福田风景系列轻型客车
使用与维修手册

OPERATION AND MAINTENANCE MANUAL

FOR FOTON VIEW SERIES LIGHT BUS

北汽福田汽车股份有限公司

BEIQI FOTON MOTOR CO.,LTD.

内 容 简 介

BRIEF INTRODUCTION

福田风景系列轻型客车是北汽福田汽车股份有限公司生产的主导产品，本《福田风景系列轻型客车使用与维修手册》较详细地介绍了风景系列轻型客车的技术维护，BJ491EQ1、BJ483ZQB、BJ486ZQ、YC4F90-21、2RZ-E、4G64S4 等发动机构造、使用、维修、故障排除，汽车底盘、电器与仪表构造、保养及故障排除、部分车辆主要技术参数等内容。

本书可供风景系列轻型客车使用、维护、修理人员参考。

FOTON VIEW series light bus is the leading product of Beiqi Foton Motor Corporation. This Operation and Maintenance Manual for FOTON VIEW Series Light Bus introduces in details the technical maintenance of VIEW series light bus; structure, operation, maintenance and troubleshooting of BJ491EQ1, BJ483ZQB, BJ486ZQ，YC4F90-21，2RZ-E，4G64S4 engines; main technical parameters for structure, maintenance and troubleshooting of automobile chassis, electricals and instruments etc.

This manual offers a reference for user and service personnel of VIEW series light bus.

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北汽福田汽车股份有限公司编

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前　言
PREFACE

福田风景系列轻型客车是北汽福田汽车股份有限公司在引进日本技术的基础上，根据用户需求进一步研制开发的系列轻型客车。该系列轻型客车采用 BJ491EQ1、BJ483ZQB、BJ486ZQ、YC4F90-21、2RZ-E、4G64S4 等汽、柴油发动机；采用了平、半高顶、高顶车身；淡化仿桃木豪华内饰、动力转向、电动窗、遥控锁、电动后视镜、后照地灯、后组合尾灯、钻石前大灯、内外温度显示器、高位刹车灯、后暖风、CD/调频一体机、VCD 机、中控锁、高靠背可调座椅、分体空调等；尾气排放达排放法规的要求，特别适用于各地区城乡使用。

VIEW series light bus has been developed to meet the demands of our customers based on the technology introduced from Japan. The light buses adopts BJ491EQ1,BJ483ZQB、BJ486ZQ, YC4F90-21，2RZ-E，4G64S4 gasoline and diesel engines; the buses among the series adopts flat/half high/ high roof bodies, they equip with peach wood imitated luxury interior trim, power steering, power window, remote lock, power rear view mirrors, rear floor lamps, rear combination tail lamps, diamond headlamps, interior and exterior temperature display, high mount brake lamp, rear warm wind, combination of CD/FM, VCD player, central lock, high back adjustable seat and individual A/C etc. The vehicles complies with emission regulations, they are ideal vehicles for city and rural areas.

风景系列轻型客车具有良好的安全性、动力性、经济性、舒适性、操作稳定性和环保性，自投放市场以来深受广大用户的欢迎。

VIEW series light bus features safety, strong power, economy and comfortability. They also have good performances such as stable operation and environment friendship. They have been very popular since the day they were put into market.

汽车性能的保持、发挥以及使用寿命的长短、可靠性等，一方面取决于汽车设计和制造过程中的质量，另一方面取决于用户的正确使用和精心维护、汽车维修厂正确的修理。为了使广大用户和维修单位对风景系列轻型客车使用与维修有一个较全面的了解，掌握该车的使用、维护与修理方法，延长车辆的使用寿命，我们特编写这本《福田风景系列轻型客车使用与维修手册》。本手册系统地介绍了风景系列轻型客车整车技术性能；几种发动机构造、使用、维护、修理和故障排除；底盘、电气设备的维护和检修；汽车维护保养制度等。

Maintaining and implementation of vehicle performance and service life / reliability depend on its orignal quality during design and manufacturing, as well as correct operation and careful

maintenance or repair by the user and service garage. This Operation and Maintenance Manual for VIEW Series Light Bus tends to make the operation and maintenance of VIEW series light bus known to the users and service stations, so that they could master vehicles' operation, maintenance and repair methods to prolong service life of the vehicle. This manual introduces systmatically VIEW series light bus's technical performance. It includes the structure, operation, maintenance, repair and troubleshooting of several engine models; also in this manual are maintenance and repair of chassis and electrical equipment as well as maintenance system of the vehicle.

本书可供风景系列轻型客车使用、维护、修理人员参考。

This manual offers a reference for user and service personnel of VIEW series light bus.

由于编写时间仓促，资料缺乏，书中难免有不足之处，恳请广大读者批评指正。

Any comment to this manual is highly appreciated.

编　者

Author

2006 年 8 月

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Chapter 1 Main data and specification of VIEW series light-bus

1.1 Main data and specification of VIEW series light-bus

1.1.1 Main data and specification of VIEW BJ6486、BJ6516

Table 1-1 General data

Model	BJ6486 FB	BJ6486 HFB	BJ6486 J1F1B	BJ6486 H2F1	BJ6486 J1F2B	BJ6486 H2F2	BJ6486 HJ1F2B	BJ6486 B1DWA	BJ6486 J1FB	BJ6486 H1F
Drive type	4×2 rear axle drive									
Seats (include driver)	9~12	←	←	←	←	←	←	6~15	←	9~12
Overall length (mm)	4900	←	4970	←	←	←	←	←	←	4900
Overall width (mm)	1690	←	←	←	←	←	←	←	←	←
Overall hight (mm)	1935	2205	1935	1995	1935	1995	2225	1935/1995	1935	1995
Wheel track (front /rear)(mm)	1450/1430	←	1460/1440	←	←	←	←	←	1450/1430	←
Min ground clearance (mm)	165	←	←	←	←	←	←	←	←	←
Wheel base (mm)	2590	←	←	←	←	←	←	←	←	←
Front extension (mm)	1200	←	1270	←	←	←	←	←	←	1200
Rear extension (mm)	1110	←	1110	←	←	←	←	←	←	←
Min turning diameter (m)	≤11.5	←	←	←	←	←	←	←	←	←
Approach angle (°)	21	←	20	←	←	←	←	←	←	21
Departure angle(°)	20	←	20	←	←	←	←	←	←	←

Table 1-2 General data

Model	BJ648 HJ1FB	BJ648 H2F	BJ648 H2FB	BJ648J 1FC	BJ648 HJ1FC	BJ648 B1DW A-8	BJ648 B1DW A-6	BJ648 B1DX A	BJ648 B1DX A-1	BJ648 B1DX A-2	BJ648 H1FB
Drive type	4×2 rear axle drive										
Seats (include driver)	6~15	9~12	←	←	←	6~15	6~12	6~15	←	←	9~12
Overall length (mm)	4970	←	←	←	←	4900	4970	←	←	←	4900
Overall width (mm)	1690	←	←	←	←	←	←	←	←	←	←
Overall hight (mm)	2205	1995		1935	2225	1935	2050			2225	1995
Wheel track (front/rear) (mm)	1450/1430	←	←	←	←	1460/1440	←	←	←	←	←
Min Ground clearance(mm)	165	←	←	←	←	←	←	←	←	←	←
Wheel base (mm)	2590	←	←	←	←	←	←	←	←	←	1200
Front extension (mm)	1270	←	←	←	←	←	←	←	←	←	←
Rear extension (mm)	1110	←	←	←	←	←	←	←	←	←	←
Min Turning diameter(m)	≤11.5	←	←	←	←	←	←	←	←	←	←
Approach angle (°)	20	←	←	←	←	←	←	←	←	←	21
Departure angle (°)	20	←	←	←	←	←	←	←	←	←	20

Note：“←” same as indicated value

Table1-3 General data

Model	BJ648 B1DW A-1	BJ648 B1DW A-2	BJ648 B1DW A-3	BJ648 B1DW A-4	BJ648 B1DW A-5	BJ648 B1DW A-7	BJ648 B1DW A-9	BJ648 B1DW C	BJ648 B1DW A	BJ648 B1DW A-1
Drive type	4×2rear axle drive									
Seats (included driver)	6~15	6~12	←	←	←	6~15	6~9	6~15	10~15	←
Overall length (mm)	4970	←	←	←	←	←	←	←	5085	←

Model	BJ648 B1DW A-1	BJ648 B1DW A-2	BJ648 B1DW A-3	BJ648 B1DW A-4	BJ648 B1DW A-5	BJ648 B1DW A-7	BJ648 B1DW A-9	BJ648 B1DW C	BJ648 B1DW A	BJ648 B1DW A-1
Overall width (mm)	1690	←	←	←	←	←	←	←	←	←
Overall hight (mm)	2225	1935	1995	2225	1995	2050	1935		1935	2050
Wheel track front/rear) (mm)	1460/1440	←	←	←	←	←	←	←	←	←
Min grond clearance(mm)	165	←	←	←	←	←	←	←	←	←
Wheel base (mm)	2590	←	←	←	←	←	←	←	←	←
Front extension(mm)	1270	←	←	←	←	←	←	←	1320	←
Rear extension(mm)	1110	←	←	←	←	←	←	←	1175	1110
Min Turning diameter(m)	≤11.5	←	←	←	←	←	←	←	←	←
Approach angle (°)	20	←	←	←	←	←	←	←	←	16
Departure angle(°)	20	←	←	←	←	←	←	←	←	←

Table 1-4 General data

Model	BJ6516 B1DW A-2	BJ6516 B1DW A-3	BJ6516 B1DW A-4	BJ6516 B1DXA	BJ6516 B1DXA -1	BJ6516 B1DXA -2	BJ6516 B1DXA -3	BJ6516 B1DXA -4	BJ6516 B1DXA -5	BJ6516 B1DXA -6
Drive type	4×2rer axle dtive									
Seats (included driver)	←	6~9	10~15	←	←	←	←	6~9	10~15	6~9
Overall length (mm)	←	5085	5085	←	←	←	←	←	←	←
Overall width (mm)	←	←	←	←	←	←	←	←	←	←
Overall hight (mm)	1935	←	←	1935	←	2050	←	1995	←	←
Wheel track (front/rear) (mm)	←	←	←	←	←	←	←	←	←	←
Min Ground clearance(mm)	←	←	←	←	←	←	←	←	←	←

Model	BJ6516 B1DW A-2	BJ6516 B1DW A-3	BJ6516 B1DW A-4	BJ6516 B1DXA	BJ6516 B1DXA -1	BJ6516 B1DXA -2	BJ6516 B1DXA -3	BJ6516 B1DXA -4	BJ6516 B1DXA -5	BJ6516 B1DXA -6
Wheel base (mm)	←	←	←	←	←	←	←	←	←	←
Front extension(mm)	←	←	←	←	←	←	←	←	←	←
Rear extension(mm)	←	1175	1175	1110	←	←	←	←	←	←
Min turning dismeter(m)	←	←	←	←	←	←	←	←	←	←
Approach angle °)	←	←	←	20	←	16	←	←	←	←
Departure angle(°)	←	←	←	←	←	←	←	←	←	←

Table 1-5 Mass data

Model	BJ6486 FB	BJ6486 HFB	BJ6486 J1F1B	BJ6486 H1F1	BJ6486 J1F2B	BJ6486 H2F2	BJ6486 HJ1F2B	BJ6486 B1DWA	BJ6486 J1FB	BJ6486 H1F
Curb weight (kg)	1640	1700	1665	1710	1660	1715	1720	1660/1690	1670	1660
Front axle (kg)	890	940	903	950	960	950	950	960/975	965	960
Rear axle (kg)	750	760	762	760	700	765	770	700/715	705	700
Max total mass (kg)	2516	2576	2541	2586	2536	2591	2596	2635/2665	2450	2440
Front axle (kg)	1270	1300	1283	1310	1280	1310	1310	1105/1115	1025	1020
Rear axle (kg)	1246	1276	1258	1276	1256	1281	1286	1530/1550	1425	1420

Table 1-6 Operation data

Max speed	⩾120	←	⩾130	←	⩾125	←	←	⩾120	←	←
Min stable speed in D gear	⩽20	←	←	←	←	←	←	←	←	←
Max climbing slope (%)	⩾30	←	←	←	←	←	←	←	←	←
Brake distance (full load at 50km/h) (m)	⩽22	←	←	←	←	←	←	←	←	←
Fuel consumption (L/100km) (average speed 50km/h)	⩽9.5	←	←	←	←	←	←	←	←	←

Table 1-7 Mass data

Model	BJ6486 HJ1FB	BJ6486 H2F	BJ6486 H2FB	BJ6486 1FC	BJ6486 HJ1FC	BJ6486 B1DW A-8	BJ6486 B1DW A-6	BJ6486 B1DX A	BJ6486 B1DX A-1	BJ6486 B1DX A-12	BJ6486 H1FB
Curb weight (kg)	1670	1680	1700	1680	1700	1660	1670	1660	1665	1740	1660
Front axle(kg)	965	980	990	980	990	960	965	960	938	1000	960
Rear axle (kg)	705	700	710	700	710	700	705	700	727	740	700
Max total mass (kg)	2405	2556	2576	2556	2576	2635	2450	3635	2640	2715	2440
Front axle (kg)	1025	1086	1096	1086	1096	1150	1070	1335	1300	1315	1020
Rear xale (kg)	1425	1470	1480	1470	1480	1530	1380	1300	1340	1400	1420

Table 1-8 Operation data

Max speed	≥120	←	←	←	←	←	←	≥125	≥130	←	≥120
Min stable speed in D gear	≤20	←	←	←	←	←	←	←	←	←	←
Max climbing slope (%)	≥30	←	←	←	←	←	←	←	←	≥38	≥30
Brake distance (m) (full load at speed 50km/h)	≤22	←	←	←	←	←	←	←	←	≤19	≤22
Fuel cansumption (L/100km) (average speed 50km/h)	≤9.5	←	←	←	←	←	←	←	←	←	←

Note ："←" same as indicated value

Table 1-9 Mass data

Model	BJ6486 B1DW A-1	BJ6486 B1DW A-2	BJ6486 B1DW A-3	BJ6486 B1DW A-4	BJ6486 B1DW A-5	BJ6486 B1DW A-7	BJ6486 B1DW A-9	BJ6486 B1DW C	BJ6516 B1DW A	BJ6516 B1DW A-1
Curb weight (kg)	1740	1660	1670	1740	1670	1670	1660	1740	1690	1690
Front axle (kg)	1110	960	965	985	965	965	960	985	975	970
Rear axle (kg)	730	700	705	755	705	705	700	755	715	720
Max tatal mass (kg)	2715	2050~2440	2060~2450	2130~2520	2050~2645	2615	2227	2715	2665	←
Front axle (kg)	1145	860~1105	865~1110	895~1140	865~1110	1110		1140	1120	1135
Rear axle (kg)	1570	1190~1530	1195~1535	1235~1575	1195~1535	1505		1575	1545	1530

Table 1-10 Operation data

Max Speed	≥120	←	←	←	←	←	←	←	←	←
Min stable speed in D gear	≤20	←	←	←	←	←	←	←	←	←
Max climbing slope（%）	≥30	←	←	←	←	←	≥38	←	←	←
Brake distance（full load at 50km/h）（m）	≤22	←	←	←	←	←	←	←	←	←
Fuel consuption（L/100km）(average speed 50km/ h)	≤9.5	←	←	←	←	←	←	←	←	←

Table 1-11 Mass data

Modle	BJ6516 B1DW A-2	BJ6516 B1DW A-3	BJ6516 B1DW A-4	BJ6516 B1DXA	BJ6516 B1DXA -1	BJ6516 B1DXA -2	BJ6516 B1DXA -3	BJ6516 B1DXA -4	BJ6516 B1DXA -5	BJ6516 B1DXA -6
Curb weight (kg)	1700	1730	1730	1690	1695	1700	1705	1735	1735	1730
Front axle (kg)	980	900	900	980	978	980	980	905	905	905
Rear axle kg)	720	830	830	720	717	720	725	830	830	830
Max total mass (kg)	2675	2297	2675	2665	2670	2645	2650	2302	2680	2297
Front axle (kg)	1140	1200	1405	1120	1123	1115	1110	1102	1280	1097
Rear axle (kg)	1530	1097	1270	1545	1547	1530	1540	1200	1400	1200

Table 1-12 Operation data

Max speed	←	←	←	≥125	≥130	≥125	≥130	←	←	←
Min stable speed in D gear （km/h）	←	←	←	←	←	←	≤22	←	←	←
Max climbing slope（%）	←	←	←	←	←	≥38	←	←	←	←
Brake distance（full load at 50km/h (m)	←	←	←	←	←	←	≤19	←	←	←
Fuel consumption（L/100km）（ average speed 50km/h）	←	←	←	←	←	←	←	←	←	←

Table 1-13 Volume data

Model	BJ6486 B1DXA-1	BJ6486 B1DXA-2	BJ6486 J1F1B	BJ6486 H2F1	BJ6516 BDXA-1	BJ6516 BDXA-3	BJ6486 J1F2B	BJ6486 HJ1F2B	BJ6486 H2F2	BJ6486 B1DXA	BJ6516 B1DXA	BJ6516 B1DXA-2	BJ6516 B1DXA-4	BJ6516 B1DXA-5	BJ6516 B1DXA-6
Fuel tank（L）	65														
Used fuel （#）	Better than 93# non-lead gasoline														
Engine lubricating system（L）	4.3						5.2								
Oil	SF class 10W/30 or 15W/40														
Engine cooling system （L）	10.1														
Anti -freezer	Ethy lene anti –frezer （or anti –corrosive anti freezer ， do not use alcoholic anti freezer ）														
Transmission（L）	2.0														
Transmission oil type	Gear oil GL-5 80W/90 in north （cold ）China ， 85W/90 for other regions														
Rear axle（L）	1.6														

Table 1-14 Volume data

Model	BJ6486 FB	BJ6486 HFB	BJ6486 H1F	BJ6486 H2F	BJ6486 H2FB	BJ6486 HFB	BJ6486 HJ1FB	BJ6486 J1FB	BJ6486 J1FC	BJ6486 HJ1FC
Fuel tank （L）	65									
Used fuel （#）	Better than 93#non-lead gasoline									
Engine lubricating system（L）	4.2									
Oil	SE class 10W/30 or 15W/40									
Engine cooling system（L）	10.1									
Anti -freezer	Ethylene anti-freezer（or anti- corrosive anti-freezer，do not use alcoholic anti-freezer ）									
Transmission （L）	2.0									
Transmission oil type	Gear oil GL-5 80W/90 in north （cold ）China，85W/90 for other area									
Rear axle （L）	2.2									

Table 1-15 Volume data

Model	BJ6486B1DWA	BJ6486B1DWA-1	BJ6486B1DWA-2	BJ6486B1DWA-3	BJ6486B1DWA-4	BJ6486B1DWA-5	BJ6486B1DWA-6	BJ6486B1DWA-7	BJ6486B1DWA-8	BJ6486B1DWA-9	BJ6516B1DWA	BJ6516B1DWA-1	BJ6516B1DWA-2	BJ6516B1DWA-3	BJ6516B1DWA-4	BJ6486B1DWC
Fuel tank （L）	65															
Fuel （#）	Better than 93# non lead gasoline															
Engine lubrication system （L）	4.2															
Oil	SE class 10W/30or 15W/40															
Engine cooling system （L）	10.1															
Coolant	Ethylene anti-freezer（or anti corrosive anti frezer，do notuse alcoholic anti freezer area）															
Transmission （L）	2.0															6.5
Transmission oil type	Gear oil GL-5 80W/90 in north （cold） china，85W/90for other area															
Rear axle（L）	2.2															

Table 1-16 Volume data

Model	BJ6486B1DXA-1	BJ6486B1DXA-2	BJ6486J1F1B	BJ6486H2F1	BJ6516BDXA-1	BJ6516BDXA-3	BJ6486J1F2B	BJ6486HJ1F2B	BJ6486H2F2	BJ6486B1DXA	BJ6486B1DXA	BJ6516B1DXA-2	BJ6516B1DXA-4	BJ6516B1DXA-5	BJ6516B1DXA-6
Rear axle oil	Gera GL-5 80W/90in north （cold ）china ,85W/90for other area														
Brake system (L)	1														
Brake fluid	V -3 –QC/T670 – 2000														
Battery	At 20℃: concentration 1.28 （full charged）; 1.16（charged 50%）; 1.06（discharged, max current 15A during quick charging; 5A during slow charging														
Refrigerant (g)	1400						1150								
Refrigerant type	R134a														

Table 1-17 Volume data

Model	BJ6486 FB	BJ6486 FB	BJ6486 H1F	BJ6486 H2F	BJ6486 H2FB	BJ6486 FB	BJ6486 HJ1FB	BJ6486 J1FB	BJ6486 J1FC	BJ6486 HJ1FC
Gear oil	Gear oil GL-5 80W/90in north （cold china,85W/90 for other aera									
Brake system (L)	1									
Brake fluid	JG3# composed brake fluid									
Battery	At 20℃: concentration 1.28 （full charged）; 1.16（charged 50%）; 1.06（discharged, max current 15A during quick charging; 5A during slow charging									
Refrigerant (g)	1500									
Refrigerant type	R134a									

Table 1-18 Volume data

Model	BJ6486 B1D WA	BJ6486 B1D WA-1	BJ6486 B1D WA-2	BJ6486 B1D WA-3	BJ6486 B1D WA-4	BJ6486 B1D WA-5	BJ6486 B1D WA-6	BJ6486 B1D WA-7	BJ6486 B1D WA-8	BJ6486 B1D WA-9	BJ6516 B1D WA-2	BJ6516 B1D WA-3	BJ6516 B1D WA-4	BJ6486 B1D WC
Rear axle oil	Rear oil GL-5 80W/90,innorth (cold)china 85W/90 other area													
Brake system（L）	1													
Brake fluid	V-3-QC/T670-2000													
Battery	At 20℃: concentration 1.28 （full charged）; 1.16（charged 50%）; 1.06（discharged, max current 15A during quick charging,5A during slow charging													
Refrigerant (g)	1500													
Refrigerant type	R134a													

Table 1-19 Adjustment data

Model	BJ6486 B1DXA-1	BJ6486 B1DXA-2	BJ6486 J1F1B	BJ6486 H2F1	BJ6516 BDXA-1	BJ6516 BDXA-3	BJ6516 BDXA-5	BJ6516 BDXA-4	BJ6486 J1F2B	BJ6486 HJ1F2B	BJ6486 H2F2	BJ6486 B1DXA	BJ6516 B1DXA	BJ6516 B1DXA
Spark plug clearance (mm)	0.7~0.8								1.1					
Belt deflection (mm)	5~7								←					

Model	BJ6486 B1DXA-1	BJ6486 B1DXA-2	BJ6486 J1F1B	BJ6486 H2F1	BJ6516 BDXA-1	BJ6516 BDXA-3	BJ6516 BDXA-5	BJ6516 BDXA-4	BJ6486 J1F2B	BJ6486 HJ1F2B	BJ6486 H2F2	BJ6486 B1DXA	BJ6516 B1DXA	BJ6516 B1DXA
Free travel -- clutch pedal (mm)	5~15								←					
Free travel-- brake pedal (mm)	1~3								←					
Free angle of steering wheel (°)	≤20(from center to left)								←					
Toe-in (mm)	3±1								←					
Camber (°)	-0° 20’ ±30’								←					
Kingpin inclination	10° 50’ ±30’								←					
Caster (°)	1° 15’ ±30’								←					
Engine														
Model	4G64S4M								2RZ-E					
Type	In-line, water cooling ,four cylinders,four strokes, electronic control multi-point injection gasoline engine													
Bore × stroke(mm × mm)	86.5×100								95×86					
Displacement	2.350								2.438					

Table 1-20 Adjustment data

Model	BJ6486 FB	BJ6486 HFB	BJ6486 H1F	BJ6486 H2F	BJ6486 H2FB	BJ6486 HFB	BJ6486 HJ1FB	BJ6486 J1FB	BJ6486 J1FC	BJ6486 HJ1FC
Spark plug clearance（mm)	0.8~1.0									
Belt deflection(mm)	5~7									
Free travel of clutch pedal (mm)	5~15									
Free travel of brake pedal (mm)	1~3									
Steering wheel free angle (°)	≤20(From center to left)									
Toe-in (mm)	3±1									
Camber(°)	-0° 20’ ±30′									
Kingpin inclination	10° 50’ ±30′									
Caster(°)	1° 15’ ±30′									
Engine										

Model	BJ6486 FB	BJ6486 HFB	BJ6486 H1F	BJ6486 H2F	BJ6486 H2FB	BJ6486 HFB	BJ6486 HJ1FB	BJ6486 J1FB	BJ6486 J1FC	BJ6486 HJ1FC
Model	491EQ									
Type	Vertical ,in-line water cooling .four cylinder ,four strokes, electronic control one-point injection gasoline engine									
Bore × stroke(mm × mm)	91×86									
Displacement（L）	2.237									

Note :“←” same as indicated value

Table1-21 Adjustment data

Model	BJ6486 B1DWA	BJ6486 B1DWA-1	BJ6486 B1DWA-2	BJ6486 B1DWA-3	BJ6486 B1DWA-4	BJ6486 B1DWA-5	BJ6486 B1DWA-6	BJ6486 B1DWA-7
Spark plug clearance (mm)	0.8~1.0							
Belt deflection (mm)	5~7							
Free travel of clutch pedal (mm)	5~15							
Free travel of brake pedal(mm)	1~3							
Steering wheel free angle (°)	≤20(from center to lift)							
Toe in (mm)	3±1							
Camber (°)	-0° 20’ ±30′							
Kingpin incliniation (°)	10° 50’ ±30′							
Caster (°)	1° 15’ ±30′							
Engine								
Model	491EQ1							
Type	In-line, water cooling, four cylinders, four strokes, electronic control multi –point Injection gasoline engine							
Bore×stroke (mm×mm)	91×86							
Displacement（L）	2.237							

Table1-22 Adjustment data

Model	BJ6486 B1DWA-8	BJ6486 B1DWA-9	BJ6516 B1DWA	BJ6516 B1DWA-1	BJ6516 B1DWA-2	BJ6516 B1DWA-3	BJ6516 B1DWA-4	BJ6486 B1DWC
Spark plug clearance (mm)	0.8~1.0							
Belt deflection (mm)	5~7							

Model	BJ6486 B1DWA-8	BJ6486 B1DWA-9	BJ6516 B1DWA	BJ6516 B1DWA-1	BJ6516 B1DWA-2	BJ6516 B1DWA-3	BJ6516 B1DWA-4	BJ6486 B1DWC
Free travel of clutch pedal (mm)	5~15							
Free travel of brake pedal (mm)	1~3							
Steering wheel free angle (°)	≤20(from center to left)							
Toe- in (mm)	3±1							
Camber (°)	-0° 20’ ±30′							
Kingpin inclination	10° 50’ ±30′							
Caster (°)	1° 15’ ±30′							
Engine								
Model	491EQ1							
Type	In-line, water cooling, four cylinders, four strokes, electronic control multi –point Injection gasoline engine							
Bore ×strok (mm×mm)	91×86							
Dispencement（L）	2.237							

Note :“←” same as indicated value

Table1-23 Adjustment data

Model		BJ6486 B1DXA-1	BJ6486 B1DXA-2	BJ6486 J1F1B	BJ6486 H2F1	BJ6516 BDXA-1	BJ6516 BDXA-3	BJ6516 BDXA-4	BJ6516 BDXA-5	BJ6486 J1F2B	BJ6486 HJ1F2B	BJ6486 H2F2	BJ6486 B1DXA	BJ6516B1 DXA	BJ6516B1 DXA-2	BJ6516B1 DXA-6
Compression ratio		9.5								9.0						
Rated power (kW)(r/min)		95/5250								88/5000						
Max torque (N.m)(r/min)		196/2750								198/2600						
Idle speed (r/min)		750±50								800/±50						
Lubricating oil pressure (kPa)	During Idle speed	≥20.4														
	During running	≥170														
Drive system																

Model		BJ6486 B1DXA-1	BJ6486 B1DXA-2	BJ6486 J1F1B	BJ6486 H2F1	BJ6516 BDXA-1	BJ6516 BDXA-3	BJ6516 BDXA-4	BJ6516 BDXA-5	BJ6486 J1F2B	BJ6486 HJ1F2B	BJ6486 H2F2	BJ6486 B1DXA	BJ6516B1 DXA	BJ6516B1 DXA-2	BJ6516B1 DXA-6
Clutch		Single disc, dry diaphram spring，hydraulic operation														
Transmission		Mechanic 5+1,gears with synchronizers														
Drive ratio	Ⅰgear	3.967								4.452						
	Ⅱgear	2.136								2.619						
	Ⅲgear	1.36								1.517						

Table 1-24 Adjustment data

Model		BJ6486 FB	BJ6486 HFB	BJ6486 H1F	BJ6486 H2F	BJ6486 H2FB	BJ6486 HFB	BJ6486 HJ1FB	BJ6486 J1FB	BJ6486 J1FC	BJ6486 HJ1FC
Compression ratio		8.8									
Rated power [kw（r/min）]		70/4600									
Max torque [N.m(r/min)]		178/3200									
Idle speed(r/min)		780±50									
Lubricating oil pressure (kPa)	During Idle speed	≥20.4									
	During running	≥170									
Drive system											
Clutch		Single disc，dry disphram spring，hydraulic operation									
Transmission		Mechanic 5+1 gears with synchronizer									
Drive ratio	Ⅰgear	4.452									
	Ⅱgear	2.619									
	Ⅲgear	1.517									

Note :“←” same as indicated value

Table 1-25 Adjustment data

Model	BJ6486B1 DWA	BJ6486B1 DWA-1	BJ6486B1 DWA-2	BJ6486B1 DWA-3	BJ6486B1 DWA-4	BJ6486B1 DWA-5	BJ6486B1 DWA-6	BJ6486B1 DWA-7
Compression ratio	8.8							
Rated power /rpm （kw(r/min)）	76/4300~4600							
Max roque	193/3200							

Model		BJ6486B1 DWA	BJ6486B1 DWA-1	BJ6486B1 DWA-2	BJ6486B1 DWA-3	BJ6486B1 DWA-4	BJ6486B1 DWA-5	BJ6486B1 DWA-6	BJ6486B1 DWA-7
[N.m(r/min)]									
Idle speed (r/min)		800±50≥							
Lubrication oil pressure（kPa）	During Idle speed	≥20.4							
	During running	≥170							
Drive system									
Torque converter ratio		/					2.3		
Clutch		Single disc，dry diaphram spring，hydraulic operation					/		
Transmission		Mechanic 5+1 gears with synchronizer					Torque converter＋Planet gears		
Drive ratio	Ⅰgear	4.452					Planet Gears ratio	Ⅰgear	2.450
	Ⅱgear	2.619						Ⅱgear	1.450
								ⅢIgear	1
								O/Dgear	0.688
	ⅢIgear	1.517						Rgear	2.222

Table 1-26 Adjustment data

Modle		BJ6486B1 DWA-8	BJ6486B1 DWA-9	BJ6516B1 DWA	BJ6516B1 DWA-1	BJ6516B1 DWA-2	BJ6516B1DWA-3	BJ6516B1DWA-4	BJ6486B1 DWC
Compression ratio		8.8							
Rated power / Rpm (kW(r/min)）		76/4300~4600							
Max torque (N.m(r/min))		193/3200							
Idle speed(r/min)		800±50							
Lubricating oil pressure（kPa）	During Idle speed	≥20.4							
	During running	≥170							
Drive system									
Torque converter ratio		/					2.3		
Clutch		Single disc，dry diaphram spring ，hydraulic operation					/		
Transmission		Mechanic 5+1 gears with synchronizers					Torque converter＋Planet gears		

Modle		BJ6486B1DWA-8	BJ6486B1DWA-9	BJ6516B1DWA	BJ6516B1DWA-1	BJ6516B1DWA-2	BJ6516B1DWA-3	BJ6516B1DWA-4	BJ6486B1DWC
Drive ratio	Ⅰgear	4.452					Planet gears ratio	Ⅰgear	2.450
	Ⅱgear	2.619						Ⅱgear	1.450
								Ⅲgear	1
								O/Dgear	0.688
	Ⅳgear	1.517						Rgear	2.222

Table 1-27 Adjustment data

Model		BJ6486B1DXA-1or -2	BJ6486J1F1B	BJ6486 2F1	BJ6516BDXA-1	BJ6516BDXA-3	BJ6516DXA-4	BJ6516DXA-5	BJ6486 1F2B	BJ6486J1F2B	BJ6486 2F2	BJ6486 1DXA	BJ6516B1DXA	BJ6516B1DXA-2	BJ6516B1DXA-6
Drive ratio	Ⅳ gear	1.000							1.000						
	Ⅴ gear	0.856							0.854						
	R gear	3.578							4.473						
Propeller shaft type		Tubular，exposed needle bearing, universal joint													
Rear axle		Integrated banjo type or tubular type													
Final drive		Single hyperbolic bevel gear													
Final drive ratio		4.1							4.27						
Differntial		Symmetric bevel gear type													
Half shaft		Semi-floating													
Running system															
Suspention	front	Torsion bar spring，double cross arm independent suspention													
	rear	Longitudinal leaf spring; non-independent suspension													
Tire		195/70R15C							195/70R15C or 205/70R15						
Tire pressure (kPa)	Front	325							325/250						
	rear	450							450/250						

Table 1-28 Adjustment data

Model		BJ6486HFBor FB	BJ6486H1F	BJ6486H2F	BJ6486H2FB	BJ6486HFB	BJ6486HJ1FB	BJ6486J1FB	BJ6486J1FC	BJ6486HJ1FC
Drive ratio	Ⅳ gear	1.000								
	Ⅴ gear	0.854								
	R gear	4.473								

Model		BJ6486HFBor FB	BJ6486H1F	BJ6486H2F	BJ6486H2FB	BJ6486HFB	BJ6486HJ1FB	BJ6486J1FB	BJ6486J1FC	BJ6486HJ1FC
Prepoller shaft type		Tubular， exposed needle bearing, universal joint								
Rear axle		Integrate bonjo type or tubular type								
Final drive		Single hyperholic bevel rear								
Final drive ratio		4.556								
Differential		Symmetric bevel gear type								
Half shaft		Semi-floating								
Running system										
Suspension	Front	Torsion bar spring， double cross arm independent suspension								
	Rear	Longitudinal leaf spring; non-independent suspension								
Tire		185R14								
Tire pressure (kPa)	Front	325								
	Rear	450								

Table 1-29 Adjustment data

Model		BJ6486B1DWA	BJ6486B1DWA-1	BJ6486B1DWA-3	BJ6486B1DWA-4	BJ6486B1DWA-5	BJ6486B1DWA-6	BJ6486B1DWA-7	BJ6486B1DWA-8	BJ6486B1DWA-9	BJ6516B1DWA	BJ6516B1DWA-1	BJ6516B1DWA-2	BJ6516B1DWA-3	BJ6516B1DWA-4	BJ6486B1DWC
Drive ratio	Ⅳgear	1.000														/
	Ⅴgear	0.854														/
	R gear	4.473														/
Propeller shaft type		Tubular，exposed，needle bearing universal joint														
Rear axle		Whole banjo type of tubular type														
Final drive		Single hyperbolic bevel gear														
Final drive ratio		4.556														
Differential		Symmetric bevel gear type														
Half shaft		Semi -floating														
Running system																
Suspension	Front	Torsion bar spring, double cross arm independent suspension														
	Rrear	Longtudinal leaf spring non-independent suspension														
Tire		185R14									195/70R15C				185R14	
Tire pressure(kPa)	Front	325														
	Rear	450														

Table 1-30 Steering gear and brake

Model		BJ6486B1DXA-1or-2	BJ6486J1F1B	BJ6486H2F1	BJ6516XA-1or -2	BJ6516XA-3	BJ6486J1F2B	BJ6486HJ1F2B	BJ6486H2F2	BJ6486B1DXA	BJ6516B1DXA	BJ6516B1DXA-4	BJ6516B1DXA-5	BJ6516B1DXA-6
Steering gear		Rack and pinion												
Drive ratio		36.42												
Max Wheel turning angle	Left	37° ±0.3°												
	Right	34° ±0.3°												
Steering Wheel position		Left												
Service brake		Hydraulic，vacuum boosting，dual circuits brake，front disk/rear drum brake												
Vehicle body and electric device	Vehicle body	Unibody												
	Wire hauness	Negative ground												
	Rated voltage（V）	12												
	Battery model	N50Z												
	Alternator model	90A					Japanese							
	Starter model	Japanese					QDY1218（Japanese）							
	Compressor	10PC15					10PA17C							

Table 1-31 Steering gear and brake

Model		BJ6486HFB0rFB	BJ6486H1F	BJ6486H2F	BJ6486 2FB	BJ6486HFB	BJ6486HJ1FB	BJ6486J1FB	BJ6486J1FC	BJ6486HJ1FC
Steering gear		Rack and pinion								
Drive ratio		36.42								
Max wheel truning angle	Left	37° ±0.3°								
	Right	34° ± 0.3°								
Steering wheel position		Left								
Running brake		Hydraulic, vacuum boosting，dual circuits brake, front disc/rear drum brake								
Vehicle body and electric device	Vehecle body	Unibody								
	Wire harness	Negative ground								
	Ratded voltage (V)	12								

Model		BJ6486 HFB0rFB	BJ6486 H1F	BJ6486 H2F	BJ6486 2FB	BJ6486 HFB	BJ6486 HJ1FB	BJ6486 J1FB	BJ6486 J1FC	BJ6486 HJ1FC
	Battery model	N50Z								
	Alternator model	65A								
	Starter model	QD121								
	Compressor	V50								

Table 1-32 Steering gear and brake

Model		BJ6486B 1DWA	BJ6486B 1DWA-1	BJ6486B 1DWA-1 or-2or-3	BJ6486B 1DWA-4 or –5or-6	BJ6486B1 DWA-7or-8 or-9	BJ6516 B1DWA	BJ651 6B1DWA -10r-2	BJ6516 B1DWA- 30r-4	BJ6486 B1DWC
Steering gear		Rear and rack								
Transmission ratio		36.42								
Max Wheel turning angle	Lifut	37° ±0.3°								
	Right	34° ± 0.3°								
Steering wheel position		Left								
Running brake		Hydraulic，vacuum booating ， daul circuits brake ， front disc ， rear drum brake								
Vehicle body and electric device	Vehicle body	All load –brearing metal body								
	Harness	Negative prond								
	Rated voltage (V)	12								
	Battry model	N50Z								
	Alternator model	65A								
	Stater model	QD121								
	compressor	V50								

1.1.2 Main data and specification of VIEW BJ6536

Table1-33

Vehicle model		BJ6536B1DBA-2	BJ6536B1DBA-4	BJ6536B1DDA-4	BJ6536B1DWA-2	BJ6536B1DWA-1
Drive Type		4×2 rear axle drive				
Persons in cab		6～9	7-9	7-9	6-9	10-12
Overall dimensions（mm）	L	5320	5320、5385	5320、5385	5320	5320
	W	1690	1690	1690	1690	1690
	H	2050	2050、2225	2050、2225	2050	2050
Wheel base （mm）		2590	2890	2890	2890	2890
Wheel track（mm）	Front	1460	1460	1460	1460	1460
	Rear	1440	1440	1440	1440	1440
Max Speed（km/h）		≥95	≥100	≥110	≥110	≥120
Max Climbing slope（%）		≥22	≥22	≥30	≥30	≥38
Min ground clearance（mm）		≥160	≥160	≥160	≥165	≥160
Curb weight（kg）		1785	1785、1825	1840、1865		1695
Total weight（kg）		2484	2484	2425、2450		2628
Engine		BJ483ZQB	BJ486ZQ	YC4F90-21	BJ491EQ1	BJ491EQ1
Type		Four cylinders，in-line， water cooling，direct injection， turbocharger diesel engine		Four cylinders，in-line water cooling，Turbo charger diesel engine	In-line，water cooling，four cylinders，four strokes，electronic control multi-point injection gasoline engine	
Bore×Stroke（mm）		83×100	86×100	92×100	91×86	91×86
Compression ratio		17．5	18.1	17．5	8.8	8.8
Reted power/Rpm（kw/rpm）		46/3300	52/3300	65/3400	76/4300-4600	76/4300-4600
Max torque/Rpm（N.m/rpm）		150/2200	175/1900-2300	215/1900-2200	193/2000-2600	193/2000-2600
Diaplacement(L)		2.164	2.324	2.66	2.237	2.237
Engine Lubricating system (L)		4.5	4．5	7．5	4.2	4.2
Engine coolanting system (L)		10．1				
Fuel tank volume(L)		65	65/70	65/70	65	65

Vehicle model		BJ6536B1DBA-2	BJ6536B1DBA-4	BJ6536B1DDA-4	BJ6536B1DWA-2	BJ6536B1DWA-1
Fuel consumption(at 50km/h,full payload,good road) L/100km)		≤9	≤8.5	≤9.5	≤	≤9.5
Transmission	Model	ZSY08	ZSY08	035H	5RYA	
	Type	Mechanic 5+1 gears with synchronizer				
Clutch		Single plate, dry type diaphragm spring				
Rear axle	Type	Whole banjo type, punch axle housing				
	Final drive ratio	4.1	4.556	4.1	Final drive ratio	4．556
	Rear axle (L)	2．2（85W/90）				
Steering gear	Type	Pinion and rack				
	Transmission (L)	1				
Sevice brake		Hydraulic,vacuum boosting , dual circuits front disk,rear drum brake，				
Front wheel alignment	King –pin inclination	-10° 50′ ±30′	-10° 50′ ±30′	-10° 50′ ±30′	-10° 50′ ± 30′	-10° 50′ ± 30′
	Caster	1° 15′ ±30′	1° 15′ ±30′	1° 15′ ±30′	1° 15′ ±30′	1° 15′ ±30′
	Camber	0° 20′ ±30′	0° 20′ ±30′	0° 20′ ±30′	0° 20′ ±30′	0° 20′ ±30′
	Toe-in	1～5 mm	1～5 mm	1～5 mm	1～5 mm	3±1 mm
Max Wheel turning angle（° ）		34～37	34～37	34～37	34～37	34～37
Free travel of brake pedal（mm）		1～3	1～3	1～3	1～3	1～3
Parking brake type		Steel cable（Wheel brake）				
Suspention system	Front	Torsion bar spring， double crose arm independent suspension， hydraulic two –way telescopic shock absorber				
	Rear	Longitudinal half –elliptic leaf spring ， non –independent suspension Hydraulic two –way telescopic shock absorber				
Electrical device	Type	Negative ground				
	Rated voltage	12V				
Type of Tire and		185R14: 325	185R14C:325	185R14C:325	185R14C:325	185R14C：325

Vehicle model	BJ6536B1DBA-2	BJ6536B1DBA-4	BJ6536B1DDA-4	BJ6536B1DWA-2	BJ6536B1DWA-1
Tire pressure (kPa)		195/70R15:250	195/70R15:250	195/70R15:250	
Type of Tire and Tire pressure（kPa）	185R14:450	185R14C:450 195/70R15:300	185R14C:450 195/70R15:300	185R14C:450 195/70R15:300	185R14C：450
Type of Rim	7JJ×15				

Table1-34

Vehicle model		BJ6536B1DBA-1	BJ6536B1DBA-5	BJ6536B1DDA-5	BJ6536B1DBA-4	BJ6536B1DDA-4
Drive Type		4×2 Rear axle drive				
Persons in cab		10～12	10-14	10-15	6-9	6-9
Over all dimensions（mm）	L	5320	5320、5385	5320、5385	5320、5385	5320、5385
	W	1690	1690	1690	1690	1690
	H	2050	2050、2225	2050、2225	2050、2225	2050、2225
Wheel base （mm）		2890	2890	2890	2890	2890
Wheel track（mm）	front	1460	1460	1460	1460	1460
	rear	1440	1440	1440	1440	1440
Max Speed（km/h）		≥95	≥100	≥110	≥100	≥110
Max Climbing slope（%）		≥22	≥25	≥30	≥25	≥30
Min ground clearance（mm）		≥160	≥160	≥160	≥160	≥160
Curb weight（kg）		1785	1785、1825	1865、1890	1785、1825	1840、1865
Gross weight（kg）		2718	2952	3032、3057	2484	2425、2450
Engine		BJ483ZQB	BJ486ZQ	YC4F90-21	BJ486ZQ	YC4F90-21
Type		Four cylinders，in-line，water cooling，supercharging，diesel engine、	Four cylinders，in-line，water cooling，direct injection，diesel engine	Four cylinders，in-line，water cooling，direct injection，diesel engine	Four cylinders，in-line，water cooling，direct injection，diesel engine	Four ylinders，in-line，water cooling，direct injection，diesel engine
Bore×Stroke（mm）		83×100	86×100	92×100	86×100	92×100
Compression ratio		17．5	18.1	17．5	18.1	17．5
Reted power/Rpm（kw/rpm）		46/3300	52/3300	65/3400	52/3300	65/3400
Max torque/Rpm（N.m/rpm		150/2200	175/1900-2300	215/1900-2200	175/1900-2300	215/1900-2200
Diaplacement		2.164（L）	2.324（L）	2.66（L）	2.324（L）	2.66（L）

Vehicle model		BJ6536B1DBA-1	BJ6536B1DBA-5	BJ6536B1DDA-5	BJ6536B1DBA-4	BJ6536B1DDA-4
Engine oil (L)		4.5	4．5	7．5	4．5	7．5
Engine coolant (L)		10．1	10．1	10．1	10．1	10．1
Fuel tank (L)		65	65/70	65	65	65
Fuel consumption(at 50km/h,full payload,good road) L/100km)		≤9	≤8.5	≤9.5	≤8.5	≤9.5
Transmission	Model					
	Type	Mechanic 5+1 gears with synchronizer				
Clutch		Single disc dry, diaphram spring, hydraulic operration				
Rear axle	Type	Whole banjo type , punch axle housing				
	Final drive ratio	4.1	4.556	4.1	4．556	4．1
	Rear axle (L)	2．2（85W/90）	2．2（85W/90）	2.2（85W/90）	2.2（85W/90）	2.2（85W/90）
Steering gear	Type	Rear and rack				
	Transmission (L)	1				
Brake system		Hydraulic,vacuum boosting ,dual circuits front disk,rear drum brake				
Front wheel alignment date	King –pin inclination	-10° 50′ ±30′	-10° 50′ ±30′	-10° 50′ ±30′	-10° 50′ ±30′	-10° 50′ ±30′
	Caster	1° 15′ ±30′	1° 15′ ±30′	1° 15′ ±30′	1° 15′ ±30′	1° 15′ ±30′
	Camber	0° 20′ ±30′	0° 20′ ±30′	0° 20′ ±30′	0° 20′ ±30′	0° 20′ ±30′
	Toe-in	1～5 mm	1～5 mm	1～5 mm	1～5 mm	1～5 mm
Max Wheel turning angle（° ）		34～37	34～37	34～37	34～37	34～37
Free travel of brake pedal（mm）		1～3	1～3	1～3	1～3	1～3
Parkong brake type		Steel cable （Wheel brake）				
Suspention system	Front	Torsion bar spring， double cross arm independent suspension, hydraulic two –way telescopic shack absorber				
	Rear	Longitudinal half –elliptic leaf spring， non –independent suspension, hydraulic two –way telescopic shack absorber				

Vehicle model		BJ6536B1DBA-1	BJ6536B1DBA-5	BJ6536B1DDA-5	BJ6536B1DBA-4	BJ6536B1DDA-4
Electrical device	Type	Negative ground				
	Rated voltage	12V				
Type of Tire andTire pressure (kPa)		185R14: 325	185R14C:325 195/70R15:250	185R14C:325 195/70R15:250	185R14C:325 195/70R15:250	185R14C:325 195/70R15:250
Type of Tire and Tire pressure (kPa)		185R14:450	185R14C:450 195/70R15:300	185R14C:450 195/70R15:300	185R14C:450 195/70R15:300	185R14C:450 195/70R15:300

1.2 Technical data of BJ491EQ1 gasoline engine

1.2.1 General structure of gasoline engine

Gasoline engine is a type of complicated machine that transforms heat energy of fuel into mechanical operation. A gasoline engine contains the following mechanisms and systems:

1.2.11 Crank-connecting rod mechanism

The function of crank-connecting rod mechanism is to change reciprocating motion of piston into rotation movement of crankshaft, and change gas pressure on top of piston into torque, producing output through crankshaft.

Crank-connecting rod mechanism contains piston / connecting rod assemblies and crankshaft/flywheel assemblies.

1.2.1.2 Cylinder block and cylinder head

Cylinder block and cylinder head form piston motion space and gasoline engine combustion chamber in which air-fuel mixture is burning. The cylinder block and cylinder head are the framework of a gasoline engine, on which all moving parts and auxiliary systems are supported and installed.

1.2.1.3 Valve train

Valve train discharges exhaust gas and sucks in air at specified timing to help combustion inside the engine.

Valve train includes valves and driving assemblies (tappet, push rod, rocker arm, rocker arm shaft, camshaft, timing chain sprocket and timing chain etc.)

Air intake/exhaust system is composed of air cleaner, intake/exhaust manifolds/pipes, throttle body, muffler and three-way catalytic converter etc.

1.2.1.4 Fuel supply system

Fuel supply system turns gasoline into combustible mixture according to the working requirement of gasoline engine, and continuously supplies cylinder to meet the needs during combustion process.

Fuel supply system is mainly composed of fuel tank, electric fuel pump, fuel filter, fuel injector, pressure regulator and fuel pipeline etc.

1.2.1.5 Lubrication system

Lubrication system is to deliver engine oil (lubricant) to friction surfaces of moving parts to perform antifriction, cooling, cleaning and antirust functions, so as to reduce friction resistance and wear, take away the heat generated during friction that ensure normal working of gasoline and prolong its service life.

BJ491EQ1 multi point electronic fuel injection gasoline engine combines to use pressure and splash lubrication methods.

The lubrication system is mainly composed of oil strainer, oil pump, oil filter and lubricant oil passages etc.

1.2.1.6 Cooling system

Cooling system is to radiate heat from excessive heat parts, so as to ensure a normal working temperature of engine and avoid damage to its mechanical parts and other adverse influences.

BJ491EQ1 multi point electronic fuel injection gasoline engine adopts a forced water-cooling method.

The cooling system is mainly composed of cylinder block and water jacket in cylinder head, water pump, fan, radiator, thermostat and silicon oil fan clutch etc.

1.2.1.7 Ignition system

Ignition system is to generate electric sparks to ignite the air-fuel mixture inside cylinder timely.

The ignition system is composed of battery, spark plug, ignition coil and high resistance cable.

1.2.1.8 Starting system

Starting system is to rotate crankshaft to a certain speed so as to suck combustible mixture into cylinder to enable ignition and combustion.

The starting system is composed of starter, battery and other devices.

1.2.1.9 Electronic control fuel injection system

Through various sensors, electronic fuel injection system input signals of air intake volume, crankshaft rotation / position and other auxiliary components to ECM. ECM processes these singals and commads auctators to get uptimum air-fuel ratio and proper ignition timing, and ignite the combustible mixture to obtain an ideal engine power performance, economical efficiency and emission index.

1.2.2 Specifications of gasoline engine

Description	BJ491EQ1
Type	4-stroke ， in-line,water cooling,wedge combustion chamber，EFI
Number of Cylinders	4
Cylinder bore ［mm］	91
Piston stroke ［mm］	86
Displacement［L］	2.237
Rated output［kW/(r/min)］	76/4600~4600
Idle rpm ［r/min］	800±50
Max torque［N·m/(r/min)］	193/2000~2600
Fuel rate	RON93 or better ， non-leaded super gasoline
Min fuel consumption ［g/(kW·h)］	≤275
Oil rate	SF or better 10W/30or 15W/40，and 5W/30 in winter
Oil /fuel consumption rate ［%］	＜0.8
Average piston speed ［m/s］	13.19
Rotating direction of crankshaft	Counter- clockwise
Compression ratio	8.8：1
Anti-freezer	Ethylene anti-freezer
Oil volume (dry)［L］	4.2

Description		BJ491EQ1
Coolant volume ［L］		7.9（With out worm pipe capacity）
Firing sequence		1-3-4-2
Valve timing	Intake open advance angle	12ºBTDC
	Intake close delayed angle	48ºABDC
	Exhaust open advance	54ºBBDC
	Exhaust close delayed angle	10ºATDC
Coolant type		Forced cooling
Lubricating		Combine to use pressure and splash lubrication
Starting type		Electric starting
Net weight [kg]		145
Spark plug clearance[mm]		1.1±0.1
Max oil temperature [℃]		110
Coolant temperature [℃]		85~105（For high pressure cooling system ）
Oil pressure [kPa]	At idle	≥30
	2000r/min	≥170
	3000r/min	245~490

1.2.3 Specifications of gasoline engine main components

Description	Type	Specifications
ECM	ITMS-6F	491-FT01 for van；491-FT02 for pick-up； 491-FT03for SUV
O_2 sensor	25327985	Heat style
Spark plug	F6RTC or F5RTC	M14×1.25， 3~9kΩ resistance
Starter	QDY1253	U=12V，P=1kW
Alternator		U=14V，I=65A/90A
Fuel injector	25343351	
Oil pump		Rotor type
Water pump		Centrifugal type
Thermostat		Valve opening temperature ；76℃，or more at 88℃，valve lift≥8mm
Oil pressure sensor		ZM10，Alarm pressure 39.2kPa
Oil filter		Paper element
Ignition coil	19005252	
Clutch		Diaphragm spring type

1.2.4 The fitting clearance of main components

Description				Data
Culinder head	Warpage -- cylinder block side			0.15mm
	Warpage -- manifold side			0.10mm
	Valve seat	Refacing angle	Intake	45°，75°
			Exhaust	45°
		Connecting angle		45°
		Connecting width		1.2~1.4mm
Valve guide bushing	Inner diameter（mm）			8.010~8.030
	Outer dirmeter	STD（mm）		13.040~13.051
		O/S0.05（mm）		13.090~13.101
Valve	Overall length	STD（mm）	Intake	108.2
			Exhaust	108.5
	Valve face angle	Intake		44.5°
		Exhaust		44.5°
	Stem diameter	Intake（mm）		7.970~7.985
		Exhaust（mm）		7.965~7.980
	Stem oil clearance	STD（mm）	Intake	0.025~0.060
			Exhaust	0.030~0.065
		Limit （mm）	Intake	0.10
			Exhaust	0.12
	Valve stem end face polishing limit（mm）	Intake		0.5
		Exhaust		0.5
	Margin thickness Limit（mm）	STD	Intake	1.0～1.4
			Exhaust	1.3～1.7
		Limit	Intake	0.5
			Exhaust	0.8
Valve spring	Free length （mm）			47
	Installed tension at 40.6mm（N）			292~336
	Squareness（mm）	Limit		2.0
Rocker arm and shaft	Oil clearance （mm）	STD		0.02~0.051
		Limit		0.08
Valve lifter and lifter hole	Oil clearence （mm）	STD		0.017~0.056
		Limit		0.10
	Leak down test at196N			7~50s/1mm

Description				Data
Manifold	Warpage		Limit（mm）	0.4
Timing chain and timing sprocket	Chain slackness at 98N		Limit（mm）	13.5
	Chain elongation		Limit（mm）	291.44
	Cranshaft sprocket wear		Limit（mm）	59（Measure with chain）
	Camshaft sprocket wear		Limit（mm）	114（Measure with chain）
Chain tensioner and vibration damper	Tensioner head thickness		Limit（mm）	12.5
	Damper thinckness		Limit（mm）	5
Camshaft	Thrust clearance（mm）	STD		0.07~0.22
		Limit		0.3
	Journal oil clearance（mm）	STD		0.025~0.111
		Limit		0.14
Camshaft	Journal diameter STD（mm）	No.1		46.459~46.475
		No.2		46.209~46.225
		No.3		45.959~45.975
		No.4		45.709~45.725
		No.5		45.459~45.475
	Out of round limit（mm）		Limit	0.06
	Cam lobe height（mm）	STD	Intake	38.620~38.720
			Exhaust	38.629~38.729
		Limit	Intake	38.26
			Exhaust	38.27
Cylinder block	Top surface warpage（mm）			0.05
	Bore diameter（mm）		STD	91.00~91.03
			Limit	91.23
	O/S 0.5（mm）			91.73
	O/S0.75（mm）			91.98
	O/S1.00（mm）			92.23
Piston and piston ring	Diameter of piston（mm）	STD		90.938~90.968
		O/S 0.5（mm）		91.438~91.468
		O/S0.75（mm）		91.688~91.718
		O/S1.00（mm）		91.938~91.968
	Piston oil clearance（mm）			0.032~0.092

Description				Data
	Piston ring end gap （mm）	NO.1		0.27~0.39
		NO.2		0.40~0.55
		Oil side rail		0.20~0.70
		Piston ring groove clearance		0.03~0.07
Connecting –rod	Thrust clearance（mm）			0.160~0.312
	Benting per 100mm		Limit	0.05
	Twisting per100mm		Limit	0.05
Flyweel	Runout		（mm）	0.10
Crankshft	Thrust clearence（mm）	STD		0.02~0.20
		Limit		0.35
	Thrust washer thickness （mm）	STD		2.450~2.490
		O/S0.125mm		2.565~2.615
		O/S0.250mm		2.69~2.89
	Main jounral oil clearence（mm）	STD		0.020~0.051
		limit		0.10
	Main journal diameter （mm）	STD		57.985~58.00
	Crank pin oil clearence（mm）	STD		0.020~0.051
		Limit		0.10
	Crank pin diameter （mm）		STD	47.985~48.00
	Circle runout（mm）		Limit	0.06
	Main journal taper and out –of round（mm）		Limit	0.02
	Crank pin taper and out –of round（mm）		Limit	0.02

1.2.5 Tightening torque of main fasteners

1.2.5.1 Tightening torque for mechanical parts of gasoline engine

Parts		Tightening torque （N.m）	Parts	Tightening torque （N.m）
Rocker arm shaft×Cylinder head		25~32	Water pump ×cylinder block	39~48
Cylinder head bolts	M12	93~105	Chain case	20~25
	M8	20~25		
Manifold ×cylinder head		49~55	Connecting cap ×rod	49~55
Spark plug ×cylinder head		25~30	Mainbearing cap × cylinder block	78~88
Chain sprocket ×camshaft		90~100	Crankshaft pilley ×crankshaft	155~165

Parts	Tightening torque（N.m）	Parts	Tightening torque（N.m）
Camshaft thrust washer ×cylinder block	20~25	Flywheel×crankshaft	83~90
Water pump×chain case	20~25	Oil pan ×cylinder block	10~13
Oil pan drain plug	38~45	Head cover ×cylinder head	6~8

1.2.5.2 Tightening torque for EFI parts

NO	Parts	Tightening torque（N.m）	NO	Parts	Tightening torque（N.m）
1	Throttle body	10~15	5	Ignition coil	10~15
2	MAP sensor	7~12	6	O_2 sensor	38~46
3	Coolant temperature sensor	20~25	7	Upper and lower ports	20~25
4	Crankshaft	7~9			

1.2.5.3 Tightening torque for other parts

NO	Parts	Tightening torque（N.m）	NO	Parts	Tightening torque（N.m）
1	M6	9~11	3	M10	41~591
2	M8	20~25	4	M12	73~

1.3 Technical specification of BJ486ZQ diesel engine

1.3.1 Technical specification of BJ486ZQ diesel engine

No	Description	Unit	Specifications
1	Type		4-stroke ,water cooling ,in line、DI supercharging，diesel engine
2	Shape of combustion chamber		DI A type
3	Cylinder number		4
4	Cylinder bore	mm	86
5	Piston stroke	mm	100
6	Compression ratio		18
7	Diplacement	L	2.324
8	Firing sequence		1-3-4-2
9	Output /rpm	Kw/r/min	52/3300
10	Max torque /rpm	N．m/r/min	175/1900～2300
11	Min fuel consumption rate	G/kw/h	225
12	Adjustable velocity	%	≤10

No	Description	Unit	Specifications
13	Idle rpm	r/min	800～850
14	Smoke	m-1	≤1.8
15	Rotating directon of crankshaft		Clockwise(see from front of diesel engine)
16	Method of lubrication		Pressure and splash
17	Starting method		Electric
18	Net weight	Kg	≤215
19	Overall dimensions	mm	754×592×671

1.3.2 Main technical parameters of BJ486ZQ diesel engine

	Description	Parameters
Valve timing	Intake valve	Intake valve opens（before T.D.C） 8º,Intake valve closes(after B.D.C)44º
	Exhaust valve	Exhaust valve opens (before BDC) 44º ; Exhaust valve closes (after TDC) 8º
	Valve clearance (cold)	Intake valve 0.35mm, Exhaust valve 0.35mm
Advance angle		8º～10ºCA(before T.D.C)
The range of temperature and pressure	Exhaust gas temperature	≤550℃
	Coolant outlet temperature	≤95℃(use high pressure water tank ≤105℃)
	Oil temperature	80℃～105℃
	Idling oil pressure	≥0.07MPa
	Nominal speed oil pressure	0.30～0.42MPa
Tightening torque(N.m)	Camshaft gear bolt	45～55
	Main bearing cap bolt	160～180
	Connecting –rod nut	55～65
	Cylinder head bolt	170～190(bolt，Cylinder head)55～65(Small bolt，Cylinder head)
	Flywheel bolt	80～90
	Crankshaft pulley bolt	250～280

1.3.3 Main fitting specification of BJ486ZQ diesel engine

	Description	Specifications
Lubrication system	Type of oil pump	Gear type
	Type of oil filter	Integral canister type
	Alarm oil pressure	80kPa

	Description	Specifications
Fuel supply sistem	Fuel filter	Rotor type
	Fuel pump	Piston
	Type of fuel injection pump	BHF4P090213 type
	Type of injector	“P”multi –hole type ， ZP20 type
	Injector open pressure	22～23MPa
Cooling system	Water pump	Centrifugal type
	Water pump flow	≥130L/min/4800r/min
	Thermostat	Wax type
	Fan	Silicon oil clutch and plastic fan
Electronic sistem	Glow plug relay	12V
	Starter	12V,2.8kw
	Alternator	14V,900W
	Alternator rotating direction	Clockwise (viewing from front)
Turbeocharger	Type	SJ44 or JP40S
	Max rpm	18000r/min
	Rated rpm	15000r/min

1.4 Technical specification of YC4F90-21 diesel engine

1.4.1 The technical specifications

NO	Description	Specifications
1	Engine type	4-stroke ， water cooling，in line，supercharging
2	Shape of combustion chamber	DI ω shape
3	Cylinder bore × Piston stroke （mm）	4-92×100
4	Displacement（L）	2.66
5	Compression ratio	17.5:1
6	Rated power/rpm kW（r/min）	65±5%/3400
7	Max torque /rpm （N.m/rpm）	210/1900~2200
8	Min fuel consumption〔g/（kW.h)〕	≤215
9	（Oil/fuel ）consumption rate	≤0.2%

NO	Description	Specifications
10	Max rpm (r/min)	≤3630
11	Min steady idle rpm	700~800
12	Firing order	1-3-4-2
13	Rotating direction of crankshaft	Clockwise（viewing from front of diesel engine）
14	Starting method	Electric
15	Starting performance	Startup at -10℃ w/o glow plug device, startup at-35℃ with glow plug device; successful startup after 3 crankings
16	Smoke at free acceleration (Rb)	≤2.0
17	Maximum smoke under full load FSN	≤3.5
18	Noise (dB) (A)	≤116
19	Oil pan volume	7.5（L）
20	Oil temperature	90～115℃
21	Lubricating oil pressure	Oil pressure at steady idling speed:>0.1MPa
		Working pressure: 0.3-0.6MPa
22	Coolant temperature	80～95℃
23	Exhaust gas temperature	≤650℃
24	Net weight（kg）	260（excl. clutch）
25	Overall dimensions （L×W×H）mm	723.6×568.3×666

1.4.2 Main components specifications

NO	Description	Specifications
1	Type of fule injection pump	BHF4PL090
2	Type of injector	CKBAL63P967
3	Turbocharger	JP50
4	EGR controller (ECU)	Max environment temperature＜80℃
5	Transmission connecting plate	Fraction face of flywheel and clutch to transmission connecting plate : 52mm ; Input shaft bearinge end face to transmission connecting plate : 25mm
6	Type of clutch	ϕ225 diaphragm spring clutch，ajusting height of clutch release lever: 36.4mm; Clutch is of involute spline type
7	Flywheel	108teeth，speed signal output from flywheel
8	Speed sensor	Mounting location aligns with flywheel gear ring center,
9	Input shaft bearing	6201 bearing，Input shaft front φ12mm

NO	Description	Specifications
10	Oil pan volume	7.5L，Engine w/o oil from factory
11	Starting motor	DC reducer motor QDJ1303/3kW/12V
12	Generator	14V/90A，built-in voltage regulator
13	Air filter flow	≥600m^3/h
14	Air filter resistance	≤2.5 kPa, with double stage elements
15	Air intake resistance –intake system	≤4 kPa，Negative pressure alarm on air filter assembly
16	Radiating area -- radiator	≥16M^2
17	Expansion tank	≥15% of total cooling system volume
18	Fuel filter flow	≥0.7L/min，particles after filter＜0.005mm
19	Cleanness of front fuel tank to fuel pump inlet pipe	＜10mg
20	Cleanness from air filter to engine intake manifold	＜10mg
21	Catalytic converter	Clear with compressed air after every 10000km
22	Battery V /Capacity	12V/80Ah
23	Engine oil	Should be higher than APL CF-4 rate according to environment temperature
24	Injection pump & oil	5W/30，CF rate diesel engine oil
25	Fuel	Choose fuel according to environment temperature

1.5 Model 2RZ-E Engine Technical specification

1.5.1 Technical specification

Model	2RZ - E
Type	In line, four cylinders, four strokes, water-cooling, multi-point EFI
No. of cylinder	4
Cylinder bore (mm)	95
Piston stroke (mm)	86
Total displacement (L)	2.438
Rated power / Rpm	85KW/5000rpm
Min. idle stablized Rpm	800 ±50 rpm
DP Rpm	2000 rpm
Max torque / Rpm	193N.m / 2600rpm
Fuel rating	95# or above unlead fuel (GB17930)

Model	2RZ - E
Oil rating	SF 10W/30 or 15W/40 (GB11121)
Crankshaft turing direction (viewing from flywheel end to gasoline engine front end)	Counter-clockwise
Compression ratio	9
Igniting sequence	1-3-4-2
Cooling	Forced water-cooling
Lubrication	Pressure and splashing
Starting	Power startup

1.5.2 Main component specification

Description	Type	Specification
EFI system	Toyota computer control system (TCCS)	
Spark plug	P16R：BPR5EP11	
Starter		U=12V P=1.4Kw
Alternator		U=13.9～15.1V, I=60A
Distributor （mm）	(type 11 A)	Singnal generator clearance: 0.2～0.4
Signal generator (sensing coil) resistance（Ω）		280～360
Ignition coil		U=12V primary coil resistance 0.4～0.5Ω; secondary coil resistance 10.0～14.0 KΩ
Oil pump		Rotary
Water pump		Centrifugal
Thermostat		Wax type, valve opening temperature 80～84°C, 95℃fully open travel ≥ 8mm
Oil filter		Fully flow type with limit valve, spin-on type with paper element
Clutch		Diaphragm spring type

1.5.3 Parameters for check and adjustment

Valve clearance (cool engine)（mm）	Intake valve	0.2～0.3
	Exhaust valve	0.25～0.35
Ignition advance angle	5°BTDC (at 800rpm)	
Ignition sequence	1-3-4-2	
Primary coil resistance（Ω）	0.4～0.5	
Secondary coil resistance（KΩ）	10.0～14.0	

Distributor signal generator (sensing coil) resistance（Ω）	280～360			
Compress pressure（KPa）	1226			
Min. pressure（KPa）	883			
Compress pressure difference among cylinders（KPa）	98			
Intake pipe vacuum (at idle)（KPa）	Larger than 53.3			
Pollutant emission at idle	CO ≤0.5%			
Spark plug clearance（mm）	1.1			
Oil pressure	Idle (800rpm)	29.4KPa		
	Mid-high rpm (3000rpm)	245～490KPa		
Oil temperature	≤110℃			
Oil volume (fill at dry)	5.2L			
Refill after draining （L）	(oil filter contains oil)	3.6		
	(oil filter contains no oil)	4.1		
Fan belt tension (pressure 10kg, the deflection under 98 N)	New belt: 5～7mm Used belt: 7～8 mm			
Coolant volume (use softened water or antifreezer) without heater	8L			
With front heater	9L			
With front and rear heater	10L			
Radiator Relieve valve opening pressure（KPa）	Standard	74～103		
	Limit	59		
Battery fluid gravity under 20°C	1．25～1．27			
Alternator	Rated output current	60 A		
	Rotor coil resistance	2.8～3.0Ω		
	Brush exposed length（mm）	Standard	10.5	
		Limit	1.5	
	Sliding ring diameter（mm）	Standard	14.2～14.4	
		Limit	12.8	
Alternator regulator	Regulator Voltage	At 25℃	13.9～15.1V	
		At 115℃	13.5～14.3V	
Starter motor	Rated voltage and output power		12V, 1.4Kw	
	Idle property	Amp	90 A or less at 11.5V	
		Rpm	3000 rpm or more	
	Brush length（mm）	Standard	15.5	
		Limit	8.5	
	Spring mounting load	Standard	18～24N	

Oil pump	Pump body clearance（mm）	Standard	0.100～0.175
		Limit	0.30
	Side clearance（mm）	Standard	0.11～0.24
		Limit	0.35
	Radial clearance（mm）	Standard	0.03～0.09
		Limit	0.15
Fuel pressure	2.7～3.1 bar		

1.5.4 Fitting sizes of main parts

	Description			Data	
Cylinder head	Warpage (contacting face with block)（mm）			Limit	0.15
	Warpage (contacting face with intake / exhaust manifolds)（mm）			Limit	0.20
	Valve seat	Cone angle		Intake valve seat	30° 45° 60°
				Exhaust valve seat	30° 45° 60°
		Contacting angle			45°
		Contacting width（mm）			1.2～1.6
Valve guide	Inner diameter（mm）				8.01～8.03
	Outer diameter	Standard（mm）			13.040～13.051
		Enlarge 0.05mm（mm）			13.090～13.091
	Projecting height（mm）				18.2～18.6
Valve	Valve length（mm）		Standard	Intake valve	102.00
				Exhaust valve	102.25
	Valve cone angle		Intake valve		44.5°
			Exhaust valve		44.5°
	Valve stem diameter（mm）		Intake valve		7.970～7.985
			Exhaust valve		7.965～7.980
	Valve stem clearance（mm）		Standard	Intake valve	0.025～0.06
				Exhaust valve	0.030～0.065
			Limit	Intake valve	0.08
				Exhaust valve	0.10
	Valve stem end face grinding limit（mm）		Intake valve		0.5
			Exhaust valve		0.5
	Valve top edge thickness limit（mm）		Intake valve		0.5
			Exhaust valve		0.8

	Description（mm）		Data
Valve spring	Free length（mm）		47.31
	Mounting tension（N）		238～265
	Un-verticality （mm）		2.0
Intake/exhaust manifolds	Sealing face warpage—intake（mm）	Limit	0.2
	Sealing face warpage—exhaust （mm）	Limit	0.7
Timing chain and sprocket	16 links chain length（mm）	Limit	146.6
	Allowable wear on crankshaft sprocket diameter（mm）	Limit	59.4
	Allowable wear on camshaft sprocket diameter（mm）	Limit	113.8
Damper plate and sliding plate	Wear of damper plate（mm）	Limit	1.0
	Wear of sliding plate （mm）	Limit	1.0
Camshaft	Axial clearance（mm）	Standard	0.08～0.18
		Limit	0.25
	Radial clearance（mm）	Standard	0.025～0.066
		Limit	0.10
	Shaft journal diameter（mm）	Standard	33.959～33.975
	Center shaft journal runout （mm）	Limit	0.06
	Cam lub height（mm）	Standard	47.84～47.94
Cylinder block	Top plane warpage（mm）	Limit	0.05
	Cylinder bore（mm）	Limit	94.99～95.00
	Fit with piston of standard size, allowable bore wear（mm）		95.06
	Fit with enlarged (0.5mm) piston, allowable bore wear（mm）		95.56
	Taper and out of round（mm）	Limit	0.01
	Main bearing hole on cylinder block（mm）	Standard No1	64.000～64.008
		No 2	64.009～64.016
		No 3	64.017～84.024
	Main bearing hole diameter at the main bearing inner hole reduction(0.25mm) non-grouping （mm）	64.000～64.024	

	Description			Data (mm)
Piton and ring	Piston diameter （mm）	Standard		94.95～94.96
		Enlarge 0.50mm		95.45～95.46
	Clearance between piston and cylinder（mm）			0.03～0.05
	Piston ring open clearance （mm）	Top ring	Standard	0.22～0.35
			Limit	0.95

	Description			Data (mm)
Piton and ring		Second ring	Standard	0.03～0.43
			Limit	1.03
		Oil ring	Standard	0.45～0.60
			Limit	1.2
	Side clearance between ring groove and ring（mm）	Standard		0.03～0.08
		Limit		0.2
	Piston pin mounting temperature			80°C
Connecting rod and bearing	Connecting rod axial clearance（mm）	Standard		0.160～0.312
		Limit		0.35
	Inner diameter -- connecting rod big end（mm）	Standard No1		56.000～56.008
		Standard No2		56.009～56.016
		Standard No3		56.017～56.024
	Connecting rod big end inner diameter at bearing inner hole reduction (0.25mm), non-grouping（mm）			56.000～56.024
	Center wall thickness -- connecting rod bearing（mm）		Standard No1	1.481～1.485
			Standard No2	1.486～1.489
			Standard No3	1.490～1.493
	Center wall thickness at bearing inner hole reduction (0.25mm), non-grouping（mm）			1.601～1.607
	Bearing clearance（mm）		Standard	0.030～0.059
			Limit	0.1
	Clearance between piston pin and bushing（mm）		Standard	0.005～0.011
			Limit	0.015
	Piston pin diameter（mm）		Standard	24.000～24.009
	Bushing inner diameter（mm）			24.008～24.017
	Bending & distortion at each 100mm（mm）		Limit	0.05
	Twisting at each 100mm（mm）		Limit	0.15
Flywheel	End face run-out （mm）		Limit	0.1
Crankshaft	Axial clearance （mm）		Standard	0.02～0.022
			Limit	0.3
	Thrust plate thickness（mm）		Standard	2.400～2.440
	Main journal radial clearance（mm）		Standard	0.020～0.049
			Limit	0.1

	Description		Data (mm)
Crankshaft	Main journal diameter（mm）		59.987～60.000
	Main journal min. diameter（mm）		59.745～59.755
	Main bearing center wall thickness（mm）	Standard No1	1.986～1.990
		Standard No2	1.991～1.994
		Standard No3	1.995～1.998
		Center wall thickness at main bearing inner hole reduction (0.25), non-grouping	1.601～1.607
	Crank pin diameter（mm）	Standard	52.987～53.000
	Crank pin min. diameter (at connecting rod bearing reduction of 0.25mm)（mm）		52.745～52.755
	Run-out （mm）	Limit	0.03
	Taper and out of round –main journal（mm）	Limit	0.005
	Taper and out of round—crank pin journal（mm）	Limit	0.005
Valve tappet	Outer diameter（mm）	Standard	37.922～37.932
	Clearance （mm）	Standard	0.028～0.053
		Limit	0.1

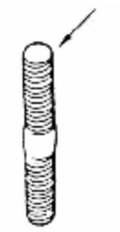
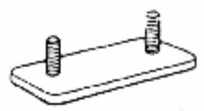
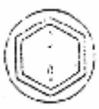
1.5.5 The specification of tightening torque

1.5.5.1 Tightening torque of main fastener

Tightened parts		N-m
Cylinder head x camshaft bearing cap		16
Cylinder head x chain tensioner		21
Cylinder head x spark plug		18
Cylinder head x exhaust manifold		49
Cylinder head x fuel pump		20
Cylinder block x oil filter bracket	Nut	12
	Joint bolt	67
Cylinder block x water plug		25

Cylinder block x cylinder head	First	44
	Second	90° turning
	Third	90° turning
Cylinder block x crankshaft main bearing cap	First	44
	Second	90° turning
Connecting rod x connecting rod bearing cap	First	25
	Second	90° turning
Crankshaft x crankshaft pulley		245
Camshaft x distributor drive gear		74
Crankshaft x flywheel		88
Crankshaft x drive plate		74
Oil pan x oil plug		25
Alternator x bracket		59
Engine mounting isolator x engine mounting bracket		44
Intake manifold x TVSV		25
Coolant bypass flange x thermostat		25
EGR valve x intake manifold		20
EGR valve x EGR pipe		20
Exhaust manifold x EGR pipe		20
Fuel outlet pipe x intake manifold		20
Fuel outlet pipe x injector cover		4.4
NO 1 fuel supply pipe x fuel outlet pipe		29
No 1 fuel supply pipe x fuel filter		29
Cold start injector pipe x cold start injector		20
Cold start injector pipe x fuel outlet pipe		20
Pressure regulator x fuel outlet pipe		25

1.5.5.2 Bolt standard tightening torque

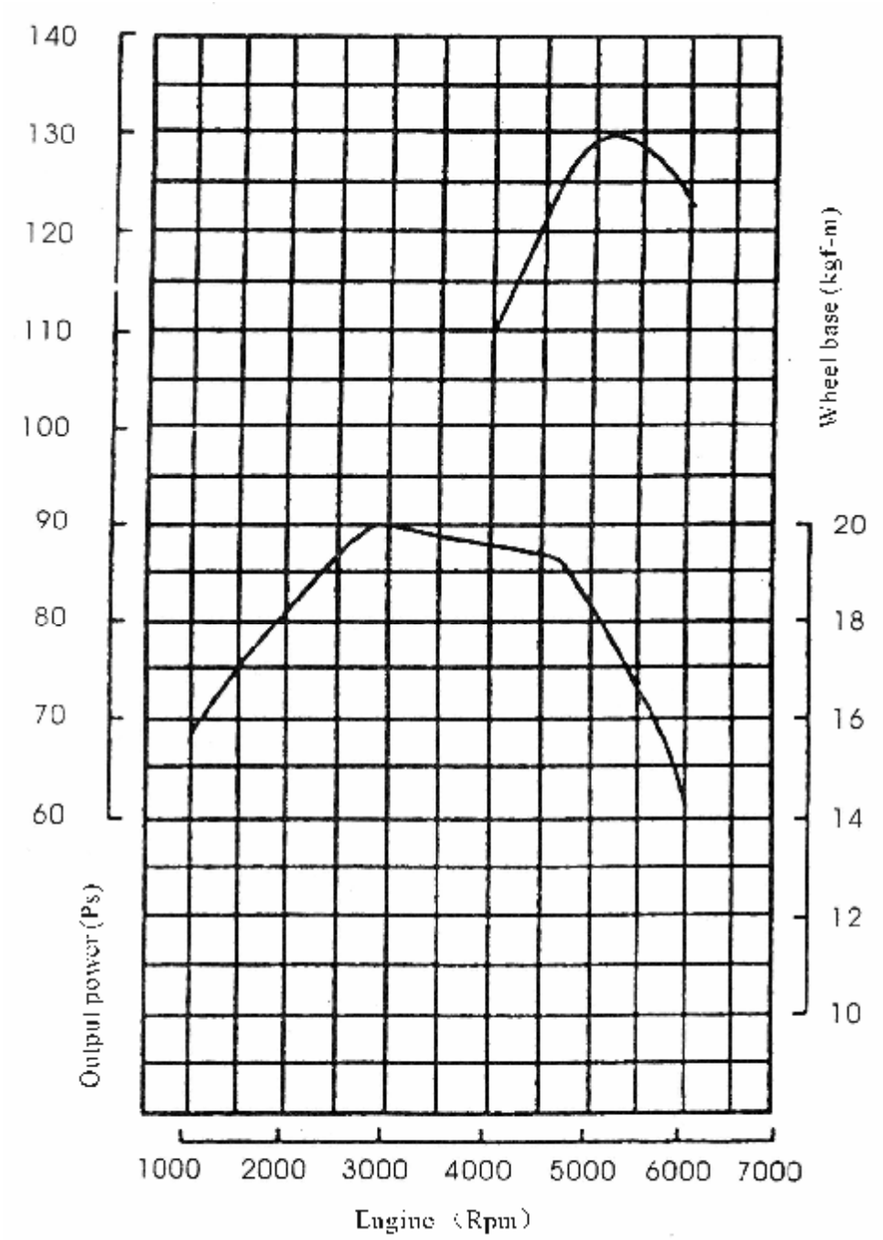
<table>
<tr><td></td><td>Mark grade</td><td>Mark grade</td></tr>
<tr><td rowspan="2">Hex bolt</td><td>No. mark on bolt head
 
4- 4T
5- 5T
6- 6T
7- 7T
8- 8T
9- 9T
10- 10T
11- 11T</td><td rowspan="2">Stud
W/o mark
 
4T</td></tr>
<tr><td>  W/o mark 4T</td></tr>
<tr><td>Hex flange bolt w. washer
Hex head bolt</td><td>  W/o mark 4T</td><td>With slot
 
6T</td></tr>
<tr><td>Hex bolt</td><td>  Two projecting lines 5T</td><td rowspan="4">Welding bolt
 
4T</td></tr>
<tr><td>Hex flange bolt w. washer
Hex head bolt</td><td>  Two projecting lines 6T</td></tr>
<tr><td>Hex bolt</td><td>  Two projecting lines 7T</td></tr>
<tr><td>Hex bolt</td><td>  Four projecting lines 8T</td></tr>
</table>

Specified tightening torque – standard bolts

Rating	Diameter (mm)	Pitch (mm)	Specified torque	
			Hex bolt	Hex flange bolt
			N-m	N-m
4T	6	1	5	6
	8	1.25	12.5	14
	10	1.25	26	29
	12	1.25	47	53
	14	1.5	74	84
	16	1.5	115	--
5T	6	1	6.5	7.5
	8	1.25	15.5	17.5
	10	1.25	32	36
	12	1.25	59	65
	14	1.5	91	100
	16	1.5	140	--
6T	6	1	8	9
	8	1.25	19	21
	10	1.25	39	44
	12	1.25	71	80
	14	1.5	110	125
	16	1.5	170	--
7T	6	1	10.5	12
	8	1.25	25	28
	10	1.25	52	58
	12	1.25	95	105
	14	1.5	145	165
	16	1.5	230	--
8T	8	1.25	29	33
	10	1.25	61	68
	12	1.25	110	120
9T	8	1.25	34	37
	10	1.25	70	78
	12	1.25	125	140
10T	8	1.25	38	42
	10	1.25	78	88
	12	1.25	140	155
11T	8	1.25	42	47
	10	1.25	87	97
	12	1.25	155	175

1.6 Model 4G64 Engine main technical specification

1.6.1 Model 4G64 S4 MPI engine performance curve



1.6.2 Engine main technical parameters

SN	Description		Parameters
1	Model		Mitsubishi 4G64 S4 MPI
2	Type		In line, four cylinders, roof type combustion chamber, SOHC 16 valves, four strokes, water cooling, multi-point EFI gasoline engine
3	No.of cylinder		4
4	Cylinder bore (mm)		86.5
5	Piston stroke(mm)		100
6	Total displacement (L)		2.351
7	Compression ratio		9.5
8	Fuel injection and ignition sequence		1-3-4-2
9	Fuel rating		PON93 or above superior unleaded gasoline (GB17930)
10	Oil rating		SE or above 10W-30 or 15W-40 (GB11121)
11	Oil volume (L)		4.3 (with 0.3L in oil filter)
12	Coolant volume (L)		8 (8.5 L with rear heater)
13	Port timing (Crankshaft turning angle)	intake valve open	18° BTDC
		Intake valve close	53° ABDC
		Exhaust valve open	50° BBDC
		Exhaust valve close	18° ATDC
14	Spark plug clearance (mm)		1±0.1
15	Cooling method		Forced close water cooling
16	Rated power / rated rpm (kw/rpm)		93/5250
17	Max torque/max torque rpm (N-m/rpm)		190.12/2750
18	Min. fuel consumption (g/kw/h)		258.4
19	Fuel consumption at limited operation (L/100km) (for light bus)		8.54
20	Idle rpm		750±50
21	Oil pressure(KPa)	at idle	≥96
		At 200 rpm	≥205
		At 3000 rpm	≥386
22	Pollutant emission	CO%	1.0±0.5
		HC(ppm)	2.≤500comply with GB18352.2
23	System fuel pressure (KPa)		300 ± 20

SN	Description	Parameters		
24	Dimension (L×W×H) (mm)	695×635×632		
25	Total mass (with engine, water pump, without clutch and housing) (kg)	161.8		
26	Thermostat opening temperature （℃）	82 (100 at fully open)		
27	Ignition advance angle	5° ± 2° BTDC		
28	Lubrication method	Pressure and splashing		
29	Crankshaft turning direction	Counter-clockwise (viewing from engine front)		
30	Cylinder sleeve type	W/o sleeve		
31	Fuel supply method	Multi-point EFI		
32	Valve train	SOHC, 16 valves (2 intake/exhaust valves for each cylinder)		
33	Drive belt deflection (under 98N.m) (mm)	Alternator	Check value	5.5～8.5
		Power steering pump	new belt	5.5～7.5
		AC compressor pump	used belt	7.5～8.5
34	Tensioner projection（mm）	3.8～4.5		

1.6.3 Fitting sizes of engine main parts

Description			Standard	Limit
Alternator belt	Tensioner arm projection (mm)		12	--
	Tensioner arm press-in (98～196N-m) (mm)		≤1	--
Camshaft	Cam height (mm)	Intake	37.39	36.89
		Exhaust	36.83	36.33
	Shaft diameter (mm)		45	
Cylinder head	Lower plane flatness (mm)		0.03	0.2
	Surface grinding limit ★total grinding amount (block and head) (mm)			★0.2
	Total height (mm)		119.9～120.1	
	Length of cylinder head bolt (mm)		97.4	≤99.4
Valve	Top edge thickness (mm)	Intake	1.0	0.5
		Exhaust	1.2	0.7
	Valve stem diameter (mm)		6.0	
	Radial clearance—valve stem and guide (mm)	Intake	0.02～0.05	0.10
		Exhaust	0.03～0.07	0.15
	Top cone angle (degree)		45～45.5	--
	Height (mm)	Intake	112.30	111.80
		Exhaust	114.11	113.61

Description		Standard	Limit
Valve spring	Free height	51	50.5
	Operating pre-tension / operating height (N/mm)	267/433	--
	Verticality (degree)	≤2	≤4
Valve guide	Contacting width (mm)	0.9～1.3	--
	Inner diameter (mm)	6	--
	Outer diameter (mm)	11	--
	Press-in height (mm)	14	--
	Valve stem projection (mm)	49.3	49.8

Description			Standard	Limit
Oil pump	Side clearance (mm)	Drive gear	0.08～0.14	--
		Driven gear	0.06～0.12	--
Piston	Piston clearance (mm)		0.02～0.04	
Piston ring	Side clearance (mm)	Top ring	0.02～0.06	0.1
		Second ring	0.02～0.06	0.1
	End clearance (mm)	Top ring	0.25～0.35	0.8
		Second ring	0.4～0.55	0.8
		Oil ring	0.10～0.40	1.0
Piston pin	Outer diameter (mm)		22.0	--
	Press-in force (N)		7399～17150	--
	Press-in temperature		Room temperature	--
Crankshaft	Radial clearance – connecting rod journal (mm)		0.02～0.05	0.1
	Radial clearance – main journal (mm)		0.02～0.04	0.1
	Main journal (mm)		57	--
	Connecting rod journal (mm)		45	--
	Axial clearance – crankshaft (mm)		0.05～0.18	0.25
Connecting rod	Big end side clearance (mm)		0.10～0.25	0.4
Cylinder block	Flatness—upper surface (mm)		0.05	0.1
	Grinding limit (mm) – upper surface ▲ total grinding of cylinder block and head (mm)		--	▲ 0.2
	Total height (mm)		290±0.1	--
	Inner diameter – bore (mm)		86.5～86.53	--
	Bore cylindricality (mm)		0.01	--

Description			Standard	Limit
Cylinder head	Enlarged and second processed size (mm) – valve guide hole (intake/exhaust)	0.05OS	11.05～11.07	
		0.25OS	11.25～11.27	
		0.50OS	11.50～11.52	
	Enlarged and second processed size (mm) – intake valve seat ring	0.30OS	34.435～34.455	
		0.60OS	34.735～37.755	
	Enlarged and second processed size (mm) – exhaust valve seat ring	0.30 OS	31.935～31.955	
		0.60OS	32.235～32.255	
Alternator	Rotor winding resistance (Ω)		3～5	--

1.6.4 Tightening torque of engine bolts

Tightening torque for main bolts

S.N.	Tightening location	Torque (N-m)
Rocker arm and camshaft	Rocker arm cap bolt	3.84
	Bolt-rocker arm and camshaft assembly	31.4
	Thrust cap bolt	18.6
Cylinder head bolt		1.96+90° ~ +90°
Oil pump front cover	Drain plug	44.1
	Oil pan	6.86
	Oil strainer bolt/nut	18.62
	Oil pressure switch	9.8
	Oil discharge plug	44.1
	Bracket bolt – oil filter	18.62
	Front cover bolt	23.52
	Plug	23.52
	Flange bolt	36.26
	Bolt – oil pump cover	15.68
	Screw – oil pump cover	9.8
Connecting rod nut		19.6 +90° ~ +90°
Crankshaft, cylinder block and flywheel	Flywheel bolt	132.3
	Rear cover plate mounting bolt	10.78
	Bell cover mounting bolt	8.82
	Oil seal cover mounting bolt	10.78
	Main bearing cap bolt	24.5 +90° ~ +90°

S.N.	Tightening location	Torque (N-m)
Throttle body	Bracket bolt	4.9
	Throttle position sensor	3.43
	Idle air valve bolt	3.43
	Mounting nut – idle speed adjusting screw	2.94
Alternator, ignition system	Cooling fan bolt	10.78
	Fan clutch bolt	10.78
	Alternator fixing bolt	23.52
	Brace bolt	23.52
	Pivot nut	22.54
	Crankshaft pulley bolt	24.5
	Spark plug	24.5
	Distributor bolt	12.74
	Ignition coil bolt	23.53
	Locating bushing bolt – camshaft pulley	9.8
Timing belt	Bolt -- front lower cover	10.78
	Bolt – tensioner	48.02
	Bolt – tensioner arm	21.56
	Bolt – auto tensioner	23.52
	Bolt—center pulley	35.28
	Brace bolt – tensioner	48.02
	Bolt – timing belt rear cover	10.78
	Timing belt indicator	8.82
	Fixing bolt – oil pump pulley	53.9
	Bolt – crankshaft pulley	117.6
	Fixing bolt – tensioner “B”	18.62
	Fixing bolt – balance shaft pulley	45.08
	Bolt – camshaft pulley	88.2
	Fixing bolt – balance shaft pulley	45.08
Fuel system	Throttle	18.62
	EGR valve	21.56
	Injector and distribution pipe	11.76
	Fuel return pressure regulator	8.82
	Intake manifold	8.82

S.N.	Tightening location	Torque (N-m)
Intake manifold	Engine lug bolt	18.62
	Engine coolant temperature sensing plug	29.4
	Coolant outlet pipe joint bolt	19.6
	Intake manifold bolt	19.6
	Coolant temperature sensor	10.78
	Intake manifold bracket	13.72
Exhaust manifold	Bolt – exhaust manifold cover	13.72
	Joint bolt – coolant inlet pipe	23.52
	Exhaust manifold nut (M8)	29.4
	Exhaust manifold nut (M10)	49
	Joint bolt – coolant bypass pipe	23.52
	Bolt – coolant pipe sets	12.74
	Bolt – thermostat case	23.52
	Water pump bolt	13.72

Tightening toque for ordinary bolts

Tightening torque for bolts and nuts

Bolt diameter	Pitch	Torque (N-m)				
		Bolt (with spring washer)			Flange bolt	
		Head mark 4	Head mark 7	Head mark 10	Head mark 4	Head mark 7
M6	1.0	--	8.82	12.74	--	10.78
M8	1.25	10.78	17.64	29.4	13.72	23.52
M10	1.25	19.6	33.32	58.8	29.4	49
M12	1.25	35.28	60.76	105.84	53.9	88.2

Bevel pitch tightening torque

Pitch size	Torque (N-m)	
	Light alloy	Cast iron, steel
NPTF 1/16	4.9～7.84	7.84～11.76
PT 1/8	7.84～11.76	14.7～21.56
PT1/4	19.6～29.4	34.3～44.1
NPTF 1/4	19.6～29.4	34.3～44.1
PT 3/8	39.2～53.9	53.9～73.5
PT 1/2	68.6～98	117.6～156.8

Plastic area tightening method (bolt)

▲ The method is used on following bolts:

1. Cylinder head bolts
2. Main bearing cap bolts
3. Connecting rod bolts

▲ Tightening methods

Tightening the bolt for another 90～100 ° (two 90° for a cylinder head) after it has been tightened with specified torque. Tightening method varies in different area. Observe the indicated methods in this book.

1.6.5 Sealant application

(1) Sealant

Sealant is used on relevant part of an engine. Special care should be taken to sealant applying amount, applying location and state of applying face so as to obtain a good sealing. Insufficient applying will lead to poor sealing and leaking, while over applying will lead to sealant overflow to block coolant / oil ducts. Correct sealant applying requires consistent and even application on connecting surface, ensuring the whole connecting surface has a layer of flat sealant.

(2) Remove sealant on connecting surface

It is usually easy to remove the sealant-combined parts. In some case, the process can apply a wood stick or same tool to knock slightly to break the sealant on connecting surface. A flat and smooth sealant scraper can also be used for removing (insert it into connecting surface), but be sure not to injure the surface. Use oil pan special tool (MD998727) to remove engine oil pan.

(3) Clean the connecting surface

Clear dirt on the surface with a sealant scraper or a wire brush to make sure the surface is flat and smooth, free from oil stain and dirt. Note to remove the sealant on mounting holes and thread holes.

(4) Applying tips

Apply sealant evenly on specified diameter to circle the mounting hole. Mount parts while sealant is still wet (with 15 minutes). Leave enough time for sealant to harden after parts-mounting (around 1 hour). Do not apply oil on applying area or run the engine during the period.

(5) Sealant application location

Location	Sealant rating
Coolant outlet pipe joint	MD970389 or equivalent
Coolant bypass pipe joint	MD970389 or equivalent
Coolant temperature unit	3MATD No. 8660 or equivalent
Oil pan	MD970389 or equivalent
Oil seal cover	MD970389 or equivalent
Oil pressure switch	3MATD No. 8660 or equivalent
Coolant temperature sensor	3M NUT LOCKING NO.4171 or equivalent

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 forced maintenance according to maintenance interval and technical requirements will keep vehicle clean and tidy, pinpoint and remove timely potential faults so as to prolong vehicle service life.

2.1 Routine maintenance

Vehicle parts tend to become loose, worn-out and damaged during vehicle's operation, which harm vehicle's performance. Routine 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 routine maintenance is very important to drive safely and avoid accident.

2.1.1 Routine maintenance procedures

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.

Figure 2-1 Vehicle routine maintenance procedures

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 tyre adjustment and wheel lugs' fastening. 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 gravity indication.
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-shield; 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.
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 routine vehicle maintenance

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

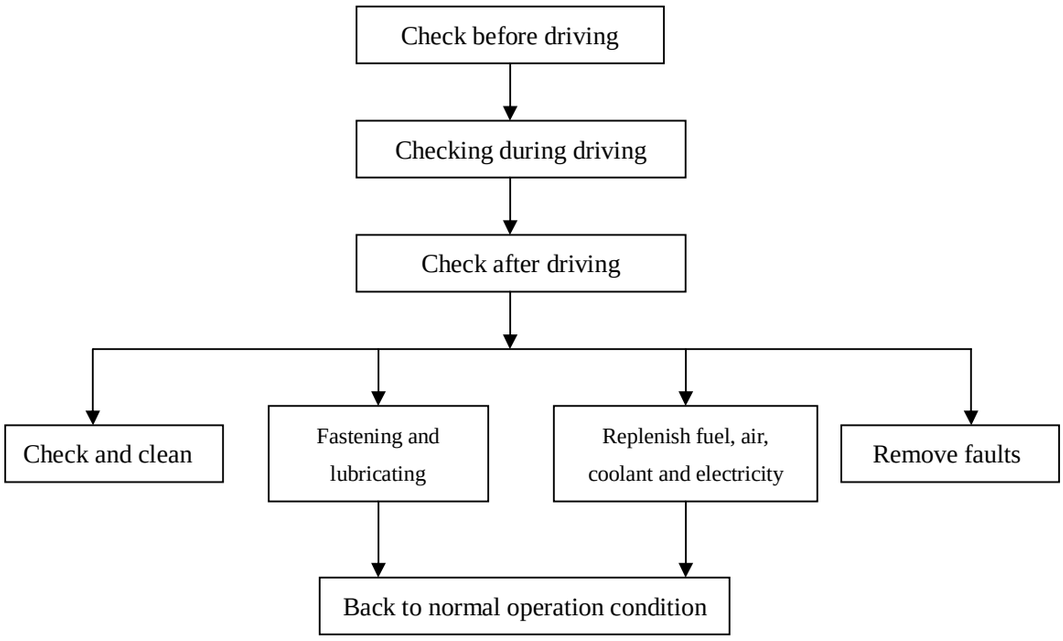


Figure 2-1 Routine maintenance flow chart

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 routine 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.
cabin and cargo body	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:

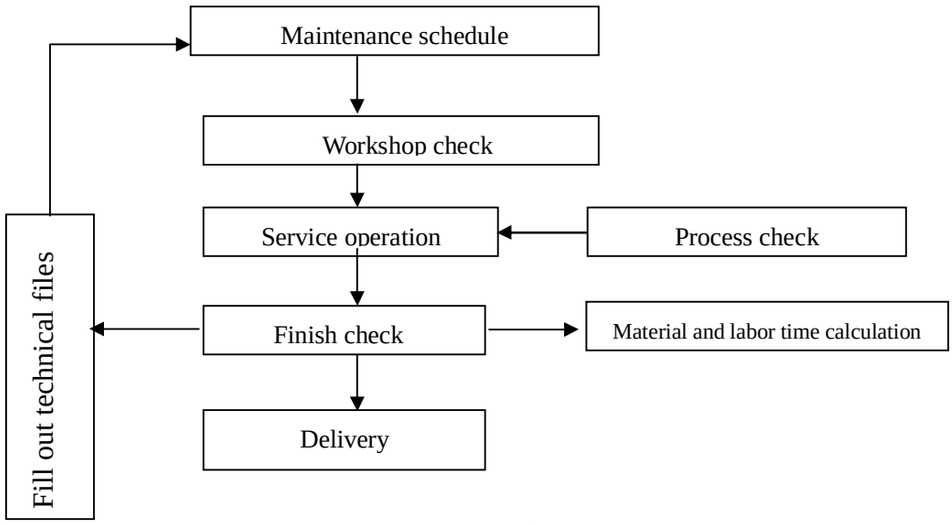


Chart 2-2 Flow chart of 1st level maintenance

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's 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 assass vehicle's technical condition, so as to determine additional procedures to 2nd maintenance's basic procedures.

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

Category	Location	Check results	Faults	Additional services
manual check	Engine	Abnormal sound - valve mechanism	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 º, stuck or heavy	Larger meshing clearance, worn gear, ball groove worn 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

Category	Location	Check results	Faults	Additional services
		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 check 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

Category	Description
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

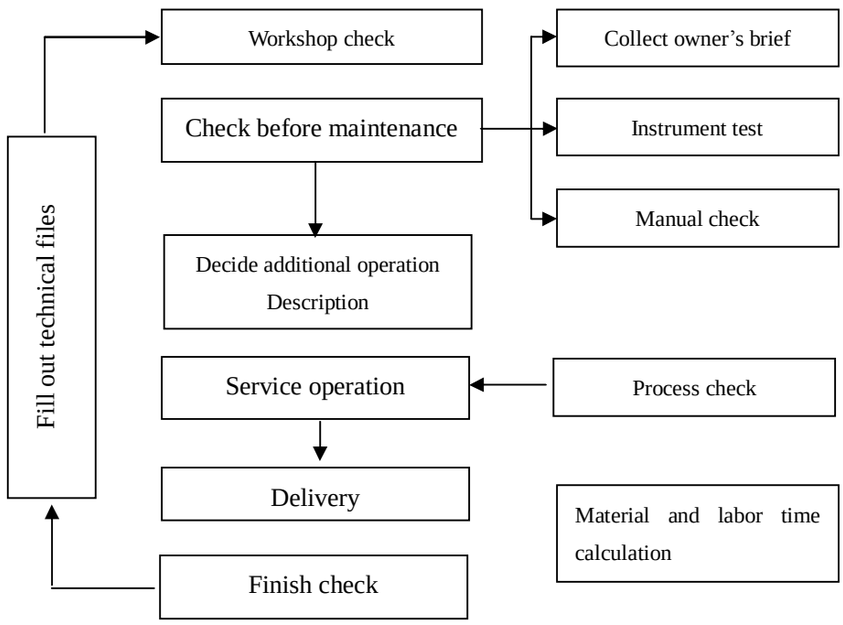


Figure 2-3 Flow chart of 2nd level maintenance

2.3.6 Requirements to 2nd level 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, gravity 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 diagnosis 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.	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 mechanism
	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 Run-in maintenance

2.4.1 Vehicle during run-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 run-in period:

1. Run-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 routine 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 run-in period is finished, vehicle should be sent vehicle for run-in service.

2.4.2 Maintenance services during run-in period

Newly purchased or overhauled vehicle must have run-in period. To keep vehicle's reliable operation and prolong its operation year, there must be a forced service. BJ1049, BJ1043 vehicle in its "Maintenance Manual " enlists detailed requirements to maintenance.

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

Vehicle run-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

BJ1049, BJ1043 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 gravity. 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 sulphate with a gravity of 1.853 (15℃) and clean distilled water to adjust a battery gravityIf battery capacity becomes low due to longer operation, it should be recharged as follows:

Constant current charging: Current: 0．1C20 (C20：20hours 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.	Lub. location	Lub. rate	Run-in maintenance（1500～2000km）	1st level maintenance（7500～15000 km or 6 month）	2nd 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
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)		Change	Change	Change
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 Structure, Adjustment and Service of BJ491EQ1 Gasoline Engine

Knowledge of structures of the gasoline engine parts, master of adjustment and maintenance essentials and correct service, and maintenance to the gasoline engine can let the gasoline engine maintain its performance and quality in long term. Following is a brief description of structures, adjustment and maintenance essentials for parts of BJ491EQ1 multi point electronic fuel injection gasoline engine.

3.1 Cylinder head parts

The cylinder head parts of BJ491EQ1 multi-point electronic fuel injection gasoline engine is as shown in Figure 3-1.

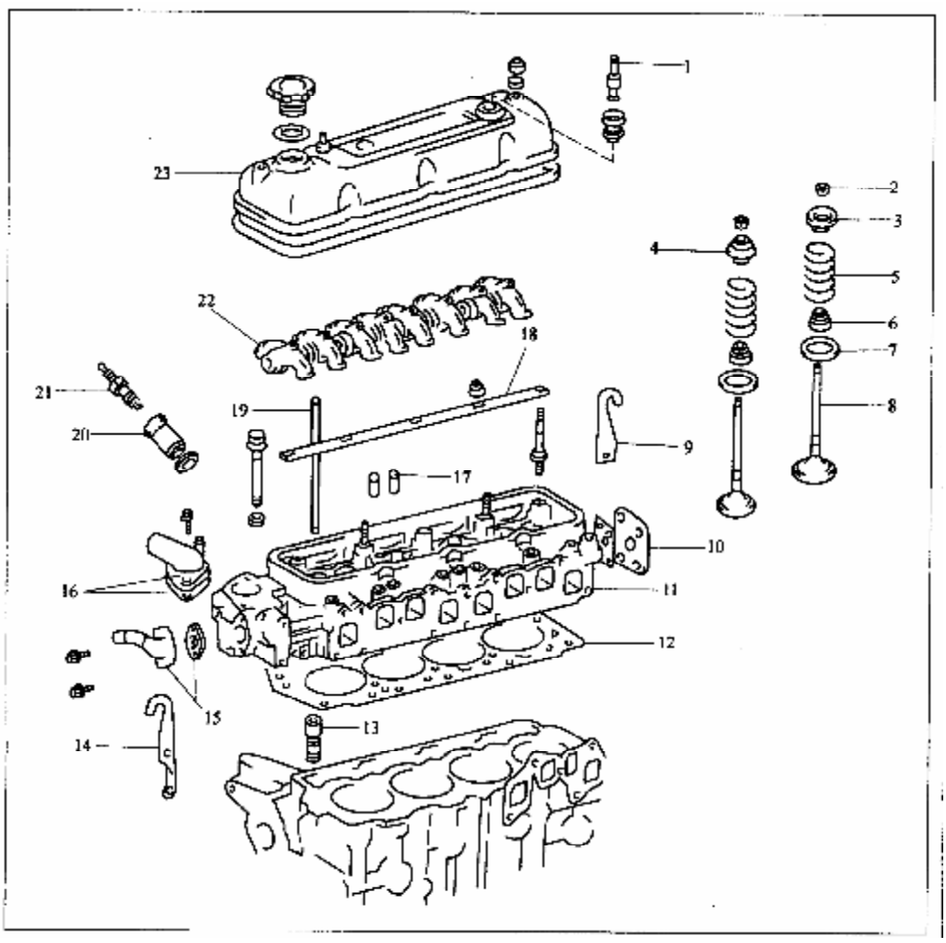


Figure 3-1 Cylinder Head Parts of BJ491EQ1 Multi Point Electronic Fuel Injection Gasoline Engine

1-PVC; 2-Valve keeper; 3-Intake valve spring top cap; 4-Exhaust valve spring top cap; 5-Valve spring; 6-Valve oil seal; 7- valve spring bottom cap; 8-Valve; 9-Rear engine lug; 10-Rear cover of cylinder head; 11-Cylinder head; 12-Cylinder gasket; 13-Hydraulic valve tappet; 14- Engine front lug; 15-Engine front water pipe assembly; 16-Exhaust pipe connector and gasket; 17-Valve guide; 18-Valve rocker arm shaft; 19-Valve push rod; 20-Spark plug cover; 21-Spark plug; 22-Valve rocker arm and spring; 23-Cylinder head cover

3.1.1 In order to prevent gas and water leakage from cylinder gasket, operator should check tightening torques of cylinder head bolts with a torque wrench at every 500km and 2000km (for a new vehicle). The tightening torques: 10 M12 bolts-- 93~105N·m; 3 M8 bolts--20~25N·m.

Tighen the bolts after the gasoline engine has cooled down. The tightening sequence is as shown in Figure 3-2.

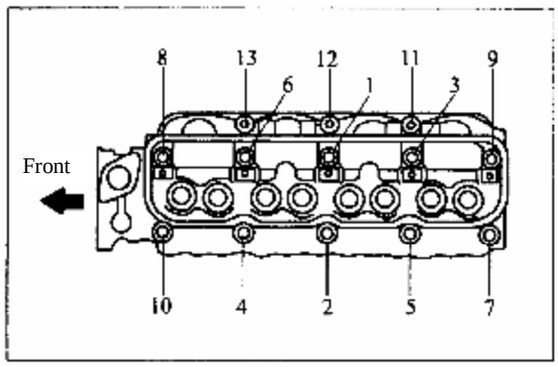


Figure 3-2 Tightening Sequence of Cylinder Head Bolts

● **Note:** A cylinder head bolt can only be used twice. If the bolt has been used twice, replace with a new one.

3.1.2 Follow the sequence indicated in figure 3-3 to disassemble the rocker arm shaft, unscrew the bolts and nuts of rocker arm shaft in 2~3 times to avoid breaking off of rocker arm shaft and damage the bolts.

Follow a sequence that is reversed to these indicated in figure 3-3 to assemble the rocker arm shaft assembly, tighten the bolts and nuts in 2~3 times. The final tightening torque is 25~32N·m.

After a new vehicle has driven 500km and 2000km, its bolts and nuts on rocker arm shaft should be tighened as per above torque requirements.

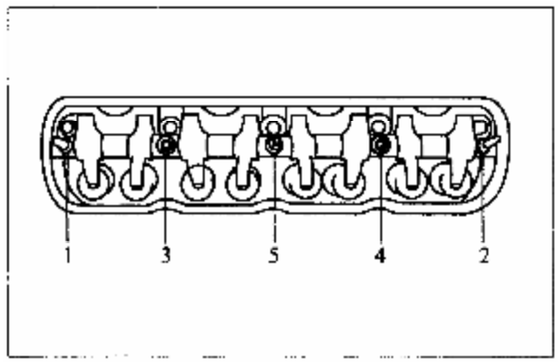


Figure 3-3 Sequence for Disassembly of Rocker Arm Bolts

3.1.3 After the gasoline engine has cooled down, follow the sequence that is reversed to these indicated in figure 3-2 to disassemble the cylinder head. Unscrew the bolts of cylinder head step by step in 3 times to avoid distortion of cylinder head.

3.1.4 When to mount a cylinder gasket, apply high temperature resistant sealant on surfaces of its both sides so as to ensure sealing performance. The gasket must be replace each time cylinder head has been dismantled (see figure 3-4).

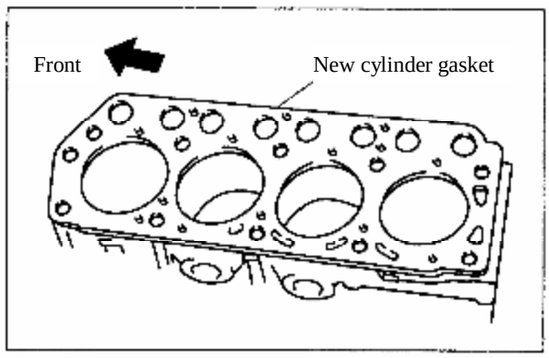


Figure 3-4 Installation of Cylinder Gasket

3.1.5 After a cylinder head has been dismantled, clear gasket leftovers embedded on surfaces of cylinder head / block with a cutter. Be careful not to scratch contact surface and prevent entry of gasket leftover into tappet hole, water jacket hole and bolt hole (see Figure 3-5).

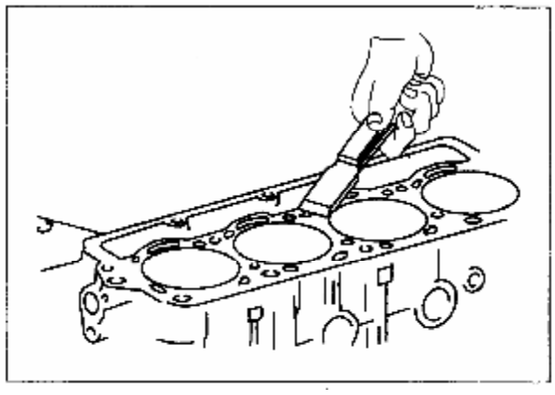


Figure 3-5 Clearing of Cylinder Head / Block

3.1.6 Check cylinder head for crack, and follow procedures indicated in figure 3-6 to measure warpages of cylinder head base and sides where intake and exhaust manifold are installed.

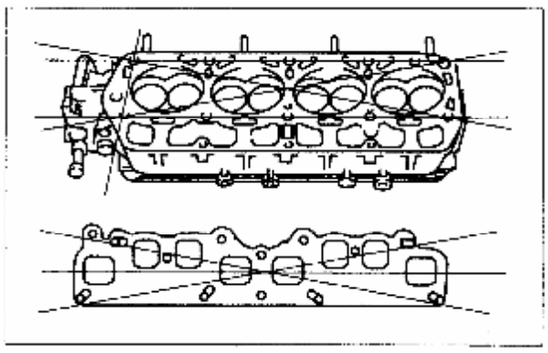


Figure3-6 Cylinder Head warpage Mesurement

Maximum warpage:

Cylinder head base: 0.15mm;

Manifold side: 0.10mm.

If its warpage exceeds the maximum value, cylinder head.should be replaced.

3.1.7 Check the fitting clearance between valve stem and valve guide hole (see Figure 3-7, Figure 3-8)

Diameter of valve guide inner hole: Φ8.010~Φ8.030mm;

Diameter of intake valve stem: Φ7.970~Φ7.985mm;

Diameter of exhaust valve stem: Φ7.965~Φ7.980mm.

Nominal fitting clearances:

Intake valve: 0.025~0.060mm;

Exhaust valve: 0.030~0.065mm;

Maximum fitting clearances:

Intake valve: 0.10mm;

Exhaust valve: 0.12mm.

If the clearance exceeds the maximum value, replace the valve and valve guide.

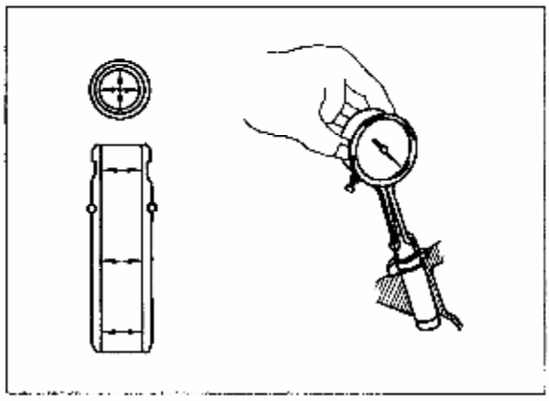


Figure 3-7 Check Diameter of Valve Guide

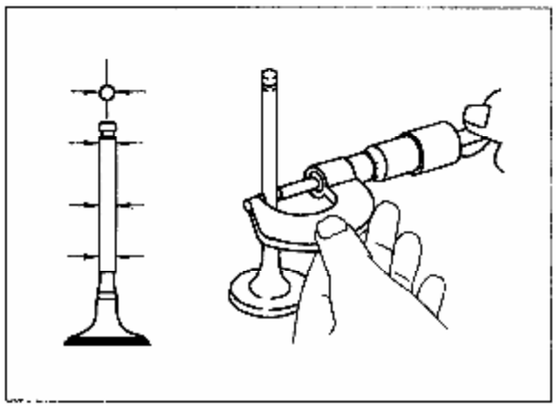


Figure 3-8 Check Diameter of Valve Stem

3.1.8 Check valve cone and plate for depression, groove and carbon deposit. If necessary, grind to correct the valve cone angle (correct angle is 44.5º). The grinding extent should be as small as possible.(see Figure 3-9).

Nominal edge thickness of intake valve: 1.0~1.4mm;

Nominal edge thickness of exhaust valve: 1.3~1.7mm;

Minimum edge thickness of intake valve: 0.5mm;

Minimum edge thickness of exhaust valve: 0.8mm.

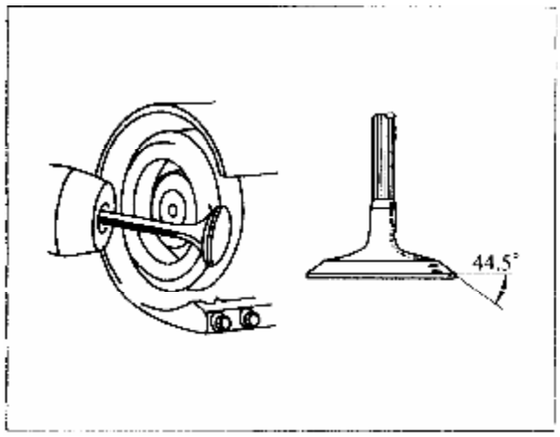


Figure 3-9 Check and Grind Valve Cone

If the edge thickness of valve head is less than minimum value, valve should be replaced. (see Figure 3-10).
Nominal length of intake valve: 108.2mm;
Nominal length of exhaust valve: 108.5mm;
Minimum length of intake valve: 107.7;
Minimum length of exhaust valve: 108.0mm.
If total length of valve is less than the minimum value, valve should be replaced.

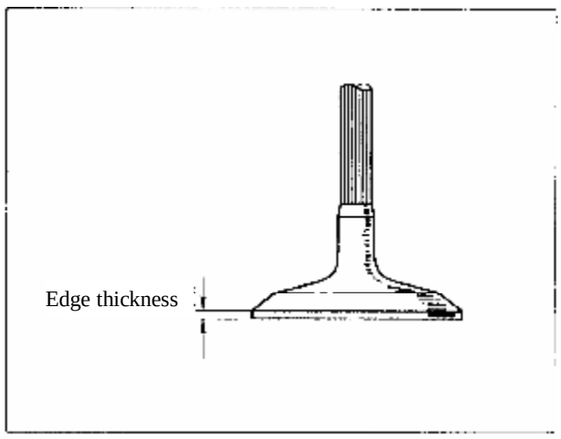


Figure 3-10 Check the Edge Thickness of Valve Head

3.1.9 Check valve seat for wear, damage and carbon deposit. If necessary, grind and clean the valve seat. The grinding extent should be as small as possible.

Coat a thin layer of Prussian blue (or white lead) on the valve cone, install the valve, gently press and turn the valve to check its seating condition. If the valve cone along 360º is covered with blue, the valve must be coaxial; otherwise replace the valve. If the valve along 360º is covered with blue, the valve guide and valve seat must be concentric; otherwise grind the valve seat. The contact annulus should be at the middle of valve cone with a width of 1.2~1.4mm (see figure 3-11).

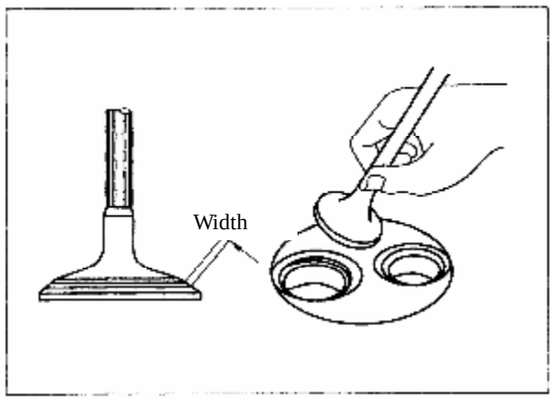


Figure 3-11 Check of Wear Status of Valve Seat

If the contact annulus fails to comply with above requirements:

(1) If the contact annulus is on top of the valve cone, grind the valve seat with 30º and 45º mill (see figure 3-12).

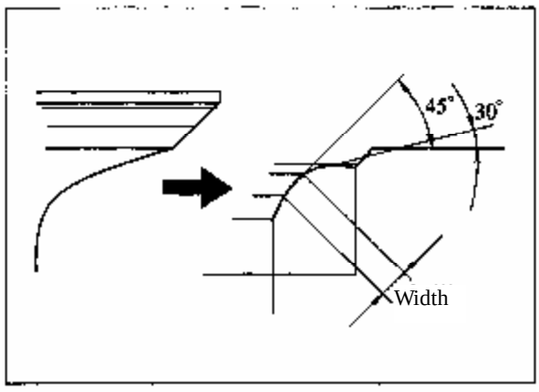


Figure 3-12 Grinding the Valve Seat with 30º and 45º mill

(2) If the contact annulus is at the bottom of the valve cone, grind the valve seat with 60º and 45º mill (see figure 3-13).

(3) Grind the valve and valve seat with valve grinding compound to make them join closely without gas leaking (see figure 3-14). After grinding, clean the valve, valve seat and inner hole of valve guide thoroughly.

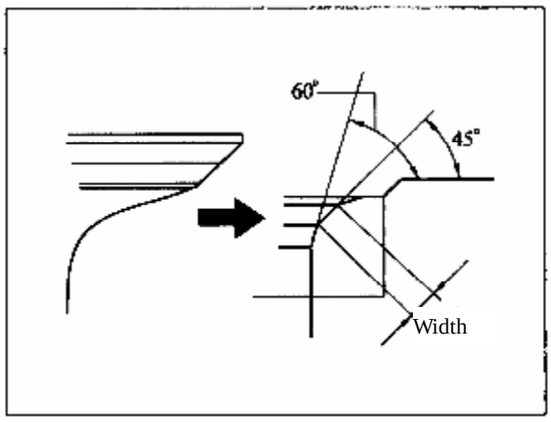


Figure 3-13 Grinding the Valve Seat with 45º and 60º Mill

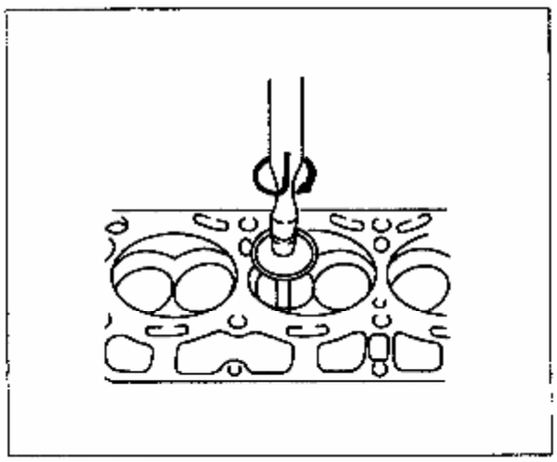


Figure 3-14 Grinding of Valve and Valve Seat

3.1.10 Measure the free length of valve spring with a caliper, the reading should be 47mm ± 0.5mm; measure perpendicularity of valve spring with a surface plate and a square, the reading should be less than or equal to 2mm. If free length or perpendicularity of valve spring exceeds the specified limit, replace the valve spring.

Measure the elastic force of valve spring at nominal installation length 40.6mm with a spring tester, the reading should be 292~336N. If the elastic force of valve spring at nominal installation length does not comply with the specified value, replace the valve spring (see figure 3-15).

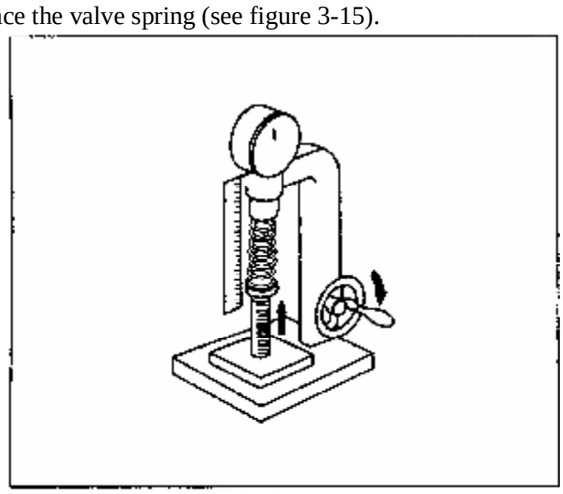


Figure 3-15 Measue elastic force of valve spring

3.1.11 Check valve rocker arm and rocker arm shaft:

(1) Check for wear on contact surface between valve rocker arm and valve, if necessary, polish this surface or replace the rocker arm.

(2) Push and turn the rocker arm by hand along the direction shown in figure 3-16, if a relative movement margin is felt, disassemble and check the fitting clearance between the valve rocker arm and the rocker arm shaft.

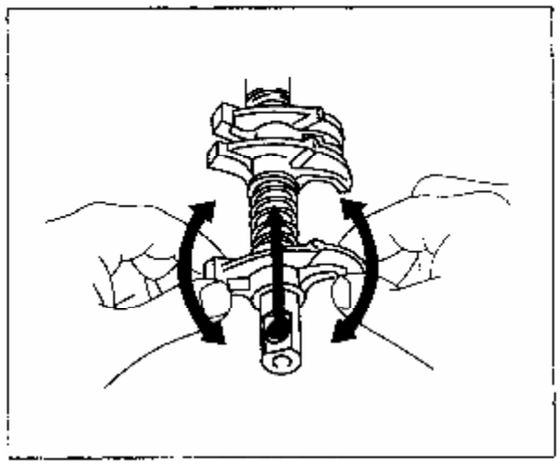


Figure 3-16 Check Valve Rocker Arm and Rocker Arm Shaft

Inner diameter of valve rocker arm: Φ18.500~Φ18.515mm;

Diameter of rocker arm shaft: Φ18.474~Φ18.487mm;

Nominal fitting clearances: 0.02~0.051 mm;

Maximum fitting clearance: 0.08mm.

If the clearance exceeds the maximum value, replace the valve rocker arm and rocker arm shaft.

(3) Make sure the direction of rear end boss (valve rocker arm shaft) is correct, and follow figure 3-17 to assemble valve rocker arm and spring. Use special tools to install and clamp during assembly.

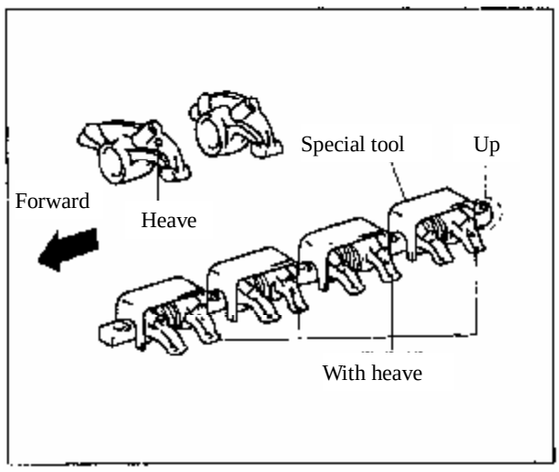


Figure 3-17 Installation of Valve Rocker Arm

3.1.12 Check push rod

(1) Follow figure 3-18 to check run-out at middle of push rod. The maximum value is 0.30mm. If the value exceeds the maximum, replace the push rod.

(2) Check oil passage hole of push rod for clogging. If clogging is present, use compressed air to clear up.

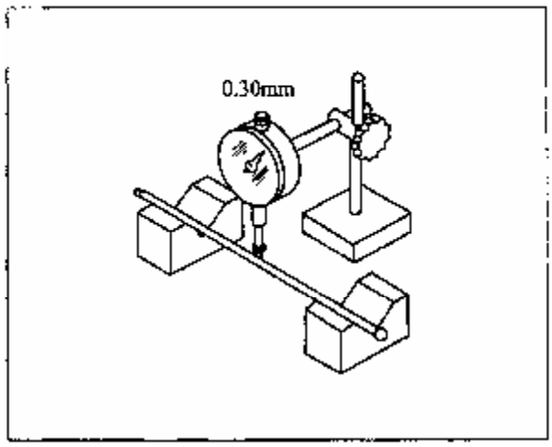


Figure 3-18 Check Run-out at Middle of Push Rod

3.1.13 Use special tools (figure 3-19) to disassemble and assemble the valve. The valve spring end with white paint faces down at mounting.

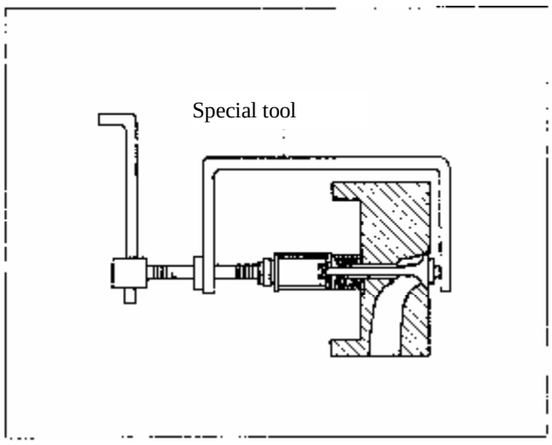


Figure 3-19 Disassembly and Installation of Valve Spring

3.2 Cylinder block parts

See Figure 3-20 for cylinder block parts and crank-connecting rod mechanism parts in BJ491EQ1 multi point electronic fuel injection gasoline engine.

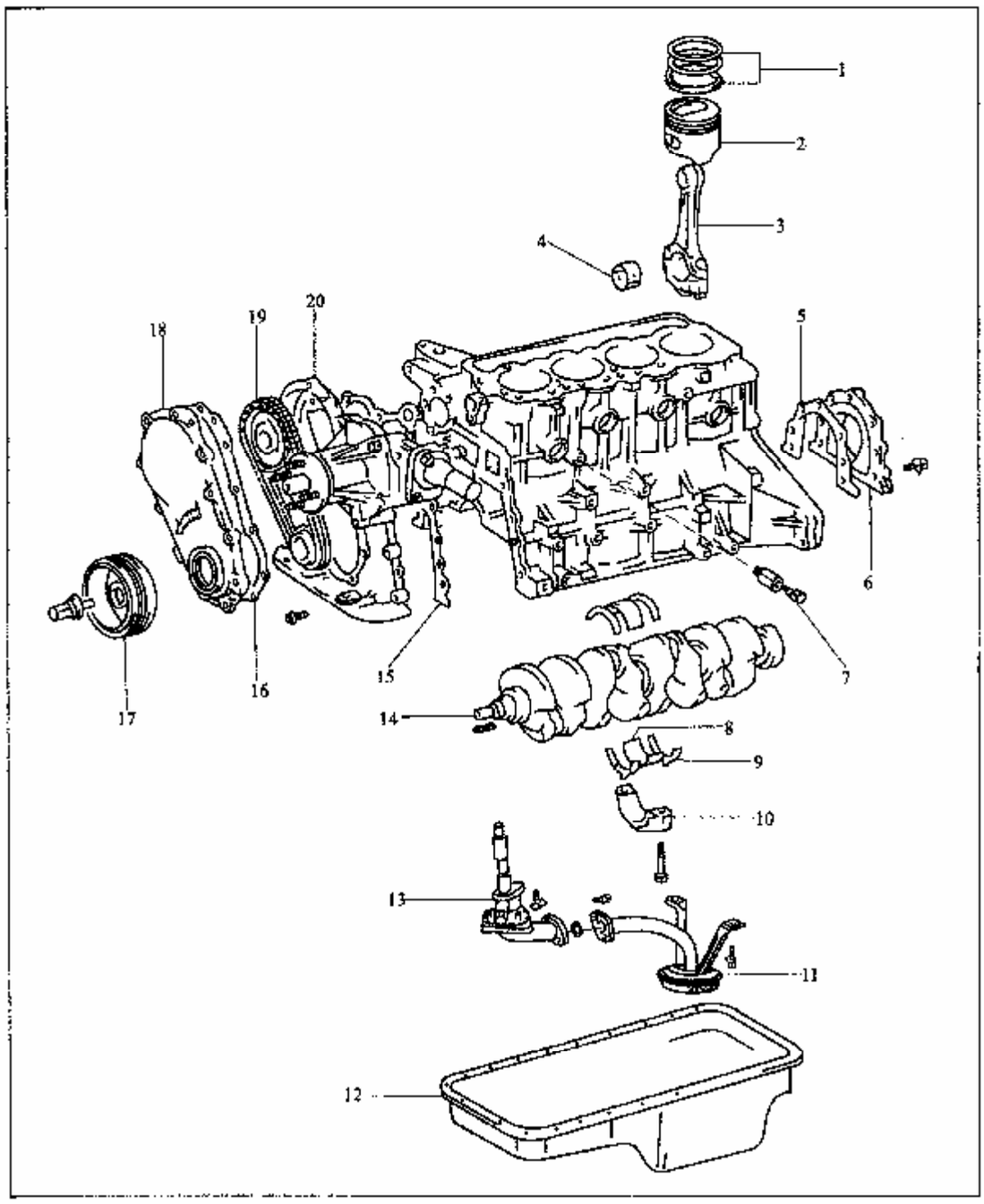


Figure 3-20 Cylinder Block Parts and Crank-connecting Rod Mechanism Parts -- BJ491EQ1 Multi Point Electronic Fuel Injection Gasoline Engine

1-Piston ring; 2-Piston; 3-Connecting rod and connecting rod cap; 4-Connecting rod bearing sleeve; 5-Rear oil seal gasket; 6-Rear oil seal cover; 7-Drain switch; 8-Main bearing shell of crank; 9-Crankshaft thrust plate; 10-Main bearing cap; 11-Engine oil strainer; 12-Oil pan assembly; 13-Engine oil pump; 14-Crank; 15-Sprocket chamber gasket; 16-Sprocket chamber cover gasket; 17-Crank pulley; 18-Sprocket chamber cover; 19-Timing chain and sprocket; 20-Sprocket chamber casing

3.2.1 Check axial clearance between big end of connecting rod and end surface of crank-connecting rod journal with a feeler or a dial indicator. Nominal clearance: 0.160~0.312mm; maximum axial clearance: 0.35mm. If the clearance exceeds the maximum value, replace the connecting rod (see Figure 3-21).

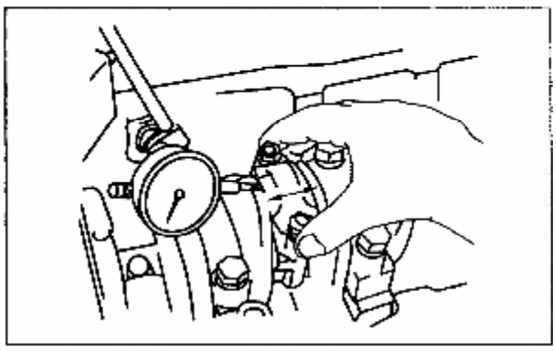


Figure 3-21 Check End Clearance of Connecting Rod Big End

3.2.2 Check end clearance of crank with a dial indicator. Nominal clearance: 0.02~0.22mm, maximum end clearance: 0.35mm. If the clearance exceeds the maximum value, replace with a new set of thrust plates. Nominal thickness of thrust plate: 2.440~2.490mm.

3.2.3 The main bearing caps are not interchangeable, and their directions (front and rear) must be correct. In order to prevent misplacement or adverse installation, the main bearing cap is marked with sequence number and cast a "forward" arrow (see Figure 3-22).

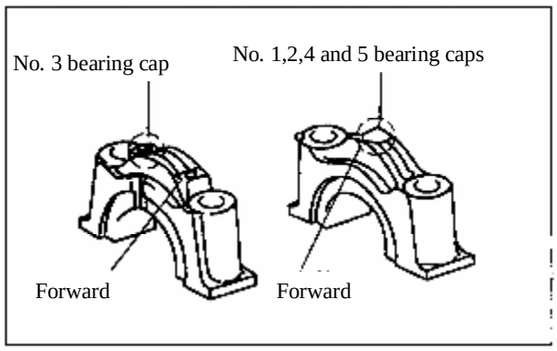


Figure 3-22 Marks on Main Bearing Cap

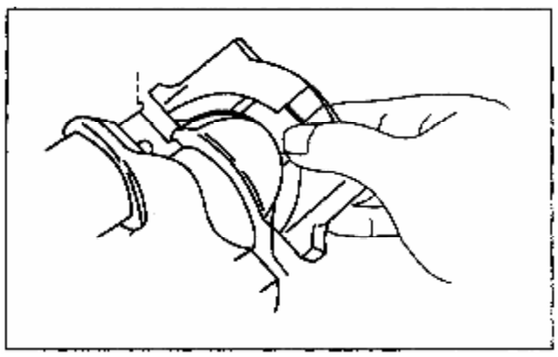


Figure 3-23 Assemble a Thrust Plate

3.2.4 Thrust plates are installed respectively on both sides of 3rd main bearing seat / cap of cylinder block.

●**Note:**

(1) When to install a thrust plate, its side with oil groove should be outward. Never install it in adverse direction (see Figure 3-23).

(2) There are oil grooves and oil holes on the main bearing cover that is installed on cylinder block. The upper and lower covers can not be installed adversely.

3.2.5 Check cylinder block for crack and damage, and follow Figure 3-24 to check warpage on top deck of cylinder block with a fine ruler and a feeler (the value should be less than 0.05mm). If the warpage exceeds the specified limit, use surface grinder to grind the top deck of the cylinder block. Or replace the unserviceable cylinder block.

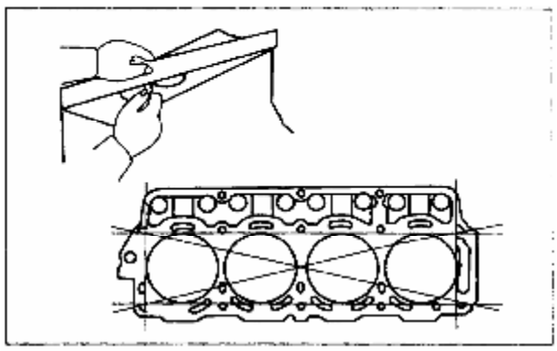


Figure 3-24 Check Warpage on Top deck of Cylinder Block

3.2.6 Measure inner diameter of each cylinder bore. Measuring position and direction see Figure 3-25. Nominal diameter of cylinder bore is Φ91.00~Φ91.03mm. See Table 3-1 for diameters of cylinder bore groups..

Table 3-1 Diameters of Cylinder Bore Groups

First group	Φ91.00mm≤D＜Φ91.01mm
Second group	Φ91.01mm≤D＜Φ91.02mm
Third group	Φ91.02mm≤D＜Φ91.03mm

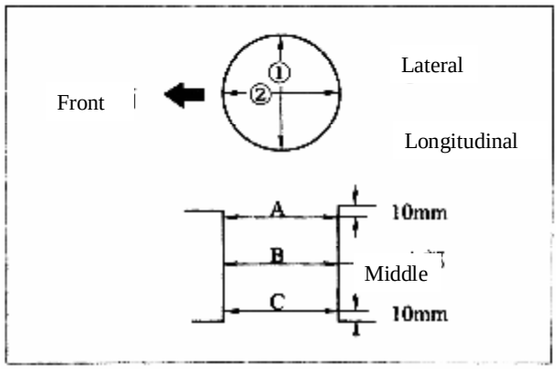


Figure 3-25 Measurement of Cylinder Bore Diameter

Maximum cylinder bore diameter: Φ91.23mm.

If diameter exceeds the maximum value, re-bore the four cylinders.

3.2.7 If deep longitudinal score or burn-out is present on cylinder wall, re-bore the four cylinders. The increased diameter of cylinder bore during repairing (+0.50mm) is Φ91.50~Φ91.53mm. After repair, the wear limit of cylinder bore is Φ91.73mm.If the value exceeds this limit, replace the cylinder block.

3.2.8 Diameter of gasoline engine piston falls into three groups (see Table 3-2) , each matches the cylinder bore in the same group. The grouping mark is on top of piston.

Table 3-2 Piston Diameter Group

First group	Φ90.938mm≤D＜Φ90.948mm
Second group	Φ90.948mm≤D＜Φ90.958mm
Third group	Φ90.958mm≤D＜Φ90.968mm

Measuring position for piston diameter: at skirt section, 24mm from top along the direction vertical to piston pin (see Figure 3-26).

The increased piston diameter for repair is Φ91.438~Φ91.468mm.

The fitting clearance between piston and cylinder is 0.052~0.072mm. Follow the following formula to calculate the required re-boring dimension.

Cylinder re-boring dimension = piston diameter + cylinder fitting clearance with piston – boring margin

The boring margin should be less than 0.02mm, because excessive boring may destroy finely machined roundness and cylindricity.

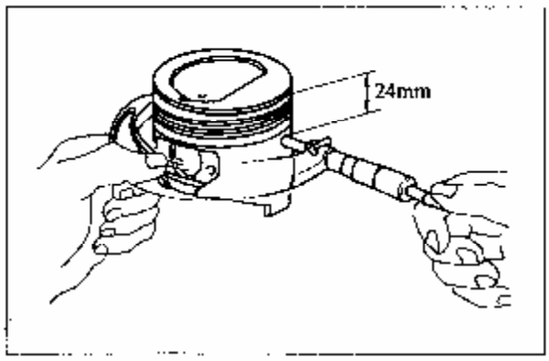


Figure 3-26 Measurement of Piston Diameter

3.2.9 The main bearing hole dimensions fall into three groups. The grouping numbers for first to fifth holes are marked on rear end of bottom plane of cylinder block. The main bearing shells also fall into three groups. During assembly, select the main bearing shell with the same grouping number as main bearing hole, and install it into corresponding main bearing hole (see Figure 3-27).

Check for fitting clearance between crankshaft main journal and main bearing shell. The nominal clearance is 0.020~0.051mm, the maximum value is 0.1mm. If the clearance exceeds the maximum, replace the main bearing shell, or replace the crankshaft if necessary.

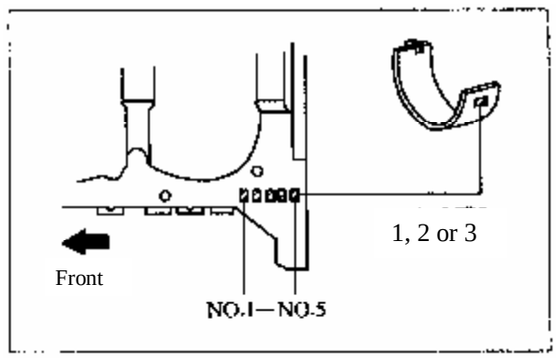


Figure 3-27 Matching of Main Bearing shell

3.2.10 Follow Figure 3-28 to check run-out of main journal at middle of crankshaft (the maximum run-out is 0.06mm). If the run-out exceeds the maximum value, replace the crankshaft.

Nominal diameter of crankshaft main journal is Φ57.985~Φ58.000mm; nominal diameter of connecting rod journal is Φ47.985~Φ48.000mm; cylindricity limit of main journal and connecting rod journal is 0.020mm. Replace the crankshaft if it is out of these range.

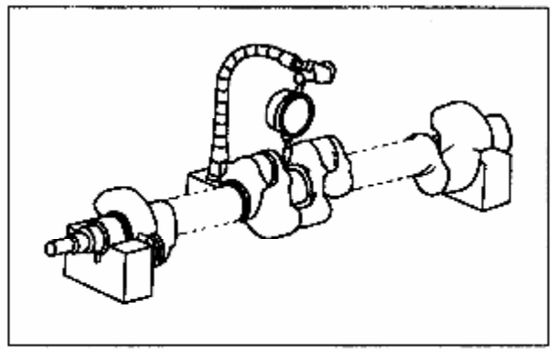


Figure 3-28 Check Crankshaft

3.3 Crank-connecting rod mechanism

The crank-connecting rod mechanism of BJ491EQ1multi point electronic fuel injection gasoline engine is as shown in Figure 3-20.

3.3.1 Check fitting clearance between crank-connecting rod journal and connecting rod shell. The nominal clearance is 0.020~0.051mm, and the maximum value is 0.100mm. If the fitting clearance exceeds this maximum value, replace the connecting rod shell or replace the crankshaft if necessary,

3.3.2 Both connecting rod big end holes and connecting rod bearing shells fall into three groups with marks as 6, 7, 8. Assembly should be made within same group.

Mating numbers are marked on sides of connecting rod body and connecting rod cap. Interchanged assembly is prohibited. The semicircle heaves on connecting rod body and connecting rod cap should be on the same side with that of piston that has a depression mark on top. They should all face engine front (see Figure 3-29).

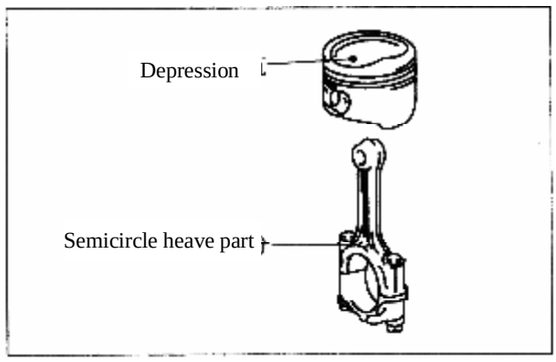


Figure 3-29 Semicircle Heaves on Connecting Rod Body and Connecting Rod Cap and Depression Mark on Top of Piston

3.3.3 Check bending extent (see Figure 3-30) and distortion (see Figure 3-31) of connecting rod with a connecting rod corrector. Maximum bending extent: 0.05mm for every 100mm; maximum distortion: 0.05mm for every 100mm. If bending extent or distortion exceeds the maximum value, replace the connecting rod.

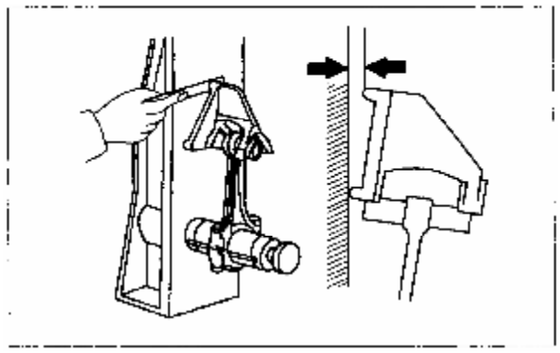


Figure 3-30 Check Bending Extent of Connecting Rod with a Connecting Rod Corrector

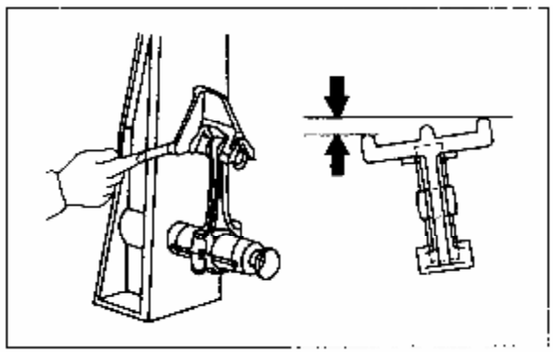


Figure 3-31 Check Distortion of Connecting Rod

●**Note:** When to replace the connecting rod, its cover and bearing shell should be replaced at the same time.

3.3.4 Check piston and piston ring groove for wear. Replace piston if necessary.

●**Note:** If piston has to be replaced, the ring on it should also be replaced.

The clearance between piston and piston ring (ring groove clearance) is 0.03~0.07mm. If the ring groove clearance does not comply with the specified value, replace the piston.

Install piston ring into cylinder bore, use piston to press it to the position where is 110mm from top of

cylinder block, and then measure ring opening clearance (end clearance) with a feeler. Nominal end clearances: first ring 0.27~0.39mm; second ring 0.40~0.55mm; oil ring: 0.20~0.70mm. Maximum end clearance: first ring: 1.11mm; second ring: 1.07mm; oil ring: 1.10mm (see Figure 3-32).

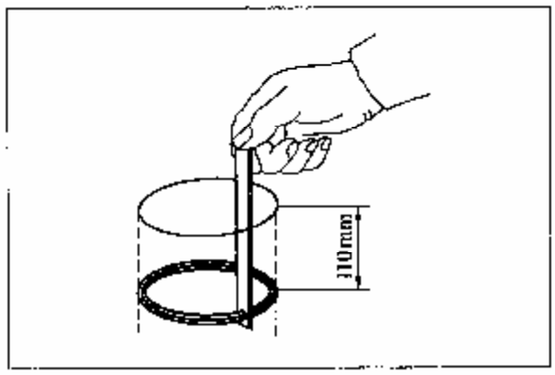


Figure 3-32 Check Piston Ring Opening Clearance

3.3.5 Use special tools to disassemble and assemble piston and connecting rod assemblies. The usage for special disassembling tools are as shown in Figure 3-33. The usage for special assembling tools are as shown in Figure 3-34.

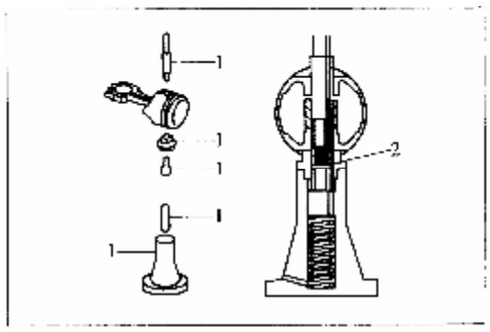


Figure 3-33 Special Tools to Dismantle Piston and Connecting Rod Assemblies

1-Special tools; 2-Piston pin

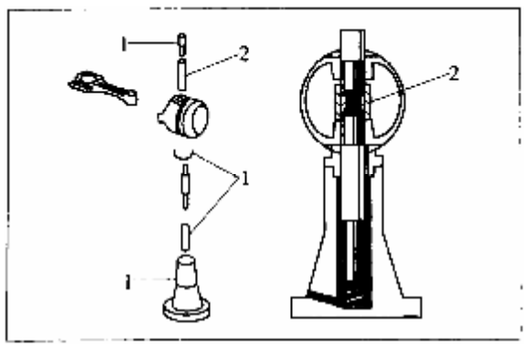


Figure 3-34 Special Tools to assemble Piston and Connecting Rod Assemblies

1-Special tools; 2-Piston pin

3.3.6 After three piston rings are installed onto ring grooves, their opening positions should be interleaving as shown in Figure 3-35 with marks on first ring and second ring facing upwards.

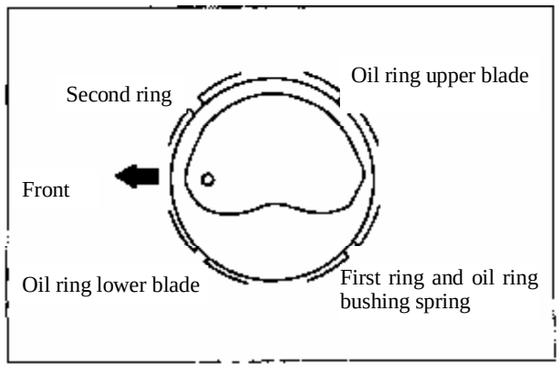


Figure 3-35 Opening Positions of Piston Rings

3.3.7 Check for fitting clearance between bearing hole and journal of camshaft. Inner diameters of bearing holes (counting from front end) are as follows:

First hole: Φ46.500~Φ46.570mm;

Second hole: Φ46.250~Φ46.320mm;

Third hole: Φ46.000~Φ46,070mm;

Fourth hole: Φ45.750~Φ45.820mm;

Fifth hole: Φ45.500~Φ45.570mm;

Nominal fitting clearances: 0.025~0.111mm;

Maximum fitting clearance: 0.140mm.

If the clearance exceeds the maximum value, replace the camshaft bearing, and replace the camshaft when necessary.

3.3.8 Measure diameter of hydraulic tappet hole. The value should be Φ21.417~Φ21.443 mm. Nominal fitting clearance between tappet hole and tappet is 0.017~0.056mm, the maximum value is 0.100mm. If the clearance exceeds the maximum, replace the tappet.

3.4 Valve Train

3.4.1 Using a wire, follow the procedures in figure 3-36 to take out the valve tappet.

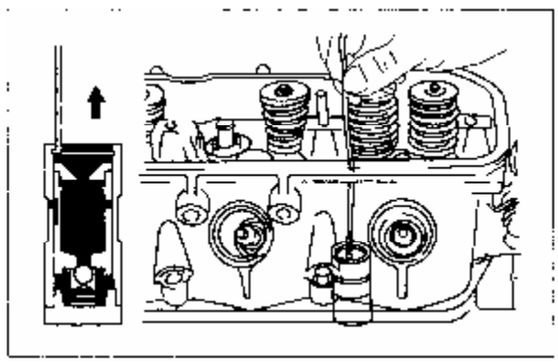


Figure 3-36 Take out Valve Tappet

● **Note**: Place orderly the valve tappets with heads up for easy re-assembly.

3.4.2 Using a spring scales to pull the timing chain with a force of 98N (Figure 3-37). Measure the clearance "△" between chain tensioner plug and support, the value should not exceed 13.5mm. Otherwise replace with new timing chain and sprocket.

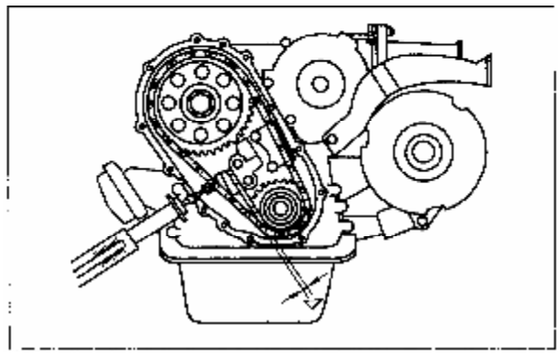


Figure 3-37 Check timing chain slackness

3.4.3 Measure journal run-out at middle of camshaft (Figure 3-38), the maximum value should be 0.06mm. Otherwise replace the camshaft.

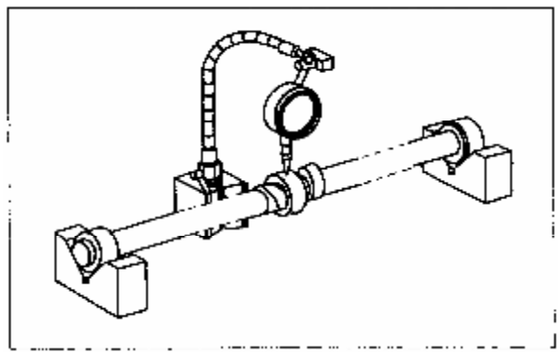


Figure 3-38 Measure Journal Run-out at Middle of Camshaft

Check cam height, the nominal heights of cams should be as follows:

Intake cam: 38.620~38.720mm;

Exhaust cam: 38.629~38.729mm;

Minimum cam height:

Intake cam: 38.26mm;

Exhaust cam: 38.27mm;

If cam height is less than the minimum value, replace the camshaft.

Check camshaft journal, the nominal diameters are (count from front end):

First journal: Φ46, 459~Φ46.475mm;

Second journal: Φ46.209~Φ46.225mm;

Third journal: Φ45.959~Φ45.975mm;

Fourth journal: Φ45.709~Φ45.725mm;

Fifth journal: Φ45.459~Φ45.475mm.

If journal dimension of is not within the specified range, follow the procedures indicated in 3.3.7 of this chapter to check the fitting clearance between camshaft bearing hole and journal.

3.4.4 Install the thrust plate and camshaft sprocket onto camshaft, tighten the fixing bolts of camshaft sprocket with a 90N.m tightening torque, and then measure axial clearance between thrust plate and first journal thrust surface with a feeler (see Figure 3-39). The nominal axial clearance is 0.07~0.22mm. The maximum axial

clearance is 0.30mm. If the clearance exceeds the maximum value, replace the camshaft bearing. Or replace the camshaft if necessary.

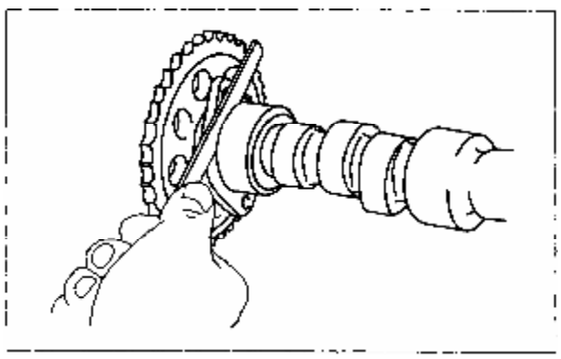


Figure 3-39 Measure Camshaft Axial Clearance

3.4.5 Check length of timing chain. Using a spring scales(Figure 3-40) to pull (49N) the chain.The maximum chain length is 291.4mm. Select 3~4 measurement points at random to measure. If chain length exceeds the maximum value, chain should be replaced.

3.4.6 Using a caliper (Figure 3-41) to measure diameters of crankshaft timing sprocket and camshaft timing sprocket (with chain). Minimum diameters are:

Crankshaft sprocket of: Φ59mm;

Camshaft sprocket: Φ114mm;

If sprocket diameters are less than the minimum value, replace the chain and two sprockets.

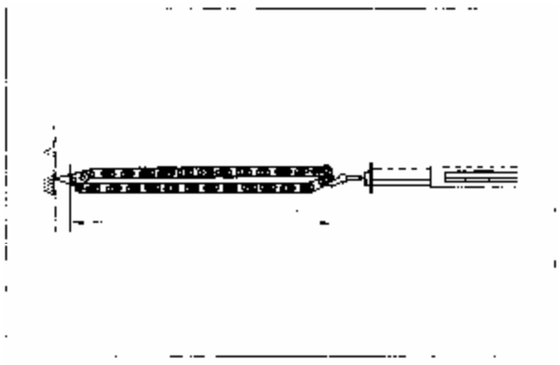


Figure 3-40 Check Timing Chain Length

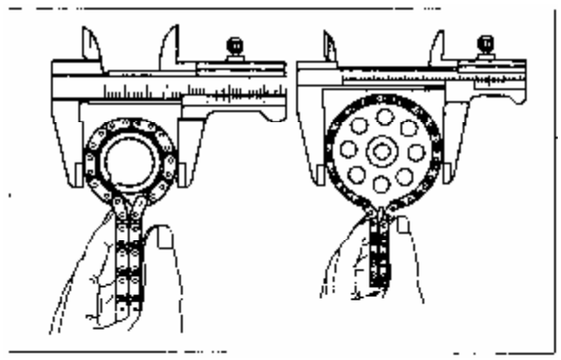


Figure 3-41 Measure Diameters of Crankshaft Timing Sprocket and Camshaft Timing Sprocket (with Chain)

3.4.7 Use a caliper to check the thickness of rubber damper. The damper is on the head of chain tensioner plug (see Figure 3-42). The nominal thickness is 15.0mm, and minimum thickness is 12.5mm.

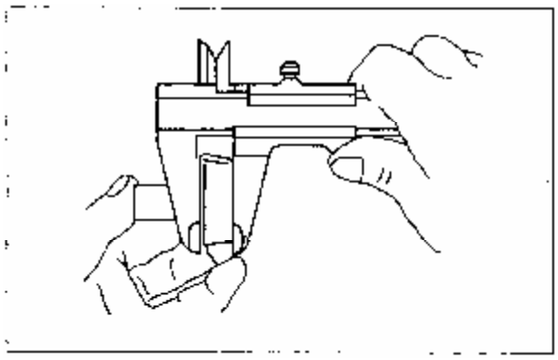


Figure 3-42 Check the Thickness of Chain Tensioner Rubber Damper

If the thickness is less than the minimum value, replace the plug or chain tensioner assembly. When to replace or re-instal the plug, operator should first apply a layer of engine oil onto chain tensioner body hole and plug's sliding surface.

3.4.8 Check thickness of rubber layer on damper. The nominal thickness is 6.6mm and minimum thickness is 5mm. If the thickness is less than minimum value, replace the damper.

3.4.9 Check outer diameter of valve tappet. The value should be 21.387~21.404mm. Otherwise check fitting clearance between tappet hole of cylinder block and valve tappet by following procedures in 3.3.8 of this chapter .

3.4.10 Before installing valve tappet onto gasoline engine, discharge the air its inner chamber first and recheck to ensure air is discharged completely. The methods are as follows (see Figure 3-43):

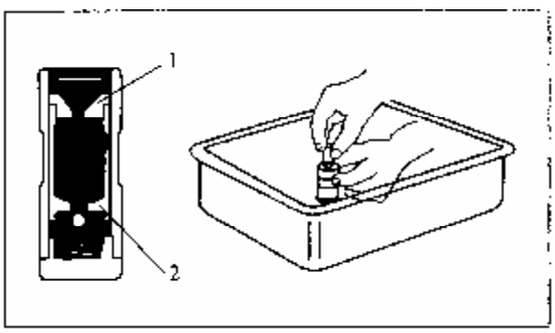


Figure 3-43 Discharge air from tappet

1-Push rod support; 2-Plunger

Dip the plunger into an engine oil pan, depress push several times to discharge air from tappet inner chamber. Then fill the chamber with engine oil. Depress push rod again, if push rod is very hard or even fail to move the plunger, this indicates tappet is in good condition; if plunger is easy to be pressed down, that indicates the tappet is leaking and should be replaced.

● **Note**: Tappet body and plunger are precise coupler, which are not allowed to disassemble or interchange at will. Be sure to use clean oil to perform these procedures.

3.4.11 Leak down test for valve tappet: if possible, use a leak down tester to check tappet leak down(Figure 3-44). The test oil is industrial alcohol or special test oil. Apply a pressure (196N) on the plunger, and measure the time required for another 1mm plunger leak down after the plunger has dropped by 2mm (the value should be 7~50s).

(testing ambient temperature is 20℃).

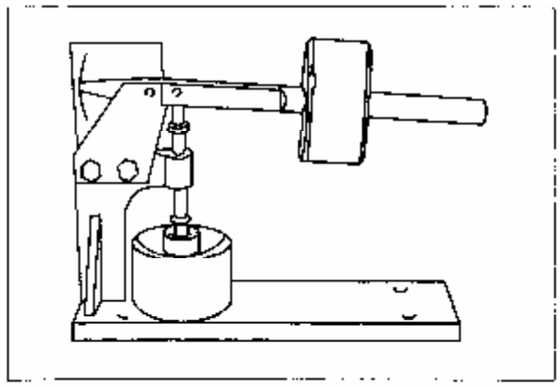


Figure 3-44 Valve Tappet Leak down test

3.4.12 Installation tips for timing sprocket and timing chain:

(1) When to install camshaft thrust plate, its side with two depressions should direct to engine front;

(2) Rotate the crankshaft to move sprocket key to the top, let the key on camshaft top and align with the depression mark on thrust plate (see Figure 3-45).

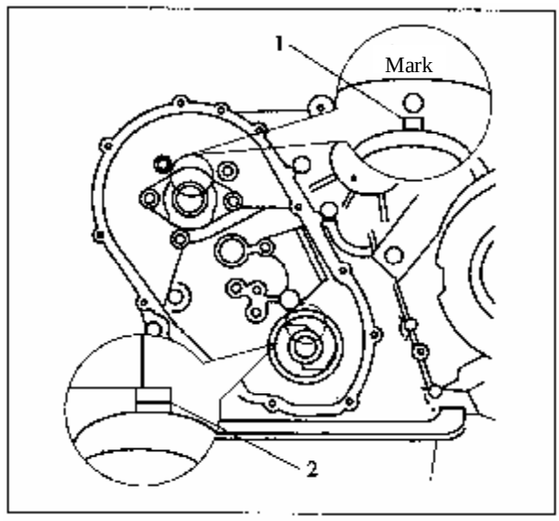


Figure 3-45 Installation of Timing Sprocket and Timing Chain

1-Aligning key of sprocket on camshaft; 2-Aligning key of sprocket on crankshaft

(3) Put the timing chain onto the timing sprockets on camshaft and on crankshaft, and let the two bright white nodes on the chain respectively align with the depressions on two sprockets.

(4) Let key notches on two sprockets respectively align with the aligning keys on crankshaft and camshaft, and then install the two sprockets and timing chains evenly and simultaneously (see Figure 3-46).

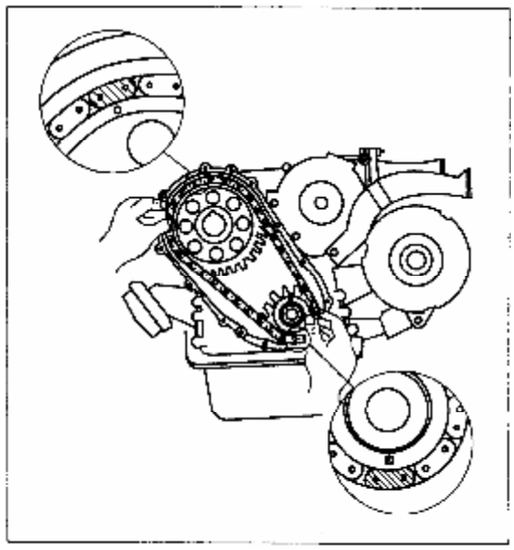


Figure 3-46 Installation of Sprocket and Chain

3.5 Lubrication system

3.5.1 Check quality of engine oil

Check engine oil in lubrication system for deterioration, moisture, color change or thinning. Change any inferior oil. Inferior oil may affect the performance and service life of a gasoline engine.

● **Note:**

(1) Dispose properly changed oil to protect environment.

(2) The engine oil used in lubrication system should comply with the specification in this manual (see 3.2.2)

3.5.1 Check volume of engine oil

Check the volume of engine oil in oil pan with the dipstick. The oil level should be within upper and lower scales of the dipstick. If the oil level is below the lower mark (L), check for leakage and fill with engine oil till the oil level reaches upper scale (F) (see Figure 3-47).

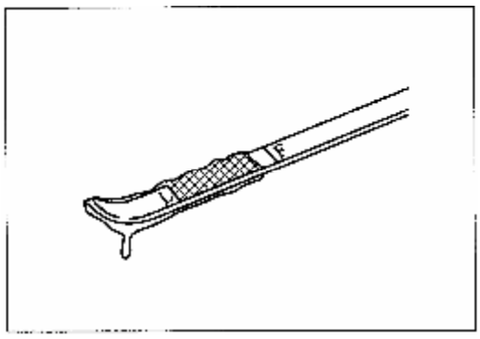


Figure 3-47 Check Oil Volume in Oil Pan with the Dipstick

● **Note:** The oil level could not be higher than the upper scale (F) on dipstick. Otherwise, oil consumption would become high and the service life of three-way catalytic converter would be shortened as well.

3.5.3 Replace engine oil filter

Use special wrench to remove the oil filter. Check and clean the installation surface on filter seat. Coat clean engine oil on new oil filter gasket (see Figure 3-48).

As shown in Figure 3-49, spin on the new filter onto the filter seat by hand until some resistance is felt, and then use a special wrench to rotate for 3/4 turn.

● **Note:** Engine oil filter is one-time service part, which can not be used repeatedly. Dispose the used engine oil and engine oil filter properly to protect environment.

3.5.4 Check engine oil pump

The engine oil pump is installed on lower front right side of cylinder block and is driven by a impeller.

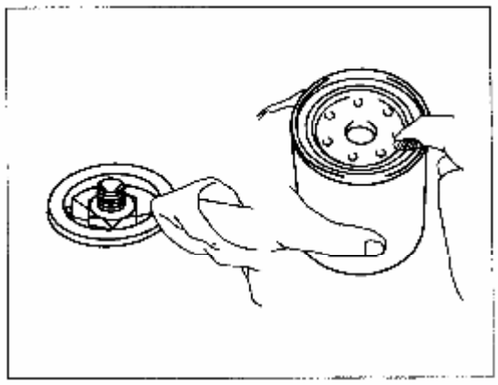


Figure 3-48 Replace Engine Oil Filter

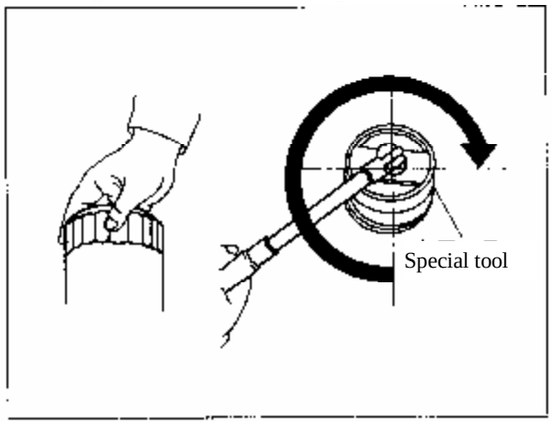


Figure 3-49 Installation of Engine Oil Filter

(1) Dip the oil strainer into engine oil, rotate the pump shaft clockwise. Engine oil should flow out from oil outlet of oil pump.

(2) Block the oil pump outlet with thumb and rotate the pump shaft with a slotted point screwdriver. It should be hard to be rotated.

3.6 Cooling system

3.6.1 Check coolant volume in reservoir

The level of coolant in reservoir should be within upper and lower scales. Add coolant if necessary.

3.6.2 Check coolant quality

(1) Check coolant for cleanness. Change any dirty coolant.

(2) Check if rust is present around radiator cap and radiator opening.

(3) Check coolant for smear.

3.6.3 Check cooling system

(1) Check cooling system for leakage.

(2) Check radiator and hose for damage and distortion.

(3) Check hose clamps for looseness.

3.6.4 Check fan belt

(1) Check fan belt for crack, extending, deterioration or serious wear. Replace if necessary.

(2) As shown in Figure 3-50, make sure the fan belt engages correctly into pulley.

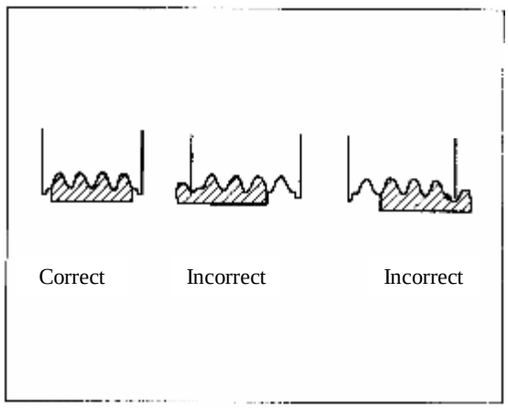


Figure 3-50 Check Engagement of Fan Belt into Pulley

(3) Check and adjust fan belt tension (see Figure 3-51): Use a force of 98N to press the belt at middle spot between alternator and water pump. If the deflection is 7~8mm (for a new belt 5-7mm), belt tension is nominal; otherwise adjust it.

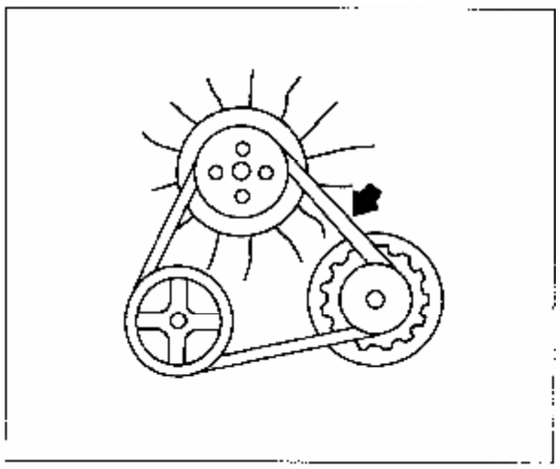


Figure 3-51 Check and Adjust Fan Belt Tension

(4) In cold region, replace with low temperature proof belt in winter.

3.6.5 Check thermostat

Dip the thermostat into water under heating. Gradually to heat up water while checking its opening temperature and valve stroke (see Figure 3-52).

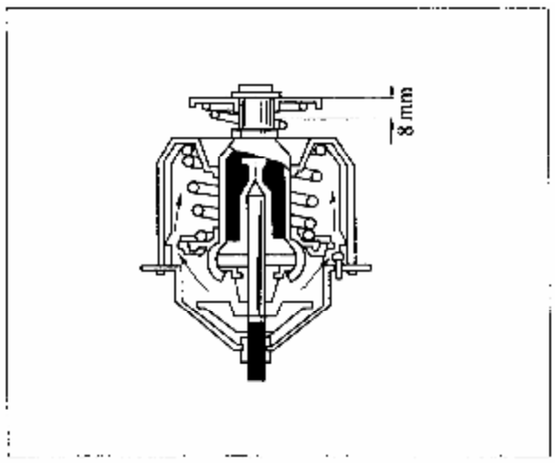


Figure 3-52 Check Thermostat

Opening temperature of the valve: 76℃;

Stroke of the valve: more than 8mm at 88℃.

If the opening temperature and stroke do not comply with specification, replace the thermostat.

The oscillating valve on the thermostat should be turn to upper left position during thermostat installation (see Figure 3-53).

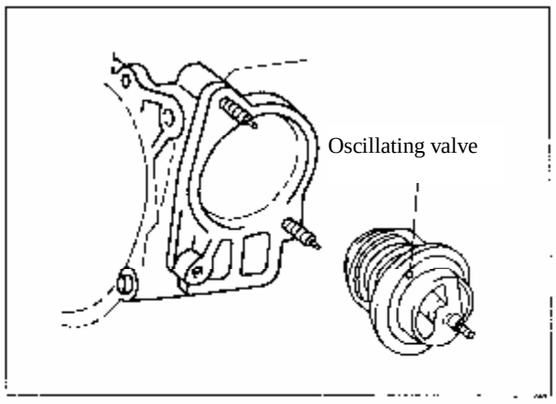


Figure 3-53 Installation of Thermostat

3.6.6 Check water pump

Check water pump and timing sprocket chamber body for crack; check fitting surface for damages, and check water pump bearing for free rotation and noise (see Figure 3-54).

● **Note:** Observe if there is coolant leaking trace from overflow opening.

3.6.7 Check silicon oil fan clutch

Check silicon oil fan clutch (excl. rigid coupling fan) for damage and silicon oil leak. If any, replace the silicon oil clutch. See Figure 3-55.

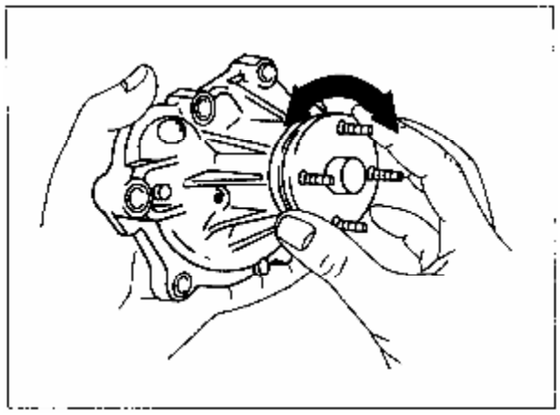


Figure 3-54 Check Water Pump

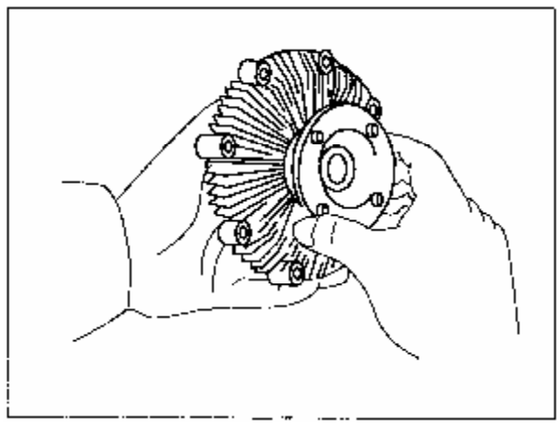


Figure 3-55 Check Silicon Oil Fan Clutch

3.7 Starting system

See figure 3-56 for the starting system of BJ491EQ1 multi point electronic fuel injection gasoline engine.

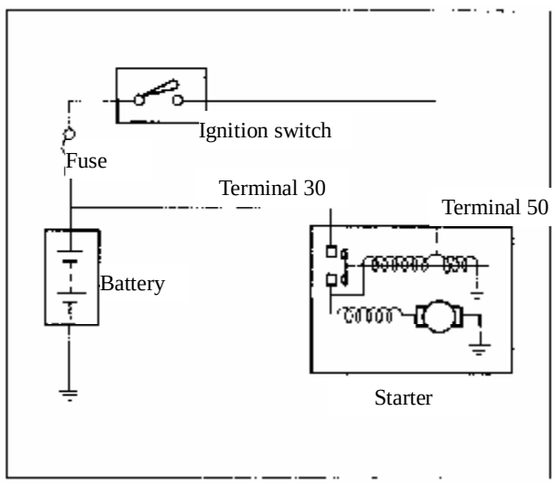


Figure 3-56 Starting System of Gasoline Engine

3.7.1 Attraction test for starter

Disconnect excitation coil from C terminal (see Figure 3-57); connect the battery to solenoid, the pinion should extend out at the moment. If the pinion does not act, replace the solenoid assembly.

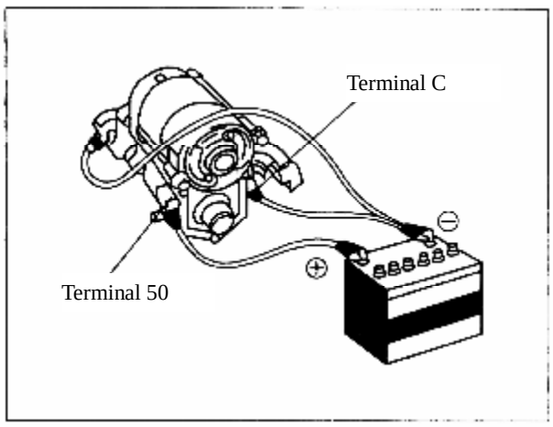


Figure 3-57 Attraction Test for Starter

3.7.2 Maintenance test for starter

As per procedures, when the pinion is in extended position, disconnect negative lead and the pinion should still be in extended out position. If the pinion retracts, replace solenoid assembly (see Figure 3-58).

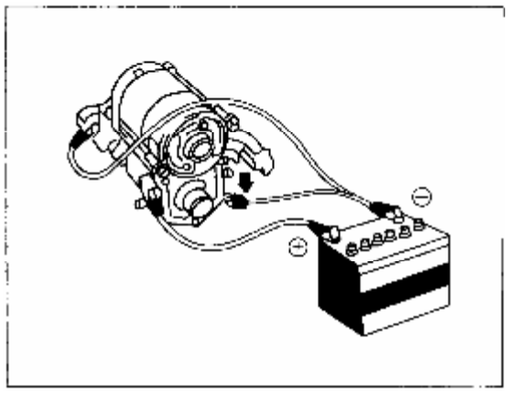


Figure 3-58 Maintenance Test for Starter

3.7.3 Check retraction of starter pinion

As shown in Figure 3-59, disconnect negative lead from the solenoid switch body, and the pinion should retract inwards. If the pinion does not retract, replace the solenoid switch assembly.

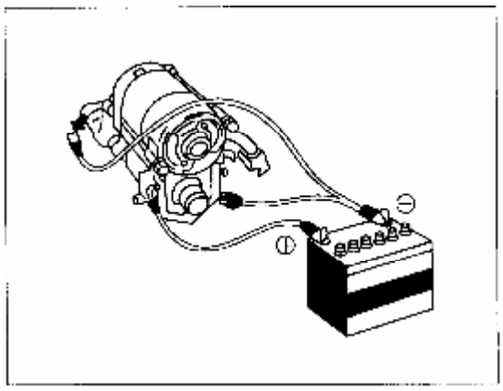


Figure 3-59 Check retraction of Starter Pinion

3.7.4 No-load performance test for starter

As shown in Figure 3-60, connect battery and an vlotage meter, and the pinion should extend out. Check if the starter rotates freely and stably. Check the current, the value should be less than 90A.

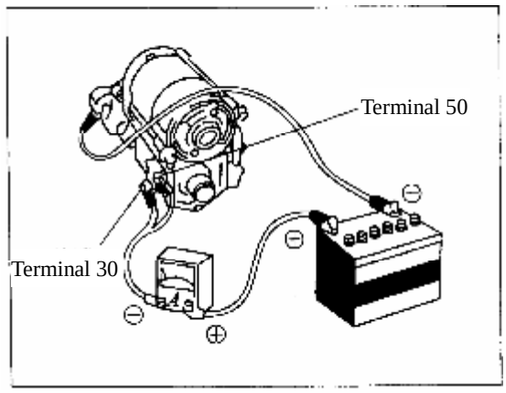


Figure 3-60 No-Load Performance Test for Starter

3.8 Charging system

Model 65A/90A alternator with regulator is used in BJ491EQ1 engine's charging system. Its connection is as shown in Figure 3-61.

3.8.1 Check alternator connection for any abnormal noise during engine running. Dismantle to check if any.

● **Warning**: Never connect or disconnect wiring during engine running to avoid accident.

3.8.2 Check charging indicator lamp circuit. Start the engine and shut it down after it has warmed up. Turn off all electrical accessories. Turn the ignition switch to "ON", the charging indicator lamp should lit then.

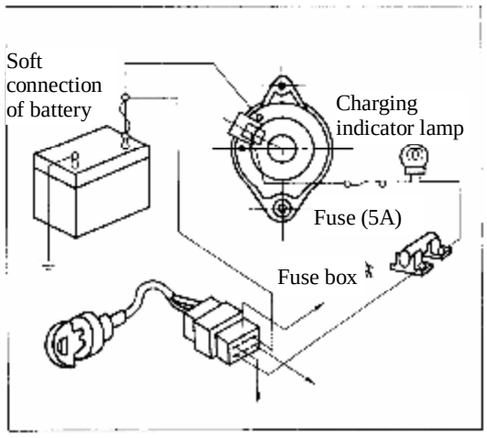


Figure 3-61 Charging System Circuit

The charging indicator lamp should extinguis after engine has started. Otherwise check circuit of charging indicator lamp.

3.9 Crankcase ventilation

BJ491EQ1 multi point electronic fuel injection gasoline engine is equipped with positive crankcase ventilation device, which sucks the exhaust gas leaking into the crankcase to intake manifold and then into the combustion chamber (via vent valve) to burn again. This design tends to protect oil from contaminatded by fuel, and protect component surface from corrosion due to anhydride formed from exhaust gas and water vapor. Therefore, never remove the crankcase ventilation device.

The crankcase ventilation system is mainly composed of the positive crankcase ventilation device (PCV) that is installed on the cylinder head cover, a vent pipe that connects vent valve to intake pipe, and a short pipe that connects valve cover to air filter pipe.

● **Note**: During operation, be sure to prevent the vent valve from being clogged. No damage and gas leak on connecting hose are allowed.

3.10 Clutch

BJ491EQ1 multi point electronic fuel injection gasoline engine adopts diaphragm spring clutch.

3.10.1 Check driven plate of clutch for wear or damage. Measure the depth of rivet head in friction plate. The depth should not be less than 0.3mm, otherwise replace the driven plate (see Figure 3-62).

If necessary, replace plate and cover assembly of a clutch.

3.10.2 Check for run-out tolerance on the edge of driven plate (see Figure 3-63). The maximum run-out tolerance is 0.8mm. If it exceeds this value, replace the driven plate.

3.10.3 Check diaphragm spring for wear. As shown in Figure 3-64, measure depth and width of wear on diaphragm spring with a caliper. The maximum value: depth 0.6mm, width 5.0mm.

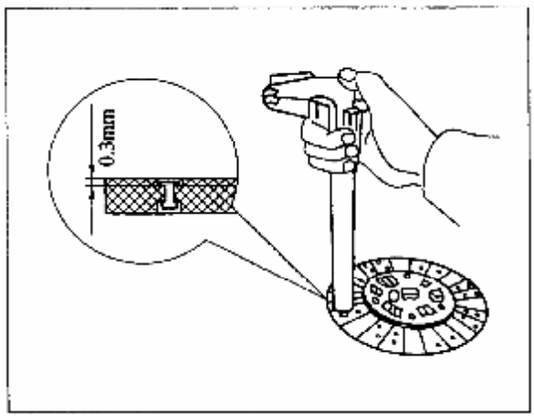


Figure 3-62 Check Driven Plate of Clutch

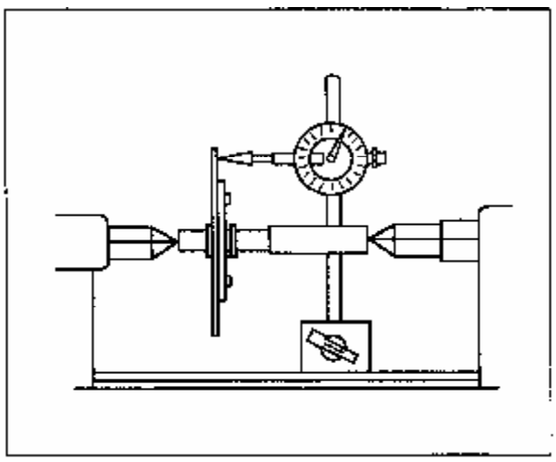


Figure 3-63 Check Run-out Tolerance of Clutch Driven Plate

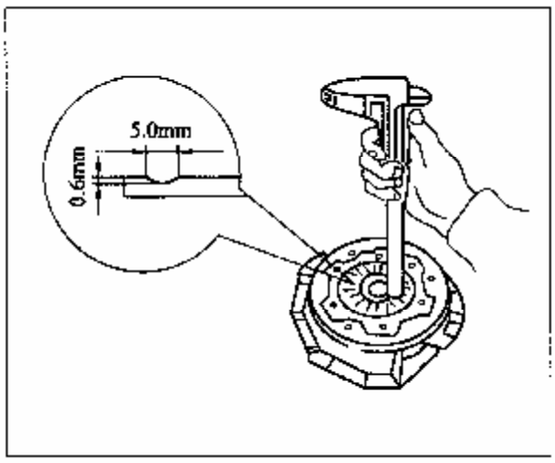


Figure 3-64 Measure Wear on Diaphragm Spring

3.10.4 Installation of clutch: use the tools same as that used on inputshaft of transmission to install the clutch driven plate onto flywheel. Align the mark on clutch housing with the mark at outer edge of flywheel, and then evenly tighten the bolts. The tightening torque is 28~35N·m (see Figure 3-65, Figure 3-66).

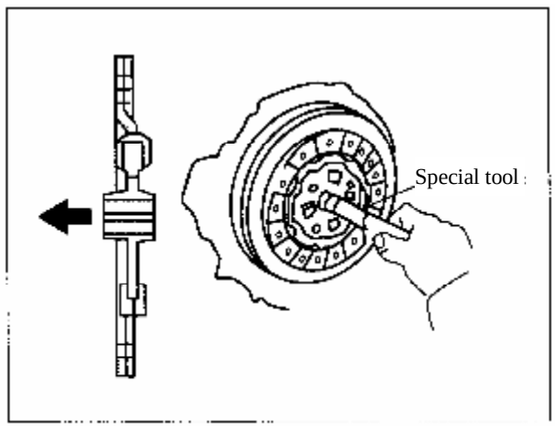


Figure 3-65 Installation of Clutch

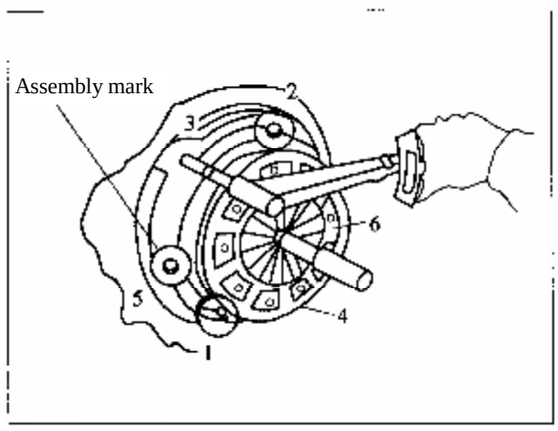


Figure 3-66 Installation of Clutch

Check alignment of diaphragm spring end with a dial indicator. The maximum unflatness is 0.5mm. Adjust it if the unflatness is too high.

● **Note**: Be careful when to repair clutch parts. Clutch parts contain asbestos fiber, excessive inhalation of this fiber may cause serious harm to human body. Therefore, always wear a mask during service. Do not use compressed air and dry brush to clean clutch parts, use special vacuum cleaner for asbestos fiber cleaning . Do not use sand paper to grind the driven plate in case of harmful dust. If the friction lining of driven plate is damaged or blurred, replace with a new driven plate. Collect the dust and dirt containing asbestos fiber into sealed bag or container to protect you and others.

Chapter 4 BJ491EQ1 Gasoline Engine Fuel Injection System

4.1 Introduction of Delphi Electronic Control Fuel Injection (EFI) System

4.1.1 Overview

BJ491EQ1 multi point injection (MPI) gasoline engine adopts Delphi ITMS-6F MPI and direct ignition technology control. ECM receives the signal from all the sensors like air intake pressure sensor and crankshaft position sensor, and then calculates the optimal fuel injection quantity and ignition timing according to its internal preset program. ECM outputs to actuating devices (fuel injector, ignition coil) will finally realize the gasoline engine control functions like fuel injection, ignition and idle speed etc.

EFI system is mainly composed of sensors, control component, actuating components and cables that connect all the components. Electronic control system composition of BJ491EQ1 MPI gasoline engine please see figure 4-1.

4.1.2 Power Supply of EFI System

EFI system adopts 12V DC power supply. The current from battery enters EFI system and ECM through different circuits: one entering system through ignition switch is the main power supply; the other one entering ECM directly through fuse supplies UPS to EFI system.

4.1.3 Fuel Injection System

Fuel supply of EFI system adopts close loop control multi-point group injection device.

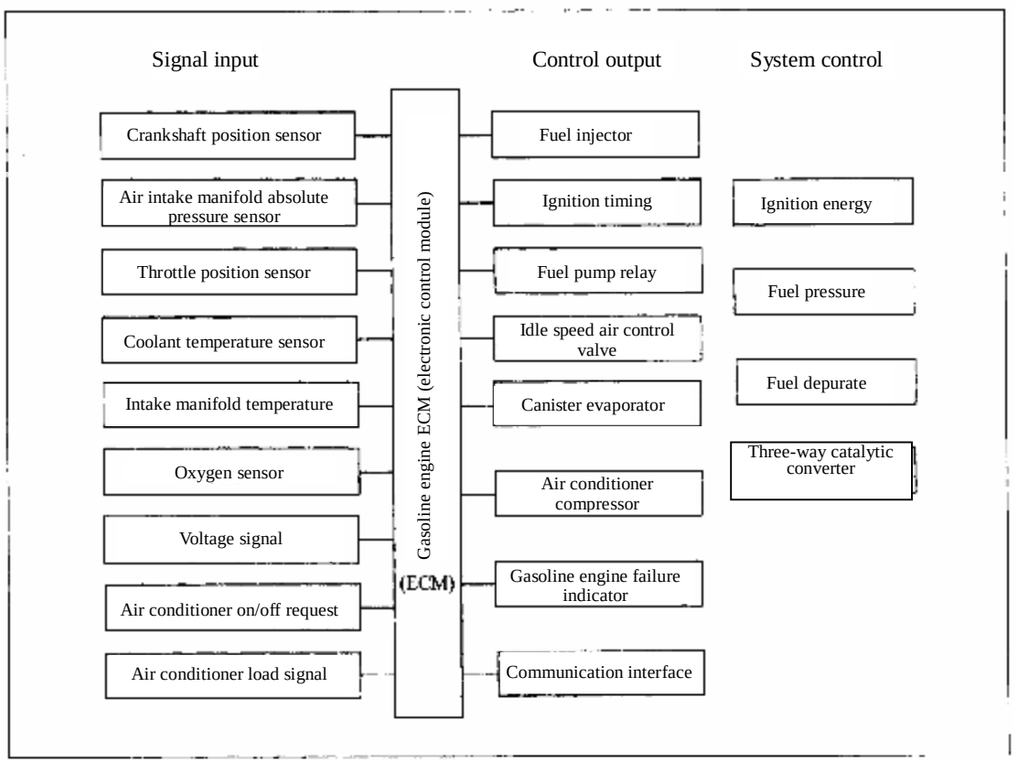


Figure 4-1 BJ491EQ1 MPI Gasoline Engine EFI System Composition

"Close loop control" refers to that ECM corrects and offsets in real time the fuel supply to improve three way catalytic converter performance. ECM uses the actual air fuel ratio from oxygen sensor when the gasoline engine is working.

"Group injection" refers to that gasoline engine cylinders are divided into two groups: 1-4 and 2-3; fuel injector controlled by ECM will inject at air inlet port of certain group when this cylinder group reach to the bottom dead center, and the cylinders at air intake stroke will suck mixed air; for the cylinders at working stroke, the injected fuel will stay around the air inlet port and mix with air completely; and the fuel quantity needed by each cylinder is injected at two times.

4.1.4 Fuel Supply System

Electric fuel pump supplies fuel to EFI system. ECM drives fuel pump relay to connect fuel pump power supply after receiving gasoline engine rotating signal, and fuel pump then begins to supply pressurized fuel to fuel supplying system. Before receiving the engine's rotating signal, ECM will not drive fuel pump to work. This would ensure the safety of fuel system.

4.1.5 Direct Ignition Device

Direct ignition device adopts grouping direct ignition technology (without distributor) that reduces energy loss ignition system, while increasing the ignition coil secondary voltage and energy output. The secondary voltage can reach 34KV. ECM controls ignition coil to ignite the corresponding spark plugs in 1-4 and 2-3 cylinder groups. After ECM unit has collected gasoline engine working signals, ignition timing could be determined based on 1-4 cylinder's TDC mark on crankshaft pulley (58X gear ring). Electronic fuel injection system does need any adjustment, and do not need to consider the wear and carbon deposit in distributor system.

4.1.6 Idle Speed Control Device

The idle control system controls on idle speed by installing idle control valve on throttle valve body, so that it can control the air input. ECM monitors the fluctuation of the engine speed, carries out closed-loop control on the actual idle speed by adjusting the injection fuel quantity, ignition time and the opening of idle control valve. ECM also adjusts the idle speed according to the coolant temperature and engine load at idle speed..

4.1.7 Canister Purge Control system

The canister purge control system controls the working time and speed of canister purging through canister purge solenoid according to engine speed and load, ensuring a ratified fuel evaporation and engine performance.

4.1.8 Close Loop Control Self-learning function

The electronic system has self-learning function on its closed loop control. It can effectively cancel the manufacturing difference between systems and other concerning mechanical components, improve the integrity of a complete machine. It could remove the error resulting from wear during practical use.

4.1.9 Fault Diagnosis Communication Device

ECM controls the operation of all system components and carries out real-time inspection. Once any fault occurs, the fault diagnosis communication system will turn on gasoline engine fault indicator light to warn the driver to perform repair. Fault indicator light can also flash to indicate the fault codes, so that service technician can perform emergency diagnoisis.

4.1.10 Air Conditioner Control Device

When turning on the A/C switch, the A/C control system will receive "A/C on request" signal, and make preparations for A/C loading according to engine condition at the moment. The AC relay connects AC compressor then. A/C control system could decide whether or not to connect A/C according to its protective need.

4.1.11 Electronic Anti Theft Device

The device is "plug to use" type. If the anti-theft device does not receive the correct code from ignition key, ECM will control the system not to inject fuel and ignite so as to perform its anti-theft function.

4.1.12 Overflow Fuel Cut off Control

In the event of engine flooding, you can depress acceleration pedal al the way down and start the engine at

the same time. ECM will stop fuel injection to discharge excessive fuel from running engine.

4.1.13 Deceleration Fuel Cut off Control

During decelerating, ECM will stop fuel supply. It will reduce harmful emission and improve the fuel economy.

4.1.14 Electronic Fan Control

ECM can control the electronic fan at dual speeds. After-maket users can install another electronic fan to improve the fuel economy and reduce over-heating.

4.2 Parts and Components of Delphi EFI System

4.2.1 Air Intake Manifold Absolute Pressure Sensor

Intake Manifold Absolute Pressure Sensor (MAP) monitors the intake pressure at the intake manifold. The signal from the intake manifold absolute pressure sensor will be sent to the ECM, and it will help to decide fuel injection amount and ignition advanced angle. Intake manifold absolute pressure sensor will be mounted with its end downward and pressure hole has a 30° angle to avoid condensed liquid on terminal from being left over inside the sensor. (See Figure 4-3)

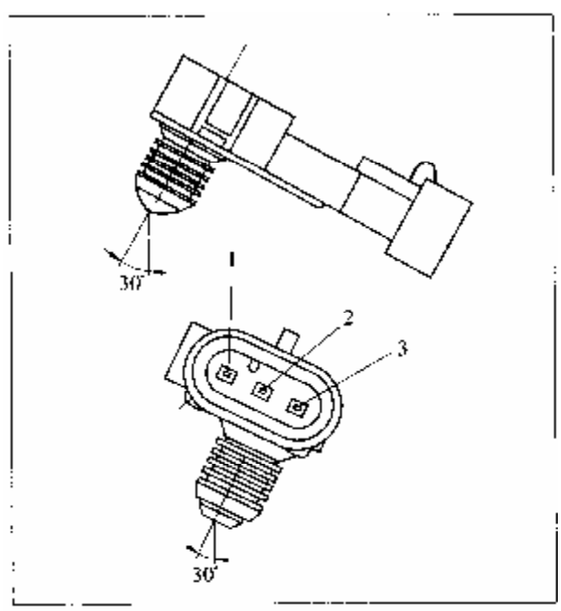


Figure 4-3 Installation of Air Intake Manifold Absolute Pressure Sensor

1- Input voltage; 2-Output voltage; 3-Grounding

Intake manifold absolute pressure sensor is composed by one sealed spring diaphragm and one magnetic core. They are put in the coil precisely. When it senses pressure, it will produce an output signal (0-5V) which is postive ratio to input pressure

4.2.2 Intake Air Temperature Sensor

Intake temperature sensor measures the intake temperature and send its signal to the ECM to compute the intake flow. Intake temperature sensor is installed at the front end of intake pipe. It is composed by one thermistor (fixed in plastic socket) and one plug blade. The resistance of thermostor is negative ratio to temperature (see Figure 4-1). MAT is shown in Figure 4-4

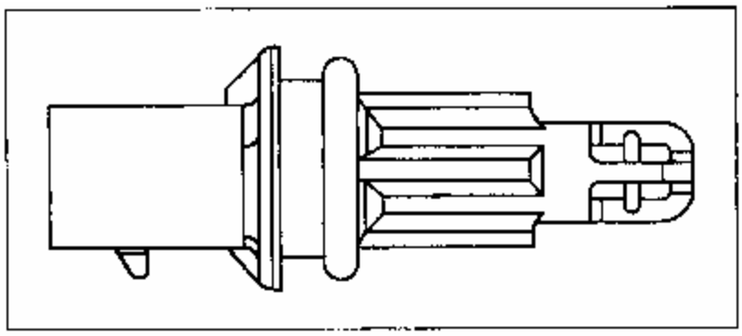


Figure 4-4 Intake Air Temperature Sensor

Table 4-1 Thermistor Resistance and Temperature

Temperature	Resistance without load
100℃	178Ω ±4.1Ω
128℃	81.65Ω ±2.9Ω

4.2.3 Coolant Temperature Sensor

The coolant temperature sensor (CTS) monitors the coolant temperature and send the signal to the ECM. It is not only used to compute the intake capacity, but also to ensure transient air-fuel ratio and idle rpm as well as adjust the ignition advanced angle. It is installed on outlet of coolant pipe. It is composed by one thermistor (fixed in plastic socket) and two plug blades. The resistance of thermostor is negative ratio to temperature. The resistant is 81.65Ω ±2.91Ω at 128℃.. Figure 4-5 shows a CTS.

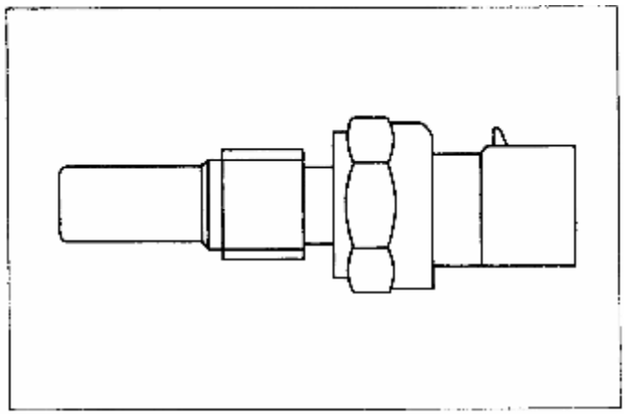


Figure 4-5 Coolant Temperature Sensor

4.2.4 Crankshaft Position Sensor

The crankshaft position sensor (CPS) measures the engine Rpm and crankshaft turning angle. ECM determines the ignition advanced angle and fuel injection timing in each cylinder according to the crankshaft turning angle signal. It is installed on the cap of timing pulley, corresponding to 58X gear ring on pulley. It is composed of one permanent magnet / coil. While the crankshaft is running, the tooth and notch on gear ring is passing the sensor at different distances, causing the change of magnetic resistance to produce different output signals (collected by sensor). The wave pattern of output signal indicates crankshaft turning position. Signal frequency is positive ratio to crankshaft rotating frequency.

The connecting wire of crankshaft position sensor has shield wrap, and it connects to the grounding lead to avoid electromagnetic disturbance. The crankshaft position sensor is shown on Figure 4-6 and the installation position shown on Figure 4-7. The principle of the crankshaft position sensor is shown on Figure 4-8.

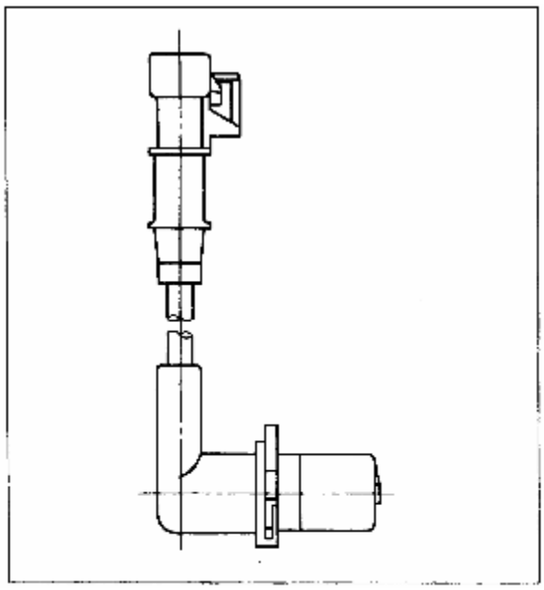


Figure 4-6 Crankshaft Position Sensor

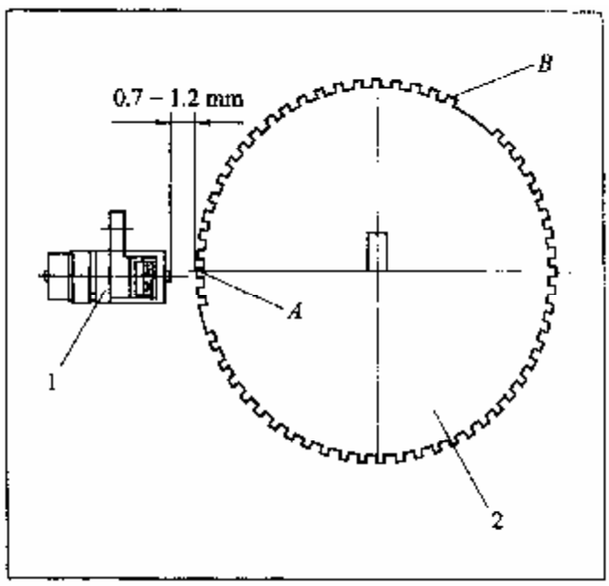


Figure 4-7 Installation Position of Crankshaft Position Sensor and Crankshaft Pulley

1-Crankshaft position sensor; 2-Crankshaft pulley ; A-20th tooth; B-1st tooth

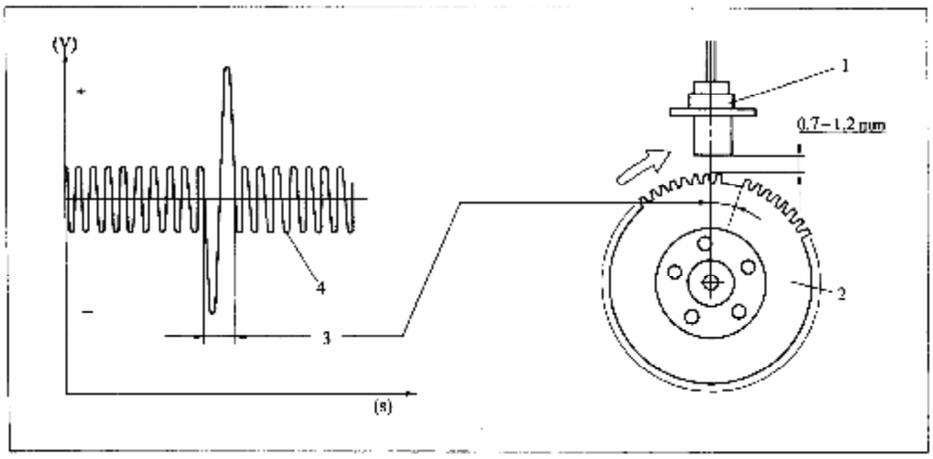


Figure 4-8 Working Principle of Crankshaft Position Sensor

1-Crankshaft position sensor; 2 -Pulley with teeth; 3-Signal corresponding with gap teeth; 4-Output signal

4.2.5 Oxygen Sensor

The oxygen sensor monitors residual oxygen concentration in exhaust gas. It compares transient air fuel ratio with theoretical air-fuel ratio, thus ECM could send command fuel injection system to "increase or decrease fuel" according to OS signal. This would keep engine operating at theoretical air-fuel ratio state.

Oxygen sensor is installed on the exhaust pipe. Oxygen sensor is not allowed to be collided. Protect its tip from contanmination by oil, detegent, lead, coke or other organic material.

OS working principal: when the temperature is high than 300℃, zirconia can separate the oxygen ion from the oxygen in the exhaust gas. In such case, different oxygen contents on two sides of sensor would produce potential difference. In other words, this potential difference would in turn help to figure out oxygen content difference in two areas (air side and exhaust gas side). The message will be sent to ECM unit, the unit will then control fuel injecting amount, adjusting air-fuel ratio to the theoretical value as close as possible.

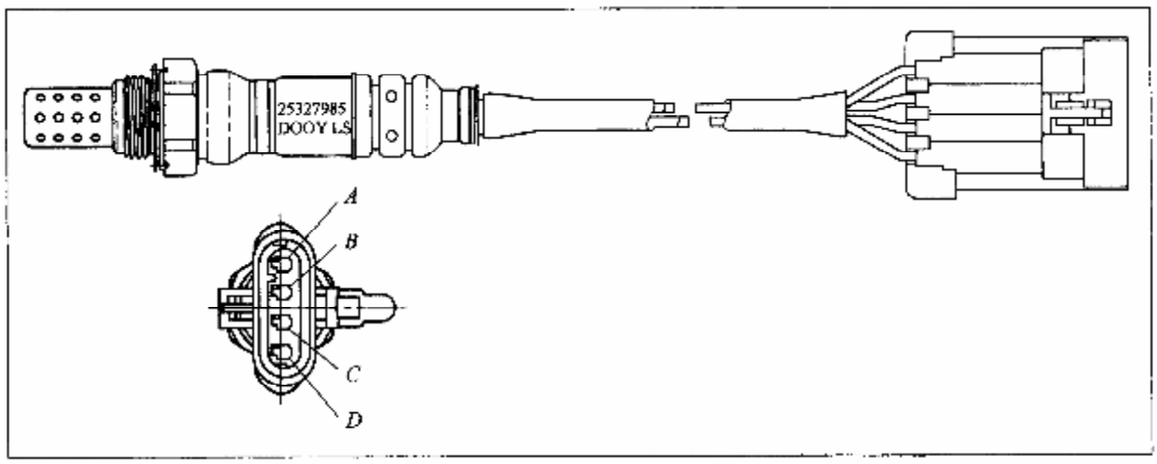


Figure 4-9 Oxygen Sensor

- **Caution**: Notice: As lead restrains platinum oxidation. The gasoline with lead will make OS failure quickly thus deteriorate emission. Therefore, BE491EQ1 gasoline engine can never use lead gasoline.

Oxygen sensor is heated type (see Figure 4-9). The connector pin, lead color and wire connection of oxygen sensor are shown in table 4-2. Oxygen sensor output signal is shown on Figure 4-10.

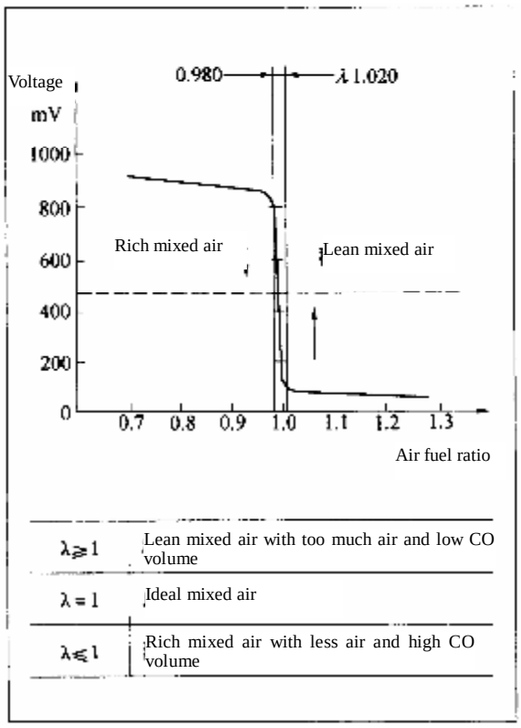


Figure 4-10 Performance Chart of Oxygen Sensor

Table 4-2 Connector pin, Lead Color and Wiring of Oxygen Sensor (also see figure 4-9)

Pin	Lead color	Pin and wiring
A	Dark brown	Oxygen sensor (grounding)
B	Purple	Oxygen sensor (output)
C	Brown	Heater
D	Brown	Heater

4.2.6 Electronic Control Module (ECM)

The ECM is a microprocessor (figure 4-11), composed of the circuit board and software. It processes signals from various sensors, and judges the working condition of an engine, then sends best ignition and fuel injecting signals to actuating mechanism, so as to keep the engine in good working condition.

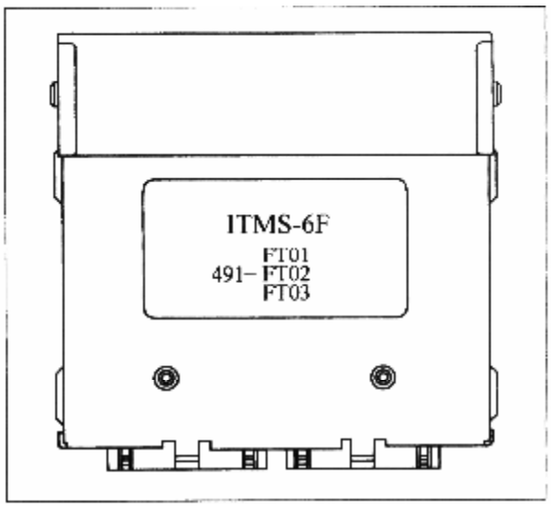


Figure 4-11 Electronic Control Module (ECM)

The installation of ECM requires dustproof, waterproof, and good heat dissipation. Its metal case must be insulated form the vehicle body. There are two 32-pin sockets (see Fig.2-12) on the ECM circuit board, and two corresponding ECM plugs on the gasoline engine harness. Be ware of the direction when to connect middle harness ECM plug into the ECM sockets-- red plug to red socket, white plug to white socket. The lock plate of harness plug should point to the locking projector on ECM socket. Plug in until a clicking sound is heard.

● **Note:**

(1) Mistaken plugging in would burn out precious ECM .

(2) Although the ECM is damp-proof, do not use high pressure washer to wash the case.

External view of ECM is shown in Figure 4-11. ECM has two 32-pin socket J1 and J2. J1 is red, J2 is white, see Figure 4-12.

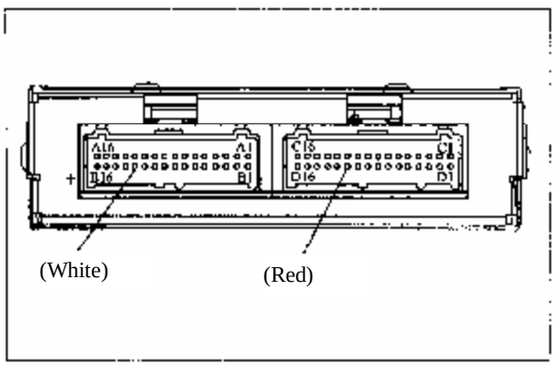


Figure 4-12 Section View of ECM

4.2.7 Electric Fuel Pump Assembly

The fuel pump is a turbine single line / electrical type, driven by DC 12V. ECM controls the fuel pump through fuel pump relay. There is a one-way valve at the outlet of fuel pump. While the engine is working, the fuel in the pipe will not retrun to fuel tank to ensure restarting performance. The fuel pump is installed inside the fuel tank with a bracket. The fuel inlet /return pipes are far away from high temperature zone such as exhaust pipe. Pipe connectors and mounting flanges should be tight and sealed. There should be no fuel leakage to avoid fire and other accidents.

Structure of electric fuel pump is shown in Figure 4-13 and power connection is shown is Figure 4-14.

4.2.8 Fuel Filter and Fuel Supply Pipeline

The fuel filter is mounted on fuel passage between fuel pump and fuel rail. Use electronic fuel injection filter to ensure filtering result.

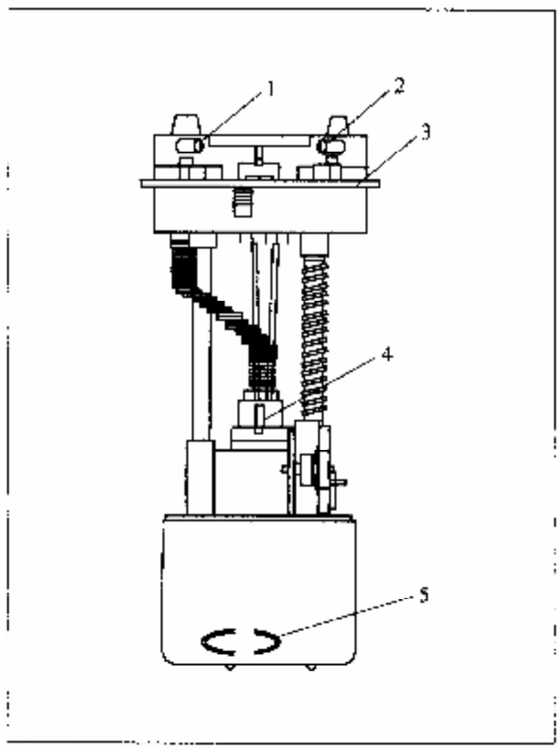


Figure 4-13 Electric Fuel Pump

1-Outlet pipe; 2-Fuel return pipe; 3-Flange; 4-Fuel pump; 5-Fuel strainer

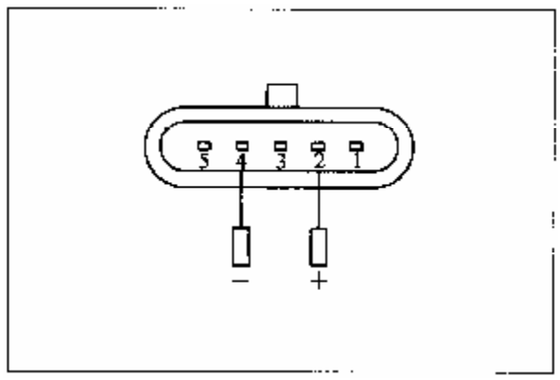


Figure 4-14 Electric Fuel Pump power connection

Fuel filter is composed of case and high performance paper element. It is a very important component as injector is quite sensitive to impurities in fuel passage.

External view of fuel filter is shown in Figure 5-15.

Replace the fuel filter at every 6000km or when pressure in the fuel pipe is less than 300kPa.

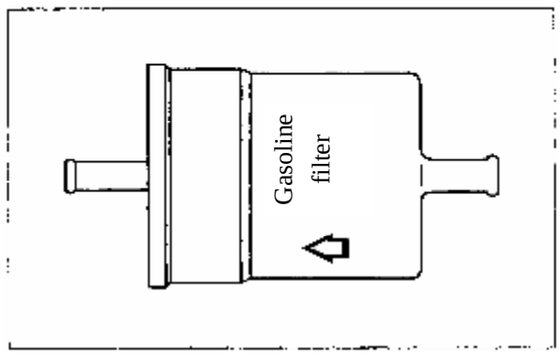


Figure 4-15 External View of Fuel (Gasoline) Filter

4.2.9 Fuel Rail Components

Fuel rail system is composed of injector, fuel rail, fuel pressure regulator, vacuum pipe, fuel return pipe and inlet pipe. (see Figure 4-16).

4.2.9.1 Fuel Rail Assembly

Fuel rail is composed by guide pipe, pressure regulating compartment, inlet/return pipe and fittings. It is installed on the air intake pipe. It offers pressure adjusing capacity (hi-pressure fuel) and pipes to each injectors as well as brackets for injectors.

4.2.9.2 Injector

The fuel injector is installed on the fuel rail. The injector is a electromagnetic switch controlled by ECM through the injection paulse width signal. Fuel mist will be sprayed to intake valve when injector opens. (figure 4-16).

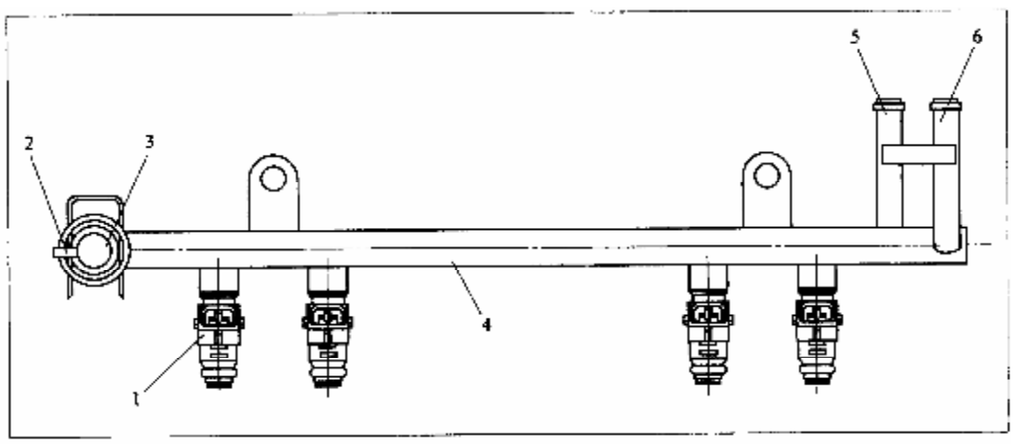


Figure 4-16 Fuel rail sets

1-Injector; 2-Vacuum air intake pipe; 3-Fuel pressure regulator; 4-Fuel rail; 5-Fuel return pipe; 6- Fuel Inlet pipe

The resistance of fuel injector coil is 12.0Ω±0.4Ω

4.2.9.3 Fuel Pressure Regulator

Fuel pressure regulator is to adjust the fuel pressure in the fuel rail, keeping its difference with that in air intake pipe at around 300kPa, so as to remove any disturbance caused by these changes as fuel supply rate, fuel supply of electric fuel pump and air intake vacuum. (See figure 2-17). It is installed on one end of fuel rail. Extra fuel through the fuel pressure regulator will return to fuel tank through return pipe (see Figure 4-17).

It is assembled on one end of fuel rail. The extra fuel regulated by the regulator will return back to fuel tank

via fuel return pipeline.

4.2.10 Ignition Coil

The ignition coil assembly integrates the ignition module and two ignition coils (shown in Figure 4-18). Primary coil is controlled by ECM through ignition module; each secondary of ignition coil is connected with spark plug in series inside two cylinders to form a loop.

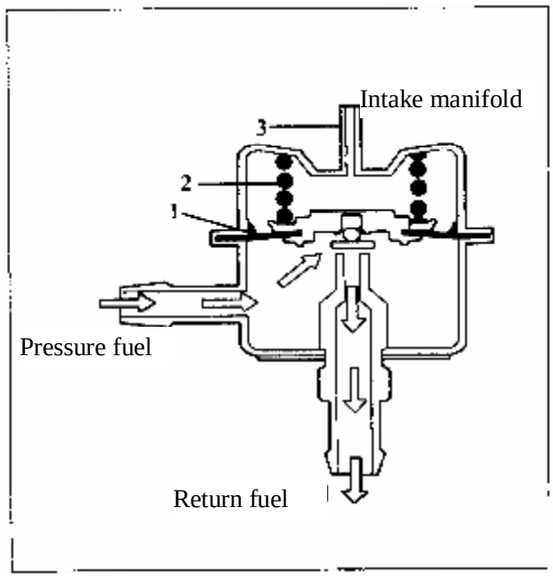


Figure 4-17 Working Principle of Fuel Pressure Regulator

1-Pressure regulating diaphragm; 2-Pressure regulating spring; 3-Manifold pressure collection hole

The primary coil resistance: 0.5 Ω±0.05Ω

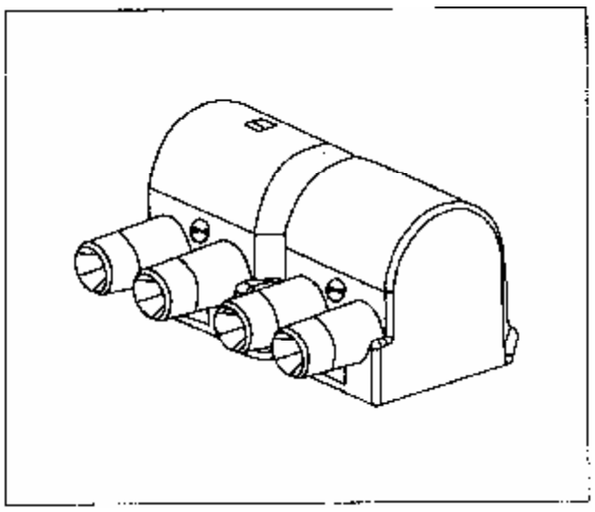


Figure 4-18 Ignition coil

The secondary coil resistance: 5200Ω±400Ω

Wiring: A-2, 3 cylinders ignition driving, B-1, 4 cylinders ignition driving,

C-Grounding, D-+12V

4.2.11 High Voltage Cable and Spark Plug

Because electronic fuel injection system adopts high energy and high voltage ignition, the high voltage cable must be endurable with high voltage, and also can restrain the radio interference occurred during ignition

4.2.11.1 Check Spark Plug

Use the steel brush to clean the spark plug. Visual check plug electrode for burnt-out, damaged thread and insulator. Replace if plug is damanged.

Type of spark plugs: F6RTC or F5RTC; thread specification: M14×1.25. Bend the side electrode carefully and adjust the electrode clearance to its correct position: 1.1 mm ± 0. 1mm (see Figure 4-19).

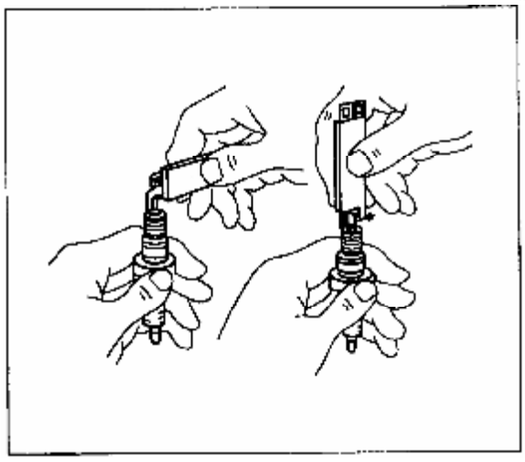


Figure 4-19 Check Spark Plug

Installation torque of spark plug: 25 ~ 30 N.m.

Replace the spark plug at every 10,000km normally.

4.2.11.2 Check High Voltage Cable

● **Caution:** Do not pull or bend the high voltage cable, otherwise its inside conductor may be damaged (see Figure 4-20).

High voltage cable is of damp type. Replace the high voltage cable if the resistance between its two ends is larger than 25 KΩ.

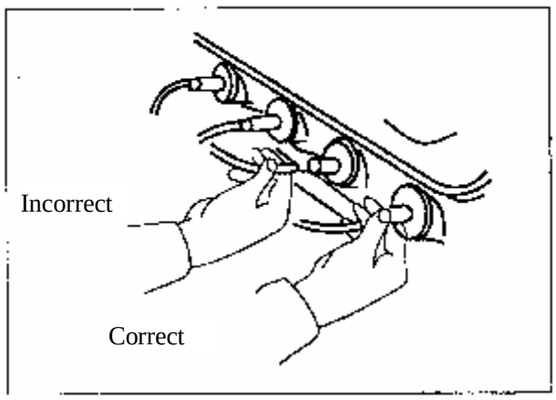


Figure 4-20 Check High Voltage cable

4.2.11.3 Check flashover in each cylinder

Dismantle at the same time the spark plugs in two cylinders, and connect them with corresponding high

voltage cable. Make sure plugs' screw thread ground to cylinder block. Start up the gasoline engine to observe the flashover.

● **Caution:** To observe the flashover, the injector in concerning cylinder should be unplugged. Otherwise unburned gasoline would burn near the three-way catalytic converter to damange injector immediately. Two spark plugs in a same group should be dismantled at the same time. Otherwise the ignition system may be damaged.

4.2.12 Throttle Valve Body

The throttle valve body is installed at the front end of intake manifold. It controls air intake flow. It is composed by throttle body, valve, accelerating mechanism, throttle position sensor and idle speed air control valve (See Figure 4-21).

4.2.12.1 Throttle Position Sensor

The throttle position sensor monitors the throttle opening angle, and sends the signal to the ECM. The signal is the basis for engine's various normal woking conditions especially at idle and transition. The sensor is installed on the throttle assembly, and has the same axis with acclerating lever and throttle. It is a lineral variable resistance type, and its sliding terminal driven by throttle shaft.

Connection: A-+5V; B-Grounding signal; C-Throttle position signal.

Resistance between A and B: 3kΩ~12kΩ

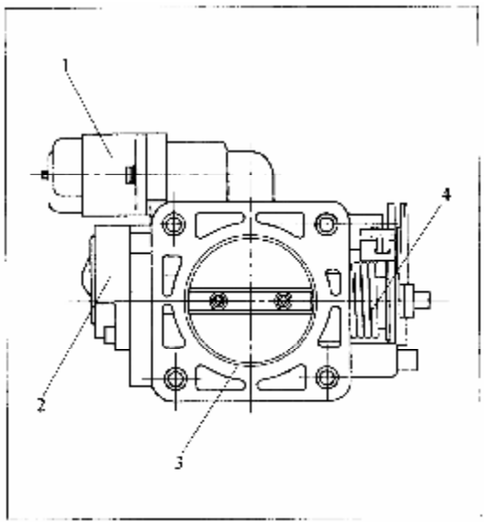


Figure 4-21 Throttle Valve Body Assembly

1-Idle speed air control valve; 2-Throttle position sensor;

3-Throttle valve body; 4- Accelerator cable plate

● **Note:** Never adjust TP screw.

4.2.12.2 Idle Speed Air Control Valve

By changing throttle bypass air, idle air control valve enables proper air intake at engine startup, warm-up and idle. The valve consists of a cone pintle and pintle carrier, fixed on throttle valve body. It is controlled by ECM output signal. It could maintain engine Rpm at preset value during warm-up and idle running through feedback control.

Connection: A-Coil B-; B-Coil B+; C-Coil A-; D-Coil A+

Resistance of idle speed air control valve coil: 53Ω ±5.3Ω

4.1.13 Canister Purge Control Solenoid

The canister purge solenoid is installed between the canister and intake manifold (figure 4-22). ECM controls

the fuel vapor volume through it. When the solenoid is not connected, it will keep in off position to avoid fuel vapor enriching air-fule mixture. The solenoid keeps “off” during engine startup and warmup processes. When engine has reached its operation temperature, ECM unit controls solenoid open/close by its paulse squre wave output so as to control fuel vapor amount entering intake manifold.

Canister purge control solenoid connection terminal: A-ECM; B-+12V.

Resistance of canister purge control solenoid: 19-22Ω

● **Note:** The pipe marked with “CAN” will be connected to the canister. It is not allowed to connect it in a wrong way.

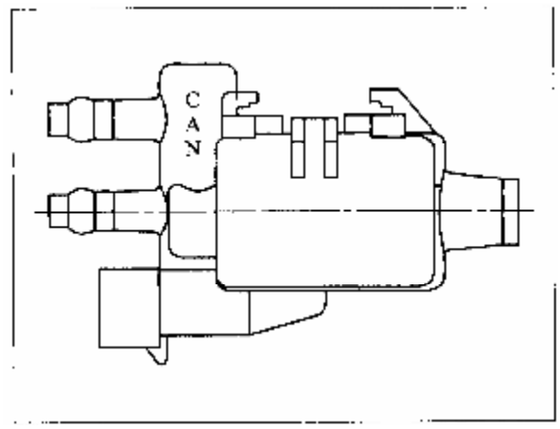


Figure 4-22 Canister Purge Control Solenoid

4.2.14 Three Way Catalytic Converter

Three-way catalytic converter is installed between the exhaust manifold and the muffler, behind oxygen sensor. It is cellular structured inside. In its cellular pipe wall are precious metal coatings (platinum, rhodium and palladium) that are used to be catalytic media. While the air-fuel ratio is 14.5～14.7, and the working temperature is 375～800℃, the harmful exhaust gas from cylinder will be reacted into unhuamful gas via conveter.

The optimal working temperature of three way catalytic converter is 375~800℃, and the maximum endurable temperature for short time period is 920℃.

● **Note:** There are model and installation arrowhead marked on the surface of three way catalytic converter, and it is not allowed to be installed on the contrary direction.

Structure of the three-way catalytic converter is shown in Figure 4-23.

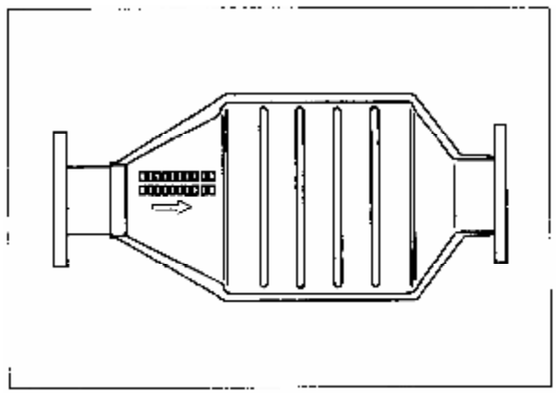


Figure 4-23 Three-Way Catalytic Converter

4.2.15 Communication and maulfunction diagonistic plug

The communication and malfunction diagnostic plug is a communication interface between electric fuel injection system and peripherals. It draws out from system harness. The emergency malfunction judgment can also be made by short circuiting “Diagnosis request” and “Grounding” to flash malfunction indicator, or retrival fault codes with radom code reader..

Table 4-3 The definitions of the malfunction diagnostic plug interface.

Table 4-3 Pins in16-Pin Diagnostic Connector

1	Diagnosis request	9	N/A
2	N/A	10	N/A
3	N/A	11	N/A
4	Grounding	12	N/A
5	Grounding	13	N/A
6	N/A	14	N/A
7	Communication	15	N/A
8	N/A	16	+12V

Table 4-4 Fault code and its definition.

Table 4-4 Fault Code of Code Reader

Fault code	Fault description
0105	Air intake absolute pressure sensor circuit failure
0110	Air intake temperature sensor circuit failure
0115	Coolant temperature sensor circuit failure
0120	Throttle valve position sensor circuit failure
0130	Oxygen sensor circuit failure
0170	Reading of oxygen sensor is abnormal
0200	Injector circuit failure
0230	Fuel pump circuit failure
0335	Crankshaft position sensor circuit failure
0351	Ignition coil of 1-4 cylinder circuit failure
0352	Ignition coil of 2-3 cylinder circuit failure
0443	Canister solenoid circuit failure
0505	Idle speed control valve circuit failure

Fault code	Fault description
0560	System voltage too high
1530	AC clutch circuit failure
1604	ECM failure
1605	
1640	

Explanation of table 4-4:

(1) The code reader can read the unerased historical fault codes in ECM. Correct fault codes can be retrivaled only when malfunction indicator flashed.

(2) If code reader indicates "---", it means electronic fuel injection system is ok. If it indicates "E", it means ignition switch is off.

(3) It is suggest to approach service station to clear up fault code after each troubleshooting.

4.2.16 Harness

The harness transmits digital signal. The signals from various sensors go to ECM through harness. After the computation and judgment, ECN sends control signals via harness to the injection system and direct ignition system. One end of harness is ECM plug, and sensor / ignition system plug on the other. ECM unit, the sensor, fuel supply system and ignition system all have its special socket. Watch carefully to avoid mistake.

4.2.16.1 Figure 4-24 shows multi point electronic injection gasoline engine system harness diagram for BJ491EQ1 Foton View Sea Lion light bus.

4.2.16.2 Figure 4-25 shows multi point electronic injection gasoline engine system harness diagram for BJ491EQ1 pick-up and SUV.

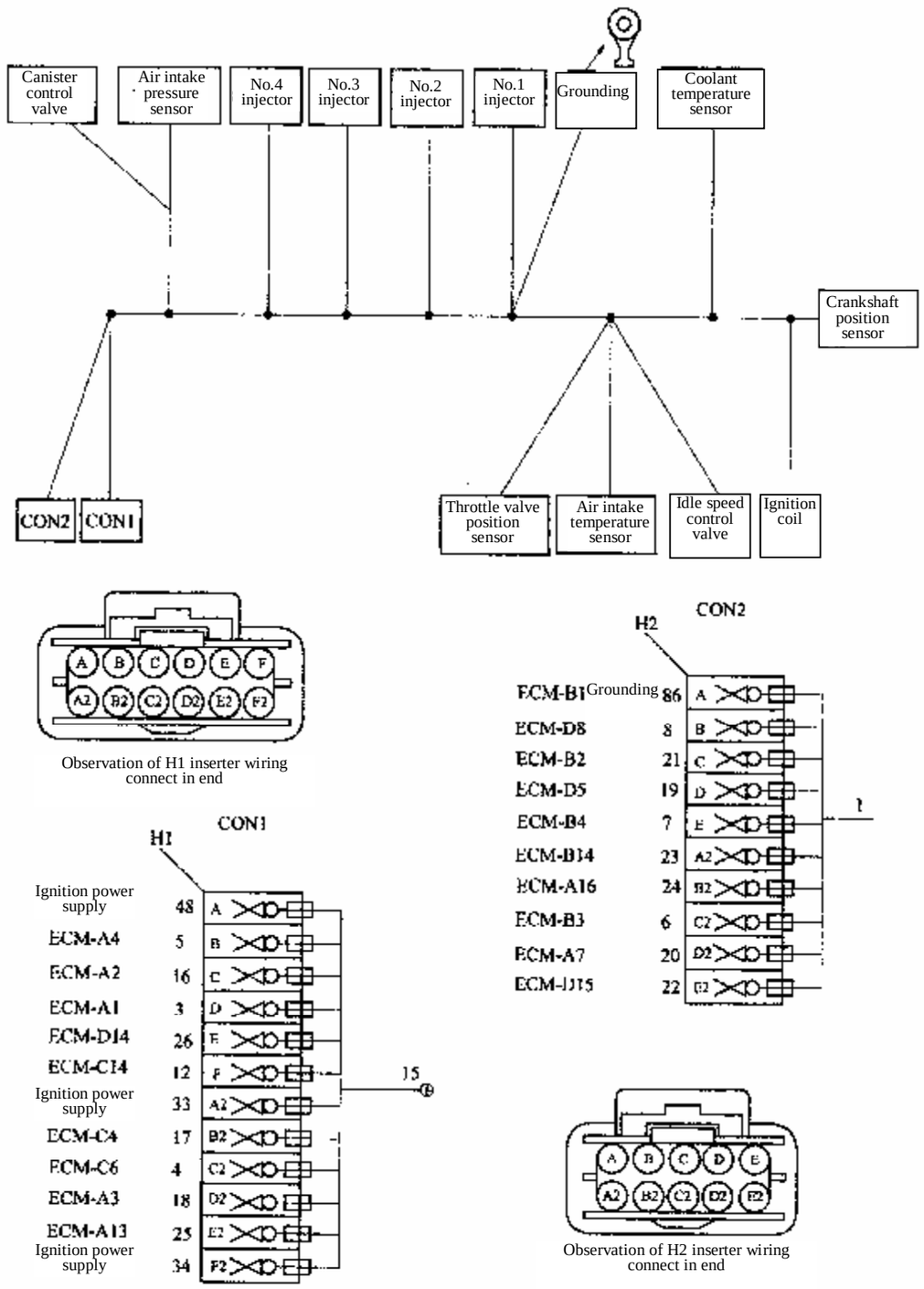


Figure 4-24 MPI Gasoline Engine Harness Diagram for BJ491EQ1 Foton View Sea Lion Light Bus

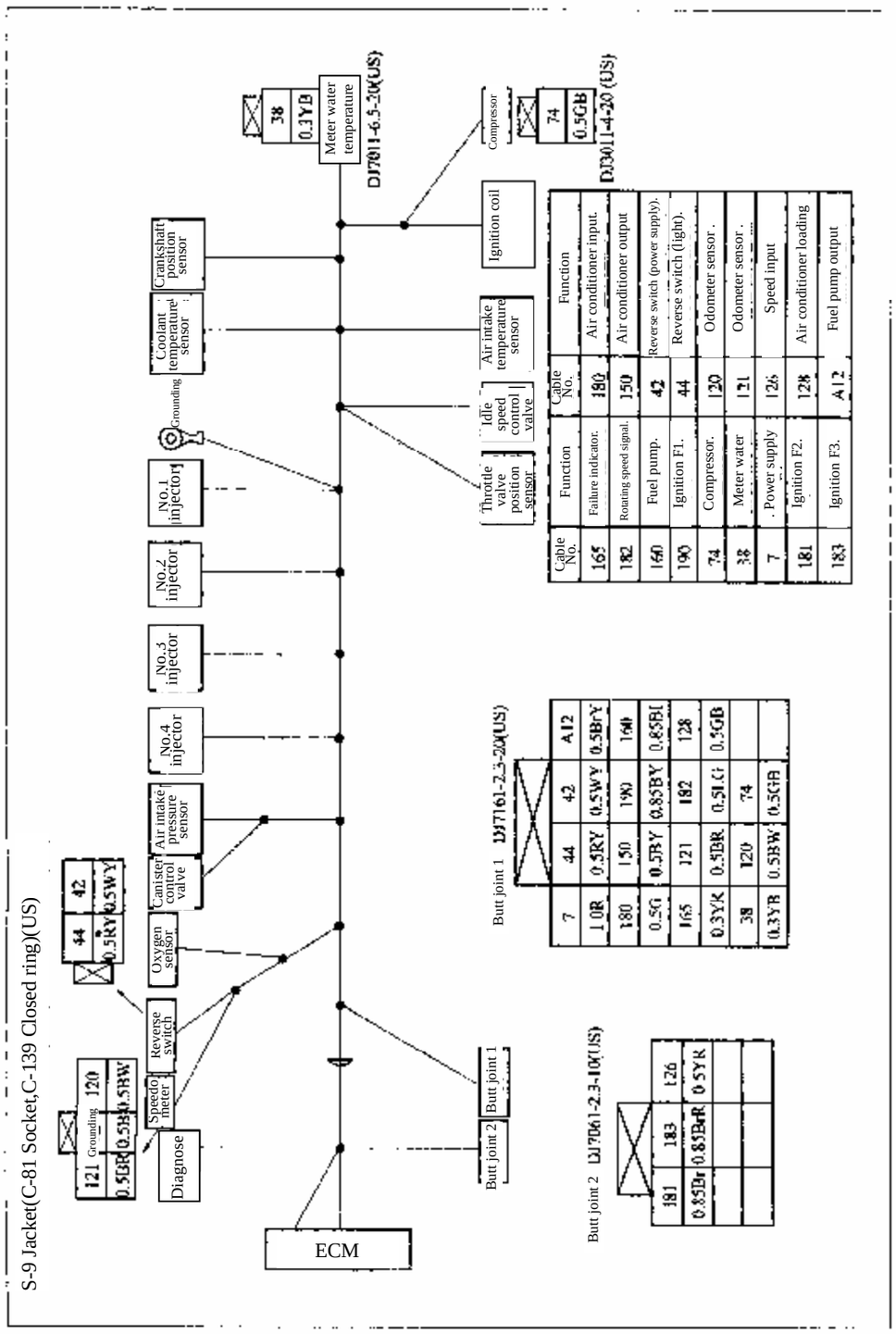


Figure 4-25 MPI Gasoline Engine System Harness Diagram for BJ491EQ1 Pick-Up and SUV

FOTON

Chapter 5 Application of BJ491EQ1 Gasoline Engine

5.1 Regulations for Safe Operating

5.1.1 The operator should know the structure of an engine and master the skills for its use and maintenance. Those who don't know the operation techniques are not allowed to start up an engine.

5.1.2 The operator should wear working clothes that meet the safety and work protection requirements. Women operators should wear safety helmet to avoid personal injuries.

5.1.3 Smoking is not allowed while filling fuel tank with gasoline.

5.1.4 When an 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.

5.1.5 When an 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..

5.1.6 Avoid being scalded while filling coolant, draining oil /coolant or approaching high-temperature locations on engine. Keep away from exhaust pipe / muffler hot surface while service or repair is in progress to avoid scalding.

5.1.7 Never remove radiator cap while the engine is hot, or hot coolant may spray out.

5.1.8 Keep away from the hot surface of exhaust pipe and muffler to avoid scalding.

5.1.9 Try to avoid contacting petrol-oil products while managing fuel/oil to prevent skin from irritated or getting poisoned. Never suck fuel with mouth.

5.1.10 Electrolyte of battery is corrosive. Never let it splash into eyes, on skin or cloth. Wash it imme -diately with clean water if that happens.

5.1.11 Make sure to keep transmission lever in "neutral" position.

5.1.12 Operator should never try to go on working when he feels bad, tired or sluggish.

5.2 Fuel, Oil and Cooling fluids

5.2.1 Gasoline

Oxygen sensor and three-way catalytic converter are adopted in the multi point electronic control fuel injection system of BJ491EQ. In order to let 3-way catalytic converter work effectively without being poisoned by lead, sulfur, and phosphorus, quality non-leaded gasoline above 93# that is in conformity with governmental standard GB 17930-1999 is required.

In order to avoid fault and prolong diesel engine's service life, engine must use clean fuel. It is required to fill clean gasoline that meets national standards in qualified gas station. For self-filling, always keep sealing during filling fuel. Precautions should be taken during fuel transportation, filling and use to avoid contamination.

High RVP gasoline must be used in cold regions to ensure engine's cold startup performance.

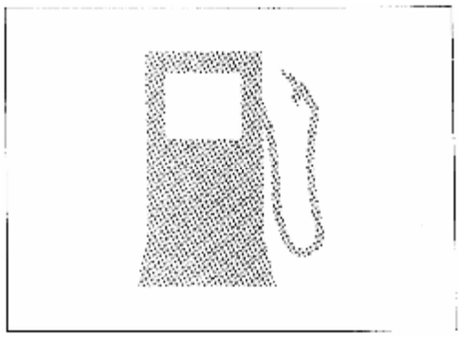


Figure 5-1 Fill clean and ratified gasoline

Caution:

(1) Catalyst in converter will get intoxicated if inferior lead free gasoline or leaded gasoline and gasoline with high contaminants are used. These fuels will restrain its functions of oxygenation and deoxidization to CO, HC and NOx, that makes engine exhausting more harmful gas to atmosphere.

(2) For a vehicle that has applied fuel additives, these symptoms are normal such as unstable idling speed, high emission and hot-startup difficulty within short time (usually happens within first 5 tanks after additive application). As additives is cleaning the fuel pipeline during the period.

(3) Clean fuel tank and fuel pipeline. Change to use ceramic fuel filter when a vehicle uses 10% ethanol gasoline. It is normal for a vehicle using ethanol gasoline to show poor accelerating performance.

5.2.2 Lubricants (engine oil)

DJ491EQ1 Engine should use ratified SF rate (or up) oil. Choose oil according to ambient temperature as indicated in figure 2 – 2.

Cautions:

(1) Use oil according to specification, don't use unspecified or inferior oil to avoid damages such as cylinder score or bearing grabbing.

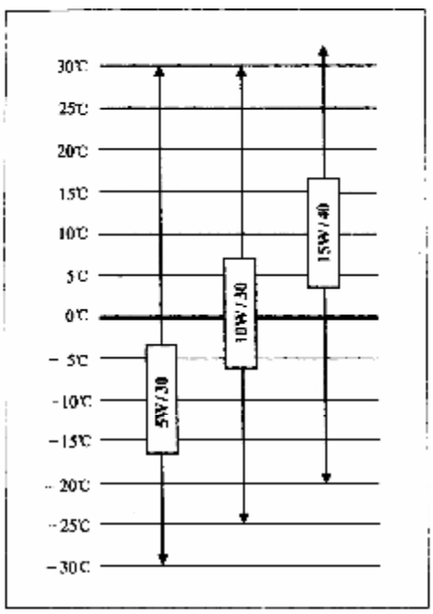


Figure 5-2 Oil application and temperature

(2) Engine oil that is to be filled shall not contain contaminants and moisture.

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

5.2.3 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.

5.2.4 Coolant

Coolant to be used in gasoline engine must has the properties such as anti-frozen, corrosion proof, anti-fouling and with higher boiling point.

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

If an 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 engine and lead to faults.

5.3 Preparations before Startup

Caution: Before starting up an engine, operator should carefully read this manual and operate strictly according to instructions.

Check following parts before starting the gasoline engine:

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

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

Note:

(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.

5.3.3 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 has moisture inside.

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

5.3.4 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.

5.3.5 Check electrolyte level in battery.

5.3.6 Check the fastening of electrical connectors on components as battery, alternator, starter, spark plug and ignition coils, ECM and other electrical devices.

5.4 Startup Procedures

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

(1) Set transmission to N gear.

(2) Depress clutch pedal to reduce load on engine during cranking.

(3) Electronic control fuel ejection system will provide suitable air fuel ratio under any working condition. Do not depress accelerator pedal no matter it is a hot or could startup, as ECM keeps monitoring the working

condition of gasoline engine based on the throttle position. Once accelerator pedal is stepped down to open the throttle, ECM will be unable to determine whether gasoline engine is starting or not, thus cannot feed fuel correctly.

(4) Turn igniton key to START to start up the gasoline engine.

(5) It may take longer time for first starting (for new vehicle or the vehicle whose fuel supply systems has just been serviced). This is because oil passage requires time to reach proper oil supplying pressure.

Caution:

(1) Each cranking should not last more than 5 seconds. This is to protect starter and battery. There should be at least 15 seconds 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.

(2) Oil warning indicator turns on during cranking.

Immediately release the ignition key after engine has started up. The ignition key will automatically reset to ON position. At this point gasoline engine is running at fast idle speed condition if it is a cold starting. Engine will automatically return to normal idle speed operation gradually.

Note: The oil warning indicator turns out once gasoline engine runs correctly.

5.5 Idle Speed & Warm-up

After start-up, the gasoline engine needs warm-up for several minutes at idle speed. It will warm up at a higher rotation speed under the control of ECM when the engine is cold, and the idle speed will slow down to normal along with the increase of coolant temperature.

When ambient temperature is lower than -10℃, gasoline engine should be warmed up for 5 minutes before driving.

Idle speed for gasoline engine will increase by about 150 r/min while A/C is on.

5.6 Check during Running

5.6.1 Check for knocking, loosening or other abnormal sound (especially after fuel filling and service).

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

5.6.3 Check fuel, cooling and lubricating systems for leakages.

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

Warning: The operator must not stand within the rotation range of fan when engine is running. Never dismantle parts while engine is running. Use special care when performing check and adjustments.

Caution: 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.

5.7 Shutdown

If the engine needs to be shut down under heavy load running, operator should first lower its Rpm gradually for 2~3min and then turn off ignition key. This is to cool diesel engine gradually and evenly to avoid parts distortion due to sharp cooling.

5.8 Component Protection

ECM, sensors and acuator must be protected from water, static electricity and strong electromagnet disturbance. Be careful not to drop them to ground or impact them during service.

5.9 Limp in

If the EFI system parts are failure, EMS could turn into safety mode which could let vehicle manage to drive to service station.

5.10 Important Points during Operation

5.10.1 According to these use and maintenance procedures in this manual to operate a gasoline engine.

5.10.2 A new or overhauled engine should have run-in period. It is not allowed to run it at high speed or under heavy load in the first place.

5.10.3 Normal coolant temperature during engine operation is 80~95℃. The normal pressure of engine oil at medium speed should be 245~392kPa, and the oil pressure warning indicator should be off (the indicator is on during engine cranking).

5.10.4 Keep constant power supply to ECM. ECM will loss all data inside its memory once its power supply is cut off. Initialization operation must be performed prior to normal starting for a newly assembled vehicles or a vehicle whose ECM had been disassembled.

5.10.4.1 Connect battery's postive and negative terminals.

5.10.4.2 Initialize the electronic control fuel injection system:

——Turn the ignition key to ON position;

——Turn off ignition key in about 3s;

——Turn ignition key again to ON position in about 5s;

——Control system initialization is finished.

5.10.4.3 "Check Engine" indicator lamp in instrument panel should lit automatically.

5.10.4.4 Initialization of electronic control fuel injection system:

——Turn the ignition key to ON;

——After several seconds, gasoline engine tends to start up or starts up completely;

——Turn off ignition key;

——Fuel supplying system initialization is finished.

5.10.4.5 Re-start the gasoline engine in about 5 seconds.

Chapter 6 Technical Maintenance of BJ491EQ1 Gasoline Engine

There are many reasons that could worsen gasoline engine technical conditions such as parts wear, loosen fasteners, clearance changes and fuel/ oil deterioration. They will lead to many maulfunctions including hard start-up, higher fuel/oil consumption, even a dead engine. It is very important to clean, check, lubricate the engine or adjust and replace its parts/components at a fixed time period according to its the technical conditions and operation time/mileage.

●**Note**: Strictly adhere to the maintenance requirements will keep the engine at a good technical condition thus prolong its service life.

6.1 Technical maintenance interval

Technical maintenance is divided into 4 levels according to wear speed of engine's various parts:

6.1.1 Rountine technical maintenance: normally carried out after each driving shift (about 8-10 hours.)

6.1.2 1000km technical maintenance

6.1.3 3000km technical maintenance

6.1.4 6000km technical maintenance

6.2 Content of technical maintenance

Perform following maintenance procedures to keep engine running properly

6.2.1 Rountine technical maintenance

(1) Check the levels of fuel, coolant and oil, and refill if necessary.

●**Note**: Check fluid levels only after the gasoline engine has cooled down and parked on flat ground.

Use #93 or above high quality lead free gasoline (GB17930-1999).

●**Caution:** Do not refill the fuel when the engine is running. Do not fill up fuel tank under higher ambient temperature as fuel might spill out due to expansion. Wipe out spilled fuel right away.

(2) Clean dirt and electrolyte away from the battery. Battery does not need maintenamce normally, but regular fluid level check is needed when a battery works in higher temperature environment. Its fluid level should be between MIN and MAX lines on battery case side. Add distilled water when electrolyte is not enough.

●**Caution:** Never add electrolyte or unclean water into battery. To do this will cause undercharging which influences battery performance. Send the battery to the service station if the fluid drops too fast.

●**Warning**: The battery electrolyte is caustic and do not spill it into eyes, on skin or clothing. Wash them right away with clean water if these happen.

(3) Check for fuel, oil, air or electricity leakages. Remove leakages immediately

(4) Check if high voltage cables are loose.

(5) Check if the gasoline engine works properly after it has started, and check instrument panel indicators.

6.2.2 Technical maintenance at 1000km

(1) Perform above rountine technical maintenance.

(2) Check the battery electrolyte concentration and battery voltage;

(3) Check for connection on alternator, ignition coil, spark plug, high voltage damping cable or connectors;

(4) Clean the air filter;

(5) Check if fastners are firmly secured.

6.2.3 Technical maintenance at 3000km

(1) Perform above 1000km maintenance procedures.

(2) Clean spark plug electrodes and adjust the clearance between electrodes. Adjust clearance: F6 RTC or F5 RTC is 1.1mm±0.1mm.

(3) Clean or replace air filter paper element.

●**Caution:** To avoid dirty air entering cylinder to damage the related parts, do not start the gasoline engine after air filter has been removed.

6.2.4 Technical maintenance after each 6000km

(1) Perform above 3000km maintenance procedures.

(2) Wash the fuel tank, check the fuel pipe and replace the fuel filter.

(3) Check if there is any crack or electric leaking on the battery.

(4) Check if the alternator works properly.

(5) Change the oil inside oil pan.

●**Note**: Must use oil that is above SF 10W/30 (or 15W/40). Use 5W/30 engine oil in winter. Do not use other oil or inferior oil; do not mix to use oil of different brands and rates.

Change oil more frequently when vehicle runs in dirty environment or under ambient temperature that is lower than -20℃.

(6) Replace oil / air filter elements (could be early or later according to actual conditions).

(7) Wash and clear gasoline engine PCV valve and its ventilation pipe, and make sure it works properly.

6.2.5 Seasonal technical maintenance

(1) Recommend to change the antifreeze and antirust coolant once a year.

(2) Change to use winter lubricant in time when the winter comes.

(3) Adjust battery electrolyte concentration according season.

6.3 Technical maintenance for lubrication system

Choose correct lubricant for gasoline engine lubricating system according to working temperature.

Normally, it is suggested to use above SF 10W/30 or 15W/40 engine oil (GD 11121); for cold winter region, it is suggested to use SF 5W/30 engine oil.

●**Caution:** Do not mix to use oil of different brands and rates.

Measure the oil level: park the vehicle on flat ground and draw out the dipstick after the oil level has been stable. Wipe the oil on dipstick with a clean cloth, and insert the dipstick back into the tube (all the way down). Draw out dipstick to observe oil level. There are two lines on the dipstick, right oil level should be higher than the middle section between these two lines.

●**Note:** Check the oil level before driving the vehicle, and keep watching oil pressure during running.

Change with new engine oil: Drain oil after each 6000 km and change to use new oil.

Oil changing procedures:

(1) Park the vehicle on flat ground;

(2) Run the gasoline engine to heat oil temperature up to 80℃.

(3) Stop the engine, put an oil tray below gasoline engine. Unscrew the drain plug and discharge oil.

●**Warning:** Avoid being scaled, dispose drained oil properly to protect environment.

(4) Put on a new washer, fasten drain plug with specified torque.

(5) Fill new oil and check oil level.

If there are heavy deposites in oil pa, wash the lubricating system with lightweight spindle oil but not gasoline or kerosene

Run the gasoline engine without load for a while each time after oil changing to facilitate oil to reach every

lubricating position.

Clean the oil filling port to prevent impurity from entering into the oil during oil filling. Check the oil level 5 minutes after the filling. Fasten the cap after oil filling.

Replace the oil filter or air filter elements at the same time of oil changing.

6.4 Technical maintenance for cooling system

When the gasoline engine is running, there must be enough coolant inside cooling system to keep the engine working properly. Check the cooling system every time before starting the vehicle, and replenish coolant in time.

Change coolant

Drain used coolant, wash cooling system with clean water. Fill coolant to a specified level in radiator. Start the gasoline engine and run it 5 minutes to flood the cooling system. Stop the engine and check the level again. Add coolant if necessary.

●**Caution:**

(1) Using tap water, mineral water and other un-treated hard is strictly prohibited. Use coolant with high quality.

(2) Using inferior coolant or mix to use coolant of different brands is strictly prohibited. Otherwise parts and components may get damaged.

(3) Abnormal high coolant consumption indicates leaking inside cooling system. Send it to service station for help.

Check the fan belt tension. Under 98N pressure, the deflection of a new belt is 5~7mm, old belt is 7~8mm.

6.5 Technical maintenance for fuel system

6.5.1 Fuel pipe

The fuel pressure inside fuel pipe is higher for an electronic fuel injection gasoline engine, so the parts on fuel supply / return pipes must be secured firmly without any leaking. Check the tightening of fuel return pipe regularly, and remove the leaking in time.

●**Warning:**

(1) During fuel pipe checking, never start the gasoline engine after fuel injector, oil rail components and fuel pipe on engine have been removed. Sparying fuel into air may cause fire.

(2) Wrap the fuel pipe joint by plastic clothing during fuel pipe maintenance to prevent fuel spilling out; do not smoke or have lighted fire around to avoid fire accident.

6.5.2 Fuel filter

Replace the fuel filter after each 6000km.

●**Caution:** There is an arrowhead on fuel filter case that indicates the gasoline flow direction. It is absolutely not allowed to assemble the fuel filter in a wrong direction. Replace fuel filter if it is assemble in wrong way.

6.5.3 Fuel injector

For a vehicle that has been laid for long, start the gasoline engine and hold for 5 to 10 minutes once in every one or two months to avoid fuel injector clogging.

During regular service, clean the fuel injector with ultrasonic after each 20000km. Make sure that there is no media which will damage the oxygen sensor and three way catalytic converter. No need to diassemble injector during this procedure.

6.5.4 Throttle body

Clean the throttle body at each 20,000 km or every year.

6.6 Technical maintenance for air intake system

6.6.1 Air filter

Detach air filter and take out element. Check filter appearance or if it is too dirty, distored, damaged or oil stained. Replace if necessary.

Clean the air filter element by compressed air if the element is contaminated by dust. Blow the dust away by compressed air from element inside.

●**Caution:**

(1) Do not blow the element from outside which will blow dust into the element.

(2) Do not use any detergent or water to wash the paper element.

Clean air filter case and air intake pipe inside.

Secure all parts firmly during mounting of air filter and element. Loose connection would let dirty air enter cylinder.

For air filter maintenance of BJ491EQ1 multi-point electronic fuel injection please see vehicle service manual or air filter service manual.

6.6.2 Air intake pipe

Check the tightness of the joint between air intake pipe and air filter, and remove the leaking immediately.

Chapter 7 BJ491EQ1 Gasoline Engine Faults and Troubleshooting

7.1 Gasoline Engine Troubleshooting Summary

During gasoline engine operation, there will be some factors that gradually deteriorate its technical condition such as part wear, distortion, incorrect use and technical service. When any of its technical data exceeds the specification, engine has already had faults. Engine can not operate well until any fault on it has been eliminated. With faults on it, engine's power and economy will be reduced, and its emission will become worse too. Moreover, Faults may cause parts early wear or even accident.

Some faults such as air in the fuel system, clogged filter, loose drive belt can be corrected after technical maintenance and adjustment. However, others could not be elinminated just by the general maintenance and adjustment methods. These faults includes damaged cylinder gasket, severe piston ring wear, valve cone face wear, excessive bearing shell wear. Such faults can be removed only by dismantle- to-repair, or replacement parts and components.

- **Note:**

(1) Remove the fault from the gasoline engine in time if any. To remove the faults, check and analyze carefully, do not disassemble engine blindly.

(2) The operators should be familiar with the structure of the gasoline engine and its technical data, technical requirements to dismantling and assembling. He must know how to perform service procedures and use service tools.

(3) The complicated faults should be diagnosed and eliminated by the technical personnel using relevent tools. If a user can't determine the faults and has no required technical condition, he is suggested to approach to FOTON authorized service station for help.

7.2 Diagnosis Basics -- Gasoline Engine Electronic Control Fuel Injection System

The gasoline engine electronic fuel injection system is sophisticated. Before faults diagnosis, the operator should master the system's principle, structure, service procedure and service tool application. First of all, he has to determine if the faults acutally come from electronic fuel injection system. If there is a fault in gasoline engine while malfunction indicator in instrument panel does not lit, the fault can not come from fuel injection system.

Fault diagnosis and check require special tool and tester. Operator should know them better before using them, including knowing their function, structure and operating method. Common tools and tester includes circuit test probe, multimeter and relevent testers.

To diagnose the faults in engine fuel injection system, you should be familiar with the following knowledge:

(1) The general information and basic principle of the electronic control fuel injection system.

(2) Performances of sensors, ECM and actuating devices, and their technical performance as well.

(3) The interface and terminal of the ECM and various sensors

7.3 Notes to Diagnosis-Gasoline Engine Electronic Control Fuel Injection System

7.3.1 DO NOT open the ECM cover, ECM is not serviceable. Once ECM cover has opened, it must be damaged even if it seems to operate well for the moment.

7.3.2 During engine operation and service, never splash water on engine harnesses and sensors, which may cause short circuit.

7.3.3 Faults on wire and its connections mainly include the open circuit, short circuit and grounding. The open circuit is generally due to wire break-off and bad contact. Wire normally breaks off on connection position, thus connection should be checked carefully. The bad contact may give rise to the terminal oxidation and the entry of foreign materials. Wiring connects directly to body (grounding) causes short circuit. To check this, inspect if wire conductor touches vehicle body or frame due to its insulating wrap has been damaged.

7.3.4 To check open circuit, unclip the ECM and related sensor connectors, and then measure the resistance between the connecting terminals so as to confirm whether there is the open circuit or contact is damanged.

7.3.5 To check grounding or short circuit, detach wire's two ends and measure resistance between the connecting terminal and body (ground).Resistance that is more than 1Ω is acceptable.

7.3.6 After having turned ignition swithe on, never disconnect any 12V electrical connections, these connections include cables of battery, idle speed control valve, injector, electric fuel pump, ignition system, ECM circuit, and A/C wiring etc.

7.3.7 The digital multimeter should be used to check the sensors and ECM. Use other tester may damage the sensors and ECM.

7.3.8 If "check engine" light keeps on during engine operation, find out the possible cause and remove it A.S.A.P..

7.3.9 Check immediately if engine fuel economy become deteriorated. Use inferior fuel will damage the oxygen sensor and three-way catalytic converter.

7.3.10 Once there is misfire happening in certain cylinder, intermediately stop driving and eliminate the faults. Otherwise unburned gas mixture may burn in the exhaust system, which will quickly damage the oxygen sensor and three-way catalytic converter. If it is difficult to remove such fault in a short time, disconnect the spark plug from the misfire cylinder.

7.4 Gasoline EngineTroubleshooting Procedures

7.4.1 Unable or hard to startup

S/N	Parts/components	Possible Cause	Solutions
1	Sensors	(1) Poor connections -- coolant temperature sensor, intake temperature sensor (2) Incorrect crankshaft position sensor clearance (3) Foreign objects and oil stains on crankshaft pulley (4) ECM has not plugged in well	(1) Reconnect the related harness (2) Check and adjust it to the proper clearance (3) Remove foreign objects and oil stains (4) Check ECM connector.
2	Starting System	(1) Battery voltage is too low (2) Battery poor connection (3) Fuse breaks off (4) Starter is failure (5) Ignition switch is failure	(1) Recharge the battery as required (2) Clean the terminal posts and tighten the battery cable (3) Replace the fuse (4) Repair or replace the starter (5) Repair or replace the ignition switch

S/N	Parts/components	Possible Cause	Solutions
3	Fuel Supply System	(1) Fuel pump relay is failure (2) Fuel system pressure is insufficient (3) Injector is leaking	(1) Replace the fuel pump relay or check the connecting lead (2) Check the fuel level in tank and the electric fuel pump working condition (3) Replace the injector
4	Ignition System	(1) The ignition coil is failure (2) The high voltage cable is damaged (3) The spark plug is failure (4) The ignition system is poorly connected.	(1) Replace the ignition coil (2) Replace the high voltage cable (3) Adjust spark plug clearance, clear the carbon deposit or replace the spark plug (4) Correctly connect the ignition system
5	Others	(1) Valve has air leakage or is burnt out (2) Cylinder gasket is damaged (3) The intake manifold or vacuum pipe is leaking (4) The piston, piston ring and cylinder bore are damaged	(1) Grind or replace the valve (2) Replace the cylinder gasket (3) Check the intake system, and remove the air leakage (4) Repair or replace the piston, piston ring or cylinder block

7.4.2 Engine Stalls (Engine Rpm goes up and down constantly while throttle is opened)

S/N	Parts/components	Possible Cause	Solutions
1	Fuel System	(1) Fuel is either enriched or too lean (2) The fuel system pressure is not stable (3) The fuel filter is clogged (4) Fuel injector is clogged or fuel leakage	(1) Check whether the oxygen sensor and fuel pressure regulator work normally (2) Check whether the electric fuel pump works normally (3) Replace the fuel filter (4) Clean or replace the injector
2	Ignition System	(1) The ignition coil secondary voltage is too low (2) The spark plug electrode gap is incorrect (3) The spark plug is burnt-out or has serious carbon deposit	(1) Check the ignition coil, replace if, necessary (2) Adjust the spark plug electrode gap to 1.1mm±0.1mm (3) Clear away the carbon deposit or replace the spark plug
3	Others	(1) ECM ground lead is poorly connected (2) The starting system voltage is not within the range of 9 V to 16 V (3) The vacuum pipe is clogged or leaking (4) The intake manifold is leaking (5) Poor valve sealing (6) Hydraulic tappet is failure (7) Excessive clearance between the valve stem and valve guide	(1) Confirm the ECM is connected reliably (2) Check whether the alternator output voltage is proper (3) Check and clear the vacuum pipe (4) Check and remove the intake manifold leakage (5) Grind the valve (6) Replace the hydraulic tappet (7) Replace the valve or valve guide

7.4.3 Engine Knock

S/N	Parts/components	Possible Cause	Solutions
1	Cooling System	(1)Coolant temperature is too high (2) Water pump belt is loosening (3) The radiator pipes are clogged (4) Thermostat is failure	(1) Add coolant and remove the leakage (2) Tighten the belt (3) Check and clear radiator pipes (4) Replace the thermostat
2	Coolant Temperature Sensor	Coolant temperature sensor output drifts	Replace the coolant temperature sensor
3	Gasoline	The gasoline octane number is too low	Change to use specified gasoline
4		The ignition timing is incorrect	Check the sensor operation and connection
5	Others	(1) Compression ratio is too high (2) Excessive combustion chamber carbon deposit	(1) Check the sizes of related parts (2) Clear carbon deposit inside combution chamber

7.4.4 Insufficent Engine Power

S/N	Parts/components	Possible Cause	Solutions
1	Intake System	The air filter is clogged	Replace the air filter element
2	Fuel Supply System	(1) Fuel is contaminated (2) Fuel pressure is too low	(1) Replace it with specified 93# or up lead free gasoline (2) Check the electric fuel pump and vacuum pipes or replace the fuel pressure regulator
3	Ignition System	(1) The ignition coil secondary voltage is too low (2) The ignition is abnormal	(1) Check the ignition coil, or replace the ignition coil if necessary (2) Check the wire and sensor concerned
4	Others	(1) The exhaust system is clogged (2) The exhaust valve opens abnormally	(1) Check and remove the exhaust system clogging (2) Check the exhaust valve opening condition, or replace the valve, camshaft and other parts and components concerned if necessary
5	Others	(1) Poor ECM grounding (2) The power system voltage not within the range of 9 V to 16 V	(1) Check the cable and confirm that the ECM can ground reliably. (2) Check whether alternator output voltage is normal, or replace alternator and regulator if necessary

7.4.5 Unsteady Engine Idle Speed

S/N	Parts/components	Possible Cause	Solutions
1	Sensor	(1) Loose connectors -- intake absolute pressure sensor, air intake temperature sensor (2) The coolant temperature sensor is failure	(1) Check and connect all sensor connectors again (2) Replace the coolant temperature sensor
2	Fuel System	(1) Fuel injector has not plugged in properly (2) The fuel system pressure is not within 300kpa range (3) The injector is leaking or fuel supply is insufficient	(1) Check and connect the injector (2) Check the fuel system pressure, replace the related parts if necessary (3) Check the injector, replace the injector if necessary,
3	Ignition System	(1) The ignition coil secondary voltage is low (2) The high voltage cable is leaking (3) The idle speed ignition advance angle is not approx. 10º (4) The spark plug electrode clearance is incorrect (5) The spark plug has carbon deposit (6) The high voltage cable is short circuit or has high internal resistance	(1) Replace the ignition coil if necessary (2) Replace the high voltage wire (3) Check the throttle position sensor, air intake pressure sensor, and if necessary, replace ECM (4) Check and adjust the spark plug clearance (5) Clear the carbon deposit, and if necessary, replace the spark plug (6) Replace high voltage cable
4	Air Intake System	(1) Air intake system is leak (2) The idle speed control valve is failure (3) The throttle position sensor is failure (4) The throttle opening is incorrect	(1) Check air intake system land eliminate leakage (2) Replace the throttle valve body (3) Replace throttle position sensor (4) Check the accelerator cable and throttle opening
5	Others	(1) The cylinder pressure is insufficient (2) The valve spring breakage or excessive cam wear	(1) Check and replace the related parts (2) Replace the related parts
6	Others	(1) The power supply system voltage is not within the range 9 V to 16 V, and idle speed control valve fails to actuate (2) The ECM grounding is incorrect	(1) Check and repair the alternator and battery, and if necessary, replace them (2) Correctly connect the ECM grounding wire

7.4.6 Highter Emission at Idle

S/N	Parts/components	Possible Cause	Solutions
1	Cooling System	The coolant temperature is abnormal	Check the cooling system and remove the faults
2	Ignition System	(1) The idle speed ignition advance angle is not approx. 10º (2) The spark plug is failure (3) The high voltage wire is failure (4) The ignition coil works abnormally	(1) Check if all sensors work normally (2) Check, clear and adjust spark plug clearance (3) Check or replace the high voltage wire (4) Check, and if necessary, replace the ignition coil
3	Air intake System	(1) The vacuum leakage (2) The crankcase ventilation valve is failure	(1) Check and remove the vacuum leakage (2) Clean or replace the crankcase ventilation valve
4	oxygen sensor, three-way catalytic converter are failure	(1) Use the leaded gasoline or the gasoline with phosphate, sulphure and impurities beyond the specified values (2) certain cylinder has misfire (3)The oxygen sensor and three-way catalytic converter are damaged	(1) Use the clean lead free gasoline as required (2) Check the fuel passage, circuit to remove the misfire faults (3) Replace the oxygen sensor and three-way catalytic converter
5	Fuel System	(1) Fuel is insufficient in fuel tank (2) The electric fuel pump works unsteadily	(1) Refill the fuel (2) Check the electric fuel pump and its circuit, and if necessary, replace the electric fuel pump
6	Others	Valve is leaking or grabbed.	Check the matching condition of the valve stem and valve guide to ensure that the valve is clogged. Or grind to repair the valve.

7.4.7 Excessive Fuel Consumption

S/N	Parts/components	Possible Cause	Solutions
1	Fuel Pipe	The fuel pipe or joint is leaking	Tighten all gasoline pipe joint
2	Air Intake/Exhaust System	(1) The air filter is clogged (2) The exhaust system leakage	(1) Check, clean or replace the air filter element (2) Remove the exhaust system leakage
3	Ignition System	(1) Poor sensor wire connection (2) The water temperature sensor, oxygen sensor, air intake temperature sensor are failure	(1) Reconnect all sensor plugs (2) Check, and if necessary, replace the sensors
4	Poor Compression	(1) The spark plug is failure (2) The high voltage wire is failure	(1) Check or replace spark plug (2) Replace the high voltage wire

S/N	Parts/components	Possible Cause	Solutions
5	Poor Compression	(1) Valve leakage (2) Failure hydraulic tappet (3) Weak valve spring (4) Cylinder gasket leakage (5) The piston ring is stuck or broken (6) Excessive piston or cylinder wear	(1) Grind the valve (2) Check , rinse or replace the hydraulic tappet (3) Replace the valve spring (4) Replace the cylinder gasket (5) Replace the piston ring (6) Repair or replace the related parts
6	Clutch	Poor clutch engagement, or clutch slip	Check and adjust the clutch

7.4.8 Excessive Oil Consumption

S/N	Symptoms	Possible Cause	Solutions
1	Oil Leakage	(1) The oil pan drain plug is loosen (2) The oil pan bolt is loosen (3) The oil pan gasket is damaged (4) The sprocket chamber cover bolt is loosen (5) The cylinder head O-ring is damaged (6) The crankshaft front/rear oil seals are damaged (7) The pump bolts are loosen or gasket damaged (8) Oil filter seat bolt is loosen or gasket damaged	(1) Tighten the oil pan drain plug (2) Tighten the oil pan fixing bolt (3) Replace the oil pan gasket (4) Tighten the bolt or replace the gasket (5) Replace the cylinder head O-ring (6) Replace the crankshaft front/rear oil seal (7) Tighten the inner fixing bolts or replace the gasket (8) Tighten the oil filter fixing bolts or replace the gasket
2	Poor Piston and Cylinder Sealing	(1) Oil ring has excessive wear or gets damaged (2) Excessive wears on piston and cylinder bore	(1) Replace oil ring (2) Check or replace the piston and cylinder block
3	Poor Valve Sealing	(1) The valve oil seal is damaged (2) Excessive valve stem and guide wear	(1) Replace the valve oil seal (2) Replace the valve and guide
4	Crankcase Ventilation System	The crankcase ventilation valve is clogged	Check and clear up crankcase ventilation valve
5	Oil Consumption is increasing	Gasoline engine operates at the high speed under the small load for a long time	Avoid that the gasoline operates at the high speed under the small load condition for a long time

7.4.9 Abnormal Sounds From Gasoline Engine

S/N	Possible Cause	Solutions
1	The hydraulic tappet is failure which afftects the valve clearance	Check or replace the hydraulic tappet
2	Too loose piston pin which generates the tap sound	Replace the piston pin or the piston
3	Excessive wears on piston, piston ring and cylinder bore	Check and replace the piston and piston ring; bore cylinder
4	Excessive wear on connecting rod bearing shell	Replace the connecting rod bearing shell
5	Excessive main bearing shell wear	Replace the main bearing shell
6	Excessive crankshaft thrust washer wear	Replace the crankshaft thrust washer
7	Too big cam axial clearance	Replace the camshaft thrust washer
8	Excessive timing chain and timing sprocket wear	Replace the timing chain and timing sprocket
9	The chain tensioner is failure	Replace the chain tensioner
10	Excessive combustion chamber carbon deposite	Clear the combustion chamber carbon deposite
11	The gasoline specification does not conform to the requirements	Use the specified gasoline

7.4.10 Engine Overheat

S/N	Possible Cause	Remedies
1	Insufficient Coolant	Add the coolant as required
2	Fan belt is loose or damaged	Adjust the tension of fan belt or replace the belt
3	Water pump is failure	Check and repair the water pump or replace the water pump
4	Thermostat is failure	Replace the thermostat
5	Radiator, cylinder block, cylinder head and pipes & passages are clogged or leaking	Clean, repair or replace the related parts
6	Silicone oil fan clutch is failure	Check and replace the silicone oil fan clutch
7	Ignition timing is too late	Check the ignition timing
8	Engine oil level or viscosity is low	Refill or change oil as required
9	Excessive cylinder head combustion chamber carbon deposite	Remove the combustion chamber carbon deposite
10	Exhaust system is clogged	Clear or replace the exhaust system parts and components

7.4.11 Engine Oil Pressure Too Low

S/N	Possible Cause	Remedies
1	Oil leakage	Check or replace the related parts
2	Oil level or viscosity is low	Refill oil or replace oil as required
3	Oil temperature is too high	Cool the gasoline engine, check and repair the cooling System
4	Oil pump pressure-limiting valve is failure	Check and repair the oil pump pressure-limiting valve
5	Oil pump is failure	Check and repair the oil pump or replace the oil pump
6	Oil strainer is clogged, connecting pipe leakage	Clear oil strainer, and tighten the pipe joint
7	Oil filter is clogged	Replace the oil filter
8	Oil pressure gauge is failure	Replace the oil pressure sensing plug
9	Oil pressure gauge failure	Replace the oil pressure gauge
10	Excessive wears on main bearing shell, connecting rod bearing shell or camshaft bearing	Replace the bearing shell or bearing concerned
11	Serious oil leakage on rocker arm shaft or chain tensioner	Check and tighten the related parts

7.4.12 Gasoline Engine Backfire

S/N	Parts/components	Possible Cause	Solutions
1	Ignition System	⑴ The spark plug electrode gap is incorrect ⑵ The spark plug has carbon deposit ⑶ The high voltage cable is short circuit ⑷ The ignition coil secondary voltage is insufficient	⑴ Adjust the spark plug electrode gap to 1.1mm±0.1mm ⑵ Clean the spark plug or replace the spark plug ⑶ Replace the high voltage cable ⑷ Replace the ignition coil
2	Crankshaft Position Sensor	Clearance between crankshaft position sensor and crankshaft pulley is incorrect	Check and adjust the clearance to the correct value
3	Others	⑴ Valve leakage ⑵ Valve timing is incorrect ⑶ Air intake/exhaust pipe leakage	⑴ Check the hydraulic tappet and valve ⑵ Check the valve and camshaft ⑶ Remove the air intake/exhaust pipe leakage

7.4.13 Engine Acceleration Delay or Lagging (Depressing accelerator pedal will not change speed when driving at various speed, on in worst case, the gasoline engine even stalls)

S/N	Parts/component	Possible Cause	Solutions
1	Fuel System	(1) The fuel system pressure is low (2) The injector drive circuit is failure (3) The electric fuel pump is damaged (4) The fuel system is clogged	(1) Check the fuel pump fuel-supply pressure, check whether the fuel filter is clogged, and check the fuel pressure regulator (2) Check the injector drive circuit (3) Replace the electric fuel pump (4) Replace the fuel filter, and clear the pipes
2	Ignition System	Certain spark plug or high voltage wire is failure	Replace the spark plug or high voltage wire
3	Voltage is abnormal	The power supply system voltage is not within the range of 9V to 16V	Check the alternator and battery
4	Others	The throttle is grabbed	Clear the carbon deposit, and if necessary, replace the throttle valve body

7.4.14 Engine Fuel Cut-off or Misfire (the gasoline engine trembles during the acceleration, and the sound of fuel after burning can be heard from the exhaust pipe when the engine operates at idle speed and low speeds)

S/N	Parts/components	Possible Cause	Solutions
1	Ignition System	(1) The spark plug clearance is incorrect (2) The spark plug has carbon deposit (3) High resistance	(1) Adjust the spark plug clearance (2) Clear the carbon deposit or replace the spark plug (3) Replace high resistance cable
2	Fuel System	(1) The fuel pressure is incorrect (2) The fuel filter is clogged (3) The injector is failure	(1) Check whether the electric fuel pump operates normally, and check the fuel pressure regulator (2) Replace the fuel filter (3) Replace the injector
3	Others	(1) The valve timing is incorrect (2) Valve leakage (3) The valve spring is broken or failure (4) The camshaft is failure	(1) Check the valve timing (2) Grind the valve, and check the hydraulic tappet (3) Replace the valve spring (4) Replace the camshaft
4	Electromagnetic disturbance	Serious electromagnetic disturbance	Check the high voltage wire for leakage

Chapter 8 Structure, Adjustment and Service of BJ483ZQB Diesel Engine

8.1 Precautions on Service and Adjustment of Diesel Engine

8.1.1 Non-professional personnel never tries to dismantle to repair a diesel engine. The customers should contact the dealers or service stations authorized by FOTON Motor Company.

8.1.2 The operators should be familiar with the structure of diesel engine and its technical data, component assembly relationship and the technical requirements for disassembly/assembly, and understand the proper methods for assembly/assembly and the maintenance tools using. Customer who does not have necessary technical skills and conditions is suggested to contact the service stations authorized by Fonton Motor Company.

8.1.3 The disassembly procedure is generally conducted in the following order: from the outside to the inside, and from the assy. to the components. To improve the assembly efficiency and ensure the correctness of the assembly, note to check and make marks on parts when disassembly. Clean the components disassembled and inspect them carefully. The components which can be reused should be sorted and stored by the assy.. The precision components should be divided from the common ones, and stored in a clean container.

8.1.4 The assembly procedure is generally conducted in the following order: from the inside to the outside, and from the parts to the components and then from the components to assy.. When assembly, pay more attention to the installation dimension, orientation, fit clearance, tightening torque and etc. to avoid the neglected installation, incorrect installation, the scuffing of component fitting surface, and the entry of foreign material into the inside of the machine. Use proper wrench and fastening torque on bolts and nuts. Use fittings correctly according to regulations, including cotter pins, spring washer, retraining washer etc. Beside, during assembly, note to cross check parts codes with assembling marks to ensure right locations and motional relations among parts.

8.1.5 Ensure that the diesel engine is in the clean, good working conditions at all times. Before the disassembly or assembly, clean or wipe parts to guarantee them clean and ensure the quality of assembly. The complicated adjustment and maintenance should be conducted in doors to prevent the inside of diesel engine from being contaminated by the environment.

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

8.2 Service and Adjustment of Diesel Engine

8.2.1 Tightening of Cylinder Head

The cylinder head is tightened to the cylinder block through the cylinder head gasket using 10 main bolts and 8 auxiliary bolts. To prevent the air leakage, the cylinder head bolts should have the sufficient tightening torque at installation. The cylinder head bolts should be evenly tightened three times in the specified sequence using the special torque wrench. The tightening sequence and the torque of the cylinder head main bolts are: 40 – 50 N·m for the first time; 90 – 100 N·m for the second time; and 145 – 160 N·m for the third time. The tightening sequence and the torque of the cylinder head auxiliary bolts are: 10 – 15 N·m for the first time; 25 – 35 N·m for the second time; and 45 – 55 N·m for the third time. The tightening operation starts from the center and alternately extends to its surroundings in sequence every time (see Figure 8-1), and at the last time, it should be tightened to the specified torque.

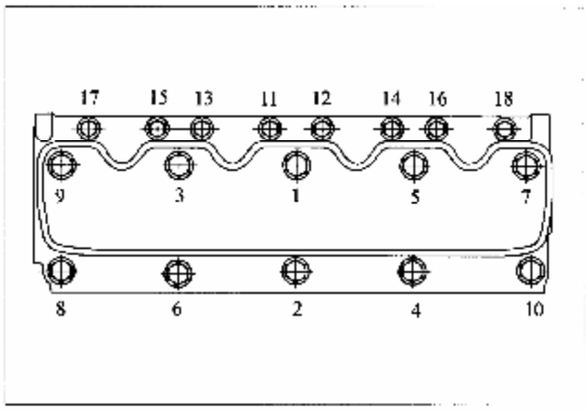


Figure 8-1 The Tightening Sequence of Cylinder Head Bolt

● **Note:**

(1) The turbocharged diesel engine adopts the integrated cylinder head gasket. During installation, there is no foreign material in the outer part of the retainer; otherwise it may cause the blow-out of the combustion gas.

(2) When the air leakage from the diesel engine's cylinder head gasket occurs, use a torque wrench to check the tightening torque of the cylinder head bolts which should be tightened after the diesel engine has cooled down.

(3) The cylinder head bolt is a kind of special high-strength bolt, and it is prohibited to substitute it with the regular bolt.

8.2.2 Assembly of Cylinder Liner

The cylinder liner is with the dry-type structure. Its body is fixed together with the intermediate fixing main bearing cap by the pin, flushing with the planes of front/rear main bearing caps. It interlinks with the main bearing cap by main bearing cap bolts.

If the wear of inner surface of the cylinder liner is above 0.35 mm, replace it.

Clean the outer surface of the cylinder liner as well as cylinder bore wall before assembling a cylinder liner. Do not apply lubricating grease on them to avoid that the grease affects the contact between the cylinder and its liner as well as their heat dissapation. Apply uniform pressure to press cylinder liner into cylinder block.

8.2.3 Tightening of Main Bearing Cap Bolt

The tightening torque of main bearing cap bolt is 160 – 170 N·m. Tighen evenly in three times in sequence: the first: 40 – 50 N·m; the second: 90 – 100 N·m; and the third: 160 – 170 N·m.

8.2.4 Assembly of Piston

The Figures 8-2 and 8-3 show the piston with the elliptical and cone-shaped head on which there are 2 gas grooves and 1 oil groove. On the top face of piston, there is a forward arrowhead installation mark which points to the front of diesel engine. In addition, the outside diameter grouping mark is engraved on the piston. Select the piston group whose dimension group matches that of cylinder liner to install.

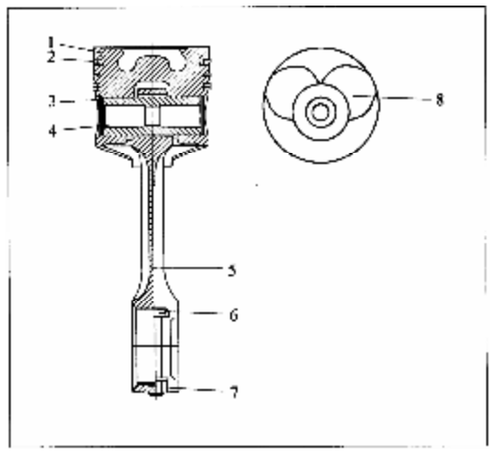


Figure 8-2 Piston and Connecting Rod

1-Piston; 2-Piston Ring; 3- Snap Ring; 4-Piston Pin; 5-Connecting Rod; 6-Connecting Rod Bushing; 7-Connecting Rod Cap; 8-Cumbustion Chamber

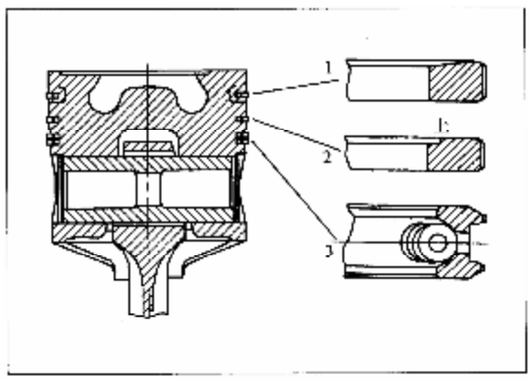


Figure 8-3 Piston and Piston Ring Structure

1-Barrel-Face Trapezoid Gas Ring; 2-Inner Chamfer Twist Type Gas Ring; 3-Spiral Spring Oil Ring

The piston pin seat locates in the middle section of the piston, and is used to support the piston pin. The grooves at both ends of pin hole are used to install the snap ring which limits the piston pin axial movement. There is an oil hole under the pin hole, which is used to collect the oil and lubricate the pin / seat friction surface.

Measure the wear of piston when repairing. Replace the piston if the wear of piston exceeds the standard value.

● **Note:** The piston ring and piston should be replaced in pair.

8.2.5 Check and Assembly of Piston Ring

The piston ring is divided into gas ring and oil ring. Each piston 2 gas rings and 1 oil ring. The first gas ring is a barrel-face trapezoid ring, the second gas ring is an inner chamfer twist type ring (the inner chamfer faces upward when installation), and the third ring is a spiral spring oil ring (Figure 8-3).

The special tools are used to reassemble the piston ring (Figure 8-4). Install the spiral oil ring first, followed by second and first rings.

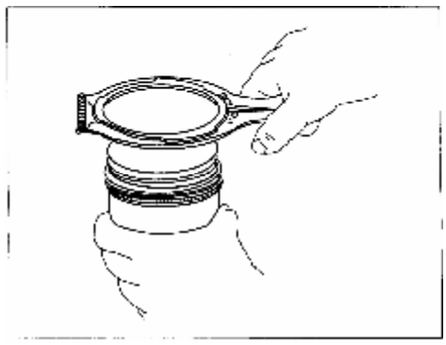


Figure 8-4 Installation of Piston Ring Using A Piston Ring Expander

Piston rings were set into cylinder liner under normal temperature. There should be proper gap at their opens —so called “open gap”. Proper gap can help to avoid it being seized due to heat expansion, and reduce leakage through gap to preserve energy and keep crankcase clean. The standard clearance values are as follows: first ring 0.25 – 0.40mm; second ring 0.25 – 0.40mm; oil ring 0.15-0.30mm.

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

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 of each piston ring is as follows: 0.06 – 0.10 mm for the first ring; 0.04 – 0.08 mm for second ring; and 0.02 – 0.06 mm for oil ring.

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

When to mount an oil ring, the lining spring connector should be installed opposite to the opening of oil ring body.

After the piston ring has installed into the piston, the ring should move freely in the ring groove without restriction. The opening positions of three piston rings should mutually stagger to each other.

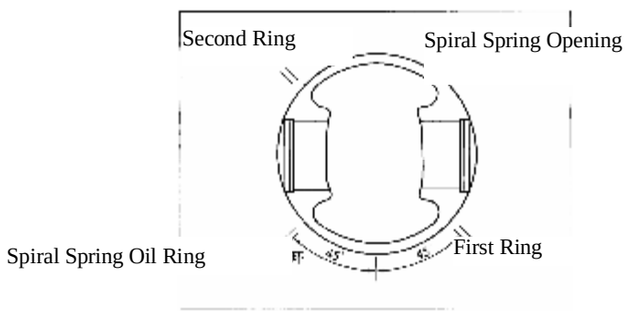


Figure 8-5 Piston Ring Installation Position

8.2.6 Assembly of Piston Pin

The piston pin is fastened by a spring retaining ring. One end of the ring bends inwards. Use a long flat nose pliers to snatch the bent on ring to take it out. No special tool is neede. (See Figure 8-6)

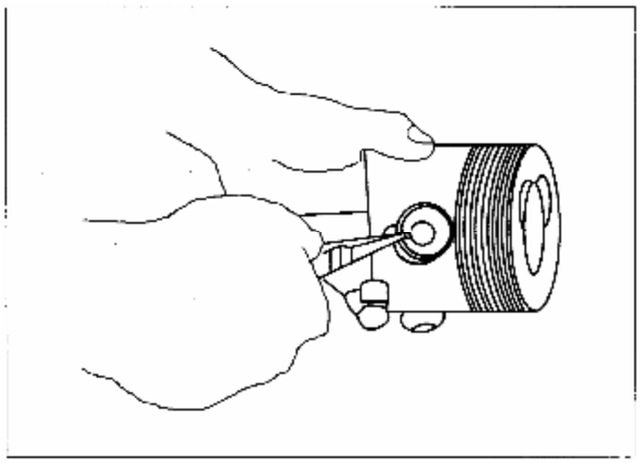


Figure 8-6 Remove spring retaining ring with nose pliers

Heat piston to 100℃ – 120℃ before mounting piston pin into piston.

● **Note:** When to install piston pin retaining ring, check locating ring surface for any damage.

8.2.7 Assembly of Connecting Rod and Its Bolts

The connecting rod connects the piston with the crankshaft. The body of connecting rod and its big end cap are attached in pair using the locating bolt, they are not interchangeable (see Figure 8-7).

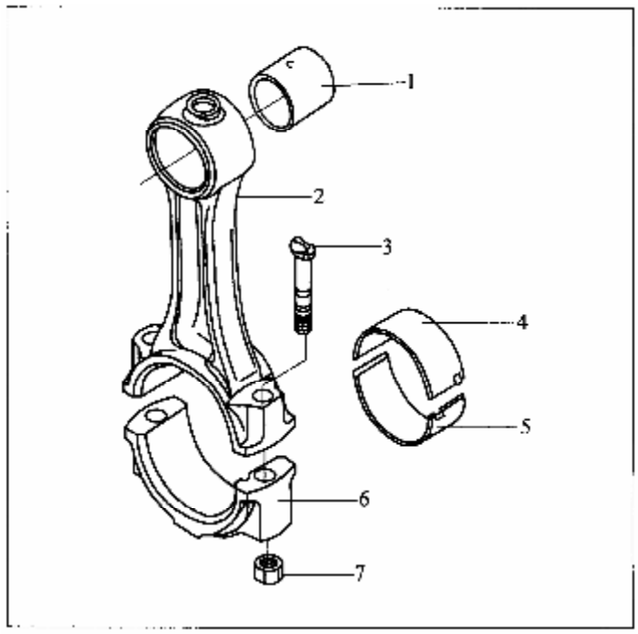


Figure 8-7 Connecting Rod Assembly

1-Connecting rod small end bushing; 2-Connecting rod body; 3-Connecting rod bolt; 4-Connecting rod upper bearing shell 5-Connecting rod lower bearing shell; 6-Connecting rod cap; 7-Connecting rod nut

Apply lubricating oil on thread surface before mounting connecting rod bolts, and tighten two bolts in three times. The tightening torque of the connecting rod bolt is 55 – 65 N·m.

Since the central plane of the connecting rod body misaligns with that of the connecting rod big end in axial

direction, i.e., the big end is eccentric to connecting rod body. Connecting rod can fit the crankshaft properly only under following conditions: arrowhead mark on the top surface of piston points front; the marks (protuberated) on connecting rods for cylinders No.1 and 3 face forward; and that for cylinders No. 2 and 4 face rearward. So, when to reassemble the piston connecting rods, these for cylinders No. 1, 3 and for No. 2, 4 should be sorted and reassembled respectively. The weight difference among groups should not be more than 5 g.

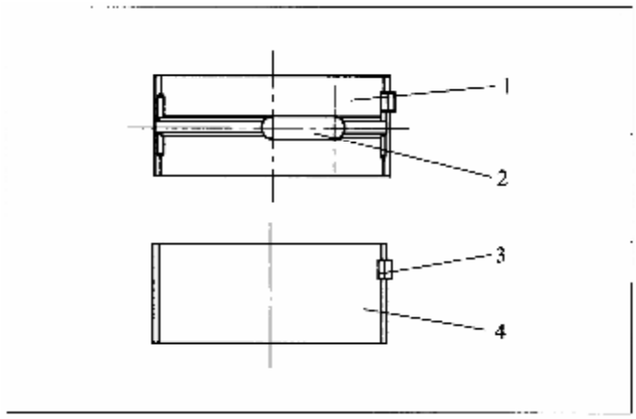


Figure 8-8 Upper/Lower Main Bearing Shell of Crankshaft

1-Upper main bearing shell; 2-Oil hole; 3-Locating protruded lip; 4-Lower main bearing shell

Before the piston connecting rod is installed into the cylinder liner, apply the clean oil on the outer surface of piston, connecting rod small end and bearing shell surface. The openings of the first and second piston rings should mutually stagger 180°, and avoid pointing to the direction of piston pin. The oil ring and the second ring should stagger 90° (see Figure 8-5).

When the piston connecting rod is installed into the block, the piston head guide groove should face the tappet side (injection pump side). After tightening the connecting rod bolt to the specified torque (55 – 65 N·m) during assembly, check if the crankshaft rotates smoothly and if there is an axial clearance in the connecting rod big end.

● **Note:** Replace the body and cap of the connecting rod in pair at the same time.

8.2.8 Assembly of Upper/Lower Bearing Shell of Crankshaft

The crankshaft journal of turbocharged diesel engine is supported on the block by the main bearing cap. The upper bearing shell of crankshaft has the oil groove and hole (see Figure 8-8), and the upper and lower bearing shells are not interchangeable.

When to press to mount the timing gear, the mark “X” on gear should face outward (see Figure 8-9).

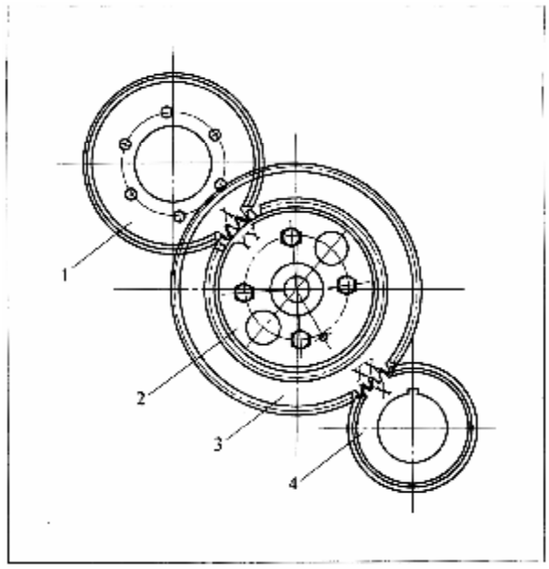


Figure 8-9 Gear Drive Mechanism

1-Injection pump gear, with Mark Y; 2-Idle gear, with marks Y, Y;

3-Camshaft gear, with marks X, X; 4-Crankshaft gear, with mark X

8.2.9 Assembly of Flywheel

The flywheel is installed by 6 bolts to ensure the reliable installation strength. During installation, tighten the bolts clockwise three times with the tightening torque of 80 – 90 N·m.

Apply oil on bolts thread before mounting flywheel bolts.

8.2.10 Assembly of Timing Drive Mechanism

The turbocharged diesel engine's gear drive mechanism includes: the injection pump drive gear, camshaft gear, idle gear, crankshaft gear and other gears, as shown in Figure 8-9.

The open/close timing of the diesel engine's intake/exhaust valves and fuel supply timing of injection pump are strickly set in relation to the movement position of crankshaft. The camshaft gear, injection pump gear and crankshaft gear are correlated via the timing idle gear. The crankshaft gear, camshaft gear, injection pump gear and idle gear all have their own assembly marks.

A tilted convex rib is forged on the gear chamber cover, and there are the inscribed lines on the crankshaft pulley (see Figure 8-10), which are used for the adjustment of top dead center.

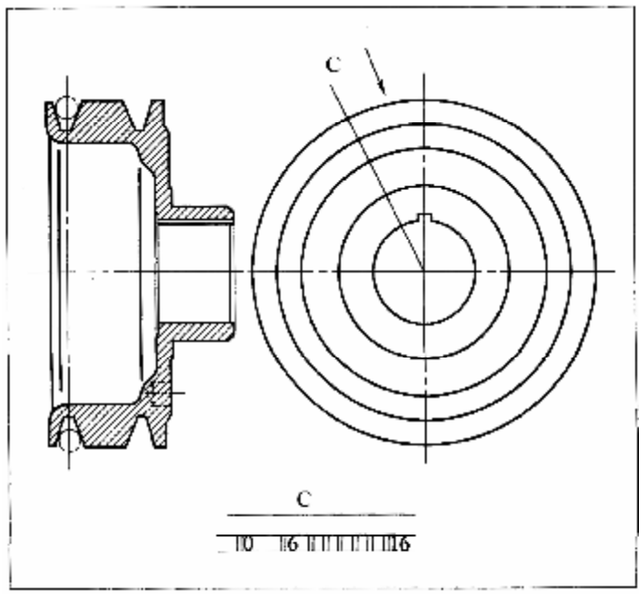


Figure 8-10 Crankshaft Pulley

Marks are inscribed on the surface of outer circle of the crankshaft pulley; 0-means the top dead center of piston; 6-means 6º before top dead center (crankshaft angle); 16-means 16º before top dead center (crankshaft angle)

When to mount timing gear drive mechanism, align these marks with each other to ensure the correct port timing and fuel supply timing. Otherwise there would be some malfunctions happening such as engine fails to start up, or its power goes down, oil consumption increases, or in worst case, the piston head could bump to valve to cause damage.

After the installation of timing gear group, check the port timing.

If the complete gear drive mechanism is required to be replaced due to the unclear and invisible marks or worn-out gear, please get to the professional service shop or the service stations authorized by Foton Motor Company.

8.2.11 Assembly of Camshaft

The highlights on the assembly of the camshaft assy.:

(1) When pressing in the cam gear and idle gear, the gear marks “X, X” and “Y, Y” should face outwards (see Figure 8-9).

(2) When to mount tappet into the tappet bore in cylinder block, apply the lubricating oil on them. Installed tappet should be able to rotate by hand.

(3) After oil pump has been tightened, the camshaft should be able to rotate by hands.

8.2.12 Assembly of Intake / Exhaust Valve

The valve is used to control the open/close of the intake / exhaust passages.

Replace any worn out valve.

● **Caution:** The valve spring locking plate should be correctly installed into the spring seat, otherwise locking plate might fall off to cause the valve dropping into the cylinder.

8.2.13 Valve Clearance

The valve clearance means the gap between the back end of valve stem and the rocker arm measured when valve closes near the top dead center of compression stroke.

Valve clearance should be appropriate. Too large clearance could cause impact among valve, valve seat and

other components, which will shorten their service life. it may also delay the valve open timing and advance the valve close timing, thus shorten compression and exhaust time to reduce engine power. While too small valve clearance will shorten the time to warm up components, valve can't fully close, that also reduces engine power. During the combustion, it could lead to the high-temperature gas leakage from the gap, overheaing or even burn out valves.

During the course of operation, all factors could ficilitate clearnance change including worn-out parts, loosened adjusting screw, overhauled cylinder head or parts and retightening of cylinder head nuts. Therefore, it is required to check and adjust the valve clearance regularly.

The intake / exhaust valve (cold state) clearance of a turbocharged diesel engine is 0.35 mm ± 0.05 mm. If it changes during the practical use, check and adjust it in accordance with the following procedures.

(1) Turn crankshaft till 1st cylinder piston reaches TDC of compression stroke, saying pulley TDC mark "0" aligns the pointer on gear cover, and intake/exhaust valves in 1st cylinder are both closed (see Figure 8-10). Perform adjustment on 1,2,3,5 valves(see Figure 8-11).

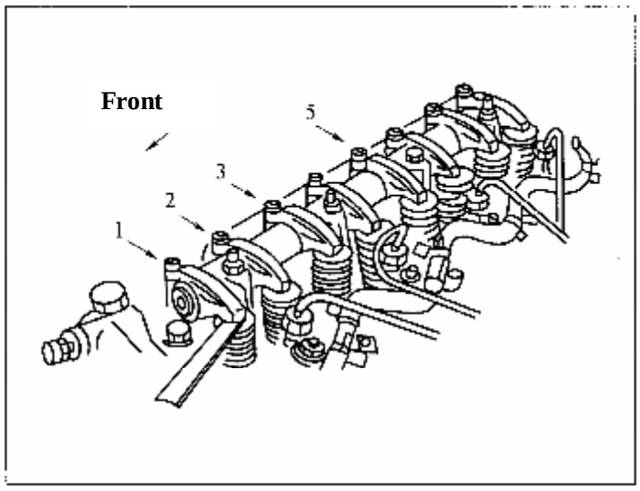


Figure 8-11 Adjustment of Valves No. 1, 2, 3 and 5

(2) Insert a feeler into rocker arm and valve (see Figure 8-12), and loosen concerning rocker arm locking nut, turn adjust screw with a screwdriver till feeler becomes snug. Then retighten the nut

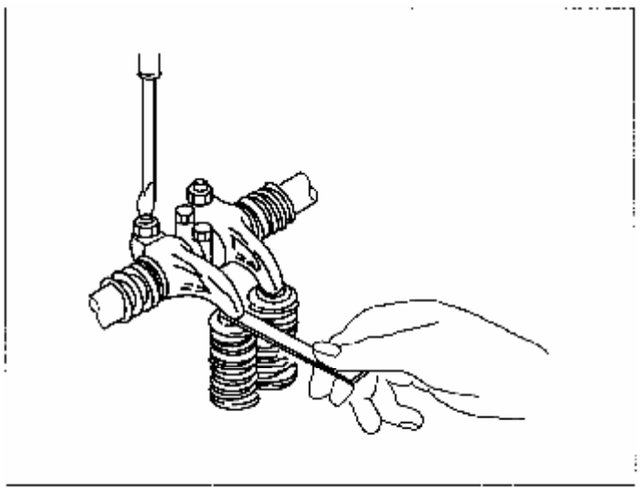


Figure 8-12 Check the Valve Clearance Using a feeler

(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.

8.2.14 Check the Turbocharger before Installation

Remover a new turbochanger's external packaging to check if its rotor rotates freely. If there are impacting sound or rotation lagging, find out the reasons and install it only after troubleshooting.

Check and clean the air filter element. Replace paper element in accordance with the technical requirements.

Check and clean compressor intake pipe and engine exhaust pipes. Keep any foreign objects off from turbocharger.

Check the oil filter and replace contaminated and damaged.filter element

Check and clean turbocharger's oil supply and return pipes to ensure it is clean without distortion. The shims for oil supply and return pipes are not allowed to block off the oil supply / return holes in turbocharger.

Check oil and change diry or deteriorated oil.

8.2.15 Installation of Turbocharger

The turbocharger should be secured reliably. The tightening torque of the exhaust pipe nut connecting to the turbocharger should be 28 – 35 Nm, and the oil inlet / return pipe should be connected reliably. When to install the oil inlet/return pipe, do not apply the sealant on the joint to avoid the entrance of the sealant into the turbocharger and thus prevent the parts and components from be damaged.

Secure the double-steel-wire clip used to fix turbocharger's rubber connection hose, avoid air leakage which causes the power down.

After a new turbocharger is installed on the diesel engine, refill the clean engine oil through the oil filler opening, turn the rotor by hand to pre-lubricate the turbocharger.

8.2.16 Check and Adjust the Turbocharger

Adjust the relative angle of turbocharger housing:

(1) Unscrew the bolt securing the compressor casing (or turbine casing), keep oil return opening on the intermediate casing downward vertically, and turn the compressor casing (or turbine casing).

● **Caution:** DO NOT fully unscrew the bolt to avoid the impeller contacts with the casing.

The torque of compressor casing bolts should be 5.7 N·m,

The torque of turbine casing bolt should be 11.3 N·m.

(2) If necessary, check the operating condition of the turbocharger rotor. Turn the rotor by hand, a normal rotor can rotate by itself at least one turn. Dismantle to check faulty turbocharger. Rotor check needs absolute tidy operating environment to keep foreign object from entering the turbocharger..

Use the special equipment and tools to disassemble and reassemble the turbocharger assembly. As only the turbocharger manufacturer and service center (station) have these special equipment and tools, user is not suggested to perform these operations by himself unless it has to.

(3) Disassemble the compressor casing and check for oil leakage. At the same time, clean the inside chamber of compressor casing and the surface of compressor impeller. Special care should be taken to protect impeller during cleaning.

8.2.17 Adjust Advance Angle of Fuel Injection Pump (Stationary State)

The optimal fuel supply advance angle of a diesel engine is preset by the manufacturer. The advance angle of fuel injection pump should be 8º - 12º CA before top dead center (crankshaft angle)of compression stroke. In winter, the angle can be adjusted up to its upper limit while down to its lower limit in summer.

The improper advance angle will influence engine's power, fuel consumption and normal operation. Adjust any improper advance angle as per following methods:

(1) Check the advance angle of fuel injection pump (stationary state)

Loosen the No 1 cylinder's high pressure fuel pipe nuts, turn the crankshaft counter-clockwise and stop turning at the moment fuel drips from the piston in No 1 cylinder. In this case, the scale reading on crankshaft pulley that aligns with pointer on gear chamber cover is the value of advance angle. The scale readings are 6º, 8º , 10º, 12º, 14º and 16º respectively.

(2) Adjust advance angle of fuel injection pump (stationary state)

If the advance angle checked above doesn't conform to the specified value, loosen three nuts on injection pump, move the injection pump slightly inward or outward. Advance angle decreases as it moves inward while advance angle increases as it goes outward. When the advance angle of fuel supply reaches its ideal position, tighten the above mentioned three nuts, and finally, check again whether or not the adjusted advance angle of fuel supply is proper.

● **Caution:** It is not allowed to dismantle the parts with lead seal on injection pump. Approach to professional help. And if necessary, conduct the testing and adjustment on the special test stand.

8.2.18 Check Fuel Injector

The turbocharged diesel engine adopts the S series multi-orifice injectors, Model CKBEL87S069 or ZP22 (see Figure 8-13). It atomizes the fuel and sprays into combustion chamber where fuel mist mixes with the air and become combustible mixture.

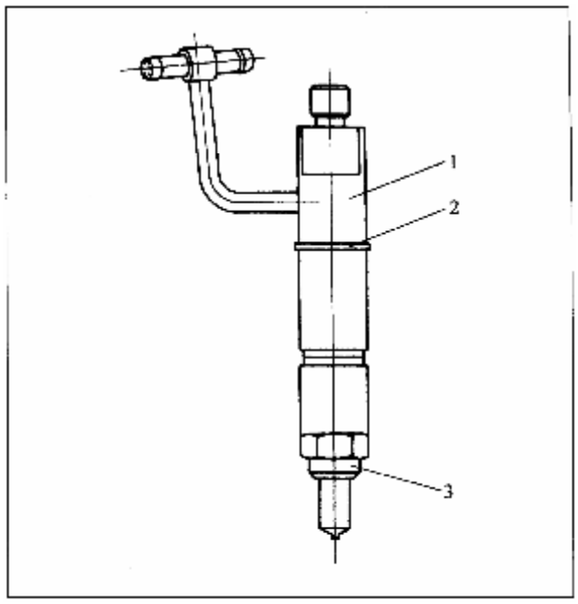


Figure 8-13 Fuel Injector Assembly

1-Injector; 2-O-ring; 3-Copper washer

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.

8.2.19 Replace Fuel Injector

● **Caution:** DO NOT let the contaminated material and dirt enter the fuel system. Before disconnect the connector, thoroughly rinse the jointing area. Use appropriate goods to cover the connector that has been opened.

(1) Disassemble the fuel return pipe.

(2) Disassemble the high pressure fuel pipe connecting nuts from the injector and injection pump. Do not bend the fuel pipe, and if necessary, disassemble the return pipe clamp.

(3) Remove retaining screw, and detach the clip, injector, O-ring, injector washer. Install new O-ring and injector washer on the new injector.

(4) Mount the new injector, O-ring and injector washer. Put on pipe clamps and retaining screw. Ensure the injector does not tilt. Evenly and gradually tighten the retaining screws.

● **Caution:** Tighten high pressure pipe connecting nuts with specified tightening torque. If any leakage occurs around nut, check whether the fuel pipe is correctly aligned with the inlet of injector. DO NOT over-tighten the injector connecting nut, otherwise fuel pipe end will be crashed, thus fuel supply is affectd.

(5) Install the high pressure pipe and tighten the connecting nut.

(6) Replace the sealing gasket and install the fuel return pipe, tighten the blots.

(7) Start the diesel engine, and check for fuel and air leakages.

8.2.20 Check the fuel injection quality of the injector

Check injecting quality. Put a fuel injector on test stand to observe its spraying quality. Clean, adjust and even replace injector in the events of poorly atomization, fuel spills, leakage and strange injecting sound (see figure 8-14).

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

● **Caution:** Do not go on using an injector which fails to satisfy the technical requirements. Replace it with a new one

8.2.21 Check the Injection Pressure of the Injector

All injectors in a new diesel engine has been checked and adjusted in the factory, users can directly use it without readjustment. However, after the diesel engine has operated for a period of time, injector spring elastic force will change, that makes injector pintle opening pressure changing. In addition, chenk ther pressure after injector had been removed and cleaned.

Check the injection pressure of injector on a test bench: secure injector on the test bench, disassemble the fuel pipes, at this momnet pressure gauge indictates “0” . Pump the fuel and observe pressure gauge indication. Check whether pressure gauge indicates specified value (20 – 21 MPa).

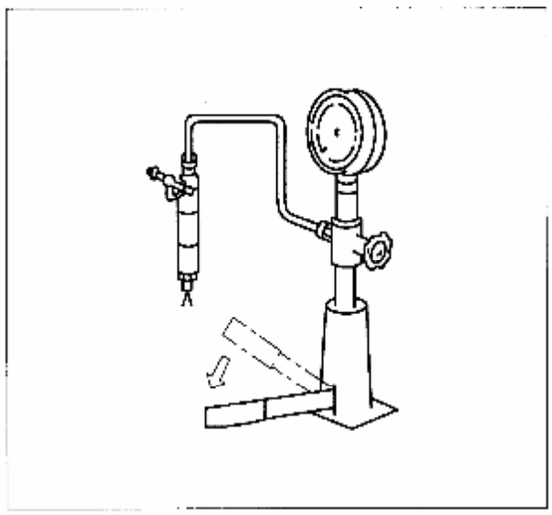


Figure 8-14 Check the Injection Quality of an Injector Using a Test Bench

8.2.22 Regulation of Injector Opening Pressure

The opening pressure of a injector in turbocharged diesel engine is regulated by increasing and decreasing the thickness of the pressure regulating shim to injector body. Increase the thickness of shim to raise the opening pressure; and decrease the shim thickness to reduce the opening pressure.

If it is required to regulate the injection pressure, operator should clean the outside of injector and unscrew the tightening nuts. Note that the coupling parts, tappet, springs and original washer should not be discarded. Keep all part and component clean.

8.2.23 Check the Thermostat

Thermostat automatically changes coolant flow in radiator according to engine temperature to maintain engine in a proper operation temperature. (figure 8-15)

The temperature sensing element of the thermostat is a paraffin-type one. The thermostat is installed in the thermostat casing at the water outlet on the cylinder head.

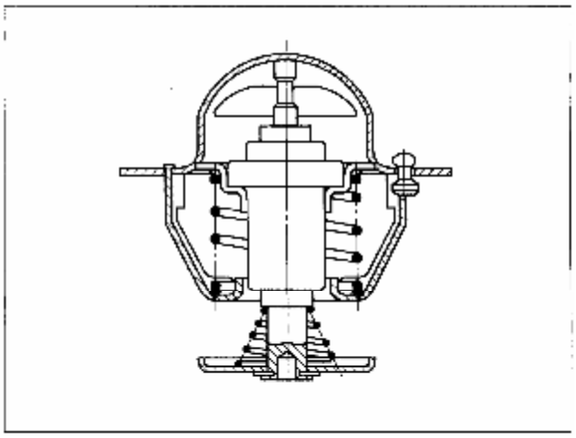


Figure 8-15 A Thermostat

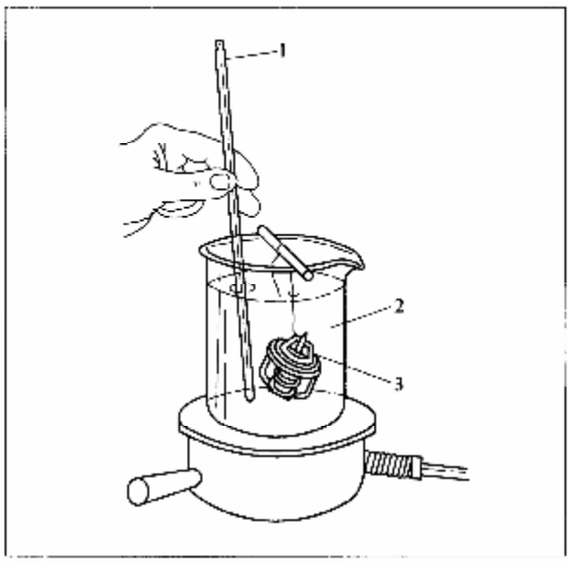


Figure 8-16 Thermostat Test

1-Thermometer; 2-Water under Heating; 3-Thermostat

A bypass valve under thermostat closes when thermostat valve opens, coolant then flows into radiator to improve cooling. The thermostat valve closes when water temperature is low, and then the bypass valve opens to cut off the passage from the water jacket to the radiator, and the coolant enters the water pump through the bypass pipe and then is driven back to the water jacket. In this case, the coolant doesn't go through the radiator, it circulates only between the water jacket and water pump. This small circulation could help to warm up diesel engine quickly. When coolant temperature is high, thermostat valve will fully open, the minor circulating bypass valve is closed at the same time to let coolant flow into the radiator and conduct the major circulation to improve heat dissipation.

Thermostat initial opening temperature is 76℃±2℃, full opening temperature is 90℃. Full opening 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 requirements (see figure 8-16). Otherwise replace thermostat.

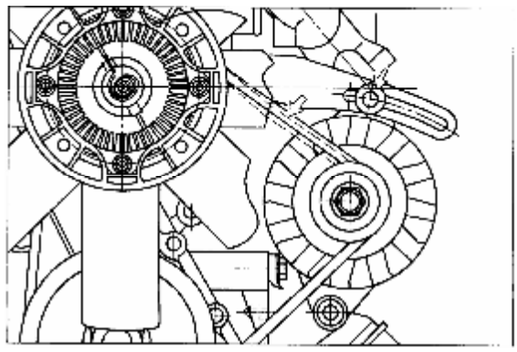


Figure 8-17 Check and adjust water pump belt tension

8.2.24 Adjust Belt Tension

Fan belt tension should be proper. If it is too loose, the belt will slip over the belt pulley. This would decrease fan speed to affect cooling system performance and speed up belt wear. While too tight belt would facilitate bearing wear and increase power consumption.Check the belt tension regularly.

Install the belt into alternator and water pump belt pulley groove first, then into the crankshaft pulley groove. To tighten the fan belt, turn the alternator outward, and tighten the fastening bolts.

Check fan belt tension after a diesel engine has operated up to 100h (vehicle milieage 4,000~ 5,000 km). Hand press the belt (70 ~80 N) at the spot between the water pump and alternator pulle. Its deflection should be preferentially 6~8 mm (see Figure 8-17).

Chapter 9
Diesel Engine Faults and Troubleshooting

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.

9.1 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.

9.2 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

9.3 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 to 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.

9.4 Abnormal noise during operation

First of all, operator 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.

9.5 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.

9.6 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.

9.7 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	（1）Replace thermostat
	（2）Coolant temperature meter is failure	（2）Measure coolant temperature, replace coolant temperature meter
Short coolant often	（1）Radiator is leaking	（1）Repair or replace radiator
	（2）Radiator hose connector is loose or hose is damaged	（2）Tighten clamp or replace hose
	（3）Water pump is leaking	（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 opening 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.

9.8 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.

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

9.10 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. (2)Rotor coil is disconnected. (3)Commutator diode is damaged. (4)Poor contacting on carbon brush. (5)Regulator is damaged.	(1)Check and repair circuit. (2)Check repair or replace alternator assembly (3)Replace commutator diode. (4)Remove dirt on brush or replace brush. (5)Repair or replace regulator.
Lower charging current	(1)Driving belt is loose. (2)Regulated voltage is too low. (3)Battery fluid is insufficient or the battery plates are severely sulphurized.	(1)Adjust belt tension. (2)Replace regulator. (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.

9.11 Lower battery volume, higher self-discharging

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

9.12 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 2Ω), 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.

9.13 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±2℃.
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℃, 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±2℃. (As thermometer error is concerned, switch is considered well even at 80～87℃.
   (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 10 Chassis Structure and Service

10.1 Clutch

10.1.1 Main Technical Parameters of Clutch

Main Technical Parameters of Clutch

Sn	Description		Data		
1	Engine Model		486ZQB	YC4F90-21	491EQ1
2	Type		Single plate, dry, diaphragm spring clutch, hydraulic operation		
3	Clutch plate size（mm）	Inner diameter	Φ160	Φ150	Φ150
		Outer diameter	Φ240	Φ235	Φ236
4	Shock absorber		Corrugated spring plus damping spring		
5	Pressure plate pressing force（N）		4000	5500	4900
6	Max driving torque（N-m）		202	281	255
7	Type of control mechanism		Hydraulic operation		
8	Release master cylinder×travel (mm)		Φ15.875×34	Φ15.875×30	Φ15.875 ×34
9	Slave cylinder inner diameter. × travel (mm)		Φ19 × 24	Φ19.5 × 29	Φ20.6 × 35
10	Clutch pedal height (mm)		170±3		
11	Free travel of clutch pedal (mm)		5~15		
12	Maximum radial circle run-out of flywheel		0.2		
13	Max run-out of driven plate (mm)		0.8		
14	Planeness of release finger tip of diaphragm spring		0.5		

10.1.2 Structure Overview

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. BJ6536 series light buss adopt diaphragm spring clutch. The clutch transfers 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 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 (Figure 10-1-1)

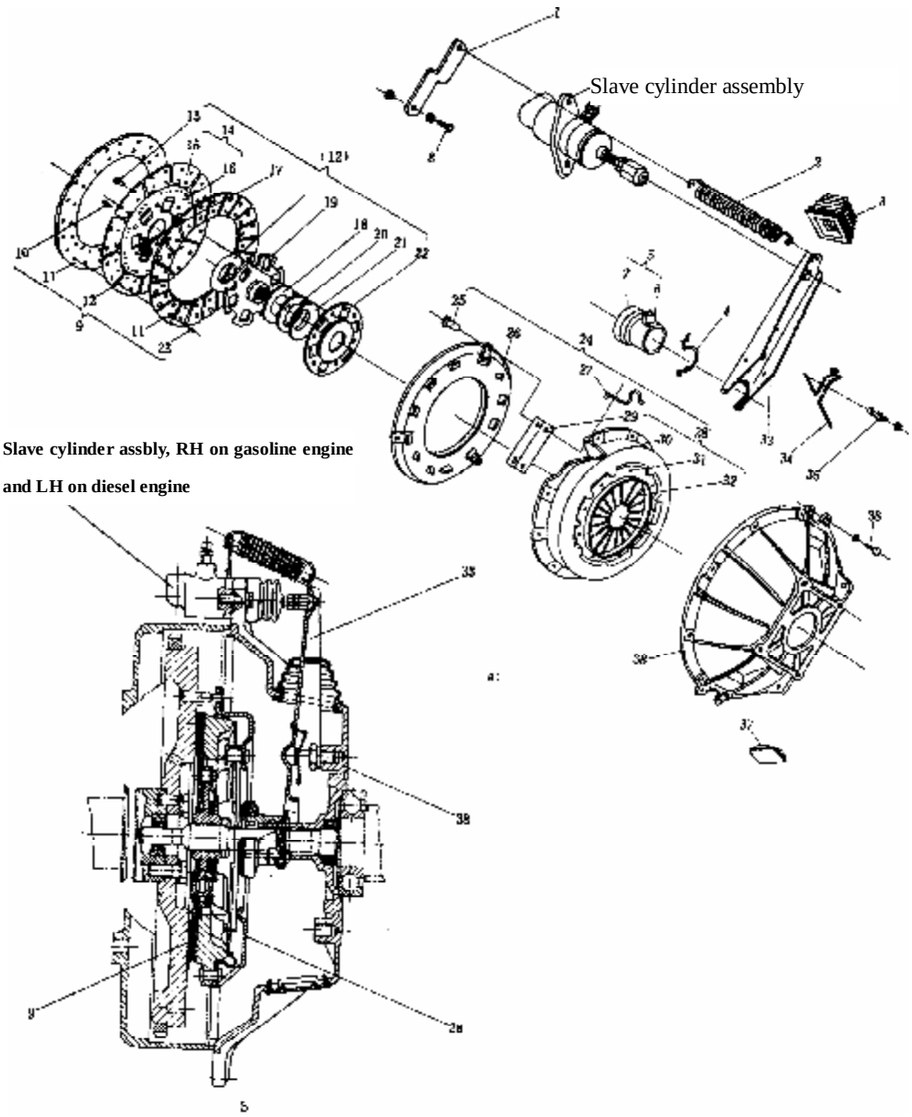


Figure 10-1-1 Diaphragm Spring Clutch

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 engage the clutch.

10.1.3 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 10-1-5). If wear amount is equal or less than limit (table 10-1-1), operator 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.

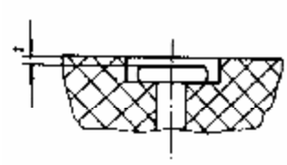


Figure 10-1-5 Measure rivet depth

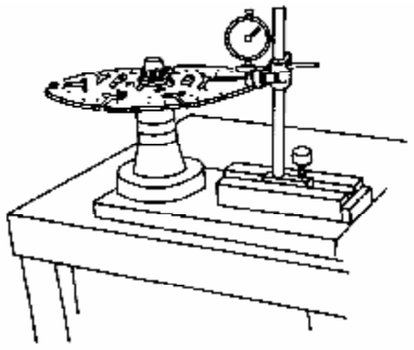


Figure 10-1-6 Axial runout check -clutch driven plate

②Check axial runout of clutch driven plate. Measure at the spot 2.5mm from driven plate edge (figure 10-1-2), if results exceed limits (table 10-1-2), driven plate should be adjusted or replaced.

Table 10-1-1 Rivet Depth (t)

Description	Standard (t)	Limit (t)
Driven plate of diaphragm spring clutch	1.3mm	0.3mm

Table 10-1-2 Run-out

description	Measuring point	Limit
Driven plate — diaphragm spring clutch	2.5mm from the edge	Less than 0.8mm

(2) Clutch diaphragm spring

On the connection spot of diaphragm spring release finger tip with release bearing, if wear exceeds 1mm, repair should be performed. If there are permanent distortion or crack on spring, diaphragm spring together with

clutch cover rivets should be replaced.

(3) Clutch pressure plate

Check pressure plate's working surface. Planish surface if wear exceeds 0.5mm or planeness exceeds 0.12mm. The required harshness is Ra0.8μm, 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 for wears on all fitting surface on rotating parts such as shaft, pin hole and sleeve. Replace part if necessary.

（2）Clutch master cylinder

① Check master cylinder tube 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). See table 10-1-3

Table 10-1-3 **Fitting standard-master cylinder and piston (mm)**

Description	Standard	Limit
Piston diameters	φ15.875H9/e8 φ15.875 (0, -0.032)	
Fitting clearance	0.02~0.06	0.12

② Check master cylinder return spring for rupture, damage and elastic force. Replace it if necessary.

(3) Check slave cylinder tube 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). See table 10-1-4.

Table 10-1-4 **Fitting standard -- slave cylinder and piston (mm)**

Description	Standard	Limit
Slave cylinder piston diameters	φ20.64 H9/e8 (φ20.64 0, -0.040)	--
Fitting clearance	0.02~0.06	0.12

10.1.4 Reassembly and Adjustment

After having checked and repaired clutch parts as per specification, reassemble the clutch and make adjustment again.

1. Locate spline hole on clutch disk hub, check run out tolerance of driven plate assembly (Figure 10-1-6). Measure at the spot 2.5mm from driven plate edge, if results exceed 0.8mm, driven plate should be adjusted or replaced.

2. Dynamic unbalance of clutch cover assembly should not exceed 28 gram-cm; dynamic unbalance of driven plate assembly should not exceed 28 gram-cm.

3. Before mounting clutch assembly on engine, clean flywheel friction face, there should be no oil dirt on fitting surface of clutch friction plate. Meanwhile, apply a thin layer of lubricant oil on fitting surfaces of release bearing sleeve, release fork, ball support of release fork and ball nut of push rod.

4. When to reassemble clutch, operator 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

5. Reassembe and adjust of clutch controls

Reassembly:

(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.

① Reassembly of master cylinder. Proceed in reverse order to disassembling.

② Check after reassembly.

▲ Piston cup of master cylinder should seal well. There should be no brake fluid weeping on it when piston goes back and forth.

▲ Perform sealing test under an oil pressure of 13Mpa. Ensure no leakage occurs in 5 seconds.

(2) Reassemble and check slave cylinder. Thoroughly clean parts before reassembly, and bath sealing ring and cup in brake fluid.

① Reassemble slave cylinder. Proceed in reverse order to disassembly.

② Check after reassembly.

▲ After reassembling, devices should operate freely without any restriction or grabbing.

▲ Perform sealing test under an fluid pressure of 13Mpa. Ensure no leakage occurs in 5 seconds.

(3) Reassemble clutch pipeline

① Proceed in reverse order to disassembly.

② During reassembly, keep oil pipe and connectors clean, clamp pipes and fasten the connectors. There should be no restriction in pipeline or weeping at connectors.

(4) Reassemble clutch pedal mechanism

① To make sure all fitting surfaces of all pins, shaft and pinhole are clean. Apply a layer of thin lubrication grease on them.

② Proceed in reverse order to disassembly.

③ After reassembly, the rotating components should be connected firmly and can move freely.

④ Install the reassembled clutch pedal mechanism onto the instrument panel and cabine floor and fix it with connecting bolts.

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.

a. Clutch release clearance adjustment. Change the length of slave cylinder push rod to adjust clearance.

Remove return spring between release fork and clutch housing, and loosen slave cylinder push rod locking nuts. Turn push rod clockwise to attach ball nut with release fork, and turn ball nut backward 1-1.5 turns. Fasten push rod locking nut, install release fork return spring. The clearance from release bearing side to diaphragm spring release finger tip at this moment is 1.5～2.mm.

b. Adjust clearance between master cylinder pushing rod and piston. Loosen locking nut on master cylinder pusing rod, turn pushing rod counter clockwise till it touchs piston, turn pushing rod clockwise 3/4 turn, and then fasten locking nut on pushing rod. The clearance should be 1mm.

② Clutch pedal height adjustment. While pedal has proper free travel, its high-low adjustment is made by means of limiting screw. Method is to loosen locking nut on screw that mounted on pedal's bracket, turn screw clockwise. Pedal height increases as screw tread grows and lowers as tread diminishes. Keep adjusting till pedal's center face is 170±3mm from cab floor. Then tighten locking nut.

③ Bleed clutch pipeline system. In order to obtain normal operation for clutch hydraulic pressure operating system, there should be no air in system fluid. To bleed the system needs two persons: one depresses clutch pedal in the cab while the other peforms venting at slave cylinder. The bleeding procedures as follows:

a. Remove vent plug and hook up a plastic hose, place other end of hose in a see-through cup of suitable size;

b. Fill up the cup with brake fluid. Be sure to keep adding fluid to the cup as bleeding is in progress to maintain at least 2/3 cup of fluid all the time.

c. Unscrew vent plug for 1/2 turn, depress-release pedal many times to flood release master cylinder, pipelines and slave cylinder;

d. Loosen vent plug, drain out fluid with air;.

e. Pedal moves downward while air fluid is being discharged. Fasten plug immediately at the moment pedal almost lowers to its extreme position.

f. Repeat procedure "e" till there is no sign of bubbles in fluid. Then fasten vent screw plug finally, remove hose and install screw cap.

10.1.5 Typical Faults and Elimination

1. Incomplete clutch release (see table 10-1-5).

Clutch can not 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 and shift difficulty.

Table 10-1-5 Incomplete clutch release—faults and Eliminations

Causes		Eliminations	
1	Larger pedal free travel	1	Correct free travel
2	Uneven height—diaphragm release finger tip	2	Adjust height
3	Clutch driven plate warped	3	Adjust or replace
4	Broken clutch plate	4	Repair or replace
5	Loosened friction plate rivet	5	Mount rivet again
6	Transmission: worn-out front bearing makes inputshaft 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
10	Inadequate slave cylinder travel		Re-design to correct the travel

2. Clutch skidding (see table 10-1-6).

Clutch driven plate skids 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.

Table 10-1-6 Clutch Skidding – faults and eliminations

Causes		Eliminations	
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 inputshaft spline, or release bearing stuck	2	Remove stuck
3	Weak or broken clutch diaphragm spring	3	Replace spring
4	Oil dirt on friction plate	4	Remove oil dirt
5	Shorter clutch pedal free travel	5	Adjust free travel to standard

3. Rough clutch engagement (see table 10-1-7).

Vehicle speed jumps up and down at startup and shifting, with forward-backward “shake” feeling.

Table 10-1-7 Rough clutch engagement – faults and elimninations

Causes		Eliminations	
1	Driven plate wave plate—cracked or damaged	1	Replace parts or assbly
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 sound from clutch (see table 10-1-8).

“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.

Table 10-1-8 Abnormal Sound from Clutch – faults and elminiations

Causes		Elminations	
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 inputshaft front bearing or lubricant is short	5	Change or add grease

10.2 Transmission

10.2.1 Main Technical Parameters of Transmission

Main Technical Parameters of Transmission

Sn	Description		Data		
1	Matched model vehicle		With 483ZQB Tang Gear ZSYO8	With BJ491EQ1 Tang Gear 5RYA4	With YC4F90-21
2	Type		Manual, fixed shaft, mechanical 5 gears OD type, synchronizer meshing at all forward gears		
3	Maximum output torque (N.m)		198	198	220
4	Center distance (mm)		72	72	72
5	Drive ratio at each gear	1 gear	4.452	4．452	3.992
		2 gear	2..619	2．619	2.15
		3 gear	1..410	1．517	1.33
		4 gear	1.000	1．000	1.000
		5 gear	0.802	0．856	0.862
		Reverse gear	4.4725	3．578	3.6
6	Type of gear		Meshing bevel gear with lock ring inertia synchronizer		
7	Lubricant		GL5, 85W/90		
8	Lubricant volume (L)		2.0	2．4	2.6
9	Weight (kg)		36	41	40.75
10	Operating mechanism		Long distance manual manipulation for side cover		

10.2.2 Structure Overview

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 powertrain employs transmission. Transmission is used to change drive ratio to make vehicle maneuvers like backward driving and power cut-off possible.

5RYA4 transmission is a three-shaft gear type with 5 forward gears and 1 reverse gear. It is connected to clutch housing with bolts.

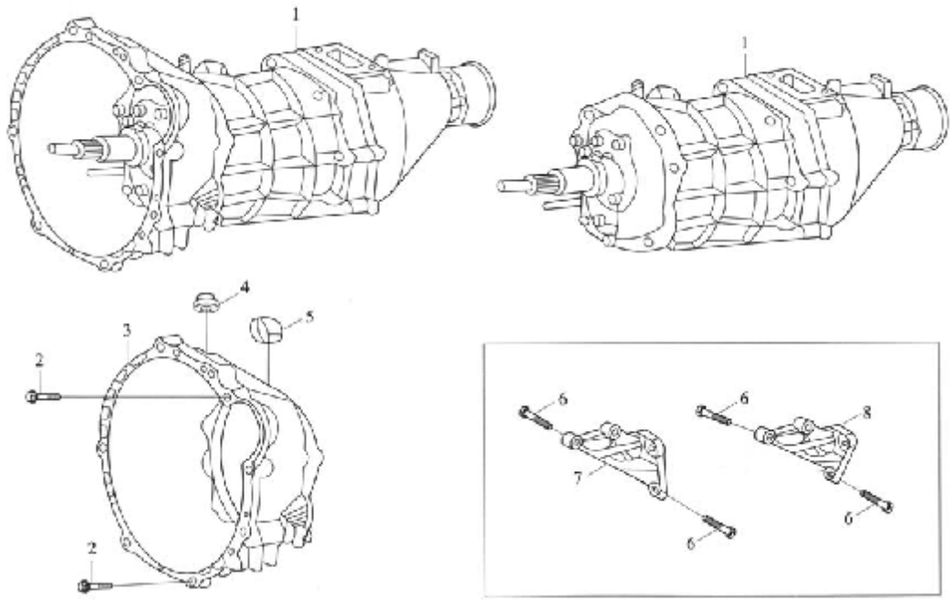


Table 10-2-1 Transmission Assembly-1

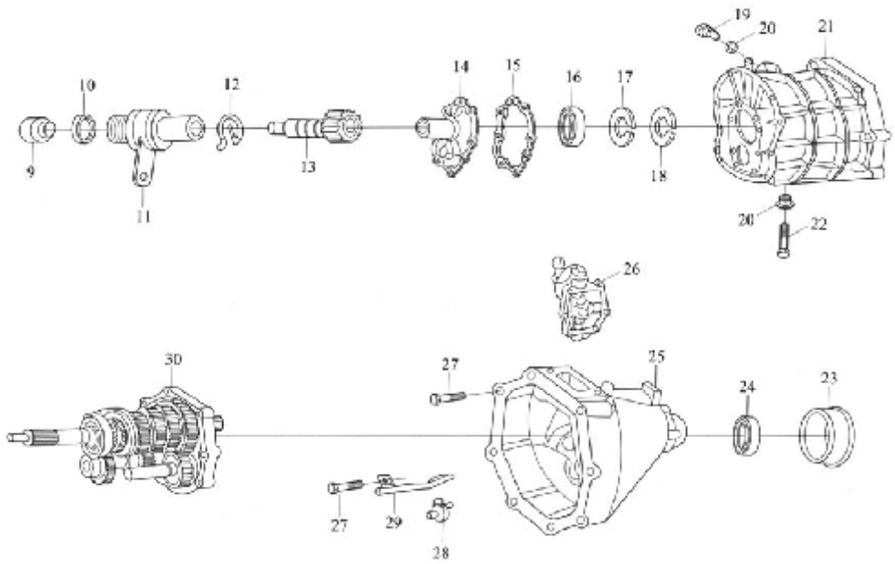


Table 10-2-2 Transmission Assembly-2

1-Transmission assembly; 2-Bolt; 3-Clutch housing; 4,5-Dust boot; 6-Bolt; 7,8-Right reinforcing plate; 9-S type oil seal; 10-O ring; 11-Driven gear bracket of odometer; 12-Driven gear circlip of odometer; 13-Driven gear of odometer; 14-Front housing; 15-Front housing gasket; 16-Front housing oil seal assembly; 17-Front bearing thrust ring of counter shaft; 18-Front bearing thrust ring of counter shaft; 19-Thrust ring of input shaft bearing; 20-Sealing; 21-Housing; 22-Hexagon magnetic bolt (drain plug); 23-Rear body dust boot; 24-Rear body oil seal assembly; 25-Rear body component; 26-Transmission cover component; 27-Bolt; 28-Nozzle; 29-Nozzle; 30-Intermiedate connecting plate component

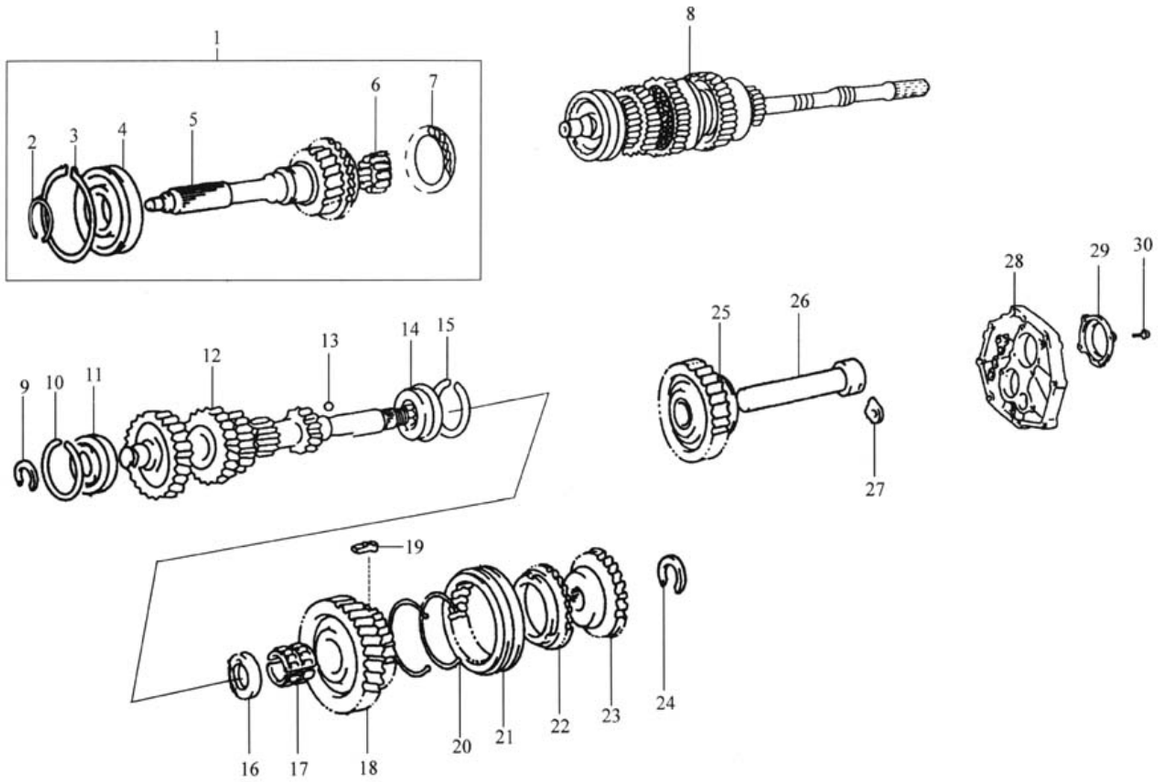


Figure 10-2-3 Intermediate Connecting Plate Component of Transmission-1

1-Input shaft subassembly; 2-Input snap ring; 3-Thrust ring of input shaft bearing; 4-Input shaft bearing; 5-Input component; 6-Needle bearing of input shaft; 7-Cynchronizer gear for 3rd, 4th, 5th gears; 8-Output shaft subassembly; 9-Front shaft snap ring of intermediate separating shaft; 10-Front bearing thrust ring of countershaft; 11-Front bearing of countershaft; 12-Connecting gear of countershaft; 13-Steel ball; 14-Rear bearing of countershaft; 15-Rear bearing thrust ring of countershaft; 16-Thrust washer of 5th gear; 17-Intermiedate 5th gear needle bearing; 18-countershaft 5th gear component; 19-5th gear synchronizer slider; 20-Piston ring of 3rd, 4th, 5th gears; 21-Sliding sleeve of 5th shift synchronizer; 22-Synchronizer gear ring for 3rd, 4th, 5th gears; 23-Connecting gear for 5th gear; 24-rear shaft snap ring of countershaft; 25-Reverse gear idler component; 26-Reverse gear idler shaft; 27-Platen of reverse gear idler shaft; 28-Intermiedate connecting plate; 29-Rear bearing cap of output shaft; 30-Hexagonal screw.

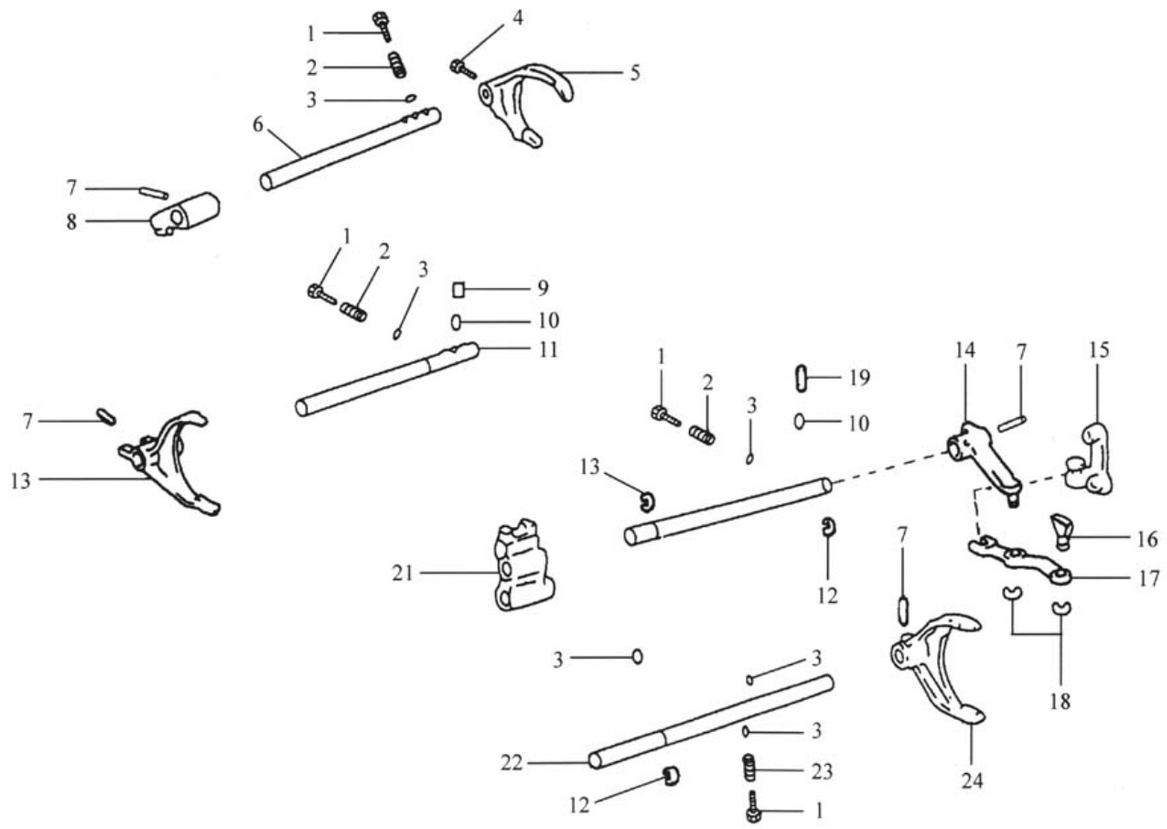


Figure 10-2-4 Intermediate Connecting Plate Component of Transmission-2

1-Screw plug of fixing spring; 2-Fork shaft fixing spring for 1st, 2nd, 3rd, 4th and reverse gears; 3-Steel ball 9.252; 4-shifting fork lock screw for 1st and 2nd gear; 5-shifting fork for 1st and 2nd gear; 6-Shifting shaft for 1st and 2nd gears; 7-spring column pin; 8-Shifting guide block for 1st and 2nd gear; 9-Short interlock pin; 10-Interlock guide column; 11-Shifting fork shaft for 3rd and 4th gear; 12- snap ring; 13-Shifting fork for 3th and 4th gear; 14-Shifting lever for reverse gear; 15-Rocker arm bracket for reverse gear; 16-Shifting block for reverse gear; 17-Reverse gear rocker arm; 18- snap ring; 19-Interlock pin; 20-Shifting fork shaft for reverse gear; 21-Shifting guide block for 5^{th}/reverse gear; 22-Shifting fork shaft for 5th gear; 23-Fork shaft fixing spring for 5th gear; 24-Shifting fork for 5th gear.

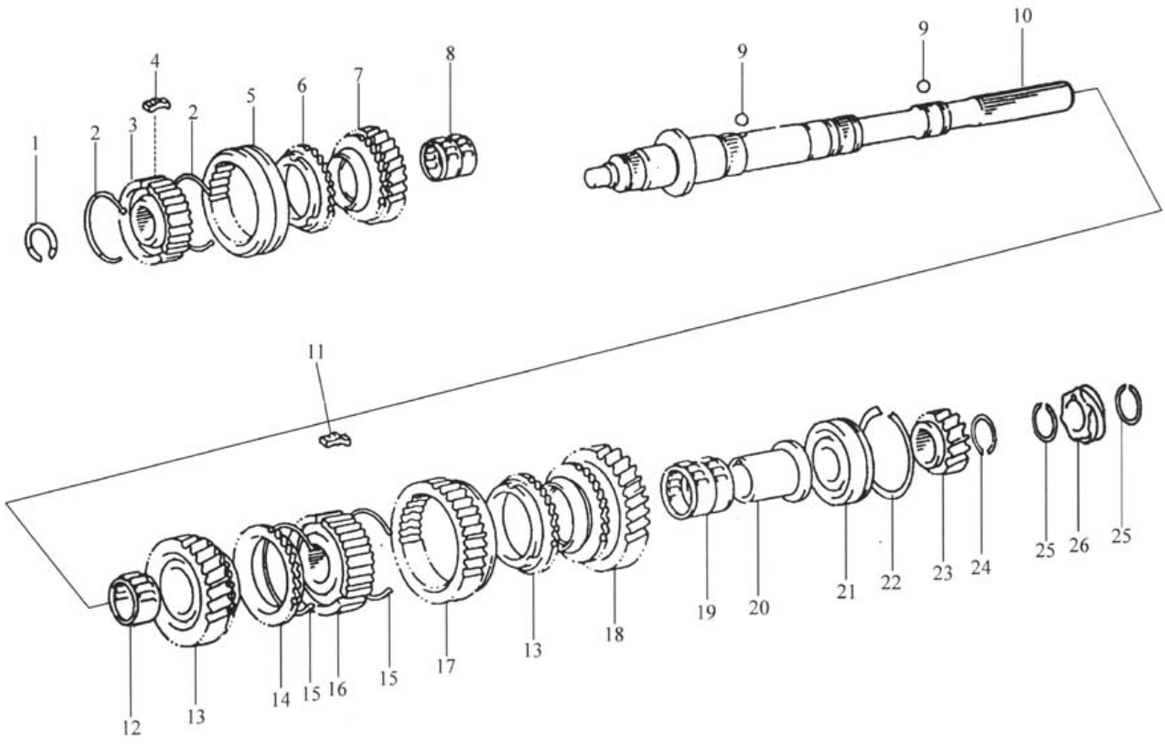


Figure 10-2-5 Output Shaft of Transmission

1-Gear hub shaft snap ring for 3rd and 4th gears; 2-Synchronizer spring piston ring for 3rd, 4th and 5th gears; 3-Synchronizer gear hub for 3rd and 4th gears; 4-Synchronizer inserts for 3rd and 4th gears; 5-Synchronizer sliding sleeve for 3rd and 4th gears; 6-Synchronizer gear ring for 3rd, 4th and 5th gears; 7-Gear component of 3rd gear; 8-Needle bearing of 3rd gear; 9-Steel ball; 10-Output shaft; 11-Synchronizer inserts of 2nd gear; 12-Needle bearing of 2nd gear; 13-Gear component of 2nd gear; 14-Synchronizer gear ring for 1st and 2nd gears; 15-Synchronizer spring piston ring for 1st and 2nd gears; 16-Synchronizer gear hub for 1st and 2nd gears; 17-Synchronizer sliding sleeve for 1st and 2nd gears; 18-Gear component of 1st gear; 19-Needle bearing of 1st gear; 20-Gear shaft bush of 1st gear; 21-Rear bearing of output shaft; 22-Rear bearing thrust ring of output shaft; 23-Gear of 5th gear; 24-Gear shaft snap ring for 5th gear; 25-Driving gear snap ring of odometer; 26-Driving gear of odometer.

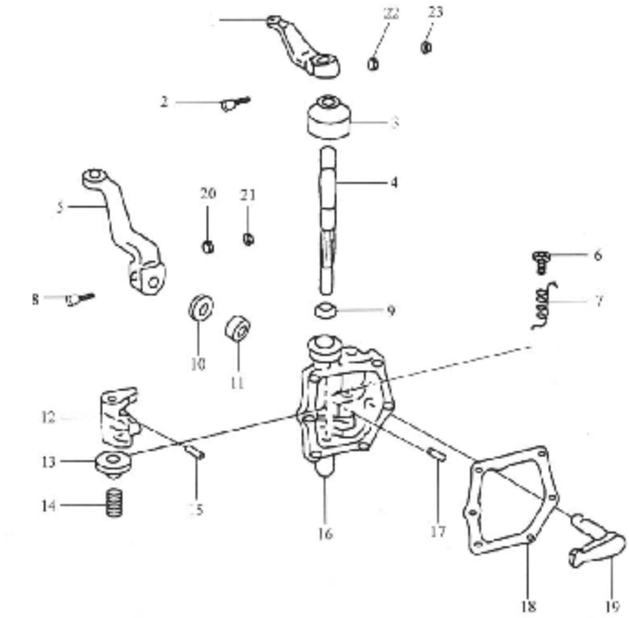


Figure 10-2-6 Side Cover Component of Transmission

1-Shifting rocker arm; 2-Big taper; 3-Dust boot; 4-Shifting shaft; 5-Rocker arm of selector; 6-Limiting stopper; 7-Pressue and torsion spring; 8-Small taper; 9-Oil seal of shifting shaft; 10-Flat washer; 11-Oil seal of selector shaft; 12-Shifting block of shifting shaft; 13-Spring seat; 14-Return spring; 15-spring column pin; 16-Transmission cover; 17-spring column pin; 18-Shifting cover gasket; 19-Selector shaft; 20-Spring washer; 21-1 type hexagon nut; 22-Spring washer; 23-1 type hexagon nut.

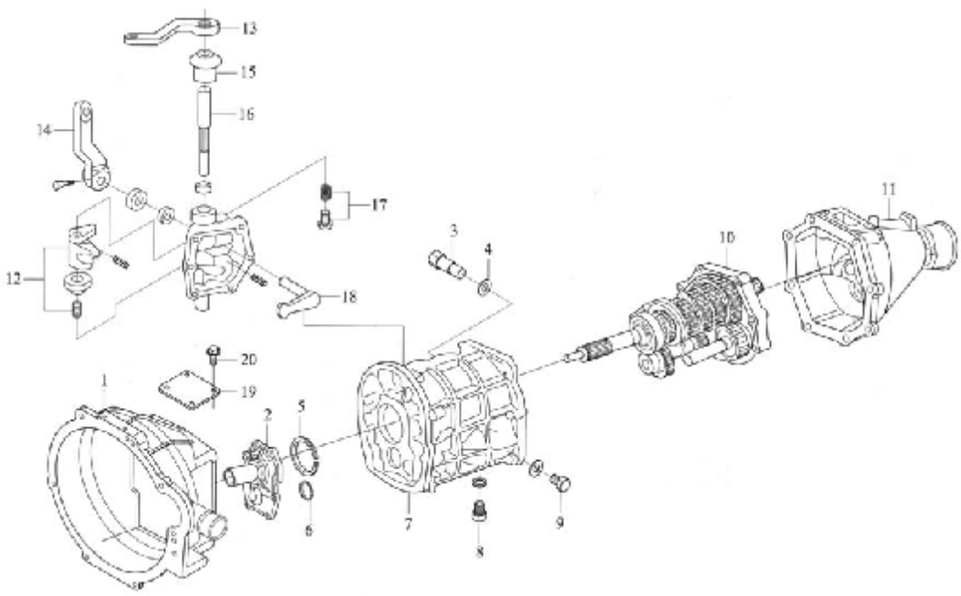


Figure 10-2-7

1-Clutch housing; 2-Front housing component; 3-Reverse switch assembly; 4-seal washer; 5-Thrust ring of input shaft bearing; 6-Front bearing thrust ring of countershaft; 7-Housing; 8-Hexagon magnetic screw plug; 9-Hexagon screw plug; 10-Intermiedate connecting plate component; 11-Rear body subassembly; 12-Return spring of Shifting block of shifting shaft; 13-Shifting rocker arm; 14-Selector rocker arm; 15-Dust boot; 16-Shifting shaft; 17-Limiting stopper of pressure and torsion spring; 18-Selector shaft; 19-Cover panel; 20-Bolt with washer.

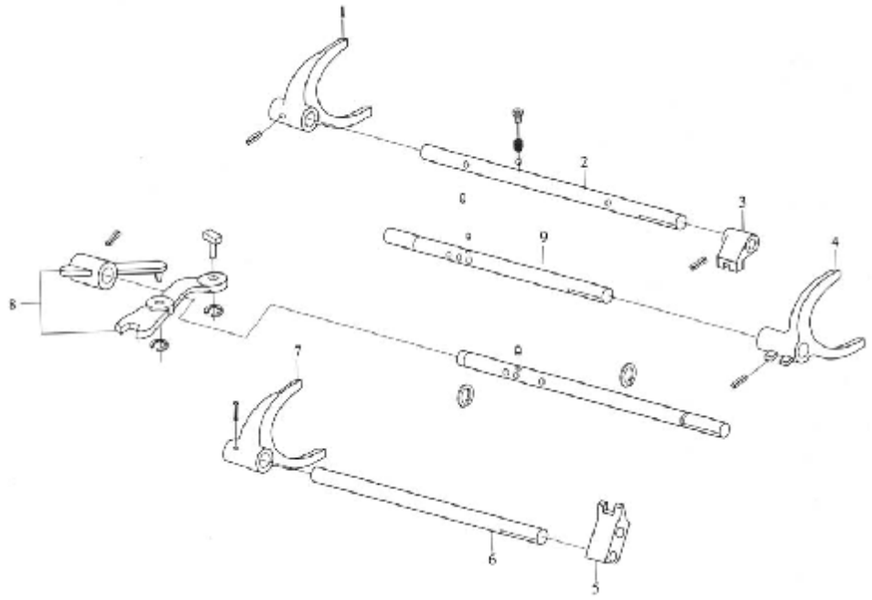


Figure 10-2-8 Intermediate Connecting Plate Component of Transmission (control part)

1-Shifting fork for 1st and 2nd gears; 2-Shifting fork shaft of 1st and 2nd gears; 3-Shifting slider of 1st and 2nd gears; 4-Fork for 3rd and 4th gears; 5-Shifting slider of 5th gear; 6-Shifting fork shaft of 5th gear; 7-Shifting fork for 5th gear; 8-Shifting rocker arm bracket component; 9-Shifting fork shaft of 3rd and 4th gears.

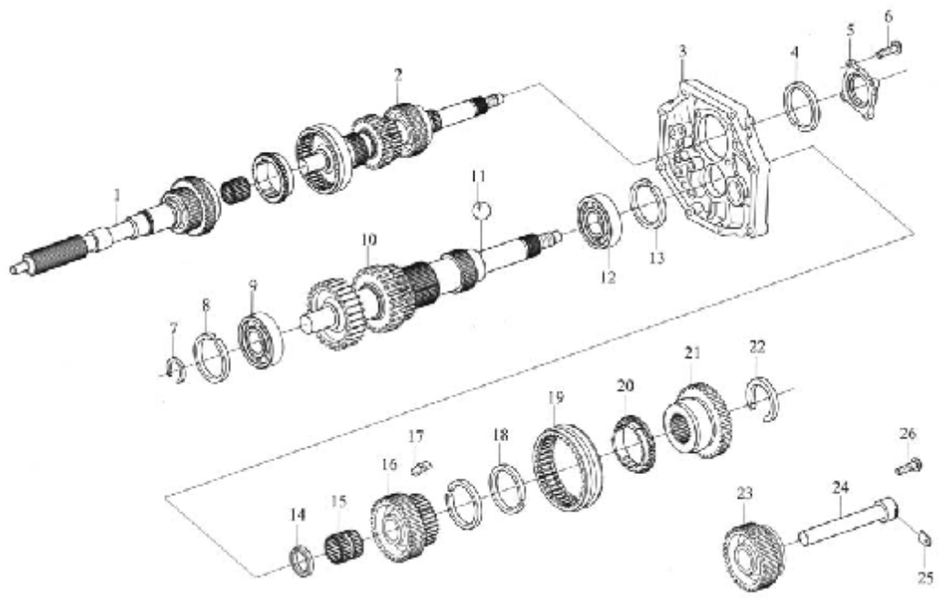


Figure 10-2-9 Intermediate Connecting Plate Component of Transmission (operating part)

1, 2-Input shaft subassembly; 3-Intermiedate connecting plate; 4-Rear bearing thrust ring of output shaft; 5-Rear bearing cap of output shaft; 6-Hexagonal screw; 7-Front shaft snap ring of countershaft; 8-Front bearing thrust ring of countershaft; 9-Front bearing of countershaft; 10-Connecting gear of countershaft; 11-Steel ball; 12-Rear bearing of countershaft; 13-Rear bearing thrust ring of countershaft; 14-Thrust washer of 5th gear; 15-Needle bearing of neutral 5th gear; 16-Gear component of neutral/5th gears; 17-Synchronizer inserts of 5th gear; 18-Synchronizer gear ring for 3rd, 4th and 5th gears; 19-Synchronizer sliding sleeve of 5th gear; 20-Synchronizer gear ring for 3rd, 4th and 5th gears; 21-Connecting gear of 5th gear; 22-Rear shaft snap ring of countershaft; 23-Reverse idler component; 24-Reverse idler shaft; 25-Platen of reverse idler shaft; 26-Hexagon bolt with washer.

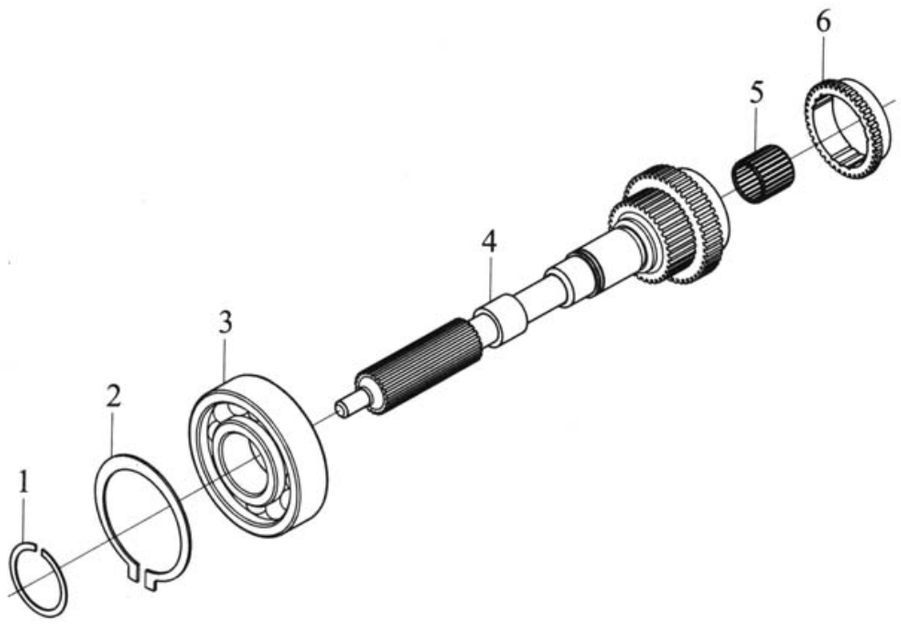


Figure 10-2-10 Input Shaft Subassembly of Transmission

1-Snap ring; 2-Thrust ring of input shaft bearing; 3-Input shaft bearing; 4-Input shaft component; 5-Needle bearing; 6-Synchronizer gear ring for 3rd, 4th and 5th gears.

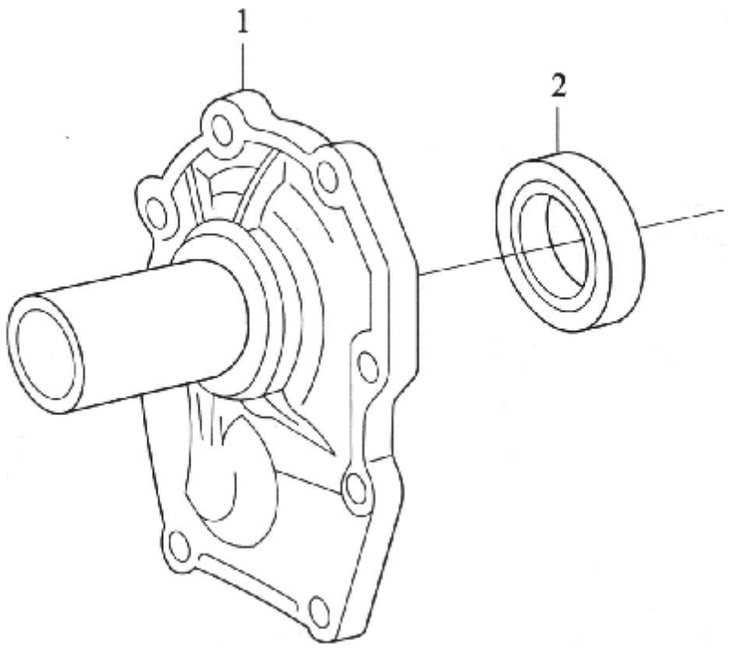


Figure 10-2-11 Front Cover Component of Transmission

1-Front cover; 2-Front cover oil seal assembly

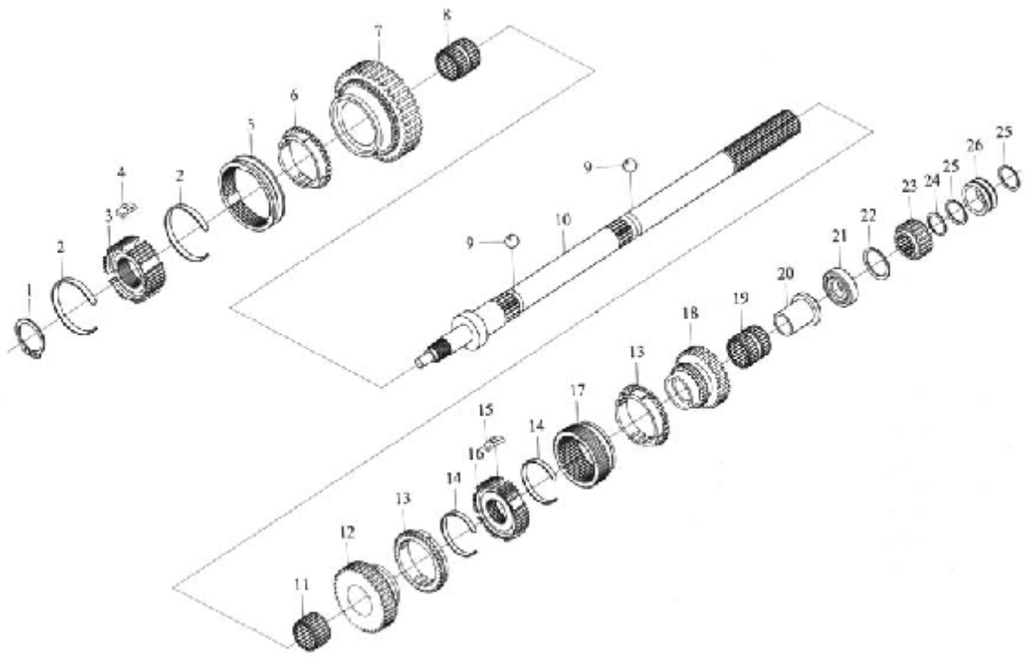


Figure 10-2-12 Output Shaft Subassembly of Transmission

1-Gear hub shaft snap ring for 3rd and 4th gears; 2-Synchronizer spring piston ring for 3rd, 4th and 5th gears; 3-Synchronizer gear hub for 3rd and 4th gears; 4-Synchronizer insert for 3rd and 4th gears; 5-Synchronizer sliding sleeve for 3rd and 4th gears; 6-Synchronizer gear ring for 3rd, 4th and 5th gears; 7-Gear component of 3rd gear; 8-Needle bearing of 3rd gear; 9-Steel ball 6.35; 10-Output shaft; 11-Needle bearing of 2nd gear; 12-Gear component of 2nd gear; 13-Synchronizer gear ring for 1st and 2nd gears; 14-Synchronizer circlip for 1st and 2nd gears; 15-Synchronizer insert of 1st and 2nd gears; 16-Synchronizer gear hub for 1st and 2nd gears; 17-Synchronizer sliding sleeve for 1st and 2nd gears; 18-Gear component of 1st gear; 19-Needle bearing of 1st gear; 20-Gear shaft bush of 1st gear; 21-Rear bearing of output shaft; 22-Rear bearing check ring of output shaft; 23-Gear of 5th gear; 24-Gear shaft snap ring for 5th gear; 25-Driving gear snap ring of odometer; 26-Driving gear of odometer.

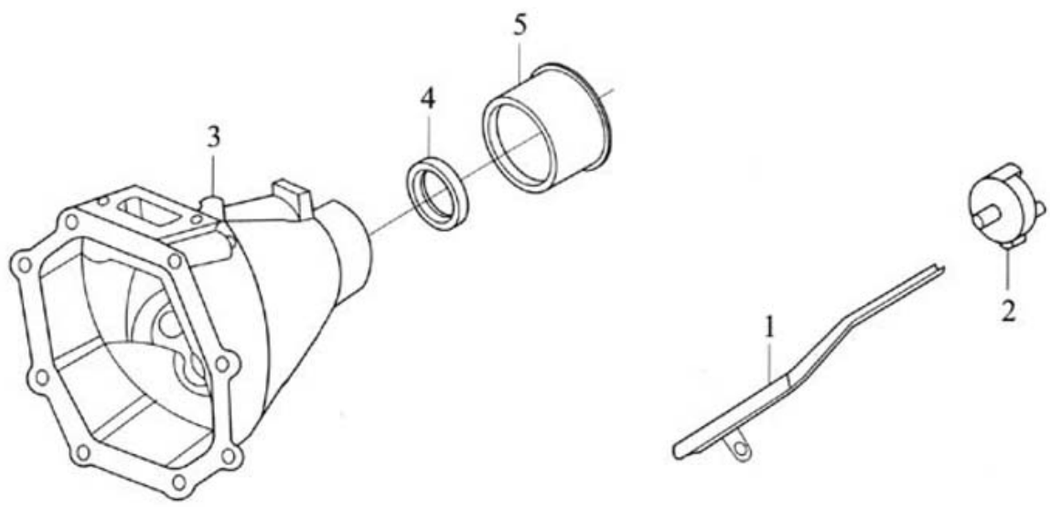


Figure 10-2-13 Rear Body Assembly of Transmission

1-Oil drain channel; 2-Oil drain channel; 3-Rear body; 4-Rear body oil seal subassembly; 5-Rear body dust boot.

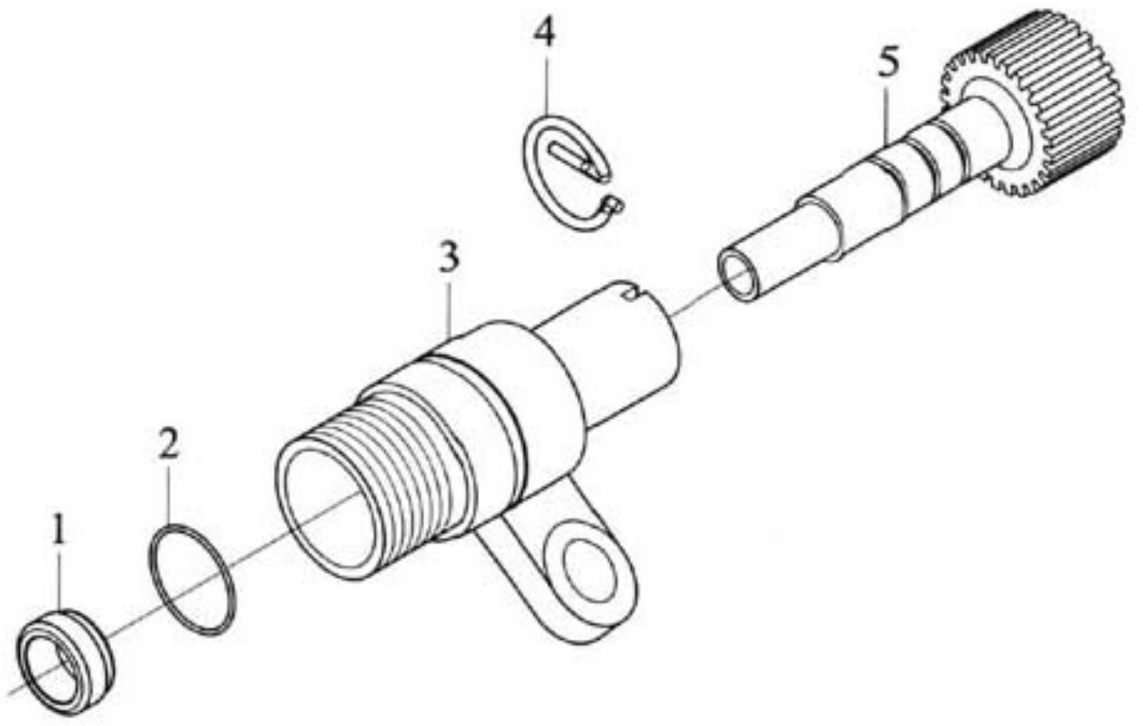


Figure 10-2-14 Transmission Odometer Driven Gear Assembly

1-Oil seal; 2-O-ring; 3-Driven gear bracket of odometer; 4-Driven gear circlip of odometer; 5-Driven gear of odometer.

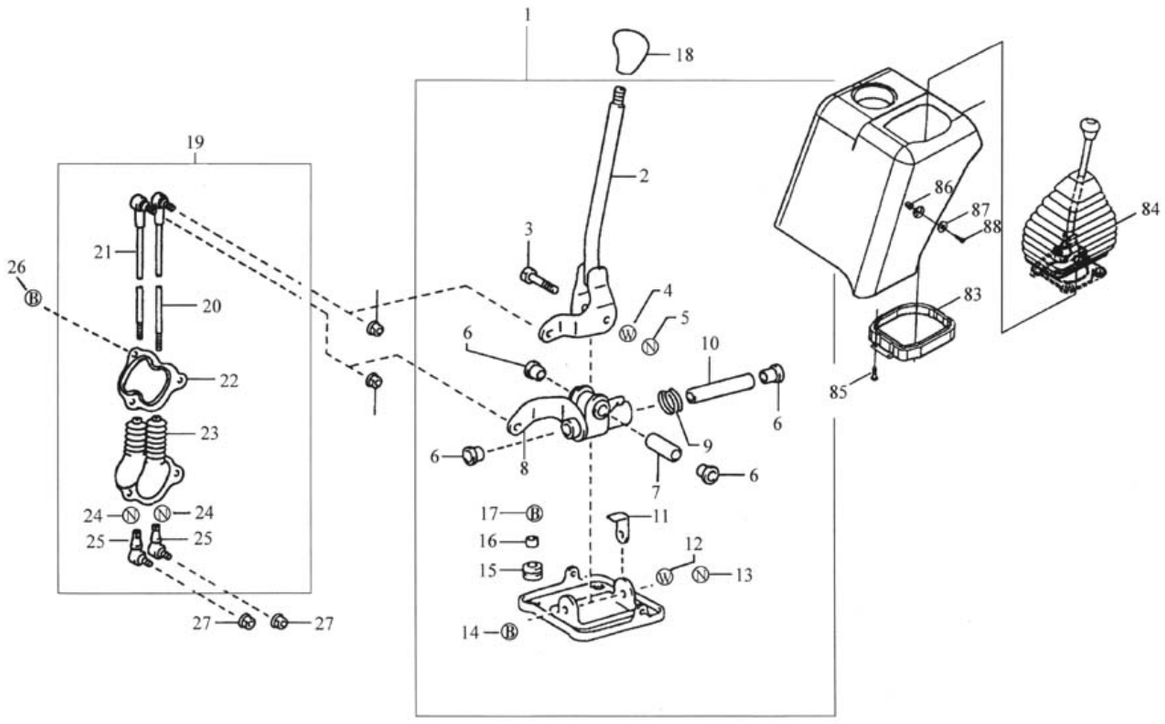


Figure 10-2-15 Shifting Control Device-1

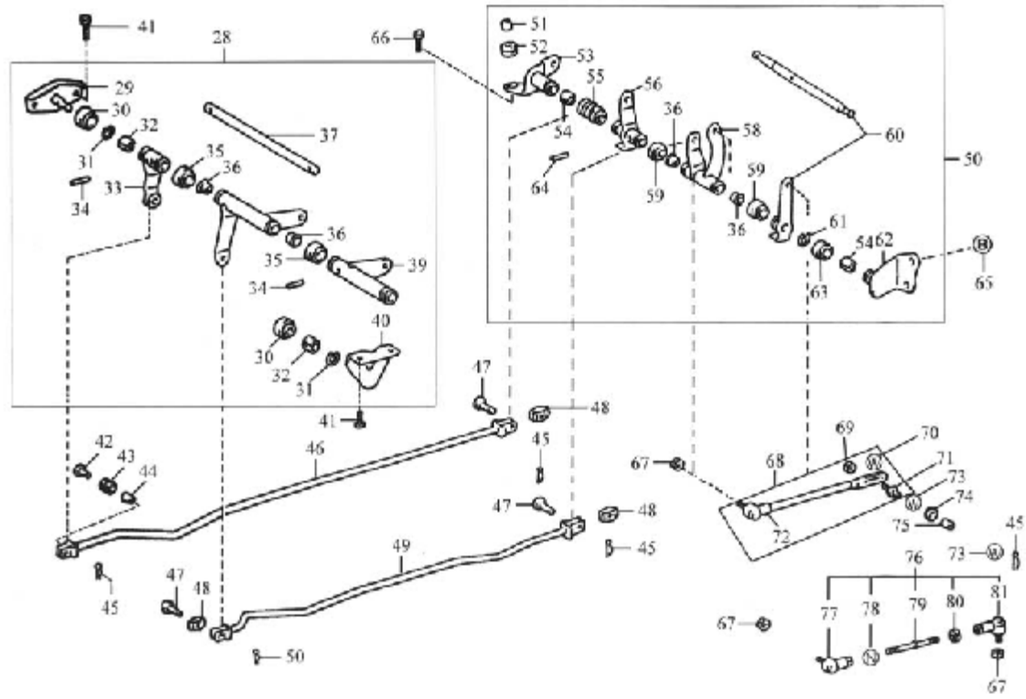


Figure 10-2-16 Shifting Control Device-2

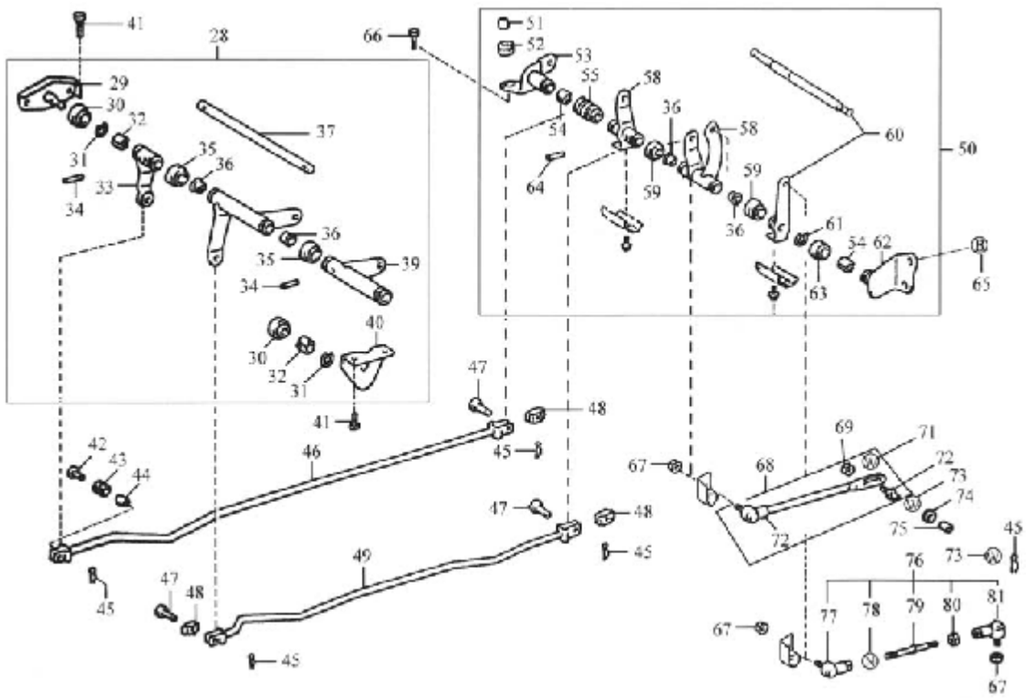


Figure 10-2-17 Shifting Control Device-3

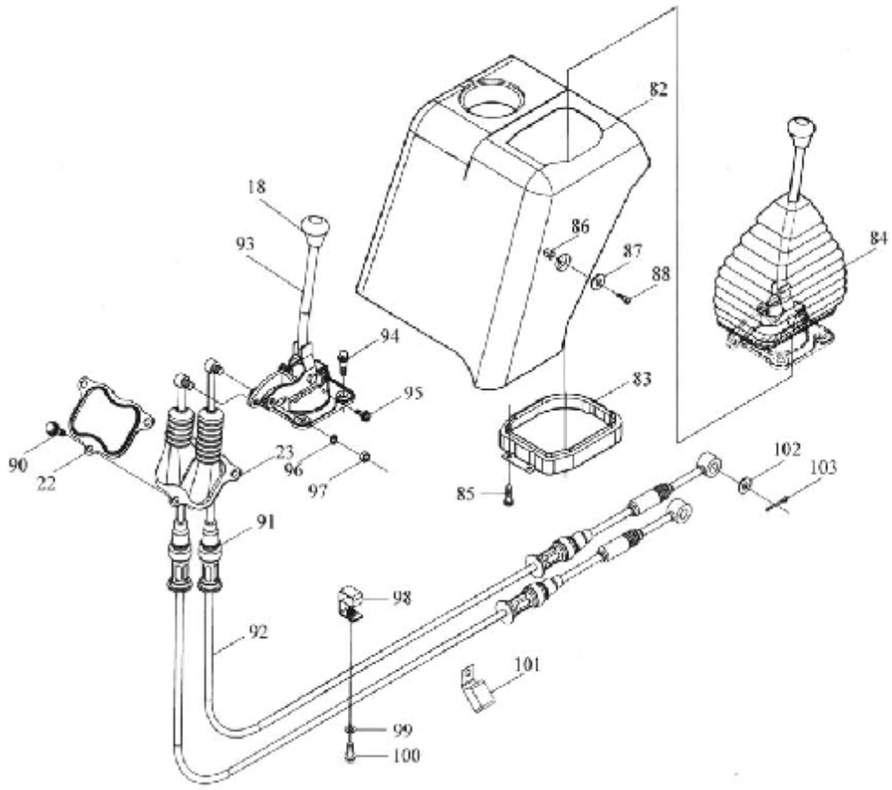


Figure 10-2-18 Shifting Control Device-4

1.shift handle assbly 2.shift lever assbly 3.bolt M8*55 4.washer M-ZnD 5.nut M8-ZnD 6.shift shaft nylon nut 7.shift lever 8.shife lever assbly 9.return spring 10.shift shaft 11.shift spring upper bracket 12.washer M-AnD 13.nut M8-ZnD 14.bolt M8*100 15.bracket retaining boot 16.bracket retaining boot shaft 17.bolt 18.shift lever knob 19. vertical shift selector lever with hood assbly 20.vertical shift lever w.hood assbly 21.vertical selector rod w. hood assbly 22.hood retaining plate 23.vertical rod dust hood 24.nut M8-ZnD 25.lower ball pin w.hood assbly 26.bolt 27.nut 28. I-shaft assbly 29.I-shaft right bracket assbly 30. shaft boot (A) 31.thrust ring16 32.I,II-shaft ball bush 33. shift right shaft sleeve assbly 34.shaft pin 35.shaft dust boot (B) 36. shaft sleeve 37. I-shaft 38. I-shaft sleeve assbly 39. shift left shaft sleeve assbly 40. I-shaft left bracket assbly 41. bolt 42.shaft pin B8*26 43. shift drop arm boot 44. shift drop arm shaft sleeve 45. circlip 46.shift pull rod assbly 47. pin B8*18 48. retaining spring 49. selector long pull rod assbly 50. II-shaft assbly 51. II-shaft right braket retaining bush 52. II-shaft right bracket retaining rubber boot 53. II-shaft right bracket 54. I,II-shaft ball bush 55. II-shaft dust boot 56. II-shaft right shift arm shaft sleeve assbly 57. shaft sleeve 58. II-shaft sleeve assbly 59. shaft dust boot(B) 60. II-shaft left shift arm assbly 61.thrust ring16 62. II-shaft left bracket assbly 63. shaft dust boot (A) 64. shaft pin 65. bolt 66. bolt 67. nut M8 68. selector short pull rod w.boot assbly 69.nut M8 70. washer 8-ZnD 71. short pull rod pin shaft 72.selector short pull rod assbly 73. flat washer 74. selector drop arm rubber boot 75. selector drop arm shaft sleeve 76. shift short pull rod w. boot assbly 77. LH ball pin assbly 78. nut 79. shift short pull rod 80. nut M8 81. lower ball pin assbly 82. controls housing 83. pressure plate 84. shift lever gurad hood 85. tap screw ST4.8*16-C-H 86. screw hole 87. washer 5-ZnD 88. tap screw ST5.5*16-C-H 89 (-) 90. screw sets M8*16 91. clamp 92. shift operating cable assbly 93. shift operating handle assbly 94. screw sets M8*25 95. screw sets M5*12 96. spring washer 97. nut M8 98. locating clip assbly 99. large washer 100. bolt M8*20 101. locating clip II 102. flat washer 103. cotter pin

Transmission drive mechanism usually adopts mesh bevel gear / lock ring inertia sychronizer construction. In this mechanism, power enters inputshaft via countershaft to outputshaft. 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.

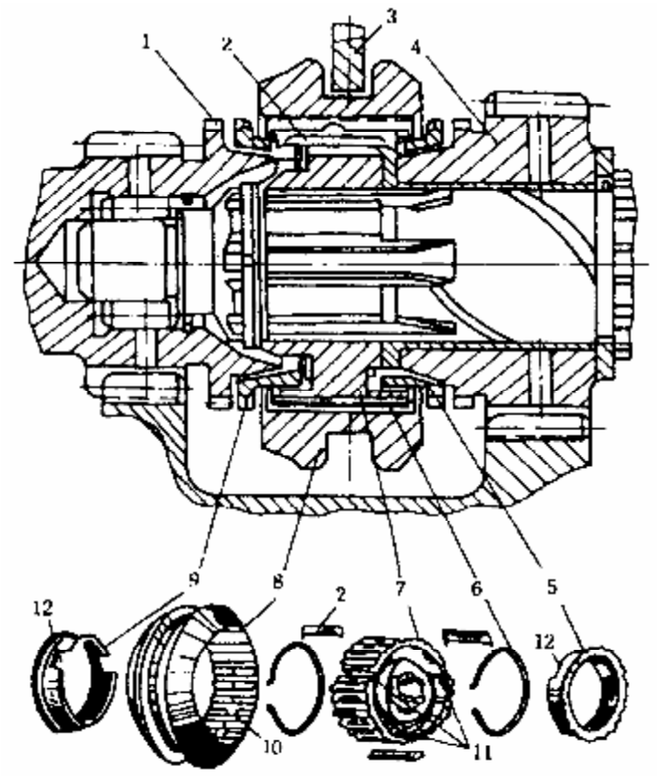


Figure 10-2-19 Lock ring inertia synchronizer

1- inputshaft 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

10.2.3 Check and Repair

1. Transmission Housing

Check transmission housing for crack. Housing sets and their sizes should be in line with these values and requirements in table 10-2-1. Bearing outer radius should match closely with bearing seat hole, otherwise operator should galvanize bearing outer spherical suface to enlarge size, or even replace bearing.

Table 10-2-1 Relevant service data -- Transmission Housing

Description	Specification (mm)
Planeness of housing top plane	Not more than 0.15
Diameter wear - input shaft bearing seat hole	≤0.08
Diameter wear - output shaft bearing seat hole	≤0.08
Diameter wear - countershaft bearing seat hole	≤0.05
Diameter wear - reverse gear shaft hole	≤0.05
Axis parallel —input/output shaft holes with countershaft hole	Not more than 0.08
Face run-out -- front end face with input/output shaft axis (within φ100)	Not more than 0.1
Face run-out -- rear end face with input/output shaft axis lines (within φ100)	Not more than 0.1

2. Transmission Shaft

Check input/output /counter/ R gear shafts, repair if there is any bend on shaft journal or ecessive wear on spline.

(1) Run-out on input/output /counter/ R gear shafts should be less that 0.2mm. Adjust or replace when necessary.

(2) Replace shafts when spline wear width on input/output shafts exceeds 0.25, or fitting clearance with groove is larger than 0.33mm..

(3) Galvanize to repair or replace when input/output/counter shaft bearing wear is less than 0.04mm.

(4) Replace input shaft when its gear tooth thinkness is less than 0.20mm or meshing clearance exceeds 0.40mm.

3. Synchronizer

Measure clearances between sychronizer insert and splined hub groove, insert and sychronizer lock ring groove. Replace insert, lock ring or splined hub if wear exceeds tolerance. Concerning mating requirements on sychronizer see table 10-2-2..

Table 10-2-2 Mating Requirement for Synchronizer

Items	Standard assembly values	Service limit
Clearance--synchronizer insert and splined hub groove	0.09~0.31	0.45~0.5
Clearance—insert and synchronizer lock ring groove	4.24~4.58	5.0~5.2
Meshing area--synchronizer bevel ring inner face and gear outer face	≥70%	≤60%

4. Transmission Cover and Shifting Mechanism

(1) Check transmission cover for crack. Cover’s inner surface planeness should be less than 0.15, otherwise repair.

(2) Check these parts for wear, distortion or damage: selector fork, fork shaft, self-lock ball, locating spring, interlock pin /hole, ball groove. Repair or replace parts when: a. wear exceeds 0.4mm on selector fork, fork shaft, ball and interlock pin; b. groove excessive wear or wear depth exceeds 0.7mm; c. fork shaft bends, and its center runout exceeds 0.1mm; d. locating spring is weak or broken.

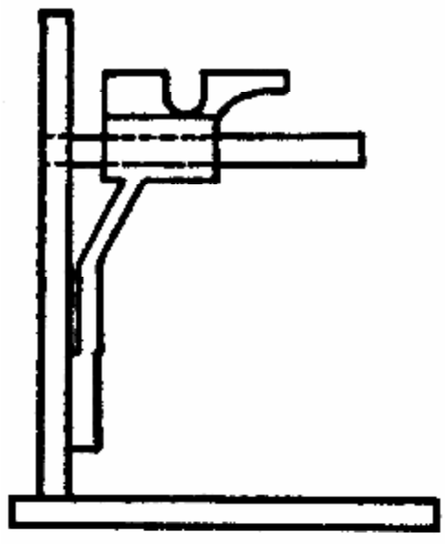


Figure 10-2-20 Check Shifting Fork for Bending and Distortion

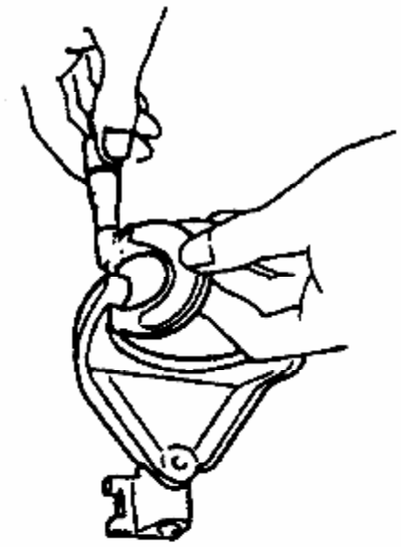


Figure 10-2-21 Check Shifting Fork for Wear

10.2.4 Assembly and Adjustment

Before assembly, clean all transmission parts; apply sealant to sealing surfaces; soak all bearings with engine oil; and apply a thin coat of engine oil to all matching surfaces. Adjust after assembly.

(1) Handling the shift level could shift to all gears freely. Otherwise make corresponding adjustment.

(2) Put assembled transmission onto test bench to perform load /non-load tests. Check operating status of gears and check for noise and leakage. Directly install it onto the vehicle for testing after bench test. When performing non-load running test (transmission input shaft Rpm is 1000rpm), the noise levels of gears (average) generally should not exceed 90db.

(3) Operate shift level assembly, and observe shifting effect and if the working position of shift level assembly is proper.

10.2.5 Typical Faults and Eliminations

1. Abnormal sound from transmission, see table 10-2-3.

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..

Table 10-2-3 Faults and eliminations—transmission abnormal noise

	Causes	Solutions	
1	Excessive wear and outer spherical larger gap to housing -- inputshaft 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 wear or damage on certain gear	6	Replace gear

2. Meshing whine-transmission gears, see Table 10-2-4.

Whining becomes louder as vehicle speed goes up when transmission runs at a certain gear.

Table 10-2-4. Faults and eliminations—transmission gears whinning

Causes		Solutions	
1	Excessive wear on certain gear sets, or poor run-in of new gear	1	Replace gear or let proper run-in
2	Bearing has excessive play	2	Replace bearing
3	Gear fluid is short	3	Replenish fluid

3. Transmission gear jump-over, see table 10-2-5.

While vehicle is running, throttle openning change makes transmissions jumping over to N gear and accelerating engine rpm.

Table 10-2-5 Faults and eliminations-- transmission gear jump-over

Causes		Solutions	
1	Gear face is worn into cone shape; worn-out output shaft splined face to create axial thrust	1	Replace the worn-out gear or output shaft
2	Excessive inputshaft bearing play due to wear; worn or damaged output shaft front bearing	2	Replace the bearing
3	Weak locating spring	3	Replace the locating spring
4	Excessive wear on shifting fork/shaft	4	Replace shifting fork shaft or fork
5	Poor gear meshing or distorted fork	5	Adjust the shifting controls or repair the fork
6	Seriously deformed housing	6	Replace

4. Transmission overheating, see table 10-2-6.

After transmission has run for while, its housing temperature goes 40～50℃ higher than ambient temperature, in worst case with “blue smoke” and burnt oil smell.

Table 10-2-6 Faults and eliminations—transmission overheating

Causes		Solutions	
1	Transmission fluid is thin or short	1	Add or replace fluid
2	Too tight gear mesh or bearing grabbing	2	Adjust or replace parts
3	Bend outputshaft or bearing has excessive play	3	Replace outputshaft or bearing

5. Transmission leakage, see table 10-2-7.

There is fluid weeping or dropping at connecting spots on housing or on bolts after transmission has run for certain mileage.

Table 10-2-7 Faults and eliminations—transmission leakage

Causes		Solutions	
1	Vent plug is clogged	1	Clear vent plug
2	Oil seal is damaged	2	Replace the oil seal
3	Loose oil filler plug, oil drain plug and bolt	3	Tighten corresponding parts. If necessary, apply sealant.
4	Excessive transmission fluid	4	Remove excessive fluid

6. Shifting difficulty -- transmission, see table 10-2-8.

Cannot shift or shift with loud noise while vehicle is driving forward or backward.

Table 10-2-8 Faults and elminiations--shifting difficulty

Causes		Solutions	
1	Too high fluid viscosity or too much fluid	1	Change or reduce fluid
2	Incomplete clutch release	2	Re-adjust the clutch
3	Stuck transmission shift/selector device	3	Remove stuck and impact at corresponding parts
4	Difficult to shift to R gear	4	Check R gear rail or backup light switch for stuck

10.3 Propeller Shaft

10.3.1 Main Technical Parameters of Propeller

Main Technical Parameters of Propeller

Sn	Items		Data
1	Type		Tubular and open type, needle bearing universal joint
2	Universal joint	Cross (shaft diameter × tip-to-face distance) (mm)	φ30×91
3	Tooth number of spline shaft and sleeve fork ×modulus × pressure angle	Internal spline of sleeve fork of propeller (Z × m× α)	21×1.27×30°
4	Flange yoke		4 φ10.2 holes with symmetrical rabbet centers and 60 X 60 rectangle intersection point distribution, convexity rabbet φ46
5	Propeller tube (outside diameter × wall thickness) (mm)		φ68.9 X 2.3
6	Length dimension (mm)	Length of propeller shaft (bearing center of front and rear universal joint flange yoke)	1000

Sn	Items	Data
7	Maximum working torque (N.m)	1600
8	The maximum cone angle at which the universal joint will not produce movement interference	22°
9	Tightening torque for connecting bolt of propeller shaft (N.m)	74±4
10	Maximum unbalance	30g.cm/3200r/min
11	Run out of propeller shaft (mm)	≤0．6
12	End clearance of cross bearing (mm)	0.05

10.3.2 Overview of Structure

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 is mainly consisted of UJ, splined shaft, tube yoke, and propeller shaft, see Figure 10-3-1.

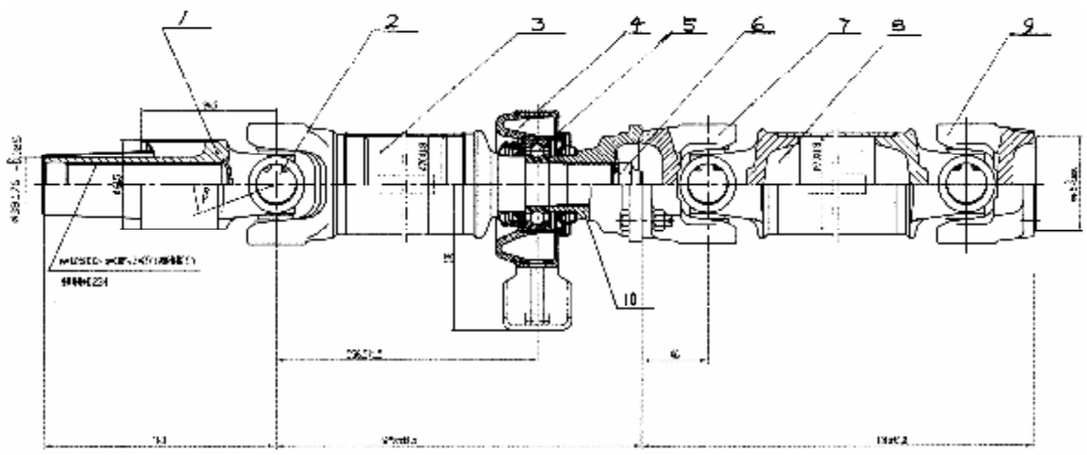


Figure 10-3-1 Propeller Shaft Assembly

1-Propeller shaft assembly; 2-Bolt; 3-Spring washer; 4-1 Nut; 5-Rear axle; 6- yoke

10.3.3 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. Exterior 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) Check flange yoke of universal joint for crack or other serious damage. Replace if necessary.

(3) Check propeller tube for distortion. The depth of depression on shaft tube should not exceed 2mm with the area not more than 6cm^2. It is not allowed to have more than 1 depression on tube.

(4) Check matching status between spline shaft and transmission. If excessive wear on spline is present, replace the spline shaft.

2. Measurement and Check

(1) Propeller shaft angularity

Support both ends of the propeller shaft tube on a V-stand after having removed paint rust at its both ends and in the middle with sandcloth. Measure run-out at any points along the overall length of the shaft tube with a dial indicator. If the reading exceeds 0.8mm, straighten the shaft tube on a press. Or replace it if correction does not work.

(2) Cross shaft bearing radial clearance

Clamp cross shaft in vice, and put needle-bearing sleeve onto cross shaft journal. Push needle bearing up and down. Use dial indicator to measure reading variations at highest point on bearing outer surface (figure 10-3-2). If clearance reading exceeds rated value (standard: 0.05mm, limit: 0.15mm), cross shaft and bearing should be replaced. If excessive diameter wear is present and exceeds the value specified (normal value φ30mm; service limit φ29.85mm), replace the parts. If the wear extent on propeller shaft journal under oil seal exceeds 0.2mm, repair or replace it.

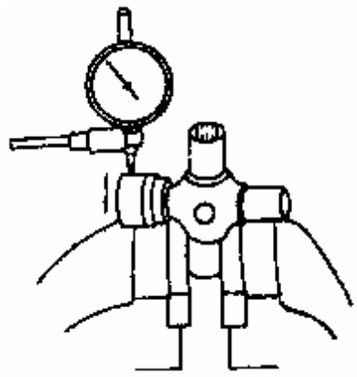


Figure 10-3-2 Check Cross Shaft Bearing Clearance

10.3.4 Reassembly and Adjustment

1. Before remounting propeller assembly, one should clean parts thoroughly and apply general lithium grease on bearing, oil seal and all fitting surfaces.

2. Check and adjustment

After reassembly, the propeller assembly should be tested and adjusted on a propeller dynamic balance tester. Before the dynamic balance test, the run out at any point along the overall length of shaft tube should not exceed 0.8mm. The dynamic unbalance of propeller should not exceed 30gram.cm (at 3200rpm). 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.

10.3.5 Typical Faults and Troubleshooting

1. Propeller shaft swings or vehicle body shivering during driving, see table 10-3-1.

While vehicle is driving, the driver 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.

Table 10-3-1 Faults and eliminations- propeller shaft swings or vehicle body shivering during driving

Causes		Solutions	
1	Distorted or bend propeller shaft	1	Repair or replace
2	Loose fittings or large dynamic unbalance	2	Repair, perform dynamic balance test or replace.
3	Serious bearing wear	3	Replace

2. Abnormal sound from propeller shaft, see table 10-3-2.

While vehicle is driving, driver can hear abnormal noise from propeller shaft, noise becomes more obvious at shifting, and reduced or diminished when vehicle speed is steady.

Table 10-3-2 Faults and eliminations-abnormal sound from propeller shaft

Causes		Solutions	
1	Serious wear on spline shaft and sleeve	1	Replace
2	Serious wear and grabbing on UJ bearing	2	Replace cross shaft or bearing
3	Distorted or bend propeller	3	Adjust or replace

3. Universal joint bearing heating, see Table 10-3-3.

After vehicle is driving for certain mileage, melted grease is found flowing out of center bracket bearing, and parts become scalding.

Table 10-3-3 Faults and eliminations—UJ baring heating

Causes		Solutions	
1	Grease short -- UJ bearing or center bracket bearing	1	Apply grease
2	Bearing is skew	2	Adjust bracket till bearing is vertical to propeller shaft
3	Oil seal is too tight	3	Running-in at low speed and apply grease on lip

10.4 Rear Axle

10.4.1 Main Technical Parameters of Rear Axle

Main Technical Parameters of Rea Axle

Sn	Description		Data
1	Type of rear axle		Integral lute type or cannula type
2	Final drive	Type	Cell grade retarder, hyperbola bevel gear
		Main drive ratio	4．556
		Number of tooth of drive bevel gear	9
		Number of tooth of driven bevel gear	41
		End surface circle run-out of engagement flange (mm)	0.1
		End surface radial circle run out of engagement flange (mm)	0.1
		Engagement clearance between driven gear and drive pinion (mm)	0.13~0.18
3	Differential	Type	Symmetrical bevel gear type
		Engagement clearance of gears (mm)	0.05~0.20

Sn	Description		Data
4	Half shaft	Type	Semi-suspension type
		Diameter (mm)	φ32
		Maximum radial circle run out (mm)	2
		Maximum end surface circle run-out of flange (mm)	0.2
5	Axle housing	Type	Stamping axle housing
		Wheel span (mm)	1440
		Maximum diameter of rear axle housing (mm)	φ272
6	Input torque (N.m)		860
7	Maximum allowable axle loading (kg)		2275/2665
8	Lubricant		GL-5, 80W/90 heavy duty gear oil
9	Lubricant volume(L)		1．6
10	Nut torque of hanger pin (N.m)		147±5
11	Torque of U-bolt (N.m)		123±5

10.4.2 Structure Overview

Rear axle consists of final drive, differential, halfshaft, 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 a location before power is distributed to drive wheels, which reduces torque that is transmitted by parts such as transmission and propeller shaft, and the size and mass of these parts are also minimized.

Differential is a speed variation driving mechanism. Plantearyary 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

Internal end of halfshaft is connected with halfshaft gear through a spline, and its external end is supported in the flange of axle housing through bearings and connected with hubs. External end of halfshaft shaft is subjected to a bending torque formed by acting forces from internal bearing in the axle housing and ground. This type of support can only avoid bending torque to internal end of halfshaft, while the external end will bear all bending torque; therefore, it is called "semi-suspension" support.

Generally, driving axle housing is made up of final drive housing and halfshaft sleeve, in which the final drive, differential and halfshaft are installed. Exterior of driving axle housing is connected with body through suspension, brake base plates will be installed on its both ends. The driving axle housing takes various acting forces and torques transferred from suspension and wheels.

BJ6486, BJ6516 series light bus is equipped with non-divided driving axle, single stage hypoid gear final drive, bevel planteary gear differential, semi-suspension halfshaft, integral stamping and welding axle housing and common rear wheel hub etc., see Figure 10-4-1, Figure 10-4-2 and Figure 10-4-3.

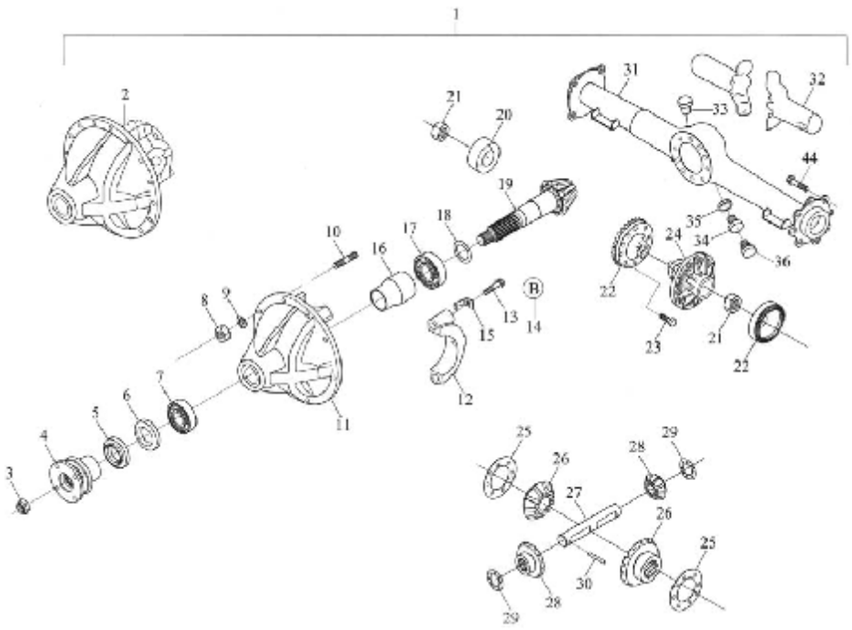


Figure 10-4-1 Rear Axle Assembly (1)

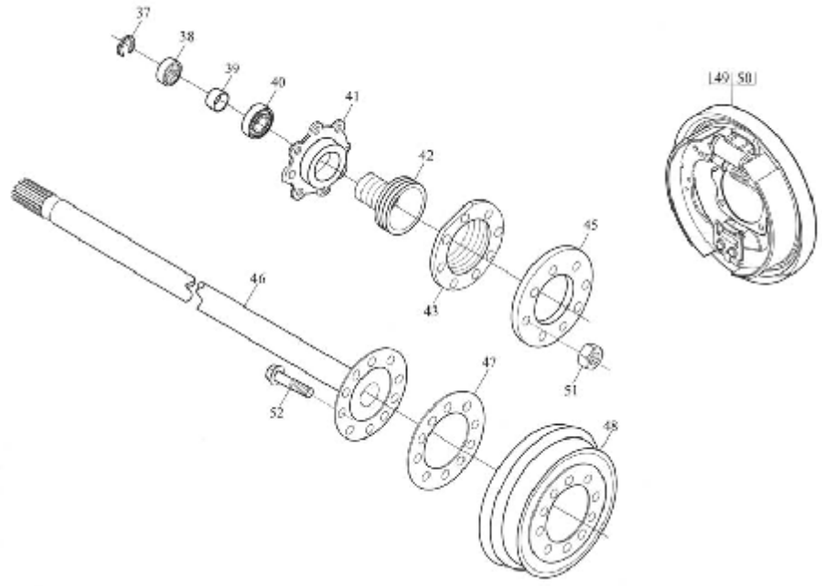


Figure 10-4-2 Rear Axle Assembly (2)

1-Rear axle assembly; 2-Final drive assembly; 3-Nut; 4-Flange of driving gear; 5-Dust boot; 6-Oil seal; 7-Front bearing; 8-1 type hexagon nut; 9-Spring washer; 10-Stud, axle housing bolt; 11-Final drive housing; 12-Bearing cap; 13-Pack of hexagon bolt and spring washer; 14-Bolt; 15-Adjusting locking plate of bearing nut; 16-Spacer; 17-Rear bearing; 18-Washer; 19-Driving gear; 20-Differential bearing; 21-Adjusting nut; 22-Driven gear; 23-Bolt; 24-Differential housing; 25-Thrust washer; 26-Differential drive gear; 27-Planteary gear shaft; 28-Planteary gear; 29-Thrust washer; 30-Differential pin shaft; 31-Rear axle housing welding assembly; 32-Rear axle housing oil shield stand; 33-Normally close air plug; 34-Filler plug; 35-Filler plug washer; 36- filler plug sub assembly; 37- snap ring; 38-Fixing sleeve of bearing; 39-S type oil seal; 40-Annular ball bearing; 41-Bearing carrier; 42-K type oil seal; 43-Oil baffle disk of brake drum; 44-Rear wheel hub bolt; 45-Washer of oil baffle disk of brake drum; 46-hafl shaft; 47-Washer; 48-Brake drum; 49-Left brake assembly; 50-Right brake assembly; 51-Nut; 52-halfshaft bolt.

The function of final drive is to decelerate, increase torque and change direction of power transfer, and finally transfer power to driving wheels to push the vehicle to run. BJ6536 series bus applies single stage hypoid gear final drive. Its structure is shown in Figure 10-4-1. It consists of a pair of hypoid gears (driving and driven gears) and supporting device. The driving bevel gear is integrated with its shaft, its front spline connected with half shaft through the driving gear flange, and it is supported on the bearing carrier through two bevel roller bearings. Driven bevel gear is connected to differential housing with bolts; and the differential is supported in the mounting hole of axle housing through two bevel roller bearings. The projection of driving gear bearing can be adjusted by inserting the adjusting washer between the internal bearing carrier. There are interconnected oil passage between the bearing and the final drive housing.

Driving and driven bevel gears apply splash lubrication method. Rotation of driven gear makes the gear oil in the axle housing splashing onto driving and driven bevel gears. Driving gear bearing is lubricated through the oil passage cast in the axle housing.

2. Differential (see Figure 10-4-2)

Differential is of ordinary plantearyary gear type, composed by two halfshaft gear, four plantearyary gears, one cross shaft and RH/LH differential housing.

RH and LH differentical cases are combined with bolts. Final drive driven bevel 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 plantearyary gear on it. Two halfshaft journals are mounted into the mounting holes in RH/LH differential cases. Each plantearyary gear meshes with two halfshaft gears at the same time, and halfshaft gears connect to halfshaft via spline.

3. Halfshaft

Rear axle halfshaft is a piece of solid shaft with flange. It transfers halfshaft gear output torque to driving wheels. It spline-meshes with halfshaft via its inner end, and it outer end connects rear wheel hubs. This type of supporting can only avoid bending torque to internal end of halfshaft, while the external end will bear all bending torque.Therefore, it is called "semi-suspension" support.

4. Rear Axle Housing

Rear axle housing is made up of gear bracket, oil seal, left and right shaft tube etc., the interior of which is used to install final drive, differential and propeller. Exterior of rear axle housing is connected with frame through suspension and brake bottom plates will be installed on both ends of it. The driving axle housing bears various acting forces and torques transferred from suspension and wheels. Rear axle housing of BJ6536 series bus is of integral welding type. The collar fixing brake bottom plates is welded on the rear axle shell. There are air bleed valve and oil drain plug on the rear axle housing, and there are oil filler plug on the bracket cap.

10.4.3 Technical Specifications for Check and Repair

1. Driving gear and driven gear of 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 plantearyary gears, halfshaft gears, cross shaft and differential housing

Check contacting faces among differential plantearyary gears, halfshaft gears and differential case for wear, and measure fitting clearances.

a) Check fitting clearance between plantearyary gear inner hole and cross shaft journal. Replace parts if clearance exceeds limit.

b) Check fitting clearance between halfshaft gear spline groove and halfshaft spline groove. Replace the part worn more or replace them both

c) Check fitting clearance between halfshaft gear shaft journal and mounting hole in differential case. Replace the part worn more or replace them all.

d) Check plantearyary gear and halfshaft gear thrust washer for thickness and wear. Replace parts if thickness or wear exceed limit.

Table 10-4-1 Wear Limit of Final drive and Differential and Meshing patch Standard (mm)

Description		Service limit
Fitting clearance - front bearing of driving bevel gear 35KC802 (JK) and housing		0.02
Fitting clearance - rear bearing of driving bevel gear HR30306C (JK) and housing		0.02
Fitting clearance - front bearing of driving bevel gear 35KC802 (JK) and journal		0.02
Fitting clearance - rear bearing of driving bevel gear HR30306C (JK) and journal		0.02
Inside diameter of planteary gear hole and outside diameter of cross shaft		0.25
Groove width of reference circle of halfshaft spline groove and tooth thickness of spline reference circle.		0.35
Journal of halfshaft and inner diameter of differential housing hole		0.25
Fitting clearance - differential bearing (NSK17887/17831) and housing		0．05
Fitting clearance - differential bearing (NSK17887/17831) and journal		0．03
Radial clearance of rear propeller bearing (4G-180308)		0．15
End clearance of driving bevel gear shaft		0．05
Lateral clearance between driving bevel gear spline and flange keyway		0．20
End clearance of planteary gear		0．50
Contact area	During assembly, the contact area should cover 2/3 tooth length and is 2~4mm away from small end surface. After loading, the contact area should cover whole tooth length and is generally 0.8~1.6mm away from the tooth top.	

3. Adjustment of pretension of driving bevel gear bearing:

During adjustment, lubricate the bearings thoroughly before installation of oil seal. After tightening the driving gear, rotate the driving gear to make the bearing rollers contact properly with inner and outer rings of bearing. Before making measurement at flange bolt hole, rotate the driving gear for 5 turns in the same direction. If the pretension is not in compliance with above requirements, increase or reduce the adjusting washers between

the two bearings of driving gear until it is proper. The thicknesses of adjusting washers are 0.05mm, 0.15mm and 0.25mm.

After adjustment of pretension, draw a marked line at end of driving gear and on end surface of tightening nut, so that the tightening nut still can be tightened along original marked line after bearing cap has disassembled, or when to install oil seal and reassemble.

4. Assembly of driving and driven bevel gears, measurement of side clearance and adjustment of tooth face contact area

Inspect and adjust the engagement of driving bevel gear of final drive and driven bevel gear. Check driving and driven bevel gears for correct engagement tooth face contact area and side clearance. If it is not correct, move the driven bevel gear left and right and the driving bevel gear back and forth to adjust. The thicknesses of adjusting washers are 0.25mm and 0.1mm and total thickness is within 1.25~2mm.

See Figure 10-4-3 for check and adjustment methods for tooth face contact area of driving and driven bevel gears and side clearance.

Drive/driven gear meshing area adjustment

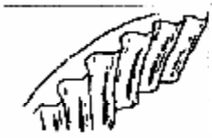
Contact position	Cause	Steps of adjustment
 Abnormal contact	Drive pinion is too far from driven gear	1. select to use thinner pinion shim 2. move driven gear from drive pinion to adjust gear clearance
 Abnormal contact	Driving pinion is too close to driven gear	1. select to use thicker pinion shim. 2. move driven gear closer to drive pinion to adjust gear clearance
 Abnormal contact	Driven gear is too far from driving pinion	1. select to use thicker pinion shim. 2. move driven gear closer to drive pinion to adjust gear clearance
 Abnormal contact	Driven gear is too close to driving pinion	1. select to use thinner pinion shim 2. move driven gear from drive pinion to adjust gear clearance
 Normal contact		

Figure 10-4-3 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 oil on gear face at each 2-3 teeth on each section. Turn driven gear while excerting 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 backlash ange is 0.13-0.18mm (measuring with magnetic seat dial indicator). Adjustment on it should be made together with the adjustment on meshing area. Above mentioned adjustment method is also applicable. In the event backlash of drive/driven gears exceed 0.06mm, gears should be replaced. While meshing condition is ok, it is not allowed to change relating positions among gears to reduce backlash. Change drive/driven gears in pair.

10.4.4 Road Test and Troubleshooting

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.

After having found and removed faults during test, one should perform running test again.

10.4.5 Typical Faults and Troubleshooting

1. Abnormal sound from rear axle, see table 10-4-4.

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.

Table 10-4-4 Abnormal Sound from Rear Axle

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 — 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 — halfshaft spline	5	Replace halfshaft or halfshaft gear

Causes		Solutions	
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. Oil leak, see table 10-4-5.

After vehicle has stopped, fluid trace or fluid weeping from connecting spots is found.

Table 10-4-5 Oil Leak

Causes		Troubleshooting	
1	Excessive gear fluid	1	Reduce to standard level
2	Oil seal damaged — drive conical gear shaft	2	Replace
3	Vent hole 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, see table 10-4-6.

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℃).

Table 10-4-6 Rear Axle Overheating

Causes		Solutions	
1	Bearing is adjusted too tight	1	Re-adjust
2	Oil seal is 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 is 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.

10.5 Front Axle

10.5.1 Main Technical Parameters of Front Axle

Main Technical Parameters of Front Axle (with BJ491EQ1 engine)

Sn	Item		Data
1	Type		Dual cross arm independent suspension
2	Wheel span (mm)		1450 or 1460
3	Front wheel alignment	Camber	0°20′ ±30′
		Kingpin inclination	10°50′ ±30′
		Caster	1°15′ ±30′
		Toe-in (mm)	3±1
4	Maximum steering angle of front wheel	Left wheel	37° ±0.3°
		Right wheel	34° ±0.3°
5	Connecting torque of torsion bar seat and cross arm (N.m)		142±5
6	Upper cross arm of front suspension assembly and frame (N.m)		147±5
7	Front suspension assembly brake and upper cross arm (N.m)		142±5
8	Front suspension assembly brake and lower cross arm (N.m)		142±5
9	Transverse stabilizer bar assembly		5~7mm thread is exposed on top end of ransverse stabilizer bar connecting shaft (3~5 threads) and the tightening toque is 11~13 (N.m)
T	Tightening torque of cam nut (N.m)		200±8
11	Distance between locknut of track bar and fixing bolt (mm)		445±3
12	Torque of track bar front end locknut (N.m)		120±5
13	The exposed length of track bar screw head (mm)		50±5
14	Front side height of body (mm)		277

10.5.2 Structure Overview

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. BJ6486, BJ6516 series vehicle steering axle adopts independent suspension.

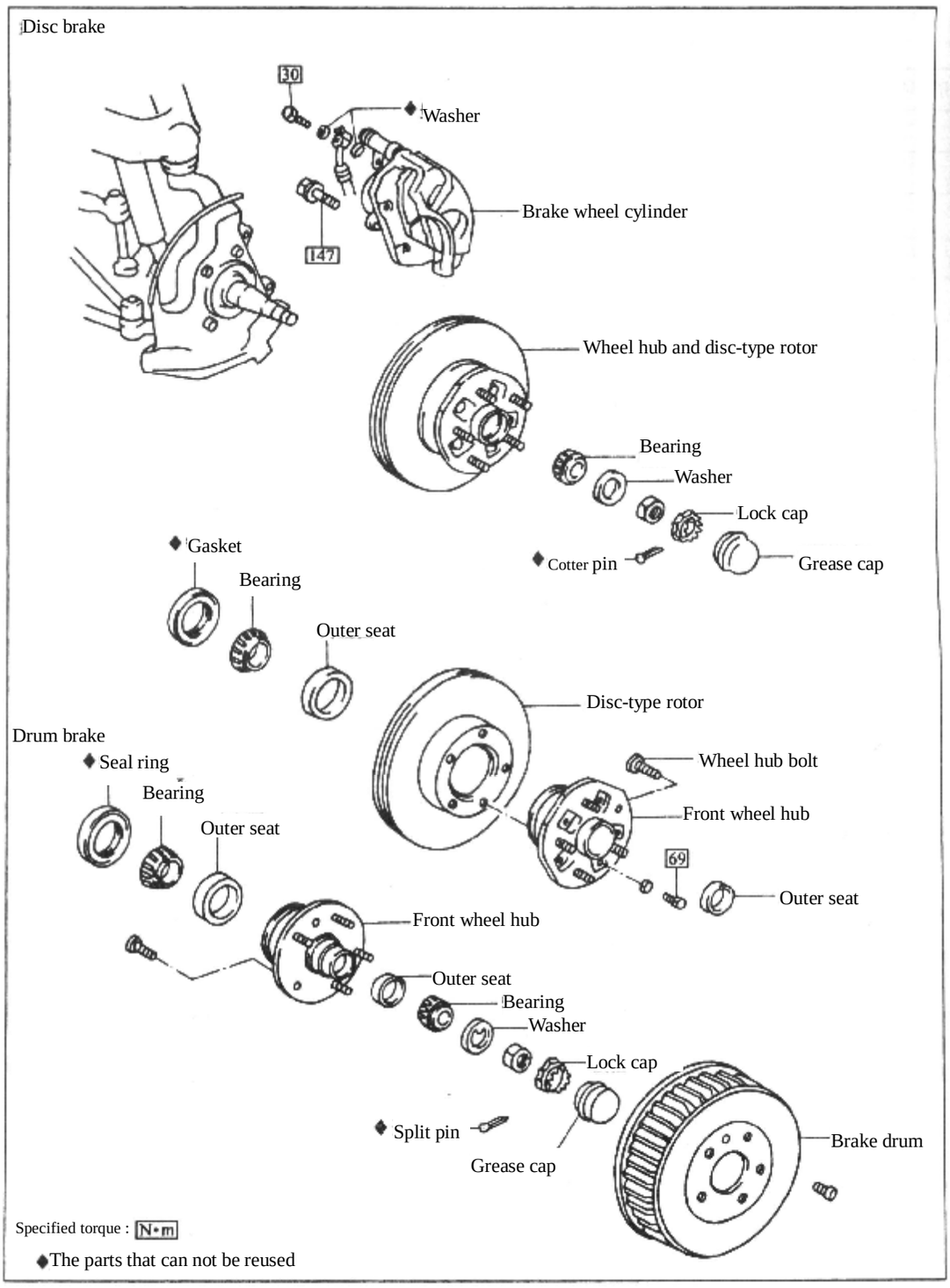


Figure 10-5-1 Decomposing View of Front Wheel Hub Assembly

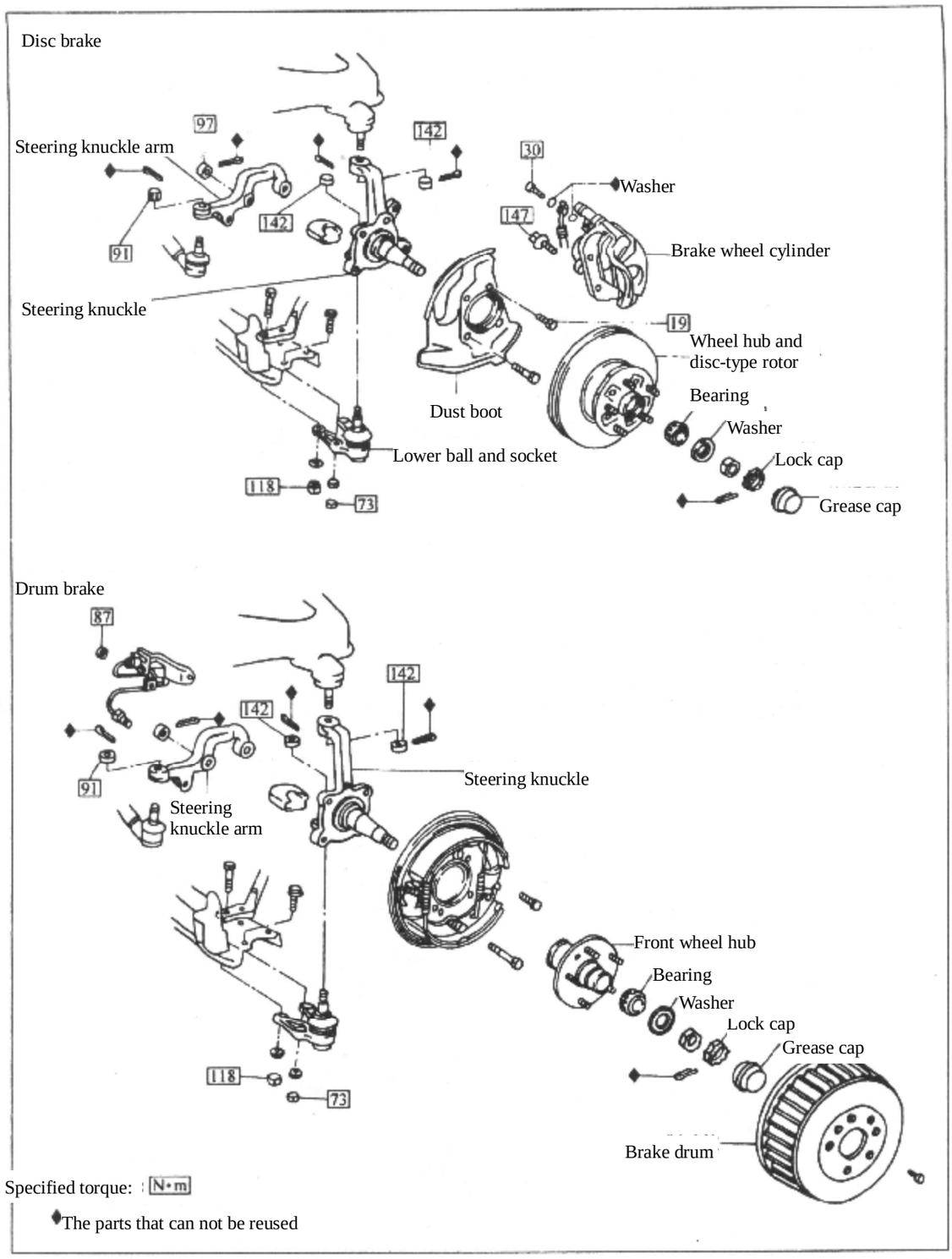


Figure 10-5-2 Decomposing View of Steering Knuckle Assembly

10.5.3 Check and Repair

1. Front wheel alignment

① Check tire for wear and pressure. For 185/195 tire, its front wheel pressure is 325±5kPa, and rear wheel is 450±5kPa. Air pressure for all 205 tires is 250±5kPa. The air pressure difference between coaxial wheels should not exceed 5kPa.

② Check for end surface run-out of wheel, the value should be below 1.2mm. (Figure 10-5-3)

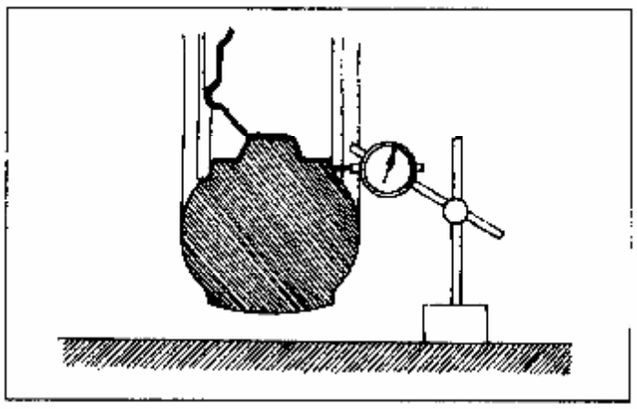


Figure 10-5-3 Check for End Surface Run-out of Wheel

① Check front wheel bearing for looseness.

② Check front suspension for looseness.

③ Check steering drive rod for looseness.

④ Check ball and socket joint for excessive looseness.

⑤ Measure heights of front and rear sides of vehicle. The front side height should be 277mm while the rear side height should be 292mm. Adjust it with torsion bar spring nut.

⑥ Check and adjustment of front wheel alignment

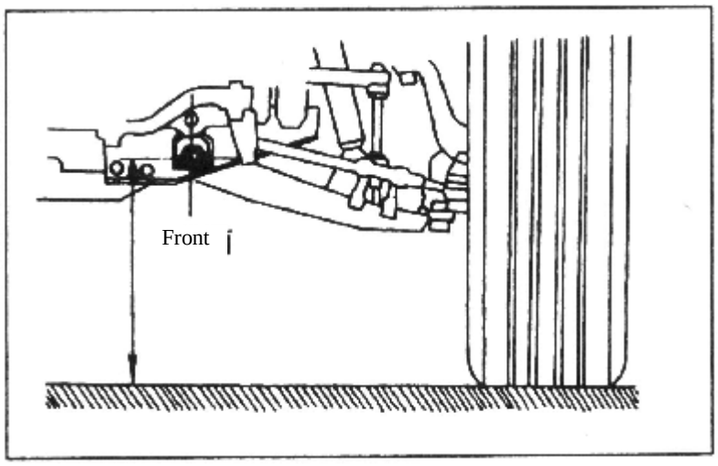


Figure 10-5-4 Measurement of Front Side Height of Vehicle

A. Install wheel aligner according to its manufactuer instruction manual.

B. Check camber, caster and kingpin inclination of wheel as indicated in figure 10-5-5.

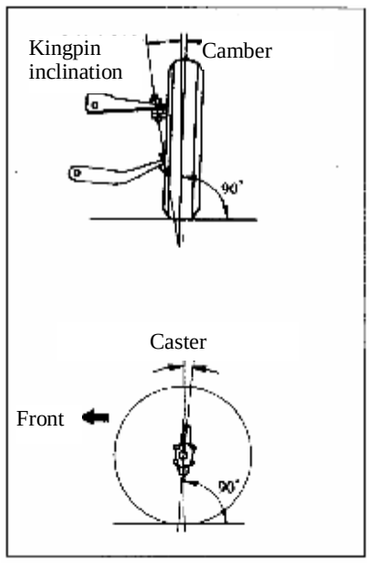


Figure 10-5-5 Front Wheel Alignment

C. Adjust camber. If camber value angle is not within the specified range, turn the adjusting cam to adjust as shown in Figure 10-5-6. **Note:** Each scale on the cam corrsponds 18′ camber change. When the cam is turned to a position 4.5 scale beyond the median line, the adjusting cam can not be turned further.

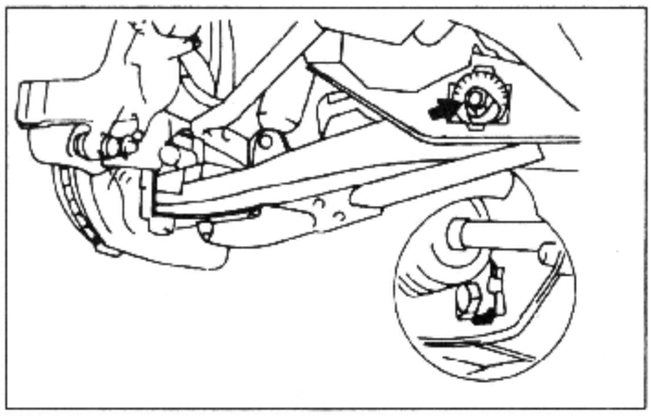


Figure 10-5-6 Adjustment of Camber

D. Adjustment of caster. If caster value is not within the specified range, turn the nut on support bar to adjust as shown in Figure 10-5-7. **Note:** Unscrew one of two nuts on the bearer of support bar, and then tighten the other nut at the opposite side in the same extent, caster therefore gets adjusted. When to adjust with nut on support bar, the nut should not be screwed up for more than 3 turns (original position as reference). Each turn of the nut indicates 30′ caster change.

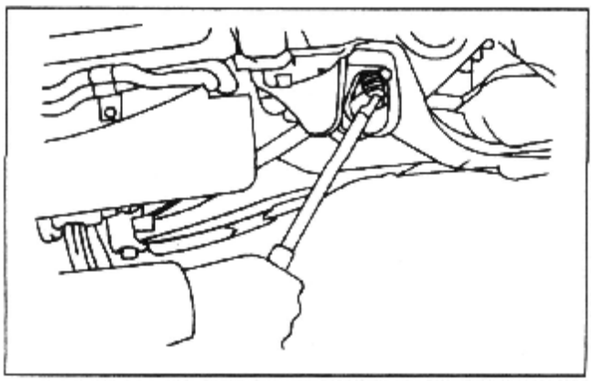


Figure 10-5-7 Adjustment of Caster

E. Check the toe-in. Measure the toe-in with a toe-in gauge.

1. Disassemble the buckle clamp of protection cover.

2. Unscrew the locknut at end of steering tie-rod.

3. Turn ends of left and right steering tie-rods to adjust the toe-in as shown in Figure 10-5-8. The left and right turning extent should be equal. **Note:** Measure lengths of left and right steering tie-rods ends. Make sure they are equal. The length difference between ends of the two steering tie-rods should be 3.0mm or less.

4. Tighten the locknut of the steering tie-rod with tightening torque of 88N.m.

5. Install the protection cover to its seat and clamp it. Be careful not to make the protection cover distort.

Adjustment of toe-in:

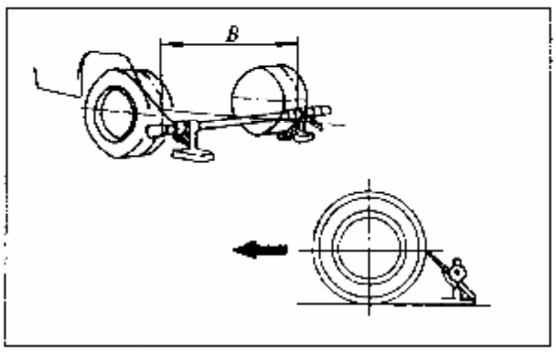


Figure 10-5-8 Check Toe-in (1)

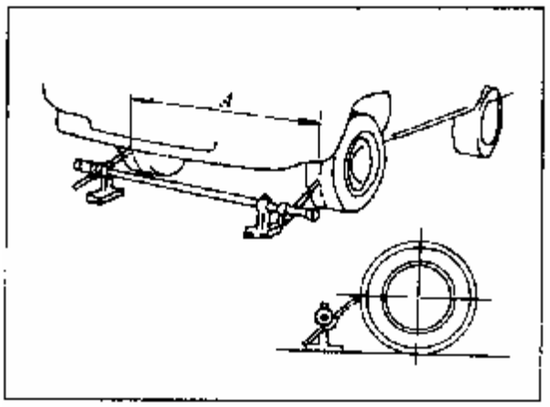


Figure 10-5-9 Check Toe-in (2)

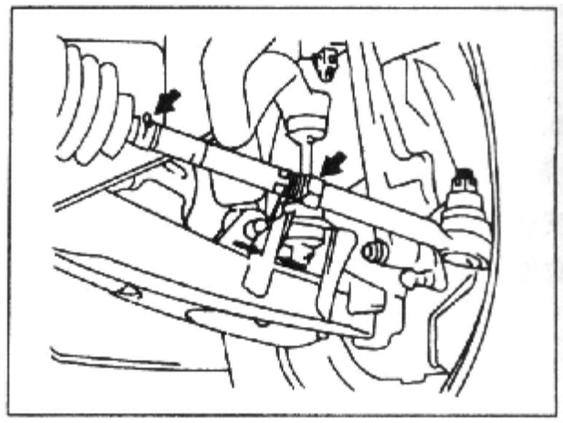


Figure 10-5-10 Adjustment of Toe-in

D. Check and adjust turning angle of wheel

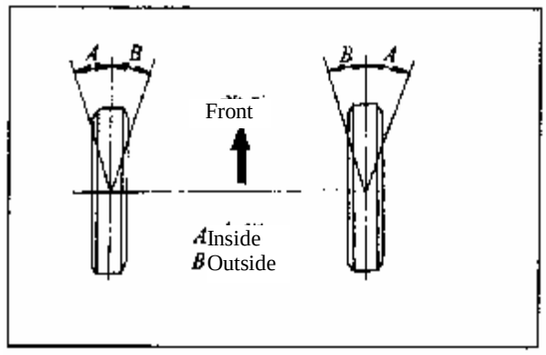


Figure 10-5-11 Check Turning Angle of Wheel

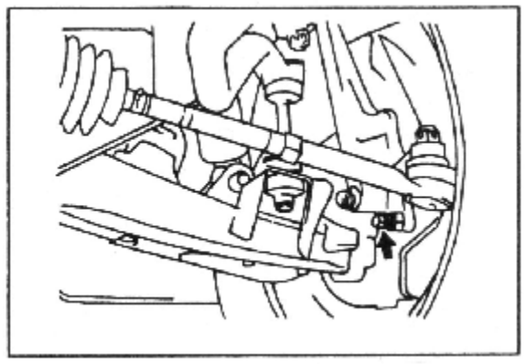


Figure 10-5-12 Adjustment of Wheel Turning Angle

2. Adjust wheel turning angle:

① Disassemble the cover of steering knuckle limit bolt.

② Unscrew the locknut.

③ Screw up the steering limit bolt.

④ Turn the steerer wheel all the way down, unscrew the steering limit bolt until it contacts with the lower

arm.

⑤ Fasten the locknut with the tightening torque as 44N.m.

⑥ Install the cover of steering knuckle limit bolt.

3. Check for side slip:

Check side slip of wheel on a sideslip tester as shown in Figure 10-5-13. The side slip of wheel should be 3.0mm or less.

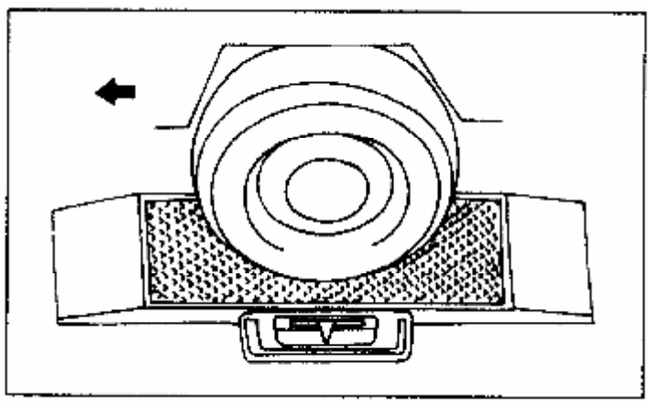


Figure 10-5-13 Check Side Slip of Wheel

10.5.4 Typical Faults and Troubleshooting

1. Hard steering, see table 10-5-1.

There is large steering resistance during vehicle's driving. This is mainly due to part pairs in steering drive mechanism are fitted too tightly.

Table 10-5-1 Hard steering

Causes		Solutions	
1	Steering knuckle is fitted too tight	1	Readjust steering knuckle washer
2	Tie rod ball joint is adjust too tight	2	Readjust
3	Incorrect toe-in	3	Correct
4	Front wheel misalignment	4	Readjust
5	Low front wheel pressure	5	Inflate tire to specification
6	Poor lubrication on parts	6	Add lubricant

2. Front wheel swing or oscillating, see table 10-5-2.

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.

Table 10-5-2 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	Re-adjust or replace
4	Loose front wheel bolts	4	Re-tighten
5	Loose front wheel hub bearing	5	Adjust or replace
7	Elasticness varies - LH/RH torsion bars spring	7	Replace
8	Inaccurate front wheel alignment	8	Re-adjust
9	Tyre pressure difference - RH/LH tyres	9	Adjust to specified air pressure
10	Excessive dynamic unbalance - wheel or brake drum	10	Perform dynamic balance test

3. Driving to one side, see table 10-5-3.

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.

Table 10-5-3 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. Excessive or uneven tire wear, see table 10-5-4.

Tire wears excessively after certain mileage. This happens together with other symptoms such as heavy steering, front wheel swing and drive to one side.

Table 10-5-4 Excessive or uneven tire 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

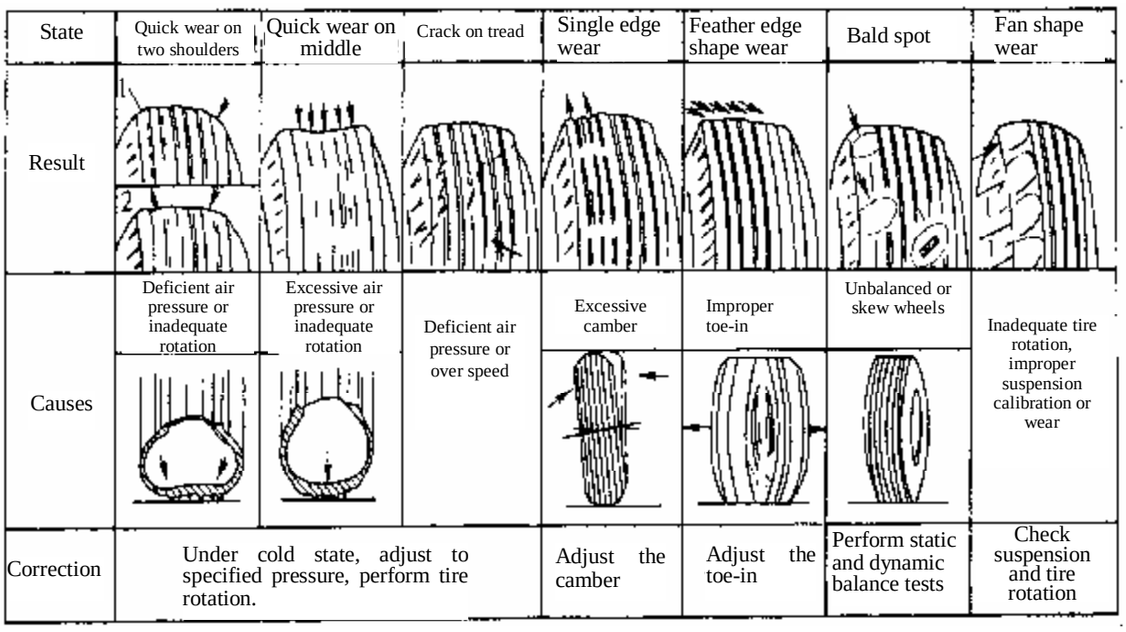


Figure 10-5-14 Abnormal Tires Wears and Correction

10.6 Steering Mechanism

10.6.1 Main Technical Parameters of Steering Mechanism

Main Technical Parameters of Steering Mechanism

Sn	Description		Data
1	Steering gear	Type	Rack pinion
		Transmission ratio	46.67
		Total number of turns of the pinion of steering gear (turn)	3.39
		Position of steering wheel	LH
3	Rack pinion sets	Modulus	1．85
		Number of rack tooth	30
		Number of pinion tooth	8
		Pinion arm shaft turning angle(or steering gear arm swinging angle)	1220º
		Reference diameter of the pinion (mm)	φ16.33
		Radial circle run-out of rack shaft	0．15
4	Steering wheel	Diameter (mm)	φ390
		Free travel (mm)	25
5	Gross weight of steering gear (kg)		9.5
6	Lubricant		QL-5 rate 80/W90

Sn	Description	Data
7	Lubricant volume (L)	0．4
8	Power assisted steering fluid	ATFⅢ automatic transmission fluid Q/SH038.501
9	Torque of track bar front end nut (N.m)	120.5±5
10	Tightening torque of cam nut (N.m)	200±8
11	Tightening torque of steering tie-rod locknut (N.m)	88±4
12	Tightening torque of ball joint of steering knuckle arm and tie-rod (N.m)	73．5~108
13	Maximum tangential force of steerer wheel	＜200
14	Driving deviation	When driving straight along center line of test track at 40km/h for 30m, the left deviation<2m while the right <1m (steering wheel is released).
15	Minimum turning radius (m)	5．75

10.6.2 Structure Overview

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 rotation into steering arm’s swing, and amplify steering operating force. BJ6536 vehicle adopts ball rack and pinion steering gear with a ratio of 46.67. 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.

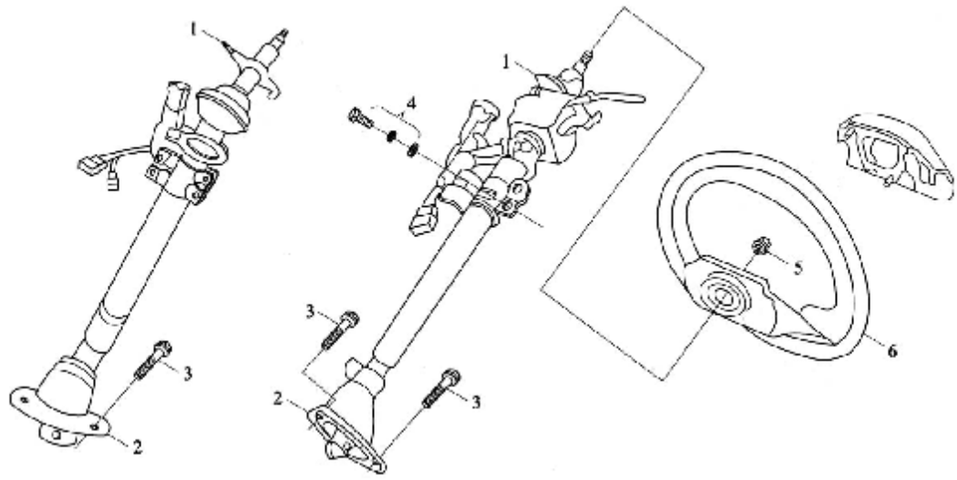


Figure 10-6-1 Steering Column-1

1-Steering column assembly；2-Steering column seat assembly；3,4Bolt；5-Nut；6-Steering wheel assembly

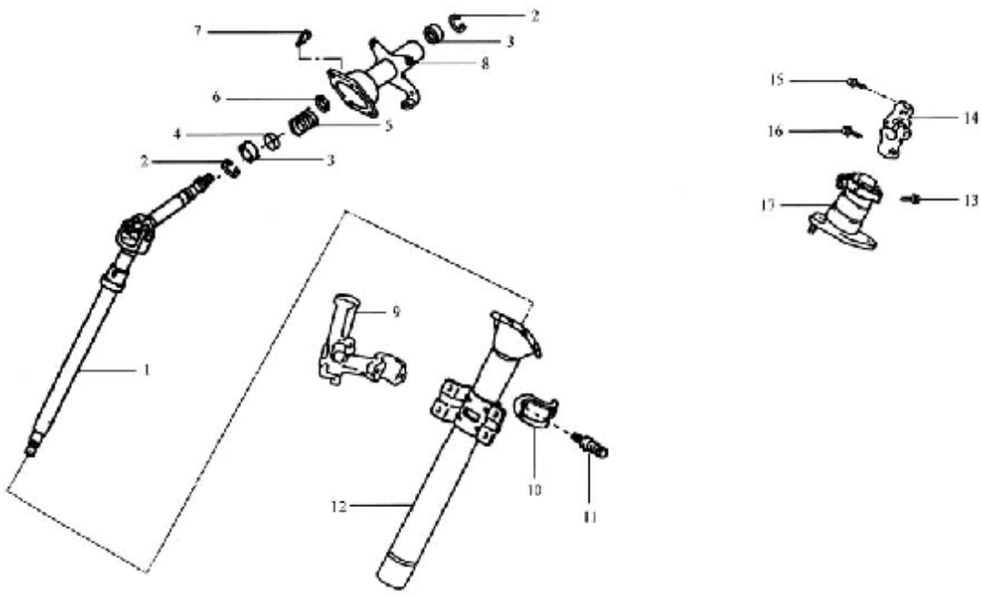


Figure 10-6-2 Steering Column-2

1-1-Upper & inner shaft assembly; 2- circlip-Type A; 3-Bearing; 4-Rigid plastic flat gasket; 5-Spring; 6-washer; 7-Hexagon bolt and spring washer M16×8; 8-Upper Steering Column assembly; 9-Ignition switch lock; 10-Clips for upper bracket; 11-Taper head bolt; 12-Intermediate steering column assembly; 13-Hexagon bolt, spring washer and flat washer set M8×20; 14-Gimbal assembly; 15-Hexagon bolt, spring washer and flat washer M8×30-8.8; 16-Bolt M8×1.5×30; 17-Base for steering column

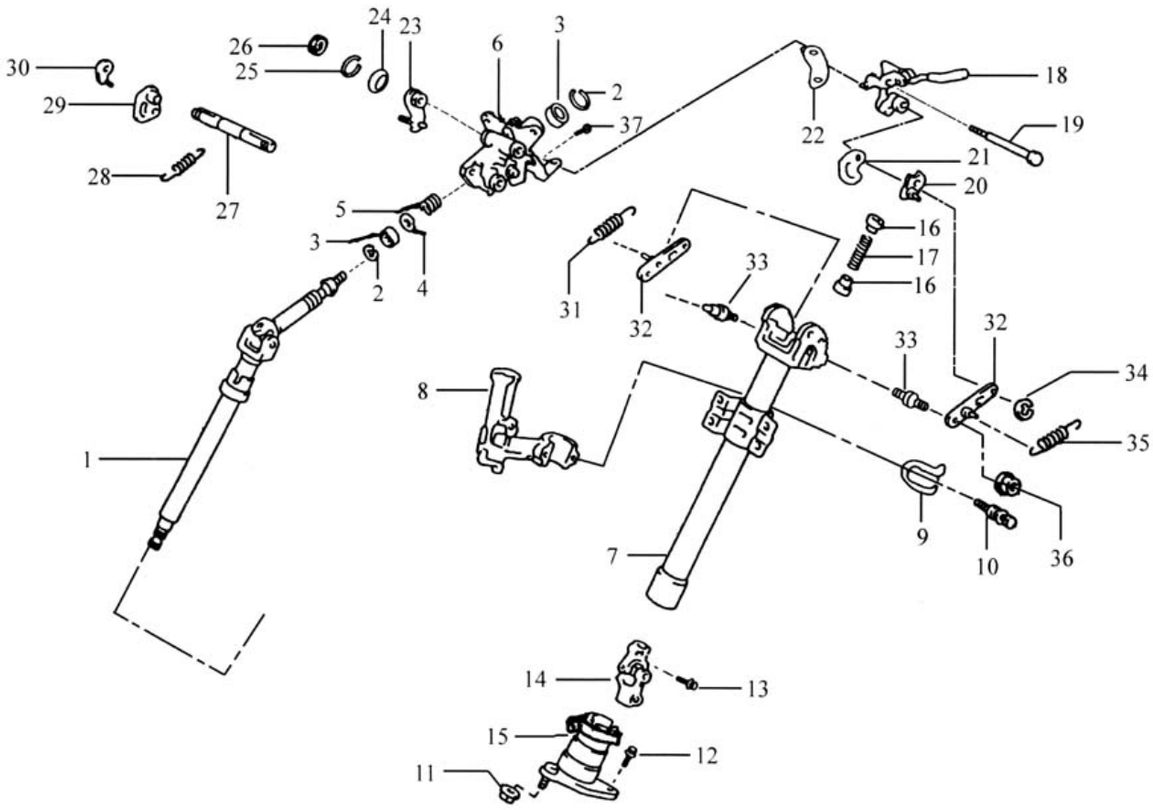


Figure 10-6-3 Steering Column-3

1-Steering drive shaft assembly; 2- snap ring; 3-Bearing; 4-Thrust ring; 5-Lower steering shaft compression spring; 6-Upper column assembly; 7-Lower column assembly; 8-Upper bracket assembly; 9-Lower bracket assembly; 10-Cone bolt; 11-Nut; 12-Bolt; 13-Stud; 14-Universal joint assembly; 15-Steering base assembly; 16-Compression spring seat; 17-Return spring; 18-Tilt control lever assembly; 19-Bolt; 20-Left ratchet stopper assembly; 21-Auxiliary tilt lever; 22-Left ratchet assembly; 23-Right ratchet assembly; 24-Big washer; 25-Spring washer; 26-Hexagon nut; 27-Lever shaft; 28-Spring; 29-Tilt lever; 30-Right ratchet stopper assembly; 31-Tension spring (2); 32-Protect panel of tilt lever; 33-Bolt shaft; 34-Split washer; 35-Tension spring (1); 36-Hexagon flange nut; 37-Stud.

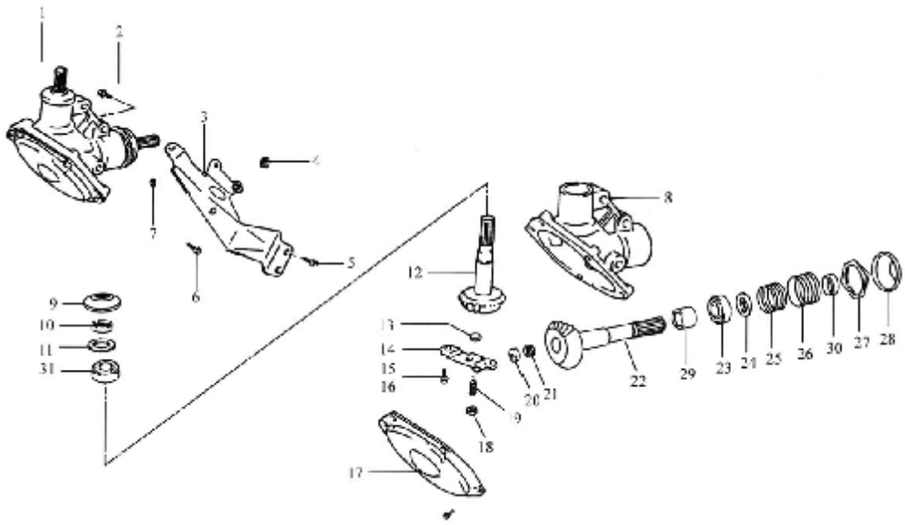


Figure 10-6-4 Steering reducer

1-Steering reducer assembly; 2-Bolt M10×1.25×42; 3-Reducer support assembly; 4-Nut M10×1.25×8; 5-Bolt M10×1.25×22; 6-Nut M10×1.25×25; 7-Nut M8×1.25×8; 8-Decelerator housing; 9-Dust cover Ⅱ; 10-Oil seal assembly; 11-Adjusting gasket/shim; 12-Bevel pinion; 13-Adjusting screw base; 14-Fixed yoke; 15-Hexagon bolt and spring washer M6×12; 16-Bolt; 17-Bottom cover assembly; 18-Hexagonal nut type 1 -fine thread M8×1; 19-Adjusting screw; 20-Spring seat; 21-Spring, Pull-out piece spring II; 22-Bigger bevel shifter; 23-Angular contact bearing 46103; Deep groove ball bearing 60202; 24-Spring stop; 25-Conical spring, Pull-out piece spring I; 26-Adjusting plug screw; 27-Lock nut; 28-Dust boot 1; 29- needle bearing 941/20; Deep groove ball bearing CHK182416; 30-Oil tight assembly, Oil tight/seal; 31-Double track needle bearing, Deep groove ball bearing CHK182416

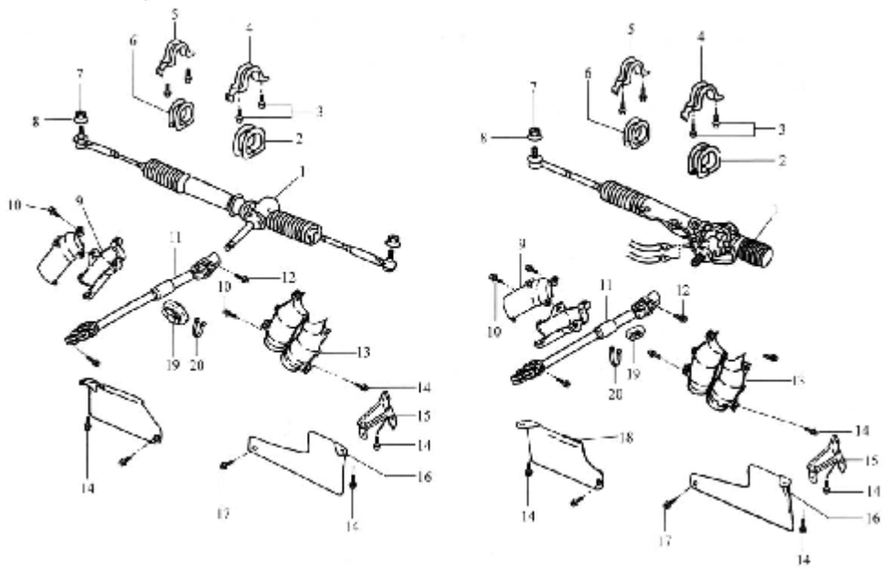


Figure 10-6-5 Steering Gear-1

1-Assembly of redirector with draw bar; 2-Left support bushing; 3-Bolt; 4-Left support assembly; 5-Right support assembly; 6-Right support bushing; 7-Split Pin 3.2×22; 8-Nut; 9-Assembly for redirecting movable bushing B; 10-Bolt; 11-Down steering shaft assembly; 12-Bolt; 13-Assembly for redirecting movable jacket A; 14-Bolt; 15-Support sealing assembly for steering drive axle jacket; 16-Left baffle for redirector B; 17-Bolt; 18-Right baffle for redirector; 19-Former jacket; 20-Ormer protective clip

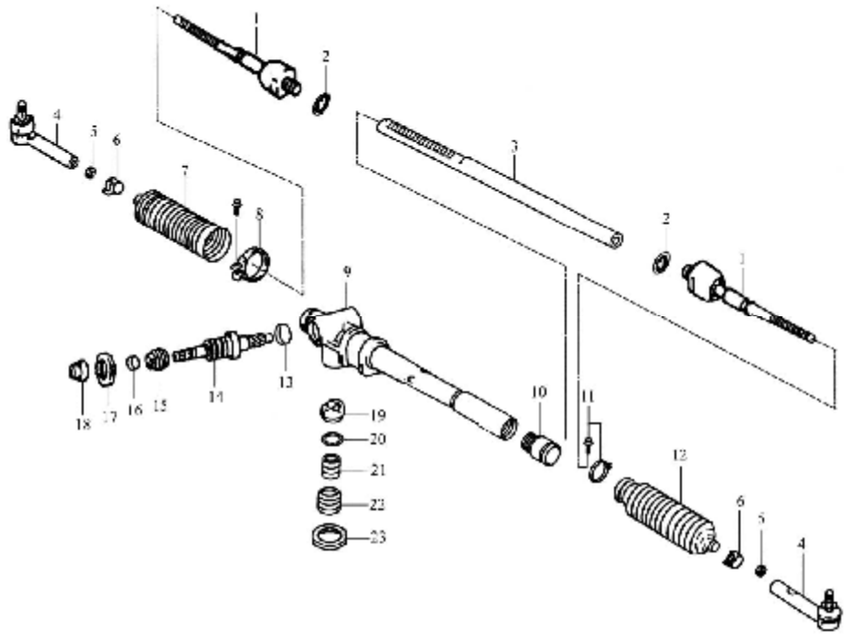


Figure 10-6-6 Steering Gear-2 (Mechanical Steering Gear)

1-Rack pull-rod subassembly; 2-Rack lock plate; 3-Rack; 4-Joint support; 5-Nut; 6-Bar clasp; 7-Left protective bushing; 8-Rack pull-rod subassembly; 9-Casing sleeve assembly; 10-Sleeve bushing; 11-Right jacket clip assembly; 12-Right protective jacket; 13-Angular contact bearing 46103; 14-Gear wheel; 15-Left jacket clip assembly; 16-Oil seal; 17-Locknut; 18-Jacket for oil seal of gear wheel; 19-Rack supporting base assembly; 20-O-shaped lock ring 45×2; 21-Spring for supporting base; 22-Adjusting plug screw; 23-Locknut

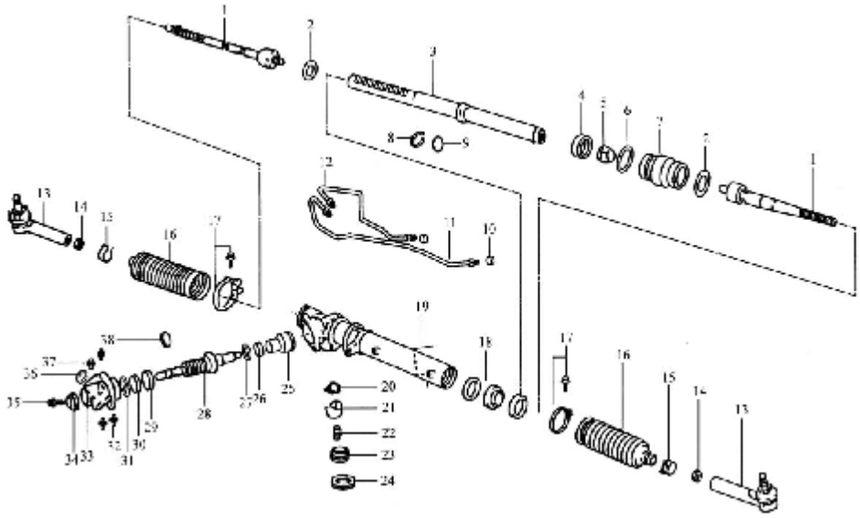


Figure 10-6-7 Steering Gear-3 (Power Steering Gear)

1-Inner ball joint assembly; 2-Pull-rod lock sheet; 3-Rack piston assembly; 4-Oil sealing assembly Φ46×Φ28.2×8; 5-Bushing; 6-O-SHAPED RING 42.5×1.8; 7-Caging turnbuckle at end of cylinder; 8-Piston ring Φ46×Φ42×2; 9-O-SHAPED RING 38.5×1.8; 10-Cone-shaped joint III; 11-Left oil tube assembly; 12-Right oil tube assembly; 13-Outer ball joint assembly; 14-Hexagon nut -Grade C M15×1.5; 15-Bar clasp; 16-Protective case/Shield; 17-Clip assembly; 18-Gasket; 19-Oil cylinder casing assembly; 20-Tile-shaped parts for bracket; 21-Bracket; 22-Spring; 23-Spring cap; 24-Luck nut; 25-Bottom cover; 26-Oil sealing assembly Φ38×Φ27×7; 27-O-SHAPED RING 43.7×1.8; 28-Spool assembly; 29-Oil sealing assembly; 30-Ball bearing; 31-O-SHAPED RING 53×1.8; 32-Coned-shaped joint I; 33-Valve body; 34-Dust cover; 35-Hexagon bolt M8×25-6h; 36-Spring washer 8; 37-Coned-shaped Joint II; 38-Seal ring

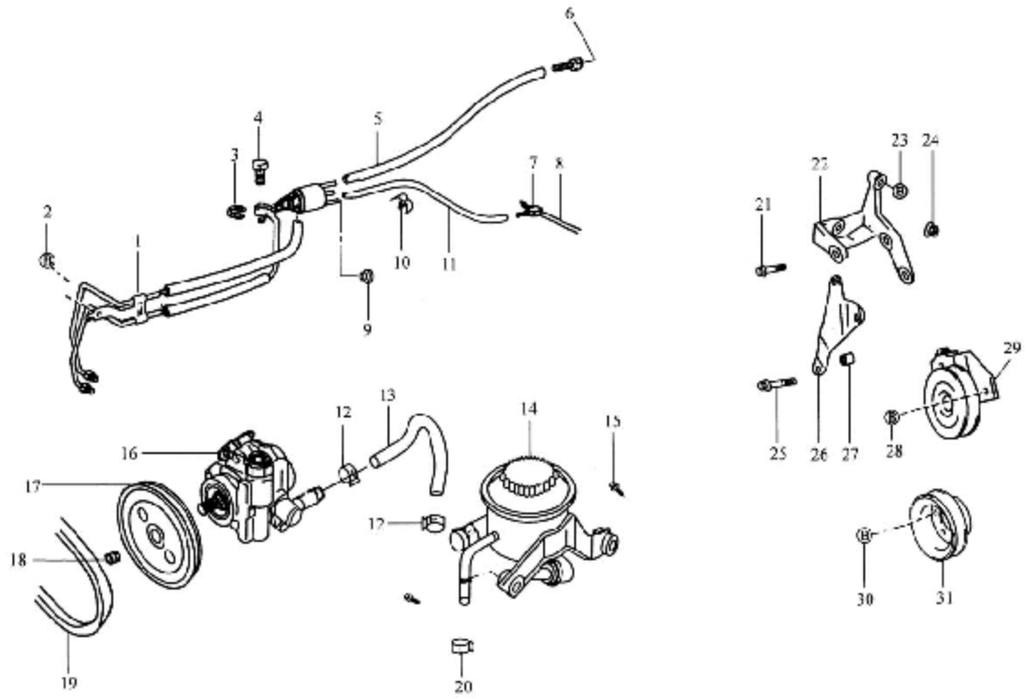


Figure 10-6-8 Power Steering cable

1-Steering cable assembly; 2-Bolt; 3-Oil pump washer; 4-Bolt; 5-Vacuum hose Ⅳ; 6-Joint; 7-Tee; 8-Vacuum hose III; 9-Filter cleaner; 10-Bar clasp; 11-Vacuum hose Ⅰ; 12-Hoop; 13-Oil pipe; 14-Steering oil tank/can; 15-Bolt; 16-Steering oil pump; 17-Oil pump pulley; 18-Bolt; 19-V-shaped belt for vehicle; 20-Hoop; 21-Subassembly of bolts; 22-Support for oil pump; 23-Bolt; 24-Nut assembly 25-Bolt; 26-Idler wheel support; 27-Nut; 28-Bolt; 29-Idler wheel belt support assembly; 30-Bolt; 31-Crankshaft belt pulley

10.6.3 Check, Maintenance and Repair

1. Check and repair – steering column tube supporter and steering shaft

(1) Check steering column tube supporter and steering 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

(4) Steering gear cross shaft assembly

① Replace bearing if its needle is broken or needle number is insufficient.

② Replace cross shaft bearing if its fitting clearance with shaft journal exceeds 0.25mm, or it cannot rotate freely.

③ Replace bearing if its sealing gasket or cover is failure.

④ Minor peel-off on cross shaft journal surface can be corrected by grinding. Replace it if there are dent on journal surface and severe peel-offs, or shaft has crack on it or it is worn seriously.

(2) UJ fork spline, spline shaft and bush

① Replace part if UJ fork spline, spline shaft and bush are corroded seriously, or they have injuries or cracks on them.

② Replace spline shaft and bush if there are over two distort or damaged teeth.

3. Check and repair of steering gear assembly

Use pure light diesel, gasoline or cleaning fluid to wash the parts disassembled from the steering gear thoroughly. Decrust the packing paper and dried sealant on steering gear connecting surfaces and side cover. Check gear, rack, housing, rack pull rod and joint bracket for crack by using the methods such as oil impregnation, knocking or magnetic particle checks. Replace if necessary. The oil seal and gasket are not reusable, replace with new ones. If the protecting cover and O ring is aged, replace with new ones.

4. Maintenance of power steering system

① A new power steering gear needs change steering fluid after the vehicle has run for 2,500km. Meanwhile, the filter in the reservoir should be washed. Since then change fluid and wash filter for every 50,000km or one year.

② Monthly check the volume of fluid for fluid consumption, deterioration or excessive impurities. Replace deteriorated fluid timely.

10.6.4 Typical Faults and Troubleshooting

1. Heavy steering wheel, see table 10-6-1.

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.

Table 10-6-1 Heavy steering wheel

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 ① Worn out or damaged screw nut race and ball ② Damaged 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, see table 10-6-2.

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.

Table 10-6-2 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. Loose or worn out steering bearing	2. Replace bearing
3. Excessive wheel dynamic unbalance	3. Perform dynamic balance check
4. Weak torsion bar spring	4. Replace
5. Incorrect front alignment angle	5. Adjust front wheel alignment angle
6. Failure shock absorber	6. Replace shock absorber
7. Distort vehicle frame (due to collision)	7. Adjust and repair

3. Insufficient steering wheel turns, see table 10-6-3.

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.

Table 10-6-3 Insufficient steering wheel turns

Causes	Solutions
1. Incorrect steering screw rotation numbers	1. Remount and adjust
2. Parts in steering mechanism is distort due to force	2. Check and replace damaged parts
3. Mis-adjust front wheel turning angle locating bolt	3. Correct to right position according to specified front angle
4. Excessive steering wheel turning number difference to left and to right from center -- front wheel max turning angle becomes small (to left or right)	4. While steering arm mounting angle is correct, adjust front wheel turning angle locating bolt to standard

10.7 Suspension

10.7 Main Technical Parameters of Suspension

Main Technical Parameters of Suspension (with BJ491EQ1 Engine)

Sn	Description		Parameters
1	Front suspension	Type	Dual cross arm torsion bar type independent suspension
		Distance between locknut of track bar and fixing bolt (mm)	445±3
		Ground clearance (mm)	At front side 277mm; at rear side 305mm.
		Torque of tire nut (N.m)	120~150
		Torque of front damper and lower cross arm (N.m)	88~97
2	Rear suspension	Type	Rigid suspension of hydraulic type shock absorber with vertical arrangement semiellipse leaf spring and bilateral action cylinder
		Rear leaf spring section	Rectangle
		First main leaf size (length x width x thickness) (total number of leafs)	1200×60×8(5), flat spring eye structure
		Clamping center distance of U-bolt (mm)	90±0.5(Φ12)
		Free static camber (to center of spring eye) (mm)	130
		Tightening torque of U-bolt under flattening state of the leaf spring (N.m)	123±5
		Tightening torque of leaf spring pin (N.m)	147±5
		Tightening torque of leaf spring shackle pin (N.m)	91±5
		Torque of tire nut	120~150N.m
		Top nut of rear shock absorber (N.m)	21.6~26.4
		Toe nut of rear shock absorber (N.m)	38.7~47.3
3	Shock absorber	Type	Bilateral action cylinder type hydraulic shock absorber
		Tightening torque of tightening nut of rear shock absorber (N.m)	At top 21.6~26.4, at toe 38.7~47.3
		Working stroke (mm)	205
		Minimum length (when compressed through, distance from the shackle center to top dust boot) (mm)	320^{+3}_{-8}
		Maximum length (when pulled off, distance from the shackle center to top dust boot) (mm)	525^{+8}_{-3}
		Type of connection	Dual shackle
		Designation of damping fluid	Q/SY11509-79 damper oil

10.7.2 Structure Overview

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.

Front suspension of BJ6536 series light bus is of independent type and its rear suspension is of rigid semiellipse leaf spring vertical arrangement type.

See figure 10-7-1, figure 10-7-2, figure 10-7-3 for front and rear suspensions of BJ6536 series light bus.

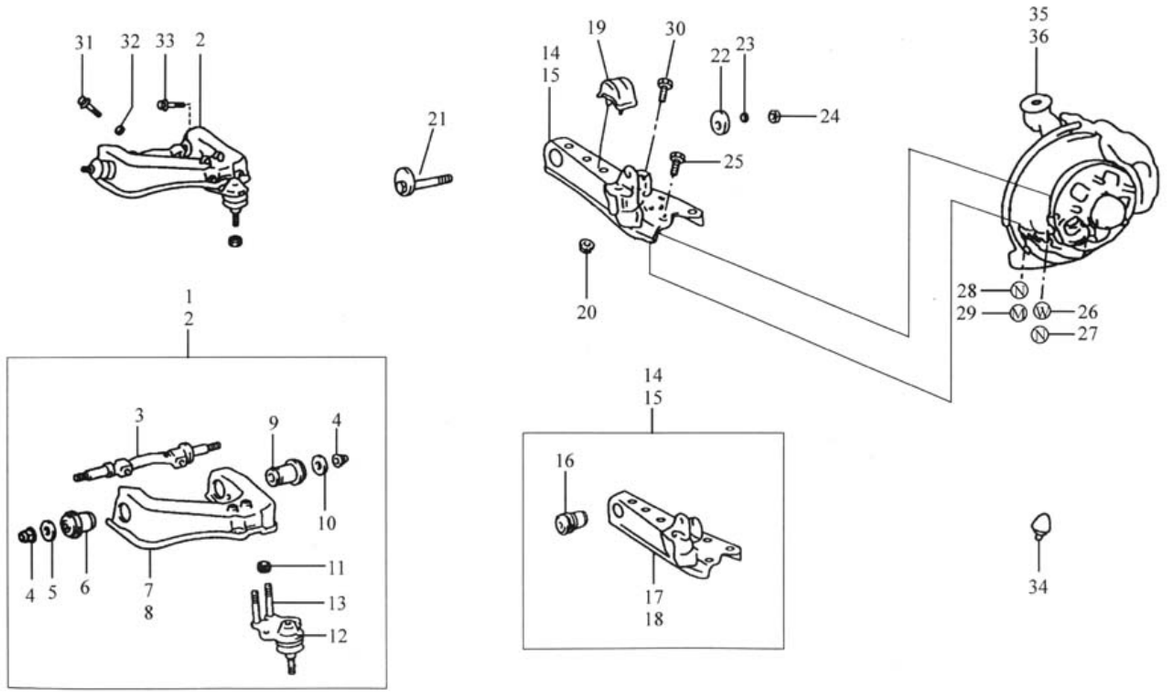


Figure 10-7-1 Front Suspension Assembly-1

1-Left top across arm, shaft and pin assembly; 2-Right top across arm, shaft and pin assembly; 3-Top across arm shaft; 4-I hexagon nut-small thread; 5-Small end cover; 6-Small outer collar, Small outer collar assembly; 7-Left top across arm seam; 8-Right top across arm seam; 9-Big outer collar, Big outer collar assembly; 10-Big end cover; 11-Nut; 12-Left top across arm ball pin assembly, Right top across arm ball pin assembly; 13-Bolt; 14-Left bottom across arm assembly; 15-Right bottom across arm assembly; 16-Rubber collar assembly; 17-Left bottom across arm seam; 18-Right bottom across arm seam; 19-Bottom buffer block assembly; 20-Metal lock nut with hexagon flange face, Spring washer; 21-Cam shaft assembly for bottom across arm; 22-Bottom across arm cam shaft; 23-Spring washer; 24-I hexagon nut; 25-Bolt M10×1.25×31; 26-Heavy spring washer; 27-Heavy spring washer; 28-Heavy spring washer; 29-Nut M12×1.25; 30-Bolt M12×1.25×50; 31-Bolt M14×1.25×66; 32-Flat washer; 33-Hexagon-flange-faced bolt; 34-Top buffer block; 35-Left knuckle disc brake assembly; 36-Right knuckle disc brake assembly

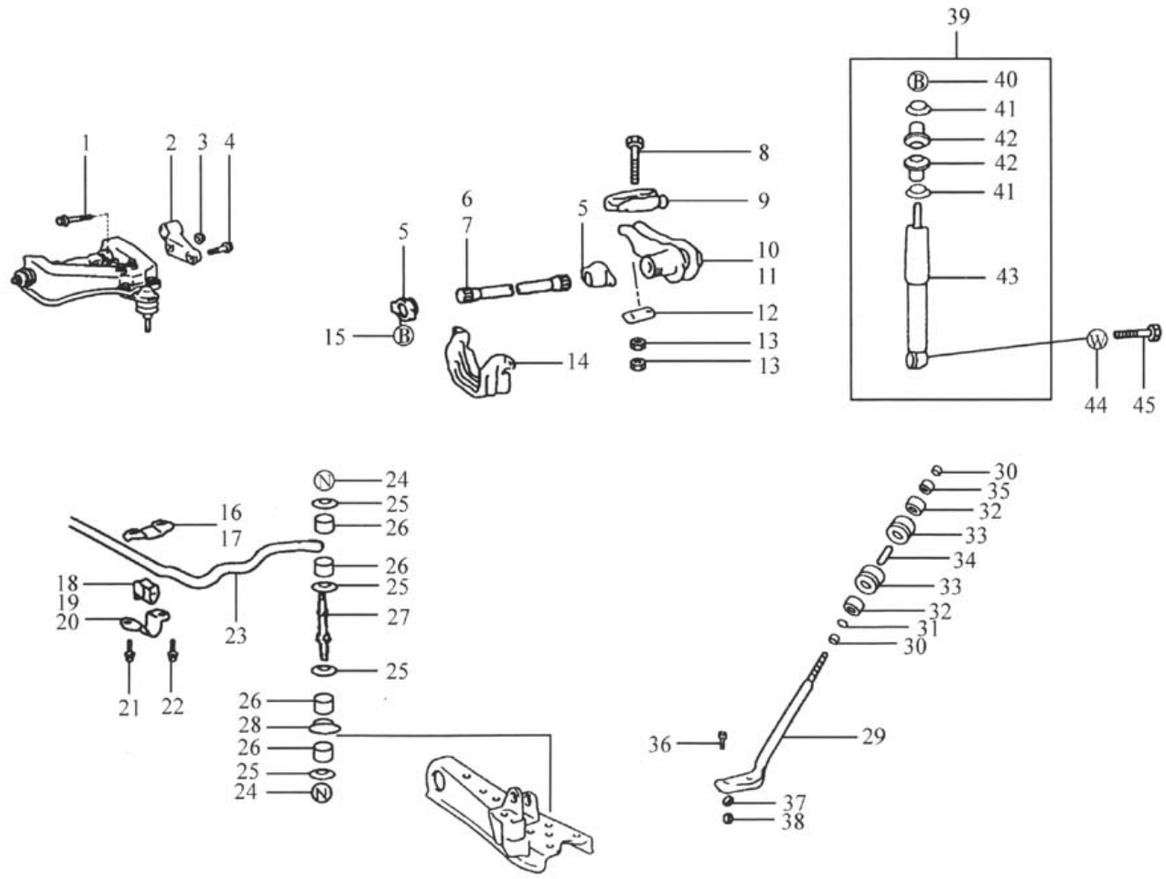


Figure 10-7-2 Front Suspension Assembly-2

1-Bolt M12×1.25×98; 2-Torque bar seal assembly; 3-Metal lock nut with hexagon flange face; 4-Hexagon-flange-faced bolt; 5-Torque bar dust cover; 6-Left torque bar; 7-Right torque bar; 8-Torque bar-rear bolt; 9-Top pad; 10-Left torque bar fixing arm assembly; 11-Right torque bar fixing arm assembly; 12-Bottom pad; 13-Torque bar fixing bolt; 14-Torque bar cover; 15-Hexagon bolt, spring washer and flat washer set; 16-Fixing plate for left stabilizer bar; 17-Fixing plate for right stabilizer bar; 18-Stabilizer bar rubber collar; 19-Fix bracket for left stabilizer bar; 20-Fix bracket for right stabilizer bar; 21-Hexagon head bolt; 22-Hexagon head bolt; 23-Stabilized bar; 24-Bolt M10×1.25; 25-Stabilized bar pad; 26-Stabilized bar rubber pad; 27-Stabilized bar connection shaft; 28-Stabilized bar pad (middle); 29-Thrust bar; 30-I hexogen nut-fine thread; 31-Thrust bar pad; 32-Thrust bar rubber retainer ring; 33-Thrust bar rubber pad; 34-Thrust bar collar; 35-Undee spring washer; 36-Hexagon head bolt; 37-Heavy spring washer; 38-Nut M12×1.25; 39-Front damper assembly; 40-I hexogen nut –fine thread; 41-Bottom pad; 42-Top attachment assembly; 43-Front damper; 44-Spring washer 12; 45-Hexogen head bolt M12×1.25×55

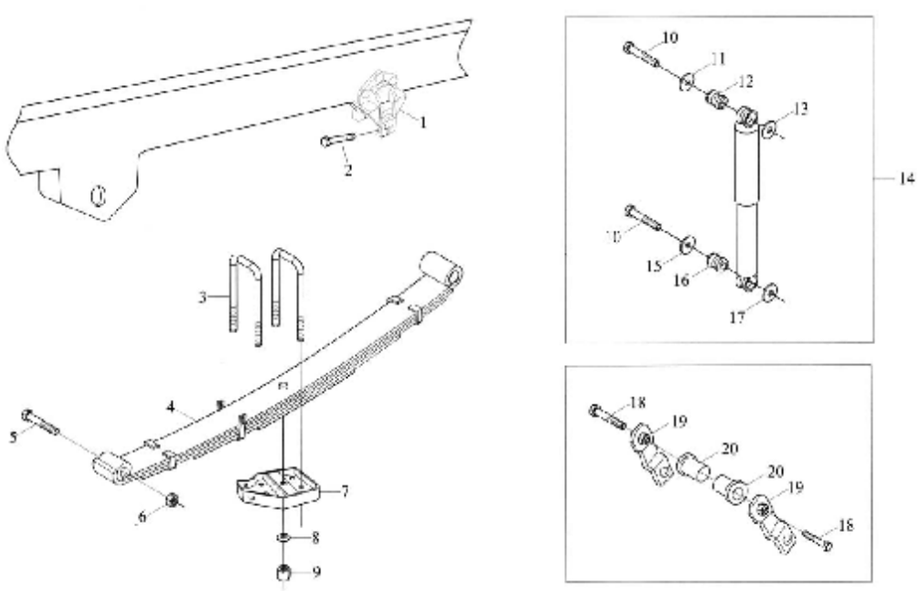


Figure 10-7-3 Rear Suspension Assembly

1-Rear stopper assembly; 2-Hexogen head bolt; 3-U bolt; 4-Rear steel plate spring assembly; 5-Steel plate spring pin; 6-Steel plate spring pin nut; 7-Rear plate splint assembly; 8-Flat washer; 9-U bolt nut; 10-Hexogen head bolt-fine thread; 11-Top pad for small hole; 12-Top ring for rear damper; 13-Top pad for big hole; 14-Rear damper assembly; 15-Bottom pad for small hole; 16-Bottom ring for rear damper; 17-Bottom pad for big hole; 18-Lifting eye pin for plate spring; 19-Outer plate for plate spring lifting eye; 20-Lifting eye pin collar for plate spring

10.7.3 Technical Specifications for Check and Repair

1. Repair of front suspension

① Check front suspension: compress and extend the shock absorber, check for abnormal resistance or working sounds. If any, replace with a new shock absorber.

② Repair torsion bar spring: make fitting marks on torsion bar spring, torsion arm and fixed arm; measure the length of extended bolt end A as shown in figure 10-7-4. The value of which will be a reference when adjusting height of the vehicle; there are left and right index marks at rear end of torsion bar spring. Do not install it to opposite direction.

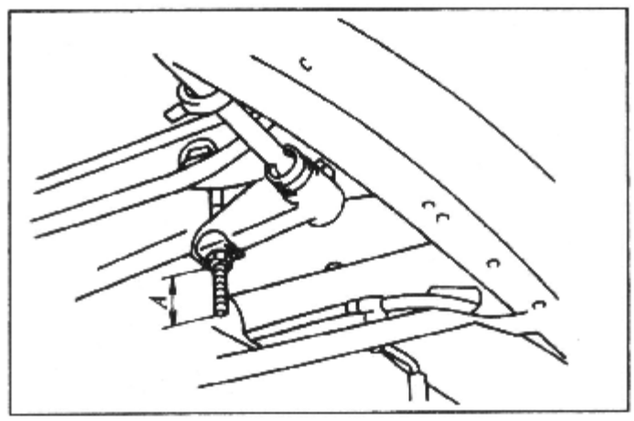


Figure 10-7-4 Measurement of Length of Bolt A

③ Mount and secure a new torsion bar spring onto the torsion arm, and adjust the nut seat and adjusting nut. **Note:** When to install the fixed arm onto the torsion bar spring, tighten the adjusting nut by hand to make the extended length of bolt being about 5mm, as shown in figure 10-7-5. Tighten the adjusting nut to screw down the bolt by 60.5mm(C). The measured value of which will be a reference during vehicle height adjusting.

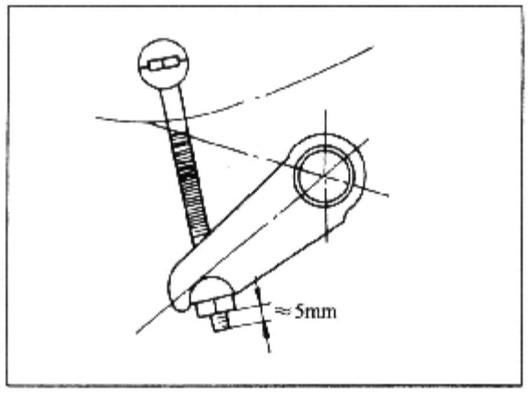


Figure 10-7-5 Installation of Torsion Bar Spring (1)

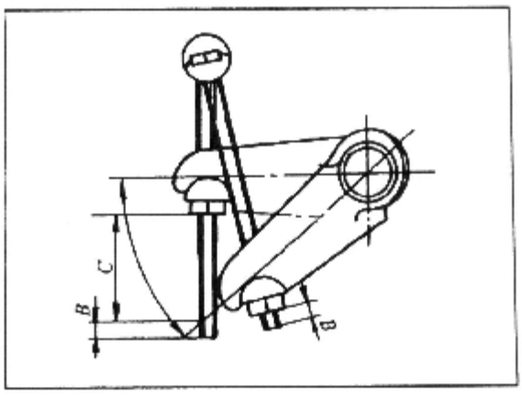


Figure 10-7-6 Installation of Torsion Bar Spring (2)

④ Check vehicle height. If the height is off standard, adjust it by using the adjusting nut of the torsion bar spring.

⑤ Check front wheel alignment by wheel alinger.

⑥ When to install the stabilizer bar, tighten the nut until the extended length of the bolt reaches 4.5~6mm, as shown in figure 10-7-7.

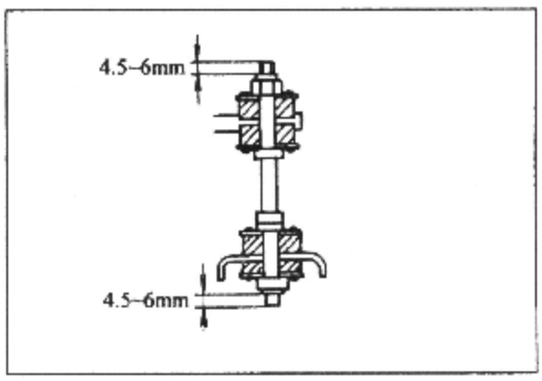


Figure 10-7-7 Installation of Stabilizer Bar

2. Leaf Spring

(1) Check each leaf for crack, breaking and 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 0.8% of leaf thickness.

(3) Measure leaf spring assembly performance after leafs have been clamped. The specifications for front/rear/auxiliary leafs should be as indicated in chart 10-7-1. Replace part if arc height and stiffness of each leaf change greatly (especially LH/RH changes) under static load.

(4) Leaf spring pin and bushing

Check front/rear leaf spring pins for uneven wear or damage by measuring their diameters. Replace parts if wear exceeds limit. See table 10-7-2.

Table 10-7-1 Performance of Leaf Spring Assembly

Description	Free arc height (coil center)
Rear spring	156±6

Table 10-7-2 Service Limit of Rear Leaf spring Pin (mm)

Description	Standard	Limit
Rear leaf spring pin	φ14	φ13.8
Rear shackle pin	φ14	φ13.8

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 that has crack. And replace part if necessary.

5. Front /rear leaf damper and auxiliary leaf bracket pad

Check them for damage, peeling or crack. Replace if necessary.

6. Rubber bushing of shock absorber shackle

Check shackle rubber bushing for aging, distortion and crack, replace if necessary.

10.7.5 Typical Faults and Troubleshooting

1. Broken or sounding leaf springs, see table 10-7-3.

Table 10-7-3 Broken or sounding leaf springs

Causes	Solutions
1. Boken 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.	2. 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, see table 10-7-4.

Table 10-7-4 Leaking or failure shock absorber

Causes	Solutions
1. Worn-out oil seal — shock absorber connecting rod 2. After long driving on rugged road, shock absorber cylinder tube becomes hot 3. Failure shock absorber 4. Worn-out or lost absorber upper rubber bush, absorber can not work normally	1. Repair or replace assembly 2. Remove to check shock absorber, replace if it is failure 3. Replace 4. Replaced damaged parts

10.8. Brake System

10.8.2.1 Main Technical Parameters of Brake System

Main Technical Parameters of Brake System (with BJ491EQ1 engine)

Sn	Description		Data
1	Type of service brake system		Hydraulic operation dual-circuit brake system with vacuum booster, front disc and rear drum brake
2	Brake	Front wheel	Disc brake
		Rear wheel	Drum brake
3	Brake disc (mm)	Standard thickness	25
		Service limit	22.5
		Lateral run-out tolerance	0．07~0．12
4	Front friction lining (mm)	Standard thickness	10
		Service limit	1．6
5	Inner diameter of brake drum (mm)	Nominal values	φ270
		Service limit	φ272
		Taper	0．15
		Out of round	0．15
6	Rear wheel friction lining (mm)	Standard thickness	5．5
		Minimum service thickness	1．0
7	Dimension of brake master cylinder (mm)	Diameter	φ25.41
		Stroke	30
8	Rear wheel cylinder diameter (mm)		φ23.81
9	Brake fluid		V-3QC/T670

Sn	Description	Data
10	Type of parking brake system	Mechanical operation, rear wheel brake supplemented with the parking brake
11	Brake pedal height (mm)	151.5±2
12	Free travel of brake pedal (mm)	1~3
13	Margin distance of pedal travel (pedal travel from the ground) (mm)	58
14	Fit clearance between brake drum and brake shoe (mm)	0.6
15	Road test the braking distance (at 30km/h on cement road surface) (no part of the vehicle is allowed to be beyond the test track by 2.5m).	Braking distance≤8m; error≤60mm
16	Requirements for parking brake	Parking brake unit creates required braking performance when it operates within 2/3 travel of operating devices

10.8.2 Structure Overview

I. Brief Introduction of the Structure

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. BJ6536 light bus adopts two independent brake systems: service brake system used on FR/RR wheels (dual hydraulic circuits with vaccum booster) and parking system used on transmission mechanism.

Service 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 service brake system is faulty during vehicle driving, driver should move vehicle by using parking brake system to a safe place or service station for check and repair.

Front disc brake is shown in figure 10-8-1.

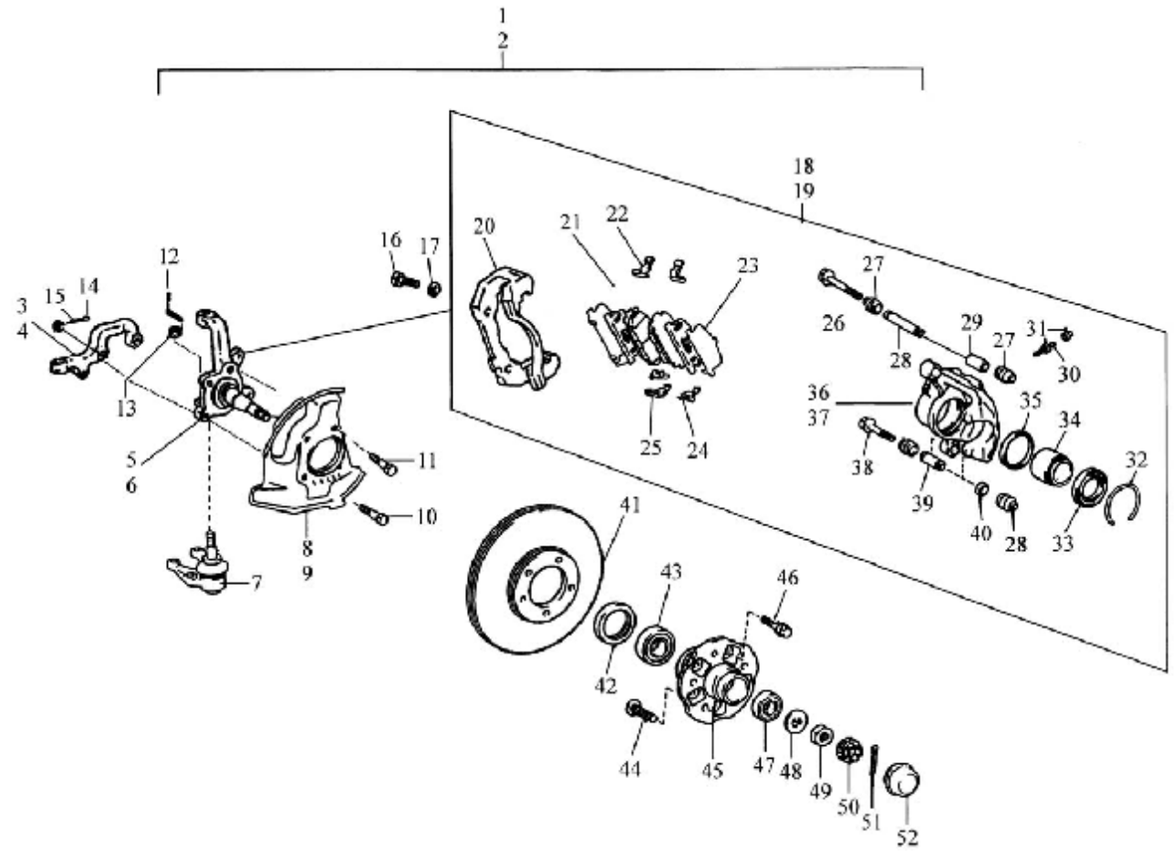


Figure 10-8-1 Front Disc Brake

1-Assembly of left disc brake; 2-Assembly of right disc brake; 3-Left steering knuckle arm; 4-Right steering knuckle arm; 5-Left steering knuckle; 6-Right steering knuckle; 7-Ball spigot assembly; 8-Left dust cover assembly; 9-Right dust cover assembly; 10-Bolts for installation of pitman arm; 11-Hexagon bolt; 12-Split pin; 13-Ball spigot nut; 14-Split pin; 15-Nut; 16-Connecting bolt for arrestor; 17- Flat gasket; 18-Left stop pliers assembly; 19-Right stop pliers assembly; 20-Tong holder; 21-Silencer; 22-Supporting spring Ⅰfor friction plate; 23-Stop friction plate assembly; 24-Alarm; 25-Supporting spring Ⅱfor friction plate; 26-Split pin; 27-Dust cover for guide sleeve; 28-Long guide sleeve; 29-Long shaft guide sleeve; 30-Air bleed bolt; 31-Dust cover for air bleed bolt; 32-Steady ring; 33-Dust cover for piston; 34-Piston for sub-pump; 35-Seal ring for piston; 36-Left stop plier; 37-Right stop plier; 38-Fixed bolt for short guide sleeve; 39-Short guide sleeve; 40-Short shaft bushing; 41-Brake disk; 42-T-type oil seal; 43-Taper roller bearing; 44-Bolt for front wheel hub; 45-Front wheel hub; 46-Bolt subassembly; 47-Taper roller bearing; 48-washer; 49-Nut; 50-Adjusting lock blade; 51-Cotter pin; 52-Cover for front wheel hub

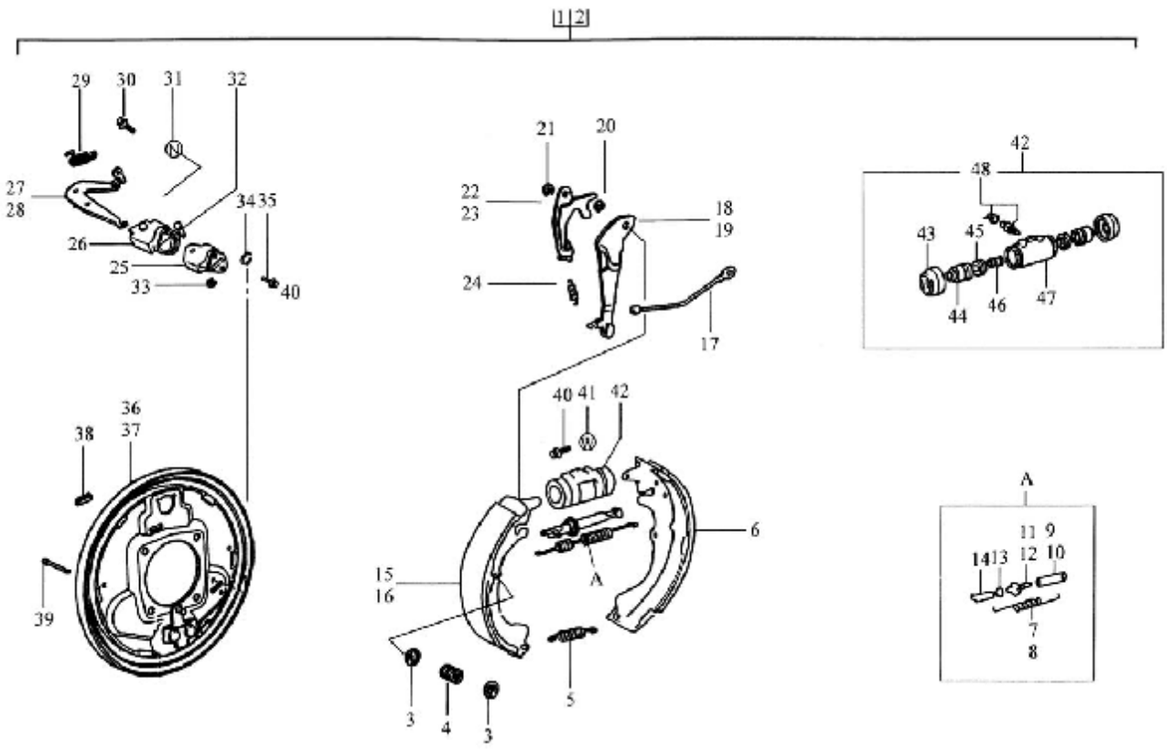


Figure 10-8-2 Rear Drum Brake

1-Left rear brake assembly; 2-Right rear brake assembly; 3-Spring seat; 4-Stop pull-out piece spring; 5-Stop extension spring; 6-Rear stop brake; 7-Left upper release spring; 8-Right upper release spring; 9-Left self adjusting turn buckle; 10-Right self adjusting turn buckle; 11-Left self – adjusting ratchet wheel; 12-Right self-adjusting ratchet wheel; 13-Self – adjusting gasket; 14-Self – adjusting sleeve; 15-Left front brake shoe; 16-Right front brake shoe; 17-Steel jacket for brake; 18-Pull rod for left brake; 19-Pull rod for right brake; 20-Split baffle ring; 21-Split baffle ring; 22-Self – adjusting bolt (left); 23-Right – adjusting bolt (right); 24-Spring; 25-Braket of rocker arm; 26-Rocker arm cover; 27-Rocker arm (left); 28-Rocker arm (right); 29-Spring; 30-Hexagon head bolt with cross channel; 31-Hexagon thin nut; 32-Clevis pin with head; 33-Split baffle ring; 34-Light type spring washer; 35-Hexagon bolt with full thread, Grade C M18×16; 36-Rear soleplate assembly (left); 37-Rear soleplate assembly (left); 38-Rubberized stop; 39-Pull rod for pull–out piece spring; 40-Hexagon bolt with full thread M8×16; 41-Light spring washer; 42-Rear brake subpump assembly; 43-Dust cover; 44-Piston assembly; 45-Leather cup; 46-Spring; 47-Cylinder body; 48-Bleed valve

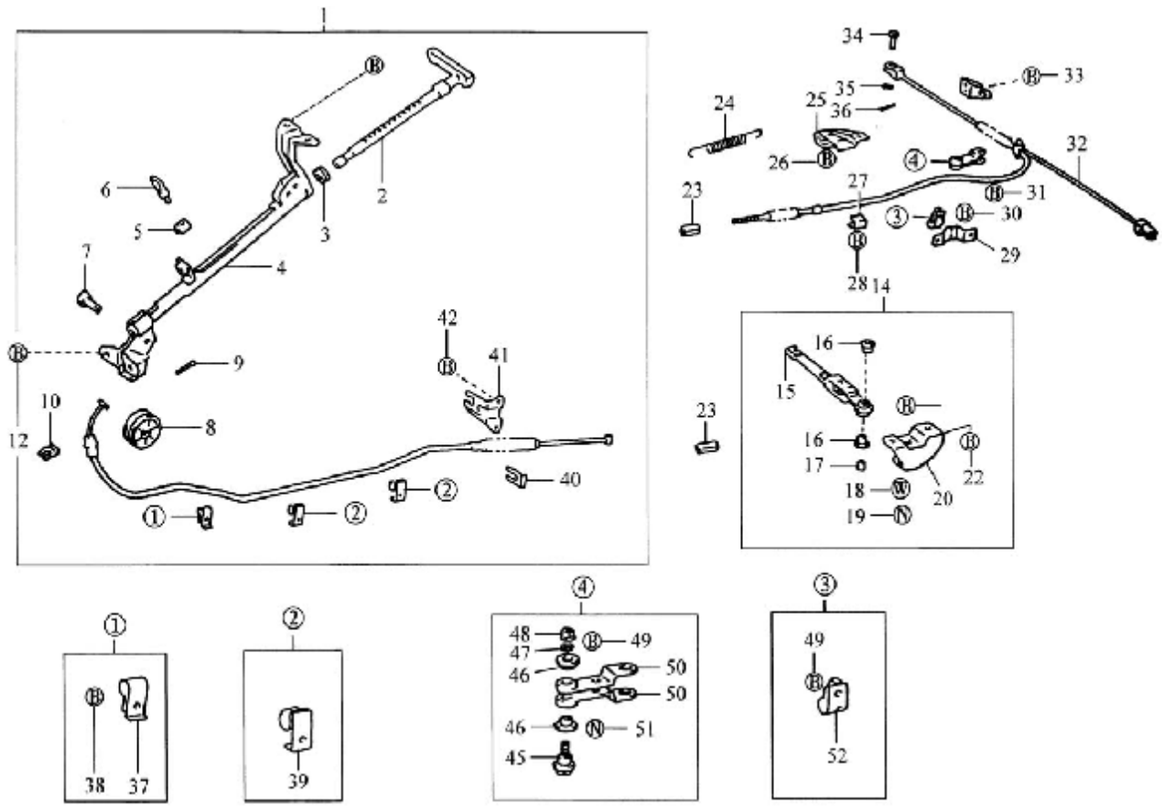


Figure 10-8-3 Parking Brake Control System

1-Front parts assembly for hand brake; 2-Handle assembly; 3-Jacket for hand brake joy stick; 4-Jacket assembly for hand brake joy stick; 5-Support sleeve; 6-Pin; 7-Pin shaft; 8-Pulley; 9-Split pin; 10-Clip/card; 11-Front pull wire assembly; Assembly for front hose with joint; 12-Hexagon bolt, spring washer and flat washer set; 13-Hexagon bolt, spring washer and flat washer set; 14-Assembly of hand brake's operating arm with support; 15-Assembly of hand brake's operating arm; 16-Bushing; 17-Inner sleeve; 18-Flat washer; 19-Hexagonal nut type 1 ; 20-Rocker arm support; 21-Hexagon bolt; 22-Hexagon bolt, spring washer and flat washer set; 23-Adjusting nut for operation of hand brake; 24-Spring of rocker arm for hand brake operation; 25-First support assembly for back pull wire; 26-Hexagon bolt, spring washer and flat washer set; 27-Upper cover board; 28-Hexagon bolt and flat washer set; 29-Second support assembly for back pull wire; 30-Hexagon bolt, spring washer and flat washer set; 31-Hexagon bolt, spring washer and flat washer set; 32-Back assembly for hand brake operation; 33-Hexagon bolt, spring washer and flat washer set; 34-Pin shaft; 35-Flat washer; 36-Split pin; 37-Front hose clip (1); 38-Hexagon bolt, spring washer and flat washer set; 39-Front hose clip (2); 40-Card; 41-Support for front pull wire; 42-Hexagon bolt, spring washer and flat washer set; 43-Jointing sleeve for second support of back pull wire; 44-Hexagon bolt, spring washer and flat washer set; 45-Bolt shaft; 46-Rubber sleeve; 47-Spring gasket; 48-Hexagonal nut type 1 ; 49-Hexagon bolt and flat washer set; 50-Assembly of balancer support; 51-Hexagonal nut type 1 /spring washer; 52-Jointing sleeve for second support of back pull wire

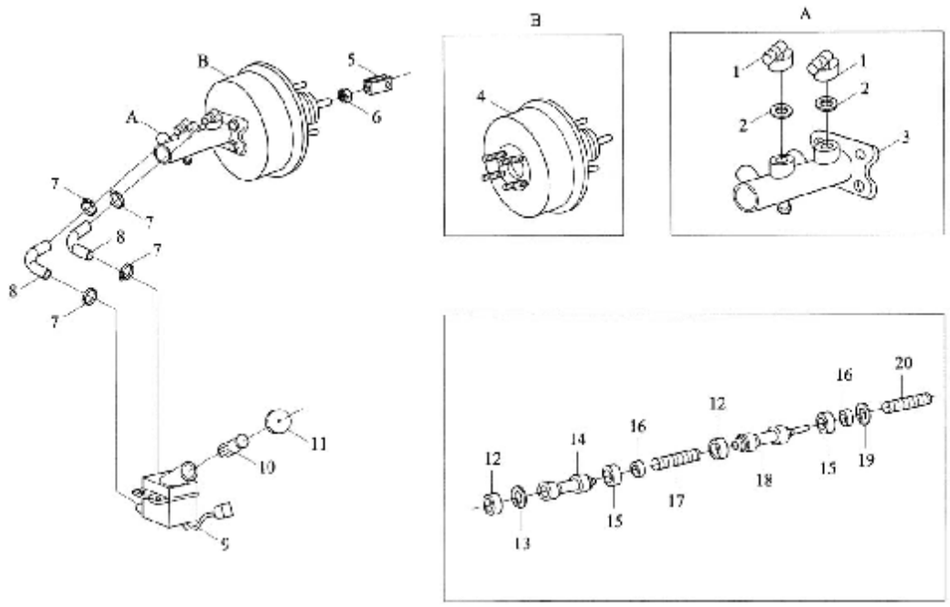


Figure 10-8-4 Vacuum Booster with Brake Master Cylinder Assembly

1-Fluid feeding joint; 2-O–shaped ring; 3-Cylinder; 4-Vacuum booster; 5-Pushing bar fork for controlling; 6-Hexagonal nut type 1 M1×1.5; 7-Steel belt type of small hoop; 8-Oil feeding hose of base pump; 9-Cup assembly; 10-Filtering net assembly; 11-Oil cup lid; 12-Bowl type of auxiliary part; 13-Spring retainer ring type A 28; 14-Rear piston; 15-Master bowl; 16-Spring seat; 17-Back spring; 18-Front spring; 19-Elasticity stop collar type A for shaft; 20-Front spring

10.8.2.2 Brake System Service

10.8.2.2.1 Check and Repair Brake System

1. Check and adjustment

① Brake pedal height. The height from the floor should be 155~165mm. Adjust he height as indicated in figure 10-8-5.

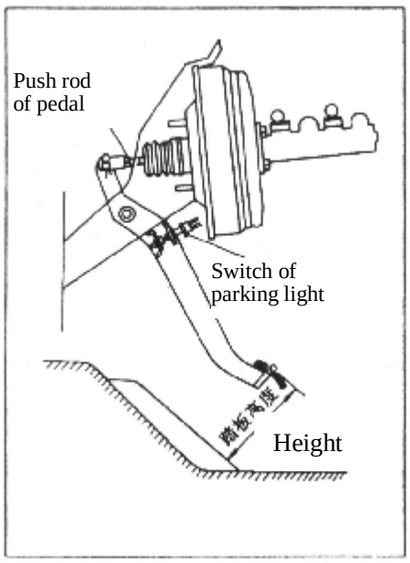


Figure 10-8-5 Check Brake Pedal Height

② Brake pedal free travel. Step down the brake pedal until some resistance is felt. The free travel should be 5~10mm. As shown in figure 10-8-6.

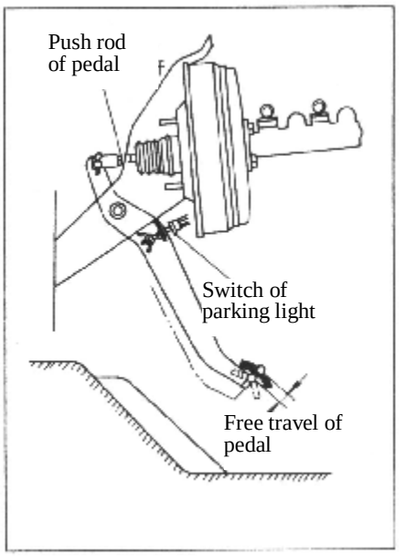


Figure 10-8-6 Check Brake Pedal Free Travel

③ Check the margin distance of pedal travel. Release parking brake manual handle while engine is running, step down the brake pedal. The margin distance of pedal travel is as shown in figure 10-8-7. Under 490N stepping force, the distance is more than 58mm. If the distance is incorrect, perform diagnosis for the brake system.

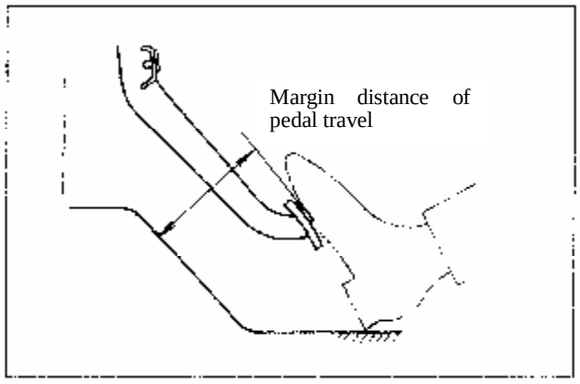


Figure 10-8-7 Check Brake Pedal Margin Travel

2. Test vacuum booster

① Before starting the engine, step down the brake pedal for several times. Check brake pedal for the stroke margin and make sure it has not changed.

② Step down the brake pedal and start the engine. If the pedal drops slightly, it is in good condition.

③ Start the engine and shut it down after 1~2 minutes. Step down the brake pedal slowly for several times. If the travel for the first application is the longest while afterward applications decrease gradually. This indicate the vacuum booster is sealed well.

④ When the engine is running, step down the brake pedal and shut down the engine. If the pedal travel margin does not change in 30 seconds, it indicates a well sealed vacuum booster.

3. Brake system bleeding. Discharge air for the brake system in following situation: the brake system has

been disassembled and re-installed, or brake system is suspected to have air in its pipeline,

4. Check and adjustment of parking brake lever travel

① Slowly pull up the parking brake lever with a force of 200N. If 18~20 clicks are heard, the parking brake is adjusted correctly. Otherwise adjust it.

② Before adjustment of parking brake, adjust the clearance between rear brake lining and brake drum. Adjust the travel of parking brake lever by the adjusting nut.

10.8.2.2.2 Repair brake master cylinder

① After disassembly and cleaning brake master cylinder parts, use compressed air to dry them up.

② Check the cylinder tube inner wall for rust or scratch.

③ Replace if wear or damage is present on the cylinder.

④ Check piston and sealing ring for scratch and replace if necessary.

⑤ After installation of brake master cylinder, adjust the length of push rod before it is installed onto the vacuum booster.

10.8.2.2.3 Repair front disc brake

① Check brake lining thickness through the check hole. The normal thickness is 10mm and the minimum thickness is 1.0mm. If its thickness is not within the specified range, replace the friction lining.

② The nominal thickness of brake disc is 25mm and its wear limit is 22.5mm.

③ Measure the radial run out within 10mm from brake disc edge. If the radial run out is more than 0.12mm, replace with a new one.

④ The maximum increment of cylinder tube should not exceed 0.05mm.

10.8.2.2.4. Repair rear drum brake

① If the thickness of brake lining is less than 1mm, replace with new one.

② The nominal inner diameter of brake drum is 254mm and the maximum inner diameter is 256mm.

③ Scratch or wear on brake drum can be corrected by fine grinding with lathe.

④ The contact area of brake lining with brake drum should be more than 70%; otherwise perform polishing process.

⑤ If the distance from the surface of brake lining to rivet head is less than 0.8mm, replace brake pad.

10.8.3 Check of Brake Performance of Vehicle

Test braking performance on a brake tester. Drive the vehicle onto tester's check platform and check respectively the weights of front axle and rear axle. Then, drive the vehicle onto the brake tester and put it straight. Operate the test in accordance with the equipment operation instruction. Only one technician is allowed to be inside the vehicle.

Table 10-8-1 Checklist for Brake Performance

	Ratio -- front axle brake force to axle load (%)	≥60%
Brake performance test	Ratio -- left and right difference of front axle(%)	≤15%
	Ratio --left and right difference of rear axle (%)	≤20%
	Ratio -- the max braking force difference to rear axle load (%) (when rear braking force is less than 60% of rear axle load)	≤7%
	Ratio-- sum of parking brake force to gross vehicle weight (%)	≥20%
	Ratio-- total brake force to vehicle total mass (%)	≥60%

Remarks:

① No brake running-in is allowed on the braking platform. If hand brake rachet tooth number is more than 24, the control cable is too long and need to be adjusted.

② When measuring the brake, in order to obtain enough adhesive force to avoid wheel lock, it is allowed to put wedges under the wheels that are not under checking.

③ When to check braking performance of BJ6486、BJ6516 series light buses on concret road at a speed of 30km/h, its braking distance should be ≤8m and error should be less than 60mm. (The stopping distance includes the factors: driver reaction time, brake system parts mechnical transferring time and braking force actuating time.)

④ Parking brake unit creates required braking performance when it operates within 2/3 travel of operating devices.

10.8.4 Typical Faults and Troubleshooting

1. Typical faults and troubleshooting for driving brake system

(1) Brake failure, see Table 10-8-2.

No braking force when brake pedal has been depressed consecutively.

Table 10-8-2 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 is detached	4. Re-mounting

(2) Ineffective brake, see Table 10-8-3

Depress brake pedal cannot stop vehicle timely, and consecutive depressing shows no good result either.

Table 10-8-3 Ineffective Brake

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

Table 10-8-4 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	4. Abrasive pad or replace

Causes	Solutions
exposed	
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.

① Brake drags on all wheels simultaneously, see table 10-8-5.

Table 10-8-5 Brake drags on all wheels 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

② Brake drag on certain wheel, see table 10-8-6.

Table 10-8-6 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) Braking noise, see table 10-8-7.

One can hear squeak at braking or intermittent rubbing sound.

Table 10-8-7 Braking 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, see table 10-8-8.

During braking, the pedal may drops to the floor suddenly. Step on repeatedly cannot make it returning.

Table 10-8-8 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, see table 10-8-9.

Pedal goes up gradually after it has depressed repeatedly during driving.

Table 10-8-9 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
3. Air in brake system	3. Bleeding.

(8) Too heavy brake pedal, see table 10-8-10.

Due to ineffective Due to vacuum booster failure, brake pedal becomes heavy without well braking force.

Table 10-8-10 Too Heavy Brake Pedal

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. Typical Faults and Troubleshooting for Parking Brake System

Ineffective hand brake, see table 10-8-11.

Lift manual brake handle cannot stop vehicle from coasting.

Table 10-8-11 Ineffective Hand Brake

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:**
  1. **Above case allows temperature difference between FR/RR, RH/LH drums.**
  2. **If drums become scalding after several emergency braking, the high temperature do not warrant that drum heating is out of normal range.**

10.9 Wheel

10.9.1 Main Technical Parameters of Wheel

Main Technical Parameters of Wheel

Sn	Description		Data
1	Type of wheel		Tubeless
2	Type of wheel rim		6 x14 wheel rim with a offset distance of 30mm
3	Spoke	Type	Web type
		Center diameter of bolt hole (mm)	5 holes, distribution circle φ114.3; diameter of bolt hole φ15±0.3; center hole $\varphi 64^{+05}_{-02}+05+02^{+05}_{-02}$
4	Tire	Type	Radial ply tire
		Dimensions	195/70R15C and 185R14C
		Air pressure of front tires (kPa)	325 (for 205 tire, 250)
		Air pressure of rear tires (kPa)	450 (for 205 tire, 250)
5	Wheel nut	Tightening torque	Tightening torque for steel wheel hub nut is 105±5N.m Tightening torque for aluminum alloy wheel hub nut is 120±5N.m
6	Total tire body	Amount of dynamic balance (add counter weight onto wheel rim)	710gram-cm (300rpm)

10.10.2 Structure Overview

Vehicle's driving performance is closely related to wheels and tires. Wheels and tires 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.

BJ6536 series light buses adopt tubeless tire (see figure 20-10-1). The tire has no inner tube. Air is directly injected through valve into outer tire. It requires good sealing performace between rim and outer tire. Tubeless tire looks the same as an ordinary tire, but a rubber sealing lining (2-3mm) applied on inner wall of outer tire makes the difference. Lining application is made by means of sulfurization. On lining's inner surface, there is layer of self-adhesive composite that can mend any possible pierce-through on tire. There are several concentric circular grooves on tire, which help tire edge to press closely on rim under air pressure inside tire, thus closed air sealing between tire and rim is guaranteed.

Valve is directed mounted on rim with rubber gasket for sealing. Rivet used to connect web and rim extends out from inside with sealant. Vacuum tire pressure will not lower abruptly after tire has been pierced through, which guarantees a safe driving. By using tubeless tire, there are no friction and stuck between inner tube and tire, and heat created can be emitted through rim directely. Tubeless tire's life span is longer plus it is simple structured and light in weight. But tubeless tire is difficult to repair in the midway, and self-adhesive lining works only when tire is pierced through. In hot weather, the lining is prone to be melted and may flow downward, interrupting dynamic balance. Therefore, some vehicles adopt tubeless tire that has no adhesive lining, its inner wall has only compressed seal lining. Compressed lining will press tightly around any possible piercing object, and keep tire prssure for quite a while even the object is removed. In this case, this type of lining partly performs the function of self-adhesive type lining.

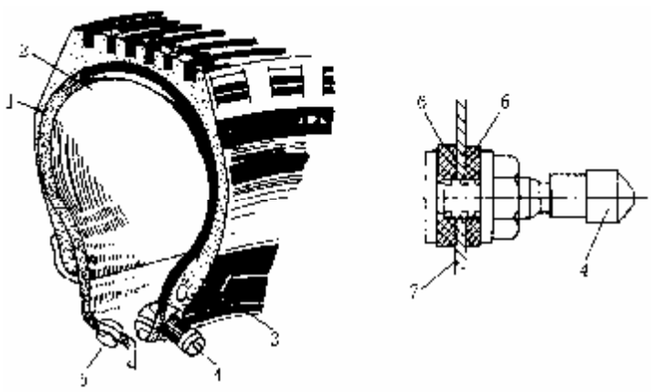


Figure 10-10-1 Tubeless Tire

1-Rubber sealant; 2-Self adhesive material layer; 3-Groove; 4-Tire valve; 5-rivet;
6-Rubber seal pad; 7-Wheel Rim.

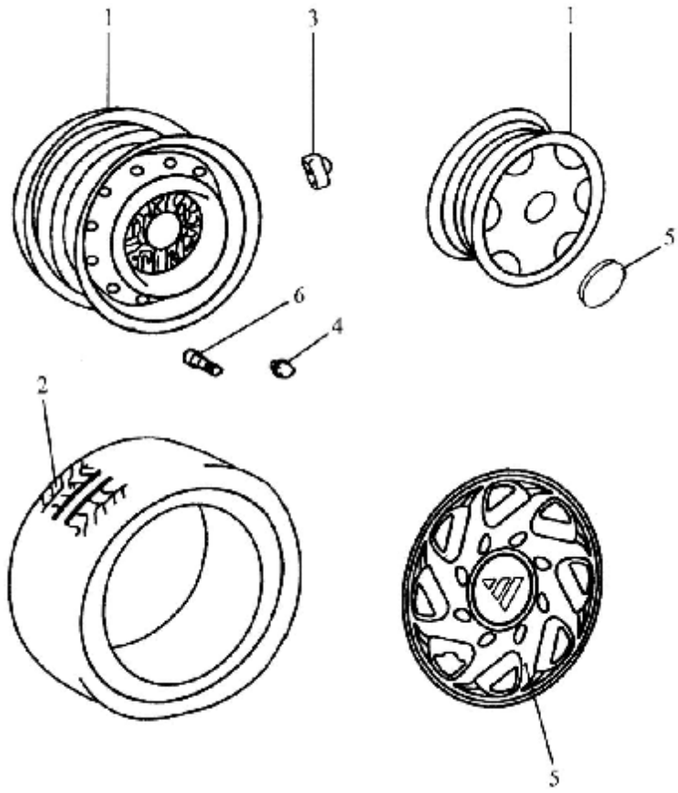


Figure 10-10-2 Wheel and Tire

1-Wheel assembly; 2-Tire; 3-Wheel rim counter weight; 4-Wheel hub nut;
5-Wheel rim assembly; 6-Valve of tubeless tire

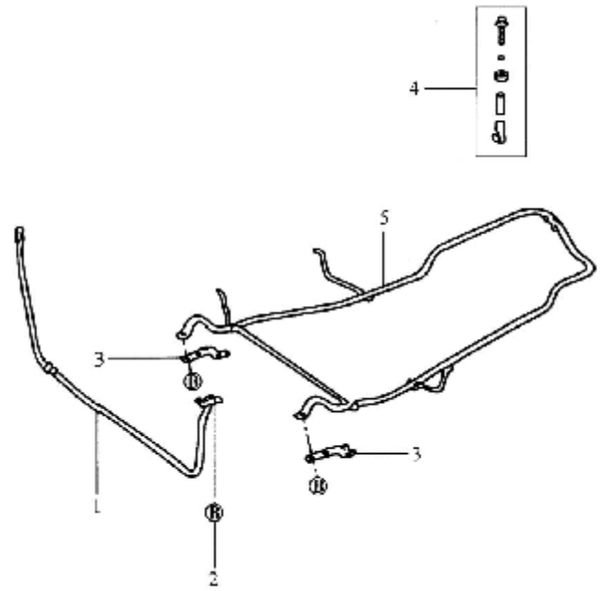


Figure 10-10-3 Spare Tire Installation Mechanism

1-Weldingon assembly of spare tire bracket (1); 2-Hexagon bolt; 3-Pressure plate; 4-Hanger assembly;
5-Weldingon assembly of spare tire bracket (2)

Crown Tire crown refers to center section between tire shoulders. Tire tread refers to crown's most outer layer (with pattern) that contacts road; baffle layer refers to fabric layer between diagonal tire tread and body, it helps to alleviate and absorb partially impact to tire from road; belt layer refers to the layer clamping tire body circularly along tread center line (for radial ply and bias belted tire), it helps to strengthen tire's circular and side stiffnesses and take most of the tread force; cord layer refers to rubber fabric composed by parallel cord in center tire body, it is the skeleton of tire body and it supports each part of outer tire.

Tire sidewall refers to the rubber layer on lateral wall of carcass between tire shoulder and tire bead. It protects tire carcass and takes force from sides

Tire bead Bead refers to the part that contacts rim. It consists of bead core and bead fabric. It prevents tire from slipping out of rim.

Wheel rim assembly is made up of wheel rim and spoke, and the spoke is welded on the wheel rim.

Balance weight is to set at unbalance spot during dynamic balance test.

There are two types of tires: bias and radial ply. Radial ply tire as shown in figure 10-1-4 arranges cord with nearly 90° angle to tread center line. Its name comes after earth's meridian line. Radial ply tire fully utilizes cord's stregthenss, its cord layer number is less than ordinary diagonal tire, and it is light in weight and with soft tire body. Radial ply tire uses multi-layer belt with small tread center line angle (10～20°), is made of cord or wire cord of high strength and low extension. The tire can take relatively larger tangential force. Belt layer is closely inset into carcass. It greatly improves tread stiffness, traction and wear-resistance.

Radial ply tire is subject to lower rolling resistance than ordinary diagonal tire is. It helps to save fuel and has characteristics such as wear-resistance, longer life span, good performance and safety. BJ6536 light bus uses radial-ply tire.

Mix to use bia and radial ply tires in same vehicle will interrupt vehicle's drivability. Do not do this!

Figure 10-10-4 Structure of Radial / Bias-ply Tires

1-5 Outer tread; 2-4, 6-Carcass; 3-Belted layer

10.10.2 Technical Specifications and Identifications of Tire

1. Technical specifications: Welding of wheel rim assembly should be firm and secure and no defects such as included slag, pore and crack etc.. The tires installed on the same vehicle and their tread patterns should be uniform. Dynamic unbalance is a major cause of direction oscillation of vehicle. The manufacturer of wheel assembly has performed dynamic balance test for the wheel assembly and counter weights also have been added. Dynamic unbalance of wheel assembly should be less than 720gram-cm (300rpm, at excircle flank of wheel rim).

2. Identifications of tires

Size marking of outer tube is shown in figure 10-1-5, and the unit is inch.

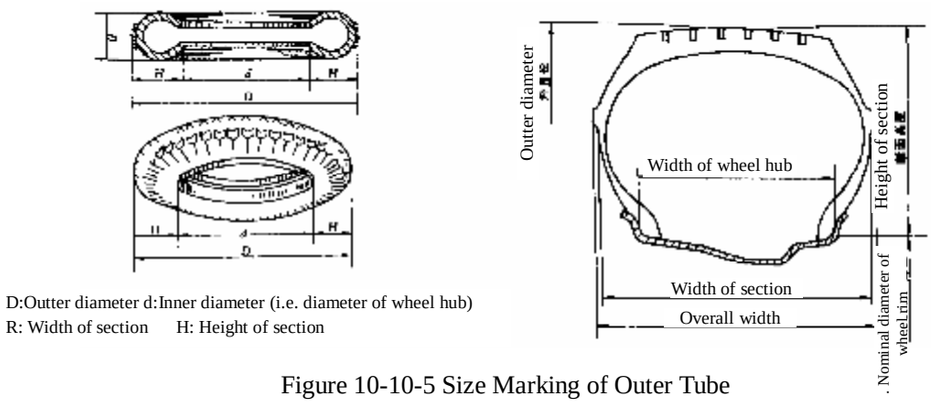


Figure 10-10-5 Size Marking of Outer Tube

High pressure tire is denoted like D x B:

D stands for nominal outer diameter of tire, B stands for section width of tire, the unit is inch, and "X" stands for high pressure tire.

Low pressure tire is denoted like B-d:

B is section width of tire, d is diameter of wheel rim, and "-" stands for low pressure tire. Because section width B approaches to section height H, so, size of wheel rim to be installed (d) can be calculated by d=D-2B.

Marks of tires fall into British system and metric system.

① Size marking for British system

Generally, ordinary section tires for truck and bias tires for sedans use this kind of mark and it is composed of the following:

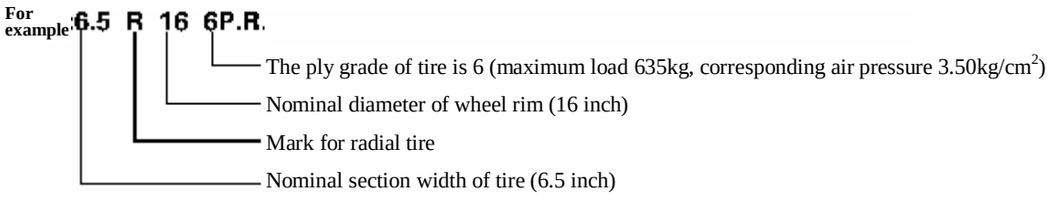
a. Nominal section width of tire, the unit is inch.

b. Structure mark of tire

c. Nominal diameter of wheel rim, the unit is inch.

d. Ply grade

Note: Ply grade refers to the specific strength mark of maximum bearable load on tire. It does not necessarily indicate the actual number of plies of cord fabric plies. For example: for a tire of " 9.00 ply grade 12", it may have several actual numbers of plies and a maximum load of 2,050kg.



② Size marking for metric system:

Generally, radial tires for sedan use this kind of mark, it includes the following:

a. Nominal section width of tire, the unit is mm.

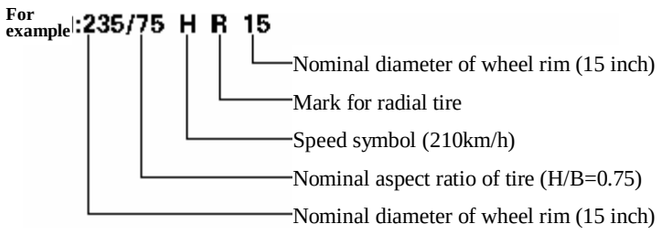
b. Nominal aspect ratio of tire

c. Speed symbol

d. Structure mark of tire

e. Nominal diameter of wheel rim, the unit is mm.

The nominal aspect ratio refers to the ratio of height and width of section assuming that the tire is installed on a theoretical wheel rim.



③ In order to be uniform, International Organization for Standardization (ISO) stipulates that the new size marking of tire should be composed of the following:

a. Nominal section width of tire, the unit is mm.

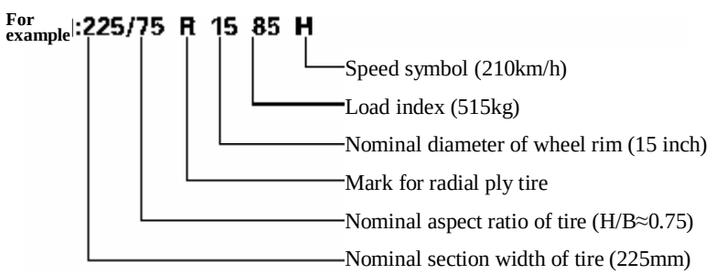
b. Nominal aspect ratio of tire

c. Structure mark of tire

d. Nominal diameter of wheel rim, the unit is inch.

e. Load index

f. Speed symbol



10.10.3 Service and Maintenance

Check tire pressure for leakage before driving. Too lower pressure leads to tire heating, higher fuel consumption and early wear; while too higher pressure leads to vehicle shaking or even tire explosion and also brings adverse effect to operating stability. Rated pressure for BJ6536 model vehicle is: front wheel 250±10Kpa, rear wheel 450±10Kpa. Tire surface cannot contact mineral oil (gas, engine oil, gear fluid and lubricants). After daily driving, one should check tire for any nail pierced, embedded stones in tread. Remove if there are.

Tires of same specification and type should be used in one car, and tires used should match corresponding model vehicle. In order to keep wear evenly, it is required to rotate wheel regularly (incl. spare tire). Rotation method see figure 10-10-6.

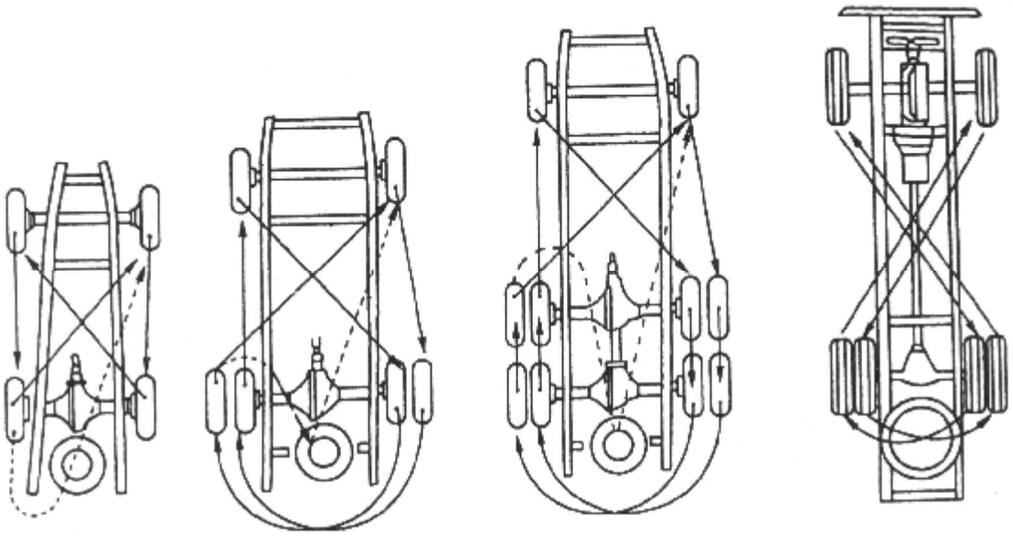


Figure 10-10-6 Tire Rotation

Chapter 11 Structure, Application and Service of Electrical Devices & Instrument

11.1 Electrical System Overview

The rated voltage for electrical devices on BJ6536 series of light bus is 12V. Single wire system is adopted for the circuit of electrical devicess, with negative grounding. The circuit for the complete vehicle is composed of three major harnesses. Front panel harness is wired inside the cab; body harness is located inside engine compartment; and chassis harness is arranged inside the frame. The insertings of front panel instrument harness and chassis harness must be dismantled before cab is to be disassembled.

Most electrical fittings and harnesses are connected with plug connector except very few of them jointed with bolts, which is beneficial to inspection and maintenance. It is not allowed to randomly change the positions of plug during use, so as to ensure the reliability and safety of the circuit. All the circuits are fitted with fuses. The fusible link is designed to protect the vehicle circuit, it breaks when circuit current becomes high. Fusible link should be replaced after a fault has been removd. It is not allowed to use other metal conductor as fuse.

Refer to the diagram for connection of vehicle electrical devices (See the electrical wiring diagram attached to this book).

11.2 Fuse Box

Fuse box integrates multiple electrical connections in one place to facilitate easy check and service on vehicle electrical devices. Refer to the indication diagram and parameters on fuse box cover to locate the wiring of each device and perform service. Use of other electrical fittings beyond specfication is not allowed..

11.3 Troubleshooting

If faults are noticed during driving and sevice check, operator can pinpoint fault locations according to electrical diagram, performs service or replacement. Never change connector location at random or connect wrong wire. Fault check starts with the most convenient place, and places where faults frequently happen such as bulb/fuse, and plug-in connectors..

11.3.1 Gasoline Engine Failure Startup

Use elementary diagram to remove gasoline engine fault. Here are some typical faults during startup:

(1) While ignition switch is set to START, cannot hear starter electro-meganetic switch clicking and starter rolling..

(2) Electo-magenetic clicking is heard, but starter does not run.

(3) Starter begins to roll, but engine does not start up.

(4) Hear continious clicking sound.

Analysis:

1. No starter switch clicks when ignition switch is set to “START”. Check if battery is connected. If battery is connected, test ignition switch and start relay power outputs. Repair or replace ignition switch or relay if there is power, otherwise test starter power connector. If the connector is hot, it indicates that starter switch attracts coil. Repair the starter.

2. When ignition switch is set to “Start”, starter electro-magnetic switch clicks but starter does not run. This indicates there is no continuity at starter due to burntout or dirty main contacts. Adjust starter switch travel and

remove dirt on main contact.

3. When ignition switch is set to “START”, starter begins to run but engine does not start up. One cause may be that starter small gear runs at high speed earlier before it meshes with flywheel gear ring due to wrong switch travel. Adjust switch travel. Another cause may be that starter non-return clutch is damaged. Repair or replace starter.

4. When ignition switch is set to “START”, starter clicks continiously. The cause may be

a)Starter rotator is short circuit. Repair or replace rotator;

b)Battery is low.

To test above two symptoms, press horn while key is at “Start”:

a)If horn works well or sound a little bit lower than usual, it indicats that battery is full, click sound is due to rotator short circuit.

b)If horn does not work or its sound is much low, it indicates that battery is low. Recharge battery.

11.3.2 Faults -- alternator, regulator and indicator

Refer to elementary diagram to check faults on alternator, regulator and indicator..

Analysis:

Check failure alternator. While power supply to whole vehicle is normal and ignition switch is set to “ON” position, check the indicator light first. Turn indicator light bracket behind the instrument panel by 90º to remove it. If the bulb is in good condition, re-mount it to proceed to further check. Open the fuse box and check the fuse for power supply. If the fuses look good, use a multimeter to test resistance. If the circuit connection of indicator light in here is good, the indicator light should be on. If an open circuit is found, turn to check harness at vehicle body or on front panel and alternator. Perform service if any bad contact or open circuit if found. When ignition switch is on “ON” position, the alternator indicator light should be on. But if the indicator light keeps on after starter has been started and alternator has been running at 100r/min or above, it indicates that the alternato is in trouble or the built-in voltage regulator has been damaged. In this case, alternator should be repaired or replaced.

11.3.3 Headlight faults diagnosis

Refer to the elementary diagram analyze headlight faults.

Analysis:

1. Low beam faults

Set headlight switch to Hi-beam, toggle Dim switch. Hi-beam is on while Lo- beam is off, Probe test Lo-beam output at combined DIM switch, if it is not hot, it indicates poor contact at DIM switch or wire dewelded. If the switch is hot, it indicates no continuity at headlight plug-in connector, Lo-beam fuse burntout or bulb failure. Repair or replace.

2. High beam faults

When headlight switch is set to Hi-beam, no high beam when toggling switch dim switch. To test this, first set headlight switch to “0” position, slowly lift combined switch handle, turn on “flash to pass” switch to see if high beam is on:

→(yes)→no continuity at DIM switch→repair or replace dim switch

→(no, and hi-beam indicator on dashboard is also off)→hi-beam output wire de-welded, cut off or poor contact

→(no, but hi-beam indicator on dashboard is on)→check fuse on fuse panel

→(fuse is ok but fuse post is not hot)→light relay damaged→repair or replace.

3. Check PASS light switch

While headlight switch is off, toggle PASS light switch, hi-beam is off. To test this, set headlight switch to Hi-beam, lift combined switch handle to trun on DIM switch. If hi-beam is off, control circuit and light relays may be the cause. If hi-beam is on, PASS light switch may be failure.

11.3.4 Faults diagnosis -- corner light, taillight and fog light

Please refer to the elementary diagram for analysis of faults of front corner light, taillight, and fog light.

Analysis:

A. While switch is set to "Lo-beam", corner light is off, probe test the continuity of corner light ouput:
→(not hot)→repair or replace switch
→(hot)→broken bulb, poor contact

B. While switch is set to "Lo-beam", corner light is on but taillight is off. Check harness connection at ceiling and taillight plug. If they are all ok, failure bulbs or poor contact may be the cause.

C. While switch is set to "Lo-beam", fog light is off. Probe test fog light switch:
→(not hot)→fog light poor contact
→(hot)check bulb and two plug connectors
→remove faults

11.3.5 Faults diagnosis --

Please refer to elementary diagram for diagnosis of faults.

Analysis:

Set ignition switch to "ON", toggle switch to "LEFT"

If : LF- light is off→check bulb and plug
LF-light is on but LR light is off→check bulb for de-welding, wrie cutoff.
LF/LR light are off→turn on emergency switch
→if lights are all on→L-switch failure
→if lights are all off→emergency switch poor contact or flash relay failure
and if: Left is on but indicator on dashboard is off→check indicator and dashboard plugs

Same measures are applied to RF, RR s.

11.3.6 Faults diagnosis – windshield wiper circuit

According to diagram to check windshile wiper circuit. While vehicle power supply is normal, turn on wiper switch. If wiper does not move, check if wiper fuses are burnt out or wiper motor 4-lead plug is connected. If all works well, turn to check wiper switch output line. Locate faults and remove them. If motor does not run after ciruit faults have been removed, the cause must be on motor. Repair or replace motor.

11.3.7 Fault diagnosis – instrument panel indicator circuit

Refer to the elementary diagram to diagnose instrument panel indicator circuit

Analysis:

a) Oil pressure indicator keeps off

Check bulb for damage →(ok)→bulb socket continuity→(ok)→ground short oil pressure sensor lead:

if: indicator lits→sensor damaged
indicator is still off →check continuity between harness at chassis behind front fender and engine compartment harness.

It can also probe to test continuity at indicator's positive side, if there is no power supply, meter's print circuit or plug may be the cause.

b) Oil pressure indicator keeps on

If pressure indicator keeps on after engine has started. Disconnect sensor lead:

if: indicator is till on→indicator's circuit grounds
indicator turns off→check oil pump performance and any restriction in oil pipe

c) Coolant temperature meter faults

According to elementary diagram to analyze faults. Follow circuit to check if sensor or meter head causes the

fault. Typical faults in this case are: damaged sensor, meter head is stuck or lead is disconnected. Their solutions see “Coolant temperature meter and sensor” in 18.5 (“Complex meters and auxiliary electrical devices3①”.)

d) Fuel meter faults

Solutions see “Fuel meter &sensors” in 18.5 (“Complex meters and auxiliary electrical devices” 3②.)

During the process, never scratch on fuel tank to check after sensor’s float has been removed.

11.3.8 Troubleshooting for other electrical devices and curcuits

BJ6536 series light buses also equip with other assemblies such as CD/Radio/Cassette player, central lock, back-up radar, washer, horn, brake lights, top lights, back-up lights buzzer, heating unit&A/C. By refering to their elementary diagrame, opeartor can locate their connector positions, find fault one by one and remove them.

Only professional or trained technician can repair CD/Radio/Cassette player and A/C system

Back up radar is a kind of vehicle back-up assisting device. It contains sensor, display, controls and circuit. It is used to detect any obstacles within the range of 0.9-0.3m right behind vehicle. At the moment obstacle is less than 0.3m to vehicle, it triggers system is to alarm. Display shows approaching distance (cm), obstacle’s position, alarm sound frequence change etc.

Summery: Fault checks stated in this section are only regular check procedures. Things are more complicated in real world. Pratically, operator should watch how and when faults happen, then carefully makes reference to diagram and knowledges on devices controlling relations. Check should start with the simplest one. This will make fault-removing much quicker.

11.4 Electrical devices

11.4.1 Battery

BJ6536 series light bus uses dry load battery. In emergent case, it could fill formulated electrolyte into battery after the electrolyte has been laid for 30 minutes, but battery normally has to be charged for 3~5 hours before use. Battery has been charged for 4 hours before delivery from factory.

1. Structure, Parameters and Performance

S/N	Description	Parameter
1	Model	Negative ground
2	Number of batterie cell	6
3	Rated Voltage (V)	12
4	Rated Capacity (V/A-h)	12/60 (BJ491EQ1)80(4D22)
5	Fluid level height above pole plate (mm)	10~15
6	Exterior dimensions (L × W× H) (mm)	254.4×164×220
7	Specific Gravity of Electrolyte	

Table 11-1 Specific Gravity of Electrolyte for Different Regions and Temperature (g/cm^3)

Climatic Condition	Specific Gravity of Electrolyte at 15℃ for Fully Charged Battery	
	Winter	Summer
Region where temperature is lower than -40℃ in winter	1.31	1.27
Region where temperature is above -40℃ in winter	1.29	1.25
Region where temperature is above -30℃ in winter	1.28	1.25
Region where temperature is above -20℃ in winter	1.27	1.24
Region where temperature is above 0℃ in winter	1.24	1.24

Table 11-2 Corrected Values of Temperature and Specific Gravity of Electrolyte

Measured Temperature of Electrolyte	+45	+30	+15	0	-15	-30	-45
Corrected Value of Readings from Gravimeter	+0.02	+0.01	0	-0.01	-0.02	-0.03	-0.04

2. Use of battery

(1) **Preparation of electrolyte:** Standard sulfuric acid and distlled water are to be used.

① Lead-acid battery electrolyte is made up of distalled water and concentrated sulfuric acid, and the density of electrolyte in a battery that is used for starting up a vehicle is 1.280±0.005g/cm^3 (25℃).

② The container used to prepare electrolyte must be glazed ceramic, glass fibre reinforced plastic, plastic tank, or lead-lined wood tank that have higher acid and temperature tolerance. Operator must wear protective articles during the process.

③ Rinse and clean the container prior to preparation with clean water.

④ Pour purified water into the container first, then fill slowly concentrated sulfuric acid into purified water while keep stiring. Never do this other way round avoid explosive splashes.

The conversion formula is d25=dt＋0.0007(t-25)

d25 : Density of electrolyte at 25℃ dt: Density of electrolyte when temperature is t

0.0007 : Temperature Coefficient t: Actually Measured Temperature of Electrolyte

The proportion of purified water (or distilled water) and sulfuric acid in electrolyte is shown in the following table.

Table 11-3 Proportion of Purified Water (or Distilled Water) and Sulfuric Acid in Electrolyte

Specific Gravity of Electrolyte at 0℃ (g/cm3)	Volume Ratio of Purified Water (or Distilled Water) and Sulfuric Acid	Weight Ratio of Purified Water (or Distilled Water) and Sulfuric Acid
1.10	9.80:1	6.28:1
1.11	8.80:1	5.84:1
1.12	8.00:1	5.40:1
1.13	7.28:1	4.40:1
1.14	6.68:1	3.98:1
1.15	6.15:1	3.63:1
1.16	5.70:1	3.35:1
1.17	5.30:1	3.11:1
1.18	4.95:1	2.90:1
1.19	4.63:1	2.52:1
1.20	4.33:1	2.36:1
1.21	4.07:1	2.22:1
1.22	3.84:1	2.09:1
1.23	3.60:1	1.97:1
1.24	3.40:1	1.86:1
1.25	3.22:1	1.76:1

Specific Gravity of Electrolyte at 0℃ (g/cm3)	Volume Ratio of Purified Water (or Distilled Water) and Sulfuric Acid	Weight Ratio of Purified Water (or Distilled Water) and Sulfuric Acid
1.26	3.05:1	1.60:1
1.27	2.80:1	1.57:1
1.28	2.75:1	1.49:1
1.29	2.60:1	1.41:1
1.30	2.47:1	1.34:1

Remark: This table is calculated based on a 1.83 specific gravity of pure sulfuric acid at 20℃.

(2) Fill fluid

① Exhaust bolt, make sure to penetrate the riser vent on the exhaust bolt, as there is gasket and sealing paper underneath it, to be removed after acid has been filled.

② Electrolyte must be cooled down to below 30℃ before filling.

③ Fluid level for plastic case battery aligns with "MAX" line, and that for electrolyte in rubber case is higher than partition board by 10~15mm.

④ Tighten vent plug to prevent fluid leak.

3. Charge a battery

(1) Charging device

DC power supply must be used to charge a battery. AC must be converted into DC before charging.

① Rectifier

Solid rectifiers such as cupric oxide rectifier, selen rectifier, and silicon rectifier, as well as gas filled valve rectifier (tungsten rectifier) and mercury rectifier are commonly used. Their input AC voltage is generally 110V or 220V, and the nominal voltage of output is 6V, 12V, and 24V. Solid rectifiers have been widely applied as they are easy to use and no service is needed during charging.

② Controllable silicon voltage regulating charger

As the number of batteries in serial is varied, voltage is to be changed during charging process to control the charging current. Therefore, it is required to use DC power source as its voltage can be regulated. Though silicon rectifier is comparatively light and easy to move, it still needs rather cumbersome voltage transformer. Controllable silicon voltage regulating charger can be adopted to overcome the above-mentioned shortage. One kind of 8kw controllable silicon voltage regulating transformer in the market uses a power supply of 220V AC, to be converted into DC through the controllable silicon rectifier, and charge the battery from its output end, with a 0~220V DC output voltage and a 0~40A current.

(2) Detecting Instrument

Densimeter, thermometer, voltmeter, and ammeter, as well as other testing instruments and necessary tools are generally required for battery charging and routine maintenance.

(3) Battery charging

① Preparation prior to charging

Check and measure if electrolyte or purified water complies with regulations. Remove vent plug on battery, and add fluid or replenish water to the maximum level line.

② Connection for charging

The charger positive is to be connected with battery positive, and negative to negative. Make sure not to connect them reversely. Charging connections must be secured.

③ Charging Mode

There are normally three kinds of charging types as constant current, constant voltage and quick charging..

Constant current charging: including initial charging, supplementary charging, general charging and equalizing charging.

▲ **Initial charging:** Initial charging is the first-time charging on a new non-dry load battery. After non-dry load battery has been filled with electrolyte, it is to be laid for 1~6 hours. Start charging when fluid temperature has cooled down to below 35℃. The current for initial charging is generally 0.07C20A, and when single frame voltage has charged to 2.4V, go on charging with half of the current.

▲ **Supplementary charging:** Supplementary charging is applied to the dry-load battery that has been stored for a long time with rather poor dry-load electrical performance, or the battery that has been laid for about one month after it was filled with acid and charged. The current for supplementary charging is 0.1C20A, and the time duration for supplementary charging is 5 hours or so, or the charging duration is to be determined based on the length of storage.

▲ **General charging**

General charging means the charging after the battery has been used after initial charging. 0.1C20A is applied for the 1st stage of general charging, it charges the battery for 8~12 hours until the voltage has risen to more than 2.4V/single frame, then go on chargingd for another 10 hours at halved current. The charging power rate is generally more than 1.5 times that of the discharging rate, or 1.3~1.5 times that of the rated charging capacity.

▲ **Equalizing charging**

It is to fully charge the battery with general charging method, and then to charge it with 0.035 C20A current. When battery emits uniform air bubble and temperature has risen, stop charging for one hour. Repeat it for 3~4 times the same way, so that each single battery can give out large amounts of air bubble. Finish charging when voltage of battery and density of electrolyte have tended to be stable.

▲ **Constant voltage charging:**

Constant voltage charging is to charge the battery with a constant voltage. At beginning the charging current is relatively larger, and then it is reduced gradually. The voltage for constant voltage charge generally remains during 2.3~2.4V. Very few evaporation occurs with such a method, and therefore, the constant voltaging charge is often applied to maintenance-free sealed lead-acid batteries.

▲ **Quick charging:**

Large current and impulse are applied for quick charging. It uses intermittent charging method with short period discharging to charge a battery. 1~2 times C20A large current is used for quick charging. Quick charging proceeds with tailor-made quick charger.

▲ **Signs of a fully charged battery**

Large amounts of air bubbles are generated in battery single frame. Battery individual voltage ranges during 2.6~2.8v, and the value can remain unchanged for more than two hours.

▲ **Notes to battery charging**

Fluid temperature shall not exceed 45℃, otherwise cooling measures should be taken (to reduce charging current or stop charging or cool down in water tank), for ventilation to be nice and fire source to be forbidden.

▲**Check and assess a faulty lead-acid battery**

Table 11-4 Specific Gravity Measurement

S.G. Value (25℃)	Assessment	Treatment
More than 1.300	Concentration of electrolyte is too high, incorrect fluid filling.	Use ion wate to adjust.r
1.250~1.280	Good	
1.250~1.220	Not fully charged	Supplementary charging
Lower than 1.220~1.100	Overdischarging, concentration is too low	Check after charging
More than 0.04 difference in specific gravity among frames	Certain single frame is faulty	Check after charging

Table 11-5 Voltage Measurement

Voltage	Assessment	Treatment
More than 12.5V	Normal	
12.5~11.5V	Not fully charged	Supplementary charging
Lower than 11.5V	Over dischargeing or internal failure	Check after charging

Table 11-6 Capacity Measurement

Display on Volume Meter	Assessment	Treatment
White Zone	Fully charged	
Green Zone	Normal	
Yellow Zone	Re-charging	Supplementary charging
Red Zone	Fully discharged	Check after supplementary charging

4. Common failures, cause analysis, and failure removal for lead battery

(1) Why does a full battery lose its power after being laid for long?

A full battery will lose its power after being shelf-stored for long. This is called “self-discharging” process. Battery material purity is the main cause of self-discharging. There are impurities in battery plates and electrolyte, they makes potential difference (PD) among impurities itselves or between impurities and plates. This could form a “partial current” loop that makes battery discharging.

As perfectly pure material will never be available, and battery plate/metal seperator also constitutes battery cell, slight self-discharging is inevitable. But use battery wrongly will accelerate self-discharging. When electrolyte iron content is over 1%, battery will be discharged completely overnight. Electrolyte splashes on battery cover will also trigger self-discharging once they connect battery terminals. Longer shelf-stored battery will let acid sink to bottom, creating PD between plate top and bottom that makes battery self-discharging.

To correct a seriously self-discharged battery, one can let it discharge completely. That is to encourage impurities to enter electrolyte. Then remove electrolyte, wash battery with distilled water. After being filled with new electrolyte and recharged, the battery can work again.

(2) What is sulfuration of battery? And what is the cause?

Battery sulfurization refers to coarse crystals (lead sulphate) layer on battery plate. These coarse crystals block seriously cavities on plate to reduce battery capacity. Crystals have very low conductivity, they increases

battery internal resistance, making battery unable to provide enough current to starter to crank engine. Besides, crystals cannot dissolve in electrolyte even in normal recharging process. Serious sulfurization kills a battery.

The main causes of sulfurization lay to: A.repeated short recharging for longer time and longer battery shelf-storing time after being discharged. In these two cases, lead sulphate will re-crystalized due to temperature change. B. Battery level is too low, larger plate area is exposed to air to make oxidization happening (especially for negative plate); C. during vehicle's driving, electrolyte contacts oxidized section on plate, creating hard layer of lead sulphate that sulfurizes upper part of the plate. Besides, much higher electrolyte gravity, impure electrolyte and abrupt temperature change are also the causes.

To cure these, one should always keep battery full; recharge drained battery within 24 hours; keep proper fluid gravity and level. Slightly sulfurized battery can be recharged with over-charging method, and serious one with de-sulfurizing charging method.

(3) What will happen after battery plate has sulfurized?

There are several abnormal symptoms such as: single cell end voltage drops sharply (testing with high sensitive discharger); early "boiling" during recharging while electrolyte gravity increases slowly (even no change); electrolyte temperature increases sharply.

(4) How to prevent plate from sulfuration ?

① Do not lay a half –discharged battery too long, and keep battery full all the time.

② Maintain fluid level is 10-15mm above plate, add distilled water if necessary

③ Do not over discharge a battery.

(5) How to fix a sulfurated battery?

① Prolonged recharging with low current can cure slightly sulfurized plate. That is to recharge continuously by second stage current after first recharging till bubbles are seen in electrolyte and electrolyte gravity reaches around 1.280.

② Seriously sulfurized plate can be cured by "water treatment". When a battery's discharge capacity reaches 80% of its rated capacity, the treatment is basically done. Otherwise repeat above process till battery restores its performance.

(6) Why are there short-circuit happening inside battery? How to fix it?

①Inferior or or defected separator plate. They let battery paste (active media) penetrate the plate to connect two (+ -) poles.

②There are heavy sheddings on the bottom. It conducts plate lower edge to make short circuit.

③Higher charging or discharging current makes plate warped, or conductive objects drop into battery to make short circuit.

Open battery to check once there is short circuit inside. Change plate if it is defect or has cavities; remove battery paste sediments; and press warped plate into flat.

(7) What is it like when plate short circuit happens?

The main symptom is: low voltage in open loop with small capacity. Single cell end voltage drops to zero quickly by testing with high sensitive discharger. And end voltage and electrolyte gravity raise very slow during charging process. There are few or even no bubbles at later charging stage.

(8) Why does battery plate become warped?

The main symptom is: low voltage in open loop with small capacity. Single frame end voltage drops to zero quickly by testing with high sensitive discharger. And end voltage and electrolyte gravity raise very slow during charging process. There are few or even no bubbles at later charging stage.

①Poor quality. At the time a battery is made, the manufacturer did not Lead-galvanize plate evenly, paste grown on plate also distributes unevenly. Therefore, chemical reactions happen on plate vary on each section, and

plate expensing and shrinking rate also differ. All these make plate warped or even cracking.

②Frequent high voltage discharging; different current density on each section of plate; and paste's different expansion rate make plate warped.

③Excessive discharging makes lead sulphate growing in the depth of plate, recharging cannot help to restore. The internal expansion occurred also makes plate warped.

(9) Why are there so much plate shadding?

Shadding happens mainly on positive plate. Paste's size keeps changing during charging and discharging. It is normal and inevitable to see they peel off from plate. But use battery wrongly will accelerate this process, these wrong doings include:

① Higher recharging voltage increases electrolyte temperature; paste expands and softens to peel off.

② Over charge battery frequently. Great amount of air escapes from plate cavities to form pressure to press paste to peel off.

③ Higher discharging current, prolonged connection to starter and warped plate also accelerate paste to peel off.

④ Unable to charge battery timely in winter, electrolyte gravity becomes low and electrolyte freezes.

⑤ Battery has subjected to strong shock while vehicle is driving.

(10) What is the cause of polar reverse in a centain frame?

The causes: the capacity of this frame reduces due to fault or other reasons. While discharge is in progress, low capacity cell discharges to zero first, discharge current from other cells will come to charge this cell. This will reverse this frame's poles (+ ←→ −). In a battery with 3 frames, if one of them reverses its pole, battery's end voltage value will be 2V rather than 6V (tested with voltmeter).

To prevent this from happening, one should maintain battery carefully, and keep watching closely all the time to notice faults early. For any low capacity charge or discharge separately any frame of low capacity or replace frame plate until its capacity approaches or equal to other normal cell's capacity.

(11) Why will battery blow up?

Battery blow-up mainly happens when a battery is over-charged, during which water in electrolyte decomposes into hydrogen and oxygen with great amount of bubbles. Other causes include: internal short-circuit, extrem sulfurization. When a battery is being recharged, electrolyte temperature will increase sharply, the process evaporates humidity in great amount. In the case battery fluid filler hole is restricted to block excessive gas to escape, battery will blow up when internal pressure reaches to centain level (or ignited by spark). Precautions include:

① Always keep vent hole on filler cover cleared;

② Keep connections on terminals tighten to avoid spark;

③ Open filler cover first when tested with high sensitive discharger;

④ Do not charge battery excessively to reduce gas production. There should be no lighted fire around charging chamber and be sure to keep good ventilation.

(12) Why will battery fluid level lower quickly?

Water evaporation and electrolysis process during recharging can lower the fluid level. One should check fluid level every 5-6 days in summer and 10-15 days in winter. If fluid level lowers too quickly, the cause may be higher charging current, one should adjust charging system.

(13) What is the cause to make fluid level in a frame lowering quickly?

Cracked case or damaged sealing may be the causes. In the event case and seal are all well, the cause may lay to short circuit or sulfulrization in this cell. While there is short circuit or sulfurization happening, temperature will go up quickly during recharging. This process overheats electrolyte to prompt water evaporation. When a

plate has sulfurized, the early “boiling” during recharging will also lower fluid level.

(14) What should be added when fluid level lewers, distilled water or electrolyte?

Add distilled water when fluid level lowers. It is water evaporation and water electrolysis (happened when discharging is almost finished) that lowers the level. Add electrolyte will increase fluid gravity, shortening battery’s life span. In the case broken battery case makes fluid leaking, one should repair the case before adding formulated electrolyte.

(15) How to test battery’s remaining capacity?

There are two methods in general:

①Test eletrolyte gravity with hydrometer, as gravity in charged battery increases and reduces in discharged battery. Gravity will help to judge how much power remained in a battery. Experience tells that 6% discharing rate equals to every 0.01g/cm gravity reduction. When a full battery’s gravity is known, one can caculate roughly discharging rate according to electrolyte gravity measured. For example, a full battery’s gravity is 1.28, measured value is 1.20, and therefore 48% of battery’s capacity has been discharged.

② Use a high-rate discharger to measure voltage of single-frame.

High-rate discharger is also called discharge tongs that is composed of one 3V DC voltmeter and one load resistor, as indicated in Figure 11-1.

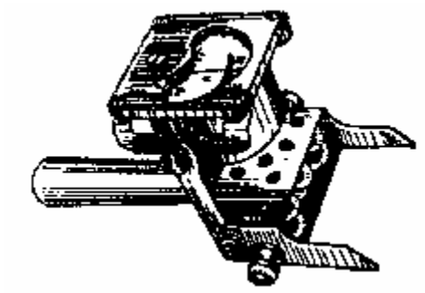


Figure 11-1 High-rate Discharger

During measurement, Press firmly tong tips on (+,－)posts of measured cell for 5 seconds, read battery end voltage value under heavy load discharging process. This will help to decide correctly the discharging rate and starting capacity.

There are different dischargers supplied by different manufacturers, one should measure and read current/voltage values according to discharger manual. A good battery’s single cell voltage should be over 5V, and the value keeps stable during 5 seconds. If in a certain cell, voltage drops quickly in 5 seconds or its read is over 0.1V lower than that of other celles, this cell is failure and should be repaired.

(16) When to formulate electrolyte, why can only pour sulphate acid into water, not the other way round?

Blending sulphate acid with water will creat great amount of heat. Water’s specific heat is quite different from that of sulphate acid, it is 1C/g/℃while concentrate sulphate acid specific heat is 0.33C/g/℃. Pouring water into concentrate sulphate acid will produce drastic sectional heating and even explosive splashes. But this will not happen when one pours acid into water because water has higher specific heat. This way is much safer.

(17) How to use and maintain a battery in the winter?

In order to keep battary in good condition to prolong its service life, follwing rules should be observed:

①Always keep battery full to aviod freezing due to low electrolyte gravity. Ice would make case broken, plate warped and sheddings.

Table 11-7 Discharging / Specific Gravity /

Temperature at Freezing Point of Battery

Discharging Degree	Fully Charged		25%		50%		75%		100%	
S.G and Freezing Point of Electrolyte	S.G. 15℃	Freezing Point 0℃	S.G 15℃	Freezing Point 0℃	S.G. 15℃	Freezing Point 0℃	S.G. 15℃	Freezing Point 0℃	S.G. 15℃	Freezing Point 0℃
	1.310	−76	1.270	−58	1.230	−36	1.190	−22	1.150	−14
	1.290	−70	1.250	−50	1.210	−28	1.170	−18	1.13.0	−10
	1.280	−69	1.240	−42	1.200	−25	1.160	−16	1.12.	−9
	1.270	−58	1.230	−36	1.190	−22	1.150	−14	1.110	−8
	1.250	−50	1.210	−28	1.170	−18	1.130	−10	1.09	−6
	1.240	−42	1.20	−25	1.160	−16	1.120	−9	1.08	−5

② In winter, it is suggested to add electrolyte with gravity of 1.40 as per chart 11-3 for adjustment..

③ In winter, adding distilled water only at the moment when engine is running (engine is recharging battery) to avoid icing due to uneven mixing water with electrolyte.

④ In winter a battery's capacity decreases. Cranking a cold engine at this time should give it enough time to preheat. When it is hard to start the engine, do not activate starter more than 15 seconds each time, and there should be 2-3 minutes interval between two consecutive crankings. If engine still cannot startup after three attempts, one should turn to check engine for fault before next try.

(18) Why are there yellow or white pastes on battery cover? How to get rid of it?

Pastes on battery cover and around terminals are the results that sulphrate splashes corrode posts, cable clamp and bracket. White paste is mainly of lead sulphrate, and yellow one is of iron sulphrate. These two types of pastes have very high electrical resistance, they forms very high contact resistance if they are present at connectors. To get rid of them, one can use rag soaked with 10% soda solution to clean electrolyte splashes on battery cover and case, then clean with water and dry them up with clean cloth. Also clean battery terminals and cables with soda solution. If there are low conductive oxidants, one can use knife to scrape them away. It is better to apply vasiline or grease on fastened terminals and cable clamps.

(19) How to cure iced battery?

Frozen battery are mainly caused by:

① Factory battery has very low electrolyte gravity, it freezes when it is used in cold climate;

② Battery has not been recharged timely after being used. Its electrolyte gravity becomes low;

③ Distilled water added has not mixed evenly with electrolyte. Upper and lower part of fluid in battery has different gravity. (Start up and run engine for some time can help to mix them evenly).

Remove a frozen battery to warm room to let it melt slowly, recharge it slowly with low current. One should keep watching each cell's voltage and electrolyte temperature. Electrolyte gravity in a charged battery should reach rated value. Otherwise one should use distlled water or sulphrate (gravity: 1.400) to make adjustment. Replace new plate to fix a seriously frozen battery.

Battery typical defect analysis and liabilities

Table 11-8 △ Liabilities of battery supplier ● Liabilities of vehicle user and dealer

Defect	Defect Analysis	Symptoms	Defect Treatment	Liability
Insufficient Charging	1. Vehicle voltage regulator's setting is low 2. Vehicle power consumption is higher than charged capacity 3. Frequent start-up, short driving distance 4. Alternator failure or circuit faults 5. Terminals or cable corrosion	1. Voltage is around 12V 1. Electrolyte gravity is lower than 1.220 2. Hard to start-up 3. To check with capacity analyzer (yellow or red area)	1.Adjust regulator 2. Recharge battery 3. Customer replaces new battery	●
Overchargeing	1.Vehicle voltage regulator's setting is higher 2. Prolonged charging 3. Prolonged and longer distance driving 4. Higher recharge voltage	1. Battery sump or vent plug turn black or yellow 2. Separator plate carbonated 3.Positive post is corroded, broken, floated 4.Wet acid on sump surface 5.Electrolyte level always lowers or fluid turns muddy 6.Plate shedding falls evenly	1. Adjust charger 2. Customre replaces new battery	●
Over Discharging	1. Use short-charged battery 2. Electrical device short circuit 3. Electrical device is kept on	1. Voltage is below 10V 2. Specific gravity of electrolyte is below 1.100 3. Low specific gravity after supplementary charging	1. Adjust charger 2. Supplementary charging 3. Customre replace a new battery	●
Short Circuit	1. Weld lead enters when a battery is assembled. 2. Plate is warped to short circuit 3. Separator is missed or broken during assembling	1. Voltage is around 10V 2. First frame gravity is the lowest among the six. 3. Tested voltage drops to lower than 8V, with "boiling" symptom in faulty frame. 3. After supplementary charging, faulty frame's gravity is still lower with less gas generation	Manufacturer replaces new battery for customer	△

Defect	Defect Analysis	Symptoms	Defect Treatment	Liability
	4. Brown or white shedding, higher charging current; over-charging; over discharging; impure electrolyte	4. Large self discharging	Customer replaces new battery	●
Open Circuit	1. Poor welding at battery assembling — terminals and plates 2. Outside short circuit 3. High current discharging	1.Voltage's extremely unstable 2.Terminal melted 3.Voltage is less than 0V at discharging, faulty frame cell smokes 4.Unable to input current at recharging, battery smokes or its fluid level goes up	Customer replaces new battery or manufacturer repairs	△ ●
Incorrect fluid adding	1. Too high or too low specific gravity at initial fluid filling 2. Fluid level drops, or wrong fluid adding (impure water)	While gravity is higher: 1. Gravity after adding≥ 300 While gravity is lower after separator is carbonated: 2. Gravity after adding ≤ 1.200 3..Separator plate color is light 4.Lower battery capacity, fluid is muddy or with abnormal color due to impure fluid	Change electrolyte, customer replaces new battery if it is seriously failure.	●
Plate Sulphation	1. Insufficient initial charge 2. Longer shelf-storing time 3. Under charged for long 4. High specific gravity of electrolyte 5. Fluid level drops, upper plate is exposed to air 6. Impure electrolyte	1.Capacity reduced during normal dischaging process 2.Gravity is lower than normal value 3.Voltage drops quickly at discharing 4.Bubble production at charing 5. PbS04 coarse crystals	1.Use over-charging method 2.Charging repeatedly 3.Water treatment method 4.Customer replaces new battery	●
Excessive Shedding	1. Brown sediment due to too large charging current 2. White sediment due to over-discharging	1. Sediments are found in fluid, brown materials goes up from bottom 2. Battery capacity	1. For plastic case battery, repalce plates and remove	●

Defect	Defect Analysis	Symptoms	Defect Treatment	Liability
	3. Impurities presence inside battery 4. Paste shedding due to prolonged higher gravity and temperature 5. Larger shedding due to poor plate quality	reduced	sediments 2.Charge with low current, adjust fluid concentration and level at later stage 3. Customer replace new battery 4.Mmanufacturer replaces new battery to customer	
Cross-frame electrolyte leakage	1. Battery separator is perforated during manufacturing 2. Poor thermal sealing	1. Lower voltage 2.Fluid gravities among crossed frames are similar, separator is light in color 3.Fluid among frames flow to each other when battery is turned down	Manufacturer replaces new battery to customer	△
	3. Impact of outside force	4. Test cross-flowing fluid (with analyzer) will creat gassing, fluid is muddy	Customer replace a new battery	●
Reversed Polarity during assembly	1. Reversed polarity during assembly 2. Reversed polarity during battery cover mounting	1. 8V for one reversed frame, and 4V for two reversed frames 2. 12V for reversed cover	Manufacturer replaces new battery to customer	△
Polarity reversal at charging	Wrong connection of positve and negative terminals during charging	1. Negative voltage value 2. Electrolyte specific gravity is lower than 1.200 3. Colors of +/- plates are reversed	Customer reversed charging or manufacutuer replace new battery for costomer.	△
Fluid Leak	1.Poor battery cover thermal sealing. 2. Poor connection between terminals and cover	1. Leakage—filler hole 2. Leakage at case and cover junction 3.Tilt battery over 60, fluid flows out	Manufacturer replaces new battery to customer	△
	3. Fluid leak dut to impact	4. Impact damage on case	Customer replace a new battery	●

Defect	Defect Analysis	Symptoms	Defect Treatment	Liability
Abrupt cracking of Battery	1. Bad welding or in short circuit	1. Check welding quality or short circuit	Manufacturer to make a replacement	△
	2.Vent plug is restricted	2. Vent plug failure due to obstruction	Manufacturer assists to repair or customer replaces new battery	●
	3. Bad contact in terminal	3. Terminal is melted and damaged		●
	4. Spark presence during charging or operating	4. Case broken, crack goes from up all the way down		●
	5. External terminal is in short circuit	5. Check terminals for possible poor contact	Customer replaces new battery	●
	6. Circuit failure			

5. Battery quality assessment procedure

Battery

White Zone	Fully Charged		
Green Zone	Normal		
Yellow Zone	Insufficient Charged	Supplementary Charging	Liability of User
Red Zone	No Power	Charging Inspection	Liability of User

＞1.30	Faulty fluid filling	Specific gravity to be adjusted	
1.250-1.280	Normal		
1.220-1.100 以下	Over discharged or failure	Charging Inspection	Liability of User
Single-frame S.G. Difference ＞0.04	There may be failure in battery.	Charging Inspection	

Above 12.5V	Normal	For direct use	
12.5-11.5V	Insufficient Charge	Supplementary Charge	Liability of User
＜11.5	There may be failure	Charging Inspection	Liability of User

	Fault Diagnosis	Effect	Treatment
Insufficient Charging	1. Low set value of regulator	1. Voltage below 12V	1. Charger to be adjusted
	2. Vehicle power consumption is larger than charging amount	2. Specific gravity of electrolyte below 1.220	2. Supplementary charging
	3. Frquent starting and short driving distance	3. Difficult to be started, weak lighting	3. Replace a new one for customer
	4. Insufficient power generation or circuit short	4. Capacity tester displayed in yellow or red	
	5. Plate or connection corroded		
Over Charging	1. High set value of regulator	1. Cell or vent plug turns black and yellow	Charger to be adjusted
	2. Long time charging	2. Carbonized battery separator	
	3. Long time long distance driving	3. Positive corrosion, crack and floating	
	4. Too large current during charging	4. Wet acid on cell surface	
		5. Liquid level frequently dropped and contaminated	
		6. Plate shadding unevenly	
Over Discharging	1. Continue to use undercharged battery	1. Voltage is below 10V	1. Charger to be adjusted
	2. Vehicle electric circuit in short circuit	2. S.G of electrolyte is below 1.100	2. Supplementary charging
	3. Electrical devices used by vehicle have not turned off	3. Low S. G. after supplementary charging	

	Cause Analysis	Liability
Battery is damaged	1. Battery is damaged	Damaged during delivery or during use
	2.Battery in bad conditon or rubber case is distorted	Liability of manufacturer
	3. Improper installation (fitting is loose)	Liability of user
Battery is blown up or damanged	1. Terminal joint loose or in bad contact	Liability of user
	2. Spark presence during charging	Liability of user
	3. External short circuit	Liability of user
	4. Vent hole has blocked or perforated	Liability of user
Battery Distortion	1. Over charging	Liability of user
	2. Too large current for charging	Liability of user
	3. Vent hole is blocked	Liability of user
Terminal is melted and damaged	1. External short circuit	Liability of user
	2. Bad connection wire	Liability of user
	3. Bad welding	Liability of manufacturer

11.4.2 Starter

Main Technical Parameters of Starter (BJ491EQ1 Gasoline Engine)

S/N	Items	Parameters
1	Model	QDY1253 Permanent-Magnet Reduction Starter
2	Graound polarity	Negative
3	Rated Voltage (V)	12
4	Rated Power (KW)	1.4
5	Rotating Direction (Viewing from the driving terminal)	Clockwise
6	Gear Ratio	Pinion 9 Teeth and Gear 108 Teeth

1. Structure Overview

This starter is an enclosed-type DC motor in 4-pole series excitation with instantaneous rated working brush. Starting is electromagnetically controlled, and roller-type isolator is adopted for torque transfer for mechanical driving. After the motor has started, it would prevent gears of starter from being damaged at their high-speed rotation along with flywheel, as the one way clutch would not transfer torque at the moment.

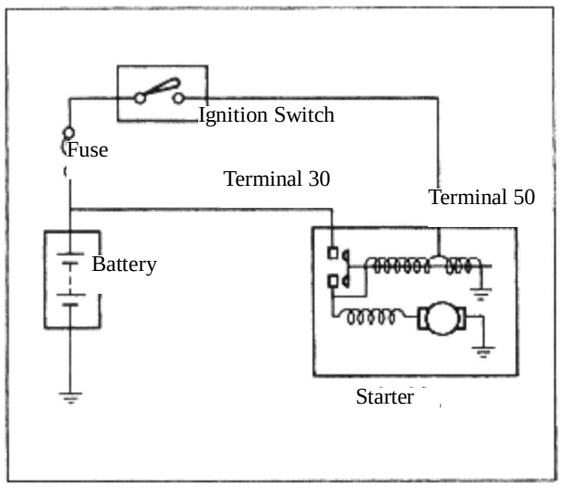


Fig 11-2 Gasoline Engine Starting System

2. Notes to starter application

(1) Before starter is activated, check if engine can work normally. And check if starter and and its connection are correctly installed, if lead contact is in good condition, and if power level of battery is sufficient.

(2) Engine cranking shall not exceed 15 seconds each time 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.

(3) After engine has been started, release ignition key immediately, so that the gear of starter can be detached. It is called low-temperature starting when starter is activated under the environment of temperature below -5℃.

3. Starter Faults and troubleshooting

(1) Starter fails to rotate, see table 11-9.

Table 11-9 Starter Fails to Rotate

Causes	Solutions
1. Battery is under charged	1. Battery to be charged or replaced after check
2. No power at starter connector (wire to starter has disconnected , poor contact at magnetic switch or terminals)	2. (Test light or voltmeter) test and repair circuit, replace battery and clean contacting points if necessary
3. Poor brush contact	3. Clean brush bracket, replace brush spring or brush
4. Starter itself in short circuit or open circuit	4. Repair after checking

(2) Starter can not start up the engine , see table 11-10

Starter runs but is unable to start up engine

Table 11-10 Starter can not start up the engine

Causes	Solutions
Battery undercharged; short battery fluid or wrong electrolyte gravity	1. Check battery, add right electrolyte; charge battery fullly and adjust fluid gravity
Poor contact between brush and cummutator	1、Repair or replace brush, brush box or spring
Armature coil in short circuit	2、Repair or replace armature
Dewelded between armature coil and reverser	3、Weld at dewelded spots
Loosened connector or oxidized damages	4、Fasten nut and remove oxidants
Burnt electro-magnetic switch contacts	5、Grind contacts with sand paper for better contacting
Excessive shaft bush wear, worn armature	6、Replace new shaft bush
One-way clutch is skipping	7、Repair or replace one-way clutch
High engine oil resistance in winter	8、Preheat engine at cranking, use winter oil

(3) Starter gear fails to disengage, see table 11-11.

Starter keeps running after engine has been started. Starter gear does not disengage

Table 11-11 Starter gear fails to disengage

Causes	Solutions
Electro-magnetic switch contactsh has melted together	1. Repair switch contacts, grind burnt spots with file or sand paper
Gasket lost between switch and drive cover, core's travel becomes short	2. Add gasket, adjust clearance between gear and thust ring to 0.2-4mm (switch is closed).

(4) Repair a starter

① Check and repair of carbon brush. Use wire hook to lift brush spring, and remove brush from bracket. Brush wear should not exceed 1/3 of a new brush (14mm). Otherwise replace it with new brush of same specification. Mating area between brush and reverser should be larger than 75%, otherwise glaze the brush. Brush wiring should be secured, and brush isolated (test with 220V test light).

②Check magnetizing coil connectors for any loosening or dewelded, followed with short circuit and cut-off checks. Check can be performed with 220V AC test light.

③ Check and repair of armature. Armature shaft jurnal and bush should be snug. One can use 00 rated sand paper to grind burnt surface on armature. If its out-of-round exceeds 0.05mm, armature should be put into machining. Do not deep cut mica between bronze plates to avoid brush powder from triggering reverser to short circuit. Bronze plates should be welded firmly

11.4.3 Alternator (matched with BJ491EQ1 alternator)

1. Main Specifications and Technical Parameters

S/N	Description	Parameters	
1	Model	JFZ1977	JF1615
2	Rated Output	14V 90A	14V 65A
3	Rated Rpm	6000r/min	6000r/min
4	Operating Rpm (Continuous)	1000~18000r/min	1000~18000r/min

S/N	Description	Parameters	
5	Overspeed Test	22000r/min 30S	22000r/min 30S
6	Rpm at Zero Current	≤1000r/min	≤1000r/min
7	Regulator Adjusting Voltage	14.1±0.2V	
8	Regulator Temperature Compensation Coefficient	-7±3mV/℃	
9	Weight of Alternator (kg)	6	5.1

JFZ1977 and JF615 automobile AD alternators are synchronous Lundell and silicon rectifying alternators with built-in electronic regulator. The alternator is provided with a continuous rated operating system with negative grounding. Alternator rotates clockwise when viewing from the driving terminal. The alternator is installed in an angle, hanged on two points. The surrounding media temperature is ranging between -40~+100℃, and the monthly average relative humidity is not higher than 90%.

2. Charging System Circuit

The circuit of charging system for gasoline engine is indicated in Figure 11-3.

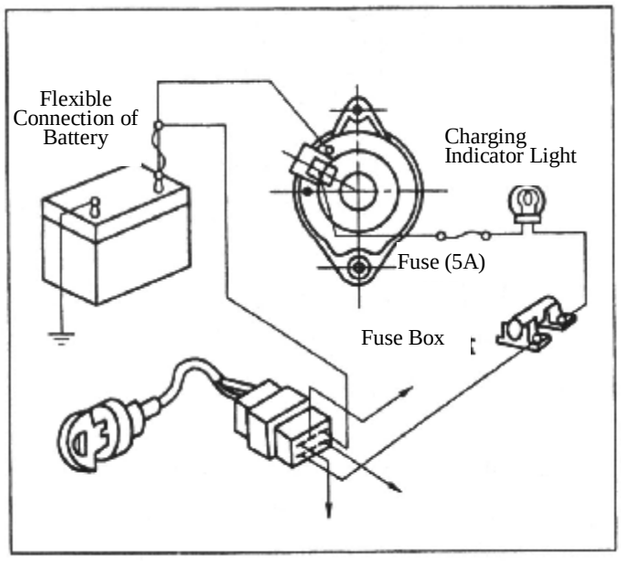


Fig 11-3 Charging System Circuit of Gasoline Engine

3. Notes to use an AD alternator

(1) Grounding polarity of alternator must be consistent to that of battery, namely negative. If mistaken connection occurs, the battery will discharge through silicon diode to burn out diode.

(2) After alternator has started running, it is not allowed to check alternator output with spark test method as the silicon diode may get damaged. Do this with bulb or multimeter.

(3) When alternator is turned off, disconnect the ignition switch. Otherwise battery will be grounded through magnetic field coil of rotor and voltage regulator, keeping discharging till gets drained.

(4) Operator should eliminate immediately the faulties such as non-power generation or very low current. In this case, alternator is not allowed perform long time opeartion, or other parts may get damaged.

4. Maintenance, Check, and Repair of Alternator

Frequently check the fixing nuts of alternator, tighten them if there is any loosening. It is not allowed to

check alternator output with live wire and magnetic field shorting methods. Alternator diode and insulation cannot be checked with megohmmeter and 220V AC current, otherwise diode may get burnt. While the alternator has not been dismantled, operator can use a multimeter to measure resistance values between alternator posts to primarily judge if there is any faulty in an alternator. Current collector, brush, and brush spring should be checked once every half year. All faulty should be eliminated timely.

(1) Check and replace diode

Disconnect diode from rotor winding to check resistance between diode's two poles with a multimeter (R x 1) as indicated in figure 11-4. Diode is in short circuit if no resistance has been measured on both terminals; and diode is in open circuit if infinite resistance has been measured

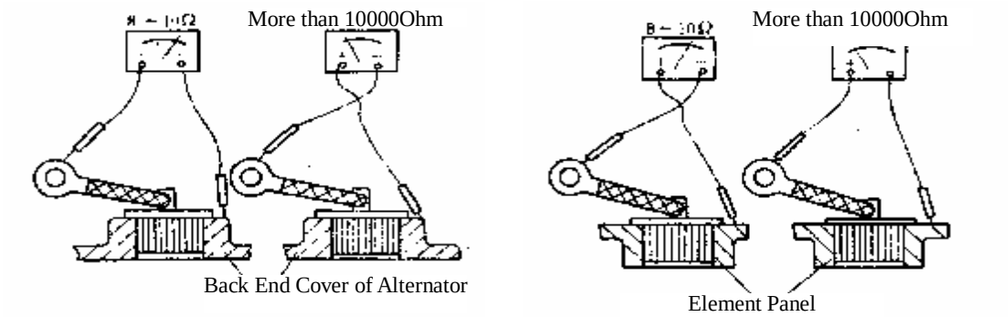


Fig 11-4 Check Silicon Diode with Multimeter

Replace diode when internal open circuit or short circuit occurs on it. Followings are notes when to replace a diode:

① Replace a new diode with same specificaiton.

② Be careful to mount negative tube (black) to end cover; positive red tube is to be mounted on element panel.

③ Do not knock diode during replacing. Use special tools to press diode in place. Diode tube and hole must be tightly matched. Precisely mount two diodes with an interference within the range of 0.07~0.09.

(2) Check and repair a rotor

Check and repair excitation winding. Open circuit and short circuit of excitation winding can be checked with a multimeter (R x1). Touching the two ends with test probe as indicated in figure 11-5. The measured resistance should comply with specification in table 18-14. If resistance is smaller than regulated value, it indicates that there is turn-to-turn fault with excitation winding; if resistance is infinitely great, it means that the excitation winding has been in open circuit.

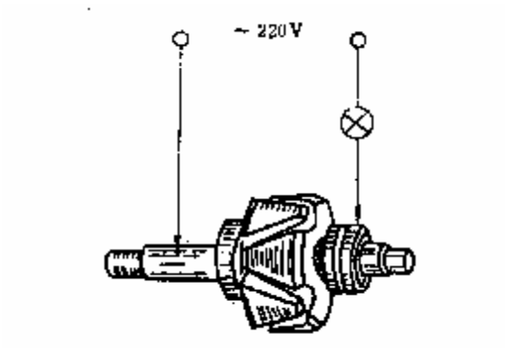


Figure 11-5 Check Excitation Winding

Open circuit of excitation winding generally occurs in the connecting part of winding lead and slip ring, which can be corrected by re-welding. Rotor must be dismantled for re-coiling if turn-to-turn fault of grounding is due to burnout of excitation winding.

The surface of rotor slip ring should keep clean, flat, and smooth, without any obvious burnout or uneven wear. Slight burnout can be polished with fine sandcloth, and it is allowed to have slight surface damage. After repair, the error on roundness of slip ring should not be larger than 0.25mm, the surface coarseness should not be higher than Ra1.6μm, and the thickness of copper collar on slip ring should not be smaller than 1.50mm. Otherwise, the slip ring should be replaced.

(1) Check and repair stator winding. Open circuit can be checked with a multimeter (R x 1), use multimeer probes to touch three outlet stubs respectively as indicated in figure 11-6. It is normal if pointer stays below 1Ω. But there must be an open circuit if the pointer remains still.

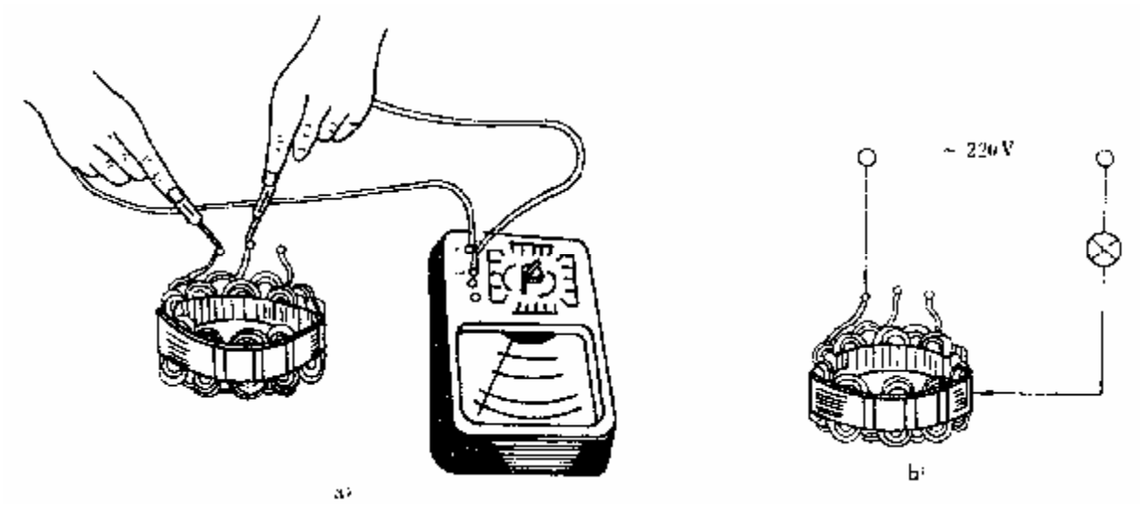


Figure 11-6 Check Stator Winding

For grounding check, touch the two test probes of multimeter with leads of winding and iron core of stator respectively. The measured resistance shall be infinitely great, or it indicates that stator winding has grounded.

If open circuit or grounding in stator winding is found, the neutral point of the three-way winding should be sealed off to further locate the failure point.

When the turn-to-turn (inter-phase short circuit) happens that could burnout coil, or when there is severe grounding that could not be corrected, the original winding shall be disassembled for re-coiling.

(2) Check and repair carbon brush. Carbon brush should move freely inside of the brush yok free from obstruction. Replace severe worn-out brush. Carbon brush yoke should be free from damage and distortion. Spring pressure should be between 1.5~2.0N.

11.4.4 Lighting System

1. Refer to the connection diagram for connection of electrical devices for the whole vehicle. The connection of lighting system see figure 11-1

2. Lights

(1) Refer to table 11-12 for types of lights and the bulbs.

Table 11-12 Lights List

S/N	Description	Spec (W)	Bulbs number
1	Headlight	55/60	2
2	Front	21	4
3	Corner Light	5	4
4	Front Fog Light	55	2
5	Rear	21	2
6	Backup Light	21/5	2
7	Rear Fog Light	21	2
8	Brake Light and Tail Light	21/5	2
9	License Light	5	2
10	Dome Light	5	1

All the lights should be complete, effective, and reliable during vehicle operation. The light form and brightness of front headlight shall comply with vehicle checking and measuring regulations.

3. Vehicle signals

① Headlight relay

Lighting relay is a mini- electromagnetic relay, fitted on the fuse box. When combination switch lever is on the headlight position, relay for headlight is connected to control the change of high and low beams. High beam is displayed on instrument panel with a blue indicatort.

② Flash relay and directional indication:

When control lever is on the corresponding directional position, the power supply for flash relay is switched on, the will flash. At the same time the directional indicator on instrument panel should also be turned on.

When the bulb of is broken, a bulb of same specification shall be replaced, otherwise the speed of lighting flash will be inconsistent. If turing light refuses to flash, operator should check if flash relay is loosened, and then short-test flash relay. If turns on now, it indicates that the flash relay is broken, use a flash relay of the same specification to replace.

4. Faults in Lighting System and troubleshooting

① Fuse is burned out immediately once the light switch is turned on. This indicates a short circuit between fuse and light.

② All lights keep off when light switch is turned on: no connection with power supply; the light fuse is broken.

③ Failure corner lights:

Bulb filament is burn out; there is open circuit in the line; bad grounding or bad contacts.

④ Failure headlight: open circuit between light switch and beam selector, or failure beam selector; Coil of lighting relay curcuit is open; fuses of left and right headlights are broken; and bulb filament is burned out.

⑤ Failure backup/brake light: switchs for backup / brake lights are damaged; bulb filament is burned out; or there is bad contact or open circuit in the line.

3. Control Mechanism

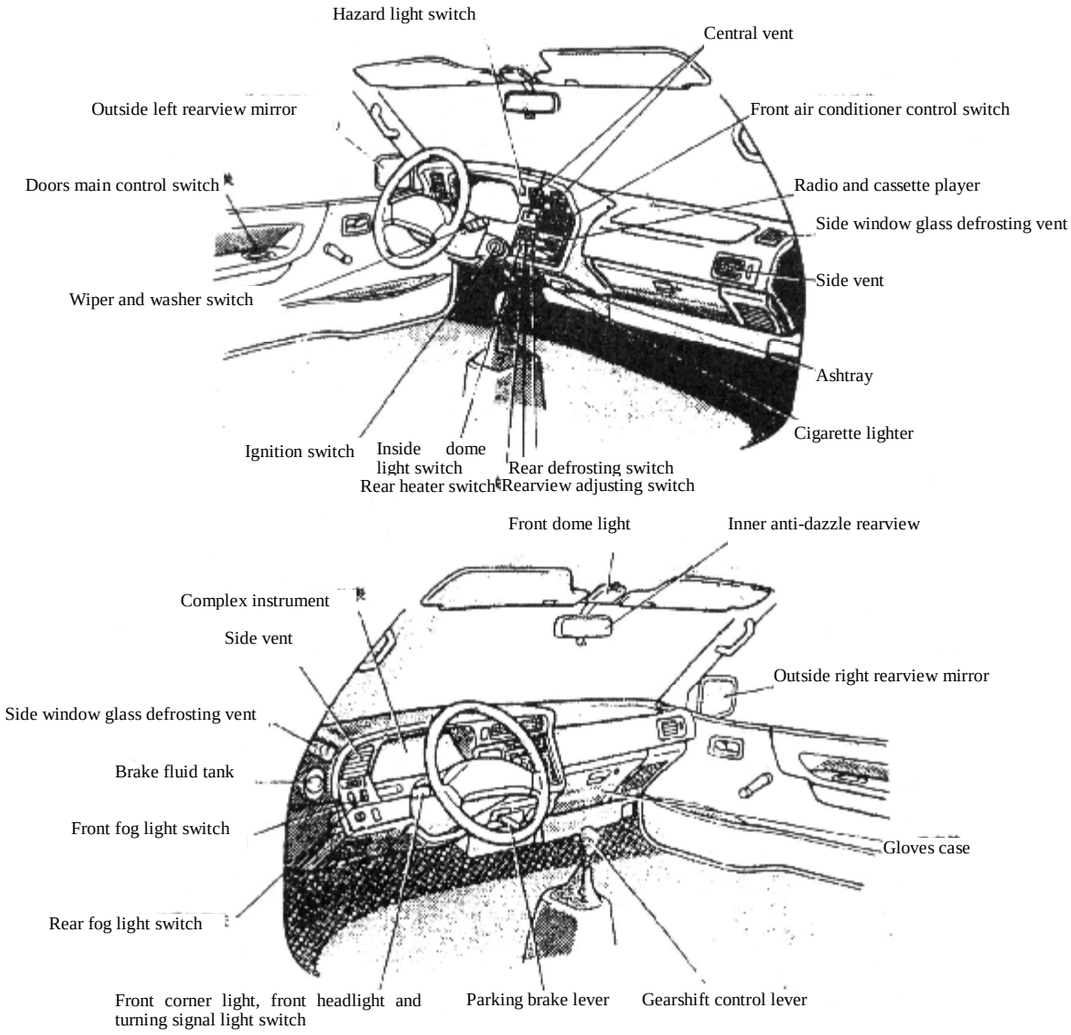


Fig 11-7 Complex instrument and Control Switch

Note:

Do not turn steering wheel when the vehicle is parking, and don't move the vehicle when steering wheel is locked. These would damage steering wheel.

(1) Switches used by BJ6536 series of light buses are listed in table 11-13.

Table 11-13 Switch List

Switch	Qty per Vehicle	Remarks
Ignition Switch	1	
Combination Switch	1	Including light switch, switch, front headlight beam selecting switch, PASS light switch, windshield wiper switch, and windshield washer switch
Rear Fog Light Switch	1	

Switch	Qty per Vehicle	Remarks
Front Fog Light Switch	1	
Hazard Switch	1	
Dome light switch	1	
A/C Switch	1	

▲Headlight Switch

Release this switch each time when this switch is lifted and the lighting switch is on "OFF" or 1st shift position, the high beam of headlight will turn on or turn out. To send the overtaking signal, repeat the operation crank, and thus the light will flash during daytime, while during nighttime the high beam and low beam will alternatively turn on.

▲ Switch

When the lever of this combination switch is turned to the intended direction, the will flash, and at the same time, the indicator on instrument panel will also flash. When steering wheel is returned to the middle position, the switch lever will automatically resume to neutral position.

▲Light Control Switch

This switch is divided into two shifts to control following lights: 1st Shift: corner light, tail light, license light, instrument panel illumination, low beam; 2nd Shift: High beam

▲Front Headlight Beam Selector

When switch lever is pulled up and down, the beam of front headlight will be alternatively switched from high beam to low beam or from low beam to high beam. When front headlight is on high beam, the high-beam indicator instrument panel will turn on.

(3) Other Switches

① Hazard Switch: When switch is pressed, front, rear, left, and right 4 s will all turn on.

② Steering gear linked lockpin: as long as ignition key is in the switch, the lockpin will not lock up the steering gear. During driving process, the key can only be turned to "ON" position. Only when vehicle has stopped driving, the key will return to "LOCK" position to be removed. At the same time, as linked lockpin can lock the directional mechanism, it also can be used for theft –proof purpose.

③ Horn Button: The button is mounted in steering wheel center. Its sound lasts less than 2 seconds each time.

④ Auto returning mechanism: Control lever for will return to middle shift from either "left" or "right" postion along with steering wheel's returning to center pistion. A return cam makes this possible.

(4) Ignition Switch

① Ignition switch performance is indicated in table 11-14.

Table 11-14 Ignition switch performance

	General Power Supply	Preheating	Receiving Player	Start	Circuit of Accessories	Remarks
LOCK	●					Ignition key can be inserted or pulled out on this position. Steering wheel will be locked and fixed when key has taken out. Engine will stop rotating when key is turned to "LOCK" position.
ACC	●		●		●	On this position, the circuit of accessories is switched on while engine has turned off.
ON	●	● When atmospheric temperature is from 15℃ to -15℃, preheating circuit automatically turned on and automatically disconnected in 30~140 second (BJ483 engine)	●		●	Circuit for the whole vehicle is switched on, and the key is to be kept on this position when engine is running
START	●			●		After engine has been started, release your hand, and the key switch will automatically return to "ON" position.

Note: ● indicates "on". When engine coolant temperature is lower than 0℃, electronic preheating device is activated. .

② Ignition Switch Function and Rated Current

Table 11-15 Ignition Switch Function and Rated Current

Name	Switch Function	Rated Current (A)	Service Life (Times)	Working Time
Ignition switch	Start	10	50000	≯15 Seconds
	Igniting	15	50000	Continuous
	Accessory	10	50000	Continuous
	Preheating			≯26

11.5 Complex instrument and Auxiliary Electrical Devices

1. Complex instrument

Complex instrument include water temperature meter, odometer, speedometer, fuel meter and reset button, etc. Print circuit board is adopted by complex instrument. Each corresponding electrical devices comes with standard plug connector. Refer to figures 11-8 and 11-9.

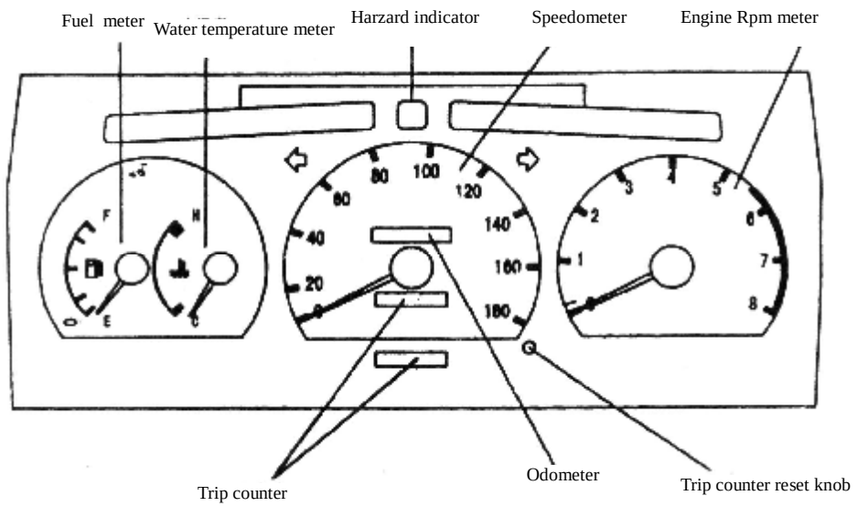


Fig 11-8 Luxurious and Superior Series Complex Instrument.

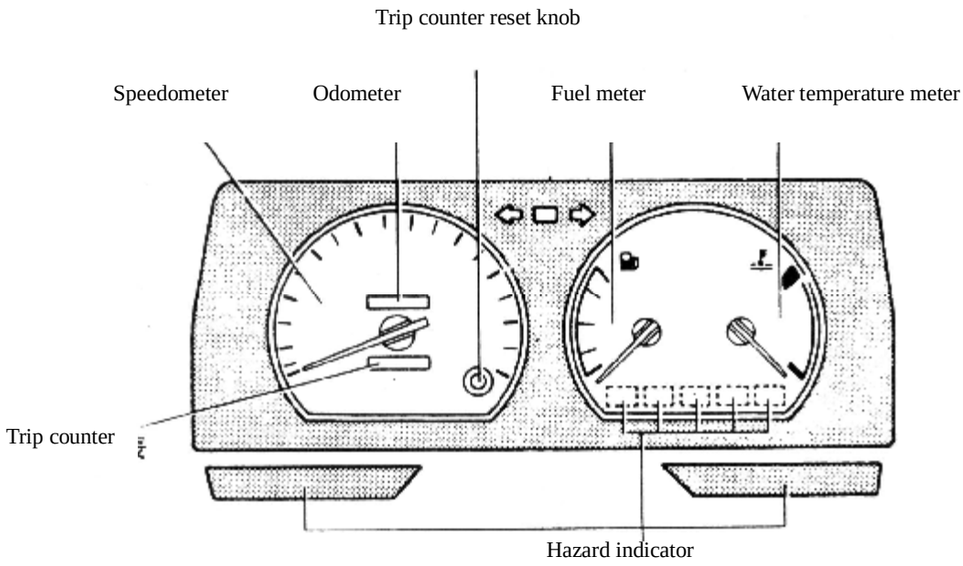


Fig 11-9 Standard Series Complex Instrument

2. Speedometer

① Technical parameters of speedometer

Structure and model	Magnetic induction type
Max indicated speed (km/h)	180

Max indicated mileage (km) 99999.9

Speedometer: Speedometer indicates the vehicle speed in km/h.

Odometer: Odometer records vehicle accumulated driving distance in km.

Mileage counter and reset button: Reset button of odometer is located on the lower corner of speedometer.

I. Odometer with single-row liquid crystal display

1. Liquid crystal display of accumulated mileage;

2. Press reset button less than 1 second to show journey mileage;

3. Press reset button again less than 1 second to return to total vehicle mileage;

4. While journey mileage is displaying, press the button longer than 2 seconds will zero the display. (Vehicle total mileage cannot be reset to "0") .

II. Odometer with double-row liquid crystal display

When reset button is pressed longer than 2 seconds, travelled mileage will be cleared into "0".

Coolant temperature meter and fuel meter

When starting switch is turned to "ON" position, coolant temperature meter will indicate the temperature of cooling water. The letters "C" and "H" on meter represent "Low Temperature" and "High Temperature", respectively. If coolant temperature meter pointer is under the red line, it indicates that coolant temperature is normal. The letters "E" and "F" on fuel meter stand for fuel "empty" and "ful" respectively. On some type of instrument panel, when ignition key is turned to "OFF" position, fuel metr pointer will not return to "E" mark, it still indicates the approximate oil level.

① Coolant temperature meter and its sensor

▲ Refer to table 11-16 for technical data of coolant temperature meter and its sensor.

▲ Check coolant temperature meter and sensor. Unplug the sensor and connect a 40Ohm resistor. Ground one resistor end. Turn on ignition switch, coolant temperature meter and its circuit are normal if the meter indicates around 100℃.

▲ Refer to table 11-17 for coolant temperature meter fault diagnosis.

Table 11-16 Technical Data of Coolant temperature meter and Its Sensor

Applicable Voltage（V）12	Coolant temperature meter (Moving Magnetic Type)				Sensor (Heat Sensitive Resistor)		
	Indicated Value（℃）	50	105	125	50	85	115
	Equivalent Resistance（Ω）	226±5	26．4±4.5	19	226±36~36.6	64±8	1.71~2.21

Note: Equivalent resistance means a stabilized resistance during the coolant temperature sensor's operating.

Table 11-17 Coolant temperature meter Fault Diagnosis

Symptom	Cause and elinmination
Instrument indicator does not work	1. Instrument socket is loosened or with bad contact 2. Open circuit inside coolant temperature meter, and the core of coolant temperature meter should be replaced if resistance is infinitely great when checked with above-mentioned method 3. There is failure inside sensor, sensor should be replaced if measured resistance is significantly different from the specified one when checked with above-mentioned method.

Symptom	Cause and elinmination
Incorrect Indication of Instrument	1. Check the coolant temperature meter with above-mentioned method, and if its pointer is excessively deviated, it indicates the meter has not been well calibrated and should be replaced. 2. Check the sensor with above-mentioned method, and if values vary significantly, it indicates there is sensor failure, sensor should be replaced.

② **Fuel meter and its sensor**

▲Refer to table 11-18 for technical data of fuel meter and its sensor.

Table 11-18 Technical Data of Fuel Meter and Its Sensor

Applicable Voltage (V)	Fuel Meter (Moving Magnetic Type)	Fuel Sensor (Slip Resistance Type)			
		Fuel Level	0(E)	1/2	1(F)
12		Output Resistance (Ω)	110(-8,0)	32.5±13	3(0,＋10)

▲Check fuel meter. Remove the sensor connecting wire and connecte with a 32.5±13 Ω (12V) resistor. Ground one end of resistor. Turn on ignition switch, if fuel meter stays around 1/2 scale mark, it indicates that fuel meter and its circuit are under normal condition.

▲Check fuel sensor

Take the fuel sensor out from fuel tank. Measure resistance between the two contacts of sensor with a multimeter and move the float position from 0 to 1/2, and to 1. Observe the readings of multimeter, if the measured resistance complies with specifications in table 18-23, the sensor is in good condition.

Notes to user:

1. Generally fill fuel to the lower edge of the filler to prevent fuel from splashing out of. For this reason, the fuel quantity is theoretically less than that in the fully filled state. Therefore, fuel meter does not indicate the full (F) level.

2. When fuel meter indicates zero (E), there is still a remaining fuel of 6~9L inside the fuel tank. The vehicle can still drive for about 50-~100km.

▲Refer to table 11-19 for fuel meter fault diagnosis and troubleshooting.

Table 11-19 Fuel Meter Fault Diagnosis And Troubleshooting

Symptom	Cause and Elimination
Instrument Fails to Work	1. Instrument socket of print circuit board lis oosened or with bad contact 2. There is open circuit inside fuel meter, and the core of meter should be replaced if resistance is infinitely great. check with above-mentioned method.
Meter pointer moves more than one scale mark when meter is powered on.	Slip resistor contact of sensor is loosened or resistor disconnected, and the sensor should be repaired or replaced. Check with above-mentioned method
Incorrect Indication	1. Fuel meter should be replaced if pointer has deviated too much. Check with above-mentioned method 2. Sensor contact position has changed, and output resistance is incorrect; adjust contact position or replace sensor. Check with above-mentioned method 3. Length of sensor rod is inconsistent to height of fuel tank. Select matching sensor rod.

5. Auxiliary Electrical Devices

Auxiliary electrical devicess include horn, Radio/casette player, windshield wiper/washer, cigarette lighter, and heating device, etc.

(1) Horn

When horn's volume is turned down or does not work, turn the adjusting screw on the back of horn until suitable volume is achieved, and then tighten and lockup the nut.

(2) Windshield Wiper

Wiper is used for cleaning windshield when vehicle is driving in raining or snowing days or days. Two shifts of wiping speeds are provided during use as per different requirements. Wiper motor is a permanent magnetic double-speed motor. Wiper is controlled (on/off/speed) by a lever under steering wheel. The first shift is low speed and the second shift is high speed. Do not use wiper dryly. Operated wipe only when fluid is present either with rain or windshield fluid. Otherwise, windshied glass could be scrached or motor could be damaged.

(3) Windshield washer

Washer is generally used together with wiper. Washer motor is designed for short-term working only, its working duration for each time should not exceed 5 seconds. Nozzle of washer can be adjusted. Insert a pin into nozzle, and gently toggle it to desired direction so that sprayed fluid could land on the middle upper part of windshield. If nozzle is blocked, use a metal wire to clear it.

Use special windshield fluid, and use antifreezing fluid in winter.

(4) Cigarette Lighter

Cigar lighter can be use only when ignition switch is on "ACC" or "ON" position. Press inward the cigarette lighter and the lighter will heat up, and pop up to normal position after heating up.

Please pay attention to the following items when cigarette lighter is used:

Make sure to push on its handle knob. Never hold the lighter body to avoid scalding. If cigar lighter will not pop up in 18 seconds, this indicates it is failure. Press again could help it to get out. Do not leave vehicle attended after having pushed down cigar lighter to avoid fire accident. Sometimes the cigarette lighter fails to eject dut to parts distortion, and fitting for the lighter should then be replaced.

(5) Heating Device

Heating device is used in cold weather. Turn the knob to activate it after engine coolant temperature has gone up. Temperature switch and fan switch can be used to control interior temperature. They also help to defrost /defog windshield by applying recycling air.

(6) Dome Light

Dome lights operate can be operated no matter which position the ignition switch is on. There are controlled by their own switches.

11.6 Air Conditioner

Vehicle air-conditioning system is the equipment to realize the ventilation, cooling and heating, dehumidifying and air cleaning within the vehicle. It provides the driver and passengers with a comfortable environment, relieve the driver from fatigue to ensure a safe driving. Air-conditioning equipment has already become a vital functional component of a vehicle, and is an important indicator for assassing the integrity of a vehicle's functions.

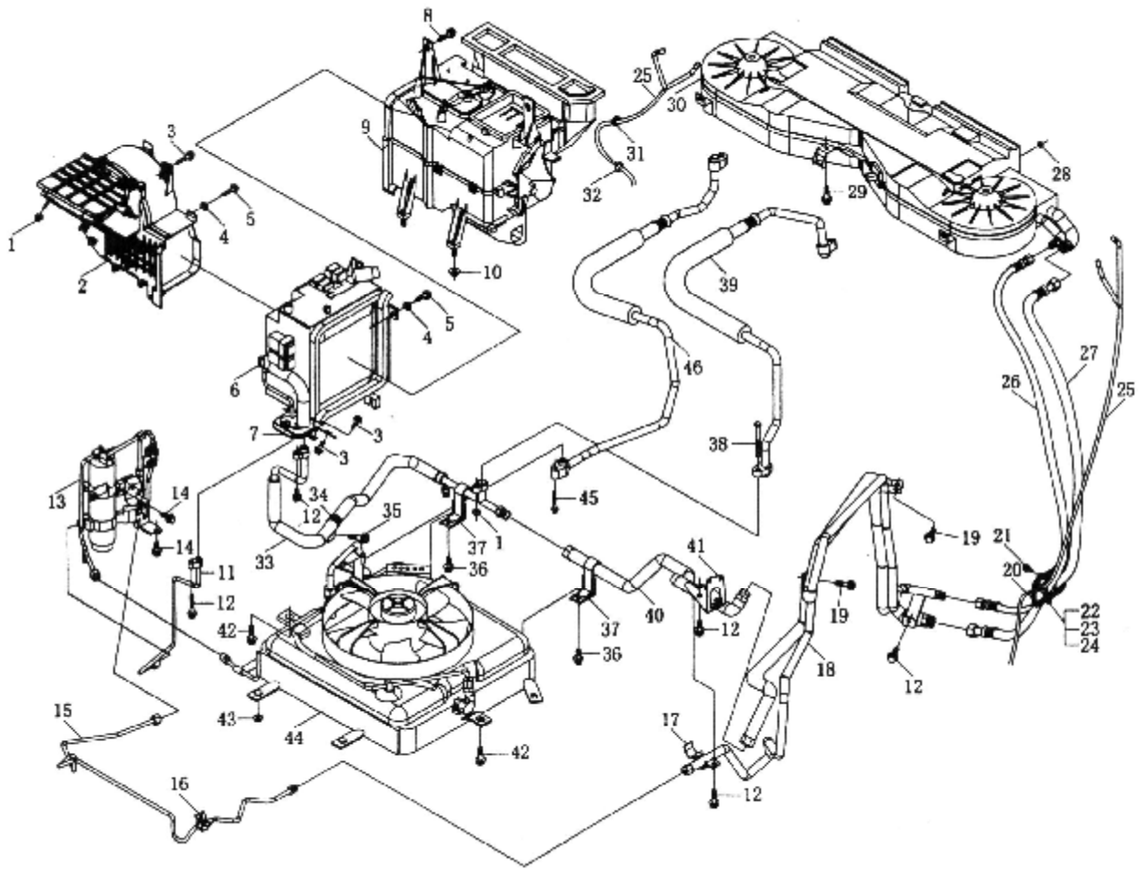


Fig11-10 AC System

1-Nut M6; 2-Blower Assembly; 3-Bolt; 4-Big Washer; 5-Self Tapping Screw; 6-Front Evaporator Assembly; 7-Hexagon Flange Nut; 8-Bolt; 9-Front Heating Radiator Assembly; 10-Hexagon Flange Nut; 11- Front Evaporator Suction Pipe Assembly; 12-Bolt; 13-Receiver Assembly; 14-Bolt; 15-Rear Evaporator Suction Pipe Assembly A; 16-Pipe Clip; 17-Pipe Clip; 18-Complex Pipe Assembly; 19-Bolt; 20-Three holes Cover Assembly; 21-Bolt; 22-Three Holes Cover Water Pipe Rubber Ring; 23- Three Holes Cover Small Rubber Ring; 24- Three Holes Cover Big Rubber Ring; 25-Rear Evaporator Water Dropping Pipe Assembly and Rear Evaporator Water Dropping Pipe; 26-Rear Evaporator Suction Pipe Assembly B; 27- Rear Evaporator Exhaust Pipe Assembly A; 28-Nut; 29-Bolt; 30- Rear Evaporator Assembly; 31-Upper Block of Water Pipe; 32-Lower Block of Water Pipe; 33- Front Evaporator Exhaust Pipe Assembly B; 34-Pipe Clip; 35-Bolt; 36-Pipe Clip Assembly; 37-Bolt Assembly; 38-Low Pressure Pipe Assembly; 39-Low Pressure Pipe Assembly; 40- Rear Evaporator Exhaust Pipe Assembly B; 41-Bracket Assembly; 42-Bolt; 43-Nut; 44-Condenser Assembly; 45-Bolt and High Pressure Pipe Assembly; 46-High Pressure Pipe Assembly

11.6.1 Principle & Structure

1. Refrigeration Cycle

Refrigerant in vehicle air-conditioner is vaporized from liquid to gas and condensed from gas to liquid. The cycle repeates continuously. This cycle is called the refrigeration cycle.

Usually gas temperature will rise when gas is compressed; and gas will turn into liquid if the temperature drops; and the liquid shall turn into gas again when pressure drops. In the refrigeration cycle, compressor compresses the refrigerant gas, the compressed high-pressure and high-temperature gas is condensed into liquid through condenser. The liquid refrigerant is vaporized by means of the orificing effect of the expansion valve.

During vaporization, it absorbs the heat from surrounding air. Fig.11-11 shows the basic process of a refrigeration cycle: flow direction, high pressure or low pressure, and the status of refrigerant. In Fig.11-11, the refrigeration cycle is divided into two sides, i.e. high pressure and low pressure sides, by the line between compressor and expansion valve, with the right side being the low pressure side, while the left side being the high pressure side.

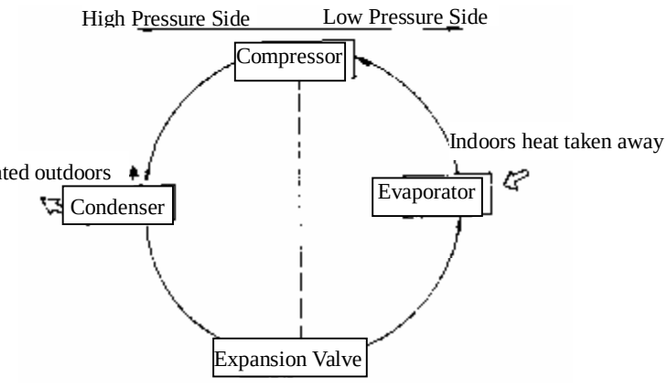


Figure 11-11 Refrigeration Cycle

2. Structure & Function

Vehicle air-conditioning system includes compressor, condenser, reservoir dryer, expansion valve, and evaporator, etc. What's shown in figure 11-12 is the refrigeration cycle of air conditioning system of BJ6536.

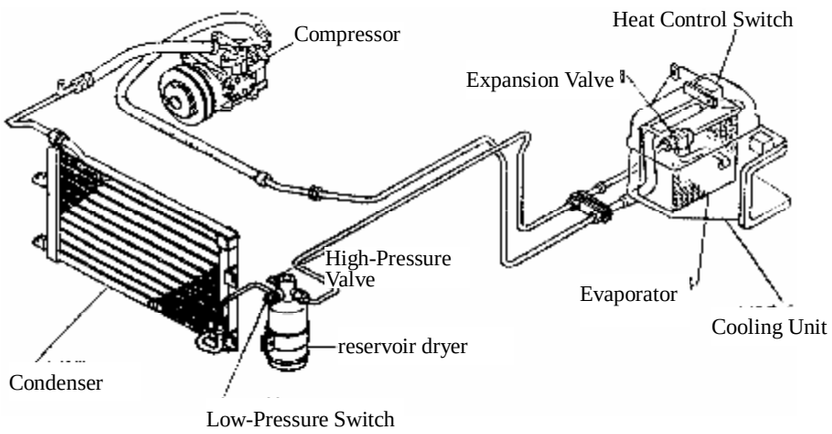


Figure 11-12 Refrigeration Cycle System

Evaporator:

The warm airflow sent from the cab by the fan flows through the radiator fin and tube of the evaporator (See Figure 11-13), and the low-temperature and low-pressure refrigerant flowing from the expansion valve absorbs large amount of heat from the warm airflow when it enters the radiator and tube of the evaporator, and thus turns into refrigerant gas. This process can cool down the warm airflow flowing through the evaporator, and thus lowers the temperature within the vehicle. When the warm airflow flows through the evaporator, the moisture in it will be condensed into drips on the radiator, the dust in water and air can be drained out from vehicle through the discharge outlet.

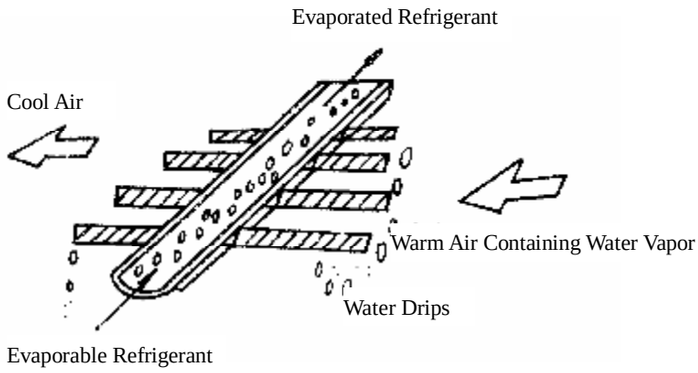


Figure 11-13 Function of Evaporator

Compressor:

Compressor is the major part of air-conditioning system, it inhales and compresses the low temperature and low pressure refrigerant gas generated by absorbing heat in the evaporator, and then sends it to the condenser after having risen its pressure and temperature.

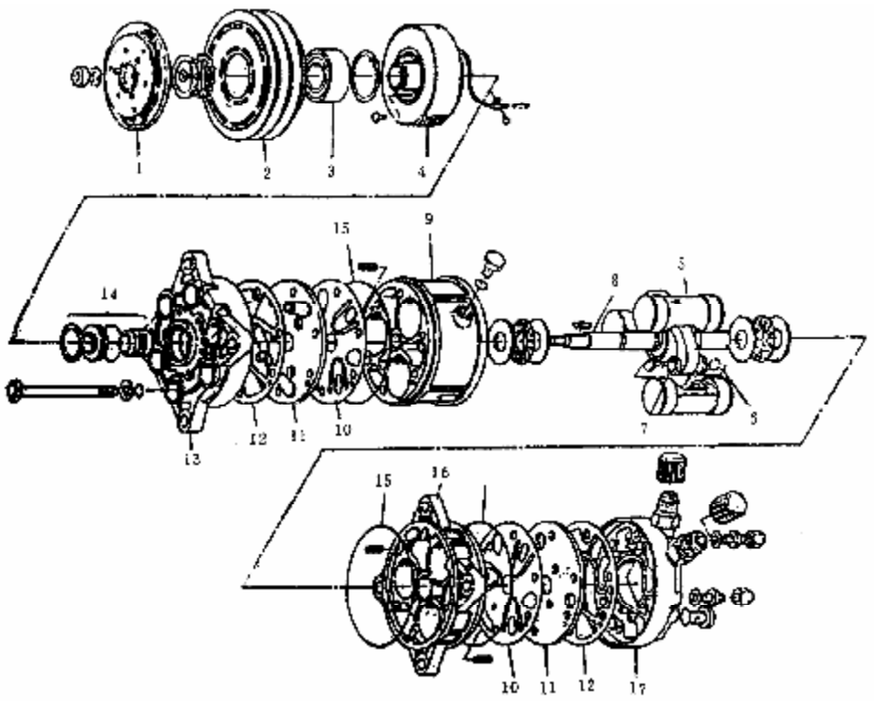


Figure 11-14 Swash Plate Compressor

1-Suction Cup; 2-Pulley; 3-Bearing; 4-Coil; 5-Piston; 6- Friction Ball; 7-Slipper; 8-Swash plate Shaft; 9-Central body; 10-Valve Plate; 11-Valve Sheet; 12-Sealing Washer; 13-Front Cylinder Block; 14-Shaft Seal; 15-O-Ring; 16-Rear body; 17-Rear cover

Condenser:

Condenser is a kind of heat exchanger, it radiates the heat in high temperature and high pressure gas refrigerant exhausted from the compressor to the outer environment, turning the gas refrigerant into high temperature and high pressure liquid refrigerant. (See Figure 11-15).

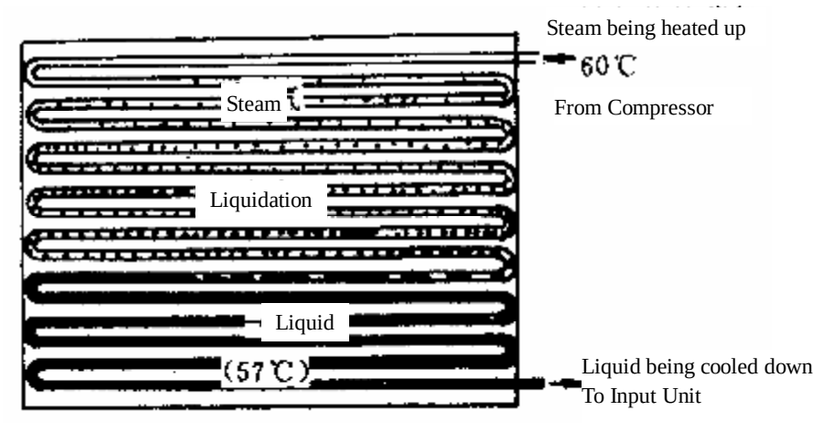


Figure 11-15 Condenser

Expansion Valve:

Expansion valve is installed on evaporator inlet. Orificing effect of expansion valve makes liquid refrigerant (from condenser and reservoir dryer) expand suddenly into low pressure moisture steam (after temperature and pressure drop). The steam enters the evaporator to absorb the air heat inside vechile. Furthermore, the expansion valve can also automatically adjust the refrigerant flow according to the refrigeration load so as to control the temperature within the vehicle.

Expansion valve is divided into inner equalizer and outer equalizer types. See figures 11-16 and 11-17.

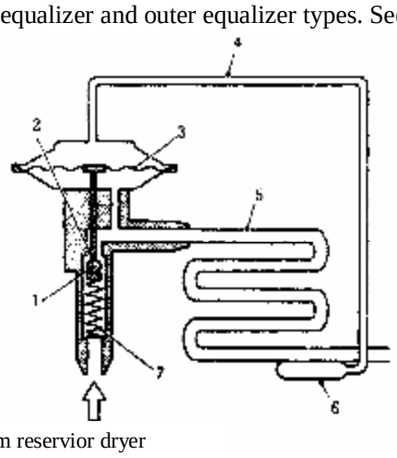


Fig 11-16 Inner Equilizer Type Expansion Valve

1- Ball Valve; 2-Pinhole; 3- Diaphragm; 4. Capillary Tube; 5-Evaporator; 6-Remote bulb; 7-Spring

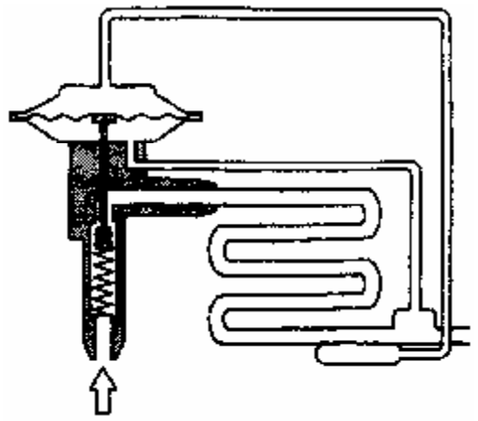


Figure 11-17 Outer Equilizer Type Expansion Valve

Reservior dryer

① R134a refrigerant has a poor water-holding capacity and ice crystal can easily form in expansion valve if there is moisture in the system. Crystal would restrain the flow of refrigerant. The moisture in the system will also have chemical effect with the refrigerant, forming the highly corrosive hydrochloric acid that could damage the steel parts in the system. The reservoir dryer is therefor used to absorb the moisture in the refrigerant. (See Figure 11-18).

② The volume of refrigerant cycling in the refrigeration system varies according to the heat load, the reservoir dryer contains and supplies neededrefrigerant timely to the cycling system, and compensates the minor-leakage as well.

③ The filtering devices in the reservoir dryer can clean out impurities and dirt in the system all the time, preventing them from entering into the refrigerant and blocking the expansion valve.

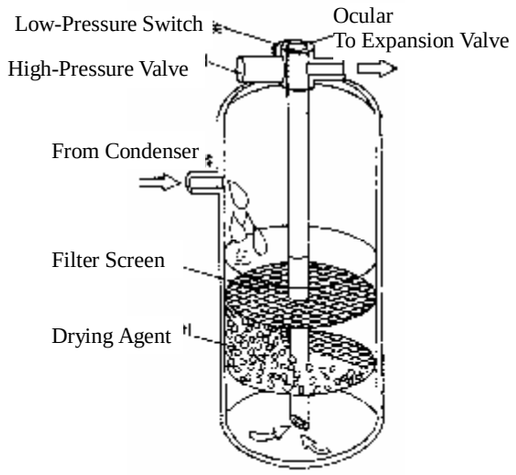


Figure 11-18 Reservior dryer

3. Refrigeration Cycle Process

The cycling of the refrigerant can be divided into four major processes, namely evaporation, compression, condensing, and depressurizing. The corresponding devicdes are the evaporator, compressor, condenser, and expansion valve. See figure 11-19.

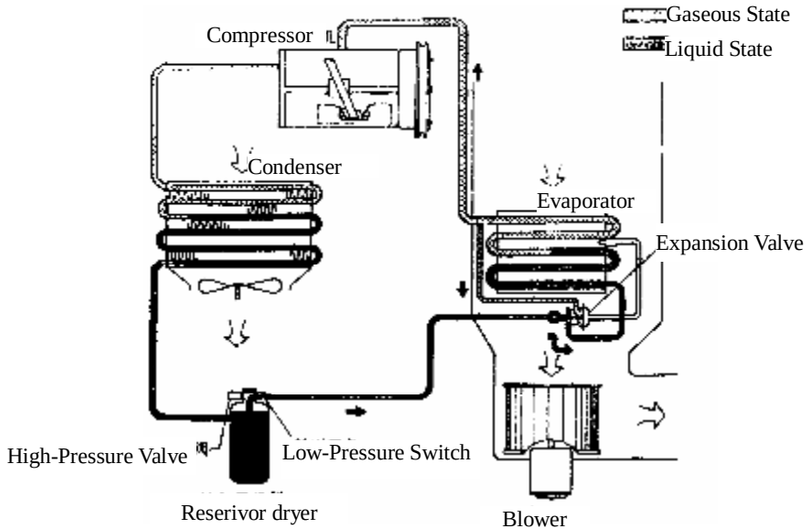


Figure. 11-19 Four Stages of Refrigerant in recirculation

(1) Compression

Compressor intakes low-pressure (147kPa) and low-temperature (0℃) refrigerating gas after its heat has been absorbed in evaporator, and compresses the gas into high-pressure (1471kPa) and high-temperature (70~80 ℃) gas and sends it into condenser.

(2) Condensation

The high temperature and high pressure refrigerant gas (entering the condenser) exchanges heat with the environment air. When the temperature of the gas drops to 40~50℃, gas condenses into liquid.

(3) Expansion

High pressure refrigerant liquid flows through the expansion valve. Valve orificing effect makes liquid into low pressure (147MPa) and low temperature (-5℃) mist.

(4) Evaporation

The orificed low pressure / temperature refrigerant enters the evaporator and evaporates by absorbing the heat within the vehicle. The temperature of the refrigerant gas in the outlet of the evaporator is about 5℃. (Note: In the actual cooling circulation, the temperature and pressure of the refrigerant are subject to the outer conditions such as air temperature and wind speed, etc.) If the compressor keeps running, the aforementioned four processes will cycle continuously

11.6.2 Check and Maintenance of Air Conditioner

1. Check prior to application season.

① Check whether the surfaces of the condenser and evaporator are clean, cleanse them if there are too many dusts, then dry them up with compressed air.

② Check whether the performance of all switches and controlling units are reliable.

③ Run the air-conditioning system, then check the remaining volume of refrigerant by looking through peephole.

2. Check after application season

Check the leakage with a leak detector. Repair any leakage even though the application season is over. Replenish refrigerant to specified amount.

Check the oil volume in compressor, and replenish when it's necessary.

Run engine run at a speed higher than idling speed. Check through peephole whether the volume of refrigerant comply with specification

Routine maintenance of air conditioner

Check the volume of the refrigerant for every two weeks through inspection window. When the air-conditioner is just turned on, the flow of air bubbles can be seen, but these air bubbles disappear in a short time, this means the air-conditioner is running properly. If the air bubbles will not disappear, it means refrigerant is insufficient, and should be replenished. If you splash water onto the condenser, and cannot find any bubbles through peephole, it means the volume of refrigerant is excessive, and should be discharged to the standard volume.

Check the tension and conditions of compressor and fan belts every month. Adjust tension if necessary, and replace cracked belt. When to check belt tension, use the thumb to press the middle point of the belt with the force of 100N, its deflection should be 8~12mm. Fasteners shall be frequently checked to prevent loosening, the checking interval should be at each 2000km.

When the air-conditioner is laid for one or a few months, it should be run for several minutes at engine idling Rpm every week, even in winter. This would ensure proper lubrication on compressor and its seals, so as to keep A/C in the best technical condition, and prolong A/C service life.

11.6.3 Maintenance & Repair of Air Conditioner

Poor A/C cooling perfomance is mainly due to refrigerant leakage.

1. locate leakage

Popular vehicle A/C refrigerant used today is R134a. It is prone to escape via connectors and oil sealings. Refrigerant leakage leads to poor or even no cooling.

① check leak trace

During its refrigerating recirculation, A/C needs fluid to lubricate its seal bearing and other moving parts in compressor. Slight amount of lubricant could enter A/C cooling system along with refrigerant. If leakage happens in refrigerating recirculation system, there must be lubricant dirt presenting at leaking spot. Therefore, lubricant dirts on pipeline or connectors indicate there are leak happening there and need to repair.

② Judging leak status of refrigerant through peephole

Start up engine (around 1000rpm) and activate A/C, set A/C temperature switch to COLD and fan switch to MAX. One can observe how refrigerant is flowing through peephole to determine if there is any leakage in refrigerating recirculation system

Normal flow of refrigerant:

Refrigerant appears transparent in general, and air from registers is cold. These indicate cooling system works well.

Insufficient refrigerant:

Bubble is flowing around, and refrigerant turns white. This indicates that cooling result is not good.

No refrigerant

If serious leakage happens, one can see nothing through inspection door. A/C will not work.

In short, oil stain on all connection spots or condenser surface indicate refrigerant leakage has happened there. Operator should immediately remove leakage and replenish refrigerant and lubricant, preventing further lubricant leakage from damaged A/C system.

2. Check A/C system operation

Park vehicle in the place with good ventiliation, keep engine running in moderate Rpm, set A/C fan switch to MAX to recycle interior air.

① Judge A/C's condition by inspecting temperatures in different locations. Touch AC system parts to check

surface temperature. In normal condition, low-pressure pipeline is cold and high-pressure pipeline is hot.

High-pressure Pipeline: compressor outlet — condenser — reservoir — expansion valve inlet. Any hot spot in the pipeline indicates poor heat radiation, while cold or frozen spot indicates restriction..

Low-pressure pipeline: expansion outlet — evaporator — comprssor inlet. Temperature goes from cool to cold along the pipeline, but there should be no frozen at expansion valve.

There should be obvious temperature difference between high side and low side of compressor. If there is no evident difference in temperature, it indicates an obvious leaking in air-conditioning system.

② Check and adjust air conditioner belt. Check A/C belt for tension and surface condition, make proper adjustment or replace when necessary.

11.6.4 Precautions for A/C Usage and service

The flowing points should be noted during the use and service of A/C system

1. Refrigerant R134a has high potential heat of vaporization, when it contacts skin or eye of a human being, it will absorb a lot of heat and vaporize, thus frostbite the human body. Watch out this during operation, in the case of the refrigerant contacts skin, you should wash with a great amount clean cold water, and go to hospital for treatment.

2. Refrigerant R134a has no color and odor, which is hard to be noticed. When it is exhausted to air, it can drop the concentration of oxygen in the air to suffocate people. Because refrigerant gas is heavier than air, it usually sinks down to the bottom of air, service man should not stand in ducts and pits to discharge refrigerant. The discharging of refrigerant should be conducted in the place with good ventilation.

3. Refrigerant gas R134a will generate toxic phosgene when it contacts lighted fire. Don't conduct any welding operations or smoke cigarette in service site.

4. Refrigerant R134a can stain the metal surface after mixed with moisture in the air. Hence, when you are discharging the refrigerant, relevant surfaces of the vehicle body should be covered by a piece of cloth.

5. Refrigerant R134a is soluble with lube oil, lube follows refrigerant R134a to circulate in the system and spread all over the internal surface of system. So refrigerant must be drained out slowly to prevent lube oil from being carried off.

6. Pressure of refrigerant R134a increased rapidly along with temperature increased. Therefore, refrigerant must be placed under the environment with temperature below 40℃.