1. Legacy

A: DIMENSIONS

Model				Sedan	Station Wagon		
				2.5 L			
				AWD	AWD		
				All	BRIGHTON	L	2.5 GT
Overall length			mm (in)	4,685 (184.4)	4,760 (187.4)		
Overall width			mm (in)	1,745 (68.7)	1,745 (68.7)		
Overall height			mm (in)	1,415 (55.7)	1,435 (56.5)		
Compartment	Leg room	Front max.	mm (in)	1,101 (43.3)	1,101 (43.3)		
		Rear min.	mm (in)	868 (34.2)	871 (34.3)		
	Head room	Front	mm (in)	987 (38.9), 967 (38.1)*1	1,020 (40.2), 977 (38.5)*1		
		Rear	mm (in)	930 (36.6)	994 (39.1), 945 (37.2)*1		
	Shoulder room	Front	mm (in)	1,368 (53.9)	1,368 (53.9)		
		Rear	mm (in)	1,362 (53.6)	1,362 (53.6)		
Wheelbase			mm (in)	2,650 (104.3)	2,650 (104.3)		
Tread		Front	mm (in)	1,460 (57.5)	1,460 (57.5)		
		Rear	mm (in)	1,460 (57.5)	1,455 (57.3)		
Minimum road clearance		M.L.V.W.	mm (in)	115 (4.5)	120 (4.7)		125 (4.9)
		C.W.	mm (in)	155 (6.1)	160 (6.3)		

*1: with sunroof

B: ENGINE

Model		Sedan/Station Wagon
Engine type		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
Valve arrangement		Overhead camshaft type
Bore × stroke	mm (in)	99.5 × 79.0 (3.917 × 3.110)
Displacement	cm^3 (cu in)	2,457 (149.9)
Compression ratio		10.0
Firing order		1 — 3 — 2 — 4
Idle speed at Park/Neutral position	rpm	650 (MT), 700 (AT)
Maximum output	kW (HP)/rpm	123 (165)/5,600
Maximum torque	N·m (kgf-m, ft-lb)/rpm	226 (23.0, 166)/3,600

C: ELECTRICAL

Model			Sedan/Station Wagon
Ignition timing at idling speed		BTDC/rpm	10°±8°/650 (MT), 15°±8°/700 (AT)
Spark plug	Type and manufacturer		CHAMPION: RC10YC4 (standard) NGK: BKR5E-11 NGK: BKR6E-11
Alternator			12V — 90A
Battery	Reserve capacity	min	90 (MT), 110 (AT)
	Cold cranking amperes	amp.	430 (MT), 490 (AT)

D: TRANSMISSION

Model			Sedan/Station Wagon	
			AWD	
Transmission type			5MT	4AT
Clutch type			DSPD	TCC
Gear ratio		1st	3.454	2.785*1, 3.027*2
		2nd	2.062	1.545*1, 1.619*2
		3rd	1.448	1.000
		4th	1.088	0.694
		5th	0.780	—
		Reverse	3.333	2.272
Reduction gear (front drive)	1st reduction	Type of gear	—	Helical
		Gear ratio	—	1.000
	Final reduction	Type of gear	Hypoid	Hypoid
		Gear ratio	3.900*1, 4.111*2	4.111*1, 4.444*2
Reduction gear (rear drive)	Transfer reduction	Type of gear	Helical	—
		Gear ratio	1.000	—
	Final reduction	Type of gear	Hypoid	Hypoid
		Gear ratio	3.900*1, 4.111*2	4.111*1, 4.444*2

5MT: 5-forward speeds with synchromesh and 1-reverse – with center differential and viscous coupling
4AT: Electronically controlled fully-automatic, 4-forward speeds and 1-reverse – with hydraulically controlled transfer clutch
*1: L, BRIGHTON
*2: 2.5 GT, 2.5 GTLO
DSPD: Dry Single Plate Diaphragm
TCC: Torque Converter Clutch

E: STEERING

Type		Rack and pinion
Turns, lock to lock		3.2
Minimum turning circle	m (ft)	Curb to curb: 11.6 (38.1), wall to wall: 10.8 (35.4)

F: SUSPENSION

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

G: BRAKE

Model	With ABS
Service brake system	Dual circuit hydraulic with vacuum suspended power unit
Front	Ventilated disc brake
Rear	Disc brake
Parking brake	Mechanical on rear brakes

H: TIRE

Model	15-inch wheel		16-inch wheel
Size	P195/60R15 87H	P205/60R15 90H	P205/55R16 89H
Type	Steel belted radial, tubeless		

I: CAPACITY

Model		AWD	
		5MT	4AT
Fuel tank	ℓ (US gal, imp. gal)	64 (16.9, 14.1)	
Engine oil (replacement)	ℓ (US qt, imp. qt)	Approx. 4.0 (4.2, 3.5)	
Transmission gear oil	ℓ (US qt, imp. qt)	3.5 (3.7, 3.1)	—
Automatic transmission fluid	ℓ (US qt, imp. qt)	—	9.3 – 9.6 (9.8 – 10.1, 8.2 – 8.4)
AT differential gear oil	ℓ (US qt, imp. qt)	—	1.1 – 1.3 (1.2 – 1.4, 1.0 – 1.1)
AWD rear differential gear oil	ℓ (US qt, imp. qt)	0.8 (0.8, 0.7), 0.9 (0.9, 0.8)*	
Power steering fluid	ℓ (US qt, imp. qt)	0.7 (0.7, 0.6)	
Engine coolant	ℓ (US qt, imp. qt)	6.8 (7.2, 6.0)	6.7 (7.1, 5.9)

*: L, BRIGHTON

J: WEIGHT

1. U.S. SPEC. VEHICLE

Model			Sedan			
			2.5 L			
			AWD			
			L		2.5 GT	
			5MT	4AT	5MT	4AT-SS
Curb weight (C.W.)	Front	kg (lb)	812 (1,790)	839 (1,850)	844 (1,860)	866 (1,910)
	Rear	kg (lb)	651 (1,435)	653 (1,440)	683 (1,505)	685 (1,510)
	Total	kg (lb)	1,463 (3,225)	1,492 (3,290)	1,527 (3,365)	1,551 (3,420)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,007 (2,220)			
	Rear	kg (lb)	989 (2,180)			
	Total	kg (lb)	1,996 (4,400)			

Model			Station Wagon			
			2.5 L			
			AWD			
			L		2.5 GT	
			5MT	4AT	5MT	4AT-SS
Curb weight (C.W.)	Front	kg (lb)	812 (1,790)	841 (1,855)	844 (1,860)	869 (1,915)
	Rear	kg (lb)	701 (1,545)	701 (1,545)	730 (1,610)	735 (1,620)
	Total	kg (lb)	1,513 (3,335)	1,542 (3,400)	1,574 (3,470)	1,604 (3,535)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,002 (2,210)			
	Rear	kg (lb)	1,064 (2,345)			
	Total	kg (lb)	2,066 (4,555)			

2. CANADA SPEC. VEHICLE

Model			Sedan		
			2.5 L		
			AWD		
			L	2.5 GT	
			4AT	5MT	4AT-SS
Curb weight (C.W.)	Front	kg (lb)	839 (1,850)	844 (1,860)	866 (1,910)
	Rear	kg (lb)	653 (1,440)	683 (1,505)	685 (1,510)
	Total	kg (lb)	1,492 (3,290)	1,527 (3,365)	1,551 (3,420)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,007 (2,220)		
	Rear	kg (lb)	989 (2,180)		
	Total	kg (lb)	1,996 (4,400)		

Model			Sedan	
			2.5 L	
			AWD	
			2.5 GTLO	
			5MT	4AT-SS
Curb weight (C.W.)	Front	kg (lb)	839 (1,850)	862 (1,900)
	Rear	kg (lb)	678 (1,495)	680 (1,500)
	Total	kg (lb)	1,517 (3,345)	1,542 (3,400)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,007 (2,220)	
	Rear	kg (lb)	989 (2,180)	
	Total	kg (lb)	1,996 (4,400)	

Model			Station Wagon				
			2.5 L				
			AWD				
			BRIGHTON		L		2.5 GT
			5MT	4AT	5MT	4AT	4AT-SS
Curb weight (C.W.)	Front	kg (lb)	807 (1,780)	832 (1,835)	812 (1,790)	841 (1,855)	869 (1,915)
	Rear	kg (lb)	678 (1,495)	683 (1,505)	701 (1,545)	701 (1,545)	735 (1,620)
	Total	kg (lb)	1,485 (3,275)	1,515 (3,340)	1,513 (3,335)	1,542 (3,400)	1,604 (3,535)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	962 (2,120)		1,002 (2,210)		
	Rear	kg (lb)	1,016 (2,240)		1,064 (2,345)		
	Total	kg (lb)	1,978 (4,360)		2,066 (4,555)		

3. TAIWAN SPEC. VEHICLE

Model			Sedan		Station Wagon
			2.5 L		
			AWD		
			L	2.5 GT	L
			4AT	4AT-SS	4AT
Curb weight (C.W.)	Front	kg (lb)	839 (1,850)	866 (1,910)	841 (1,855)
	Rear	kg (lb)	653 (1,440)	685 (1,510)	701 (1,545)
	Total	kg (lb)	1,492 (3,290)	1,551 (3,420)	1,542 (3,400)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,007 (2,220)		1,002 (2,210)
	Rear	kg (lb)	989 (2,180)		1,064 (2,345)
	Total	kg (lb)	1,996 (4,400)		2,066 (4,555)

2. OUTBACK

A: DIMENSIONS

Model				Sedan	Wagon	
				AWD	AWD	
				4AT	5MT	4AT
Overall length			mm (in)	4,685 (184.4)	4,760 (187.4)	
Overall width			mm (in)	1,745 (68.7)	1,745 (68.7)	
Overall height			mm (in)	1,480 (58.3)	1,580 (62.2)	
Compartment	Leg room	Front max.	mm (in)	1,101 (43.3)	1,101 (43.3)	
		Rear min.	mm (in)	868 (34.2)	871 (34.3)	
	Head room	Front	mm (in)	987 (38.9), 967 (38.1)*1	1,020 (40.2), 977 (38.5)*1	
		Rear	mm (in)	930 (36.6)	994 (39.1), 945 (37.2)*1	
	Shoulder room	Front	mm (in)	1,368 (53.9)	1,368 (53.9)	
		Rear	mm (in)	1,362 (53.6)	1,362 (53.6)	
Wheelbase			mm (in)	2,650 (104.3)	2,650 (104.3)	
Tread		Front	mm (in)	1,470 (57.9)	1,470 (57.9)	
		Rear	mm (in)	1,465 (57.7)	1,465 (57.7)	
Minimum road clearance		M.L.V.W.	mm (in)	150 (5.9)	150 (5.9)	
		C.W.	mm (in)	185 (7.3)	185 (7.3)	

*1: With sunroof

B: ENGINE

Model		Sedan/Wagon	
		2.5 L	3.0 L
Engine type		Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine	Horizontally opposed, liquid cooled, 6-cylinder, 4-stroke gasoline engine
Valve arrangement		Overhead camshaft type	Double overhead camshaft type
Bore × stroke	mm (in)	99.5 × 79.0 (3.917 × 3.110)	89.2 × 80.0 (3.512 × 3.150)
Displacement	cm^3 (cu in)	2,457 (149.9)	3,000 (183.06)
Compression ratio		10.0	10.7
Firing order		1 — 3 — 2 — 4	1 — 6 — 3 — 2 — 5 — 4
Idle speed at Park/ Neutral position	rpm	650 (MT), 700 (AT)	600
Maximum output	kW (HP)/rpm	123 (165)/5,600	158 (212)/6,000
Maximum torque	N·m (kgf-m, ft-lb)/rpm	226 (23.0, 166)/3,600	282 (28.8, 208)/4,400

C: ELECTRICAL

Model			Sedan/Wagon	
			2.5 L	3.0 L
Ignition timing at idling speed		BTDC/rpm	10°±8°/650 (MT), 15°±8°/700 (AT)	10°±8°/600
Spark plug	Type and manufacturer		CHAMPION: RC10YC4 (standard) NGK: BKR5E-11 NGK: BKR6E-11	NGK: PLFR6A-11
Alternator			12V — 90A	12V — 100A
Battery	Reserve capacity	min	90 (MT), 110 (AT)	110
	Cold cranking amperes	amp.	430 (MT), 490 (AT)	490

D: TRANSMISSION

Model			Sedan/Wagon		
			2.5 L		3.0 L
			AWD		
Transmission type			5MT	4AT	
Clutch type			DSPD	TCC	
Gear ratio		1st	3.454	3.027	2.785
		2nd	2.062	1.619	1.545
		3rd	1.448	1.000	
		4th	1.088	0.694	
		5th	0.871	—	
		Reverse	3.333	2.272	
Reduction gear (front drive)	1st reduction	Type of gear	—	Helical	
		Gear ratio	—	1.000	
	Final reduction	Type of gear	Hypoid		
		Gear ratio	4.111	4.444	4.111
Reduction gear (rear drive)	Transfer reduction	Type of gear	Helical	—	
		Gear ratio	1.000	—	
	Final reduction	Type of gear	Hypoid		
		Gear ratio	4.111	4.444	4.111

5MT: 5-forward speeds with synchromesh and 1-reverse – with center differential and viscous coupling
4AT: Electronically controlled fully-automatic, 4-forward speeds and 1-reverse – with hydraulically controlled transfer clutch
DSPD: Dry Single Plate Diaphragm
TCC: Torque Converter Clutch

E: STEERING

Type		Rack and pinion
Turns, lock to lock		3.4
Minimum turning circle	m (ft)	Curb to curb: 12.0 (39.4), wall to wall: 11.2 (36.7)

F: SUSPENSION

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

G: BRAKE

Model	With ABS
Service brake system	Dual circuit hydraulic with vacuum suspended power unit
Front	Ventilated disc brake
Rear	Disc brakes
Parking brake	Mechanical on rear brakes

H: TIRE

Model	16-inch wheel	
Size	P215/60R16*	P225/60R16 97H
Type	Steel belted radial, tubeless	

*: Recommended winter (snow) tire size.

I: CAPACITY

Model		2.5 L		3.0 L
		AWD		
		5MT	4AT	
Fuel tank	ℓ (US gal, imp. gal)	64 (16.9, 14.1)		
Engine oil (replacement)	ℓ (US qt, imp. qt)	Approx. 4.0 (4.2, 3.5)		Approx. 5.6 (5.9, 4.9)
Transmission gear oil	ℓ (US qt, imp. qt)	3.5 (3.7, 3.1)	—	
Automatic transmission fluid	ℓ (US qt, imp. qt)	—	9.3 – 9.6 (9.8 – 10.1, 8.2 – 8.4)	
AT differential gear oil	ℓ (US qt, imp. qt)	—	1.1 – 1.3 (1.2 – 1.4, 1.0 – 1.1)	
AWD rear differential gear oil	ℓ (US qt, imp. qt)	0.8 (0.8, 0.7)		
Power steering fluid	ℓ (US qt, imp. qt)	0.7 (0.7, 0.6)		
Engine coolant	ℓ (US qt, imp. qt)	6.8 (7.2, 6.0)	6.7 (7.1, 5.9)	7.9 (8.4, 7.0)

J: WEIGHT

1. U.S. SPEC. VEHICLE

Model			Sedan	
			2.5 L	3.0 L
			AWD	
			4AT	4AT*1
Curb weight (C.W.)	Front	kg (lb)	894 (1,970)	943 (2,080)
	Rear	kg (lb)	692 (1,525)	694 (1,530)
	Total	kg (lb)	1,586 (3,495)	1,637 (3,610)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,007 (2,220)	1,061 (2,340)
	Rear	kg (lb)	989 (2,180)	989 (2,180)
	Total	kg (lb)	1,996 (4,400)	2,050 (4,520)

Model			Wagon			
			2.5 L			
			Cold weather		LTD	
			5MT	4AT	5MT	4AT
Curb weight (C.W.)	Front	kg (lb)	844 (1,860)	869 (1,915)	857 (1,890)	882 (1,945)
	Rear	kg (lb)	712 (1,570)	717 (1,580)	735 (1,620)	739 (1,630)
	Total	kg (lb)	1,556 (3,430)	1,586 (3,495)	1,592 (3,510)	1,621 (3,575)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,002 (2,210)			
	Rear	kg (lb)	1,064 (2,345)			
	Total	kg (lb)	2,066 (4,555)			

Model			Wagon		
			2.5 L		3.0 L
			Others		All
			5MT	4AT	4AT*1
Curb weight (C.W.)	Front	kg (lb)	841 (1,855)	866 (1,910)	943 (2,080)
	Rear	kg (lb)	712 (1,570)	716 (1,580)	741 (1,635)
	Total	kg (lb)	1,553 (3,425)	1,582 (3,490)	1,684 (3,715)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,002 (2,210)		1,061 (2,340)
	Rear	kg (lb)	1,064 (2,345)		1,070 (2,360)
	Total	kg (lb)	2,066 (4,555)		2,131 (4,700)

*1: Excludes the weights of audio, VDC

2. CANADA SPEC. VEHICLE

Model			Sedan	
			2.5 L	3.0 L
			AWD	
			4AT	4AT*1
Curb weight (C.W.)	Front	kg (lb)	894 (1,970)	943 (2,080)
	Rear	kg (lb)	692 (1,525)	694 (1,530)
	Total	kg (lb)	1,586 (3,495)	1,637 (3,610)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,007 (2,220)	1,061 (2,340)
	Rear	kg (lb)	989 (2,180)	989 (2,180)
	Total	kg (lb)	1,996 (4,400)	2,050 (4,520)

Model			Wagon			
			2.5 L			3.0 L
			Cold weather		LTD	All
			5MT	4AT		4AT*1
Curb weight (C.W.)	Front	kg (lb)	844 (1,860)	869 (1,915)	882 (1,945)	943 (2,080)
	Rear	kg (lb)	712 (1,570)	717 (1,580)	739 (1,630)	741 (1,635)
	Total	kg (lb)	1,556 (3,430)	1,586 (3,495)	1,621 (3,575)	1,684 (3,715)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,002 (2,210)			1,061 (2,340)
	Rear	kg (lb)	1,064 (2,345)			1,070 (2,360)
	Total	kg (lb)	2,066 (4,555)			2,131 (4,700)

*1: Excludes the weights of audio, VDC

3. TAIWAN SPEC. VEHICLE

Model			Wagon
			2.5 L
			AWD
			4AT
Curb weight (C.W.)	Front	kg (lb)	882 (1,945)
	Rear	kg (lb)	739 (1,630)
	Total	kg (lb)	1,621 (3,575)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,002 (2,210)
	Rear	kg (lb)	1,064 (2,345)
	Total	kg (lb)	2,066 (4,555)

4. CHILE SPEC. VEHICLE

Model			Sedan	Wagon
			3.0 L	
			AWD	
			4AT	
Curb weight (C.W.)	Front	kg (lb)	950 (2,095)	950 (2,095)
	Rear	kg (lb)	694 (1,530)	741 (1,635)
	Total	kg (lb)	1,644 (3,625)	1,691 (3,730)
Gross vehicle weight (G.V.W.)	Front	kg (lb)	1,061 (2,340)	1,061 (2,340)
	Rear	kg (lb)	989 (2,180)	1,070 (2,360)
	Total	kg (lb)	2,050 (4,520)	2,131 (4,700)

MEMO

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

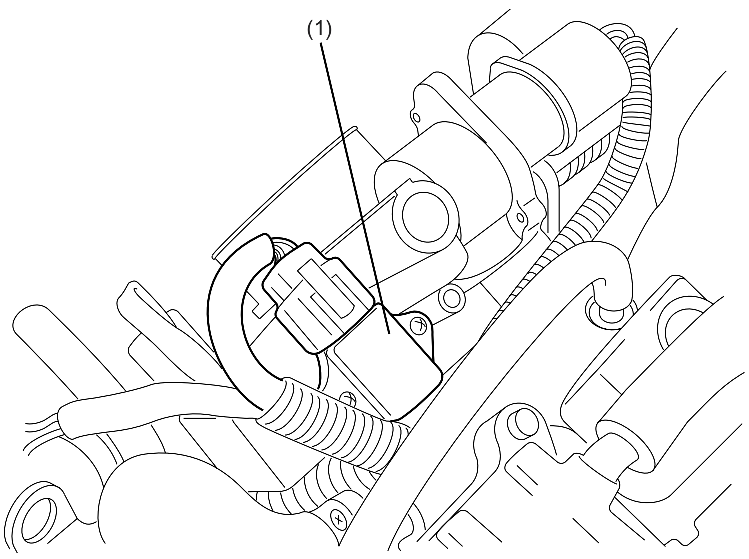
2. Air Line

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.

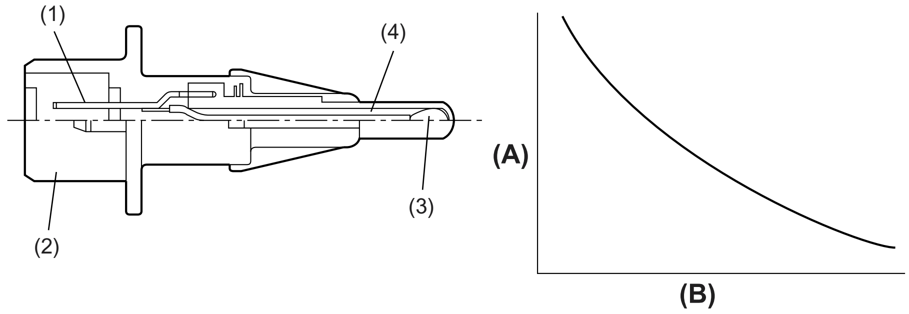


FU-00213

(1) Pressure sensor

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.

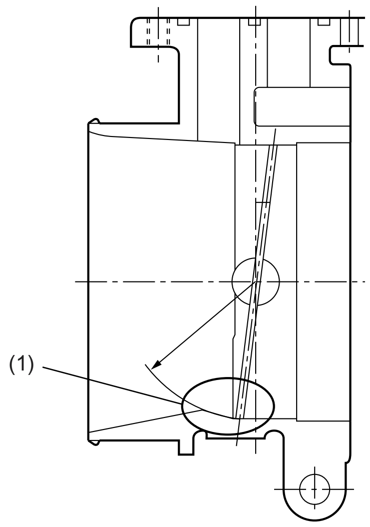


FU-00214

(1)	Terminal	(3)	Thermistor	**(A)**	Resistance (Ω)
(2)	Connector	(4)	Housing	**(B)**	Intake air temperature (°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 vehicles)

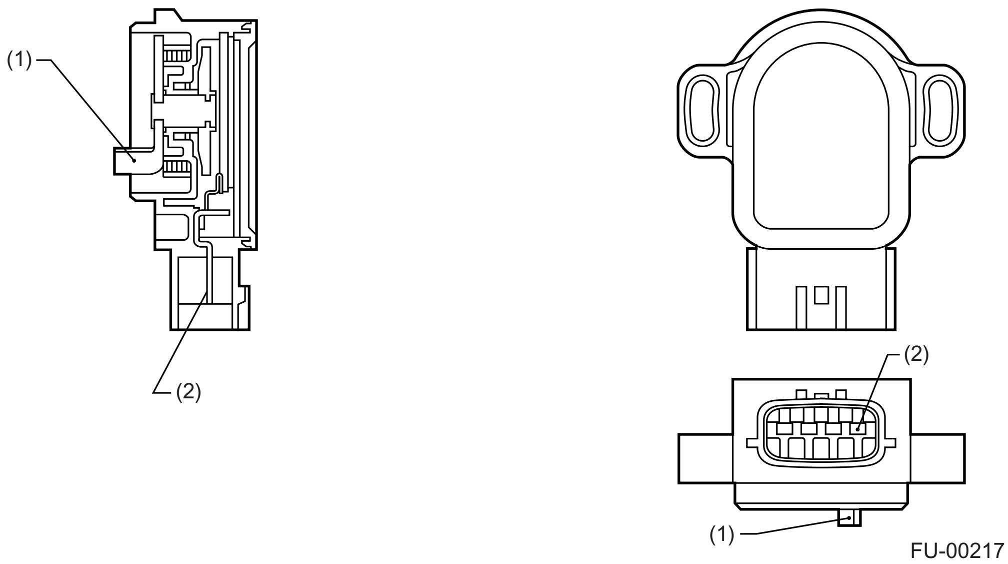


FU-00216

(1) Spherical surface

E: THROTTLE POSITION SENSOR

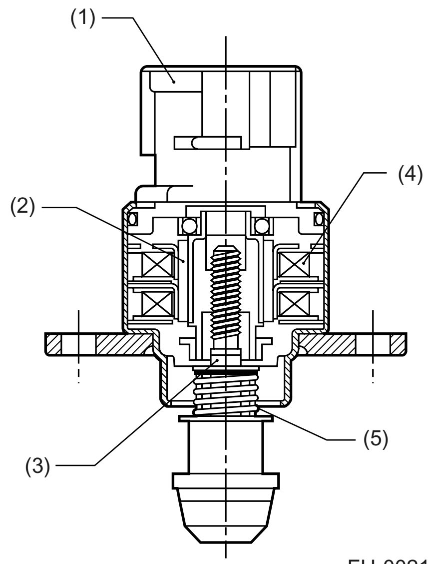
- The throttle position sensor is mounted in the throttle body and linked to the throttle valve.
- The throttle position sensor sends the ECM voltage signal corresponding to the opening of the throttle valve. When the sensor's output voltage exceeds a predetermined level, the ECM interprets it as complete 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.

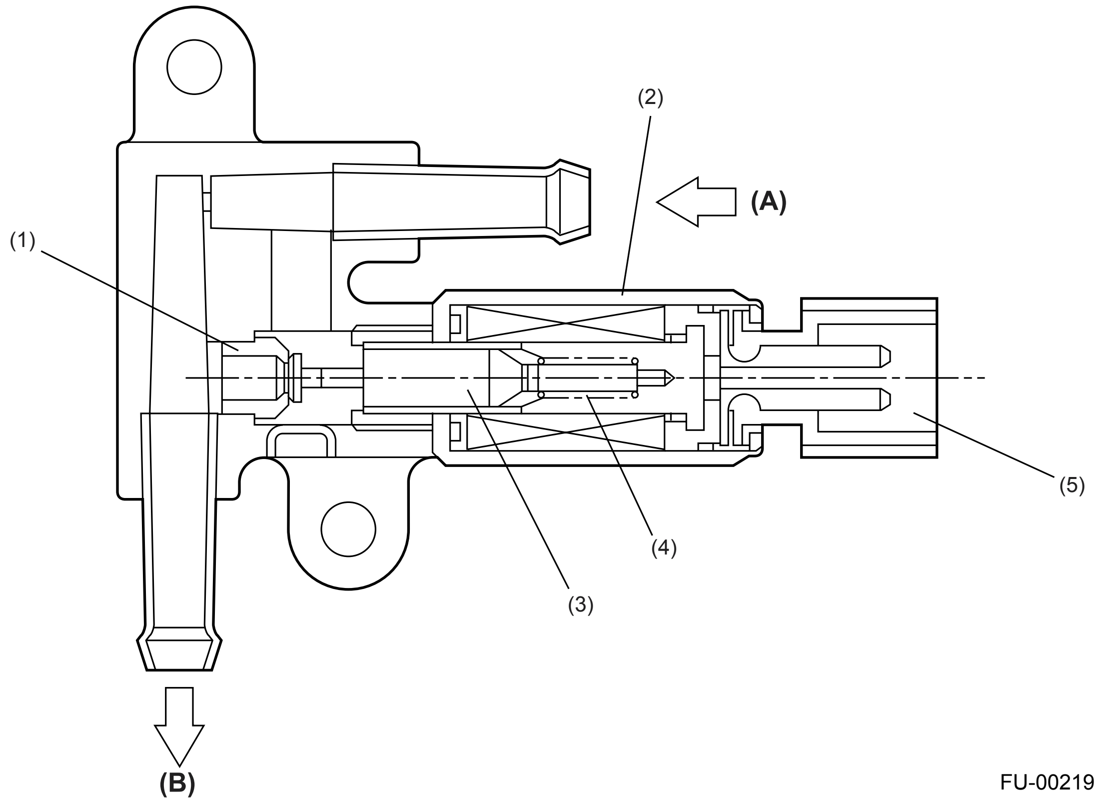


FU-00218

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

G: AIR ASSIST INJECTOR SOLENOID VALVE

The air assist injector solenoid valve is located in the piping between the throttle body and the injector and secured to the intake manifold. This solenoid valve is opened or closed by the signals from the ECM, adjusting the flow rate of air supplied to the injector.



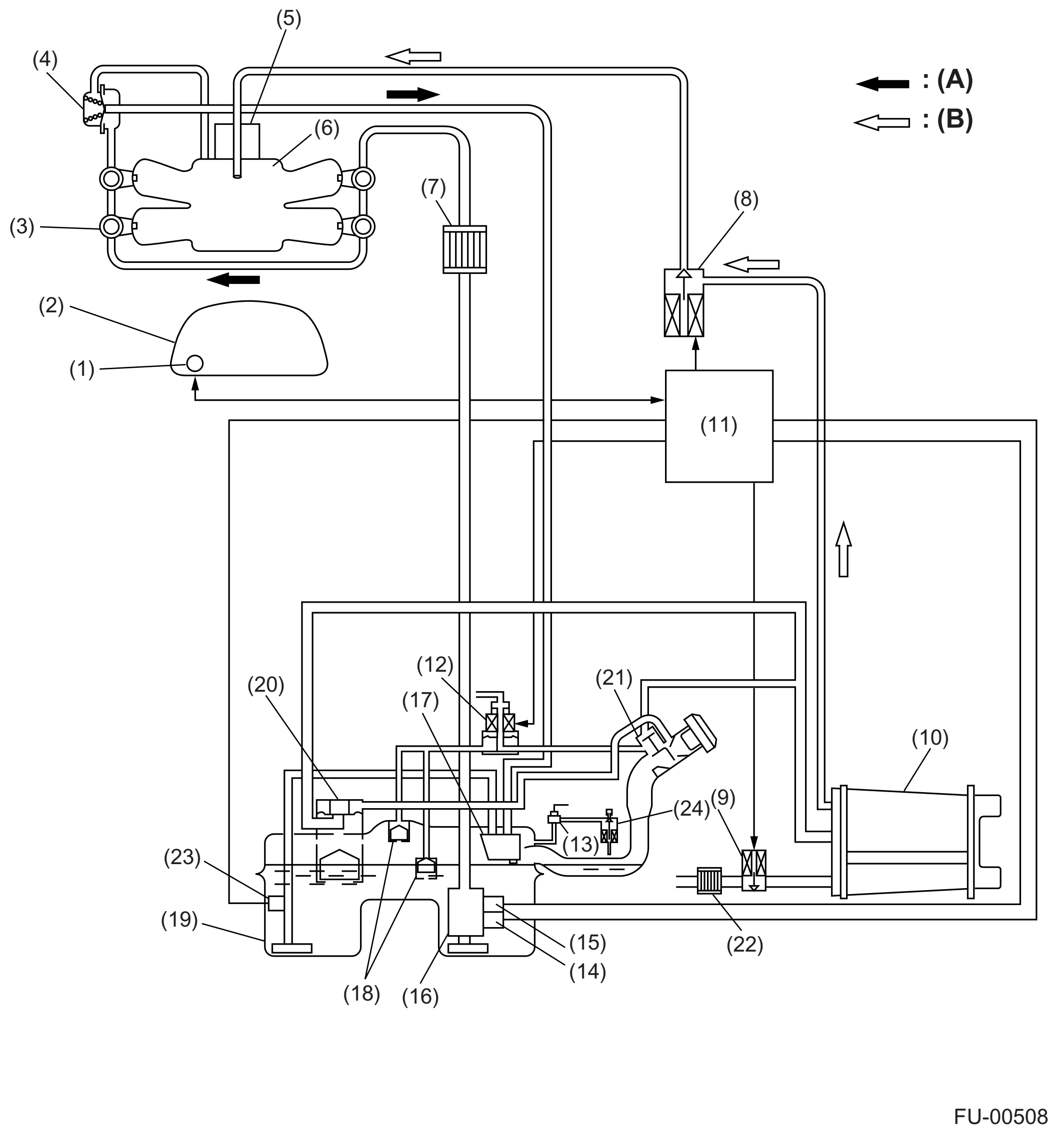
- (1) Valve seat
- (2) Solenoid
- (3) Plunger and valve
- (4) Spring
- (5) Connector

- **(A)** From idle air control valve
- **(B)** To injector

3. Fuel Line

A: GENERAL

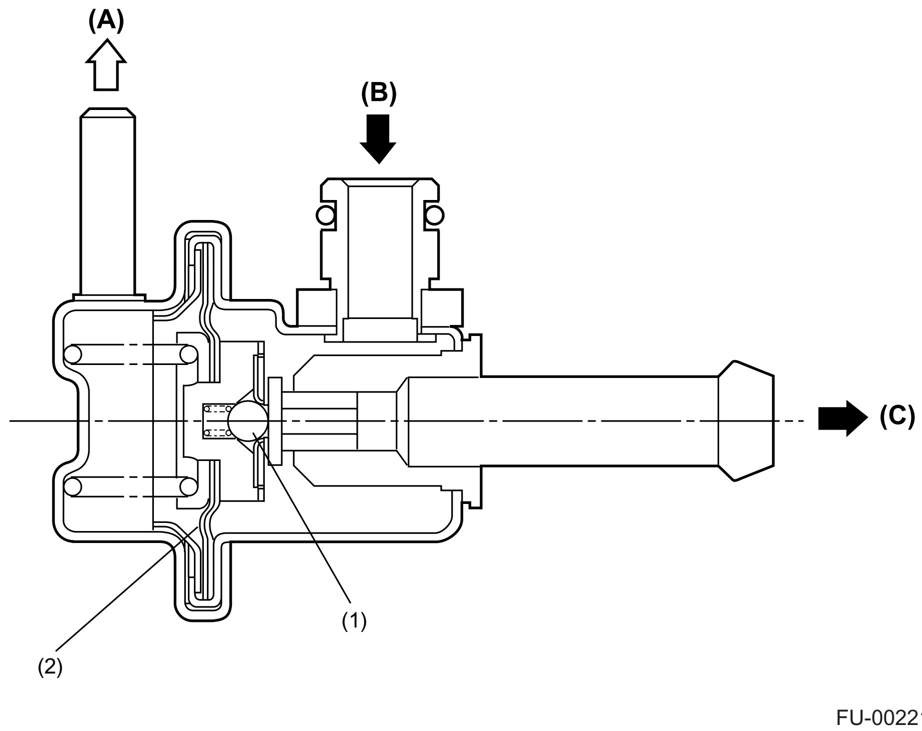
- The fuel pressurized by the fuel tank inside pump is delivered to each fuel injector by way of the fuel pipe and fuel filter. Fuel injection pressure is regulated to an optimum level by the pressure regulator.
- Each injector injects fuel into the intake port of the corresponding cylinder where the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



(1)	Fuel gauge	(10)	Canister	(19)	Fuel tank
(2)	Combination meter	(11)	ECM	(20)	Vent valve
(3)	Fuel injector	(12)	Pressure control solenoid valve	(21)	Shut-off valve
(4)	Pressure regulator	(13)	Fuel tank pressure sensor	(22)	Drain filter
(5)	Throttle body	(14)	Fuel temperature sensor	(23)	Fuel sub level sensor
(6)	Intake manifold	(15)	Fuel level sensor	(24)	Fuel tank sensor control valve
(7)	Fuel filter	(16)	Fuel pump		
(8)	Purge control solenoid valve	(17)	Jet pump	**(A)**	Fuel line
(9)	Drain valve	(18)	Fuel cut valve	**(B)**	Fuel evaporation line

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/cm^2, 43.4 psi) to precisely control the amount of injected fuel.



(1) Relief valve
(2) Diaphragm

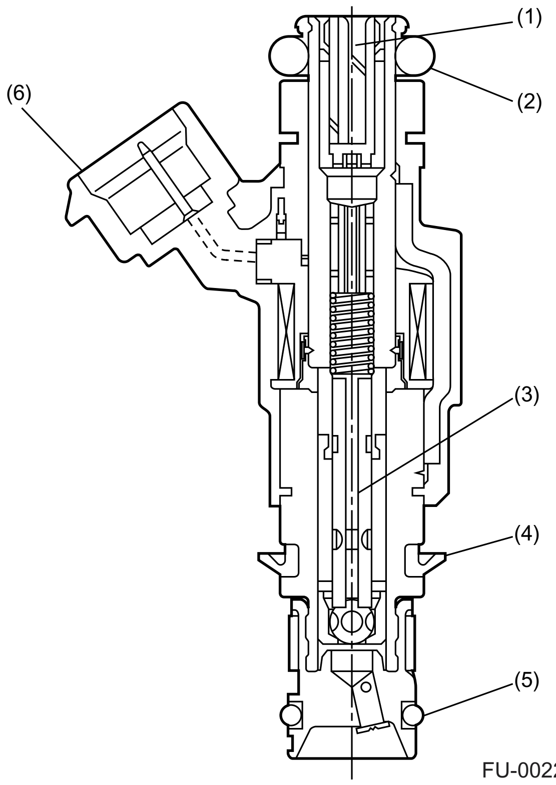
(A) To intake manifold
(B) Fuel IN
(C) Fuel OUT

C: FUEL INJECTOR

- The MFI system employs top feed type fuel injectors with an air assist feature.
- 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 injectors 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.
- Fuel atomization is enhanced using assist air supplied from the air assistant injector solenoid valve passing through the passage formed in the intake manifold at the area in which each injector is installed. This contributes not only to higher combustion efficiency and higher output but also to cleaner exhaust emissions.

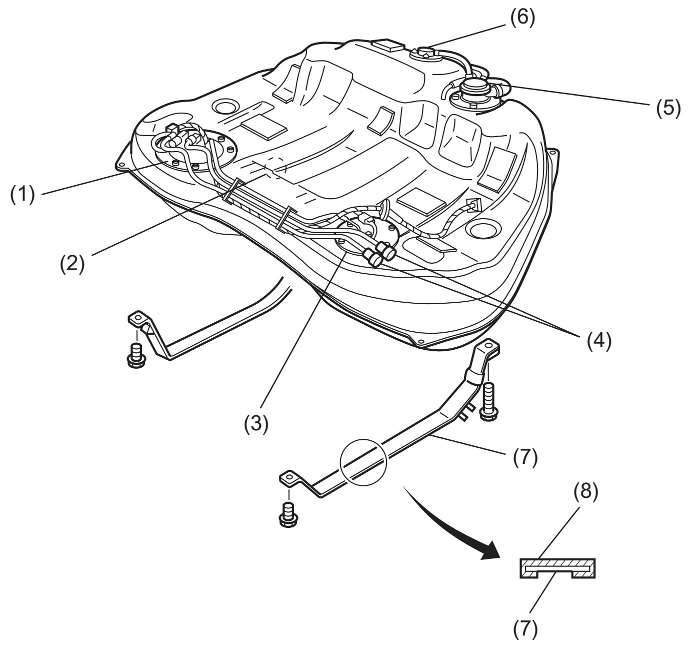


(1) Filter	(4) Seal
(2) O-ring	(5) O-ring
(3) Plunger	(6) Connector

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.

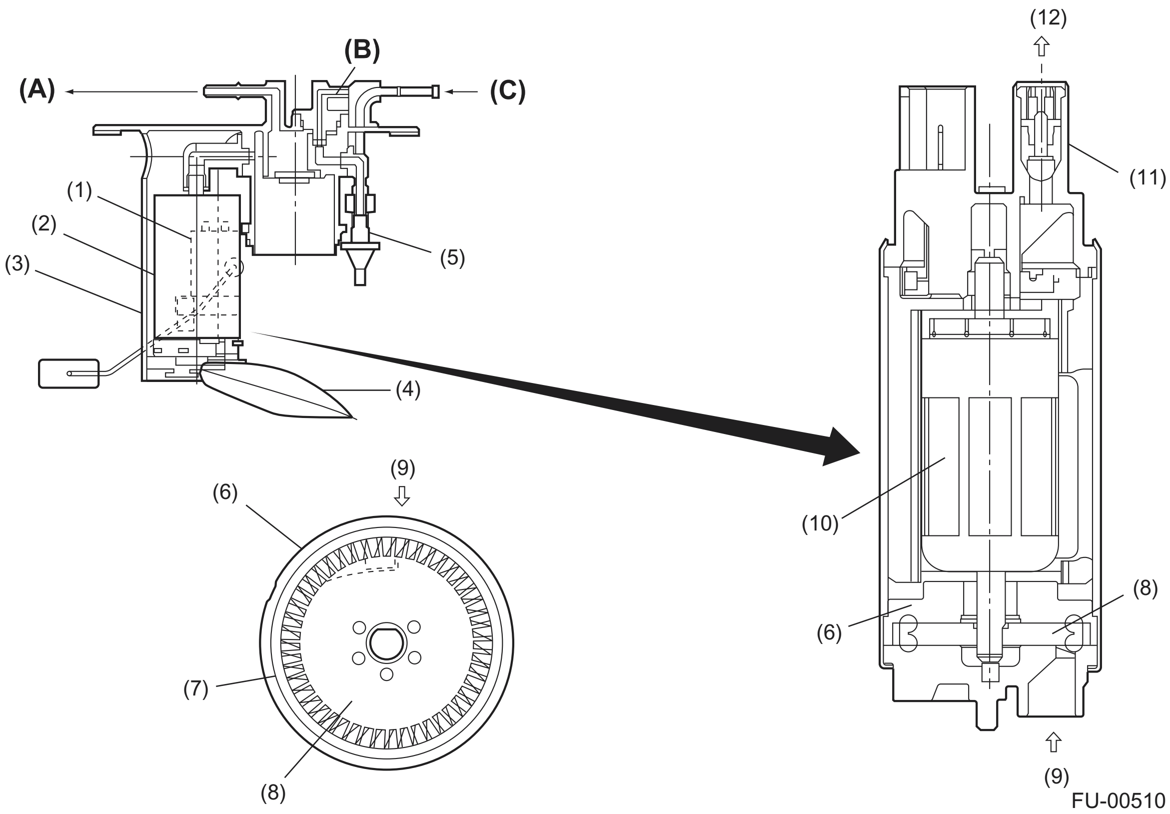


(1)	Fuel pump and fuel level sensor assembly	(5)	Vent valve
(2)	Fuel cut valve (sub-compartment)	(6)	Fuel cut valve (main compartment)
(3)	Fuel sub level sensor	(7)	Cushion
(4)	Quick connector	(8)	Steel

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.

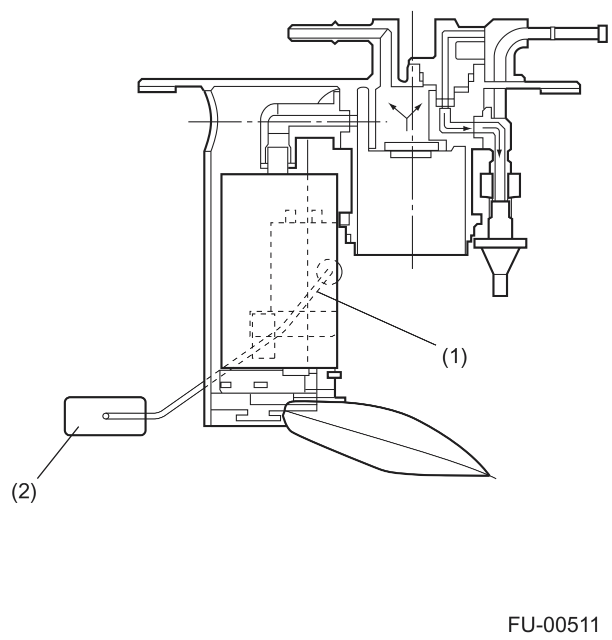


(1)	Fuel level sensor	(7)	Fuel passage	**(A)**	To engine (delivery line)
(2)	Fuel pump	(8)	Impeller	**(B)**	From engine (return line)
(3)	Pump cover	(9)	Suction	**(C)**	From sub tank
(4)	Filter	(10)	Motor armature		
(5)	Jet pump	(11)	Check valve		
(6)	Pump casing	(12)	Discharge		

● 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

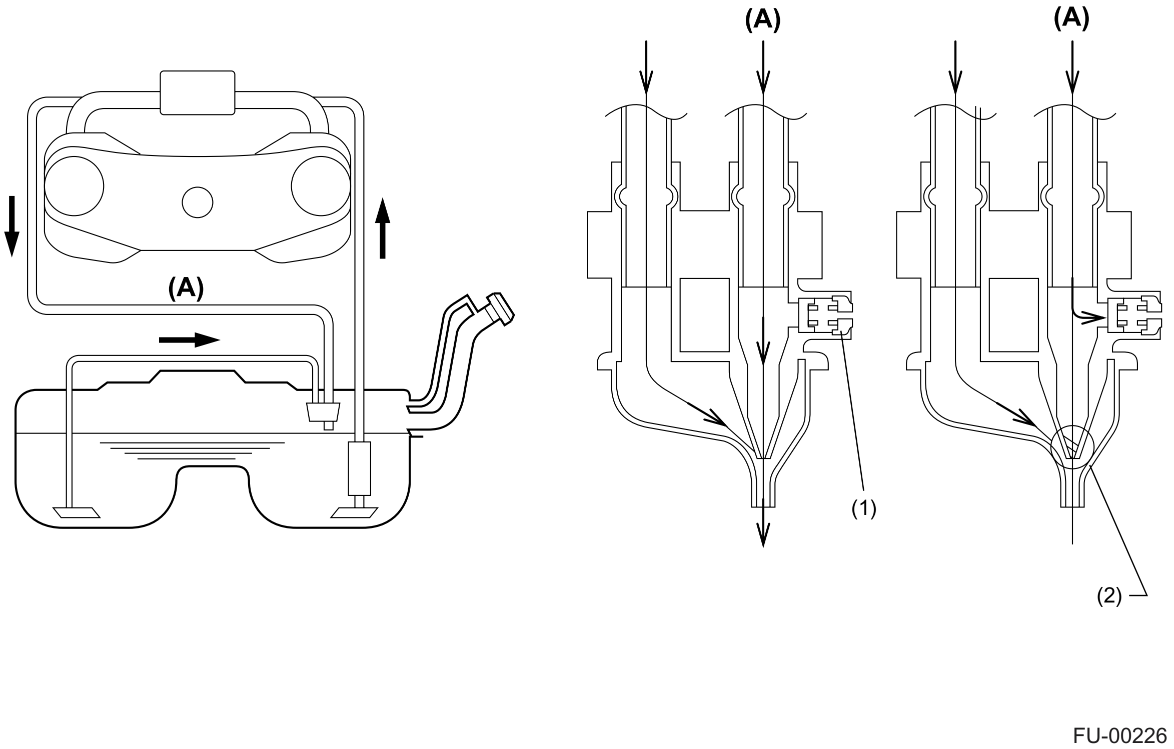
The fuel level sensor is integrated with the fuel pump which is located in the fuel tank. The sensor outputs an electric resistance signal that varies with movement of its float to indicate the level of the fuel remaining in the tank.



(1) Fuel level sensor
(2) Float

3. JET PUMP

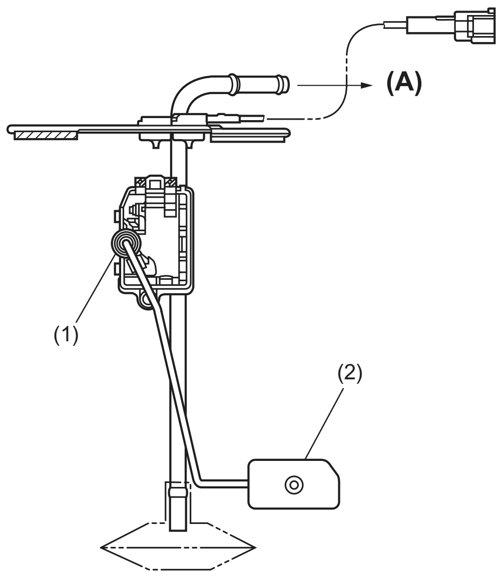
- The jet pump utilizes the velocity of fuel returning from the engine to produce negative pressure in it.
- Using the pumping effect produced by the negative pressure, the jet pump transfers fuel from the sub-compartment to the main compartment of the fuel tank.
- When the return line nozzle is clogged,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



(1) Relief valve
(2) Nozzle
(A) Return line

F: SUB-COMPARTMENT FUEL LEVEL SENSOR

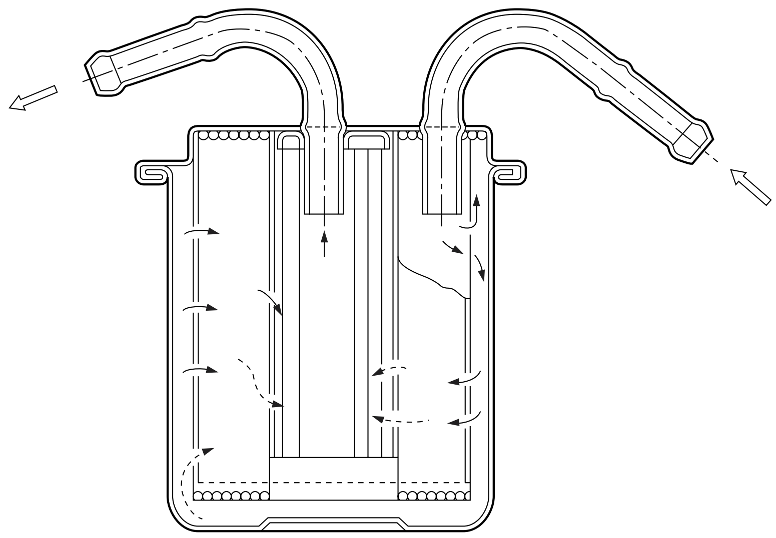
This sensor detects the level of the fuel in the sub-compartment (the compartment in which the fuel pump is not located) and acts as part of the fuel transfer line when the jet pump is in operation to maintain the fuel in both compartments at the same level.



(1)	Fuel level sensor	**(A)**	To jet pump
(2)	Float		

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.

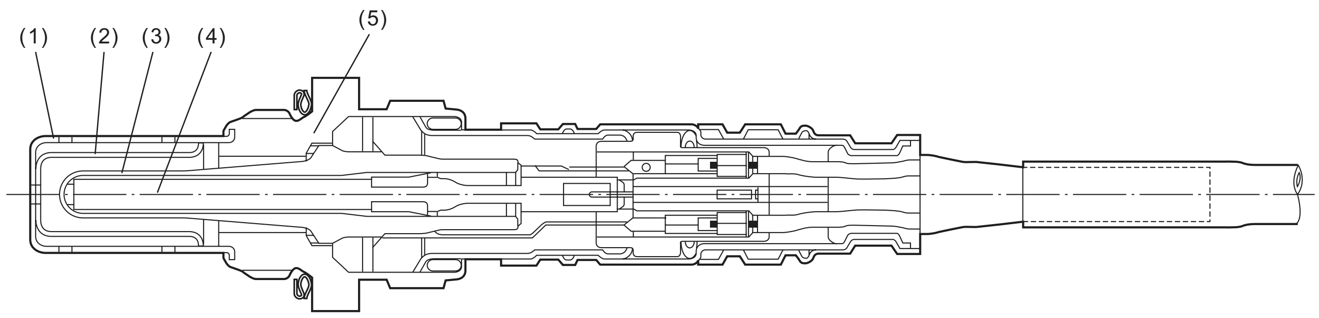


FU-00228

4. Sensors and Switches

A: FRONT OXYGEN (A/F) SENSOR

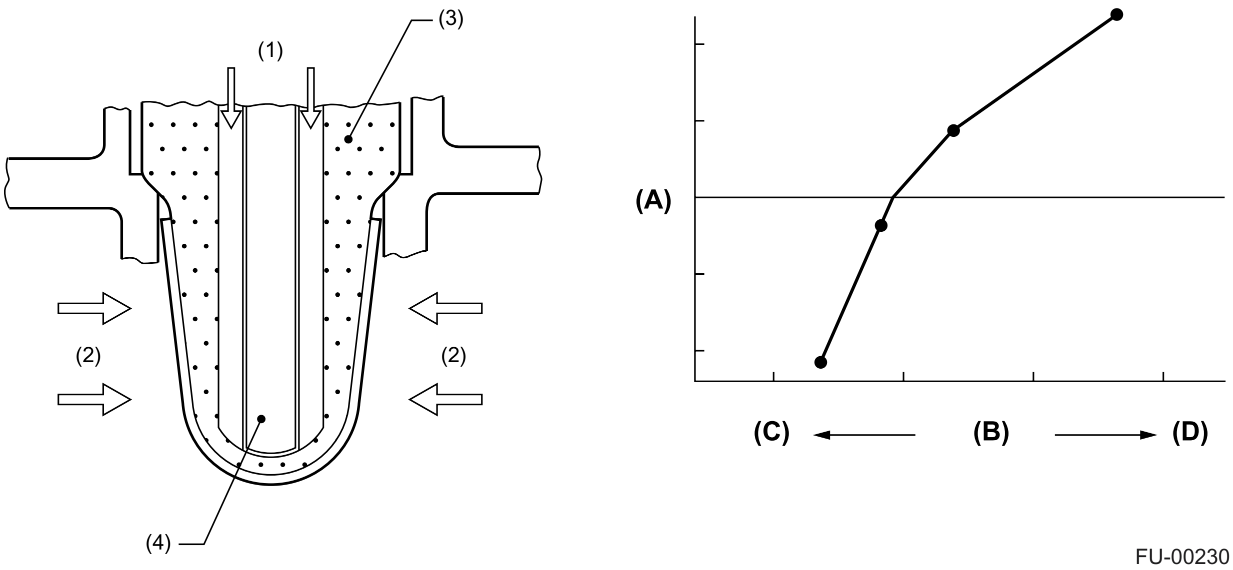
- The front oxygen sensor uses zirconium oxide (ZrO_2) which is a solid electrolyte, at portions exposed to exhaust gas.
- The zirconium oxide has the property of generating electromotive force when its both sides are exposed to oxygen ions of different concentration and the magnitude of this electromotive 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).



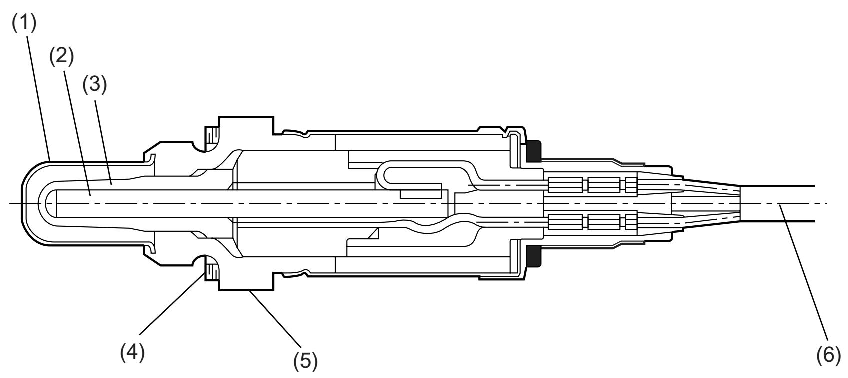
FU-00230

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

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

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.



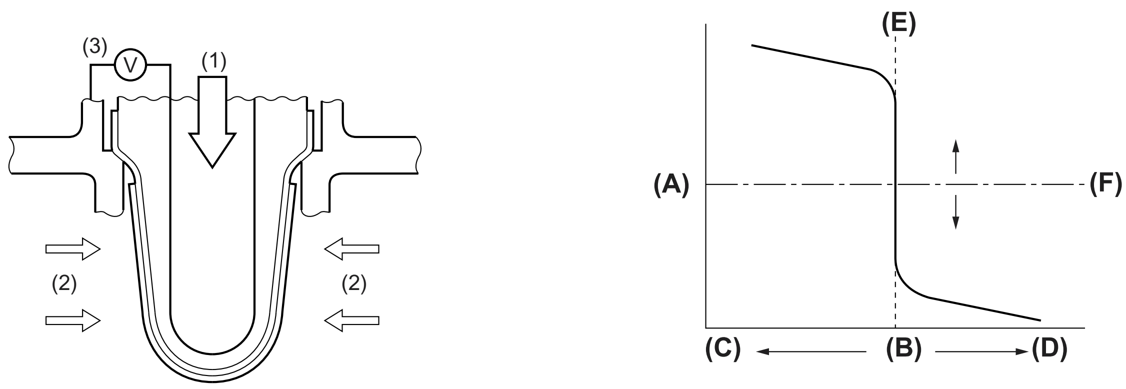
FU-00231

(1) Protection tube	(4) Gasket
(2) Ceramic heater	(5) Sensor housing
(3) Zirconia tube	(6) Harness

● 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).



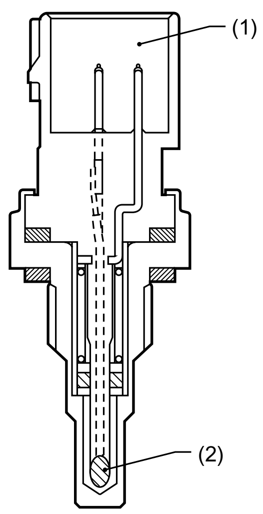
FU-00232

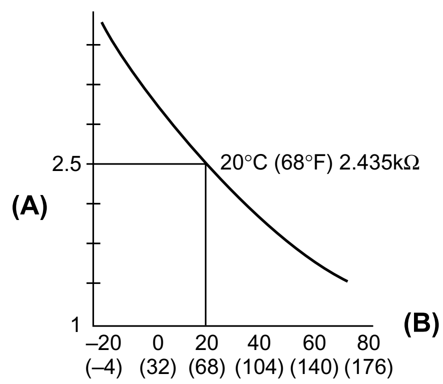
(1) Atmospheric air
(2) Exhaust gas
(3) Electromotive force

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

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.





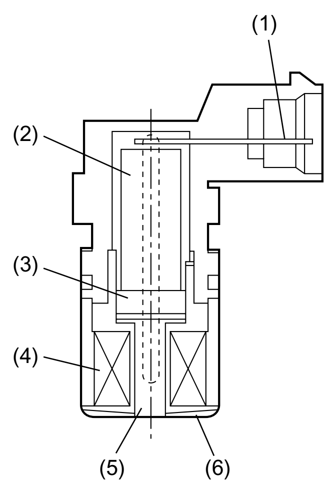
FU-00624

(1) Connector
(2) Thermistor element

(A) Resistance (Ω)
(B) Temperature °C (°F)

D: CRANKSHAFT POSITION SENSOR

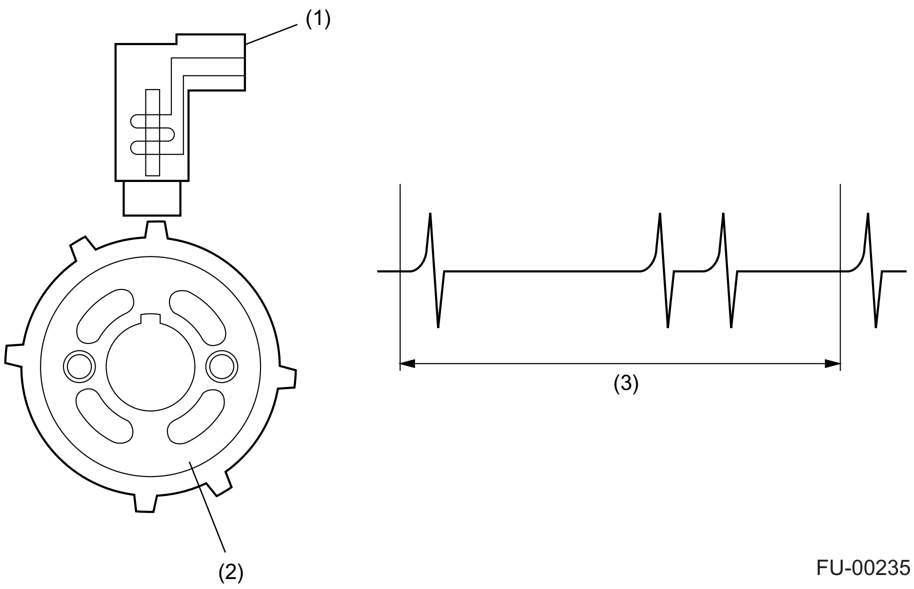
- The crankshaft position sensor is installed on the oil pump which is located in the front center portion of the cylinder block. The sensor generates a pulse when one of the teeth on the perimeter of the crankshaft sprocket (rotating together with the crankshaft) passes in front of it. The ECM determines 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	(4)	Coil
(2)	Yoke core	(5)	Core
(3)	Magnet	(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.

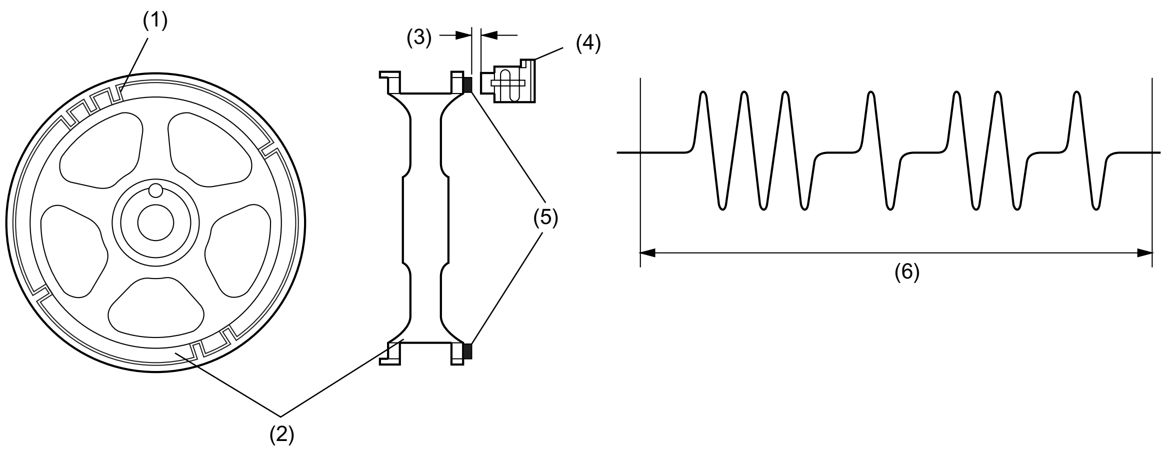


(1) Crankshaft position sensor
(2) Crankshaft sprocket
(3) Crankshaft half rotation

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.

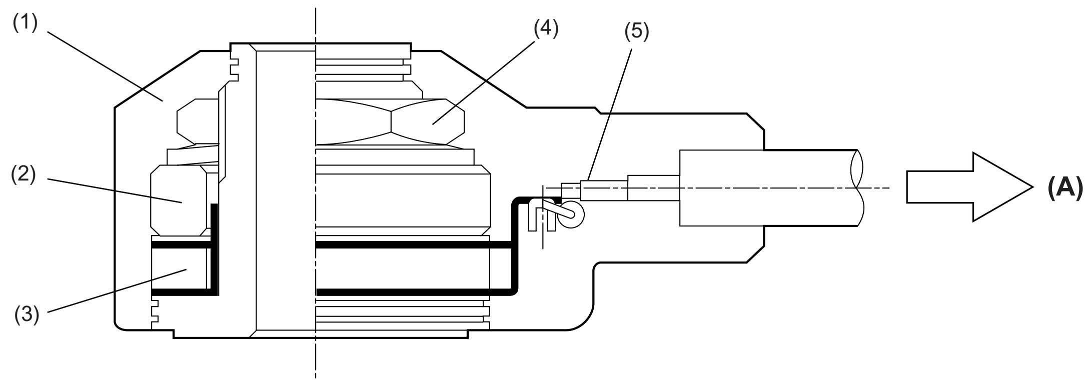


FU-00236

(1) Boss
(2) Camshaft sprocket
(3) Air gap
(4) Camshaft position sensor
(5) Boss
(6) Camshaft one rotation (Crankshaft two rotations)

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 engine harness.



FU-00418

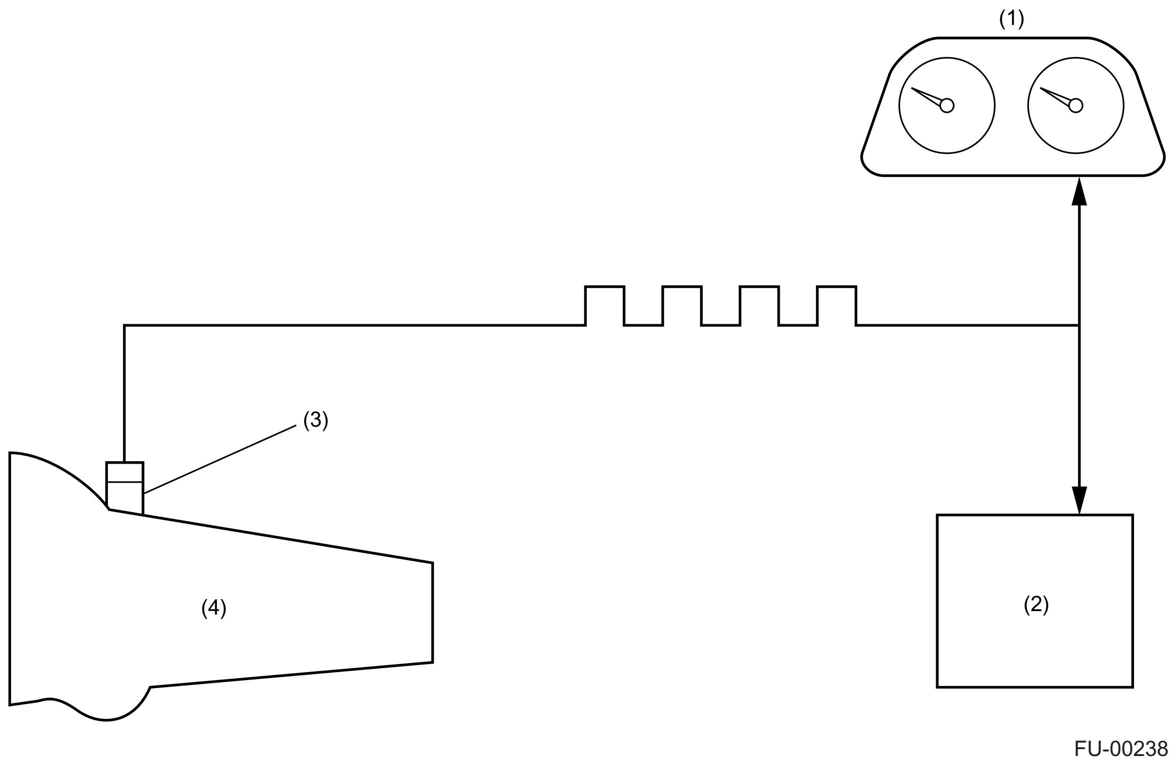
(1) Case
(2) Weight
(3) Piezo-electric element
(4) Nut
(5) Resistance

(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.

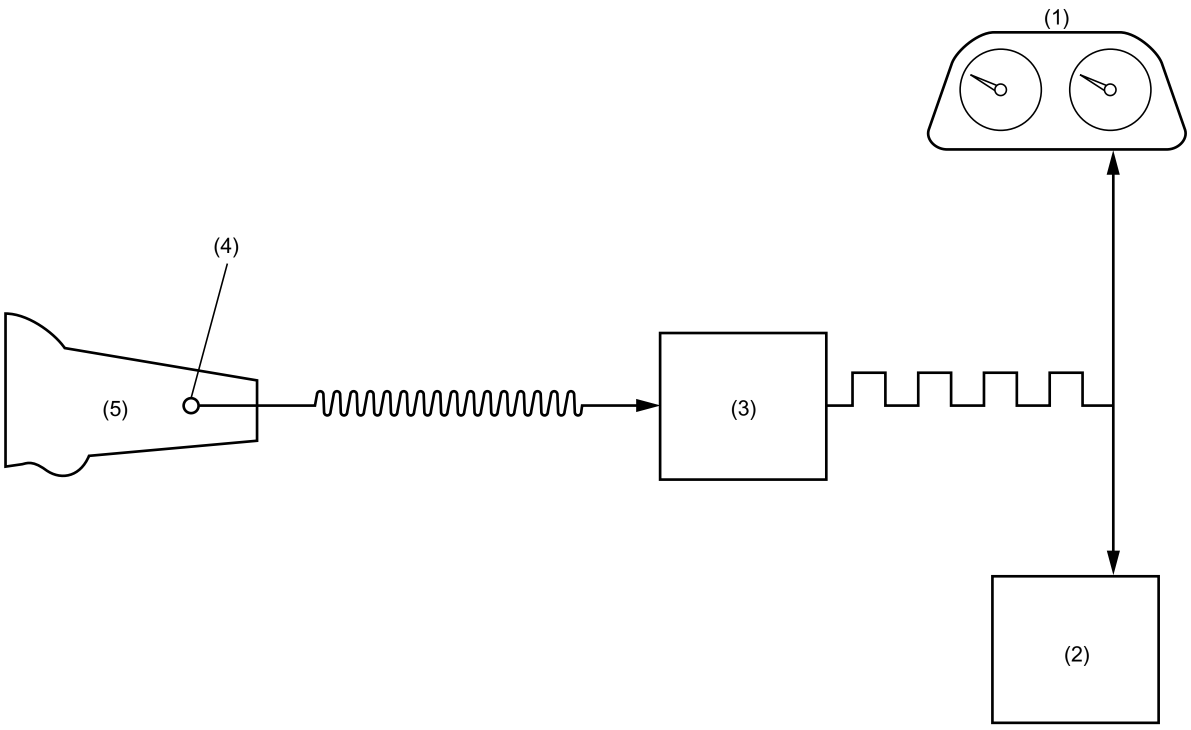


(1) Combination meter
(2) ECM
(3) Vehicle speed sensor
(4) Transmission

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 (H4SO) – Emission Control (Aux. Emission Control Devices) Evaporative Emission Control System”.
*2: Radiator fan control is described under “CO (H4SO) – Cooling”.

B: INPUT AND OUTPUT SIGNALS

Signal	Unit	Function
Input signals	Intake air pressure sensor	Detects the intake air pipe (absolute) pressure.
	Intake air temperature sensor	Detects the intake air temperature.
	Atmospheric pressure sensor (incorporated in ECM)	Detects the amount of intake air (measures 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 the 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.
	Park/Neutral position switch (AT)	Detects shift positions.
	Torque control signal	Controls engine torque.
	Heater circuit of front and rear oxygen sensors	Detects abnormality in the heater circuit of the front and rear oxygen sensors.
	Diagnostics of TCM (AT)	Detects the self-diagnostics of TCM.
	A/C switch	Detects ON-OFF operation of the A/C switch.
	Fuel temperature sensor	Detects the temperature of the fuel in the fuel tank.
	Fuel level sensor	Detects the level of the fuel in the fuel tank.
	Fuel tank pressure sensor	Detects the evaporation gas pressure 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 injector	Activates an injector.
	Ignition signal	Turns the primary ignition coil current ON or OFF.
	Fuel pump relay	Turns the fuel pump relay ON or OFF.
	A/C control 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	Controls ON/OFF of the main power supply relay.
	Pressure control solenoid valve	Controls evaporation pressure in fuel tank.
	Drain valve	Closes the evaporation line between the fuel tank and canister to detect leakage of evaporation gases.

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 × 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:

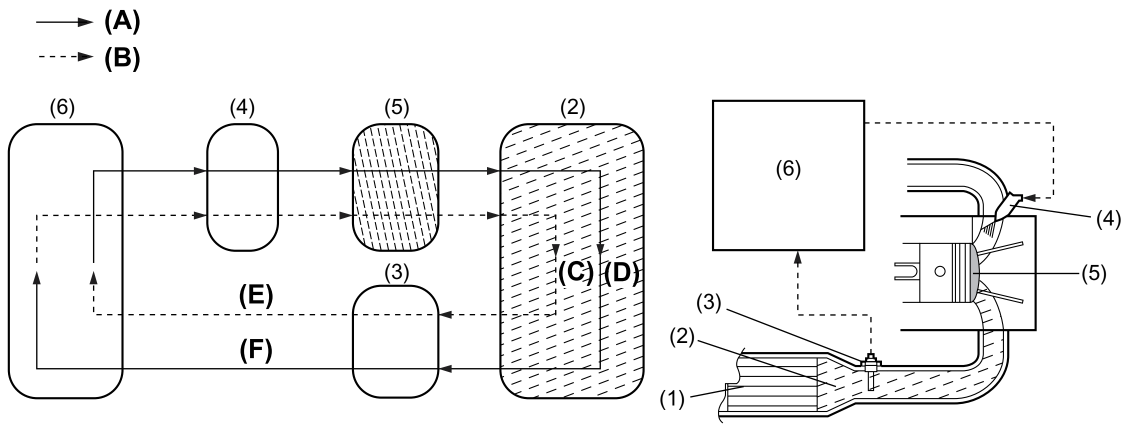
This factor is used to increase the fuel injection duration depending on the relationship between the throttle position sensor signal and manifold pressure sensor signal.

- 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

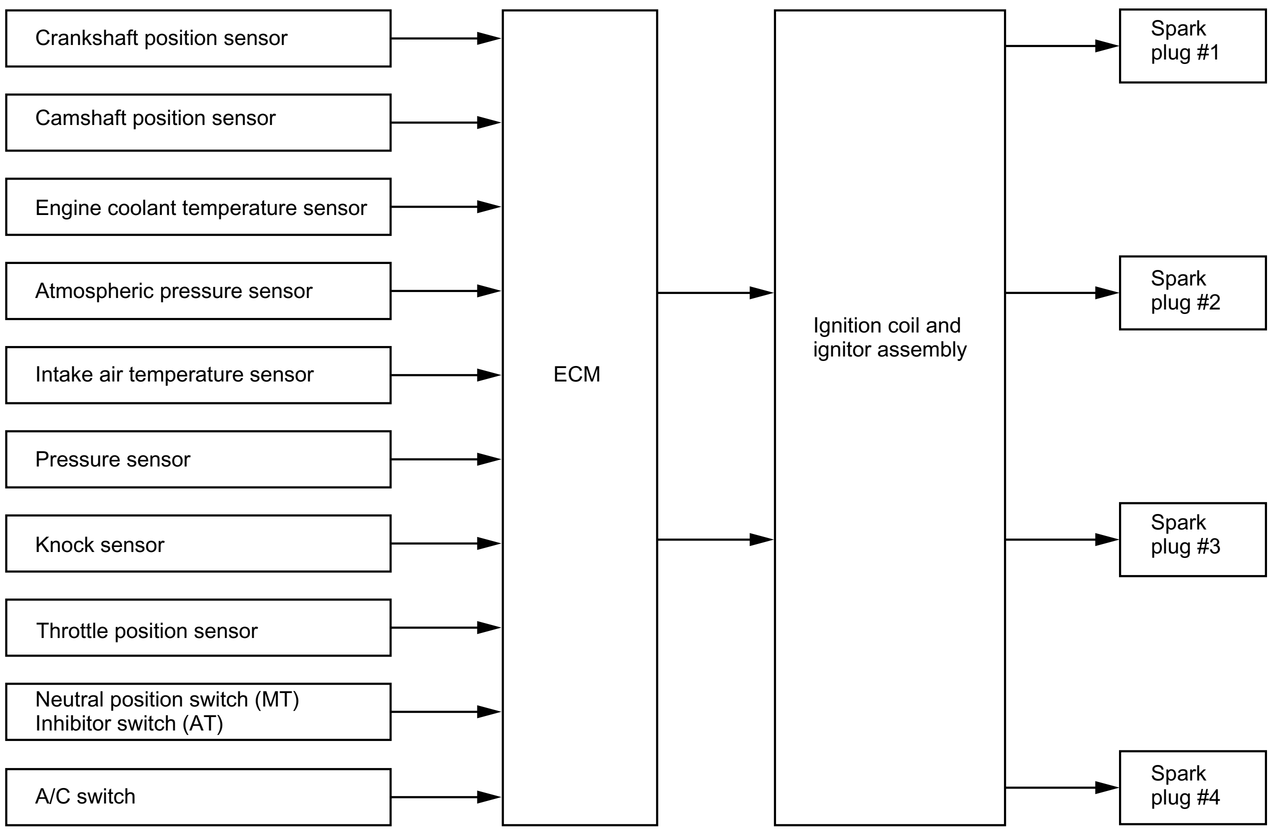
4. LEARNING FEATURE

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.

D: IGNITION CONTROL

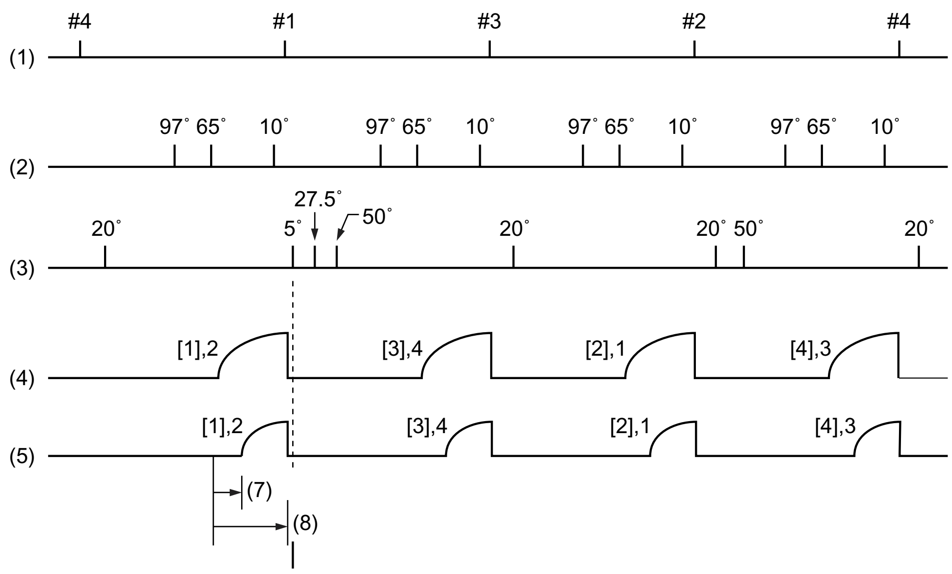
- The ECM determines operating condition of the engine based on signals from the pressure sensor, engine coolant temperature sensor, intake air temperature sensor, crankshaft position sensor and other sources. It then selects the ignition timing most appropriate for the condition thus determined from 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-upEngine 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-00241

- 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.

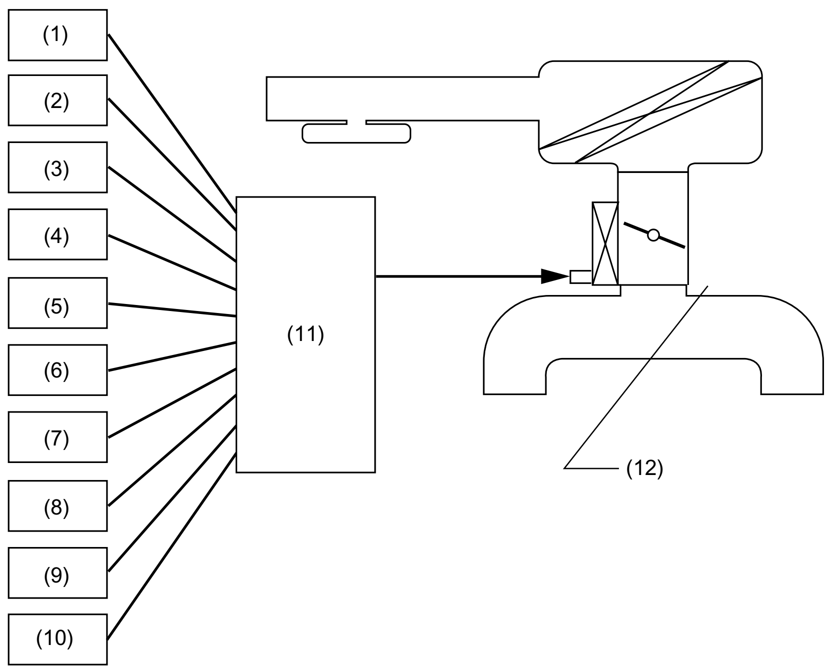


FU-00242

(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

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
(2) Pressure sensor
(3) Crankshaft position sensor
(4) Camshaft position sensor
(5) Throttle position sensor
(6) Engine coolant temperature sensor
(7) Vehicle speed sensor
(8) Ignition switch
(9) A/C switch
(10) Neutral position switch (MT)
Inhibitor switch (AT)
(11) ECM
(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.)

1. System Overview

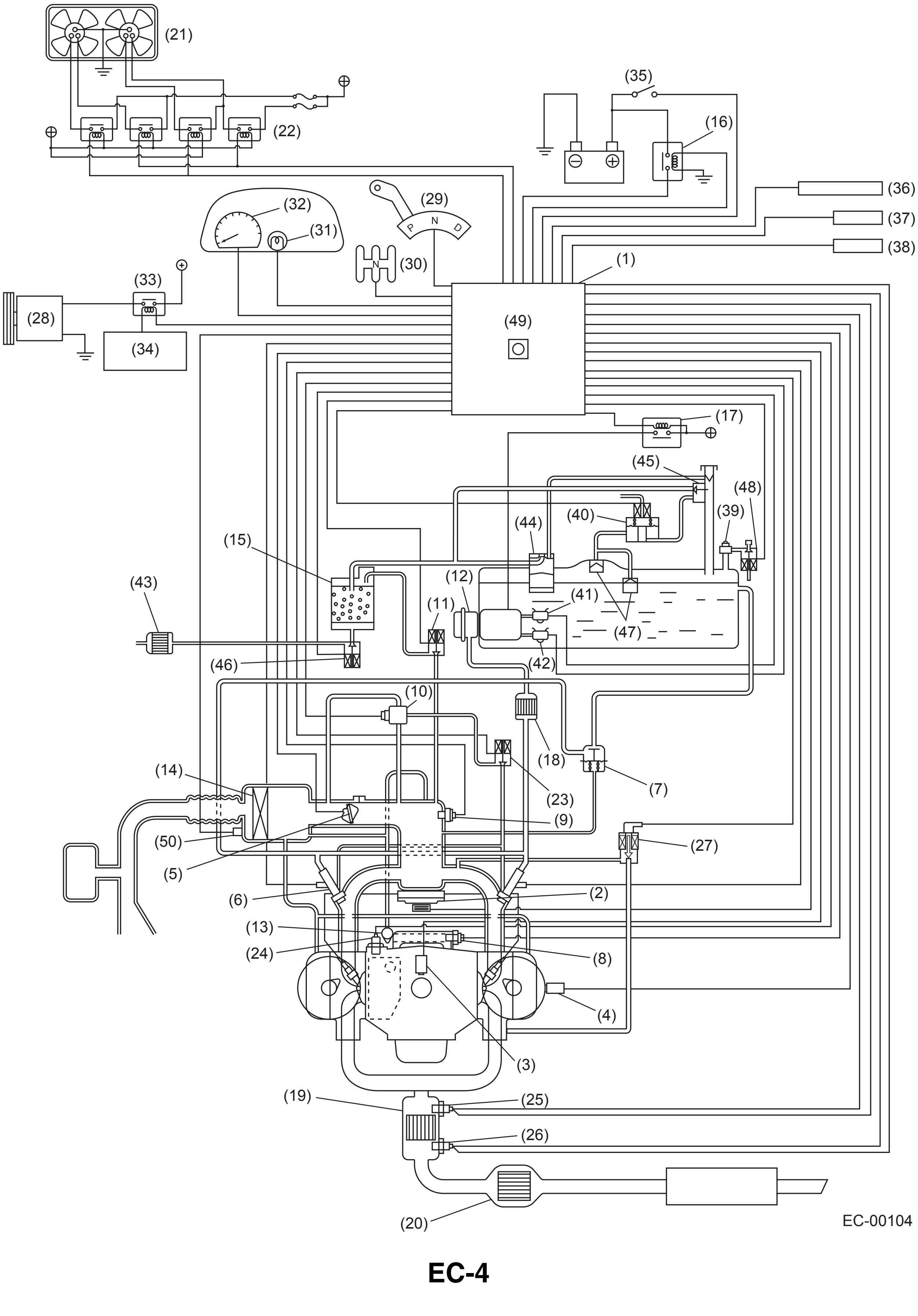
There are three emission control systems which are as follows:

- Crankcase emission control system
- Exhaust emission control system
  - Catalyst system
  - Air/fuel (A/F) control system
  - Ignition control system
- Evaporative emission control system
  - On-board refueling vapor recovery (ORVR) system

<table>
<tr><td colspan="3">Item</td><td>Main components</td><td>Function</td></tr>
<tr><td colspan="3">Crankcase emission control system</td><td>Positive crankcase ventilation (PCV) valve</td><td>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.</td></tr>
<tr><td rowspan="13">Exhaust emission control system</td><td rowspan="2">Three-way catalyst system</td><td>Front</td><td rowspan="2">Three-way catalyst</td><td rowspan="2">Oxidizes HC and CO contained in exhaust gases as well as reducing NOx.</td></tr>
<tr><td>Rear</td></tr>
<tr><td colspan="2" rowspan="6">Air/fuel (A/F) control system</td><td>Engine control module (ECM)</td><td>Receives input signals from various sensors, compares signals with stored data, and emits a signal for optimal control of air-fuel mixture ratio.</td></tr>
<tr><td>Front oxygen (A/F) sensor</td><td>Detects quantity of oxygen contained exhaust gases.</td></tr>
<tr><td>Rear oxygen sensor</td><td>Detects density of oxygen contained exhaust gases.</td></tr>
<tr><td>Throttle position sensor</td><td>Detects throttle opening.</td></tr>
<tr><td>Intake air pressure sensor</td><td>Detects absolute pressure of intake manifold.</td></tr>
<tr><td>Intake air temperature sensor</td><td>Detects intake air temperature of air cleaner case.</td></tr>
<tr><td colspan="2" rowspan="5">Ignition control system</td><td>ECM</td><td>Receives various signals, compares signals with basic data stored in memory, and emits a signal for optimal control of ignition timing.</td></tr>
<tr><td>Crankshaft position sensor</td><td>Detects engine speed (revolution).</td></tr>
<tr><td>Camshaft position sensor</td><td>Detects reference signal for combustion cylinder discrimination.</td></tr>
<tr><td>Engine coolant temperature sensor</td><td>Detects coolant temperature.</td></tr>
<tr><td>Knock sensor</td><td>Detects engine knocking.</td></tr>
<tr><td colspan="3" rowspan="3">Evaporative emission control system</td><td>Canister</td><td>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.</td></tr>
<tr><td>Purge control solenoid valve</td><td>Receives a signal from ECM and controls purge of evaporative gas absorbed by canister.</td></tr>
<tr><td>Pressure control solenoid valve</td><td>Controls evaporation pressure in fuel tank.</td></tr>
<tr><td colspan="3" rowspan="2">ORVR system</td><td>Vent valve</td><td>Closes the port to the canister when the fuel tank is full of fuel.</td></tr>
<tr><td>Drain valve</td><td>Closes the evaporation line by receiving a signal from ECM to check the evaporation gas leak.</td></tr>
</table>

MEMO

2. Schematic Diagrams



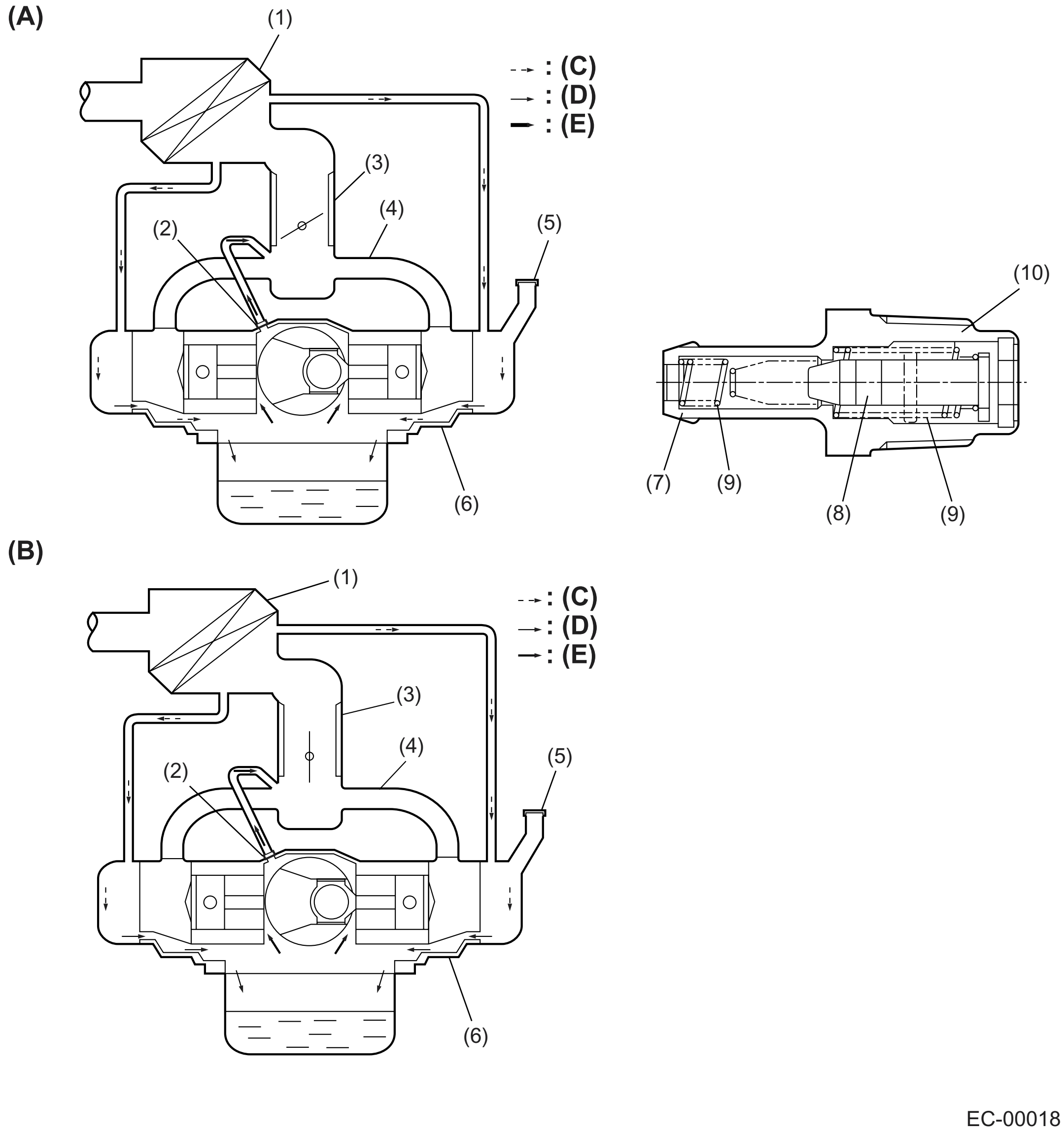
(1) Engine control module (ECM)
(2) Ignition coil and ignitor assembly
(3) Crankshaft position sensor
(4) Camshaft position sensor
(5) Throttle position sensor
(6) Fuel Injector
(7) Pressure regulator
(8) Engine coolant temperature sensor
(9) Pressure sensor
(10) Idle air control solenoid valve
(11)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

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.



(1)	Air cleaner case	(6)	Crankcase	**(A)**	Part-throttle condition
(2)	PCV valve	(7)	Case	**(B)**	Wide-open-throttle condition
(3)	Throttle body	(8)	Valve	**(C)**	Fresh air
(4)	Intake manifold	(9)	Spring	**(D)**	Mixture of air and blow-by gas
(5)	Oil filler cap	(10)	PCV valve	**(E)**	Blow-by gas

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 ceramic (carrier). To avoid damaging the catalyst, only unleaded gasoline should be used.
- The catalyst reduces HC, CO and NOx 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

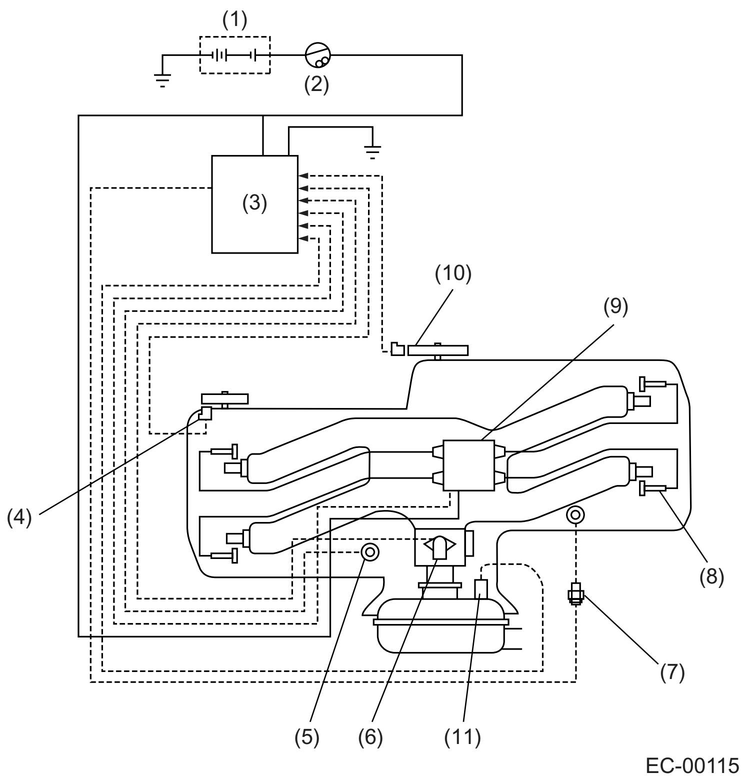
- The air/fuel (A/F) control system makes a correction to the basic fuel injection duration in accordance with the signals from the front oxygen (A/F) sensor and the rear oxygen sensor so that the stoichiometric ratio is maintained, thus ensuring most effective exhaust gas purification by the three-way 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.

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.

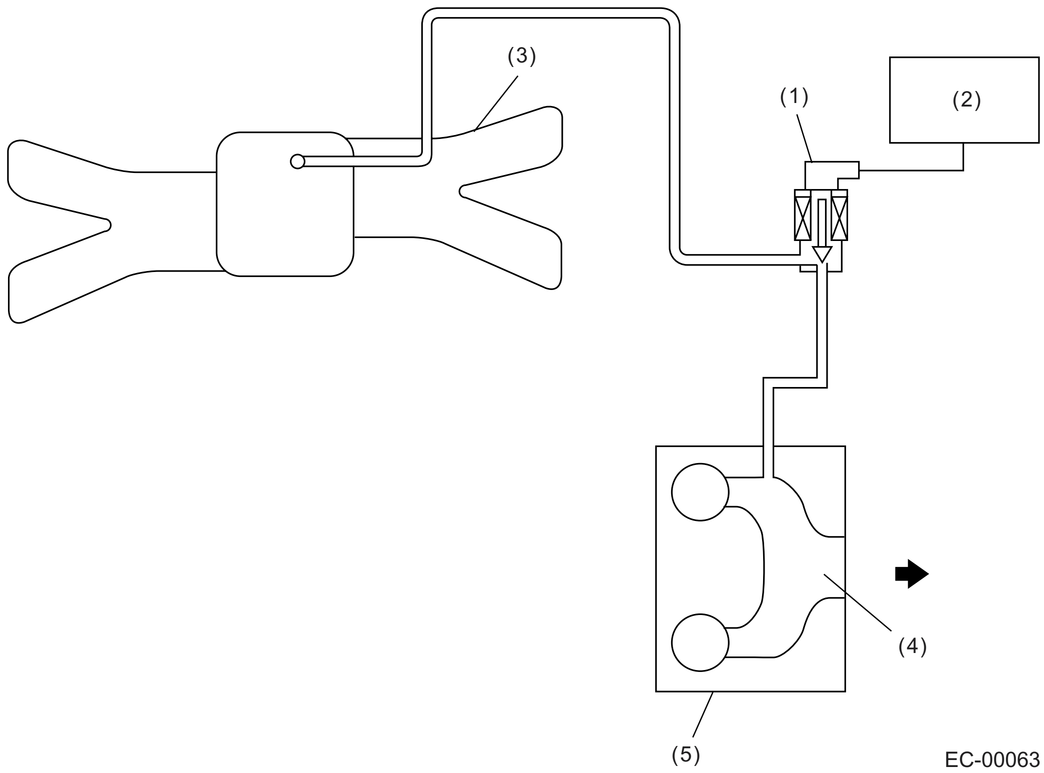


(1)	Battery	(7)	Engine coolant temperature sensor
(2)	Ignition switch	(8)	Spark plug
(3)	ECM	(9)	Ignition coil and ignitor assembly
(4)	Camshaft position sensor	(10)	Crankshaft position sensor
(5)	Knock sensor	(11)	Intake air temperature sensor
(6)	Pressure sensor		

7. Exhaust Gas Recirculation (EGR) System

A: GENERAL

- The EGR system aims at reduction of NOx by lowering the combustion temperature through recirculation 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.

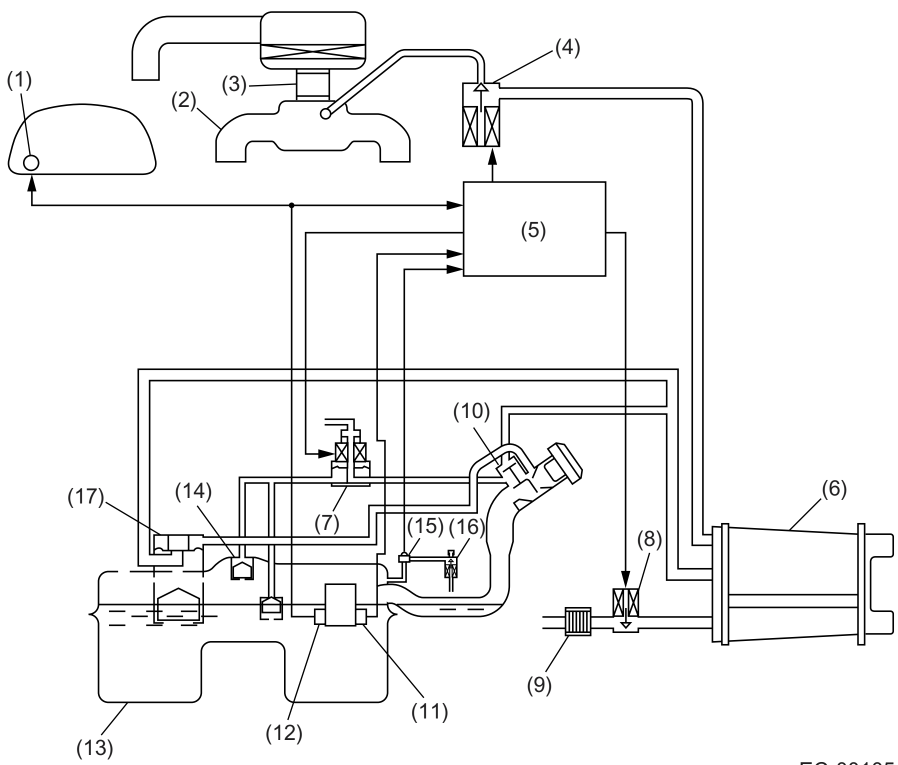


(1) EGR valve
(2) ECM
(3) Intake manifold
(4) Exhaust port
(5) Cylinder head LH

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.
- The pressure control solenoid valve incorporated in the fuel tank evaporation line regulates the pressure/vacuum in the fuel tank.

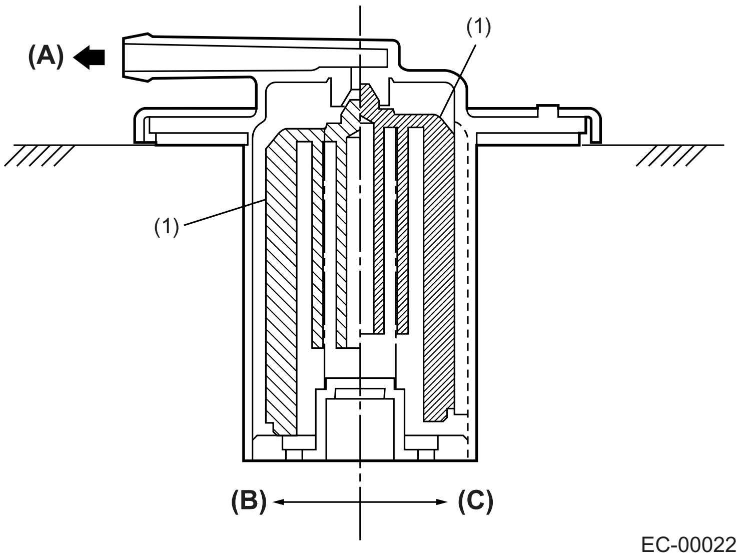


EC-00105

(1) Fuel gauge	(7) Pressure control solenoid valve	(13) Fuel tank
(2) Intake manifold	(8) Drain valve	(14) Fuel cut valve
(3) Throttle body	(9) Drain filter	(15) Fuel tank pressure sensor
(4) Purge control solenoid valve	(10) Shut-off valve	(16) Fuel tank sensor control valve
(5) Engine control module (ECM)	(11) Fuel temperature sensor	(17) Vent valve
(6) Canister	(12) Fuel level sensor	

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 enter the evaporation line.



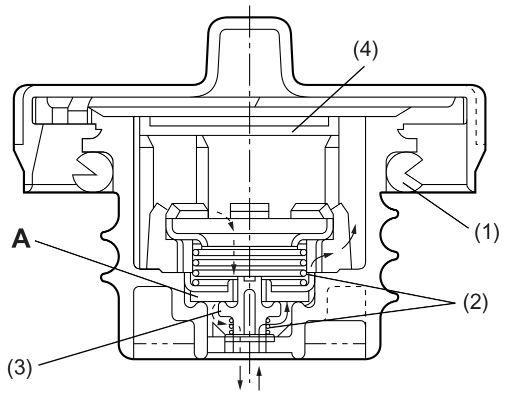
(1) Float

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

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.

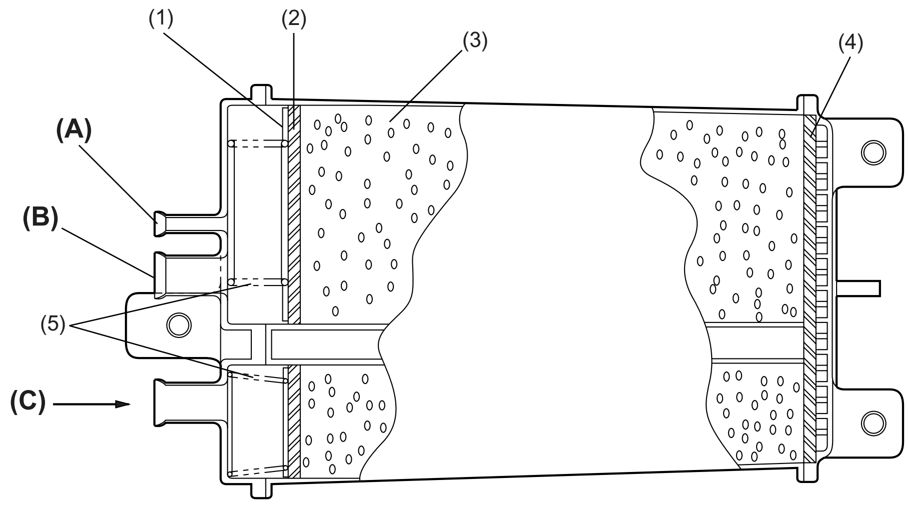
When there is no problem with the fuel vapor line, the filler pipe is sealed at the portion (A) and by the seal pressed against the filler pipe end. If vacuum develops in the fuel tank, the atmospheric pressure forces the spring down to open the valve; consequently outside air flows into the fuel tank,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



(1) Seal
(2) Spring
(3) Valve
(4) Filter

D: CANISTER

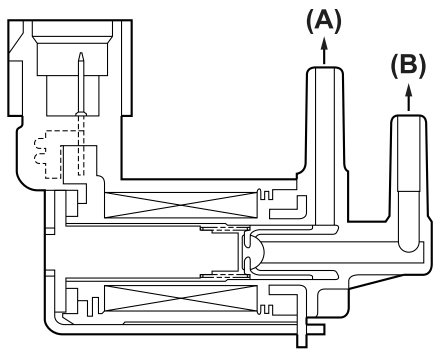
The charcoal filled in the canister temporarily stores fuel vapors. When the purge control solenoid valve is opened by a signal from the ECM, the external fresh air entering the canister carries the fuel vapors into the collector chamber.



(1)	Grid	**(A)**	To purge control solenoid valve
(2)	Filter	**(B)**	From fuel tank
(3)	Activated charcoal	**(C)**	Air
(4)	Filter		
(5)	Spring		

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.

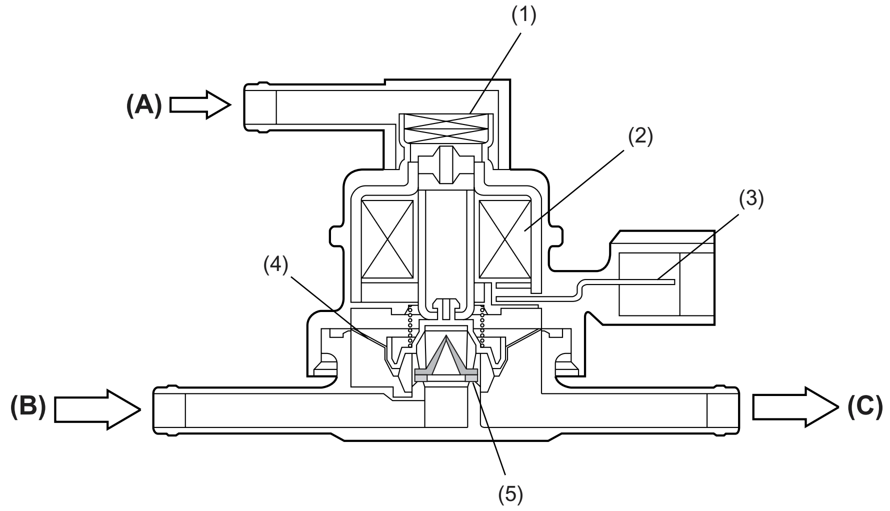


EC-00025

(A) To canister
(B) To intake manifold

F: PRESSURE CONTROL SOLENOID VALVE

The fuel tank pressure control solenoid valve is located in the evaporation line between the canister and the fuel tank.
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 from the drain valve into the canister.
The pressure control solenoid valve can also be electrically closed for the system diagnosis purposes.



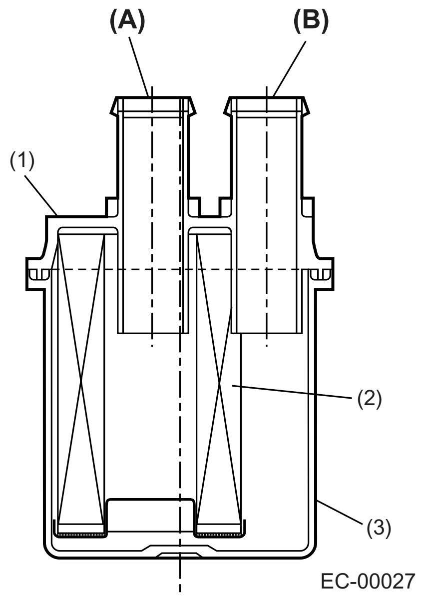
EC-00026

(1) Filter
(2) Coil
(3) Connector terminal
(4) Diaphragm
(5) Valve

(A) Atmospheric pressure
(B) Shut-off valve
(C) To fuel tank

G: DRAIN FILTER

The drain filter is installed at the air inlet port of the vent control solenoid valve. It cleans the air taken in the canister through the vent control solenoid valve.

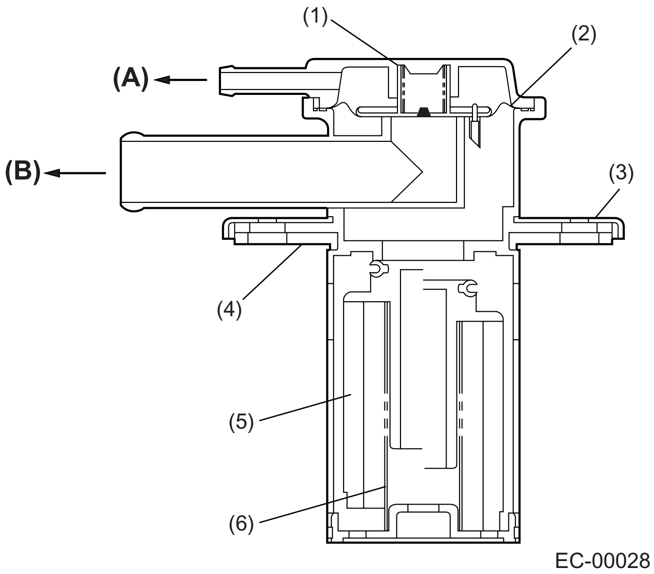


(1) Cap
(2) Element
(3) Case

(A) To drain valve
(B) To atmosphere

H: VENT VALVE

The vent valve is located in the fuel tank.During filling the fuel tank, fuel vapors are introduced into the canister through the vent valve.
When the fuel vapor pressure becomes higher than the atmospheric pressure and overcomes the spring force which is applied to the back side of the diaphragm, the port toward the canister is opened.The vent valve also has a float which rises and block the port toward the canister when the fuel is full.

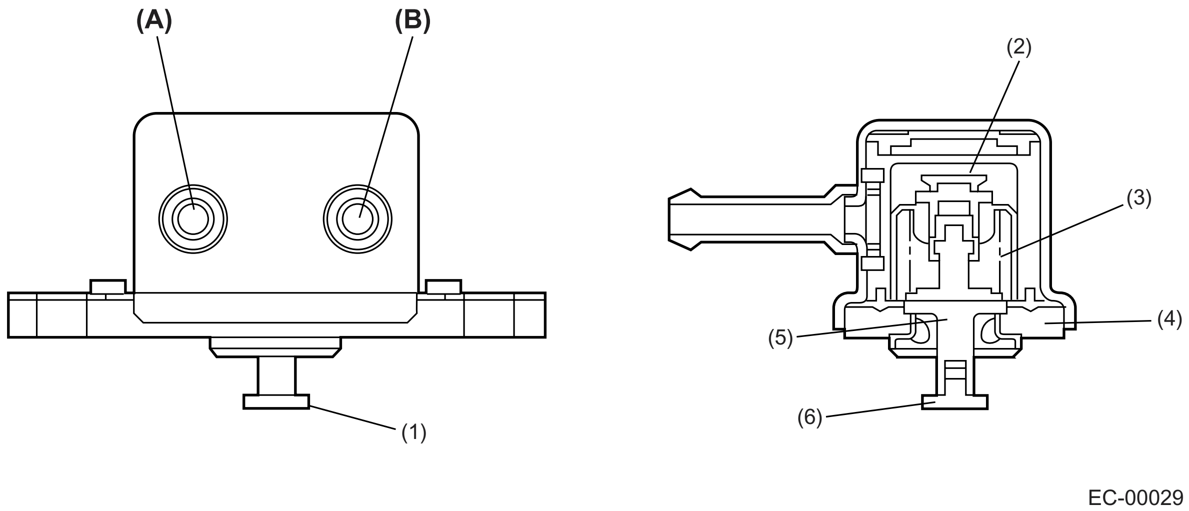


(1) Spring
(2) Diaphragm
(3) Plate cover
(4) Packing
(5) Float
(6) Float spring

(A) To filler pipe
(B) To canister

I: SHUT-OFF VALVE

The shut-off valve is located at the top of the fuel filler pipe.When a filler gun is inserted into the filler pipe, the shut-off valve closes the evaporation line.

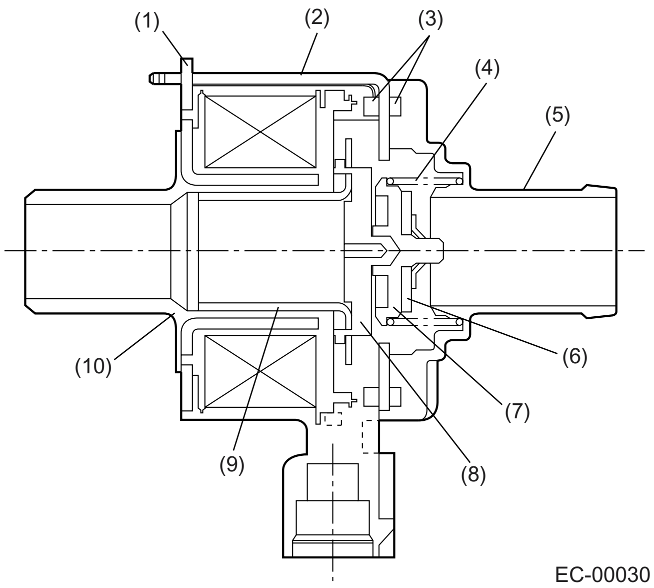


(1) Pin
(2) Valve
(3) Spring
(4) Plate
(5) Shaft
(6) Pin

(A) To canister
(B) To fuel tank

J: DRAIN VALVE

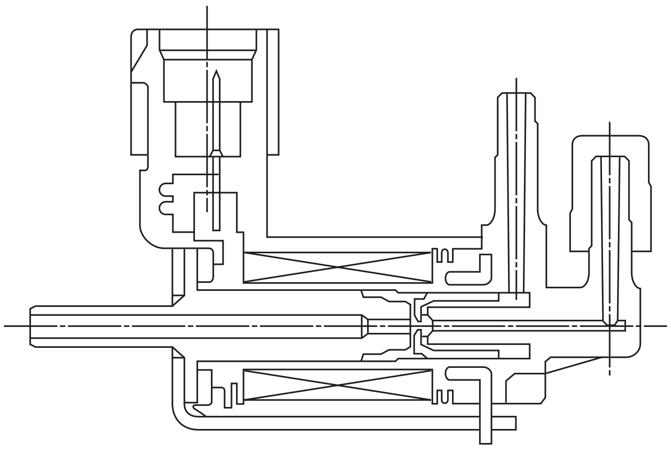
The drain valve is located on the line connecting the drain filter and canister, just below the drain filter.The drain valve is forcibly closed by a signal from the ECM while the evaporation system diagnosis is being conducted.



(1) Magnetic plate	(6) Valve
(2) Yoke	(7) Plate
(3) Packing	(8) Retainer
(4) Spring	(9) Moving core
(5) Valve seat	(10) Bobin

K: FUEL TANK SENSOR CONTROL VALVE

The fuel tank sensor control valve closes the passage from the fuel tank to the air when the OBD system is activated to make a diagnosis.



EC-00031

9. On-board Refueling Vapor Recovery (ORVR) System

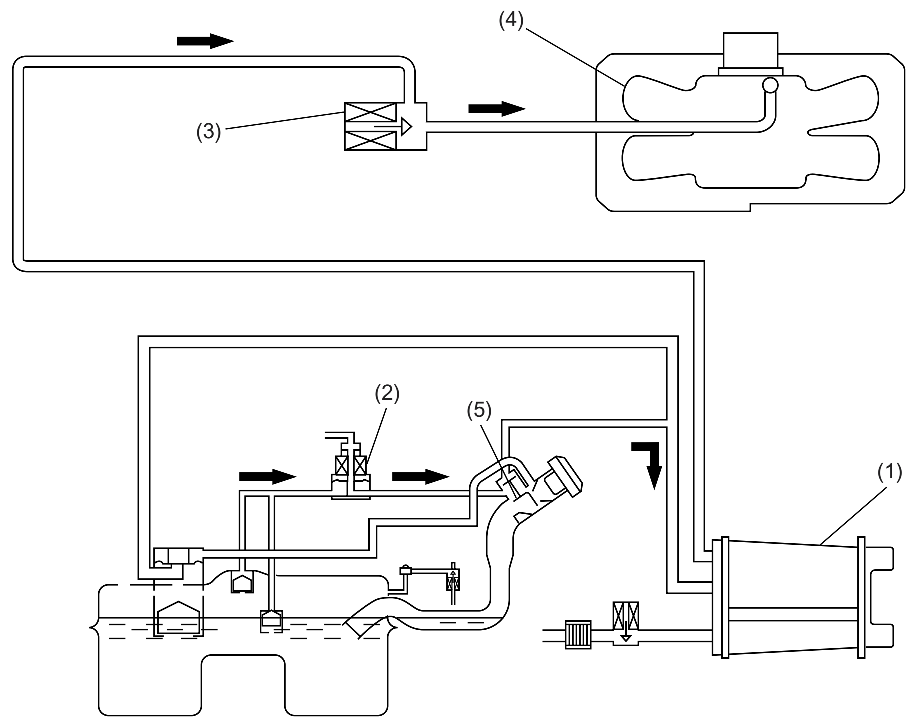
A: GENERAL

The on-board refueling vapor recovery system allows the fuel vapors in the fuel tank to be introduced directly into the canister through the vent valve when the fuel tank inside pressure increases as a result of refueling.
The diagnosis of the system is performed by monitoring the fuel tank inside pressure data from the fuel tank pressure sensor while forcibly closing the drain valve.

B: OPERATION

- While driving

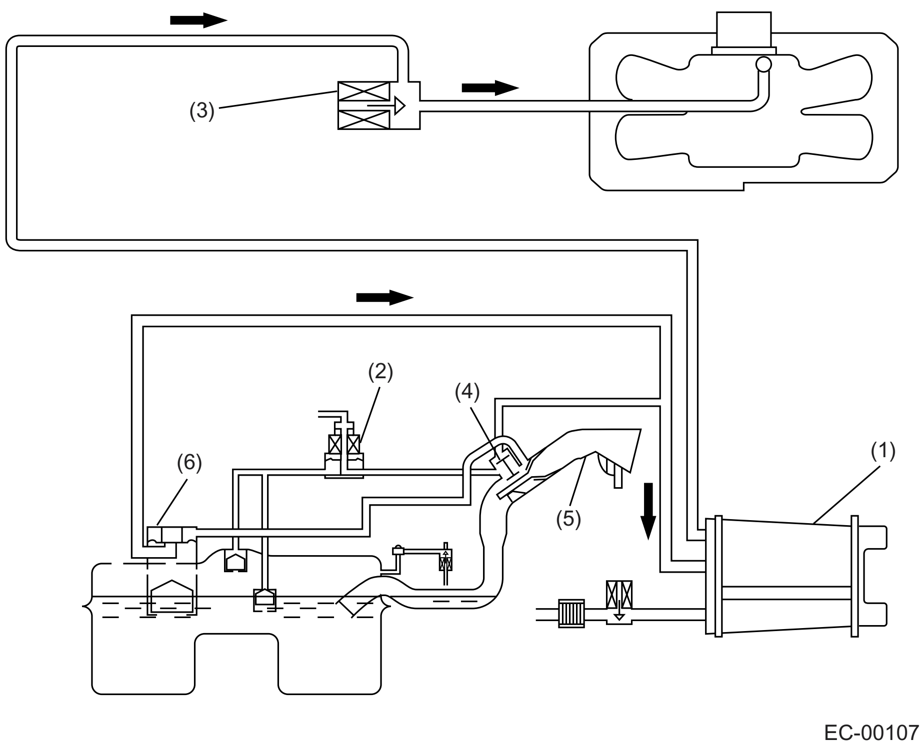
Since the back side of the diaphragm in the pressure control solenoid valve is open to the atmosphere, the diaphragm is held pressed by the atmospheric pressure in the position where only the external air is introduced into the canister. When the fuel vapor pressure acting on the other side of the diaphragm increases and overcomes the atmospheric pressure, it pushes the diaphragm and opens the port through which the fuel vapors make their way to the canister.



(1) Canister
(2) Pressure control solenoid valve
(3) Purge control solenoid valve
(4) Intake manifold
(5) Shut-off valve: Open

● While refueling

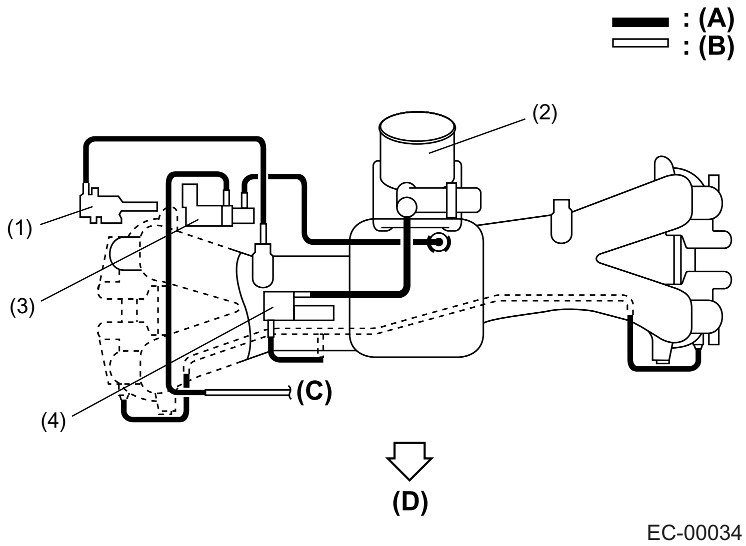
As the fuel enters the fuel tank, the tank inside pressure increases. When the inside pressure becomes higher than the atmospheric pressure, the port of the vent valve opens, allowing the fuel vapors to be introduced into the canister through the vent line. The fuel vapors are absorbed by charcoal in the canister, so the air discharged from the drain valve contains no fuel. When a filler gun is inserted, the shut-off valve closes the evaporation line.



- (1) Canister
- (2) Pressure control solenoid valve
- (3) Purge control solenoid valve
- (4) Shut-off valve: Closed
- (5) Filler gun
- (6) Vent valve

10.Vacuum Connections

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



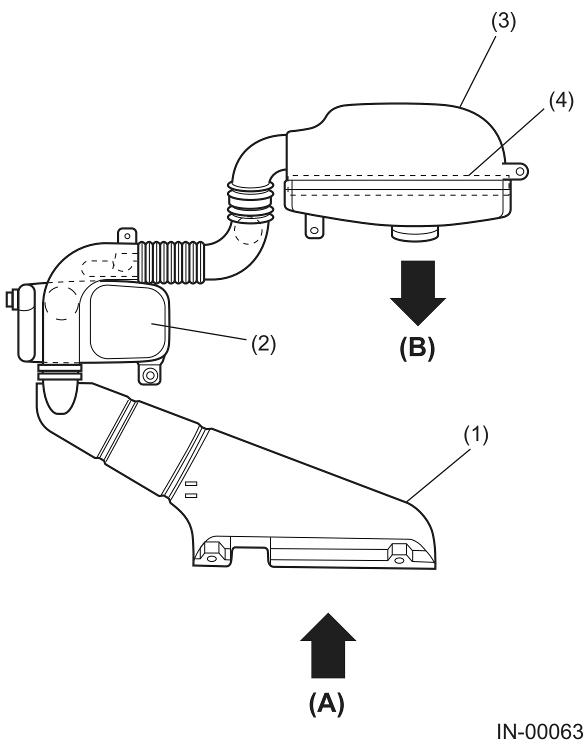
(1) Pressure regulator
(2) Throttle body
(3) Purge control solenoid valve
(4) Air assist injector solenoid valve

(A) Hose
(B) Pipe
(C) To canister
(D) Front of vehicle

MEMO

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.



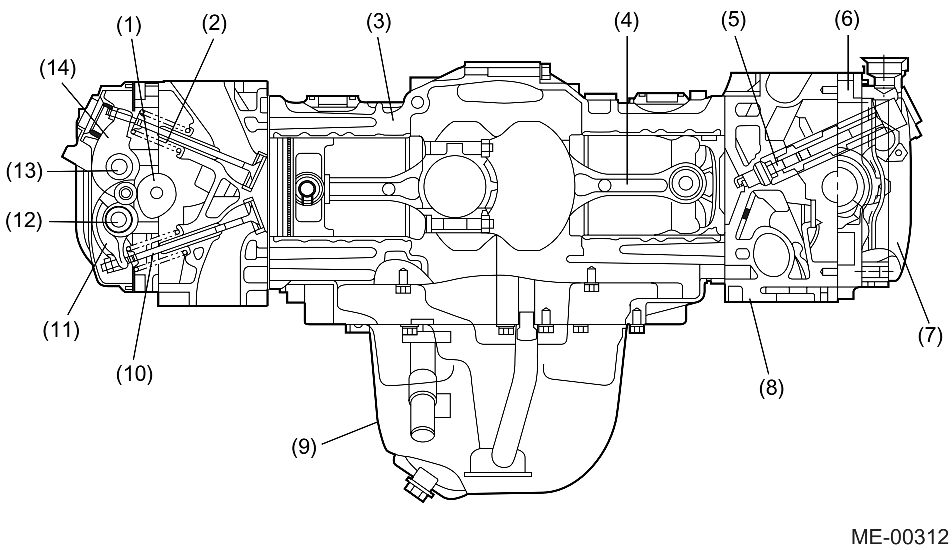
(1)	Intake duct	**(A)**	Fresh air
(2)	Resonator chamber	**(B)**	To throttle body
(3)	Air cleaner case		
(4)	Air cleaner element		

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:

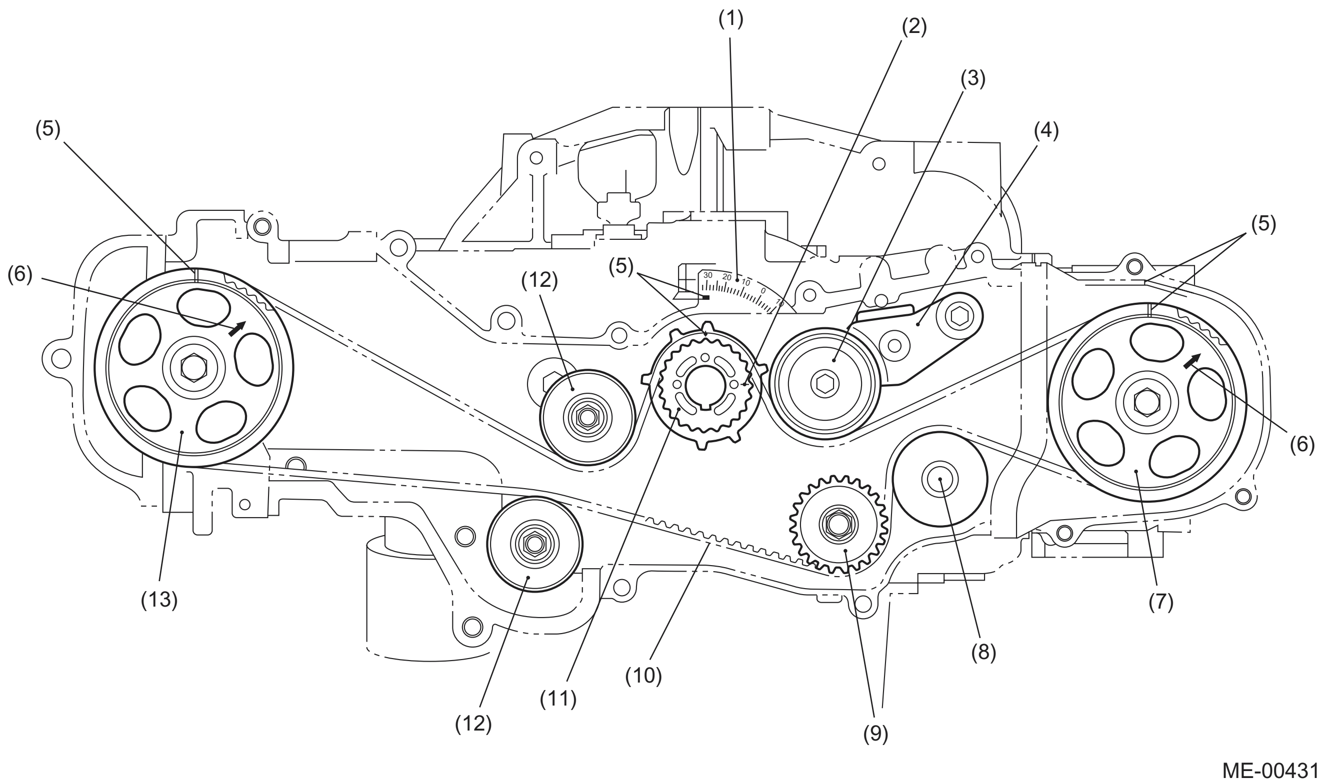
- The cylinder head forms pentroof combustion chambers, each having a spark plug located at its center and two each of intake and exhaust valves (four valves per cylinder). The intake and exhaust ports are located in a cross-flow arrangement.
- There are a screw and nut at the valve end of each rocker 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.



(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.

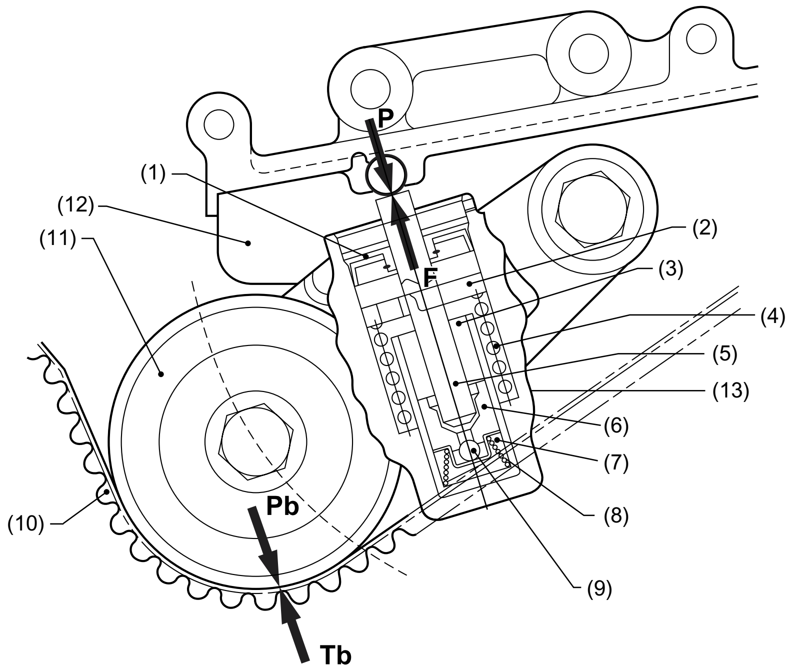


(1)	Timing indicator (for timing mark of crankshaft pulley)	(8)	Water pump pulley
(2)	*Piston position mark	(9)	Idler No. 2
(3)	Belt tension pulley	(10)	Timing belt
(4)	Automatic belt tension adjuster	(11)	Crankshaft sprocket
(5)	Alignment mark	(12)	Idler
(6)	**Piston position mark	(13)	Camshaft sprocket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

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

- 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 Pb to the timing belt.

- Timing belt tension balancing action

When the belt tension pulley is pushed against the timing belt with pressure Pb, reaction force Tb of the timing belt generates the reaction force P at the point on which the adjustor 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

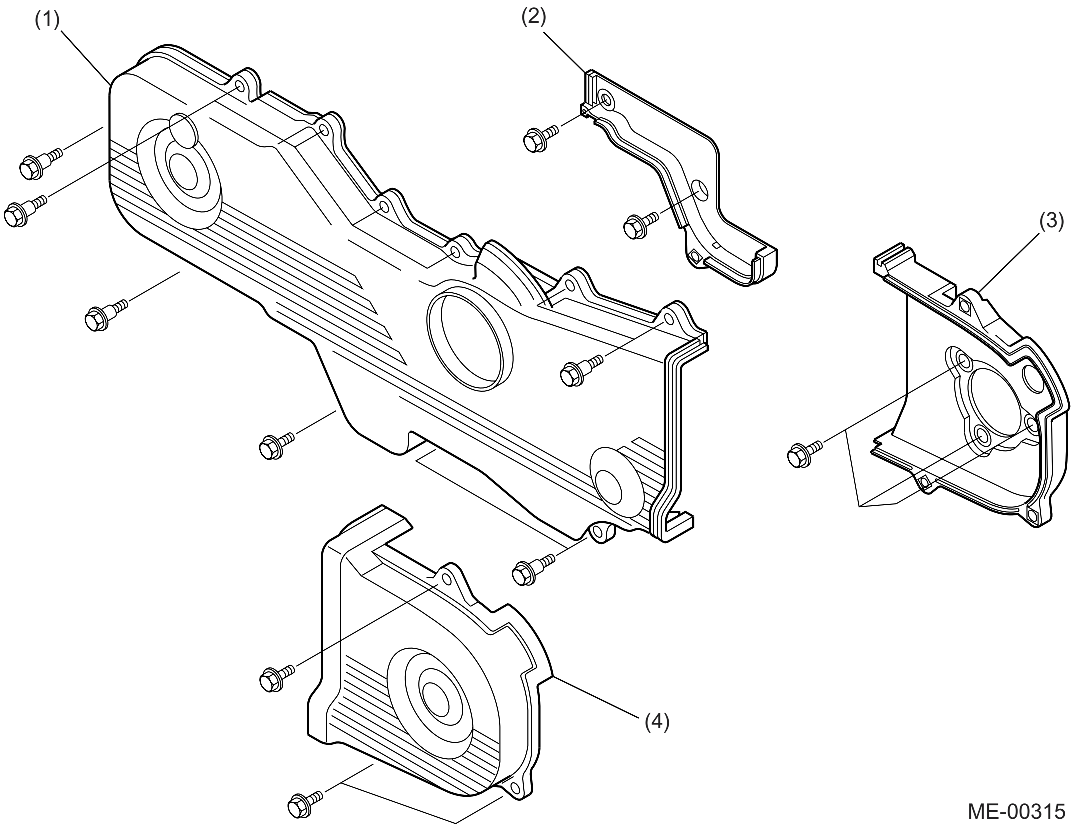
If the tension of the timing belt increases excessively, the force P becomes larger than the thrust force F and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force P balances again with the thrust force F.Thus the timing belt tension is maintained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

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.

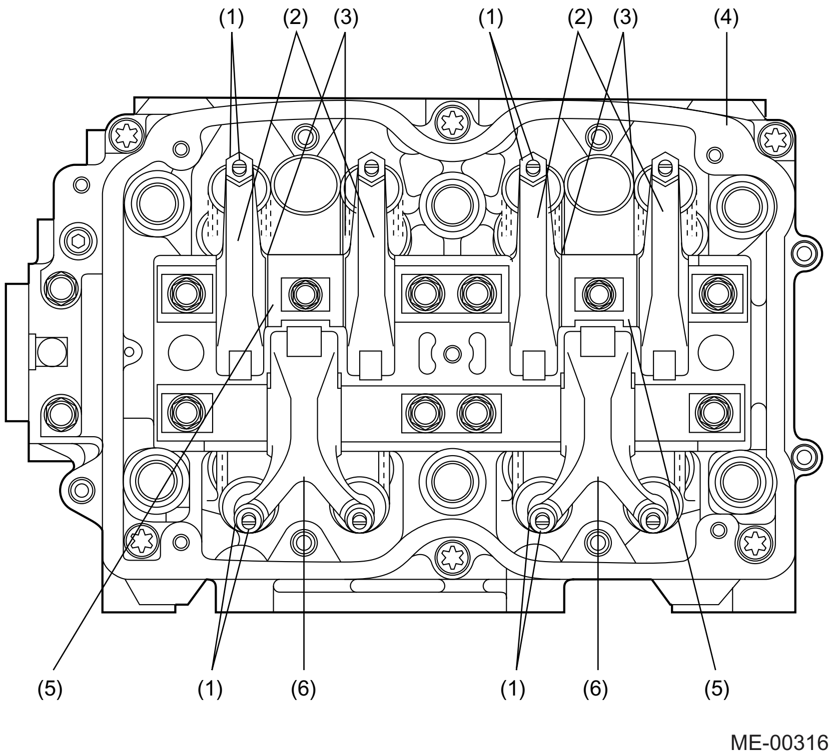
● The front belt cover has a line mark for ignition-timing checking.



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

5. Valve Rocker Assembly

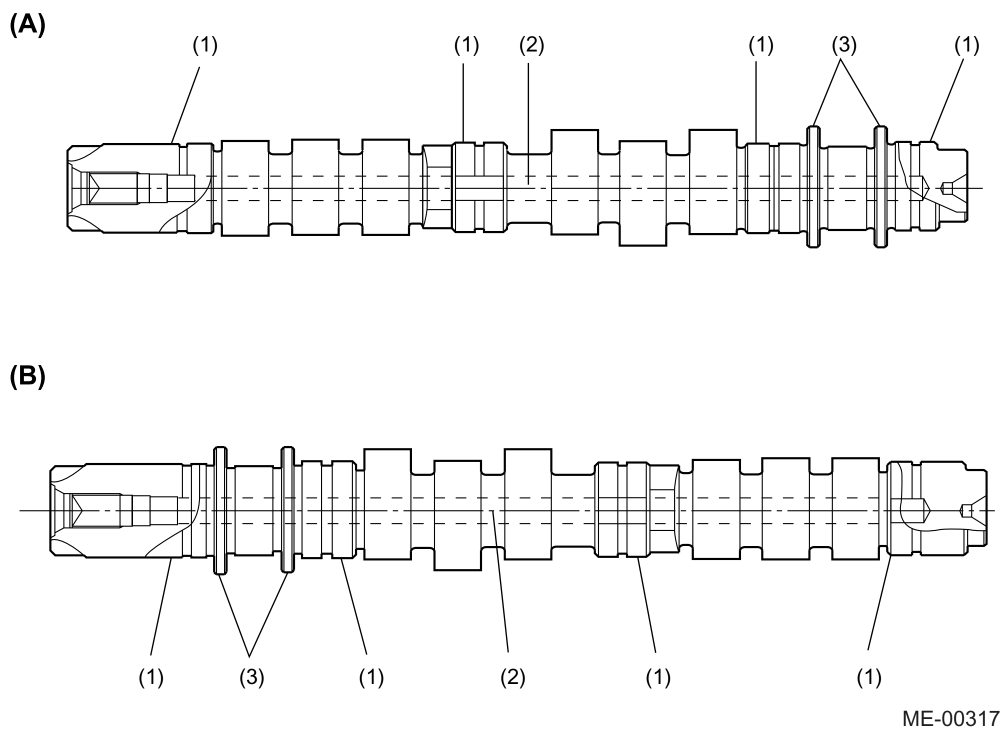
- The intake valve rocker arms and the exhaust valve rocker arms are installed on their own rocker shafts both of which are retained by the camshaft caps.
- The valve end of each rocker arm is provided with valve rocker adjusting screw and nut.Turning of this screw adjusts the valve clearance
- The exhaust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



(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

6. Camshaft

- The camshaft is supported inside the cylinder head at four journals.
- The two flanges on each camshaft supports thrust forces to limit the end play of the camshaft within the tolerance.
- Each camshaft has an oil passage in it.

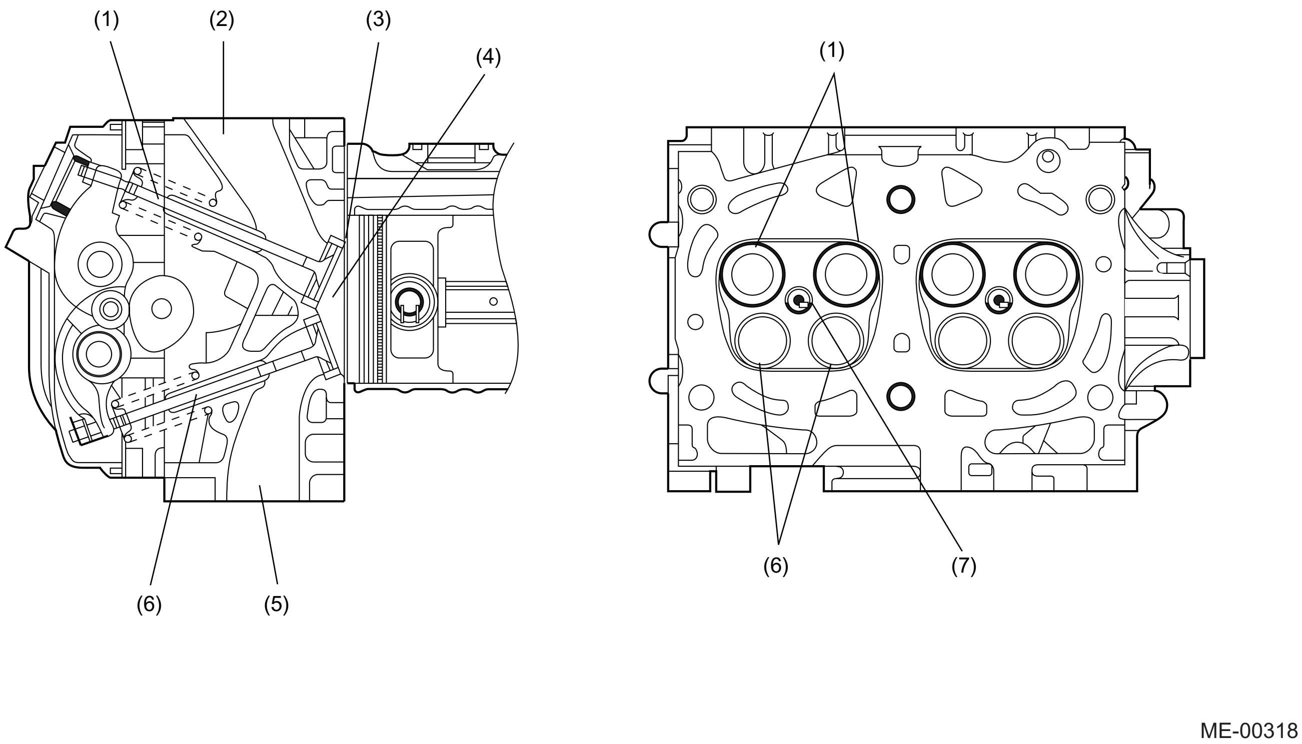


(A) RH
(B) LH

(1) Journal
(2) Oil passage
(3) Shaft flange

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 stainless steel sheets.The gasket is highly resistant to heat and maintains high level of sealing performance for a long period.



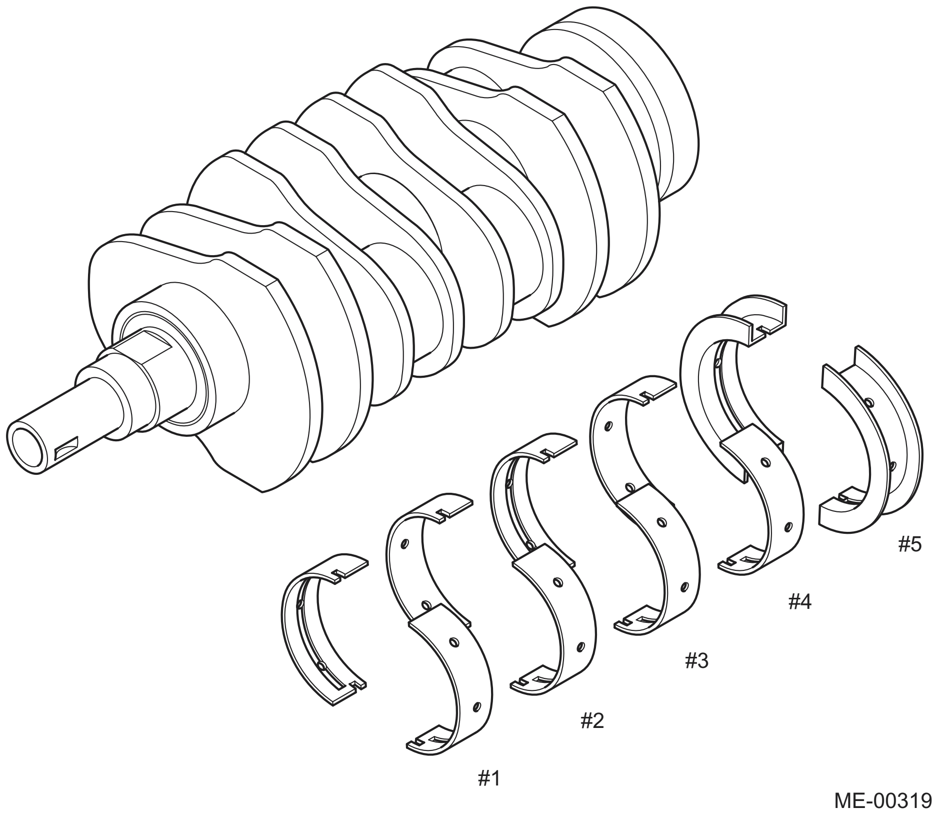
(1) Intake valve
(2) Intake port
(3) Squish area
(4) Combustion chamber
(5) Exhaust port
(6) Exhaust valve
(7) Spark plug

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.

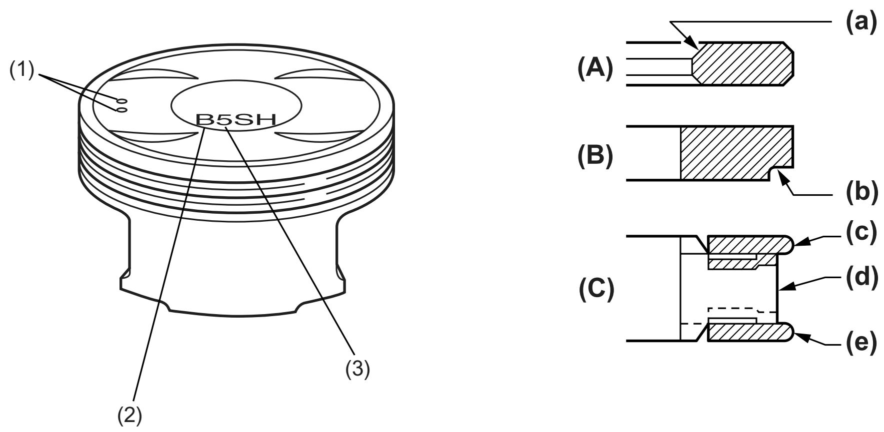
9. Crankshaft

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.



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.

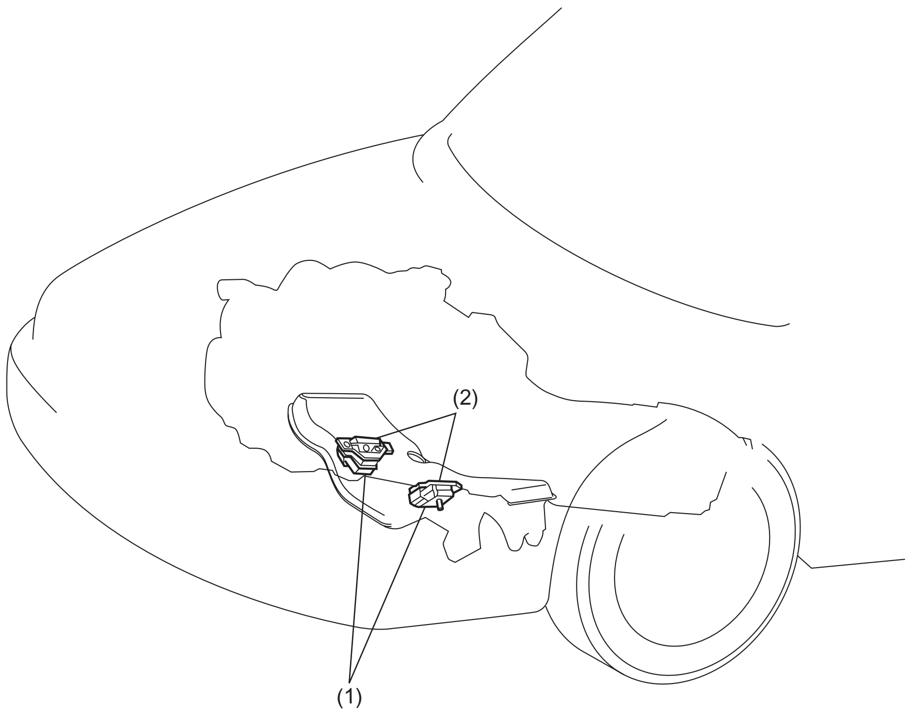


ME-00432

(1)	Location mark (engine front side)	**(A)**	Top ring	**(a)**	Inner-bevel
(2)	Identification mark (piston size)	**(B)**	Second ring	**(b)**	Cut
(3)	Engine capacity (2500 cc)	**(C)**	Oil ring	**(c)**	Upper rail
				(d)	Spacer
				(e)	Lower rail

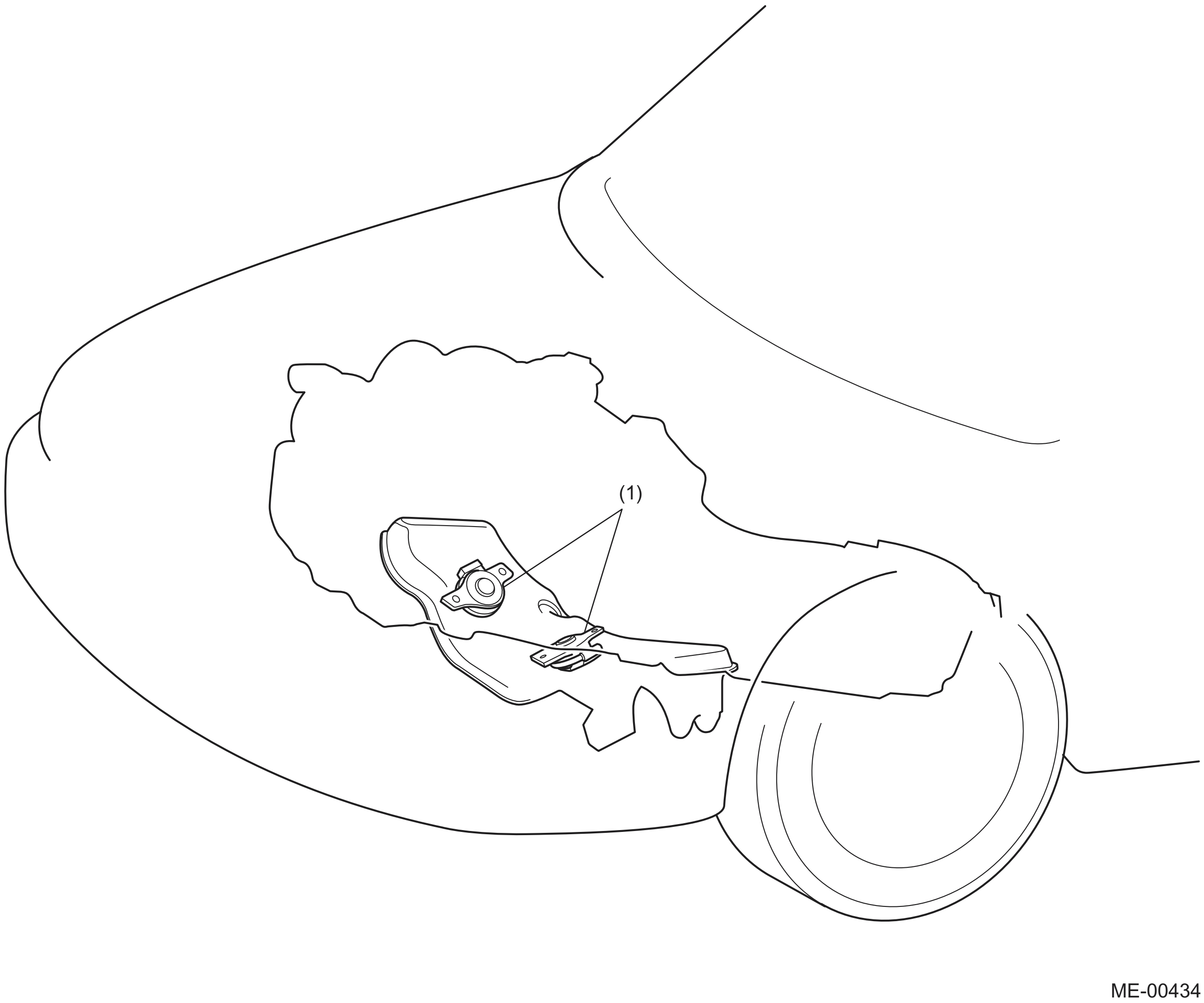
11.Engine Mounting

A: STANDARD TYPE (BRIGHTON AND L AT VEHICLES)



(1) Cushion rubber
(2) Bracket

B: LIQUID-FILLED TYPE (EXCEPT BRIGHTON AND L AT VEHICLES)

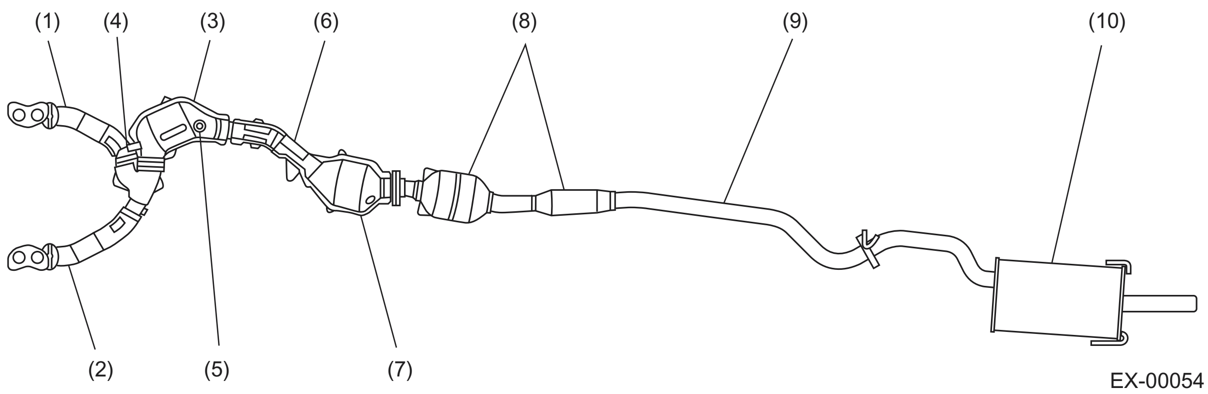


(1) Cushion rubber

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 a sound suppression design; the two branches of the front exhaust pipe join at a point almost equal in distance from the engines exhaust ports and the rear exhaust pipe has resonance chambers in addition to a large capacity muffler.



EX-00054

(1) Front exhaust pipe RH
(2) Front exhaust pipe LH
(3) Front catalytic converter
(4) Front oxygen (A/F) sensor
(5) Rear oxygen sensor
(6) Center exhaust pipe
(7) Rear catalytic converter
(8) Resonance chamber
(9) Rear exhaust pipe
(10) Muffler

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 subfan depending on the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch.

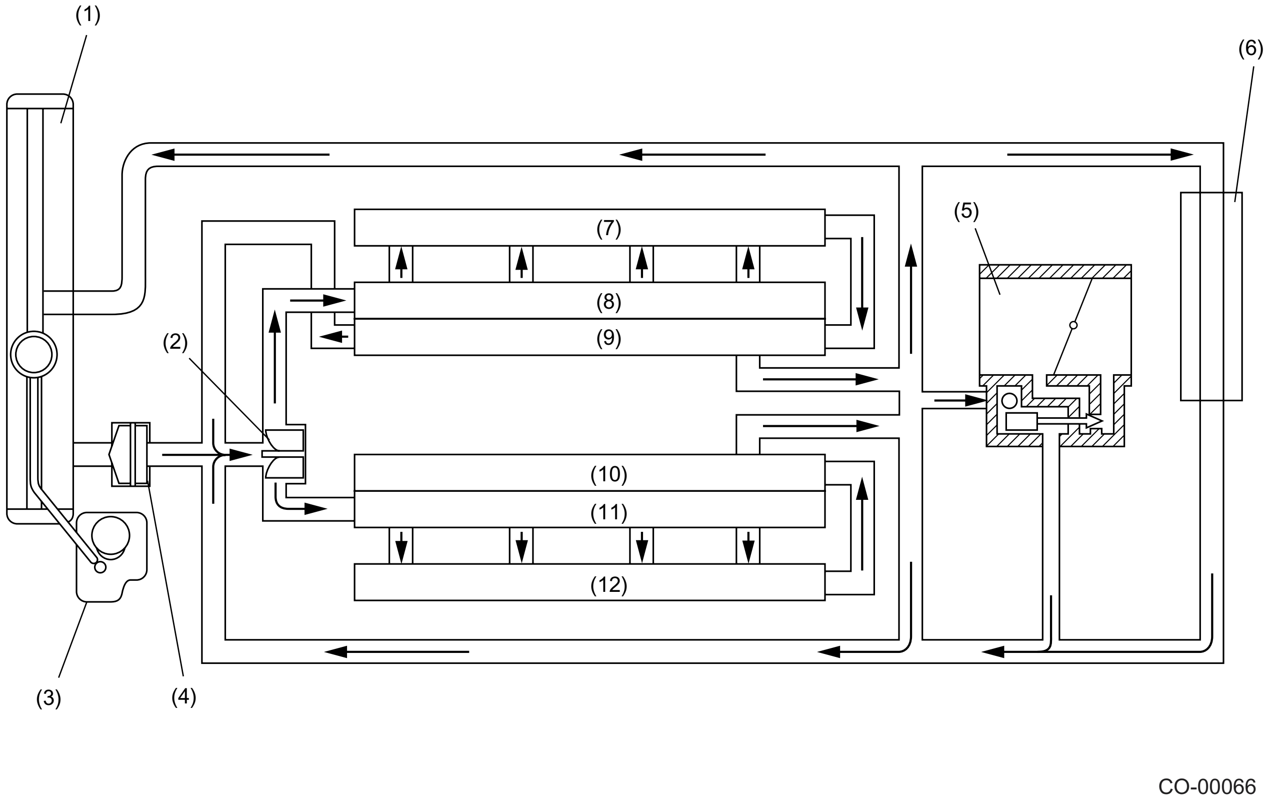
2. Cooling Circuits

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.

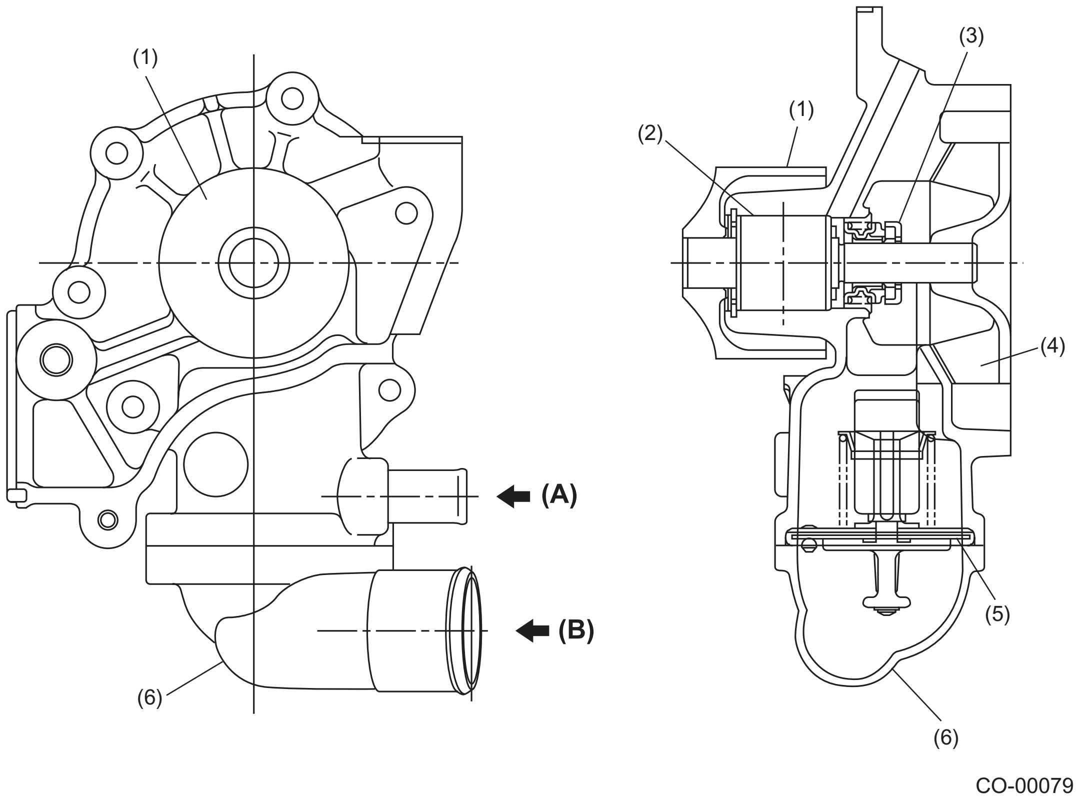
● 3rd phase (thermostat open and radiator fan operating)
When the engine coolant temperature sensor sends a signal indicating a temperature above 95°C (203°F) to the ECM, it causes the radiator fan (or fans) to operate.



(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

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.

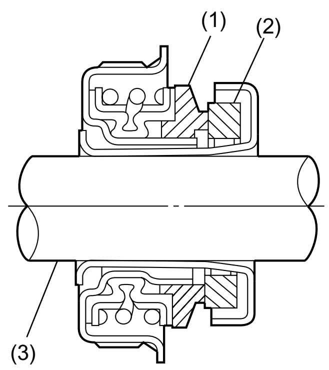


(A) From heater circuit
(B) From radiator

(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.

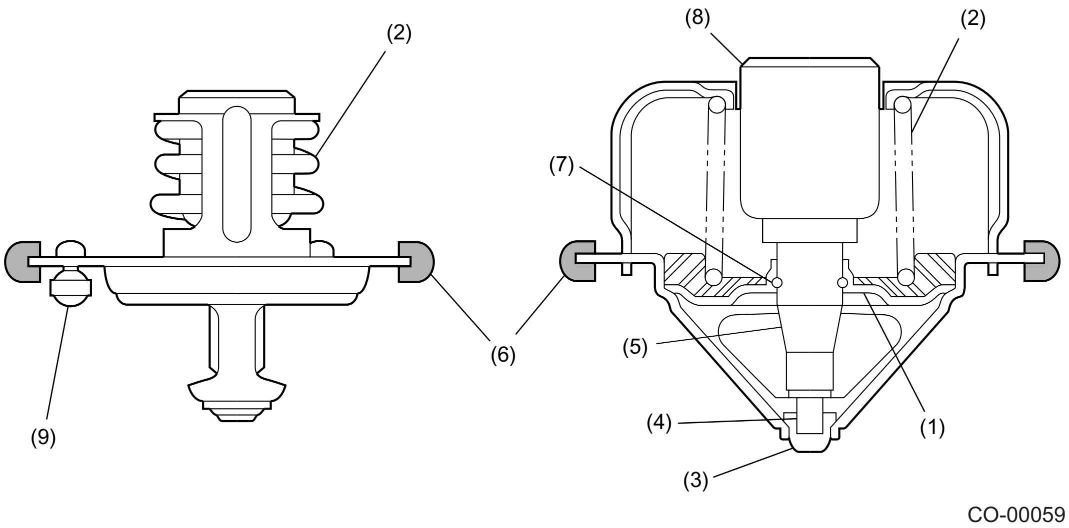


CO-00058

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

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.

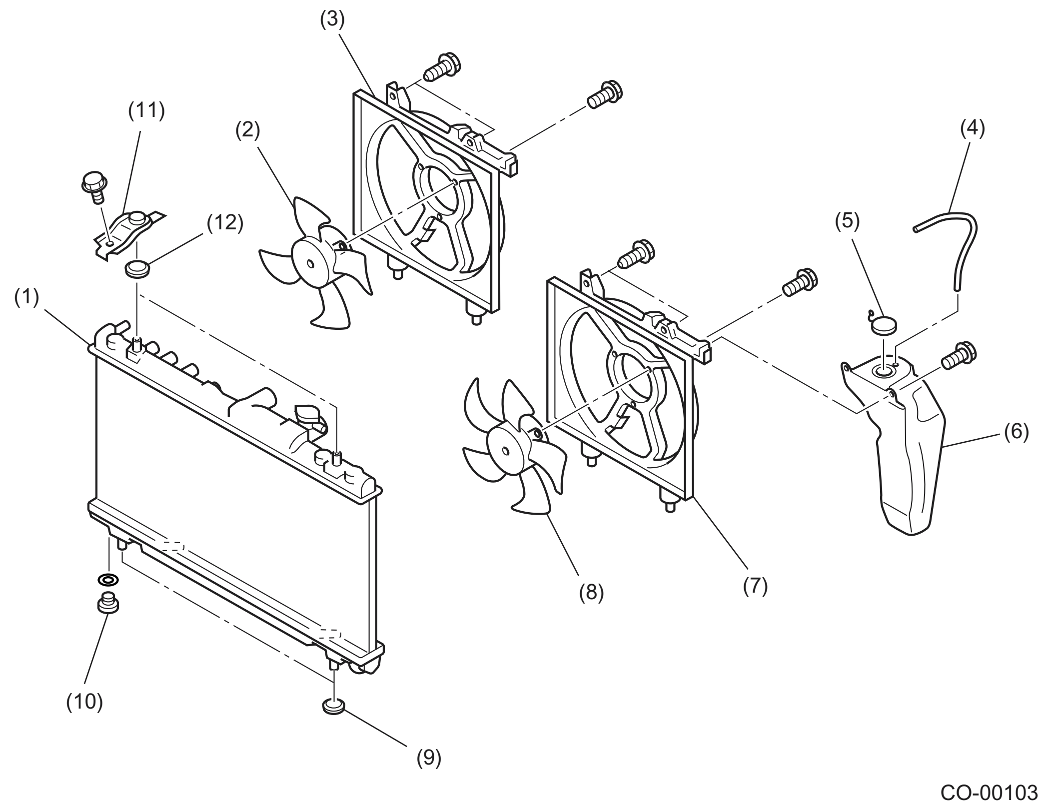


(1)	Valve	(4)	Piston	(7)	Stop ring
(2)	Spring	(5)	Guide	(8)	Wax element
(3)	Stopper	(6)	Rubber packing	(9)	Jiggle valve

6. Radiator Fan

A: DESCRIPTION

Each radiator fan is made of plastic. It is driven by an electric motor which is retained on a shroud.



(1)	Radiator	(7)	Radiator main fan shroud
(2)	Radiator subfan and subfun motor assembly (model with A/C)	(8)	Radiator main fan and fan motor assembly
(3)	Radiator subfan shroud (model with A/C)	(9)	Lower cushion
(4)	Overflow hose	(10)	Drain plug
(5)	Reservoir tank cap	(11)	Upper bracket
(6)	Reservoir tank	(12)	Upper cushion

B: FUNCTION

The operation of the radiator fan is controlled by the ECM. In a model equipped with an air conditioning system (A/C), the ECM uses for the control the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch. The ECM on a model without an A/C performs the control based on the signal from the engine coolant temperature and vehicle speed sensors.

1. MODEL WITH A/C

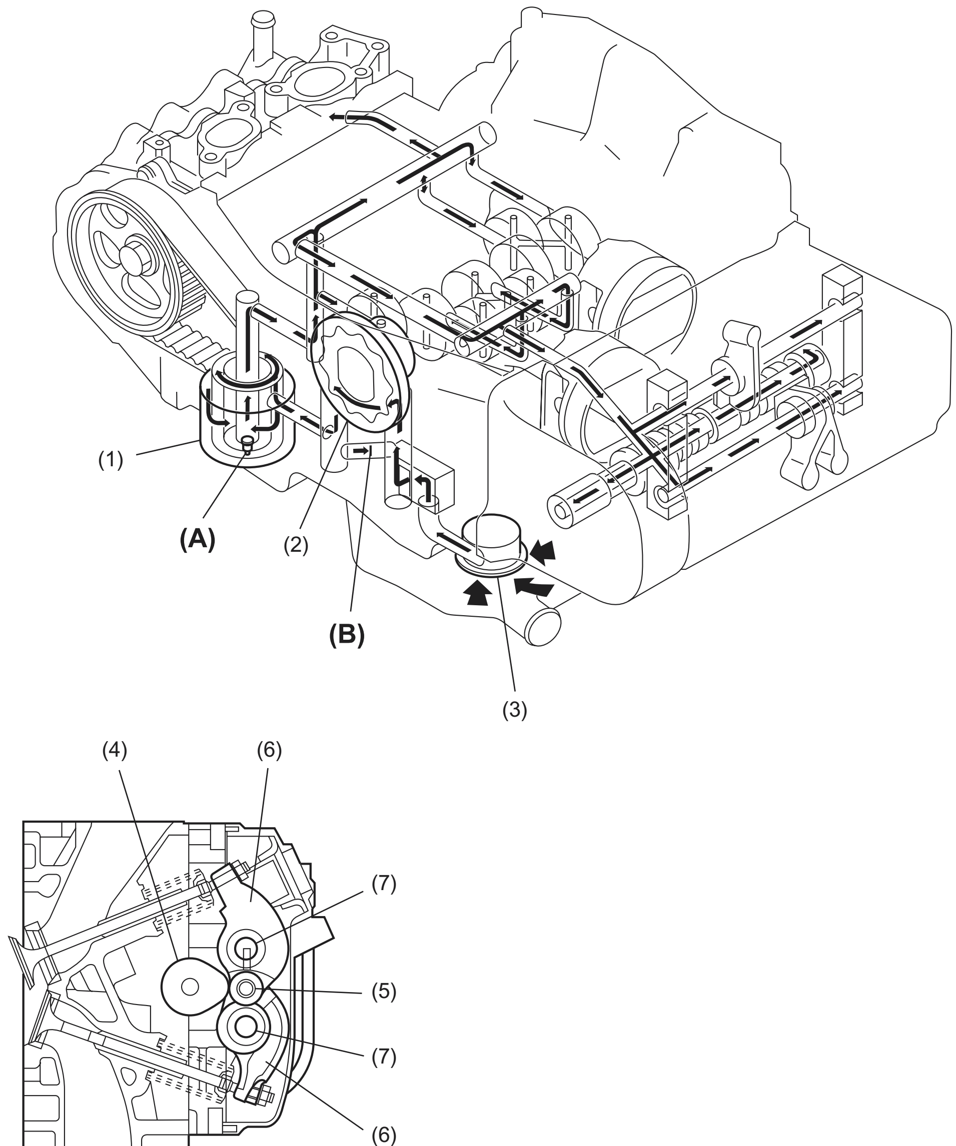
Vehicle speed	A/C compressor	Engine coolant temperature					
		Lower than 95°C (203°F)		Between 96 and 99°C (203 and 210°F)		Higher than 100°C (212°F)	
		Operation of radiator fans		Operation of radiator fans		Operation of radiator fans	
		Main fan	Sub fan	Main fan	Sub fan	Main fan	Subfan
19 km/h (12 MPH) or less	OFF	OFF	OFF	ON	OFF	ON	ON
	ON	ON	ON	ON	ON	ON	ON
Between 20 and 69 km/h (12 and 43 MPH)	OFF	OFF	OFF	ON	OFF	ON	ON
	ON	ON	ON	ON	ON	ON	ON
Between 70 and 105 km/h (43 and 65 MPH)	OFF	OFF	OFF	OFF	OFF	ON	ON
	ON	ON	OFF	ON	ON	ON	ON
Higher than 106 km/h (66 MPH)	OFF	OFF	OFF	OFF	OFF	ON	ON
	ON	OFF	OFF	ON	OFF	ON	ON

2. MODEL WITHOUT A/C

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

1. General

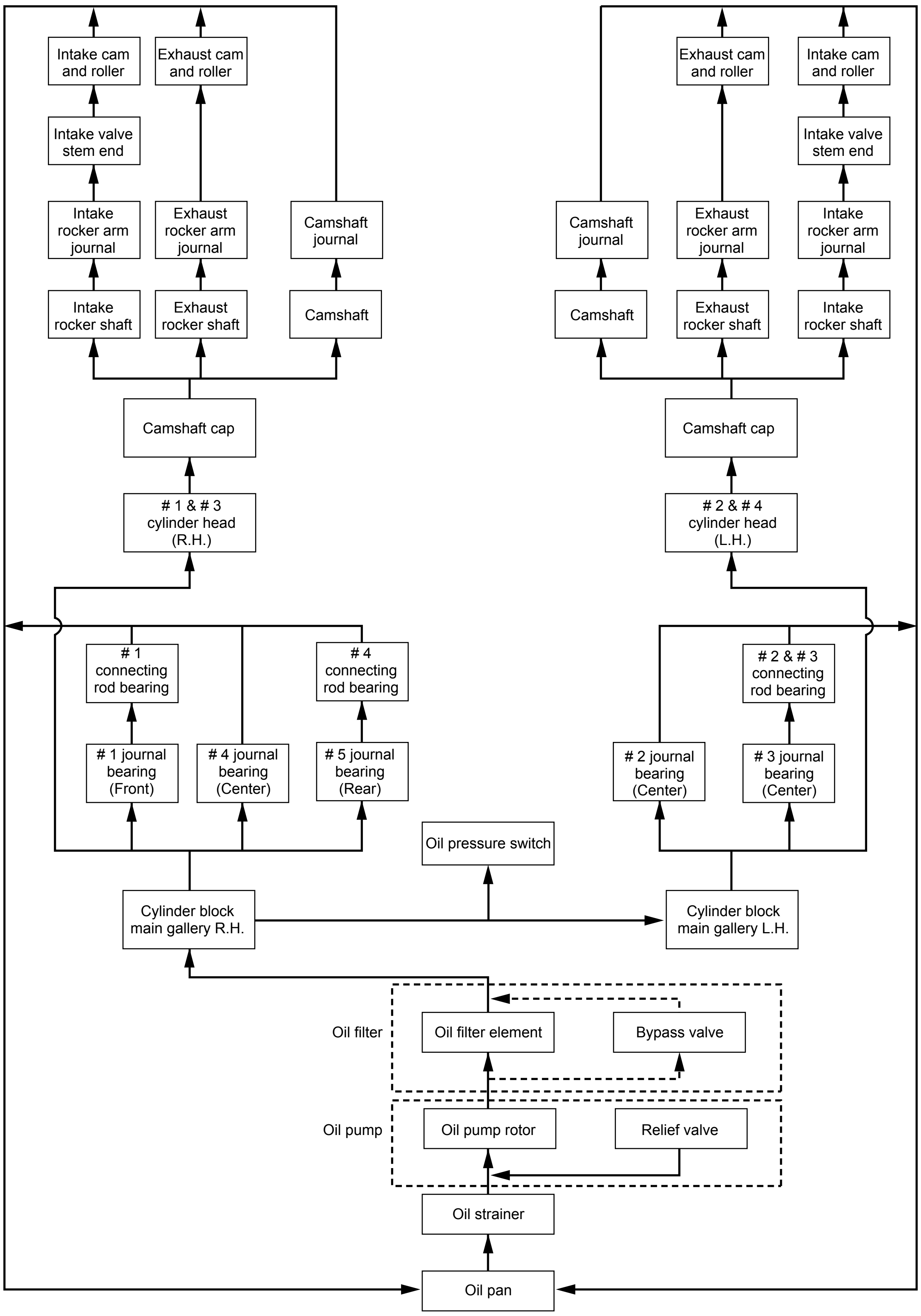
- The lubrication system force-circulates engine oil throughout the engine using an oil pump. The oil pressure is regulated by the relief valve built into the oil pump.
- The oil pump is a thin, large-diameter trochoid rotor type which can accommodate the engine's high output.The pump is directly driven 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.



LU-00107

(1)	Oil filter	(6)	Rocker arm
(2)	Oil pump	(7)	Rocker shaft
(3)	Oil strainer	**(A)**	Bypass valve opening pressure: 157 kPa (1.6 kgf/cm^2, 23 psi)
(4)	Camshaft	**(B)**	Relief valve opening pressure: 490 kPa (5.0 kgf/cm^2, 71 psi)
(5)	Roller		

2. Engine Oil Flow

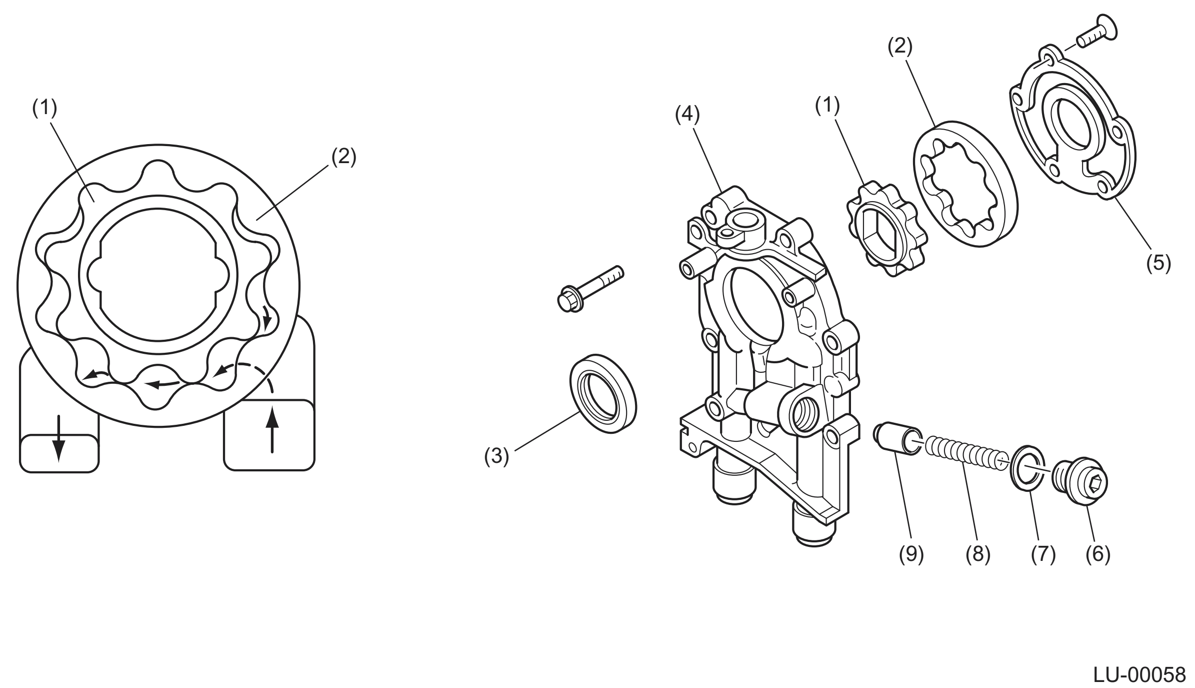


LU-00108

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.

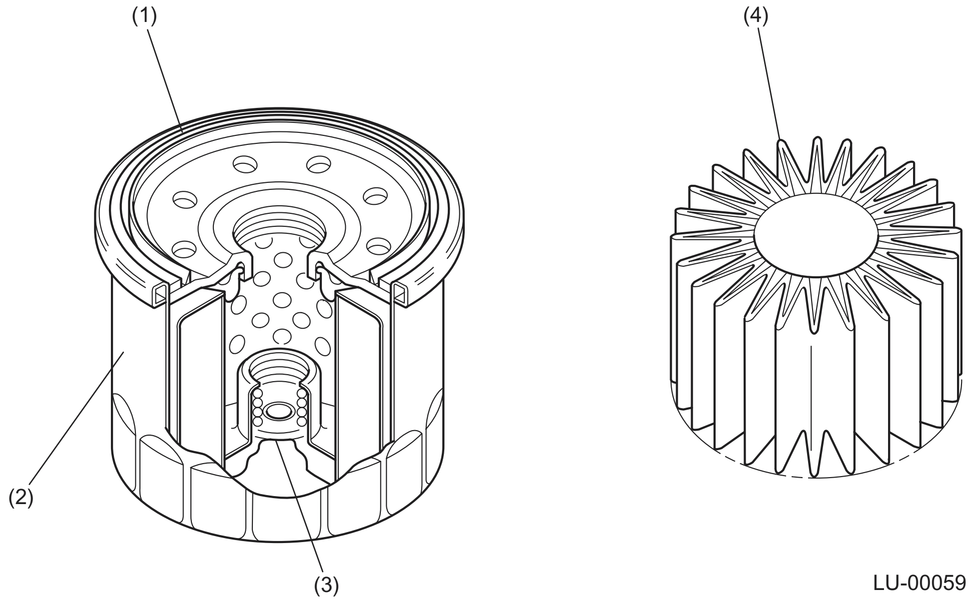
● Engine oil is drawn into the large space created near the inlet of the pump. It is then carried to the discharge port. As the pump rotates, the space carrying the oil becomes smaller, thus the oil is pressurized and discharged from the outlet port. Oil pressure is regulated by the relief valve built into the pump. Excess oil is directly returned to the inlet port.



(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

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.

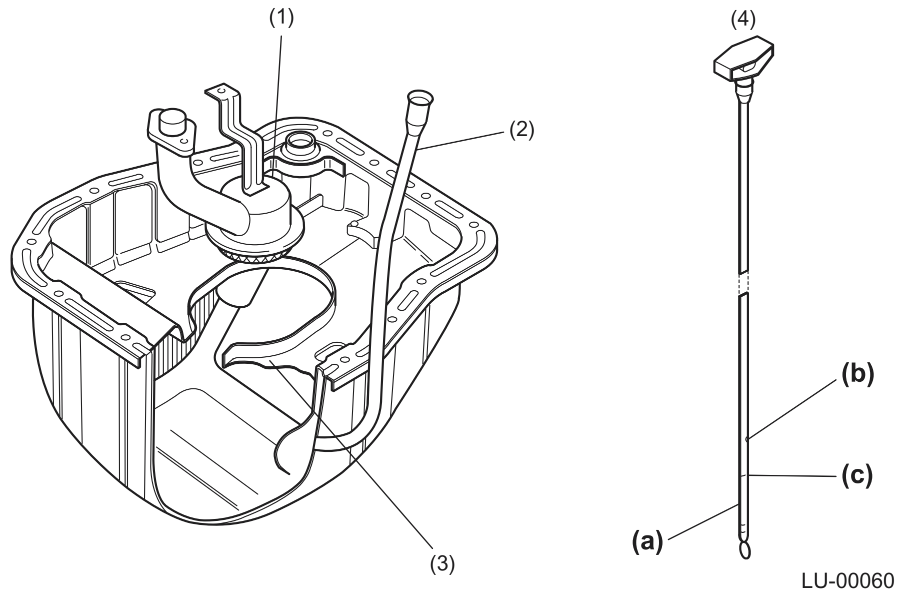


(1) Oil seal
(2) Filter body
(3) Bypass valve
(4) Pleated element

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.

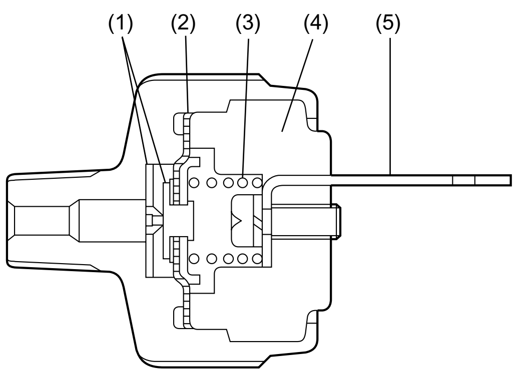


(1) Oil strainer
(2) Level gauge guide
(3) Baffle plate
(4) Oil level gauge

(a) LOW level
(b) FULL level (Engine HOT condition)
(c) FULL level (Engine COLD condition)

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

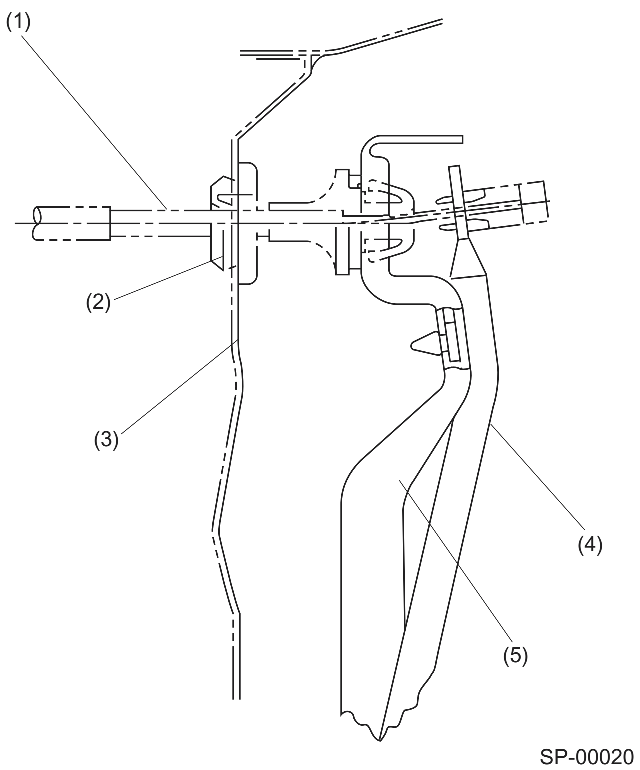
(1) Contact point
(2) Diaphragm
(3) Spring
(4) Molded portion
(5) Terminal

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/cm^2, 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.

1. General

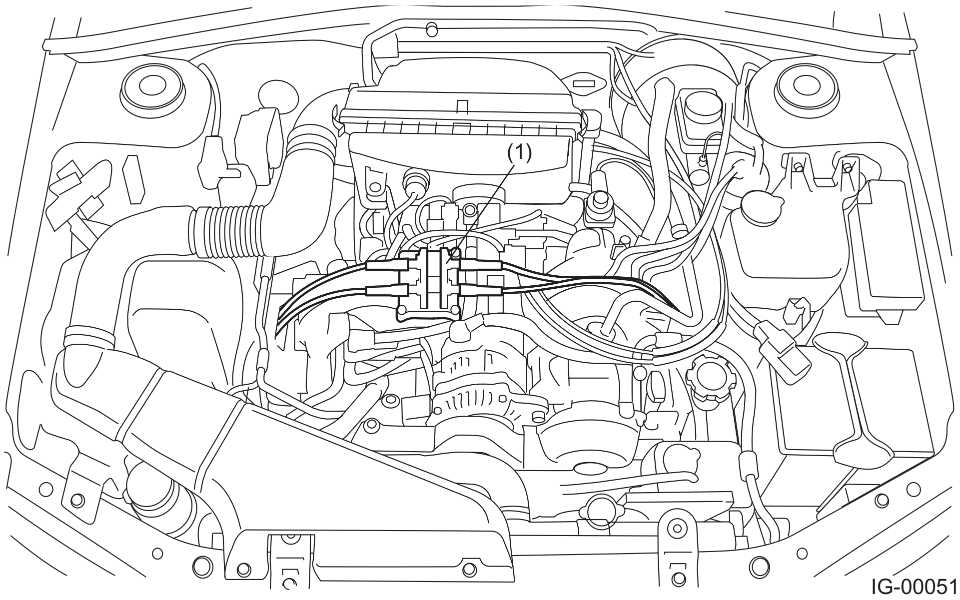
The accelerator outer cable is secured to the accelerator pedal bracket rather than to the toeboard. Securing the outer cable in this way has a merit of making the ratio of throttle valve movement to cable stroke less variable. This arrangement is also effective to prevent unsmooth cable return movement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



(1) Accelerator cable
(2) Grommet
(3) Toeboard
(4) Accelerator pedal
(5) Bracket

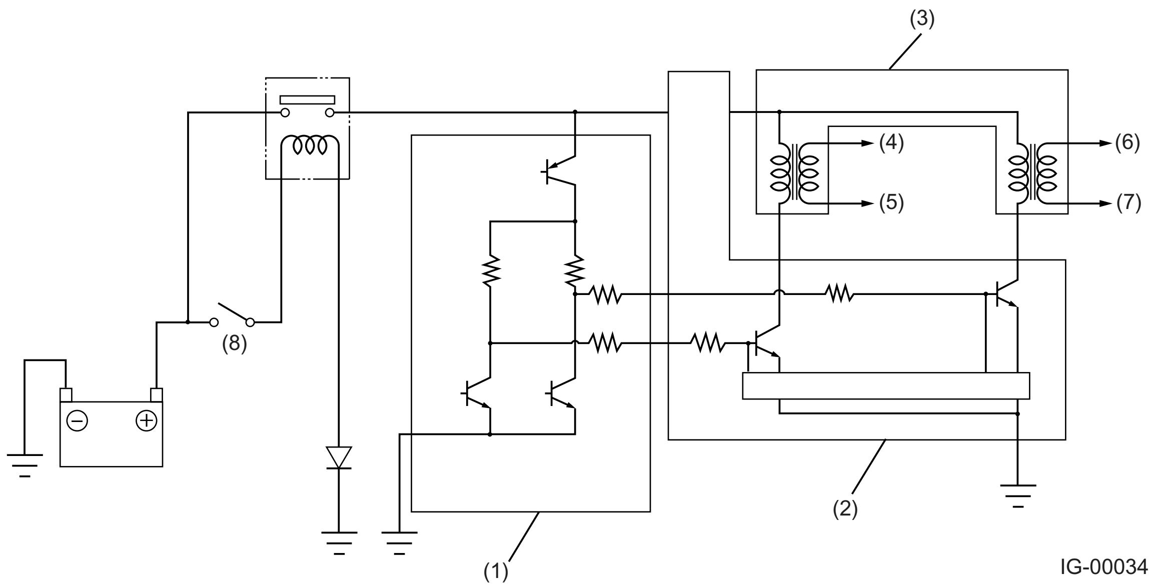
1. Ignition Coil

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.



(1) Ignition coil and ignitor assembly

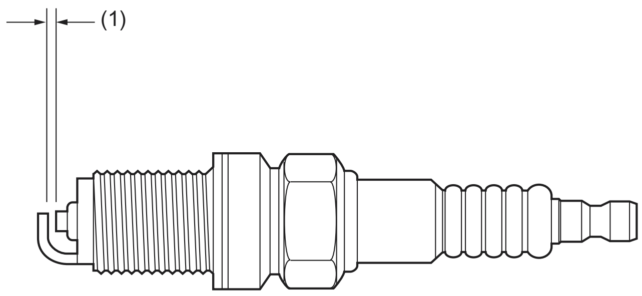
IGNITION COIL



(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

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).

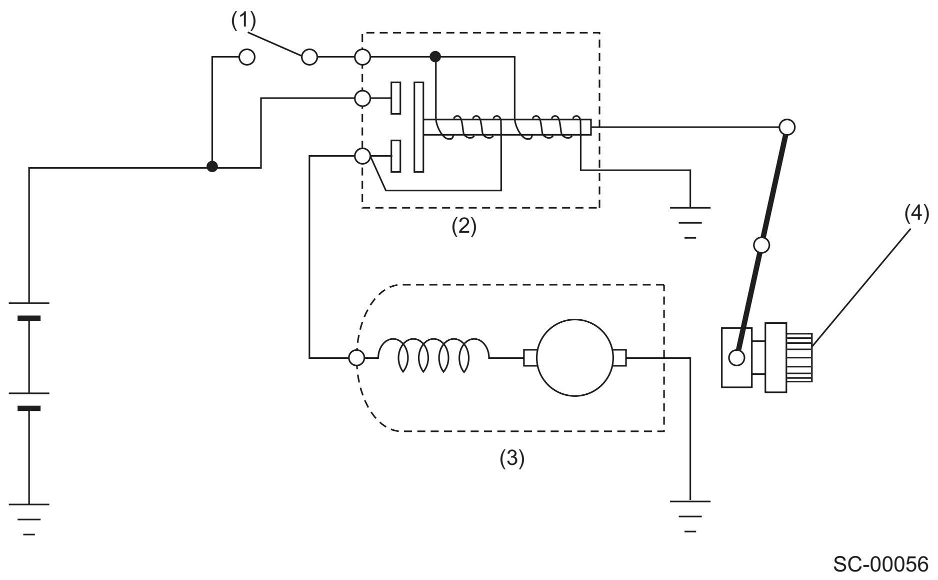


IG-00035

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

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.



(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:

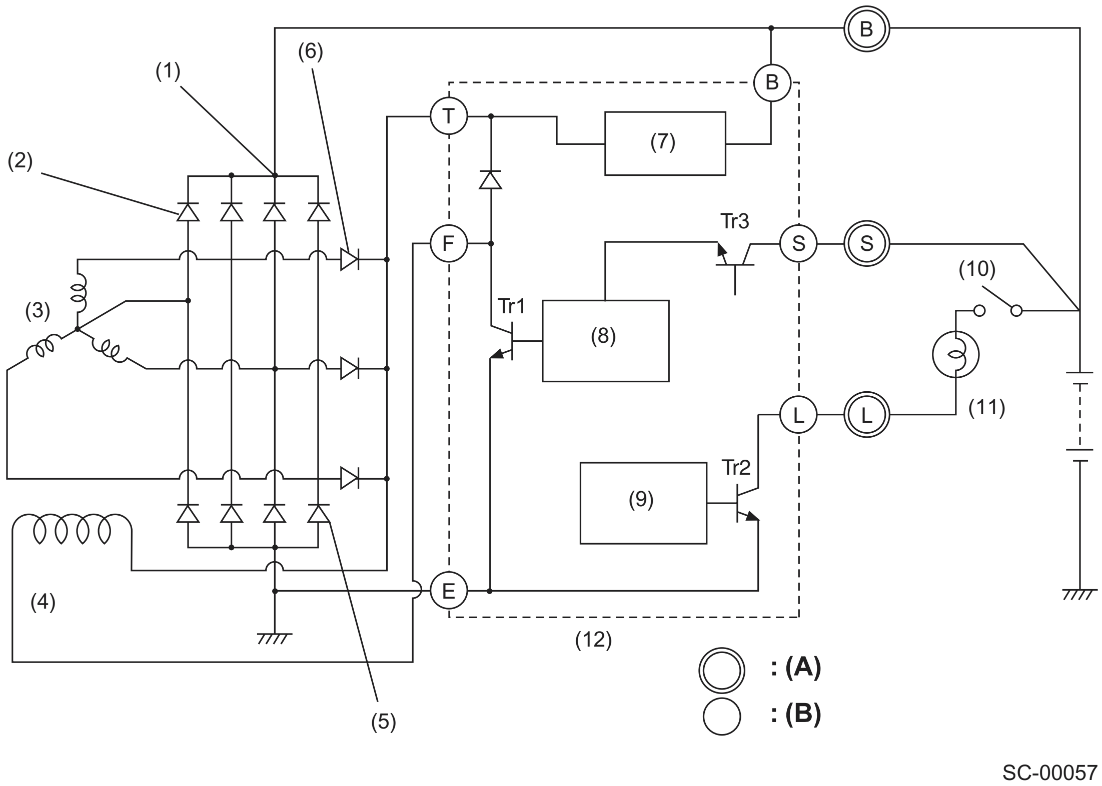
1) Voltage regulation

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.



(1) Positive side diodes (3 pcs.)	(7) Energizing circuit	**(A)** Alternator terminal
(2) Additional diodes (2 pcs.)	(8) Constant voltage circuit	**(B)** Regulator terminal
(3) Stator coil	(9) Diagnostic and warning circuit	
(4) Field coil	(10) Ignition switch	
(5) Negative side diodes (3 pcs.)	(11) Charge light	
(6) Trio diodes (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.

MEMO

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

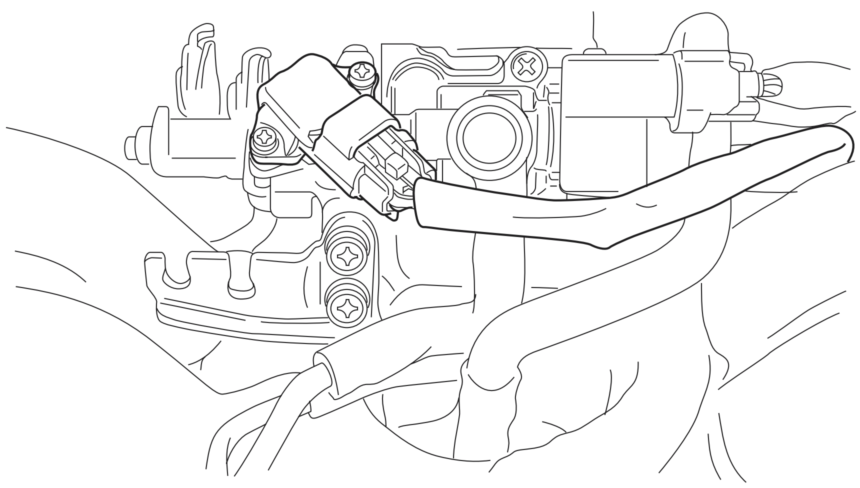
2. Air Line

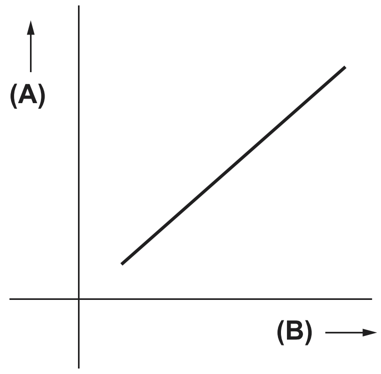
A: GENERAL

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: INTAKE MANIFOLD PRESSURE SENSOR

The intake manifold 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.





FU-00601

(A) Output voltage
(B) Absolute pressure

C: THROTTLE BODY

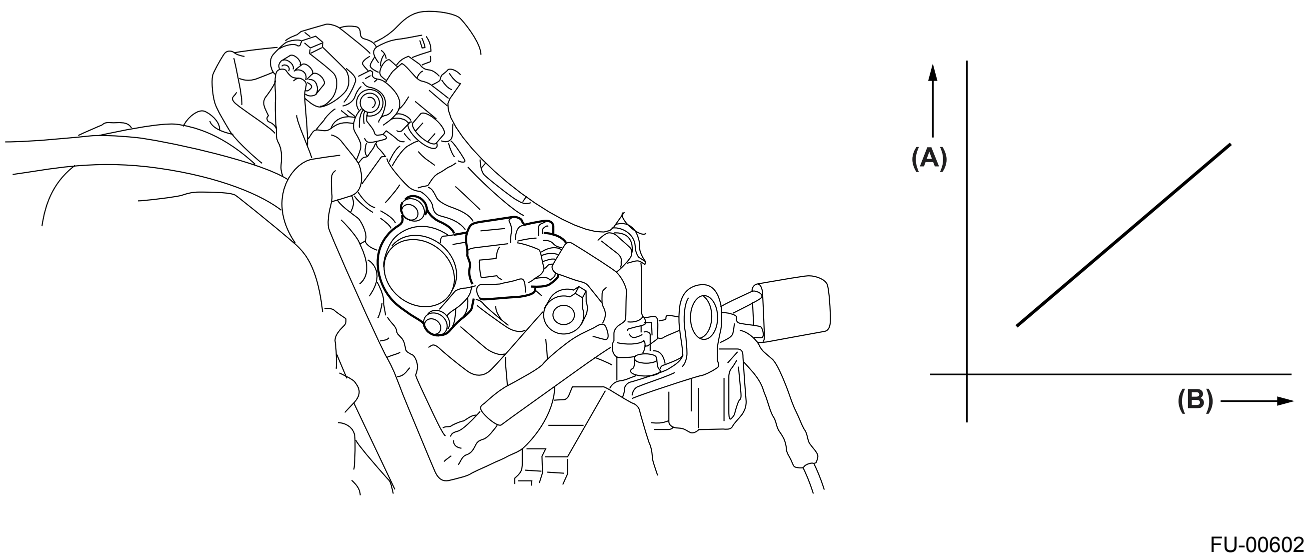
In response to operation of the accelerator pedal, the throttle valve in the throttle body opens/closes to regulate the volume of the air drawn into the combustion chamber.

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

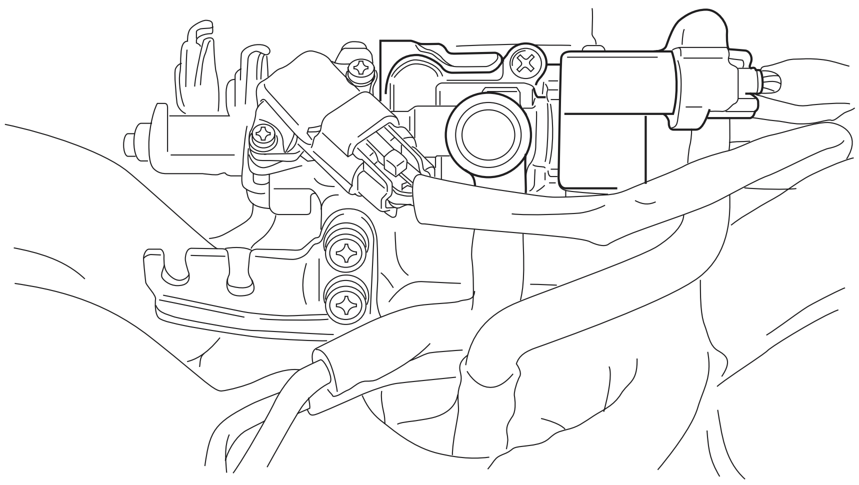
- The throttle position sensor is mounted in the throttle body and linked to the throttle valve.
- The throttle position sensor sends the ECM voltage signal corresponding to the opening of the throttle valve. When the sensor's output voltage exceeds a predetermined level, the ECM interprets it as complete 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.



(A) Output voltage
(B) Throttle opening

E: IDLE AIR CONTROL SOLENOID VALVE

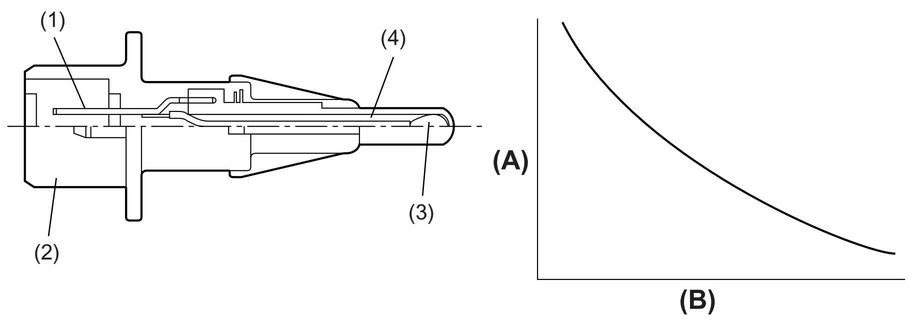
- The idle air control solenoid valve is located in the throttle body and regulates the amount of intake air that flows bypassing the throttle valve into the intake manifold during engine idling. It is activated by a signal from the ECM in order to maintain the engine idling speed at a target speed.
- 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-00603

F: 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.

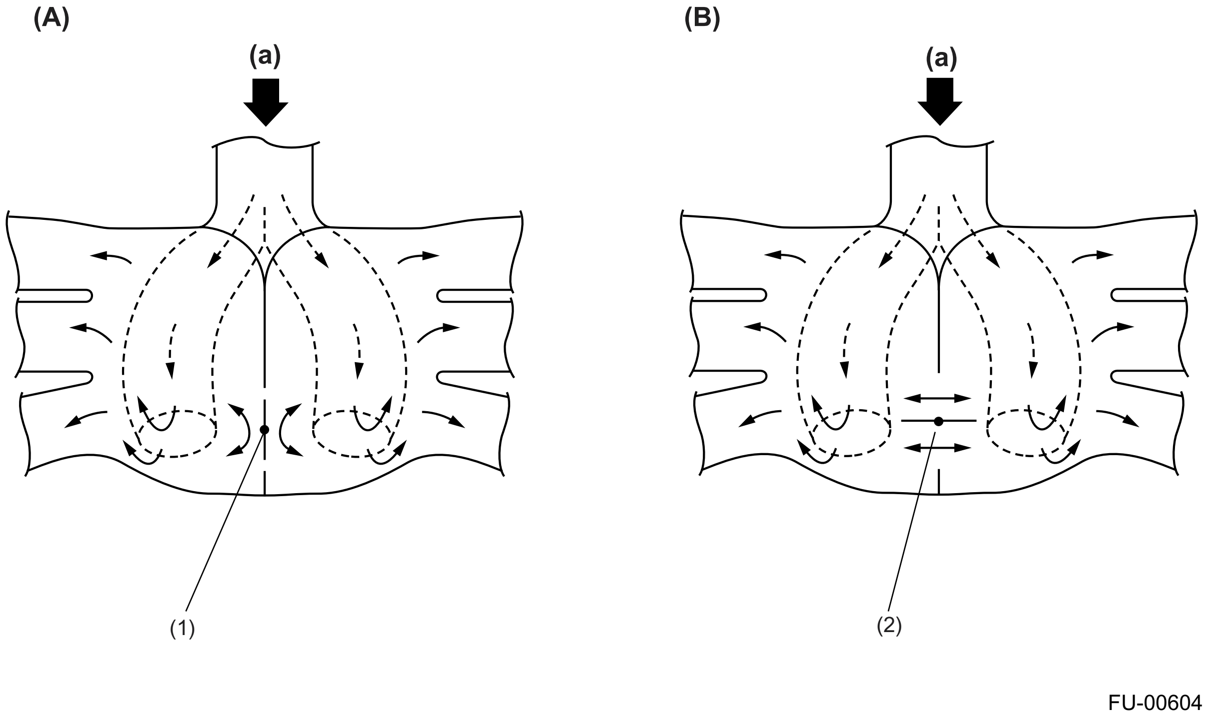


FU-00214

(1)	Terminal	(3)	Thermistor	**(A)**	Resistance (Ω)
(2)	Connector	(4)	Housing	**(B)**	Intake air temperature (°C)

G: INDUCTION CONTROL SYSTEM

There is a butterfly valve on the partition between the intake manifolds right bank and left bank chambers. This valve is operated by the induction valve actuator installed under the intake manifold. During operation of the engine, pressure waves are generated in the intake manifold. The pressure waves have an effect of improving air intake efficiency. To make the most of this effect, the direction of the pressure wave is changed by opening and closing the induction valve in accordance with the engine speed so that increased engine output torque is obtained in all speed ranges.



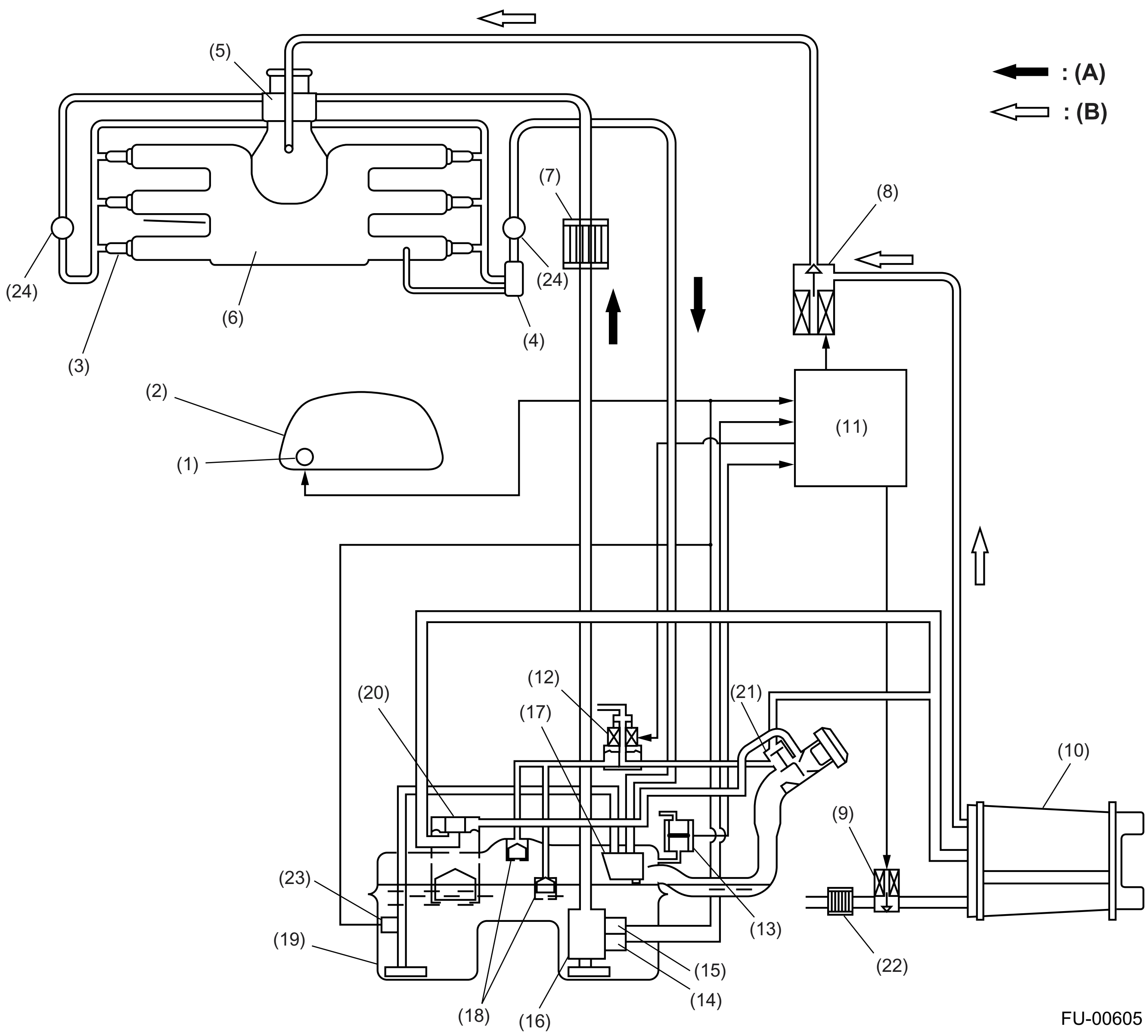
(A)	Mid-speed range	(1)	Induction valve (closed)	**(a)**	From air cleaner
(B)	Low and high speed ranges	(2)	Induction valve (open)		

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.

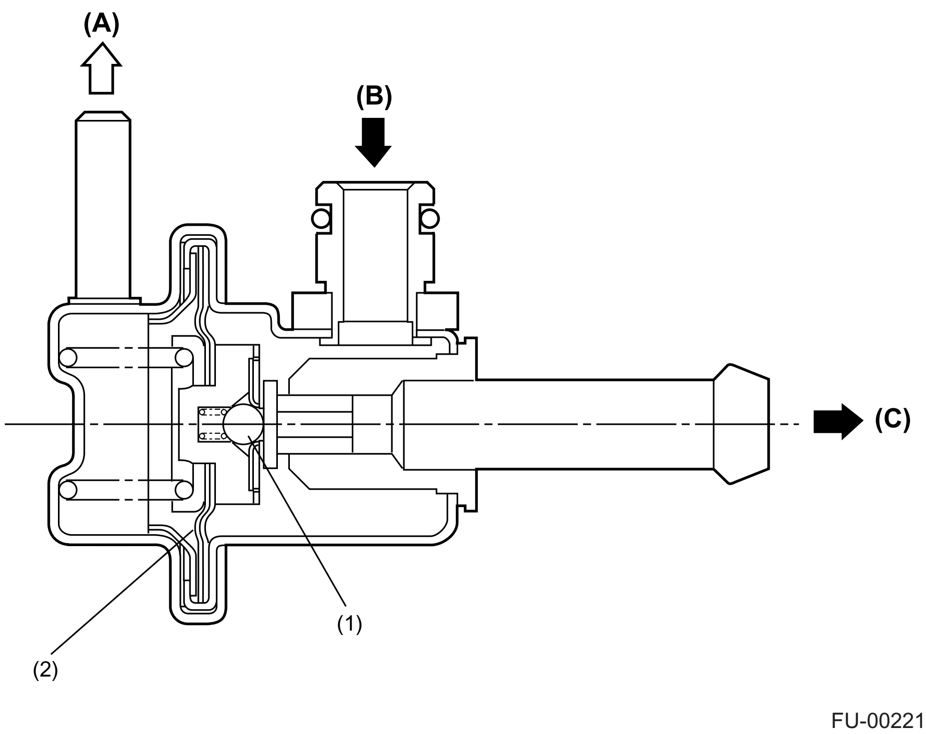
Fuel injection amount and timing are regulated by the ECM.



(1) Fuel gauge	(10) Canister	(19) Fuel tank
(2) Combination meter	(11) ECM	(20) Vent valve
(3) Fuel Injector	(12) Pressure control solenoid valve	(21) Shut-off valve
(4) Pressure regulator	(13) Fuel tank pressure sensor	(22) Drain filter
(5) Throttle body	(14) Fuel temperature sensor	(23) Fuel sub level sensor
(6) Intake manifold	(15) Fuel level sensor	(24) Pressure damper
(7) Fuel filter	(16) Fuel pump	
(8) Purge control solenoid valve	(17) Jet pump	**(A)** Fuel line
(9) Drain valve	(18) Fuel cut valve	**(B)** Fuel evaporation line

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. The 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/cm^2, 43.4 psi) to precisely control the amount of injected fuel.



(1) Relief valve
(2) Diaphragm

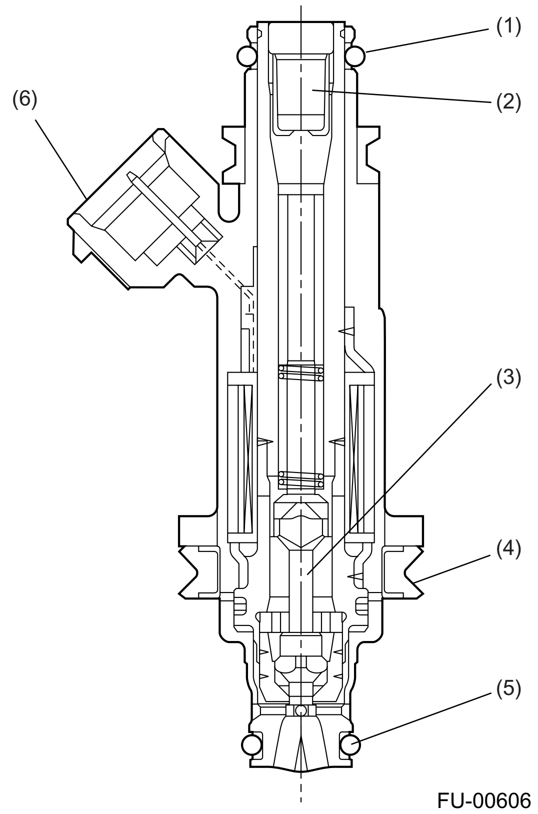
(A) To intake manifold
(B) Fuel IN
(C) Fuel OUT

C: FUEL INJECTOR

- The MFI system employs top feed type fuel injectors with an air assist feature.
- 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.
- Fuel atomization is enhanced using assist air supplied from the idle air control solenoid valve passing through the passage formed in the intake manifold at the area in which each injector is installed. This contributes not only to higher combustion efficiency and higher output but also to cleaner exhaust emissions.

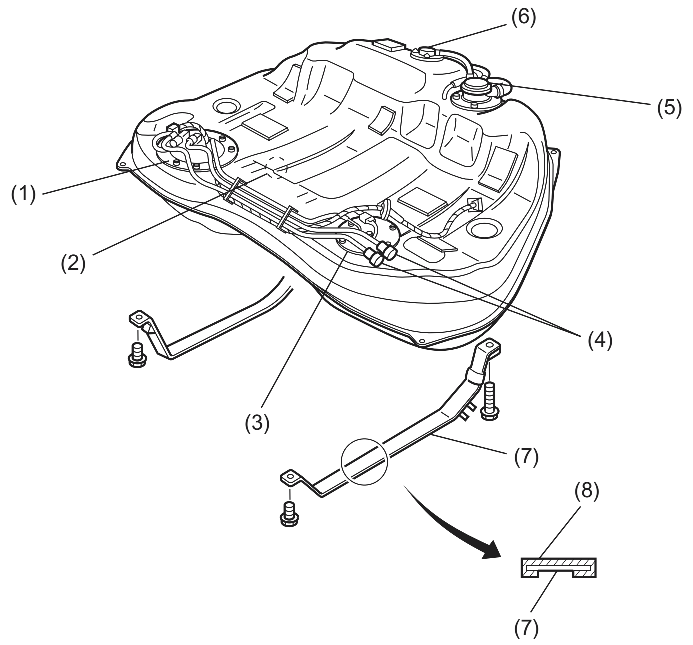


(1) O-ring
(2) Filter
(3) Plunger
(4) Seal
(5) O-ring
(6) Connector

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.

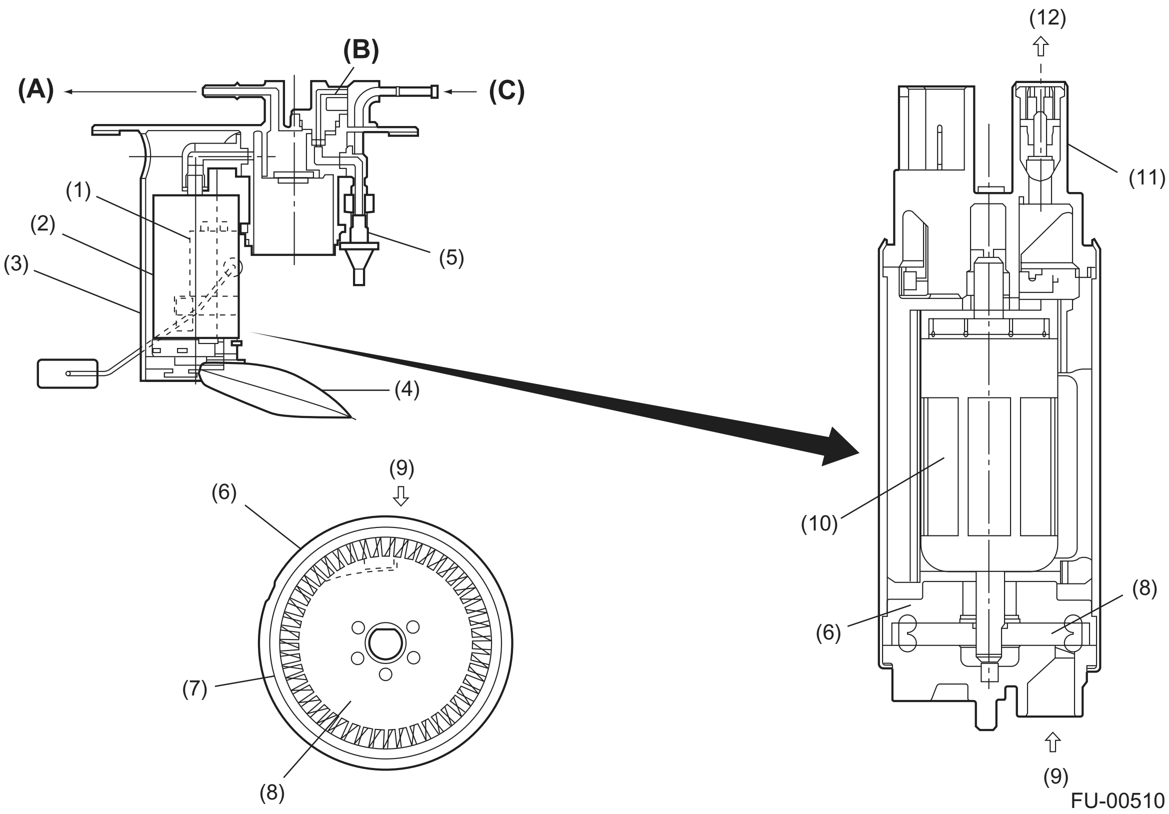


(1)	Fuel pump and fuel level sensor assembly	(5)	Vent valve
(2)	Fuel cut valve (sub-compartment)	(6)	Fuel cut valve (main compartment)
(3)	Fuel sub level sensor	(7)	Cushion
(4)	Quick connector	(8)	Steel

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.

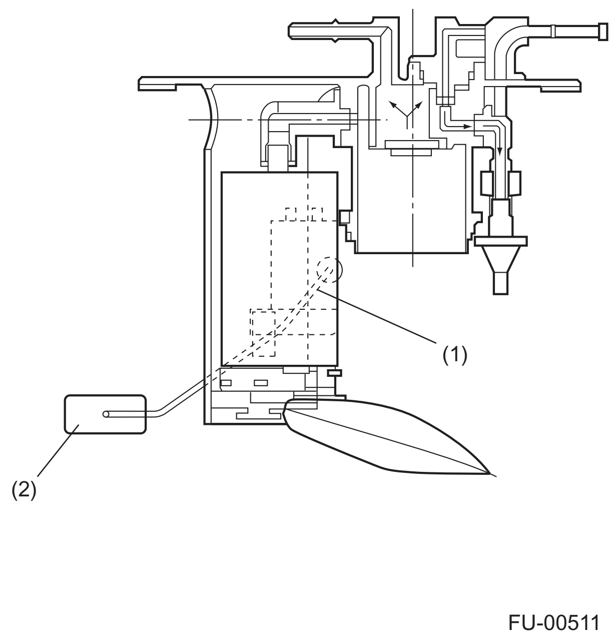


(1)	Fuel level sensor	(7)	Fuel passage	**(A)**	To engine (delivery line)
(2)	Fuel pump	(8)	Impeller	**(B)**	From engine (return line)
(3)	Pump cover	(9)	Suction	**(C)**	From sub tank
(4)	Filter	(10)	Motor armature		
(5)	Jet pump	(11)	Check valve		
(6)	Pump casing	(12)	Discharge		

- 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.

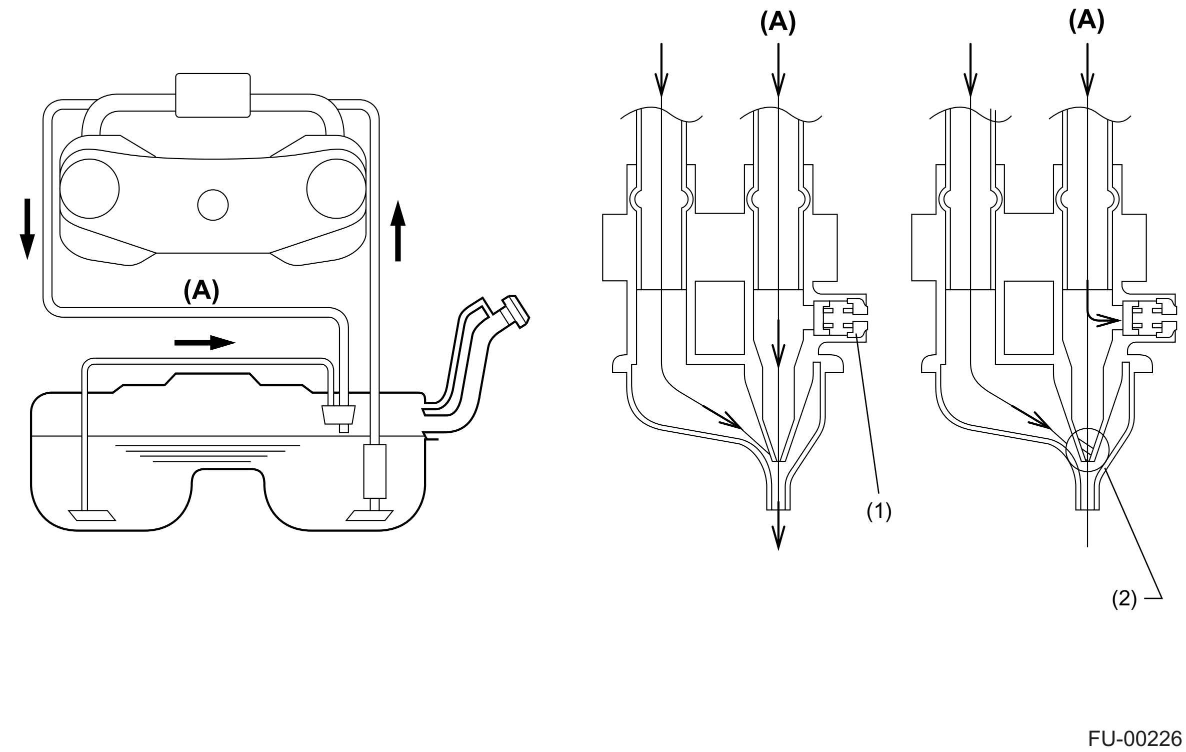


(1) Fuel level sensor

(2) Float

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.

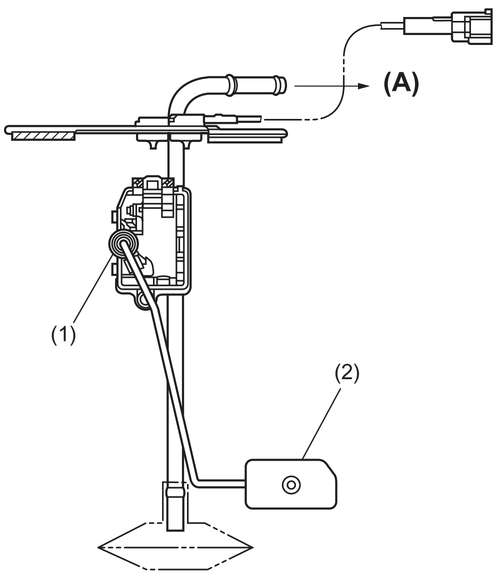


(1) Relief valve
(2) Nozzle

(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.

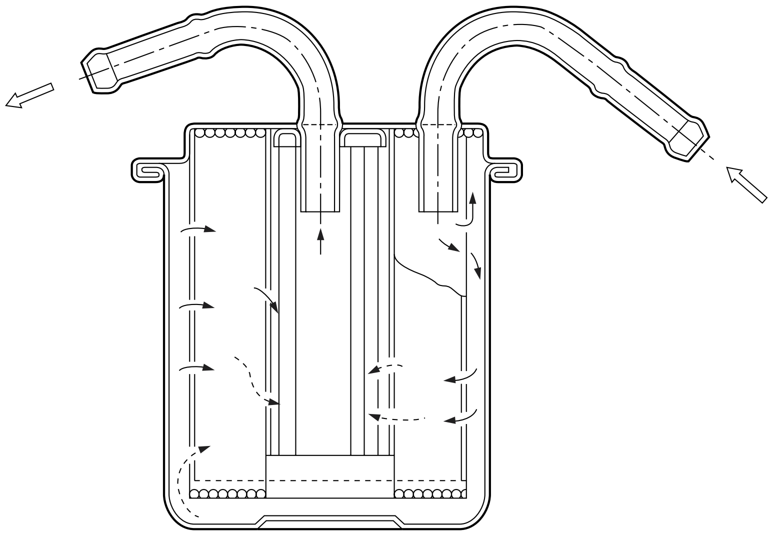


(1) Fuel level sensor
(2) Float

(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.

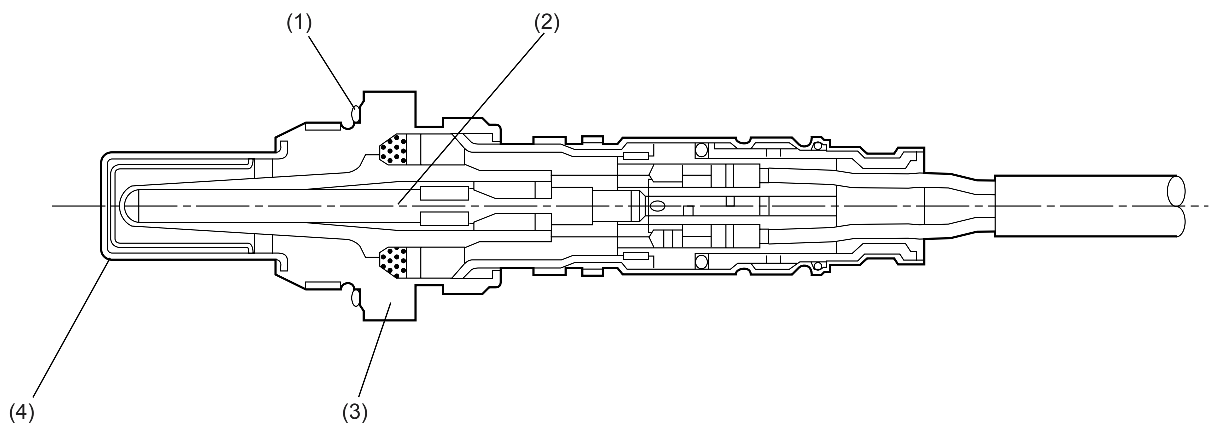


FU-00228

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.



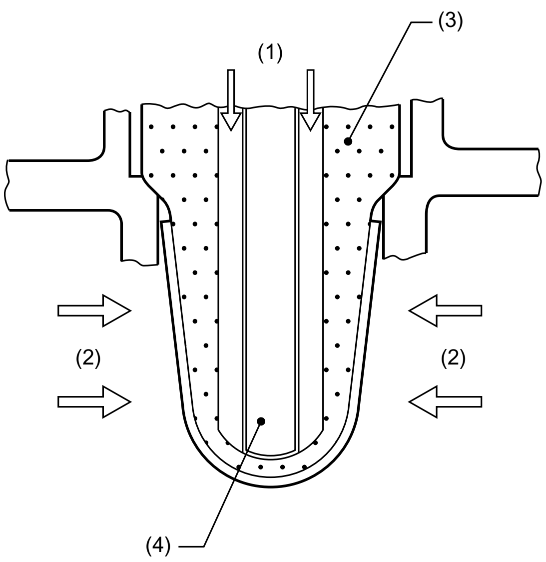
FU-00607

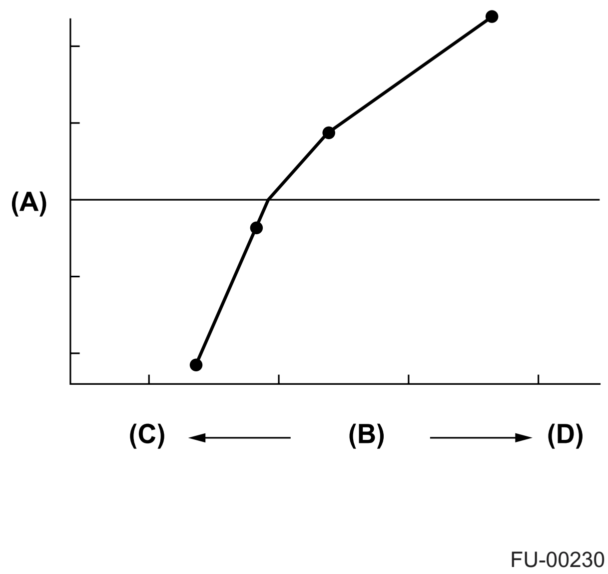
(1) Gasket
(2) Ceramic heater
(3) Sensor housing
(4) Protection tube

● 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).



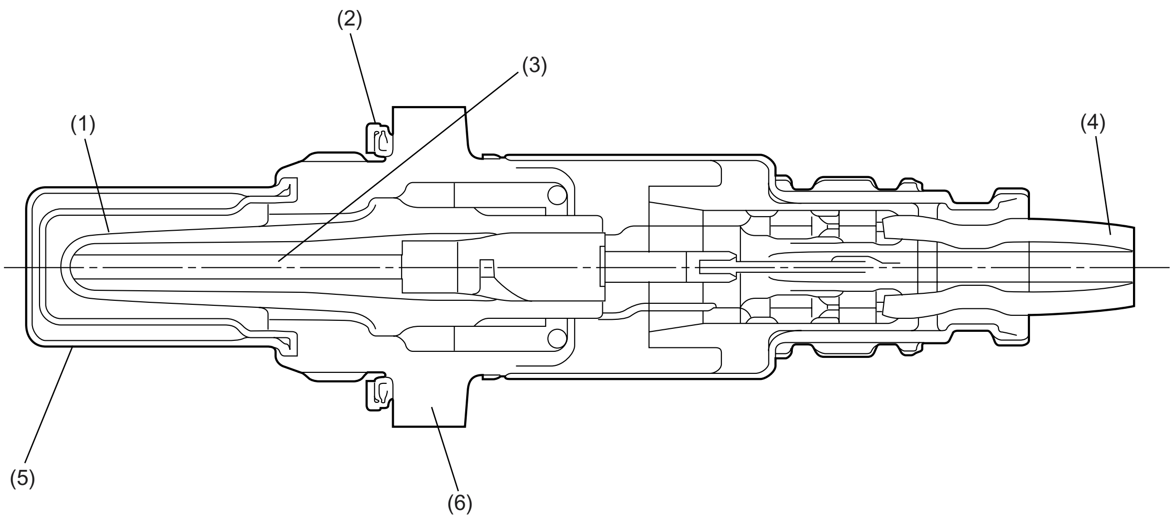


(1) Atmospheric air
(2) Exhaust gas
(3) ZrO_2
(4) Ceramic heater

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

B: REAR OXYGEN SENSOR

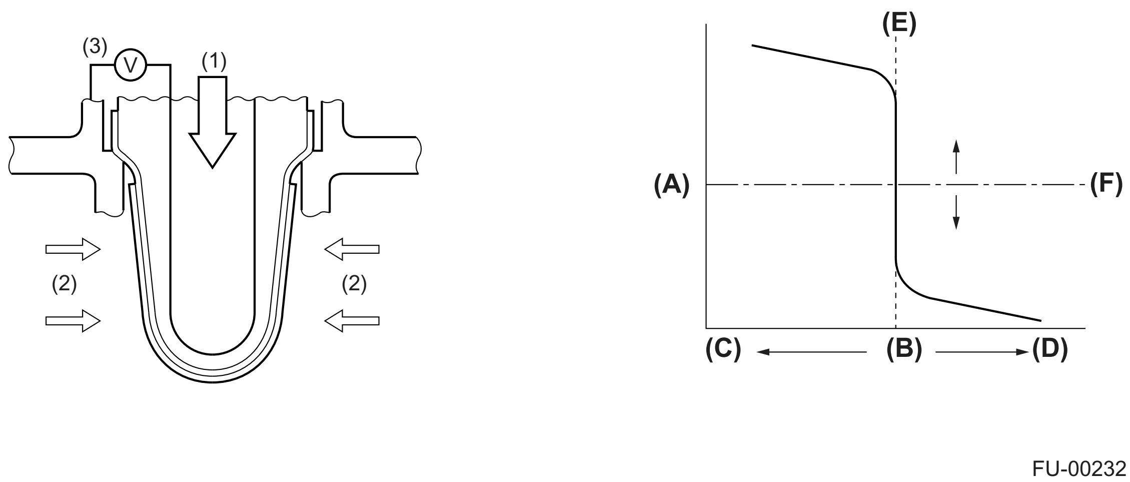
- The rear oxygen sensor is used to sense oxygen concentration in the exhaust gas. If the air-fuel ratio is leaner than the stoichiometric ratio in the mixture (i.e., excessive amount of air), the exhaust gas contains more oxygen. To the contrary, if the fuel ratio is richer than the stoichiometric ratio, 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-00608

(1) Zirconia tube	(4) Harness
(2) Gasket	(5) Protection tube
(3) Ceramic heater	(6) Sensor housing

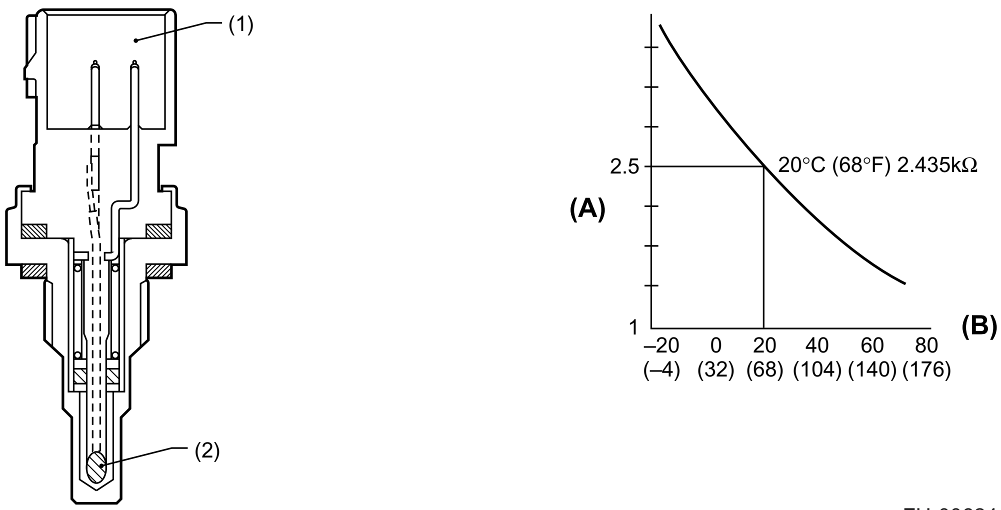
- When rich air-fuel mixture is burnt in the cylinder, the oxygen in the exhaust gases is almost completely used in the catalytic reaction by the platinum coating on the external surface of the zirconia tube. This results in a very large difference in the oxygen ion concentration between the inside and 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 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	**(A)**	Electromotive force	**(D)**	Lean
(2)	Exhaust gas	**(B)**	Air/fuel ratio	**(E)**	Stoichiometric ratio
(3)	Electromotive force	**(C)**	Rich	**(F)**	Comparison voltage

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.



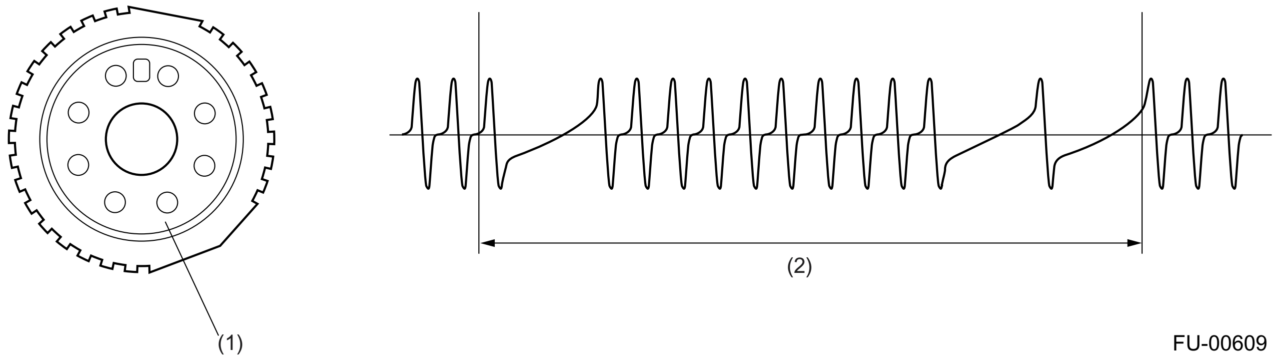
FU-00624

(1) Connector
(2) Thermistor element

(5) Resistance (kΩ)
(6) Temperature °C (°F)

D: CRANKSHAFT POSITION SENSOR

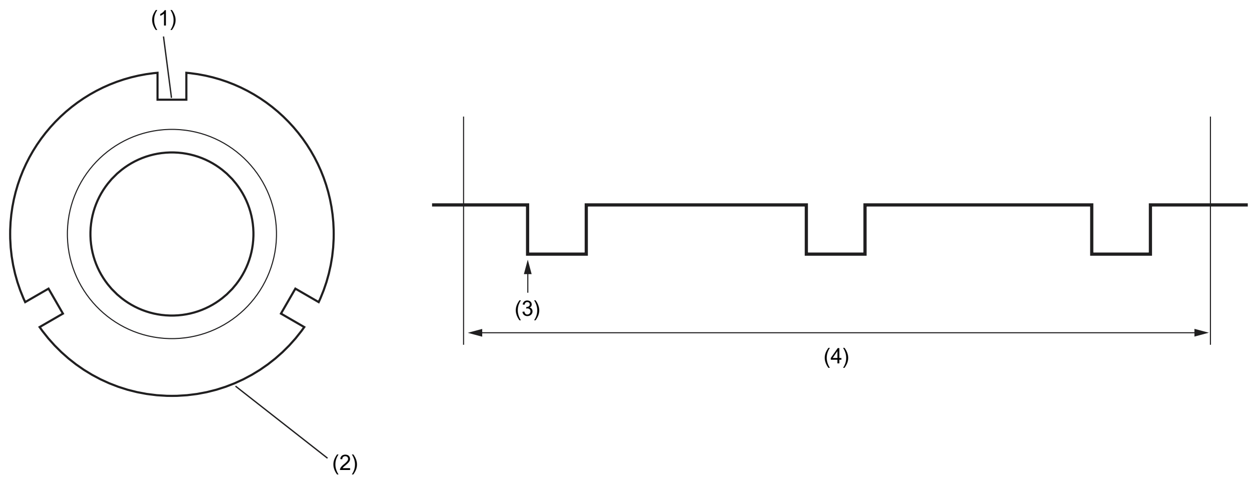
- The crankshaft position sensor is installed on the rear end of the cylinder block. The sensor generates a pulse when one of the teeth on the perimeter of the crankshaft plate (rotating together with the crankshaft) passes in front of it. The ECM determines the crankshaft angular position by counting the number of pulses.
- As the crankshaft rotates, each tooth of the crankshaft plate aligns with the crankshaft position sensor so that the magnetic flux in the sensor's coil changes since the air gap between the sensor pickup and the crankshaft plate changes. This change in magnetic flux induces a voltage pulse in the sensor and the pulse is transmitted to the ECM.



(1) Crankshaft plate
(2) Crankshaft half rotation

E: CAMSHAFT POSITION SENSOR

- The camshaft position sensor is located on the right-hand cylinder head. It detects the combustion cylinder at any given moment.
- The sensor generates a pulse when one of the slots in the right-hand camshaft plate passes in front of the sensor. The ECM detects the camshaft position by measuring the pulse.
Three slots are provided on the plate as shown below.



FU-00610

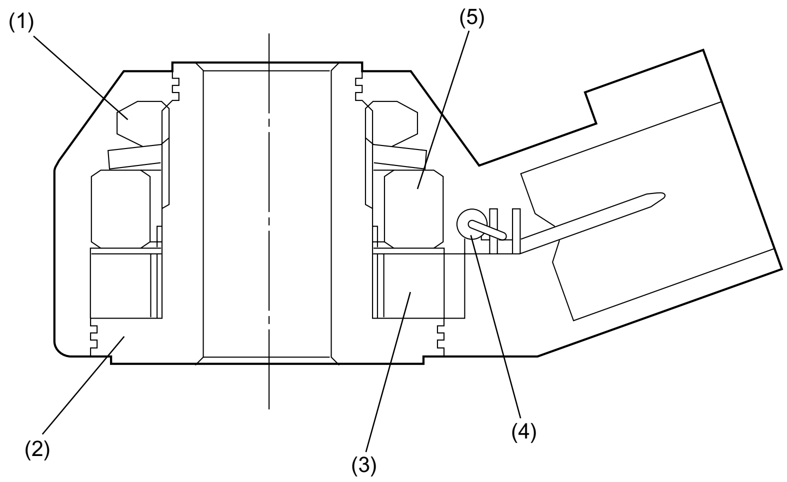
(1) Slot
(2) Camshaft plate
(3) Detection point
(4) Camshaft one rotation (crankshaft two rotations)

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.

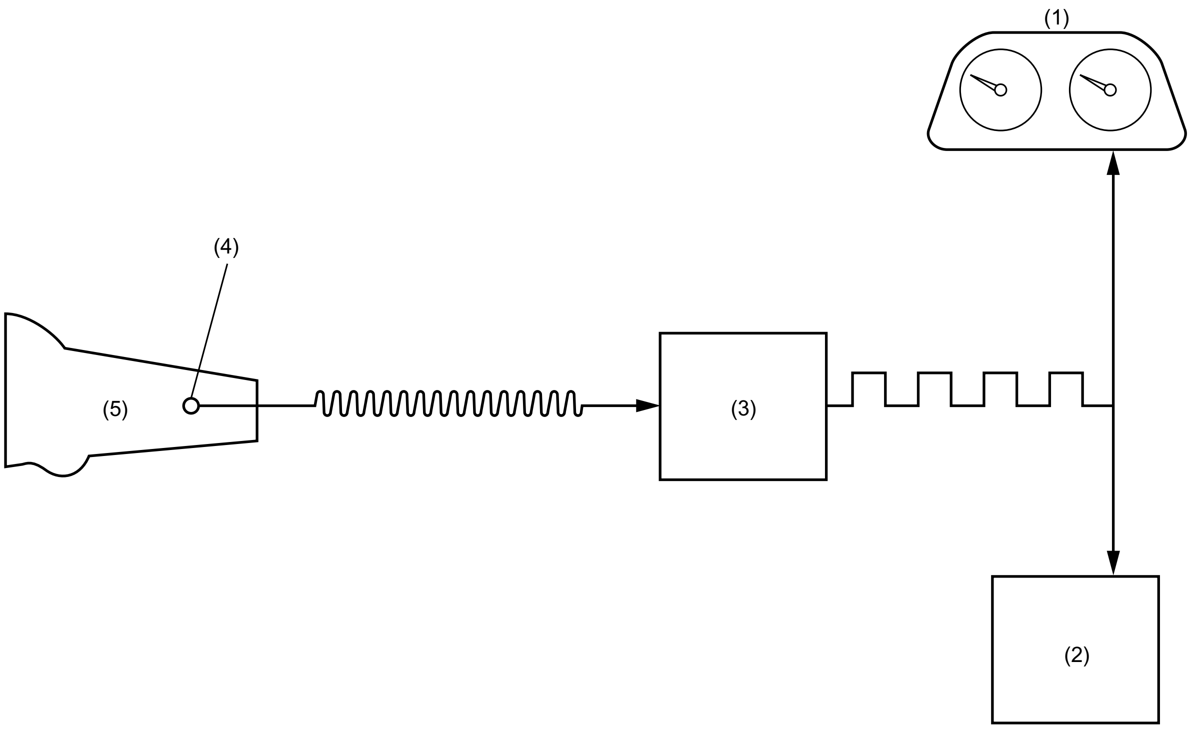


FU-00611

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

G: VEHICLE SPEED SENSOR

- 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 control
- Idle air control
- Canister purge control*1
- Radiator fan control*2
- Fuel pump control
- On-board diagnosis function

*1: Canister purge control is described under “EC (H6) Emission Control (Aux. Emission Control Devices) Evaporative Emission Control System”.

*2: Radiator fan control is described under “CO (H6) Cooling”.

B: INPUT AND OUTPUT SIGNALS

Signal	Unit	Function
Input signals	Intake manifold pressure sensor	Detects the amount of intake air (measures the absolute pressure).
	Intake air temperature sensor	Detects the temperature 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 rear 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.
	Front vehicle speed sensor	Detects the vehicle speed.
	Ignition switch	Detects operation of the ignition switch.
	Starter switch	Detects the condition of engine cranking.
	Inhibitor switch	Detects shift positions.
	Diagnostic of AT	Detects the self-diagnostics of AT
	Heater circuit of front and rear oxygen sensors	Detects abnormality in the heater circuit of the front and rear oxygen sensors.
	A/C switch	Detects ON-OFF operation of the A/C switch.
	Fuel temperature sensor	Detects the temperature of the fuel in the fuel tank.
	Fuel level sensor	Detects the level of the fuel in the fuel tank.
	Fuel tank pressure sensor	Detects the evaporation gas pressure 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 Injector	Activates an injector.
	Ignition signal	Turns the primary ignition coil current ON or OFF.
	Fuel pump relay	Turns the fuel pump relay ON or OFF.
	Fuel pump controller	Controls the voltage supplied to the fuel pump.
	A/C control 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.
	Induction control solenoid valve	Controls induction control valve.
	EGR solenoid valve	Controls EGR valve.
	Malfunction indicator lamp	Indicates existence of abnormality.
	Purge control solenoid valve	Controls purge of evaporative gas absorbed by the canister.
	Power supply	Controls ON/OFF of the main power supply relay.
	Pressure control solenoid valve	Controls evaporation pressure in fuel tank.
	Drain valve	Closes the evaporation line between the fuel tank and canister to detect leakage of evaporation gases.

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 × 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 details.)

● 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.

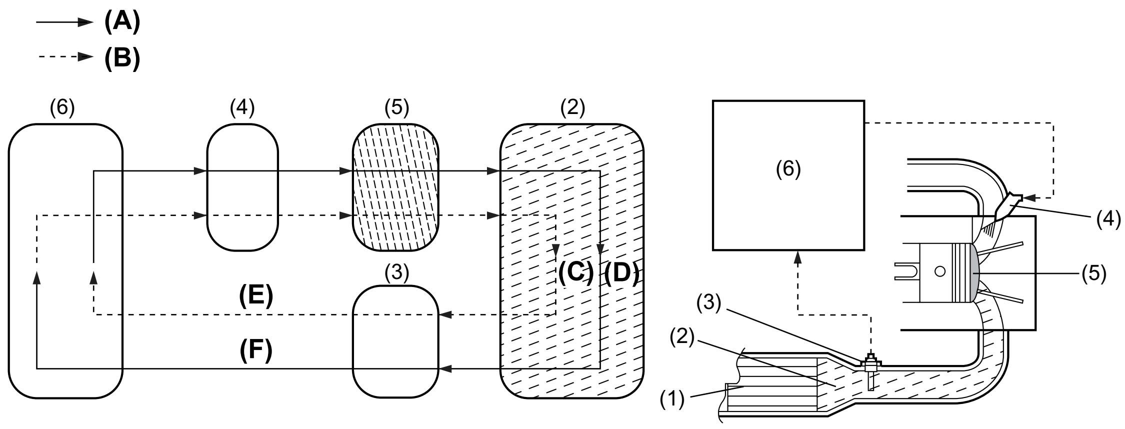
● After-start increment factor:
- This factor is used to increase the fuel injection duration for a certain period immediately after start of the engine to stabilize engine operation.
- The increment depends on the coolant temperature at the start of the engine.

● 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 current 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 current 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	**(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.)

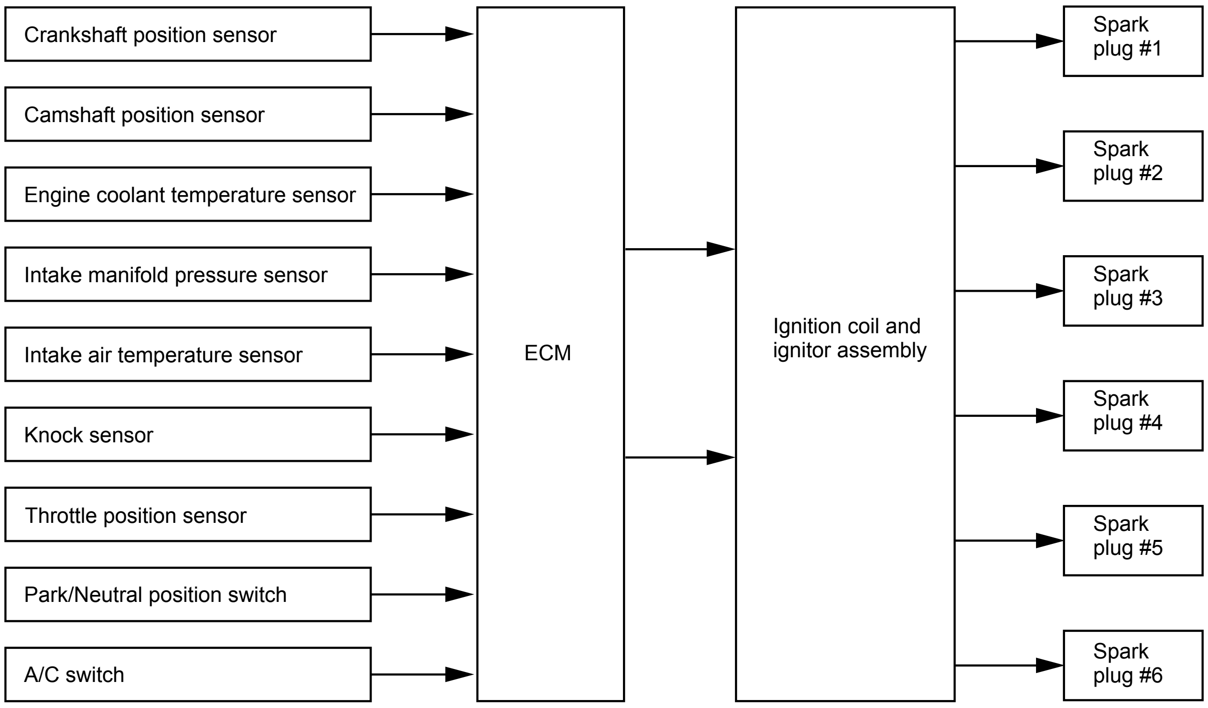
● Without a learning feature, the ECM carries out the above-mentioned process every time. This means that if the amount of necessary correction is large, the air-fuel ratio feedback control becomes less responsive and less accurate.

● 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.

D: IGNITION CONTROL SYSTEM

- 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.

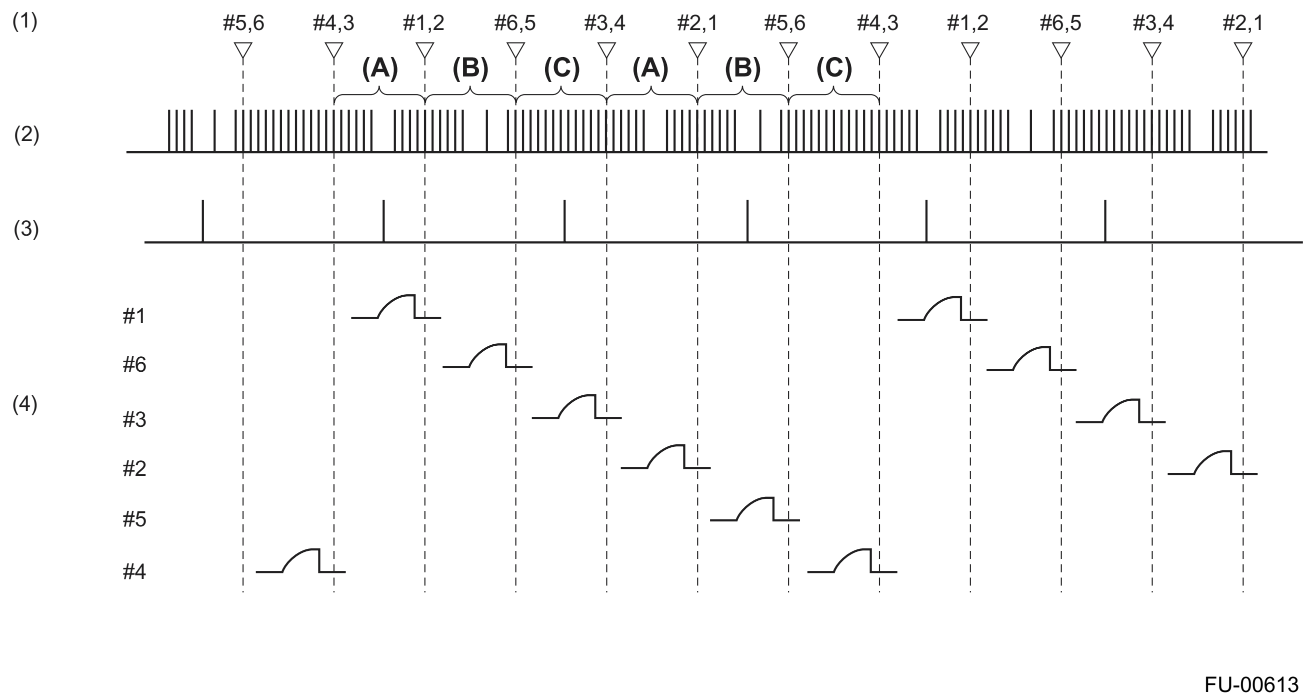


FU-00612

● The ECM receives two types of crank angle signal pulse; one is generated every 10× of crankshaft rotation and the other, every 30× of crankshaft rotation. Using these two types of signal pulse, the ECM determines the position of each piston as follows:

The ECM interprets the pulses of range (A) shown below as the No. 1 and No. 2 cylinder pistons being at TDC, the pulses of range (B) as the No. 5 and No. 6 cylinder pistons being at TDC, and the pulses of range (C) as the No. 3 and No. 4 cylinder pistons being at TDC.

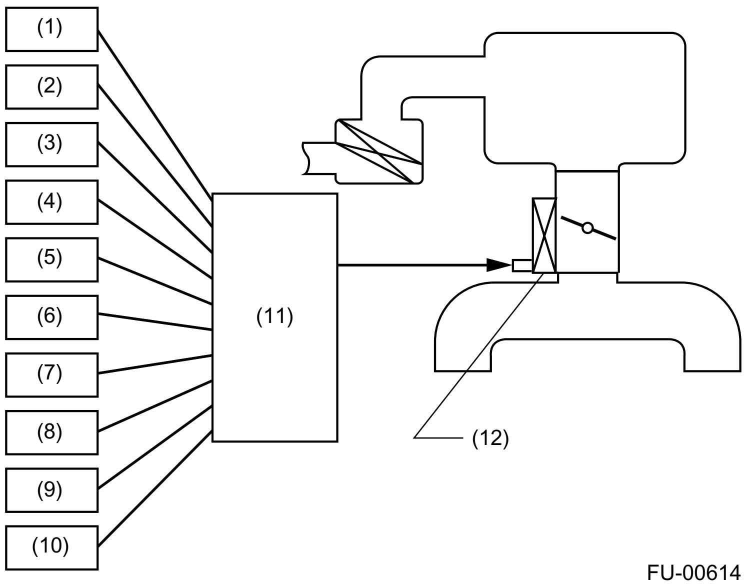
● The ECM outputs an ignition signal for the No. 1, No. 3 or No. 5 cylinder when it receives a camshaft angle pulse before a TDC signal and for the No. 2, No. 4 or No. 6 cylinder when it receives no camshaft angle pulse before a TDC signal.



(1) Cylinder number (TDC)
(2) Crank angle pulse
(3) Cam angle pulse
(4) Ignition timing

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.



(1) Intake manifold pressure sensor
(2) Intake air temperature sensor
(3) Crankshaft position sensor
(4) Camshaft position sensor
(5) Throttle position sensor
(6) Engine coolant temperature sensor
(7) Front vehicle speed sensor
(8) Ignition switch
(9) A/C switch
(10) Inhibitor switch
(11) ECM
(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

- Also, by controlling the voltage supplied to the fuel pump with the fuel pump controller, the fuel temperature is lowered and fuel consumption is reduced.

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 read and 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.)

1. System Overview

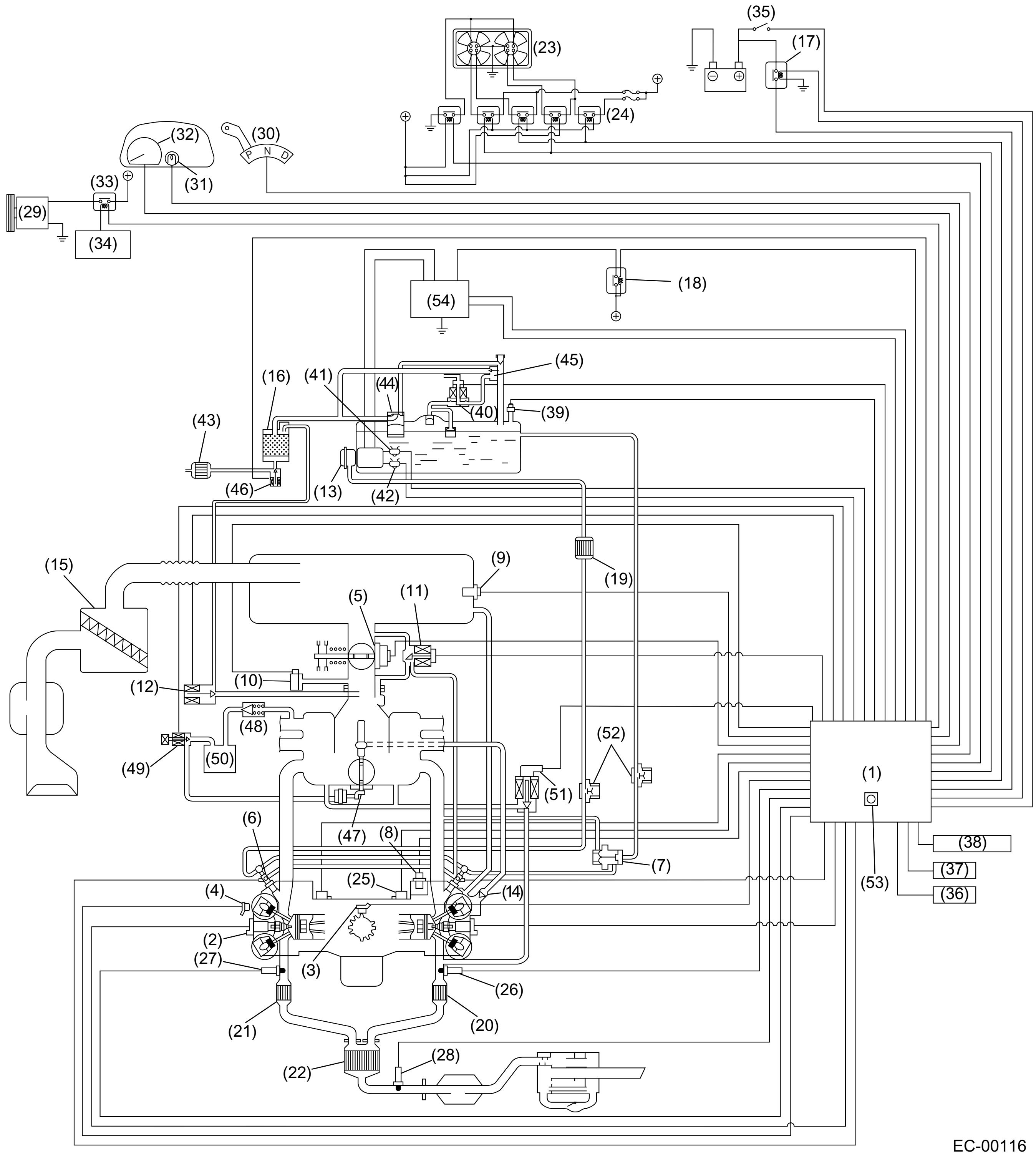
There are three emission control systems which are as follows:

- 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
  - On-board refueling vapor recovery (ORVR) 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	Three-way catalyst system	Front	Three-way catalyst	Oxidizes HC and CO contained in exhaust gases as well as reducing NOx.
		Rear		
	Air/fuel (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 in exhaust gases.
			Throttle position sensor	Detects throttle opening.
			Intake manifold pressure sensor	Detects absolute pressure of intake manifold.
			Intake air temperature sensor	Detects intake air temperature of 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.
			Pressure control solenoid valve	Receives a signal from ECM and controls evaporative gas pressure in fuel tank.
ORVR system			Vent valve	Controls evaporation pressure in fuel tank.
			Drain valve	Closes the evaporation line by receiving a signal from ECM to check the evaporation gas leak.

MEMO

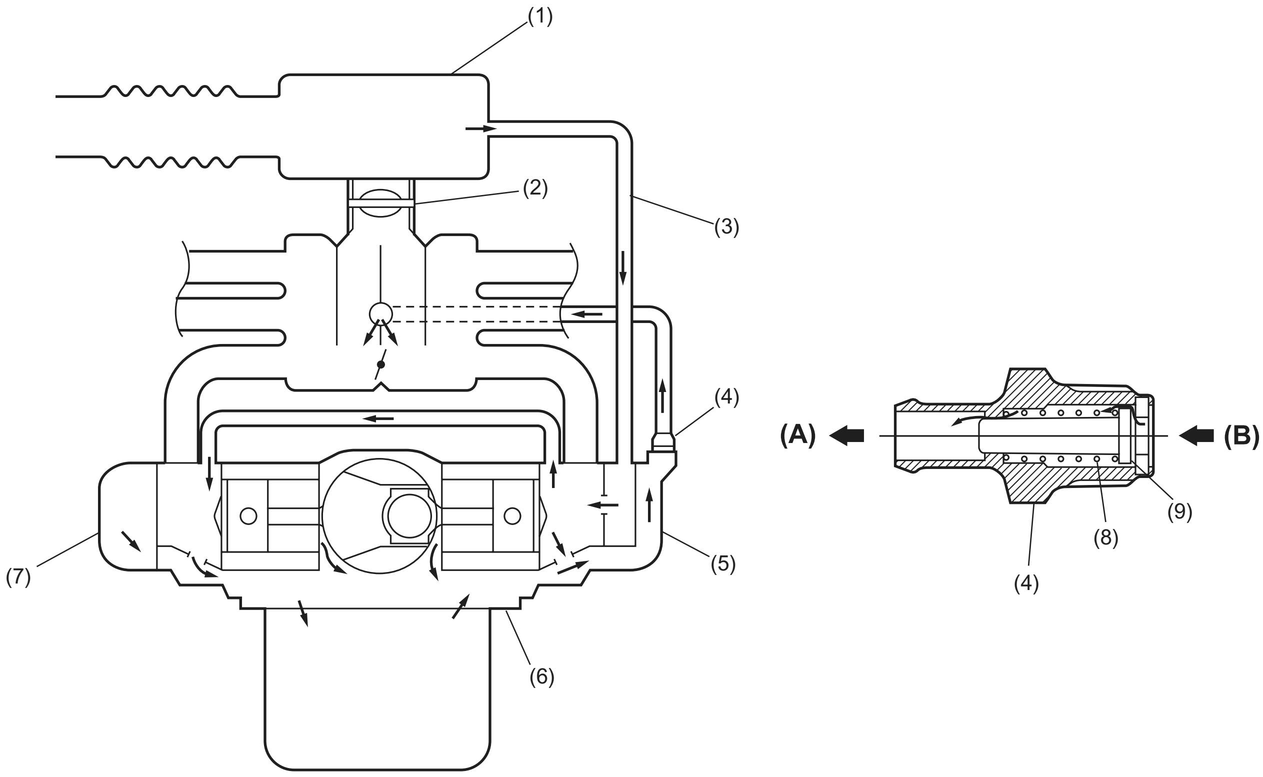
2. Schematic Diagrams



(1) Engine control module (ECM)
(2) Ignition coil and ignitor assembly
(3) Crankshaft position sensor
(4) Camshaft position sensor
(5) Throttle position sensor
(6) Fuel Injector
(7) Pressure regulator
(8) Engine coolant temperature sensor
(9) Intake air temperature sensor
(10) Intake manifold pressure sensor
(11) Idle air control solenoid valve
(12) Purge control solenoid valve
(13) Fuel pump
(14) PCV valve
(15) Air cleaner element
(16) Canister
(17) Main relay
(18) Fuel pump relay
(19) Fuel filter
(20) Front catalytic converter LH
(21) Front catalytic converter RH
(22) Rear catalytic converter
(23) Radiator fan
(24) Radiator fan relay
(25) Knock sensor
(26) Front oxygen (A/F) sensor LH
(27) Front oxygen (A/F) sensor RH
(28) Rear oxygen sensor
(29) A/C compressor
(30) Inhibitor switch
(31) CHECK ENGINE malfunction indicator lamp (MIL)
(32) Tachometer
(33) A/C control relay
(34) A/C control module
(35) Ignition switch
(36) Vehicle speed sensor
(37) Data link connector
(38) Transmission control module (TCM)
(39) Fuel tank pressure sensor
(40) Pressure control solenoid valve
(41) Fuel temperature sensor
(42) Fuel level sensor
(43) Drain filter
(44) Vent valve
(45) Shut-off valve
(46) Drain valve
(47) Induction valve
(48) Check valve
(49) Induction valve control solenoid
(50) Vacuum tank
(51) EGR valve
(52) Fuel damper
(53) Atmospheric pressure sensor
(54) Fuel pump controller

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 rocker covers with fresh air inlet, connecting hoses, a PCV valve and a chamber.



(1) Chamber	(6) Crankcase	**(A)** To intake manifold
(2) Throttle body	(7) Rocker cover LH	**(B)** Blow-by gas
(3) Connecting hose	(8) Spring	
(4) PCV valve	(9) Valve	
(5) Rocker cover RH		

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 honeycomb or porous ceramics of an oval or round shape (carrier). To avoid damaging the catalyst, only unleaded gasoline should be used.
- The catalyst reduces HC, CO and NOx 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 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.

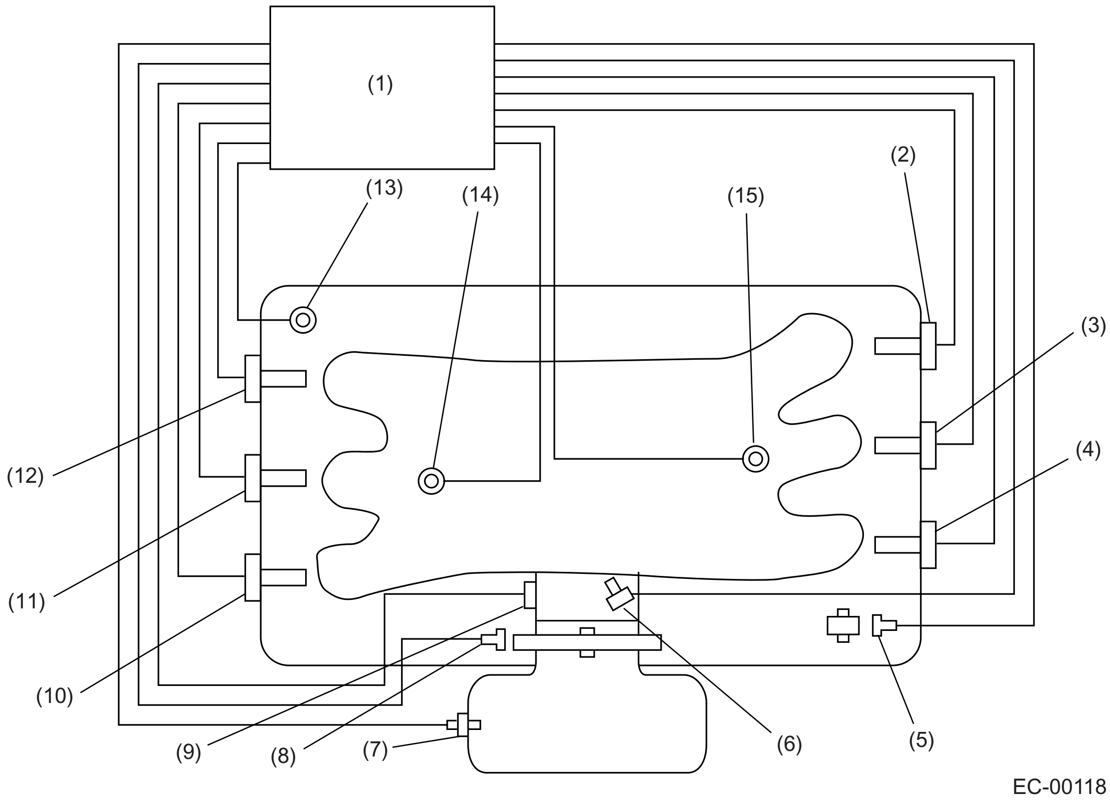
● This system also has a “learning” control function which stores the corrected data in relation to the basic fuel injection in the memory map. This allows an appropriate air-fuel ratio correction to be added automatically in quick response to any situation that requires such an effect. Thus, the air-fuel 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.

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.

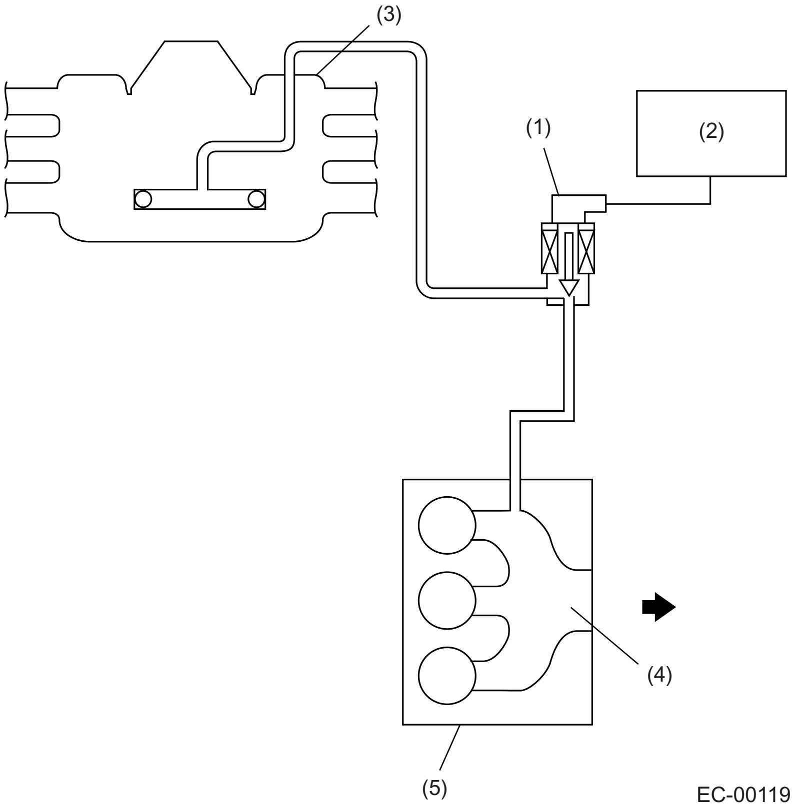


(1)	ECM	(9)	Throttle position sensor
(2)	#1 Ignition coil	(10)	#6 Ignition coil
(3)	#3 Ignition coil	(11)	#4 Ignition coil
(4)	#5 Ignition coil	(12)	#2 Ignition coil
(5)	Camshaft position sensor	(13)	Engine coolant temperature sensor
(6)	Pressure sensor	(14)	Knock sensor LH
(7)	Intake air temperature sensor	(15)	Knock sensor RH
(8)	Crankshaft position sensor		

7. Exhaust Gas Recirculation (EGR) System

A: GENERAL

- The EGR system aims at reduction of NOx by lowering the combustion temperature through recirculation 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.

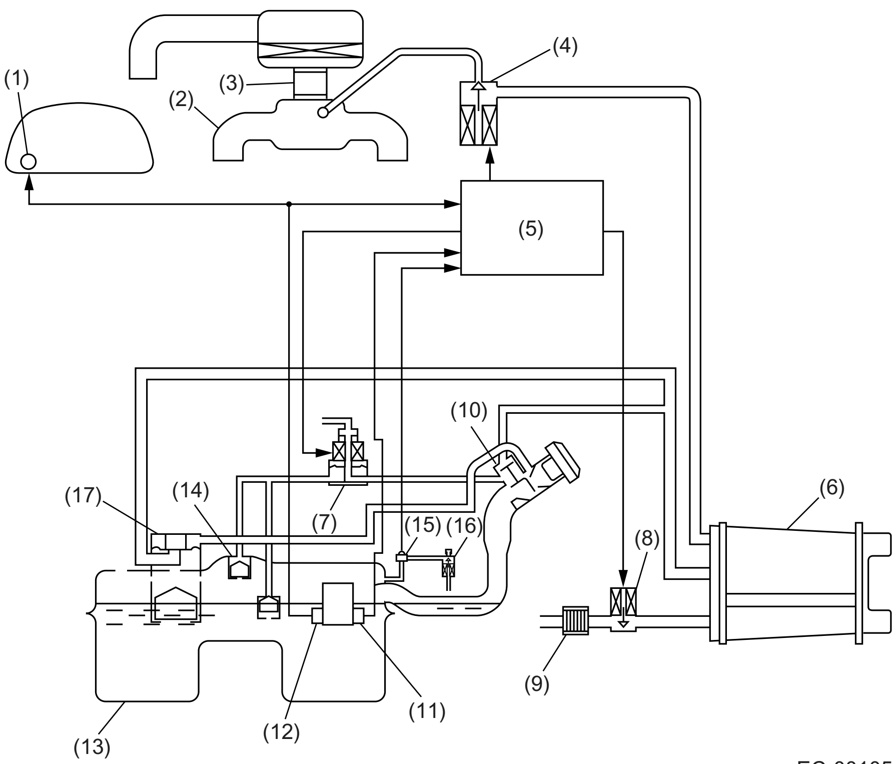


(1) EGR valve
(2) ECM
(3) Intake manifold
(4) Exhaust port
(5) Cylinder head LH

8. Evaporative Emission Control System

A: GENERAL

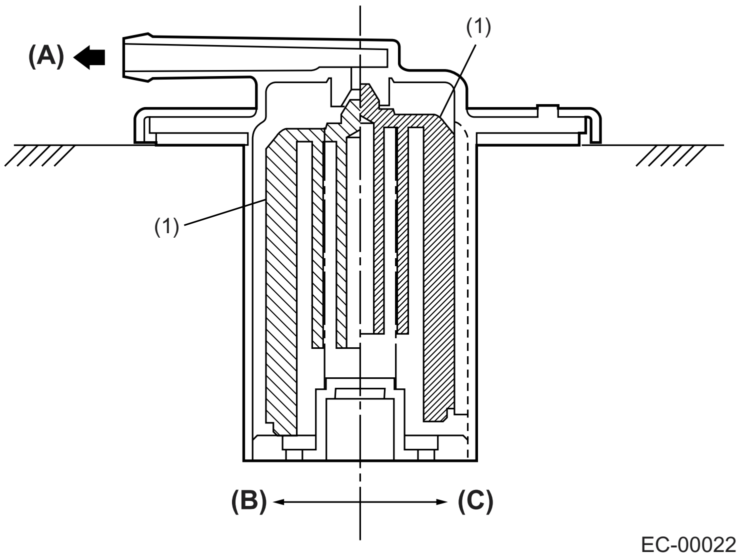
- The evaporative emission control system prevents fuel vapors from escaping into atmosphere. This system includes a canister, purge control solenoid valve, fuel cut valve, and the lines connecting them.
- Fuel vapors in the fuel tank is introduced into the canister through the evaporation line, and 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.
- The pressure control solenoid valve incorporated in the fuel tank evaporation line regulates the pressure/vacuum in the fuel tank under the control of the ECM which uses the signal from the fuel tank pressure sensor.



(1)	Fuel gauge	(7)	Pressure control solenoid valve	(13)	Fuel tank
(2)	Intake manifold	(8)	Drain valve	(14)	Fuel cut valve
(3)	Throttle body	(9)	Drain filter	(15)	Fuel tank pressure sensor
(4)	Purge control solenoid valve	(10)	Shut-off valve	(16)	Vent valve
(5)	Engine control module (ECM)	(11)	Fuel temperature sensor		
(6)	Canister	(12)	Fuel level sensor		

B: FUEL CUT VALVE

The fuel cut valve is built onto the evaporation pipe of the fuel tank cap. 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 to the evaporation line.



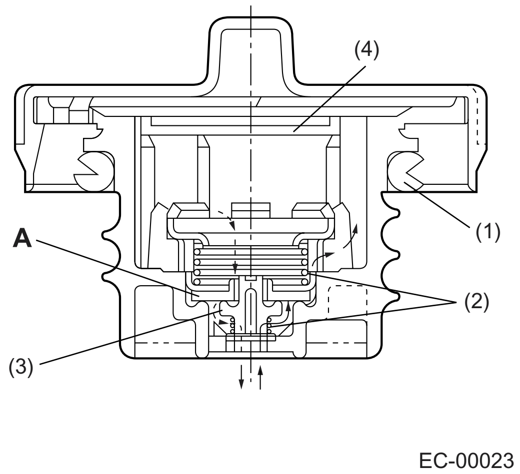
(1) Float

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

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.

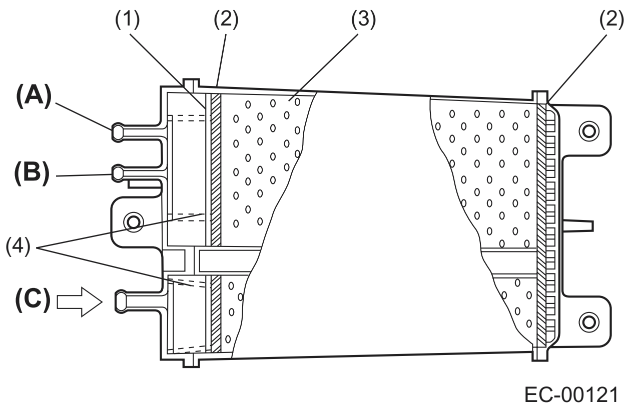
When there is no problem with the fuel vapor line, the filler pipe is sealed at the portion (A) and by the seal pressed against the filler pipe end. If vacuum develops in the fuel tank, the atmospheric pressure forces the spring down to open the valve; consequently outside air flows into the fuel tank,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



(1) Seal	(3) Valve
(2) Spring	(4) Filter

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.

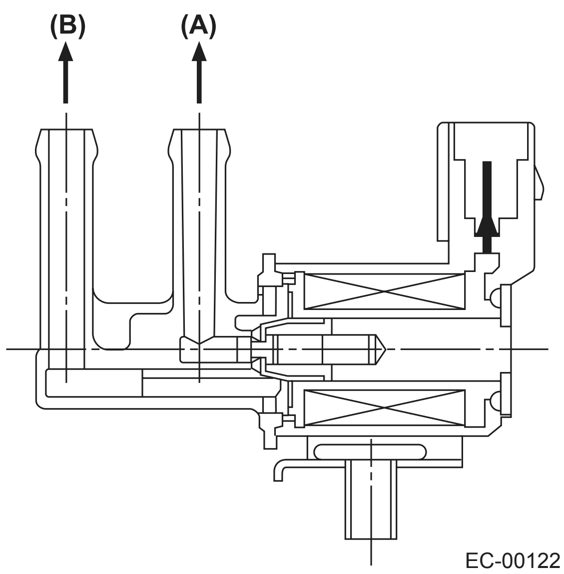


(1) Grid
(2) Filter
(3) Activated charcoal
(4) Spring

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

E: PURGE CONTROL SOLENOID VALVE

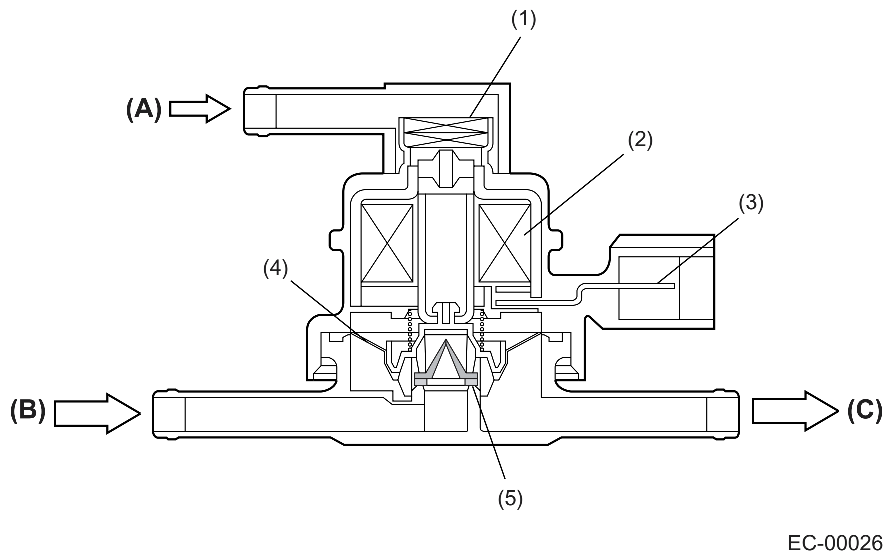
The purge control solenoid valve is on the evaporation line between the canister and throttle body. It is installed at the underside of intake manifold.



(A) To canister
(B) To throttle body

F: PRESSURE CONTROL SOLENOID VALVE

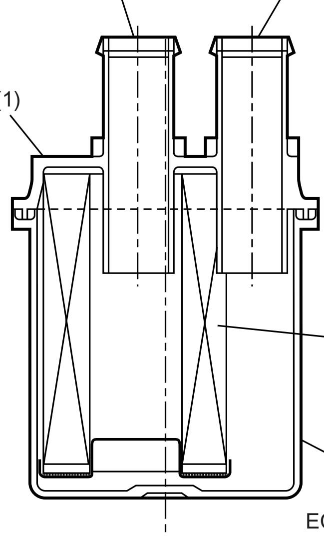
The fuel tank pressure control solenoid valve is located in the evaporation line between the shut-off valve on fuel filler pipe and the fuel tank. It adjusts the fuel tank inside pressure under the control of the ECM.
When the tank inside pressure becomes higher than the atmospheric pressure, the valve 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 from the drain valve into the canister.
The pressure control solenoid valve can also be electrically closed for the system diagnosis purposes.



(1)	Filter	**(A)**	Atmospheric pressure
(2)	Coil	**(B)**	From shut-off valve
(3)	Connector terminal	**(C)**	To fuel tank
(4)	Diaphragm		
(5)	Valve		

G: DRAIN FILTER

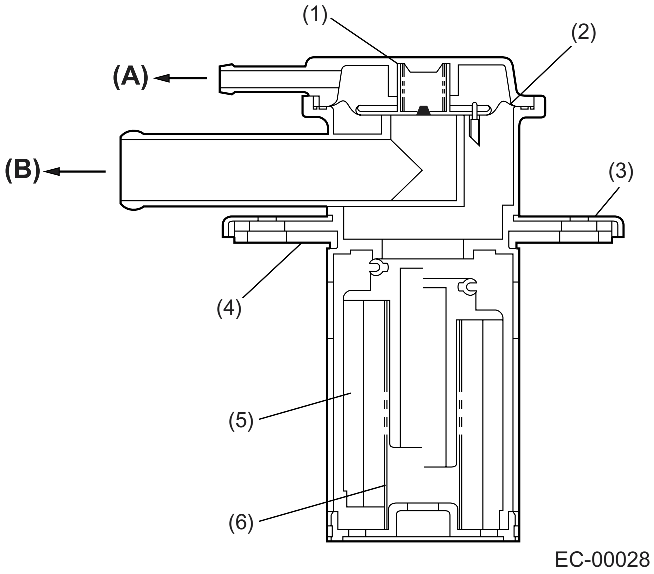
The drain filter is installed at the air inlet port of the drain valve. It cleans the air taken in the canister through the drain valve.



(1)	Cap	**(A)**	To drain valve
(2)	Element	**(B)**	To atmosphere
(3)	Case		

H: VENT VALVE

The vent valve is located on the fuel tank. During filling the fuel tank, fuel vapors are introduced into the canister through the vent valve.
When the fuel vapor pressure becomes higher than the atmospheric pressure and overcomes the spring force which is applied to the back side of the diaphragm, the port toward the canister is opened. The vent valve also has a float which blocks the fuel vapor passage when the tank is filled up. Increasing fuel level raises the float to close the port toward the canister.

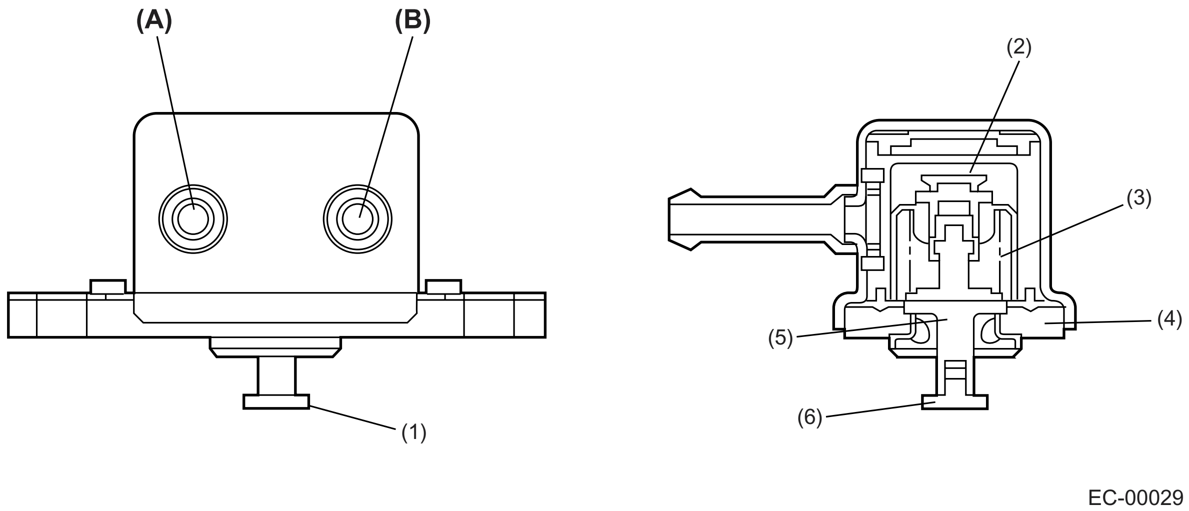


(1) Spring
(2) Diaphragm
(3) Plate cover
(4) Packing
(5) Float
(6) Float spring

(A) To filler pipe
(B) To canister

I: SHUT-OFF VALVE

The shut-off valve is located at the top of the fuel filler pipe. When a filler gun is inserted into the filler pipe, the shut-off valve closes the evaporation line.

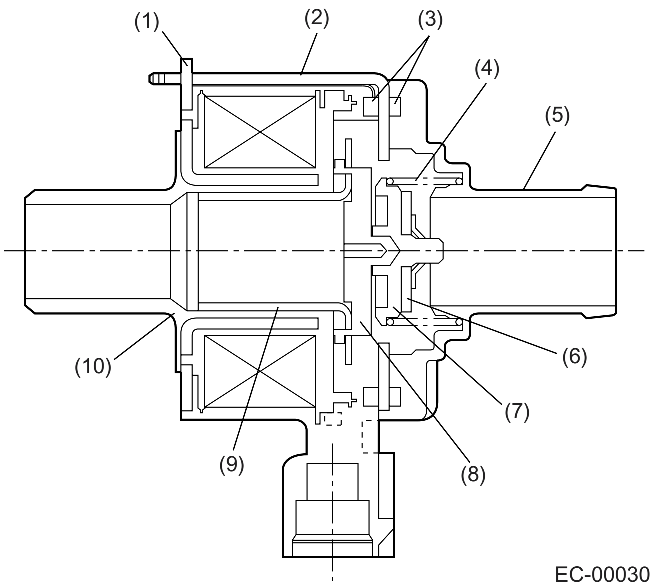


(1) Pin
(2) Valve
(3) Spring
(4) Plate
(5) Shaft
(6) Pin

(A) To canister
(B) To fuel tank

J: DRAIN VALVE

The drain valve is located on the line connecting the drain filter and canister, just below the drain filter. The drain valve is forcibly closed by a signal from the ECM while the evaporation system diagnosis is being conducted.



(1)	Magnetic plate	(6)	Valve
(2)	Yoke	(7)	Plate
(3)	Packing	(8)	Retainer
(4)	Spring	(9)	Moving core
(5)	Valve seat	(10)	Bobin

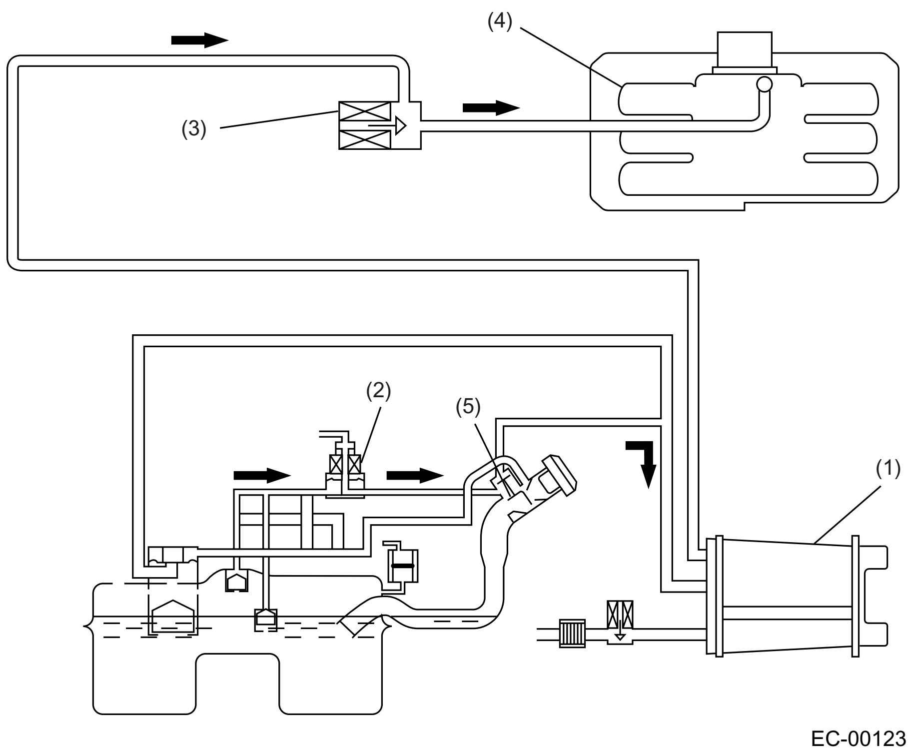
9. On-board Refueling Vapor Recovery (ORVR) System

A: GENERAL

The on-board refueling vapor recovery system allows the fuel vapors in the fuel tank to be introduced directly into the canister through the vent valve when the fuel tank inside pressure increases as a result of refueling.
The diagnosis of the system is performed by monitoring the fuel tank inside pressure data from the fuel tank pressure sensor while forcibly closing the drain valve.

B: OPERATION

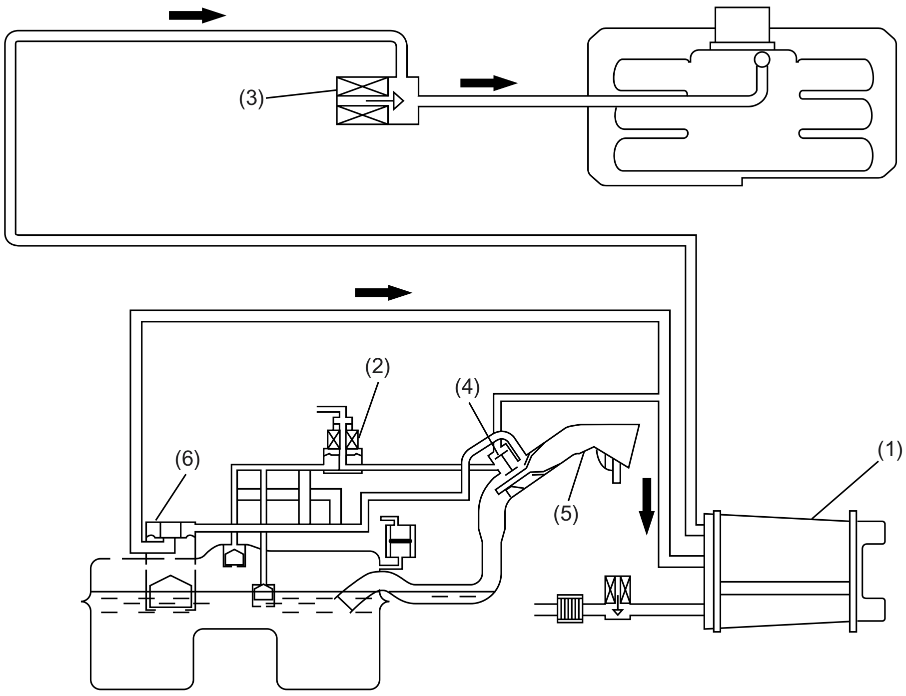
● While driving
Since the back side of the diaphragm in the pressure control solenoid valve is open to the atmosphere, the diaphragm is held pressed by the atmospheric pressure in the position where only the external air is introduced into the canister. When the fuel vapor pressure acting on the other side of the diaphragm increases and overcomes the atmospheric pressure, it pushes the diaphragm and opens the port through which the fuel vapors make their way to the canister.



(1) Canister
(2) Pressure control solenoid valve
(3) Purge control solenoid valve
(4) Intake manifold
(5) Shut-off valve: open

- While refueling

As the fuel enters the fuel tank, the tank inside pressure increases. When the inside pressure becomes higher than the atmospheric pressure, the port of the vent valve opens, allowing the fuel vapors to be introduced into the canister through the vent line. The fuel vapors are absorbed by charcoal in the canister, so the air discharged from the drain valve contains no fuel. When a filler gun is inserted, the shut-off valve closes the evaporation line.

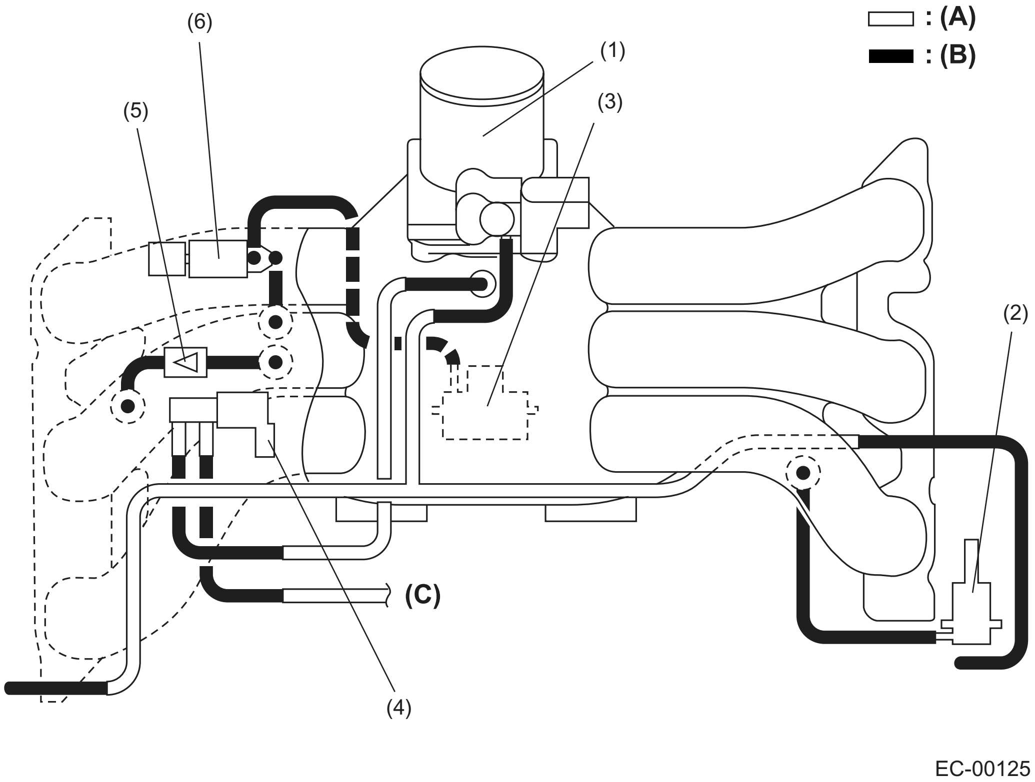


EC-00124

(1) Canister
(2) Pressure control solenoid valve
(3) Purge control solenoid valve
(4) Shut-off valve: closed
(5) Filler gun
(6) Vent valve

10.Vacuum Connections

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

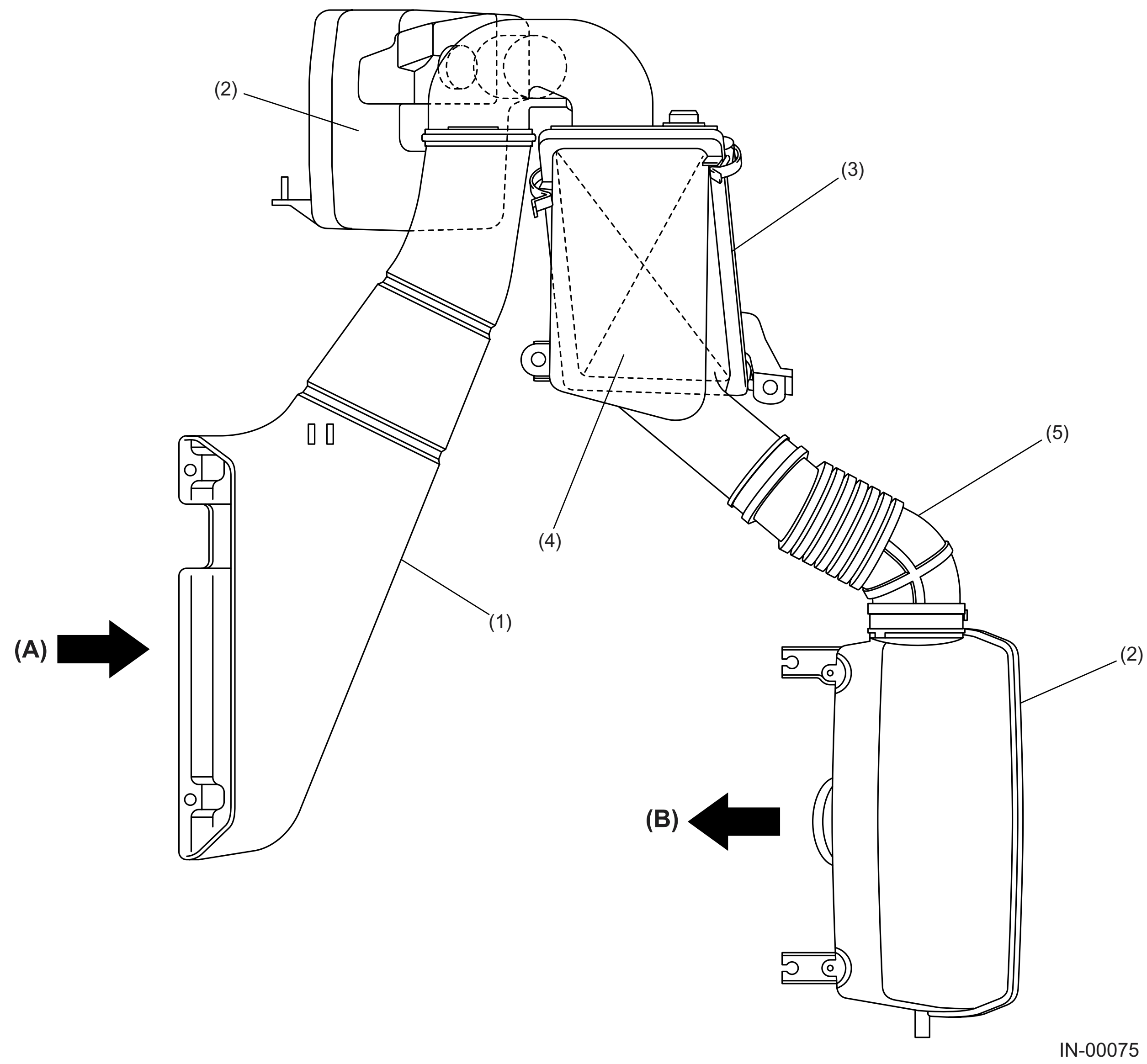


(1) Throttle body
(2) Pressure regulator
(3) Induction valve
(4) Purge control solenoid valve
(5) Check valve
(6) Induction valve control solenoid

(A) Hose
(B) Pipe
(C) To fuel tank

1. General

The intake system consists of an air intake duct, two resonator chambers, an air cleaner case, and a duct. The resonator chambers (one is located upstream of the air cleaner and the other downstream of the air cleaner) effectively reduce the intake noise level.



(1) Intake duct
(2) Resonator chamber
(3) Air cleaner case
(4) Air cleaner element
(5) Duct

(A) Fresh air
(B) To throttle body

1. General

The H6 engine is of a horizontally opposed, six-cylinder design. This four-stroke-cycle, water-cooled, DOHC engine uses a total of 24 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:

- A maintenance-free, chain-and-sprocket type camshaft drive mechanism is used which also contributes to reduction in the overall length of the engine.
- The cylinder block is an aluminum die casting fitted with iron die-cast cylinder liners.
- Lightweight and compact design.

The cylinder bore pitch is 98.4 mm (3.874 in), which is much shorter than 113 mm (4.45 in) of the H4 engine.

The cylinder bore and piston stroke dimensions have been selected optimally for sufficient output and reduced size of the engine; they are 89.2 mm (3.512 in) and 80 mm (3.150 in) in contrast to 99.5 mm (3.917 in) and 79.0 mm (3.110 in) of the H4 engine.

The cylinder block is of a "triple siamese cylinder" design with the three cylinders of each bank cast without coolant passages between cylinders, while ensuring adequate cooling by employing an open-deck design.

The right bank camshafts and the left bank camshafts are driven by different timing chains, whereas the accessories are driven through their own pulleys by a single serpentine belt (two belts were used in the previous model's engine).

- Quiet operation

Unlike V6 engines, horizontally opposed six-cylinder engines do not generate secondary vibration (which is caused by primary operational vibration in a V6 engine and has a frequency twice as large as that of the primary vibration) although V6 engines have space saving merit. In addition to this inherent quietness provided by complete dynamic balance, the H6 engine incorporates the following quietly operating considerations:

The crankshaft is supported by seven bearings and has a diameter of 64.0 mm (2.52 in), which is 4.0 mm (0.157 in) larger than with the previous model's engine.

The chains driving the camshafts are provided with hydraulic tension adjusters and covered by a chain cover at the front of the engine.

An aluminum die-cast upper oil pan reinforces the joint of the right and left cylinder block banks, while giving additional rigidity to the crankshaft bearing areas.

The engine is connected to the transmission more rigidity than with the previous model by using 11 bolts (eight bolts in the previous model).

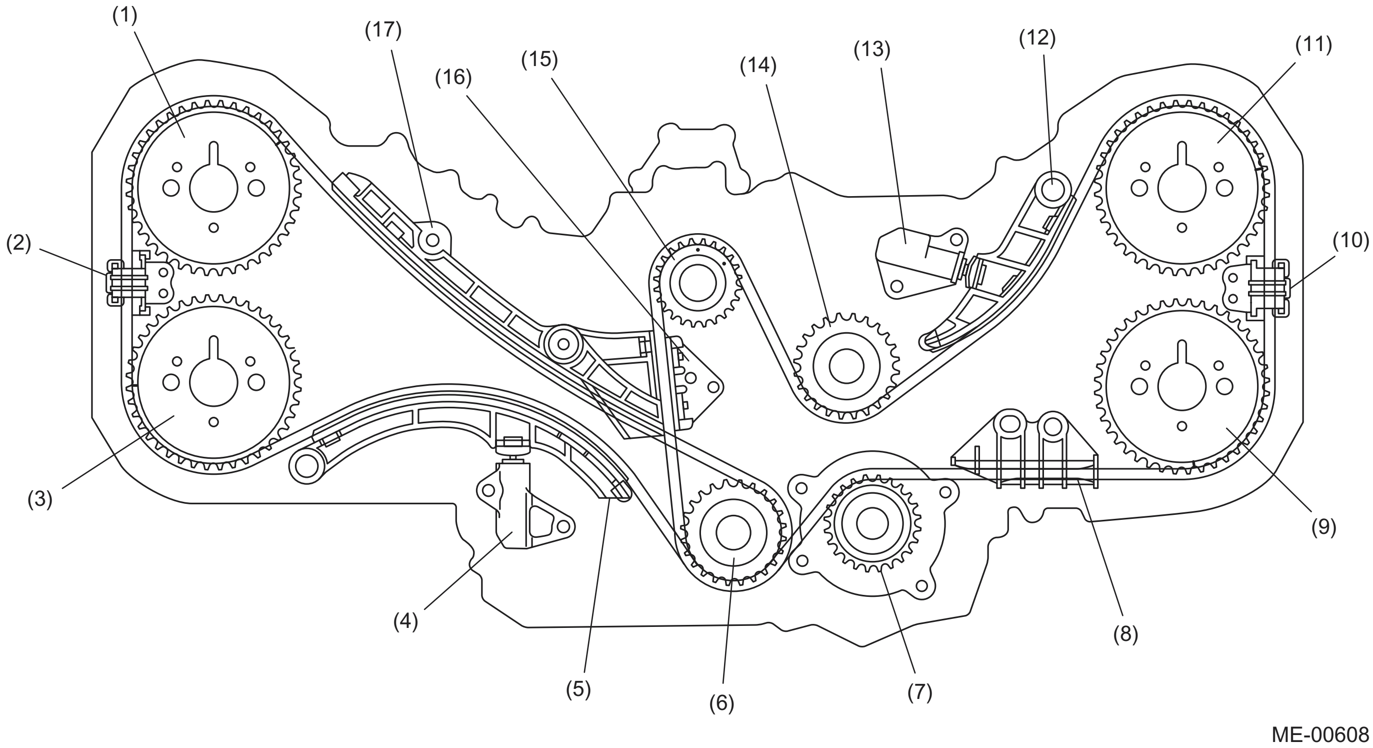
- Clean exhaust gas and high power

The H6 engine has enabled the Legacy to comply with US LEV standard without sacrificing output power by adopting, among others, tumble flow generating intake ports and a variable length intake manifold that creates a resonance ramcharging effect.

2. Timing Chains

● Two timing chains are used to drive the camshafts, one each for driving the two camshafts on each bank. Every camshaft is fitted with a sprocket through which it is driven by the corresponding timing chain. The left bank timing chain transmits the power from the crankshaft sprocket directly to the left bank camshaft sprockets, whereas the right bank timing chain transmits the crankshaft power via the lower idler sprocket which is driven by the left bank timing chain. (The lower idler gear has two tooth rows; the left bank timing chain engages with the inner row teeth and the right bank chain engages with the outer row teeth.)By this way, the right and left bank camshafts rotate in synchronization with each other.
The left bank timing chain also drives the water pump.

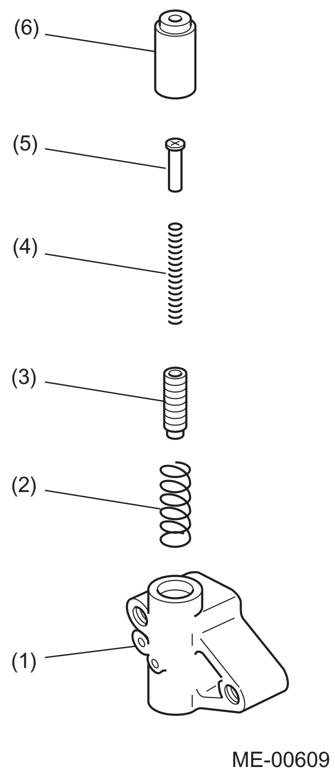
● The hydro-mechanical automatic chain tension adjuster provided for each chain constantly maintains the specified chain tension necessary to properly drive the camshafts, as well as to provide this chain and sprocket camshaft drive mechanism with a “maintenance-free” feature.



(1)	Intake camshaft sprocket RH	(7)	Water pump sprocket	(13)	Tension adjuster LH
(2)	Chain guide RH No.1	(8)	Chain guide LH No.2	(14)	Upper idler sprocket
(3)	Exhaust camshaft sprocket RH	(9)	Exhaust camshaft sprocket LH	(15)	Crankshaft sprocket
(4)	Chain tension adjuster RH	(10)	Chain guide LH No.1	(16)	Center chain guide
(5)	Chain tension adjuster lever RH	(11)	Intake camshaft sprocket LH	(17)	Chain guide RH No.2
(6)	Lower idler sprocket	(12)	Tension adjuster lever LH		

3. Automatic Chain Tension Adjuster

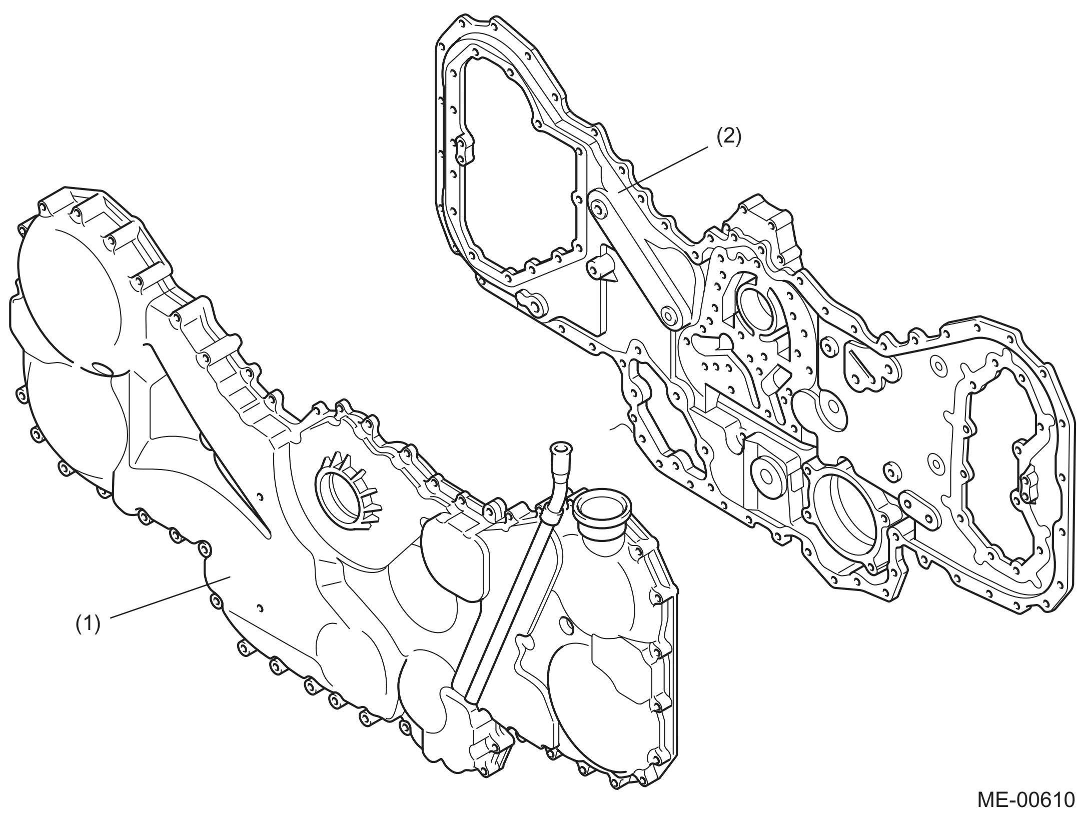
The right and left bank timing chains are provided with their own tensioners. The tensioners are of a hydro-mechanical type that utilizes the engine oil pressure and can automatically keep the tension of the chains at a proper level without need for manual adjustments.
The tensioner case has an oil port that aligns with the oil port in the cylinder block when it is installed in position. The inside of the tensioner case is a high-pressure hydraulic chamber with a check ball. The pressure of the oil in the chamber is adjusted by the relief valve. Featuring a plunger with external screw threads, the tensioner can keep the chain taut constantly even when the engine is stationary.



(1) Tensioner case
(2) Spring
(3) Plunger
(4) Spring
(5) Adjuster rod
(6) Plunger case

4. Timing Chain Case

- The timing chain case is formed by the front chain cover and rear chain cover, both made of aluminum die casting. This two-piece chain case design helps reduce noise.
- Sealing materials used between the engine block and rear chain cover are an O-ring, metal gasket, and liquid gasket. Between the front and rear chain covers, liquid gasket is used to prevent oil from leaking out.
- A fluorocarbon resin oil seal is used at the crankshaft opening in the front chain cover.



(1) Front chain cover
(2) Rear chain cover

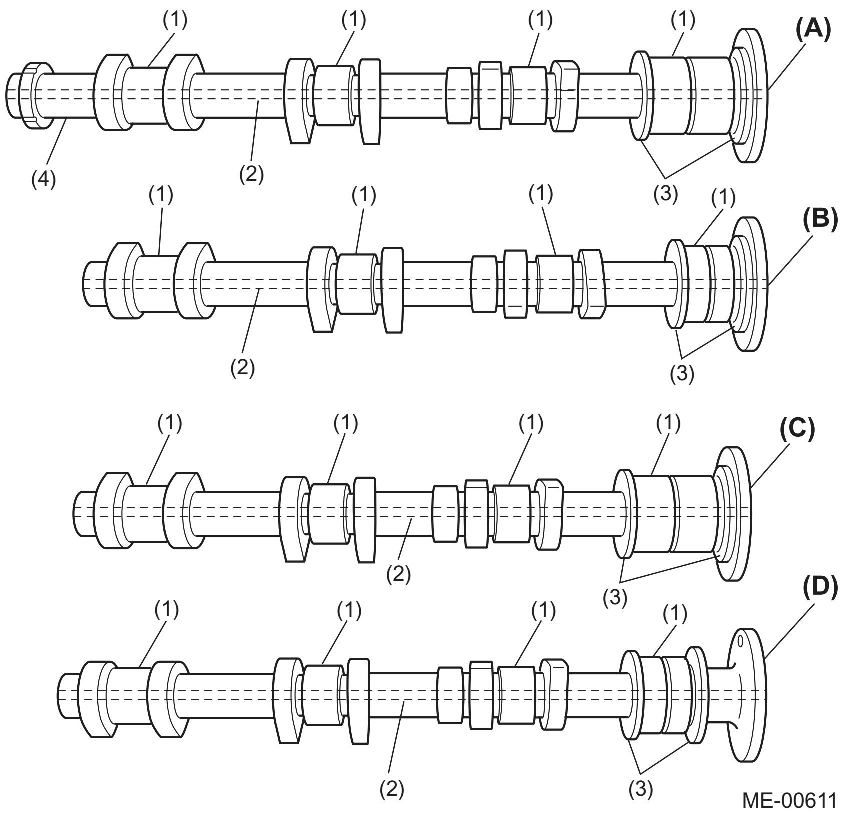
5. Camshaft

● The camshafts are of a composite material type using sintered steel for cam lobes and carbon steel for pipe part (first in Subaru).
The sintered steel cams are very high in the resistance to wear, which enables the cam lift to be increased. In addition, use of the sintered steel cams contributes to reduction in weight.

● Each camshaft is supported at its four journals by the corresponding bearings. The front-most bearing has flanges on its both ends to receive thrust loads that are generated during movement of the camshaft.

● The bearings are lubricated by the oil that enters the passage in each camshaft from the port at the front-end journal and flows out through the hole in each journal.

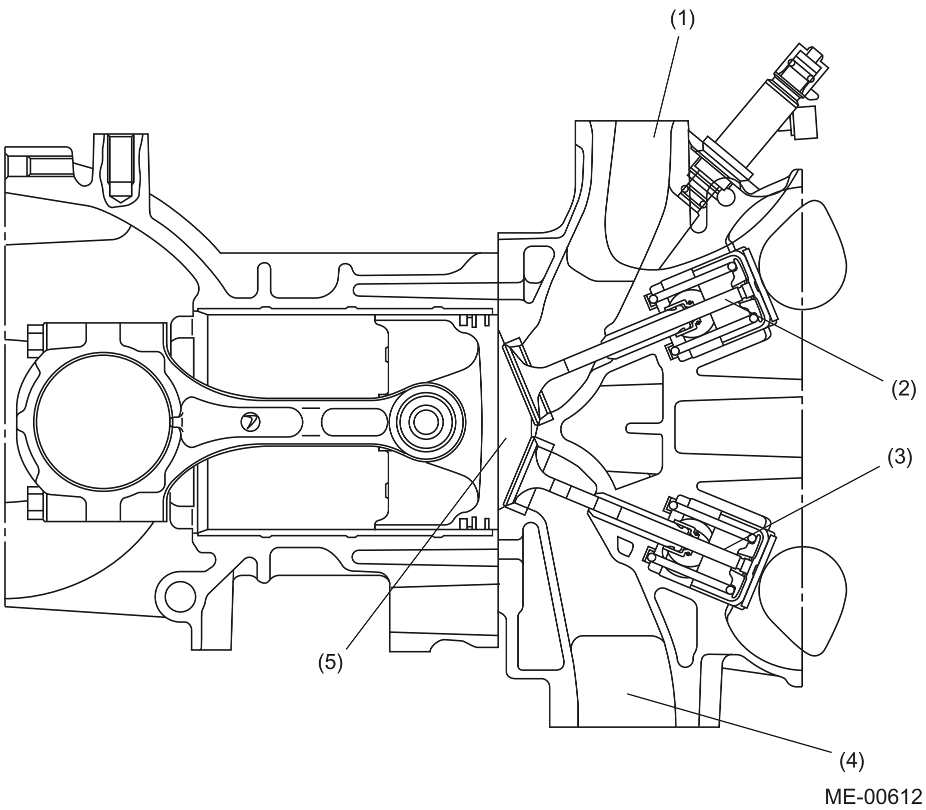
● The right intake camshaft has at its rear end a flange which is used as an angle sensing wheel by the camshaft position sensor.



(1)	Journal	**(A)**	Right intake camshaft
(2)	Oil passage	**(B)**	Right exhaust camshaft
(3)	Shaft flange	**(C)**	Left intake camshaft
(4)	Camshaft position sensor flange	**(D)**	Left exhaust camshaft

6. Cylinder Head

- The cylinder heads are made of aluminum alloy which features light weight and high cooling efficiency.
- Each cylinder head incorporates a DOHC mechanism which is adapted to the four valves per cylinder arrangement. The two intake ports are designed to create tumble flow in the cylinder, whereas the two exhaust ports join each other in the cylinder head to form a single oval port. These design features contribute together to cleaner exhaust emissions and higher output.
- The combustion chamber is of a compact pentroof design with the spark plug located at its top center. In combination with the tumble promoting intake ports, a squish area formed between the piston top surface and combustion chamber helps improve mixing of air and fuel and thus combustion efficiency.
- Coolant flows from the rear to the front of the cylinder head of each bank. This serial-flow coolant line arrangement ensures highly efficient cooling of the engine.
- A metal gasket is used between the cylinder head and cylinder block. Tightening the cylinder head bolts by the angle-tightening method ensures invariable sealing performance of this gasket.



(1) Intake port
(2) Intake valve
(3) Exhaust valve
(4) Exhaust port
(5) Combustion chamber

7. Cylinder Block

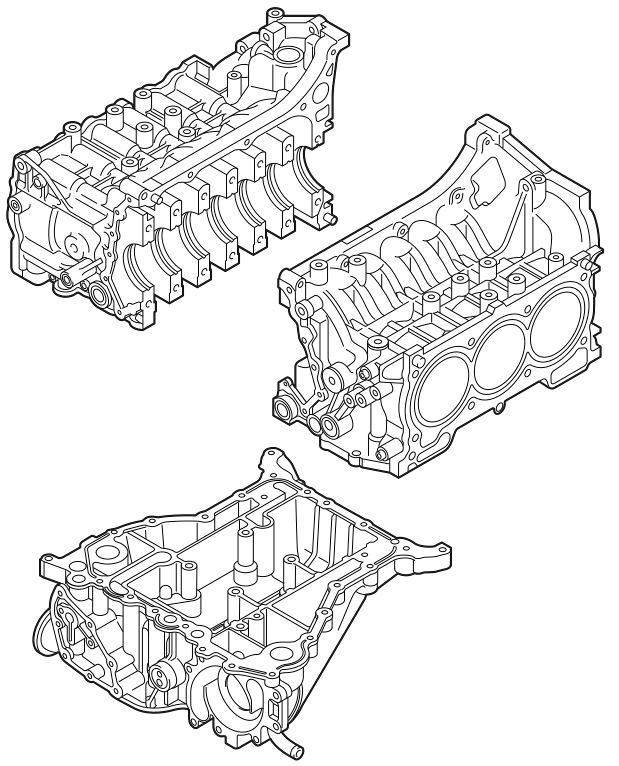
● The cylinder block of this horizontally-opposed-cylinder engine is made of aluminum die casting. It is split into right and left halves at its center where the crankshaft is supported. The cylinder liners are made of cast iron and are embedded as integral part of the cylinder block body during the casting process.

● The coolant passages of the right and left banks are independent of each other (parallel-flow type). The water jackets around the cylinder liners are open at the cylinder head side end of each bank (open-deck design).

● The cylinder block supports the crankshafts journals through seven main bearings rigidly and quietly. The #7 bearing is a flanged thrust bearing which controls the crankshafts end play.

● Rigid engine-to-transmission connection is ensured by 11 bolts (three more bolts than with the four-cylinder engine).

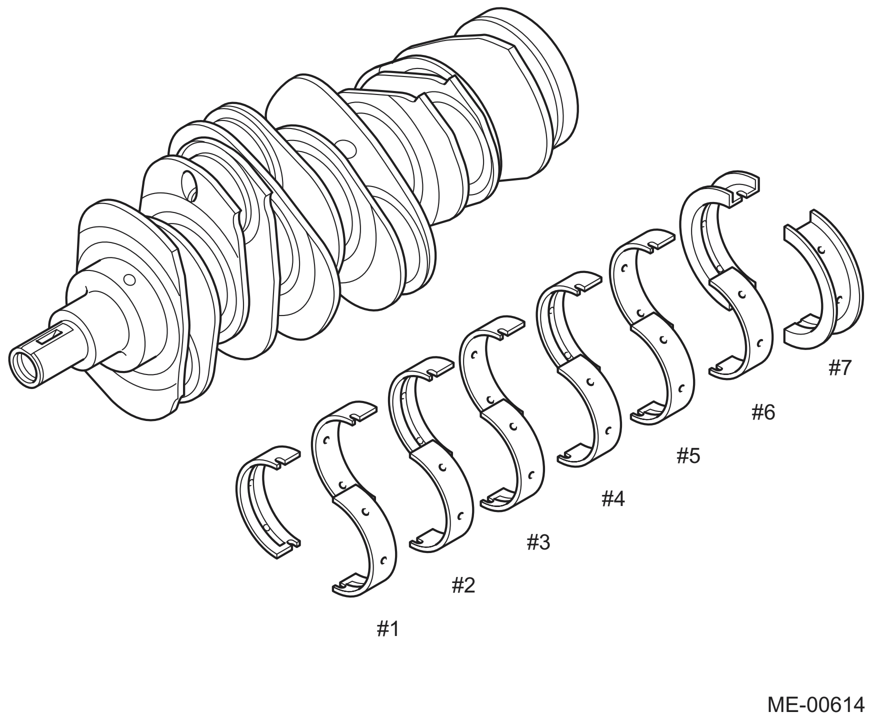
● The aluminum die-cast upper oil pan located below the cylinder block reinforces connection between the cylinder block banks and its special form provides a baffle effect to suppress large fluctuation of oil level. In addition, the upper oil pan constitutes part of the oil and cooling circuits as well as the water pump volute chamber and thermostat chamber.



ME-00613

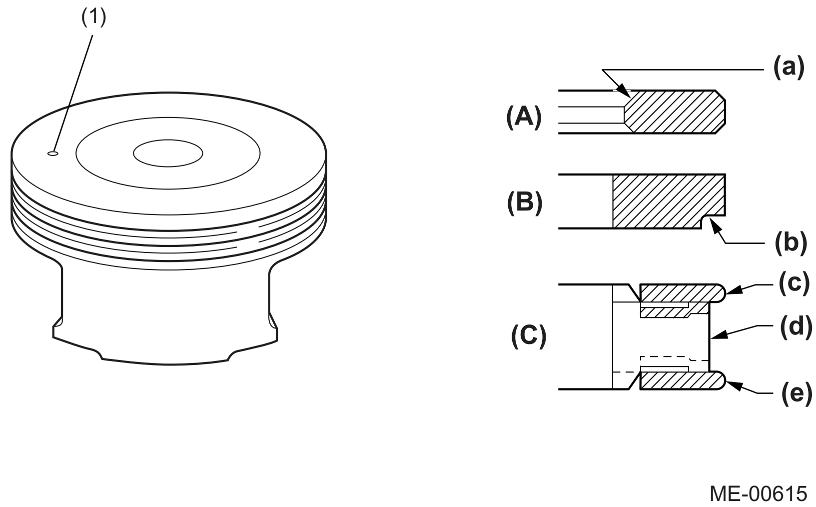
8. Crankshaft

The crankshaft is supported in the cylinder block by seven 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 seven crankshaft bearings are made of aluminum alloy and the No. 7 bearing is provided with a flanged metal to support thrust forces.



9. Piston

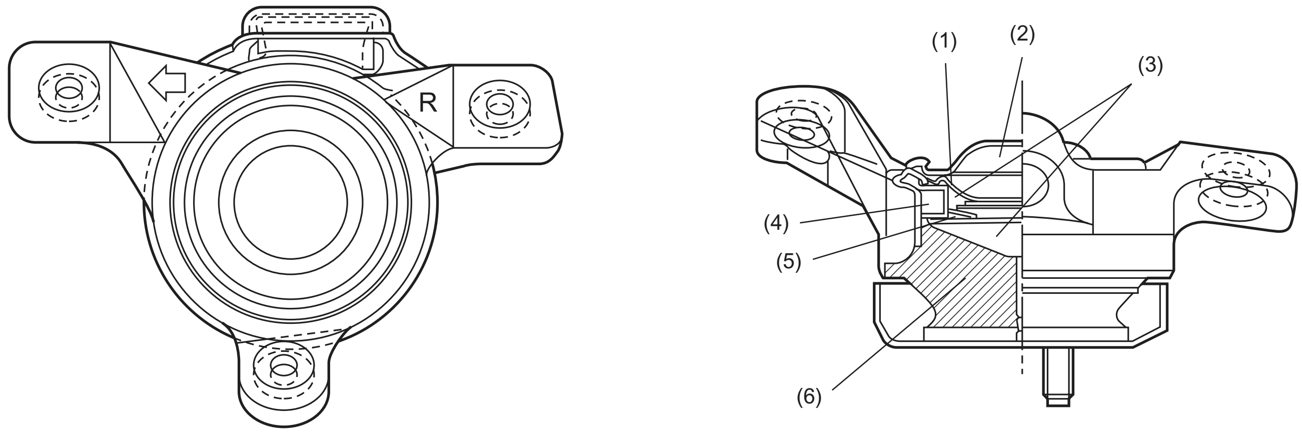
- The pistons are of a slipper skirt design for reduced weight and friction. The oil control ring groove utilizes a thermal design.
- The piston pin is offset either downward (Nos. 1, 3 and 5 pistons) or upward (Nos. 2, 4 and 6 pistons).
- The piston crown is spherically concaved and has no recesses for valve head clearance. All the right and left bank pistons are the same in shape. Each piston has a location mark (mark indicating the front of engine) on its top.
- 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.



(1)	Location mark (engine front side)	**(A)**	Top ring	**(a)**	Inner-bevel
		(B)	Second ring	**(b)**	Cut
		(C)	Oil ring	**(c)**	Upper rail
				(d)	Expander
				(e)	Lower rail

10.Engine Mounting

The H6 engine is supported by liquid-filled elastic mounts specially developed for use with it. Each mount is rigidly attached to the engine at three points. The mount can effectively reduce vibration and noise thanks to presence of a membrane between the two liquid chambers. The membrane has a function of reducing the spring constant of the mount.



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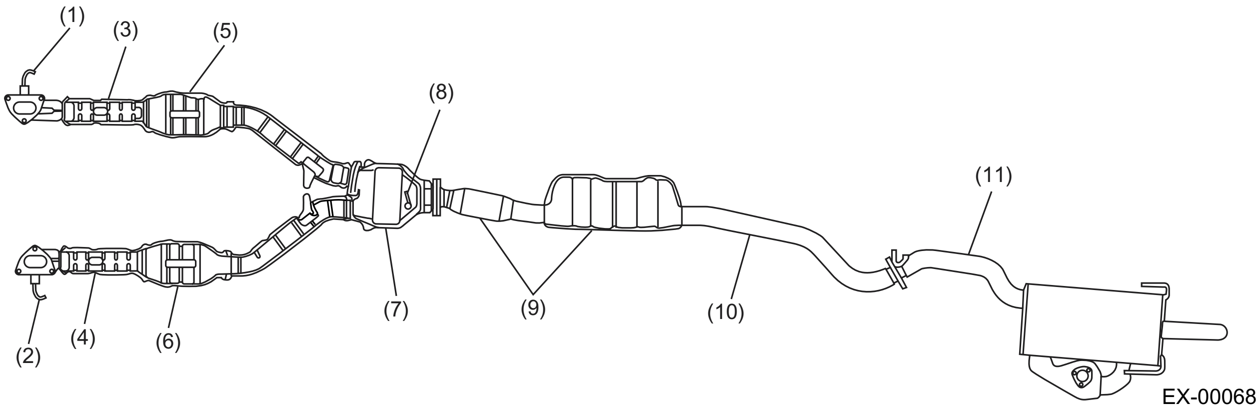
(1) Diaphragm
(2) Air chamber
(3) Liquid chamber
(4) Orifice
(5) Membrane
(6) Rubber piece

MEMO

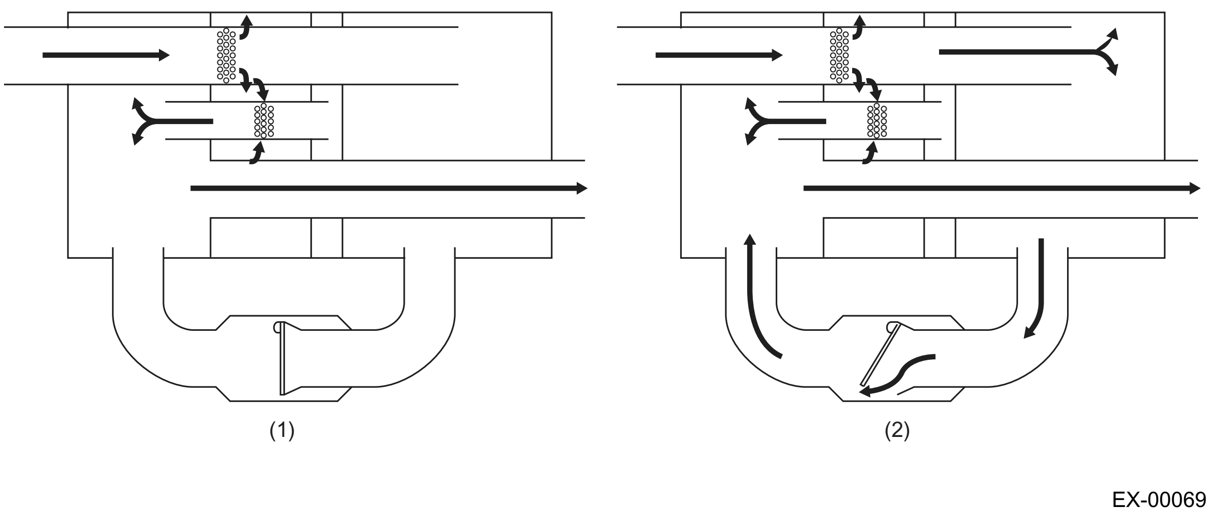
1. General

● The exhaust system consists of a front exhaust pipe assembly, a rear exhaust pipe with two resonance chambers, and a variable-flow muffler. The front exhaust pipe assembly consists of right and left exhaust pipes each incorporating a front catalytic converter, and a rear catalytic converter that is located at the joint of the two pipes.



(1)	Front oxygen (A/F) sensor RH	(7)	Rear catalytic converter
(2)	Front oxygen (A/F) sensor LH	(8)	Rear oxygen sensor
(3)	Front exhaust pipe RH	(9)	Resonance chamber
(4)	Front exhaust pipe LH	(10)	Rear exhaust pipe
(5)	Front catalytic converter RH	(11)	Muffler
(6)	Front catalytic converter LH		

● The variable-flow muffler has a valve which opens when the exhaust pressure increases. This helps reducing exhaust noise and increasing engine output simultaneously.



(1) Low engine speed
(2) High engine speed

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 designed to eliminate the need for replenishing coolant.
- The ECM controls the operation of the radiator main fan and subfan depending on the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch.

2. Cooling Circuits

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

- 1st phase (thermostat closed)

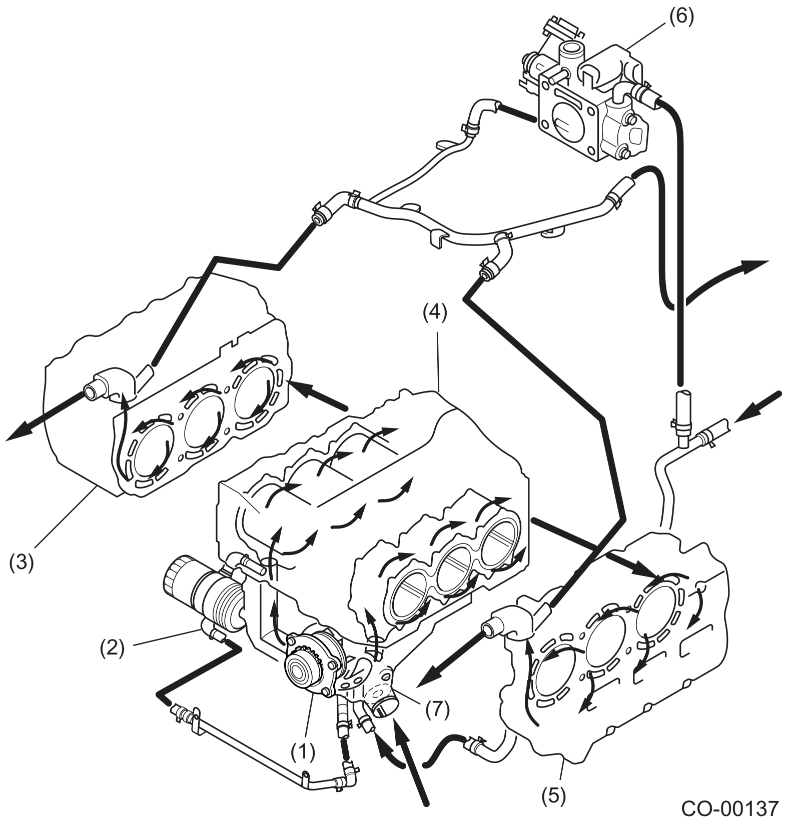
When the engine coolant temperature is below 76°C (169°F), the thermostat remains closed. The coolant flows through the bypass and heater circuits.
This permits the engine to warm up quickly.

- 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)

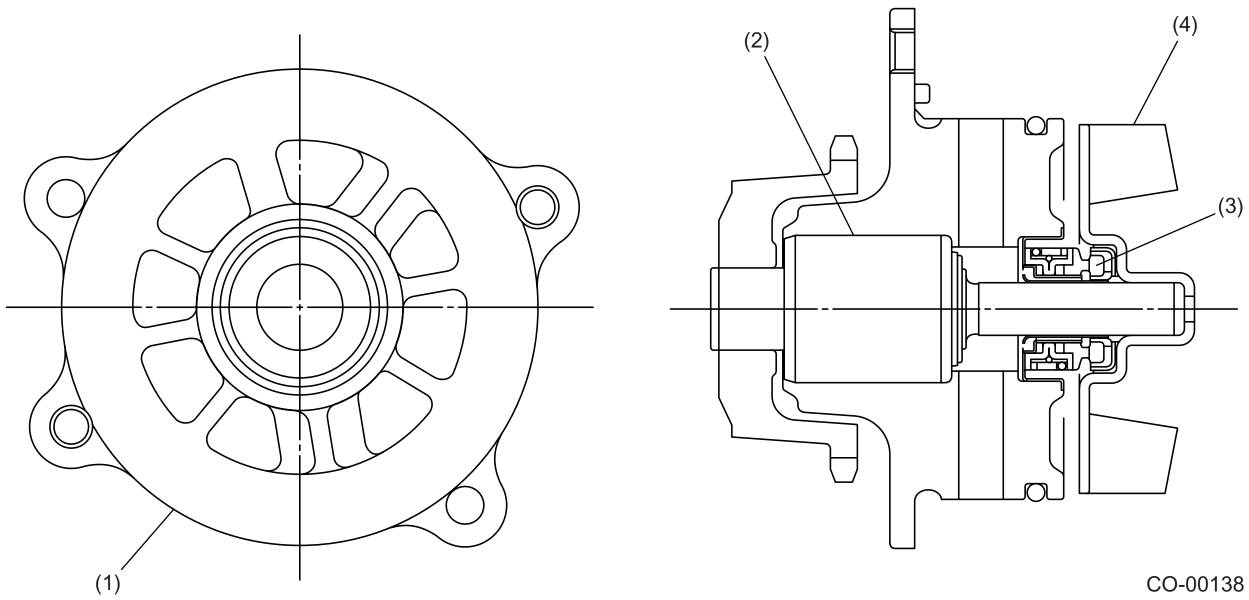
When the engine coolant temperature sensor sends a signal indicating a temperature above 91°C (196°F) to the ECM, it causes the radiator fan (or fans) to operate.



(1) Water pump
(2) Oil cooler
(3) Cylinder head RH
(4) Cylinder block
(5) Cylinder head LH
(6) Throttle body
(7) Thermostat

3. Water Pump

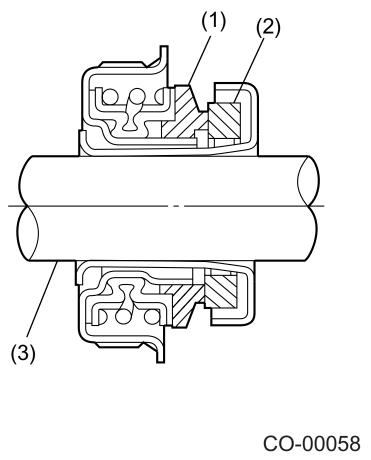
The water pump is fitted in a housing formed in the rear chain cover using an O-ring as a seal between the pump case and the housing. The pump is driven by the timing chain through a sprocket and rotation of the impeller in a volute chamber creates flow of coolant toward the cylinder block.
The pump case is made of aluminum die casting and the impeller is made of steel sheet. The impeller shaft is supported by a ball bearing and a roller bearing. Its end exposed to coolant is sealed by a mechanical seal and the other end exposed to engine oil is sealed by an oil seal.
The volute chamber is formed by the rear chain cover and the upper oil pan. A metal gasket is used at the joint between the chain cover and upper oil pan.



(1) Pump case
(2) Ball bearing
(3) Mechanical seal
(4) Impeller
(5) O-ring

4. Mechanical Seal

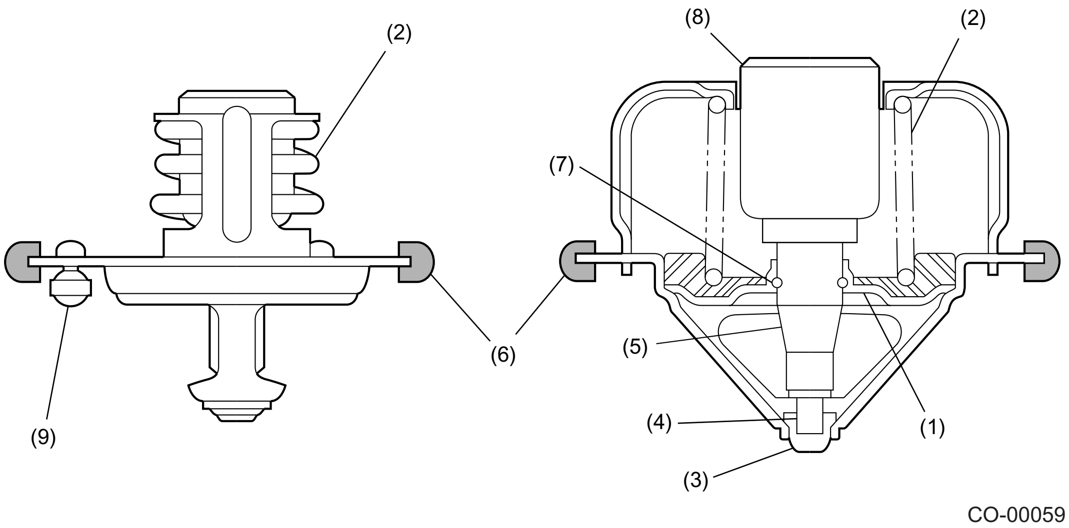
The mechanical seal has its seat tightly fitted on the water pump shaft. Since it is a hermetic seal forming an integral part of the water pump, the water pump cannot be disassembled.



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

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.

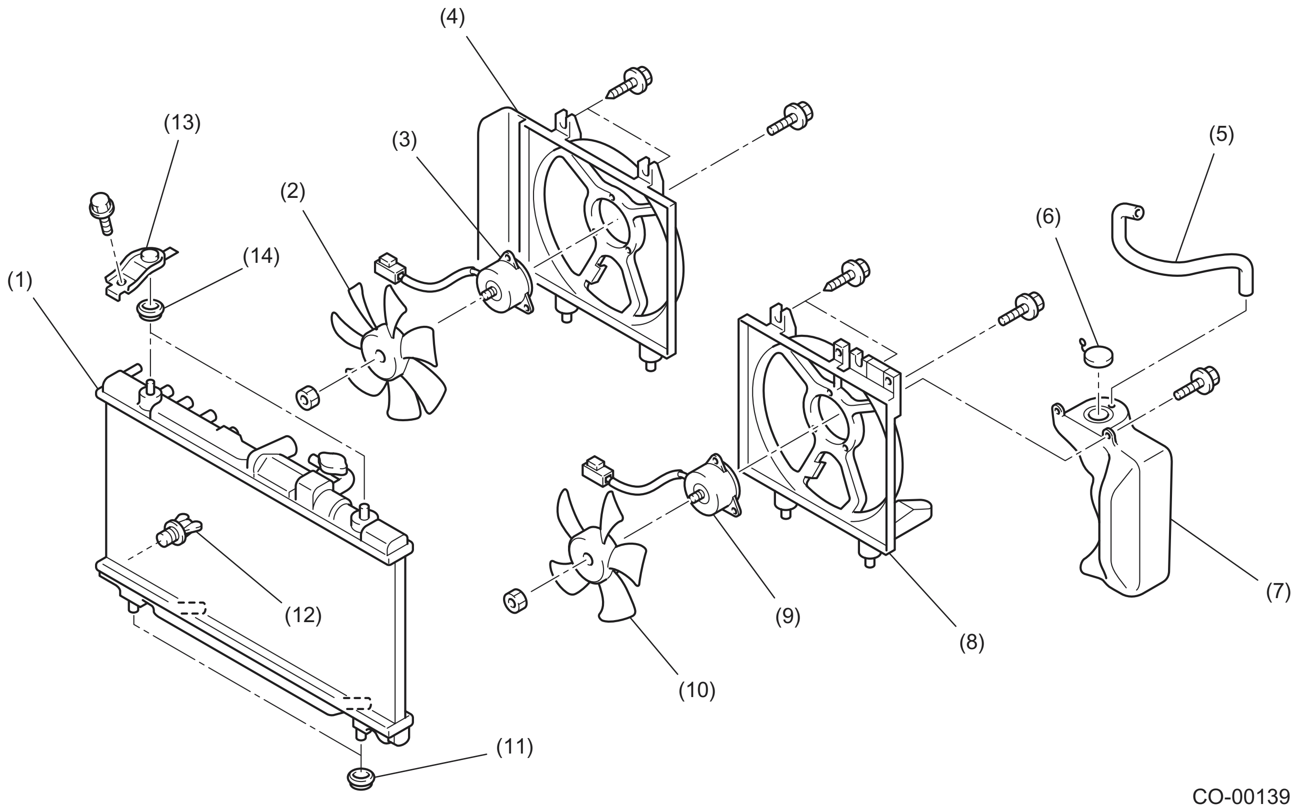


(1) Valve	(4) Piston	(7) Stop ring
(2) Spring	(5) Guide	(8) Wax element
(3) Stopper	(6) Rubber packing	(9) Jiggle valve

6. Radiator Fan

A: DESCRIPTION

Each radiator fan is made of plastic. It is driven by an electric motor which is retained on a shroud.



(1)	Radiator	(8)	Radiator main fan shroud
(2)	Radiator subfan	(9)	Radiator main fan motor
(3)	Radiator subfan motor	(10)	Radiator main fan
(4)	Radiator subfan shroud	(11)	Lower cushion
(5)	Overflow hose	(12)	Drain plug
(6)	Reservoir tank cap	(13)	Upper bracket
(7)	Reservoir tank	(14)	Upper cushion

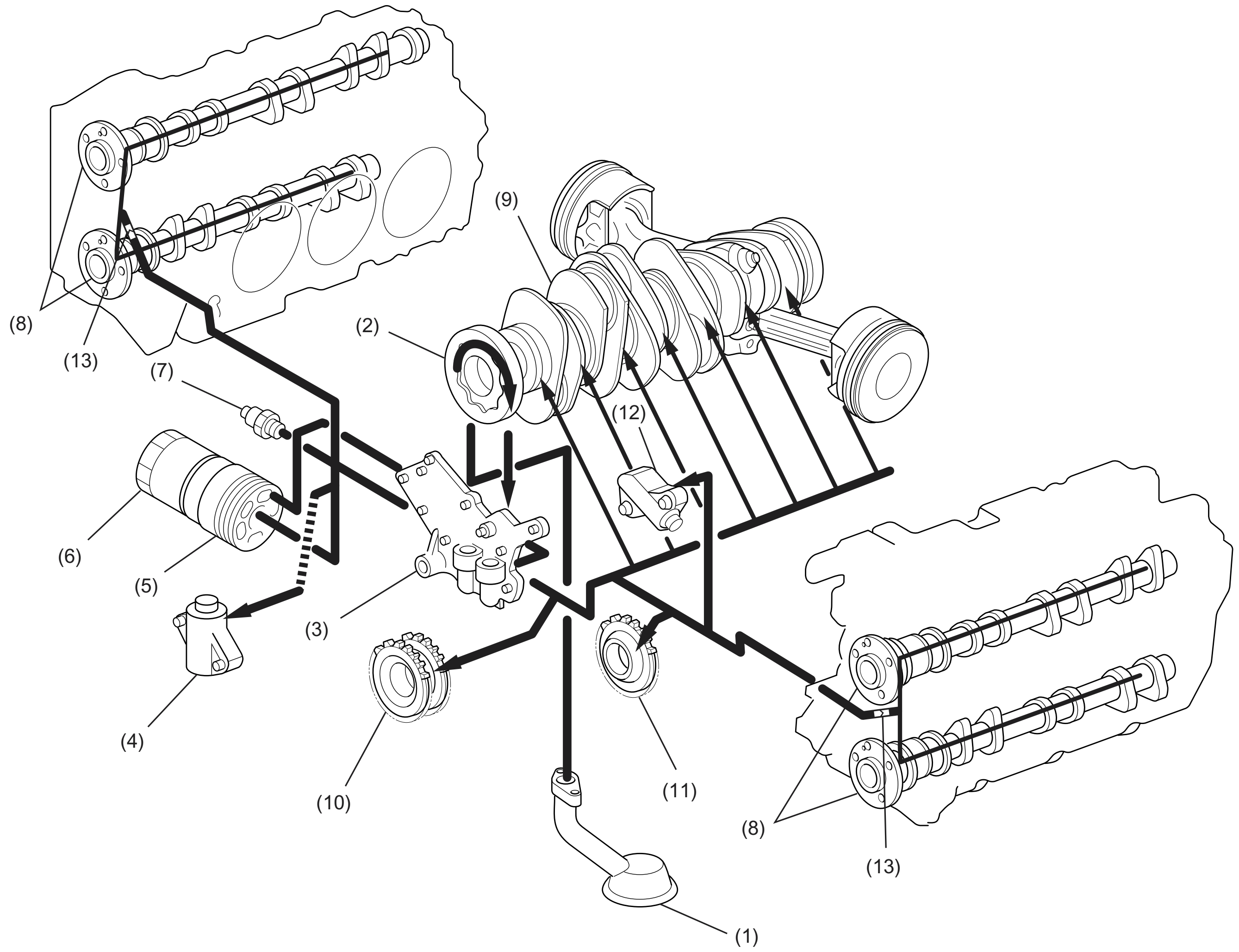
B: FUNCTION

The operation of the radiator fan is controlled by the ECM, depending on the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch as shown below.

Vehicle speed	A/C compressor	A/C pressure switch level	Engine coolant temperature					
			Lower than 95°C (203°F)		Between 96 and 99°C (203 and 210°F)		Higher than 100°C (212°F)	
			Operation of radiator fans		Operation of radiator fans		Operation of radiator fans	
			Main fan	Sub fan	Main fan	Sub fan	Main fan	Sub fan
Lower than 19 km/h (12 MPH)	Off		Off	Off	Low-speed	Low-speed	Mid-speed	Mid-speed
	On	Low	Low-speed	Low-speed	Mid-speed	Mid-speed	High-speed	High-speed
		High	Mid-speed	Mid-speed	High-speed	High-speed	High-speed	High-speed
Between 20 and 69 km/h (12 and 43 MPH)	Off		Off	Off	Mid-speed	Mid-speed	High-speed	High-speed
	On	Low	High-speed	High-speed	High-speed	High-speed	High-speed	High-speed
		High	High-speed	High-speed	High-speed	High-speed	High-speed	High-speed
Between 70 and 105 km/h (43 and 65 MPH)	Off		Off	Off	Mid-speed	Mid-speed	High-speed	High-speed
	On	Low	Mid-speed	Mid-speed	High-speed	High-speed	High-speed	High-speed
		High	High-speed	High-speed	High-speed	High-speed	High-speed	High-speed
Higher than 106 km/h (66 MPH)	Off		Off	Off	Mid-speed	Mid-speed	High-speed	High-speed
	On	Low	Off	Off	Mid-speed	Mid-speed	High-speed	High-speed
		High	Mid-speed	Mid-speed	Mid-speed	Mid-speed	High-speed	High-speed

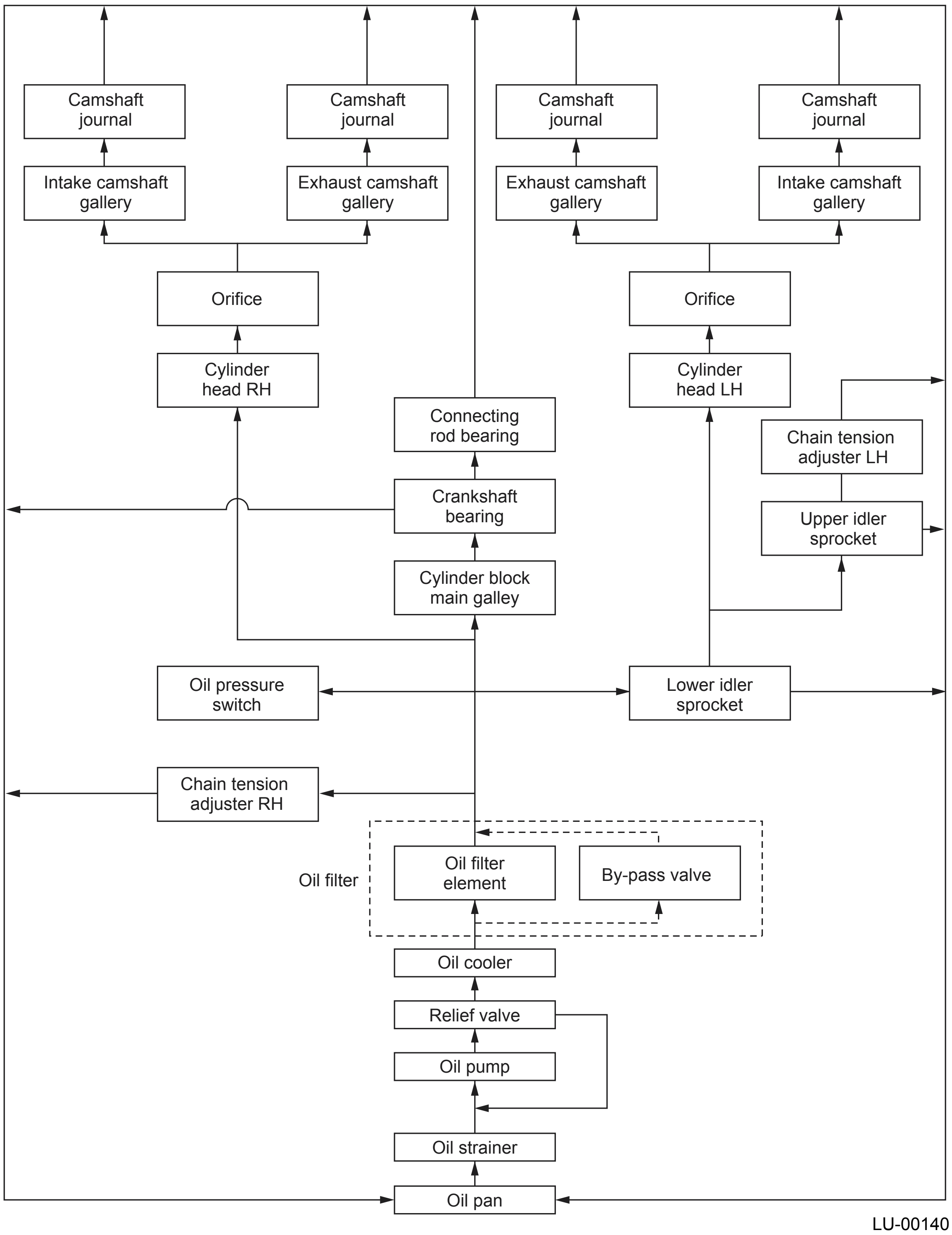
1. General

- The lubrication system force-circulates engine oil throughout the engine using an oil pump. The oil pressure is regulated by the relief valve.
- 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 engine oil discharged from the oil pump is delivered to the journal bearings, connecting rod bearings, and other parts requiring lubrication and cooling via an oil passage, oil filter, and oil galleries.
- 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 cylinder head oil gallery.



(1)	Oil strainer	(8)	Camshaft
(2)	Oil pump	(9)	Crankshaft
(3)	Relief valve case	(10)	Lower idler sprocket
(4)	Chain tension adjuster RH	(11)	Upper idler sprocket
(5)	Oil cooler	(12)	Chain tension adjuster LH
(6)	Oil filter	(13)	Orifice
(7)	Oil pressure switch		

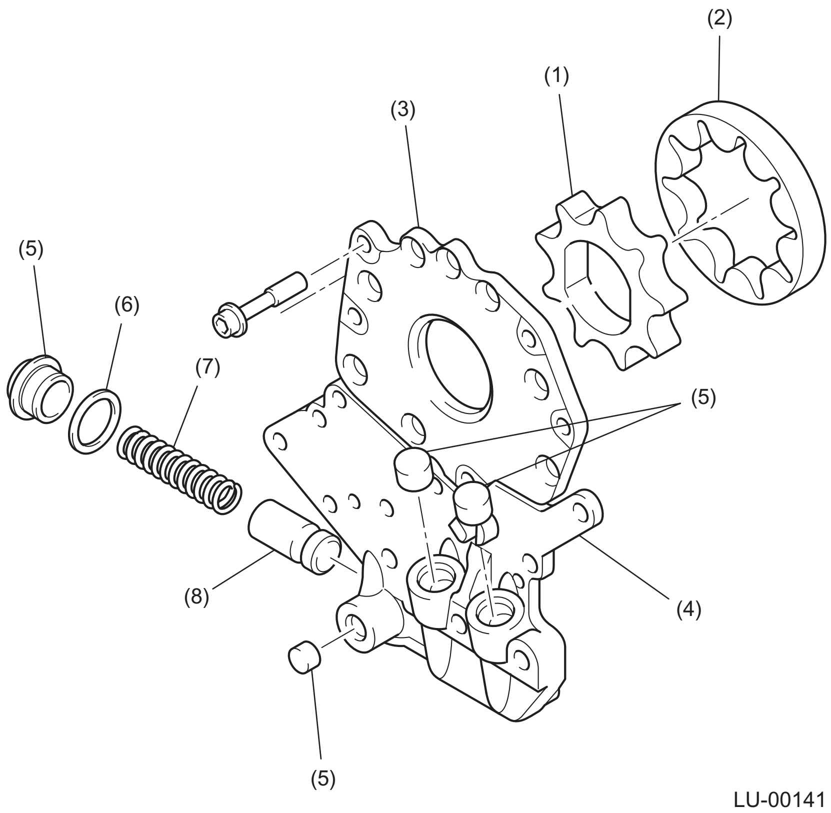
2. Engine Oil Flow



3. Oil Pump and Relief Valve

● The oil pump is a thin, large-diameter trochoid roller pump directly driven by the crankshaft. Its outer rotor and inner rotor are assembled with each other inside the rotor housing which is formed in the rear chain cover. The rotor housing is closed by the oil pump cover. The outer rotor, inner rotor and the oil pump cover are made of sintered metal.

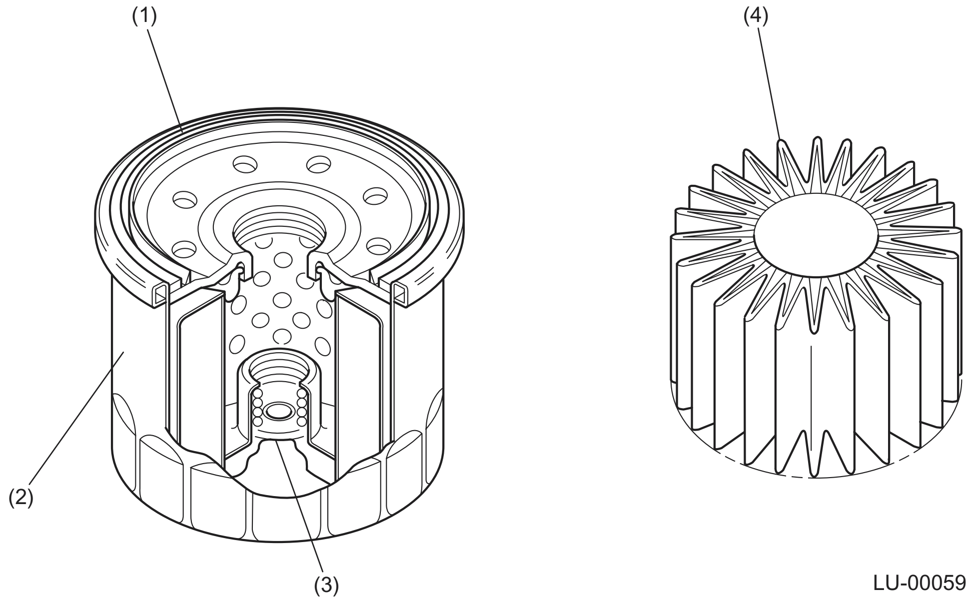
● When the pump discharge pressure exceeds a certain level, the relief valve located at the outlet port of the oil pump opens and allows excess oil to return to the inlet of the pump. The relief valve is a single-spool type and housed in an aluminum die-cast case. It is mounted on the rear chain cover with a metal gasket.



(1) Inner rotor	(5) Plug
(2) Outer rotor	(6) Gasket
(3) Oil pump cover	(7) Relief valve spring
(4) Relief valve case	(8) Relief valve

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.

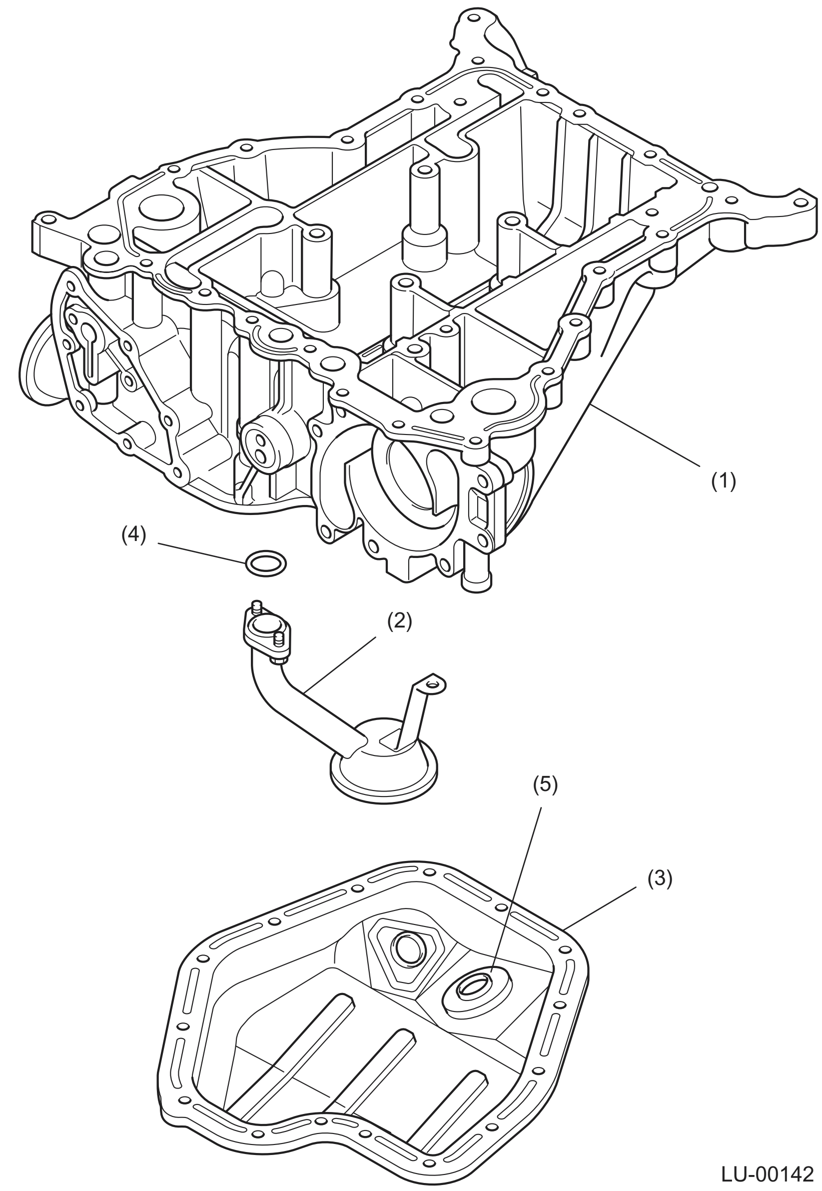


(1) Oil seal
(2) Filter body
(3) Bypass valve
(4) Pleated element

5. Oil Pan and Oil Strainer

● The oil pan consists of an upper oil pan (aluminum die-casting) and a lower oil pan (formed steel plate). The upper oil pan has a baffle plate molded in it to improve stability of the oil level.

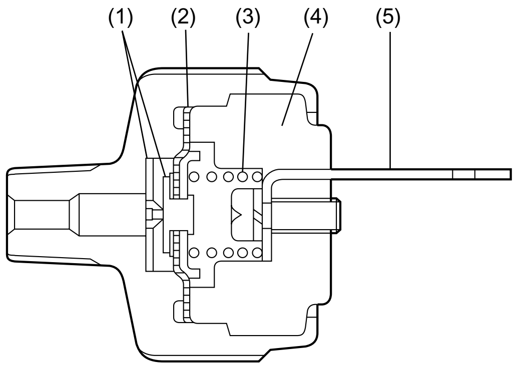
● The oil strainer has a stay whose end is attached to the upper oil pan. The strainer's pipe is connected to the oil pump using an O-ring. The strainer is located close to the bottom at the center of the oil pan where the oil level changes the least.



(1) Upper oil pan	(4) O-ring
(2) Strainer	(5) Magnet
(3) Lower oil pan	

6. Oil Pressure Switch

The oil pressure switch is located at the right of the upper oil pan. 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
(2) Diaphragm
(3) Spring
(4) Molded portion
(5) Terminal

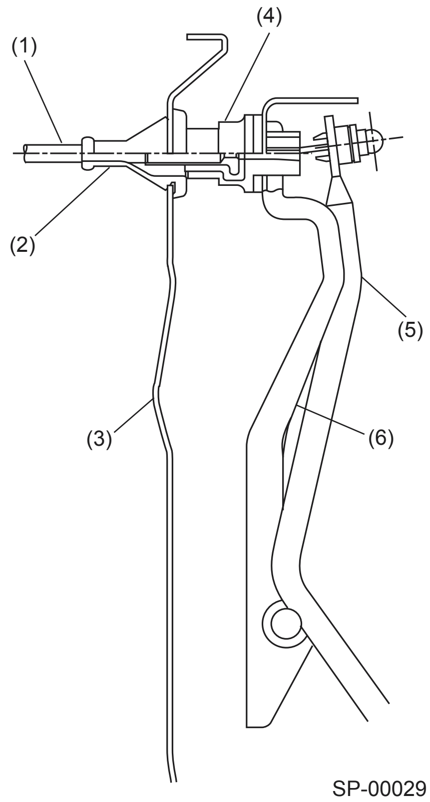
1) When oil pressure does not build up (immediately after ignition switch is turned ON):
The diaphragm is pushed toward the upper oil pan by the spring force (a force equivalent to the specified oil pressure). This closes the contact points, causing the oil pressure warning light in the combination meter 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/cm^2, 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.

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 unsmooth cable return movement that may result from deformation of the toeboard or improper installation of the accelerator pedal and, therefore, to improve safety.

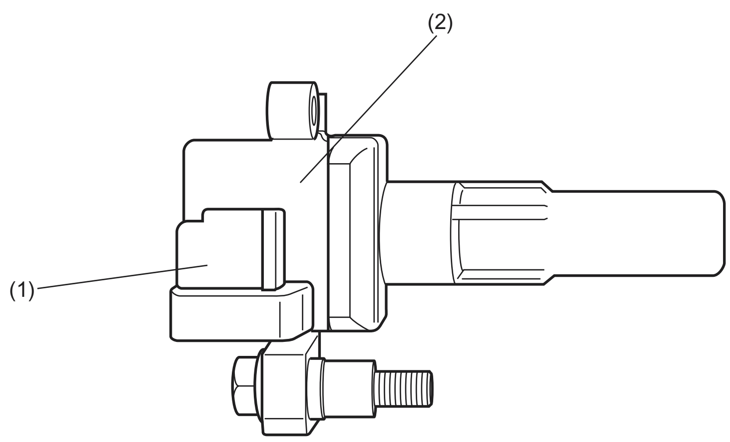
In addition, the floating type casing cap through which the cable is attached to the bracket reduces vibration of the pedal, thus improving quietness.



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

1. Ignition Coil

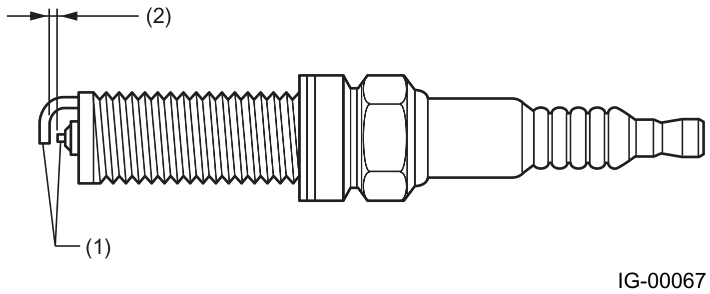
The engine uses a direct ignition system with one ignition coil mounted for each cylinder (or spark plug).
The secondary terminal of the ignition coil is in contact with the spark plug terminal nut.
Since no spark plug cable is used, secondary voltage drop, leaks, or other problems that are inherent in a system using spark plug cables do not occur. The result is high performance and high reliability.



(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 1.0 and 1.1 mm (0.039 and 0.043 in).

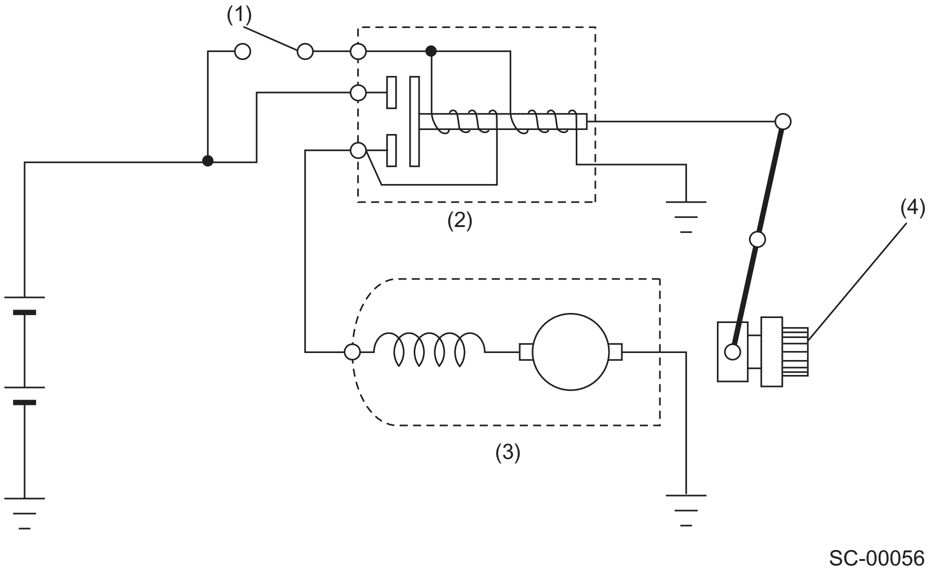


(1) Platinum tipped electrode
(2) Gap : 1.0 – 1.1 mm (0.039 – 0.043 in)

MEMO

1. Starter

The starter is of a reduction type. Its output is 1.4 kW.



(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

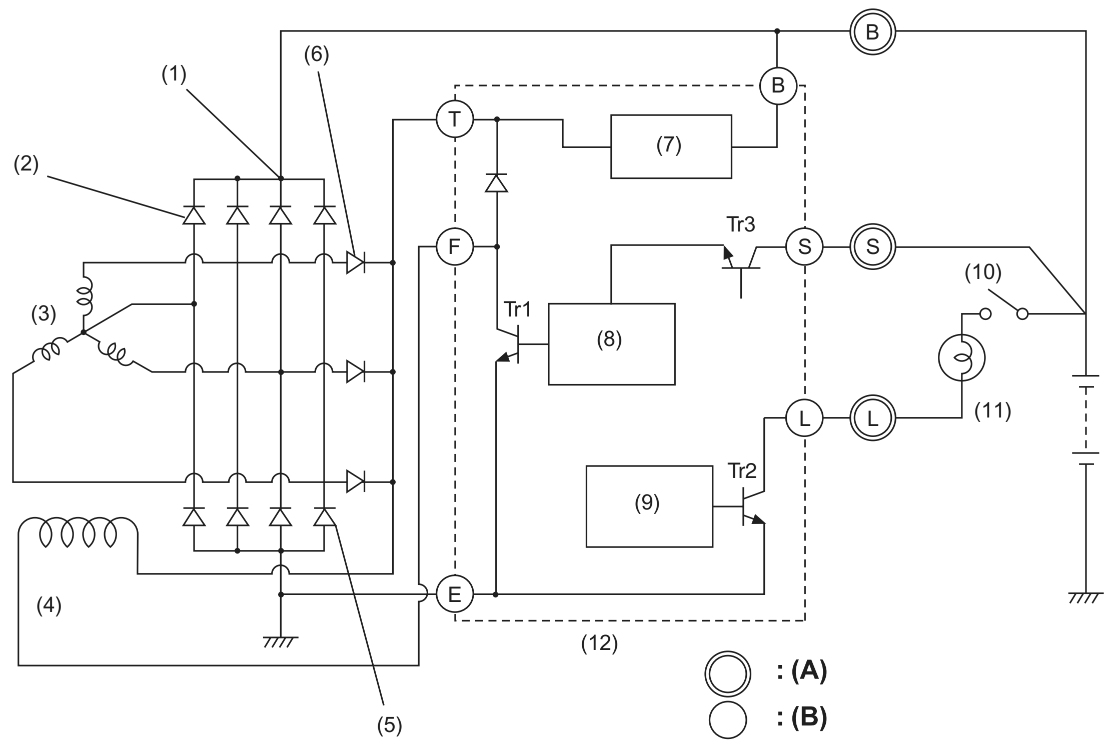
When any of the following problems occur, the charge lamp illuminates.

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.



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

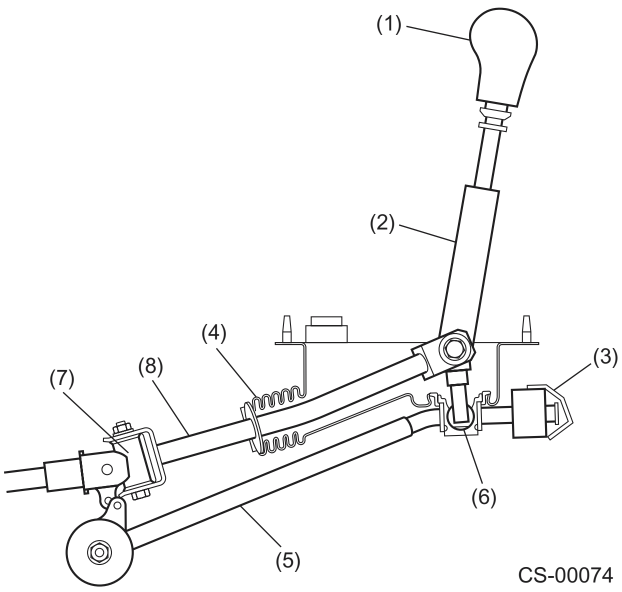
3. Battery

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

MEMO

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.

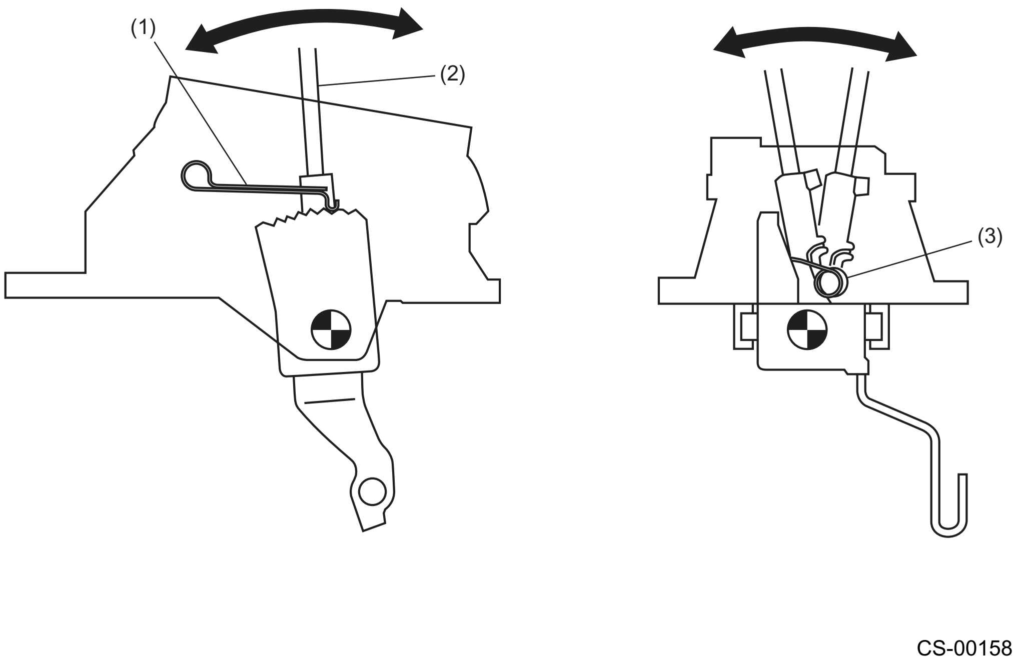


(1) Knob
(2) Gear shift lever
(3) Cushion rubber
(4) Boot
(5) Stay
(6) Bush B
(7) Joint
(8) Rod

2. Select Lever

A: EXCEPT VEHICLES WITH SPORTS SHIFT

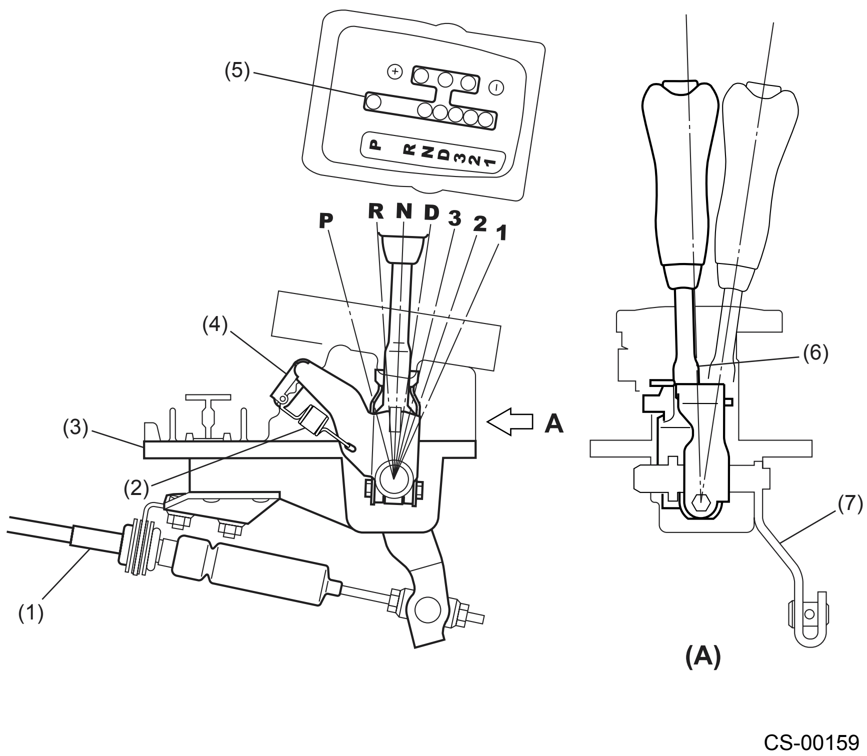
- The automatic transmission's select lever moves through seven positions.
- The select lever makes shift direction (longitudinal) movements as well as select direction (lateral) movements. The select lever is guided by a gate to make these movements.
- To transmit movements of the select lever to the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



(1) Detent spring
(2) Select lever
(3) Lateral spring

B: VEHICLES WITH SPORTS SHIFT

- The automatic transmission select lever can be moved to either of the 7 ranges (P, R, N, D, 3, 2, or 1) and also enables switching to sports shift mode (manual mode) by moving the lever laterally from the D range.
- 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.
- In the sports shift mode, the transmission upshifts when the selector lever is moved forward ("+" direction) and downshifts when the lever is moved rearward ("–" direction).

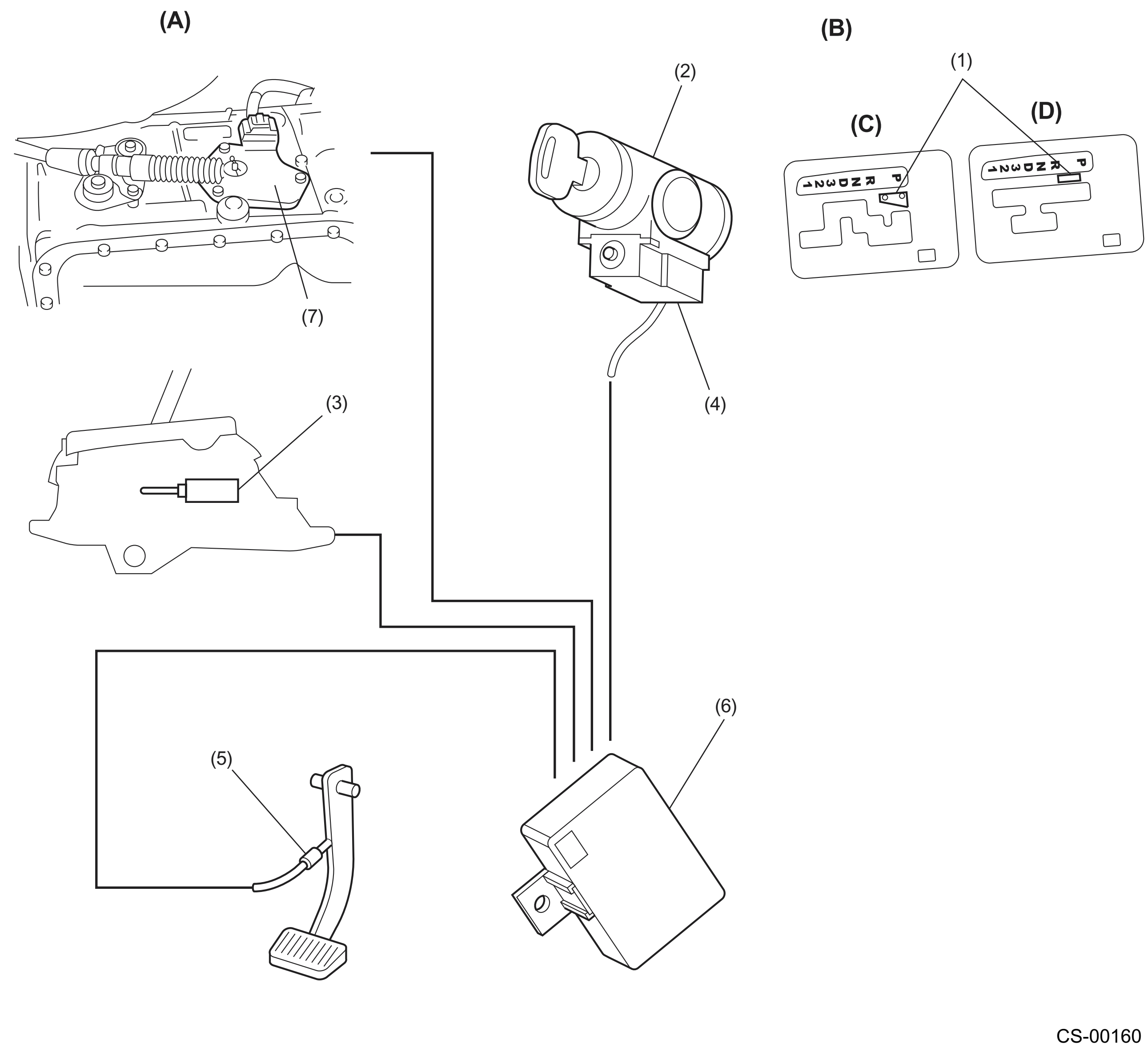


(1) Push-pull cable
(2) Detent spring
(3) Base plate
(4) Detent arm
(5) Gate
(6) Select lever assembly
(7) Arm
(A) View A

3. Shift Lock and Key Interlock System

A: GENERAL

To increase safety during standing start, the shift lock system prevents movement of the select lever from the “P” position to any other position unless the brake pedal is depressed. This system is also provided with a key interlock function which prevents removal of the ignition key from the key cylinder unless the selector lever is placed in the “P” position.

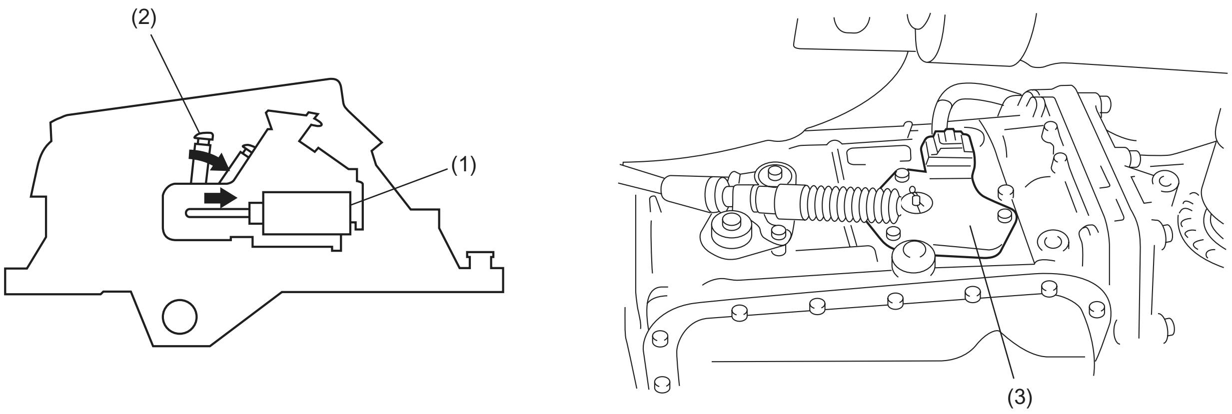


(A)	Shift lock system	**(B)**	Key interlock system
(B)	Except vehicles with sports shift	**(D)**	Vehicles with sports shift
(1)	“P” position switch	(5)	Brake pedal switch
(2)	Key cylinder	(6)	Integrated module
(3)	Shift lock solenoid	(7)	Inhibitor switch
(4)	Key lock solenoid		

B: SHIFT LOCK SYSTEM OPERATION

1. EXCEPT VEHICLES WITH SPORTS SHIFT

The shift lock system has a solenoid-operated plunger (1). With the select lever in the "P" position, the plunger remains extended, holding the lock arm (2) in its raised (locking) position. When the brake pedal is depressed with the ignition switch in either the ON or START position, the solenoid is energized and the plunger is retracted. This causes the lock arm to tilt forward to the select lever release position. The select lever now can be moved to any other position. The "P" position of the select lever is detected by the inhibitor switch (3).

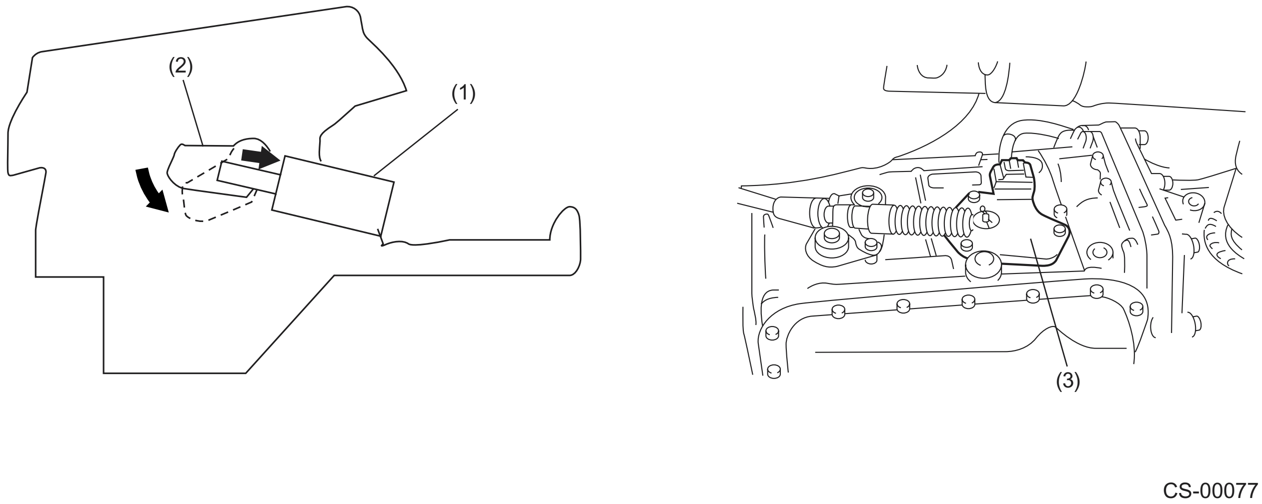


CS-00161

(1) Solenoid
(2) Lock arm
(3) Inhibitor switch

2. VEHICLES WITH SPORTS SHIFT

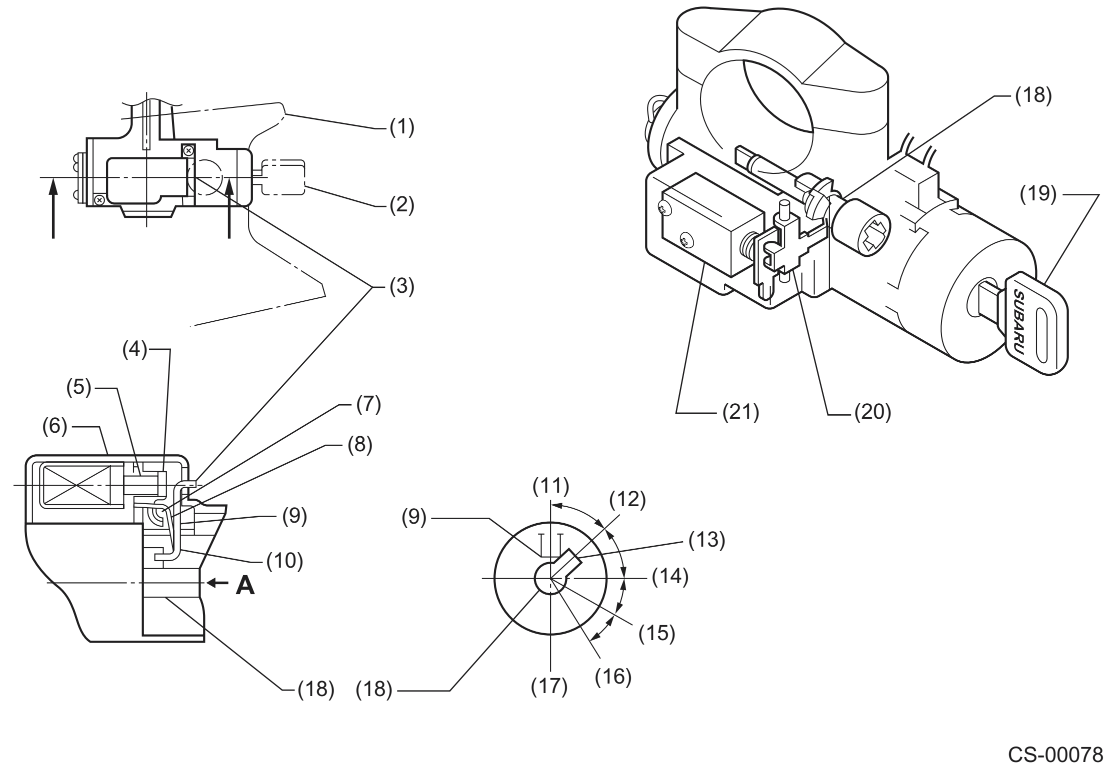
The shift lock system has a solenoid-operated plunger (1). With the select lever in the “P” position, the plunger remains extended, holding the plate (2) in its raised (locking) position. When the brake pedal is depressed with the ignition switch in either the ON or START position, the solenoid is energized and the plunger is retracted. This causes the plate to tilt downward to the select lever release position. The select lever now can be moved to any other position. The “P” position of the select lever is detected by the inhibitor switch (3).



(1) Solenoid
(2) Plate
(3) Inhibitor switch

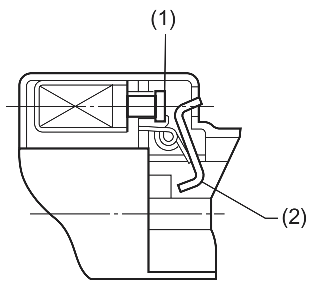
C: KEY INTERLOCK FUNCTION

● When the select lever is at any position other than “P”, the solenoid is energized and its pin is held extended. Being caused to stay in its upright position by extension of the pin, the interlock lever interferes with the stopper portion of the rotator which turns together with the ignition key. Thus, the ignition key cannot be rotated to the “LOCK” position.



(1)	Column cover	(12)	Interlock position
(2)	Key	(13)	Stopper
(3)	Push button	(14)	ACC
(4)	Extended	(15)	ON
(5)	Solenoid pin	(16)	START
(6)	Solenoid unit	(17)	View A
(7)	Lever fulcrum	(18)	Rotator
(8)	Lever spring	(19)	Key
(9)	Interlock lever	(20)	Interlock lever
(10)	Interlock activated	(21)	Solenoid
(11)	Lock		

● When the select lever is moved to “P”, the inhibitor switch in the select lever assembly operates, deenergizing the solenoid. As the push force of the solenoid pin is removed, the lever spring causes the interlock lever to tilt and become clear of the rotator's stopper. Then the key can be rotated to the “LOCK” position and removed from the ignition switch.



CS-00079

(1) Retracted

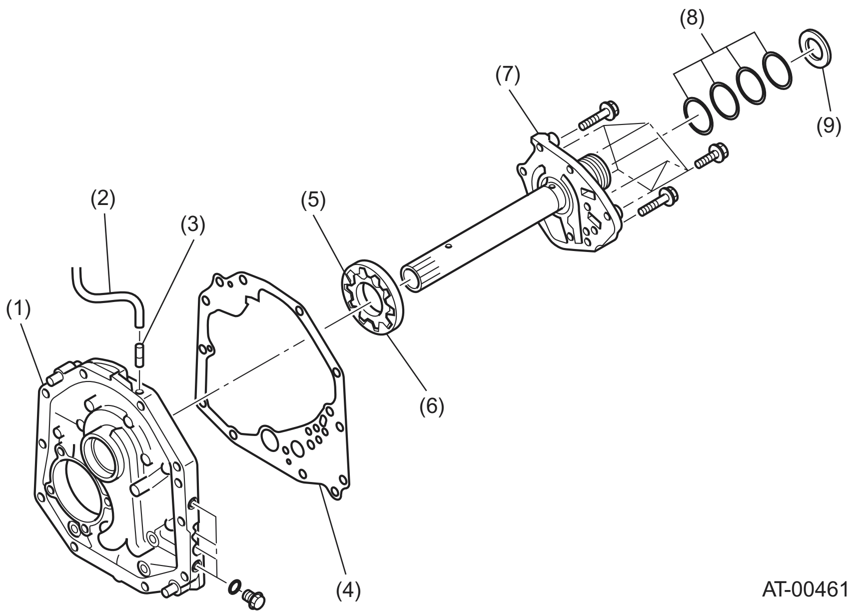
(2) Interlock deactivated

MEMO

1. Oil Pump

A: CONSTRUCTION

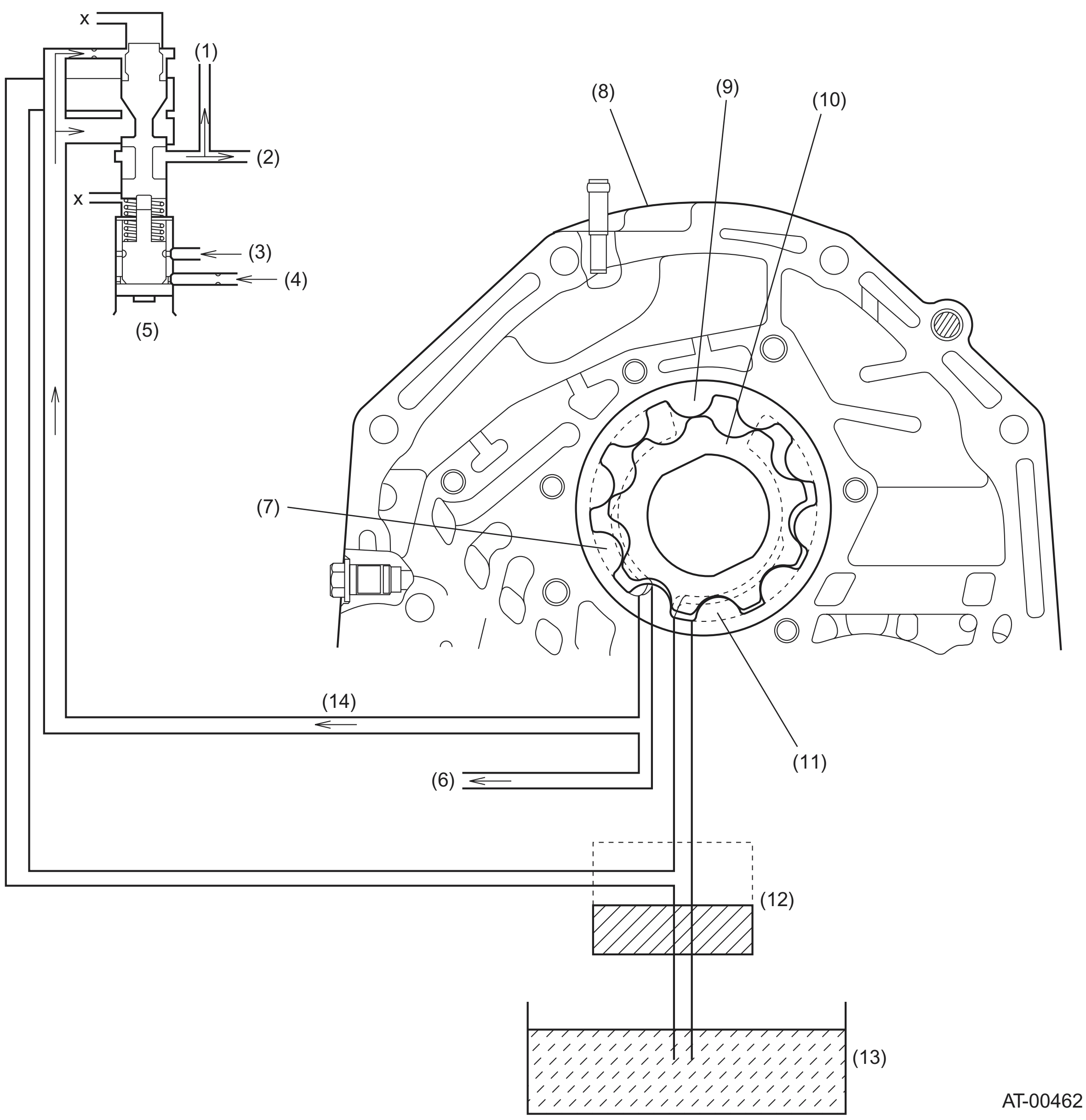
The pump consists of a parachoid rotor pair, a housing and a cover. The inner rotor has nine teeth and the outer rotor has ten teeth.



(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

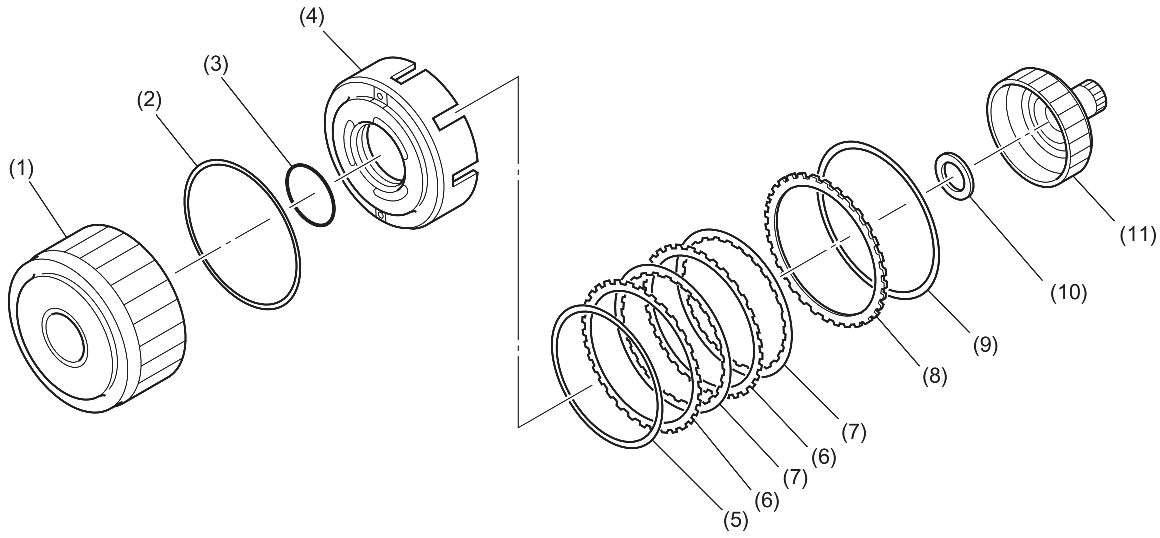
- The pump draws automatic transmission fluid (ATF) from the oil pan through the oil strainer located under the hydraulic control valve assembly. The ATF then flows through a passage in the transmission case, and after passing through the oil pump housing and oil pump cover, it enters the suction port.
- 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.



(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

2. Reverse Clutch

A: CONSTRUCTION

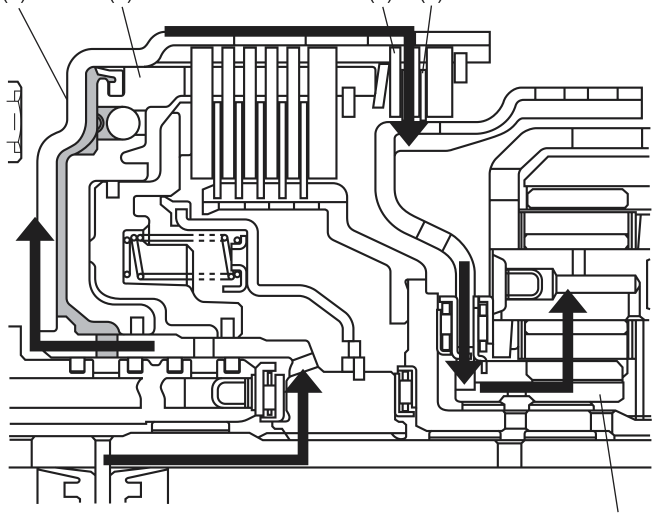


(1)	High clutch drum	(7)	Drive plate
(2)	Lip seal	(8)	Retaining plate
(3)	Lathe cut seal ring	(9)	Snap ring
(4)	Reverse clutch piston	(10)	Thrust needle bearing
(5)	Dish plate	(11)	High clutch hub
(6)	Driven plate		

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.

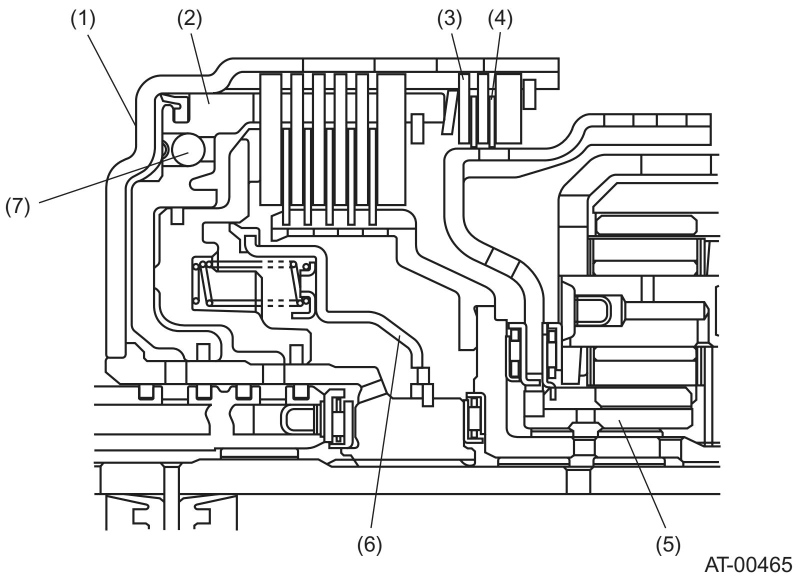


(1) High clutch drum
(2) Reverse clutch piston
(3) Driven plate
(4) Drive plate
(5) Front sun gear

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.

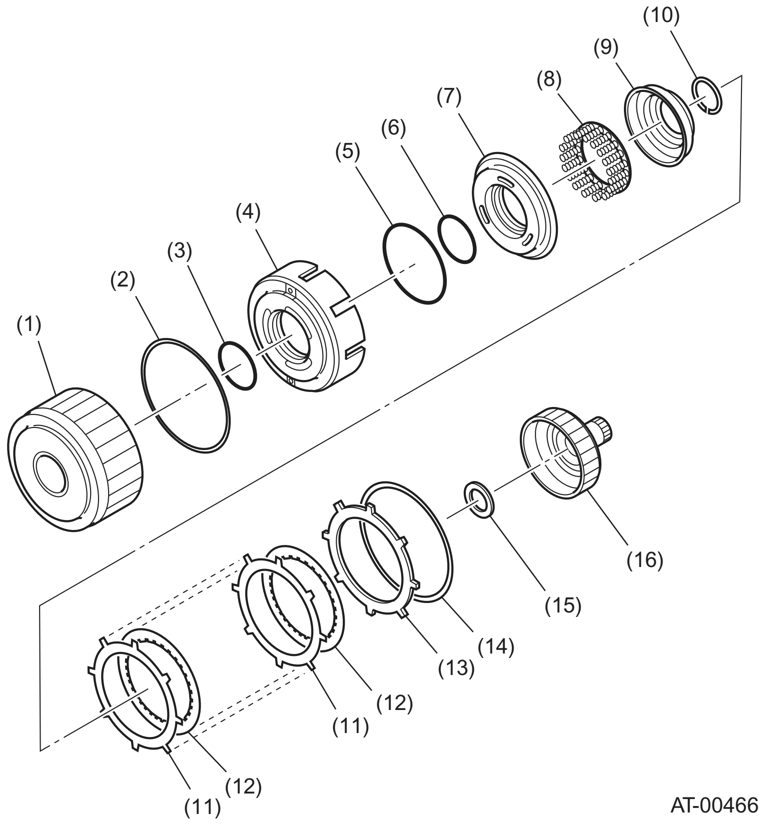


(1) High clutch drum
(2) Reverse clutch piston
(3) Driven plate
(4) Drive plate
(5) Front sun gear
(6) Cover
(7) Check ball

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.



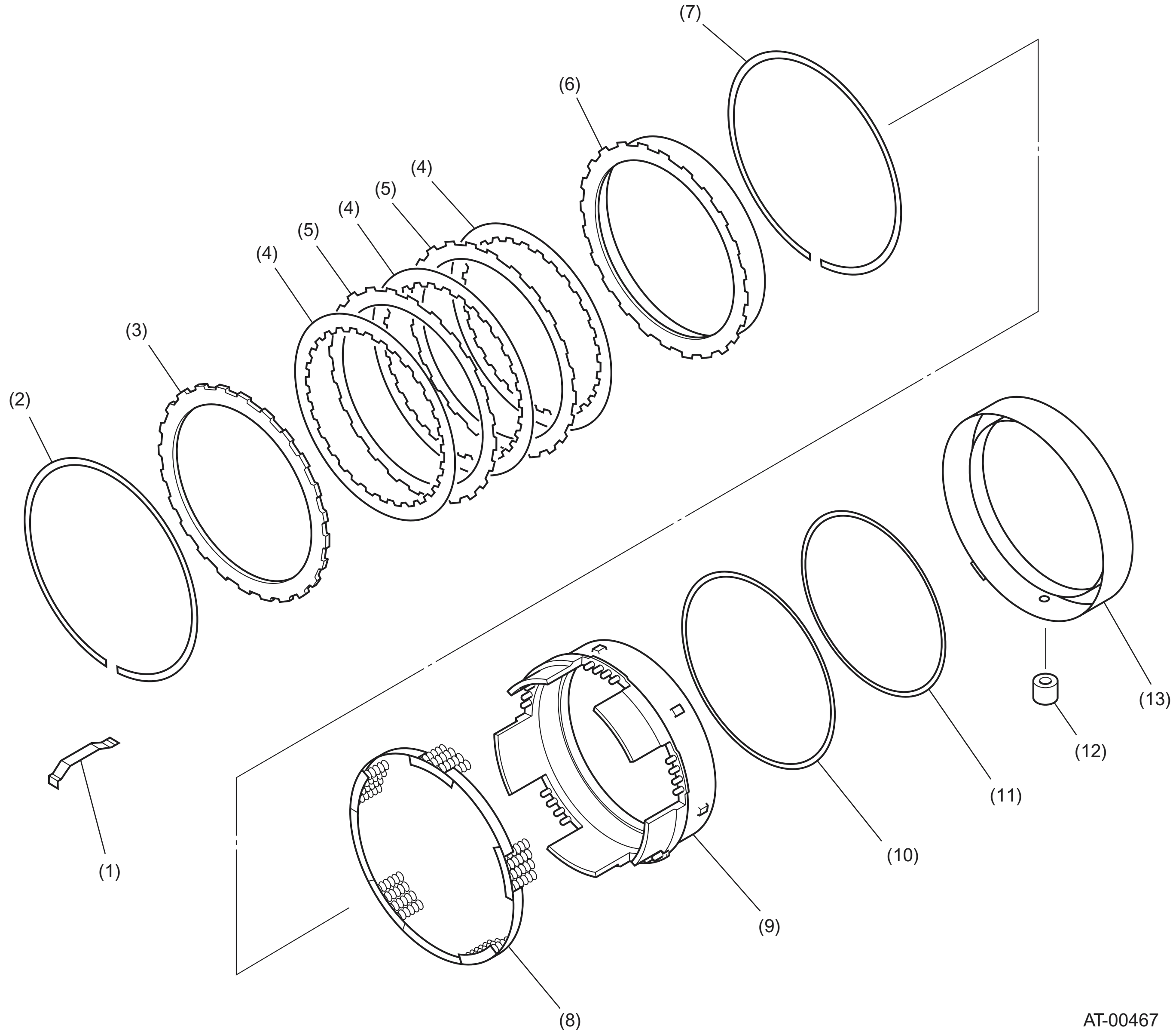
(1)	High clutch drum	(7)	High clutch piston	(13)	Retaining plate
(2)	Lip seal	(8)	Return spring	(14)	Snap ring
(3)	Lathe cut seal ring	(9)	Cover	(15)	Thrust needle bearing
(4)	Reverse clutch piston	(10)	Snap ring	(16)	High clutch hub
(5)	Lathe cut seal ring (outer)	(11)	Driven plate		
(6)	Lathe cut seal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

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.

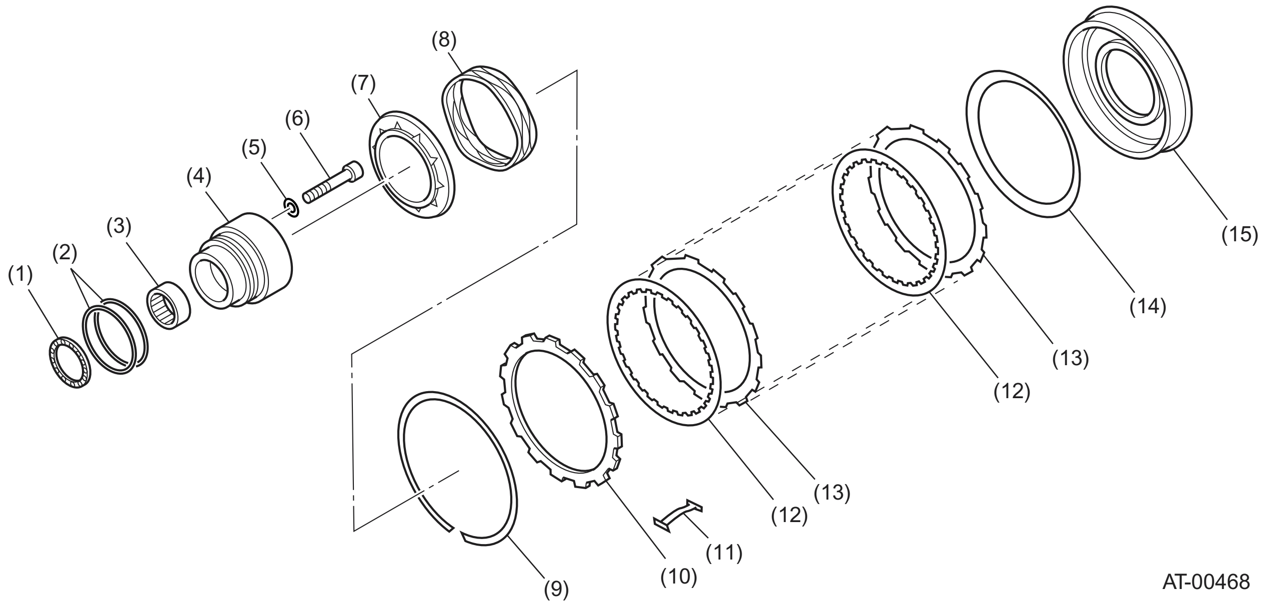


(1) Leaf spring	(6) Pressure rear plate	(10) Lathe cut seal ring
(2) Snap ring	(7) Snap ring	(11) Lathe cut seal ring
(3) Retaining plate	(8) Return spring	(12) 2-4 brake piston seal
(4) Drive plate	(9) 2-4 brake piston	(13) 2-4 brake piston retainer
(5) Driven plate		

5. Low & Reverse Brake

A: CONSTRUCTION

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



(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

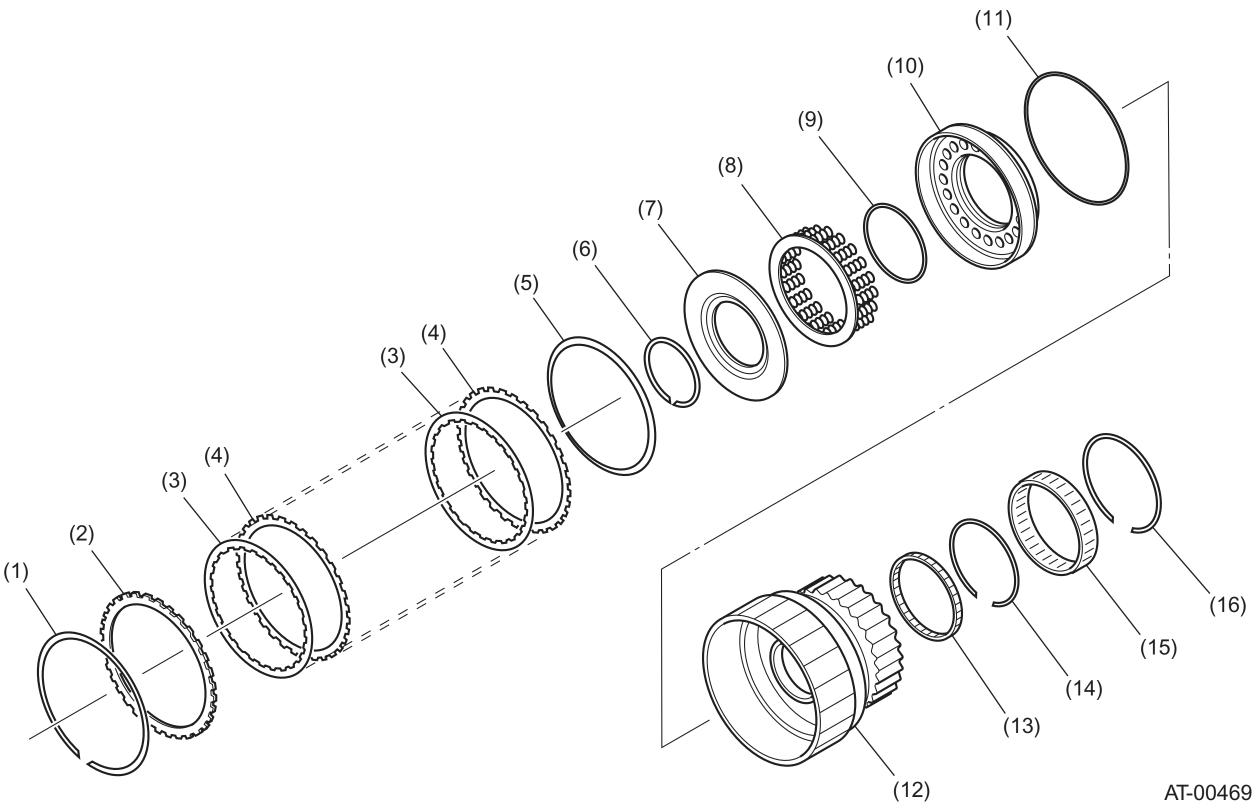
B: FUNCTION

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.

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.

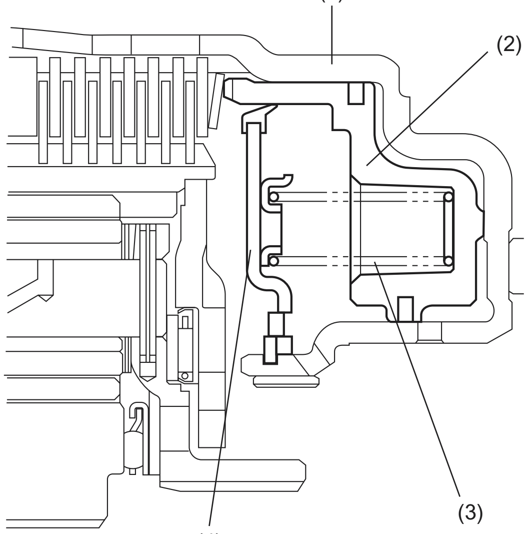


(1)	Snap ring	(7)	Cover	(13)	Needle bearing
(2)	Retaining plate	(8)	Return spring	(14)	Snap ring
(3)	Drive plate	(9)	Lathe cut seal ring	(15)	One-way clutch
(4)	Driven plate	(10)	Low clutch piston	(16)	Snap ring
(5)	Dish plate	(11)	Lathe cut seal ring		
(6)	Snap ring	(12)	Low clutch drum		

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.

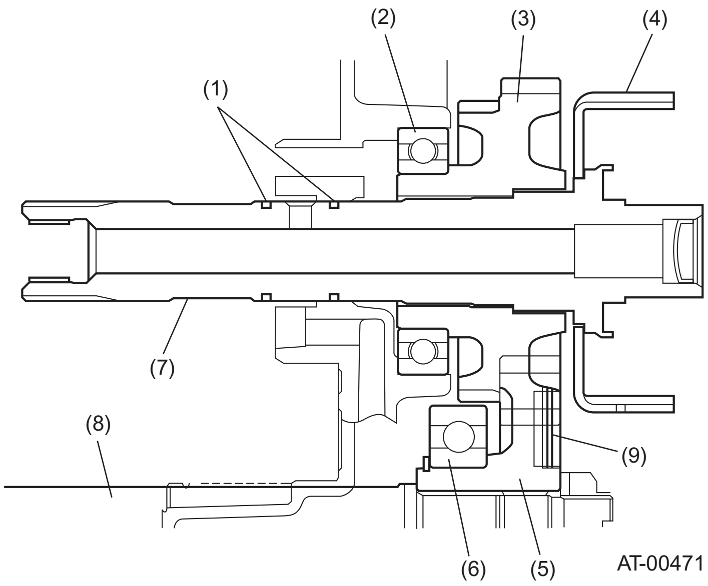
A cover is placed inside the piston, and the space between the piston and the cover is filled with ATF. When the low clutch is not in engagement, the centrifugal force generated in the ATF inside the cover cancels out the centrifugal force generated in the ATF remaining behind the low clutch piston, 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	(3) Return spring
(2) Low clutch piston	(4) Cover

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.



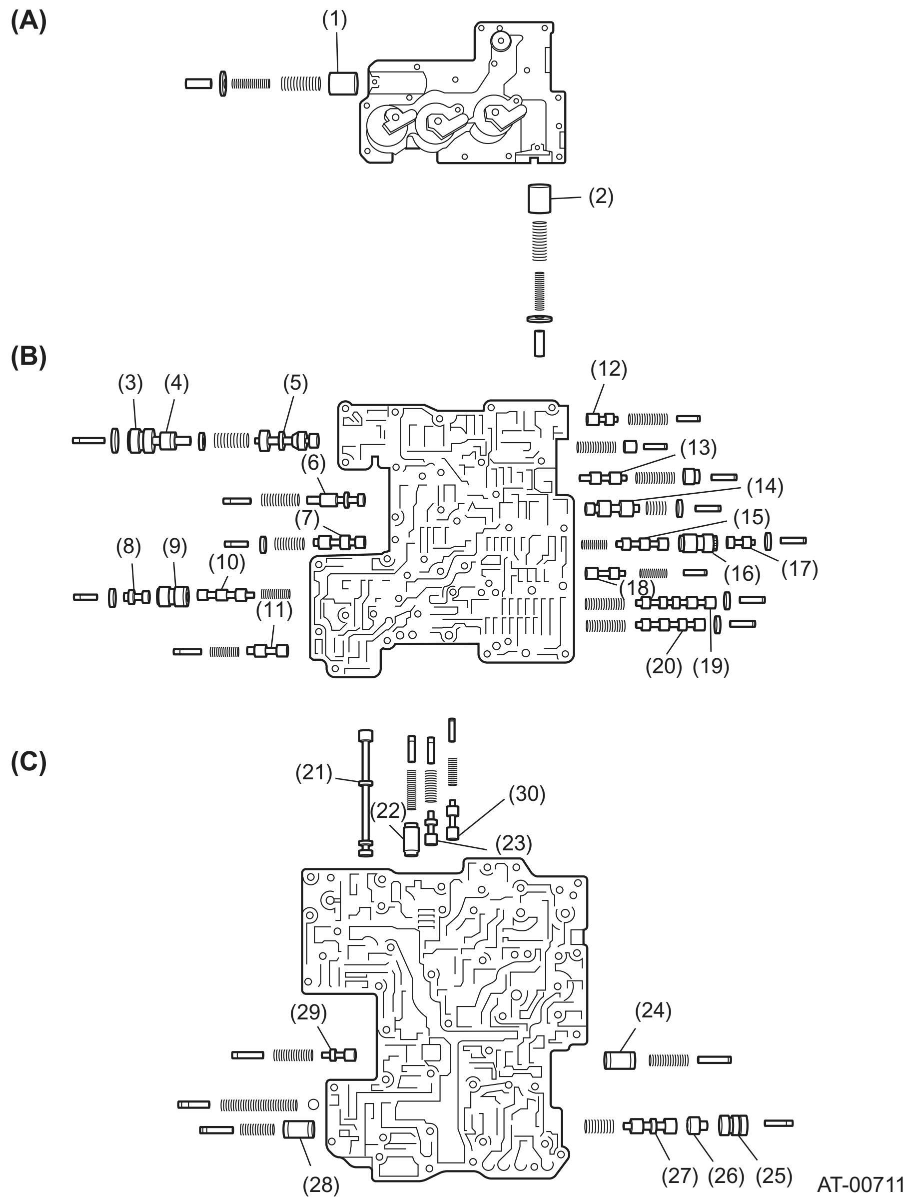
(1) Seal ring
(2) Ball bearing
(3) Reduction drive gear
(4) Transfer clutch hub
(5) Reduction driven gear
(6) Ball bearing
(7) Reduction drive shaft
(8) Drive pinion shaft
(9) Snap ring

MEMO

8. Hydraulic Control Valve

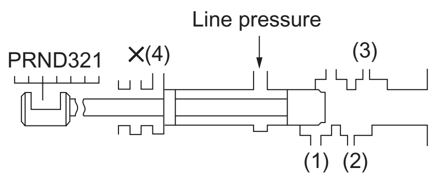
The hydraulic control system of the automatic transmission consists of an oil pump, valve bodies containing valves, clutches, fluid passages and pipes. The operation of the system is initiated by driver's manual inputs and electric inputs from the TCM.

A: CONSTRUCTION



(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 inhibitor 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	(30)	Sports shift control valve (vehicles with sports shift)
(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

B: FUNCTION

<table>
<tr><th>Name</th><th>Function</th></tr>
<tr><td>Pressure regulator valve</td><td>Regulates the pressure of ATF delivered from the oil pump to an optimum level (line pressure) corresponding to vehicle running conditions.</td></tr>
<tr><td>Pressure modifier valve</td><td>Adjusts the pressure modifier output pressure depending on the driving condition to keep the line pressure at the optimum level.</td></tr>
<tr><td>Pressure modifier accumulator piston</td><td>Cushions the pressure modifier valve output pressure to remove pulsation in line pressure.</td></tr>
<tr><td>Line pressure relief valve</td><td>Prevents excessive rise of the line pressure.</td></tr>
<tr><td>Manual valve</td><td>Allows the line pressure to the circuit corresponding to the selected range.
<table>
<tr><th>Circuit
Range</th><th>(1)</th><th>(2)</th><th>(3)</th><th>(4)</th></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>
</table>


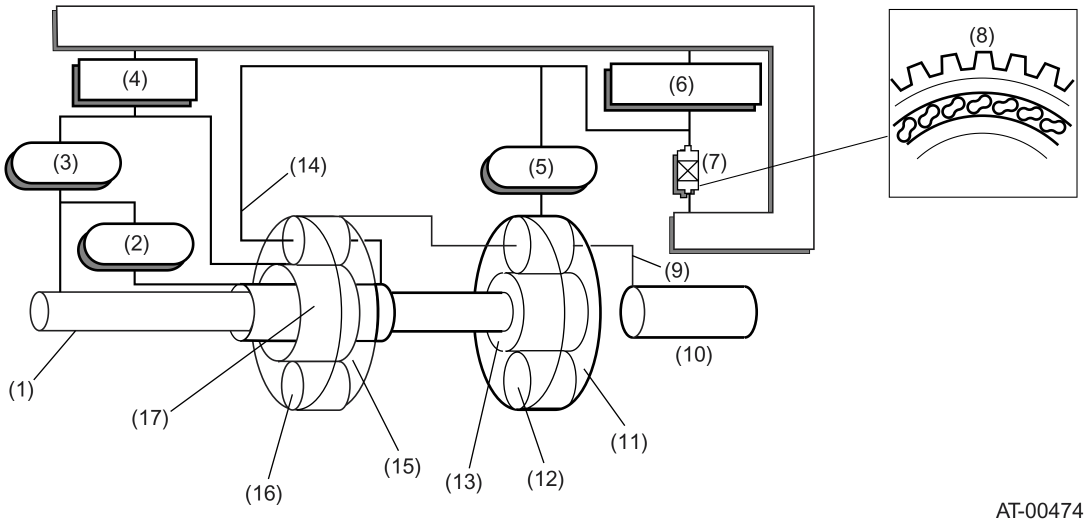
AT-00473
When the valve is placed in the position allowing the line pressure to go nowhere, the pressure is released.</td></tr>
<tr><td>Pilot valve</td><td>Reduces the line pressure to create a constant pressure (pilot pressure) for use in controlling the line pressure, lock-up pressure, and shifting and transfer clutch/brake pressures.</td></tr>
<tr><td>Torque converter clutch regulator valve</td><td>Prevents excessive rise of torque converter clutch pressure.</td></tr>
<tr><td>Lock-up control valve</td><td>Engages or disengages the lock-up clutch.
Also regulates the lock-up clutch engaging pressure to prevent lock-up shocks.</td></tr>
<tr><td>Shift valve A</td><td>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.</td></tr>
<tr><td>Shift valve B</td><td>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.</td></tr>
<tr><td>Low clutch timing valve A</td><td>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.</td></tr>
<tr><td>Low clutch timing valve B</td><td>Returns the low clutch timing valve A to the original position after 3rd-to-4th upshifting.</td></tr>
<tr><td>2-4 brake timing valve A</td><td>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.</td></tr>
<tr><td>2-4 brake timing valve B</td><td>Returns the 2-4 brake timing valve A to the original position after 2nd-to-3rd upshifting.</td></tr>
<tr><td>Reverse inhibitor valve</td><td>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.</td></tr>
<tr><td>1st reducing valve</td><td>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.</td></tr>
</table>

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.
Sports shift control valve (vehicles with sports shift)	Engages the low & reverse brake when 1st speed is selected in sports shift mode.

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.



(1)	Input shaft	(7)	One-way clutch	(13)	Rear sun gear
(2)	High clutch (Operates in 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)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(16)	Front pinion gear
(5)	Low clutch	(11)	Rear internal gear	(17)	Front sun gear
(6)	Low & reverse brake	(12)	Rear pinion gear		

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		○	○			
	Sports shift	1ST				○	○	
		2ND		○		○		
		3RD			○	○		
		4TH		○	○			

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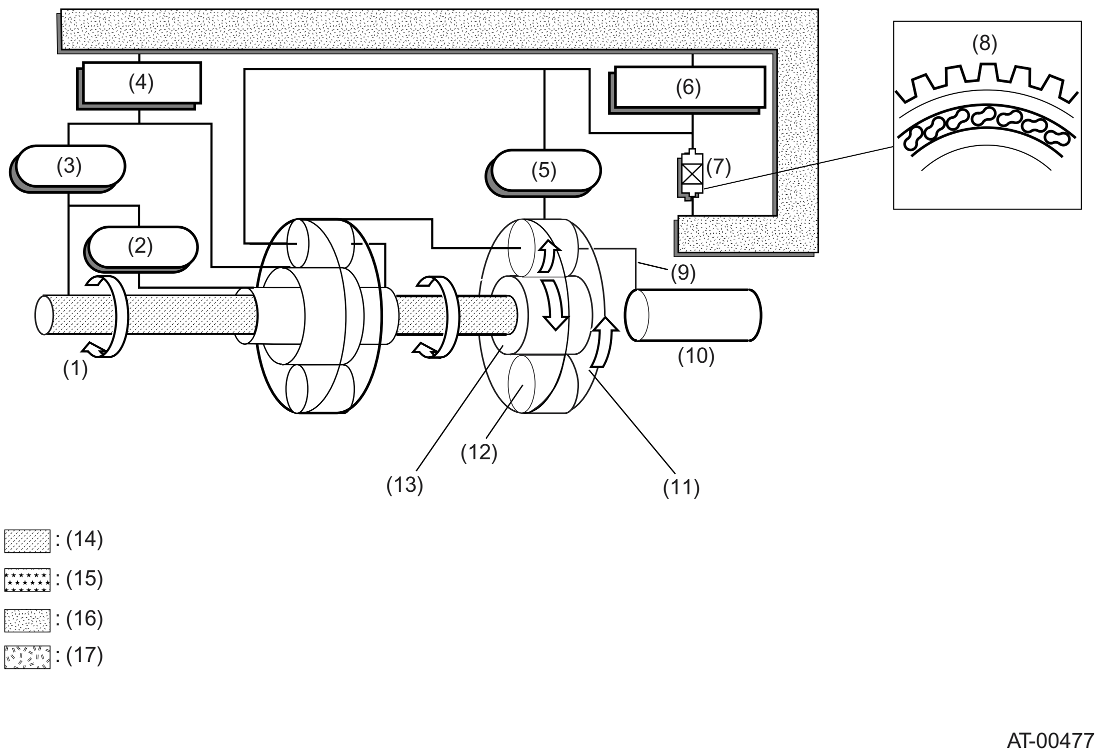
2. N RANGE

Since the rear sun gear and the high clutch drum are in mesh with the input shaft, they rotate together with the 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	Input shaft ↓ Rear sun gear ↓ Rear pinion gear ↓ Rear internal gear ↓ Low clutch (free) AT-00476

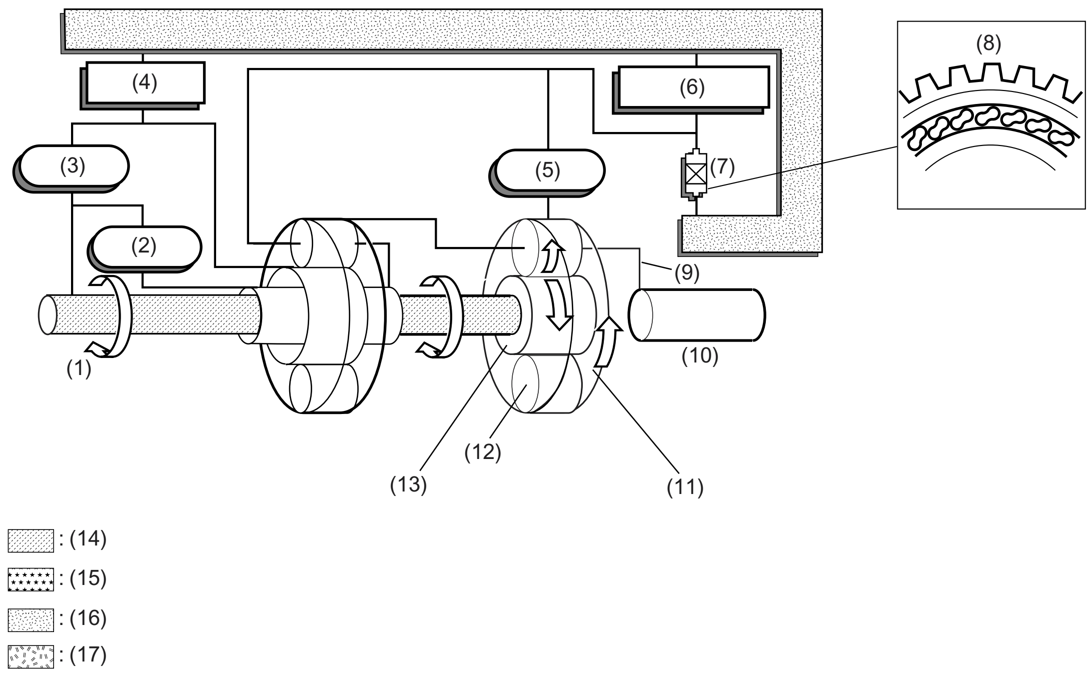


(1)	Input shaft	(7)	One-way clutch	(13)	Rear sun gear
(2)	High clutch	(8)	No effect	(14)	Input
(3)	Reverse clutch	(9)	Rear planetary carrier	(15)	Output
(4)	2-4 brake	(10)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(16)	Locked
(5)	Low clutch	(11)	Rear internal gear	(17)	Planetary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

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	Input shaft ↓ Rear sun gear ↓ Rear pinion gear ↓ Rear internal gear ↓ Low clutch (free) AT-00476



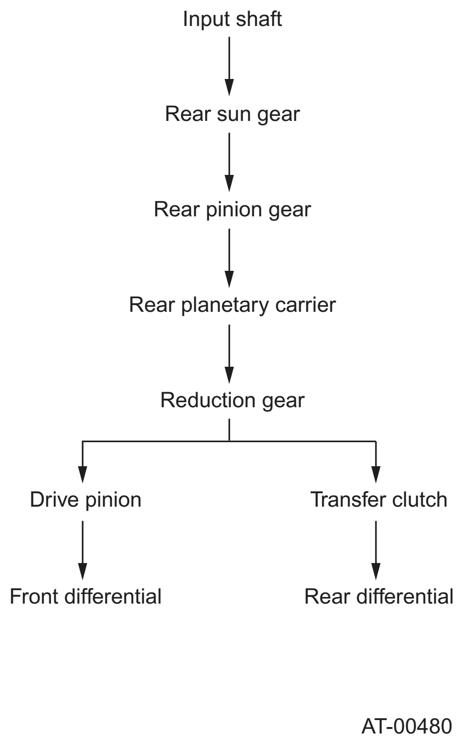
(1)	Input shaft	(7)	One-way clutch	(13)	Rear sun gear
(2)	High clutch	(8)	No effect	(14)	Input
(3)	Reverse clutch	(9)	Rear planetary carrier	(15)	Output
(4)	2-4 brake	(10)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(16)	Locked
(5)	Low clutch	(11)	Rear internal gear	(17)	Planetary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

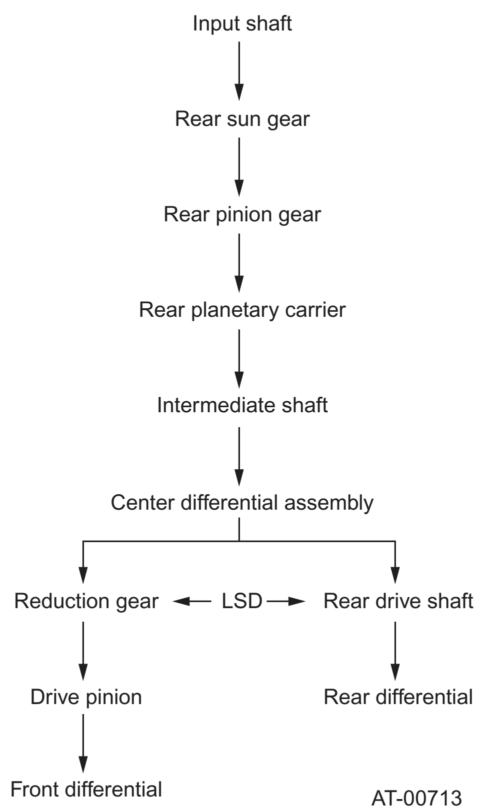
4. 1ST GEAR OF D OR 3 RANGE (D_1, 3_1)

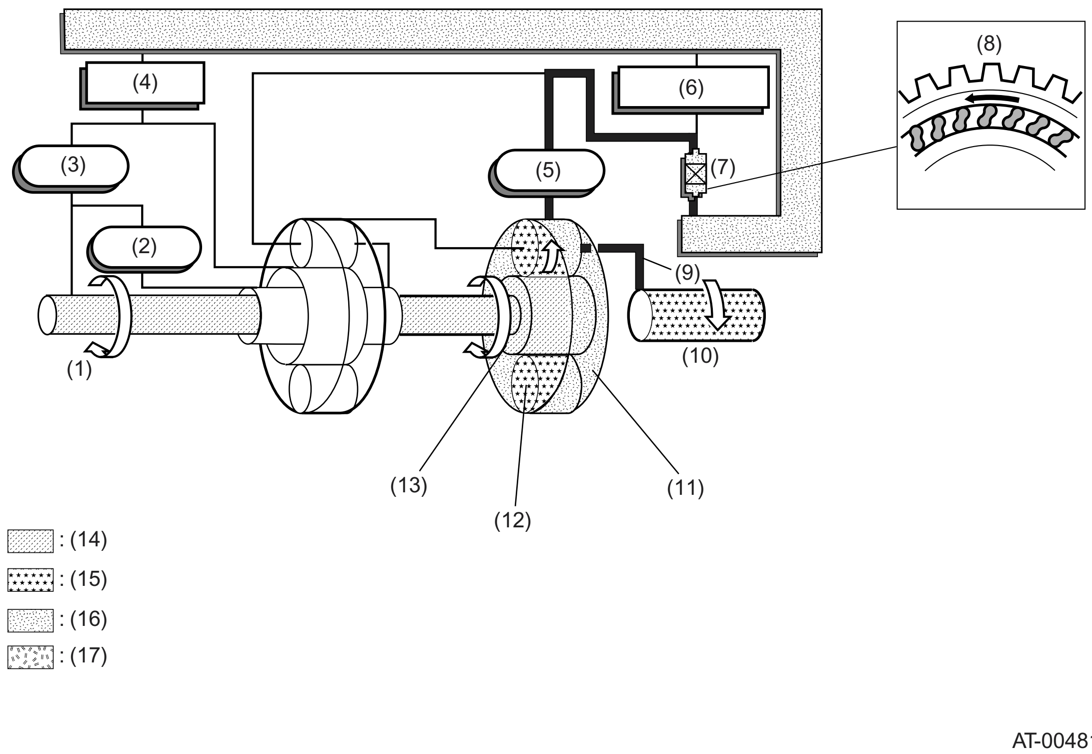
When the 1st gear is selected in the D or 3 range, only the low clutch is engaged. In this state, the rear internal gear attempts to rotate counterclockwise but it is impossible by the action of the one-way clutch which locks the internal gear to the transmission case. As a result, rotation of the rear 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.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components	
Low clutch : engaged One-way clutch : locked	
Power flow (in acceleration)	
MPT models	**VTD models**
See below	See below







(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)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(16)	Locked
(5)	Low clutch	(11)	Rear internal gear	(17)	Planetary gear components involved in power transmission
(6)	Low & reverse brake	(12)	Rear pinion gear		

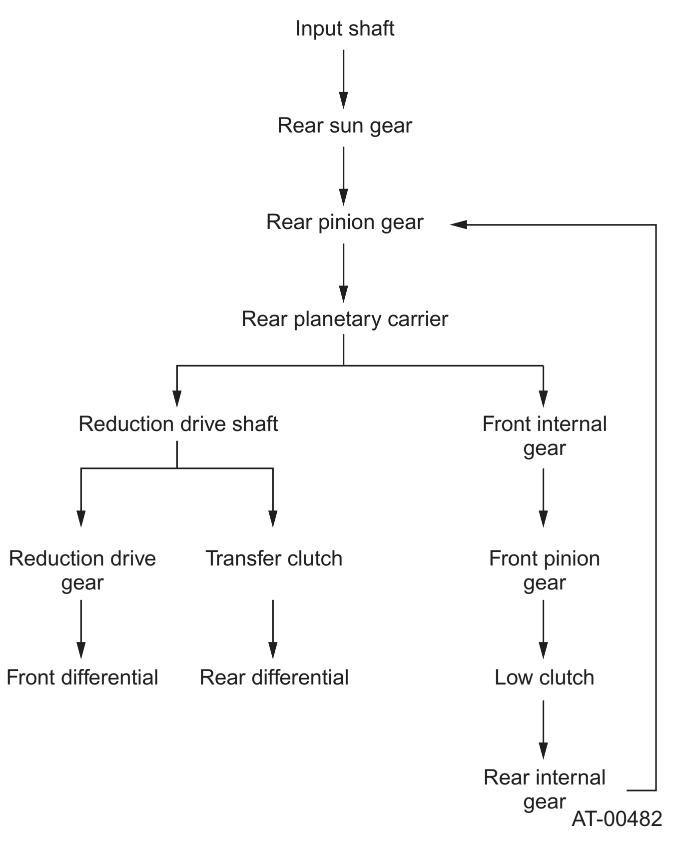
5. 2ND GEAR OF D, 3, 2 RANGE OR IN SPORTS SHIFT MODE (D_2, 3_2, 2_2, S_2)

When the 2nd gear is selected in D, 3, 2 range or in sports shift mode, 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.

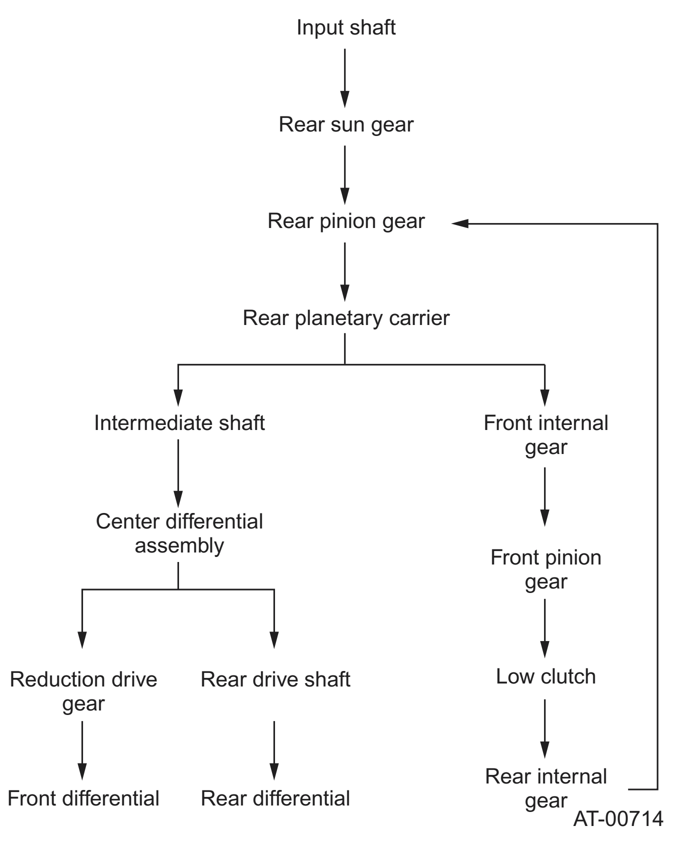
*: MPT models only. VTD models are equipped with an intermediate shaft.

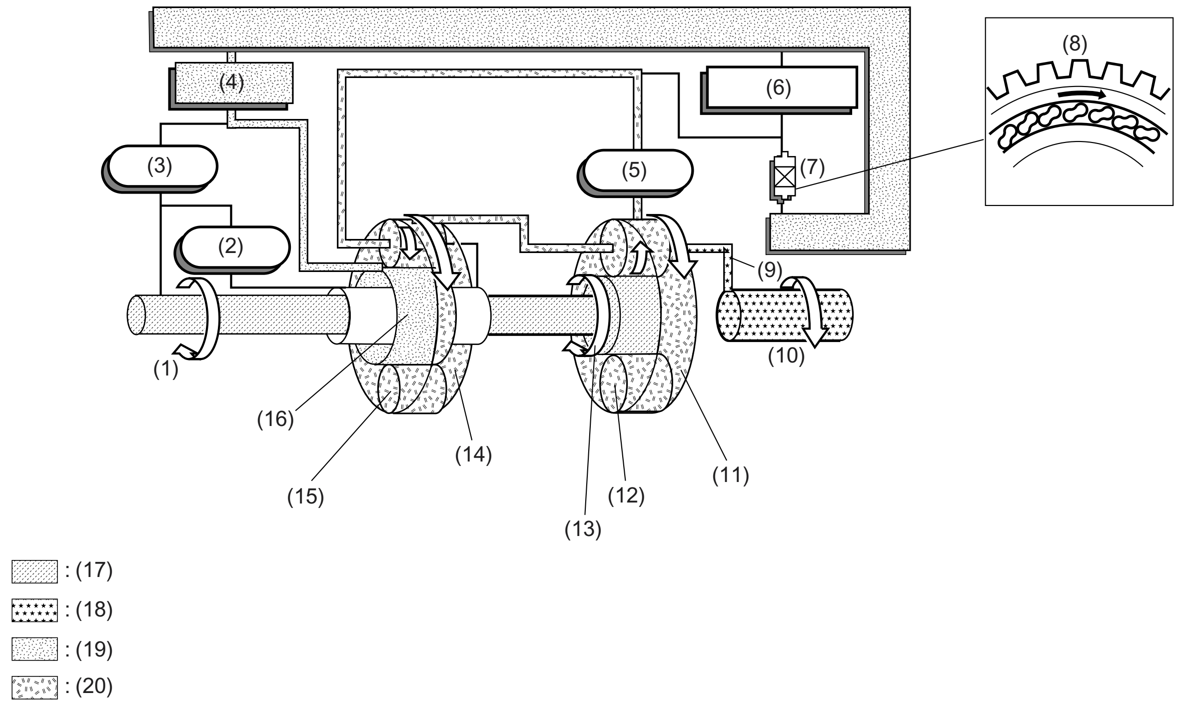
Operating condition of components
Low clutch : engaged 2-4 brake : engaged
Power flow (in acceleration)

MPT models



VTD models





(1)	Input shaft	(8)	Free	(15)	Front pinion gear
(2)	High clutch	(9)	Rear planetary carrier	(16)	Front sun gear
(3)	Reverse clutch	(10)	MPT models: Reduction drive shaft VTD models: Intermediate 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 components involved in power transmission
(7)	One-way clutch	(14)	Front internal gear		

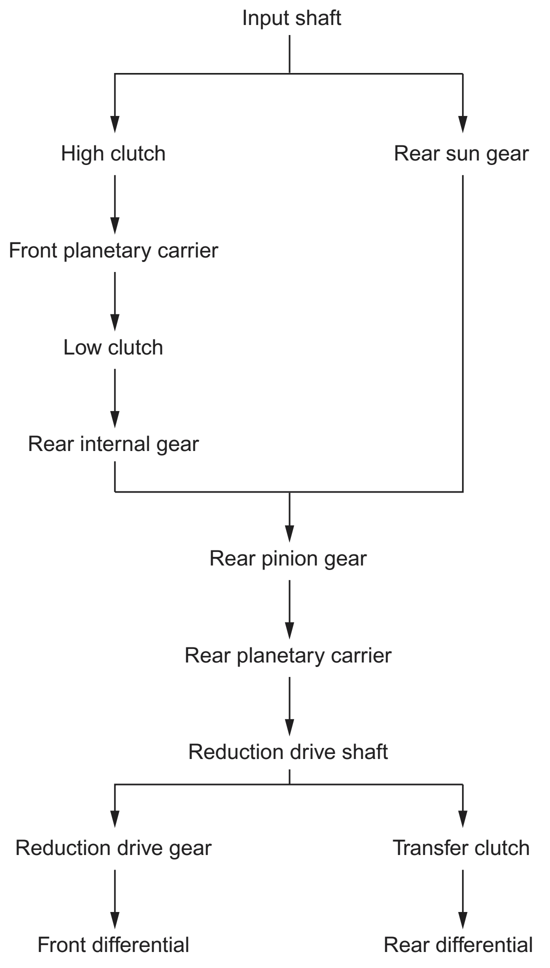
6. 3RD GEAR OF D, 3, RANGE OR IN SPORTS SHIFT MODE (D_3, 3_3, S_3)

When the 3rd gear is selected in the D or 3 range or in sports shift mode, 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.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components
High clutch : engaged Low clutch : engaged
Power flow (in acceleration)

MPT models



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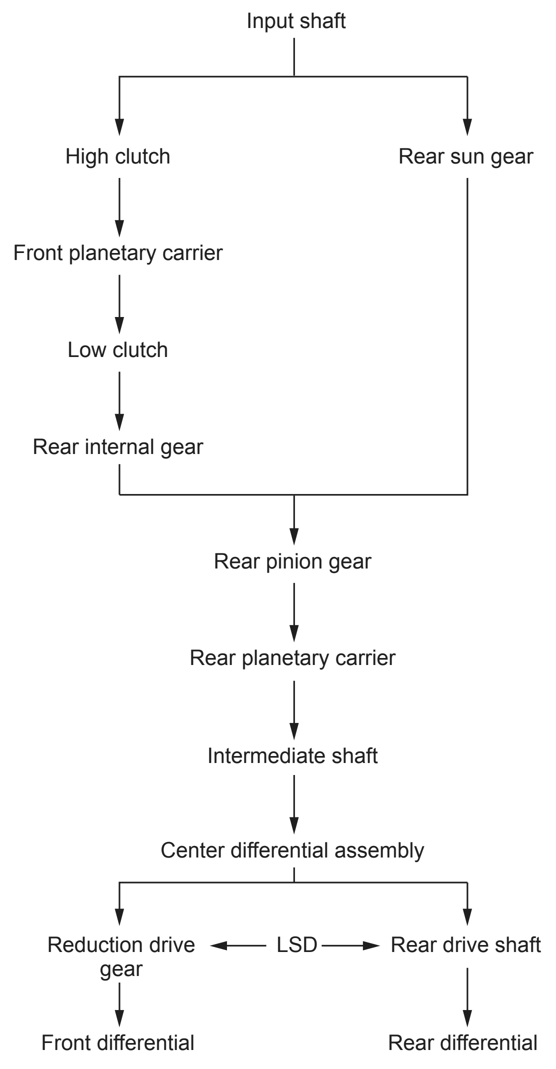
VTD models



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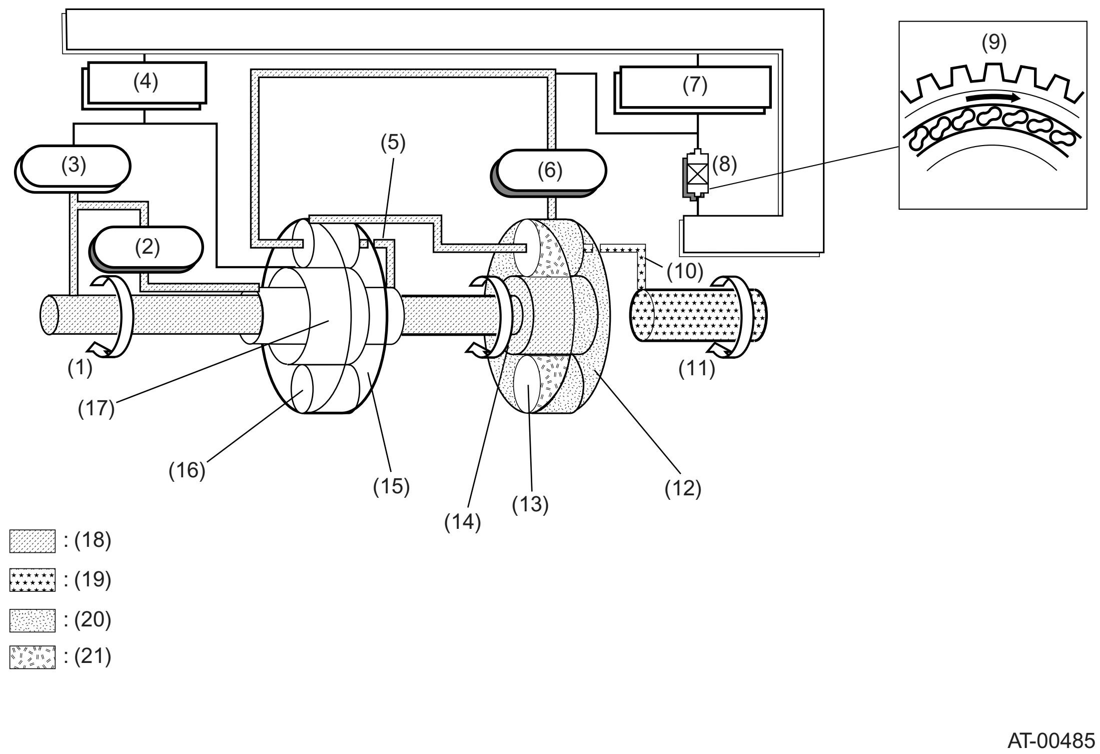
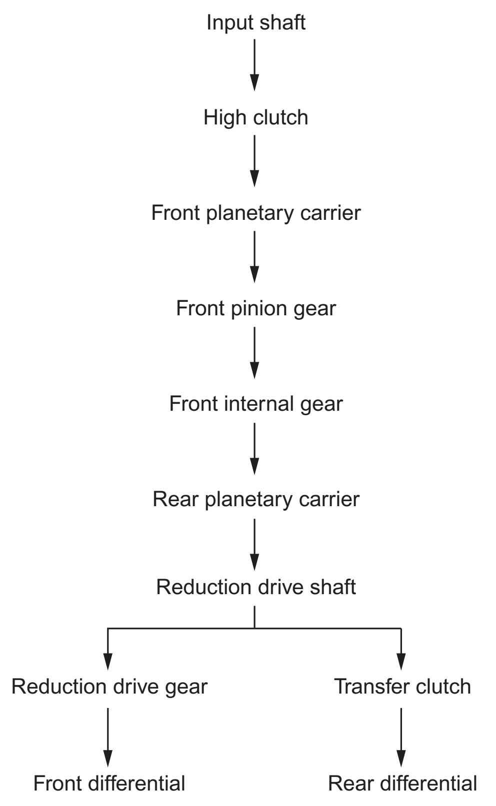
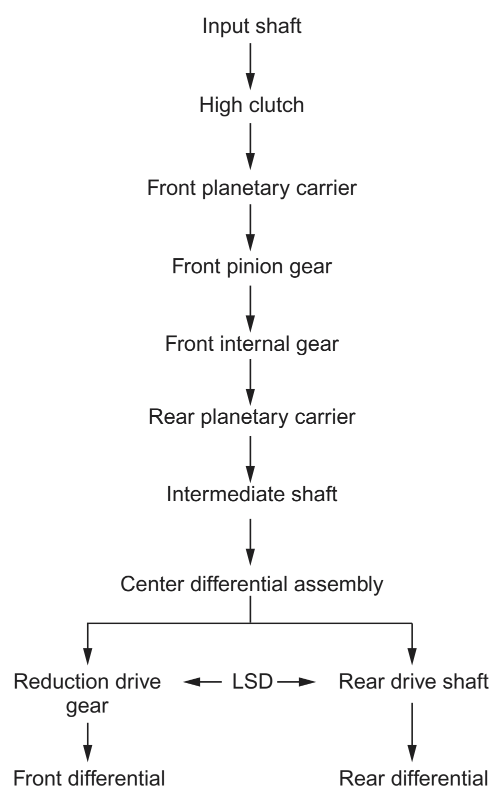


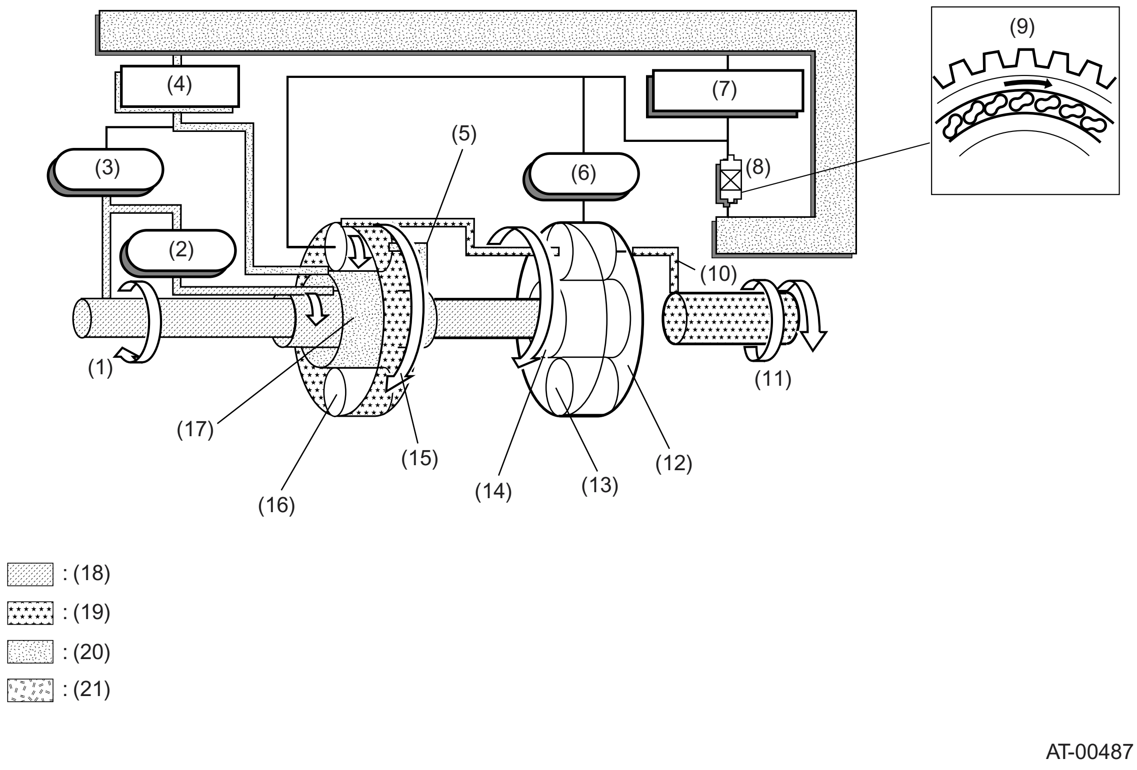
(1)	Input shaft	(8)	One-way clutch	(15)	Front internal gear
(2)	High clutch	(9)	Free	(16)	Front pinion gear
(3)	Reverse clutch	(10)	Rear planetary carrier	(17)	Front sun gear
(4)	2-4 brake	(11)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(18)	Input
(5)	Front planetary carrier	(12)	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

7. 4TH GEAR OF D RANGE OR IN SPORTS SHIFT MODE (D_4, S_4)

When the 4th gear is selected in the D range or in sports shift mode, 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.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components	
2-4 brake : engaged High clutch : engaged	
Power flow (in acceleration)	
MPT models	**VTD models**
 AT-00486	 AT-00716

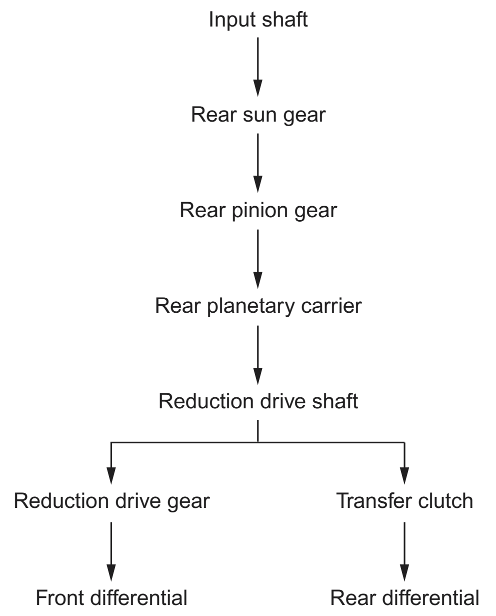


(1)	Input shaft	(8)	One-way clutch	(15)	Front internal gear
(2)	High clutch	(9)	Free	(16)	Front pinion gear
(3)	Reverse clutch	(10)	Rear planetary carrier	(17)	Front sun gear
(4)	2-4 brake	(11)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(18)	Input
(5)	Front planetary carrier	(12)	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 OR IN SPORTS SHIFT MODE (1_1, S_1)

When the 1st gear is selected in the 1 range or in sports shift mode, 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.

*: MPT models only. VTD models are equipped with an intermediate shaft.

<table>
<tr><td colspan="2">Operating condition of components</td></tr>
<tr><td colspan="2">Low clutch : engaged
Low & reverse brake : engaged
One-way clutch : no effect</td></tr>
<tr><td colspan="2">Power flow (in acceleration)</td></tr>
<tr><td>MPT models</td><td>VTD models</td></tr>
<tr><td>


AT-00488
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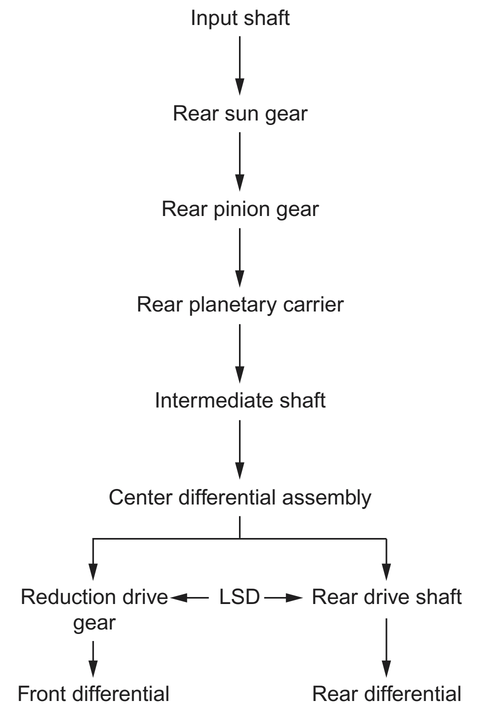

AT-00717
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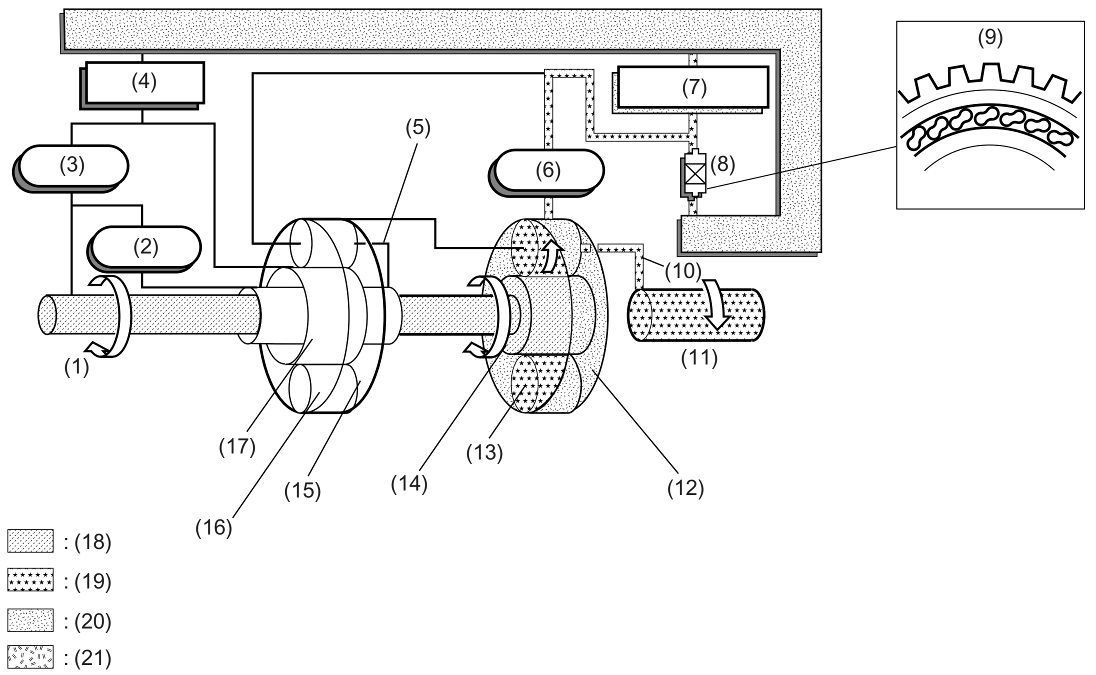


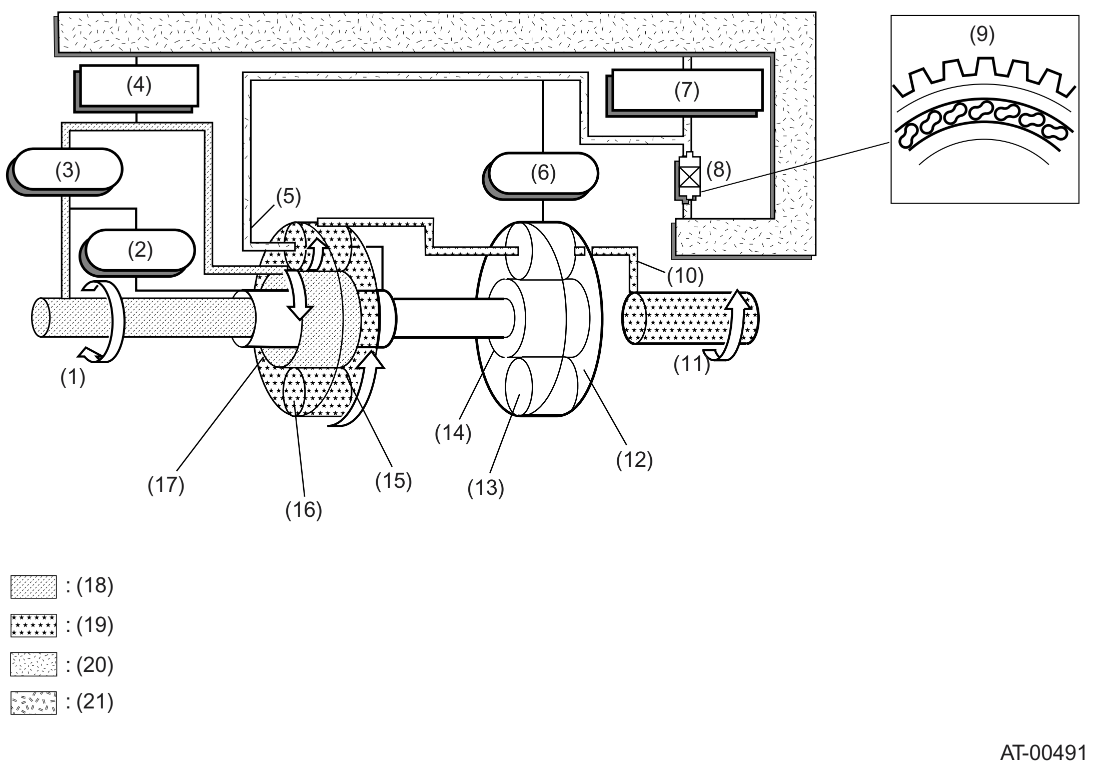
(1)	Input shaft	(8)	One-way clutch	(15)	Front internal gear
(2)	High clutch	(9)	No effect	(16)	Front pinion gear
(3)	Reverse clutch	(10)	Rear planetary carrier	(17)	Front sun gear
(4)	2-4 brake	(11)	MPT models: Reduction drive shaft VTD models: Intermediate shaft	(18)	Input
(5)	Front planetary carrier	(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

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.
The rotation of the front sun gear causes the front pinion gear to rotate in the opposite 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.

*: MPT models only. VTD models are equipped with an intermediate shaft.

Operating condition of components	
Reverse clutch : engaged Low & reverse brake : engaged	
Power flow (in acceleration)	
MPT models	**VTD models**
Input shaft ↓ Reverse clutch ↓ Front sun gear ↓ Front pinion gear ↓ Front internal gear ↓ Rear planetary carrier ↓ Reduction drive shaft ↓ Reduction drive gear → Front differential ↓ Transfer clutch → Rear differential AT-00490	Input shaft ↓ Reverse clutch ↓ Front sun gear ↓ Front pinion gear ↓ Front internal gear ↓ Rear planetary carrier ↓ Intermediate shaft ↓ Center differential assembly ↓ Reduction drive gear → Front differential ↓ Rear drive shaft → Rear differential Reduction drive gear ← LSD → Rear drive shaft AT-00718



(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)	MPT models: Reduction drive shaft VTD models: Intermediate 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

MEMO

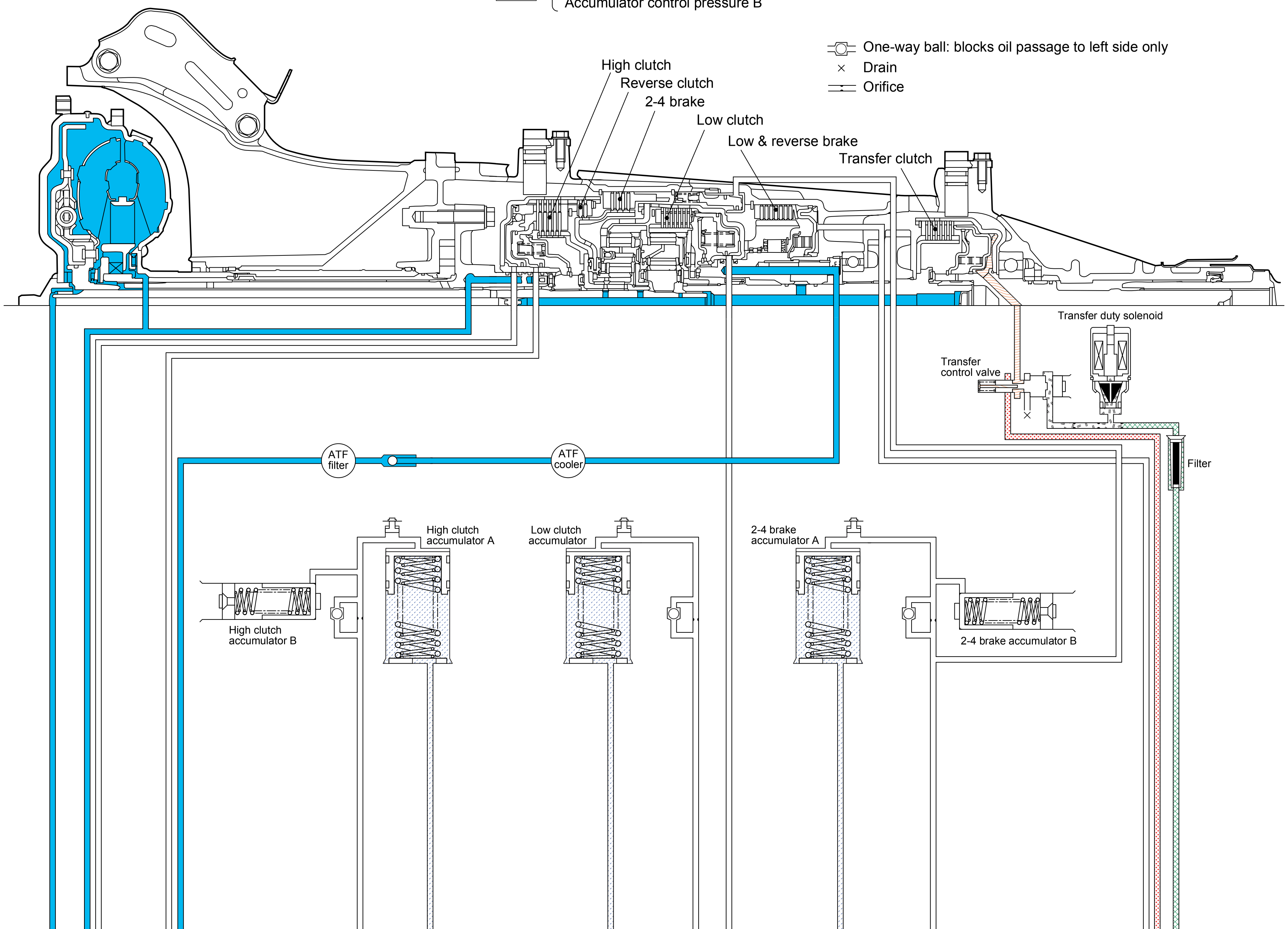
10.Schematic Drawings

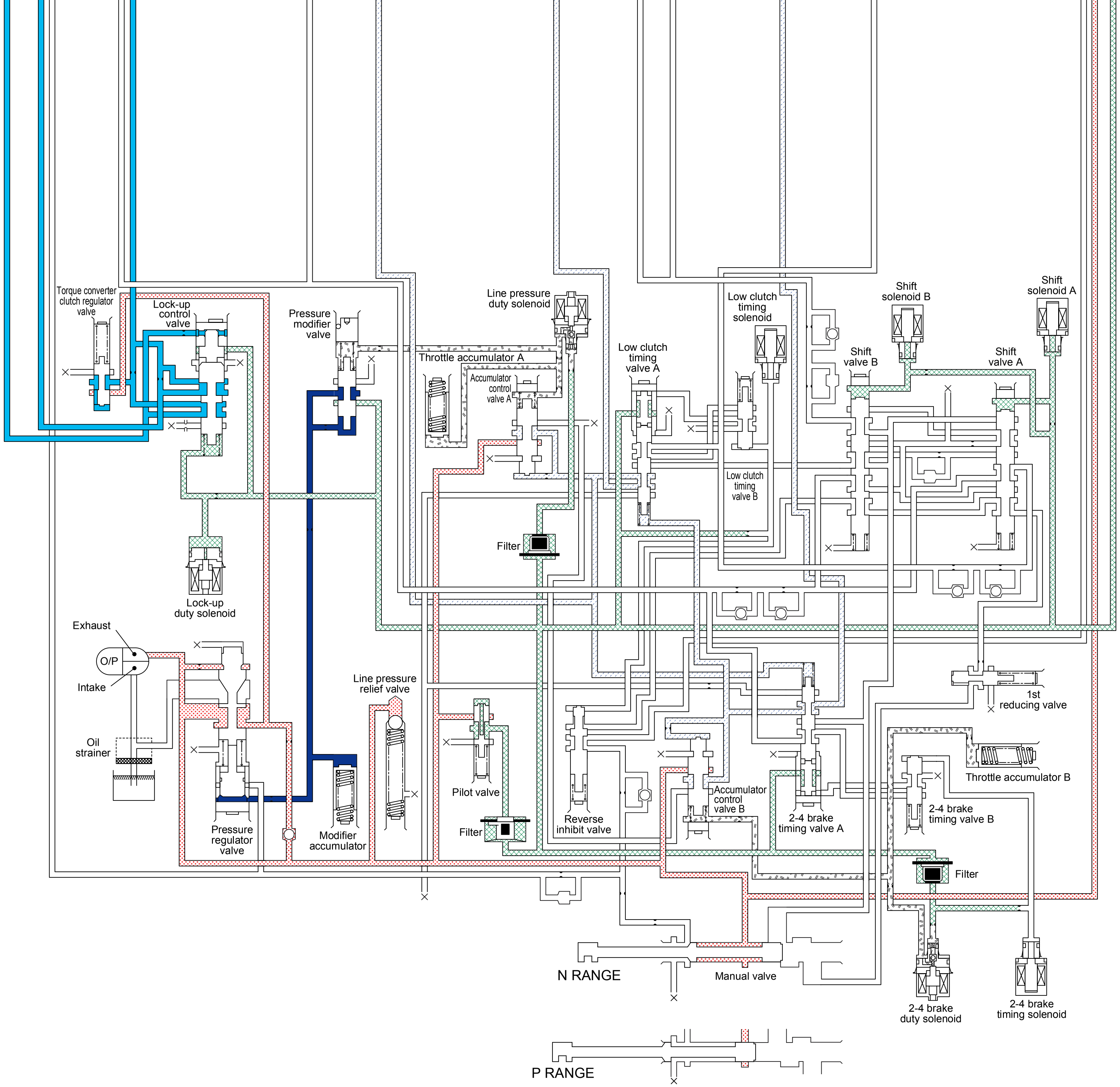
A: EXCEPT VEHICLES WITH SPORTS SHIFT

1. P AND N 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

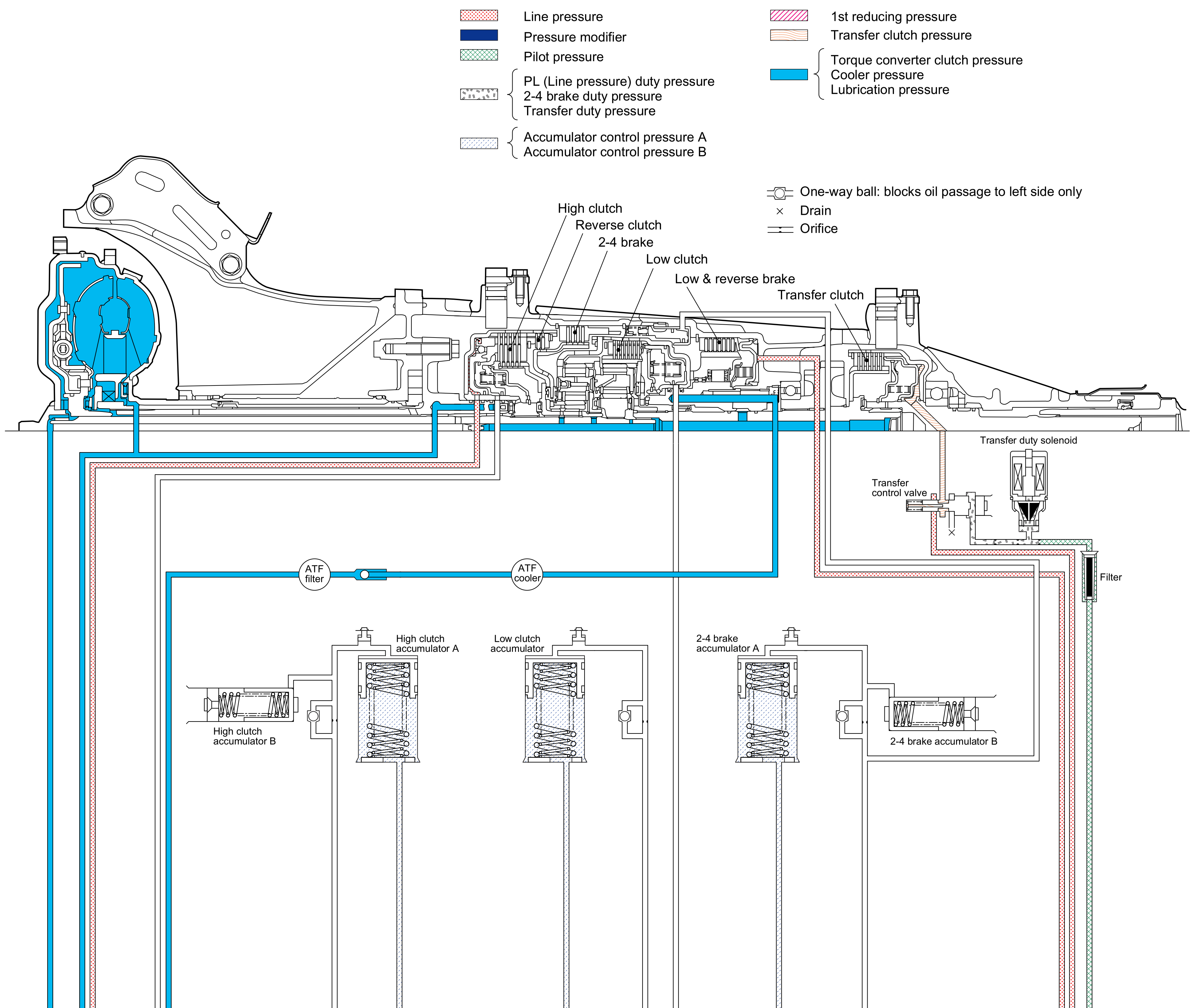
One-way ball: blocks oil passage to left side only
Drain
Orifice



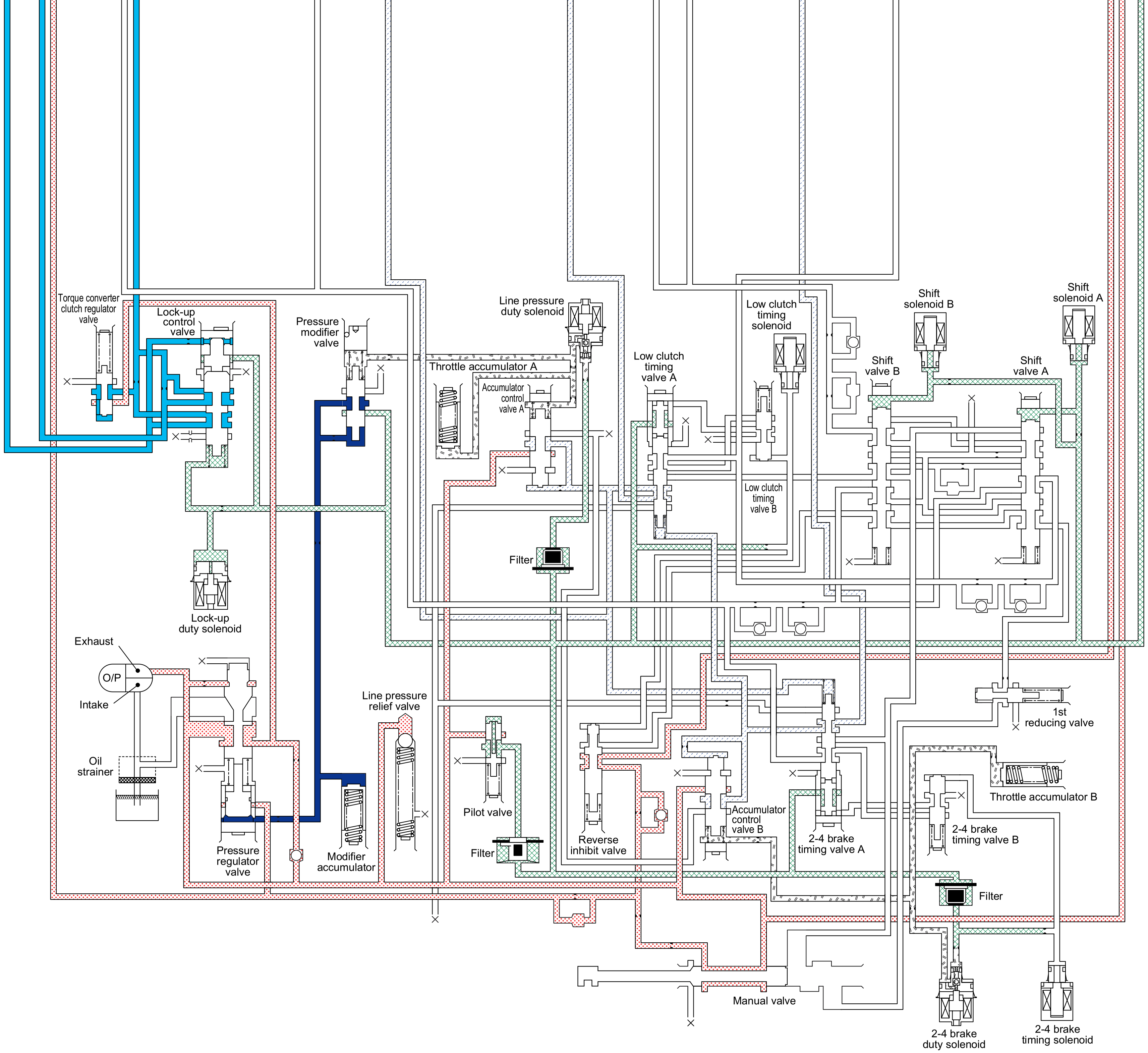

Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
N RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
P RANGE

AT-00492

2. R RANGE



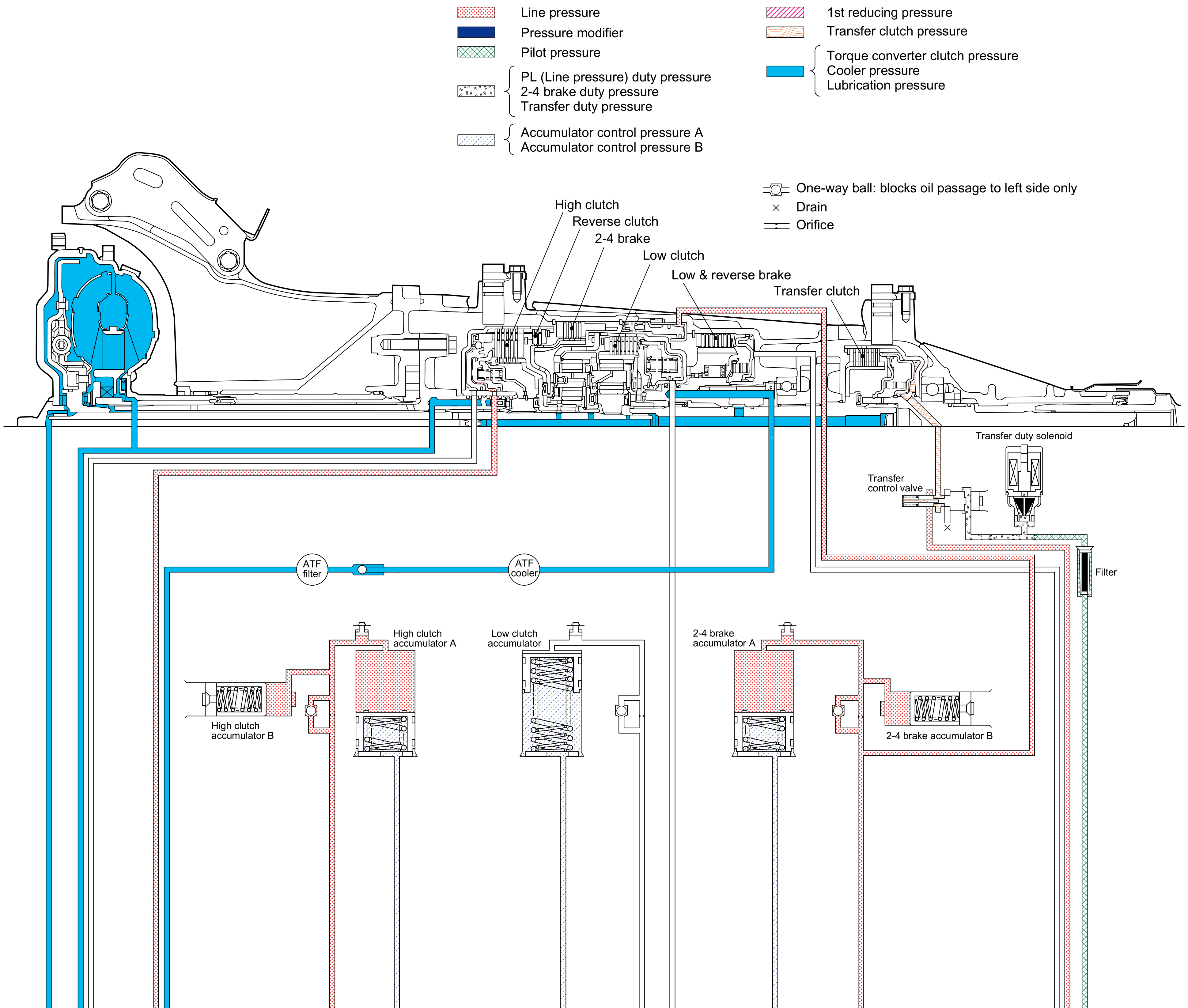
Line pressure
Pressure modifier
Pilot pressure
PL (Line pressure) duty pressure
2-4 brake duty pressure
Transfer duty pressure
Accumulator control pressure A
Accumulator control pressure B
1st reducing pressure
Transfer clutch pressure
Torque converter clutch pressure
Cooler pressure
Lubrication pressure
One-way ball: blocks oil passage to left side only
Drain
Orifice
High clutch
Reverse clutch
2-4 brake
Low clutch
Low & reverse brake
Transfer clutch
Transfer duty solenoid
Transfer control valve
Filter
ATF filter
ATF cooler
High clutch accumulator A
Low clutch accumulator
2-4 brake accumulator A
High clutch accumulator B
2-4 brake accumulator B

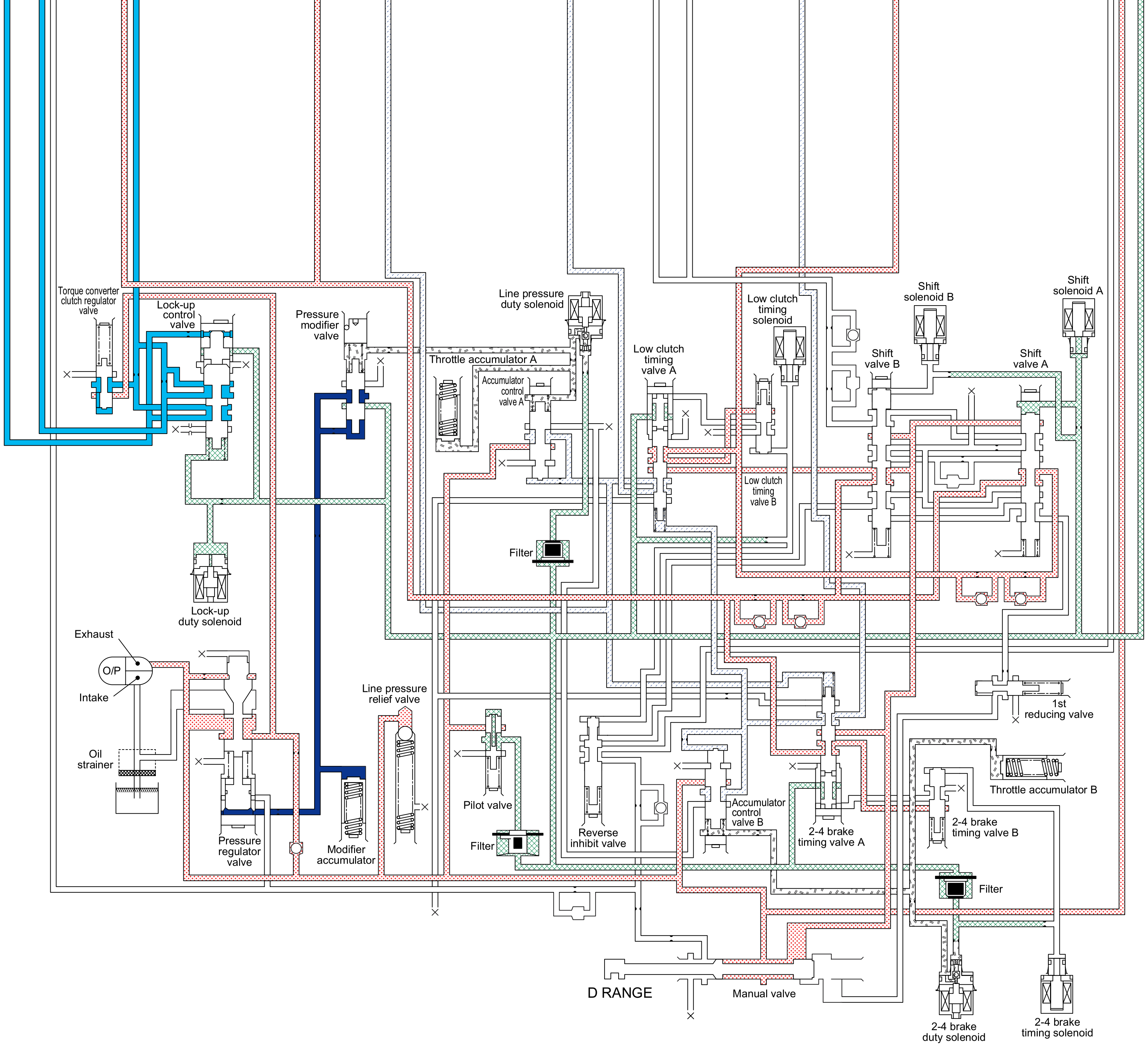


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
Pressure regulator valve
Modifier accumulator
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid

AT-00493

3. 4TH SPEED GEAR OF D RANGE (LOCK-UP OFF)

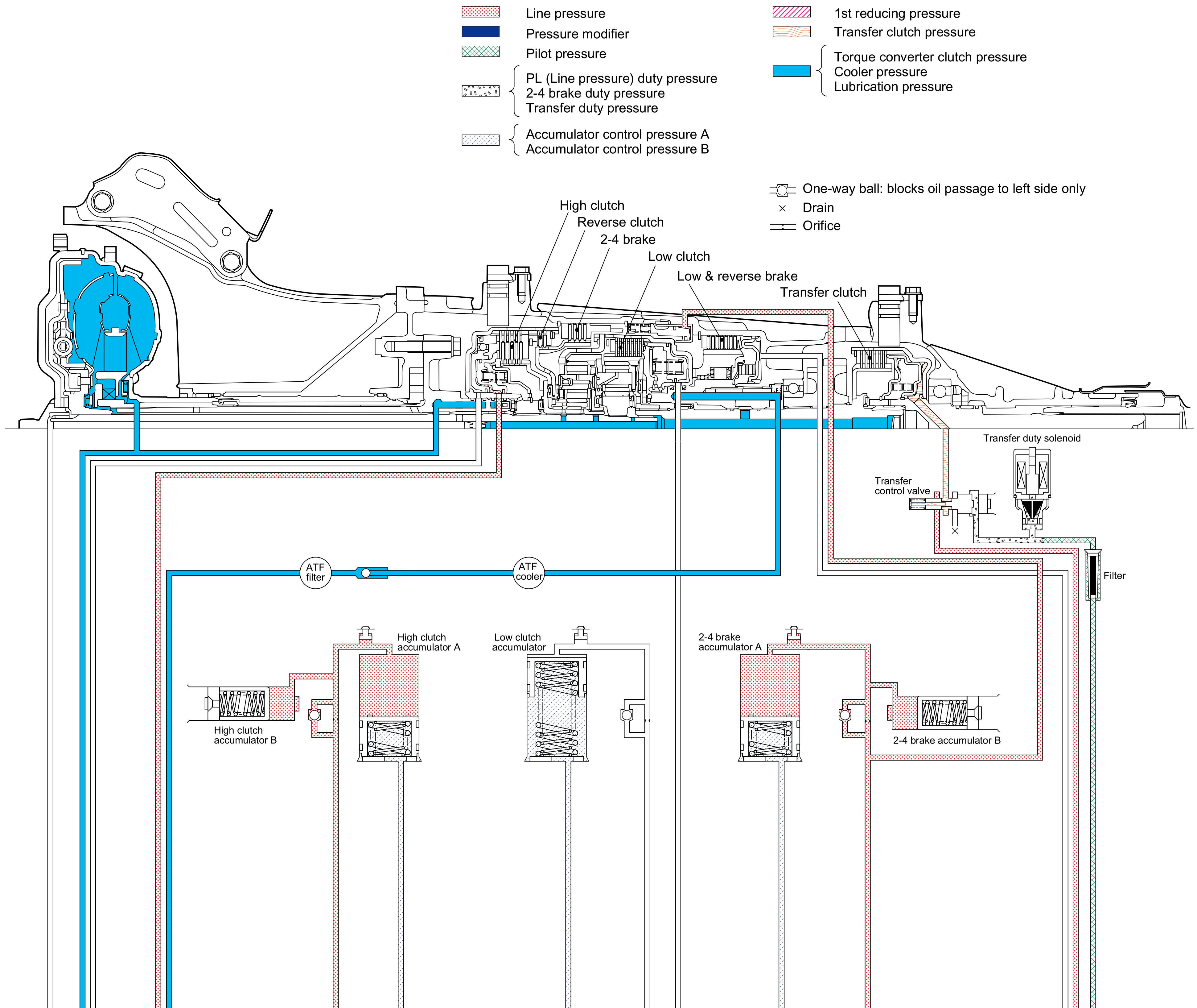


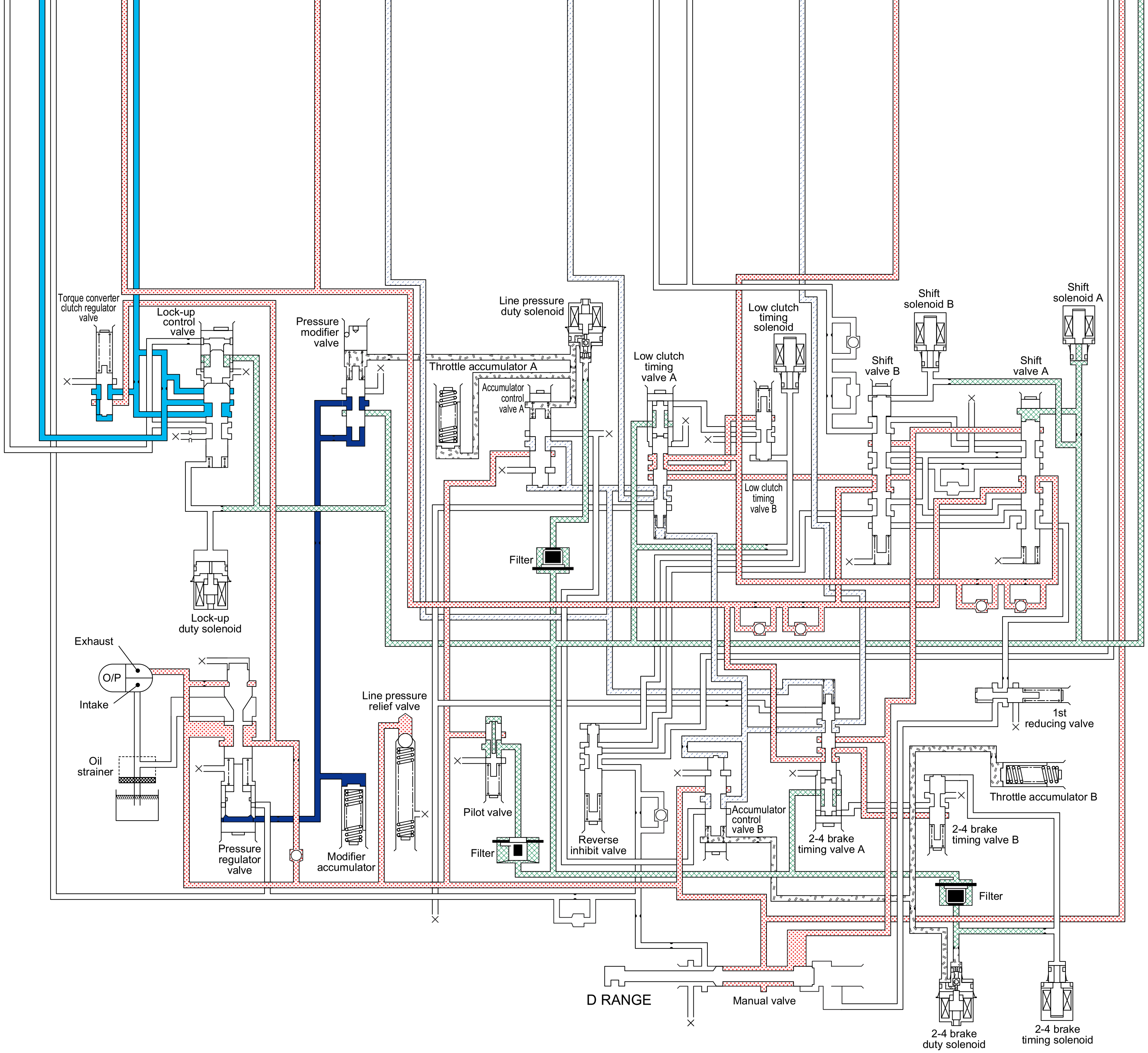


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
2-4 brake timing valve B
Throttle accumulator B
1st reducing valve
Filter
D RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid

AT-00494

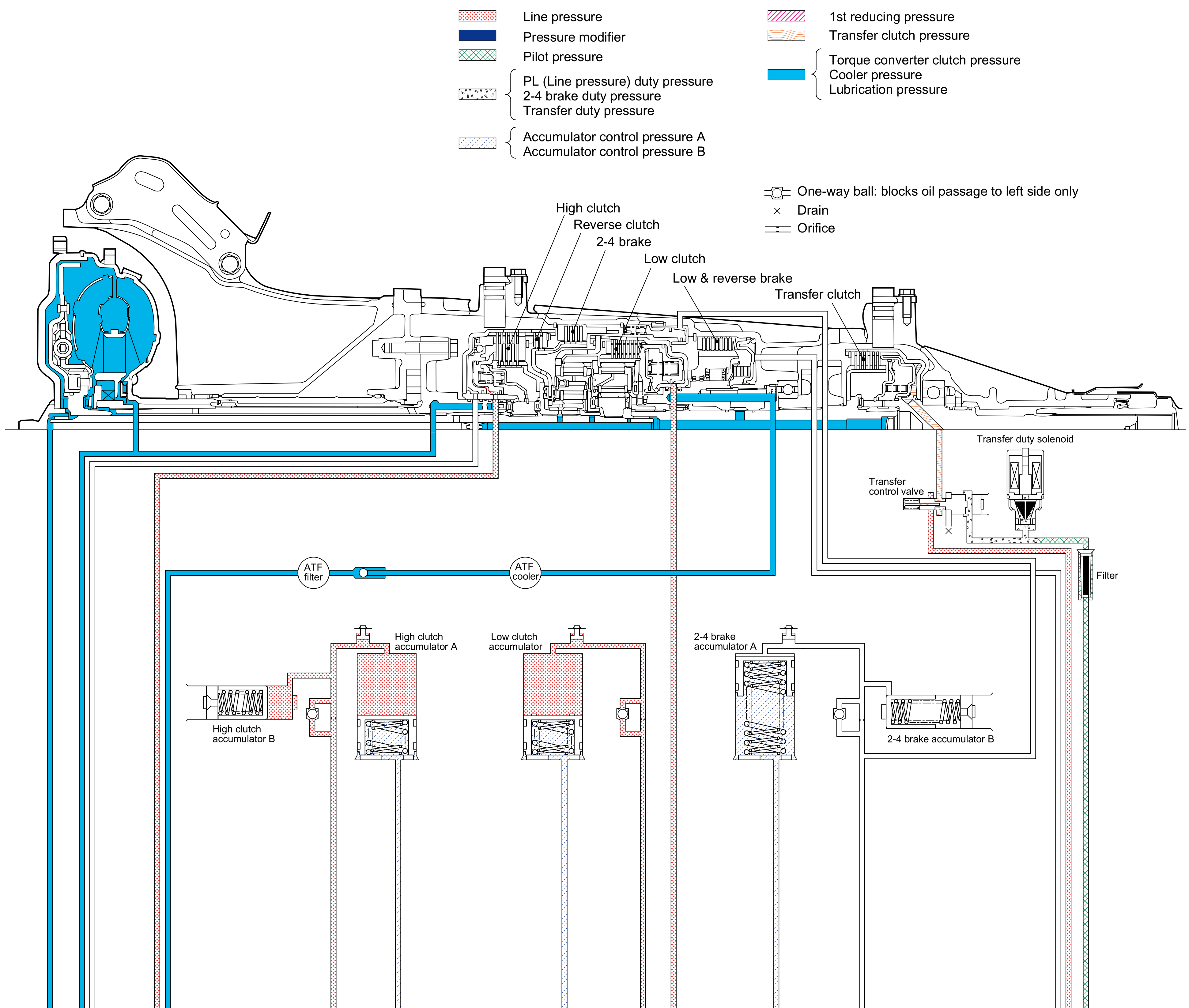
4. 4TH SPEED GEAR OF D RANGE (LOCK-UP ON)

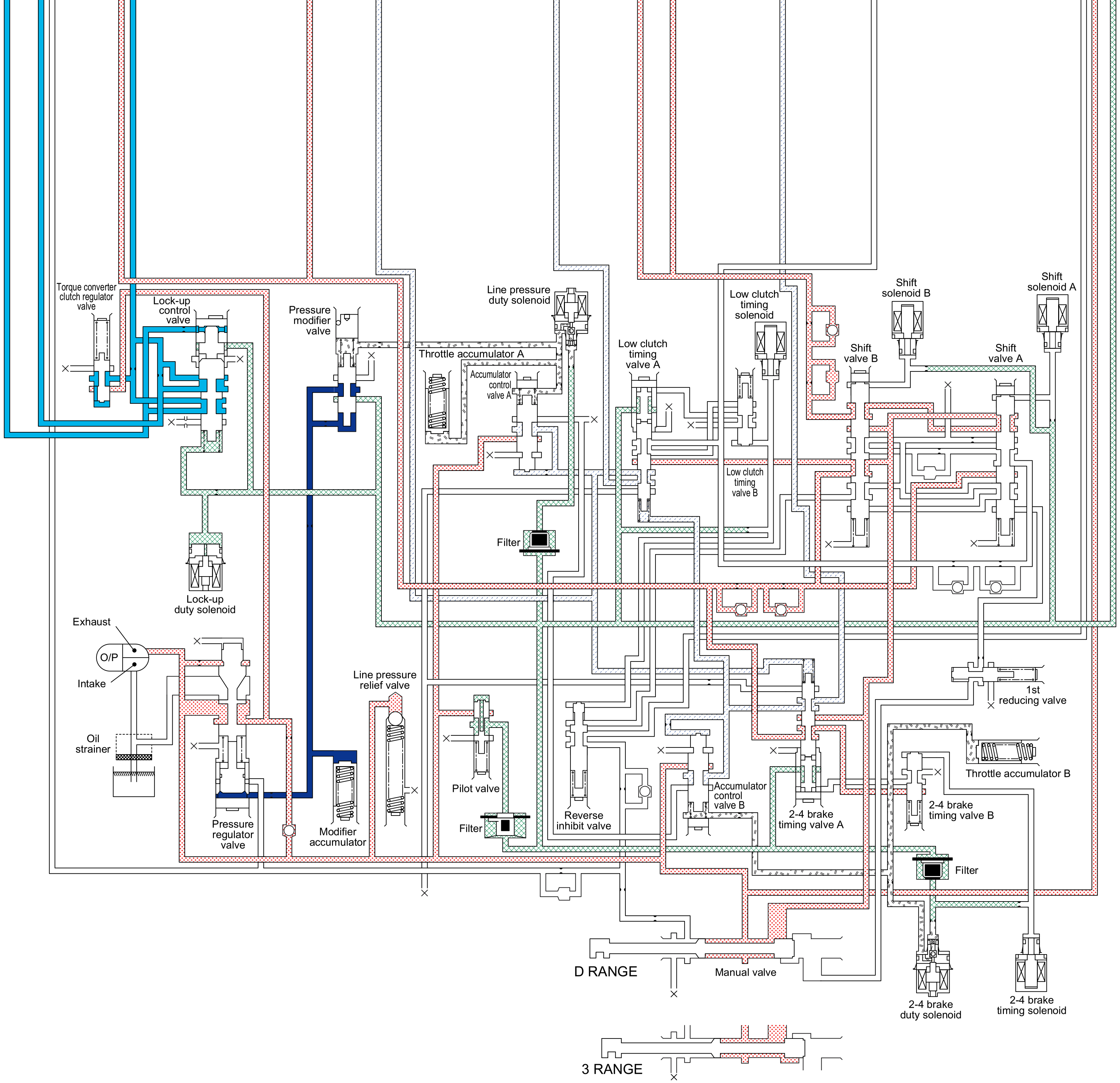



Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pilot valve
Filter
Pressure regulator valve
Modifier accumulator
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid

AT-00495

5. 3RD SPEED GEAR OF D AND 3 RANGES

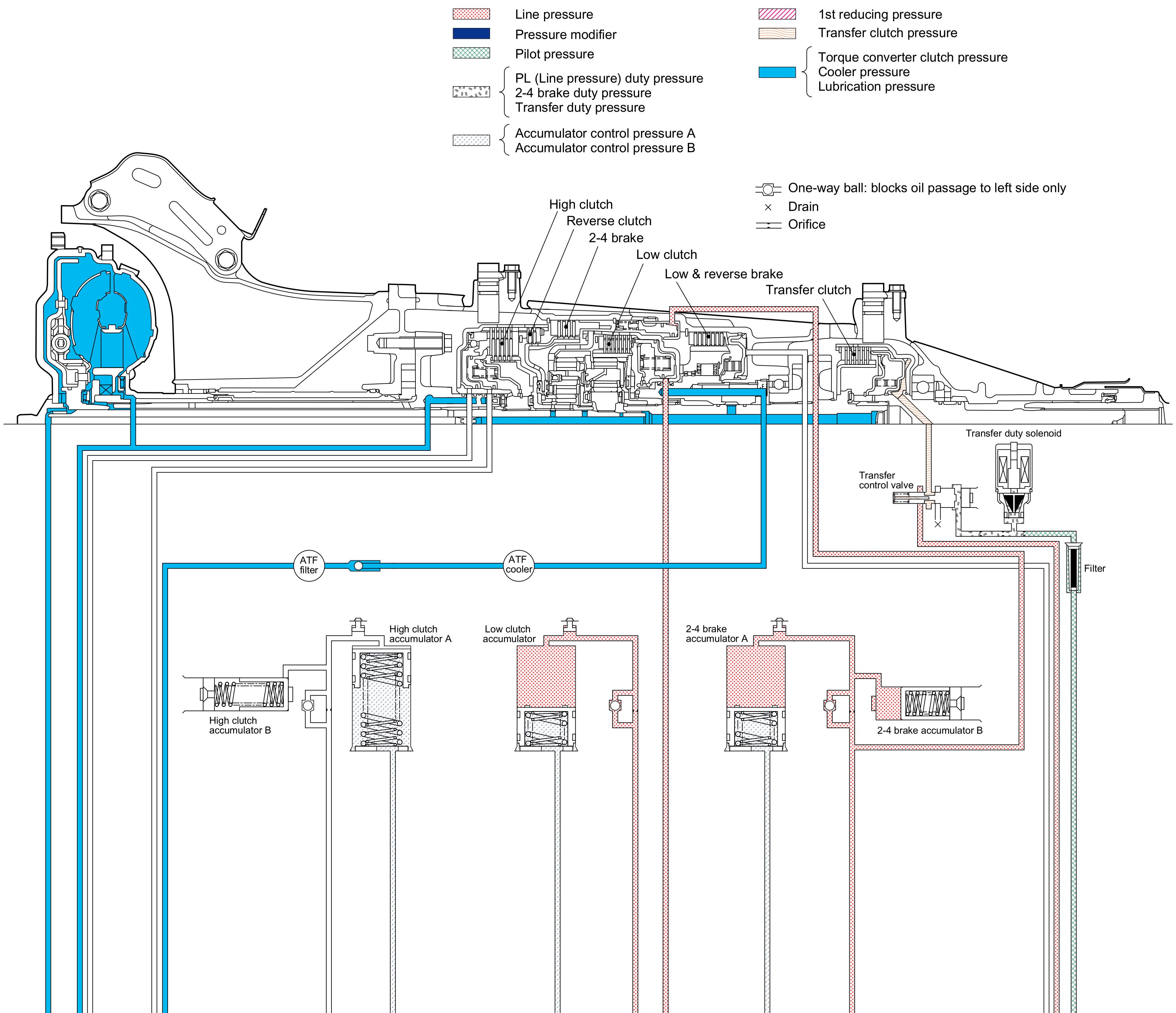


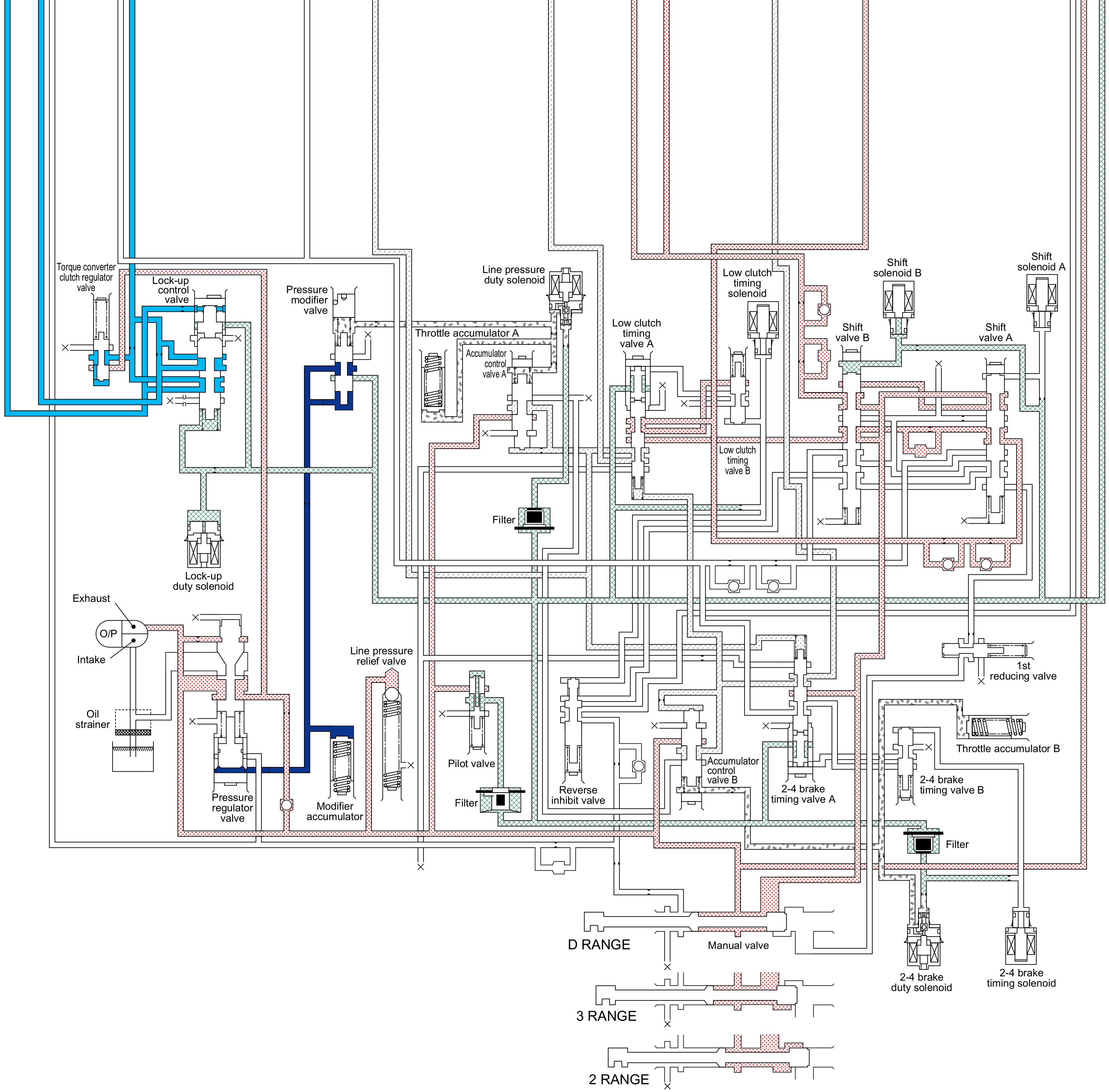


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
3 RANGE

AT-00496

6. 2ND SPEED GEAR OF D, 3 AND 2 RANGES

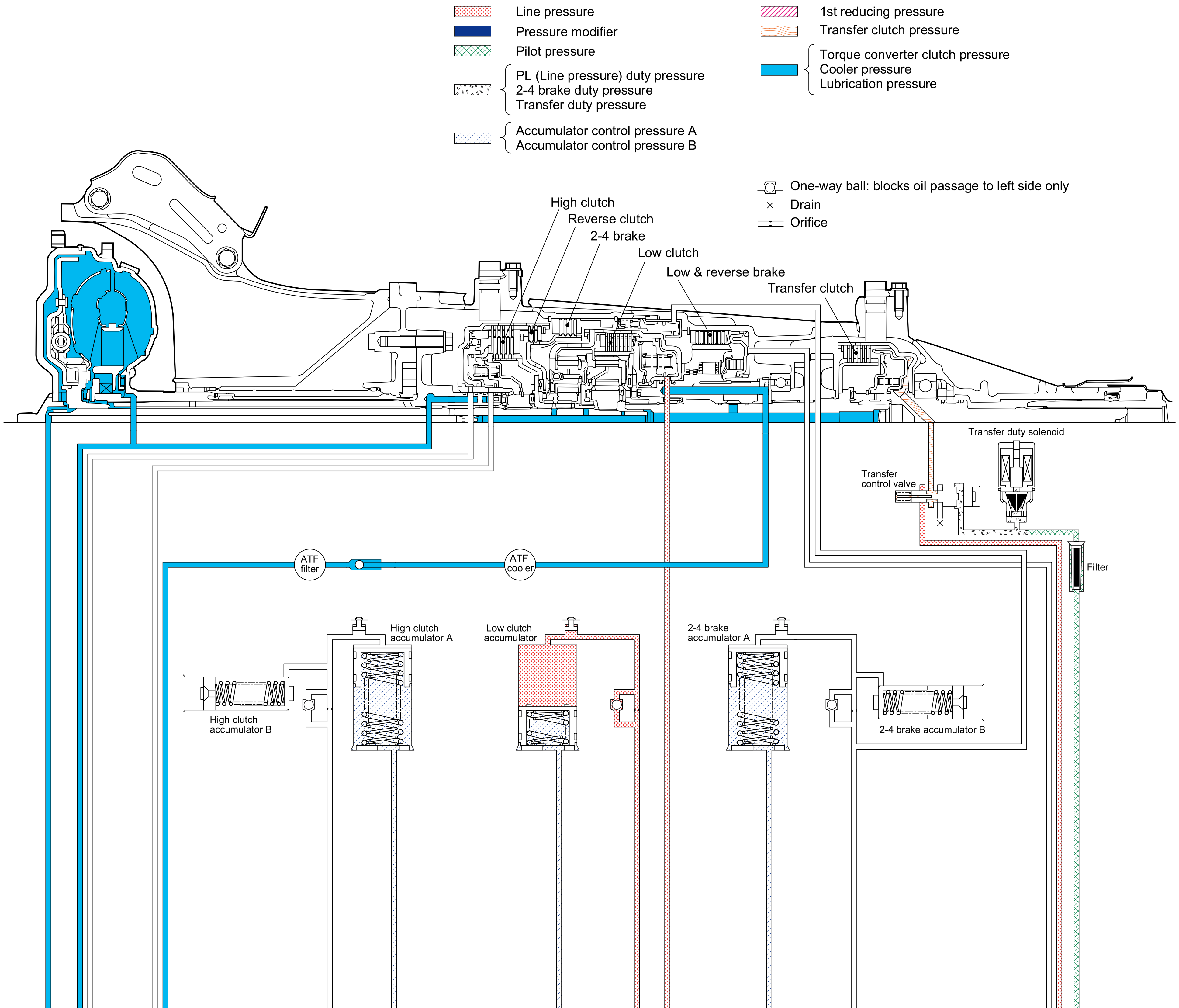


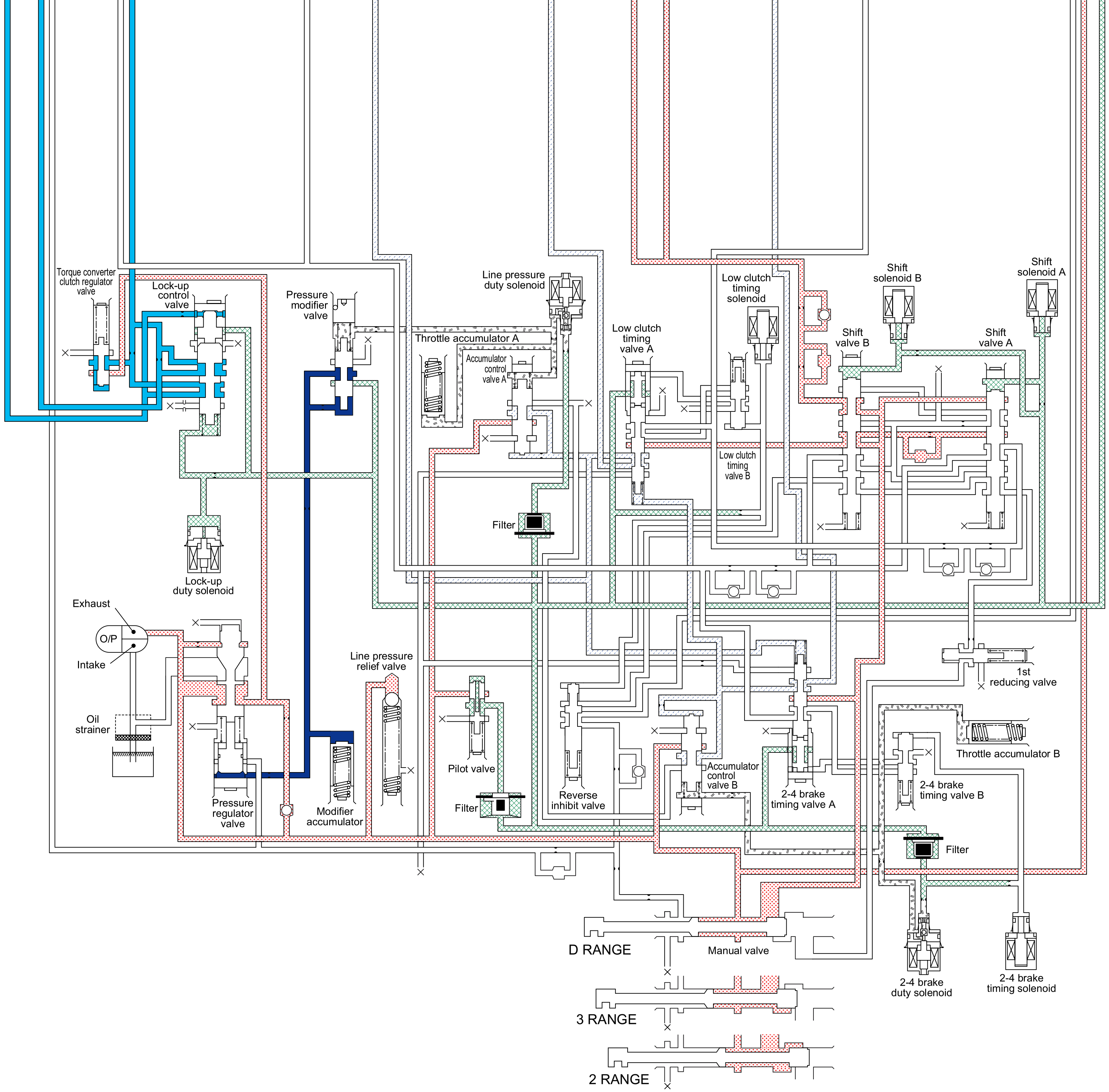


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
3 RANGE
2 RANGE

AT-00497

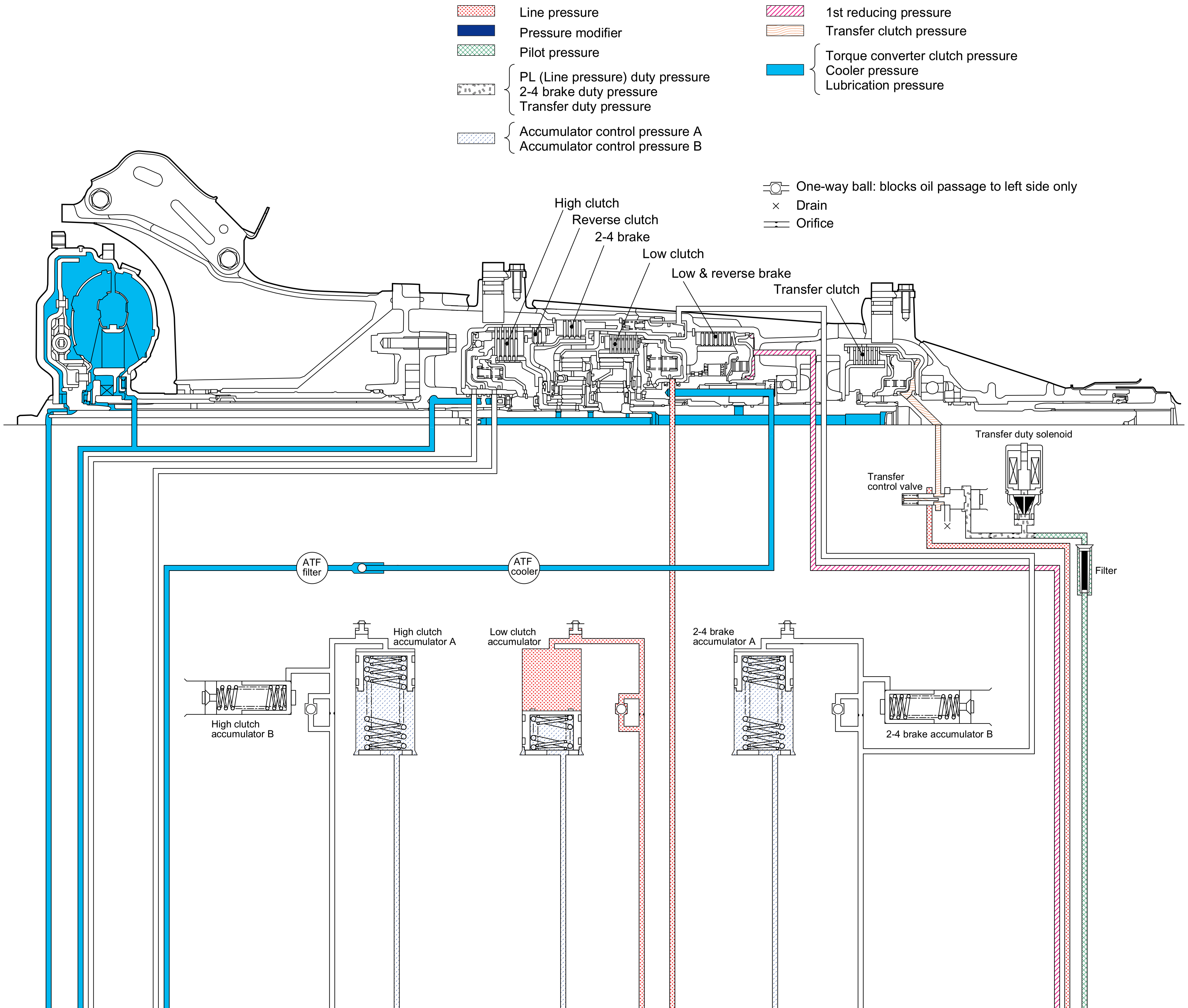
7. 1ST SPEED GEAR OF D AND 3 RANGES

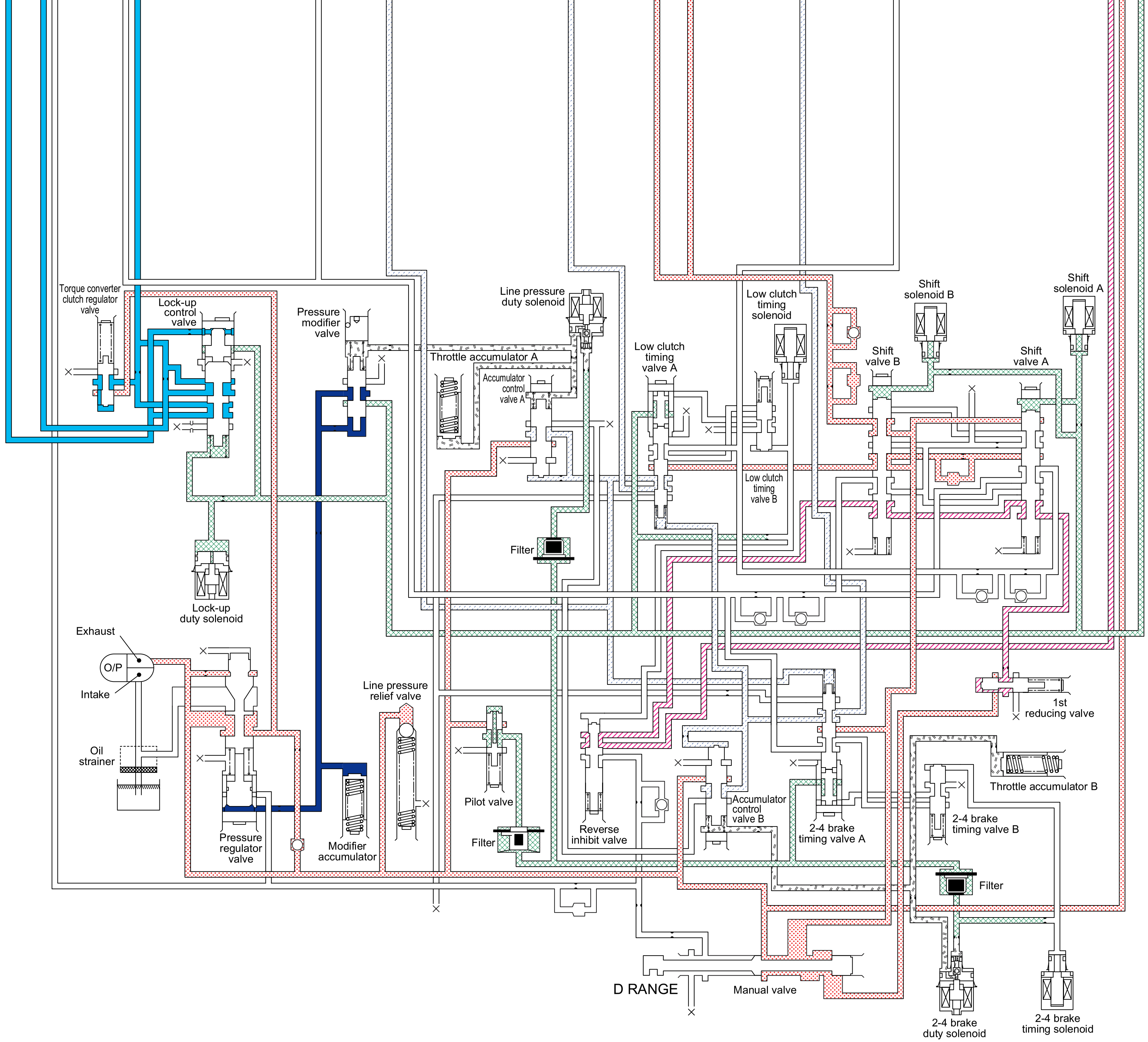



Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
1st reducing valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
Manual valve
3 RANGE
2 RANGE
2-4 brake duty solenoid
2-4 brake timing solenoid

AT-00498

8. 1ST SPEED GEAR OF 1 RANGE



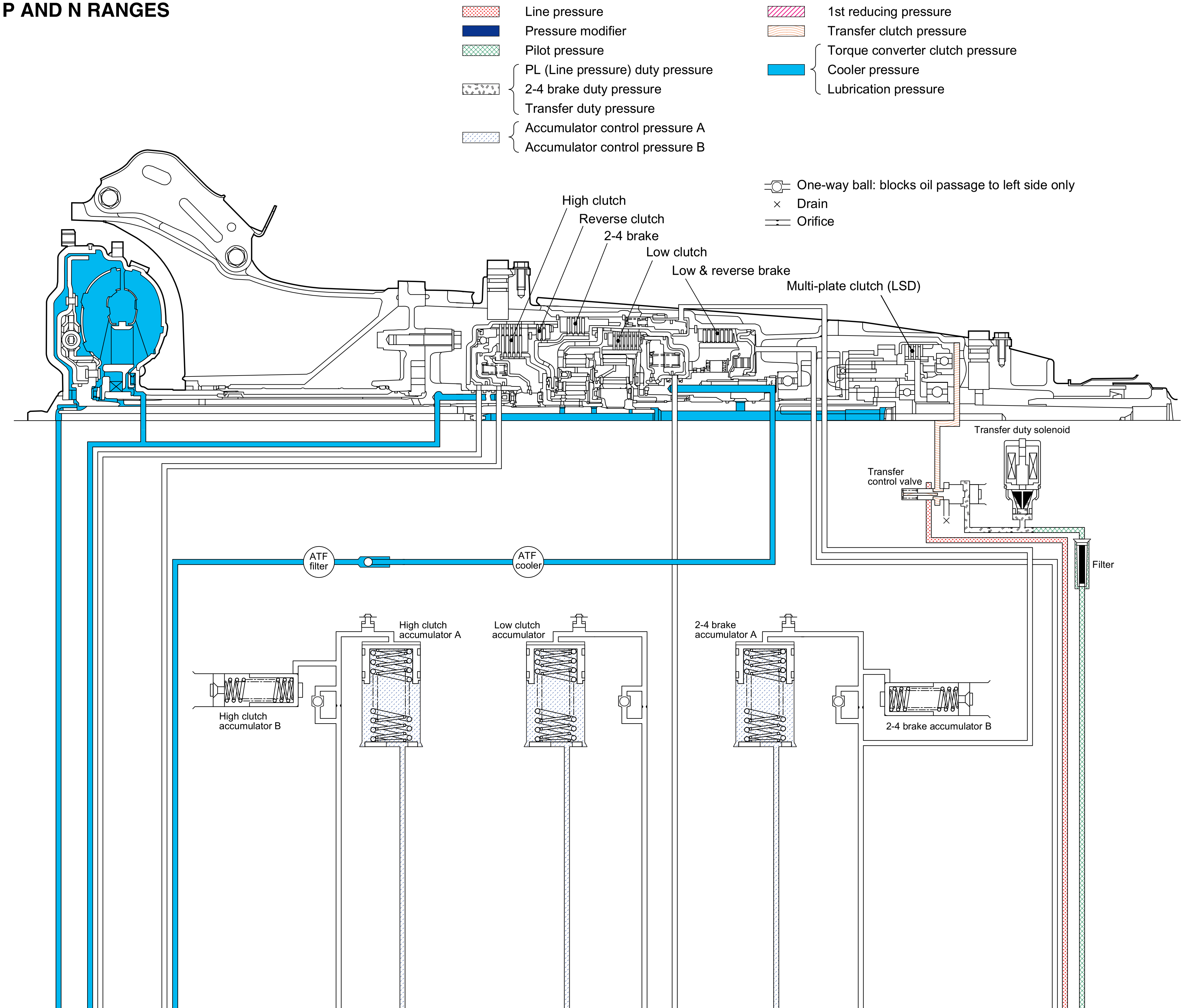


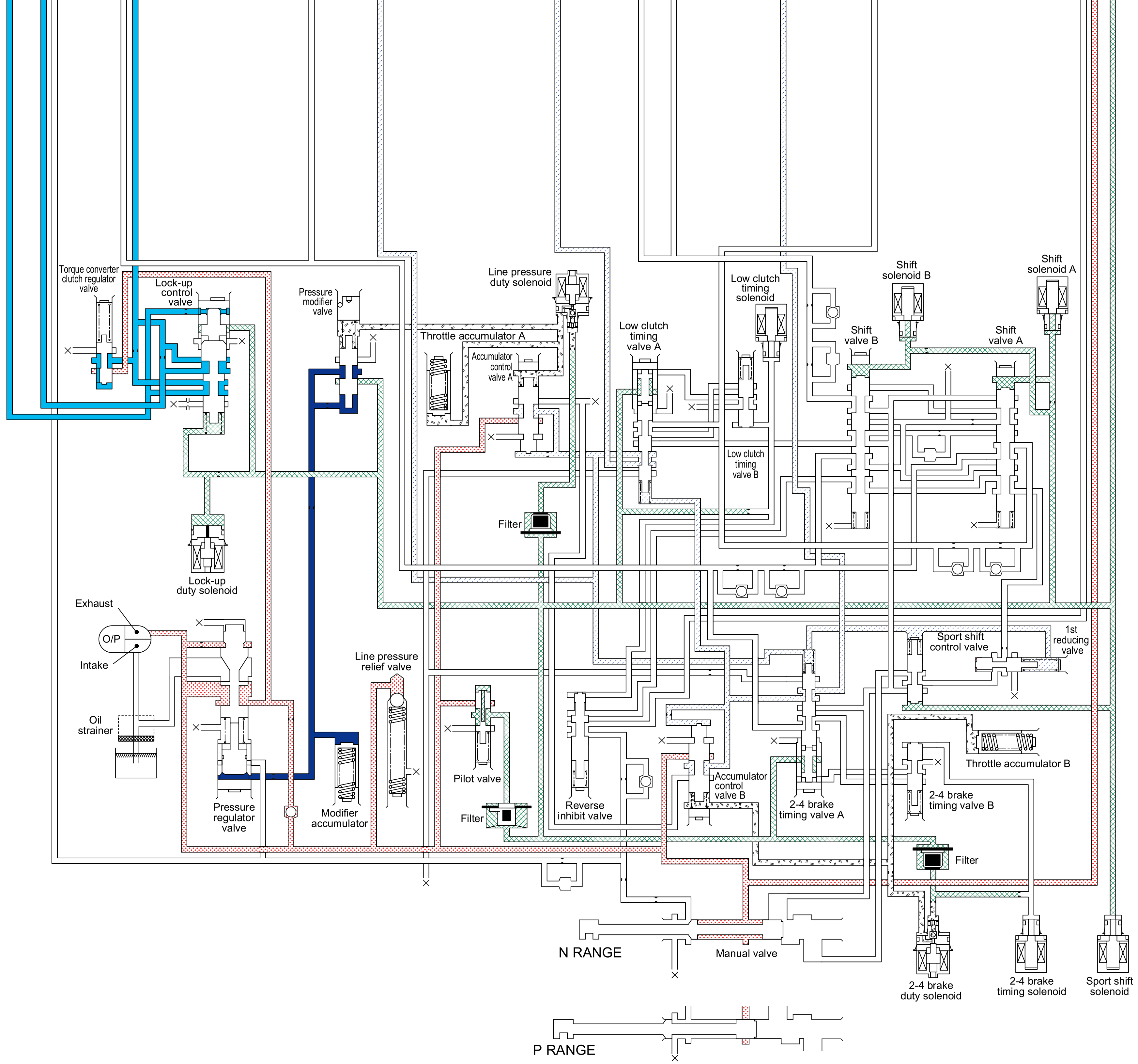
Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid

AT-00499

B: VEHICLES WITH SPORTS SHIFT

1. P AND N RANGES

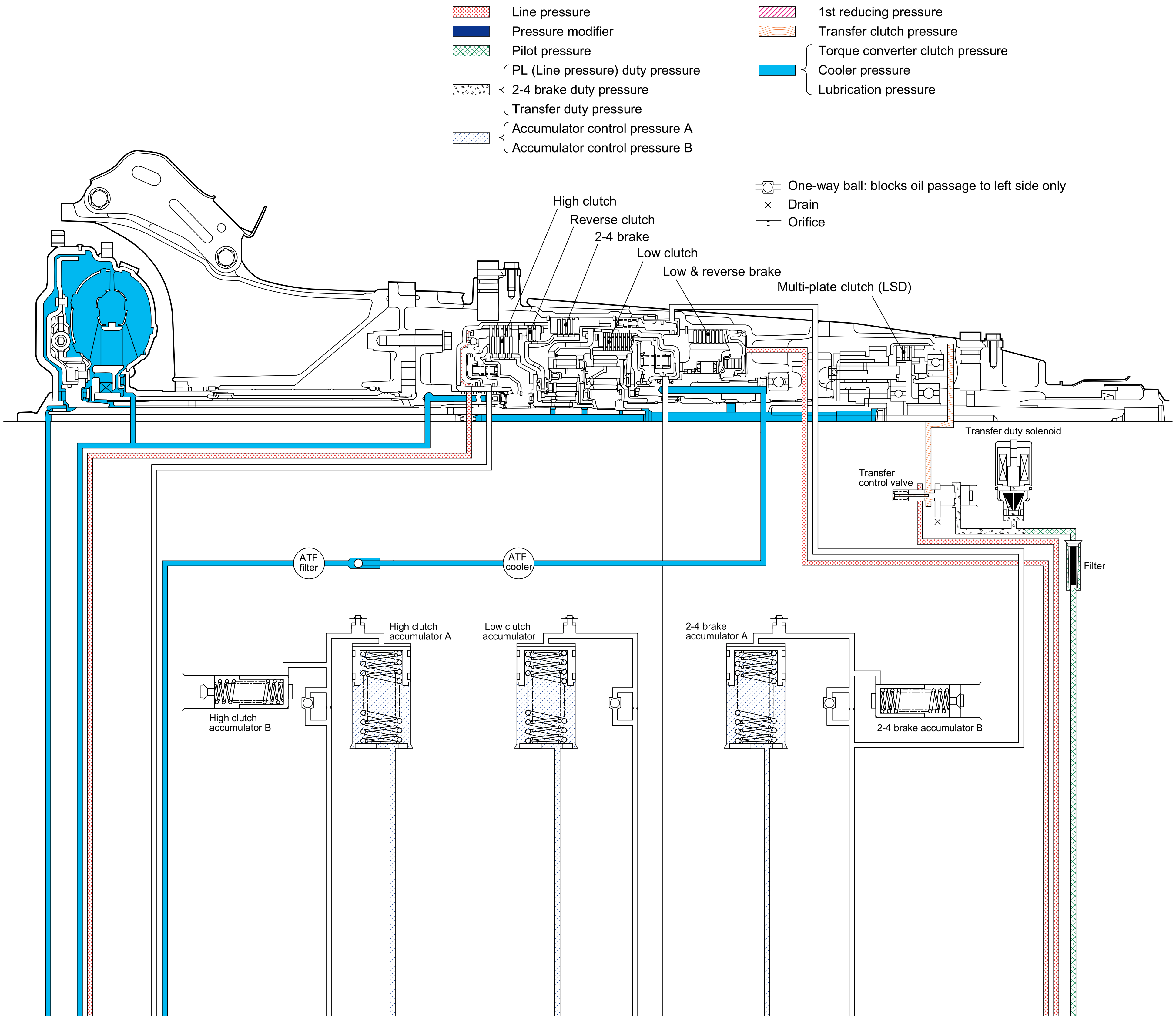




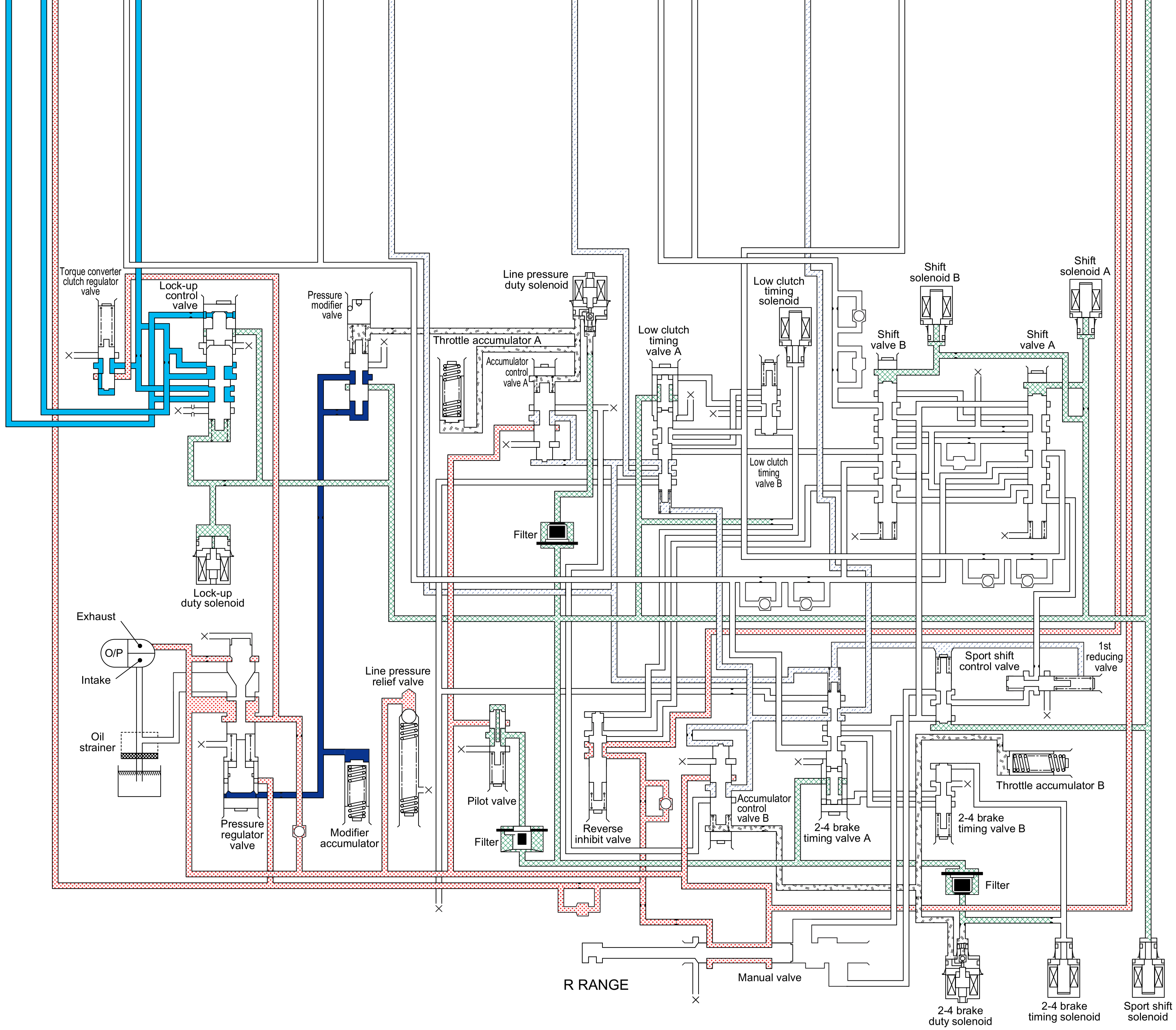
Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Throttle accumulator A
Accumulator control valve A
Line pressure duty solenoid
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
N RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid
P RANGE

AT-00719

2. R RANGE

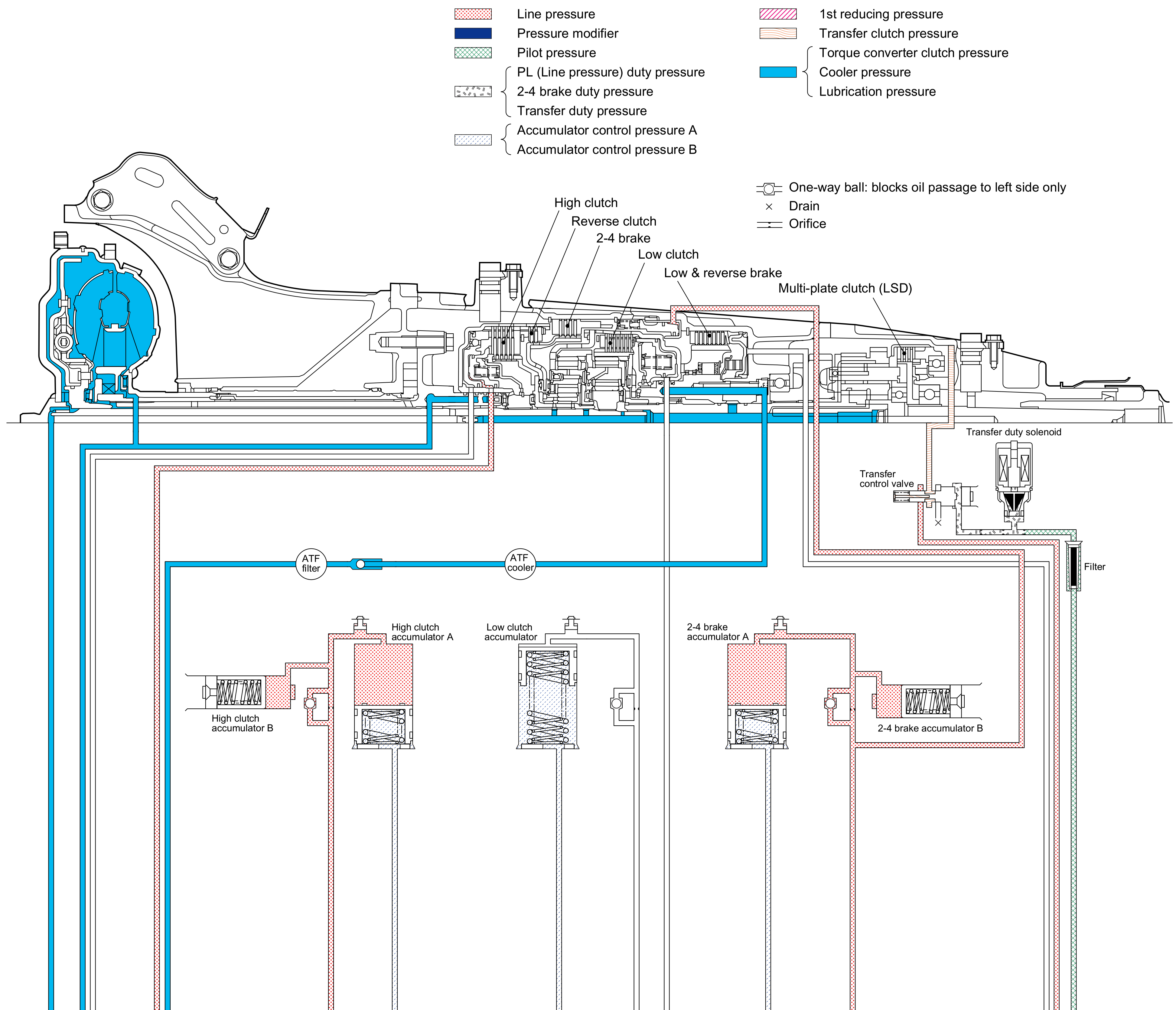


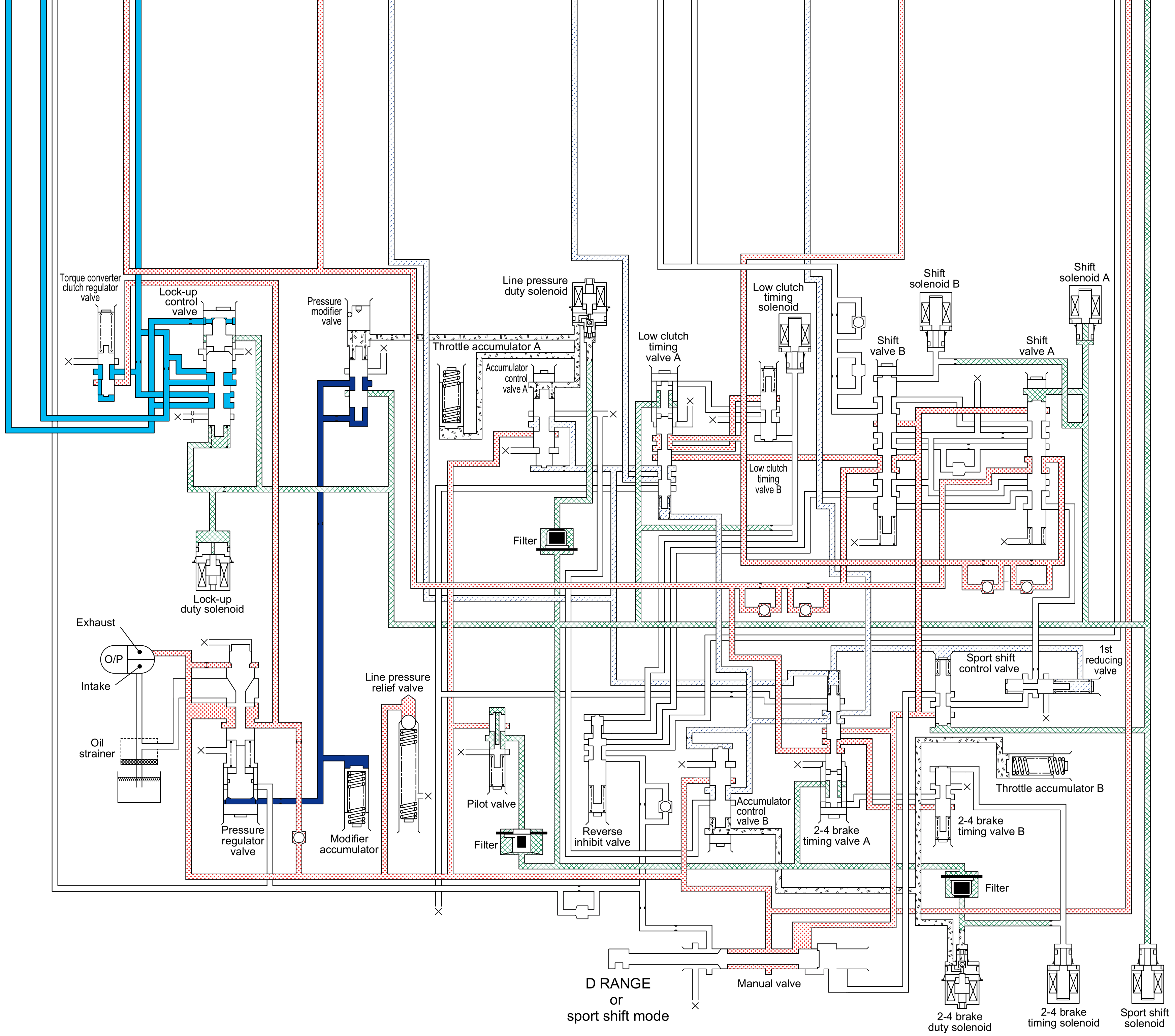
Line pressure
Pressure modifier
Pilot pressure
PL (Line pressure) duty pressure
2-4 brake duty pressure
Transfer duty pressure
Accumulator control pressure A
Accumulator control pressure B
1st reducing pressure
Transfer clutch pressure
Torque converter clutch pressure
Cooler pressure
Lubrication pressure
One-way ball: blocks oil passage to left side only
Drain
Orifice
High clutch
Reverse clutch
2-4 brake
Low clutch
Low & reverse brake
Multi-plate clutch (LSD)
Transfer duty solenoid
Transfer control valve
Filter
ATF filter
ATF cooler
High clutch accumulator A
Low clutch accumulator
2-4 brake accumulator A
High clutch accumulator B
2-4 brake accumulator B


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
R RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00720

3. 4TH SPEED GEAR OF D RANGE AND SPORTS SHIFT MODE (LOCK-UP OFF)



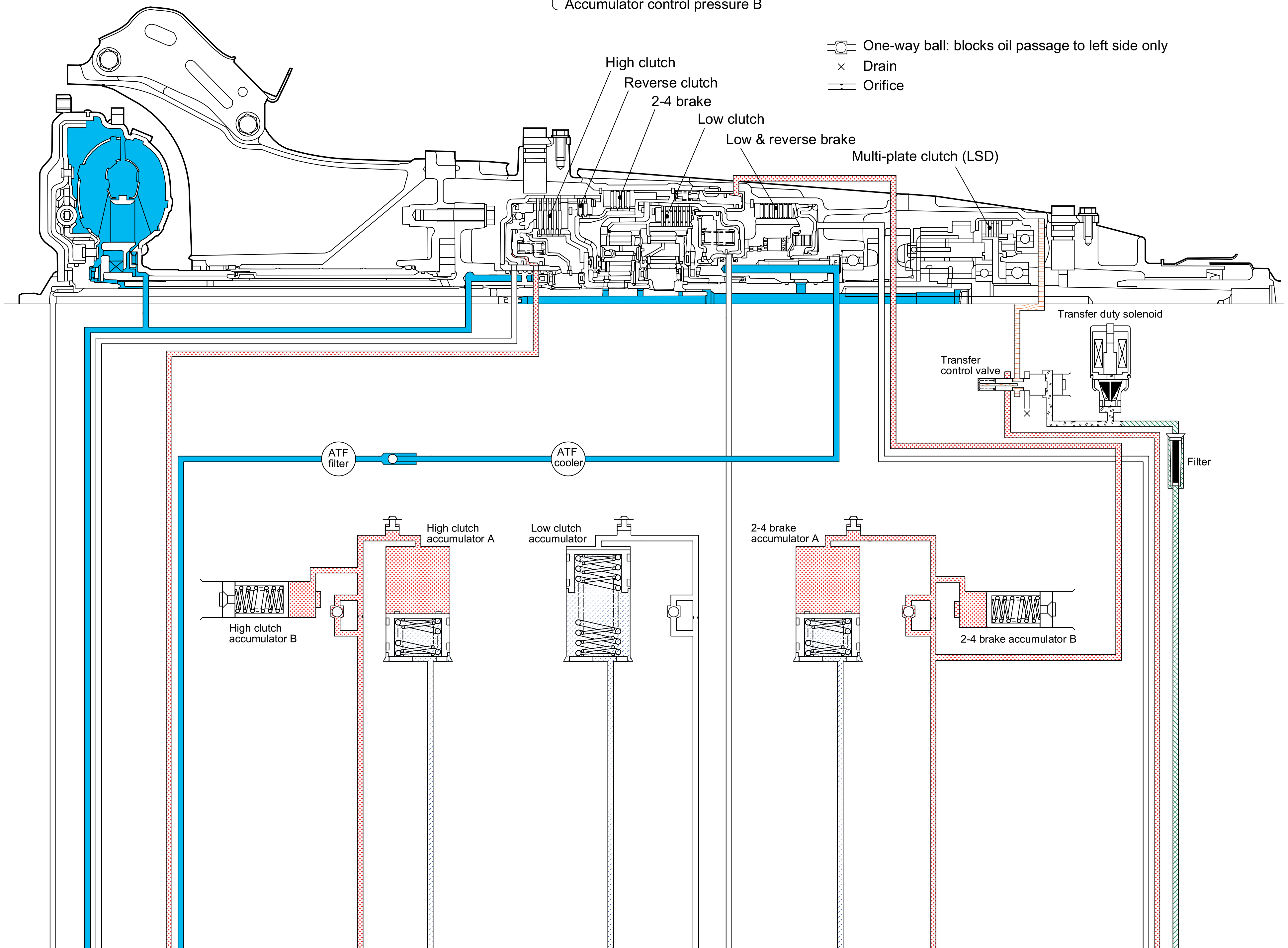

Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Throttle accumulator A
Line pressure duty solenoid
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
or
sport shift mode
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

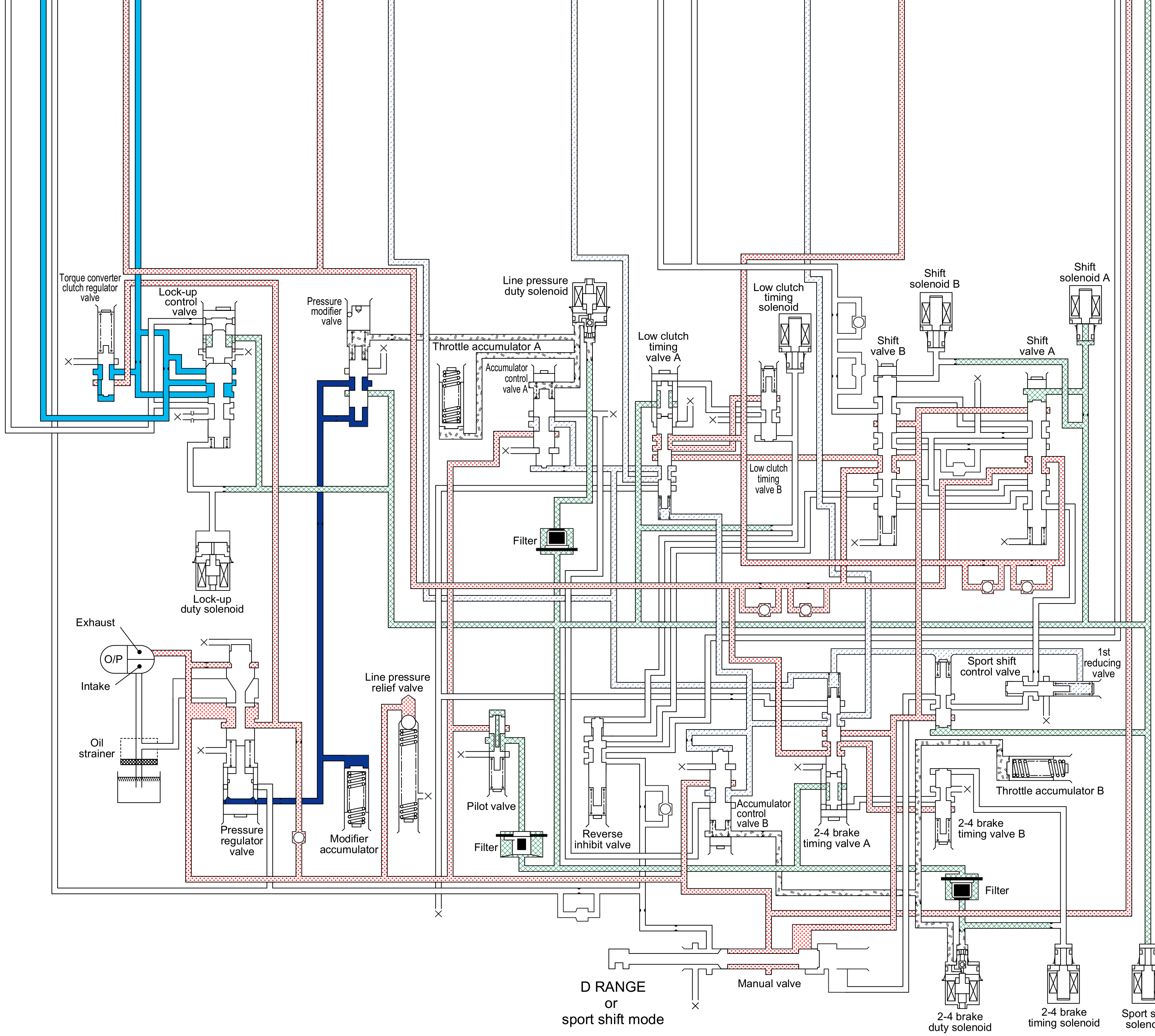
AT-00721

4. 4TH SPEED GEAR OF D RANGE AND SPORTS SHIFT MODE (LOCK-UP ON)

- 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

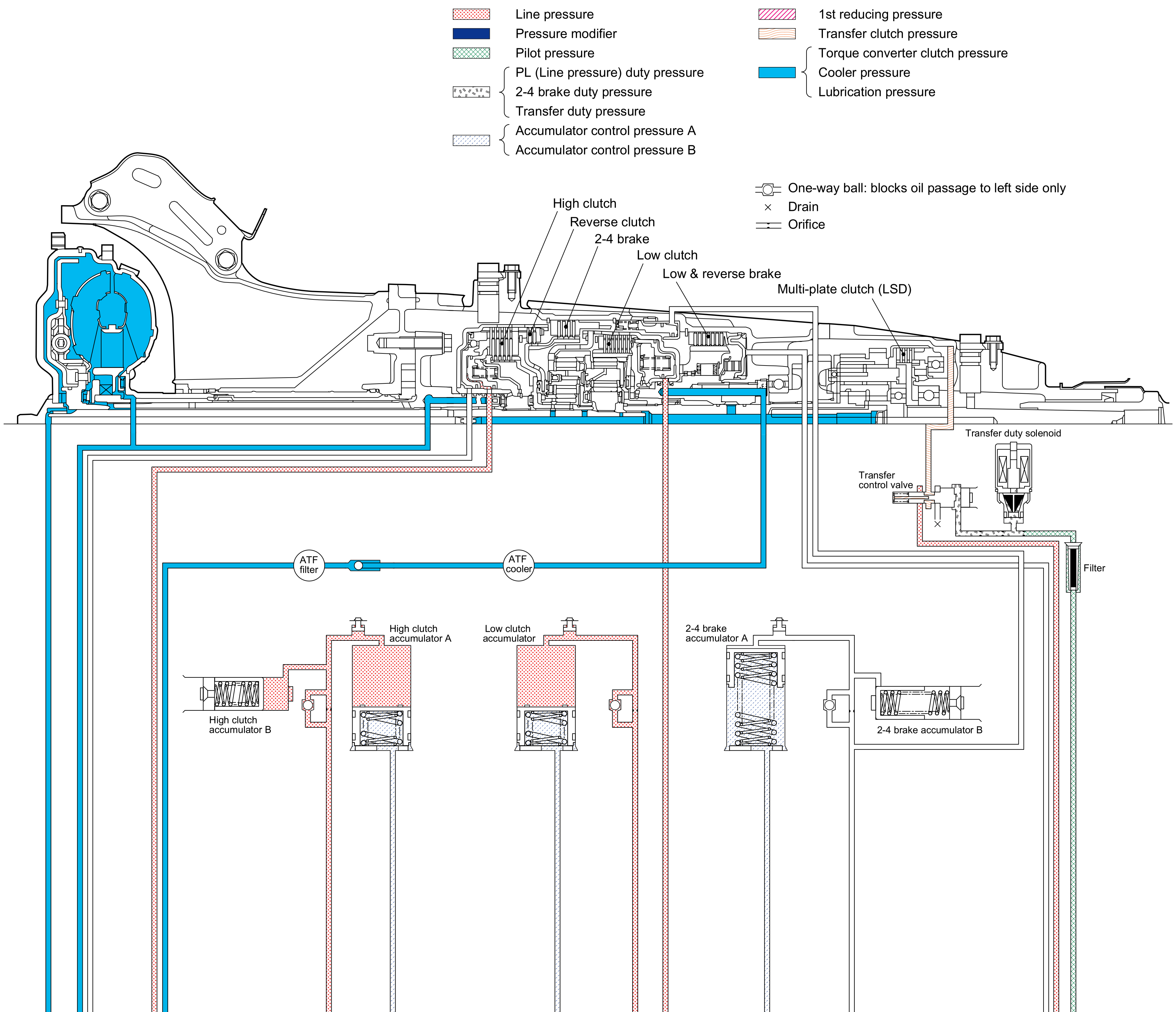


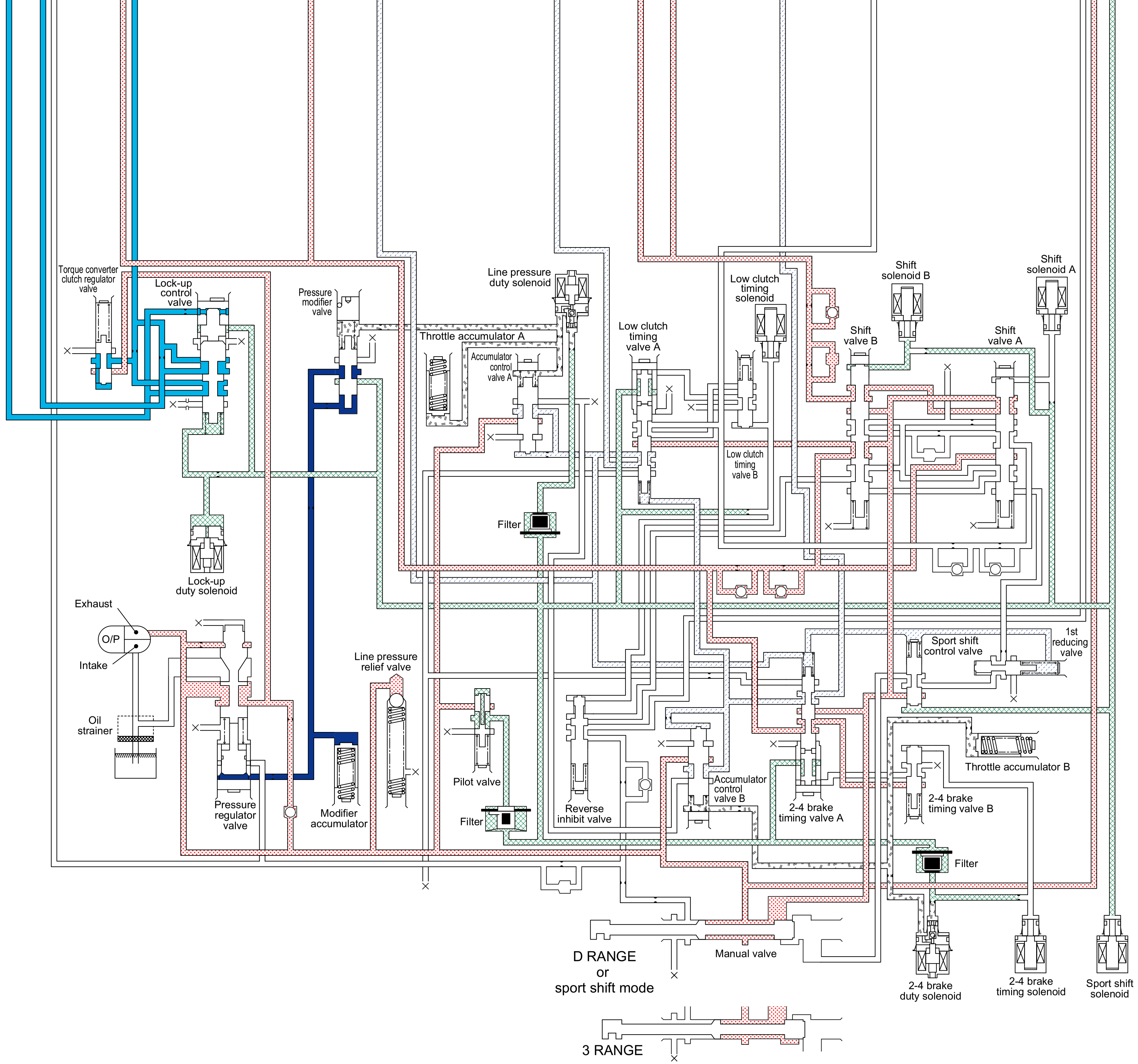


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
Manual valve
D RANGE or sport shift mode
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00722

5. 3RD SPEED GEAR OF D, 3 RANGES AND SPORTS SHIFT MODE

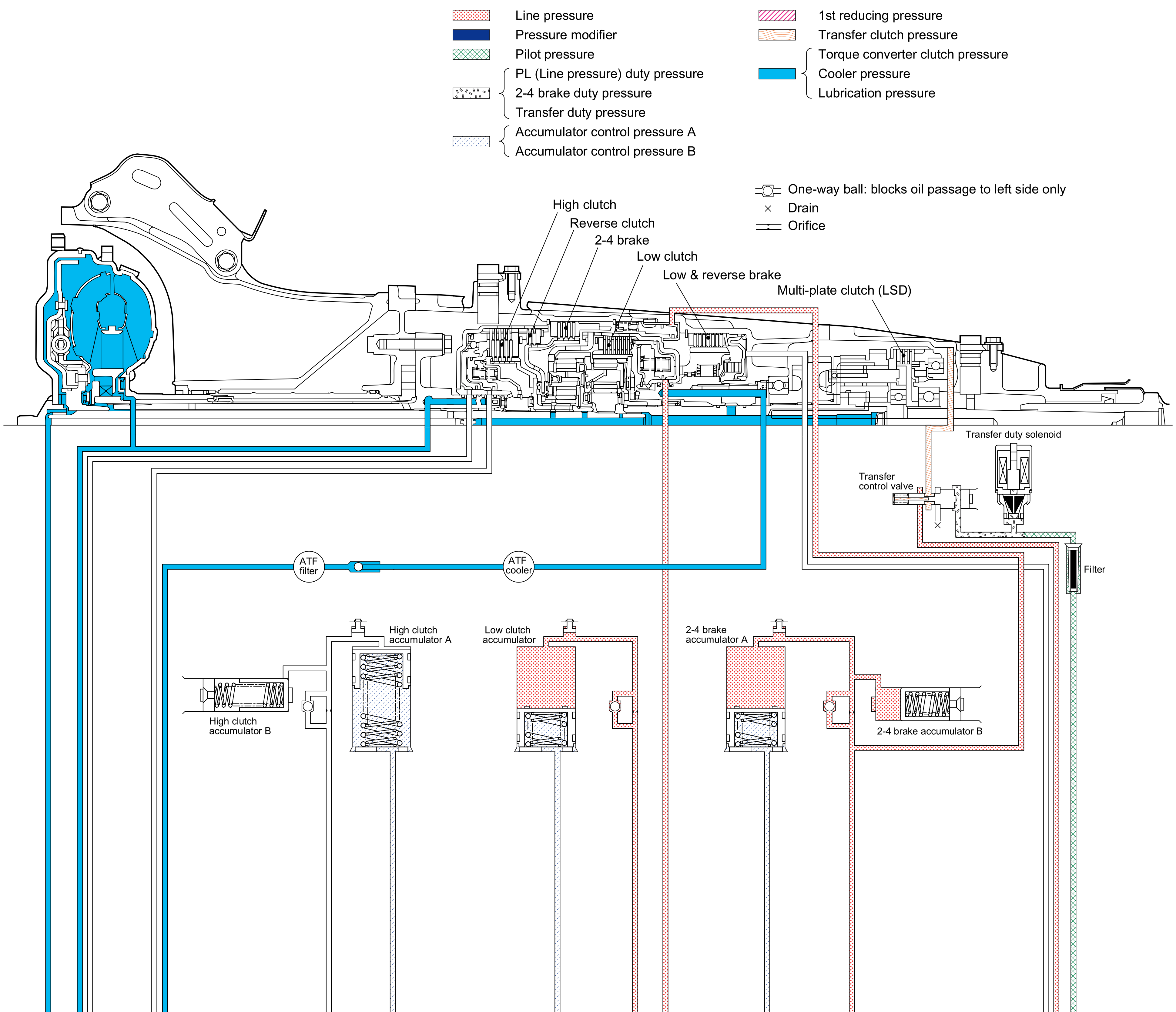


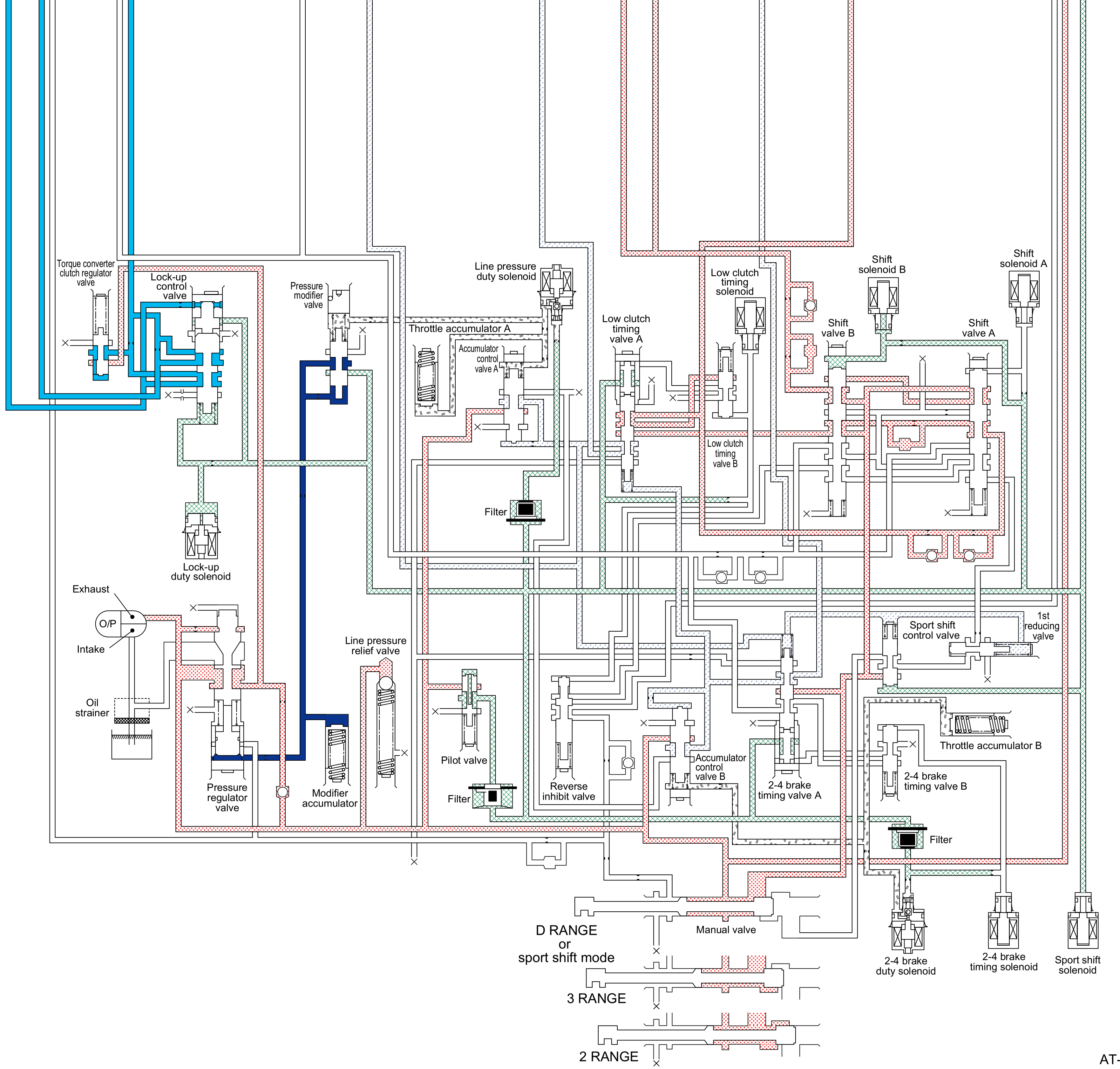


Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
Manual valve
D RANGE
or
sport shift mode
3 RANGE
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00723

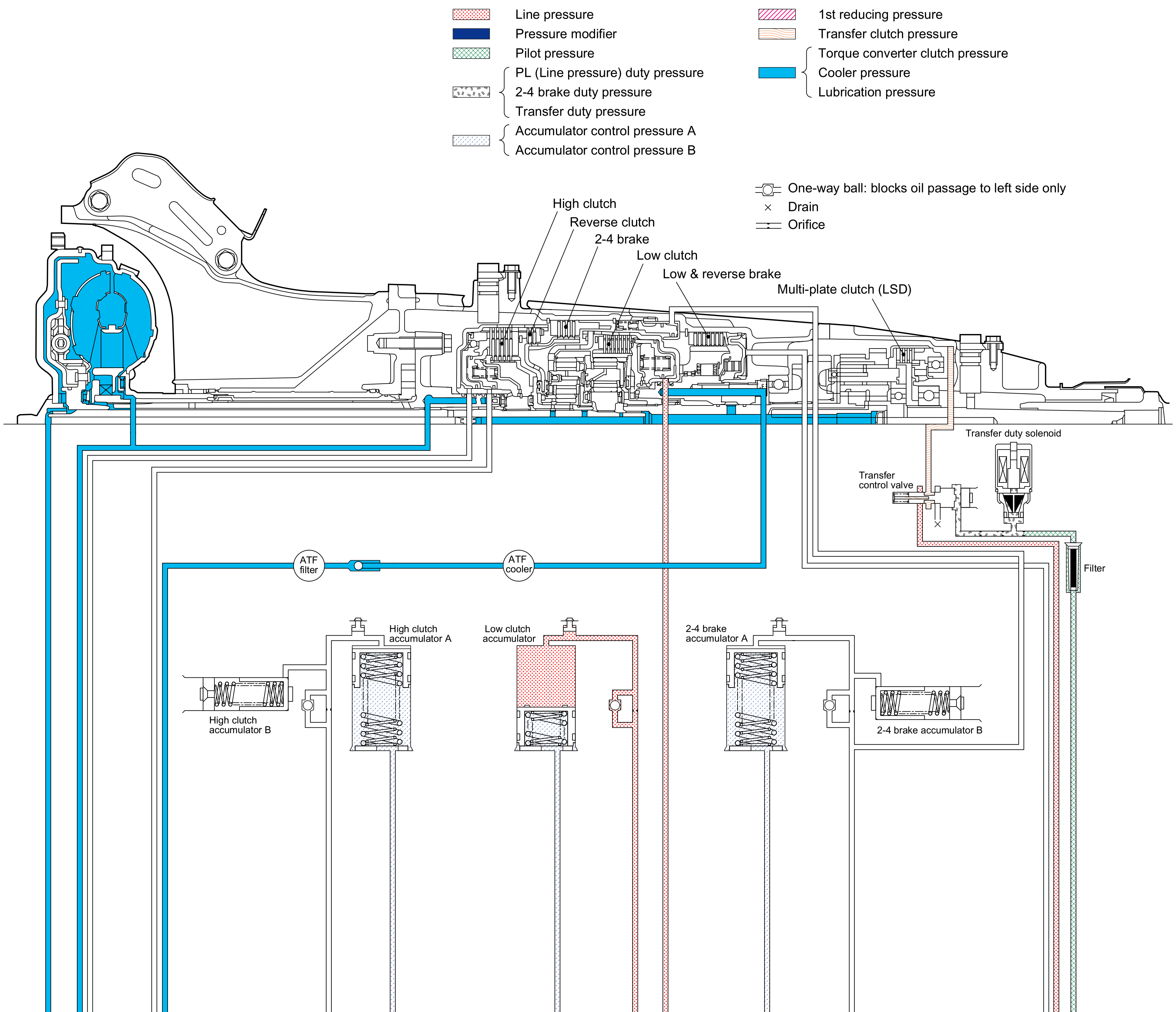
6. 2ND SPEED GEAR OF D, 3 , 2 RANGES AND SPORTS SHIFT MODE

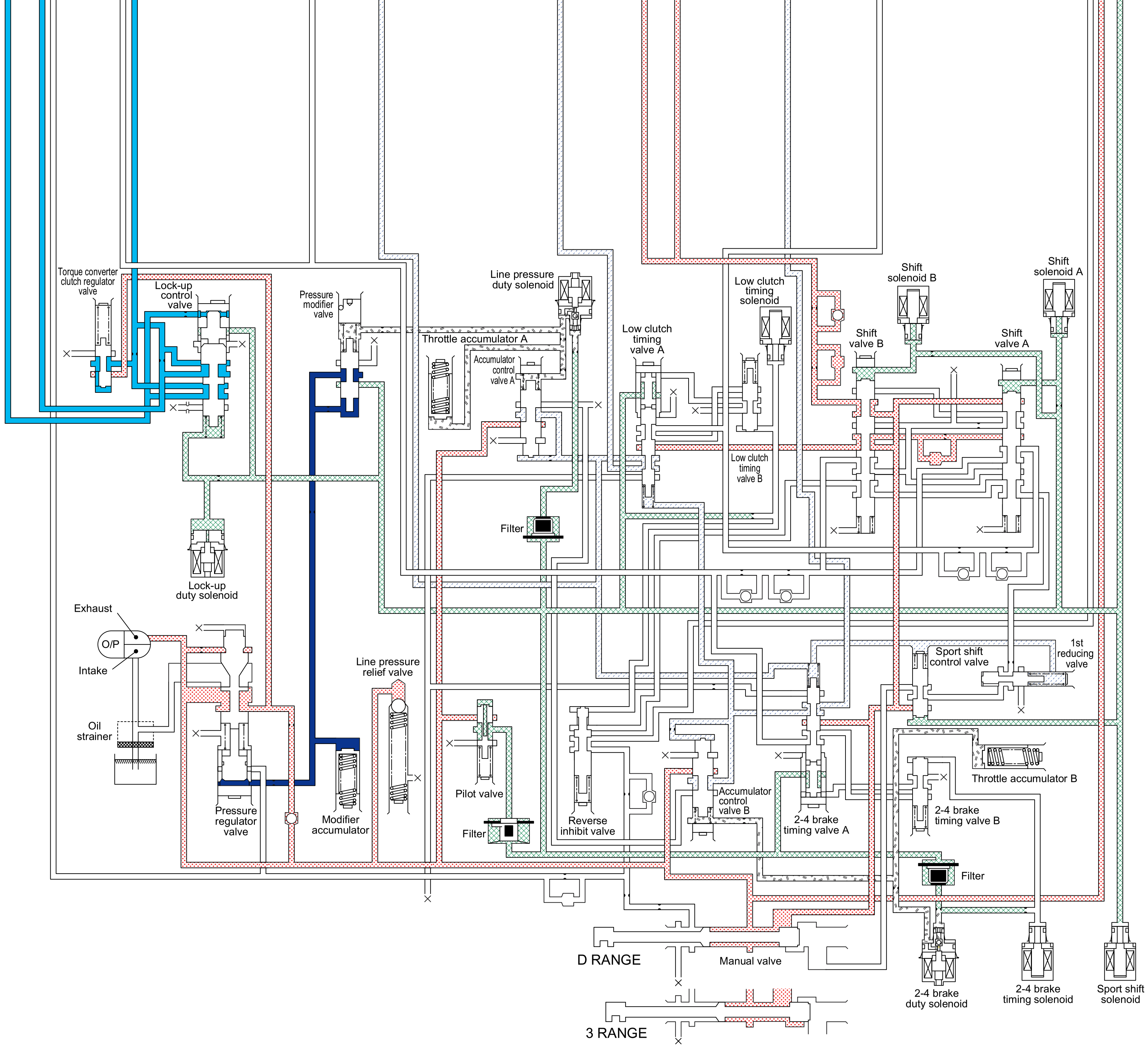



Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
Manual valve
D RANGE
or
sport shift mode
3 RANGE
2 RANGE
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00740

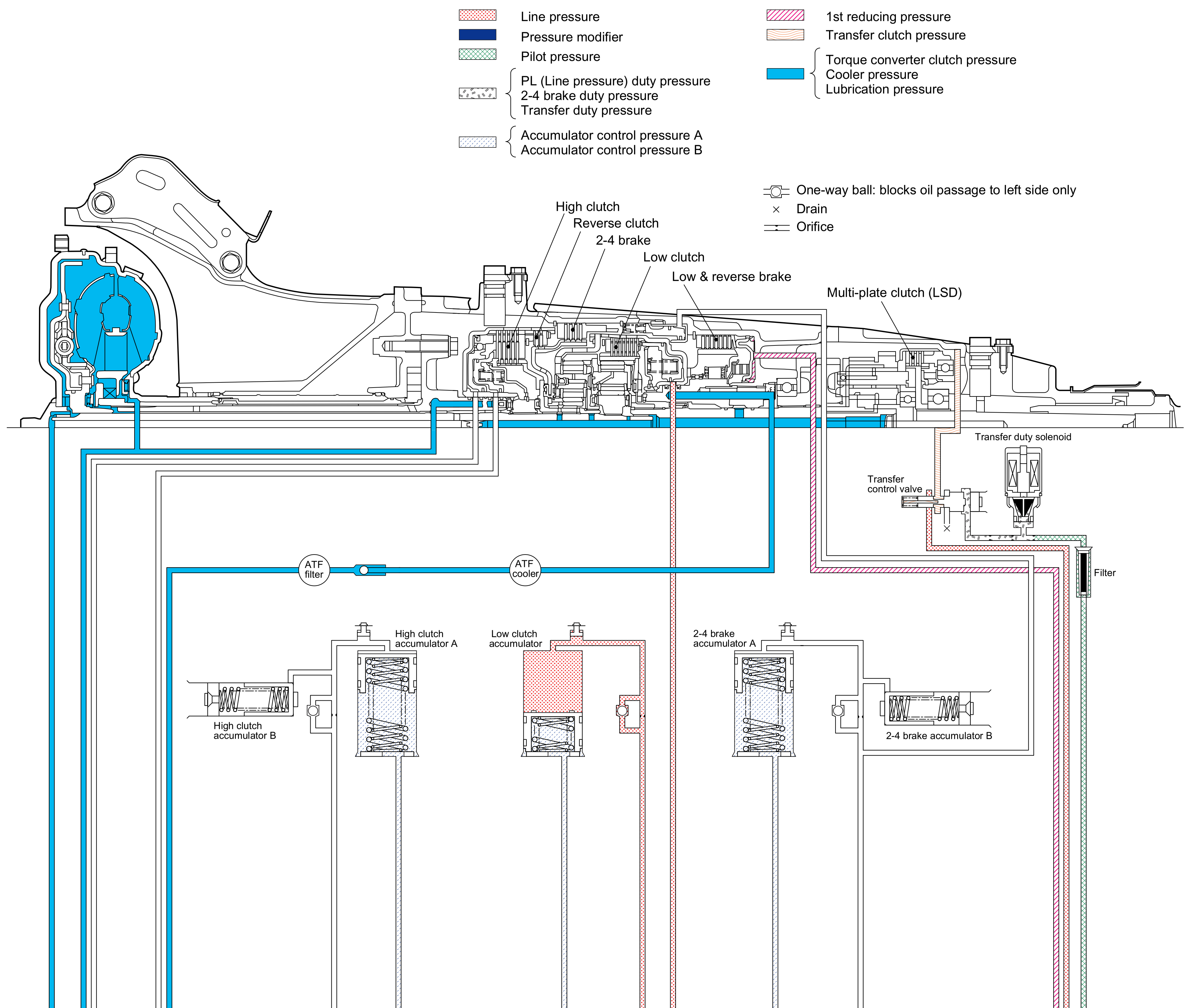
7. 1ST SPEED GEAR OF D, 3 RANGES

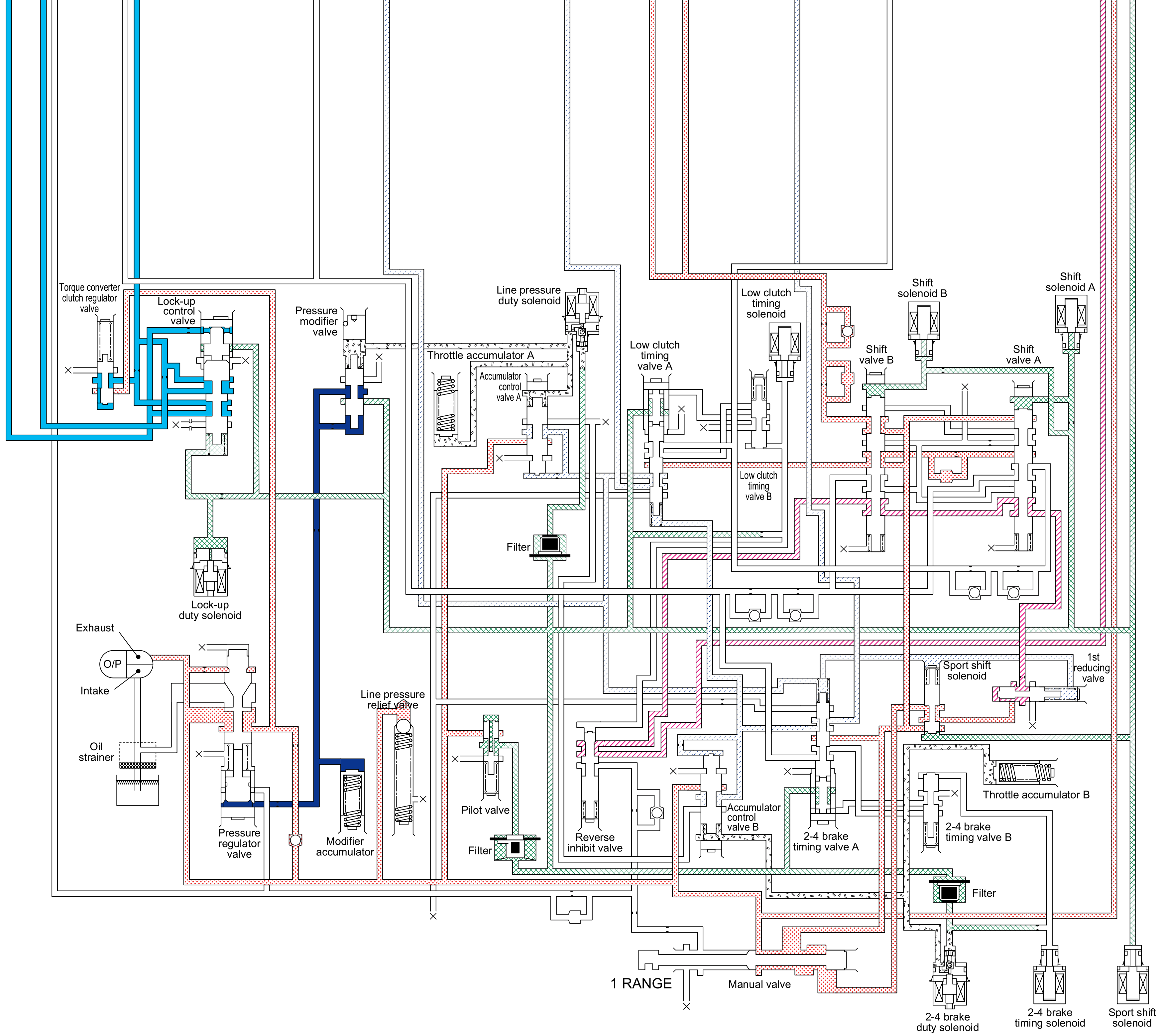



Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pressure regulator valve
Modifier accumulator
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
D RANGE
Manual valve
3 RANGE
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00741

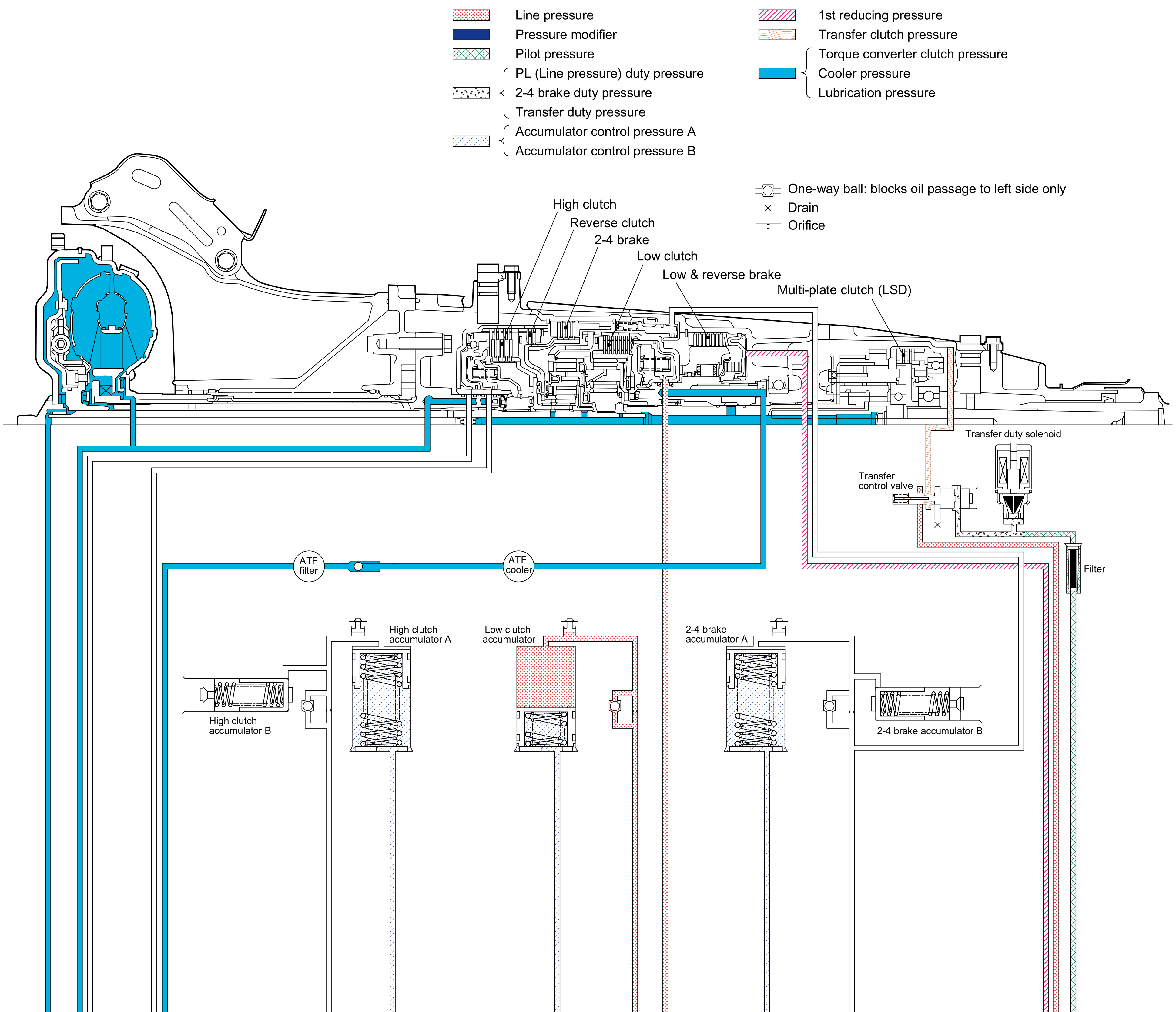
8. 1ST SPEED GEAR OF 1 RANGE

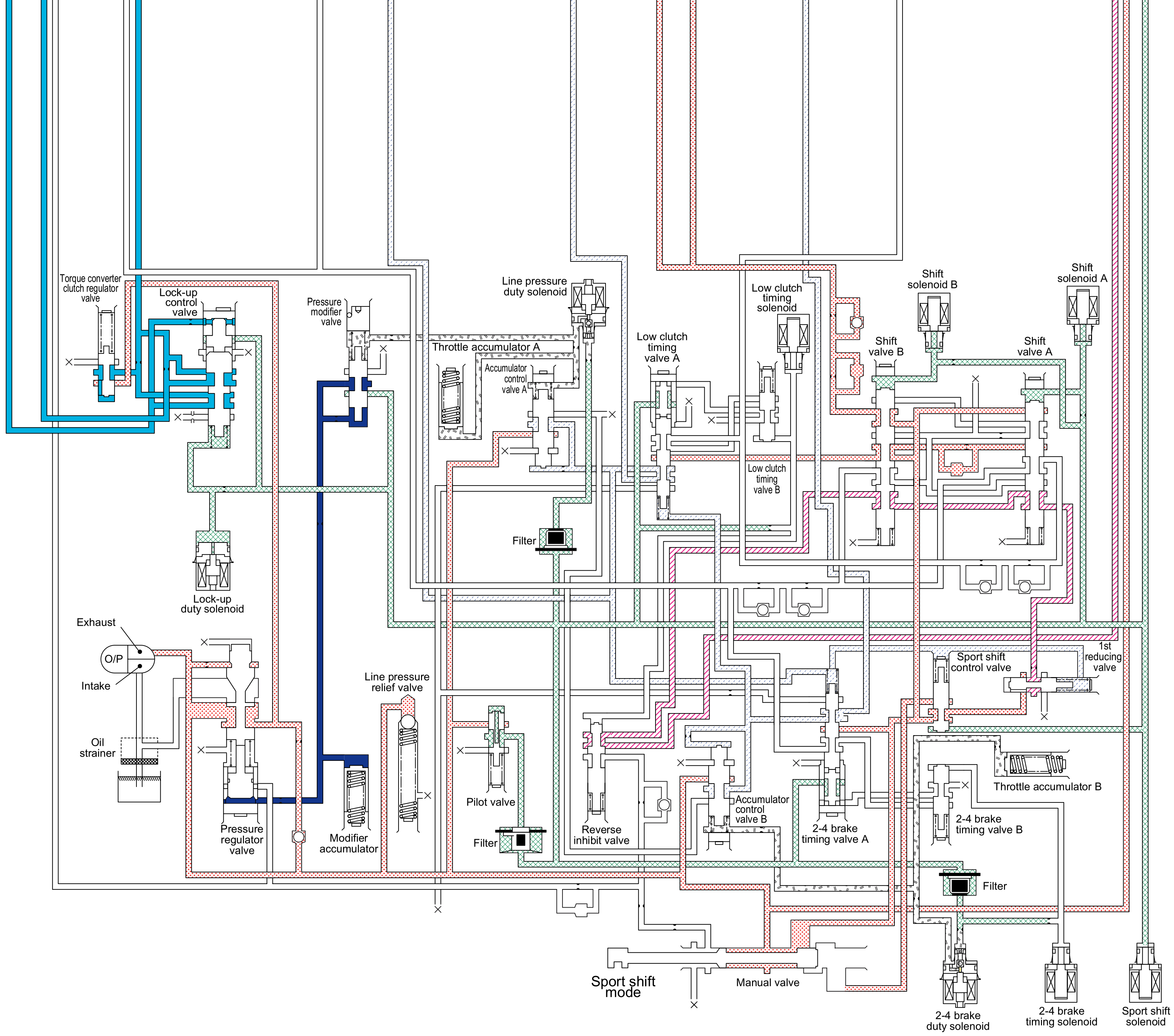



Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Throttle accumulator A
Accumulator control valve A
Line pressure duty solenoid
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Pressure regulator valve
Modifier accumulator
Line pressure relief valve
Pilot valve
Filter
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift solenoid
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
1 RANGE
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00742

9. 1ST SPEED GEAR OF SPORTS SHIFT MODE




Torque converter clutch regulator valve
Lock-up control valve
Pressure modifier valve
Line pressure duty solenoid
Throttle accumulator A
Accumulator control valve A
Low clutch timing valve A
Low clutch timing solenoid
Low clutch timing valve B
Shift solenoid B
Shift valve B
Shift solenoid A
Shift valve A
Filter
Lock-up duty solenoid
Exhaust
O/P
Intake
Oil strainer
Line pressure relief valve
Pilot valve
Filter
Pressure regulator valve
Modifier accumulator
Reverse inhibit valve
Accumulator control valve B
2-4 brake timing valve A
Sport shift control valve
1st reducing valve
Throttle accumulator B
2-4 brake timing valve B
Filter
Sport shift mode
Manual valve
2-4 brake duty solenoid
2-4 brake timing solenoid
Sport shift solenoid

AT-00743

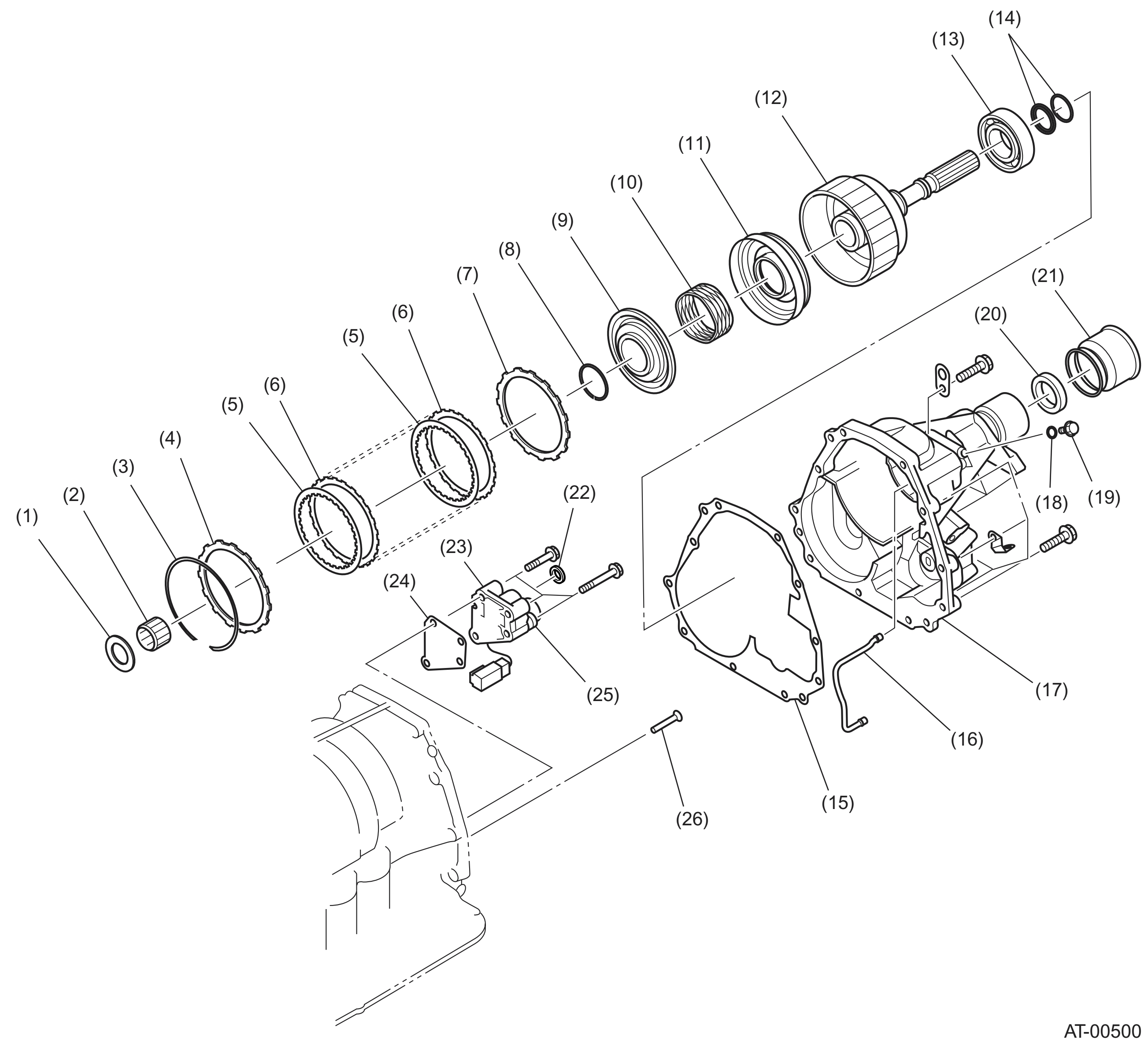
11.AWD Transfer System

A: MPT MODELS

1. GENERAL

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.



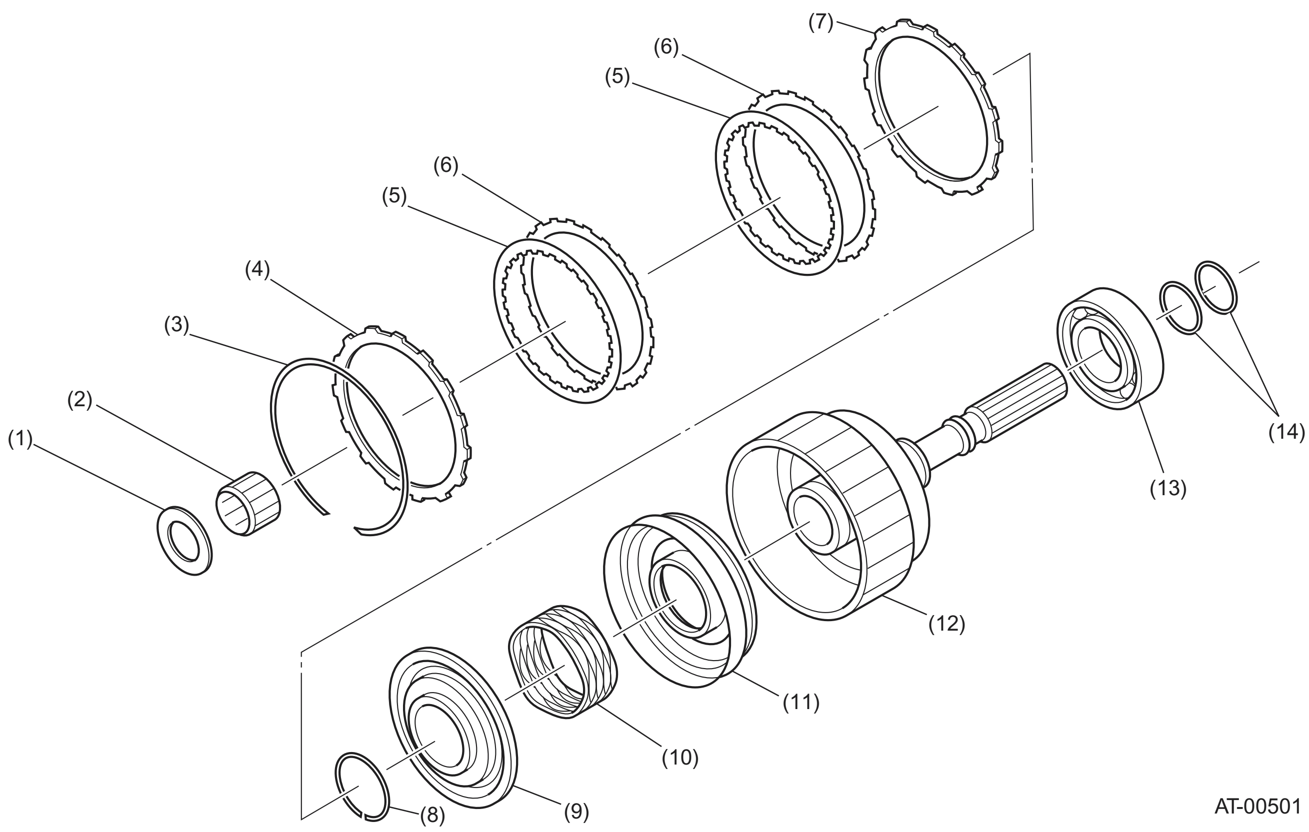
AT-00500

(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		

2. CONSTRUCTION

● 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.

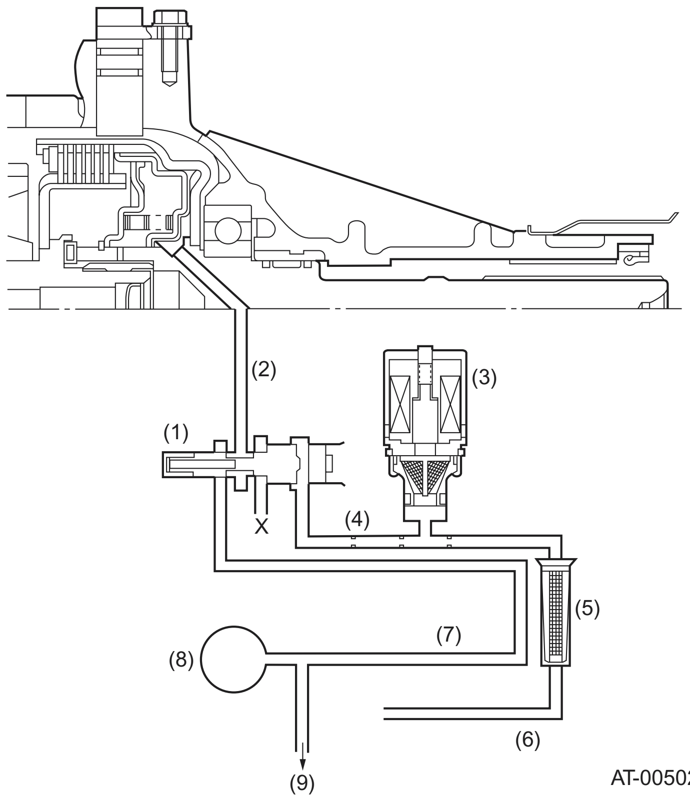


(1)	Thrust bearing	(6)	Driven plate	(11)	Transfer clutch piston
(2)	Needle bearing	(7)	Pressure plate	(12)	Rear drive shaft
(3)	Snap ring	(8)	Snap ring	(13)	Ball bearing
(4)	Pressure plate	(9)	Transfer piston seal	(14)	Seal ring
(5)	Drive plate	(10)	Return spring		

- 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.

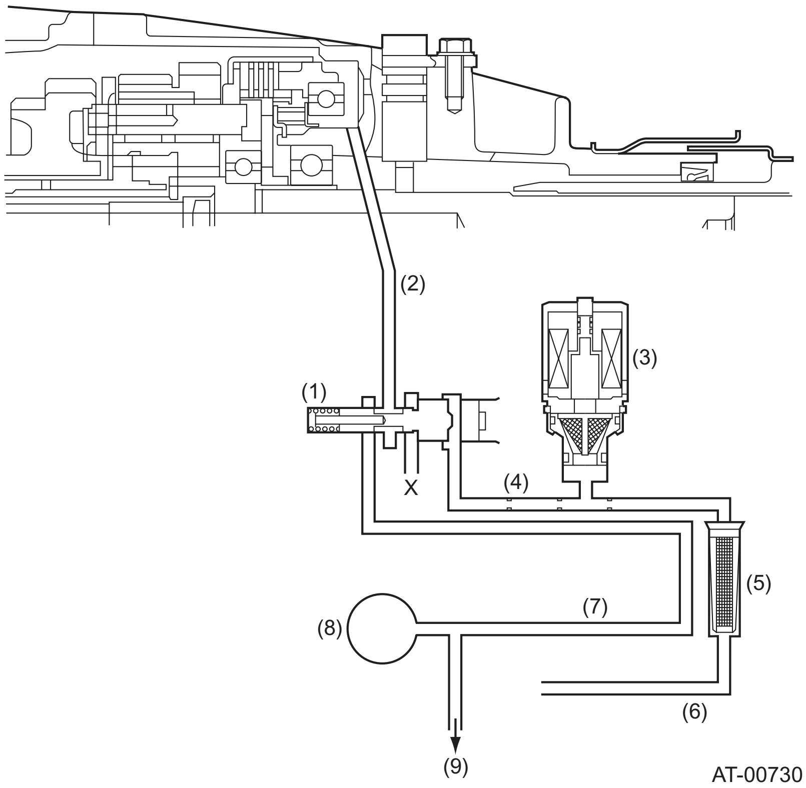


(1) Transfer control valve	(4) Transfer pressure	(7) Line pressure
(2) Transfer clutch pressure	(5) Filter	(8) Oil pump
(3) Transfer duty solenoid	(6) Pilot pressure	(9) Transmission hydraulic control valve assembly

B: VTD MODELS

1. GENERAL

Used in the transfer of the VTD models is the SUBARU drive power distribution system which combines a compound planetary gear type center differential installed in the transfer case behind the transmission and a hydraulically operated multi-plate differential action limiting device (LSD) located between the output components of the center differential. Differential action limiting control is performed by the TCM according to driving and road surface conditions. This system allows combining stability provided by the AWD design with good operability.
The input torque is transmitted to the 1st sun gear of the center differential through the intermediate shaft. From the 1st sun gear, the torque is transmitted through the 1st pinion to the output carrier in the front wheel output components, and through the 2nd pinion to the 2nd sun gear in the rear wheel output components.
The center differential performs the differential functions of absorbing the speed difference between the front and rear wheels and also distributes drive forces to the front and rear wheels at a predetermined ratio. In normal conditions (when there is almost no difference in the speed between the front and rear wheels), the drive force distribution ratio is 45.5 % to the front wheels and 54.5 % to the rear wheels. The hydraulic multi-plate clutch connected in parallel with the center differential between the carrier and 2nd sun gear functions as a differential action limiting device (LSD) and also as a device that controls torque distribution according to driving conditions.
The differential action limiting control is based on the parameters that include the throttle angle, engine speed, vehicle speed, and speed ratio of front and rear wheels. The LSD clutch piston is operated by the fluid whose pressure is adjusted by the duty solenoid and the transfer control valve in the transfer case. According to the pressure applied to the piston, the torque distribution ratio changes from the ratio set for the center differential to the direct AWD ratio.
The speed of the front and rear wheels determine the basic signals for the differential action limiting control. The rear wheel speed is detected by sensor installed above the rear drive shaft and the front wheel speed is detected by the sensor on the parking gear above the reduction drive shaft gear.



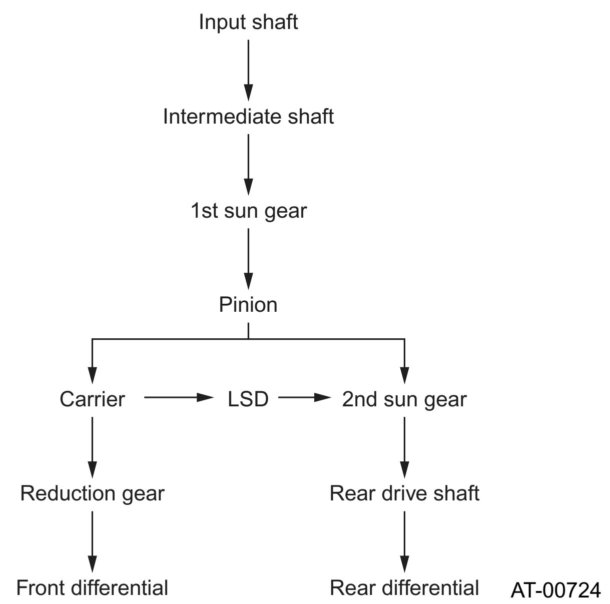
(1)	Transfer control valve	(4)	Transfer pressure	(7)	Line pressure
(2)	Transfer clutch pressure	(5)	Filter	(8)	Oil pump
(3)	Transfer duty solenoid	(6)	Pilot pressure	(9)	Transmission hydraulic control valve assembly

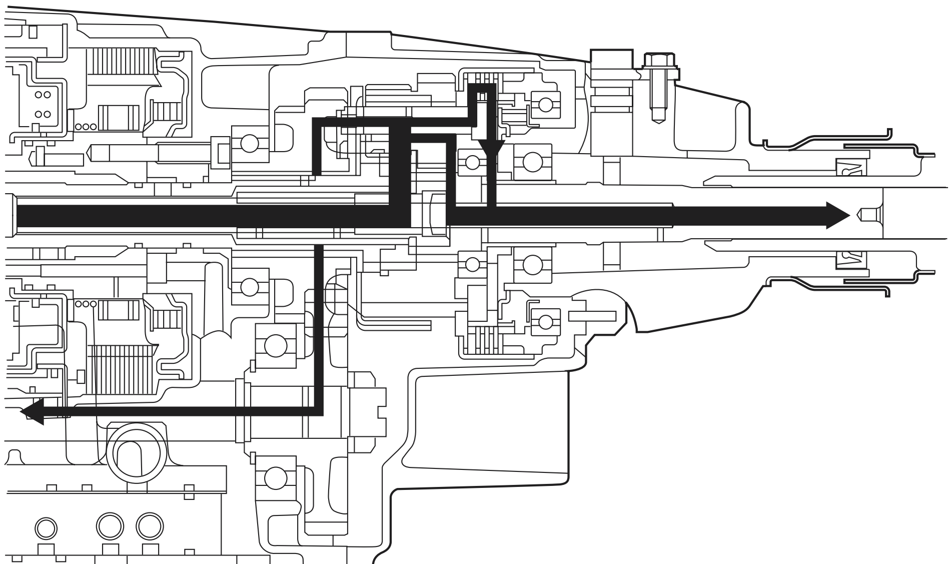
2. VARIABLE TORQUE DISTRIBUTION CENTER DIFFERENTIAL

The front-rear torque distribution ratio is basically determined by the gear tooth ratio of center differential's compound planetary gears and varied by changing the degree of engagement of the hydraulically operated multi-plate clutch that connects the center differential output elements according to driving conditions and road surface conditions. The torque distribution ratio is calculated using the following equations which include torque distribution coefficients (determined by number of gear teeth), input torque to the center differential, and torque capacity of the multi-plate clutch as factors.

1) When the front wheel speed is higher than the rear wheel speed:
$T_R = 0.545 \times T_i + T_C$
$T_F = 0.455 \times T_i - T_C$
where
T_R: Rear wheel output torque
T_i: Input torque to center differential
T_C: Torque capacity of multi-plate clutch
T_F: Front wheel output torque
0.545: Coefficient of rear wheel torque determined by number of gear teeth
0.455: Coefficient of front wheel torque determined by number of gear teeth

Power flow





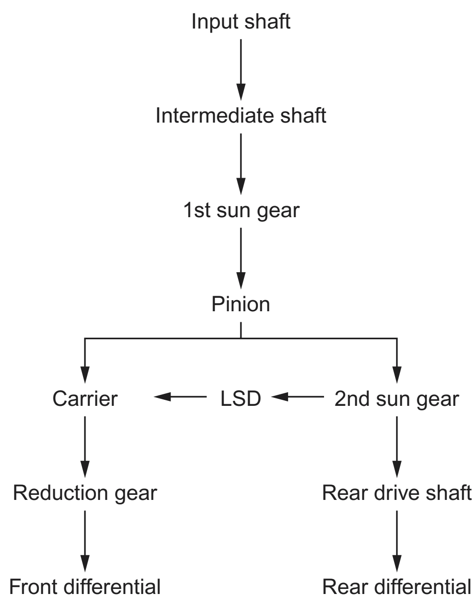
AT-00725

2) When the rear wheel speed is higher than the front wheel speed:

$T_R = 0.545 \times T_i - T_C$

$T_F = 0.455 \times T_i + T_C$

Power flow



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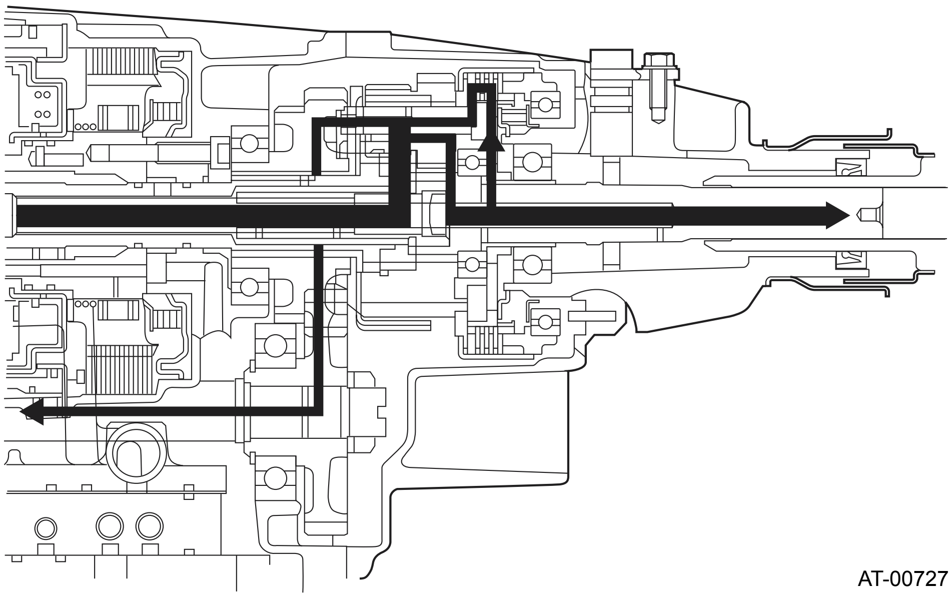


Calculation of front and rear wheel torques
If the frictional resistance resulting from meshing of the planetary gears and sliding of rotational components are ignored, the torques distributed to the front and rear wheels are expressed by the following equations:

$T_R = [(Z_{P1} \times Z_{S2}) \div (Z_{S1} \times Z_{P2})] \times T_i$
$T_F = [1 - (Z_{P1} \times Z_{S2}) \div (Z_{S1} \times Z_{P2})] \times T_i$

where
Z_{P1}: Number of teeth of 1st planetary gear
Z_{P2}: Number of teeth of 2nd planetary gear
Z_{S1}: Number of teeth of 1st sun gear
Z_{S2}: Number of teeth of 2nd sun gear
T_i: Input torque

If the number of teeth in each component is the same as that assumed in the equations on the previous page, the following ratios are the calculation results of the equations shown above.

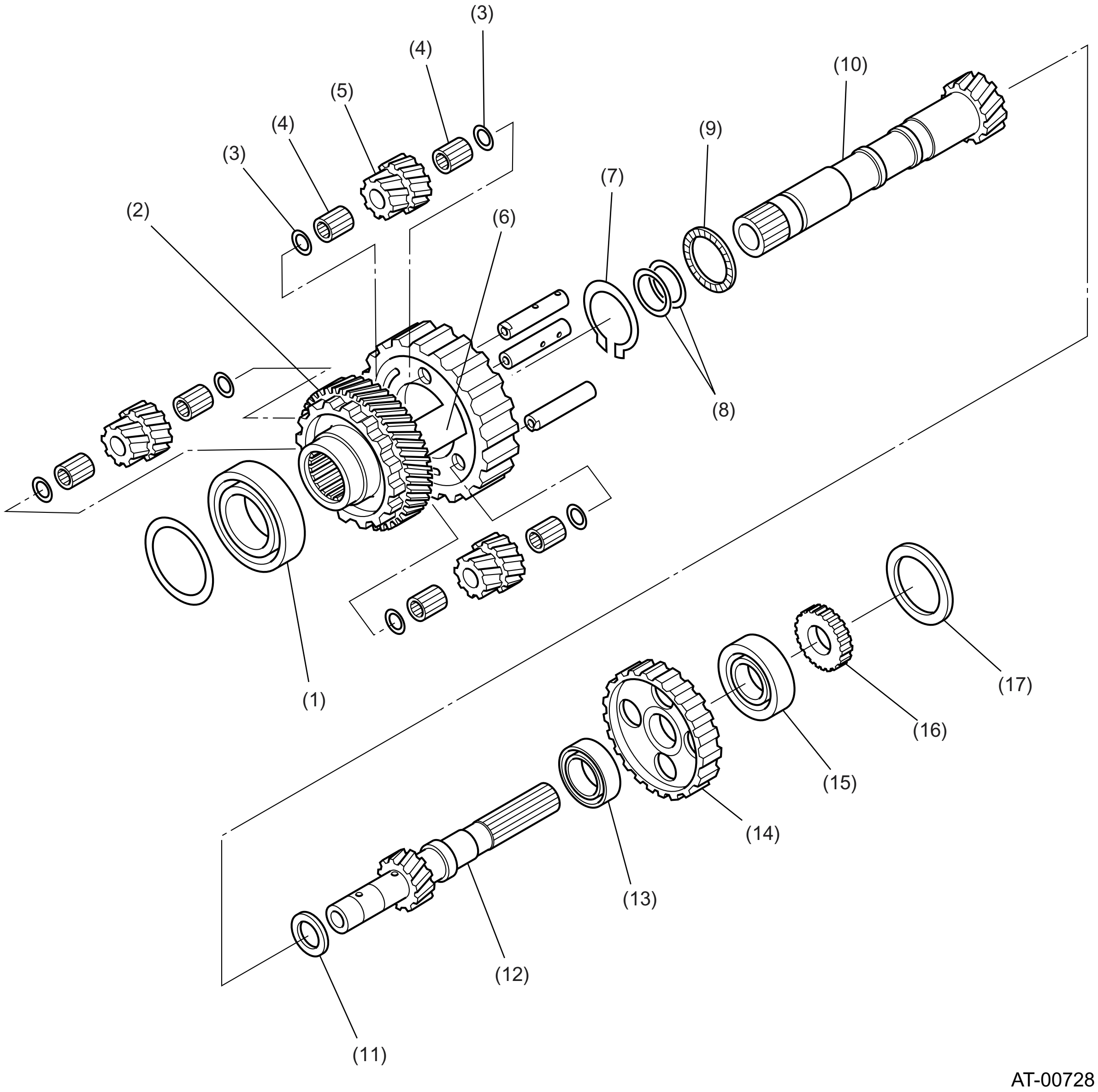
$T_R = 0.545 \times T_i$
$T_F = 0.455 \times T_i$

As a result, the front-rear torque distribution ratio of the compound planetary gear set without an adjustment by the multi-plate clutch is 45.5 : 54.5.

MEMO

3. CENTER DIFFERENTIAL ASSEMBLY

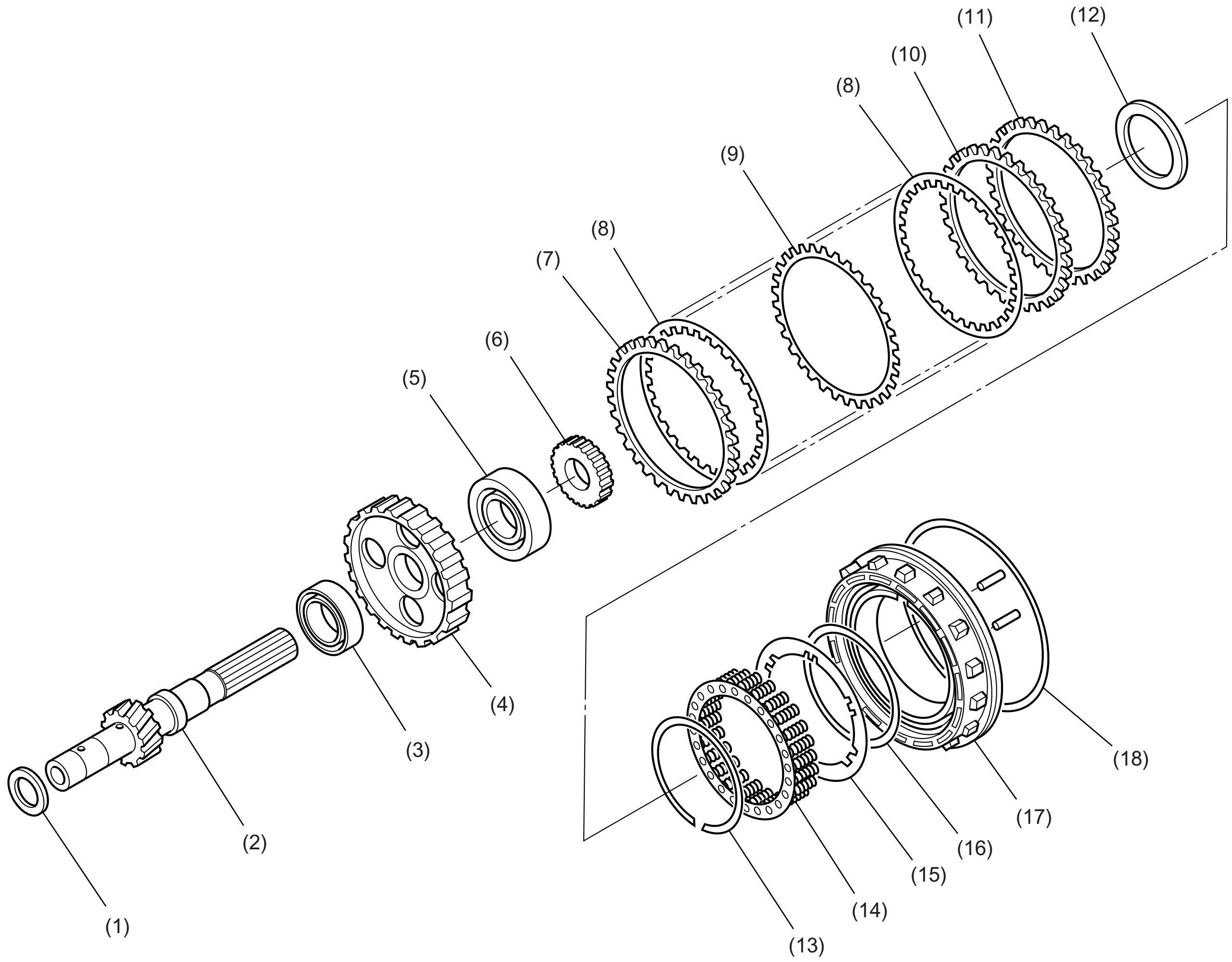
The center differential is a compound planetary gear set without internally-toothed gears. The input torque from the automatic transmission is transmitted to the input element of the center differential (1st sun gear). The front wheel output elements of the center differential are connected to the carrier and the rear wheel output elements are connected to the 2nd sun gear.
The compound planetary gears uses helical gears for quiet operation and strength. The three pinions are arranged to ensure the best motion balance during operation.



(1)	Ball bearing	(7)	Snap ring	(13)	Ball bearing
(2)	Reduction drive gear	(8)	Seal ring	(14)	Multi-plate clutch hub
(3)	Washer	(9)	Thrust needle bearing	(15)	Ball bearing
(4)	Needle bearing	(10)	Intermediate shaft	(16)	Revolution gear
(5)	Pinion gear	(11)	Thrust washer	(17)	Rear drive shaft shim
(6)	Carrier	(12)	Rear drive shaft		

4. MULTI-PLATE CLUTCH (LSD)

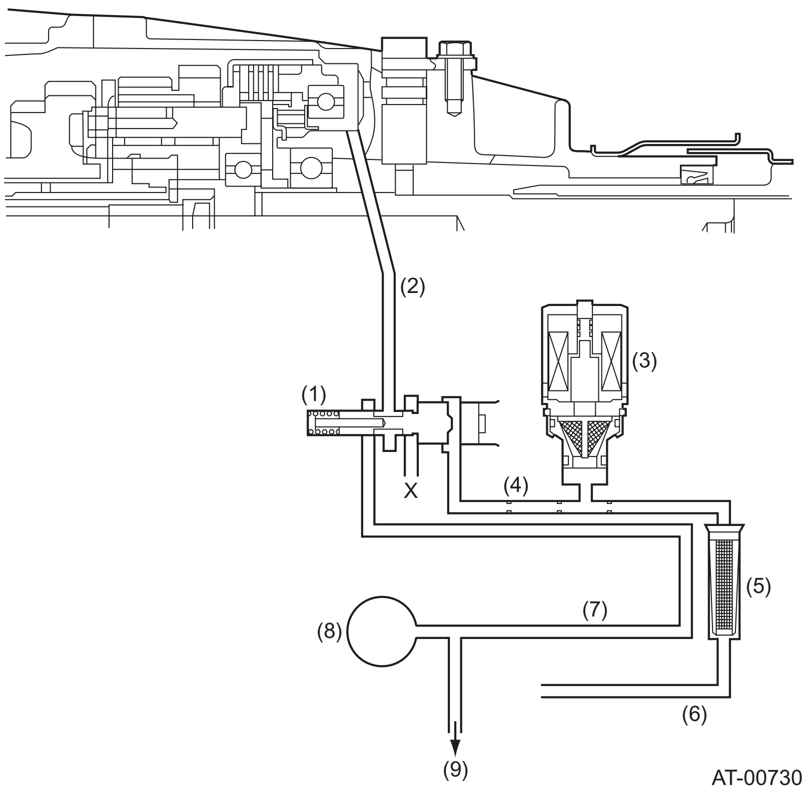
The transfer's differential action limiting device (LSD) consists of a multi-plate clutch and a transfer hydraulic pressure control unit incorporating a transfer duty solenoid.
The transfer duty solenoid is an electromagnetic valve which is controlled by the TCM using various duty ratios stored in its memory as explained in "1. GENERAL".
The rear drive shaft has drilled oil passages for lubrication of multi-plate clutch and extension bushing and ball bearing in it.



(1)	Thrust washer	(7)	Driven plate (thicker)	(13)	Snap ring
(2)	Rear drive shaft	(8)	Drive plate	(14)	Spring retainer
(3)	Ball bearing	(9)	Driven plate (thinner)	(15)	Plate
(4)	Multi-plate clutch hub	(10)	Driven plate (thicker)	(16)	Lathe cut seal ring
(5)	Ball bearing	(11)	Adjust plate	(17)	Multi-plate clutch piston
(6)	Revolution gear	(12)	Rear drive shaft shim	(18)	Lathe cut seal ring

5. 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 control valve depending on the signals from the TCM. The transfer control 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.



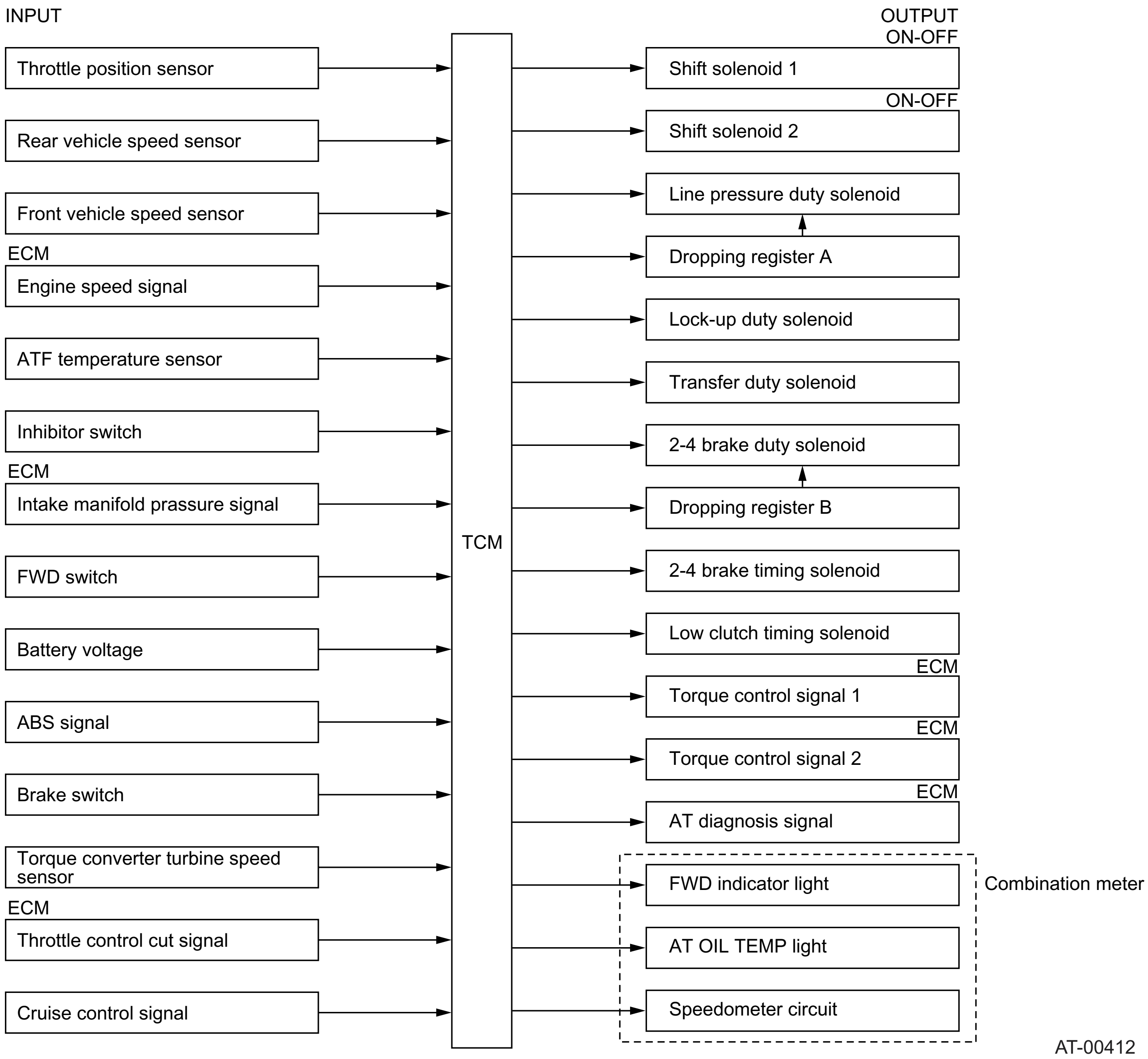
(1) Transfer control valve
(2) Transfer clutch pressure
(3) Transfer duty solenoid
(4) Transfer pressure
(5) Filter
(6) Pilot pressure
(7) Line pressure
(8) Oil pump
(9) Transmission hydraulic control valve assembly

12.Electrohydraulic Control System

A: DESCRIPTION

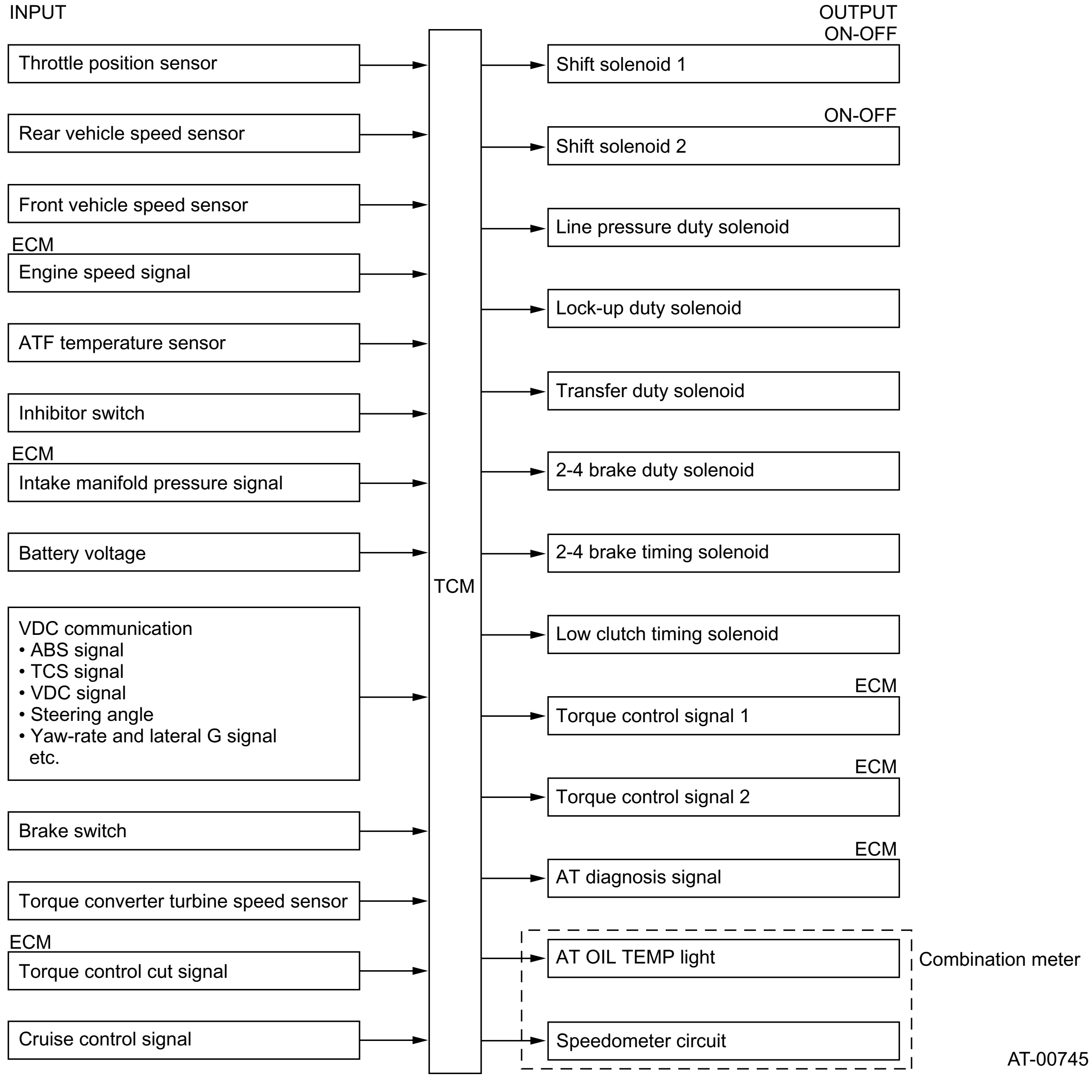
1. VEHICLES WITHOUT VDC SYSTEM AND SPORTS SHIFT

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, automatic control pattern selection (“Base” 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.



2. VEHICLES WITH VDC SYSTEM

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, automatic control pattern selection ("Base" and "Power"), and gear-shift timing.It also controls operation of the transfer multi-plate clutch (LSD).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.



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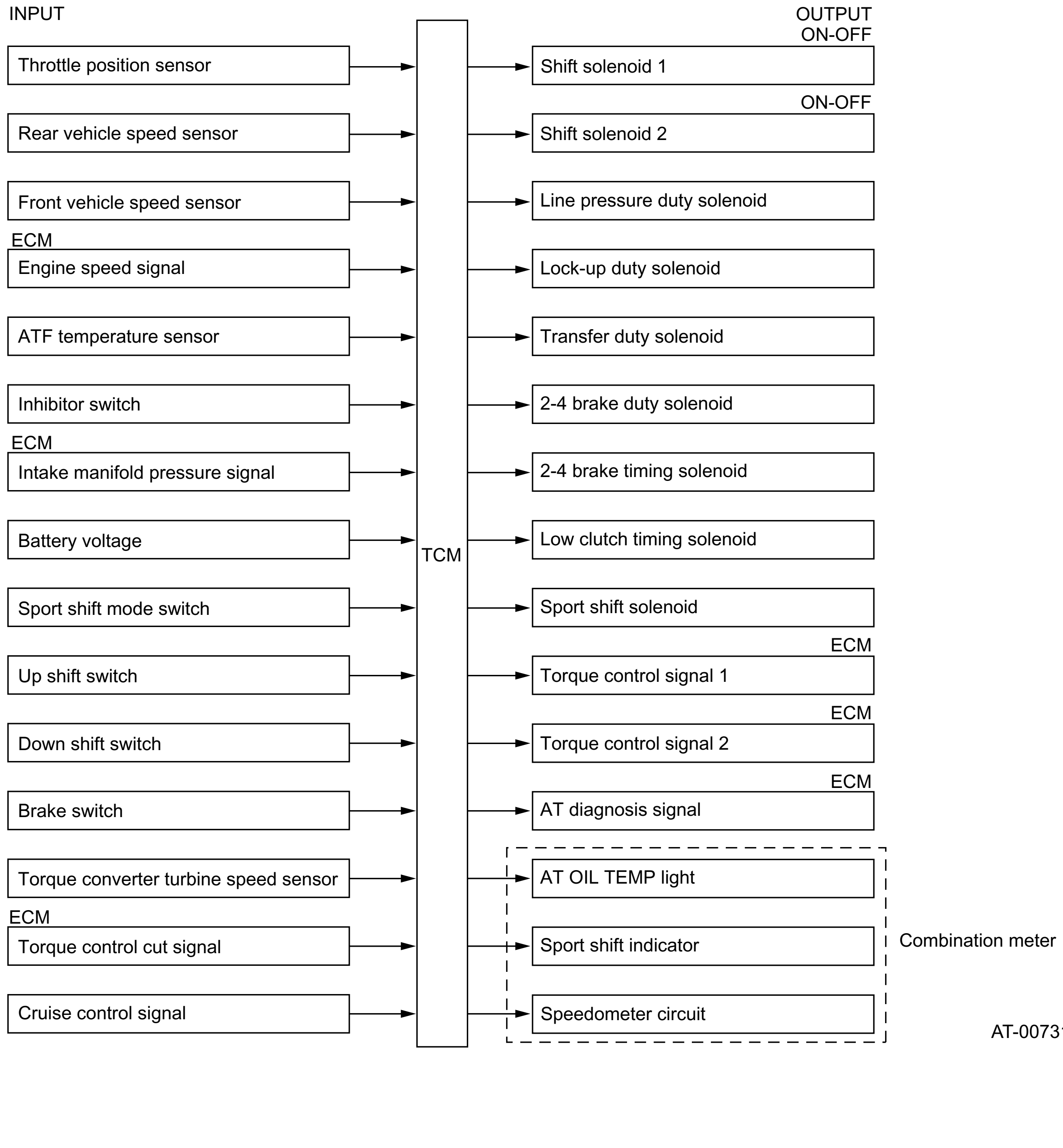
3. VEHICLES WITH SPORTS SHIFT

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, automatic shift pattern selection ("Base" 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.A sports shift solenoid is also equipped to make engine braking effect available when 1st speed gear is selected in sports shift mode.



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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 (vehicles without VDC system and sports shift)	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 convertor 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	Used to determine line pressure of gear shifting.
Brake switch	If this signal is issued during downhill driving, TCM makes downshift control, causing the vehicle speed to be reduced.
Sports shift mode switch (vehicles with sports shift)	Used to switch between normal shift mode and sports shift mode.
Upshift switch (vehicles with sports shift)	The TCM makes upshift control when a signal is input while driving in sports shift mode.
Downshift switch (vehicles with sports shift)	The TCM makes downshift control when a signal is input while driving in sports shift mode.
TCS signal (vehicles with VDC system)	Used when TCS is operating to optimize TCS control. In this control, transfer clutch torque is controlled to eliminate the influence of engine braking and reduce the degree of coupling between front and rear wheels.
VDC signal (vehicles with VDC system)	Used when VDC is operating to optimize VDC control. In this control, transfer clutch torque is controlled to eliminate the influence of engine braking and reduce the degree of coupling between front and rear wheels.
Steering angle sensor (vehicles with VDC system)	Used to monitor the vehicle behavior and send signals for transfer control.
Yaw-rate and lateral G sensor (vehicles with VDC system)	Used to monitor the vehicle behavior and send signals for transfer control.

C: OUTPUT SIGNALS

Signal name	Function
Shift solenoid 1 and 2	Each of these signals controls gear speed 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).This light is also used for on-board diagnostics.
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.
Sports shift solenoid (vehicles with sports shift)	Turns the hydraulic pressure to the low & reverse brake ON or OFF to make engine braking effect available when 1st speed gear is selected in sports shift mode.
Buzzer (vehicles with sports shift)	Operates when the ATF temperature is low or high, switched to sports shift mode, or to prevent engine over-revving when a downshift operation is tempted at a speed higher than the specified limit.

D: CONTROL ITEMS

1. MPT MODELS

Control items			Description of control
Transmission control	Shifting control	Base shift control ● 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 is locked in 3rd when ABS signal enters.
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.
	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 operation	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.)j
		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.
		Shifting 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	Gear speed control	ON/OFF timing for shift solenoid is controlled.
		Lock-up operation	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 ≥ 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.

2. VTD MODELS

CONTROL ITEMS			Description of control
Transmission control	Shifting control	Base shift control ● 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 is locked in 3rd when ABS signal enters.
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.
	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 operation	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.
		Shifting 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	Gear speed control	ON/OFF timing for shift solenoid is controlled.
		Lock-up operation	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 multi-plate clutch (LSD) control	Ordinary transfer control		Multi-plate clutch (LSD) pressure is regulated according to the torque input to the transfer and the driving condition.
	Start control		When starting, the LSD pressure is adjusted proportionately to the throttle value angle.
	Turning control		When the front and rear wheel speed ratio is less than the set value for a vehicle speed, the LSD pressure is decreased.
	Slip control		When a front or rear wheel starts slipping, the LSD pressure is decreased.
	ABS-in-operation control		The LSD pressure is adjusted to the set level immediately after reception of ABS signal.
	Base brake control		When the brake switch is ON and throttle valve is fully closed, the LSD pressure is lowered.
	1 range control		The LSD pressure is increased to improve driveability.

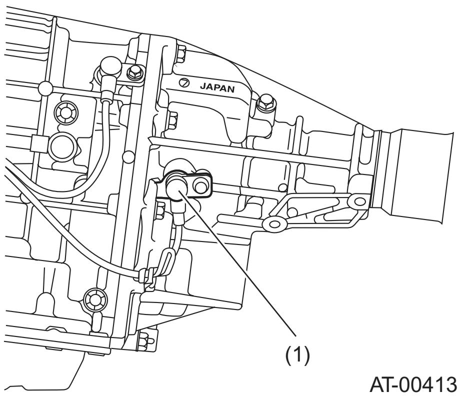
E: THROTTLE POSITION SENSOR

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.

F: REAR VEHICLE SPEED SENSOR

1. MPT MODELS

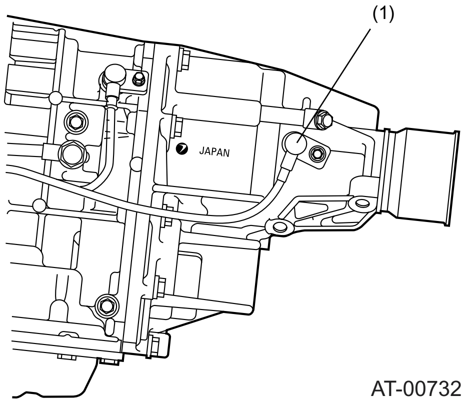
This vehicle speed sensor (output shaft speed sensor) is externally mounted on the extension case. It detects the rear wheel speed in terms of the peripheral speed of the transfer clutch drum and sends sine wave signals (30 pulses per rotation) to the TCM.



(1) Rear vehicle speed sensor

2. VTD MODELS

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 rear drive shaft and sends sine wave signals (22 pulses per rotation) to the TCM.



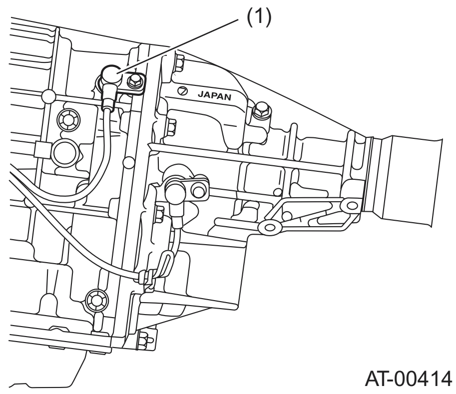
(1) Rear vehicle speed sensor

G: 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.

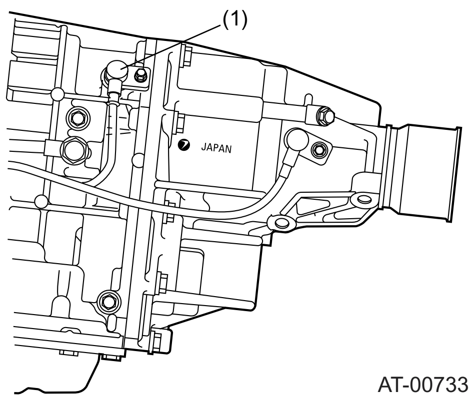
The TCM converts the signals into pulse signals and outputs them to both the engine control module (ECM) and the combination meter.

- MPT models



(1) Front vehicle speed sensor

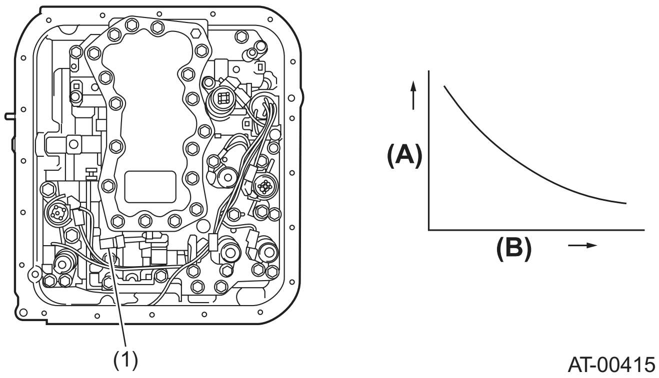
- VTD models



(1) Front vehicle speed sensor

H: ATF TEMPERATURE SENSOR

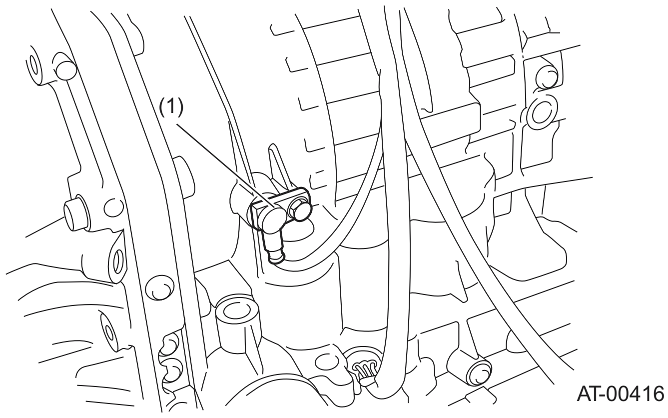
This sensor is mounted on the hydraulic control valve body of the transmission.It detects the temperature of ATF and outputs it as an electrical resistance signal.The output characteristics of the sensor are shown below.



(1) ATF temperature sensor **(A)** Resistance **(B)** Temperature

I: 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.



(1) Torque converter turbine speed sensor

J: INHIBITOR SWITCH

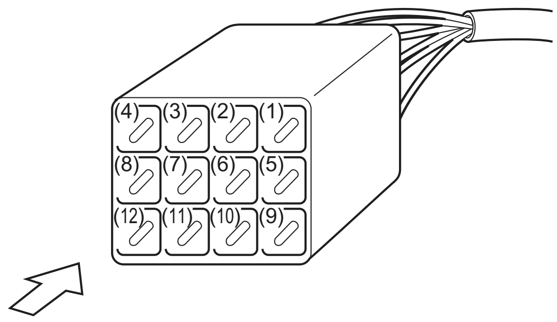
The inhibitor switch assures safety when starting the engine.This switch is mounted on the right side of the transmission case, and is operated by the selector lever.

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



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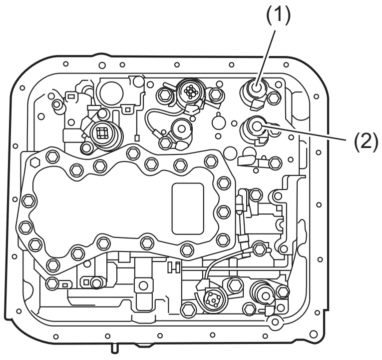
Range position	Pin No.
P	(4) – (3) (12) – (11)
R	(4) – (2) (10) – (9)
N	(4) – (1) (12) – (11)
D	(4) – (8)
3	(4) – (7)
2	(4) – (6)
1	(4) – (5)

K: 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.

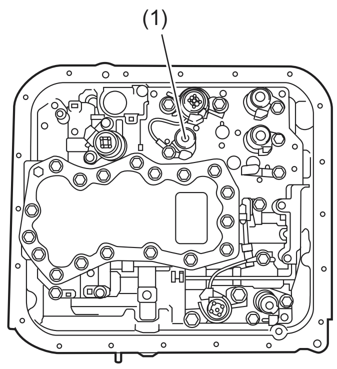


AT-00418

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

L: 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.

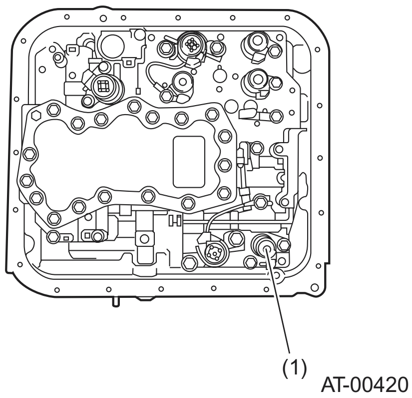


AT-00419

(1) Low-clutch timing solenoid

M: 2-4 BRAKE TIMING SOLENOID

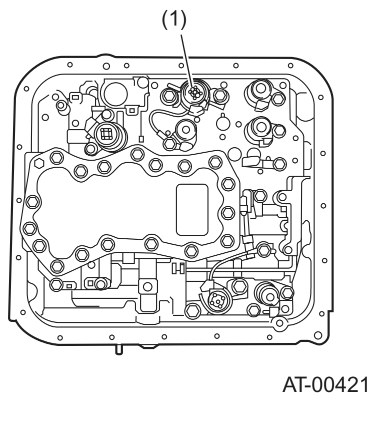
This solenoid is mounted on the transmission hydraulic control valve body.It is turned ON or OFF according to signals from the TCM.It then controls the 2-4 brake timing valve B to decrease the change gear shock.



(1) 2-4 brake timing solenoid

N: LINE PRESSURE DUTY SOLENOID

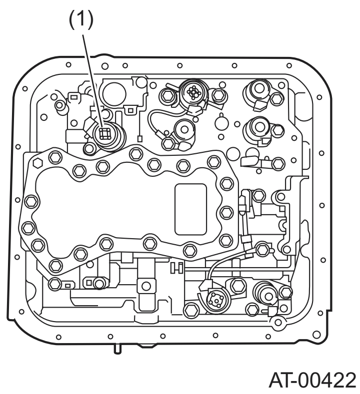
This solenoid is mounted on the transmission hydraulic control valve body.Its duty ratio is controlled by signals from the TCM.This solenoid then controls the pressure modifier valve and accumulator control valve A to adjust the line pressure to an optimum pressure level suitable for operating conditions.



(1) Line pressure duty solenoid

O: LOCK-UP DUTY SOLENOID

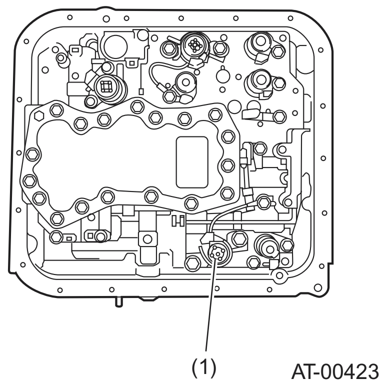
This solenoid is mounted on the transmission hydraulic control valve body.Its duty ratio is controlled by signals from the TCM.It then controls the lock-up control valve to provide smooth engagement and disengagement of the lock-up clutch.



(1) Lock-up duty solenoid

P: 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.

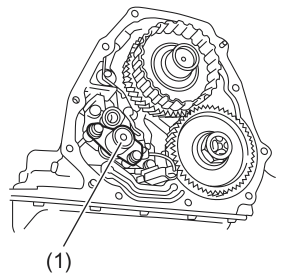


(1) 2-4 brake duty solenoid

Q: TRANSFER DUTY SOLENOID

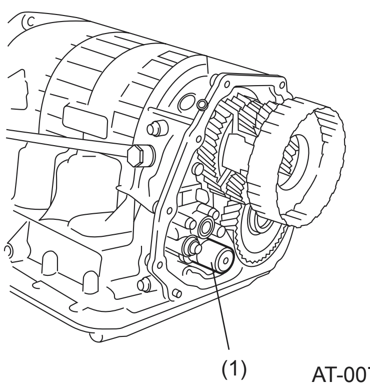
This solenoid is mounted on the transfer hydraulic pressure control unit on the rear end of transmission case.Its duty ratio is controlled by signals from the TCM.It then controls the transfer clutch/ control valve to control the pressure applied to the transfer clutch.

- MPT models



(1) Transfer duty solenoid

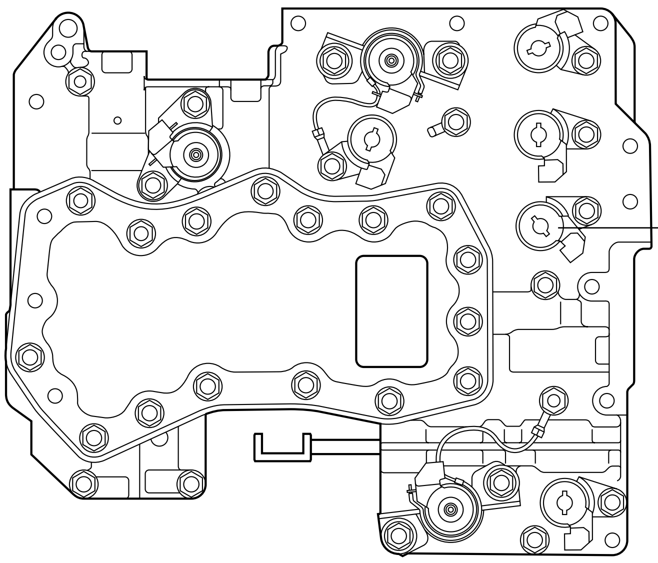
- VTD models



(1) Transfer duty solenoid

R: SPORTS SHIFT SOLENOID

This solenoid is mounted on the transfer hydraulic control valve body on the rear end of transmission case.It is turned ON or OFF according to signals from the TCM.Thus the sports shift control valve is controlled when 1st speed gear is selected in sports shift mode.



(1) Sports shift solenoid

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

1. MPT MODELS

Control items		Input signals
Shifting control	Ordinary shift control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor 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
	Grade control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch Inhibitor switch Engine speed rpm Intake manifold pressure
Lock-up operation	Ordinary lock-up control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor switch
	Smooth control	Throttle position sensor
	Hydraulic oil temperature control	ATF temperature sensor

Control items		Input signals
Oil pressure control	Ordinary pressure control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor switch ATF temperature sensor
	Shifting control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Torque converter turbine speed sensor Inhibitor switch ATF temperature sensor
	Starting control	Engine speed rpm 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
	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

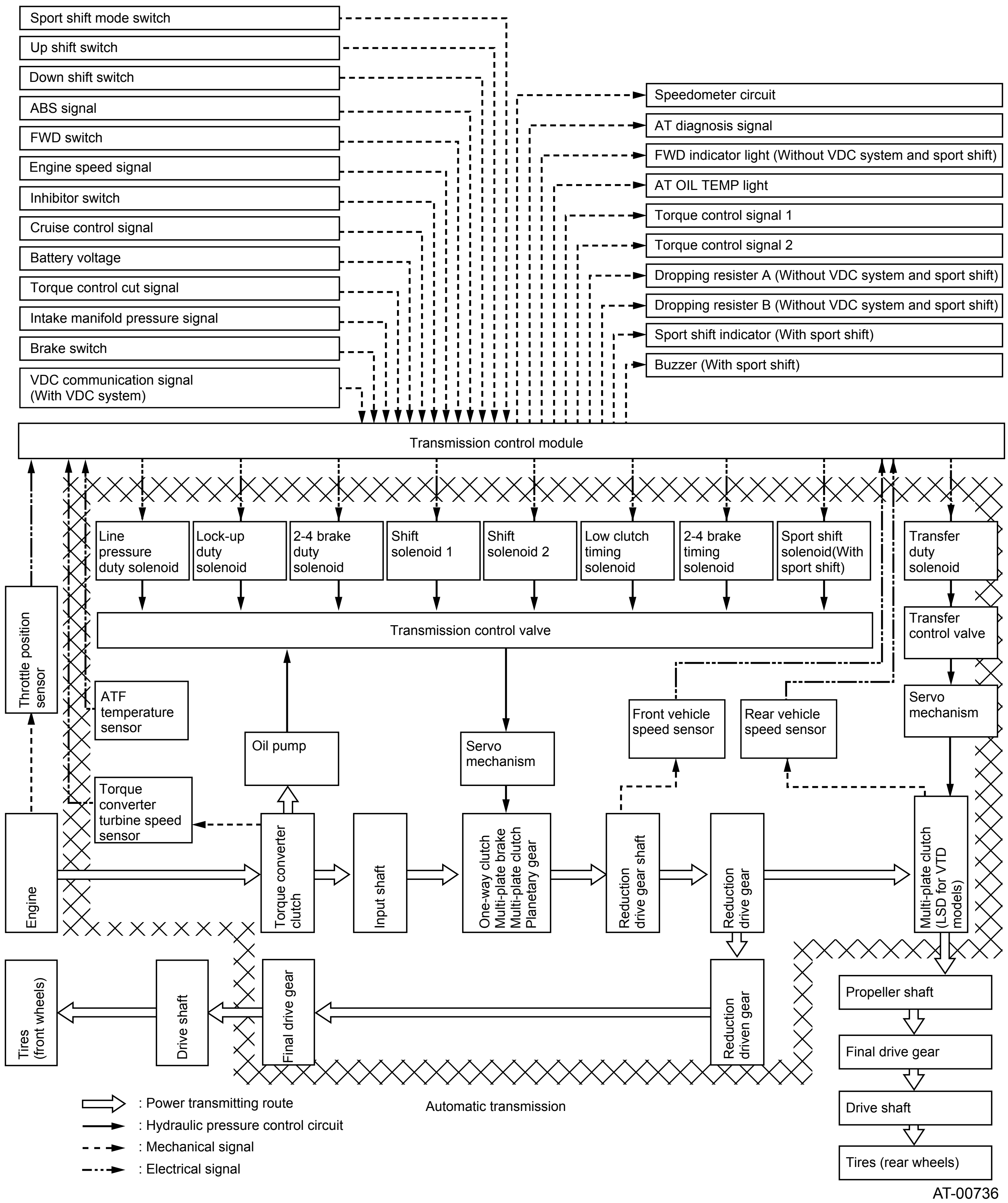
2. VTD MODELS

Control items		Input signals
Shifting control	Ordinary shift control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor 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
	Grade control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Brake switch Inhibitor switch Engine speed rpm Intake manifold pressure
	Sports shift control (vehicles with sports shift)	Sports shift mode switch Upshift switch Downshift switch Front vehicle speed sensor Rear vehicle speed sensor Engine speed rpm ATF temperature sensor Inhibitor switch
Lock-up operation	Ordinary lock-up control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor switch
	Smooth control	Throttle position sensor
	Hydraulic oil temperature control	ATF temperature sensor

Control items		Input signals
Oil pressure control	Ordinary pressure control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Inhibitor switch ATF temperature sensor
	Shifting control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Engine speed rpm Torque converter turbine speed sensor Inhibitor switch ATF temperature sensor
	Starting control	Engine speed rpm 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

Control items		Input signals
AWD multi-plate clutch (LSD) control	Ordinary transfer control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor switch ATF temperature sensor Steering angle sensor Yaw-rate and lateral G sensor
	1 range control	Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor Inhibitor 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
	Base brake control	Throttle position sensor Front vehicle speed sensor Brake switch
	TCS-in-operation signal (vehicles with VDC system)	TCS signal (VDC communication signal) Throttle position sensor Rear vehicle speed sensor Front vehicle speed sensor
	VDC-in-operation signal (vehicles with VDC system)	VDC signal (VDC communication signal) Rear vehicle speed sensor Front vehicle speed sensor

B: SYSTEM DIAGRAM

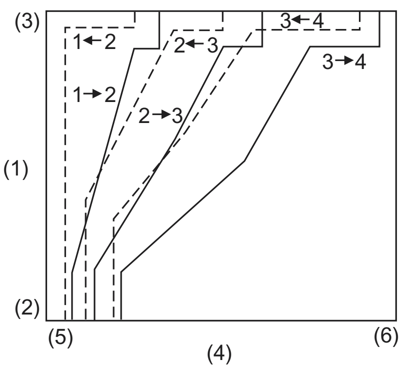


C: SHIFTING CONTROL

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 speed	ON	ON
2nd speed	OFF	ON
3rd speed	OFF	OFF
4th speed	ON	OFF



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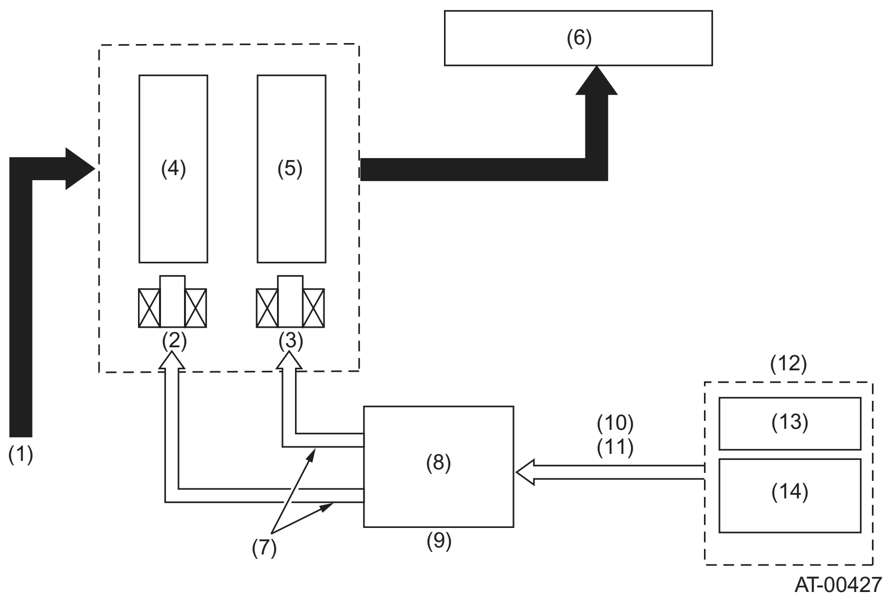
(1) Throttle opening
(2) Small
(3) Large
(4) Vehicle speed
(5) Low
(6) High

- 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.



(1)	Clutch fluid	(8)	TCM
(2)	Solenoid 1	(9)	Determination of optimum gear position (including selection of shift pattern)
(3)	Solenoid 2	(10)	Throttle opening
(4)	Shift valve A	(11)	Vehicle speed
(5)	Shift valve B	(12)	Sensor
(6)	Shift clutch	(13)	Vehicle speed sensor
(7)	Shift command signal	(14)	Throttle position sensor

D: LOCK-UP CONTROL

- The TCM has pre-programmed lock-up clutch engagement and disengagement conditions for each gear and shift pattern.In addition, it specifies engagement of the clutch whenever the 4th gear is selected in the D range.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 "disengaging" 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 for all the speed gears except the 4th gear of the D range.

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.

This operation is performed for all the speed gears and always when the 4th gear is selected in the D range.

E: LINE-PRESSURE CONTROL

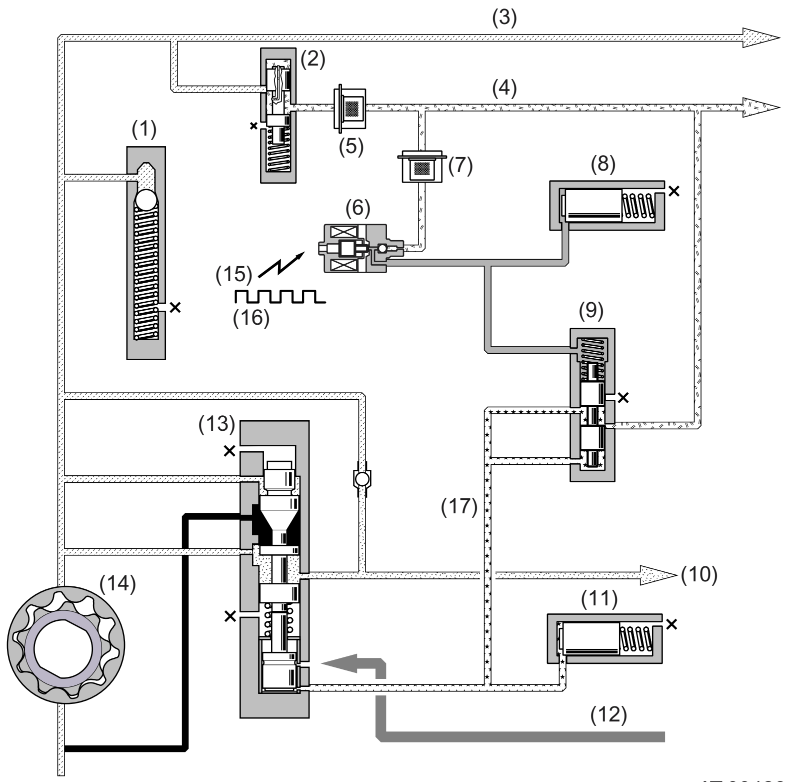
● The oil pump delivery pressure (line pressure) is regulated to a constant pressure by the pilot valve.This pressure is used as the pilot pressure for controlling spool valves.

● 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.



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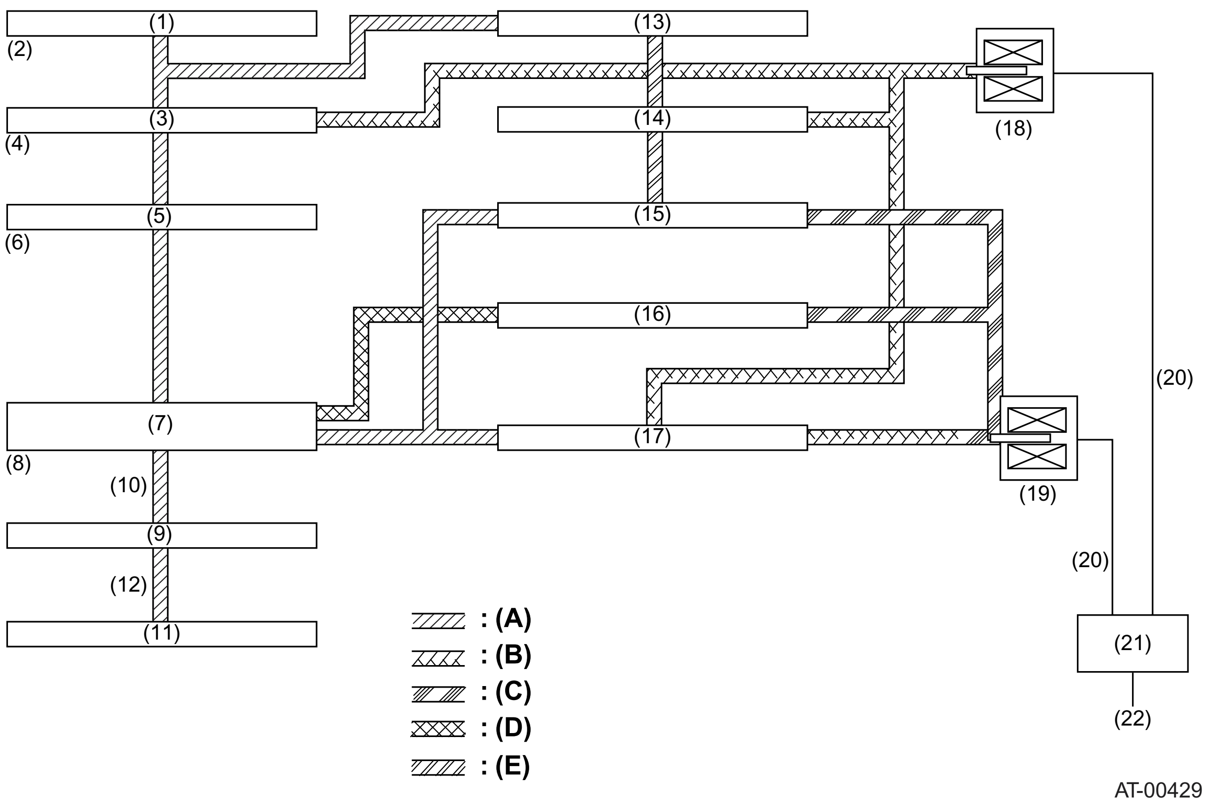
(1)	Relief valve	(7)	Filter	(13)	Pressure regulator valve
(2)	Pilot valve	(8)	Accumulator	(14)	Oil pump
(3)	Line pressure	(9)	Pressure modifier valve	(15)	ON
(4)	Pilot pressure	(10)	To ATF cooler circuit	(16)	OFF
(5)	Filter	(11)	Pressure modifier accumulator	(17)	Pressure modifier pressure
(6)	Line pressure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

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.



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

(A) Line pressure
(B) Pilot pressure
(C) Line pressure duty pressure
(D) Modifier pressure
(E) Accumulator control

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

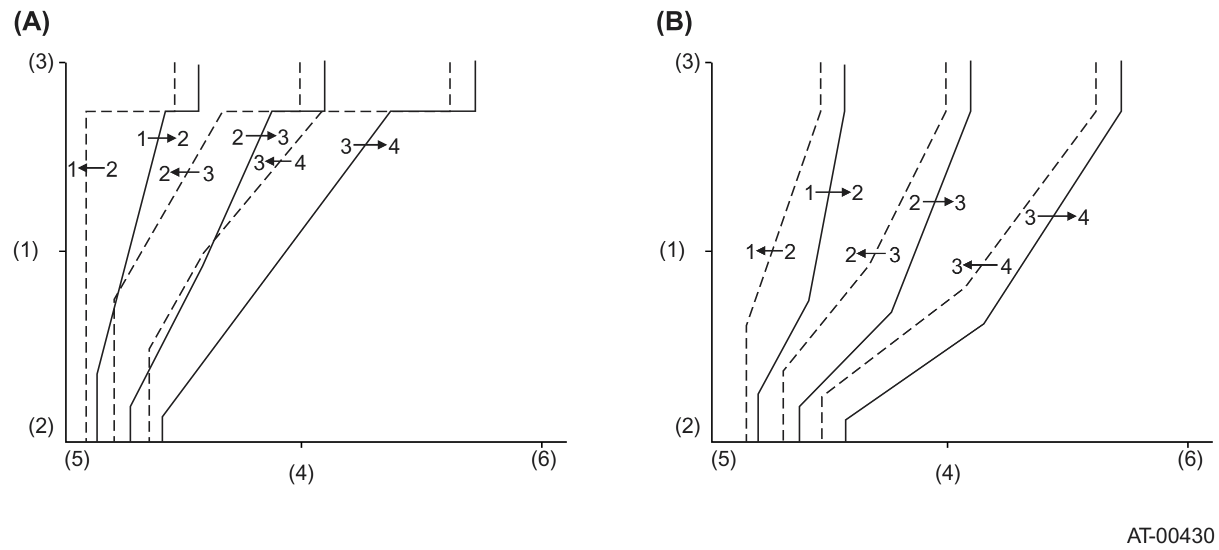
- The TCM receives signals such as throttle position signal and accelerator pedal speed signal. Based on these input signals, it issues a control signal to the line pressure duty solenoid.
- The pressure from the line pressure duty solenoid (line pressure duty pressure) is converted by the pressure modifier 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.

G: SHIFT PATTERN SELECTION CONTROL

The TCM changes its gear shift control pattern automatically between the Base pattern suitable for ordinary economy driving 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.

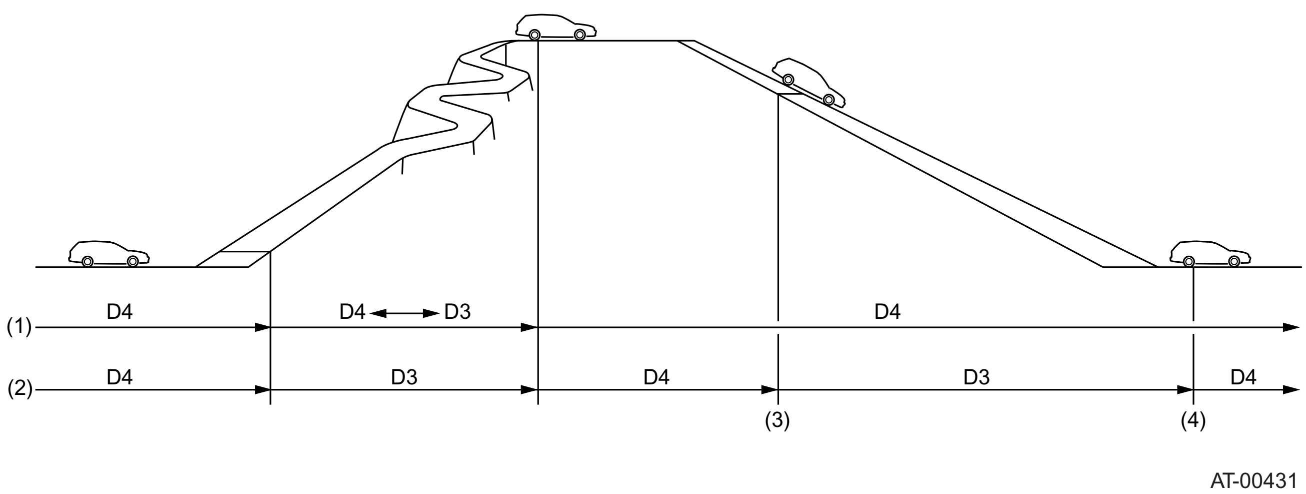
Selector lever position	Changeover from Base to Power pattern
D and 3 ranges	Performed automatically according to accelerator pedal depression speed.



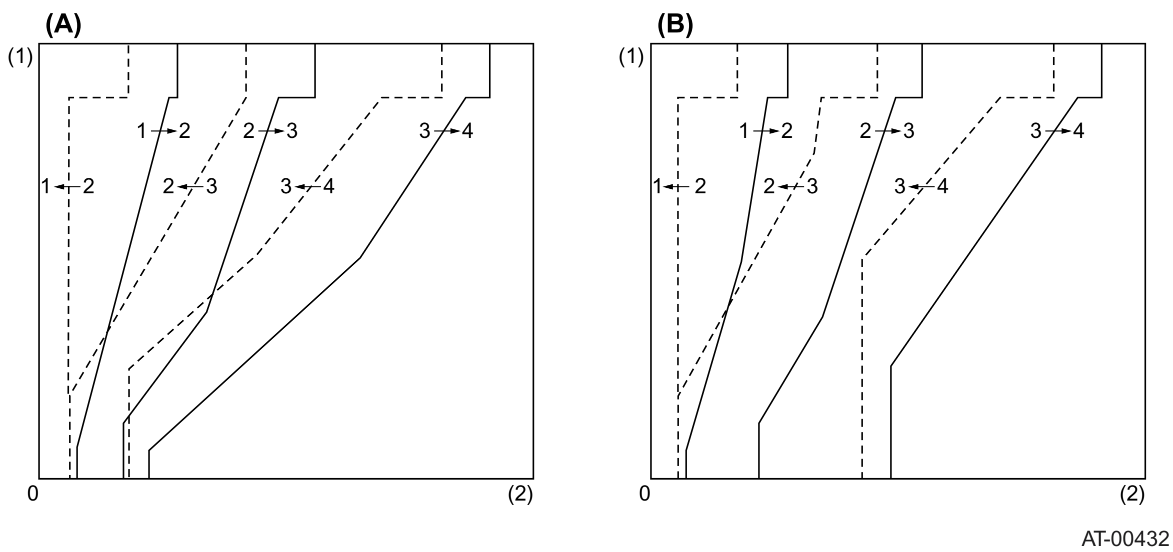
(A) D range (Base pattern)
(1) Throttle opening
(2) Small
(3) Large
(B) D range (Power pattern)
(4) Vehicle speed
(5) Low
(6) High

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/h (50 MPH), 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.



(1) Without grade control
(2) With grade control
(3) Brake pedal ON
(4) Re-acceleration



(A) D range (Base pattern)
(1) Throttle opening
(B) D range (grade control pattern)
(2) Vehicle speed

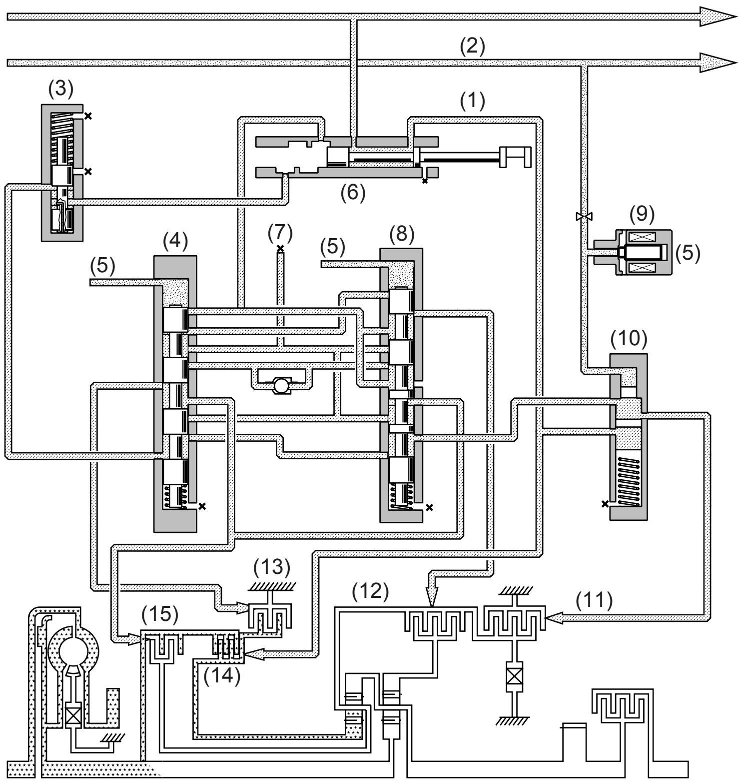
I: LEARNING CONTROL

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.

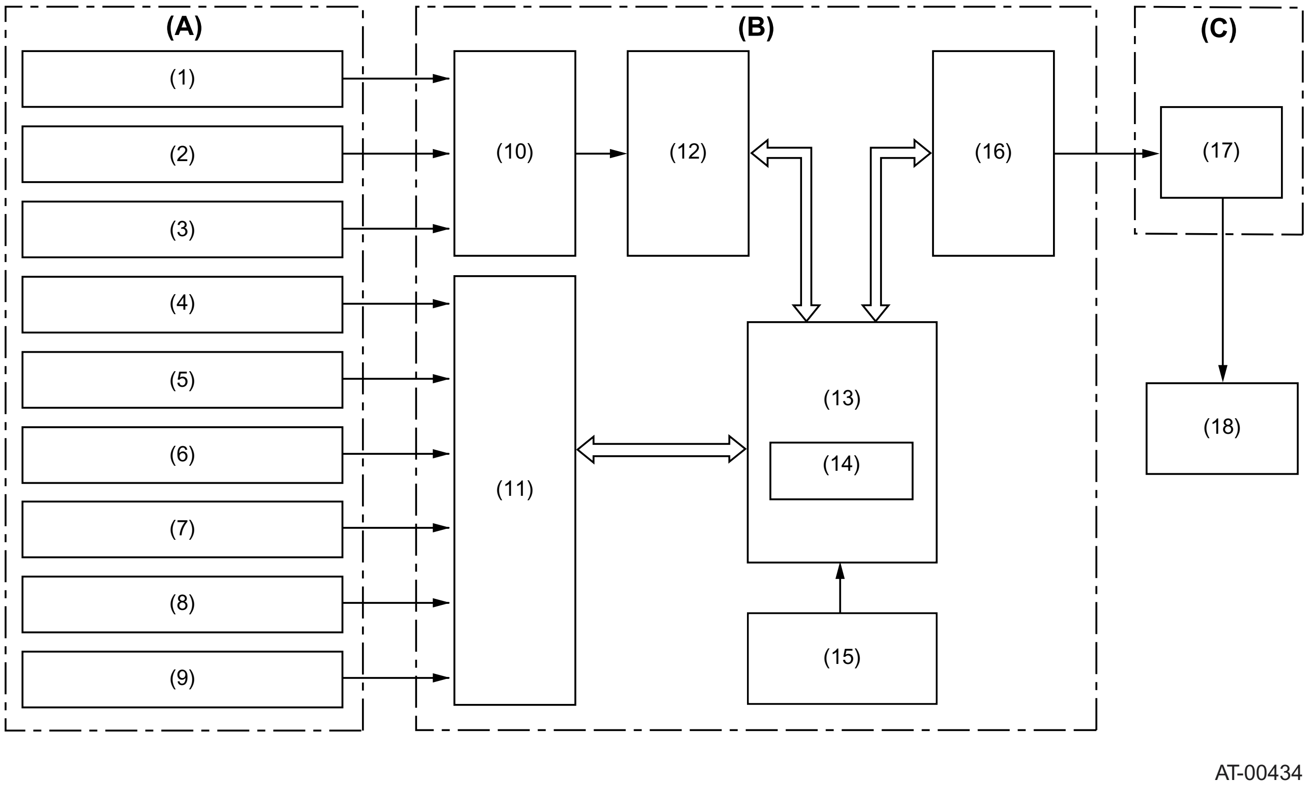
If the selector lever is moved to the R position during driving at a speed faster than the predetermined speed, the low clutch timing solenoid is energized.Then, the pilot pressure is supplied to the reverse inhibitor valve.This causes the reverse inhibitor valve to move downward, closing the low & reverse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

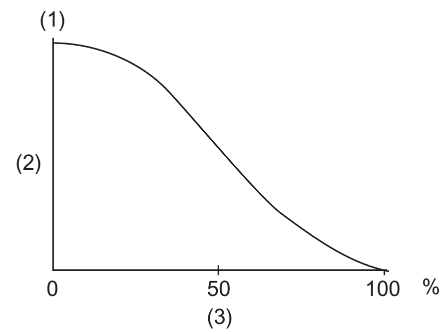
(1)	Line pressure	(6)	Manual valve (P range)	(11)	Low & reverse brake (released)
(2)	Pilot pressure	(7)	Drain	(12)	Low clutch
(3)	1st reducing valve	(8)	Shift valve B	(13)	2-4 brake
(4)	Shift valve A	(9)	Low-clutch timing solenoid	(14)	Reverse clutch
(5)	ON	(10)	Reverse inhibitor valve	(15)	High clutch

K: AWD TRANSFER CLUTCH CONTROL (MPT MODELS)



(A)	Sensor	**(B)**	TCM	**(C)**	Actuator
(1)	Battery pressure	(7)	FWD switch	(13)	CPU
(2)	Throttle position sensor	(8)	Brake switch	(14)	Memory
(3)	ATF temperature sensor	(9)	ABS signal	(15)	Constant voltage power 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

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	 AT-00435 (1) Ordinary control (2) Transfer clutch capacity (3) Duty-ratio

2. 1 RANGE CONTROL

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

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: AWD CENTER DIFFERENTIAL CONTROL (VTD MODELS)

1. CONTROL DESCRIPTION

The TCM controls the engagement of the center differential's multi-plate clutch (LSD) using maps that are pre-programmed based on the throttle opening and engine speed.It selects a map according to driving conditions and use it as the control basis.

2. ORDINARY CONTROL

The torque input to the multi-plate clutch is calculated according to various factors such as intake manifold pressure, torque converter turbine speed and selected speed gear.Based on the calculation result, the basic coupling force of the clutch is determined.

The basic coupling force thus obtained is then corrected according to the road slipperiness (which is determined based on steering angle, yaw rate, lateral G signals from the VDC control module) and the feedback correction factor which is used for making the actual yaw rate agree with the yaw rate estimated from the steering angle sensor signals.

3. START CONTROL

When the vehicle speed is 0 km/h (0 MPH), the TCM makes control to generate differential action limiting torque that is proportional to the throttle angle.

This enables the vehicle to start smoothly without swerving even on a slippery road.

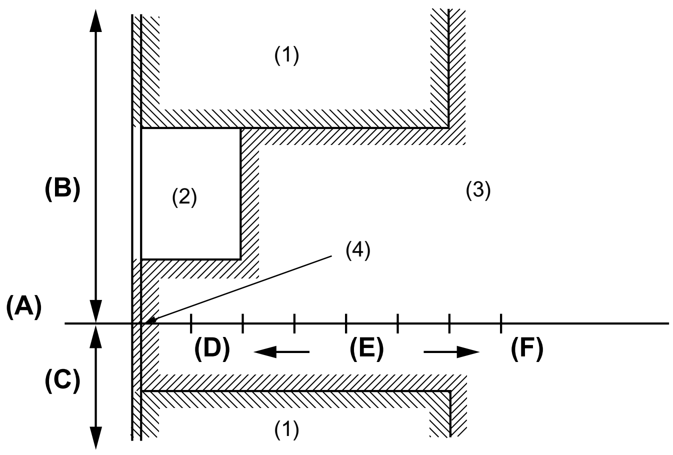
4. TURNING CONTROL

The TCM makes a correction such that the input torque to the multi-plate clutch is reduced as the steering angle increases.

This function is performed to improves turning performance at certain vehicle speed range.

5. SLIP CONTROL

When front or rear wheels start slipping with the vehicle running slower than the predetermined speed, the TCM makes control to increase the differential action limiting torque.
This function maintains traction and improves driving stability.



(A)	Front and rear wheel speed ratio	(1)	Slip control
(B)	Front wheel slip	(2)	Turning control
(C)	Rear wheel slip	(3)	Ordinary control
(D)	Low	(4)	Start control
(E)	Vehicle speed		
(F)	High		

6. ABS CONTROL

When the TCM receives an ABS operation signal from the ABS unit, it adjusts the differential action limiting torque to the predetermined level and selects the 3rd gear in which the one-way clutch is freewheeling.
This function improves ABS control.

7. BASE BRAKE CONTROL

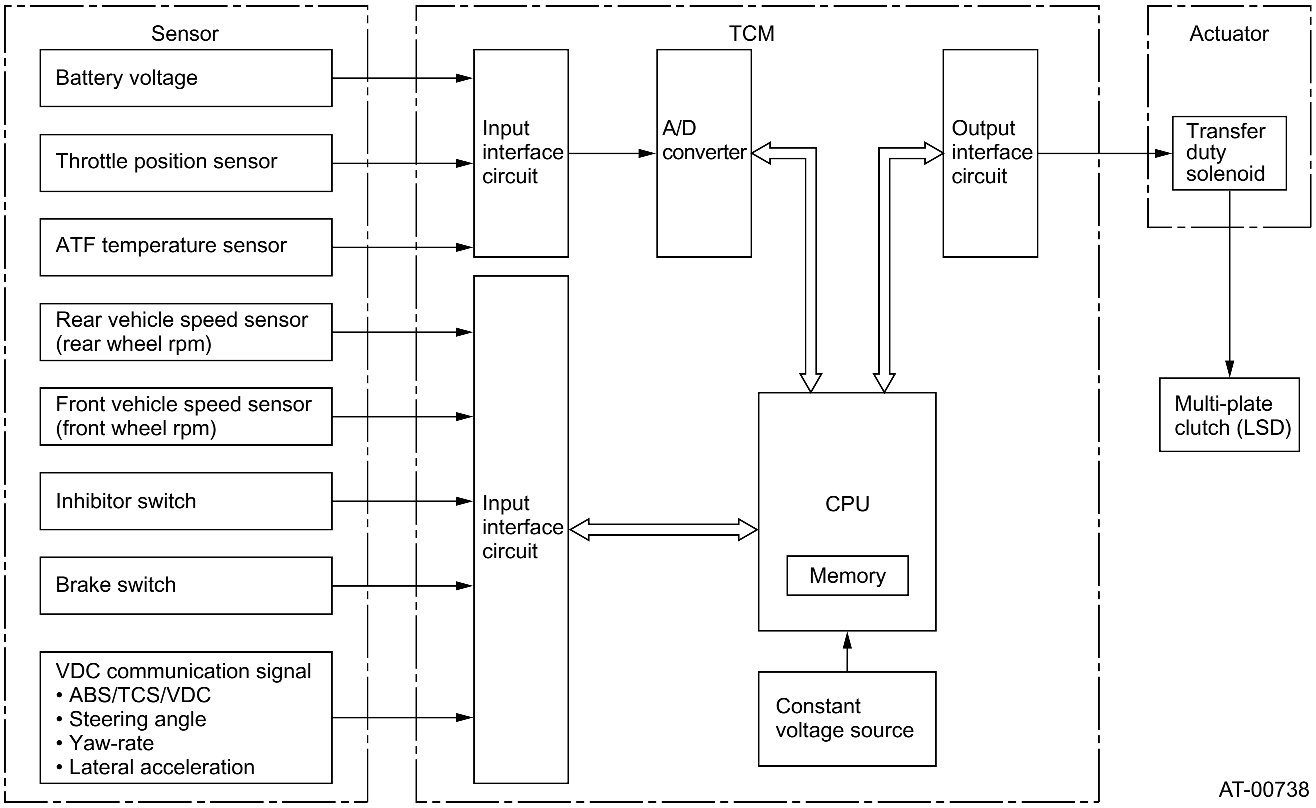
When the brake switch is ON and the throttle valve is fully closed, the TCM makes control to decrease the differential action limiting torque.The ABS control has priority over this control.
This function improves stability during braking.

8. 1 RANGE CONTROL

When the 1 range is selected, the TCM makes control to increase the differential action limiting torque.
This function improves driving performance and traction.

9. CONTROL SYSTEM

The TCM is constantly monitoring the driving conditions of the vehicle using the eleven input signals.Based on the conditions it has determined, the TCM adjusts the duty ratio of current to the transfer duty solenoid thus changing the engagement of the multi-plate clutch.The input signals are used also for automatic transmission control.



M: TRANSFER CONTROL

1. MPT MODELS

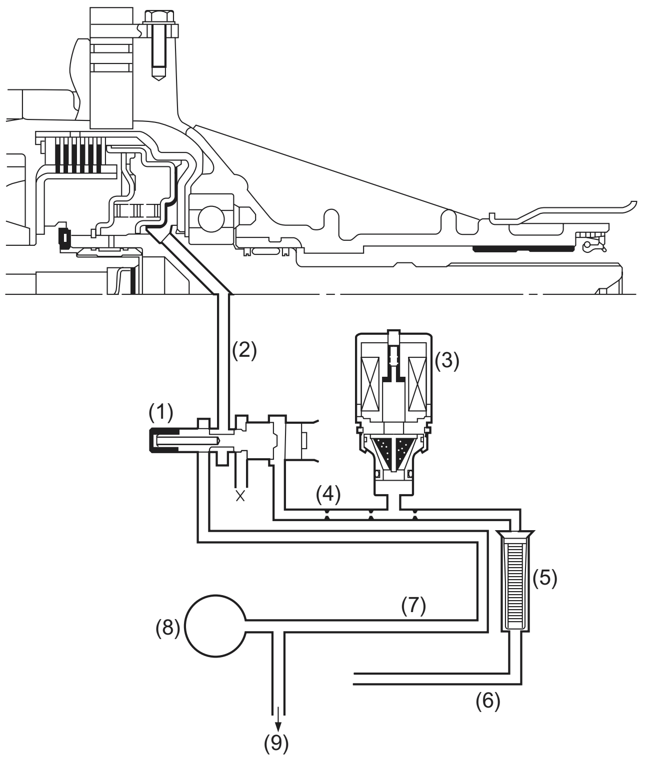
The transfer hydraulic pressure control unit includes a valve body attached to the side of the extension case through a gasket and separator plate.

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 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.



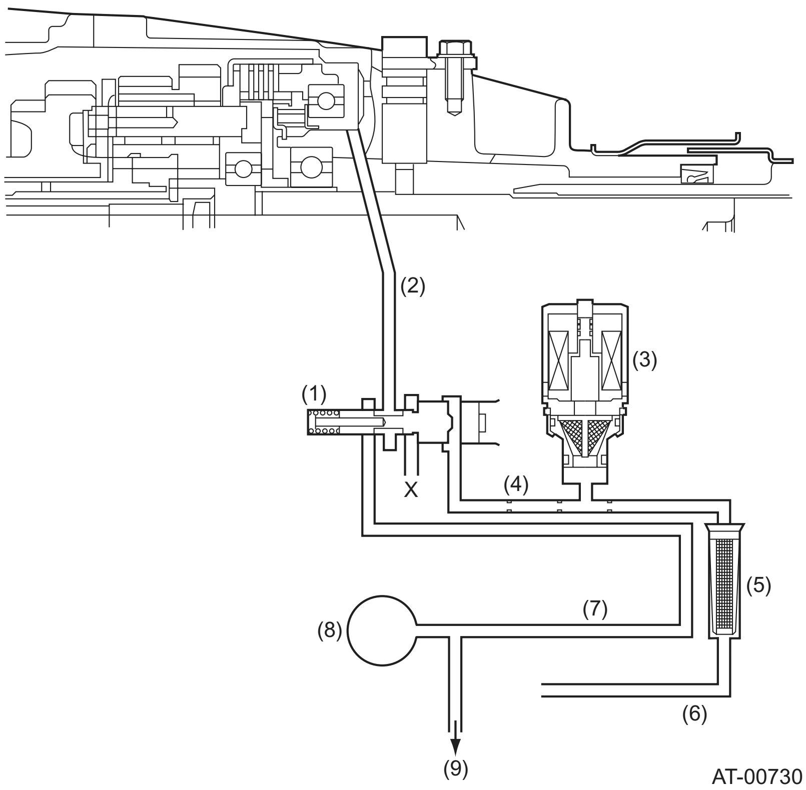
(1) Transfer control valve	(4) Transfer pressure	(7) Line pressure
(2) Transfer clutch pressure	(5) Filter	(8) Oil pump
(3) Transfer duty solenoid	(6) Pilot pressure	(9) Control valve

2. VTD MODELS

The drive power distribution system includes a valve body attached to the side of the extension case through a gasket and separator plate.
The pressurized fluids for the drive power distribution system (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 pilot pressure created by passing through the pilot valve in the transmission's hydraulic control assembly is further regulated into the transfer pressure by the transfer duty solenoid.
- The transfer duty solenoid is controlled by the TCM.The TCM changes the solenoid controlling duty ratio according to driving conditions.
- The transfer pressure thus created 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 multi-plate clutch (LSD) and engages the clutch to a controlled degree.

In this way, the degree of multi-plate clutch engagement is varied so that optimum torque is distributed to the rear wheels.



(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

N: SPORTS SHIFT CONTROL

When the select lever is moved to the sports shift gate side, the TCM interprets this as the shift pattern is switched to the sports shift mode.In this state, moving the select lever forward (“+” direction) will cause an upshift and moving the lever rearward (“–” direction) will cause a downshift to occur. However, if there is a possibility of the engine speed to go out of the preset shifting range, the following control is performed.

- Upshift inhibiting and auto downshift control

The gear upshifts from 1st to 4th speed, one by one for each time the select lever is moved forward (“+” direction).However, when the vehicle speed is too low for the gear speed, the TCM inhibits further upshifting.If the vehicle speed becomes even slower, a downshift will be made to prevent engine stall.When the vehicle comes to a stop, the transmission will always be controlled to shift to 1st speed.

- Downshift inhibiting control

The gear downshifts from 4th to 1st speed, one by one for each time the select lever is moved rearward (“–” direction).However, when the vehicle speed is too high for the gear speed, the TCM inhibits further downshifting.A buzzer will sound to warn the driver.

- If the engine speed exceeds the preset value during accelerating, the fuel supply is cut to prevent over-revving of the engine.

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.

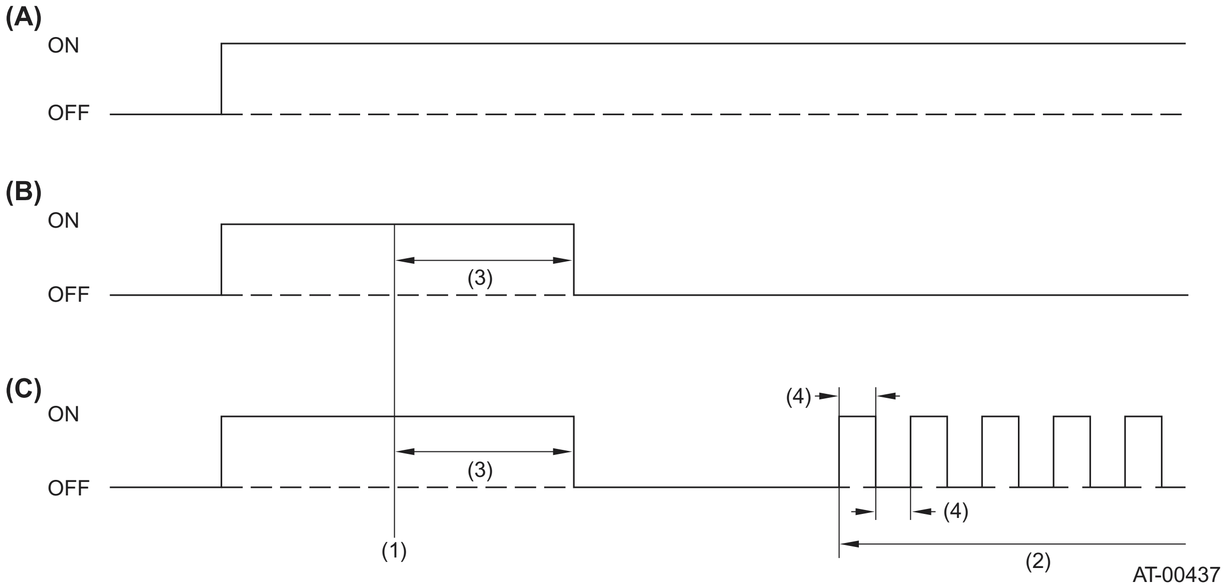
Rear vehicle speed sensor	Transfer duty solenoid	Low-clutch timing solenoid
Front vehicle speed sensor	ATF temperature sensor	Torque converter turbine speed sensor
Throttle position sensor	Engine speed signal circuit	Sports shift solenoid
Shift solenoid 1	Line pressure duty solenoid	VDC communication system
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 AT OIL TEMP warning 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 AT OIL TEMP WARNING LIGHT

On starting the engine, the AT OIL TEMP warning light illuminates and then goes out as shown in the “Normal” diagram below. If any problem exists, the warning light continues flashing as shown in the Abnormal diagram below.



(A) Ignition switch ON (engine OFF)
(B) Normal
(C) Abnormal

(1) Engine cranking
(2) Blink
(3) 2 seconds
(4) 0.3 seconds

C: DIAGNOSTIC TROUBLE CODES

DTC	Faulty component
11	Engine speed signal circuit
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
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
78	Sports shift solenoid
79	Transfer duty solenoid
86	VDC communication
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.

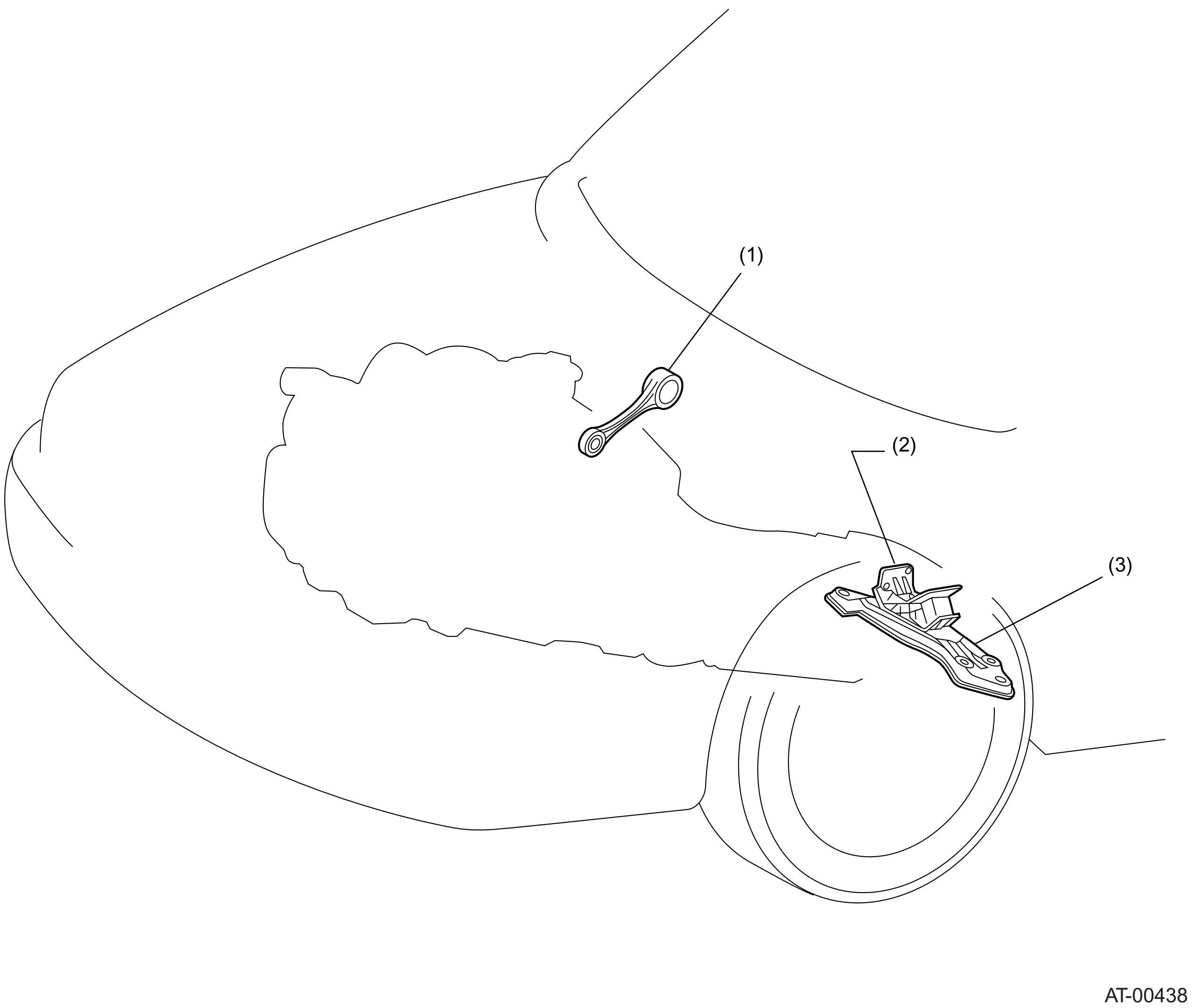
- Torque converter turbine speed sensor

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

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.



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

1. General

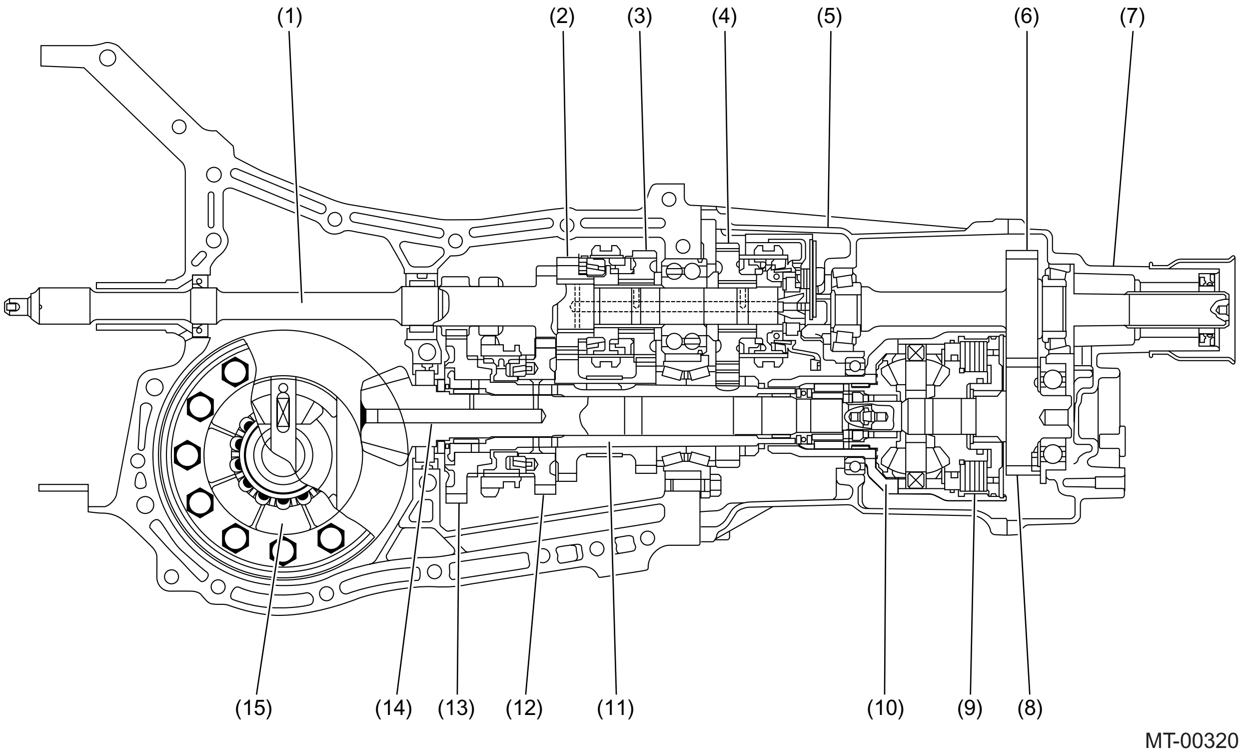
The single-range manual transmission is of a full-time all-wheel-drive design integrating a transmission assembly, front differential, and transfer gear assembly with center differential into a single unit. The transmission creates five forward speeds and one reverse using the corresponding gears all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



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

2. 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.

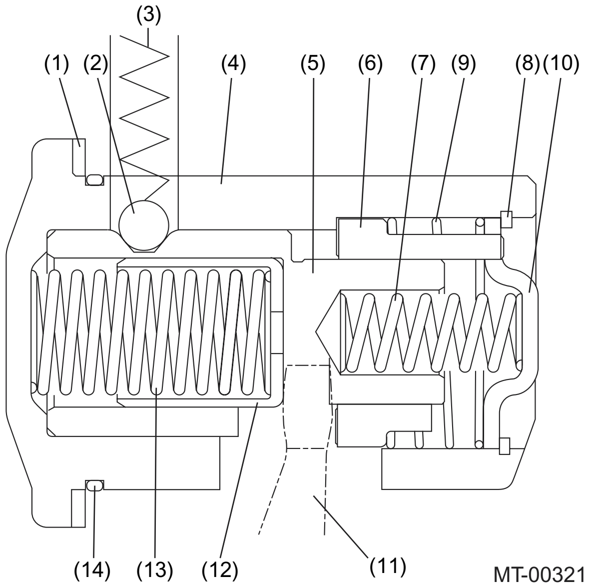
The reverse accent shaft has hollows in both ends.In the left end hollow are the 1st return spring and its cap and in the right end hollow is the reverse return spring which pushes the shaft leftward.

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.

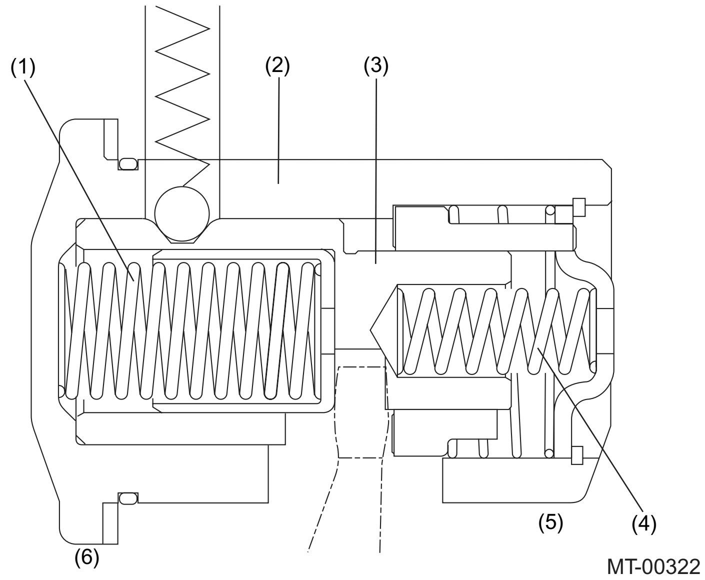


(1)	Select adjust shim	(6)	Reverse check cam	(11)	Selector arm
(2)	Detent ball	(7)	Reverse return spring	(12)	Spring cap
(3)	Reverse accent spring	(8)	Reverse check spring	(13)	1st return spring
(4)	Reverse check sleeve	(9)	Snap ring	(14)	O-ring
(5)	Reverse accent shaft	(10)	Reverse check plate		

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.

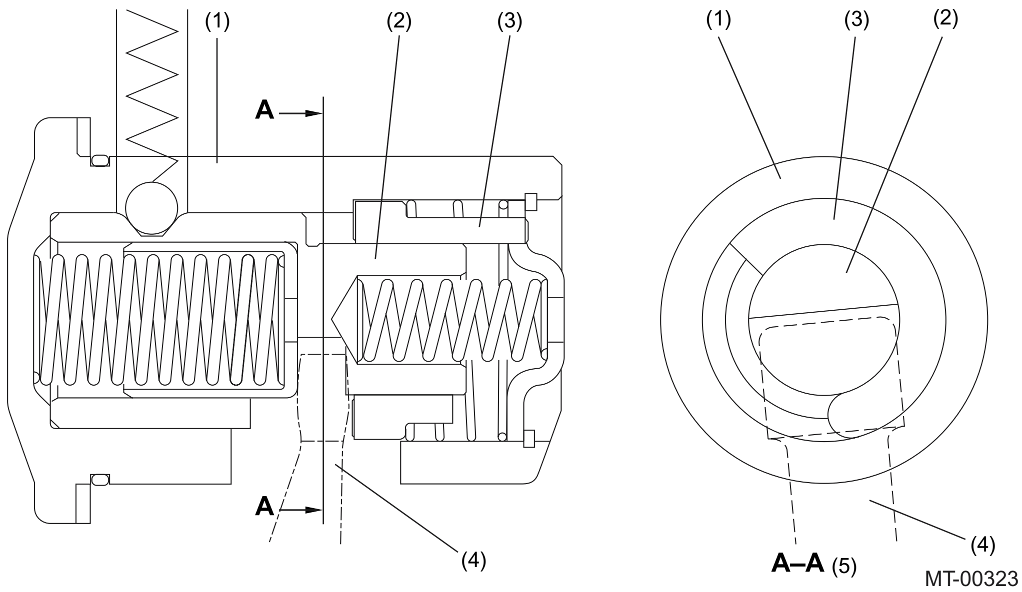
The following explanation describes how the selector arm and reverse check mechanism operate when the driver selects the 5th gear and then selects the reverse gear.



(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

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

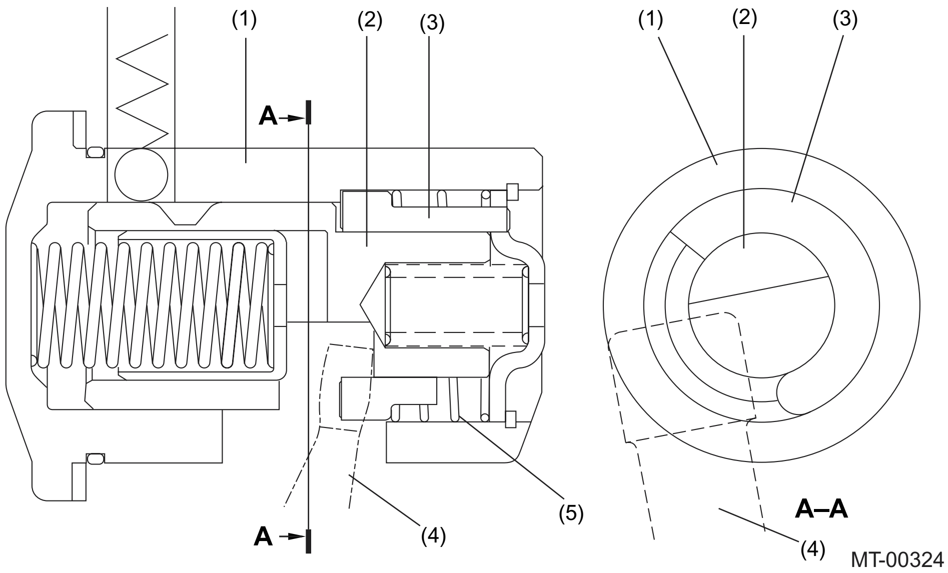
The selector arm moves rightward while pushing both the reverse accent shaft and reverse check cam simultaneously.



(1) Reverse check sleeve	(3) Reverse check cam	(5) Neutral position
(2) Reverse accent shaft	(4) Selector arm	

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.

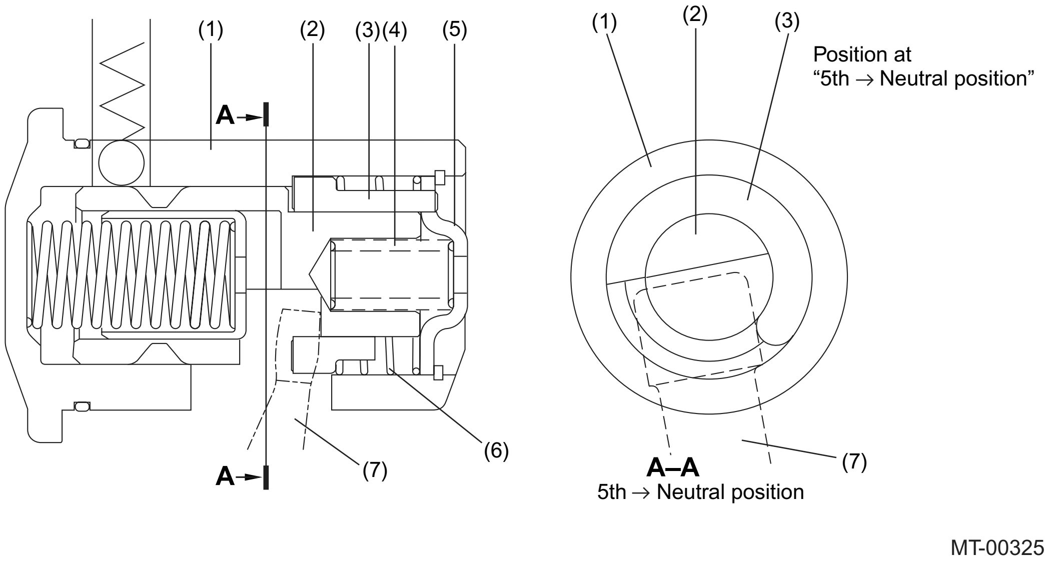


(1) Reverse check sleeve
(2) Reverse accent shaft
(3) Reverse check cam
(4) Selector arm
(5) Reverse check spring

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).

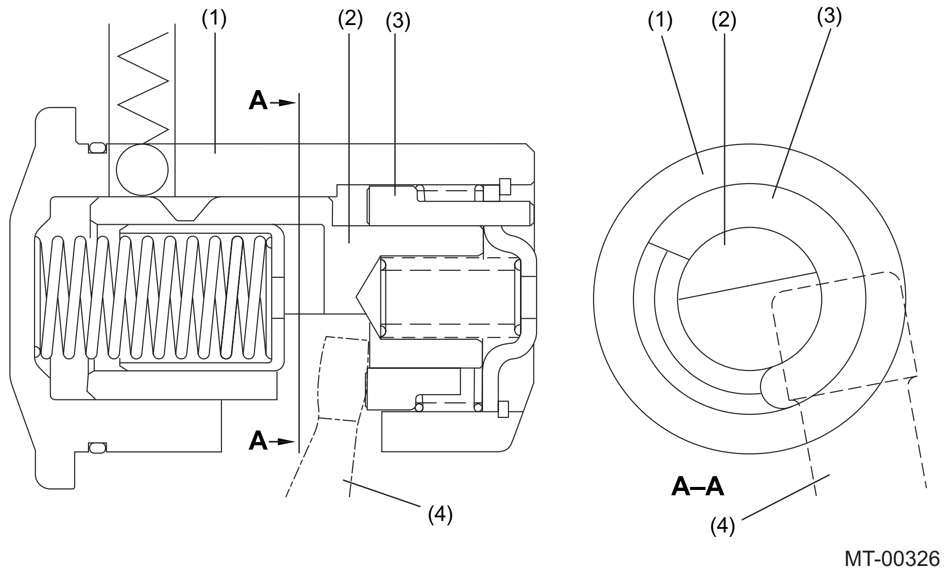
The reverse check cam, however, stops to rotate at a point where its stopper hits against the reverse check plate (this point corresponds to the neutral position in terms of the angle) and prevents the selector arm from moving toward the reverse gear selection direction.The selector arm is then axially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



(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

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.



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

3. Center Differential

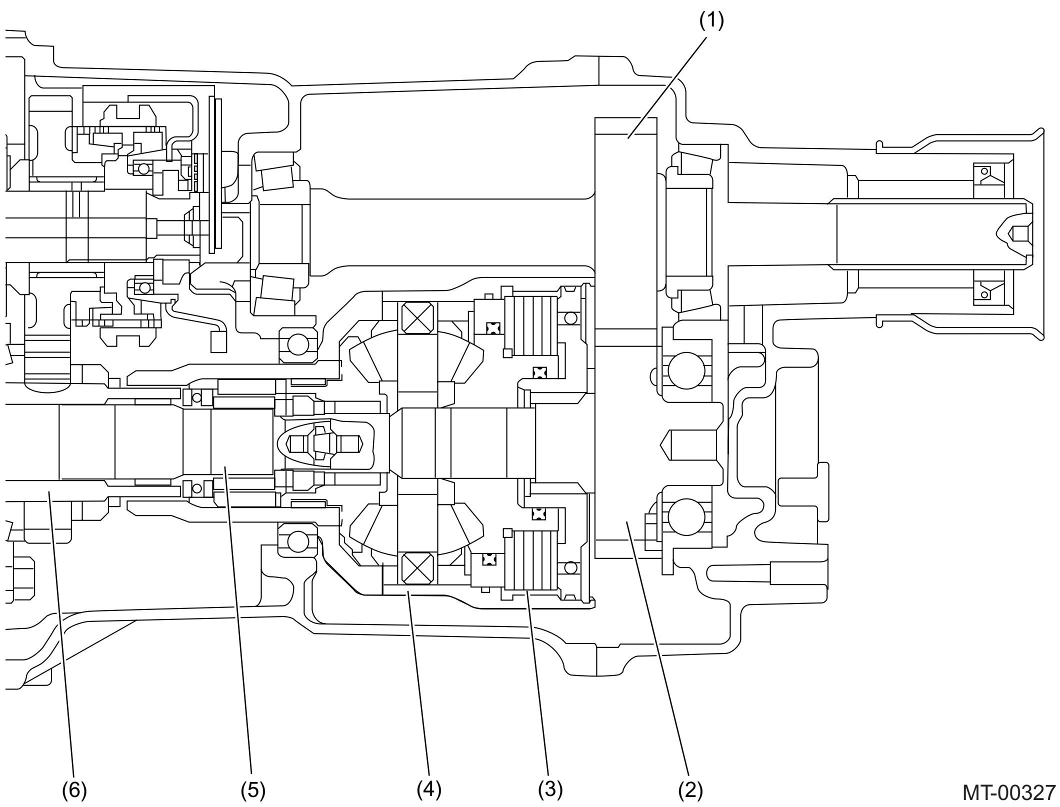
A: CONSTRUCTION

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 engine 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.

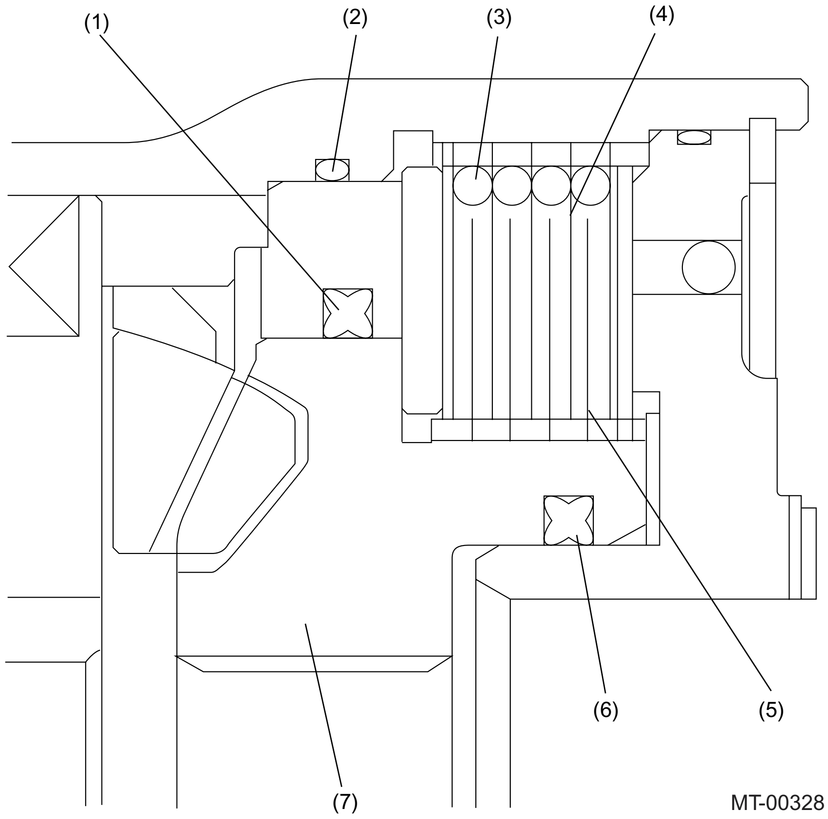
The viscous coupling limits the bevel gear set's differential action when either front or rear wheels spin so that adequate torques are transmitted to the front and rear wheels and proper traction is obtained.



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

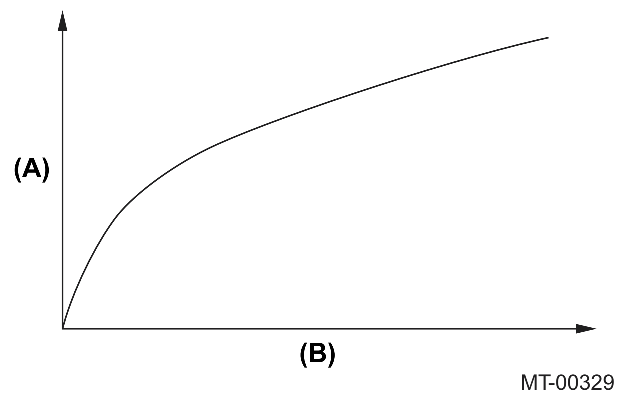


(1) X-section ring
(2) O-ring
(3) Spacer ring
(4) Outer plate
(5) Inner plate
(6) X-section ring
(7) Side gear (rear)

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) Driving 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”.

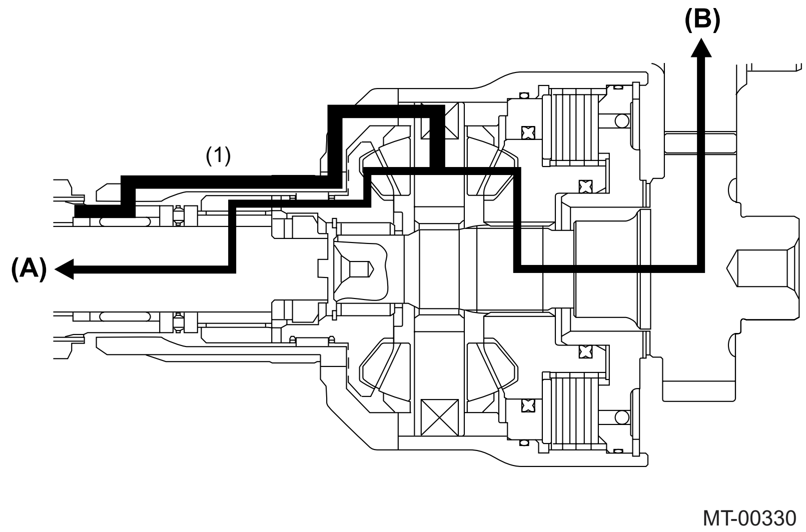
The hump eliminates the rotating speed difference between the center differential case and the rear side gear (or locks the differential), so soon after it has occurred, the internal pressure and temperature drop.The viscous coupling then returns to the normal viscosity shearing torque transmitting operation.(The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

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

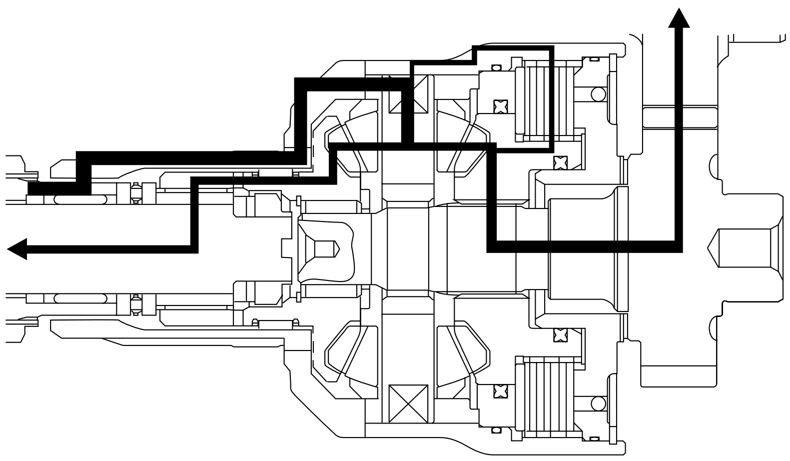
During straight-line driving on a flat road at a constant speed, all the four wheels rotate at the same speed.The center differential delivers engine torque evenly to the front and rear wheels.The viscous coupling does not generate viscosity shearing torque because there is no relative movements between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



(1) Engine torque **(A)** To front differential **(B)** To rear differential

2. DURING TURNS AT LOW SPEEDS

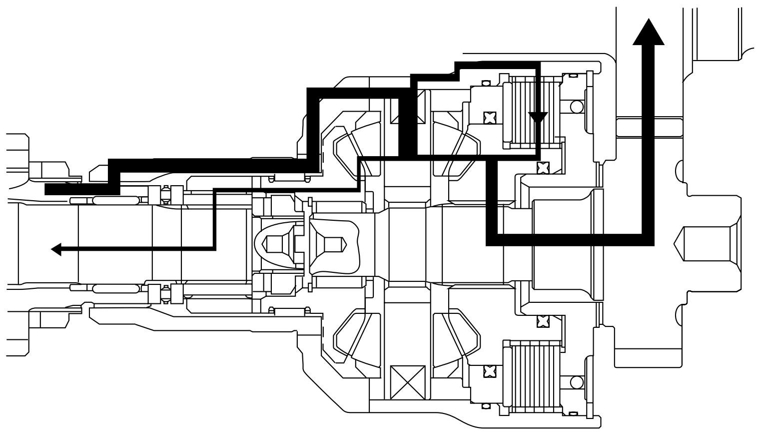
During turns at low speeds, rotating speed difference occurs between the front and rear wheels, as well as between the left and right wheels.More particularly, the front wheels rotate faster than the rear wheels.The center differential then acts to absorb the speed difference to enable smooth driving.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

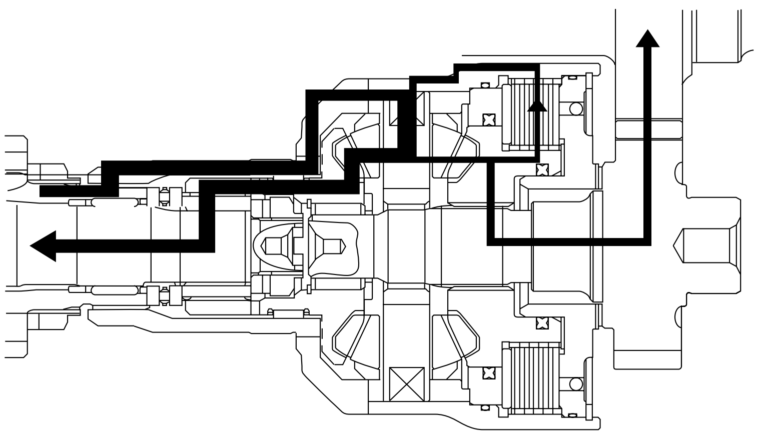
3. DRIVING ON ROUGH OR SLIPPERY ROADS

● 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.

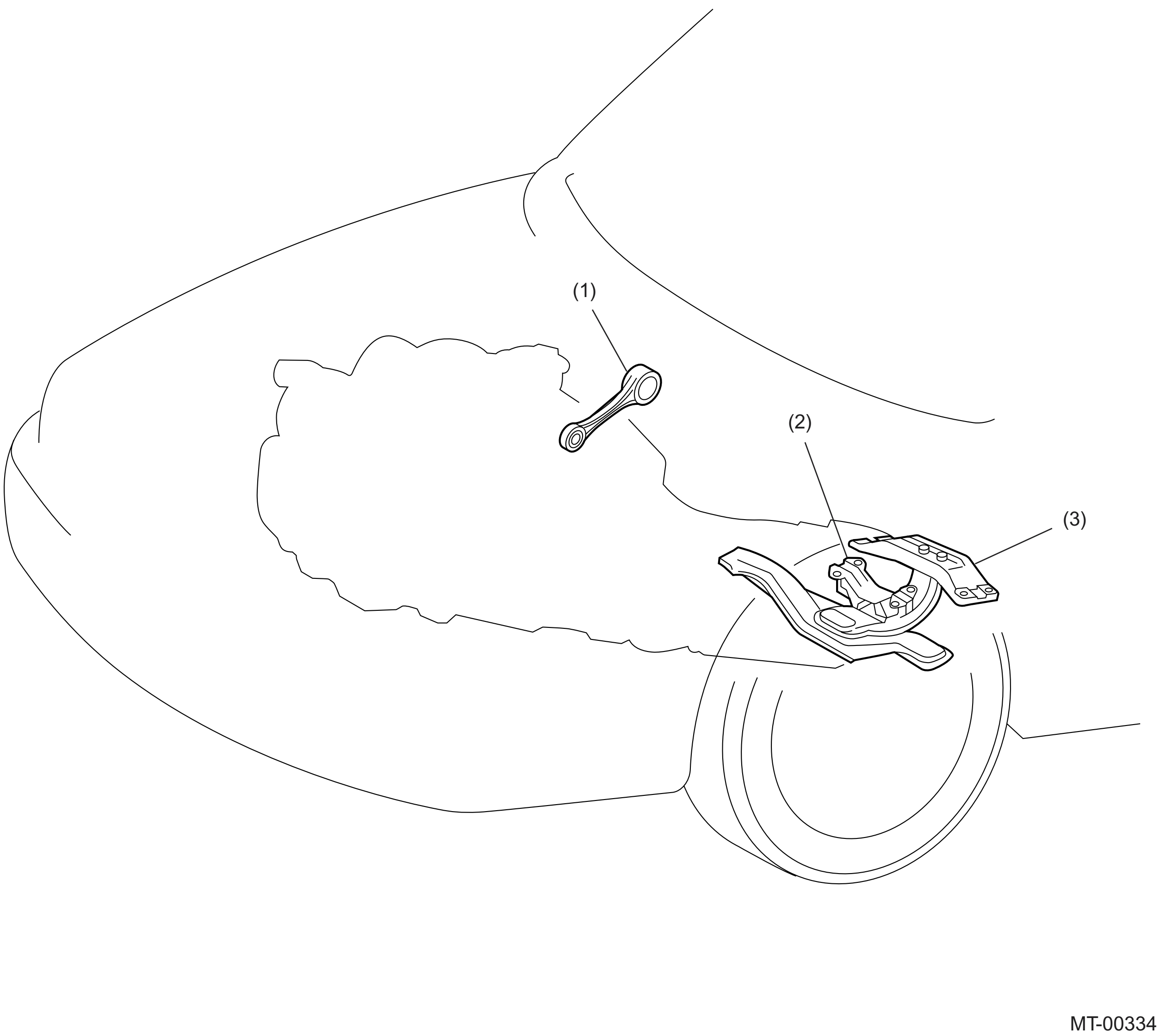


MT-00367

4. 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.



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

MEMO

1. General

● 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.

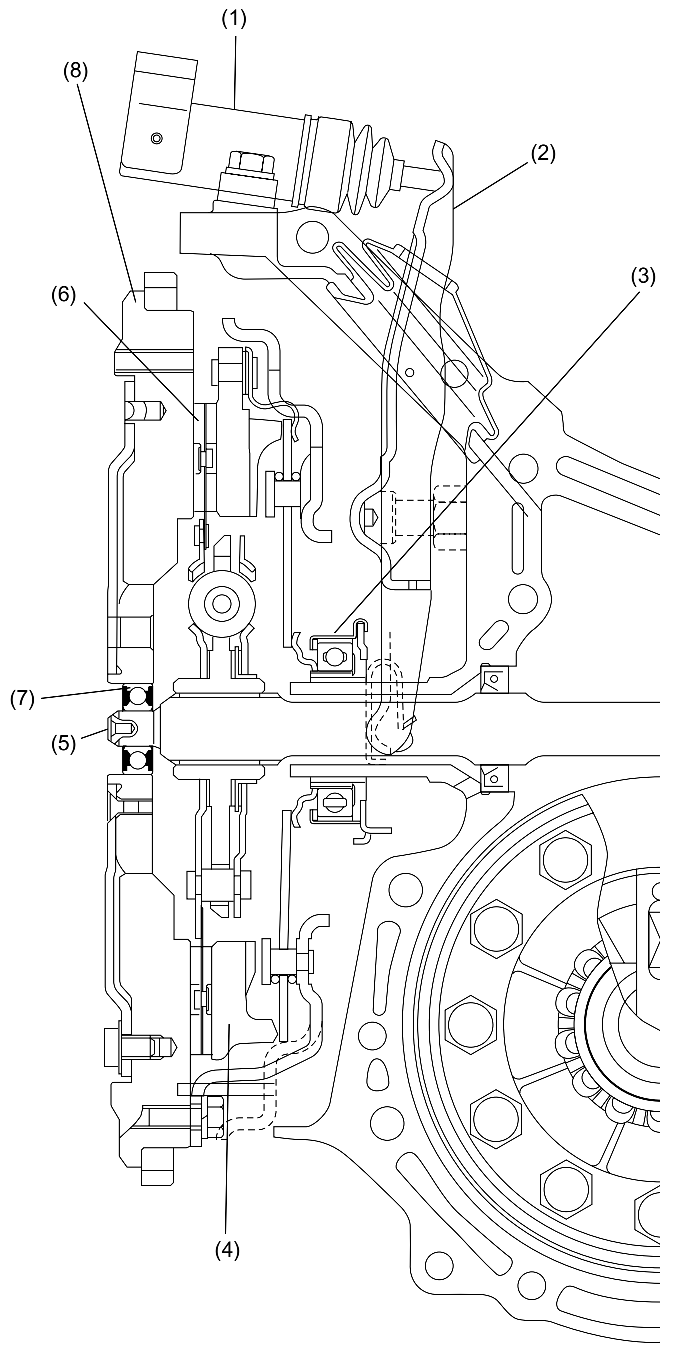
● Inside the clutch cover, there is a cover and a pressure plate combined with each other by means of strap plates, which also serve to prevent the pressure plate from relatively turning.

2. Operation

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.

3. Cross Sectional View



(1) Operating cylinder	(4) Clutch cover	(7) Pilot bearing
(2) Release lever	(5) Transmission main shaft	(8) Flywheel
(3) Release bearing	(6) Clutch disc	

4. Flywheel

A: GENERAL

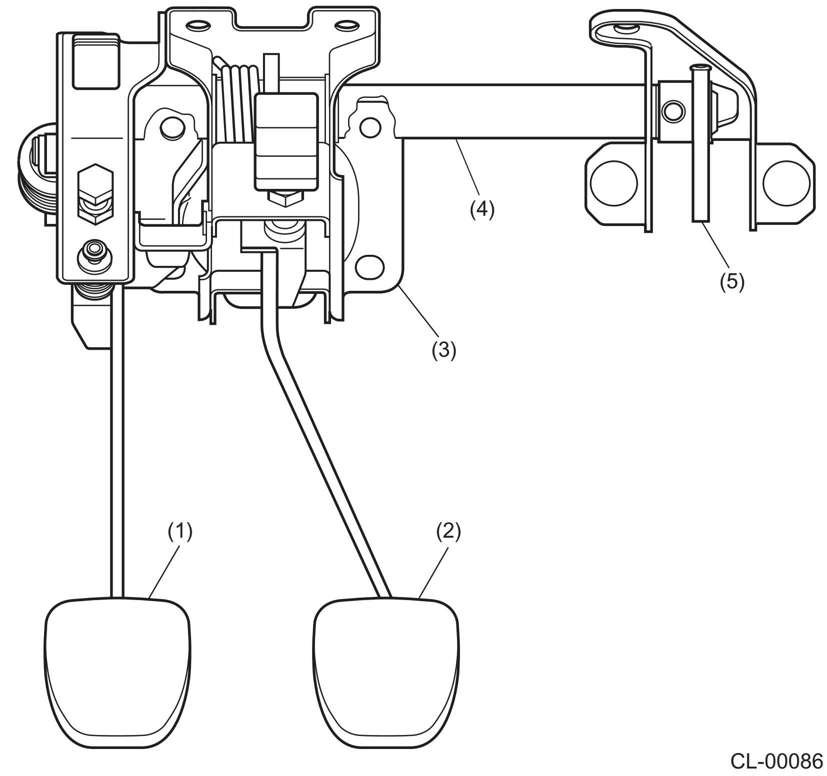
The flywheel is of a flexible type, consisting of a drive plate, reinforcement and mass flywheel.

This type of flywheel is characterized by less vibration and less noise, since it transmits the engine power from the crankshaft through the drive plate and mass flywheel to 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.
- A starter interlock mechanism is provided to prevent the engine from starting unless the clutch pedal is pressed.

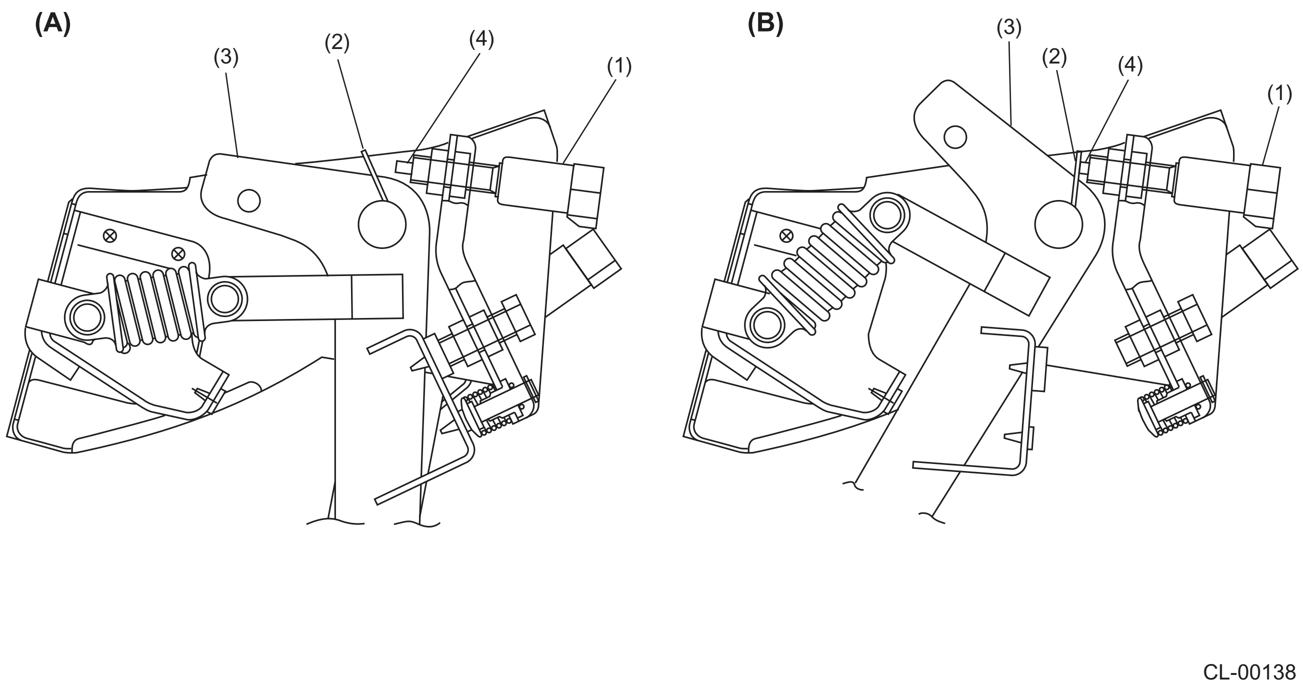


(1) Clutch pedal
(2) Brake pedal
(3) Brake and clutch pedal bracket
(4) Rod
(5) Lever

B: OPERATION

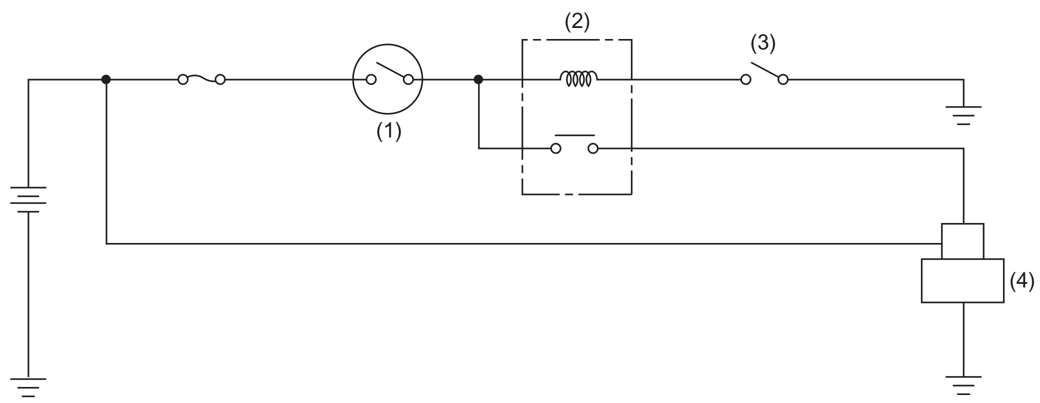
1. STARTER INTERLOCK MECHANISM

When the clutch pedal is fully depressed, the stopper on the pedal pushes the clutch switch pushrod inwards.
When the pushrod is pressed in, the switch turns ON and connects the ignition switch to the starter circuit enabling engine start.



(A) When clutch switch is OFF	**(B)** When clutch switch is ON
(1) Clutch switch	(3) Clutch pedal
(2) Stopper	(4) Pushrod

- CIRCUIT DIAGRAM



(1) Ignition switch
(2) Starter relay
(3) Clutch switch
(4) Starter motor

1. Front Suspension

A: GENERAL

The front suspension is a strut-type independent suspension, with cylindrical double-acting, oil-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. This type also maintains a wide distance between the upper and lower supporting points and makes adjustment of the caster unnecessary.

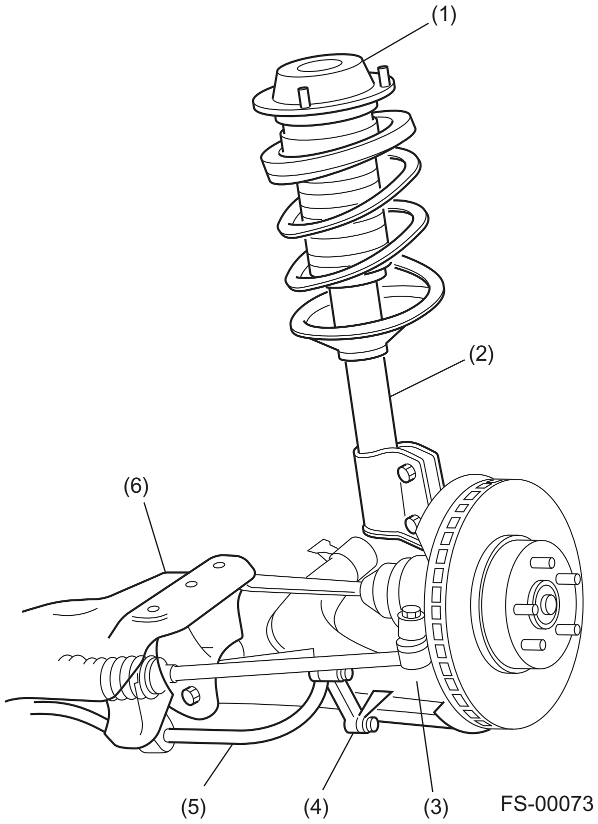
The transverse link is an “L” shaped arm design to increase steering stability and reduce road noise. The transverse link has a maintenance-free ball joint fitted by a castle nut at its outer end. The front of the link’s inner end is fitted to the front crossmember through a rubber cushion and the rear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

The lower end of the stabilizer link is connected to the transverse link through rubber bushings.

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



(1)	Strut mount	(4)	Stabilizer link
(2)	Strut	(5)	Stabilizer
(3)	Transverse link	(6)	Front crossmember

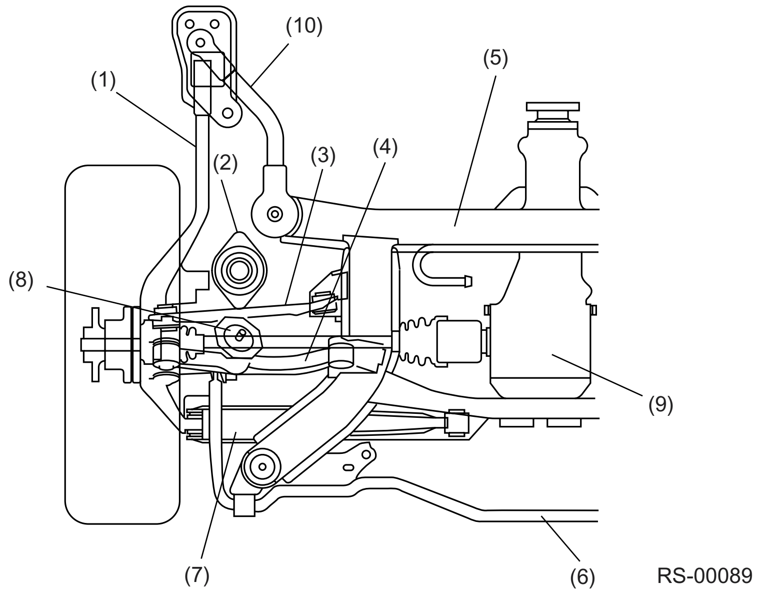
MEMO

1. Rear Suspension

A: GENERAL

The rear suspension is a multilink type. This type of suspension is characterized by small changes in camber and toe-in against external input of vertical, longitudinal and lateral forces. This enables full use of tire performance and ensures high kinetic performance and stability of the vehicle.

This suspension also features quiet operation because the front link, rear link, upper link and rear differential are all attached to a subframe which in turn is installed to the vehicle body through heavy-duty bushings.



(1)	Rear arm	(5)	Subframe	(9)	Rear differential
(2)	Shock absorber and coil spring	(6)	Stabilizer	(10)	Support subframe front
(3)	Front link	(7)	Rear link		
(4)	Upper link	(8)	Helper		

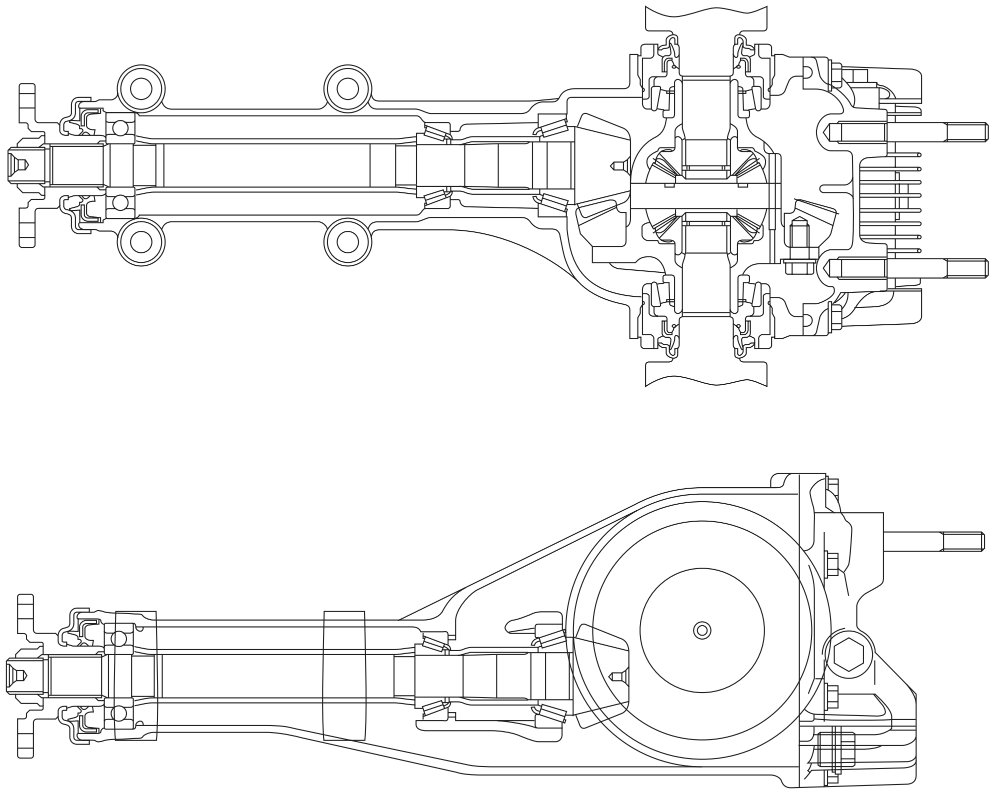
Component	Key feature	Function
Rear arm	Made of cast iron for sufficient rigidity.	Supports longitudinal dynamic load.
Front link	Made of sheet metal with U-shaped section for sufficient rigidity.	Supports lateral dynamic load.
Rear link	Made of sheet metal with U-shaped section for sufficient rigidity.	Supports lateral dynamic load.
Upper link	Made of cast iron for sufficient rigidity against impact from helper when suspension is bumped.	Supports lateral dynamic load.
Shock absorber and coil spring	Overall length is optimally minimized to eliminate protrusion into the passenger compartment.	Supports and controls vertical dynamic load.
Stabilizer	Ball joint type stabilizer link is used to minimize transient rolling of the body.	Controls body rolling.
Helper	Attached to the body independently of shock absorber to avoid its protrusion into the passenger compartment.	Combined with upper link to serve as vehicle bump stopper.
Subframe	Attached to the body through heavy duty bushings for quiet operation.	Supports front link, rear link, upper link and rear differential.
Support subframe front	Made of steel pipe whose ends fixed to the rear arm bracket and subframe.	Improves steerability.

MEMO

1. Rear Differential

A: VA-TYPE

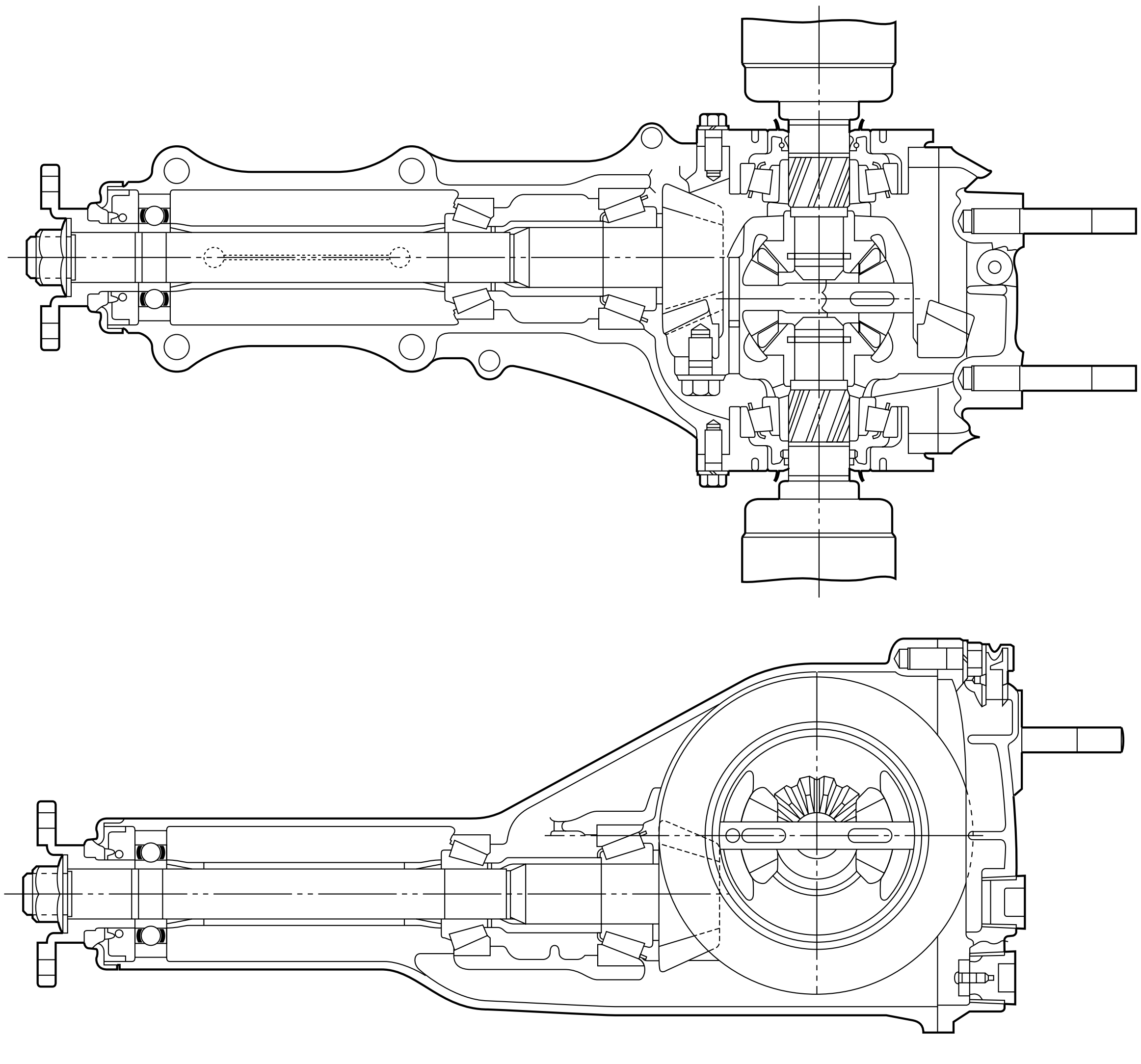
The drive gear is a hypoid gear with nominal diameter of 152 mm (5.98 in).The drive pinion shaft is supported by three bearings.The bearing preload is adjusted by selecting a spacer and washer combination of a proper thickness.The drive pinion height is adjusted by properly selecting the thickness of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



DI-00307

B: T-TYPE

The drive gear is a hypoid gear with 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-00231

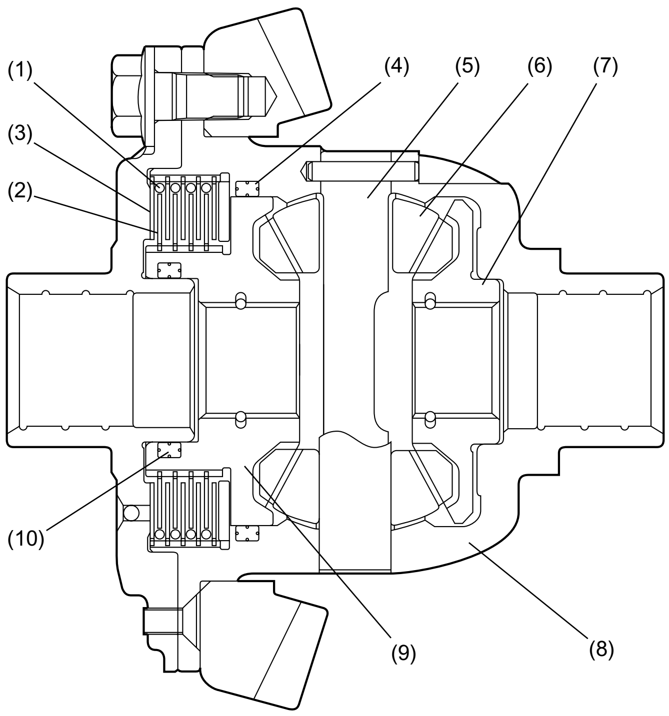
2. Limited Slip Differential (LSD)

A: GENERAL

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.



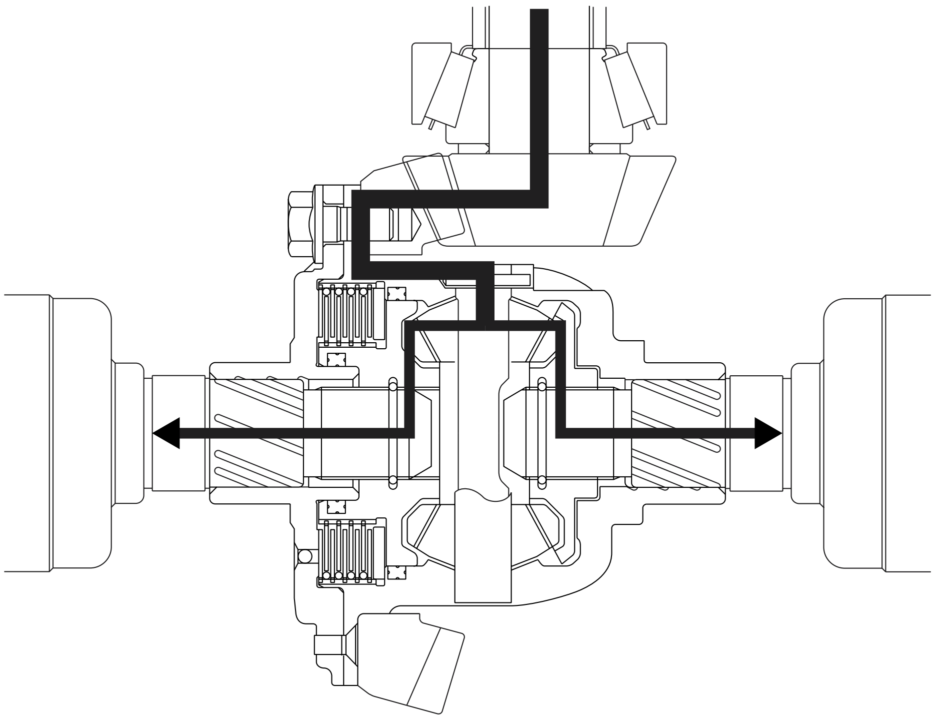
DI-00295

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

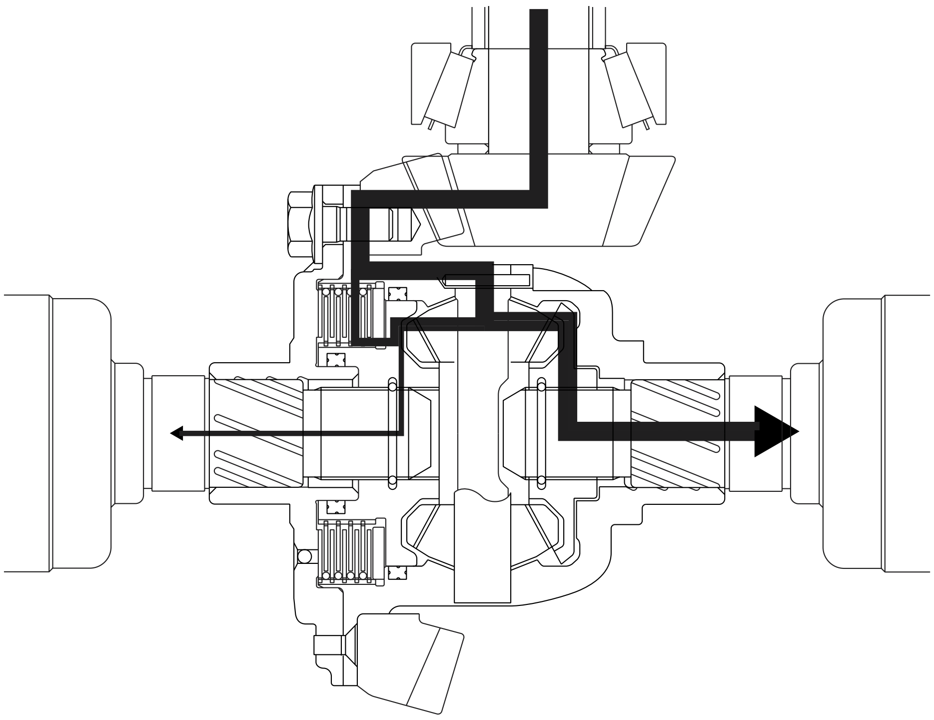


DI-00296

2. WHEN RIGHT AND LEFT WHEELS ROTATE AT DIFFERENT SPEEDS

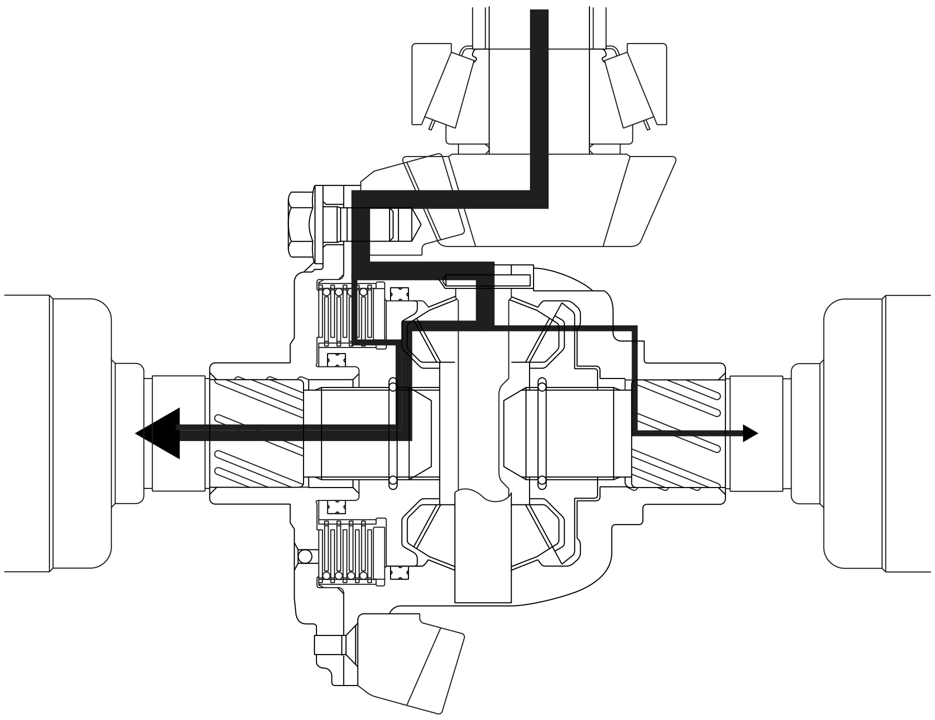
When a speed difference occurs between the right and left wheels, the differential case and the left side gear do not rotate at the same speed any more.The speed difference between them corresponds to that between both the wheels.Because of the viscosity shearing force caused in the silicone oil, a differential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

MEMO

1. Center Differential

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

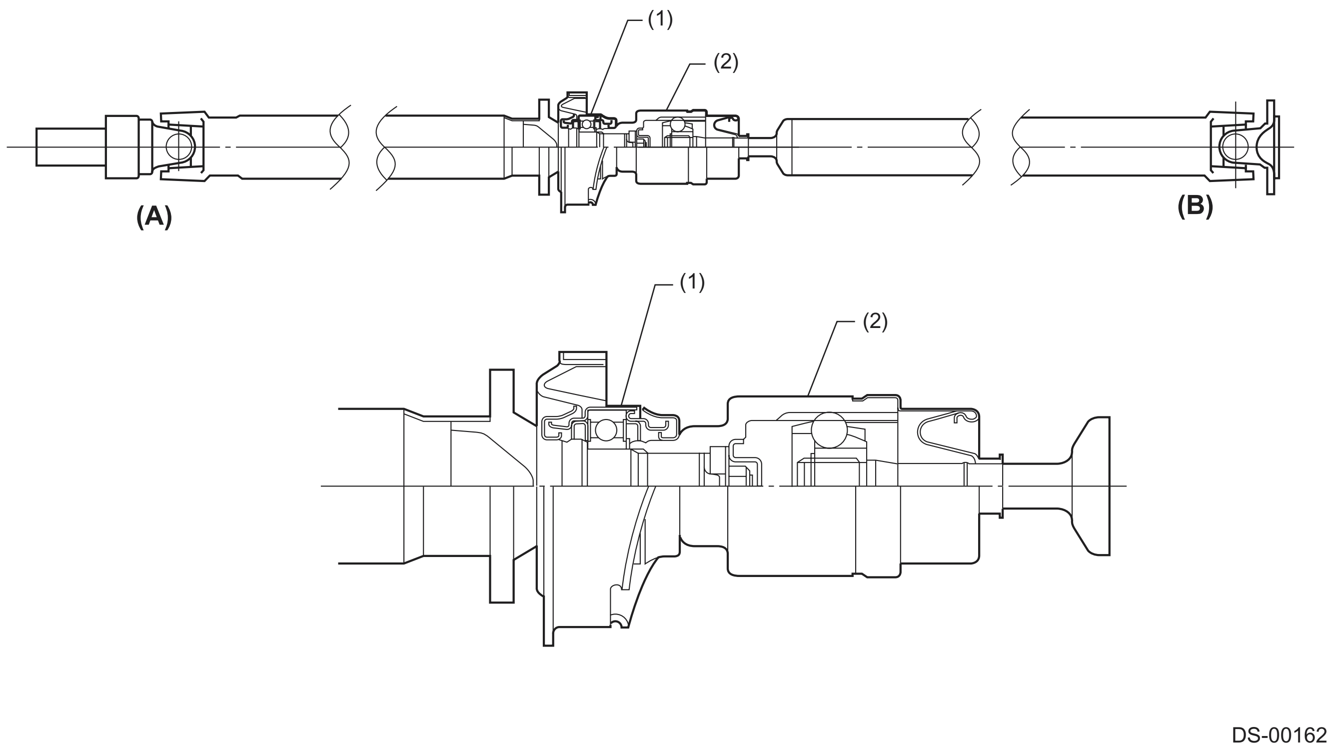
2. AWD Transfer System

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

MEMO

1. Propeller Shaft

The propeller shaft uses constant velocity joints for quiet operation of the driveline components. The center joint is a double offset joint (DOJ) type which can extend and retract in the axial directions.



(1) Center bearing
(2) Double offset joint (DOJ)

(A) Transmission side
(B) Rear differential side

MEMO

2. Front Axle

A: GENERAL

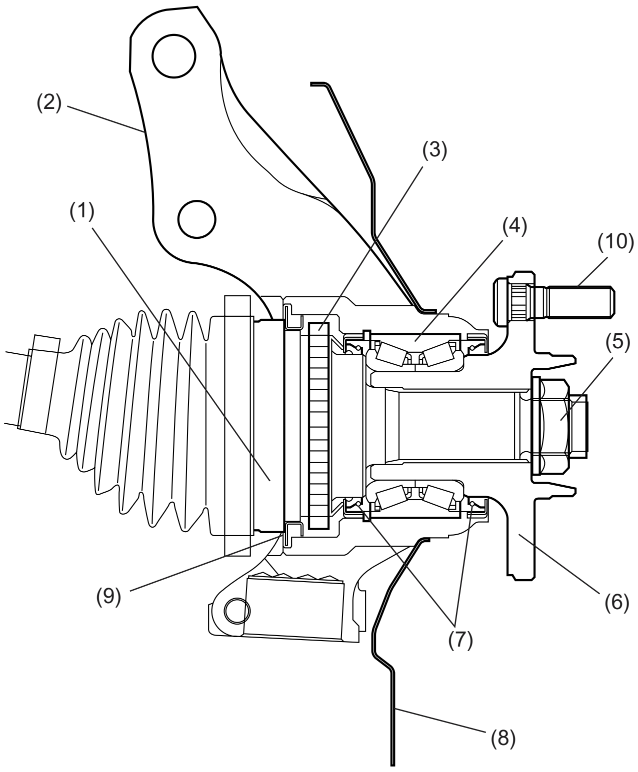
- The inboard end of each axle shaft is connected to the transmission via a constant velocity joint (shudder-less free ring tripod joint: SFJ) which is flexible in the axial directions while the outboard end is connected via a bell joint (BJ) to the wheel hub which is supported by a taper roller bearing located inside the axle housing. The BJ features a large operating angle.
Both the constant velocity joints (SFJ and BJ) ensure smooth, regular rotation of the drive wheels with minimum vibration.
- The bearing is a preloaded, non-adjustable tapered roller unit bearing.
Each hub is fitted in the axle housing via the tapered roller bearing.
- The BJ'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.

1) 3.0L ENGINE MODEL

- The hubs are induction-hardened.

2) 2.5 L ENGINE MODEL

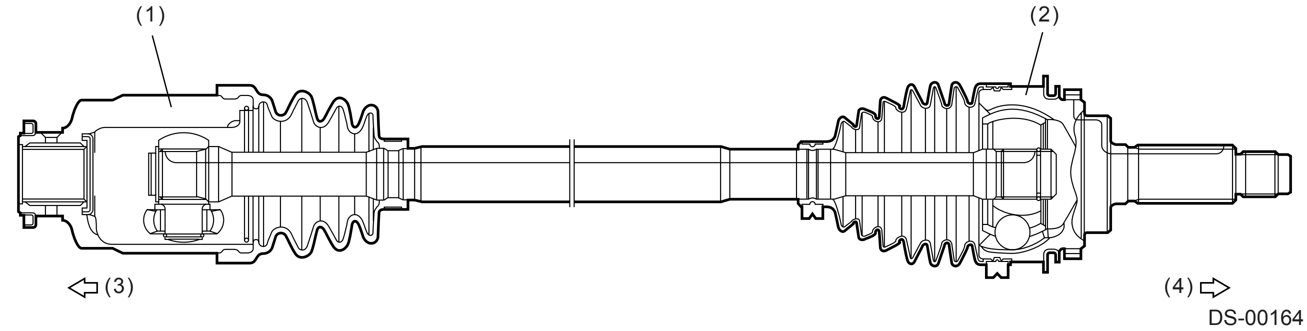
- The hubs are same as those used in the previous model.



(1)	Bell joint (BJ)	(5)	Axle nut	(9)	Baffle plate
(2)	Axle housing	(6)	Hub	(10)	Hub bolt
(3)	Tone wheels	(7)	Oil seal		
(4)	Bearing	(8)	Brake backing plate		

B: FRONT DRIVE SHAFT

- A shudder-less free ring tripod joint (SFJ) is used on the differential side of each front drive shaft. The SFJ can be disassembled for maintenance. It provides a maximum operating angle of 25° and can be moved in the axial directions.
- A bell joint (BJ) is used on the wheel side of each front drive shaft. The BJ's maximum operating angle is 47.5°.

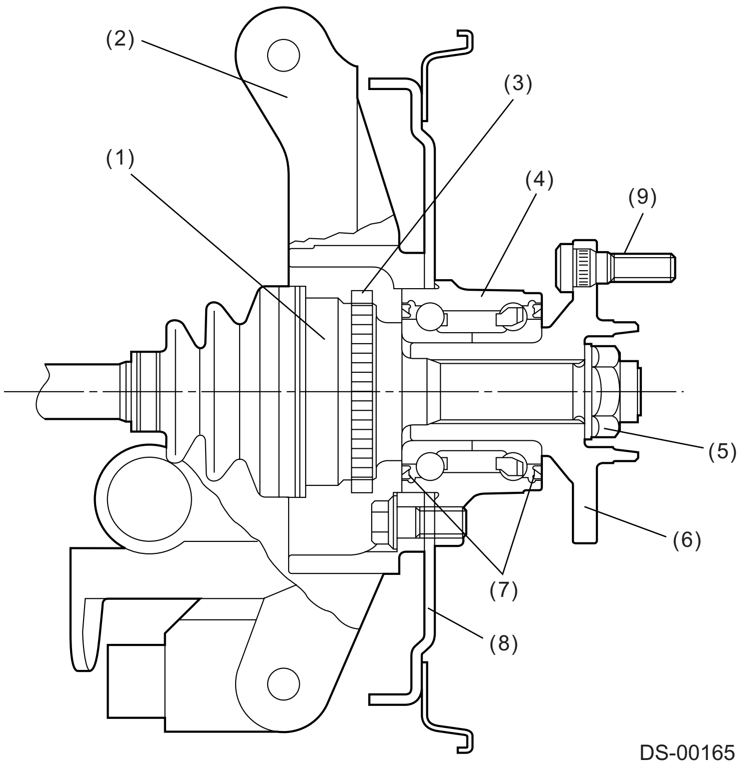


(1) Shudder-less free ring tripod joint (SFJ)
(2) Bell joint (BJ)
(3) Transmission side
(4) Wheel side

3. Rear Axle

A: GENERAL

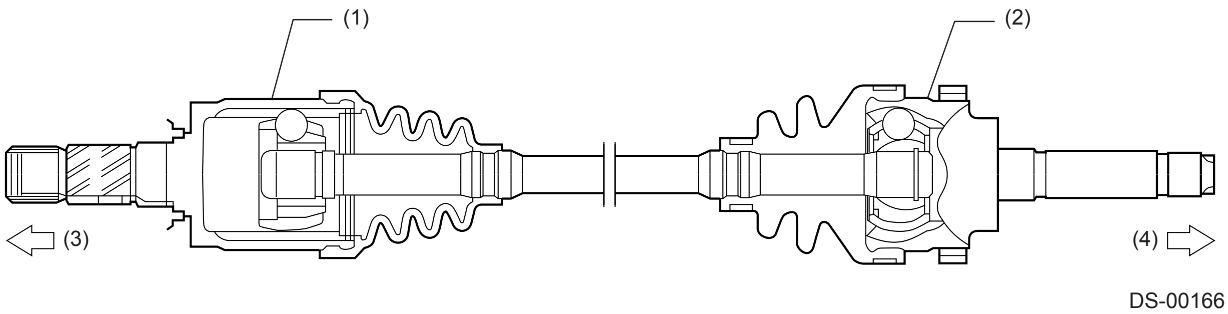
- The inboard end of each axle shaft is connected to the differential via a constant velocity joint (double offset joint: DOJ) which is flexible in the axial directions.
- The axle shafts outboard end is connected via a bell joint (BJ) to the wheel hub which is supported by the hub unit bearing. The BJ 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 hub unit bearing's outer race forms integral part of the mounting flange.
The hub unit bearing is bolted to the rear knuckle arm with the brake backing plate in between.
Oil seals are fitted on both sides of the bearing.
The bearing is a preloaded, non-adjustable angular contact ball unit bearing.
- The BJ's spindle is splined to the hub and is secured with an axle nut clinched to it.
- The disc rotor and drum are an external mounting type. It is secured to the disc wheel using hub bolts to facilitate maintenance of the disc rotor and drum.



(1) Bell joint (BJ)
(2) Rear knuckle arm
(3) Tone wheels
(4) Hub unit bearing
(5) Axle nut
(6) Hub
(7) Oil seal
(8) Brake backing plate
(9) Hub bolt

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. Its maximum operating angle is 42°.



(1) Double offset joint (DOJ)
(2) Bell joint (BJ)
(3) Differential side
(4) Wheel side

MEMO

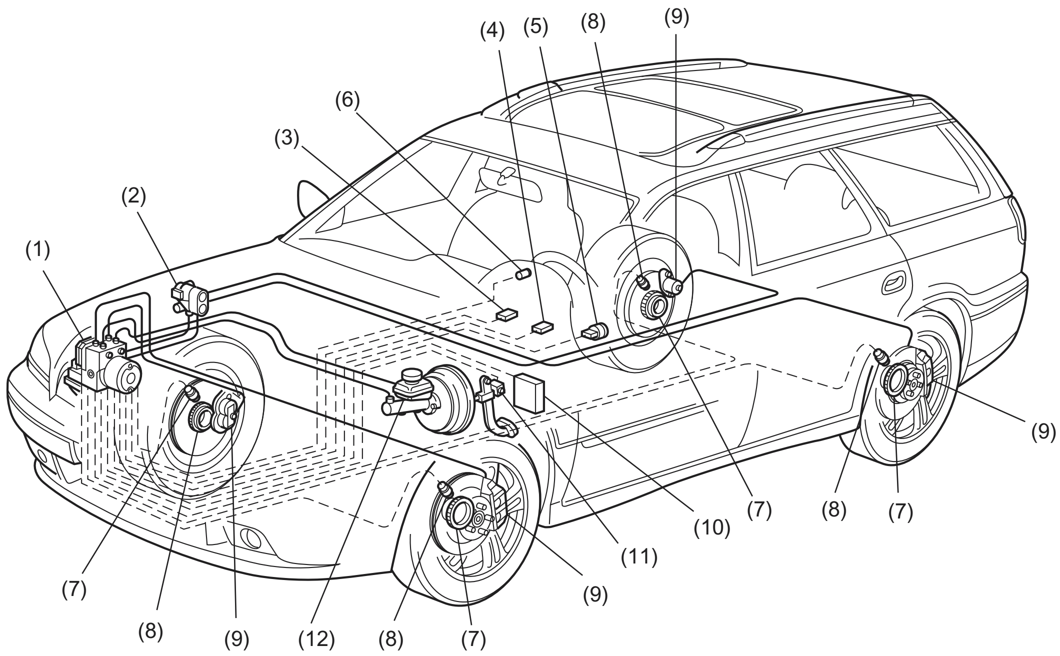
1. Anti-lock Brake System (ABS)

A: FEATURE

- The 5.3i type ABS used in the Legacy 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)

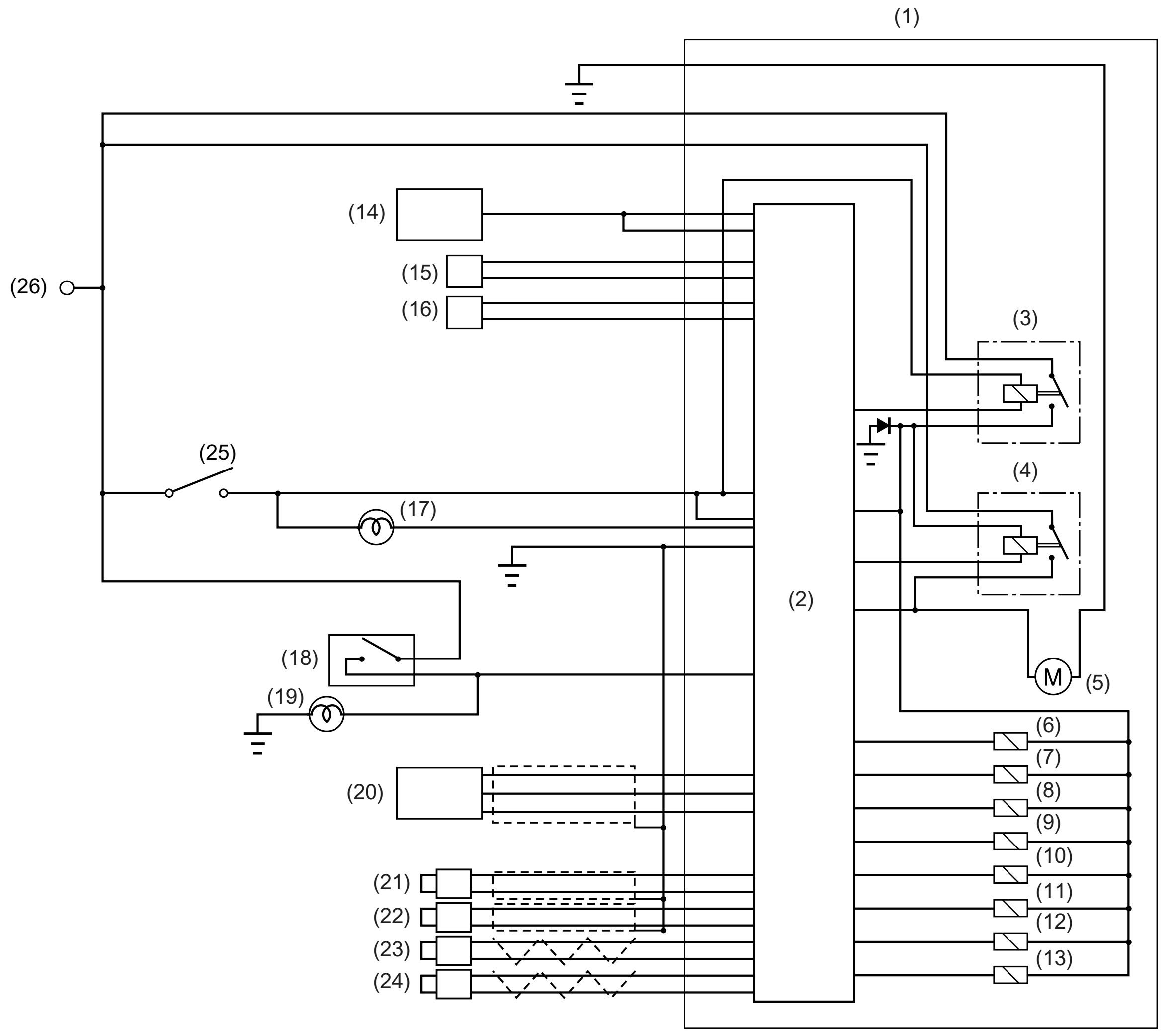


(1)	ABS control module and hydraulic control unit (ABSCM & H/U)	(5)	G sensor	(9)	Wheel cylinder
(2)	Proportioning valve	(6)	ABS warning light	(10)	Automatic transmission control module
(3)	Diagnosis connector	(7)	Tone wheels	(11)	Brake switch
(4)	Data link connector (for SUBARU select monitor)	(8)	ABS sensors	(12)	Master cylinder

B: FUNCTIONS OF SENSORS AND ACTUATORS

Name		Function
ABS control module and hydraulic control unit (ABSCM & H/U)	ABSCM section	● 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	● 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)		They 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 wheels		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 switch		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 and changing power transmission to front and rear wheels in response to control signals from the ABSCM.

MEMO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ABS00276

(1) ABS control module and hydraulic control unit
(2) ABS control module section
(3) Valve relay
(4) Motor relay
(5) Motor
(6) Front left inlet solenoid valve
(7) Front left outlet solenoid valve
(8) Front right inlet solenoid valve
(9) Front right outlet solenoid valve
(10) Rear left inlet solenoid valve
(11) Rear left outlet solenoid valve
(12) Rear right inlet solenoid valve
(13) Rear right outlet solenoid valve
(14) Automatic transmission control module
(15) Diagnosis connector
(16) Data link connector
(17) ABS warning light
(18) Stop light switch
(19) Stop light
(20) G sensor
(21) Front left ABS sensor
(22) Front right ABS sensor
(23) Rear left ABS sensor
(24) Rear right ABS sensor
(25) IGN
(26) Battery

C: PRINCIPLE OF ABS CONTROL

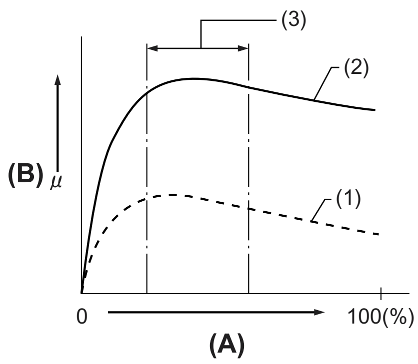
When the brake pedal is depressed during driving, the wheel speed decreases and the vehicle speed does as well. The decrease in the vehicle speed, however, is not always proportional to the decrease in the wheel speed. The non-correspondence between the wheel speed and vehicle speed is called “slip” and the magnitude of the slip is expressed by the “slip ratio” which is defined as follows:

Slip ratio = (Vehicle speed – Wheel speed)/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.

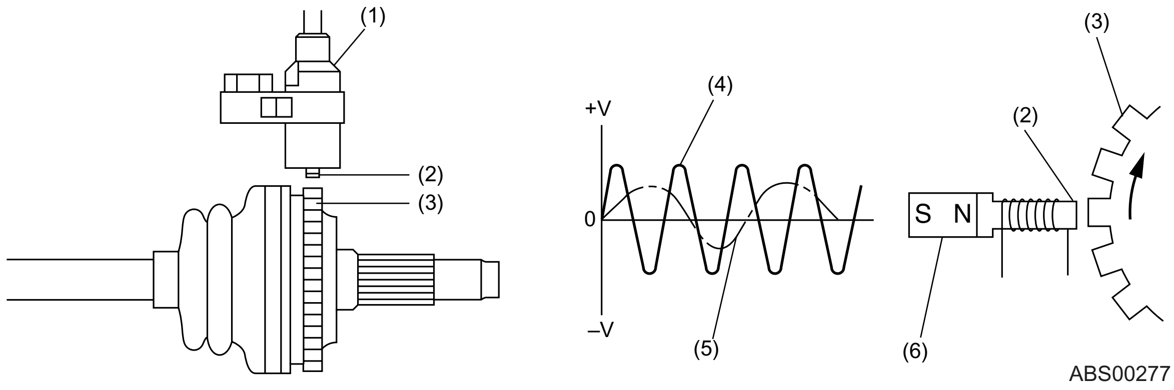


ABS00007

(A)	Slip ratio	(1)	Icy road
(B)	Coefficient of friction between tire and road surface	(2)	Asphalt-paved road
		(3)	Control range by ABS

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.



(1) Sensor body
(2) Pole piece
(3) Tone wheels
(4) Full speed
(5) Low-speed
(6) Permanent magnet

E: ABS CONTROL MODULE AND HYDRAULIC CONTROL UNIT (ABSCM & H/U)

● ABS CONTROL MODULE SECTION (ABSCM)

The ABSCM contains two microcontrol modules (MCMs) that complement 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 EEP ROM. 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 status information in the event of a fault (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 functions:
- ABS fault alerting
- Trouble code indication (by flashing in the diagnosis mode)
- Valve ON/OFF indication (when sequence control pattern is initiated)

● 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).

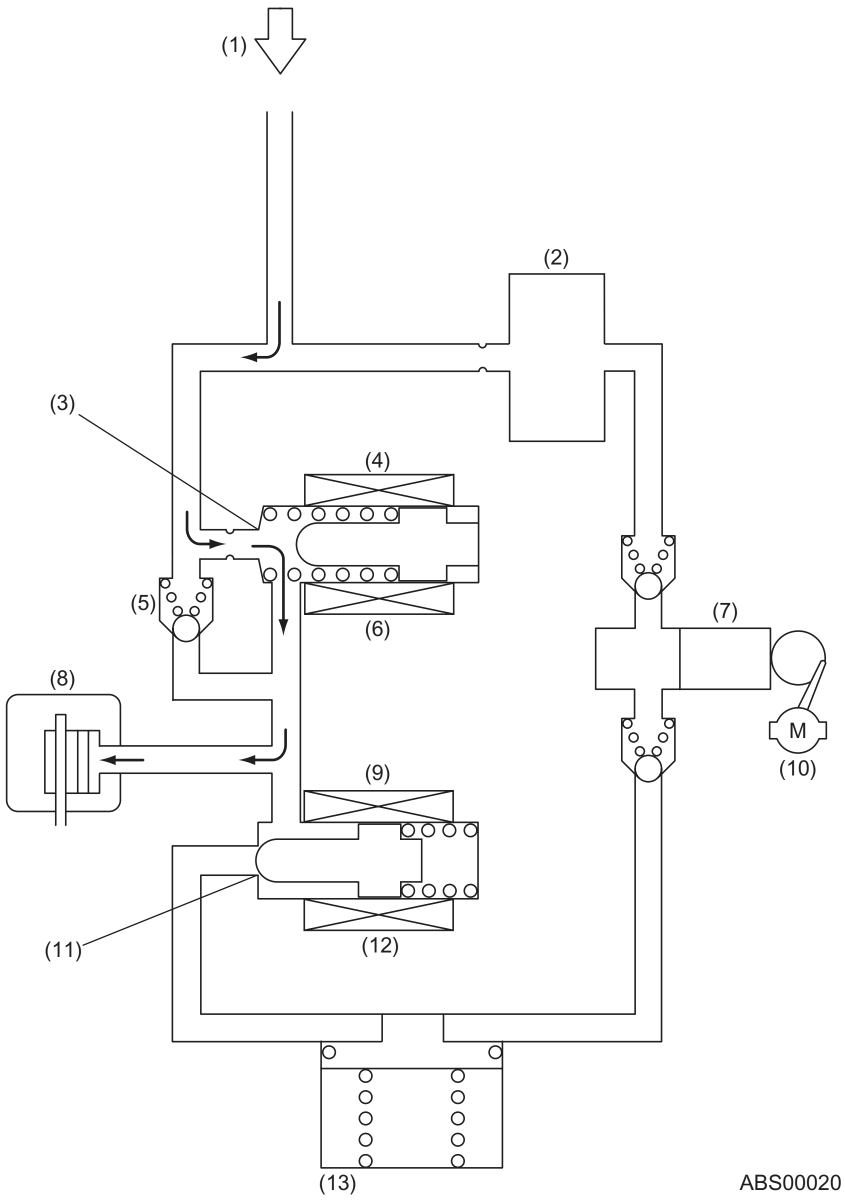
● The motor relay closes and supplies power to the pump motor in response to a command from the ABSCM during the ABS drive mode operations.

The H/U has four operating modes; normal mode (non-ABS mode), and three ABS active modes, i.e., “increase”, “hold” and “decrease” modes.

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.

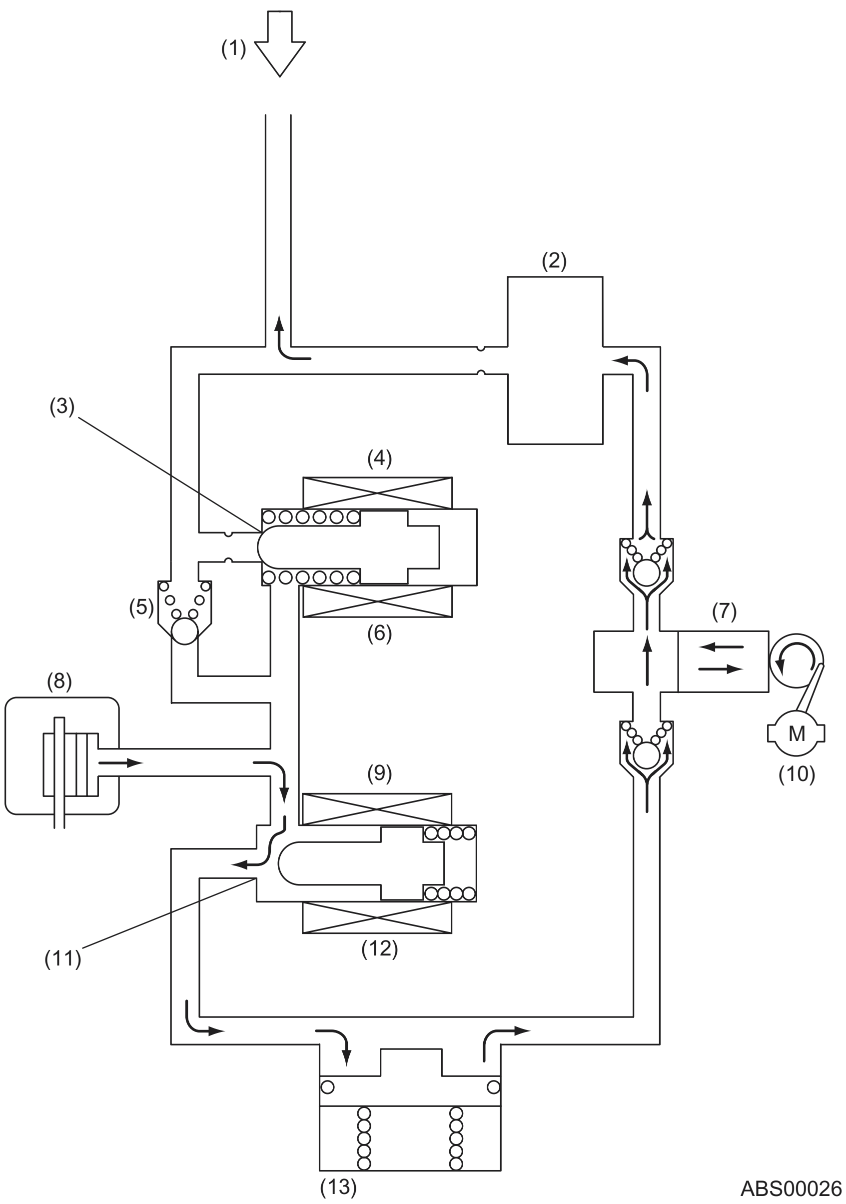


(1) From master cylinder
(2) Damper chamber
(3) Inlet port open
(4) Inlet solenoid valve
(5) Check valve
(6) Deenergized
(7) Pump
(8) Wheel cylinder
(9) Outlet solenoid valve
(10) Motor
(11) Outlet port closed
(12) Deenergized
(13) Reservoir

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.

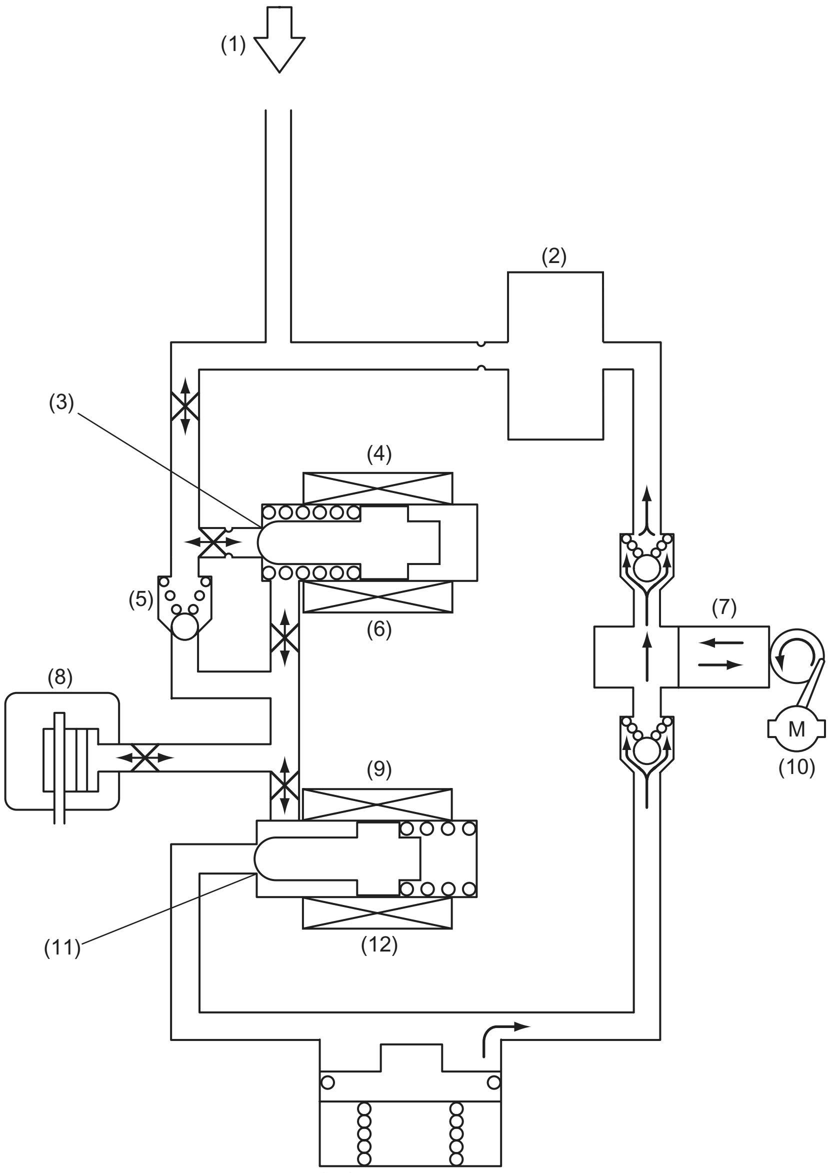


(1) From master cylinder
(2) Damper chamber
(3) Inlet port closed
(4) Inlet solenoid valve
(5) Check valve
(6) Energized
(7) Pump
(8) Wheel cylinder
(9) Outlet solenoid valve
(10) Motor
(11) Outlet port open
(12) Energized
(13) Reservoir

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.

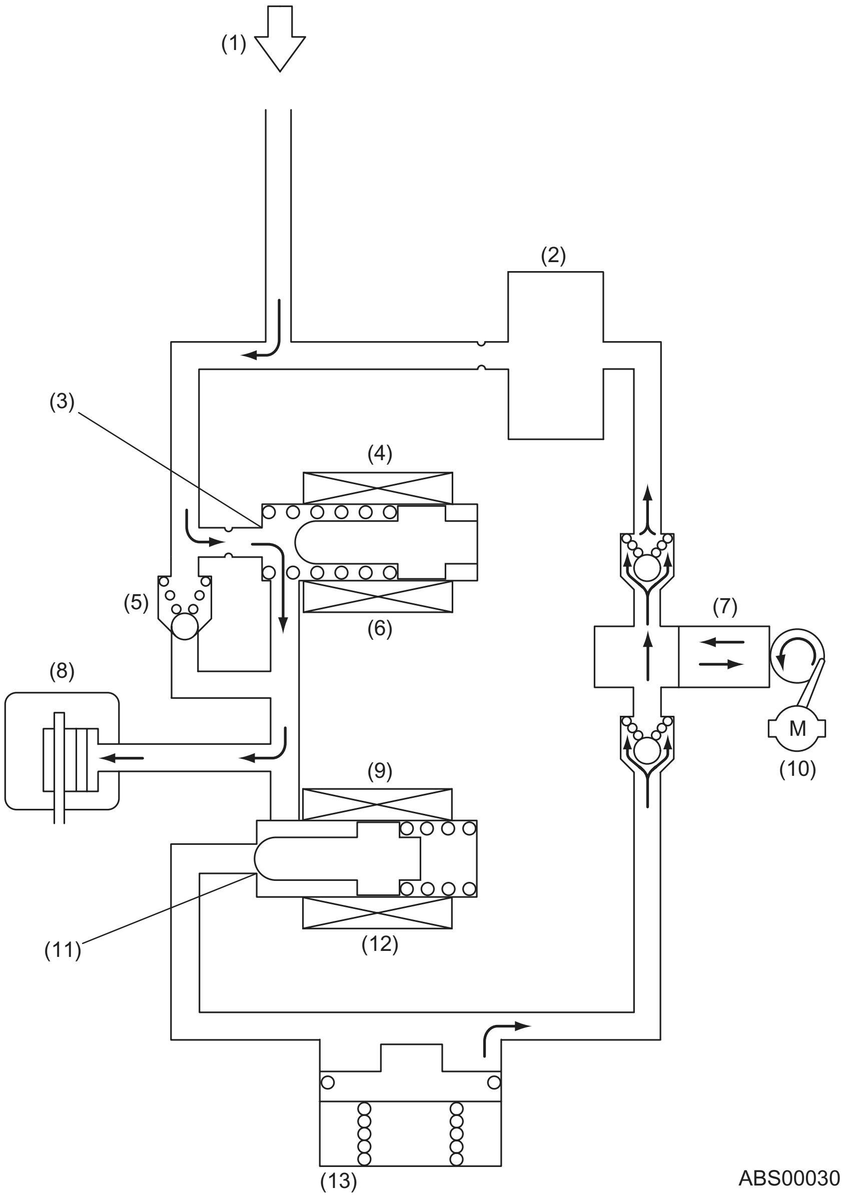


(1) From master cylinder
(2) Damper chamber
(3) Inlet port closed
(4) Inlet solenoid valve
(5) Check valve
(6) Energized
(7) Pump
(8) Wheel cylinder
(9) Outlet solenoid valve
(10) Motor
(11) Outlet port closed
(12) Deenergized
(13) Reservoir

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.



(1) From master cylinder
(2) Damper chamber
(3) Inlet port open
(4) Inlet solenoid valve
(5) Check valve
(6) Deenergized
(7) Pump
(8) Wheel cylinder
(9) Outlet solenoid valve
(10) Motor
(11) Outlet port closed
(12) Deenergized
(13) Reservoir

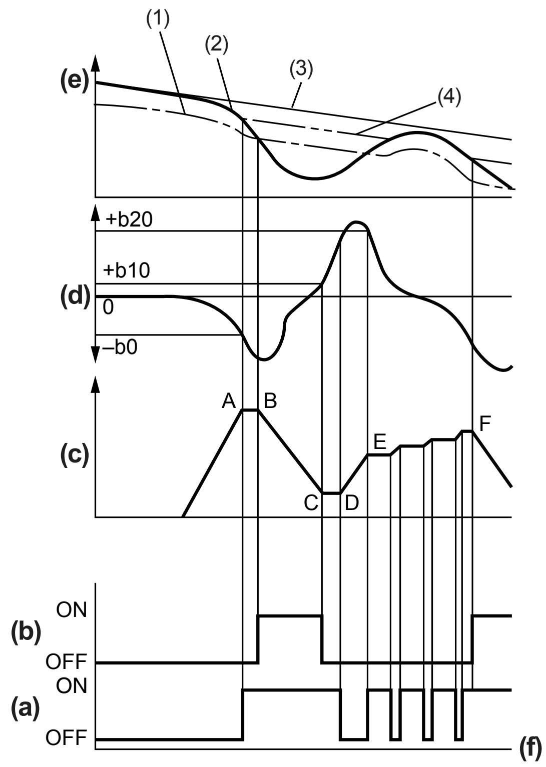
F: ABS CONTROL CYCLE CURVES

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

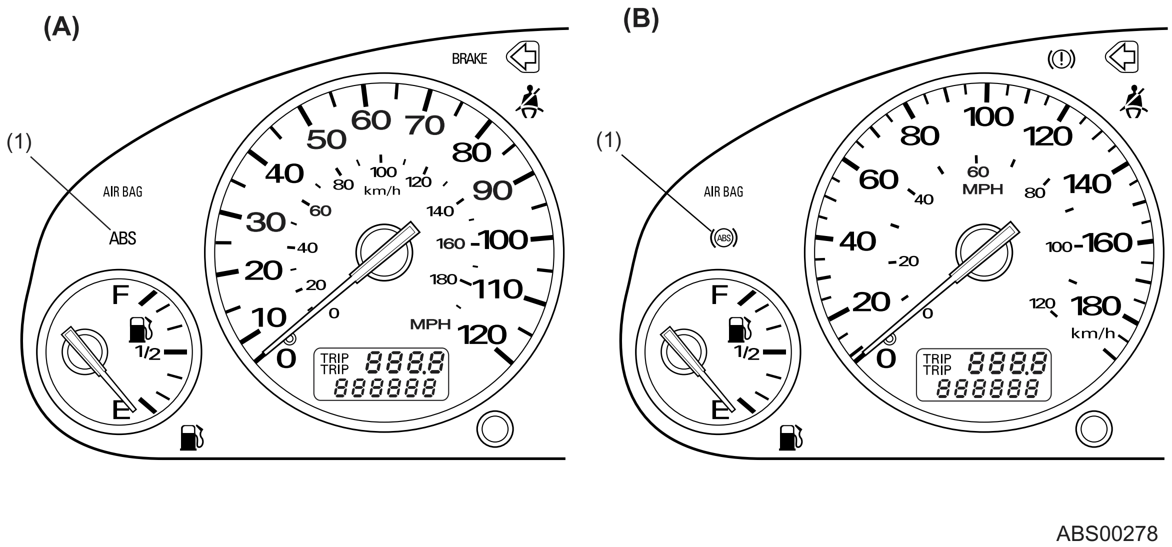
(1) Slip ratio setting
(2) Wheel speed
(3) Vehicle speed
(4) Dummy vehicle speed

Brake fluid Pressure	Inlet valve	Outlet valve
Increase	OFF	OFF
Hold	ON	OFF
Decrease	ON	ON

G: ABS WARNING LIGHT

When a fault occurs in the signal transmission system or the ABSCM, the ABS warning light in the combination meter comes 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.

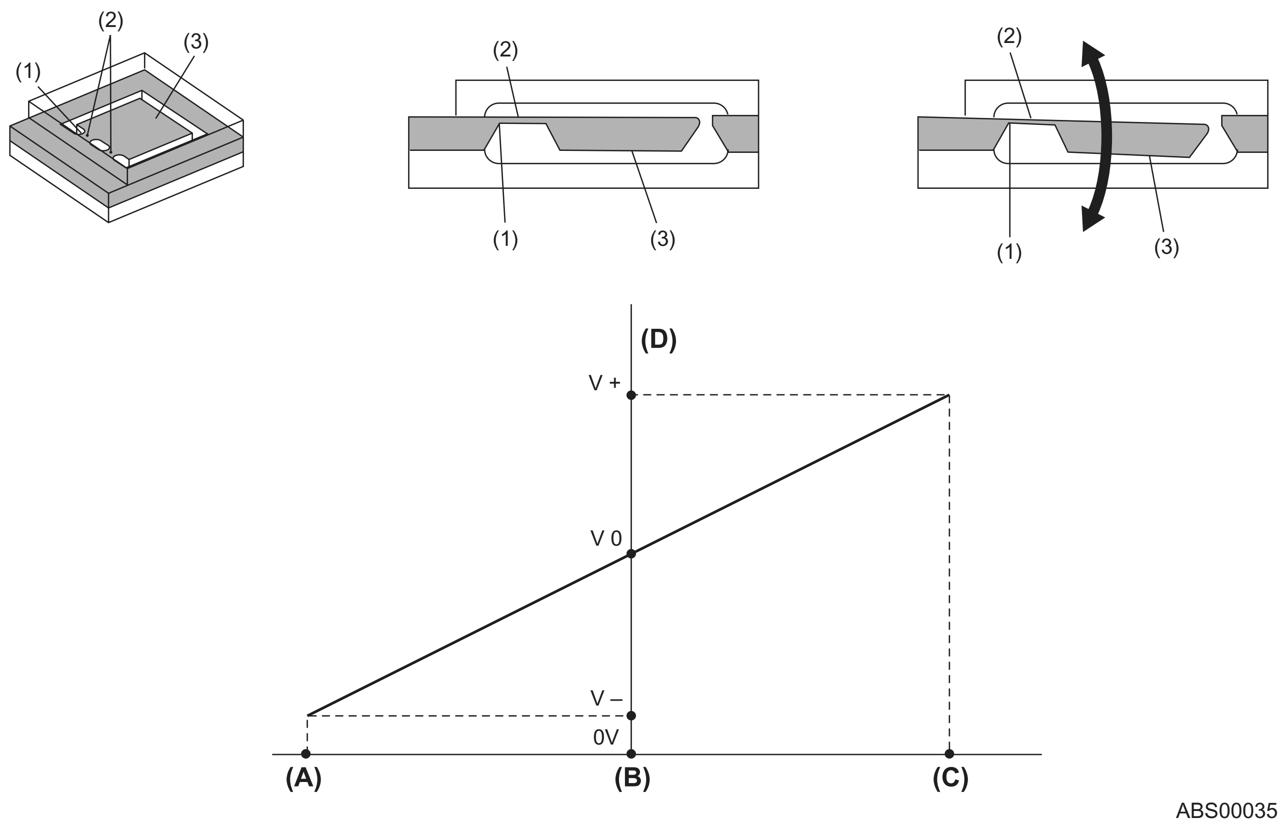
If the warning light comes on, one or more trouble codes should be stored in the ABSCM. They must be identified using the warning light's code indicating function.



(A) U.S. spec. vehicle
(B) Canada spec. vehicle
(1) ABS warning light

H: 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.



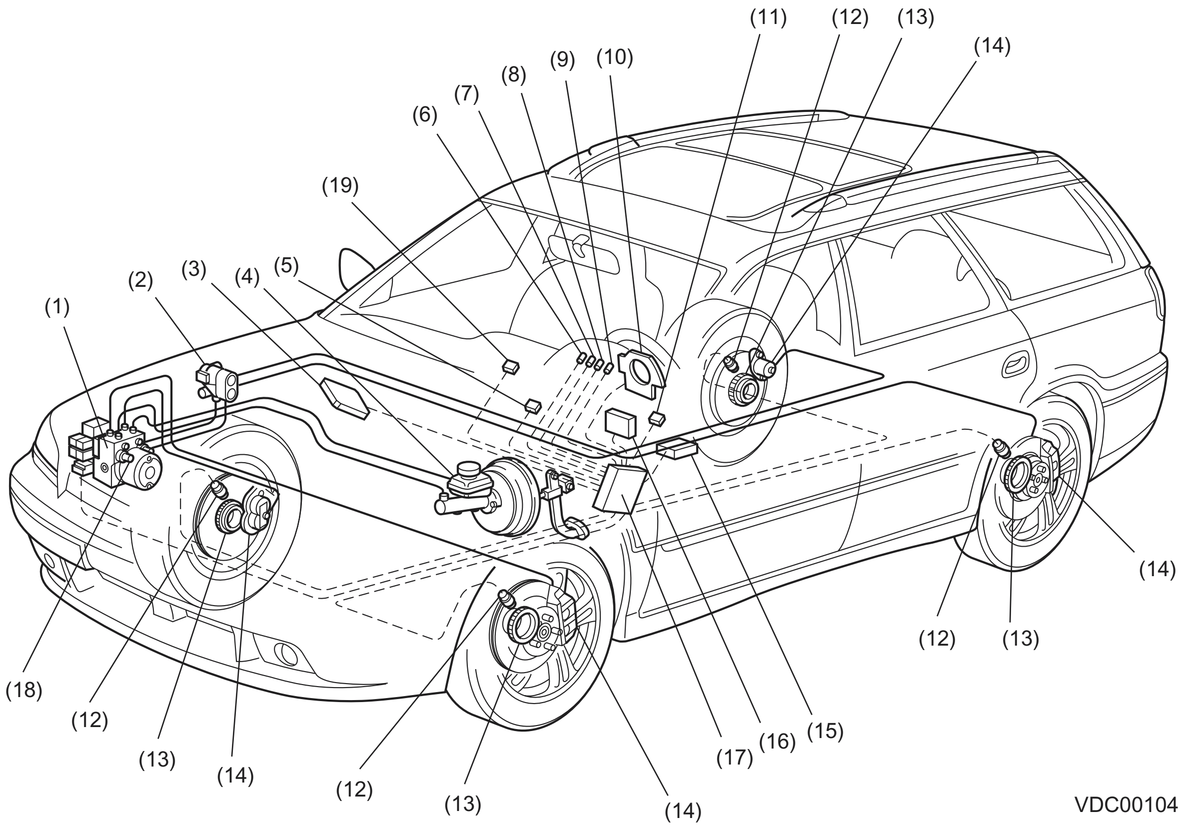
(1)	Beam	(2)	Piezo-resistor	(3)	Mass area
(A)	Accelerating	**(B)**	Cruising	**(C)**	Decelerating
(D)	G sensor output voltage				

MEMO

1. Vehicle Dynamics Control (VDC) System

A: GENERAL

The vehicle dynamics control (VDC) system is a driver assist system which enhances vehicle's running stability by utilizing the anti-lock brake system (ABS) and traction control system (TCS) functions in combination with its own function which reduces sudden changes in vehicle behavior that are likely to occur when traveling on a slippery road or quickly avoiding an obstacle on the road.

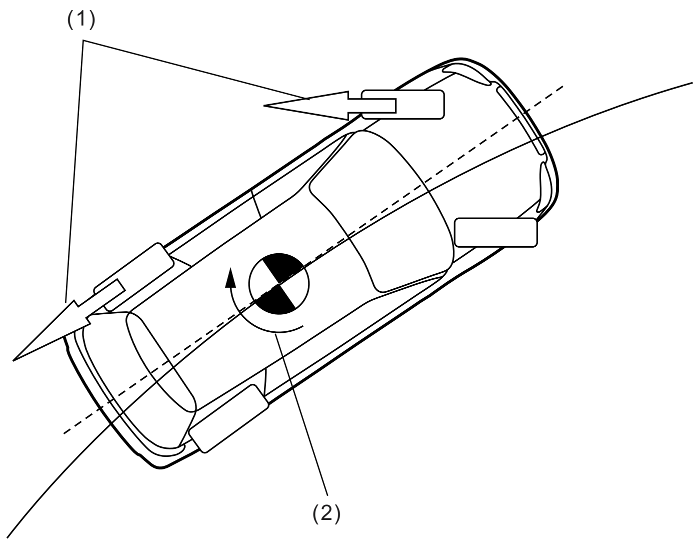


(1)	VDC hydraulic control unit	(8)	VDC operation indicator light	(15)	Yaw-rate and lateral G sensor
(2)	Proportioning valve	(9)	VDC OFF indicator light	(16)	Automatic transmission control module
(3)	Engine control module	(10)	Steering angle sensor	(17)	VDC control module
(4)	Master cylinder	(11)	Data link connector (for SUBARU select monitor)	(18)	Pressure sensor
(5)	Diagnosis connector	(12)	ABS sensors	(19)	VDC OFF switch
(6)	ABS warning light	(13)	Tone wheels		
(7)	VDC warning light	(14)	Wheel cylinder		

B: OPERATION PRINCIPLE OF VDC

1. OVERSTEER BEHAVIOR SUPPRESSION

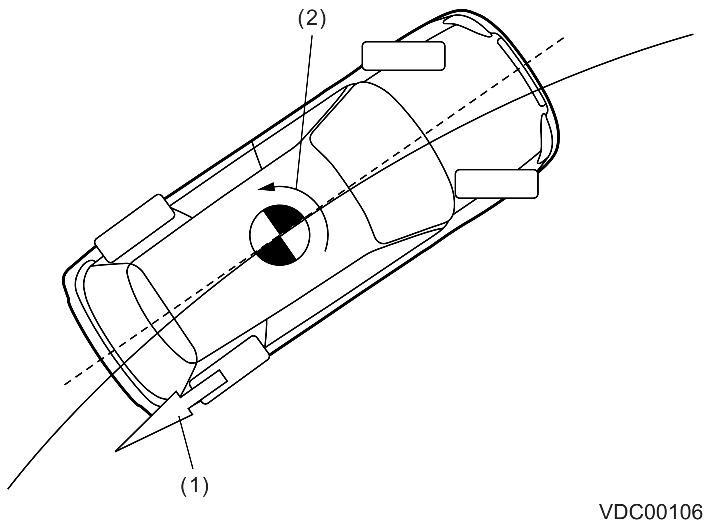
When the vehicle starts to spin during cornering, the VDC control module (VDCCM) actuates the brakes on the front and rear outer wheels. As a result, a yaw moment is generated in a direction that counteracts the yaw moment resulting from oversteer so that the vehicle's behavior is stabilized.



(1) Braking force
(2) Yaw moment resulting from oveersteer

2. UNDERSTEER BEHAVIOR SUPPRESSION

When the vehicle starts to drift outward during cornering, the VDCCM causes the rear inner wheel to be braked. As a result, a yaw moment is generated in a direction that counteracts the yaw moment resulting from understeer so that the vehicle's behavior is stabilized.



(1) Braking force
(2) Yaw moment resulting from understeer

C: FUNCTIONS USED IN VEHICLE'S BEHAVIOR STABILIZATION CONTROL

VDC function	The VDC determines the driver's intention from the data provided by the steering angle sensor, braking pressure sensor, engine-related sensors and other relevant sources and recognizes the result as the target vehicle behavior. At the same time, it determines the vehicle's actual behavior from the data provided by the yaw-rate sensor, lateral G sensor, ABS sensor and other relevant sources. Then, the module compares the target and actual vehicle behaviors to estimate how the vehicle is running (whether it understeers, oversteers, slips or is in other condition), and based on the result, performs braking control of individual wheels, engine output control and AWD control as necessary to correct the vehicle's running condition.
TCS function	The TCS constantly receives signals from the relevant sensors to monitor the vehicle speed. When the running wheels slip exceeding a certain limit, it performs braking control of individual wheels, engine output control and AWD control as required to maintain optimal traction and adequate side force.
ABS function	The ABS constantly receives signals from the relevant sensors to monitor the vehicle speed. When the slip of wheels during braking exceeds a certain limit, it performs braking control of individual wheels and AWD control as required to maintain optimal traction and adequate side force.

NOTE:
- "Braking control" is effected by the VDCCM as follows:
The VDCCM calculates the required braking force for each wheel and sends signals to the VDC hydraulic unit. The hydraulic unit's motor pump is then operated to generate the required hydraulic pressure. Further, it controls the hydraulic unit's solenoid valves to increase, maintain or decrease the hydraulic pressure applied to the brake wheel cylinder as required.
When the brakes are applied by the driver, however, the braking force is controlled by the hydraulic pressure resulting from the driver's action.

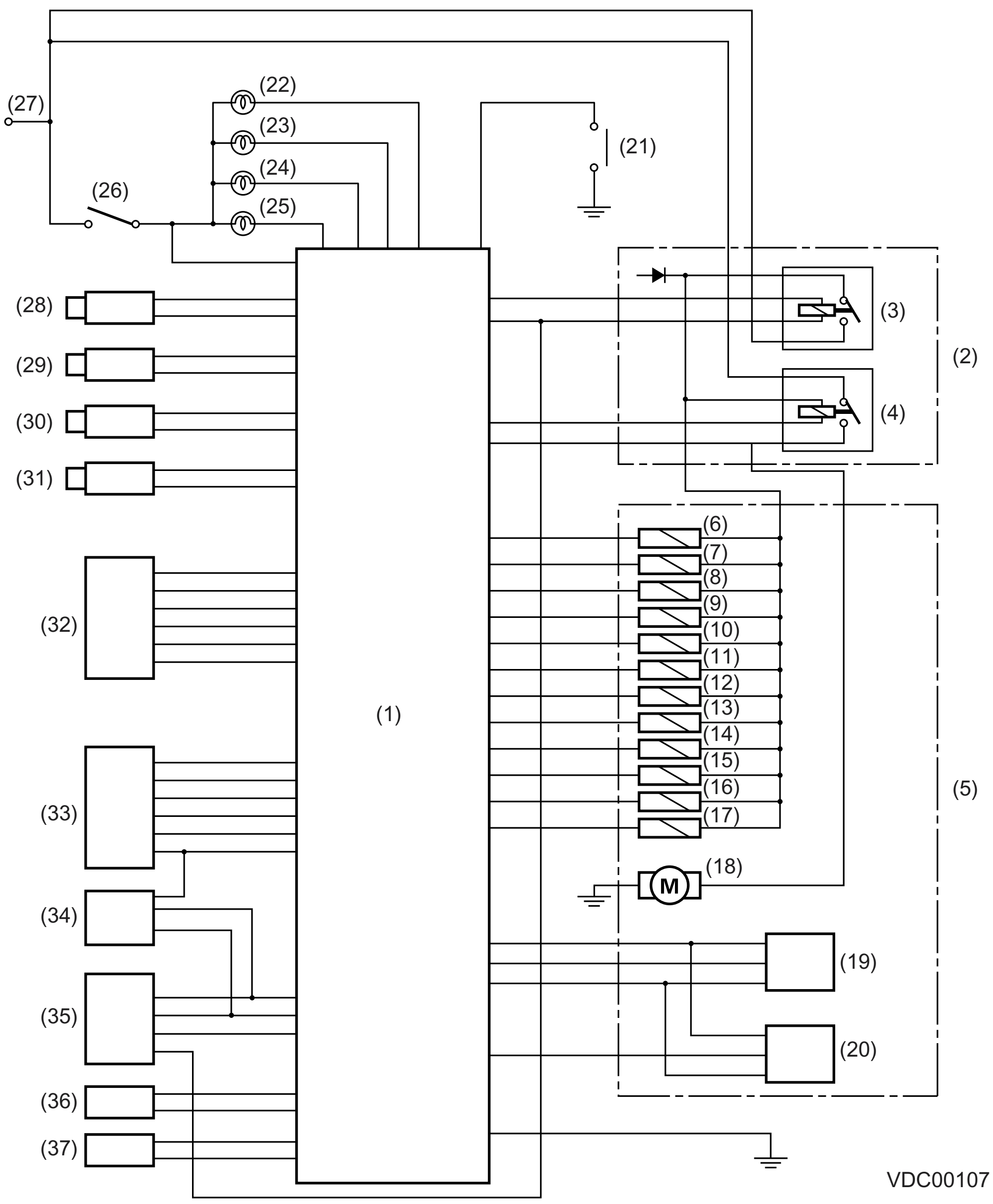
- "Engine output control" is effected by the VDCCM as follows:
The VDCCM calculates the target engine output for each condition, and compares it with the current engine output. Based on the result of comparison, it determines the number of cylinders for which fuel injection is to be stopped and sends a command to the engine control module. The targeted engine output is then achieved.

- "AWD control" is effected by the VDCCM as follows:
When necessary, the VDCCM sends a command to the automatic transmission control module. According to the command, the transmission control module controls the transfer clutch so that the torque is distributed between the front and rear axles optimally.

D: SYSTEM COMPONENTS AND FUNCTIONS

VDCCM	● Determines the vehicle's running condition from various sensor signals and, based on the result, controls the VDC hydraulic control unit, ABS and TCS as required. ● Performs CAN communication with the automatic transmission control module and the steering angle sensor. ● Causes the system to stop and the warning light to illuminate if a fault occurs in a circuit of the electrical system. Stores the code that indicates the location of the fault.
VDC Hydraulic Control Unit (VDCH/U)	Actuates the pump motor in response to a command from the VDCCM and changes fluid passages using solenoid valves to control the hydraulic pressures applied to the wheel cylinders.
Steering angle sensor	Detects the steering direction and angle when the steering wheel is operated by the driver and outputs signals corresponding to them to the VDCCM.
Yaw-rate and lateral G sensor	Detects the yaw-rate and lateral G of the vehicle and outputs it to the VDCCM.
Pressure sensor	Detects the hydraulic pressure resulting from driver's brake pedal operation and outputs it to the VDCCM.
ABS sensors (wheel speed sensors)	Detects the speed of each wheel and outputs it to the VDCCM.
Tone wheels	Causes changes in magnetic flux density as its teeth move to enable the ABS sensor to detect the wheel speed.
Engine control module (ECM)	Controls the engine output in response to commands from the VDCCM. Further, it transmits current engine output and engine speed signals to the VDCCM.
Automatic transmission control module	Controls the transfer clutch in response to commands from the VDCCM during VDC control, ABS control or TCS control so that torque is distributed optimally between the front and rear axles.
ABS warning light	It alerts the driver to an ABS fault.
VDC warning light	Alerts the driver to a VDC or TCS fault.
VDC operation indicator light	Blinks when the VDC is operating or lights steadily when the TCS is operating.
VDC OFF indicator light	Illuminates to tell the driver that the VDC and TCS are inactive (not due to a system failure).
VDC OFF switch	● Allows the driver to temporarily disengage VDC control. ● In "temporarily disengaged" status, the VDC OFF indicator light illuminates.

NOTE:
CAN (Controller Area Network) communication refers to bidirectional multiplex high-speed communication.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VDC00107

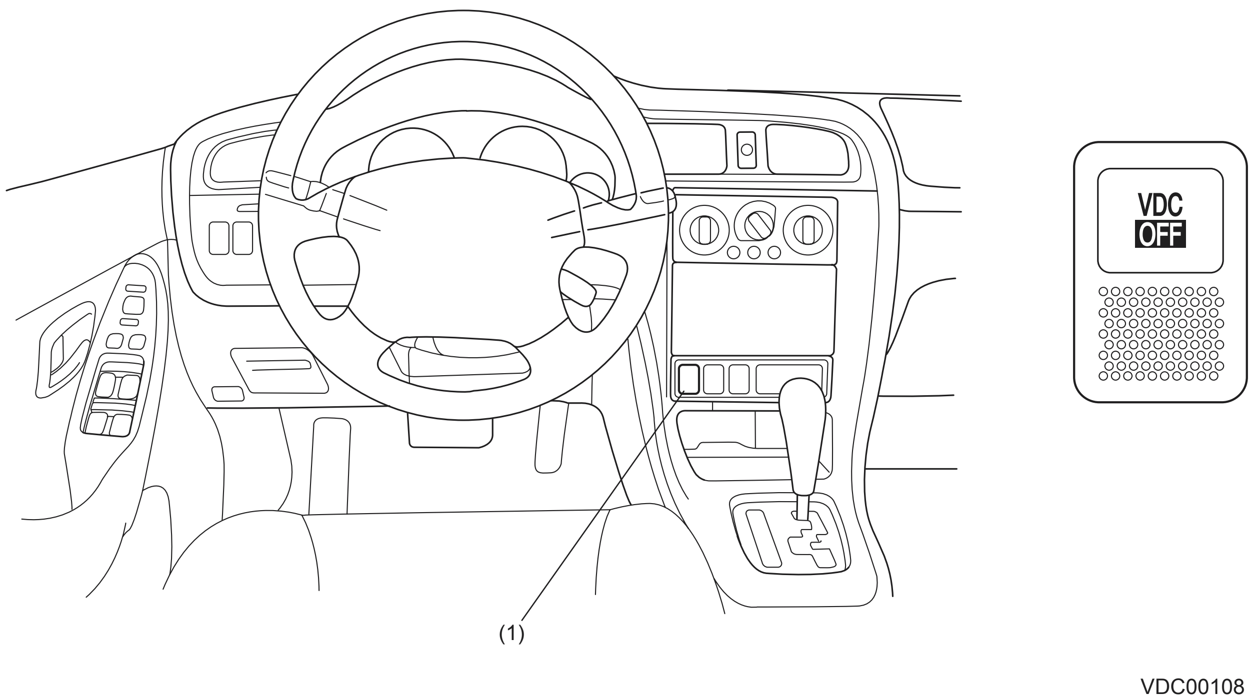
(1) VDC control module
(2) Relay box
(3) Valve relay
(4) Motor relay
(5) Hydraulic control unit
(6) Front left inlet solenoid valve
(7) Front left outlet solenoid valve
(8) Front right inlet solenoid valve
(9) Front right outlet solenoid valve
(10) Rear left inlet solenoid valve
(11) Rear left outlet solenoid valve
(12) Rear right inlet solenoid valve
(13) Rear right outlet solenoid valve
(14) Primary suction solenoid valve
(15) Primary cut solenoid valve
(16) Secondary suction solenoid valve
(17) Secondary cut solenoid valve
(18) Pump motor
(19) Primary pressure sensor
(20) Secondary pressure sensor
(21) VDC OFF switch
(22) ABS warning light
(23) VDC warning light
(24) VDC operation indicator light
(25) VDC OFF indicator light
(26) Ignition relay
(27) Battery
(28) Front left ABS sensor
(29) Front right ABS sensor
(30) Rear left ABS sensor
(31) Rear right ABS sensor
(32) Yaw-rate and lateral G sensor
(33) Engine control module
(34) Automatic transmission control module
(35) Steering angle sensor
(36) Diagnosis connector
(37) Data link connector

E: VDC OFF SWITCH

A switch which allows the driver to temporarily disengage VDC control is added.
In some occasions, better results are obtained by canceling the VDC to allow the drive wheels to slip for a certain amount:

- When starting the vehicle on icy or unpaved, steep uphill roads.
- When escaping from mud or snow when the wheels are caught in them.

● When the VDC OFF switch is pressed while the engine is running, the VDC OFF indicator light in the combination meter illuminates, and VDC control is temporarily disengaged.
When the VDC OFF switch is pressed again, the VDC OFF indicator light turns off and the system returns to “engaged” status. Temporarily disengaged status and engaged status are altered each time the switch is pressed.)
● The VDC control “temporarily disengaged” status automatically returns to “engaged” status when the vehicle speed exceeds 60 km/h (38 MPH). (VDC control cannot be temporarily disengaged at vehicle speeds higher than 60 km/h (38 MPH).
● If the VDC OFF switch is pressed and held for more than 10 seconds, the VDC OFF indicator light in the combination meter turns off. The system will not allow further operation of the switch until the engine is started for the next time.



(1) VDC OFF switch

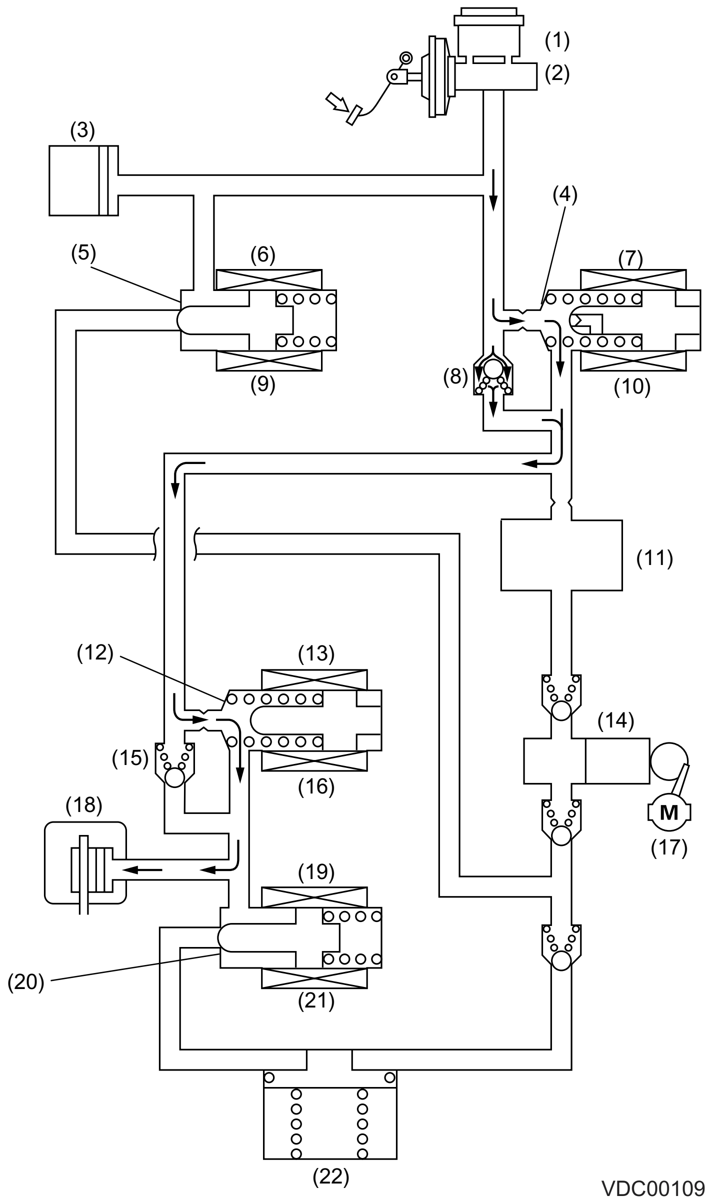
F: OPERATION OF VDC HYDRAULIC CONTROL UNIT (VDC H/U)

1. DURING NORMAL BRAKING

No solenoid valves are energized. The ports of the inlet solenoid valve and cut solenoid valve are open, while the ports of the outlet solenoid valve and suction solenoid valve are closed.

In this state, the fluid pressure generated by the master cylinder can be applied to the wheel cylinder through the open ports of the cut solenoid valve and inlet solenoid valve.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



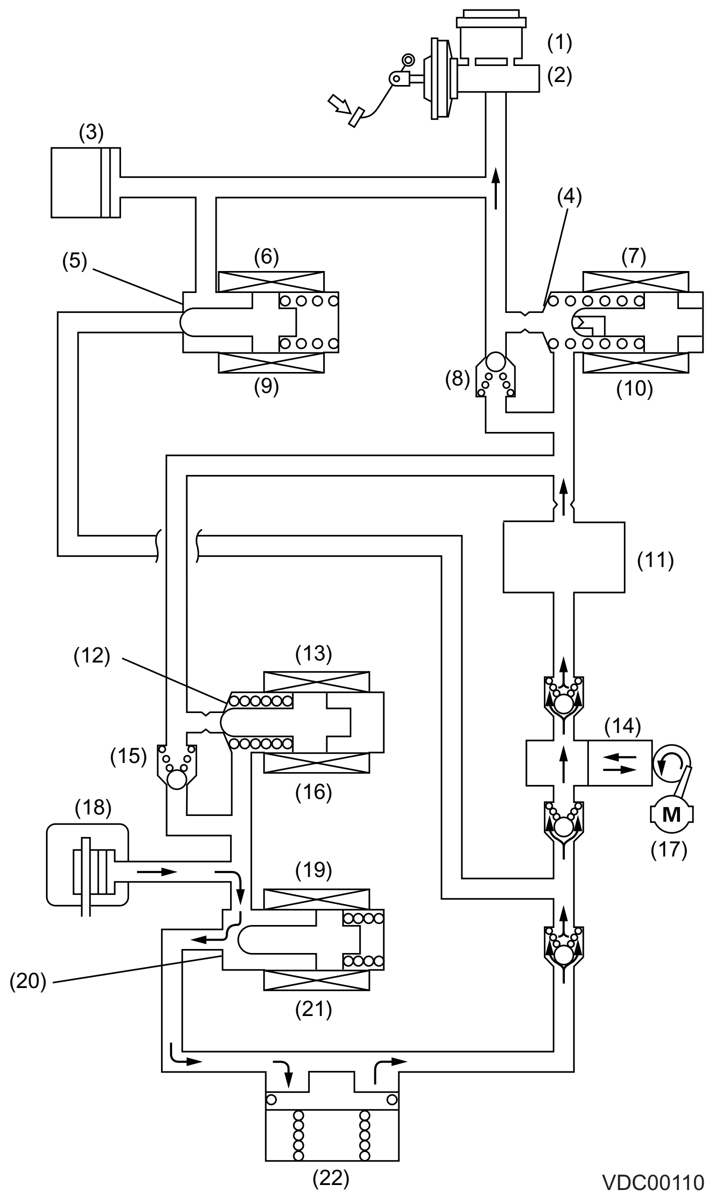
(1)	Reservoir tank	(9)	Deenergized	(17)	Motor
(2)	Master cylinder	(10)	Deenergized	(18)	Wheel cylinder
(3)	Pressure sensor	(11)	Damper chamber	(19)	Outlet solenoid valve
(4)	Port open	(12)	Port open	(20)	Port closed
(5)	Port closed	(13)	Inlet solenoid valve	(21)	Deenergized
(6)	Suction solenoid valve	(14)	Pump	(22)	Reservoir
(7)	Cut solenoid valve	(15)	Check valve		
(8)	Check valve	(16)	Deenergized		

2. PRESSURE “DECREASE” CONTROL WITH BRAKE PEDAL DEPRESSED

The inlet solenoid valve and outlet solenoid valve are energized, while the other solenoid valves are not energized. This means that the ports of the inlet solenoid valve and suction solenoid valve are closed, while those of the outlet solenoid valve and cut solenoid valve are open.

Although the fluid pressure generated by the master cylinder can reach the inlet solenoid valve through the open port of the cut solenoid valve, the pressurized fluid cannot go further since the passage is blocked there. On the other hand, since the port of the outlet solenoid valve is open, the brake fluid in the wheel cylinder can flow out into the reservoir. The fluid pressure in the wheel cylinder decreases as a result. The brake fluid in the reservoir is pumped back into the master cylinder.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



(1)	Reservoir tank	(9)	Deenergized	(17)	Motor
(2)	Master cylinder	(10)	Deenergized	(18)	Wheel cylinder
(3)	Pressure sensor	(11)	Damper chamber	(19)	Outlet solenoid valve
(4)	Port open	(12)	Port closed	(20)	Port open
(5)	Port closed	(13)	Inlet solenoid valve	(21)	Energized
(6)	Suction solenoid valve	(14)	Pump	(22)	Reservoir
(7)	Cut solenoid valve	(15)	Check valve		
(8)	Check valve	(16)	Energized		

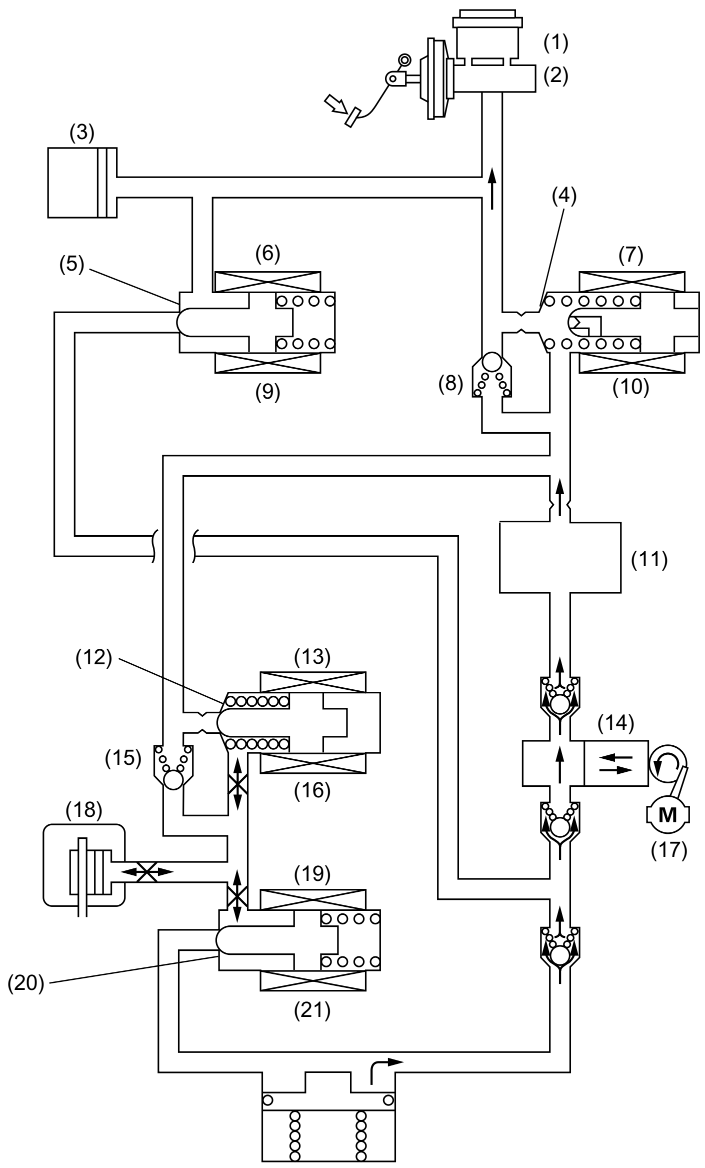
3. PRESSURE “HOLD” CONTROL WITH BRAKE PEDAL DEPRESSED

Only the inlet solenoid valve is energized. This means that the ports of the inlet solenoid valve, outlet solenoid valve and suction solenoid valve are all closed except that of the cut solenoid valve.

In this state, the fluid pressure generated by the master cylinder is transmitted through the open port of the cut solenoid valve to the inlet solenoid valve but not beyond the inlet solenoid valve since the passage is blocked there. Since the port of the outlet solenoid valve is also closed, the fluid pressure in the wheel cylinder is held unreleased.

The pump is always operated whenever commanded by the VDCCM.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



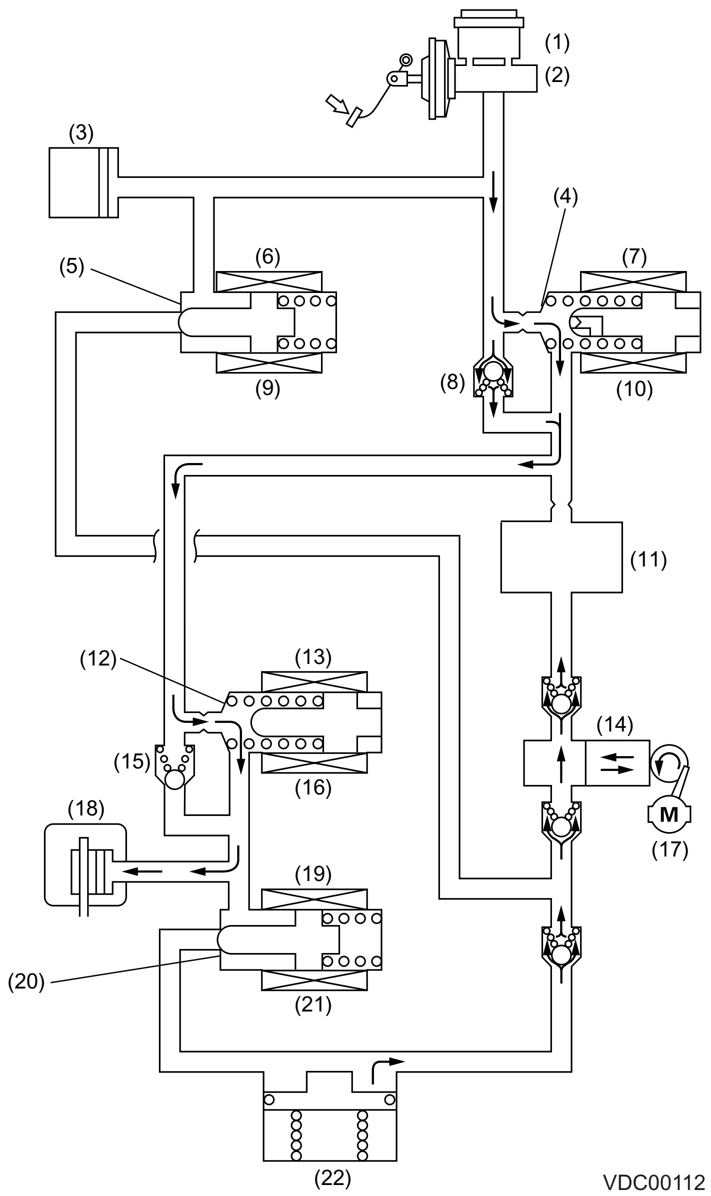
(1)	Reservoir tank	(9)	Deenergized	(17)	Motor
(2)	Master cylinder	(10)	Deenergized	(18)	Wheel cylinder
(3)	Pressure sensor	(11)	Damper chamber	(19)	Outlet solenoid valve
(4)	Port open	(12)	Port closed	(20)	Port closed
(5)	Port closed	(13)	Inlet solenoid valve	(21)	Deenergized
(6)	Suction solenoid valve	(14)	Pump	(22)	Reservoir
(7)	Cut solenoid valve	(15)	Check valve		
(8)	Check valve	(16)	Energized		

4. PRESSURE “INCREASE” CONTROL WITH BRAKE PEDAL DEPRESSED

No solenoid valves are energized. This means that the ports of the inlet solenoid valve and cut solenoid valve are open, while those of the outlet solenoid valve and suction solenoid valve are closed.

In this state, the fluid pressure generated by the master cylinder is transmitted to the wheel cylinder through the open ports of the cut solenoid valve and inlet solenoid valve, applying the brake with an increased force. The pump is always operated whenever commanded by the VDCCM.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



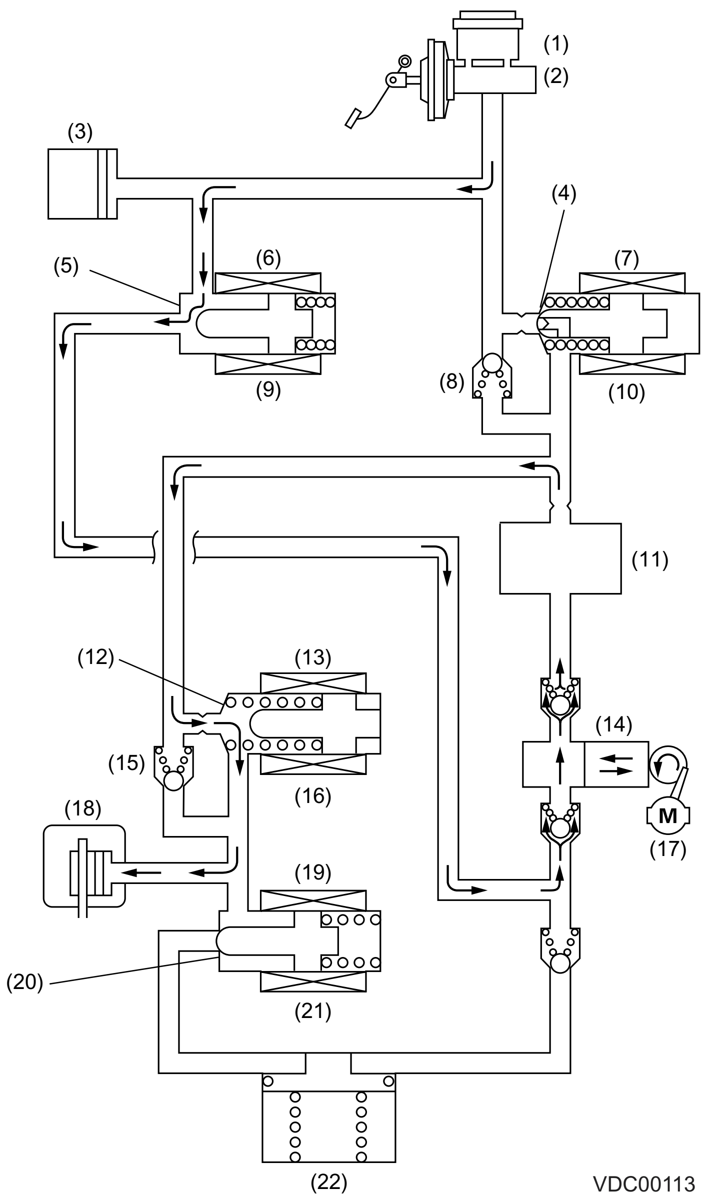
(1)	Reservoir tank	(9)	Deenergized	(17)	Motor
(2)	Master cylinder	(10)	Deenergized	(18)	Wheel cylinder
(3)	Pressure sensor	(11)	Damper chamber	(19)	Outlet solenoid valve
(4)	Port open	(12)	Port open	(20)	Port closed
(5)	Port closed	(13)	Inlet solenoid valve	(21)	Deenergized
(6)	Suction solenoid valve	(14)	Pump	(22)	Reservoir
(7)	Cut solenoid valve	(15)	Check valve		
(8)	Check valve	(16)	Deenergized		

5. PRESSURE "INCREASE" CONTROL WITH BRAKE PEDAL NOT DEPRESSED

The cut solenoid valve and suction solenoid valve are energized while the other solenoid valves are not energized. This means that the ports of the cut solenoid valve and outlet solenoid valve are closed, while those of the inlet solenoid valve and suction solenoid valve are open.

In this state, the pump is activated, forcing the brake fluid in the master cylinder reservoir tank into the wheel cylinder through the open port of the suction solenoid valve and then through the open port of the inlet solenoid valve. The brake is then applied with an increased force.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



(1)	Reservoir tank	(9)	Energized	(17)	Motor
(2)	Master cylinder	(10)	Energized	(18)	Wheel cylinder
(3)	Pressure sensor	(11)	Damper chamber	(19)	Outlet solenoid valve
(4)	Port closed	(12)	Port open	(20)	Port closed
(5)	Port open	(13)	Inlet solenoid valve	(21)	Deenergized
(6)	Suction solenoid valve	(14)	Pump	(22)	Reservoir
(7)	Cut solenoid valve	(15)	Check valve		
(8)	Check valve	(16)	Deenergized		

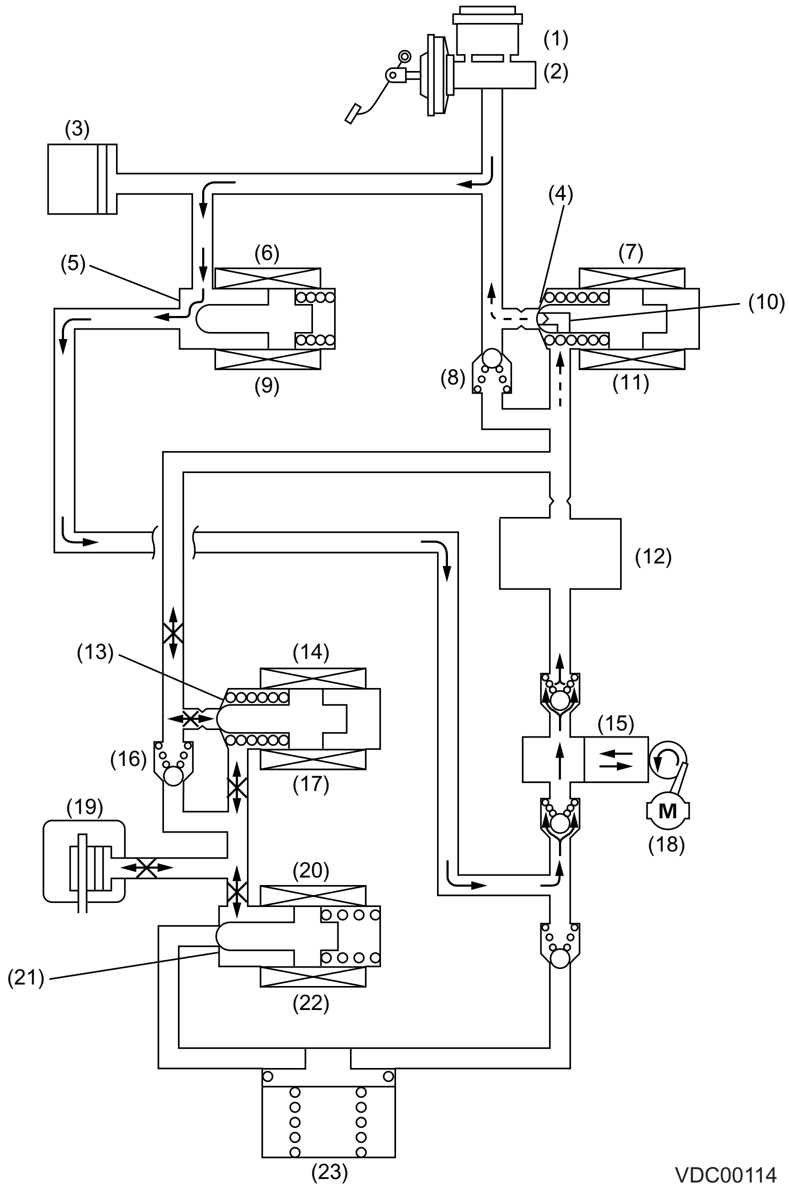
6. PRESSURE “HOLD” CONTROL WITH BRAKE PEDAL NOT DEPRESSED

The cut solenoid valve, suction solenoid valve and inlet solenoid valve are all energized, while the outlet solenoid valve is de-energized. This means that the ports of the cut solenoid valve, inlet solenoid valve and outlet solenoid valve are closed, while the port of the suction solenoid valve is open.

In this state, the pump is activated, forcing the brake fluid in the master cylinder reservoir tank through the open port of the suction solenoid valve. The fluid passage is, however, blocked by the closed inlet solenoid valve. Since the port of the outlet solenoid valve is also closed, the fluid pressure in the wheel cylinder is held unreleased.

The fluid pressure generated by the pump becomes higher and higher because the port of the inlet solenoid valve is closed. When it reaches a certain level, the built-in relief valve of the cut solenoid valve opens and allows the brake fluid to return into the master cylinder reservoir tank.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



(1)	Reservoir tank	(9)	Energized	(17)	Energized
(2)	Master cylinder	(10)	Relief valve	(18)	Motor
(3)	Pressure sensor	(11)	Energized	(19)	Wheel cylinder
(4)	Port closed	(12)	Damper chamber	(20)	Outlet solenoid valve
(5)	Port open	(13)	Port closed	(21)	Port closed
(6)	Suction solenoid valve	(14)	Inlet solenoid valve	(22)	Deenergized
(7)	Cut solenoid valve	(15)	Pump	(23)	Reservoir
(8)	Check valve	(16)	Check valve		

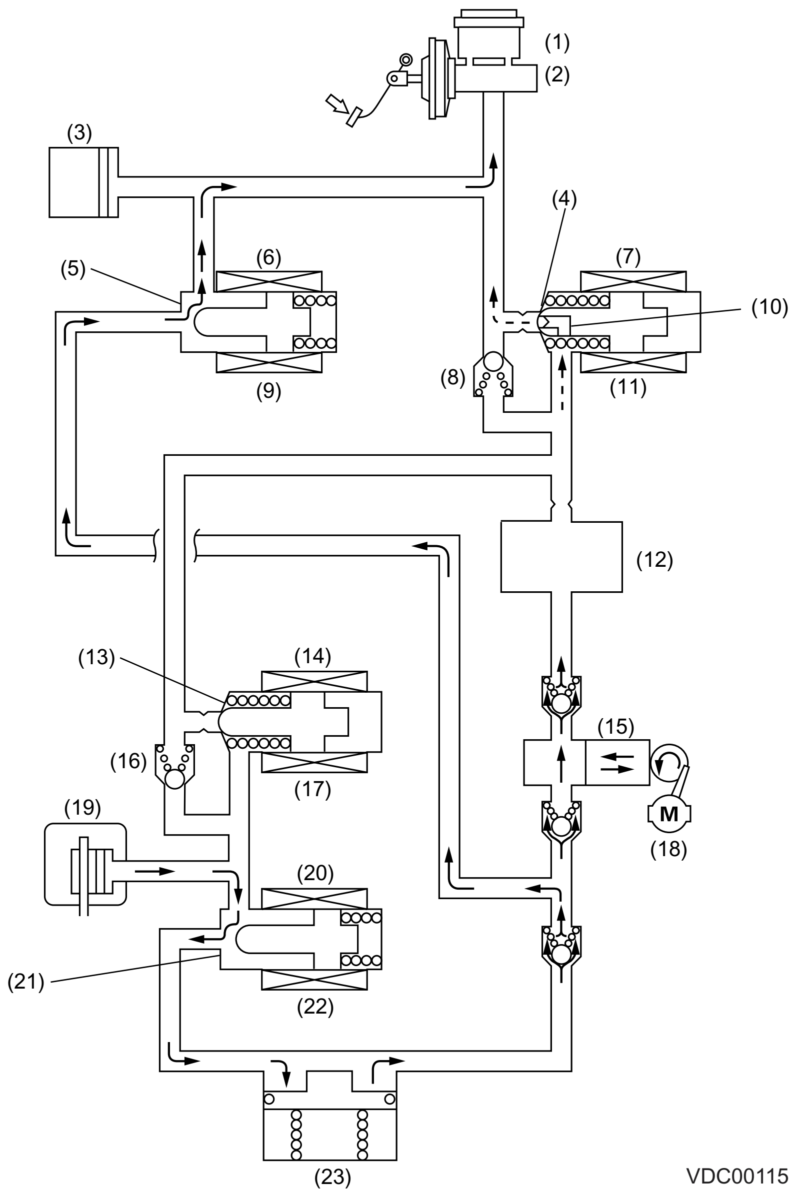
7. PRESSURE "DECREASE" CONTROL WITH BRAKE PEDAL NOT DEPRESSED

The cut solenoid valve, suction solenoid valve, inlet solenoid valve and outlet solenoid valve are all energized. This means that the ports of the cut solenoid valve and inlet solenoid valve are closed, while those of the suction and outlet solenoid valves are open.

In this state, the pump is activated drawing the brake fluid from the reservoir and forcing it toward the master cylinder through the open port of the suction solenoid valve. The fluid passage is blocked by the inlet solenoid valve, so the fluid cannot flow toward the wheel cylinder. Since the port of the outlet solenoid valve is open, on the other hand, the brake fluid in the wheel cylinder is allowed to be drawn into the reservoir, so the fluid pressure in the wheel cylinder decreases. The brake fluid drawn into the reservoir is raised from it and forced into the master cylinder reservoir tank through the suction solenoid valve.

The pressure of the fluid in the passage toward the cut solenoid valve becomes higher and higher as the pump operates since the valve is closed. When the pressure reaches a certain level, the build-in relief valve of the cut solenoid valve opens, releasing the brake fluid into the master cylinder reservoir tank.

NOTE:
For simplicity of explanation, operation of the hydraulic control unit is represented by operation of a single wheel circuit.



(1) Reservoir tank
(2) Master cylinder
(3) Pressure sensor
(4) Port closed
(5) Port open
(6) Suction solenoid valve
(7) Cut solenoid valve
(8) Check valve
(9) Energized
(10) Relief valve
(11) Energized
(12) Damper chamber
(13) Port closed
(14) Inlet solenoid valve
(15) Pump
(16) Check valve
(17) Energized
(18) Motor
(19) Wheel cylinder
(20) Outlet solenoid valve
(21) Port open
(22) Energized
(23) Reservoir

MEMO

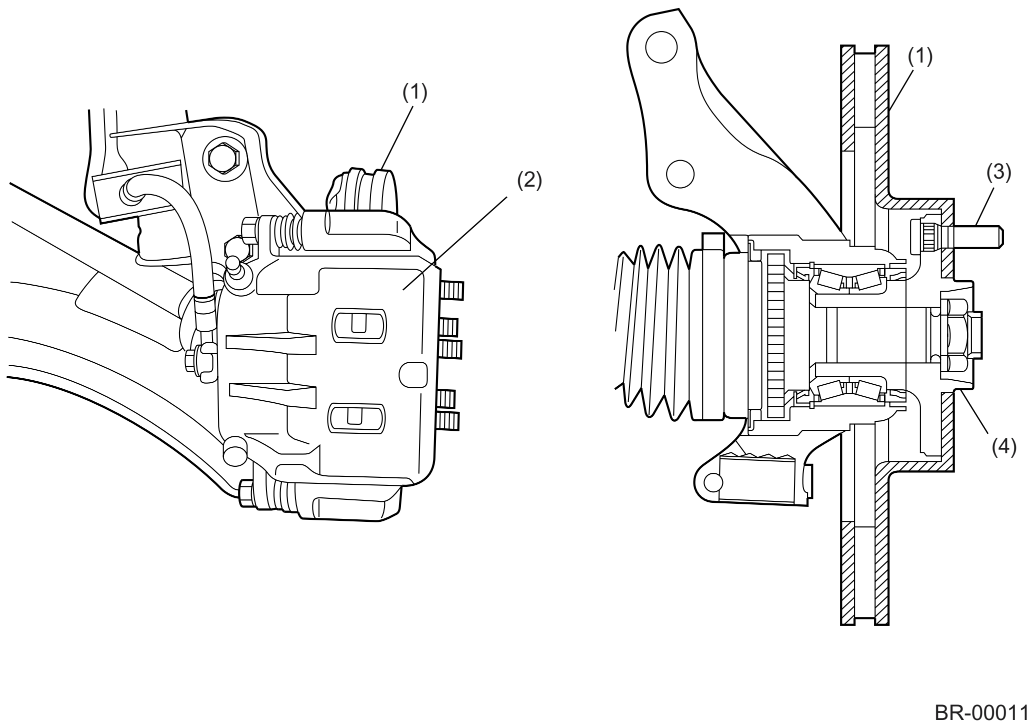
1. Front and Rear Disc Brakes

● The front disc brakes are of a ventilated disc type which features high heat dissipation and superb braking stability. In addition, the front brakes quickly restores their original braking performance even when they get wet.

● The rear brakes are disc brakes.

● 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.

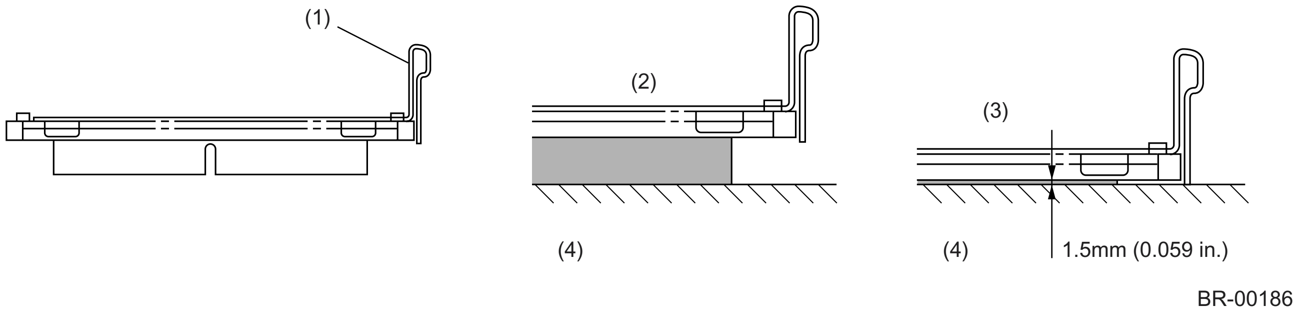
● The inner brake pad is provided with a wear indicator.



(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	(3) Worn pad
(2) New pad	(4) Disc rotor

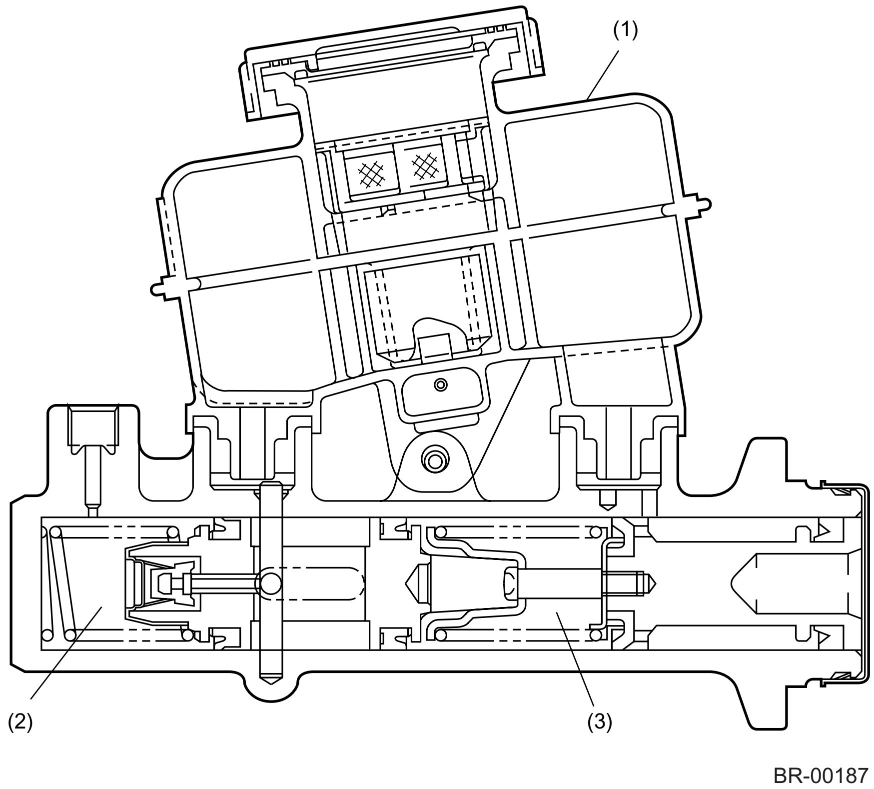
B: FRICTIONAL MATERIAL OF BRAKE PADS

The brake pads materials do not contain any asbestos which is harmful to human body.

2. Master Cylinder

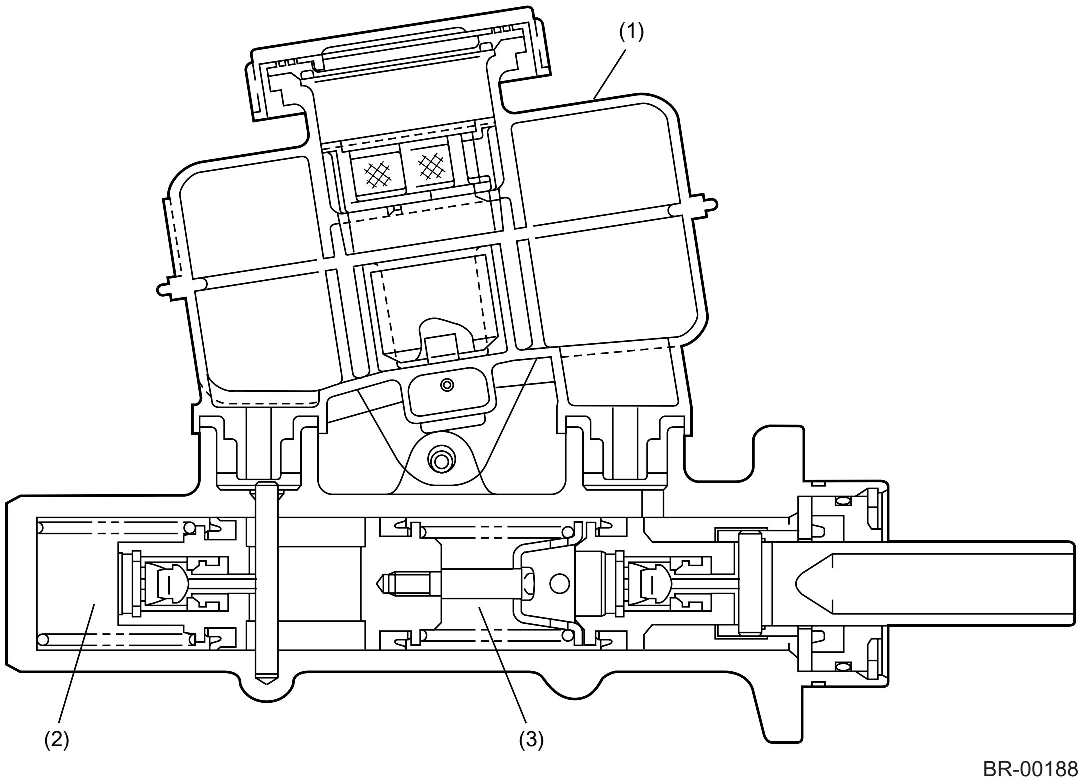
- There is a brake fluid reservoir tank on the master cylinder.

ABS model



(1) Reservoir tank
(2) Secondary hydraulic chamber (chamber S)
(3) Primary hydraulic chamber (chamber P)

VDC model



(1) Reservoir tank

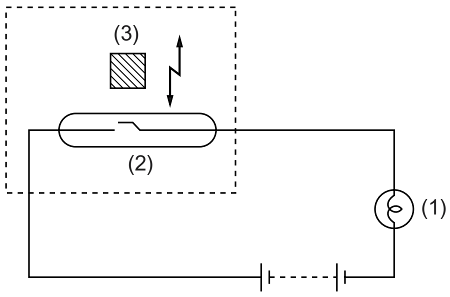
(2) Secondary hydraulic chamber (chamber S)

(3) Primary hydraulic chamber (chamber P)

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.

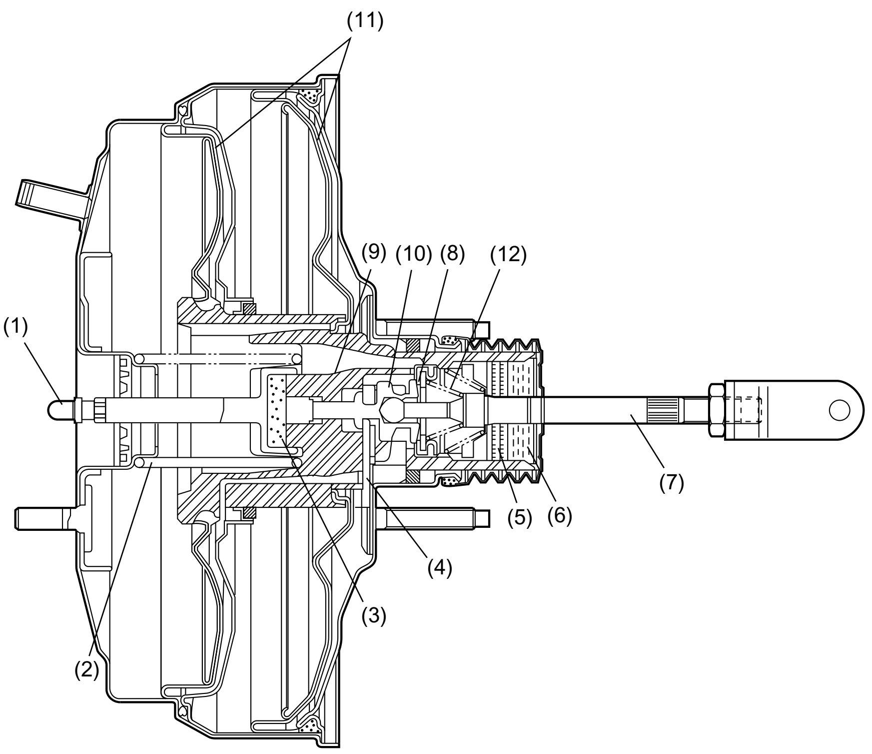


BR-00147

(1) Warning light (2) Reed switch (3) Permanent magnet

3. 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.
- All models are equipped with an 8 inch + 9 inch booster.

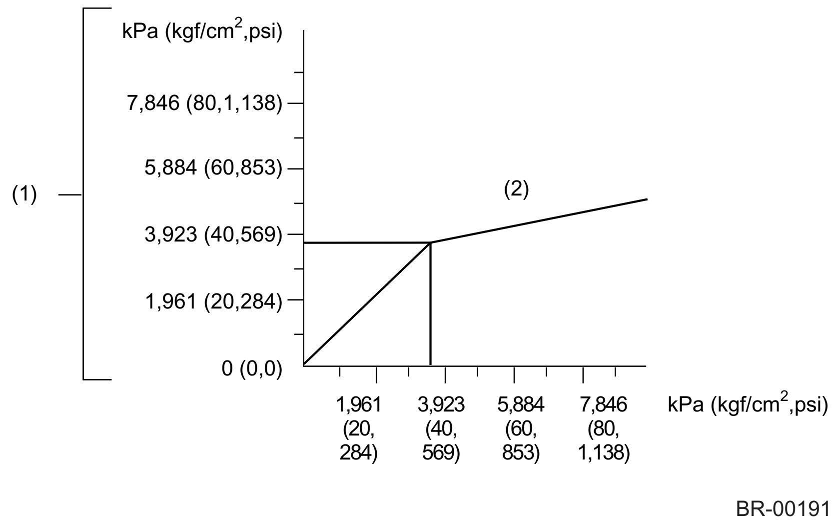


(1) Pushrod	(5) Filter	(9) Valve body
(2) Return spring	(6) Silencer	(10) Plunger valve
(3) Reaction disc	(7) Operating rod	(11) Diaphragm plate
(4) Key	(8) Poppet valve	(12) Valve return spring

4. Proportioning Valve

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.

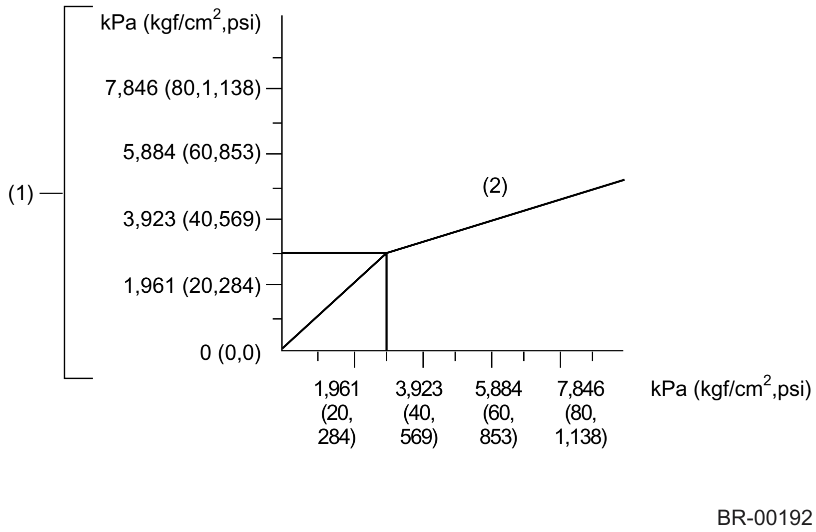
VDC model



(1) Rear wheel cylinder fluid pressure

(2) Master cylinder fluid pressure in case of split point 3,677 kPa (37.5 kgf/cm^2, 533 psi)

Except VDC model



(1) Rear wheel cylinder fluid pressure

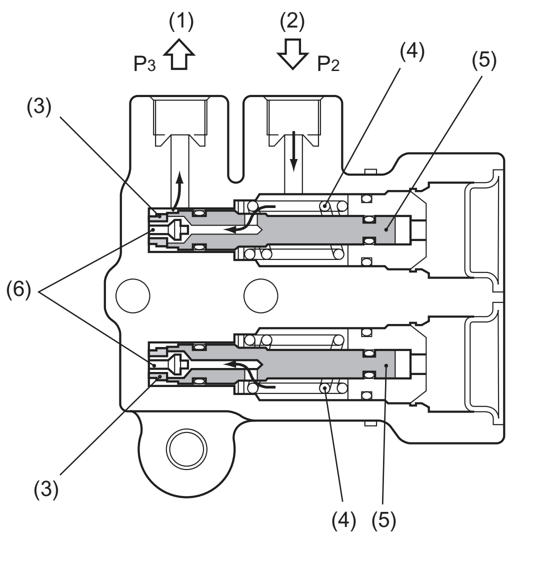
(2) Master cylinder fluid pressure in case of split point 2,942 kPa (30 kgf/cm^2, 427 psi)

A: OPERATION

1) Operation before the split point

The piston is held pressed toward the left by the spring so that the valve is kept away from its seat.

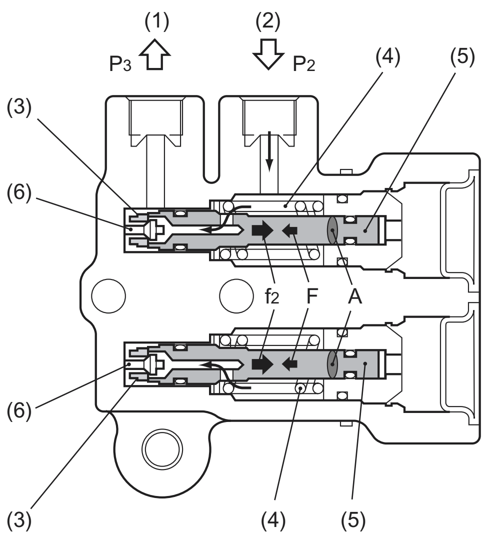
Under this condition, fluid pressure “P_3” to the rear wheel cylinders is equal to fluid pressure “P_2” from the master cylinder.



(1) To rear wheel cylinder	(4) Spring
(2) From master cylinder	(5) Piston
(3) Seat	(6) Valve

2) Operation at the split point pressure

When pressure “P_2” increases to the split point pressure, force “f_2” is generated. (Pistons 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 valve seat moves together with the piston rightward and comes in contact with the valve, blocking the passage toward the rear wheel cylinders.



BR-00194

(1) To rear wheel cylinder
(2) From master cylinder
(3) Seat
(4) Spring
(5) Piston
(6) Valve

3) Operation after reaching the split point pressure

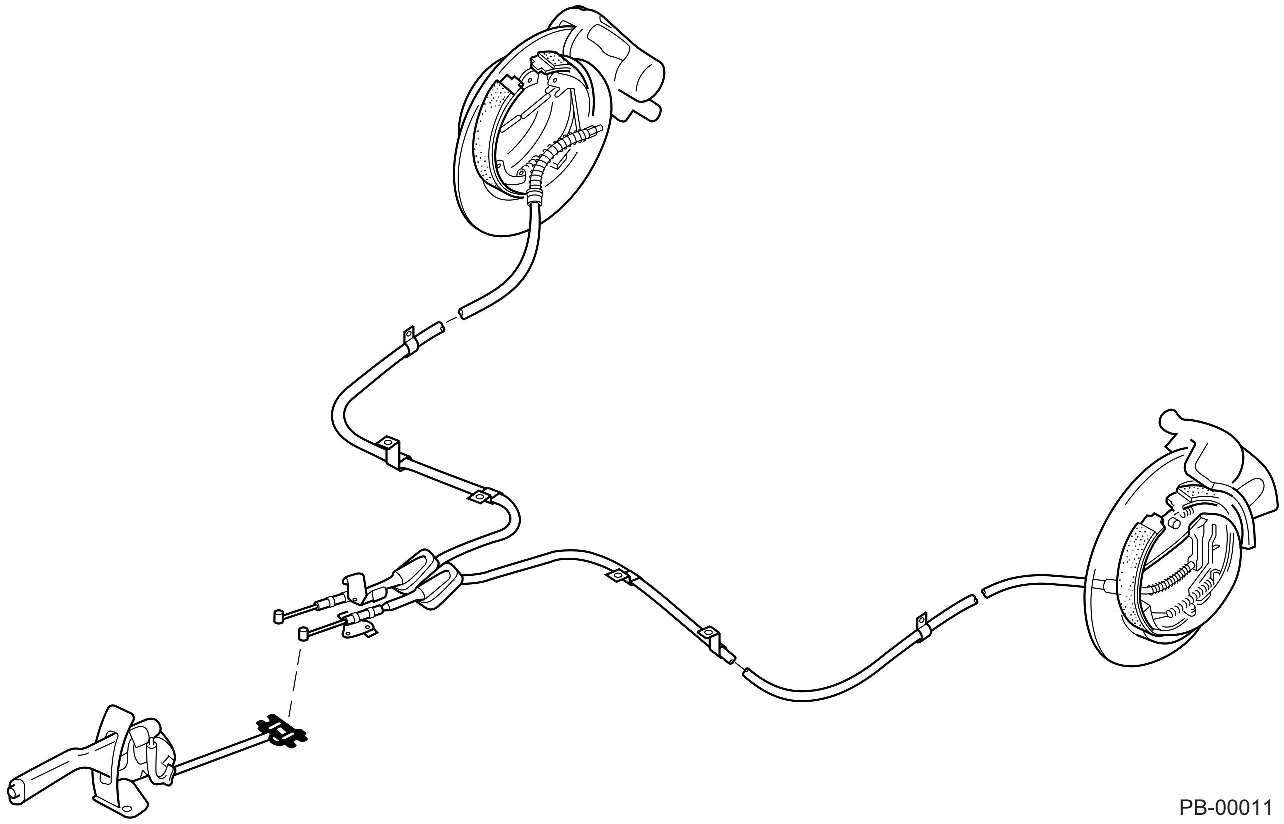
Immediately before the fluid passage toward the rear wheel cylinders is closed, pressure “P_2” is slightly higher than pressure “P_3”. So the piston can move in the spring force acting direction and the fluid can flow to the wheel cylinders. However, as soon as pressure “P_2” becomes equal to “P_3”, the valve 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.

MEMO

1. Parking Brake

The parking brake uses a drum housed in the disc rotor of each rear disc brake. The shoes are mechanically controlled through linkage and cables.

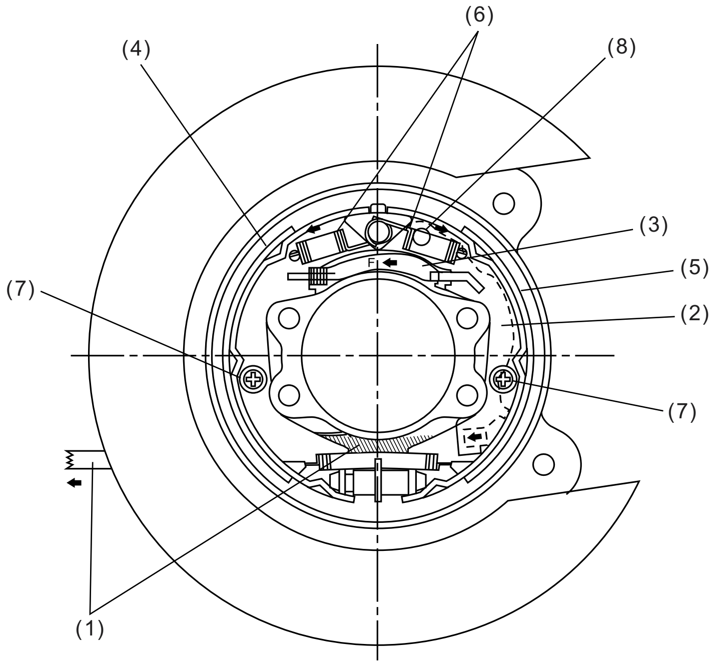


A: OPERATION

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.

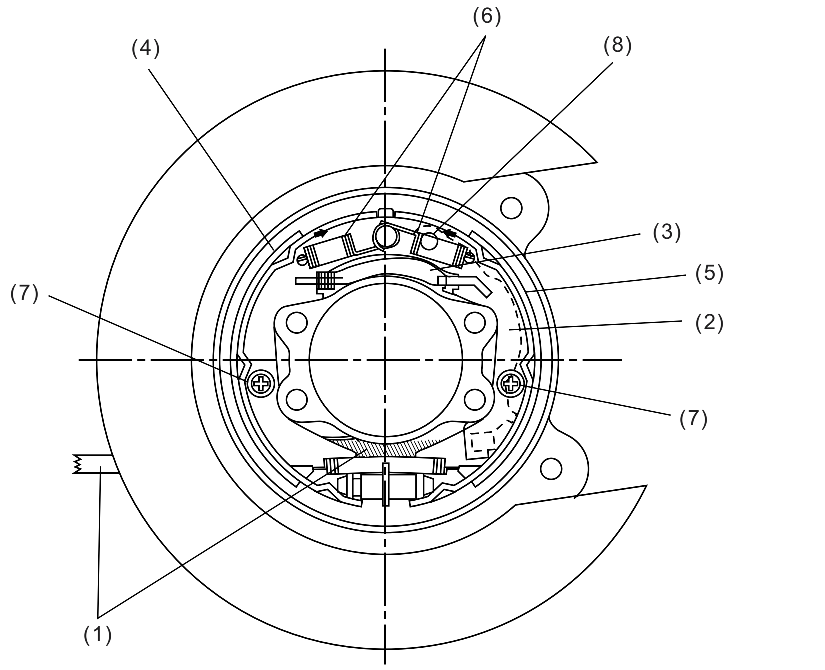


PB-00030

(1)	Parking brake cable	(5)	Brake shoe B
(2)	Lever	(6)	Shoe return spring
(3)	Strut	(7)	Shoe hold down pin
(4)	Brake shoe A	(8)	Point “P”

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.

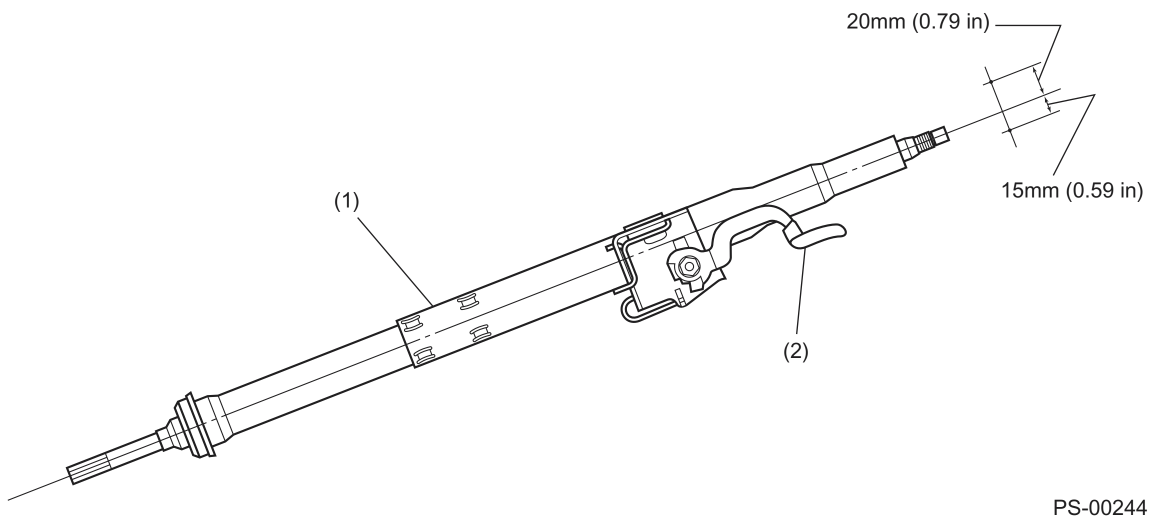


(1) Parking brake cable
(2) Lever
(3) Strut
(4) Brake shoe A
(5) Brake shoe B
(6) Shoe return spring
(7) Shoe hold down pin
(8) Point “P”

1. Tilt Steering Column

A: TILT MECHANISM

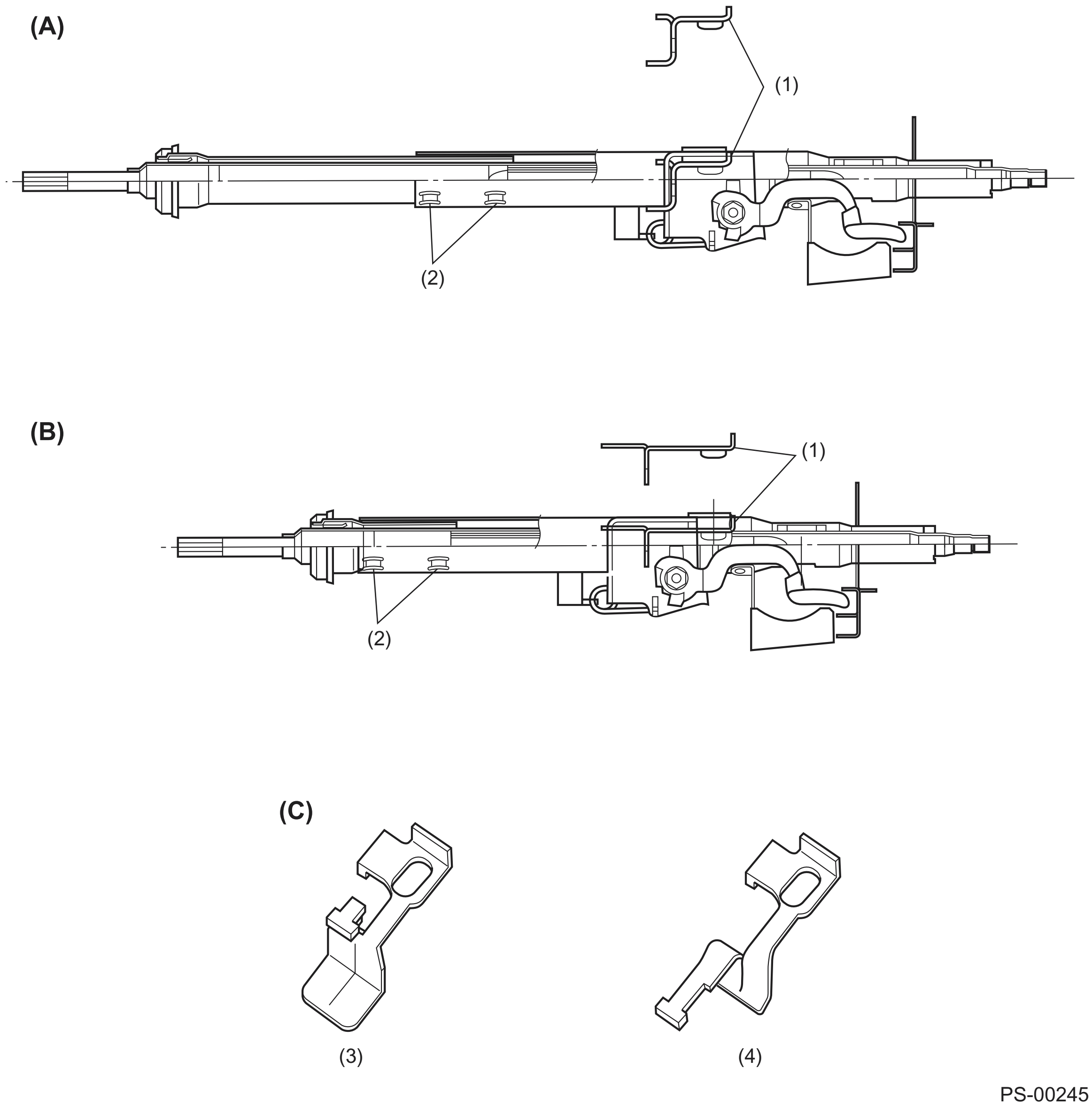
● The steering wheel vertical position can be adjusted within a 35 mm (1.38 in) range by using the tilt lever to unlock the steering column and lock it again at the desired position.



(1) Tilt steering column
(2) Tilt lever

B: ENERGY-ABSORBING MECHANISM

- To absorb the backward movement energy generated in the engine in the event of a frontal collision, an elliptical fitting type steering column pipe has been adopted. When an impact load exceeding a certain level is applied to the steering column, the elliptical fittings crash and their ends come in contact with each other. The column bending load is supported by the fittings.
- Another measure to alleviate impact on the driver in the event of a collision is the ripping plate which is located between the steering column and the tilt bracket attached to the steering support beam. When a large impact load is applied to the steering column, the ripping plate is deformed and torn progressively. The impact energy is absorbed during this process.

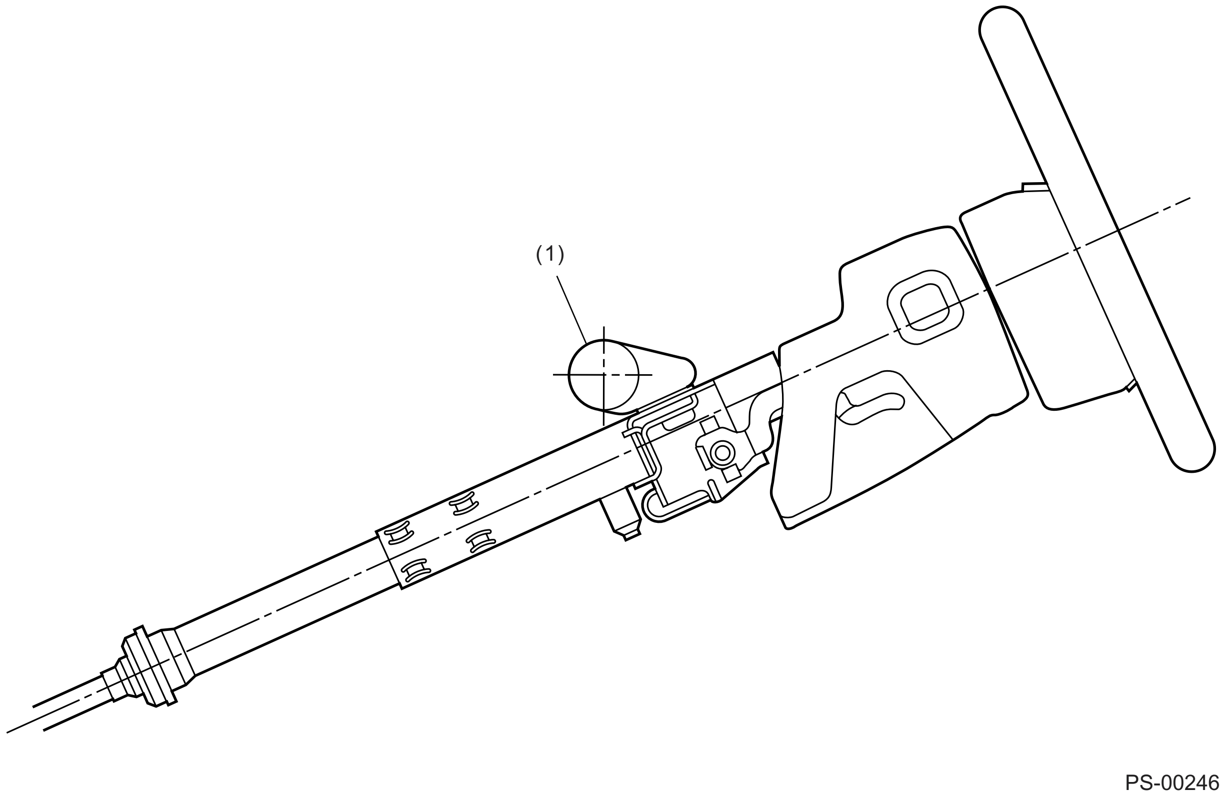


(A) Before absorption of impact energy
(B) After absorption of impact energy
(C) Ripping plate

(1) Ripping plate
(2) Elliptical fitting
(3) Before ripping
(4) After ripping

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.



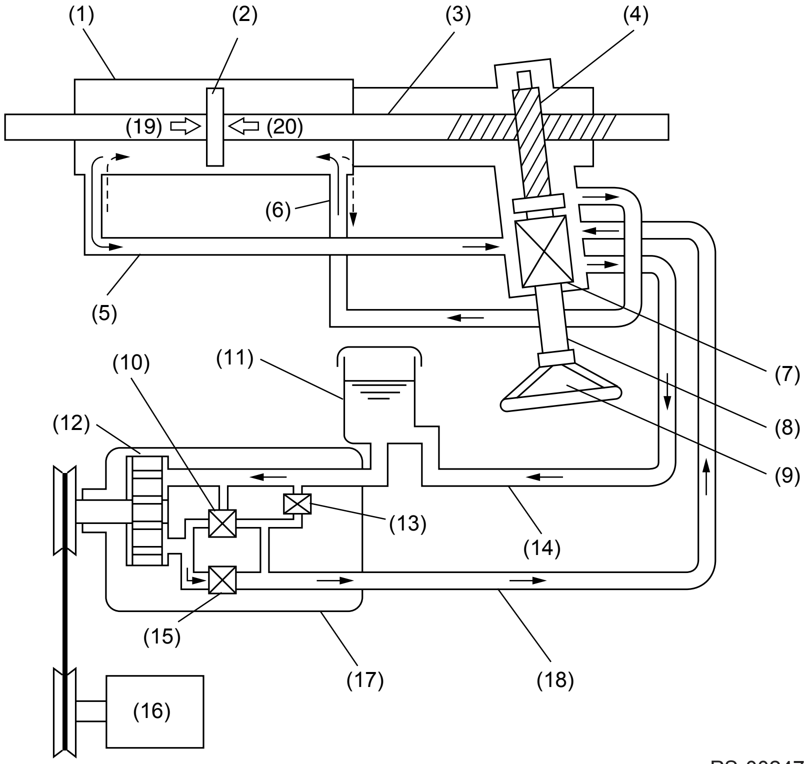
(1) Steering support beam

2. Power Steering System

A: HYDRAULIC SYSTEM

- The fluid pump is directly driven by the engine through a belt.
- When the steering wheel is not being turned, the pressure-sensitive valve in the pump opens to drain the fluid into the fluid reservoir tank.
- The fluid pressure is maintained almost constant regardless of change in the engine speed by the function of the flow control valve. The pressure-regulated fluid is delivered to the control valve via 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 be operated 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.

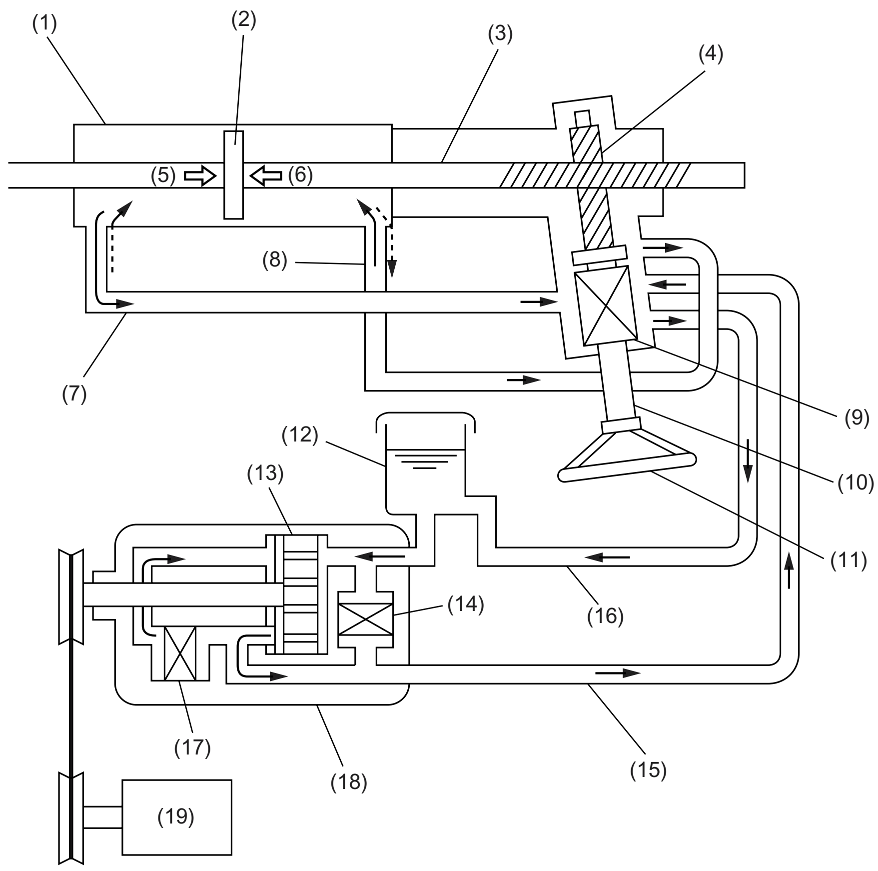
2.5 L MODEL



PS-00247

(1)	Power cylinder	(8)	Steering shaft	(15)	Flow control valve
(2)	Rack piston	(9)	Steering wheel	(16)	Engine
(3)	Rack shaft	(10)	Pressure-sensitive valve	(17)	Fluid pump
(4)	Pinion shaft	(11)	Tank	(18)	Hose A
(5)	Pipe A	(12)	Vane pump	(19)	Chamber A
(6)	Pipe B	(13)	Relief valve	(20)	Chamber B
(7)	Rotary control valve	(14)	Hose B		

3.0 L MODEL



PS-00009

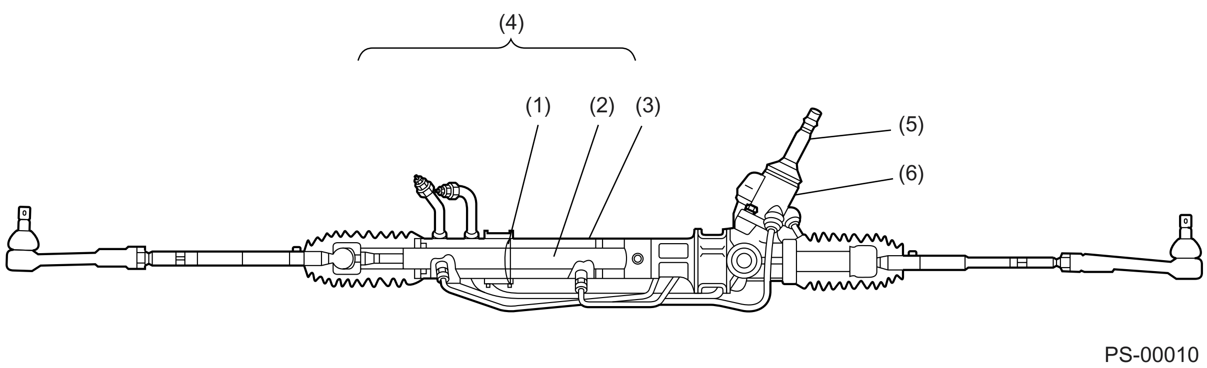
(1) Power cylinder
(2) Rack piston
(3) Rack shaft
(4) Pinion shaft
(5) Chamber A
(6) Chamber B
(7) Pipe A
(8) Pipe B
(9) Rotary control valve
(10) Steering shaft
(11) Steering wheel
(12) Tank
(13) Vane pump
(14) Relief valve
(15) Hose A
(16) Hose B
(17) Pump control valve
(18) Fluid pump
(19) Engine

B: GEARBOX ASSEMBLY

1. POWER CYLINDER

The gearbox 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.



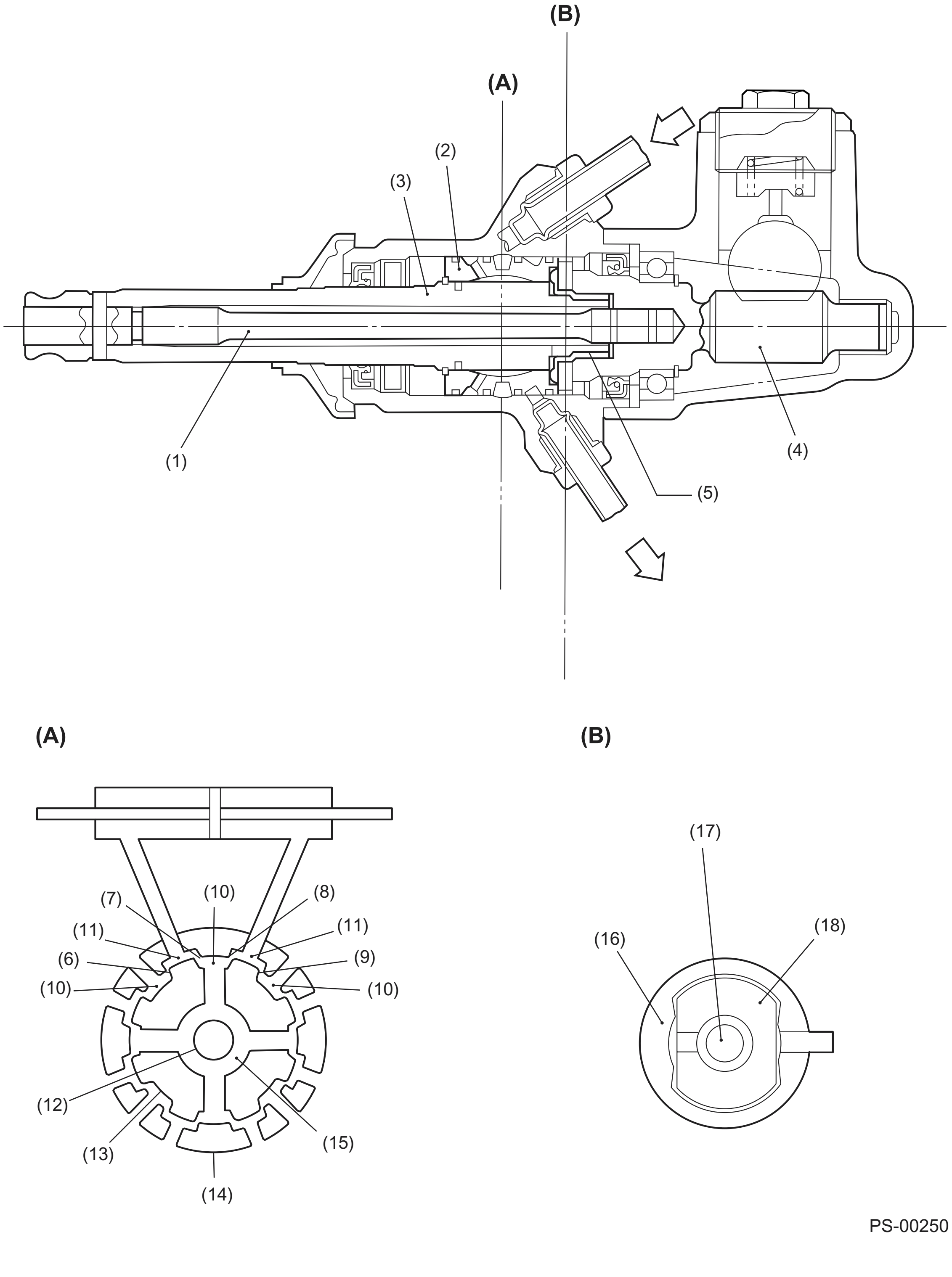
(1)	Piston	(4)	Power cylinder
(2)	Rack shaft	(5)	Pinion shaft
(3)	Cylinder	(6)	Control valve

MEMO

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).


(A)
(B)
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
(15)
(16)
(17)
(18)
PS-00250

(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

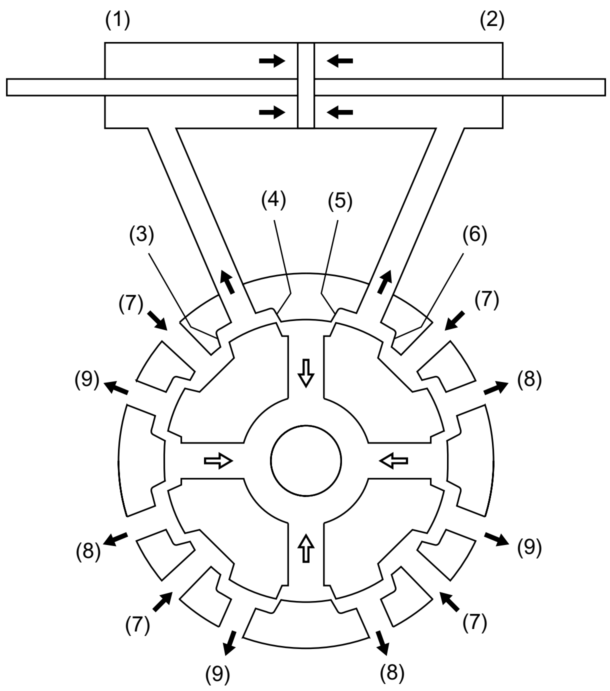
(A) Cross-sectional view A (fluid passage switching circuit)
(B) Cross-sectional view B (pinion-to-rotor engagement)

- 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 and V_3, 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.

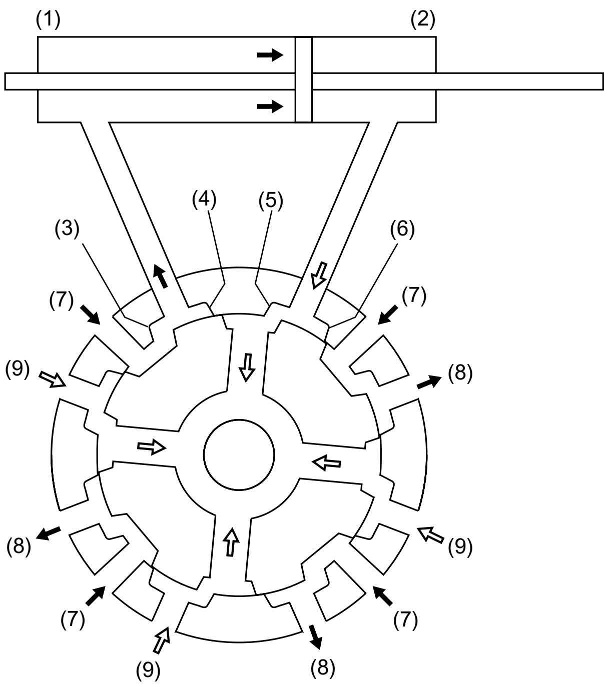


PS-00012

(1) Chamber A	(4) V_2	(7) From fluid pump
(2) Chamber B	(5) V_3	(8) To A
(3) V_1	(6) V_4	(9) To B

- 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.



PS-00013

(1)	Chamber A	(4)	V_2	(7)	From fluid pump
(2)	Chamber B	(5)	V_3	(8)	To A
(3)	V_1	(6)	V_4	(9)	From B

C: FLUID PUMP AND RESERVOIR TANK

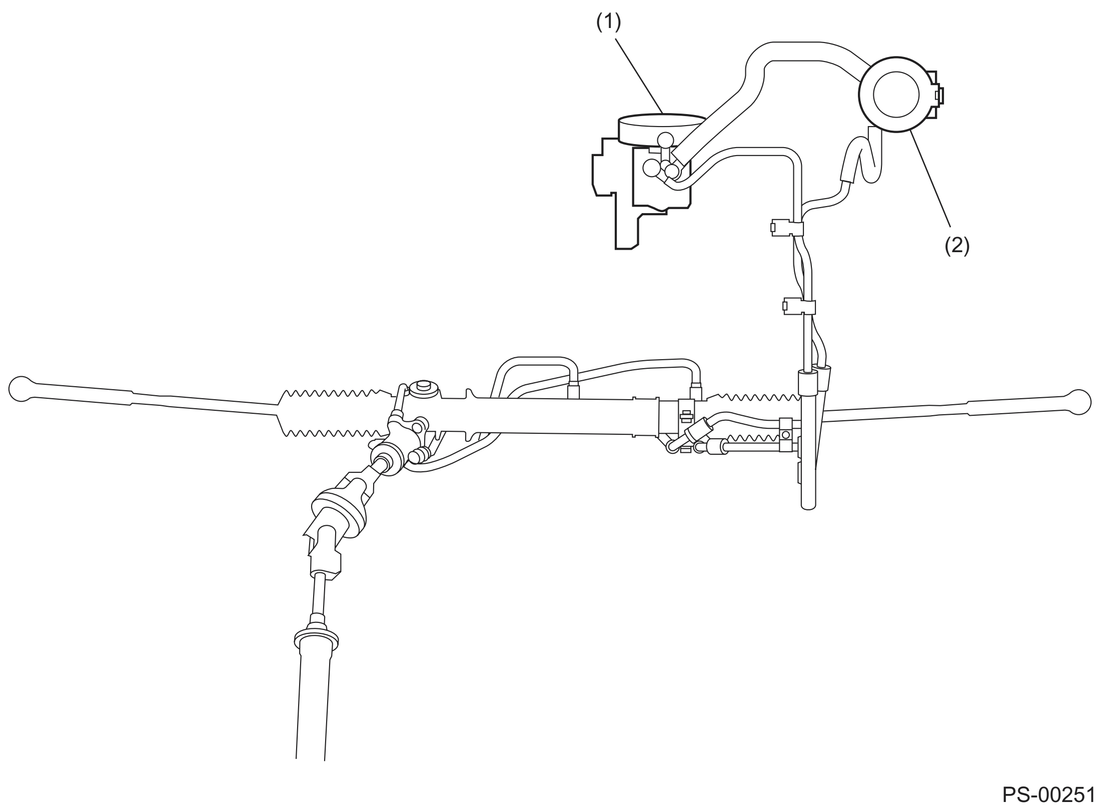
1. 2.5 L MODEL

The fluid pump is a vane type driven by the engine via belt.

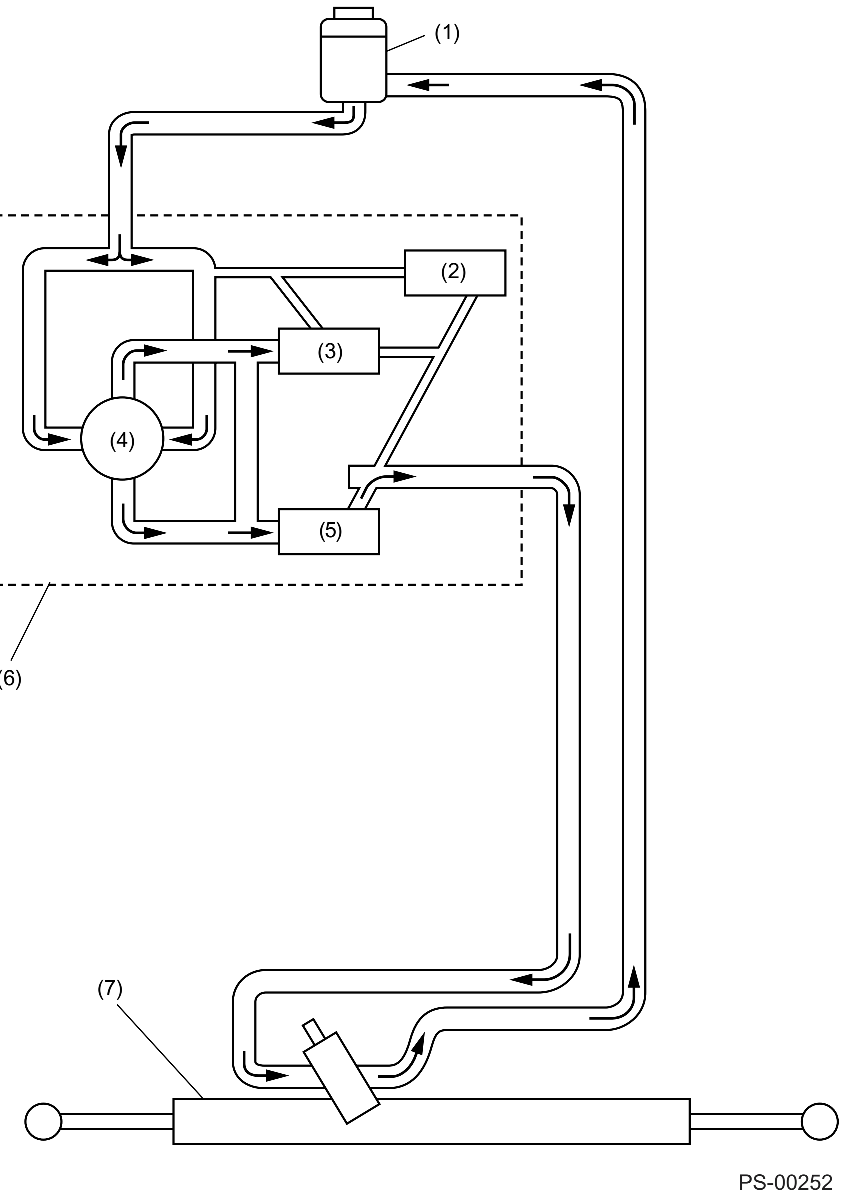
The reservoir tank is mounted on the vehicle body.

The fluid pump incorporates the flow control valve, pressure-sensitive 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 pressure-sensitive valve returns the fluid to the reservoir tank when there is no steering input.
- 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.



(1) Fluid pump
(2) Reservoir tank

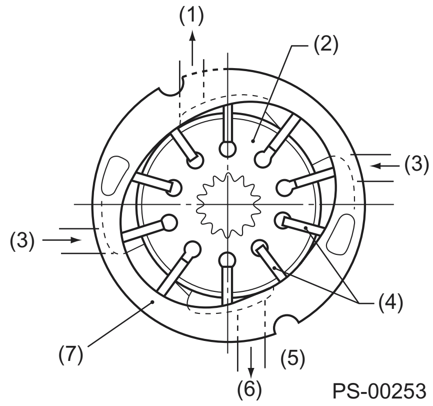


(1)	Reservoir tank	(5)	Flow control valve
(2)	Relief valve	(6)	Fluid pump
(3)	Pressure-sensitive valve	(7)	Steering gearbox
(4)	Vane pump		

● **VANE PUMP**

The vane pump consists of a rotor, a cam ring, and ten vanes.

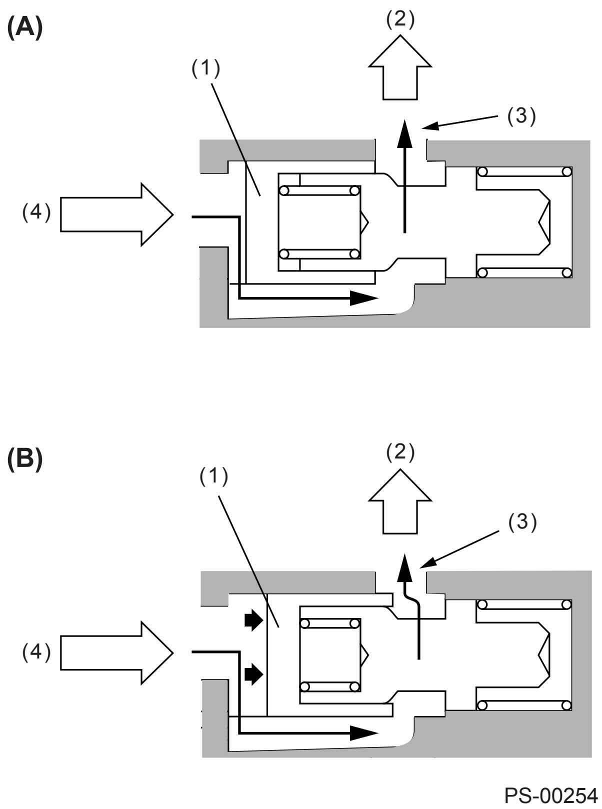
When the rotor rotates, the vane movably fitted in each slot of the rotor is radially moved out by centrifugal force and pressed against the inside wall of the cam ring. Since the inside of the cam ring is oval-shaped, the fluid from the suction port is confined and pressurized in the chamber formed between two adjacent vanes as the rotor rotates and is delivered through the discharge port. The pressurized fluid circulates through the hydraulic circuit.



(1) Discharge
(2) Rotor
(3) Suction
(4) Vane
(5) Vane pump
(6) Discharge
(7) Cam ring

● FLOW CONTROL VALVE

The flow control valve consists of a sub-spool which is pushed to the right when the fluid pressure rises as the engine speed increases (and consequently, the pump discharge rate becomes higher). When the sub-spool is shifted to the right, the variable orifice is narrowed, thus the discharge rate is reduced.

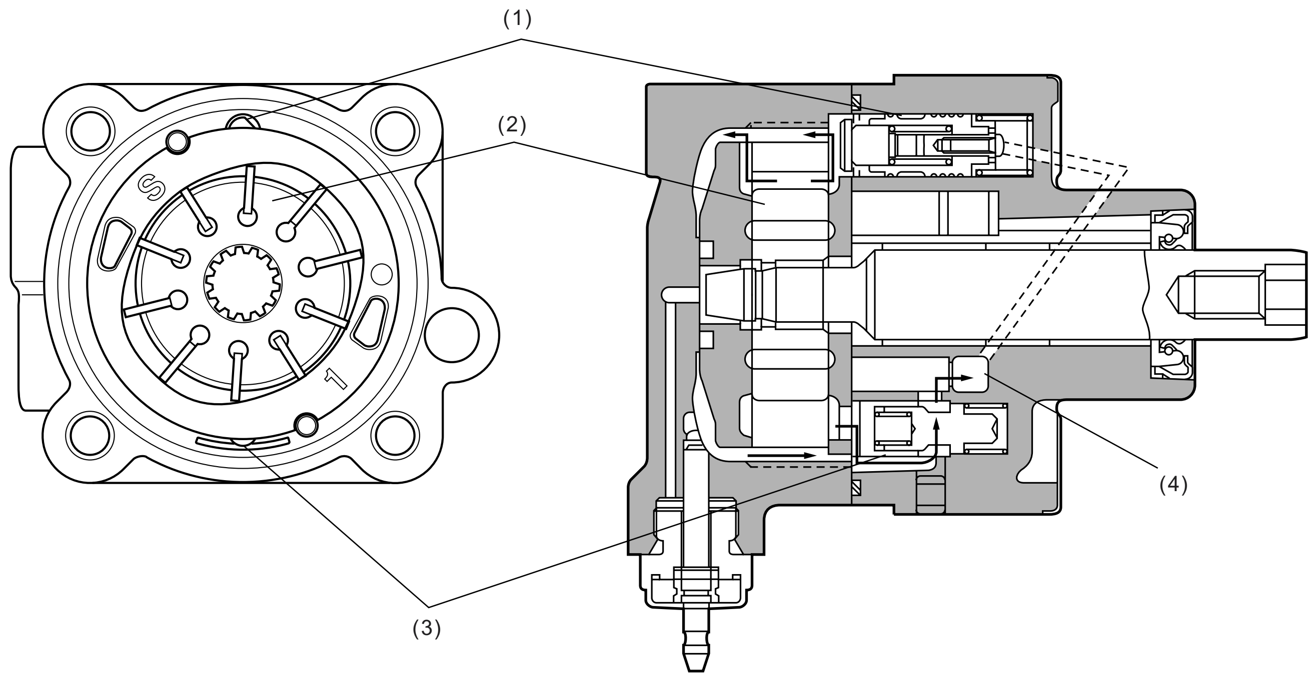


(A) Engine speed low
(B) Engine speed high

(1) Sub-spool
(2) To steering gearbox
(3) Variable orifice
(4) From vane pump

● PRESSURE-SENSITIVE VALVE

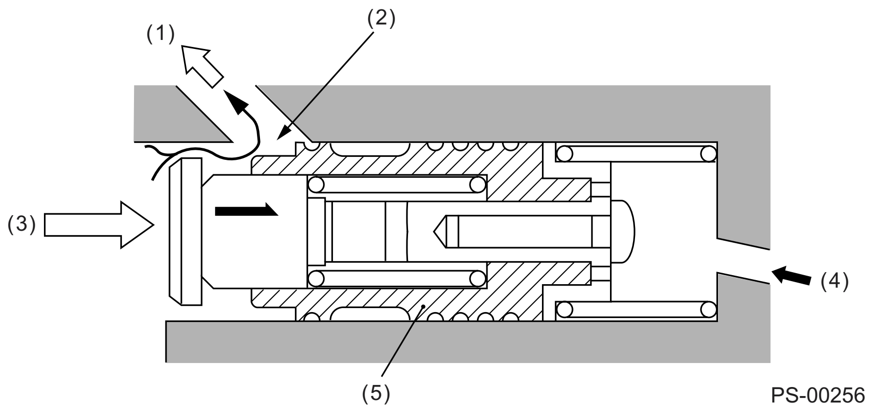
The pressure-sensitive valve’s left end is exposed to the fluid pump discharge-pressure and its right end to the flow control valve outlet pressure (the pressure of the fluid being directed to the steering gearbox).



(1) Pressure-sensitive valve
(2) Fluid pump
(3) Flow control valve
(4) To steering gearbox

● When the steering wheel is not being turned, the fluid that has passed through the flow control valve is directed to the steering gearbox but it is returned to the reservoir tank without entering the rotary control valve's passages in the gearbox. Therefore, the pressure acting on the valve's right end does not increase.

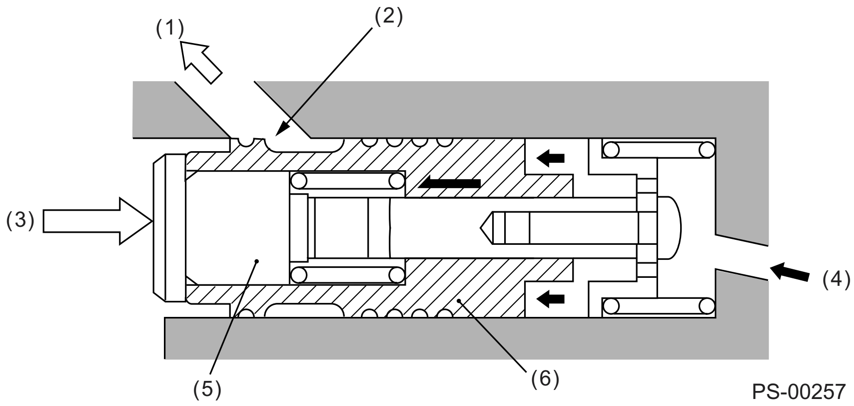
On the other hand, the pressure acting on the left end of valve is the fluid pump-discharge pressure which is higher than the pressure acting on the right end. This causes the pressure-sensitive valve's spool assembly to move to the right. As a result, the drain port which was closed by the outer spool is now opened. The pump discharged fluid then flows to the reservoir tank and the pressure inside the pump is reduced.



(1) To reservoir tank
(2) Drain port open
(3) Pressure from vane pump (high)
(4) Fluid pressure after passing through flow control valve (low)
(5) Outer spool

● When the steering wheel is turned in either direction, the pressure of the fluid that has passed through the flow control valve and directed into the steering gearbox increases as it enters the power cylinder and acts on the rack piston.

The inner spool of the pressure-sensitive valve is kept pressed to the right by the pump-discharge pressure acting on its left end. On the other hand, the fluid pressure acting on the right end of the valve is also high. So, the outer spool is moved to the left, closing the drain port. As a result, the pump internal pressure increases so that the fluid with a high pressure necessary for power assistance is supplied to the gearbox.

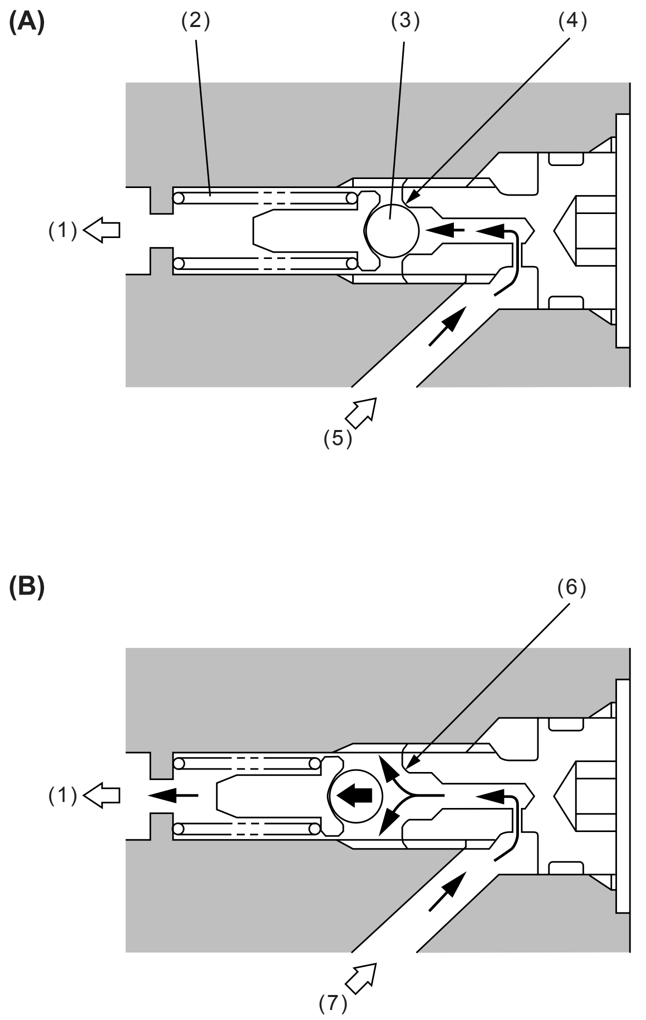


(1) To reservoir tank	(4) Fluid pressure after passing through flow control valve (increased)
(2) Drain port closed	(5) Inner spool
(3) Pressure from vane pump	(6) Outer spool

- **RELIEF VALVE**

The relief valve consists of a check ball and a spring. The check ball is exposed to the fluid pressure that is regulated by the flow control valve (branched from the line to the steering gearbox).

If the pressure acting on the check ball is increased abnormally due to, for example, rotation of the steering wheel to a stop and overcomes the spring tension, the ball is pushed to the left, allowing the fluid to be drained into the reservoir tank. Therefore, the pressure to the steering gearbox is prevented from becoming excessively high.



PS-00258

(A) Relief valve not in operation

(B) Relief valve in operation

(1) To reservoir tank

(2) Spring

(3) Check ball

(4) Valve closed

(5) Fluid pressure after passing through flow control valve (low)

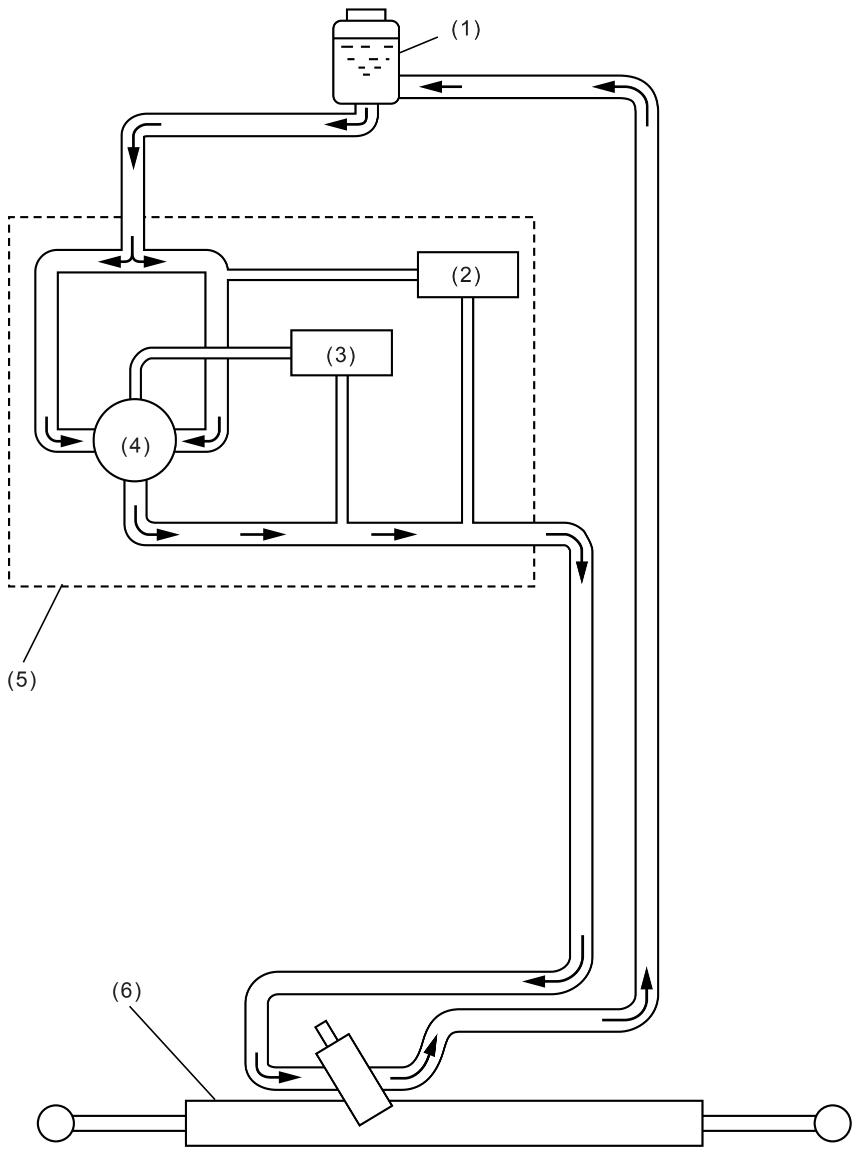
(6) Valve open

(7) Fluid pressure after passing through flow control valve (higher than preset level)

2. 3.0 L MODEL

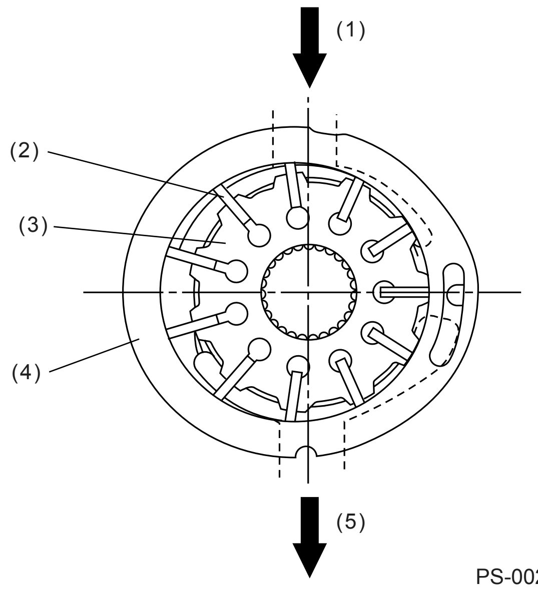
- The reservoir tank is mounted on the vehicle body.
- The fluid pump is belt-driven by the engine. The fluid flow is controlled according to the engine speed so that an adequate steering resistance is given during high-speed operation.

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.



(1) Reservoir tank	(4) Vane pump
(2) Relief valve	(5) Fluid pump assembly
(3) Pump control valve	(6) Steering gearbox

● 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.

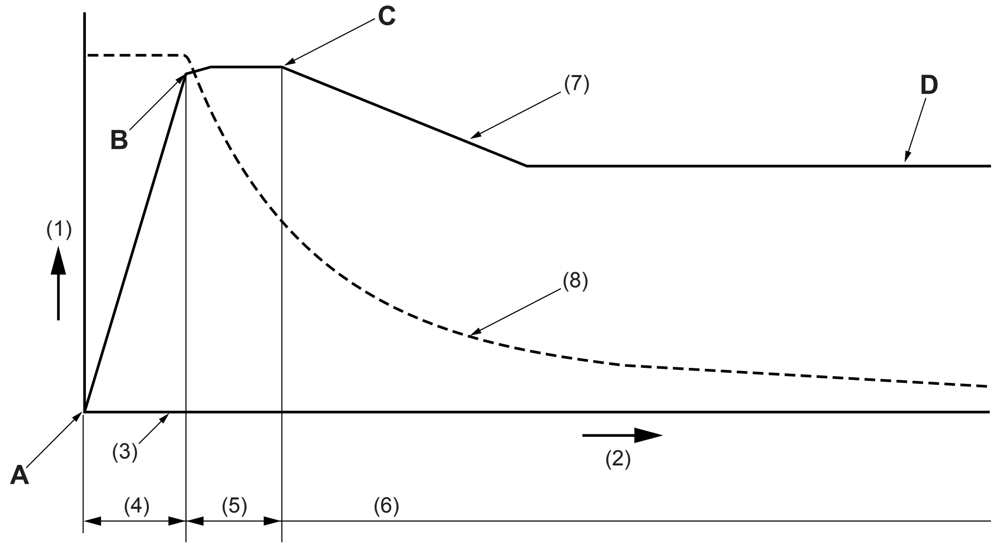


PS-00260

(1) Suction
(2) Vane
(3) Rotor
(4) Cam ring
(5) Discharge

- **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).

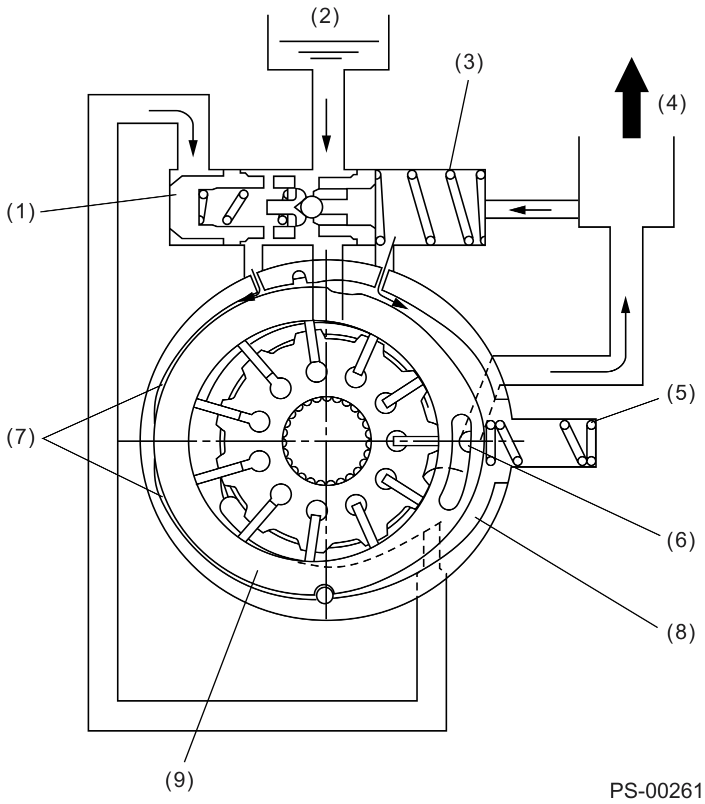


(1) Fluid flow	(5) Mid-speed
(2) Pump speed	(6) High-speed
(3) Idling	(7) Delivery rate per unit time
(4) Low-speed	(8) Delivery rate per rotation of pump

NOTE:
In the following description, pump speed ranges will be indicated using the speed points A through D shown in the drawing above.

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 reservoir 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.

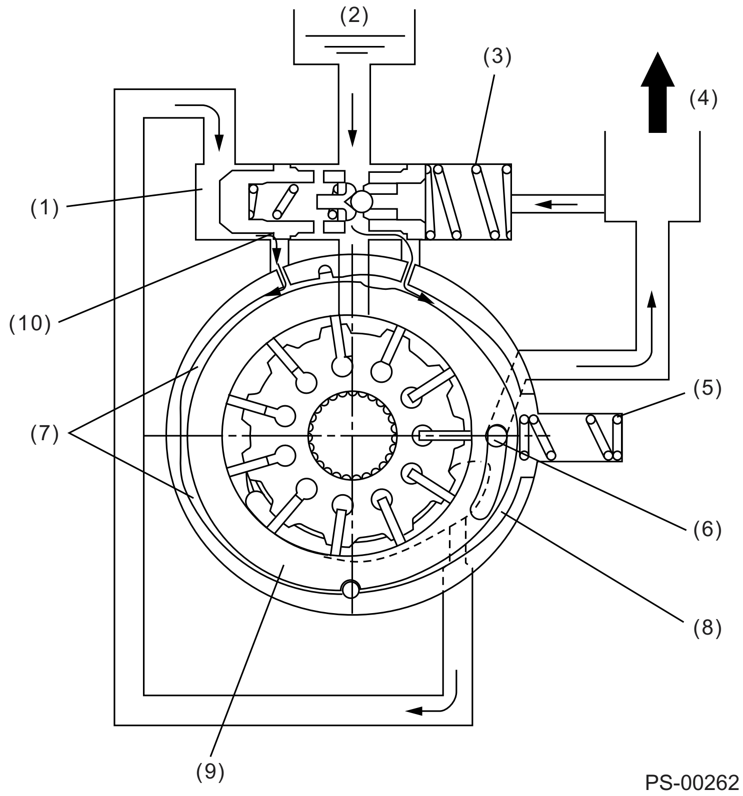


(1) Control valve
(2) Reservoir tank fluid
(3) Control valve spring
(4) Gear box
(5) Cam ring spring
(6) Variable orifice
(7) Pressure chamber A
(8) Pressure chamber B
(9) Cam ring

Mid-range-speed operation (B – D 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 after being adjusted to a necessary pressure* by the port opening area created by the control valve. On the other hand, chamber B receives the reservoir pressure (suction pressure). 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.
The above control is performed when the pump is operating at a speed in the B – D range.

* The “necessary pressure” for chamber A is a pressure required to move the cam ring to the position corresponding to each predetermined flow rate (pump delivery rate). The pressure is obtained by changing the port opening area appropriately through displacement of the control valve. The displacement of the control valve is determined by how much the pressure before the variable orifice is different from that after the orifice.

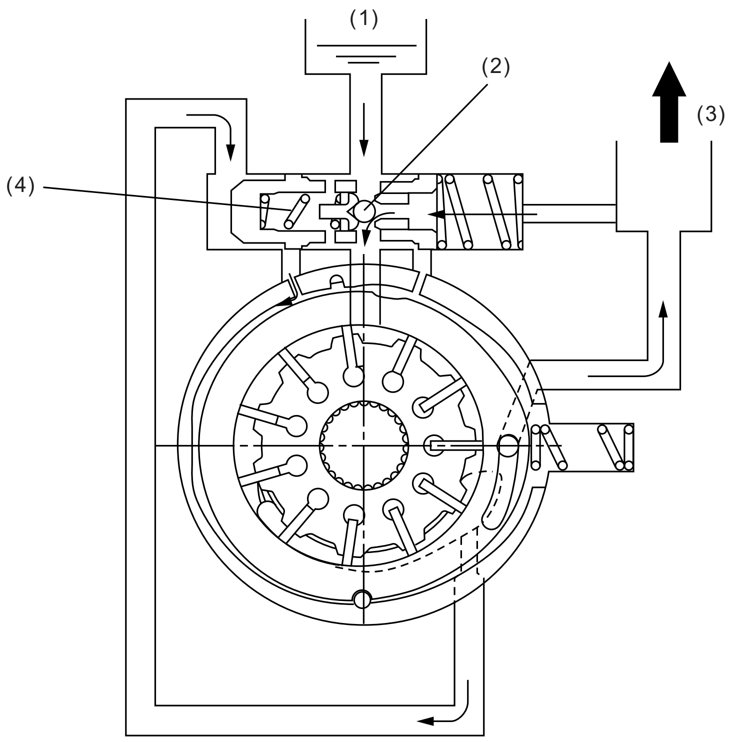


(1)	Control valve	(6)	Variable orifice
(2)	Reservoir tank fluid	(7)	Pressure chamber A
(3)	Control valve spring	(8)	Pressure chamber B
(4)	Gear box	(9)	Cam ring
(5)	Cam ring spring	(10)	Opening area

Maximum pressure control

When the hydraulic circuit in the steering gear box is closed as a result of a steering action, the pressure in the circuit increases to a very high level. The relief valve prevents the pressure from exceeding a preset safe level in the following way:

If the fluid in the circuit is pressurized to the preset pressure, the fluid pushes the ball of the valve overcoming the tension of the relief spring. Through the opened relief valve, the fluid makes its way to the pump's suction side passage, thus maintaining the circuit pressure at a level lower than the preset pressure.



PS-00263

(1) Reservoir tank fluid
(2) Relief valve
(3) Gear box
(4) Relief spring

1. Heater System

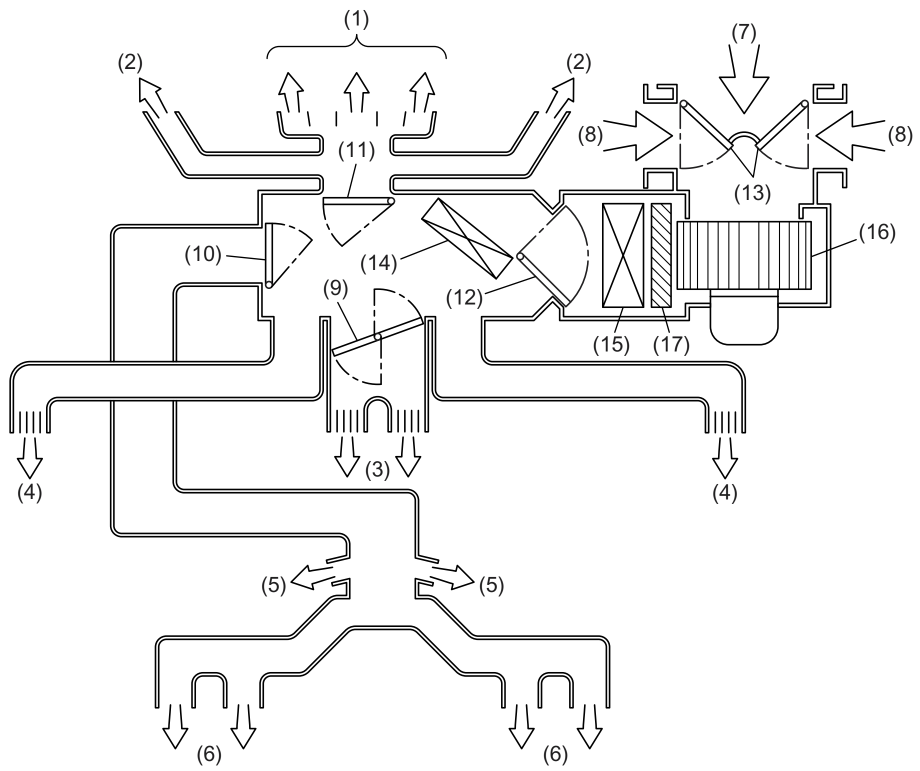
The heater control unit is located in the middle portion of the instrument panel.

The heater unit has mode doors and an air mix door. The intake unit has an intake door and a blower motor. The heater unit and the intake unit are regulated by their control units.

Fresh outside air is introduced into the cabin through the center and side ventilators when the blower fan is operated.

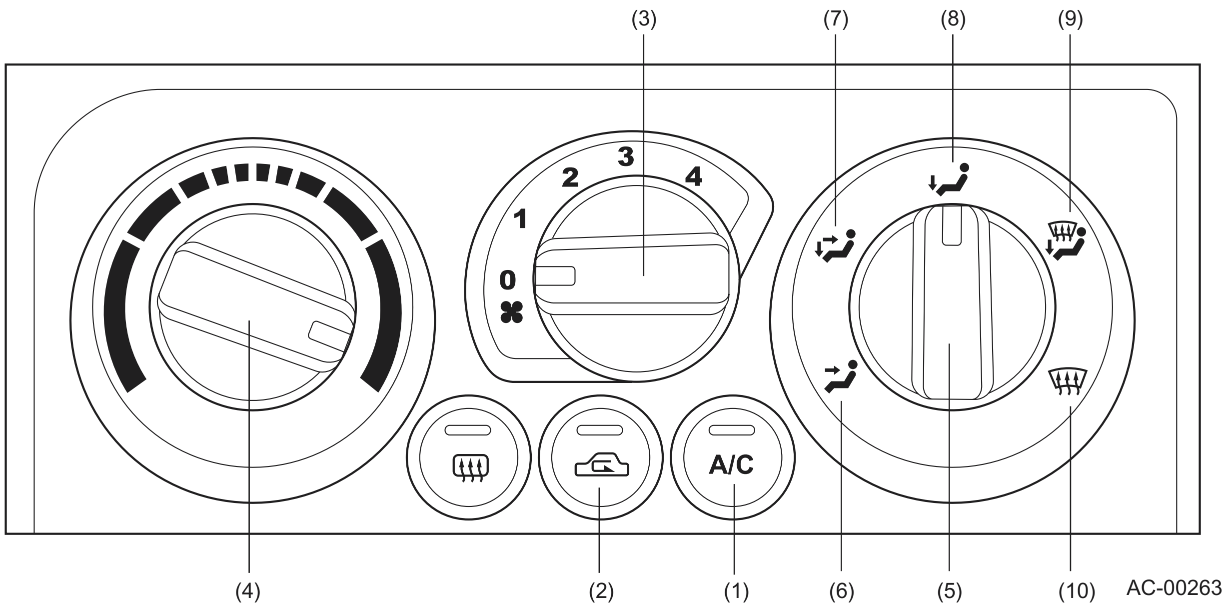
All models are equipped with front side window defrosters.

An optional filter is provided in front of the evaporator inlet.



(1)	Front defroster outlet	(7)	Fresh air	(13)	Intake door
(2)	Side defroster outlet	(8)	Recirculated air	(14)	Heater core
(3)	Center ventilator outlet	(9)	Ventilator door	(15)	Evaporator (A/C model)
(4)	Side ventilator outlet	(10)	Heater door	(16)	Blower fan
(5)	Front heater outlet	(11)	Defroster door	(17)	Filter (option)
(6)	Rear heater outlet	(12)	Air mix door	A/C:	Air conditioner

2. Switch Functions

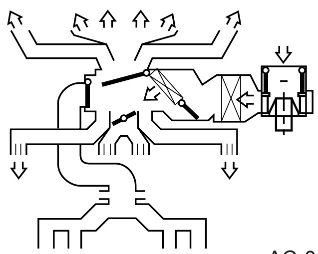
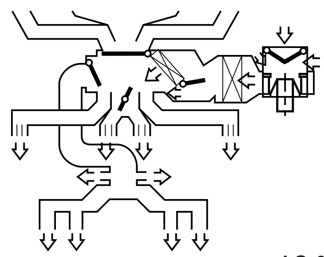
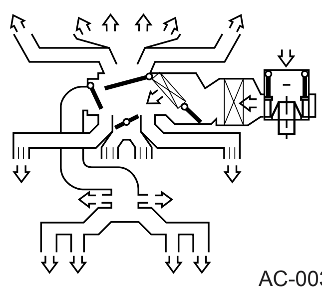
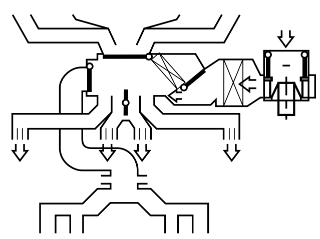
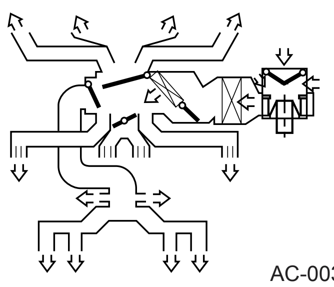


<table>
<tr><td rowspan="3">(1)</td><td rowspan="3">Air conditioner switch</td><td colspan="2">Indicator</td><td colspan="2">*1ON</td><td colspan="2">OFF</td></tr>
<tr><td colspan="2">Compressor</td><td colspan="2">ON</td><td colspan="2">OFF</td></tr>
<tr><td colspan="6">*1: When the fan switch is turned ON, the indicator and compressor also turn ON.</td></tr>
<tr><td rowspan="2">(2)</td><td rowspan="2">Recirculation switch</td><td colspan="2">Indicator</td><td colspan="2">ON</td><td colspan="2">OFF</td></tr>
<tr><td colspan="2">Intake door position</td><td colspan="2">Recirc</td><td colspan="2">Fresh</td></tr>
<tr><td rowspan="2">(3)</td><td rowspan="2">Fan switch</td><td colspan="2">Switch position</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Fan speed</td><td>1st (slow)</td><td>2nd</td><td>3rd</td><td>4th (fast)</td></tr>
<tr><td>(4)</td><td>Temperature control switch</td><td colspan="6">Any temperature can be selected between COLD and HOT.</td></tr>
<tr><td rowspan="3">(5)</td><td rowspan="3">Mode selector switch</td><td>Switch position</td><td>(6)</td><td>(7)</td><td>(8)</td><td>(9)</td><td>(10)</td></tr>
<tr><td>Air outlet</td><td>Ventilator</td><td>Ventilator/
heater</td><td>Heater</td><td>Defroster/
heater*2</td><td>Defroster*2</td></tr>
<tr><td colspan="6">*2: When the defroster or defroster/heater position is selected, the air conditioner switch automatically turns ON and the recirculation switch automatically turns OFF (to Fresh mode).

Reference: In defroster and defroster/heater modes the compressor operates in connection. However, the compressor may not operate in conditions such as when the outside air temperature is low.</td></tr>
</table>

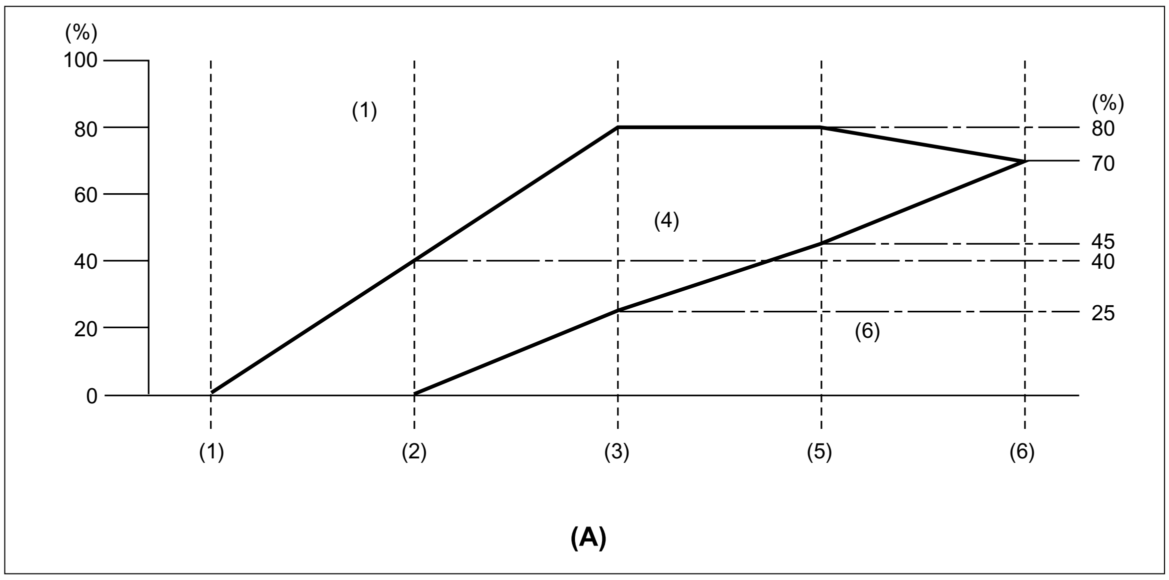
3. Mode Selector Switch and Air Flow

A: AIR FLOW

Mode selector switch position	Air flow	Mode selector switch position	Air flow
DEF	 AC-00326	BILEVEL	 AC-00329
DEF/HEAT	 AC-00327	VENT	 AC-00330
HEAT	 AC-00328		

B: AIR DISTRIBUTION RATIO

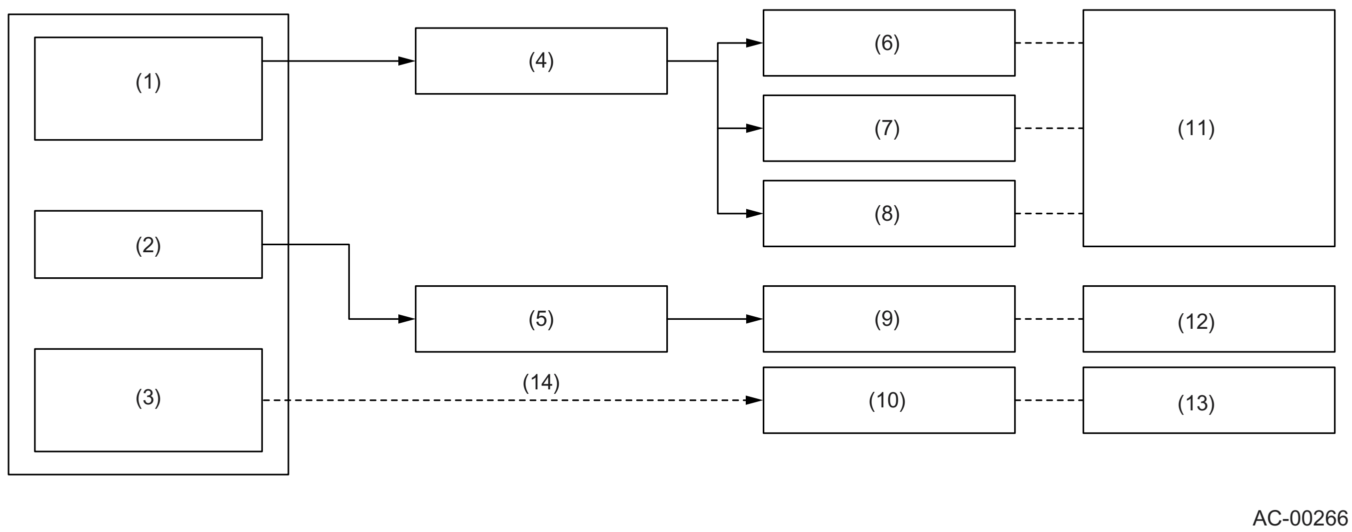
The following diagram shows air distribution for each position of the mode selector switch.



AC-00265

(1) VENT
(2) BILEVEL
(3) HEAT
(4) FOOT
(5) DEF/HEAT
(6) DEF
(A) Mode selector switch position

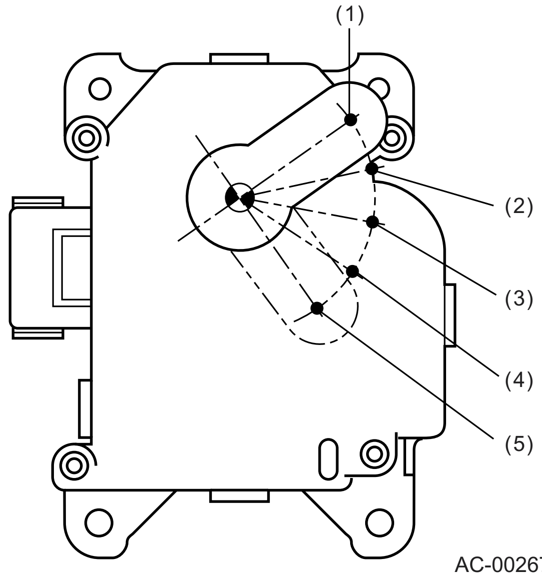
C: SYSTEM CONTROL FLOW



(1)	Mode selector switch	(6)	Ventilator door	(11)	Air outlets
(2)	RECIRC switch	(7)	Heater door	(12)	Fresh air introduction or inside air recirculation
(3)	Temperature control switch	(8)	Defroster door	(13)	Outlet air temperature
(4)	Mode door motor	(9)	Intake door	(14)	(Cable)
(5)	Intake door motor	(10)	Air mix door		

4. Mode Door Control

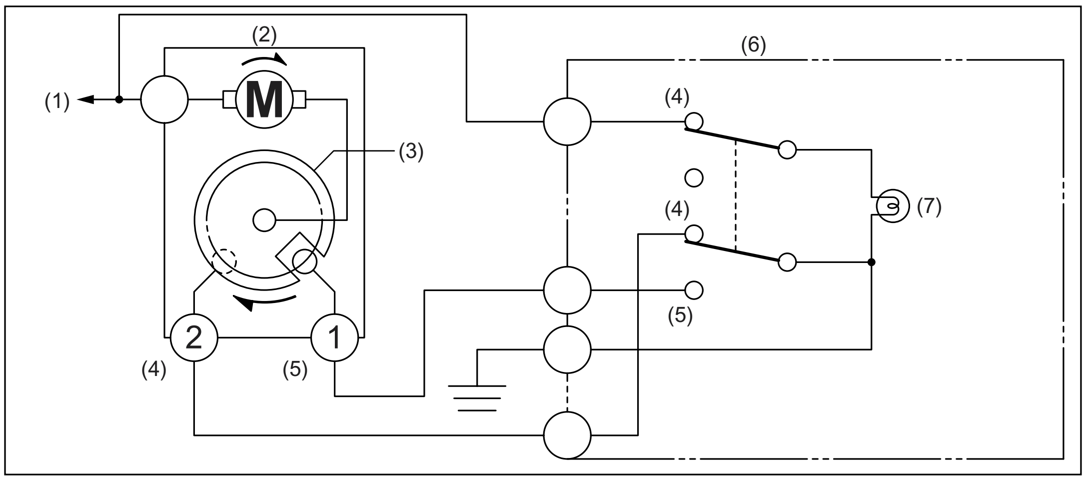
The servo motor for driving the mode door is installed on the side facing the driver's seat of the heater unit. Operating the mode selector switch sends a signal to the servo motor. In response to the signal, the motor makes a clockwise or counterclockwise rotation to drive the mode door through a link.
When DEF position (1) or DEF/HEAT position (2) is selected, the air conditioner switch automatically turns ON and the recirculation turns OFF.



(1) DEF position
(2) DEF/HEAT position
(3) HEAT position
(4) VENT/HEAT position
(5) VENT position

5. Intake Door Control

The intake door motor is located on the upper part of the intake unit. It opens and closes the intake doors through a rod and a link. When the recirculation switch is pressed (the indicator comes on), the ground circuit of the intake door motor is formed through terminal 2 of the moving contact instead of through terminal 1. This causes the motor to make a rotation to close the intake doors. Since the moving contact is built into the motor and rotates together with it, the ground circuit of the motor opens when the contact's slot reaches terminal 2. The motor then stops.
When the recirculation switch is pressed again (the indicator goes out), the ground circuit is formed through terminal 1 rather than terminal 2. The motor makes a rotation in the same direction as when the switch is first pressed – but now opening the intake doors – until the moving contact's slot reaches terminal 1.

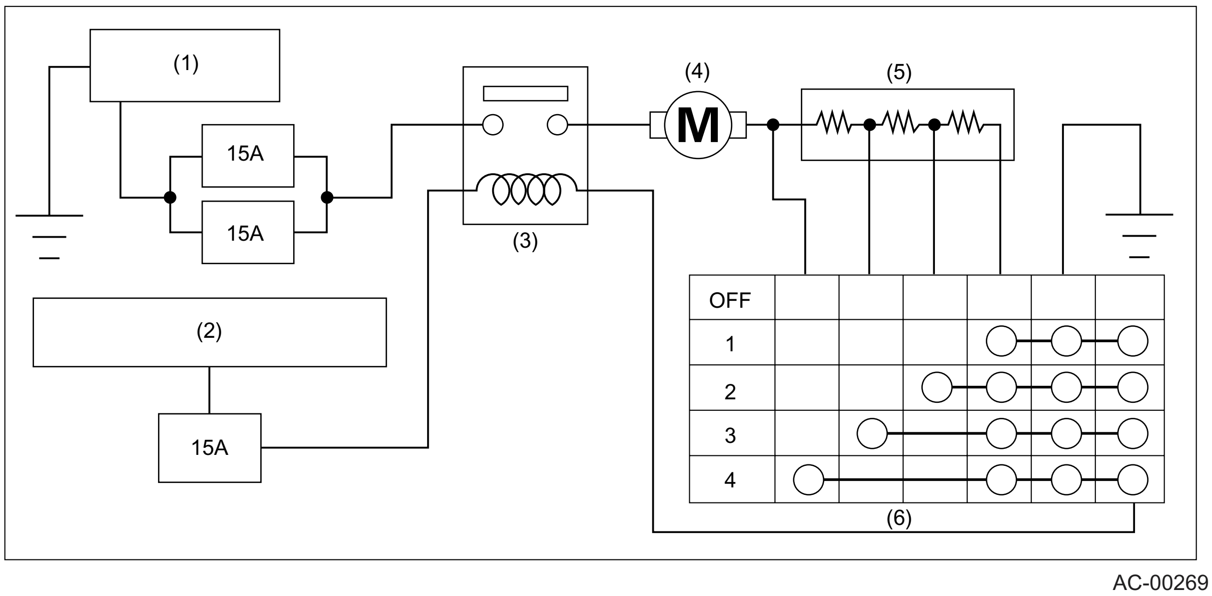


AC-00268

(1) To ignition switch
(2) Intake door motor
(3) Switch moving contact
(4) Inside air recirculation
(5) Fresh air introduction
(6) RECIRC switch
(7) Indicator

6. Blower System

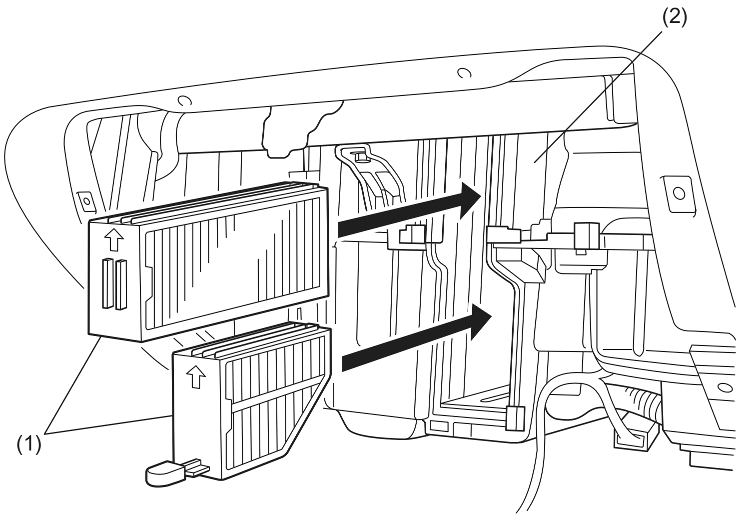
The blower relay is ready to be activated when the ignition switch is in the ON position. With the ignition switch ON, placing the fan switch in any position other than OFF activates the relay, allowing electric current to flow from the battery to the ground through the blower motor, the resistor, and the selected fan switch contacts. The connected resistor(s) vary depending on the selected position of the fan switch and cause the blower motor speed to change.



(1) Battery
(2) Ignition switch (ON)
(3) Blower relay
(4) Blower motor
(5) Resistor
(6) Fan switch

7. Filter (Option)

The optional filter is located in front of the cooling unit's evaporator inlet.
The air conditioner may fail to exhibit its full performance if the filter is excessively clogged with dust and dirt. It is essential to replace the filter with a new one at the specified interval.



AC-00270

(1) Filter
(2) Cooling unit

8. Air Conditioning Cycle

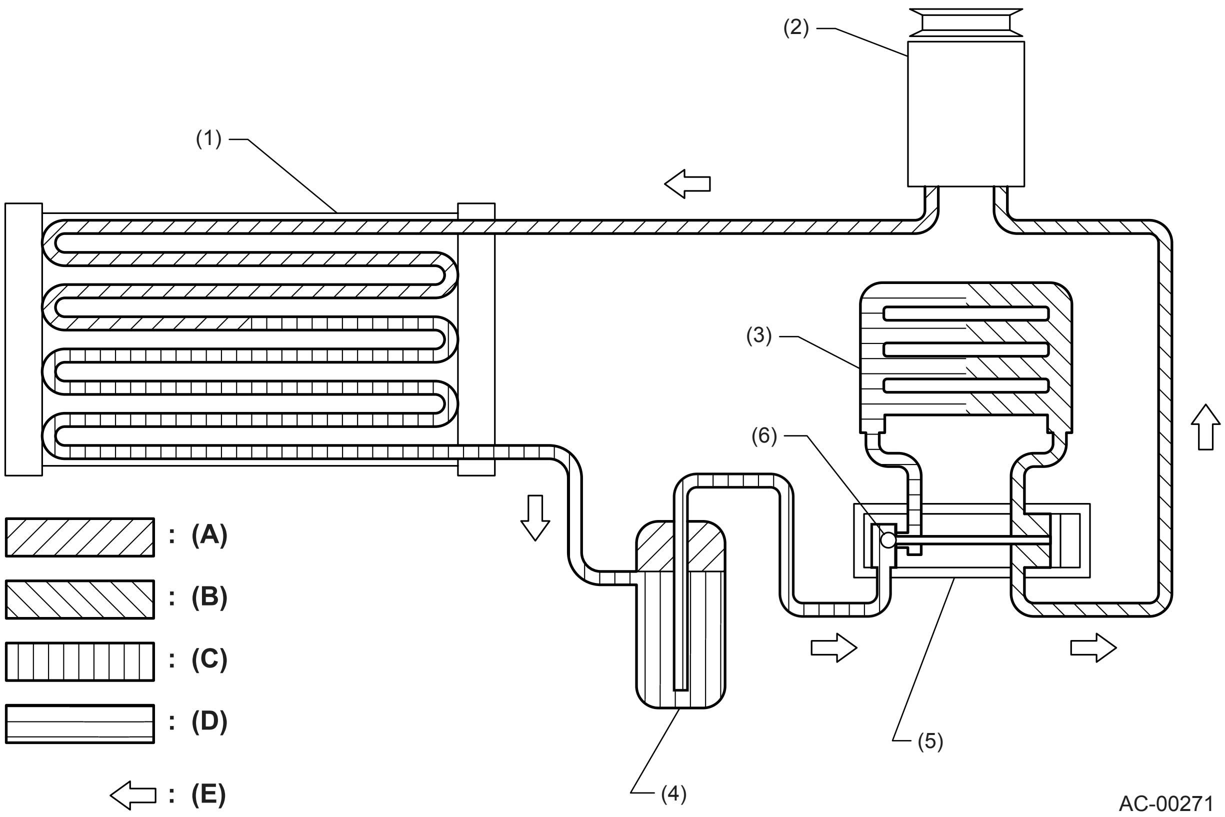
A: GENERAL

The refrigerant recirculates in the air conditioning system, flowing out of the compressor, passing through the condenser, receiver drier and evaporator, and returning to the compressor.

The flow of refrigerant to the evaporator is controlled by an expansion valve located inside the evaporator.

The compressor operates and stops repeatedly to maintain the evaporator temperature within a specified range. When the evaporator temperature falls below the specified temperature, the thermo-control amplifier stops the compressor operation. When the evaporator temperature rises above the specified temperature, the thermo-control amplifier puts back the compressor into operation.

The refrigerant system is protected against excessively high or low pressures by a pressure switch. If the system pressure rises or drops excessively, the pressure switch is activated to prevent the compressor from operating.

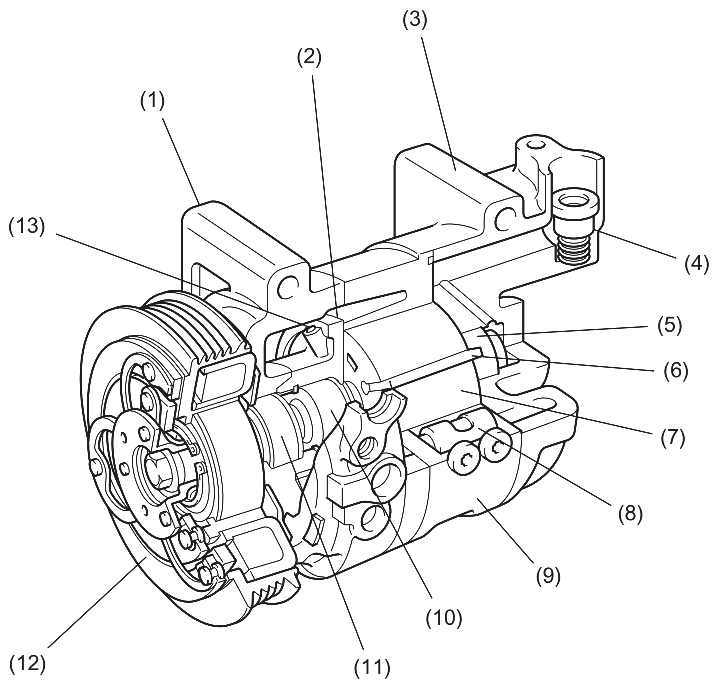


(A)	High-pressure gas	(1)	Condenser
(B)	Low-pressure gas	(2)	Compressor
(C)	High-pressure liquid	(3)	Evaporator
(D)	Low-pressure liquid	(4)	Receiver drier
(E)	Refrigerant flow	(5)	Expansion valve
		(6)	IN

9. Compressor

1. GENERAL

The compressor is a rotary type that has a rotor fitted with five radially movable vanes. The rotor rotates together with the vanes in an elliptical cylinder. As the rotor rotates, the volume of each closed space formed between two adjacent vanes (referred to as “cylinder chamber” in the following description) decreases, so that the pressure of the refrigerant gas confined in the cylinder chamber increases. In this way, the rotary compressor performs its function as a pump. The pumping cycle consisting of suction, compression and discharge takes place 10 times during every rotation of the rotor.
On the discharge side of the cylinder, a roll valve is provided that opens at a predetermined high pressure. Air tightness between the rotor shaft and front head is ensured by the shaft seal. The trigger valve incorporated in the front side block provides the function of applying back pressure to the vanes. The compressor contains necessary quantity of compressor oil. The oil is distributed to all the parts requiring lubrication and sealing by utilizing the discharge pressure of the refrigerant.



AC-00272

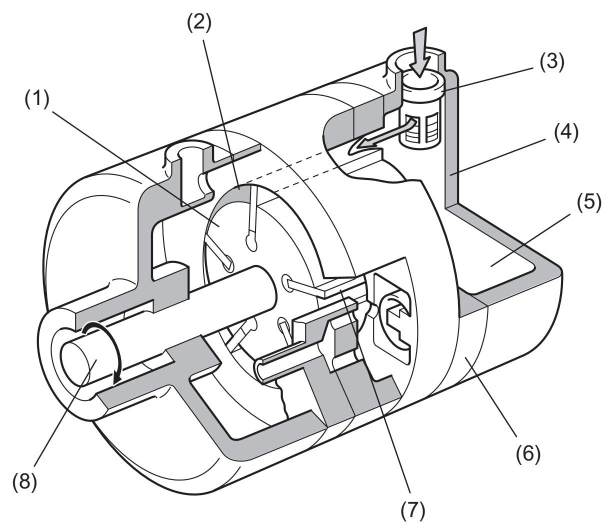
(1)	Front head	(6)	Vane	(11)	Shaft seal
(2)	Side block	(7)	Rotor	(12)	Magnet clutch
(3)	Rear head	(8)	Roll valve	(13)	Trigger valve
(4)	Check valve	(9)	Cylinder		
(5)	Rear bearing	(10)	Front bearing		

2. FUNCTION

As the rotor rotates, the volume of each cylinder chamber changes. This creates the compressor's suction, compression and discharge functions as explained in the following:

1) Suction:

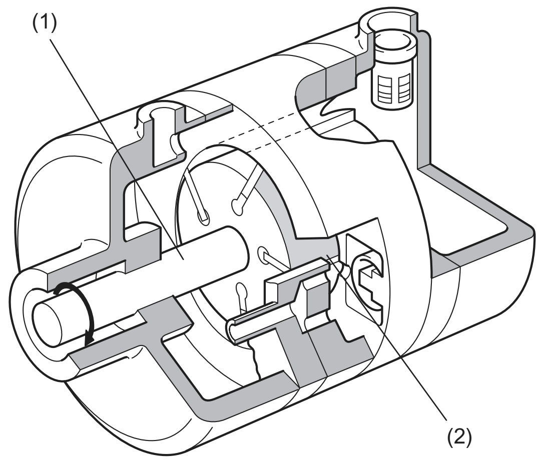
Low-pressure gaseous refrigerant is forced out from the evaporator by rotation of the compressor. It enters the low-pressure chamber in the rear head through the check valve. The refrigerant is then drawn into the cylinder by rotation of the vane-fitted rotor through the two suction ports provided in the rear side block. Air tightness of the cylinder chambers is maintained by the compressor oil.



(1) Rotor	(4) Rear head	(7) Vane
(2) Refrigerant	(5) Low-pressure chamber	(8) Drive shaft
(3) Check valve	(6) Rear side block	

2) Compression:

Further rotation of the rotor after suction makes the volume of each cylinder chamber smaller, thus compression occurs.

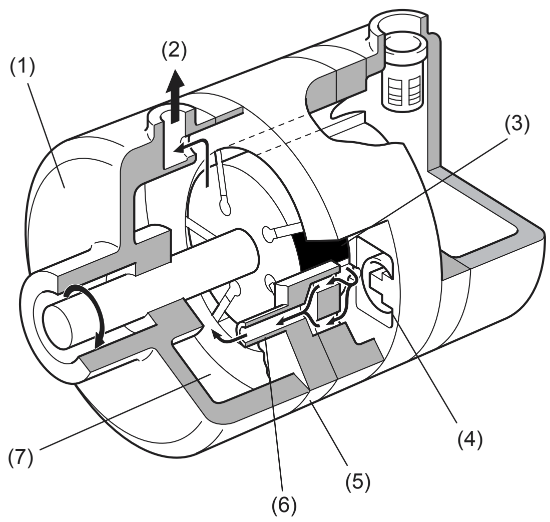


(1) Drive shaft

(2) Refrigerant

3) Discharge:

When the pressure of refrigerant in the cylinder chamber exceeds a predetermined pressure, the roll valve opens to discharge the refrigerant through a pipe-shaped passage built in the front side block into the high-pressure chamber in the front head. The gaseous refrigerant in the high-pressure chamber is led to a baffle, which separates the compressor oil contained in the refrigerant before it flows into the high-pressure piping.

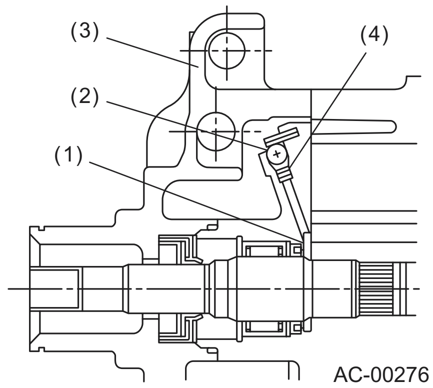


AC-00275

(1) Front head	(4) Roll valve	(7) High-pressure chamber
(2) Refrigerant (Discharging)	(5) Front side block	
(3) Refrigerant (high-pressure)	(6) Pipe	

3. TRIGGER VALVE

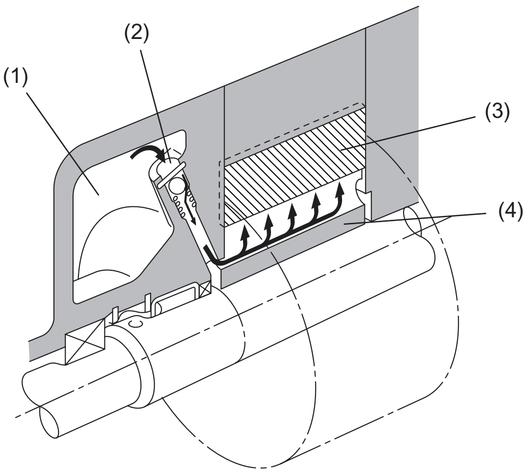
This valve has a function of maintaining a proper level of pressure behind the vanes (vane back pressure) such that they can move easily upon start of the compressor. The trigger valve is incorporated in the front side block and its end opens to a cavity called “K-ditch” that is provided in the rotor side end of the side block. The valve consists of a check ball and a spring.
The vanes are prone to chatter if there is only small difference between the high- and low-pressures. This condition typically occurs when the compressor is started. In such a condition, the spring raises the ball to open the valve and allows the back pressure to act on the vanes, thereby ensuring smooth operation.



(1) K-ditch
(2) Check ball
(3) Front head
(4) Spring

1) When compressor starts or when load is low:

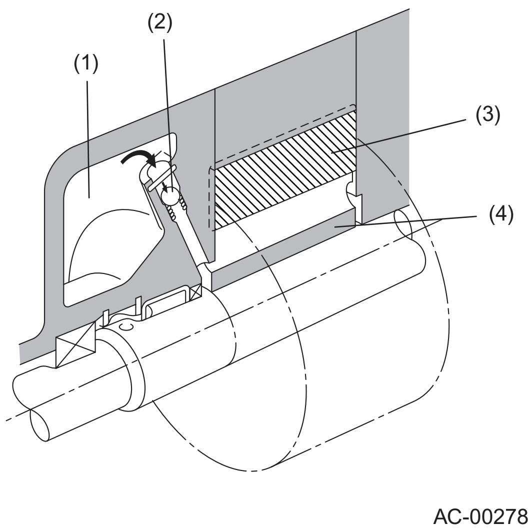
When the compressor starts or when the load is low (the high-pressure level is low), the spring can raise the check ball clear of its seat, so the trigger valve is opened. The pressure of the high-pressure chamber then acts on the back end surface of each vane to prevent it from chattering.



(1) High-pressure chamber
(2) Trigger valve (open)
(3) Vane
(4) Rotor

2) When compressor is in regular operation:

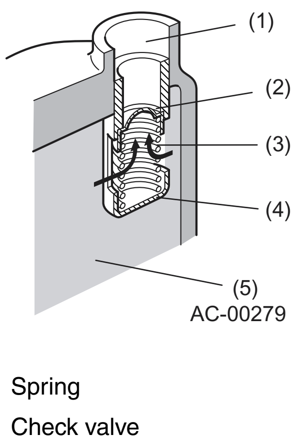
When the pressure in the high-pressure chamber of the compressor increases, the pressure overcomes the spring tension and pushes the check ball against its seat, so the trigger valve closes. The oil port pressure coming through the side block is applied to the end surface of vane to maintain proper back pressure.



(1) High-pressure chamber
(2) Trigger valve (Closed)
(3) Vane
(4) Rotor

4. CHECK VALVE

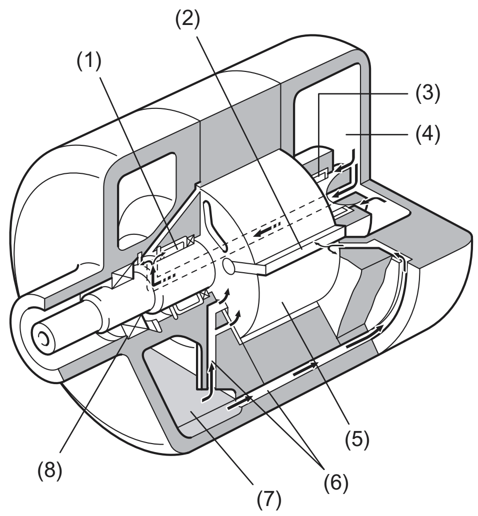
A check valve consisting of a spherical plate and spring is provided at the suction port of the rear head. Immediately after the compressor has stopped, there is large difference between the high- and low-pressures. This would cause reverse rotation of the compressor and consequent reverse flow of refrigerant to the evaporator if no check valve is provided. Immediately after the compressor has stopped, the high-pressure refrigerant forces the check valve plate upward and closes the suction port to prevent flow of refrigerant from the high-pressure side to the low-pressure side.



(1) Refrigerant suction port
(2) Plate
(3) Spring
(4) Check valve
(5) Refrigerant

5. LUBRICATION

The lubrication oil is collected at the bottom of the high-pressure chamber. The high-refrigerant pressure in the chamber forces the oil upward through the oil passages in the front side block to lubricate the front end of the rotor. The high-chamber pressure also forces the oil through the passages in the bottom of the cylinder to lubricate the rear end of the rotor. The oil that has lubricated each end of the rotor enters the low-pressure chamber by the internal pressure of the compressor. The oil contained in the gaseous refrigerant from the evaporator passes through the low-pressure chamber and lubricates the rear bearing. The oil also passes through the passage in the drive shaft and lubricates the front bearing and shaft seal before entering the suction port of the cylinder.
Since the pressure in the suction port of the cylinder is slightly lower than that in the low-pressure chamber, the oil that has lubricated all the parts enters the suction port and is finally brought by the refrigerant back to the high-pressure chamber.



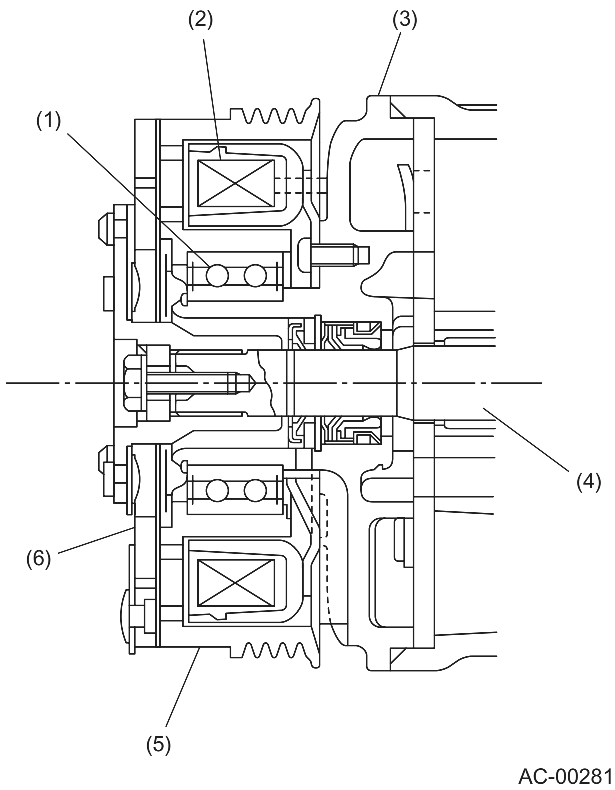
AC-00280

(1) Front bearing	(4) Low-pressure chamber	(7) High-pressure chamber
(2) Vane	(5) Rotor	(8) Shaft seal
(3) Rear bearing	(6) Oil port	

6. MAGNET CLUTCH

The magnet clutch serve to transmit engine power to the compressor module. It is built into the compressor shaft. When current flow through the magnet clutch coil, the drive plate is attracted so that the pulley and compressor shaft rotate as a module. When the compressor is not in use, the pulley alone rotates freely.

The compressor used with the six-cylinder engine has a lock sensor. If the sensor detects locking of the compressor resulting from a fault, it causes disengagement of the magnet clutch to protect the engine and the power steering drive.



(1) Bearing
(2) Magnet clutch coil
(3) Compressor
(4) Drive shaft
(5) Clutch pulley
(6) Drive plate

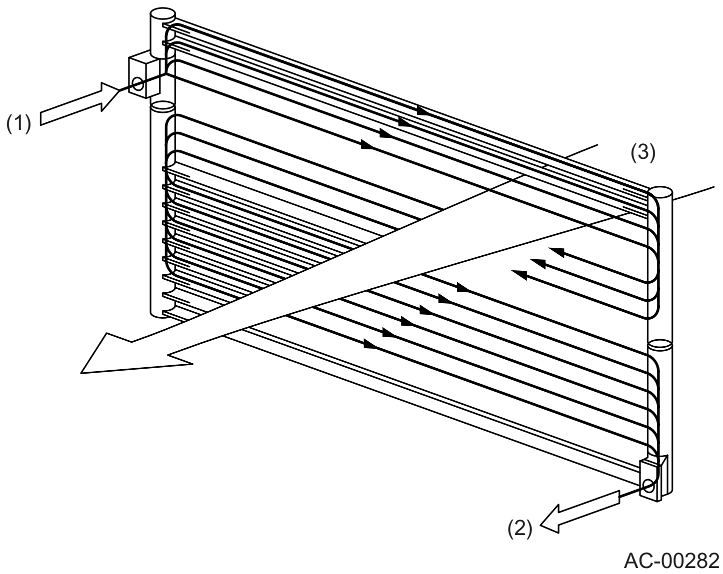
10.Condenser

A: MECHANISM

The high-temperature and high-pressure gaseous refrigerant discharged from the compressor is cooled down and converted into liquid by the condenser.

The condenser consists of tubes and radiating fins.

The heat of the refrigerant flowing through the condenser tubes is released into to the ambient air which is caused to flow across the fins by the cooling fan.



(1) Refrigerant inlet (High-pressure gas refrigerant)
(2) Refrigerant outlet (High-pressure liquid refrigerant)
(3) Fresh air

11.Receiver Drier

A: MECHANISM

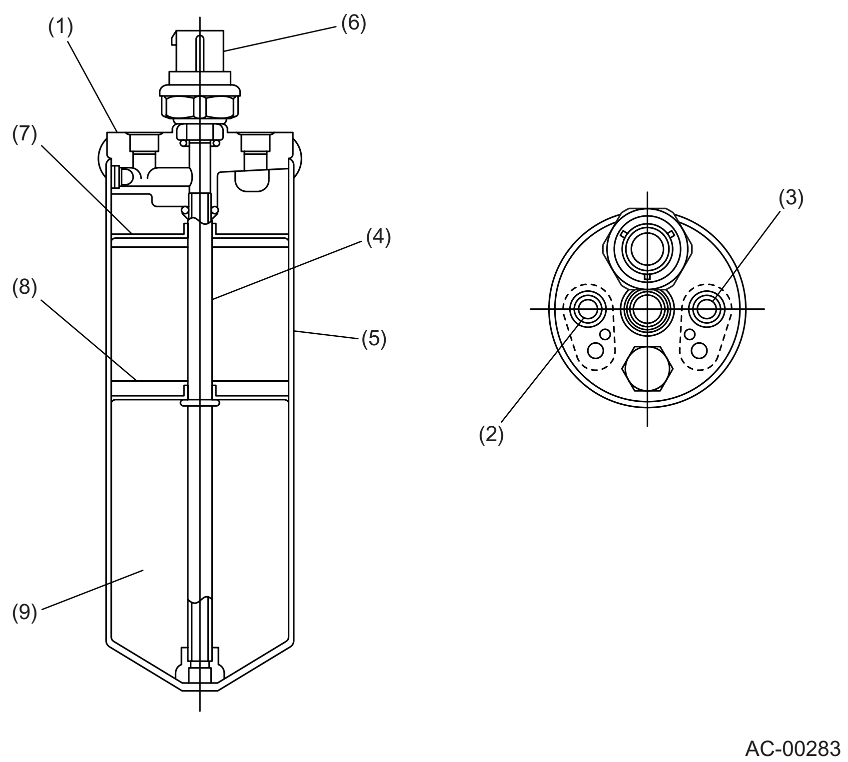
The amount of refrigerant necessary to circulate in the system varies with change in the heat load. The receiver drier stores part of the liquid refrigerant until an increased heat load requires its use again. The receiver drier also has the following functions:

1) It removes bubbles from the liquid refrigerant. (If bubbles are present, the refrigerant passing through the expansion valve varies in quantity, temperature, and pressure, resulting in insufficient cooling.)

2) It removes moisture from the refrigerant.

3) It removes foreign substance from the refrigerant.

The receiver drier contains a strainer to remove foreign substance and desiccant to absorb moisture from refrigerant.



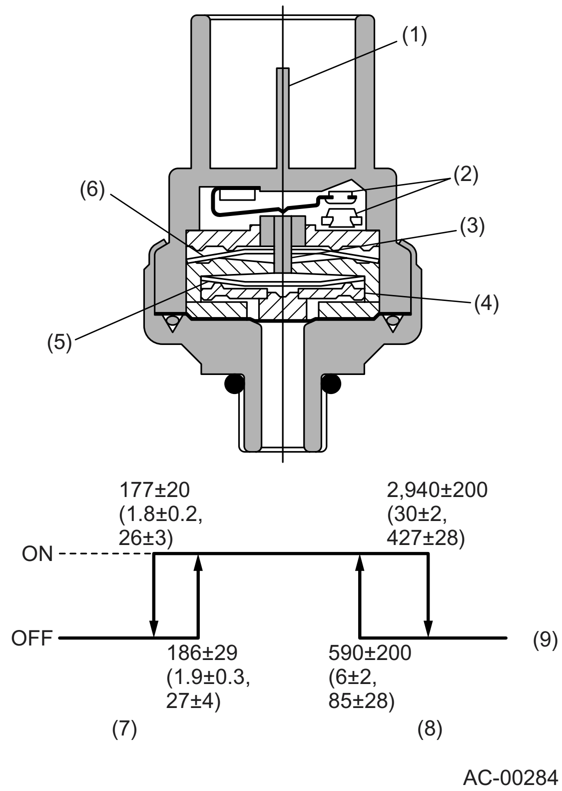
(1) Head block
(2) Inlet
(3) Outlet
(4) Inside pipe
(5) Body
(6) Pressure switch
(7) Strainer
(8) Strainer cushion
(9) Desiccant

12.Pressure Switch

The pressure switch is located on the high-pressure line to the receiver drier. When an abnormally high or low pressure occurs in the high-pressure line, the pressure switch turns OFF to stop operation of the compressor.

- When the pressure is abnormally low [177 kPa (1.8 kgf/cm^2, 26 psi) or less]
The pressure switch turns OFF assuming that the refrigerant is lost due to leakage.

- When the pressure is abnormally high [2,940 kPa (30 kgf/cm^2, 427 psi) or more]
The pressure switch turns OFF to prevent the system from being damaged.



(1) Point terminal
(2) Contact point
(3) Guide pin
(4) Pressure guide
(5) High-pressure disc spring
(6) Low-pressure disc spring
(7) Low pressures
(8) High pressures
(9) Unit: kPa (kgf/cm^2, psi)

13.Evaporator

A: MECHANISM

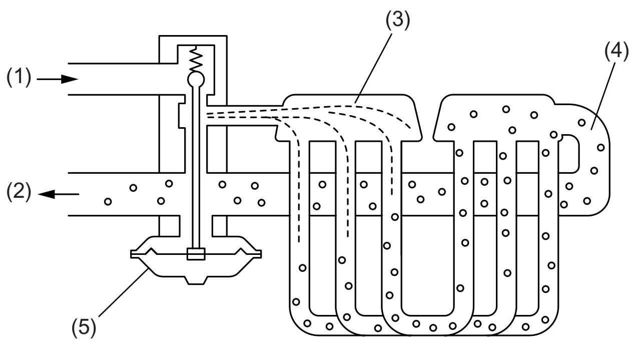
Air pushed by the blower passes through the cooling fins and tubes of the evaporator. Since the air is warmer than the refrigerant, the heat of air moves to the refrigerant through the fins and tubes. As the low-pressure refrigerant moves through the evaporator, heat from the air causes the refrigerant to boil. By the time the refrigerant has passed through the evaporator, it becomes vapor. Moisture in the air condenses to water drops as it moves around the tubes and fins of the evaporator. Water and dirt are then discharged outside the vehicle through a drain hose.

The evaporator is a laminated type and consists of thin, rectangular aluminum plates arranged in multiple layers and fins that are attached between them. During flow through the evaporator, the state of the refrigerant changes as follows:

Misty refrigerant (very close to liquid form) from the expansion valve at a low-pressure, enters the lower tube of the evaporator, where it soaks up heat from the compartment. The refrigerant boils and vaporizes quickly due to the rapid heat exchange. Then the refrigerant is pushed upward by the force of the bubble generated during the heat exchange and enter the upper tube. When it reaches the upper tank, the refrigerant is in a thoroughly vaporized state.

The evaporator has a single tank, and its surface has been given the following treatments.

- Rustproof treatment
- Waterproof treatment
- Moldproof treatment



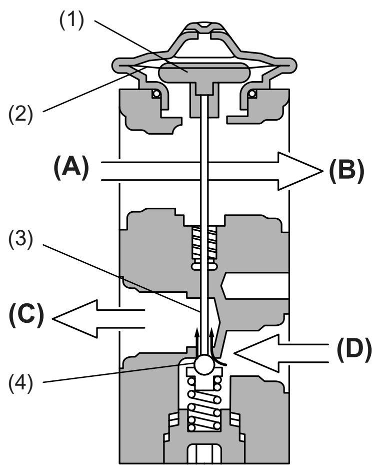
AC-00285

(1) From receiver drier
(2) To compressor
(3) Misty refrigerant
(4) Vapor
(5) Expansion valve

14.Expansion Valve

1. MECHANISM

The expansion valve is connected to both the evaporator inlet and outlet pipes. It converts high-pressure liquid refrigerant which comes from the receiver drier to misty, low-pressure refrigerant which is delivered to the evaporator. Being at low pressure and low temperature, this refrigerant can easily evaporate in the evaporator and remove heat from the cabin air. The valve performs this conversion by automatically controlling the flow rate of refrigerant according to the cooling ability required by the heat load.
The refrigerant temperature is sensed by the temperature sensing element located in the low-pressure refrigerant passage of the expansion valve, and the flow rate of the refrigerant is controlled by changing the lift of the valve ball located in the high-pressure passage.



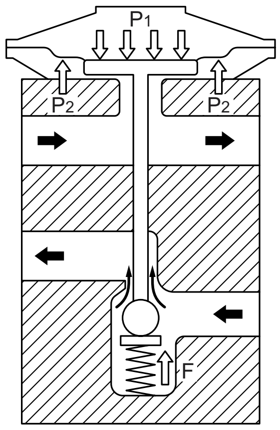
AC-00286

(1) Temperature sensing element
(2) Diaphragm
(3) Orifice
(4) Valve ball

(A) From evaporator (low-pressure)
(B) To compressor
(C) To evaporator (low-pressure)
(D) From receiver drier

2. FUNCTION

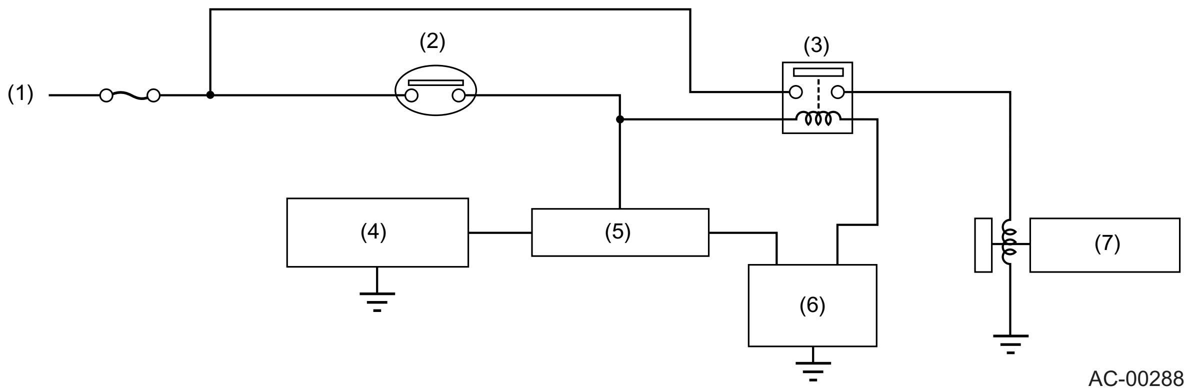
When the heat load to the air conditioning system increases, the refrigerant temperature at the evaporator outlet rises and therefore the pressure P_1 around the temperature sensing area increases. As this pressure P_1 becomes higher than the sum of the evaporator outlet (low-pressure side) pressure P_2 and the spring force F ($P_1 > P_2 + F$), the diaphragm is pressed down, moving the valve ball connected to the diaphragm clear of its seat. This increases the flow of the refrigerant.
When the heat load is small, the action of the valve's inner elements is contrary to the above; the valve ball closes and the flow of the refrigerant decreases.



AC-00287

15.Compressor Clutch “ON” Delay System

When the A/C switch and fan switch are turned ON, a signal is sent to the engine control module. The engine control module then judges whether the engine is in operation. If the engine is operating, the engine control module activates the A/C relay. The maximum clutch “ON” delay times is 0.8 seconds after the A/C relay is activated.



(1) Ignition switch
(2) Pressure switch
(3) A/C relay
(4) Fan switch
A/C switch
(5) Thermostat
(6) Engine control module
(7) Compressor

16.Compressor Control System

A: GENERAL

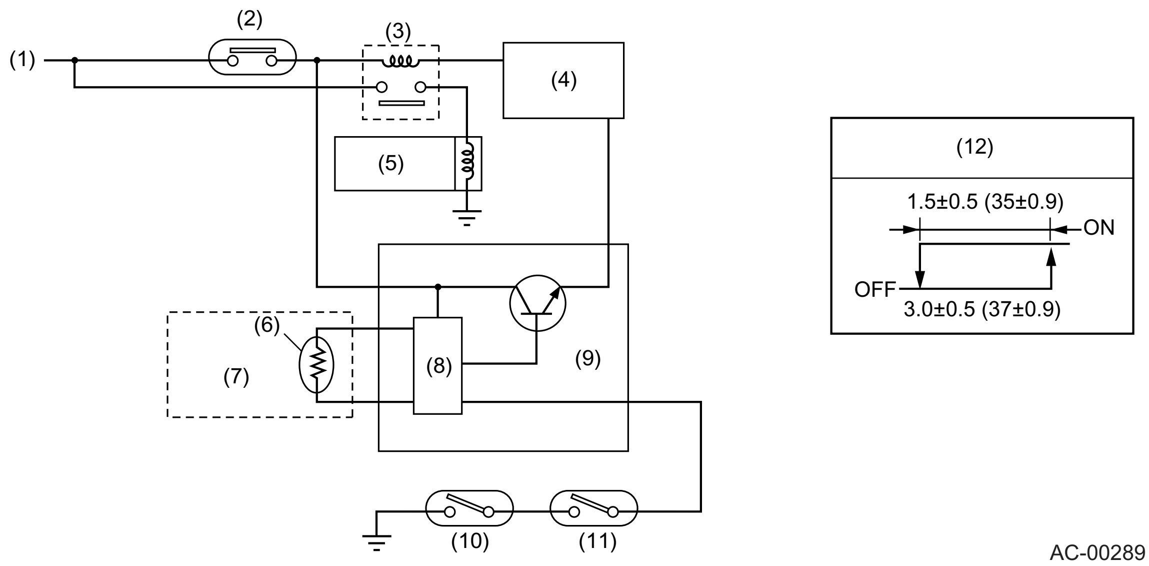
1) When the A/C switch and fan switch are turned ON, the A/C relay is activated. The compressor starts operating, and then the main and sub fans also operate.

2) The thermo control amplifier, when activated, disengages the compressor clutch and the main and sub fans.

3) When the pressure switch turns on, the compressor clutch is disengaged and the main and sub fans also stop.

B: THERMO CONTROL AMPLIFIER

The thermo control amplifier disconnects the magnet clutch circuit to prevent the evaporator from becoming frosted when the temperature of the evaporator fin drops close to 3°C (37°F). When the limit temperature is reached, the thermistor (located on the evaporator fin) interrupts the base current of the amplifier. This deactivates the A/C relay, which in turn disconnects the magnet clutch circuit.

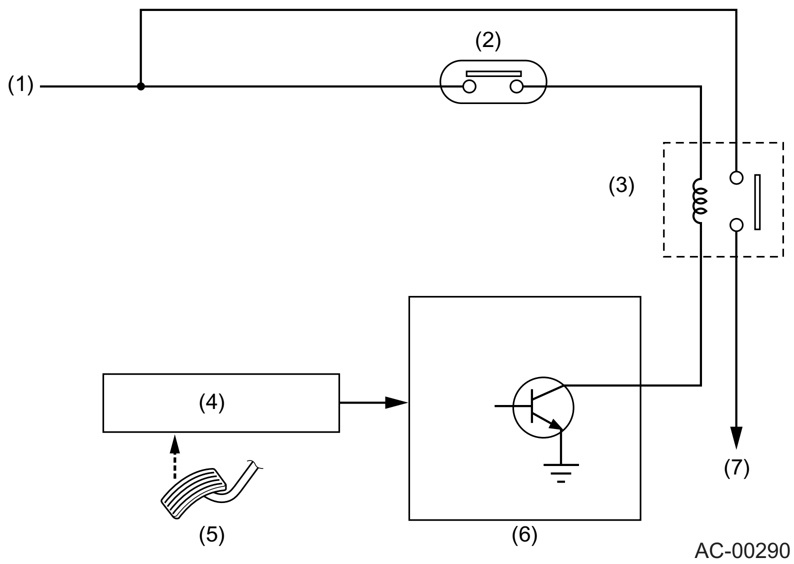


(1)	Ignition switch +12 V	(7)	Evaporator
(2)	Pressure switch	(8)	Thermo control amplifier
(3)	A/C relay	(9)	Fan switch
(4)	Engine control module	(10)	A/C switch
(5)	Compressor	(11)	Thermo control amplifier operation °C (°F)
(6)	Thermistor		

C: ACCELERATION CUT SYSTEM

The A/C switch turns the air conditioning system ON and OFF. The on-off signals from the switch are transmitted to the engine control module (ECM).

When the ECM receives a full-throttle signal from the throttle sensor during compressor operation, it deactivates the A/C relay to interrupt electric current to the compressor magnet clutch. This prevents the degradation of acceleration performance. The A/C relay is in the main fuse box located on the left side of the engine compartment.

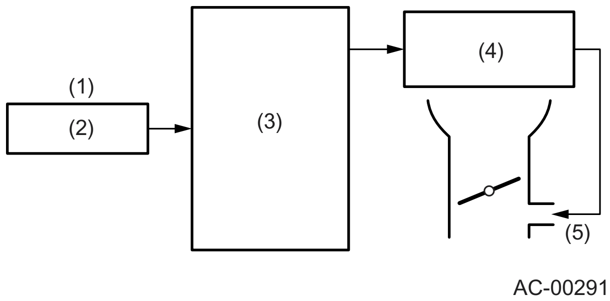


(1) +12 V
(2) Pressure switch
(3) A/C relay
(4) Throttle sensor
(5) Accelerator pedal
(6) Engine control module
(7) To magnet clutch

D: IDLE SPEED CONTROL

The idle air control solenoid valve increases the engine idling speed when the compressor is in operation.

The engine control module activates the idle air control solenoid valve when it receives an A/C switch ON signal so that necessary by-pass air is introduced into the throttle body to ensure proper idling speed for an increased engine load.



(1) Input signals
(2) A/C switch
(3) Engine control module
(4) Idle air control solenoid valve
(5) Air

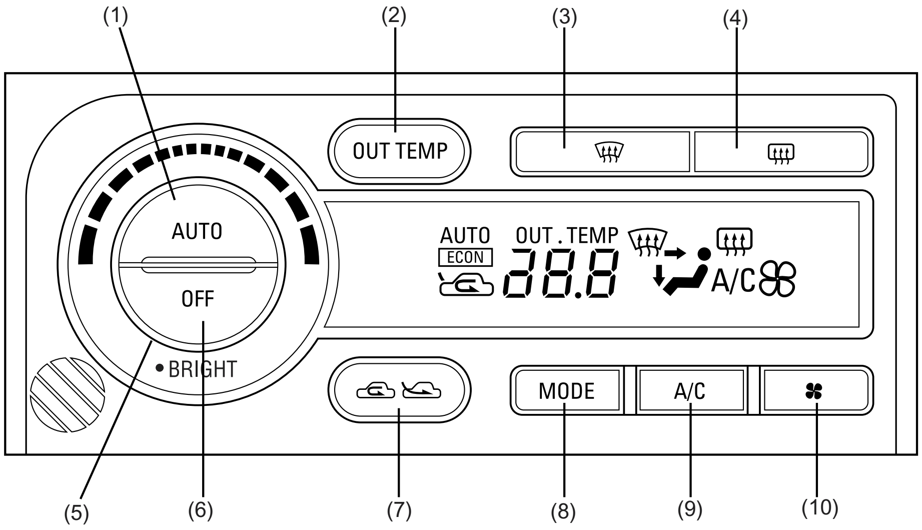
E: FAN CONTROL

The main fan and sub fan are switched ON and OFF according to the operating modes as shown in the following table.

Vehicle speed	A/C compressor	Engine coolant temperature					
		Lower than 95°C 203°F		Between 95 and 99°C (203 and 210°F)		100°C or more (212°F)	
		Operation of radiator fans		Operation of radiator fans		Operation of radiator fans	
		Main	Sub	Main	Sub	Main	Sub
Lower than 19 km/h (12 MPH)	OFF	OFF	OFF	ON	OFF	ON	ON
	ON	ON	ON	ON	ON	ON	ON
Between 20 and 69 km/h (12 and 43 MPH)	OFF	OFF	OFF	ON	OFF	ON	ON
	ON	ON	ON	ON	ON	ON	ON
Between 70 and 105 km/h (43 and 65 MPH)	OFF	OFF	OFF	OFF	OFF	ON	ON
	ON	ON	OFF	ON	ON	ON	ON
Higher than 106 km/h (66 MPH)	OFF	OFF	OFF	OFF	OFF	ON	ON
	ON	OFF	OFF	ON	OFF	ON	ON

17.Automatic Air Conditioning

A: SWITCH FUNCTIONS



AC-00292

(1) AUTO switch
(2) Ambient temperature display switch
(3) Defroster switch
(4) Rear defogger switch
(5) Temperature set switch
(6) OFF/Bright switch
(7) Fresh/Recirc switch
(8) Mode selector switch
(9) A/C switch
(10) Blower fan switch

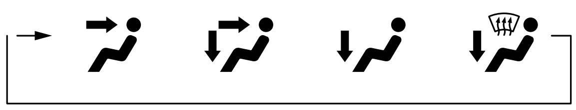
NOTE:
The beeper for button operation confirmation has been discontinued.

1. AUTOMATIC CONTROL OPERATION

- AUTO switch: When this switch is pressed (ON), the air outlet selection, blower fan speed, air temperature, fresh/recirculation switching, and compressor operation are automatically controlled.
When the AUTO switch is pressed for the second time, the compressor operates in the ECON mode. In the ECON mode, the ECM controls compressor operation based on inputs from the intake air temperature sensor. Compressor operating time in the ECON mode is shorter than in the AUTO mode.
- Temperature setting switch: A desired cabin temperature can be set in 0.5°C (0.9°F) increments.
- OFF/Bright switch: When this switch is pressed, the blower fan and compressor stop and all the indicators go out.
Setting the light switch to the or position causes the illuminating icons on the display panel to dim. When traveling with the lights on in gloomy daylight or in twilight, press the OFF switch for 1 second or longer if you feel it is too hard to identify the icons clearly. The brightness comes back to normal.

2. MANUAL CONTROL OPERATION

- A/C switch: The air-conditioner turns on when this switch is pressed first and turns off when it is pressed for the second time.
- Blower fan switch: Fan speed changes in the order of Lo, M1, M2 and Hi, every time it is pressed.
- Ambient temperature display switch: When this switch is pressed momentarily, the ambient temperature is indicated on the display for 5 seconds. When this switch is depressed for more than 1 seconds, the ambient temperature is continuously indicated.
- Defroster switch: Air is directed to the windshield for defrosting when this switch is pressed.
- Rear defogger switch: Pressing this switch causes the rear defogger to operate for 15 minutes.
- FRESH/RECIRC switch: Every time this switch is pressed, switching takes place between fresh air introduction and inside air recirculation alternately.
- Mode selector switch: Pressing this switch changes the outlets to which the air is directed in the order shown below.

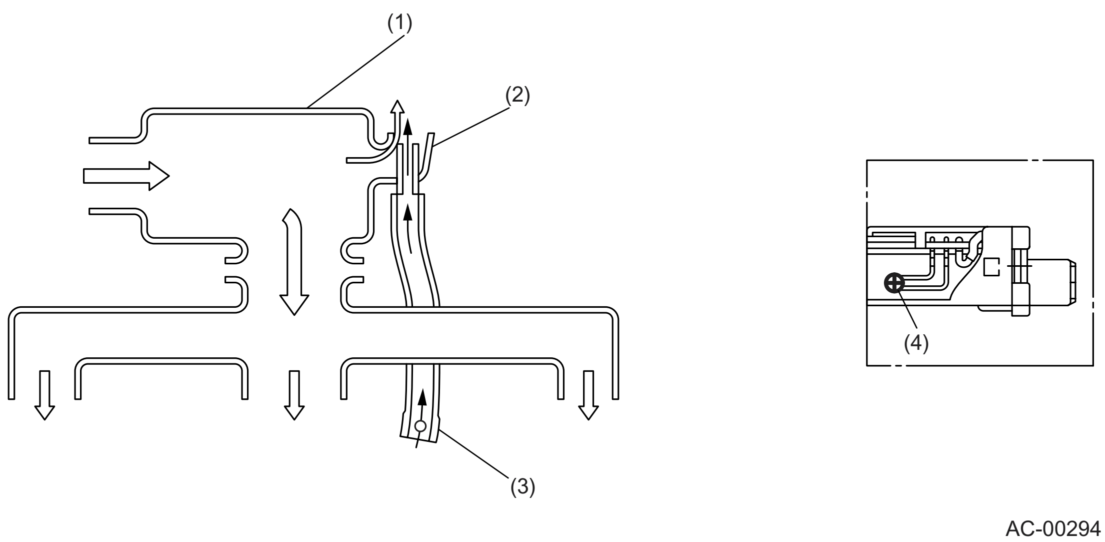


AC-00293

B: CABIN TEMPERATURE SENSOR

The cabin temperature sensor sends signals to the ECM.

This sensor consists of an aspirator and a thermistor, the resistance of which changes in inverse proportion to the temperature. The aspirator uses the vacuum created by the heater unit to direct cabin air to the thermistor. (The cabin temperature sensor, therefore, functions only while the blower fan is in operation.)



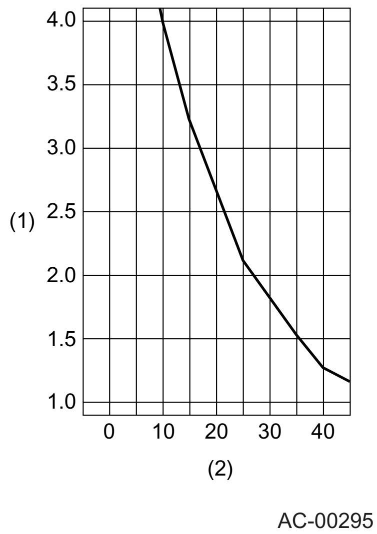
(1) Heater unit
(2) Aspirator
(3) Cabin temperature sensor
(4) Thermistor

C: AMBIENT TEMPERATURE SENSOR

This sensor uses a thermistor to detect the ambient temperature and sends signals the ECM.

The thermistor can detect only an average temperature of the outside air but cannot respond to sharp changes in the temperature because its exterior is made of a plastic to increase the thermal capacity.

The ambient temperature sensor is located on the radiator stay behind the front grille for efficient exposure to the outside air.



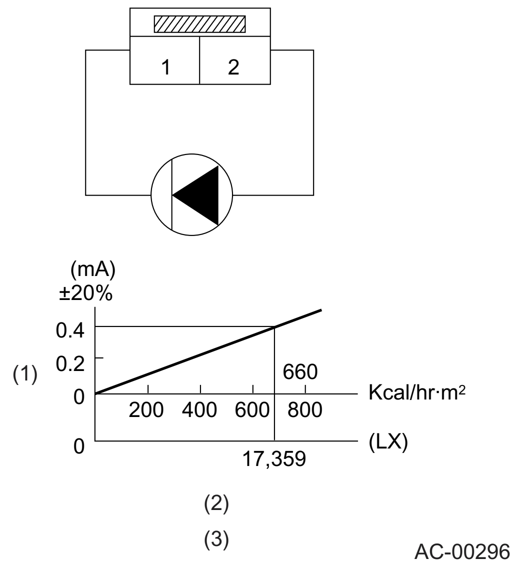
(1) Resistance (kΩ)

(2) Intake air temperature (°C)

D: SUNLOAD SENSOR

A photodiode is used in the sunload sensor. The photodiode detects changes in the sunbeam intensity and converts the results into current signals to send to the ECM.

The sunload sensor is built into the front defroster grille.

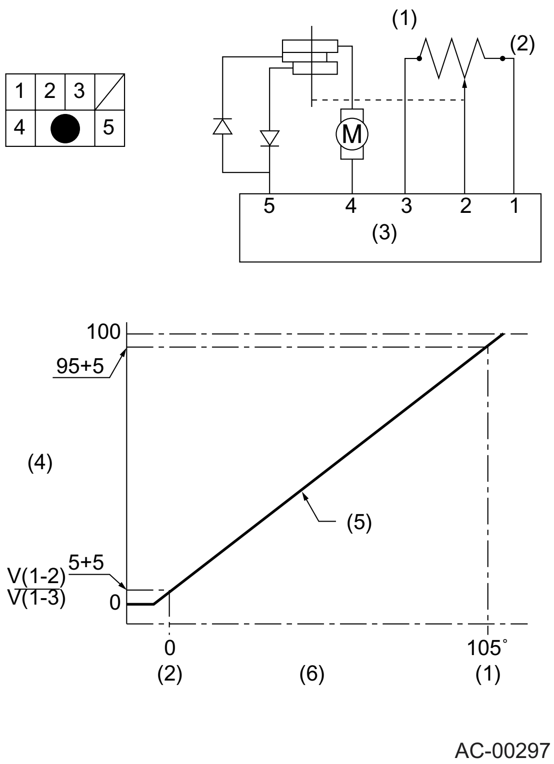


(1) Output current
(2) Sunbeam intensity
(3) Sunbeam intensity and output current

E: AIR MIX SERVO MOTOR

According to signals from the ECM, the servo motor forming integral part of the air mix damper rotates in one or the other direction to change the opening of the damper via a link.

The motor has a built-in potentiometer which detects the opening of the air mix damper and sends the result to the ECM.

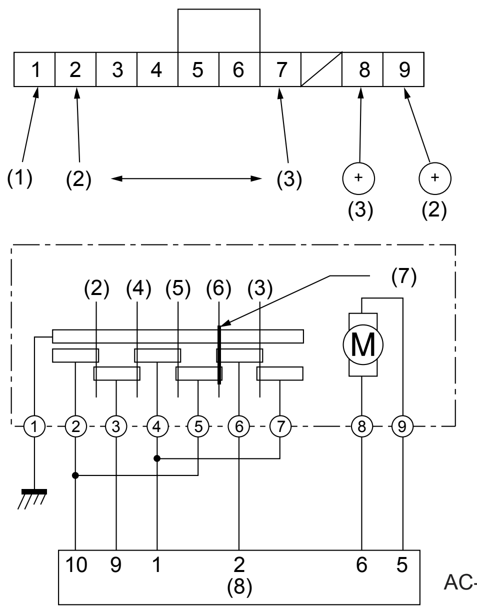


(1) Full HOT
(2) Full COOL
(3) ECM
(4) Outlet voltage ratio (%)
(5) Reference line
(6) Rotation angle (°)

F: AIR OUTLET SWITCHING SERVO MOTORS

According to signals from the ECM, the servo motor incorporated into each air outlet switching damper rotates in one or the other direction to open or close the damper via a link to control the air from the corresponding outlet(s).

Each motor has a built-in potentiometer which detects the position of its damper and send the result to the ECM.

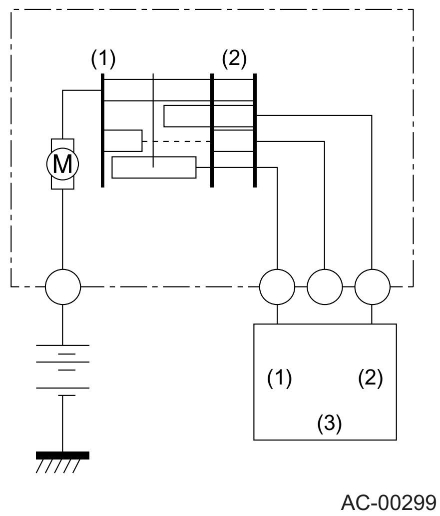


AC-00298

(1)	Ground	(5)	HEAT
(2)	VENT	(6)	DEF/HEAT
(3)	DEF	(7)	Brush
(4)	BILEVEL	(8)	ECM

G: FRESH/RECIRC SWITCHING SERVO MOTOR

According to signals from the ECM, the servo motor incorporated into the FRESH/RECIRC switching damper rotates in one or the other direction to perform switching between the fresh air introduction and inside air recirculation modes via a link.



(1) Fresh air introduction
(2) Inside air recirculation
(3) ECU

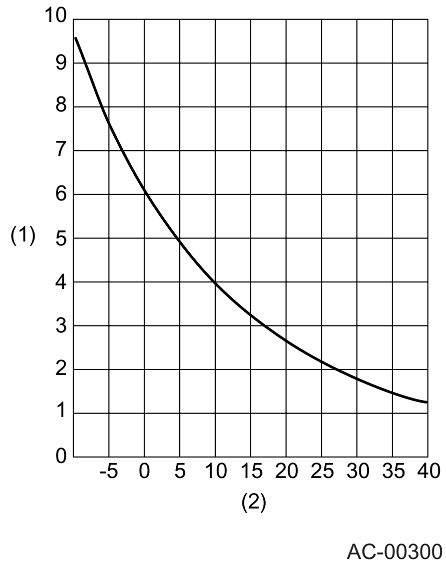
H: BLOWER SPEED CONTROL POWER TRANSISTOR

The base voltage of the power transistor changes according to blower drive signals from the ECM. The blower speed changes steplessly in accordance with the change in the power transistor's base voltage.

Should an over-current occur, the thermal fuse connected to the circuit (rated to blow at 144°C or 291°F) cuts off the current to the blower.

I: EVAPORATOR SENSOR

The evaporator sensor detects the temperature at the evaporator outlet and sends the result to the ECM.



(1) Resistance (kΩ)

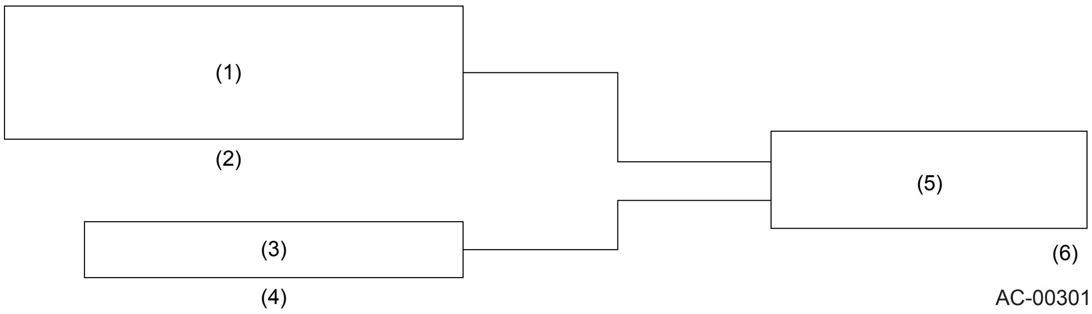
(2) Intake air temperature (°C)

J: CONTROL SYSTEM

1. CALCULATION OF REQUIRED BLOW-OUT AIR TEMPERATURE (TAO)

1) REQUIRED BLOW-OUT AIR TEMPERATURE (TAO)

Upon reception of temperature set switch signals in addition to cabin temperature, ambient temperature and sunload sensor signals, the ECM calculates the TAO first and then, based on the calculated temperature, it determines the outlets from which the air is to be blown out.



(1) Cabin temperature (cabin temperature sensor)
Ambient temperature (ambient temperature sensor)
Intensity of sunload (sunload sensor)
Intake air temperature (intake sensor)

(2) (Sensor transmitted data)

(3) Set temperature (between 18.0 and 32.0°C or between 64.4 and 89.6°F)

(4) (Driver input data)

(5) Determination of air temperature and outlets

(6) (TAO)

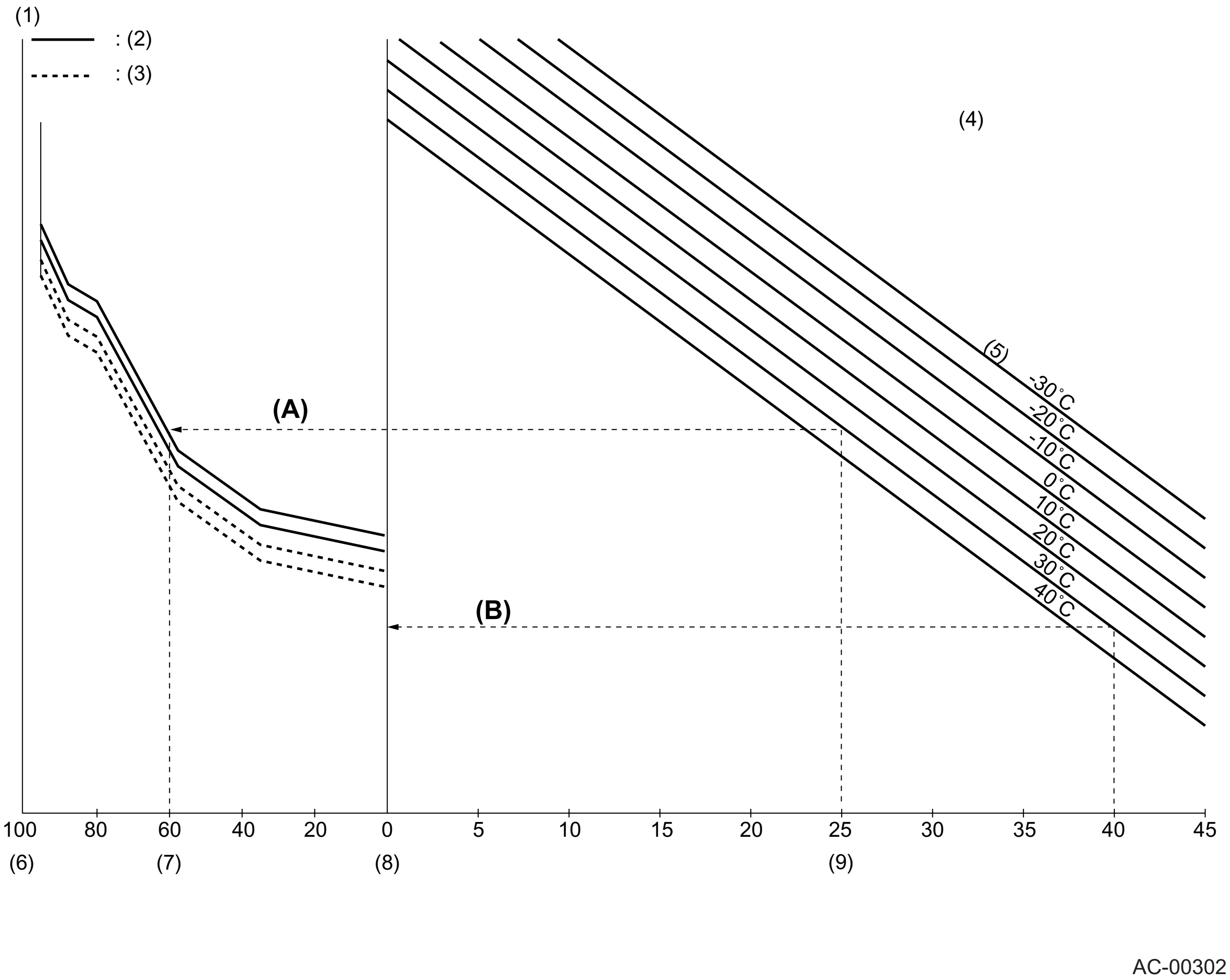
2) CALCULATION OF REQUIRED TAO:

- When the set temperature is 18.0°C (64.4°F), the TAO is fixed at the MAX COOL.
- When the set temperature is 32.0°C (89.6°F), the TAO is fixed at the MAX HOT.
- When the set temperature is 18.5°C to 31.5°C (65.3°F to 88.7°F), an optimum TAO is calculated based on the set temperature, as well as the cabin temperature, ambient temperature and sunload data at that time.

MEMO

2. TEMPERATURE CONTROL

The temperature control is made based on the driver's inputs from the temperature set switch and the data from various temperature sensors; the ECM determines the TAO using these data and operates the air mix motor so that the TAO can be attained.
The ECM compares the air mix damper opening it has received from the air mix damper potentiometer with the target opening it has calculated and, if necessary, operates the motor to move the damper to the HOT or COOL side and hold the damper in an appropriate position.
The target damper opening is corrected using the sunlight intensity data.
The air mix damper is moved fully to the HOT side and held there when the temperature set switch is placed at the FULL HOT position (32°C, 89.6°F), while it is moved fully to the COOL side and held there when the switch is placed at the FULL COOL position (18°C, 64.4°F).



(1) Measurement condition: inlet air temperature 0°C (32°F)

(2) When exposed to sunbeam

(3) When not exposed to sunbeam

(4) Measurement condition: set temperature 25°C (77°F)

(5) Ambient temperature

(6) Full HOT

(7) Air mix damper opening (%)

(8) Full COOL

(9) Cabin temperature (°C)

(A) If the vehicle is exposed to sunbeam, the air mix damper opening is set to 60% when the cabin temperature is 25°C (77°F) and the ambient temperature is 30°C (86°F).

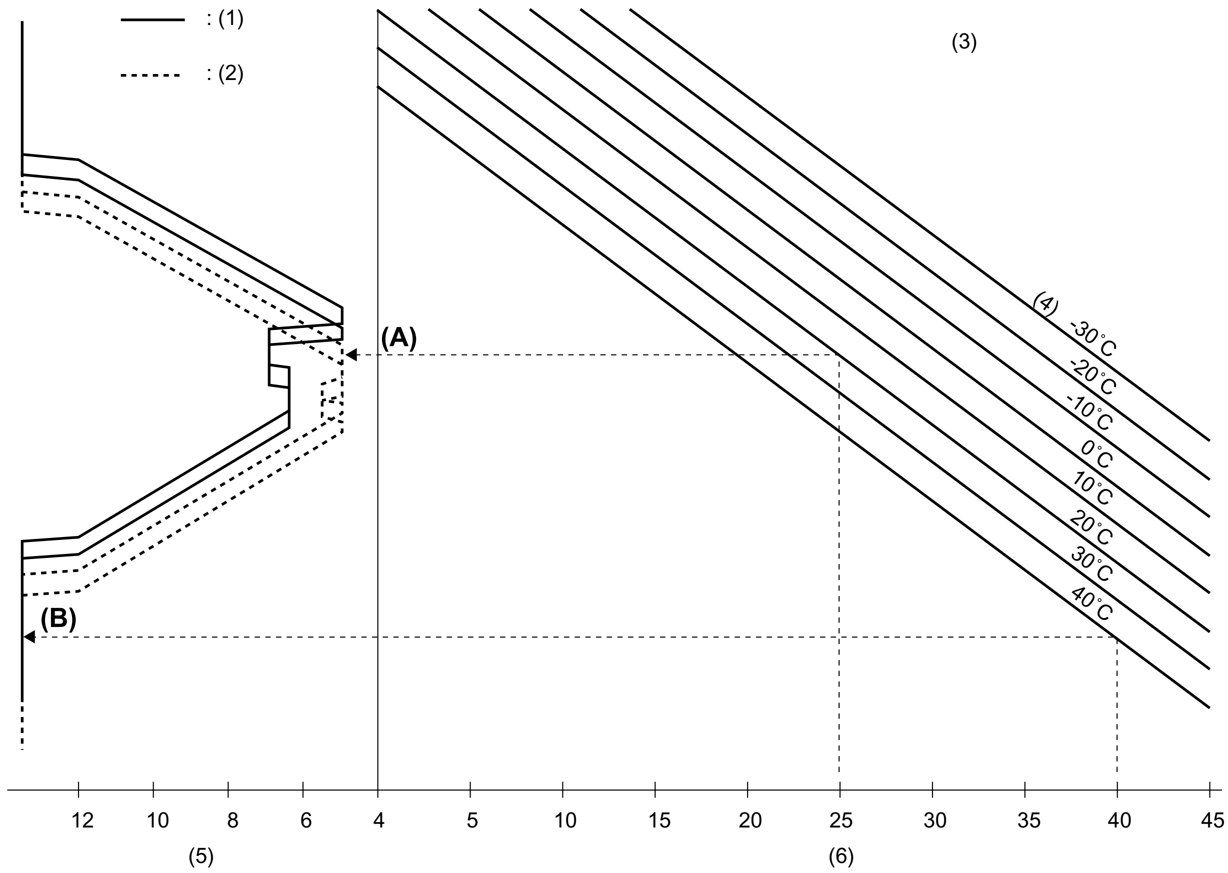
(B) The air mix damper opening is set to 0% (maximum cool position) when the cabin temperature is 40°C (104°F) and ambient temperature is 30°C (86°F).

3. AIR FLOW CONTROL

- Normal air flow control:

When the air conditioning system is in the automatic control mode, the air flow is determined based on the TAO calculated by the ECM. The blower fan speed is controlled accordingly.

In the automatic control mode, the minimum air flow is different between DEF mode and the other modes. For the minimum air flow in BILEVEL, HEAT and DEF/HEAT modes, a voltage of 5.5 V is applied to the blower motor, while for the DEF mode a voltage of 9.0 V is applied.
The minimum air flow is corrected by the sunbeam intensity if the VENT or BILEVEL mode is selected.



AC-00303

(1) When exposed to sunbeam

(2) When not exposed to sunbeam

(3) Measurement condition: set temperature 25°C (77°F)

(4) Ambient temperature

(5) Voltage applied to blower motor (V)

(6) Cabin temperature (°C)

(A) If the vehicle is not exposed to sunbeam, a voltage of approx. 5V is applied to the blower motor when the cabin temperature is 25°C (77°F) and the ambient temperature is 40°C (104°F).

(B) The system (battery) voltage is applied to the blower motor when the cabin temperature is 40°C (104°F) and the ambient temperature is 40°C (104°F).

- Blower fan starting speed control

When the blower motor is turned ON in the automatic control mode, the fan speed is initially low and then gradually increases (applied voltage increases by 1V every second until an appropriate voltage is reached) to prevent air from blowing out in a gust.)

- Blower fan control at low coolant temperatures

Even when the blower motor is automatically turned ON, the blower fan is kept stopped or allowed to rotate at the minimum speed for a maximum of 150 seconds depending on the cabin temperature and the ambient temperature, if the engine coolant temperature is below 49°C (120.2°F) with the air outlets for the VENT or DEF mode selected.

After the conditions for prohibiting blower fan operation or limiting its speed are removed, the voltage applied to the blower motor is increased gradually (by 0.34 V every minute) such that a large amount of cold air does not blow out toward the leg area.
Once the coolant temperature exceeds 49°C (120.2°F), the normal blower fan control is performed including the starting speed control.

- Blower fan stop control with compressor ON

The blower fan is stopped for 3 seconds if the compressor is turned ON with the intake sensor-detected temperature is higher than 35°C (95°F).

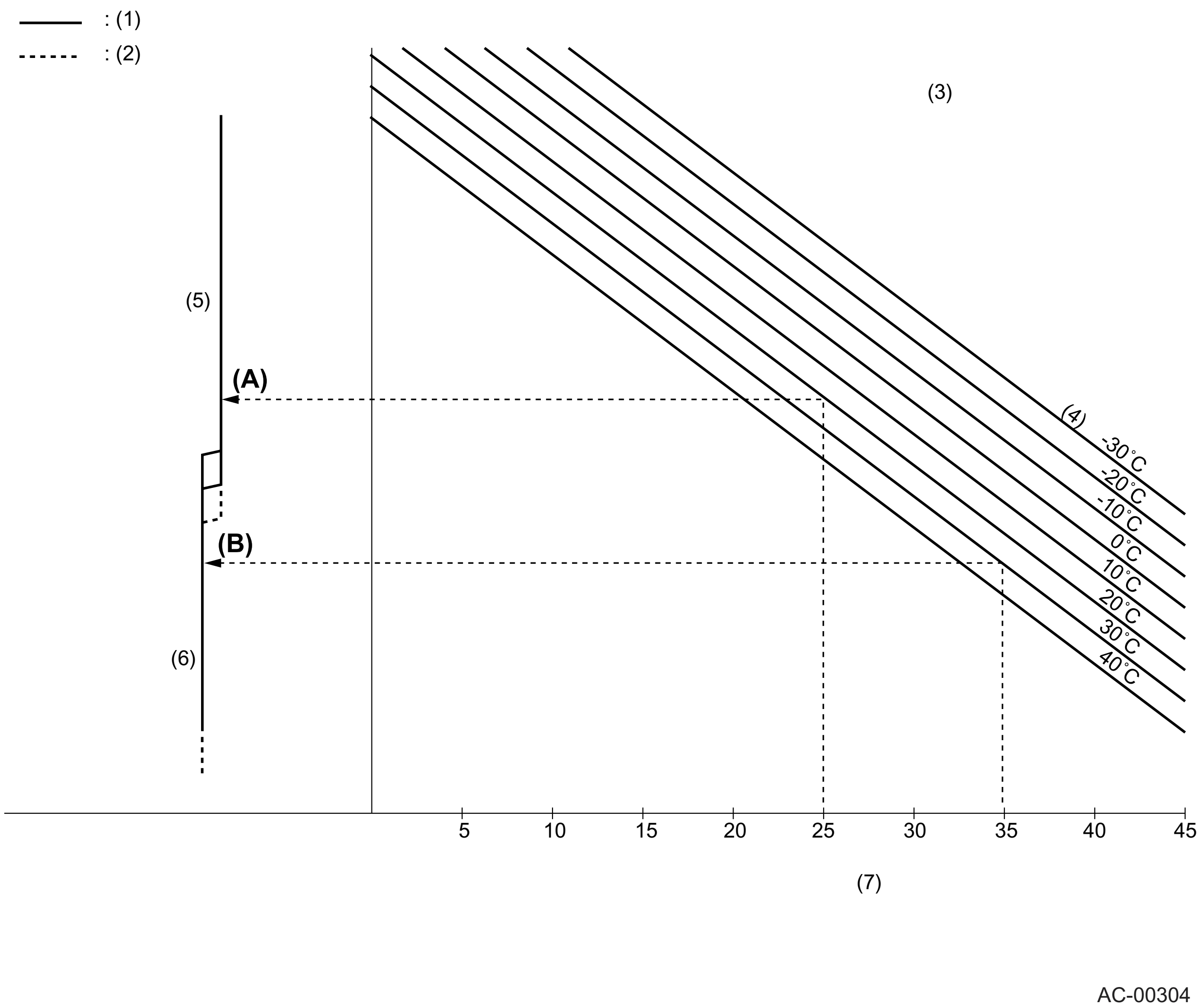
MEMO

4. AIR INLET CONTROL SYSTEM

The air inlet control system determines whether the air inlet damper is to be opened depending on the TAO calculated by the ECM, thus selecting either inside air recirculation or fresh air introduction.

The damper is generally opened for fresh air introduction when the compressor is turned OFF.

It is also opened generally when the DEF position is selected.



(1) When exposed to sunbeam

(2) When not exposed to sunbeam

(3) Measurement condition: set temperature 25°C (77°F)

(4) Ambient temperature

(5) Fresh air introduction

(6) Inside air recirculation

(7) Cabin temperature (°C)

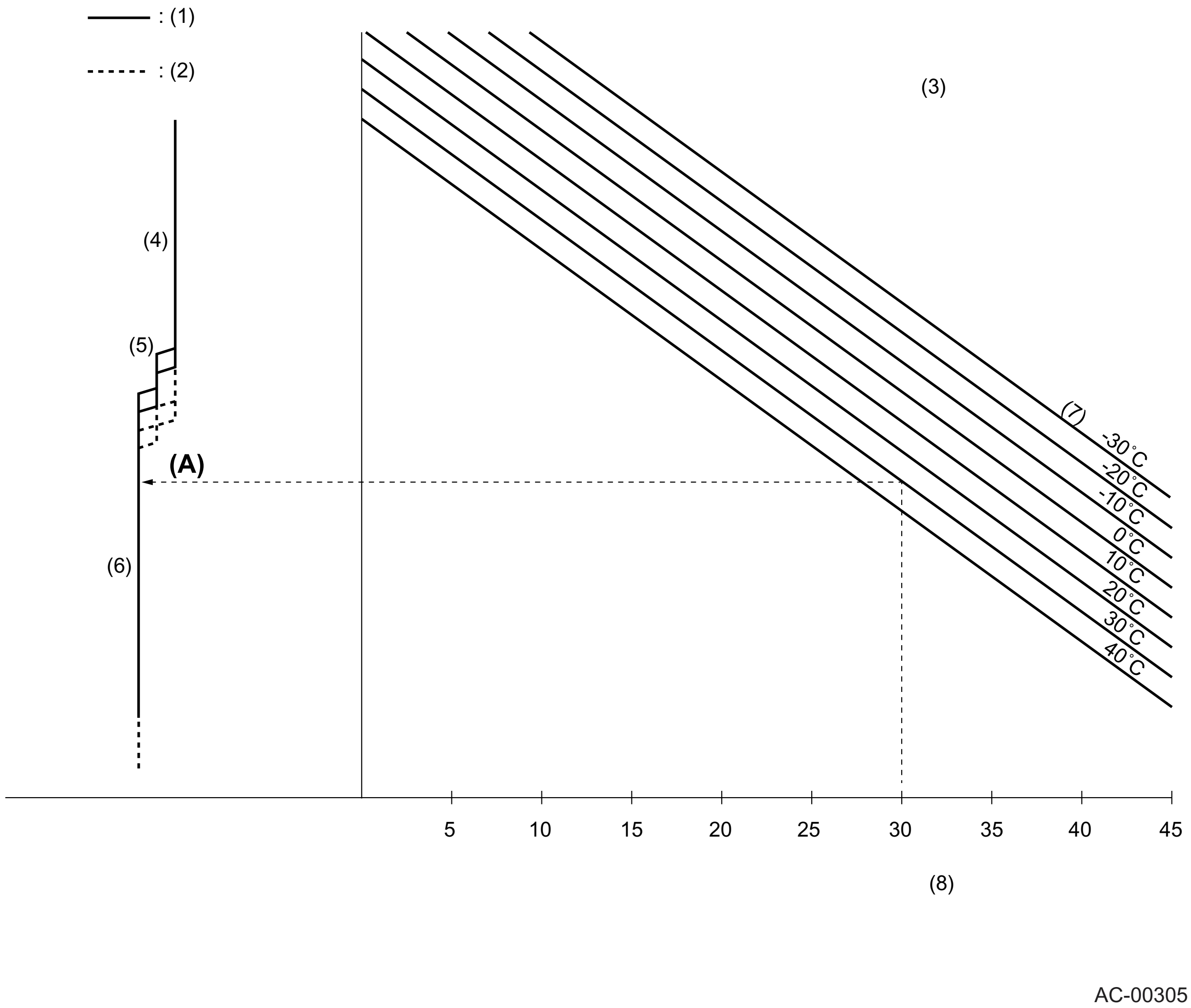
(A) The air inlet damper is opened for fresh air introduction when the cabin temperature is 25°C (77°F) and the ambient temperature is 20°C (68°F).

(B) The air inlet damper is closed for inside air recirculation when the cabin temperature is 35°C (95°F) and the ambient temperature is 30°C (86°F).

5. AIR OUTLET CONTROL SYSTEM

The air outlet control system automatically selects the most appropriate air outlet combination depending on the ECM-calculated TAO by activating servo-motors for the VENT, BILEVEL or HEAT modes.

When the OFF switch is pressed position, the air outlet control system is held in the HEAT mode.

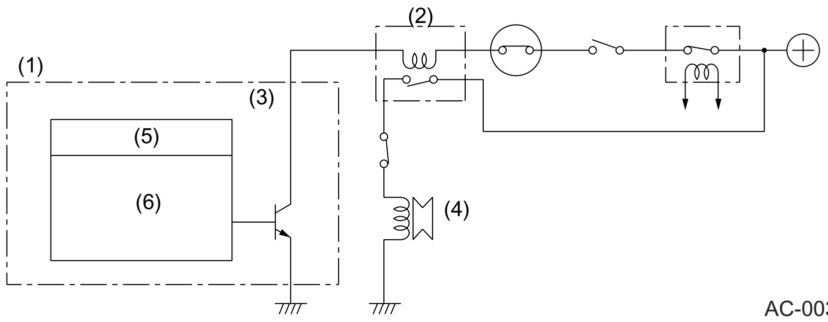


(1) When exposed to sunbeam
(2) When not exposed to sunbeam
(3) Measurement condition: set temperature 25°C (77°F)
(4) HEAT, DEF/HEAT
(5) BILEVEL
(6) VENT
(7) Ambient temperature
(8) Cabin temperature (°C)
(A) The air outlets for the VENT mode are selected when the cabin temperature is 30°C (86°F) and the ambient temperature is 30°C (86°F).

6. COMPRESSOR CONTROL SYSTEM

In the automatic air-conditioning mode, the A/C relay is activated or deactivated depending on the TAO (required blow-out air temperature), TAM (ambient temperature) and T INT (suction air temperature) to operate or stop the compressor.

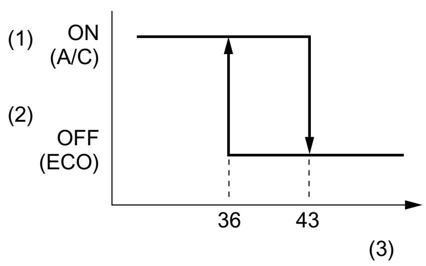
The compressor operation circuit supplies current to the magnet clutch as the ECM activates the A/C relay by connecting its coil to the ground.



AC-00306

(1) ECM
(2) A/C relay
(3) MCR
(4) MAGNET CLUTCH
(5) Compressor control
(6) Control by TAO and TAM

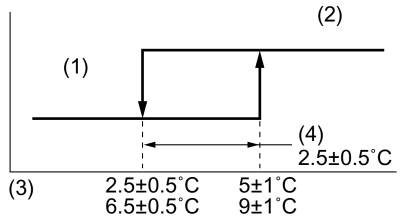
- Control by TAO and TAM



AC-00307

(1) MCR
(2) Operation
(3) TAO - TAM

- Control by T INT



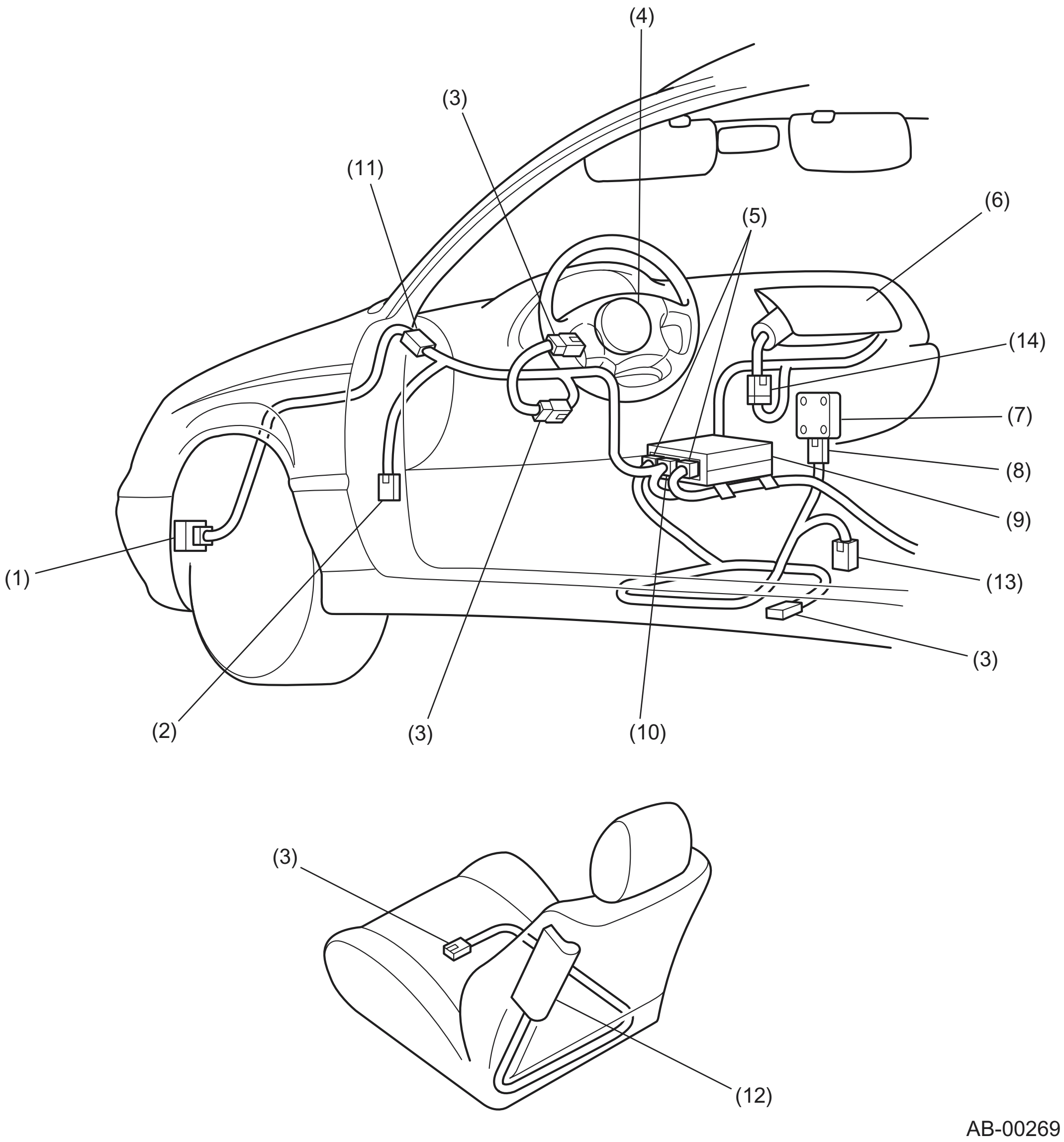
AC-00308

(1) Compressor OFF
(2) Compressor ON
(3) A/C
ECON
(4) DEF

MEMO

1. Airbag System

A: CONSTRUCTION

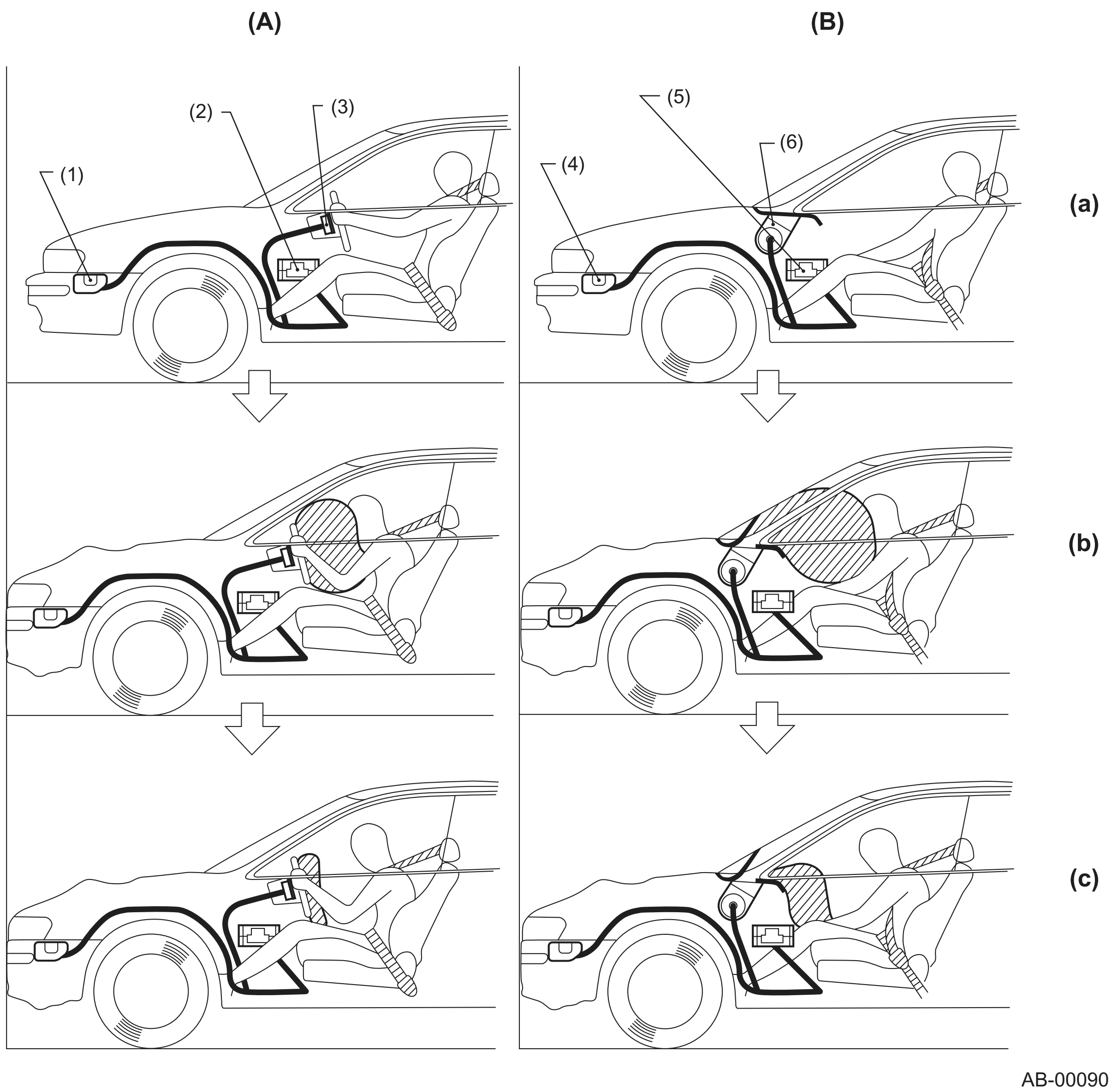


(1)	Front sub sensor	(8)	4-pin connector (yellow)
(2)	12-pin connector (yellow)	(9)	Airbag control module
(3)	2-pin connector (yellow)	(10)	28-pin connector (yellow)
(4)	Airbag module (driver)	(11)	2-pin connector (blue)
(5)	12-pin connector (yellow)	(12)	Airbag module (side)
(6)	Airbag module (passenger)	(13)	2-pin connector (yellow) (to seat belt pretensioner)
(7)	Side airbag sensor	(14)	4-pin connector (yellow)

B: FUNCTION

1. FRONT AIRBAG

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 sensors generate an electrical pulse to inflate the airbags in the airbag modules, thus preventing the driver's and passenger's upper bodies from directly hitting against the steering wheel, instrument panel and/or windshield.



(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

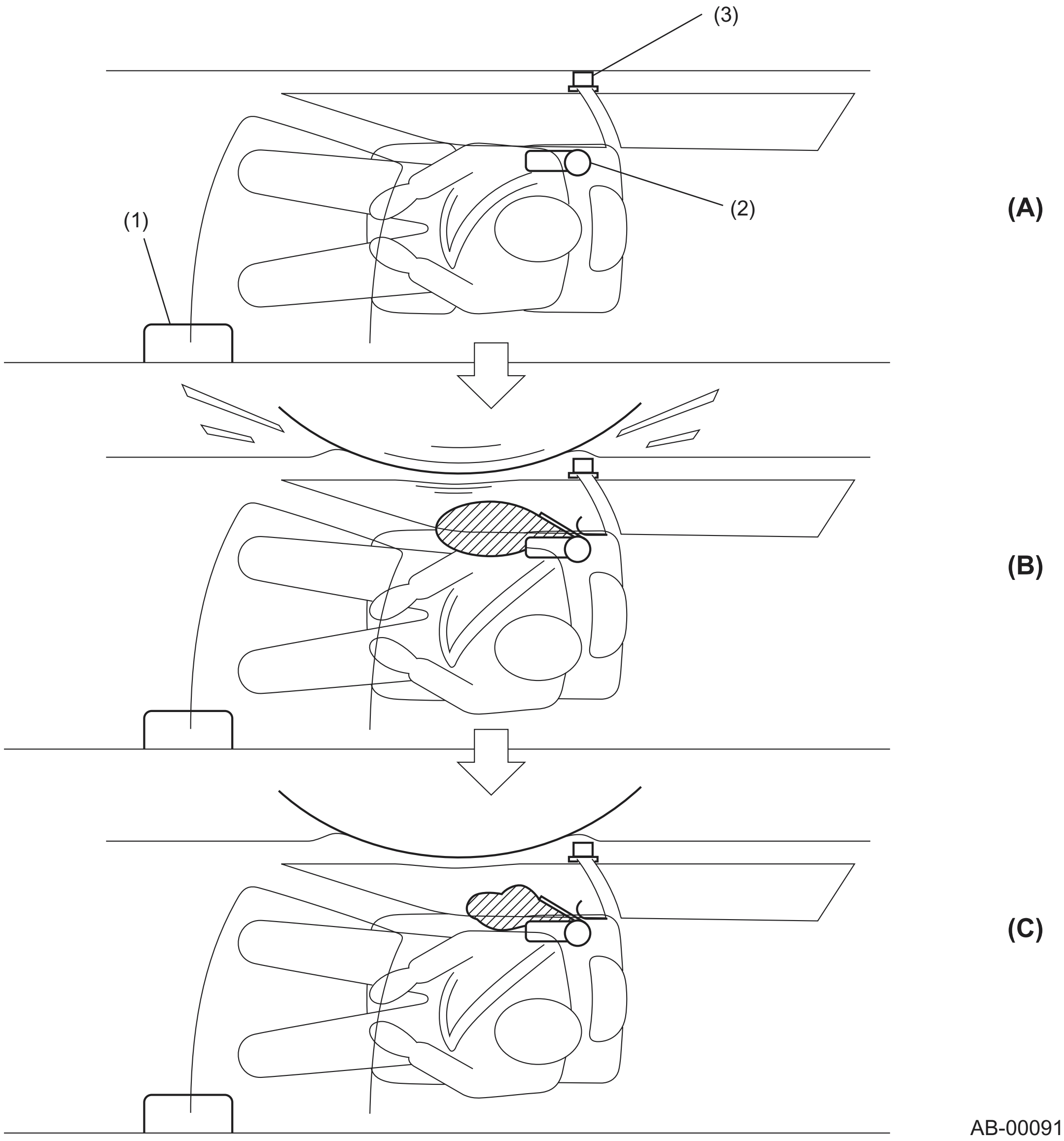
(a)
- Collision occurs.

(b)
- Front sub sensor, electric sensor and safety sensor detect an impact greater than the set level.
- Inflators is ignited.
- Gas is generated.
- Airbag inflation completes.
- Gas is discharged.

(c)
- Airbags deflate.

2. SIDE AIRBAG

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 relevant side airbag sensor sends an ignition signal to the corresponding airbag control module. The airbag control module activates the side airbag module to inflate the airbag, thus reducing the shock inflicted in the outside upper body (chest) of the driver or front passenger.



(1) Airbag control module
(2) Inflator
(3) Side airbag sensor

(A) • Collision occurs.
(B) • The side airbag sensor detects an impact greater than the set level.
- Inflators is ignited.
- Gas is generated.
- Airbag inflation completes.
- Gas is discharged.

(C) • Airbags deflate.

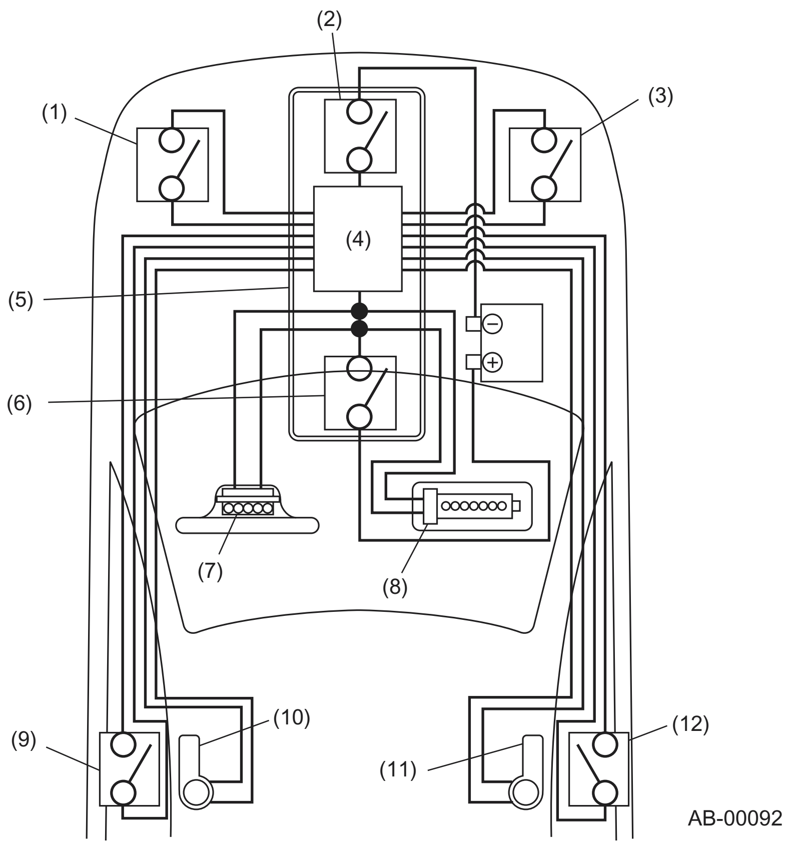
2. Construction

A: GENERAL

● 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 side airbag modules each containing an inflator and airbag (side airbag equipped model).

● FRONT AIRBAG SYSTEM:
A frontal impact exceeding the set level causes the electric sensor and one or both front sub sensors to input impact signals to the CPU. The CPU determines whether the airbags should be inflated or not based on these signals.

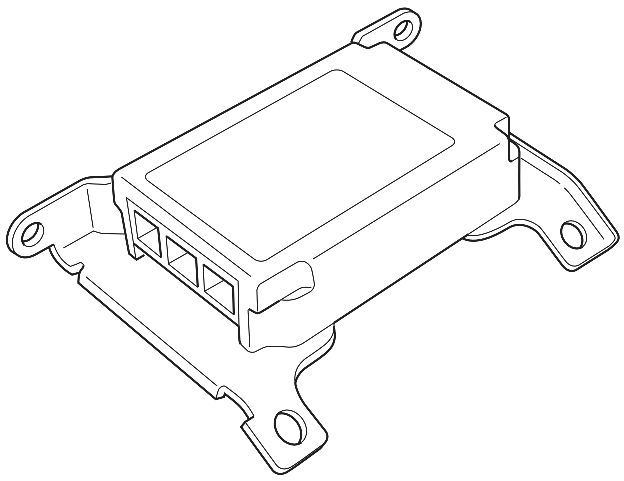
● SIDE AIRBAG SYSTEM:
Input of a shock energy greater than the set level causes the airbag on the corresponding side to inflate.



(1)	Front left sub sensor	(5)	Airbag control module	(9)	Left side airbag sensor
(2)	Safety sensor	(6)	Electric sensor	(10)	Left side inflator
(3)	Front right sub sensor	(7)	Inflator (driver)	(11)	Right side inflator
(4)	CPU	(8)	Inflator (passenger)	(12)	Right side airbag sensor

B: AIRBAG CONTROL MODULE

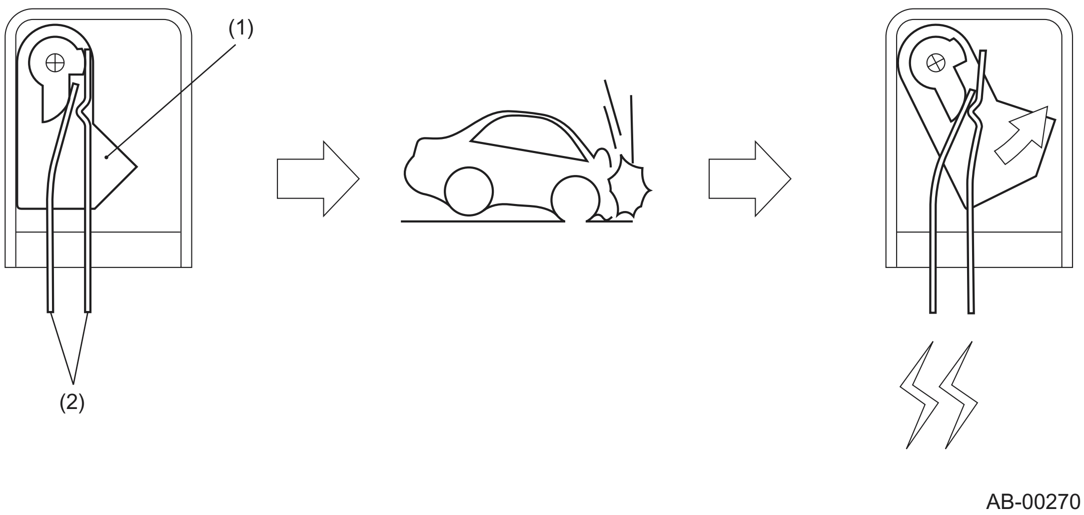
The airbag control module is installed on the front floor tunnel. It detects the vehicles deceleration by receiving electrical signals from its inside electric sensor as well as the front sub sensors and judges whether to inflate the airbags. This control module has a built-in system diagnosis function. If a fault occurs in the system, it lights up the airbag warning light in the combination meter. The fault data is stored in the 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: FRONT SUB SENSOR

One front sub sensor is installed on each side, in front of the front side frame.The front sub sensor is a pendulum type sensor. If the sensor receives a frontal impact exceeding a certain limit, the mass in the sensor rotates forward to turn the switch ON.



(1) Mass

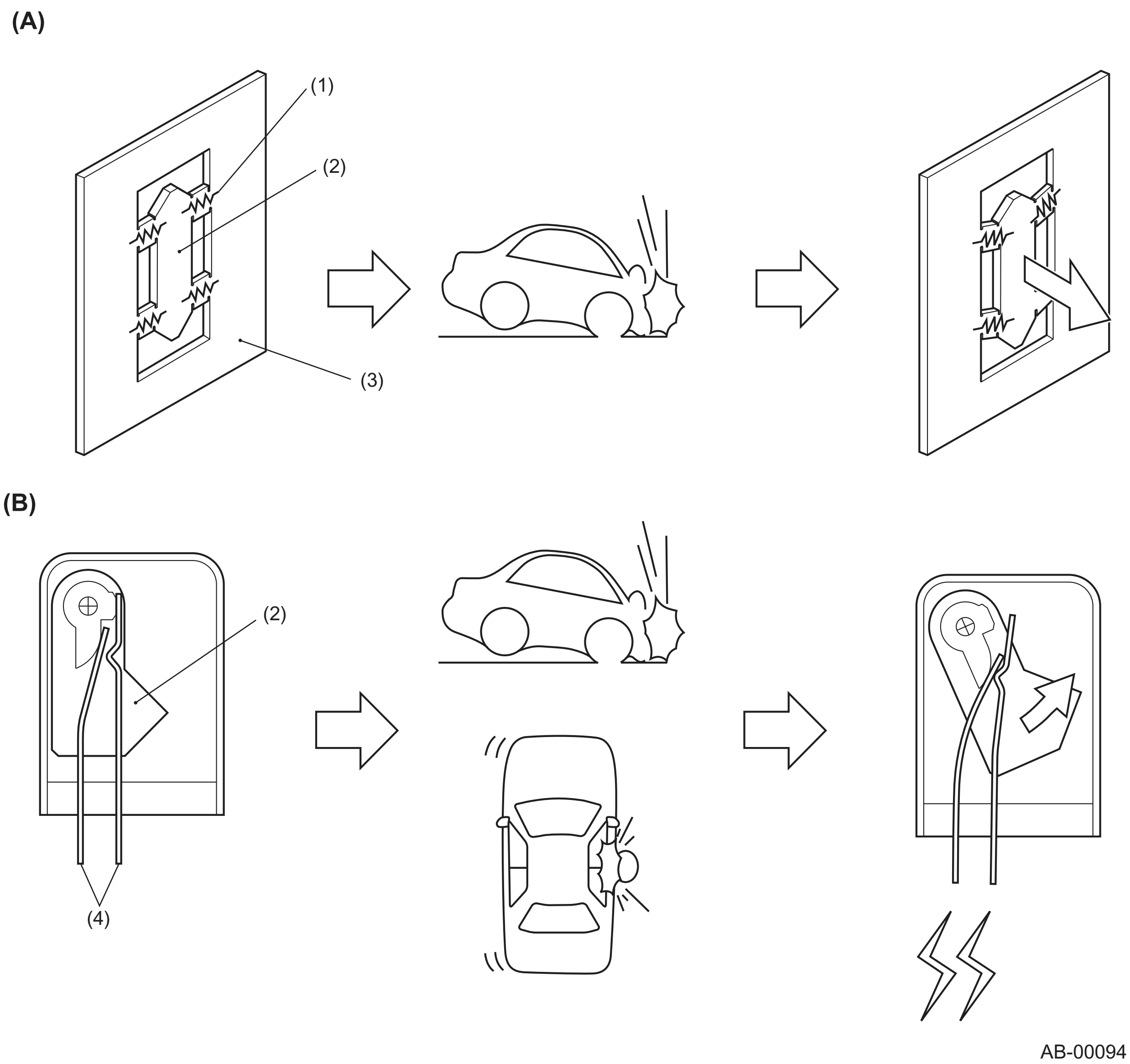
(2) Switch contacts

D: AIRBAG SENSOR

The safety sensor and electric sensor are incorporated into the airbag control module and the side airbag sensors.

The safety sensor is also a pendulum type sensor. If the sensor receives a frontal or side impact exceeding a certain limit, the mass in the sensor moves in the direction opposite to the impact direction to turn the switch ON.

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.



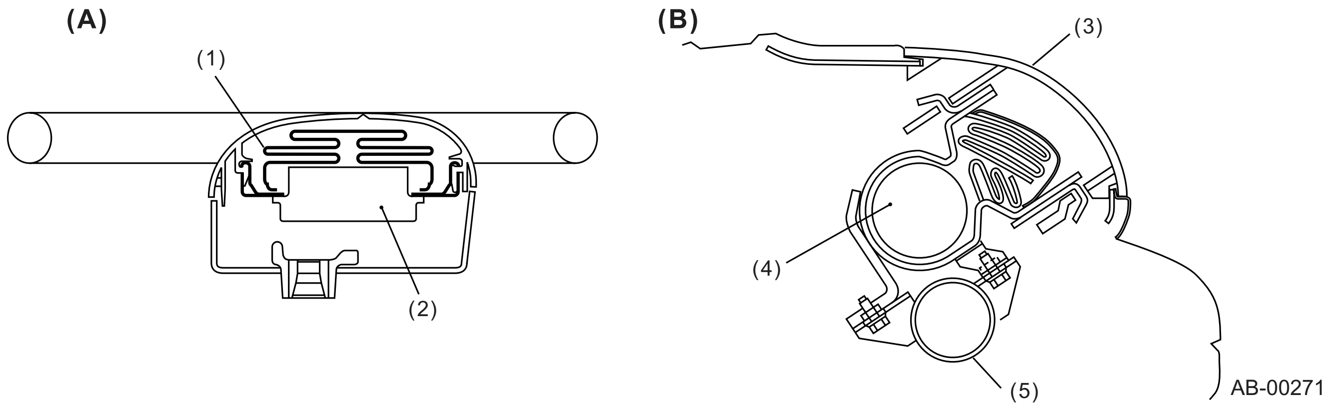
(A) Electric sensor
(B) Safety sensor

(1) Electrical resistance
(2) Mass
(3) Semiconductor
(4) Switch contacts

E: AIRBAG MODULE

1. FRONT AIRBAG

The driver's airbag module is located at the center of the steering wheel and the passenger's airbag module is located at upper portion of instrument panel. Each 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.

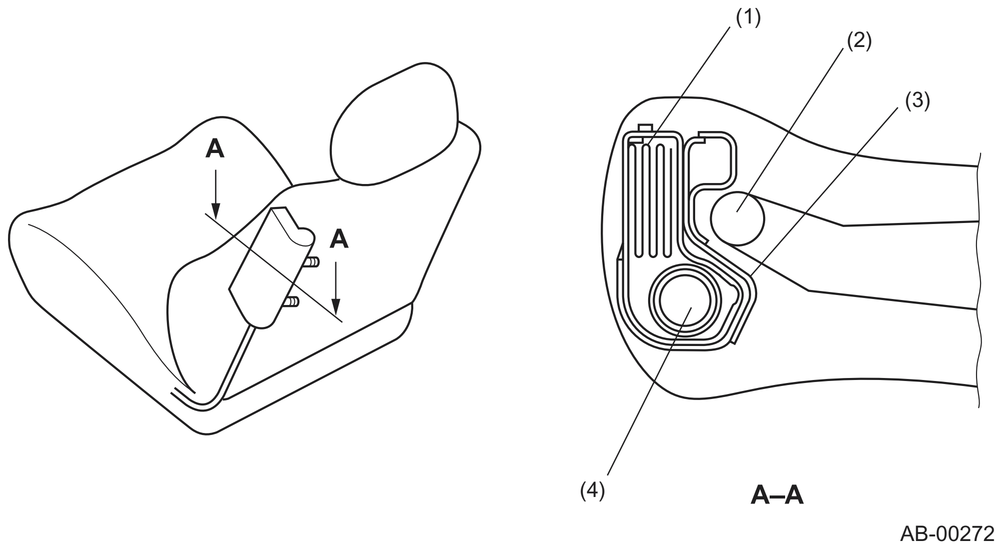


(A) Driver's module
(1) Airbag
(2) Inflator (driver)

(B) Passenger's module
(3) Airbag module lid
(4) Inflator (passenger)
(5) Steering support beam

2. 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.



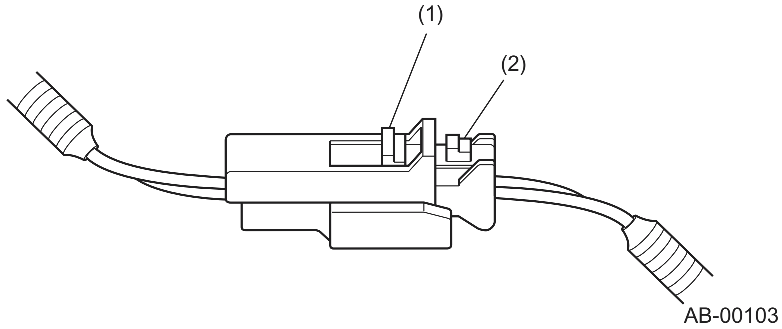
(1) Airbag
(2) Seat frame
(3) Bracket
(4) Inflator

F: AIRBAG CONNECTORS

1. DESCRIPTION

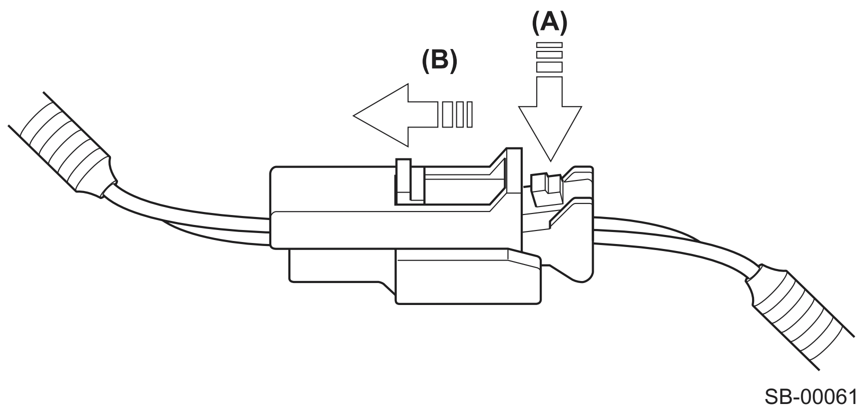
The airbag system uses connectors with a double lock mechanism and an incomplete coupling detection mechanism for enhanced reliability. If coupling is incomplete, the airbag warning light comes on in the combination meter.

2. AIRBAG HARNESS-TO-AIRBAG HARNESS CONNECTOR

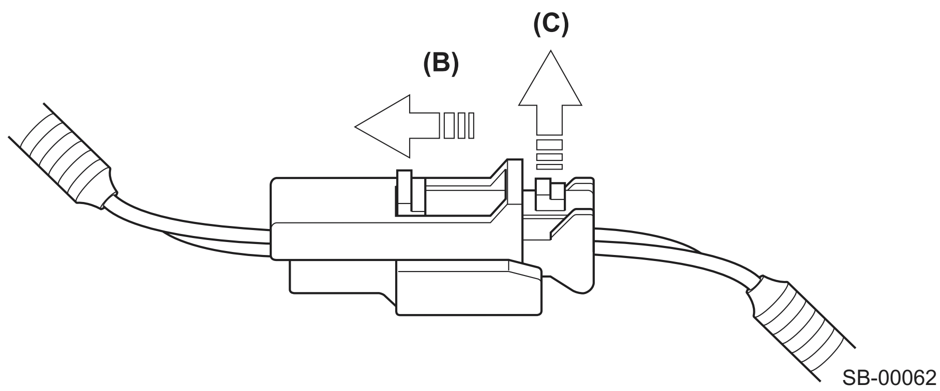


(1) Slide lock
(2) Lock arm

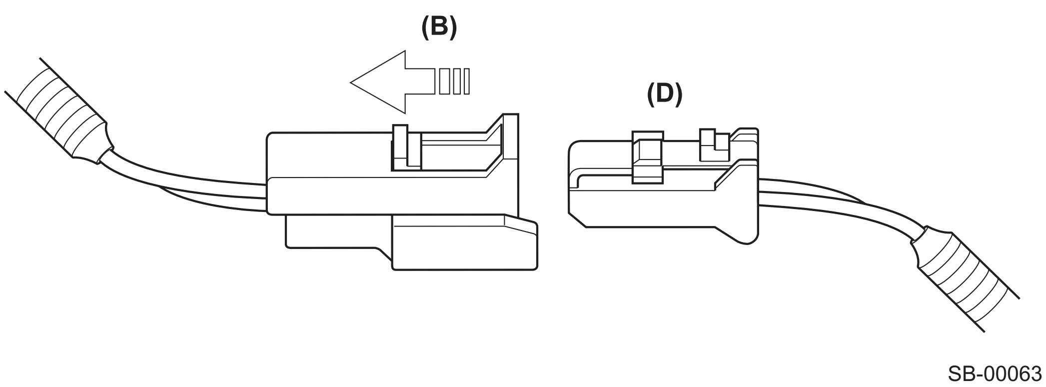
Disconnection:
1)



2)



3)



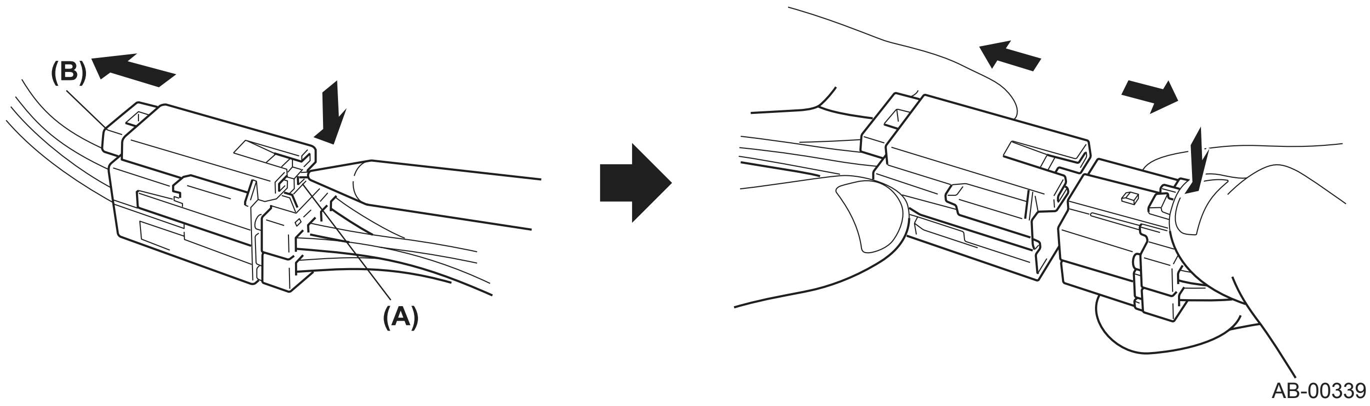
(A) Step 1: Push.
(B) Step 2: Slide and hold.
(C) Step 3: Release.
(D) Step 4: Disconnect.

Connection:
Insert the male side connector half into the other connector half until a “click” is heard.

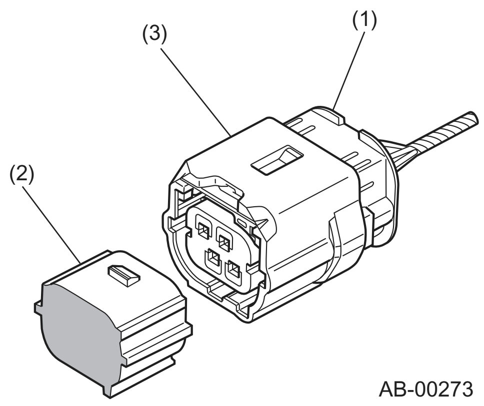
3. AIRBAG HARNESS-TO-BODY HARNESS CONNECTOR

Disconnection:
Press the lever (A) to let the green lever (B) pop out.This unlocks the double lock mechanism.Then separate the connector halves by pulling them apart while pressing the lever (A).

Connection:
Insert the male side connector half into the other until a “click” is heard, then push in the green lever (B) until a “click” is heard.This engages the double lock mechanism.

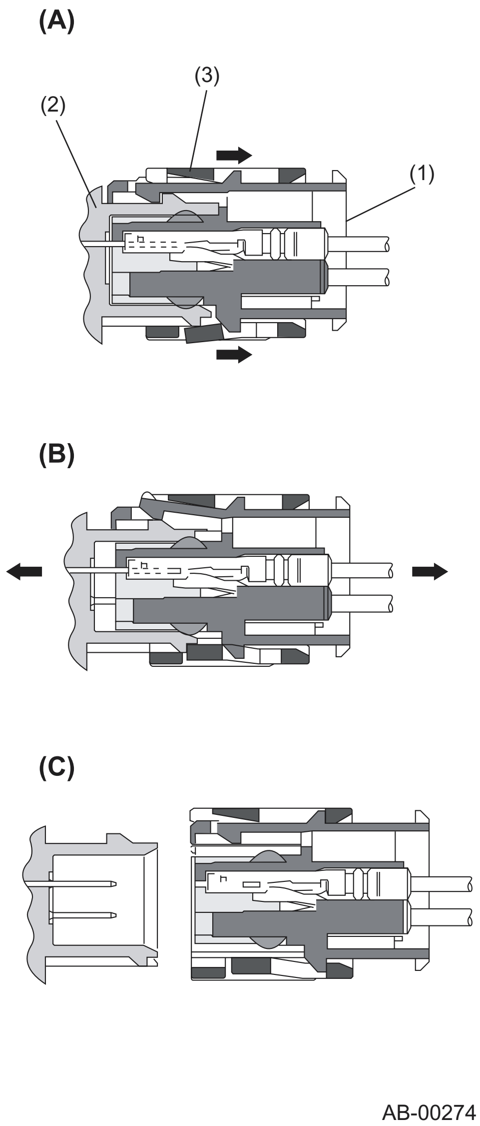


4. FRONT SUB SENSOR AND SIDE AIRBAG SENSOR CONNECTORS



(1) Housing A
(2) Housing B
(3) Outer cover

Disconnection:



(A)	Step 1: Pull housing A in the direction of the arrow while pulling down the outer cover.	(1)	Housing A
(B)	Step2: Release lock of connector.	(2)	Housing B
(C)	Step 3: Separate housing A and housing B.	(3)	Outer cover

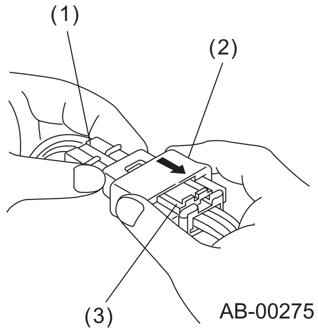
Connection:

Insert housing B into housing A until a “click” is heard.

5. PASSENGER'S AIRBAG MODULE CONNECTOR

Disconnection:
Hold pin insulator with one hand and the cover insulator with the other hand.Pull the cover insulator in the direction of the arrow in the drawing.

NOTE:
Do not hold the cover insulator.

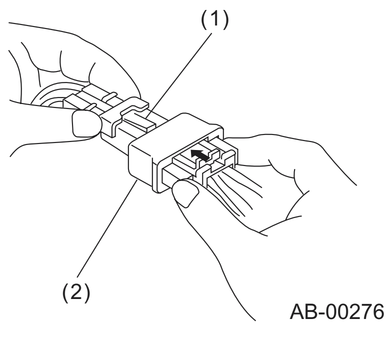


(1) Pin insulator
(2) Cover insulator
(3) Socket insulator

Connection:
Step 1: Insert the socket insulator into the pin insulator such that the pin insulator's claw is pressed against the cover insulator.

NOTE:
Do not hold the cover insulator.

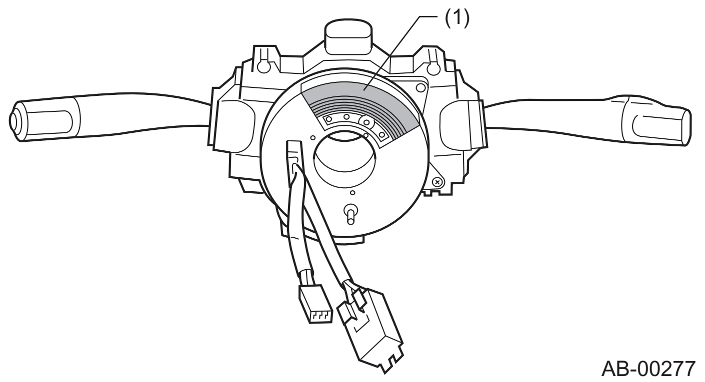
Step 2: Push the socket insulator forcibly toward the pin insulator.The cover insulator will move riding over the claw to complete engagement of the connector.



(1) Claw
(2) Cover insulator

G: 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.

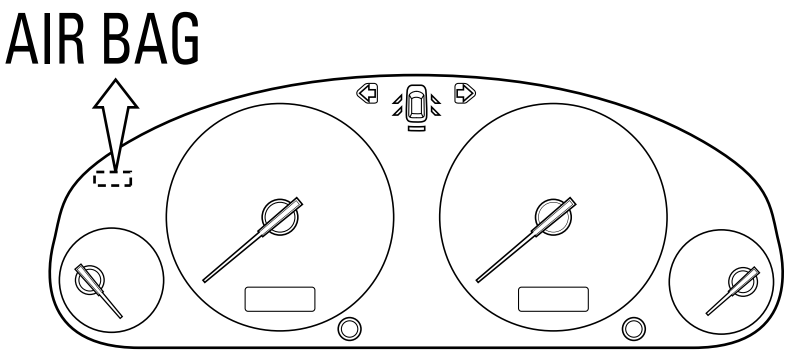


AB-00277

(1) Flat cable

H: 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 seconds later.

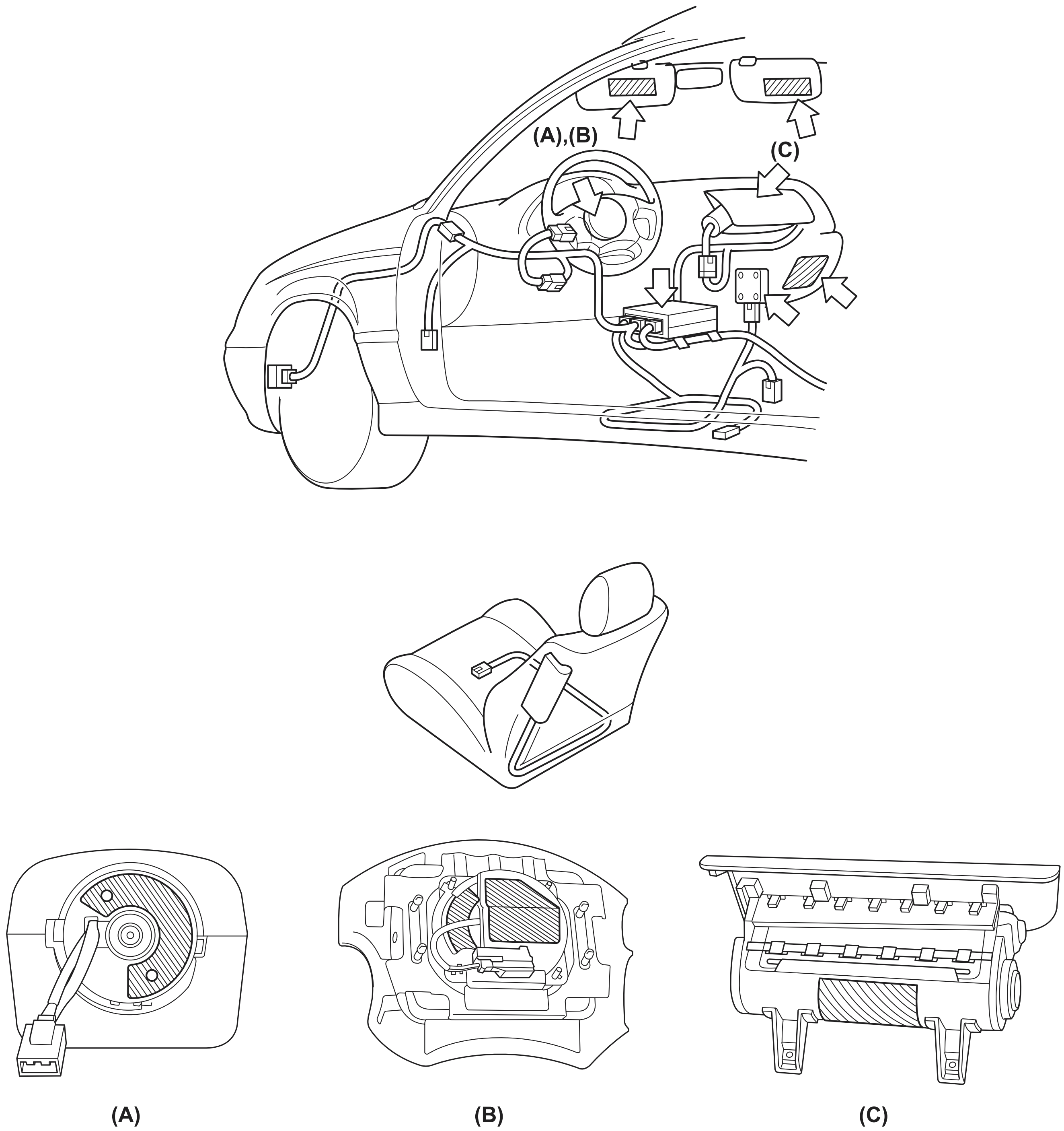


AB-00278

I: WIRE HARNESS

The wire harness of the airbag is entirely covered with a yellow protective tube, and can easily be distinguished from the other systems' harnesses.

J: LOCATIONS OF WARNING AND CAUTION LABELS



AB-00279

(A) VIew A

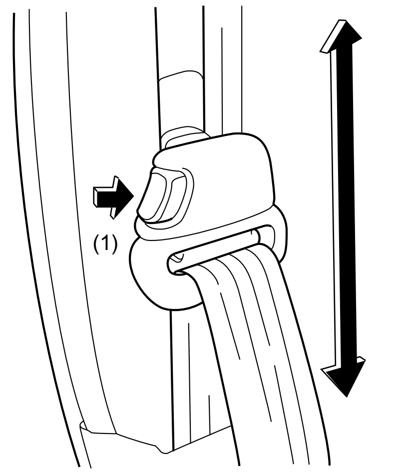
(B) View B

(C) View C

1. Seat Belt

A: ADJUSTABLE SHOULDER BELT ANCHOR

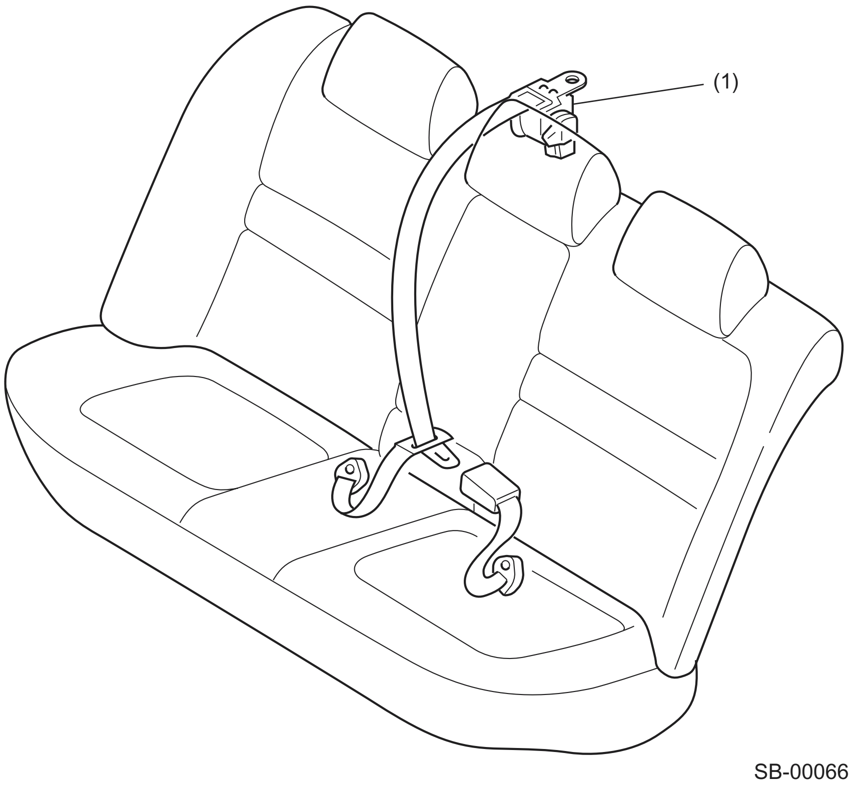
Each front seat belt system has an adjustable shoulder belt anchor which allows the occupant to select the most appropriate anchor height from among the five positions in a 100 mm (3.94 in) range.



(1) Push

B: REAR CENTER THREE-POINT TYPE SEAT BELT (SEDAN)

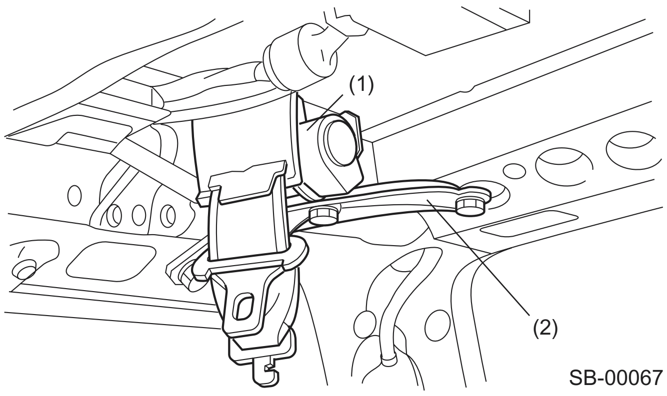
A three-point type seat belt is available for the center seating position of the rear seat.
The retractor for the seat belt is installed on the luggage shelf behind the seating position.



(1) Retractor

C: REAR CENTER THREE-POINT TYPE SEAT BELT (WAGON)

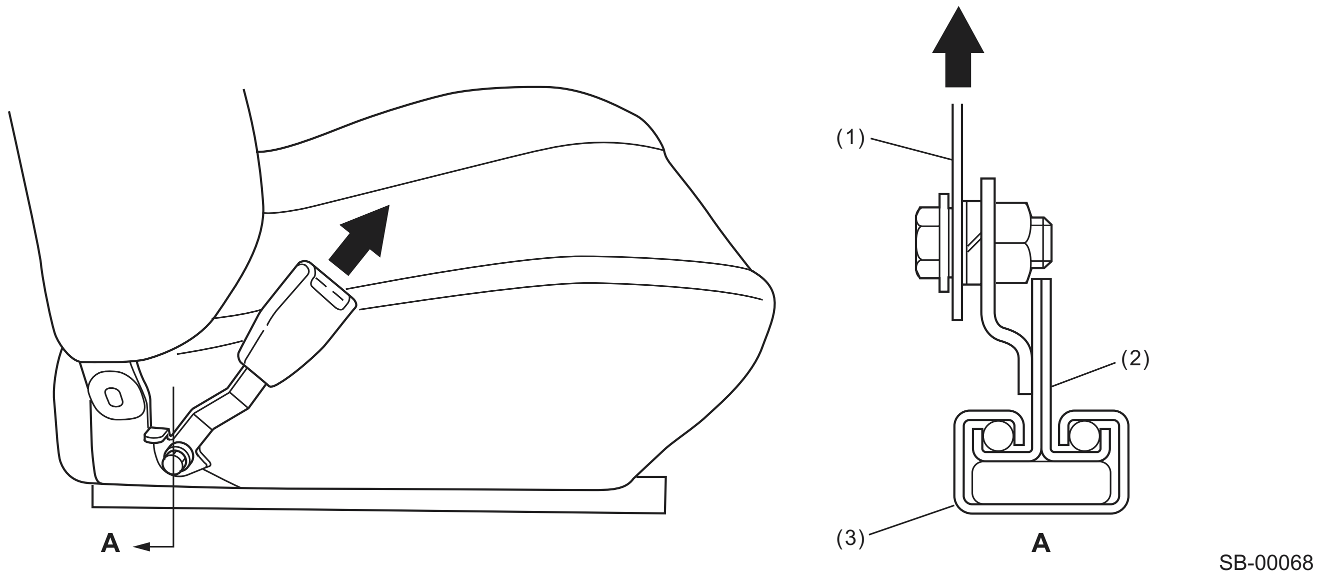
A three-point type seat belt is available for the center seating position of the rear seat.
The retractor for the seat belt is installed on the ceiling at the rear right of the cabin.



(1) Retractor
(2) Bracket

D: SEAT ANCHORED INNER BELT

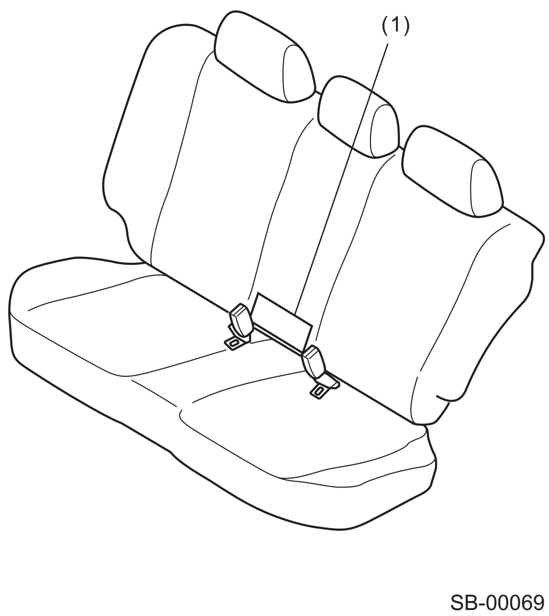
The front inner belt (buckle stalk) is attached to the front seat rather than to the floor. This keeps the position of the occupant relative to the front inner belt always constant even when the front seat is moved for adjustment.



(1) Inner belt
(2) Upper hook
(3) Lower hook

E: INNER BELT BUCKLE (WAGON)

The rear inner belt buckles can be stowed in the belt pocket located at the lower part of the center seat.

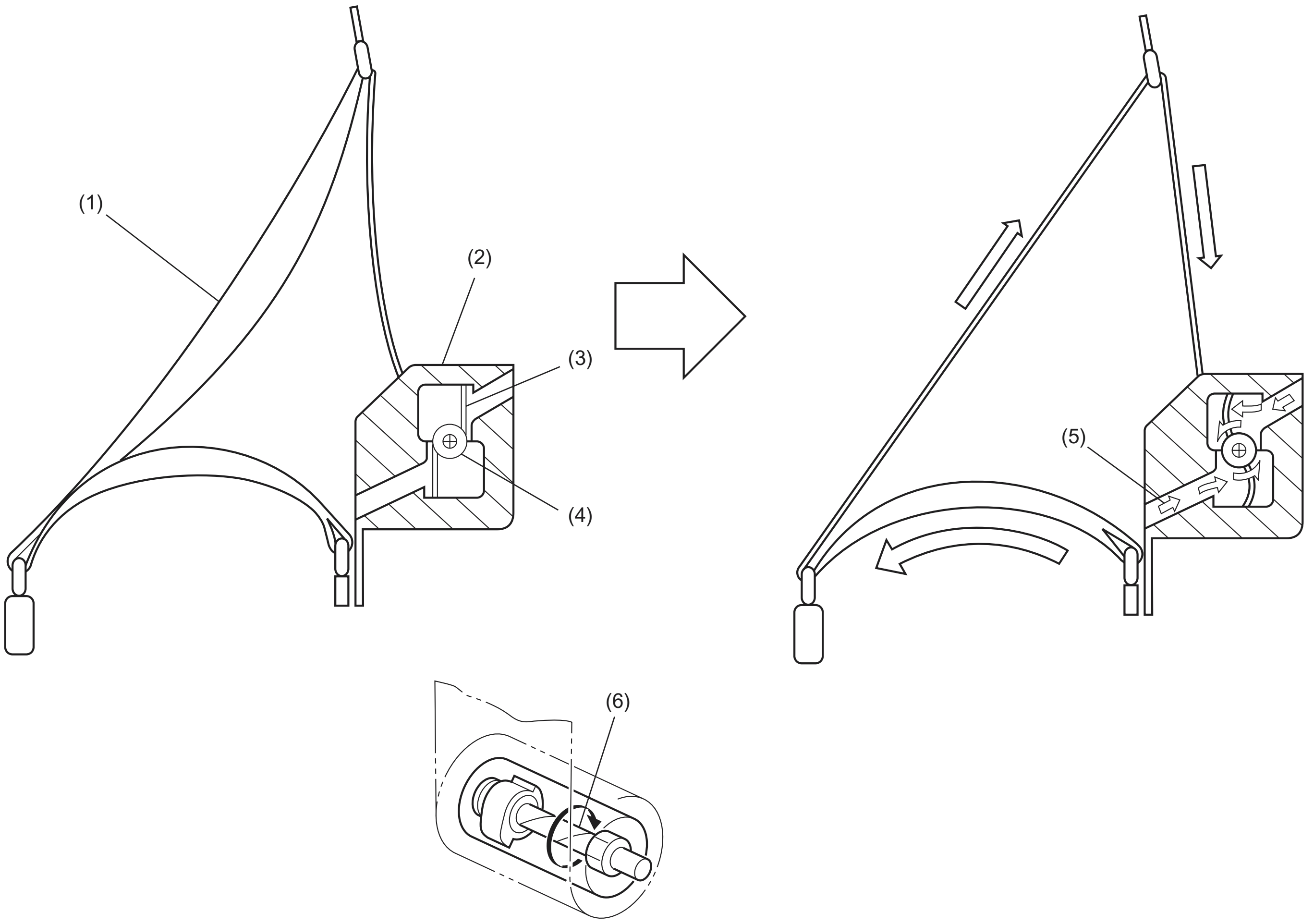


(1) Belt pocket

F: PRETENSIONER

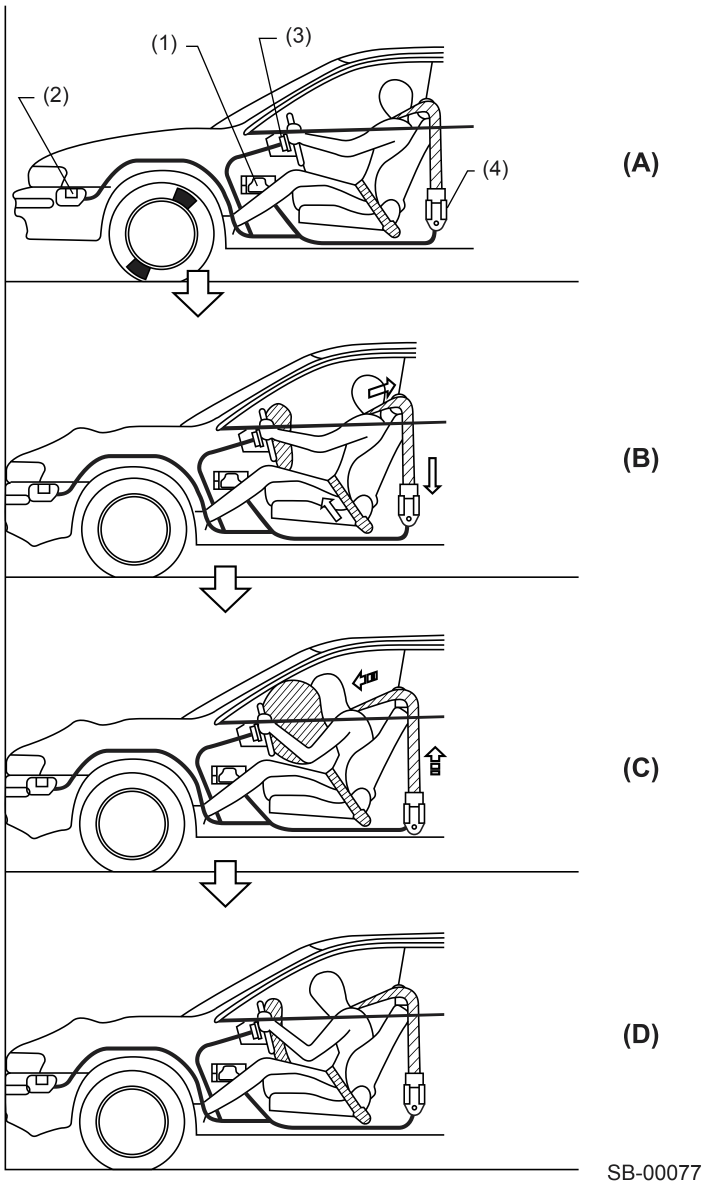
1. CONSTRUCTION

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 pulled 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.



(1) Webbing
(2) Retractor
(3) Strip
(4) Shaft
(5) Gas
(6) Torsion bar

2. FUNCTION



(A) ● Collision occurs

(B) ● Front sub sensor, electric sensor and safety sensor detect an impact greater than the set level
Operation of pretensioner
● Airbag starts to inflate

(C) ● Load limiter operates

(D) ● Operation complete

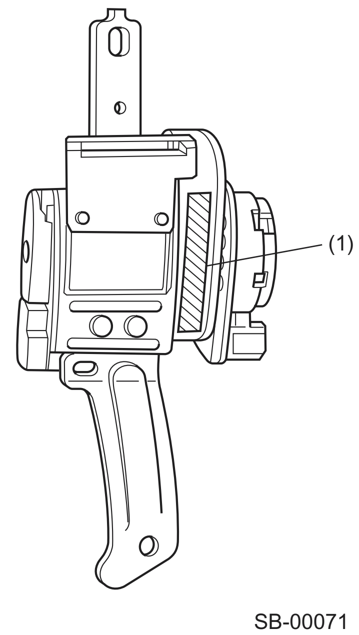
(1) Safety sensor and electric sensor

(2) Front sub sensor

(3) Airbag

(4) Retractor with pretensioner

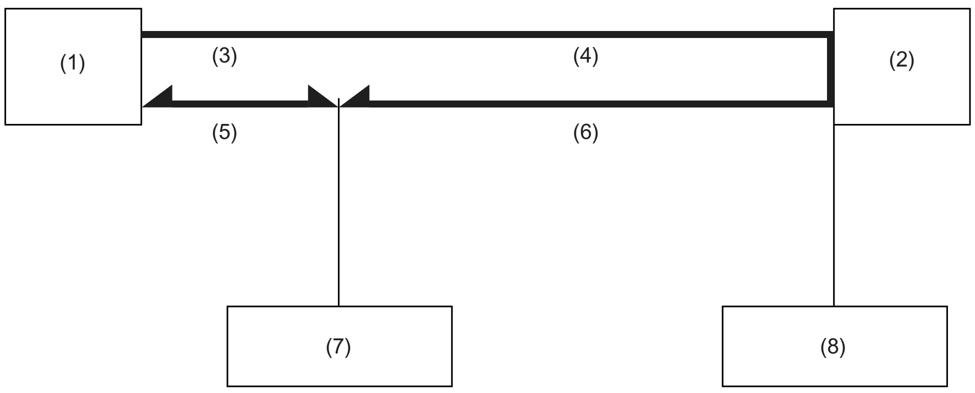
3. LOCATIONS OF WARNING AND CAUTION LABELS



(1) Caution label

G: AUTOMATIC RETRACTOR

When each of the rear seat belts (for right, left and center seating positions) are drawn out completely, its retractor is 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.

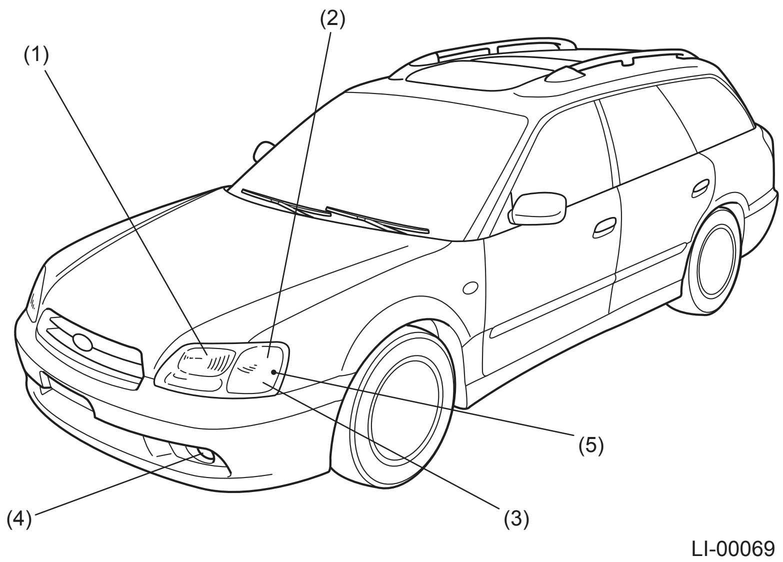


SB-00032

(1) Fully retracted
(2) Fully extended
(3) Normal mode
(4) Auto lock mode
(5) Belt can be retracted and pulled out.
(6) Belt can be retracted but cannot be extended.
(7) Automatic locking mode to normal mode changeover
(8) Normal locking mode to automatic locking mode changeover

1. Front

A: GENERAL



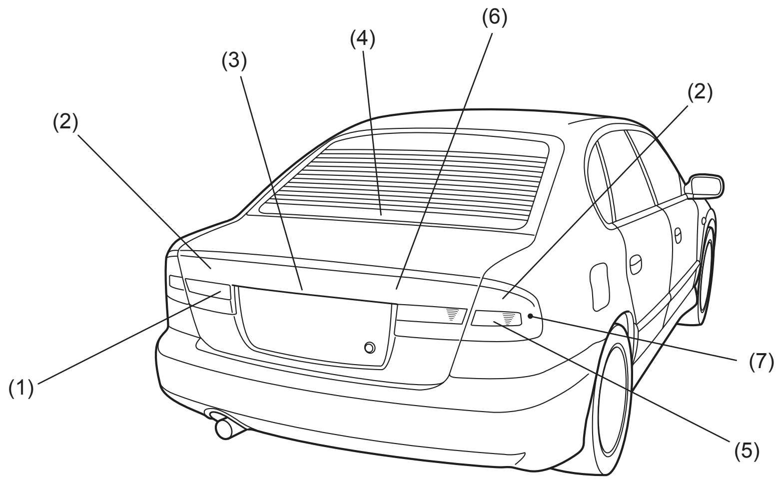
(1) Headlight
(2) Turn signal/hazard warning light
(3) Clearance/parking/front side marker/turn signal/hazard warning light
(4) Front fog light
(5) Front side reflex reflector

- The headlight is either a two bulb type or four bulb type and each type has 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, clearance/parking light, front side marker light, and front side reflex reflector are incorporated into the headlight.
- The sedan and wagon models have projector type front fog lights, and the outbacks have large sized multiple aspect reflector type front fog lights.
- A keyless answerback feature is added to the hazard warning lights.When the keyless entry system is operated, the hazard warning lights will flash.

2. Rear

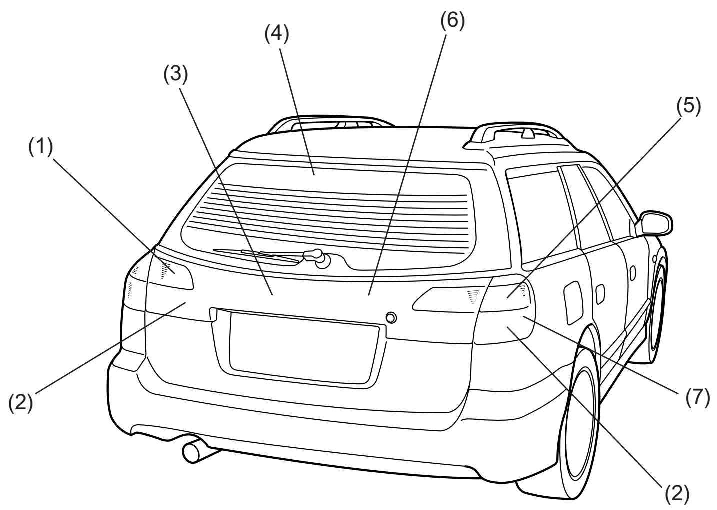
A: GENERAL

SEDAN



LI-00070

WAGON



LI-00071

(1) Backup light
(2) Stop/tail/parking/rear side marker light
(3) License plate light
(4) High mount stop light
(5) Turn signal/hazard warning light
(6) Rear finisher light
(7) Rear combination light

- The rear turn signal/hazard warning light, stop/tail/parking light, and the backup light are incorporated into the rear combination light and rear finisher light. The side marker light and rear reflex reflector are also incorporated into the rear combination light.
- The high mount stop light is installed to the bottom inside of the rear window on sedans, and to the top inside of the rear gate on wagons.

1. Front Wiper and Washer

A: DESCRIPTION

1. FRONT WIPER

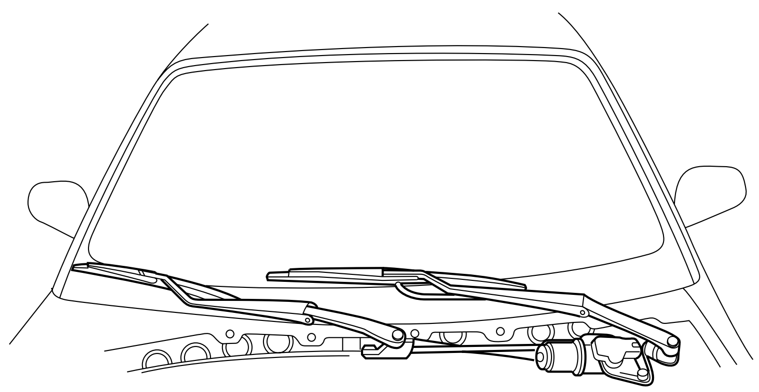
1) The front wiper is of a tandem type featuring wide wiping area. The blade is installed to the arm by means of U-hook joint to improve serviceability.

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-00038

2. FRONT WASHER SYSTEM

1) The washer system consists of a washer tank, a 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 washer motor and pump unit is installed at the bottom of the washer tank.

4) The washer nozzles are installed on the hood.Each nozzle is a diffusion nozzle.

5) Each washer nozzle is provided with a check valve which is located just below it.

3. SPECIFICATION

Washer tank	Capacity			4.0 liters (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	72 ± 6 rpm
			LOW	47 ± 5 rpm
	Locked rotor characteristics	HIGH	Torque	29.4 N m (300 kg cm 2.2 ft-lb)
			Current	36 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		500 mm (19.69 in)

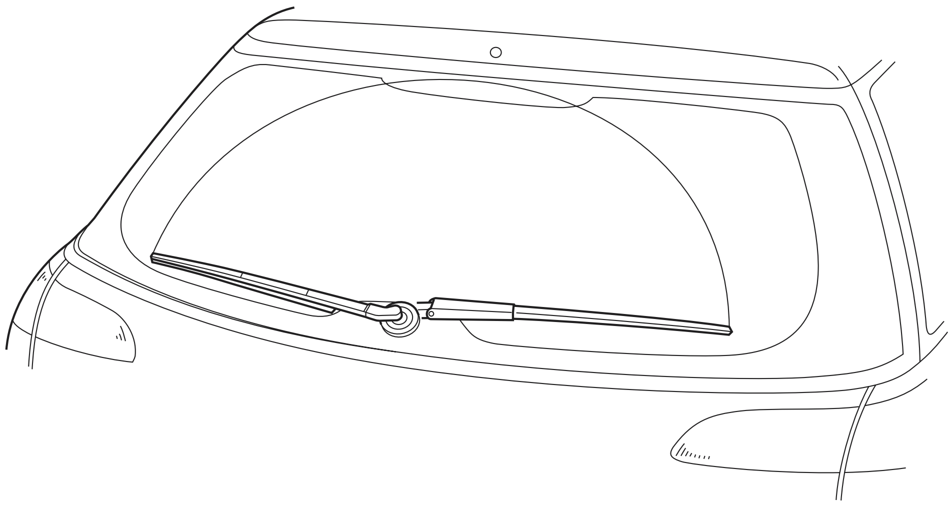
2. Rear Wiper and Washer

A: DESCRIPTION

1. REAR WIPER

1) The rear wiper operates intermittently at a 10-second interval.

2) The rear wiper operates over a 168-degree angle.



WW-00104

3) The wiper blade is attached to the arm by means of a U-hook joint in the same way as with the front wipers.

2. REAR WASHER SYSTEM

1) The same washer tank is shared by the front and rear washer systems.

2) The rear washer motor and pump unit 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.

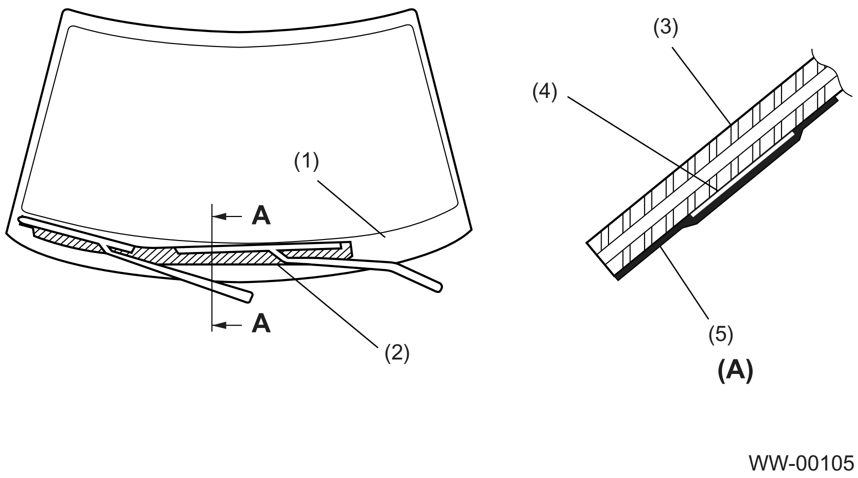
3. SPECIFICATION

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)]	30 ± 5 rpm or more
	Locked rotor current	13 A or less
Wiper Blade	Length	375 mm (14.76 in)

3. Windshield Wiper Deicer

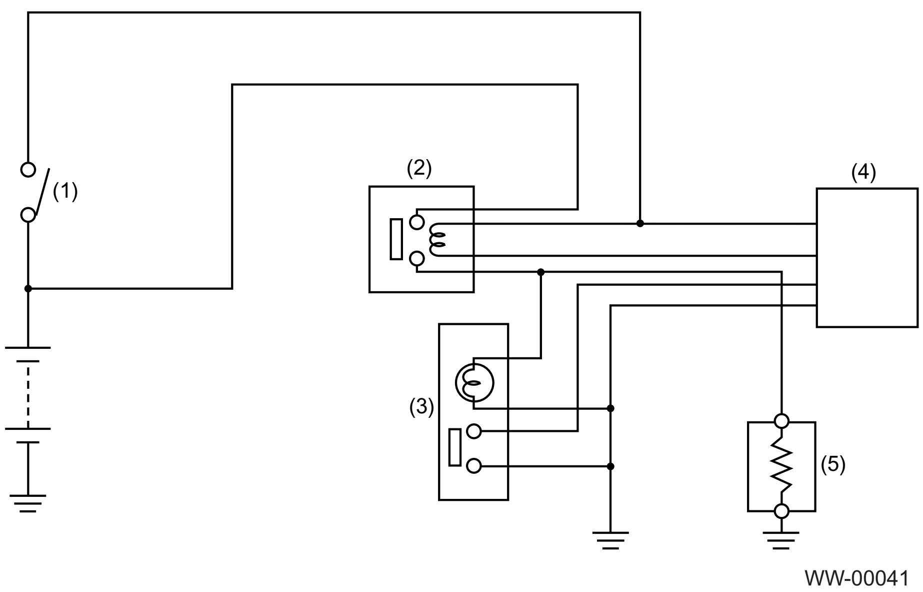
A: CONSTRUCTION

The wiper deicer system is activated when the wiper deicer switch is pressed with the ignition switch turned ON. It 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.



(1)	Printed ceramic	(4)	Wiper deicer heater wire
(2)	Heating area of wiper deicer	(5)	Printed ceramic
(3)	Windshield	**(A)**	Section A–A

B: CIRCUIT DIAGRAM

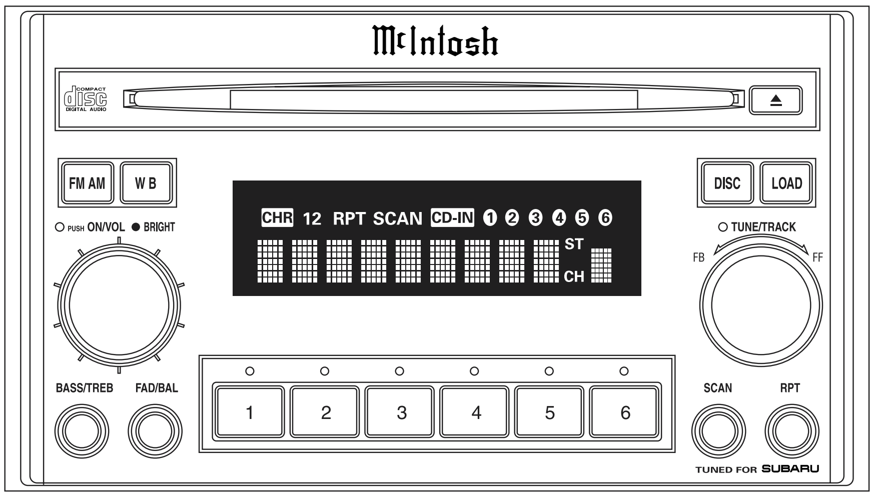


(1) Ignition switch
(2) Wiper deicer relay
(3) Wiper deicer switch
(4) Timer
(5) Wiper deicer

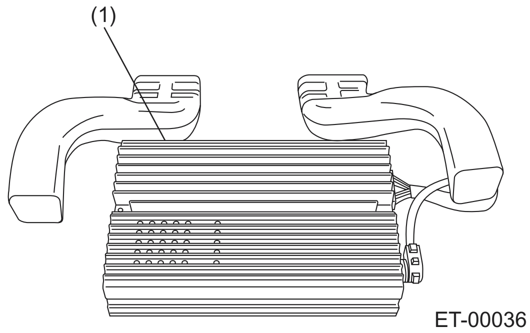
1. Audio System

A: DESCRIPTION

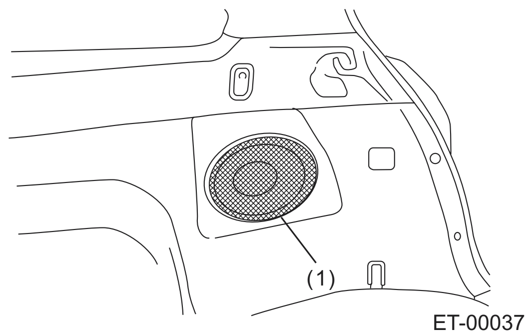
The McIntosh™ system consists of a head unit, a speaker amplifier, two tweeters, four mid-range speakers, and a woofer. The speaker amplifier is located below the front passengers seat and the woofer at the right rear quarter trim (wagon) or left rear shelf trim (sedan).
The output power handled by each of the four channels is 24W and that handled by the woofer is 60W. The total harmonic distortion of the system is as low as 0.05% which is comparable to that of high-class home-use audio systems.



ET-00038



(1) Speaker amplifier



(1) Woofer

Speakers

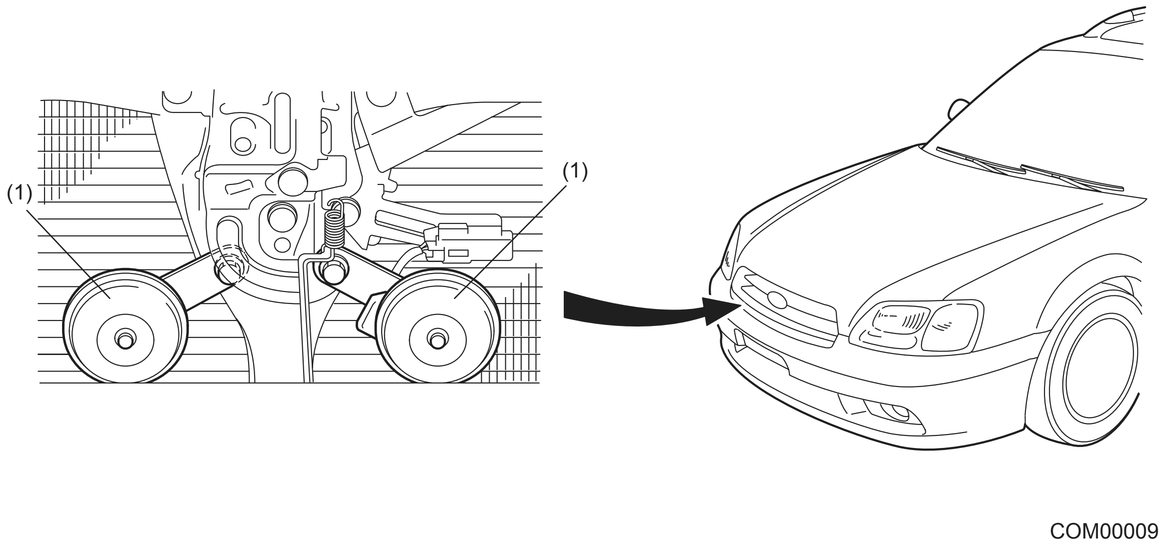
Type	Diameter	Number
Front tweeter	20 mm (0.8 in)	2
Front mid-range speaker	160 mm (6.3 in)	2
Rear mid-range speaker	160 mm (6.3 in)	2
Woofer (oval shaped)	152 mm (6 in) × 229 mm (9 in)	1

McIntosh: McIntosh is a registered trademark of McIntosh Laboratory, Inc.

MEMO

1. Horn

A: GENERAL



(1) Horn

Two horns (high and low tone) are installed in front of the radiator.

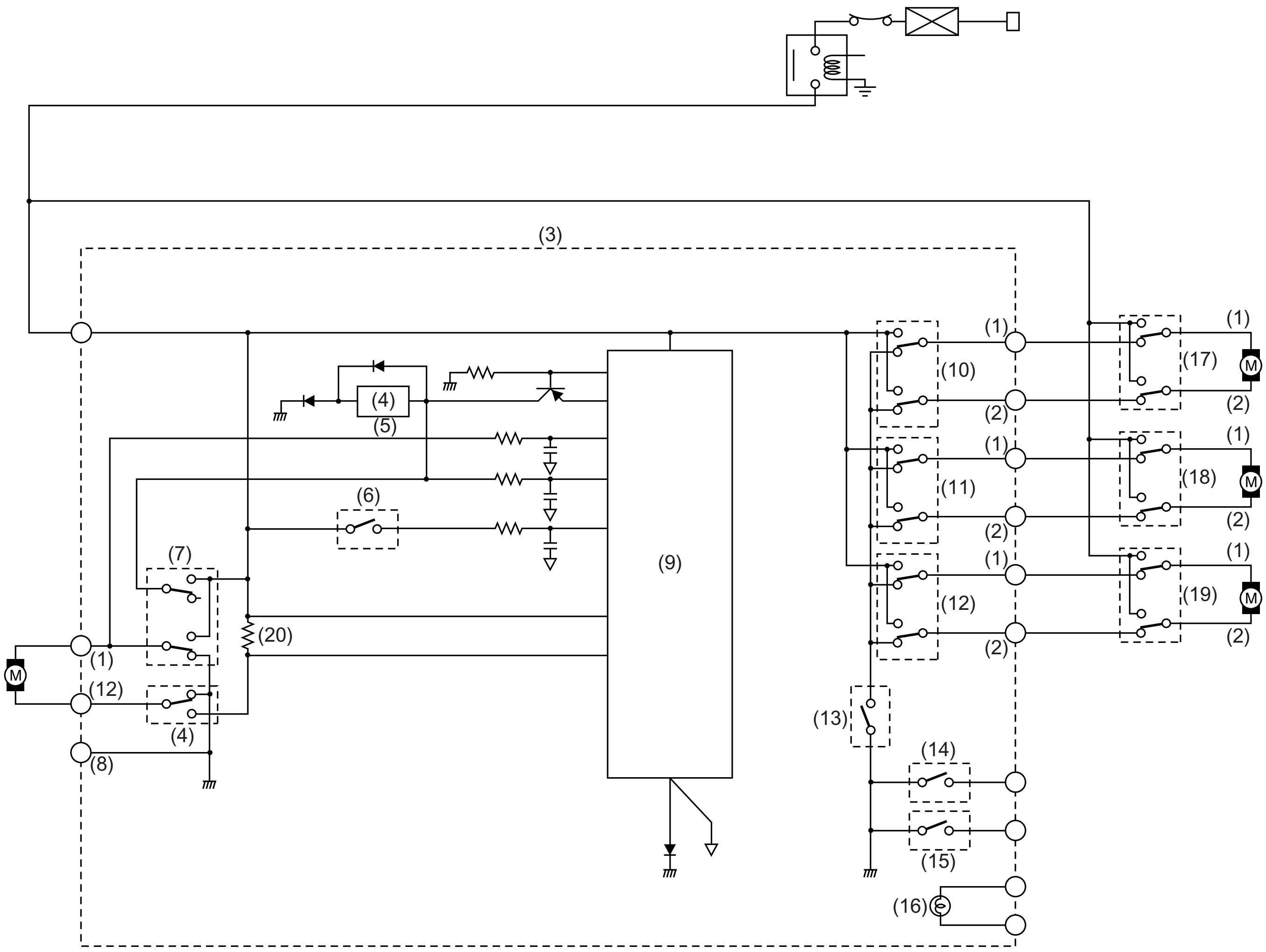
1. Power Window

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-00141

(1)	Raise	(11)	Rear left
(2)	Lower	(12)	Rear right
(3)	Power window main switch	(13)	Power window lock
(4)	Lowering relay	(14)	Unlock
(5)	Relay 1	(15)	Lock
(6)	Automatic lowering switch	(16)	Lamp 1
(7)	Switch 1	(17)	Passenger's switch
(8)	Ground	(18)	Rear left passenger's switch
(9)	Automatic circuit	(19)	Rear right passenger's switch
(10)	Passenger	(20)	Current detection resistor

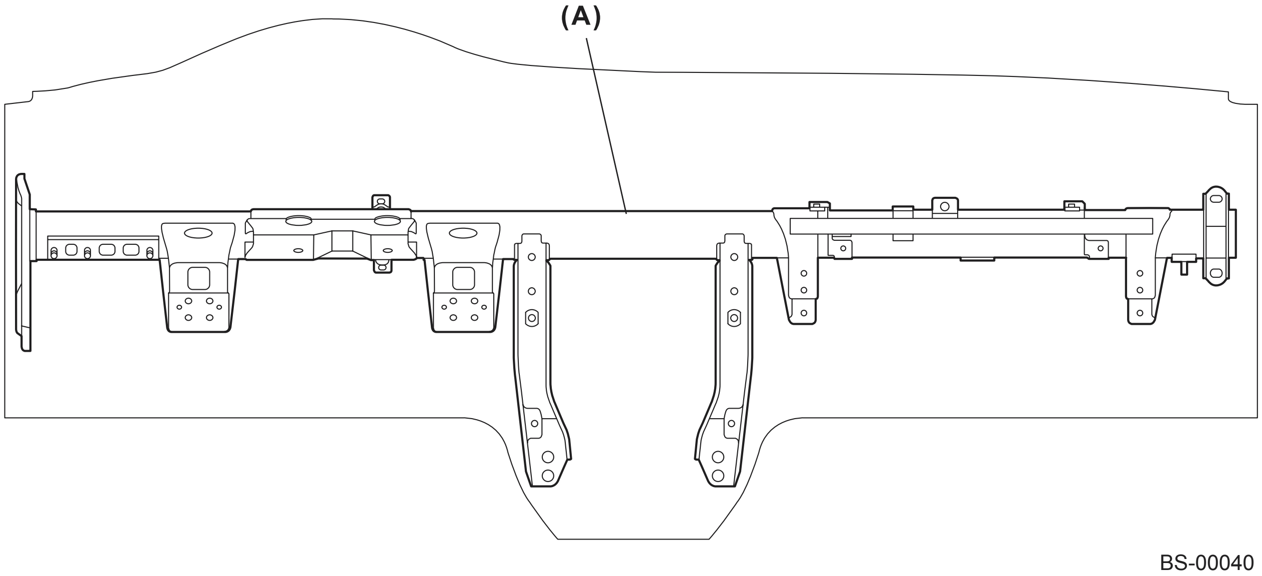
MEMO

1. General

- The Legacy's body structure is of a semi-monocoque design mainly consisting of press-formed steel sheets welded together.
- A combination of longitudinal frames and annulus frames arranged like a cage forms both a crushable zone that collapses in a controlled manner in the event of a collision (thus absorbing the impact force) and a rigid cabin that is highly resistant to deformation stresses (thus maintaining a survival space for the occupants).

2. Steering Support Beam

A steering support beam (A) is provided between the left and right front pillars for reinforced support of the steering column. It also minimizes vibration of the steering column and limits its extension to a minimum in the event of a collision.

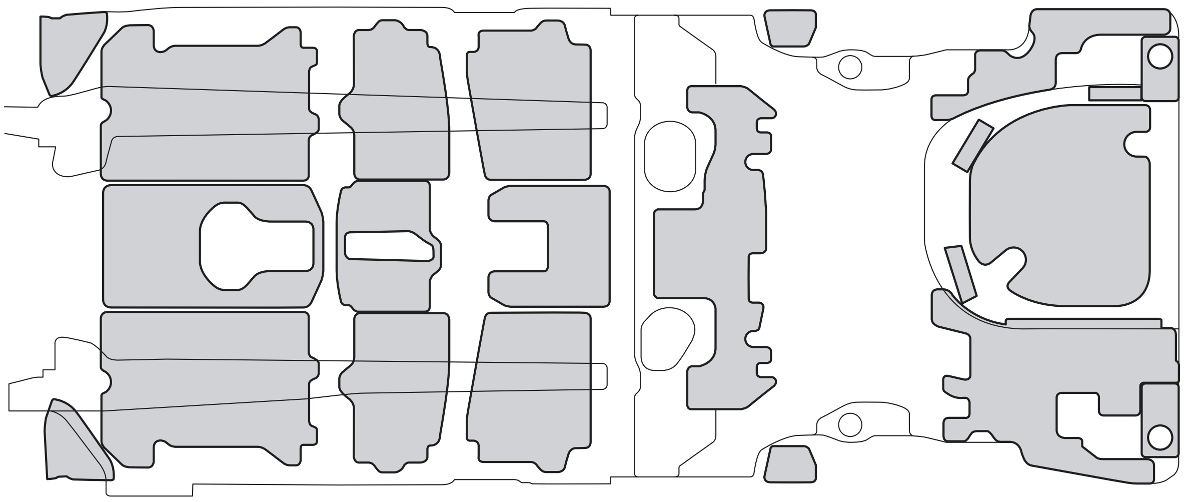


3. Quietness

Silencers, dual-wall panels, sound-absorbing materials, etc. are utilized in conjunction with a high-rigidity and vibration/noise-proof body structure in order to ensure quietness of the passenger compartment.

A: SILENCER

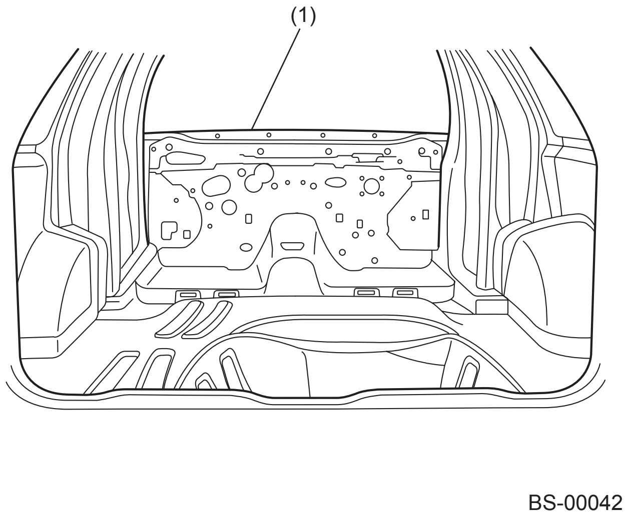
Silencers (= asphalt sheets) minimize transmission of noise/vibration into the passenger compartment.



BS-00041

B: DUAL-WALL TOEBOARD

The toeboard is a dual-wall design consisting of an asphalt sheet placed between two steel panels to reduce the transmission of noise and vibration from the engine compartment to the passenger compartment.



(1) Toeboard insulator

4. Body Sealing

A: SEALED PARTS

All gauge holes and other holes used during the body manufacturing process are plugged to prevent entry of water and dust.

Any time the vehicle body has been repaired, the affected holes should be properly plugged with the use of the specified plugs.

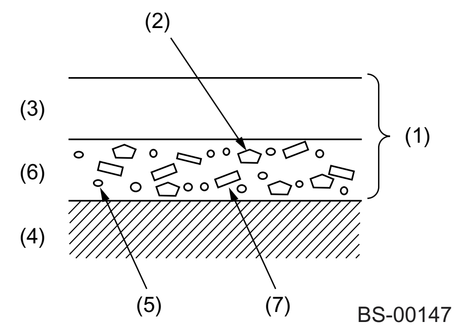
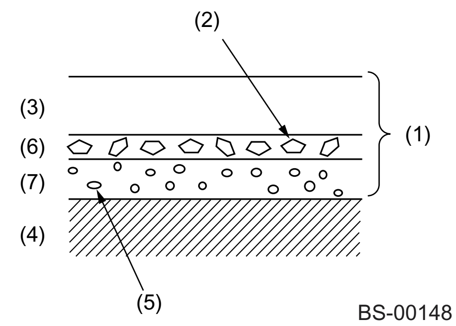
5. Painting

A: SPECIFICATION

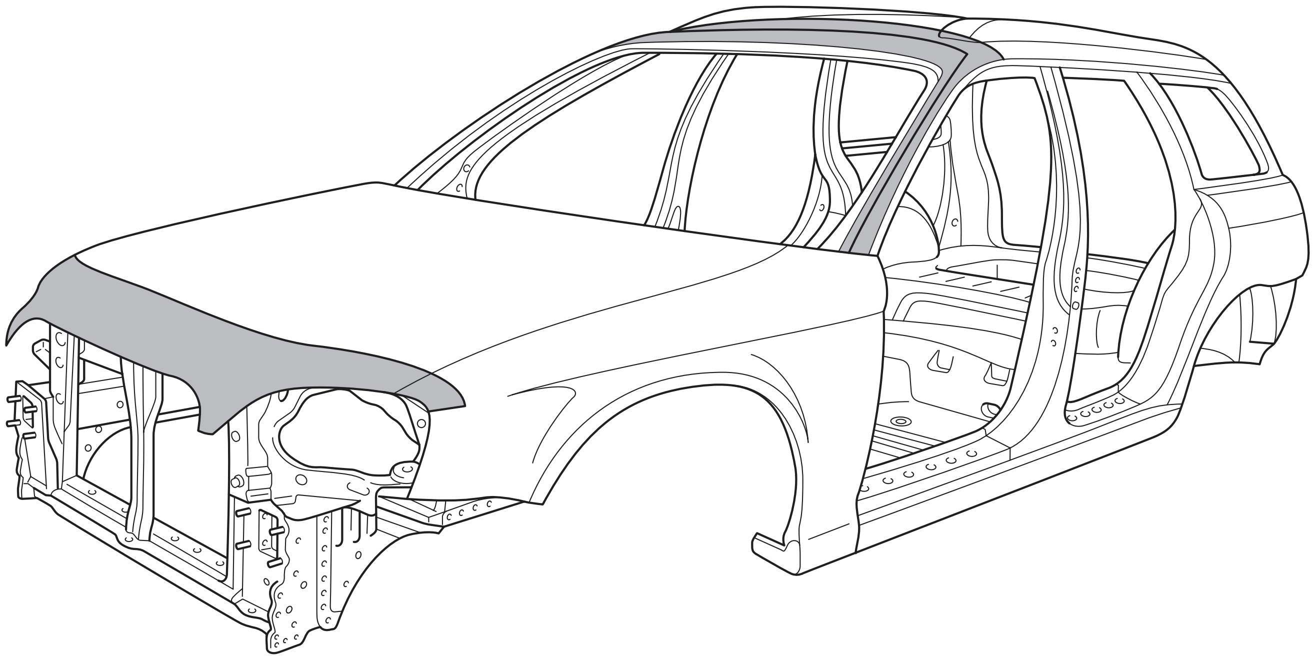
Color name	Color code
DARK GREEN MICA	83N
WARM GRAY OPAL	89N
BRIGHT SILVER (M)	19X
BLACK MICA	54A
DARK BLUE MICA	17X
YELLOWISH RED MICA	18X
GREENISH GRAY OPAL	19Y
★ DARK GREEN MICA / WARM GRAY OPAL	8K4 (83N/89N)
★ DARK BLUE MICA / WARM GRAY OPAL	1Y1 (17X/89N)
★ BLACK MICA / WARM GRAY OPAL	8Y7 (54A/89N)
★ YELLOWISH RED MICA / WARM GRAY OPAL	1Y2 (18X/89N)
★ GREENISH GRAY OPAL / WARM GRAY OPAL	1Y4 (19Y/89N)
★ WHITE PEARL MICA 2 (M) / WARM GRAY OPAL	0E8 (01X/89N)

(M): Metallic
★: 2-tone

B: PAINT FILM STRUCTURE

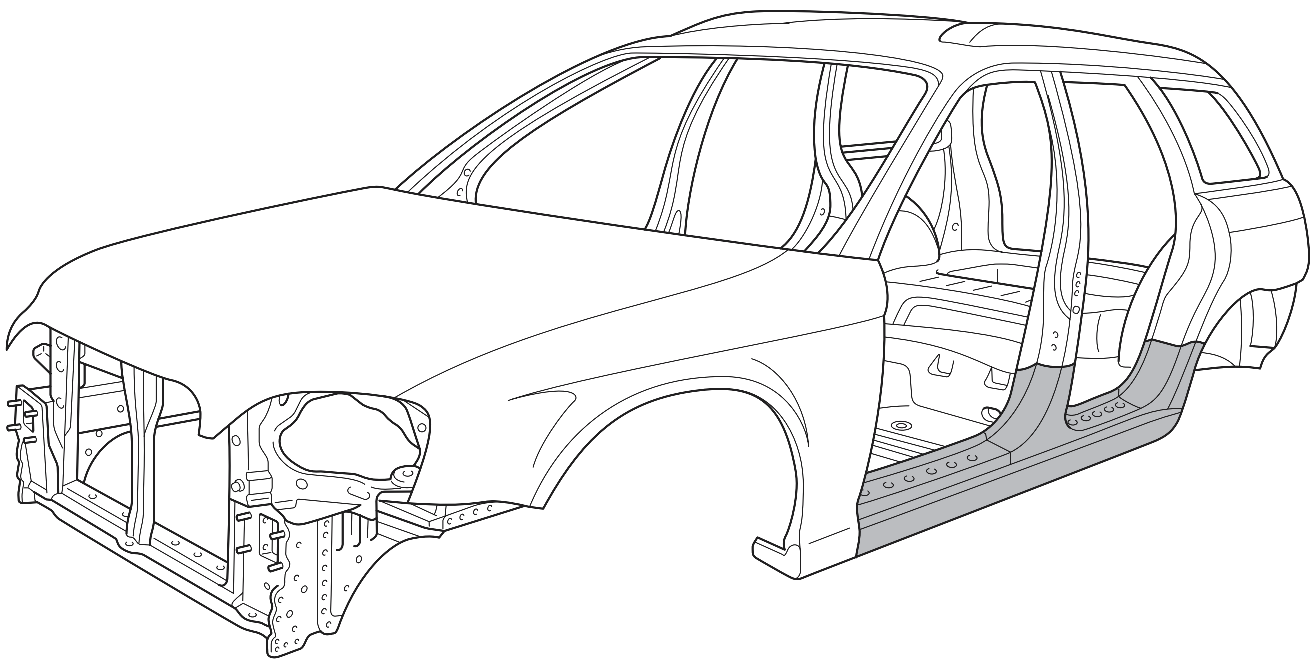
Color name	Paint film structire	
• DARK GREEN MICA • WARM GRAY OPAL • BRIGHT SILVER (M) • BLACK MICA • DARK BLUE MICA • YELLOWISH RED MICA • GREENISH GRAY OPAL (M): Metallic	 BS-00147	(1) Top coat (2) Colored mica (3) Clear coat (4) Primer surfacer (5) Pigment (6) Color base, mica base (7) Aluminum pigment
• WHITE PEARL MICA 2	 BS-00148	(1) Top coat (2) Colored mica (3) Clear coat (4) Primer surfacer (5) Pigment (6) Mica base (7) Color base

6. Anti Chipping Coat (ACC) Application



BS-00044

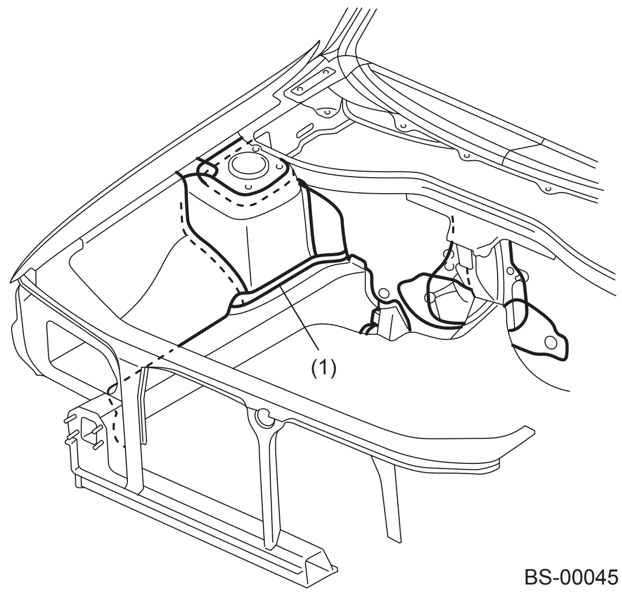
7. Stone Guard Coat (SGC) Application



BS-00149

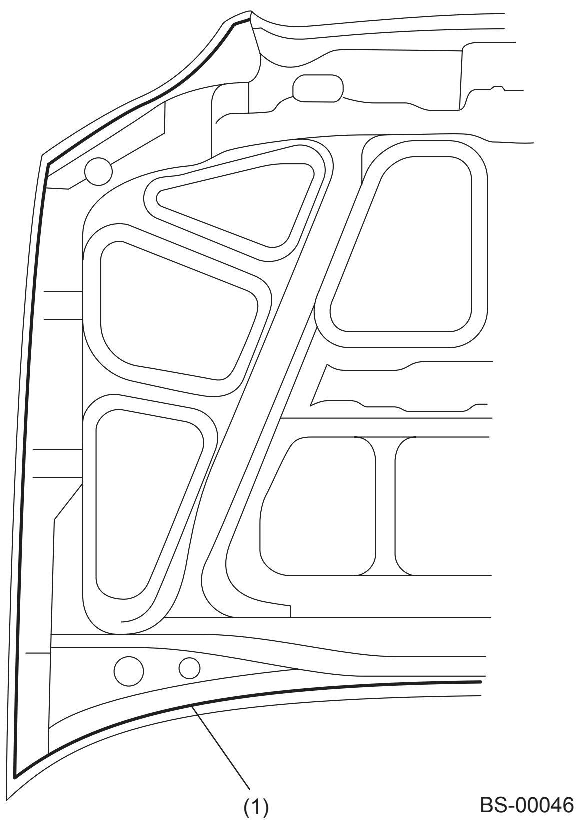
8. Sealer Application

A: ENGINE COMPARTMENT



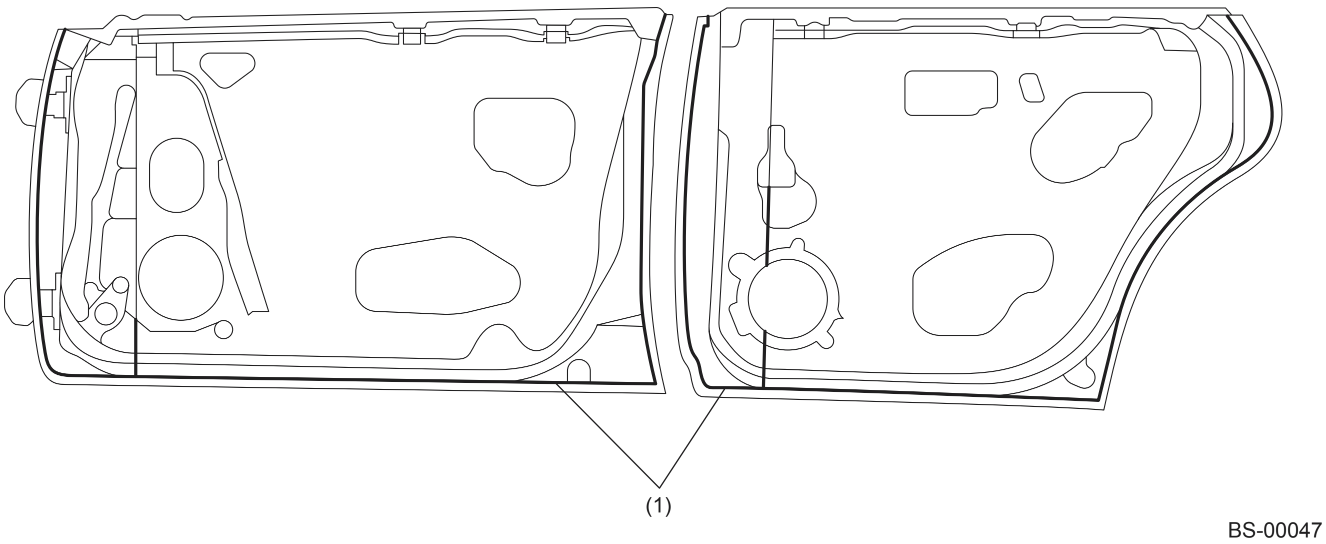
(1) Sealer

B: FRONT HOOD



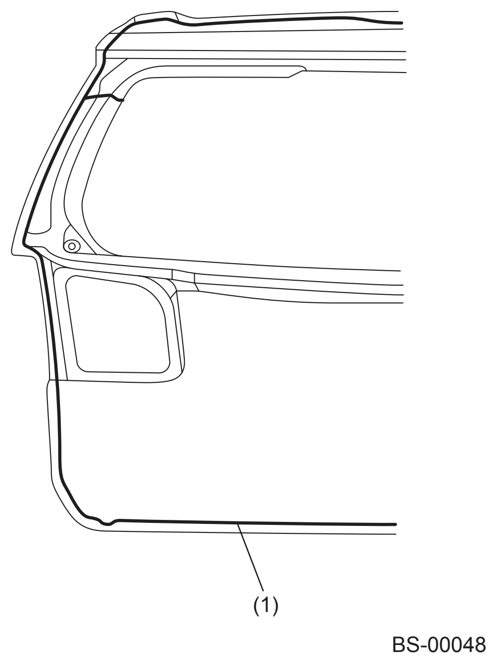
(1) Sealer

C: DOOR



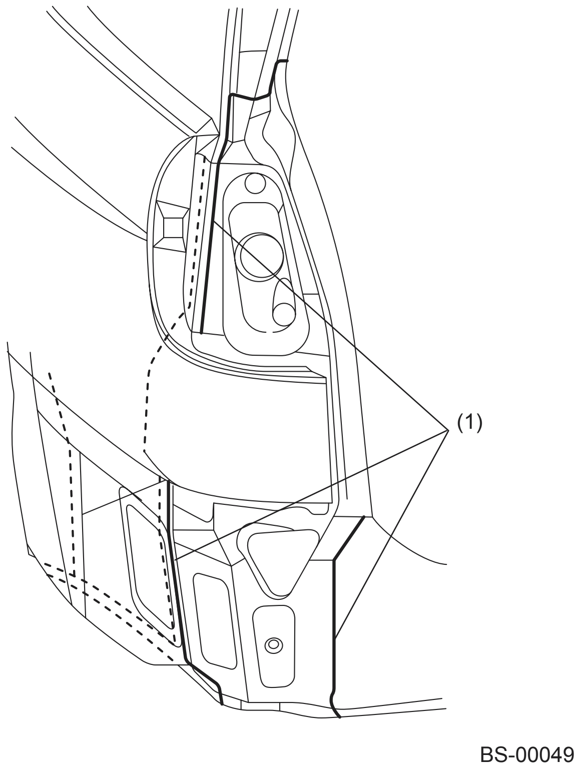
(1) Sealer

D: REAR GATE



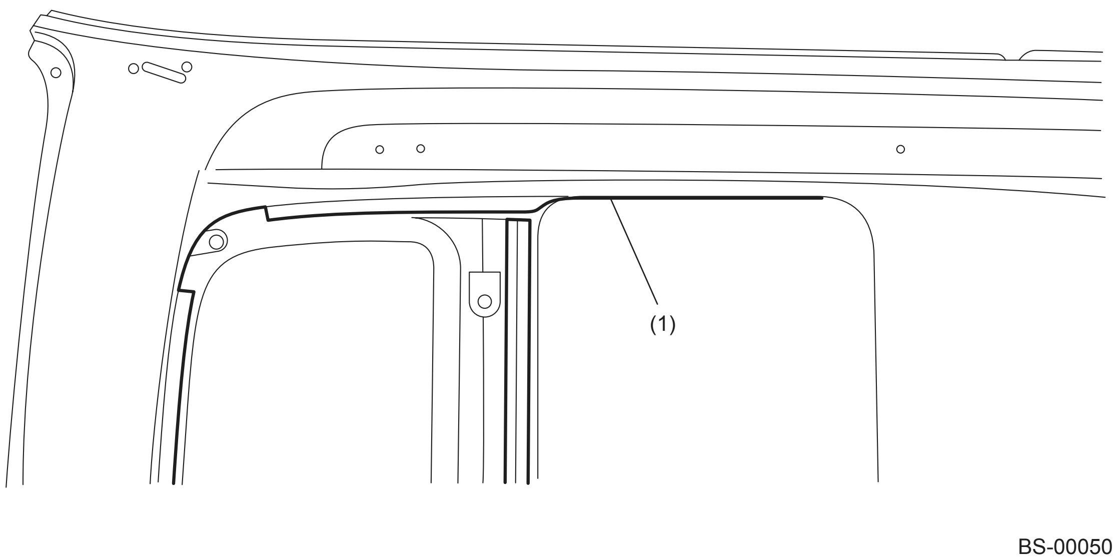
(1) Sealer

E: REAR END (WAGON)



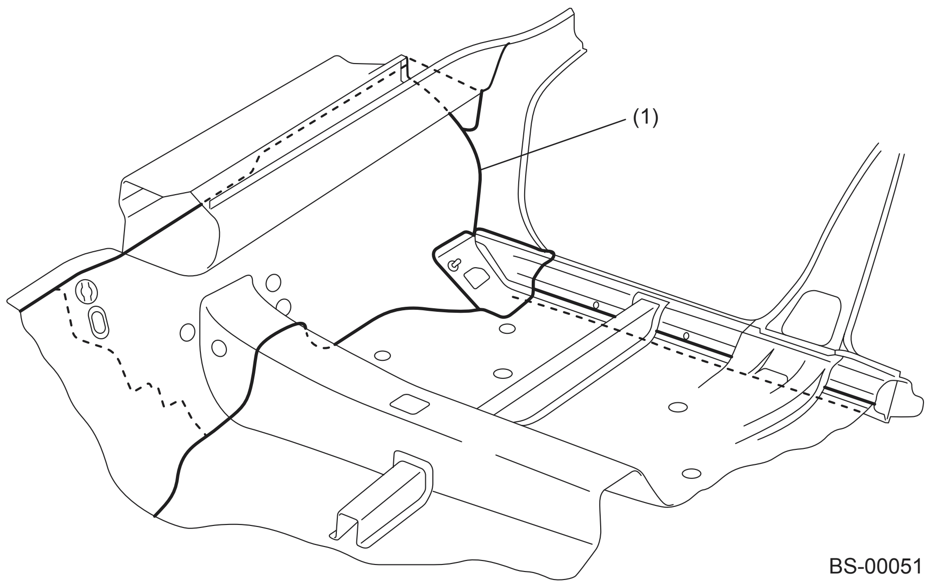
(1) Sealer

F: ROOF PANEL (SUN-ROOFED WAGON)



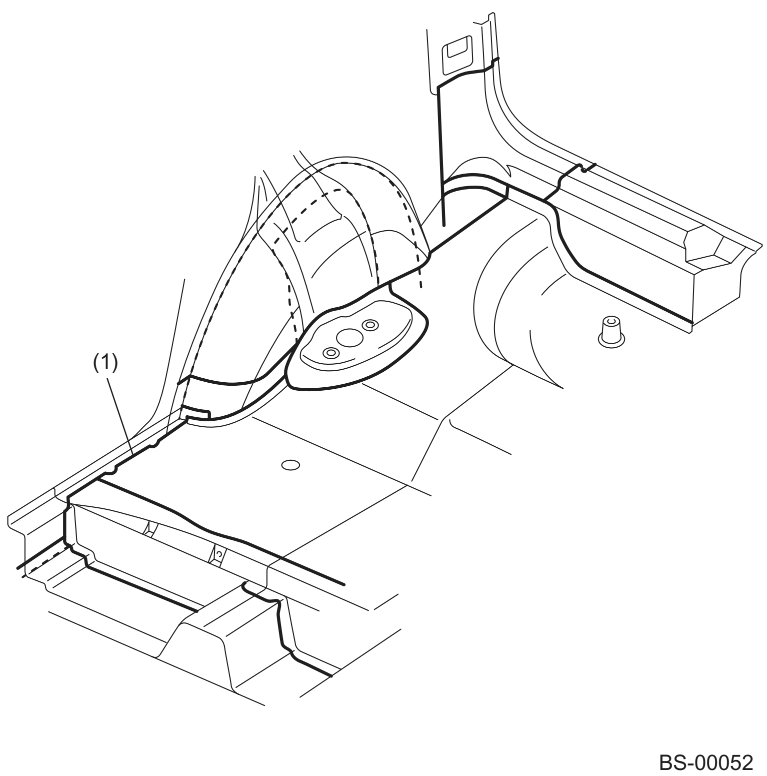
(1) Sealer

G: FRONT FLOOR



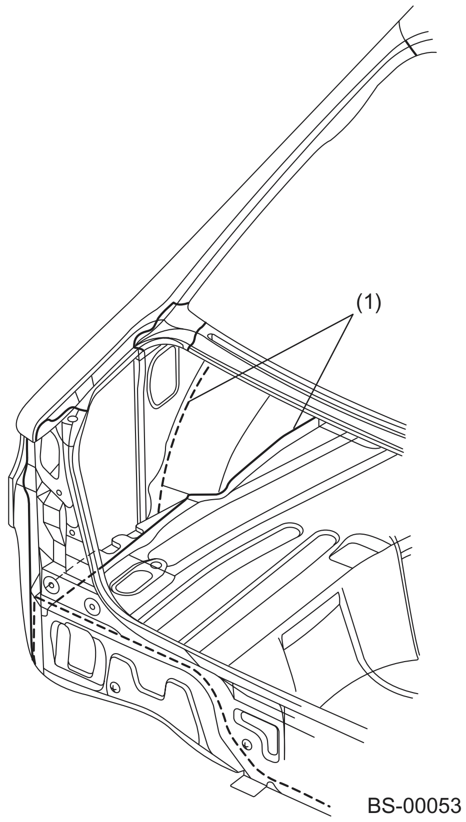
(1) Sealer

H: REAR FLOOR



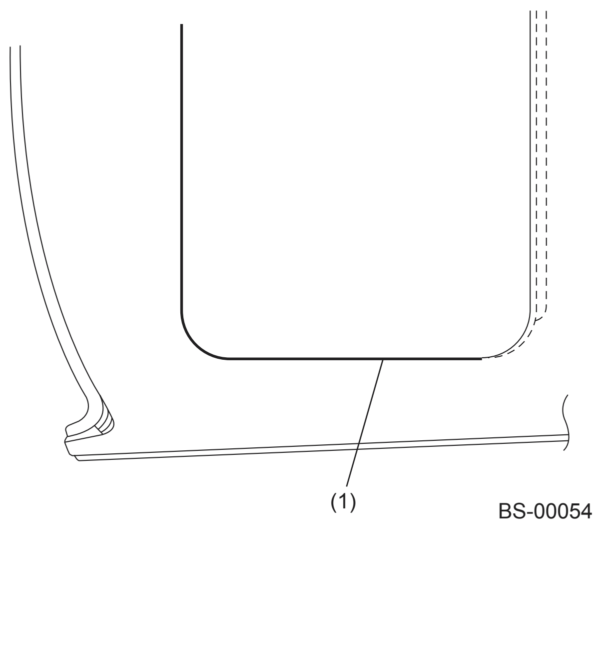
(1) Sealer

I: REAR END (SEDAN)



(1) Sealer

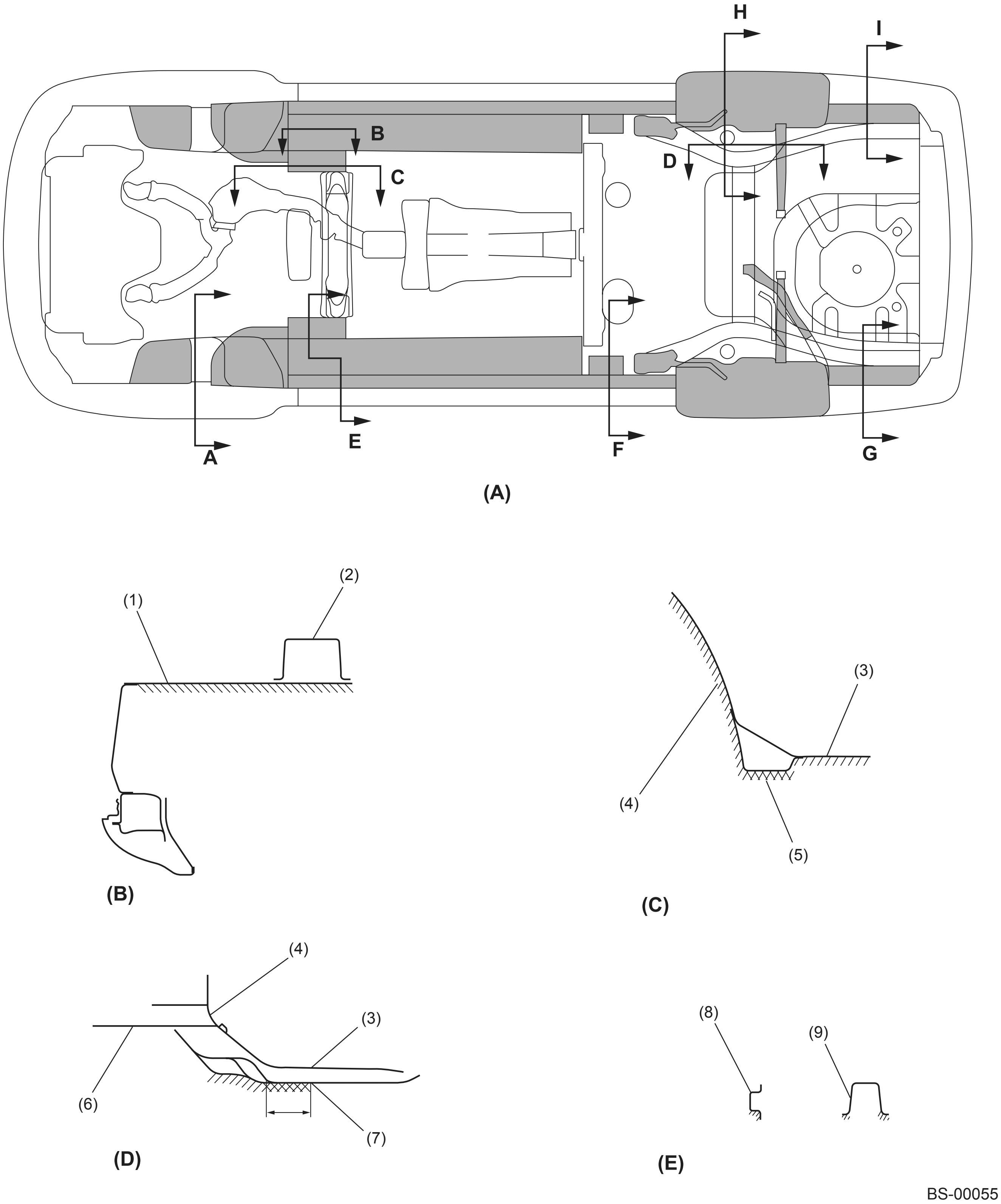
J: ROOF PANEL (SUN-ROOFED SEDAN)



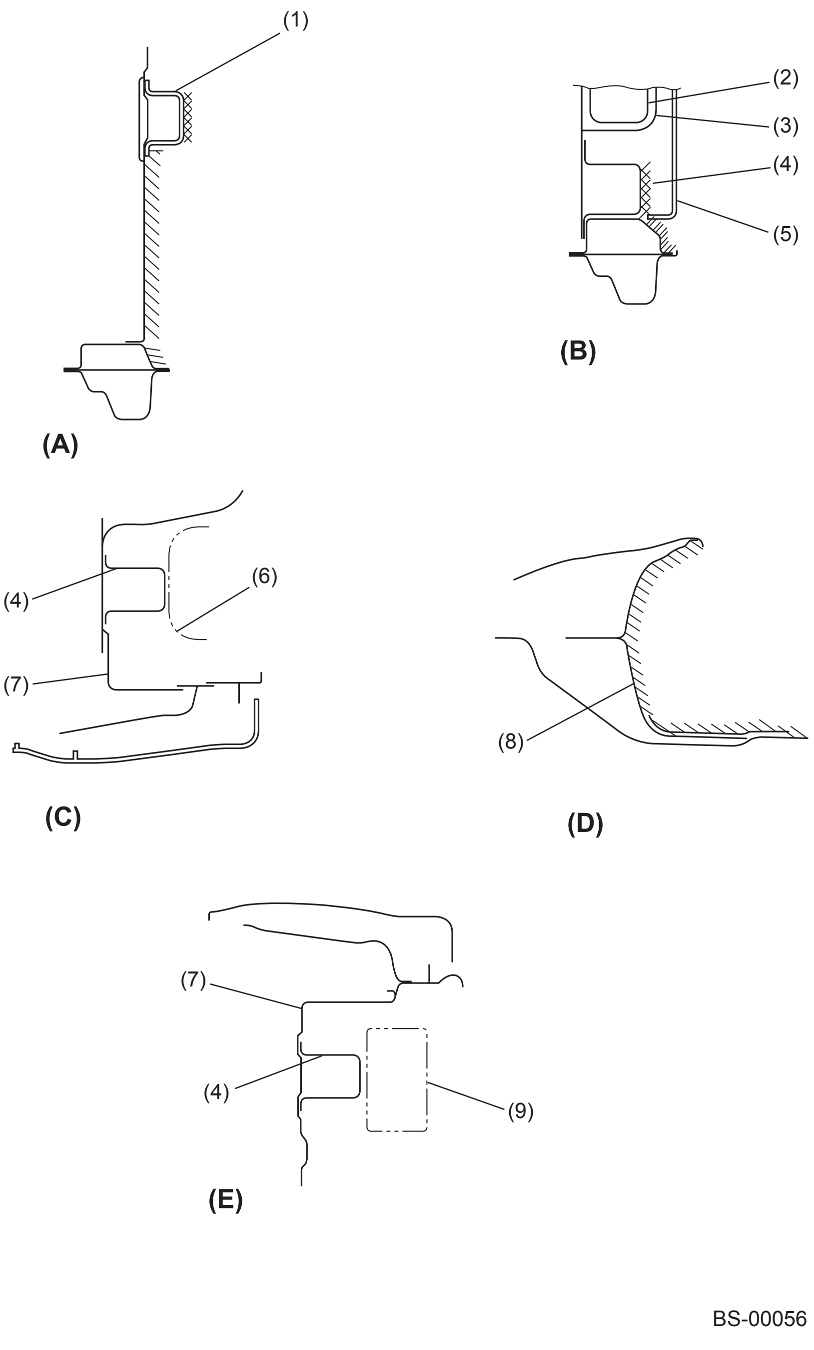
(1) Sealer

MEMO

9. Anti-rust Wax (Bitumen Wax) Application

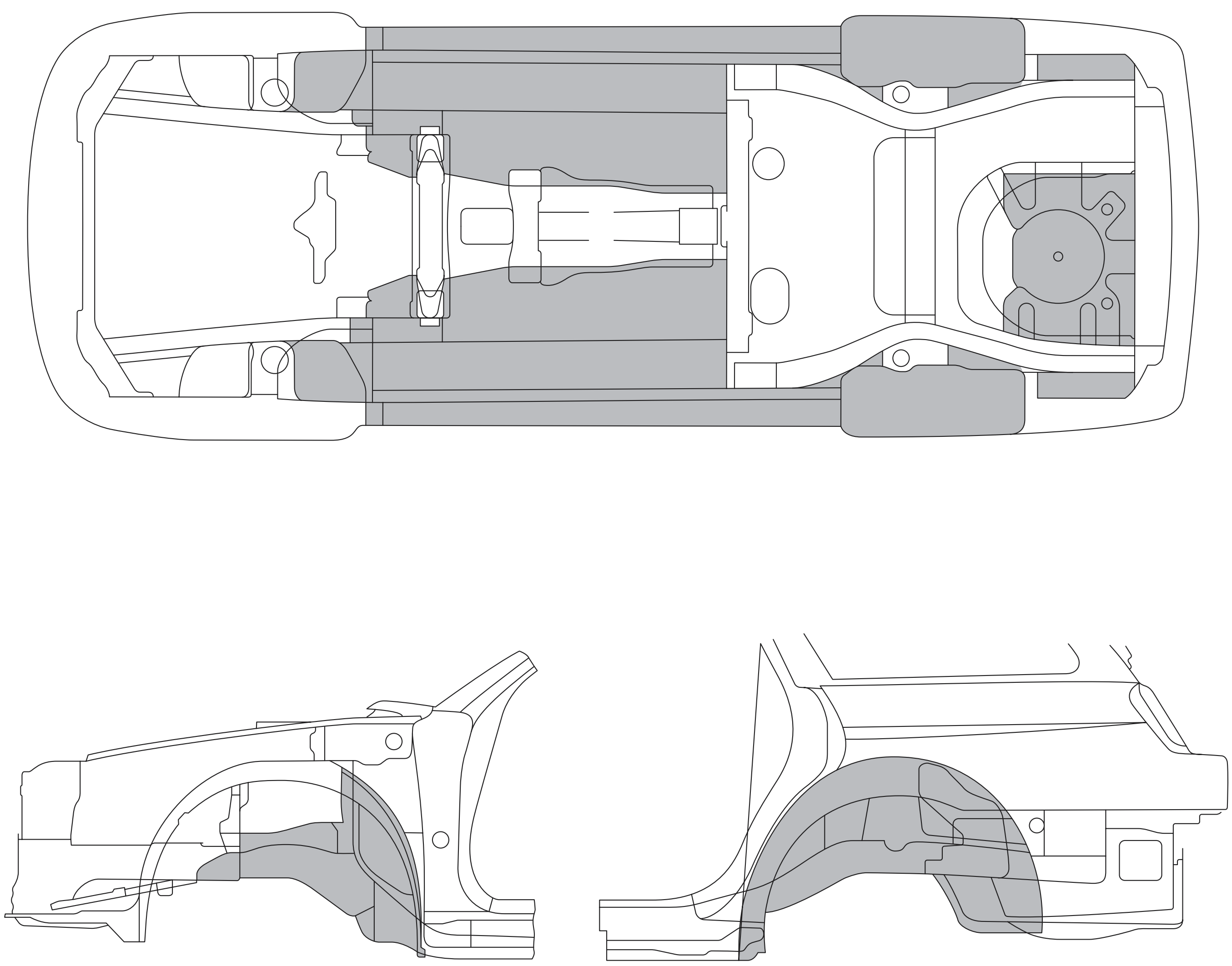


(1) Front suspension lower bracket
(2) Side frame
(3) Front floor pan
(4) Toeboard
(5) Toeboard lower reinforcement
(6) Front side frame
(7) Rear side frame
(8) Front right link assembly
(9) Rear right link assembly
(A) Body lower surface
(B) Section A
(C) Section B
(D) Section C
(E) Section D



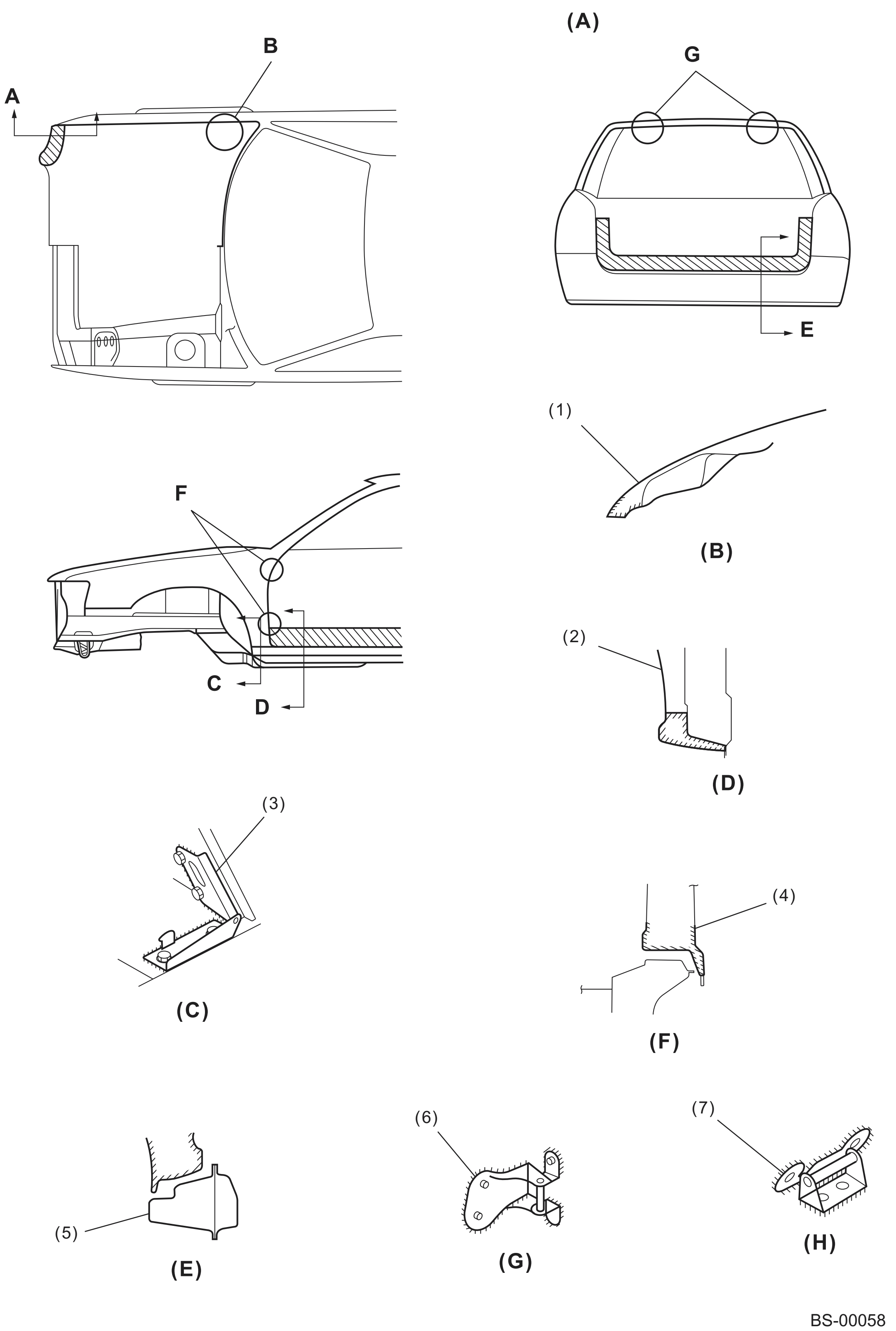
(1)	Side front frame	(6)	Muffler cover	**(A)**	Section E
(2)	Fuel tank	(7)	Rear floor side	**(B)**	Section F
(3)	Protector	(8)	Rear wheel apron	**(C)**	Section G
(4)	Rear floor side frame	(9)	Canister	**(D)**	Section H
(5)	Tank protector			**(E)**	Section I

10.Polyvinyl Chloride (PVC) Application

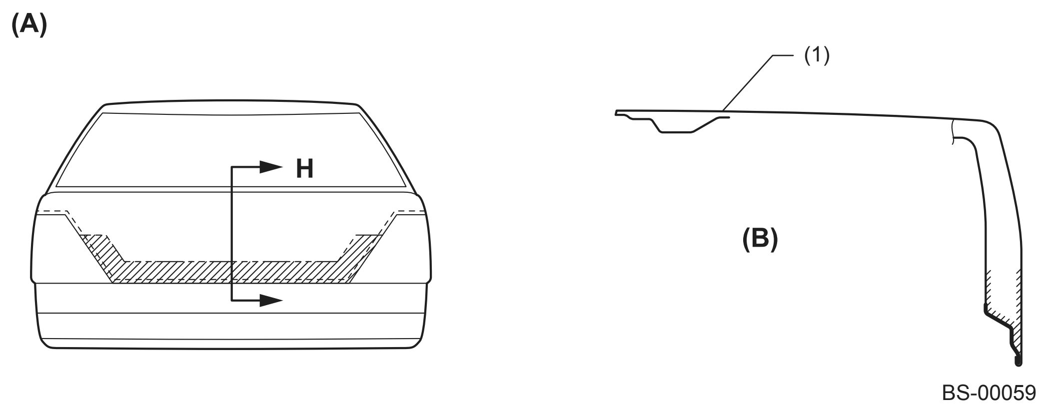


BS-00057

11.Hot Wax Application

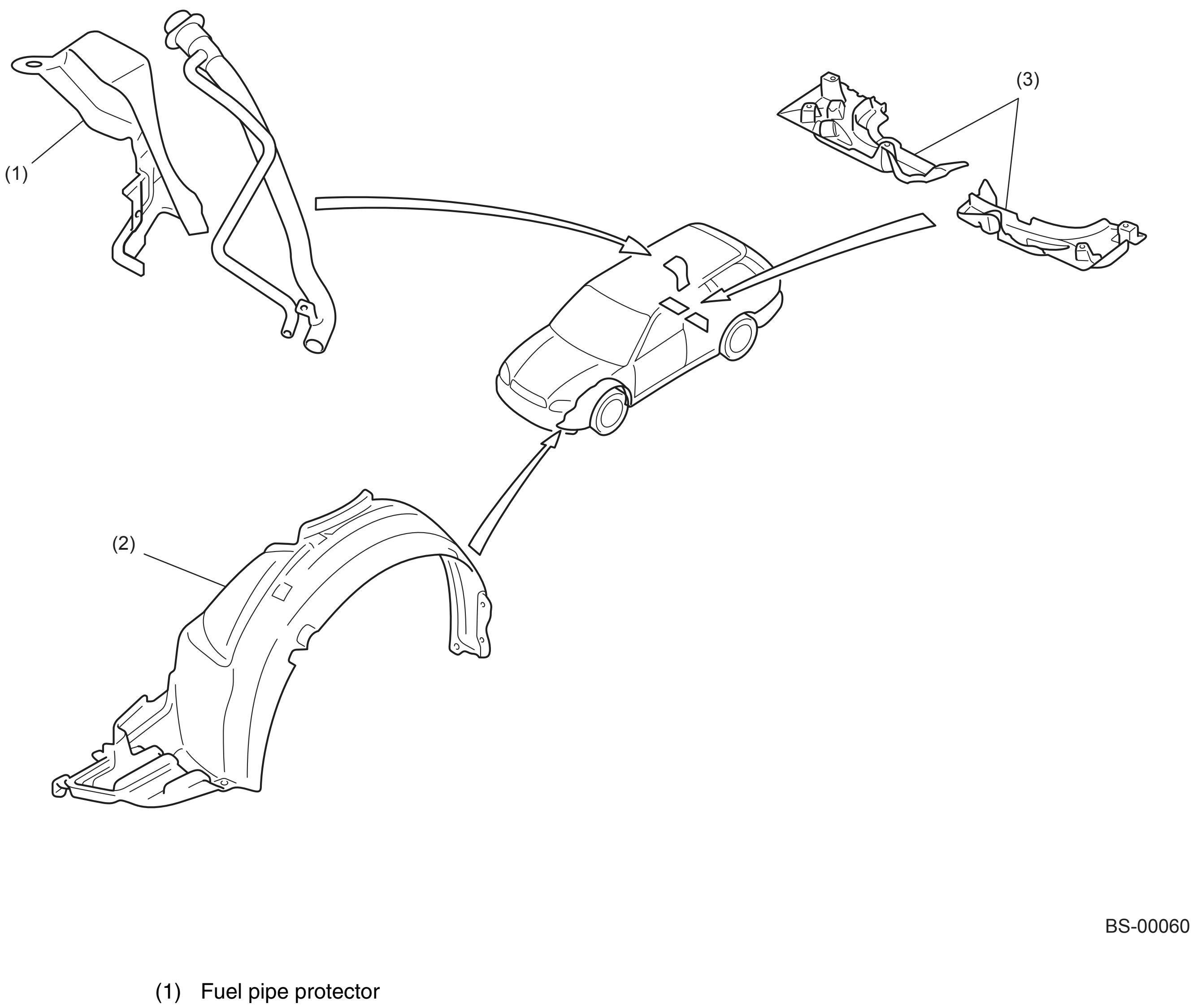


(1)	Front hood panel	(5)	Side sill	**(A)**	Wagon	**(E)**	Section D
(2)	Front fender panel	(6)	Front and rear door hinge	**(B)**	Section A	**(F)**	Section E
(3)	Front hood hinge	(7)	Rear gate hinge	**(C)**	View B	**(G)**	Section F
(4)	Rear gate outer panel			**(D)**	Section C	**(H)**	Section G



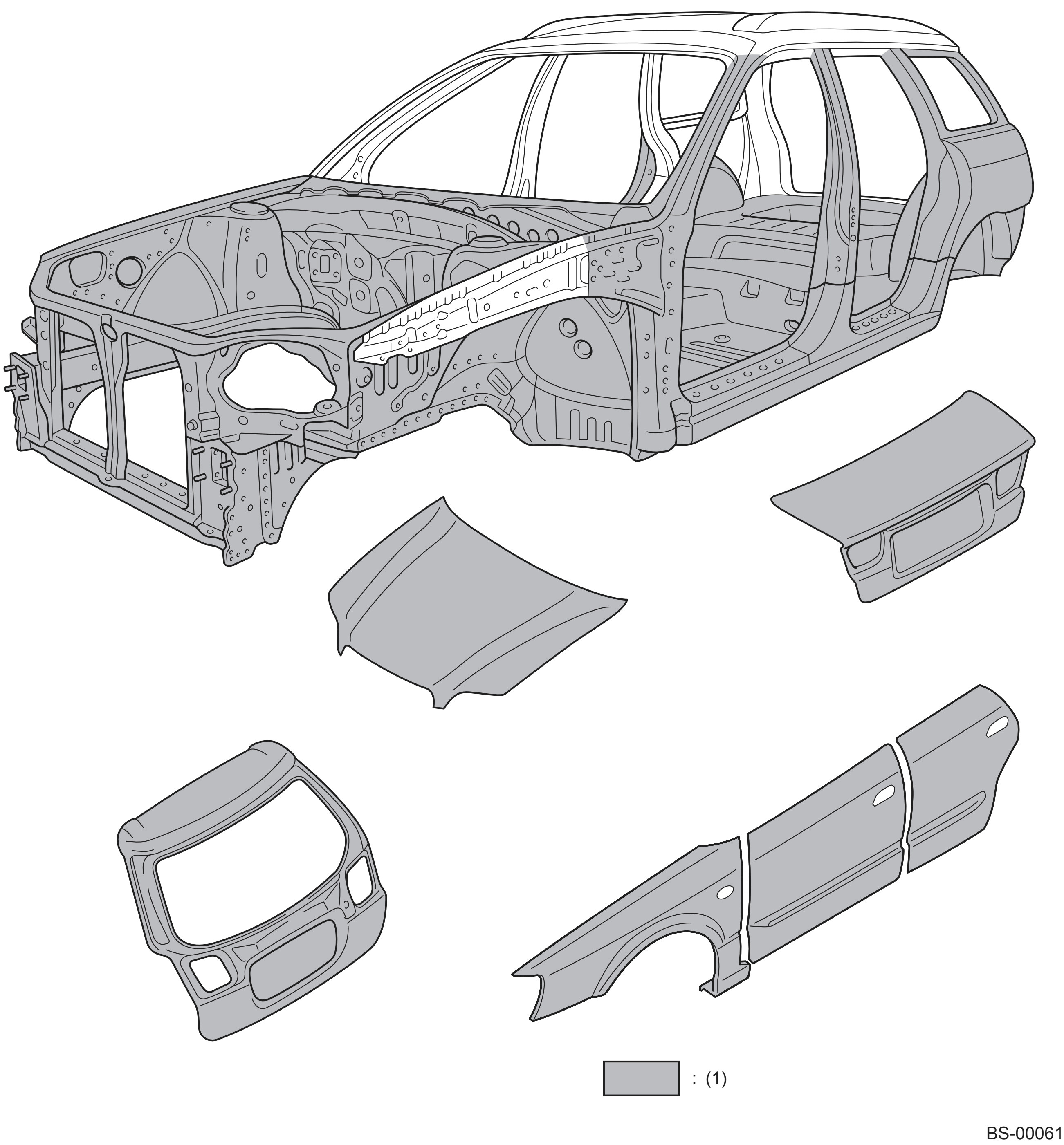
(1)	Trunk lid	**(A)**	Sedan
		(B)	Section H

12.Rustproof Parts



(1) Fuel pipe protector
(2) Front mud guard
(3) Fuel tank protector

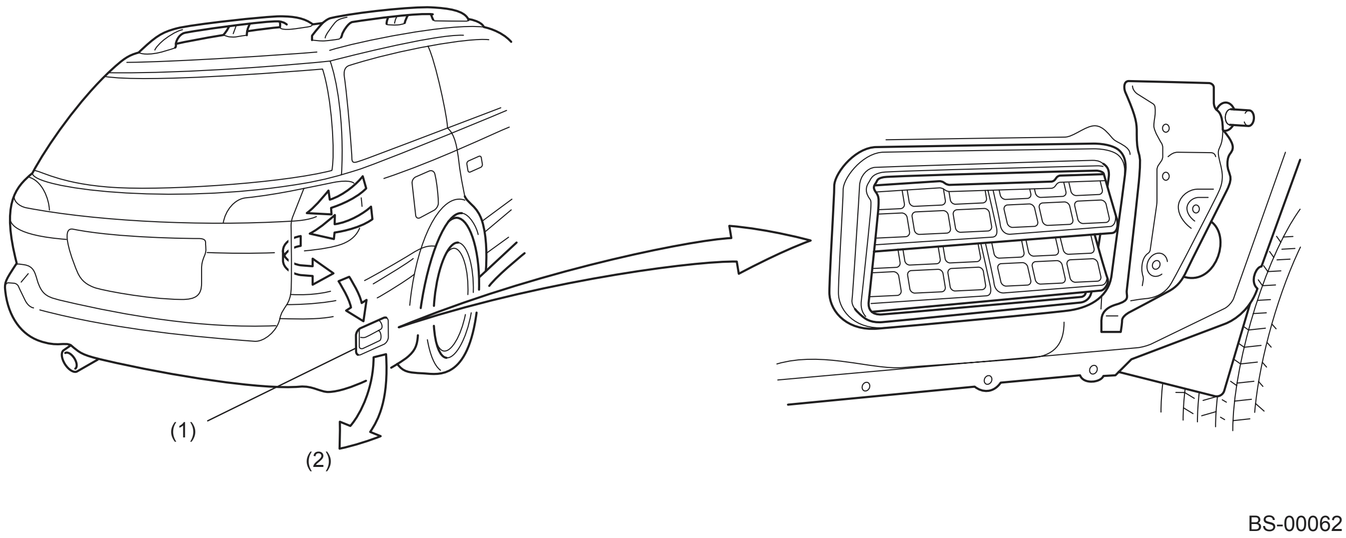
13.Galvanized Sheet Metal Parts



(1) Galvanized on both sides

14. Ventilation

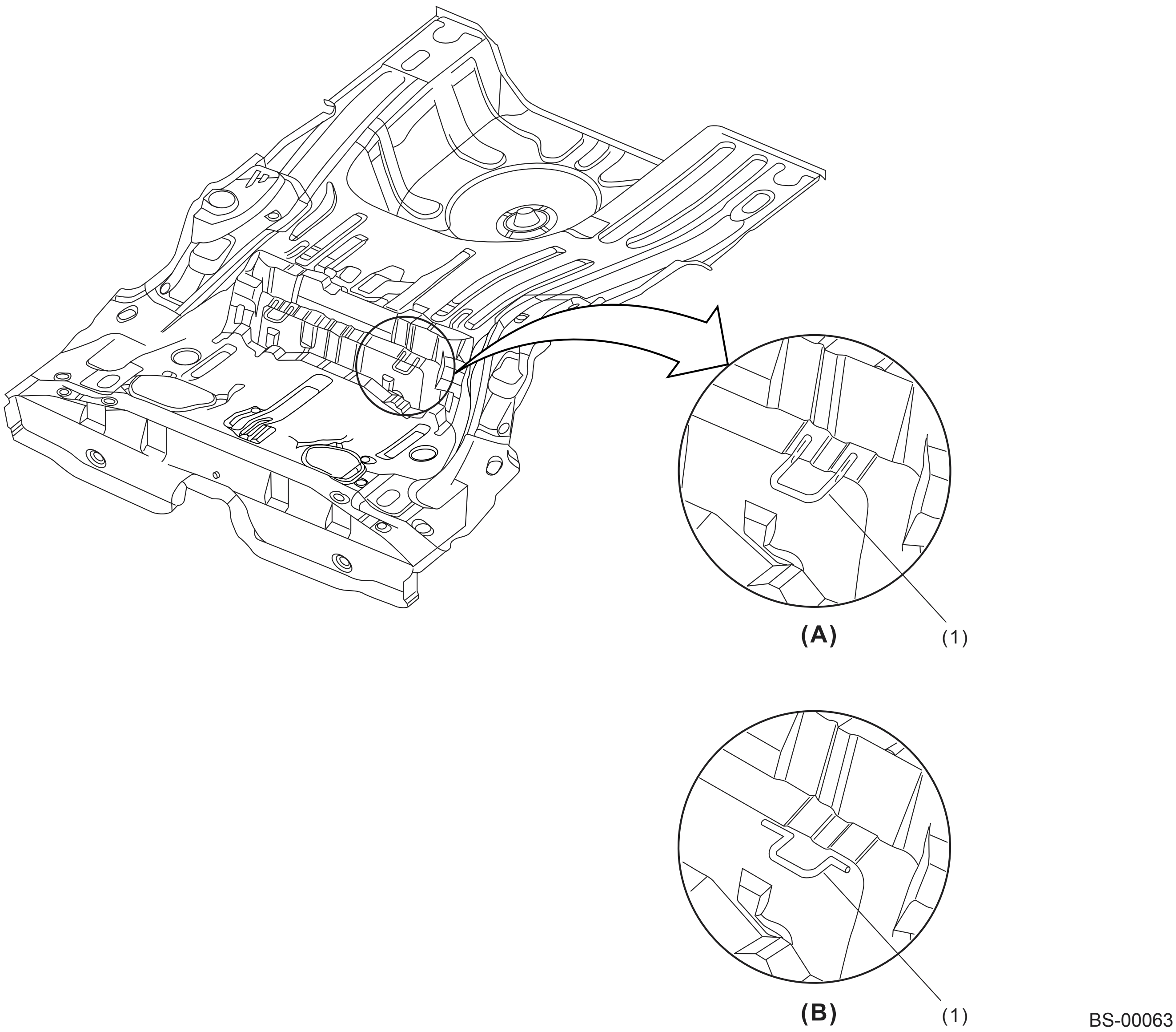
A: EXHAUST PORT



(1) Exhaust port
(2) Air flow

15.Child Seat Anchors

Two child seat anchors are added to the rear floor panel below both side seating positions of the rear seat in order to conform with the FMVSS225 (ISO-FIX) requirements for child restraint anchorage systems.

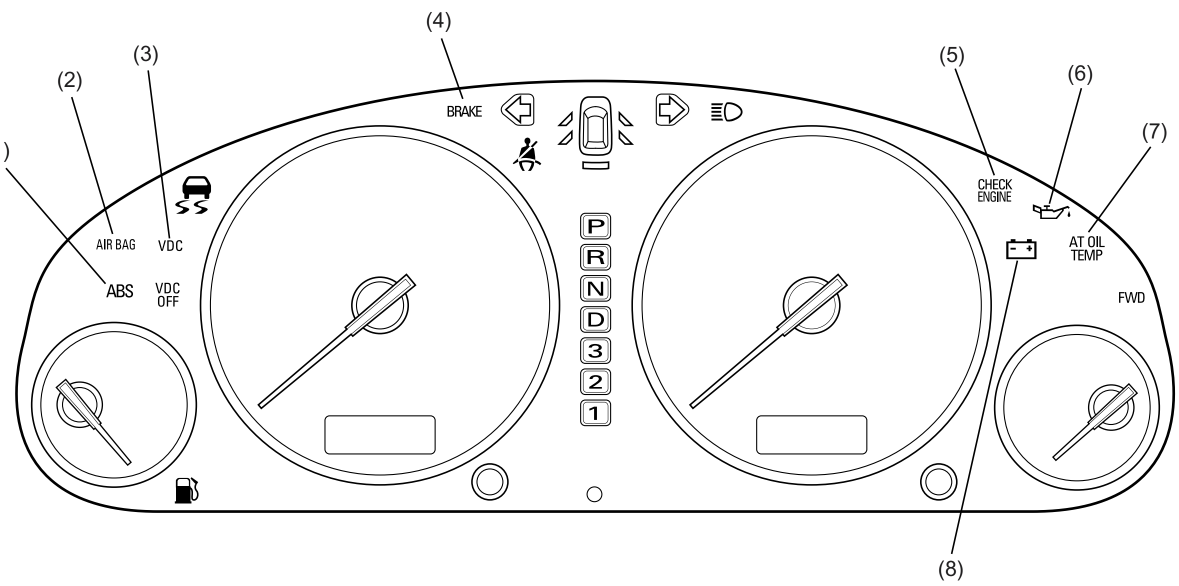


(A) Wagon
(B) Sedan
(1) Anchor

MEMO

1. Combination Meter

A: WARNING AND INDICATOR LIGHTS



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(1) ABS warning light
This warning light illuminates when a fault occurs in any electrical component of the ABS (Anti-lock Brake System).

(2) AIR BAG system warning light
This light illuminates when a fault occurs in the airbag system.

(3) VDC warning light
This light illuminates when a fault occurs in any electrical component of the VDC (Vehicle Dynamics Control).

(4) 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.

(5) CHECK ENGINE warning light
This light illuminates when a fault occurs in the MFI (Multiple point Fuel Injection) system.

(6) Oil pressure warning light
This light illuminates when the engine oil pressure decreases below 14.7 kPa (0.15 kgf/cm^2, 2.1 psi).

(7) AT oil temperature warning light
This warning light illuminates when the ATF temperature exceeds 150°C (302°F); it blinks when a fault occurs in the AT control system.

(8) Charge indicator light
This light illuminates when a fault occurs in the charging system while the engine is running.

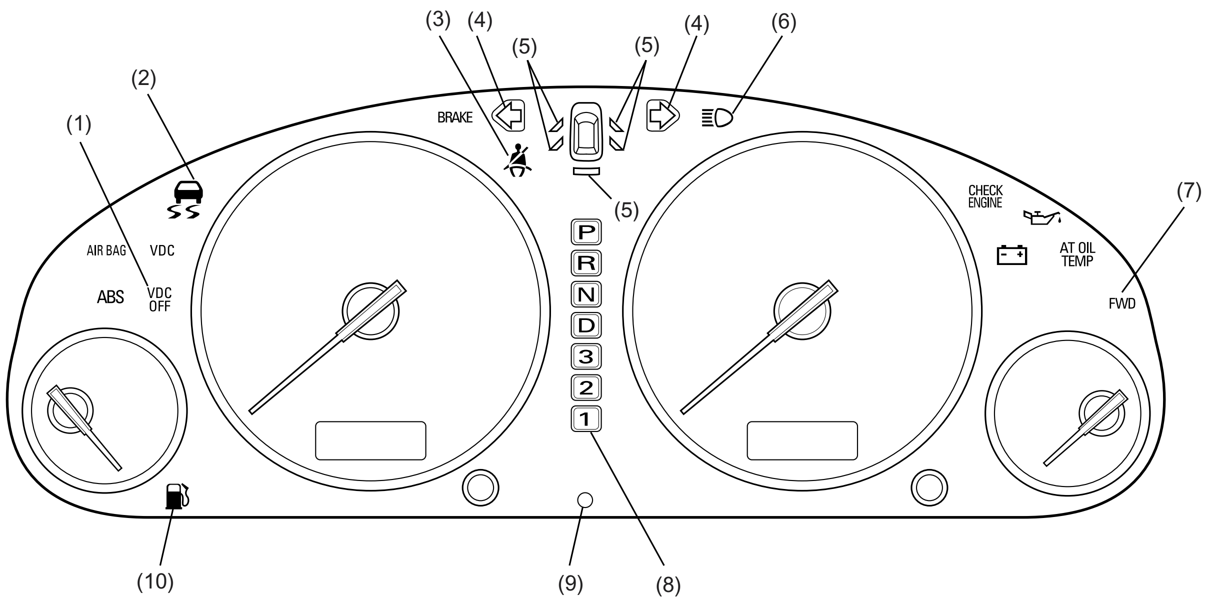
If everything is normal, the warning and indicator lights should be ON or OFF as shown below according to ignition switch positions.

Warning/Indicator light	Ignition switch position			
	LOCK/ACC	ON	ST	While engine is running
(1) ABS	OFF	*1	*1	*1
(2) AIR BAG	OFF	*2	*2	*2
(3) VDC	OFF	ON	ON	OFF
(4) Brake fluid level / parking brake	OFF	ON	ON	*3
(5) CHECK ENGINE	OFF	ON	ON	OFF
(6) Oil pressure	OFF	ON	ON	OFF
(7) AT oil temperature	OFF	ON	ON	OFF
(8) Charge	OFF	ON	ON	OFF

*1: This light stays ON for about 2 seconds, and then goes out.
*2: This light stays ON for about 6 seconds, and then goes out.
*3: This light comes ON when the parking brake is applied.

B: TELLTALE (GRAPHIC MONITOR)

VEHICLES WITHOUT SPORTS SHIFT



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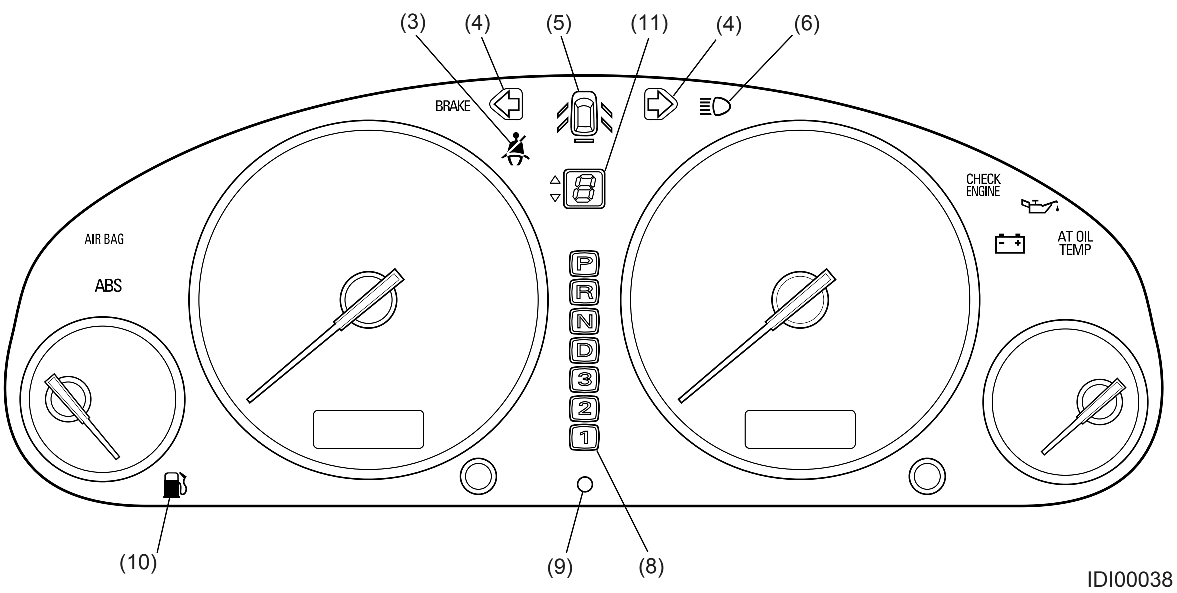
VEHICLES WITH SPORTS SHIFT



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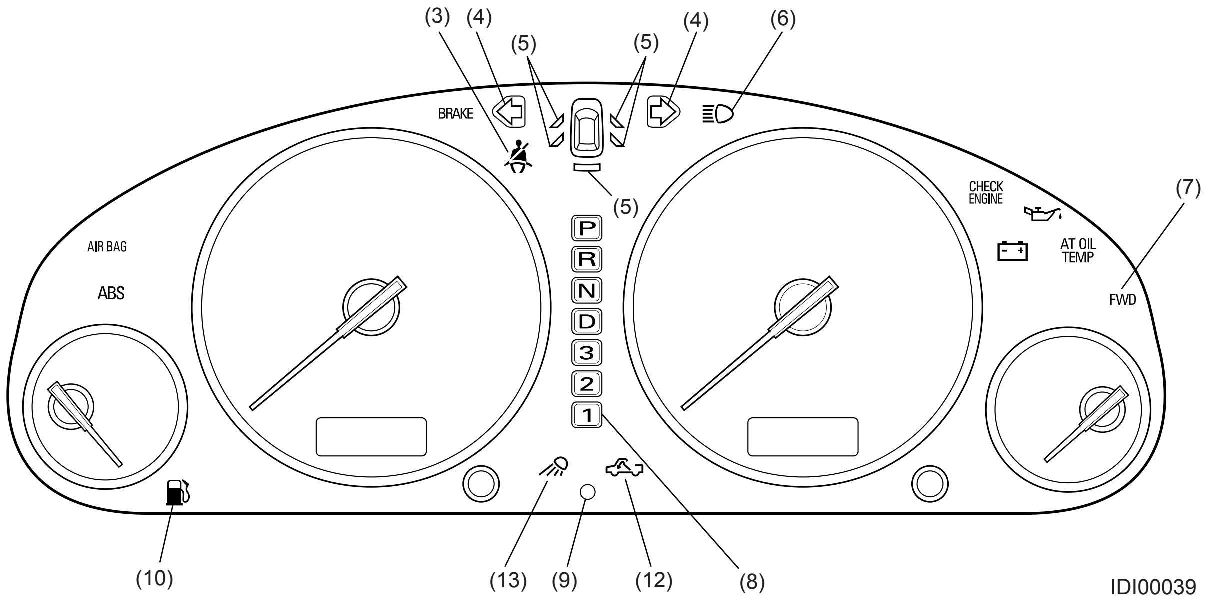
PICKUP VEHICLES



(1) VDC OFF indicator light
This light illuminates when the VDC or TCS is deactivated.

(2) VDC operation indicator light
This light flashes when the VDC system is operating. It also illuminates when the TCS is operating.

(3) Seat belt warning light
This light stays illuminated for about 6 seconds after the ignition switch has been 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) Door open warning light
This light illuminates when one or more doors and/or rear gate are not completely closed.

(6) Headlight beam indicator light
This light illuminates when the headlights are in the high-beam position.

(7) FWD indicator light
This light illuminates when the drive mode is changed from AWD to FWD (with the fuse installed in the FWD switch).

(8) AT selector lever 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.

(9) Security indicator light
This light illuminates when the security system is armed.

(10) Low fuel warning light
This light illuminates when the quantity of the fuel remaining in the tank has decreased to 10 ℓ (2.6 US gal, 2.2 imp gal) or smaller.

(11) Sports shift indicator
This indicator indicates the current gear position when the AT selector lever is moved from the automatic mode (D range) to the sports shift mode and causes the D range light to turn off.

(12) Switch back gate indicator light
This light illuminates when the switch back gate is opened while the ignition switch is in the ON position.Also, this light blinks for 20 seconds and then turns off when the switch back gate is opened while the ignition switch is in the OFF position.

(13) Cargo light indicator light
This light illuminates when the cargo light switch is turned ON.

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) VDC OFF		OFF	ON	ON	*1
(2) VDC operation		OFF	*2	ON	OFF
(3) Seat belt		OFF	*3	*3	*3
(4) Turn signal		*4	Blink	Blink	Blink
(5) Door or rear gate open	● Open	ON	ON	ON	ON
	● Closed	OFF	OFF	OFF	OFF
(6) Headlight beam	● High beam	OFF	ON	ON	ON
	● Low beam	OFF	OFF	OFF	OFF
(7) FWD	● FWD	OFF	ON	ON	ON
	● AWD	OFF	OFF	OFF	OFF
(8) AT selector lever position		OFF	ON	ON	ON
(9) Security		*5	OFF	OFF	OFF
(10) Low fuel		OFF	*6	*6	*6
(11) Sports shift indicator		OFF	OFF	OFF	*7
(12) Switch back gate		*8	*8	*8	*8
(13) Cargo light		*9	*9	*9	*9

*1: This light stays ON for about 4 seconds, and then goes out.
*2: This light stays ON for about 2 seconds, and then goes out.
*3: This light stays illuminated for about 6 seconds after the ignition switch has been turned ON.
*4: This light blinks when the hazard warning switch is turned ON.
*5: This light illuminates when the security system is armed.
*6: This light illuminates when quantity of the fuel remaining in the tank has decreased to 10 ℓ (2.6 US gal, 2.2 imp gal) or smaller.
*7: This light indicates the current gear position when the AT selector lever is moved from the D range to the sport shift mode.
*8: This light illuminates when the switch back gate is opened while the ignition switch is ON, and blinks for 20 second and then goes OFF when the switch back gate opened while the ignition switch is OFF.
*9: This light illuminates when the cargo light switch is turned ON.

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.

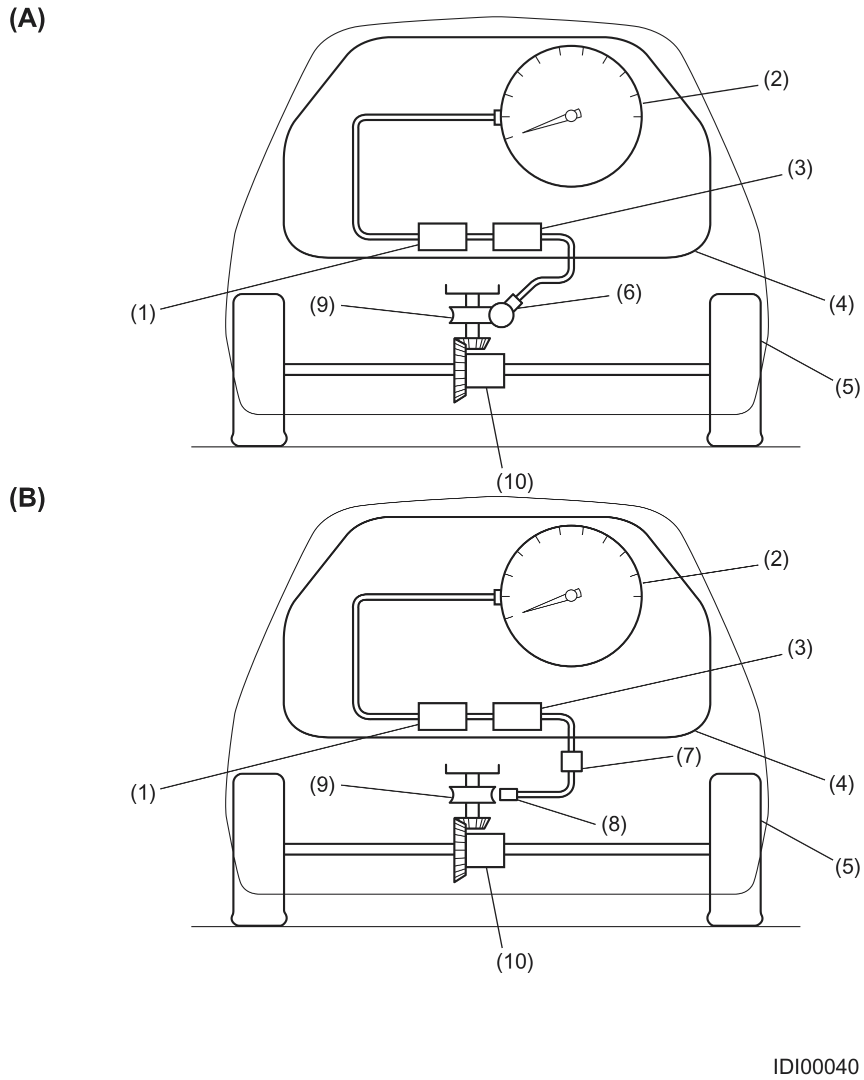
2. OPERATION

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 in the speedometer.

AT model: The TCM sends vehicle speed signals to the speedometer 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. SYSTEM DIAGRAM



(A) MT model
(B) AT model
(1) Speedometer movement
(2) Speedometer
(3) Speedometer drive circuit
(4) Combination meter
(5) Front wheel
(6) Speed sensor
(7) TCM
(8) Electromagnetic pick-up
(9) Gear for the speed sensor
(10) Differentials

4. SPECIFICATION

Speedometer	Type	Electric pulse type.
	Indication	Needle points to 60 km/h (37.3 miles) when 2,548 pulses are input per minute.

D: ODOMETER/TRIPMETER

1. DESCRIPTION

- The odometer and trip meter 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 sensors driven shaft) to the odometer/trip meter drive circuit in the speedometer.

AT model: The TCM sends vehicle speed signals to the odometer/trip meter drive circuit in the speedometer.

3. SPECIFICATION

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.)
Trip meter	Type	Pulse count type
	Display	LCD/4 digits; 0 to 999.9 and 1000 to 9999 km (mile).
	Indication	Counts up 1 km per 2,548 pulses (1 mile per 4,104 pulses). (To change the trip meter from A to B or B to A, push the knob momentarily. To return the trip meter to zero indication, keep the knob pushed for more than 1 second.

E: VEHICLE SPEED SENSOR

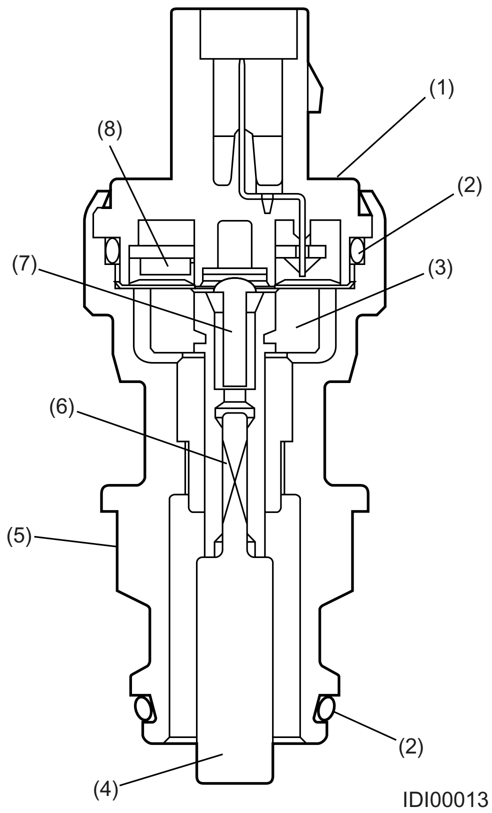
The vehicle speed sensor uses a Hall IC pick-up to generate speed signals. (MT model)

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.



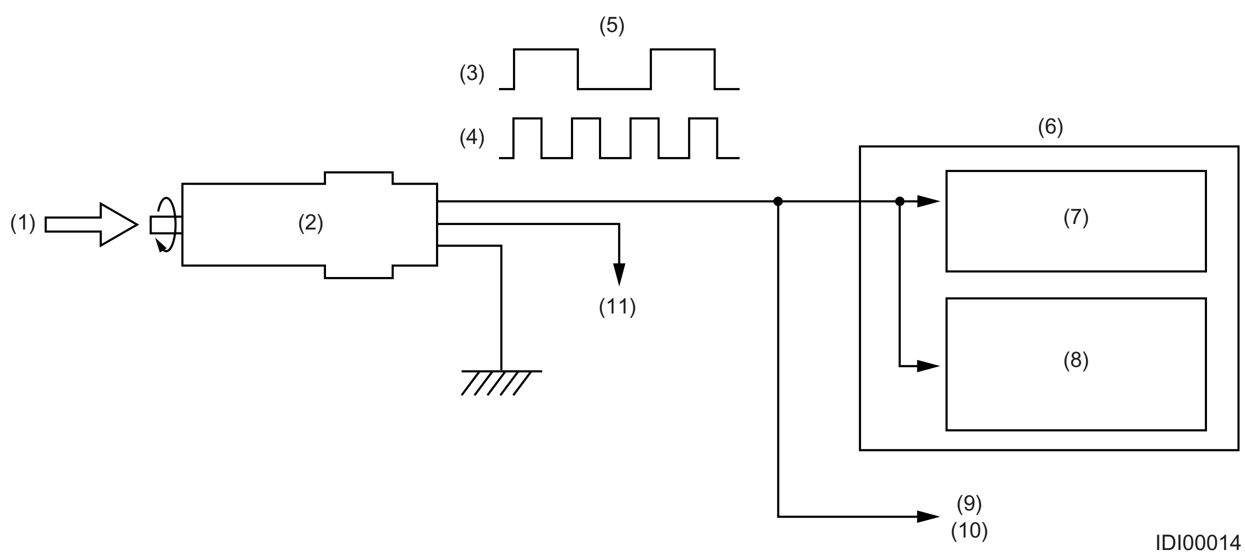
(1) Upper case
(2) O-ring
(3) Magnet ring
(4) Driven key
(5) Lower case
(6) Driven shaft
(7) Rivet
(8) Hall IC

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.



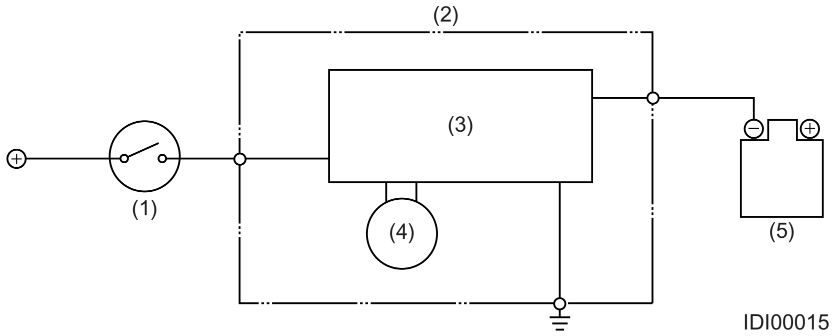
(1) Revolution of transmission output gear
(2) Vehicle speed sensor
(3) Low-speed
(4) High-speed
(5) Signal (4 pulses per revolution)
(6) Combination meter
(7) Speedometer drive circuit
(8) Odometer and trip meter drive circuit
(9) Engine control module
(10) Cruise control module
(11) Ignition switch

F: 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.

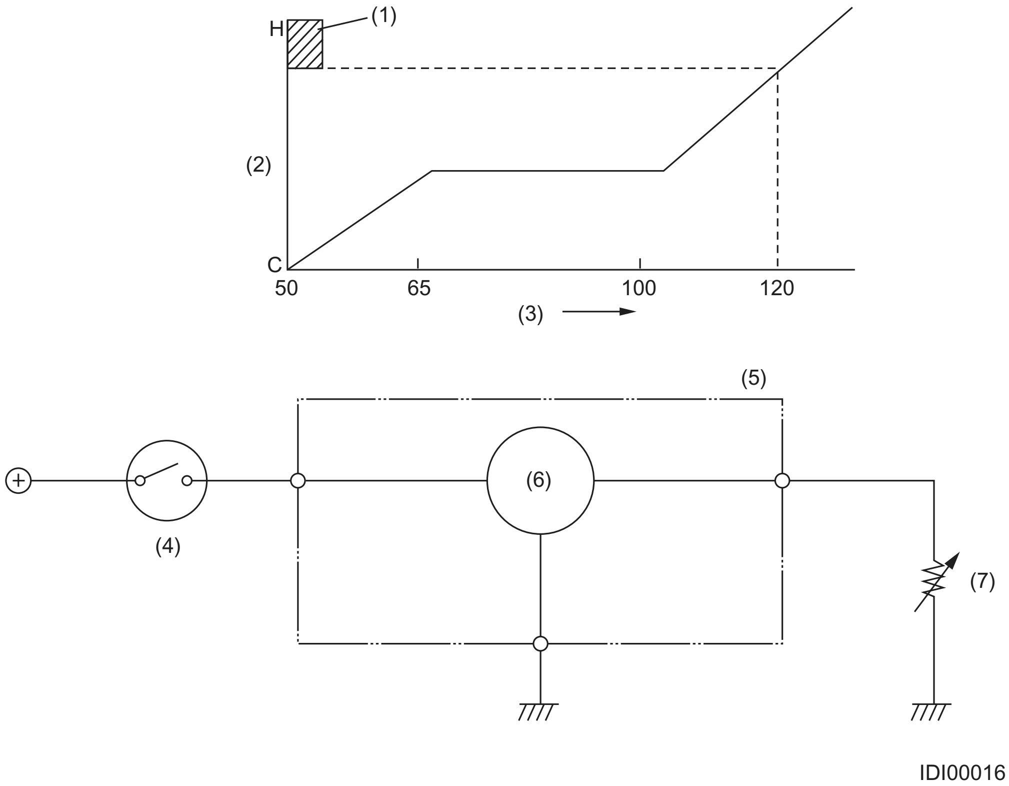
The tachometer needle then moves in accordance with change in the engine speed.



(1) Ignition switch
(2) Combination meter
(3) Tachometer drive circuit
(4) Tachometer
(5) ECM

G: WATER TEMPERATURE GAUGE

- The water temperature gauge is a cross-coil type.
- The water temperature signal is sent from the thermo gauge located on the engine.
- The resistance of the thermo gauge 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.

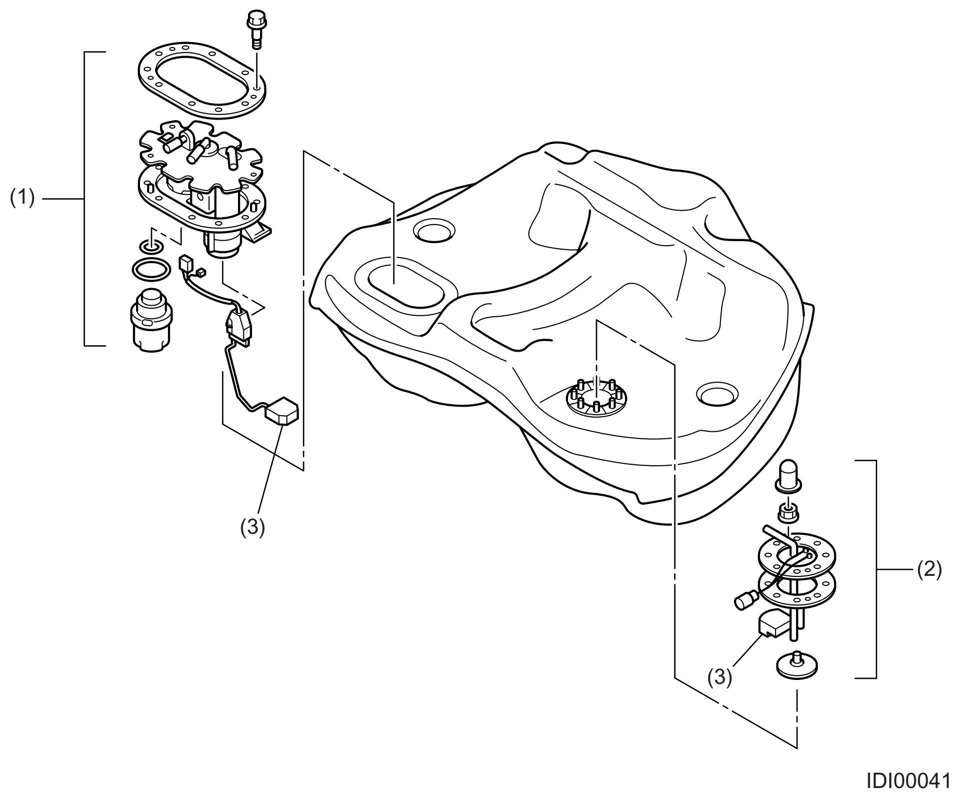


(1) Red zone
(2) Indication
(3) Intake air temperature (°C)
(4) Ignition switch
(5) Combination meter
(6) Water temperature gauge
(7) Engine coolant temperature sensor

H: 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.



(1) Main fuel level sensor

(2) Sub fuel level sensor

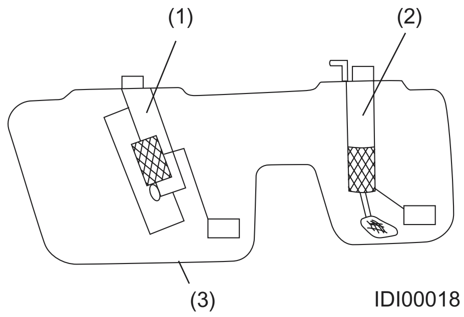
(3) Float

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. 76 Ω) 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.

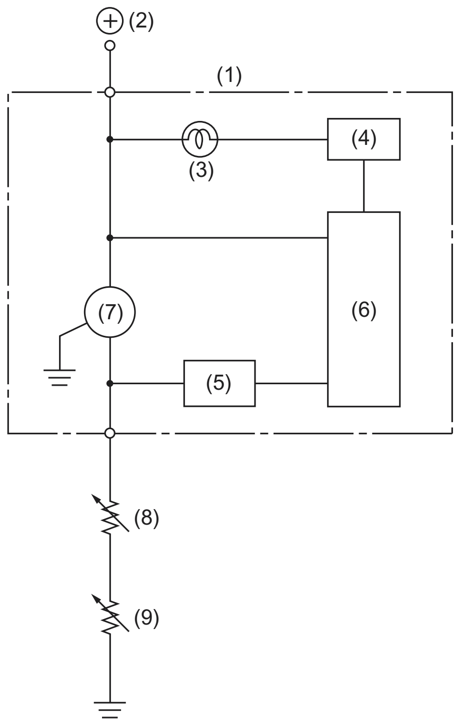


(1) Main fuel level sensor
(2) Sub fuel level sensor
(3) Fuel tank

3. SPECIFICATION

	Fuel amount	Resistance
Main fuel level sensor	Full	0.5–2.5 Ω
	1/2	18.5–22.5 Ω
	Empty	52.5–54.5 Ω
Sub fuel level sensor	Full	0.5–2.5 Ω
	1/2	23.6–27.6 Ω
	Empty	39.5–41.5 Ω

4. CIRCUIT DIAGRAM



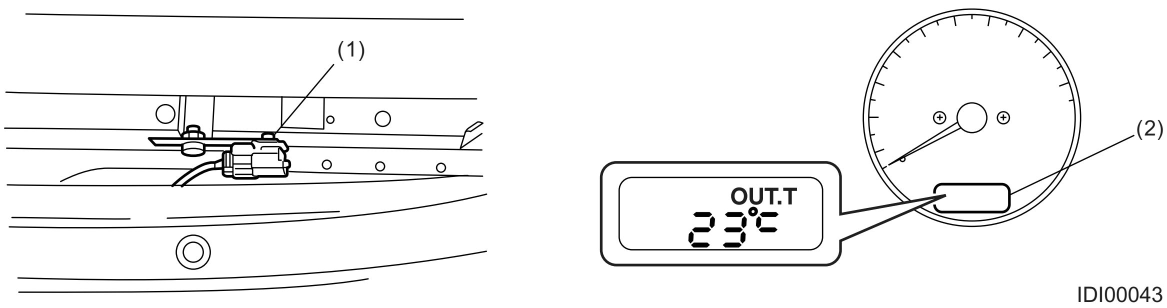
IDI00042

- (1) Combination meter
- (2) Ignition switch
- (3) Low fuel warning light
- (4) Driver circuit
- (5) Interface
- (6) CUSTOM CPU
- (7) Fuel gauge
- (8) Sub fuel level sensor
- (9) Main fuel level sensor

2. Outside Air Temperature Display

A: CONSTRUCTION

The outside air temperature display system consists of an ambient sensor (1), 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.



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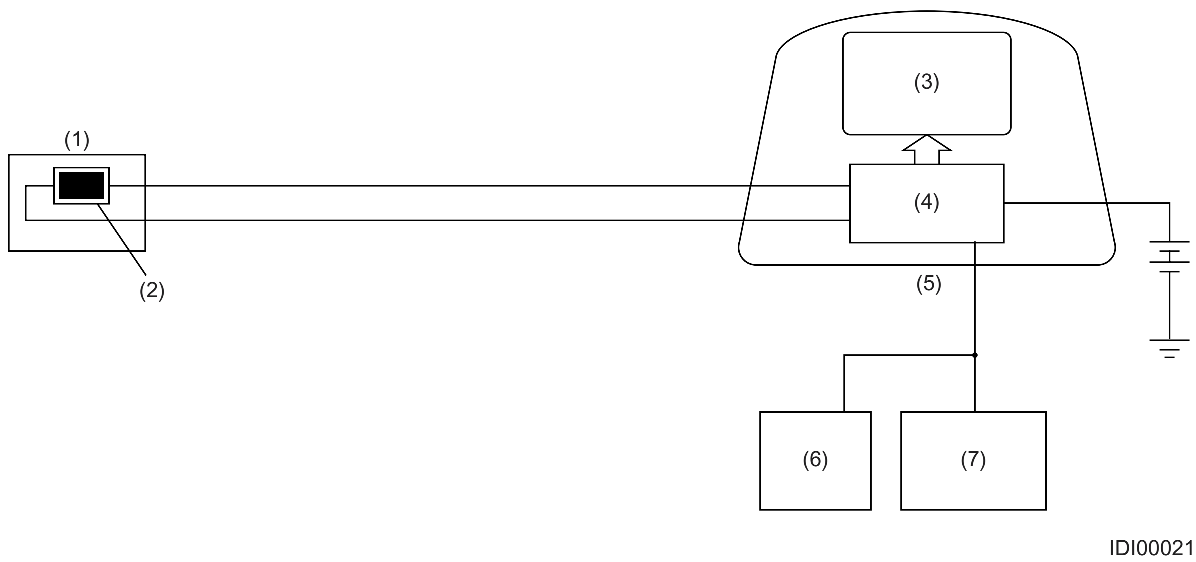
(1) Ambient sensor
(2) Outside air temperature display

B: CIRCUIT DIAGRAM



(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)

1. Front Seat

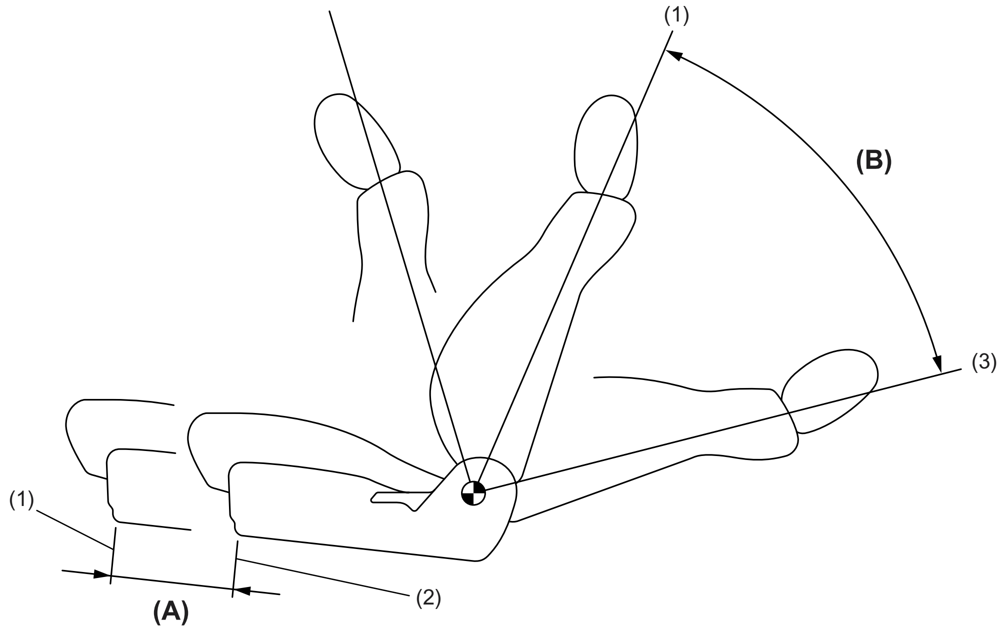
A: ADJUSTMENT

1. STANDARD SEAT

● The height of each headrest is adjustable to any of the 4 positions available at 18 mm (0.71 in) steps.

● The angle of each backrest is adjustable to any of the 32 positions available at 2° steps.

● The front seat can be slid back and forth to one of the 17 positions available at 13.5 mm (0.53 in) steps.



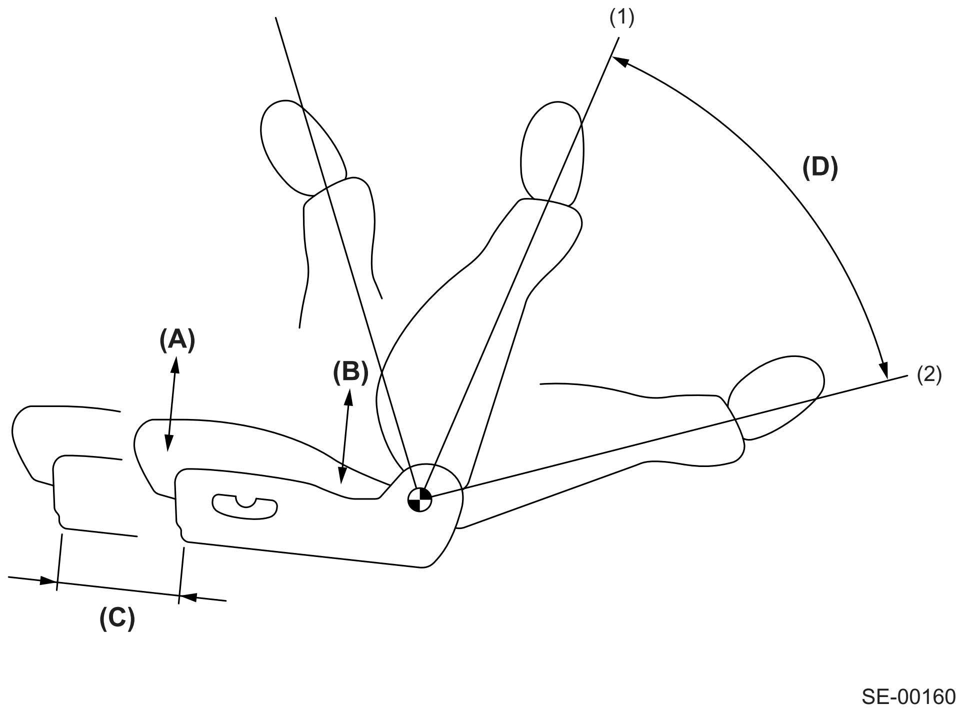
SE-00159

(1) 1st position
(2) 18th position
(3) 33rd position

(A) 17×13.5 mm (0.53 in)
(B) 32×2°

2. POWER SEAT (6-WAY)

- The driver's 6-way power seat has a function of automatically adjusting its fore-aft position, cushion's front and rear portion heights, backrest angle, and headrest height in response to operation of the corresponding switches.
- The height of each headrest is adjustable to any of the 4 positions available at 18 mm (0.71 in) steps.
- The angle of the backrest is adjustable to any of the 32 positions available at 2° steps.
- The front seat can be slid back and forth steplessly within a 229.5 mm (9.04 in) range.
- The front portion height of the seat cushion can be adjusted steplessly within a 35 mm (1.38 in) range.
- The rear portion height of the seat cushion can be adjusted steplessly within a 25 mm (0.98 in) range.

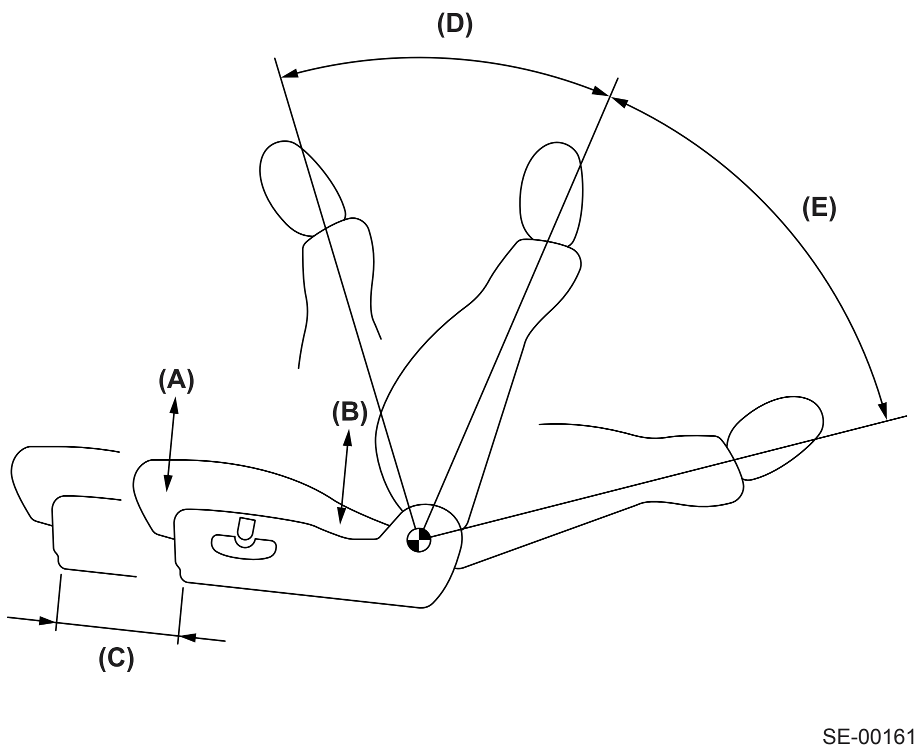


(1) 1st position
(2) 33rd position

(A) 35 mm (1.38 in)
(B) 25 mm (0.98 in)
(C) 229.5 mm (9.04 in)
(D) 32×2°

3. POWER SEAT (8-WAY)

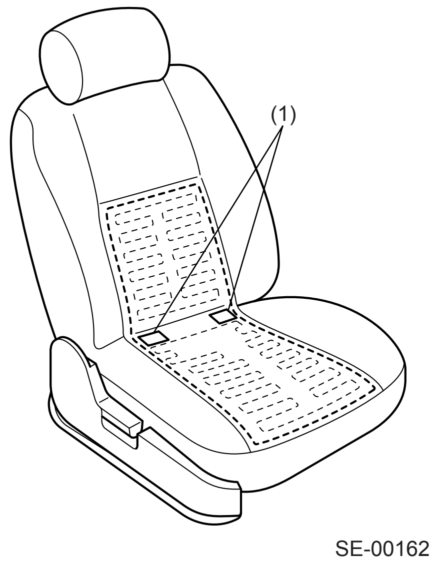
- The driver’s 8-way power seat has a function of automatically adjusting its fore-aft position, cushion's front and rear portion heights, backrest forward and backward angles, and headrest height in response to operation of the corresponding switches.
- The height of each headrest is adjustable to any of the 4 positions available at 18 mm (0.71 in) steps.
- The angle of the backrest is adjustable steplessly within a range from 18° forward to 58° backward.
- The front seat can be slid back and forth steplessly within a 229.5 mm (9.04 in) range.
- The front portion height of the seat cushion can be adjusted steplessly within a 35 mm (1.38 in) range.
- The rear portion height of the seat cushion can be adjusted steplessly within a 25 mm (0.98 in) range.



(A) 35 mm (1.38 in)
(B) 25 mm (0.98 in)
(C) 229.5 mm (9.04 in)
(D) 18°
(E) 58°

B: SEAT HEATER

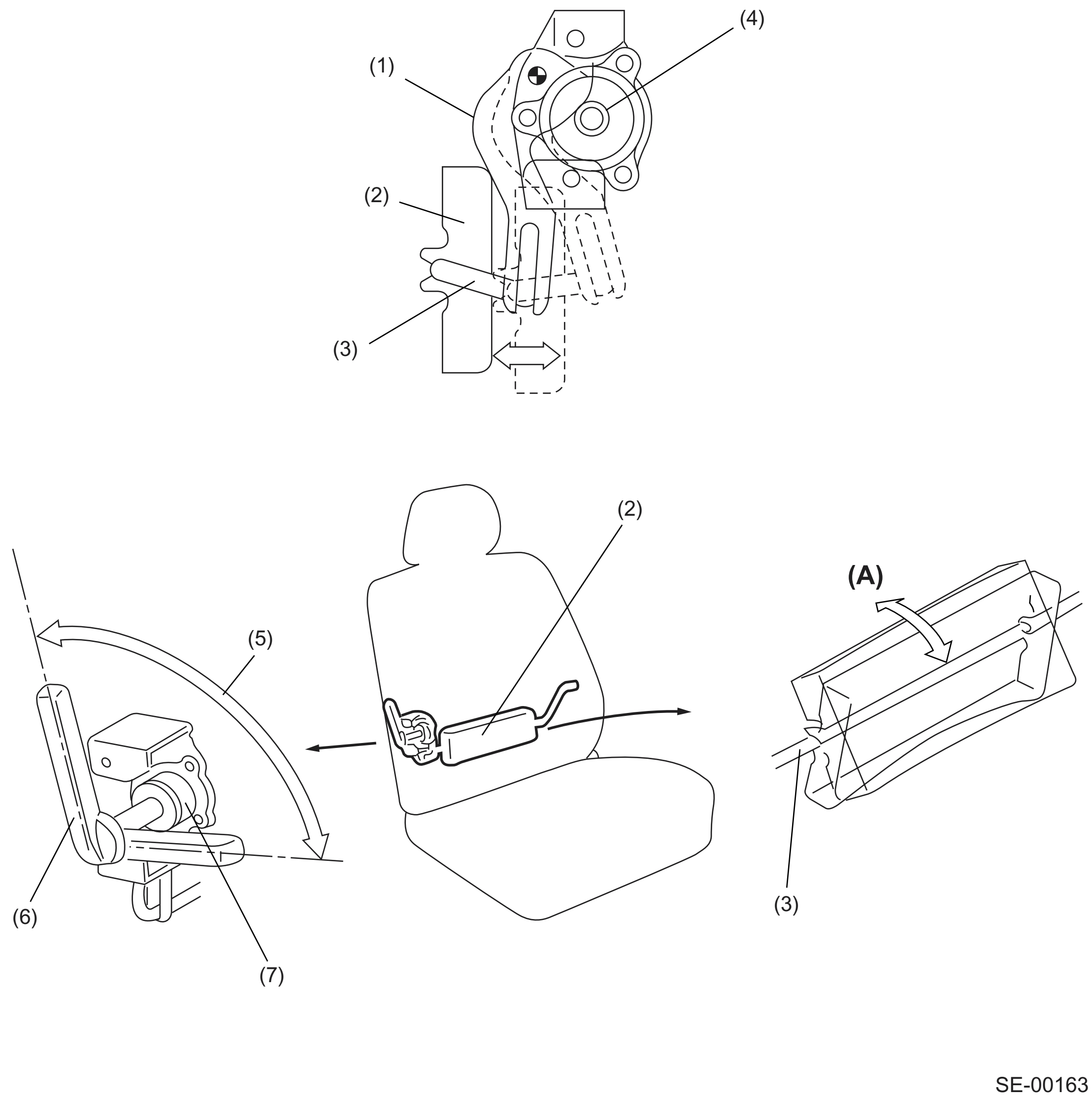
The electric seat heater consists of wire heating elements embedded in the seat cushion and backrest under the seat covering. Heating temperature can be selected between two settings: high-temperature setting for quick warming and low-temperature setting for continuous warming. Two thermostats are used to maintain a selected temperature and ensure safety.



(1) Thermostat

C: LUMBAR SUPPORT

The position of the lumbar support plate in the backrest changes as the lumbar support adjustment lever is operated to adjust the force of support to the occupant's lower back.
The lumbar support mechanism has been modified to feature stepless adjustment. The material of the support plate is also changed to plastic for a better fit with the occupant's back.

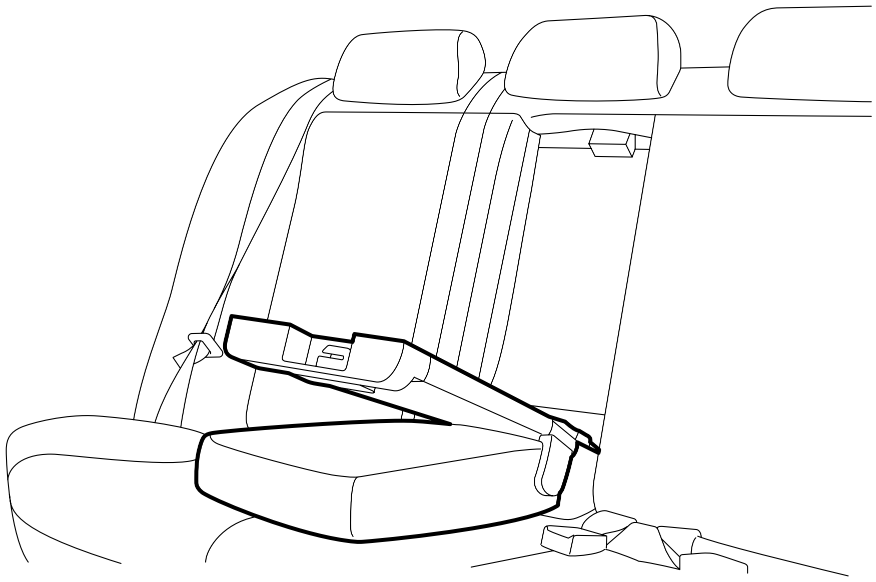


(1) Driven gear plate	(5) Stepless adjustable range	**(A)** Rotates
(2) Lumbar support plate	(6) Lumbar support lever	
(3) Torsion bar	(7) Bearing with built-in pinion gear	
(4) Pinion gear		

2. Rear Seat

SEDAN

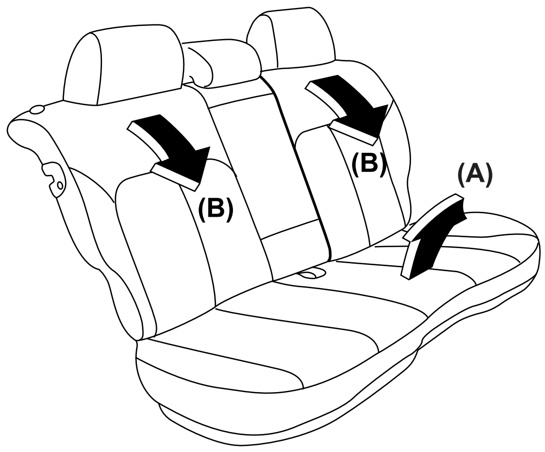
A trunk-through hatch is provided behind the armrest. It is accessed by folding down the central portion of backrest which also serves as an armrest in its down position.



SE-00164

WAGON

The rear seat is foldable by following the illustrated steps.



SE-00165

(A) Step 1

(B) Step 2

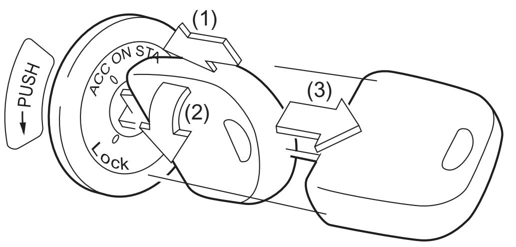
MEMO

1. Ignition Switch

A: GENERAL

1. IGNITION SWITCH

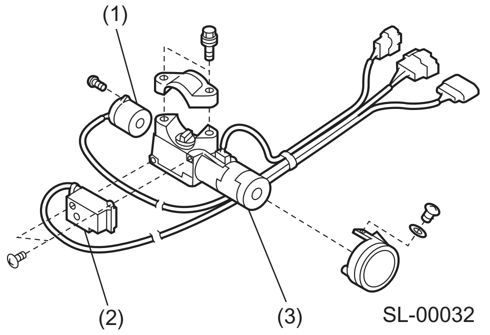
● The ignition switches on the MT models have a safety mechanism that prevents inadvertent locking of the steering wheel during driving. The driver cannot turn the ignition key from “ACC” to “LOCK” unless the key is pushed inward at the “ACC” position (arrow 1 in the drawing below).



SL-00031

● The ignition switches on the AT models have a key interlock mechanism to avoid locking of the steering wheel during driving.The ignition key can be turned to the “LOCK” position only when the select lever is in the P position.

NOTE:
Should the key be impossible to turn to “LOCK” when the select lever is in the P position due to failure of the key interlock mechanism, the interlocking can be cancelled by operating the release lever located on the underside of the steering column.



SL-00032

(1) Ignition switch
(2) Key interlock solenoid (AT)
(3) Ignition key cylinder

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

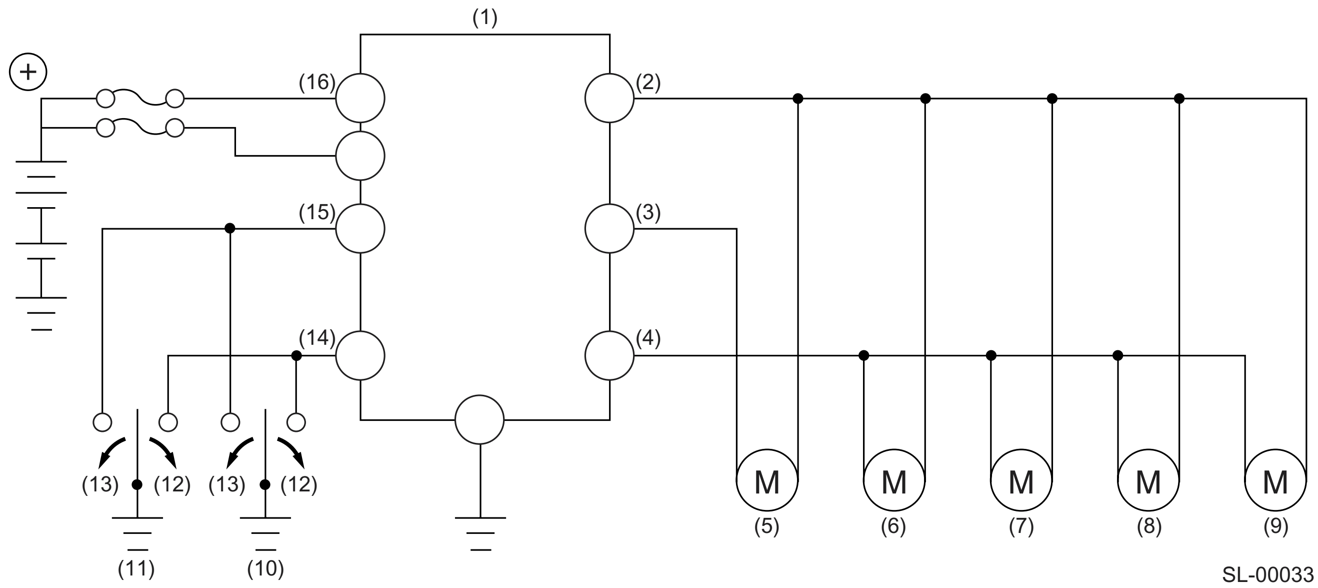
The ignition switch illumination turns off 10 seconds after the driver’s door is closed.Also, when the key is inserted into the ignition switch while the illumination is on, it turns off immediately.
An integrated module controls the off delay function.

2. Power Door Lock

A: CONSTRUCTION

- The power door lock system consists of an integrated module, driver's and front passenger's door lock switches, front door lock actuators, rear door lock actuators, and a rear gate lock actuator.
- When the driver's/front passenger'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



(1)	Integrated module	(7)	Rear LH actuator	(13)	Lock
(2)	Lock output	(8)	Rear RH actuator	(14)	Unlock switch input
(3)	Unlock output (driver's door)	(9)	Rear gate lock actuator	(15)	Lock switch input
(4)	Unlock output (except driver's door)	(10)	Front passenger's door lock switch	(16)	Battery power
(5)	Front LH actuator	(11)	Driver's door lock switch		
(6)	Front RH actuator	(12)	Unlock		

3. Keyless Entry System

A: CONSTRUCTION

● The keyless entry system consists of a transmitter, keyless entry control module (with a built-in antenna), integrated module, door lock actuators, door switches, horn, buzzer, and interior light.

● 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 buzzer sounds once and the hazard warning lights flash once.

2. DOOR UNLOCKING (DRIVER'S DOOR)

1) Push the transmitter's UNLOCK button once.

2) The driver's door is unlocked and the interior light turns ON (when the interior light switch is set at the DOOR position).

NOTE:
The interior light illuminates for 30 seconds and then fades out within 4 seconds.
● If any door is opened and then closed during the 30 seconds illumination period, the interior light illuminates for 3 seconds, then dim gradually and go out. Also, when a door lock is operated before the illumination go out, the interior light turns off immediately.

3) Check that the buzzer sounds twice and the hazard warning lights flash twice.

3. DOOR UNLOCKING (ALL DOORS)

1) Push the transmitter's UNLOCK button twice within 5 seconds.

2) All doors are unlocked.

3) Check that the buzzer sounds twice and the hazard warning lights flash twice.

NOTE:
When pushing the transmitter's UNLOCK button twice to unlock all doors, the system may not respond if the interval between the 1st time and 2nd time is too short.

4. SELF POSITION DETECTION FUNCTION

1) Push the transmitter's LOCK button 3 times within 5 seconds.

2) Check that the horn sounds once and the hazard warning lights flash 3 times.

5. PANIC ALARM SETTING

1) Push the transmitter's LOCK button for more than 2 seconds.

2) The horn sounds intermittently and the hazard warning lights will flash too. The panic alarm sounds for 30 seconds, however, to stop the alarm within this 30 seconds period, push any button on the transmitter.

6. ANSWER BACK (BUZZER SIGNALING) ON/OFF SELECTION

1) Push the transmitter's UNLOCK button.

2) Push the transmitter's LOCK and UNLOCK buttons simultaneously for more than 2 seconds to deactivate the answer back function. Push the two buttons again to activate.

3) When the answer back function is activated, the buzzer will sound once and the hazard warning lights flash once. When it is deactivated, the buzzer will sound twice and the hazard warning lights flash twice.

7. DOOR OPEN WARNING FUNCTION

The buzzer sounds five times and the hazard warning lights flash five times if the transmitter's LOCK button is pressed with any door, the rear gate, or the trunk lid open.

4. Security System

A: FEATURE

● The security system protects the vehicle from a theft action (unauthorized entry into the vehicle). Upon detection of such an action, it gives audible and visible alarms by causing the horn to sound and the hazard warning lights to flash.It also immobilizes the vehicle by disabling the starter circuit.

● Unauthorized entry is monitored through the switches on the doors, rear gate and trunk lid.If one of the switches is turned ON, the system interprets it as an attempt of unauthorized entry and gives alarms while disabling the starter circuit.

● Unauthorized entry is also monitored by the impact sensor.The system operates in the same manner as mentioned above whenever the sensor senses an abnormal impact on the vehicle.

1. ALARMS

● When activated, the security system causes the hazard warning lights to flash and the horn to sound intermittently.In addition, the security indicator light on combination meter flashes fast and the starter motor circuit is disabled.

● The alarms automatically turn OFF after 30 seconds.However, they will be reactivated if the vehicle is tampered with again.

● The alarms are activated when a door, rear gate or trunk lid is opened without using the keyless entry transmitter.(When the system is armed, a warning is given even if a door is opened by operating the inner door handle.)

● The alarms are also activated when an impact on vehicle body is sensed.

2. HOW TO ARM THE SYSTEM

1) Remove the key from the ignition switch.

2) Close all the windows.Close and all doors, rear gate, and the trunk lid.

3) Push the transmitter’s LOCK button.

4) The buzzer will sound once and the hazard warning lights flash once.

NOTE:
The system can be armed even if the windows are open.

5) Confirm that the security indicator light blinks slowly (once every two seconds).If any of the doors, rear gate or trunk lid is not properly closed, the system warns the driver of this by causing the buzzer to sound 5 times, the hazard warning lights to flash 5 times, and the security indicator to flash rapidly.When the door, rear gate or trunk lid is closed, it will be automatically locked and the security system starts working.The indicator light blinks every 2 seconds when the system is armed and continues to blink until the system is disarmed.

3. HOW TO DISARM THE SYSTEM

1) Push keyless entry transmitter's UNLOCK button.

2) The buzzer will sound twice and the hazard warning lights flash twice.

3) The security indicator light turns OFF.

4) The interior light will illuminate for 30 seconds and then turns OFF.(However, if a system arming procedure is performed during this period, the interior light will turn OFF.)

4. HOW TO STOP ALARMS

Push the transmitter's UNLOCK button or turn the ignition switch from “LOCK” to “ON” repeatedly 3 times at an interval shorter than 5 seconds.

MEMO

1. Sunroof

A: SEDAN

1. DESCRIPTION

The sunroof has both tilting and sliding mechanisms. The tilting mechanism raises or lowers the rear of the glass lid when the tilt switch is operated; the sliding mechanism moves the lid backward to open or forward to close when the OPEN/CLOSE switch is operated.

The sunroof has the following features:

- Reduced thickness of the sunroof provides extra overhead clearance in the passenger compartment.
- Extensive use of aluminum die castings for sunroof components contributes to reduction in weight.

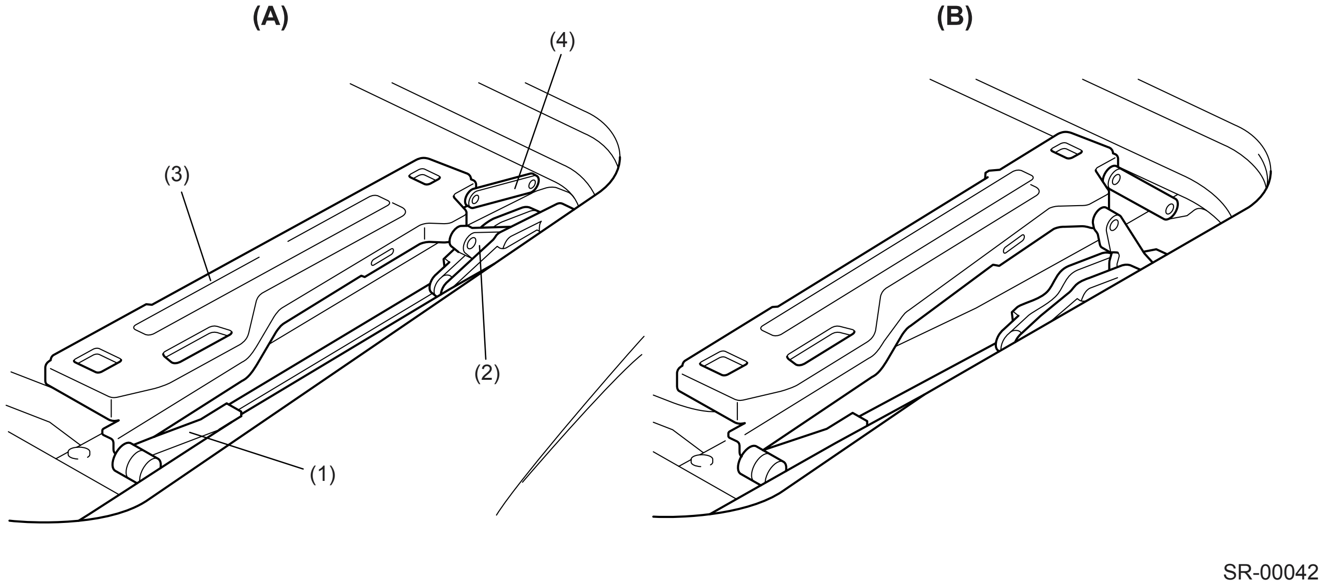
2. FUNCTION

- **SUNROOF TILTING AND SLIDING OPERATION**
  - With the sunroof fully closed, pushing the rear side of the tilt switch causes the rear end of the sunroof lid to rise by 50 mm (1.97 in). Pushing then the front side of the switch causes the lid to lower to the original position.
  - Pushing the OPEN/CLOSE switch rearward causes the sunroof lid to slide rearward and open. Pushing the switch forward causes the glass lid to move forward and stop at a point 150 mm (5.91 in) before the fully closed position. Pushing the switch again closes the lid completely.
- **SUNSHADE OPERATION**
  - The sun shade can be opened or closed manually when the sunroof is closed.
  - The sun shade, if closed, moves rearward together with the glass lid when the OPEN side of the OPEN/CLOSE switch is pushed.

3. SLIDING AND TILTING MECHANISMS

The motor installed at the front of the sunroof frame rotates a pinion gear to move the drive wire.

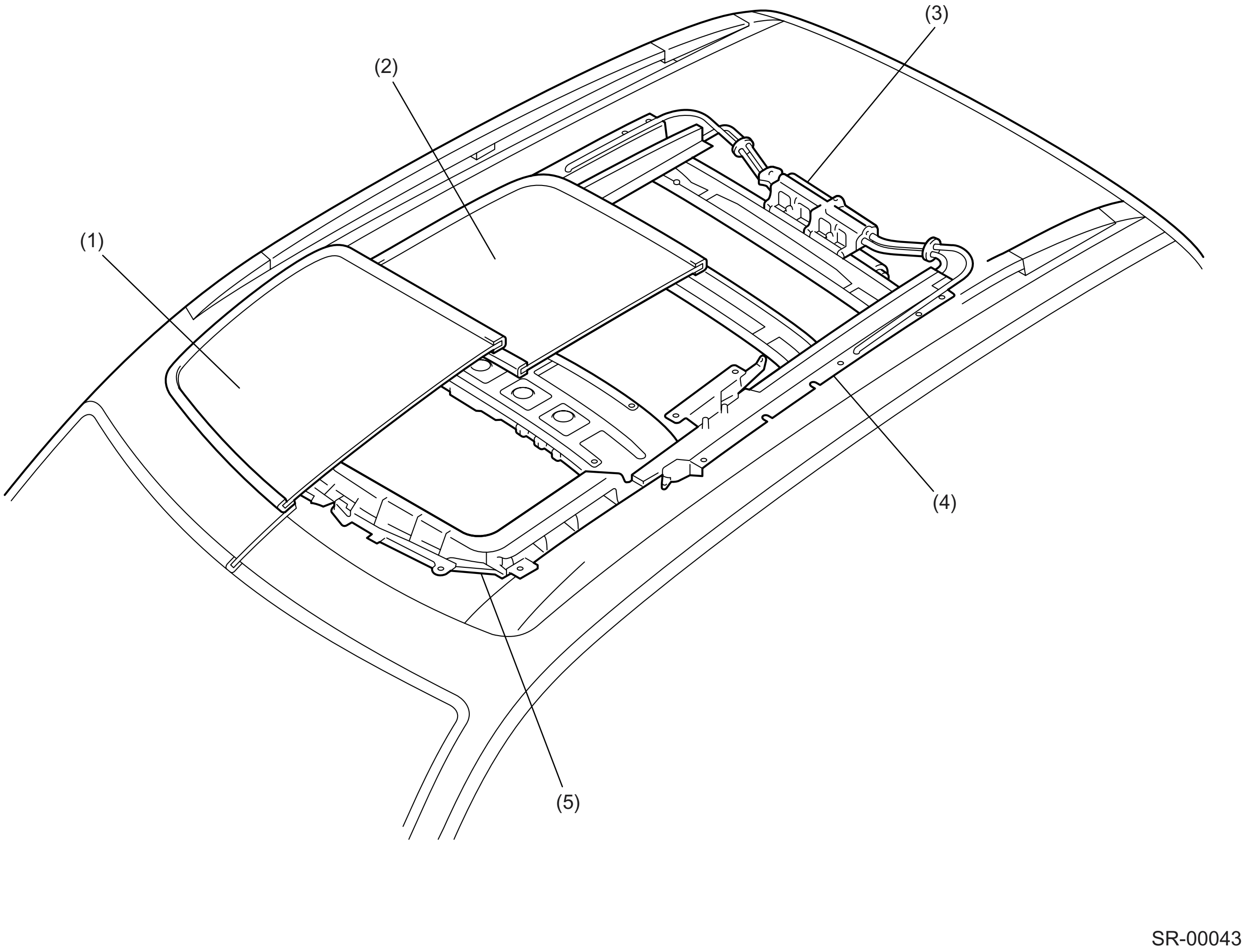
This opens, closes, tilts up or tilts down the glass lid by way of the rear guide connected to the drive wire.



(A) Fully closed
(B) Tilted up
(1) Front guide
(2) Rear guide
(3) Lid bracket
(4) Link

B: WAGON

1. DESCRIPTION



(1) Front glass lid
(2) Rear glass lid
(3) Motor
(4) Rear frame
(5) Front frame

- The front sunroof is a tilting type. The rear end of the glass lid can rise by 50 mm (1.97 in).
- The rear sunroof is a sliding type. When the sunroof is fully opened, the opening area is 340 mm (13.39 in) long and 632 mm (24.88 in) wide.
- Each sunroof uses a 4 mm (0.16 in) thick glass lid and a sunshade.

2. FUNCTION

● OPEN AND CLOSE OPERATIONS

● With the front sunroof fully lowered, holding the OPEN side of the sunroof switch pressed causes the rear end of the front glass lid to tilt up by 50 mm (1.97 in) and then come to a stop. If the switch is released and its OPEN side pressed again, the rear glass lid now opens, sliding rearward by 200 mm (7.87 in) and stops there. The rear glass lid further goes to the fully open position if the OPEN side of the sunroof switch is pressed again.

● With the rear sunroof fully open, holding the CLOSE side of the sunroof switch pressed causes the glass lid to move forward until its front edge reaches a point 150 mm (5.91 in) away from the fully closed position. The rear glass lid moves to the fully closed position if the CLOSE side of the sunroof switch is released and then pressed again.
Pressing the same side of the switch after complete closure of the rear sunroof causes the front glass lid to tilt down completely.

● SUNSHADE OPERATION

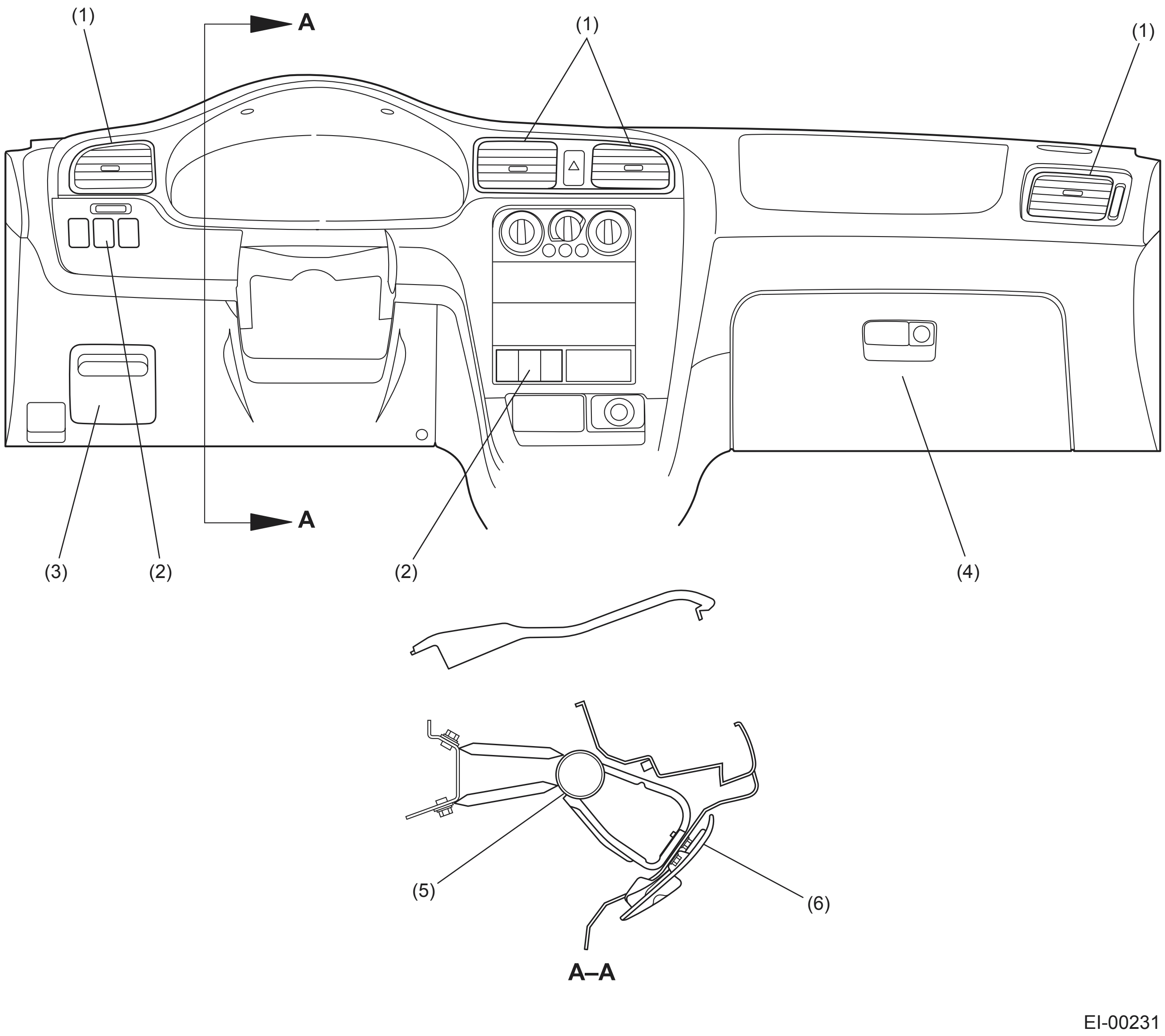
● The front sunshade can be manually opened or closed regardless of the position of the front glass lid.

● The rear sunshade is automatically opened or closed together with the glass lid. In addition, when the glass lid is fully closed, the sunshade can be opened or closed manually.

MEMO

1. Instrument Panel

- The glove compartment has a lockable lid.
- A coin tray is provided.
- The vent grills are barrel type.
- The dashboard lower cover is fitted with a knee cover.
- The steering support beam connecting the left and right pillars is located behind the instrument panel. The instrument panel is mounted on the support beam.

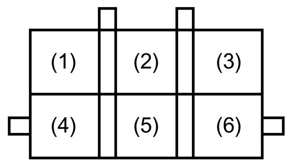


(1)	Barrel type vent grill	(4)	Glove compartment
(2)	Optional accessory switches	(5)	Steering support beam
(3)	Coin tray	(6)	Knee pad

2. Trailer Lights Connector

A: DESCRIPTION

The lights of a trailer (e.g., camping car) can be supplied with power through this connector.



EI-00232

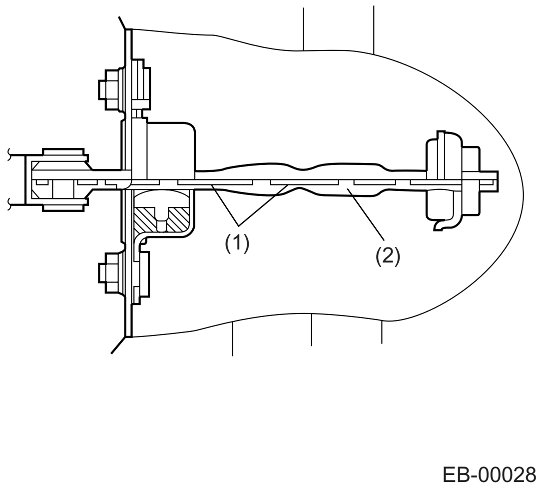
(1) Battery +B
(2) Turn signal RH
(3) Stop light
(4) Turn signal LH
(5) Tail light
(6) Ground

MEMO

1. Door

A: DOOR CHECKER

The door checkers have a resin arm which feels better when operated.

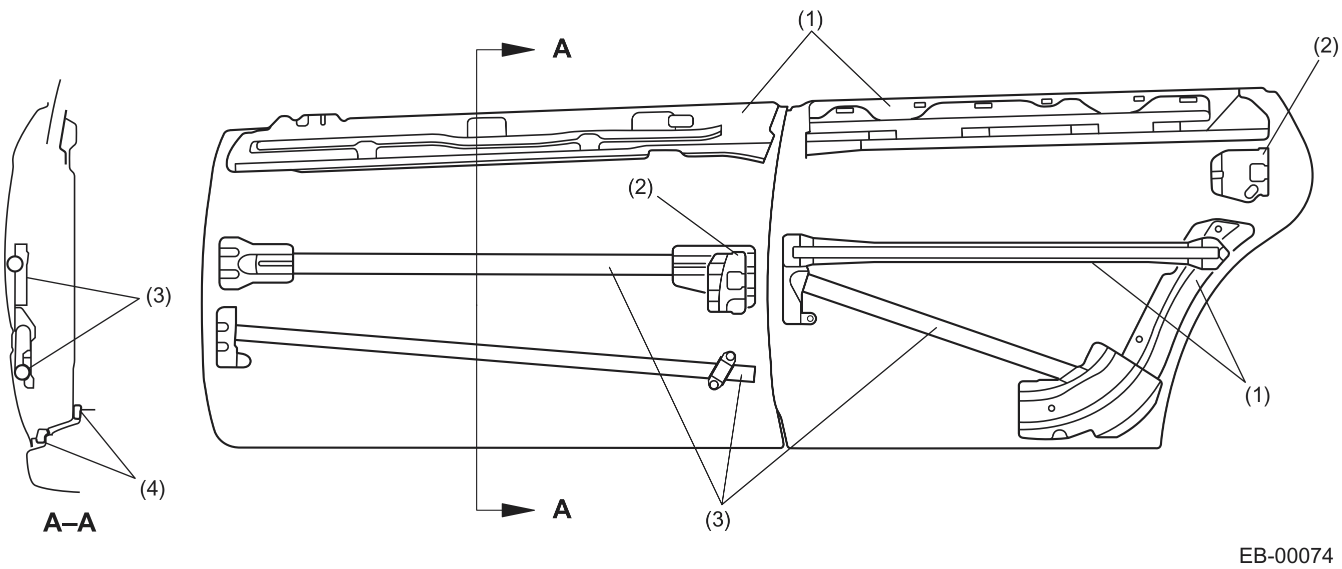


(1) Sheet metal

(2) Resin

B: DOOR CONSTRUCTION

- All the front and rear doors have in their inside side door beams, inner reinforcements and reinforcement latches.
- Tight closure at the bottom of each door is ensured by dual sealing.



(1) Inner reinforcement
(2) Reinforcement latch
(3) Side door beam
(4) Dual sealing

MEMO

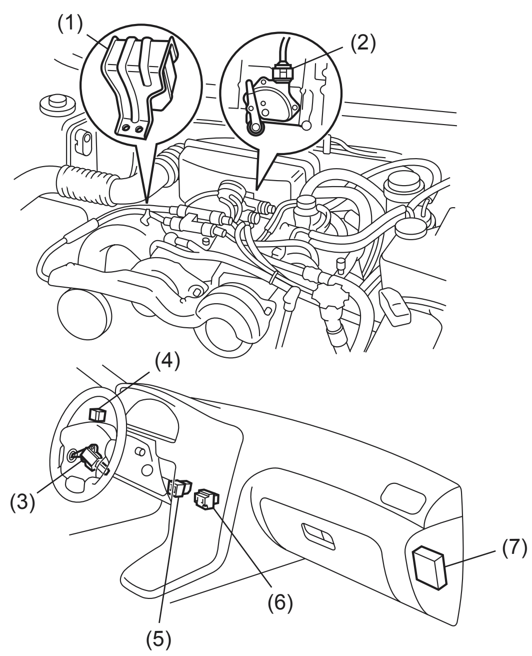
1. Cruise Control

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



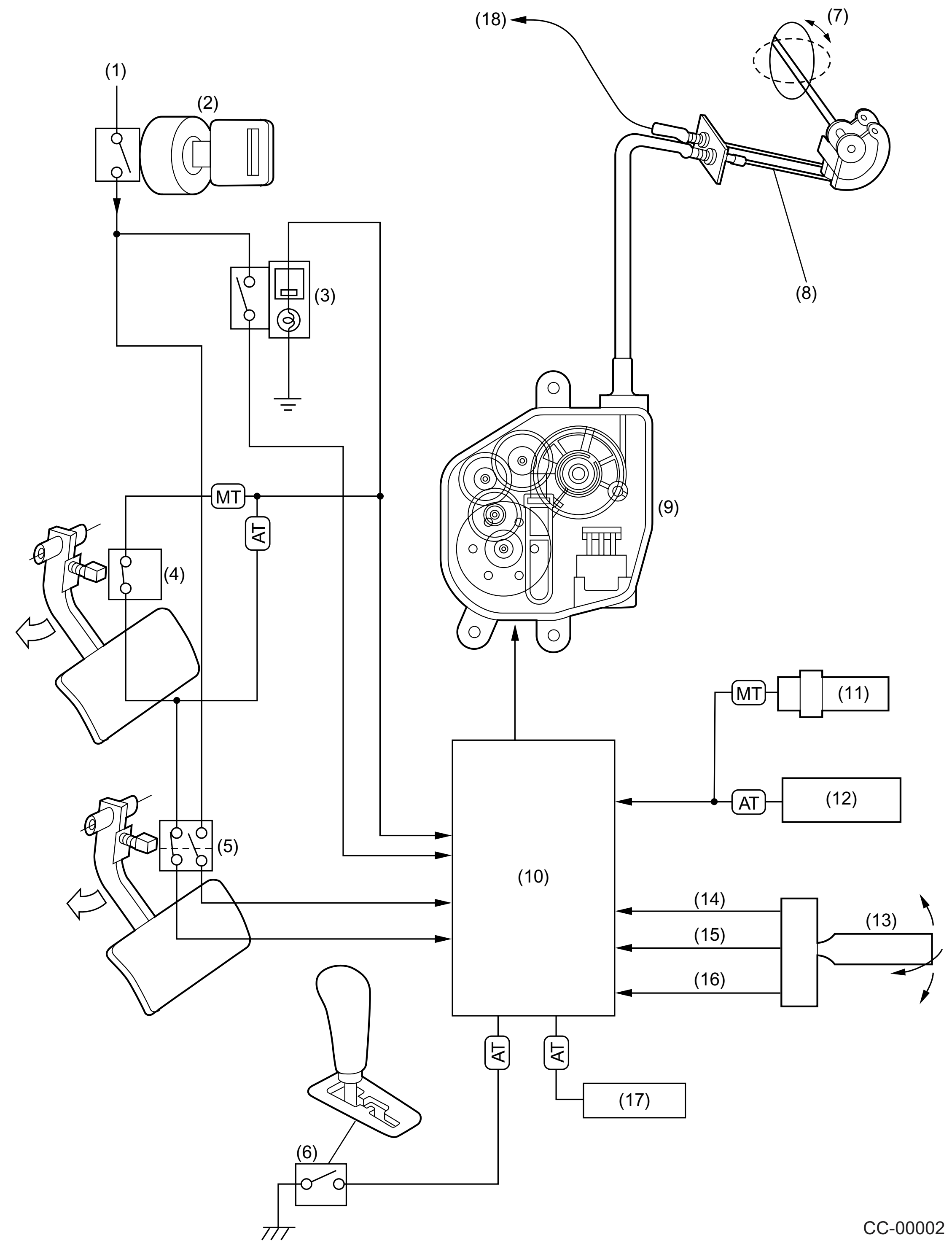
CC-00090

(1) Actuator
(2) Inhibitor switch (AT)
(3) Command switch (cruise control lever)
(4) Main switch
(5) Clutch switch (MT)
(6) Stop and brake switch
(7) Control module

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 decelerate by a certain amount. 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 decreases by 8 km/h (5.0 MPH) or more from the memorized speed, the clutch is turned ON again so that the cruise control resumes.

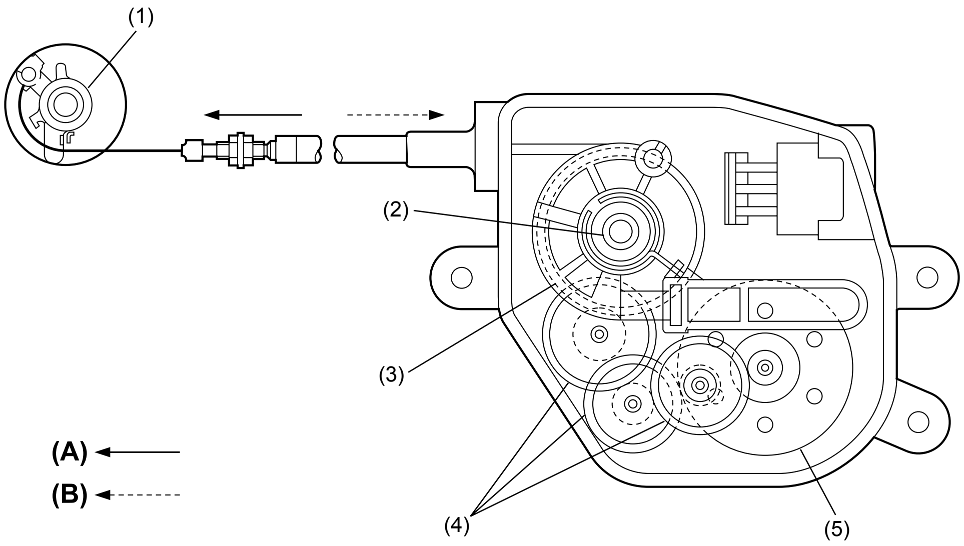
D: SCHEMATIC



(1) Battery
(2) Ignition switch
(3) Main switch
(4) Clutch switch (MT)
(5) Stop and brake switch
(6) Inhibitor switch (AT)
(7) Engine throttle valve
(8) Cruise control cable
(9) Actuator
(10) Cruise control module
(11) Vehicle speed sensor (MT)
(12) TCM (AT)
(13) Command switch
(14) RESUME/ ACCEL switch
(15) CANCEL switch
(16) SET/COAST switch
(17) TCM (AT)
(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.



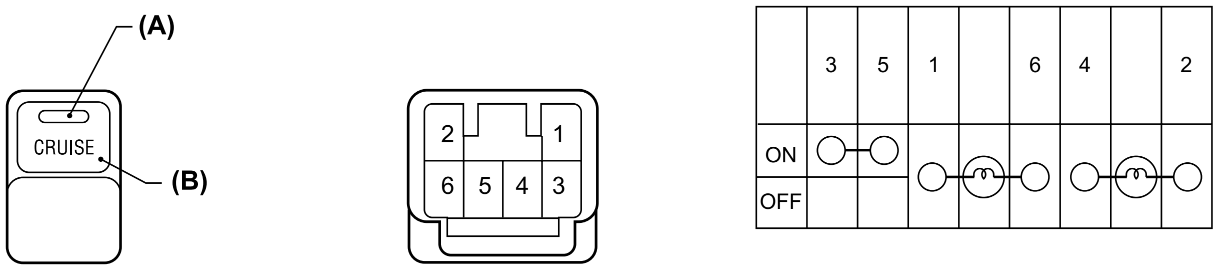
CC-00003

(1) Throttle cam	(4) Gear	(A) Release
(2) Clutch	(5) Stepping motor	(B) Pull
(3) Pulley		

F: MAIN SWITCH

● The main switch is the main power supply switch of the cruise control module. It has a built-in power indicator (A) and a night illumination light (B).

● 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.



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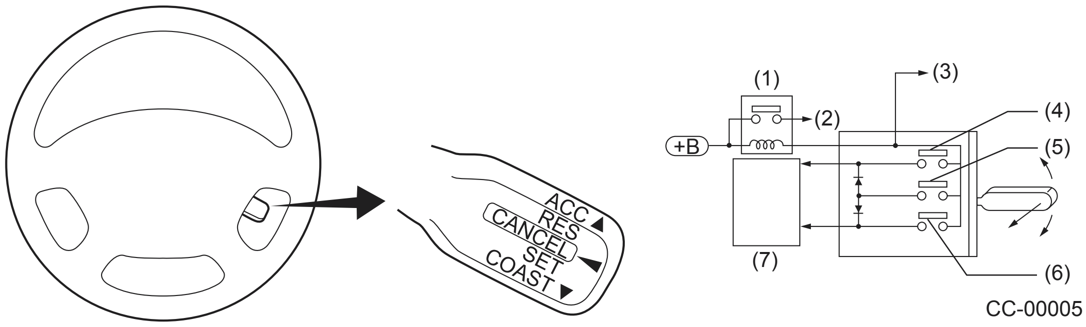
G: COMMAND SWITCH (CRUISE CONTROL LEVER)

● When the vehicle is driven with the cruise control activated, the command switch controls its operation. It inputs SET/COAST signal, RESUME/ACCEL 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.

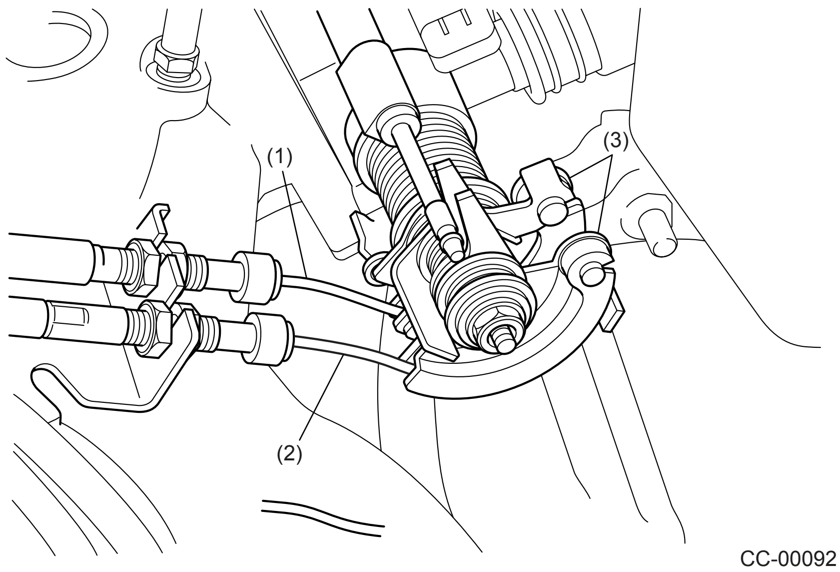
- Stop light switch
- Brake switch
- Clutch switch (MT model)
- Inhibitor switch (AT model)
- Main switch
- Command switch (CANCEL position)

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).

J: ENGINE THROTTLE

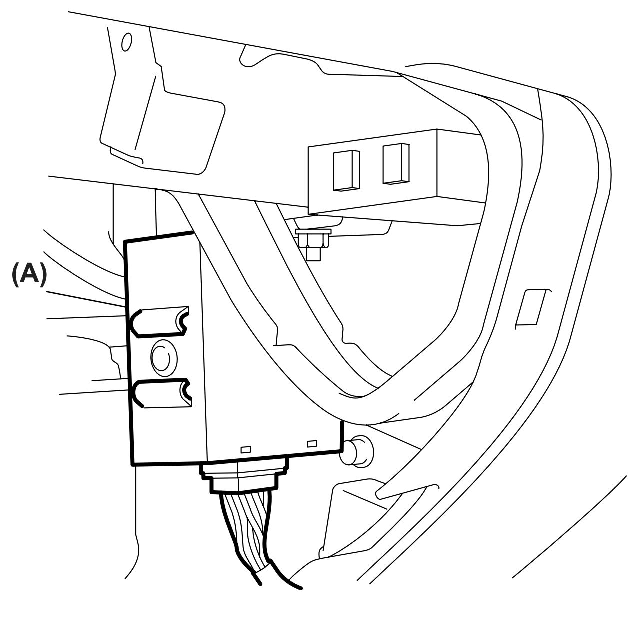
- The throttle body is equipped with two throttle cams. One is used during acceleration and the other during cruising in order to open or close the throttle valve.
- These cams operate independently of each other. In other words, when one cam operates, the other may not.



(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 (A) is located inside of the front pillar lower portion (passenger side).



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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 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 or the main switch is turned OFF.

1) The stepping motor terminal is grounded or disconnected; or the stepping motor drive circuit is broken due to a short-circuit.

2) The stepping motor clutch drive circuit is shorted.

3) Vehicle speed variation in a 350 ms period exceeds ±10km/h (±16 MPH).

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

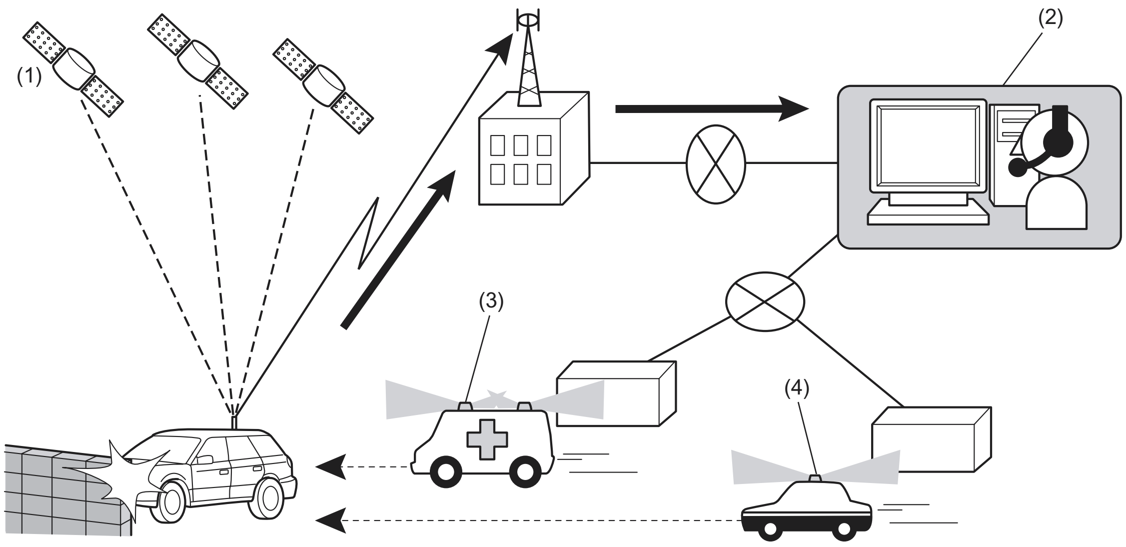
The cruise control system is deactivated if either of the following abnormalities occurs in the stepping motor.

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 by any of these causes, it cannot be reactivated for 2 – 20 minutes after detection of the abnormal condition.

1. General

The OnStar® system offers various services by determining the vehicle' location using GPS technology and connecting to the OnStar® call center via a cellular telephone network.



OS-00001

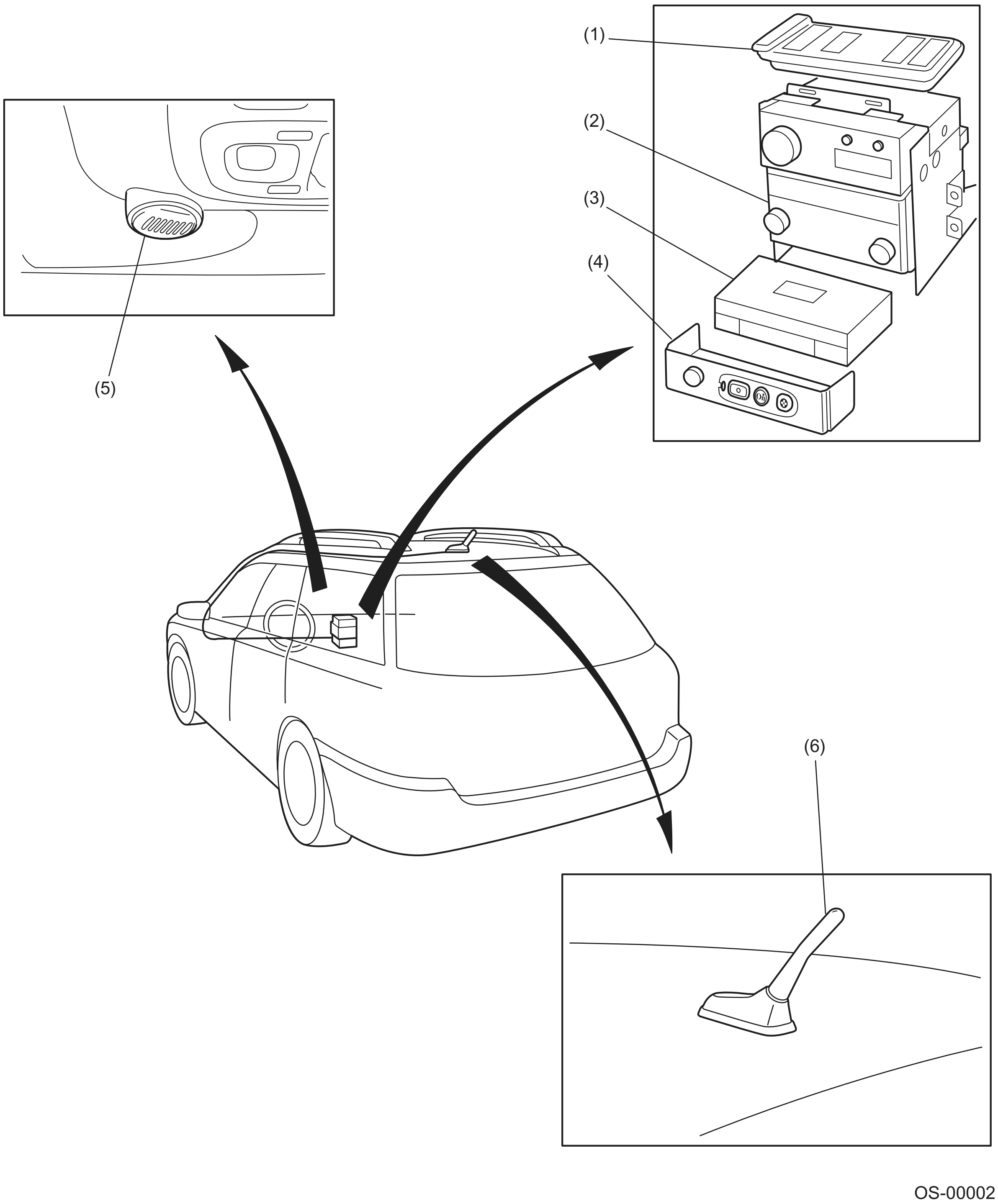
(1) Global positioning system (GPS)
(2) OnStar® call center
(3) Emergency services
(4) Police

1. SERVICES INCLUDED

- Airbag deployment notification
- Personal calling
- Virtual advisor
- Emergency services
- Stolen vehicle tracking
- Remote door unlock
- Roadside assistance
- Accident assistance
- OnStar® MED-NET
- Online concierge

For details of each service, see the OnStar® booklet and the contract sheet.

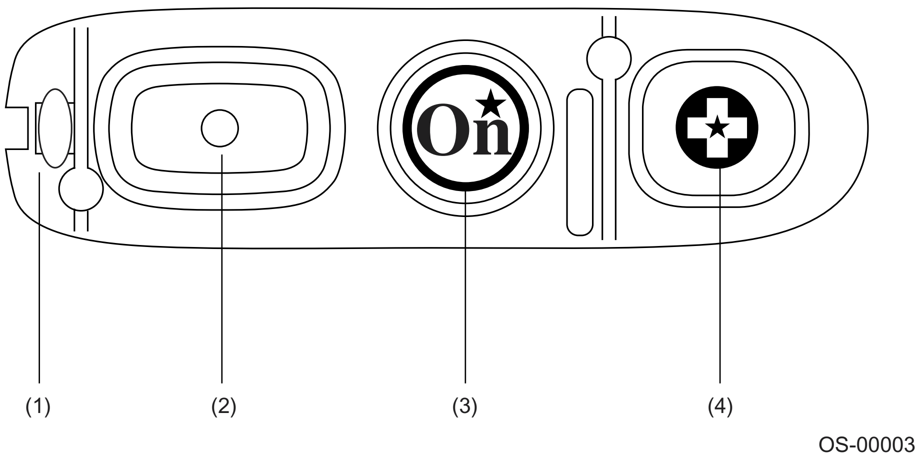
2. System Layout



(1) Vehicle communication unit (VCU)
(2) OnStar® audio
(3) Vehicle interface unit (VIU)
(4) Button assembly
(5) Microphone
(6) Antenna (caller and GPS antenna)

3. Button Assembly

The OnStar® system is operated with 3 buttons.
The LED indicates the operating status and diagnostic trouble codes of the OnStar® system.When the system is operating properly, the LED lights in green.When an abnormality is detected the LED lights in red.



(1) LED
(2) Answer/end button
(3) OnStar® button
(4) Emergency button

1. ANSWER/END BUTTON

- Press this button to answer a call from the OnStar® call center.
- Press this button to end a call.
- Also press this button to cancel if one of the other buttons is accidentally pressed.You will then hear the words "OnStar® request ended".

2. OnStar® BUTTON

- Press this button to connect to an OnStar® call center.You will hear a chime, followed by the words "Connecting to OnStar®."
- The OnStar® call center operator or a virtual advisor will be able to help you with a broad range of services.

3. EMERGENCY BUTTON

- In an emergency, press this button to send a priority call to an OnStar® call center.You will hear a chime, followed by the words "Connecting to OnStar® emergency."
- The OnStar® call center advisor will contact the nearest emergency services provider who can dispatch ambulance, police, fire or other emergency services to the location of your vehicle.

NOTE:
While connected to the OnStar® call center, "CALL" is indicated on the OnStar® audio display.