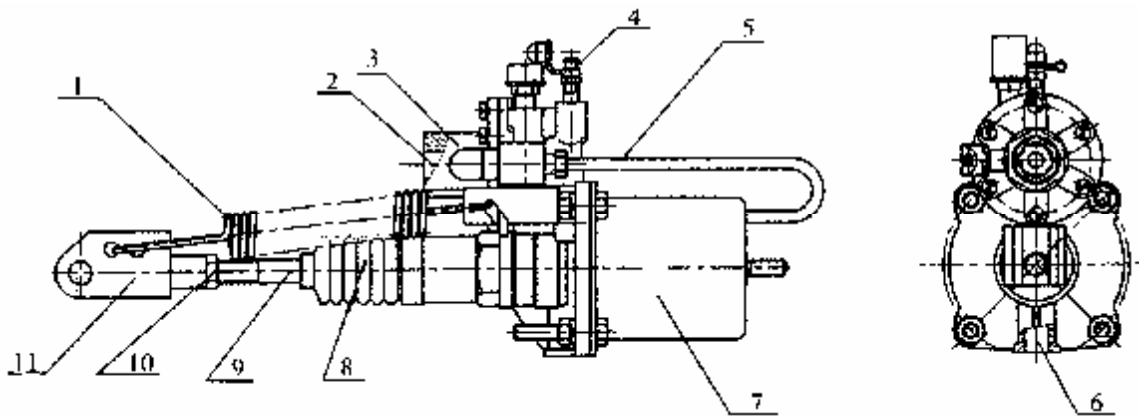


Figure 7-1-6 Clutch pneumatic booster

1-extension spring 2-socket 3-connector 4-vent screw 5-air tube 6-socket
7-cylinder tube 8-dust boot 9-connecting rod 10-nut 11-connector

(4) Clutch pedal mechanism consists of pedal arm assembly, master cylinder bracket assembly, pedal shaft pin/bush and return spring. Pedal mechanism and release master cylinder sets are mounted in driver cab. Master cylinder connects to slave cylinder via pipes.

7.1.3 Check and repair

Check each part after clutch and its operating mechanism have been removed from vehicle. Carry out necessary maintenance and repair.

1.Check and repair—clutch assembly

(1) Clutch driven plate assembly

①Wear on friction plate. Measure 2 rivets’ depth on driven plate (from friction plate surface to rivet head, “t” in figure 7-1-1). If wear amount is equal or less than limit (chart 7-1-1), one should replace driven plate assembly or fix friction plate again with rivets. Remount rivet if it is loosening. Replace two friction plates at the same time.

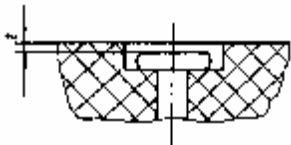


Figure 7-1-1 Measure rivet depth

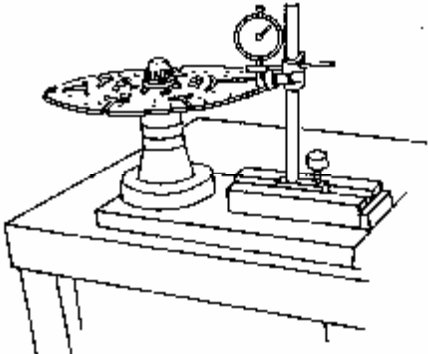


Figure 7-1-8 Axial run-out check -clutch driven plate

②Check axial run-out of clutch driven plate. Measure at the spot 2.5mm from driven plate edge (figure 7-1-8), if results exceed limits (chart 7-1-2), driven plate should be adjusted or replaced.

Chart 7-1-1 Rivet depth (t)



Description	Standard	Limit
Driven plate — diaphragm spring clutch	2mm	0.3mm

Chart 7-1-2 Axial displacement

Description	Measuring spot	Standard	Limit
Driven plate — diaphragm spring clutch	2.5mm from edge	0.15mm	0.7mm

③The fitting clearance allowance (overhaul) between driven plate hub spline groove and transmission input shaft spline is +0.015~+0.20mm, limit: 0.06mm.

④Release clutch and sleeve fitting clearance is -0.075~+0.013mm.

⑤Release sleeve and transmission input shaft bearing cover fitting clearance +0.075~+0.165mm, overhaul allowance +0.075 ~+0.30mm.

⑥Clearance between release fork and fork shaft sleeve: overhaul allowance: +0.06~+0.25mm.

⑦Driven plate assembly: dynamic unbalance amount ≤15g.cm

(2) Clutch diaphragm spring

On connection spot of diaphragm spring release finger end with release bearing, if wear exceeds 1mm, repair should be performed. If there are permanent distortion or crack on spring, one should replace diaphragm spring together with clutch cover rivets.

(3) Clutch pressure plate

Check pressure plate’s working surface. Planish surface if wear exceeds 0.5mm or flatness exceeds 0.12mm. The required harshness is Ra0.8 μ m, general grinding limit is less than 1.5mm. Static balance test should be carried out after grinding, and its unbalance amount should not be more than 28g.cm. If pressure plate thickness is 1.5mm less than standard thickness after repair, the plate should be replaced.

2. Check and repair — clutch release mechanism parts

(1) Clutch housing. Check case for crack and distortion. Replace if necessary.

(2)Clutch release bearing. Clean bearing race, check release bearing for wear or damage. Its rotation should be smooth without abnormal noise. Otherwise replace it.

(3) Release sleeve and fork. Check release sleeve upper part and release fork contacting face for wear or damage. Repair any uneven wear, and replace parts if wear exceeds 1mm.

3. Check and repair — clutch operating mechanism

(1) Clutch pedal mechanism. Check all fitting surface on rotating parts such as shaft, pin hole, sleeve for wear. Replace part if necessary.

(2) Clutch master cylinder

▲Check cylinder block and piston for wear. If cylinder tube cylindricality discrepancy exceeds 0.025mm, repair it till the value is not more than 0.01mm. Replace part if wear or damage become serious. Fitting standard (cylinder tube and piston) charts see 7-1-3.

Chart 7-1-3 Fitting standard-master cylinder and piston (mm)



Description	Standard	Limit
Cylinder inner diameter.	$\phi 19 +0.021$ 0	---
Piston outer diameter	$\phi 19 -0.021$ -0.041	---
Fitting clearance	0.021~0.062	0.12

Chart 7-1-4 Fitting standard -- slave cylinder and piston (mm)

Description	Standard	Limit
Cylinder inner diameter	$\phi 22 +0.021$ 0	---
Piston outer diameter	$\phi 22 -0.021$ -0.041	---
Fitting clearance	0.021~0.062	0.12

7.1.4 Reassembly and adjustment

1. Reassembling of clutch assembly

(1) Before mounting clutch assembly on engine, one should clean flywheel friction face, there should be no oil dirt on fitting surface of clutch friction plate.

(2) When reassembly clutch, one should first mount adjusted clutch driven plate assembly and then cover assembly on flywheel face (be sure to set the short end of clutch plate hub in driven plate assembly to the front). In order to make these two assemblies and flywheel concentric, one should insert a piece of spline bar (may use transmission input shaft as a tool) into flywheel pilot bearing to locate driven plate assembly, and put pressure plate and cover assembly in place by flywheel locating pin. Fix them with bolts.

(3) Coat release bearing sleeve and release fork with a thin layer of oil. Remount release mechanism parts into clutch housing, then reinstall clutch housing and transmission onto engine, connect clutch-operating mechanism.

2. Reassembly — clutch-operating mechanism.

(1) Reassemble and check master cylinder. Thoroughly clean parts before reassembly, and bath sealing cups and rings in brake fluid. Be sure not to block oil holes on master cylinder inner wall and piston. Perform following checks after reassembling:

▲Master cylinder piston cup should work well. There should be no brake fluid weeping on it when piston goes back and forth,

▲Test sealing result with brake fluid is less than 12MPa pressure. Keep pressure for 3 minutes, there should be no weeping at any spot, and pressure drop should not be more than 0.3MPa.

(2) Reassemble and check slave cylinder. Thoroughly clean parts before reassembly, and bath sealing ring and cup in brake fluid. Perform following checks after reassembling:

▲After reassembling, devices should operate easily without any restriction or grabbing.

▲Test sealing result under 9Mpa pressure for 3 minutes. There should be no weeping at any spot and pressure drop should not more than 0.3MPa.

(3) After check and make sure it is qualified, reassemble clutch booster by referring to master and slave cylinder procedures.

(4) Reassemble clutch pipeline



During reassembly, one should keep oil pipe and connectors clean, clamp pipes and fasten the connectors. There should be no restriction in pipeline or weeping at connectors.

(5) Reassemble clutch pedal mechanism

To make sure all fitting surfaces of all pins, shaft and pinhole are clean. Apply a layer of thin lubrication grease on them. All reassembled parts should be reliable and operating freely. Mount reassembled clutch pedal mechanism assembly on cab’s dashboard and floor, and fix them with connecting bolts.

3. Adjustment

(1) Clutch pedal free travel. Free travel is the joint results made by the distance (i.e. release clearance) between diaphragm spring release finger (or lever) end and release bearing, as well as distance between release master cylinder pushing rod and piston. Adjust pedal free travel is in fact to adjust these two distances. Adjustment should be made according to requirements.

(2) Clutch release clearance adjustment. Change the length of slave cylinder push rod to adjust clearance.

7.1.5 Regular faults and solutions

Regular faults in clutch include incomplete release, slippery, rough engagement and abnormal noise

1. Clutch incomplete release

Clutch cannot cut off engine power output while pedal is depressed to floor, clutch then keeps running by being dragged by engine. Incomplete release may lead to gear shock, heavy shift or shift difficulty.

Clutch incomplete release—causes and solutions

Causes		Solutions	
1	Larger pedal free travel	1	Correct free travel
2	Uneven height—diaphragm release finger ends	2	Adjust height
3	Clutch driven plate warped	3	Adjust or replace
4	Clutch plate broken	4	Repair or replace
5	Loosened friction plate rivet	5	Mount rivet again
6	Transmission: worn-out front bearing makes input shaft incline.	6	Replace bearing
7	Clutch pressure plate warped	7	Grind or replace pressure plate
8	Release master/slave cylinder leakage	8	Replace piston cup or replace assembly
9	Air in brake fluid	9	Re-bleeding

2. Clutch slippery.

Clutch driven plate slips when clutch pressure plate cannot press driven friction plate tightly on flywheel surface. Depress acceleration pedal under heavy load will only make engine roaming rather than speeding up. Minor slippery is hard to be noticed, but high temperature due to friction will burn out friction plates.

Clutch slippery—causes and solution s

Causes		Solutions	
1	Operating mechanism unadjusted after friction plate has worn	1	Readjust operating mechanism or replace excessive worn friction plates
2	Clutch driven plate caught on input shaft spline, or release bearing stuck	2	Remove stuck
3	Weak or broken clutch diaphragm spring	3	Replace spring



Causes		Solutions	
4	Oil dirt on friction plate	4	Remove oil dirt
5	Shorter clutch pedal free travel	5	Adjust free travel to standard

3. Rough engagement—clutch

Vehicle speed jumps up and down at startup and shifting, with forward-backward “shake” feeling.

Rough clutch engagement—causes and solutions

Causes		Solutions	
1	Driven plate wave plate—cracked or damaged	1	Replace parts or assembly
2	Driven plate distorted or uneven wear	2	Adjust or replace
3	Uneven wear on pressure plate or flywheel	3	Repair or replace
4	Uneven height on release fingers ends	4	Adjust to standard height

4. Abnormal noise from clutch.

“Click, click, click” sound is heard when transmission is at N gear and engine is running at idle. Abnormal noise comes out when clutch pedal is depressed or released.

Abnormal clutch noise—causes and solutions

Causes		Solutions	
1	Driven connecting plate broken and pinot loosened	1	Repair or replace
2	Release bearing’s return spring distorted, broken, loosened	2	Repair to replace
3	Flywheel bolt loosened	3	Fasten or replace
4	Clutch release bearing worn, dirty, damaged or short lubrication	4	Repair or replace
5	Worn-out transmission input shaft front bearing or lubrication is short	5	Change or add grease

7.2 Transmission

7.2 .1 Transmission main technical parameters

Transmission main technical parameters

No.	Description	Data		
1	Model vehicle	BJ1049V9JD6-C	BJ1049V9JE6-A	BJ1043V8JE6-D
2	Transmission model	MSB-5M	5T108	LC5T30
3	Type	Manual, fixed shaft, mechanical 5 gears OD type, synchronizer meshing at all forward gears		
4	Max input torque (N-m)	230	420	320
5	Center distance (mm)	88	108	97



No.	Description		Data		
6	Drive ratio at each gear	1 st gear	5.594	4.754	4.766
		2nd gear	2.814	2.733	2..496
		3rd gear	1..660	1.680	1..429
		4th gear	1	1	1
		5th gear	0.794	0.751	0.728
		R gear	5.334	5.084	4.774
7	Gear type		Mesh bevel gear with lock ring inertia synchronizer		
8	Lubricant		GL-5 80W/90		
9	Lubricant volume (L)		2.7	3.8	2.7
10	Weight (kg)		56.7	110	90
11	Operating mechanism		Distant manual operation from side cover		

7.2.2 Briefs on construction

Vehicle operates differently in different situations, such as it works during start-up, accelerating, decelerating, driving at low/high speed, driving uphill, backing up, parking etc. These need vehicle’s traction and speed to be changed in a larger range. But torque/speed output from current vehicle engine is too limited to meet this demand. To compensate this, vehicle power-train employs transmission. Transmission is used to change drive ratio to make vehicle maneuvers like backward driving and power cut-off possible.

BJ1049, BJ1043 light trucks use model MSB-5M, LC5T30 and 5T108 transmission. They are of 3-shafts gear types, have 5 forward gears and 1 reverse gear. And lock ring synchronizer comes with each forward gear. There is PTO door on right side of transmission housing for PTO devices that transmit part of engine power via transmission to drive concerning mechanics to meet the demands of various vehicles.

1. MSB-5M Transmission construction

MSB-5M transmission assembly consists of driving mechanism and shift mechanism (cover assembly).

(1) Transmission driving mechanism

Following parts composes the driving mechanism: transmission housing, gears at each speed, synchronizer, bearing and four parallel shafts (input shaft, countershaft, output shaft and R gear shaft). Input shaft output shaft and countershaft assemblies are mounted on ball or needle bearings, and R gear is directly mounted on supporting holes on housing.



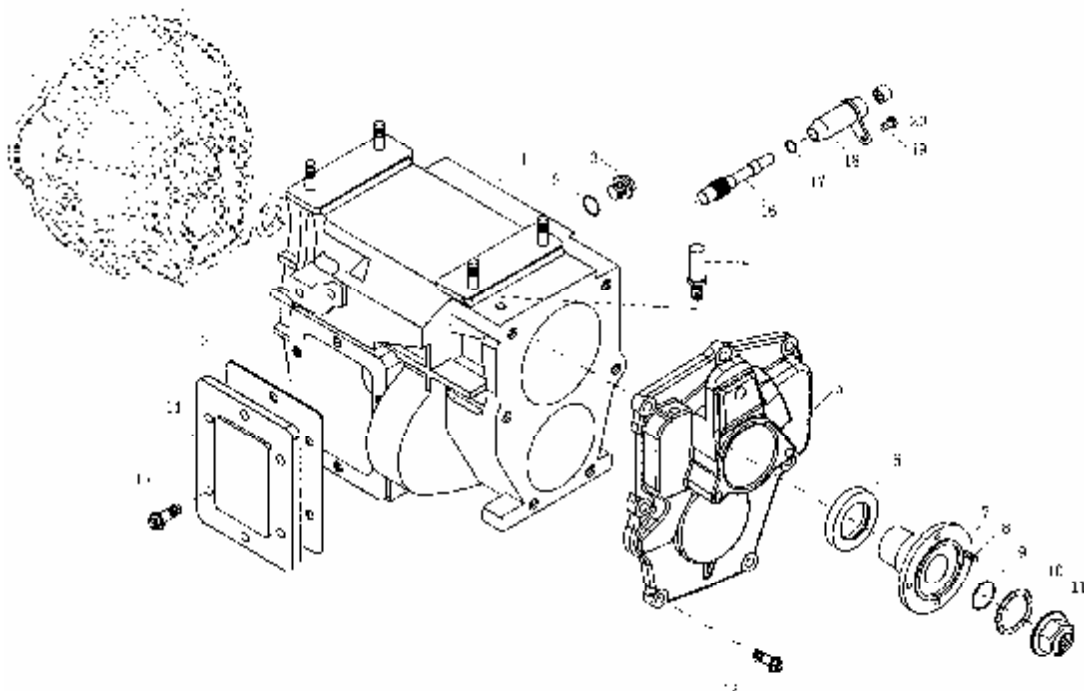


Figure 7-2-1 MSB-5M transmission housing

1.housing 2-O-ring 20x2.4 3-oil drain plug 4-vent plug assembly 5-rear cover 6-oil seal (rear cover) 7-outputshaft flange disc 8-stud 9-O-ring 10-outputshaft flange washer 11-outputshaft nut 12-bolt 13-gasket 14-side cover 15-bolt 16-odometer driven gear 17-O-ring 18-odometer sleeve 19-bolt 20-oil seal-odometer sleeve

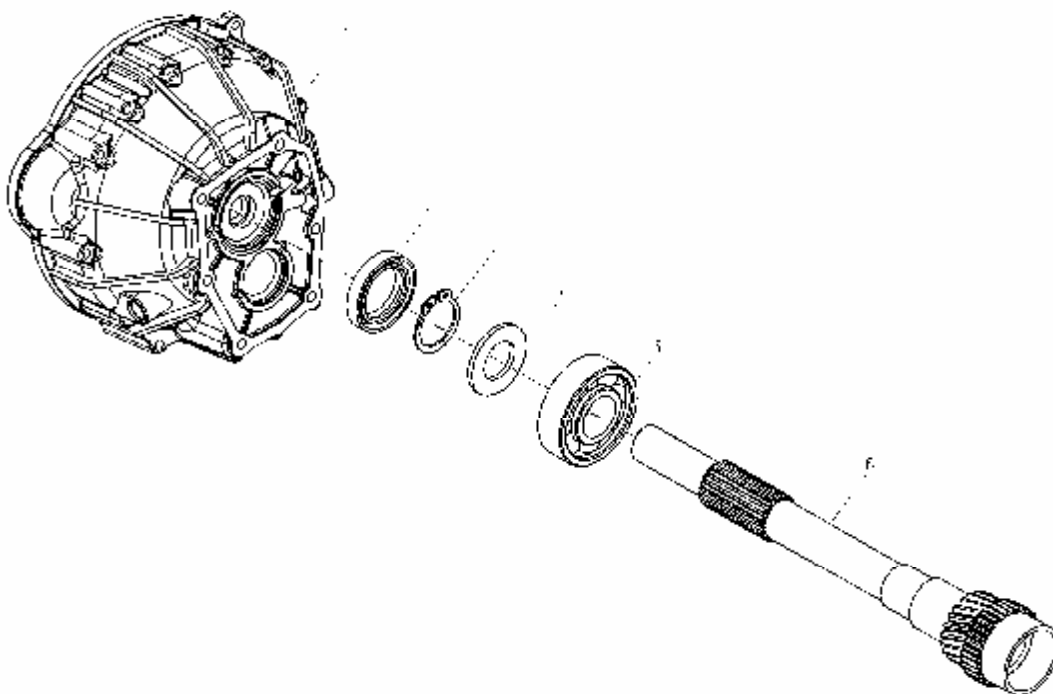


Figure 7-2-2 MSB-5M transmission input shaft and clutch housing

1.clutch housing 2-oil seal 3-snap ring 4-input shaft washer
5-inputshaft bearing 6-inputshaft/gear ring sets

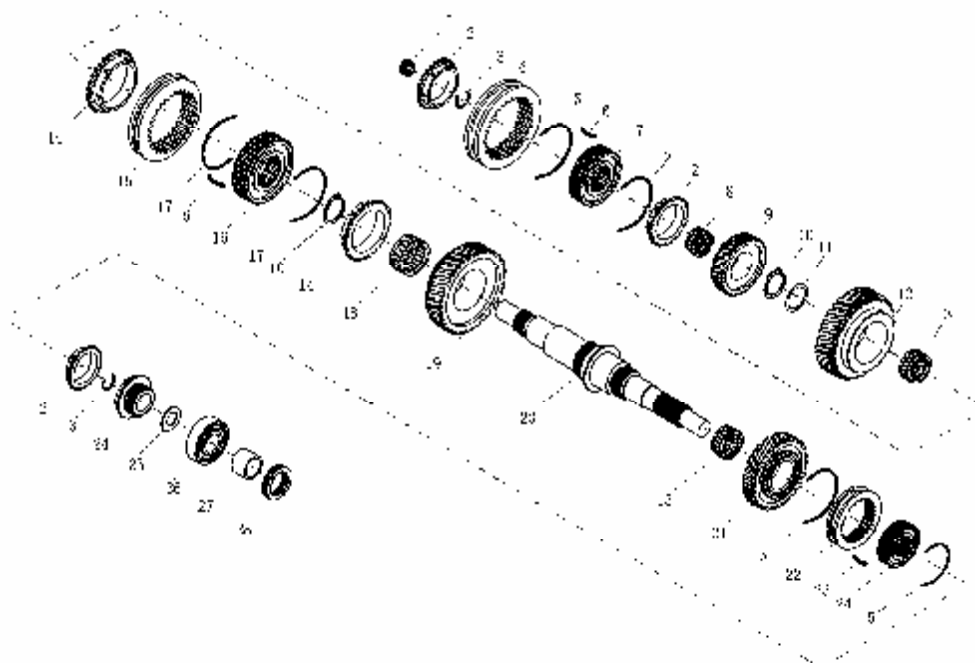


Figure 7-2-3 MSB-5M transmission output shaft assembly and accessories

1-needle bearing 2-synchronizer ring 3-snap ring 4-synchronizer sleeve—3/4 gear 5-synchronizer clip 6-synchronizer insert 7-synchronizer hub-3/4 gear 8-needle bearing 9-3rd gear-output shaft 10-circlip 11-thrust washer 12-2nd gear-output shaft 13-needle bearing 14-synchronizer ring -1/2gear 15-synchronizer sleeve-1/2gear 16-synchronizer hub -1/2gear 17-synchronizer ring-1/2gear 18-needle bearing 19-1st gear-output shaft 20-outputshaft 21-R gear-output shaft 22-synchronizer sleeve-R/5th gear 23-synchronizer insert-R/5th gear 24-synchronizer hub-R/5th gear 25-thrust washer 26-bearing 27-spacer ring 28-odometer drive gear

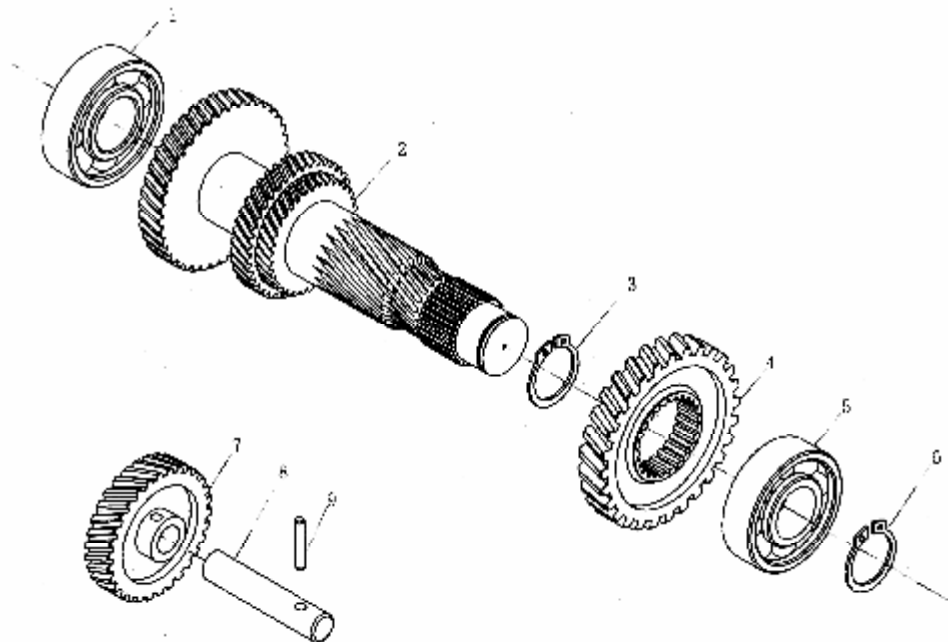


Figure 7-2-4 MSB-5M transmission countershaft and R gear shaft

1-bearing 2-countershaft assembly 3-snap ring 4-5th gear -countershaft 5-bearing 6-circlip 7-Gear assembly-R gear 8-R gear shaft 9-R gear shaft pin

Transmission drive mechanism usually adopts mesh bevel gear / lock ring inertia synchronizer construction. In this mechanism, power enters input shaft via countershaft to output shaft. Except at D gear, all other gears transmit power through countershaft by 2 pairs of gears, R gear drives with 3 pairs of gears.

Lock ring inertia synchronizer (figure 7-5-2) consists of sleeve (8), lock ring(9), splined hub (7), insert(2) and spring circlip (6). Sleeve (8) engages lock ring (5,9) by using spring circlip's radial pressure, the pressure pushes insert (2) to sleeve and land its center convex perfectly on sleeve's inner groove. The engagement is done when insert's both ends are put into notch center of lock ring (5,9). All these are the results of friction forces between lock-ring (5,9) and gear meshed cone face, and also by rotating inertia value difference between clutch driven parts and transmission gears, the difference makes hub (7) synchronizing with gear to be meshed, so that sleeve (8) can mesh smoothly without causing impact among gears during shifting.

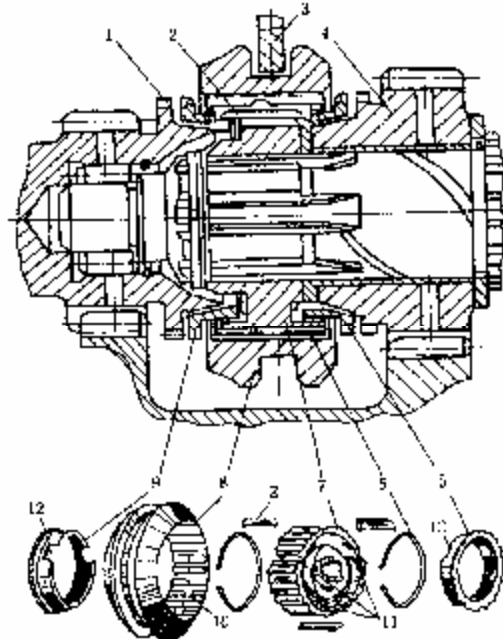


Figure 7-2-5 Lock ring inertia synchronizer

1-input shaft gear 2-insert 3-fork 4-outputshaft gear 5-lock ring 6-spring circlip
7-spline hub 8-sleeve 9-lock ring 10-ring groove 11-axial grooves (3) 12-notch

On MSB-5M transmission, the distance from input shaft small end face to housing front end face varies according to engine types. The value is 192mm when it works with BJ493ZLQ engine. The spline is involute type (24 teeth). Oil seal construction is used. Parts are mounted on transmission housing by means of bolts.

(2) Transmission shift mechanism

The mechanism consists of transmission cover, 3 shift forks and 3 parallel shifting shafts (see figure 7-2-6). On transmission cover are shift arm shaft sets and selector lever.

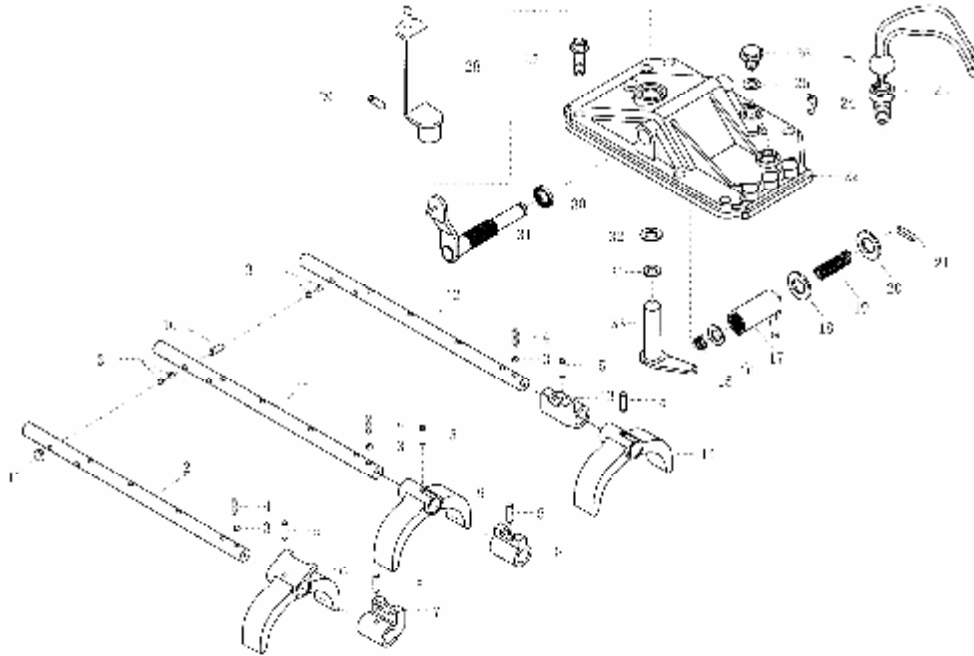


Figure 7-2-6 MSB-5M transmission cover and shift mechanism

1-plug 2-fork shaft – 1/2 gear 3-ball 4-ball-locking spring 5- spring column pin sets 6-shift fork-1/2gear 7-selector lever/1/2 gear 8- selector lever/3/4 gear 9- selector fork/1/2 gear 10-interlock top pin 11- fork shaft/3/4 gear 12-fork shaft-R/5 gear 13-selector lever-R/5 gear 14- selector fork-R/5 gear 15-spring 16-washer 17-selector arm 18-wahser 19-R gear limit spring 20-washer 21-pin 22-transmission cover 23-Backup light switch assembly 24-wire circlip 25-O-ring 26-plug 27-bolt 28-shift lever weld 29-spring column pin sets 30-oil seal 31-shift arm shaft sets 32-baffle plate 33-selector arm shaft sets

Selector fork is fixed on selector shaft with a spring column pin. All 3 selector shafts can move axially, and be self-locked by ball-locking spring and 3 balls. Beside, interlock top pin and ball are also used for self-lock among selector shafts. During shifting, selecting and shifting operations are interactive to each other. Selector arm selects gear by sliding along arm shaft to the lever groove of aimed gear. Meantime, with the turning of selector arm shaft, selector arm moves selector fork, driving synchronizer sleeve meshes with gear. Gear shifting therefore is obtained.

To shift to R gear. Only when selector arm compresses R gear limit spring can arm shaft slides into lever groove of R/5 gear. This prevents shifting wrongly to R gear during vehicle's driving.

1. Transmission operating mechanism

MSB-5M transmission mechanism consists following parts: operating mechanism assembly, shift cable assembly, selector cable assembly, rocker arm sets and connecting rod sets.

7.2.3 Dismantle and check assembly

1.General procedures to dismantle a transmission assembly

- (1)Place transmission on a firm bench;
- (2)Remove oil drain plug and drain transmission fluid;
- (3)Remove bolts connecting clutch housing to transmission;

☆Do not damage oil seal lip during operation.

- (1)Set transmission assembly to N gear, remove transmission cover assembly,.
- (2)Remove odometer cable sleeve and driven gear;
- (3)Loosen output-shaft locking nut and remove flange disc;
- (4)Remove transmission rear cover



☆Do not damage oil seal lip when removing rear cover.

- (1) Remove odometer drive gear and cable sleeve;
- (2) Remove shafts and forks from transmission housing;
- (3) Remove inner/outer retaining rings from countershaft bearing;
- (4) Remove countershaft rear bearing with special tool (figure 7-2-7);
- (5) Remove countershaft front shaft with same method (figure 7-2-7);
- (6) Remove input shaft assembly;
- (7) Remove needle bearing and synchronizer ring;
- (8) Hammer output shaft front end with copper bar, move output shaft backward 3mm;
- (9) Remove rear bearing with dismantling tool;
- (10) Remove output shaft assembly from housing;

☆Do not let gears bump up to each other.

- (1) Remove transmission side cover;
- (2) Push out R gear shaft;
- (3) Remove limiting circlip of 5th gear from countershaft;
- (4) Remove gear of R gear (figure 7-2-9);
- (5) Remove countershaft assembly.

☆Do not let gears bump up to each other.

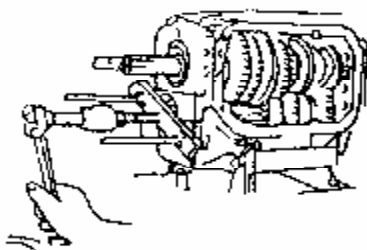


Figure 7-2-7

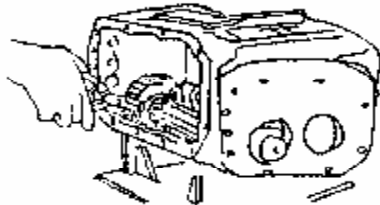


Figure 7-2-8

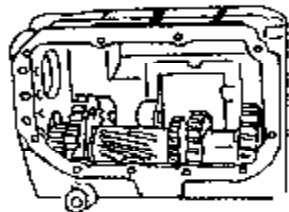


Figure 7-2-9

2. Check and repair

Repair or replace failure or worn-out parts after checking.

▲Measure selector fork tip thickness. Figure 7-2-10

Selector fork tip thickness.	Standard	Limits
	10.0	9.0



Fig.7-2-10 measure fork tip

▲Measure self-lock spring free length,

Figure 7-2-10

Self-lock spring free length (mm)	Standard	Limit
	31.6	30.1



Fig.7-2-11

Measure self-lock spring free length

▲Measure clearance—synchronizer ring to gear cone face, figure 7-2-12。

Clearance	Standard (mm)	Limit
3/4 gear	1.0	0.5
1/2/5 gear	1.5	

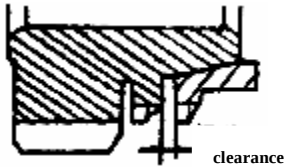


Fig.7-2-12
measure synchronizer ring to gear cone face clearance

▲Measure clearance—synchronizer ring to insert, Figure 7-12-3

Clearance	Standard (mm)
2、3、4、5 gear	4.34~4.66
1 st gear	4.84~5.16

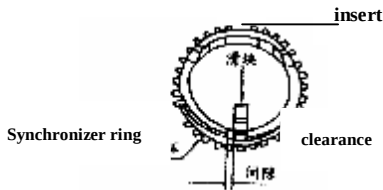


Fig.7-2-13 synchronizer ring to insert clearance

▲Measure clearance -- synchronizer hub to inserts
Figure 7-2-14

Clearance	0.09~0.31
-----------	-----------

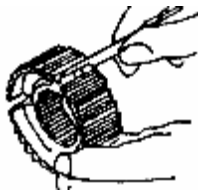


Fig.7-2-14 synchronizer hub to insert clearance

▲Measure output run-out, figure 7-2-15

Limit (mm)	0.1
------------	-----



Fig. 7-2-15 output shaft run-out

▲Measure: clearance gear sleeve to fitting shaft, figure 7-2-16。

	Standard (mm)	Limit (mm)
3 rd gear	0.05~0.08	0.2
R gear	0.04~0.08	0.2

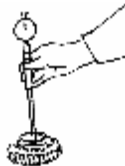


Fig.7-2-16 gear sleeve to shaft clearance

▲Measure ball bearing run-out, figure 7-2-17

Limit (mm)	0.2
------------	-----



Fig.7-2-17 ball bearing run-out

7.2.4 Reassembling and adjustment

1. Reassembling procedures

Install parts:

Select adjusting washer location according to X value.

A. Input shaft assembly mounting.

Press bearing to location,

B. Output shaft parts mounting

1. Mount needle bearing after dipping it in lubrication oil;

2. Mount 1st gear;

☆ watch mounting direction of 1/2 synchronizer assembly

Wide sides of sleeve/fork groove face down.

3. Press to mount 1/2 gear synchronizer assembly;

4. Mount 1/2 gear synchronizer circlip

☆ 1st gear axial clearance: 0.2-0.33mm

5. Mount needle bearing

6. Mount 2nd gear of output shaft

7. Mount 2nd gear circlip

☆ 2nd gear axial clearance: 0.2-0.43mm

8. Mount 3rd gear needle bearing

9. Mount 3rd gear

10. Mount 3rd gear synchronizer ring

☆ 3rd gear axial clearance: 0.2-0.33mm

11. Mount 3/4 synchronizer assembly

The side with ID groove in outer sleeve faces down

12. Press into 3/4 gear synchronizer assembly

13. Mount circlip

14. Mount needle bearing into output shaft after dipping in oil

15. Mount output shaft R gear

16. Mount 5/R gear synchronizer assembly

☆ The side with oil groove face down

17. Press into 5/R gear synchronizer assembly

18. Press into circlip

19. Mount 5th gear synchronizer ring

20. Mount 5th gear sets and thrust washer

Coat oil on inner hole of rear cover oil seal before mounting

21. Press with special tool the oil seal into rear cover

☆ Oil main lip faces down

oil seal end play $\leq 0.15\text{mm}$

Apply lithium grease before and after pressing into oil seal, ensure grease is full at lip

22. Press into transmission operating cover select/shift oil seals

23. Mount spring column pin

☆ Watch mounting angles of selector rocker lever and shift lever.

24. Mount output shaft flange disc bolt

Press bolt to location

- Coat inner hole of transmission housing with oil
25. Press into oil seal with special tool
- Lip side face up
- Protect lip by applying lithium grease on inner lip
- Transmission assembling procedures
1. Mount countershaft assembly
 - ☆ Avoid bumping up.
 2. Mount gear of R gear
 - ☆ Watch mounting direction
 3. Fix gear (R gear) with R gear shaft
 - ☆ Press circlip into groove
 4. Assemble side cover
 - ☆ Gum line should be even, consistent, apply grease in each hole.

Tighten bolt diagonally, torque: 10-25N.m
 5. Mount output shaft into housing
 - ☆ Avoid gears bump up to each other.
 6. Mount output shaft rear bearing
- Check X value (distance from housing outside end to synchronizer hub end)
- if $X > 53.85\text{mm}$, mark “+” on housing
- if $X < 53.85\text{mm}$, mark “-” on housing
- Select adjusting shim of proper thickness and its location for input shaft.
7. Assemble input shaft assembly parts
 8. Mount needle bearing and synchronizer ring
 - ☆ Dip needle bearing in oil before mounting
 9. Assemble input shaft
 10. Assemble countershaft bearing
- Turn input shaft and output shaft they should turn freely
11. Mount circlips at bearing's both ends
 12. Mount forks and moving shafts
 13. Mount balls and interlock pins
 - ☆ Avoid miss-mounting
 14. Punch spring column pin into location
 15. Mount spacer sleeve and odometer drive gear
- Put on boot after mounting to protect oil seal inner lip
- Gum line should be even and consistent
- Tighten bolts diagonally with torque of 15-25 N.m
- Dip output shaft flange slightly in oil
16. Mount output shaft flange disc
 17. Mount odometer cable sleeve parts
 18. Gum vent plug thread
 19. Tighten odometer fix with torque of 11-19N.m
 20. Tighten vent plug bolts with torque of 10-15N.m
 21. Tighten output shaft nuts with torque of 147-190N.m
 22. Turn flange disc, it should turn freely. Mount oil screw plug.



23. Mount balls
- ☆ Avoid miss-mounting
24. Mount transmission operating cover
- Gum line should be even and consistence
- Tighten bolts diagonally, toque 15-25N.m
- ☆ Put on protective boot on input shaft
25. Mount clutch housing parts
- Gum bolts
- Tightening torque 69-93N.m

7.2.5 Regular faults and solutions

1. Abnormal noise—transmission

Abnormal noise from transmission when engine is running at idle, noise is gone while clutch pedal is depressed and re-occurs at releasing the pedal.

Causes and solutions—transmission abnormal noise

Causes		Solutions	
1	Excessive wear and outer spherical larger gap to housing – input shaft bearing	1	Replace bearing
2	Worn-out mesh gear	2	Replace gear
3	Worn-out output shaft bearing	3	Replace bearing
4	Gear fluid short or deteriorate	4	Add or replace fluid
5	Excessive worn selector fork/shaft	5	Replace selector fork/shaft
6	Excessive worn or damaged on certain gear	6	Replace gear
7	While engine is running, gear noise comes out at clutch engagement on N gear, and disappears at releasing clutch: (1)Bad or insufficient lubrication fluid; (2)Gear/bearing damaged or has excessive play; (3)Worn-out spline—output shaft Retard synchronizer, damaged spring	7	Poor mesh gear performance, replace gear
8	Noise comes out at low gears, turns down or disappears at higher gears	8	Hoist and support rear axle, run transmission at low gears or R gear. Listen at output shaft rear bearing and R gear; or set transmission to N gear while engine is off, release manual brake, shake radially output shaft flange, larger shaking amount indicates output shaft rear bearing is loosening or damaged
9	Abnormal noise at all gears except D gear,	9	Check countershaft bearing and needle bearing in output shaft front end. Replace if necessary.
10	Abnormal noise at all gears	10	Check and replace



Causes		Solutions	
11	Excessive clearance between hub and sleeve	11	Replace
12	Excessive interlock pin wear	12	Replace
13	Damaged gear teeth	13	Replace
14	Tooth clearance enlarged or gear damaged	14	Replace

2. Meshing whine-transmission gears

Whining becomes louder as vehicle speed goes up when transmission runs at a certain gear.

Causes and solutions-transmission gear whining

Causes		Solutions	
1	Excessive worn on certain gear sets, or poor break-in of replaced gear	1	Replace gear or let proper break-in
2	Bearing has excessive play	2	Replace bearing
3	Gear fluid short	3	Replenish fluid

3. Transmission gear jump-over.

While vehicle is running, throttle change makes transmissions jumping over to N gear and accelerating engine rpm.

Causes and solutions—transmission gear jump-over

Causes		Solutions	
1	Gears can not mesh properly due to distort or worn shifting mechanism	1	Replace
2	Excessive clearances—input shaft/output shaft bearings	2	Check output shaft nuts used to fix flange disc for loosening. If yes, output shaft gear axial position will change. Tighten the nuts.
3	Worn-relating gears and shafts	3	Replace
4	Worn or low hardness inserts	4	Replace
5	Disqualified clutch housing and 3 shafts in rear cover	5	Check fabrications on clutch housing and 3 shafts in rear cover
6	Distort ball locking spring	6	Find and remove fault
7	Excessive wear of interlock pin	7	Replace
8	Excessive wear on fork shaft arc groove	8	Check shaft groove when large clearance is felt, and also check locating spring for wear or failure.
9	Excessive wear on fork working face	9	Replace
10	Excessive wear on contacting face of gear ring and sleeve	10	Replace
11	Axial loosening of gear	11	Find and remove faults
12	Wrong adjustment on rod	12	Adjust rod



4. Transmission overheating

After transmission has run for while, its housing temperature becomes 40~50℃ higher than ambient temperature, in worst case with “blue smoke” and burnt oil smell.

Causes and solutions—transmission overheating

Causes		Solutions	
1	Transmission fluid thin or short	1	Add or replace fluid
2	Too tight gear mesh or bearing restriction	2	Adjust or replace parts
3	Bend output shaft or bearing with excessive play	3	Replace output shaft or bearing

5. Transmission leak (incl. Weeping)

There is fluid weeping or dropping at connecting spots on housing or on bolts after transmission has run for certain mileage.

Causes and solutions—transmission leak

Causes		Solutions	
1	Clogged vent screw plug	1	Clear vent hole
2	Damaged oil seal	2	Replace oil seal
3	Loosened oil fill /drain plug and bolt	3	Fastening, and gumming when necessary
4	Excessive transmission fluid	4	Remove excess fluid
5	Crack on housing, fluid weeping	5	Replace
6	Damaged gasket	6	Replace
7	Excessive wear or damaged oil seal	7	Replace
8	Uneven sealing gum, paper gasket damaged	8	Replace
9	Rough contacting face due to bumping	9	Remove fitting parts, check injury, planish and gum
10	Wrong bolt pitch	10	Replace
11	Transmission cover bolts have not been tightened as required torque	11	Tighten as standard torque
12	Excessive bearing axial clearance, output shaft axial play to make rear cover leaking	12	Replace
13	Flange out of round after being mounted on output shaft	13	Find and remove faults
14	Unbalance- propeller shaft to output shaft	14	Perform dynamic balancing



6. Shift difficulty—transmission

Cannot shift or shift with loud noise while vehicle is driving forward or backward.

Causes and solutions—transmission shift difficulty

Causes		Solutions	
1	Higher fluid viscosity or excessive fluid	1	Replace or reduce fluid
2	Incomplete clutch release	2	Readjust clutch
3	Stuck--transmission shift/selector device	3	Remove parts stuck
4	Stuck--R gear track and backup light switch	4	Repair
5	Worn synchronizer ring	5	Replace
6	Excessive wear or out-of-adjustment—shift operating mechanism, long distance operating mechanism	6	Adjust
7	Weak synchronizer insert circlip	7	Replace

7. Causes and solutions – bearing damaged abnormally

Causes and solutions – bearing damaged abnormally

Causes		Solutions	
1	Dirt lubrication fluid	1	Change lubrication fluid
2	Insufficient lubrication or disqualified fluid	2	Check fluid level, add or change fluid
3	Disqualified bearing	3	Replace bearing
4	Axial play enlarges bearing axial clearance	4	Check distance from clutch to rear cover bearing

8. Causes and solution—shift difficulty with heavy knock sound

Release parts are ok, but it is hard to shift, and heavy knock is felt. Or shift difficulty happens only on certain gear, with regularly knocking sound and even noise.

Causes and solution—shift difficulty with heavy knock sound

Causes		Solutions	
1	Excessive wear of interlock pin. Worn or damaged selector rocker arm lever, or detached from selector arm groove	1	Find faults and remove.
2	Teeth broken	2	Dismantle, check, clean or replace damaged gear and bearing
3	Tooth clearance enlarged or gear damaged	3	Replace
4	Worn bearing	4	Replace
5	Short lubrication fluid	5	Replenish



9. Causes and solutions – transmission gear chaos

Causes and solutions—transmission gear chaos

Causes		Solutions	
1	Outer shift arm sets locating pin plays, that lost its control, can not move lever correctly	1	Repair or replace
2	Outer shift arm becomes bend, worn interlock pin and groove, that can not make locating correctly	2	Replace
3	Excessive wears on outer shift arm lower end (working face) and on lever groove, lever can not be moved correctly	3	Replace
4	Fork spring column pin detached	4	Replace
5	Fork broken	5	Replace

10.Causes and solutions -- Backup light switch failure

Causes and solutions -- Backup light switch failure

Causes		Solutions	
1	Rust ball	1	Remove rust on ball
2	Inner spring failure	2	Replace backup light switch
3	Wrong gumming, gum on ball	3	Avoid gum from entering ball inside

7.3 Propeller shaft

7.3.1 Propeller shaft main technical parameters

Propeller shaft main technical parameters

No.	Description		Data
1	Model vehicle		BJ1049V9JD6-C; BJ1049V9JE6-A; BJ1043V8JE6-D
2	Type		Flare, FR/RR sections, with 3 UJs and a center support
3	UJ	Cross shaft (diameter.× end face gap) (mm)	φ 29×76
		Needle bearing type	φ 2.42 length 11.8
4	Spline shaft tooth No.× modular No.× pressure angle	FR propeller shaft spline	17×1.667×20°
		RR propeller shaft spline	17×1.667×20°
		RR propeller shaft tube fork inner spline	17×1.667×20°
5	Flange	FR propeller shaft flange	4 holes φ 10.2 divided circle φ 85 holes symmetrical center intersection angle 36° rim φ 65
		RR propeller shaft UJ flange fork	4 holes φ 10.2 divided circle φ 85 holes symmetrical center intersection angle 36° rim φ 65



No.	Description		Data
6	Propeller shaft tube (outer diameter.×wall thickness) (mm)		φ 68.9×2.3
7	FR propeller shaft supporting bearing (outer diameter.×inner diameter.)		φ 63× φ 32
8	Length (mm)	FR propeller shaft assembly (with FR UJ flange fork)	5 holes φ 10.2 divided circle φ 85 holes symmetrical center intersection angle 36° rim φ 65
		RR propeller shaft assembly (with FR/RR UJ flange forks)	5 holes φ 10.2 divided circle φ 85 holes symmetrical center intersection angle 36° rim φ 65
9	Max. operating torque (N·m)		1800
10	Max. allowed pivot angle		18°
11	RR propeller shaft spline shaft max. sliding (mm)		50
12	Propeller shaft bolt torque (N·m)		64±6
13	Spline shaft max. operating torque (N·m)		1800
14	Max unbalance		≤40g·cm/3200r/min
	Propeller shaft run-out (mm)		≤0.8mm

7.3.2 Briefs on construction

Transmission output shaft axis intersects axis of rear axle drive gear, their corresponding position keeps changing. Universal drive unit is employed to maintain power transmitting between these two. The unit mainly consists of UJ, propeller shaft and center bracket devices.

The light truck (wheel base 3360mm) equips with flared open type propeller shaft, composed by front/rear propeller shafts, three UJs and one center bracket device. Front propeller shaft consists of front shaft and center bracket assembly. It is of single UJ construction (figure 7-3-1).



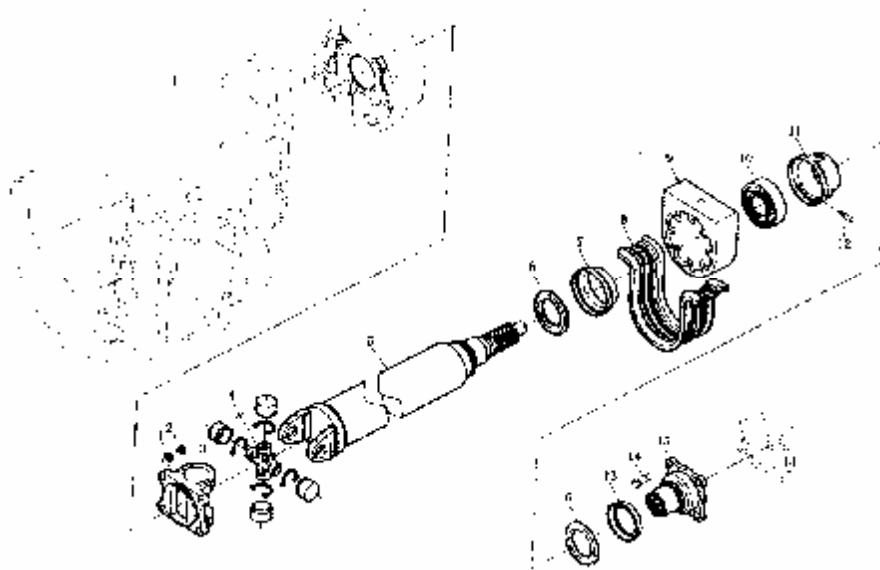


Figure 7-3-1 Front propeller shaft assembly

1-spring washer 2-nut 3-flange fork 4-cross shaft assembly 5-front propeller shaft weld sets 6-oil seal assembly 7-center bracket rubber sleeve 8-center bracket 9-center bracket rubber boot 10-single row radial ball bearing 11-center bearing cap 12-straight injecting oil cup 13-dust boot 14-bolt 15-propeller shaft center flange

An UJ is mounted at front end of front propeller shaft, it connects to output shaft flange disc via UJ flange fork 3; rear end of propeller shaft is mounted in bracket rubber boot by a bearing, suspending under vehicle frame transverse beam via center bracket 8.

Front propeller shaft bracket assembly consists following parts: rubber ring 7, single row radial ball bearing 10, center bracket rubber boot 9, center bracket 8 and center bearing cap 11. Rubber boot 9 absorbs part of vibration from transmission system to reduce noise.

Front propeller shaft flange is mounted on rear spline shaft, it connects to rear propeller shaft.

Rear propeller shaft consists of tube weld assembly 9, sliding fork 5 and two UJs (figure 7-3-2).

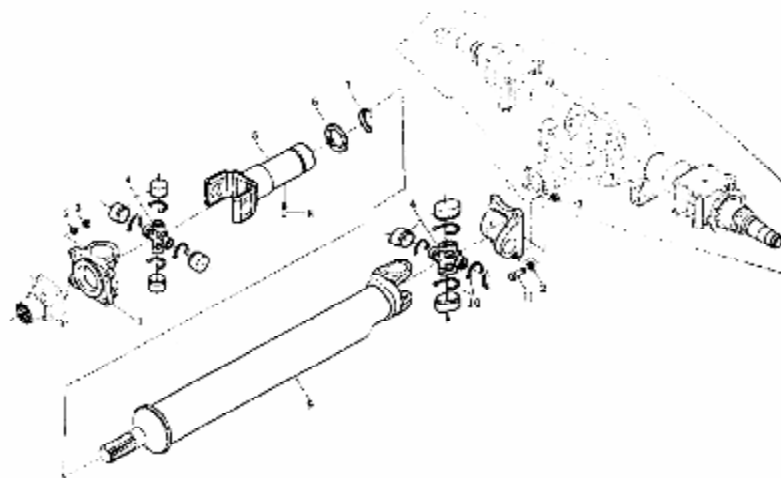


Figure 7-3-2 Rear propeller shaft assembly

1-flange fork 2-spring washer 3-nut 4-cross shaft assembly 5-sliding fork 6-oil seal 7-dust boot 8-straight injecting oil cup 9-propeller shaft tube weld assembly 10-cross shaft circlip 11-bolt

A spline shaft is welded on front end of shaft tube 9, and mounted into sliding fork assembly 5. UJs are mounted on sliding fork assembly, it lets propeller shaft extend ,withdraw and turn freely. UJ flange fork 1 connects front propeller shaft. The UJ mounted on rear end of rear propeller shaft connects to rear axle flange via flange fork 1.

7.3.3 Check and repair

After assembly has been dismantled, all parts should be washed with kerosene or diesel. Check them one by one and perform necessary service and repair.

1.Visual check

(1) check cross shaft journal, spline shaft journal. If shallow dent or slight peeling is seen, one can use grindstone to repair. Replace if necessary.

(2) Replace parts in following cases: excessive center bracket bearing, aged or cracked center bracket rubber boot, twisted or bend spline shaft and tube.

2.Measure to check

(1) Propeller shaft angularity

Support both ends of front or rear propeller shaft as indicated in figure 7-3-3. Use dial indicator to measure radial play at any circle spot on shaft. Adjust these whose reading exceeds rated value (chart 7-3-1) on press bench. Replace part if adjustment does not work.

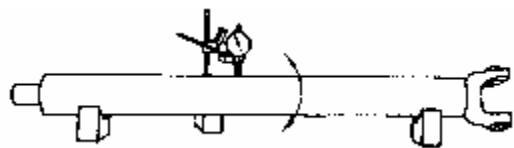


Figure 7-3-3 Angularity check – front/rear propeller shafts

Chart 7-3-1 propeller shaft angularity

Description	Standard	Limit
Front propeller shaft	0.8	1.2
Rear propeller shaft	0.8	1.2

(2) Spline pair fitting clearance

Clamp rear propeller shaft sliding fork (or front propeller shaft flange) with vice, insert spline shaft as per mounting mark into sliding fork (or flange), (leave part of spline outside). Load 10N force to forward direction to turn spline shaft. Measure to get reading difference from sides of spline with a dial indicator (figure 7-3-4). If clearance reading exceeds rated value (standard: 0.1mm, limit: 0.3mm), the parts is worn seriously should be replaced, or replace both.

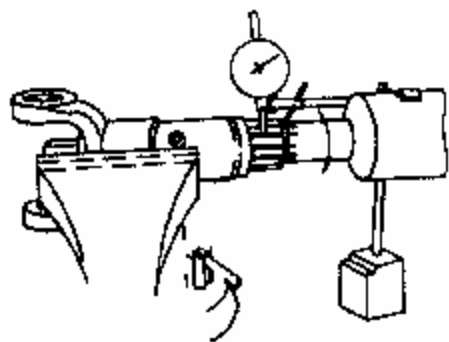


Figure 7-3-4 Check spline shaft turning clearance

(3) Cross shaft bearing radial clearance

Clamp cross shaft in vice, and put needle-bearing sleeve on cross shaft journal. Push needle bearing up and down. Use dial indicator to measure reading variations at highest point on bearing outer surface (figure 7-3-5). If clearance reading exceeds rated value (standard: 0.02mm, limit: 0.09mm), cross shaft and bearing should be replaced. One may also measure wear amount of UJ cross shaft journal. Replace it if its wear exceeds limit (standard: $\Phi 18.46\text{mm}$, limit: $\Phi 18.31\text{mm}$).

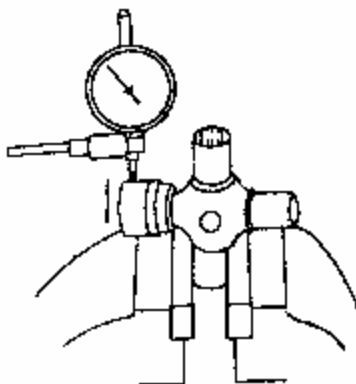


Figure 7-3-5 Check cross shaft bearing clearance

(4) Front propeller shaft center bracket bearing and spline shaft bearing journal

Front propeller shaft center bracket bearing cannot be loosened. It should turn smoothly without abnormal sound. Replace part if fitting clearance between bearing and front propeller shaft journal exceeds 0.05mm. Repair or replace part if wear on shaft journal under oil seal exceeds 0.2mm.

7.3.4 Reassembly, adjustment and lubrication

Before remounting propeller assembly, one should clean parts thoroughly and apply general lithium grease on bearings, oil seals and parts fitting surfaces. Check propeller shaft with dynamic balancer after it has been remounted. Before dynamic balance check, any point on front/rear shaft tube should not have radial play that goes beyond 0.8mm. Otherwise one should correct it then perform dynamic balance test again. Shaft dynamic unbalance value should be less than 40g/cm (both front and rear shaft). After dynamic check, weld counter weights to concerning spots on shaft tube both ends. Weld less than two weights at each end. Perform again dynamic balance check after welding.

Mount propeller assembly starts from front. Connect UJ flange fork on front shaft to flange disc behind transmission with 4 bolts (torque: $64\pm 6\text{N.m}$), fix center bracket onto transverse beam with bolt. Connect rear propeller shaft (the end with sliding fork) to front shaft (rear end flange), and connect another end to rear axle flange. After remounting, lubricate 3 UJs, spline shaft and center propeller shaft with oil, and apply general lithium grease.

7.3.5 Regular faults and solutions

Regular faults include propeller shaft swing, vehicle shivering during driving, UJ or center bracket bearing heating.

1. Propeller shaft swings or vehicle body shivering during driving

While vehicle is driving, one can obviously feel strong oscillation transmitted from power train to vehicle body, and the symptom varies at acceleration and coasting. The symptom diminished when vehicle stops while engine runs at all rpm.

Causes and solutions- Propeller shaft swings or vehicle body shivering during driving

Causes		Solutions	
1	Incorrect mounting direction of UJ fork	1	Remounting
2	Twisted or bend propeller shaft	2	Repair or replace
3	Loosened parts or excessive dynamic balance amount	3	Repair or perform balance test again

2. Propeller shaft abnormal noise.

While vehicle is driving, one can hear abnormal noise from propeller shaft, noise becomes more obvious at shifting, and reduced or diminished when vehicle speed is steady.

Causes and solutions -- Propeller shaft abnormal noise

Causes		Solutions	
1	Excessive wear on contraction spline	1	Replace
2	Excessive worn, damaged or stuck UJ bearing	2	Replace cross shaft or bearing
3	Worn or burnt center bracket bearing	3	Replace sets
4	Loosened fittings	3	Re-fastening

3. UJ or center bracket bearing heating

After vehicle is driving for certain mileage, melted grease is found flowing out of center bracket bearing, and parts become scalding.

Causes and solutions – UJ or center bracket bearing heating

Causes		Solutions	
1	Grease short -- UJ bearing or center bracket bearing	1	Apply grease
2	Center bracket skewed	2	Adjust bracket till bearing is vertical to propeller shaft
3	Oil seal too tight	3	Let break-in at low speed and apply grease on lip

7.4 Rear axle

7.4 .1 Rear axle main technical parameters

Rear axle main technical parameters

No.	Description	Data		
	Model vehicle	BJ1043V8JE6-D	BJ1049V9JE6-A	BJ1049V9JD6-C
1	Engine model	CY4102ZLQ	Phaser110Ti	BJ493ZLQ
2	Rear axle type	Integrated fully floating		



No.	Description		Data		
3	Final drive	Type	Uni-stage reduction gear, hypoid bevel gear	NPR	Uni-stage reduction gear, hypoid bevel gear
		Main drive ratio	5.375	4.875	5.571
		Drive bevel gear tooth No.	8	8	7
		Driven bevel gear tooth No.	43	39	39
		Drive bevel gear pitch diameter (mm)		92	52
		Driven bevel gear pitch diameter (mm)		292	292
4	Differential	Type	Bevel gear, 4 planetary gears		
5	Half shaft	Type	Fully floating		
		Stem diameter. (mm)	φ 38	φ 38	φ 36
		Allowed max. torque (N-m)	4500		
6	Axle housing	Type	Integrated banjo type, press axle housing		
		Wheel span (mm)	1485	1485	1425
		Spring leaf bracket center distance (mm)	920	920	840
		RR axle housing max. diameter. (mm)	φ 334	φ 334	φ 334
7	Input torque (N-m)		1800	1800	1400
8	Allowed max. axle load (kg)		5000	5000	4000
9	Lubricant		Chinese NE, NW regions: GL—5、 80W/90; Other regions: 85W/90 South of Yangtze River: SAE90 gear fluid		
10	Lubricant volume (L)		3.5		
11	Drive/driven gear clearance (mm)		0.15~0.20		

7.4.2 Briefs on construction

Rear axle consists of final drive, differential, half shaft wheel hub, wheel and axle case.

Final drive is used to reduce rotating speed and increase rotating torque, and change rotating direction for longitudinal engine. In final drive, gears with fewer teeth drive these with more teeth speed reduction thus is obtained. Conical helix gear, if used, can change rotation direction. Final drive is set to location before power is distributed to drive wheels, which reduces torque that is transmitted by parts such as transmission and propeller shaft, and size and mass of these parts are also minimized.

Differential is a speed variation driving mechanism. Planetary gears’ rotation and revolution drive LH and RH half shaft to rotate at different speeds, that ensures power transmission of each drive wheel at varied moving conditions to avoid wheel skip. Differential transmits power to half shaft, wheel hub and wheel by means of half



shaft gears.

Half shaft transmits output torque from differential half shaft gear to drive wheel. Foton light trucks made for export use fully floating half shaft.

Wheel hubs are supported on axle case sleeve via hub bearing, they connect to and rotate with wheels.

Axle case is composed by final drive case and half shaft sleeve. It has final drive, differential and half shaft inside. Axle connects to vehicle frame via suspension, and brake base plates are mounted on both sides, which connect to wheels via wheel hubs. Axle case is subjected to various forces / torque transmitted from suspension and wheels.

BJ1049, BJ1043 light trucks adopt un-divided axle, single stage hypoid gear final gear, conical helix differential, fully floating half shaft integrated banjo cast axle case and ordinary rear wheel hub. See figure 7-4-1, 7-4-2, 7-4-3.

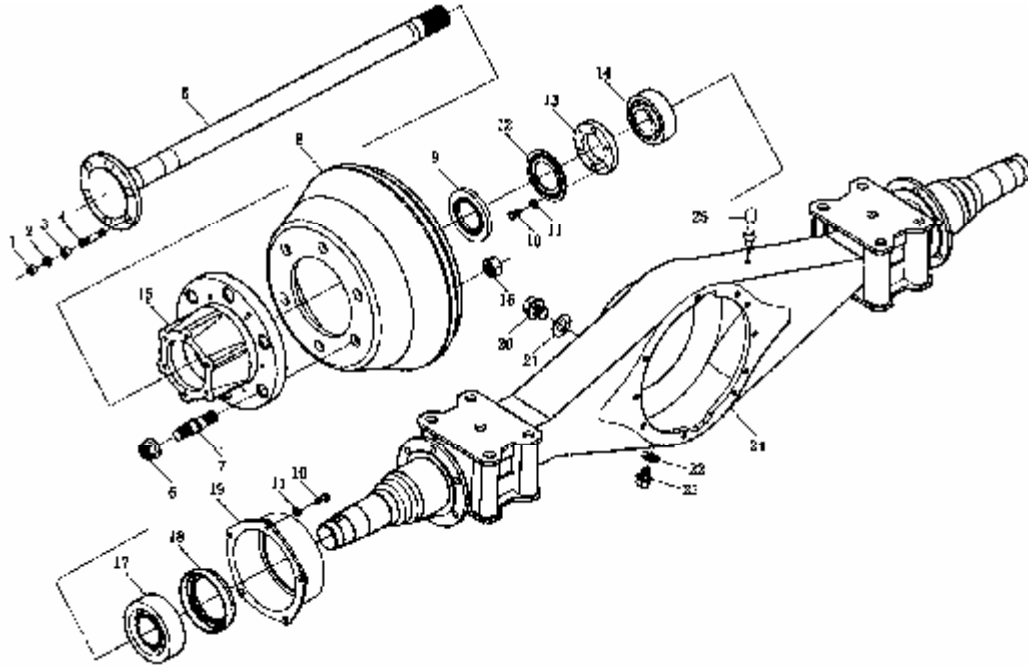


Figure 7-4-1 Rear axle assembly

1-hex nut 2-spring washer 3-cone washer 4-stud 5-halfshaft 6-wheel nut 7-wheel bolt 8-brake drum 9-outer oil seal-rear wheel hub 10-bolt 11-spring washer 12-locking washer 13-wheel hub bearing nut 14-outer bearing of rear wheel hub 15-rear wheel hub 16-wheel bolt fastening nut 17-inner bearing-rear wheel hub 18-inner oil seal-rear wheel hub 19-oil shield 20-oil filling plug 21-plug washer 22-drain plug washer 23-magnetic drain plug 24-rear axle case assembly 25-vent plug assembly

1. Final drive

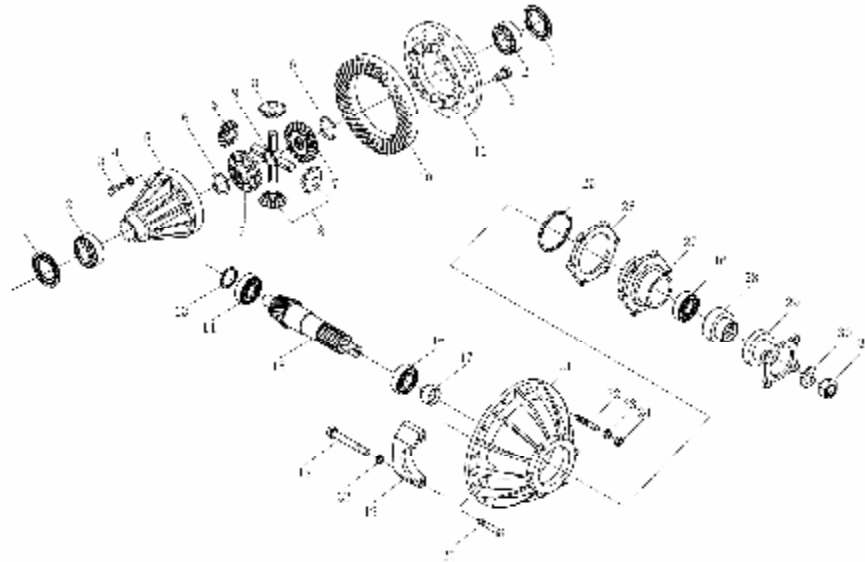


Figure 7-4-2 Final drive

1.adjusting nut-differential bearing 2-differential bearing 3-bolt-differential case 4-spring washer 5-differential case (A) 6-thrust washer-half shaft gear 7-halfshaft gear 8-planetary gear 9-planetary gear shaft 10-driven gear 11-differential case (B) 12-driven gear bolt 13-pilot bearing retaining ring 14-pilot bearing-drive cone gear 15-drive gear shaft 16-drive gear bearing 17-spring spacer ring 18-bearing cap bolt 19-differential bearing cover 20-bolt-final drive to axle case 21-final drive case 22-stud 23-spring washer 24-nut 25-O-ring 26-adjusting shim 27-drive gear bearing race ring 28-drive gear oil seal 29-drive gear flange assembly 30-flange washer 31-flange nut 32-spring washer

Final drive is of single stage reduction type (figure 7-4-2). A pair of conical helix gear and bracket devices composes it. Drive cone gear integrates with shaft, supported by conical ball bearing on both small ends. Its small ends seat on pilot bearing, forming so called U type supporting. This ensures drive gear has enough supporting rigidity.

Driven cone gears are fixed on differential case by bolts. Two halves of differential are combined by bolts, mounted on mounting holes of final case via conical ball bearing.

Drive and driven conical gear use splash lubrication. Driven gear rotates to splash gear oil in axle case onto drive and driven conical gears. And drive gear bearing gets lubrication via oil ducts that are cast on interior of axle case.

2. Differential (figure 7-4-3)

Differential is of ordinary planetary gear type, composed by two half shaft gear, four planetary gears, one cross shaft and RH/LH differential cases.

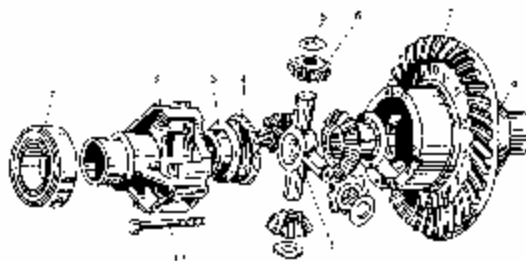


Figure 7-4-3 Differential construction

1-bearing 2-LH differential case 3-flat washer 4-halfshaft gear 5-circular washer 6-planetary gear
7-driven gear 8-RH differential case 9-cross shaft 10-bolt

RH and LH differential cases are combined with bolts. Final drive driven gears are fixed with bolts to RH differential case flange, cross shaft journals are set onto the groove on RH/LH differential case's fitting face. Each journal has a planetary gear on it. Two half shaft journals are mounted into the mounting holes in RH/LH differential cases. Each planetary gear meshes with two half shaft gears at the same time, and half shaft gears connect to half shaft via spline.

Differential gear gets lubricated by means of oil catcher mounted on differential case. The catcher rotates with differential, sweeping through oil level contentiously to send lubrication oil into differential case.

3. Half shaft (figure 7-4-1)

Rear axle half shaft is a piece of solid shaft with flange. It spline-meshes with half shaft via its inner end, and its outer end connects rear wheel hubs. Its fully floating type makes half shaft taking only torque, not flexural torque.

4. Rear axle case (figure 7-4-1)

The case is of integrate-welded type. It connects to final drive case via bolts. Hub bearings are mounted at the outside of half shaft sleeve, the bearings are fixed with inner/outside locking nuts and retaining washer. The flange disc (to fix brake base plate) and bracket (to fix spring leaves) are welded onto half shaft sleeve. There are oil filling/draining holes on rear axle case for normal lubrication to internal gears. And a vent hole is set on the case to prevent lubrication oil from overflowing.

5. Rear wheel hub

Rear wheel hubs are mounted on half shaft sleeve outside rear axle case via two conical ball bearings. For better sealing, there is oil seal assembly inside the hub, and half shaft flange gasket outside the hub. The adjustment on rear wheel hub bearing is made through inner/outside locking nuts and retaining washer.

7.4.3 Technical requirements to check and repair

1. Drive and driven gears -- final drive

(1) Check final drive gears for damage, wear and meshing strength at clockwise and counter-clockwise rotations. Repair minor injury and replace parts in the events of scratch, peeling, cavity, crack or excessive wear. Replace drive/driven gear in pair.

(2) Check drive gear shaft journal that supports bearing and small end retraining ring groove for wear. Repair or replace parts if wear exceeds limit.

2. Check differential planetary gears, half shaft gears, cross shaft and differential case

Check contacting faces among differential planetary gears, half shaft gears and differential case for wear, and measure fitting clearances.

- a) Check fitting clearance between planetary gear inner hole and cross shaft journal. Replace parts if clearance exceeds limit.
- b) Check fitting clearance between half shaft gear spline groove and half shaft spline groove. Replace the part worn more or replace them both
- c) Check fitting clearance between half shaft gear shaft journal and mounting hole in differential case. Replace the part worn more or replace them all.
- d) Check planetary gear and half shaft gear thrust washer for thickness and wear. Replace parts if thickness or wear exceed limit.



Chart 7-4-1 Wears on drive gear shaft journal and ring groove

Description	Limits (mm)
Outer diameter. – drive gear front conical roller bearing shaft journal	Wear ≤ 0.04
Outer diameter. – drive gear rear conical roller bearing shaft journal	Wear ≤ 0.04
Outer diameter. - drive gear small end roller bearing shaft journal	Wear ≤ 0.04
Outer diameter. - drive gear small end retaining ring groove	Retaining ring is not allowed to move
Fitting clearance-planetary gear inner hole to cross shaft outer journal	0.25
Clearance – half shaft gear spline groove divided circle groove width to spline tooth divided circle tooth thickness	0.45
Clearance – half shaft gear shaft journal to differential case inner hole	0.45
Thrust washer - planetary, half shaft gear	1.00

3. Half haft, axle case and wheel hub

- (1) Half shaft
- ①Check half shaft spline for wear, twist or crack. Replace half shaft if spline gear wears exceeds 0.22mm or twist exceeds 1mm.

②Check half shaft arm for angularity and flange for verticality, correct or replace according to chart 7-4-2.

Chart 7-4-2 Half shaft stem angularity and flange verticality

Description	Standard	Limit
Radial play-half shaft center (unprocessed section)	Not more than 1.8mm	Not more than 2.3mm
Circular play—half shaft flange inner end face	Not more than 0.12mm	Not more than 0.2mm

- (2) Axle housing
- ①Check axle housing for crack, leakage. Weld if necessary.

②Check axle for deformation

a) Measure half shaft sleeve head, repair or replace if journal wear exceeds 0.08mm

b) Use rear axle housing contacting face as basis, measure verticality at half shaft sleeve journals on both sides. Correct if verticality exceeds 1.55mm.

c) Check welding points at half shaft sleeve (with axle housing) for crack, also check wears at wheel hub oil seal journal. Repair or replace if necessary.

- (3) Wheel hub
- ①Check wheel hubs. Replace them in the event of crack and slip.

②Check hub inner/outer bearing mounting hole necks for wear (figure 7-4-3). If holes are worn so seriously that bearing outer race rings become loosening, one should repair (bore hole, inset bush etc.) or replace them.

Chart 7-4-3 wheel hub mounting hole neck and bearing outer race ring

Description	Limit
Wheel hub inner mounting hole neck	No loosening after contacting with bearing outer race ring
Wheel hub outer mounting hole neck	No loosening after contacting with bearing outer race ring



7.4.4 Reassembly and adjustment

1. Clean, check and lubrication

Clean each part before reassembly, and check each part for injury and apply a thin layer of oil on each contacting face. Rear axle reassembly includes pretension adjustment on drive pinion gear bearing, and check/adjustment on final drive assembly's gear meshing position and fitting clearance.

2.Reassemble drive gear assembly of final drive and adjust bearing pretension

- (1) Mount drive gear pilot bearing on shaft journal (small end). Fix it firmly with retaining ring into the shaft groove on small end.
- (2) Mount pilot bearing on drive gear shaft journal (closely pressed on large end).
- (3) Press pilot and rear bearing outer race rings into drive gear bearing race holes.
- (4) Mount spacer ring, adjusting shim, bearing and flange according to specified sequence into drive gear shaft. Tighten flange nuts.
- (5) Check drive gear for pretension. Drive gear should turn when it is towed with spring weigh (1.0-1.5) from flange bolt hole.
- (6) Pretension adjustment is made without oil seal, and bearing should get enough lubrication. After having tightened flange nuts, one should turn drive gear to let bearing rollers contact inner/outer rings correctly. When to check towing force at flange bolt holes, operator should turn drive gear to same direction at least 5 turns. Increase or reduce adjusting shim to adjust pretension. There are shims with various thicknesses such as 0.25, 0.15 and 0.05mm.
- (7) After pretension has been adjusted, draw a line on the end of drive gear shaft and flange nut end face. The line will ensure correct fastening torque when remounting oil seal.
- (8) Coat oil seal assembly with oil and mount it into bearing holes. Install in sequence the flange, washer, and flange nuts. Tighten flange nuts with rated torque and lock them

3.Check and adjust drive/driven gears meshing conditions

Mainly to check meshing area (drive/driven gear) and tooth side clearance.

Adjust drive and driven gear meshing area



Drive/driven gear meshing area adjustment		
Abnormal meshing area	Causes	Adjusting procedures
	Drive pinion too far from driven gear	1、 select to use thinner pinion shim 2、 move driven gear from drive pinion to adjust gear clearance
	Drive pinion too close to driven gear	1、 select to use thicker pinion shim. 2、 move driven gear closer to drive pinion to adjust gear clearance
	Driven gear too far from drive pinion	1、 select to use thicker pinion shim. 2、 move driven gear closer to drive pinion to adjust gear clearance
	Driven gear too close to drive pinion	1、 select to use thinner pinion shim 2、 move driven gear from drive pinion to adjust gear clearance
 Normal meshing area		

Figure 7-4-5 Adjust meshing area of drive/driven bevel gear

- ▲ Check and adjustment – gear meshing area
- Divide driven gear circumference into 3 sections coat a thin layer of red lead on gear face at each 2-3 teeth on each section. Turn driven gear while keeping some resistance from drive gear. Observe mesh patch position on driven gear. As driven gear convex face is main working face, it needs higher requirement than concave face does. Adjustment is made mainly based on convex mesh patch.
- Meshing area adjustment is made by means of changing front/rear positions of drive/driven gears. There are shims of different thickness. Add or reduce shim number to adjust correctly drive/driven gear meshing area.
- ▲ Check and adjustment – tooth side clearance
- In normal meshing condition, correct tooth side clearance range is 0.15-0.4mm (measure with magnetic seat dial indicator). Adjustment on it should be made together with the adjustment on meshing area. In the event tooth

clearance exceeds 0.06mm, gear should be replaced. While meshing condition is ok, it is not allowed to change relating positions among gears to reduce clearance. Change drive/driven gears in pair.

7.4.5 Road test and adjustment

In the event that professional test equipment is not available, repaired rear axle can be tested by mounting it onto vehicle. Using vehicle check/test line can make test and regulation.

Check Description and requirements as follows:

- (1) Final drive gear and differential gear should operate well. There should be no gear knock or abnormal loudness-changing sound at acceleration, deceleration or turning.
- (2)Tyres and brake drums should rotate smoothly. There should be no friction with brake pad and any axial movement or obvious radial play. There should be no noise.
- (3) Rear axle noise should not be more than 86dB (A).
- (4) After having run for 15-20 minutes, bearing mounting locations and brake drums should not be scalding.
- (5) There should be no leaks at oil seal and contacting faces.
- (6) After having found and removed faults during test, one should perform running test again.

7.4.6 Regular faults and solutions

Regular faults include abnormal noise, fluid leak and overheating.

1. Rear axle abnormal noise

While vehicle is driving at normal speed, acceleration, high-speed or turning, one can hear continuous or intermittent knocking or metal noise from rear axle.

Symptom 1: Noise comes out at acceleration, and reduces or diminishes when gas pedal is released. The symptom may due to final drive gear convex contacts poorly or is worn seriously.

Symptom 2: Noise comes out when gas pedal is released and diminishes at acceleration. This may due to final drive gear concave contacts poorly or is worn seriously.

Symptom 3: Noise comes out when vehicle makes turning while diminishes at driving straightforward. This may due to differential failure.

Rear axle abnormal noise

Causes		Solutions	
1	Incorrect gear contact patch -- higher or lower	1	Adjust contact patch and tooth side clearance
2	Insufficient gear fluid	2	Add fluid to standard
3	Excessive play or worn out — drive gear bearing, differential bearing and wheel hub bearing	3	Readjust bearing pre-tension or replace bearing
4	Excessive play — driven gear bolt	4	Fastening
5	Excessive clearance — half shaft spline	5	Replace half shaft or half shaft gear
6	Foreign matter in axle housing	6	Remove foreign matter
7	Foreign matter in brake drum	7	Check and remove foreign matter
8	Worn-out differential gear or gasket	8	Replace worn-out parts
9	Tooth peeled or damaged	9	Replace drive/driven gears
10	Gears mesh too tight or loose	10	Readjust mesh clearance



2. Fluid leak, see chart 20-4-5

After vehicle has stopped, fluid trace or fluid weeping from connecting spots is found.

Fluid leak

Causes		Solutions	
1	Excessive gear fluid	1	Reduce to standard level
2	Oil seal damaged — drive conical gear shaft	2	Replace
3	Vent hole is clogged	3	Clean or replace
4	Bolts loosened or gasket damaged — axle case to final drive case	4	Fasten bolt or replace parts
5	Crack or sand inclusion — rear axle case/ final drive case	5	Repair sand inclusion or replace
6	Worn-out rear wheel hub oil seal, grease enters brake drum	6	Replace oil seal, clean brake drum

3. Rear axle overheating

After a serviced or new vehicle has driven for a period of time during break-in period, its rear axle case, differential case, wheel hubs and brake drums become scalding (drums normal operating temperature should not be 70℃ more than ambient temperature, and operating temperature on rear axle, differential case and wheel hubs should not exceed 65℃).

Causes and solutions -- Rear axle overheating

Causes		Solutions	
1	Bearing adjusted too tight	1	Re-adjust
2	Oil seal too tight	2	Lubricate lip and let break in at low speed
3	Short gear fluid	3	Add fluid to standard
4	Smaller gear meshing clearance	4	Re-adjust gear meshing clearance
5	Brake shoe contacts drum	5	Adjust pad clearance
6	Rear axle case bended or distorted	6	Adjust bended/distorted parts or replace

4. Early abnormal wear – Final drive gear

After driving a period of time or several thousand kilometers, new or overhauled vehicle may be subjected to severe gear teeth wear at final drive’s drive/driven conical gears. Using wrong rear axle fluid may be the most possible cause, i.e. not the required hypoid gear fluid. To transmit turning torque, hypoid gear teeth rub to each other heavily, thus lubricant film on them is prone to be removed. If general gear fluid is used on them, gear face might be injured or worn quickly, this will greatly shorten their life. Therefore, one must use hypoid gear fluid with scratchproof additive to reduce friction force and improve operating efficiency.



7.5 Front axle

7.5.1 Front axle main technical parameters

Front axle main technical parameters					
No.	Description		Data		
1	Model vehicle		BJ1043V8JE6-D	BJ1049V9JE6-A	BJ1049V9JD6-C
2	Engine model		CY4102ZLQ	Phaser110Ti	BJ493ZLQ1
3	Type		Undivided steering axle		
4	Front axle assembly		Forging I-beam, integrated rear tie rod linkage		
5	Middle I-beam section size (H×W) (mm)		75×70	75×70	75×70
6	Wheel span (mm)		1530	1530	1530
7	Spring leaf bracket center distance (mm)		720	720	720
8	Kingpin center distance (mm)		1370	1370	1370
9	Front wheel alignment	Front camber	1° 30′	1° 30′	1° 30′
		Kingpin inclination	7° ±15′	7°	7°
		Caster	3°	2° 40′ power steering 4° 10′	
		Toe-in (mm)	4~6、1~3 (radial-ply tyre)		
10	Front wheel max. steering angle	Inward	37°	37°	37°
		Outward	28°	28°	28°
11	Allowed max. axle load mass (kg)		2400	2400	2400
12	Kingpin diameter (mm)		φ 30	φ 30	φ 30

7.5.2 Briefs on construction

Vehicle axles includes steering axle, steering transaxle, transaxle and supporting axle. The one on which steered wheels are mounted is called steering axle. Steering axle can be used with independent or dependent suspensions. FOTON Company’s export light truck adopts un-divided steering axle. It consists of front axle assembly, front brake assembly and front wheel hub assembly.

Front axle (figure 7-5-1) is an integrated structural frame forged by steel with I section. There are two enlarged spring leaf brackets on upper edges. Bracket’s two ends are thickened with holes into that steering knuckle pin (kingpin) is inserted and retained with kingpin locking pin. Steering knuckle upper/lower eyes connects to bracket’s two ends via kingpin. Steering knuckle thrust bearing is mounted between knuckle lower eye and bracket end. Outside two eyes are knuckle pin covers that used for dust-proof. Beside, there are bolt holes around bracket two ends that used to mount front shock absorber lower pin.



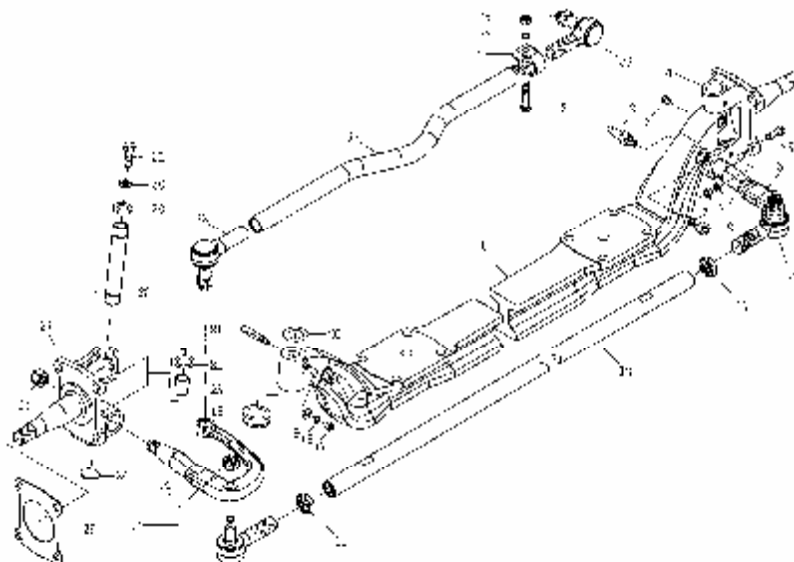


Figure 7-5-1 Front axle and steering knuckle

1-front axle 2-shock absorber pin 3-straight grease fitting 4-RH knuckle 5-brake base plate bolt 6-cross steering lever 7-spring washer 8- I- hex nut 9- I-hex nut 10-tie rod connector assembly (RH) 11-hex thin nut 12-tie rod 13-hex thin nut 14-tie rod connector assembly(LH) 15-knuckle arm 16-knuckle thrust bearing 17- I-hex nut 18-spring washer 19-flat washer 20-knuckle adjusting washer 21-knuckle locking pin 22-O-ring 23-knuckle sleeve 24-knuckle blank cover 25-front wheel oil shield 26-steering arm retaining nut 27-LH knuckle 28-knuckle pin 29-knuckle pin cover 30-flat washer 31-hex bolt 32-drag link LH connector assembly 33-drag link 34-track rod connector clamp 35- I-hex nut 36-spring washer 37-hex bolt 38-drag link RH connector assembly

One end of LH knuckle arm (figure 7-5-1) connects to LH knuckle, another end to drag link assembly via drag link ball joint. And its center connects to one end of tie rod whose another end connects to RH knuckle arm. RH/LH connectors of tie rod adopt ball joint design. Tie rod uses screw connector, which makes toe-in adjustment easy.

A flange on knuckle (the end close to knuckle pin hole) is used to fix brake base plate. Front wheel hub is supported on shaft journal outside knuckle via two conical roller bearings. Bearing tightness can be adjusted with knuckle nut. In order to drive vehicle stably, reduce wears on tyres and other parts, as well as improve wheels auto return, alignment angles are set for steered front wheels.

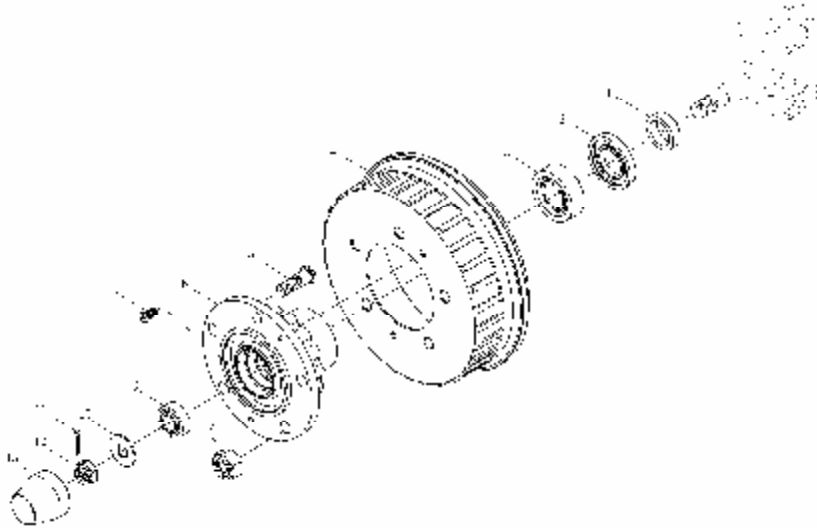


Figure 7-5-2 Front wheel hub and brake drum

1- front wheel hub oil seal sleeve 2-oil seal 3-conical roller bearing 4-front brake drum 5-front wheel bolts sets (RH)
6-front wheel hub 7-cross bolt 8-wheel nut 9-conical roller bearing 10-knuckle nut locking washer 11-cotter pin
12-knuckle nut 13-front wheel hub cover

7.5.3 Check and repair

Clean parts after front axle assembly has been dismantled. Check and repair them if necessary.

1.Front axle

(1) Check and repair bend or twist front axle

①Horizontal bending or twisting. Check if axial lines of two kingpin holes and centerlines of two spring leafs mounting holes land on same longitudinal section of front axle. Kingpin hole (top end) offset value should not be more than $\pm 20'$ ($\pm 0.6\text{mm}$)

a、Fix front axle horizontally on vice to check if it is bend. Insert knuckle pin into kingpin hole. Tie a string on centers of two kingpin ends (figure 7-5-3), observe from above. Axle is not bend horizontally if string aligns to two center holes of spring leaf. Otherwise correct it on press under ambient temperature.

B、Check twisting from sides of two kingpins (vertical to center face of two spring leaf holes). Axle is not twist if two kingpins overlap (figure 7-5-4). Otherwise correct it.

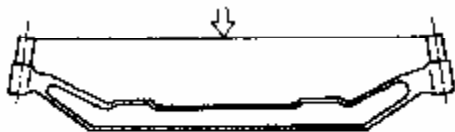


Figure 7-5-3 Check front axle horizontal bending



Figure 7-5-4 Check front axle twisting

②Front axle vertical bending. Check if two spring leaf brackets are in a same plane. Correct flatness should not be more than 0.3mm. Measure to determine if axle is bend vertically by referring to standard sizes indicated in

figure 7-5-5. Correct or replace vertically bend front axle.

- (2) Check and repair front axle kingpin hole
- ①Kingpin hole diameter is 30mm. Insert new pin to check. Repair or replace front axle if new pin is loose or any hole is flare-shaped.

②Kingpin hole’s inward angle should be 7 degree. Insert new pin to measure the angle. Correct holes if angle exceeds standard.

③Repair or replace if kingpin end face wear exceeds 2mm.

④Replace parts if there are cracks on front axle or dropped spring leaf bracket due to excessive wear.

2、Steering knuckle

(1) Check and repair kingpin and bush. Measure kingpin diameter and bush inner diameter. Change bush if fitting clearance exceeds limit. Change kingpin if its outer diameter is smaller than limits due to wear. See figure 7-5-1.

7-5-1 Fitting clearances-kingpin and bush (mm)				
Description	Nominal size	Limit	Fitting clearance	
Kingpin outer diameter	$\phi 30 \begin{smallmatrix} 0 \\ -0.014 \end{smallmatrix}$	$\phi 29.95$	0.02~0.064	0.15
Upper/lower bush inner diameter	$\phi 30 \begin{smallmatrix} +0.05 \\ +0.02 \end{smallmatrix}$	-----		

- (2) Check and repair steering knuckle
- ①Perform defect-detecting test for any cracks on knuckle shaft journal and upper/lower eyes. Replace parts with crack.

②Replace knuckle shaft journal if tread is damaged (over two teeth).

③Check shaft journal wear. Replace worn-out parts (figure 7-5-2).

Chart 7-5-2 Repairing sizes for steering knuckle shaft journal		
Description	Nominal size	(Bearing/oil seal) fitting clearance repairing limit
Shaft journal A	$\phi 35 \begin{smallmatrix} -0.009 \\ -0.025 \end{smallmatrix}$	0.10
Shaft journal B	$\phi 50 \begin{smallmatrix} -0.009 \\ -0.025 \end{smallmatrix}$	
Shaft journal C	$\phi 96 \begin{smallmatrix} 0 \\ -0.14 \end{smallmatrix}$	

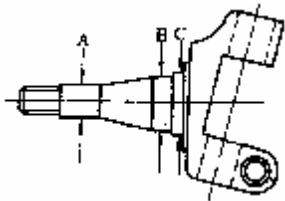


Figure 7-5-7 Check steering knuckle

- ④ Check the contacting of bevel hole of knuckle lower eye with knuckle arm (figure 7-5-8). Replace part if contact area is less than 75% of hole’s inner surface.

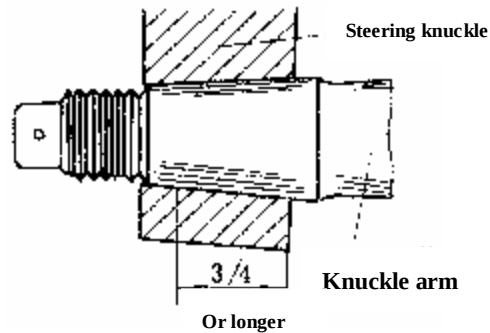


Figure 7-5-8 contacting of steering knuckle bevel hole with knuckle arm

Grind to correct minor wear on knuckle contacting area. Replace part if eccentric wear on it becomes serious.

3.Check and repair steering knuckle arm

(1) Check knuckle arm for bending, distort, crack and other injuries. Replace if these defects are found.

(2) Check contacting of each arm bevel hole with knuckle pin. Repair or replace parts if contacting area is less than 75% of hole inner surface. Replace part in pair if eccentric wear on it becomes serious.

4.Check and repair track rod ball joint

(1) Check track rod ball joint for wear or damage. Replace part with serious defect. Replace ball joint with uneven wear or dent.

(2) Measure ball head diameter of ball joint. Replace ball joint if its clearance to ball carrier becomes too large, and replace ball carrier at the same time.

(3) Apply red lead on ball joint cone handle. Repair or replace parts if contacting area is less than 75%.

5.Check and repair -- drag link and tie rod

(1) Check drag link and tie rod for crack, and tread for wear and damage. Replace parts if necessary.

(2) Check tie rod for bending on V-iron. Its radial play should not exceed 3mm. Otherwise correct it with press or replace it.

(3) Check ball carrier, spring and screw plug inside drag link assembly and tie rod connector assembly for wear and damage. Replace if necessary. Replace ball carrier together with ball joint.

6.Check and repair bearing and oil seal

(1) Check knuckle pin thrust bearing, inner wheel hub, outer conical bearing (after having cleaned them) for peeling, excessive wear or turning noise. Replace if necessary.

(2) Check wheel oil seal for damage or failure. Replace if necessary.

7.Check and repair front wheel hub

Check and repair procedures on front wheel hub are the same as that on rear wheel hub. The fitting clearance values between front wheel hub bearing hole and bearing outer race ring see chart 7-5-3.

Chart 7-5-3 Fitting clearance values - front wheel hub bearing hole and bearing outer race ring

Description	Nominal size	Limit
Front wheel hub inner bearing hole diameter	90	No loose when mating with bearing outer race ring
Front wheel hub outer bearing hole diameter	72	No loose when mating with bearing outer race ring

7.5.4 Reassembly and adjustment

1. Clean, check and lubrication

Clean parts before reassembling. Check parts for dirt and damages and apply thin layer of oil on them. Apply



grease on bearing.

2.Reassembly and adjustment—steering knuckle

(1) Press knuckle upper/lower sleeve into pinhole with oil duct open facing upward, and oil sleeve oil hole aligning knuckle oil hole.

(2) Mount circular key onto LH knuckle arm, and punch it with copper hammer slightly into bevel hole in LH knuckle lower eye. Tighten throttled nut. Mount RH knuckle arm with same procedures.

3.Reassembly and adjustment – front axle (figure 7-5-1)

(1) Clamp front axle in vice, mount LH/RH knuckle assemblies on two ends of axle. Mount thrust bearing on front axle kingpin hole, insert from below the knuckle pin into pinhole. Mount proper adjusting shims between lower plane of upper knuckle eye and upper plane of knuckle pinhole. The clearance should not exceed 0.15mm. Knock knuckle pin slightly to move it upward till flush upper eye bush end face, and pin locking groove aligns pin hole in front axle. The turning effort measured (front and knuckle assembly) should be 9.8-39.2N, and action center is on tip of knuckle (tread section). The adjustment of turning effort is made with washer. After adjustment, insert knuckle pin catch, put on washer/nut and tighten. Finally mount two knuckle pin covers and kingpin hole cover into upper/lower bracket holes

(2) Mount reassembled front axle with steering knuckle assembly onto spring leaf, mount spring leaf U-bolts, spring washers and nuts. Tighten nut with torque of 126-154N.m. And mount lower hanger of front shock absorber assembly onto lower connecting pin, and tighten the nuts to fix them.

(3) Unscrew locking nuts from tie rod assembly LH/RH ball joints. Mount ball joints on LH/RH knuckle arms and bevel holes, tighten locking nuts again with torque of 49-117.6 N.m. Be sure bevel journal small end on ball joint is lower than upper end face of knuckle arm bevel hole (but do not excess 2mm). Mount cotter pin, do not unscrew nut for aligning cotter pin hole.

(4) Unscrew ball joint locking nuts on rear ends of drag link assembly. Mount drag link into bevel hole of knuckle arm (its front end connects steering gear rocker arm). Retighten nuts with torque of 49-117.6N.m. Check and adjust as procedures in (3). Install cotter pins.

(5) Mount brake base plates (two front brake assemblies) on flanges of FR/RR knuckles. Tighten brake base plate bolts.

(6) Mount LH/RH brake drums with hub assembly onto LH/RH knuckle shaft journal as per procedures of remounting rear wheel hubs and rear brake drums. Put on outer bearing and thrust washers of knuckle nuts. Be sure washers are embedded into shaft journal grooves. Put on knuckle locking nuts and tighten them with torque around 98N.m. Turing front brake drum at the moment will feel resistance but no axial loose. Unscrew knuckle nuts 1/3 turn, align cotter pin groove on nuts with cotter pin hole on knuckle. Install cotter pins, and mount and tighten front wheel hub covers.

(7) Adjust clearance between front brake drums with brake pads.

(8) Remount front brake hose assembly and front wheels. Tighten wheel lugs in two steps—tighten them one by one and do it diagonally, fastening torque is 226-343N.m.

3.Check and adjustment -- front wheel alignment and max turning angle

(1) Check and adjustment -- front wheel alignment

Front wheel alignment refers to camber, kingpin inclination, caster and toe-in. among which camber, kingpin inclination and caster are guaranteed at design, usually do not need to adjust. Adjustment is made on toe-in.

Before front wheel alignment adjustment, be sure following parts' condition is well: front wheel hub, kingpin (knuckle pin), tie rod ball joint and spring leaf U-bolt (not loosening on them); spring leaf (not broken or excessive fatigue);tyre pressure (up to standard) Park vehicle on flat ground.

① Camber (figure 7-5-10)

Viewing wheels from vehicle front, the angle that front wheel top inclines outward is called front wheel camber. The angle was set at design, used to reduce front wheel turning resistance and make front wheel vertical to ground under full vehicle load (wheels are pressed toward to inner large bevel bearing), so that front wheel can running safely.

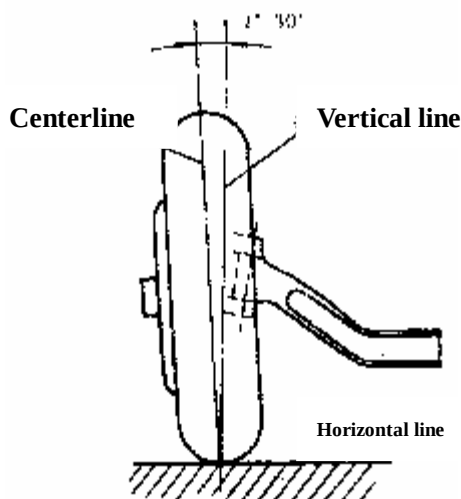


Figure 7-5-10 Cambers

Measure camber with alignment indicator. The nominal value for FOTON export vehicle is $1^{\circ}30'$. Camber is not adjustable.

Perform repairs in the events of worn-out on kingpin/bush, loose front wheel hub bearing and bend front axle.

② kingpin inclination (figure 7-5-11)

Viewing wheels from vehicle front, the angle kingpin upper end face inclines inward is called kingpin inclination (the joint angle of kingpin center line with ground vertical line). It is the angle formed by axial line from kingpin hole inclines inward. It is designed to let wheel return automatically after turning, making steering maneuver freely. Standard value of FOTON export vehicle is 7° . Its check and repair measures are same as that of camber.

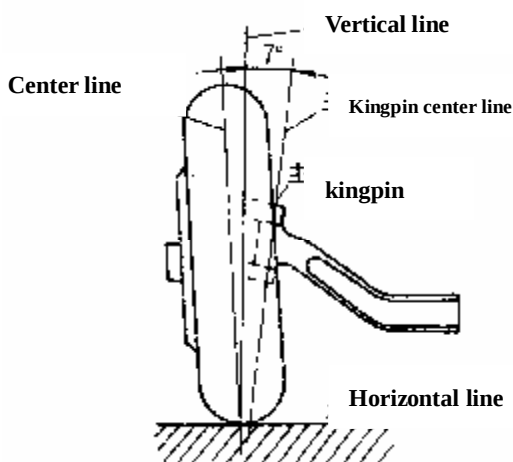


Figure 7-5-11 Kingpin inclination

③ Caster (figure 7-5-12)

Viewing vehicle front wheels from sides, the angle kingpin inclines backward is called caster (the joint angle of kingpin center line with ground vertical line). It was determined at design according to spring leaf's rear lug,

used to let wheel return automatically after turning, and maintain direction when driving straight forward.

Kingpin inclination is also measured with alignment indicator. The standard value of BJ1049 is $2^{\circ}40'$, and the value for power steering system is $4^{\circ}10'$. Kingpin inclination for BJ1043 is 3° .

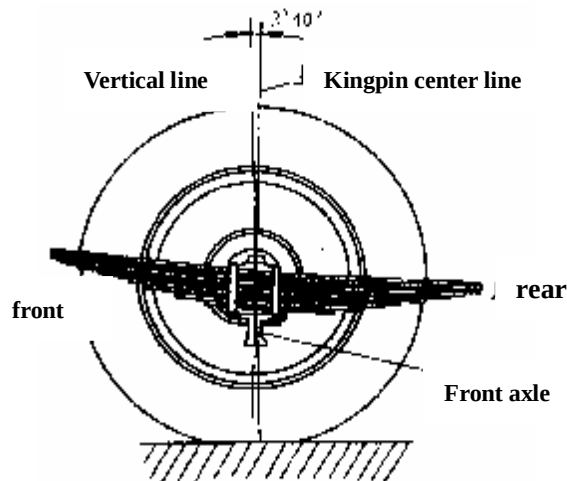


Figure 7-5-12 Casters

Caster may change due to distort spring leaf (due to fatigue) or twist front axle. This can be corrected by inserting adjusting shim between front spring leaf and front axle spring leaf bracket.

④ Toe-in (figure 7-5-13a)

Distance difference between two front wheels' inner rear end B and front end A (as indicated in figure 7-5-13a, B-A difference) is called toe-in. Toe-in could be obtained easily by measuring distance between rear end centerlines of two front wheels (figure 7-5-13b). Toe-in is adjusted by using tie rod. Incorrect adjustment will accelerate tyre wear, heavy steering or front wheel swinging.

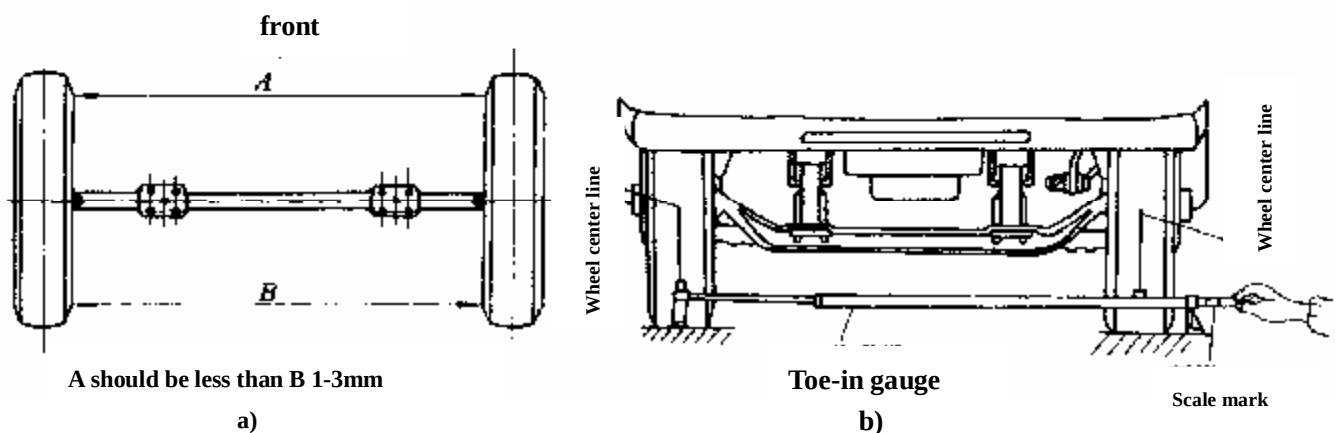


Figure 7-5-13 Toe-in and check

(a) toe-in (b) check toe-in

The standard toe-in values for bias belted tyre are 4-6mm, and 1-3mm for radial-ply tyre. Measure methods are as follows (figure 7-5-13b):

a. Set front wheels on straight line driving position. Mark with chalk the two front tyres' surface centers. The marks locate at the spots whose heights are the same as knuckle shaft journal center. Use toe-in gauge (or roll ruler) to measure distance A between LH, RH marks on the front ends.

b. Move vehicle to let front wheels rotate half turn (while marks move to rear end). Measure again distance B between LH, RH marks on the ends. Figure out difference between A and B, the difference is the toe-in value needed.

Outranged toe-in value can be adjusted with following procedures: unscrew locking nuts on two ends of tie rod to loose bolts, turn tie rod with pipe wrench. Forward turning will increase toe-in and backward turning reduce toe-in. After adjustment, retighten nuts with rated torque to fasten bolts.

(2) Check and adjustment – front wheel max turning angle

Front wheel max turning angle refers to steered front wheel’s extreme turning angle during vehicle’s turning. Set front wheel turning angle to maximum to get the smallest turning radius.

Front max turning angle can be measured with measuring instrument. When turning to left, left wheel’s max turning angle is 37°; turning right, left wheel’s max turning radius is 28°.

The angle can be adjusted with retaining bolt mounted on knuckle arm. Turn steering wheel to right and left while adjust the retaining bolt. At the moment front wheel reach rated max angles, retaining bolt should be stopped by projection on front axle. Lock the nut at retaining bolt after adjustment.

7.5.5 Regular faults and solutions

Regular faults on front axle are hard steering, front wheel swing and oscillating, driving to one side, worn-out tyre or uneven wear etc.

1. Hard steering

There is large steering resistance during vehicle’s driving. This is mainly due to parts in steering drive mechanism are fitted too tightly.

Causes and solutions -- hard steering

Causes		Solutions	
1	Upper/lower transverse arm ball pins are mounted too tight	1	Readjust ball pin clearance
2	Adjusted too tight — tie rod ball pin	2	Readjust
3	Incorrect toe-in	3	Correct
4	Misalignment — front wheel	4	Readjust
5	Low front tyre pressure	5	Inflate tyre to standard
6	Poor lubrication on parts	6	Add lubricant

2. Front wheel swing or oscillating

Front wheels swing or oscillate when they are rolling over bumps, driving on rugged road, or vehicle is driving at 25km/h and changing speed. This is mainly due to excessive clearance among moving parts of steering mechanism. Excessive tyre unbalance may also create the symptom.

Causes and solutions -- Front wheel swing or oscillating

Causes		Solutions	
1	Ball joint excessive play — front axle upper/lower transverse arms	1	Adjust or replace
2	Ball pin excessive play — tie rod	2	Readjust or replace
4	Loose front wheel lug	4	Re-fastening
5	Loose front wheel hub bearing	5	Adjust or replace



Causes		Solutions	
7	Elasticness varies — LH/RH torsion bars spring	7	Replace
8	Incorrect front wheel alignment	8	Readjust
9	Tyre pressure difference — RH/LH tyres	9	Adjust to standard pressure
10	Excessive dynamic unbalance — wheel or brake drum	10	Perform dynamic balancing

3、Driving to one side

Vehicle cannot drive in straight line or cannot return to straight properly. These are mainly due to vehicle skewed frame or incorrect front wheel alignment.

Causes and solutions – Driving to one side

Causes		Solutions	
1	Tyre pressure difference — RH/LH tyres	1	Adjust to standard pressure
2	LH or RH brake drum rubbing	2	Adjust brake
3	Different spring elastic ness—RH/ LH torsion bars	3	Repair or replace
4	Uneven wheel base	4	Adjust wheel base
5	Distort front shaft parts, or skewed or distort vehicle frame	5	Check distort parts, repair or replace
6	Front wheel misalignment	6	Check concerning distort parts that affect alignment, repair or replace
7	Moving parts are poorly lubricated	7	Add lubricant

4.Worn-out tyre or uneven tyre wear

Tyre wears excessively after certain mileage. This happens with other symptoms such as heavy steering, front wheel swing and drive to one side. The causes and solutions see figure 7-5-10.

Causes and solutions – worn-out tyre or uneven tyre wear

Causes		Solutions	
1	Incorrect tyre pressure Tyre center face wear — pressure too high Tyre edge wear – pressure too low	1	Adjust to standard pressure
2	Incorrect front wheel alignment A. Uneven face wear — tyre inner/outer edge B. Even circular wear — tyre inner or outer edges	2	Re-adjust and replace parts if necessary
3	Bend or distort steering knuckle	3	Replace
4	Excessive steering knuckle bearing clearance	4	Re-adjust



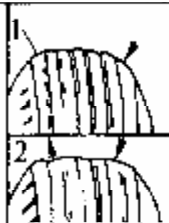
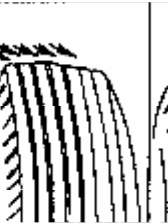
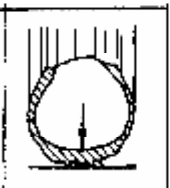
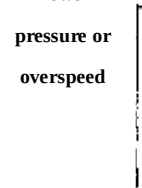
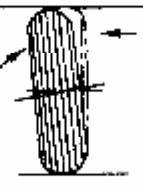
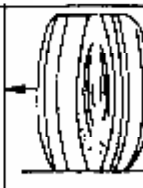
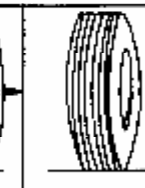
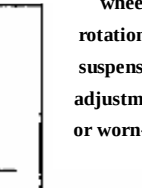
Result	shoulder wear	center wear	tyre break	one side wear	leather wear	spot wear	circular wear	
Results								
cause	Lower pressure or incorrect rotation 		Higher 	Lower pressure or overspeed 	Excessive camber 	Incorrect toe-in 	Unbalance or skewed wheels 	Incorrect wheel rotation or suspension adjustment, or worn-out 
correct	Adjust to specified pressure while tyres are cold, rotate tyres			Adjust camber	Adjust toe-in	Wheel static/ dynamic balance	Check suspension and rotate tyres	

Figure 7-5-10 Tyre abnormal wear and correction

7.6 Steering system

7.6.1 Steering system main technical parameters

Steering system main technical parameters					
No.	Description		Data		
1	Model vehicle		BJ1049V9JD6-C	BJ1049V9JE6-A	BJ1043V8JE6-D
2	Power steering gear	Steering gear type	ZDZ4-X	ZDZ-5 series	ZDZ-5 series
		Max operating pressure	10.3MPa	10.3MPa	10.3MPa
		Type	Recalculating ball power steering gear		
		Drive ratio	21.92	18.85	18.85
		Worm total turning number	4.3	4.8	4.8
		Oil pump flow	8~13.2L/min	8~11L/min	8~11L/min
		Working temp.	-40~120℃	-40~120℃	-40~120℃
		Output torque (nominal)	1920N.m	1580~1630N.m	1580~1630N.m
		Front axle load	2T~3.5T	1.5T~3T	1.5T~3T
		Net weight	24kg	22.5kg	22.5kg
		Power steering fluid	ATF vehicle auto transmission fluid		
		Volume (L)	Around 3L		
		Steering gear lubricant	Use power steering fluid		



No.	Description		Data		
3	Ball screw nut sets	Race spiral direction	LH	LH	LH
		Spiral nominal diameter. (mm)	φ 30	φ 30	φ 30
		Pitch (mm)	10.319	10.319	10.319
		Screw total race number	6	6	6
		Ball number	30	30	30
		Ball diameter (mm)	φ 7.1438	φ 7.1438	φ 7.1438
4	Rack pinion sets	Modular number	6	6	6
		Rack tooth number	3	3	3
		Pinion tooth number	3	3	3
		Pinion arm shaft turning angle (or steering gear arm swing angle)	70.5°	70.5°	70.5°
		Steering arm shaft pinion divided circle diameter. (mm)	φ 72	φ 72	φ 72
5	UJ	Cross shaft diameter×length (mm)	φ 16×40	φ 16×40	10.319
6	Steering wheel	Diameter (mm)	φ 425	φ 425	φ 425
		Free turning angle	± 10°	± 10°	± 10°

7.6.2 Briefs on construction

Vehicle in driving needs to change direction (steering) often. Driver turns wheels (steered wheels) to an angle with vehicle longitudinal axial line via steering axle (usually front axle). Beside, vehicle driving straight line are often subjected to side interference on its steered wheels from road. The force makes steered wheels swinging to change driving direction. Driver can turn steered wheel to reverse direction then, returning vehicle to its original driving direction.

Steering system is composed mainly by steering operating mechanism, steering gear and steering driving mechanism. Steering operating mechanism consists of steering wheel, steering spindle and steering column. Steering gear changes steering wheel’s turn into steering arm’s swing, and amplify steering operating force. Foton export light vehicles adopt ball rack and pinion steering gear. It has two stage driving sets: the first stage is screw and nut driving sets, and second stage is rack and pinion driving sets. Steering mechanism transmits output from steering gear to knuckle, turning wheels according to certain arrangement. The mechanism consists of steering arm, drag link, tie rod and knuckle arm.



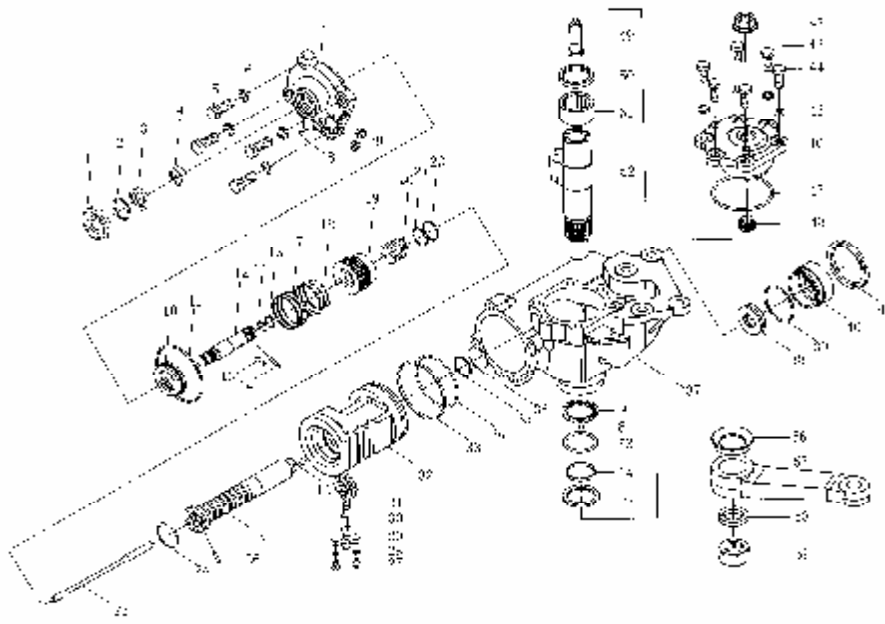


Figure 7-6-1 Power steering gear

1-dust boot 2-spring retaining ring 3-cup sets 4-needle bearing 5-hex bolt 6-spring washer 7-upper case 8-ball 9-fitting 10-thrust ball bearing 11-O-ring 12-steering spindle 13-ball pin 14-column pin 15-sealing ring 16-O-ring 17-sealing ring 18-O-ring 19-valve sleeve 20-valve plug 21-sealing ring 22-O-ring 23-torsion bar 24-O-ring 25-steering screw 26-column pin 27-hex bolt 28-light spring washer 29-pressure plate 30-ball guide 31-ball 32-steering nut 33-sealing ring 34-O-ring 35-O-ring 36-sealing ring 37-lower case 38-thrust needle bearing 39-sealing ring 40-adjusting nut 41-locking nut 42-hex self-lock thin nut 43-hex bolt 44-hex bolt 45-light spring washer 46-side cover 47-O-ring 48-screw collar 49-adjusting nut 50-cup sets 51-needle bearing 52-steering arm shaft 53-sealing ring 54-sealing ring 55-dust ring sets 56-dust seal 57-steering arm 58-spring washer 59-thin hex nut

7.6.3 Check and repair

1.Check and repair – steering column tube supporter and steering shaft

- (1) Check steering column tube supporter and steering and shaft for bending and distortion. Correct if they are bend, and shaft linearity error should not exceed 1.5mm.
- (2) Replace parts if steering shaft spline is worn-out and spline has over two distort or damaged teeth.
- (3) Replace steering bearing if it cannot rotate freely, and there is ball loss on inner/outer race or retaining device is distorted.

2.Check and repair -- steering gear UJ and spline shaft/bush

- (1) Steering gear cross shaft assembly
 - ①Replace bearing if its needle is broken or needle number is insufficient.
 - ②Replace cross shaft bearing if its fitting clearance with shaft journal exceeds 0.25mm, or it cannot rotate freely.
 - ③Replace bearing if its sealing gasket or cover is failure.
 - ④Minor peel-off on cross shaft journal surface can be corrected by grinding. Replace it if there is dent on journal surface, severe peel-off, or shaft has crack on it or it is worn seriously.
- (2) UJ fork spline, spline shaft and bush
 - ①Replace part if UJ fork spline, spline shaft and bush are corroded seriously, or they have injuries or cracks on them.
 - ②Replace spline shaft and bush if there are over two distort or damaged teeth.

7.6.4 Reassembly and adjustment

1.Clean, check and lubrication

Clean all part before reassembling, and apply oil or grease on parts fitting surface.

2.Reassembly and adjustment – steering mechanism

(1) Mount steering gear with UJ assembly onto vehicle frame and outer side of longitudinal beam. Mount hex bolt, washer, spring washer and hex nut. Tightening torque for nut is 75-113N.m.

(2) Mount steering shaft with spline shaft/bush assembly into column bracket; set UJ under spline bush onto spline shaft journal (steering worm end). Mount and tighten locking bolts with torque of 23-26N.m. Mount ignition switch assembly into steering column bracket and switch bearing into concerning steering shaft journal. Mount a shaft spring retaining ring into journal groove of steering bearing to locate axially steering shaft. Mount combined switch on ignition switch. Add washer (according to required number) onto shaft spring retaining ring to locate steering wheel.

(3) Mount steering wheel assembly. Tighten nuts used to fix steering wheel with torque of 40-50N.m. Measure steering wheel tension with a dynamometer (spring weigh) pulling from outer edge of steering wheel (figure 7.6.2). The tangential pulling force range should be 0.44-1.11kgf (the value is measured when steering wheel is turned 80° to left and right from center position under the condition that steering screw bearing has been adjusted correctly). Proceed to next mounting in the event the force needed to turn steering wheel is within this range. Or readjust steering gear if a larger force is needed.

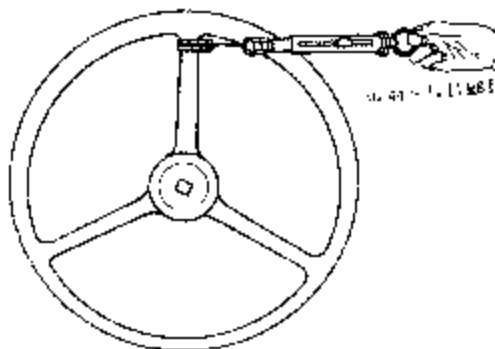


Figure 7-6-2 Measure the force needed to turn steering wheel

(4) Mount drag link rear ball joint into steering knuckle arm, tighten slotted nut with torque of 180-220N.m. insert cotter pin to lock it. After drag link length has adjusted to specified value or steering arm has adjusted to initial position, mount drag link into steering arm bevel hole, put on slotted nut, align open of link clip with link open, then tighten clip nut with torque of 30-35N.m. After this, tighten slotted nut on top of drag link with torque of 180~220N.m. Insert cotter pin to lock.

(5) After all steering mechanism has been installed on vehicle, proceed to check its flexibility during running, that is to check whether steering wheel is heavy, or any free play (free turning when driving straight forward should be within $\pm 10^\circ$). Otherwise, one has to adjust bolt (be sure to gum adjusting bolt thread during adjustment to avoid leakage), and measure front wheel max turning angle as well.

7.6.5 Regular faults and solutions

1.Heavy steering wheel

Steering wheel is found heavy during driving. Jack up front axle, steering wheel still feels heavy after having separated steering arm from drag link, the fault may come from steering mechanism due to over tighten moving parts sets.

Heavy steering wheel – causes and solutions

Causes	Solutions
1. Bend steering spindle or over tighten bearing	1. Adjust or replace
2.Incorrect steering gear adjustment ① Steering nut rack meshes too tightly with pinion arm shaft ② Excessive steering screw bearing pre-tension	2.Re-check and adjust
3. Damaged or stuck steering driving parts ①Worn out or damaged screw nut race and ball ②Damaged screw bearing retaining bracket	3. Repair or replace
4.Insufficient lubrication inside steering gear	4. Add gear fluid

2. Steered wheel oscillating and steering wheel shivering

Steered wheels oscillate and steering wheel shivers while vehicle is driving or during manufacturing and assembling. These are due to that steered wheels keep swinging around kingpin.

Steered wheel oscillation has two types: self-simulated vibration and forced vibration.

Tyre deformed to sides creates self-stimulated vibration. Forces from road input eternal energy to steering system during a vibration cycle. If energy input amount exceeds dumping energy inside steering system, the system will increase its vibration to offset till balance is obtained. In this case, system keeps continuous vibration in certain amplitude to create oscillation, its frequency is almost the same as system own frequency but different from wheel rotation speed. This happens within a wider vehicle speed range. Usually, self-stimulated oscillation happens at low speed.

In the event that steered wheels and steering system are under cycling stimulations, such as wheel misalignment, excessive end face play, incorrect tyre geometrical/mechanical properties and motional interference, they will form cycled interference as long as wheels are rolling. These continuous interferences create forced vibration. Once interference frequency matches system frequency, resonance is then created. Under resonance, steered wheel oscillates with a frequency that is the same as that of wheel rotating speed, and usually comes with obvious resonance speed, and its resonance range is narrow (3-5km/h). Oscillation happened at high vehicle speed is usually of forced vibration type.

It is very complicated to pinpoint the cause and effect of steered wheel oscillation. It may be due to defects during design and manufacturing such as wheel misalignment, incorrect wheel mechanical property, weak system stiffness and damping, wrong steered wheel location angle and gyro effects. Mis-mounting and mis-adjustment may be other causes, such as incorrect clearances among front axle steering system (it affects system stiffness) and wrong friction coefficient (it affects damping) etc. There are many ways to restrain front wheel oscillation, such as to select right parameters, make and assemble parts carefully. Other effective solutions include improving stiffness of steering gear assembly/tie rod, vertical stiffness of suspension and tyre side stiffness, and adding transverse shock absorber to increase damping ability etc.

Causes and solutions -- steered wheel oscillating and steering wheel shivering

Causes	Solutions
1. Excessive fitting clearance between steering worm and nut, or worn out	1. Readjust or replace
2. Excessive clearance between steering arm pinion and steering nut rack	2. Readjust



Causes	Solutions
3. Loose or worn out steering bearing	3. Replace bearing
4. Loose steering drive UJ cross bearing	4. Check, repair or replace
5. Excessive wheel dynamic unbalance	5. Perform dynamic balance check
6. Weak torsion bar spring	6. Replace
7. Incorrect front alignment angle	7. Adjust front wheel alignment angle
8. Failure shock absorber	8. Replace shock absorber
9. Distort vehicle frame (due to collision)	9. Adjust and repair

3.Insufficient steering wheel turns

While vehicle is driving, front wheel max turning angle becomes smaller (to RH or LH) while turning radius becomes larger with poor steering sensitiveness. This is mainly due to incorrect adjustment and wrong mounting location of parts such as steering gear, steering drive mechanism and front wheel turning angle-locating bolts.

Causes and solutions -- Insufficient steering wheel turns

Causes	Solutions
1. Incorrect steering screw rotation numbers	1. Remount and adjust
2. Incorrect steering arm mounting angle	2. Check and remount with locating key mark
3. Parts in steering mechanism is distort due to force	3. Check and replace damaged parts
4. Mis-adjust front wheel turning angle locating bolt	4. Correct to right position according to specified front angle
5. Excessive steering wheel turning number difference to left and to right from center -- front wheel max turning angle becomes small (to left or right)	5. While steering arm mounting angle is correct, adjust front wheel turning angle locating bolt to standard

4. Stuck steering

This is a serious steering gear fault. It is mainly caused by restrictions to moving sets inside steering gear.

Causes and solutions – stuck steering

Causes	Solutions
1. Worn-out or damaged steering screw bearing retaining bracket	1. Replace timely
2. Recalculation guide tip is squeezed and damaged by ball, can not form rolling cycle	2. Check and replace
3. Steering nut and screw each has different tolerance range, or mix-mounting ball for different rolling race	3. Re-measure and group up
4. Pinion and nut rack are not in center meshing position before their clearance adjustment	4. Remount and adjust according to specification



7.7 Suspension

7.7.1 Suspension main technical parameters

Suspension main technical parameter				
No.	Description		Data	
1	Model vehicle		BJ1049V9JD6-C	BJ1049V9JE6-A BJ1043V8JE6-A
2	Front suspension	Type	Non-independent suspension– longitudinal semi-oval leaf spring, single eye two way hydraulic cylindrical shock absorber	
		Front leaf spring section	Rectangular	
		first piece size (L × W × thickness) (total number)	1140×60×9(7) up coil type	1200×70×14(3) up coil type
		U-bolt clip center distance（mm）	76	86
		U-bolt torque at press-to-flat leaf（N·m）	126～154	199～243
		Spring leaf pin tightening torque（N·m）	199～243	287～336
		Shock absorber upper nut torque（N·m）	46～56	46～56
		Shock absorber lower nut torque（N·m）	75～92	78～96
		Static arc height (to coil center)（mm）	LH:101.5-RH:91.5	106
3	Shock absorber	Type	2-way hydraulic cylindrical shock absorber	
		Working cylinder diameter (mm)	Φ 30	Φ 30
		Working travel (mm)	Front225、Rear215	Front 230、Rear220
		Min. length (shackle center to upper plane of dust boot cover at fully depressed) (mm)	Front 320、Rear330	Front 350、Rear 330
		Max. length (shackle center to upper plane of dust boot cover at fully extended) (mm)	Front 545、Rear 545	Front 580、Rear 550
		Connecting type	Front: bolt (upper), shackle (lower) Rear: dual shackle	
		Shock absorber fluid	Q/SY11509-79	
		Fluid volume (L)	0.39	



No.	Description		Data		
4	Rear suspension	Type	Non-independent suspension -- longitudinal semi-oval leaf spring, with auxiliary leaf and double 2-way hydraulic cylindrical shock absorber		
		Rear leaf section	Rectangular		
		First main leaf size (L×W×H) and numbers	1250×70×11(4) main/aux.leaf integrated, upper coil	1250×70×10(6) main/aux.leaf integrated, upper coil	1250×70×10(6) main/aux.leaf integrated, upper coil
		First aux. Leaf size (L×W×H) and numbers	970×70×9(5)	960×70×9(6)	960×70×9(6)
		U-bolt clip center distance (mm)	130	140	140
		Main leaf free static arc height (to coil center) (mm)	137±5.5	115	115
		Aux. Leaf free static arc height in operating length range (mm)	79±3	65	65
		U-bolt torque at depress-to-flat leaf (N·m)	199~243	396~465	396~465
		Leaf spring pin torque (N·m)	126~154	45~56	45~56
		Shock absorber retaining nut torque (N·m)	126~154	75~92	75~92

7.7.2 Briefs on construction

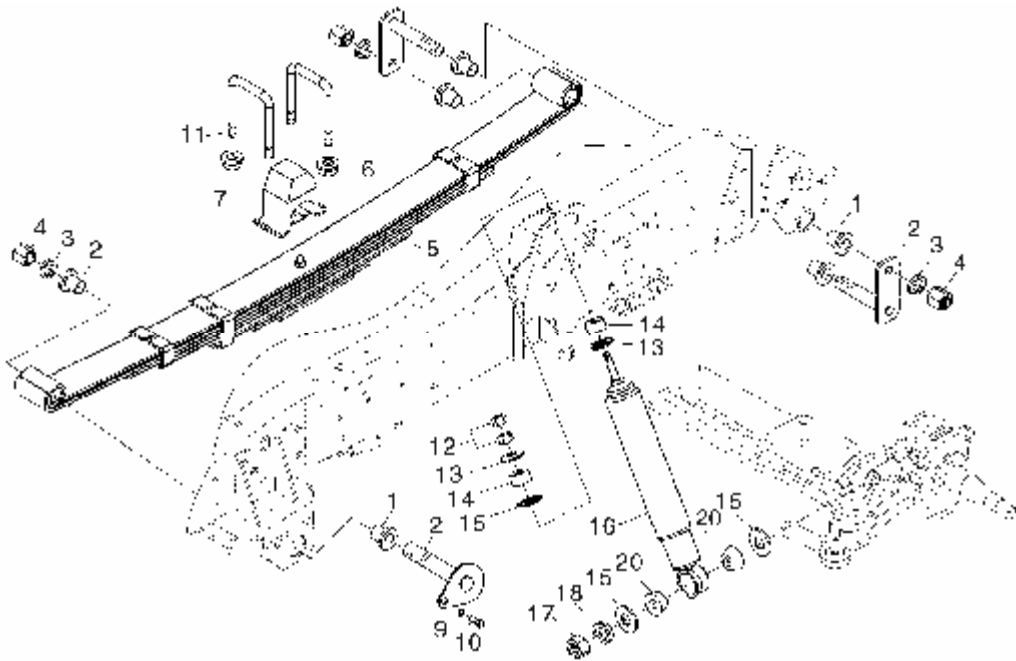
If vehicle frame or body is directly mounted on axle, they will vibrate up and down on road. This will make passenger uncomfortable or damage cargo. A suspension device must be adopted. The suspension refers to all connecting devices between vehicle frame / body and axle, it is used to connect elastically axle to frame or body, damping jerk to vehicle during driving to protect cargo and keep human comfort. The suspension reduces vibration caused by spring system, transmits vertical, longitudinal and side counter force and moment of force; it also guides wheel jump at certain trace corresponding to that of body.

Suspension consists of spring parts, guide mechanism, shock absorber and transverse stabilizer bar. light vehicle front and rear suspension adopts longitudinal semi-oval leaf spring, shackle and two way hydraulic cylindrical shock absorber.

1. Front leaf spring assembly (figure 7-7-1)

Front suspension (figure 7-7-1) mainly consists of front leaf spring assembly (5), shackle plate/pin assembly (2), front damper (12) and front shock absorber assembly (figure 7-7-2).





1-front leaf spring bush 2-front leaf shackle assembly 3-spring washer 4- I-hex nut 5-front leaf spring assembly (LH, RH) 6-nut 7-front damper assembly 8-front leaf front pin assembly 9-spring washer 10-hex bolt 11-front leaf U bolt 12- I-hex nut-fine 13-retaining ring 14-shock absorber bush 15-washer 16-front absorber assembly 17- I-hex nut-fine 18-spring washer 19-shock absorber eye ring rubber bush washer 20-shock absorber eye ring rubber bush 21-washer

Front leaf spring consists of 7 leafs of oval rectangular section. First front leaf is bent to coil, an anti-wear nylon bush (1) is pressed into the coil. The second leaf is rolled upward (135°) to wrap the first leaf, strengthening the first leaf. Two ends of 3-7 leafs are drawn down. A center bolt (7) holds all leaf together through a center hole on each leaf. Center bolt is also a locating pin used to mount leaf spring onto front axle. There are inner/outer clamps (3 pieces) in front leaf spring, they are used to prevent leafs from moving laterally.

Front leaf spring assembly (5) is fixed by two U-bolt (11) into front axle spring seat. And by using leaf pin, its front coil hinges to spring bracket on vehicle frame and end coil to shackle (2). And shackle hinges to shackle bracket on frame, its rear end can move back and forth to let leaf jump up and down freely (avoid breaking). A front damper assembly (12) is mounted on top of center front leaf spring assembly to avoid leaf distortion due to strong impact, protecting leaf while limiting suspension jumping space.

2. Front shock absorber assembly

The connecting screw of front shock absorber is fixed on front shock absorber bracket (1) (on vehicle frame). A shackle is welded on top of reservoir tube, it connects to shock absorber connecting pin hole near front axle end via rubber bush 44 and lower connecting pin 46. When front axle interacts with frame, shock absorber fluid in cylinder tube and reservoir tube flows in and out the orifice on piston. Orifice damps fluid flowing, which quickly reduces frame vibration.

3. Rear suspension assembly

Rear suspension assembly (figure 7-7-2) consists of rear and auxiliary leaf spring assembly (6), rear leaf shackle assembly (3), rear spring damper assembly (17), auxiliary leaf spring bumper pad (14) and rear spring shock absorber.

Main leaf in rear leaf spring (6) (figure 7-7-2) consists of 4 rectangular section leaf. First rear leaf is bent to coil, an anti-wear nylon bush (2) is pressed into the coil. The second leaf is rolled upward (135°) to wrap the first leaf, strengthening the first leaf. Two ends of 3-4 leafs are drawn down.



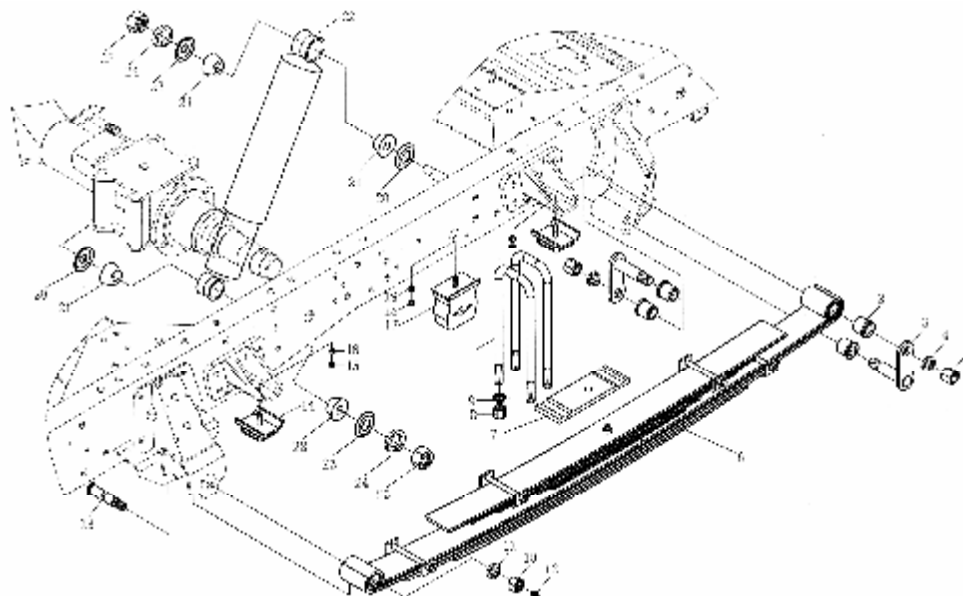


Figure 7-7-2 Rear suspension

1-rear leaf U-bolt 2-rear leaf bush 3-rear leaf shackle assembly 4-spring washer 5- I-hex nut 6-rear leaf spring assembly 7-rear leaf spring cover 8-nut 9-heavy load spring washer 10-nut 11-spring washer 12-straight oil injection cup 3-rear leaf spring front pin 14-auxiliary bracket bumper pad 15-spring washer 16- I-hex nut 17-rear damper assembly 18-spring washer 19- I-hex nut -fine 20-large washer 21-shock absorber shackle rubber bush 22-shock absorber assembly 23-washer 24-spring washer 25- I-hex nut

Auxiliary leaf spring consists of 5 rectangular section leaf. A center bolt holds leafs together through center holes on each main / auxiliary leaf. Center bolt on main leaf aligns rear axle leaf seat center hole to retain the position. Meanwhile, there are clamps mounted on main and auxiliary leafs.

The way to connect rear leaf spring assembly to frame and rear axle is the same as that on front leaf spring. Its front end hinges to leaf spring bracket on frame via leaf pin 13, and rear end to shackle 3. Auxiliary leaf spring is mounted above main leaf. Two U-bolts (20) and rear leaf cover (7) fix tightly the center of main/auxiliary leaf onto rear axle leaf spring bracket. When load is not large, only main leaf works to ensure normal vehicle ride. Auxiliary joins in when load increases to certain degree that auxiliary leaf contacts two bumper pads (14). Main and auxiliary leafs take load at this moment to increase suspension stiffness.

A rear leaf damper assembly (17) is mounted on frame above rear axle. It protects leaf spring from being distort due to strong impact.

4. Rear shock absorber assembly

7.7.3 Technical requirements to check and repair

1. Leaf spring

(1) Check each leaf for crack, break, scratch; check center bolts and leaf clamps for distortion and damage. Replace if necessary.

(2) Check each leaf's laterally twisting. Measure by using center of leaf center hole as basis, the difference to each end should not exceed 1.5mm.

(3) Measure leaf spring assembly performance after leafs have been clamped. The specifications for front/rear/auxiliary leafs should be as indicated in chart 7-7-1. Replace part if arc height and stiffness of each leaf change greatly (especially LH/RH changes) under static load.

- 2.Leaf spring pin and bush
- (1) Check front/rear leaf spring pins for uneven wear or damage by measuring their diameters. Replace parts if wear exceeds limit. See chart 7-2-2.

(2) Measure fitting clearance between front/rear leaf spring and bush. Replace bush if clearance exceeds limit. See chart 7-3-3.

Chart 7-7-1 Leaf spring assembly performance (mm)	
Description	Free arc height (coil center)
Front leaf spring	LH:101.5 RH91.5
Rear leaf spring	125
Auxiliary leaf spring	84

Chart 7-7-2 Front/rear leaf spring limit (mm)		
Description	Standard	Limit
Front leaf pin and shackle pin	$\phi 22^{0}_{-0.084}$	$\phi 21.80$
Rear leaf pin	$\phi 25^{0.019}_{-0.044}$	$\phi 24.80$
Rear shackle pin	$\phi 16.5^{+0.2}_{0}$	$\phi 15.80$

Chart 7-7-3 Fitting between front/rear leaf spring pin and bush (mm)			
Description	Nominal size	Fitting clearance	
		Standard	Limit
Outer diameter.—front leaf pin	$\phi 22^{0}_{-0.084}$	0~0.284	0.8
Bush—front leaf pin	$\phi 22^{+0.2}_{0}$		
Outer diameter.—rear leaf pin	$\phi 25^{0.019}_{-0.044}$	0.019~0.159	
Bush inner diameter.— rear leaf	$\phi 25^{+0.115}_{0}$		
Rear shackle pin	$\phi 16.5^{0.07}_{-0.23}$	0.07~0.43	
Rear shackle pin bush	$\phi 16.5^{+0.2}_{0}$		

3. U-bolt
- Check it for distortion, crack and damaged thread. Replace if necessary.
4. Leaf spring bracket and front shock absorber upper bracket.
- Check and remount loose rivets. Check bracket for distortion. Repair bracket with crack. And replace part if necessary.
5. Front /rear leaf damper and auxiliary leaf bracket pad
- Check them for damage peel or crack. Replace if necessary.
6. Shock absorber
- (1) Clean dismantled parts with kerosene and soft bush. Check parts carefully for damage. Replace worn-out or damaged parts (never clean shock absorber rubber parts with petroleum).

(2) There should be no any damage on connecting rod chroming surface. Otherwise replace it.

(3) Check fitting clearance between cylinder tube and piston. Measure cylinder inner diameter and piston



outer diameter. If clearance exceeds limit, one should born cylinder tube or use larger piston, or replace with new parts. See chart 7-7-4.

Chart 7-7-4 Fitting clearance between cylinder tube and piston (mm)

Description	Nominal size	Fitting clearance	
		Standard	Limit
Cylinder tube inner diameter.	Φ 30	0.05~0.125	0.2
Piston outer diameter.	Φ 30		

7. Shackle rubber bush

Check shackle rubber bush for aging, distortion or crack. Replace if necessary.

7.7.4 Reassembly and adjustment

1. Reassembly and adjustment -- Front / rear leaf spring assembly

- (1) Remove dirt on leaf springs before reassembling. Apply lithium or graphite grease on their surfaces.
- (2) Assemble front/rear/auxiliary leaf springs with center bolt. Mount inner/outer clamps and clamp bolts according to specification. Tighten with nuts. .

Clamped leafs should overlap each other closely. There should be no obvious clearance between leafs within 120mm from center bolt two sides. And relating lateral movement between main leaf and other leafs should be less than 2mm.

(3) Press leaf spring bushes into coil holes of front/rear leaf. Bush should be fixed tightly and its inner diameter should not exceed specification. When inserting a new leaf spring pin into bush, it should access freely but be no excessive play.

Two axial lines of coil bush holes should be parallel to leaf bottom layer base plane, and vertical to longitudinal center plane. To measure this, one can insert new leaf pins into RH and LH bushes. Measure longitudinal distance of two pins. The difference to LH and to RH should be less than 1.2mm. Then measure two leaf pins’ ends (4 points) to check if they are on a same plane. The error should not exceed 1.2mm.

7.7.5 Regular faults and solutions

Regular faults in suspension system include broken leaf spring, leak or failure shock absorber.

1.Broken or sounding leaf springs

Causes and solutions – broken or sounding leaf springs

Causes	Solutions
1 Broken leaf spring due to overload or driving on rugged road	1. Load vehicle as specification, adjust vehicle speed.
2. Loose U-bolt or worn-out pin/bush disturb wheel alignment, or incorrect front/rear wheel base, which lead to brake leaning and hard steering	2. Fasten U-bolt as per specification while leafs are pressed to flat, repair or replace worn-out parts
3. Short lubrication — among leafs and on leaf pins	3. Re-lubricate or replace parts
4. Elasticity diminishing varies among leafs, or certain broken leaf make vehicle body slant.	4.Check replace broken leaf or assembly
5. Broken leaf or failure shock absorber, or damper lost to disturb vehicle ride.	5. Replace broken leaf, shock absorber or damper



2. Leaking or failure shock absorber

Causes and solutions – leak or failure shock absorber	
Causes	Solutions
1. Worn-out oil seal — shock absorber connecting rod	1. Repair or replace assembly
2. After long driving on rugged road, shock absorber cylinder tube becomes hot	2. Remove to check shock absorber, replace if it is failure
3. Failure shock absorber	3. Replace
4. Worn-out or lost absorber upper rubber bush, absorber can not work normally	4. Replaced damaged parts

7.8 Brake system

7.8.1 Brake system main technical parameters

Brake system main technical parameters					
No.	Description		Data		
	Model vehicle		BJ1049V9JD6-C	BJ1049V9JE6-A	BJ1043V8JE6-D
1	Driving brake system		Hydraulic 4 wheel (pad) brakes; vacuum booster dual loop system		
2	Brake	Front wheel	One way dual LT shoe brake - air brake		
		Rear wheel	Two way dual LT brake		
3	Brake drum inner diameter. (mm)	Front wheel	Disc, effective diameter. ϕ 241	ϕ 310	ϕ 310
		Rear wheel	ϕ 300	ϕ 310	ϕ 310
4	Pad size (diameter. $\times$ W $\times$ H)(mm)	FR/FR pad	FR disc thickness 35	310 $\times$ 75	310 $\times$ 75
		FR/RR pad		310 $\times$ 75	310 $\times$ 75
		RR/FR pad	300 $\times$ 75 $\times$ 7.6	310 $\times$ 75	310 $\times$ 100
		RR/RR pad	300 $\times$ 75 $\times$ 7.6	310 $\times$ 75	310 $\times$ 100
5	Master cylinder size (mm)	Cylinder diameter	ϕ 32	ϕ 32	ϕ 32
		Travel	FR14/RR19	FR14/RR19	FR14/RR19
6	Wheel cylinder bore (mm)	Front wheel	ϕ 54	ϕ 32	ϕ 32
		Rear wheel	ϕ 30.16	ϕ 28.58	ϕ 28.58
7	Vacuum booster		9+10" dual diaphragm		
8	Brake fluid		V-3-QC/T670		
9	Parking brake type		Central drum brake		
10	Parking brake pad (diameter. $\times$ W $\times$ H)(mm)		178 $\times$ 35 $\times$ 5	178 $\times$ 35 $\times$ 5	178 $\times$ 35 $\times$ 5
11	Parking brake drum inner diameter. (mm)		178	178	178



7.8.2 Briefs on construction

The device sets used to force vehicle to stop by applying force from road on wheels are called brake system. It is used to force vehicle to decelerate and stop, or park a vehicle firmly on various road conditions (including on hill), and keep stable vehicle speed at driving down hill. Light-duty trucks series vehicle adopt two independent brake systems: driving brake system used on FR/RR wheels and parking system used on transmission mechanism.

Driving brake system consists of wheel brake and hydraulic driving mechanism, and is operated by human foot. Parking brake system consists of central drum brake and parking brake transmission mechanism, used at parking or starting up on uphill, is operated by hand. In emergency braking situation, parking brake system and driving brake system are used at the same time. In the event driving brake system is faulty during vehicle driving, driver should move vehicle by using parking brake system to safe place or service station for check and repair.

1. Wheel brakes

BJ1049V9JD6-C front brakes use caliper-disc brakes, and BJ1049V9JE6-A and BJ1043V8JE6-D use dual LT shoe drum brakes. See figure 7-8-1. It is mainly composed by brake drum, wheel pump (13,16), brake base plate (8) and FF/RR brake shoe assembly (12). Brake base plate 8 is fixed with bolt on front wheel knuckle. Rod (11), compress spring (15) and spring seat (14) on base plate are used to limit axial play of brake shoes. Brake shoe is hooked by return spring, its end adheres to wheel cylinder piston. Friction lining is riveted on outer face of brake shoe. Construction of rear brake (figure 7-8-2) is the same as that of front brake.

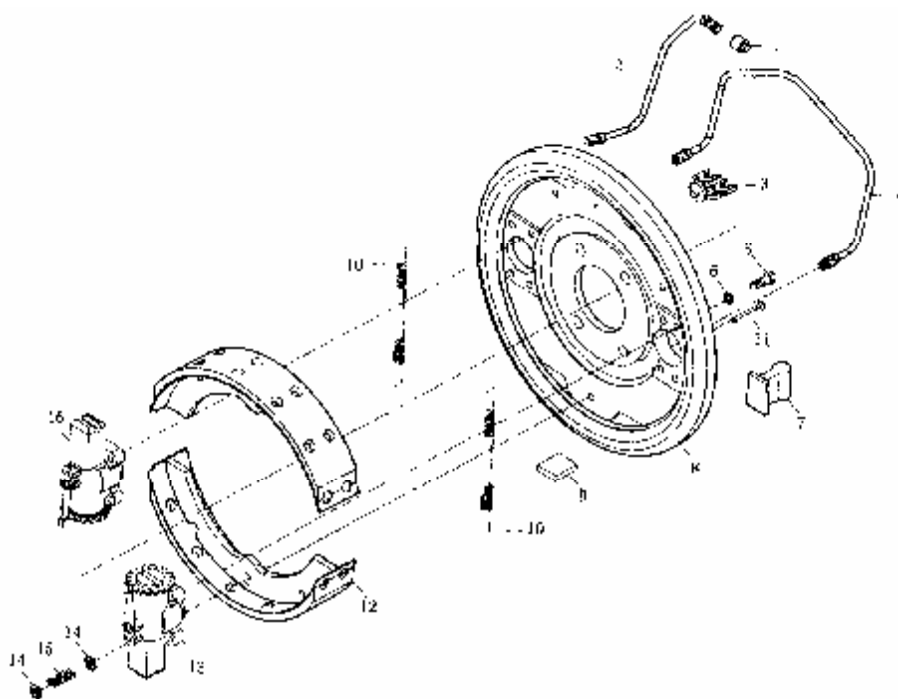


Figure 7-8-1 Front brake assembly

1-vent screw cap 2-front fluid pipe assembly 3-pipe clip—FF brake 4-FF brake fluid pipe assembly 5-bolt 6-spring washer 7-dust plug-adjust hole 8-FF base plate assembly 9-pillar sealing ring 10-FF shoe return spring 11-front pull rod 12-FF brake shoe assembly 13-FF wheel pump assembly (a) 14-shoe compress spring seat 15-shoe compress spring 16-FF wheel cylinder assembly (b)

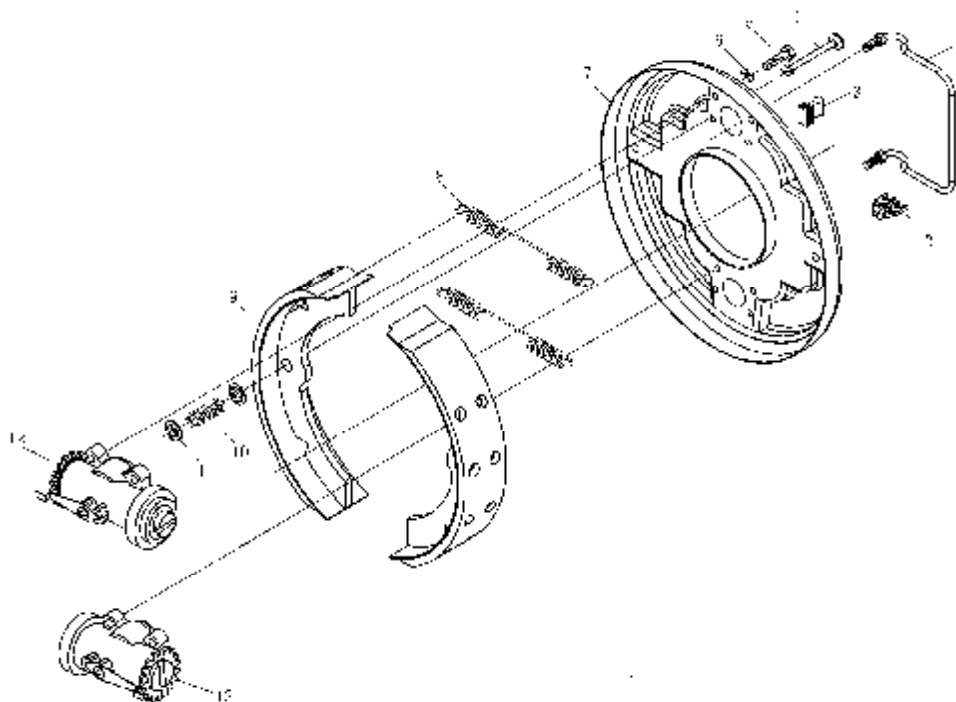


Figure 7-8-2 Rear brake assembly

1-oil pipe; 2-oil pipe clip; 3-dust plug; 4-pulling rod; 5-bolt; 6-spring washer; 7-base plate assembly; 8-shoe return spring; 9-RR brake shoe assembly; 10-shoe compress spring; 11-shoe compress spring seat; 12-RR wheel cylinder assembly (a); 13-RR wheel cylinder assembly (b)

When brake pedal is depressed, vacuum booster diaphragm is activated to move master cylinder push rod, pushing brake fluid front and rear wheel cylinders to push piston. Meanwhile, brake pads overcome return spring to expand outward, contacting brake drum to brake vehicle. When brake pedal is released, return spring draw pads back, and brake fluid in brake pipe returns to master cylinder to cancel braking.

2. Hydraulic transmission mechanism

The mechanism consists of brake pedal, vacuum booster, master cylinder, FR/RR brake pipes and FR/RR wheel cylinders.

Vacuum boost pipe system (figure 7-8-3) consists of vacuum pump, vacuum reservoir, vacuum booster with master cylinder, brake pedal operating assembly and vacuum pipe.

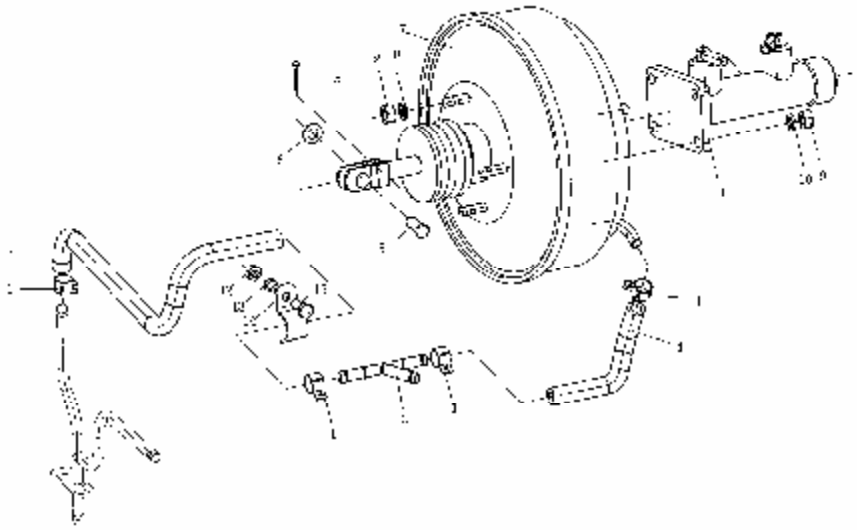


Figure 7-8-3 Vacuum booster (diesel engine –body part)

1-band clamp; 2-vacuum boost hose1; 3- T-vacuum pipe 2 (clutch boost), I-vacuum tube (w/o clutch boost); 4-brake boost hose; 5-cotter pin; 6-washer; 7-vacuum booster (FR disc and FR drum); 8- axis pin; 9- l -hex nut-fine; 10-spring washer; 11-master cylinder assembly; 12- l -hex nut; 13-spring washer; 14-pipe clip; 15-hex bolt;

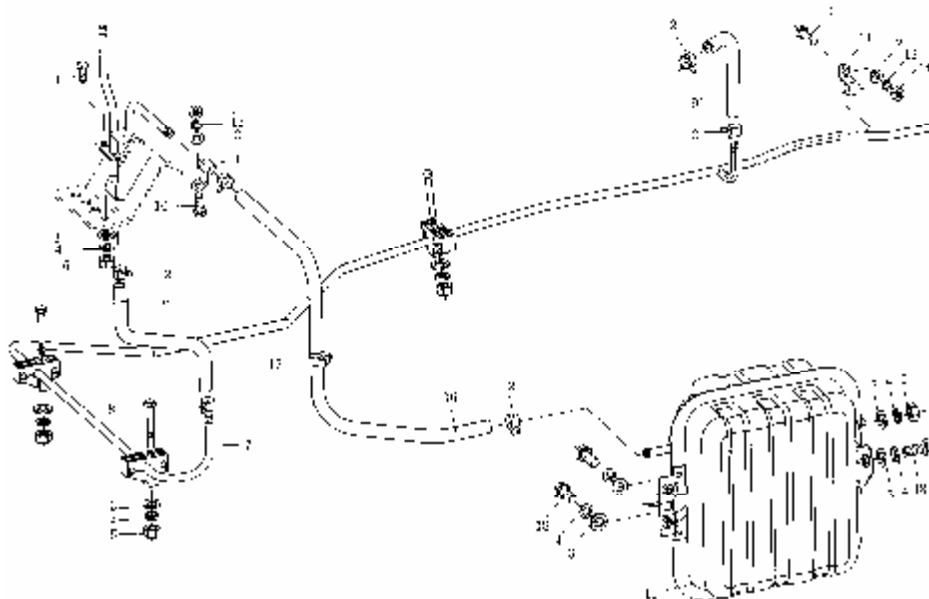


Figure 7-8-4 Vacuum booster (diesel engine –chassis part)

1-hex bolt; 2-band clamp; 3-washer; 4-spring washer; 5- l -hex nut; 6-vacuum hose(front hose),vacuum booster hose with check valve assembly (front drum); 7-vacuum tube assembly; 8-hex bolt; 9-vacuum tube—vacuum pump hose assembly; 10-hex bolt; 11-T tube clip; 12-washer; 13-spring washer; 14- l -hex nut; 15-vacuum reservoir assembly; 16-vacuum hose to reservoir via T tube; 17-vacuum hose clip; 18-hex bolt; 19-welded vacuum hose T-tube bracket sets;

In diesel engine vehicle, a vacuum pump connected to alternator produces vacuum, moves push rod and piston in master cylinder via vacuum booster. This reduces force used to depress brake pedal, and produce pressure inside brake system.

▲ Master cylinder is a dual piston cylinder, consisting of cylinder tube, piston, cup, sealing ring and FR/RR end covers. Master cylinder is mounted on vacuum booster. They two are mounted on brake pedal bracket inside driver cab. Piston push rod connect to brake pedal via interlink mechanism. While brake pedal is depressed, rod pushes master cylinder piston forward. When cap taken by piston moves to cover bypass hole to seal master cylinder working chamber, fluid pressure inside system goes up, pushing wheel cylinder pistons to activate brake. While releasing brake pedal, wheel cylinder and master cylinder pistons were pulled back by returning springs, brake fluid flows back to master cylinder to control braking.

▲ Wheel cylinder -- front wheel cylinder uses single piston and rear wheel cylinder uses dual pistons. Front wheel cylinder consists of tube, piston, cup, vent screw and adjusting screw. Rear wheel cylinder (figure 7-8-5) is composed by tube (7), piston assembly (2), wheel cylinder cup, (3) adjusting screw, (4) and vent screw (5). FR/RR wheel cylinders are mounted brake base plates on each wheel cylinder's two ends contact ends of FR/RR brake shoes. There are fluid inlet orifices and vent holes on tube rear face. When brake pedal is depressed, fluid flows from tube connector through orifice to enter tube, piston moves outward under hydraulic pressure, expanding brake shoe to press on brake drum.

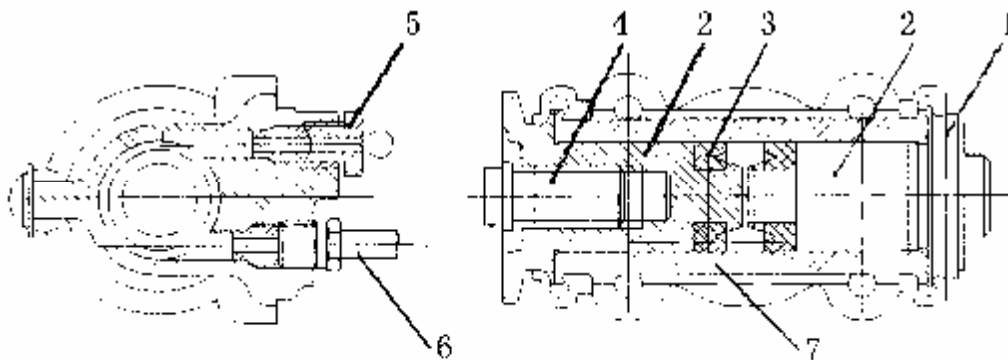


Figure 7-8-5 Rear wheel cylinder

1-RR wheel cylinder cover; 2-RR wheel cylinder piston assembly; 3-RR wheel cylinder cup;
4-adjusting screw; 5-vent screw; 6-wheel cylinder connector and tube; 7-RR wheel cylinder tube

▲ vacuum booster

Dual diaphragm vacuum booster (figure 7-8-6) consists of vacuum chamber, diaphragm plate and diaphragm return spring, control valve body, valve stem and push rod.

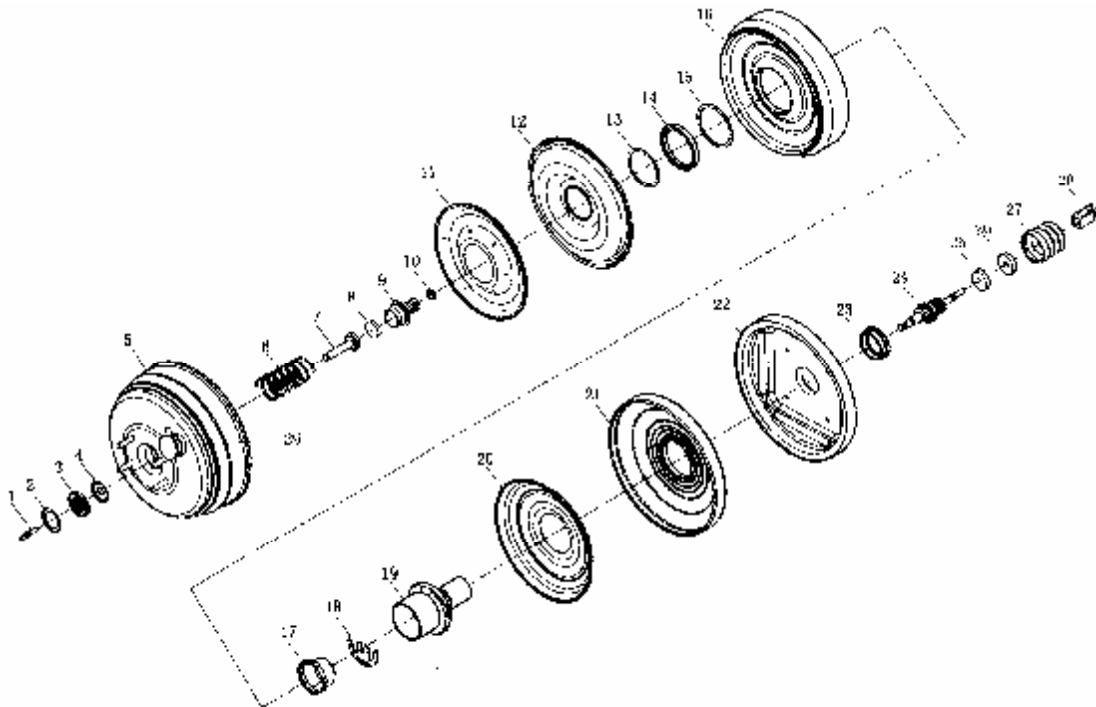


Figure 7-8-6 Dual diaphragm vacuum booster assembly

1.adjusting screw; 2-FR retaining ring; 3-FR air seal; 4-FR air seal retaining ring; 5-vacuum chamber assembly; 6-booster return spring; 7-master push rod assembly; 8-reaction plate; 9-plug guide bush; 10-O-ring ; 11-FR chamber diaphragm plate assembly; 12-FR diaphragm; 13-FR diaphragm washer; 14-sealing ring; 15-sealing ring retainer; 16-spacer ring (FR-RR chambers); 17-vacuum /pressure variation chamber spacer bush; 18-lock pin; 19-control valve body; 20-RR chamber diaphragm plate; 21-RR chamber diaphragm; 22-pressure variation chamber casing assembly; 23-pressure variation chamber sealing ring assembly; 24-control valve stem assembly; 25-filter; 26-felt element; 27-protection cover; 28-push rod fork; 29-check valve

▲ Vacuum check valve

Vacuum check valve is mounted inside brake pipeline. It is a important part to retain vacuum inside booster. Brake pedal mechanism (figure 7-8-7) consists of pedal bracket assembly(7), pedal arm assembly (7), pedal shaft (1), brake light switch assembly(12) and pedal return spring (16). Pedal operating mechanism and booster are mounted inside driver cab. When pedal is depressed, vacuum booster activates master cylinder and produces hydraulic pressure inside pipeline system. The pressure expands brake shoe via wheel cylinder to press on brake drum.

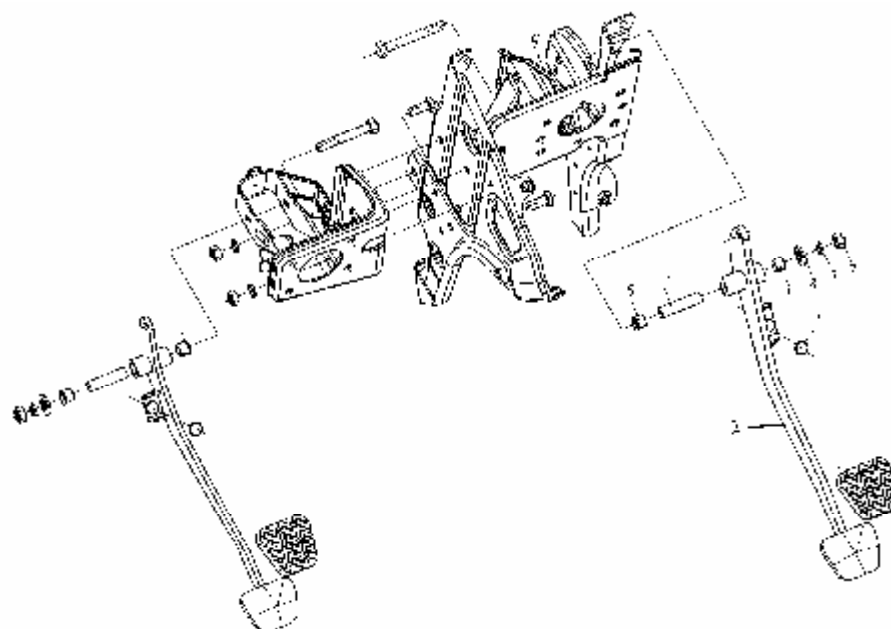


Figure 7-8-7 Brake pedal assembly

1-pedal rubber lining; 2-pedal arm assembly; 3-limiting rubber washer; 4-pedal arm shaft tube;
5-pedal arm shaft bush; 6-washer; 7-nut; 8-spring washer; 9-brake pedal assembly

3. Parking brake system (figure 7-8-8)

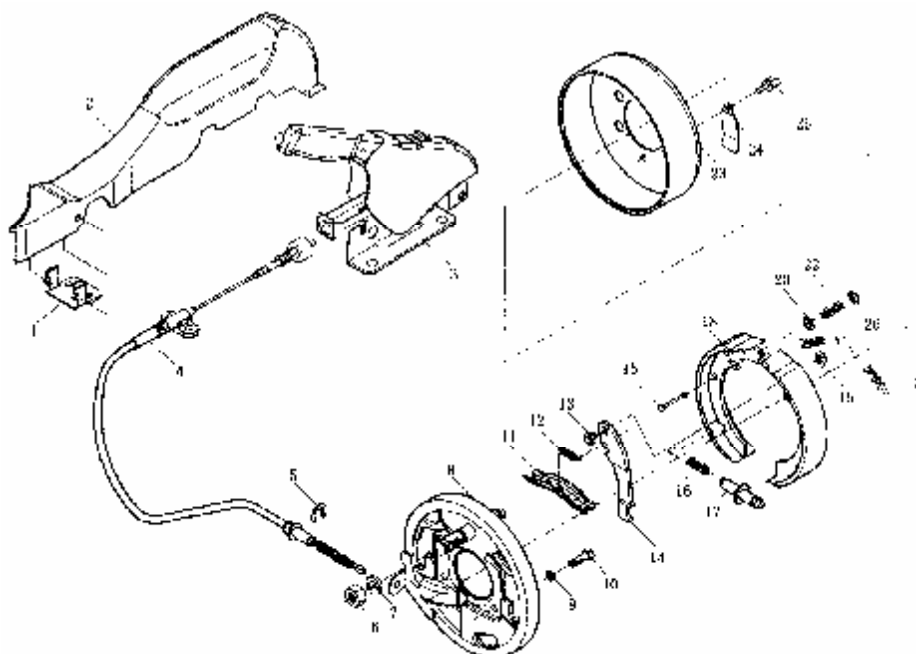


Figure 7-8-8 Parking brake and operating devices

1-handle hood retaining bracket; 2-handle hood; 3-manual brake handle; 4-manual brake cable assembly; 5-open retaining ring ; 6-nut; 7-spring washer; 8-brake base plate assembly; 9-spring washer; 10-bolt; 11-spreader; 12-lever extension spring; 13-brake pin; 14-brake lever; 15-brake shoe pin; 16-lower extension spring; 17-adjusting screw assembly; 18-brake shoe assembly; 19-limiting ring; 20-shoe spring cap; 21-secondary stage return spring; 22-shoe compress spring; 23-manual brake drum; 24- parking brake adjusting hole cover; 25-bolt; 26-primary return spring

Parking brake is a central drum brake. The system consists of manual brake handle (3), manual brake cable assembly (4), brake base plate assembly (8), brake lever (14) and return spring (21). Manual brake drum is fixed on transmission output shaft flange, and brake base plate on transmission rear cover via two bolts and one nut.

4. Parking brake operating mechanism

Parking brake is of a distant mechanical operating type. An operating handle mounted inside driver cab performs distance controlling via brake cable. When driver moves handle to parking position, brake shoe will expand to press on drum’s inner surface to create friction, forming a park braking state.

7.8.3 Check and repair

1. Master cylinder

Clean parts with alcohol brake fluid or alcohol (never use solvent or petroleum), then proceed to check one by one.

(1) Master cylinder tube and piston

①Check tube wall for wear, scratch or corrosion, and oil return orifice or compensation orifice for restriction. Replace parts if necessary.

②heck piston for wear, corrosion, and measure fitting clearance between piston and cylinder. Replace piston if clearance exceeds limit.

Figure 7-8-1 Fitting clearance — piston with master cylinder (mm)

Parts	Nominal size	Fitting clearance	
		Standard	Limit
Piston outer diameter.	φ 26.99	0.025~0.077	0.12
Master cylinder bore	φ 26.99		

(2) Piston return spring. Check spring for distortion or breaking. Replace worn-out or broken spring.

(3) Rubber parts and other parts

① Check piston rubber cup, ring and rubber parts at inlet/outlet fluid valves for wear, crack and expansion. They protects master cylinder and has to be replaced if necessary.

② Check master cylinder hood, piston steel washer for damage or distortion. Replace if necessary.

2. FR/RR wheel brakes

(1) Pad. Check pad for scratch, wear, crack and lining deterioration due to overheating. Replace if necessary.

(2) The depth limit that rivet inserted into pad see figure 7-8-9. Replace worn-out pad.

Chart 7-8-2 Rivet embedding depth into pad (t) (mm)

Parts	Standard (A)	Limit (t)
Front wheel	2.5	≤0.20
Rear wheel	4.5	

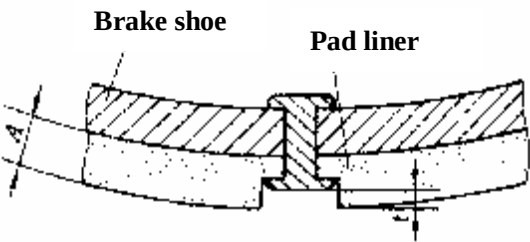


Figure 7-8-9 Measure embedded depth of rivet

Replace rivet that cannot be used to next service interval even depth value t is larger than 0.2mm. Replace FR/RR pads at the same time.

- (2) Shoe plate。 Check shoe plate for distortion and crack. Replace if necessary.
- (3) Base plate. Check base plate for distortion and crack. Correct base plate when its flatness error exceeds 0.60mm. Replace when necessary.
- (4) Shoe return spring. Check spring for distort extension, weakness or uneven elasticity. Replace when necessary.
- (5) Wheel cylinder
- ① Check wheel cylinder inner wall for wear, scratch and corrosion.; defects on vent screw sealing face; skidding or damaged thread in screw hole. Replace when necessary.
- ② Check piston for wear, corrosion and scratch. Replace if necessary. Measure fitting clearance between piston and wheel cylinder, replace it if clearance exceeds limit. See chart 7-8-3.
- ③ Check wheel cylinder piston spring for breaking and weakness. Replace weak spring.
- ④ Check wheel cylinder cup lip for wear, crack and breach or if cup is aged. Replace if necessary.

Figure 7-8-3 fitting clearance – piston with wheel cylinder bore (mm)

Parts		Nominal size	Fitting clearance	
			Standard	Limit
Piston	FR wheel	φ 28.57	0.025~0.077	0.15
	RR wheel	φ 25.4		
Wheel cylinder bore	FR wheel	φ 28.57		
	RR wheel	φ 25.4		

3. Brake drum

Check brake drum for crack, distortion or uneven wear. Measure distort drum on its bore wear and roundness error (run-out) (figure 7-8-10).

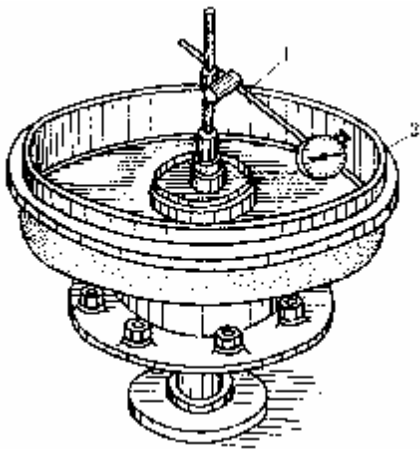


Figure 7-8-10 Measure brake drum roundness error with dial indicator
1-dial indicator; 2-brake drum

Grind drum when its wear and roundness error exceed limits. inner surface axial play of repaired drum should be less than 0.15mm, and inner diameter difference of LH/RH drums in same vehicle should be less than

1mm. Replace drum when its wear exceeds limit (see chart 7-8-4).

Chart 7-8-4 Drum repairing size (mm)

Parts		Nominal size	Repairing size		Limit
			Wear	Run-out	
Drum inner diameter	FR wheel	φ 300	2mm	Less than 0.15mm	φ 304

4. Vacuum booster

(1) Assembly check. Before or after repair, one should check vacuum booster. Check is usually performed on professional workbench or sent to service station. Check mainly focuses on booster sealing.

①Non-working sealing test: When booster input push rod is in its primary position, the vacuum drop should not be more than 3.3Kpa within 15 seconds.

②Sealing test under max boosting point: input pressure is 50%~70% of max boosting point (design value). Vacuum drop should not be more than 6.6Kpa within 15 seconds.

③Sealing test above max boosting point: input pressure is 120%~140% of max boosting point (design value). Vacuum drop should not be more than 3.3Kpa within 15 seconds.

(2) Parts check. After vacuum has been dismantled, clean and blow dry all parts and proceed to check one by one.

5. Fittings of brake and vacuum pipeline

(1) Check thread and sealing on connectors, T-connectors of brake pipe and hose. Replace worn out parts. Used sealing bronze washer should be replaced if it is distort.

(2) Check brake hose for crack, squeezing, damage, and if flare opens at two ends are distort or squeezed. Replace if necessary.

(3) Check vacuum pipe especially hose for aging, crack, wear or squeezing. Replace if necessary.

(4) Check vacuum reservoir for sealing. Put reservoir into water and input compressed air not less than 196Kpa. Bubbles indicate reservoir is leaking, need to be welded.

6. Parking brake

(1) Check brake drum for deep groove, wear or crack. Grind or replace it when necessary.

(2) Check pad for deep groove, wear, crack or deterioration due to overheating. Replace if necessary.

(3) Check brake shoe for distortion or crack, and brake lever for wear. Replace parts if necessary.

(4) Check manual brake shoe spring for weakness or corrosion. Replace weak spring.

7. Parking brake operating mechanism

(1) Check parking brake operating lever ratchet and lever lock for wear. Replace if necessary.

(2) Check parking brake cable front/rear connector, protecting tube connector for loose and damage, and if cable and return spring are damaged. Replace if necessary.

7.8.4 Reassembly, adjustment and check

1. Driving brake system

(1) Re-assemble brake assembly

Before reassembling, lubricate with castor oil or alcohol brake fluid the surfaces of wheel cylinder, cup, piston and return spring. And apply grease on shoe supporting pins. Be sure not to drop oil on pad surface and drum inner surface.

(2) Re-mount brake pedal mechanism

In the event that pedal mechanism has been removed from vehicle and dismantled, one should remount



vacuum booster and master cylinder. Be sure all fitting faces of rotating parts as pin, shaft and pin hole are clean. Apply grease on these faces. All rotating parts should be connected firmly and operate freely.

(3) Adjust pedal free travel and height

① Adjust pedal free travel

Free travel refers to the distance that pedal moves downward till master cylinder piston starts to operate. It is the gap between master cylinder push rod to piston.

Adjusting methods (figure 7-8-15): unscrew locking nut on master cylinder push rod, turn push rod till it extends to touch piston, retighten nut for 0.5-1 thread. Leave a gap between master cylinder piston and push rod (0.1~0.5mm), then fix it with locking nut. Larger gap will lead to failure braking while smaller gap to incomplete releasing.

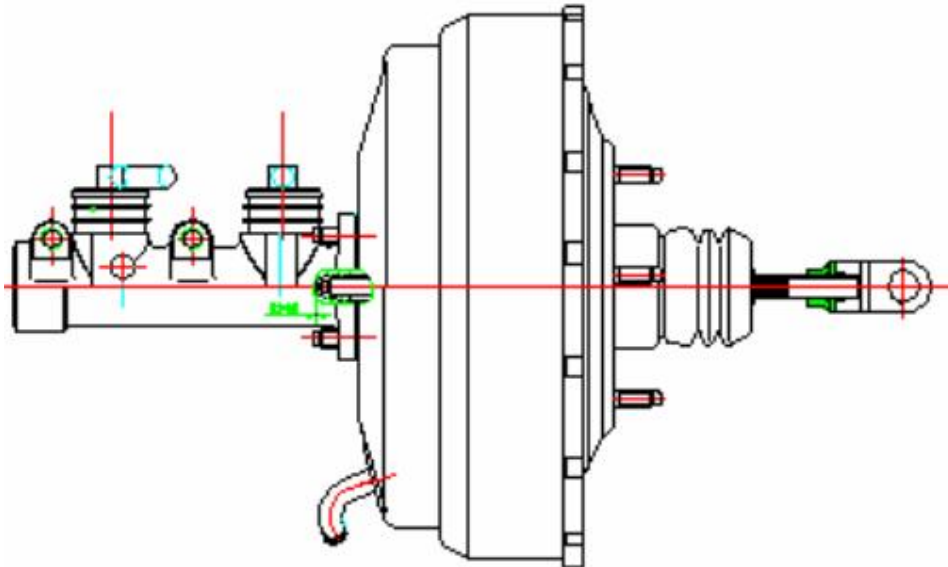


Figure 7-8-15 Gap between master cylinder piston to push rod

② Adjust brake pedal height

While brake pedal free travel is guaranteed, its high-low positions are adjusted by means of brake light switch assembly. Loosen locking nut on switch and turn switch clockwise, Pedal height lowers as screw thread grows and increases as thread diminishes. Keep adjusting till pedal center face is 165mm from cab floor.

(4) Adjust brake system

Procedures to bleed brake system are as follows:

① Fill reservoir cup with brake fluid. Watch out fluid amount in the cup during bleeding and keep replenishing fluid into the cup.

② Depress pedal slowly and consecutively. The bleeding process should be a repeat-pause cycle, this will send air dispersed in the system to vent screws at booster and FR/RR wheel cylinder and get discharged easily.

③ Bleeding operation needs two persons, here are the procedures:

▲ remove vent screw cap, and put on one end of a see-through hose. Put another end of hose into a container with brake fluid.

▲ A operator in the cab depresses and releases brake pedal consecutively (depress quickly and release slowly), then stops and keeps pedal (when pedal resistance is strong) at its middle traveling position.

▲ Another operator loosen vent screw for 1/2~3/4 turn. At this moment, air in pipeline is discharged

together with fluid (many bubbles and foam in fluid). Retighten vent screw quickly before releasing brake pedal. Repeat this process many times till pedal is felt “tough” and no bubbles in drained fluid.

▲ After bleeding, tighten vent screw to working condition, and add fluid to reservoir cup.

2. Parking brake system

Re-assembly and adjustment

(1) Before reassembling, clean and lubricate the surfaces of parts with grease. Be sure not to drop oil or grease on parking brake pad outer surface.

(2) Adjust parking brake assembly. If manual brake parts have been replaced, the parking brake must be adjusted as per following procedures.

① Adjust it with adjusting screw till clearance between pad and drum reaches 0.5mm (i.e. check on upper/lower sections of FR/RR manual brake pads by inserting feeler blade of 0.3~0.5mm).

② Move pulling arm of parking brake shoe15~20mm to activate parking brake fully.

7.8.6 Regular faults and solutions

Regular faults in driving brake system include brake failure, insufficient braking, brake bias, brake drag (on all wheels or certain wheel), abnormal noise, pedal raises or drops gradually and heavy pedal. And faults commonly seen in parking brake system are brake failure, abnormal noise and brake heating.

1.Regular faults and solutions—driving brake system

(1) Brake failure. No braking force when brake pedal is depressed consecutively.

Causes and solutions – brake failure

Causes	Solutions
1.Brake fluid short or no fluid in master cylinder	1.Add fluid to standard
2.Worn-out master cylinder or damaged master/wheel cylinders cups	2.Replace
3.Broken brake pipeline or damaged connector	3.Repair or replace pipeline
4.Master cylinder push rod pin detached	4.Re-mounting

(2) Insufficient braking。Depress brake pedal cannot stop vehicle timely, and consecutive depressing shows no good result either

Causes and solutions – insufficient braking

Causes	Solutions
1. Air in brake pipeline or fluid leakage	1. Bleeding, remove leakage
2. Excessive pedal free travel	2. Adjust pedal free travel
3. Excessive clearance between drum and pad	3. Adjust clearance
4. Brake cup expands to stick	4. Replace cup
5. Excessive pad lining wear, poor contact or oil dirt on it	5. Grind or replace pad
6. Drum out-of-round, incorrect friction coefficient	6. Repair or replace drum
7. Aged brake hose to inflate	7. Replace hose

(3) Brake bias

Braking forces on both sides are not even or synchronizing, this makes vehicle driving to one side.



Causes and solutions – brake bias

Causes	Solutions
1. Pad clearances on both side are not even	1.Adjust clearance
2. Certain hose/connector clogged, or air in pipeline	2.Remove restriction or bleed system
3. Certain brake cup expands to stick	3.Replace cup
4. Certain pad has oil dirt or becomes worn-out, rivet exposed	4.Abrasive pad or replace
5. Uneven tyre pressures on LH/RH tyres	5.Inflate tyre to standard
6. Certain drum is out of round	6.Repair
7. Drums become distort after rim covers have been installed	7.Measure and check after installing rim cover, grinding if necessary
8. Different friction coefficient on RH/LH drums	8.Replace with drums of same coefficient
9. Brake lag—RH/LH	9.Locate cause and adjust
10. Vehicle frame distortion, wheel base unparallel	10.Measure and adjust

(4) Brake drag (drum overheating)

Release brake pedal cannot cancel braking timely while drum temperature increases. Normal drum working temperature should be not 70℃ more than ambient temperature (the value might be higher during long hill drive in mountain area). In order to find the cause of drum overheating, one can either test vehicle’s coast distance or driving without braking.

Set off an unloaded vehicle to coast on paved and dry road at initial speed of 30km/h. At the time the vehicle stops completely, for ordinary vehicle, the coast distance (average value of two round tests) should not be less than 220m, and 180m for front drive vehicle. If drum contacts pad, the distance will be shortened and drum heated.

Drive vehicle for 3-5km, if drum becomes very hot, this may due to causes like pad contacts drum, wheel hub bearing is loosing or rear axle case is bend etc. One can make further check by jacking up vehicle on the hot drum side and turning the wheel. If pad does not contact drum, the symptom may due to loose wheel hub bearing or warped rear axle case.

①Brake drags on all wheels simultaneously

Causes and solutions -- Brake drags on all wheel simultaneously

Causes	Solutions
1. Master cylinder returns slowly	1. Repair master cylinder
2. Short pedal free travel	2. Adjust free travel
3. Clogged pipeline, restricted fluid return	3. Clear pipeline

②Brake drag on certain wheel

Causes and solutions -- Brake drag on certain wheel

Causes	Solutions
1. Smaller clearance — drum to pad	1. Adjust clearance
2. Weak shoe return spring	2. Replace spring or adjust supporting pin and eccentric
3. Wheel cylinder cup inflated or piston stuck	3. Repair or replace
4. Brake hose inflated and choked	4. Replace hose



(5) Brake noise

One can hear whining at braking or intermittent rubbing sound.

Causes and solutions -- Brake noise

Causes	Solutions
1. Drum out-of-round or uneven wear	1. Repair or replace drum
2. Dirt pad or un-secure riveting	2. Grinding or remount rivet
3. Shoe contacts drum	3. Repair and adjust
4. Excessive pad wear, pivot end contacts drum	4. Replace shoe/pad assembly

(6) Brake pedal drops gradually

Pedal is depressed to the floor suddenly. Step on repeatedly cannot make it returning.

Causes and solutions -- Brake pedal drops gradually

Causes	Solutions
1. Brake pipeline leakage or air in the system	1. Repair and bleeding
2. Worn-out master cylinder cup and ring, fluid leaks at braking	2. Repair and replace parts
3. Wheel cylinder cup reversed	3. Repair

(7) Brake pedal goes up gradually

Pedal goes up gradually after it is depressed repeatedly during driving.

Causes and solutions -- Brake pedal goes up gradually

Causes	Solutions
1. Master cylinder fluid compensation hole blocked or sealing ring covers the hole, excessive fluid can not flow back to fluid cup	1. Clear compensation hole or readjust
2. Smaller free clearance -master cylinder piston push rod	2. Readjust

(8) Brake pedal too heavy

Due to vacuum booster failure, brake pedal becomes heavy without well braking force.

Causes and solutions -- Brake pedal too heavy

Causes	Solutions
1. Diaphragm air leak or broken spring -vacuum booster	1. Repair damaged parts in vacuum booster
2. Diaphragm fluid leak-control valve	2. Repair damaged parts in vacuum booster
3. Vacuum valve ajar - control valve	3. Repair damaged parts in vacuum booster
4. Vacuum hose air leak	4. Replace hose or tighten connectors
5. Check valve failure	5. Replace check valve

2.Regular faults and solutions— parking brake system

Manual brake failure. Lift manual brake handle cannot stop vehicle from coasting.



Causes and solutions -- Manual brake failure

Causes	Solutions
1. Parking brake cable is too long	1. Readjust
2. Larger clearance between pad and drum or they contact poorly	2. Readjust
3. Worn-out pad, rivet exposed	3. Replace pad
4. Dirt on pad or on drum	4. Remove dirt with sand paper

- Tips: Test whether drum heating is normal or not:
Drive vehicle on nice and plane road for 10km. Apply brake normally. Touch brake drum with hand. If temperature is endurable, break drum heating is in normal range;
- Notes:
- Above case allows temperature difference between FR/RR, RH/LH drums.
 - If drums become scalding after several emergency braking, the high temperature do not warrant that drum heating is out of normal range.

7.9 Vehicle frame

7.9.1 Vehicle frame main technical parameters

Vehicle frame main technical parameters

No.	Description		Data		
1	Model vehicle		BJ1043V8JE6-D	BJ1049V9JD6-C	BJ1049V9JE6-A
2	Engine model		YZ4102ZLQ	BJ493ZLQ	Phaser110Ti
3	Type		Channel rivet frame		
4	Middle side member max section H×W×thickness（mm）		195×60×5	170×65×5	195×60×5
5	Frame outer width （mm）	FR	780	780	780
		RR	780	700	780
6	Total frame length（mm）		5840	5766	5841

7.9.2 Briefs on construction

Vehicle frame is the connection foundation of vehicle. Engine, transmission, steering gear, propeller shaft and FR/RR axle are all mounted on frame.

Frame takes majority weight of a vehicle. During vehicle driving, frame is subject to forces from parts mounted on it. While vehicle is driving on rugged road, frame will be bend under load, and parts on it will change their relating location too. Larger frame distortion will affect negatively the operation of these parts. Meanwhile, frame is under large impact load. Due to these factors, it requires frame to have enough hardness and stiffness. And frame should be light in weight and simple in construction to reduce vehicle weight.

FOTON export light trucks adopt channel rivet frame (figure 7-9-1), composed by two channel section side members and several cross members (connected by bolt or riveting).

Frame assembly is the base of whole vehicle. Driver cab, engine, cargo, suspension, FR/RR axles and wheels are all mounted on frame. Frame has to support their normal operation while to take impact loads under various working conditions. Meanwhile frame is subject to bending and twisting deflection. Therefore, it must have



enough hardness and stiffness. Material used to make frame is hot rolled steel whose mechanical property is up to Chinese national standards.

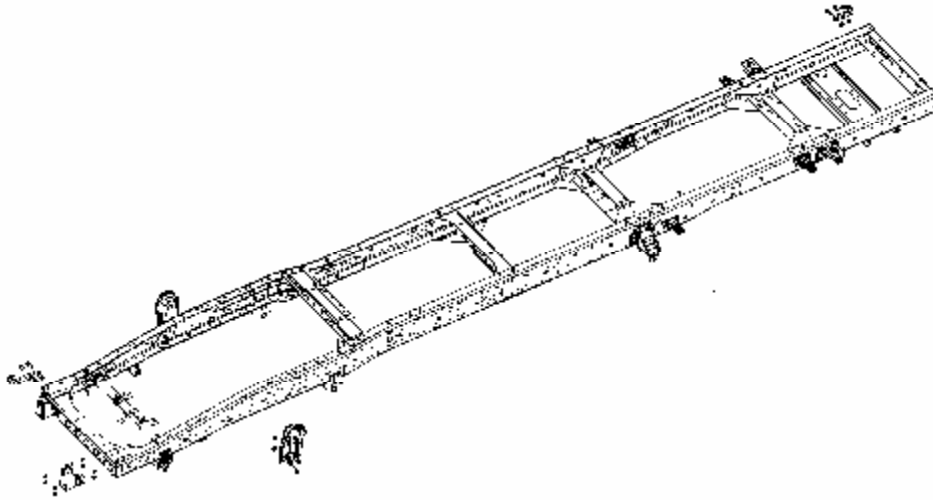


Figure 7-9-1 Frame assembly

7.9.3 Frame assembly technical specifications

1. Side member technical specifications

(1) Section shape deviation (figure 7-9-2)

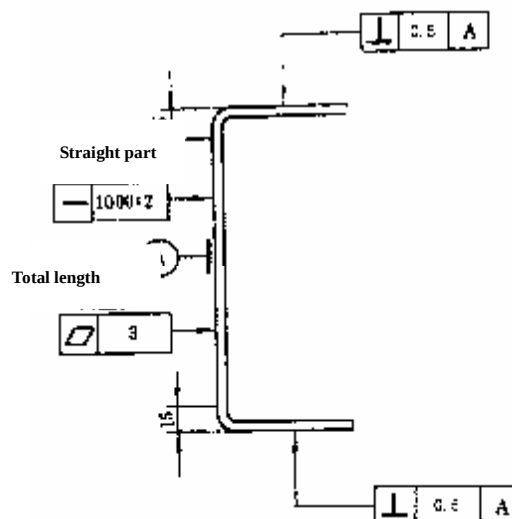


Figure 7-9- 2 Section shape deviation

(2) Linearity on straight part of upper/lower flange should not be more than 1.5mm.

(3) Relating position on holes in side member is $\phi 0.5\text{mm}$. Distance deviation from rivet hole(riveting FR/RR spring leaf bracket and shackle bracket) to side member lower wing face should not be more than $\pm 0.3\text{mm}$.

(4) Within 400mm to side member rear end, wrinkle (due to factory pressing) length should not exceed 200mm, and 100mm in other parts of side member. There should be no more than 3 wrinkle sections through whole length. It is allowed to weld wrinkle, but polishing work is needed. Distance between weld joints should not be less than 300mm.

2. Frame assembly technical specifications

(1) Upper surfaces of LH/RH side members should be in a plane, flatness deviation through whole length should not be more than 3mm.

(2) For outer side surfaces of LH/RH side members, their upper and lower width deviation in same section should not be more than 2.5mm.

(3) Distance difference between left and right bracket pin hole axial of front spring leaf should not be more than 2mm.

(4) Length difference between diagonal line A and B , C and D should not be more than 2mm (figure 7-9-3).

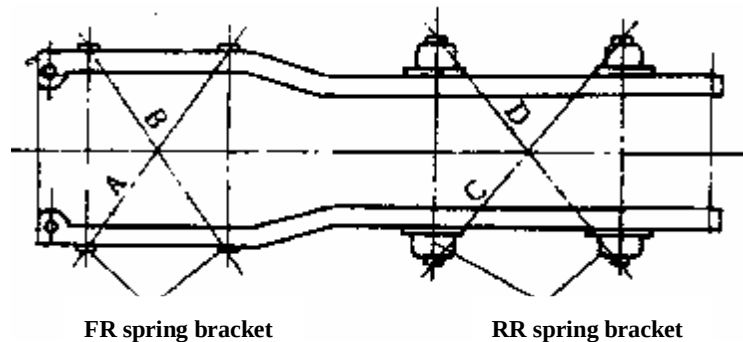


Figure 7-9-3 Check frame assembly diagonal lines

(5) Riveting should comply following requirements:

① Connecting face of riveting parts should be tight. Rivet range diameter D (figure 7-9-4) should not be 3 times less than rivet diameter.

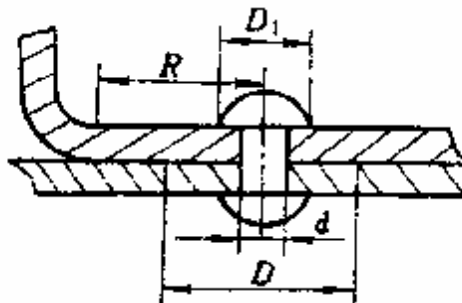


Figure 7-9-4 Riveting technical requirements

② Rivet head should be so close to stem that one can not insert feeler of 0.2mm.

③ After riveting, riveting head diameter should not be 1.5 times (hot riveting) and 1.3 times (cold riveting) less than stem diameter d . Riveted head height should not be lower than preformed head height.

④ If crack is seen after riveting, one should remove rivet and do riveting process again. It is not allowed to re-weld directly without removing old one.

3. Apply primer and final coating, paint should be even and good.

7.9.4 Check and repair

1. Check

Vehicle frame damages include corrosion, bending, twisting, skewed, partial deflection, crack, broken and loose rivet. Check frame geometry, correct and straighten frame when necessary.

(1) check rivet for damage

There are two causes that lead to loose rivet: shearing force and deflection during operation; poor

manufacturing in factory and bad maintenance. Check each rivet in frame during frame overhaul. Measures to check loose and broken rivet include visual check, hearing check (by knocking) and check with instruments.

Rivet head dislocation or any corrosion trace indicates a rivet is loose. One can also check this by applying paint on rivet for a vehicle in operation, i.e. clean area around rivet and apply paint, drive vehicle after paint has dried. Check again after driving. Crack paint in the area indicates a loose rivet. Knock rivet directly with a hammer can also find a loose rivet by hearing the sound.

(2) Check frame with crack and broken frame

Check seeable crack on frame should be performed after frame has been cleaned thoroughly and de-rusted by blasting, chemical and electrochemical methods. Lateral gashes extending to whole section on side and cross members are called cracks. Cracks are easily identified. But partial gashes on frame are not easy to be noticed. Frame gash usually happens on side members, usual locations are: middle side member behind driver cab where is under max force; connection spot of side and cross member; between holes in upper/lower flange faces and member flanges; reinforce plate end of upper and lower flange faces. Crack and gash are mainly caused by metal early fatigue due to overload and impact on vehicle that has been driven under overload or on rugged road for much longer time.

2. Repair

(1) Re-riveting frame rivet

A loose rivet would cause loosening and damage to other rivets if it has not been replaced timely. When one is repairing a frame, he must remove old rivet and use new rivet. Never use a loose rivet for re-riveting.

(2) Select rivet hole and rivet

① Rivet hole

Loose rivet will wear out rivet hole. During frame service, wear on old rivet hole should be not more than 0.5mm of nominal size. Otherwise expand hole.

② Rivet hole and rivet diameter

Rivet hole diameter should be larger than that of rivet stem. Their relation should comply with concerning specifications. See figure 7-9-1.

Figure 7-9-1 Rivet hole and rivet diameter

No.	Rivet diameter (mm)	Rivet hole (mm)
1	φ 8	φ 8.2 (fine riveting)
2	φ 10	φ 11 (rough riveting)
3	φ 12	φ 13 (rough riveting)
4	φ 14	φ 15 (rough riveting)

③ Rivet

Vehicle frame uses half-circle head rivet. The size should comply with standard specification.

(3) Repair frame gash and crack

Fill welding can repair frame gashes that have not extended to all flange surfaces. In the event of longer crack or crack happening on regular position of one model frame, a reinforced plate may be needed after fill welding. Fill welding is usually applied on positions where are under lesser force, or in the case that crack length on side member is less than 2/3 width of flange surface. If crack happens on main force-applied position or it is longer, one has to weld on a reinforced plate after fill welding.



7.10 Vehicle wheel

7.10.1 Wheel main technical parameters

Wheel main technical parameters				
No.	Description		Data	
1	Model vehicle		BJ1049V9JD6-C	BJ1049V9JE6-A BJ1043V8JE6-D
2	Wheel type		Detachable disk type with retaining ring	
3	Rim type		5.5k full groove integrated rim	5.50F-15 half groove rim 5.5F-16 half groove rim
4	Wheel disk	Type	Web type	
		Bolt hole center diameter（mm）	5 hole distribution circle ϕ 203.2; bolt hole diameter. ϕ 21; center hole ϕ 146mm; tightening torque 250~300N.m	6 hole ϕ 19; bolt hole diameter. ϕ 21; center hole ϕ 140mm; tightening torque250~300N.m
5	Tyre	Type	Bias or radial-ply tyre	
		Size	6.50R16[12]	6.50-16[12] 6.50-16[12]
		FR tyre pressure (KPa)	625	530 530
		RR tyre pressure (KPa)	625	530 530

7.10.2 Briefs on construction

Vehicle’s driving performance is closely related to wheels and tyres. Wheels and tyres are used to support vehicle body, alleviate impact force from road, and receive and transmit braking and driving forces. Meanwhile, tyre helps to resist side skipping, and wheel by itself can return to straight line automatically, ensuring vehicle to make a turn and drive in straight line.

Light truck uses the rim and wheel as indicated in figure 7-10-1.



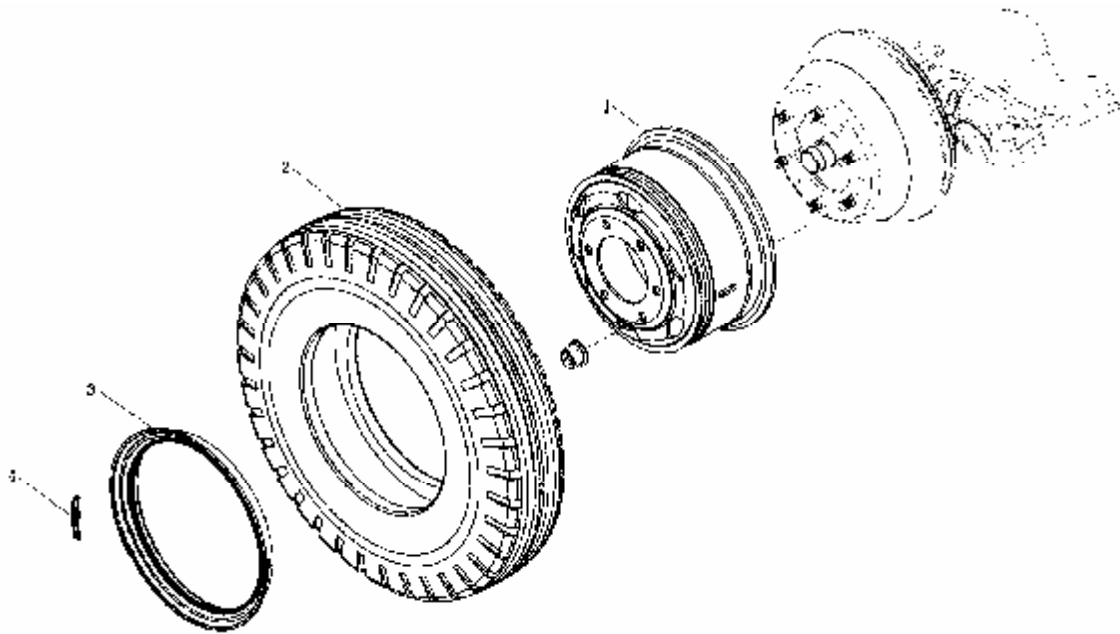


Figure 7-10-1 FR wheel dismembering diagram

1-rim with web assembly; 2-tyre; 3-spring retaining ring; 4-counter weight

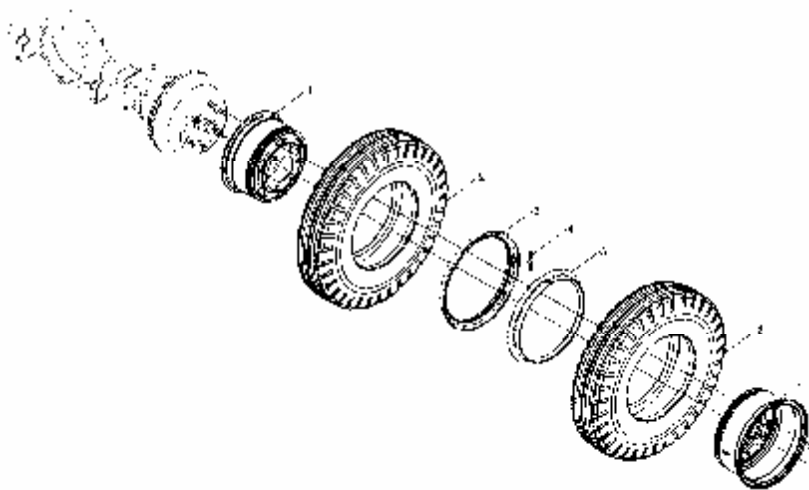


Figure 7-10-2 RR wheel dismembering diagram

1-rim with web assembly; 2-tyre; 3-spring retaining ring; 4-counter weight

Wheel is composed by tyre, inner tube, wheel disk, rim, retaining ring, air valve and counter weight. Tyre cord layer is composed by nylon thread. Inner tube is a rubber loop and a valve is mounted on it to inflate or discharge air. Wheel rim assembly consists of rim and web. Web is welded on rim and fixed on wheel hub with studs and nuts.

BJ1049 model vehicle adopts bias ply and radial-ply tyres. Radial-ply tyre as indicated in figure 7-10-3 (a) arranges cord thread with a nearly 90° angle to tread center line. Radial ply tyre fully utilizes cord's strength, and its cord layer number is less than ordinary bias ply tyre. The tyre is light in weight and its tyre case is soft. Radial ply tyre uses multi belt layer with small tread center line angle ($10^\circ \sim 20^\circ$), is made of cord or wire cord of high strength and low extension. The tyre can take relatively larger tangential force during rolling. Belt layer is closely

inset into tyre case this greatly improves tread stiffness, traction and wear-resistance.

Radial ply tyre has lower rolling resistance than ordinary bias ply tyre does. It helps to save fuel and has characteristics such as wear-resistance, longer life span, good performance and safety.

Mix to use bias and radial ply tyres in same vehicle will interrupt vehicle's drivability. Do not do this!

7.10.2 Technical requirements

Welding of rim assembly should be reliable without defects like dirt, air hole and crack. Run-out should be less than 1.3mm. Tyres used in a vehicle should be the same in their tyre and tread. . Dynamic unbalance is one of the causes that makes vehicle swing. Vehicle manufacturer has already performed wheel dynamic balancing and set counter weight. Dynamic unbalance value of wheel assembly should be less than 1000g/cm.

7.10.3 service and maintenance

Check tyre pressure for leakage before driving. Lower pressure will lead to tyre heating, higher fuel consumption and early wear, while higher pressure will lead to vehicle shaking or even tyre explosion, that negatively affects operating stability. Tyre surface cannot contact mineral oil. After daily driving, driver should check and remove any pierced nail, embedded stone in tread and between tyres.

Apply talcum powder between tyre and inner tube to protect inner tube during tyre changing. At 2nd grade maintenance, tyres should be rotated (include spare tyre) for even wear.

7.10.4 Spare tyre lifting devices

FOTON light truck adopts a gear spare tyre lifter. Turning cranking handle to lift spare tyre till it attaches cross member. The gear mechanism can be self-locked; spare tyre thus will not drop automatically. Check spare tyre fastening before everyday driving, and also check and replace any broken bracket and chain. Apply grease regularly on driving locations of lifter to avoid rust and make lifting easy. Twisting chain or insufficient lubrication may make a lifter stuck. Turning cranking bar forcibly at the moment will damage lifter.

