



SUBARU
FORESTER

2003 Model Year
PDF Service Manual

NEW CAR INFORMATION SECTION
(W8070GE)

NEW CAR INFORMATION SECTION

FOREWORD

This manual has been prepared to provide information for the construction, operation and other technical details of SUBARU vehicles. Read this manual thoroughly and make the most of it to give better service to your customers and improve your knowledge of vehicle maintenance.

All information, illustration and specifications contained in this manual are based on the latest product information available at the time of publication approval.

FUJI HEAVY INDUSTRIES LTD.

Specifications	SPC
Fuel Injection (Fuel System)	FU (SOHC)
Emission Control (Aux. Emission Control Devices)	EC (SOHC)
Intake (Induction)	IN (SOHC)
Mechanical	ME (SOHC)
Exhaust	EX (SOHC)
Cooling	CO (SOHC)
Lubrication	LU (SOHC)
Speed Control System	SP (SOHC)
Ignition	IG (SOHC)
Starting/Charging	SC (SOHC)
Fuel Injection (Fuel System)	FU (TURBO)
Emission Control (Aux. Emission Control Devices)	EC (TURBO)
Intake (Induction)	IN (TURBO)
Mechanical	ME (TURBO)
Exhaust	EX (TURBO)
Cooling	CO (TURBO)
Lubrication	LU (TURBO)

Speed Control System	SP (TURBO)
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Ignition	IG (TURBO)
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Starting/Charging	SC (TURBO)
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Control System	CS
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Automatic Transmission	AT
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Manual Transmission and Differential	MT
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Clutch	CL
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Front Suspension	FS
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Rear Suspension	RS
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Wheel and Tire System	WT
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Differentials	DI
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Transfer Case	TC
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Drive Shaft System	DS
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ABS	ABS
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Brakes	BR
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Parking Brake	PB
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Power Assisted System (Power Steering)	PS
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HVAC System (Heater, Ventilator and A/C)	AC
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Airbag System	AB
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Seat Belt System	SB
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Lighting System	LI
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Wiper and Washer Systems	WW
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Entertainment System	ET
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Communication System	COM
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Glass/Windows/Mirrors	GW
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Body Structure	BS
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Instrumentation/Driver Info	IDI
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Seats	SE
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Security and Locks	SL
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Sunroof/T-top/Convertible Top	SR
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Exterior/Interior Trim	EI
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Exterior Body Panels	EB
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Cruise Control System	CC
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FOREWORD

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SPECIFICATIONS *SPC*

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FORESTER

Specifications

1. Forester

A: DIMENSIONS

Model		2.0L Non-turbo	2.0L Turbo	2.5L Non-turbo
Overall length	mm (in)	4,450 (175.2)		
Overall width	mm (in)	1,735 (68.3)		
Overall height (at C.W.)	mm (in)	1,590 (62.6)	1,585 (62.4)	1,590 (62.6)
Compartment	Length	1,795 (70.7)		
	Width	1,455 (57.3)		
	Height	1,245 (49.0), 1,210 (47.6)★		
Wheelbase	mm (in)	2,525 (99.4)		
Tread	Front	1,495 (58.9)		
	Rear	1,485 (58.5)		
Minimum road clearance	mm (in)	190 (7.5)	195 (7.7)	200 (7.9)

★: With sunroof

B: ENGINE

Model		2.0L Non-turbo	2.0L Turbo	2.5L Non-turbo
Engine type		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine		
Valve arrangement		Overhead camshaft type		
Bore × Stroke	mm (in)	92 × 75 (3.62 × 2.95)		99.5 × 79 (3.92 × 3.11)
Displacement	cm ³ (cu in)	1,994 (121.67)		2,457 (149.94)
Compression ratio		10.0 ± 0.2	8.0 ± 0.2	10.0 ± 0.2
Firing order		1 — 3 — 2 — 4		
Idle speed at Park/Neutral position	rpm	650 ± 100	700 ± 100	650 ± 100
Maximum output	kW (PS)/rpm	92 (125)/5,600	130 (177)/5,600	115 (156)/5,600
Maximum torque	N·m (kgf-m, ft-lb)/rpm	184 (18.8)/3,600	245 (25.0)/3,200	223 (22.7)/3,600

C: ELECTRICAL

Model		2.0L Non-turbo	2.0L Turbo	2.5L Non-turbo
Ignition timing at idling speed	BTDC/rpm	10°±10°/650	12°±10°/700	MT: 10°±10°/650 AT: 15°±10°/650
Spark plug	Type and manufacturer	CHAMPION: RC10YC4	NGK: PFR6G	CHAMPION: RC10YC4
		Alternate CHAMPION: RC8YC4 NGK: BKR6E-11 DENSO: K20PR-U11		Alternate CHAMPION: RC8YC4 NGK: BKR6E-11 DENSO: K20PR-U11
Generator		12 V — 90 A		
Battery	Type and capacity (5HR)	MT: 12 V — 48 AH (55D23L) AT: 12 V — 52 AH (65D23L)		12 V — 27 AH (34B19L) 12 V — 48 AH (55D23L)★

★: For Australia model

D: TRANSMISSION

Model		2.0L Non-turbo		2.0L Turbo		2.5L Non-turbo		
Transmission type		5MT	4AT	5MT	4AT	5MT	4AT	
Clutch type		DSPD	TCC	DSPD	TCC	DSPD	TCC	
Gear ratio		1st	3.454	2.785	3.454	2.785	3.454	2.785
		2nd	2.062	1.545	1.947	1.545	2.062	1.545
		3rd	1.448	1.000	1.366	1.000	1.448	1.000
		4th	1.088	0.694	0.972	0.694	1.088	0.694
		5th	0.871	—	0.738	—	0.780	—
		Reverse	3.333	2.272	3.333	2.272	3.333	2.272
		Dual range	1.447	—	—	—	1.196	—
Reduction gear (front drive)	1st reduction	Type of gear	—	Helical	—	Helical	—	Helical
		Gear ratio	—	1.000	—	1.000	—	1.000
	Final reduction	Type of gear	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid
		Gear ratio	4.111	4.444	4.444	4.111	4.111	4.444
Reduction gear (rear drive)	Transfer reduction	Type of gear	Helical	—	Helical	—	Helical	—
		Gear ratio	1.000	—	1.081★, 1.000	—	1.000	—
	Final reduction	Type of gear	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid
		Gear ratio	4.111	4.444	4.111★, 4.444	4.111	4.111	4.444

5MT: 5 forward speeds with synchromesh and 1-reverse

4AT: Electronically controlled fully-automatic, 4-forward speeds and 1-reverse

DSPD: Dry Single Plate Diaphragm

TCC: Torque Converter Clutch

★: Europe spec vehicle

E: STEERING

Type	Rack and pinion		
Turns, lock to lock	3.0		
Minimum turning circle	m (ft)	Curb to curb	10.6 (34.8)
		Wall to wall	11.4 (37.4)

F: SUSPENSION

Front	Macpherson strut type, independent, coil spring
Rear	Dual-link type, independent, coil spring

G: BRAKE

Model	2.0L Non-turbo, 2.5L Non-turbo	2.0L Turbo, 2.5L Non-turbo★
Service brake system	Dual circuit hydraulic with vacuum suspended power unit	
Front	Ventilated disc brake	
Rear	Drum brake	Disc brake
Parking brake	Mechanical on rear brakes	

★: RHD model

FORESTER

Specifications

H: TIRE

Rim size	15 × 6J	16 × 6 ¹ / ₂ J
Tire size	205/70 R15 95H	215/60 R16 95V, P215/60 R16 94H
Type	Steel belted radial, tubeless	

I: CAPACITY

Model		2.0L Non-turbo		2.0L Turbo		2.5L Non-turbo	
		5MT	4AT	5MT	4AT	5MT	4AT
Fuel tank	ℓ (US gal, imp. gal)	60 (15.9, 13.2)					
Engine oil (When replacing)	ℓ (US qt, imp. qt)	Approx. 4.0 (4.2, 3.5)		Approx. 4.5 (4.8, 4.0)		Approx. 4.0 (4.2, 3.5)	
Transmission gear oil	ℓ (US qt, imp. qt)	4.0 (4.2, 3.5)	—	3.5 (3.7, 3.1) 3.9 (4.1, 3.4)★1	—	4.0 (4.2, 3.5)	—
Automatic transmission fluid	ℓ (US qt, imp. qt)	—	8.4 (8.9, 7.4)	—	9.3 (9.8, 8.2)	—	9.3 (9.8, 8.2)
AT differential gear oil	ℓ (US qt, imp. qt)	—	1.2 (1.3, 1.1)	—	1.2 (1.3, 1.1)	—	1.2 (1.3, 1.1)
AWD rear differential gear oil	ℓ (US qt, imp. qt)	0.8 (0.8, 0.6)					
Power steering fluid	ℓ (US qt, imp. qt)	0.7 (0.7, 0.6)					
Engine coolant	ℓ (US qt, imp. qt)	6.6 (7.0, 5.8)	6.5 (6.9, 5.7)	7.4 (7.8, 6.5)	7.3 (7.7, 6.4)★2	6.9 (7.3, 6.1)	6.8 (7.2, 6.0)

★1: With oil pump

★2: MT vehicles with oil cooler included

J: WEIGHT

1. LHD MODEL

Option code ★		EC		K4		KS		
Model		2.0L				2.5L		
		AWD						
		2.0X				2.5X		
		5MT	4AT	5MT	4AT	5MT	4AT	
Curb weight (C.W.)	Front	kgf (lb)	760 (1,675)	775 (1,710)	775 (1,710)	790 (1,740)	780 (1,720)	800 (1,765)
	Rear	kgf (lb)	600 (1,325)	600 (1,325)	595 (1,310)	595 (1,310)	620 (1,365)	620 (1,365)
	Total	kgf (lb)	1,360 (3,000)	1,375 (3,035)	1,370 (3,020)	1,385 (3,050)	1,400 (3,085)	1,420 (3,130)
Maximum permissible axle weight (M.P.A.W.)	Front	kgf (lb)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)
	Rear	kgf (lb)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)
Maximum permissible weight (M.P.W.)	Total	kgf (lb)	1,880 (4,140)	1,880 (4,140)	1,880 (4,140)	1,880 (4,140)	1,880 (4,140)	1,880 (4,140)
Option	Sport package base		—	—	—	—	—	—
	Aluminum wheel		○	○	○	○	○	○
	Front fog light		—	—	—	—	○	○
	Cruise control		—	—	—	—	○	○
	High-grade audio		—	—	—	—	—	—
	Sport steering		—	—	—	—	—	—
	Leather package base		—	—	—	—	—	—
	Leather seat, Leather door trim		—	—	—	—	—	—
	Air conditioner		—	—	○	○	○	○
	Side airbag		—	—	—	—	—	—
	Sunroof		—	—	—	—	—	—
	Self-leveling function Rr		○	○	—	—	—	—
	Cold area pack A		○	○	—	—	—	—
	Cold area pack B		—	—	—	—	—	—
	Cold area pack C		—	—	—	—	—	—
Security system		—	—	—	—	—	—	

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Specifications

Option code		EC		K4		
Model		2.0L				
		AWD				
		2.0XT				
		5MT	4AT	5MT	4AT	
Curb weight (C.W.)	Front	kgf (lb)	790 (1,740)	810 (1,785)	815 (1,795)	835 (1,840)
	Rear	kgf (lb)	620 (1,365)	620 (1,365)	630 (1,390)	630 (1,390)
	Total	kgf (lb)	1,410 (3,105)	1,430 (3,150)	1,445 (3,185)	1,465 (3,230)
Maximum permissible axle weight (M.P.A.W.)	Front	kgf (lb)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)
	Rear	kgf (lb)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)
Maximum permissible weight (M.P.W.)	Total	kgf (lb)	1,950 (4,295)	1,950 (4,295)	1,950 (4,295)	1,950 (4,295)
Option	Sport package base		—	—	—	—
	Aluminum wheel		○	○	○	○
	Front fog light		○	○	—	—
	Cruise control		—	—	○	○
	High-grade audio		—	—	—	—
	Sport steering		—	—	—	—
	Leather package base		○	○	○	○
	Leather seat, leather door trim		—	—	—	—
	Air conditioner		—	—	○	○
	Side airbag		—	—	○	○
	Sunroof		—	—	○	○
	Self-leveling function Rr		○	○	—	—
	Cold area pack A		○	○	—	—
	Cold area pack B		—	—	—	—
	Cold area pack C		—	—	—	—
Security system		—	—	—	—	

★: For the option codes, refer to ID section. <Ref. to ID-6, Option code.>

FORESTER

Specifications

2. RHD MODEL

Option code ★		EK		KA		EK		
Model		2.0L		2.5L		2.0L		
		AWD						
		2.0X		2.5X		2.0XT		
		5MT	4AT	5MT	4AT	5MT	4AT	
Curb weight (C.W.)	Front	kgf (lb)	775 (1,705)	790 (1,740)	765 (1,685)	785 (1,730)	815 (1,795)	835 (1,840)
	Rear	kgf (lb)	600 (1,325)	600 (1,325)	625 (1,380)	625 (1,380)	635 (1,400)	635 (1,400)
	Total	kgf (lb)	1,375 (3,030)	1,390 (3,065)	1,390 (3,065)	1,410 (3,110)	1,450 (3,195)	1,470 (3,240)
Maximum permissible axle weight (M.P.A.W.)	Front	kgf (lb)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)	1,010 (2,225)
	Rear	kgf (lb)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)	1,035 (2,280)
Maximum permissible weight (M.P.W.)	Total	kgf (lb)	1,880 (4,145)	1,880 (4,145)	1,950 (4,300)	1,950 (4,300)	1,950 (4,300)	1,950 (4,300)
Option	Sport package base		—	—	—	—	—	—
	Aluminum wheel		○	○	○	○	○	○
	Front fog light		—	—	○	○	○	○
	Cruise control		—	—	○	○	○	○
	High-grade audio		—	—	○	○	—	—
	Sport steering		—	—	○	○	—	—
	Leather package base		—	—	○	○	○	○
	Leather seat, leather door trim		—	—	○	○	○	○
	Air conditioner		○	○	○	○	○	○
	Side airbag		—	—	○	○	○	○
	Sunroof		—	—	○	○	○	○
	Self-leveling function Rr		○	○	—	—	○	○
	Cold area pack A		○	○	○	○	—	—
	Cold area pack B		—	—	—	—	—	—
	Cold area pack C		—	—	—	—	○	○
Security system		—	—	—	—	—	—	

★: For the option codes, refer to ID section. <Ref. to ID-6, Option code.>

FORESTER

Specifications

3. OPTION

Option		Front kgf (lb)	Rear kgf (lb)	Total kgf (lb)
Sport package base		0.1 (0.2)	0.4 (0.9)	0.5 (1.1)
Aluminum wheel	15 IN	-6.5 (-14.3)	-6.5 (-14.3)	-13.0 (-28.6)
	16 IN	-7.3 (-16.1)	-7.3 (-16.1)	-14.6 (-32.2)
Front fog light		0.7 (1.5)	-0.1 (-0.2)	0.6 (1.3)
Cruise control		1.5 (3.3)	0.2 (0.5)	1.7 (3.8)
High-grade audio		0.8 (1.8)	0.4 (0.9)	1.2 (2.7)
Sport steering		0.2 (0.5)	0.1 (0.2)	0.3 (0.7)
Leather package base		0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Leather seat, leather door trim		1.2 (2.6)	3.0 (6.6)	4.2 (9.2)
Air conditioner		16.9 (37.3)	-1.4 (-3.1)	15.5 (34.2)
Side airbag		2.0 (4.4)	2.4 (5.3)	4.4 (9.7)
Sunroof		3.5 (7.7)	13.2 (29.1)	16.7 (36.8)
Self-leveling function Rr	2.0X	0.1 (0.2)	3.0 (6.6)	3.1 (6.8)
	2.0XT	0.1 (0.2)	3.1 (6.8)	3.2 (7.0)
Cold area pack A		0.1 (0.2)	0.2 (0.5)	0.3 (0.7)
Cold area pack B		0.1 (0.2)	0.3 (0.7)	0.4 (0.9)
Cold area pack C		0.1 (0.2)	0.3 (0.7)	0.4 (0.9)
Security system		0.3 (0.7)	0.3 (0.7)	0.6 (1.4)

FUEL INJECTION (FUEL SYSTEM) *FU* (SOHC)

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1. General

- The Multipoint Fuel Injection (MFI) system supplies optimum air-fuel mixture under every engine operating condition through the use of the latest electronic control technology.

This system pressurizes the fuel to a constant pressure and injects it into each intake air port in the cylinder head. The injection quantity of fuel is controlled by an intermittent injection system where an electro-magnetic injection valve or injector opens for a short period that is precisely controlled depending on the quantity of air appropriate for each condition of operation. In actual control, an optimum fuel injection quantity is achieved by varying the duration of an electric pulse applied to the injector. This way of control enables simple, yet highly precise metering of the fuel.

- The engine control module (ECM) that controls the fuel injection system corrects the fuel injection amount depending on the vehicle speed, throttle opening, coolant temperature and other vehicle-operation-related information. The ECM receives the information in the form of electric signals from the corresponding sensors and switches.

The MFI system also has the following features:

- Reduced exhaust emissions
- Reduced fuel consumption
- Increased engine output
- Quick response to accelerator and brake pedal operation
- Superior startability and warm-up performance in cold weather due to corrective controls made according to coolant and intake air temperatures

2. Air Line

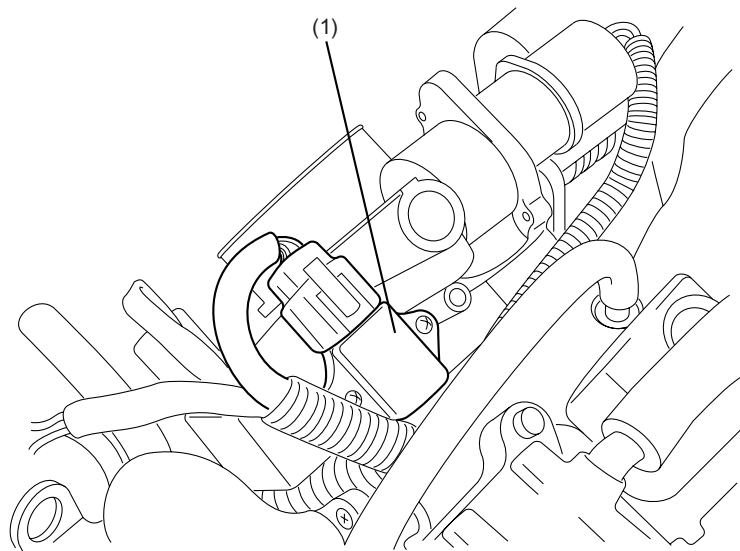
A: GENERAL

The air filtered by the air cleaner enters the throttle body where it is regulated in the volume by the throttle valve and then enters the intake manifold. It is then distributed to each cylinder where the air is mixed with fuel injected by the injector. During idling operation, air flows into the cylinder through the idle air control solenoid valve, bypassing the throttle valve. This enables controlling the engine idling speed properly.

B: PRESSURE SENSOR

The pressure sensor is mounted on the top of the throttle body and measures the absolute air pressure in the intake manifold.

The measured pressure is converted into an electrical signal and sent to the ECM. The ECM uses these signals to control injection and ignition timing as well as the fuel injection amount.



FU-00213

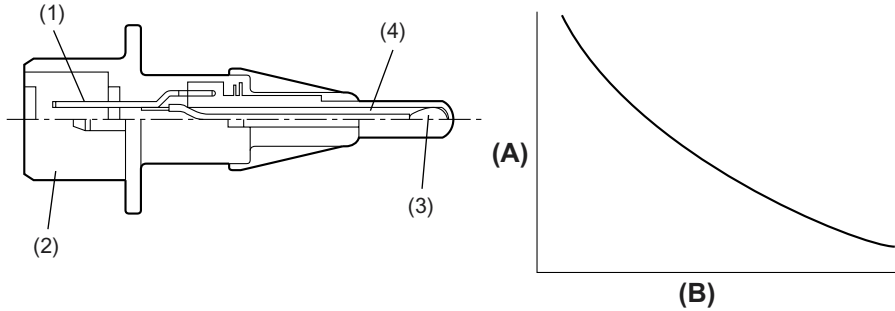
(1) Pressure sensor

AIR LINE

Fuel Injection (Fuel System)

C: INTAKE AIR TEMPERATURE SENSOR

The intake air temperature sensor is located in the air cleaner case and detects the temperature of the intake air introduced through the air intake duct. The ECM uses the resistance signal from the sensor to correct the fuel injection amount.



FU-00214

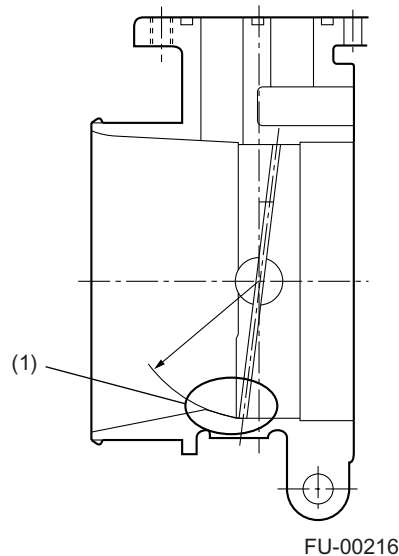
(1) Terminal
(2) Connector

(7) Thermistor
(8) Housing

(A) Resistance (Ω)
(B) Intake air temperature ($^{\circ}\text{C}$)

D: THROTTLE BODY

- In response to operation of the accelerator pedal, the throttle valve in the throttle body opens/closes to regulate the volume of the air drawn into the combustion chamber.
- During idling, the throttle valve is almost fully closed and the volume of air passing through the throttle body is less than that passing through the idle air control solenoid valve.
- More than half of the air necessary for idling is supplied to the intake manifold via the idle air control solenoid valve which controls properly the engine idling speed, so the idling speed needs not be adjusted.
- To reduce shock when the throttle is slightly opened and enhance comfort, the inside of the throttle body is contoured in a spherical shape (MT models).



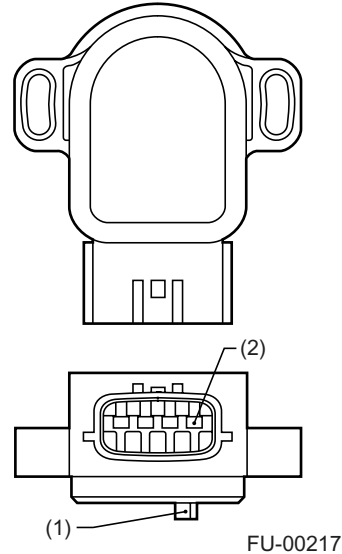
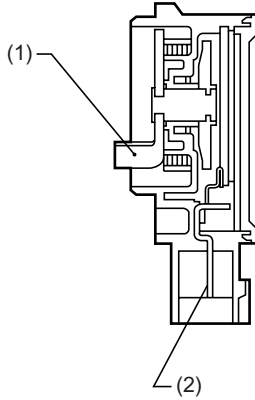
(1) Spherical surface

AIR LINE

Fuel Injection (Fuel System)

E: THROTTLE POSITION SENSOR

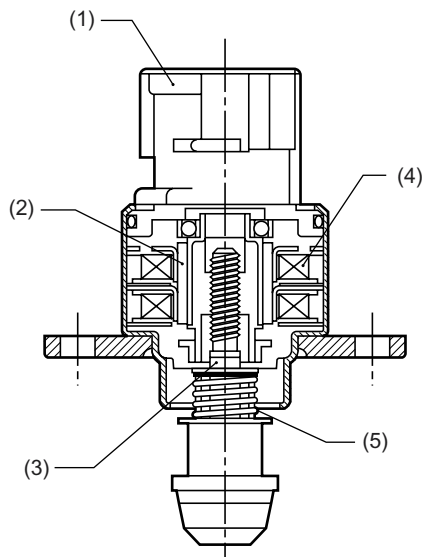
- The throttle position sensor is mounted in the throttle body and linked to the throttle valve.
- The throttle position sensor sends the ECM voltage signal corresponding to the opening of the throttle valve. When the sensor's output voltage exceeds a predetermined level, the ECM interprets it as complete closure of the throttle valve. When the output voltage is at another predetermined level, the ECM recognizes that the throttle valve is at a wide open position. Since the output characteristics of the sensor change over years, the ECM is provided with a learning function to be able to interpret signals into throttle valve angles always correctly.



- (1) Lever
- (2) Terminal

F: IDLE AIR CONTROL SOLENOID VALVE

- The idle air control solenoid valve is located in the throttle body and regulates the amount of intake air that flows bypassing the throttle valve into the intake manifold during engine idling. It is activated by a signal from the ECM in order to maintain the engine idling speed at a target speed.
- The idle air control solenoid valve is a stepping motor type solenoid-actuated valve which consists of coils, a shaft, a permanent magnet, a spring and a housing. The housing is an integral part of the throttle body.
- The stepping motor consists of two paired coils, the coils of each pair being arranged face to face with a shaft in between.
- The shaft has a screw at the end around which the permanent magnets are arranged.
- As current flows in the form of pulses through the paired coils sequentially while alternating the polarity, the N and S poles of the permanent magnets around the shaft are repelled by the same poles of the magnetism generated by the coils. This causes a nut externally fixed to the magnets and internally engaging with the screw of the shaft to turn. The shaft then goes upward or downward.
- This upward and downward motions of the shaft open or close the valve port, adjusting the amount of bypass air.



FU-00218

- (1) Connector
- (2) Permanent magnet
- (3) Shaft
- (4) Coil
- (5) Spring

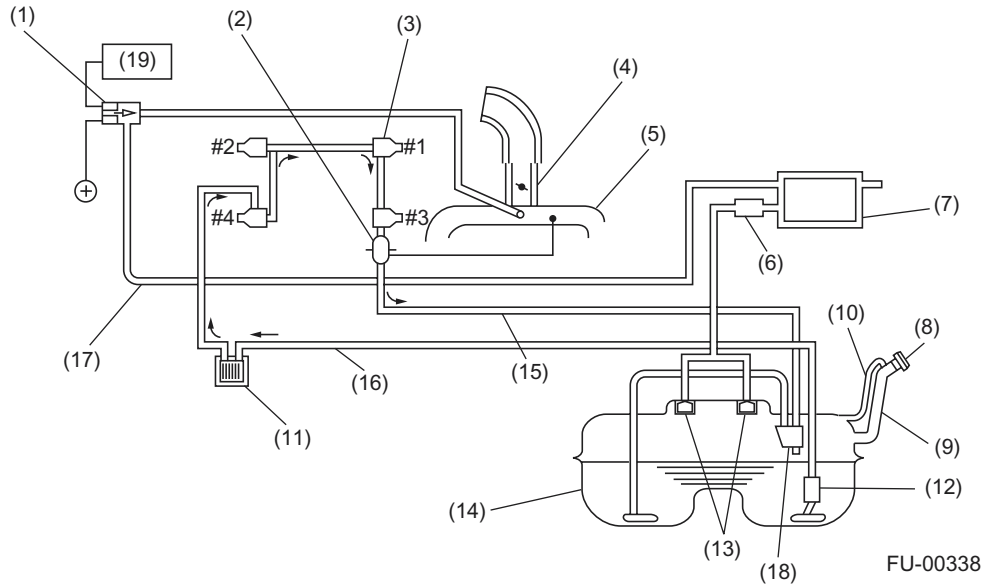
FUEL LINE

Fuel Injection (Fuel System)

3. Fuel Line

A: GENERAL

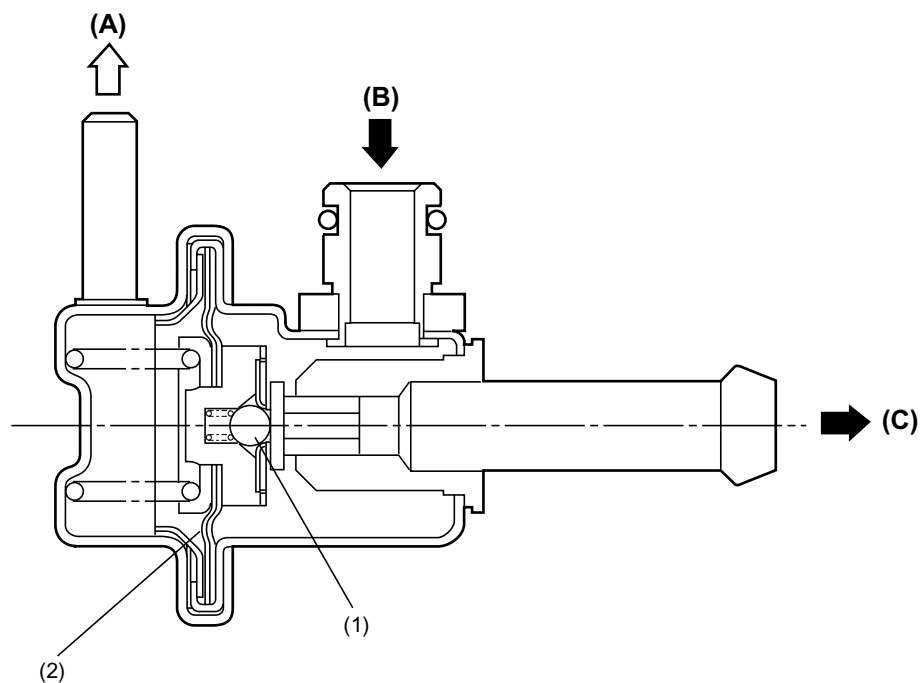
- The fuel pressurized by the fuel tank inside pump is delivered to each fuel injector by way of the fuel pipe and fuel filter. Fuel injection pressure is regulated to an optimum level by the pressure regulator.
- Each injector injects fuel into the intake port of the corresponding cylinder where the fuel is mixed with air. The mixture then enters the cylinder. Fuel injection amount and timing are regulated by the ECM.



- | | |
|----------------------------------|----------------------------|
| (1) Purge control solenoid valve | (11) Fuel filter |
| (2) Pressure regulator | (12) Fuel pump |
| (3) Fuel injector | (13) Fuel cut valve |
| (4) Throttle lever | (14) Fuel tank |
| (5) Intake manifold | (15) Fuel return line |
| (6) Two-way valve | (16) Fuel delivery line |
| (7) Canister | (17) Fuel evaporation line |
| (8) Filter cap | (18) Jet pump |
| (9) Filter pipe | (19) ECM |
| (10) Air vent valve | |

B: PRESSURE REGULATOR

The pressure regulator is installed at the injector end of the fuel supply line. It has a fuel chamber and spring chamber separated by a diaphragm. Fuel chamber is connected to the fuel supply line and the spring chamber is connected to the intake manifold. Fuel chamber also has a relief valve connected to the fuel return line through which fuel returns to the fuel tank. When the intake manifold vacuum increases, the diaphragm is pulled and the relief valve opens to decrease the fuel supply line pressure (or fuel injection pressure). When the intake manifold vacuum decreases, the diaphragm is pushed by the spring to increase the fuel supply line pressure. Thus, the difference between the fuel injection pressure and the intake manifold vacuum is kept at a constant level of 299.1 kPa (3.05 kgf/cm², 43.4 psi) to precisely control the amount of injected fuel.



FU-00221

- (1) Relief valve
- (2) Diaphragm

- (A) To intake manifold
- (B) Fuel IN
- (C) Fuel OUT

FUEL LINE

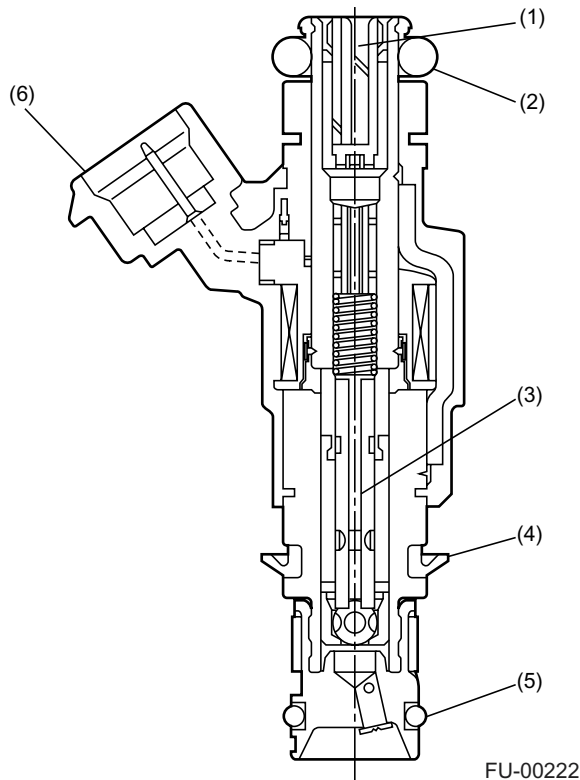
Fuel Injection (Fuel System)

C: FUEL INJECTORS

- The MFI system employs top feed type fuel injectors.
- Each injector is installed in the fuel pipe in such a way that the injector is cooled by fuel.
- The features of this type of fuel injector are as follows:

- 1) High heat resistance
- 2) Low driving noise
- 3) Easy to service
- 4) Small size

- The injector injects fuel according to the valve open signal from the ECM. The needle valve is lifted by the solenoid which is energized on arrival of the valve open signal.
- Since the injector's nozzle hole area, the lift of valve and the fuel pressure are kept constant, the amount of fuel injected is controlled only by varying the duration of the valve open signal from the ECM.



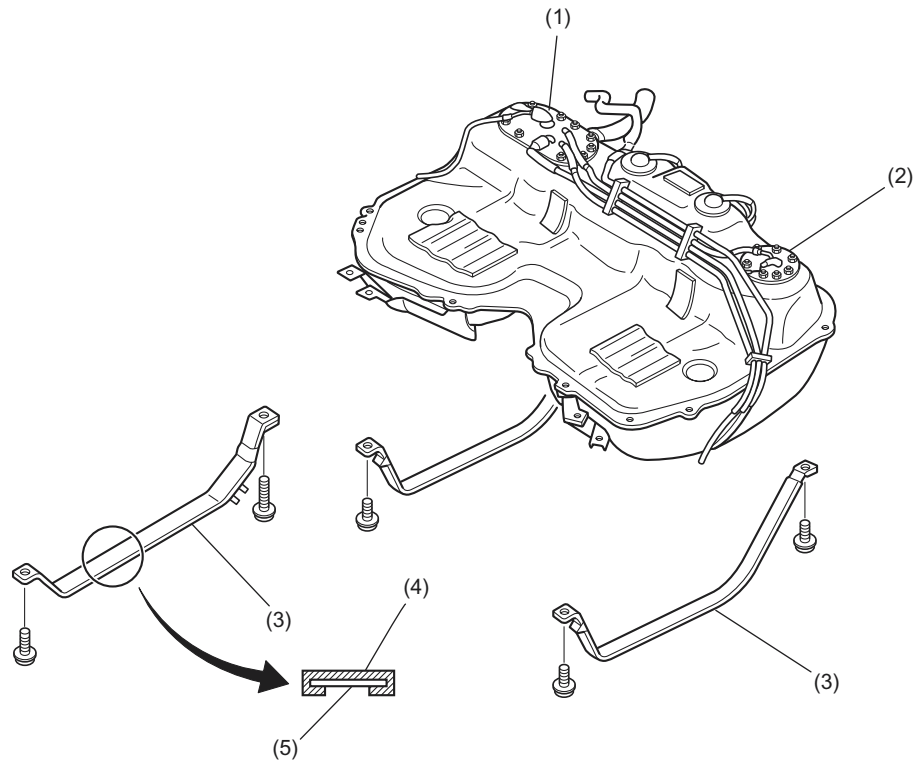
- (1) Filter
- (2) O-ring
- (3) Plunger

- (4) Seal
- (5) O-ring
- (6) Connector

D: FUEL TANK

The fuel tank utilizes a two-compartment design to ensure sufficient capacity without interfering with the rear differential. It is provided with a suction jet pump (included in the fuel pump and fuel level sensor assembly) which transfers fuel from one compartment to the other. Each compartment has an individual fuel level sensor.

The fuel tank is located under the rear seat and secured with hold-down bands.



FU-00689

- (1) Fuel pump and fuel level sensor assembly
- (2) Fuel sub level sensor
- (3) Band

- (4) Cushion
- (5) Steel

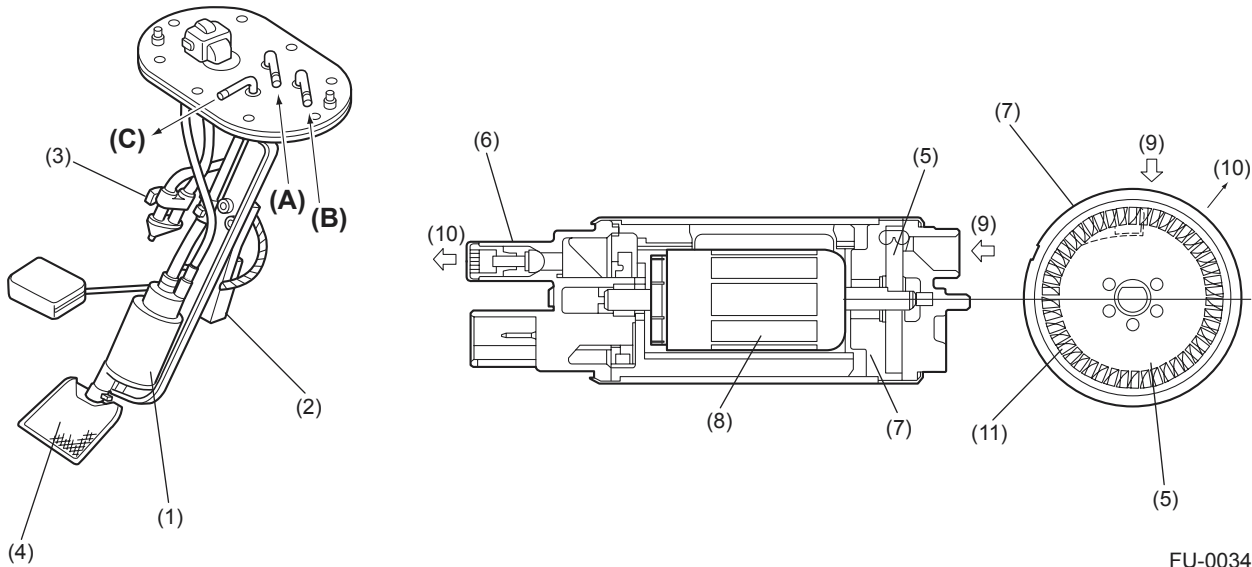
FUEL LINE

Fuel Injection (Fuel System)

E: FUEL PUMP AND FUEL LEVEL SENSOR ASSEMBLY

1. FUEL PUMP

The fuel pump consists of a motor, impeller, pump casing, pump cover, check valve and filter. It is located in the fuel tank and combined with the fuel level sensor into a single unit. The operation of this impeller type pump is very quiet.

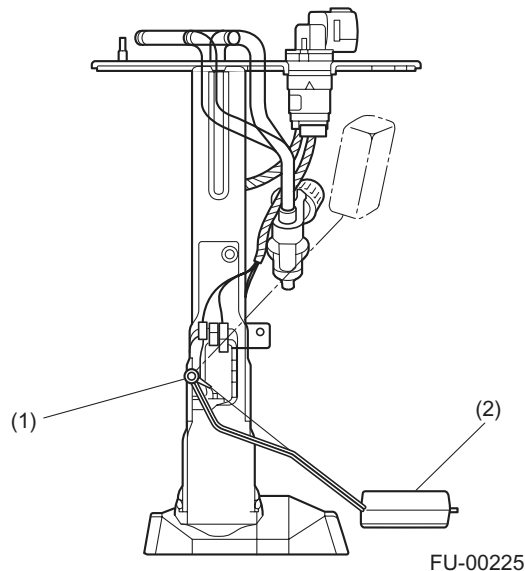


- | | | |
|-----------------------|--------------------|-------------------------------|
| (1) Fuel pump | (7) Pump casing | (A) From engine (return line) |
| (2) Fuel level sensor | (8) Motor armature | (B) From sub tank |
| (3) Jet pump | (9) Suction | (C) To engine (delivery line) |
| (4) Mesh filter | (10) Discharge | |
| (5) Impeller | (11) Vane groove | |
| (6) Check valve | | |

- When the ignition switch is turned ON, fuel pump relay is activated. Then the motor operates to rotate the impeller.
- As the impeller rotates, fuel in a vane groove of the impeller flows along the fuel passage into the next vane groove by centrifugal force. When fuel flows from one groove to the next, a pressure difference occurs due to friction. This creates a pumping effect.
- The fuel pushed up by rotation of the impeller then passes through the clearance between the armature and the magnet of the motor and is discharged through the check valve.
- When the fuel discharge pressure reaches the specified level, the relief valve opens and excess fuel is released into the fuel tank. In this manner, the relief valve prevents an abnormal increase in fuel pressure.
- When the engine and the fuel pump stop, spring force acts on the check valve to close the discharge port, so that the fuel pressure in the fuel delivery line is retained.

2. FUEL LEVEL SENSOR

The fuel level sensor forms part of the fuel pump and located in the fuel tank. The sensor outputs an electric resistance signal that varies with movement of its float to indicate the level of the fuel remaining in the tank.



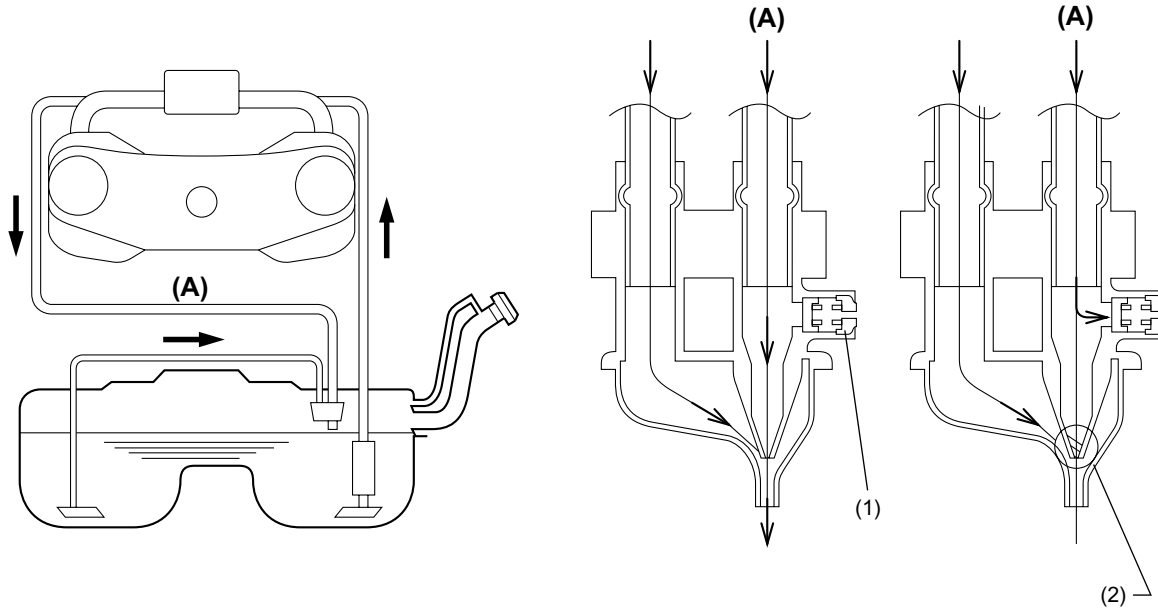
- (1) Fuel level sensor
- (2) Float

FUEL LINE

Fuel Injection (Fuel System)

3. JET PUMP

- The jet pump utilizes the velocity of fuel returning from the engine to produce negative pressure in it.
- Using the pumping effect produced by the negative pressure, the jet pump transfers fuel from the sub-compartment to the main compartment of the fuel tank.
- When the return line nozzle is clogged, the fuel sent back through the return line flows back into the fuel tank via the relief valve.



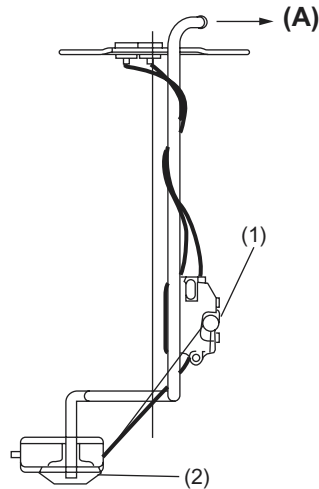
FU-00226

- (1) Relief valve
- (2) Nozzle

(A) Return line

F: SUB-COMPARTMENT FUEL LEVEL SENSOR

This sensor detects the level of the fuel in the sub-compartment (the compartment in which the fuel pump is not located) and acts as part of the fuel transfer line when the jet pump is in operation to maintain the fuel in both compartments at the same level.



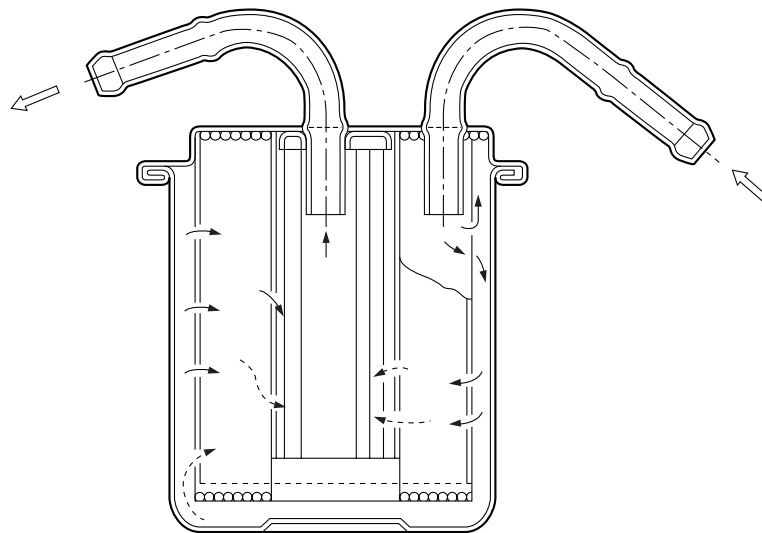
FU-00227

- (1) Fuel level sensor
- (2) Float

(A) To jet pump

G: FUEL FILTER

The fuel filter located in the engine compartment is a pressure-withstanding, cartridge type. It has a filter element in a metal case. The fuel entering the filter flows from the perimeter of the element to the center of the filter and goes out from there.

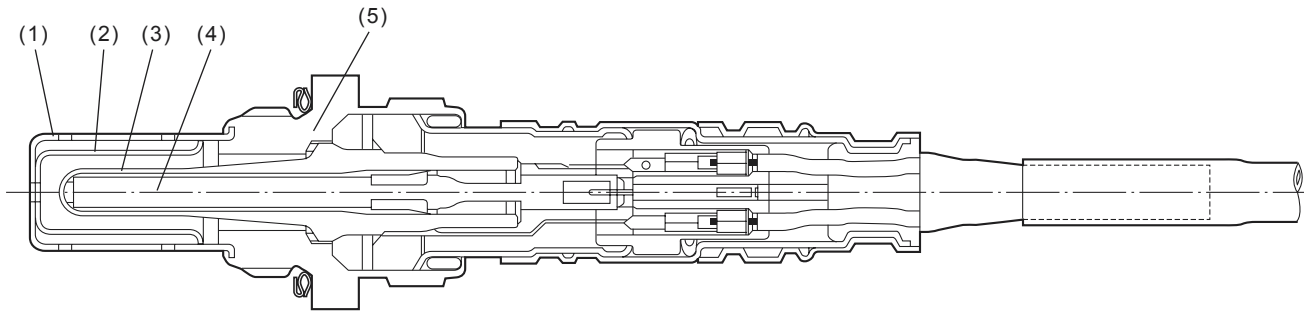


FU-00228

4. Sensors and Switches

A: FRONT OXYGEN (A/F) SENSOR

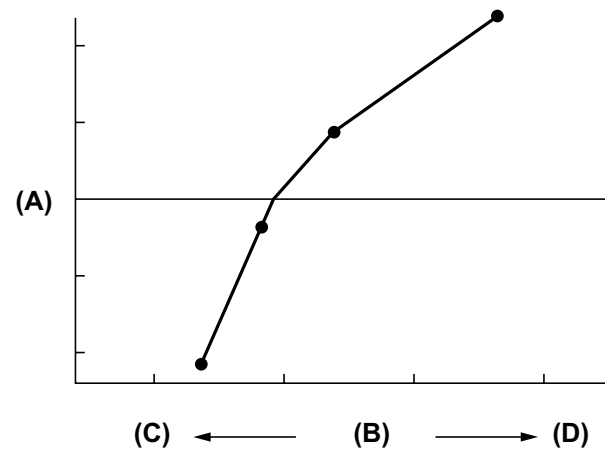
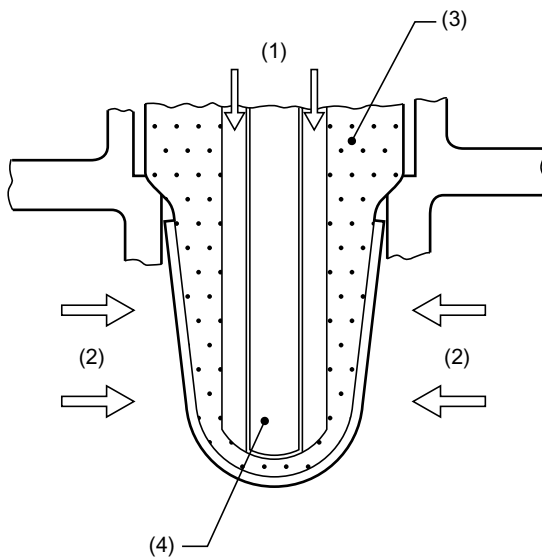
- The front oxygen (A/F) sensor uses zirconium oxide (ZrO_2) which is a solid electrolyte, at portions exposed to exhaust gas.
- The zirconium oxide has the property of generating electromotive force when its both sides are exposed to oxygen ions of different concentration and the magnitude of this electromotive force depends on how much the difference is.
- The front oxygen (A/F) sensor detects the amount of oxygen in exhaust gases by making use of this property of the zirconium oxide material.
- The zirconium oxide material is formed into a closed end tube and its external surface is exposed to exhaust gases with smaller oxygen ion concentration, whereas its internal surface is exposed to atmospheric air. The external surface has a porous platinum coating. The sensor housing is grounded to the exhaust pipe and the inside is connected to the ECM through the harness to be able to use the current output from the sensor.
- The sensor incorporates a ceramic heater to improve its performance at low temperatures.



FU-00419

- (1) Element cover (outer)
- (2) Element cover (inner)
- (3) Sensor element
- (4) Ceramic heater
- (5) Sensor housing

- When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases is almost completely used in the catalytic reaction by the platinum coating on the external surface of the zirconia tube. This results in a very large difference in the oxygen ion concentration between the inside and outside of the tube, and the electromotive force generated is large.
- When a lean air-fuel mixture is burnt in the cylinder, relatively large amount of oxygen remains in the exhaust gases even after the catalytic action, and this results in a small difference in the oxygen ion concentration between the tube's internal and external surfaces. The electromotive force in this case is very small.
- The difference in oxygen concentration changes drastically in the vicinity of the stoichiometric air-fuel ratio, and hence the change in the electromotive force is also large. By using this information, the ECM can determine the air-fuel ratio of the supplied mixture easily. The front oxygen (A/F) sensor does not generate much electromotive force when the temperature is low. The output characteristics of the sensor stabilize at a temperature of approximately 700°C (1,292°F).



- (1) Atmospheric air
- (2) Exhaust gases
- (3) ZrO_2
- (4) Ceramic heater

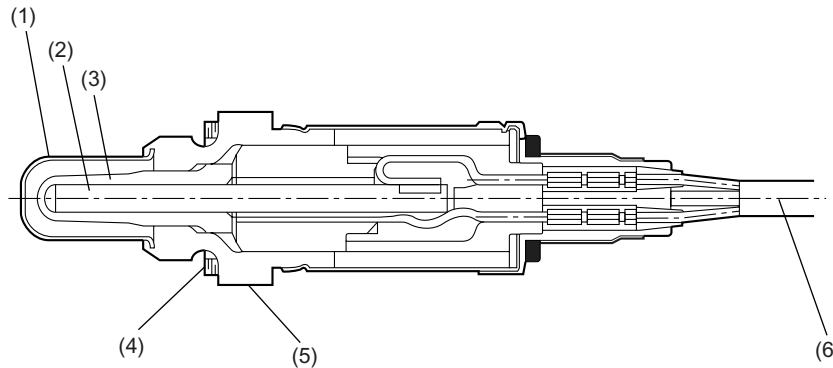
- (A) Electromotive force
- (B) Air-fuel ratio
- (C) Lean
- (D) Rich

FU-00230

SENSORS AND SWITCHES

B: REAR OXYGEN SENSOR

- The rear oxygen sensor is used to sense oxygen concentration in the exhaust gas. If the air-fuel ratio is leaner than the stoichiometric ratio in the mixture (i.e., excessive amount of air), the exhaust gas contains more oxygen. To the contrary, if the fuel ratio is richer than the stoichiometric ratio, the exhaust gas contains almost no oxygen.
- Detecting the oxygen concentration in exhaust gas using the oxygen sensor makes it possible to determine whether the air-fuel ratio is leaner or richer than the stoichiometry.
- The rear oxygen sensor has a zirconia tube (ceramic) which generates voltage if there is a difference in oxygen ion concentration between the inside and outside of the tube. Platinum is coated on the inside and outside of the zirconia tube as a catalysis and electrode material. The sensor housing is grounded to the exhaust pipe and the inside is connected to the ECM through the harness.
- A ceramic heater is employed to improve performance at low temperatures.



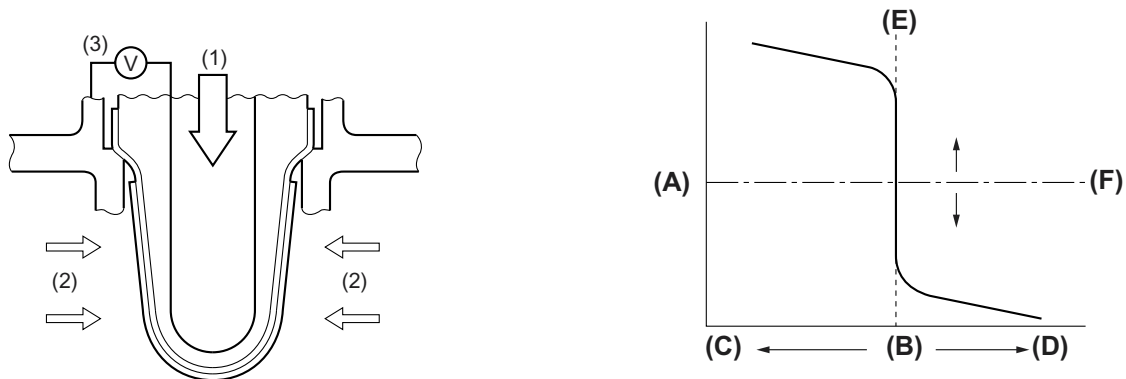
FU-00231

- (1) Protection tube
- (2) Ceramic heater
- (3) Zirconia tube

- (4) Gasket
- (5) Sensor housing
- (6) Harness

SENSORS AND SWITCHES

- When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases is almost completely used in the catalytic reaction by the platinum coating on the external surface of the zirconia tube. This results in a very large difference in the oxygen ion concentration between the inside and outside of the tube, and the electromotive force generated is large.
- When a lean air-fuel mixture is burnt in the cylinder, relatively large amount of oxygen remains in the exhaust gases even after the catalytic action, and this results in a small difference in the oxygen ion concentration between the tube's internal and external surfaces. The electromotive force in this case is very small.
- The difference in oxygen concentration changes drastically in the vicinity of the stoichiometric air-fuel ratio, and hence the change in the electromotive force is also large. By using this information, the ECM can determine the air-fuel ratio of the supplied mixture easily. The rear oxygen sensor does not generate much electromotive force when the temperature is low. The output characteristics of the sensor stabilize at a temperature of approximately 300 to 400°C (572 to 752°F).



FU-00232

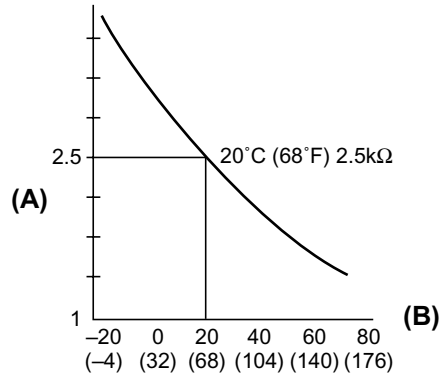
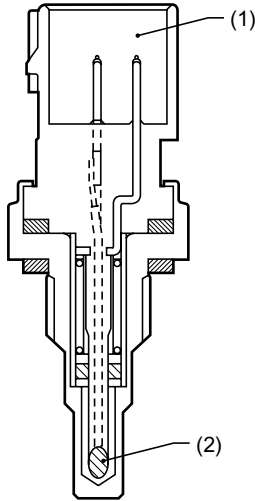
- (1) Atmospheric air
- (2) Exhaust gases
- (3) Electromotive force

- (A) Electromotive force
- (B) Air-fuel ratio
- (C) Rich
- (D) Lean
- (E) Stoichiometric mixture ratio
- (F) Comparison voltage

SENSORS AND SWITCHES

C: ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor is located on the engine coolant pipe. The sensor uses a thermistor whose resistance changes inversely with temperature. Resistance signals as engine coolant temperature information are transmitted to the ECM to make fuel injection, ignition timing, purge control solenoid valve and other controls.



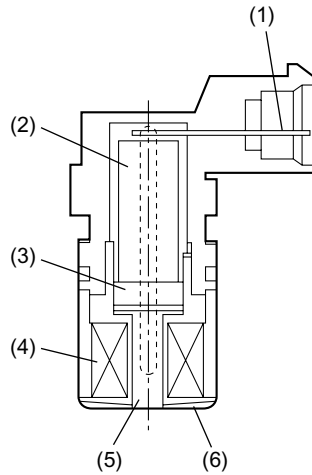
FU-00233

- (1) Connector
- (2) Thermistor element

- (A) Resistance (kΩ)
- (B) Temperature °C (°F)

D: CRANKSHAFT POSITION SENSOR

- The crankshaft position sensor is installed on the oil pump which is located in the front center portion of the cylinder block. The sensor generates a pulse when one of the teeth on the perimeter of the crankshaft sprocket (rotating together with the crankshaft) passes in front of it. The ECM determines the crankshaft angular position by counting the number of pulses.
- The crankshaft position sensor is a molded type which consists of a magnet, core, coil, terminals and other components as illustrated below.



FU-00234

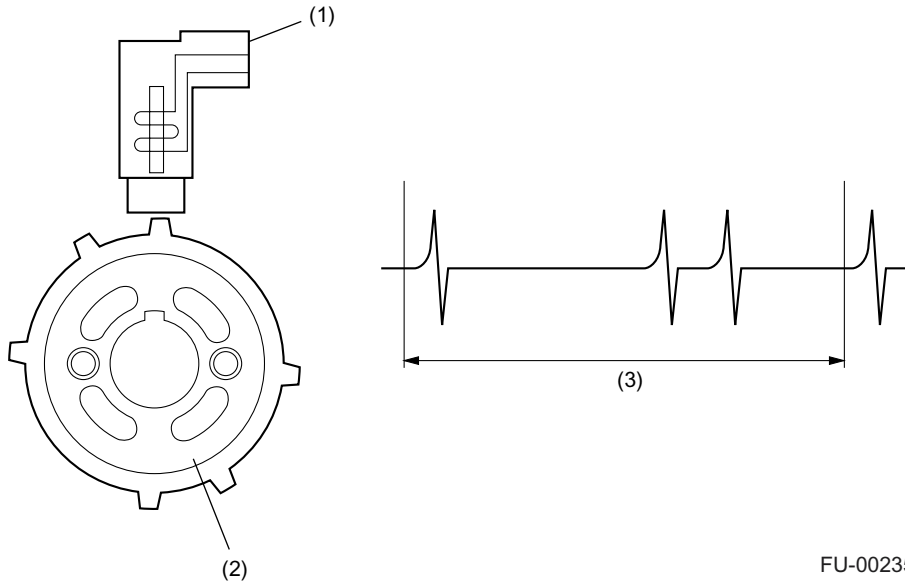
- (1) Terminal
- (2) Yoke core
- (3) Magnet

- (4) Coil
- (5) Core
- (6) Cover

SENSORS AND SWITCHES

Fuel Injection (Fuel System)

- As the crankshaft rotates, each tooth aligns with the crankshaft position sensor. At that time, the magnetic flux in the sensor's coil changes since the air gap between the sensor pickup and the sprocket changes. This change in magnetic flux induces a voltage pulse in the sensor and the pulse is transmitted to the ECM.



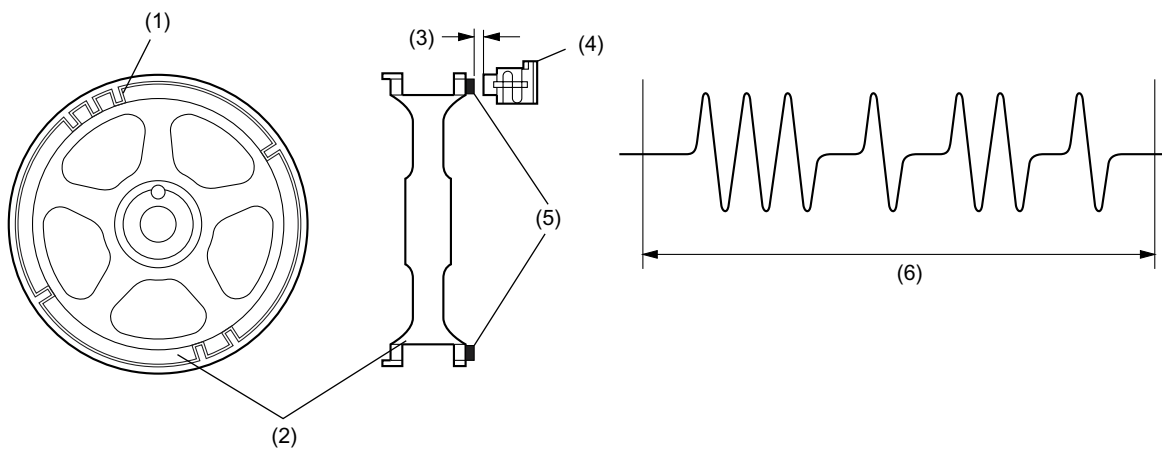
FU-00235

- (1) Crankshaft position sensor
- (2) Crankshaft sprocket
- (3) Crankshaft half rotation

E: CAMSHAFT POSITION SENSOR

- The camshaft position sensor is located on the left-hand camshaft support. This sensor detects the combustion cylinder at any given moment.
- The sensor generates a pulse when one of the bosses on the back of the left-hand camshaft drive sprocket passes in front of the sensor. The ECM determines the camshaft angular position by counting the number of pulses.

Internal construction and the basic operating principle of the camshaft position sensor are similar to those of the crankshaft position sensor. A total of seven bosses are arranged at equally spaced four locations (one each at two locations, two at one location, and three at one location) of the sprocket as shown below.



FU-00236

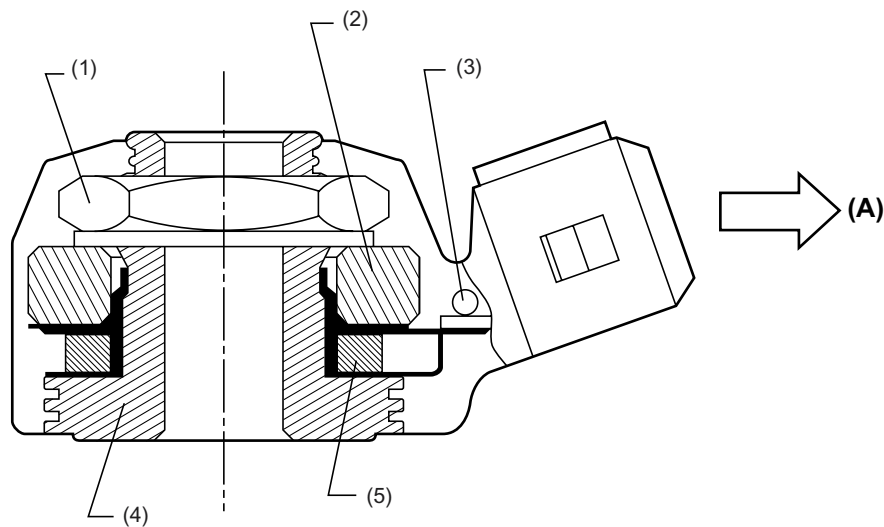
- (1) Boss
- (2) Camshaft sprocket
- (3) Air gap

- (4) Camshaft position sensor
- (5) Boss
- (6) Camshaft one rotation (Crankshaft two rotations)

SENSORS AND SWITCHES

F: KNOCK SENSOR

- The knock sensor is installed on the cylinder block, and senses knocking that occurs in the engine.
- The sensor is a piezo-electric type which converts vibration resulting from knocking into electric signals.
- In addition to a piezo-electric element, the sensor has a weight and case as its components. If knocking occurs in the engine, the weight in the case moves causing the piezo-electric element to generate a voltage.
- The knock sensor harness is connected to the bulkhead harness.



FU-00237

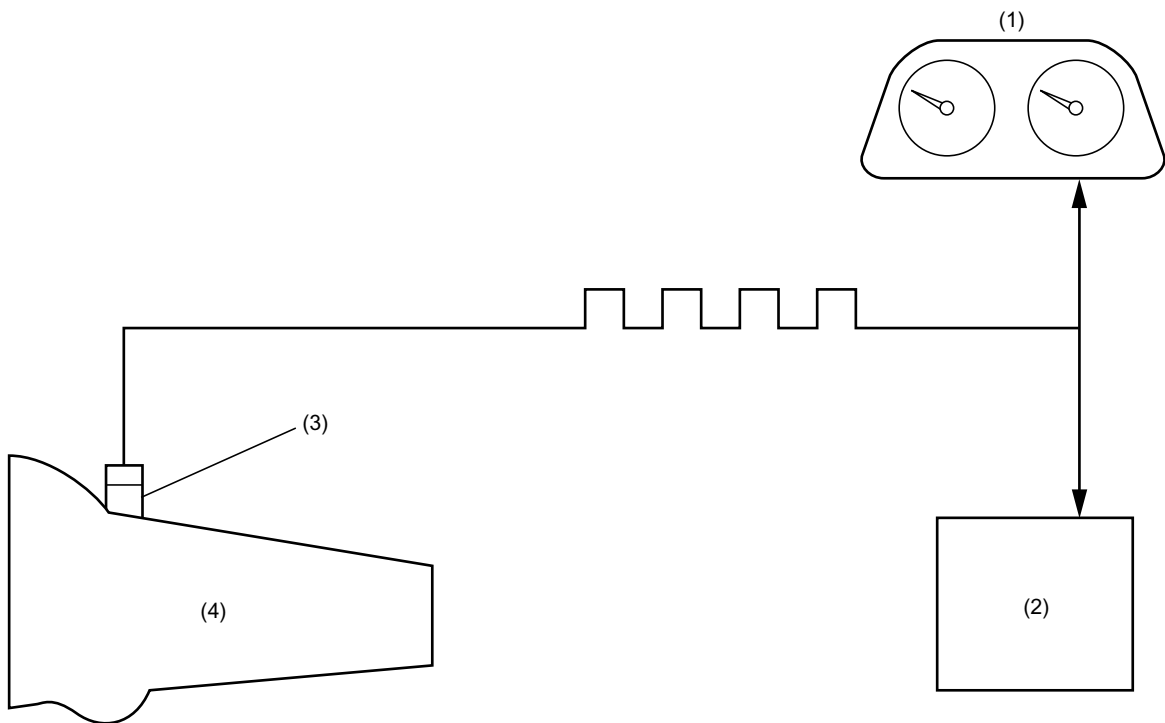
- (1) Case
- (2) Weight
- (3) Piezo-electric element
- (4) Nut
- (5) Resistor

(A) To knock sensor harness

G: VEHICLE SPEED SENSOR

1. MT VEHICLES

- The vehicle speed sensor is mounted on the transmission.
- The vehicle speed sensor generates a 4-pulse signal for every rotation of the front differential and send it to the ECM and the combination meter.



FU-00238

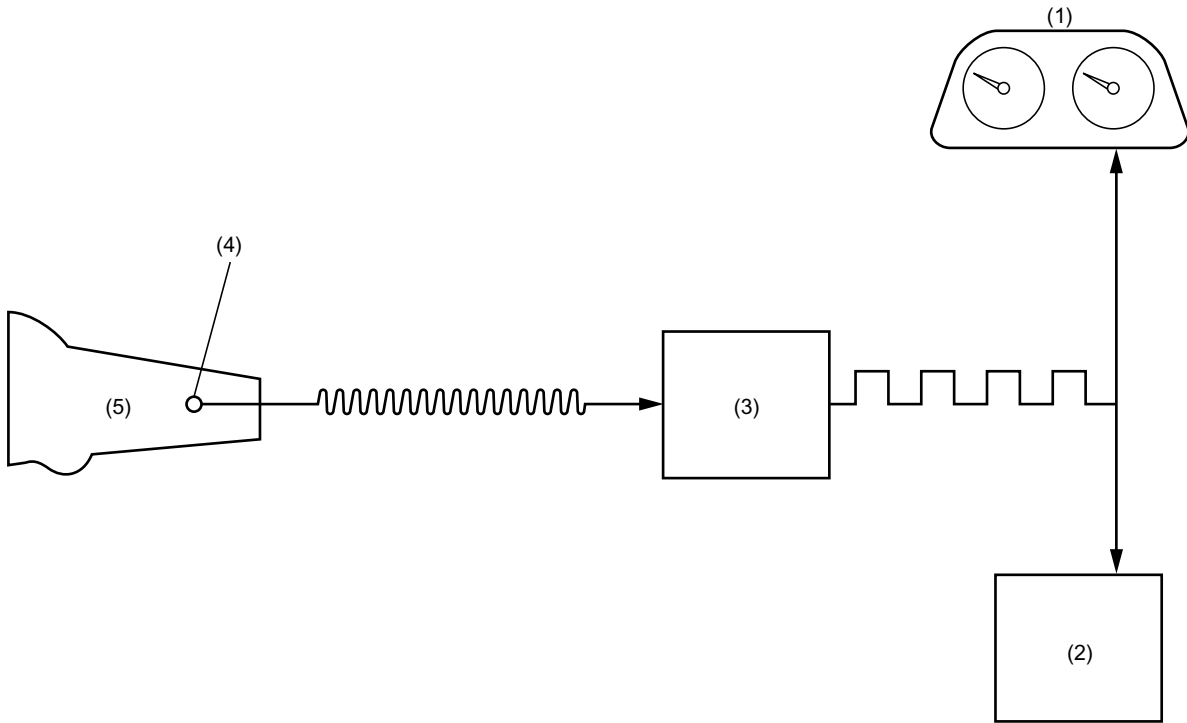
- (1) Combination meter
- (2) ECM
- (3) Vehicle speed sensor
- (4) Transmission

SENSORS AND SWITCHES

Fuel Injection (Fuel System)

2. AT VEHICLES

- The vehicle speed sensor is mounted on the transmission.
- The vehicle speed sensor generates a 16-pulse signal for every rotation of the front differential and send it to the transmission control module (TCM). The signal sent to the TCM is converted there into a 4-pulse signal, and then sent to the ECM and the combination meter.



FU-00239

- (1) Combination meter
- (2) ECM
- (3) TCM
- (4) Vehicle speed sensor
- (5) Transmission

5. Control System

A: GENERAL

The ECM receives signals from various sensors, switches, and other control modules. Using these signals, it determines the engine operating conditions and if necessary, emits signals to one or more systems to control them for optimum operation.

Major control items of the ECM are as follow:

- Fuel injection control
- Ignition system control
- Idle air control
- Fuel pump control
- Canister purge control^{*1}
- Radiator fan control^{*2}
- On-board diagnosis function

*1: Canister purge control is described under “EC (SOHC) – Emission Control (Aux. Emission Control Devices) Evaporative Emission Control System”.

*2: Radiator fan control is described under “CO (SOHC) – Cooling”.

CONTROL SYSTEM

Fuel Injection (Fuel System)

B: INPUT AND OUTPUT SIGNALS

Signal	Unit	Function
Input signals	Intake air pressure sensor	Detects the pressure of intake air (measures the absolute pressure).
	Intake air temperature sensor	Detects the temperature of intake air.
	Atmospheric pressure sensor	Detects the amount of intake air (measure the atmospheric pressure).
	Throttle position sensor	Detects the throttle valve position.
	Front oxygen (A/F) sensor	Detects the density of oxygen in exhaust gases at the upstream of the front catalytic converter.
	Rear oxygen sensor	Detects the density of oxygen in exhaust gases at the downstream of the front catalytic converter.
	Crankshaft position sensor	Detects the crankshaft angular position.
	Camshaft position sensor	Detects the combustion cylinder.
	Engine coolant temperature sensor	Detects the engine coolant temperature.
	Knock sensor	Detects engine knocking.
	Vehicle speed sensor	Detects vehicle speed.
	Ignition switch	Detects operation of the ignition switch.
	Starter switch	Detects the condition of engine cranking.
	Neutral position switch (MT)	Detects that the gear is in neutral.
	Inhibitor switch (AT)	Detects shift positions.
	Torque control signal (AT)	Controls engine torque.
	Heater circuit of front and rear oxygen sensor	Detects abnormality in the heater circuit of the front and rear oxygen sensors.
	Diagnostics of TCM (AT)	Detects the self-diagnostics of the TCM.
	A/C switch	Detects ON-OFF operation of the A/C switch.
	Fuel level sensor	Detects the level of the fuel in the fuel tank.
Output signals	Small light switch	Detects ON-OFF operation of the small light switch.
	Blower fan switch	Detects ON-OFF operation of the blower fan switch.
	Rear defogger switch	Detects ON-OFF operation of the rear defogger switch.
	Fuel injectors	Activates an injector.
	Ignition signal	Turns the primary ignition current ON or OFF.
	Fuel pump relay	Turns the fuel pump relay ON or OFF.
	A/C relay	Turns the A/C control relay ON or OFF.
	Radiator fan control relay	Turns the radiator fan control relay ON or OFF.
	Idle air control solenoid valve	Adjusts the amount of air flowing through the bypass line in the throttle body.
	Malfunction indicator lamp	Indicates existence of abnormality.
Purge control solenoid valve	Controls purge of evaporative gas absorbed by the canister.	
Power supply	Control ON/OFF of the main power supply relay.	

C: FUEL INJECTION CONTROL

- The ECM receives signals from various sensors and based on them, it determines the amount of fuel injected and the fuel injection timing. It performs the sequential fuel injection control over the entire engine operating range except during start-up of the engine.
- The amount of fuel injected depends upon the length of time the injector stays open. The fuel injection duration is determined according to varying operating condition of the engine. For the purpose of achieving highly responsive and accurate fuel injection duration control, the ECM performs a new feedback control that incorporates a learning feature as detailed later.
- The sequential fuel injection control is performed such that fuel is injected accurately at the time when the maximum air intake efficiency can be achieved for each cylinder (i.e., fuel injection is completed just before the intake valve begins to open).

1. FUEL INJECTION DURATION

Fuel injection duration is basically determined as indicated below:

- During engine start-up:

The duration defined below is used.

- Duration of fuel injection during engine start-up Determined according to the engine coolant temperature detected by the engine coolant temperature sensor.

- During normal operation:

The duration is determined as follows:

Basic duration of fuel injection x Correction factors + Voltage correction time

- Basic duration of fuel injection The basic length of time fuel is injected. This is determined by two factors – the amount of intake air detected by the manifold pressure sensor and the engine speed monitored by the crankshaft position sensor.
- Correction factors See the next section.
- Voltage correction time This is added to compensate for the time lag before operation of injector that results from variation in the battery voltage.

2. CORRECTION FACTORS

The following factors are used to correct the basic duration of fuel injection in order to make the air-fuel ratio meet the requirements of varying engine operating conditions:

- **Air-fuel ratio feedback factor:**

This factor is used to correct the basic duration of fuel injection in relation to the actual engine speed. (See the next section for more detail.)

- **Start increment factor:**

This factor is used to increase the fuel injection duration only while the engine is being cranked to improve its startability.

- **Coolant-temperature-dependent increment factor:**

This factor is used to increase the fuel injection duration depending on engine coolant temperature signals to facilitate cold starting. The lower the coolant temperature, the greater the increment.

- **After-start increment factor:**

- This factor is used to increase the fuel injection duration for a certain period immediately after start of the engine to stabilize engine operation.
- The increment depends on the coolant temperature at the start of the engine.

- **Wide-open-throttle increment factor:**

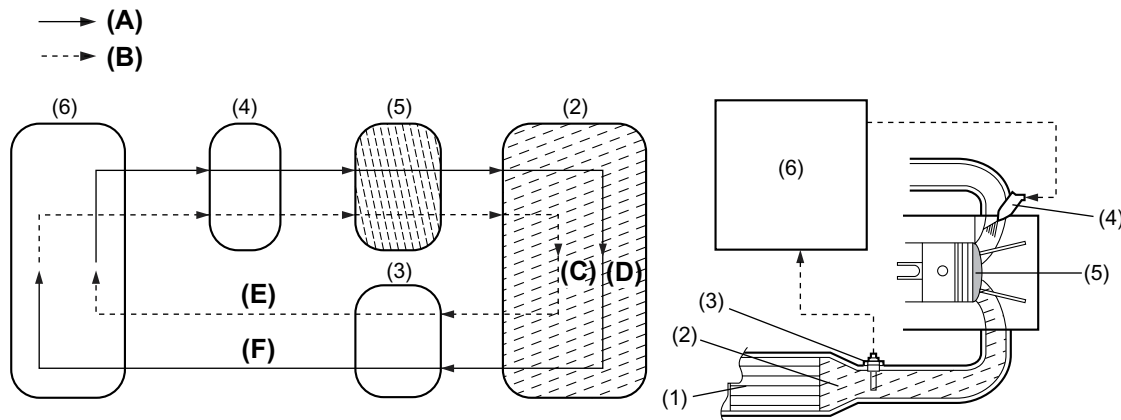
This factor is used to increase the fuel injection duration depending on the relationship between the throttle position sensor signal and manifold pressure sensor signal.

- **Acceleration increment factor:**

This factor is used to increase the fuel injection duration to compensate for a time lag between air flow measurement and fuel injection control for better engine response to driver's pedal operation during acceleration.

3. AIR-FUEL RATIO FEEDBACK FACTOR

The ECM creates this factor utilizing the front oxygen (A/F) sensor signal. When the signal voltage is high, the air-fuel ratio is richer than the stoichiometric ratio. The ECM then makes the fuel injection duration shorter by modifying the factor. When the voltage is low showing that the mixture is lean, the ECM modifies the factor to make the injection duration longer. In this way, the air-fuel ratio is maintained at a level close to the stoichiometric ratio at which the three-way catalyst acts most effectively.



FU-00240

- | | |
|-------------------------------|---|
| (1) Front catalyst | (A) Injection duration increment signal |
| (2) Exhaust gas | (B) Injection duration decrement signal |
| (3) Front oxygen (A/F) sensor | (C) High oxygen density |
| (4) Fuel injector | (D) Low oxygen density |
| (5) Combustion chamber | (E) Lean signal |
| (6) ECM | (F) Rich signal |

4. LEARNING FEATURE

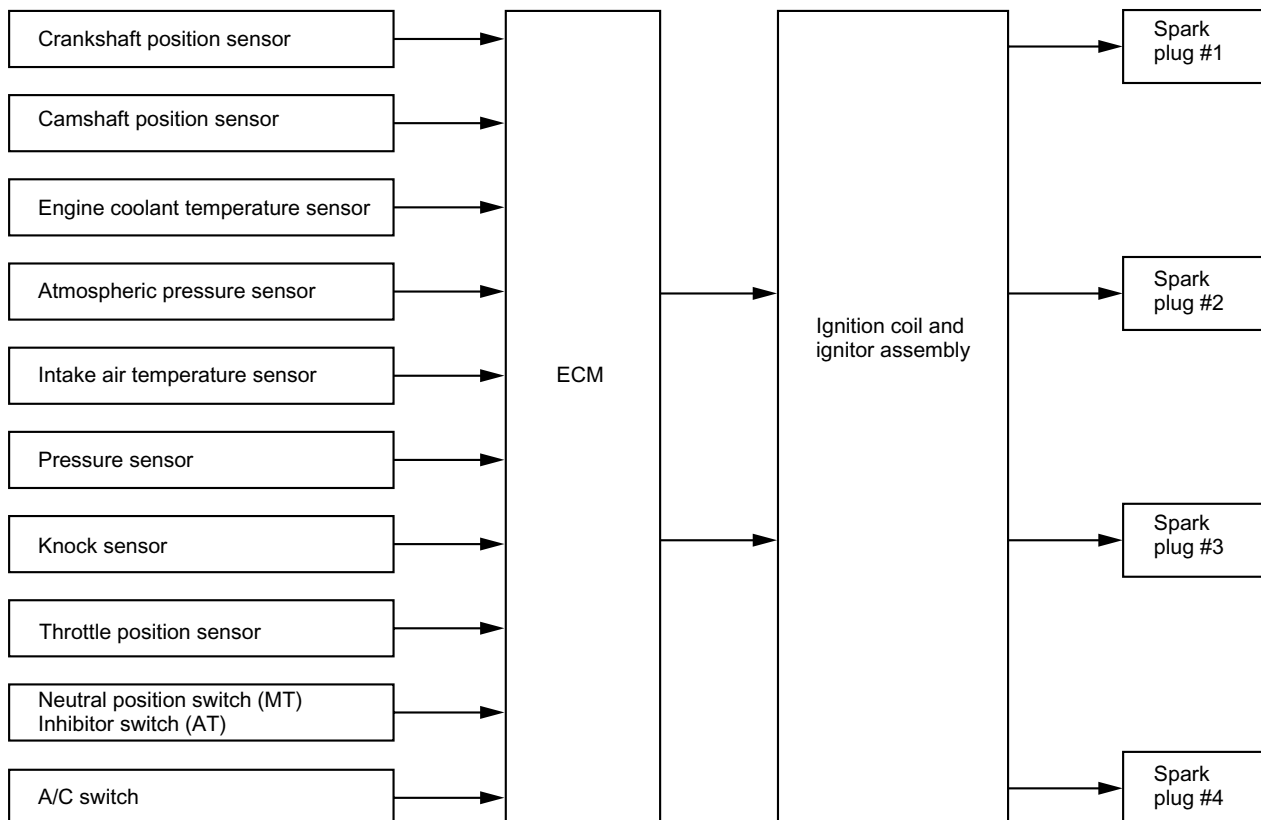
The air-fuel ratio feedback control includes a learning feature which contributes to more accurate and responsive control.

- In the air-fuel ratio feedback control, the ECM calculates the necessary amount of correction based on data from the oxygen sensor and adds the result to the basic duration (which is stored in the ECM's memory for each condition defined by the engine speed and various loads.)
- Without a learning feature, the ECM carries out the above-mentioned process every time. This means that if the amount of necessary correction is large, the air-fuel ratio feedback control becomes less responsive and less accurate.
- The learning feature enables the ECM to store the amount of correction into memory and add it to the basic fuel injection duration to create a new reference fuel injection duration. Using the reference duration as the basic duration for the injection a few times later, the ECM can reduce the amount of correction and thus make its feedback control more accurate and responsive to changes in the air-fuel ratio due to difference in driving condition and sensor/actuator characteristics that may result from unit-to-unit variation or aging over time.

CONTROL SYSTEM

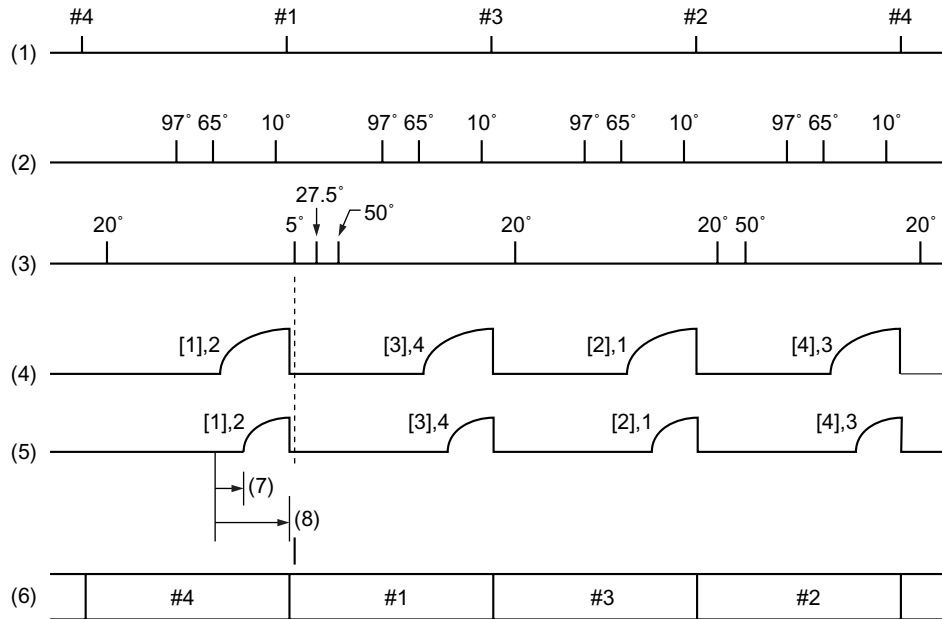
D: IGNITION SYSTEM CONTROL

- The ECM determines operating condition of the engine based on signals from the pressure sensor, engine coolant temperature sensor, intake air temperature sensor, crankshaft position sensor and other sources. It then selects the ignition timing most appropriate for the condition thus determined from those stored in its memory and outputs at that timing a primary current OFF signal to the ignitor to initiate ignition.
- This control uses a quick-to-response learning feature by which the data stored in the ECM memory is processed in comparison with information from various sensors and switches.
- Thus, the ECM can always perform optimum ignition timing taking into account the output, fuel consumption, exhaust gas, and other factors for every engine operating condition.
- Ignition control during start-up Engine speed fluctuates during start of the engine, so the ECM cannot control the ignition timing. During that period, the ignition timing is fixed at 10° BTDC by using the 10° signal from the crankshaft position sensor.



● Ignition control after start of engine

Between the 97° and 65° crank angle signal, the ECM measures the engine speed, and by using this data it decides the dwell set timing and ignition timing according to the engine condition.



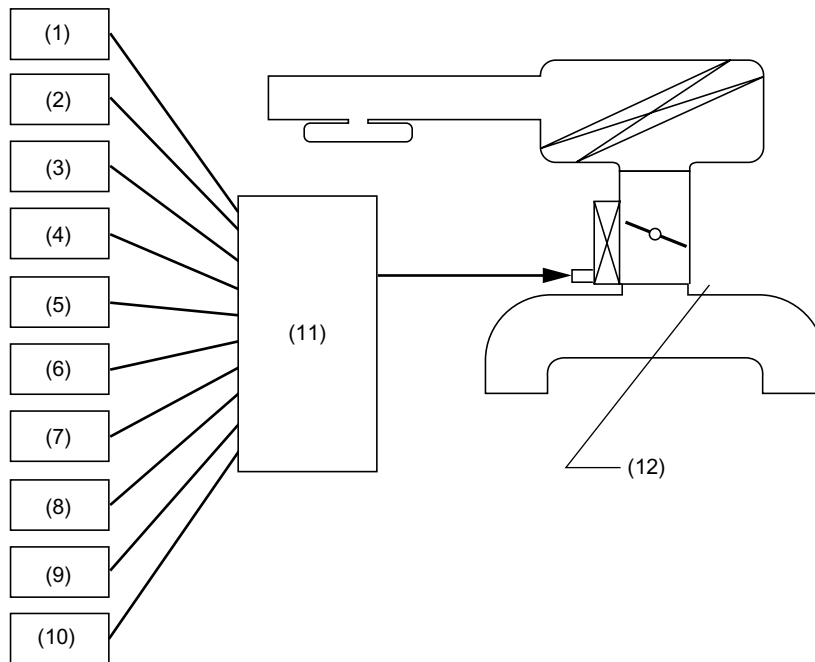
FU-00242

- | | |
|---------------------------------|---|
| (1) Cylinder number | (5) Ignition timing at normal condition |
| (2) Crank angle pulse (BTDC) | (6) Burning cylinder |
| (3) Cam angle pulse (ATDC) | (7) Dwell set |
| (4) Ignition timing at starting | (8) Ignite |

CONTROL SYSTEM

E: IDLE AIR CONTROL

- The ECM activates the idle air control solenoid valve to control the bypass air flowing through the bypass passage in the throttle body depending on signals from the crankshaft position sensor, engine coolant temperature sensor, pressure sensor and A/C switch so that the proper idle speed for each engine load is achieved.
- The idle air control solenoid valve is a stepping motor type valve which moves a shaft up and down to adjust the air flow through the bypass passage according to the signal from the ECM. Thus, the idling speed can always be maintained at the target speed.
- The bypass air control is necessary for:
 - Increasing idling speed when the air conditioning system and/or electrical loads are turned on.
 - Increasing idling speed during early stage of warm up period.
 - Obtaining dashpot function when the throttle valve is quickly closed.
 - Prevention of engine speed variation during idling.



FU-00243

- | | |
|---------------------------------------|--|
| (1) Intake air temperature sensor | (7) Vehicle speed sensor |
| (2) Pressure sensor | (8) Ignition switch |
| (3) Crankshaft position sensor | (9) A/C switch |
| (4) Camshaft position sensor | (10) Neutral position switch (MT)
Inhibitor switch (AT) |
| (5) Throttle position sensor | (11) ECM |
| (6) Engine coolant temperature sensor | (12) Idle air control solenoid valve |

F: FUEL PUMP CONTROL

Using the signal from the crankshaft position sensor, the ECM controls operation of the fuel pump by turning its relay ON or OFF. To improve safety, the fuel pump is stopped if the engine stalls with the ignition switch ON.

Ignition switch ON	Fuel pump relay	Fuel pump
A certain period of time after ignition switch is turned ON	ON	Operates
While cranking the engine	ON	Operates
While engine is operating	ON	Operates
When engine stops	OFF	Does not operate

6. On-board Diagnosis System

A: GENERAL

- The on-board diagnosis system detects and indicates a fault by generating a code corresponding to each fault location. The malfunction indicator lamp (CHECK ENGINE light) on the combination meter indicates occurrence of a fault or abnormality.
- When the malfunction indicator lamp comes on as a result of detection of a fault by the ECM, the corresponding diagnostic trouble code (DTC) and freeze frame engine condition are stored in the ECM.
- On the OBD-II conformable car, it is necessary to connect the Subaru Select Monitor (SSM) or General Scan Tool (GST) to the data link connector in order to check the DTC.
- The SSM and GST can erase DTCs. They can also read freeze frame data in addition to other pieces of engine data.
- If there is a failure involving sensors which may affect drive control of the vehicle, the fail-safe function ensures minimum level of driveability.

B: FAIL-SAFE FUNCTION

For a sensor or switch which has been judged faulty in the on-board diagnosis, the ECM, if appropriate, generates an associated pseudo signal to keep the vehicle operational. (The control becomes degraded.)

EMISSION CONTROL (AUX. EMISSION CONTROL DEVICES)

EC (SOHC)

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SYSTEM OVERVIEW

Emission Control (Aux. Emission Control Devices)

1. System Overview

There are three emission control systems which are as follows:

- Crankcase emission control system
- Exhaust emission control system
 - Three-way catalyst system
 - Air/fuel (A/F) control system
 - Ignition control system
- Evaporative emission control system

Item		Main components	Function	
Crankcase emission control system		Positive crankcase ventilation (PCV) valve	Draws blow-by gas into intake manifold from crankcase and burns it together with air-fuel mixture. Amount of blow-by gas to be drawn in is controlled by intake manifold pressure.	
Exhaust emission control system	Catalyst system	Front	Three-way catalyst	Oxidizes HC and CO contained in exhaust gases as well as reducing NOx.
		Rear		
	A/F control system		Engine control module (ECM)	Receives input signals from various sensors, compares signals with stored data, and emits a signal for optimal control of air-fuel mixture ratio.
			Front oxygen (A/F) sensor	Detects quantity of oxygen contained in exhaust gases.
			Rear oxygen sensor	Detects density of oxygen contained in exhaust gases.
			Throttle position sensor	Detects throttle position.
			Intake air pressure sensor	Detects absolute pressure of intake manifold.
			Intake air temperature sensor	Detects intake air temperature at air cleaner case.
	Ignition control system		ECM	Receives various signals, compares signals with basic data stored in memory, and emits a signal for optimal control of ignition timing.
			Crankshaft position sensor	Detects engine speed (revolution).
			Camshaft position sensor	Detects reference signal for combustion cylinder discrimination.
		Engine coolant temperature sensor	Detects coolant temperature.	
		Knock sensor	Detects engine knocking.	
Evaporative emission control system		Canister	Absorbs evaporative gas which occurs in fuel tank when engine stops, and releases it to combustion chambers for a complete burn when engine is started. This prevents HC from being discharged into atmosphere.	
		Purge control solenoid valve	Receives a signal from ECM and controls purge of evaporative gas absorbed by canister.	

SYSTEM OVERVIEW

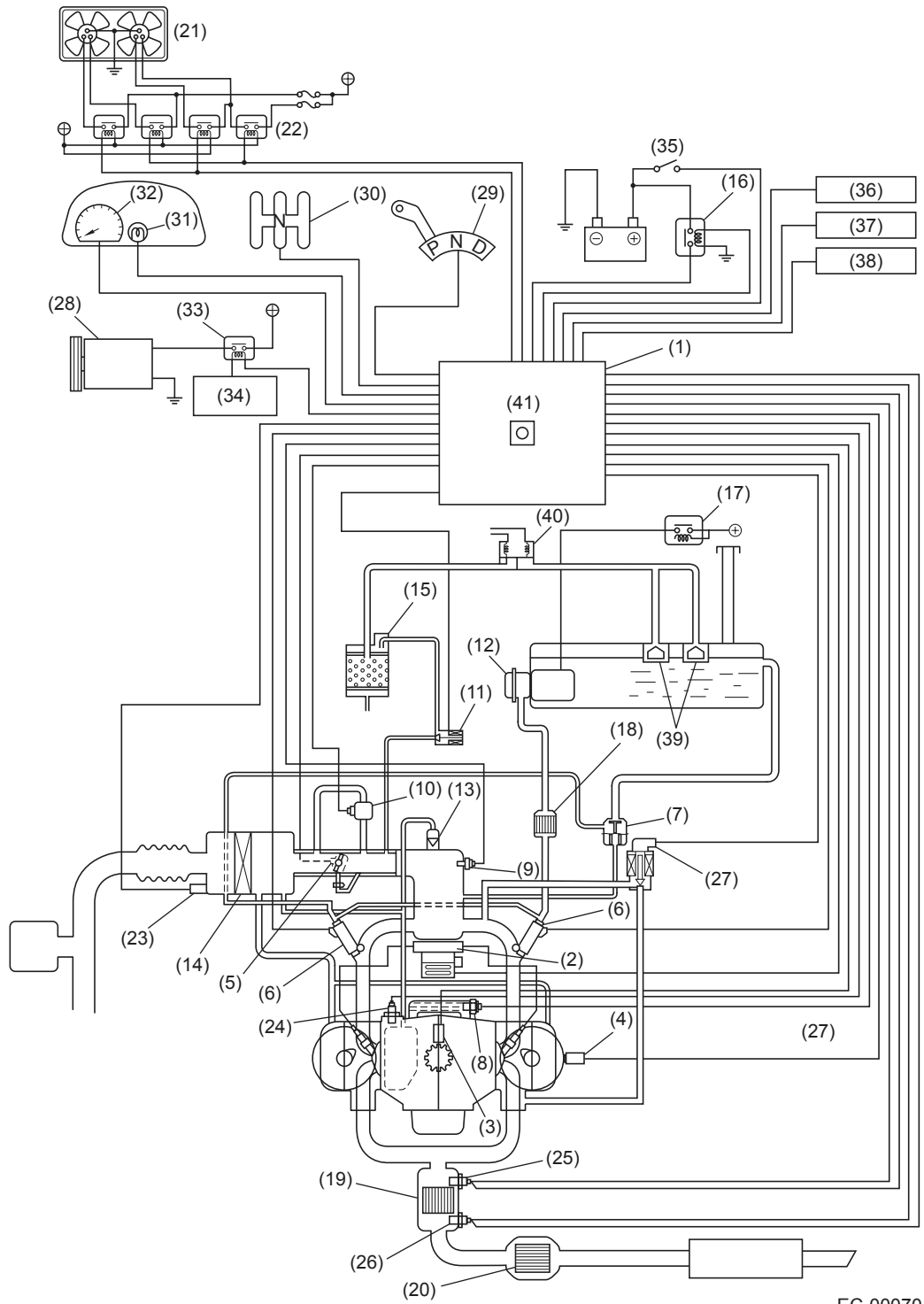
Emission Control (Aux. Emission Control Devices)

MEMO

SCHEMATIC DIAGRAMS

Emission Control (Aux. Emission Control Devices)

2. Schematic Diagrams



EC-00070

SCHEMATIC DIAGRAMS

Emission Control (Aux. Emission Control Devices)

- | | | |
|--|------------------------------------|---|
| (1) Engine control module (ECM) | (15) Canister | (29) Inhibitor switch (AT vehicles only) |
| (2) Ignition coil and ignitor assembly | (16) Main relay | (30) Neutral switch (MT vehicles only) |
| (3) Crankshaft position sensor | (17) Fuel pump relay | (31) CHECK ENGINE malfunction indicator lamp (MIL) |
| (4) Camshaft position sensor | (18) Fuel filter | (32) Tachometer |
| (5) Throttle position sensor | (19) Front catalytic converter | (33) A/C relay |
| (6) Fuel injectors | (20) Rear catalytic converter | (34) A/C control module |
| (7) Pressure regulator | (21) Radiator fan | (35) Ignition switch |
| (8) Engine coolant temperature sensor | (22) Radiator fan relay | (36) Transmission control module (TCM) (AT vehicles only) |
| (9) Pressure sensor | (23) Intake air temperature sensor | (37) Vehicle speed sensor |
| (10) Idle air control solenoid valve | (24) Knock sensor | (38) Data link connector |
| (11) Purge control solenoid valve | (25) Front oxygen (A/F) sensor | (39) Fuel cut valve |
| (12) Fuel pump | (26) Rear oxygen sensor | (40) Two-way valve |
| (13) PCV valve | (27) EGR valve | (41) Atmospheric pressure sensor |
| (14) Air cleaner element | (28) A/C compressor | |

CRANKCASE EMISSION CONTROL SYSTEM

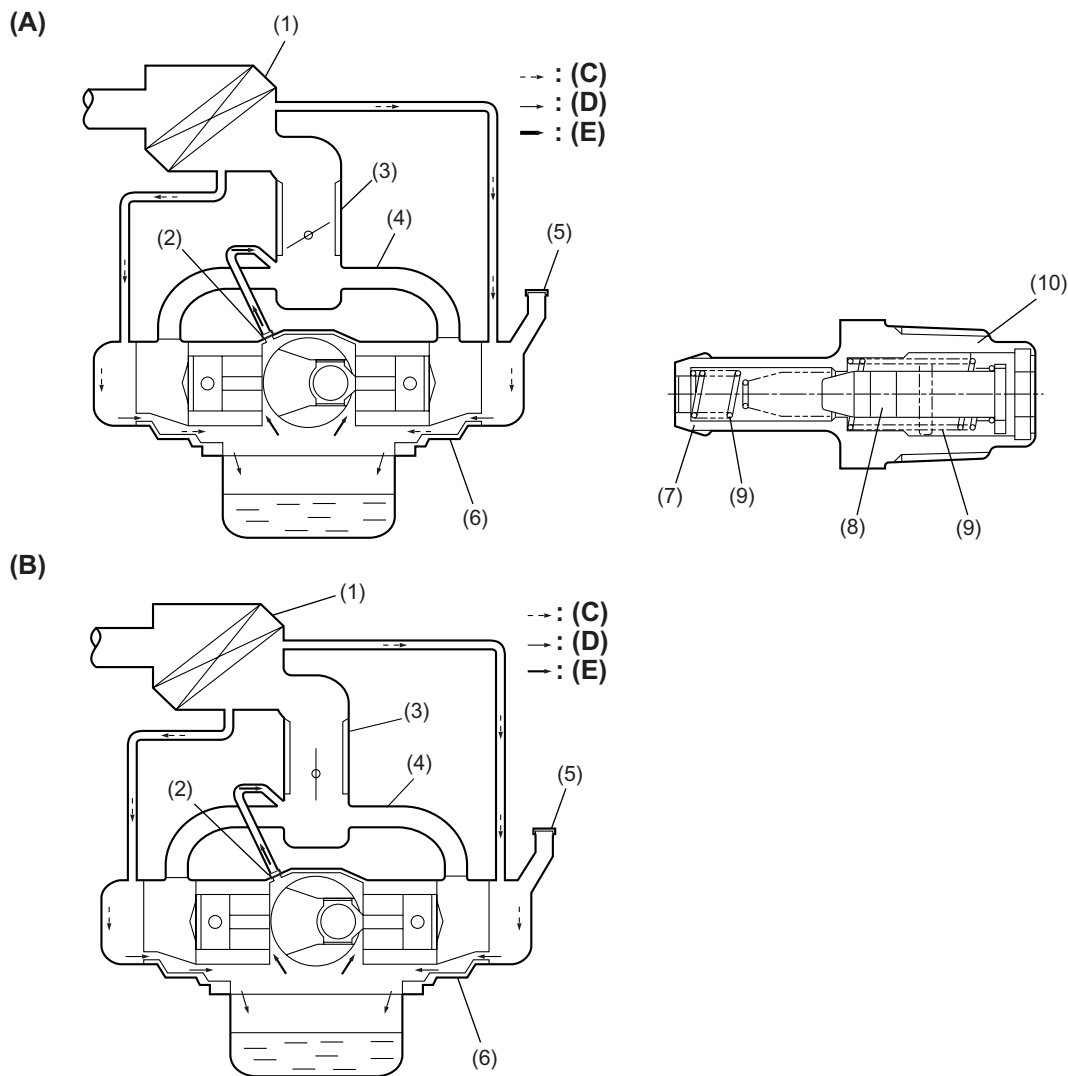
Emission Control (Aux. Emission Control Devices)

3. Crankcase Emission Control System

- The positive crankcase ventilation (PCV) system prevents air pollution which will be caused by blow-by gas being emitted from the crankcase. The system consists of a sealed oil filler cap, rocker covers with fresh air inlet, connecting hoses, a PCV valve and an air intake duct.
- In a part-throttle condition, the blow-by gas in the crankcase flows into the intake manifold through the connecting hose of crankcase and PCV valve by the strong vacuum created in the intake manifold. Under this condition, fresh air is introduced into the crankcase through the connecting hose of the rocker cover.
- In a wide-open-throttle condition, a part of blow-by gas flows into the air intake duct through the connecting hose and is drawn into the throttle chamber, because under this is condition, the intake manifold vacuum is not strong enough to introduce through the PCV valve all blow-by gases that increase in the amount with engine speed.

CRANKCASE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)



EC-00018

- (1) Air cleaner case
- (2) PCV valve
- (3) Throttle body
- (4) Intake manifold
- (5) Oil filler cap

- (6) Crankcase
- (7) Case
- (8) Valve
- (9) Spring
- (10) PCV valve

- (A) Part-throttle condition
- (B) Wide-open-throttle condition
- (C) Fresh air
- (D) Mixture of air and blow-by gas
- (E) Blow-by gas

THREE-WAY CATALYST

Emission Control (Aux. Emission Control Devices)

4. Three-way Catalyst

- The basic material of three-way catalyst is platinum (Pt), rhodium (Rh) and palladium (Pd), and a thin coat of their mixture is applied onto a honeycomb or porous ceramics piece (carrier). To avoid damaging the catalyst, only unleaded gasoline should be used.
- The catalyst reduces HC, CO and NO_x in exhaust gases through chemical reactions (oxidation and reduction). These harmful components are reduced most efficiently when their concentrations are in a certain balance. These concentrations vary with the air-fuel ratio. The ideal air-fuel ratio for reduction of these components is the stoichiometric ratio.
- Therefore, the air-fuel ratio needs to be controlled to around the stoichiometric ratio to purify the exhaust gases most efficiently.

5. A/F Control System

- The air/fuel (A/F) control system makes a correction to the basic fuel injection duration in accordance with the signal from the front oxygen (A/F) sensor and rear oxygen sensor so that the stoichiometric ratio is maintained, thus ensuring most effective exhaust gas purification by the three-way catalyst. Different basic fuel injection durations are preset for various engine speeds and loads, as well as the amount of intake air.
- This system also has a “learning” control function which stores the corrected data in relation to the basic fuel injection in the memory map. This allows an appropriate air-fuel ratio correction to be added automatically in quick response to any situation that requires such an effect. Thus, the air-fuel ratio is optimally maintained under various conditions while purifying exhaust gases most effectively, improving driving performance and compensating for changes in sensors’ performance over time.

IGNITION CONTROL SYSTEM

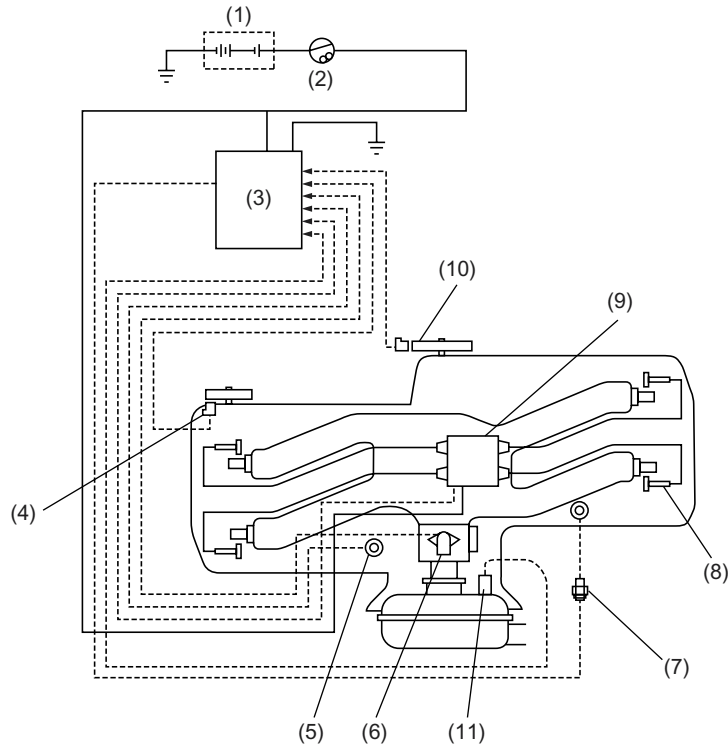
Emission Control (Aux. Emission Control Devices)

6. Ignition Control System

- The ignition system is controlled by the ECM.

The ECM monitors the operating condition of the engine using the signals from the sensors and switches shown below and determines the ignition timing most appropriate for each engine operating condition. Then it sends a signal to the ignitor, commanding generation of a spark at that timing.

- The ECM uses a preprogrammed map for a “closed-loop” control which provides its ignition timing control with excellent transient characteristics, i.e., highly responsive ignition timing control.



EC-00115

- | | |
|------------------------------|--|
| (1) Battery | (7) Engine coolant temperature sensor |
| (2) Ignition switch | (8) Spark plug |
| (3) ECM | (9) Ignition coil and ignitor assembly |
| (4) Camshaft position sensor | (10) Crankshaft position sensor |
| (5) Knock sensor | (11) Intake air temperature sensor |
| (6) Pressure sensor | |

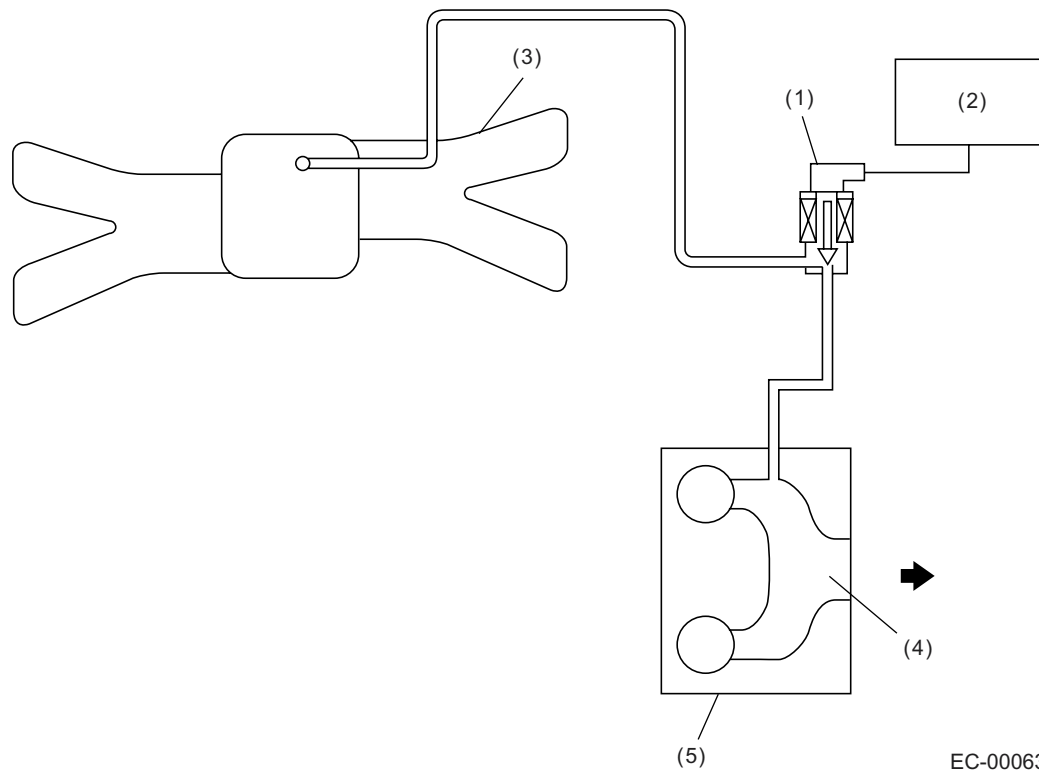
EXHAUST GAS RECIRCULATION (EGR) SYSTEM

Emission Control (Aux. Emission Control Devices)

7. Exhaust Gas Recirculation (EGR) System

A: OUTLINE

- The EGR system aims at reduction of NO_x by lowering the combustion temperature through re-circulation of a part of exhaust gas into cylinders via the intake manifold.
- The EGR valve is controlled by the ECM according to the engine operating condition.



- (1) EGR valve
- (2) ECM
- (3) Intake manifold

- (4) Exhaust port
- (5) Cylinder head LH

EC-00063

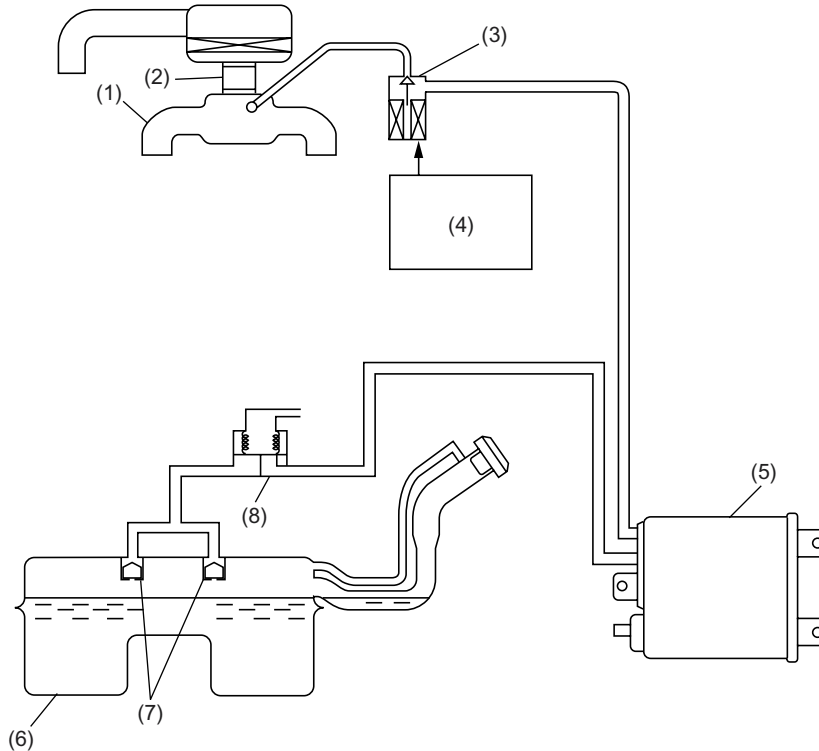
EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

8. Evaporative Emission Control System

A: GENERAL

- The evaporative emission control system prevents fuel vapors from escaping into atmosphere. This system includes a canister, purge control solenoid valve, fuel cut valve, and the lines connecting them.
- Fuel vapors in the fuel tank is introduced into the canister through the evaporation line, and are absorbed by activated carbon in it. The fuel cut valve is also incorporated in the fuel tank line.
- The purge control solenoid valve is controlled optimally by the ECM according to the engine condition.



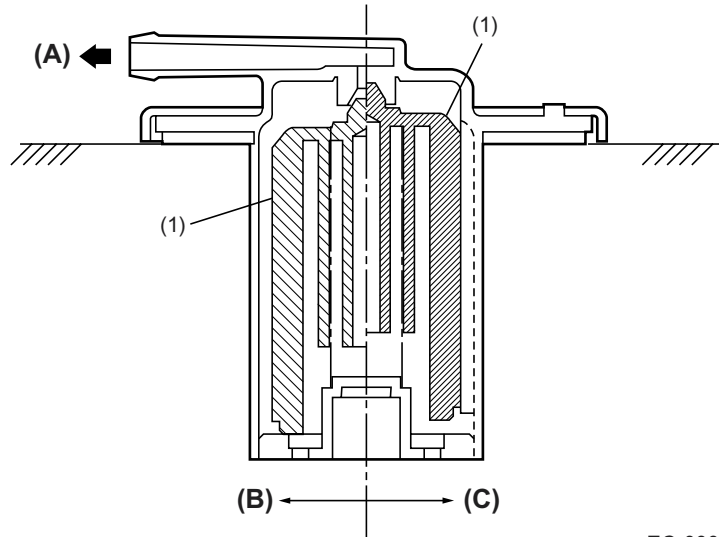
- | | |
|----------------------------------|--------------------|
| (1) Intake manifold | (5) Canister |
| (2) Throttle body | (6) Fuel tank |
| (3) Purge control solenoid valve | (7) Fuel cut valve |
| (4) Engine control module (ECM) | (8) Two-way valve |

EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

B: FUEL CUT VALVE

The fuel cut valve is built onto the evaporation pipe of the fuel tank. The rising level of the fuel in the fuel tank causes the float to move up and close the cap hole so that no fuel can flow through the evaporation line.



EC-00022

(1) Float

- (A) To canister
- (B) Valve open
- (C) Valve closed

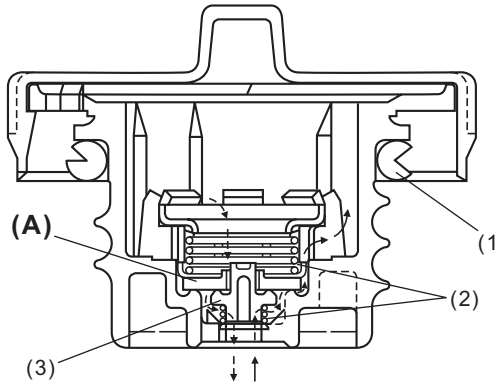
EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

C: FUEL TANK CAP

The fuel tank cap has a relief valve which prevents development of vacuum in the fuel tank in the event of a problem with the fuel vapor line.

When there is no problem with the fuel vapor line, the filler pipe is sealed at the portion (A) and by the seal pressed against the filler pipe end. If vacuum develops in the fuel tank, the atmospheric pressure forces the spring down to open the valve; consequently outside air flows into the fuel tank, thus controlling the inside pressure.



EC-00065

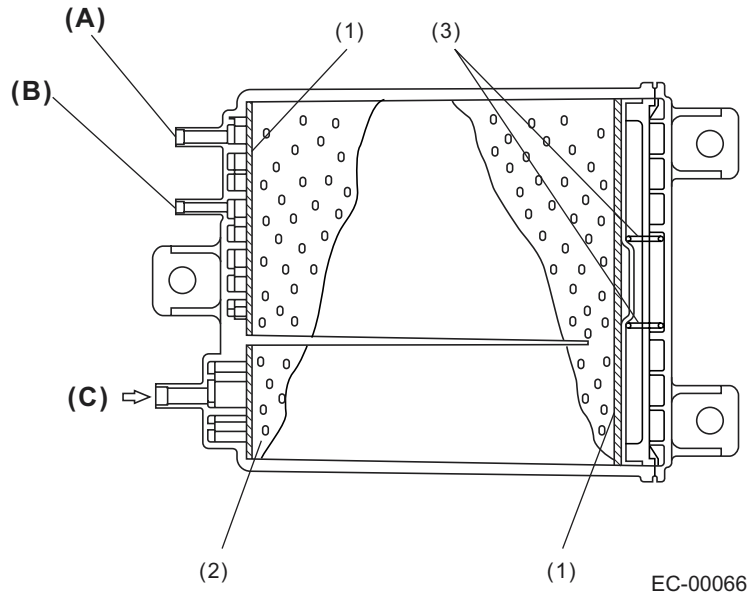
- (1) Seal
- (2) Spring
- (3) Valve

EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

D: CANISTER

The charcoal filled in the canister temporarily stores fuel vapors. When the purge control solenoid valve is opened by a signal from the ECM, the external fresh air entering the canister carries the fuel vapors into the intake manifold.



EC-00066

- (1) Filter
- (2) Charcoal
- (3) Spring

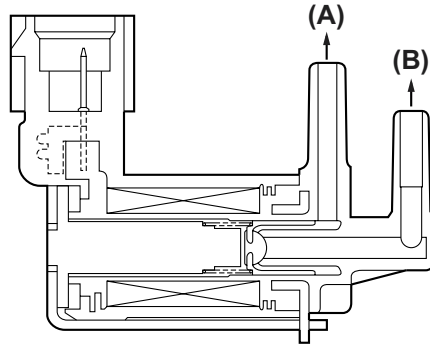
- (A) To purge control solenoid valve
- (B) From fuel tank
- (C) Air

EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

E: PURGE CONTROL SOLENOID VALVE

The purge control solenoid valve is on the evaporation line between the canister and intake manifold. The valve is installed at the underside of intake manifold.



EC-00025

(A) To canister

(B) To intake manifold

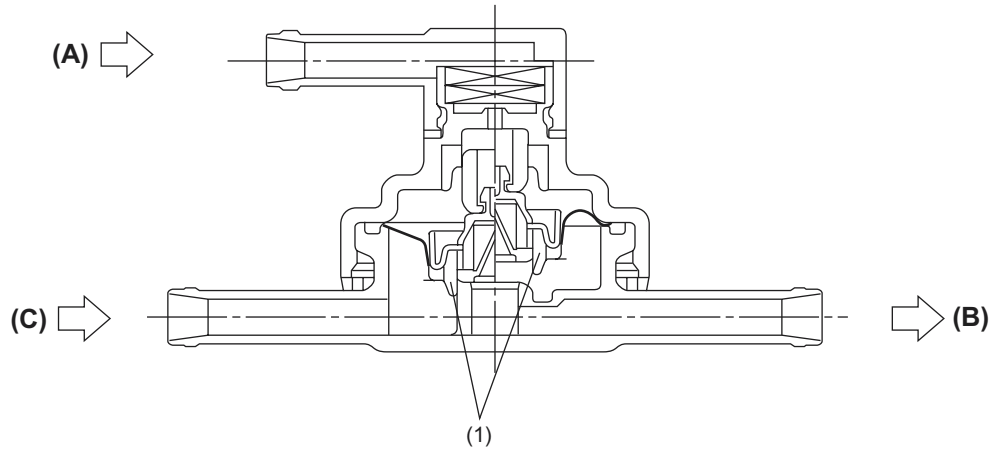
EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

F: TWO-WAY VALVE

The two-way valve is located in the evaporation line between the fuel tank and the canister. When the tank inside pressure becomes higher than the atmospheric pressure, the valve is opened allowing fuel vapors to be introduced into the canister.

On the other hand, when the tank inside pressure becomes lower than the atmospheric pressure, external air is taken into the canister.



EC-00067

(1) Valve

(A) Atmospheric pressure

(B) To canister

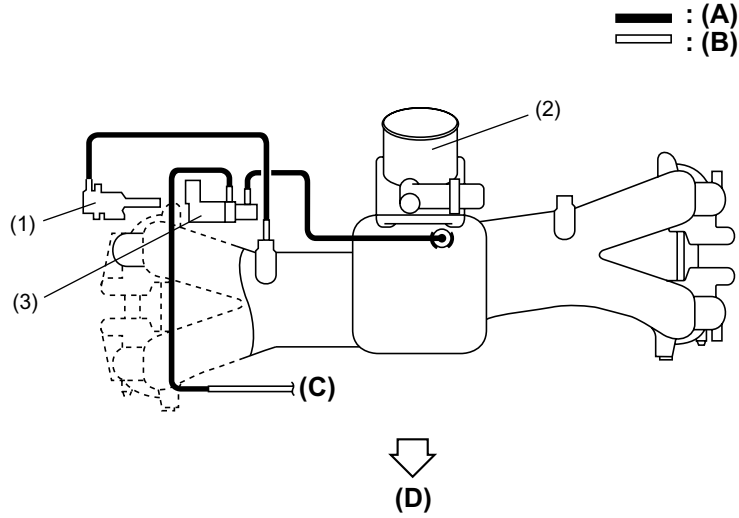
(C) From fuel tank

VACUUM CONNECTIONS

Emission Control (Aux. Emission Control Devices)

9. Vacuum Connections

The hose and pipe connections of the intake manifold, throttle body and other related parts are as shown in the illustration.



EC-00068

(1) Pressure regulator

(2) Throttle body

(3) Purge control solenoid valve

(A) Hose

(B) Pipe

(C) To canister

(D) Front of vehicle

INTAKE (INDUCTION) ***IN*** (***SOHC***)

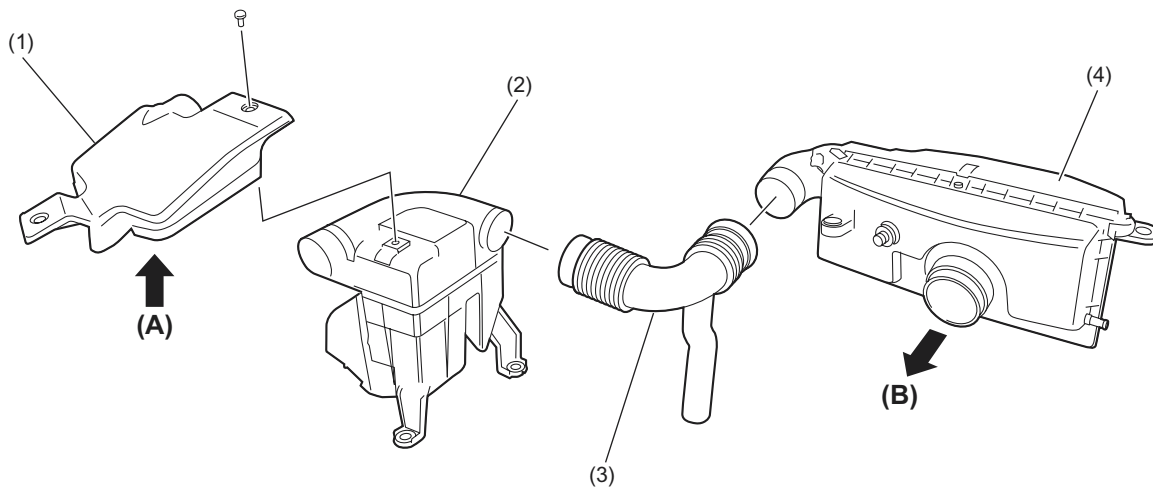
	Page
1. General	2

GENERAL

Intake (Induction)

1. General

The intake system consists of an air intake duct, a resonator chamber, and an air cleaner element housed in its case. The resonator, located upstream of the air cleaner case, effectively reduces the intake noise level.



IN-00037

- (1) Air intake duct
- (2) Resonator chamber
- (3) Air intake duct
- (4) Air cleaner case

- (A) Fresh air
- (B) To throttle body

MECHANICAL *ME* (SOHC)

	Page
1. General	2
2. Timing Belt	3
3. Automatic Belt Tension Adjuster	4
4. Belt Cover	6
5. Valve Rocker Assembly	7
6. Camshaft	8
7. Cylinder Head	9
8. Cylinder Block	10
9. Crankshaft	11
10. Piston	12
11. Engine Mounting	14

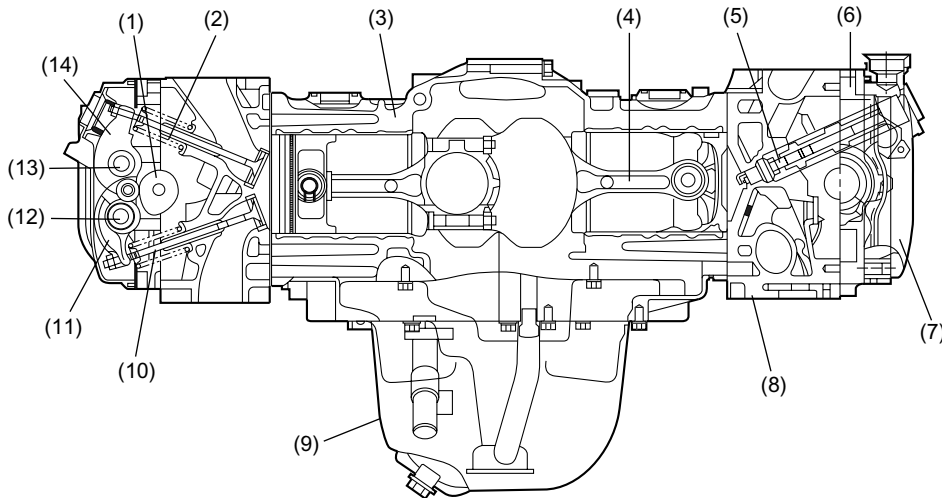
GENERAL

1. General

The engine used in this vehicle is of a horizontally opposed, four-cylinder design. This four-stroke-cycle, water-cooled, SOHC engine uses a total of 16 valves and its main components are made of aluminum alloy. It is fueled by a multiple fuel injection system.

The engine's major structural and functional features are as follows:

- The cylinder head forms pentroof combustion chambers, each having a spark plug located at its center and two each of intake and exhaust valves (four valves per cylinder). The intake and exhaust ports are located in a cross-flow arrangement.
- There are a screw and nut at the valve end of each rocker arm. They are used for adjusting the valve clearance.
- A single timing belt drives two camshafts on the left and right banks and the engine coolant pump on the left bank. Belt tension is automatically adjusted by a belt tension adjuster, eliminating need for a manual adjustment.
- The crankshaft is supported by five bearings with high rigidity and strength.
- The cylinder block is an aluminum die casting fitted with iron die-cast cylinder liners.

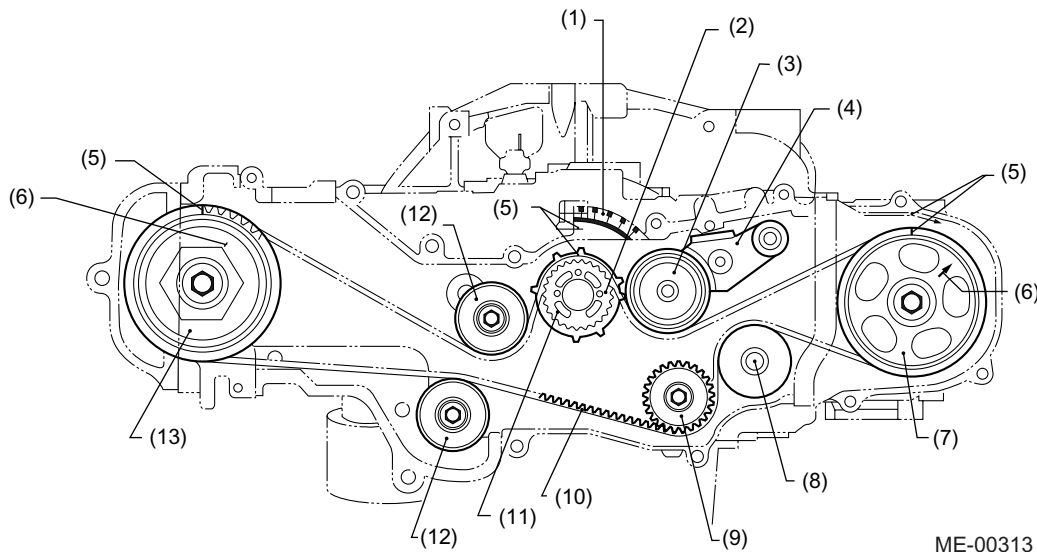


ME-00312

- | | | |
|--------------------|------------------------|---------------------------|
| (1) Camshaft | (6) Camshaft cap | (11) Exhaust rocker arm |
| (2) Intake valve | (7) Valve rocker cover | (12) Exhaust rocker shaft |
| (3) Cylinder block | (8) Cylinder head | (13) Intake rocker shaft |
| (4) Connecting rod | (9) Oil pan | (14) Intake rocker arm |
| (5) Spark plug | (10) Exhaust valve | |

2. Timing Belt

- A single timing belt drives two camshafts (one in the left bank and one in the right bank). The belt also drives the water pump by its non-toothed side.
- The timing belt teeth have a specially designed round profile which contributes to quiet operation. The timing belt is made of strong and inflexible core cords, wear-resistant canvas and heat-resistant rubber material.
- A hydraulic automatic belt tension adjuster always keeps the belt taut to the specified tension. Any manual belt tension adjustment is unnecessary.



- | | |
|---|---------------------------|
| (1) Timing indicator (For timing mark of crankshaft pulley) | (8) Water pump pulley |
| (2) *Piston position mark | (9) Idler No. 2 |
| (3) Belt tension pulley | (10) Timing belt |
| (4) Automatic belt tension adjuster | (11) Crankshaft sprocket |
| (5) Alignment mark | (12) Idler |
| (6) **Piston position mark | (13) Camshaft sprocket RH |
| (7) Camshaft sprocket LH | |

NOTE:

*: The #1 piston is at TDC when the piston position mark on the crankshaft sprocket is aligned with the timing mark on the cylinder block.

** : The #1 piston is at TDC on the compression stroke when the piston position mark on the camshaft sprocket is aligned with the timing mark on the belt cover.

AUTOMATIC BELT TENSION ADJUSTER

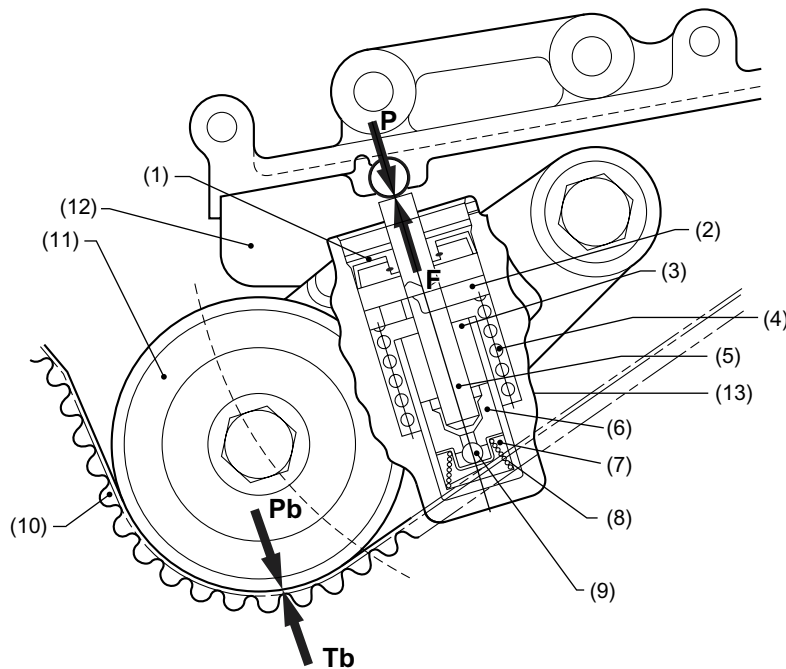
Mechanical

3. Automatic Belt Tension Adjuster

The automatic belt tension adjuster consists of a tensioner unit and a bracket. It maintains the timing belt tension automatically at a specified level to enable the belt to transmit power correctly, reduce operating noise and increase the life of the belt.

The cylinder of the tensioner unit incorporates an adjuster rod, wear ring, plunger spring, return spring, check ball and silicone oil.

The automatic belt tension adjuster gives tension to the belt by a levering action which is produced by the push force of the tensioner unit's adjuster rod. It operates in the process detailed below.



ME-00314

- | | |
|---------------------------|--------------------------|
| (1) Oil seal | (8) Plunger spring |
| (2) Wear ring | (9) Check ball |
| (3) Oil reservoir chamber | (10) Timing belt |
| (4) Return spring | (11) Belt tension pulley |
| (5) Adjuster rod | (12) Tensioner bracket |
| (6) Plunger | (13) Cylinder |
| (7) Oil pressure chamber | |

- Timing belt tensioning action

When the belt becomes slack, the adjuster rod is pushed upward by the return spring. The oil in the reservoir chamber, which is pressurized by the plunger spring to a certain level, pushes open the check ball and flows into the oil pressure chamber to keep the pressure constant. The thrust force F resulting from extension of the adjuster rod applies a counterclockwise torque to the tensioner bracket, which causes the belt tension pulley at its end to turn in the same direction. This applies tensioning pressure P_b to the timing belt.

- Timing belt tension balancing action

When the belt tension pulley is pushed against the timing belt with pressure P_b , reaction force T_b of the timing belt generates the reaction force P at the point on which the adjuster rod force is acting. This force P pushes the adjuster rod until it balances with the sum of the thrust force F and the pressure of the oil in the oil pressure chamber. Therefore, the timing belt tension is kept constant.

- Overtension correction action

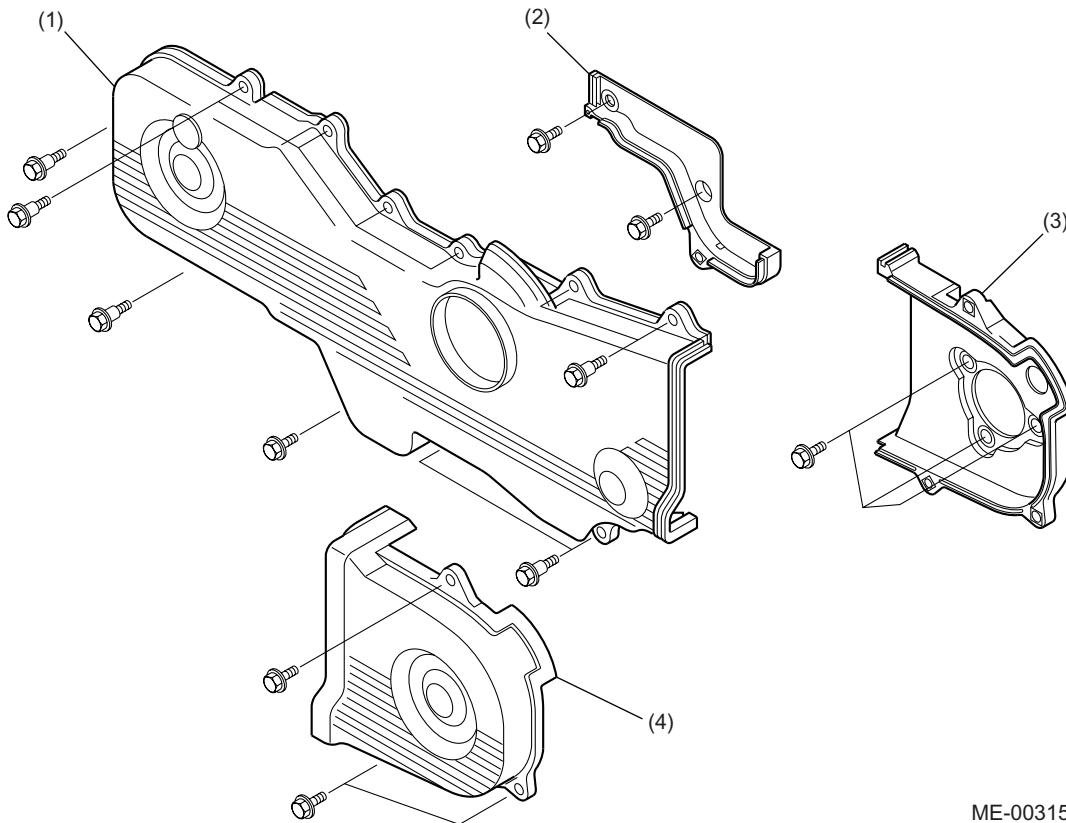
If the tension of the timing belt increases excessively, the force P becomes larger than the thrust force F and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force P balances again with the thrust force F . Thus the timing belt tension is maintained at the specified level at all times.

BELT COVER

Mechanical

4. Belt Cover

- The belt cover is made of lightweight, heat resistant synthetic resin molding. It constitutes a totally enclosed housing with its cylinder block mating edges sealed with rubber gaskets. This effectively protects the inside components from dust and liquid.
- Rubber seals used between the cylinder block and the belt cover effectively reduces transmission of noise and vibration.
- The front belt cover has a line mark for ignition-timing checking.

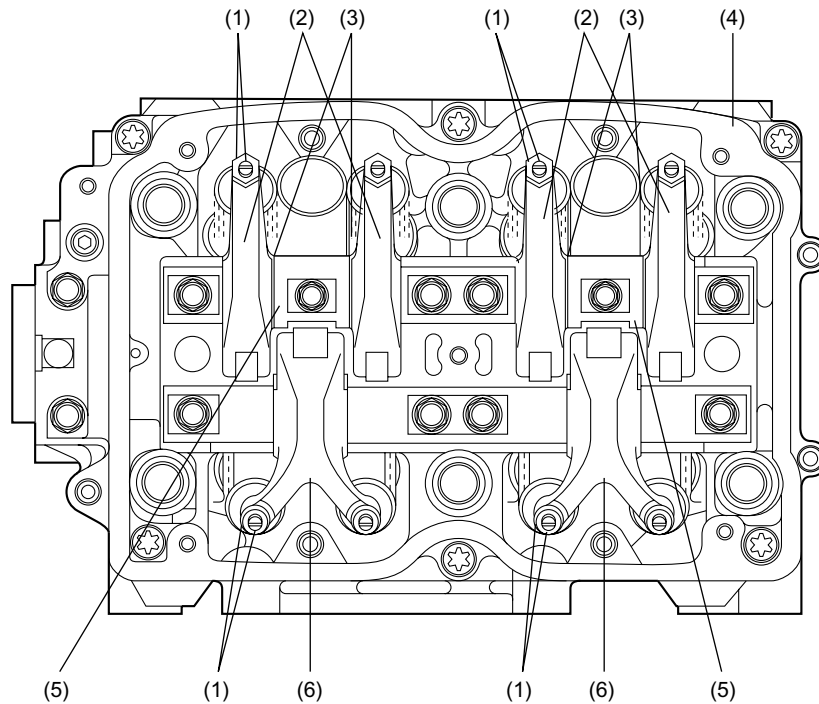


ME-00315

- (1) Front belt cover
- (2) Belt cover No. 2 (RH)
- (3) Belt cover No. 2 (LH)
- (4) Belt cover (LH)

5. Valve Rocker Assembly

- The intake valve rocker arms and the exhaust valve rocker arms are installed on their own rocker shafts both of which are retained by the camshaft caps.
- The valve end of each rocker arm is provided with valve rocker adjusting screw and nut. Turning of this screw adjusts the valve clearance.
- The exhaust valve rocker arms are Y-shaped, and each arm operates two exhaust valves simultaneously.
- Each rocker shaft has an oil passage in it.

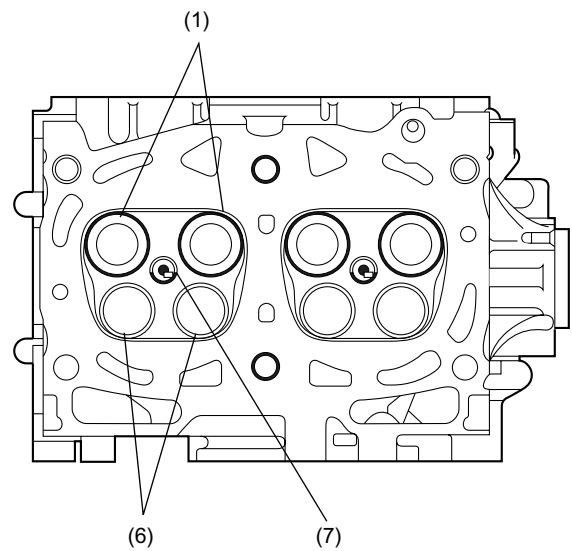
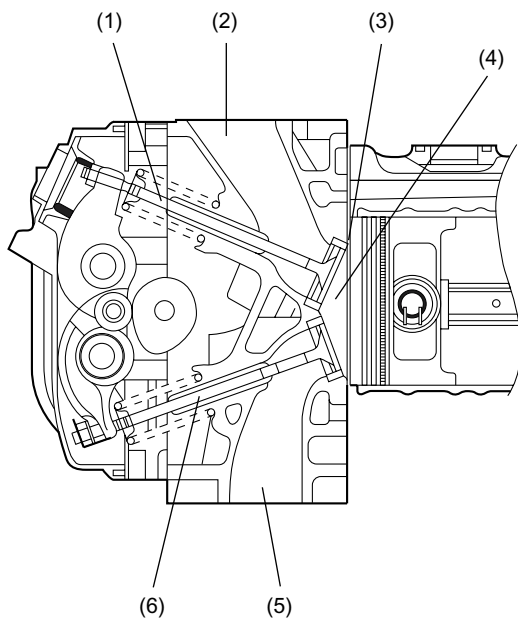


ME-00316

- | | |
|--|------------------------------|
| (1) Valve rocker adjusting screw and nut | (4) Camshaft cap |
| (2) Intake valve rocker arm | (5) Supporter |
| (3) Wave washer | (6) Exhaust valve rocker arm |

7. Cylinder Head

- The cylinder head is made of aluminum die casting.
- Each combustion chamber in the cylinder head is a compact, pentroof design. The spark plug is located at the center of the combustion chamber, which contributes to creation of a wide “squish area” for increased combustion efficiency.
- The two intake and two exhaust valves are arranged on opposite sides for a cross-flow feature.
- The cylinder head gasket is a metallic gasket consisting of three layers of the stainless steel sheets. It is highly resistant to heat and maintains high level of sealing performance for a long period.



ME-00318

- (1) Intake valve
- (2) Intake port
- (3) Squish area
- (4) Combustion chamber

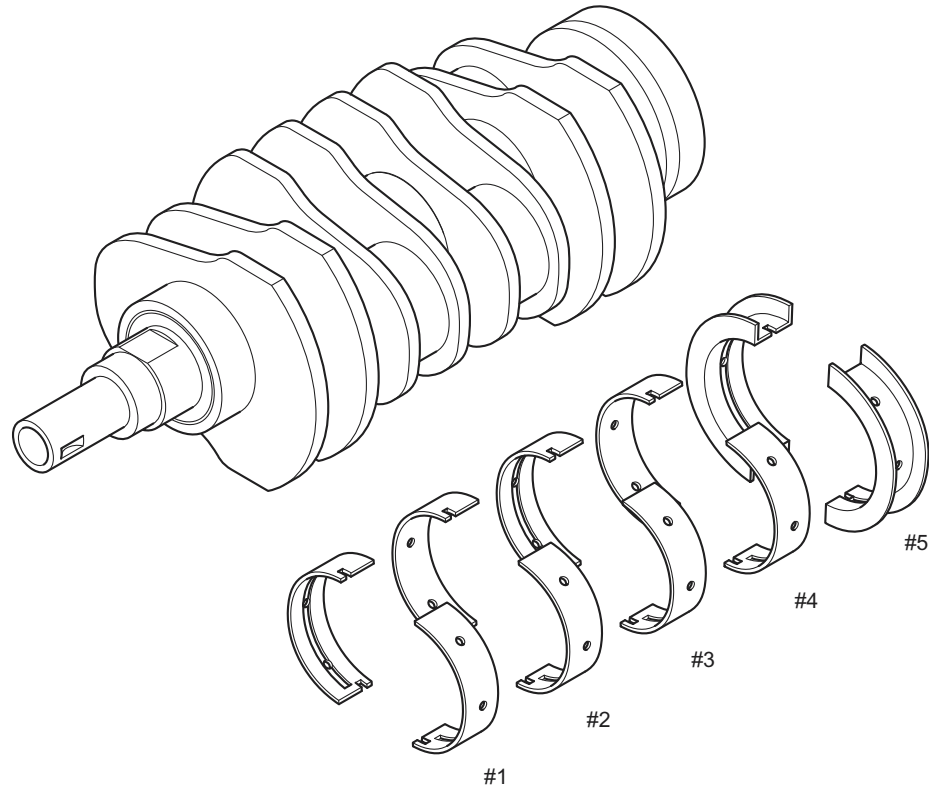
- (5) Exhaust port
- (6) Exhaust valve
- (7) Spark plug

8. Cylinder Block

- The cylinder block is made of aluminum die casting. Its open-deck design provides it with such advantageous features as relatively small weight, high rigidity and excellent cooling efficiency.
- The cylinder liners are made of cast iron. They are dry type which means their outer surfaces are entirely in contact with the cylinder block.
- The cylinder block supports the crankshaft at its five journals. The journal supporting portions are designed such that sufficient stiffness and quiet operation are ensured.
- The oil pump is located in the front center of the cylinder block and the engine coolant pump is located at the front of the left-cylinder bank. At the rear of the right-cylinder bank is an oil separator which removes oil mist contained in blow-by gas.

9. Crankshaft

The crankshaft is supported in the cylinder block by five bearings. Each corner formed by a journal or pin and a web is finished by fillet-rolling method which increases strength of that area. The five crankshaft bearings are made of aluminum alloy and the No. 5 bearing is provided with a flanged metal to support thrust forces.

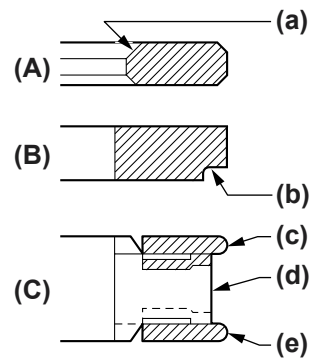
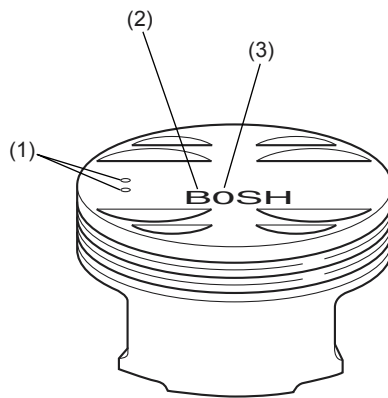


ME-00319

10.Piston

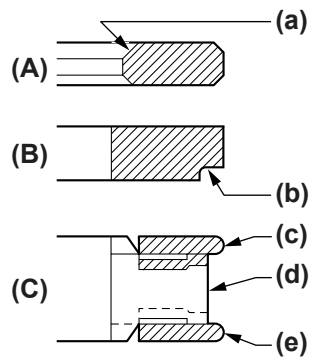
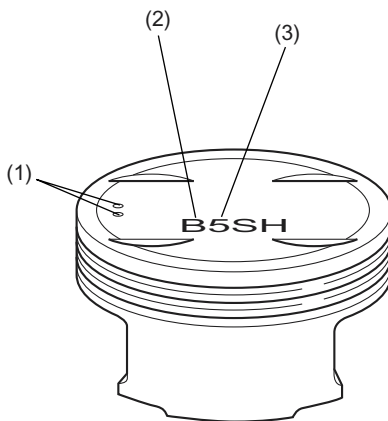
- The pistons are of a slipper skirt design for reduced weight and friction. The oil control ring groove utilizes a thermal design.
- The piston pin is offset either downward (Nos. 1 and 3 pistons) or upward (Nos. 2 and 4 pistons).
- The piston head has recesses to prevent interference with the intake and exhaust valves. It also has engraved marks to identify the piston size and the direction of installation. All the pistons are common in their design.
- Three piston rings are used for each piston – two compression rings and one oil control ring. The top piston ring has inner bevels and the second piston ring has an interrupt (cut) on the bottom outside to reduce oil consumption.

2L Model



ME-00347

2.5L Model



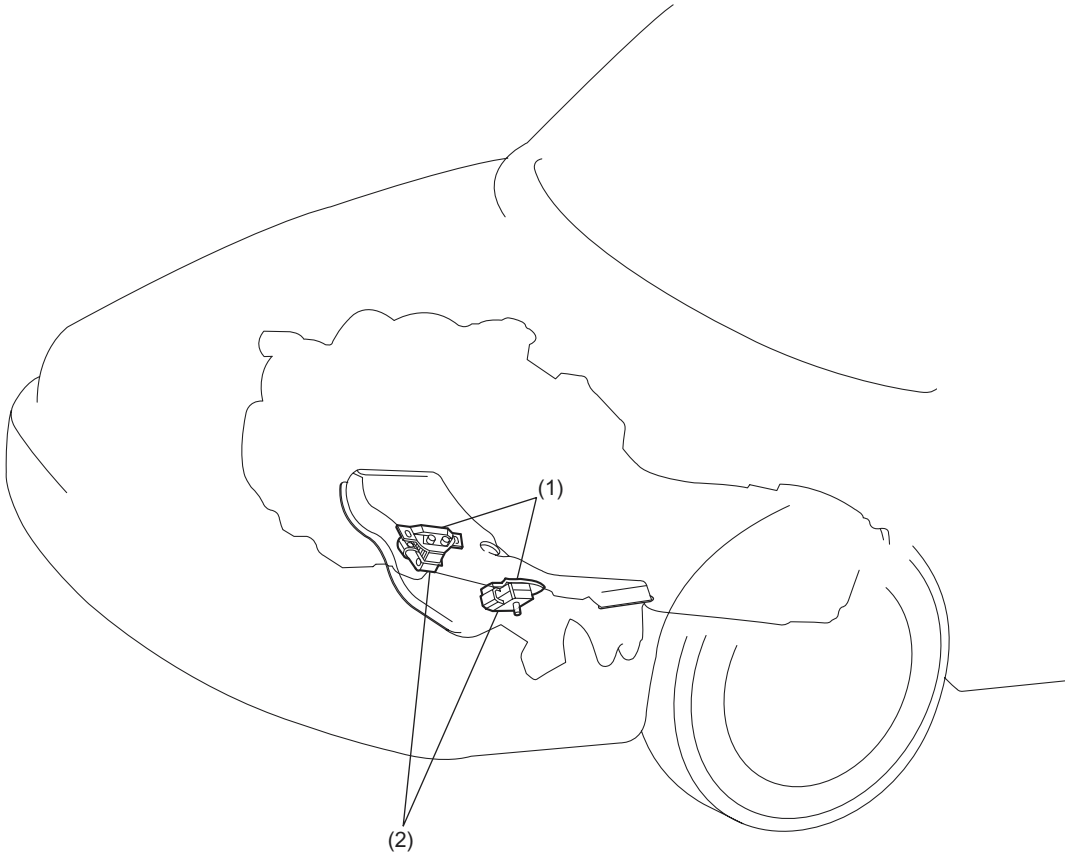
ME-00348

- (1) Location mark (Engine front side)
- (2) Identification mark (Piston size)
- (3) Engine displacement

- (A) Top ring
- (B) Second ring
- (C) Oil ring

- (a) Inner-bevel
- (b) Cut
- (c) Upper rail
- (d) Spacer
- (e) Lower rail

11.Engine Mounting



ME-00321

- (1) Bracket
- (2) Cushion rubber

EXHAUST *EX* (SOHC)

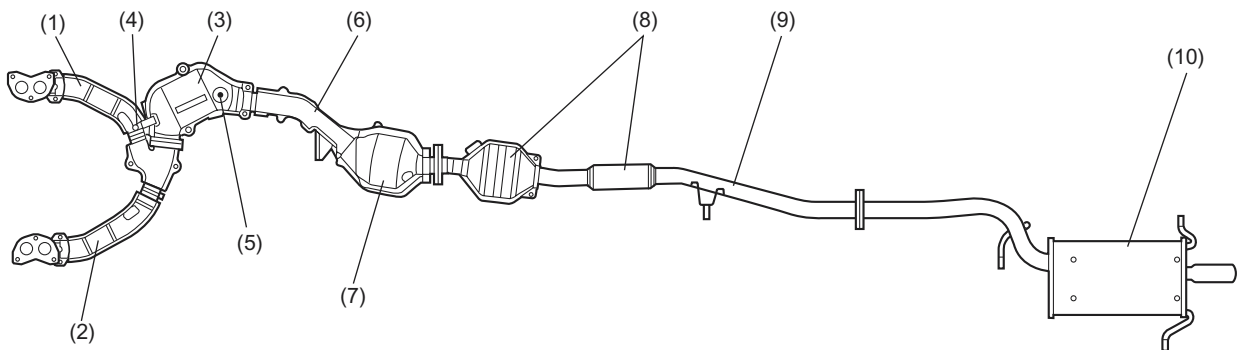
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2. Composition	3

1. General

- The exhaust system consists of front exhaust pipes, catalytic converters, a center exhaust pipe, a rear exhaust pipe and a muffler. The front catalytic converter and rear catalytic converter are incorporated in the center exhaust pipe.
- The exhaust system features an improved sound suppression design; the two branches of the front exhaust pipe join at a point almost equal in distance from the engine's exhaust ports. The exhaust system also has resonator chambers in addition to a large capacity muffler.

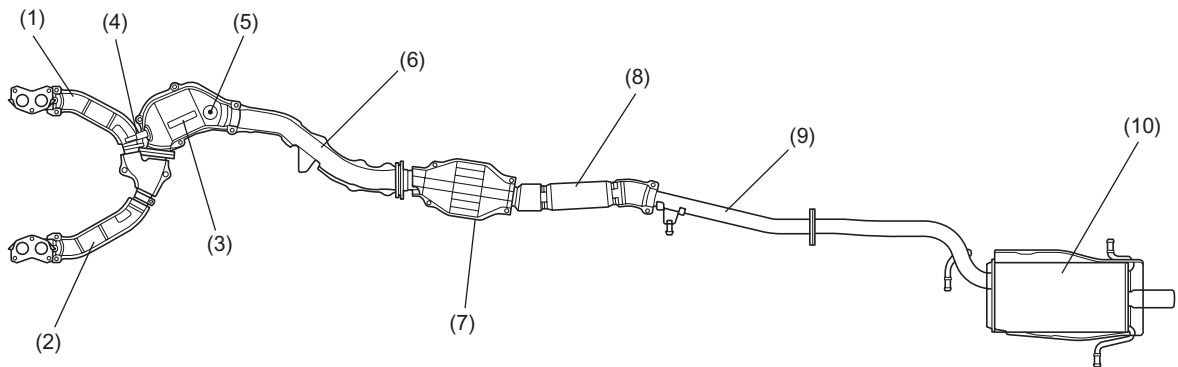
2. Composition

2L model



EX-00067

2.5L model



EX-00034

- | | |
|-------------------------------|------------------------------|
| (1) Right front exhaust pipe | (6) Center exhaust pipe |
| (2) Left front exhaust pipe | (7) Rear catalytic converter |
| (3) Front catalytic converter | (8) Resonance chamber |
| (4) Front oxygen (A/F) sensor | (9) Rear exhaust pipe |
| (5) Rear oxygen sensor | (10) Muffler |

COMPOSITION

Exhaust

MEMO

COOLING *CO* (SOHC)

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1. General	2
2. Cooling Circuits	3
3. Water Pump	5
4. Mechanical Seal	7
5. Thermostat	8
6. Radiator Fan	9

1. General

- The engine cooling system consists of a down-flow radiator which features high heat-dissipation performance, an electric-motor-driven fan, a water pump, a thermostat, and an engine coolant temperature sensor.
- The reservoir tank is made of translucent resin and enables easy confirmation of the coolant level. Also, coolant should be added to the reservoir tank when replenishment is necessary.
- The ECM controls the operation of the radiator main fan and sub fan depending on the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch.

2. Cooling Circuits

A: NON-TURBO MODEL

The cooling system operates in three different phases depending on the temperature of the engine coolant.

- 1st phase (thermostat closed)

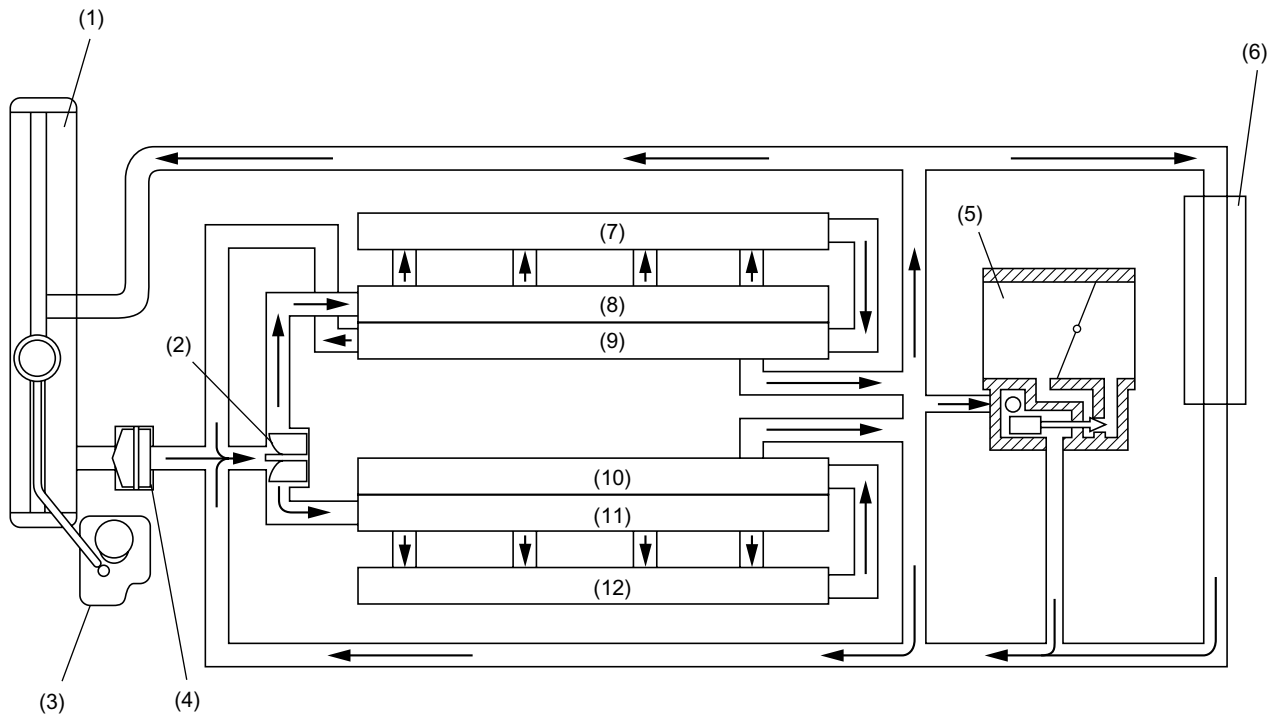
When the engine coolant temperature is below 80°C (176°F), the thermostat remains closed. The coolant flows through the bypass and heater circuits. This permits the engine to warm up quickly.

- 2nd phase (thermostat open)

When the engine coolant temperature is above 80 – 84°C (176 – 183.2°F), the thermostat opens. The coolant flows through the radiator where it is cooled.

- 3rd phase (thermostat open and radiator fan operating)

When the engine coolant temperature sensor sends a signal indicating a temperature above 95°C (203°F) to the ECM, it causes the radiator fan (or fans) to operate.



CO-00066

- | | |
|-----------------------------------|-------------------------|
| (1) Radiator | (7) Cylinder head RH |
| (2) Water pump | (8) Cylinder jacket RH |
| (3) Engine coolant reservoir tank | (9) Cylinder block RH |
| (4) Thermostat | (10) Cylinder block LH |
| (5) Throttle body | (11) Cylinder jacket LH |
| (6) Heater core | (12) Cylinder head LH |

COOLING CIRCUITS

Cooling

B: TURBO MODEL

The cooling system operates in three different phases depending on the temperature of the engine coolant.

- 1st phase (thermostat closed)

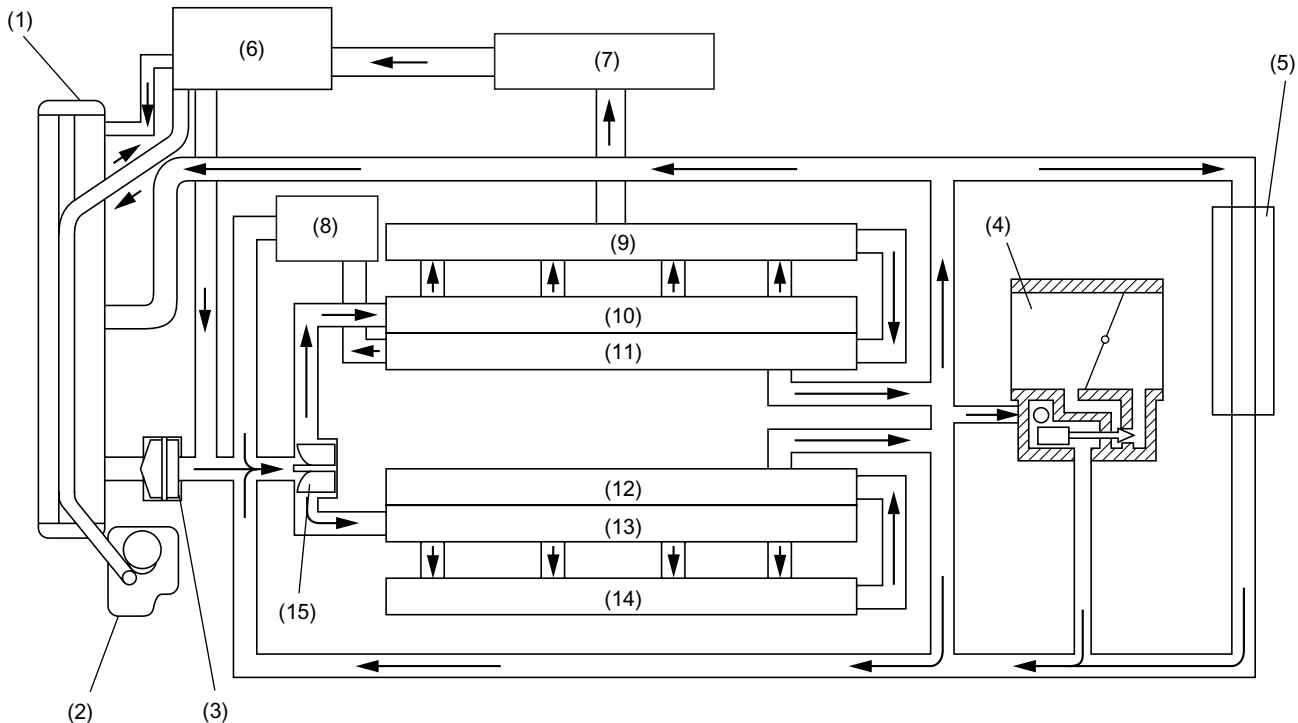
When the engine coolant temperature is below 76°C (169°F), the thermostat remains closed. The coolant flows through the bypass and heater circuits. This permits the engine to warm up quickly.

- 2nd phase (thermostat open)

When the engine coolant temperature is above 76 – 80°C (169 – 176°F), the thermostat opens. The coolant flows through the radiator where it is cooled.

- 3rd phase (thermostat open and radiator fan operating)

When the engine coolant temperature sensor sends a signal indicating a temperature above 91°C (195.8°F) to the ECM, it causes the radiator fan (or fans) to operate. When the engine is stopped after high-speed operation, vapor produced in the turbocharger cooling section flows from the coolant filler tank to the reservoir tank where it condenses back into water. Water is then absorbed by the coolant filler tank as the engine cools down.



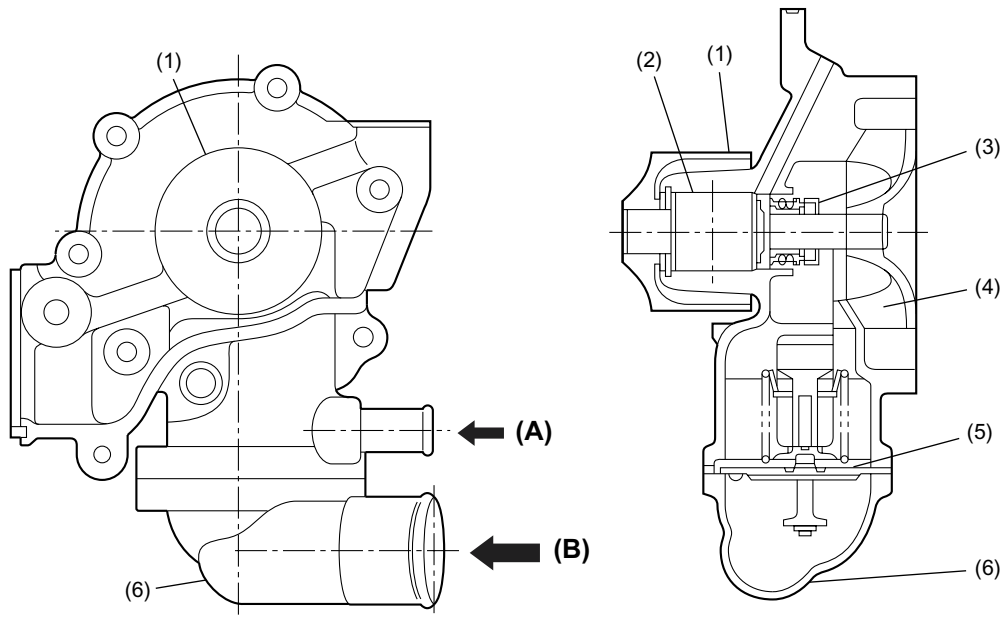
CO-00067

- | | |
|-----------------------------------|-------------------------|
| (1) Radiator | (9) Cylinder head RH |
| (2) Engine coolant reservoir tank | (10) Cylinder jacket RH |
| (3) Thermostat | (11) Cylinder block RH |
| (4) Throttle body | (12) Cylinder block LH |
| (5) Heater core | (13) Cylinder jacket LH |
| (6) Coolant filler tank | (14) Cylinder head LH |
| (7) Turbocharger | (15) Water pump |
| (8) Oil cooler | |

3. Water Pump

The water pump is located in the front portion of the left bank cylinder block and is driven by the engine through the timing belt. The thermostat is fitted into the coolant inlet at the bottom of the water pump. When the pump's impeller rotates, the coolant is drawn into the pump from the lower pipe (which is connected to the radiator hose) via the thermostat. It then flows along the perimeter of the impeller and then is discharged for circulation through a circuit depending on the coolant temperature.

A: NON-TURBO MODEL



CO-00056

(A) From heater circuit

(B) From radiator

(1) Pulley

(2) Ball bearing

(3) Mechanical seal

(4) Impeller

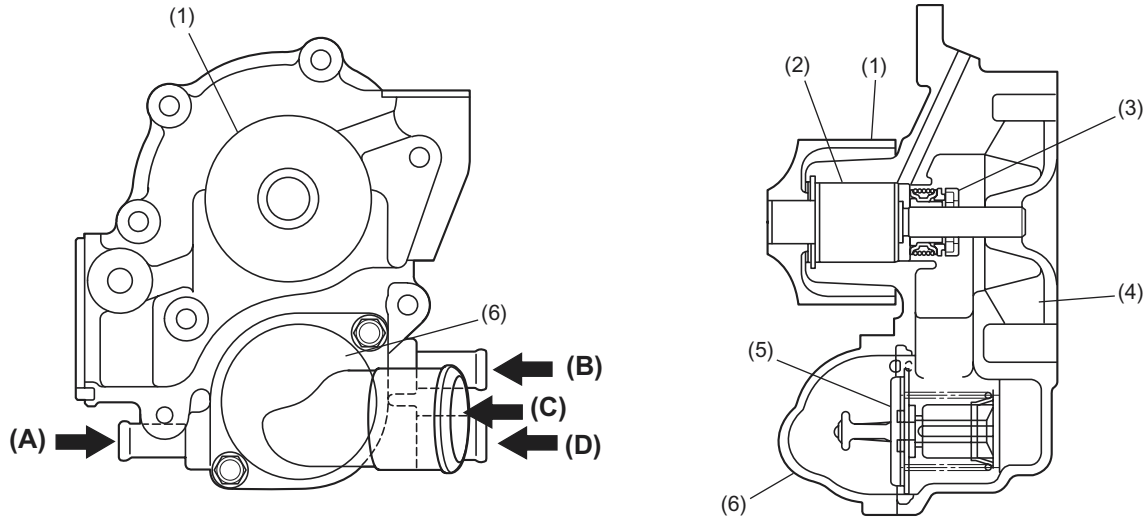
(5) Thermostat

(6) Thermostat case

WATER PUMP

Cooling

B: TURBO MODEL



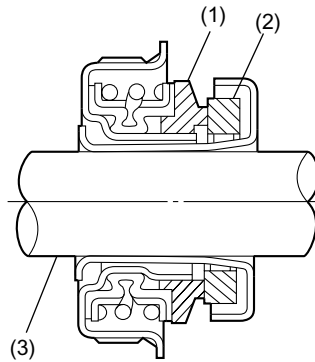
CO-00068

- (A) From engine oil cooler
- (B) From water tank
- (C) From radiator
- (D) From heater

- (1) Pulley
- (2) Ball bearing
- (3) Mechanical seal
- (4) Impeller
- (5) Thermostat
- (6) Thermostat case

4. Mechanical Seal

The mechanical seal has its seat tightly fitted on the water pump shaft. Since it is a hermetic seal forming an integral part of the water pump, the water pump cannot be disassembled.



CO-00058

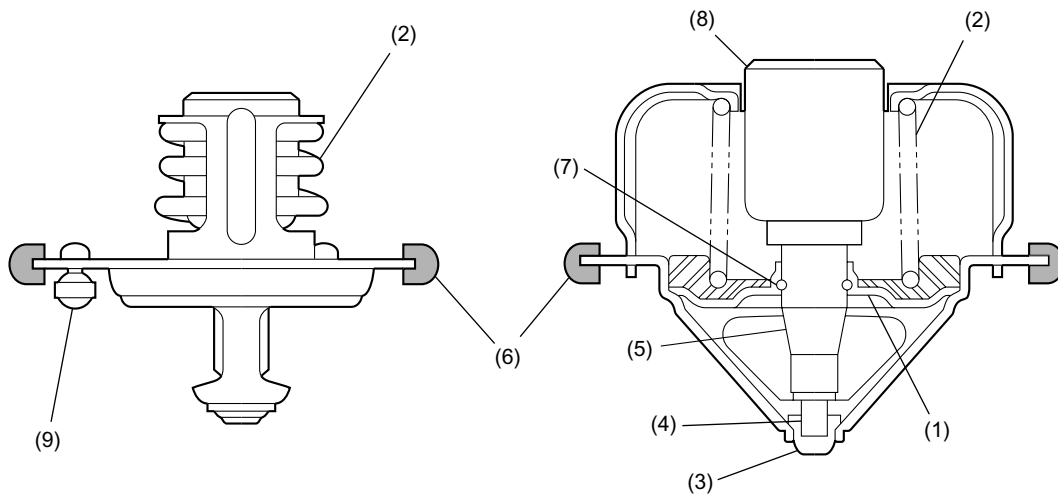
- (1) Carbon seal
- (2) Ceramics seat
- (3) Water pump shaft

THERMOSTAT

Cooling

5. Thermostat

The thermostat has a totally-enclosed wax pellet which expands as the coolant temperature increases. It opens and closes accurately at the preset temperatures and features high durability.



CO-00059

- (1) Valve
- (2) Spring
- (3) Stopper

- (4) Piston
- (5) Guide
- (6) Rubber packing

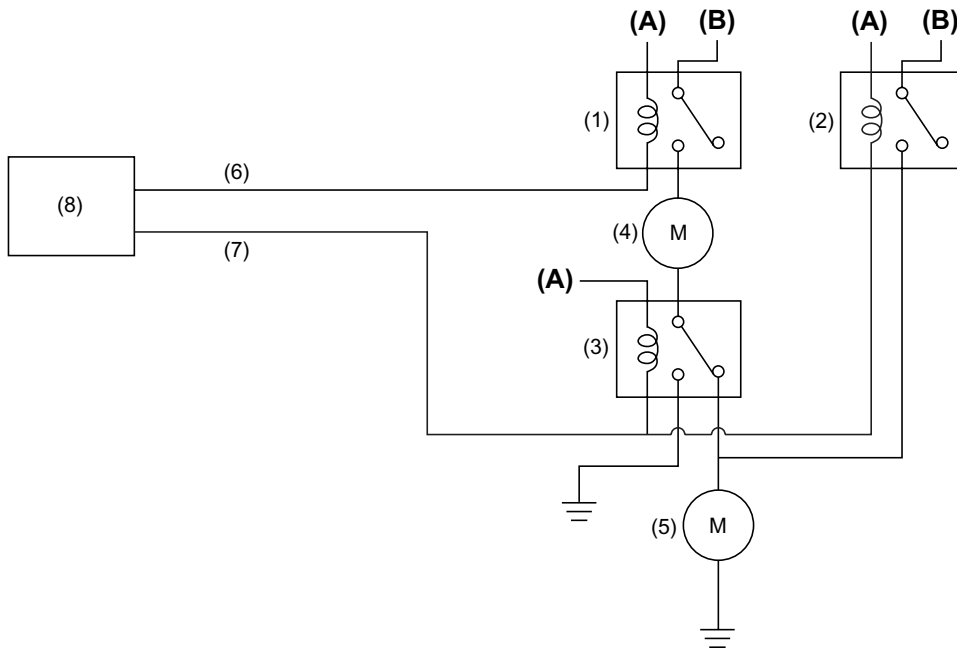
- (7) Stop ring
- (8) Wax element
- (9) Jiggle valve

RADIATOR FAN

Cooling

2. MODELS WITH A/C

To reduce fan noise, the fan output can be switched to Low or High according to the load on A/C, coolant temperature, and vehicle speed. This control is accomplished by a circuit as shown below; the output is changed by switching the connection of two motors between serial and parallel instead of using components such as resistors.



CO-00060

- | | |
|--------------------|--------------------------|
| (1) Main fan relay | (6) Low speed signal |
| (2) Sub fan relay | (7) High speed signal |
| (3) Fan mode relay | (8) ECM |
| (4) Main fan motor | (A) From ignition switch |
| (5) Sub fan motor | (B) From battery |

B: FUNCTION

1. MODELS WITHOUT A/C

The ON-OFF control of the radiator fan is performed by the ECM which receives signals from the engine coolant temperature sensor and the vehicle speed sensor.

Vehicle speed	Engine coolant temperature		
	Lower than 95°C (203°F)	96 – 99°C (203 – 210°F)	Higher than 100°C (212°F)
	Operation of radiator fan	Operation of radiator fan	Operation of radiator fan
Lower than 19 km/h (12 MPH)	OFF	ON	ON
20 – 69 km/h (12 – 43 MPH)	OFF	ON	ON
70 – 105 km/h (43 – 65 MPH)	OFF	ON	ON
Higher than 106 km/h (66 MPH)	OFF	OFF	ON

2. MODELS WITH A/C

On models equipped with an air conditioning system, the ECM receives signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch, and based on these signals, the ECM controls the fan speed to Hi or Low.

Vehicle speed	A/C compressor load	Engine coolant temperature		
		Lower than 95°C (203°F)	96 – 99°C (203 – 210°F)	Higher than 100°C (212°F)
		Operation of radiator fans	Operation of radiator fans	Operation of radiator fans
Lower than 19 km/h (12 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	Low-speed	Low-speed	High-speed
	High	High-speed	High-speed	High-speed
20 – 69 km/h (12 – 43 MPH)	OFF	OFF	Low-speed	High-Speed
	Low	High-speed	High-speed	High-speed
	High	High-speed	High-speed	High-speed
70 – 105 km/h (43 – 65 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	OFF	Low-speed	High-speed
	High	Low-speed	High-speed	High-speed
Higher than 106 km/h (66 MPH)	OFF	OFF	OFF	High-Speed
	Low	OFF	Low-speed	High-speed
	High	OFF	Low-speed	High-speed

RADIATOR FAN

Cooling

MEMO

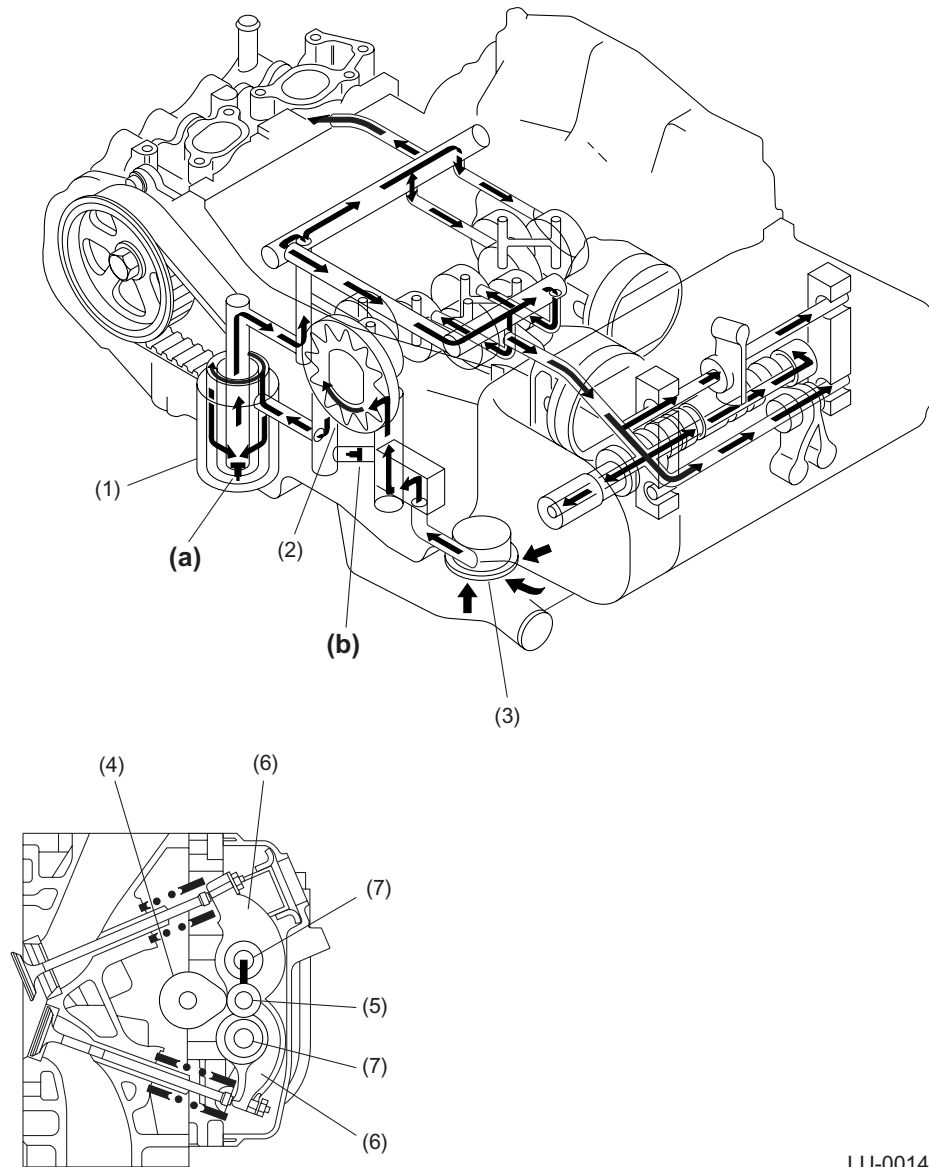
LUBRICATION *LU* (SOHC)

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2. Engine Oil Flow	5
3. Oil Pump	7
4. Oil Filter	8
5. Oil Pan and Oil Strainer	9
6. Oil Pressure Switch	10
7. Oil Cooler (Turbo Model Only)	11

1. General

- The lubrication system force-circulates engine oil throughout the engine using an oil pump. The oil pressure is regulated by the relief valve built into the oil pump.
- The oil pump is a thin, large-diameter trochoid rotor type which can accommodate the engine's high output. The pump is directly driven by the crankshaft.
- The engine oil is cleaned by a full-flow, paper element type oil filter. The filter has a bypass valve which allows the engine oil to flow bypassing the filter if it is clogged.
- The inside of the oil pan is fitted with a baffle plate which reduces changes in the oil level due to movement of the vehicle, thus ensuring uninterrupted suction of oil.
- The engine oil discharged from the oil pump is delivered to the journal bearings, connecting rod bearings, and other parts requiring lubrication and cooling via the vertical passage in the right bank of the cylinder block, the oil filter, and the oil galleries in the right and left banks of the cylinder block.
- The engine oil is also distributed to each cylinder head valve mechanism at a proper flow rate achieved by metering by the orifice provided in each oil gallery.
- A water-cooled oil cooler is located between the oil filter and cylinder block to keep the engine oil in an optimum temperature range and prevent degradation of lubrication performance (turbo model).

A: NON-TURBO MODEL



LU-00143

- (1) Oil filter
- (2) Oil pump
- (3) Oil strainer
- (4) Camshaft

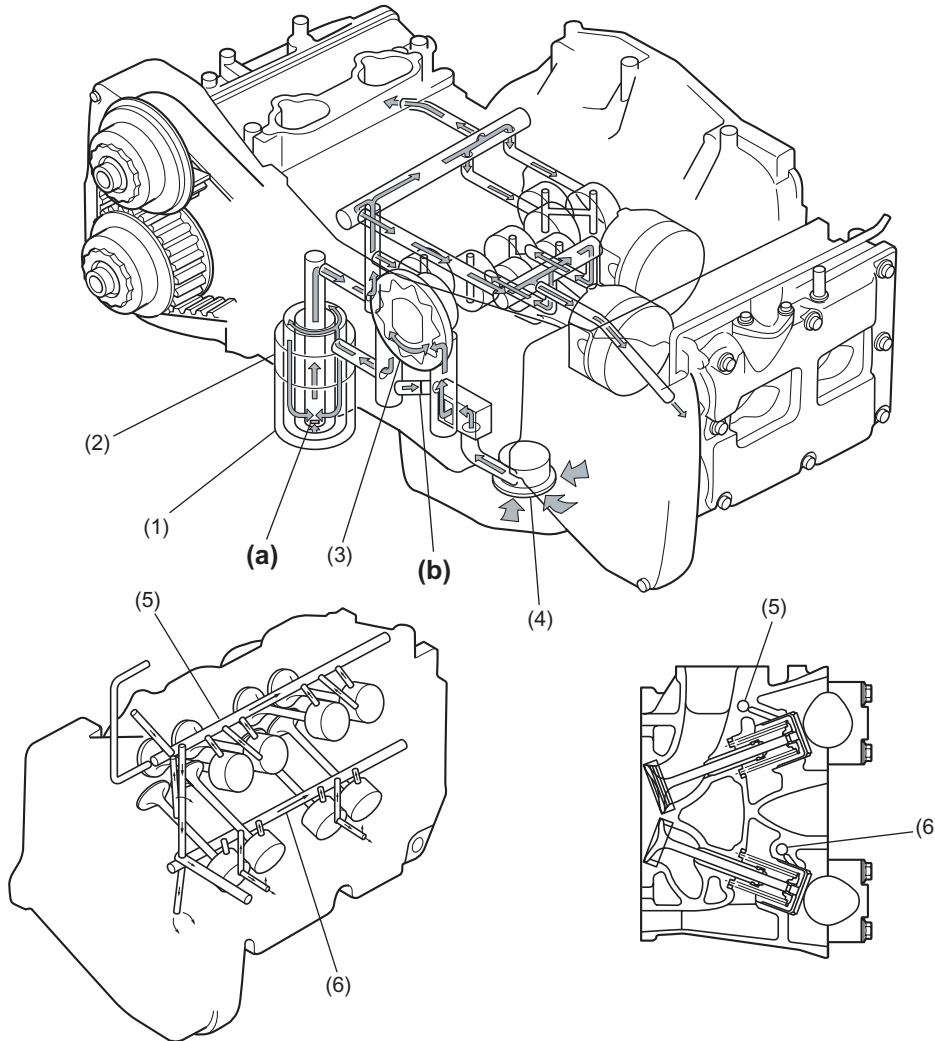
- (5) Roller
- (6) Rocker arm
- (7) Rocker shaft

- (a) Bypass valve opening pressure:
157 kPa (1.6 kgf/cm², 23 psi)
- (b) Relief valve opening pressure:
490 kPa (5.0 kgf/cm², 71 psi)

GENERAL

Lubrication

B: TURBO MODEL



LU-00066

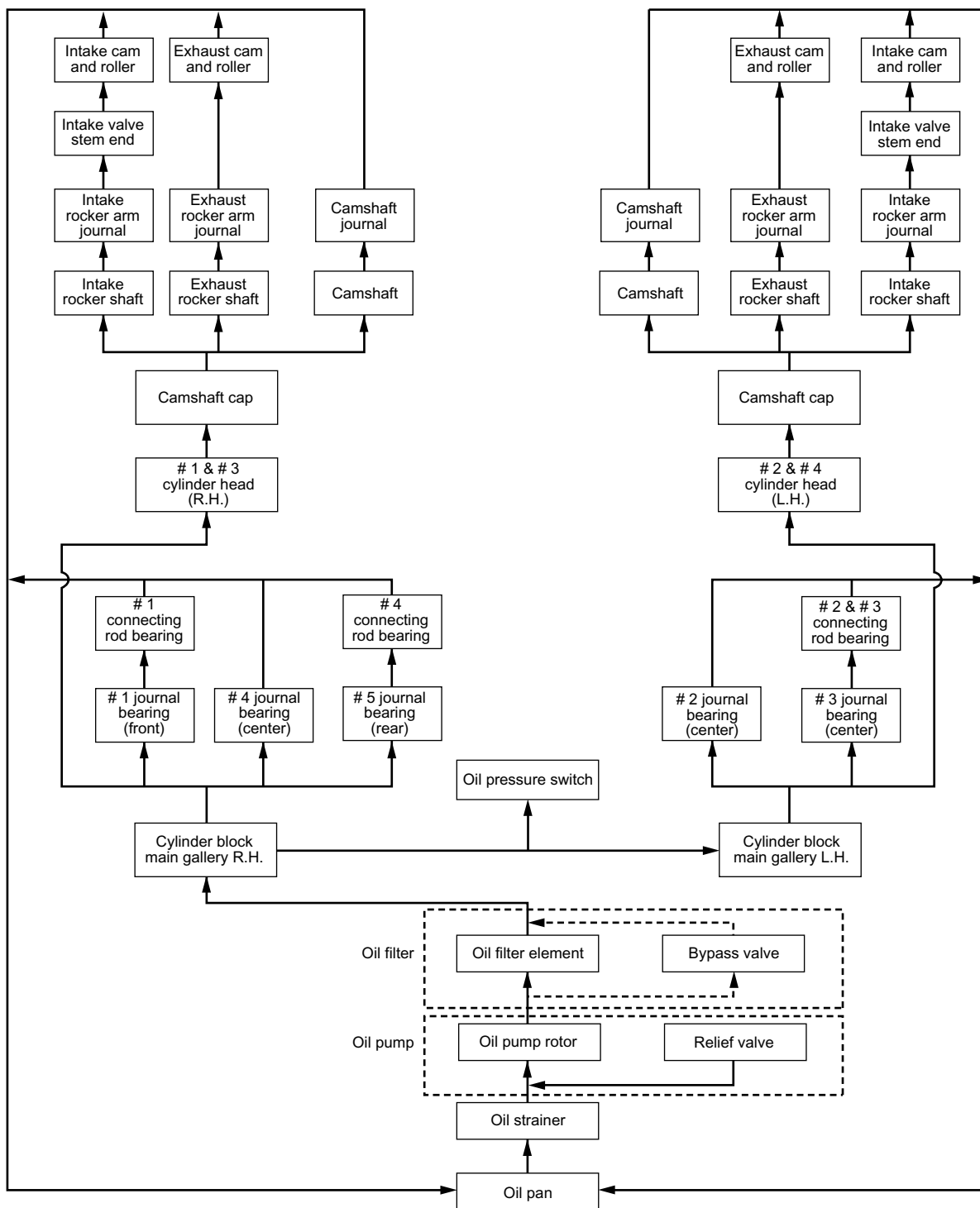
- (1) Oil filter
- (2) Oil cooler
- (3) Oil pump

- (4) Oil strainer
- (5) Intake gallery
- (6) Exhaust gallery

- (a) Bypass valve opening pressure:
157 kPa (1.6 kgf/cm², 23 psi)
- (b) Relief valve opening pressure:
588 kPa (6.0 kgf/cm², 85 psi)

2. Engine Oil Flow

A: NON-TURBO MODEL

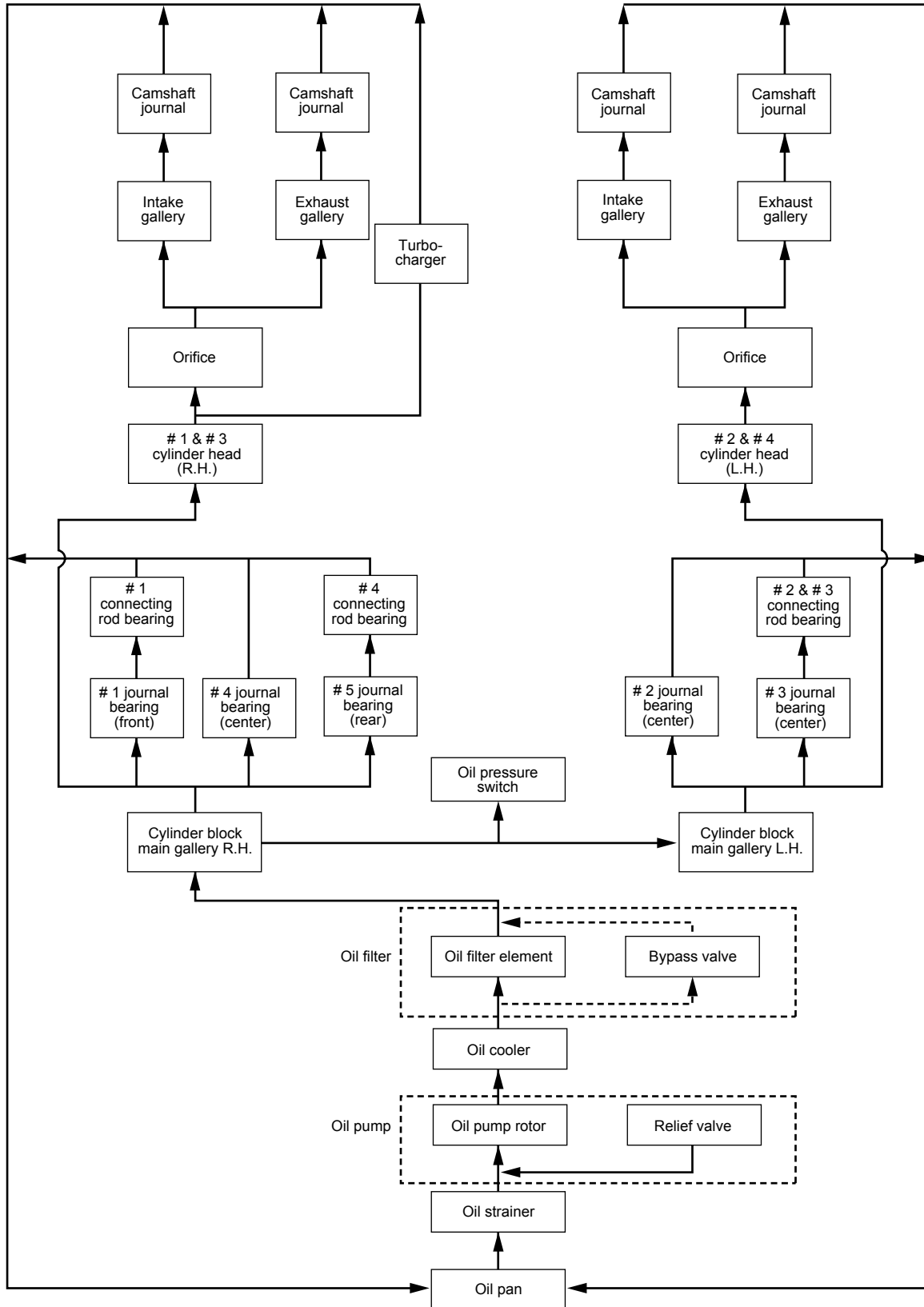


LU-00144

ENGINE OIL FLOW

Lubrication

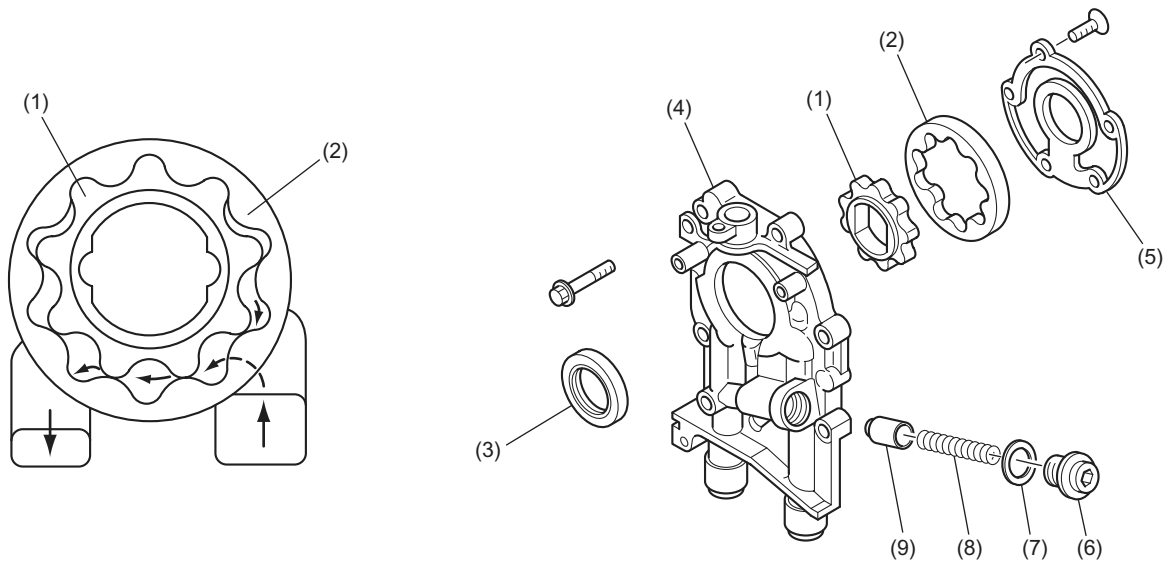
B: TURBO MODEL



LU-00068

3. Oil Pump

- The oil pump is a trochoid rotor type consisting of an inner rotor and outer rotor assembled with each other in a pump body. When the inner rotor is driven by the crankshaft, the outer rotor is rotated, changing the space between it and the inner rotor. The change in the space occurs because of the difference in the number of teeth between the rotors.
- Engine oil is drawn into the large space created near the inlet of the pump. It is then carried to the discharge port. As the pump rotates, the space carrying the oil becomes smaller, thus the oil is pressurized and discharged from the outlet port. Oil pressure is regulated by the relief valve built into the pump. Excess oil is directly returned to the inlet port.



LU-00058

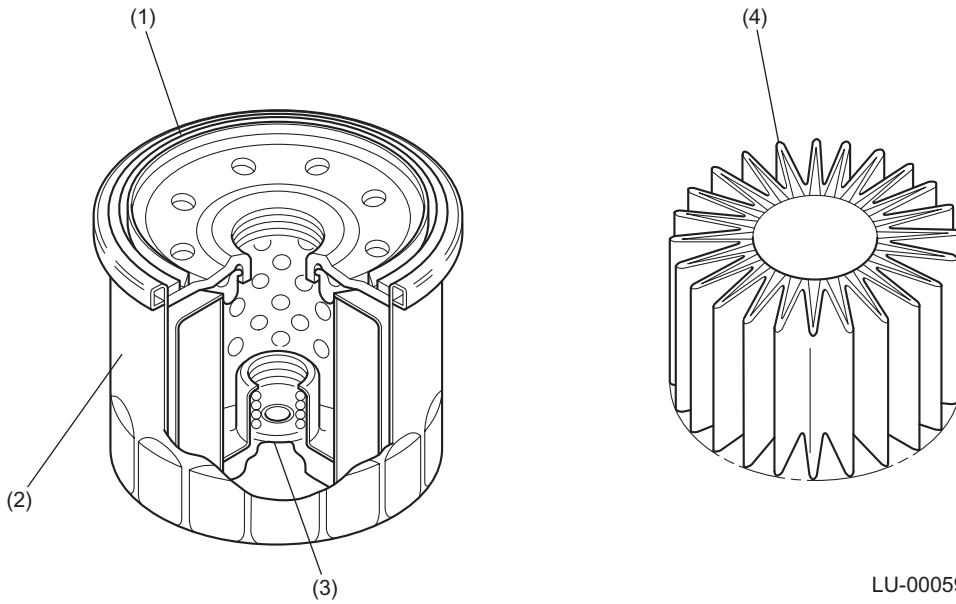
- (1) Inner rotor
- (2) Outer rotor
- (3) Oil seal
- (4) Oil pump case
- (5) Oil pump cover

- (6) Plug
- (7) Gasket
- (8) Relief valve spring
- (9) Relief valve

OIL FILTER

4. Oil Filter

The oil filter is a full-flow filtering, cartridge type that utilizes a paper element. It also has a built-in bypass valve. The filter element has a special pleat design to increase the effective filtering area.

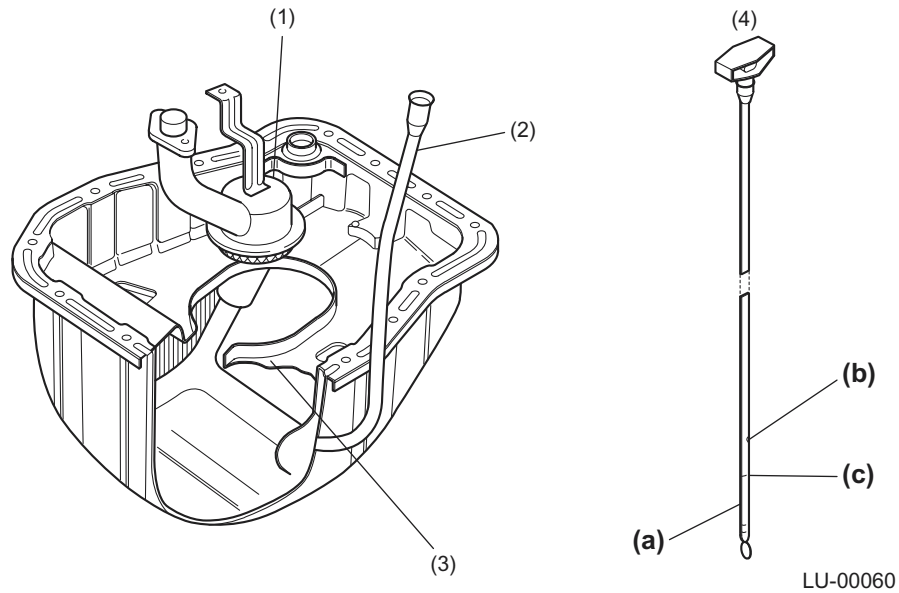


- (1) Oil seal
- (2) Filter body
- (3) Bypass valve
- (4) Pleated element

LU-00059

5. Oil Pan and Oil Strainer

- The oil pan is attached to the cylinder block using liquid gasket for sealing. The oil strainer is a metal net type and removes large foreign particles from the engine oil. It is located in the middle of the oil pan. The pipe from the strainer is connected to the suction port of the oil pump in the left bank of the cylinder block.
- There is a baffle plate in the oil pan, near the bottom of the cylinder block. It stabilizes the oil level and reinforces the oil pan.



- (1) Oil strainer
- (2) Level gauge guide
- (3) Baffle plate
- (4) Oil level gauge

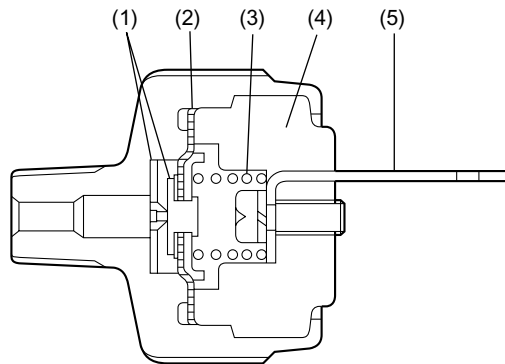
- (a) LOW level
- (b) FULL level (engine HOT condition)
- (c) FULL level (engine COLD condition)

OIL PRESSURE SWITCH

Lubrication

6. Oil Pressure Switch

The oil pressure switch is located in the front upper portion of the right cylinder block bank. The purpose of this switch is to monitor the operation of the oil pump as well as the lubricating oil pressure when the engine is running.



LU-00061

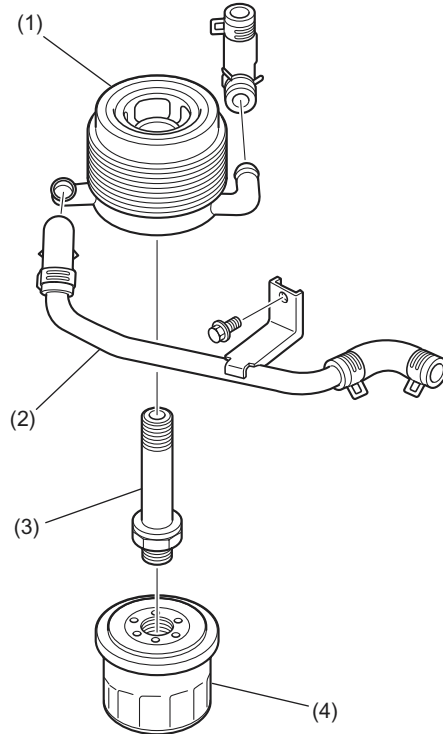
- | | |
|-------------------|--------------------|
| (1) Contact point | (4) Molded portion |
| (2) Diaphragm | (5) Terminal |
| (3) Spring | |

1) When oil pressure does not build up (immediately after ignition switch is turned ON):
The diaphragm is pushed toward the cylinder block by the spring force (a force equivalent to the specified oil pressure). This closes the contact points, causing the oil pressure warning light in the combination meter to illuminate.

2) When oil pressure reaches the specified value (after engine starts):
After reaching the specified value of 14.7 kPa (0.15 kgf/cm², 2.1 psi), the oil pressure pushes the diaphragm overcoming the spring force. This opens the contact points and the oil pressure warning light goes out.

7. Oil Cooler (Turbo Model Only)

The oil cooler used in turbo models is of a water cooled type. It serves to maintain engine oil in proper temperature range and so prevent degradation of lubricating oil performance.



LU-00067

- (1) Oil cooler
- (2) Connector

- (3) Water pipe
- (4) Oil filter

OIL COOLER (TURBO MODEL ONLY)

Lubrication

MEMO

SPEED CONTROL SYSTEM *SP* (*SOHC*)

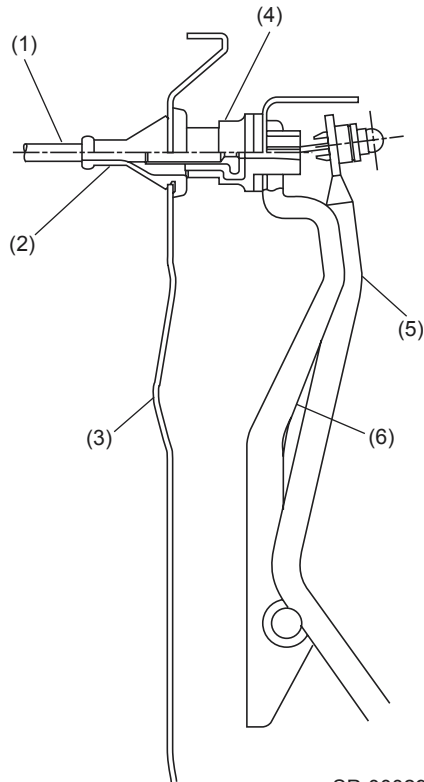
	Page
1. General	2

GENERAL

1. General

The accelerator outer cable is secured to the accelerator pedal bracket rather than to the toeboard. Securing the outer cable in this way has a merit of making the ratio of throttle valve movement to cable stroke less variable. This arrangement is also effective to prevent uneven cable return movement that may result from deformation of the toeboard or improper installation of the accelerator pedal and, therefore, to improve safety.

In addition, the floating type casing cap through which the cable is attached to the bracket reduces vibration of the pedal, thus improving quietness.



- (1) Accelerator cable
- (2) Grommet
- (3) Toeboard
- (4) Casing cap (floating type)
- (5) Accelerator pedal
- (6) Bracket

IGNITION *IG* (SOHC)

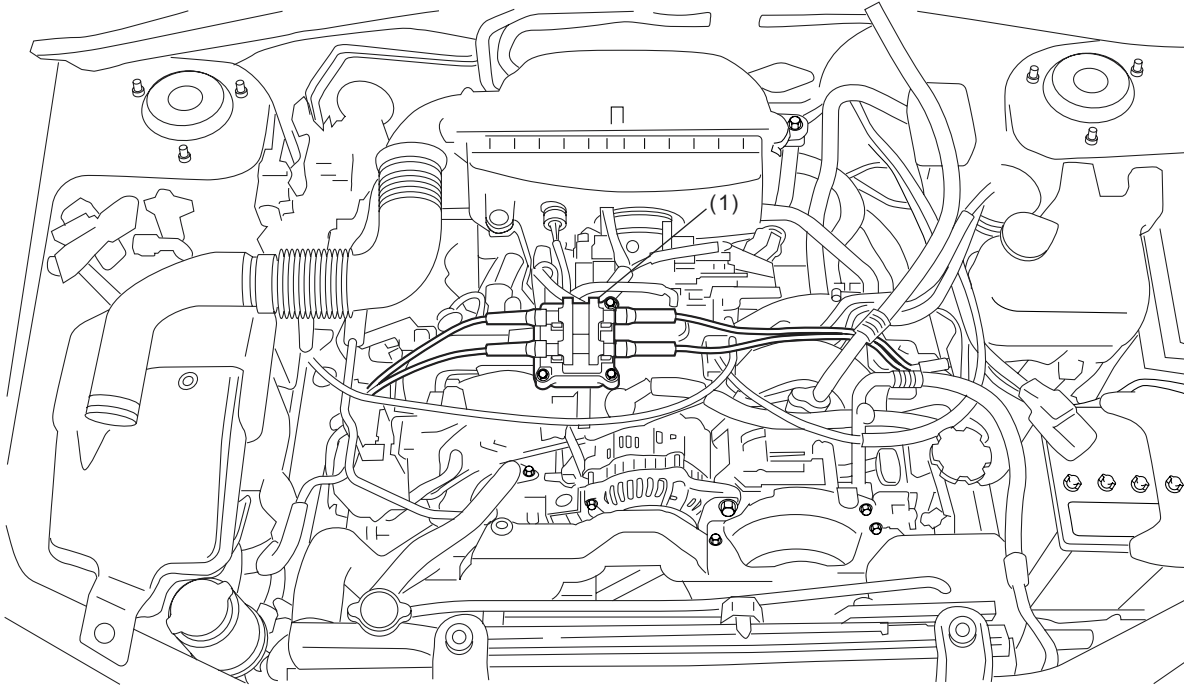
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IGNITION COIL

Ignition

1. Ignition Coil

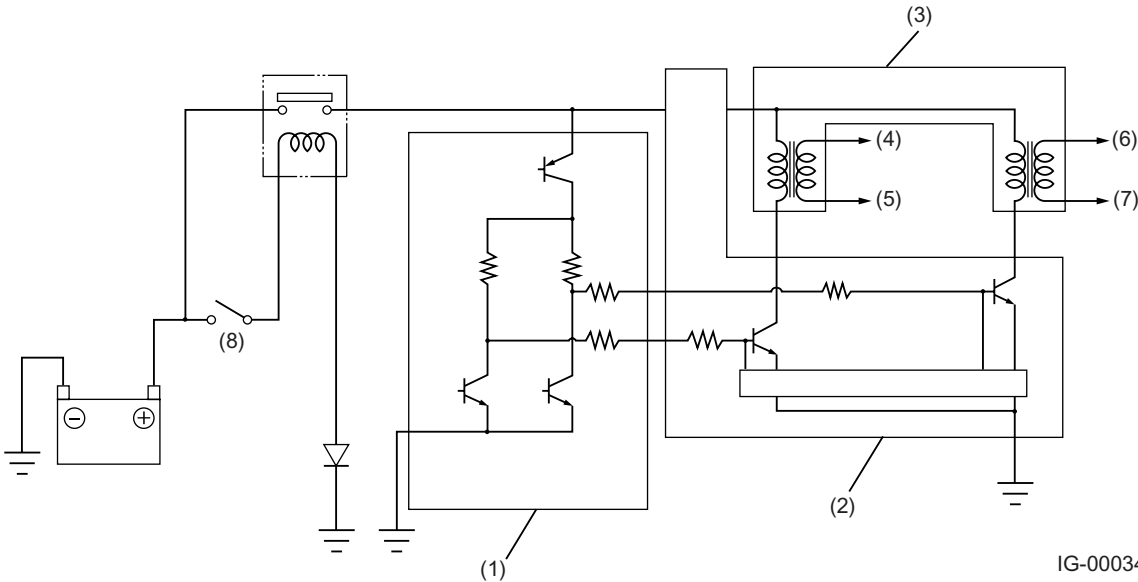
Ignition coils are made integral with an ignitor. The ignition system is of a dual-ignition-coil design, each coil causing two plugs to generate sparks simultaneously. In response to the signal from the ECM, the ignitor supplies current to an ignition coil and the ignition coil supplies high-voltage current to a pair of spark plugs (#1 and #2 or #3 and #4) simultaneously.



IG-00068

(1) Ignition coil and ignitor assembly

IGNITION COIL



IG-00034

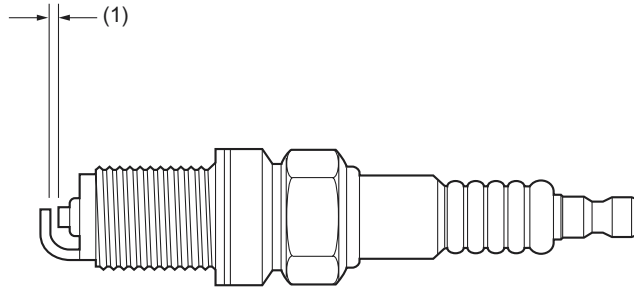
- (1) ECM
- (2) Ignitor
- (3) Ignition coil
- (4) Spark plug #1
- (5) Spark plug #2
- (6) Spark plug #3
- (7) Spark plug #4
- (8) Ignition switch

SPARK PLUG

Ignition

2. Spark Plug

The spark plug's thread diameter is 14 mm (0.551 in) and the gap is controlled to a value between 1.0 and 1.1 mm (0.039 and 0.043 in).



IG-00035

(1) Gap: 1.0 – 1.1 mm (0.039 – 0.043 in)

STARTING/CHARGING **SC** (SOHC)

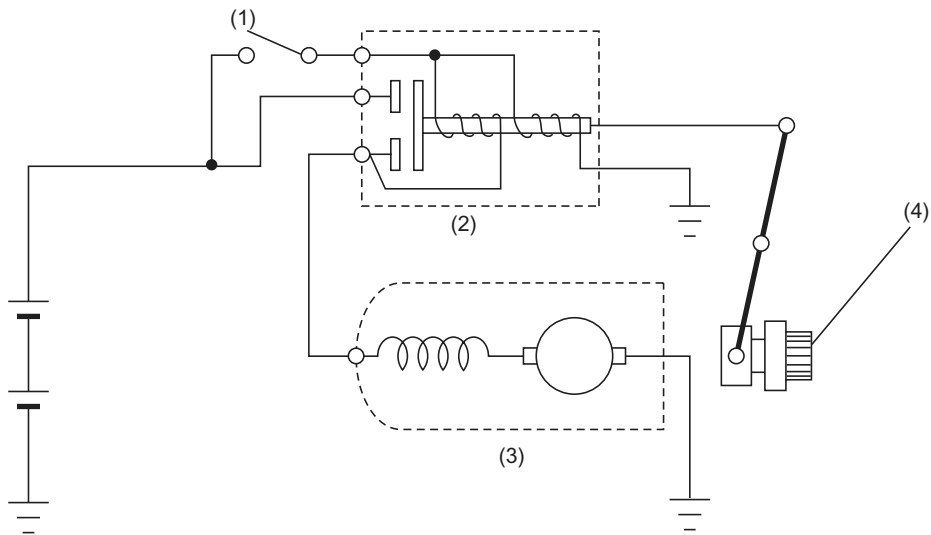
	Page
1. Starter	2
2. Generator	3
3. Battery	5

STARTER

Starting/Charging

1. Starter

The starter is of a reduction type. Its output is 1.0 kW on the MT model and 1.4 kW on the AT model.



SC-00056

- (1) Starter switch
- (2) Magnet switch
- (3) Starter
- (4) Pinion

2. Generator

The generator has a built-in regulator which provides diagnostic functions in addition to a voltage regulating function as follows:

1) Voltage regulation

The on-off operation of transistor Tr_1 connects and disconnects the field current circuit, providing a constant level of output voltage.

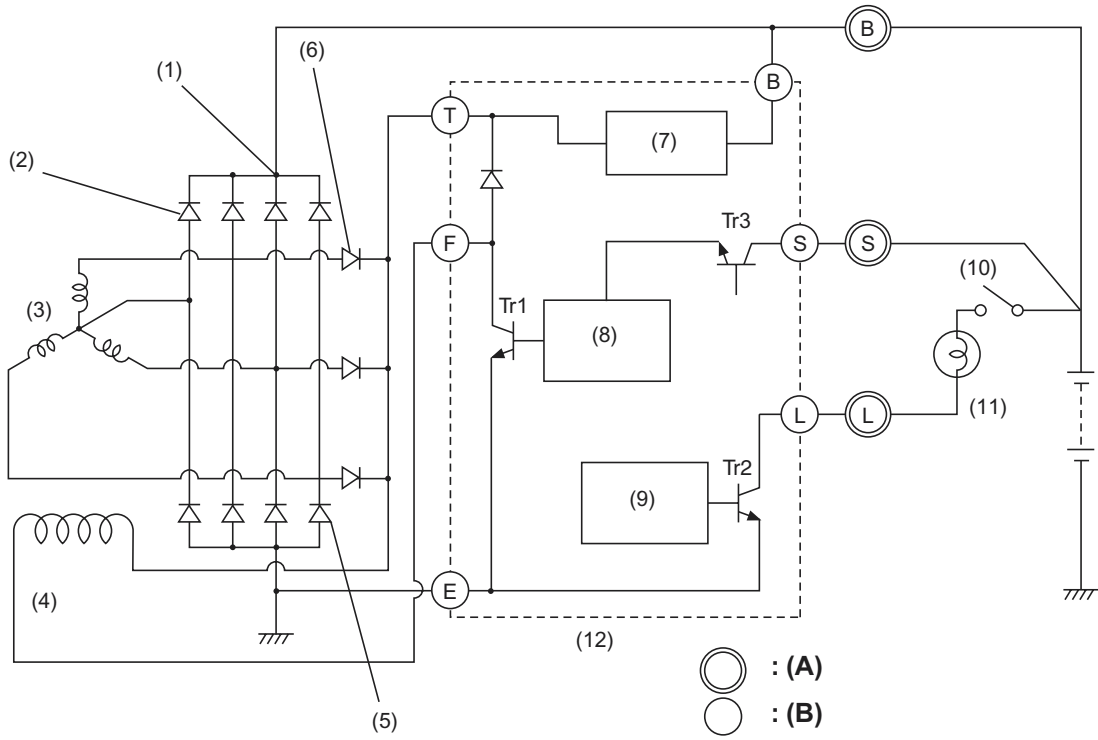
2) Diagnosis warning

When any of the following problems occur, the charge lamp illuminates.

- a. No voltage generation
Brush wear exceeds specified wear limits, field coil circuit is broken, etc.
- b. Excessive output
Output voltage is greater than 16 volts (approx).
- c. Terminal B disconnection
Harness is disconnected from alternator terminal B.
- d. Terminal S disconnection
Harness is disconnected from alternator terminal S. In this case, voltage is slightly greater than specified regulated voltage; however, voltage regulation is still controlled and the battery is prevented from becoming overcharged.

GENERATOR

Starting/Charging



SC-00057

- | | | |
|----------------------------------|----------------------------------|--------------------------------|
| (1) Positive side diode (3 pcs.) | (7) Energizing circuit | (A) Alternator terminal |
| (2) Additional diode (2 pcs.) | (8) Constant voltage circuit | (B) Regulator terminal |
| (3) Stator coil | (9) Diagnostic & warning circuit | |
| (4) Field coil | (10) IG switch | |
| (5) Negative side diode (3 pcs.) | (11) Charge light | |
| (6) Trio diode (3 pcs.) | (12) IC regulator | |

3. Battery

The battery is located in the left front part of the engine compartment. It is held on a tray by the battery holder.

BATTERY

Starting/Charging

MEMO

FUEL INJECTION (FUEL SYSTEM) *FU* (TURBO)

	Page
1. General	2
2. Air Line	3
3. Fuel line	7
4. Sensors and Switches	15
5. CONTROL SYSTEM	26
6. On-board Diagnosis System	35

1. General

- The Multipoint Fuel Injection (MFI) system supplies optimum air-fuel mixture under every engine operating condition through the use of the latest electronic control technology.

This system pressurizes the fuel to a constant pressure and injects it into each intake air port in the cylinder head. The injection quantity of fuel is controlled by an intermittent injection system where an electro-magnetic injection valve or injector opens for a short period that is precisely controlled depending on the quantity of air appropriate for each condition of operation. In actual control, an optimum fuel injection quantity is achieved by varying the duration of an electric pulse applied to the injector. This way of control enables simple, yet highly precise metering of the fuel.

- The engine control module (ECM) that controls the fuel injection system corrects the fuel injection amount depending on the vehicle speed, throttle opening, coolant temperature and other vehicle-operation-related information. The ECM receives the information in the form of electric signals from the corresponding sensors and switches.

The MFI system also has the following features:

- Reduced exhaust emissions
- Reduced fuel consumption
- Increased engine output
- Quick response to accelerator and brake pedal operation
- Superior startability and warm-up performance in cold weather due to corrective controls made according to coolant and intake air temperatures

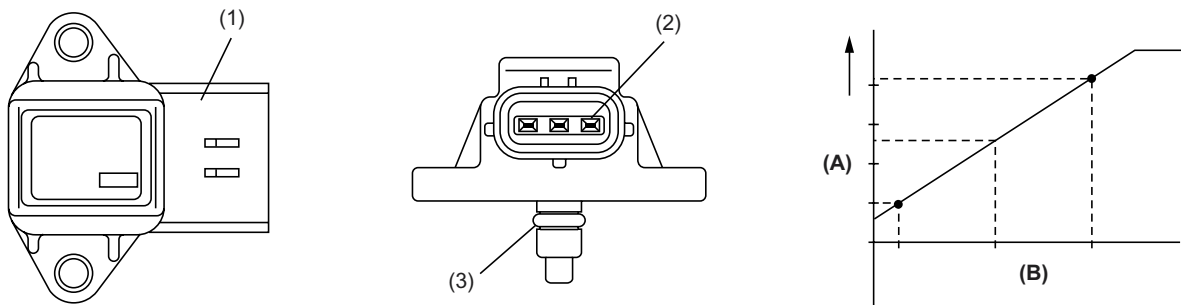
2. Air Line

A: GENERAL

The air filtered by the air cleaner enters the throttle body where it is regulated in the volume by the throttle valve and then enters the intake manifold. It is then distributed to each cylinder where the air is mixed with fuel injected by the injector. During idling operation, air flows into the cylinder through the idle air control solenoid valve, bypassing the throttle valve. This enables controlling the engine idling speed properly.

B: PRESSURE SENSOR

The pressure sensor is attached to the top of the throttle body, and continuously sends to the engine control module (ECM) voltage signals that are proportional to intake manifold absolute pressures. The ECM controls the fuel injection and ignition timing based on the intake manifold absolute pressure signals in addition to other signals from many sensors and other control modules.



- (1) Connector
- (2) Terminal
- (3) O-ring

- (A) Output voltage
- (B) Absolute pressure

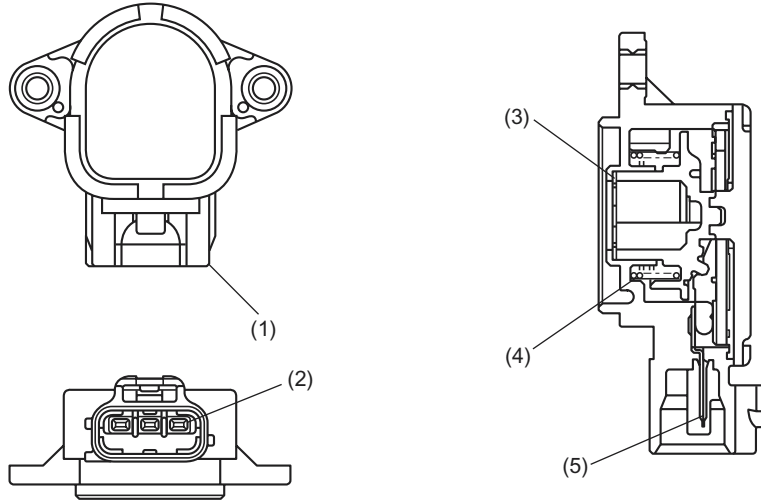
FU-00343

C: THROTTLE BODY

- In response to operation of the accelerator pedal, the throttle valve in the throttle body opens/closes to regulate the volume of the air drawn into the combustion chamber.
- During idling, the throttle valve is almost fully closed and the volume of air passing through the throttle body is less than that passing through the idle air control solenoid valve.
- More than half of the air necessary for idling is supplied to the intake manifold via the idle air control solenoid valve which controls properly the engine idling speed, so the idling speed needs not be adjusted.

D: THROTTLE POSITION SENSOR

- The throttle position sensor is mounted in the throttle body and linked to the throttle valve.
- The throttle position sensor sends the ECM voltage signal corresponding to the opening of the throttle valve. When the sensor's output voltage exceeds a predetermined level, the ECM interprets it as complete closure of the throttle valve. When the output voltage is at another predetermined level, the ECM recognizes that the throttle valve is at a wide open position. Since the output characteristics of the sensor change over years, the ECM is provided with a learning function to be able to interpret signals into throttle valve angles always correctly.



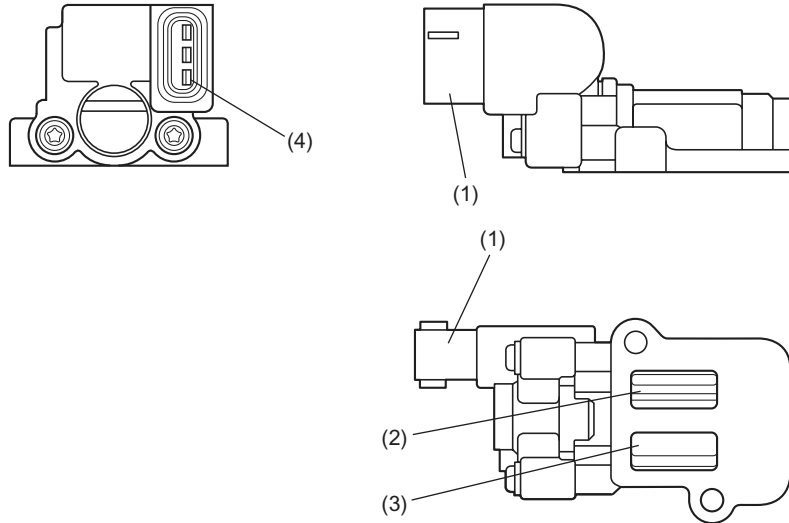
FU-00344

- (1) Connector
- (2) Terminal
- (3) Wave washer

- (4) Return spring
- (5) Terminal

E: IDLE AIR CONTROL SOLENOID VALVE

- The idle air control solenoid valve is located in the throttle body and regulates the amount of intake air that flows bypassing the throttle valve into the intake manifold during engine idling. It is activated by a signal from the ECM in order to maintain the engine idling speed at a target speed.
- The idle air control solenoid valve is a solenoid-actuated rotary valve consisting of a coil, rotary valve, spring and housing. The housing is an integral part of the throttle body and provided with a bypass air port whose opening area is changed by the rotary valve.



FU-00345

- (1) Connector
- (2) Air outlet port

- (3) Air inlet port
- (4) Terminal

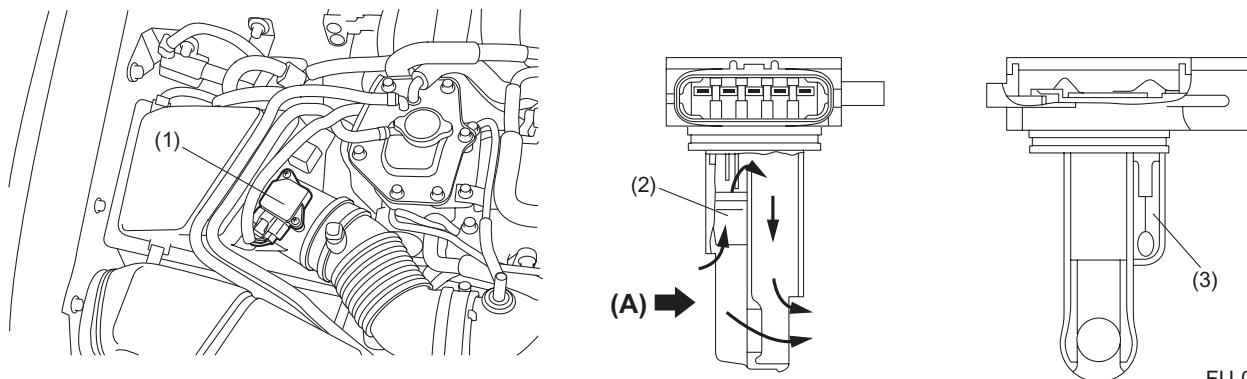
AIR LINE

Fuel Injection (Fuel System)

F: MASS AIR FLOW AND INTAKE AIR TEMPERATURE SENSOR

The mass air flow and the intake air temperature sensors are integrated into a single unit. The unit is mounted on the air cleaner case and measures the amount as well as the temperature of the intake air.

The measured amount and temperature are converted into electrical signals and sent to the ECM. The ECM uses these signals to control injection and ignition timing as well as the fuel injection amount.



FU-00346

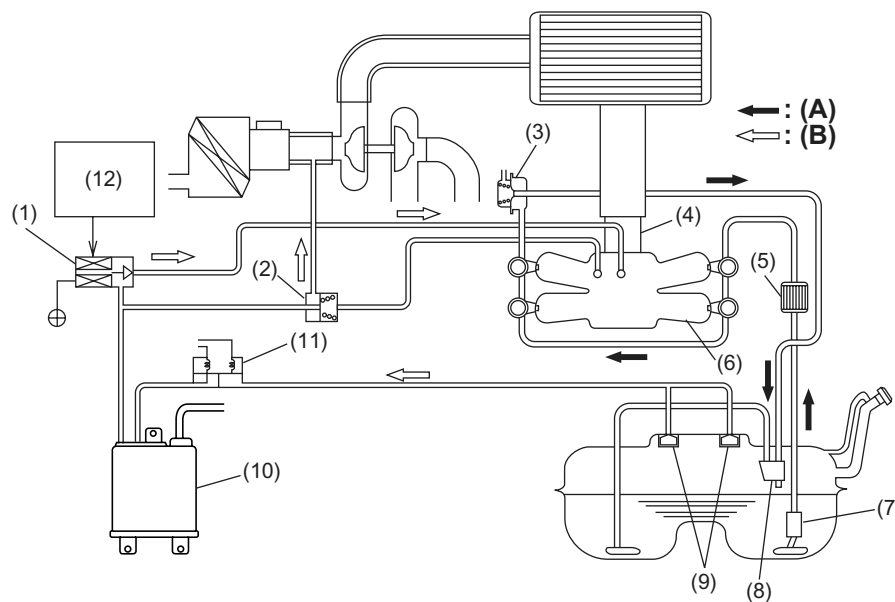
- (1) Mass air flow and intake air temperature sensor
 - (2) Mass air flow sensor
 - (3) Intake air temperature sensor
- (A) Air

3. Fuel line

A: GENERAL

- The fuel pressurized by the fuel tank inside pump is delivered to each fuel injector by way of the fuel pipe and fuel filter. Fuel injection pressure is regulated to an optimum level by the pressure regulator.
- Each injector injects fuel into the intake port of the corresponding cylinder where the fuel is mixed with air. The mixture then enters the cylinder.

Fuel injection amount and timing are regulated by the ECM.



FU-00348

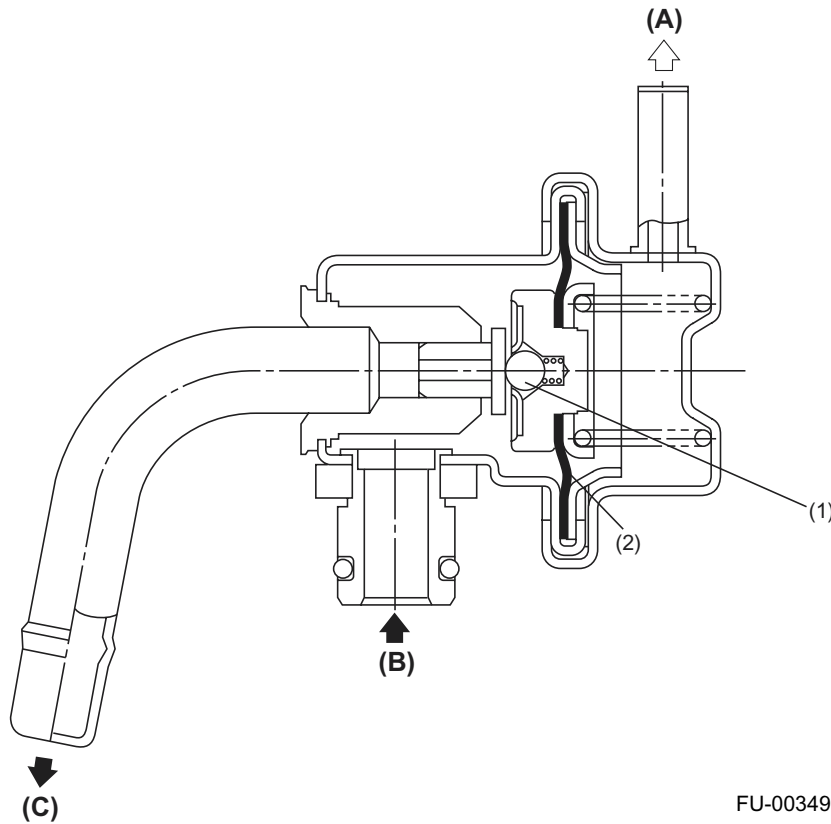
- | | |
|----------------------------------|----------------------|
| (1) Purge control solenoid valve | (8) Jet pump |
| (2) Purge valve | (9) Fuel cut valve |
| (3) Pressure regulator | (10) Canister |
| (4) Throttle body | (11) Two-way valve |
| (5) Fuel filter | (12) ECM |
| (6) Intake manifold | (A) Fuel line |
| (7) Fuel pump | (B) Evaporation line |

FUEL LINE

Fuel Injection (Fuel System)

B: PRESSURE REGULATOR

The pressure regulator is installed at the injector end of the fuel supply line. It has a fuel chamber and spring chamber separated by a diaphragm. Fuel chamber is connected to the fuel supply line and the spring chamber is connected to the intake manifold. Fuel chamber also has a relief valve connected to the fuel return line through which fuel returns to the fuel tank. When the intake manifold vacuum increases, the diaphragm is pulled and the relief valve opens to decrease the fuel supply line pressure (or fuel injection pressure). When the intake manifold vacuum decreases, the diaphragm is pushed by the spring to increase the fuel supply line pressure. Thus, the difference between the fuel injection pressure and the intake manifold vacuum is kept at a constant level of 294 kPa (3.00 kgf/cm², 43.0 psi) to precisely control the amount of injected fuel.



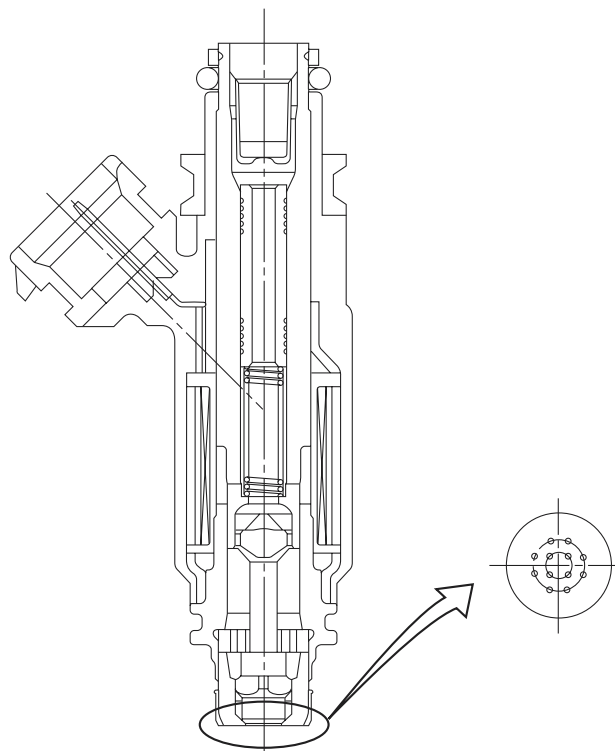
FU-00349

- (A) To intake manifold
- (B) Fuel IN
- (C) Fuel OUT

- (1) Relief valve
- (2) Diaphragm

C: FUEL INJECTORS

- The MFI system employs top feed type fuel injectors.
- Each injector is installed in the fuel pipe in such a way that the injector is cooled by fuel.
- The features of this type of fuel injector are as follows:
 - 1) High heat resistance
 - 2) Low driving noise
 - 3) Easy to service
 - 4) Small size
- The injector injects fuel according to the valve open signal from the ECM. The needle valve is lifted by the solenoid which is energized on arrival of the valve open signal.
- Since the injector's nozzle hole area, the lift of valve and the fuel pressure are kept constant, the amount of fuel injected is controlled only by varying the duration of the valve open signal from the ECM.
- The multi-hole nozzle makes it possible for the injector to produce fine fuel particles, which enhances the combustion efficiency and output performance of the engine.



FU-00350

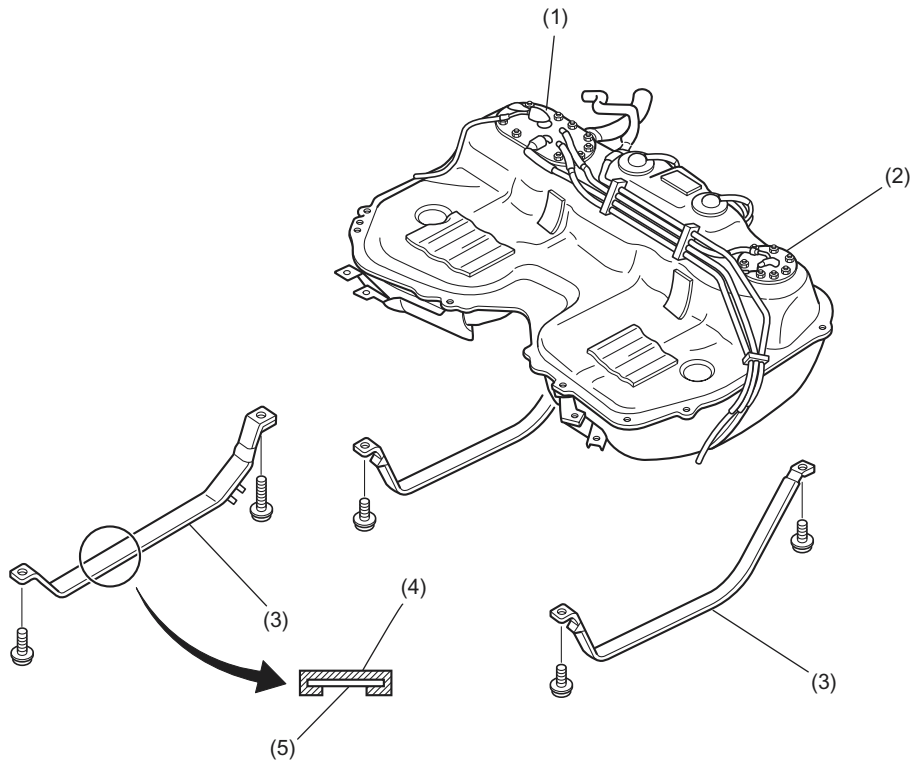
FUEL LINE

Fuel Injection (Fuel System)

D: FUEL TANK

The fuel tank utilizes a two-compartment design to ensure sufficient capacity without interfering with the rear differential. It is provided with a suction jet pump (included in the fuel pump and fuel level sensor assembly) which transfers fuel from one compartment to the other.

Each compartment has an individual fuel level sensor. The fuel tank is located under the rear seat and secured with hold-down bands.



FU-00689

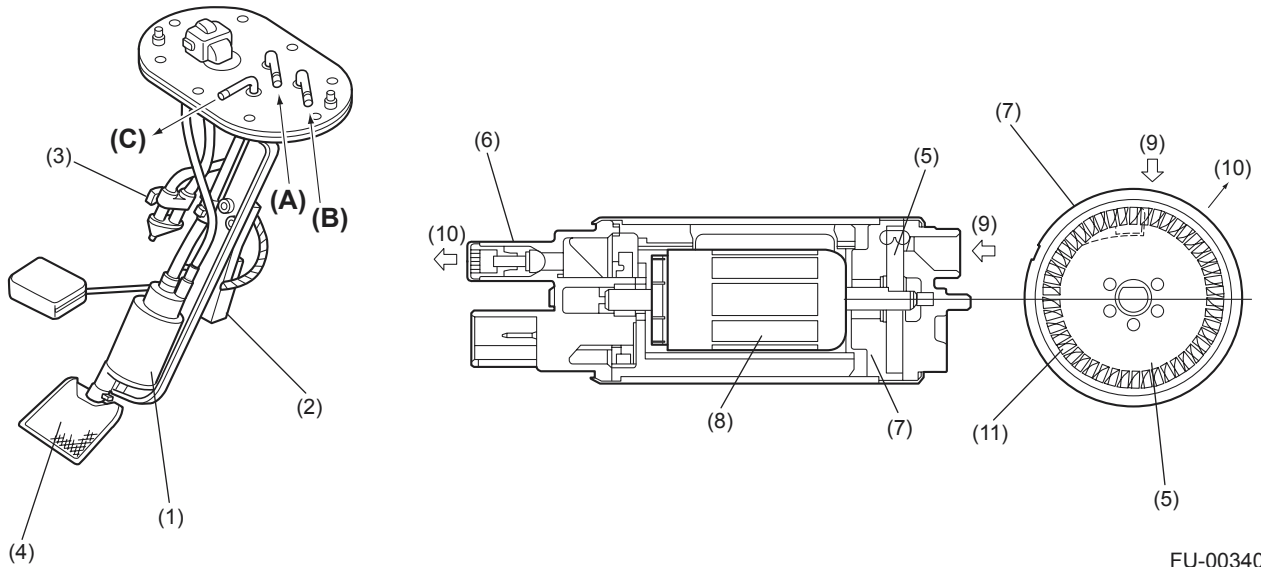
- (1) Fuel pump and fuel level sensor assembly
- (2) Fuel sub level sensor
- (3) Band

- (4) Cushion
- (5) Steel

E: FUEL PUMP AND FUEL LEVEL SENSOR ASSEMBLY

1. FUEL PUMP

The fuel pump consists of a motor, impeller, pump casing, pump cover, check valve and filter. It is located in the fuel tank and combined with the fuel level sensor into a single unit. The operation of this impeller type pump is very quiet.



- | | | |
|-----------------------|--------------------|-------------------------------|
| (1) Fuel pump | (7) Pump casing | (A) From engine (return line) |
| (2) Fuel level sensor | (8) Motor armature | (B) From sub tank |
| (3) Jet pump | (9) Suction | (C) To engine (delivery line) |
| (4) Mesh filter | (10) Discharge | |
| (5) Impeller | (11) Vane groove | |
| (6) Check valve | | |

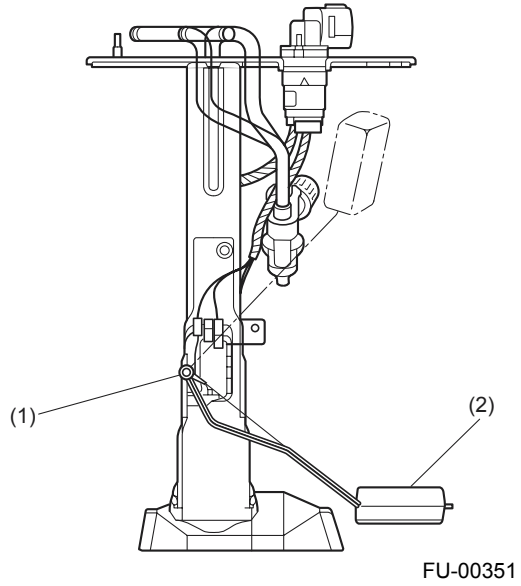
- When the ignition switch is turned ON, fuel pump relay is activated. Then the motor operates to rotate the impeller.
- As the impeller rotates, fuel in a vane groove of the impeller flows along the fuel passage into the next vane groove by centrifugal force. When fuel flows from one groove to the next, a pressure difference occurs due to friction. This creates a pumping effect.
- The fuel pushed up by rotation of the impeller then passes through the clearance between the armature and the magnet of the motor and is discharged through the check valve.
- When the fuel discharge pressure reaches the specified level, the relief valve opens and excess fuel is released into the fuel tank. In this manner, the relief valve prevents an abnormal increase in fuel pressure.
- When the engine and the fuel pump stop, spring force acts on the check valve to close the discharge port, so that the fuel pressure in the fuel delivery line is retained.

FUEL LINE

Fuel Injection (Fuel System)

2. FUEL LEVEL SENSOR

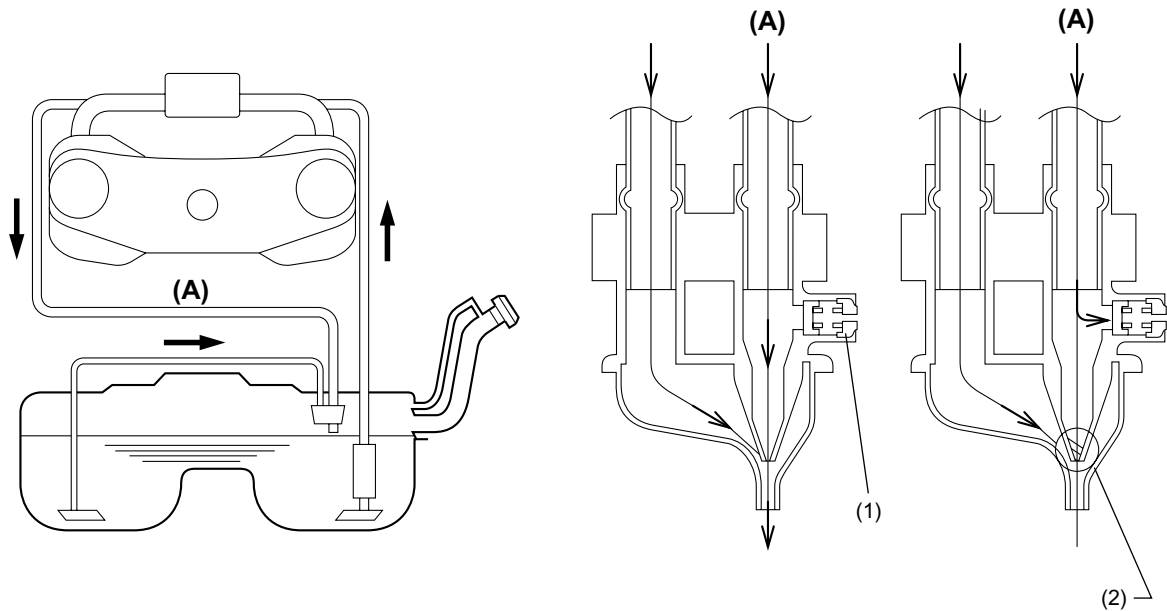
The fuel level sensor forms part of the fuel pump and located in the fuel tank. The sensor outputs an electric resistance signal that varies with movement of its float to indicate the level of the fuel remaining in the tank.



- (1) Fuel level sensor
- (2) Float

3. JET PUMP

- The jet pump utilizes the velocity of fuel returning from the engine to produce negative pressure in it.
- Using the pumping effect produced by the negative pressure, the jet pump transfers fuel from the sub-compartment to the main compartment of the fuel tank.
- When the return line nozzle is clogged, the fuel sent back through the return line flows back into the fuel tank via the relief valve.



FU-00226

- (1) Relief valve
- (2) Nozzle

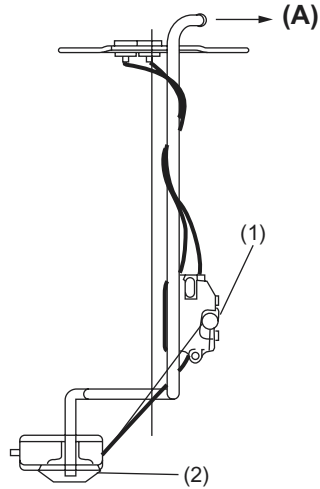
(A) Return line

FUEL LINE

Fuel Injection (Fuel System)

F: SUB-COMPARTMENT FUEL LEVEL SENSOR

This sensor detects the level of the fuel in the sub-compartment (the compartment in which the fuel pump is not located) and acts as part of the fuel transfer line when the jet pump is in operation to maintain the fuel in both compartments at the same level.



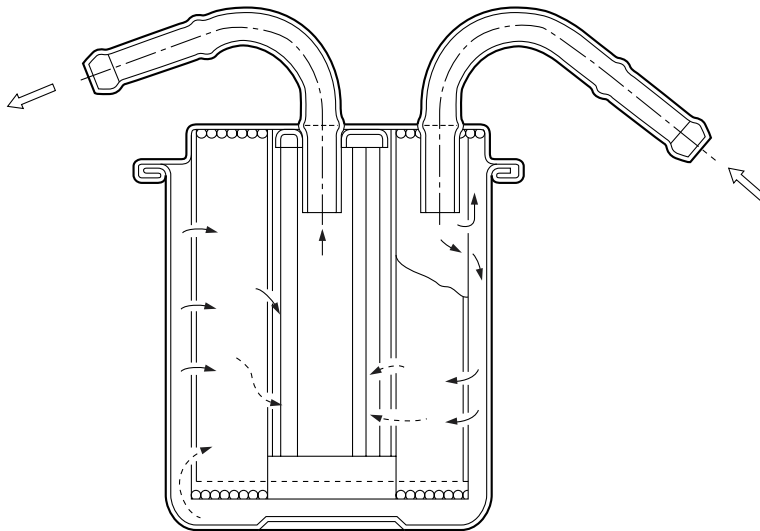
FU-00227

- (1) Fuel level sensor
- (2) Float

(A) To jet pump

G: FUEL FILTER

The fuel filter located in the engine compartment is a pressure-withstanding, cartridge type. It has a filter element in a metal case. The fuel entering the filter flows from the perimeter of the element to the center of the filter and goes out from there.

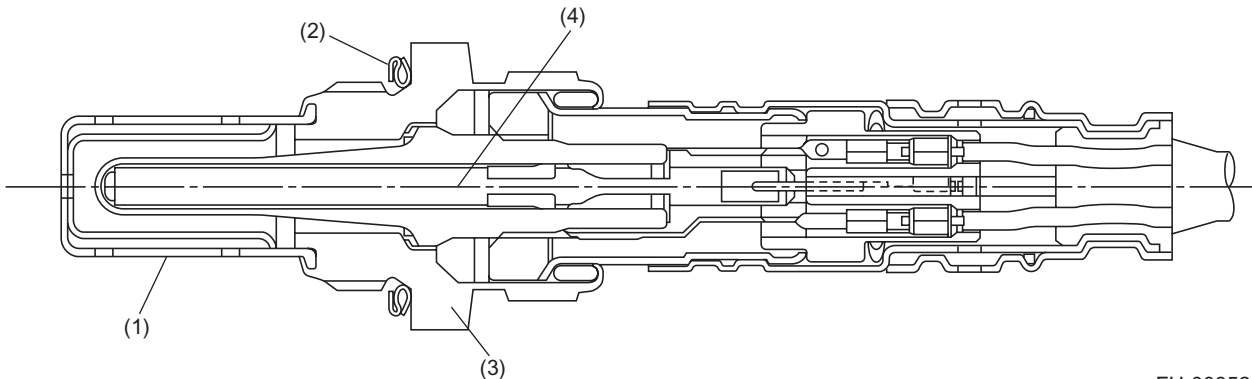


FU-00228

4. Sensors and Switches

A: FRONT OXYGEN (A/F) SENSOR

- The front oxygen (A/F) sensor uses zirconium oxide (ZrO_2) which is a solid electrolyte, at portions exposed to exhaust gas.
- The zirconium oxide has the property of generating electromotive force when its both sides are exposed to oxygen ions of different concentration and the magnitude of this electromotive force depends on how much the difference is.
The front oxygen (A/F) sensor detects the amount of oxygen in exhaust gases by making use of this property of the zirconium oxide material.
- The zirconium oxide material is formed into a closed end tube and its external surface is exposed to exhaust gases with smaller oxygen ion concentration, whereas its internal surface is exposed to atmospheric air. The external surface has a porous platinum coating. The sensor housing is grounded to the exhaust pipe and the inside is connected to the ECM through the harness to be able to use the current output from the sensor.
- The sensor incorporates a ceramic heater to improve its performance at low temperatures.



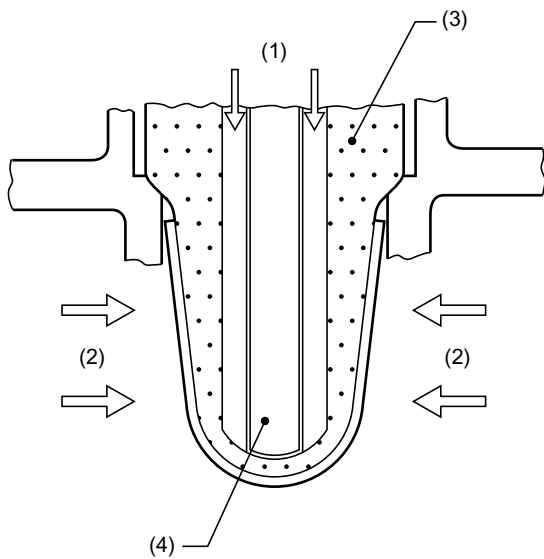
FU-00352

- (1) Protection tube
- (2) Gasket
- (3) Sensor housing
- (4) Ceramic heater

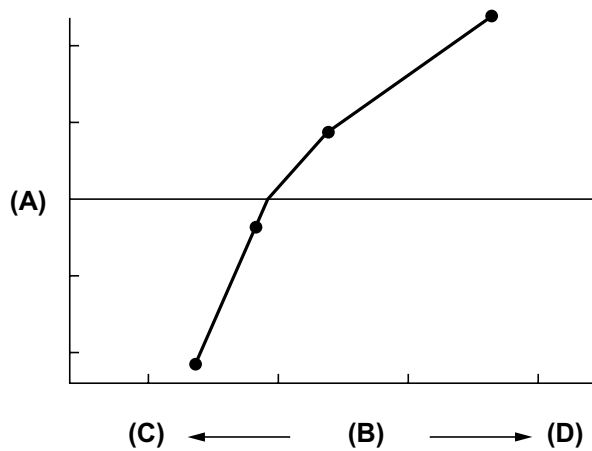
SENSORS AND SWITCHES

Fuel Injection (Fuel System)

- When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases is almost completely used in the catalytic reaction by the platinum coating on the external surface of the zirconia tube. This results in a very large difference in the oxygen ion concentration between the inside and outside of the tube, and the electromotive force generated is large.
- When a lean air-fuel mixture is burnt in the cylinder, relatively large amount of oxygen remains in the exhaust gases even after the catalytic action, and this results in a small difference in the oxygen ion concentration between the tube's internal and external surfaces. The electromotive force in this case is very small.
- The difference in oxygen concentration changes drastically in the vicinity of the stoichiometric air-fuel ratio, and hence the change in the electromotive force is also large. By using this information, the ECM can determine the air-fuel ratio of the supplied mixture easily. The front oxygen sensor does not generate much electromotive force when the temperature is low. The output characteristics of the sensor stabilize at a temperature of approximately 700°C (1,292°F).



- (1) Atmospheric air
- (2) Exhaust gases
- (3) ZrO_2
- (4) Ceramic heater

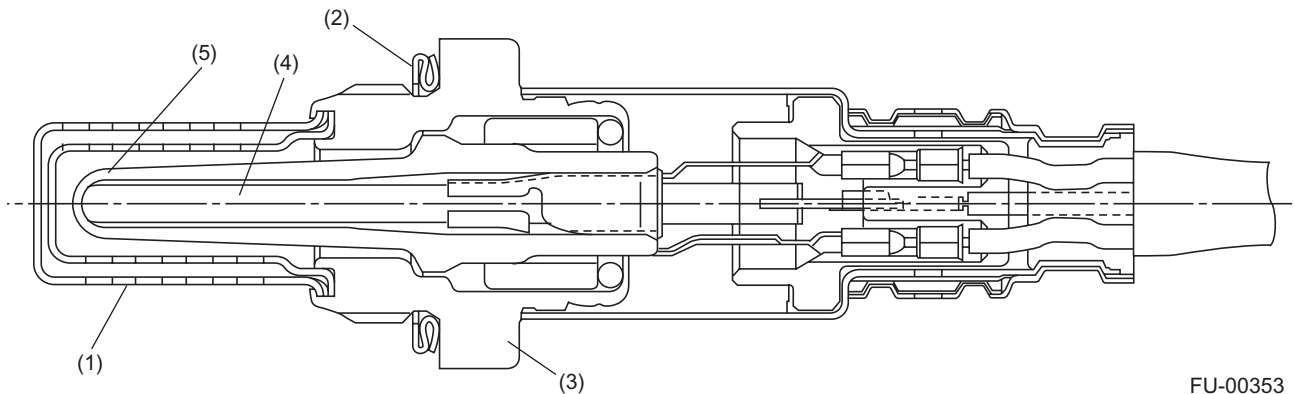


- (A) Electromotive force
- (B) Air-fuel ratio
- (C) Lean
- (D) Rich

FU-00230

B: REAR OXYGEN SENSOR

- The rear oxygen sensor is used to sense oxygen concentration in the exhaust gas. If the air-fuel ratio is leaner than the stoichiometric ratio in the mixture (i.e., excessive amount of air), the exhaust gas contains more oxygen. To the contrary, if the fuel ratio is richer than the stoichiometric ratio, the exhaust gas contains almost no oxygen.
- Detecting the oxygen concentration in exhaust gas using the oxygen sensor makes it possible to determine whether the air-fuel ratio is leaner or richer than the stoichiometry.
- The rear oxygen sensor has a zirconia tube (ceramic) which generates voltage if there is a difference in oxygen ion concentration between the inside and outside of the tube. Platinum is coated on the inside and outside of the zirconia tube as a catalysis and electrode material. The sensor housing is grounded to the exhaust pipe and the inside is connected to the ECM through the harness.
- A ceramic heater is employed to improve performance at low temperatures.



FU-00353

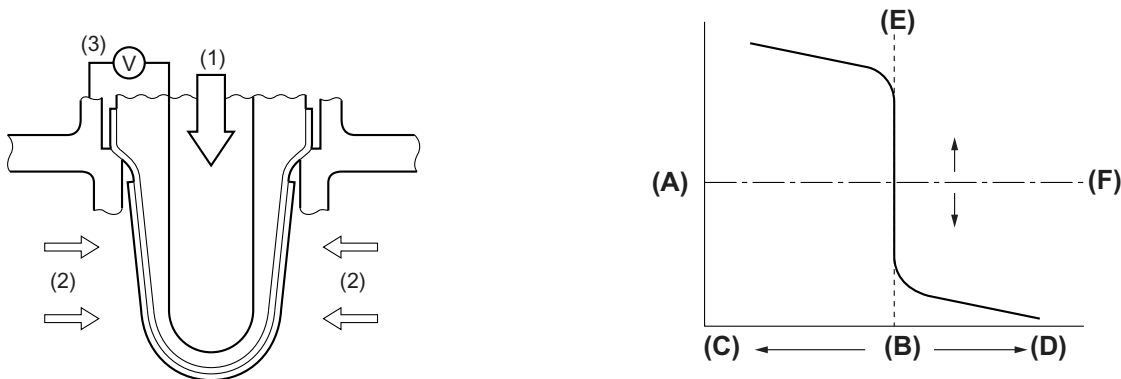
- (1) Protection tube
- (2) Gasket
- (3) Sensor housing

- (4) Ceramic heater
- (5) Zirconia tube

SENSORS AND SWITCHES

Fuel Injection (Fuel System)

- When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases is almost completely used in the catalytic reaction by the platinum coating on the external surface of the zirconia tube. This results in a very large difference in the oxygen ion concentration between the inside and outside of the tube, and the electromotive force generated is large.
- When a lean air-fuel mixture is burnt in the cylinder, relatively large amount of oxygen remains in the exhaust gases even after the catalytic action, and this results in a small difference in the oxygen ion concentration between the tube's internal and external surfaces. The electromotive force in this case is very small.
- The difference in oxygen concentration changes drastically in the vicinity of the stoichiometric air-fuel ratio, and hence the change in the electromotive force is also large. By using this information, the ECM can determine the air-fuel ratio of the supplied mixture easily. The rear oxygen sensor does not generate much electromotive force when the temperature is low. The output characteristics of the sensor stabilize at a temperature of approximately 300 to 400°C (572 to 752°F).



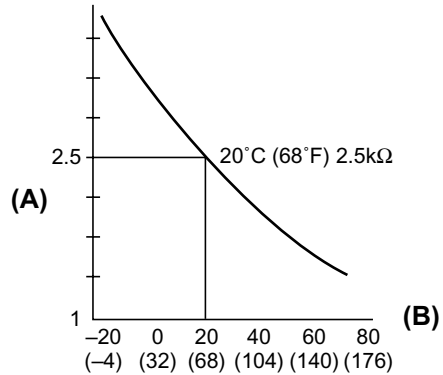
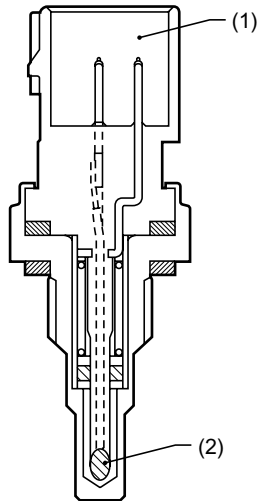
- (1) Atmospheric air
- (2) Exhaust gases
- (3) Electromotive force

- (A) Electromotive force
- (B) Air-fuel ratio
- (C) Lean
- (D) Rich
- (E) Stoichiometric mixture ratio
- (F) Comparison voltage

FU-00232

C: ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor is located on the engine coolant pipe. The sensor uses a thermistor whose resistance changes inversely with temperature. Resistance signals as engine coolant temperature information are transmitted to the ECM to make fuel injection, ignition timing, purge control solenoid valve and other controls.



FU-00233

- (1) Connector
- (2) Thermistor element

- (A) Resistance (kΩ)
- (B) Temperature °C (°F)

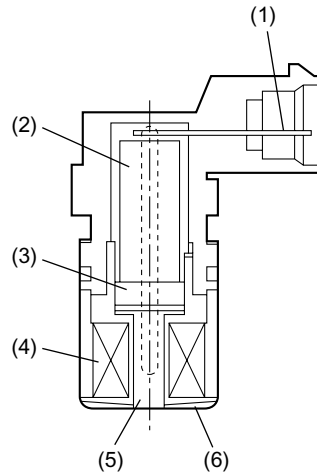
D: EXHAUST GAS TEMPERATURE SENSOR

The exhaust gas temperature sensor is located on the joint pipe and used to monitor the condition of the precatalytic converter.

SENSORS AND SWITCHES

E: CRANKSHAFT POSITION SENSOR

- The crankshaft position sensor is installed on the oil pump which is located in the front center portion of the cylinder block. The sensor generates a pulse when one of the teeth on the perimeter of the crankshaft sprocket (rotating together with the crankshaft) passes in front of it. The ECM determines the crankshaft angular position by counting the number of pulses.
- The crankshaft position sensor is a molded type which consists of a magnet, core, coil, terminals and other components as illustrated below.

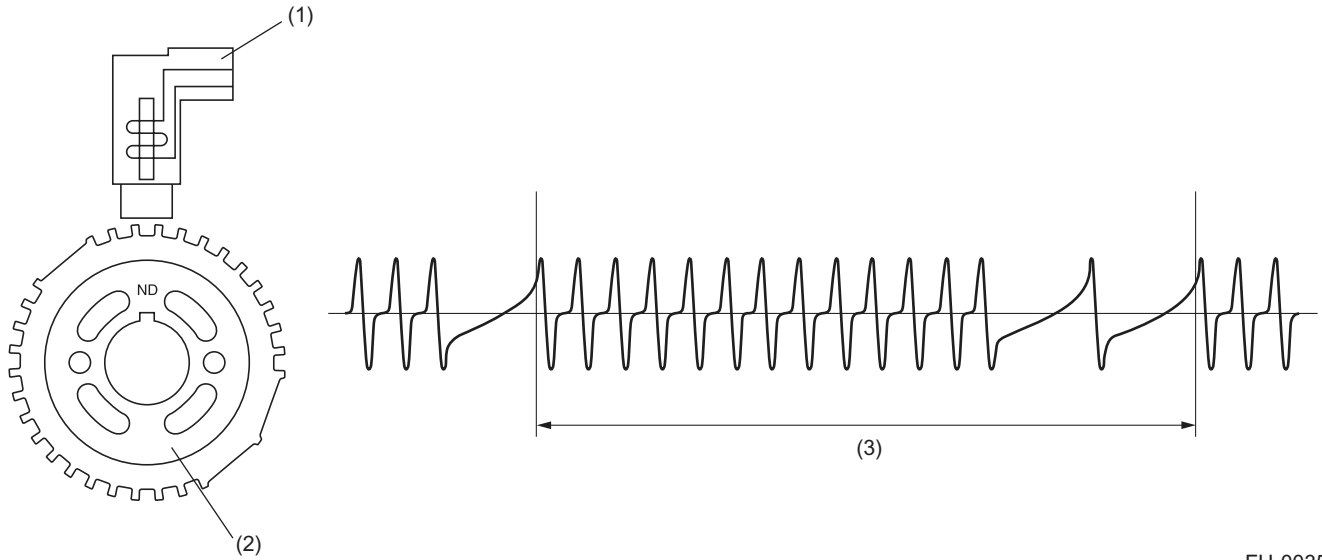


FU-00234

- (1) Terminal
- (2) Yoke core
- (3) Magnet

- (4) Coil
- (5) Core
- (6) Cover

- As the crankshaft rotates, each tooth aligns with the crankshaft position sensor. At that time, the magnetic flux in the sensor's coil changes since the air gap between the sensor pickup and the sprocket changes. This change in magnetic flux induces a voltage pulse in the sensor and the pulse is transmitted to the ECM.



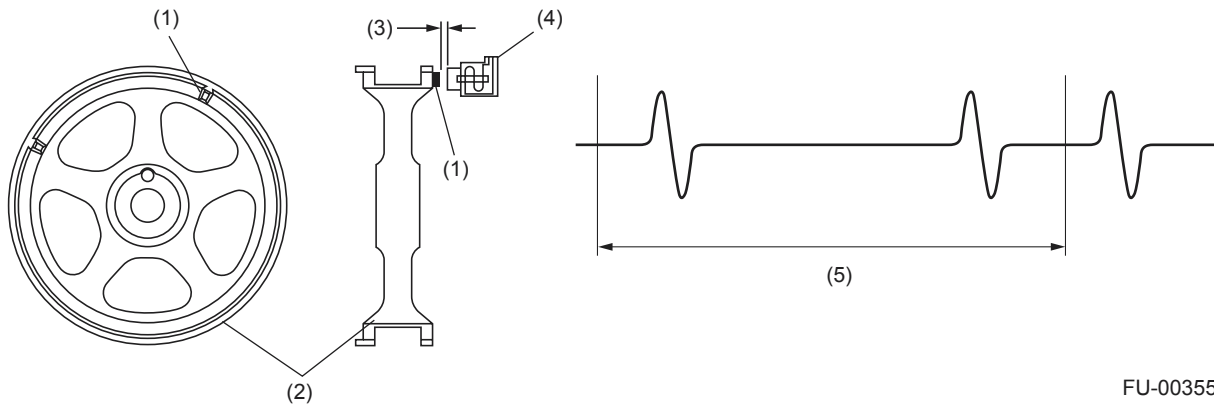
FU-00354

- (1) Crankshaft position sensor
- (2) Crankshaft sprocket
- (3) Crankshaft half rotation

SENSORS AND SWITCHES

F: CAMSHAFT POSITION SENSOR

- The camshaft position sensor is located on the left-hand camshaft support. This sensor detects the combustion cylinder at any given moment.
- The sensor generates a pulse when one of the bosses on the back of the left-hand camshaft drive sprocket passes in front of the sensor. The ECM determines the camshaft angular position by counting the number of pulses. Internal construction and the basic operating principle of the camshaft position sensor are similar to those of the crankshaft position sensor. Two bosses are provided on the sprocket as shown below.



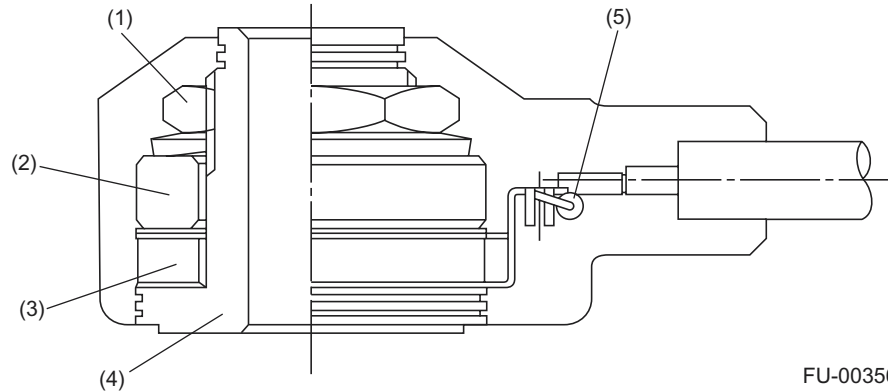
FU-00355

- (1) Boss
- (2) Camshaft sprocket
- (3) Air gap

- (4) Camshaft position sensor
- (5) Camshaft one rotation (crankshaft two rotations)

G: KNOCK SENSOR

- The knock sensor is installed on the cylinder block, and senses knocking that occurs in the engine.
- The sensor is a piezo-electric type which converts vibration resulting from knocking into electric signals.
- In addition to a piezo-electric element, the sensor has a weight and case as its components. If knocking occurs in the engine, the weight in the case moves causing the piezo-electric element to generate a voltage.
- The knock sensor harness is connected to the bulkhead harness.



FU-00356

- (1) Nut
- (2) Weight
- (3) Piezo-electric element
- (4) Housing
- (5) Resistor

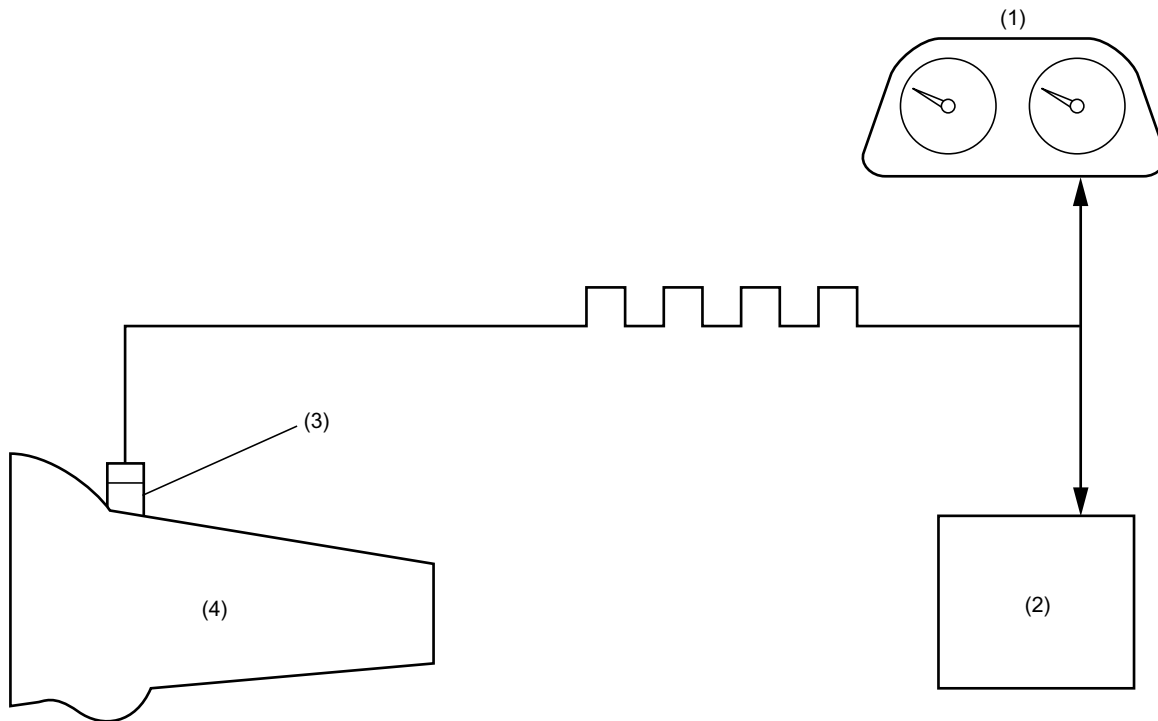
SENSORS AND SWITCHES

Fuel Injection (Fuel System)

H: VEHICLE SPEED SENSOR

1. MT VEHICLES

- The vehicle speed sensor is mounted on the transmission.
- The vehicle speed sensor generates a 4-pulse signal for every rotation of the front differential and send it to the ECM and the combination meter.

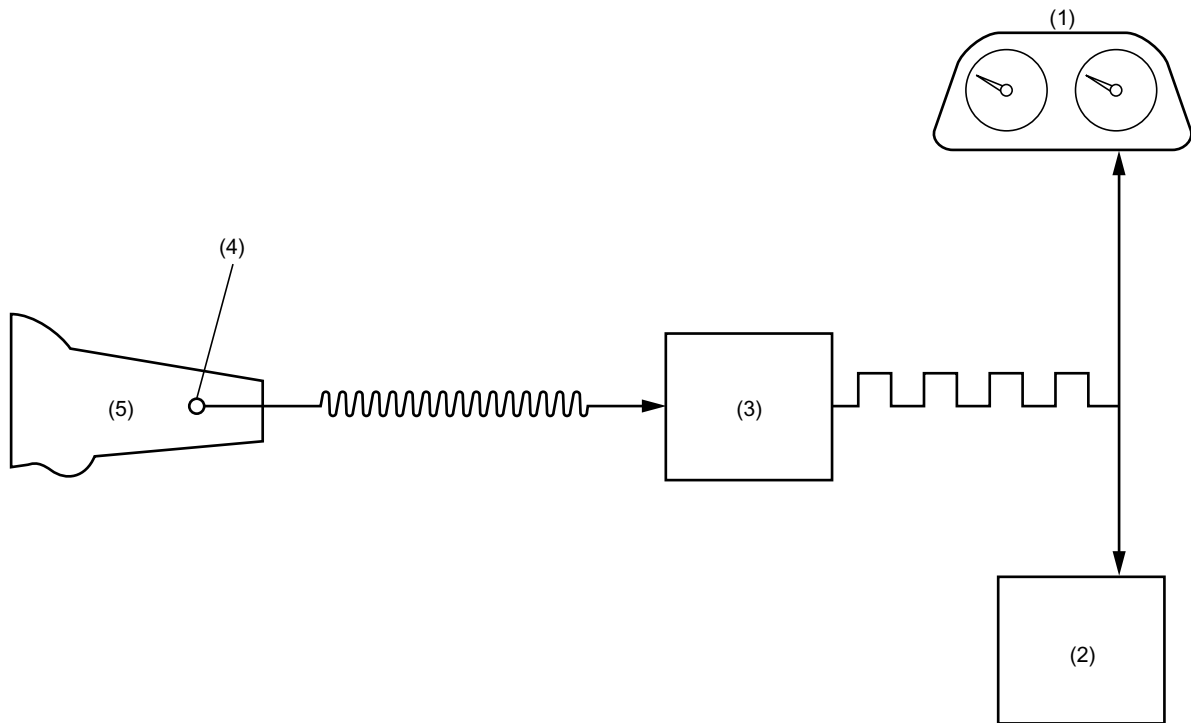


FU-00238

- (1) Combination meter
- (2) ECM
- (3) Vehicle speed sensor
- (4) Transmission

2. AT VEHICLES

- The vehicle speed sensor is mounted on the transmission.
- The vehicle speed sensor generates a 16-pulse signal for every rotation of the front differential and send it to the transmission control module (TCM). The signal sent to the TCM is converted there into a 4-pulse signal, and then sent to the ECM and the combination meter.



FU-00239

- (1) Combination meter
- (2) ECM
- (3) TCM
- (4) Vehicle speed sensor
- (5) Transmission

5. CONTROL SYSTEM

A: GENERAL

The ECM receives signals from various sensors, switches, and other control modules. Using these signals, it determines the engine operating conditions and if necessary, emits signals to one or more systems to control them for optimum operation.

Major control items of the ECM are as follow:

- Fuel injection control
- Ignition system control
- Idle air control
- Fuel pump control
- Canister purge control^{*1}
- Radiator fan control^{*2}
- On-board diagnosis function

*1: Canister purge control is described under “EC (TURBO) – Emission Control (Aux. Emission Control Devices) Evaporative Emission Control System”.

*2: Radiator fan control is described under “CO (SOHC) – Cooling”.

CONTROL SYSTEM

Fuel Injection (Fuel System)

B: INPUT AND OUTPUT SIGNALS

Signal	Unit	Function
Input signals	Pressure sensor	Detects the amount of intake air (Measures the absolute pressure).
	Mass air flow and intake air temperature sensor	Detects the temperature and amount of intake air.
	Throttle position sensor	Detects the throttle valve position.
	Front oxygen (A/F) sensor	Detects the density of oxygen in exhaust gases at the upstream of the front catalytic converter.
	Rear oxygen sensor	Detects the density of oxygen in exhaust gases at the downstream of the front catalytic converter.
	Exhaust gas temperature sensor	Detects the exhaust gas temperature.
	Crankshaft position sensor	Detects the crankshaft angular position.
	Camshaft position sensor	Detects the combustion cylinder.
	Engine coolant temperature sensor	Detects the engine coolant temperature.
	Knock sensor	Detects engine knocking.
	Vehicle speed sensor	Detects vehicle speed.
	Ignition switch	Detects operation of the ignition switch.
	Starter switch	Detects the condition of engine cranking.
	Neutral position switch (MT)	Detects that the gear is in neutral.
	Inhibitor switch (AT)	Detects shift positions.
	Heater circuit of front and rear oxygen sensor	Detects abnormality in the heater circuit of the front and rear oxygen sensors.
	Diagnostics of TCM (AT)	Detects the self-diagnostics of the TCM.
	Torque control signal (AT)	Controls engine torque.
	A/C switch	Detects ON-OFF operation of the A/C switch.
	Fuel level sensor	Detects the level of the fuel in the fuel tank.
Small light switch	Detects ON-OFF operation of the small light switch.	
Blower fan switch	Detects ON-OFF operation of the blower fan switch.	
Rear defogger switch	Detects ON-OFF operation of the rear defogger switch.	
Output signals	Fuel injectors	Activates an injector.
	Ignition signal	Turns the primary ignition current ON or OFF.
	Fuel pump controller	Controls the fuel pump.
	A/C relay	Turns the A/C control relay ON or OFF.
	Radiator fan control relay	Turns the radiator fan control relay ON or OFF.
	Idle air control solenoid valve	Adjusts the amount of air flowing through the bypass line in the throttle body.
	Wastegate control solenoid valve	Controls supercharging pressure.
	Malfunction indicator lamp	Indicates existence of abnormality.
	Purge control solenoid valve	Controls purge of evaporative gas absorbed by the canister.
	Power supply	Control ON/OFF of the main power supply relay.

C: FUEL INJECTION CONTROL

- The ECM receives signals from various sensors and based on them, it determines the amount of fuel injected and the fuel injection timing. It performs the sequential fuel injection control over the entire engine operating range except during start-up of the engine.
- The amount of fuel injected depends upon the length of time the injector stays open. The fuel injection duration is determined according to varying operating condition of the engine. For the purpose of achieving highly responsive and accurate fuel injection duration control, the ECM performs a new feedback control that incorporates a learning feature as detailed later.
- The sequential fuel injection control is performed such that fuel is injected accurately at the time when the maximum air intake efficiency can be achieved for each cylinder (i.e., fuel injection is completed just before the intake valve begins to open).

1. FUEL INJECTION DURATION

Fuel injection duration is basically determined as indicated below:

- During engine start-up:

The duration defined below is used.

- Duration of fuel injection during engine start-up Determined according to the engine coolant temperature detected by the engine coolant temperature sensor.

- During normal operation:

The duration is determined as follows:

Basic duration of fuel injection x Correction factors + Voltage correction time

- Basic duration of fuel injection The basic length of time fuel is injected. This is determined by two factors – the amount of intake air detected by the manifold pressure sensor and the engine speed monitored by the crankshaft position sensor.
- Correction factors See the next section.
- Voltage correction time This is added to compensate for the time lag before operation of injector that results from variation in the battery voltage.

2. CORRECTION FACTORS

The following factors are used to correct the basic duration of fuel injection in order to make the air-fuel ratio meet the requirements of varying engine operating conditions:

- **Air-fuel ratio feedback factor:**

This factor is used to correct the basic duration of fuel injection in relation to the actual engine speed. (See the next section for more detail.)

- **Start increment factor:**

This factor is used to increase the fuel injection duration only while the engine is being cranked to improve its startability.

- **Coolant-temperature-dependent increment factor:**

This factor is used to increase the fuel injection duration depending on engine coolant temperature signals to facilitate cold starting. The lower the coolant temperature, the greater the increment.

- **After-start increment factor:**

- This factor is used to increase the fuel injection duration for a certain period immediately after start of the engine to stabilize engine operation.
- The increment depends on the coolant temperature at the start of the engine.

- **Wide-open-throttle increment factor:**

This factor is used to increase the fuel injection duration depending on the relationship between the throttle position sensor signal and manifold pressure sensor signal.

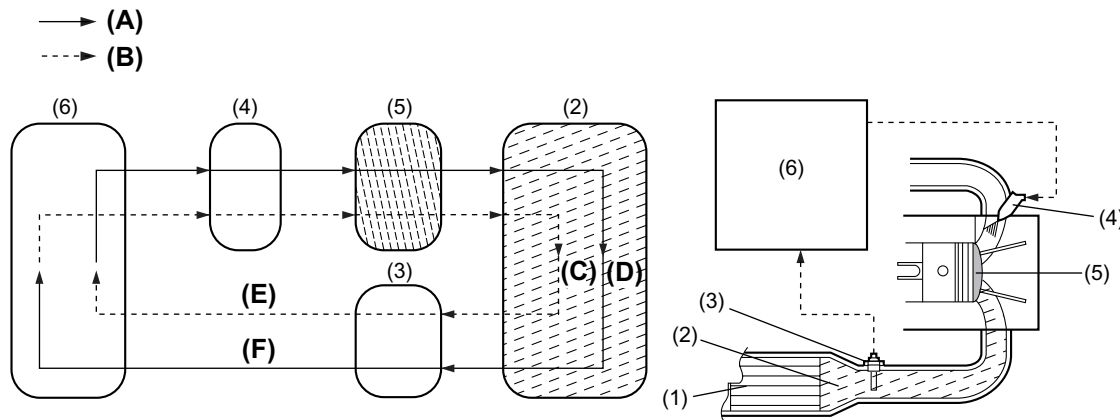
- **Acceleration increment factor:**

This factor is used to increase the fuel injection duration to compensate for a time lag between air flow measurement and fuel injection control for better engine response to driver's pedal operation during acceleration.

CONTROL SYSTEM

3. AIR-FUEL RATIO FEEDBACK FACTOR

The ECM creates this factor utilizing the front oxygen (A/F) sensor signal. When the signal voltage is low, the air-fuel ratio is richer than the stoichiometric ratio. The ECM then makes the fuel injection duration shorter by modifying the factor. When the voltage is high showing that the mixture is lean, the ECM modifies the factor to make the injection duration longer. In this way, the air-fuel ratio is maintained at a level close to the stoichiometric ratio at which the three-way catalyst acts most effectively.



FU-00240

- (1) Front catalyst
- (2) Exhaust gas
- (3) Front oxygen (A/F) sensor
- (4) Fuel injectors
- (5) Combustion chamber
- (6) ECM

- (A) Injection duration increment signal
- (B) Injection duration decrement signal
- (C) High oxygen density
- (D) Low oxygen density
- (E) Lean signal
- (F) Rich signal

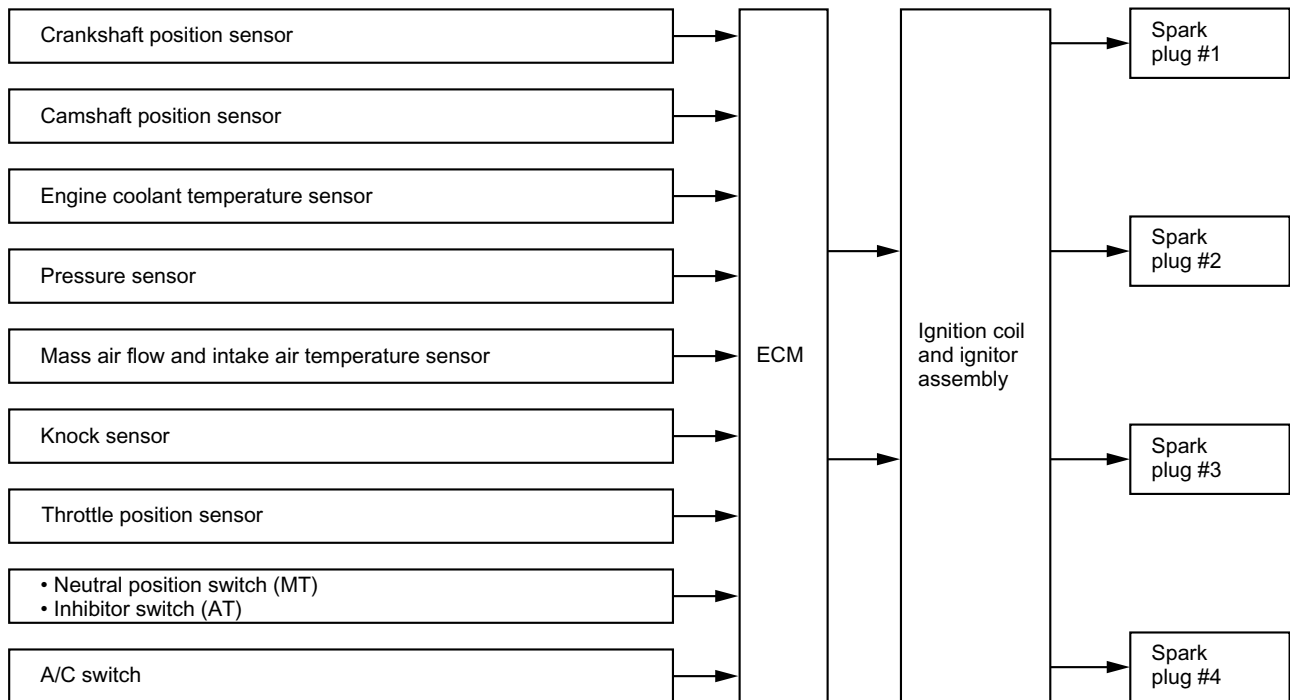
4. LEARNING FEATURE

The air-fuel ratio feedback control includes a learning feature which contributes to more accurate and responsive control.

- In the air-fuel ratio feedback control, the ECM calculates the necessary amount of correction based on data from the oxygen sensor and adds the result to the basic duration (which is stored in the ECM's memory for each condition defined by the engine speed and various loads.)
- Without a learning feature, the ECM carries out the above-mentioned process every time. This means that if the amount of necessary correction is large, the air-fuel ratio feedback control becomes less responsive and less accurate.
- The learning feature enables the ECM to store the amount of correction into memory and add it to the basic fuel injection duration to create a new reference fuel injection duration. Using the reference duration as the basic duration for the injection a few times later, the ECM can reduce the amount of correction and thus make its feedback control more accurate and responsive to changes in the air-fuel ratio due to difference in driving condition and sensor/actuator characteristics that may result from unit-to-unit variation or aging over time.

D: IGNITION SYSTEM CONTROL

- The ECM determines operating condition of the engine based on signals from the pressure sensor, engine coolant temperature sensor, intake air temperature sensor, crankshaft position sensor and other sources. The ECM then selects the ignition timing most appropriate for the condition thus determined from those stored in its memory and outputs at that timing a primary current OFF signal to the ignitor to initiate ignition.
- This control uses a quick-to-response learning feature by which the data stored in the ECM memory is processed in comparison with information from various sensors and switches.
- Thus, the ECM can always perform optimum ignition timing taking into account the output, fuel consumption, exhaust gas, and other factors for every engine operating condition.
- Engine speed fluctuates during start of the engine, so the ECM cannot control the ignition timing. During that period, the ignition timing is fixed at 10° BTDC by using the 10° signal from the crankshaft position sensor.

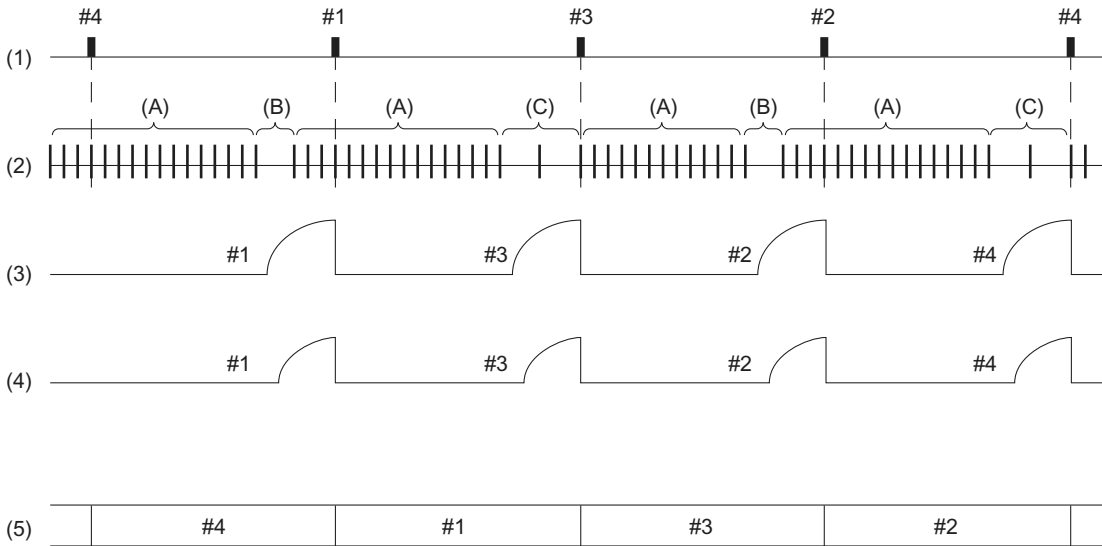


FU-00357

CONTROL SYSTEM

Fuel Injection (Fuel System)

- The ECM identifies cylinders at TDC and determines ignition timing as follows:
 - Within the range (A), the crank angle signal is input every 10° rotation of the crankshaft.
 - The ECM discriminates a TDC cylinder group from the other by detecting the ranges (B) and (C) where no signals are input.
 - The ECM judges that the No. 1 and No. 2 cylinders are at TDC when it detects the range (B), and that the No. 3 and No. 4 cylinders are at TDC when it detects the range (C).

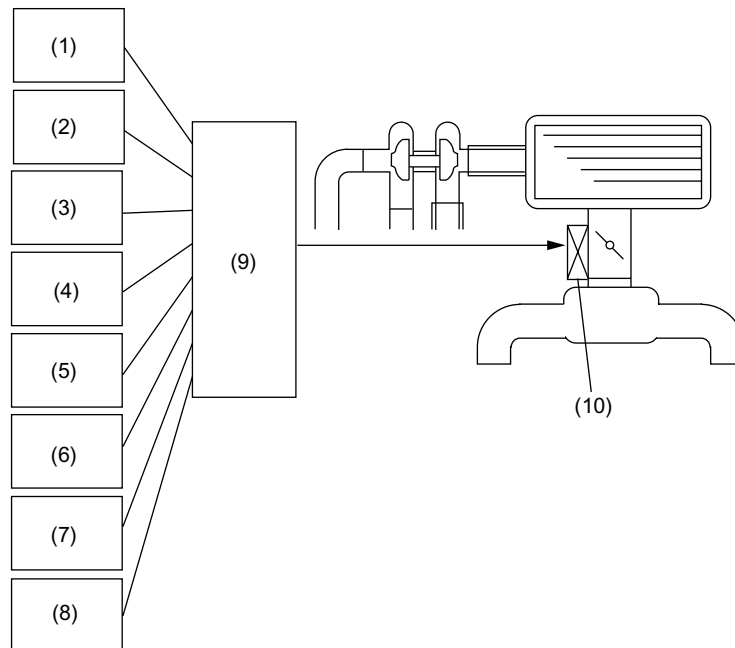


FU-00358

- (1) Cylinder number (TDC)
- (2) Crank angle pulse
- (3) Ignition timing at starting
- (4) Ignition timing at normal condition
- (5) Burning cylinder

E: IDLE AIR CONTROL

- The ECM activates the idle air control solenoid valve to control the bypass air flowing through the bypass passage in the throttle body depending on signals from the crankshaft position sensor, engine coolant temperature sensor, pressure sensor and A/C switch so that the proper idle speed for each engine load is achieved.
- The idle air control solenoid valve uses a duty-ratio-controlled solenoid which can continuously vary the opening area of the rotary valve. As the ECM increases the duty ratio, opening of the rotary valve increases so that the bypass air flow increases, and the engine idling speed becomes higher as a result.
- The bypass air control is necessary for:
 - Increasing idling speed when the air conditioning system and/or electrical loads are turned on.
 - Increasing idling speed during early stage of warm up period.
 - Obtaining dashpot function when the throttle valve is quickly closed.
 - Prevention of engine speed variation during idling.



FU-00359

- | | |
|---------------------------------------|---|
| (1) Crankshaft position sensor | (6) Ignition switch |
| (2) Camshaft position sensor | (7) A/C switch |
| (3) Throttle position sensor | (8) Neutral position switch (MT)
Inhibitor switch (AT) |
| (4) Engine coolant temperature sensor | (9) ECM |
| (5) Vehicle speed sensor | (10) Idle air control solenoid valve |

CONTROL SYSTEM

Fuel Injection (Fuel System)

F: FUEL PUMP CONTROL

Using the signal from the crankshaft position sensor, the ECM controls operation of the fuel pump by turning its relay ON or OFF. To improve safety, the fuel pump is stopped if the engine stalls with the ignition switch ON.

Ignition switch ON	Fuel pump relay	Fuel pump
A certain period of time after ignition switch is turned ON	ON	Operates
While cranking the engine	ON	Operates
While engine is operating	ON	Operates
When engine stops	OFF	Does not operate

6. On-board Diagnosis System

A: GENERAL

- The on-board diagnosis system detects and indicates a fault by generating a code corresponding to each fault location. The malfunction indicator lamp (CHECK ENGINE light) on the combination meter indicates occurrence of a fault or abnormality.
- When the malfunction indicator lamp comes on as a result of detection of a fault by the ECM, the corresponding diagnostic trouble code (DTC) and freeze frame engine condition are stored in the ECM.
- On the OBD-II conformable car, it is necessary to connect the Subaru Select Monitor (SSM) or General Scan Tool (GST) to the data link connector in order to check the DTC.
- The SSM and GST can erase DTCs. They can also read freeze frame data in addition to other pieces of engine data.
- If there is a failure involving sensors which may affect drive control of the vehicle, the fail-safe function ensures minimum level of driveability.

B: FAIL-SAFE FUNCTION

For a sensor or switch which has been judged faulty in the on-board diagnosis, the ECM, if appropriate, generates an associated pseudo signal to keep the vehicle operational. (The control becomes degraded.)

ON-BOARD DIAGNOSIS SYSTEM

Fuel Injection (Fuel System)

MEMO

EMISSION CONTROL (AUX. EMISSION CONTROL DEVICES)

EC (TURBO)

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8. Vacuum Connections	16

SYSTEM OVERVIEW

Emission Control (Aux. Emission Control Devices)

1. System Overview

There are three emission control systems which are as follows:

- Crankcase emission control system
- Exhaust emission control system
 - Three-way catalyst system
 - A/F control system
 - Ignition control system
- Evaporative emission control system

Item		Main components	Function	
Crankcase emission control system		Positive crankcase ventilation (PCV) valve	Draws blow-by gas into intake manifold from crankcase and burns it together with air-fuel mixture. Amount of blow-by gas to be drawn in is controlled by intake manifold pressure.	
Exhaust emission control system	Catalyst system	Pre	Three-way catalyst	Oxidizes HC and CO contained in exhaust gases as well as reducing NOx.
		Front		
		Rear		
	A/F control system		Engine control module (ECM)	Receives input signals from various sensors, compares signals with stored data, and emits a signal for optimal control of air-fuel mixture ratio.
			Front oxygen (A/F) sensor	Detects quantity of oxygen contained exhaust gases.
			Rear oxygen sensor	Detects density of oxygen contained exhaust gases.
			Throttle position sensor	Detects throttle position.
			Pressure sensor	Detects absolute pressure of intake manifold.
			Mass air flow and intake air temperature sensor	Detects amount of intake air.
				Detects intake air temperature in the air cleaner case.
	Ignition control system		ECM	Receives various signals, compares signals with basic data stored in memory, and emits a signal for optimal control of ignition timing.
		Crankshaft position sensor	Detects engine speed (revolution).	
		Camshaft position sensor	Detects reference signal for combustion cylinder discrimination.	
		Engine coolant temperature sensor	Detects coolant temperature.	
		Knock sensor	Detects engine knocking.	
Evaporative emission control system		Canister	Absorbs evaporative gas which occurs in fuel tank when engine stops, and releases it to combustion chambers for a complete burn when engine is started. This prevents HC from being discharged into atmosphere.	
		Purge control solenoid valve	Receives a signal from ECM and controls purge of evaporative gas absorbed by canister.	

SYSTEM OVERVIEW

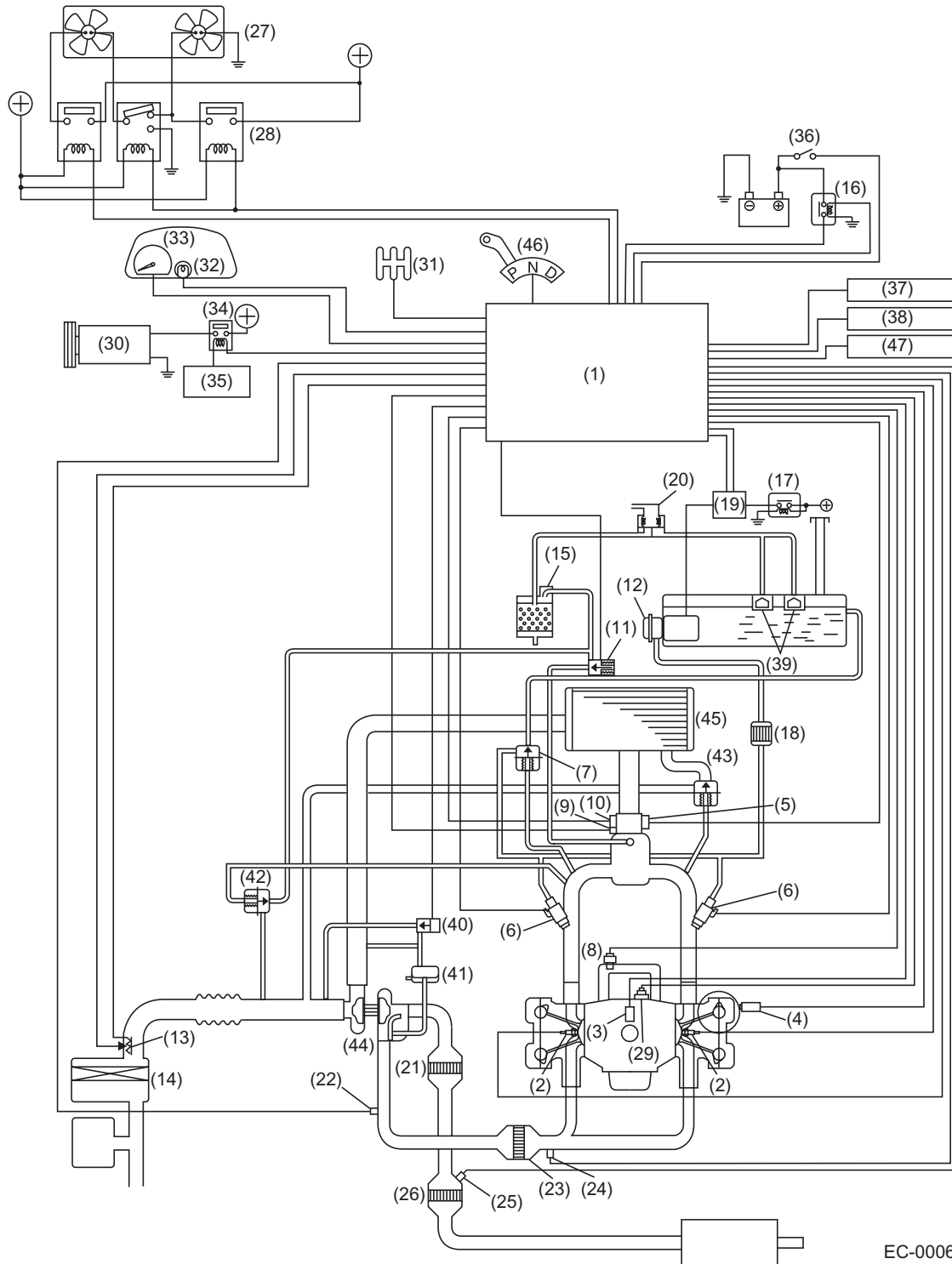
Emission Control (Aux. Emission Control Devices)

MEMO

SCHEMATIC DIAGRAMS

Emission Control (Aux. Emission Control Devices)

2. Schematic Diagrams



EC-00069

SCHEMATIC DIAGRAMS

Emission Control (Aux. Emission Control Devices)

- | | | |
|--|--|---|
| (1) Engine control module (ECM) | (17) Fuel pump relay | (33) Tachometer |
| (2) Ignition coil and ignitor assembly | (18) Fuel filter | (34) A/C relay |
| (3) Crankshaft position sensor | (19) Fuel pump controller | (35) A/C control module |
| (4) Camshaft position sensor | (20) Two-way valve | (36) Ignition switch |
| (5) Throttle position sensor | (21) Front catalytic converter | (37) Vehicle speed sensor |
| (6) Fuel injectors | (22) Exhaust temperature sensor | (38) Data link connector |
| (7) Pressure regulator | (23) Precatalytic converter | (39) Fuel cut valve |
| (8) Engine coolant temperature sensor | (24) Front oxygen (A/F) sensor | (40) Waste gate controller |
| (9) Pressure sensor | (25) Rear oxygen sensor | (41) Waste gate controller |
| (10) Idle air control solenoid valve | (26) Rear catalytic converter | (42) Purge valve |
| (11) Purge control solenoid valve | (27) Radiator fan | (43) Air bypass valve |
| (12) Fuel pump | (28) Radiator fan relay | (44) Turbocharger |
| (13) Mass air flow and intake air temperature sensor | (29) Knock sensor | (45) Intercooler |
| (14) Air cleaner element | (30) A/C compressor | (46) Inhibitor switch (AT vehicles only) |
| (15) Canister | (31) Neutral switch (MT vehicles only) | (47) Transmission control module (TCM) (AT vehicles only) |
| (16) Main relay | (32) CHECK ENGINE malfunction indicator lamp (MIL) | |

CRANKCASE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

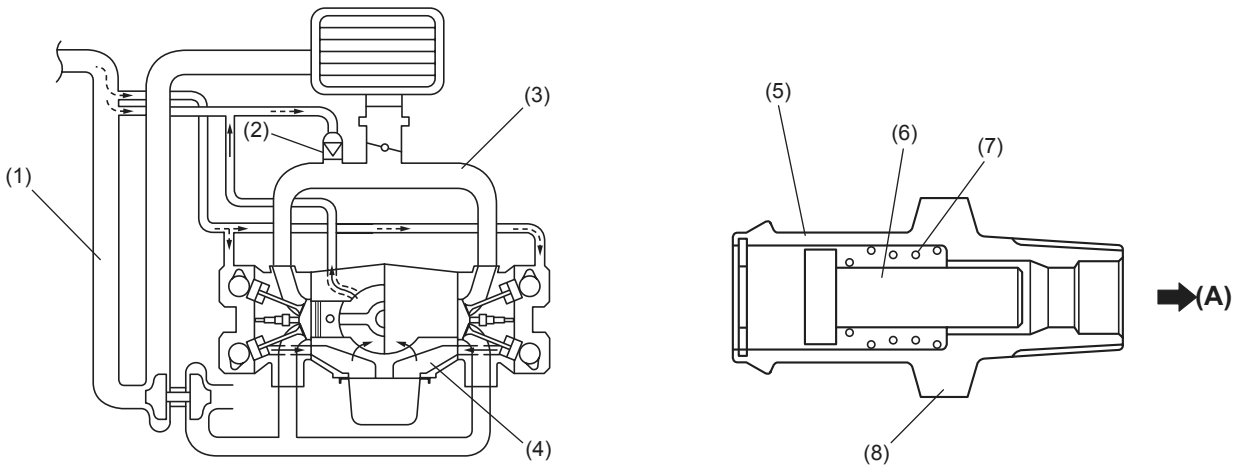
3. Crankcase Emission Control System

- The positive crankcase ventilation (PCV) system prevents air pollution which will be caused by blow-by gas being emitted from the crankcase.

The system consists of a sealed oil filler cap, rocker covers with fresh air inlet, connecting hoses, a PCV valve and an air intake duct.

- In a part-throttle condition, the blow-by gas in the crankcase flows into the intake manifold through the connecting hose of crankcase and PCV valve by the strong vacuum created in the intake manifold. Under this condition, fresh air is introduced into the crankcase through the connecting hose of the rocker cover.

- In a wide-open-throttle condition, a part of blow-by gas flows into the air intake duct through the connecting hose and is drawn into the throttle chamber, because under this is condition, the intake manifold vacuum is not strong enough to introduce through the PCV valve all blow-by gases that increase in the amount with engine speed.



EC-00071

- | | |
|---------------------|---------------|
| (1) Air intake duct | (5) Case |
| (2) PCV valve | (6) Valve |
| (3) Intake manifold | (7) Spring |
| (4) Crankcase | (8) PCV valve |

(A) To intake manifold

THREE-WAY CATALYST

Emission Control (Aux. Emission Control Devices)

4. Three-way Catalyst

- The basic material of three-way catalyst is platinum (Pt), rhodium (Rh) and palladium (Pd), and a thin coat of their mixture is applied onto a honeycomb or porous ceramics piece (carrier). To avoid damaging the catalyst, only unleaded gasoline should be used.
- The catalyst reduces HC, CO and NO_x in exhaust gases through chemical reactions (oxidation and reduction). These harmful components are reduced most efficiently when their concentrations are in a certain balance. These concentrations vary with the air-fuel ratio. The ideal air-fuel ratio for reduction of these components is the stoichiometric ratio.
- Therefore, the air-fuel ratio needs to be controlled to around the stoichiometric ratio to purify the exhaust gases most efficiently.

A/F CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

5. A/F Control System

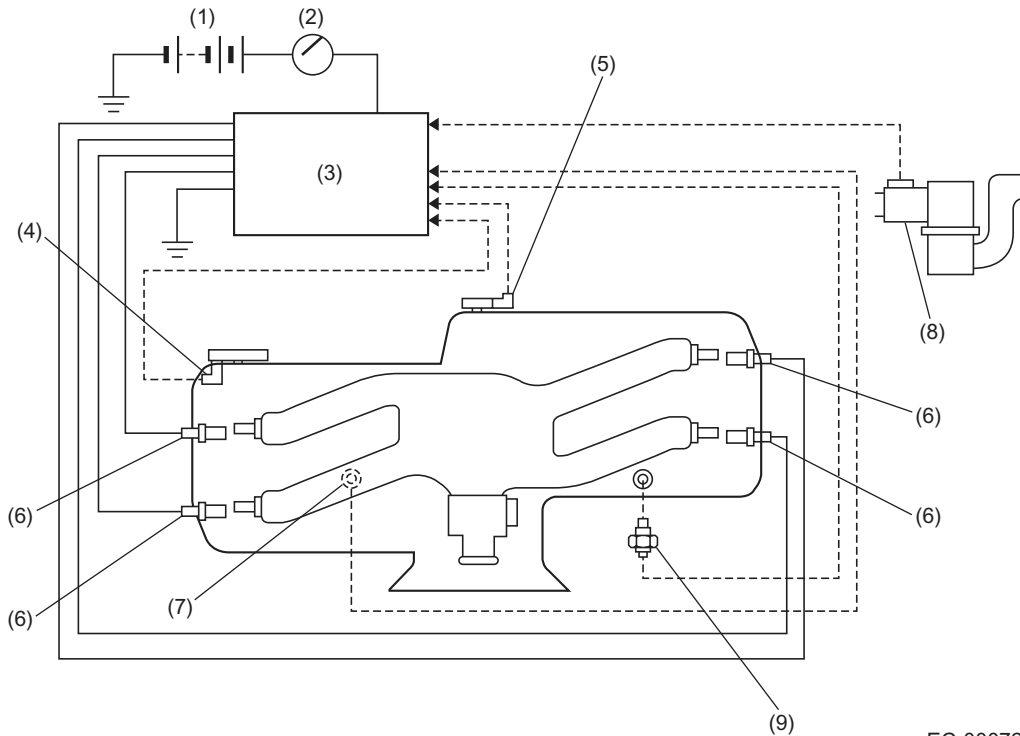
- The air/fuel (A/F) control system makes a correction to the basic fuel injection duration in accordance with the signal from the front oxygen (A/F) sensor and rear oxygen sensor so that the stoichiometric ratio is maintained, thus ensuring most effective exhaust gas purification by the three-way catalyst. Different basic fuel injection durations are preset for various engine speeds and loads, as well as the amount of intake air.
- This system also has a “learning” control function which stores the corrected data in relation to the basic fuel injection in the memory map. This allows an appropriate air-fuel ratio correction to be added automatically in quick response to any situation that requires such an effect. Thus, the air-fuel ratio is optimally maintained under various conditions while purifying exhaust gases most effectively, improving driving performance and compensating for changes in sensors’ performance over time.

IGNITION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

6. Ignition Control System

- The ignition system is controlled by the ECM. The ECM monitors the operating condition of the engine using the signals from the sensors and switches shown below and determines the ignition timing most appropriate for each engine operating condition. Then it sends a signal to the ignitor, commanding generation of a spark at that timing.
- The ECM uses a preprogrammed map for a “closed-loop” control which provides its ignition timing control with excellent transient characteristics, i.e., highly responsive ignition timing control.



EC-00072

- | | |
|--------------------------------|---|
| (1) Battery | (6) Ignition coil and ignitor assembly |
| (2) Ignition switch | (7) Knock sensor |
| (3) ECM | (8) Mass air flow and intake air temperature sensor |
| (4) Camshaft position sensor | (9) Engine coolant temperature sensor |
| (5) Crankshaft position sensor | |

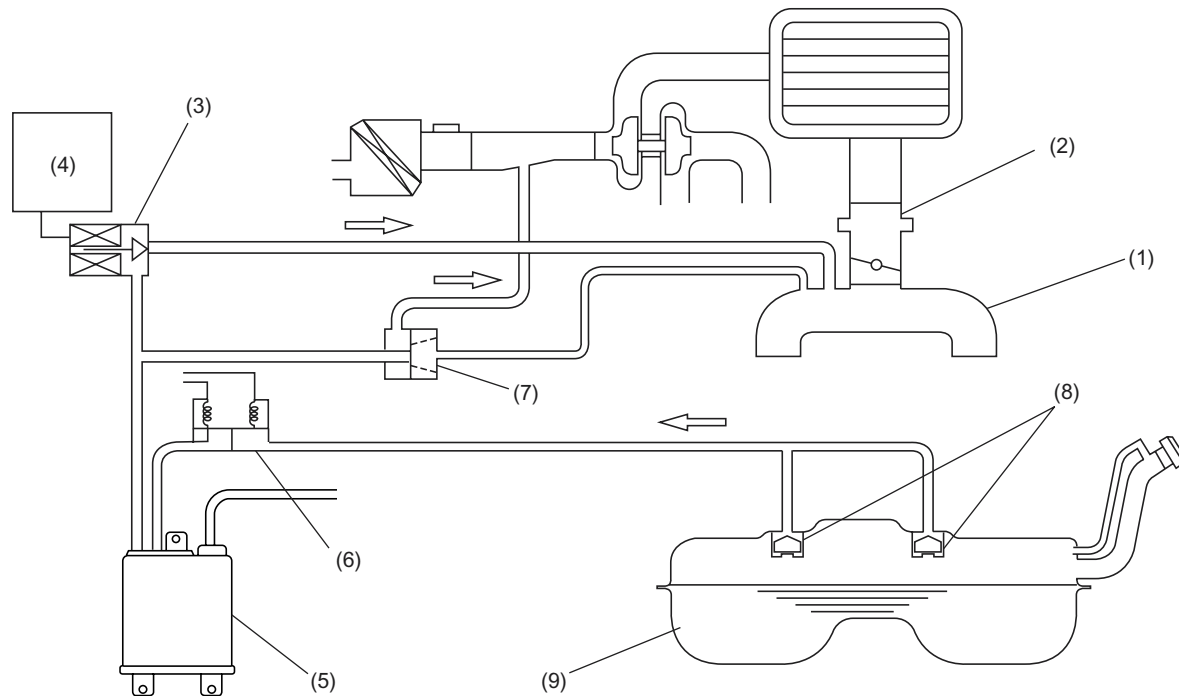
EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

7. Evaporative Emission Control System

A: GENERAL

- The evaporative emission control system prevents fuel vapors from escaping into atmosphere. This system includes a canister, purge control solenoid valve, fuel cut valve, and the lines connecting them.
- Fuel vapors in the fuel tank is introduced into the canister through the evaporation line, and are absorbed by activated carbon in it. The fuel cut valve is also incorporated in the fuel tank line.
- The purge control solenoid valve is controlled optimally by the ECM according to the engine condition.



EC-00073

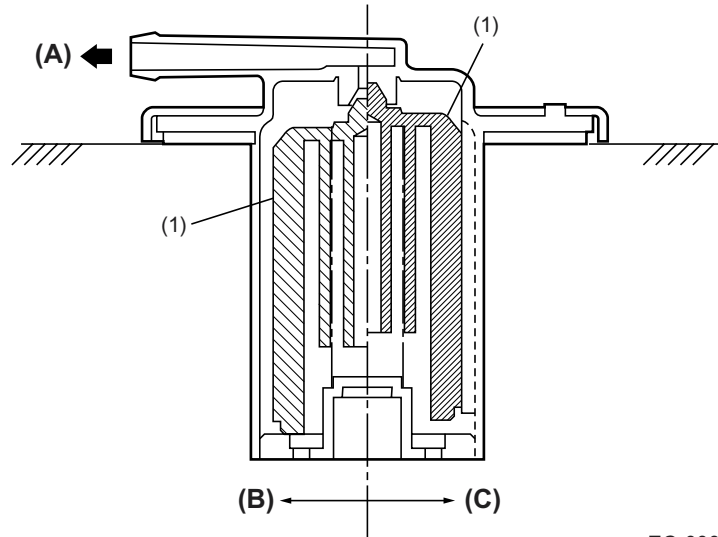
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|----------------------------------|--------------------|
| (1) Intake manifold | (6) Two-way valve |
| (2) Throttle body | (7) Purge valve |
| (3) Purge control solenoid valve | (8) Fuel cut valve |
| (4) ECM | (9) Fuel tank |
| (5) Canister | |

EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

B: FUEL CUT VALVE

The fuel cut valve is built onto the evaporation pipe of the fuel tank. The rising level of the fuel in the fuel tank causes the float to move up and close the cap hole so that no fuel can flow through the evaporation line.



EC-00022

(1) Float

- (A) To canister
- (B) Valve open
- (C) Valve closed

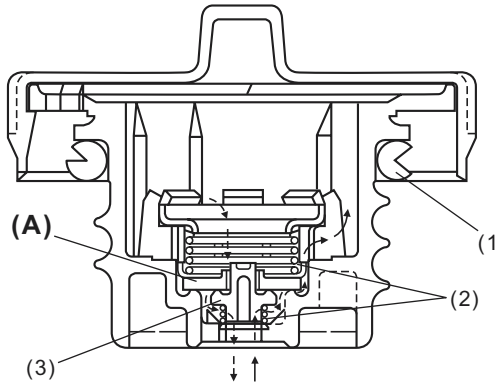
EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

C: FUEL TANK CAP

The fuel tank cap has a relief valve which prevents development of vacuum in the fuel tank in the event of a problem with the fuel vapor line.

When there is no problem with the fuel vapor line, the filler pipe is sealed at the portion (A) and by the seal pressed against the filler pipe end. If vacuum develops in the fuel tank, the atmospheric pressure forces the spring down to open the valve; consequently outside air flows into the fuel tank, thus controlling the inside pressure.



EC-00065

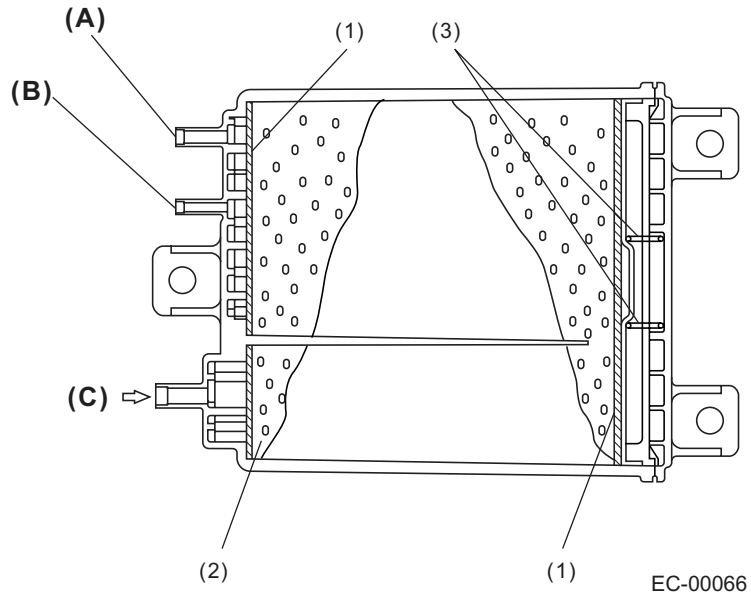
- (1) Seal
- (2) Spring
- (3) Valve

EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

D: CANISTER

The charcoal filled in the canister temporarily stores fuel vapors. When the purge control solenoid valve is opened by a signal from the ECM, the external fresh air entering the canister carries the fuel vapors into the collector chamber.



- (1) Filter
- (2) Charcoal
- (3) Spring

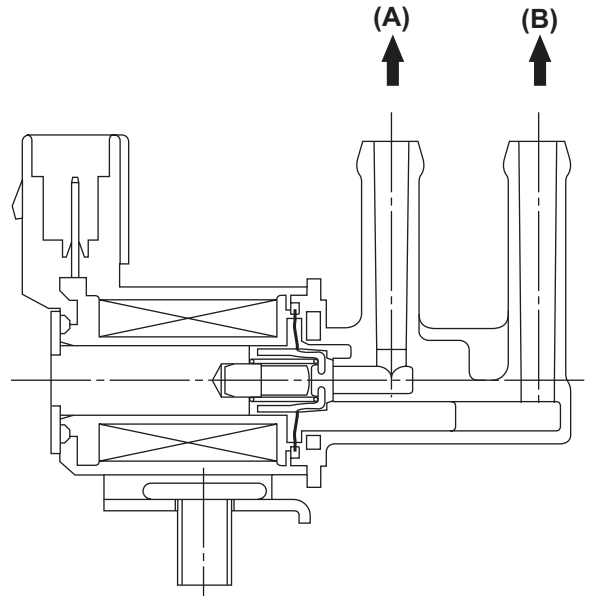
- (A) To purge control solenoid valve
- (B) From fuel tank
- (C) Air

EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

E: PURGE CONTROL SOLENOID VALVE

The purge control solenoid valve is on the evaporation line between the canister and intake manifold. The valve is installed at the underside of intake manifold.



EC-00074

(A) To canister

(B) To intake manifold

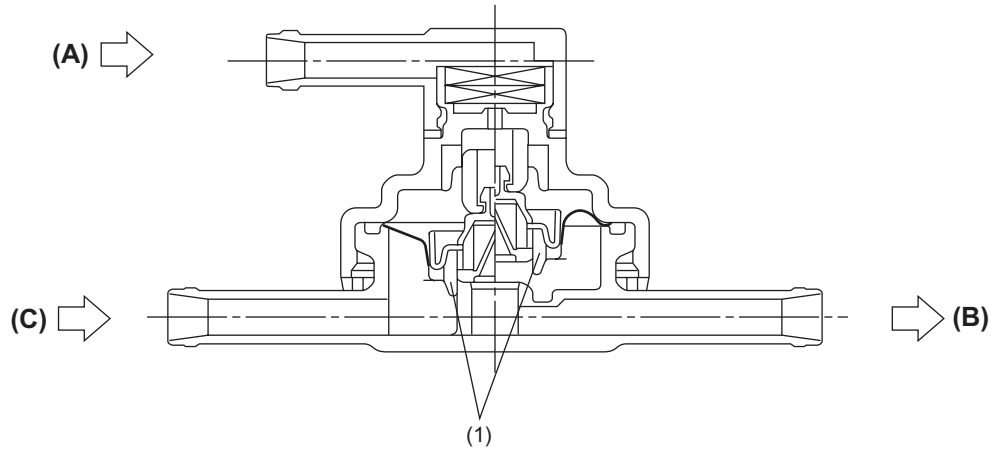
EVAPORATIVE EMISSION CONTROL SYSTEM

Emission Control (Aux. Emission Control Devices)

F: TWO-WAY VALVE

The two-way valve is located in the evaporation line between the fuel tank and the canister. When the tank inside pressure becomes higher than the atmospheric pressure, the valve is opened allowing fuel vapors to be introduced into the canister.

On the other hand, when the tank inside pressure becomes lower than the atmospheric pressure, external air is taken into the canister.



EC-00067

(1) Valve

(A) Atmospheric pressure

(B) To canister

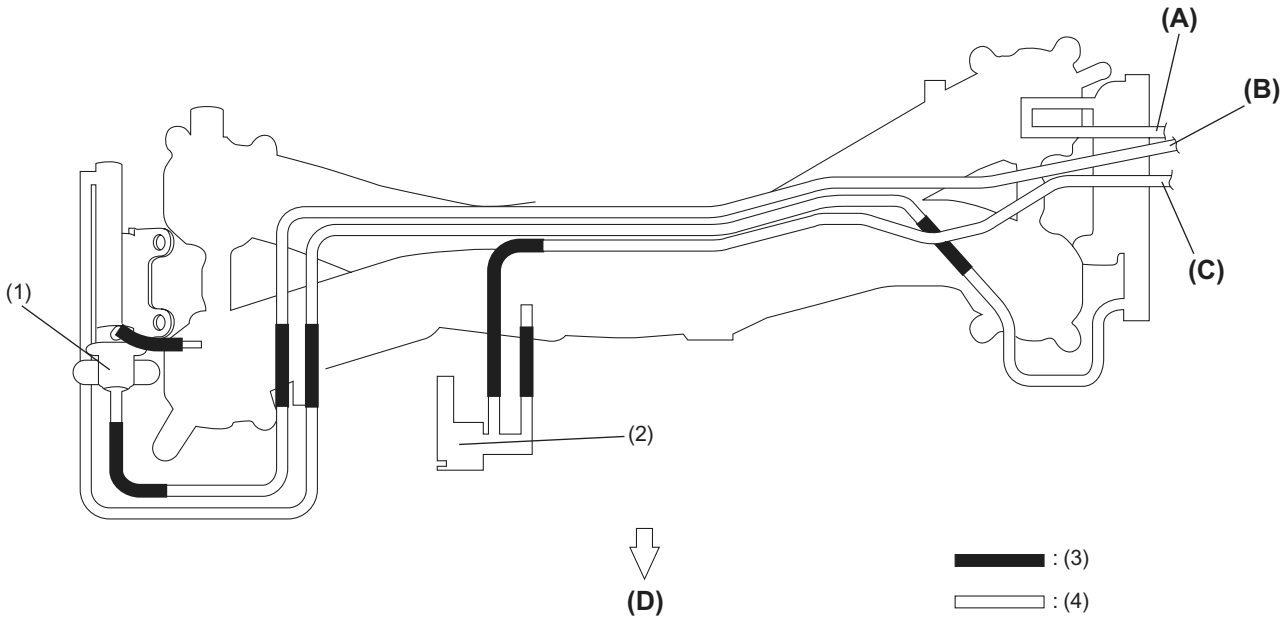
(C) From fuel tank

VACUUM CONNECTIONS

Emission Control (Aux. Emission Control Devices)

8. Vacuum Connections

The hose and pipe connections of the intake manifold, throttle body and other related parts are as shown in the illustration.



EC-00075

- (1) Pressure regulator
- (2) Purge control solenoid valve
- (3) Hose
- (4) Pipe

- (A) Delivery valve
- (B) Return pipe
- (C) Evaporation pipe
- (D) Front of vehicle

INTAKE (INDUCTION) ***IN*** (***TURBO***)

	Page
1. Intake System	2
2. Turbocharger System	3

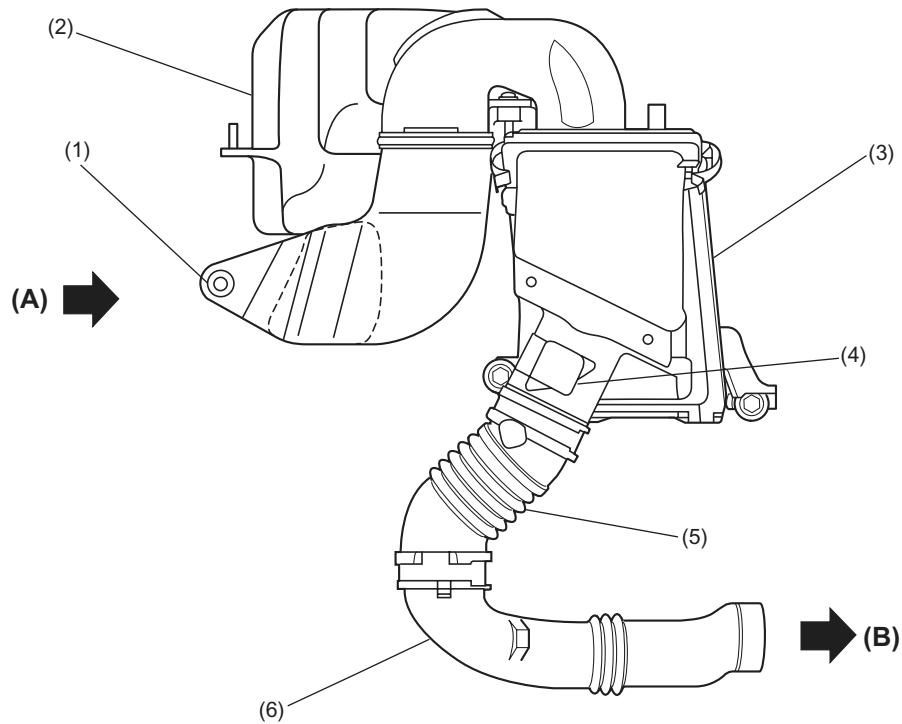
INTAKE SYSTEM

Intake (Induction)

1. Intake System

A: GENERAL

The intake system consists of an air intake duct, a resonator chamber, and an air cleaner element housed in its case. The resonator, located upstream of the air cleaner case, effectively reduces the intake noise level.



IN-00110

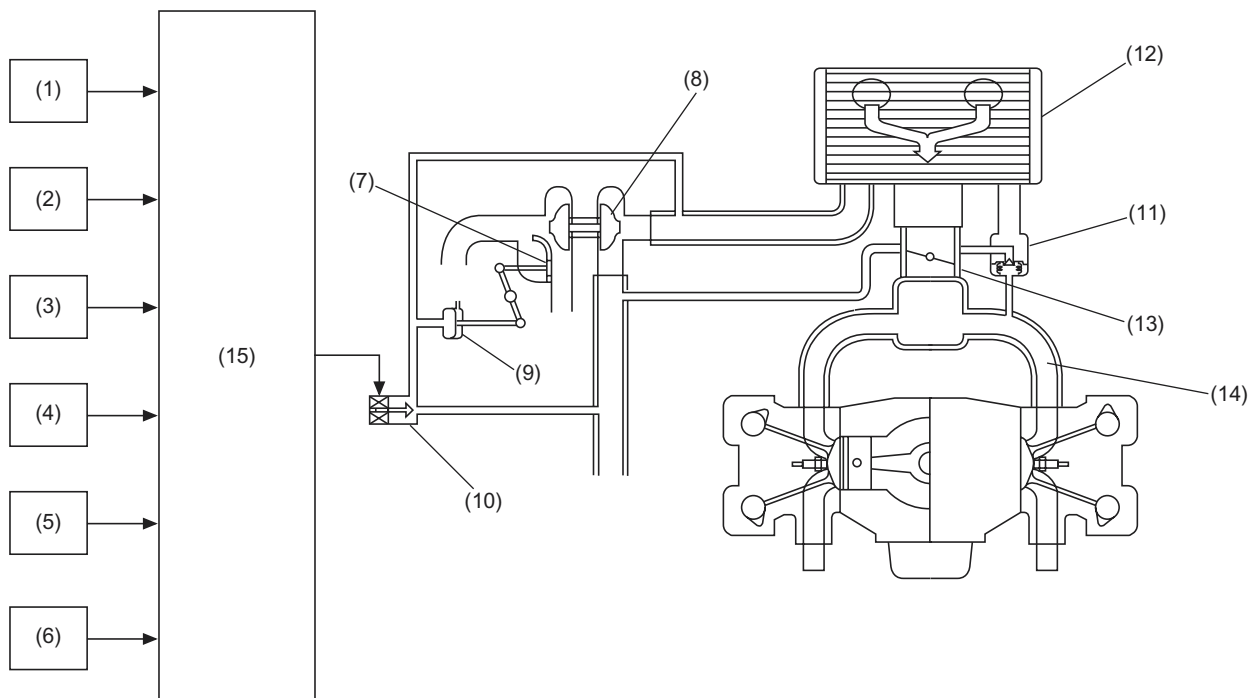
- (1) Air intake duct
- (2) Resonator chamber
- (3) Air cleaner case
- (4) Mass air flow/intake air temperature sensor
- (5) Intake boot
- (6) Intake duct

- (A) Fresh air
- (B) To turbocharger

2. Turbocharger System

A: GENERAL

- The turbocharger system consists of a water-cooled turbocharger, air-cooled intercooler, wastegate control solenoid valve, etc.
- The outlet side turbine, rotated by exhaust gas pressure, rotates the inlet side turbine.
- As a result, the inlet side turbine compresses the intake air before it is delivered to the intake manifold.
- This turbocharger system controls the supercharging pressure according to changes in the atmospheric pressure. Even at a high altitude, therefore, the system offers stable performance without being affected by variations in atmospheric pressure.



IN-00046

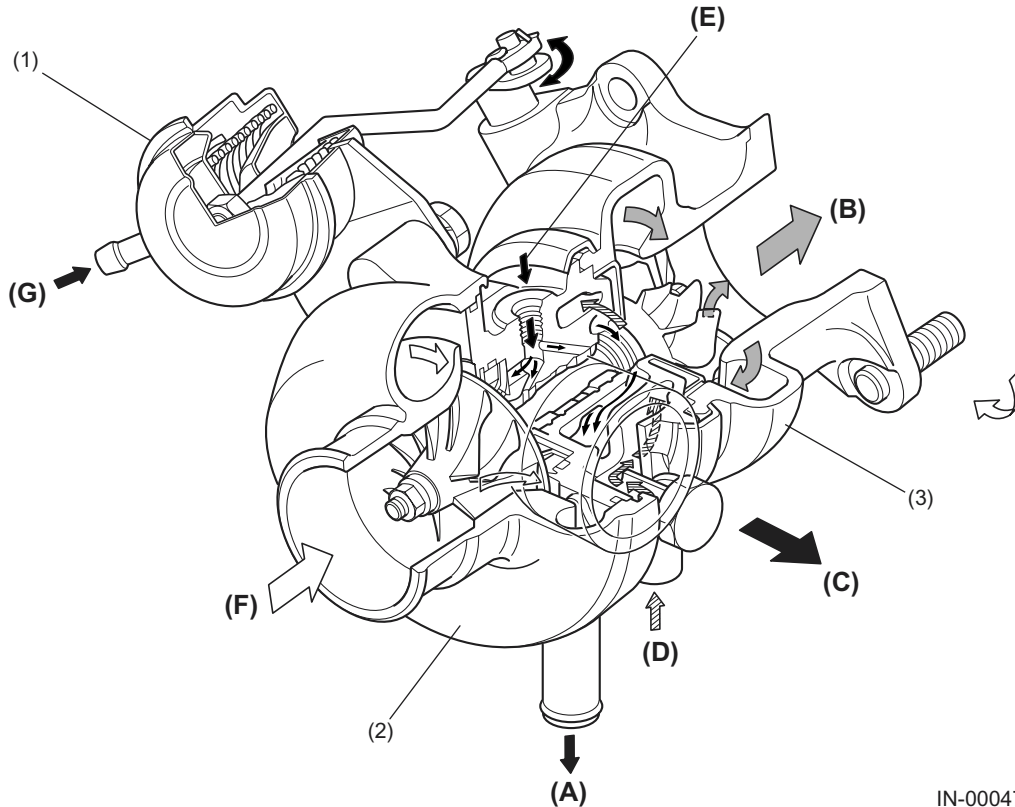
- | | |
|---|---------------------------------------|
| (1) Pressure sensor | (9) Wastegate controller |
| (2) Crankshaft position sensor | (10) Wastegate control solenoid valve |
| (3) Camshaft position sensor | (11) Air bypass valve |
| (4) Throttle position sensor | (12) Intercooler |
| (5) Engine coolant temperature sensor | (13) Throttle body |
| (6) Mass air flow/intake air temperature sensor | (14) Intake manifold |
| (7) Wastegate valve | (15) ECM |
| (8) Turbocharger unit | |

TURBOCHARGER SYSTEM

Intake (Induction)

B: TURBOCHARGER UNIT

The turbocharger is water-cooled. It utilizes a wastegate valve to adjust its supercharging pressure to an optimum level. The turbine is housed in a lightweight, thin-wall, heat-resistant casting. The compressor housing is made of thin-wall, aluminum alloy casting. The shaft for turbine and compressor is supported by a full-floating metal bearing system.



IN-00047

- (1) Wastegate controller
- (2) Compressor housing
- (3) Turbine housing

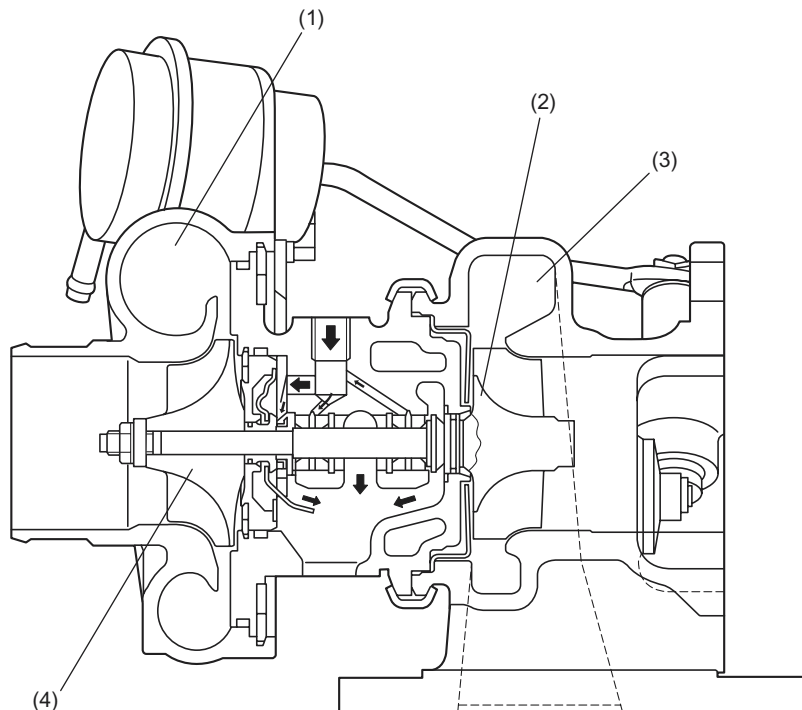
- (A) Lubricating oil outlet
- (B) Exhaust gas outlet
- (C) Air outlet
- (D) Engine coolant inlet

- (E) Lubricating oil inlet
- (F) Air inlet
- (G) Wastegate valve operating pressure

C: LUBRICATION OF TURBOCHARGER

The turbocharger is lubricated by engine oil branched out from the oil pump. To cope with very high speed of the turbocharger turbine and the compressor shaft which may reach a maximum of several hundred thousands of rpm, full-floating type bearings are used which can form adequate oil films on their inside and outside during running.

Further the oil supplied to the turbocharger also plays a role of cooling the turbine so that heat from exhaust gas does not transmitted to the bearings.



IN-00048

(1) Compressor housing

(3) Turbine housing

(2) Turbine wheel

(4) Compressor impeller

D: COOLING OF TURBOCHARGER

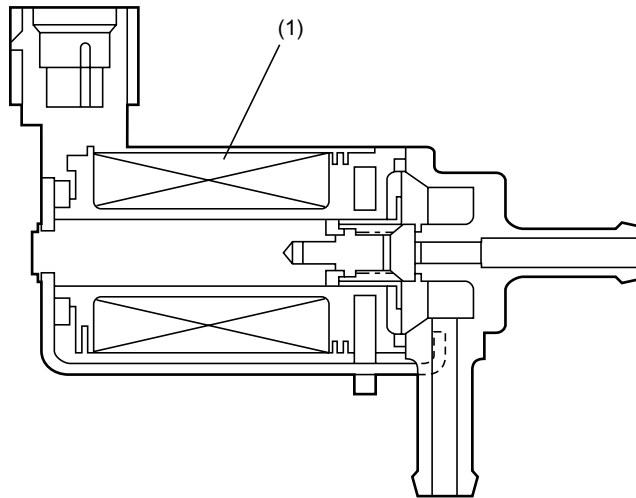
The turbocharger unit is cooled by engine coolant, which enhances the reliability and durability of the unit. The engine coolant from the coolant drain hose located under the cylinder head is led by a pipe to the coolant passage provided in the turbocharger bearing housing. After cooling the bearing housing, the engine coolant is led into the coolant filler tank through a pipe.

TURBOCHARGER SYSTEM

Intake (Induction)

E: WASTEGATE CONTROL SOLENOID VALVE

The wastegate control solenoid valve switches the intake air pressure passages to the wastegate controller in response to signals from the ECM. When the solenoid valve is closed, the intake air pressure upstream of the turbocharger unit is applied to the wastegate controller. When the solenoid valve is opened, the intake air pressure downstream of the turbocharger unit (supercharged air pressure) is applied to the wastegate controller.



IN-00055

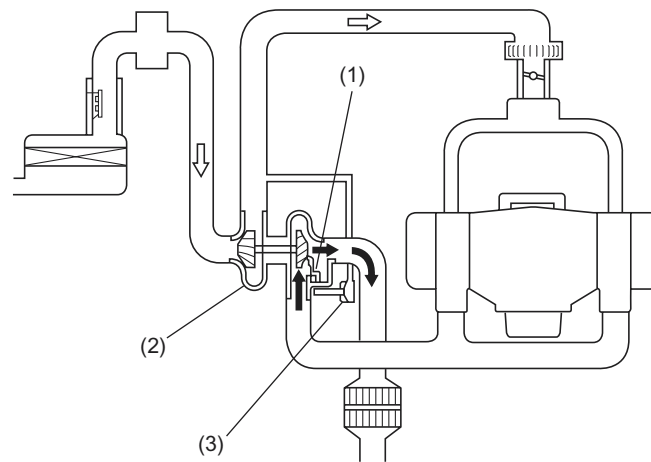
(1) Coil

F: REGULATION OF SUPERCHARGING PRESSURE

1. BASIC FUNCTION OF THE WASTEGATE VALVE

When the engine speed increases as the throttle valve opens, the amount of exhaust gas increases. This increases the speed of the turbine (approx. 20,000 to 150,000 rpm), the supercharging pressure and the engine output.

If the resultant supercharging pressure is extremely high, however, it may cause knocking and an excessively high thermal load on such engine components as pistons. In the worst case, the engine may be damaged or broken. To prevent this, the wastegate valve and its controller are provided. By sensing the supercharging pressure, the wastegate valve controller controls the operation of the wastegate valve to maintain the supercharging pressure below a predetermined level.



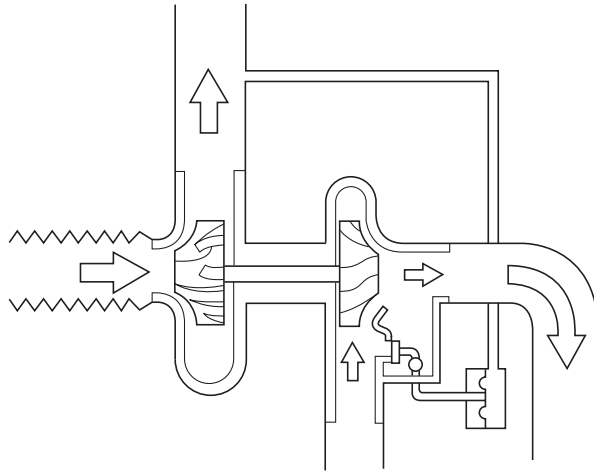
IN-00049

- (1) Wastegate valve
- (2) Turbocharger
- (3) Wastegate valve controller

TURBOCHARGER SYSTEM

Intake (Induction)

While the supercharging pressure is lower than the predetermined level, the wastegate valve is closed so that entire exhaust gas is directed to the turbine.



IN-00050

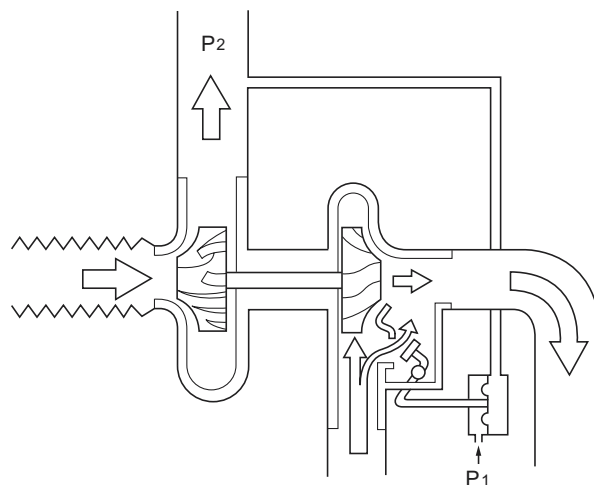
When the supercharging pressure reaches the predetermined level, the wastegate controller lets the supercharging pressure press the diaphragm. This causes the wastegate valve to open through a linkage. With the wastegate valve open, part of the exhaust gas is allowed to flow into the exhaust gas pipe that bypasses the passage to the turbine.

This decreases the exhaust gas pressure that rotates the turbine and keeps the supercharging pressure constant.

- It means $P_2 - P_1 = \text{constant}$.

P_1 : Atmospheric pressure

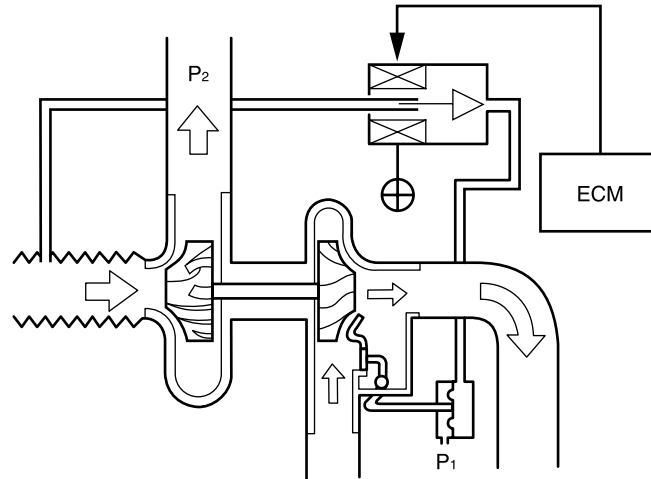
P_2 : Supercharging pressure



IN-00051

2. CONCEPT OF THE WASTEGATE VALVE CONTROL

At high altitudes, the atmospheric pressure (P_1) is low, so that the supercharging pressure (P_2) is also low in a conventional system. The wastegate solenoid valve operates in such a way that a constant supercharging pressure (P_2) is maintained by acting in response to change in the atmospheric pressure.



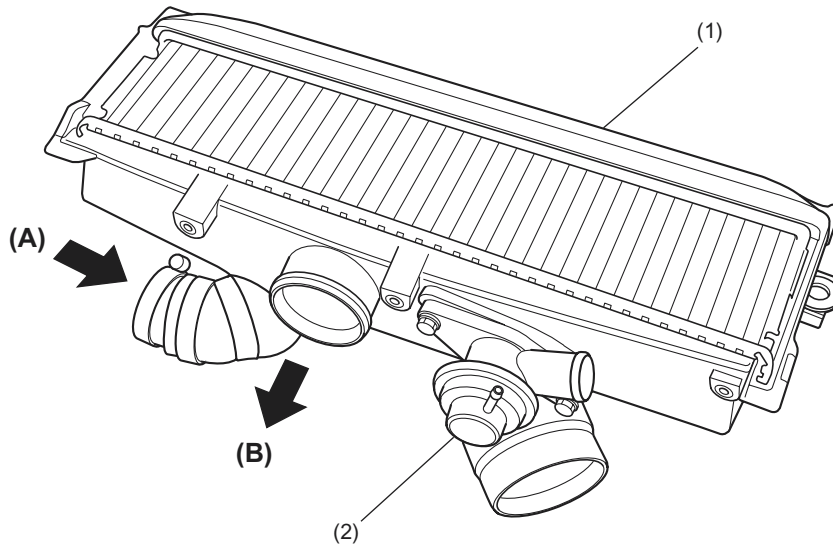
IN-00052

TURBOCHARGER SYSTEM

Intake (Induction)

G: INTERCOOLER

- Since the intake air having passed through the turbocharger unit is heated to a very high temperature, the air itself is expanded, resulting in a lower supercharging efficiency. The intercooler is provided just before the throttle body to cool down the intake air and improve the supercharging efficiency.
- The intercooler is an air cooled type. The air delivered from the air duct provided at the engine hood flows through the core and cools the intake air passing through the intercooler.



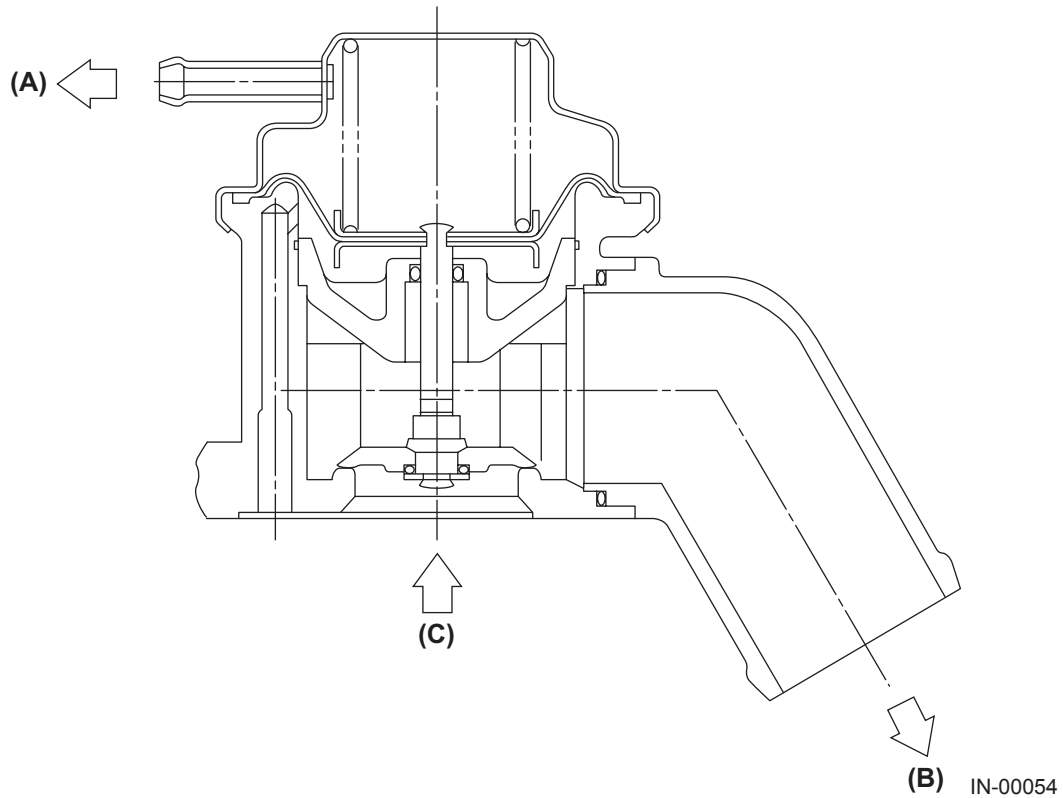
IN-00053

- (1) Intercooler
- (2) Air bypass valve

- (A) From turbocharger
- (B) To throttle body

H: AIR BYPASS VALVE

When a throttle valve is suddenly closed, low air suction noise may occur due to a sudden rise of the air pressure in the passage between the turbocharger and throttle body. To prevent this, an air bypass valve and air passage are provided. The air bypass valve, actuated by the vacuum created by a sudden closure of the throttle valve, allows the suction air to bypass the turbocharger and flow directly upstream, thus lowering the pressure in the air passage.



- (A) To intake manifold
- (B) To turbocharger inlet duct
- (C) From intercooler

TURBOCHARGER SYSTEM

Intake (Induction)

MEMO

MECHANICAL *ME* (TURBO)

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2. Timing Belt	3
3. Automatic Belt Tension Adjuster	4
4. Belt Cover	6
5. Cam shaft	7
6. Cylinder head	9
7. Cylinder block	10
8. Crankshaft	11
9. Piston	12
10. Engine Mounting	13

GENERAL

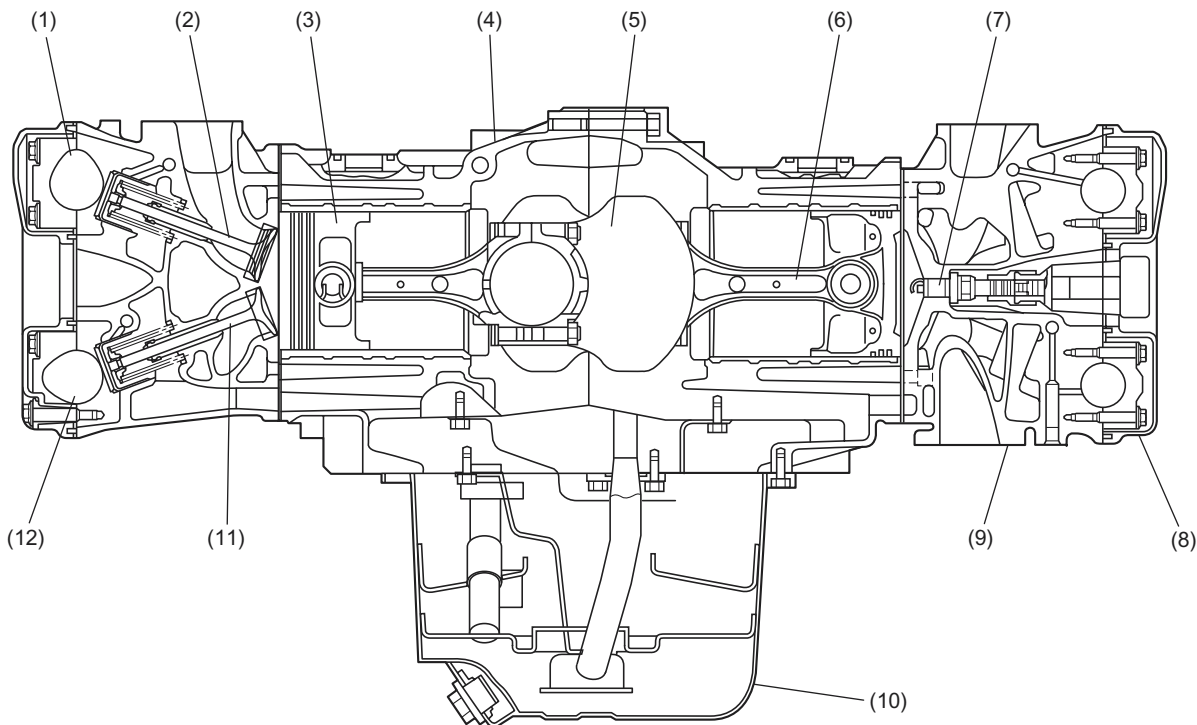
Mechanical

1. General

The engine used in this vehicle is of a horizontally opposed, four-cylinder design. This four-stroke-cycle, water-cooled, DOHC turbocharged engine uses a total of 16 valves and its main components are made of aluminum alloy. It is fueled by a multiple fuel injection system.

The engine's major structural and functional features are as follows:

- The cylinder head forms pentroof combustion chambers, each having a spark plug located at its center and two each of intake and exhaust valves (four valves per cylinder). The intake and exhaust ports are located in a cross-flow arrangement.
- A single timing belt drives four camshafts on the left and right banks and the engine coolant pump on the left bank. Belt tension is automatically adjusted by a belt tension adjuster, eliminating need for a manual adjustment.
- The crankshaft is supported by five bearings with high rigidity and strength.
- The cylinder block is an aluminum die casting fitted with iron die-cast cylinder liners.

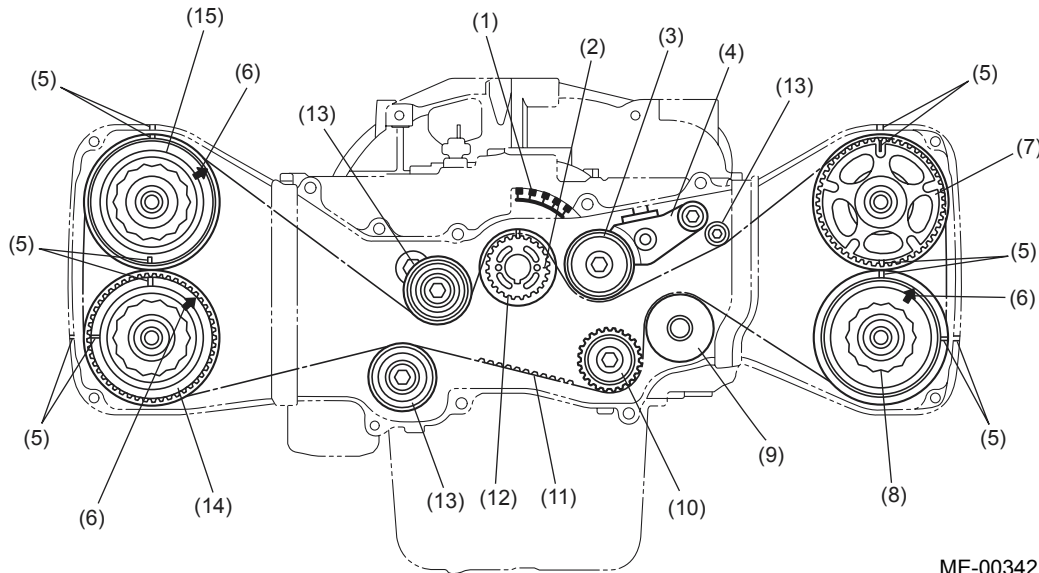


ME-00341

- | | | |
|---------------------|------------------------|-----------------------|
| (1) Intake camshaft | (5) Crankshaft | (9) Cylinder head |
| (2) Intake valve | (6) Connecting rod | (10) Oil pan |
| (3) Piston | (7) Spark plug | (11) Exhaust valve |
| (4) Cylinder block | (8) Valve rocker cover | (12) Exhaust camshaft |

2. Timing Belt

- A single timing belt drives four camshafts (intake and exhaust camshafts on each bank). The belt also drives the water pump by its non-toothed side.
- The timing belt teeth have a specially designed round profile which contributes to quiet operation. The timing belt is made of strong and inflexible core cords, wear-resistant canvas and heat-resistant rubber material.
- A hydraulic automatic belt tension adjuster always keeps the belt taut to the specified tension. Any manual belt tension adjustment is unnecessary.



ME-00342

- | | |
|---|-----------------------------------|
| (1) Timing indicator (For timing mark of crankshaft pulley) | (9) Water pump pulley |
| (2) *Piston position mark | (10) Idler No. 2 |
| (3) Belt tension pulley | (11) Timing Belt |
| (4) Automatic belt tension adjuster assembly | (12) Crankshaft sprocket |
| (5) Alignment mark | (13) Idler |
| (6) **Piston position mark | (14) Exhaust camshaft sprocket RH |
| (7) Intake camshaft sprocket LH | (15) Intake camshaft sprocket RH |
| (8) Exhaust camshaft sprocket LH | |

NOTE:

*: The #1 piston is set at the top dead center (TDC) when the piston-position mark on the crankshaft sprocket is aligned with the mark on cylinder block.

** : The #1 piston is set at TDC on the compression stroke when the piston-position mark on the camshaft sprocket is facing directly upward.

AUTOMATIC BELT TENSION ADJUSTER

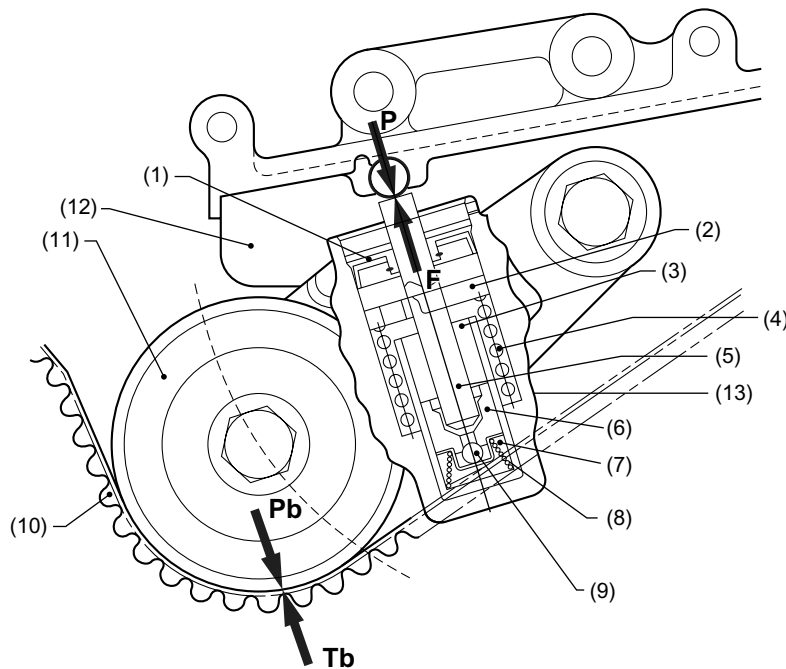
Mechanical

3. Automatic Belt Tension Adjuster

The automatic belt tension adjuster consists of a tensioner unit and a bracket. It maintains the timing belt tension automatically at a specified level to enable the belt to transmit power correctly, reduce operating noise and increase the life of the belt.

The cylinder of the tensioner unit incorporates an adjuster rod, wear ring, plunger spring, return spring, check ball and silicone oil.

The automatic belt tension adjuster gives tension to the belt by a levering action which is produced by the push force of the tensioner unit's adjuster rod. It operates in the process detailed below.



ME-00314

- | | |
|---------------------------|--------------------------|
| (1) Oil seal | (8) Plunger spring |
| (2) Wear ring | (9) Check ball |
| (3) Oil reservoir chamber | (10) Timing belt |
| (4) Return spring | (11) Belt tension pulley |
| (5) Adjuster rod | (12) Tensioner bracket |
| (6) Plunger | (13) Cylinder |
| (7) Oil pressure chamber | |

AUTOMATIC BELT TENSION ADJUSTER

Mechanical

- Timing belt tensioning action

When the belt becomes slack, the adjuster rod is pushed upward by the return spring. The oil in the reservoir chamber, which is pressurized by the plunger spring to a certain level, pushes open the check ball and flows into the oil pressure chamber to keep the pressure constant.

The thrust force F resulting from extension of the adjuster rod applies a counterclockwise torque to the tensioner bracket, which causes the belt tension pulley at its end to turn in the same direction. This applies tensioning pressure P_b to the timing belt.

- Timing belt tension balancing action

When the belt tension pulley is pushed against the timing belt with pressure P_b , reaction force T_b of the timing belt generates the reaction force P at the point on which the adjuster rod force is acting.

This force P pushes the adjuster rod until it balances with the sum of the thrust force F and the pressure of the oil in the oil pressure chamber. Therefore, the timing belt tension is kept constant.

- Overtension correction action

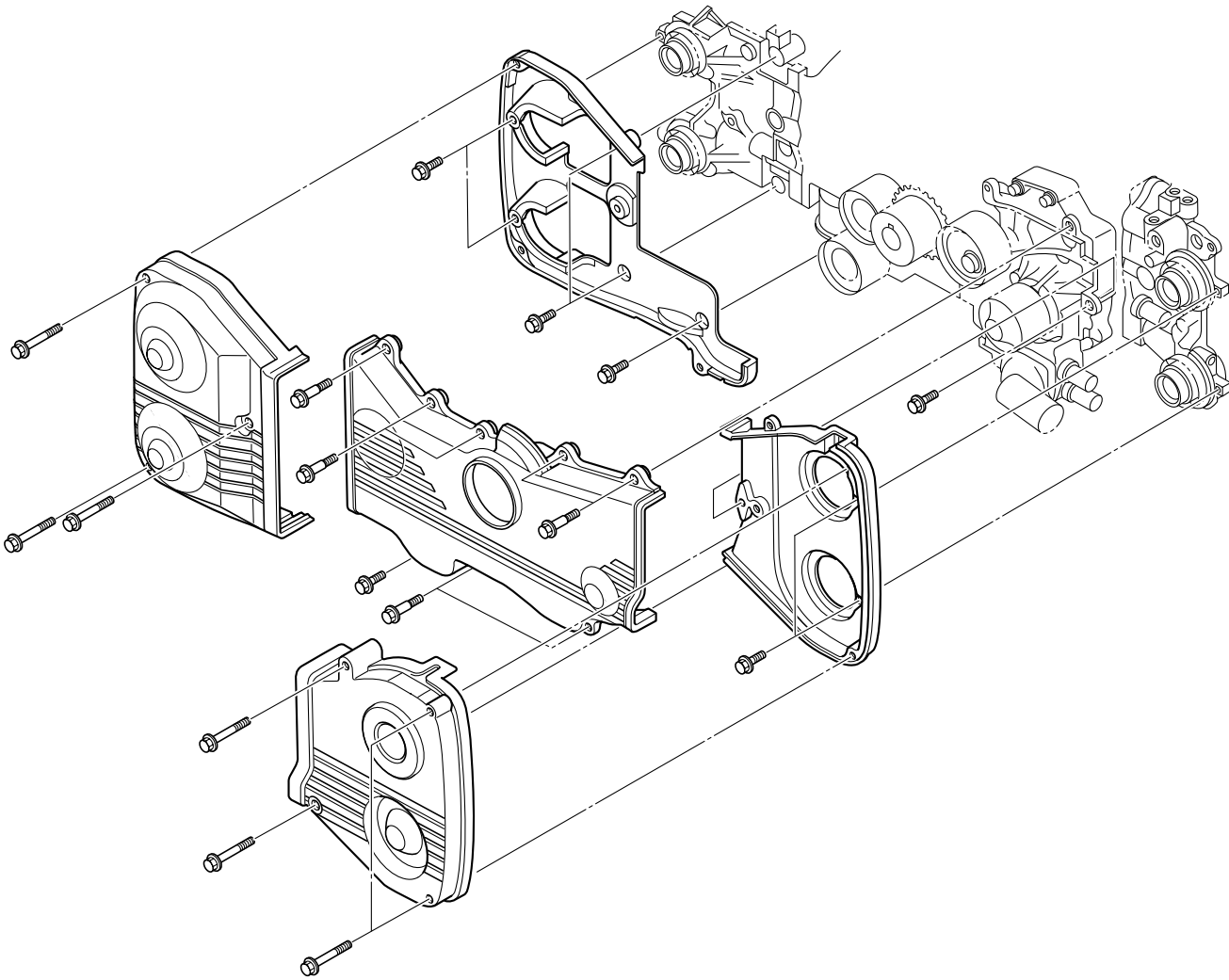
If the tension of the timing belt increases excessively, the force P becomes larger than the thrust force F and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force P balances again with the thrust force F . Thus the timing belt tension is maintained at the specified level at all times.

BELT COVER

Mechanical

4. Belt Cover

- The belt cover is made of lightweight, heat resistant synthetic resin molding. It constitutes a totally enclosed housing with its cylinder block mating edges sealed with rubber gaskets. This effectively protects the inside components from dust and liquid.
- Rubber seals used between the cylinder block and the belt cover effectively reduces transmission of noise and vibration.
- The front belt cover has a line mark for ignition-timing checking.



ME-00343

5. Cam shaft

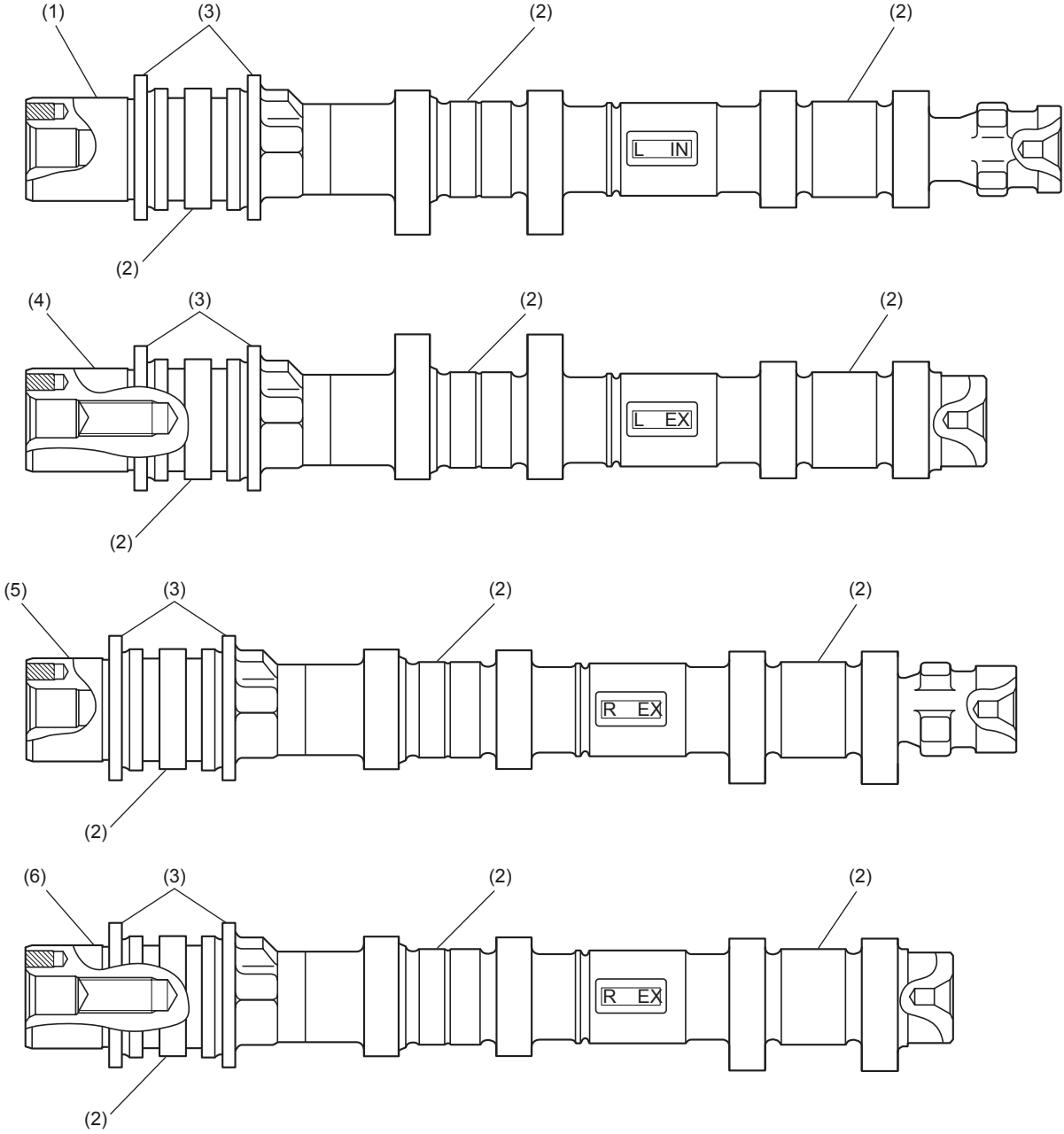
The DOHC engine uses four camshafts in all; intake and exhaust camshafts on each of the right and left banks.

The cam lobe noses are finished by “chill” treatment to increase wear resistance and anti-scuffing properties.

Each camshaft is supported at its three journals and held in position by three camshaft caps. Each camshaft has a flange which fits in the corresponding groove in the cylinder head to receive thrust forces generated in the camshaft.

CAM SHAFT

Mechanical

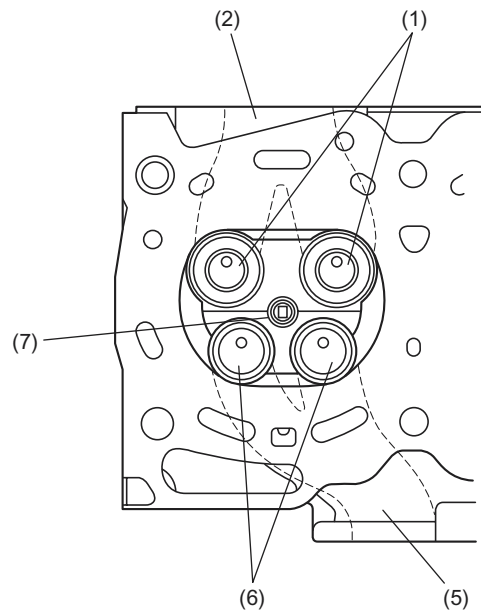
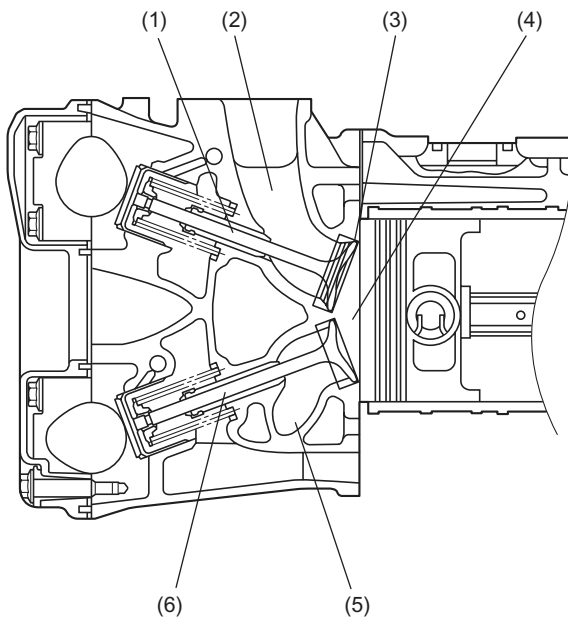


ME-00344

- (1) Left intake camshaft
- (2) Journal
- (3) Flange
- (4) Left exhaust camshaft
- (5) Right intake camshaft
- (6) Right exhaust camshaft

6. Cylinder head

- The cylinder head is made of aluminium die casting.
- Each combustion chamber in the cylinder head is a compact, pentroof design. The spark plug is located at the center of the combustion chamber, which contributes to creation of a wide “squish area” for increased combustion efficiency.
- The two intake and two exhaust valves are arranged on opposite sides for a cross-flow feature.
- The cylinder head gasket is a metallic gasket consisting of three layers of the stainless steel sheets. It is highly resistant to heat and maintains high level of sealing performance for a long period.



ME-00345

- (1) Intake valve
- (2) Intake port
- (3) Squish area
- (4) Combustion chamber

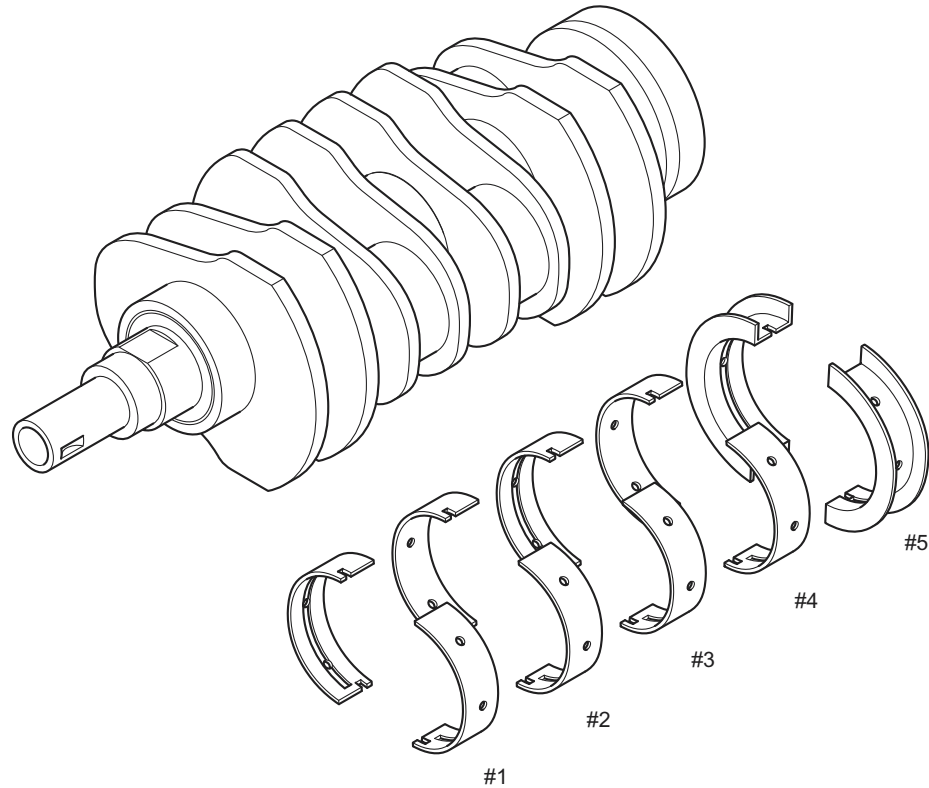
- (5) Exhaust port
- (6) Exhaust valve
- (7) Spark plug

7. Cylinder block

- The cylinder block is made of aluminium die casting. Its open-deck design provides it with such advantageous features as relatively small weight, high rigidity and excellent cooling efficiency.
- The cylinder liners are made of cast iron. They are dry type which means their outer surfaces are entirely in contact with the cylinder block.
- The cylinder block supports the crankshaft at its five journals. The journal supporting portions are designed such that sufficient stiffness and quiet operation are ensured.
- The oil pump is located in the front center of the cylinder block and the engine coolant pump is located at the front of the left-cylinder bank. At the rear of the right-cylinder bank is an oil separator which removes oil mist contained in blow-by gas.

8. Crankshaft

The crankshaft is supported in the cylinder block by five bearings. Each corner formed by a journal or pin and a web is finished by fillet-rolling method which increases strength of that area. The five crankshaft bearings are made of aluminum alloy and the No. 5 bearing is provided with a flanged metal to support thrust forces.



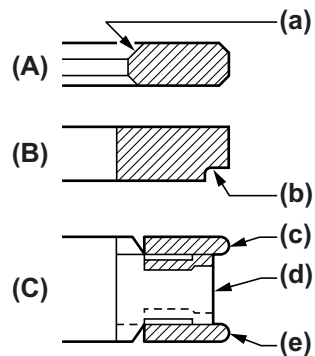
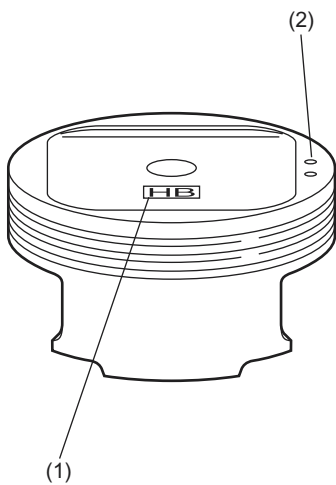
ME-00319

PISTON

Mechanical

9. Piston

- The pistons are of a slipper skirt design for reduced weight and friction. The oil control ring groove utilizes a thermal design.
- The piston pin is offset either downward (Nos. 1 and 3 pistons) or upward (Nos. 2 and 4 pistons).
- The piston head has recesses to prevent interference with the intake and exhaust valves. It also has engraved marks to identify the piston size and the direction of installation. All the pistons are common in their design.
- Three piston rings are used for each piston - two compression rings and one oil control ring. The top piston ring has inner bevels and the second piston ring has a cut on the bottom outside to reduce oil consumption.



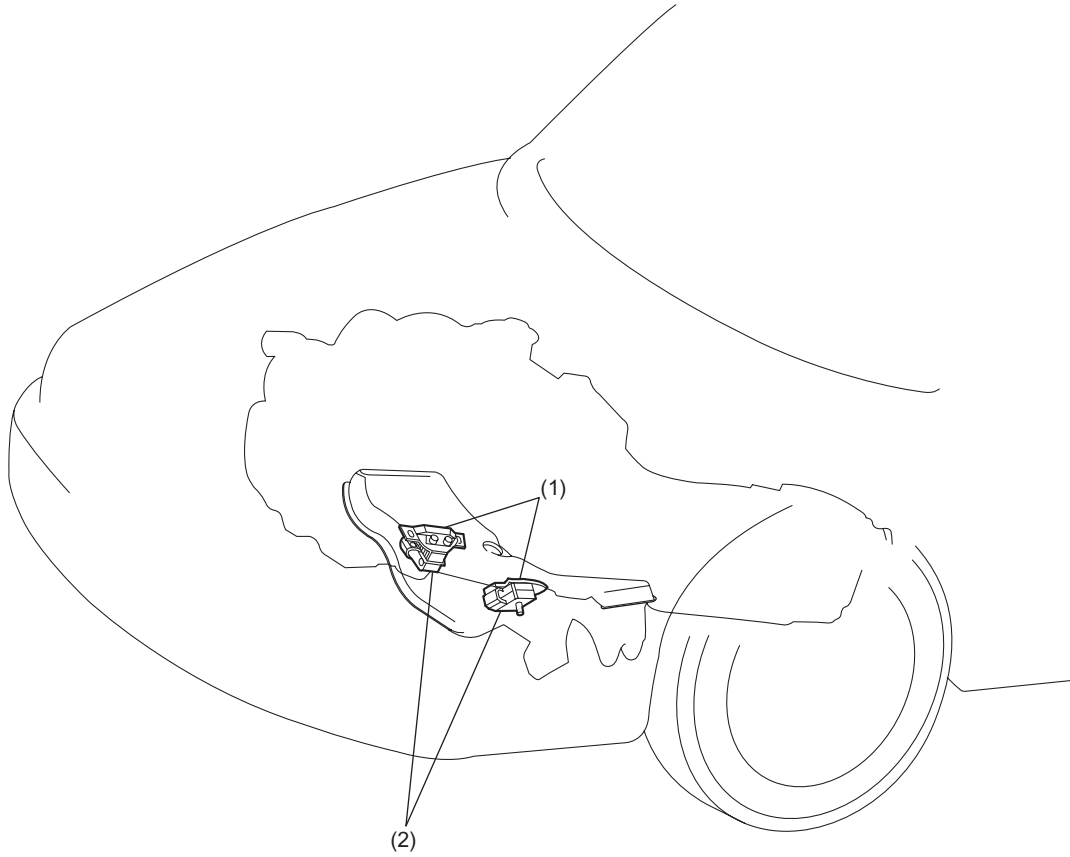
ME-00346

- (1) Identification mark
(2) Location mark (Engine front side)

- (A) Top ring
(B) Second ring
(C) Oil ring

- (a) Inner-bevel
(b) Cut
(c) Upper rail
(d) Spacer
(e) Lower rail

10.Engine Mounting



ME-00321

- (1) Bracket
- (2) Cushion rubber

ENGINE MOUNTING

Mechanical

MEMO

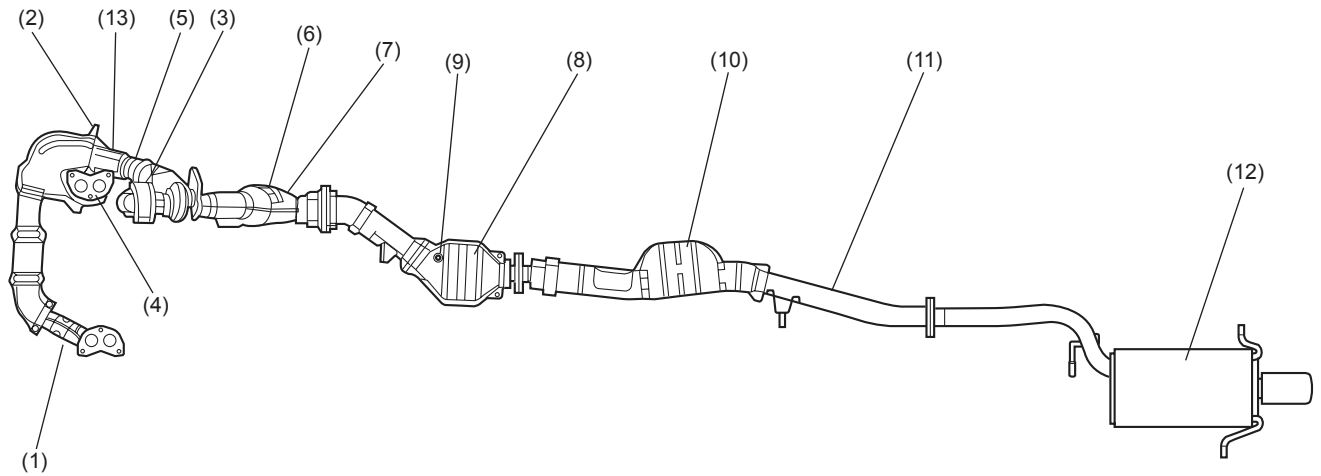
EXHAUST *EX* (TURBO)

	Page
1. General	2
2. Construction	3

1. General

- The exhaust system consists of left and right exhaust manifolds, a front joint pipe, a turbocharger joint pipe, a center exhaust pipe, a rear exhaust pipe and a muffler. The turbocharger joint pipe incorporates the precatalytic converter, the center exhaust pipe incorporates the front catalytic converter, and the rear exhaust pipe incorporates the rear catalytic converter.
- The exhaust system features an improved sound suppression design and has a resonator chamber in addition to a large capacity muffler.

2. Construction



EX-00033

- | | |
|--------------------------------|------------------------------|
| (1) Left exhaust manifold | (8) Rear catalytic converter |
| (2) Front oxygen (A/F) sensor | (9) Rear oxygen sensor |
| (3) Exhaust temperature sensor | (10) Chamber |
| (4) Right exhaust manifold | (11) Rear exhaust pipe |
| (5) Precatalytic converter | (12) Muffler |
| (6) Front catalytic converter | (13) Turbocharger joint pipe |
| (7) Center exhaust pipe | |

CONSTRUCTION

Exhaust

MEMO

COOLING *CO* (TURBO)

	Page
1. General	2

1. General

Specifications for the turbo models are included in section "CO (SOHC) – COOLING". Refer to section "CO (SOHC) – COOLING".

LUBRICATION *LU* (TURBO)

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1. General

Specifications for the turbo models are included in section “LU (SOHC) – LUBRICATION”. Refer to section “LU (SOHC) – LUBRICATION”.

SPEED CONTROL SYSTEM *SP* (TURBO)

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1. General	2

1. General

Specifications for the turbo models are the same as those for the non-turbo models. Refer to section "SP (SOHC) – SPEED CONTROL SYSTEM".

IGNITION *IG* (TURBO)

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2. Spark plug	3

IGNITION COIL

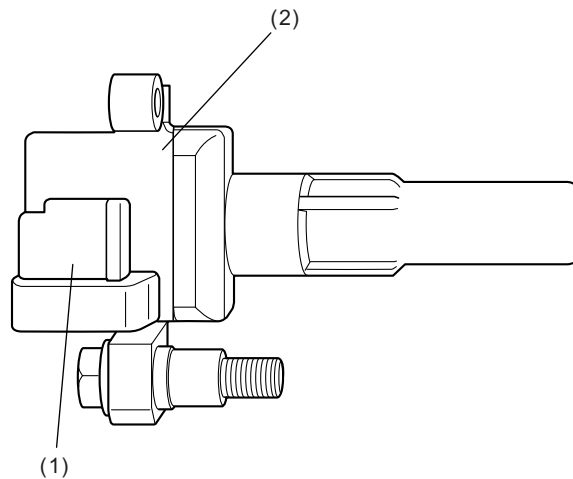
Ignition

1. Ignition coil

The engine uses a direct ignition system with one ignition coil mounted for each cylinder (or spark plug).

The secondary terminal of the ignition coil is in contact with the spark plug terminal nut.

Since no spark plug cable is used, secondary voltage drop, leaks, or other problems that are inherent in a system using spark plug cables do not occur. The result is high performance and high reliability.



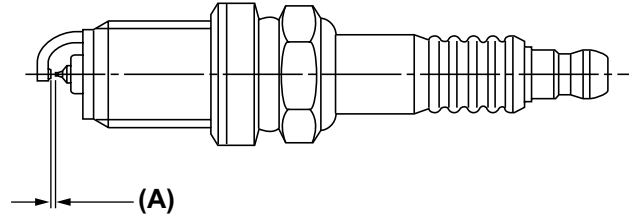
IG-00040

(1) Connector

(2) Ignition coil

2. Spark plug

The spark plug has a platinum tipped electrode. The thread diameter is 14 mm (0.551 in) and the gap is controlled to a value between 0.7 and 0.8 mm (0.028 and 0.031 in).



IG-00041

(A) Gap: 0.7 – 0.8 mm (0.028 – 0.031 in)

SPARK PLUG

Ignition

MEMO

STARTING/CHARGING **SC** (*TURBO*)

	Page
1. General	2

1. General

Specifications for the turbo models are the same as those for the non-turbo models. Refer to section "SC (SOHC) – STARTING/CHARGING".

CONTROL SYSTEM **CS**

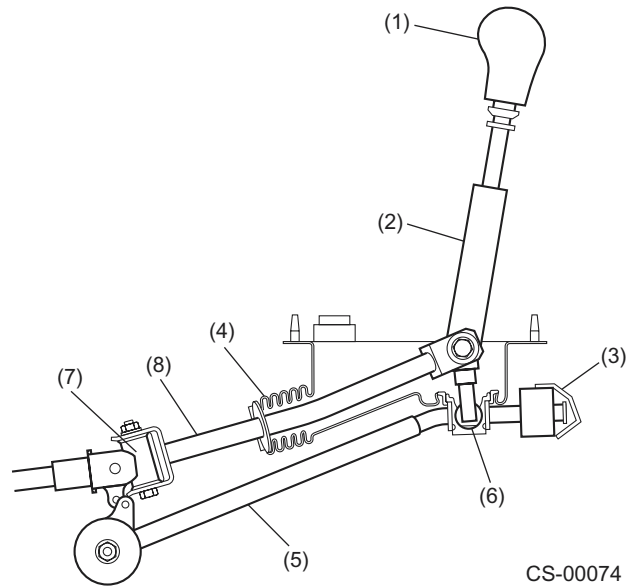
	Page
1. Gear Shift Lever	2
2. Select Lever	3
3. Dual Range Selector Lever	4

GEAR SHIFT LEVER

Control System

1. Gear Shift Lever

The manual transmission's gear shift lever system is a parallel link type whose stay is mounted through a cushion rubber.

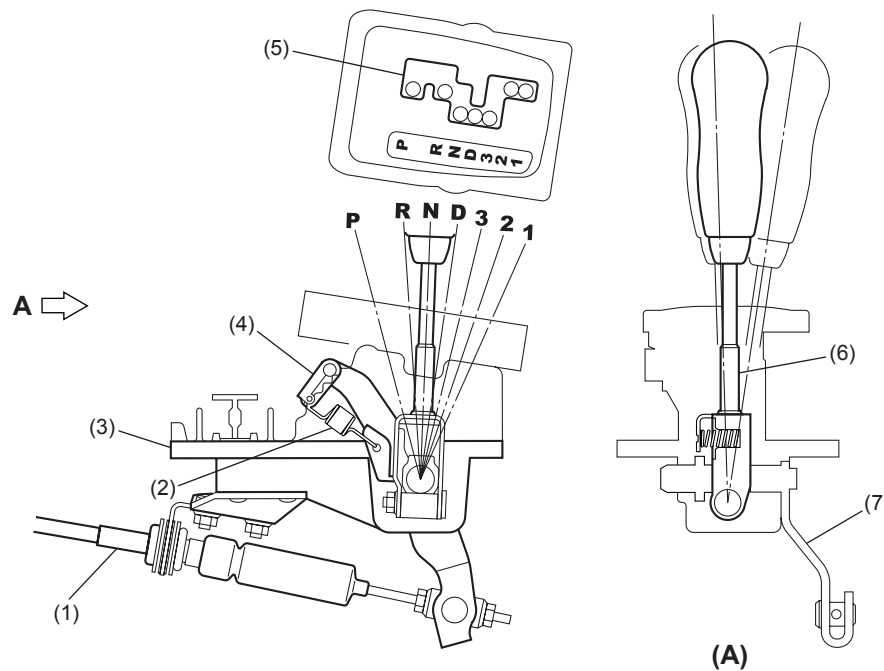


- (1) Knob
- (2) Lever
- (3) Cushion rubber
- (4) Boot

- (5) Stay
- (6) Bush B
- (7) Joint
- (8) Rod

2. Select Lever

- The automatic transmission's select lever moves through seven positions.
- The select lever makes shift direction (longitudinal) movements as well as select direction (lateral) movements. The select lever is guided by a gate to make these movements.
- To transmit movements of the select lever to the transmission, a push-pull cable is used.
- The select lever mechanism has a detent spring and a detent arm. It ensures more precise positioning of the select lever.



CS-00075

- (1) Push-pull cable
- (2) Detent spring
- (3) Base plate
- (4) Detent arm
- (5) Gate

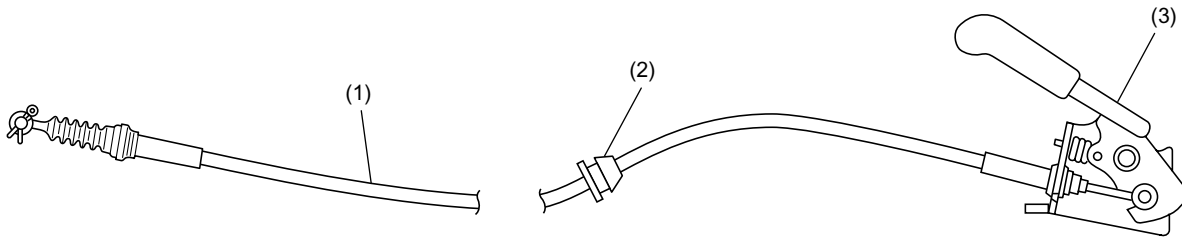
- (6) Select lever assembly
- (7) Arm
- (A) View A

DUAL RANGE SELECTOR LEVER

Control System

3. Dual Range Selector Lever

The dual range selector lever is provided behind the transmission shift lever. Moving the range selector lever up and down shifts the Hi-Lo coupling sleeve of the auxiliary transmission gear mechanism via a cable, thereby selecting the low range and high range, respectively.



CS-00117

- (1) Cable
- (2) Grommet
- (3) Dual range selector lever assembly

AUTOMATIC TRANSMISSION *AT*

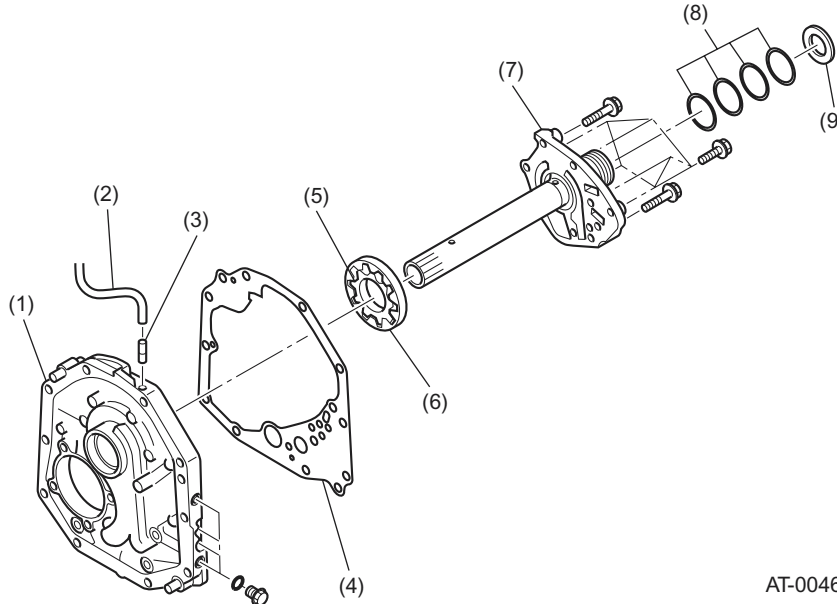
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6. Low Clutch	10
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OIL PUMP

1. Oil Pump

A: CONSTRUCTION

The pump consists of a prachoid rotor pair, a housing and a cover. The inner rotor has nine teeth and the outer rotor has ten teeth.



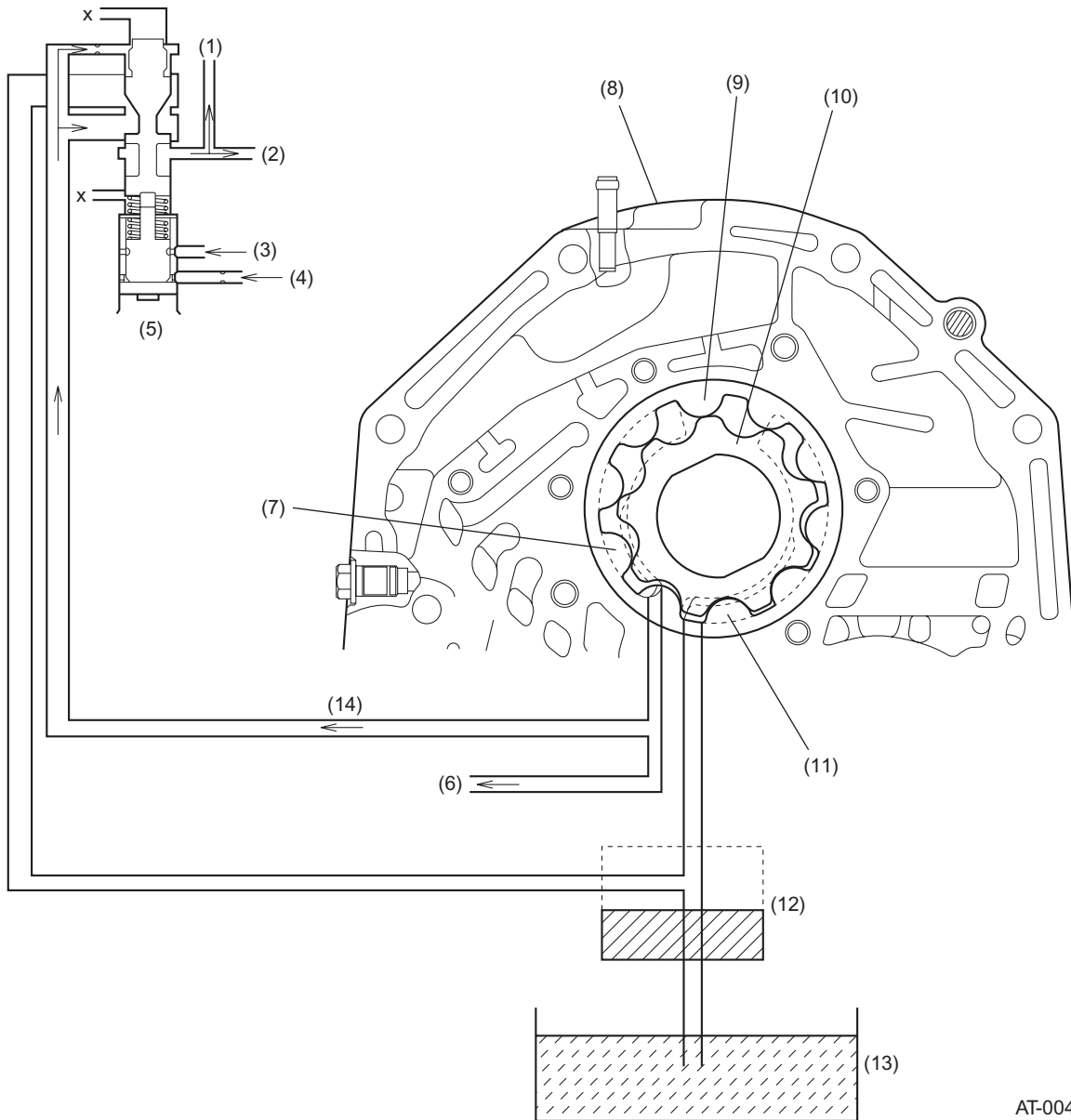
AT-00461

- | | | |
|----------------------|-----------------|--------------------|
| (1) Oil pump housing | (4) Gasket | (7) Oil pump cover |
| (2) Hose | (5) Inner rotor | (8) Seal ring |
| (3) Nipple | (6) Outer rotor | (9) Thrust bearing |

B: FUNCTION

- The pump draws automatic transmission fluid (ATF) from the oil pan through the oil strainer located under the hydraulic control valve assembly. The ATF then flows through a passage in the transmission case, and after passing through the oil pump housing and oil pump cover, it enters the suction port.
- As the inner rotor rotates, the outer rotor also rotates. This motion causes the ATF to be sucked up through the suction port and discharged from the discharged port.
- The discharged ATF flows through a passage in the oil pump cover and then a passage in the oil pump housing. It then goes through a passage in the transmission case to the pressure regulator valve in the control valve assembly, from which the ATF is directed to various clutches, brakes, and torque converter lock-up clutch for acting as hydraulic fluid and lubricating oil. Part of the ATF also flows, directly and after passing through the regulator valve, to the manual valve, from where it is distributed to the circuit corresponding to the range selected by the selector lever.
- As engine speed increases, the delivery rate of the oil pump also increases.

OIL PUMP



AT-00462

- (1) To torque converter regulator valve
- (2) To manual valve
- (3) From reverse clutch
- (4) From pressure modifier valve
- (5) Pressure regulator valve
- (6) To manual valve
- (7) Delivery port

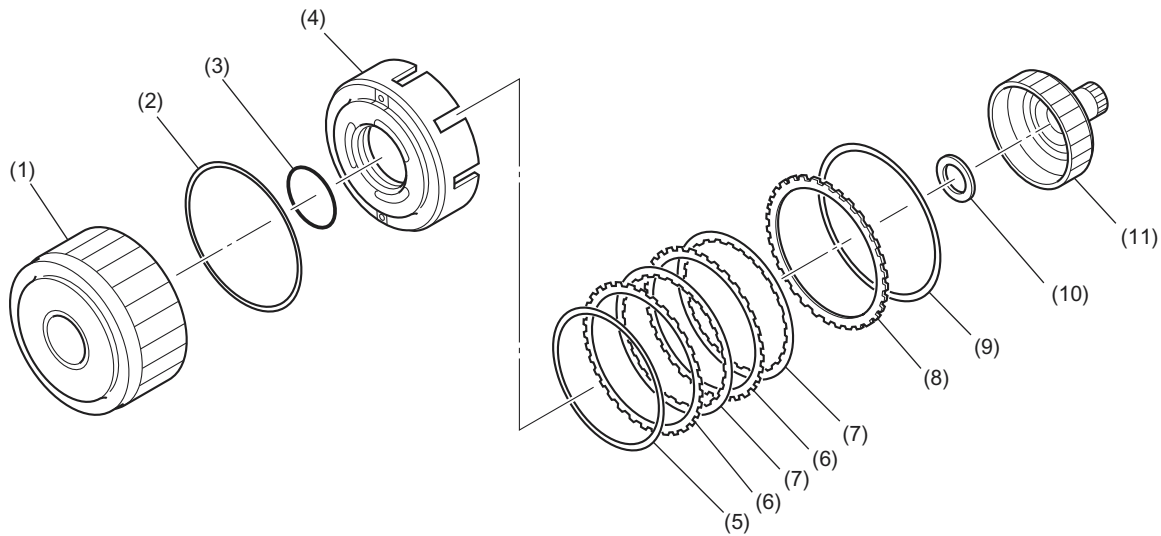
- (8) Oil pump housing
- (9) Outer rotor
- (10) Inner rotor
- (11) Suction port
- (12) Oil strainer
- (13) Oil pan
- (14) Line pressure

REVERSE CLUTCH

Automatic Transmission

2. Reverse Clutch

A: CONSTRUCTION



AT-00463

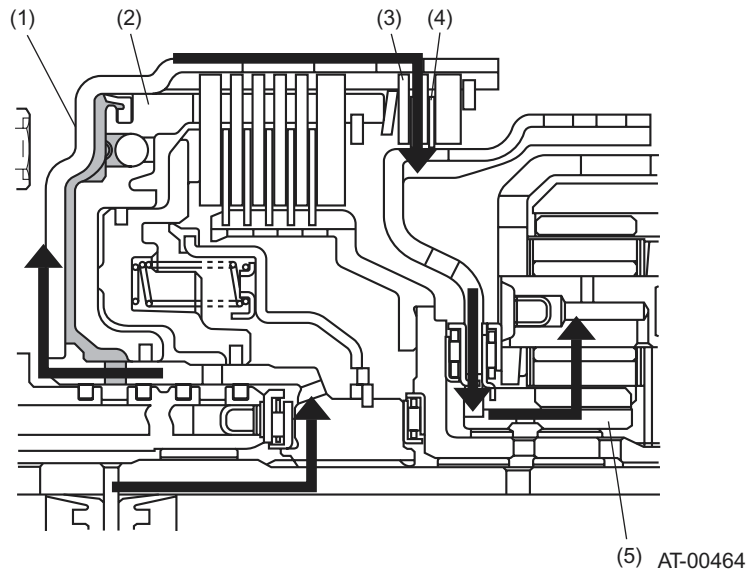
- (1) High clutch drum
- (2) Lip seal
- (3) Lathe cut seal ring
- (4) Reverse clutch piston
- (5) Dish plate
- (6) Driven plate

- (7) Drive plate
- (8) Retaining plate
- (9) Snap ring
- (10) Thrust needle bearing
- (11) High clutch hub

B: FUNCTION

1. WHEN REVERSE IS SELECTED

Hydraulic pressure from the hydraulic control valve is applied to the reverse clutch piston when a shift is made into the reverse. The drive and driven plates are pressed together by this pressure, so that the engine torque from the high clutch drum is transmitted to the front sun gear through the 2-4 brake hub.



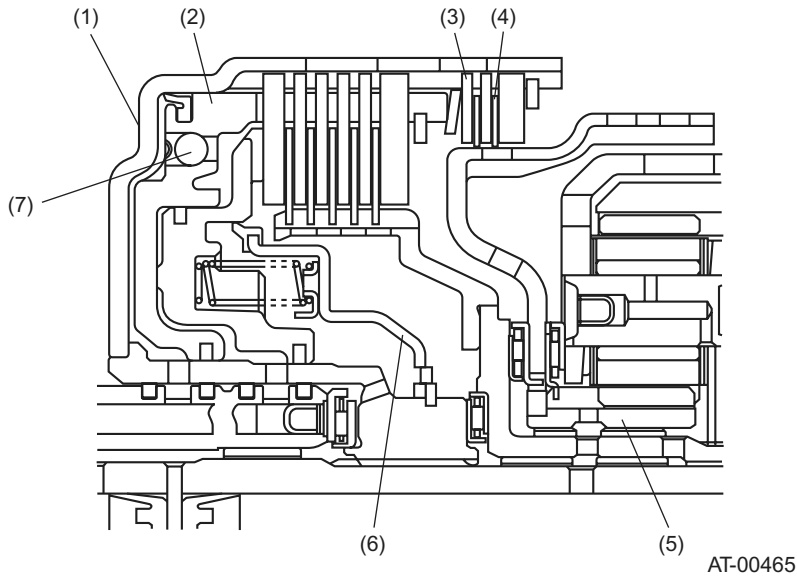
- | | |
|---------------------------|--------------------|
| (1) High clutch drum | (4) Drive plate |
| (2) Reverse clutch piston | (5) Front sun gear |
| (3) Driven plate | |

REVERSE CLUTCH

2. WHEN REVERSE IS NOT SELECTED

When the selector lever is in any position other than the reverse, no pressure is applied to the reverse clutch piston. Hence the drive and driven plates are separated from each other, transmitting no power to any element beyond them.

A check ball is built into the clutch piston. This check ball has a function of releasing the pressure which may build up in the fluid remaining behind the piston by centrifugal force generated by the idly rotating high clutch drum, thereby avoiding a half-engaged state of the clutch.



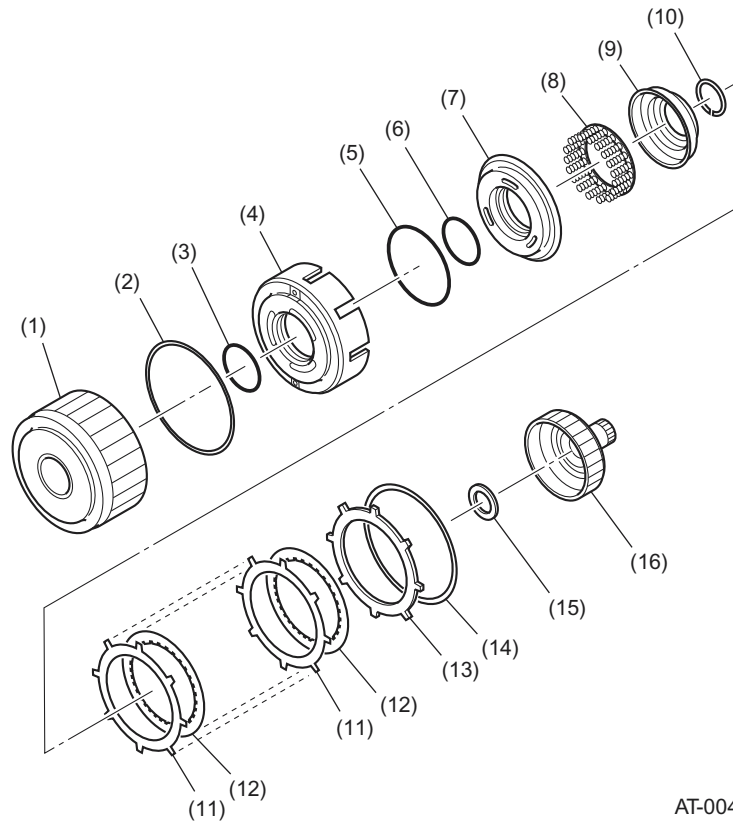
- | | |
|---------------------------|--------------------|
| (1) High clutch drum | (5) Front sun gear |
| (2) Reverse clutch piston | (6) Cover |
| (3) Driven plate | (7) Check ball |
| (4) Drive plate | |

3. High Clutch

When the 3rd or 4th gear is selected, hydraulic pressures are applied to the high clutch from the shift valve and pressure regulator valve. The clutch's drive and driven plates are pressed together, thus transmitting the engine power from the input shaft to the front planetary carrier through the high clutch hub.

A cover is placed inside the piston, and the space between the piston and the cover is filled with ATF. When the high clutch is not in engagement, the centrifugal force generated in the ATF inside the cover cancels out the centrifugal force generated in the ATF remaining behind the high clutch piston, thus preventing incomplete disengagement of the clutch.

When the high clutch is engaged, the pressure pushing the clutch piston is much larger than the counteracting force of the ATF in the cover, so the clutch remains engaged.



AT-00466

- | | | |
|---------------------------------|------------------------|----------------------------|
| (1) High clutch drum | (7) High clutch piston | (13) Retaining plate |
| (2) Lip seal | (8) Return spring | (14) Snap ring |
| (3) Lathe cut seal ring | (9) Cover | (15) Thrust needle bearing |
| (4) Reverse clutch piston | (10) Snap ring | (16) High clutch hub |
| (5) Lathe cut seal ring (outer) | (11) Driven plate | |
| (6) Lathe cut seal ring (inner) | (12) Drive plate | |

2-4 BRAKE

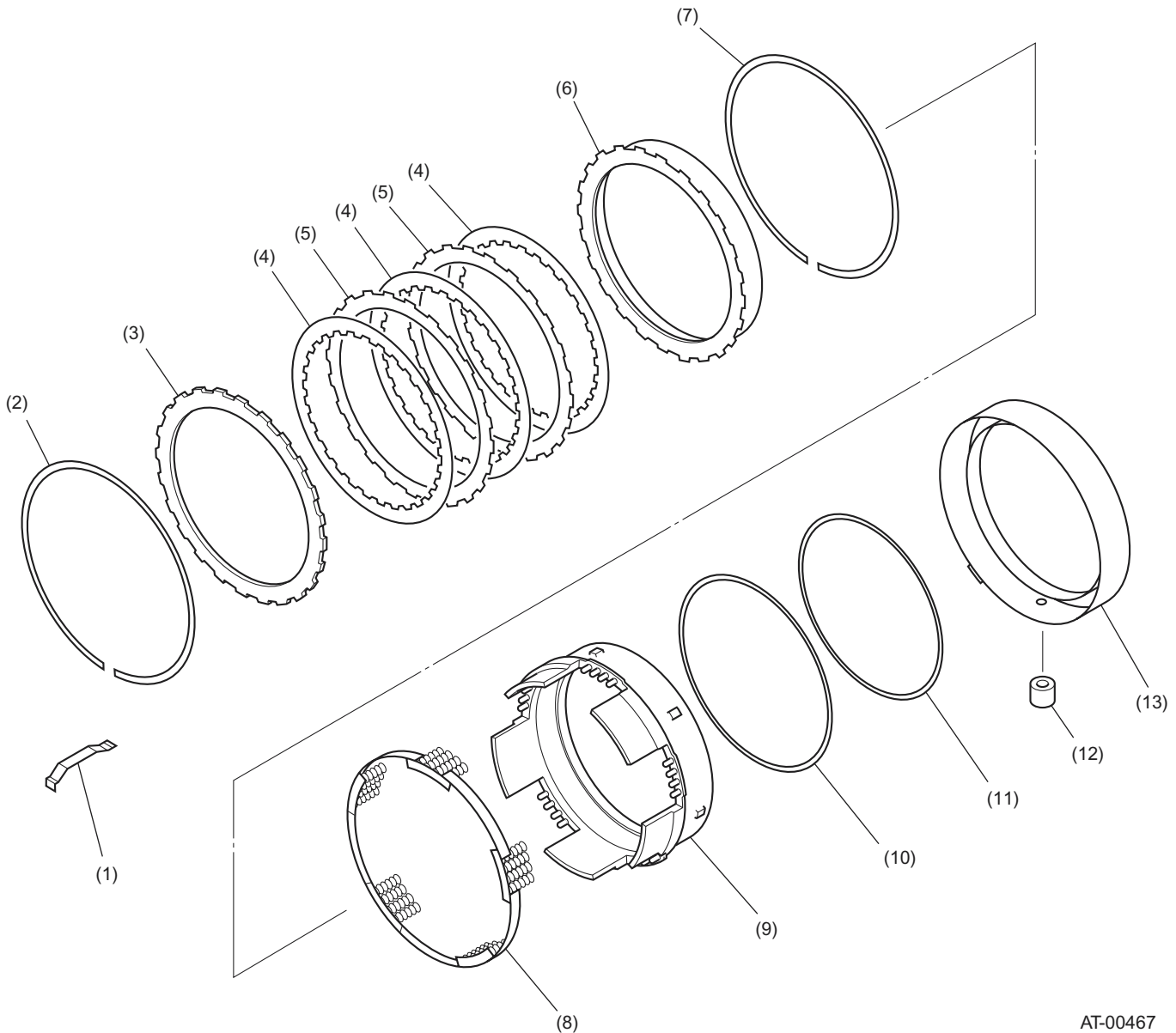
Automatic Transmission

4. 2-4 Brake

A: CONSTRUCTION

The 2-4 brake consists of a 2-4 brake piston, a return spring, a pressure plate, drive plates and driven plates.

This brake is engaged by the hydraulic pressure from the transmission control valve and locks the front sun gear when the 2nd gear is selected in the D, 3 or 2 range, or when the 4th gear is selected in the D range.



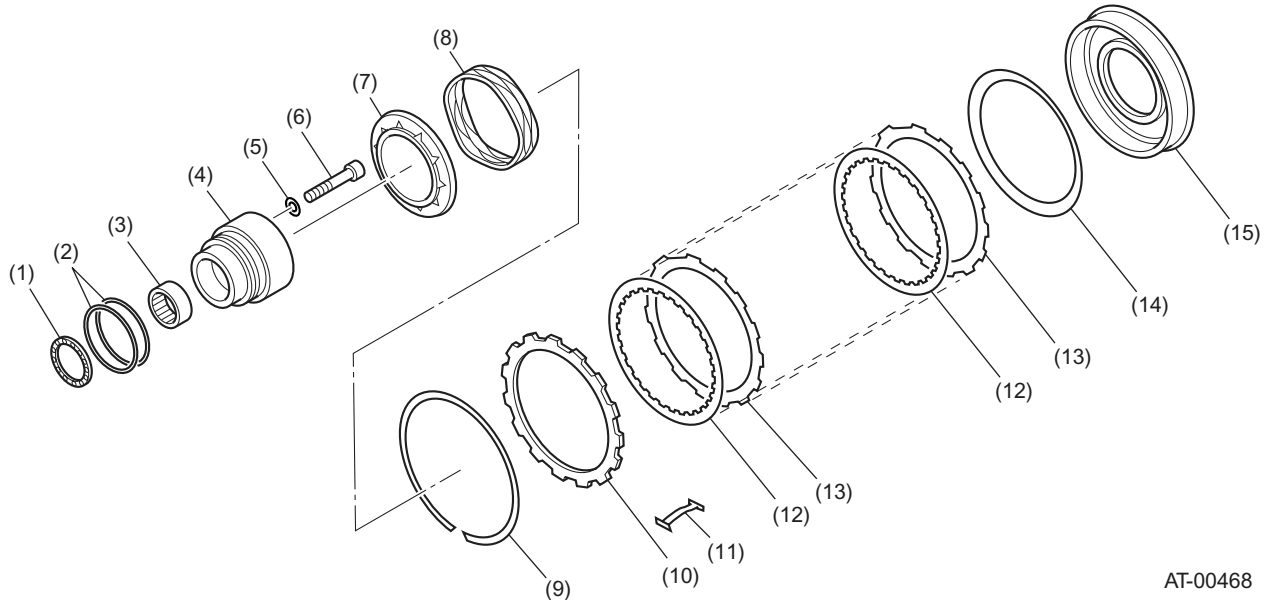
AT-00467

- | | | |
|---------------------|-------------------------|--------------------------------|
| (1) Leaf spring | (6) Pressure rear plate | (10) Lathe cut seal ring |
| (2) Snap ring | (7) Snap ring | (11) Lathe cut seal ring |
| (3) Retaining plate | (8) Return spring | (12) 2-4 brake piston seal |
| (4) Drive plate | (9) 2-4 brake piston | (13) 2-4 brake piston retainer |
| (5) Driven plate | | |

5. Low & Reverse Brake

A: CONSTRUCTION

The low & reverse brake consists of a piston, a dish plate, drive plates, driven plates, a retaining plate and a snap ring that are placed in a housing formed in the transmission case.



AT-00468

- | | | |
|-------------------------------|----------------------|---------------------------------|
| (1) Thrust bearing | (6) Bolt | (11) Leaf spring |
| (2) Seal ring | (7) Spring retainer | (12) Drive plate |
| (3) Needle bearing | (8) Return spring | (13) Driven plate |
| (4) One-way clutch inner race | (9) Snap ring | (14) Dish plate |
| (5) Washer | (10) Retaining plate | (15) Low & reverse brake piston |

B: FUNCTION

When the 1st gear is selected in the 1 range or the reverse is selected, the pressure from the pressure regulator valve is applied to the low & reverse brake piston. The piston then presses the drive and driven plates together and causes the low clutch to lock.

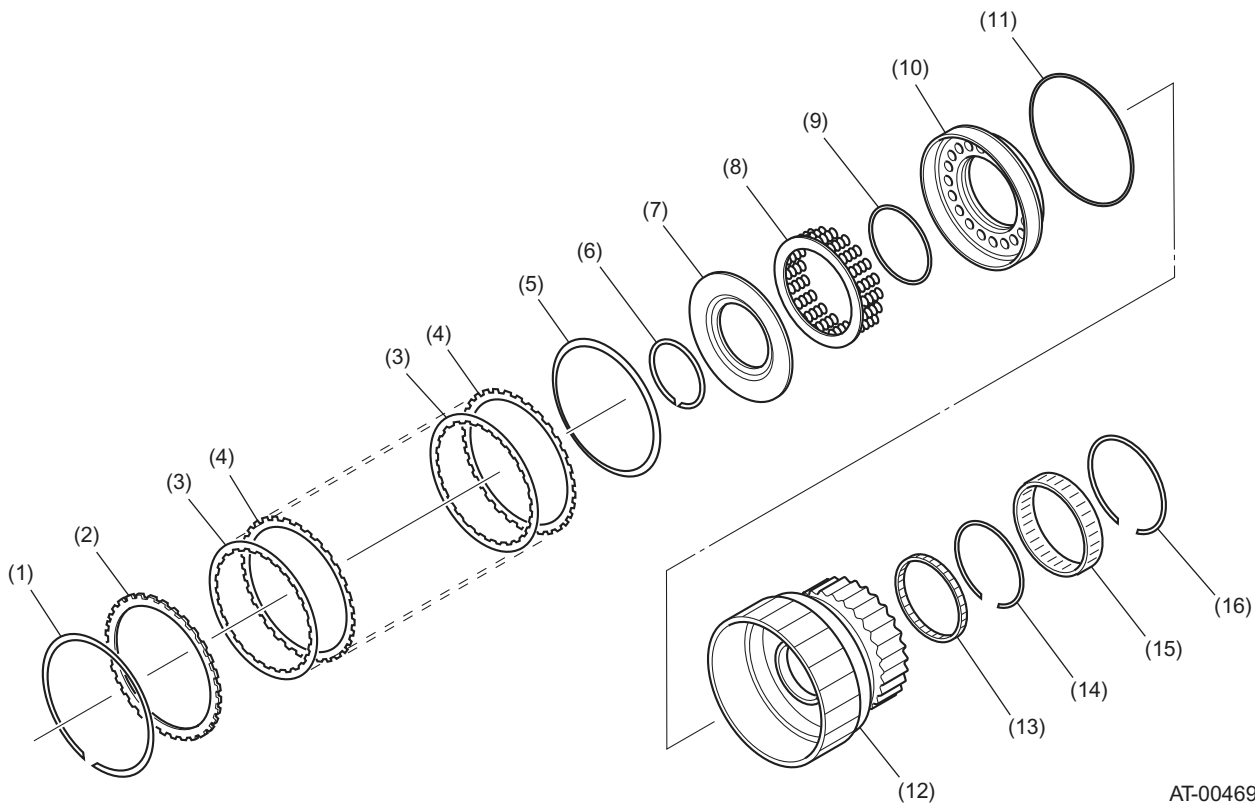
LOW CLUTCH

6. Low Clutch

A: CONSTRUCTION

The low clutch consists of a drum, a piston, return springs, a cover, drive plates, driven plates, a one-way clutch, and other sealing and retaining elements.

The low clutch drum is made of a press-formed metal sheet. The drum's outer race and sleeve are welded together to the drum by an electron beam welding technique.



AT-00469

- | | | |
|---------------------|--------------------------|---------------------|
| (1) Snap ring | (7) Cover | (13) Needle bearing |
| (2) Retaining plate | (8) Return spring | (14) Snap ring |
| (3) Drive plate | (9) Lathe cut seal ring | (15) One-way clutch |
| (4) Driven plate | (10) Low clutch piston | (16) Snap ring |
| (5) Dish plate | (11) Lathe cut seal ring | |
| (6) Snap ring | (12) Low clutch drum | |

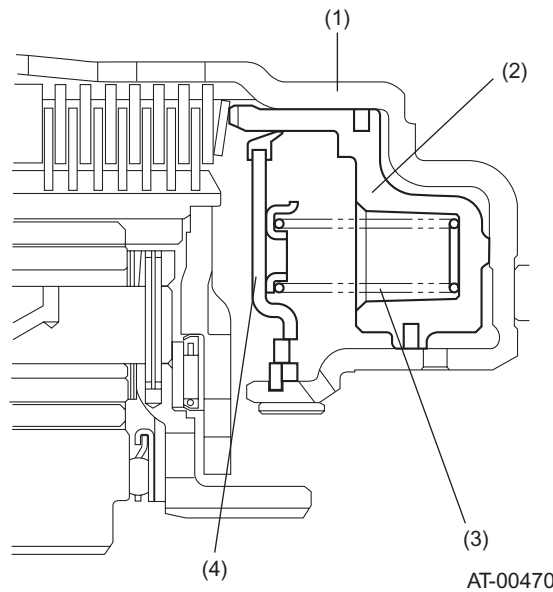
B: FUNCTION

The low clutch operates in the D range (1st, 2nd, and 3rd gears), 3 range (1st, 2nd, and 3rd gears), 2 range (2nd and 3rd gears), and 1 range (1st, 2nd, and 3rd gears).

This clutch engages when the hydraulic pressure from the transmission control valve is applied to its piston, transmitting the power to the reduction drive shaft.

A cover is placed inside the piston, and the space between the piston and the cover is filled with ATF. When the low clutch is not in engagement, the centrifugal force generated in the ATF inside the cover cancels out the centrifugal force generated in the ATF remaining behind the low clutch piston, thus preventing incomplete disengagement of the clutch.

When the low clutch is engaged, the pressure pushing the clutch piston is much larger than the counteracting force of the ATF in the cover, so the clutch remains engaged.



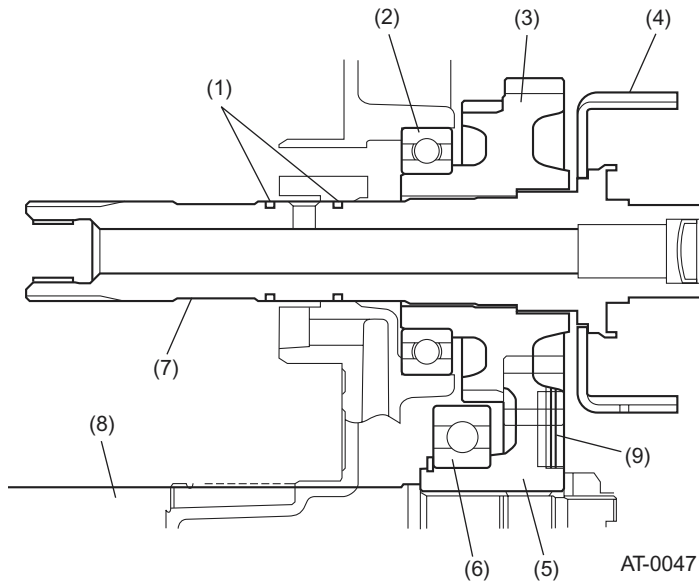
- (1) Low clutch drum
- (2) Low clutch piston

- (3) Return spring
- (4) Cover

REDUCTION GEARS

7. Reduction Gears

Engine torque is transmitted from the rear planetary carrier to the reduction drive shaft and the reduction drive gear. The torque is then transmitted to the front final gears through the reduction driven gear and drive pinion. The torque is also transmitted to the rear wheels from the transfer clutch hub (welded to the side of the reduction drive gear) through the transfer clutch and the following path: rear drive shaft → propeller shaft → rear differential.



- | | | |
|--------------------------|---------------------------|---------------------------|
| (1) Seal ring | (4) Transfer clutch hub | (7) Reduction drive shaft |
| (2) Ball bearing | (5) Reduction driven gear | (8) Drive pinion shaft |
| (3) Reduction drive gear | (6) Ball bearing | (9) Snap ring |

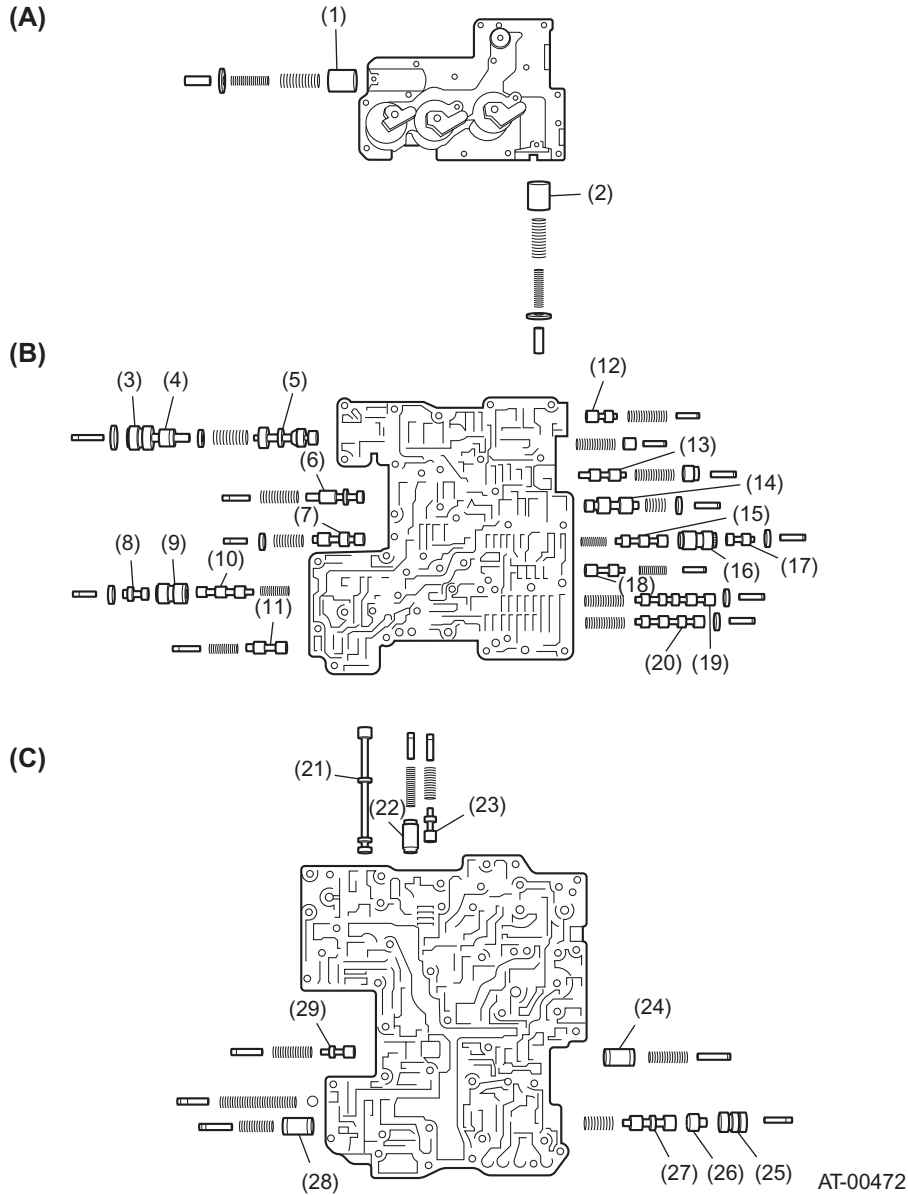
MEMO

HYDRAULIC CONTROL VALVE

8. Hydraulic Control Valve

The hydraulic control system of the automatic transmission consists of an oil pump, valve bodies containing valves, clutches, fluid passages and pipes. The operation of the system is initiated by driver's manual inputs and electric inputs from the TCM.

A: CONSTRUCTION



HYDRAULIC CONTROL VALVE

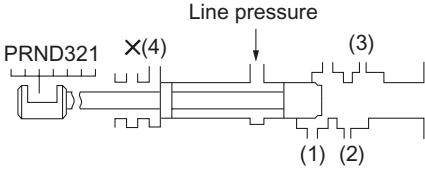
Automatic Transmission

- | | | |
|--------------------------------------|---------------------------------------|------------------------------------|
| (1) High clutch accumulator piston B | (12) Torque converter regulator valve | (23) 1st reducing valve |
| (2) 2-4 brake accumulator piston B | (13) Pressure modifier valve | (24) Throttle accumulator piston A |
| (3) Pressure regulator sleeve | (14) Accumulator control valve A | (25) Lock-up control sleeve |
| (4) Pressure regulator plug | (15) Low clutch timing valve A | (26) Lock-up control plug |
| (5) Pressure regulator valve | (16) Low clutch timing sleeve A | (27) Lock-up control valve |
| (6) Reverse inhibit valve | (17) Low clutch timing plug A | (28) Modifier accumulator piston |
| (7) Accumulator control valve B | (18) Low clutch timing valve B | (29) Pilot valve |
| (8) 2-4 brake timing plug A | (19) Shift valve B | |
| (9) 2-4 brake timing sleeve A | (20) Shift valve A | (A) Upper valve body |
| (10) 2-4 brake timing valve A | (21) Manual valve | (B) Middle valve body |
| (11) 2-4 brake timing valve B | (22) Throttle accumulator piston B | (C) Lower valve body |

HYDRAULIC CONTROL VALVE

Automatic Transmission

B: FUNCTION

Name	Function																																													
Pressure regulator valve	Regulates the pressure of ATF delivered from the oil pump to an optimum level (line pressure) corresponding to vehicle running conditions.																																													
Pressure modifier valve	Adjusts the pressure modifier output pressure depending on the driving condition to keep the line pressure at the optimum level.																																													
Pressure modifier accumulator piston	Cushions the pressure modifier valve output pressure to remove pulsation in line pressure.																																													
Line pressure relief valve	Prevents excessive rise of the line pressure.																																													
Manual valve	<p>Allows the line pressure to the circuit corresponding to the selected range</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Circuit</th> <th>(1)</th> <th>(2)</th> <th>(3)</th> <th>(4)</th> </tr> </thead> <tbody> <tr> <td>Range</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>P</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>R</td> <td></td> <td></td> <td></td> <td>○</td> </tr> <tr> <td>N</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>D</td> <td>○</td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td>○</td> <td></td> <td></td> <td></td> </tr> <tr> <td>2</td> <td>○</td> <td>○</td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>○</td> <td>○</td> <td>○</td> <td></td> </tr> </tbody> </table>  <p style="text-align: right;">AT-00473</p> <p>When the valve is placed in the position allowing the line pressure to go nowhere, the pressure is released.</p>	Circuit	(1)	(2)	(3)	(4)	Range					P					R				○	N					D	○				3	○				2	○	○			1	○	○	○	
Circuit	(1)	(2)	(3)	(4)																																										
Range																																														
P																																														
R				○																																										
N																																														
D	○																																													
3	○																																													
2	○	○																																												
1	○	○	○																																											
Pilot valve	Reduces the line pressure to create a constant pressure (pilot pressure) for use in controlling the line pressure, lock-up pressure, and shifting and transfer clutch/brake pressures.																																													
Torque converter clutch regulator valve	Prevents excessive rise of torque converter clutch pressure.																																													
Lock-up control valve	Engages or disengages the lock-up clutch. Also regulates the lock-up clutch engaging pressure to prevent lock-up shocks.																																													
Shift valve A	Simultaneously changes three different ATF passages using shift solenoid 1 output pressure which varies according to such operating condition factors as vehicle speed and throttle position. In combination with shift valve B, this valve creates 1st, 2nd, 3rd, and 4th speeds.																																													
Shift valve B	Simultaneously changes three different ATF passages using shift solenoid 2 output pressure which varies according to such operating condition factors as vehicle speed and throttle position. In combination with shift valve A, this valve creates 1st, 2nd, 3rd, and 4th speeds.																																													
Low clutch timing valve A	Switches the ATF passages when the 2-4 brake pressure rises to a certain level during 3rd-to-4th upshifting in order to drain the low clutch accumulator back-pressure and to release the low clutch. This ensures smoother shifting.																																													
Low clutch timing valve B	Returns the low clutch timing valve A to the original position after 3rd-to-4th upshifting.																																													
2-4 brake timing valve A	Switches the ATF passages when the high clutch pressure rises to a certain level during 2nd-to-3rd upshifting in order to drain the 2-4 brake accumulator A back-pressure and to release the 2-4 brake. This ensures smoother shifting.																																													
2-4 brake timing valve B	Returns the 2-4 brake timing valve A to the original position after 2nd-to-3rd upshifting.																																													
Reverse inhibit valve	Allows the ATF in the low & reverse brake circuit to drain during forward driving at a speed higher than the predetermined value, preventing shifting into the reverse even when R range is selected.																																													
1st reducing valve	Reduces the low-reverse brake pressure so as to reduce engine braking shock when changing from the 2nd to the 1st in the 2 range.																																													

HYDRAULIC CONTROL VALVE

Automatic Transmission

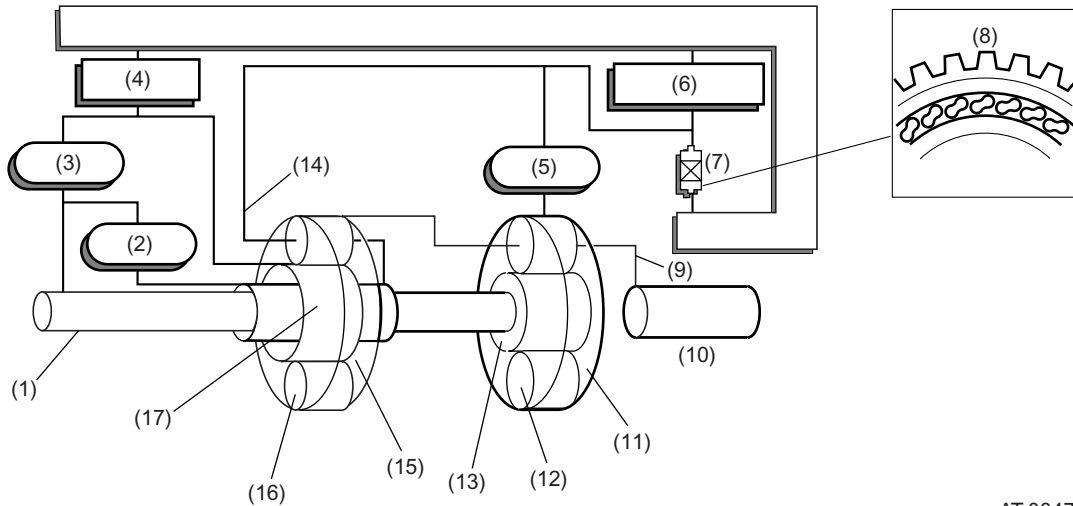
Name	Function
Accumulator control valve A	Regulates the accumulator control A pressure (low clutch accumulator A back-pressure, high clutch accumulator A back-pressure, 2-4 brake timing control signal pressure) depending upon driving conditions.
Accumulator control valve B	Regulates the accumulator control B pressure (2-4 brake accumulator A back-pressure, low clutch timing control signal pressure) depending upon driving conditions.
Low clutch accumulator	Modulates the low clutch pressure gradually to damp shifting shocks when the low clutch is engaged and disengaged.
2-4 brake accumulator A	Modulates the 2-4 brake clutch pressure gradually to damp shifting shocks when the 2-4 brake clutch is engaged and disengaged.
2-4 brake accumulator B	Slows down the 2-4 brake clutch pressure increase rate during 3rd-to-4th upshifting to prevent timing variation which may occur when the low clutch timing valve A is switched (to damp shifting shocks).
High clutch accumulator A	Modulates the high clutch pressure gradually to damp shifting shocks when the high clutch is engaged and disengaged.
High clutch accumulator B	Slows down the high clutch pressure increase rate during 2nd-to-3rd upshifting to prevent timing variation which may occur when the 2-4 brake clutch timing valve A is switched (to damp shifting shocks).
Throttle accumulator A	Cushions the output pressure of the line pressure duty solenoid valve to remove pulsation.
Throttle accumulator B	Cushions the output pressure of the 2-4 brake duty solenoid valve to remove pulsation.

GEAR TRAIN

9. Gear Train

A: CONSTRUCTION

The gear train consists of two sets of planetary gears, three sets of multi-plate clutches, two sets of multi-plate brakes and one set of one-way clutch.



AT-00474

- | | | |
|---|----------------------------|------------------------------|
| (1) Input shaft | (7) One-way clutch | (13) Rear sun gear |
| (2) High clutch (Operates at 3rd and 4th speeds) | (8) Free/Locked | (14) Front planetary carrier |
| (3) Reverse clutch (Operates while moving in reverse) | (9) Rear planetary carrier | (15) Front internal gear |
| (4) 2-4 brake | (10) Reduction drive shaft | (16) Front pinion gear |
| (5) Low clutch | (11) Rear internal gear | (17) Front sun gear |
| (6) Low & reverse brake | (12) Rear pinion gear | |

GEAR TRAIN

Automatic Transmission

B: OPERATION

1. OPERATION TABLE

		Reverse clutch	2-4 brake	High clutch	Low clutch	Low & reverse brake	One-way clutch	
Selector lever operation	(P)							
	(R)	○				○		
	(N)							
	(D)	1ST ↑ ↓				○		○
		2ND ↑ ↓		○		○		
		3RD ↑ ↓			○	○		
		4TH ↑ ↓		○	○			
	(3)	1ST ↑ ↓				○		○
		2ND ↑ ↓		○		○		
		3RD ↑ ↓			○	○		
		4TH ↑		○	○			
	(2)	1ST				○		○
		2ND		○		○		
		3RD ↑			○	○		
		4TH ↑		○	○			
	(1)	1ST				○	○	
		2ND ↑		○		○		
		3RD ↑			○	○		
		4TH ↑		○	○			

AT-00506

GEAR TRAIN

2. N RANGE

Since the rear sun gear and the high clutch drum are in mesh with the input shaft, they rotate together with input shaft.

The high clutch drum does not transmit the torque to the planetary unit since the reverse clutch and the high clutch are not engaged.

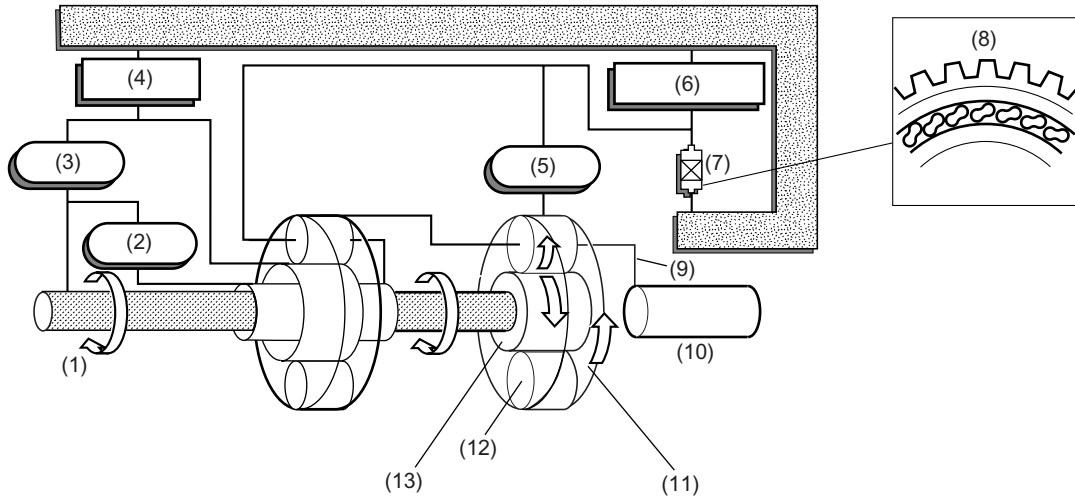
The torque of the rear sun gear is transmitted to the rear internal gear through the pinion gear.

However, the torque of the rear sun gear is not transmitted to the rear planetary carrier since the low clutch is disengaged and, therefore, the rear internal gear is freewheeling.

As a result, the torque of the input shaft is not transmitted to the reduction drive shaft.

Operating condition of components	Power flow (in acceleration)
All clutches and brakes : Disengaged	<pre>graph TD; A[Input shaft] --> B[Rear sun gear]; B --> C[Rear pinion gear]; C --> D[Rear internal gear]; D --> E[Low clutch (free)];</pre> <p style="text-align: right;">AT-00476</p>

GEAR TRAIN



- (14) : (14)
- (15) : (15)
- (16) : (16)
- (17) : (17)

AT-00477

- | | | |
|-------------------------|----------------------------|--|
| (1) Input shaft | (7) One-way clutch | (13) Rear sun gear |
| (2) High clutch | (8) No effect | (14) Input |
| (3) Reverse clutch | (9) Rear planetary carrier | (15) Output |
| (4) 2-4 brake | (10) Reduction drive shaft | (16) Locked |
| (5) Low clutch | (11) Rear internal gear | (17) Planetary gear component involved in power transmission |
| (6) Low & reverse brake | (12) Rear pinion gear | |

GEAR TRAIN

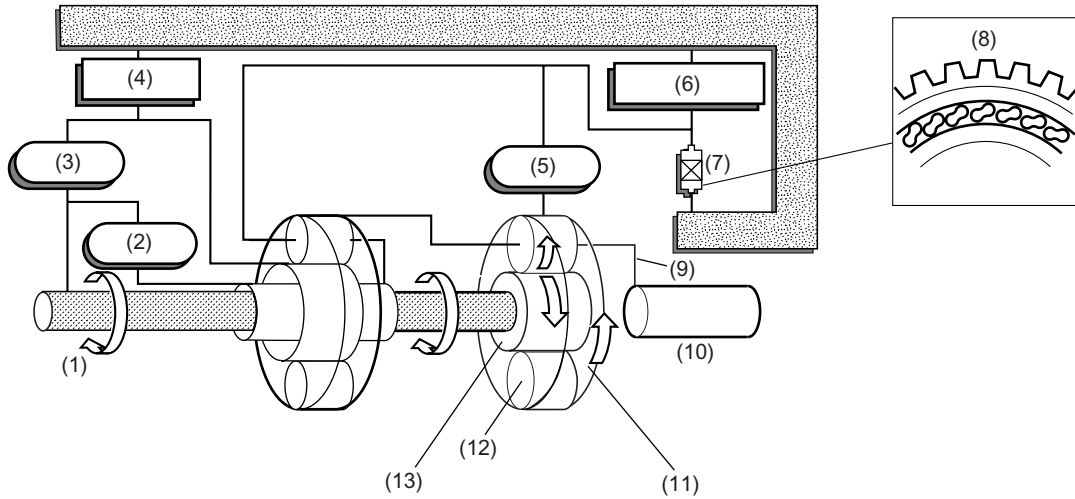
Automatic Transmission

3. P RANGE

All the clutches and brakes are free, just as in the N range. The parking pawl engages with the parking gear which forms an integral part of the reduction drive gear, preventing the gear from rotating.

Operating condition of components	Power flow (in acceleration)
All clutches and brakes : Disengaged	<pre>graph TD; A[Input shaft] --> B[Rear sun gear]; B --> C[Rear pinion gear]; C --> D[Rear internal gear]; D --> E[Low clutch (free)];</pre> <p style="text-align: right;">AT-00476</p>

GEAR TRAIN



- (14) : (14)
- (15) : (15)
- (16) : (16)
- (17) : (17)

AT-00477

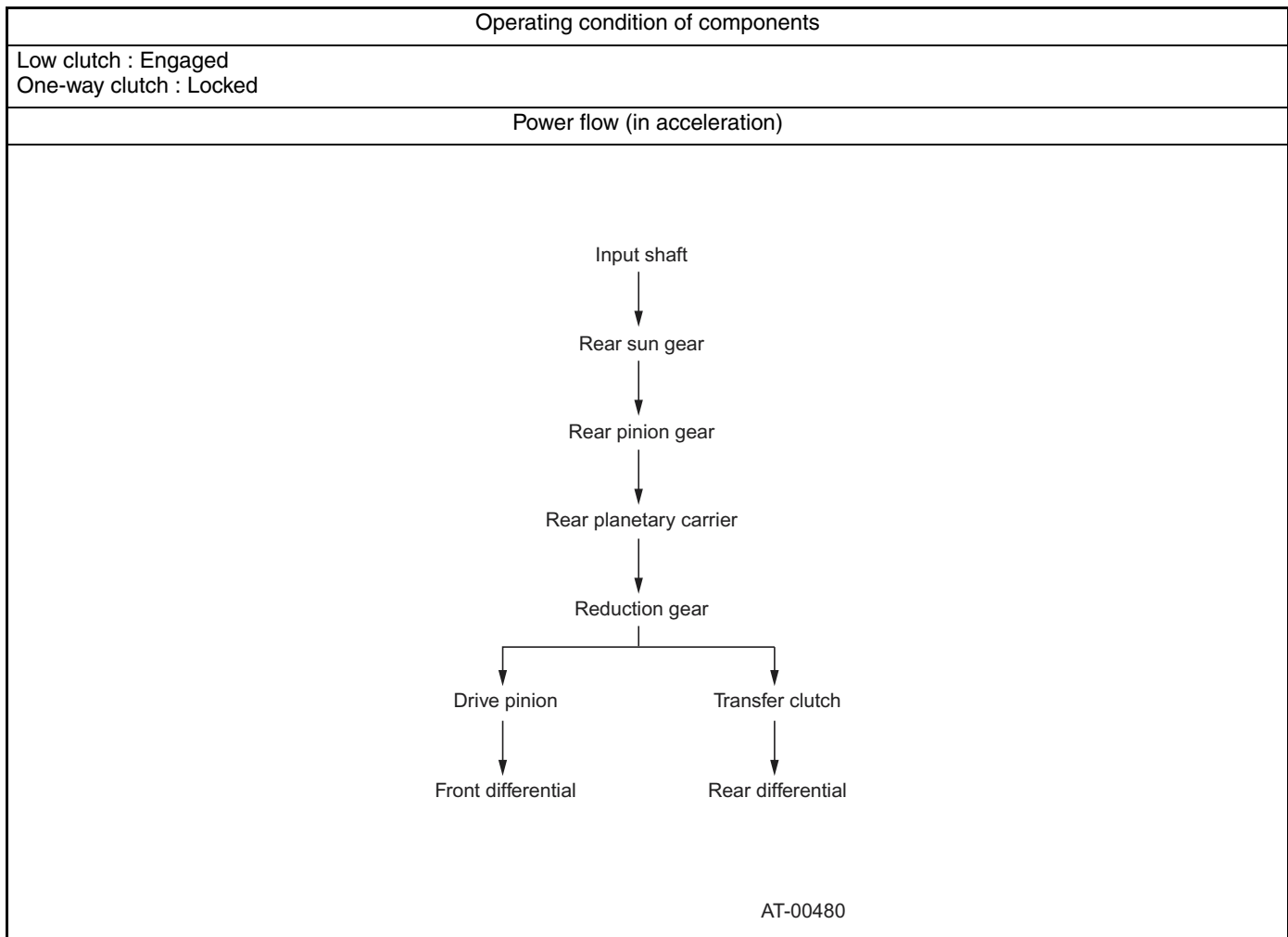
- | | | |
|-------------------------|----------------------------|--|
| (1) Input shaft | (7) One-way clutch | (13) Rear sun gear |
| (2) High clutch | (8) No effect | (14) Input |
| (3) Reverse clutch | (9) Rear planetary carrier | (15) Output |
| (4) 2-4 brake | (10) Reduction drive shaft | (16) Locked |
| (5) Low clutch | (11) Rear internal gear | (17) Planetary gear component involved in power transmission |
| (6) Low & reverse brake | (12) Rear pinion gear | |

GEAR TRAIN

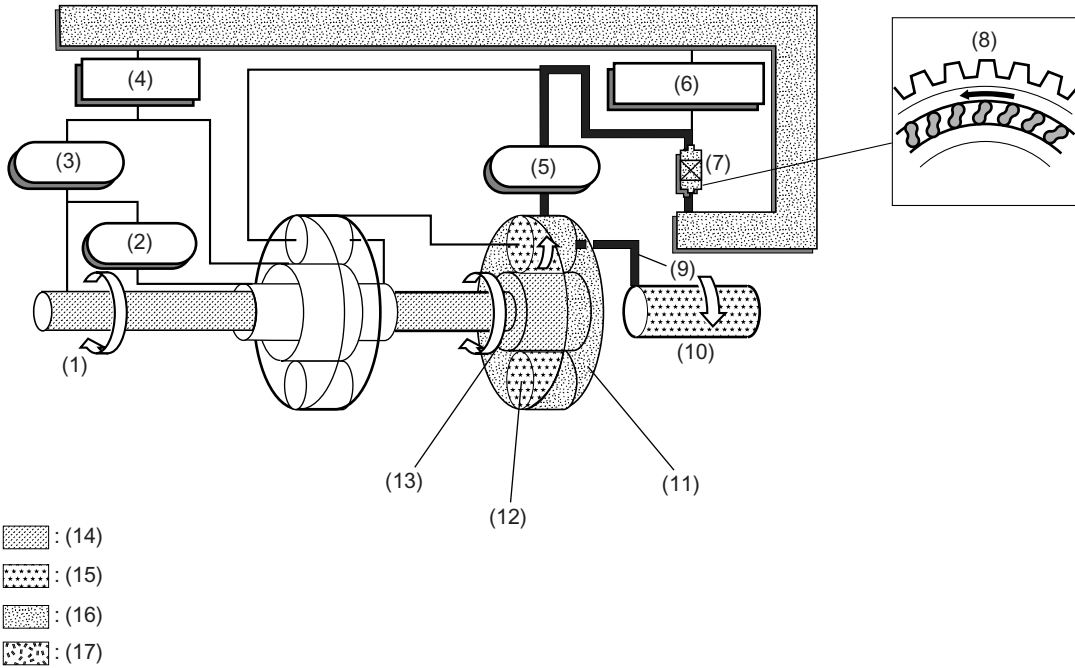
4. 1ST GEAR OF D, 3, OR 2 RANGES ($D_1, 3_1, 2_1$)

When the 1st gear is selected in the D, 3, or 2 range, only the low clutch is engaged. In this state, the rear internal gear attempts to rotate counterclockwise but it is impossible by the action of the one-way clutch which locks the internal gear to the transmission case. As a result, rotation of the rear sun gear causes the pinion gears to rotate around the sun gear. This causes the planetary carrier to rotate. In this way, rotation of the input shaft is transmitted to the reduction drive shaft after being subjected to speed reduction by the planetary gear train.

On the other hand, the rear internal gear rotates clockwise if the reverse driving force is applied to it by the reduction drive shaft during coasting. This clockwise rotation of the internal gear causes the one-way clutch to freewheel. Since the power path between the reduction drive shaft and the input shaft is lost as a result, no engine braking effect is available.



GEAR TRAIN



AT-00481

- | | | |
|-------------------------|----------------------------|---|
| (1) Input shaft | (7) One-way clutch | (13) Rear sun gear |
| (2) High clutch | (8) Locked | (14) Input |
| (3) Reverse clutch | (9) Rear planetary carrier | (15) Output |
| (4) 2-4 brake | (10) Reduction drive shaft | (16) Locked |
| (5) Low clutch | (11) Rear internal gear | (17) Planetary gear component
involved in power transmission |
| (6) Low & reverse brake | (12) Rear pinion gear | |

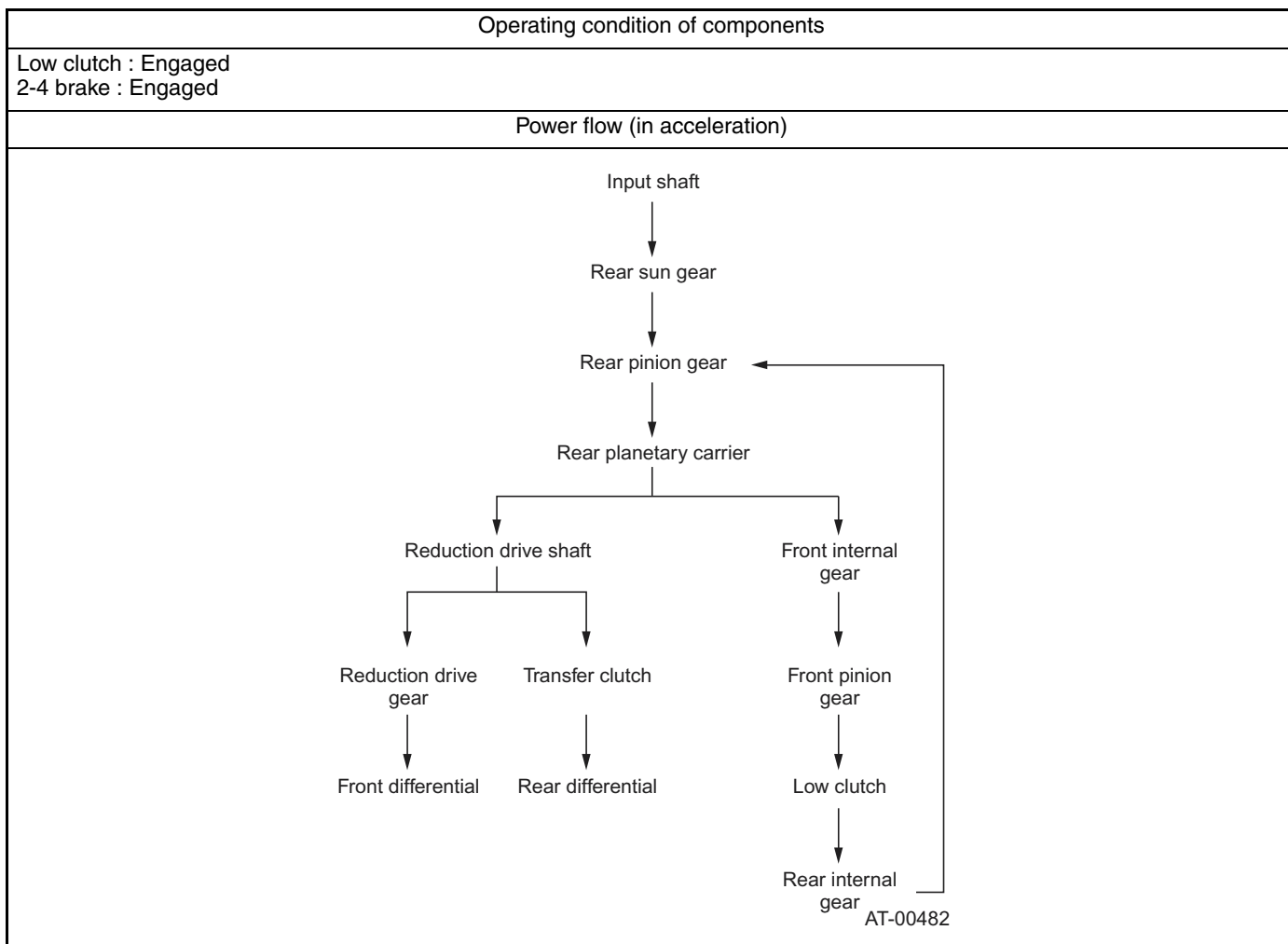
GEAR TRAIN

5. 2ND GEAR OF D, 3 OR 2 RANGE ($D_2, 3_2, 2_2$)

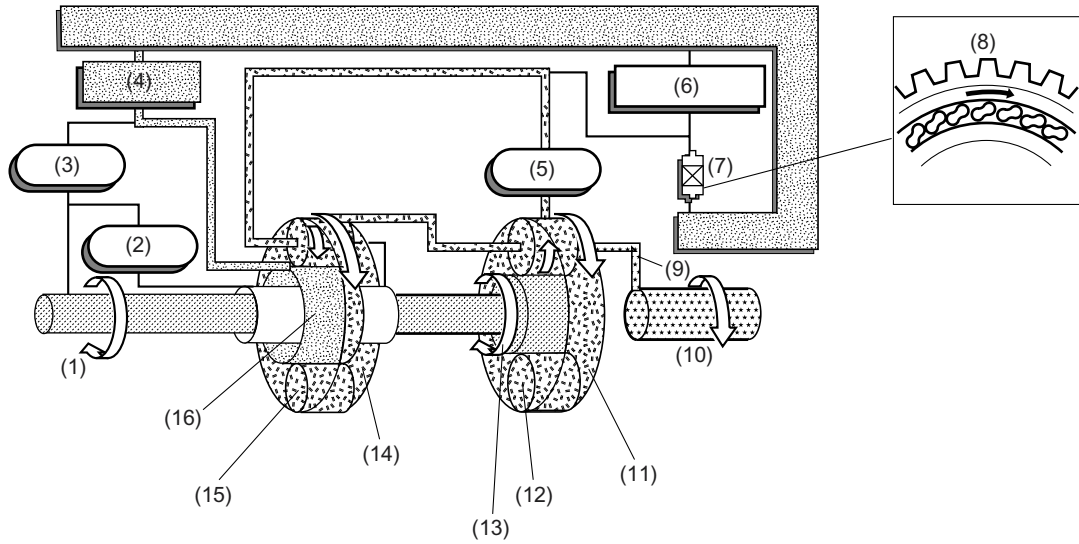
When the 2nd gear is selected in the D, 3 or 2 range, the 2-4 brake and the low clutch are engaged. The front sun gear is now locked to the transmission case due to engagement of the 2-4 brake. In this state, the torque of the rear sun gear is transmitted to the rear internal gear through the path of the front internal gear, front pinion gears, low clutch drum and low clutch. At this time, the one-way clutch is freewheeling since the low clutch drum is rotating clockwise.





In this power flow configuration, the rear pinion gears are rotated by the rear internal gear at a speed faster than that available from the configuration for the 1st gear, so the rotation speed of the reduction drive shaft is higher than that of the 1st gear.

Since the drive power is transmitted without passing through the one-way clutch in the 2nd gear, the backward driving force from the wheels is transmitted through the reduction drive shaft to the input shaft; this makes the engine braking effect available.



GEAR TRAIN



-  : (17)
-  : (18)
-  : (19)
-  : (20)

AT-00483

- | | | |
|--------------------------|----------------------------|--|
| (1) Input shaft | (8) Free | (15) Front pinion gear |
| (2) High clutch | (9) Rear planetary carrier | (16) Front sun gear |
| (3) Reverse clutch | (10) Reduction drive shaft | (17) Input |
| (4) 2-4 brake | (11) Rear internal gear | (18) Output |
| (5) Low clutch | (12) Rear pinion gear | (19) Locked |
| (6) Low & reverse clutch | (13) Rear sun gear | (20) Planetary gear component involved in power transmission |
| (7) One-way clutch | (14) Front internal gear | |

GEAR TRAIN

6. 3RD GEAR OF D OR 3 RANGE (D_3 , 3_3)

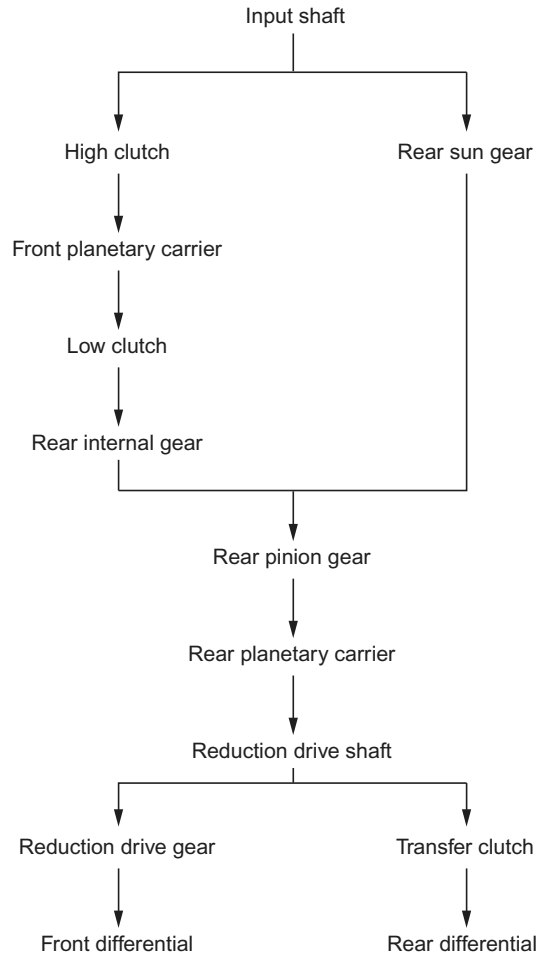
When the 3rd gear is selected in the D or 3 range, the low clutch and the high clutch are engaged. The engaged high clutch rotates through its drum the front planetary carrier, and rotation of the carrier is transmitted to the rear internal gear through the engaged low clutch. In this power flow configuration, the rear sun gear and the rear internal gear rotate at the same speed since the rear pinion gears are solid on their axes and the whole planetary gear train rotates as a unit at the same speed as its sun gear. As a result, the input shaft and the reduction drive shaft rotate at the same speed. In the 3rd gear, the one-way clutch is freewheeling because the low clutch is rotating clockwise. Since the drive power is transmitted without passing through the one-way clutch, the backward driving force from the wheels is transmitted through the reduction drive shaft to the input shaft; this makes the engine braking effect available.

GEAR TRAIN

Operating condition of components

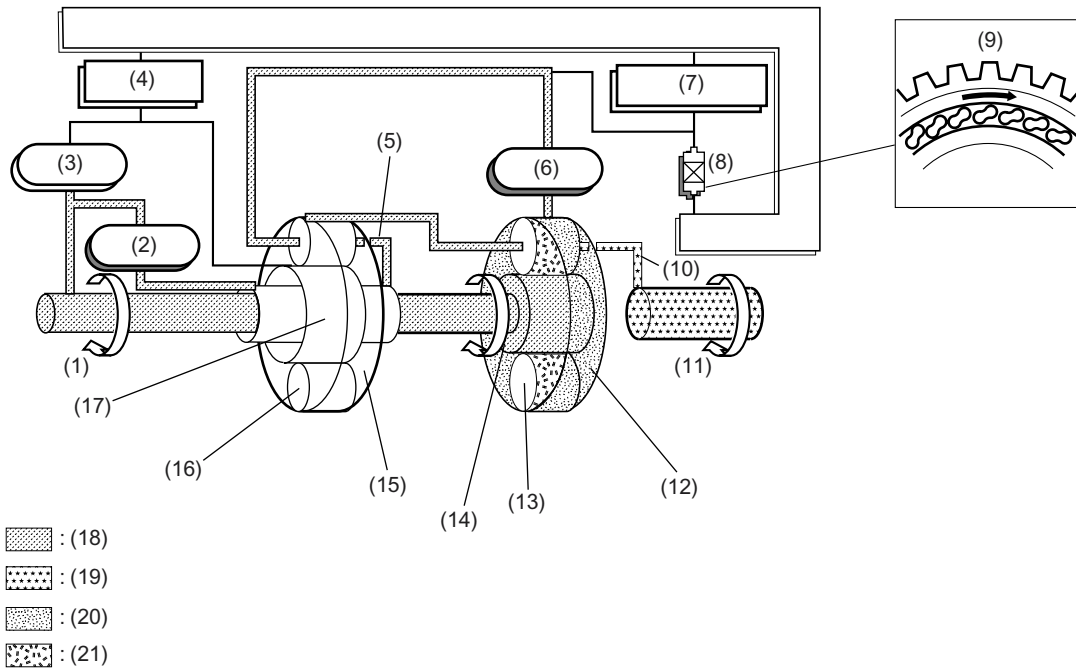
High clutch : Engaged
Low clutch : Engaged

Power flow (in acceleration)



AT-00484

GEAR TRAIN



AT-00485

- | | | |
|-----------------------------|-----------------------------|--|
| (1) Input shaft | (8) One-way clutch | (15) Front internal gear |
| (2) High clutch | (9) Free | (16) Front pinion gear |
| (3) Reverse clutch | (10) Rear planetary carrier | (17) Front sun gear |
| (4) 2-4 brake | (11) Reduction drive shaft | (18) Input |
| (5) Front planetary carrier | (12) Rear internal gear | (19) Output |
| (6) Low clutch | (13) Rear pinion gear | (20) Locked |
| (7) Low & reverse brake | (14) Rear sun gear | (21) Planetary gear component involved in power transmission |

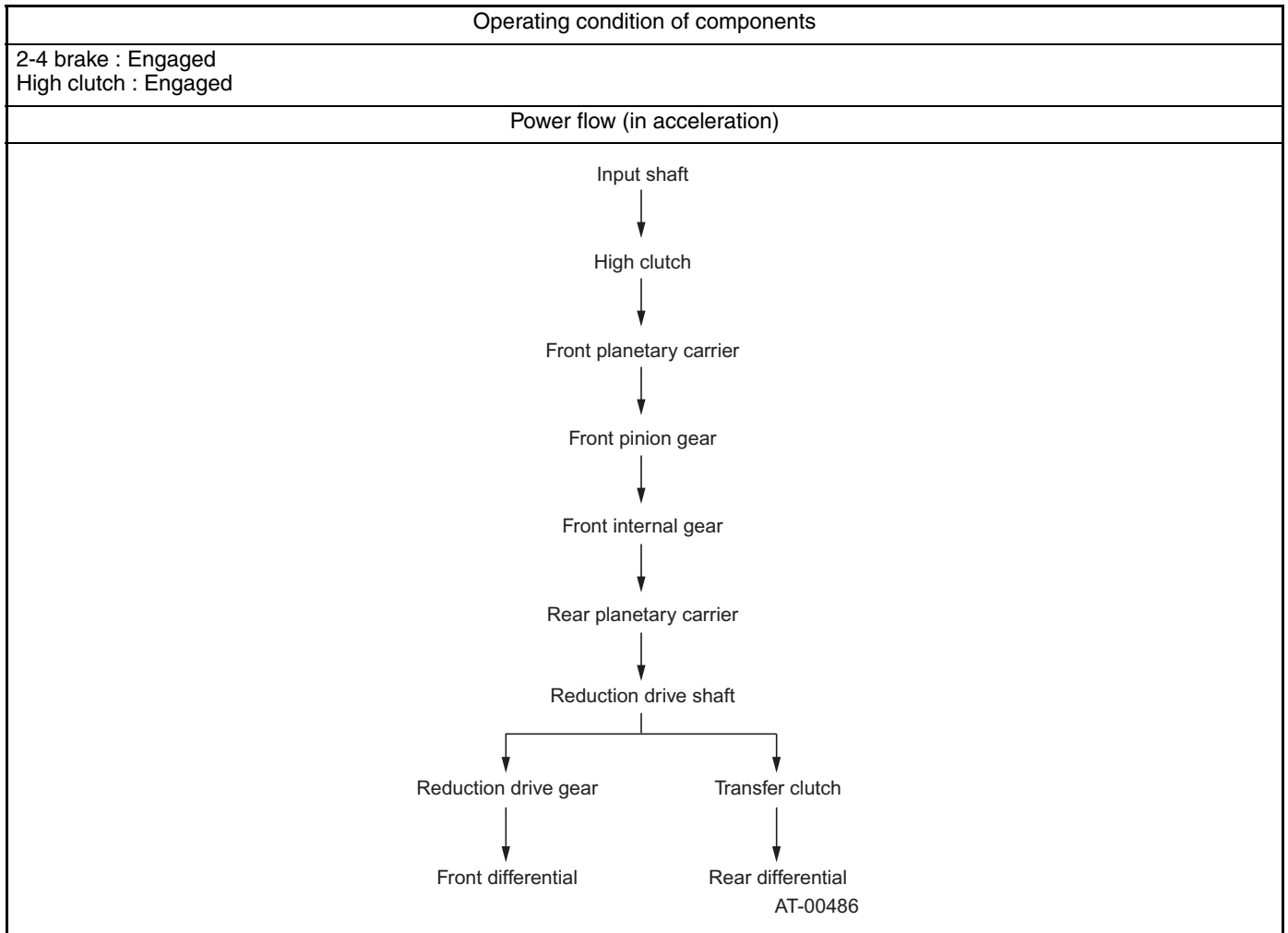
7. 4TH GEAR OF D RANGE (D₄)

When the 4th gear is selected in the D range, the high clutch and the 2-4 brake are engaged. The engaged high clutch causes the front planetary carrier to rotate, whereas the engaged 2-4 brake causes the front sun gear to be locked to the transmission case.

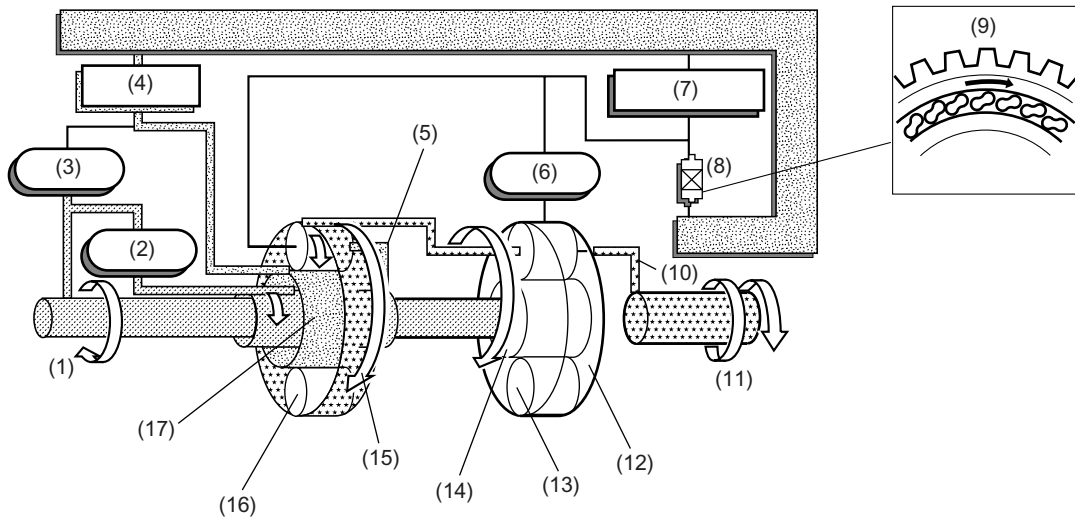
The front planetary carrier rotates at the same speed as the input shaft. The rotation of the front planetary carrier causes the front pinion gears to revolve around the stationary front sun gear, which causes the front internal gear to rotate faster than the input shaft.





As a result, the reduction drive shaft is driven at a higher speed than the input shaft.

In the 4th gear, the one-way clutch is freewheeling because the low clutch is rotating clockwise. Since the drive power is transmitted without passing through the one-way clutch, the backward driving force from the wheels is transmitted through the reduction drive shaft to the input shaft; this makes the engine braking effect available.



GEAR TRAIN



-  : (18)
-  : (19)
-  : (20)
-  : (21)

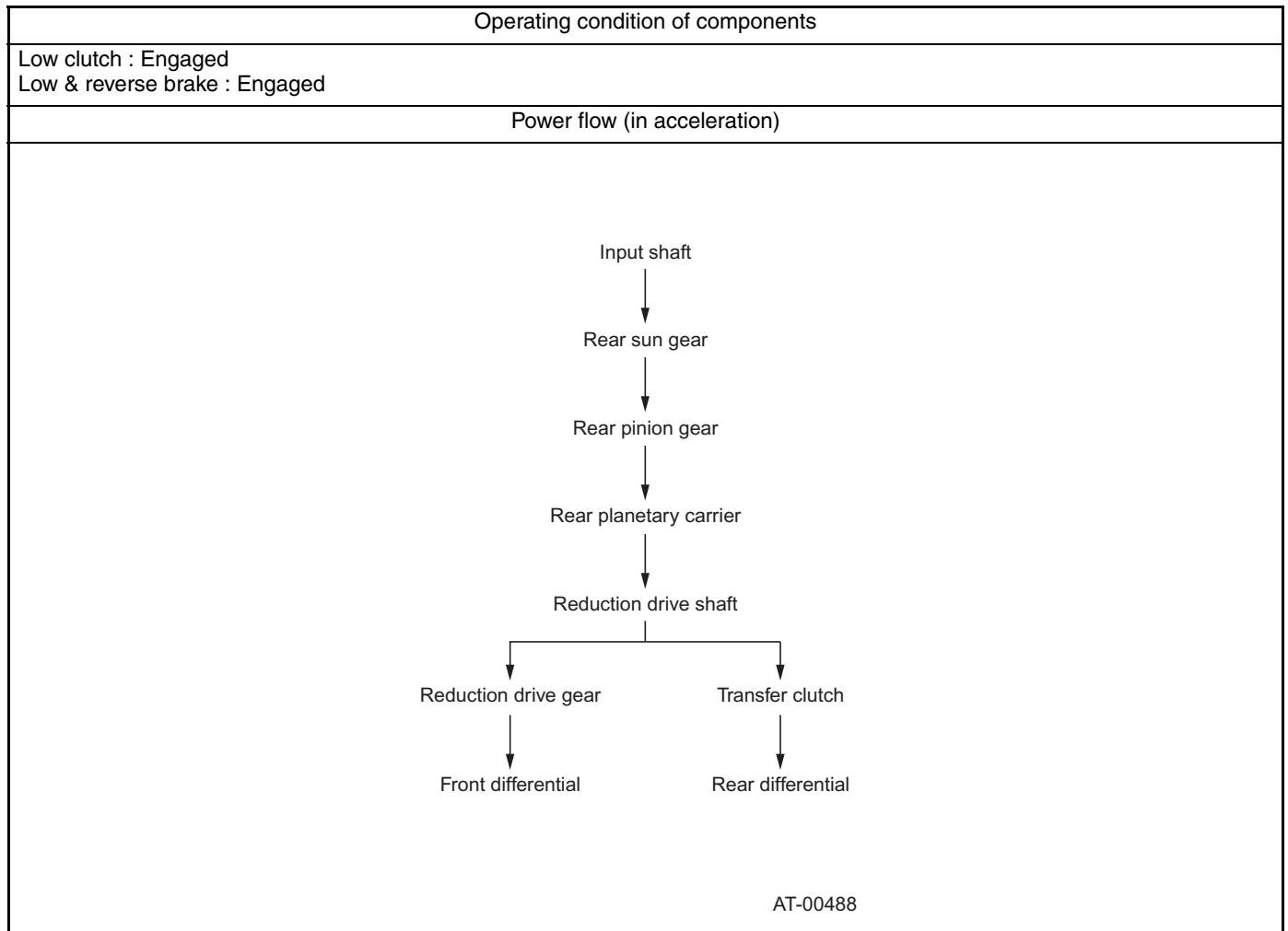
AT-00487

- | | | |
|-----------------------------|-----------------------------|--|
| (1) Input shaft | (8) One-way clutch | (15) Front internal gear |
| (2) High clutch | (9) Free | (16) Front pinion gear |
| (3) Reverse clutch | (10) Rear planetary carrier | (17) Front sun gear |
| (4) 2-4 brake | (11) Reduction drive shaft | (18) Input |
| (5) Front planetary carrier | (12) Rear internal gear | (19) Output |
| (6) Low clutch | (13) Rear pinion gear | (20) Locked |
| (7) Low & reverse brake | (14) Rear sun gear | (21) Planetary gear components
involved in power transmission |

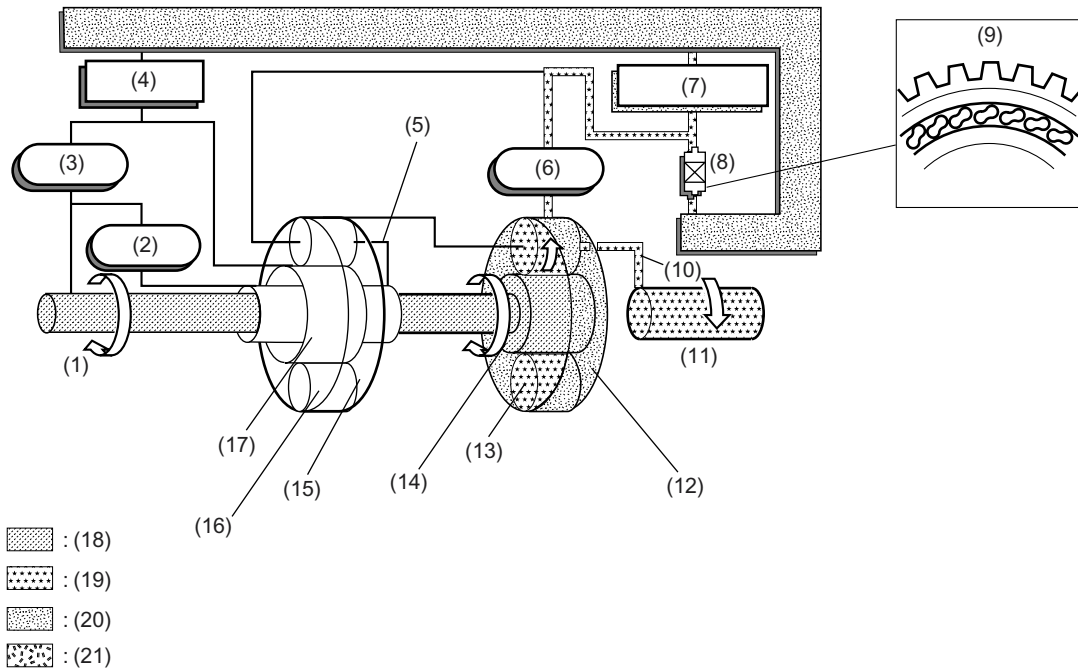
8. 1ST GEAR OF 1 RANGE (1₁)

When the 1st gear is selected in the 1 range, both the low clutch and the low & reverse brake are engaged. Although the power flow configuration is the same as that with the 1st gear in the D or 3 range, the one-way clutch produces no freewheeling effect because the low & reverse brake is locking the rear internal gear always to the transmission case.

During coasting, therefore, the backward driving force from the wheels is transmitted through the reduction drive gear to the input shaft. This means, unlike the 1st gear in D or 3 range, that the engine braking effect is available in this range.



GEAR TRAIN



AT-00489

- | | | |
|-----------------------------|-----------------------------|--|
| (1) Input shaft | (8) One-way clutch | (15) Front internal gear |
| (2) High clutch | (9) No effect | (16) Front pinion gear |
| (3) Reverse clutch | (10) Rear planetary carrier | (17) Front sun gear |
| (4) 2-4 brake | (11) Reduction drive shaft | (18) Input |
| (5) Front planetary carrier | (12) Rear internal gear | (19) Output |
| (6) Low clutch | (13) Rear pinion gear | (20) Locked |
| (7) Low & reverse brake | (14) Rear sun gear | (21) Planetary gear component involved in power transmission |

9. R RANGE

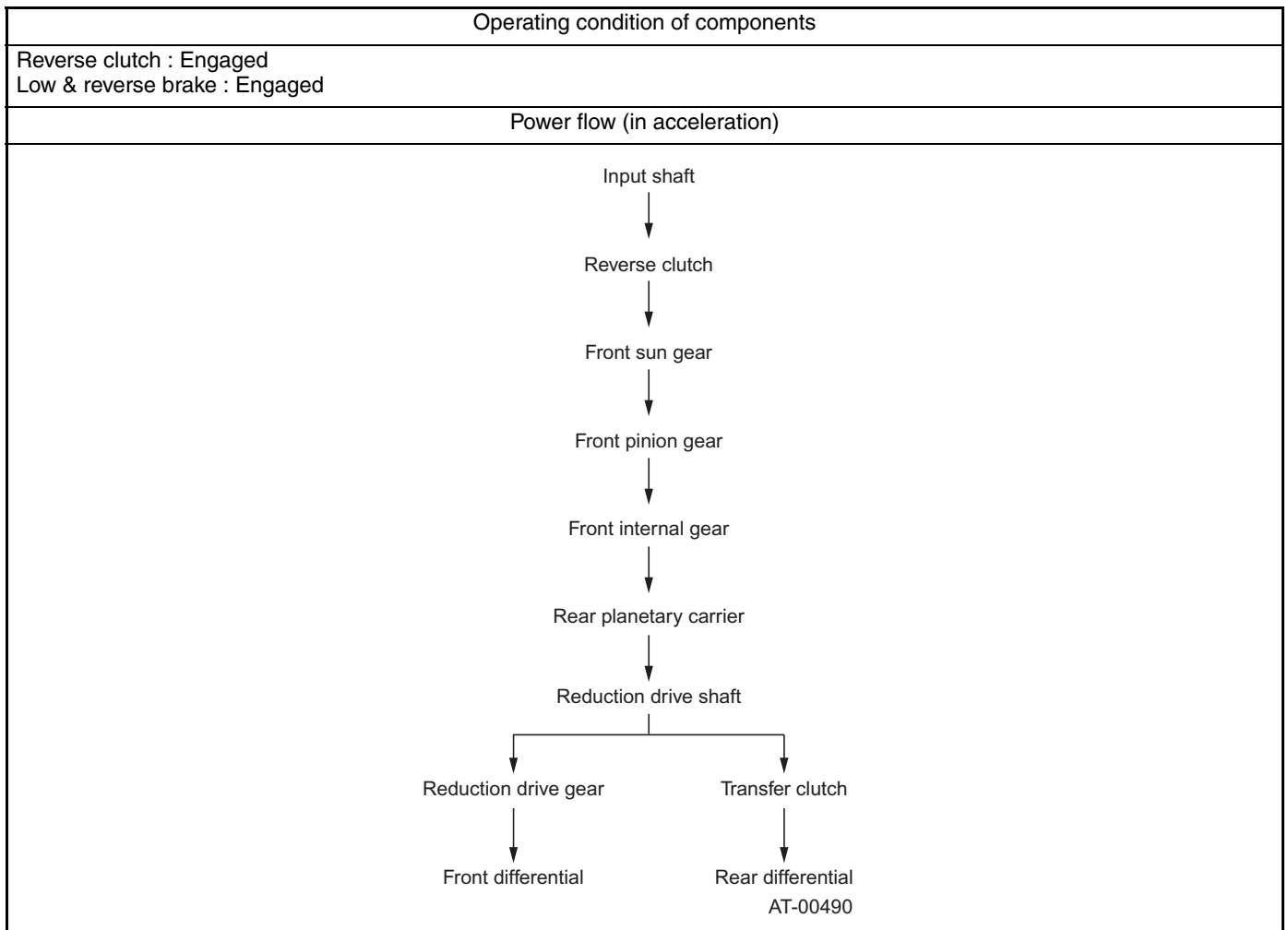
When the selector lever is placed in the R position, the reverse clutch and the low & reverse brake are engaged. The reverse clutch allows the input shaft torque to be transmitted to the front sun gear, while the low & reverse brake allows the low clutch drum to be interlocked with the transmission case.

Rotation of the front sun gear causes the front pinion gears to rotate in the reverse driving direction and, therefore, the front internal gear rotates in the same direction.

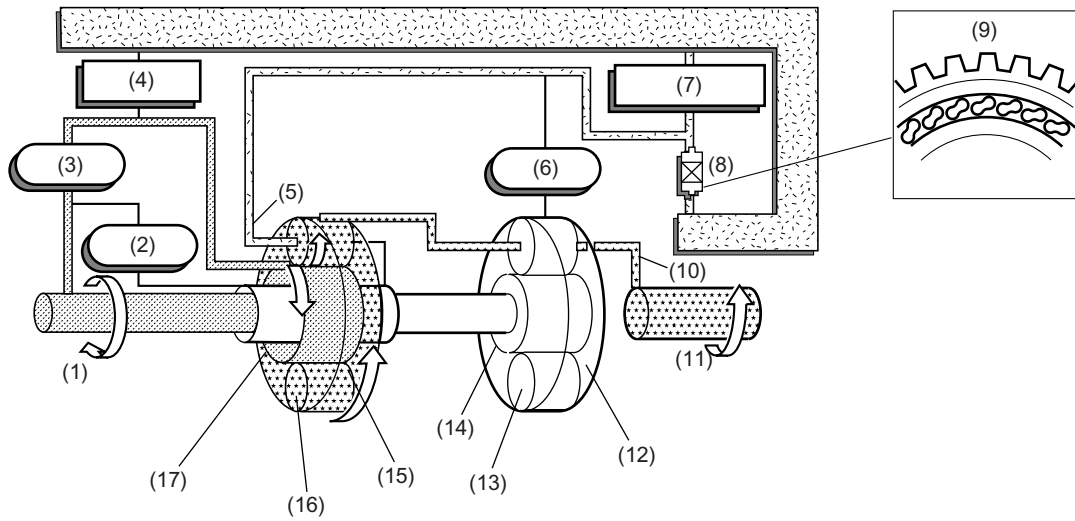
At this time, the rotation speed transmitted to the front internal gear is reduced through gearing between the front sun gear and the front pinion gears.





The one-way clutch produces no freewheeling effect because the low & reverse brake is in engagement.

In this range, since the power transmission is made without passing through the one-way clutch, the driving force from the wheels is transmitted through the reduction drive shaft to the input shaft; this makes the engine braking effect available.



GEAR TRAIN



-  : (18)
-  : (19)
-  : (20)
-  : (21)

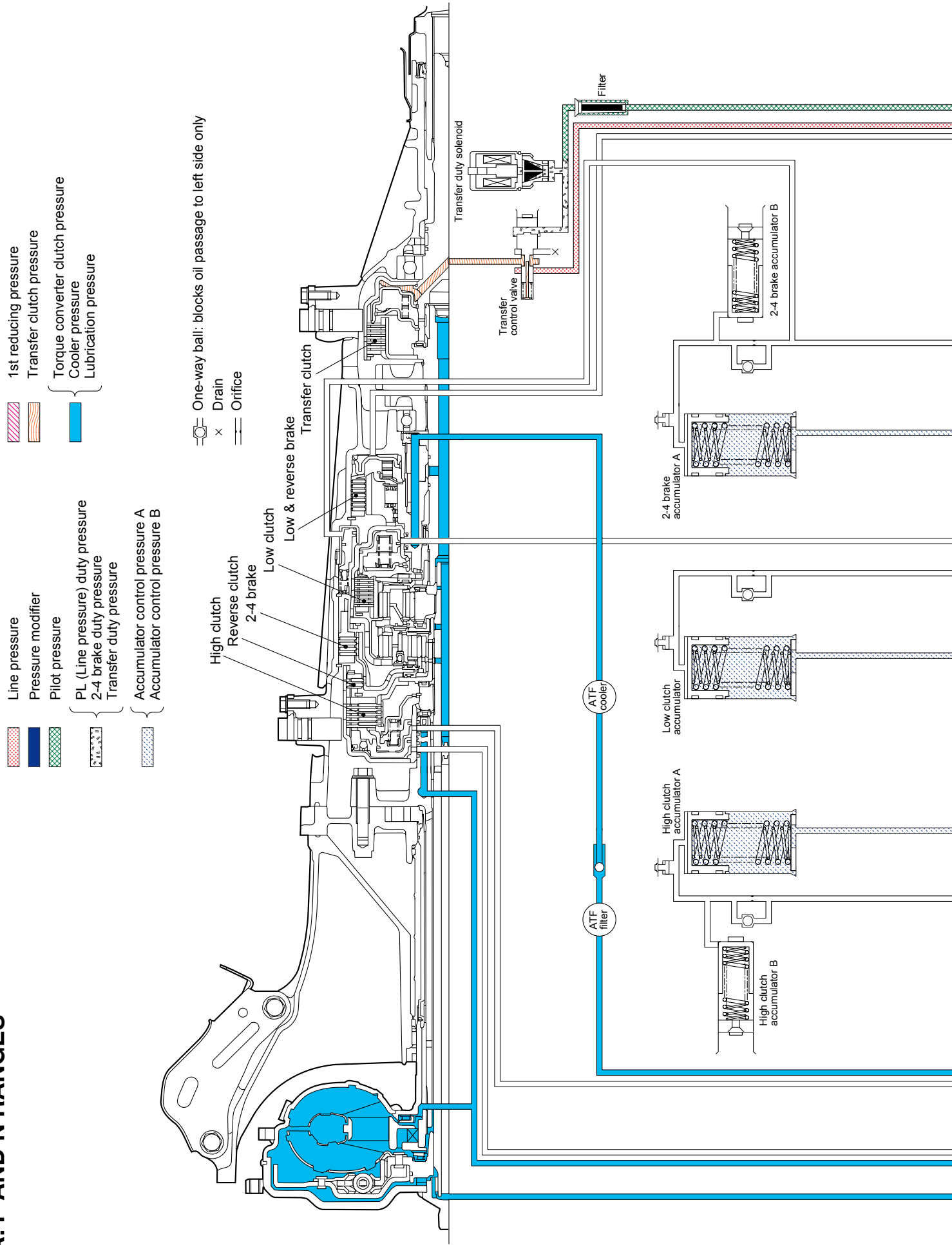
AT-00491

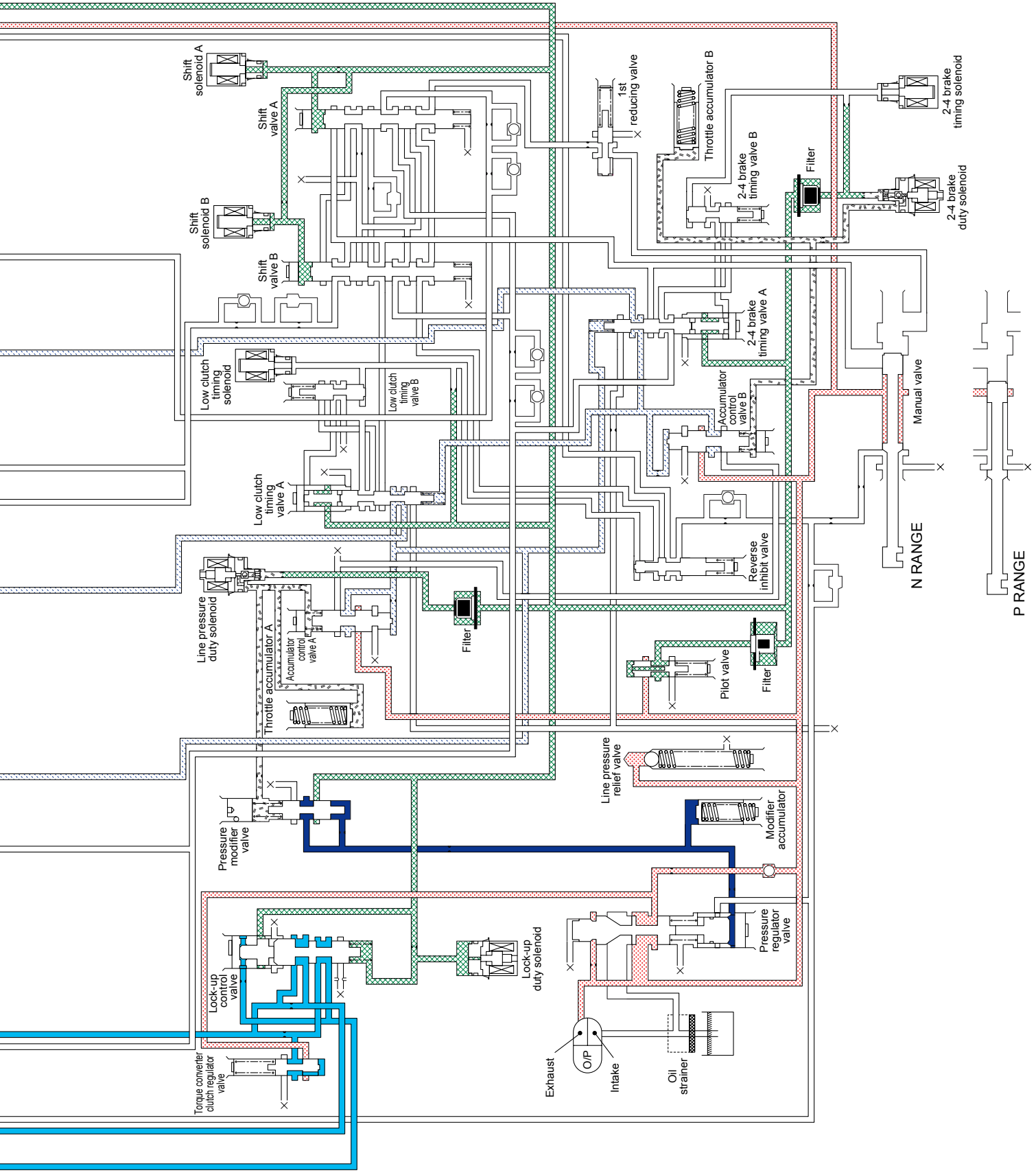
- | | | |
|-----------------------------|-----------------------------|--|
| (1) Input shaft | (8) One-way clutch | (15) Front internal gear |
| (2) High clutch | (9) No effect | (16) Front pinion gear |
| (3) Reverse clutch | (10) Rear planetary carrier | (17) Front sun gear |
| (4) 2-4 brake | (11) Reduction drive shaft | (18) Input |
| (5) Front planetary carrier | (12) Rear internal gear | (19) Output |
| (6) Low clutch | (13) Rear pinion gear | (20) Locked |
| (7) Low & reverse brake | (14) Rear sun gear | (21) Planetary gear component involved in power transmission |

MEMO

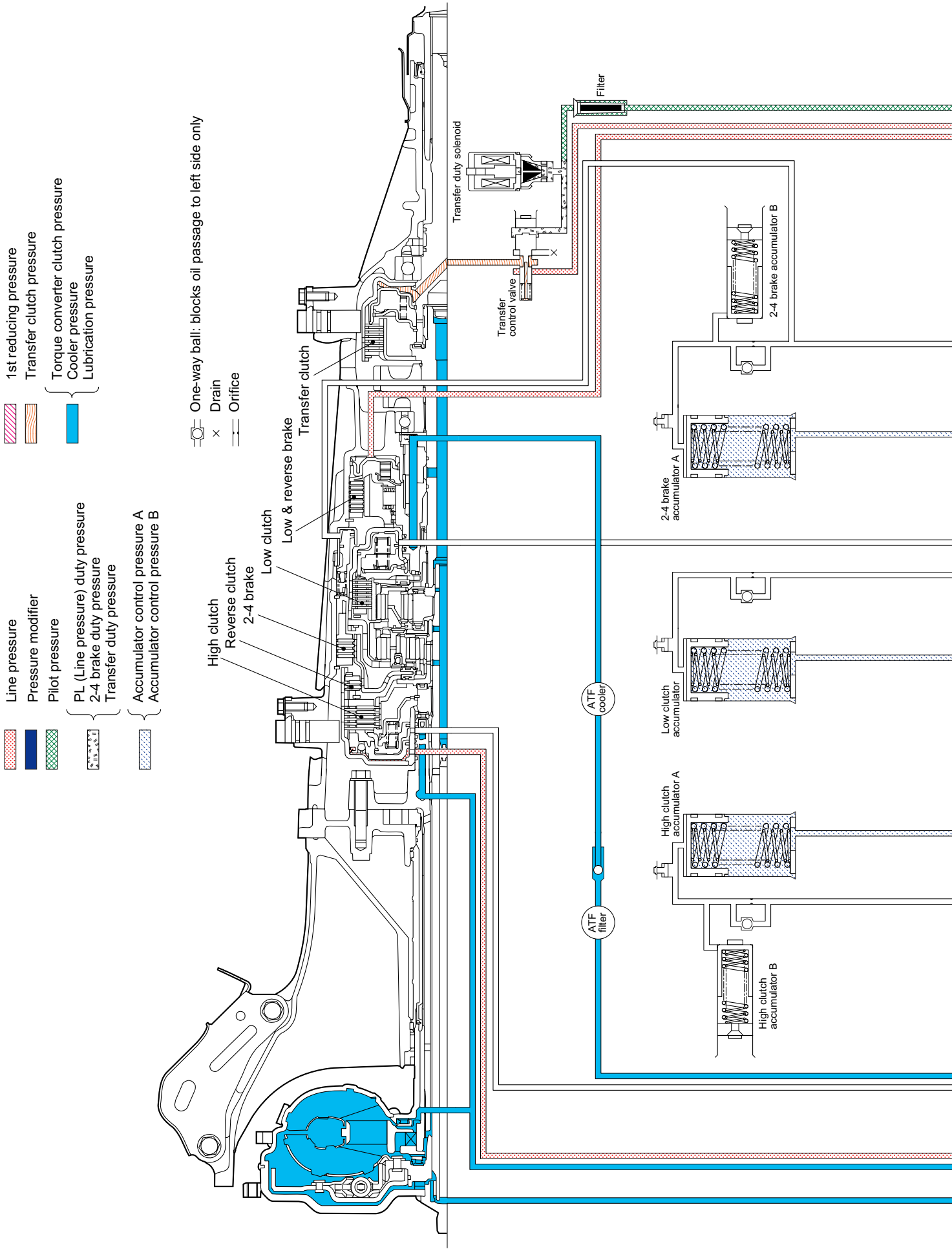
10. Schematic Drawing

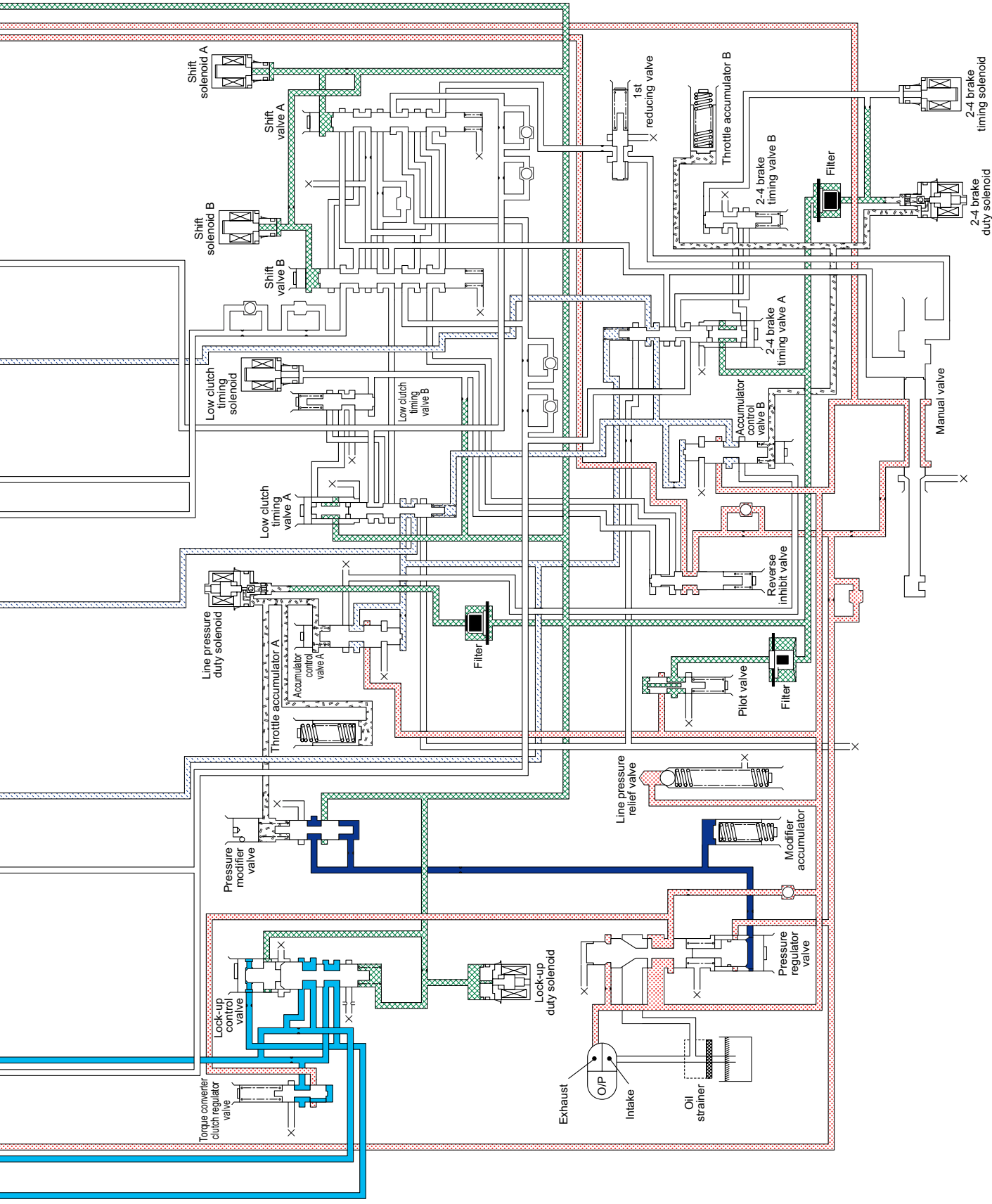
A: P AND N RANGES


















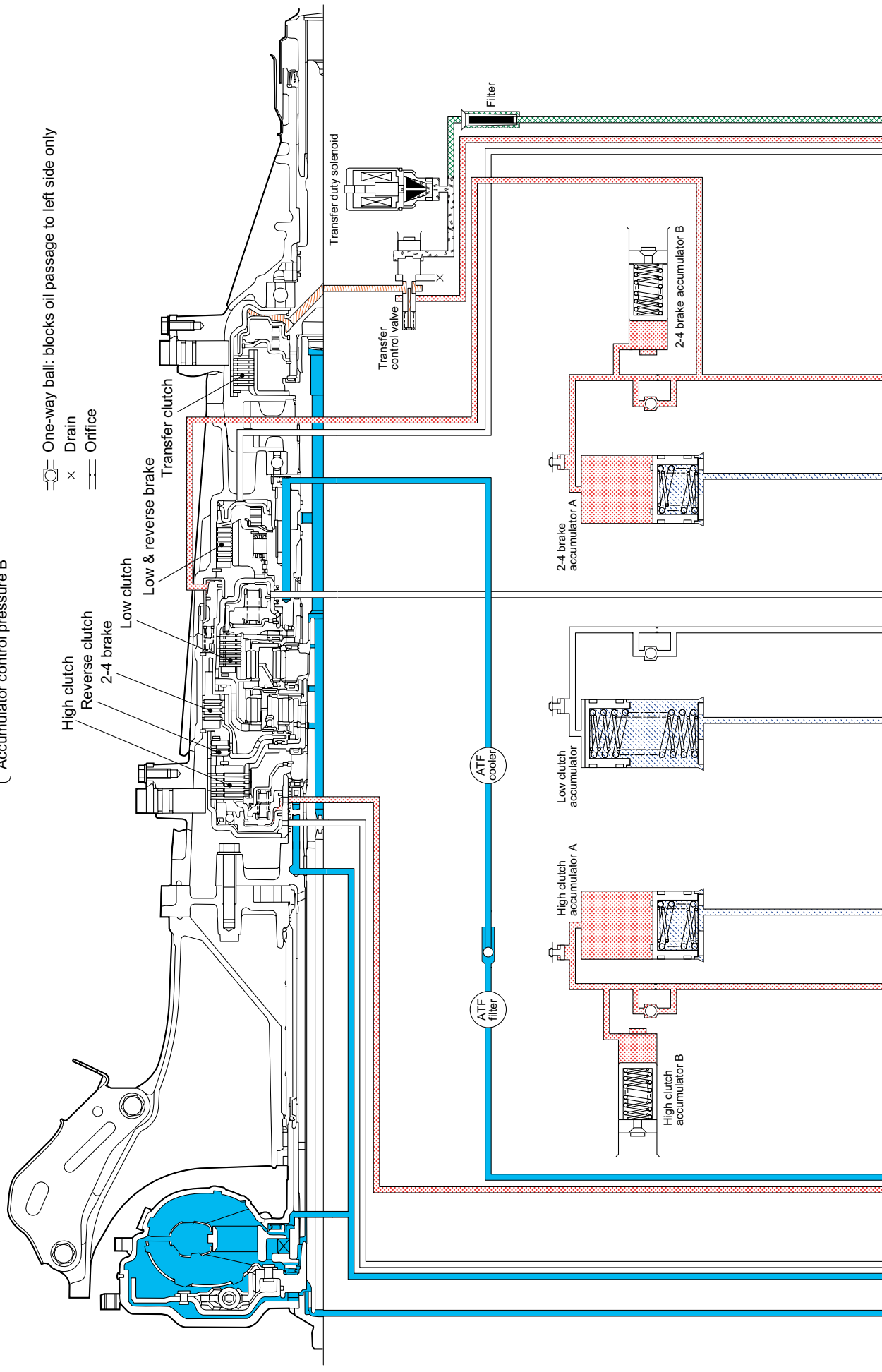
B: R RANGE

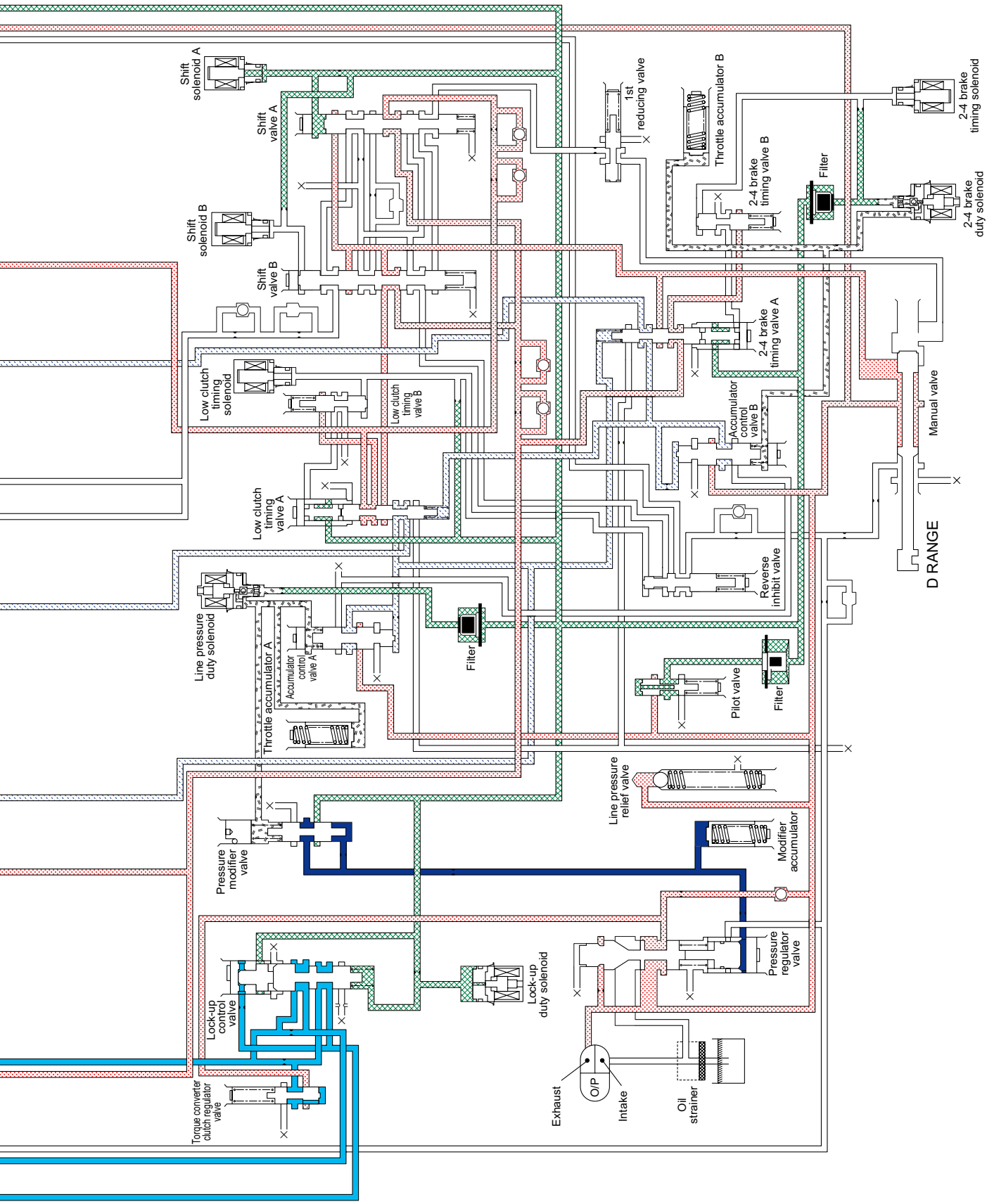




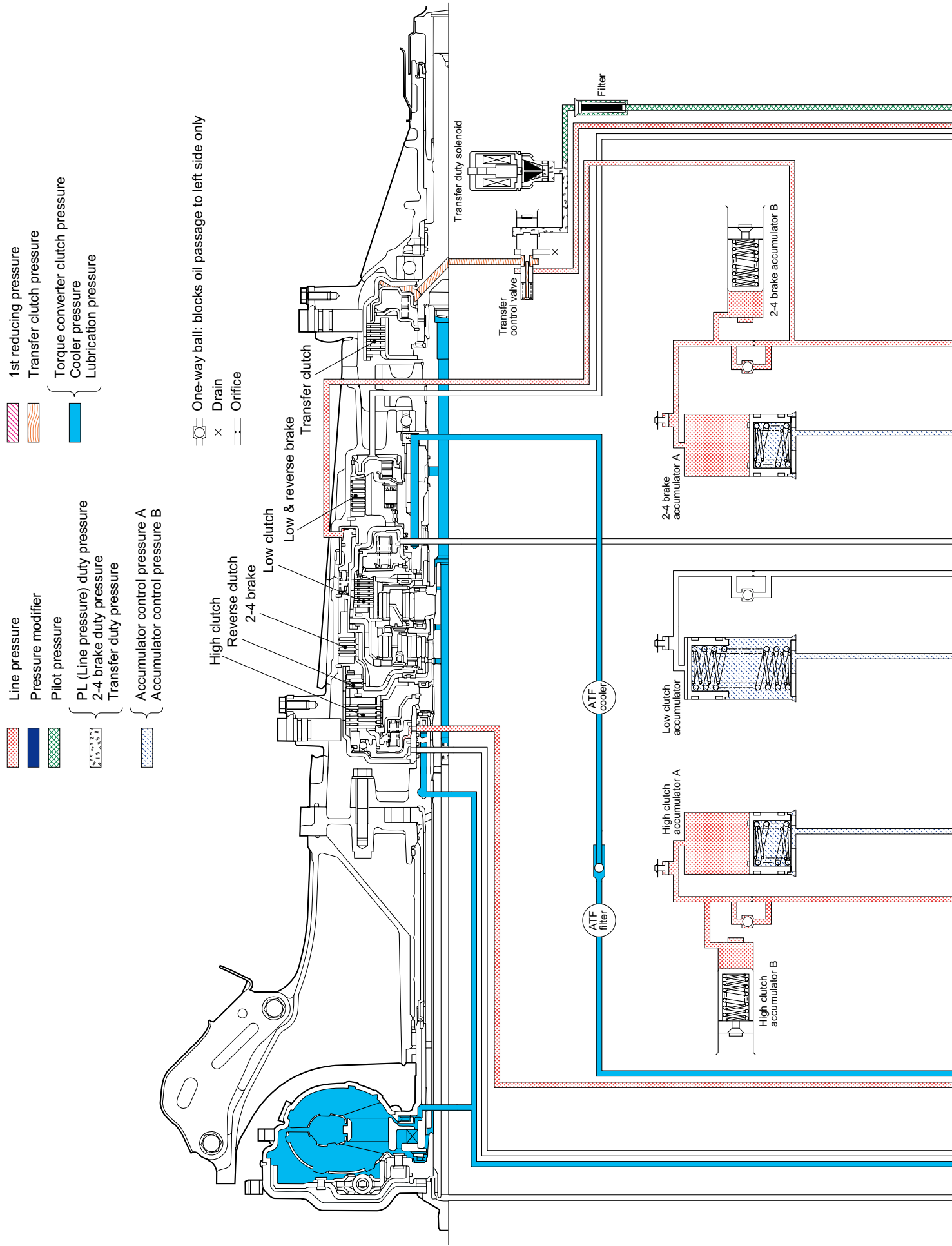
C: 4TH GEAR OF D RANGE (LOCK-UP OFF)

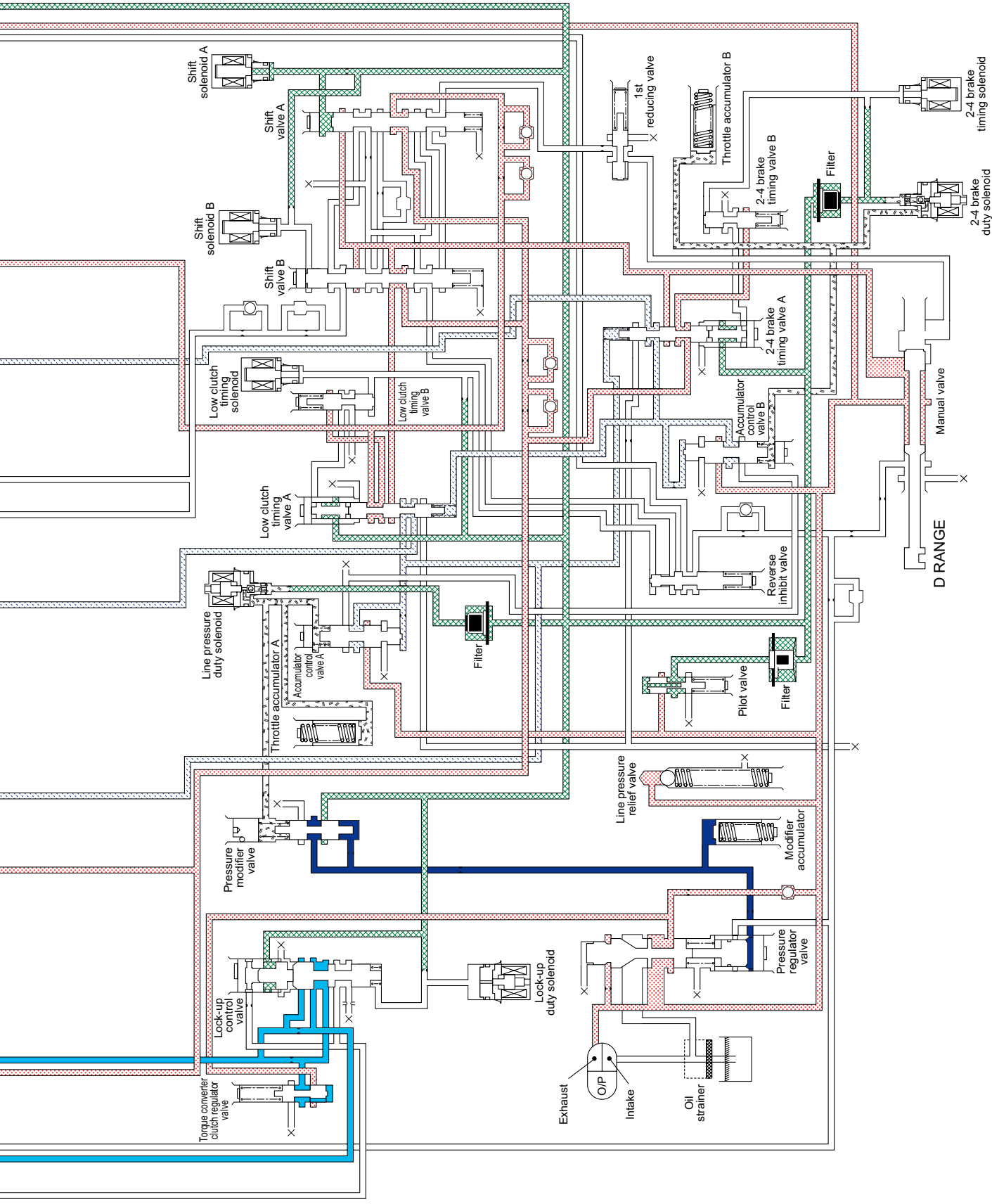
-  Line pressure
 -  Pressure modifier
 -  Pilot pressure
 -  PL (Line pressure) duty pressure
 -  2-4 brake duty pressure
 -  Transfer duty pressure
 -  Accumulator control pressure A
 -  Accumulator control pressure B
-
-  1st reducing pressure
 -  Transfer clutch pressure
 -  Torque converter clutch pressure
 -  Cooler pressure
 -  Lubrication pressure



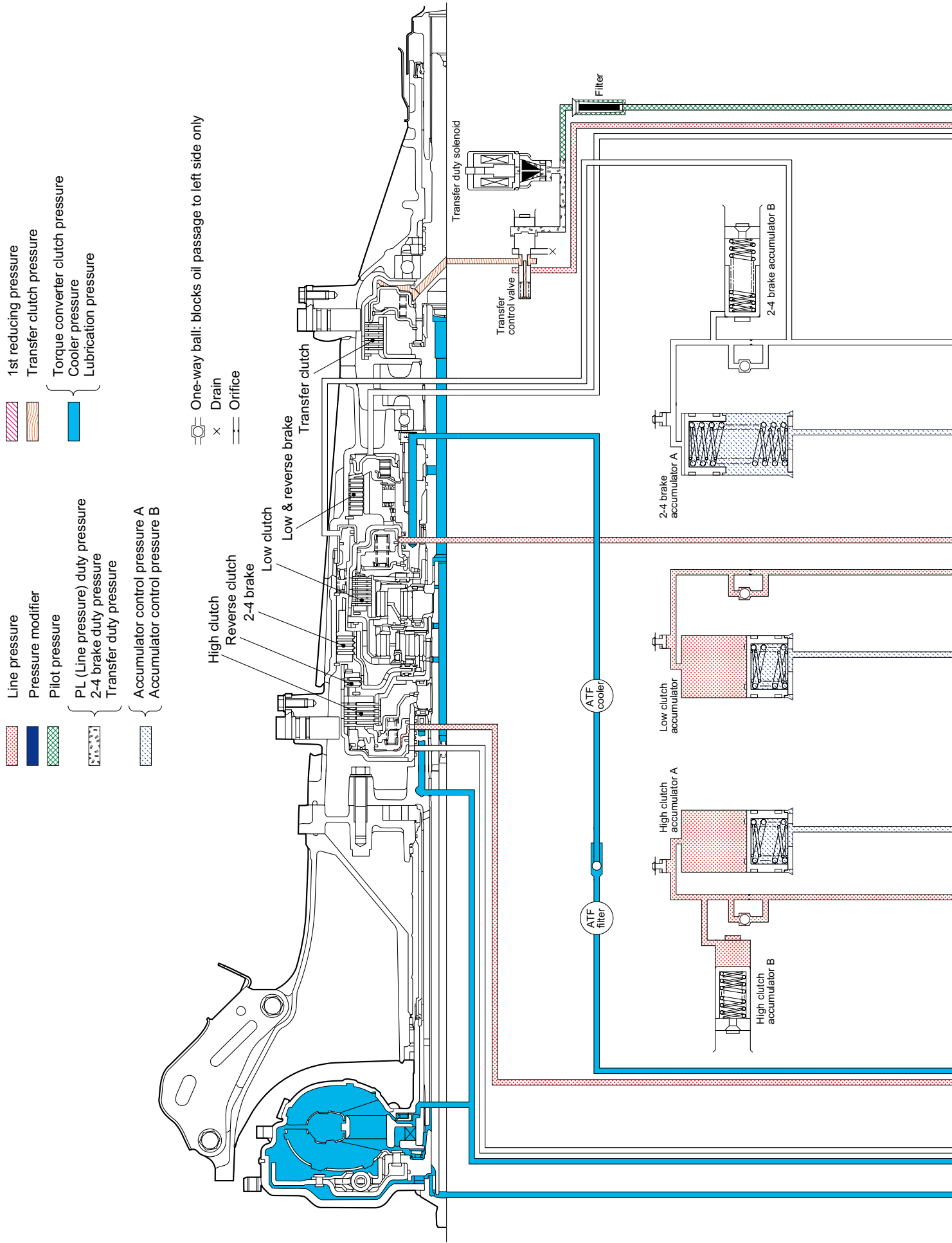


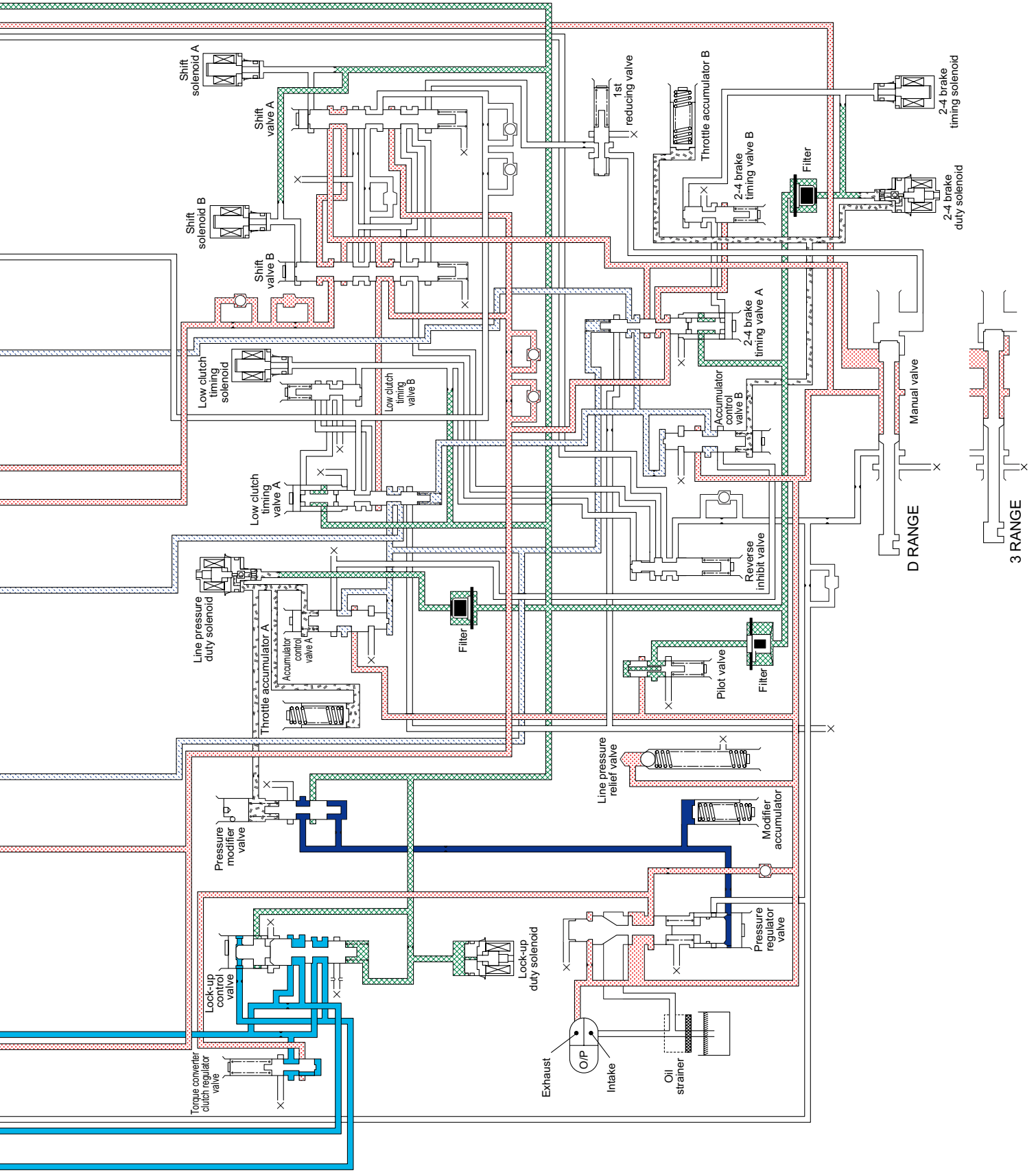
D: 4TH GEAR OF D RANGE (LOCK-UP ON)





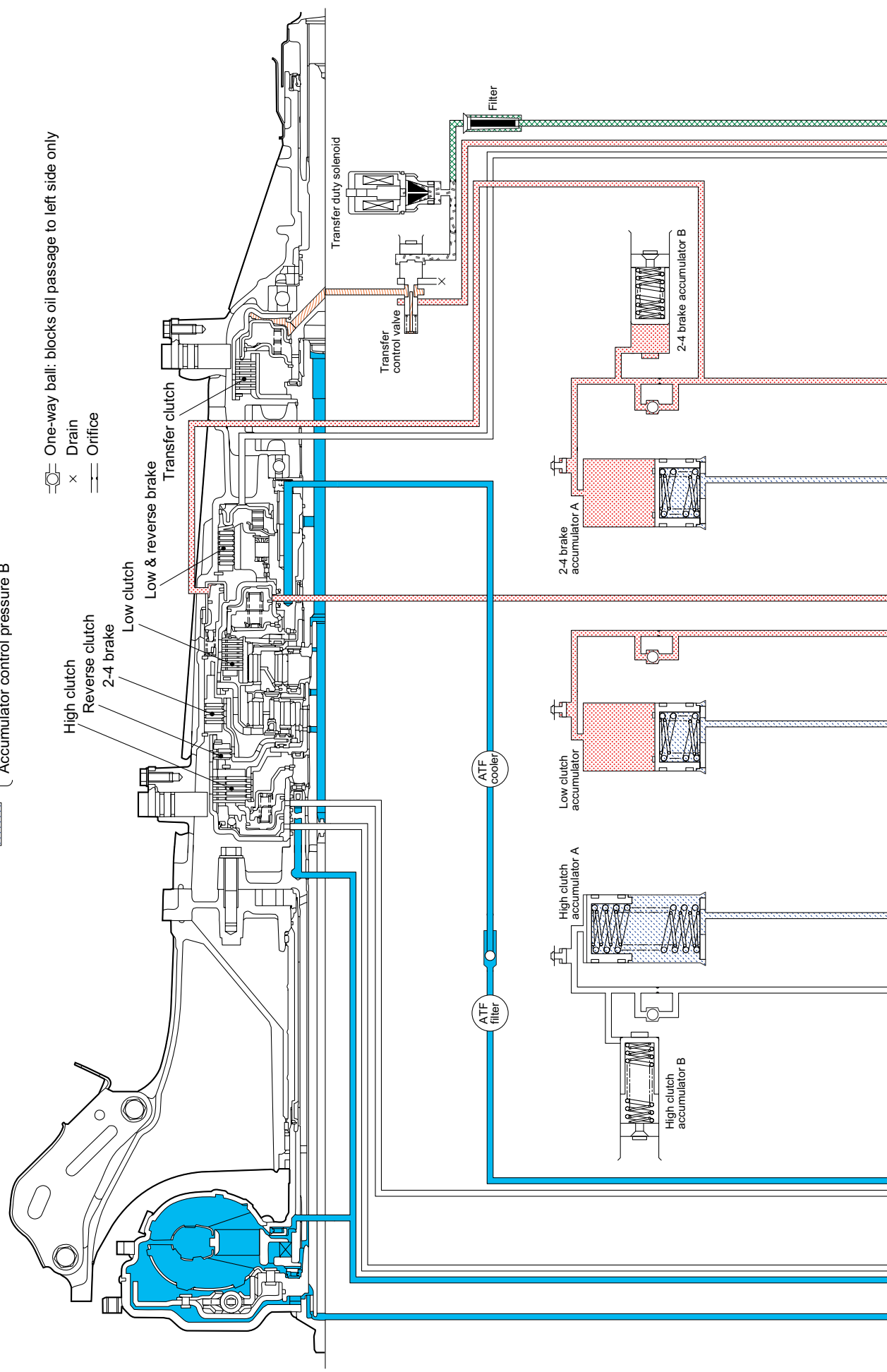
E: 3RD GEAR OF D AND 3 RANGES



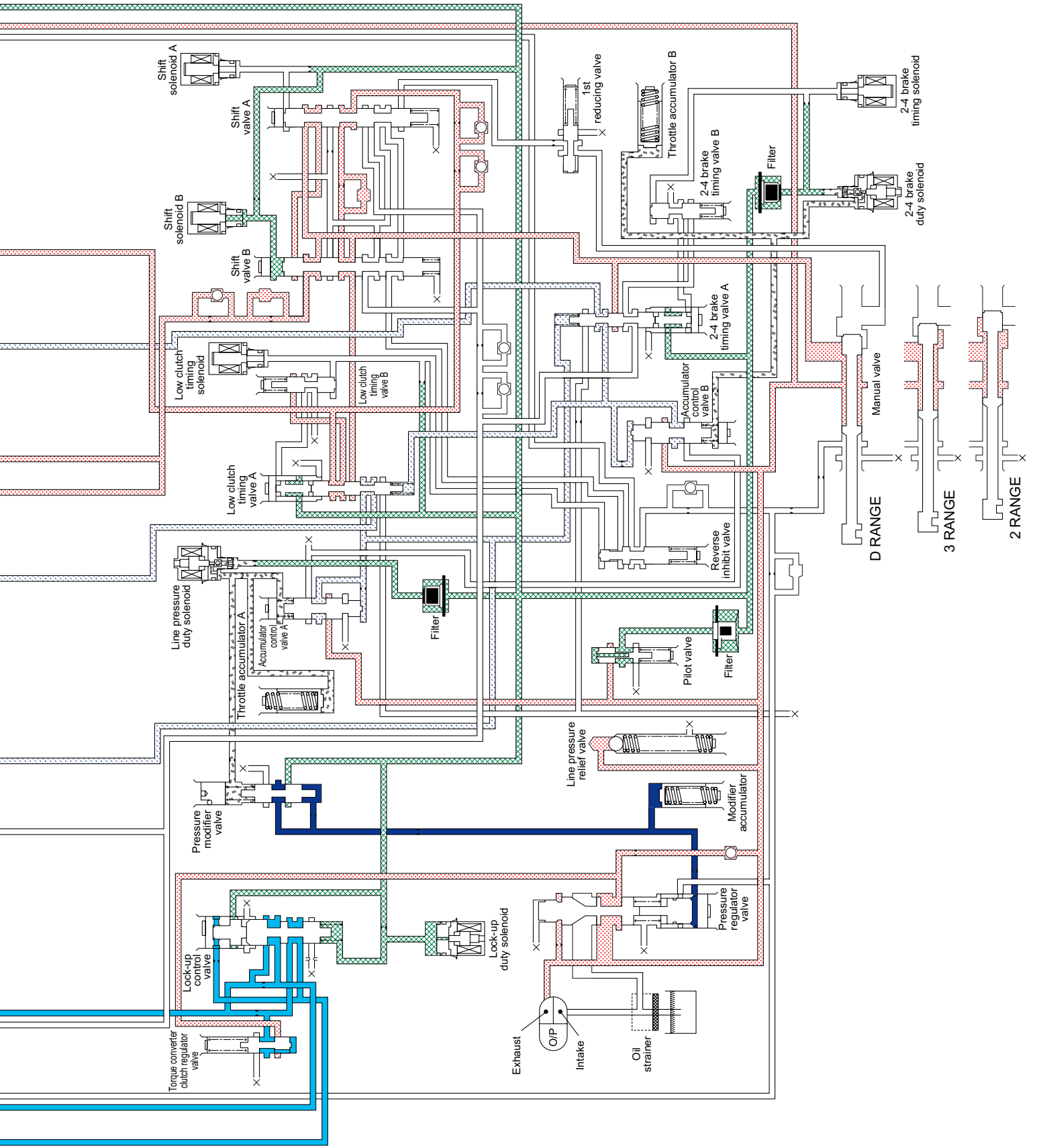


F: 2ND GEAR OF D, 3 AND 2 RANGES

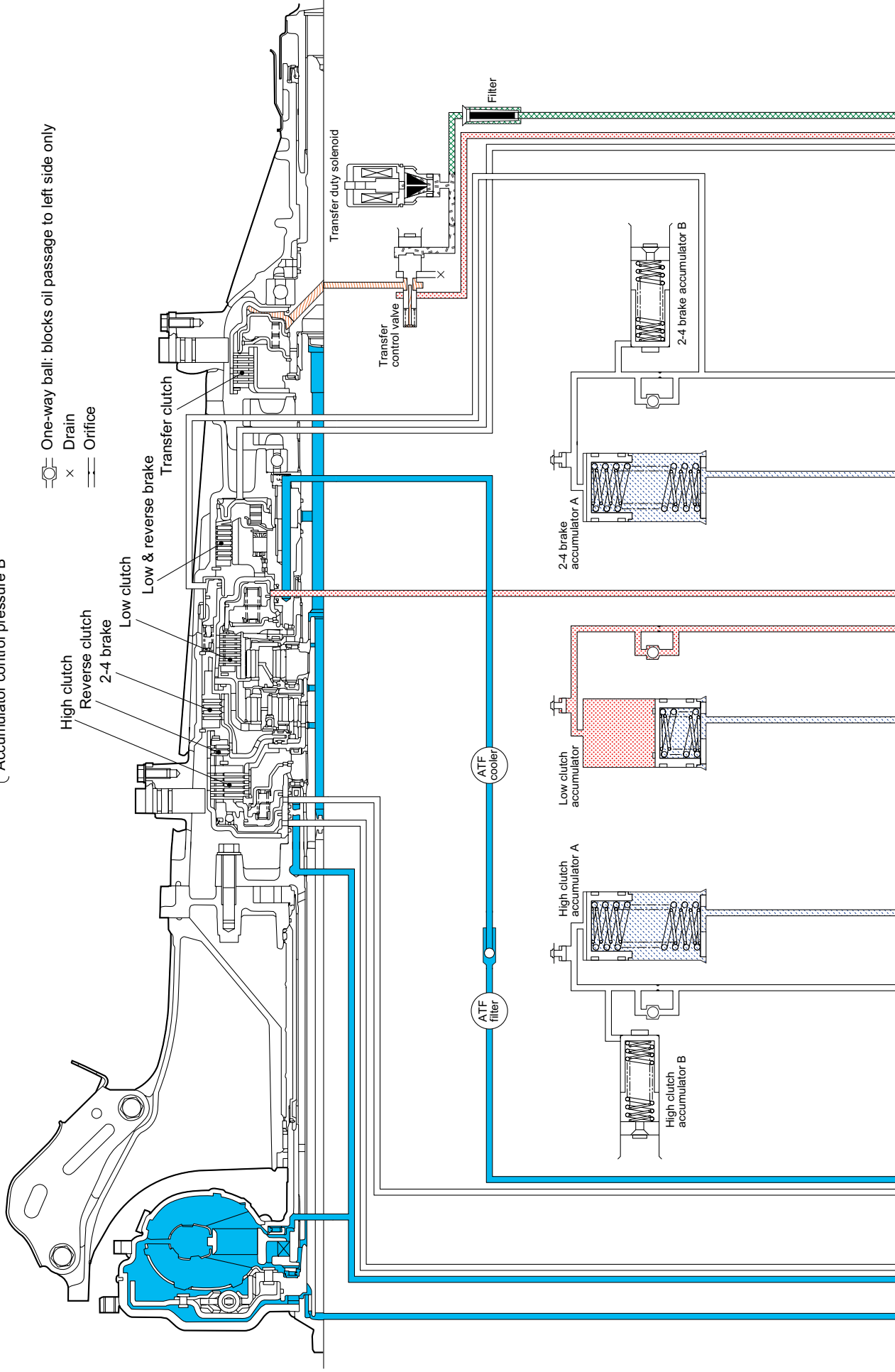
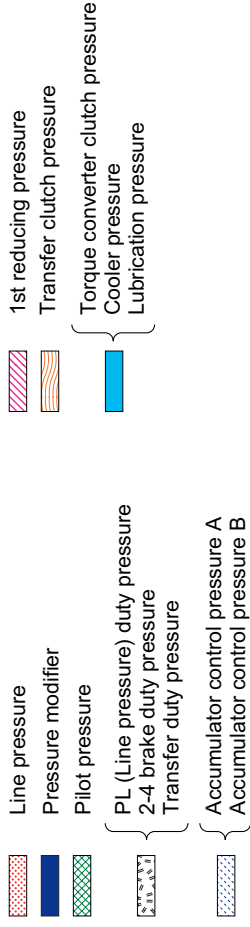
- Line pressure
 - Pressure modifier
 - Pilot pressure
 - PL (Line pressure) duty pressure
 - 2-4 brake duty pressure
 - Transfer duty pressure
 - Accumulator control pressure A
 - Accumulator control pressure B
-
- 1st reducing pressure
 - Transfer clutch pressure
 - Torque converter clutch pressure
 - Cooler pressure
 - Lubrication pressure



- One-way ball: blocks oil passage to left side only
- Drain
- Orifice



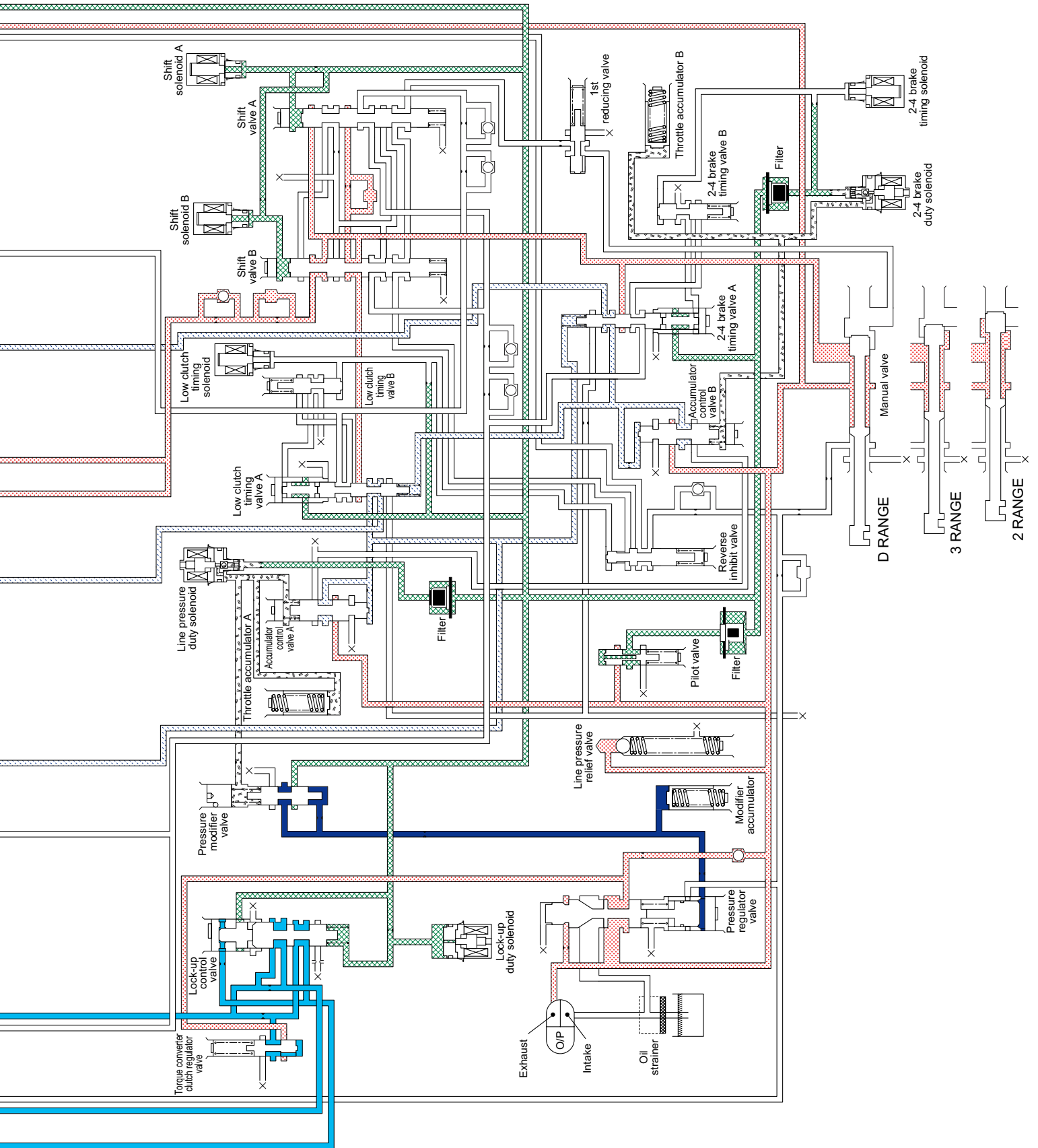
G: 1ST GEAR OF D, 3, AND 2 RANGES



One-way ball: blocks oil passage to left side only

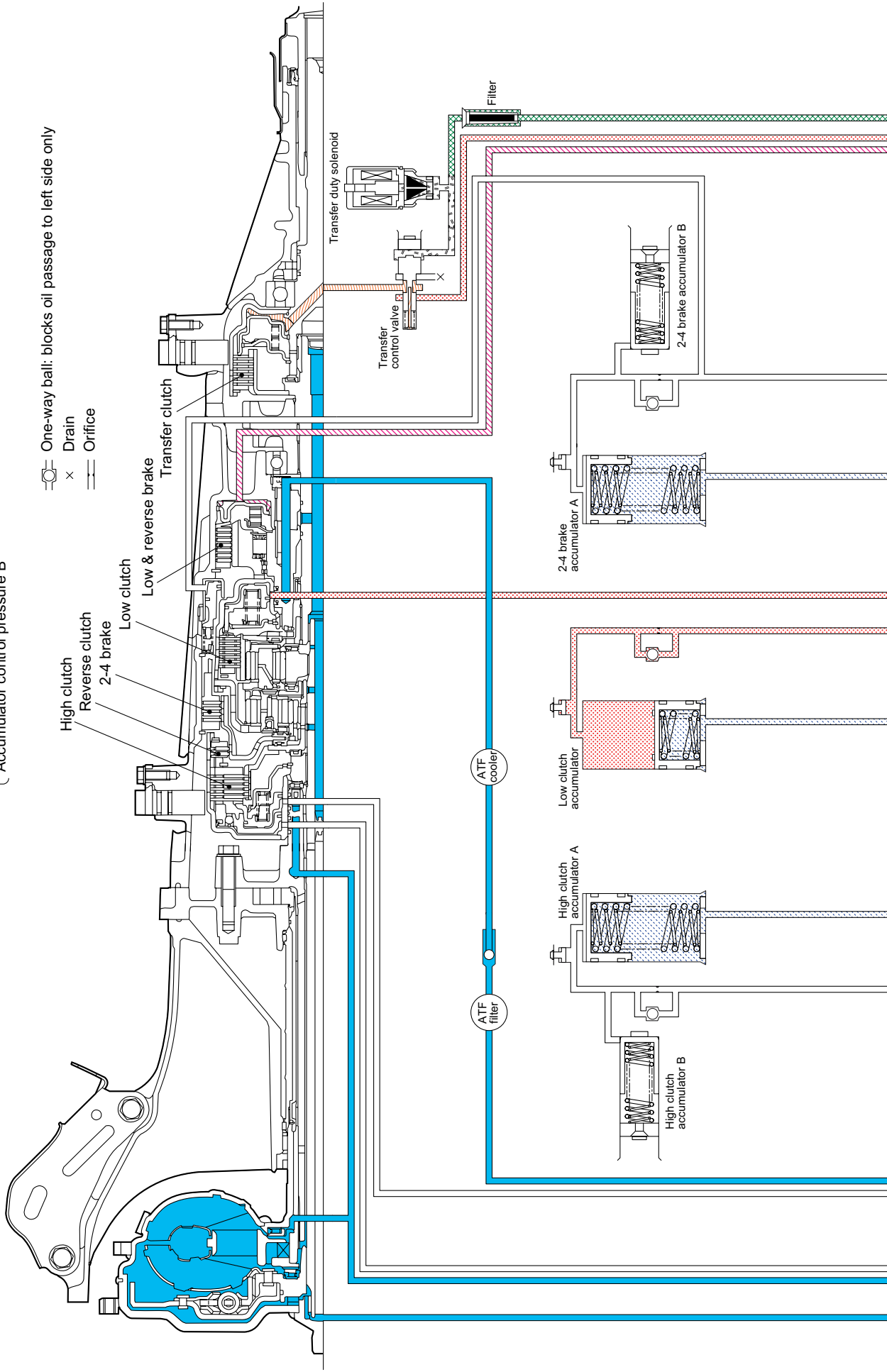
Drain

Orifice



H: 1ST SPEED OF 1 RANGE

- Line pressure
 - Pressure modifier
 - Pilot pressure
 - PL (Line pressure) duty pressure
 - 2-4 brake duty pressure
 - Transfer duty pressure
 - Accumulator control pressure A
 - Accumulator control pressure B
-
- 1st reducing pressure
 - Transfer clutch pressure
 - Torque converter clutch pressure
 - Cooler pressure
 - Lubrication pressure



- One-way ball: blocks oil passage to left side only
- Drain
- Orifice

11.AWD Transfer System

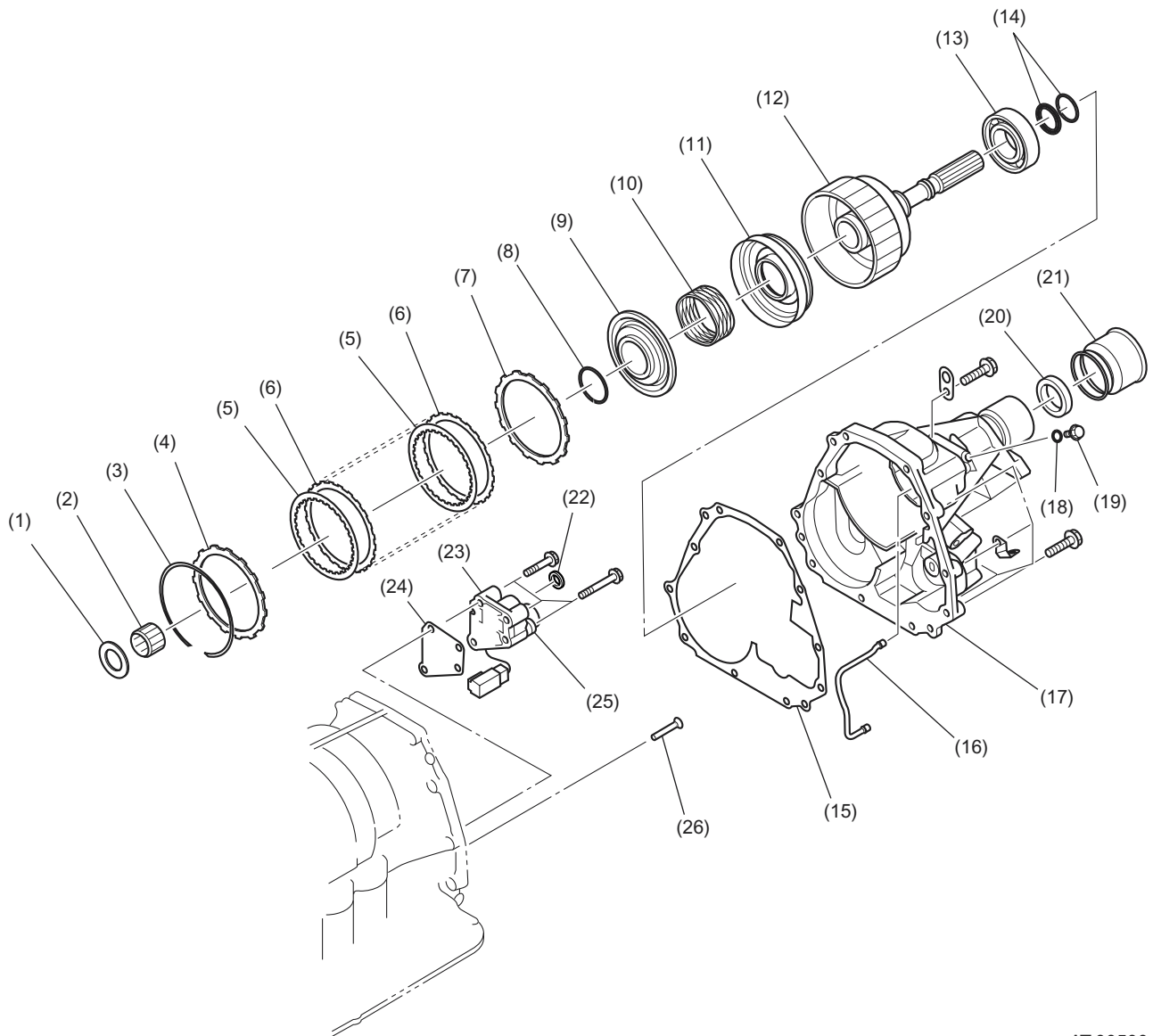
A: OUTLINE

This all-wheel-drive (AWD) transfer system uses an electronically controlled multi-plate type transfer clutch. The clutch is controlled by the TCM through the transfer hydraulic pressure control unit which consists of a duty-cycle-controlled solenoid valve and is located at the rear of the automatic transmission section together with the vehicle speed sensor.

The TCM has in its memory a set of duty ratio data, each defining at what ratio the transfer clutch should transmit the torque for a particular driving condition. Based on the driving condition information it receives from the corresponding sensors (vehicle speed, throttle opening, gear range, slip of wheels, etc.), the TCM selects an appropriate duty ratio from the memory and uses it to control the solenoid valve. The solenoid valve then regulates the pilot pressure of the transfer control valve which creates the pressure to the clutch from the line pressure. The clutch is engaged to a degree determined by the transfer clutch pressure thus created. Through this process, the torque from the engine is distributed to the rear wheels optimally according to driving conditions.

AWD TRANSFER SYSTEM

Automatic Transmission



AT-00500

- | | | |
|--------------------------|-----------------------------|-----------------------------|
| (1) Thrust bearing | (10) Return spring | (19) Plug |
| (2) Needle bearing | (11) Transfer clutch piston | (20) Oil seal |
| (3) Snap ring | (12) Rear drive shaft | (21) Dust cover |
| (4) Pressure plate | (13) Ball bearing | (22) Transfer clutch seal |
| (5) Drive plate | (14) Seal ring | (23) Transfer control valve |
| (6) Driven plate | (15) Gasket | (24) Transfer valve plate |
| (7) Pressure plate | (16) Transfer clutch pipe | (25) Transfer duty solenoid |
| (8) Snap ring | (17) Extension case | (26) Inlet filter |
| (9) Transfer piston seal | (18) O-ring | |

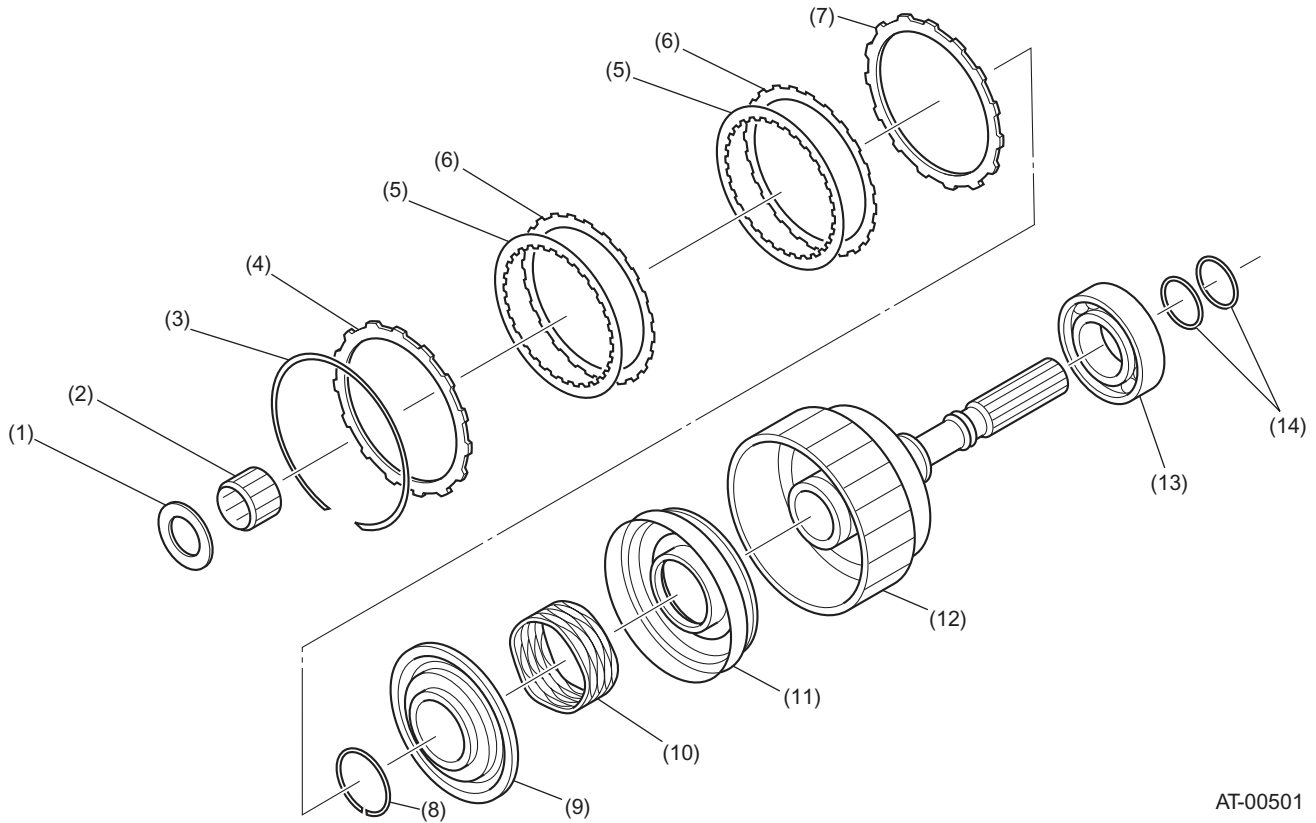
AWD TRANSFER SYSTEM

Automatic Transmission

B: CONSTRUCTION

1. TRANSFER CLUTCH

The transfer clutch drum and rear drive shaft are joined to each other by welding. The rear drive shaft has drilled oil passages for transfer clutch control and also for lubrication of extension bushing and ball bearing in it.



AT-00501

- | | | |
|--------------------|--------------------------|-----------------------------|
| (1) Thrust bearing | (6) Driven plate | (11) Transfer clutch piston |
| (2) Needle bearing | (7) Pressure plate | (12) Rear drive shaft |
| (3) Snap ring | (8) Snap ring | (13) Ball bearing |
| (4) Pressure plate | (9) Transfer piston seal | (14) Seal ring |
| (5) Drive plate | (10) Return spring | |

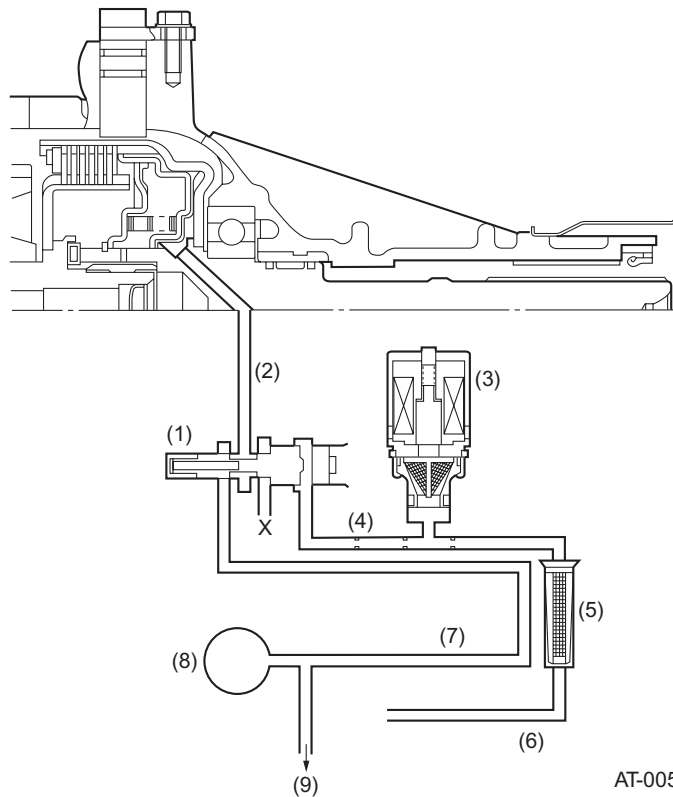
2. TRANSFER HYDRAULIC PRESSURE CONTROL UNIT

The transfer hydraulic pressure control unit is bolted at the rear end of transmission case through the transfer valve plate.

The hydraulic pressures used for the transfer hydraulic pressure control unit (line pressure and pilot pressure) are supplied from the transmission's hydraulic control valve assembly through the passages formed in the transmission case.

The transfer duty solenoid adjusts the pilot pressure of the transfer clutch valve depending on the signals from the TCM. The transfer clutch valve in turn modulates the line pressure into the transfer clutch pressure before it is applied to the clutch piston.

The transfer clutch pressure adjusted in this way engages the clutch to different degrees according to driving conditions so that the optimum torque is distributed to the rear wheels.



AT-00502

- | | | |
|------------------------------|-----------------------|---|
| (1) Transfer control valve | (4) Transfer pressure | (7) Line pressure |
| (2) Transfer clutch pressure | (5) Filter | (8) Oil pump |
| (3) Transfer duty solenoid | (6) Pilot pressure | (9) Transmission hydraulic control valve assembly |

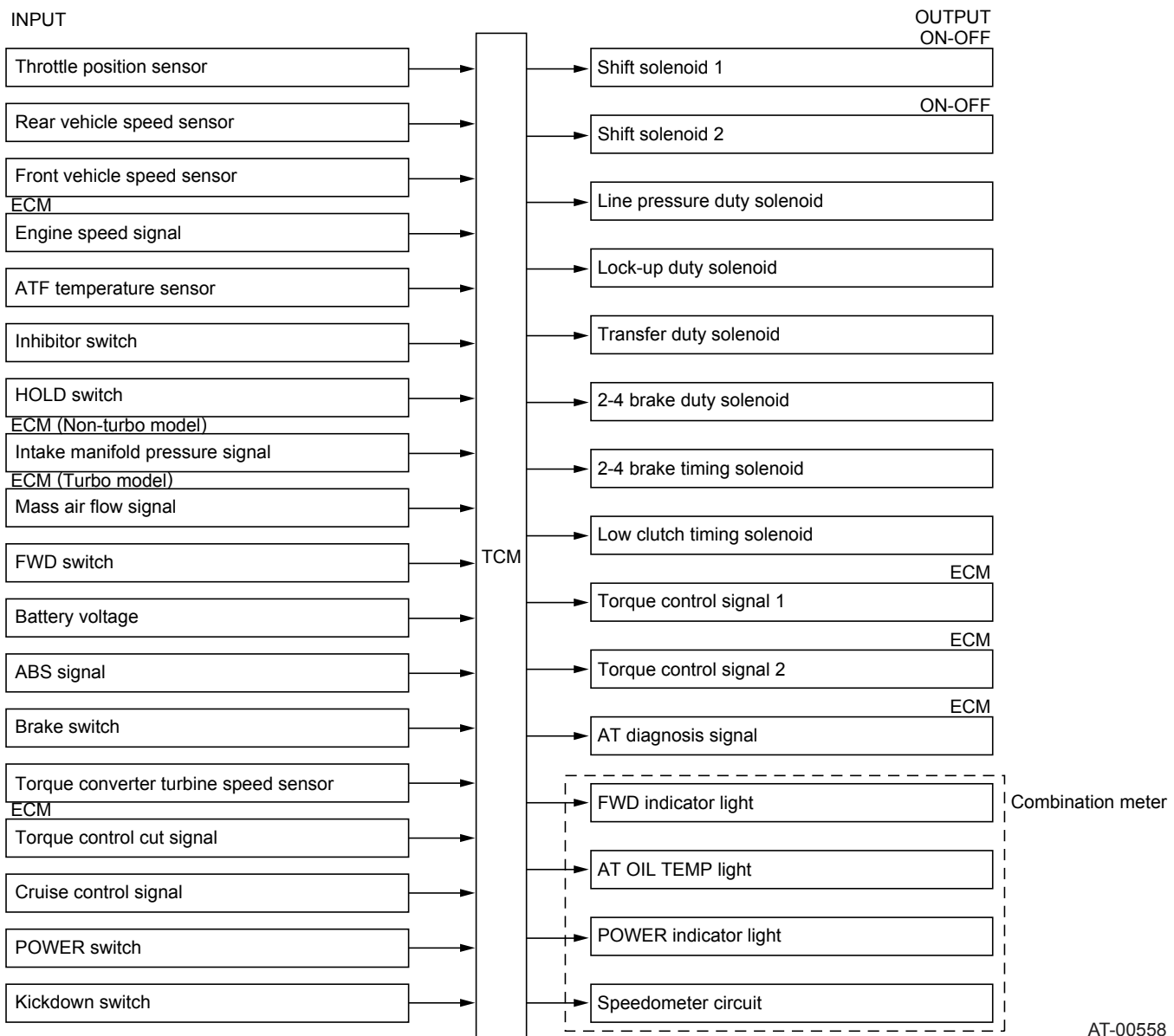
ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

12. Electrohydraulic Control System

A: GENERAL

The electrohydraulic control system for the transmission and transfer consists of various sensors and switches, a transmission control module (TCM) and the hydraulic controlling units including solenoid valves. The system controls the automatic transmission operation, including gear shifting, lock-up clutch operation, line pressure, selection (Base, Hold, and Power), and gear-shift timing. It also controls the operation of the transfer clutch. The TCM determines vehicle operating conditions from various input signals and controls a total of eight solenoids (shift solenoids 1 and 2, low clutch timing solenoid, 2-4 brake timing solenoid, line pressure duty solenoid, lock-up duty solenoid, transfer duty solenoid, and 2-4 brake duty solenoid) by sending appropriate signals to them.



AT-00558

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

B: INPUT SIGNALS

Signal name	Major function
Throttle position sensor	Indicates the throttle valve position. This signal is used to determine shift point, line pressure, and lock-up engaging vehicle speed, which vary with engine load.
Front vehicle speed sensor (located on transmission case)	Indicates the vehicle speed. This signal is used for control of gear shifting, lock-up engaging, line pressure, and transfer clutch operation.
Rear vehicle speed sensor (located on extension case)	Used to control transfer clutch, and also as backup signal in case of failure of front vehicle speed sensor.
Engine speed signal	Indicates the engine speed. This signal is used for control of lock-up clutch to ensure smooth engagement.
Inhibitor switch	Used to determine gears and line pressures in each of ranges "P", "R", "N", "D", "3", "2" and "1".
ATF temperature sensor	Indicates the ATF temperature. This signal is used for inhibition of lock-up, release of OD and determination of ATF temperature.
FWD switch	Used to change the mode from AWD to FWD. Also used to adapt the vehicle to FWD tester roller. Changeover from AWD to FWD can be made by inserting a fuse into the fuse holder.
ABS signal	Used when ABS is operating to optimize ABS control. In this control, transfer clutch torque load capacity is adjusted to eliminate the influence of engine braking and reduce the degree of coupling between front and rear wheels.
Cruise control signal	Indicates operation of cruise control system. It is used to expand "4th" operating range.
Torque converter turbine speed sensor	Tells the rotation speed of the input shaft. The proportion of this speed to the vehicle speed determines whether shifting should be made or not.
Torque control cut signal	Sent from engine control module (ECM) to TCM to temporarily inhibit the torque control when starting off with low coolant temperature.
Intake manifold pressure signal (non-turbo model)	Used to determine line pressure of gear shifting.
Brake switch	If this signal is issued during downhill driving, TCM makes shift down control, causing the vehicle speed to be reduced.
Mass air flow signal	Used to determine line pressure of gear shifting.
HOLD switch	With this switch ON, the vehicle starts in 2nd gear (if the D, 3, or 2 range is selected), which facilitates drive away on a slippery road.
POWER switch	With this switch ON, the TCM controls gear shifting in the Power mode which is convenient when rapid acceleration or great power is required.
Kickdown switch	Indicates full throttle opening. TCM uses this signal to make kickdown control.

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

C: OUTPUT SIGNALS

Signal name	Function
Shift solenoid 1 and 2	Each of these signals controls shift step by turning the corresponding solenoid ON/OFF. Activating timing is controlled for each solenoid to reduce shift shock.
Line pressure duty solenoid	Regulates the line pressure according to driving conditions.
Lock-up duty solenoid	Regulates the hydraulic pressure of the lock-up clutch to operate it in three modes (open, smooth and lock-up).
Transfer duty solenoid	Regulates the hydraulic pressure of the transfer clutch to control the driving force to the rear drive shaft.
AT OIL TEMP light	Causes the light to illuminate when ATF becomes excessively hot (exceeds a set temperature level).
2-4 brake duty solenoid	Regulates 2-4 brake operating pressure to reduce shifting shocks.
2-4 brake timing solenoid	Switches on or off the pressure acting on 2-4 brake timing valve B to control the release timing of the 2-4 brake.
Low clutch timing solenoid	Switches on or off the pressure acting on the low clutch timing valve B to control the release timing of the low clutch. Also switches on or off the pressure acting on the reverse inhibit valve to control the reverse inhibit function.
Torque control signal 1	Reduces engine torque during range selection and gear change.
Torque control signal 2	Reduces engine torque during range selection and gear change.
POWER indicator light	Indicates whether the shift pattern is Base or Power. The indicator lights in the Power mode. This light is also used to display diagnostic trouble codes for the on-board diagnostics function.
HOLD indicator light	Indicates whether the shift pattern is Base or Hold. The indicator lights in the Power mode.

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

D: CONTROL ITEM

Control item		Description of control	
Transmission control	Shift control	Base shift control <ul style="list-style-type: none"> • Base pattern • Power pattern 	Upshifting and downshifting are set for each range, gear and pattern according to throttle position and vehicle speed.
		ABS-in-operation control	Gear speed is determined according to vehicle speed etc. when ABS signal is input.
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.
		Hold control	With HOLD switch ON, vehicle starts in 2nd gear (if the D, 3 or 2 range is selected).
		Power pattern control (POWER light ON)	Power pattern is selected when POWER switch is ON.
		Base pattern control (POWER light OFF)	Base pattern is selected when POWER switch is OFF.
	Automatic pattern select control	Power pattern control	Power pattern is selected when throttle opening is changed at a speed exceeding the preset value.
		Base pattern control	When throttle opening is changed at a speed less than the preset value, Base pattern is resumed.
	Lock-up control	Base lock-up control	Lock-up ON is set for D-range 4th gear; ON/OFF is set for all gears (except D-range 4th) and patterns. Lock-up control is performed according to throttle position and vehicle speed. (Basically lock-up is OFF during gear shifting.)
		Smooth control	Smooth lock-up is performed when lock-up is switched on.
	Line pressure control	Ordinary control	Line pressure is regulated according to throttle position, vehicle speed and range signals.
		Shift control	Line pressure is regulated when shifting to lessen shifting shock.
		Starting control	Line pressure is lowered to a minimum so as to reduce engine cranking load.
	Shift timing control	Shift step control	ON/OFF timing for shift solenoid is controlled.
		Lock-up control	When shifting, the lock-up clutch is temporarily released.
Line pressure control		When shifting, line pressure is controlled to the optimum level so as to reduce shifting shock.	
AWD transfer clutch control	Ordinary transfer control	Transfer clutch pressure is regulated according to the throttle valve angle and vehicle speed.	
	1 range control	Transfer clutch pressure is increased.	
	Slip control	Immediately after detecting a slip, transfer clutch pressure is controlled to the same pressure as 1 range. (This control is canceled if $V \geq 60$ km/h (37 MPH), or when throttle valve is closed fully.)	
	Turning control	Transfer clutch pressure is reduced after detecting a turn.	
	ABS-in-operation control	Transfer clutch pressure is adjusted to a set level immediately after reception of ABS signal.	

E: THROTTLE POSITION SENSOR

The throttle position sensor provides electrical signals corresponding to throttle valve positions. The throttle valve angular position and accelerator depressing speed are detected by this throttle position sensor.

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

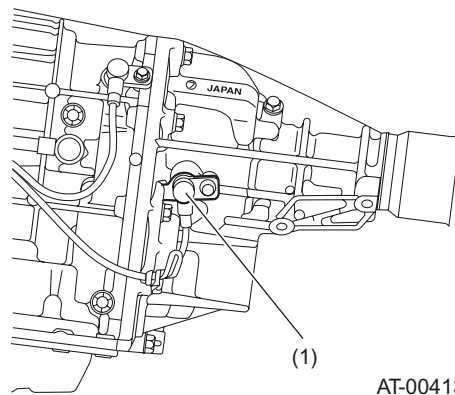
F: POWER INDICATOR LIGHT

The automatic transmission equipped vehicle is capable of selecting two driving patterns; “Base” pattern for ordinary driving and “Power” pattern for uphill driving or rapid acceleration. The POWER indicator light lights when the Power pattern is selected. See the table below:

Selector lever position	Change of pattern	POWER indicator light
D, 3, 2 range	Pattern is changed when POWER switch is turned ON.	<ul style="list-style-type: none">• Base pattern: OFF• Power pattern: ON

G: REAR VEHICLE SPEED SENSOR

This vehicle speed sensor (output shaft speed sensor) is externally mounted on the extension case. It detects the rear wheel speed in terms of the peripheral speed of the transfer clutch drum and sends sine wave signals (30 pulses per rotation) to the TCM.



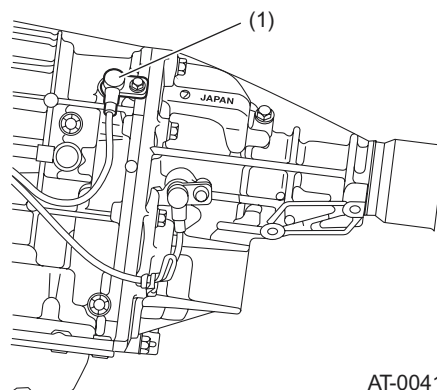
AT-00413

(1) Rear vehicle speed sensor

H: FRONT VEHICLE SPEED SENSOR

This vehicle speed sensor (output shaft speed sensor) is externally mounted on the transmission case. It detects the front wheel speed and sends sine wave signals (16 pulses per rotation) to the TCM.

The TCM converts the signals into pulse signals and outputs them to both the engine control module (ECM) and the combination meter.

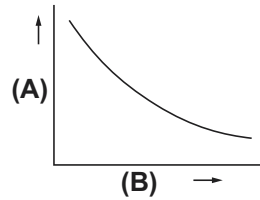
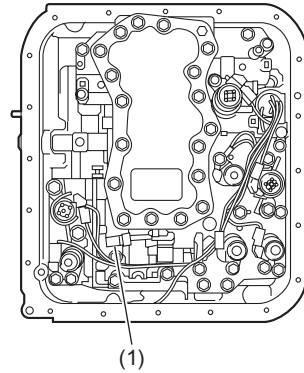


AT-00414

(1) Front vehicle speed sensor

I: ATF TEMPERATURE SENSOR

This sensor is mounted on the hydraulic control valve body of the transmission. It detects the temperature of ATF and outputs it as an electrical resistance signal. The output characteristics of the sensor are shown below.



AT-00415

(1) ATF temperature sensor

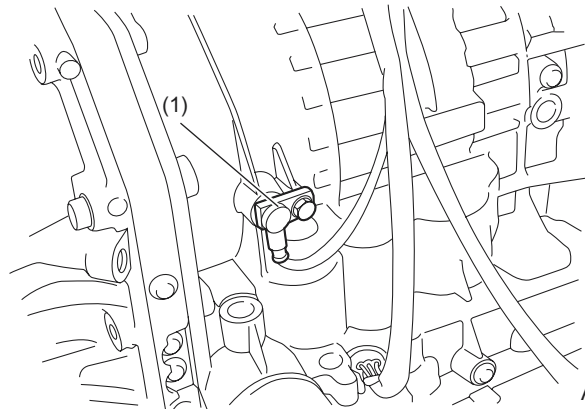
(A) Resistance

(B) Temperature

J: TORQUE CONVERTER TURBINE SPEED SENSOR

The torque converter turbine speed sensor (output shaft speed sensor) is externally mounted on the transmission case.

The sensor detects the torque converter turbine speed in terms of the rotation speed of the periphery of the high clutch drum coupled to the input shaft, and sends sine wave signals (32 pulses per rotation) to the TCM. The TCM calculates the proportion of the input shaft speed to the vehicle speed and determines whether the shifting is to be made or not.



AT-00416

(1) Torque converter turbine speed sensor

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

K: INHIBITOR SWITCH

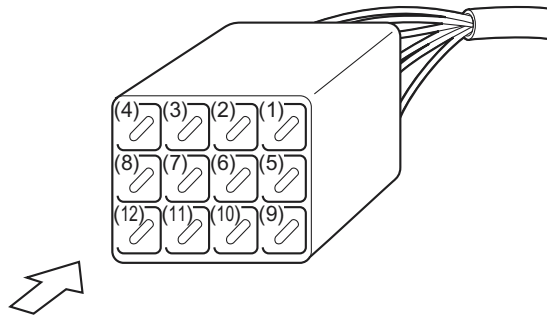
The inhibitor switch assures safety when starting the engine. This switch is mounted on the right side of the transmission case, and is operated by the selector lever.

When the selector lever is set to P or N, the electrical circuit in the inhibitor switch is closed and the starter circuit is completed for cranking the engine.

When the selector lever is in the R, D, 3, 2 or 1 range, the electrical circuit in the inhibitor switch is open. Hence engine cranking is disabled. In the R range, the backup light circuit is completed in the switch, and the backup lights come on.

In addition to the above function, the inhibitor switch incorporates a circuit for detecting the selected range position and sending the range signal to the TCM.

Inhibitor switch side connector

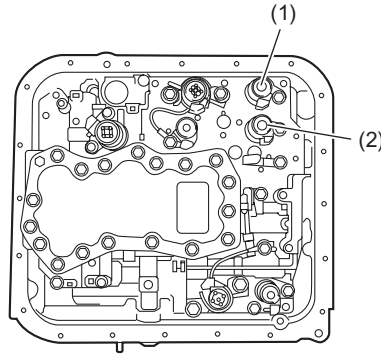


AT-00417

Range position	Pin No.
P	(4) – (3) (12) – (11)
R	(4) – (2) (10) – (9)
N	(4) – (1) (12) – (11)
D	(4) – (8)
3	(4) – (7)
2	(4) – (6)
1	(4) – (5)

L: SHIFT SOLENOIDS 1 AND 2

These solenoids are mounted on the transmission hydraulic control valve body. They are turned ON or OFF according to signals from the TCM. The gear positions are changed according to the ON and OFF condition of these solenoids.

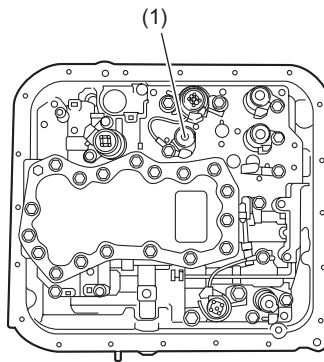


AT-00418

- (1) Shift solenoid 2
- (2) Shift solenoid 1

M: LOW CLUTCH TIMING SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. It is turned ON or OFF according to signals from the TCM. It then controls the low clutch timing valve B and reverse inhibitor valve.



AT-00419

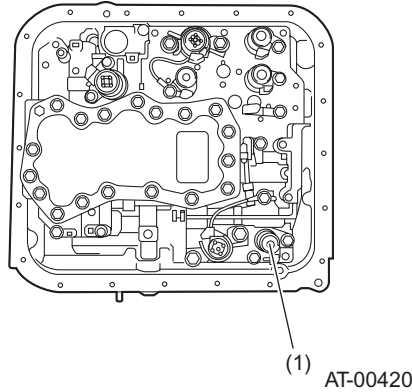
- (1) Low clutch timing solenoid

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

N: 2-4 BRAKE TIMING SOLENOID

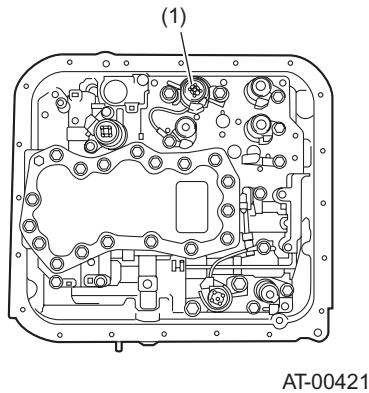
This solenoid is mounted on the transmission hydraulic control valve body. It is turned ON or OFF according to signals from the TCM. It then controls the 2-4 brake timing valve B to decrease the change gear shock.



(1) 2-4 brake timing solenoid

O: LINE PRESSURE DUTY SOLENOID

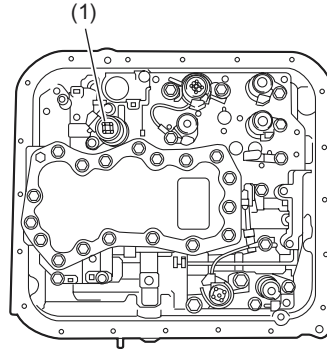
This solenoid is mounted on the transmission hydraulic control valve body. Its duty ratio is controlled by signals from the TCM. This solenoid then controls the pressure modifier valve and accumulator control valve A to adjust the line pressure to an optimum pressure level suitable for operating conditions.



(1) Line pressure duty solenoid

P: LOCK-UP DUTY SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. Its duty ratio is controlled by signals from the TCM. It then controls the lock-up control valve to provide smooth engagement and disengagement of the lock-up clutch.

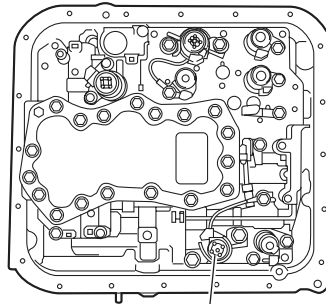


AT-00422

(1) Lock-up duty solenoid

Q: 2-4 BRAKE DUTY SOLENOID

This solenoid is mounted on the transmission hydraulic control valve body. Its duty ratio is controlled by signals from the TCM. It modulates the 2-4 brake pressure when the 2-4 brake is operated, reducing shifting shocks.



(1) AT-00423

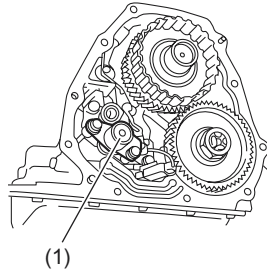
(1) 2-4 brake duty solenoid

ELECTROHYDRAULIC CONTROL SYSTEM

Automatic Transmission

R: TRANSFER DUTY SOLENOID

This solenoid is mounted on the transfer hydraulic pressure control unit on the rear end of transmission case. Its duty ratio is controlled by signals from the TCM. It then controls the transfer clutch/control valve to control the pressure applied to the transfer clutch.



AT-00424

(1) Transfer duty solenoid

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

13. Transmission Control Module (TCM)

The TCM receives various sensor signals and determines the running conditions of the vehicle. It then sends control signals to each solenoid according to the preset gearshift characteristic data, lock-up operation data, and transfer clutch torque data (duty ratios).

A: CONTROL SYSTEM

Control item		Input signals
Shift control	Ordinary shift control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch POWER switch Kickdown switch
	ABS-in-operation control	ABS signal Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch
	Hydraulic oil temperature control	ATF temperature sensor
	Reverse inhibition control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch
	Shift pattern (Base/Power) select control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch POWER switch
	Grade control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch Inhibitor switch Engine speed Intake manifold pressure (non-turbo model) Mass air flow pressure (turbo model)
Lock-up control	Ordinary lock-up control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch HOLD switch POWER switch
	Smooth control	Throttle position sensor
	Hydraulic oil temperature control	ATF temperature sensor

TRANSMISSION CONTROL MODULE (TCM)

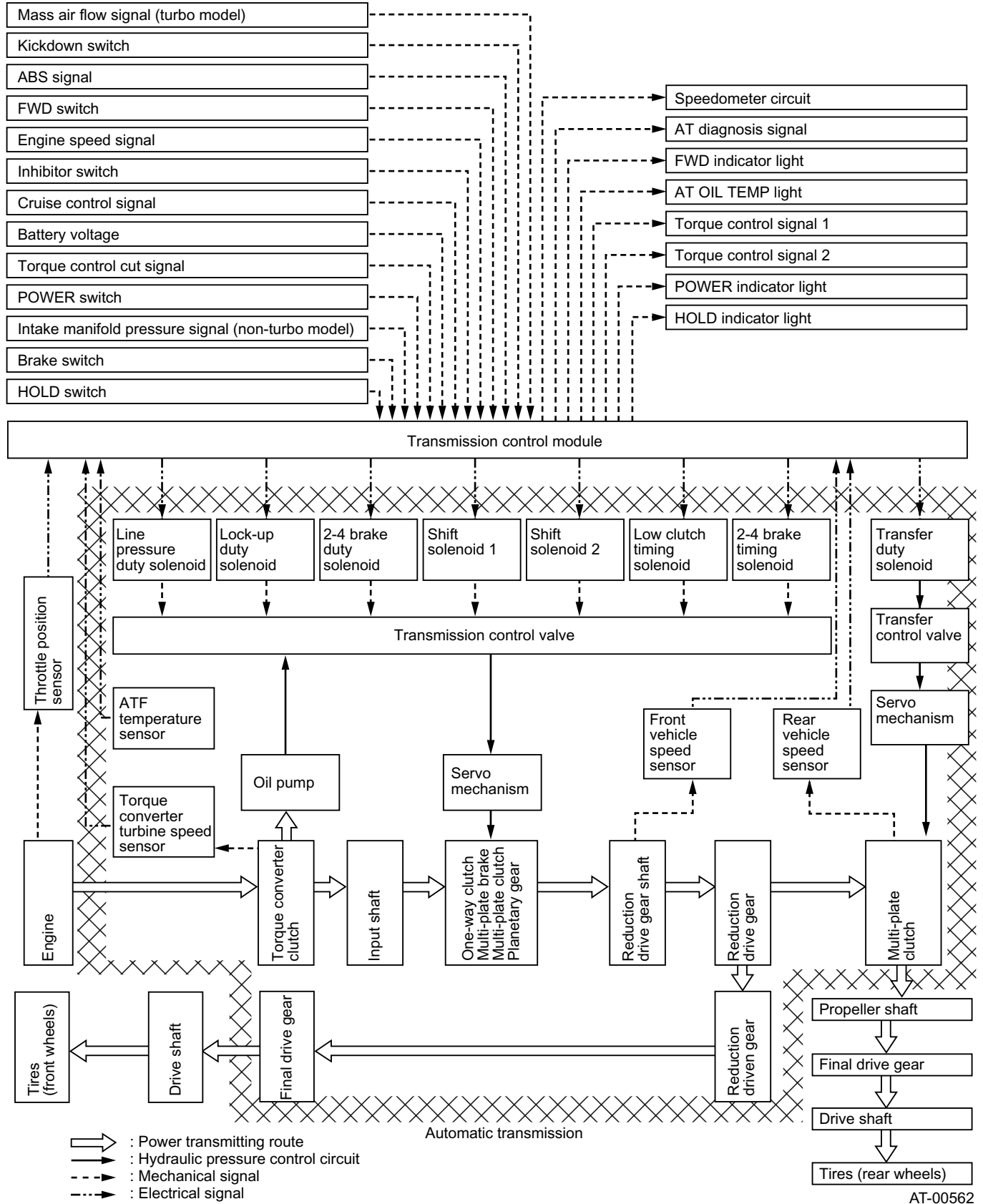
Automatic Transmission

Control item		Input signals
Oil pressure control	Ordinary pressure control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Inhibitor switch ATF temperature sensor
	Shifting control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed Torque converter turbine speed sensor Inhibitor switch ATF temperature sensor
	Starting control	Engine speed ATF temperature sensor Inhibitor switch
	Learning control	Shift solenoid A Shift solenoid B Rear vehicle speed sensor Front vehicle speed sensor Throttle position sensor Torque converter turbine speed sensor ATF temperature sensor
AWD transfer clutch control	Ordinary transfer control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch ATF temperature sensor FWD switch
	1 range control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch HOLD switch
	Slip detection control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	Steering control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	ABS-in-operation control	ABS signal Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

B: SYSTEM DIAGRAM



AT-00562

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

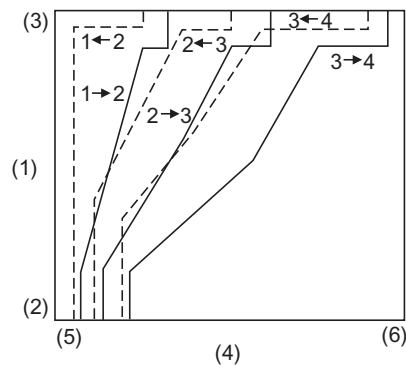
C: SHIFT CONTROL

The TCM performs gear shifting control according to driving conditions by using the shift point characteristic data stored in its memory. Appropriate solenoids are operated at the proper timing corresponding to the shift pattern, throttle position, and vehicle speed for smooth shifting.

NOTE:

When the ATF temperature is below approximately 10°C (50°F), the gear cannot be shifted to the 4th speed.

	Solenoid 1	Solenoid 2
1st	ON	ON
2nd	OFF	ON
3rd	OFF	OFF
4th	ON	OFF



AT-00426

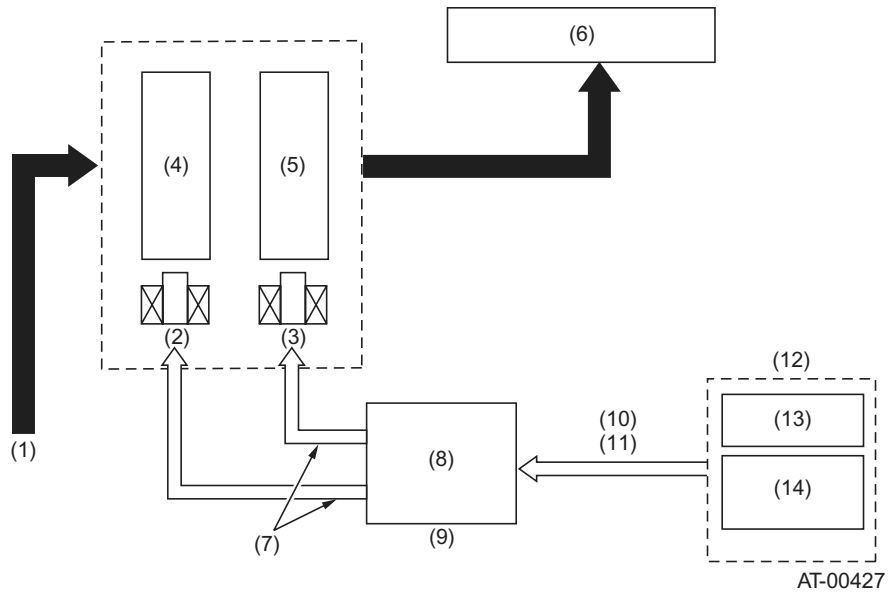
- (1) Throttle position
- (2) Small
- (3) Large

- (4) Vehicle speed
- (5) Low
- (6) High

- The TCM activates both solenoids 1 and 2 in response to throttle and vehicle speed signals.
- Shift valves move in response to operation of the solenoids, supplying or interrupting the line pressure to each clutch.
- A shift to each gear takes place according to ON-OFF operation of both the solenoids as indicated in the table above.

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission



(1) Clutch fluid

(2) Solenoid 1

(3) Solenoid 2

(4) Shift valve A

(5) Shift valve B

(6) Shift clutches

(7) Shift command signals

(8) TCM

(9) Determination of optimum gear position (including selection of shift pattern)

(10) Throttle position

(11) Vehicle speed

(12) Sensors

(13) Vehicle speed sensor

(14) Throttle position sensor

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

D: LOCK-UP CONTROL

- The TCM has pre-programmed lock-up clutch engagement and disengagement conditions for each gear and shift pattern. The engagement and disengagement conditions are defined in terms of the throttle valve position and vehicle speed.
- The TCM controls the operation of the lock-up clutch by means of the duty solenoid which in turn controls the lock-up control valve as described below:

1. NON-LOCK-UP OPERATION

The duty solenoid allows the pilot pressure (supplied from the pilot valve) to be applied to the “dis-engaging” end of the lock-up control valve spool. The lock-up control valve then opens the clutch disengaging circuit port to allow the lock-up operating pressure (torque converter clutch regular pressure) to build up in the circuit. On the other hand, the valve opens the clutch engaging circuit’s port and allows the fluid in the circuit to flow to the ATF cooler, thus lowering the pressure in the circuit. As a result, the lock-up clutch is disengaged due to difference in pressure between both circuits.

This operation is performed according to the throttle valve opening and vehicle speed.

2. LOCK-UP OPERATION

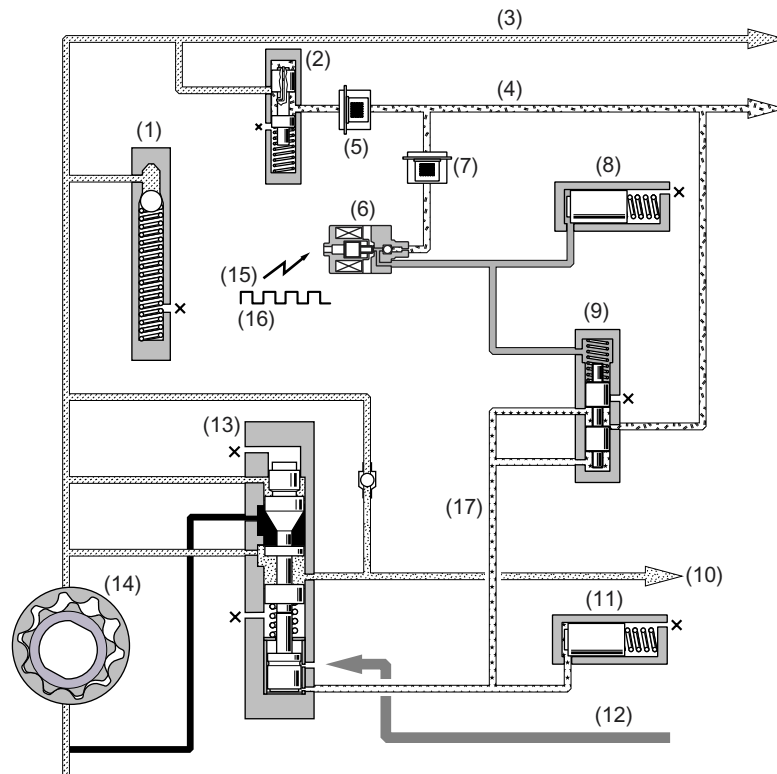
The duty solenoid allows the pilot pressure to be applied to the “engaging” end of the lock-up control valve spool. The lock-up control valve then opens the clutch engaging circuit’s port that communicates to the torque converter’s impeller chamber, allowing high pressure fluid to flow to the lock-up clutch. The clutch then engages.

- The TCM controls the current to the duty solenoid by gradually changing the current. As a result, the lock-up control valve also moves gradually, so the clutch engagement pressure increases smoothly. This causes the lock-up clutch to become initially in a half-engaged state and then in a fully engaged state, thus preventing shock during engagement. Also, in case of European models, lock-up is inhibited when the ATF temperature is below 23°C.

This operation is performed according to the throttle valve opening and vehicle speed.

E: LINE PRESSURE CONTROL

- The oil pump delivery pressure (line pressure) is regulated to a constant pressure by the pilot valve. This pressure is used as the pilot pressure for controlling spool valves.
- The pilot pressure applied to the pressure modifier valve is modulated into pressure modifier pressure at the line pressure duty solenoid by activating the pressure modifier valve.
- The pressure modifier valve is an auxiliary valve for the pressure regulator valve, and it creates a signal pressure (pressure modifier pressure). The pressure modifier pressure is used to regulate the line pressure to a level optimum for a particular driving condition.
- This pressure modifier pressure is applied to the pressure regulator valve which controls the oil pump delivery pressure.
- The pressure modifier pressure from the pressure modifier valve is cushioned by the pressure modifier accumulator to remove pulsation of the pressure.



AT-00428

- | | | |
|---------------------------------|------------------------------------|---------------------------------|
| (1) Relief valve | (7) Filter | (13) Pressure regulator valve |
| (2) Pilot valve | (8) Accumulator | (14) Oil pump |
| (3) Line pressure | (9) Pressure modifier valve | (15) ON |
| (4) Pilot pressure | (10) To ATF cooler circuit | (16) OFF |
| (5) Filter | (11) Pressure modifier accumulator | (17) Pressure modifier pressure |
| (6) Line pressure duty solenoid | (12) From R range pressure circuit | |

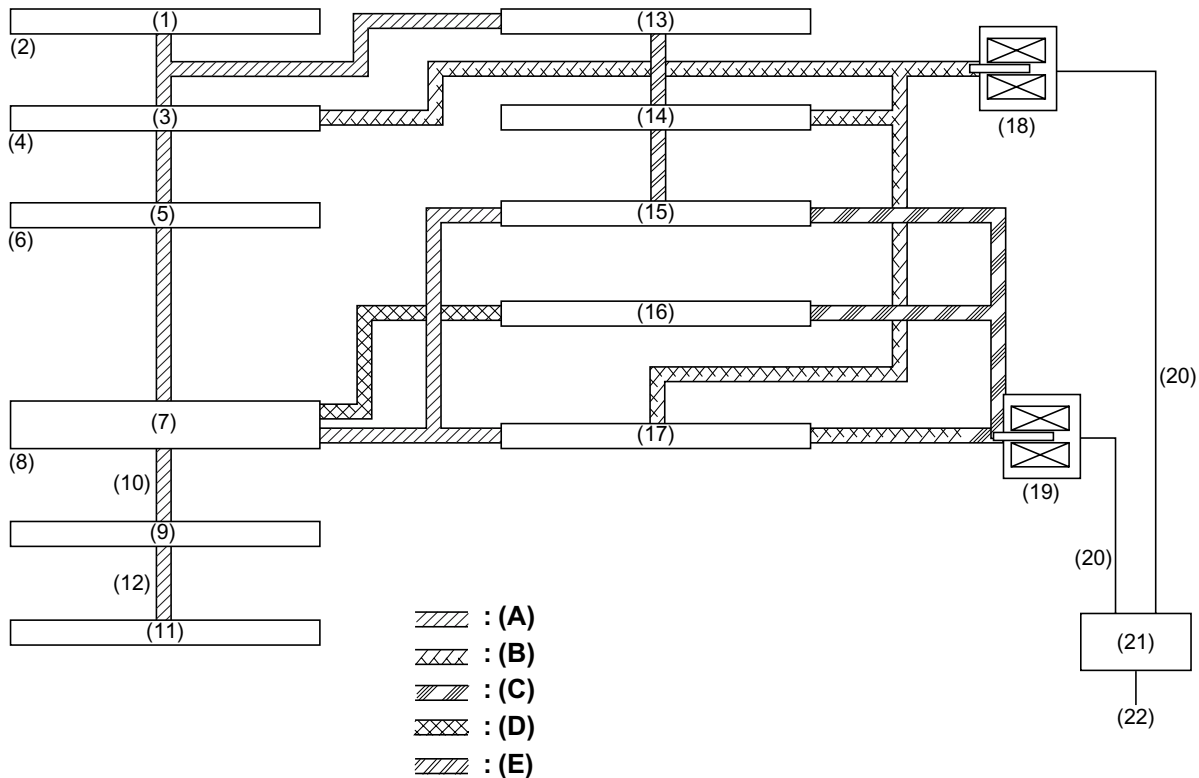
TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

F: LINE-PRESSURE CONTROL DURING SHIFTING

The line pressure which engages shift clutches to create 1st to 4th speeds is controlled by the TCM to meet varying operating conditions.

During gear shifting, the TCM decreases the line pressure to a level that matches the selected gear in order to minimize shifting shock loads.



AT-00429

- | | | |
|--|----------------------------------|--|
| (1) Shift clutches | (11) Oil pan | (21) TCM |
| (2) Transient oil pressure to operate clutches | (12) Suction | (22) Throttle position, accelerator pedal depressing speed, etc. |
| (3) Shift valves | (13) Low clutch accumulator | (A) Line pressure |
| (4) Shift select valve | (14) Low clutch timing valve A | (B) Pilot pressure |
| (5) Manual valves | (15) Accumulator control valve A | (C) Line pressure duty pressure |
| (6) Manual shift valve operated through selector lever | (16) Pressure modifier valve | (D) Modifier pressure |
| (7) Pressure regulator valve | (17) Pilot valve | (E) Accumulator control pressure |
| (8) Line pressure optimally regulated for clutch operation | (18) Shift solenoid 1 and 2 | |
| (9) Oil pump | (19) Line pressure duty solenoid | |
| (10) Line pressure built up by oil pump | (20) Output signal | |

During gear shifting, the TCM controls the line pressure as follows:

- The TCM receives signals such as throttle position signal and accelerator pedal speed signal. Based on these input signals, it issues a control signal to the line pressure duty solenoid.
- The pressure from the line pressure duty solenoid (line pressure duty pressure) is converted by the pressure modifier valve into a modifier pressure, and the modifier pressure is applied to the pressure regulator valve.
- The pressure regulator valve adjusts the oil-pump-generated line pressure according to the modifier pressure to make the line pressure matched to the driving condition.

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

G: SHIFT PATTERN SELECTION CONTROL

1. POWER PATTERN CONTROL

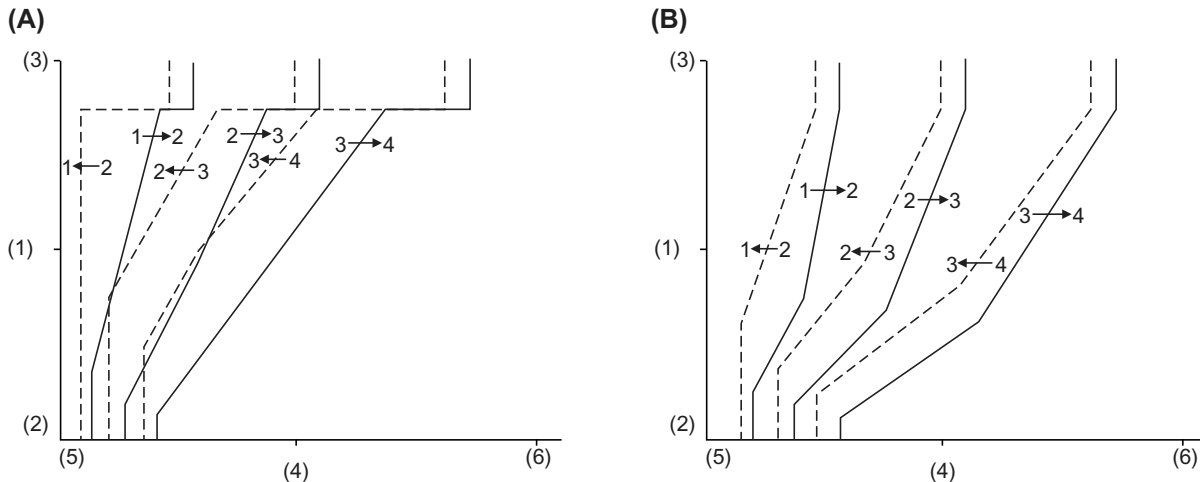
Shift pattern is selectable between the Base pattern suitable for ordinary economy running and the Power pattern suitable for climbing uphill or rapid acceleration.

In the Power pattern, the downshift point and upshift point are set higher than those of the Base pattern.

When the Power pattern is selected, the POWER indicator light in the combination meter lights up.

Selector lever position	Changeover from Base to Power pattern	Changeover from Power to Base pattern	POWER indicator light
D, 3, and 2 ranges	Occurs when POWER switch is turned ON	Occurs when POWER switch is turned OFF	<ul style="list-style-type: none"> • Base pattern: OFF • Power pattern: OFF

The Power pattern selection is possible in the D, 3 or 2 range and only when the hold switch is in the OFF position because the hold pattern control takes precedence over the Power pattern control.



AT-00430

(A) "D" range (Base pattern)

(1) Throttle position

(2) Small

(3) Large

(B) "D" range (Power pattern)

(4) Vehicle speed

(5) Low

(6) High

2. HOLD PATTERN CONTROL

The Hold pattern control enables maintaining the transmission in the selected gear (in the 2, 3, and D ranges) or lower when going up or down steep slopes, running on sand, mud or slippery surfaces.

When the Hold pattern is selected, the HOLD indicator light in the combination meter lights up.

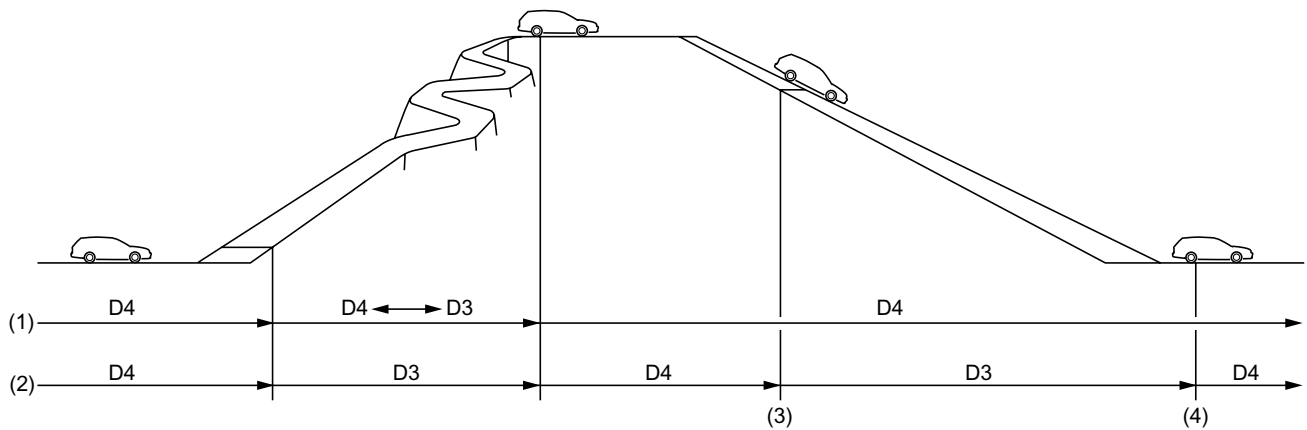
Selector position (HOLD switch ON)	Shift pattern
D range	2nd ↔ 3rd ↔ 4th
3 range	2nd ↔ 3rd ← 4th
2 range	2nd ← 3rd ← 4th

H: GRADE CONTROL

While the vehicle is driving up a hill, the gear is fixed to the 3rd to avoid repeated gear shift between the 3rd and 4th gears.

When the vehicle is descending a steep slope at a speed of approximately 80 km/hour (50 miles/hour), a 4th to 3rd downshift occurs automatically when the brake pedal is depressed. This gearshift control is cancelled when the accelerator pedal is depressed.

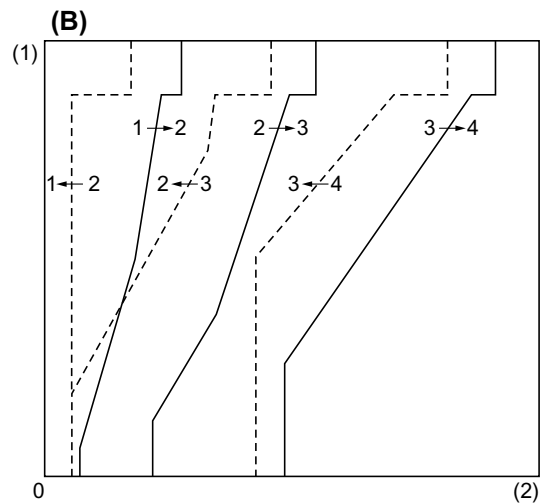
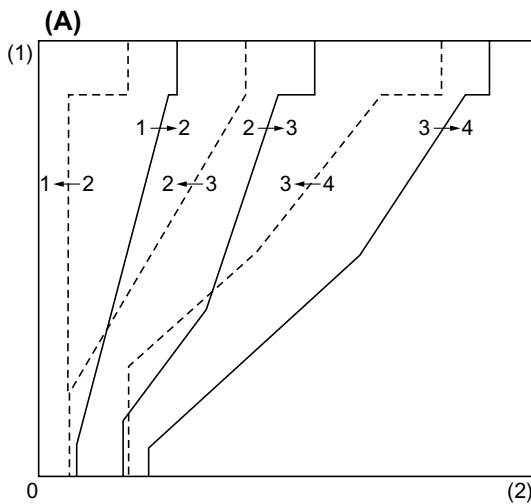
The TCM performs these controls based mainly on the throttle opening, engine speed and vehicle speed.



AT-00431

- (1) Without grade control
- (2) With grade control

- (3) Brake pedal ON
- (4) Re-acceleration



AT-00432

- (A) "D" range (Base pattern)
- (1) Throttle opening

- (B) "D" range (Grade control pattern)
- (2) Vehicle speed

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

I: LEARNING CONTROL

The TCM has a learning control function with which it can adapt gear shift timing optimally to the current vehicle conditions by updating correction factors in the memory.

For this reason, gear shift shock may become larger after the power supply is interrupted (disconnection of battery, flat battery, etc.) or immediately after the ATF is replaced.

Larger gear shift shock after power supply interruption occurs because the correction data is reset to those for the new vehicle condition.

The TCM starts learning function again as soon as the power supply is restored. After driving for a while, therefore, the transmission will become able to make gear shifts at the optimum timing. Larger shift shock immediately after ATF change is caused by change in friction characteristics of the transmission internal parts. Also in this case, the transmission recovers shockless gear shifting after driving for a while.

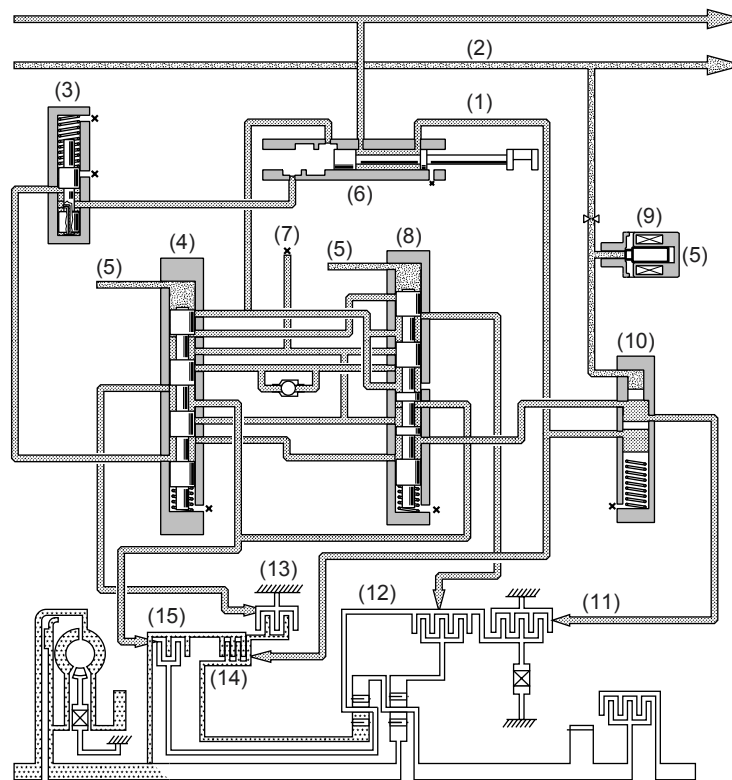
J: REVERSE INHIBITION CONTROL

This control prevents the transmission from shifting into the reverse gear when the select lever is accidentally placed in the R position, thus protecting the components such as reverse clutch from being damaged.

If the selector lever is moved to the R position during driving at a speed faster than the predetermined speed, the low clutch timing solenoid is energized. Then, the pilot pressure is supplied to the reverse inhibitor valve. This causes the reverse inhibitor valve to move downward, closing the low & reverse brake port.

In this condition, the low & reverse brake does not engage since the ATF flowing from the manual valve is blocked by the reverse inhibitor valve.

As a result, the transmission is put into the neutral state, and the shifting into the reverse gear is inhibited.



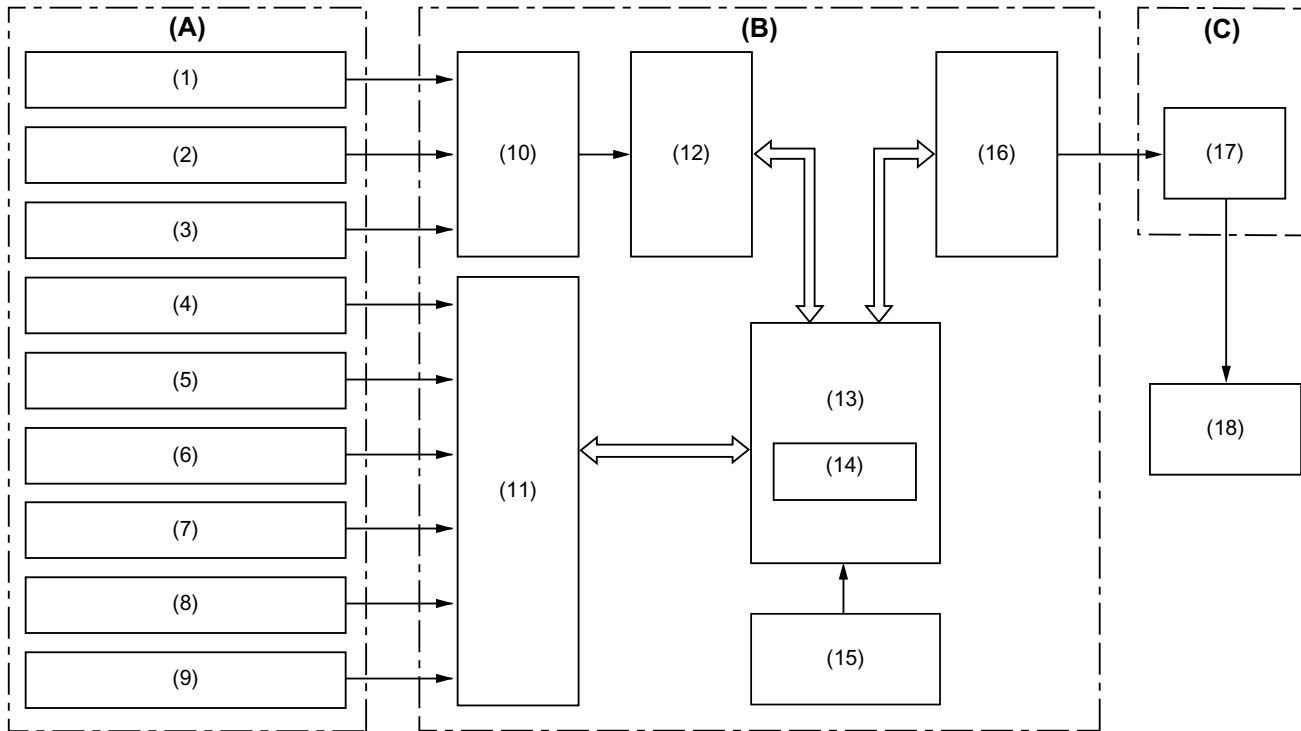
AT-00433

- | | | |
|------------------------|--------------------------------|------------------------------------|
| (1) Line pressure | (6) Manual valve (P range) | (11) Low & reverse brake (Release) |
| (2) Pilot pressure | (7) Drain | (12) Low clutch |
| (3) 1st reducing valve | (8) Shift valve B | (13) 2-4 brake |
| (4) Shift valve A | (9) Low clutch timing solenoid | (14) Reverse clutch |
| (5) ON | (10) Reverse inhibitor valve | (15) High clutch |

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

K: AWD TRANSFER CLUTCH CONTROL



AT-00434

- | (A) Sensor | (B) TCM | (C) Actuator |
|--|------------------------------|-------------------------------|
| (1) Battery voltage | (7) FWD switch | (13) CPU |
| (2) Throttle position sensor | (8) Brake switch | (14) Memory |
| (3) ATF temperature sensor | (9) ABS signal | (15) Constant voltage source |
| (4) Rear vehicle speed sensor (rear wheel rpm) | (10) Input interface circuit | (16) Output interface circuit |
| (5) Front vehicle speed sensor (front wheel rpm) | (11) Input interface circuit | (17) Transfer duty solenoid |
| (6) Inhibitor switch | (12) A/D converter | (18) Transfer clutch |

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

1. BASIC CONTROL

Type of control	Regulates transfer clutch pressure in response to throttle position and vehicle speed.
Gear position	1st thru 4th and reverse
Remarks	<div style="text-align: center;"> <p>AT-00435</p> <p>(1) Normal control (2) Transfer clutch capacity (3) Duty ratio</p> </div>

2. 1 RANGE CONTROL

Type of control	Increases transfer clutch pressure above basic control pressure.
Gear position	1st
Remarks	—

3. SLIP CONTROL

Type of control	Increases transfer clutch pressure to the same level as in the 1 range immediately after a slip is detected.
Gear position	1st thru 4th and reverse
Remarks	Release: The transfer clutch pressure is lowered when a turn under turning control is detected while running faster than the set vehicle speed with fully closed throttle.

4. TURNING CONTROL

Type of control	Decreases transfer clutch pressure upon detection of a turn.
Gear position	1st thru 4th and reverse
Remarks	—

5. ABS CONTROL

Type of control	Regulates to the specified transfer clutch pressure quickly when the ABS signal is input.
Gear position	1st thru 4th and reverse
Remarks	—

TRANSMISSION CONTROL MODULE (TCM)

Automatic Transmission

6. P and N range control

Type of control	Regulates to the specified transfer clutch pressure immediately after a P or N range signal is input.
Gear position	P and N
Remarks	—

L: TRANSFER CONTROL

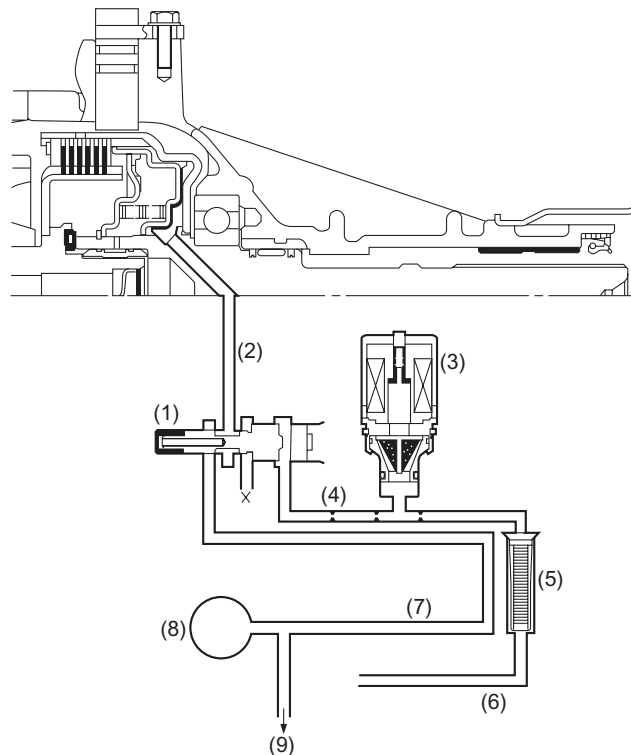
The transfer hydraulic pressure control unit includes a valve body attached to the side of the extension case through a gasket and separator plate.

The pressurized fluids for the transfer hydraulic pressure control (line pressure and pilot pressure) are supplied from the oil pump by way of the passages formed in the transmission case and then the passages in the extension case that lead to the hydraulic circuit in the transfer valve body.

The line pressure is regulated by the transfer control valve whose opening is controlled by the transfer pressure created by the transfer duty solenoid.

- The transfer duty solenoid is controlled by the TCM. The TCM changes the solenoid controlling duty ratio according to the driving conditions.
- The transfer duty solenoid creates the transfer pressure from the pilot pressure. The transfer pressure is applied to the transfer control valve and adjusts the valve's opening.
- The line pressure directly led to the transfer control valve, on the other hand, is regulated by the transfer control valve and becomes the transfer clutch pressure.
- The transfer clutch pressure is applied to the transfer clutch and engages the clutch to a controlled degree.

In this way, the degree of transfer clutch engagement is varied so that optimum torque is distributed to the rear wheels according to vehicle driving conditions.



AT-00436

- | | | |
|------------------------------|-----------------------|-------------------|
| (1) Transfer control valve | (4) Transfer pressure | (7) Line pressure |
| (2) Transfer clutch pressure | (5) Filter | (8) Oil pump |
| (3) Transfer duty solenoid | (6) Pilot pressure | (9) Control valve |

ON-BOARD DIAGNOSTICS SYSTEM

Automatic Transmission

14. On-board Diagnostics System

A: FUNCTION

The on-board diagnostics system detects and stores in the form of a code a fault that has occurred in any of the following input and output signal systems.

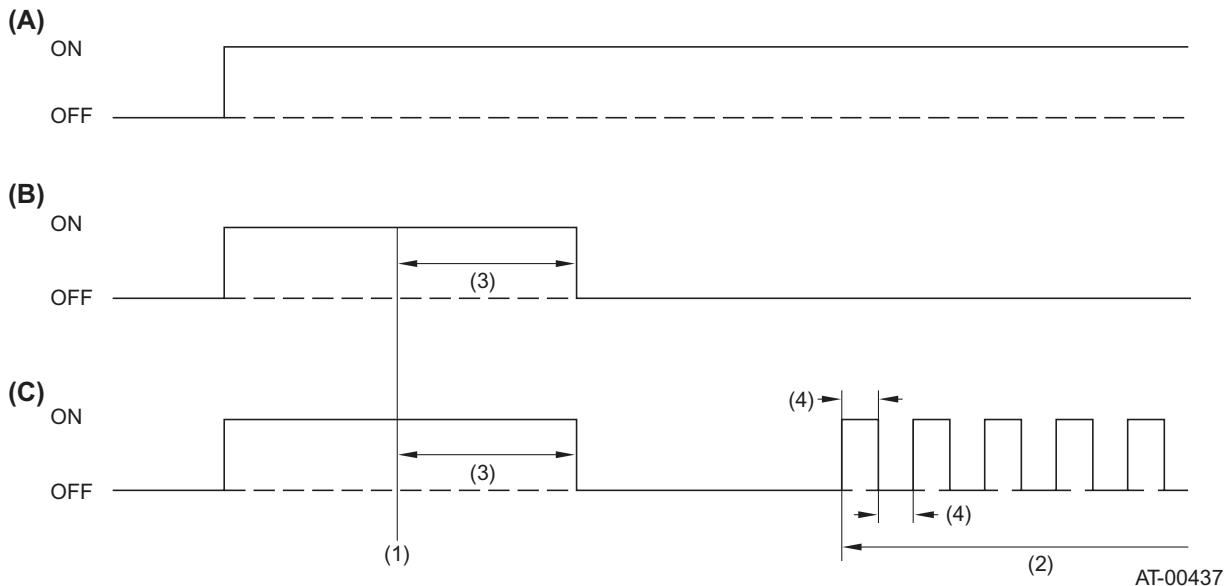
Rear vehicle speed sensor	Transfer duty solenoid	Low clutch timing solenoid
Front vehicle speed sensor	ATF temperature sensor	Torque converter turbine speed sensor
Throttle position sensor	Engine speed signal circuit	—
Shift solenoid 1	Line pressure duty solenoid	—
Shift solenoid 2	AT load signal circuit	—
2-4 brake timing solenoid	Torque control signal circuit	—
Lock-up duty solenoid	2-4 brake duty solenoid	—

If a fault has been detected, the system tells the fault by causing the POWER indicator light to operate as follows:

- Repeated flashing at 4 Hz frequency ...Errors such as battery trouble
- Repeated flashing at 2 Hz frequency ...No faults in the system
- Flashing at different intervals and frequencies ...Diagnostic trouble codes of corresponding faults
- Continued illumination of light ...Fault in inhibitor switch, idle switch, or wiring

B: OPERATION OF POWER INDICATOR LIGHT

On starting the engine, the POWER indicator light illuminates and then goes out as shown in the "Normal" diagram below. If any problem exists, the light continues flashing as shown in the "Abnormal" diagram below.



- (A) Ignition switch to ON (Engine OFF)
(B) Normal
(C) Abnormal

- (1) Engine starts
(2) Flashes
(3) 2 secs
(4) 0.3 secs

AT-00437

C: DIAGNOSTIC TROUBLE CODE

DTC	Faulty component
11	Engine speed signal circuit
23	Mass air flow signal circuit (turbo model)
27	ATF temperature sensor
31	Throttle position sensor
33	Front vehicle speed sensor
36	Torque converter turbine speed sensor
38	Torque control signal circuit
45	Intake manifold pressure signal circuit (non-turbo model)
71	Shift solenoid 1
72	Shift solenoid 2
73	Low clutch timing solenoid
74	2-4 brake timing solenoid
75	Line pressure duty solenoid
76	2-4 brake duty solenoid
77	Lock-up duty solenoid
79	Transfer duty solenoid
93	Rear vehicle speed sensor

D: SELECT MONITOR

Various sensor and switch data as well as diagnostic trouble codes for faults that are currently present and occurred in the past can be monitored by connecting the select monitor to the select monitor terminal located under the instrument panel.

15.Fail-safe Function

The fail-safe control function ensures minimum level of driveability even if a fault should occur in the vehicle speed sensors, throttle position sensor, inhibitor switch, or any of the solenoids.

- FRONT AND REAR VEHICLE SPEED SENSORS

A dual speed-sensing system is used. The speed signal is taken from the transmission (by the output shaft speed sensor). Even if one sensor system fails, the vehicle can be controlled normally with the other normally operating sensor system.

If both the front and rear vehicle speed sensors become faulty, the vehicle is made to operate only in the 1st and 3rd speeds.

- THROTTLE POSITION SENSOR

If the throttle position sensor becomes faulty, the throttle opening is fixed at the predetermined angle.

- INHIBITOR SWITCH

If the TCM receives different signals simultaneously from a faulty inhibitor switch, it selects a range in the following priority:

D > N (P) > R > 3 > 2 > 1 >

- SHIFT SOLENOID 1 AND 2

If a fault occurs in either of solenoids 1 and 2, both the solenoids are de-energized, and the gear is held in the 3rd. If both the solenoids should fail, the TCM invariably selects and keeps the 3rd gear.

- LINE PRESSURE DUTY SOLENOID

If the line pressure duty solenoid fails, the solenoid is de-energized and the line pressure is raised to the maximum to enable the vehicle to operate.

In this condition, the usable gears are limited to the 1st and 3rd.

- LOCK-UP DUTY SOLENOID

If the lock-up duty solenoid fails, the solenoid is de-energized and the lock-up clutch is disengaged.

- TRANSFER DUTY SOLENOID

When the transfer duty solenoid becomes faulty, it is de-energized. This causes maximum oil pressure to be applied to the transfer clutch so that the power is always transmitted to the rear axle (direct-coupled AWD condition).

- 2-4 BRAKE DUTY SOLENOID

If a fault occurs in the 2-4 brake duty solenoid, the solenoid is de-energized and the usable gears are limited to the 1st and 3rd.

- LOW CLUTCH TIMING SOLENOID

If a fault occurs in the low clutch timing solenoid, the solenoid is de-energized and the usable gears are limited to the 1st and 3rd.

- 2-4 BRAKE TIMING SOLENOID

If a fault occurs in the 2-4 brake timing solenoid, the solenoid is de-energized and the usable gears are limited to the 1st and 3rd.

FAIL-SAFE FUNCTION

Automatic Transmission

- TORQUE CONVERTER TURBINE SPEED SENSOR

If a fault occurs in the torque converter turbine speed sensor, the usable gears are limited to the 1st and 3rd.

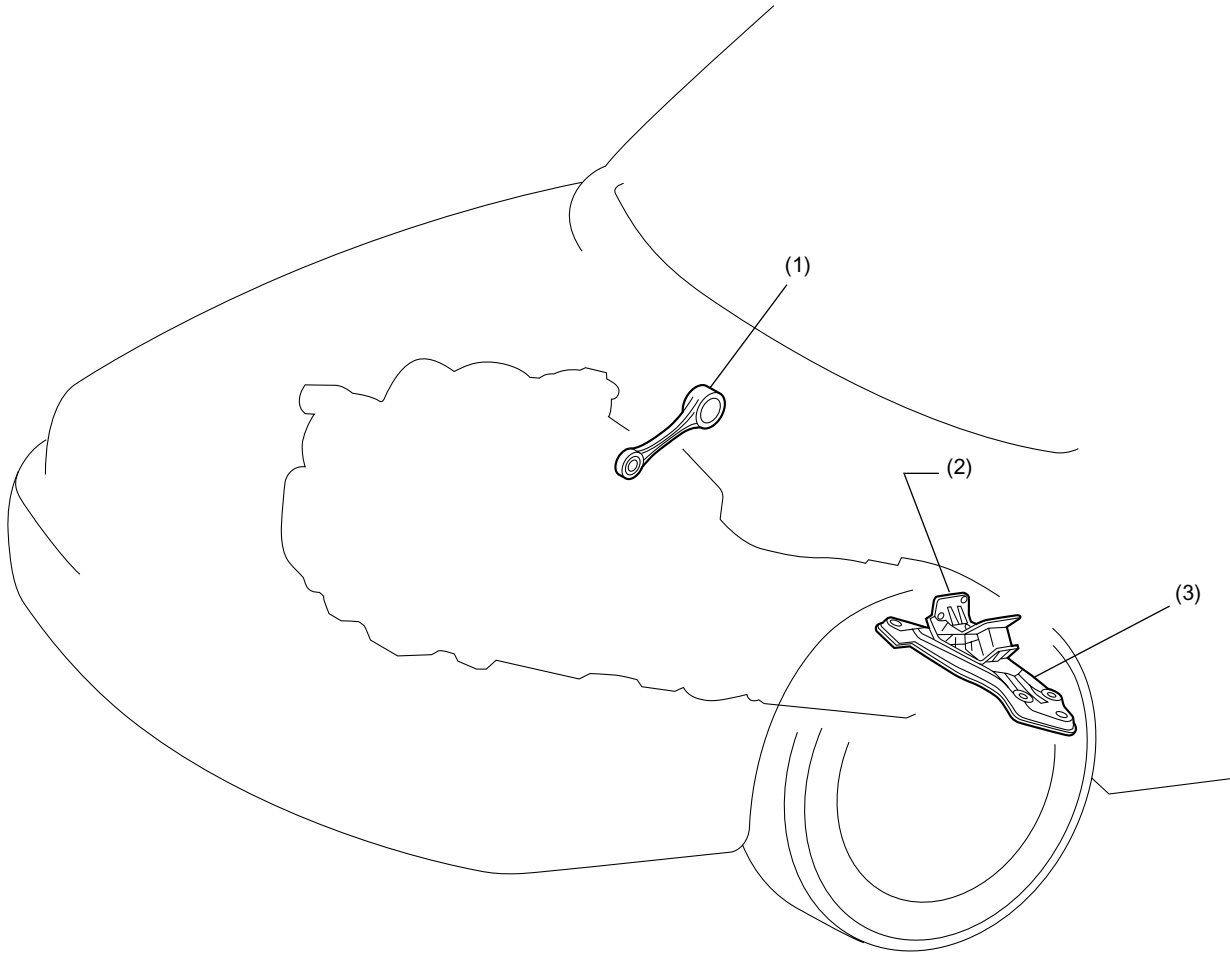
TRANSMISSION MOUNTING

Automatic Transmission

16. Transmission Mounting

A: GENERAL

The transmission mounting consists of a pitching stopper, cushion rubber, and a cross member. In addition to support the transmission, these components absorb noise and vibration caused by the transmission.



AT-00438

- (1) Pitching stopper
- (2) Cushion rubber
- (3) Cross member

MANUAL TRANSMISSION AND DIFFERENTIAL *MT*

	Page
1. General	2
2. Auxiliary Transmission Gears	6
3. Reverse Check Mechanism	7
4. Center Differential	14
5. Oil Pump	20
6. Transmission Mounting	22

1. General

A: SINGLE-RANGE MODEL

The single-range manual transmission is of a full-time all-wheel-drive design integrating a transmission assembly, front differential, and transfer gear assembly with center differential into a single unit. The transmission creates five forward speeds and one reverse using the corresponding gears all provided with inertia lock-key type synchronizers.

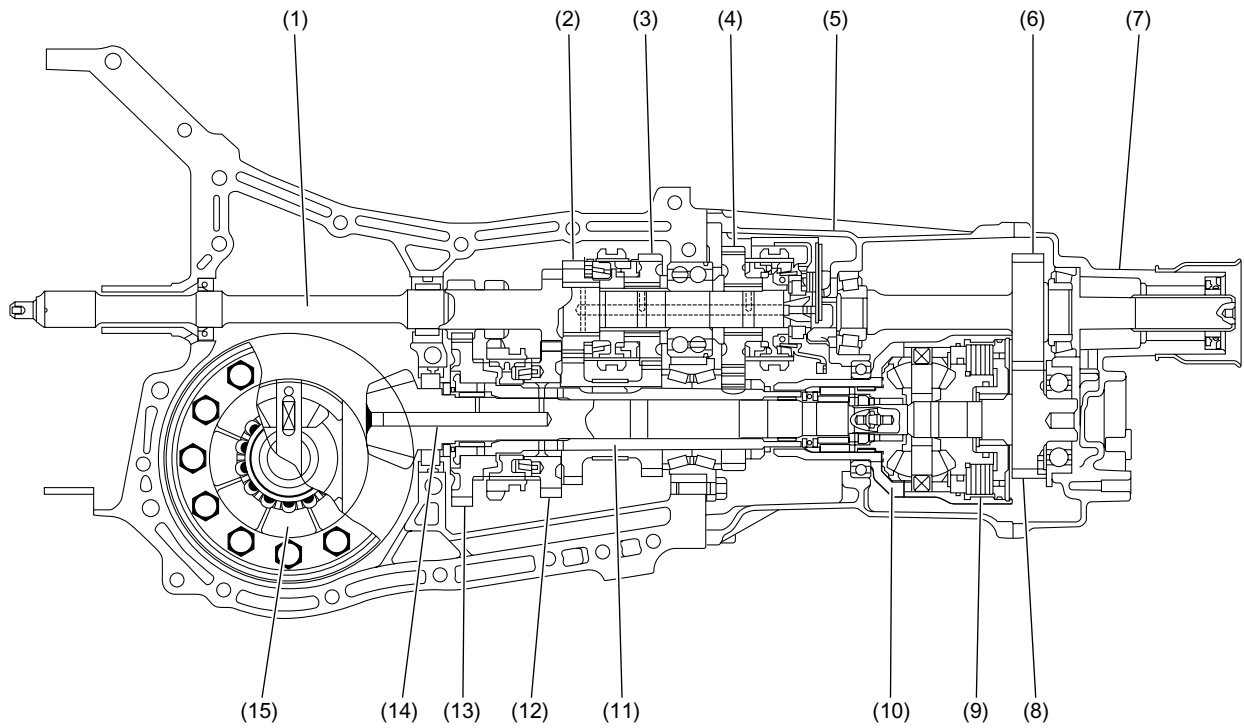
The transmission and front differential are housed in an aluminum case which is split into right and left halves and constitutes also a clutch housing. Located at the rear and joined each other are the transfer case and extension case which house the transfer gears and center differential as well as part of the transmission assembly.

The major features of the transmission are as follows:

- The forward speed gears are helical gears featuring high tooth face strength, large tooth contact areas, and quiet operation.
- Reversing rotation is achieved by making a slidable reverse idler gear engage with both the reverse drive gear on the main shaft and the reverse driven gear integral with the 1st-2nd synchronizer hub on the drive pinion shaft.

The center differential compensates for the difference in front and rear axle speeds. It consists of a bevel gear set and a viscous coupling located at its rear end which are housed in a single case. The center differential, together with a pair of transfer gears, transmits the power from the transmission to the drive pinion shaft (front wheel drive shaft) and the rear drive shaft. The viscous coupling functions as a differential-action-control element.

GENERAL



MT-00320

- | | | |
|--------------------|-----------------------------------|----------------------------------|
| (1) Main shaft | (6) Transfer driven gear | (11) Driven shaft (countershaft) |
| (2) 3rd drive gear | (7) Extension case | (12) 2nd driven gear |
| (3) 4th drive gear | (8) Transfer drive gear | (13) 1st driven gear |
| (4) 5th drive gear | (9) Viscous coupling | (14) Drive pinion shaft |
| (5) Transfer case | (10) Center differential assembly | (15) Front differential assembly |

B: DUAL-RANGE MODEL

The dual-range manual transmission is of a full-time all-wheel-drive design integrating a transmission assembly, front differential, and transfer gear assembly with center differential into a single unit. The transmission creates five forward speeds and one reverse using the corresponding gears all provided with inertia lock-key type synchronizers.

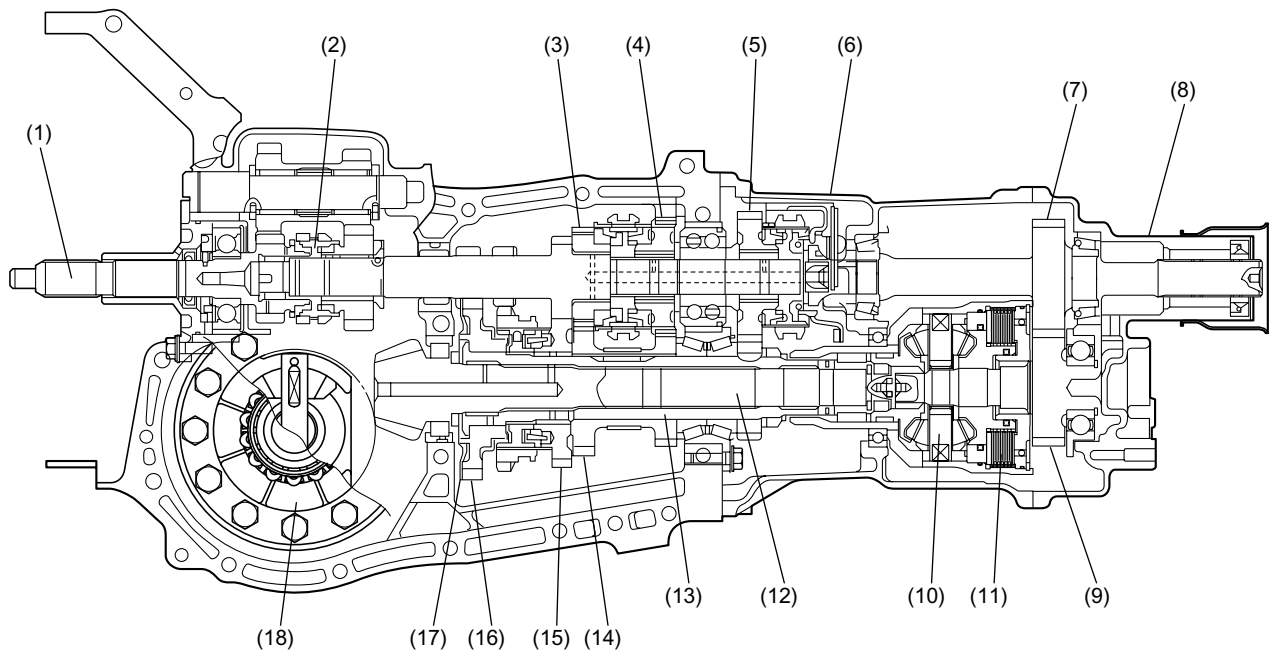
The transmission and front differential are housed in an aluminum case which is split into right and left halves and constitutes also a clutch housing. Located at the rear and joined each other are the transfer case and extension case which house the transfer gears and center differential as well as part of the transmission assembly.

The major features of the transmission are as follows:

- The forward speed gears are helical gears featuring high tooth face strength, large tooth contact areas, and quiet operation.
- Reversing rotation is achieved by making a slidable reverse idler gear engage with both the reverse drive gear on the mainshaft and the reverse driven gear integral with the 1st-2nd synchronizer hub on the drive pinion shaft.
- The 1st driven gear on the drive pinion shaft has a subgear which helps reduce noise during engagement.

The center differential compensates for the difference in front and rear axle speeds. It consists of a bevel gear set and a viscous coupling located at its rear end which are housed in a single case. The center differential, together with a pair of transfer gears, transmits the power from the transmission to the drive pinion shaft (front wheel drive shaft) and the rear drive shaft. The viscous coupling functions as a differential-action-control element.

On the part just above the front differential of the input shaft, there are auxiliary transmission gears of synchromesh design. They provides a dual-range function that allows the driver to select “high” or “low” range as desired. Switching of the range is possible even during driving if the clutch pedal is depressed and then the range selector lever is moved.



MT-00343

- | | | |
|----------------------------------|-----------------------------------|----------------------------------|
| (1) Input shaft | (7) Transfer driven gear | (13) Driven shaft (countershaft) |
| (2) Auxiliary transmission gears | (8) Extension case | (14) 3rd driven gear |
| (3) 3rd drive gear | (9) Transfer drive gear | (15) 2nd driven gear |
| (4) 4th drive gear | (10) Center differential assembly | (16) 1st driven gear |
| (5) 5th drive gear | (11) Viscous coupling | (17) 1st driven sub-gear |
| (6) Transfer case | (12) Drive pinion shaft | (18) Front differential assembly |

AUXILIARY TRANSMISSION GEARS

2. Auxiliary Transmission Gears

The auxiliary transmission gear mechanism consists of the input high gear (integral part of the input shaft), input low gear, counter gear and Hi-Lo coupling sleeve.

- High range

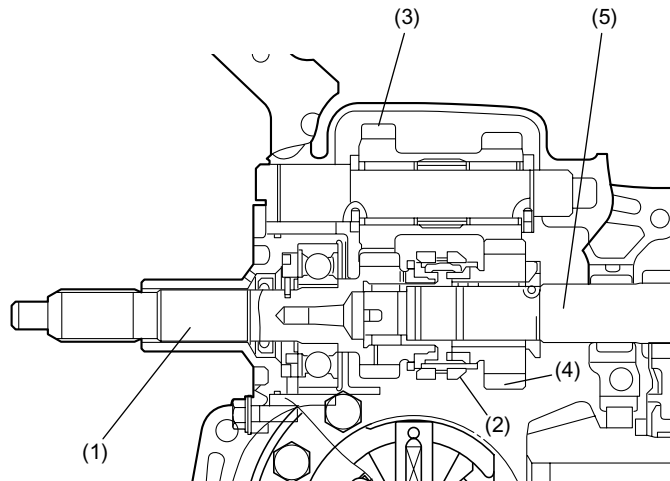
The splines of the Hi-Lo coupling sleeve are in mesh with the splines of the input high gear. The input high gear and the main shaft are directly connected and rotate at the same speed.

The power flow in this range is as follows: input shaft → input high gear → Hi-Lo coupling sleeve → Hi-Lo synchronizer hub → main shaft.

- Low range

The splines on the Hi-Lo coupling sleeve are in mesh with the splines of the input low gear. The input low gear and the main shaft rotate as a unit.

The power flow in this range is as follows: input shaft → counter gear → input low gear → Hi-Lo coupling sleeve and hub → main shaft.



MT-00344

- | | |
|--|--------------------|
| (1) Input shaft (with integrally formed input high gear) | (4) Input low gear |
| (2) Hi-Lo coupling sleeve | (5) Main shaft |
| (3) Counter gear | |

3. Reverse Check Mechanism

Located in the transfer case, the reverse check mechanism prevents a direct 5th-to-reverse shift by using a selector arm and cam combination which allows the gear to be shifted into the reverse only after it has been returned once into the neutral.

A: CONSTRUCTION

The construction of the reverse check mechanism is as shown in the drawing on the opposing page.

The reverse check sleeve is bolted to the transfer case and houses the mechanism's main components.

The reverse accent shaft is slidable inside the reverse check sleeve and its smaller-diameter end is fitted with the reverse check cam. The cam is rotatable and axially movable on the shaft but its leftward movement is restricted by a step formed on the sleeve's inner wall.

The reverse accent shaft has hollows in both ends. In the left end hollow are the 1st return spring and its cap and in the right end hollow is the reverse return spring which pushes the shaft leftward.

Around the check cam is the reverse check spring whose left end applies simultaneous leftward and rotational forces to the cam.

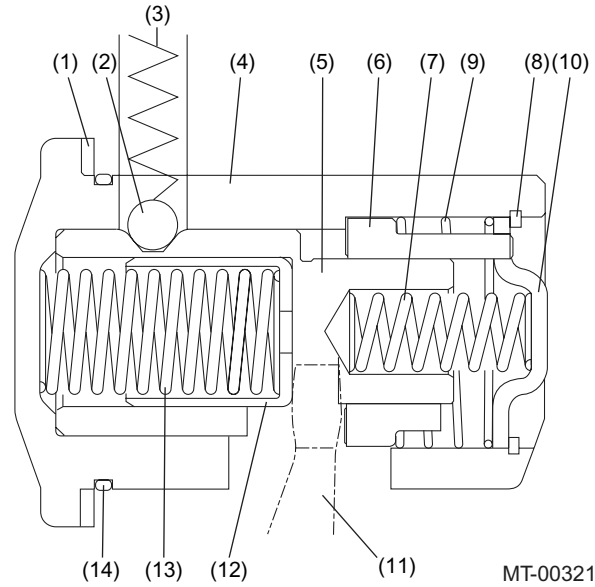
Both the reverse check spring and reverse return spring are retained at their right ends by the reverse check plate which is held in place by the snap ring.

The reverse accent shaft has a V-groove in which the detent ball is pressed by the reverse accent spring fitted through the hole in the reverse check sleeve.

The reverse check sleeve and reverse accent shaft have a slot and a notch at their bottoms, respectively, and the selector arm is inserted in the notch through the slot.

REVERSE CHECK MECHANISM

Manual Transmission and Differential



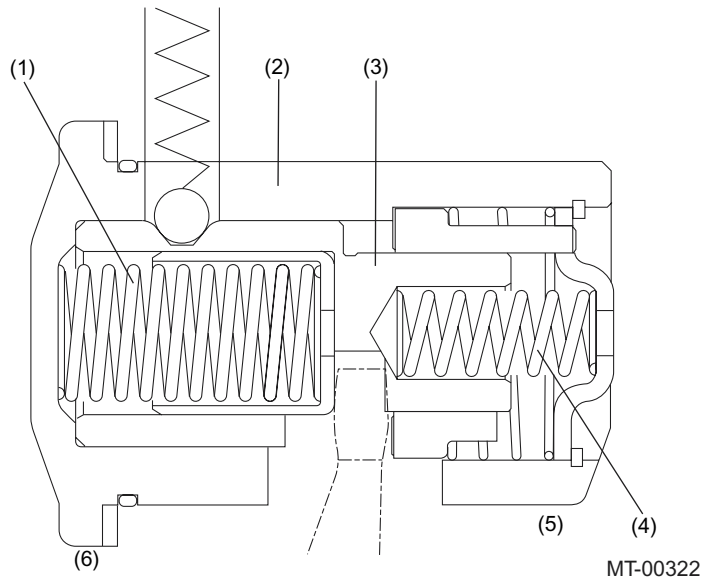
- | | | |
|---------------------------|---------------------------|------------------------|
| (1) Select adjust shim | (6) Reverse check cam | (11) Selector arm |
| (2) Detent ball | (7) Reverse return spring | (12) Spring cap |
| (3) Reverse accent spring | (8) Reverse check spring | (13) 1st return spring |
| (4) Reverse check sleeve | (9) Snap ring | (14) O-ring |
| (5) Reverse accent shaft | (10) Reverse check plate | |

REVERSE CHECK MECHANISM

B: OPERATION

The drawing below shows the state of the reverse check mechanism when the selector arm is in the neutral position. The 1st and 2nd gears will be selected if the selector arm is moved leftward from this point to a stop and then turned in either way. A rightward movement of the arm to a stop will enable selection of the 5th and reverse gears. In the neutral position, the selector arm receives a rightward force (force toward the 5th and reverse gear side) from the 1st return spring and a leftward force (force toward the 1st and 2nd gear side) from the reverse return spring to stay in that position.

The following explanation describes how the selector arm and reverse check mechanism operate when the driver selects the 5th gear and then selects the reverse gear.



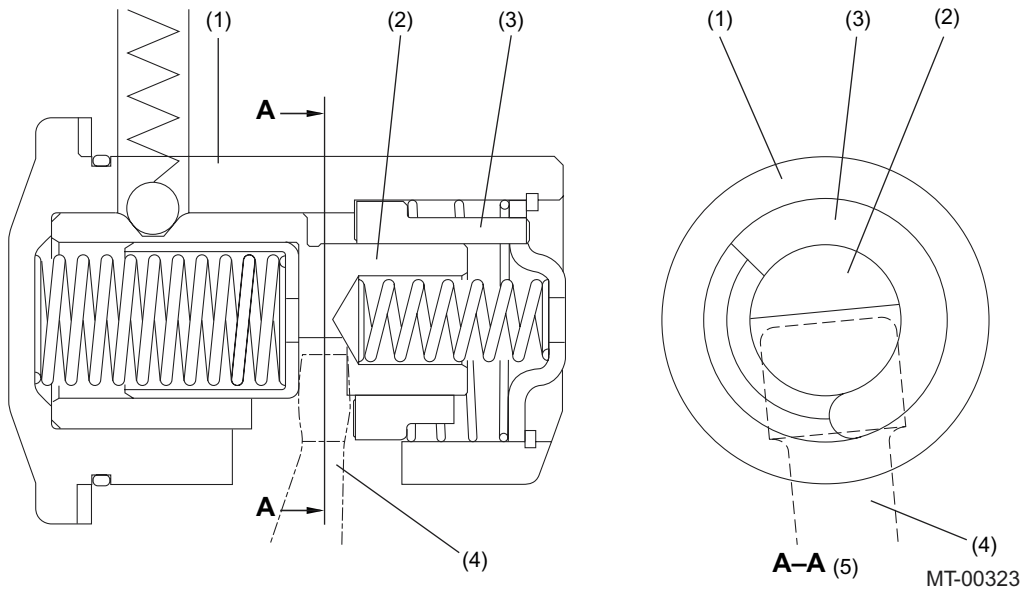
- | | | |
|--------------------------|---------------------------|-------------------------------|
| (1) 1st return spring | (3) Reverse accent shaft | (5) 5th and reverse gear side |
| (2) Reverse check sleeve | (4) Reverse return spring | (6) 1st and 2nd gear side |

REVERSE CHECK MECHANISM

Manual Transmission and Differential

1. WHEN SELECTOR ARM IS MOVED TOWARD 5TH AND REVERSE GEAR SIDE

The selector arm moves rightward while pushing both the reverse accent shaft and reverse check cam simultaneously.



- (1) Reverse check sleeve
- (2) Reverse accent shaft

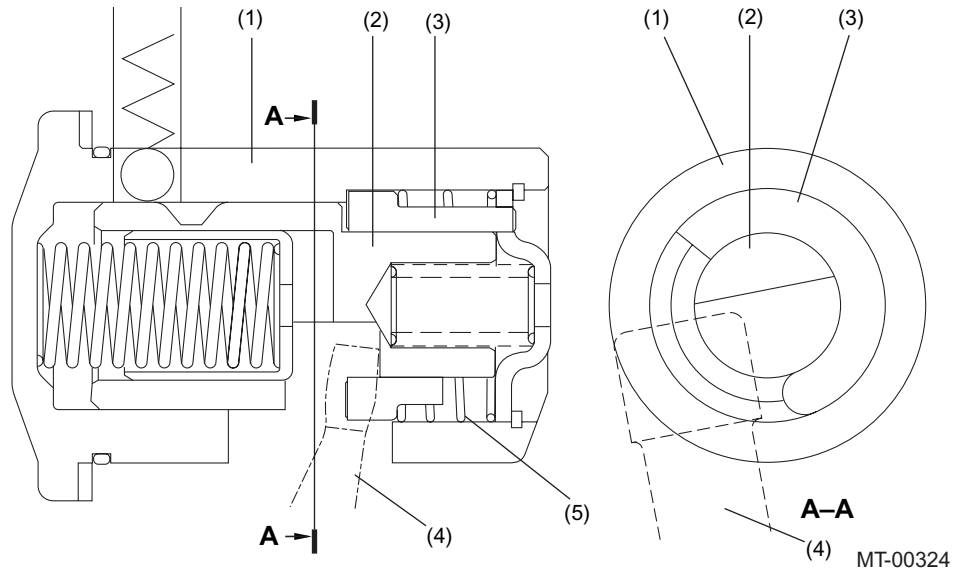
- (3) Reverse check cam
- (4) Selector arm

- (5) Neutral position

REVERSE CHECK MECHANISM

2. WHEN SHIFT IS MADE TO 5TH GEAR

The selector arm is turned toward the 5th gear selection direction. When the arm clears the edge of the reverse check cam as it turns, the cam becomes free of the selector arm's pressure and returns to its original position by the force of the reverse check spring.



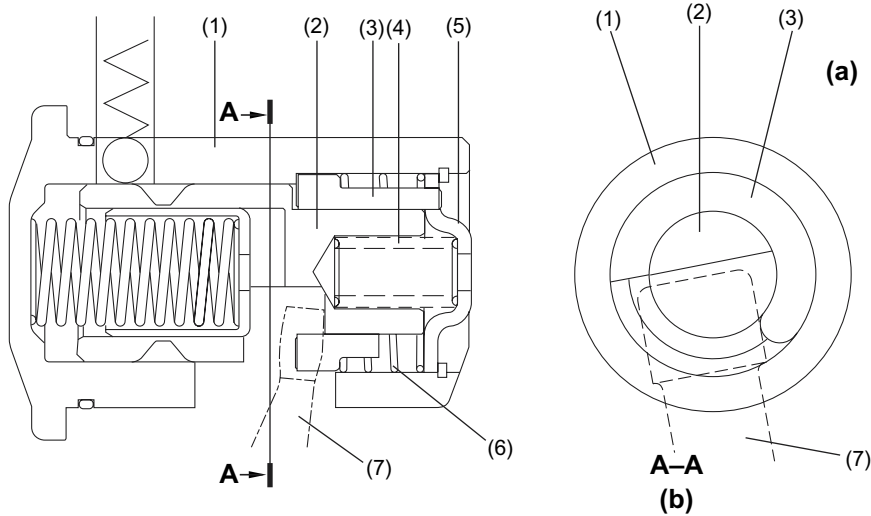
- (1) Reverse check sleeve
- (2) Reverse accent shaft
- (3) Reverse check cam
- (4) Selector arm
- (5) Reverse check spring

REVERSE CHECK MECHANISM

3. WHEN A SHIFT FROM 5TH TO REVERSE IS ATTEMPTED

The selector arm turns toward the reverse gear while pushing the reverse accent shaft rightward and the reverse check cam counterclockwise (as viewed in the direction of arrows A).

The reverse check cam, however, stops to rotate at a point where its stopper hits against the reverse check plate (this point corresponds to the neutral position in terms of the angle) and prevents the selector arm from moving toward the reverse gear selection direction. The selector arm is then axially pushed to the neutral position by the reverse accent shaft which is given a leftward force by the reverse return spring.



MT-00347

- (1) Reverse check sleeve
- (2) Reverse accent shaft
- (3) Reverse check cam
- (4) Reverse return spring

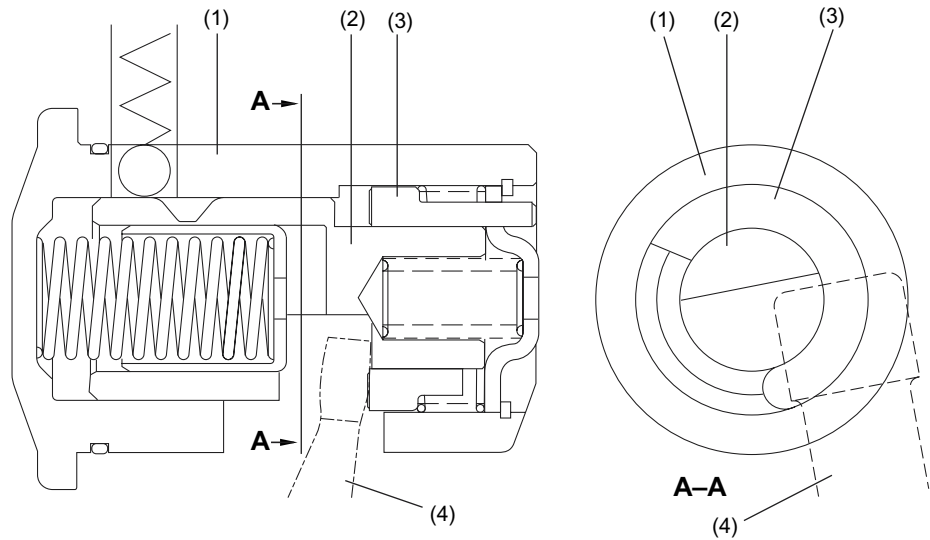
- (5) Reverse check plate
- (6) Snap ring
- (7) Selector arm

- (a) Position at "5th → Neutral position"
- (b) 5th → Neutral position

REVERSE CHECK MECHANISM

4. WHEN A SHIFT TO REVERSE IS MADE AFTER RETURN OF SELECTOR ARM TO NEUTRAL

As the ends of the reverse accent shaft and the reverse check cam are on the same plane, the selector arm now can turn toward the reverse gear selection direction after pushing leftward both the shaft and cam simultaneously.



MT-00326

- (1) Reverse check sleeve
- (2) Reverse accent shaft

- (3) Reverse check cam
- (4) Selector arm

CENTER DIFFERENTIAL

4. Center Differential

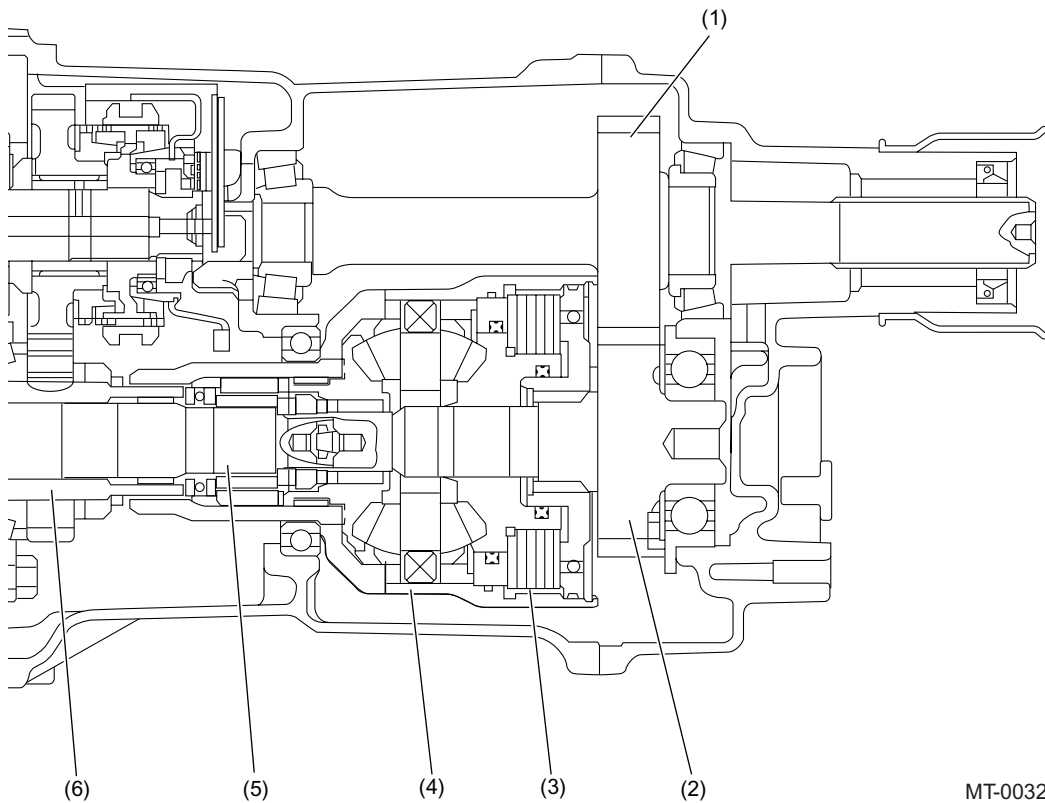
A: CONSTRUCTION

The center differential consists of a set of bevel gears and a viscous coupling.

The center differential has the following two functions: distributing the engine torque to the front and rear wheel drive shafts and absorbing the difference in rotating speed between the front and rear wheels.

The engine torque enters the center differential case from the transmission's driven shaft. The torque is then distributed through the bevel gear set directly to the drive pinion shaft and via the transfer drive and driven gears to the rear drive shaft.

The viscous coupling limits the bevel gear set's differential action when either front or rear wheels spin so that adequate torques are transmitted to the front and rear wheels and proper traction is obtained.

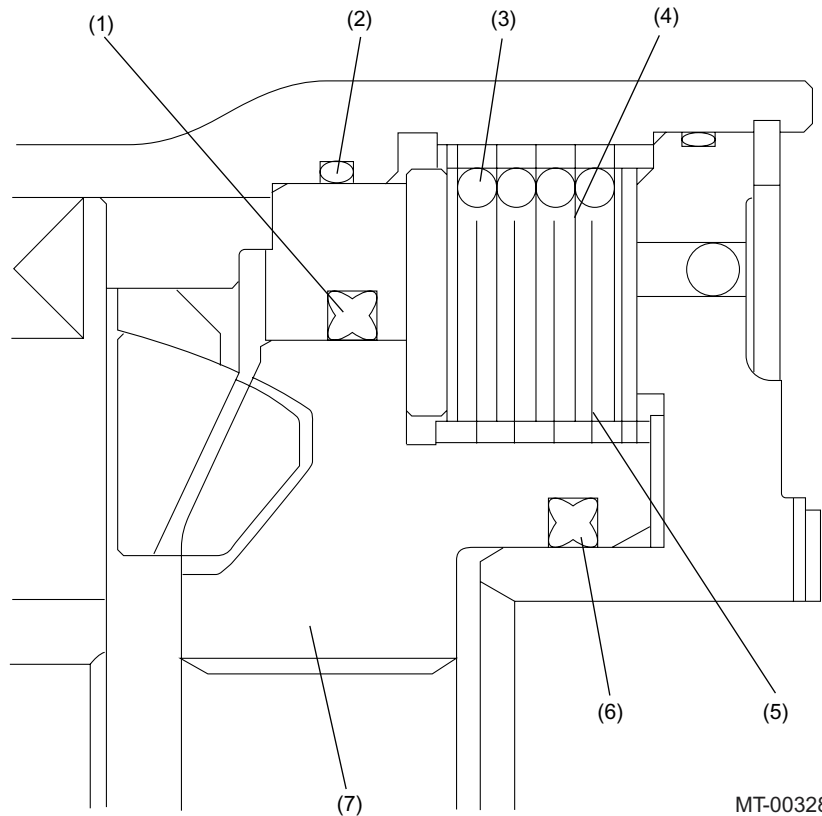


MT-00327

- | | |
|--------------------------|---|
| (1) Transfer driven gear | (4) Center differential (with viscous coupling) |
| (2) Transfer drive gear | (5) Drive pinion shaft |
| (3) Viscous coupling | (6) Driven shaft |

B: MECHANISM OF VISCOUS COUPLING

The viscous coupling consists of a number of alternately arranged inner and outer plates and air-and-silicone oil mixture filled into a sealed space that is formed by the center differential case and the rear side gear of the differential gear set. The inner plates have their inner perimeters splined to the side gear and the outer plates have their outer perimeters splined to the center differential case. The outer plates are held apart by spacer rings. There are no spacer rings between the inner rings, so the inner plates are movable slightly in axial directions. X-section rings are used to prevent leakage of silicone oil which would otherwise occur if the oil is heat expanded and pressurized due to large difference in front and rear axle speeds.



MT-00328

- (1) X-section ring
- (2) O-ring
- (3) Spacer ring
- (4) Outer plate

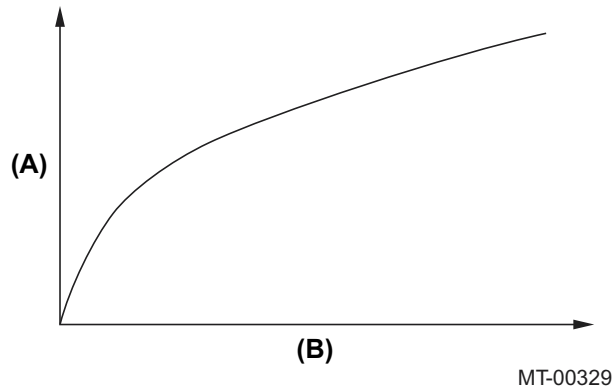
- (5) Inner plate
- (6) X-section ring
- (7) Side gear (rear)

CENTER DIFFERENTIAL

1. TORQUE CHARACTERISTICS

When a speed difference occurs between the center differential case and the rear side gear, a viscosity shearing force is generated in the silicone oil placed between the outer and inner plates. The torque is then transmitted by the silicone oil between the center differential case and the rear side gear.

The greater the speed difference, the greater the viscosity shearing force generated in the silicone oil. The relationship between the torque transmission and the speed difference is shown in the figure below. As can be seen from the figure, the smaller the speed difference, the smaller the torque transmission and the differential action.



(A) Drive torque

(B) Speed difference

2. HUMP PHENOMENON

Silicone oil is heated and expanded as differential action continues. This causes the pressure of air inside the viscous coupling to increase and the pressure of oil between plates to decrease. As a result, the inner and outer plates are pushed together. This direct plate-to-plate contact causes a non-viscous operation to occur. This phenomenon is called “hump”.

The hump eliminates the rotating speed difference between the center differential case and the rear side gear (or locks the differential), so soon after it has occurred, the internal pressure and temperature drop. The viscous coupling then returns to the normal viscosity shearing torque transmitting operation. (The hump phenomenon does not occur under normal operating conditions.)

CENTER DIFFERENTIAL

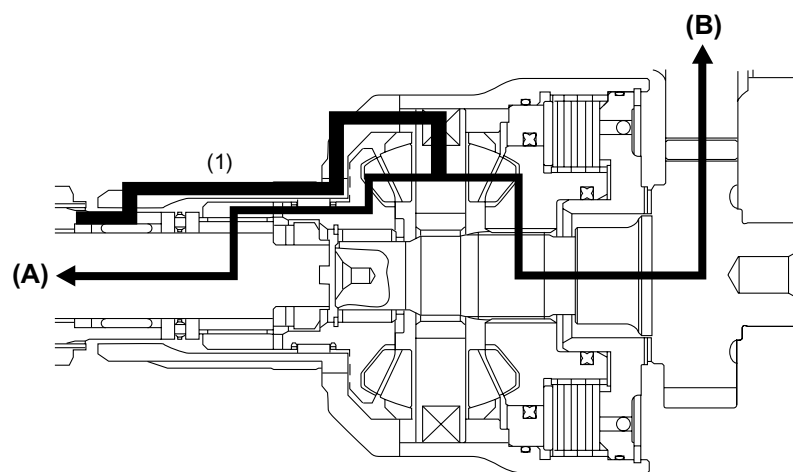
C: FUNCTION

When there is no speed difference between the front and rear wheels, the center differential delivers the engine torque to the front and rear wheels at a ratio of 50:50.

When a rotating speed difference occurs between the front and rear wheels, the center differential operates to absorb it in a controlled way by the function of the viscous coupling.

1. DURING NORMAL DRIVING

During straight-line driving on a flat road at a constant speed, all the four wheels rotate at the same speed. The center differential delivers engine torque evenly to the front and rear wheels. The viscous coupling does not generate viscosity shearing torque because there is no relative movements between the inner and outer plates.



MT-00330

(1) Engine torque

(A) To front differential

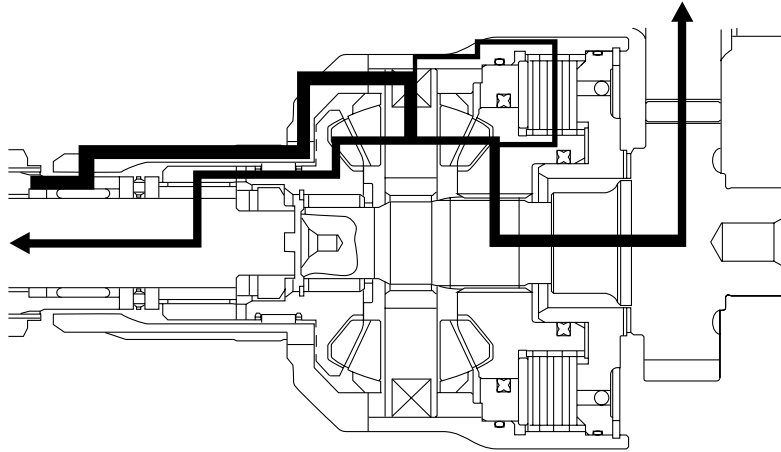
(B) To rear differential

CENTER DIFFERENTIAL

2. DURING TURNS AT LOW SPEEDS

During turns at low speeds, rotating speed difference occurs between the front and rear wheels, as well as between the left and right wheels. More particularly, the front wheels rotate faster than the rear wheels. The center differential then acts to absorb the speed difference to enable smooth driving.

Although the speed difference is small under this condition, operation of the viscous coupling causes more torque to be transmitted to the rear than to the front.

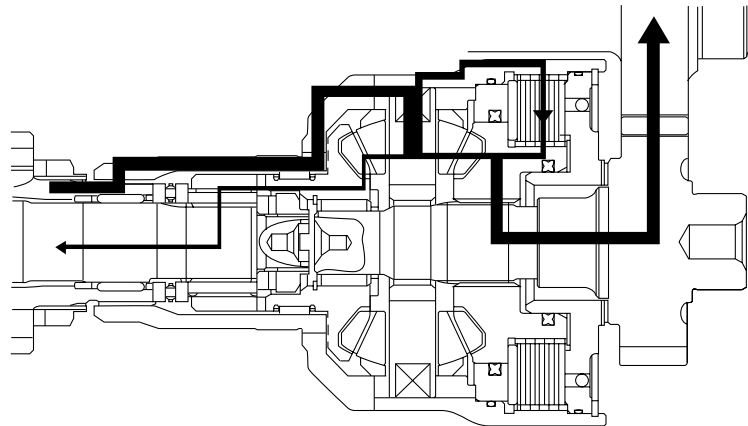


MT-00331

3. DRIVING ON ROUGH OR SLIPPERY ROADS

- When front wheels are on a slippery surface

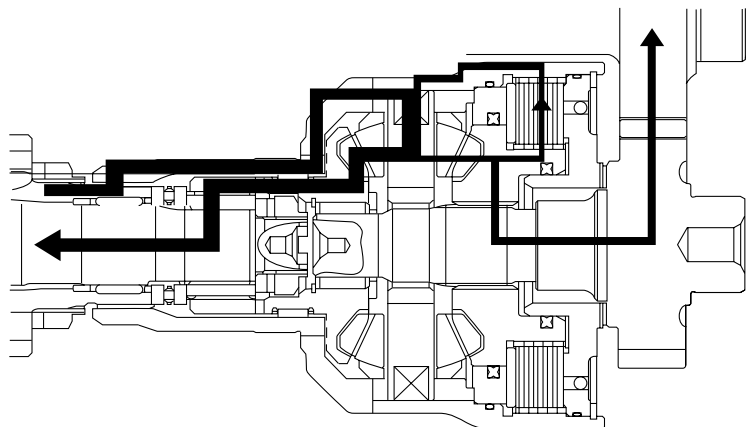
When the front wheels begin to spin, the resulting speed difference between the front and rear drive shafts causes the viscous coupling to generate significant amount of viscosity shearing torque. As a result, the torque distributed to the rear wheels becomes much larger than that distributed to the spinning front wheels. The traction and driving stability are thus ensured on a rough or slippery road.



MT-00332

- When rear wheels are on a slippery surface

When the vehicle is accelerated quickly from a standing start with the rear wheels on a slippery surface, the distribution of the vehicle weight on the front and rear wheels changes and the rear wheels start spinning. Due to the resulting speed difference between the front and rear drive shafts, the viscous coupling generates a significant amount of viscosity shearing torque, now in the direction opposite to that generated when the front wheels are on a slippery surface. As a result, the torque distributed to the front wheels becomes much larger than that distributed to the rear wheels.



MT-00367

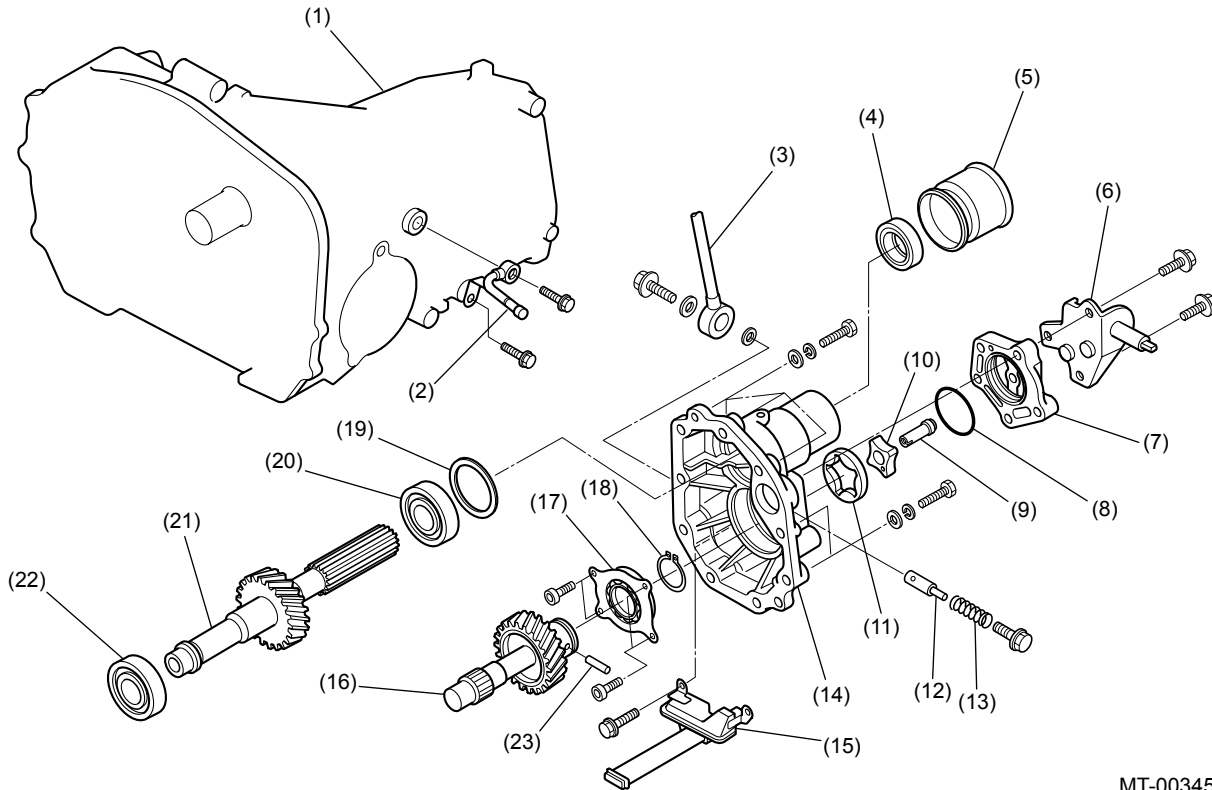
OIL PUMP

5. Oil Pump

A: CONSTRUCTION

The turbo model's manual transmission is provided with an oil pump at the rear end of the extension case.

After being sucked by the oil pump through the oil strainer in the transfer, the transmission gear oil is sent to the oil cooler in the radiator through the outlet pipe in the extension case. The transmission gear oil cooled down there is then routed back to the transmission case through the inlet pipe in the transmission case.

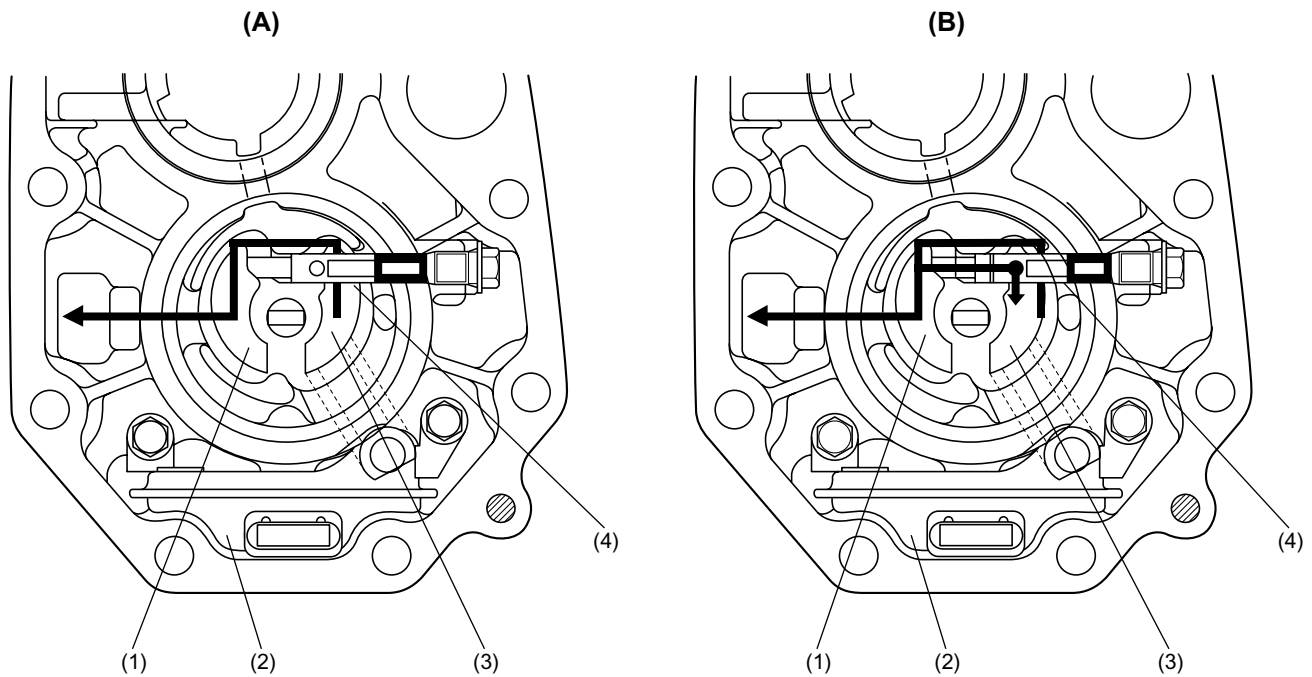


MT-00345

- | | | |
|-----------------------|--------------------------|---------------------------|
| (1) Transmission case | (9) Oil pump shaft | (17) Ball bearing |
| (2) Inlet pipe | (10) Inner rotor | (18) Snap ring |
| (3) Outlet pipe | (11) Outer rotor | (19) Washer |
| (4) Oil seal | (12) Relief valve | (20) Taper roller bearing |
| (5) Dust cover | (13) Return spring | (21) Transfer driven gear |
| (6) Bracket | (14) Extension case | (22) Taper roller bearing |
| (7) Oil pump cover | (15) Oil strainer | (23) Straight pin |
| (8) O-ring | (16) Transfer drive gear | |

B: FUNCTION

The oil pump is a trochoid type oil pump and is driven together with the transfer driven gear. The oil pump is provided with a relief valve. This valve opens when the transmission gear oil temperature rises beyond the predetermined level, allowing some part of the transmission gear oil that entered the discharge chamber to flow back into the suction chamber through the passage in it to stabilize the oil pressure.



MT-00346

(A) Normal

(B) When oil pressure is high

(1) Discharge chamber

(2) Oil strainer

(3) Suction chamber

(4) Relief valve

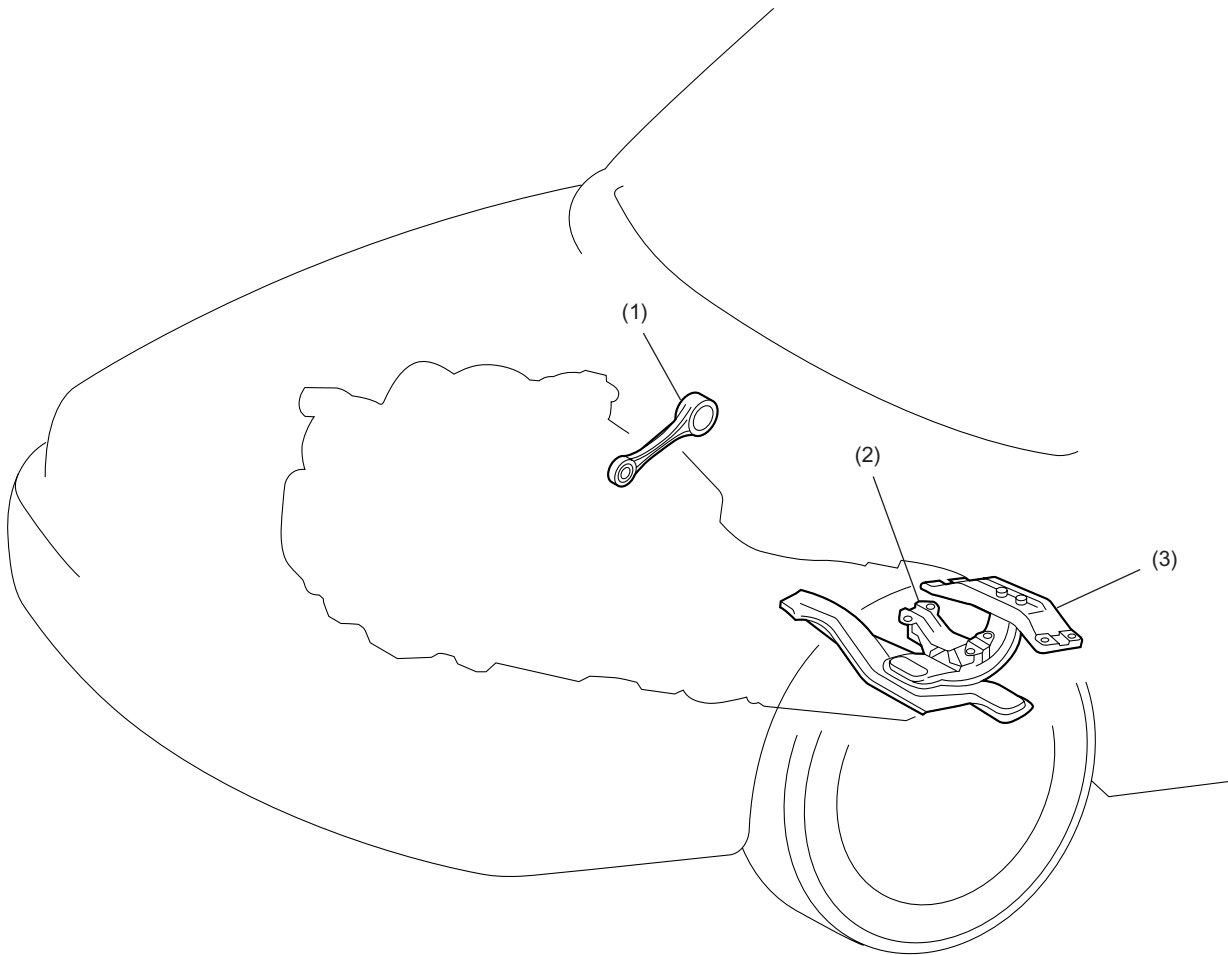
TRANSMISSION MOUNTING

Manual Transmission and Differential

6. Transmission Mounting

A: GENERAL

The transmission mounting consists of a pitching stopper, cushion rubber, and a cross member. In addition to support the transmission, these components absorb noise and vibration caused by the transmission.



MT-00334

(1) Pitching stopper

(2) Cushion rubber

(3) Cross member

CLUTCH *CL*

	Page
1. Outline	2
2. Operation	3
3. Cross Sectional View	4
4. Flywheel	8
5. Hydraulic Clutch Pedal System	9

1. Outline

A: NON-TURBO MODEL

- The clutch control operates the release fork using the hydraulic pressure generated in the master cylinder when the pedal is depressed.
- The clutch itself is a push type clutch. When the clutch pedal is depressed, the self-aligning release bearing is caused to slide on a guide pressing the center of the diaphragm spring. The warped diaphragm spring disengages the pressure plate from the clutch disc.
- The clutch has a clutch disc between the flywheel and the pressure plate.
- Inside the clutch cover, there is a cover and a pressure plate combined with each other by means of strap plates, which also serve to prevent the pressure plate from relatively turning.

B: TURBO MODEL

- The turbo model adopts a hydraulic control which is appropriate for increased clutch load.
- The clutch control system operates the release fork using the hydraulic pressure that is generated in the master cylinder when the clutch pedal is depressed.
- The clutch itself is a pull type clutch. When the clutch pedal is depressed, the self-aligning release bearing is caused to slide on a guide pulling the center of the diaphragm spring. The warped diaphragm spring disengages the pressure plate from the clutch disc.
- The clutch has a clutch disc between the flywheel and the pressure plate.
- Inside the clutch cover, there is a cover and a pressure plate combined with each other by means of strap plates, which also serve to prevent the pressure plate from relatively turning against to the clutch cover.

2. Operation

A: NON-TURBO MODEL

Applying foot pressure to the clutch pedal moves the release lever. This causes the release bearing to slide on the guide, pressing the center of the diaphragm spring. The diaphragm spring is warped and the force having pressed the pressure plate is released. As a result, the flywheel, clutch disc and pressure plate are disengaged, disconnecting the driving power.

The push type clutch has the point of action at the peripheral tips of the diaphragm spring fingers, through which the pressure plate is pressed to the clutch disc. When the power transmission is to be interrupted, the diaphragm spring is forced to warp using the pivots established on the inward side of the spring finger tips (on the principle of the lever and fulcrum) to disengage the pressure plate from the clutch disc.

B: TURBO MODEL

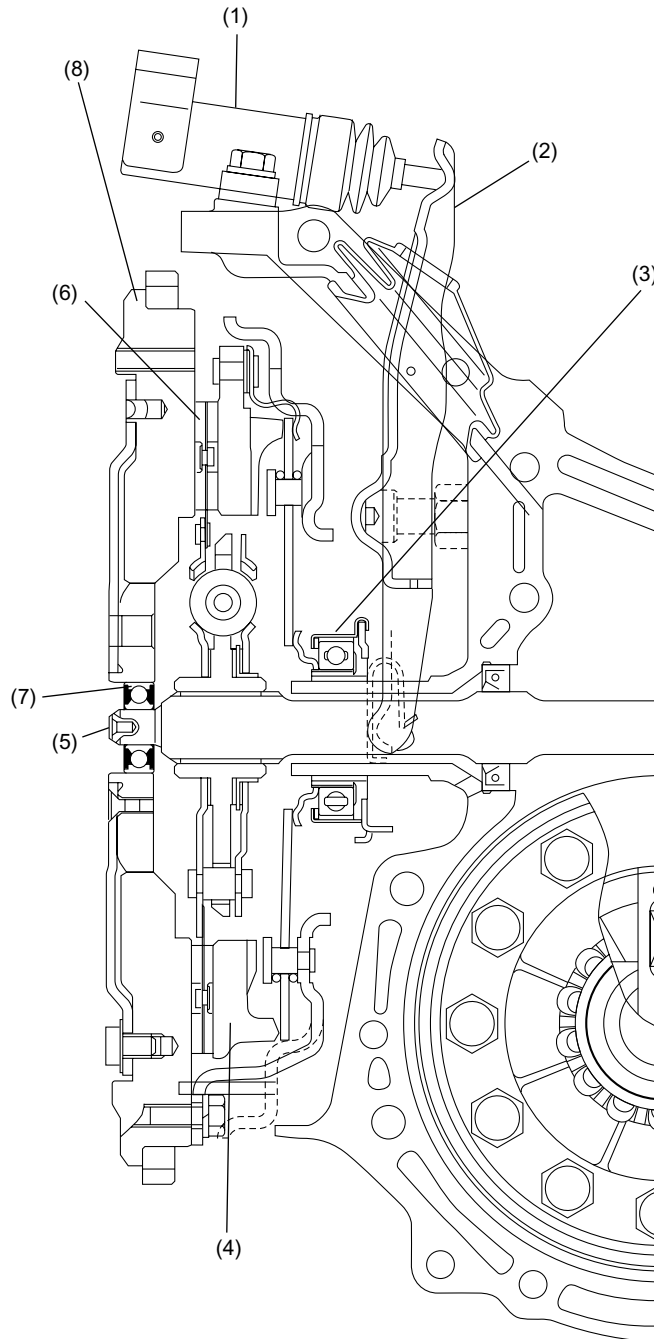
Applying foot pressure to the clutch pedal moves the release lever. This causes the release bearing to slide on the guide, pulling the center of the diaphragm spring. The diaphragm spring is warped and the force having pressed the pressure plate is released. As a result, the flywheel, clutch disc and pressure plate are disengaged, disconnecting the driving power.

In the pull type clutch, the diaphragm spring has the point of action located inward from the tip, through which the pressure plate is pressed against the clutch disc. When the power transmission is to be interrupted, the diaphragm spring is forced to pivot on the tip and warp away from the pressure plate (on the principle of lever and fulcrum).

CROSS SECTIONAL VIEW

Clutch

3. Cross Sectional View A: EXCEPT 2.5L RHD MODELS



CL-00085

CROSS SECTIONAL VIEW

Clutch

(1) Operating cylinder

(2) Release lever

(3) Release bearing

(4) Clutch cover

(5) Transmission main shaft

(6) Clutch disc

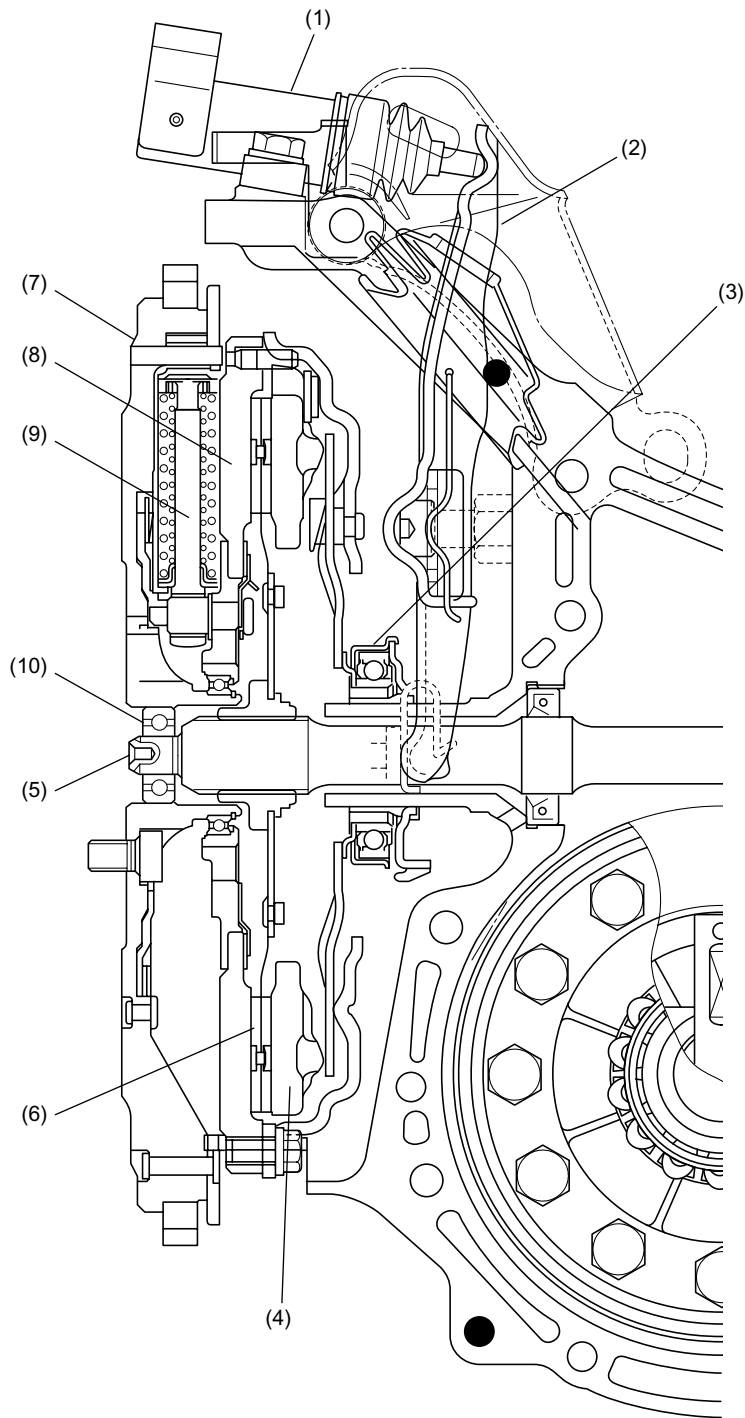
(7) Pilot bearing

(8) Flywheel

CROSS SECTIONAL VIEW

Clutch

B: 2.5L RHD MODELS



CL-00118

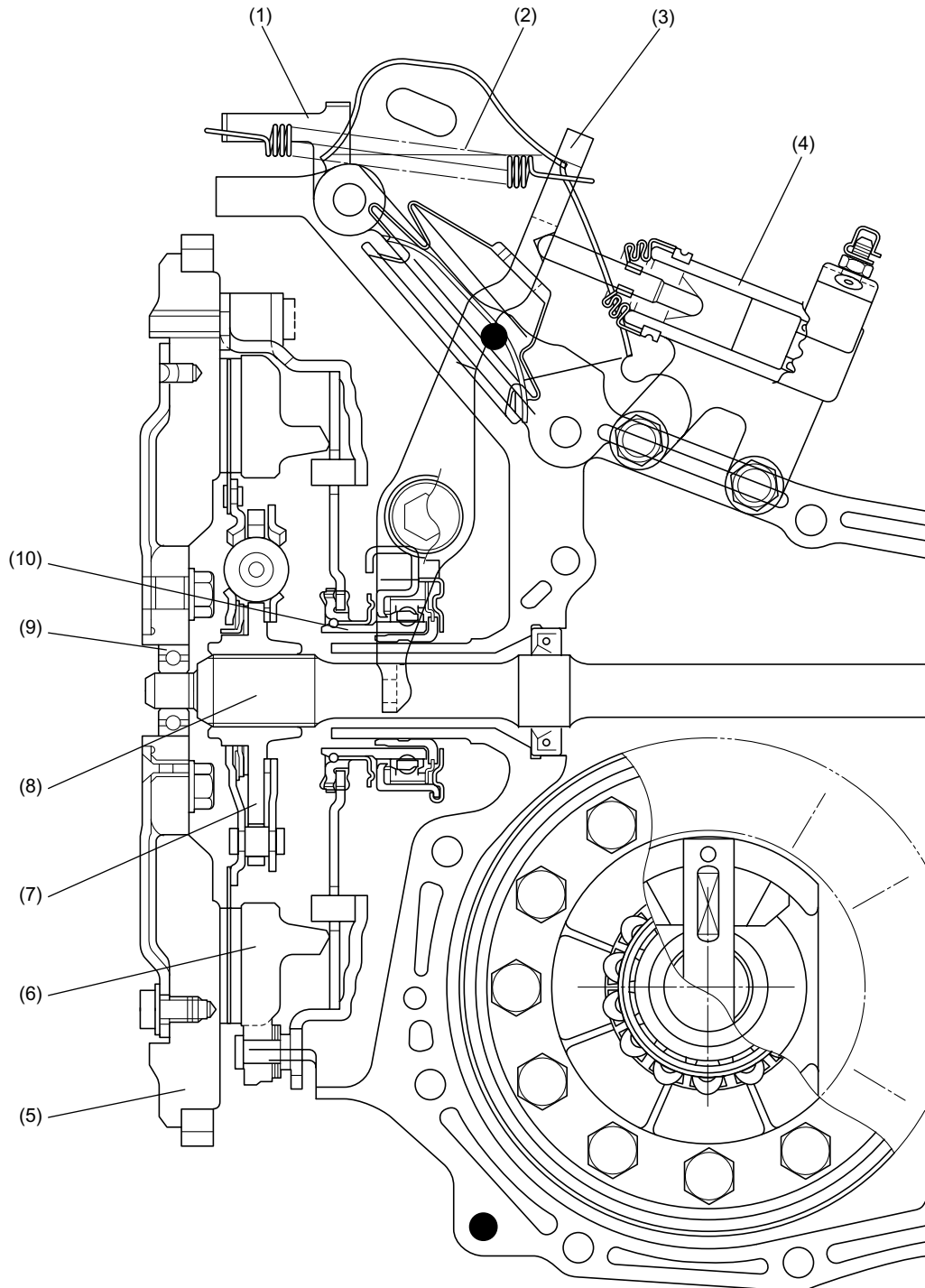
- | | | |
|------------------------|-----------------------------|--------------------|
| (1) Operating cylinder | (5) Transmission main shaft | (9) Spring box |
| (2) Release lever | (6) Clutch disc | (10) Pilot bearing |
| (3) Release bearing | (7) Primary flywheel | |
| (4) Clutch cover | (8) Secondary flywheel | |

CL-6

CROSS SECTIONAL VIEW

Clutch

C: TURBO MODEL



CL-00119

(1) Spring bracket

(2) Spring

(3) Release lever

(4) Operating cylinder

(5) Flywheel

(6) Clutch cover

(7) Clutch disc

(8) Transmission main shaft

(9) Pilot bearing

(10) Release bearing

4. Flywheel

A: OUTLINE

1. EXCEPT 2.5L RHD MODELS

The flywheel is of a flexible type, consisting of a drive plate, reinforcement and mass flywheel.

This type of flywheel is characterized by less noise and less vibration, since it transmits the engine power from the crankshaft through the drive plate and mass flywheel to the clutch disc.

2. 2.5L RHD MODELS

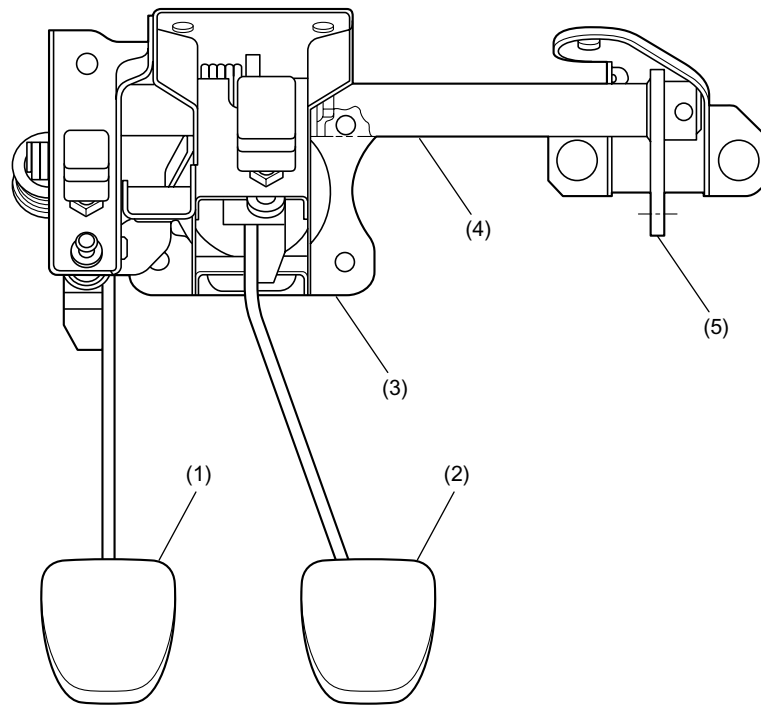
The flywheel is of a dual mass type. This flywheel consists of two flywheel masses and a spring box sandwiched between them.

The engine torque from the crankshaft is first transmitted to the primary mass and then to the spring box. The spring box dampens variations in the torque before it transmits the torque to the secondary mass. As a result, a stabler torque is transmitted to the transmission mainshaft through the clutch disc.

5. Hydraulic Clutch Pedal System

A: CONSTRUCTION

- The hydraulic clutch pedal is connected to the master cylinder via a rod.
- The clutch pedal and brake pedal are mounted on the same bracket.
- The clutch pedal has a mechanism that reduces (assists) the force required to depress the clutch pedal and reduce the initial pedal depressing force.
- **LHD models**



CL-00120

(1) Clutch pedal

(2) Brake pedal

(3) Brake and clutch pedal bracket

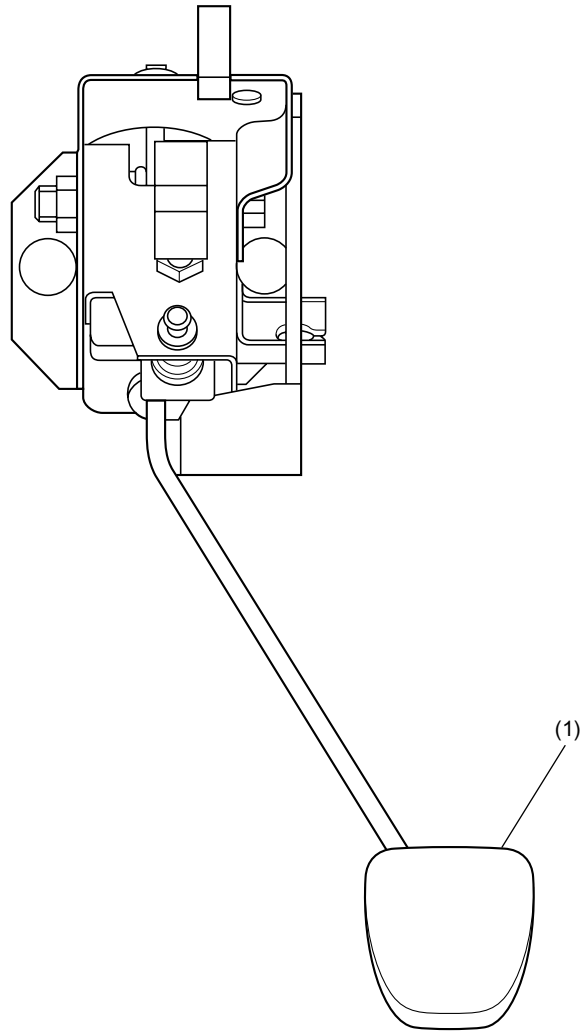
(4) Rod

(5) Lever

HYDRAULIC CLUTCH PEDAL SYSTEM

Clutch

- RHD models



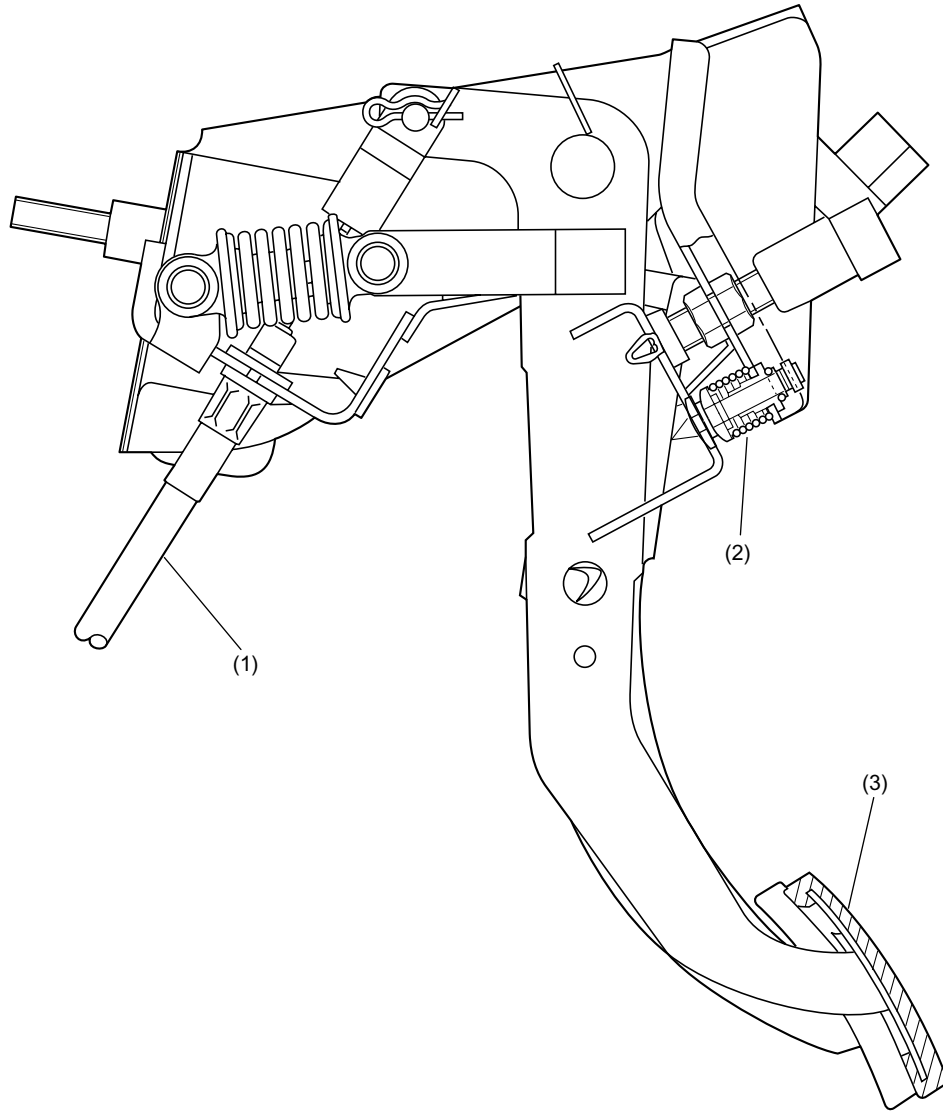
CL-00121

(1) Clutch pedal

HYDRAULIC CLUTCH PEDAL SYSTEM

Clutch

- The clutch pedal has a mechanism that reduces the initial force required to depress the clutch pedal.
- A hill holder control cable is connected to the clutch pedal.



CL-00122

(1) PHV cable (hill holder)

(2) Initial pedal effort reducing mechanism

(3) Clutch pedal

HYDRAULIC CLUTCH PEDAL SYSTEM

Clutch

MEMO

FRONT SUSPENSION *FS*

	Page
1. Front Suspension	2

1. Front Suspension

A: OUTLINE

The front suspension is a strut-type independent suspension, with cylindrical double-acting, low-pressure-gas-filled dampers and coil springs. The top of each strut assembly is attached to the body through a rubber cushion. Used in combination with other rubber cushions, this rubber cushion effectively insulate vibration and shock and thus improves ride comfort.

The transverse link is an “L” shaped arm design to increase steering stability and reduce road noise. The transverse link has a maintenance-free ball joint fitted by a castle nut at its outer end. The front of the link’s inner end is fitted to the front crossmember through a rubber cushion and the rear of the inner end is bolted to the vehicle body through a fluid-filled bushing.

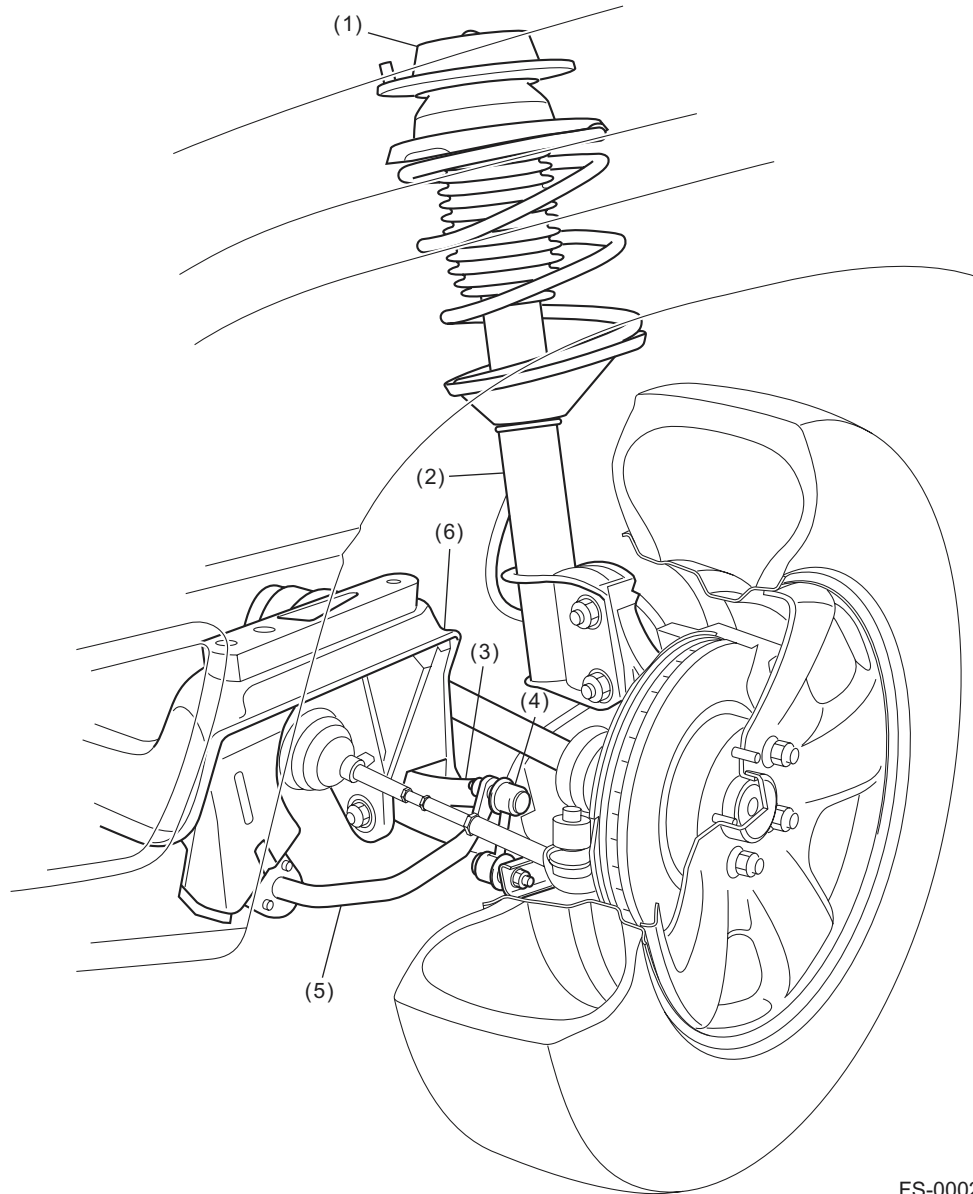
The front crossmember is bolted to the vehicle body.

The stabilizer is attached to the front crossmember through rubber cushions and its right and left ends are connected to the stabilizer links through ball joints.

The lower end of the stabilizer link is connected to the transverse link through ball joints.

A camber angle adjustment mechanism, which uses eccentric bolts, is provided at the joint of the damper strut and axle housing.

FRONT SUSPENSION



FS-00020

- (1) Strut mount
- (2) Strut
- (3) Transverse link

- (4) Stabilizer link
- (5) Stabilizer
- (6) Front crossmember

FRONT SUSPENSION

Front Suspension

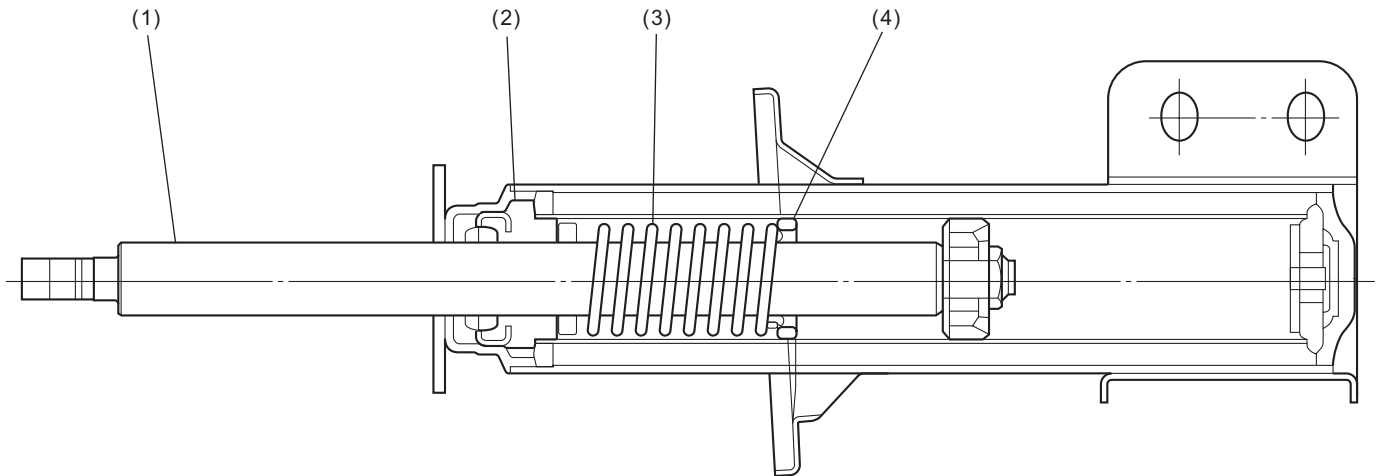
B: CONSTRUCTION

1. TRANSVERSE LINK

For enhanced handling stability, a longer transverse link is used and the tread is larger by 20 mm (0.79 in) than the previous model.

2. STRUTS

- All models use struts with low-pressure-gas-filled dampers that feature stable shock attenuating performance. They improve ride quality and reduce vibration and noise.
- The strut contains a rebound spring which acts on the piston rod toward its extending direction to reduce attitude change due to roll.



FS-00021

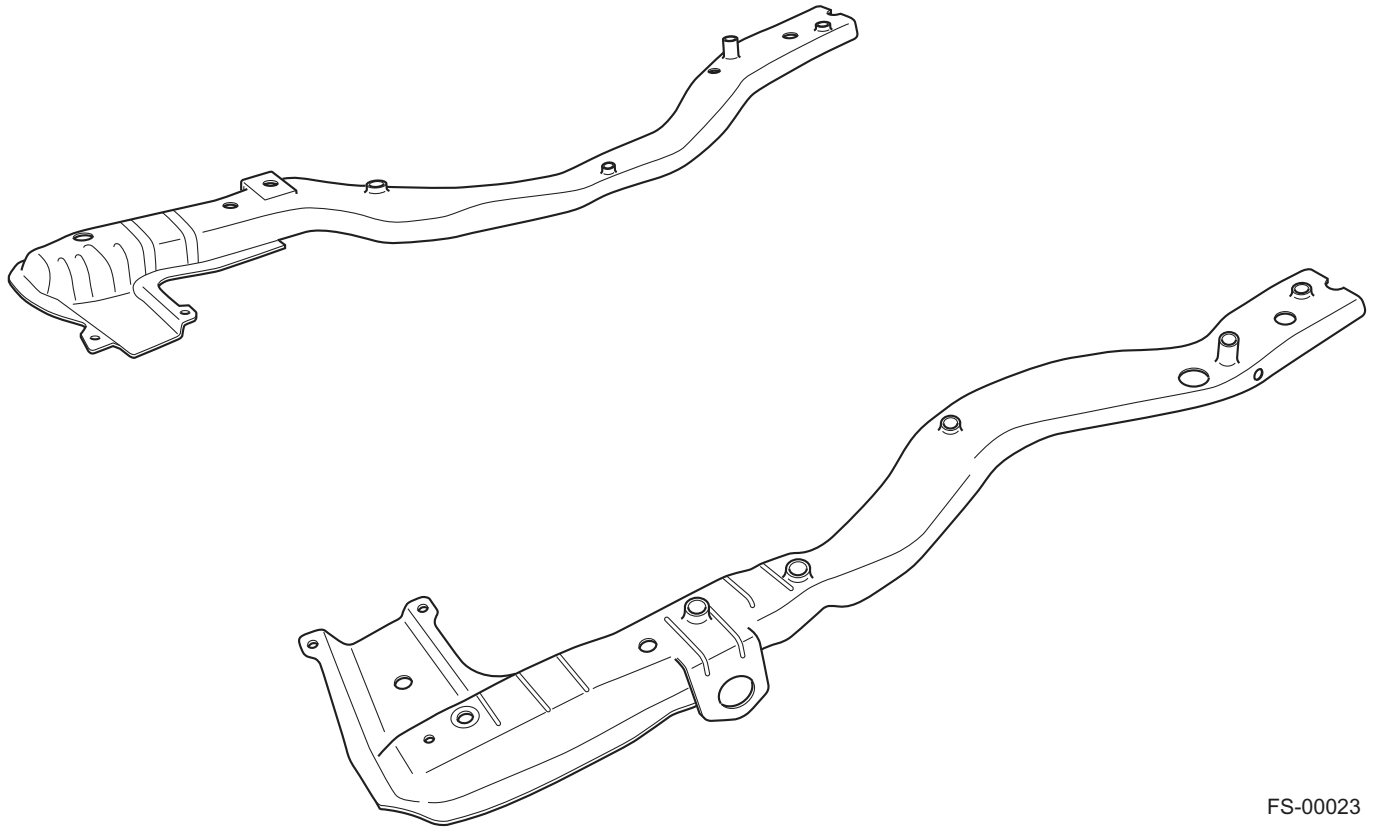
- (1) Piston rod
- (2) Rod guide

- (3) Rebound spring
- (4) Retainer

3. SUB FRAME

- A sub frame is used to effectively dissipate and absorb impact energy in case of a collision.
- The sub frame consists of left and right parts and bolted to the body.
- The sub frame is manufactured by hydro-forming technology which enables large sectional area contributing to increased strength and rigidity as well as decreased weight.

(Hydro-forming: A manufacturing method of forming by applying fluid pressure to the inner side of a pipe material placed inside an outer mold. Compared to the conventional flange welded type, a larger sectional area of the component can be obtained resulting in increased strength and rigidity.)



FS-00023

FRONT SUSPENSION

Front Suspension

MEMO

REAR SUSPENSION *RS*

	Page
1. Rear Suspension	2

REAR SUSPENSION

1. Rear Suspension

A: OUTLINE

The rear suspension is an independent, dual link strut type. The suspension on each side consists of two parallel arranged lateral links, a trailing link, and a strut assembly. The strut assembly consists of a cylindrical double-acting low pressure gas and oil-filled damper and coil spring.

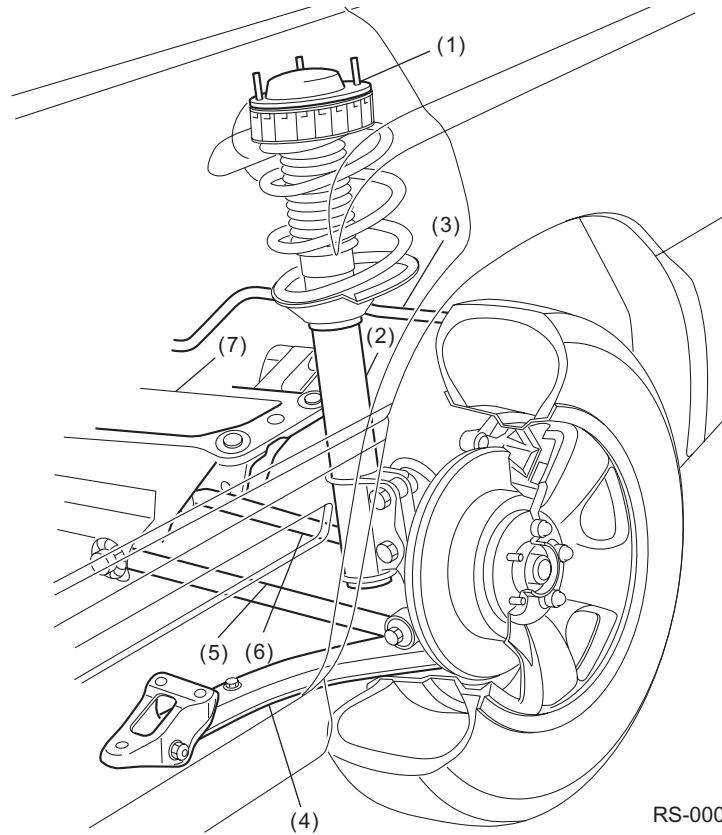
The respective component parts of this suspension are optimally designed to act in response to vertical, lateral and longitudinal loads transmitted from the tires.

- Longitudinal loads act on each trailing link.
- Vertical loads act on each coil spring, strut and rubber mount.
- Lateral loads act on the two lateral links on each side.

The crossmember is installed on the body frame via bushings.

The stabilizer that extends to the rear of the crossmember, is installed on the body frame via a bracket and to the wheel side end of each rear lateral link via a stabilizer link.

REAR SUSPENSION



- (1) Strut mount
- (2) Strut
- (3) Stabilizer

- (4) Trailing link
- (5) Front lateral link
- (6) Rear lateral link

- (7) Rear crossmember

REAR SUSPENSION

Rear Suspension

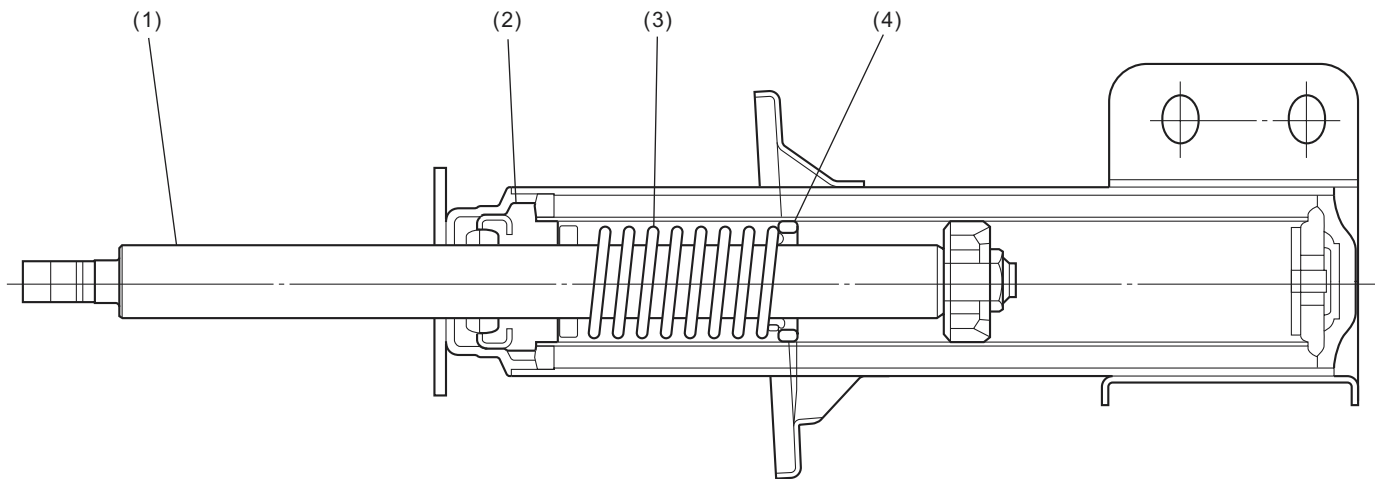
B: CONSTRUCTION

1. LATERAL LINKS

- For enhanced handling stability, a longer lateral link is used and the tread is larger by 20 mm (0.79 in) than the previous model.
- Unsprung weight has been made smaller than the previous model by using a pair of steel-pipe lateral links. This enhances both handling stability and riding comfort.

2. STRUTS

- The dampers used in the struts are of a gas-filled type that features stable shock attenuating performance. They improve ride quality and reduce vibration and noise.
- The strut contains a rebound spring which acts on the piston rod toward its extending direction to reduce attitude change due to roll.
- Each strut has at its top a new type strut mount. The strut mounts effectively disperse input forces from coil springs so that vibration and noise are reduced and riding comfort is improved. The body attaching flange of each strut mount is adequately rigid, which helps improve handling stability.
- The helper made of highly durable urethane enhances handling stability when the vehicle is loaded. It also satisfies riding comfort and anti-roll rigidity requirements simultaneously.

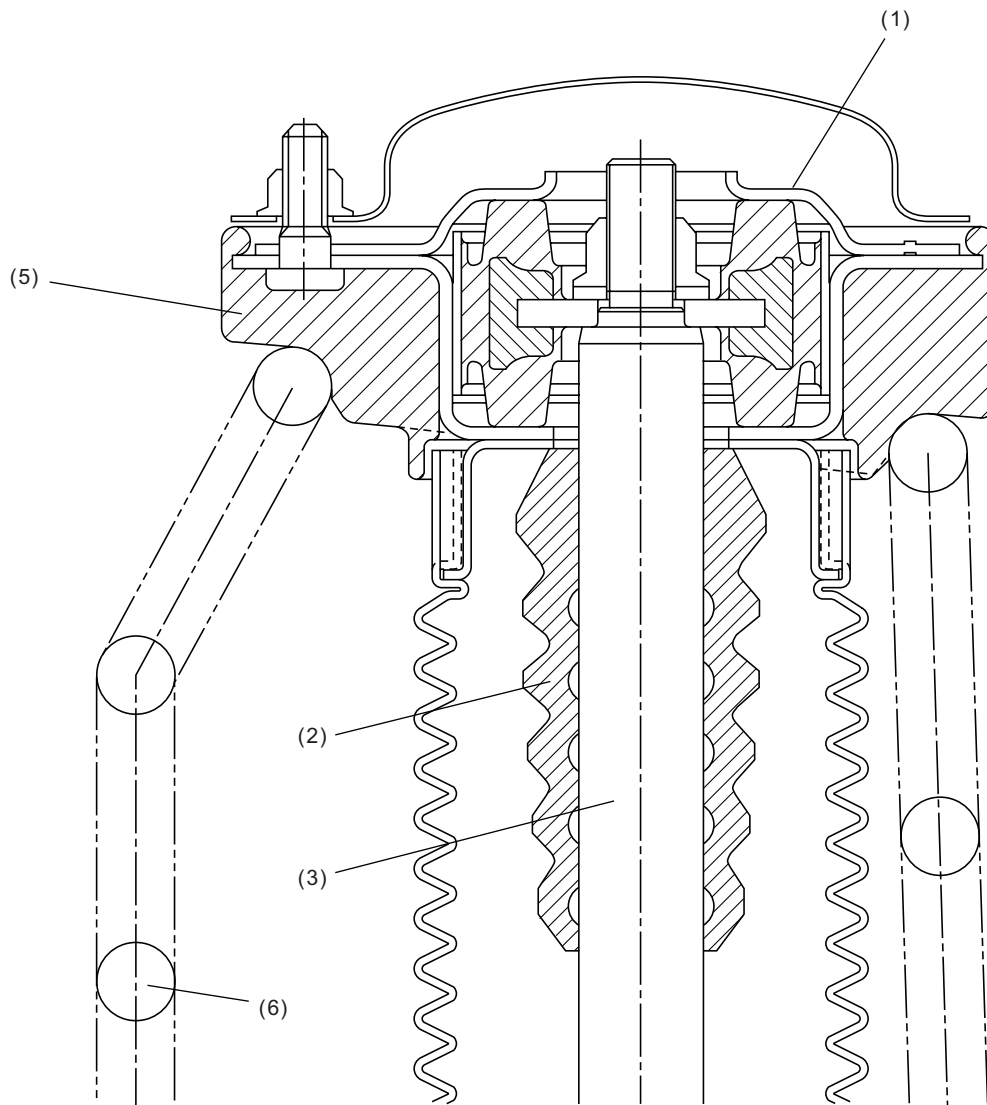


FS-00021

- (1) Piston rod
- (2) Rod guide

- (3) Rebound spring
- (4) Retainer

REAR SUSPENSION



RS-00151

- (1) Strut mount
- (2) Helper
- (3) Damper strut

- (4) Dust cover
- (5) Rubber seat
- (6) Coil spring

REAR SUSPENSION

Rear Suspension

MEMO

WHEEL AND TIRE SYSTEM *WT*

	Page
1. Description	2

DESCRIPTION

1. Description

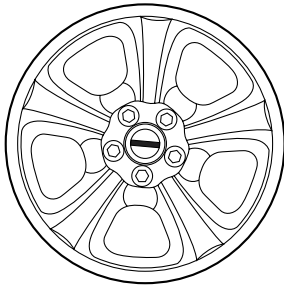
Five types of disk wheels are provided according to the model grade or optional selection.

Each wheel has a center cap designed exclusively for the type.

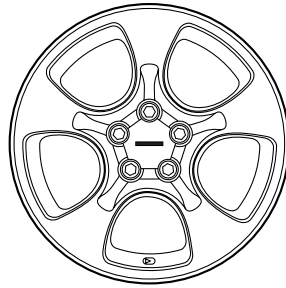
A steel wheel is provided for the spare tire disk wheel on all models.

Three types of tires are provided according to the model grade.

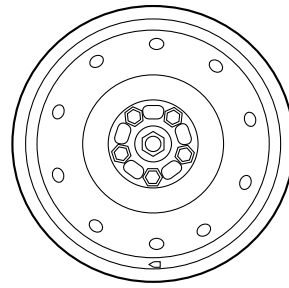
A spare tire of the same size as the standard tire is equipped on all models.



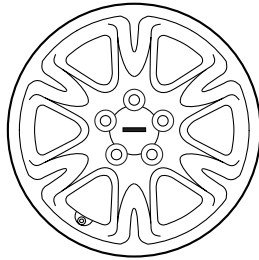
(A)



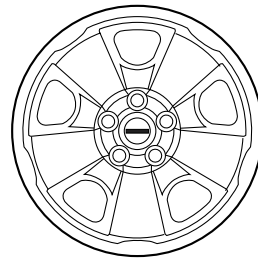
(B)



(C)



(D)



(E)

WT-00021

- (A) 16 x 6 $\frac{1}{2}$ J (steel wheel)
- (B) 16 x 6 $\frac{1}{2}$ JJ (aluminum wheel)
- (C) 16 x 6 $\frac{1}{2}$ JJ (steel wheel)
- (D) 15 x 6JJ (aluminum wheel)
- (E) 15 x 6J (steel wheel)

DIFFERENTIALS *DI*

	Page
1. Rear Differential	2
2. Limited Slip Differential (LSD)	4

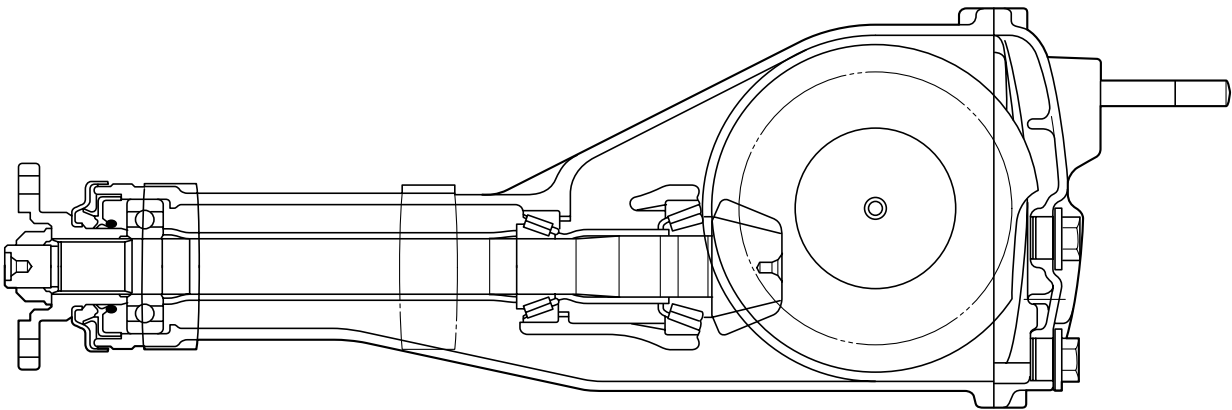
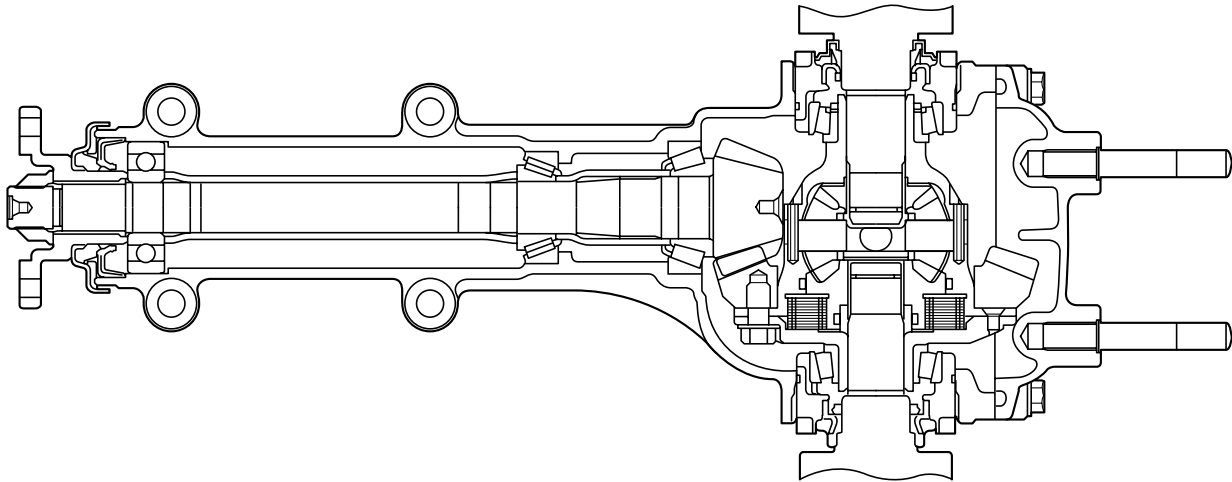
REAR DIFFERENTIAL

Differentials

1. Rear Differential

A: VA-TYPE

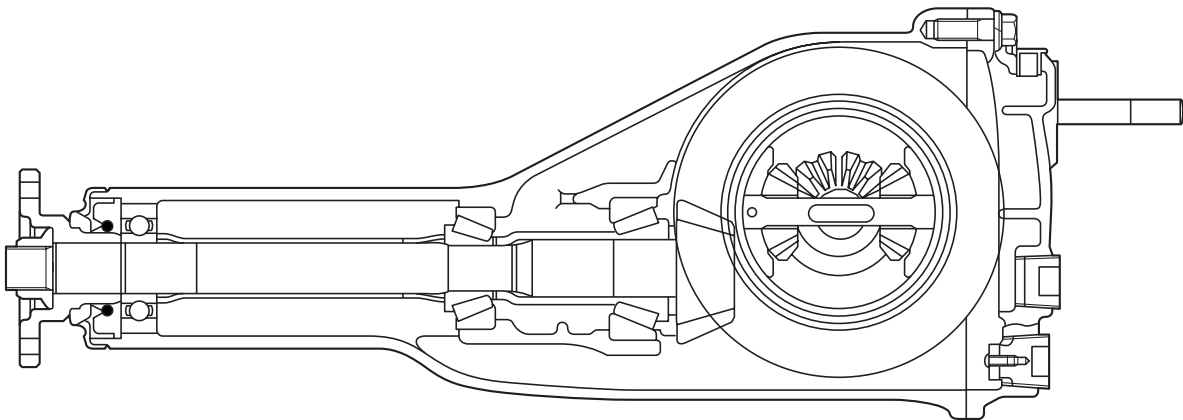
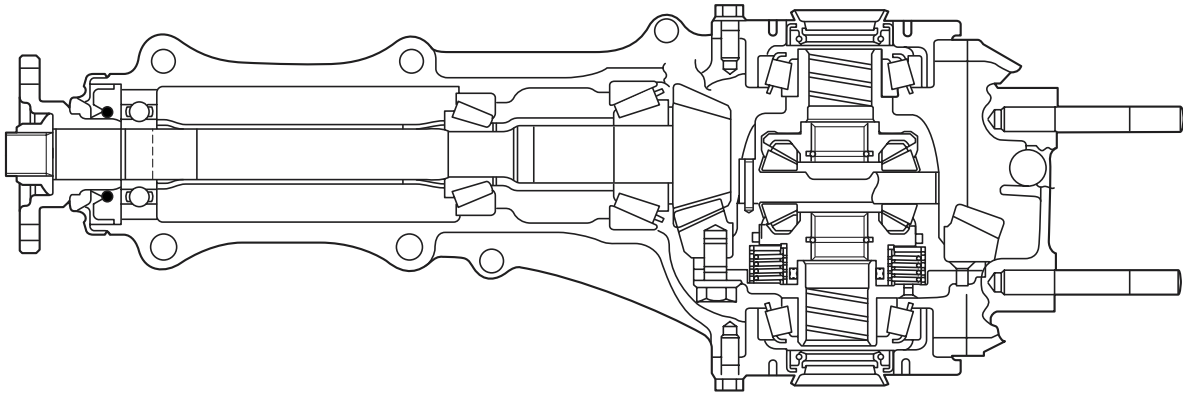
The drive gear is a hypoid gear with nominal diameter of 152 mm (5.98 in). The drive pinion shaft is supported by three bearings. The bearing preload is adjusted by selecting a spacer and washer combination of a proper thickness. The drive pinion height is adjusted by properly selecting the thickness of the washers located at the drive pinion neck using Dummy Shaft and Gauge.



DI-00236

B: T-TYPE

The drive gear is a hypoid gear with a nominal diameter of 160 mm (6.30 in). The drive pinion shaft is supported by three bearings. The bearing preload is adjusted by selecting a spacer and washer combination of a proper thickness. The drive pinion height is adjusted by properly selecting the thickness of the washers located at the drive pinion neck using Dummy Shaft and Gauge.



DI-00237

LIMITED SLIP DIFFERENTIAL (LSD)

2. Limited Slip Differential (LSD)

A: OUTLINE

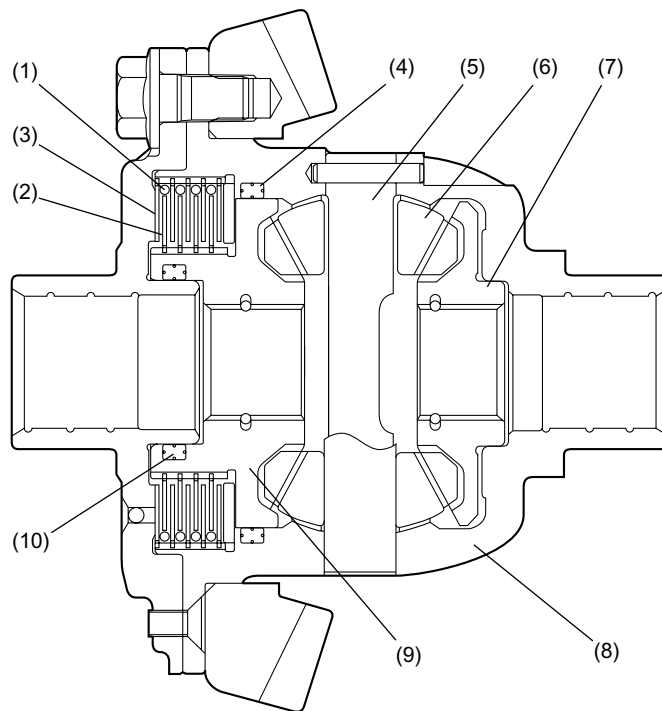
The limited slip differential is of a viscous coupling (V/C) type which automatically limits the differential action and distributes torque to the left and right wheels adequately to enhance driving stability when the left and right wheels are rotating at speeds different from each other during driving on a slippery road (muddy, snow-covered or slushy road) or cornering.

B: CONSTRUCTION

The V/C type LSD has outer plates and inner plates arranged alternately. Each outer plate is splined to the inside of the differential case at its outer periphery and each inner plate is splined to the outer circumference of the left side gear at its inner periphery.

The outer plates are held in position by spacer rings while the inner plates can slide in the axial direction along the spline teeth.

The space between the differential case and the left side gear is filled with a mixture of high viscosity silicone oil and air and hermetically sealed with X-rings.



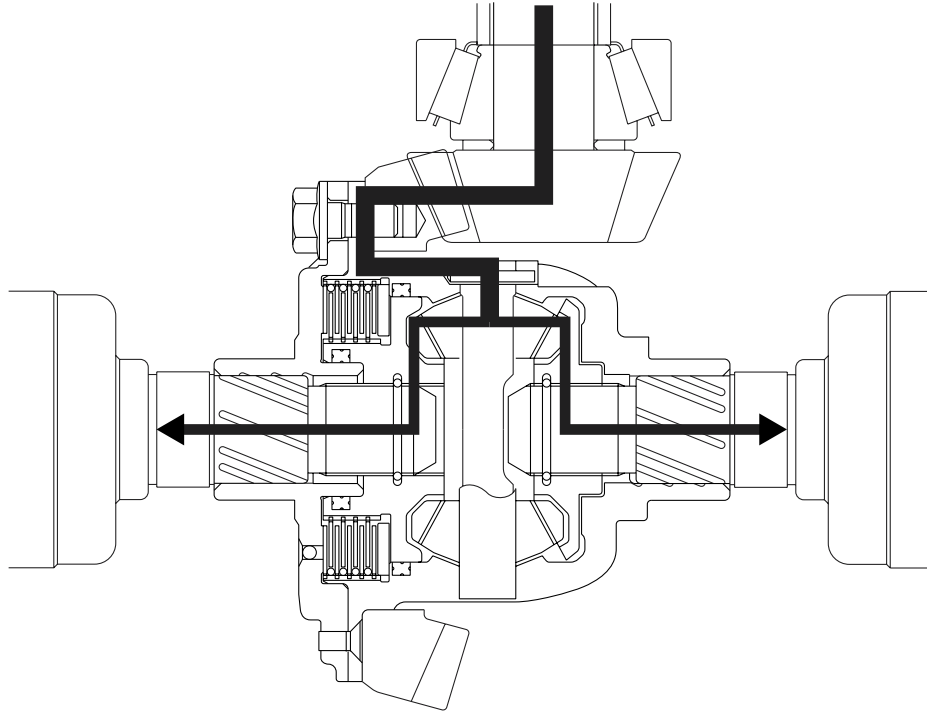
DI-00295

- | | |
|------------------|-----------------------|
| (1) Spacer ring | (6) Pinion gear |
| (2) Inner plate | (7) Side gear (right) |
| (3) Outer plate | (8) Differential case |
| (4) X-ring | (9) Side gear (left) |
| (5) Pinion shaft | (10) X-ring |

C: OPERATION

1. WHEN RIGHT AND LEFT WHEELS ROTATE AT THE SAME SPEED

During normal straight-ahead driving where the right and left wheels rotate at the same speed, the differential case and side gears rotate together, just as in conventional differentials. As a result, driving torque is distributed equally to the right and left side gears.



DI-00296

LIMITED SLIP DIFFERENTIAL (LSD)

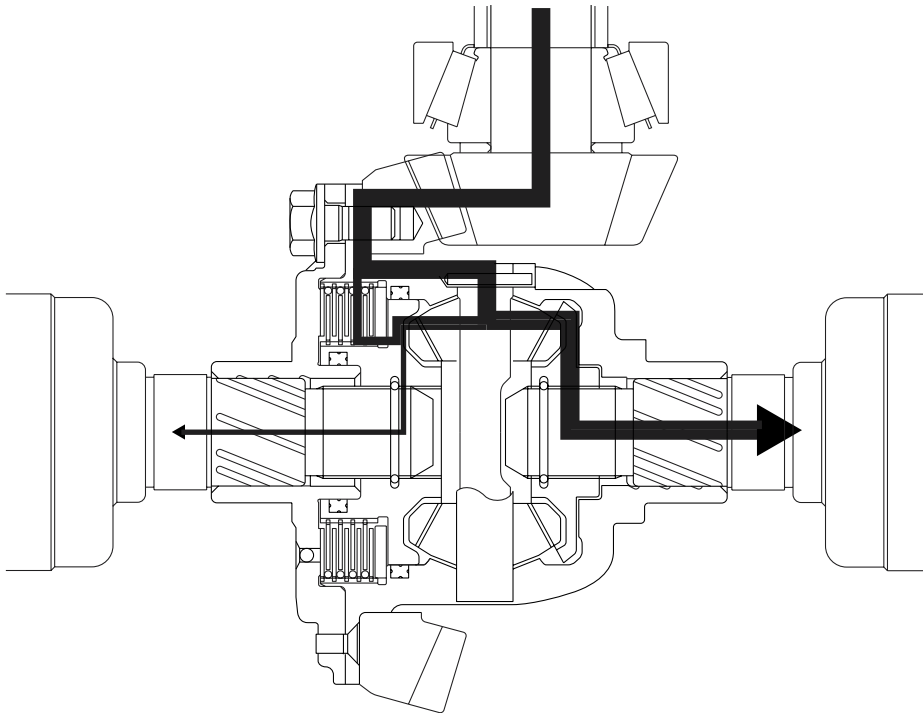
2. WHEN RIGHT AND LEFT WHEELS ROTATE AT DIFFERENT SPEEDS

When a speed difference occurs between the right and left wheels, the differential case and the left side gear do not rotate at the same speed any more. The speed difference between them corresponds to that between both the wheels. Because of the viscosity shearing force caused in the silicone oil, a differential torque is then generated, which limits differential action.

For example, if the left wheel spins due to small road resistance, a speed difference occurs between the right and left wheels. Since there is the V/C between the differential case and left side gear, a differential torque corresponding to the speed difference is generated in the V/C. This differential torque is transferred from the left wheel to the right wheel. As a result, a greater driving torque is distributed to the right wheel which is rotating at a lower speed.

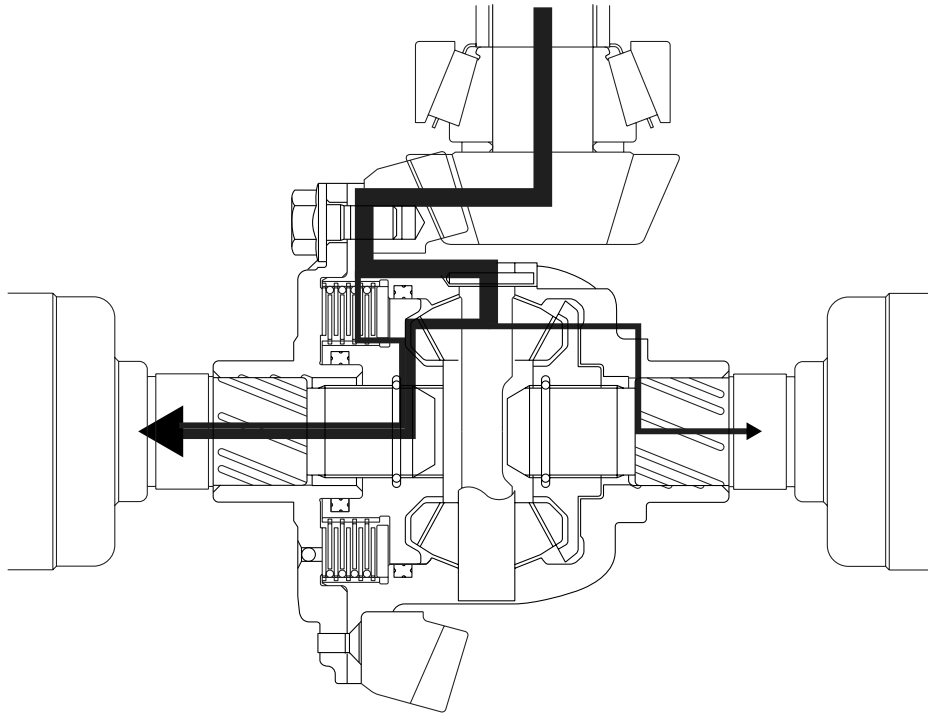
When the right wheel spins, the differential torque is transferred from the right wheel to the left wheel. Also in this case, a torque greater by the differential torque than the torque to the spinning wheel is transmitted to the wheel rotating at the lower speed.

When left wheel spins



DI-00297

When right wheel spins



DI-00298

D: SERVICE PROCEDURES FOR LSD

It is not recommended to disassemble the LSD assembly as component parts of LSD assembly are not available individually.

LIMITED SLIP DIFFERENTIAL (LSD)

Differentials

MEMO

TRANSFER CASE *TC*

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1. Center Differential	2
2. AWD Transfer System	3
3. Oil Pump	4

CENTER DIFFERENTIAL

Transfer Case

1. Center Differential

Regarding the construction and operation of the center differential, refer to the "MT" section. (Ref. to "MT" section "Center Differential".)

2. AWD Transfer System

Regarding the construction and operation of the AWD transfer system, refer to the “AT” section. (Ref. to “AT” section “AWD Transfer System”.)

OIL PUMP

Transfer Case

3. Oil Pump

Regarding the construction and operation of the oil pump, refer to the "MT" section. (Ref. to "MT" section "Oil Pump".)

DRIVE SHAFT SYSTEM *DS*

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1. Propeller Shaft	2
2. Front Axle	4
3. Rear Axle	6

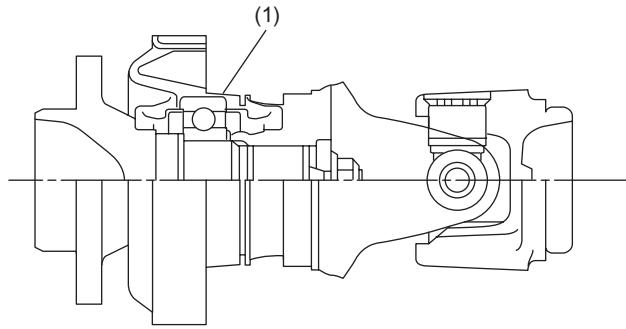
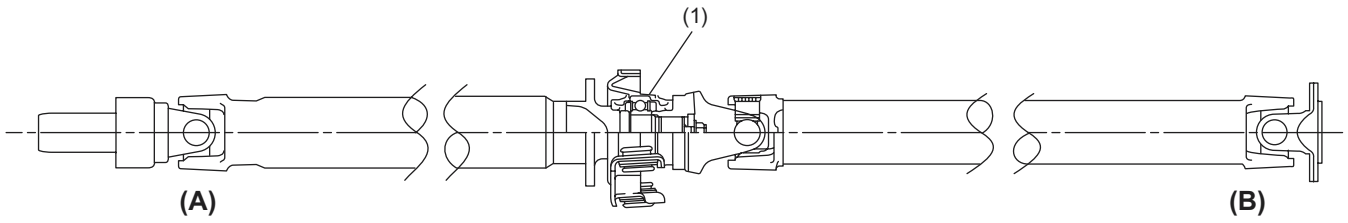
PROPELLER SHAFT

Drive Shaft System

1. Propeller Shaft

A: UJ TYPE

The propeller shaft is of a two-piece design that uses three joints.



DS-00007

(1) Center bearing

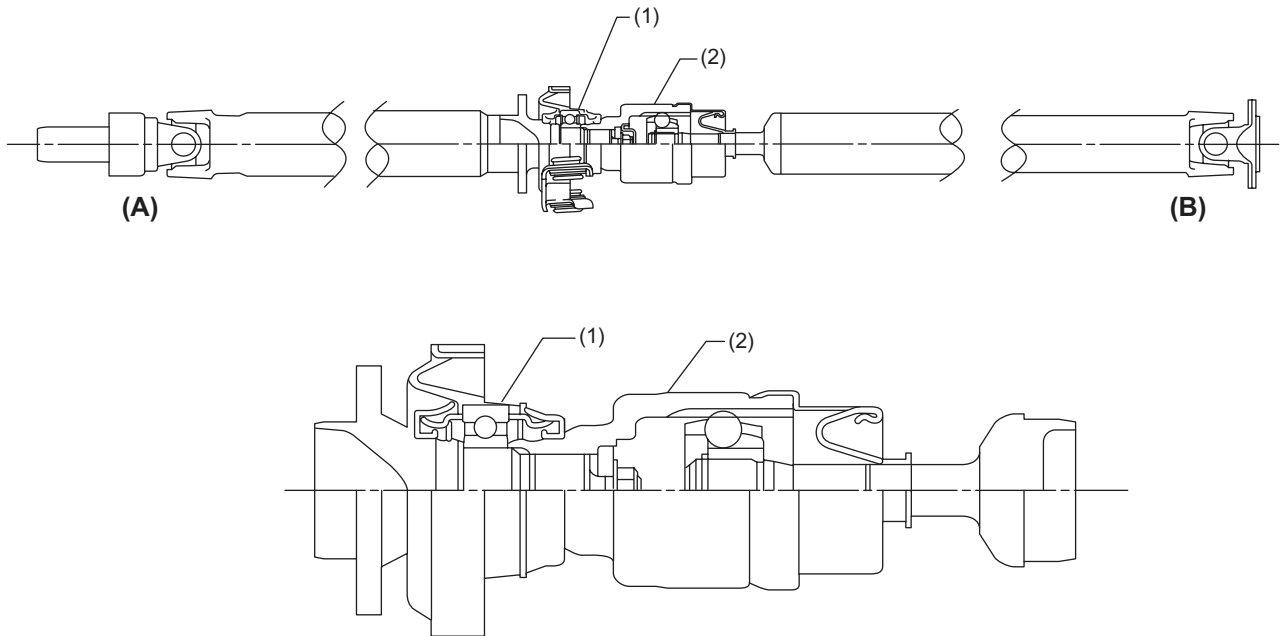
(A) Transmission side

(B) Rear differential side

PROPELLER SHAFT

B: DOJ TYPE

The center joint is a double offset joint (DOJ) type which can extend and retract in the axial directions.



DS-00008

(1) Center bearing

(2) DOJ

(A) Transmission side

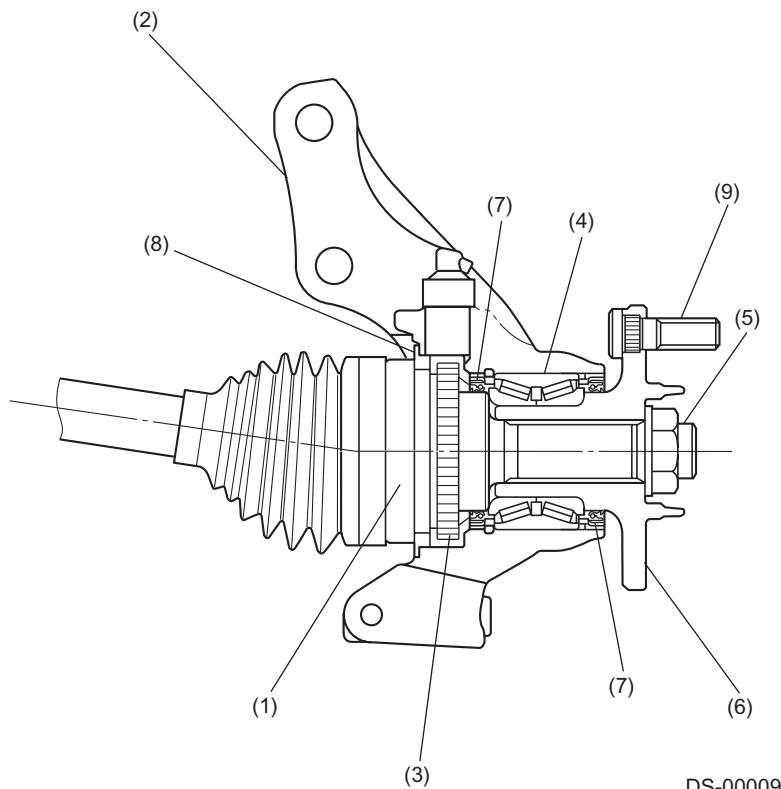
(B) Rear differential side

FRONT AXLE

2. Front Axle

A: OUTLINE

- The inboard end of the axle shaft is connected to the transmission via a constant velocity joint (Angular Adjusted Roller-improved: AARi) which is flexible in the axial directions, while the outboard end is connected via an AC (Angular Contact) joint to the wheel hub which is supported by a taper roller bearing located inside the axle housing.
- The bearing is a preloaded, non-adjustable taper roller bearing. The hub is fitted in the axle housing via the tapered roller bearing.
- The AC's spindle is splined to the hub and is secured with an axle nut clinched to it.
- The disc rotor is an external mounting type. It is secured to the disc wheel using hub bolts to facilitate maintenance of the disc rotor.

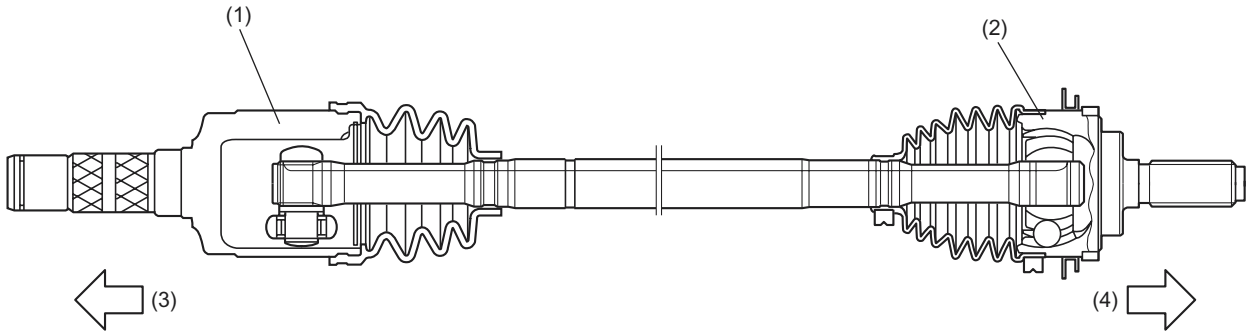


DS-00009

- | | | |
|------------------|--------------|------------------|
| (1) AC | (4) Bearing | (7) Oil seal |
| (2) Axle housing | (5) Axle nut | (8) Baffle plate |
| (3) Tone wheel | (6) Hub | (9) Hub bolt |

B: FRONT DRIVE SHAFT

- An AARi (Angular Adjusted Roller-improved) joint is used on the transmission side of each front drive shaft. The AARi can be disassembled for maintenance. The AARi provides a maximum operating angle of 23° and can be moved in the axial directions.
- An AC (Angular Contact) joint is used on the wheel side of each front drive shaft. The AC's maximum operating angle is 47.5° .



DS-00010

- (1) AARi
- (2) AC

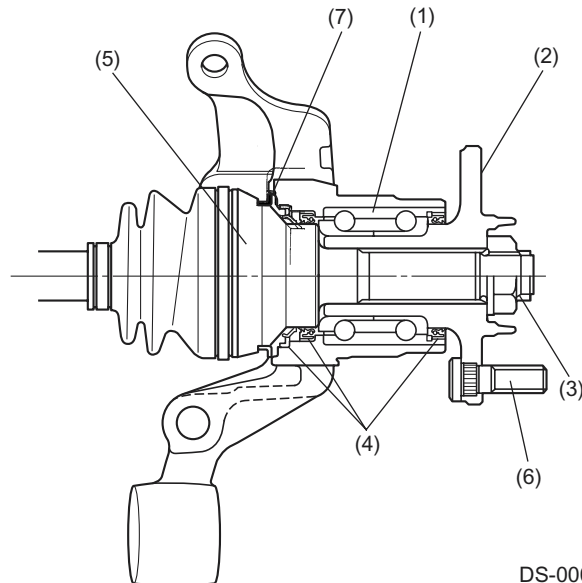
- (3) Transmission side
- (4) Wheel side

REAR AXLE

3. Rear Axle

A: OUTLINE

- The inboard end of each axle shaft is connected to the transmission via a double offset joint (DOJ) which can extend and retract in the axial directions.
- The outboard end of the axle shaft is supported by angular contact ball bearings located inside the axle housing via a bell joint (BJ) which features a large operating angle. Both the constant velocity joints (DOJ and BJ) ensure smooth, regular rotation of the drive wheels with minimum vibration.
- The bearing is a preloaded, non-adjustable angular contact ball unit type. Each hub is fitted in the axle housing via the angular contact ball bearing.
- The BJ's spindle is splined to the hub and secured with an axle nut clinched to it.
- The disc rotor or brake drum is held in position by the hub bolts and wheel nuts together with the wheel. This facilitates removal and installation of the disc rotor or brake drum and thus improves serviceability.

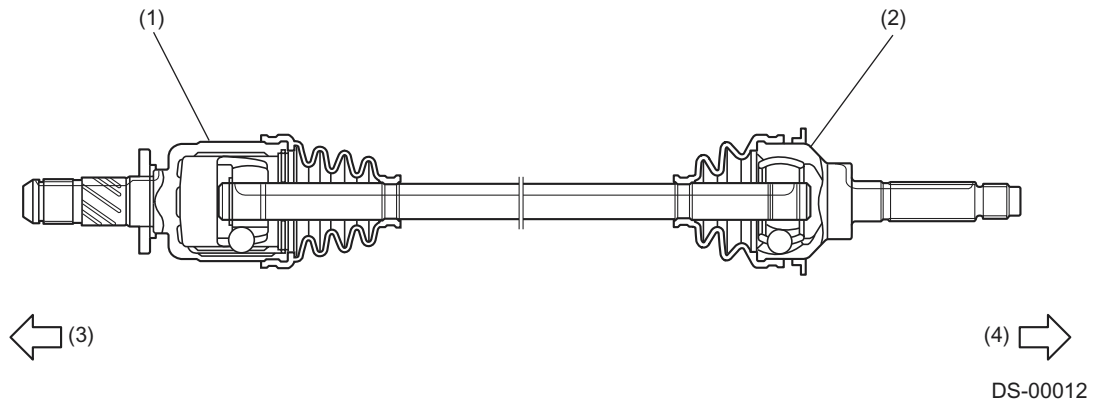


DS-00011

- | | |
|--------------|------------------|
| (1) Bearing | (5) BJ |
| (2) Hub | (6) Hub bolt |
| (3) Axle nut | (7) Baffle plate |
| (4) Oil seal | |

B: REAR DRIVE SHAFT

- A double offset joint (DOJ) is used on the differential side of each rear drive shaft. The DOJ can be disassembled for maintenance. It provides a maximum operating angle of 23° and can be moved in the axial directions.
- A bell joint (BJ) is used on the wheel side of each rear drive shaft. The BJ's maximum operating angle is 42° .



- (1) DOJ
- (2) BJ
- (3) Differential side
- (4) Wheel side

REAR AXLE

Drive Shaft System

MEMO

ABS *ABS*

Page

1. Anti-lock Brake System (ABS) 2

1. Anti-lock Brake System (ABS)

A: FEATURES

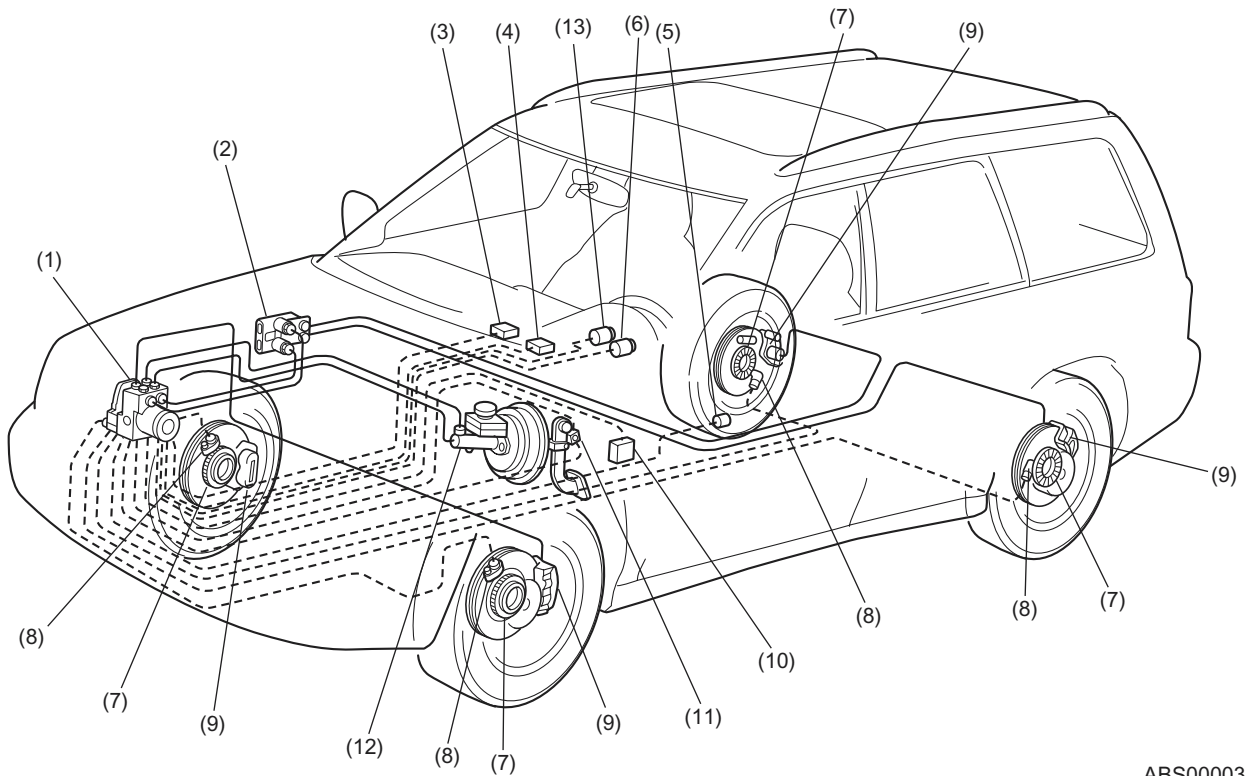
- The 5.3i type ABS used in the FORESTER has a hydraulic control unit, an ABS control module, a valve relay and a motor relay integrated into a single unit (called “ABSCM & H/U”) for circuit simplicity and reduced weight.
- The ABS electrically controls the brake fluid pressure to each wheel to prevent the wheel from locking during braking on slippery road surfaces, thereby enabling the driver to maintain the directional control.
- If the ABS becomes inoperative, a fail-safe system is activated to ensure same level of braking performance as with a conventional brake system. In that case, the warning light comes on to indicate that the ABS is malfunctioning.
- The ABS is a 4-sensor, 4-channel system. The front wheel system is an independent control design^{*1}, while the rear wheel system is a select-low control design^{*2}.

*1: A system which controls the front wheel brakes individually.

*2: A system which applies the same fluid pressure to both the rear wheels if either wheel starts to lock. The pressure is determined based on the lower of the frictional coefficients of both wheels.

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS



ABS00003

- | | | |
|---|--|--|
| (1) ABS control module and hydraulic control unit (ABSCM & H/U) | (6) ABS warning light | (11) Brake switch |
| (2) Proportioning valve (Except EBD) | (7) Tone wheel | (12) Master cylinder |
| (3) Diagnosis connector | (8) ABS sensor | (13) Brake warning light (also functions as EBD warning light) |
| (4) Data link connector (for SUBARU select monitor) | (9) Wheel cylinder | |
| (5) G sensor | (10) Automatic transmission control module | |

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

B: FUNCTIONS OF SENSORS AND ACTUATORS

Name		Function
ABS control module and hydraulic control unit (ABSCM & H/U)	ABSCM section	<ul style="list-style-type: none"> It determines the conditions of the wheels and the vehicle body from the wheel speed data and controls the hydraulic unit depending on the result. When the ABS is active, the ABSCM provides the automatic transmission control module with control signals which are used by the module for cooperative control of the vehicle with the ABSCM. Whenever the ignition switch is placed at ON, the module performs a self diagnosis sequence. If anything wrong is detected, the module cuts off the system. It communicates with the SUBARU select monitor.
	H/U section	<ul style="list-style-type: none"> When the ABS is active, the H/U changes fluid passages to the wheel cylinders in response to commands from the ABSCM. It constitutes the brake fluid passage from the master cylinder to the wheel cylinders together with the piping.
	Valve relay section	It serves as a power switch for the solenoid valves and motor relay coil. It operates in response to a command from the ABSCM.
	Motor relay section	It serves as a power switch for the pump motor. It operates in response to a command from the ABSCM.
ABS sensors (wheel speed sensors)		These sensors detect the wheel speed in terms of a change in the density of the magnetic flux passing through them and convert it into an electrical signal. The electrical signal is sent to the ABSCM.
Tone wheel		They give a change in the magnetic flux density by the teeth around themselves to let the ABS sensors generate electrical signals.
G sensor		It detects a change in acceleration in the longitudinal direction of the vehicle and outputs it to the ABSCM as a voltage signal.
Stop light signal		It provides information on whether the brake pedal is depressed or not to the ABSCM. The ABSCM uses it to determine ABS operation.
ABS warning light		It alerts the driver to an ABS fault. When the diagnosis connector and diagnosis terminal are connected, the light flashes to indicate a trouble code stored in the ABSCM.
Automatic transmission control module		It provides gear controls (fixing the speed at 3rd or changing power transmission to front and rear wheels) in response to control signals from the ABSCM.
Brake warning light		It alerts the driver to an EBD fault. This warning light is also used for parking brake warning and brake fluid level warning.

MEMO

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

-
- | | | |
|---|--|----------------------------------|
| (1) ABS control module and hydraulic control unit | (11) Rear left outlet solenoid valve | (21) Front left ABS sensor |
| (2) ABS control module section | (12) Rear right inlet solenoid valve | (22) Front right ABS sensor |
| (3) Valve relay | (13) Rear right outlet solenoid valve | (23) Rear left ABS sensor |
| (4) Motor relay | (14) Automatic transmission control module | (24) Rear right ABS sensor |
| (5) Motor | (15) Diagnosis connector | (25) IGN |
| (6) Front left inlet solenoid valve | (16) Data link connector | (26) Battery |
| (7) Front left outlet solenoid valve | (17) ABS warning light | (27) Brake warning light |
| (8) Front right inlet solenoid valve | (18) Stop light switch | (28) Parking brake warning light |
| (9) Front right outlet solenoid valve | (19) Stop light | (29) Brake fluid level switch |
| (10) Rear left inlet solenoid valve | (20) G sensor | |

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

C: PRINCIPLE OF ABS CONTROL

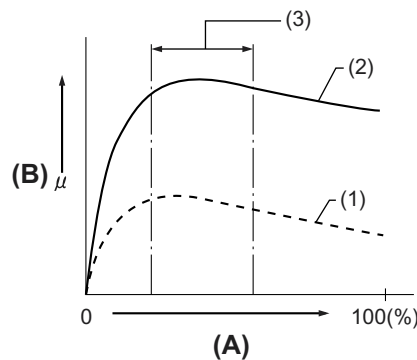
When the brake pedal is depressed during driving, the wheel speed decreases and the vehicle speed does as well. The decrease in the vehicle speed, however, is not always proportional to the decrease in the wheel speed. The non-correspondence between the wheel speed and vehicle speed is called “slip” and the magnitude of the slip is expressed by the “slip ratio” which is defined as follows:

$$\text{Slip ratio} = (\text{Vehicle speed} - \text{Wheel speed}) / \text{Vehicle speed} \times 100\%$$

When the slip ratio is 0%, the vehicle speed corresponds exactly to the wheel speed. When it is 100%, the wheels are completely locking (rotating at a zero speed) while the vehicle is moving.

The braking effectiveness is represented by the “coefficient of friction” between the tire and road surface. The larger the coefficient, the higher the braking effectiveness. The diagram below shows the relationship between the coefficient of friction and the slip ratio for two different road surface conditions (asphalt-paved road and icy road), assuming that the same tires are used for both the conditions and the vehicles are moving forward. Although the braking effectiveness (coefficient of friction) depends on the road surface condition as shown and also on the type of the tire, its peak range generally corresponds to the 8 – 30% range of the slip ratio.

The ABS controls the fluid pressure to each wheel so that a coefficient of friction corresponding to this slip ratio range is maintained.

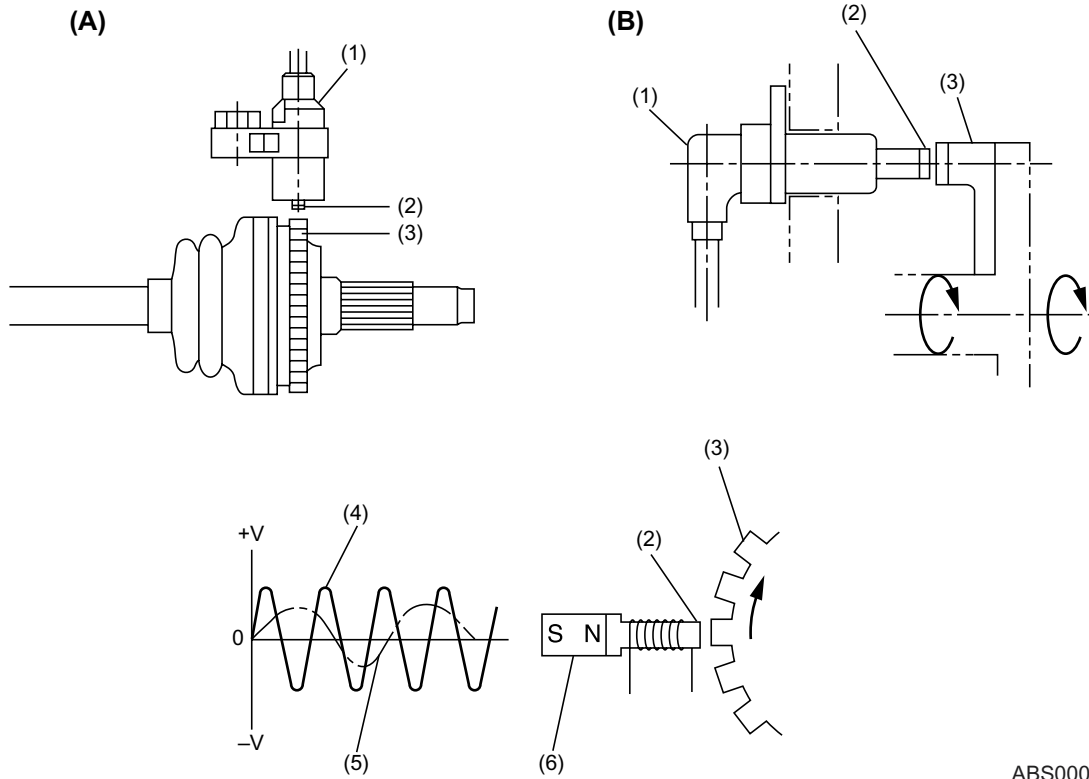


ABS00007

- | | |
|---|------------------------|
| (A) Slip ratio | (1) Icy road |
| (B) Coefficient of friction between tire and road | (2) Asphalt-paved road |
| | (3) ABS control range |

D: ABS SENSORS

Each of the ABS sensors detects the speed of the corresponding wheel. The sensor consists of a permanent magnet, coil and tone wheel. The magnetic flux produced by the permanent magnet changes as each tooth of the tone wheel (which rotates together with the wheel) passes in front of the magnet's pole piece. The changing magnetic flux induces voltages at a frequency corresponding to the wheel speed.



ABS00018

(A) Front
(B) Rear

(1) Sensor body
(2) Pole piece
(3) Tone wheel

(4) Full speed
(5) Low speed
(6) Permanent magnet

ANTI-LOCK BRAKE SYSTEM (ABS)

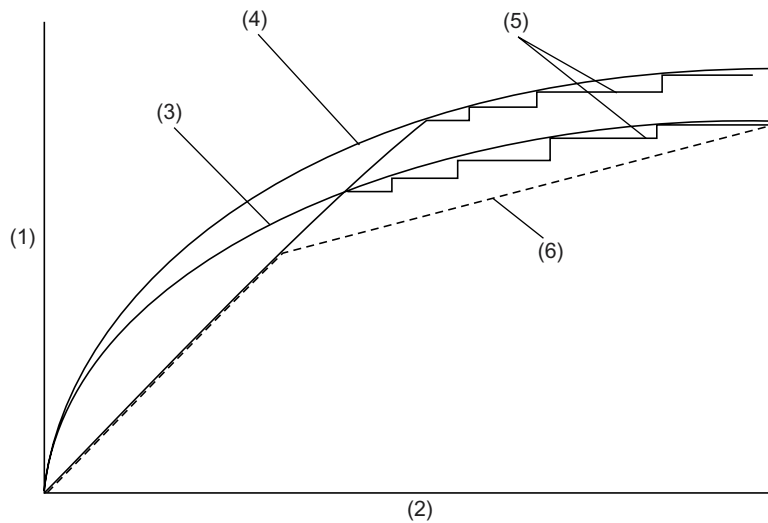
ABS

E: EBD (ELECTRONIC BRAKE FORCE DISTRIBUTION)

The EBD system utilizes the function of the conventional ABS. This system prevents premature locking of the rear wheels by using electronic control instead of a proportioning valve. The system provides a feature to optimize the brake force distribution to the front and rear wheels according to change in loading conditions or displacement of the center of gravity during deceleration.

The ABSCM calculates the optimum brake force distribution from the difference in speed between the front and rear wheels. Based on the results, the ABSCM controls the rear wheel brake pressure through the ABS hydraulic unit (H/U) to achieve the optimum brake force distribution suitable for the driving condition.

The proportioning valve is disused on EBD equipped vehicles.



ABS00019

- (1) Brake force to rear wheels
- (2) Brake force to front wheels
- (3) Optimum brake force distribution for light loaded conditions
- (4) Optimum brake force distribution for heavy loaded conditions
- (5) EBD controlled brake force distribution
- (6) PCV controlled brake force distribution (reference)

F: ABS CONTROL MODULE AND HYDRAULIC CONTROL UNIT (ABSCM & H/U)

● ABS CONTROL MODULE SECTION (ABSCM)

The ABSCM contains two micro control modules (MCMs) which communicate with each other. Both the MCMs process the same program and each MCM monitors the other's outputs. If a mismatch occurs between their outputs, the ABSCM cuts off the system and activate the fail-safe function.

The ABSCM can store a maximum of 3 trouble codes in an EEPROM. If more than 3 faults have occurred, only the 3 most recent failures are stored and others are erased. Trouble codes remain stored until they are internally or externally erased.

The ABSCM has a test routine (sequence control pattern) which facilitates checking of the hydraulic control unit.

● ABS control

Using primarily the wheel speed data from each ABS sensor and secondarily the vehicle deceleration rate data from the G sensor as parameters, the ABSCM generates a simulated vehicle speed when there is a risk of wheel lock-up. Using the simulated vehicle speed (called "dummy" vehicle speed) as a reference, the ABSCM determines the state of the wheel in terms of the tendency toward lock-up. If the result shows that the wheels are about to lock, the ABSCM issues commands to energize or de-energize the solenoid valves and activate the motor pump of the H/U to modulate the brake fluid pressures that act on the wheel cylinders, thereby preventing the wheels from locking.

The ABSCM controls the right and left front wheel fluid pressures independently and the rear wheel fluid pressures based on the wheel which is the most likely to lock (select-low control).

● Functions available using SUBARU select monitor

When the SUBARU select monitor is connected, the ABSCM allows it

- To read out analog data
- To read out ON/OFF data
- To read out or erase trouble code
- To read out data showing conditions under which a trouble code has been stored (Freeze frame data)
- To initiate ABS sequence control pattern

● Indication functions

Under the control of the ABSCM, the ABS warning light provides the following three indication function:

- ABS fault alerting
- Trouble code indication (by flashing in the diagnosis mode)
- Valve ON/OFF indication (when sequence control pattern is initiated)

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

● HYDRAULIC CONTROL UNIT SECTION (H/U)

The H/U is a fluid pressure controller consisting of, among others, a motor, solenoid valves, a housing and relays. It also constitutes passage of the two diagonally split brake circuits.

- The pump motor drives an eccentric cam which in turn moves the plunger pump to generate hydraulic pressure.
- The housing accommodates the pump motor, solenoid valve and reservoir. It also constitutes a brake fluid passage.
- The plunger pump, when operated, draws the brake fluid from the reservoir, lets the fluid in a wheel cylinder drain into the reservoir, and/or forces the fluid into the master cylinder.
- The outlet solenoid valve is a 2-position type. It opens or closes the brake fluid passage between a wheel cylinder and the reservoir according to commands from the ABSCM.
- The inlet solenoid valve is duty-controlled to reduce brake fluid pulsation for minimum ABS operation noise.
- The reservoir temporarily stores the brake fluid drained from a wheel cylinder when pressure “decrease” control is performed.
- The damper chamber suppresses brake fluid pulsation which would occur during pressure “decrease” control in the fluid discharged from the plunger pump to minimize kickbacks of the brake pedal.
- The valve relay controls power supply to the solenoid valves and motor relay in response to a command from the ABSCM. In normal (IG ON) condition, the relay is closed to supply power to the solenoid valves and motor relay. When an error occurs in the system, the valve relay is turned OFF to keep the fluid pressure circuit in the normal mode (non-ABS mode).
- The motor relay closes and supplies power to the pump motor in response to a command from the ABSCM during the ABS drive mode operations.

The H/U has four operating modes; normal mode (non-ABS mode), and three ABS active modes, i.e., “increase”, “hold” and “decrease” modes.

MEMO

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

1. DURING NORMAL BRAKING (ABS NOT ACTIVE)

Both the inlet and outlet solenoid valves are not energized.

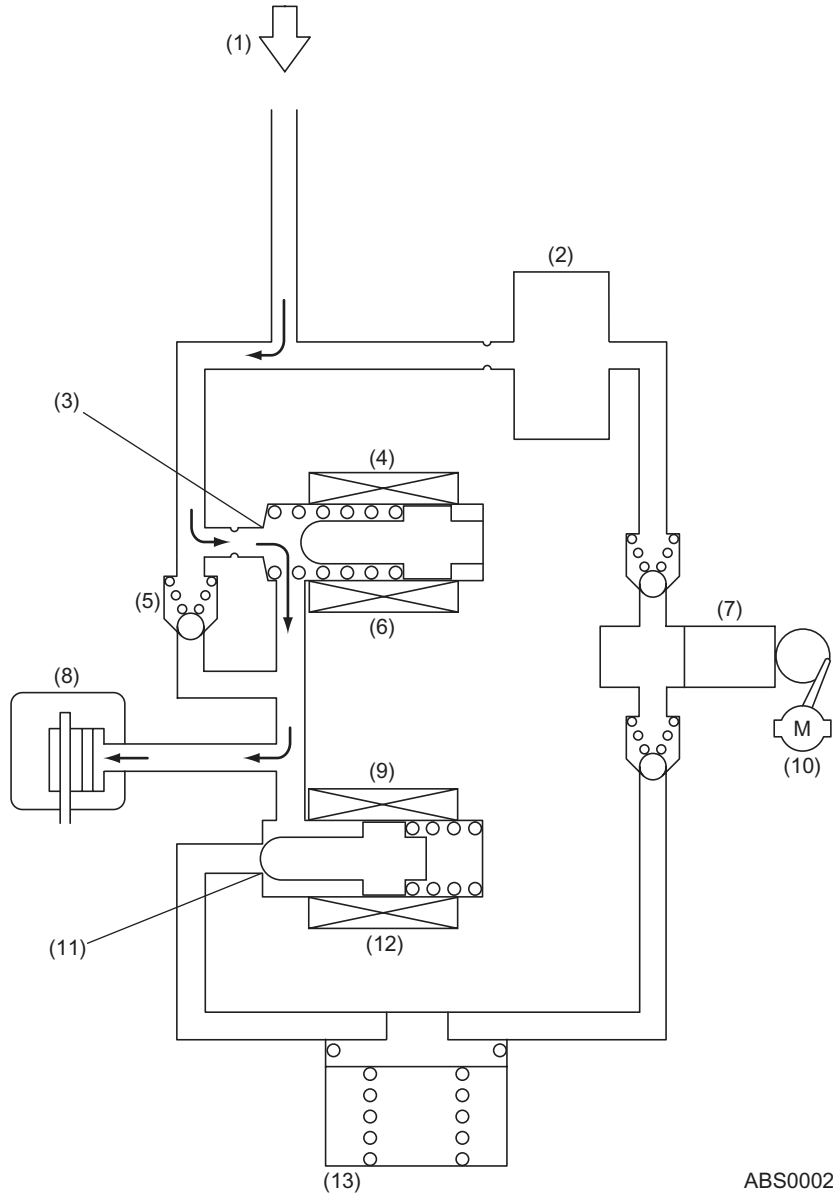
This means that the inlet port of the inlet solenoid valve is open, whereas the outlet port of the outlet solenoid valve is closed. So the fluid pressure generated in the master cylinder is transmitted to the wheel cylinder, producing a brake force.

NOTE:

For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS



ABS00020

- | | |
|--------------------------|---------------------------|
| (1) From master cylinder | (8) Wheel cylinder |
| (2) Damper chamber | (9) Outlet solenoid valve |
| (3) Inlet port open | (10) Motor |
| (4) Inlet solenoid valve | (11) Outlet port closed |
| (5) Check valve | (12) De-energized |
| (6) De-energized | (13) Reservoir |
| (7) Pump | |

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

2. PRESSURE “DECREASE” CONTROL (ABS ACTIVE)

Both the inlet and outlet solenoid valves are energized, which means that the inlet port is closed and the outlet port is open.

In this state, the wheel cylinder is isolated from the master cylinder but open to the reservoir, so the brake fluid in it can be drained into the reservoir, decreasing its pressure and reducing the braking force of the wheel.

The brake fluid collected in the reservoir is forced into the master cylinder by the pump.

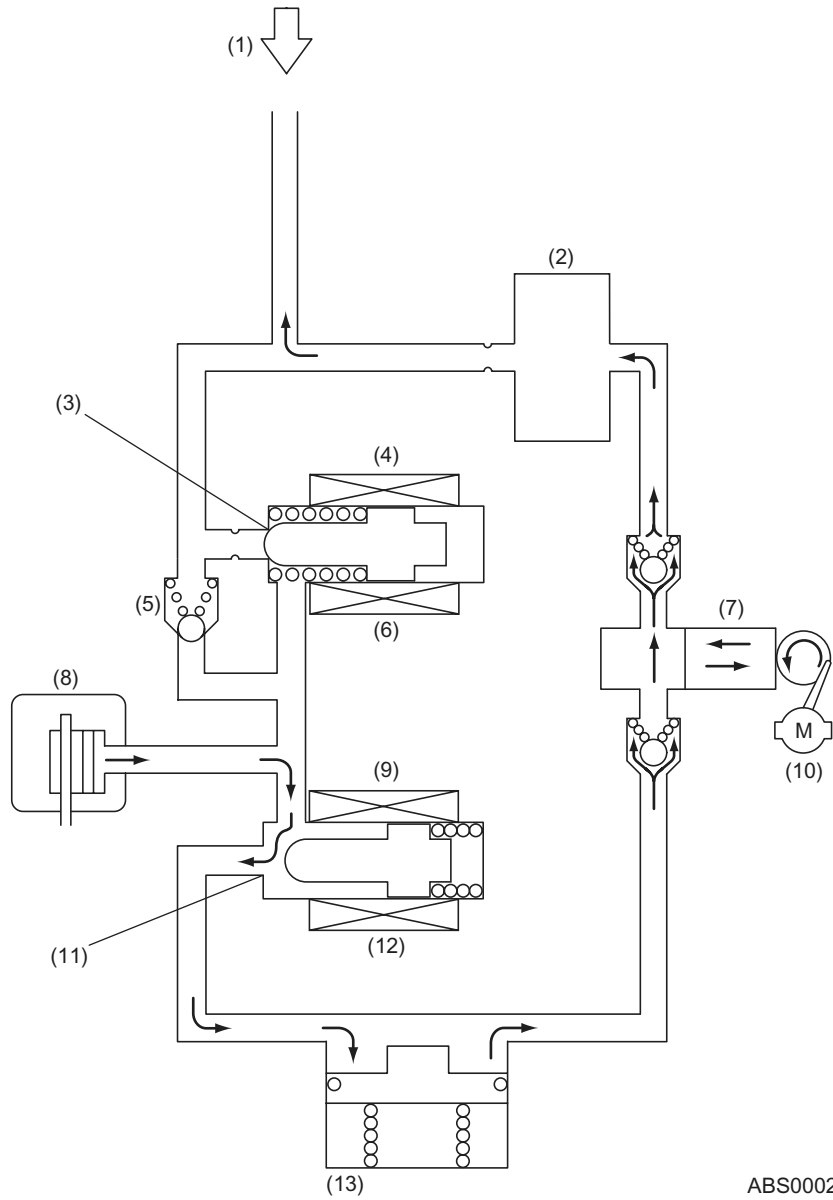
During this phase of ABS operation, the pump motor continues operating.

NOTE:

For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS



ABS00026

- | | |
|--------------------------|---------------------------|
| (1) From master cylinder | (8) Wheel cylinder |
| (2) Damper chamber | (9) Outlet solenoid valve |
| (3) Inlet port closed | (10) Motor |
| (4) Inlet solenoid valve | (11) Outlet port open |
| (5) Check valve | (12) Energized |
| (6) Energized | (13) Reservoir |
| (7) Pump | |

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

3. PRESSURE “HOLD” CONTROL (ABS ACTIVE)

The inlet solenoid valve is energized, so the inlet port is closed.

On the other hand, the outlet solenoid valve is de-energized, so the output port is also closed. In this state, all the passages connecting the wheel cylinder, master cylinder and reservoir are blocked. As a result, the fluid pressure in the wheel cylinder is held unchanged.

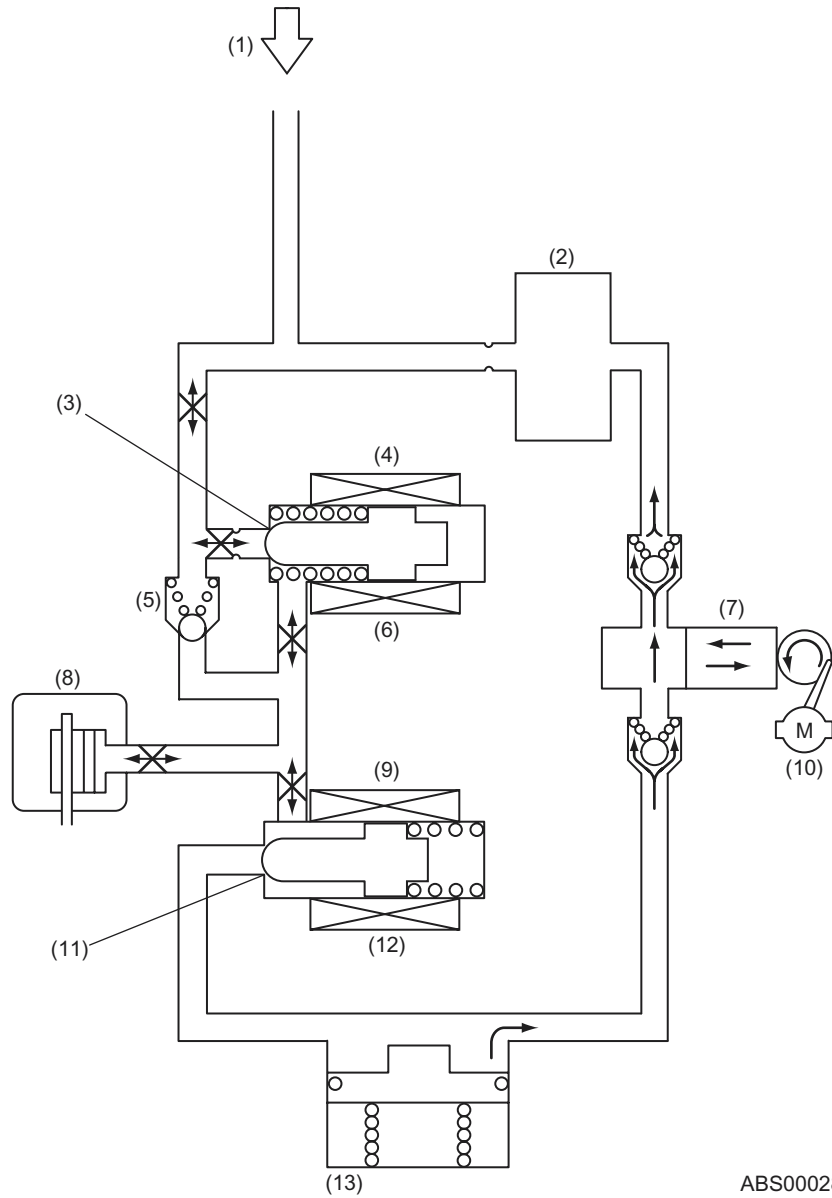
During this phase of ABS operation, the pump motor continues operating.

NOTE:

For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS



ABS00028

- (1) From master cylinder
- (2) Damper chamber
- (3) Inlet port closed
- (4) Inlet solenoid valve
- (5) Check valve
- (6) Energized
- (7) Pump

- (8) Wheel cylinder
- (9) Outlet solenoid valve
- (10) Motor
- (11) Outlet port closed
- (12) De-energized
- (13) Reservoir

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

4. PRESSURE “INCREASE” CONTROL (ABS ACTIVE)

Both the inlet and outlet solenoid valves are de-energized, which means that the inlet port of the inlet solenoid valve is open, whereas the outlet port of the outlet solenoid valve is closed. So the fluid pressure generated in the master cylinder is transmitted to the wheel cylinder and increased fluid pressure in the wheel cylinder applies the brake with a larger force.

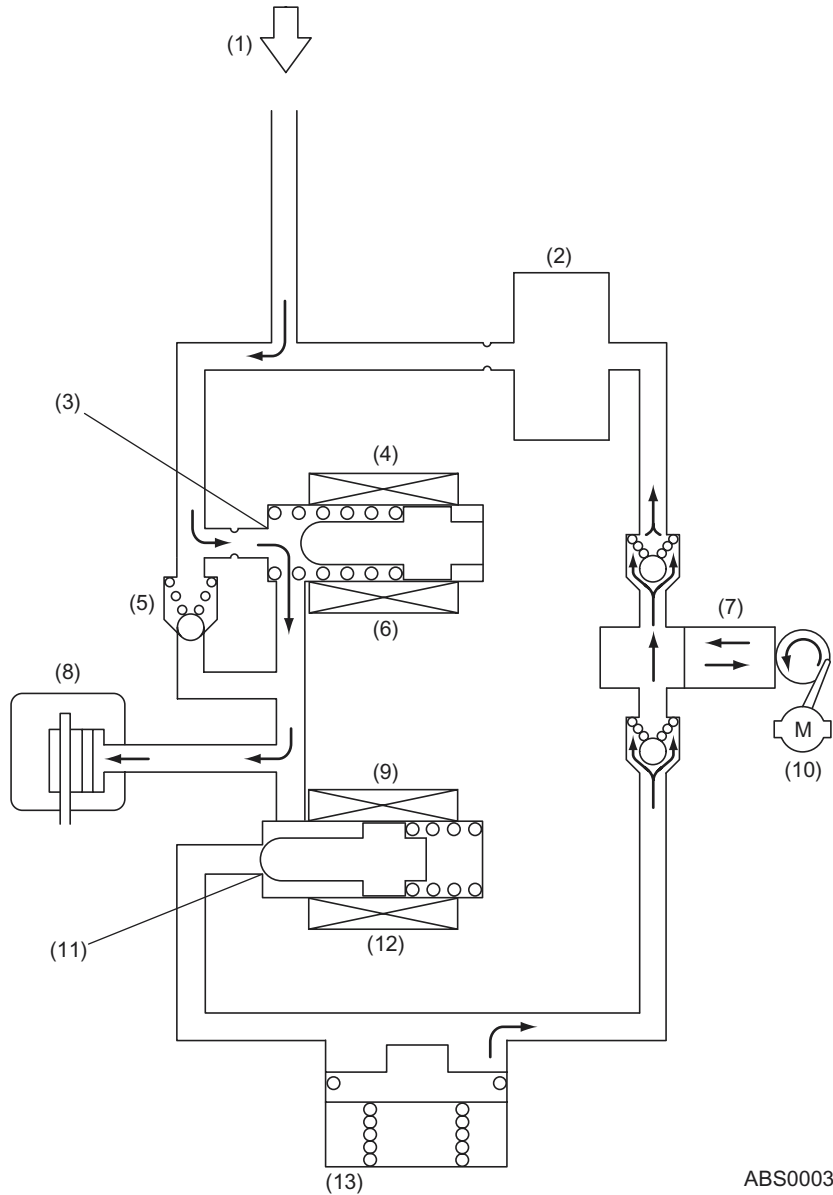
During this phase of ABS operation, the pump motor continues operating.

NOTE:

For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS



ABS00030

- | | |
|--------------------------|---------------------------|
| (1) From master cylinder | (8) Wheel cylinder |
| (2) Damper chamber | (9) Outlet solenoid valve |
| (3) Inlet port open | (10) Motor |
| (4) Inlet solenoid valve | (11) Outlet port closed |
| (5) Check valve | (12) De-energized |
| (6) De-energized | (13) Reservoir |
| (7) Pump | |

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

G: ABS CONTROL CYCLE CURVES

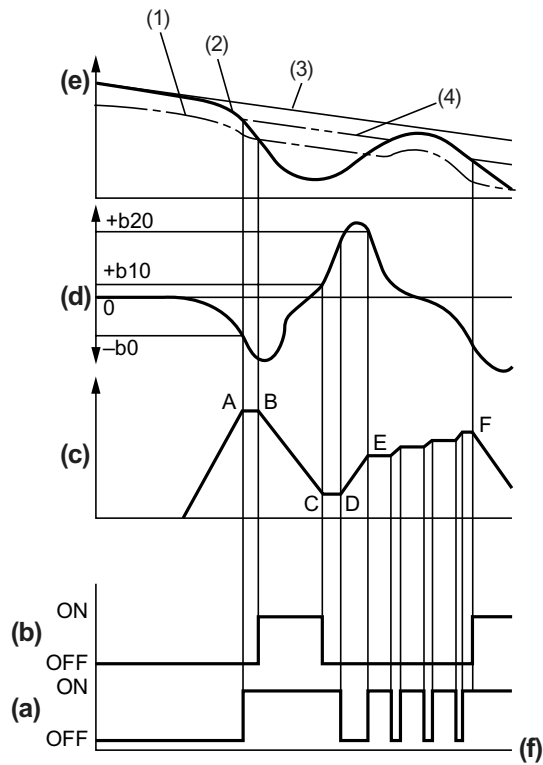
Depressing the brake pedal increases the brake fluid pressure in each wheel cylinder, which in turn decreases the wheel speed (or increases the wheel deceleration rate). When the brake fluid pressure is increased to a level of point “A” of the brake fluid pressure curve in the diagram below (at which the wheel deceleration rate exceeds threshold “ $-b_0$ ”), the ABSCM makes a pressure “hold” control. At the same time, the ABSCM calculates a “dummy” vehicle speed which is a reference speed it uses in the next stage of control.

When the wheel speed then drops below the slip ratio setting, i.e., a speed lower than the “dummy” vehicle speed by the predetermined value (at point “B” of the pressure curve), the ABSCM makes a control to prevent the wheel from locking, or a pressure “decrease” control.

As the wheel cylinder pressure decreases, the wheel speed starts increasing (or the wheel acceleration rate starts rising). When the wheel acceleration rate exceeds threshold “ $+b_{10}$ ” (at point “C” of the pressure curve), the ABSCM makes a pressure “hold” control. When the wheel acceleration rate exceeds threshold “ $+b_{20}$ ” (at point “D” of the pressure curve), the ABSCM recognizes that wheel lock-up will not occur and then makes a pressure “increase” control.

When the wheel acceleration rate drops below threshold “ $+b_{20}$ ”, (at point “E” of the pressure curve), the ABSCM starts pressure “hold” and “increase” control cycles at a given interval.

When the wheel deceleration rate then exceeds threshold “ $-b_0$ ” (at point “F” of the pressure curve), the ABSCM immediately makes a pressure “decrease” control.



ABS00033

- (a) Inlet valve
- (b) Outlet valve
- (c) Brake fluid pressure
- (d) Wheel acceleration/deceleration
- (e) Speed
- (f) Time
- (1) Slip ratio setting
- (2) Wheel speed
- (3) Vehicle speed
- (4) "Dummy" vehicle speed

Brake fluid Pressure	Inlet valve	Outlet valve
Increase	OFF	OFF
Hold	ON	OFF
Decrease	ON	ON

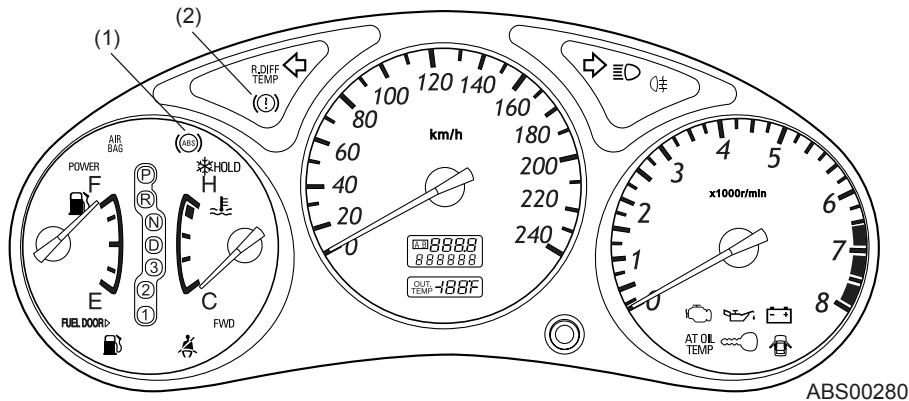
ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

H: ABS WARNING LIGHT AND BRAKE WARNING LIGHT (ALSO FUNCTIONS AS EBD WARNING LIGHT)

When a fault occurs in the signal transmission system or the ABSCM, the ABS warning light and the brake warning light in the combination meter come on. At the same time, the current to the hydraulic control unit is interrupted. The brake system then functions in the same manner as a system without ABS. The warning light utilizes a dual circuit design.

If the warning light comes on, one or more trouble codes should be stored in the control module. They must be identified using the warning light's code indicating function.

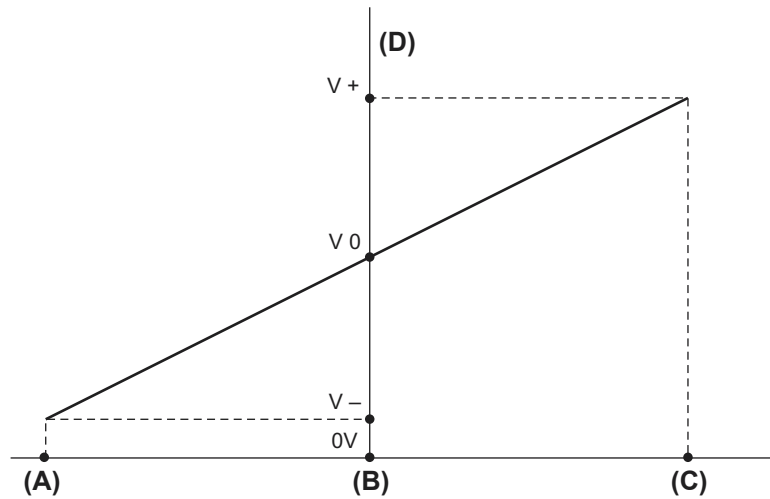
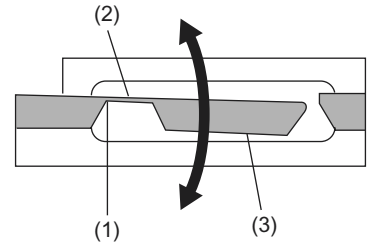
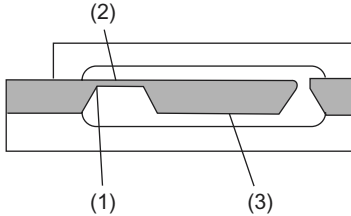
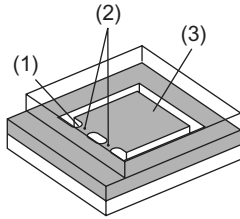


- (1) ABS warning light
- (2) Brake warning light (also functions as EBD warning light)

I: G SENSOR

The G sensor detects changes in the vehicle's acceleration/deceleration rate in the longitudinal direction.

A piezo-resistor is formed on the beam. When the mass area moves during acceleration and deceleration, the beam distorts causing the resistance of the piezo-resistor to change. This change is converted into change in voltage and sent to the ABSCM.



ABS00035

- | | | |
|-----------------------------|--------------------|----------------------|
| (1) Beam | (2) Piezo-resistor | (3) Mass |
| (A) -1G: Accelerated | (B) 0G: Cruising | (C) +1G: Decelerated |
| (D) G sensor output voltage | | |

ANTI-LOCK BRAKE SYSTEM (ABS)

ABS

MEMO

BRAKES *BR*

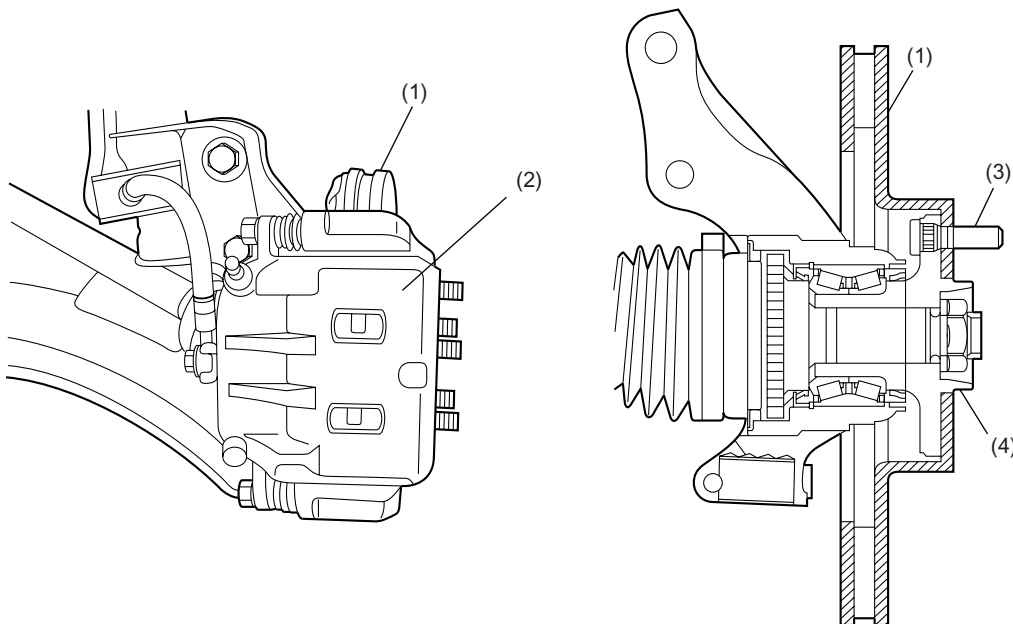
	Page
1. Front and Rear Disc Brakes	2
2. Rear Drum Brakes	4
3. Master Cylinder	6
4. Brake Booster	8
5. Proportioning Valve (Models with Rear Drum Brake)	9
6. Hill Holder	12
7. Brake pedal	19

FRONT AND REAR DISC BRAKES

Brakes

1. Front and Rear Disc Brakes

- The disc brakes are of a ventilated disc type which features high heat dissipation and superb braking stability. In addition, the front brakes quickly restore their original braking performance even when they get wet.
- Ventilated discs are used only on the front wheels.
- Each disc rotor, which is fitted on the outside of the hub, is secured together with the wheel using the hub bolts. This facilitates its removal and installation.
- The inner brake pad is provided with a wear indicator.



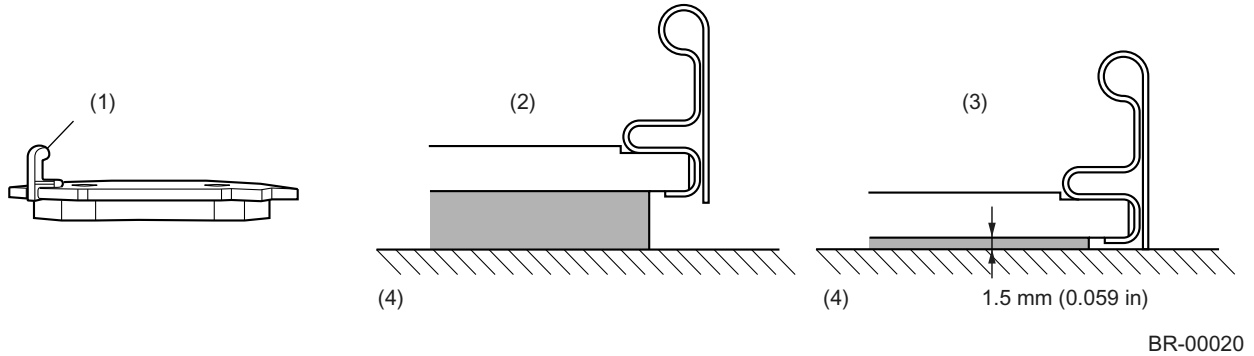
BR-00011

- (1) Disc rotor
- (2) Caliper body

- (3) Hub bolt
- (4) Hub

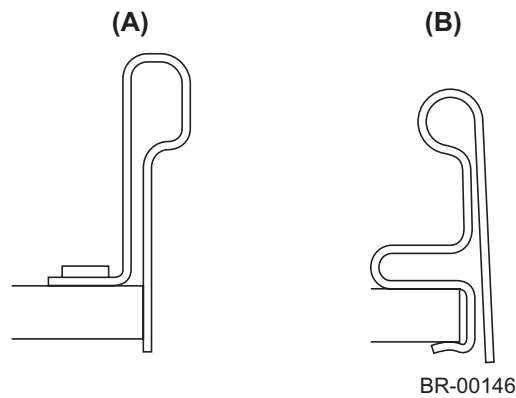
A: PAD WEAR INDICATOR

A wear indicator is provided on the inner disc brake pads. When the pad wears down to 1.5 mm (0.059 in) the tip of the wear indicator comes into contact with the disc rotor, and makes a squeaking sound as the wheel rotates. This alerts the driver to the situation.



- (1) Wear indicator
- (2) New pad

- (3) Worn pad
- (4) Disc rotor



- (A) Front brake pad
- (B) Rear brake pad

B: FRICTION MATERIAL OF BRAKE PADS

The brake pads materials do not contain any asbestos which is harmful to human body.

REAR DRUM BRAKES

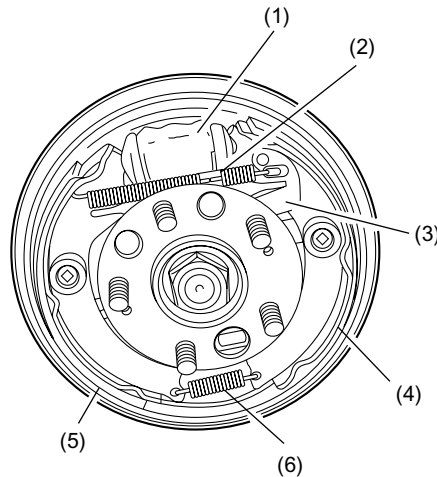
2. Rear Drum Brakes

- The rear drum brakes are of a leading-trailing shoe type. When fluid pressure is applied to each wheel cylinder, the piston expands the leading and trailing shoes. During expansion of the shoes, the lower shoe return spring joint acts as a pivot. The shoes come in contact with the inner surface of the drum, producing braking action.

- When brakes are applied during the forward movement, the tip of the brake leading shoe lining is pressed against the inner surface of the drum so as to oppose the drum's rotating force. This increases the braking force. The trailing shoe, however, undergoes a force that pushes it back so that braking force applied to the trailing shoe decreases.

The above shoe actions are reverse while the vehicle is moving backward; the braking force exerted on the trailing shoe is greater than that on the leading shoe. This means that there is no difference in braking force between when the vehicle is moving forward and when it is reversing.

- An inspection hole is provided in the backing plate for easier inspection of the linings for wear. The hole is closed with a rubber cap.



BR-00038

(1) Wheel cylinder

(2) Upper shoe return spring

(3) Adjuster lever

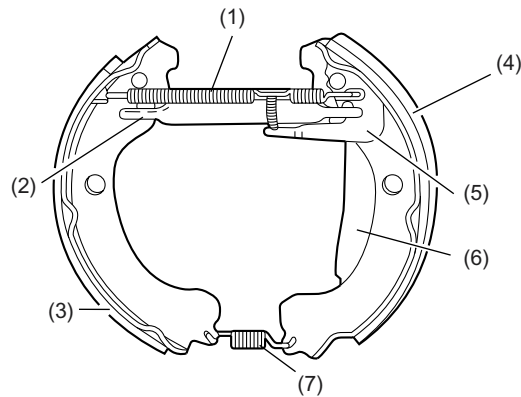
(4) Trailing shoe

(5) Leading shoe

(6) Lower shoe return spring

A: AUTOMATIC ADJUSTER

The brake lining-to-drum clearance is automatically adjusted by the automatic adjuster. When the brake shoe is contracting after expansion, the adjuster lever rotates the adjuster assembly's screw to lengthen the adjuster assembly so that the clearance is maintained at the specified value.



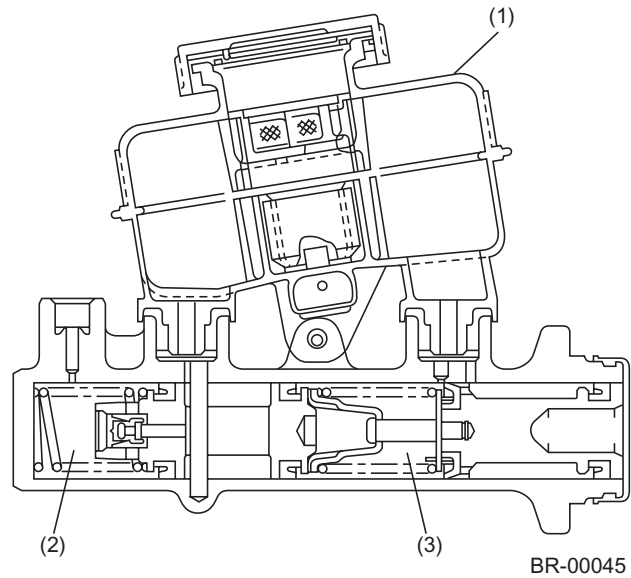
BR-00044

- | | |
|------------------------------|------------------------------|
| (1) Upper shoe return spring | (5) Adjuster lever |
| (2) Adjuster assembly | (6) Parking lever |
| (3) Leading shoe | (7) Lower shoe return spring |
| (4) Trailing shoe | |

MASTER CYLINDER

3. Master Cylinder

- There is a brake fluid reservoir tank on the master cylinder. The reservoir is completely sealed for extended service life of the brake fluid.



- (1) Reservoir tank
- (2) Secondary hydraulic chamber
- (3) Primary hydraulic chamber

A: BRAKE FLUID LEVEL SWITCH

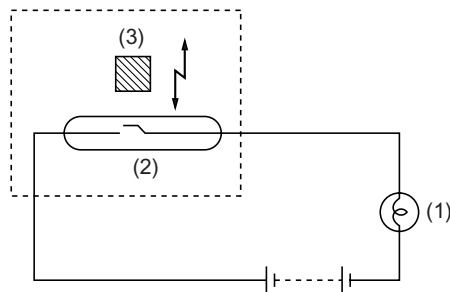
The brake fluid level switch is located inside the brake fluid reservoir tank and causes the brake system warning light on the combination meter to come on when the fluid level has dropped below the predetermined level.

The switch assembly consists of a reed switch (normally open) and a permanent magnet that is incorporated in a float.

When the brake fluid level is normal, the float is far above the reed switch, so the force of the magnet is unable to act on the reed switch. The warning light circuit, therefore, remains open.

When the brake fluid level drops to a level approximately 30 mm (1.18 in) below the maximum level and the float lowers accordingly, the magnet aligns with the reed switch, activating the reed switch contact. The warning light then comes on to warn the driver of the situation.

The warning light may, although momentarily, illuminate even when the brake fluid level is normal if the vehicle tilts or swing largely.



BR-00147

(1) Warning light

(2) Reed switch

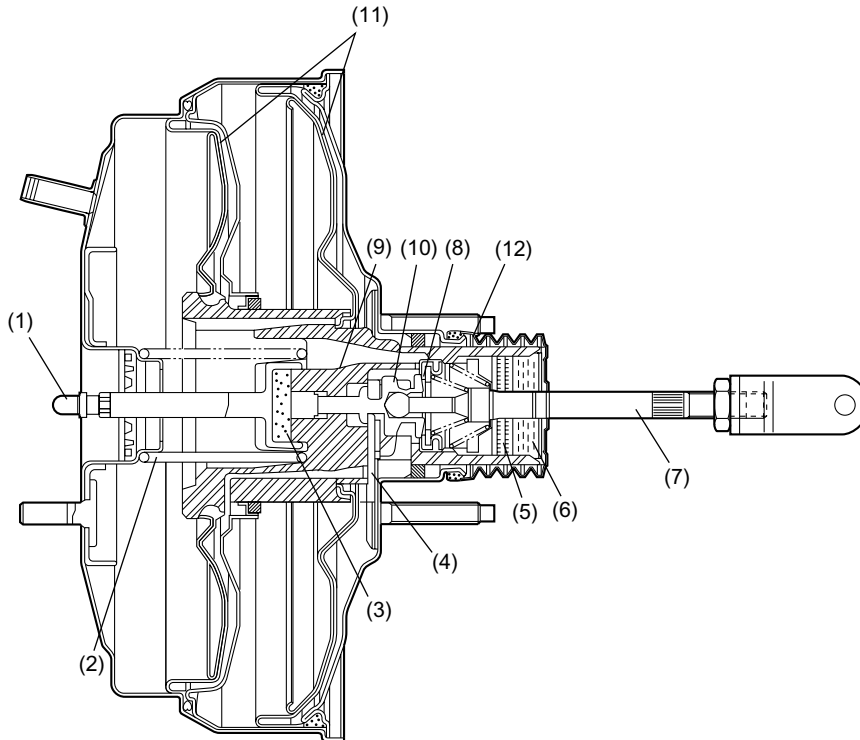
(3) Permanent magnet

BRAKE BOOSTER

Brakes

4. Brake Booster

The brake booster is a tandem type that uses two diaphragms. This design provides high brake boosting effects in spite of a reduced diameter.

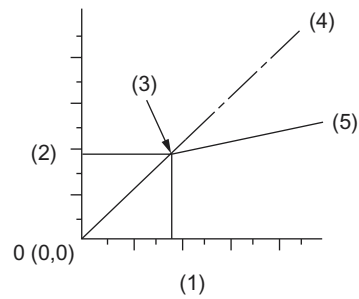


BR-00057

- | | | |
|-------------------|-------------------|--------------------------|
| (1) Push rod | (5) Filter | (9) Valve body |
| (2) Return spring | (6) Silencer | (10) Plunger valve |
| (3) Reaction disc | (7) Operating rod | (11) Diaphragm plate |
| (4) Key | (8) Poppet valve | (12) Valve return spring |

5. Proportioning Valve (Models with Rear Drum Brake)

The proportioning valve prevents the rear wheels from locking and resultant skidding that would occur during hard braking due to transfer of vehicle weight toward the front wheels. The valve distributes a reduced pressure to the rear wheel brakes as compared with the pressure to the front wheel brakes when a specified master cylinder fluid pressure (called "split point") is exceeded as shown in the diagrams below.



BR-00148

- (1) Master cylinder fluid pressure kPa (kgf/cm², psi)
- (2) Rear wheel cylinder fluid pressure kPa (kgf/cm², psi)
- (3) Split point
- (4) Without proportioning valve
- (5) Proportioning valve operating

PROPORTIONING VALVE (MODELS WITH REAR DRUM BRAKE)

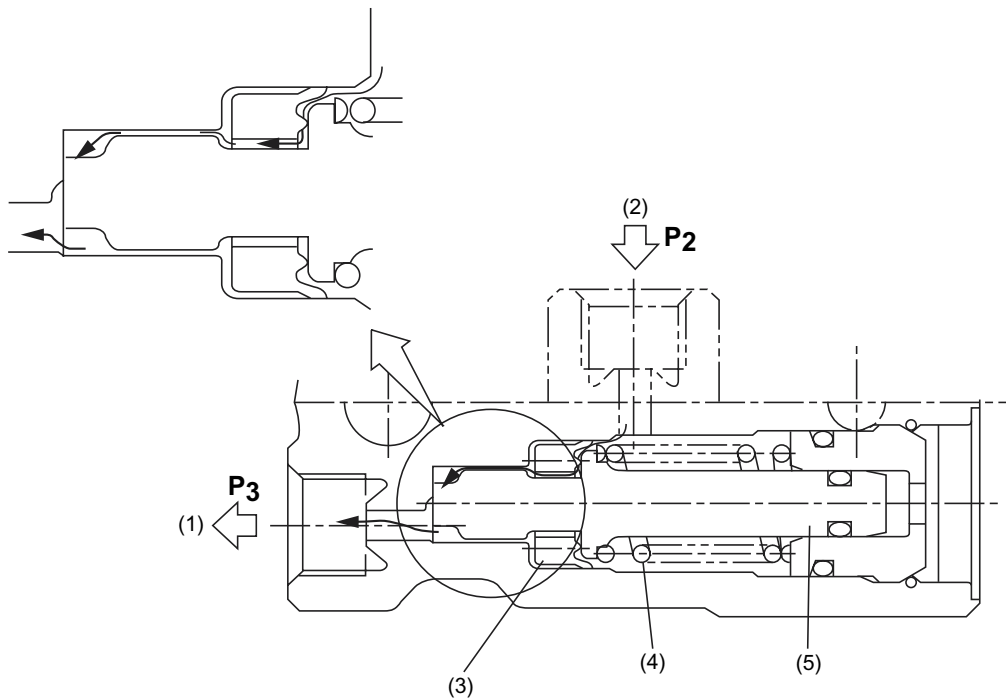
Brakes

A: OPERATION

1) Operation before the split point

The piston is held pressed toward the left by the spring so that the piston is kept away from its lip seal.

Under this condition, fluid pressure " P_3 " to the rear wheel cylinders is equal to fluid pressure " P_2 " from the master cylinder.



BR-00064

- (1) To rear wheel cylinder
- (2) From master cylinder
- (3) Lip seal

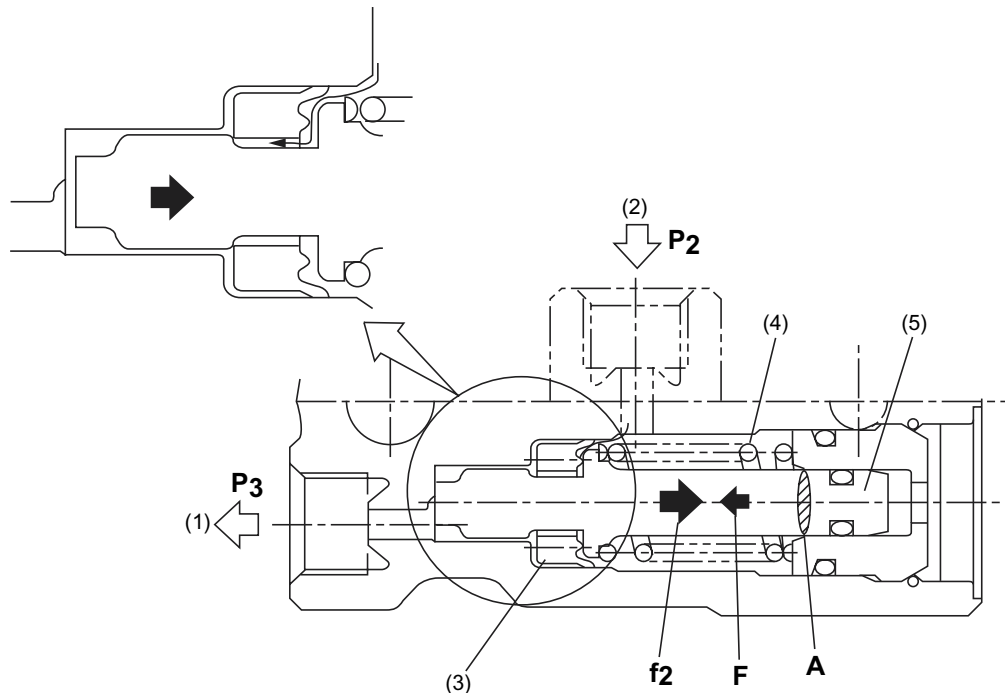
- (4) Spring
- (5) Piston

PROPORTIONING VALVE (MODELS WITH REAR DRUM BRAKE)

Brakes

2) Operation at the split point pressure

When pressure " P_2 " increases to the split point pressure, force " f_2 " is generated. (Piston's cross sectional area " A " has been selected so that the force is generated starting with the split point pressure.) The pressure pushes the piston rightward, overcoming spring force " F ". As a result, the piston moves rightward and comes in contact with the lip seal, blocking the passage toward the rear wheel cylinders.



BR-00065

- (1) To rear wheel cylinder
- (2) From master cylinder
- (3) Lip seal

- (4) Spring
- (5) Piston

3) Operation after reaching the split point pressure

Immediately before the fluid passage toward the rear wheel cylinders is closed, pressure " P_2 " is slightly higher than pressure " P_3 ". So the piston can move in the spring force acting direction and the fluid can flow to the wheel cylinders. However, as soon as pressure " P_2 " becomes equal to " P_3 ", the passage closes.

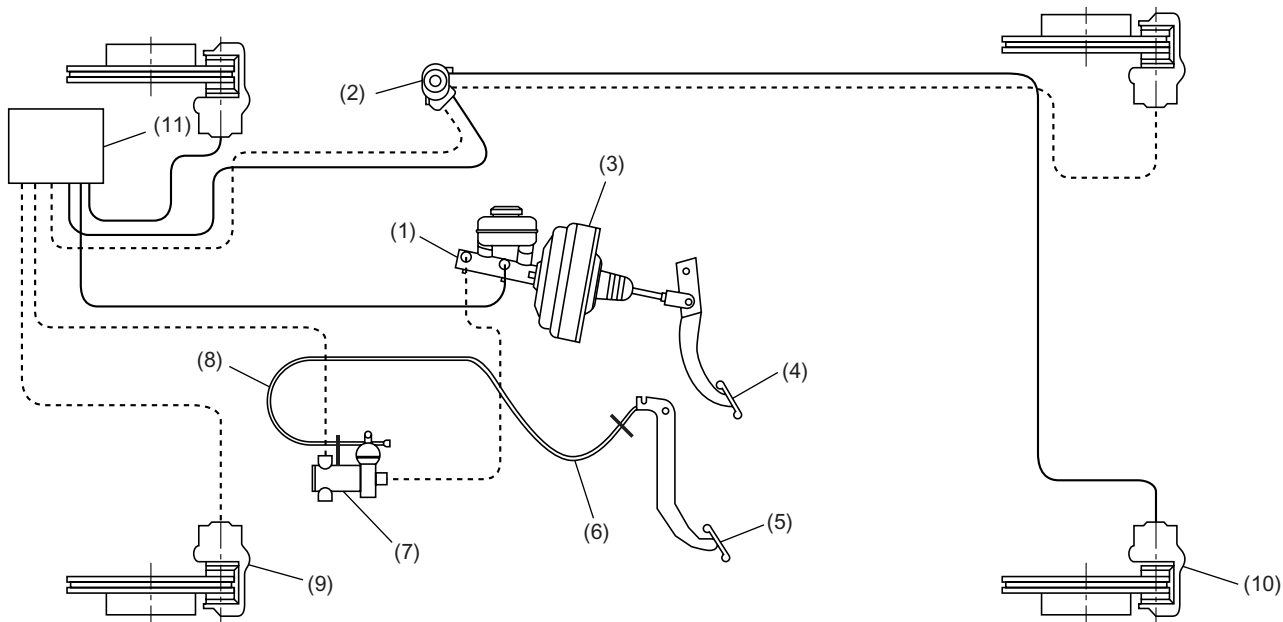
This cycle is repeated as long as the pedal is depressed further, but pressure increasing rate of the rear wheel cylinders is smaller than that of the front wheel cylinders.

HILL HOLDER

6. Hill Holder

The hill holder is a device that facilitates starting on an uphill road. With the help of this device, even an unexperienced driver can start the vehicle smoothly.

When starting the vehicle on an uphill road, the driver depresses the clutch pedal while keeping the brake pedal depressed and then releases the brake pedal. At this time the hill holder keeps the brakes still applied until the clutch pedal is released. This enables the driver to start the vehicle in a usual manner by depressing the accelerator while releasing the clutch pedal without being troubled by brake pedal operation.



BR-00071

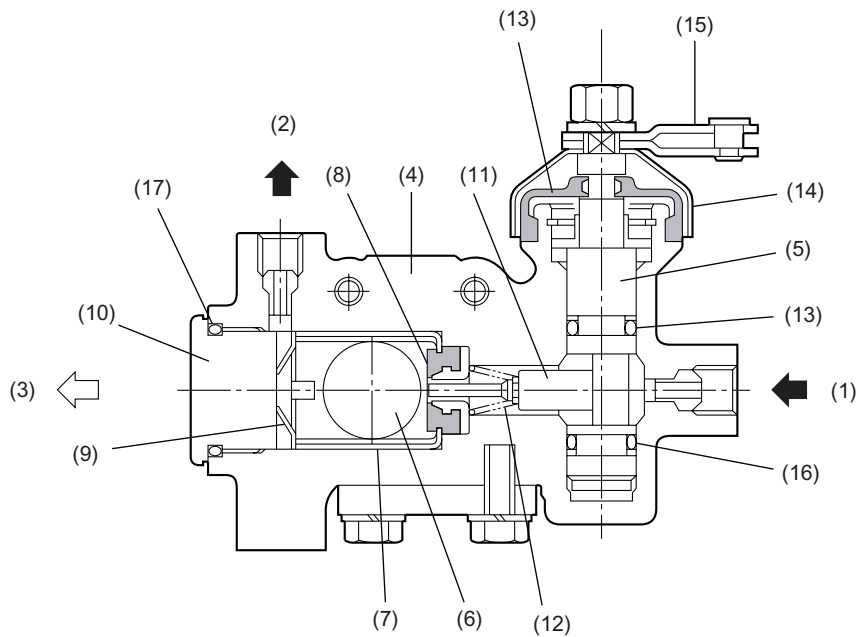
- | | | |
|---|-------------------------------------|--|
| (1) Master cylinder | (5) Clutch pedal | (9) Front brake |
| (2) Proportioning valve
(models with rear drum brake only) | (6) Clutch cable | (10) Rear brake |
| (3) Brake booster | (7) Pressure hold valve | (11) ABS control module/
hydraulic control unit |
| (4) Brake pedal | (8) Pressure hold valve (PHV) cable | |

A: PRESSURE HOLD VALVE (PHV)

- The PHV is located on the piping that connects the master cylinder and the ABS control module/hydraulic control unit. It has a camshaft which turns either way by rotation of the lever which is linked to the clutch pedal. The cam of the camshaft allows the pushrod in the PHV to move rightward (in the drawing below) under the force of a spring when the clutch pedal is depressed and pushes it leftward against the force of the spring when the clutch pedal is released. At the left of the pushrod, there is a ball housed in a chamber which has a seat for the ball. When the vehicle is on a level road, this ball stays at the left (front) of the chamber, but on an uphill road, it tends to move rightward by the gravity. In the latter case, the ball makes contact with the seat unless it is forced to leave the seat by a leftward movement of the pushrod (resulting from release of the clutch pedal).
- When the vehicle is stopped on an uphill road, the driver depresses both the brake and clutch pedals. In this condition, the ball is in the rear (right) position, making contact with its seat and preventing flow of the brake fluid toward the master cylinder. The driver then release the brake pedal while keeping the clutch pedal depressed to restart the vehicle. The brakes, however, remains applied because the pressure in the line to the wheel cylinders is kept unreleased. Then, the driver can release the clutch pedal in the same way as with on a level road while depressing the accelerator pedal since the release of the clutch pedal causes the pushrod to push the ball away from its seat and the brakes are released.

HILL HOLDER

Brakes



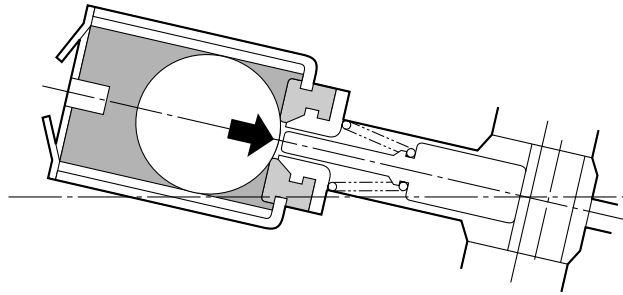
BR-00092

- | | | |
|--|------------------|-------------|
| (1) From master cylinder | (7) Ball guide | (13) Boot |
| (2) To ABS control module and hydraulic unit | (8) Seal | (14) Cover |
| (3) Front | (9) Plate spring | (15) Lever |
| (4) Body | (10) Cap | (16) O-ring |
| (5) Camshaft | (11) Pushrod | (17) O-ring |
| (6) Ball | (12) Spring | |

1. CONDITIONS IN WHICH THE HILL HOLDER OPERATES

The hill holder operates only when the clutch and brake pedals are depressed with the vehicle stopped on an uphill road.

In this condition, the PHV's ball blocks the fluid passage back to the master cylinder and, therefore, the hydraulic pressure in the wheel cylinder circuits is maintained even after the brake pedal has been released as long as the clutch pedal is held depressed.



BR-00097

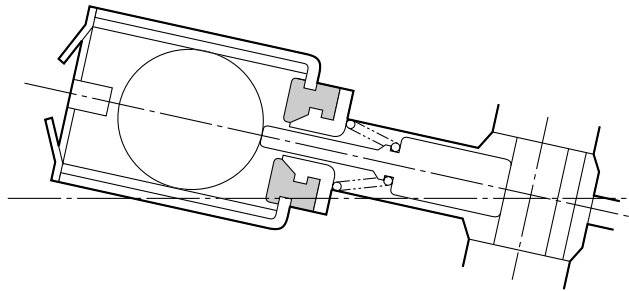
HILL HOLDER

2. CONDITIONS IN WHICH THE HILL HOLDER DOES NOT OPERATE

The hill holder does not operate in the following conditions:

- During acceleration and constant speed driving on an uphill road

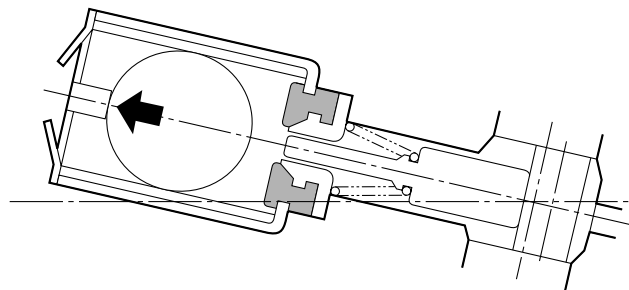
Since driver does not depress the clutch pedal during acceleration or driving at a constant speed, the pushrod keeps the ball away from the seat. The hill holder cannot maintain the pressure in the wheel cylinder circuits when the brake pedal is released.



BR-00112

- During deceleration on an uphill road

Even if the clutch pedal is depressed during deceleration, the ball is kept away from the seat by the inertia force. So, the hill holder cannot maintain the wheel cylinder circuit pressure.

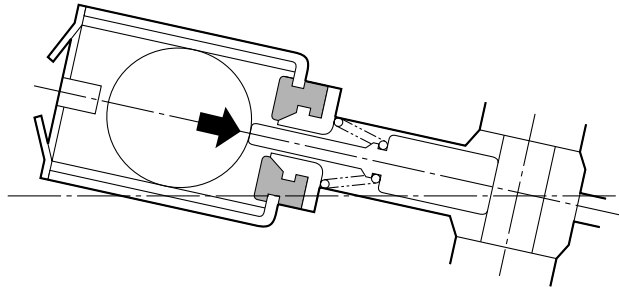


BR-00113

HILL HOLDER

- When stopping on an uphill road without depressing the clutch pedal

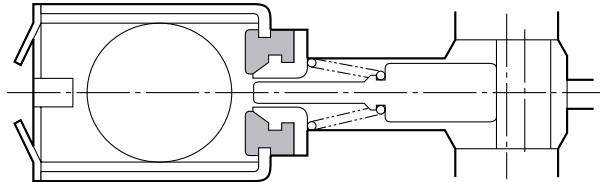
If the driver does not depress the clutch pedal simultaneously with the brake pedal when stopping the vehicle on an uphill road, the hill holder cannot keep the wheel cylinder circuit pressure unreleased when the brake pedal is release.



BR-00114

- On a level road

The ball does not move itself toward its seat except when the vehicle is braked during reversing, so the hill holder does not function during level road driving.



BR-00115

HILL HOLDER

B: OPERATIONAL PRECAUTIONS

- The hill holder is a device that facilitates starting on an uphill road. When stopping on an uphill road, therefore, the driver must keep the brake pedal depressed or set the parking brake firmly.
- The hill holder may not function on a slope with a small angle of inclination.
- If the brake force is insufficient to hold the vehicle after releasing the brake pedal with the clutch pedal depressed, depress the brake pedal again with a stronger force.
- If the clutch pedal is released halfway and then depressed again (for example, when the driver abandons an attempt of start or changes gear to the low gear from another improperly selected gear), the pressure in the wheel cylinder circuit is not retained any more. The driver, therefore, must depress the brake pedal again to use the hill holder function next time.
- Before leaving the vehicle, the driver must apply firmly the parking brake and confirm that the vehicle does not move after releasing the clutch pedal.
- When reversing on a level road, the phenomena listed below may occur. These phenomena are caused by activation of the hill holder and do not mean an abnormality.
 - Braking effect continues when the vehicle is reversed with the clutch and brake pedals depressed and then the brake pedal released.
 - A slight shock occurs in the vehicle when moving the vehicle forward after a reverse movement.

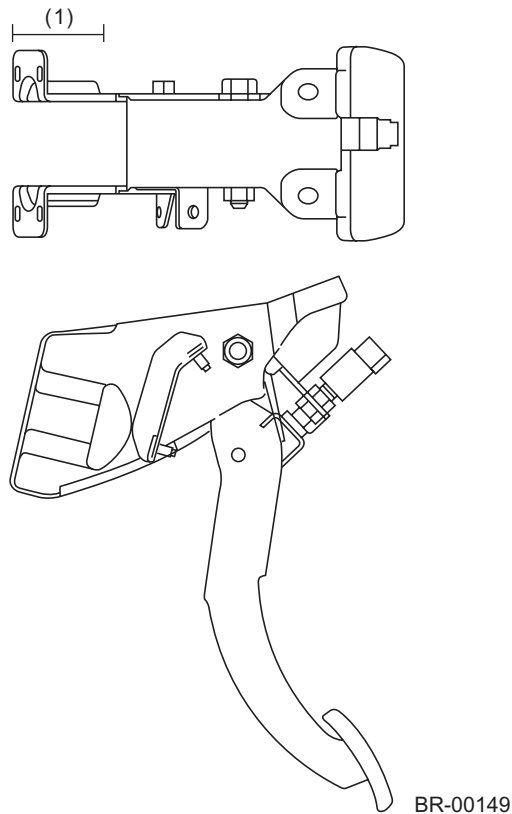
7. Brake pedal

- LHD models

To minimize brake pedal rearward movement in case of a collision for extra safety, the shape of the brake pedal bracket has been changed.

An impact absorbing area is provided at the side of the pedal bracket.

In case of a front collision, the brake pedal bracket impact absorbing area deforms to minimize shock to the driver.



(1) Impact absorbing area

BRAKE PEDAL

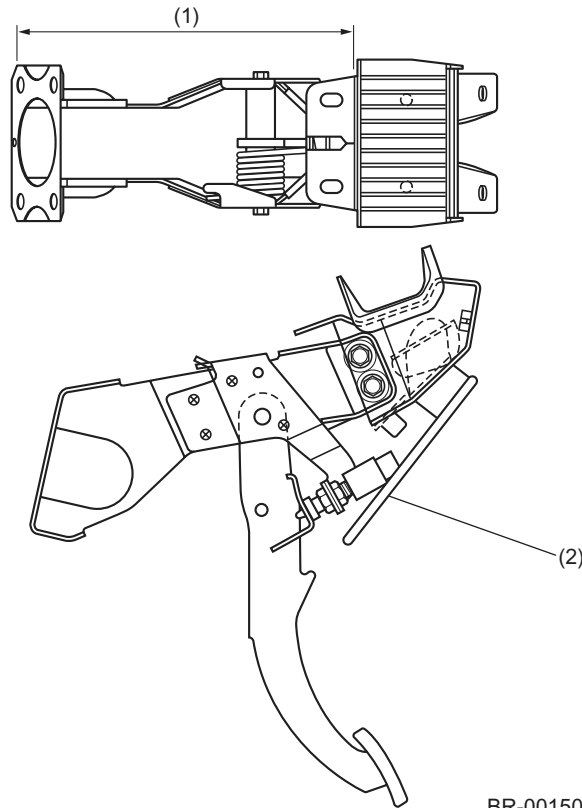
Brakes

● RHD models

To minimize brake pedal rearward movement in case of a collision for extra safety, the shape of the brake pedal bracket has been changed.

The pedal bracket is made in an impact absorbing structure and a pedal catcher is added.

In case of a front collision, the pedal catcher prevents initial rearward movement of the pedal, and the brake pedal bracket deforms to absorb the impact.



BR-00150

- (1) Impact absorbing area
- (2) Pedal catcher

PARKING BRAKE *PB*

	Page
1. Parking Brake (Rear Disc Brakes)	2
2. Parking Brake (Rear Drum Brakes)	5

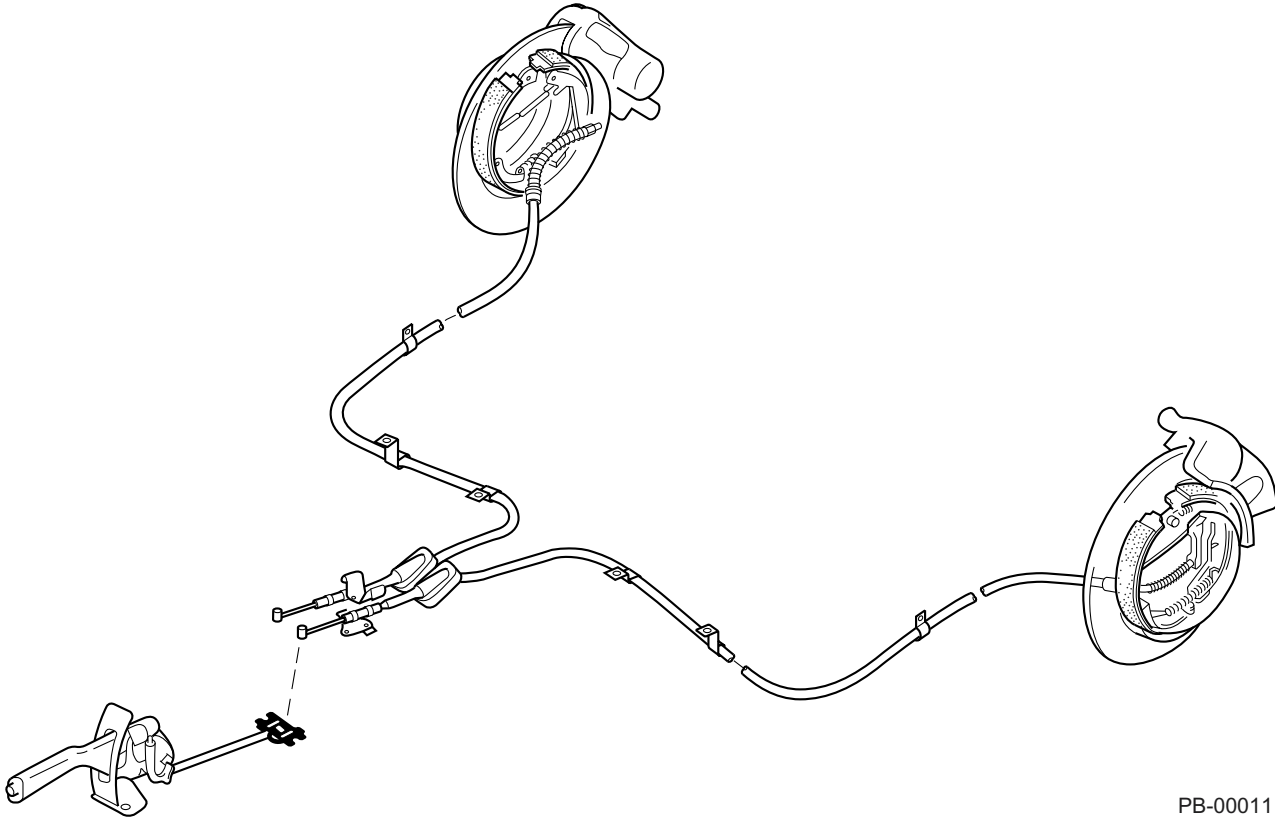
PARKING BRAKE (REAR DISC BRAKES)

Parking Brake

1. Parking Brake (Rear Disc Brakes)

The parking brakes are applied by manually operating the lever to mechanically control the rear wheels through a cable.

Each rear disc brake rotor contains a drum brake mechanism which is used exclusively for the parking brake.



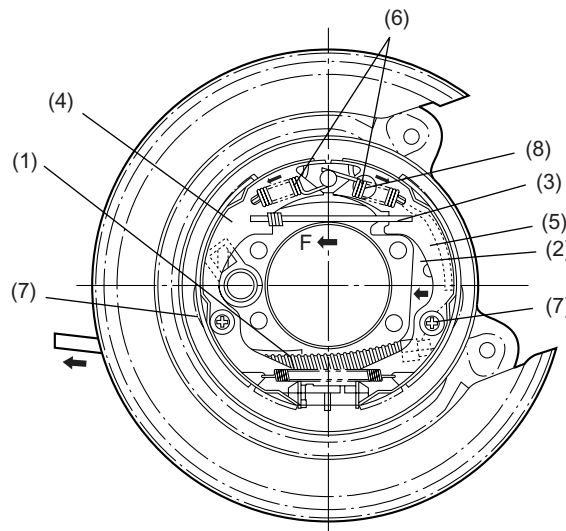
PB-00011

A: OPERATION

1. SETTING

When the parking brake lever is pulled, the shoe actuating lever to which the end of the parking brake cable is connected turns the strut in direction "F" around point "P".

The strut then presses the brake shoes A and B against the drum. These brake shoes utilize a floating design and are movably supported by hold-down pins. The force applied to brake shoe A and the reaction force "F" applied to the brake shoe B via point "P" press them against the brake drum.



PB-00012

- (1) Parking brake cable
- (2) Lever
- (3) Strut
- (4) Brake shoe A

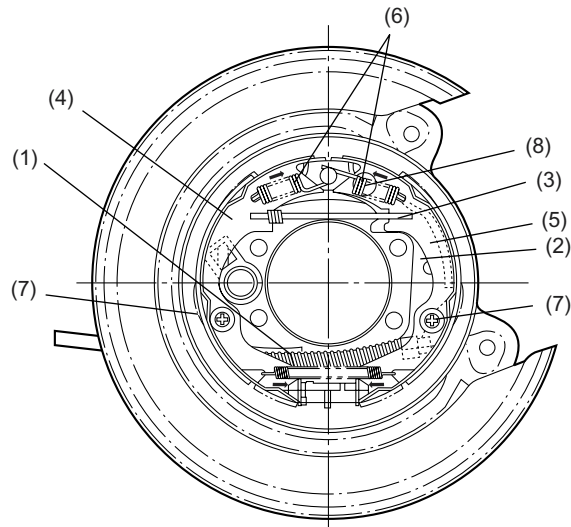
- (5) Brake shoe B
- (6) Shoe return spring
- (7) Shoe hold down pin
- (8) Point "P"

PARKING BRAKE (REAR DISC BRAKES)

Parking Brake

2. RELEASING

When the parking brake lever is returned to the release position and the parking brake cables are slackened, the brake shoes A and B are moved back to their original positions by the tension of return springs, so that the parking brake is released.



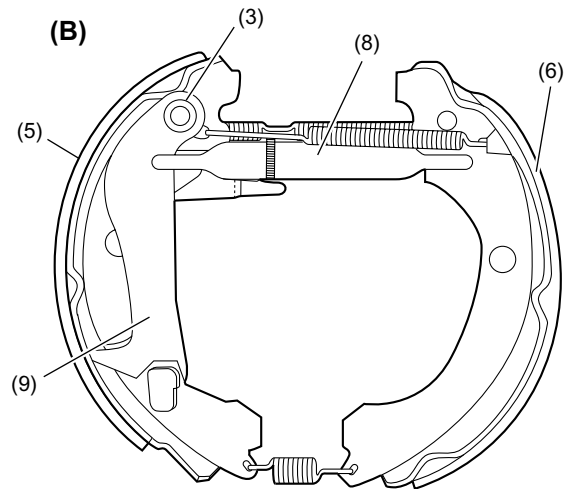
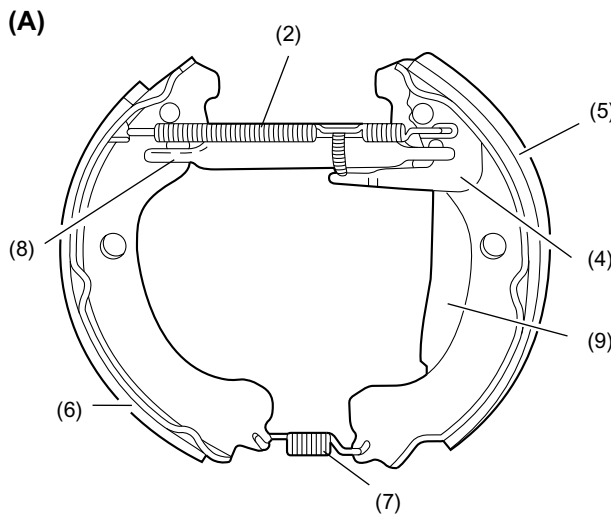
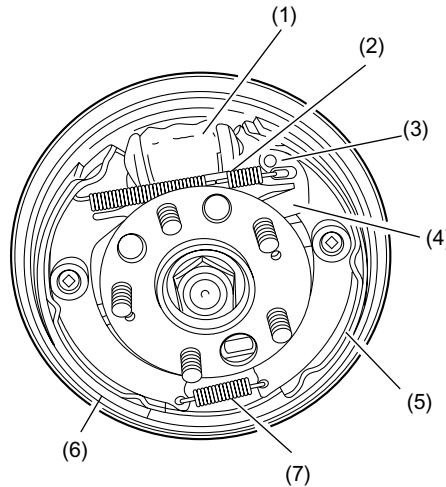
PB-00018

- (1) Parking brake cable
- (2) Lever
- (3) Strut
- (4) Brake shoe A

- (5) Brake shoe B
- (6) Shoe return spring
- (7) Shoe hold down pin
- (8) Point "P"

2. Parking Brake (Rear Drum Brakes)

When the parking brake lever is moved up, the parking lever in each rear drum brake moves around point "A" so that the trailing shoe expands. The leading shoe also expands by way of the adjuster assembly. The shoes are thus pressed against the drum to generate a wheel locking force.



PB-00019

- (1) Wheel cylinder
- (2) Upper shoe return spring
- (3) Point "A"
- (4) Adjuster lever
- (5) Trailing shoe
- (6) Leading shoe

- (7) Lower shoe return spring
- (8) Adjuster assembly
- (9) Parking lever

(A) Automatic brake lining clearance adjustment mechanism

(B) Parking brake mechanism

PARKING BRAKE (REAR DRUM BRAKES)

Parking Brake

MEMO

POWER ASSISTED SYSTEM (POWER STEERING) *PS*

	Page
1. Tilt Steering Column	2
2. Power Steering System	5

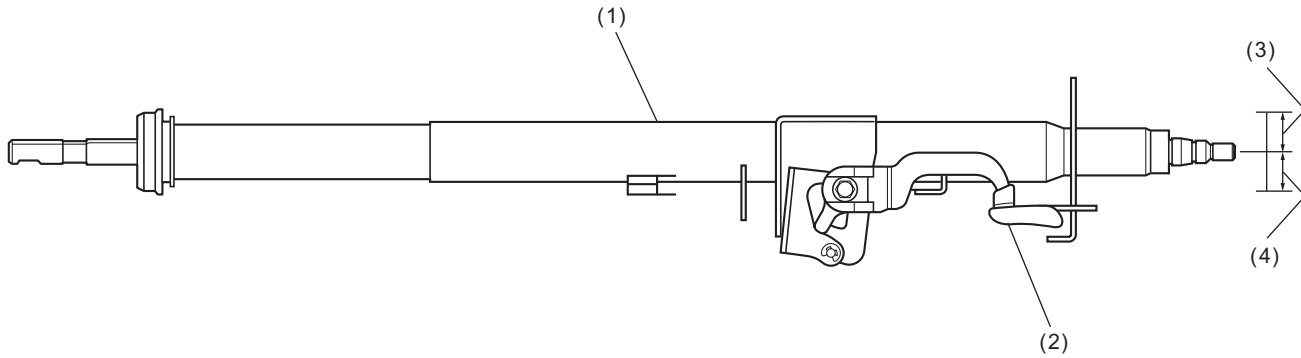
TILT STEERING COLUMN

Power Assisted System (Power Steering)

1. Tilt Steering Column

A: TILT MECHANISM

- The steering wheel vertical position can be adjusted within a 40 mm (1.58 in) range by using the tilt lever to unlock the steering column and lock it again at the desired position.



PS-00269

- (1) Tilt steering column
- (2) Tilt lever
- (3) 20 mm (0.79 in)
- (4) 20 mm (0.79 in)

TILT STEERING COLUMN

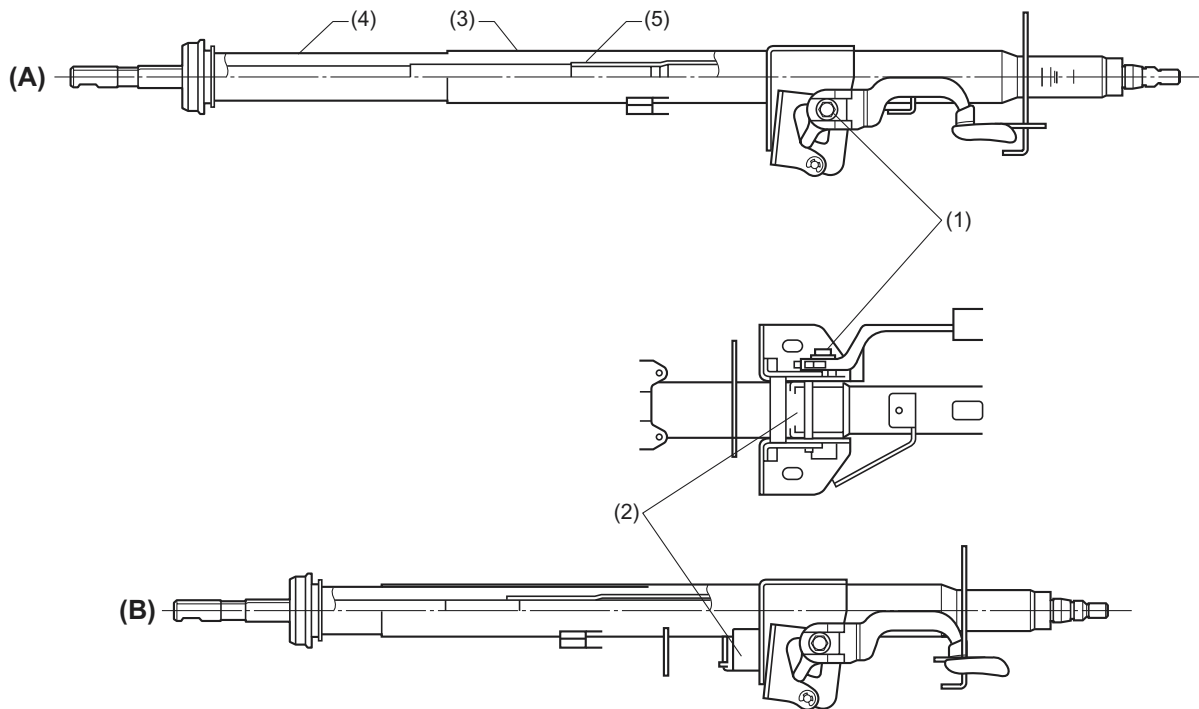
Power Assisted System (Power Steering)

B: ENERGY-ABSORBING MECHANISM

● To absorb the backward movement energy generated in the engine in the event of a frontal collision, a press-fitted pipes type steering column jacket has been adopted.

When an impact load exceeding a certain level is applied to the steering column, jacket A slides on jacket B.

Since jacket B is press-fitted in jacket A, friction generated between them absorbs the impact. The column bending load is supported by the press-fitted jackets.



PS-00270

(A) Before absorption of impact energy

(B) After absorption of impact energy

(1) Tilt pin

(2) Distance plate

(3) Jacket A

(4) Jacket B

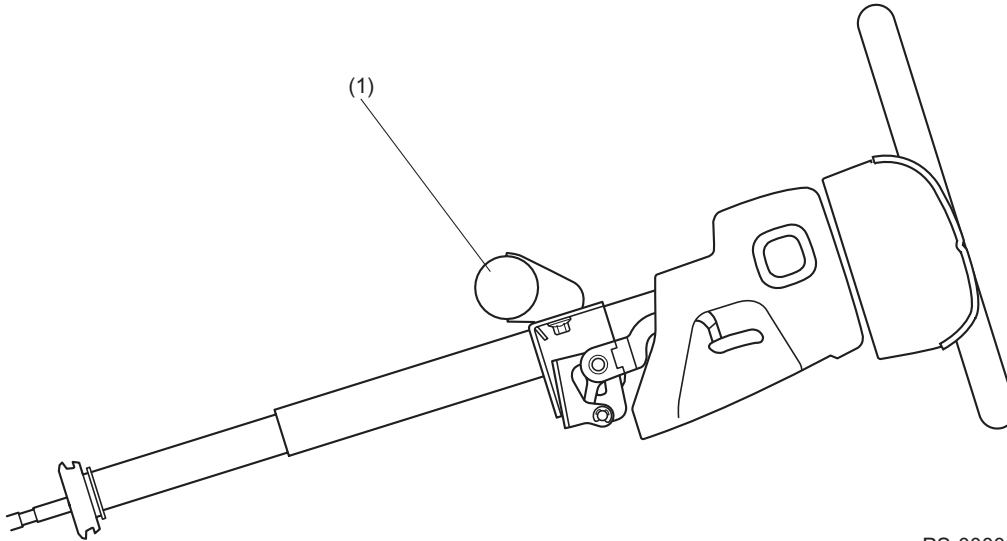
(5) Shaft

TILT STEERING COLUMN

Power Assisted System (Power Steering)

C: STEERING SUPPORT BEAM

- The steering column is held in position by a support beam which is installed crosswise in the vehicle body at a level close to the steering wheel to reduce the overhang distance of the steering wheel from the supporting point of the column. The steering shaft upper bearing is also located close to the steering wheel to increase supporting efficiency as well as to minimize vibration of the steering wheel.



PS-00008

(1) Steering support beam

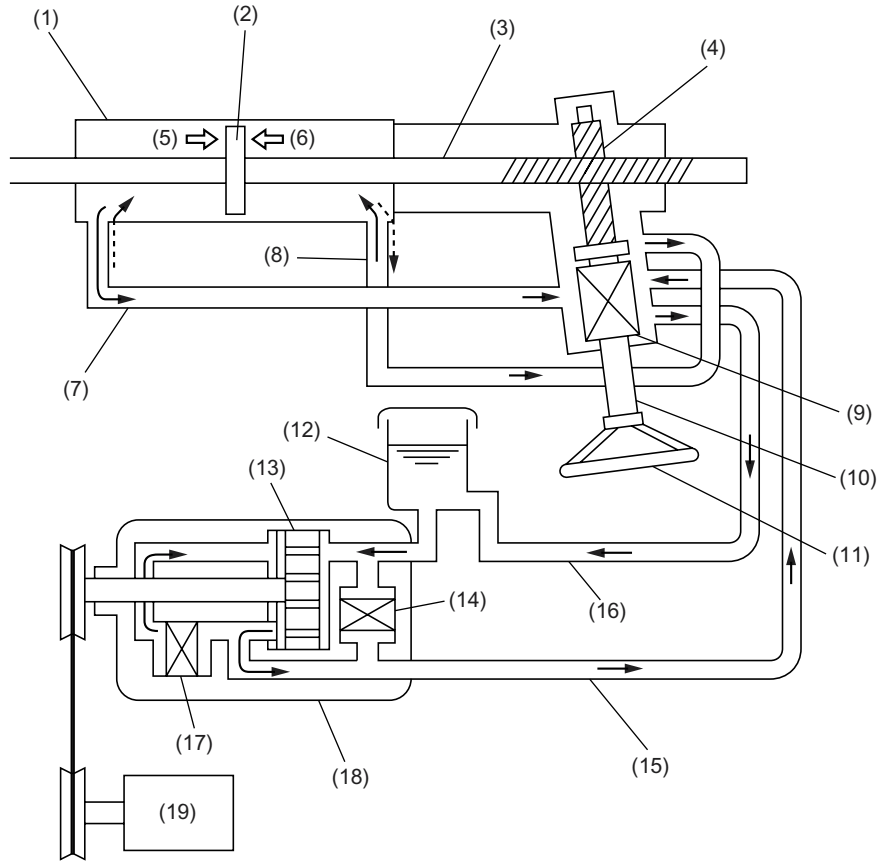
2. Power Steering System

A: HYDRAULIC SYSTEM

- The fluid pump is directly driven by the engine through a belt.
- The fluid flow is maintained almost constant regardless of change in the engine speed by the function of the flow control valve. The flow-regulated fluid is delivered to the control valve through hose A.
- When the steering wheel is turned, the rotary control valve connected to the pinion shaft opens the hydraulic circuit corresponding to the direction in which the steering wheel is turned. The fluid then flows into chamber A or B via pipe A or B.
- The fluid pressure in chamber A or B acts on the rack piston in the same direction as that in which the rack shaft is moved by rotation of the steering wheel. This helps reduce the effort required of the driver to operate the steering wheel.
- Movement of the rack piston causes the fluid in the other chamber to return to the reservoir tank via pipe A or B, control valve, and hose B.
 - As the steering shaft is connected to the pinion shaft mechanically via the rotary control valve, the steering system can operate as a manual system even if the hydraulic system becomes inoperative.
 - To control the maximum fluid pressure, a relief valve is built into the fluid pump to prevent build-up of an excessive fluid pressure.

POWER STEERING SYSTEM

Power Assisted System (Power Steering)



PS-00191

- | | |
|---------------------|-------------------------|
| (1) Power cylinder | (11) Steering wheel |
| (2) Rack piston | (12) Tank |
| (3) Rack shaft | (13) Vane pump |
| (4) Pinion shaft | (14) Relief valve |
| (5) Chamber A | (15) Hose A |
| (6) Chamber B | (16) Hose B |
| (7) Pipe A | (17) Pump control valve |
| (8) Pipe B | (18) Fluid pump |
| (9) Control valve | (19) Engine |
| (10) Steering shaft | |

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

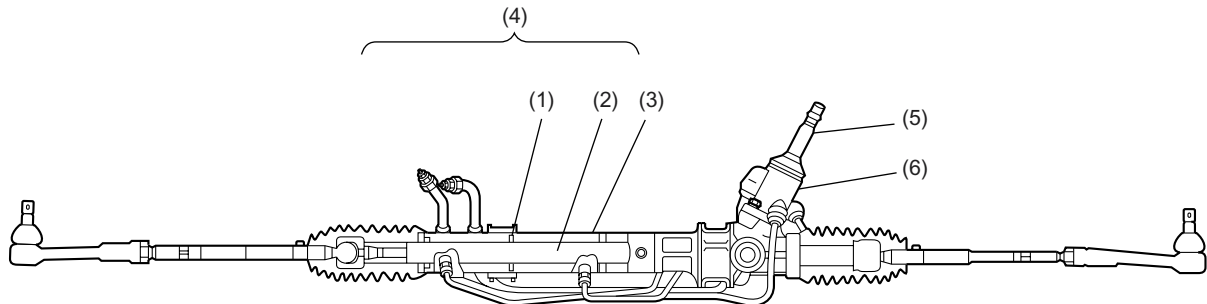
B: GEARBOX ASSEMBLY

1. POWER CYLINDER

The gear box integrates the control valve and power cylinder into a single unit. The rack shaft serves as a power cylinder piston. The rotary control valve is located around the pinion shaft.

The rotary control valve and power cylinder are connected to each other by two pipes through which hydraulic fluid flows.

LHD MODEL

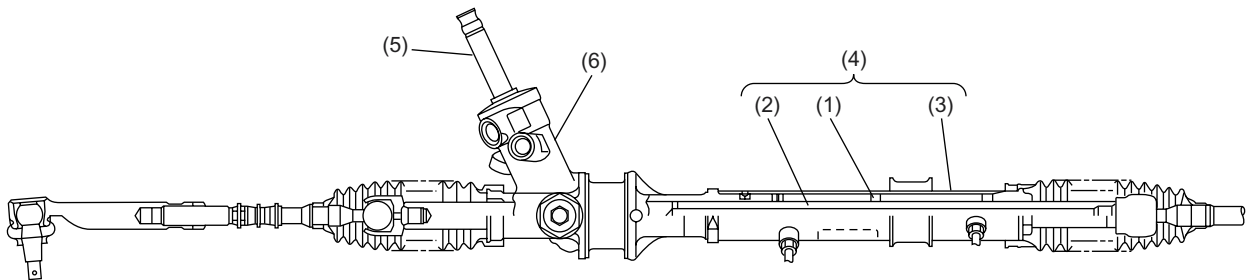


PS-00192

- (1) Piston
- (2) Rack shaft
- (3) Cylinder

- (4) Power cylinder
- (5) Pinion shaft
- (6) Control valve

RHD MODEL



PS-00265

- (1) Piston
- (2) Rack shaft
- (3) Cylinder

- (4) Power cylinder
- (5) Pinion shaft
- (6) Control valve

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

2. ROTARY CONTROL VALVE

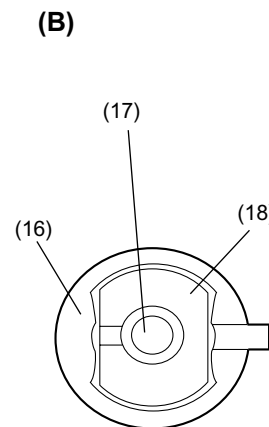
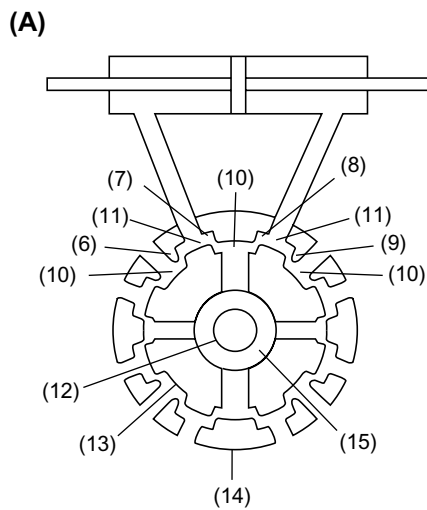
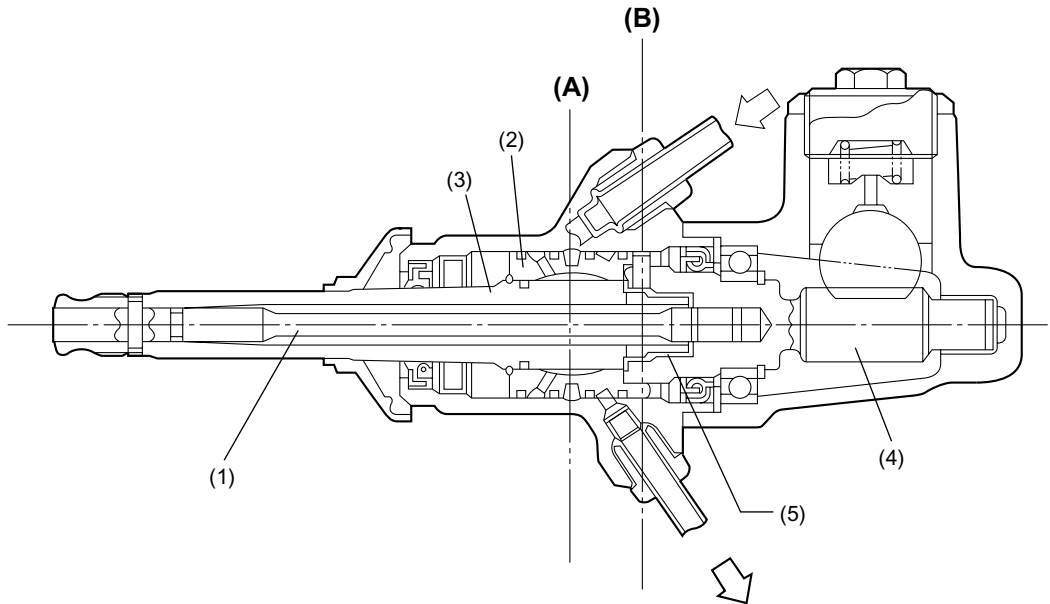
The rotary control valve consists of a rotor (which rotates together with the steering shaft), a pinion (which is connected to the rotor and torsion bar), and a sleeve (which rotates together with the pinion). The rotor and sleeve have grooves C and D, respectively, which form fluid passages V_1 through V_4 .

The pinion is in mesh with the rotor with adequate clearance, which enable the rack to be moved manually by rotating the steering shaft (fail-safe feature).

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

LHD MODEL



PS-00011

- (1) Torsion bar
- (2) Sleeve
- (3) Rotor
- (4) Pinion
- (5) Pinion-to-rotor engagement (fail-safe feature)
- (6) Fluid passage V_1
- (7) Fluid passage V_2
- (8) Fluid passage V_3
- (9) Fluid passage V_4
- (10) Groove C
- (11) Groove D

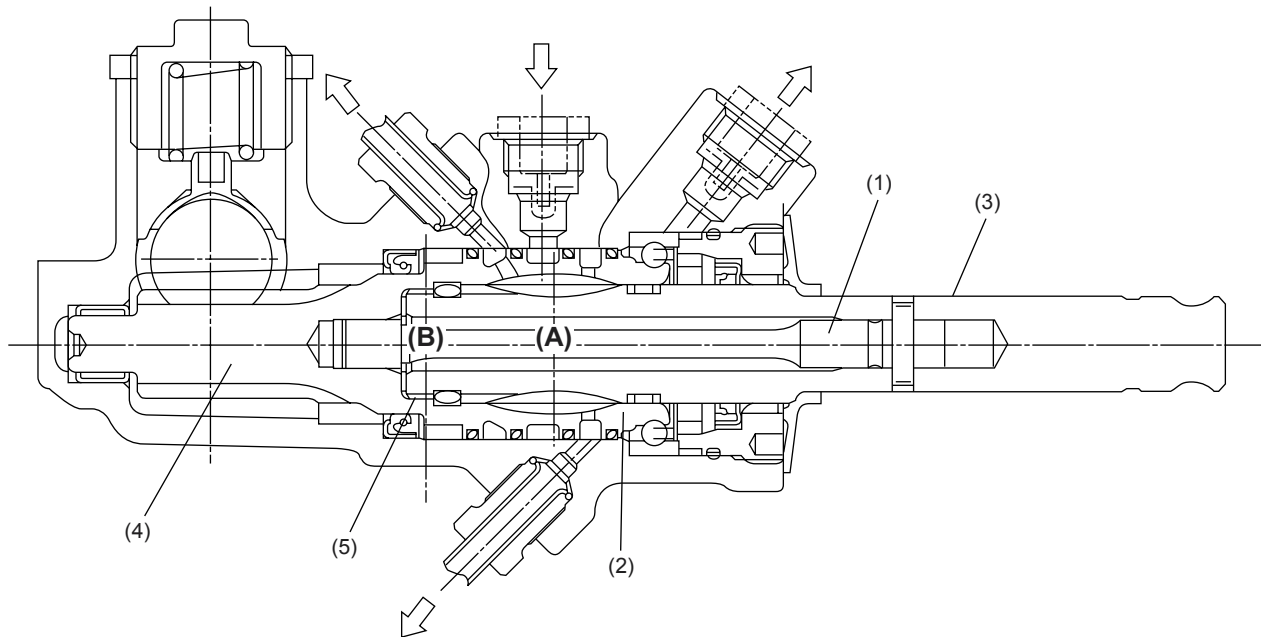
- (12) Torsion bar
- (13) Rotor
- (14) Sleeve
- (15) Fluid return line (to reservoir tank)
- (16) Pinion
- (17) Torsion bar
- (18) Rotor

- (A) Cross-sectional view A (fluid passage switching circuit)
- (B) Cross-sectional view B (pinion-to-rotor engagement)

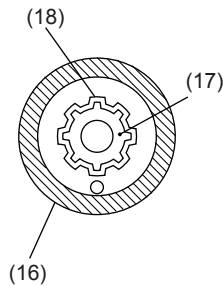
POWER STEERING SYSTEM

Power Assisted System (Power Steering)

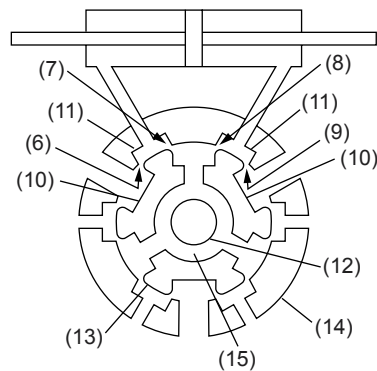
RHD MODEL



(B)



(A)



PS-00266

- | | |
|--|--|
| (1) Torsion bar | (12) Torsion bar |
| (2) Sleeve | (13) Rotor |
| (3) Rotor | (14) Sleeve |
| (4) Pinion | (15) Fluid return line (to reservoir tank) |
| (5) Pinion-to-rotor engagement (fail-safe feature) | (16) Valve housing |
| (6) Fluid passage V_1 | (17) Rotor |
| (7) Fluid passage V_2 | (18) Pinion |
| (8) Fluid passage V_3 | |
| (9) Fluid passage V_4 | |
| (10) Groove C | (A) Cross-sectional view A
(fluid passage switching circuit) |
| (11) Groove D | (B) Cross-sectional view B (pinion-to-rotor engagement) |

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

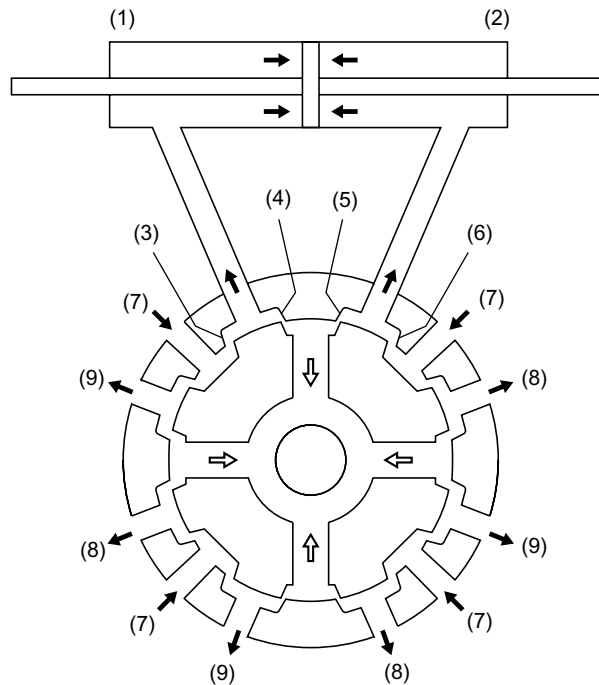
- Principle of operation

When the torsion bar is twisted by a rotational force applied to the steering wheel, the relative position between the rotor and sleeve changes. This changes the cross-sectional area of fluid passages V_1 , V_2 , V_3 and V_4 . The fluid passages are thus switched and the fluid pressure is controlled in accordance with the operation of the steering wheel.

- When no steering force is applied

The rotor and sleeve are held at the neutral position. Fluid passages V_1 , V_2 , V_3 and V_4 , which are formed by grooves C and D are open equally. Under this condition, the fluid from the pump returns to the reservoir tank so that neither fluid pressure builds up nor the rack piston moves in the power cylinder.

LHD MODEL



PS-00012

- (1) Chamber A
- (2) Chamber B
- (3) V_1

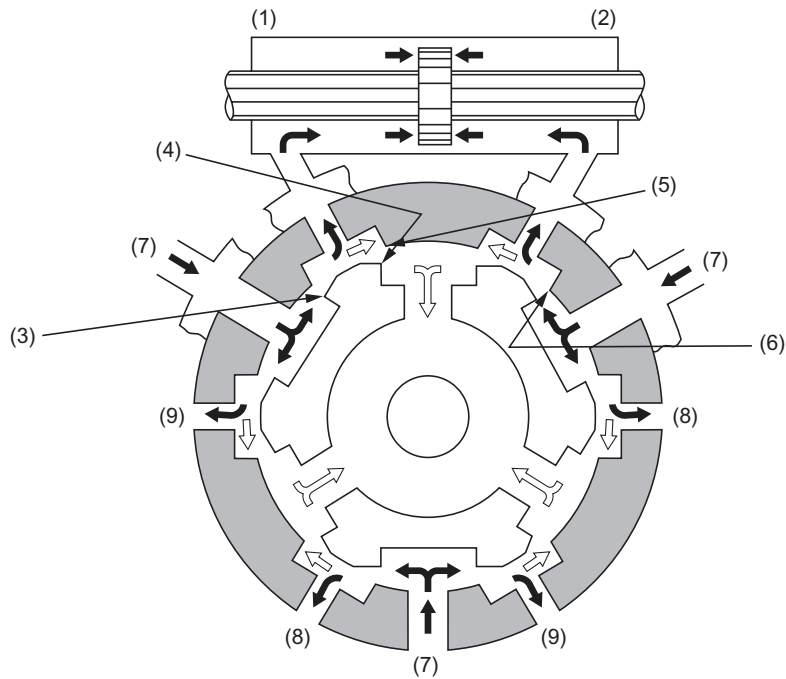
- (4) V_2
- (5) V_3
- (6) V_4

- (7) From fluid pump
- (8) To A
- (9) To B

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

RHD MODEL



PS-00267

- (1) Chamber A
- (2) Chamber B
- (3) V_1

- (4) V_2
- (5) V_3
- (6) V_4

- (7) From fluid pump
- (8) To A
- (9) To B

POWER STEERING SYSTEM

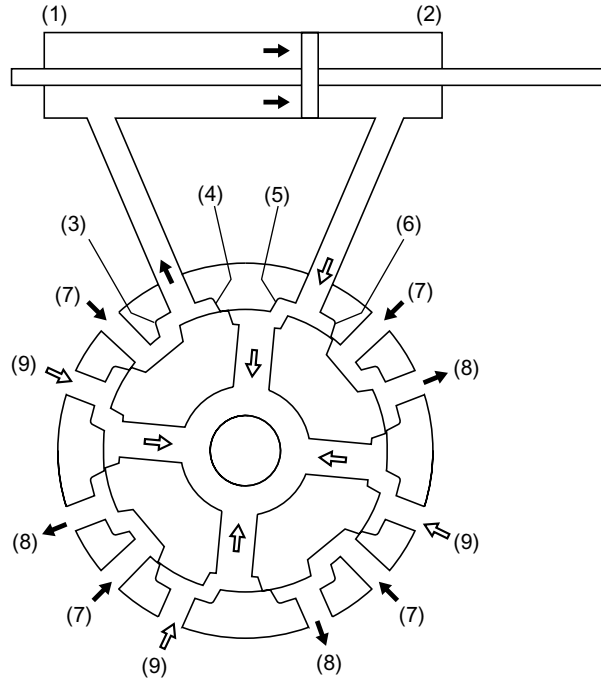
Power Assisted System (Power Steering)

- When steering force is applied

When the steering wheel is turned to the right, for example, fluid passages V_1 and V_3 are opened while fluid passages V_2 and V_4 are nearly closed.

At this point, the fluid pressure in chamber A of the power cylinder increases depending on the degree of closure of fluid passages V_2 and V_4 so that the rack piston moves to the right. The fluid in chamber B, on the other hand, is drained through fluid passage V_3 into the reservoir tank.

LHD MODEL



PS-00013

- (1) Chamber A
- (2) Chamber B
- (3) V_1

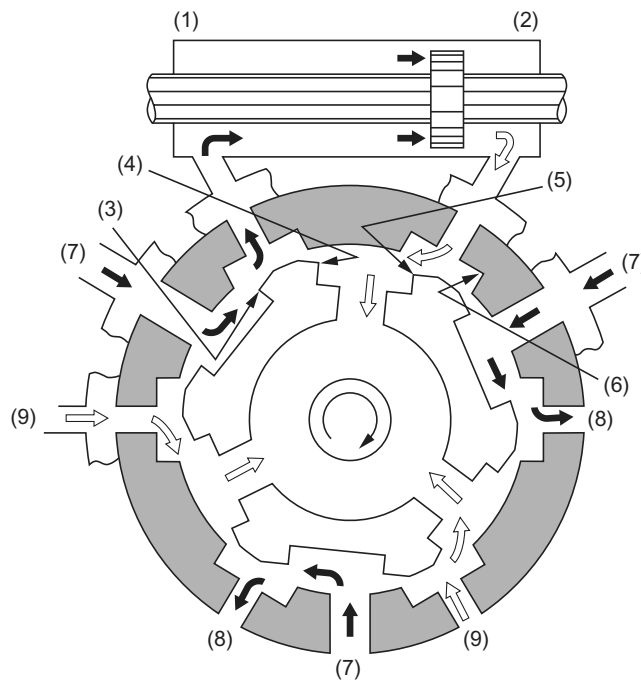
- (4) V_2
- (5) V_3
- (6) V_4

- (7) From fluid pump
- (8) To A
- (9) From B

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

RHD MODEL



PS-00268

- (1) Chamber A
- (2) Chamber B
- (3) V_1

- (4) V_2
- (5) V_3
- (6) V_4

- (7) From fluid pump
- (8) To A
- (9) From B

- **Fail-safe feature**

If fluid pressure fails to build up due to, for example, a broken fluid pump drive belt, the steering wheel rotating torque is transmitted from the valve rotor to the pinion through mechanical engagement between them.

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

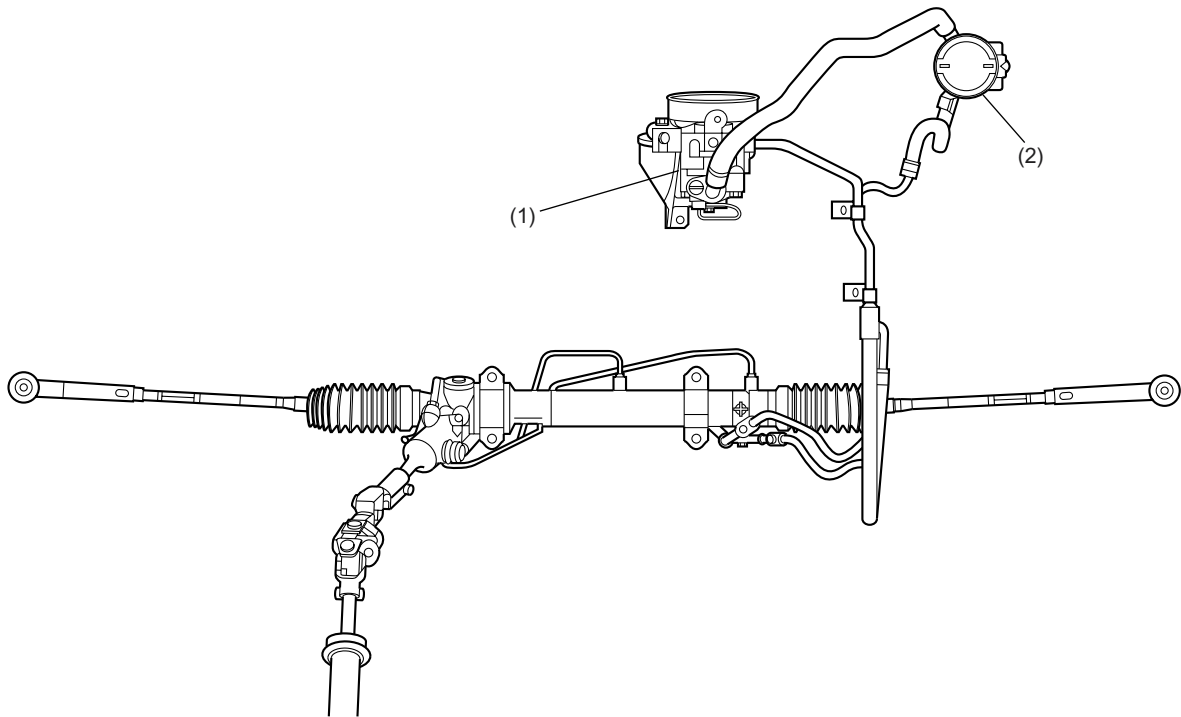
C: FLUID PUMP AND RESERVOIR TANK

The fluid pump is a vane type driven by the engine via belt.

The reservoir tank is mounted on the vehicle body.

The fluid pump incorporates the flow control valve and relief valve, each performing the following functions:

- The flow control valve regulates the flow rate of discharged fluid to a constant level irrespective of the engine speed.
- The relief valve protects the system from an excessively high pressure which may occur, for example, when the steering wheel is turned all the way.

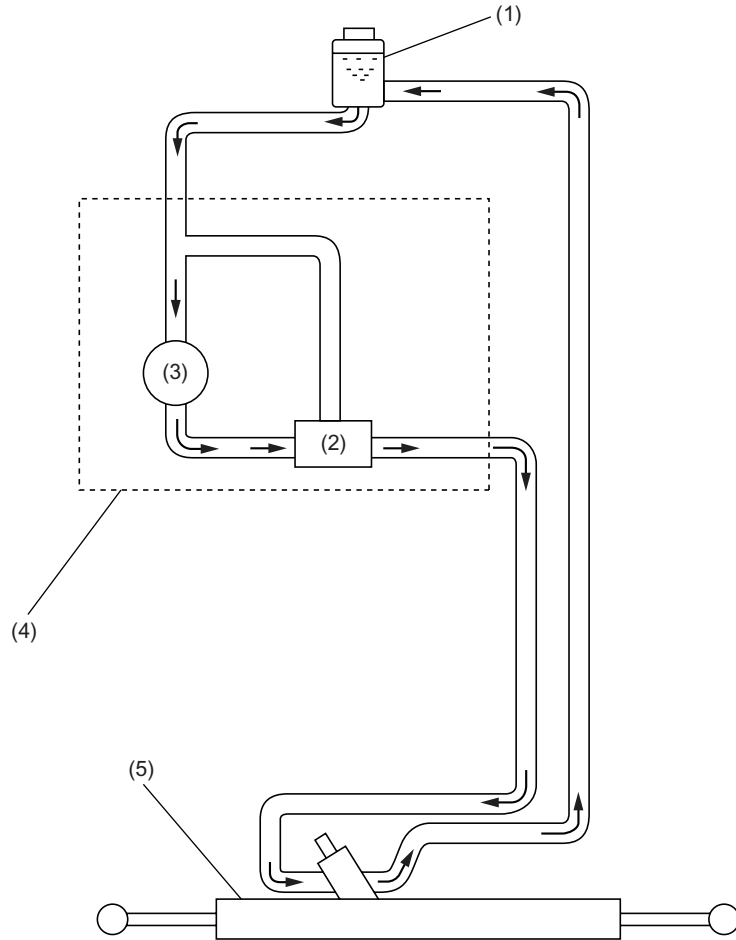


PS-00014

- (1) Fluid pump
- (2) Reservoir tank

POWER STEERING SYSTEM

Power Assisted System (Power Steering)



PS-00015

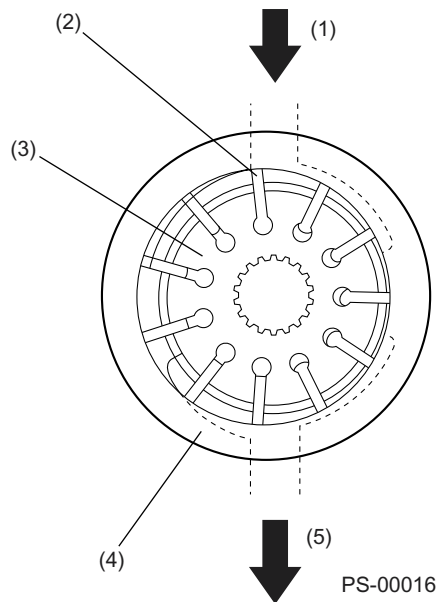
- (1) Reservoir tank
- (2) Flow control and relief valve assembly
- (3) Vane pump
- (4) Fluid pump assembly
- (5) Steering gearbox

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

- The fluid pump is belt-driven by the engine. The fluid flow is controlled according to the engine speed so that an adequate steering resistance is given during high-speed operation. The fluid pump is a variable capacity type vane pump whose delivery rate per rotation decreases as the engine speed increases. The pump is integral with a pump control valve and relief valve.

- The vane pump consists of a rotor, a cam ring, and eleven vanes. When the rotor rotates, the vane in each slot of the rotor is radially moved out by centrifugal force and pressed against the cam ring. The fluid from the suction port is confined in chambers formed between two adjacent vanes and carried to the discharge port. Since the cam ring is movable in relation to the rotor, the volume of each chamber is variable. This enables the delivery rate per rotation of the pump to be changed.



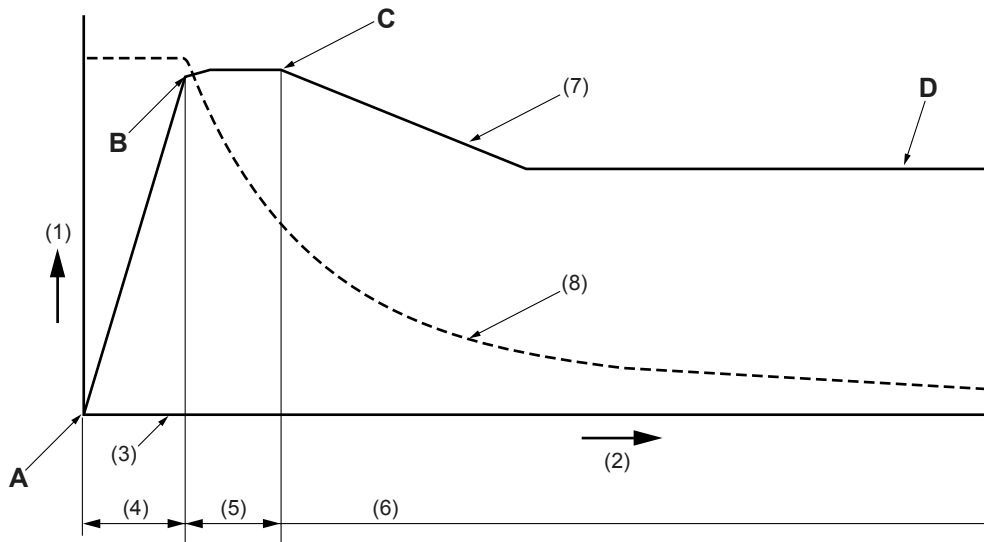
- (1) Suction
- (2) Vane
- (3) Rotor
- (4) Cam ring
- (5) Discharge

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

● FLOW CONTROL

The variable capacity pump changes its delivery rate per rotation by changing the degree of eccentricity of the cam ring according to its rotating speed (engine speed).



PS-00017

- | | |
|----------------------|--|
| (1) Fluid flow | (5) Mid-range speeds |
| (2) Pump speed | (6) High speeds |
| (3) Idling | (7) Delivery rate per unit time |
| (4) Low-range speeds | (8) Delivery rate per rotation of pump |

NOTE:

In the following description, pump speed ranges will be indicated using the speed points A through D shown in the drawing above.

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

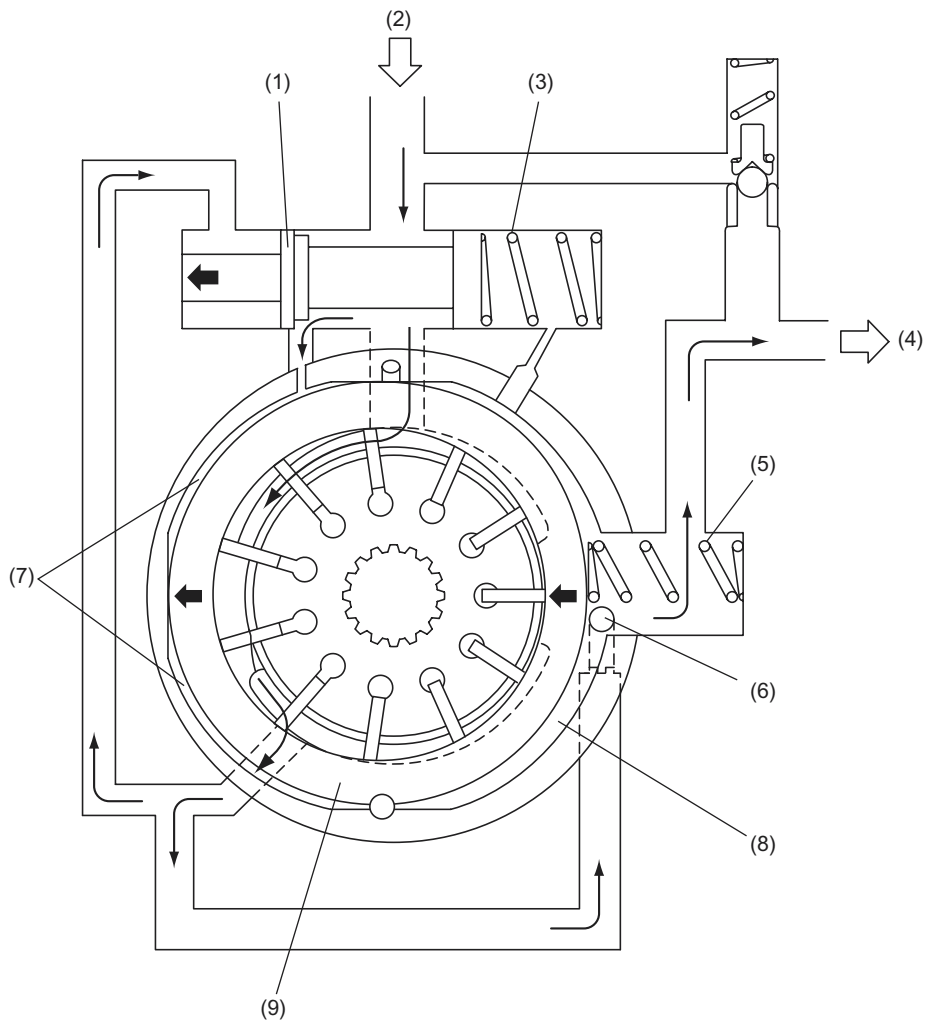
Low-range-speed operation (A – B range)

In this speed range, as well as in all the other speed ranges, two different pump discharge pressures are always applied to the control valve; one is directly led from the discharge port to the left end of the valve and the other is led through an orifice (variable orifice) to the right end of the valve. Since the orifice has a pressure reducing effect, the latter pressure is lower than the former.

When the pump is operating at a low speed, its discharge pressure is also low, resulting in only small difference between the two pressures. In this condition, the valve stays pushed leftward by the spring, allowing the non-pressurized tank fluid to enter chamber A. To chamber B, on the other hand, the orifice-reduced discharge pressure is applied, so the cam ring is pushed leftward by the cam ring spring. This makes the eccentricity of the cam ring a maximum and, therefore, the delivery rate per rotation of the pump become a maximum.

POWER STEERING SYSTEM

Power Assisted System (Power Steering)



PS-00018

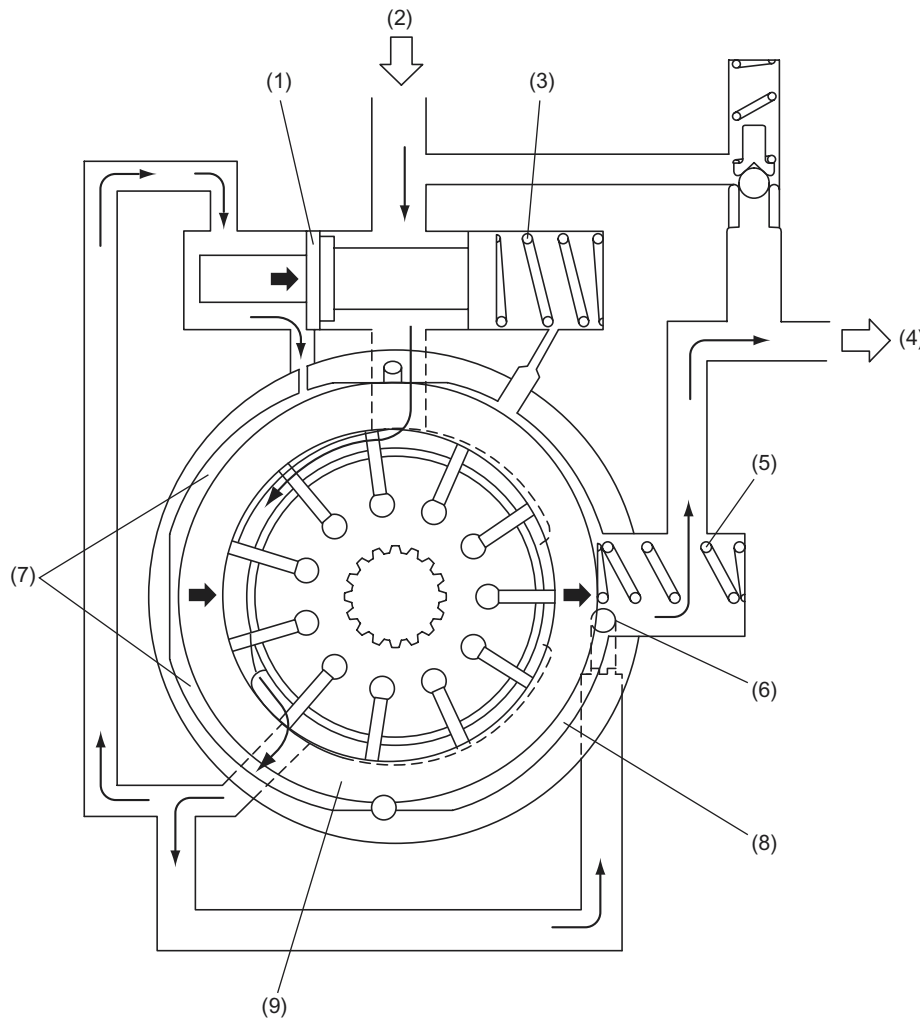
- | | |
|--------------------------|------------------------|
| (1) Control valve | (6) Variable orifice |
| (2) Tank fluid | (7) Pressure chamber A |
| (3) Control valve spring | (8) Pressure chamber B |
| (4) Gear box | (9) Cam ring |
| (5) Cam ring spring | |

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

Mid-range-speed operation (B – C range)

During mid-range speed operation, the pump increases its delivery rate. Since the pressure before passing through the variable orifice increases, the control valve moves rightward, overcoming the tension of the control valve spring. This movement of the control valve allows the pressure upstream of the variable orifice to be directed to chamber A. On the other hand, chamber B receives a pressure reduced by the orifice. This means that the pressure in chamber A is higher than that in chamber B. As a result, the cam ring moves rightward against the tension of the cam spring. This causes the delivery rate per rotation of the pump to be reduced, so that the flow rate of the fluid to the steering gear box decreases accordingly.



PS-00019

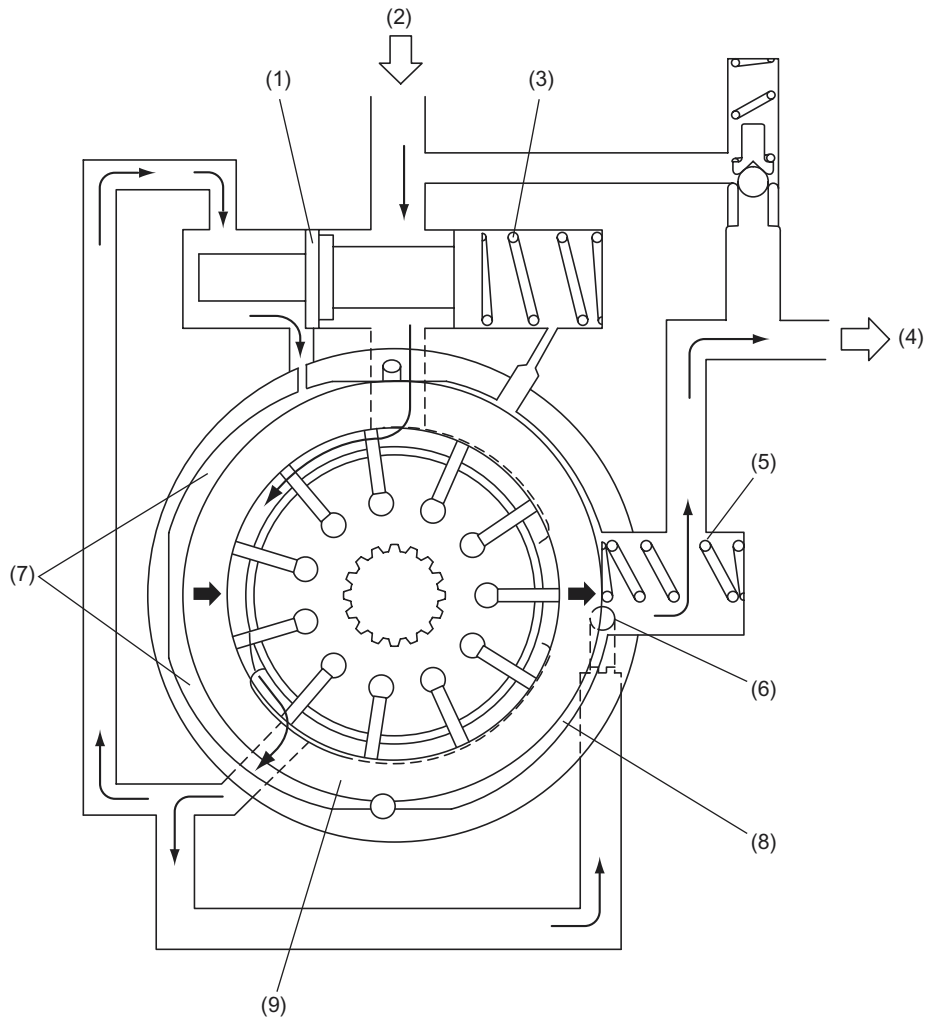
- | | |
|--------------------------|------------------------|
| (1) Control valve | (6) Variable orifice |
| (2) Tank fluid | (7) Pressure chamber A |
| (3) Control valve spring | (8) Pressure chamber B |
| (4) Gear box | (9) Cam ring |
| (5) Cam ring spring | |

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

High-speed operation (C – D range)

When the pump speed increases to a certain point, the cam ring moves to the extreme right position, making the variable orifice opening the minimum. In this state, the delivery rate per rotation of the pump becomes the minimum and the minimum delivery rate is maintained even if the pump speed increases further.



PS-00020

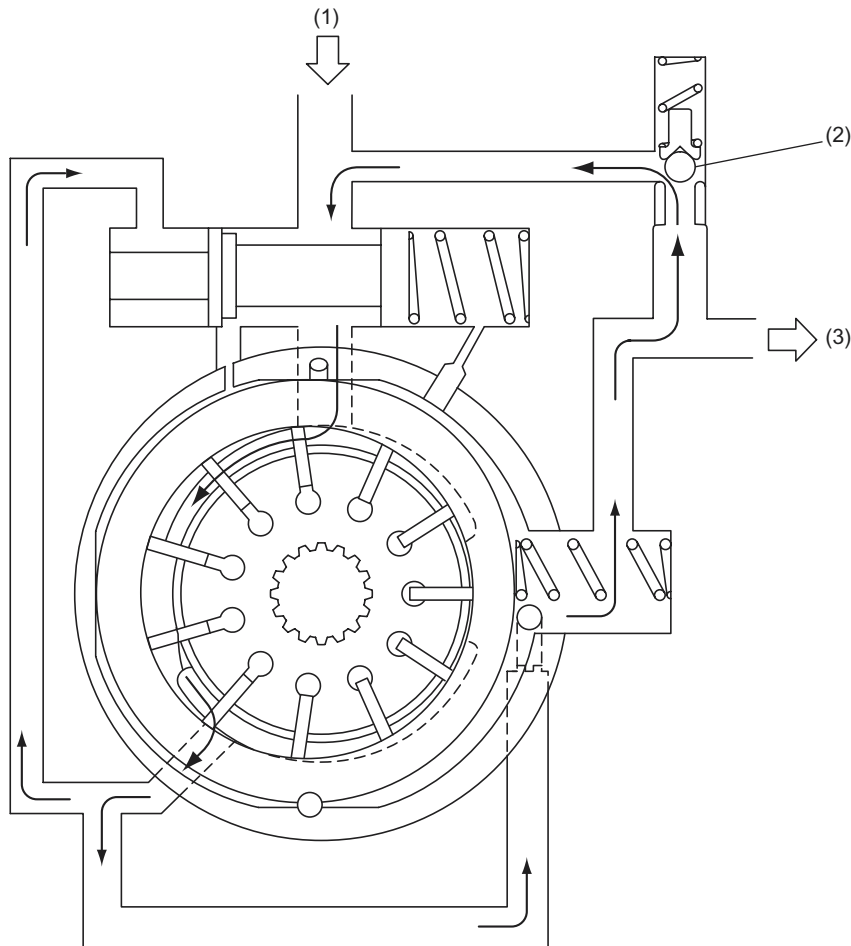
- | | |
|--------------------------|------------------------|
| (1) Control valve | (6) Variable orifice |
| (2) Tank fluid | (7) Pressure chamber A |
| (3) Control valve spring | (8) Pressure chamber B |
| (4) Gear box | (9) Cam ring |
| (5) Cam ring spring | |

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

Maximum pressure control

When the overall delivery rate of the pump exceeds a preset value, the relief valve opens to allow part of the discharged fluid to flow toward the suction side of the pump, thereby controlling the maximum pressure.



PS-00021

- (1) Tank fluid
- (2) Relief valve
- (3) Gear box

POWER STEERING SYSTEM

Power Assisted System (Power Steering)

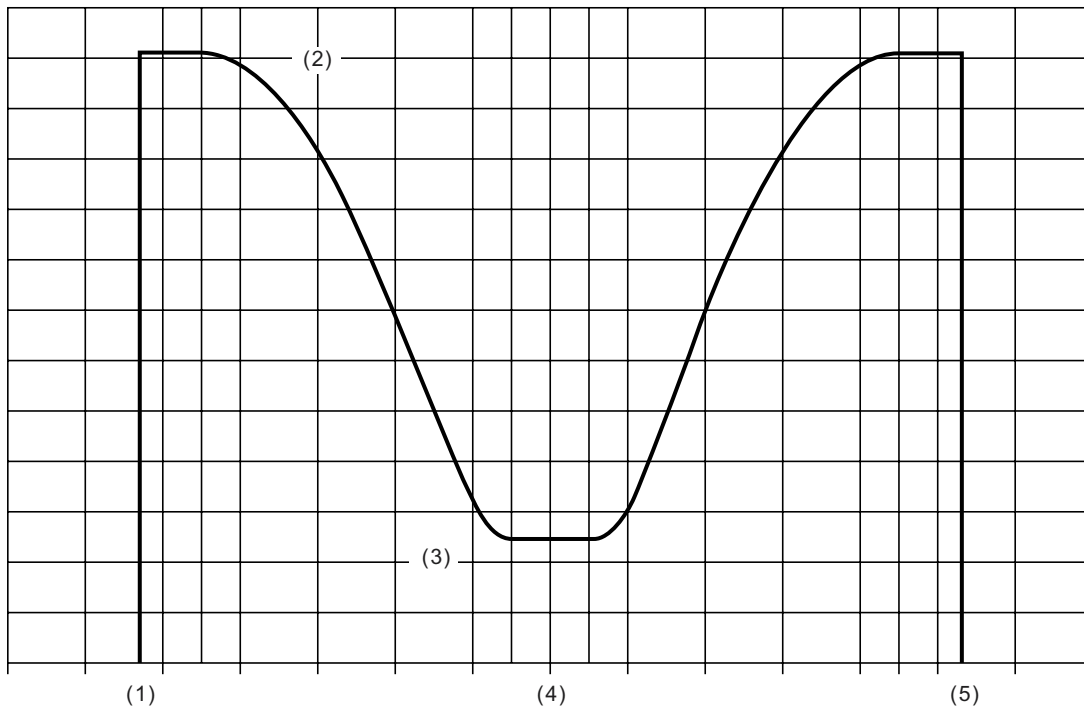
D: VARIABLE GEAR RATIO (VGR) POWER STEERING

All models are equipped with a VGR power steering system.

The steering gear ratio of this system is 1:19 at around the straight-ahead position for higher stability during high-speed driving.

Near the right and left maximum steering angle positions, the gear ratio is made smaller than that of the straight-ahead position so that the system can respond quickly to steering wheel inputs.

Gear ratio curve



PS-00264

- (1) Left stop position
- (2) Gear ratio (1:15)
- (3) Gear ratio (1:19)
- (4) Straight-ahead position
- (5) Right stop position

HVAC SYSTEM (HEATER, VENTILATOR AND A/C) **AC**

	Page
1. Heater System	2
2. Air Conditioner	15

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

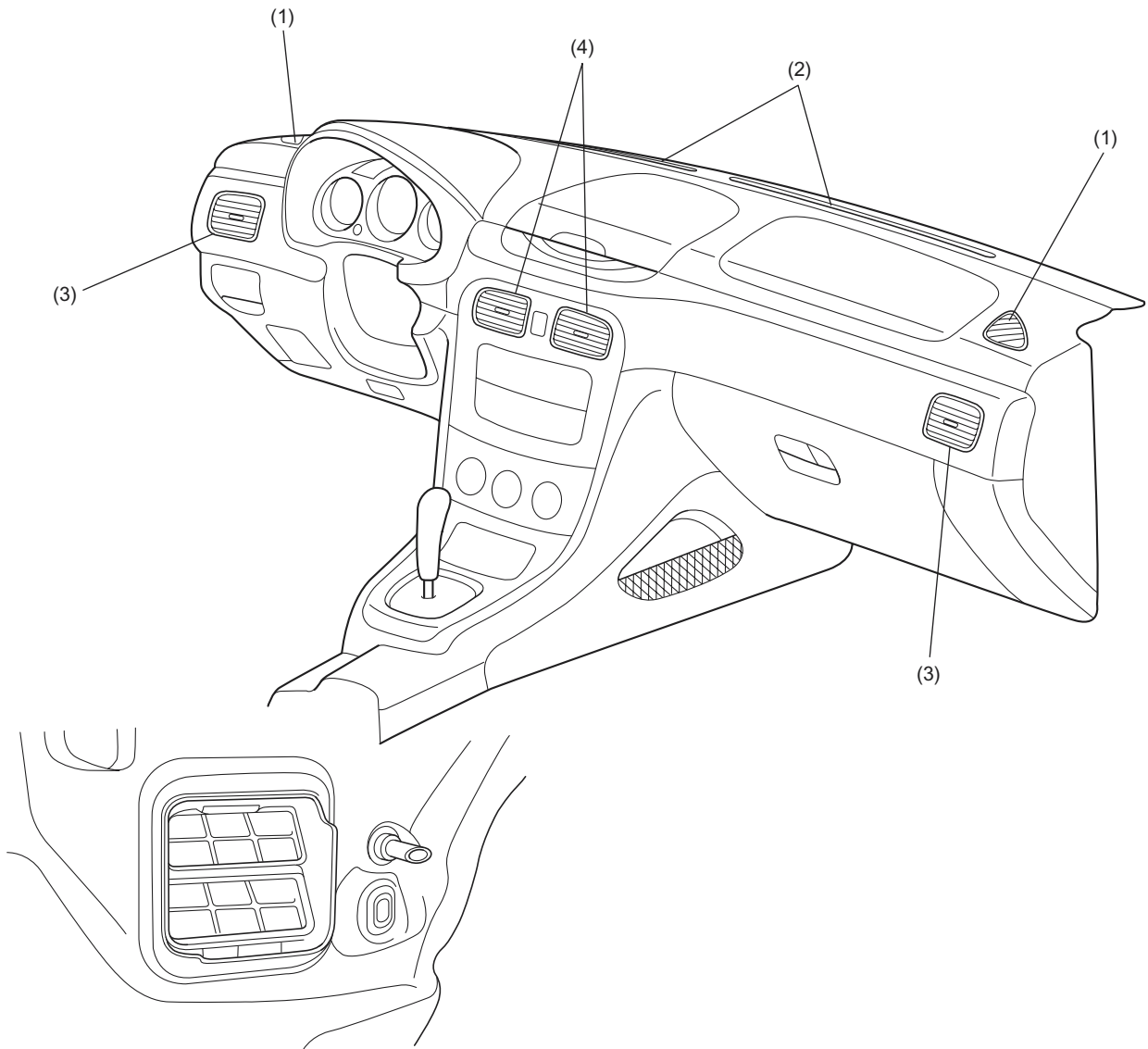
1. Heater System

A: GENERAL

- The HVAC system uses an integral air conditioning unit with thin-wall, high-performance heater core at the front and evaporator core at the rear. Being compact in size, this unit enables providing sufficient front passenger's legroom while ensuring a high air-distribution efficiency by minimizing air flow resistance in all air passages. Overall, the system can create comfortable interior air conditions quietly and in all seasons by its excellent heating, cooling, ventilating, and defrosting performances.
- There are three ventilation grilles in the dashboard.
- To ensure adequate ventilation, large-size air outlets are provided behind the side portions of the rear bumper where high-level vacuums are generated during driving.

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)



AC-00112

- (1) Side defroster
- (2) Front defroster

- (3) Side ventilation grille
- (4) Center ventilation grille

1. SPECIFICATIONS

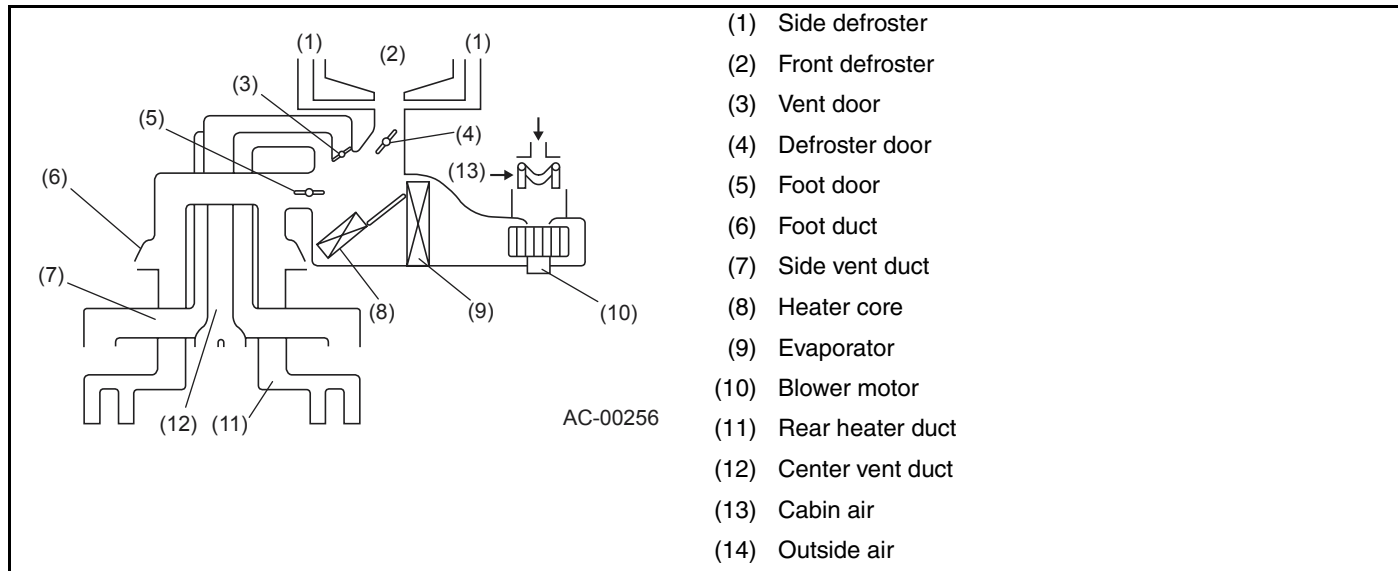
Heating type	Heating performance (W)	Blower power consumption (W)	Maximum blower capacity (m ³ /h)		
			VENT	HEAT	DEF
Coolant-heated air/Outside air mixing type ("full-air-mix" type)	5000	Auto A/C: 230 or less Manual A/C: 260 or less	480	280	300

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)


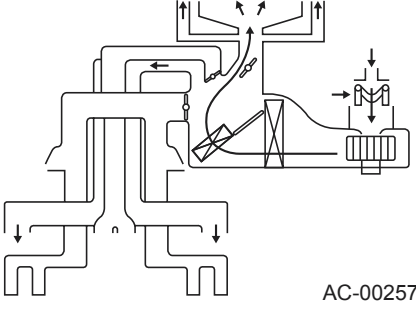

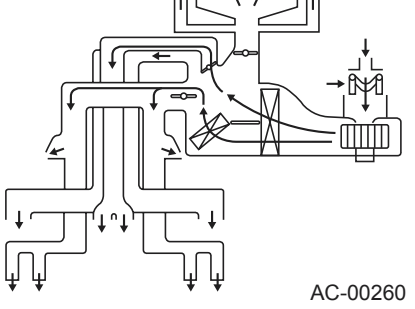

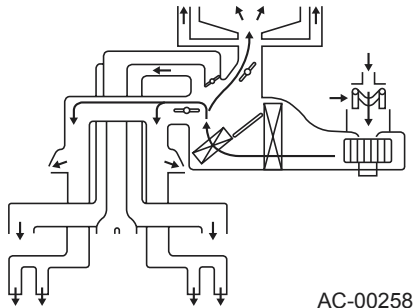

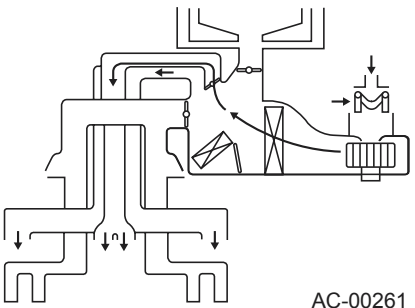

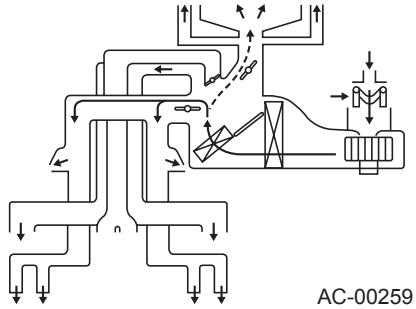

B: AIR FLOW MODES

1. LHD MODELS



HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

Position		Heater unit door positions		Position		Heater unit door positions	
Air outlet switching dial	 DEF AC-00119	 AC-00257	Air outlet switching dial	 BILEVEL AC-00122	 AC-00260		
	 DEF/HEAT AC-00120	 AC-00258		 VENT AC-00123	 AC-00261		
	 HEAT AC-00121	 AC-00259		RECIRC switch	 AC-00124	<p>This button allows selecting either of cabin-air-recirculation or outside-air-introduction modes. When this button is pressed the indicator light illuminates and the system enter the cabin-air-recirculation mode.</p>	

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

2. RHD MODELS

		<ul style="list-style-type: none"> (1) Side defroster (2) Front defroster (3) Vent door (4) Defroster door (5) Foot door (6) Foot duct (7) Vent duct (8) Heater core (9) Evaporator (10) Blower motor (11) Rear heater duct (12) Cabin air (13) Outside air 			
<p>Position</p> <p>Heater unit door positions</p>		<p>Position</p> <p>Heater unit door positions</p>			
Air outlet switching dial	<p>DEF</p> <p>AC-00119</p>	<p>AC-00114</p>	Air outlet switching dial	<p>BILEVEL</p> <p>AC-00122</p>	<p>AC-00117</p>
	<p>DEF/HEAT</p> <p>AC-00120</p>	<p>AC-00115</p>		<p>VENT</p> <p>AC-00123</p>	<p>AC-00118</p>
	<p>HEAT</p> <p>AC-00121</p>	<p>AC-00116</p>		RECIRC switch	<p>RECIRC</p> <p>AC-00124</p>

HEATER SYSTEM

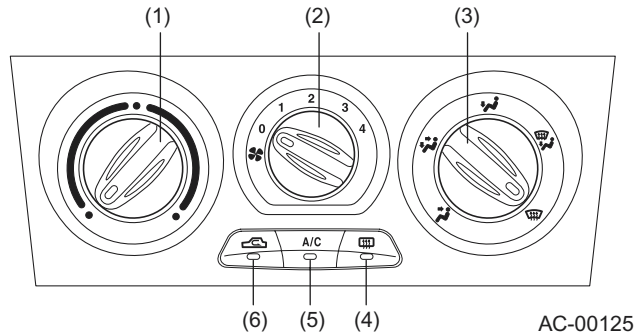
HVAC System (Heater, Ventilator and A/C)

C: CONTROL PANEL

- The HVAC control panel is incorporated into the center panel.
- A rear window defogger switch is located in the control panel.

1. MANUAL AIR CONDITIONING SYSTEM

- The control panel uses three large-diameter, dial type switches for easy operation and good visual recognition.



- (1) Temperature control dial
This dial allows adjusting the temperature of air delivered through the ventilators.
- (2) Fan speed control dial
This dial allows turning on/off the blower and selecting any of the four blower speeds.

0 1 2 3 4

AC-00126

- (3) Air outlet switching dial
This dial allows selecting any of the five air flow modes.



AC-00127

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

(4) Rear window defogger switch

This switch activates the rear defogger.

To prevent prolonged operation when the switch is left on, a timer keeps the defogger activated for 15 minutes after the switch is turned ON (the switch illuminates) and then turns it off automatically.

(5) Air conditioning switch (vehicles with A/C)

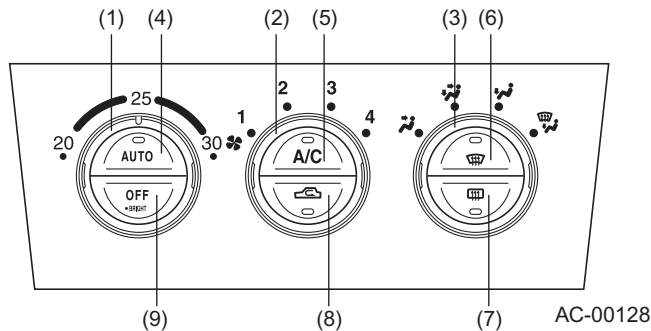
This switch engages (the switch illuminates) and disengages the air conditioning compressor.

(6) RECIRC switch

When this switch is turned ON (the switch illuminates) the system enters the cabin-air-recirculation mode, and when OFF the system is in the outside-air-introduction mode.

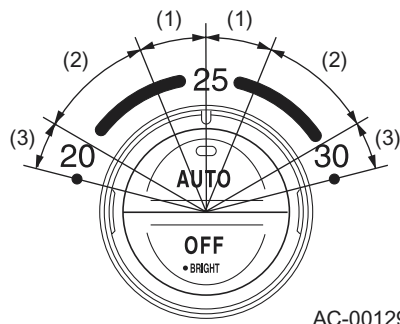
2. AUTOMATIC AIR CONDITIONING

- Servo motors are used for air outlet switching, temperature control, and air intake mode switching.
- The control panel uses three large-diameter, dial type switches for easy operation and good visual recognition.



(1) Temperature control dial

This dial allows adjusting the temperature of air delivered through the ventilators within a range from 18 to 32°C in 21 steps.



(1) Three clicks: 0.5°C/click

(2) Five clicks: 0.7°C/click

(3) Two clicks: 1.0°C/click

(2) Fan speed control dial

In manual control, this dial allows selecting any of the four blower fan speeds.

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

(3) Air outlet switching dial

In manual control, this dial allows selecting any of the four air flow modes.



AC-00130

(4) AUTO switch

By operating this switch the system will operate in full automatic mode. The air flow, air outlets switching, air intake mode switching, and the A/C compressor engagement/disengagement are automatically controlled.

(5) Air conditioning switch

This switch engages (the switch illuminates) and disengages the air conditioning compressor.

(6) Defroster switch

When this switch is turned ON (the switch illuminates) the system enters defroster mode. When the switch is pressed again the system returns to the mode in which the system was operating before the defroster mode was selected.

(7) Rear window defogger switch

This switch activates the rear defogger.

To prevent prolonged operation when the switch is left on, a timer keeps the defogger activated for 15 minutes after the switch is turned ON (the switch illuminates) and then turns it off automatically.

(8) RECIRC switch

When this switch is turned ON (the switch illuminates) the system enters the cabin-air-recirculation mode, and when OFF the system is in the outside-air-introduction mode.

(9) OFF/BRIGHT switch

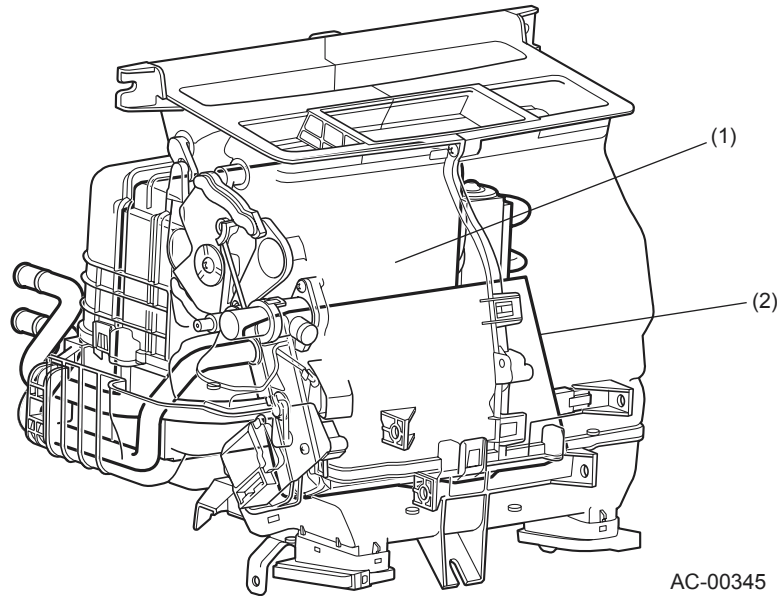
OFF: all functions are deactivated. (Air intake mode selection remains unchanged.) BRIGHT: When the switch is pressed longer than 1 second, the system enters bright mode and the dimming of the indicators when the position lights and headlights are ON will be cancelled.

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

D: HEATER AND COOLING UNIT

- Having an evaporator core at the front and a heater core at the rear, this single unit combines both heating and cooling functions.
- The heater and cooling unit incorporates mode doors for creating different air flow modes and an air mix door for mixing heated air and cooled air.
- In the automatic air conditioning system, actuators switch each mode doors and the air mix door.
- In the manual air conditioning system, air flow mode switching doors and the air mixing door are moved by cables through corresponding linkages.



- (1) Evaporator core
- (2) Heater core

1. SPECIFICATIONS

Heater core size	Heat output
134.1 x 224.3 x 32	5000W

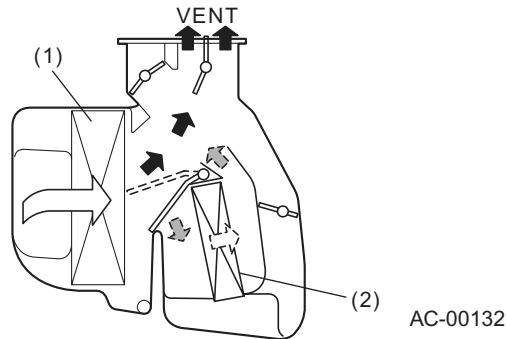
HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

2. DESIGN FEATURES FOR EACH AIR FLOW MODE

1) Ventilation (VENT) mode

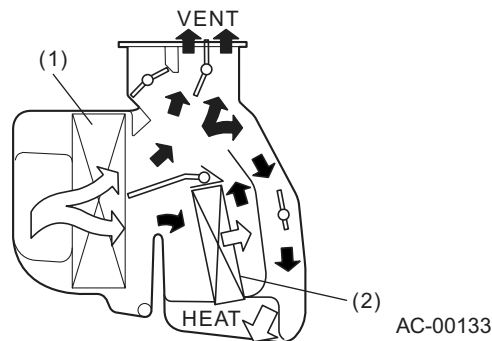
- The passage leading air from the evaporator to the ventilation outlet (VENT) is made straight to reduce air flow resistance.
- When the air temperature is necessary to be adjusted, heated air is blown at right angles against the flow of cool air from the evaporator. This allows the airs to mix thoroughly.



- (1) Evaporator
- (2) Heater core

2) Foot/face (BILEVEL) mode

The air that has passed through the evaporator is divided into two directions. A part of the air passes through the heater core where the air is heated. The remaining air is unheated and flows directly to the air outlet, where the unheated air is mixed with the heated air from the heater core. The mixed air flows to the vent grille and heat grille.



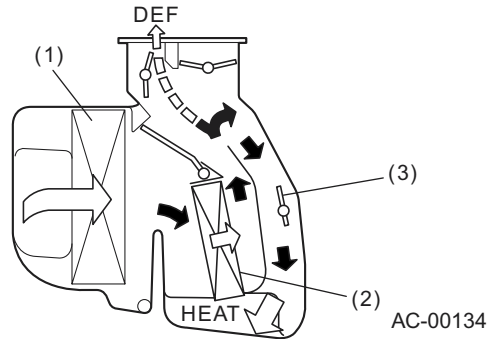
- (1) Evaporator
- (2) Heater core

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

3) Heating (HEAT) mode

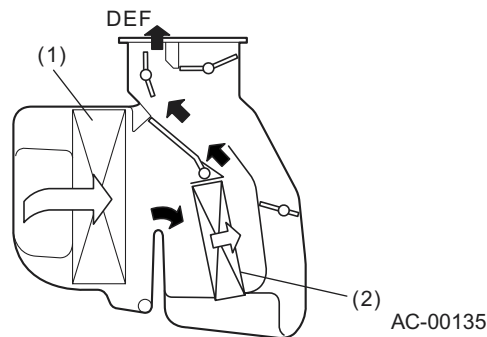
- The air that has passed through the evaporator is heated at the heater core and flows through the foot door to the foot duct.
- To defog the windshield, the defroster door is also slightly open in heater mode operation and warm air will flow to the defroster duct too.



- (1) Evaporator
- (2) Heater core
- (3) Foot door

4) Defroster (DEF) mode

- The air from the evaporator passes through the heater core and the warmed air flows through the defroster door to the defroster (DEF) duct.
- The air passages toward the defroster (DEF) outlet is long enough to equalize the airflow rate at all outlets.



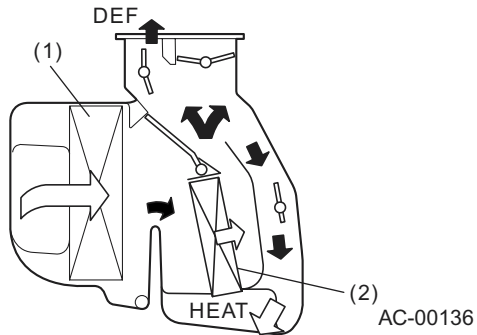
- (1) Evaporator
- (2) Heater core

HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

5) Defroster (DEF)/Heater (HEAT) mode

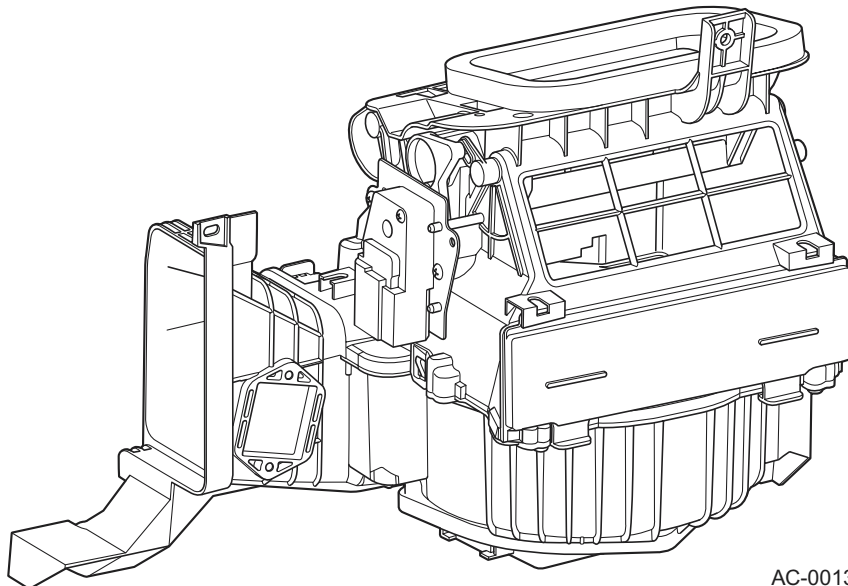
- The air from the evaporator flows through the heater core and the warmed air flows to the defroster (DEF) duct and foot duct to defog the windshield while sending warm air to the legs.
- The warm air that has flowed to the defroster duct will be delivered from the front defroster duct and side defroster duct to defog the windows.



- (1) Evaporator
- (2) Heater core

E: BLOWER UNIT

- The blower unit uses a low-noise-type motor.

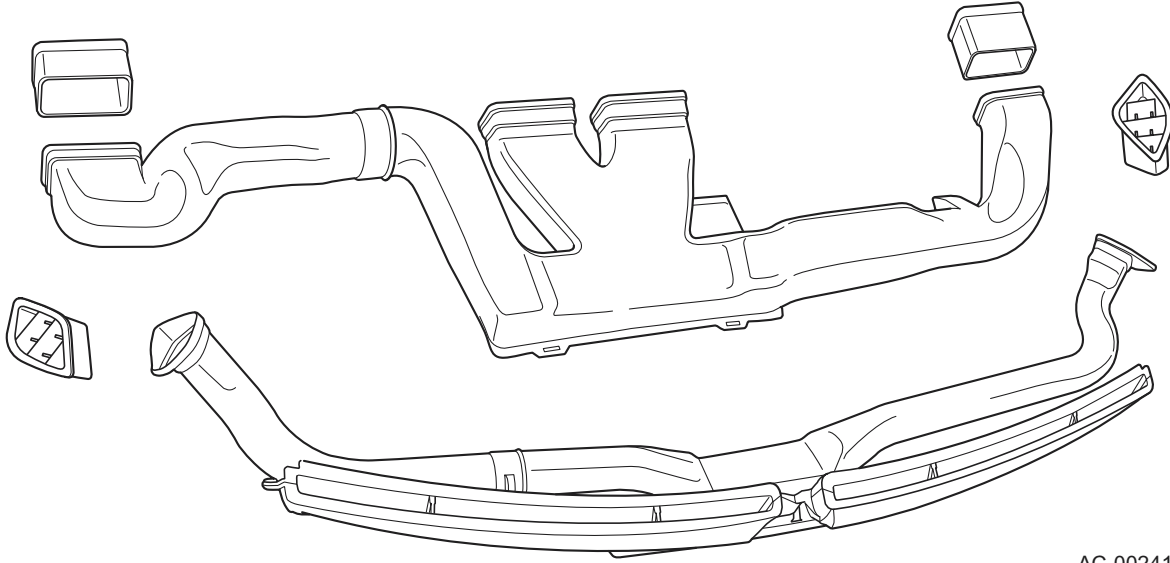


HEATER SYSTEM

HVAC System (Heater, Ventilator and A/C)

F: DUCTS

- The ventilation duct and defroster duct are located behind the instrument panel. Both the ducts have been modified in the shape to reduce air flow resistance.
- Defrosting air flow is divided at the center, so that air can flow out evenly through a wide center defroster as well as right and left side defrosters.



AC-00241

2. Air Conditioner

A: GENERAL

The air conditioner has a newly-developed subcool condenser for improved heat-exchange efficiency.

As with the previous model's air conditioner, the refrigerant employed is the chlorine-free HFC-134a (R134a), which does not contribute to ozone-layer damage.

A simple system structure is realized by incorporating the receiver dryer with the condenser.

AIR CONDITIONER

HVAC System (Heater, Ventilator and A/C)

1. SPECIFICATIONS

MANUAL AIR CONDITIONING SYSTEM

Item	Specification		Remarks	
Air Conditioner	"Full-air-mix" type			
Cooling performance	Cooling capacity (W)	5100		
	Air flow rate (m ³ /h)	480		
Refrigerant quantity	HFC-134a (g)	600 ± 50		
Compressor	Type	Rotary type with vanes DKV-14G	Zexel Valeo climate control	
	Capacity (g/revolution)	140		
	Maximum permissible speed (rpm)	7000		
	Lubricant (amount contained in compressor in g)	ZXL200PG (150)		
Magnetic clutch	Type	Dry, single disc		
	Power consumption (W)	38 (12VDC, 25°C)		
	Pulley ratio	1:1.064 (crankshaft pulley diameter: 133 mm; compressor pulley diameter: 125 mm)		
	Belt	Polyurethane V-belt with four ribs		
Condenser	Type	Multi-flow type (subcooling type with incorporated receiver drier)		
	Fan	Type		Electric-motor-driven axial flow fan
		Fan diameter		320 mm (7+5 blades)
		Power consumption (W)		70 x 2
Evaporator	Type	Laminated		
	Expansion valve	External pressure equalizing type		
	Temperature control sensor	Electronic thermistor		
Other controls	Fast idle control	Performed by engine control module (ECM)		
	High and low pressure limit control (MPa)	Low pressure switch: Turns off compressor at a pressure lower than 0.177 Mid pressure switch: Interprets 1.77 or higher as compressor high load and controls radiator fan High pressure switch: Turns off compressor at a pressure higher than 2.94		
	High-speed limit control	Performed by ECM		
	Radiator and condenser fan control	Performed by ECM		

AIR CONDITIONER

HVAC System (Heater, Ventilator and A/C)

AUTOMATIC AIR CONDITIONING SYSTEM

Item	Specification		Remarks	
Air Conditioner	"Full-air-mix" type			
Cooling performance	Cooling capacity (W)	5100		
	Air flow rate (m ³ /h)	480		
Refrigerant quantity	HFC-134a (g)	600 ± 50		
Compressor	Type	Rotary type with vanes DKV-14G	Zexel Valeo climate control	
	Capacity (g/revolution)	140		
	Maximum permissible speed (rpm)	7000		
	Lubricant (amount contained in compressor in g)	ZXL200PG (150)		
Magnetic clutch	Type	Dry, single disc		
	Power consumption (W)	38 (12VDC, 25°C)		
	Pulley ratio	1:1.064 (crankshaft pulley diameter: 133 mm; compressor pulley diameter: 125 mm)		
	Belt	Polyurethane V-belt with four ribs		
Condenser	Type	Multi-flow type (subcooling type with incorporated receiver drier)		
	Fan	Type		Electric-motor-driven axial flow fan
		Fan diameter		320 mm (7+5 blades)
		Power consumption (W)		70 x 2
Evaporator	Type	Laminated		
	Expansion valve	External pressure equalizing type		
	Temperature control sensor	Electronic thermistor		
Auto control	Temperature control	Full-air-mix type		
	Air flow control	Auto: stepless control Manual: 4 steps		
	Intake control	Auto: RECIRC, FRESH		
	Outlet control	Auto: VENT, BILEVEL, HEAT Manual: VENT, BILEVEL, HEAT, DEF/HEAT, DEF		
Other controls	Fast idle control	Performed by engine control module (ECM)		
	High and low pressure limit control (MPa)	Low pressure switch: Turns off compressor at a pressure lower than 0.177 Mid pressure switch: Interprets 1.77 or higher as compressor high load and controls radiator fan High pressure switch: Turns off compressor at a pressure higher than 2.94		
	High-speed limit control	Performed by ECM		
	Radiator and condenser fan control	Performed by ECM		
Diagnosis function Others	Sensor check, actuator diagnosis Manual setting to MAX HOT and MAX COOL possible			

AIR CONDITIONER

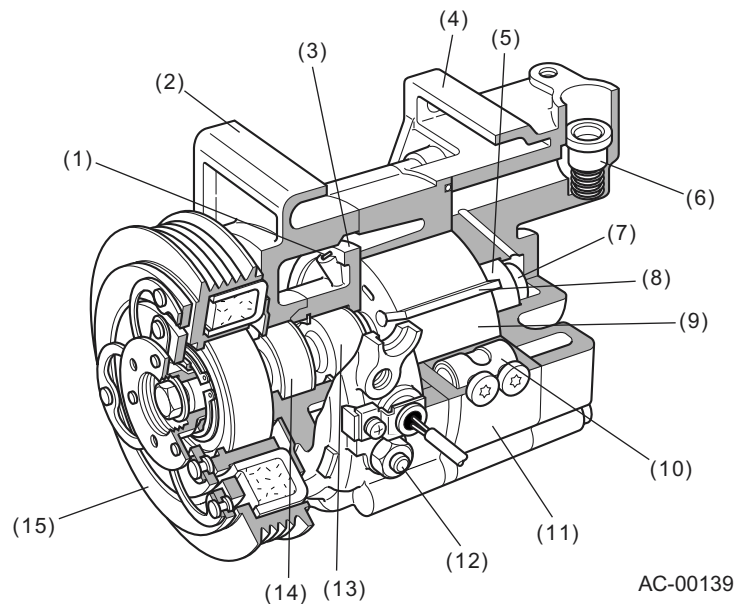
HVAC System (Heater, Ventilator and A/C)

B: COMPRESSOR

The rotary type compressor consists of an integrally formed rotor and shaft, five vanes, and a cylinder.

As the rotor turns, the vanes that are movably fitted in the rotor slide over the wall of the oval-shaped cylinder while drawing, compressing, and discharging refrigerant gas.

There is a check valve in the rear head to avoid reverse flow of refrigerant which would otherwise occur when the compressor is stopped.



- | | |
|-------------------|----------------------------|
| (1) Trigger valve | (9) Rotor |
| (2) Front head | (10) Discharge valve |
| (3) Side block | (11) Cylinder |
| (4) Rear head | (12) Pressure relief valve |
| (5) Rear bearing | (13) Front bearing |
| (6) Check valve | (14) Shaft seal |
| (7) Shaft | (15) Magnet clutch |
| (8) Vane | |

AIR CONDITIONER

HVAC System (Heater, Ventilator and A/C)

1. PRESSURE RELIEF VALVE

This valve opens if the pressure of the high-pressure refrigerant gas rises to a dangerously high level to release part of refrigerant into the atmosphere, thus protecting the compressor. The valve is designed to limit the amount of released gas to the necessary minimum.

Valve opening pressure: 3.6 MPa (36.5 kgf/cm²)

Valve closing pressure: 2.99 MPa (30.5 kgf/cm²)

2. TRIGGER VALVE

This valve applies back pressure to the vanes.

3. CHECK VALVE

This valve is attached to the refrigerant suction port in the rear head and prevents reverse flow of the refrigerant when the compressor is stopped.

4. DISCHARGE VALVE

This valve is attached to the outlet port in the cylinder and prevents reverse flow of the refrigerant.

5. COMPRESSOR OIL

A specified amount of oil is filled in the cylinder and this oil is delivered to various locations by the refrigerant output pressure.

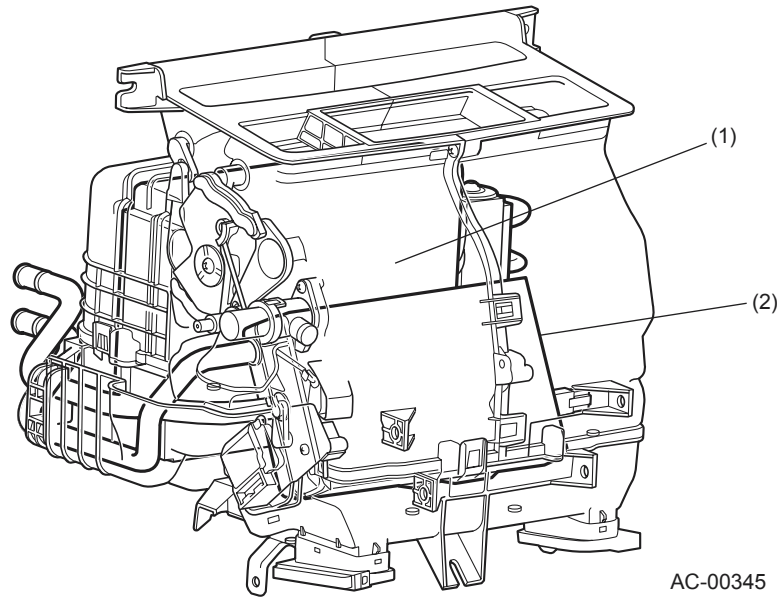
AIR CONDITIONER

HVAC System (Heater, Ventilator and A/C)

C: COOLING UNIT

The heater unit and cooling unit are integrated into a single “heater and cooling unit”.

The cooling section components of this unit include an evaporator, expansion valve, and case.



- (1) Evaporator core
- (2) Heater core

AIR CONDITIONER

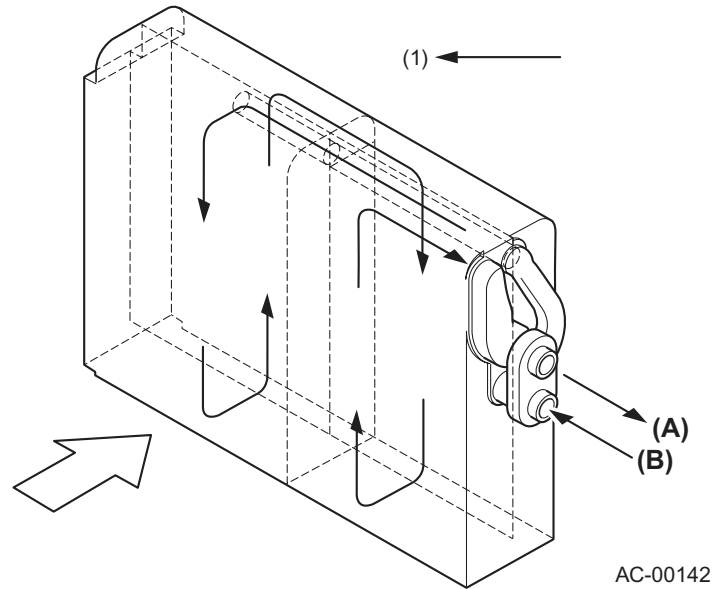
HVAC System (Heater, Ventilator and A/C)

1. EVAPORATOR

The evaporator is a laminated type.

When a low-pressure, low-temperature refrigerant is sprayed by the expansion valve into the evaporator, it evaporates and cools the evaporator surfaces.

The cabin air is drawn by the blower and cooled down as it flows over the evaporator. The cooled air then flows passing through the heater unit and delivered into the cabin through versions outlets.



(1) Flow of refrigerant

(A) Outlet

(B) Inlet

AIR CONDITIONER

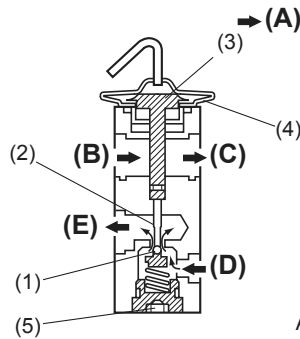
HVAC System (Heater, Ventilator and A/C)

2. EXPANSION VALVE

The expansion valve regulates the flow of refrigerant such that heat exchange takes place optimally.

The expansion valve performs two functions; it sprays the high-pressure refrigerant from the condenser using a throttle valve, and it regulates the amount of the spray by changing opening of the throttle valve.

The expansion valve consists of such main components as a heat sensing cylinder, diaphragm, ball valve, spring, and adjusting screw.



AC-00143

- | | |
|-----------------------|---|
| (1) Ball valve | (A) Flow of refrigerant |
| (2) Shaft | (B) From evaporator (low-pressure side) |
| (3) Heat sensing part | (C) To compressor |
| (4) Diaphragm | (D) From condenser |
| (5) Adjusting screw | (E) To evaporator (high-pressure side) |

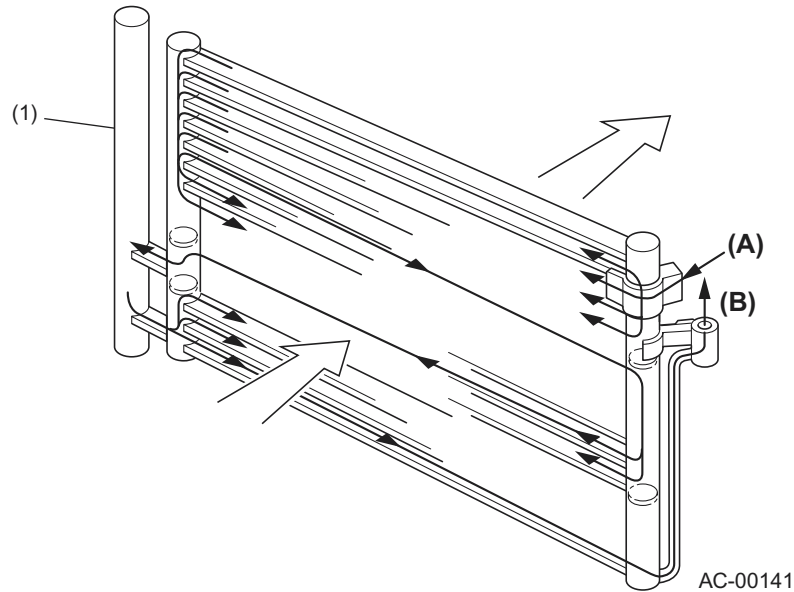
The heat (temperature) sensing cylinder is held in contact with the evaporator outlet pipe so that a pressure corresponding to the sensed temperature may be applied to the chamber above the diaphragm. There is a pressure equalizing hole which communicates with the chamber below the diaphragm to transmit changes in the refrigerant pressure to the chamber. The ball valve is linked with the diaphragm and moves according to changes in the balance between the force applied to the diaphragm and the tension of the spring.

D: CONDENSER

The condenser used in the air conditioning system is the newly developed “subcooling condenser” that integrates a multi-flow type condenser and a receiver drier (gas-liquid separator) into a single unit. The condenser has a high heat-exchange efficiency.

1. SUBCOOLING CONDENSER

The subcooling condenser has a subcooling section where part of the refrigerant that remains in gas form is cooled and reduced into liquid form. This enables almost 100% of the refrigerant to be requefied.



(1) Receiver drier

(A) Inlet

(B) Outlet

AIR CONDITIONER

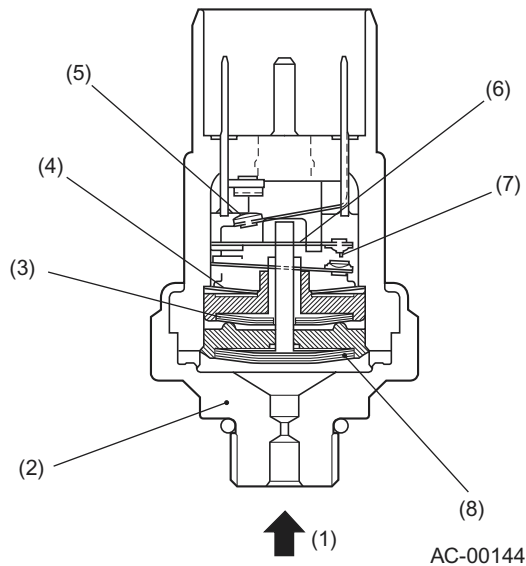
HVAC System (Heater, Ventilator and A/C)

E: PRESSURE SWITCH

The pressure switch is a high-pressure side component of the refrigeration cycle (cooling cycle). It consists of a diaphragm that receives refrigerant gas pressure, a snap plate, a rod, contacts that open both when the gas pressure is too low and when it is too high, and a contact that operates at mid-pressure.

The pressure switch plays the following roles:

- Preventing “no-gas” operation due to leakage (when gas pressure is too low)
- Protecting the cooling system against abnormally high refrigerant pressure (when gas pressure is too high)
- Detection of compressor load (mid pressure contact: electric cooling fan output control)



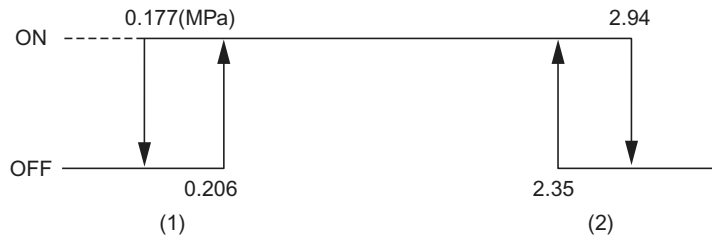
- | | |
|-------------------------------|-------------------------------|
| (1) Pressure | (5) Mid pressure contact |
| (2) Housing | (6) Lever (high pressure) |
| (3) Diaphragm (high pressure) | (7) High/low pressure contact |
| (4) Diaphragm (low pressure) | (8) Diaphragm (mid pressure) |

AIR CONDITIONER

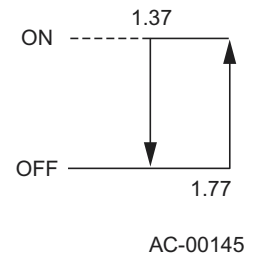
HVAC System (Heater, Ventilator and A/C)

ON-OFF PRESSURES

(A)



(B)



(A) High/low pressure contact

(B) Mid pressure contact

(1) Low pressure

(2) High pressure

AC-00145

1. SPECIFICATIONS

HIGH/LOW PRESSURE CONTACT (COMPRESSOR ON/OFF CONTROL)

Low limit pressure	OFF	0.177 MPa (1.7 kgf/cm ²) or lower
Normal pressure	Normal pressure	0.177 – 2.94 MPa (1.7 – 29 kgf/cm ²)
High limit pressure	OFF	2.94 MPa (29 kgf/cm ²) or higher

MID PRESSURE CONTACT (ELECTRIC COOLING FAN OUTPUT CONTROL)

Compressor low load	OFF	1.37 MPa (13.7 kgf/cm ²) or lower
Compressor high load	ON	1.77 MPa (17.7 kgf/cm ²) or higher

AIR CONDITIONER

HVAC System (Heater, Ventilator and A/C)

MEMO

AIRBAG SYSTEM **AB**

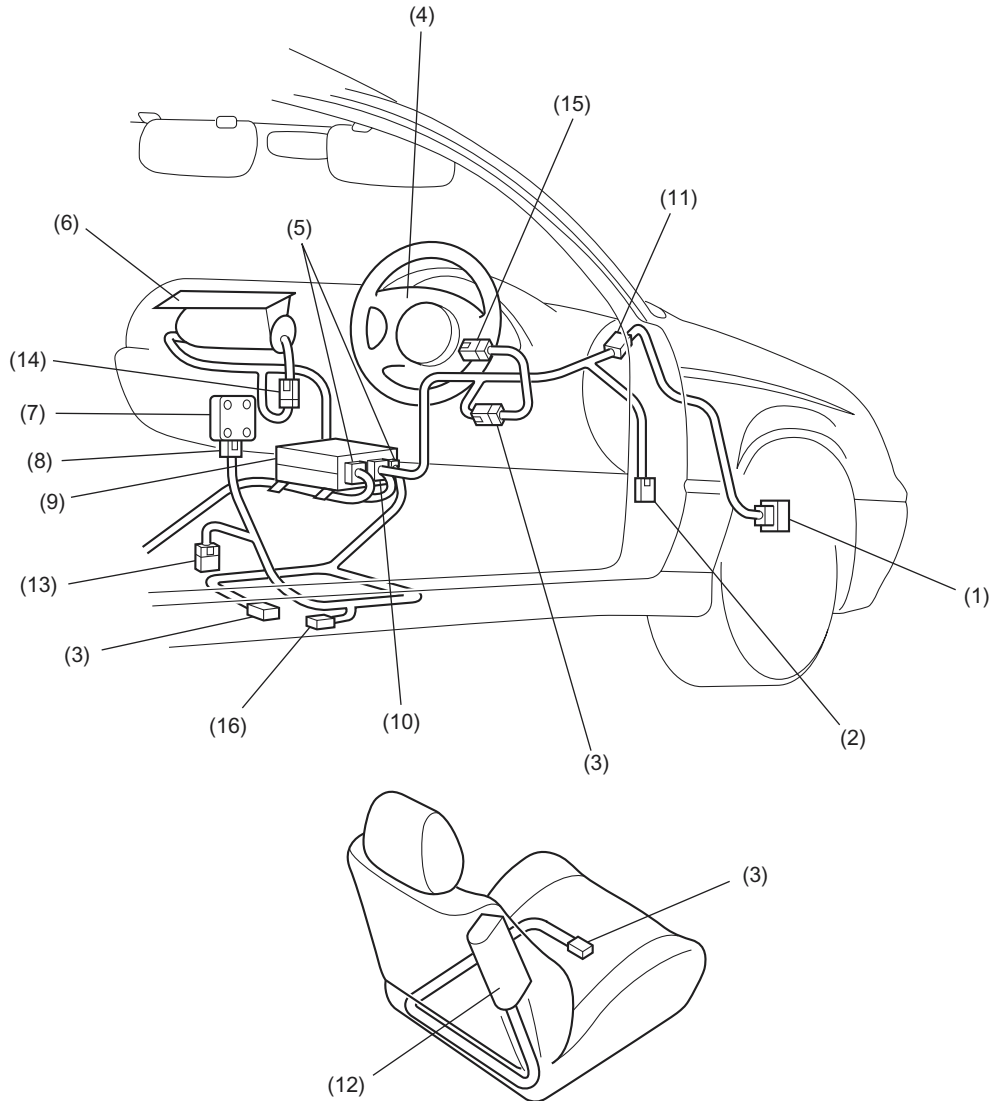
	Page
1. Airbag System	2
2. Construction	7

AIRBAG SYSTEM

Airbag System

1. Airbag System

A: CONSTRUCTION



AB-00196

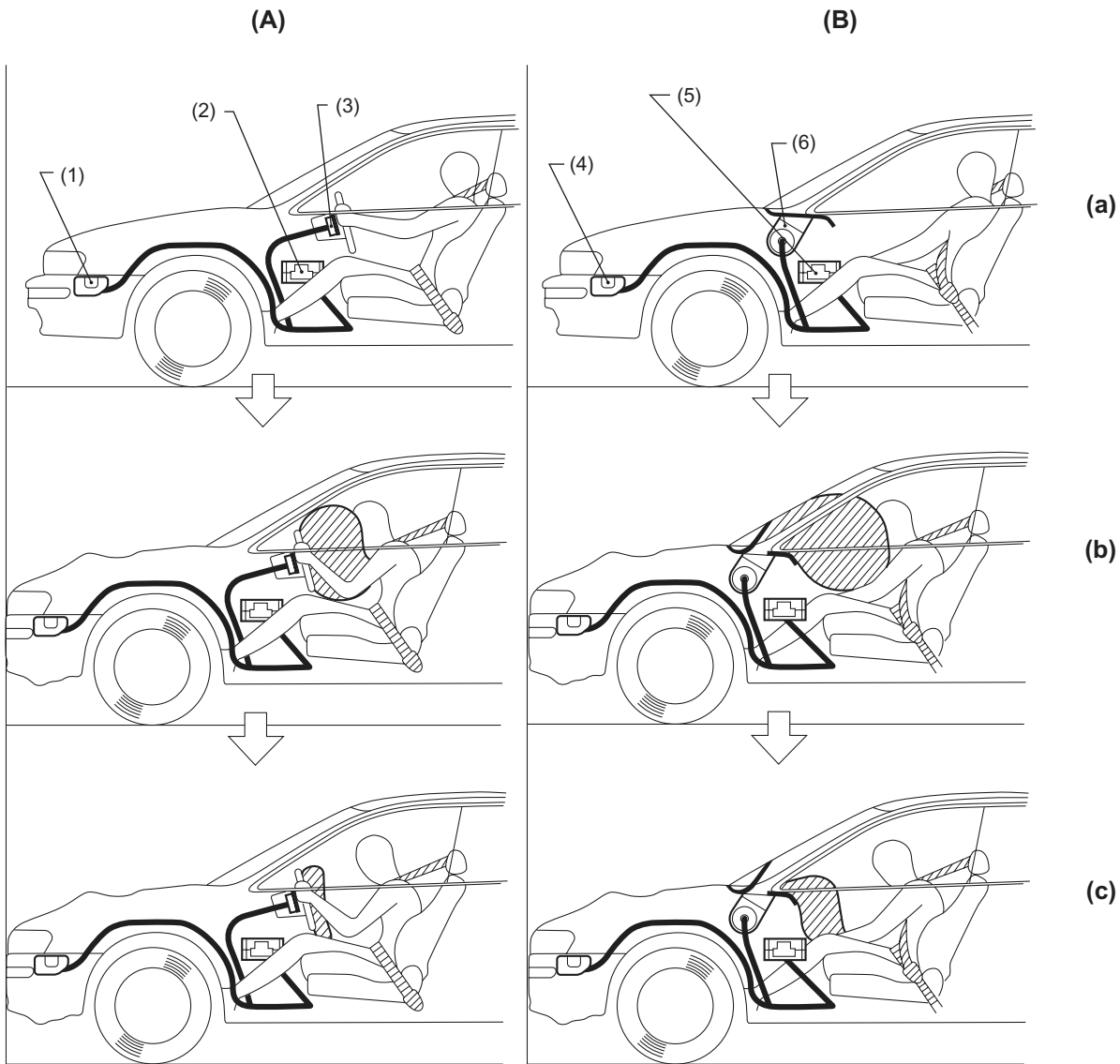
- | | |
|-------------------------------|--|
| (1) Front sub sensor | (9) Airbag control module |
| (2) 6-pin connector (yellow) | (10) 28-pin connector (yellow) |
| (3) 2-pin connector (yellow) | (11) 2-pin connector (yellow) |
| (4) Airbag module (driver) | (12) Airbag module (side) |
| (5) 12-pin connector (yellow) | (13) 2-pin connector (yellow) (to seat belt pretensioner) |
| (6) Airbag module (passenger) | (14) 4-pin connector (yellow) |
| (7) Side airbag sensor | (15) 2-pin connector (black) |
| (8) 4-pin connector (yellow) | (16) 2-pin connector (orange)
(to lap pretensioner: vehicles for Australia) |

B: FUNCTION

1. FRONT AIRBAGS

The airbag system is provided as a driver and front passenger restraint system supplementary to the seat belts. When an impact greater than a set level is applied to the front of the vehicle, the airbag control module activates the airbag modules in response to the signal from the sensor. The airbag modules activate to inflate the airbags, thus preventing the driver's and passenger's upper bodies from directly hitting against the steering wheel, instrument panel and/or windshield.

AIRBAG SYSTEM



AB-00090

(A) Driver side

(B) Passenger side

(1) Front sub sensor

(2) Safety sensor and electric sensor

(3) Inflator

(4) Front sub sensor

(5) Safety sensor and electric sensor

(6) Inflator

(a) • Collision.

(b) • Front sub sensor, electric sensor and safety sensor detect an impact greater than the set level.

• Inflators are ignited.

• Gas is generated.

• Airbag inflation completes.

• Gas is discharged.

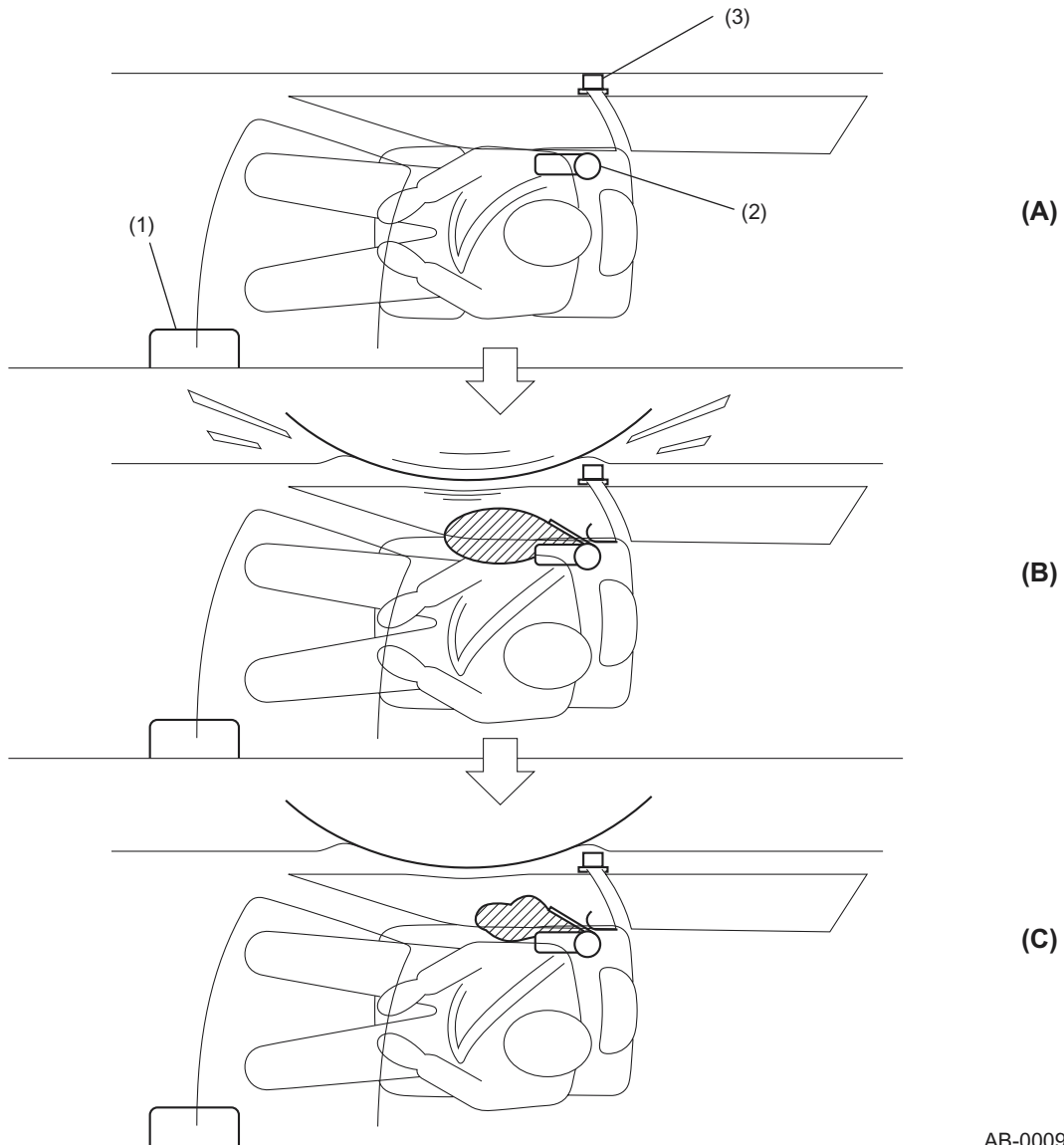
(c) • Airbags deflate.

2. SIDE AIRBAGS

The side airbags provide the driver and front passenger with a restraint supplementary to that by the seat belts in the event of a side-on collision. When an impact greater than the set level is applied to either side of the vehicle, the airbag control module activates the corresponding side airbag module in response to the ignition signal sent from the side airbag sensor on the relevant side. The side airbag module operates to inflate the airbag, thus reducing the shock inflicted in the outside upper body (chest and head) of the driver or front passenger.

AIRBAG SYSTEM

Airbag System



2. Construction

A: GENERAL DESCRIPTION

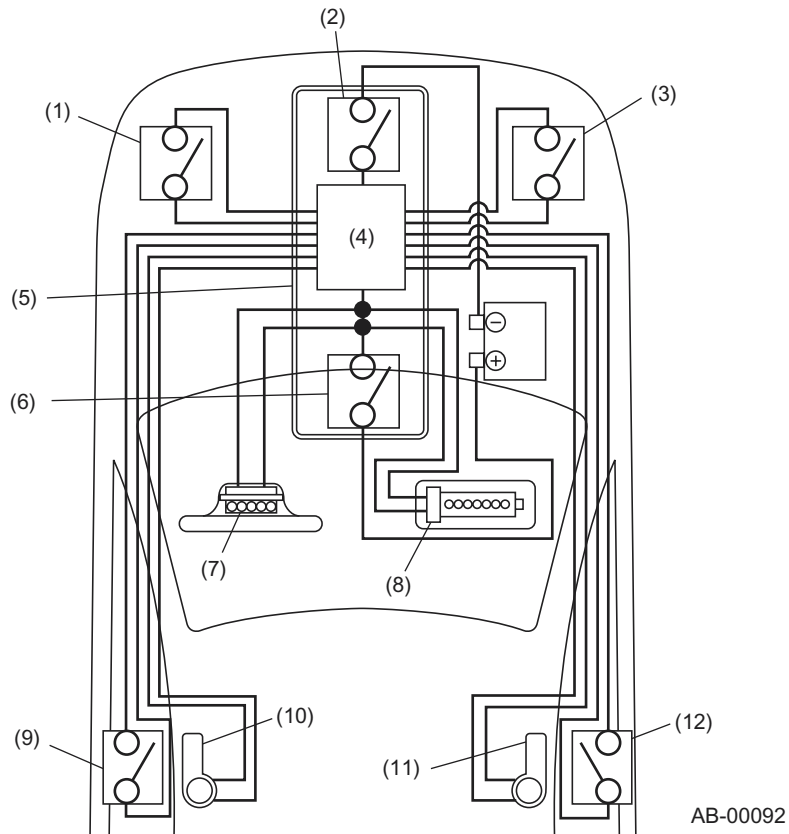
- The airbag system consists of an airbag control module, left and right front sub sensors, an electric sensor and safety sensor built into the control module, driver's and passenger's airbag modules each containing an inflator and airbag, and side airbag sensors and modules each containing an inflator and airbag (side airbag equipped model).

- **Front airbag system:**

A frontal impact exceeding the set level causes the safety sensor, electric sensor and one or both front sub sensors to input signals to the CPU. The CPU determines whether the airbags should be inflated or not based on these signals.

- **Side airbag system:**

Input of a side impact signal showing shock energy greater than the set level causes the airbag on the corresponding side to inflate.



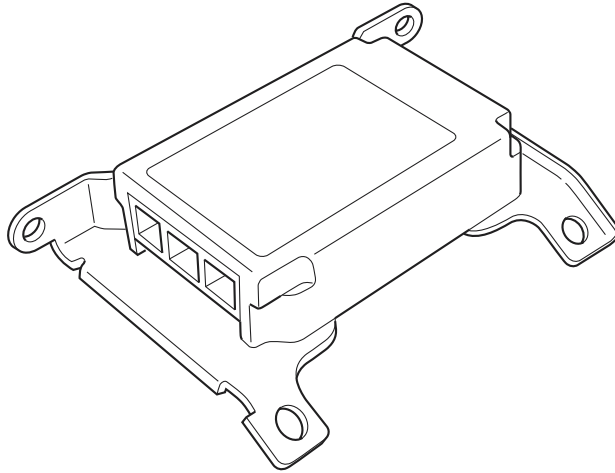
- (1) Front sub sensor (LH)
- (2) Safety sensor
- (3) Front sub sensor (RH)
- (4) CPU
- (5) Airbag control module
- (6) Electric sensor

- (7) Inflator (Driver)
- (8) Inflator (Passenger)
- (9) Side airbag sensor (LH)
- (10) Inflator (Side-LH)
- (11) Inflator (Side-RH)
- (12) Side airbag sensor (RH)

CONSTRUCTION

B: AIRBAG CONTROL MODULE

The airbag control module is installed in front of the front floor tunnel. It detects the vehicle's deceleration by receiving electrical signals from its inside safety and electric sensors as well as the front sub sensors and judges whether to inflate the airbags. This control module has a built-in self-diagnosis function. If a fault occurs inside the system, it lights up the airbag warning light in the combination meter. The fault data is stored in the control module. A back-up power supply is provided for possible damage to the battery during an accident, and a boosting circuit is built into the control module in case of a battery voltage drop.



AB-00093

C: AIRBAG SENSOR

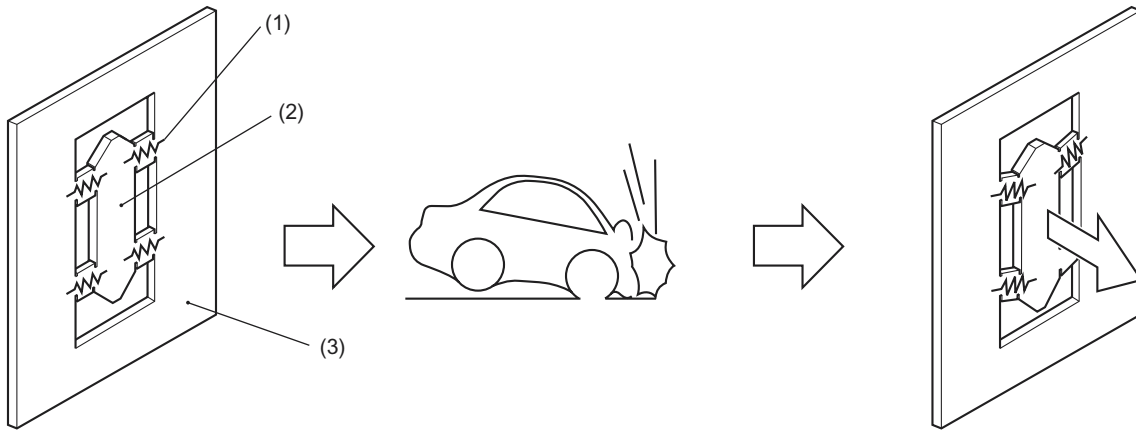
The airbag control module and side airbag sensor contain an electric sensor and a safety sensor.

The electric sensor consists of a semiconductor type sensor which senses the deceleration caused by collision in terms of change in the electrical resistance of the impact sensing circuit.

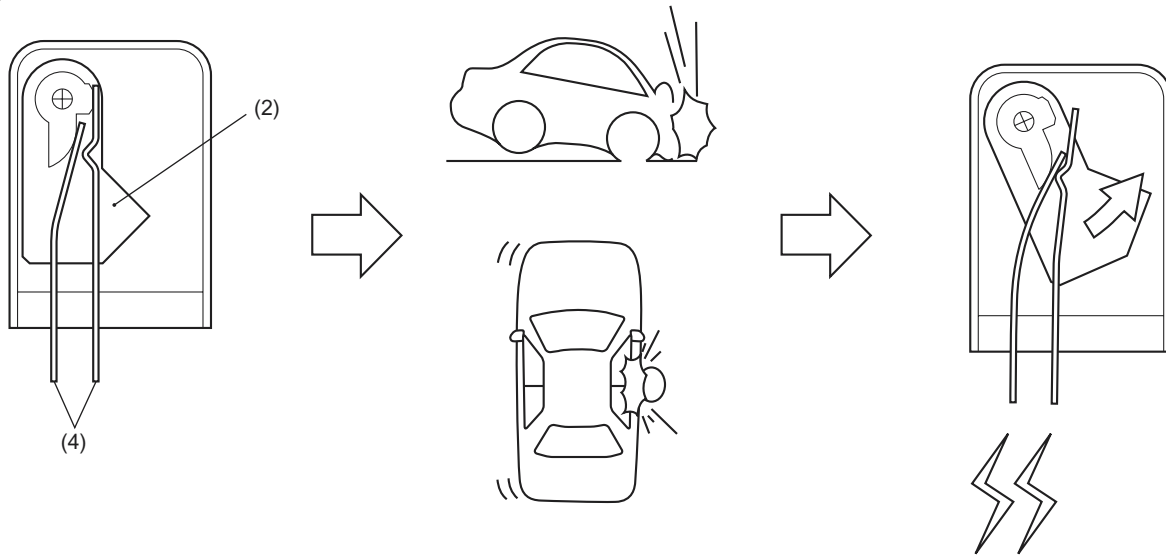
The safety sensor is a pendulum type sensor. If the sensor receives a frontal or side impact exceeding a certain limit, the mass in the sensor move in the direction opposite to the impact direction to turn the switch ON.

CONSTRUCTION

(A)



(B)



AB-00094

(A) ELECTRIC SENSOR

(B) SAFETY SENSOR

(1) Electrical resistance

(2) Mass

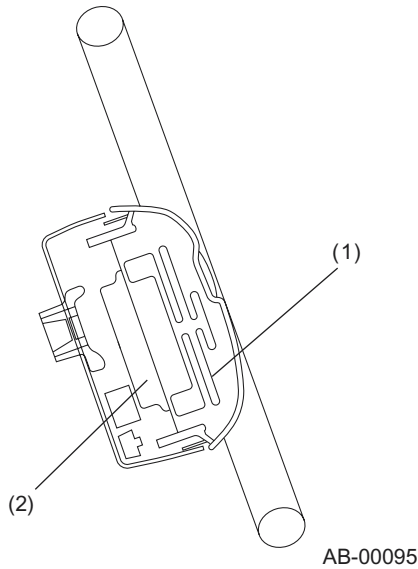
(3) Semiconductor

(4) Switch contacts

D: AIRBAG MODULE

1. DRIVER'S AIRBAG

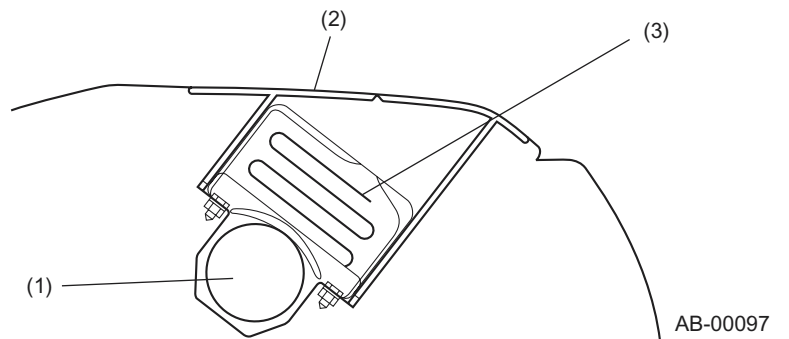
The driver's airbag module is located at the center of the steering wheel. The module contains an airbag and an inflator. If a collision occurs, the inflator produces a large volume of gas to inflate the airbag in a very short time.



- (1) Airbag
- (2) Inflator

2. PASSENGER'S AIRBAG

The passenger's airbag module is located at the upper portion of the instrument panel. The module uses a 2-stage inflator to control the output of the inflator.



- (1) Inflator
- (2) Airbag module lid
- (3) Airbag

The 2-stage inflator houses two igniters and gas heating agents, together with compressed gas inside a metal container. The airbag sensor system detects the magnitude of the impact caused by the collision, and controls the ignition timing of the inflator.

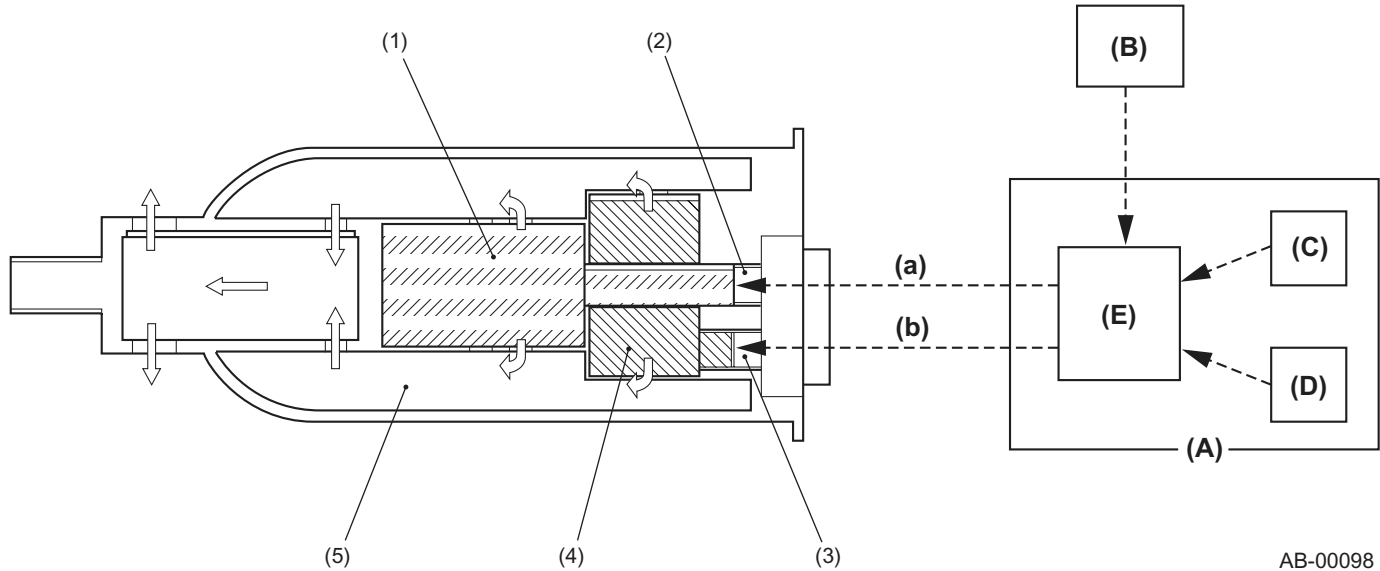
CONSTRUCTION

Airbag System

1) If a collision occurs at low to mid speed, the inflator is ignited in 2 stages. By delaying the ignition of the 2nd stage gas heating agent, the output of the inflator is reduced.

2) If a collision occurs at a high speed, both stages of the inflator are ignited simultaneously. The gas heating agent for the 1st stage and the 2nd stage are ignited at the same time.

By optimizing the airbag deployment according to the condition as explained above, the passenger restraint operation at low to mid speeds is improved.



AB-00098

- (1) 1st stage heating agent
- (2) 1st stage igniter
- (3) 2nd stage igniter
- (4) 2nd stage heating agent
- (5) Compressed gas

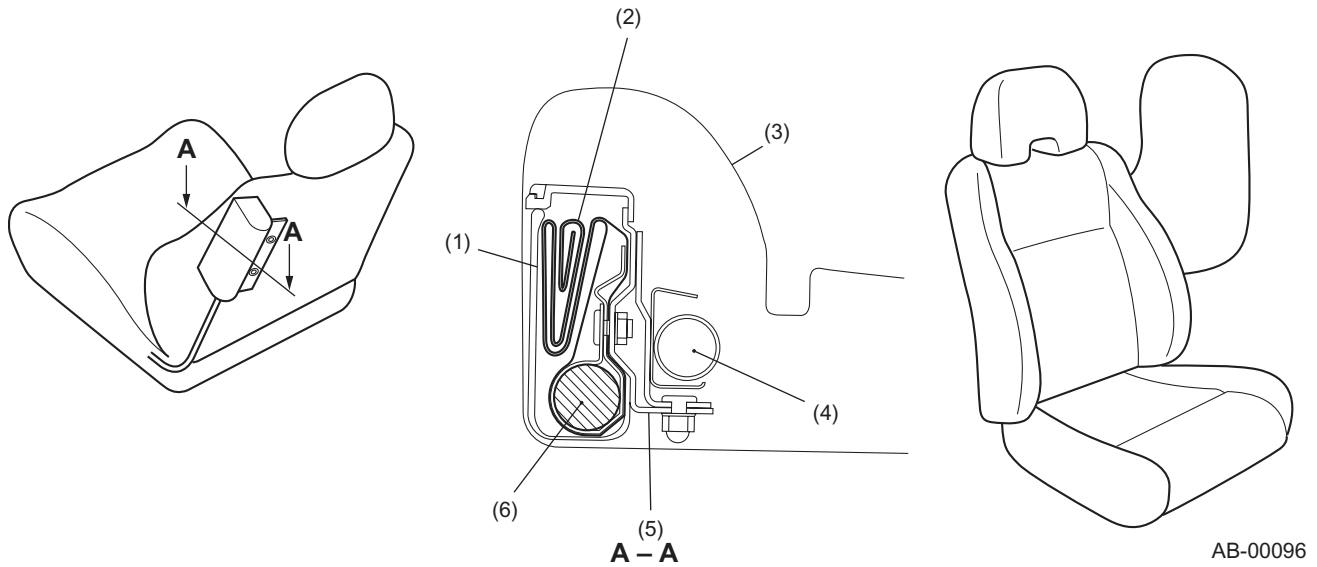
- (a) 1st stage ignition signal
- (b) 2nd stage ignition signal

- (A) Airbag control module
- (B) Front sub sensor
- (C) Safety sensor
- (D) Electric sensor
- (E) CPU

3. SIDE AIRBAG

A side airbag module is located at the outer side of each front seat backrest, and it contains an airbag and an inflator.

If a side-on collision occurs, the inflator produces a large volume of gas to inflate the airbag in a very short time.



- (1) Cover
- (2) Airbag
- (3) Seat upholstery

- (4) Seat frame
- (5) Bracket
- (6) Inflator

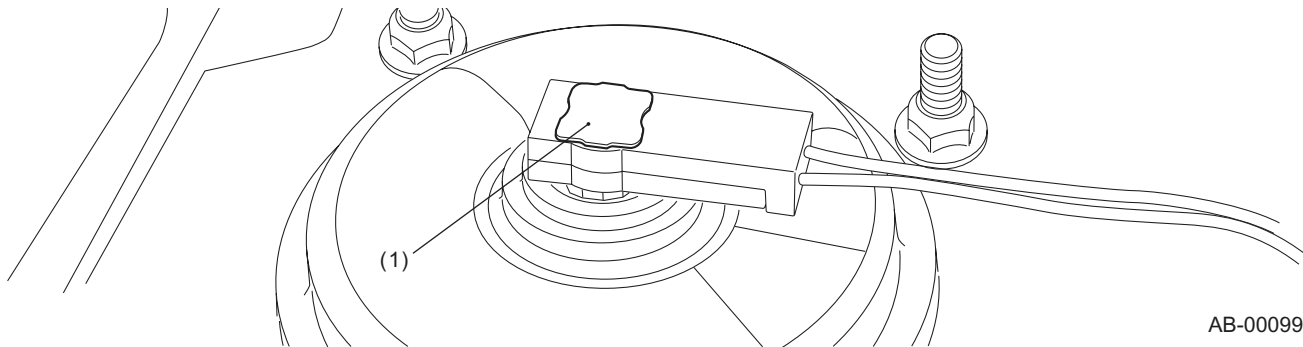
CONSTRUCTION

E: AIRBAG CONNECTORS

1. DESCRIPTION

The airbag system uses connectors with a double lock mechanism and an incomplete coupling detection mechanism for enhanced reliability. If coupling is incomplete, the airbag warning light comes on in the combination meter.

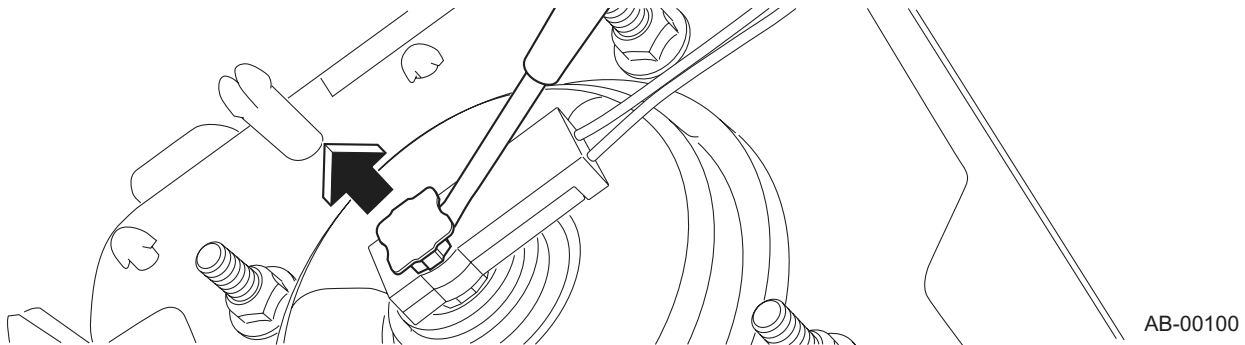
2. DRIVER'S AIRBAG MODULE-TO-ROLL CONNECTOR HARNESS CONNECTOR



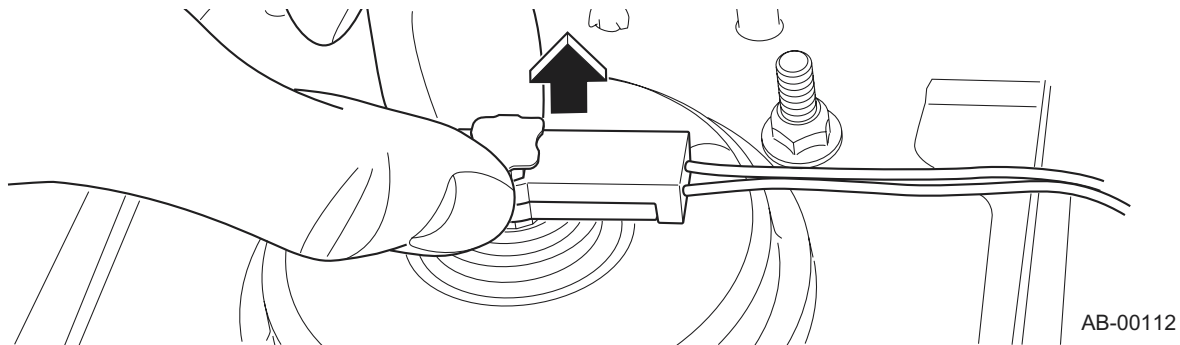
(1) Lock button

Disconnection:

1) Lift the lock button using a thin tipped tool like a miniature screwdriver.



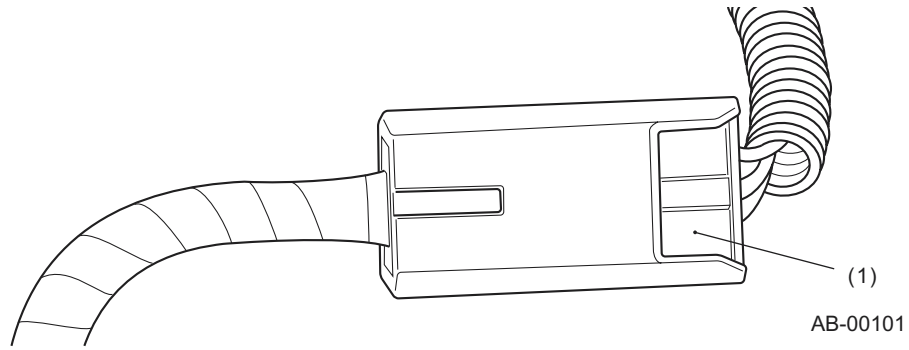
2) Pull the connector out from the airbag module.



Connection:

Carefully insert the connector into the airbag module. Push in the lock button until a “click” is heard.

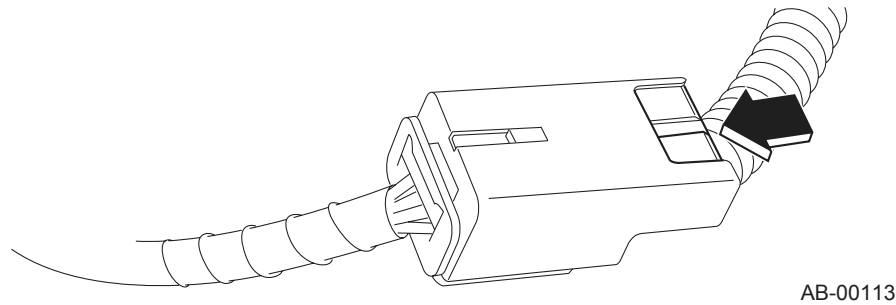
3. PASSENGER'S AIRBAG MODULE-TO-AIRBAG MAIN HARNESS CONNECTOR



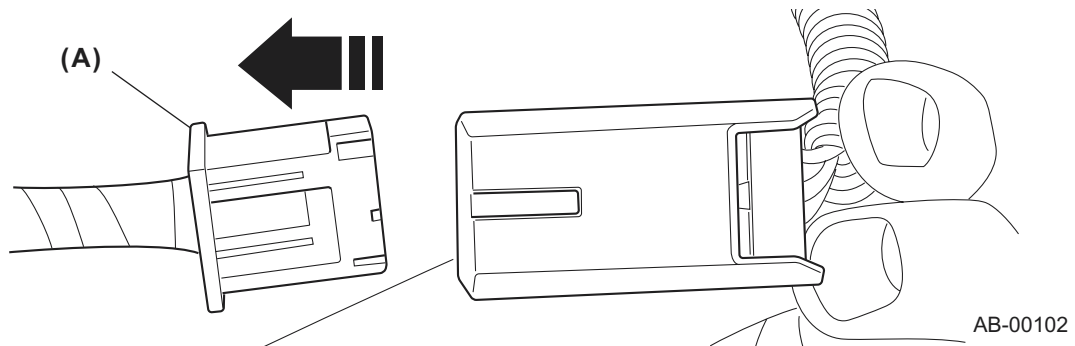
(1) Slide lock

Disconnection:

1) Push the slide lock inwards.



2) While the slide lock pushed in, disconnect the connector (A).



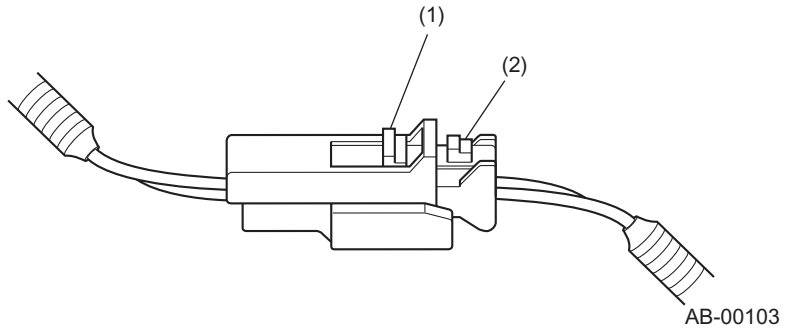
Connection:

Insert the female side connector half into the other until a "click" is heard.

CONSTRUCTION

Airbag System

4. AIRBAG HARNESS-TO-AIRBAG HARNESS CONNECTOR

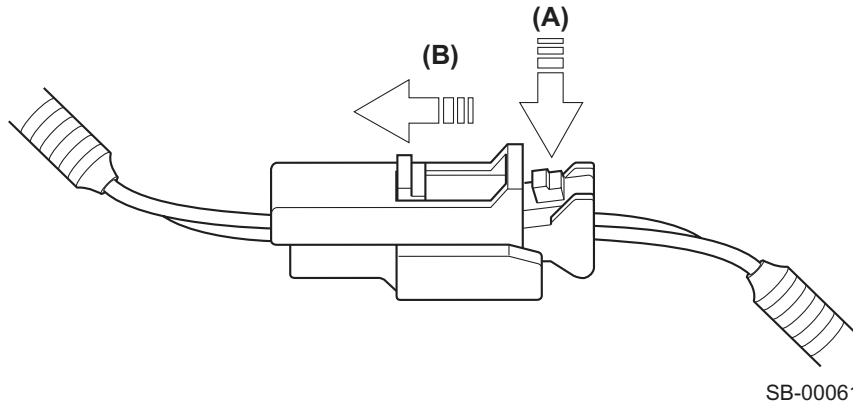


(1) Slide lock

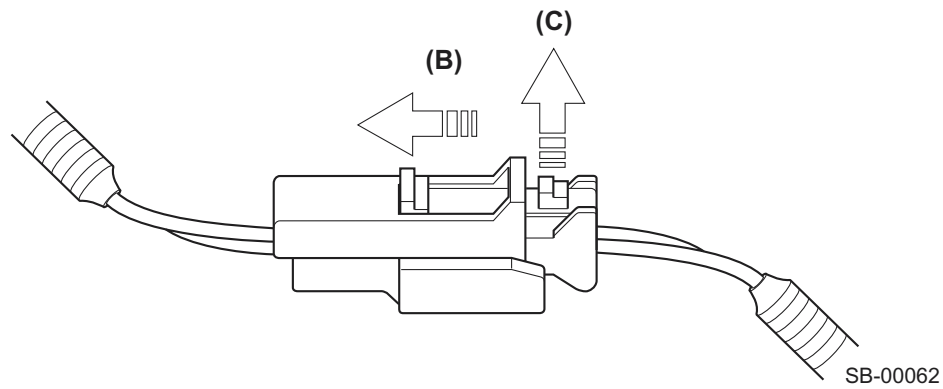
(2) Lock arm

Disconnection:

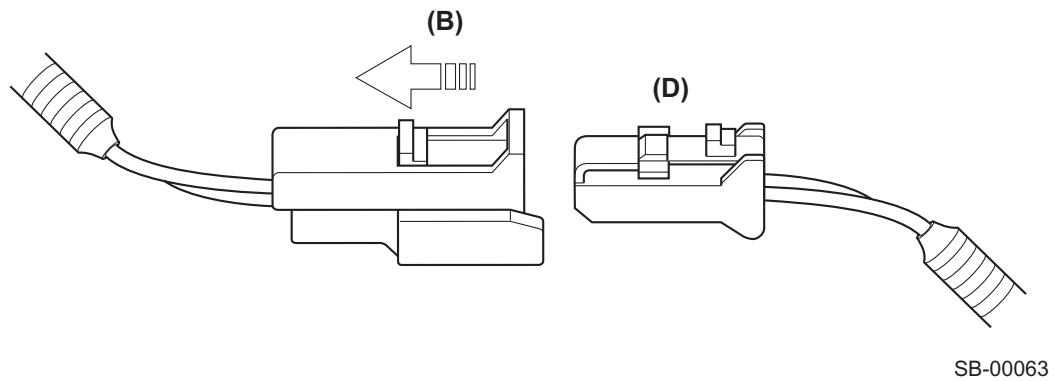
1)



2)



3)



- (A) Step 1: Push
- (B) Step 2: Slide and hold
- (C) Step 3: Release
- (D) Step 4: Disconnect

Connection:

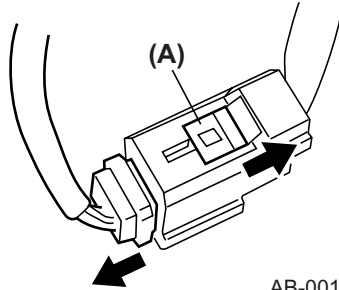
Insert the female side connector half into the other until a “click” is heard.

CONSTRUCTION

5. AIRBAG HARNESS-TO-BODY HARNESS CONNECTOR, AIRBAG HARNESS-TO-FRONT SUB SENSOR HARNESS CONNECTOR

Disconnection:

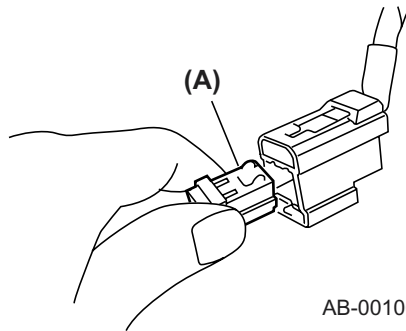
Hold slide lock (A) moved in the direction of the arrow, then pull the female connector in the direction of the arrow.



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Connection:

Push the connector (A) into the male connector carefully until a “click” is heard.

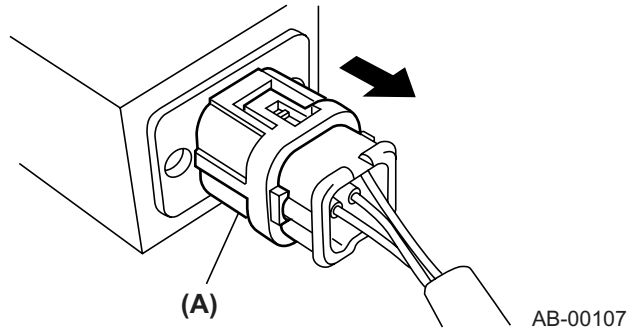


AB-00106

6. FRONT SUB SENSOR AND SIDE AIRBAG SENSOR CONNECTORS

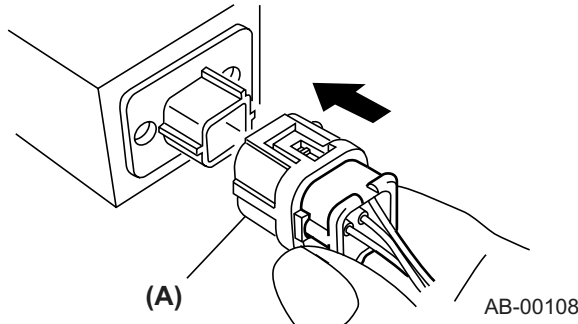
Disconnection:

Holding the outer part (A), pull the connector in the direction of the arrow.



Connection:

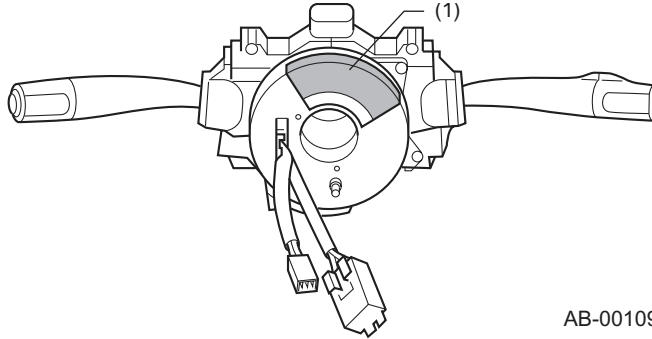
Holding the inner part, push the connector into the socket carefully until a “click” is heard. Do not hold the outer part (A) as it moves back during connection of the connector.



CONSTRUCTION

F: STEERING ROLL CONNECTOR

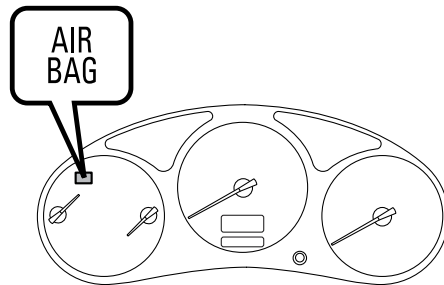
The steering roll connector is located between the steering column and steering wheel. The connector contains a spirally wound flat cable. The cable can follow rotational movements of the steering wheel and ensures connection between the airbag module in the steering wheel and the airbag harness through which electrical signals are transmitted from the airbag control module.



(1) Flat cable

G: AIRBAG WARNING LIGHT

The airbag warning light is located inside the combination meter. It illuminates if a poor connection in the airbag circuit occurs, or if the airbag control module detects an abnormal condition. When the airbag system is normal, this light comes on when the ignition switch is turned ON and then goes out about 7 second later.



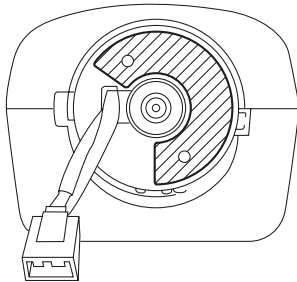
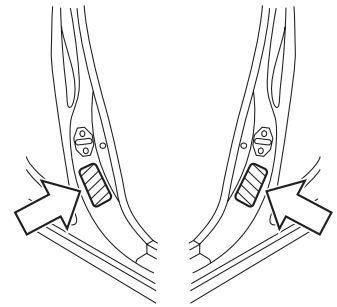
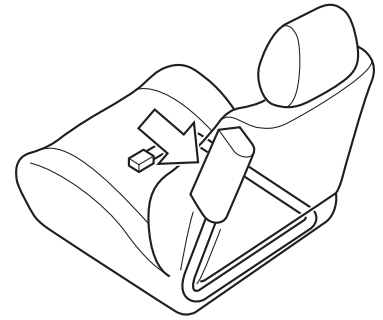
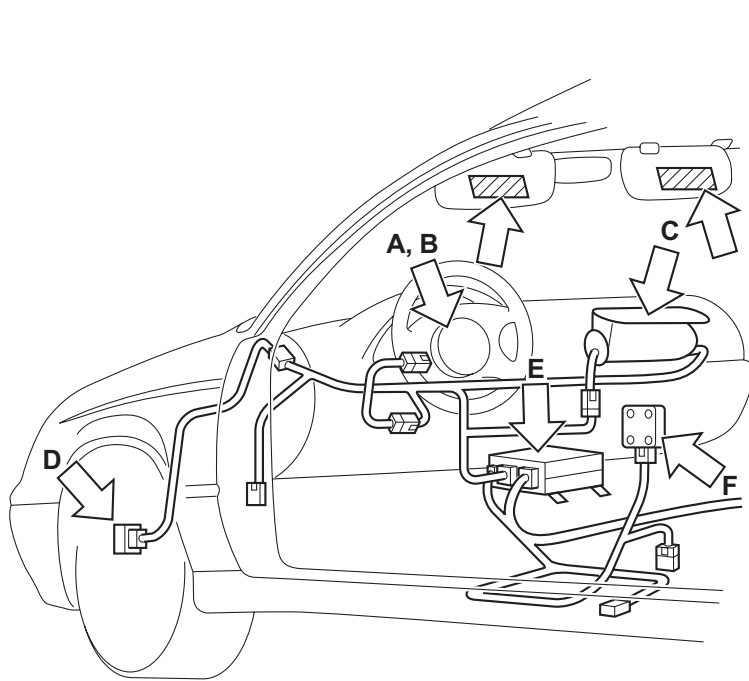
AB-00110

H: WIRE HARNESS

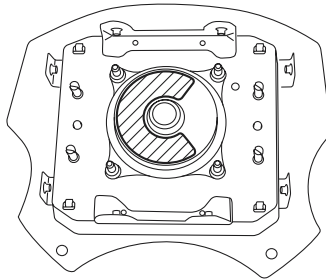
The airbag harnesses are integrated into the body harness as follows:

- Front sub sensor harness: integrated into the front harness.
- Airbag main harness: Integrated into the bulkhead harness.
- Pretensioner and side airbag harnesses: Integrated into the rear harness.

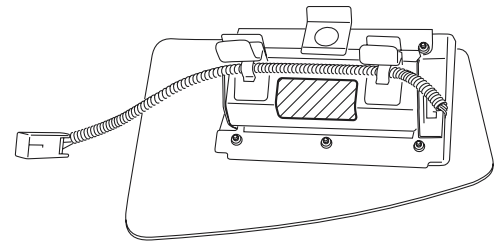
I: LOCATIONS OF WARNING AND CAUTION LABELS



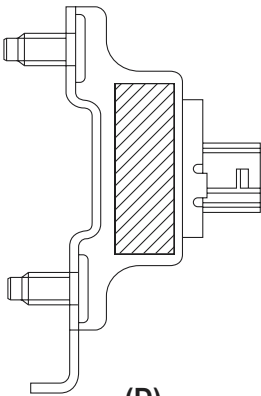
(A)



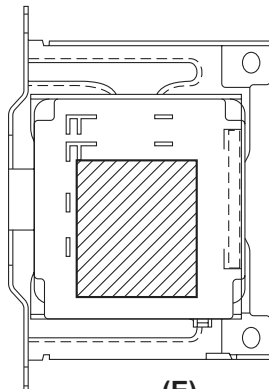
(B)



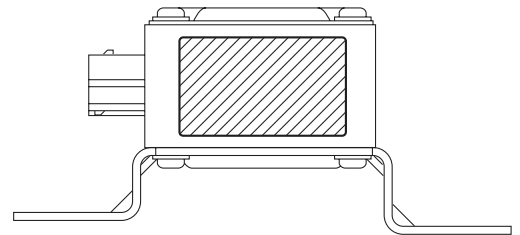
(C)



(D)



(E)



(F)

AB-00303

CONSTRUCTION

Airbag System

MEMO

SEAT BELT SYSTEM **SB**

	Page
1. Seat Belt	2

SEAT BELT

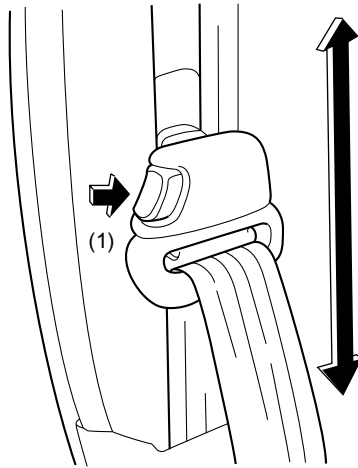
Seat Belt System

1. Seat Belt

A: ADJUSTABLE SHOULDER BELT ANCHOR

1. FRONT

Each front seat belt system has an adjustable shoulder belt anchor which allows the occupant to select the most appropriate anchor height from among the five positions in a 90 mm (3.54 in) range.

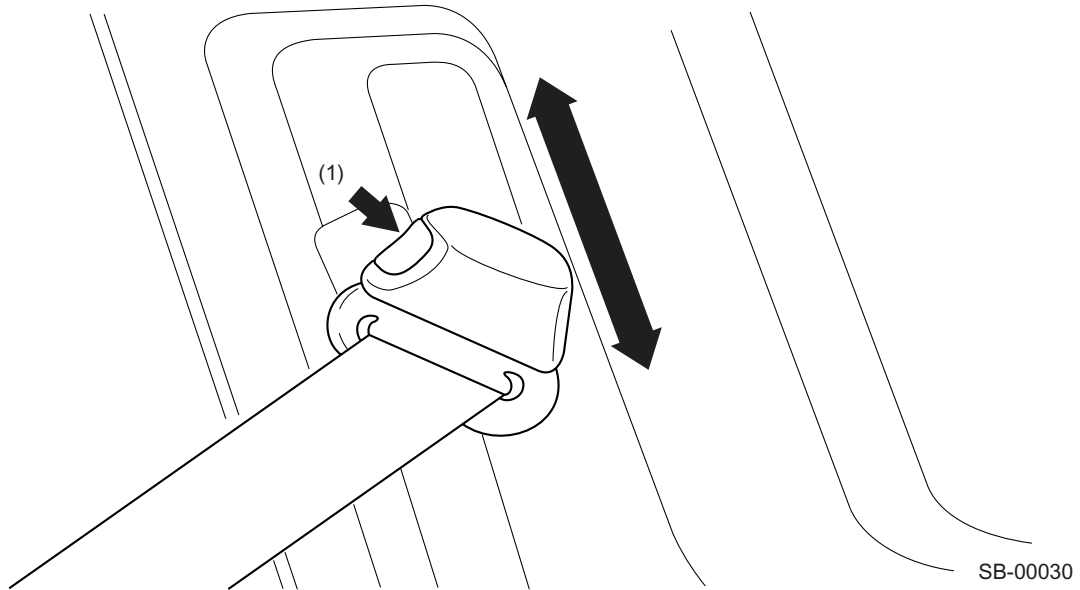


SB-00029

(1) Push

2. REAR

The outer rear seat belt system has an adjustable shoulder belt anchor which allows the occupant to select the most appropriate anchor height from among the three positions in a 48 mm (1.89 in) range.



(1) Push

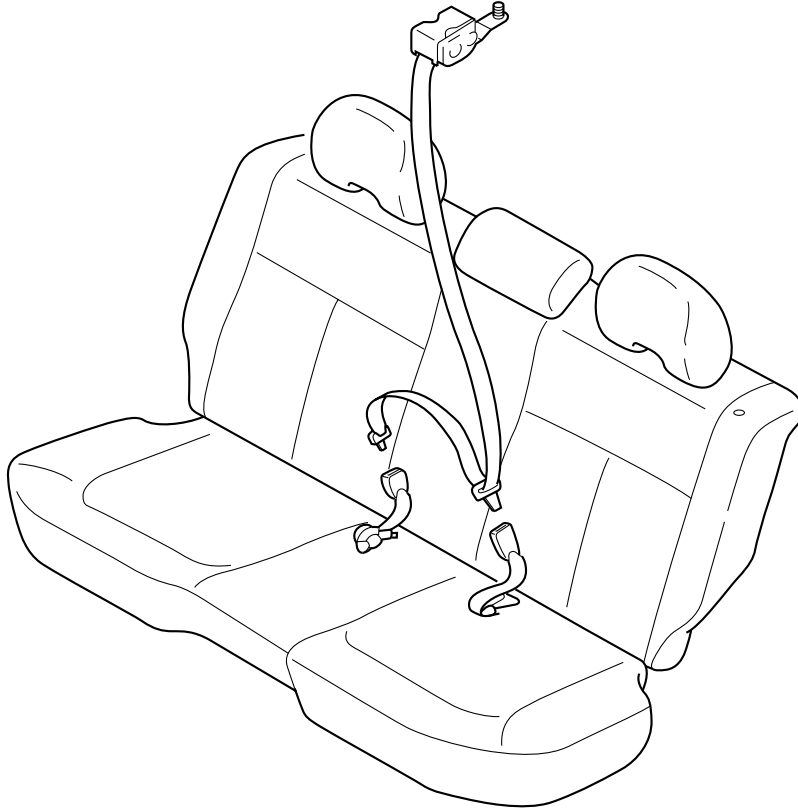
SB-00030

SEAT BELT

Seat Belt System

B: REAR CENTER THREE-POINT TYPE SEAT BELT

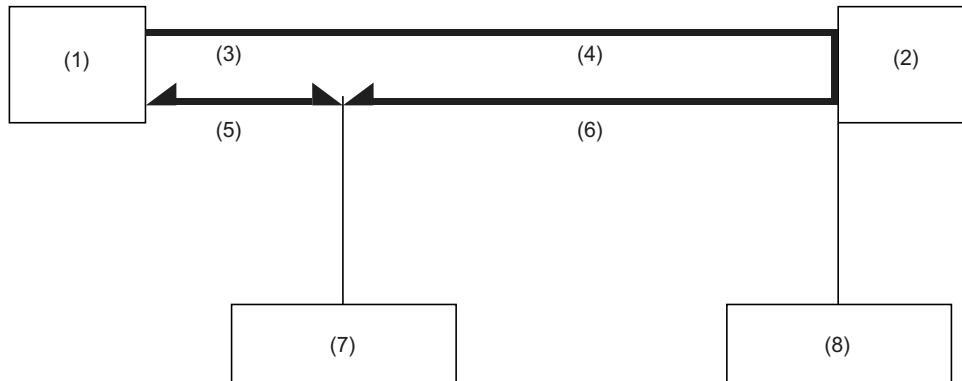
A three-point type seat belt is available for the center seating position of the rear seat. The retractor for the seat belt is installed on the right rear side of the luggage compartment ceiling.



SB-00031

C: AUTOMATIC RETRACTOR

When the front passenger's seat belt and all the rear seat belts are drawn out completely, their retractors are placed in the automatic locking mode which is used when installing a child restraint system. In this mode, the belt can be retracted but cannot be extended. When the belt is retracted to a certain length, this mode is cancelled and normal operation is restored.



SB-00032

- (1) Fully retracted
- (2) Fully extended
- (3) Normal mode
- (4) Automatic locking mode
- (5) Belt can be extended and retracted.
- (6) Belt can be retracted but cannot be extended.
- (7) Automatic locking mode to normal mode changeover
- (8) Normal mode to automatic locking mode changeover

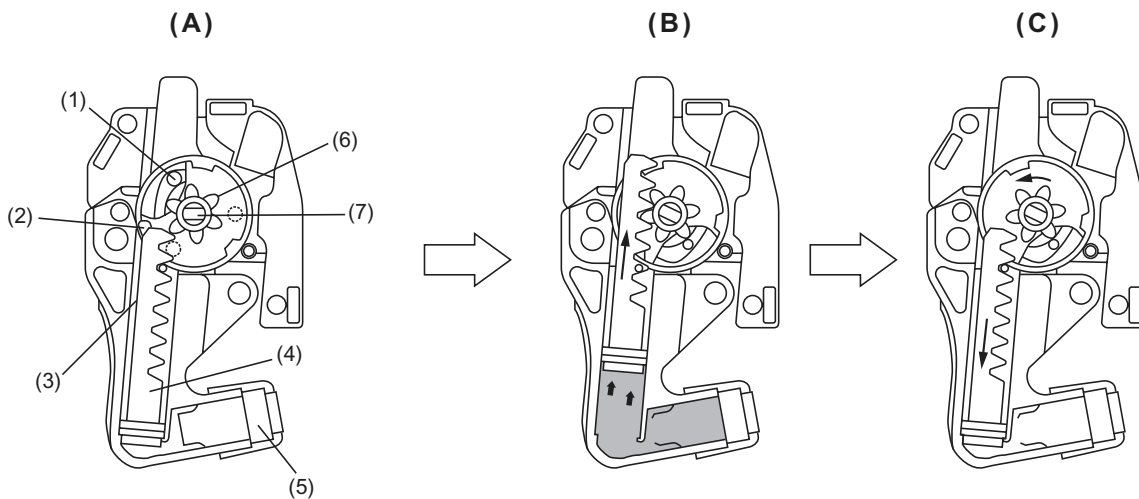
SEAT BELT

D: PRETENSIONER

1. CONSTRUCTION

The driver's and front passenger's seat belts are equipped with seat belt pretensioners. The pretensioners use the front sub sensors and the airbag control module inside sensors to control their operation. If the sensors detect an impact exceeding the predetermined level during a frontal or front-angled collision, the front seat belts are quickly rewound by the retractors to take up slacks for maximum restraining of the seat occupants. If the load placed on a seat belt exceeds the predetermined level, the torsion bar twists to allow the belt to be payed out, thus lessening the load imposed on the belt wearer's chest. Once the seat belt pretensioner has been activated, the seat belt retractor remains locked.

2. OPERATION OF PRETENSIONER



SB-00058

(A) Initial state

- (1) Roller
- (2) Shear rib
- (3) Shear pin

(B) Pretensioner operating

- (4) Piston
- (5) Gas generator
- (6) Pinion

(C) Load limiter operating

- (7) Sleeve

1) Initial state

- The piston is held in place by the shear pin in the case gear, and the pinion is held in place by the shear rib in the case gear (when operated, the shear pin and shear rib are sheared off).
- The sleeve rotates while transmitting torque of the spring to the spool, and the roller and sleeve rotate freely because a gap is maintained.

2) Pretensioner starts operating and the belt is retracted

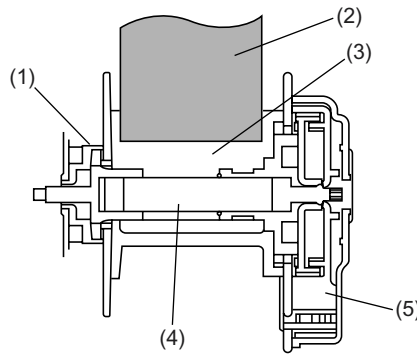
- When the gas generator is triggered in response to the ignition signal from the airbag control unit, the piston moves upward by gas pressure. As a result, the rack gear of the piston becomes engaged with the pinion and the linear motion is converted into a rotating motion.
- When the pinion rotates, the slant of the pinion causes the roller to move in an axial direction and be caught in the sleeve engaging the clutch. The pinion, sleeve, and spool starts to rotate together as a unit and retract the belt.

3) Load limiter

When the passenger restraining load increases and the torsion bar begins to be twisted, the rotation of spool, sleeve and piston is reversed thus returning the piston. The piston moves downwards while releasing pressure from the gas vent hole, and when the piston reaches the bottom position it is disengaged with the pinion enabling it to rotate freely.

(1) Initial state

The draw out of the belt is detected and the lock mechanism operates. When the belt is drawn out further, the spool and lock mechanism try to rotate relatively.



- (1) Sleeve
- (2) Belt
- (3) Spool

- (4) Torsion bar
- (5) Lock mechanism

SEAT BELT

(2) Belt extraction

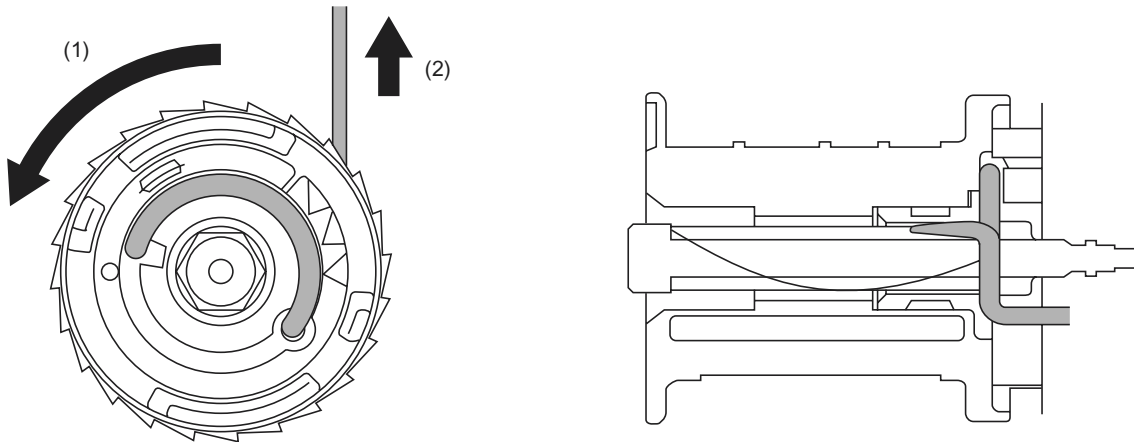
Except Australia models: torsion bar operates

The belt is extracted while the torsion bar is twisted and the belt extracting load is kept constant.

Australia models: wire and torsion bar operates

When the belt is drawn out further, the torsion bar is twisted and the wire begins to be rubbed.

Plastic deformation occurs in the wire and torsion bar and the belt extracting load is kept constant. When this occurs, the wire gradually comes out from the spool and gets wound around the lock mechanism.



SB-00060

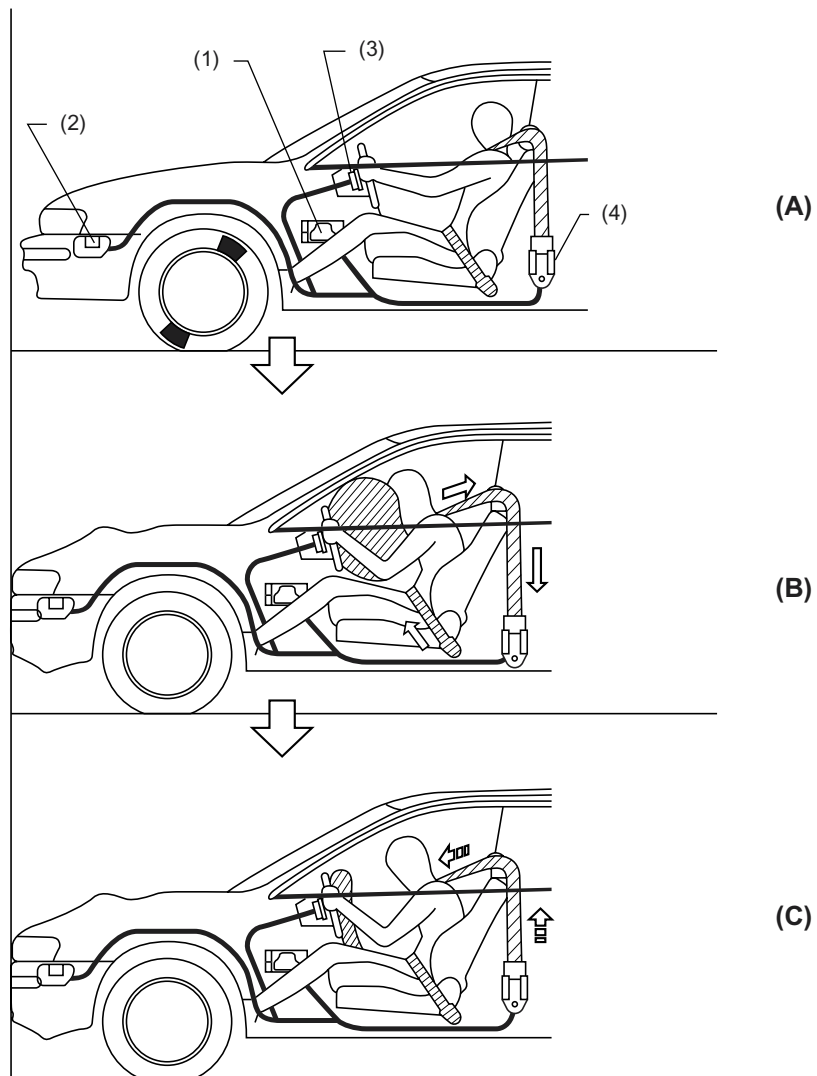
(1) Spool rotating direction

(2) Belt drawn out

(3) Belt extraction (only torsion bar operates – Australia models only)

After the wire comes out from the spool completely, the load is kept constant by the twist of the torsion bar only.

3. FUNCTION



SB-00035

- (A)** • Collision occurs
- (B)** • Front sub sensor, electric sensor and safety sensor detect an impact exceeding predetermined level.
 - Pretensioner operates
- (C)** • Completion
 - (1) Safety sensor and electric sensor
 - (2) Front sub sensor
 - (3) Air bag
 - (4) Retractor with pretensioner

SEAT BELT

Seat Belt System

4. PRETENSIONER CONNECTOR

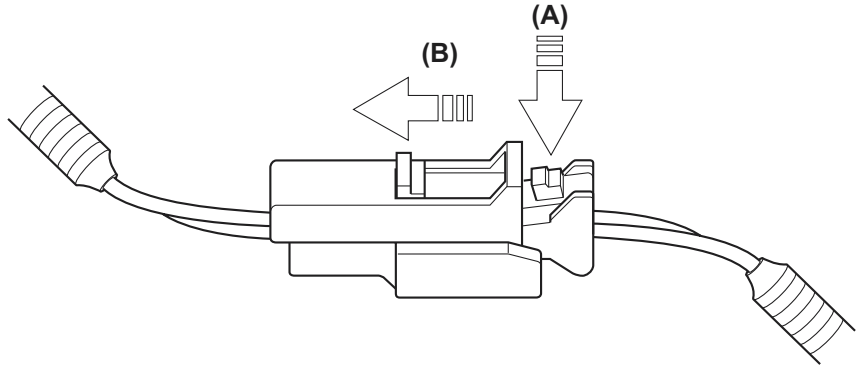
Disconnection:

Hold slide lock moved in the direction of the arrow (B), then pull out the connector.

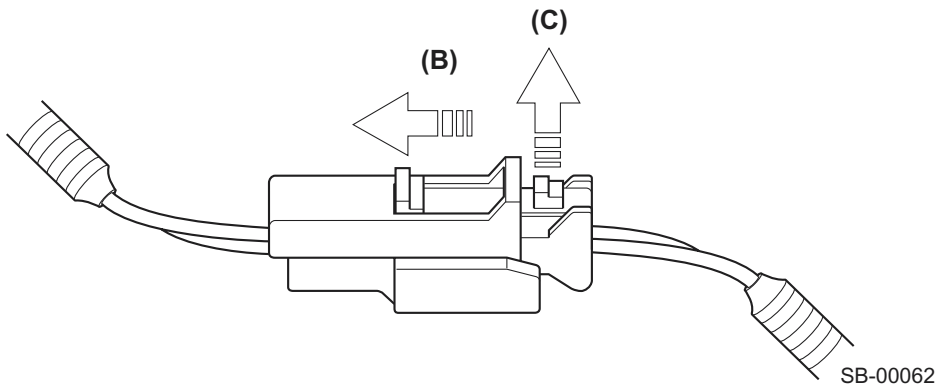
Connection:

Push the connector into the male connector carefully until a click is heard.

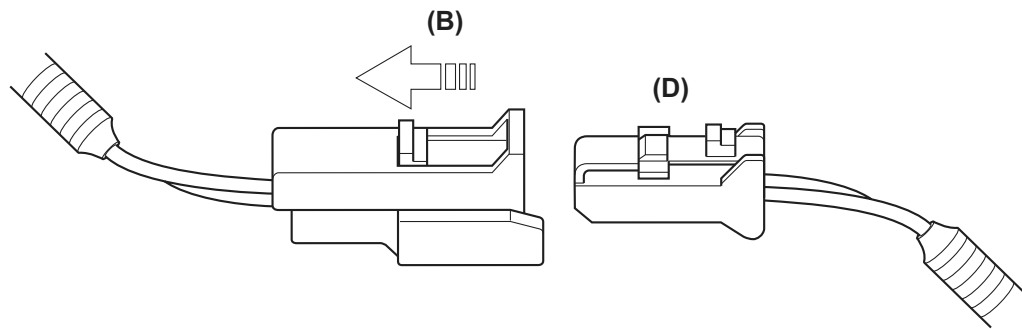
1)



2)



3)



SB-00063

- (A) Step 1: Push
- (B) Step 2: Slide and hold
- (C) Step 3: Release
- (D) Step 4: Disconnect

SEAT BELT

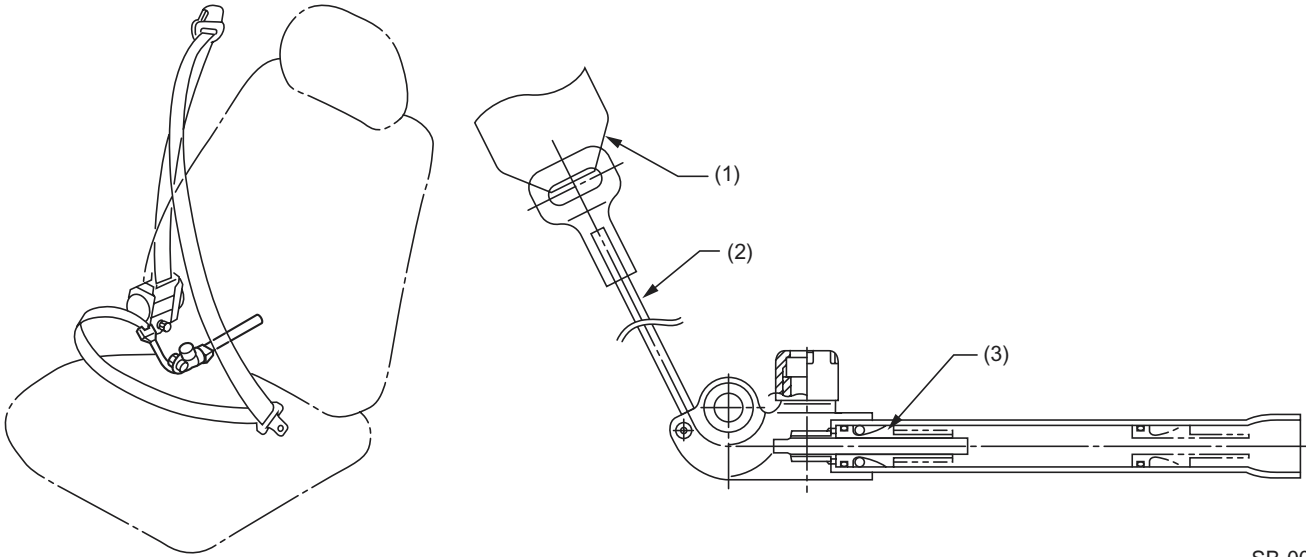
Seat Belt System

E: LAP BELT PRETENSIONER (AUSTRALIA MODELS)

1. CONSTRUCTION

The driver's seat belt is equipped with a lap belt pretensioner.

The lap belt pretensioner is installed to the lower part of the center pillar and has a gas generator and a piston to retract the belt.



SB-00072

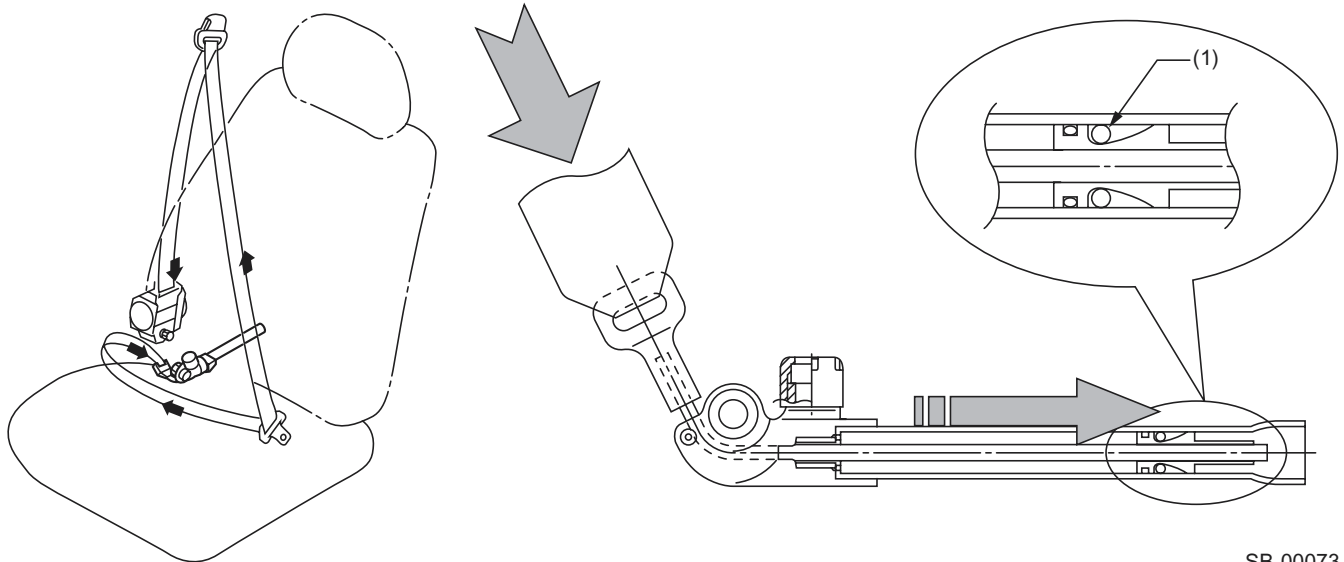
- (1) Belt
- (2) Wire
- (3) Piston

2. OPERATION

Similar to the retractor pretensioner at the shoulder belt end, the lap belt pretensioner uses the front sub sensor and the airbag control module inside sensor to control its operation.

Upon receipt of a signal from the airbag control module, the igniter agent inside the gas generator is triggered. When the igniter is ignited and the gas generating agent combusts, the pressure of the gas increases rapidly and moves the piston causing the belt to retract instantaneously.

The lap belt pretensioner operates almost simultaneously with the airbag system and the retractor pretensioner to enhance the passenger restraint ability in case of a collision.



SB-00073

(1) Stopper

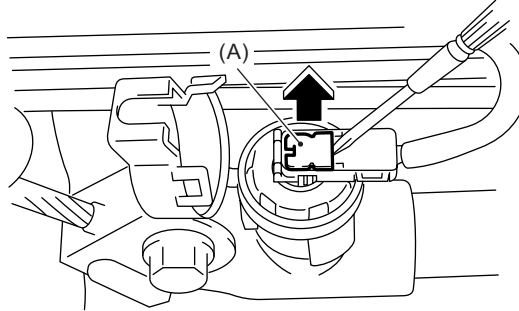
SEAT BELT

Seat Belt System

3. LAP BELT PRETENSIONER CONNECTOR

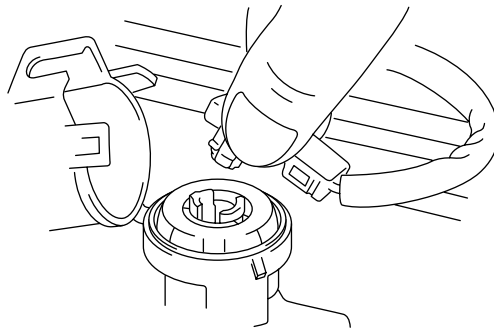
Disconnection:

- 1) Pry upwards to release the push lock (A) using a flat blade screwdriver, etc.



AB-00115

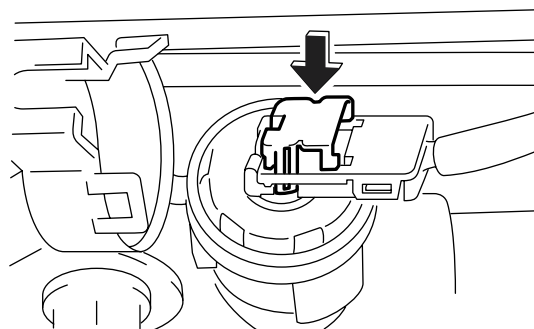
- 2) Pull and disconnect the connector from the lap belt pretensioner.



AB-00026

Connection:

Insert the connector into the lap belt pretensioner and then press the push lock carefully until a “click” is heard.



AB-00027

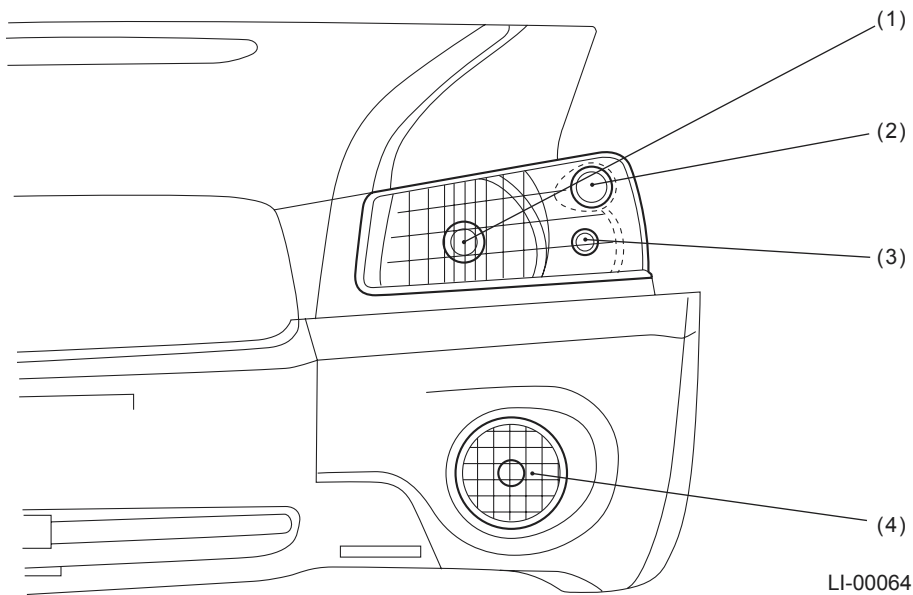
LIGHTING SYSTEM *LI*

	Page
1. Front	2
2. Rear	3

FRONT

1. Front

A: DESCRIPTION



(1) Headlight

(2) Clearance light

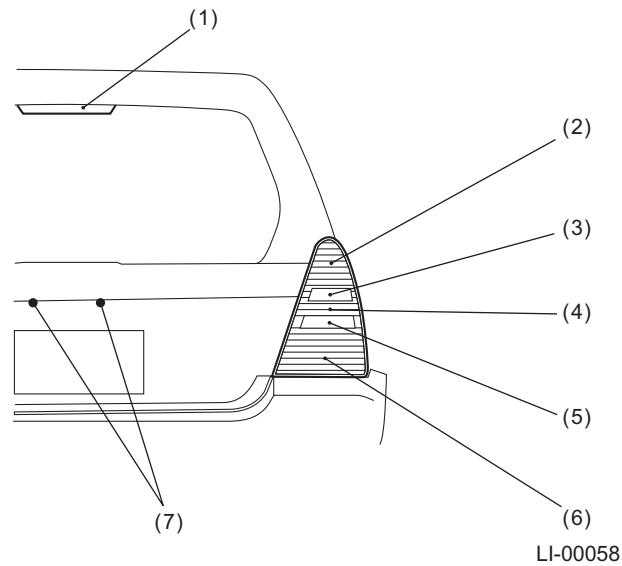
(3) Turn signal/hazard light

(4) Front fog light

- The headlight has two halogen bulbs and a multiple aspect reflector. The reflector controls the distribution of the light and no lens cutting is done on the shield for all models.
- The front turn signal/hazard warning light and clearance light are incorporated into the front light.
- The fog light is large sized with a multiple aspect reflector.
- A keyless answerback feature using the hazard lights is adopted. When the keyless entry system is operated, the hazard lights will flash.

2. Rear

A: DESCRIPTION



- | | |
|------------------------------|-------------------------|
| (1) High mount stop light | (5) Backup light |
| (2) Stop/tail light | (6) Rear fog light |
| (3) Turn signal/hazard light | (7) License plate light |
| (4) Rear reflex reflector | |

- The rear turn signal/hazard warning light, stop/tail light, backup light, and rear fog light (in left side on LHD vehicles or in right side on RHD vehicles) are incorporated into the rear combination light. The rear reflex reflector is also incorporated into the rear combination light.
- The high mount stop light is located at the top inside of the rear gate.

MEMO

WIPER AND WASHER SYSTEMS



	Page
1. Front Wiper and Washer	2
2. Rear Wiper and Washer	6
3. Windshield Wiper Deicer	7

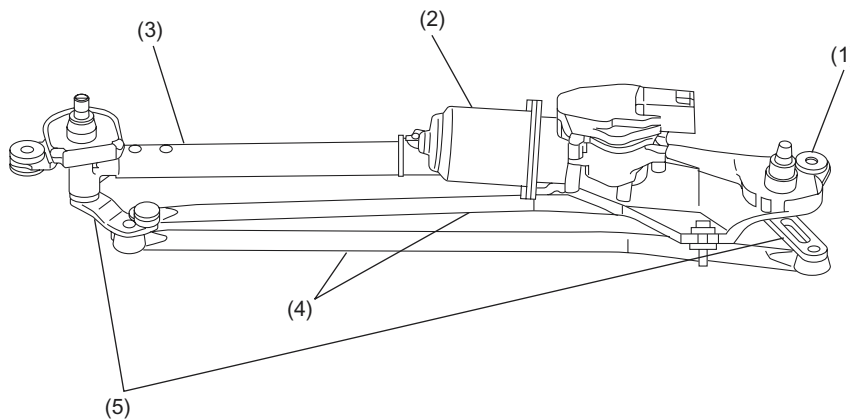
FRONT WIPER AND WASHER

1. Front Wiper and Washer

A: DESCRIPTION

1. FRONT WIPER

- 1) The front wiper is of a tandem type featuring wide wiping area. The blade is installed to the arm by means of U-hook joint to improve serviceability.
- 2) The front wiper operates in the HI and LOW speed modes and the INTERMITTENT mode. The operation modes can be selected by turning the wiper switch incorporated in the combination switch.
- 3) In the INTERMITTENT mode, the intermittent unit installed behind the combination switch controls the front wiper operation interval.
- 4) The front wiper system uses a modular construction in which the wiper motor forms an integral part of the linkage. The motor is installed on the body through rubber mounting.

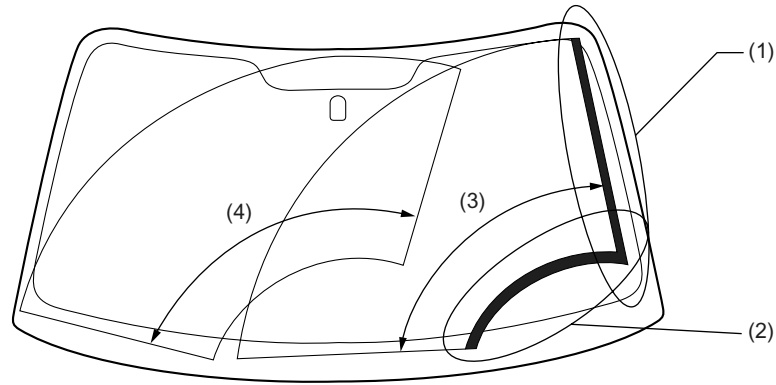


WW-00096

- | | | |
|-----------------|---------------|----------|
| (1) Sleeve | (3) Main pipe | (5) Link |
| (2) Wiper motor | (4) Rod | |

FRONT WIPER AND WASHER

5) The driver's side wiper blade is elongated by 25 mm (1 in) to reduce the not wiped area at the bottom of the windshield. Also, the rigidity of the wiper assembly is increased by modularizing the wiper system and this contributes to reducing the not wiped area near the front pillar.

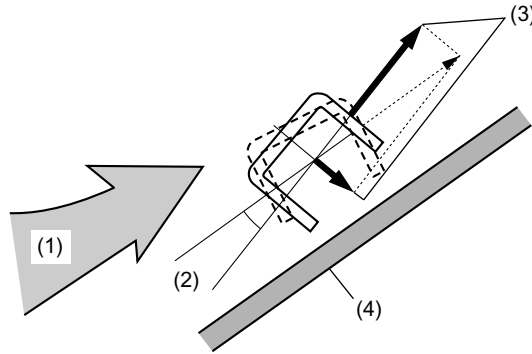


WW-00042

- (1) Rigidity is increased by modularizing the wiper assembly contributing to reduce the not wiped area.
- (2) Not wiped area is reduced by elongating the wiper blade.
- (3) 80°
- (4) 92.8°

FRONT WIPER AND WASHER

6) The driver's side wiper arm is angled to disperse the force applied to the wiper arm by the air flow. A part of the dispersed force acts to press the wiper blade against the windshield helping to prevent the wiper blade being lifted up.



WW-00043

- (1) Air flow
- (2) Angle of twist

- (3) Dispersed force
- (4) Windshield

FRONT WIPER AND WASHER

2. FRONT WASHER SYSTEM

- 1) The washer system consists of a washer tank, motor and pump unit, and a pair of nozzles.
- 2) The washer tank is installed at the front of the strut mount on the left side of the engine compartment.
- 3) The motor and pump unit for the washer is installed at the bottom of the washer tank.
- 4) The washer nozzles are installed on the hood. Each nozzle has two spray holes.
- 5) Each washer nozzle is provided with a check valve which is located just below it.

3. SPECIFICATIONS

Washer tank	Capacity	4.0 L (4.2 US qt, 3.5 Imp qt)		
Wiper motor	Rated voltage	12 V		
	No-load current	4 A or less		
	Speed at 2.0 N·m (20 kg-cm, 17 in-lb)	HIGH	66 ± 6 rpm	
		LOW	43 ± 5 rpm	
	Locked rotor characteristics	HIGH	Torque	29.4 N·m (300 kg-cm, 2.2 ft-lb) or more
			Current	36.0 A or less
LOW		Torque	34.3 N·m (350 kg-cm, 2.5 ft-lb)	
		Current	31.5 A or less	
Wiper blade	Length	Driver side	550 mm (21.65 in)	
		Passenger side	475 mm (18.70 in)	

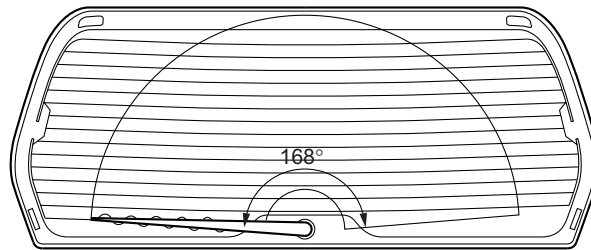
REAR WIPER AND WASHER

2. Rear Wiper and Washer

A: DESCRIPTION

1. REAR WIPER

- 1) The rear wiper operates intermittently at a 10-second interval.
- 2) The rear wiper operates over a 168° angle.



WW-00039

2. REAR WASHER SYSTEM

- 1) The same washer tank is shared by the front and rear washer systems.
- 2) The motor and pump unit for the rear washer is installed at the bottom of the washer tank, adjacent to the front washer's unit.
- 3) The washer nozzle is installed on the upper portion of rear gate panel. The nozzle has two spray holes.
- 4) The washer nozzle is provided with a check valve which is located just below it.

3. SPECIFICATIONS

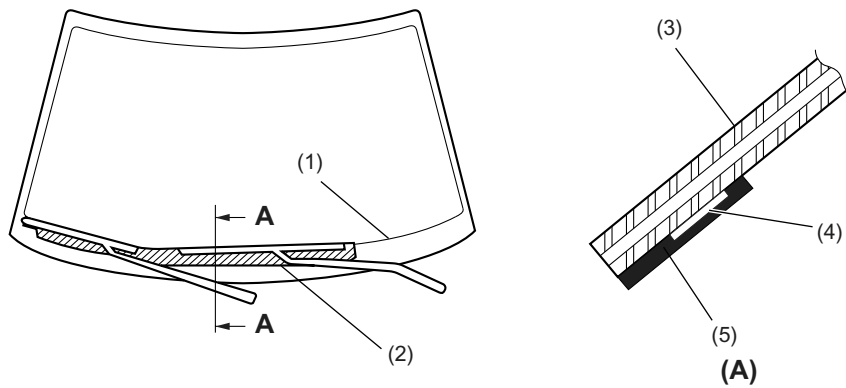
Wiper motor	Rated voltage	12 V
	No-load current	2 A or less
	Speed at 0.5 N·m (5 kg-cm, 4.3 in-lb)	25 rpm or more
	Locked rotor current	13 A or less
Wiper blade	Length	375 mm (14.76 in)

3. Windshield Wiper Deicer

A: CONSTRUCTION

The wiper deicer system is activated when the wiper deicer switch is pressed with the ignition switch turned ON. The system heats the lower part of the windshield with a heater wire to melt the ice that blocks the wiper blades.

The system turns off automatically in 15 minutes after the wiper deicer switch is turned ON.



WW-00108

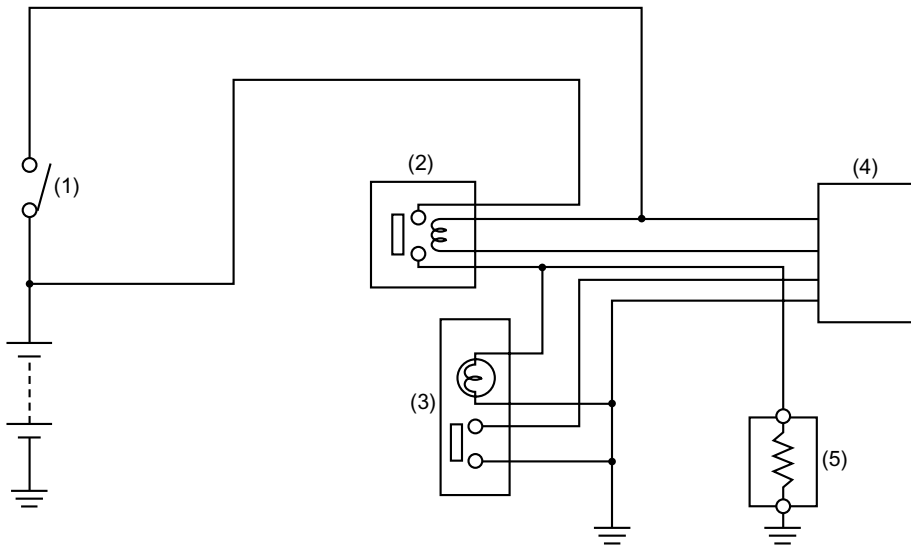
- (1) Printed ceramic
- (2) Heating area of wiper deicer
- (3) Windshield

- (4) Wiper deicer heater wire
- (5) Printed ceramic
- (A) Section A-A

WINDSHIELD WIPER DEICER

Wiper and Washer Systems

B: CIRCUIT DIAGRAM



WW-00041

- (1) Ignition switch
- (2) Wiper deicer relay

- (3) Wiper deicer switch
- (4) Timer

- (5) Wiper deicer

ENTERTAINMENT SYSTEM *ET*

	Page
1. Audio System	2

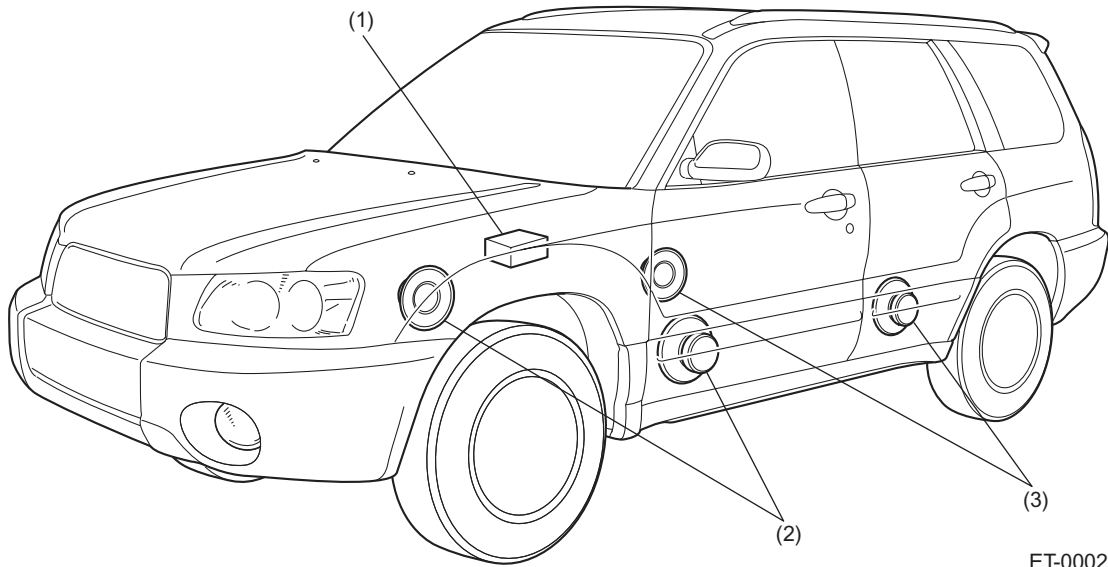
AUDIO SYSTEM

Entertainment System

1. Audio System

A: DESCRIPTION

- The audio unit is either a 2-DIN type or 1-DIN type depending on the model grade.
- A four speaker system consisting of two front speakers and two rear speakers is used.



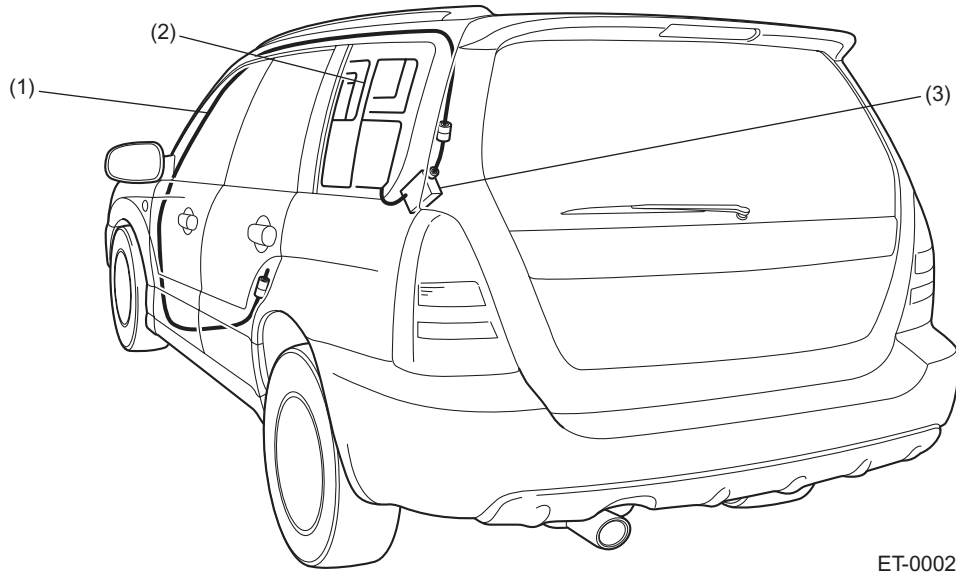
(1) Audio unit

(2) Front speakers

(3) Rear speakers

1. ANTENNA

- An on-glass antenna is equipped on all models.
- The antenna amplifier is installed at the bottom of the rear left pillar.



ET-00021

(1) Feeder cable

(2) On-glass antenna

(3) Antenna amplifier

AUDIO SYSTEM

Entertainment System

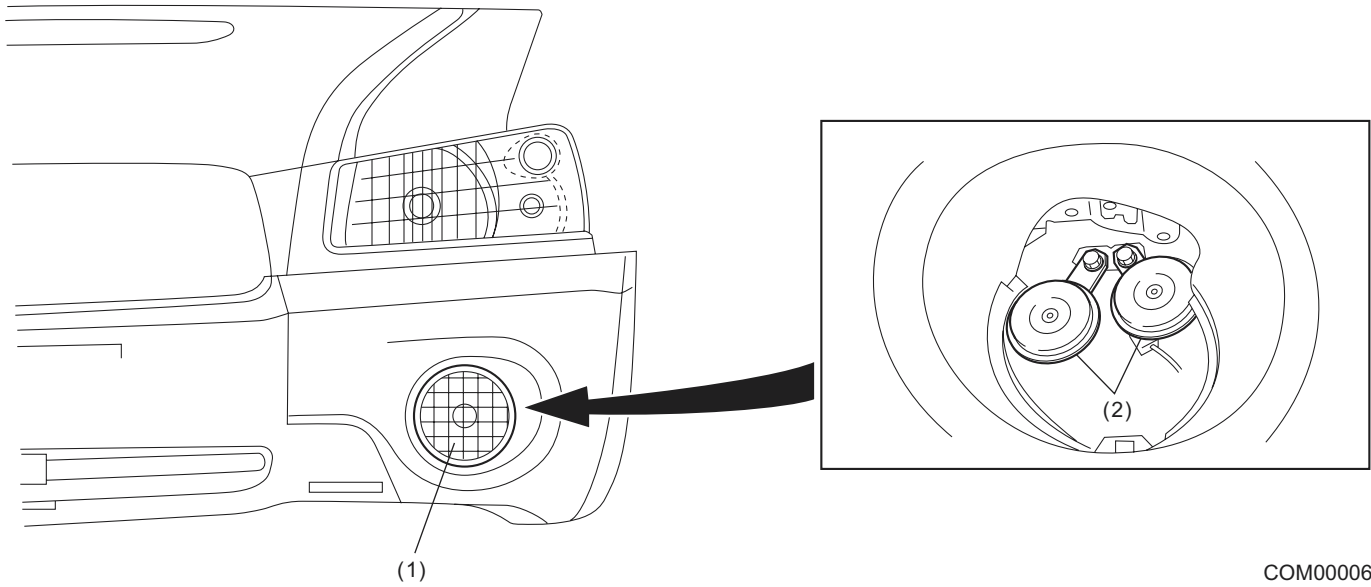
MEMO

COMMUNICATION SYSTEM *COM*

	Page
1. Horn	2

1. Horn

A: DESCRIPTION



COM00006

- (1) Front fog light
- (2) Horn

To minimize damage of other parts in a slight collision, the horn is installed behind the left front fog light.

GLASS/WINDOWS/MIRRORS **GW**

	Page
1. Power Window	2
2. Windshield	4
3. Front Door Glass	5

POWER WINDOW

Glass/Windows/Mirrors

1. Power Window

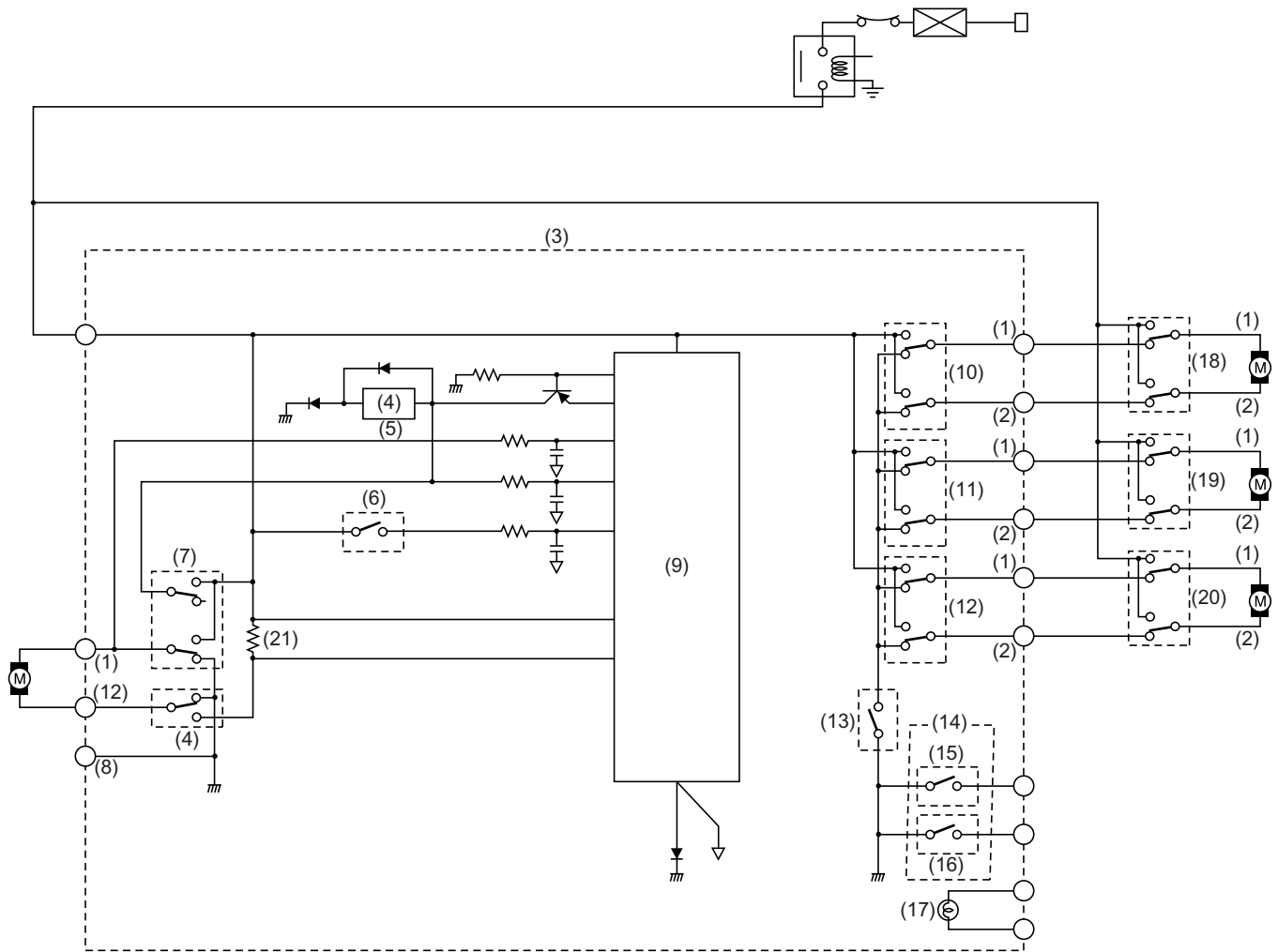
A: CONSTRUCTION

- The power window system consists of regulator motors and switches for individual doors, relays and a circuit breaker unit.
- Each door window opens/closes by pushing down/pulling up the switch.
- Only the driver's door window switch has a 2-stage mechanism:
 - When the switch is pushed lightly and held in the pushed position, the window continues to lower until the switch is released.
 - When the switch is pushed down fully, the window lowers to the end position automatically.

NOTE:

For the sake of safety, the power window system is designed to operate only when the ignition switch is in the ON position.

B: CIRCUIT DIAGRAM



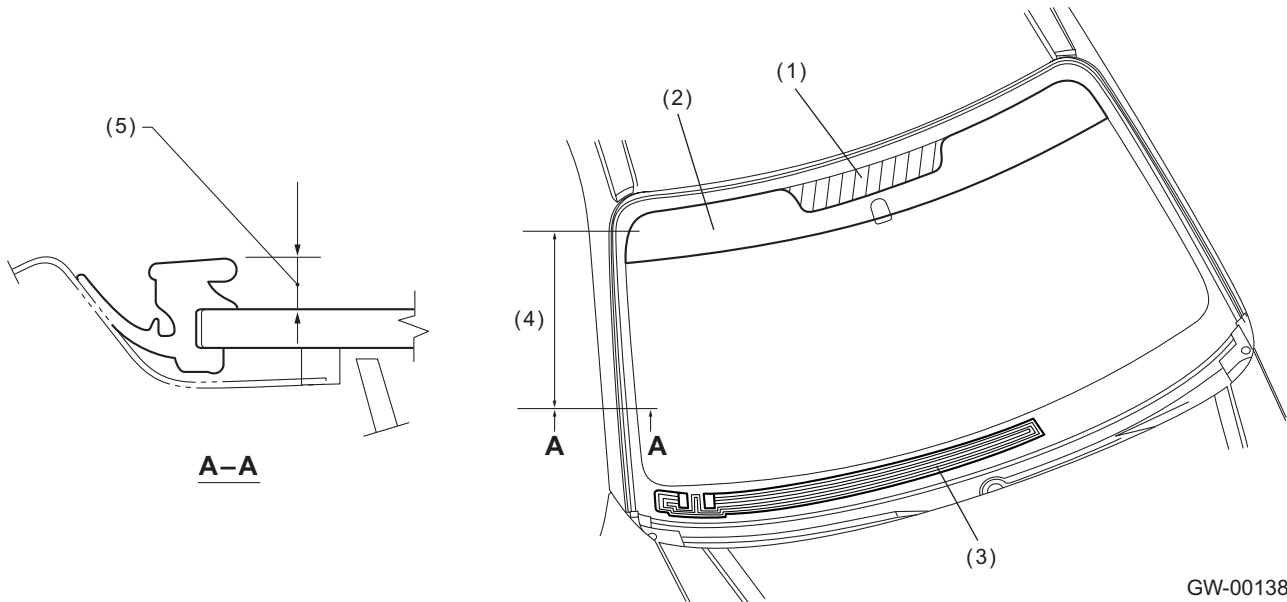
GW-00058

- | | |
|------------------------------|------------------------------------|
| (1) Up | (12) Rear right |
| (2) Down | (13) Power window lock |
| (3) Power window main switch | (14) Door lock |
| (4) Down relay | (15) Unlock |
| (5) Relay 1 | (16) Lock |
| (6) Auto down switch | (17) Lamp 1 |
| (7) Switch 1 | (18) Assistant's switch |
| (8) Ground | (19) Rear left passenger's switch |
| (9) Auto circuit | (20) Rear right passenger's switch |
| (10) Assistant's | (21) Current detection resistance |
| (11) Rear left | |

WINDSHIELD

2. Windshield

- To improve shading, a ceramic visor is printed on the upper center area of the windshield where cannot be shaded with the sun visors.
- A shading band is provided at the top of the windshield on all models.
- A wiper deicing system is provided at the bottom of the windshield on some models to prevent freezing of the wipers.
- Rain flowing from both sides of the windshield to the door windows are minimized by changing the height of the drip guides at the roof area and the center area of the pillars.

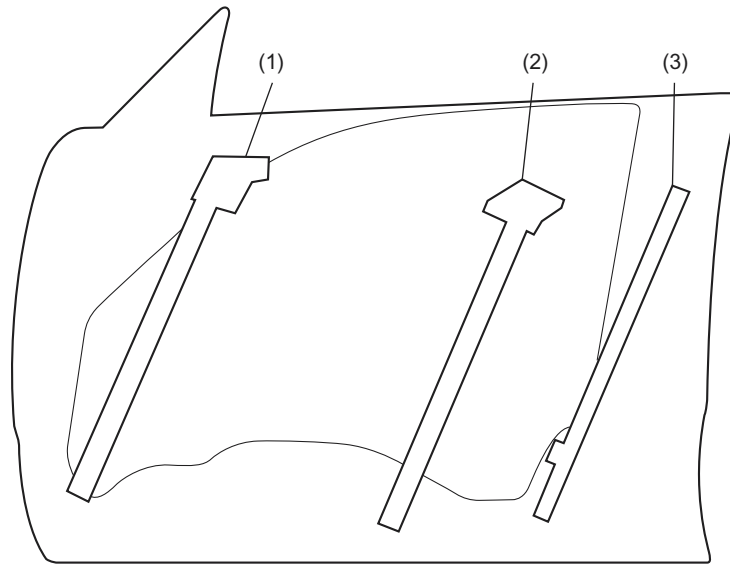


GW-00138

- (1) Ceramic visor
- (2) Shading band
- (3) Wiper deicer
- (4) Drip guide height difference
- (5) Drip guide height is 3.5 mm (0.14 in) from the roof.

3. Front Door Glass

The rear sash of the front door glass regulator is moved to a forward position and a guide rail is added. Thus, vibration caused by opening and closing the door is reduced while the passenger protecting ability in case of a side collision is enhanced.



GW-00059

(1) Front sash

(2) Rear sash

(3) Guide rail

FRONT DOOR GLASS

Glass/Windows/Mirrors

MEMO

BODY STRUCTURE *BS*

Page

Refer to G8071GZ SUPPLEMENT for this section.

MEMO

INSTRUMENTS/DRIVER INFO *IDI*

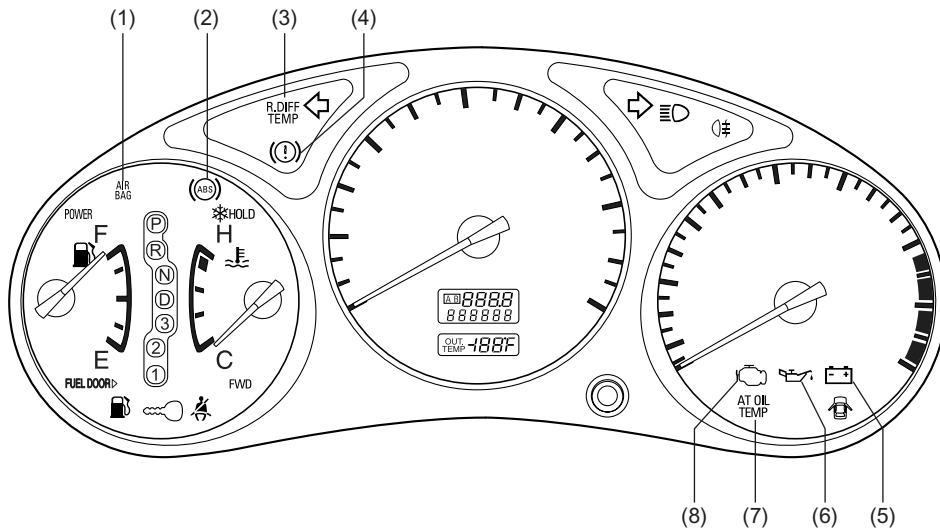
	Page
1. Combination Meter	2
2. Outside Air Temperature Display	15

COMBINATION METER

Instruments/Driver Info

1. Combination Meter

A: WARNING AND INDICATOR LIGHTS



IDI00025

- (1) AIR BAG system warning light
This warning light illuminates when a fault occurs in the airbag system.
- (2) ABS warning light
This warning light illuminates when a fault occurs in any electrical component of the ABS (Anti-lock Brake System).
- (3) Brake fluid level warning / parking brake indicator light
This light illuminates when the fluid level in the brake reservoir tank lowers below the specified level and/or when the parking brake is applied.
- (4) Rear differential oil temperature warning light
This light illuminates when the rear differential oil temperature exceeds 150°C (302°F).
- (5) Charge warning light
This warning light illuminates when a fault occurs in the charging system while the engine is running.
- (6) Oil pressure warning light
This warning light illuminates when the engine oil pressure decreases below 14.7 kPa (0.15 kgf/cm², 2.1 psi).
- (7) AT oil temperature warning light
This warning light illuminates when the ATF temperature exceeds 140°C (284°F); it blinks when a fault occurs in the AT control system.
- (8) CHECK ENGINE warning light
This warning light illuminates when a fault occurs in the MFI (Multiple point Fuel Injection) system.

COMBINATION METER

Instruments/Driver Info

If everything is normal, the warning and indicator lights should be ON or OFF as shown below according to ignition switch positions.

Warning/Indicator light		Ignition switch position			
		LOCK/ACC	ON	ST	While engine is running
(1)	AIR BAG	OFF	*1	*1	*1
(2)	ABS	OFF	*2	*2	*2
(3)	Brake fluid level / parking brake	OFF	ON	ON	*3
(4)	Rear differential oil temperature	OFF	ON	ON	OFF
(5)	Charge	OFF	ON	ON	OFF
(6)	Oil pressure	OFF	ON	ON	OFF
(7)	AT oil temperature	OFF	ON	ON	OFF
(8)	CHECK ENGINE	OFF	ON	ON	OFF

*1: This warning light comes ON for about 6 seconds, and then goes out.

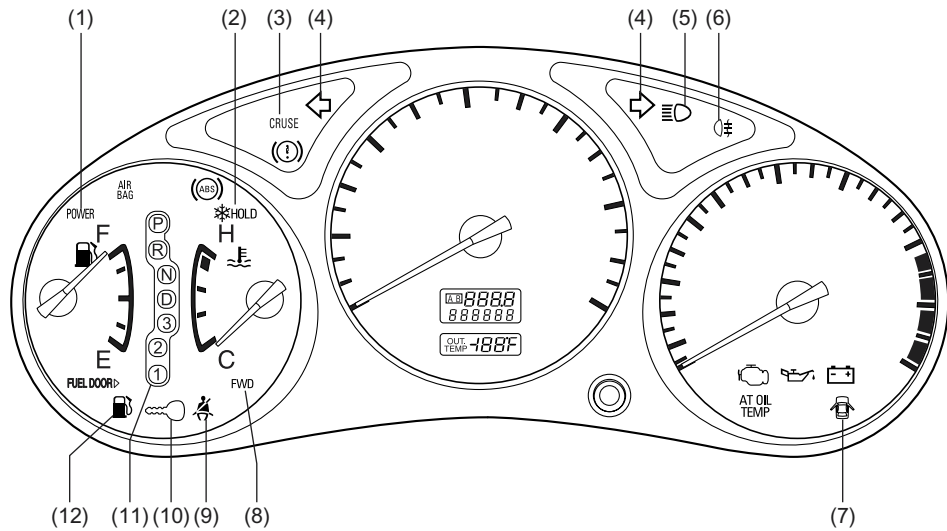
*2: This warning light comes ON for about 2 seconds, and then goes out.

*3: This warning light comes ON when the parking brake is applied.

COMBINATION METER

Instruments/Driver Info

B: TELLTALE (GRAPHIC MONITOR)



IDI00026

- (1) **POWER indicator light**
This light illuminates when the transmission is in POWER mode.
- (2) **HOLD indicator light (AT model)**
This light illuminates when the transmission is in HOLD mode.
LO indicator light (MT model)
This light illuminates when the dual range selector lever is in LO position.
- (3) **Cruise indicator light (Vehicles for Australia)**
This light illuminates when the cruise control main switch is turned ON.
- (4) **Turn signal indicator light**
This light blinks in unison with the corresponding turn signal lights when the turn signal switch or hazard warning switch is operated.
- (5) **High beam indicator light**
This light illuminates when the headlights are in the high-beam position.
- (6) **Rear fog light indicator light**
This light illuminates when the rear fog light is ON.
- (7) **Door open warning light**
This light illuminates when one or more doors and/or rear gate are not completely closed.
- (8) **FWD indicator light (AT model)**
This light illuminates when the drive mode is changed from AWD to FWD (with the fuse installed in the FWD switch).
- (9) **Seat belt warning light**
This light stays illuminated for about 6 seconds after the ignition switch has been turned ON. (Vehicles for Saudi Arabia)
This light illuminates when the driver's seat belt is not fastened while the ignition switch is in the ON position. (Vehicles for Australia)
- (10) **Immobilizer indicator light**
This light illuminates when the immobilizer system is armed.
- (11) **Shift position indicator**
The light corresponding to the present AT select lever position illuminates when the ignition switch is in any position other than ACC and LOCK.
- (12) **Low fuel warning light**
This light illuminates when the quantity of the fuel remaining in the tank has decreased to about 9 liters (2.4 US gal, 2.0 Imp gal) or smaller.

COMBINATION METER

If everything is normal, the telltales should be ON, OFF or in other states as shown below according to ignition switch positions.

Telltale light		Ignition switch position				
		LOCK/ACC	ON	ST	While engine is running	
(1)	POWER	OFF	ON	*5	*5	
(2)	HOLD	OFF	*6	*6	*6	
	LO	• Low range	OFF	ON	ON	ON
		• High range	OFF	OFF	OFF	OFF
(3)	Cruise	OFF	*4	*4	*4	
(4)	Turn signal	*8	Blink	Blink	Blink	
(5)	High beam	• High beam	OFF	ON	ON	ON
		• Low beam	OFF	OFF	OFF	OFF
(6)	Rear fog light	OFF	*7	*7	*7	
(7)	Door or rear gate open	• Open	ON	ON	ON	ON
		• Shut	OFF	OFF	OFF	OFF
(8)	FWD	• FWD	OFF	ON	ON	ON
		• AWD	OFF	OFF	OFF	OFF
(9)	Seat belt	OFF	*2	*2	*2	
(10)	Immobilizer	*3	OFF	OFF	OFF	
(11)	Shift position	OFF	ON	ON	ON	
(12)	Low fuel	OFF	*1	*1	*1	

*1: This light illuminates when the quantity of the fuel remaining in the tank has decreased to about 9 liters (2.4 US gal, 2.0 Imp gal) or smaller.

*2: This light stays illuminated for about 6 seconds after the ignition switch has been turned ON. (Vehicles for Saudi Arabia)

This light illuminates when the driver's seat belt is not fastened. (Vehicles for Australia)

*3: This light illuminates when the immobilizer system is armed.

*4: This light illuminates when the cruise control main switch is turned ON.

*5: This light illuminates when the automatic transmission is in POWER mode.

*6: This light illuminates when the automatic transmission is in HOLD mode.

*7: This light illuminates when the rear fog light is ON.

*8: This light blinks when the hazard switch is turned ON.

COMBINATION METER

C: SPEEDOMETER

1. DESCRIPTION

- The speedometer system is an electrical type that uses electric signals from the speed sensor in the MT model or the transmission control module (TCM) in the AT model.
- The vehicle speed sensor is installed on the manual transmission.
- Since the system does not use mechanical components such as rotating cable, there are no opportunities of occurring such problems as meter needle vibration and cable disconnection. Also, it does not constitute any means of mechanical noise transmission.
- The odometer and tripmeter readings appear on a liquid crystal display (LCD).

2. OPERATION

MT model: The vehicle speed sensor sends vehicle speed signals (4 pulses per rotation of speed sensor's driven shaft) to the speedometer drive circuit and odometer/tripmeter drive circuit in the speedometer.

AT model: The TCM sends vehicle speed signals (4 pulses per rotation of output shaft) to the speedometer drive circuit and odometer/tripmeter drive circuit in the speedometer.

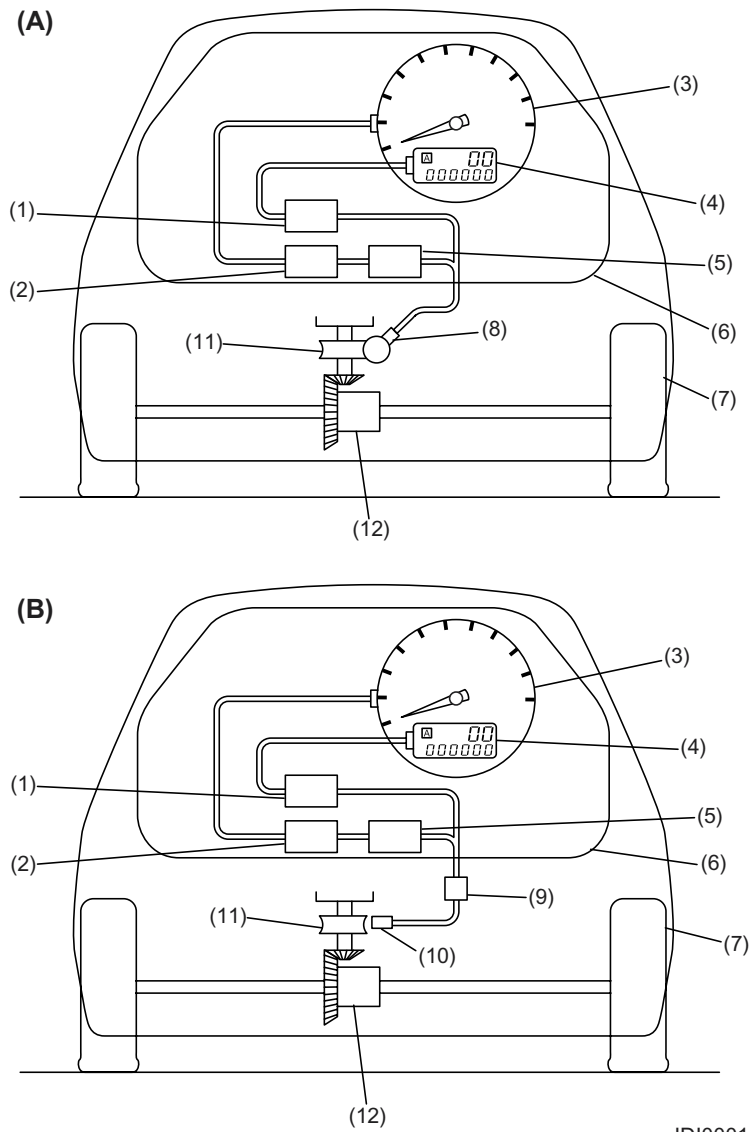
NOTE:

Signals from the speed sensor or TCM are also used by the engine control module, automatic transmission control module, etc.

3. SPECIFICATIONS

Speedometer	Type	Electric pulse type
	Indication	Needle points to 60 km/h (37.3 mph) when 2,548 pulses are input per minute.
Odometer	Type	Pulse count type
	Display	LCD/6 digits; 0 to 999,999 km (mile).
	Indication	Counts up 1 km per 2,548 pulses (1 mile per 4,104 pulses). (Count down is impossible.)
Tripmeter	Type	Pulse count type
	Display	LCD/4 digits; 0 to 999.9 km (mile) or 1,000 to 9,999 km (mile).
	Indication	Counts up 1 km per 2,548 pulses (1 mile per 4,104 pulses). (To change the tripmeter from A to B or B to A, push the knob momentarily. To return the tripmeter to zero indication, keep the knob pushed for more than 1 second.)

4. SYSTEM DIAGRAM



IDI00012

(A) MT model

(B) AT model

(1) Odometer/tripmeter drive circuit

(2) Speedometer movement

(3) Speedometer

(4) Odometer/tripmeter

(5) Speedometer drive circuit

(6) Combination meter

(7) Front wheel

(8) Speed sensor

(9) TCM

(10) Electromagnetic pick-up

(11) Gear for the speed sensor

(12) Differentials

COMBINATION METER

Instruments/Driver Info

D: VEHICLE SPEED SENSOR

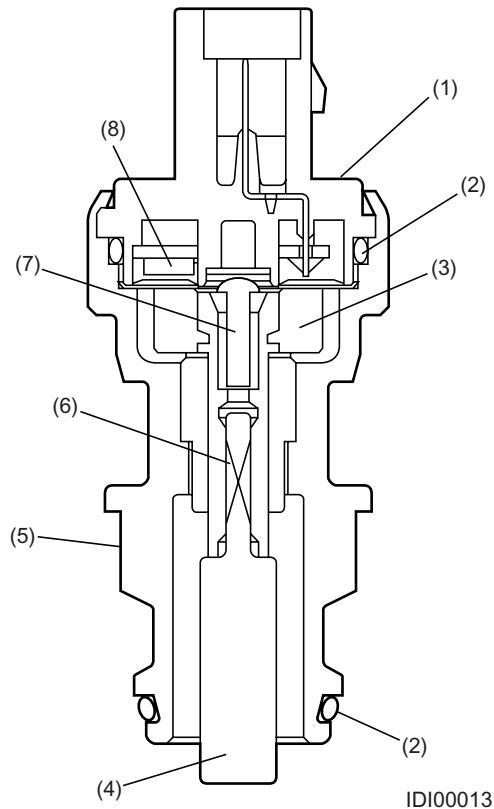
The vehicle speed sensor uses a Hall IC pick-up to generate speed signals (MT model).

This sensor is installed on the transmission case and detects rotating speed of the transmission output gear.

The sensor generates 4 pulses per rotation of the speed sensor driven shaft and send them to the speedometer.

1. CONSTRUCTION

The speed sensor mainly consists of a Hall IC, magnet ring, driven shaft and spring.



- (1) Upper case
- (2) O-ring
- (3) Magnet ring

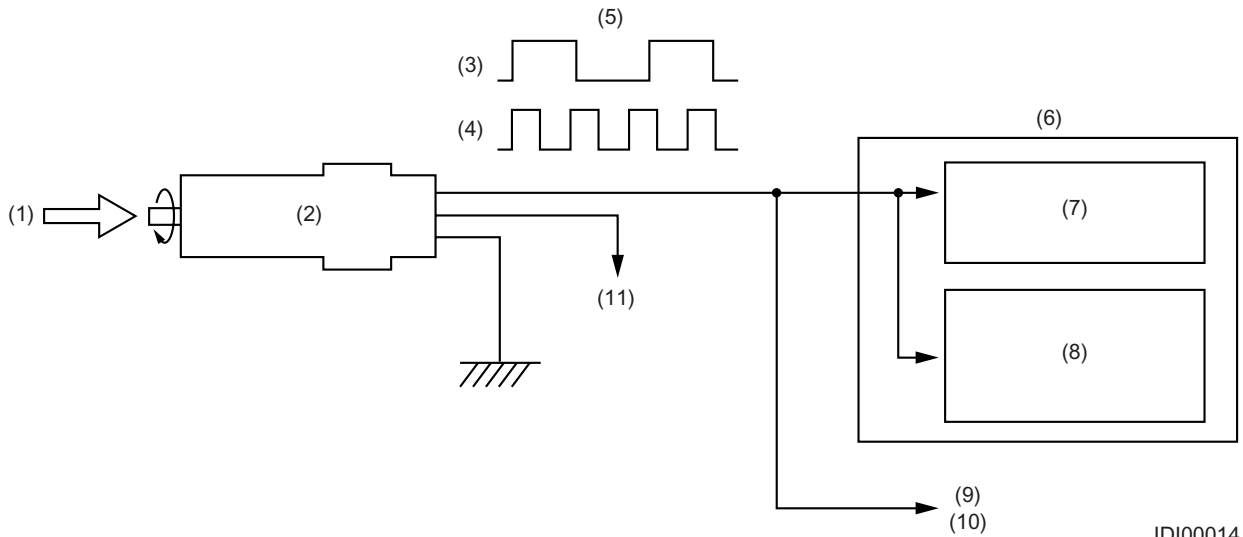
- (4) Driven key
- (5) Lower case
- (6) Driven shaft

- (7) Rivet
- (8) Hall IC

2. OPERATION

As the driven key rotates, the magnet turns causing the magnetic field of the Hall IC to change. The Hall IC generates a signal that corresponds to a change in the magnetic field.

One turn of the driven key in the speed sensor sends 4 pulses to the combination meter, engine control module and cruise control module.



IDI00014

- (1) Revolution of transmission output gear
- (2) Vehicle speed sensor
- (3) Low speed
- (4) High speed
- (5) Signal (4 pulses per revolution)
- (6) Combination meter

- (7) Speedometer drive circuit
- (8) Odometer and tripmeter drive circuit
- (9) Engine control module
- (10) Cruise control module
- (11) Ignition switch

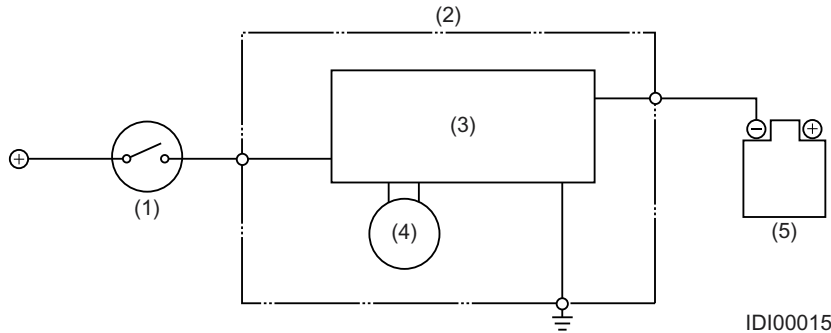
COMBINATION METER

E: TACHOMETER

The tachometer drive circuit is connected to the engine speed sensing circuit in the engine control module.

When the engine speed increases or decreases, the voltage of the circuit also increases or decreases, changing the magnetic force of the tachometer drive coil.

The tachometer needle then moves in accordance with change in the engine speed.

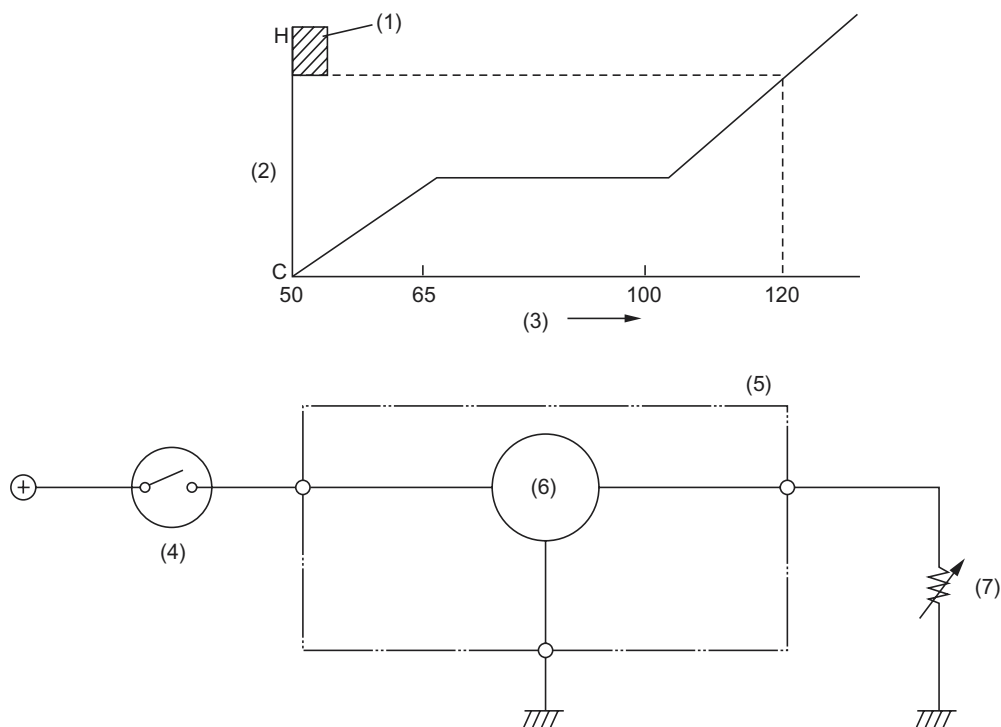


- (1) Ignition switch
- (2) Combination meter
- (3) Tachometer drive circuit

- (4) Tachometer
- (5) ECM

F: WATER TEMPERATURE GAUGE

- The water temperature gauge is a cross-coil type.
- The water temperature signal is sent from the water temperature sensor located on the engine.
- The resistance of the water temperature sensor changes according to the engine coolant temperature. Therefore, the current sent to the water temperature gauge also changes according to the engine coolant temperature. As the change in current causes the magnetic force of the coil to change, the gauge's needle moves according to the engine coolant temperature.
- When the coolant is at a normal operating temperature of approx. 70 to 100°C (158 to 212°F), the gauge's needle stays in the middle of the indication range as shown below.



IDI00016

- | | |
|----------------------|------------------------------|
| (1) Red zone | (5) Combination meter |
| (2) Indication | (6) Water temperature gauge |
| (3) Temperature (°C) | (7) Water temperature sensor |
| (4) Ignition switch | |

COMBINATION METER

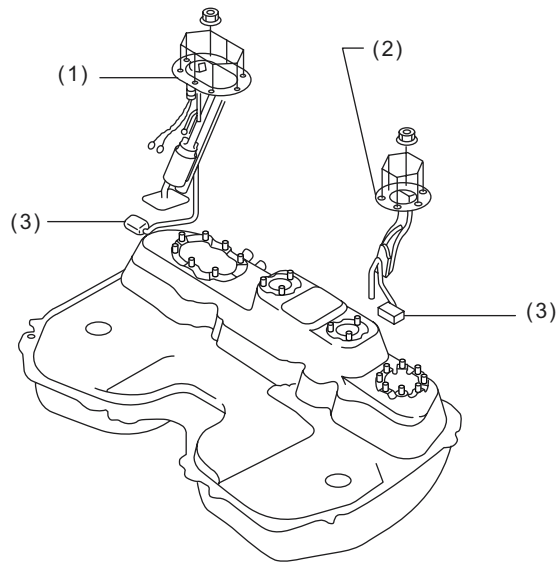
Instruments/Driver Info

G: FUEL GAUGE

1. GENERAL

- The fuel gauge unit consists of a float and a potentiometer whose resistance varies depending on movement of the float. It is located inside the fuel tank and forms an integral part of the fuel pump. The fuel gauge indicates the fuel level in the tank even when the ignition switch is in the LOCK position.

- All models are equipped with two fuel level sensors. These sensors are installed in the fuel tank, one on the right side and the other on the left side. Two sensors are necessary because the fuel tank is divided into main and sub tank compartments.



IDI00017

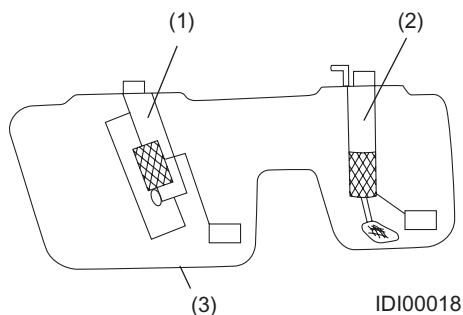
- (1) Main fuel level sensor
- (2) Sub fuel level sensor
- (3) Float

2. OPERATION

The low fuel warning light operates as follows:

The combination meter CPU continually monitors the resistance signal from the fuel level sensor. It turns on the low fuel warning light if a resistance value corresponding to the critical fuel level (approx. 78Ω) is detected successively for about 10 minutes or the period spent for driving a distance of 10 km.

This monitoring time has been decided to avoid false operation of the warning light which may happen when a large part of remaining fuel is collected temporarily in the sub tank compartment.



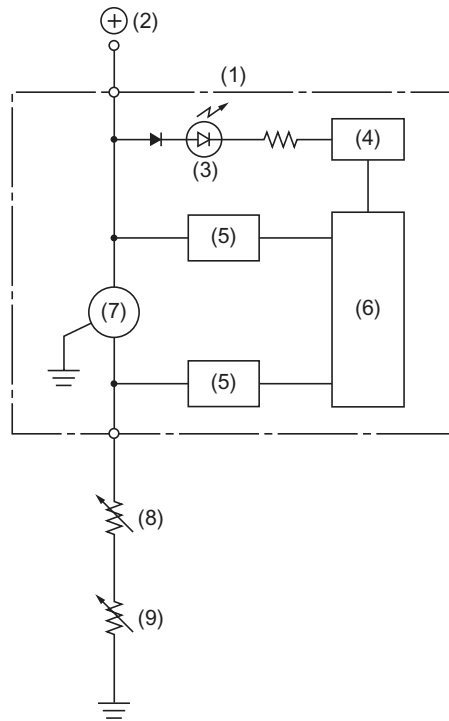
- (1) Main fuel level sensor
- (2) Sub fuel level sensor
- (3) Fuel tank

3. SPECIFICATIONS

	Fuel amount	Resistance
Main fuel level sensor	FULL	0,5–2,5 Ω
	1/2	20,7–24,7 Ω
	EMPTY	50,0–52,0 Ω
Sub fuel level sensor	FULL	0,5–2,5 Ω
	1/2	19,5–23,5 Ω
	EMPTY	42,0–44,0 Ω

COMBINATION METER

4. CIRCUIT DIAGRAM



IDI00019

- | | |
|----------------------------|----------------------------|
| (1) Combination meter | (6) CPU |
| (2) Ignition | (7) Fuel gauge |
| (3) Low fuel warning light | (8) Sub fuel level sensor |
| (4) Driver | (9) Main fuel level sensor |
| (5) I/F | |

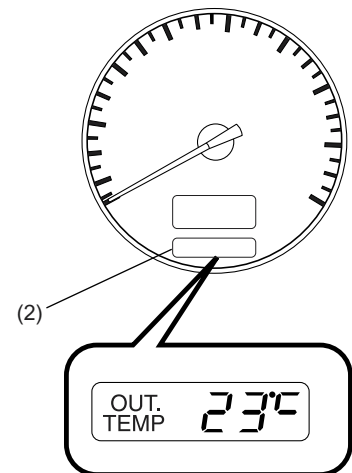
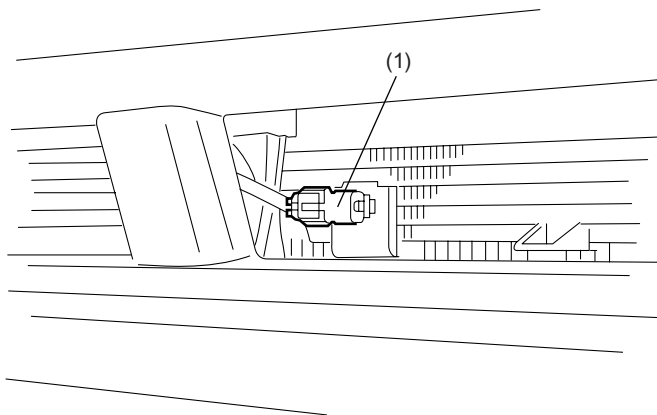
2. Outside Air Temperature Display

A: CONSTRUCTION

The outside air temperature display system consists of an ambient sensor, the CUSTOM CPU and a liquid crystal display installed in the combination meter. The ambient sensor detects the outside air temperature using the built-in thermistor which varies its resistance according to change in ambient temperature, and sends signals to the CUSTOM CPU.

As soon as the ignition switch is turned ON, the CUSTOM CPU compares the temperature data sent from the ambient sensor with the one that was stored in its memory when the ignition switch was turned OFF last time and it causes the lower of the temperatures to be displayed. However, if 60 minutes or more time has passed between the last turning OFF and the next turning ON of the ignition switch, the temperature that is displayed is a sensor-provided temperature.

When the vehicle is running slowly, the heat released from the engine compartment raises the temperature of the air around the ambient sensor and this affects the temperature data the sensor sends to the CUSTOM CPU. The CPU then makes a special control using the vehicle speed data, i.e., when the vehicle is running at a speed slower than 10 km/h, the CPU uses the temperature that was detected during the most recent vehicle's movement at a speed exceeding 10 km/h rather than a temperature currently being provided by the ambient sensor.



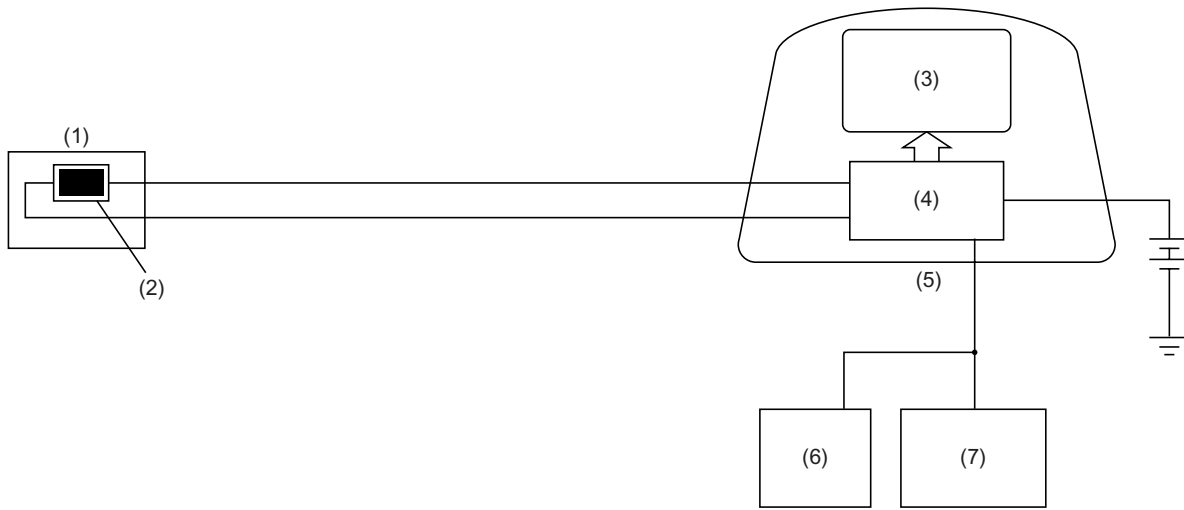
IDI00020

- (1) Ambient sensor
- (2) Outside air temperature display

OUTSIDE AIR TEMPERATURE DISPLAY

Instruments/Driver Info

B: CIRCUIT DIAGRAM



IDI00021

- (1) Ambient sensor
- (2) Thermistor
- (3) Outside air temperature display
- (4) CUSTOM CPU

- (5) Combination meter
- (6) Vehicle speed sensor (MT)
- (7) Transmission control module (AT)

SEATS *SE*

	Page
1. Front Seat	2
2. Rear Seat	5

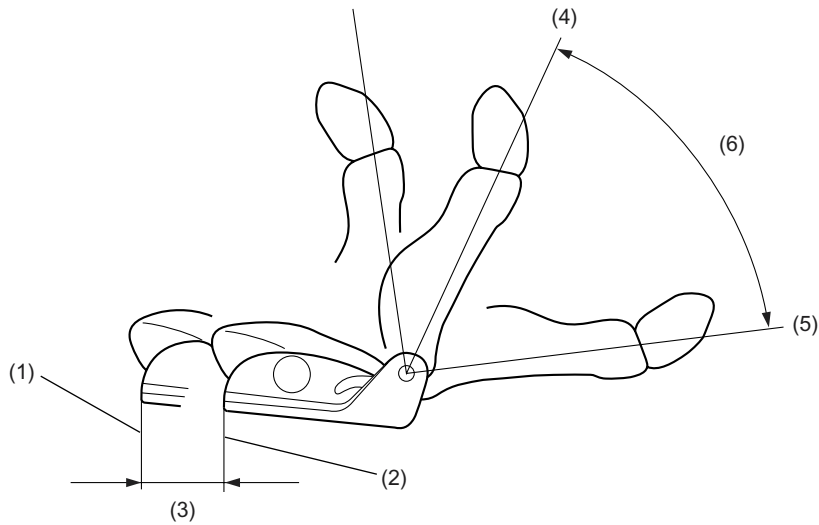
FRONT SEAT

Seats

1. Front Seat

A: ADJUSTMENT

- The height of each headrest is adjustable to any of the 3 positions available.
- The angle of each backrest is adjustable to any of the 40 positions available at 2° steps.
- The front seat can be slid back and forth to one of the 16 positions available at 13.5 mm (0.53 in) steps.



SE-00034

(1) 1st position
(2) 17th position

(3) 16 x 13.5 mm (0.53 in)
(4) 1st position

(5) 33rd position
(6) 40 x 2°

B: HEIGHT ADJUSTER

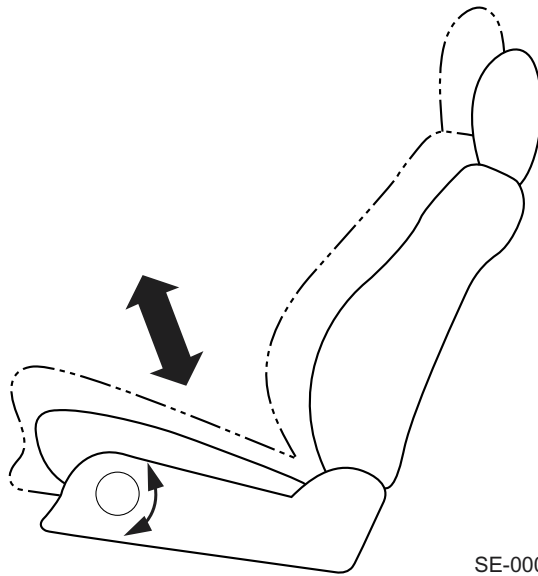
The driver's seat is provided with a height adjuster. This adjuster allows adjusting the seat height within a range of 50 mm (2 in).

1. LHD MODELS

Both the seat cushion and backrest rise when the lifter knob is turned counterclockwise; they lower when the knob is turned clockwise.

2. RHD MODELS

Both the seat cushion and backrest rise when the lifter knob is turned clockwise; they lower when the knob is turned counterclockwise.

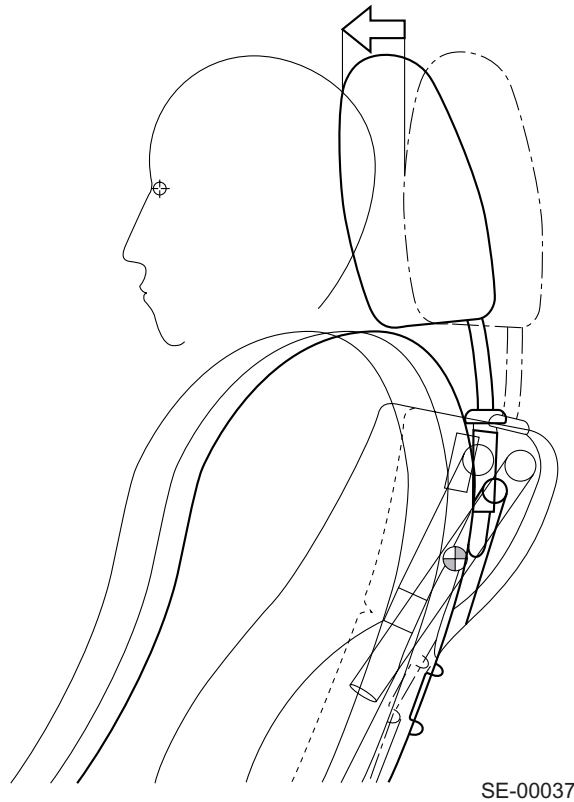
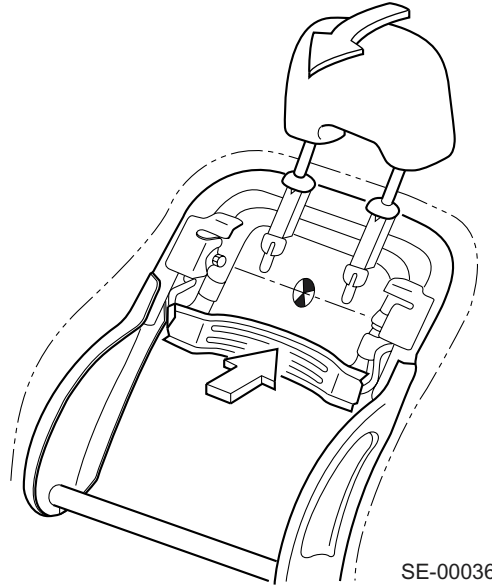


FRONT SEAT

Seats

C: ACTIVE HEAD REST

In case of rear-end collision, the head rest moves forward to immediately support the passenger's head to reduce the possibility of injury to the neck.

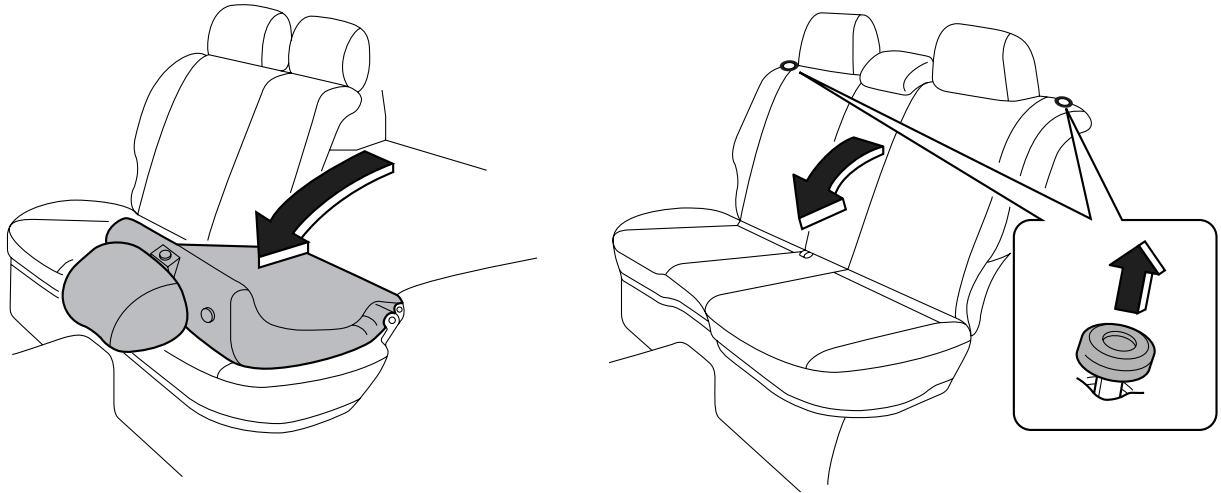


- 1) In case of rear-end collision, the passenger's body will move rearward by the impact.
- 2) When the body moves rearward, the thrust receiving plate inside the seat is pressed in.
- 3) When the thrust receiving plate is pressed in, the head rest moves forward due to a levering action.

2. Rear Seat

A: OPERATION

Unlock the seatback by pulling the release knob and then fold the seatback down.



SE-00038

REAR SEAT

Seats

MEMO

SECURITY AND LOCKS *SL*

	Page
1. Ignition Switch	2
2. Power Door Lock (Vehicles without Double Lock)	3
3. Power Door Lock (Vehicles with Double Lock)	4
4. Keyless Entry System (Vehicles without Double Lock)	6
5. Keyless Entry System (Vehicles with Double Lock)	8
6. Immobilizer System	9

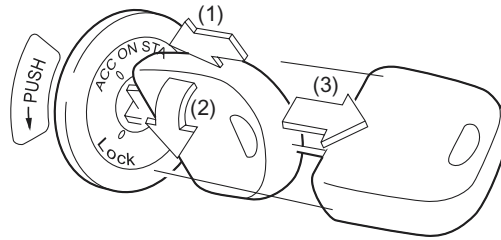
IGNITION SWITCH

1. Ignition Switch

A: GENERAL

1. IGNITION SWITCH

- The ignition switches on the MT models have a safety mechanism that prevents inadvertent locking of the steering wheel during driving. The driver cannot turn the ignition key from “ACC” to “LOCK” unless the key is pushed inward at the “ACC” position (arrow 1 in the drawing below).



SL-00031

2. KEY REMINDER CHIME

The reminder chime sounds when the driver's door opens and the ignition key is in the “LOCK” or “ACC” position. The chime stops when the key is removed from the ignition switch.

3. IGNITION SWITCH ILLUMINATION

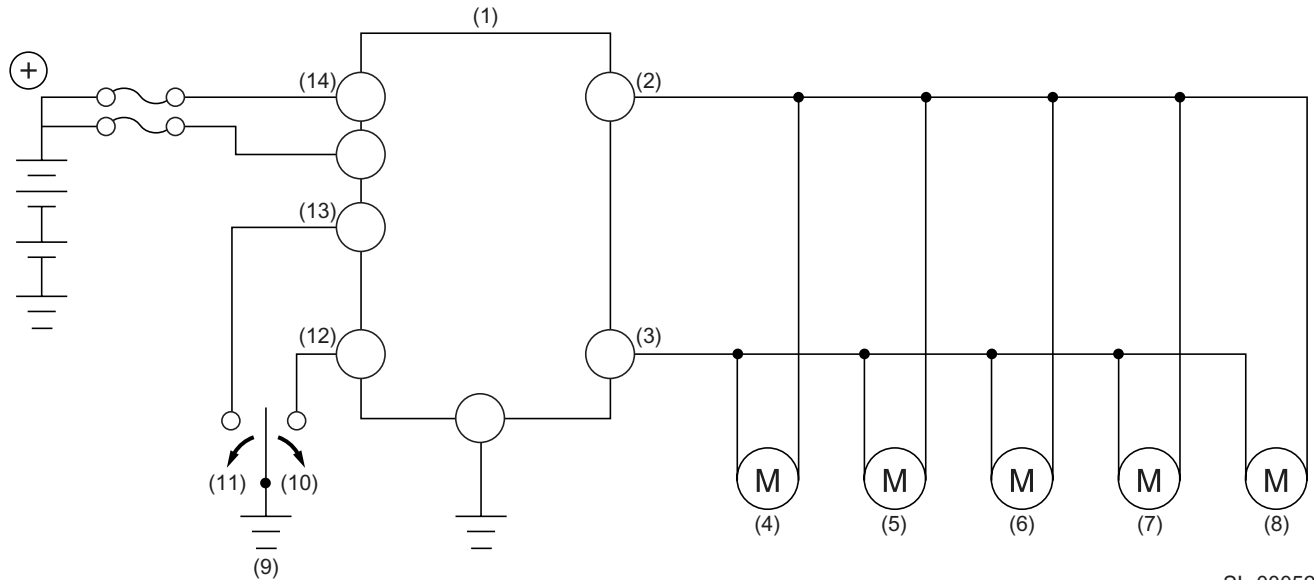
The ignition switch illumination turns off 15 seconds after the driver's door is closed. The keyless entry control module controls the off delay function.

2. Power Door Lock (Vehicles without Double Lock)

A: CONSTRUCTION

- The power door lock system consists of a keyless entry control module, drivers door lock switch, front door lock actuators, rear door lock actuators, and a rear gate lock actuator.
- When the driver's door is locked or unlocked using the door lock switch, the other doors and the rear gate are also locked or unlocked automatically.

B: CIRCUIT DIAGRAM



SL-00052

- | | |
|----------------------------------|-----------------------------|
| (1) Keyless entry control module | (8) Rear gate lock actuator |
| (2) Lock output | (9) Door lock switch |
| (3) Unlock output | (10) Unlock |
| (4) Front LH actuator | (11) Lock |
| (5) Front RH actuator | (12) Unlock switch |
| (6) Rear LH actuator | (13) Lock switch |
| (7) Rear RH actuator | (14) Battery |

POWER DOOR LOCK (VEHICLES WITH DOUBLE LOCK)

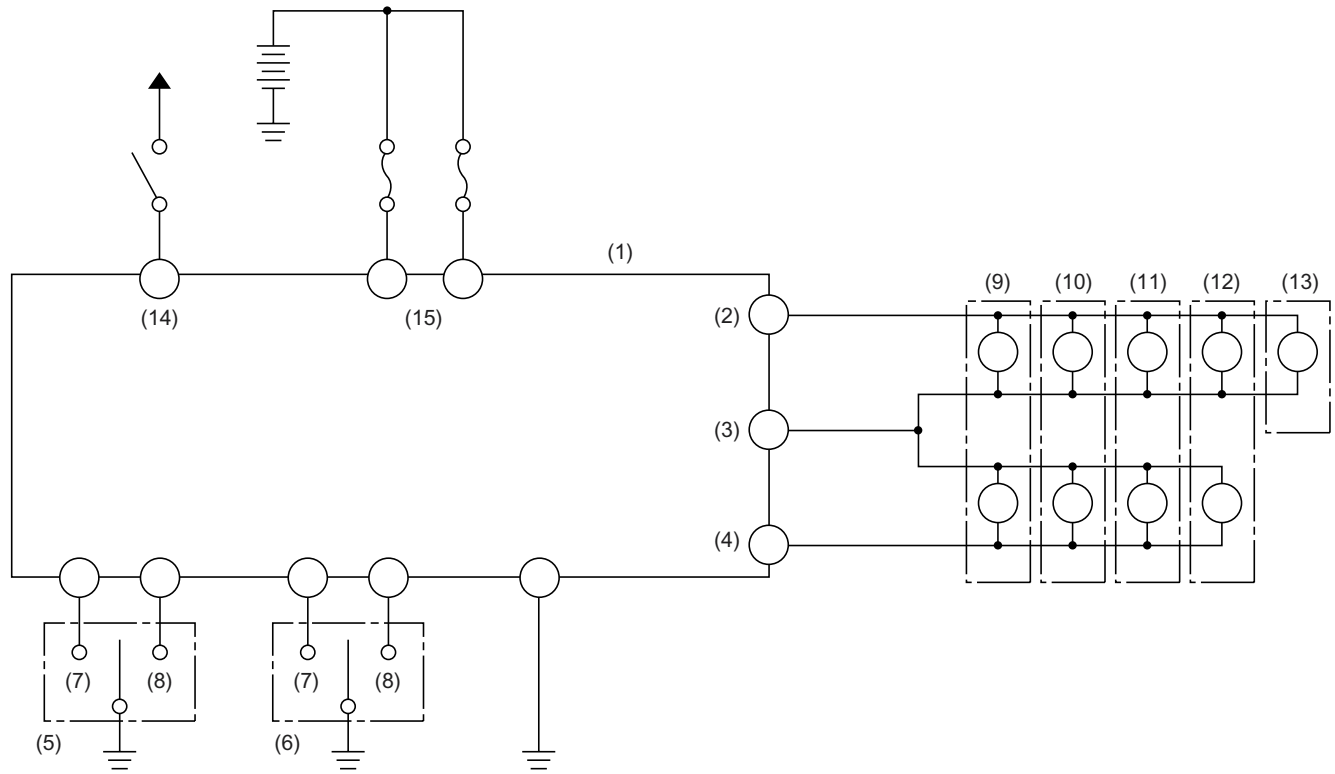
3. Power Door Lock (Vehicles with Double Lock)

A: CONSTRUCTION

- The power door lock system consists of a double lock control module, ignition switch, driver's door lock switch, door key cylinder switch, front door lock actuators, rear door lock actuators, and a rear gate lock actuator.
- When locked with the door key cylinder, all doors will be double-locked and the rear gate will be locked.
- When unlocked with the door key cylinder, all doors and the rear gate will be unlocked.
- When locked with the driver's door lock switch, all doors and the rear gate will be normally locked, and when unlocked with the switch, all doors and the rear gate will be unlocked.
- In the double-locked state the locks cannot be released by operating the driver's door lock switch.
- When the ignition switch is turned ON while in the double-locked state, all doors and the rear gate will be unlocked.

POWER DOOR LOCK (VEHICLES WITH DOUBLE LOCK)

B: CIRCUIT DIAGRAM



SL-00105

- | | |
|---|------------------------------|
| (1) Double lock control module | (9) Front RH actuator |
| (2) Lock output | (10) Front LH actuator |
| (3) Unlock and double lock release output | (11) Rear RH actuator |
| (4) Double lock set output | (12) Rear LH actuator |
| (5) Driver's door lock switch | (13) Rear gate lock actuator |
| (6) Door key cylinder switch | (14) Ignition switch |
| (7) Lock | (15) Battery |
| (8) Unlock | |

KEYLESS ENTRY SYSTEM (VEHICLES WITHOUT DOUBLE LOCK)

4. Keyless Entry System (Vehicles without Double Lock)

A: CONSTRUCTION

- The keyless entry system consists of a transmitter, keyless entry control module (with a built-in antenna), door lock actuators, door switches, hazard warning lights, interior lights, and ignition switch illumination.
- The keyless entry system operates on a radio frequency, so its transmitter can be used in almost all directions relative to the vehicle.

B: FUNCTION

1. DOOR LOCKING

- 1) Push the transmitter's LOCK button once.
- 2) All doors are locked.
- 3) Check that the hazard warning lights flash once.

2. DOOR UNLOCKING

- 1) Push the transmitter's OPEN button once.
- 2) All doors are unlocked and the interior light and ignition switch illumination turn ON (when the interior light switch is set at the DOOR position).

NOTE:

The interior light and ignition switch illumination is lit for 15 seconds and then gradually goes out every time it receives an unlock signal. (However, if a door locking procedure is performed again during this period, the lights will go out immediately.)

- 3) Check that the hazard warning lights flash twice.

3. AUTO-LOCK FUNCTION

The doors and the rear gate will be automatically locked if either of the following operations is not performed within 30 seconds after the transmitter's OPEN button is pushed.

- Open the door.
- Insert the key into the ignition switch.
- Push the transmitter's LOCK button.

4. TRANSMITTER REGISTRATION

NOTE:

- Up to 3 transmitters per vehicle can be registered.
 - When replacing a transmitter (key), the immobilizer system must also be registered.
- 1) Remove the side sill cover at the driver's seat side and connect the registration connector which is located under the front pillar.
 - 2) Release the door locks.
 - 3) To register, push either of the transmitter's button twice while the door lock switch pressed and held at the unlock side.
 - 4) The door lock automatically locks and then unlocks. This indicates that the registration of the transmitter is completed.
 - 5) To register the second or third transmitter, repeat steps 3) and 4).
 - 6) When the registration is completed, disconnect the registration connector. Confirm the operation of the door locks using the newly registered transmitter(s) and then install the side sill cover.

KEYLESS ENTRY SYSTEM (VEHICLES WITH DOUBLE LOCK)

5. Keyless Entry System (Vehicles with Double Lock)

A: CONSTRUCTION

- The keyless entry system consists of a transmitter, keyless entry control module (with a built-in antenna), double door lock module, double door lock actuators, rear gate door lock actuator, door switches, hazard warning lights, interior light, and ignition switch illumination.
- The keyless entry system operates on a radio frequency, so its transmitter can be used in almost all directions relative to the vehicle.

B: FUNCTION

1. DOOR LOCKING (DOUBLE LOCK SETTING)

- 1) Push the transmitter's LOCK button once.
- 2) All doors are double-locked and the rear gate is locked.
- 3) Check that the hazard warning lights flash once.

2. DOOR UNLOCKING (DOUBLE-LOCK RELEASE AND UNLOCK)

- 1) Push the transmitter's OPEN button once.
- 2) All door's double-locks and locks are released, and the rear gate is unlocked. When this occurs the interior light and ignition switch illumination turn ON (when the interior light switch is set at the DOOR position).

NOTE:

The interior light and ignition switch illumination is lit for 15 seconds and then gradually goes out every time it receives an unlock signal. (However, if a door locking procedure is performed again during this period, the lights will go out immediately.)

- 3) Check that the hazard warning lights flash twice.

3. TRANSMITTER REGISTRATION

The registration method is the same as vehicles without double lock.

6. Immobilizer System

A: CONSTRUCTION

The immobilizer system consists of the following components: an indicator light in the combination meter, an immobilizer control module (IMM ECM), an engine control module (ECM), a transponder inside the ignition key, and an antenna fitted to the key cylinder.

The antenna receives a vehicle ID code emitted from the transponder when the key is inserted into the key cylinder.

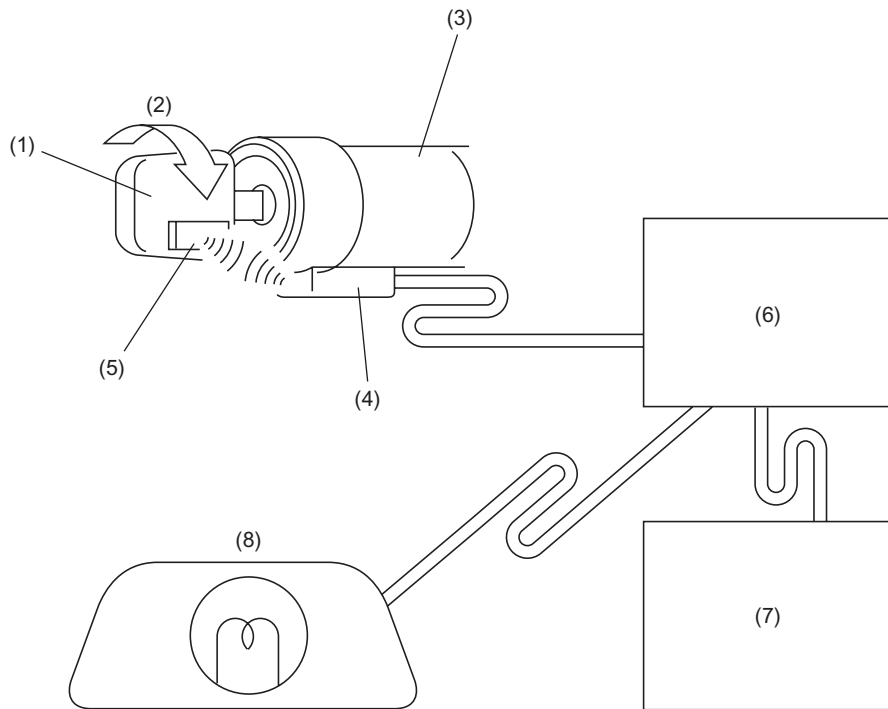
The ID code is transmitted to the IMM ECM. The IMM ECM compares the code with a one that has been registered in it. If these ID codes match with each other, the system allows the engine to be started. If they do not match but the key fits in, turning the key may be able to start the engine. The engine, however, will automatically stop after a few seconds.

The immobilizer function is activated automatically when the key is removed from the key cylinder and when 60 seconds have passed after the ignition switch was turned to the "ACC" or "OFF" position. When the function is activated, the indicator light flashes at intervals of 0.2-second ON and 2.8-second OFF.

This indicator light flashing indicates that the system is ready to function if an action of theft is attempted.

In the event that the immobilizer system develops a fault, the immobilizer indicator light illuminates when the ignition switch is turned to the "ON" position.

IMMOBILIZER SYSTEM



SL-00053

- | | |
|------------------------|---------------------------------|
| (1) Key | (5) Transponder |
| (2) Ignition switch ON | (6) Immobilizer control module |
| (3) Key cylinder | (7) Engine control module |
| (4) Antenna | (8) Immobilizer indicator light |

B: TEACHING OPERATION

The teaching operation is a procedure that must be carried out when an additional key is purchased, the IMM ECM is replaced, or the keys are replaced. The procedure includes initialization of the system and re-registration of the ID code. Once initialized, the system loses the ID code it has retained so far and has no code until a new code is registered. An ID code can be registered with an IMM ECM for up to four keys (transponders).

Any set of keys (four maximum) can be registered only with one IMM ECM. So, if an IMM ECU is replaced with a new one, the keys having been used with the old IMM ECU cannot be used with the new IMM ECU. Therefore, the keys must be replaced simultaneously with the IMM ECU.

The teaching operation is carried out using a select monitor and a special program by an authorized person. Access to the program is strictly controlled for reasons of security.

SUNROOF/T-TOP/ CONVERTIBLE TOP **SR**

	Page
1. Sunroof	2

SUNROOF

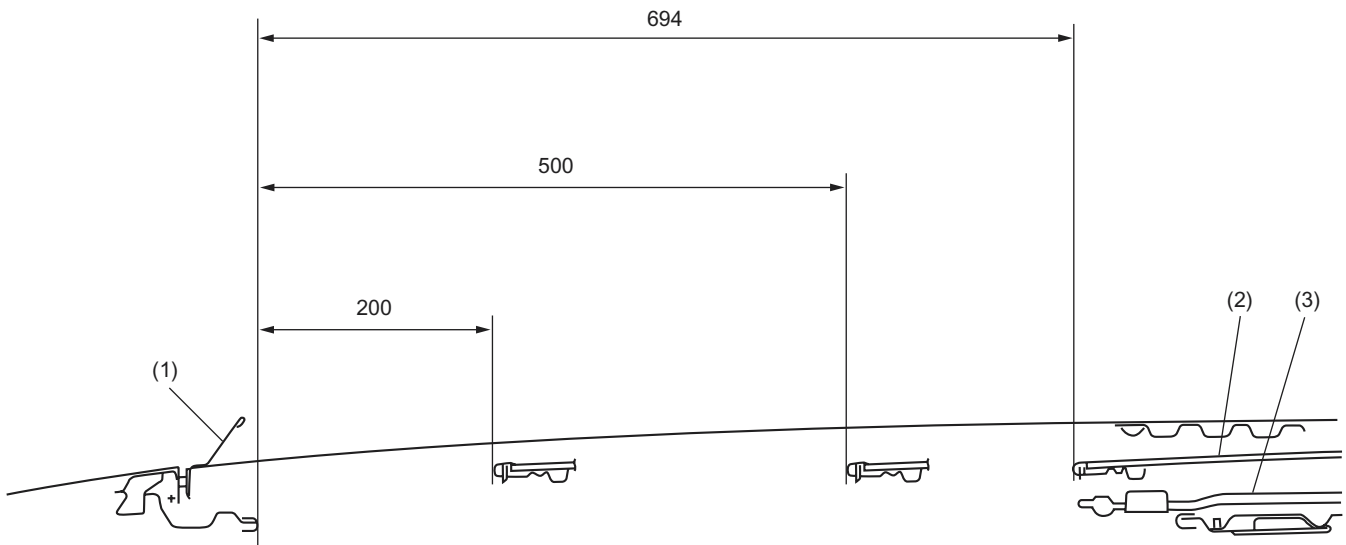
Sunroof/T-top/Convertible Top

1. Sunroof

A: DESCRIPTION

- The sunroof is a sliding glass type with an automatic opening and closing mechanism.
- The automatic opening and closing mechanism is provided with a jamming prevention feature.
- The sunroof opening in the roof is 694 mm (27.32 in) in length and 710 mm (27.95 in) in width.

B: CONSTRUCTION



SR-00012

- (1) Deflector
- (2) Glass lid
- (3) Sunshade

1. OPEN AND CLOSE OPERATIONS

- The sunroof will operate automatically when the sunroof switch is pressed longer than 0.3 second, and operate manually when the switch is pressed less than 0.3 second.
- When the OPEN side of the sunroof switch is pressed, the sunroof lid will slide open. The sunroof lid will stop at a point opened 500 mm (19.69 in) in length. The lid goes to the fully open position if the switch is pressed again.
- When the CLOSE side of the sunroof switch is pressed, the sunroof lid will slide toward the closed position. The sunroof lid will stop at a point 200 mm (7.87 in) before the fully closed position. Pressing the switch again closes the lid completely.

2. SUNSHADE OPERATION

- The sunshade can be opened or closed manually when the sunroof is closed.
- The sunshade, if closed, moves rearward together with the glass lid when the OPEN side of the sunroof switch is pressed.

3. JAMMING PREVENTION FEATURE

- If the system detects a jamming due to an object being caught in during an automatic closing operation, the lid will travel back in the opening direction for about 150 mm (5.91 in) from that position.

SUNROOF

Sunroof/T-top/Convertible Top

MEMO

EXTERIOR/INTERIOR TRIM *EI*

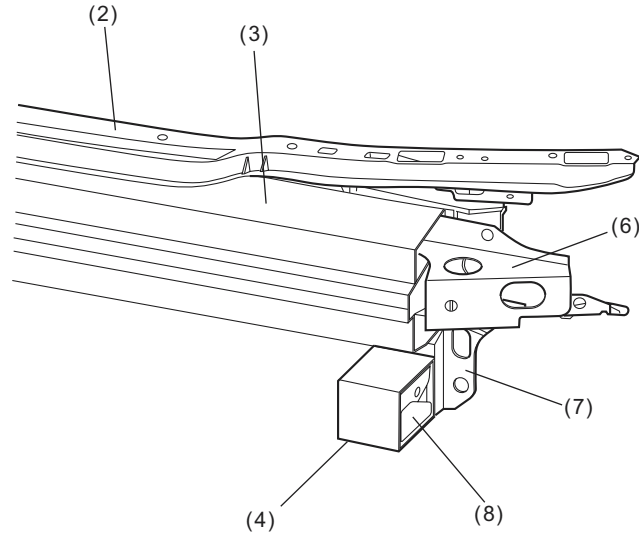
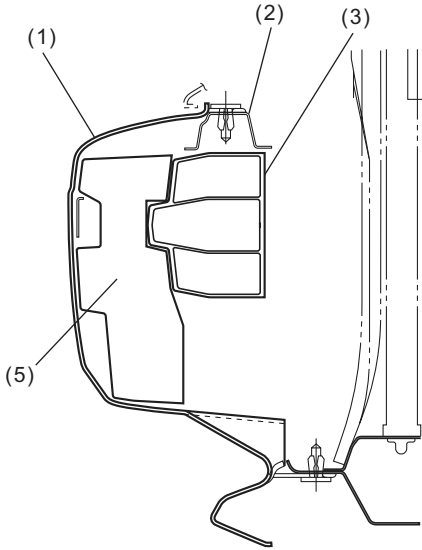
	Page
1. Front Bumper	2
2. Under Cover	3
3. Instrument Panel and Center Console	4
4. Overhead Console	6

FRONT BUMPER

Exterior/Interior Trim

1. Front Bumper

- To enhance safety and absorb the impact energy in case of a collision, the main beam is made of hollow aluminum.
- The main beam is fixed at the left and right ends by side brackets A and B, and installed to the body as a bumper beam assembly.
- The front bumper consists of a bumper face, main beam, upper beam, energy-absorbing foam, pushing part outer, pushing part inner, side bracket A, and side bracket B.



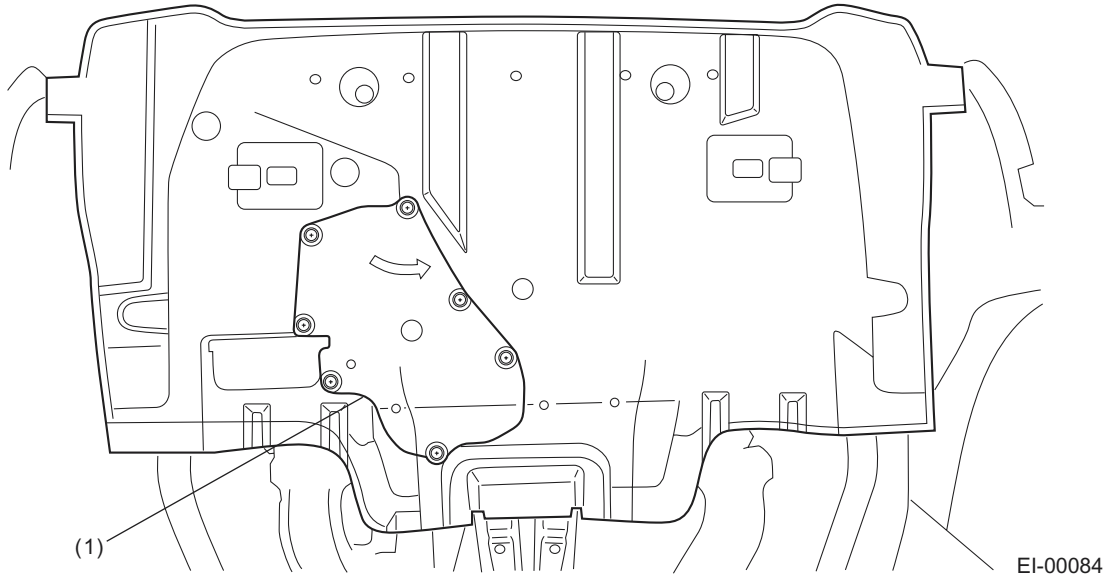
EI-00227

- (1) Bumper face
- (2) Upper beam
- (3) Main beam
- (4) Outer pushing part

- (5) Energy absorbing foam
- (6) Side bracket A
- (7) Side bracket B
- (8) Inner pushing part

2. Under Cover

- An insulator is installed inside the under cover to reduce noise.
- A service hole is provided to improve serviceability when replacing engine oil and oil filter.



(1) Service hole

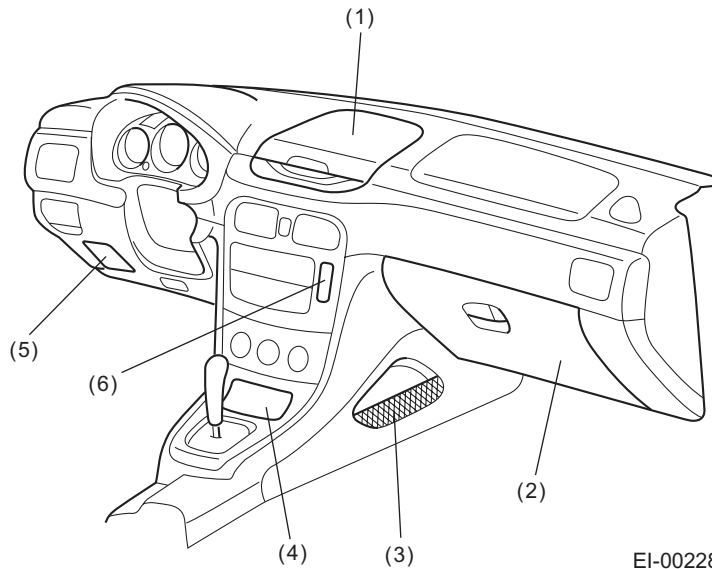
INSTRUMENT PANEL AND CENTER CONSOLE

Exterior/Interior Trim

3. Instrument Panel and Center Console

A: INSTRUMENT PANEL AND CENTER CONSOLE

- The following items are equipped on the instrument panel and center console.
 - Center storage box
 - Glove compartment
 - Net pocket
 - Cigarette lighter socket and ashtray
 - Coin tray
 - Cup holder

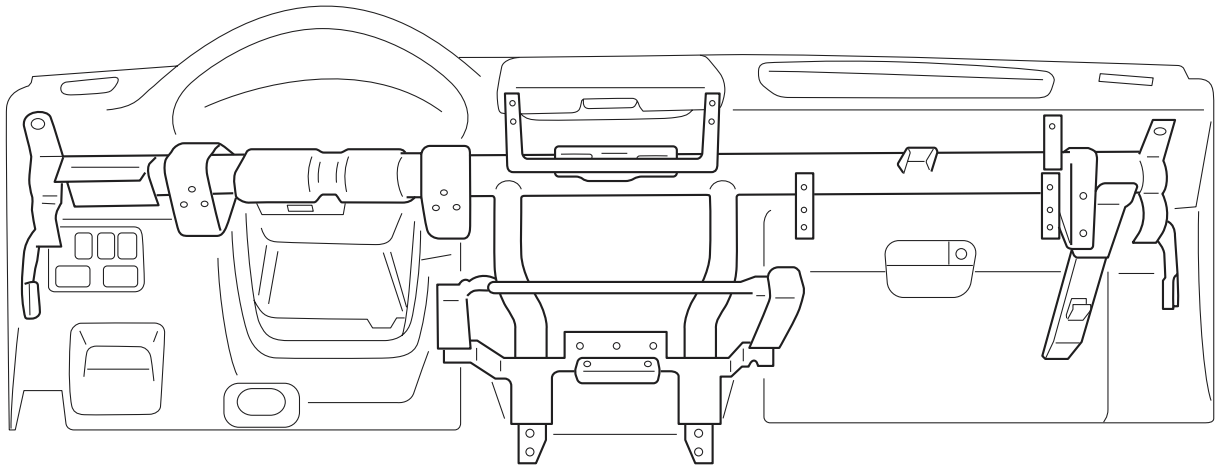


EI-00228

- | | |
|------------------------|--|
| (1) Center storage box | (4) Cigarette lighter socket and ashtray |
| (2) Glove compartment | (5) Coin tray |
| (3) Net pocket | (6) Cup holder |

B: STEERING SUPPORT BEAM

- The steering support beam is installed to the instrument panel. At the rear side of the instrument panel, the steering support beam is fixed to the left and right front pillars.
- The steering support beam is located between the left and right front pillars and supports the reinforcement of the steering column. This also minimizes the vibration of the steering, and prevents the steering wheel from moving rearward toward the driver by impact during a collision.



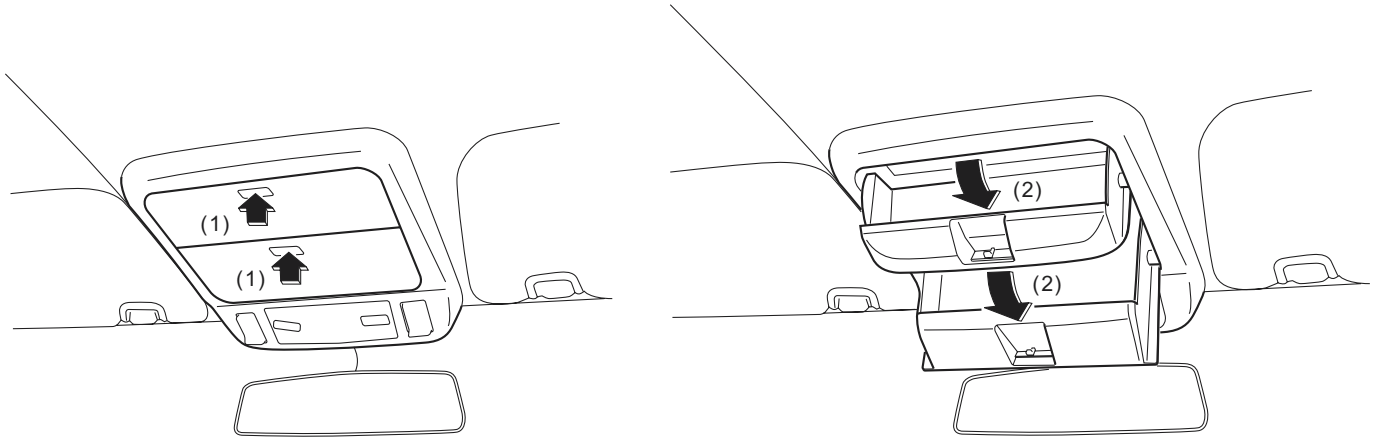
EI-00239

OVERHEAD CONSOLE

Exterior/Interior Trim

4. Overhead Console

A tandem type storage box is installed at the upper front center over the front seats.



EI-00088

(1) Push

(2) Open

EXTERIOR BODY PANELS *EB*

	Page
1. Door	2

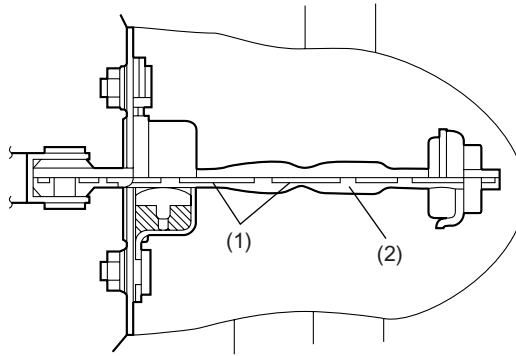
DOOR

Exterior Body Panels

1. Door

A: DOOR CHECKER

The door checkers have a resin arm which feels better when operated.

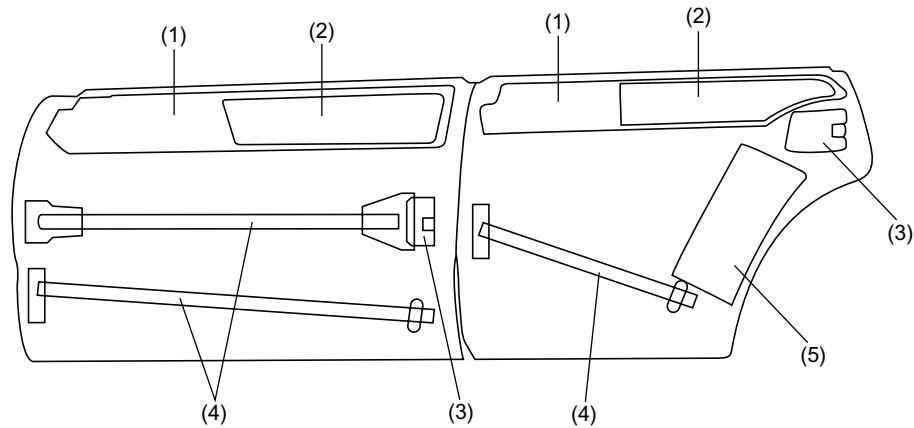


EB-00028

- (1) Sheet metal
- (2) Resin

B: DOOR CONSTRUCTION

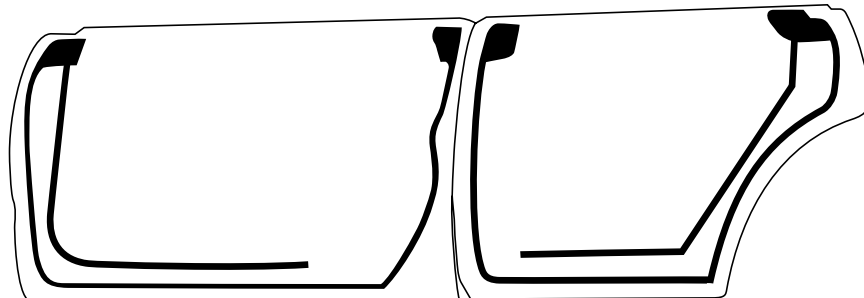
- All the front and rear doors have side door beams (two on front doors and one on rear doors), a door shoulder reinforcement, a latch area reinforcement, and an arch area reinforcement.
- An additional reinforcement has been provided for each rear door upper reinforcement.
- A lower reinforcement has been added to each door.



EB-00029

- | | |
|---------------------------------|---------------------------------------|
| (1) Upper reinforcement | (4) Side door beam |
| (2) Door shoulder reinforcement | (5) Rear door arch area reinforcement |
| (3) Latch area reinforcement | |

- Intrusion of road noise etc. is minimized by dual sealing at the bottom of each door.



EB-00030

DOOR

Exterior Body Panels

MEMO

CRUISE CONTROL SYSTEM **CC**

	Page
1. Cruise Control	2

1. Cruise Control

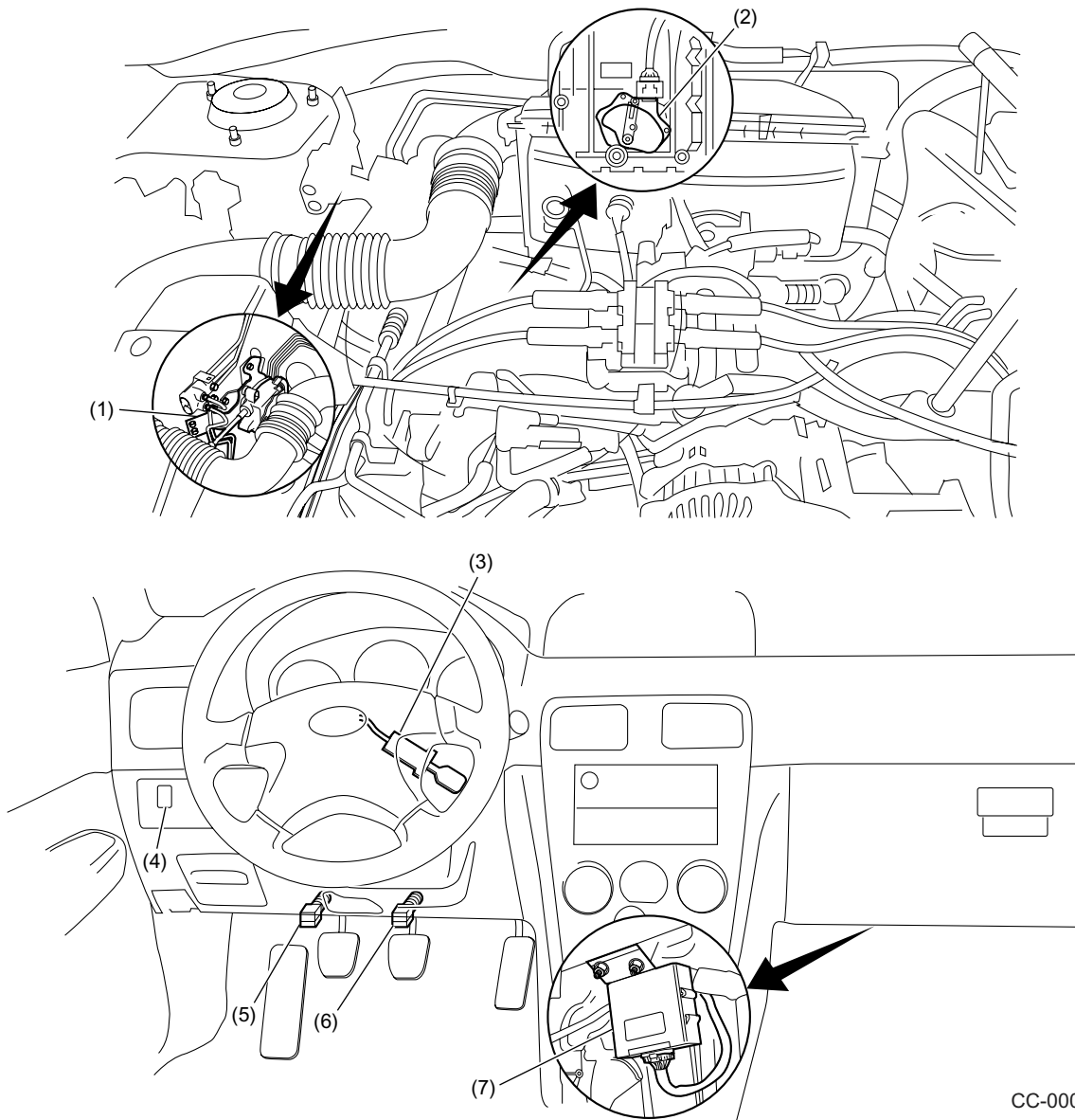
A: OPERATION

- The cruise control system automatically controls the vehicle speed. It allows the vehicle to run at a constant speed without need for the driver to keep the accelerator pedal depressed.
- When the driver has activated the system and made a desired speed setting, the cruise control module compares the actual vehicle speed detected by the speed sensor (MT) or transmission control module (AT) with the preset speed in the memory, then generates a signal according to the difference between the two speeds.

This signal is transmitted to the actuator located in the engine compartment.

The actuator operates the throttle cam as necessary to keep the preset vehicle speed.

B: COMPONENT LOCATION



CC-00001

- | | |
|---|---------------------------|
| (1) Actuator | (5) Clutch switch (MT) |
| (2) Inhibitor switch (AT) | (6) Stop and brake switch |
| (3) Command switch (cruise control lever) | (7) Control module |
| (4) Main switch | |

The electrical component locations are for LHD vehicles. The cruise control actuator and the cruise control module locations for RHD vehicles are symmetrically opposite.

CRUISE CONTROL

Cruise Control System

C: CONTROL AND OPERATION

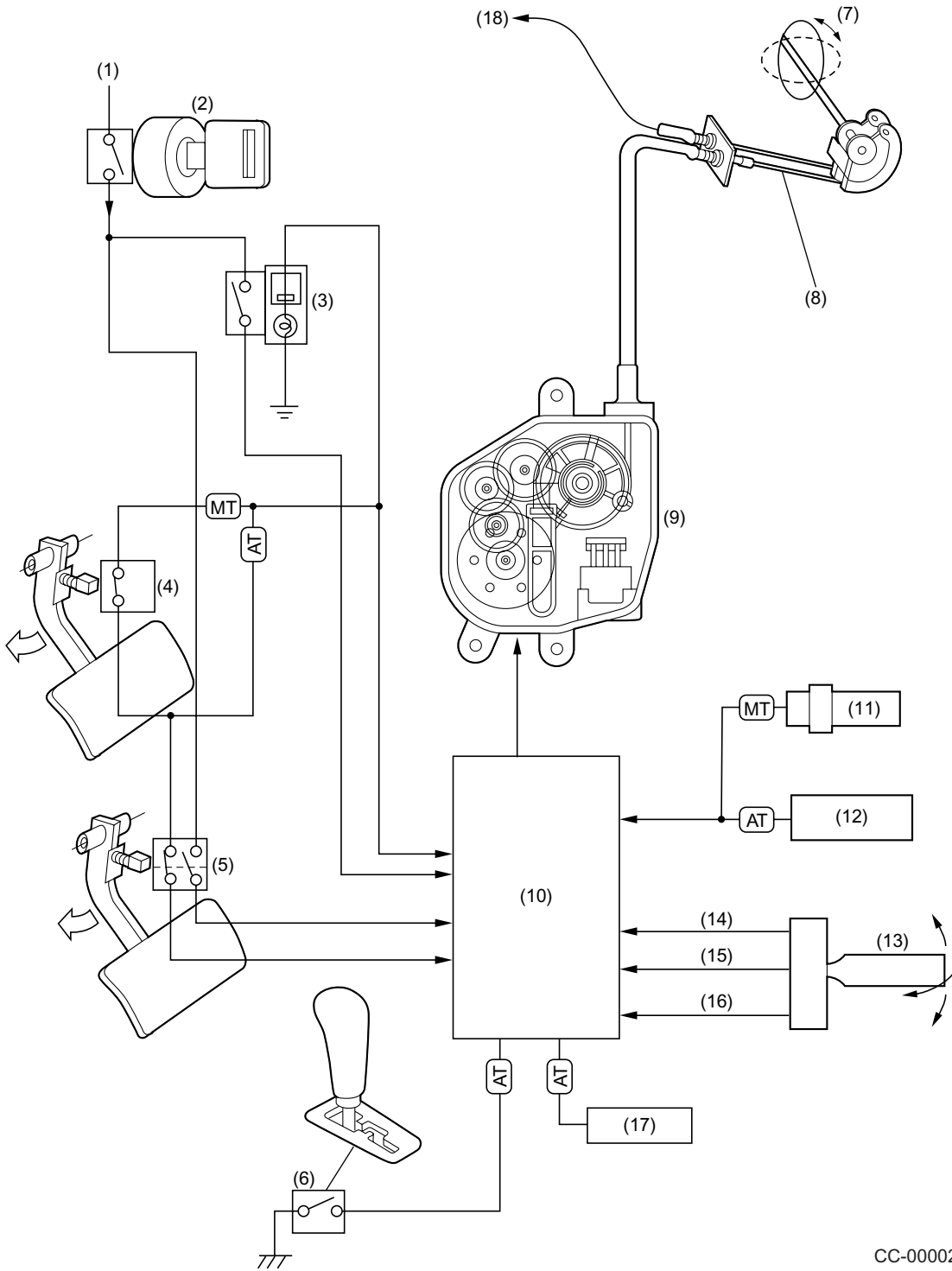
Constant speed control	When actual vehicle speed is higher than the “set” speed, the motor in the actuator operates to move the throttle valve in the closing direction by the amount corresponding to the difference between the two speeds. When actual driving speed is lower than “set” speed, the motor operates to move the throttle valve in the opening enabling direction according to the difference in speed.
Speed setting control	When SET/COAST switch is pressed with main switch ON while the vehicle is being driven at a speed greater than 40 km/h (25 MPH), current flows to the actuator. This causes the clutch in the actuator to engage, enabling the motor to operate. The motor moves the throttle valve to the position corresponding to the accelerator pedal position. The vehicle is driven at the set speed.
Deceleration control	When SET/COAST switch is turned ON while the vehicle is cruising at a constant speed, the motor in the actuator rotates to move the throttle valve in the closing direction. This causes the vehicle to coast. When the switch is turned OFF, the vehicle speed is stored in memory and the vehicle maintains that speed thereafter.
Acceleration control	When RESUME/ACCEL switch is turned ON while the vehicle is cruising at a constant speed, the motor in the actuator rotates to move the throttle valve in the opening direction. This causes the vehicle to accelerate by a certain amount. When the switch is turned OFF, the vehicle speed is stored in memory and the vehicle maintains that speed thereafter.
Resume control	When RESUME/ACCEL switch is turned ON after the cruise control is temporarily cancelled, vehicle speed returns to that speed which was stored in memory just before the cruise control is cancelled. This occurs only when the vehicle is running at a speed greater than 32 km/h (20 MPH). In the following cases, however, the set vehicle speed is completely cleared. Therefore, no resume control is performed. (1) Ignition switch is turned OFF (2) Main switch is turned OFF
Manual cancel control	When any of the following signals is entered into the cruise control module, the clutch is disengaged and the cruise control is deactivated. (1) Stop light switch ON signal (brake pedal depressed) (2) Brake switch OFF signal (brake pedal depressed) (3) Clutch switch OFF signal (clutch pedal depressed – MT) (4) Inhibitor switch ON signal (selector lever set to “N” – AT) (5) CANCEL switch ON signal (command switch cruise control lever pulled) (6) Ignition switch OFF signal (7) Main switch OFF signal
Low speed limit control	When the vehicle speed drops below 32 km/h (20 MPH), the cruise control is automatically cancelled. Cruise control at any speed lower than 40 km/h (25 MPH) cannot be effected.
Motor control	When the vehicle speed becomes 10 km/h (6 MPH) or more higher than the memorized speed while vehicle is running utilizing the cruise control (in a downgrade, for example), the actuator’s clutch is turned OFF so that the vehicle decelerates. When the vehicle’s speed becomes 8 km/h (5 MPH) or more lower than the memorized speed, the clutch is turned ON again so that the cruise control resumes.

MEMO

CRUISE CONTROL

Cruise Control System

D: SCHEMATIC

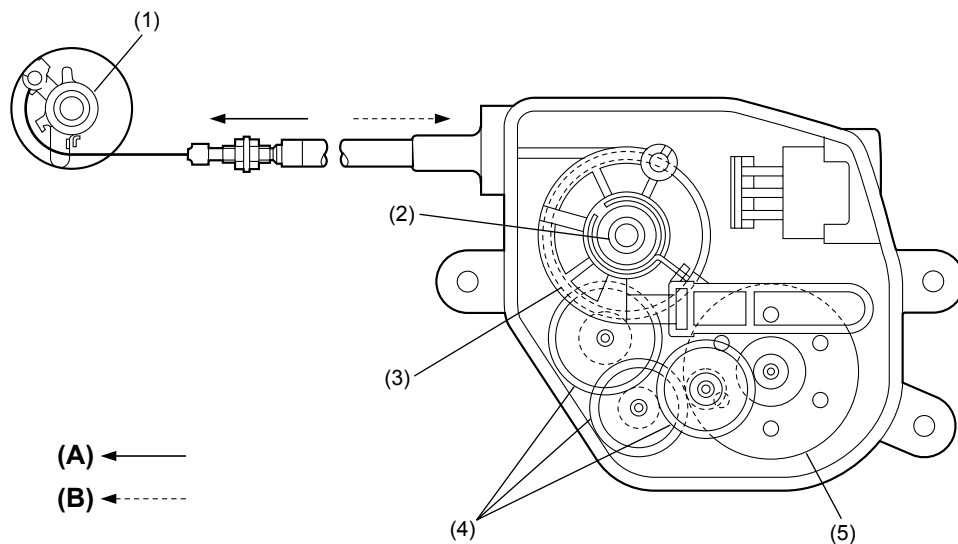


CC-00002

- | | |
|---------------------------|--------------------------------|
| (1) Battery | (10) Cruise control module |
| (2) Ignition switch | (11) Vehicle speed sensor (MT) |
| (3) Main switch | (12) TCM (AT) |
| (4) Clutch switch (MT) | (13) Command switch |
| (5) Stop and brake switch | (14) RESUME/ ACCEL switch |
| (6) Inhibitor switch (AT) | (15) CANCEL switch |
| (7) Engine throttle valve | (16) SET/COAST switch |
| (8) Cruise control cable | (17) TCM (AT) |
| (9) Actuator | (18) To accelerator pedal |

E: ACTUATOR

In response to a signal from the cruise control module, the clutch in the actuator is turned ON. This causes the stepping motor to operate, pulling the throttle cam for speed control.

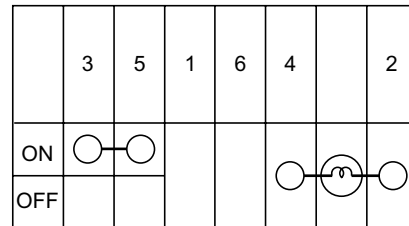
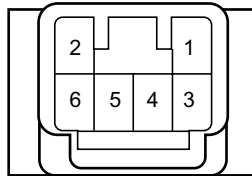
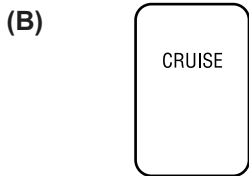
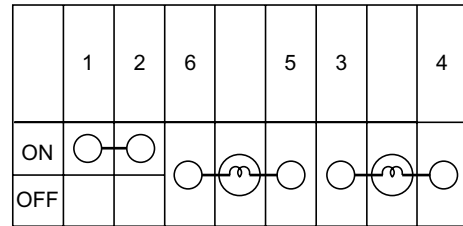
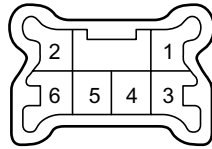
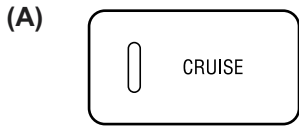


- | | |
|--------------------|-------------|
| (1) Throttle cam | (A) Release |
| (2) Clutch | (B) Pull |
| (3) Pulley | |
| (4) Gear | |
| (5) Stepping motor | |

CRUISE CONTROL

F: MAIN SWITCH

- The main switch is the main power supply switch of the cruise control module. The main switch has a built-in night illumination light.
- When the ignition switch is placed in the OFF position with the main switch ON, the main switch is also turned OFF. Even if the ignition switch is turned ON again, the main switch will stay in the OFF state.



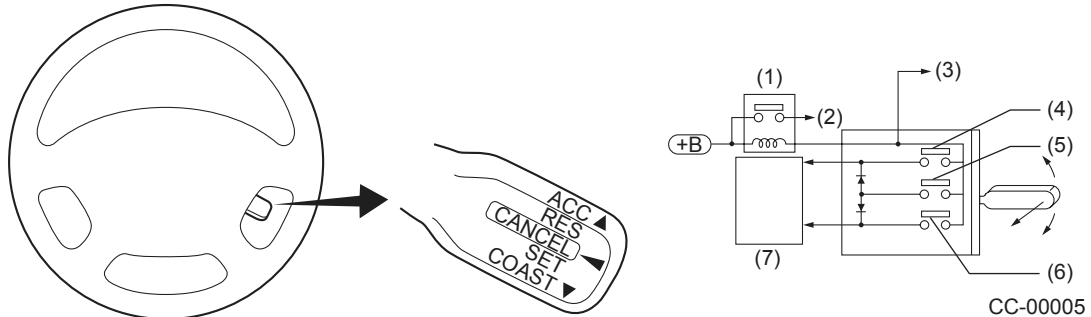
CC-00094

(A) Vehicles for Europe

(B) Vehicles for Australia

G: COMMAND SWITCH (CRUISE CONTROL LEVER)

- When the vehicle is driven with the cruise control activated, the command switch controls its operation. It inputs SET/COAST signal, ACCEL/RESUME signal or CANCEL signal to the cruise control module.



- (1) Horn relay
- (2) Horn
- (3) Horn switch
- (4) SET/COAST

- (5) CANCEL
- (6) RESUME/ACCEL
- (7) Control module

- The command switch is located on the right side of the steering wheel, so the driver can operate it without releasing hands from the steering wheel.
- The command switch is a self-returning lever type.

1. RESUME/ACCEL AND SET/COAST SWITCH

Each switch contact is held closed as long as the lever is kept pressed in the relevant direction and resulting current is applied as a signal to the control module.

2. CANCEL SWITCH

All the switch contacts are closed as long as the lever is pulled toward the CANCEL position (toward the driver). This causes the RESUME/ACCEL and SET/COAST ON signals to be sent to the control module simultaneously.

H: CANCEL SIGNALS

The cancel signal deactivates the cruise control function. Operating any of the following switches results in generation of the cancel signal. On receiving the signal, the cruise control module cancels the cruise control function.

- Stop light switch
- Brake switch
- Clutch switch (MT model)
- Inhibitor switch (AT model)
- Main switch
- Command switch (CANCEL position)

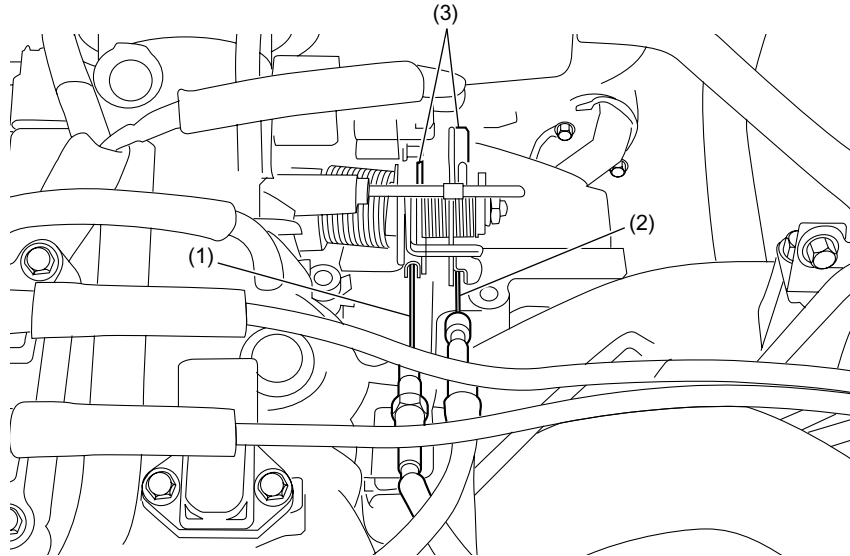
I: VEHICLE SPEED SENSOR

Vehicle speed sensor is installed on the transmission, and sends signal to the cruise control module which uses it in controlling the cruise control function (MT model).

CRUISE CONTROL

J: ENGINE THROTTLE

- The throttle body is equipped with two throttle cams. One is used during acceleration and the other during cruising in order to open or close the throttle valve.
- These cams operate independently of each other. In other words, when one cam operates, the other may not.

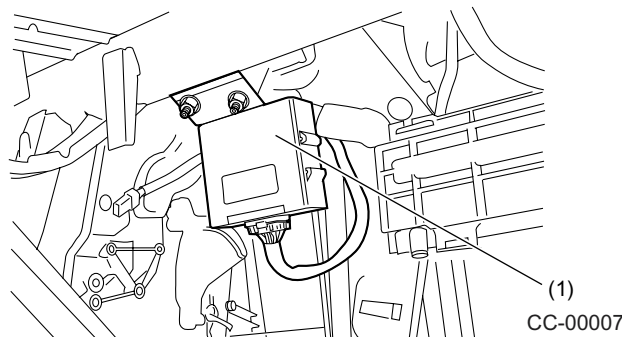


CC-00006

- (1) Accelerator cable
- (2) Cruise control cable
- (3) Throttle cam

K: CONTROL MODULE

- Based on signals from the related switches and sensors, the cruise control module controls all the following control functions:
Constant speed control; speed setting control; deceleration control; acceleration control; resume control; manual cancel control; low speed limit control; stepping motor control; cruise control
- The control module is located behind the glove compartment.



CC-00007

- (1) Control module

L: FAIL-SAFE FUNCTION

The cruise control system has a fail-safe function that cancels the cruise control operation when any of the following conditions occurs.

1. CONFLICT BETWEEN CRUISE CONTROL SWITCHES AND CANCELLATION SIGNAL GENERATING SWITCHES

1) The cruise control system is deactivated if any of the cruise control switches (SET/COAST, RESUME/ACCEL, and CANCEL switches) is turned ON while any of the cancellation signal generating switches (brake, stop lamp, clutch, and inhibitor switches) is being operated. The system is re-activated when the cruise control switch is turned OFF and then turn ON again after the cancellation signal generating switch has been returned to its released position.

2) The cruise control system becomes deactivated if the ignition switch is turned ON with any of the cruise control switches (including the main switch) in the ON position. The system deactivating function is retained until the ignition switch is turned OFF.

2. ABNORMALITIES IN ELECTRIC CIRCUITS

The cruise control system is deactivated and the set speed is also canceled if any of the following abnormalities occurs in the system's electric circuits.

The system deactivation function is retained until the ignition switch is turned OFF.

1) The stepping motor terminal is grounded; or the stepping motor drive circuit is broken due to a short- or open-circuit.

2) The stepping motor clutch drive circuit is shorted.

3) Vehicle speed variation in a 350 ms period exceeds +/- 10km/h.

4) Fusion has occurred in an internal relay and is detected while the vehicle is running with the cruise control deactivated.

5) The cruise control module becomes inoperative or its operation is faulty.

6) There is discrepancy between the values stored in the two RAMs of the control module.

7) An abnormality is detected as a result of the self-diagnosis performed after turning ON of the ignition switch.

3. ABNORMALITIES IN STEPPING MOTOR

The cruise control system is deactivated if either of the following abnormalities occurs in the stepping motor.

1) The stepping motor does not operate properly.

2) The stepping motor is energized for unduly long period and too frequently.

When the system is deactivated, it cannot be reactivated for 2 – 20 minutes after detection of the abnormal condition.

CRUISE CONTROL

Cruise Control System

MEMO