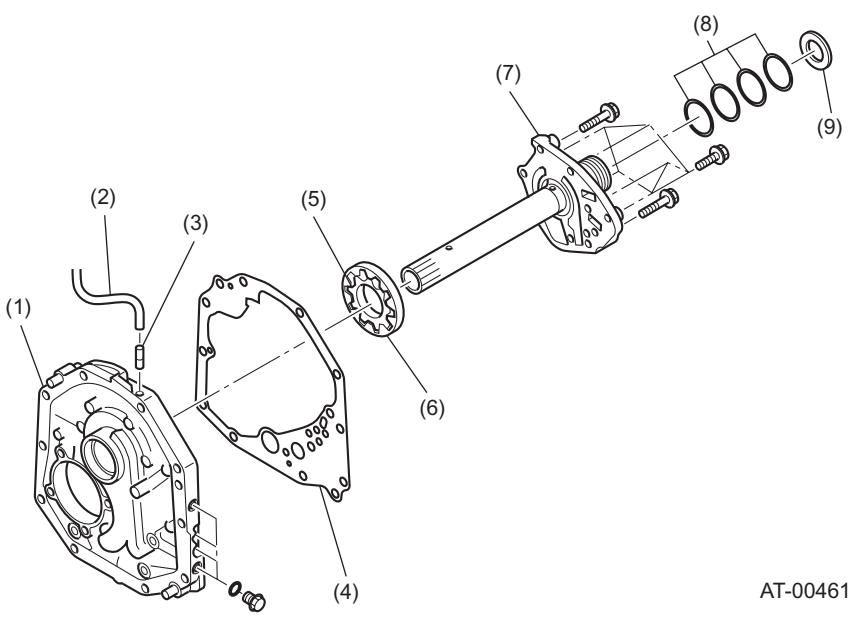
AUTOMATIC TRANSMISSION (4AT)

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

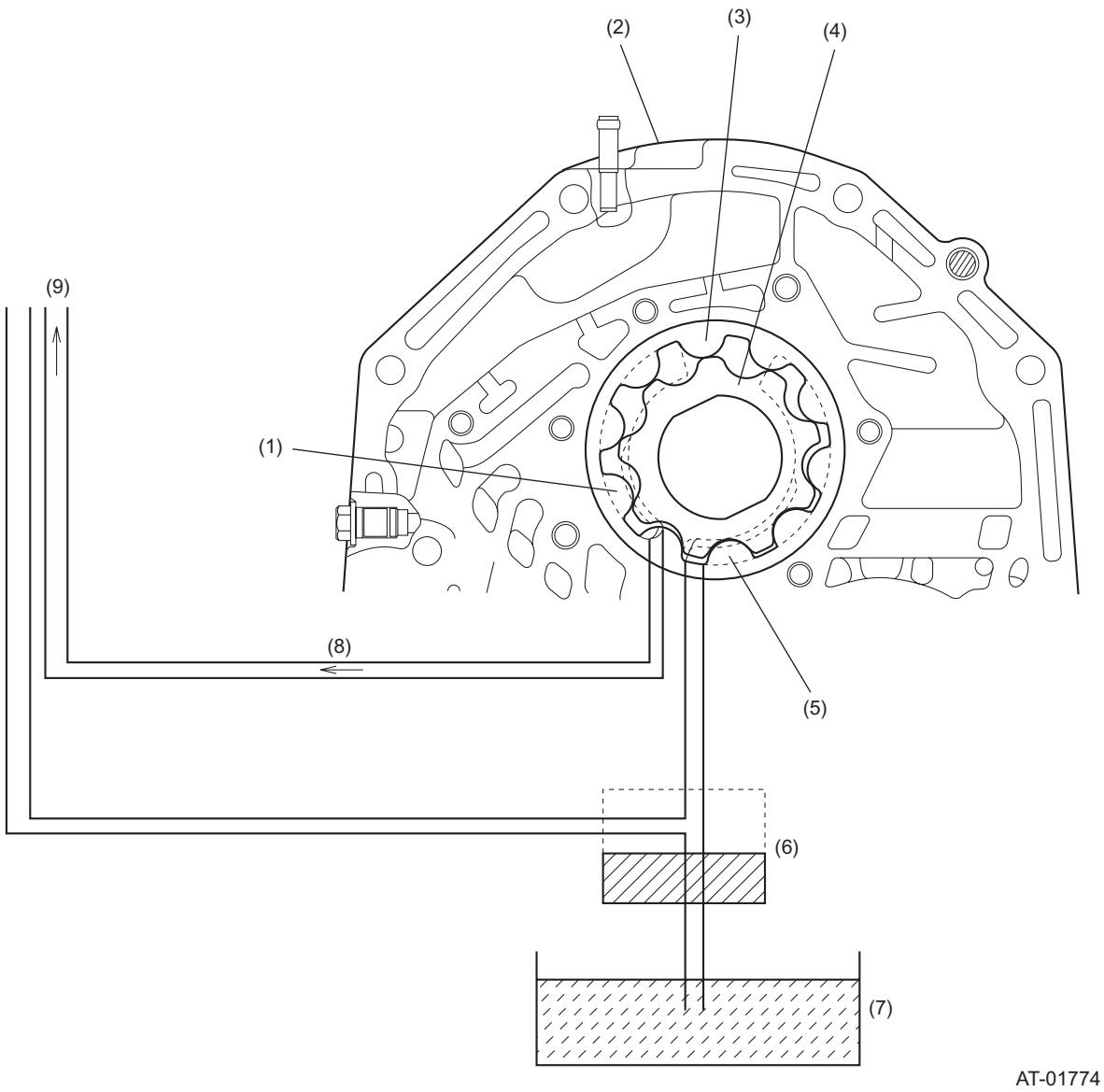
B: FUNCTION

● The pump draws automatic transmission fluid (ATF) from the oil pan through the oil strainer located under the 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 discharge 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 control valve assembly, from which the ATF is directed to various clutches, brakes, and torque converter lockup clutch for acting as hydraulic fluid and lubricating oil. Part of the ATF also flows 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.

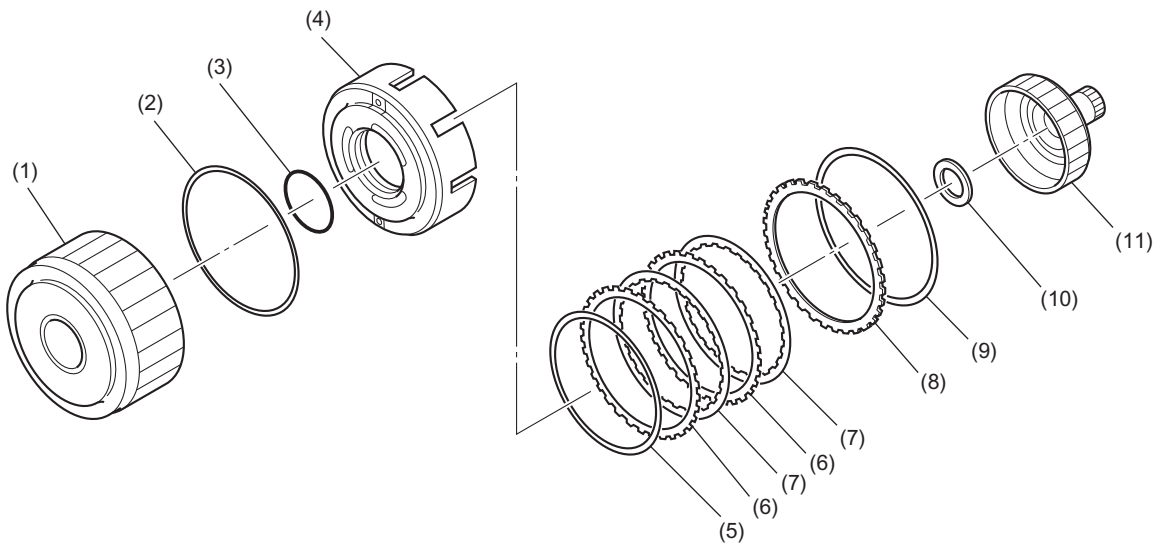


AT-01774

(1) Delivery port
(2) Oil pump housing
(3) Outer rotor
(4) Inner rotor
(5) Suction port
(6) Oil strainer
(7) Oil pan
(8) Line pressure
(9) To control valve

2. Reverse Clutch

A: CONSTRUCTION



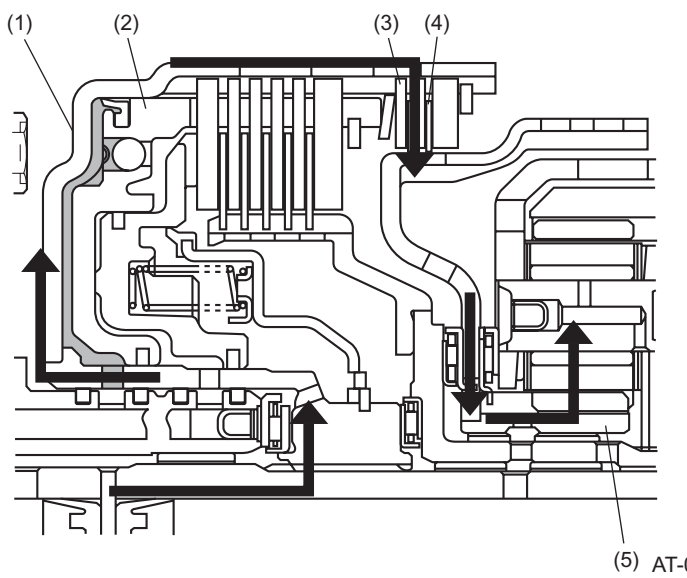
AT-00463

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

B: FUNCTION

1. WHEN REVERSE IS SELECTED

Hydraulic pressure from the 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.

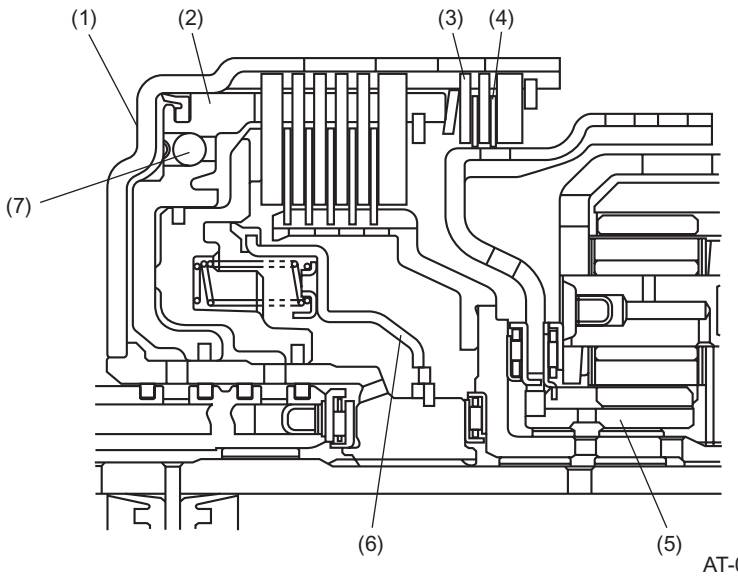


(1) High clutch drum
(2) Reverse clutch piston
(3) Driven plate
(4) Drive plate
(5) Front sun gear

2. WHEN REVERSE IS NOT SELECTED

When the select lever is in any position other than 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.

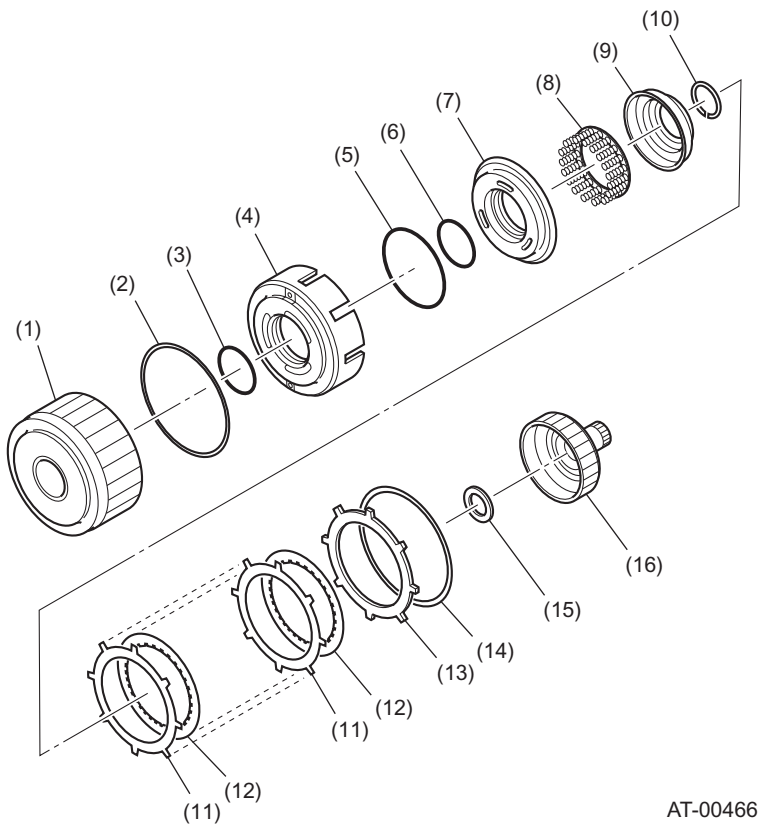


(1) High clutch drum
(2) Reverse clutch piston
(3) Driven plate
(4) Drive plate
(5) Front sun gear
(6) Cover
(7) Check ball

3. High Clutch

When the 3rd or 4th gear is selected, hydraulic pressure is applied to the high clutch from the shift valve and pressure regulator valve. The clutch 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.



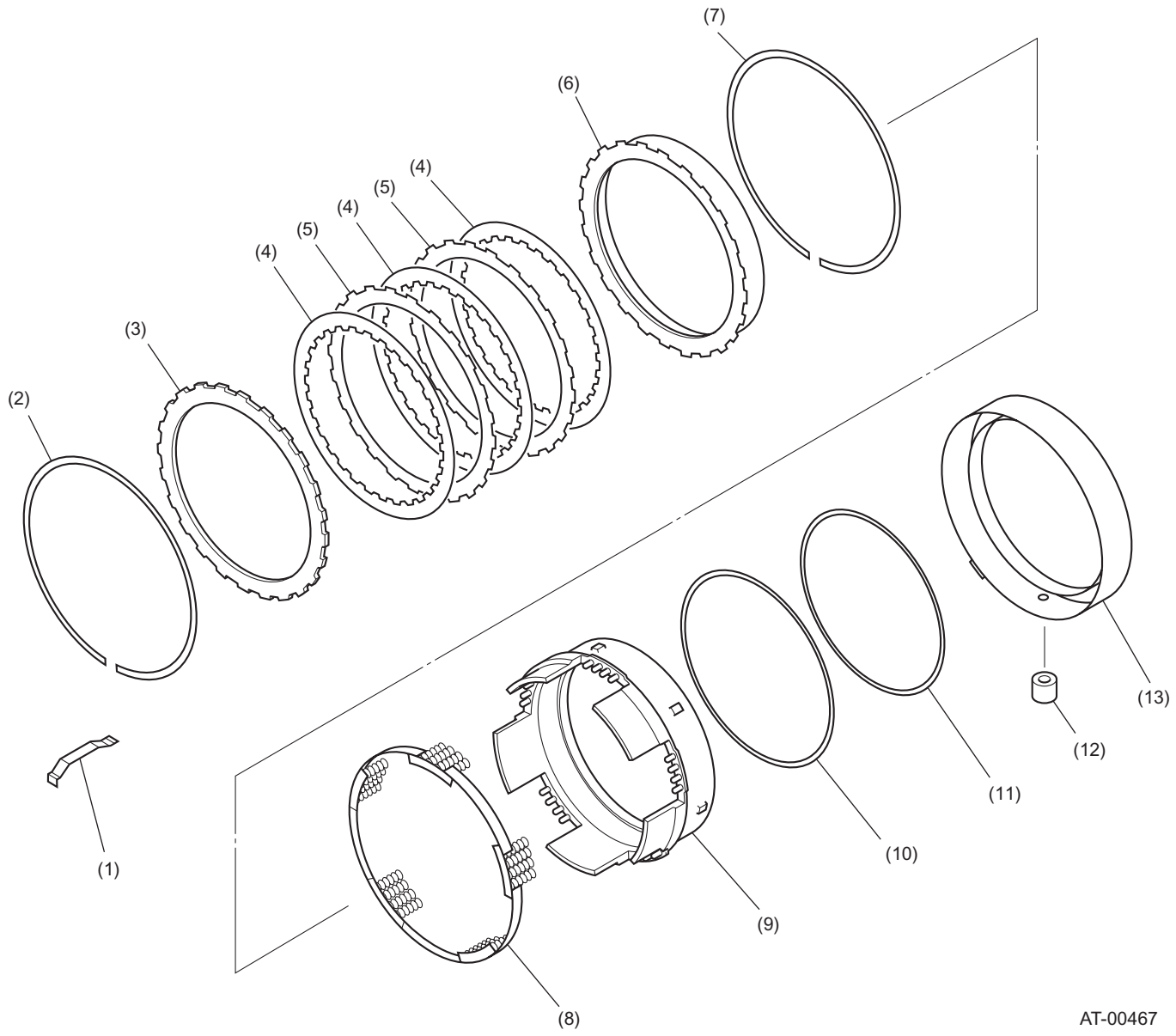
(1) High clutch drum
(2) Lip seal
(3) D-ring
(4) Reverse clutch piston
(5) D-ring (outer)
(6) D-ring (inner)
(7) High clutch piston
(8) Return spring
(9) Cover
(10) Snap ring
(11) Driven plate
(12) Drive plate
(13) Retaining plate
(14) Snap ring
(15) Thrust needle bearing
(16) High clutch hub

4. 2-4 Brake

A: CONSTRUCTION

The 2-4 brake consists of a 2-4 brake piston retainer, 2-4 brake piston, return spring, pressure plate, drive plates, driven plates, and a snap ring that fits in a housing formed in the transmission case.

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

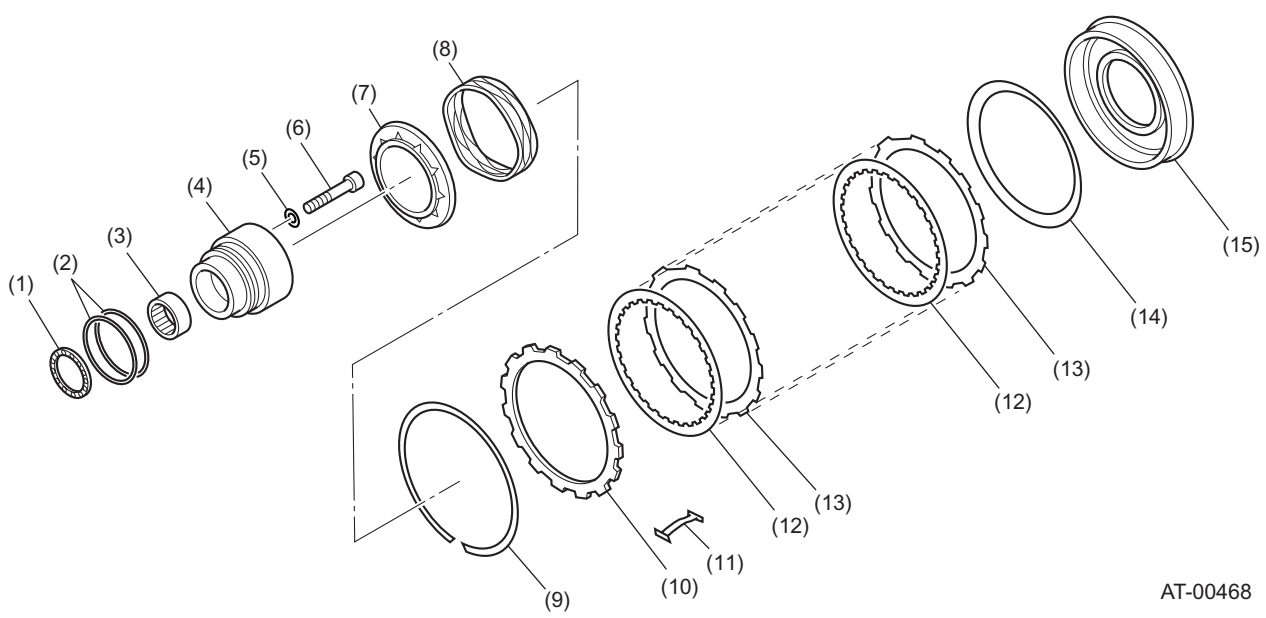


(1) Leaf spring
(2) Snap ring
(3) Retaining plate
(4) Drive plate
(5) Driven plate
(6) Pressure rear plate
(7) Snap ring
(8) Return spring
(9) 2-4 brake piston
(10) D-ring
(11) D-ring
(12) 2-4 brake piston seal
(13) 2-4 brake piston retainer

5. Low & Reverse Brake

A: CONSTRUCTION

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



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

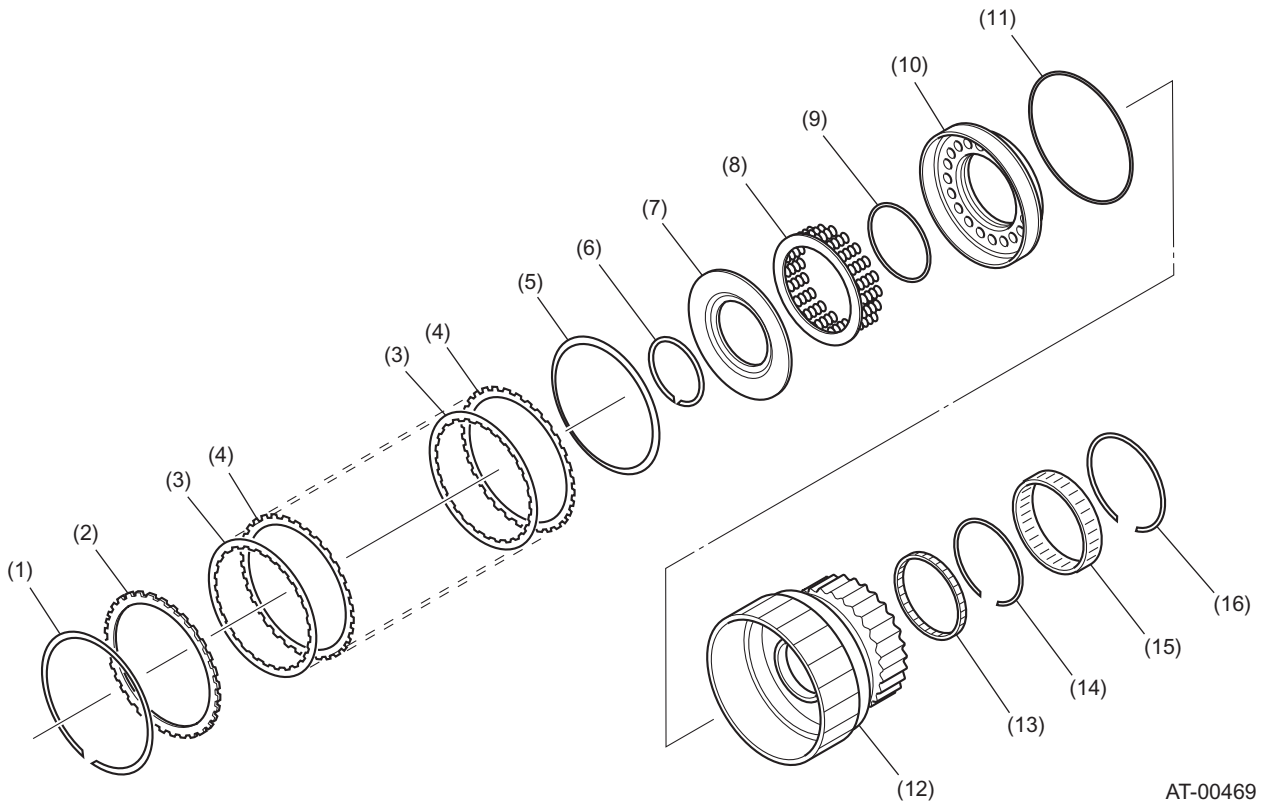
B: FUNCTION

When the 1st gear of manual mode or reverse is selected, the pressure from the control valve is applied to the low & reverse brake piston. The piston then presses the drive and driven plates together and causes the low clutch drum to lock.

6. Low Clutch

A: CONSTRUCTION

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



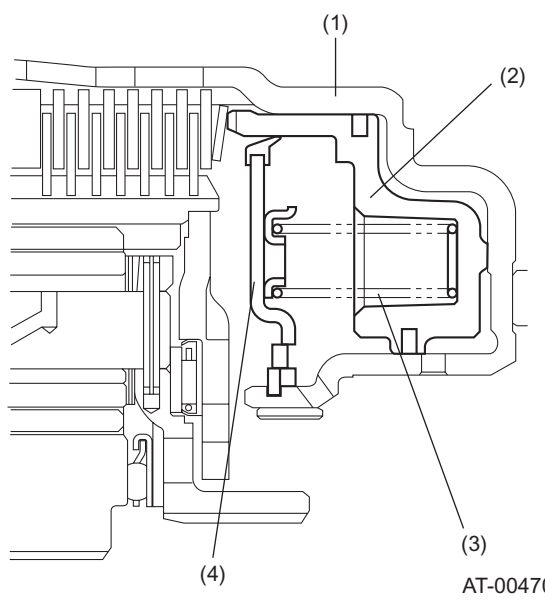
(1) Snap ring
(2) Retaining plate
(3) Drive plate
(4) Driven plate
(5) Dish plate
(6) Snap ring
(7) Cover
(8) Return spring
(9) D-ring
(10) Low clutch piston
(11) D-ring
(12) Low clutch drum
(13) Needle bearing
(14) Snap ring
(15) One-way clutch
(16) Snap ring

B: FUNCTION

The low clutch operates in the 1st, 2nd and 3rd speed gears.

This clutch engages when hydraulic pressure from the control valve is applied to the low clutch piston, transmitting power through the rear planetary carrier 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.

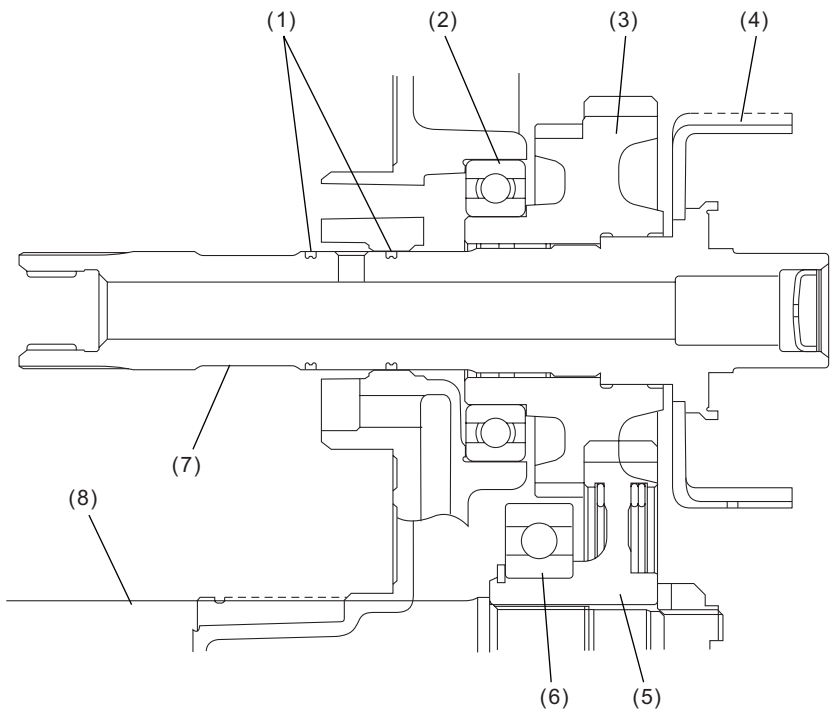


(1) Low clutch drum
(2) Low clutch piston
(3) Return spring
(4) Cover

7. Reduction Gear

A: GENERAL

Engine output is transmitted from the rear planetary carrier to the reduction drive shaft and the reduction drive gear. Power to the front wheels is then transmitted through the reduction driven gear and drive pinion to the front final gears and front wheels. Power to the rear wheels is transmitted sequentially from the transfer clutch hub through the transfer clutch, rear drive shaft, propeller shaft, and rear differential to the rear wheels.



AT-02183

(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

8. 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 controlled by driver's manual inputs and electrical inputs from the TCM.

A: CONSTRUCTION

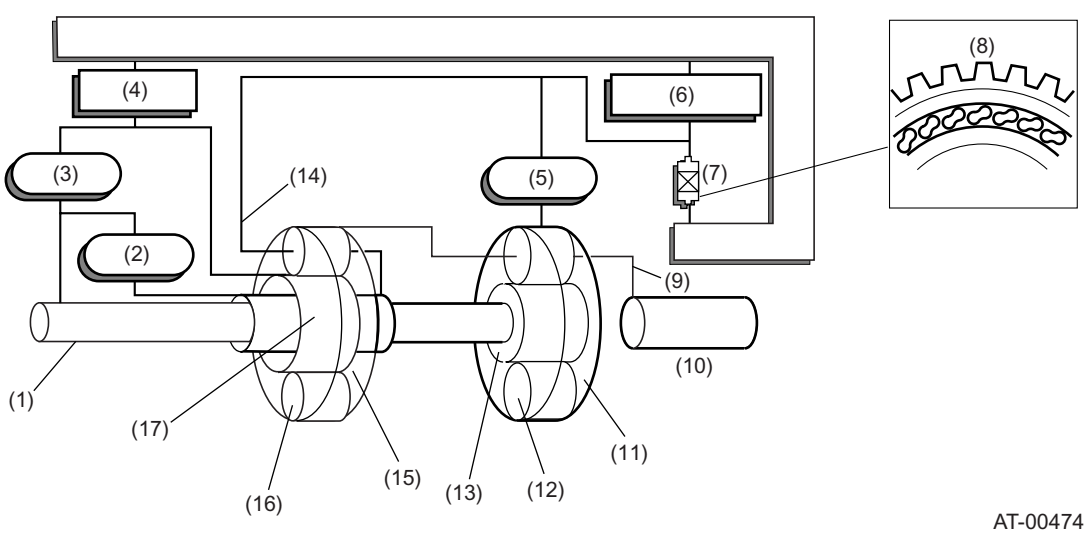
The structure of the control valve is simplified by disusing the accumulator and decreasing the number of mechanical valves. This allowed a two-layered body structure, which contributes to minimizing the size and weight. Also, the transfer hydraulic control mechanism is contained in the control valve.

Oil pressure from the duty solenoid for each clutch will be directly applied to the clutch/brake without flowing through an accumulator, therefore the engagement/disengagement control range is widened and the response during gear shift is improved.

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
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse brake
(7) One-way clutch
(8) Free/locked
(9) Rear planetary carrier
(10) Reduction drive shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Front planetary carrier
(15) Front internal gear
(16) Front pinion gear
(17) Front sun gear

B: OPERATION

1. OPERATION TABLE

Select lever position			Reverse clutch	2-4 brake	High clutch	Low clutch	Low & reverse brake	One-way clutch
	P							
	R		○				○	
	N							
	D	1st				○		○
		2nd		○		○		
		3rd			○	○		
		4th		○	○			
	Manual mode	1st (Above preset speed)				○	○	
		1st (Below preset speed)				○		○
		2nd		○		○		
		3rd			○	○		
		4th		○	○			

AT-02305

2. N RANGE

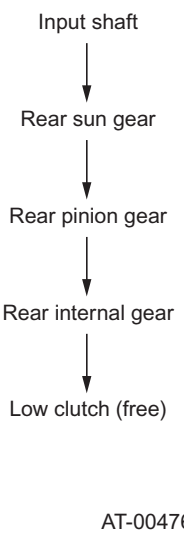
Since the rear sun gear and the high clutch drum are in mesh with the input shaft, they rotate together with the input shaft.

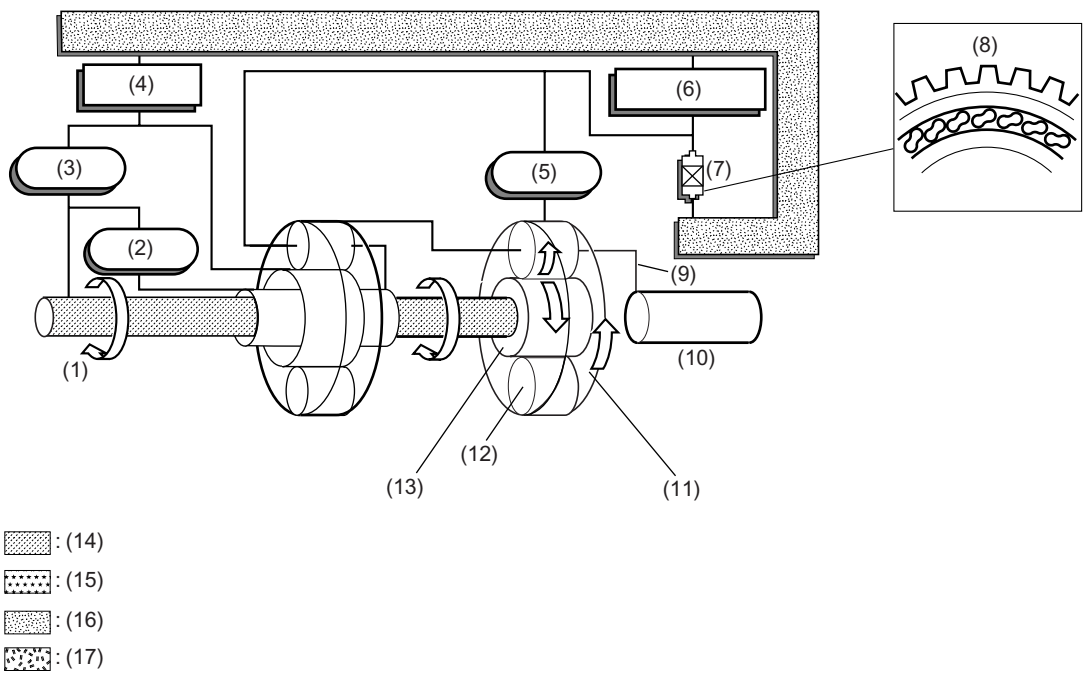
The high clutch drum does not transmit the torque to the planetary unit since the reverse clutch and the high clutch are not engaged.

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	



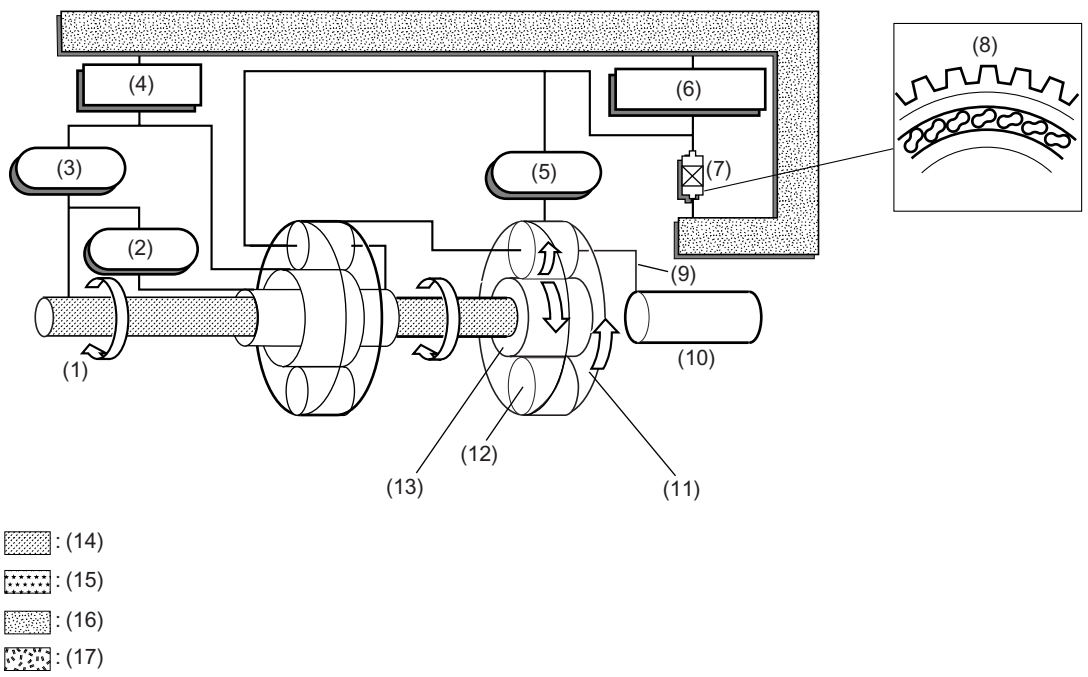
AT-00477

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

3. P RANGE

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

Operating condition of components	Power flow (in acceleration)
All clutches and brakes: disengaged	Input shaft ↓ Rear sun gear ↓ Rear pinion gear ↓ Rear internal gear ↓ Low clutch (free) AT-00476



AT-00477

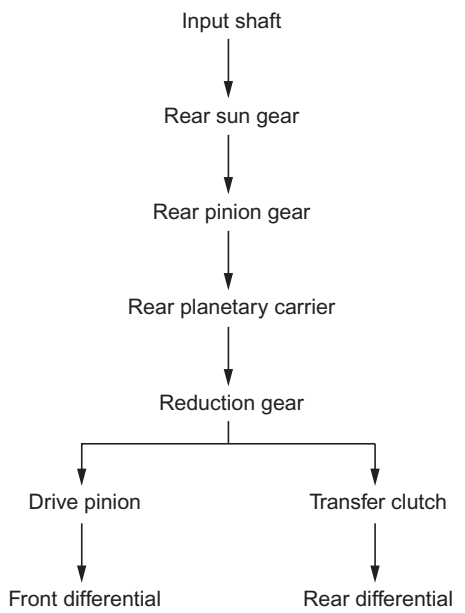
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low & reverse brake
(7) One-way clutch
(8) No effect
(9) Rear planetary carrier
(10) Reduction drive shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Input
(15) Output
(16) Locked
(17) Planetary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

4. 1st GEAR OF D RANGE OR MANUAL MODE (BELOW SET SPEED) (D_1)

When the 1st gear is selected in the D range or in manual mode (below set speed), 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.

Operating condition of components
Low clutch : engaged One-way clutch : locked
Power flow (in acceleration)



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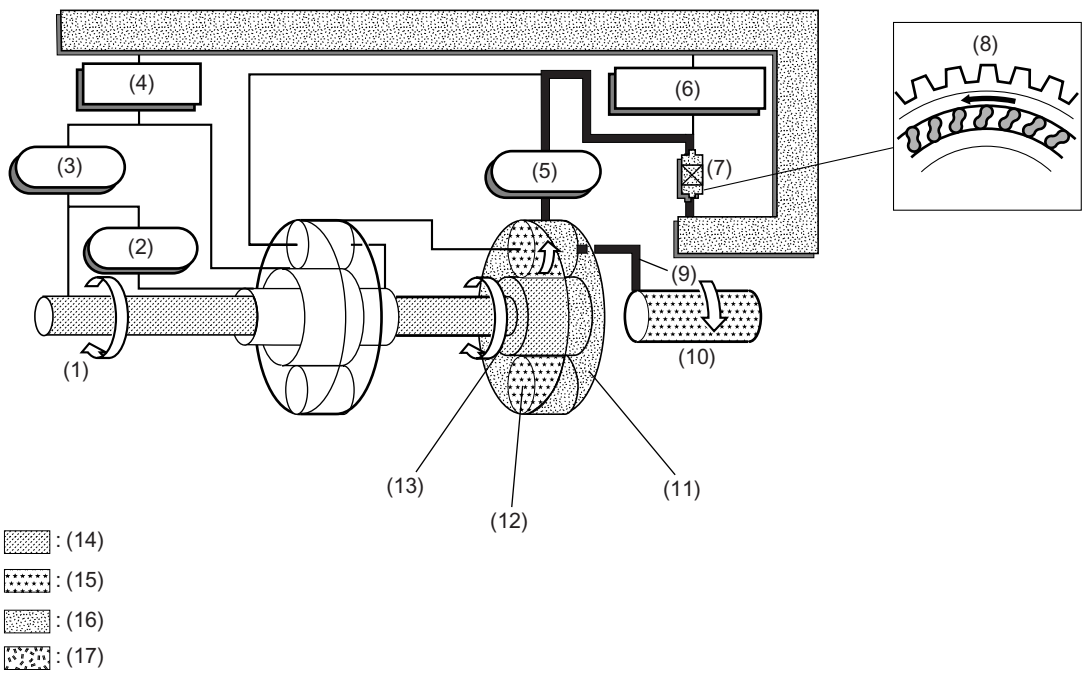


AT-00481

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

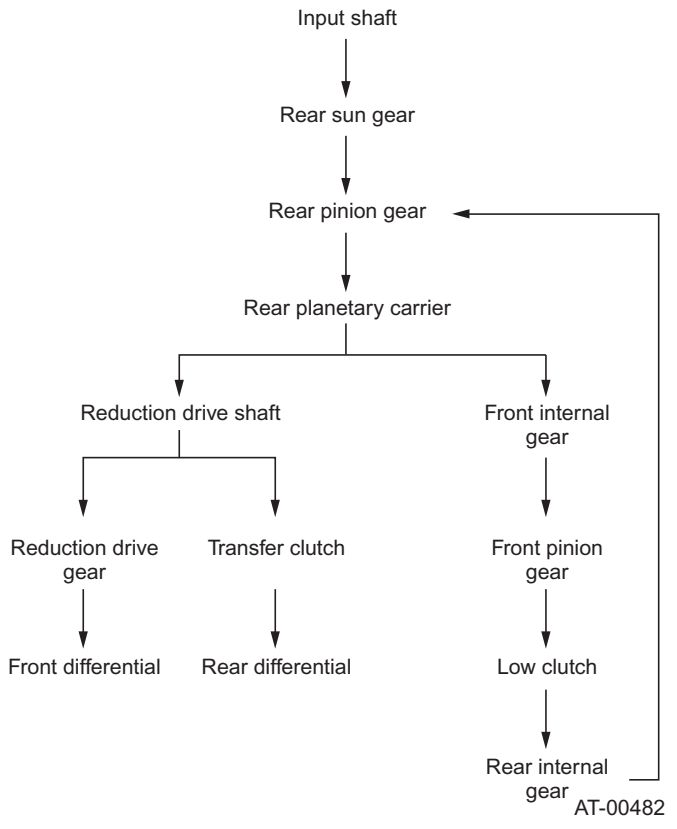
5. 2nd GEAR

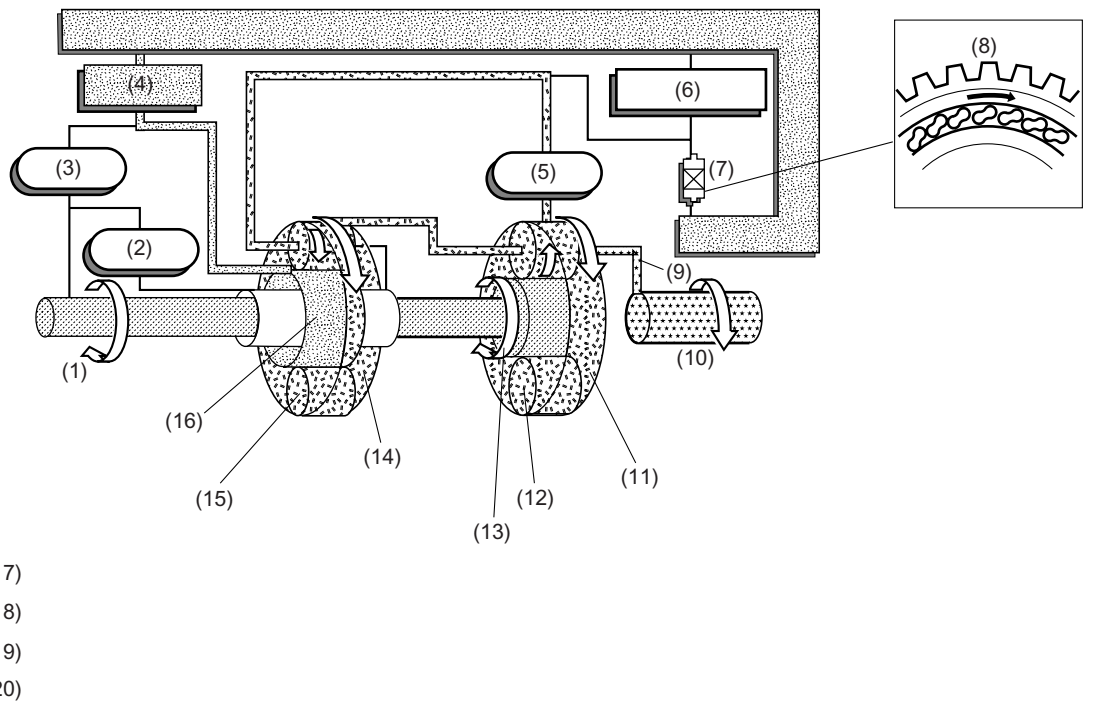
When the 2nd gear is selected, the 2-4 brake and the low clutch are engaged. The front sun gear is now locked to the transmission case due to engagement of the 2-4 brake. In this state, the torque of the rear sun gear is transmitted to the rear internal gear through the path of the front internal gear, 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.

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





AT-00483

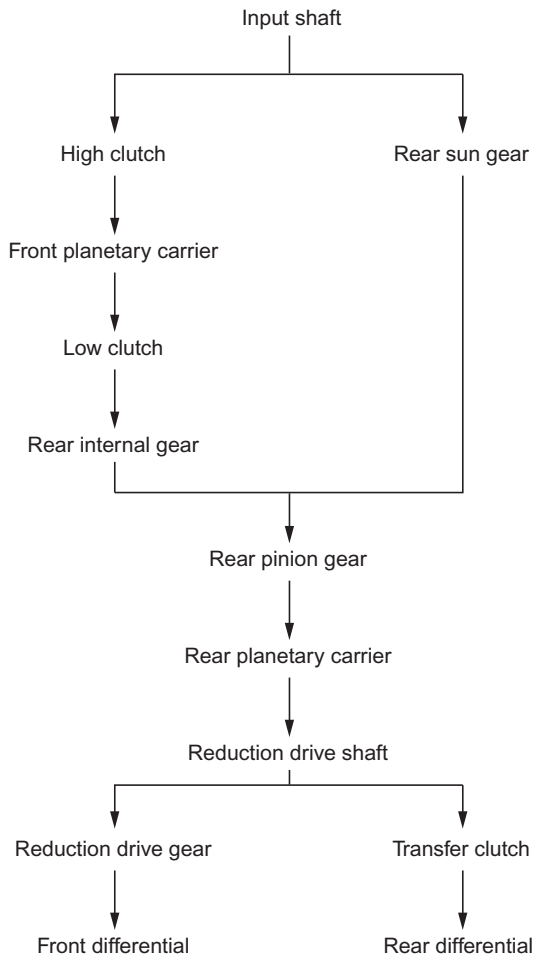
(1) Input shaft
(2) High clutch
(3) Reverse clutch
(4) 2-4 brake
(5) Low clutch
(6) Low and reverse clutch
(7) One-way clutch
(8) Free
(9) Rear planetary carrier
(10) Reduction drive shaft
(11) Rear internal gear
(12) Rear pinion gear
(13) Rear sun gear
(14) Front internal gear
(15) Front pinion gear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

6. 3rd GEAR

When the 3rd gear is selected, 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.

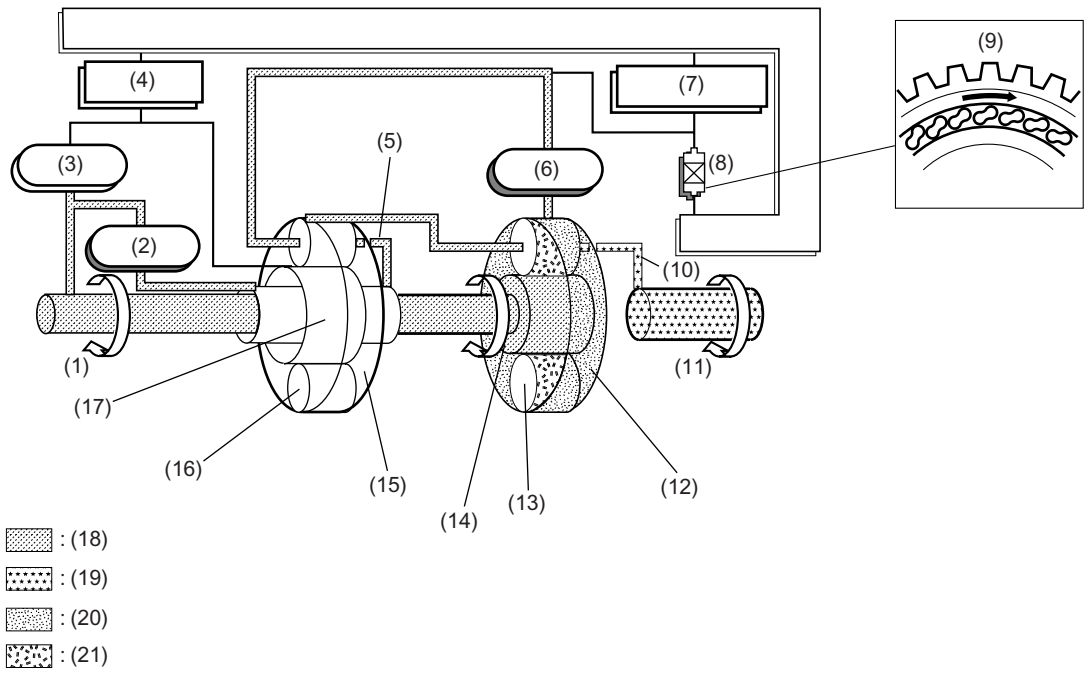
In the 3rd gear, the one-way clutch is freewheeling because the low clutch is rotating clockwise. Since the drive power is transmitted without passing through the one-way clutch, the backward driving force from the wheels is transmitted through the reduction drive shaft to the input shaft; this makes the engine braking effect available.

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



AT-00484

GEAR TRAIN



AT-00485

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

MEMO

7. 4th GEAR

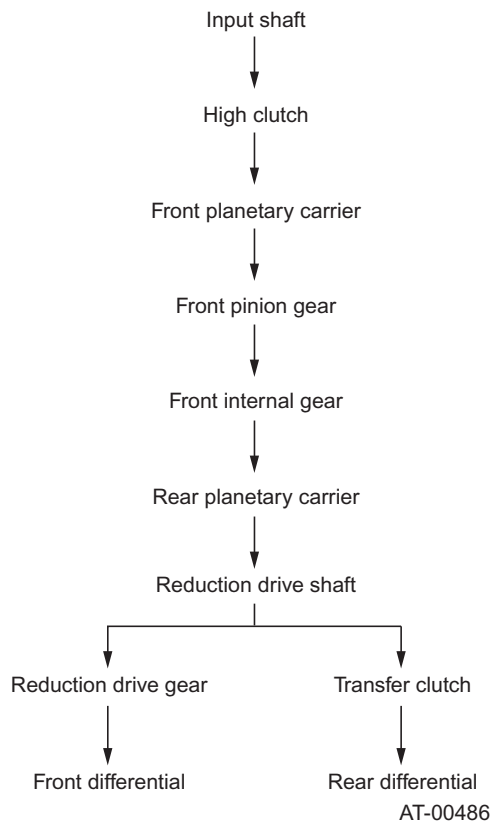
When the 4th gear is selected, the high clutch and the 2-4 brake are engaged. The engaged high clutch causes the front planetary carrier to rotate, whereas the engaged 2-4 brake causes the front sun gear to be locked to the transmission case.

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.

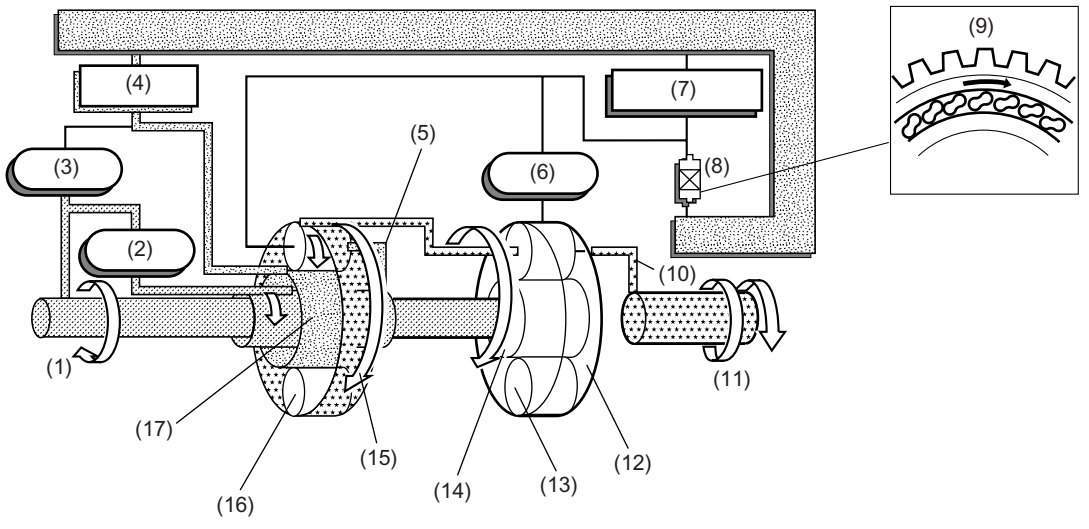
As a result, the reduction drive shaft is driven at a higher speed than the input shaft.

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.

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



GEAR TRAIN



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

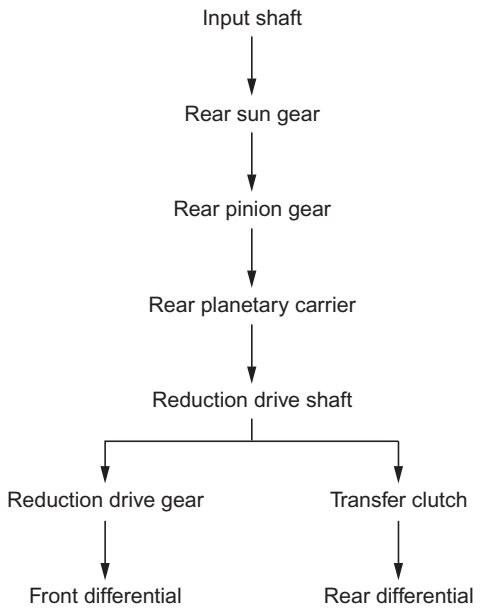
AT-00487

8. 1st SPEED GEAR OF MANUAL MODE (OVER SET SPEED)

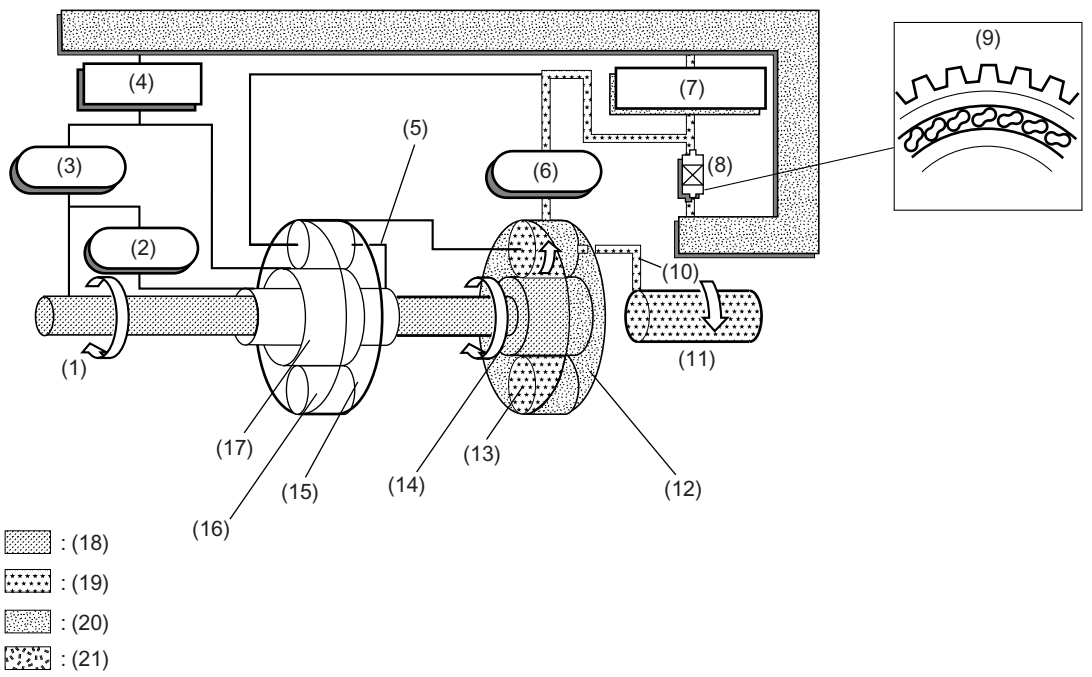
When the 1st gear is selected in manual mode (over set speed), both the low clutch and the low & reverse brake are engaged. Although the power flow configuration is the same as that with the 1st gear in the D range, the one-way clutch produces no freewheeling effect because the low & reverse brake is 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 range, that the engine braking effect is available in this range.

Operating condition of components
Low clutch : engaged Low & reverse brake: engaged One-way clutch : No effect
Power flow (in acceleration)



AT-00488



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

9. R RANGE

When the select 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.

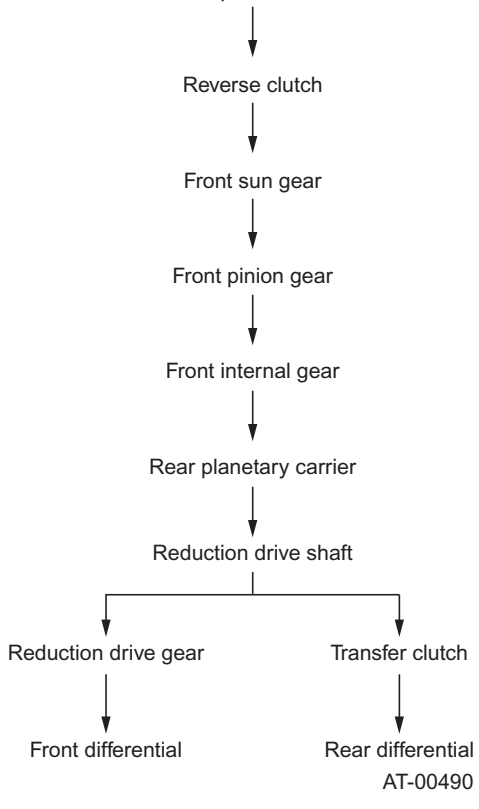
The rotation of the front sun gear causes the front pinion gear to rotate in the opposite direction and therefore the front internal gear rotates in the same direction.

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.

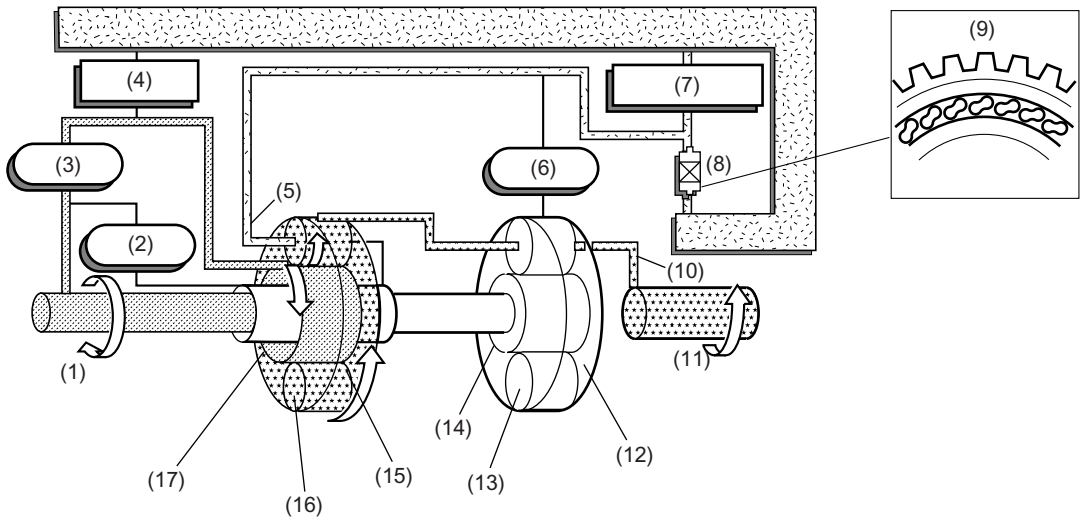
The one-way clutch produces no freewheeling effect because the low & reverse brake is in engagement.

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.

Operating condition of components
Reverse clutch : engaged Low & reverse brake: engaged
Power flow (in acceleration)



GEAR TRAIN



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

AT-00491

10.AWD Transfer System

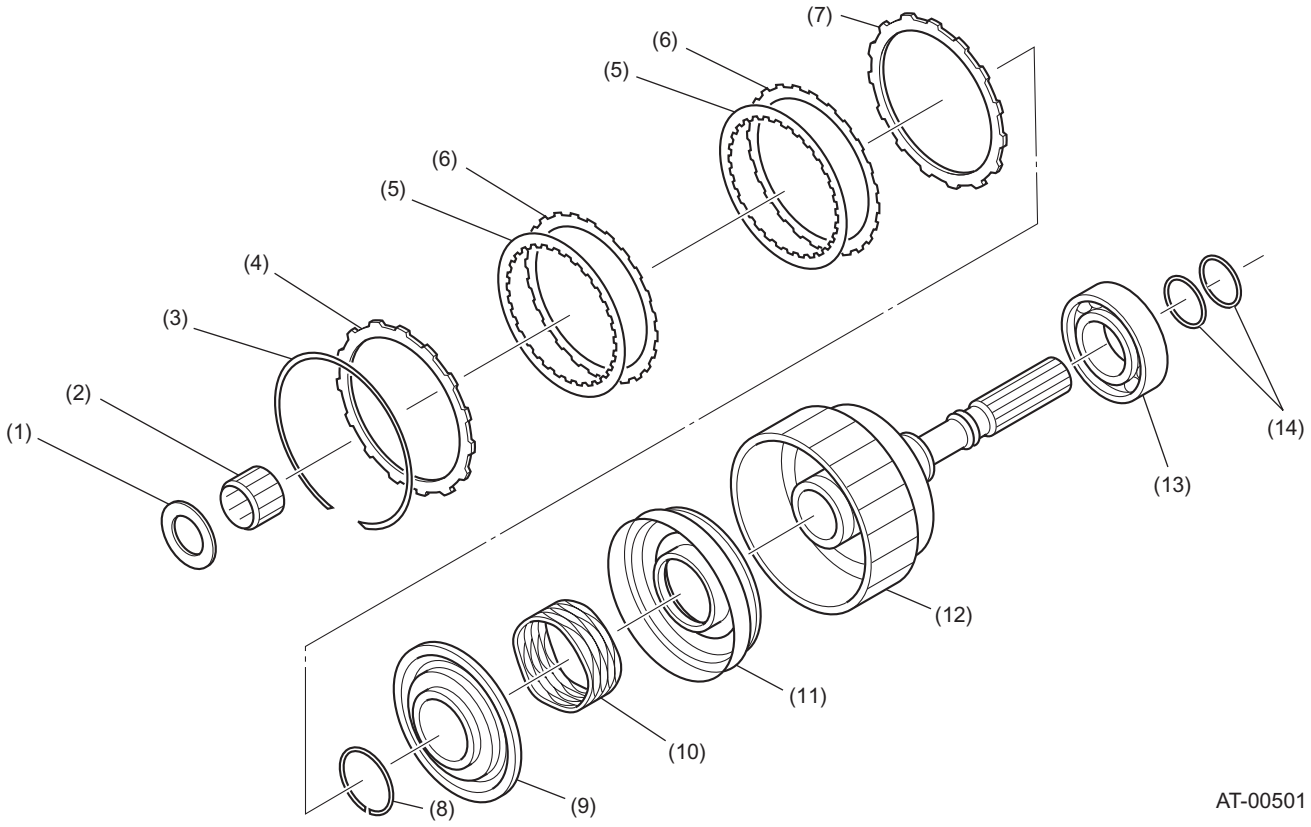
A: GENERAL

This all-wheel-drive (AWD) transfer system uses a hydraulic multi-plate type clutch. The clutch is controlled by the TCM through a control valve.

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 (engine torque, 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.

B: CONSTRUCTION

The transfer clutch drum and rear drive shaft are joined to each other by welding. The rear drive shaft is provided with oil passages for transfer clutch control.

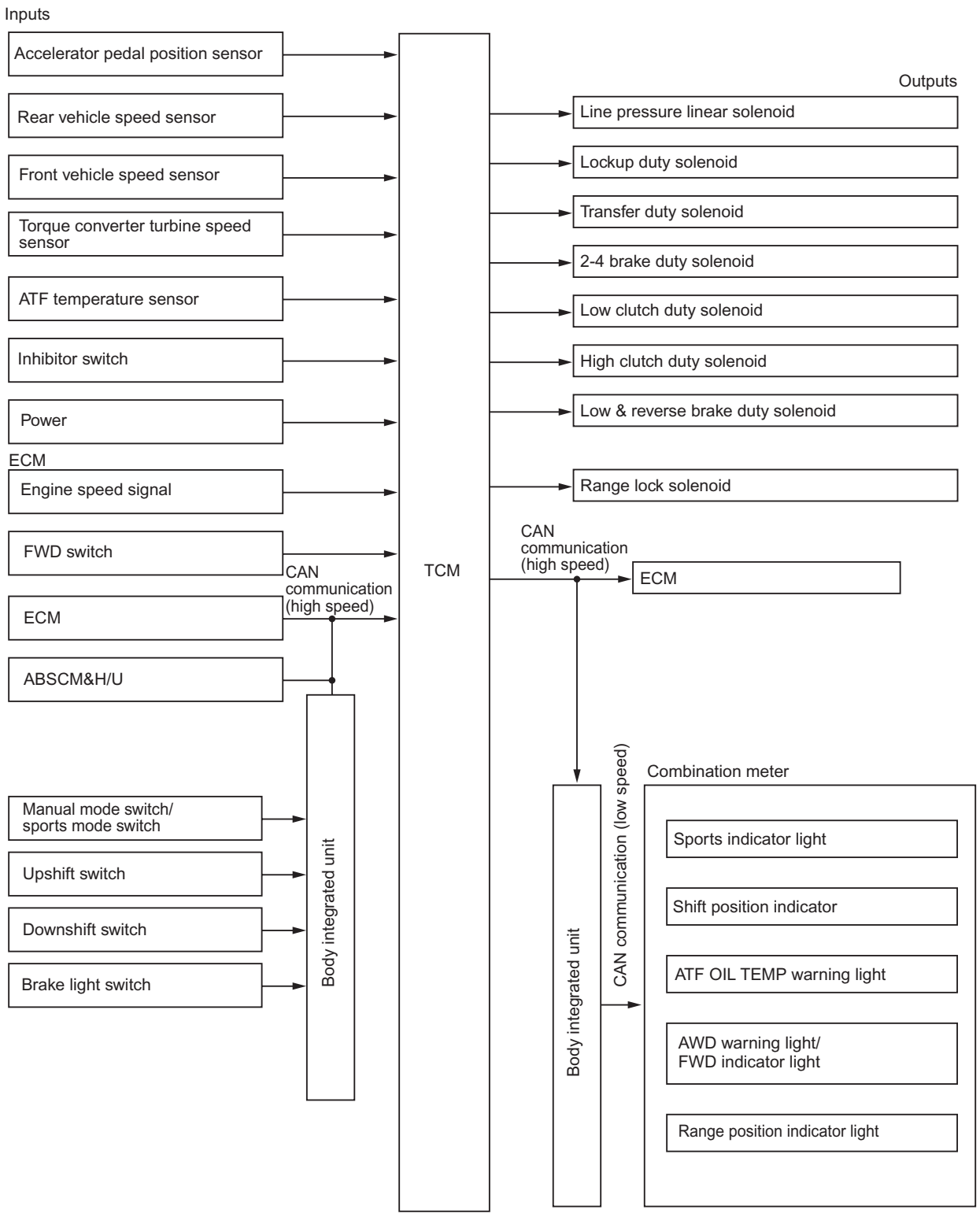


(1) Thrust bearing
(2) Needle bearing
(3) Snap ring
(4) Pressure plate
(5) Drive plate
(6) Driven plate
(7) Pressure plate
(8) Snap ring
(9) Transfer piston seal
(10) Return spring
(11) Transfer clutch piston
(12) Rear drive shaft
(13) Ball bearing
(14) Seal ring

11.Electro-hydraulic Control System

A: GENERAL

The electro-hydraulic control system for the transmission and transfer consists of various sensors and switches, a transmission control module (TCM) and the control valves including solenoid valves. The system controls the automatic transmission operation, including gear shifting, lockup clutch operation, line pressure, pattern selection (NORMAL and SPORTS), and gear-shift timing. It also controls the operation of the transfer clutch. The TCM determines the vehicle's operating conditions from various input signals and controls a total of seven solenoids (line pressure linear solenoid, lockup duty solenoid, 2-4 brake duty solenoid, low clutch duty solenoid, high clutch duty solenoid, low & reverse duty solenoid, and transfer duty solenoid) by sending appropriate signals to them.


Inputs
Accelerator pedal position sensor
Rear vehicle speed sensor
Front vehicle speed sensor
Torque converter turbine speed sensor
ATF temperature sensor
Inhibitor switch
Power
ECM
Engine speed signal
FWD switch
CAN communication (high speed)
ECM
ABSCM&H/U
Manual mode switch/ sports mode switch
Upshift switch
Downshift switch
Brake light switch
Body integrated unit
TCM
Outputs
Line pressure linear solenoid
Lockup duty solenoid
Transfer duty solenoid
2-4 brake duty solenoid
Low clutch duty solenoid
High clutch duty solenoid
Low & reverse brake duty solenoid
Range lock solenoid
CAN communication (high speed)
ECM
Body integrated unit
CAN communication (low speed)
Combination meter
Sports indicator light
Shift position indicator
ATF OIL TEMP warning light
AWD warning light/ FWD indicator light
Range position indicator light

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B: INPUT SIGNALS

Signal name	Major function
Accelerator pedal position sensor	Indicates the throttle opening. This signal is used to determine shift point, line pressure, and lockup 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, lockup 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 lockup clutch to ensure smooth engagement.
Inhibitor switch	Used to determine gears and line pressures in each of ranges P, R, N, and D.
ATF temperature sensor	Indicates the ATF temperature. This signal is used for inhibition of lockup, release of OD and determination of ATF temperature.
FWD switch	Used for changing the mode from AWD to FWD. Also used for adapting the vehicle to FWD tester roller. Changeover from AWD to FWD can be made by inserting a fuse into the fuse holder.
Torque converter turbine speed sensor	Tells the rotation speed of the input shaft. The proportion of this speed to the vehicle speed determines whether shifting should be made or not.
CAN communication signals	Receives information from ECM, ABSCM and body integrated unit to control the transmission.

C: OUTPUT SIGNALS

Signal name	Function
Line pressure linear solenoid	Regulates the line pressure according to driving conditions.
Lockup duty solenoid	Regulates the hydraulic pressure of the lockup clutch to operate it in three modes (open, smooth and lockup).
Transfer duty solenoid	Regulates the hydraulic pressure of the transfer clutch to control the driving force to the rear drive shaft.
2-4 brake duty solenoid	Regulates 2-4 brake operating pressure to reduce shifting shocks.
High clutch duty solenoid	Regulates high clutch operating pressure to reduce shifting shocks.
Low clutch duty solenoid	Regulates low clutch operating pressure to reduce shifting shocks.
Low & reverse duty solenoid	Regulates low & reverse brake operating pressure to reduce shifting shocks.
Shift lock solenoid	Controls the shift lock solenoid during range lock control.
CAN communication signals	Outputs transmission information to control modules and the body integrated unit.

D: CONTROL ITEMS

Control items			Description of control
Transmission control	Shifting control	Base shift control	Upshifting and downshifting are set for each range, gear and pattern according to the accelerator pedal position and vehicle speed.
		ABS-in-operation control	Gear speed is determined according to vehicle speed when ABS signal and brake signal is input.
		ATF low temperature control	Shifting into 4th gear is prevented when ATF temperature is below the preset value.
		Sports pattern control (SPORTS light ON)	Sports pattern is selected when the select lever is moved to the manual mode position.
		Base pattern control (SPORTS light OFF)	Base pattern is selected when the select lever is in D range.
	Lockup control	Base lockup control	Lockup control is performed according to throttle position and vehicle speed. (Basically lockup is OFF during gear shifting.)
		Smooth control	Smooth lockup is performed when lockup is switched on.
	Line pressure control	Ordinary control	Line pressure is regulated according to the accelerator pedal position and vehicle speed signals.
	Shift timing control	Gear speed control	Controls each solenoid.
		Lockup control	When shifting, the lockup clutch is temporarily released.
	Adaptive control	Accelerator pedal quick return control	When the accelerator pedal is quickly released from a depressed condition, the gear is held in the current speed.
		Accelerator pedal quick depressing control	When the accelerator pedal is quickly depressed, the transmission down shifts immediately.
		Map switch control	Switches the shift point setting according to the driving condition.
		Braking control	To ensure engine braking effect during braking and improve the re-acceleration performance, the transmission is downshifted in accordance with the deceleration.
	CAN communication signals control		Sends and receives vehicle information between control modules and controls each module.
AWD transfer clutch control	Ordinary transfer control		Transfer clutch pressure is regulated according to the throttle valve angle, vehicle speed, and engine torque.
	Slip control		Regulates transfer clutch pressure in accordance with the amount of slip.
	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.

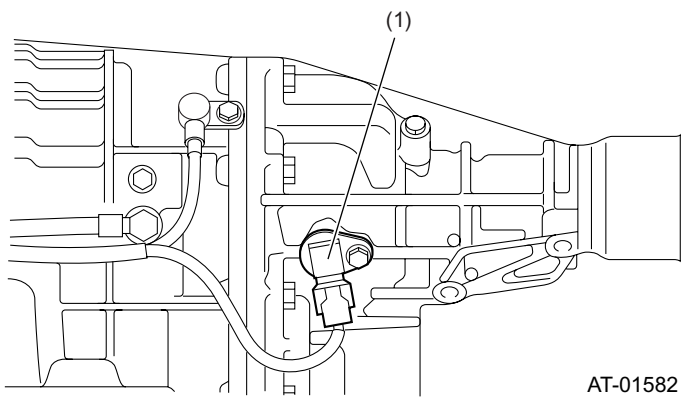
12.Sensor Systems

A: ACCELERATOR PEDAL POSITION SENSOR

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

B: REAR VEHICLE SPEED SENSOR

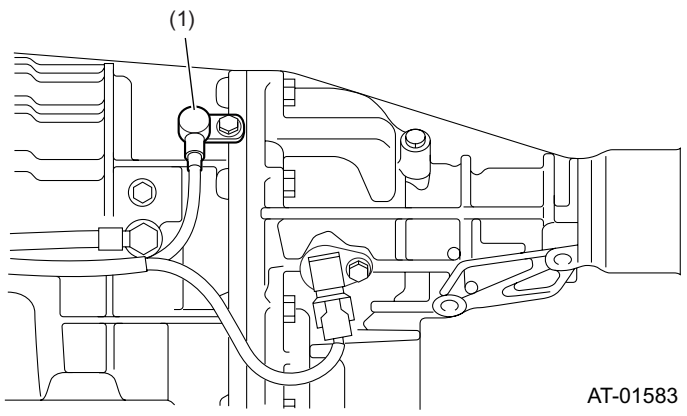
This vehicle speed sensor (output shaft speed sensor) is a Hall element type sensor and is externally mounted on the extension case. It detects the rear drive shaft speed in terms of the peripheral speed of the transfer clutch drum and sends pulse signals (30 pulses per rotation) to the TCM.



(1) Rear vehicle speed sensor

C: FRONT VEHICLE SPEED SENSOR

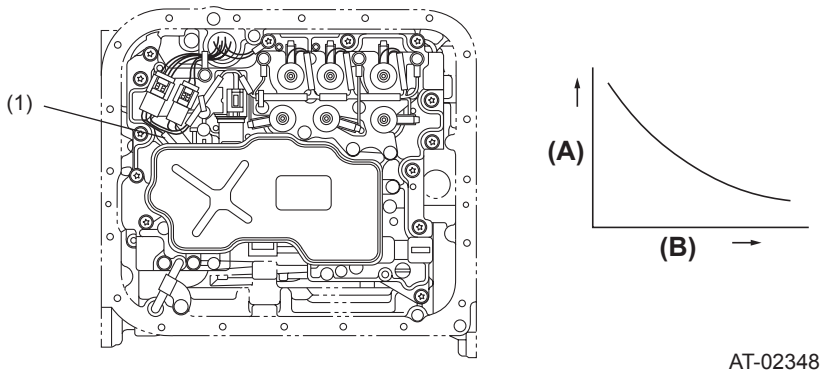
This vehicle speed sensor (output shaft speed sensor) is externally mounted on the transmission case. It detects the front drive pinion shaft speed and sends sine wave signals (16 pulses per rotation) to the TCM.



(1) Front vehicle speed sensor

D: ATF TEMPERATURE SENSOR

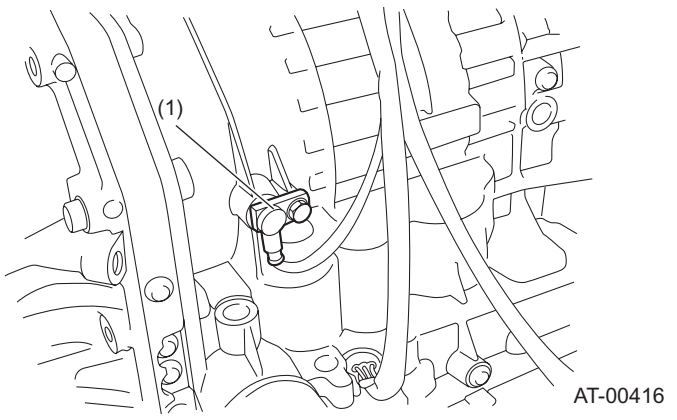
This sensor is integrated with the transmission harness and is mounted on the transmission control valve body. Its resistance varies in accordance with the ATF temperature. The characteristics of the sensor are as shown below.



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

E: 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 converts this signal into turbine speed to use it for shifting control.



(1) Torque converter turbine speed sensor

F: INHIBITOR SWITCH

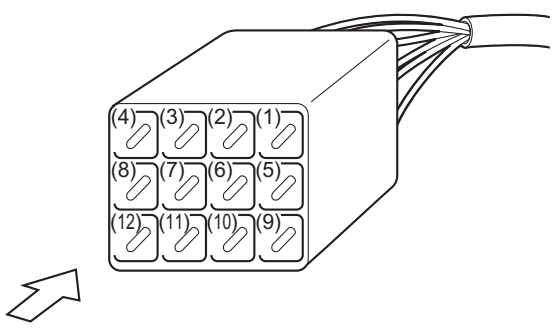
The inhibitor switch assures safety when starting the engine. This switch is mounted on the right side of the transmission case, and is operated by the selector lever.

When the selector lever is set to P or N, the electrical circuit in the inhibitor switch is connected to the starter circuit to enable cranking of the engine.

When the selector lever is in the R or D range, the electrical circuit in the inhibitor switch is disconnected. 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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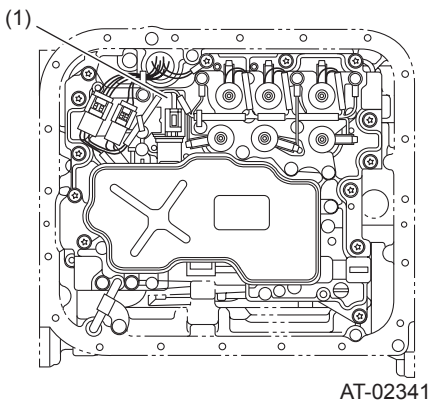
Range position	Pin No.
P	(4) — (3) (12) — (11)
R	(4) — (2) (10) — (9)
N	(4) — (1) (12) — (11)
D	(4) — (8)

G: LINE PRESSURE LINEAR SOLENOID

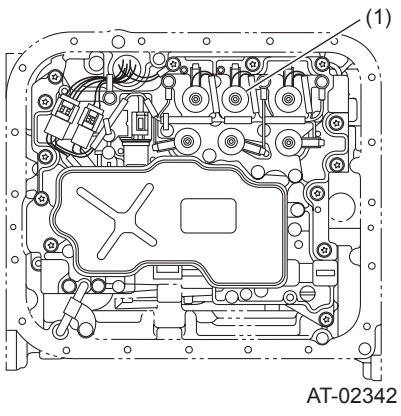
This solenoid is mounted on the transmission control valve. This adjusts the line pressure in response to electrical current instructions from the TCM. The line pressure is regulated to an optimum level according to the driving condition.



(1) Line pressure linear solenoid 2

H: 2-4 BRAKE DUTY SOLENOID

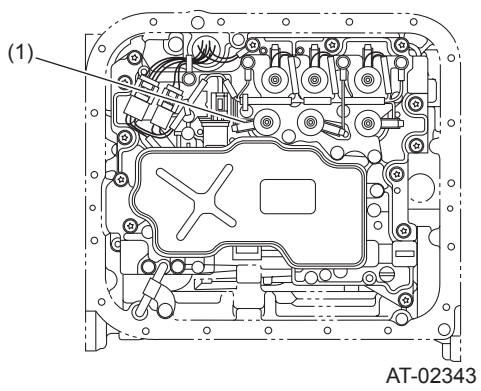
This solenoid is mounted on the transmission control valve. This adjusts the pressure applied to the 2-4 brake in response to the duty instructions from the TCM. The engaging force of the 2-4 brake during shifting is properly controlled and shift shocks are reduced.



(1) 2-4 brake duty solenoid

I: LOCKUP DUTY SOLENOID

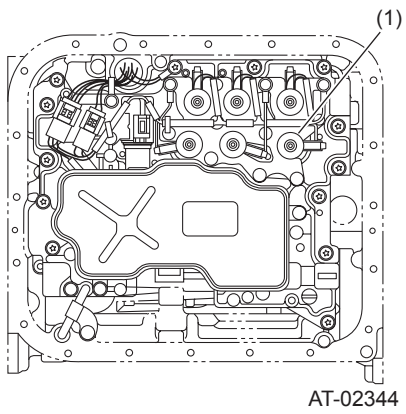
This solenoid is mounted on the transmission control valve. Its duty ratio is controlled by signals from the TCM. The solenoid provides smooth engagement and disengagement of the lockup clutch.



(1) Lockup duty solenoid

J: LOW CLUTCH DUTY SOLENOID

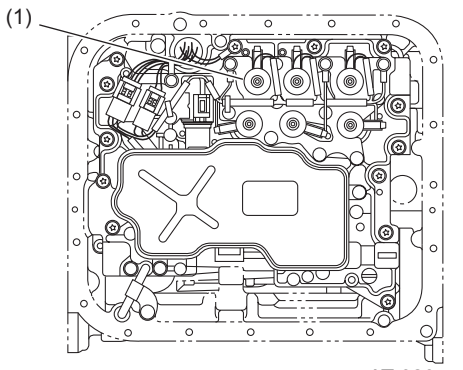
This solenoid is mounted on the transmission control valve. This adjusts the pressure applied to the low clutch in response to the duty instructions from the TCM. The engaging force of the low clutch during shifting is properly controlled and shift shocks are reduced.



(1) Low clutch duty solenoid

K: HIGH CLUTCH DUTY SOLENOID

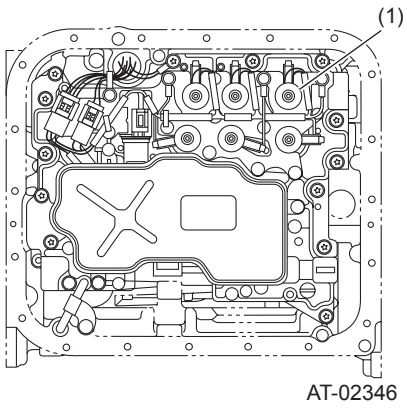
This solenoid is mounted on the transmission control valve. This adjusts the pressure applied to the high clutch in response to the duty instructions from the TCM. The engaging force of the high clutch during shifting is properly controlled and shift shocks are reduced.



(1) High clutch duty solenoid

L: LOW & REVERSE BRAKE DUTY SOLENOID

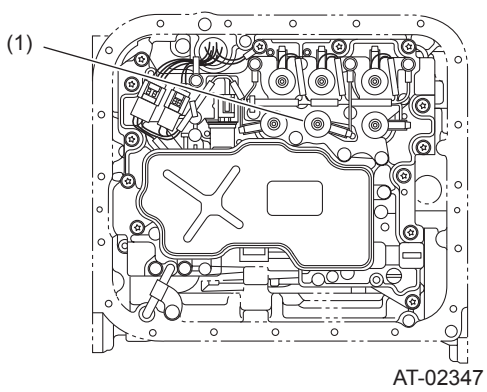
This solenoid is mounted on the transmission control valve. This adjusts the pressure applied to the low & reverse brake in response to the duty instructions from the TCM. The engaging force of the low & reverse brake during shifting is properly controlled and shift shocks are reduced.



(1) Low & reverse brake duty solenoid

M: TRANSFER DUTY SOLENOID

This solenoid is mounted on the transmission control valve. This adjusts the pressure applied to the transfer in response to the duty instructions from the TCM. Torque distribution to the front and rear is controlled by properly controlling the engagement force of the transfer clutch.



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(1) Transfer duty solenoid

13.Transmission Control Module (TCM)

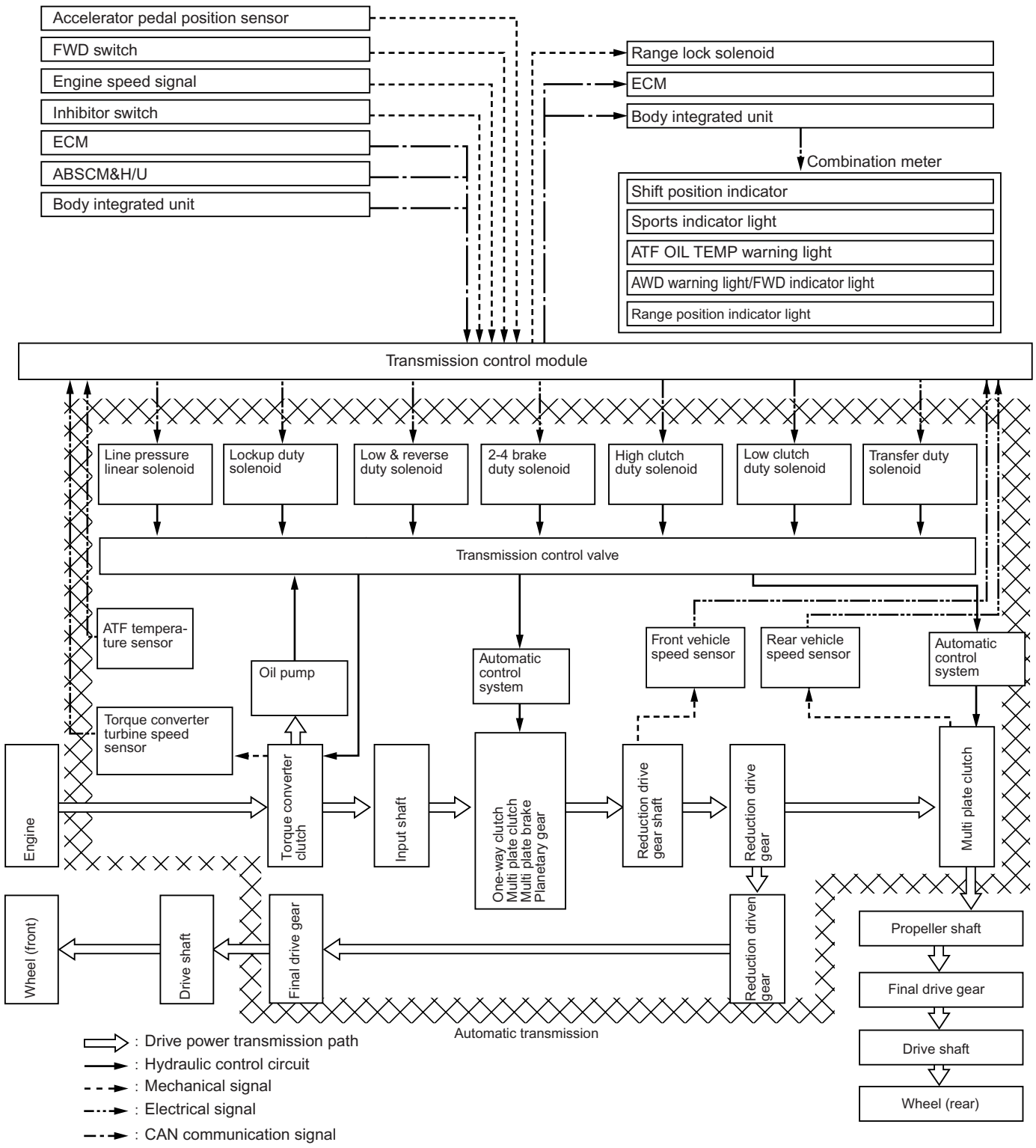
The TCM receives various sensor signals and determines the running conditions of the vehicle. It then sends control signals to each solenoid according to the preset gearshift characteristic data, lockup operation data, and transfer clutch torque data (duty ratios).

A: CONTROL SYSTEM

Control items		Input signals
Shifting control	Ordinary shift control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed signal Range signal
	ABS-in-operation control	ABS signal Rear vehicle speed signal Front vehicle speed signal Brake switch signal
	Shift pattern select control	Cruise control signal ATF temperature signal Accelerator pedal position signal Manual mode switch signal
	Grade control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Brake switch signal Range signal Engine speed signal Engine torque signal
	Sports shift control	CAN communication signals (sports mode switch, upshift switch, downshift switch) Front vehicle speed signal Rear vehicle speed signal Engine speed signal ATF temperature signal Range signal
	Adaptive control	Accelerator pedal position signal Front vehicle speed signal Rear vehicle speed signal Engine speed signal ATF temperature signal Brake switch signal Torque converter turbine speed signal
Lockup control	Ordinary lockup control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed signal Range signal
	Hydraulic oil temperature control	ATF temperature sensor

Control items		Input signals
Oil pressure control	Ordinary pressure control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed signal Inhibitor switch signal ATF temperature signal
	Shifting control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed signal Torque converter turbine speed signal Range signal ATF temperature signal
AWD transfer clutch control	Ordinary transfer control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Range signal ATF temperature signal FWD switch signal
	Slip detection control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal
	Steering control	Throttle position signal Rear vehicle speed signal Front vehicle speed signal
	ABS-in-operation control	ABS signal Rear vehicle speed signal Front vehicle speed signal Brake switch signal
Range lock control		Front vehicle speed signal Rear vehicle speed signal Range signal

B: SCHEMATIC DIAGRAM



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C: SHIFTING CONTROL

1. ORDINARY SHIFT CONTROL

The TCM controls each solenoid based on input signal information such as inhibitor switch signals, vehicle speed signals and accelerator pedal position signals, to automatically select the optimum gear position from the shifting map.

2. ENGINE COOPERATIVE CONTROL

During shifting, the TCM outputs a torque-down requirement signal, and the ECM receives this to retard the ignition timing of each cylinder to temporary decrease the output torque from the engine. Simultaneously with this control, the TCM constantly monitors the shift sequence through vehicle speed sensors and the turbine speed sensor to perform feedback control and optimize gear shifts. Because of this control, a smooth and comfortable gear shifting is ensured under all conditions.

3. ABS COOPERATIVE CONTROL

When the ABS is operating, the optimum gear speed for the vehicle speed is selected by cooperative operation with the ABSCM to prevent degrading the operation of the ABS.

4. CONTROL AT HIGH OIL TEMPERATURES

If the ATF temperature becomes extremely high, shifting control is performed by automatically switching to a shifting map that is less likely to cause temperature rise.

5. CONTROL WHEN ATF OR ENGINE COOLANT TEMPERATURE IS LOW

When the ATF temperature or engine coolant temperature is extremely low at engine start, etc., shifting control is performed by automatically switching to a shifting map that causes temperature rise easier.

6. CONTROL WHEN CRUISE CONTROL IN OPERATION

When the cruise control is operating, shifting control is performed by automatically switching to a shifting map that is suitable for cruise control.

D: LOCKUP CONTROL

● The TCM has pre-programmed lockup clutch engagement and disengagement conditions for each gear and shift pattern.The engagement and disengagement conditions are defined in terms of the accelerator pedal position and vehicle speed.

● The TCM controls lockup clutch operation through duty solenoids.

1. NON-LOCKUP OPERATION

The duty solenoid allows the pilot pressure to be applied to the disengaging end of the valve in the control valve body. The valve then opens the clutch disengaging circuit port to add the lockup operating pressure (torque converter clutch regulating pressure) to the disengaging circuit. Moreover, the valve opens the lockup clutch engaging circuit port and allows the hydraulic fluid in the circuit to flow to the ATF cooler, thus lowering the pressure in the circuit. As a result, the lockup clutch is disengaged due to difference in pressure between both circuits.

This control is performed in all gear positions.

2. LOCKUP OPERATION

The duty solenoid allows the pilot pressure to be applied to the engaging end of the valve in the control valve body. The valve then opens the clutch engaging circuit port that communicates to the torque converters impeller chamber, allowing high pressure fluid to flow to the lockup clutch. The clutch then engages.

● The TCM controls the current to the duty solenoid by gradually changing the current.As a result, the valve also moves gradually, so the clutch engagement pressure increases smoothly. This causes the lockup clutch to become initially in a half-engaged state and then in a fully engaged state, thus preventing shock during engagement.
This control is performed in all gear positions.

E: LINE PRESSURE CONTROL

The oil pump discharge pressure (line pressure) is controlled by the line pressure linear solenoid and the line pressure is regulated to an optimum level corresponding to the vehicle's running conditions.

1. LINE-PRESSURE CONTROL DURING SHIFTING

The line pressure is controlled by the TCM as follows to meet varying operating conditions.

● The TCM receives throttle angle signals, and the TCM sends a control signal to the line pressure linear solenoid. The pressure from the line pressure linear solenoid is sent to the valve where the line pressure is regulated. The valve adjusts the oil-pump-generated line pressure to make the line pressure matched to the driving condition.

F: SHIFT PATTERN SELECTION CONTROL

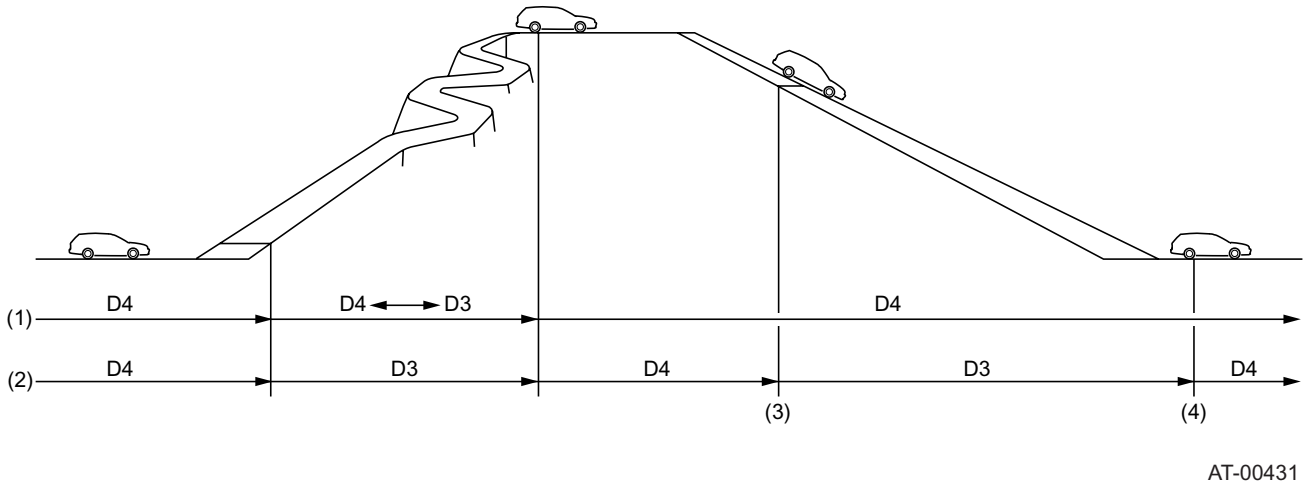
1. ADAPTIVE CONTROL

This control is performed to improve the drivability of the vehicle by optimizing gear shifts in accordance with the drivers intention to accelerate or decelerate, and driving conditions such as hill climbing and descending, etc.

● Shift pattern automatic switching control
This control enables selection of the optimum gear speed by automatically switching the shift pattern by estimating driver's intentions and driving conditions through sensor information such as driving resistance, engine speed, acceleration, vehicle speed, and also from calculated values.
Any of the three patterns NORMAL, SPORTS, and SLOPE are continuously and automatically selected under the following conditions.

D range
NORMAL⇔SPORTS⇔SLOPE
D range, in sports mode
SPORTS⇔SLOPE

Normal pattern: covers a wide range from normal driving to high speed driving.
Sports pattern: a shift pattern suitable for driving conditions requiring deep accelerator pedal positions, such as winding road driving.
Slope pattern: this shift pattern controls upshifting to prevent too frequent gear shifting during climbing or descending hills. By combining braking control (in sports mode only) (explained later), engine braking will be positively used when descending hills.



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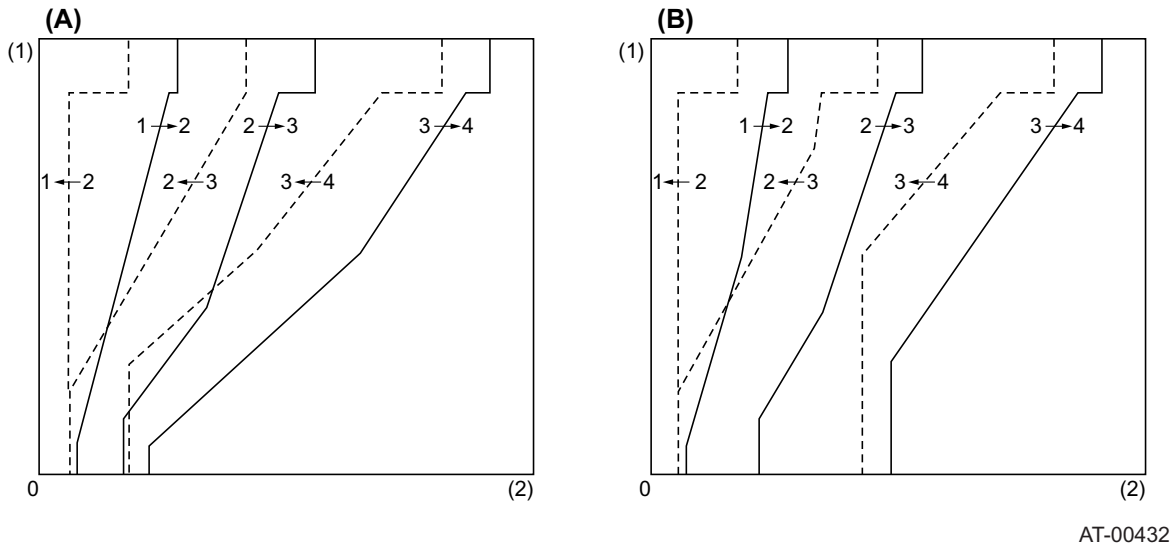
(1) Without climbing and descending control
(2) With climbing and descending control
(3) Brake pedal ON
(4) Re-acceleration



(A) Base pattern
(1) Accelerator pedal position
(B) Grade control pattern
(2) Vehicle speed

● Accelerator pedal quick depressing control
When the accelerator pedal is quickly depressed, the TCM interprets this as acceleration is required, and the transmission is downshifted earlier to obtain a greater drive force.

● Accelerator pedal quick return control
When the accelerator pedal is quickly released, the TCM interprets this as deceleration is required, and upshift is prohibited in order to hold the transmission in the current gear speed to prevent frequent shifting and to maintain engine braking effect (operates in sports mode only).

● Braking control
According to the braking force (deceleration) during braking, downshifts are hastened to ensure engine braking effect and obtain a larger driving power for accelerating after braking (operates in sports mode only).

2. SPORTS MODE CONTROL

When the shift lever is moved toward the manual gate side in D range, the SPORT light in the combination meter illuminates and the system enters the Sports mode. Gearshift timings are set at higher vehicle and engine speeds to make more use of low speed gears. The full lockup vehicle speed in 4th is also set higher than in the normal mode.

3. MANUAL MODE CONTROL

By operating the “+” or “–” switch on the select lever in D range with the sports shift switch ON (in sports mode), the system switches to manual mode. In this state, operating the “+” switch causes upshifting while operating the “–” switch causes downshifting; manual shifting is enabled and the selected gear position is held while driving.

However, at certain vehicle speeds or ATF temperatures, the following inhibiting control is performed.

● Upshift inhibiting and auto downshift control
The gear upshifts each time the “+” switch is operated, however, when the vehicle speed is too low

for the selected gear speed, the TCM inhibits further upshifting.If the vehicle speed becomes too slow for the current gear speed, a downshift will be made automatically to prevent engine stall. When the vehicle comes to a stop, the transmission will always be controlled to shift to 1st speed unless the vehicle was in Manual mode 2nd hold control.

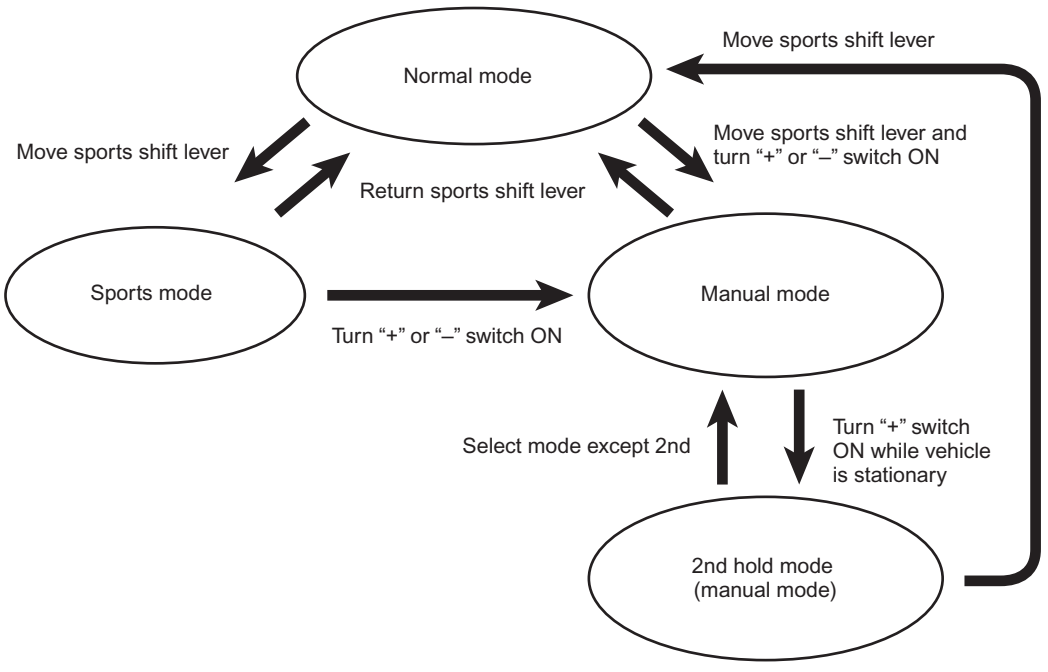
● Downshift inhibiting control
The gear downshifts each time the "–" switch is operated, however, when the vehicle speed is too low for the selected gear speed, the TCM inhibits further shifting.A manual shifting inhibiting buzzer will sound to warn the driver.

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

● Control when the temperature is low or hot
When the ATF temperature is low as in cases such as immediately after start in winter, upshifting to 4th is inhibited to quicken warm up. Upshifting to 4th is also inhibited if the ATF temperature becomes extremely high after severe driving, to prevent further temperature rise.

4. 2nd HOLD CONTROL (IN MANUAL MODE)

When the "+" switch is operated when the vehicle is in Manual mode and not moving, the transmission shifts to 2nd speed enabling start in 2nd.This status is held unless the manual mode is canceled, or a speed other than 2nd is selected with the "–" switch. Also, the transmission is held in 2nd when the vehicle is stopped.



AT-02340

5. ILLUMINATION CONTROL OF VARIOUS INDICATORS

Illuminations of the various indicators on the combination meter are controlled in accordance with the shift pattern selection as shown below.

Indicator / Status	D ●	SPORT	▲▼	1	Operation mode
Normal D range	D ●	SPORT	△▽	(extinguished)	Normal mode
In sports mode	D ●	SPORT	△▽	(extinguished)	Sports mode
Manual shift mode	D ○	SPORT	▲▼	1 — 4	Manual mode

NOTE:
Indicators printed in solid black show their illuminated status.

AT-02881

G: LEARNING CONTROL OF SHIFTING HYDRAULIC PRESSURES

To constantly ensure excellent shift quality regardless of the variance between friction material and aging, learning control of shifting hydraulic pressures is used.

Learning takes place for every normal shifting under certain conditions, and the learned values are not lost even when the power is turned OFF (or battery's negative terminal disconnected).

H: RANGE LOCK CONTROL

This control prevents the select lever from being moved to the R position when the vehicle is running. Thus damage to components such as the reverse clutch is prevented.

When the specified speed is exceeded the TCM turns off the shift lock solenoid for the select lever. Therefore the range lock control works to inhibit operation from N range to R range, preventing the transmission from put into reverse.

I: CAN COMMUNICATION SIGNALS CONTROL

By interchanging information between control modules such as the TCM, ECM, ABSCM & H/U, etc., the modules are controlled in accordance with the vehicle's driving conditions.

In CAN (Controller Area Network) communication, each control module is connected with 2 lines and a large amount of information is interchanged through such a small number of wiring. Each control module sends and receives information and reads only the necessary information for its own purpose.

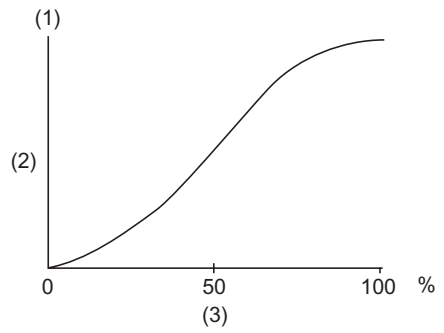
Main signals sent and received for transmission control

	TCM	ECM	ABSCM&H/U	Body integrated unit	Combination meter
Sports mode switch-cum-manual mode switch signal	IN			OUT	
Upshift signal (manual mode)	IN			OUT	
Downshift signal (manual mode)	IN			OUT	
Brake switch signal	IN			OUT	
ABS signal	IN		OUT		
ENG AT cooperation signal	IN	OUT			
	OUT	IN			
Range position signal	OUT	IN		IN/OUT	IN
AT warning light signal (SPORT indicator light)	OUT			IN/OUT	IN
Sports shift warning buzzer signal	OUT			IN/OUT	IN
AWD warning light signal Also used as FWD indicator light signal	OUT			IN/OUT	IN

IN: received
OUT: sent

J: AWD TRANSFER CLUTCH CONTROL

● Basic control

Type of control	Regulates transfer clutch pressure in response to engine torque, throttle position and vehicle speed.
Gear position	1st thru 4th and reverse
Remarks	 AT-01761 (1) Ordinary control (2) Transfer clutch capacity (3) Duty-ratio

● Slip control

Type of control	Regulates transfer clutch pressure in accordance with the amount of slip.
Gear position	1st thru 4th and reverse
Remarks	Release: Released when the amount of slip becomes smaller than the specified value.

● Turning control

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

● 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	—

● 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	—

14.On-board Diagnostics System

A: FUNCTION

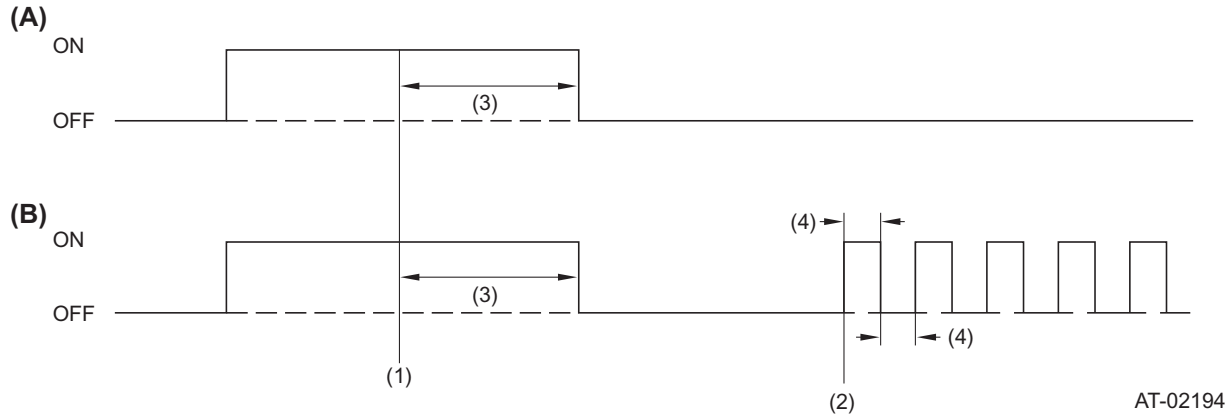
The on-board diagnostics system detects and stores in the form of a code a fault that has occurred in any of the following input and output signal systems.

Rear vehicle speed sensor	High clutch duty solenoid	Sports shift switch
Front vehicle speed sensor	Low & reverse duty solenoid	Engine speed signal
Throttle position sensor	Transfer duty solenoid	Lockup clutch
Line pressure linear solenoid	ATF temperature sensor	Torque converter turbine speed sensor
2-4 brake duty solenoid	CAN communication signal circuit	1, 2, 3, 4, R gear ratios
Lockup duty solenoid	Inhibitor switch	Shift lock solenoid
Low clutch duty solenoid	Brake switch	

If a fault has been detected, the system tells the fault by causing the SPORT indicator light to blink.

B: OPERATION OF SPORT INDICATOR LIGHT

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



(A) When normal
(B) When abnormal

(1) Engine cranking
(2) After abnormality is detected
(3) 2 seconds
(4) 0.25 seconds

15.Fail-safe Function

The failsafe control function ensures minimum level of drivability even if a fault should occur in the vehicle speed sensors, accelerator pedal 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.

- Accelerator pedal position sensor

If the accelerator position sensor becomes faulty, control will be maintained by assuming that the accelerator pedal position is at a certain angle.

- Inhibitor switch

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

- Line pressure linear solenoid

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

- Lockup duty solenoid

If the lockup duty solenoid system fails, the solenoid is de-energized and the lockup clutch is disengaged.

- Transfer duty solenoid

When the transfer duty solenoid system becomes faulty, it is de-energized. This causes oil pressure to the transfer clutch to be interrupted and no power is transmitted to the rear axle. (FWD state)

- 2-4 brake duty solenoid

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

- Low clutch duty solenoid

If a fault occurs in the low clutch duty solenoid system, the solenoid is de-energized and the gears are limited to the 3rd or 4th.

- High clutch duty solenoid

If a fault occurs in the high clutch duty solenoid system, the solenoid is de-energized and the gears are limited to the 2nd or 3rd.

- Torque converter turbine speed sensor

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

- Low & reverse duty solenoid

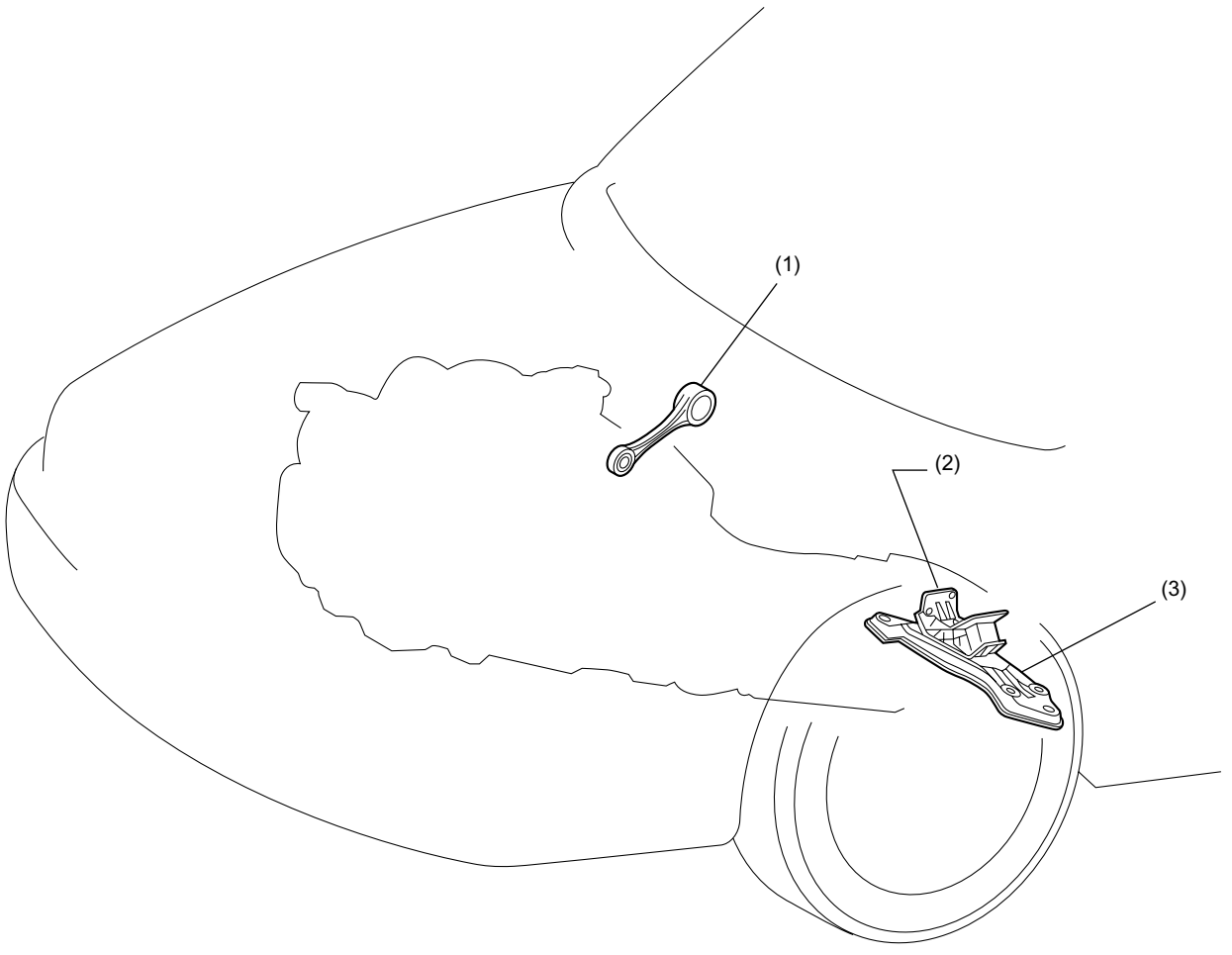
If a fault occurs in the low and reverse duty solenoid system, the solenoid is de-energized and the gears are limited to the 1st.

16.Transmission Mounting

A: GENERAL

The transmission mounting consists of a pitching stopper, cushion rubber, and a cross member.

In addition to support the transmission, these components absorb noise and vibration caused by the transmission.



AT-00438

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

AUTOMATIC TRANSMISSION (5AT)

1. General

To improve the dynamic performance and fuel efficiency of the vehicle, a new 5-speed automatic transmission is developed. The features of this new automatic transmission are as follows:

A: NEW CONSTRUCTION

- The planetary gears layout has been changed from the conventional 2-planetary to a 3-planetary arrangement.
- The construction of the torque converter has been changed to achieve a higher efficiency.
- The layout of the oil pump has been changed to reduce friction.
- The drive pinion gear has been changed.
- Major components are made of aluminum.

B: CHANGES FOR BETTER DRIVING PERFORMANCE

1. IMPROVED SHIFTING PERFORMANCE

- By using a wide ranged and crossed ratio gears, a high driving power is ensured at a wide vehicle speed range, and the torque differential between before and after shifting is minimized.
- By using a system that controls the clutch pressure directly and electronically (direct hydraulic control), an accurate and highly responsive control is achieved.
- By using a one-way clutch, smooth shifting without torque interruption is realized.
- By using a new adaptive control, the shifting map is automatically switched and a more active shifting control is performed in the manual mode.
- The control enables manual shifting by operating the steering switch to UP or DOWN while driving in D range, and returns to normal automatic shifting when certain conditions are met.
- To reduce gear noise from the reduction driven gear and prevent the bending moment of the drive pinion shaft from affecting the engagement of reduction gears, the front and rear ends are supported with bearings.
- To reduce driving noise, the drive shafts and joints are integrated and the transmission side drive axle shaft is abolished.

C: MODIFICATION MADE FOR BETTER FUEL EFFICIENCY

1. OPTIMIZED GEAR RATIO

● The wider gear ratio range obtained by five speeds contribute to better dynamic performance, while improving fuel efficiency at constant speed cruising by enabling use of lower engine speeds.

2. IMPROVED EFFICIENCY

● The efficiency of the torque converter has been increased.

● Friction in the oil pump and gear train are reduced.

● Drive pinion gear teeth are changed to uniform height teeth, and their offset amount is reduced.

● Ranges in which the transmission operates in slipping lockup and full lockup states are widened.

3. WEIGHT REDUCTION

● An aluminum bearing plate is used.

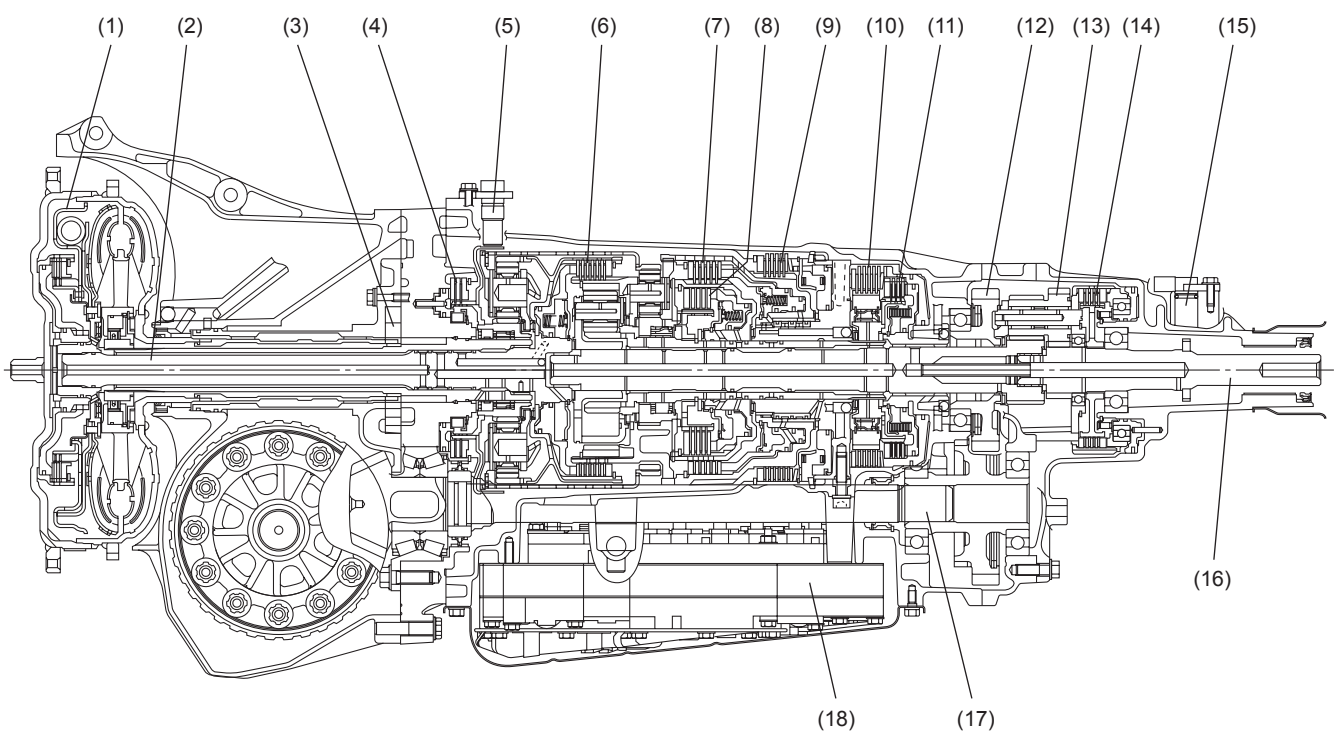
● The planetary carrier, clutch drum and the hub are made of aluminum.

● The wall thickness of the transmission case is reduced.

D: CONVENTIONAL MECHANISMS

● The transfer is provided with a VTD (Variable Torque Distribution) system which consists of a planetary gear type center differential and a hydraulic multi-plated LSD, to electronically control the differential operation and improve safety and drivability.

2. Cross Sectional View



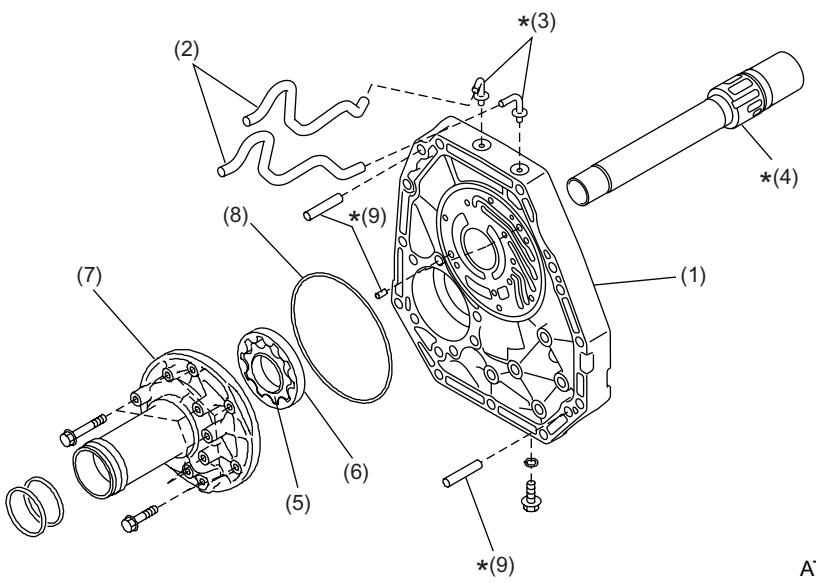
AT-02812

(1) Torque converter assembly
(2) Input shaft
(3) Oil pump
(4) Front brake
(5) Turbine speed sensor 1
(6) Input clutch
(7) Direct clutch
(8) High and low reverse clutch
(9) Reverse brake
(10) Forward brake
(11) Low coast brake
(12) Reduction gear
(13) Variable torque distribution (VTD)
(14) Transfer clutch
(15) Rear vehicle speed sensor
(16) Rear drive shaft
(17) Drive pinion shaft
(18) Control valve

3. Oil Pump

A: CONSTRUCTION

The pump consists of a inner-teeth type rotor, oil pump housing, and an oil pump cover. The inner rotor has nine teeth and the outer rotor has ten teeth.



(1) Oil pump cover
(2) Air breather hose
(3) Nipple
(4) Stator shaft
(5) Inner rotor
(6) Outer rotor
(7) Oil pump housing
(8) O-ring
(9) Straight pin
* : Parts that cannot be disassembled

B: OPERATION

The inner rotor is connected to the engine crankshaft via a oil pump shaft, impeller side of the torque converter, and drive plate; when the inner rotor turns the outer rotor also turns.

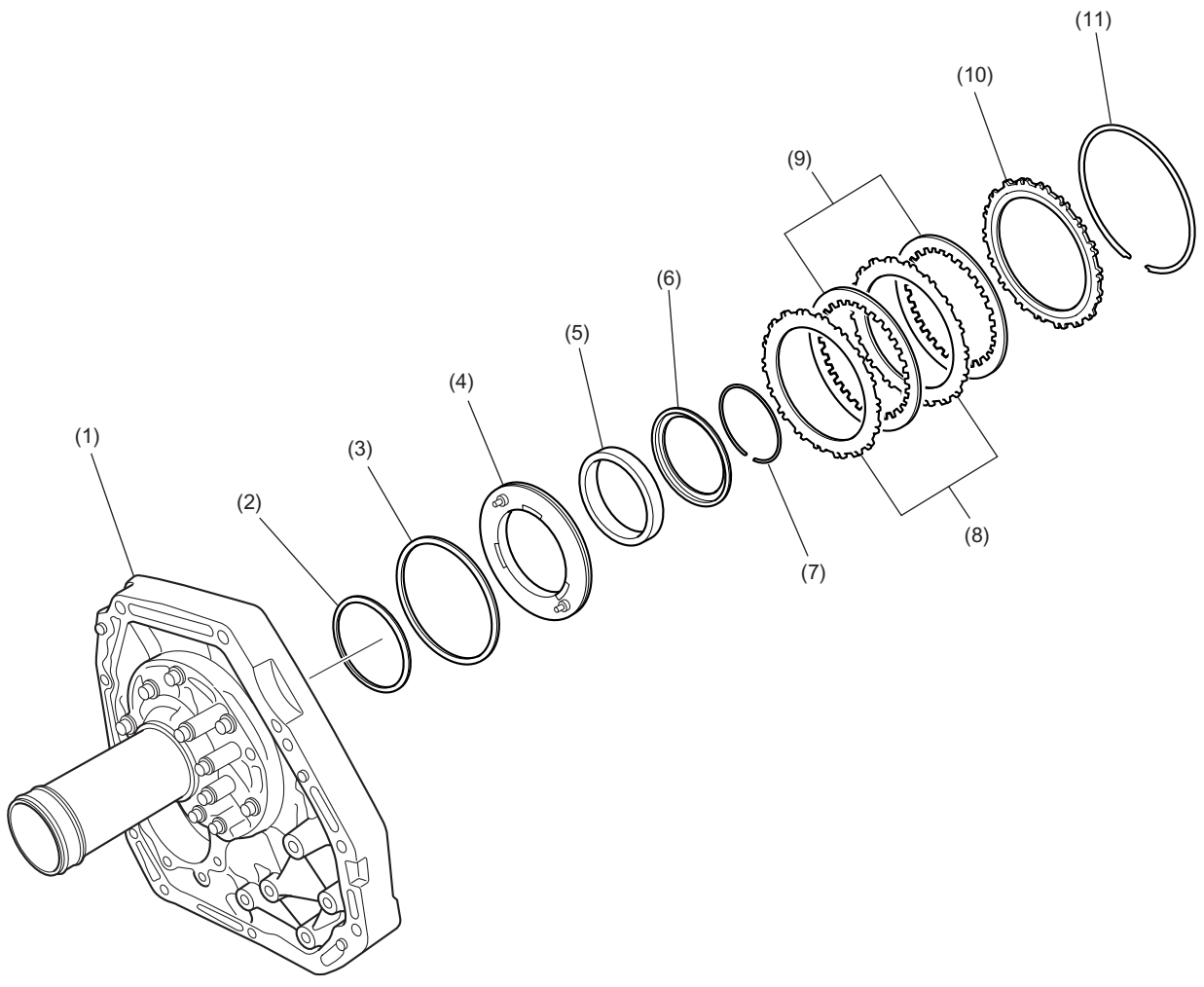
Since the number of teeth on the inner rotor and outer rotor are not the same, a space is formed between the inner rotor and outer rotor and its capacity changes as the rotors turn. Oil is drawn in when the capacity is large and is compressed and discharged when the capacity becomes smaller.

4. Front Brake

A: CONSTRUCTION

The front brake consists of a front brake piston, return spring, drive plates, driven plates, and a retaining plate.

This brake engages to lock the front sun gear when engine braking is used in the 1st, 2nd and 3rd speeds and in the 5th speed and reverse range.



AT-01560

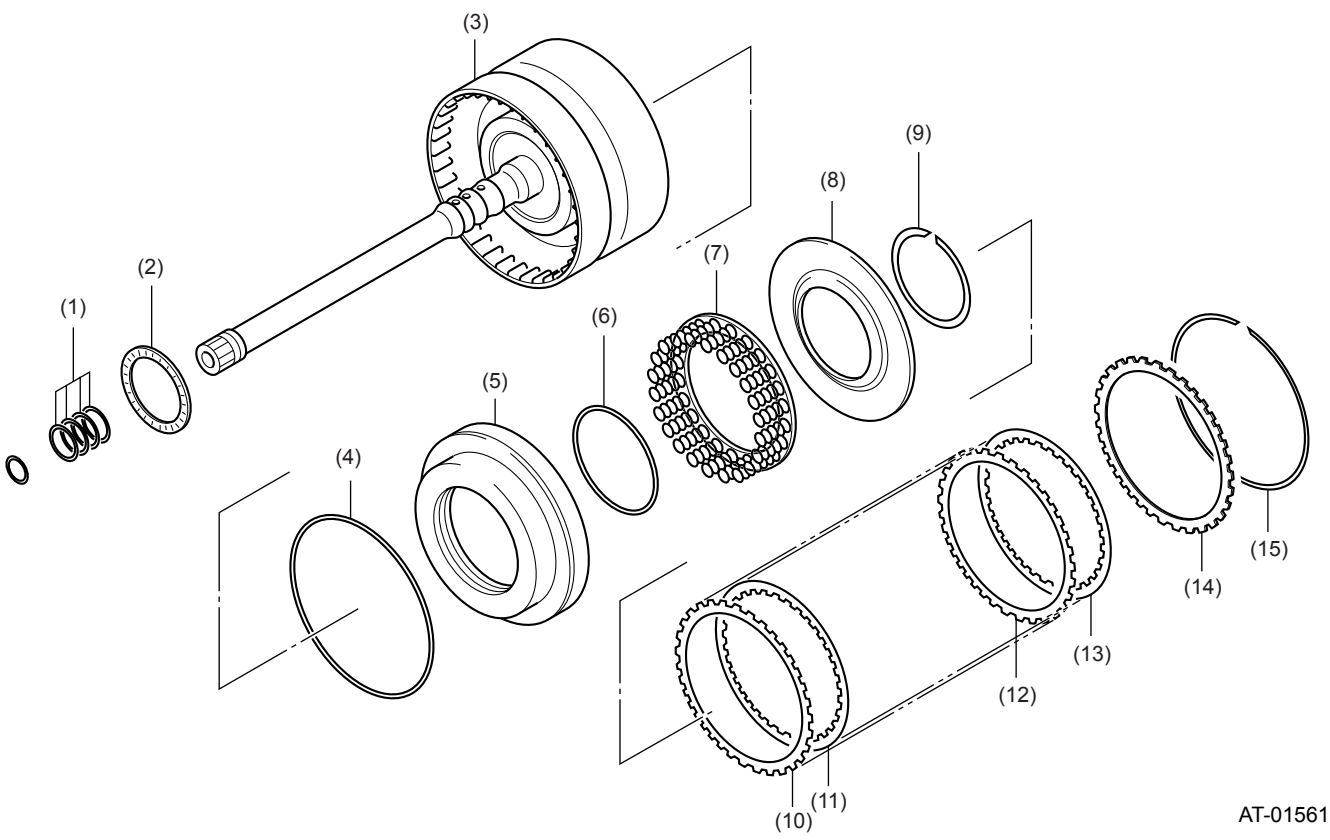
(1) Oil pump housing
(2) D-ring (inner)
(3) D-ring (outer)
(4) Front brake piston
(5) Return spring
(6) Retainer
(7) Snap ring
(8) Driven plate
(9) Drive plate
(10) Retaining plate
(11) Snap ring

5. Input Clutch

A: CONSTRUCTION

The input clutch consists of an input clutch piston, retainer spring, drive plates, driven plates, and a retaining plate.

This clutch engages to connect the front internal gear and mid internal gear in the 4th and 5th speeds.



(1) Seal ring
(2) Thrust bearing
(3) Input clutch drum
(4) D-ring (outer)
(5) Input clutch piston
(6) D-ring (inner)
(7) Return spring
(8) Cover
(9) Snap ring
(10) Driven plate
(11) Drive plate
(12) Driven plate
(13) Drive plate
(14) Retaining plate
(15) Snap ring

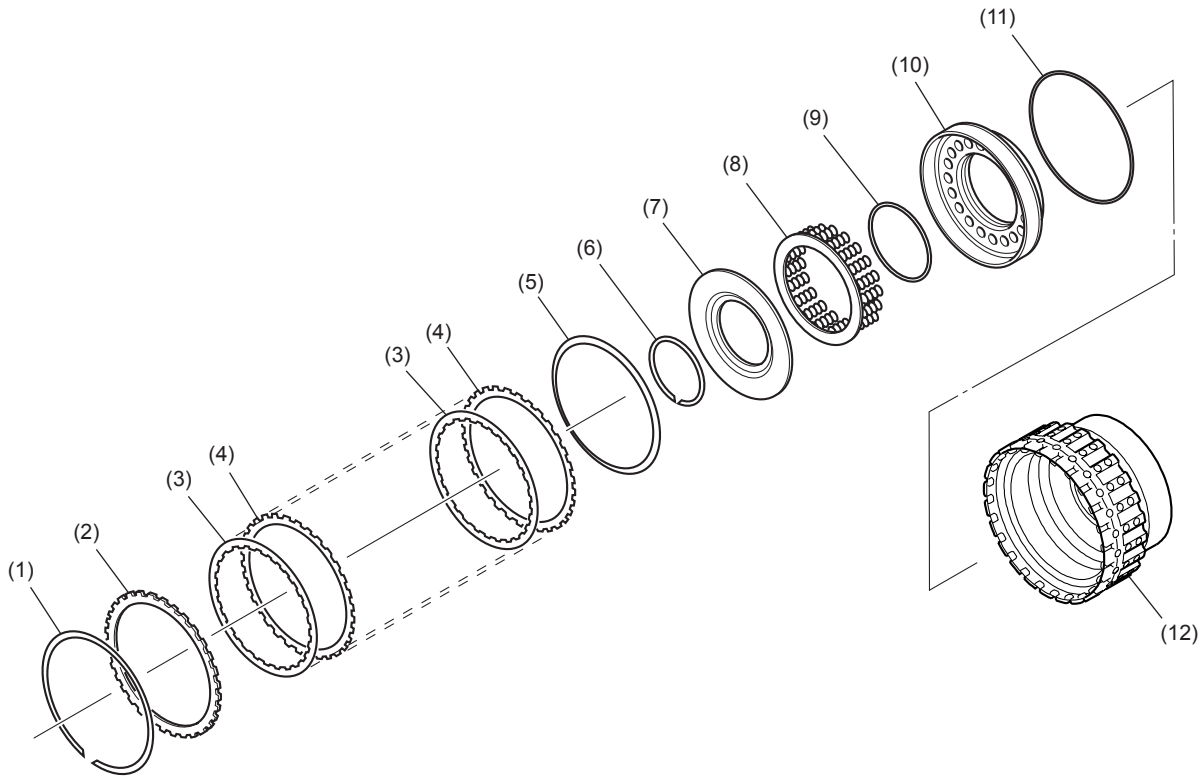
6. Direct Clutch

A: CONSTRUCTION

The direct clutch consists of a direct clutch piston, retainer spring, drive plates, driven plates, and a retaining plate.

This clutch engages to connect the rear carrier and rear sun gear in the 2nd, 3rd and 4th speeds.

(The direct clutch cannot be disassembled.)



AT-01562

(1) Snap ring
(2) Retaining plate
(3) Drive plate
(4) Driven plate
(5) Dish plate
(6) Snap ring
(7) Cover
(8) Return spring
(9) D-ring (inner)
(10) Direct clutch piston
(11) D-ring (outer)
(12) Direct clutch drum

7. High and Low Reverse Clutch

A: CONSTRUCTION

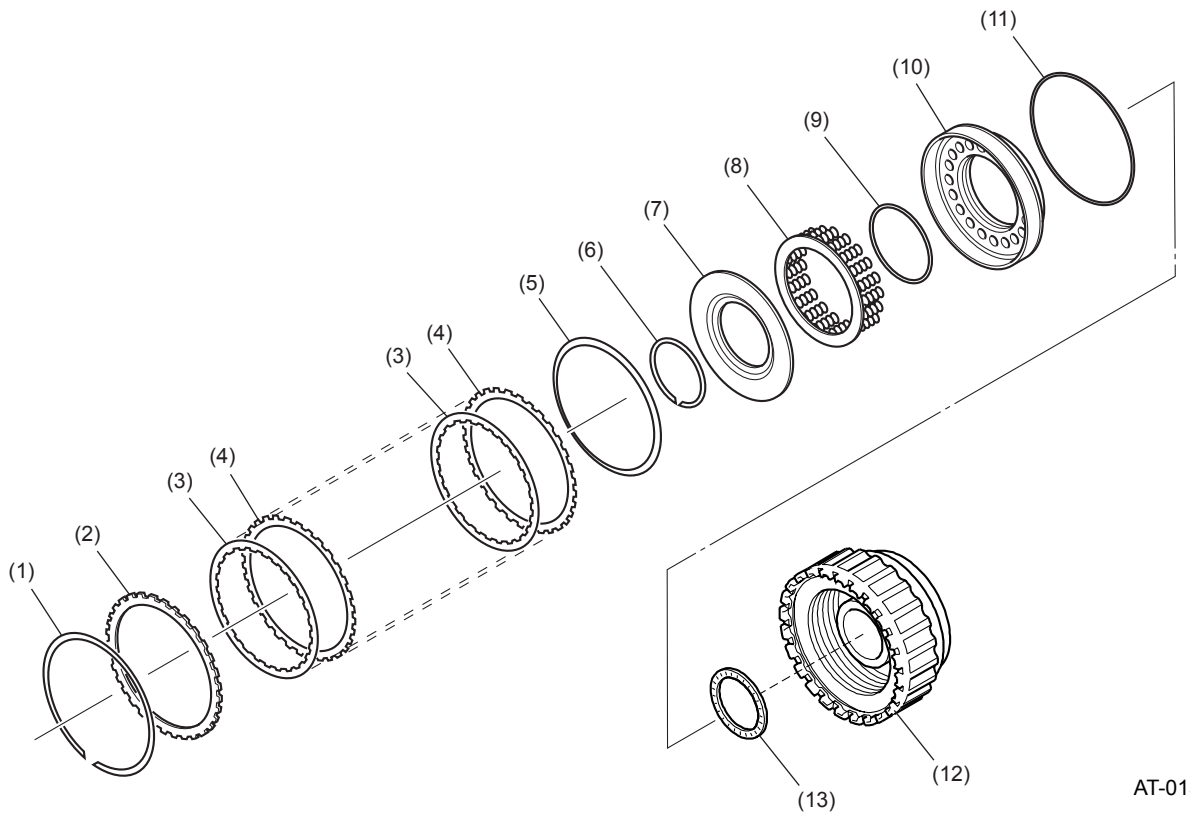
The high and low reverse clutch consists of a high and low reverse clutch piston, retainer spring, drive plate, driven plate, and a retaining plate.

This clutch engages to fix the mid sun gear with the rear sun gear in the 3rd, 4th and 5th speeds.

It also fix the mid sun gear and rear sun gear when engine braking is used in 1st speed.

In reverse, the mid sun gear and rear sun gear are connected.

(The high & low reverse clutch cannot be disassembled.)



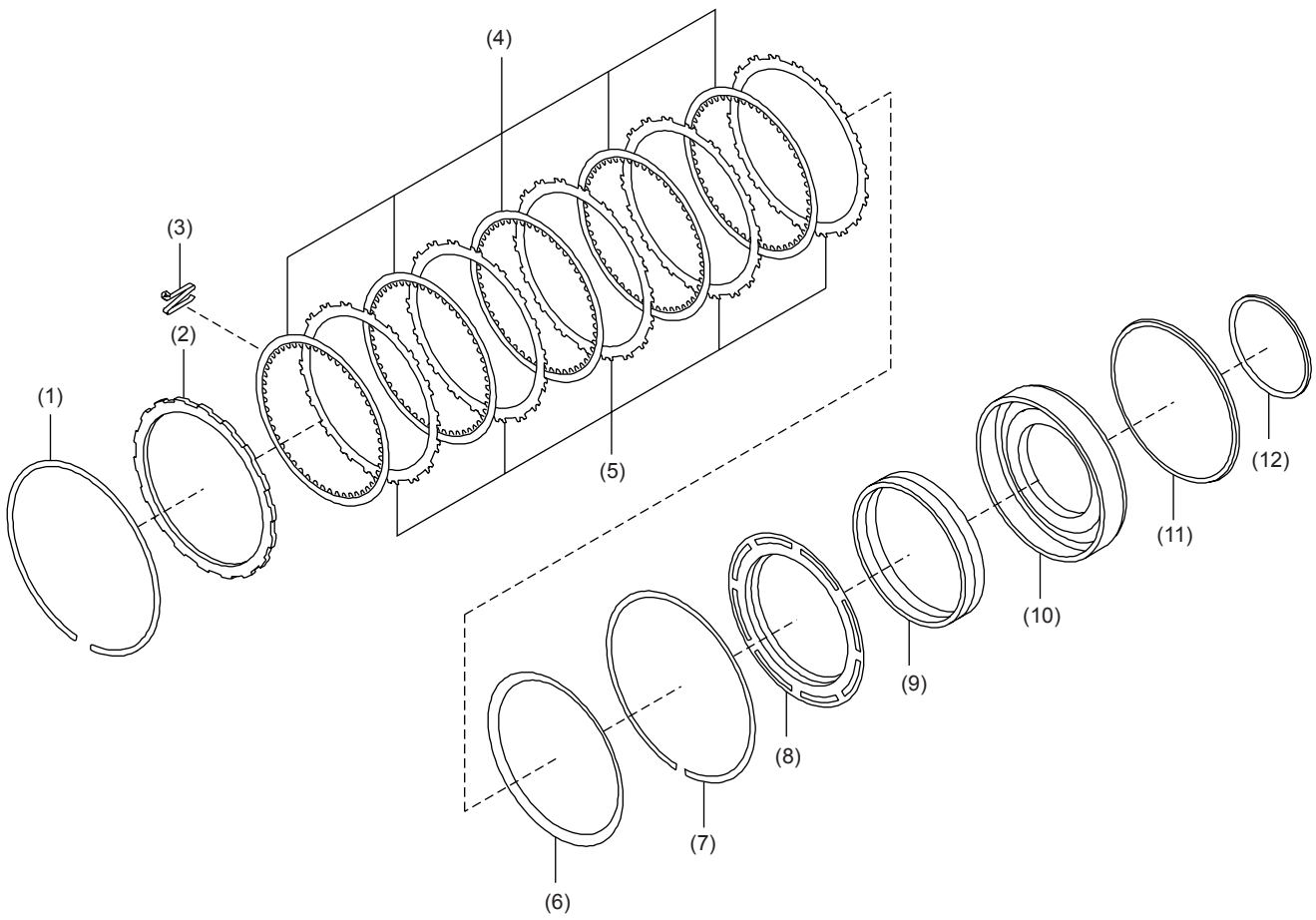
(1) Snap ring
(2) Retaining plate
(3) Drive plate
(4) Driven plate
(5) Dish plate
(6) Snap ring
(7) Cover
(8) Return spring
(9) D-ring (inner)
(10) High and low clutch piston
(11) D-ring (outer)
(12) High and low clutch drum
(13) Thrust bearing

8. Reverse Brake

A: CONSTRUCTION

The reverse brake which consists of a reverse brake piston, return spring, dish plate, drive plates, driven plates and retaining plate, is placed in a housing formed in the transmission case.

This brake fixes the rear carrier in reverse range.



(1) Snap ring
(2) Retainer plate
(3) Leaf spring
(4) Drive plate
(5) Driven plate
(6) Dish plate
(7) Snap ring
(8) Retainer
(9) Return spring
(10) Reverse brake piston
(11) D-ring (outer)
(12) D-ring (inner)

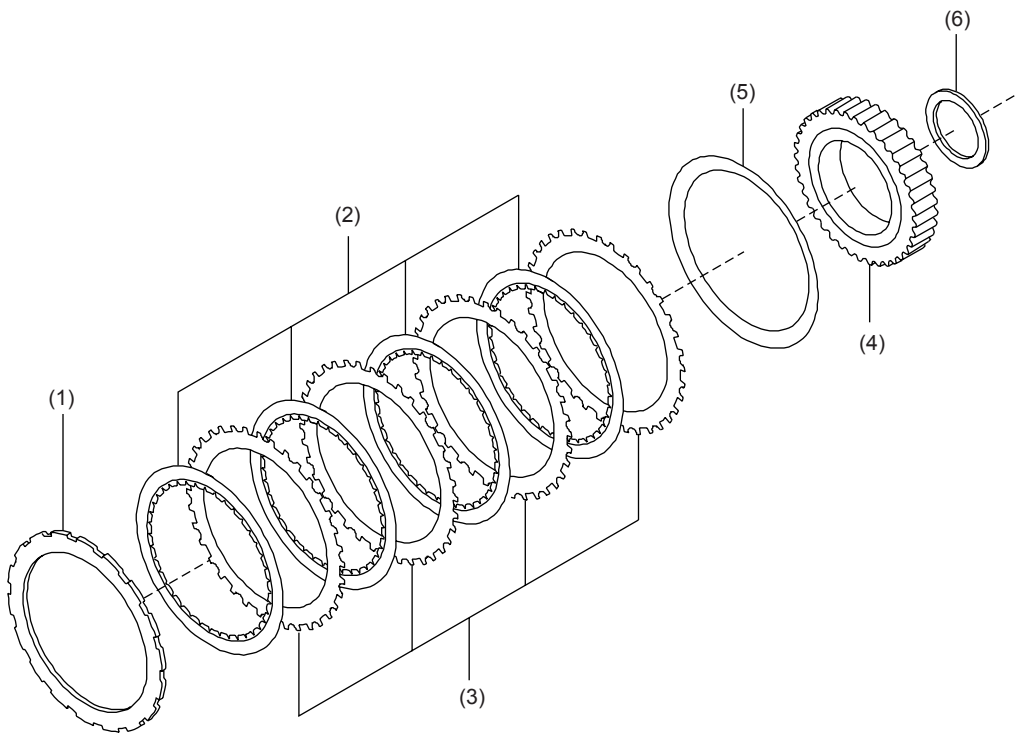
9. Forward Brake

A: CONSTRUCTION

The forward brake consists of a forward brake hub, forward brake piston, dish plate, drive plates, driven plates, and a retaining plate.

The forward brake restricts the reverse rotation of the mid sun gear in 1st and 2nd speeds.

(The forward brake cannot be disassembled.)



AT-01565

(1) Retainer plate
(2) Drive plate
(3) Driven plate
(4) Forward brake hub
(5) Dish plate
(6) Thrust bearing

10.Low Coast Brake

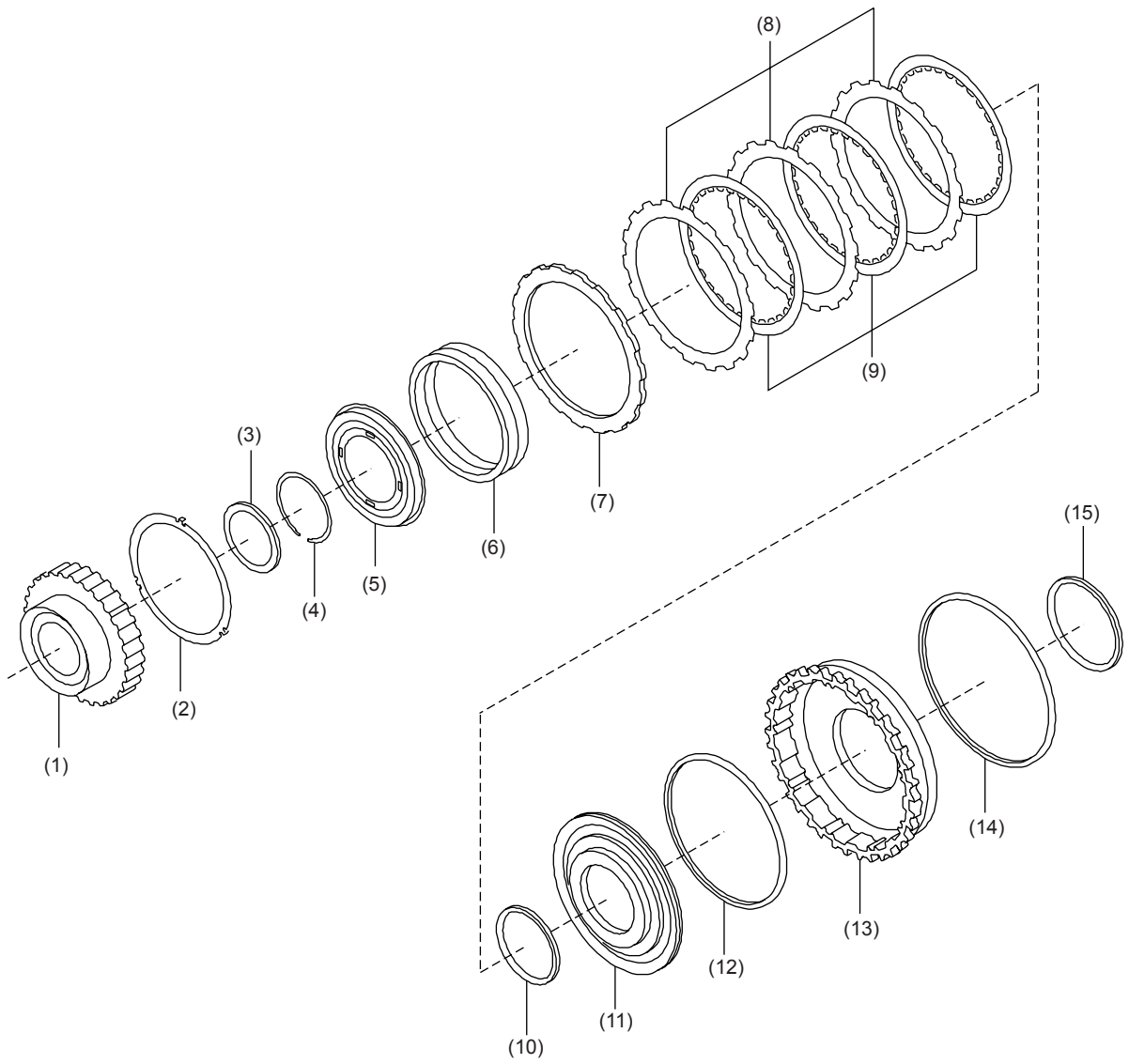
A: CONSTRUCTION

The low coast brake consists of a low coast brake hub, low coast piston, drive plates, driven plates, and a retaining plate.

The low coast brake restricts the reverse rotation of the mid sun gear when engine braking is used in 1st and 2nd speeds of the manual mode.

(The low coast brake cannot be disassembled.)

LOW COAST BRAKE



AT-01566

(1) Low coast brake hub
(2) Washer
(3) Thrust bearing
(4) Snap ring
(5) Retainer
(6) Return spring
(7) Retainer plate
(8) Driven plate
(9) Drive plate
(10) D-ring (inner)
(11) Low coast brake piston
(12) D-ring (outer)
(13) Forward brake pistion
(14) D-ring (outer)
(15) D-ring (inner)

11.Control Valve

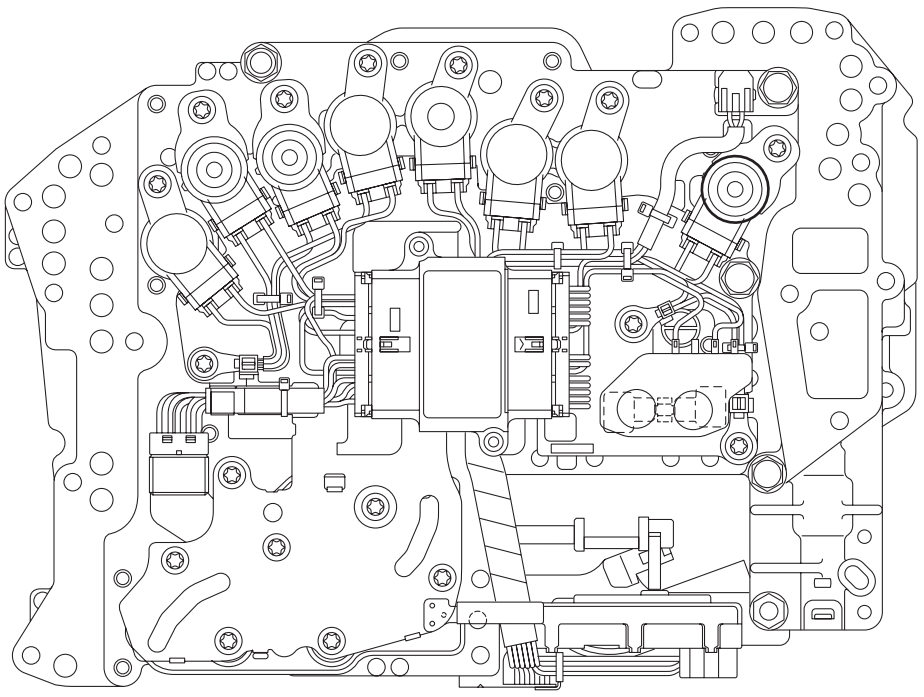
The control system of the automatic transmission consists of an oil pump, valve bodies containing valves, clutches, and fluid passages. The operation of the system is controlled by driver's manual inputs and electrical inputs from the TCM.

A: FUNCTION

Name	Function
• Torque converter regulator valve	Regulates the line pressure to an optimum level (torque converter operating pressure) to prevent excessive torque converter supply pressure.
• Pressure regulator valve • Pressure regulator plug • Pressure regulator sleeve	Regulates the pressure of oil discharged from the oil pump to an optimum level (line pressure) which is suitable for the vehicle's running condition.
• Front brake control valve	Regulates the line pressure to an optimum level (front brake pressure) when the front brake is engaged, and supplies this pressure to the front brake. (regulates clutch pressure in 1st, 2nd, 3rd and 5th speeds)
• Accumulator control valve	Regulates the pressure to the accumulator piston and low coast reducing valve (accumulator control pressure) in accordance with the vehicle's running condition.
• Pilot valve A	Regulates the line pressure to create a constant pressure (pilot pressure) necessary for line pressure control, gear shift control, and lockup control.
• Pilot valve B	Regulates the line pressure to create a constant pressure (pilot pressure) necessary for gear shift control.
• Low coast brake switch valve	Supplies line pressure to the low coast brake reducing valve when engine braking is used.
• Low coast brake reducing valve	Regulates the line pressure to an optimum level (low coast brake pressure) when the low coast brake is engaged, and supplies this pressure to the low coast brake.
• N-R accumulator	Builds a shelf-pressure when N-R is selected.
• Direct clutch piston switching valve	Operates in 4th speed and switches the engaging capacity of the direct clutch.
• High and low reverse clutch control valve	Regulates the line pressure to an optimum level (high and low reverse clutch pressure) when the high and low reverse clutch is engaged, and supplies this pressure to the high and low reverse clutch. (regulates clutch pressure in 1st, 2nd, 4th and 5th speeds)
• Input clutch control valve	Regulates the line pressure to an optimum level (input clutch pressure) when the input clutch is engaged, and supplies this pressure to the input clutch. (regulates clutch pressure in 4th and 5th speeds)
• Direct clutch control valve	Regulates the line pressure to an optimum level (direct clutch pressure) when the direct clutch is engaged, and supplies this pressure to the direct clutch. (regulates clutch pressure in 2nd, 3rd and 4th speeds)
• Lockup control valve • Lockup control plug • Lockup control sleeve	Engages or releases lockup. It also provides a smooth lockup by performing lockup gradually.
• Torque converter lubrication valve	Operates when lockup is engaged and switches the oil passages of the torque converter, cooling and lubrication systems.
• Cooler bypass valve	Detours excessive cooler circuit oil.
• Line pressure relief valve	Drains excessive line pressure circuit oil.
• N-D accumulator	Builds a shelf-pressure when N-D is selected.
• Manual valve	Delivers line pressure to the circuits according to the selected position. Circuits, which are not delivered with line pressure becomes drain.

Name	Function
• Front brake hydraulic switch	Monitors front brake oil pressure and lets the system enter the fail safe mode if abnormality is found.
• Low coast brake hydraulic switch	Monitors low coast brake oil pressure and lets the system enter the fail safe mode if abnormality is found.
• Input clutch hydraulic switch	Monitors input clutch oil pressure and lets the system enter the fail safe mode if abnormality is found.
• Direct clutch hydraulic switch	Monitors direct clutch oil pressure and lets the system enter the fail safe mode if abnormality is found.
• High and low reverse clutch hydraulic switch	Monitors high and low reverse clutch oil pressure and let the system enter the fail safe mode if abnormality is found.

B: ARRANGEMENT

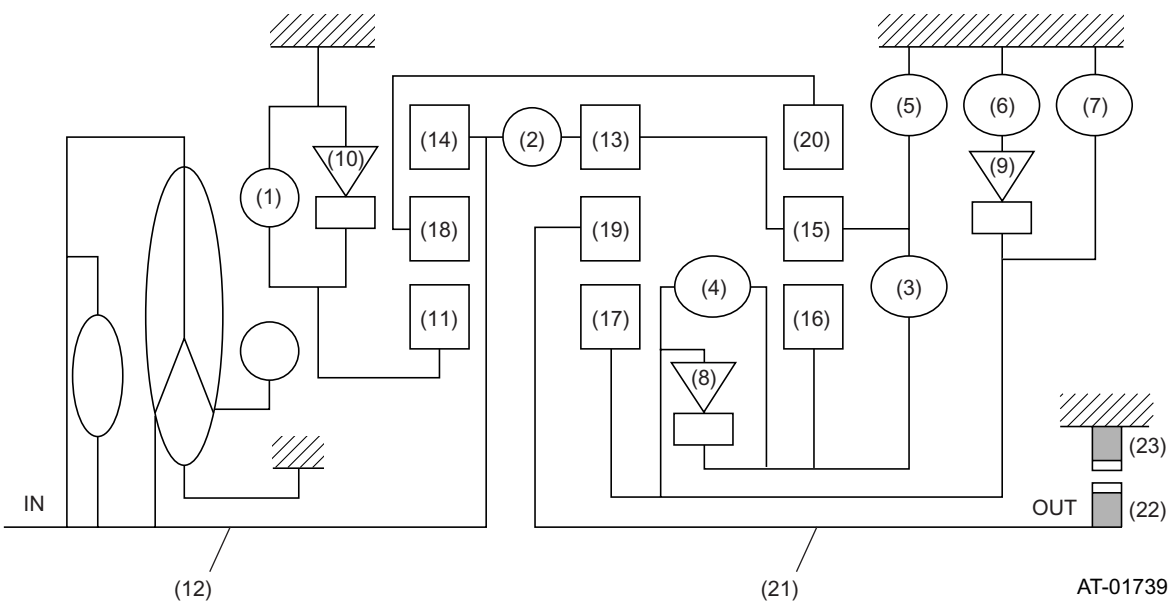


AT-01551

12.Gear Train

A: CONSTRUCTION

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



(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

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B: OPERATION

1. OPERATION TABLE

Select lever position			Input clutch	High & low reverse clutch	Direct clutch	Reverse brake	Front brake	Low coast brake	Forward brake	1st one-way clutch	Forward one-way clutch	3rd one-way clutch
	P			△			△					
	R			○		○	○			◎		◎
	N			△			△					
	D	1st		△*			△	△* ◇*	○	◎	◎	◎
		2nd			○		△	◇*	○		◎	◎
		3rd		○	○		○		△	◇		◎
		4th	○	○	○				△	◇		
		5th	○	○			○		△	◇		◇

○ : Engaged

◎ : Participates in torque transmission only when driven

◇ : Participates in torque transmission only when coasting

◇* : Engaged in sports mode

△ : Engaged but no effect to output

△* : Engaged when vehicle speed is within certain range

AT-02094

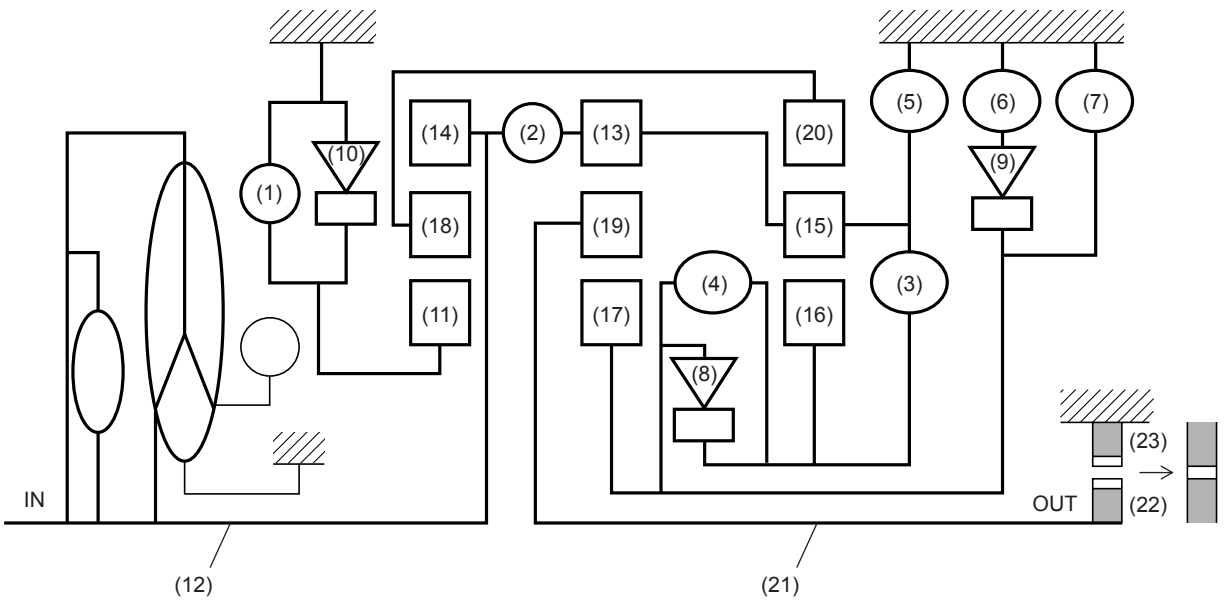
2. N RANGE

Since the forward and reverse brakes are disengaged, driving power from the input shaft is not transmitted to the output shaft.

3. P RANGE

● Since the forward and reverse brakes are disengaged as in the N range, driving power from the input shaft is not transmitted to the output shaft.

● The parking pawl, which is linked with the selector lever engages with the parking gear and mechanically holds the output shaft.

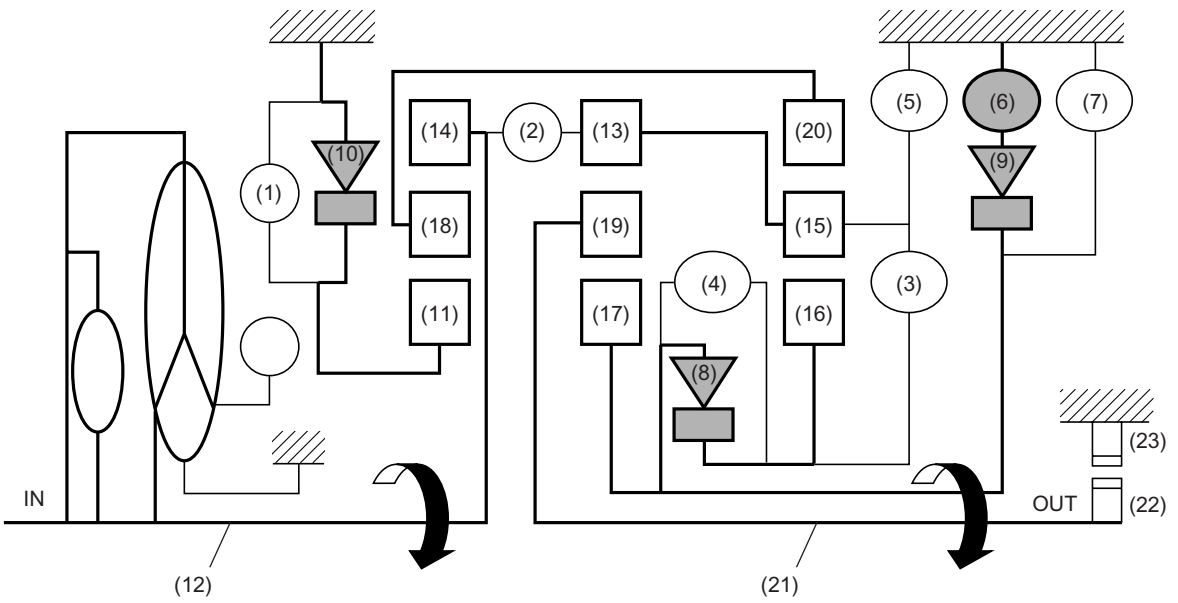


AT-01741

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

4. 1st SPEED GEAR OF D RANGE

- The forward brake and forward one-way clutch operates to control the reverse rotation of the mid sun gear.
- The 1st one-way clutch operates to control the reverse rotation of the rear sun gear.
- The 3rd one-way clutch operates to control the reverse rotation of the front sun gear.
- As the mid sun gear spins during deceleration, the forward one-way clutch spins and engine braking effect will not be available.



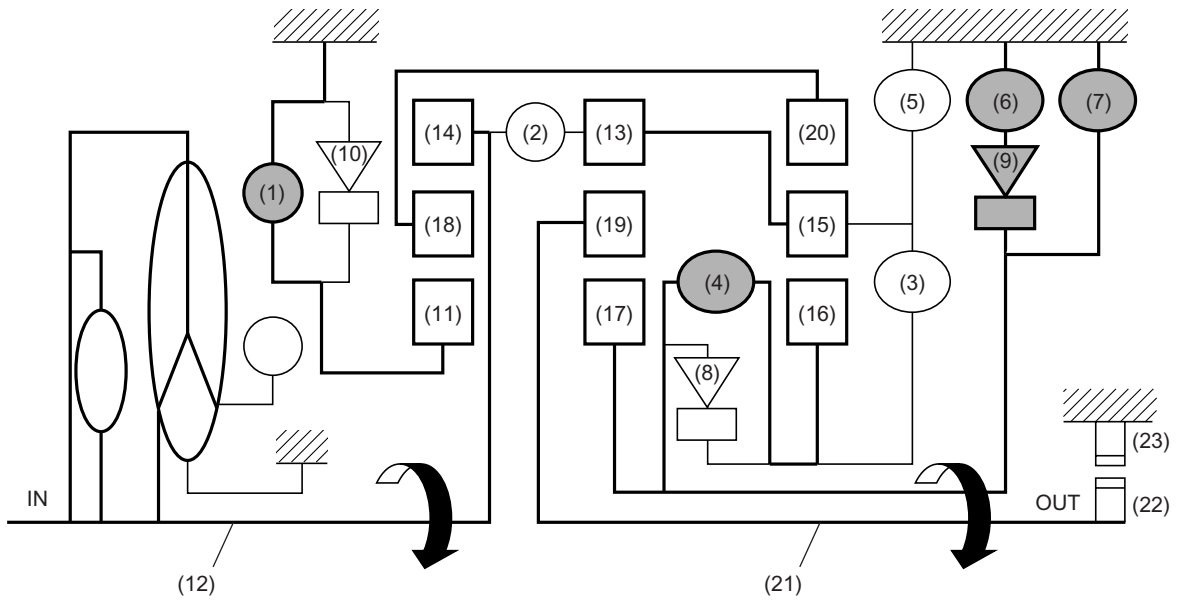
Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨
Rear internal gear ⇨ Rear carrier ⇨ Mid internal gear ⇨
Mid carrier ⇨ Output shaft

AT-01929

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

5. 1st SPEED GEAR OF MANUAL MODE

- The front brake operates to hold the front sun gear.
- The forward brake and forward one-way clutch operates to control the reverse rotation of the mid sun gear.
- The high and low reverse clutch operates to engage the rear sun gear and the mid sun gear.
- The low coast brake operates to hold the mid sun gear.
- During deceleration, the low coast brake controls the reverse rotation of the mid sun gear and engine braking effect will be available.



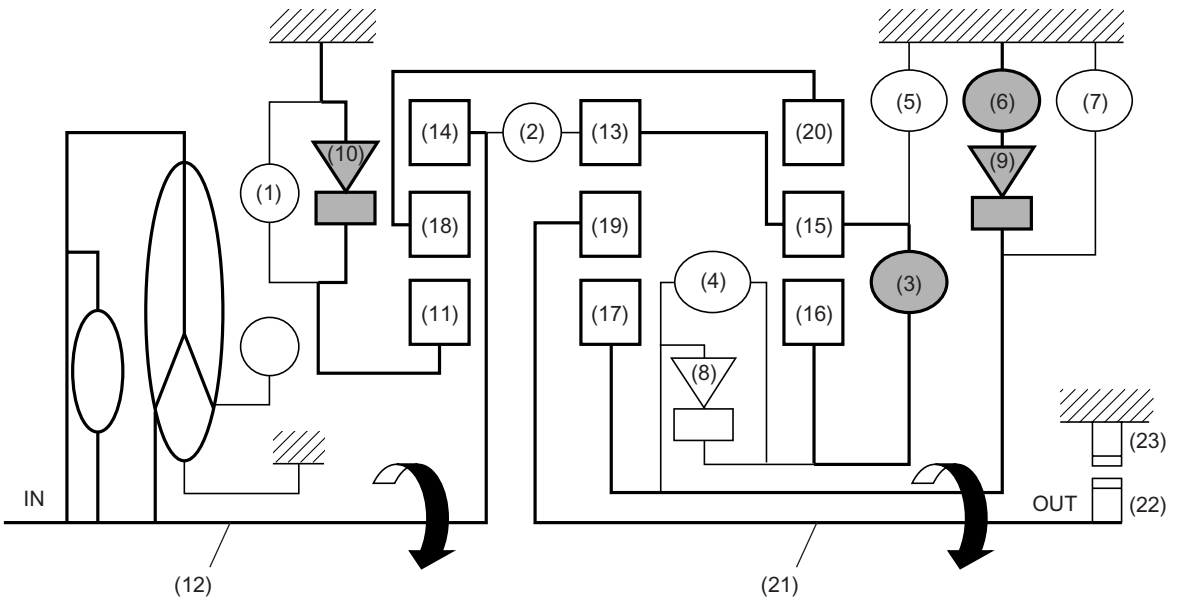
Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨
Rear internal gear ⇨ Rear carrier ⇨ Mid internal gear ⇨
Mid carrier ⇨ Output shaft

AT-01934

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

6. 2nd SPEED GEAR OF D RANGE

- The forward brake and forward one-way clutch operates to control the reverse rotation of the mid sun gear.
- The 3rd one-way clutch operates to control the reverse rotation of the front sun gear.
- The direct clutch engages to connect the rear carrier and rear sun gear.
- As the mid sun gear spins during deceleration, the forward one-way clutch spins and engine braking effect will not be available.



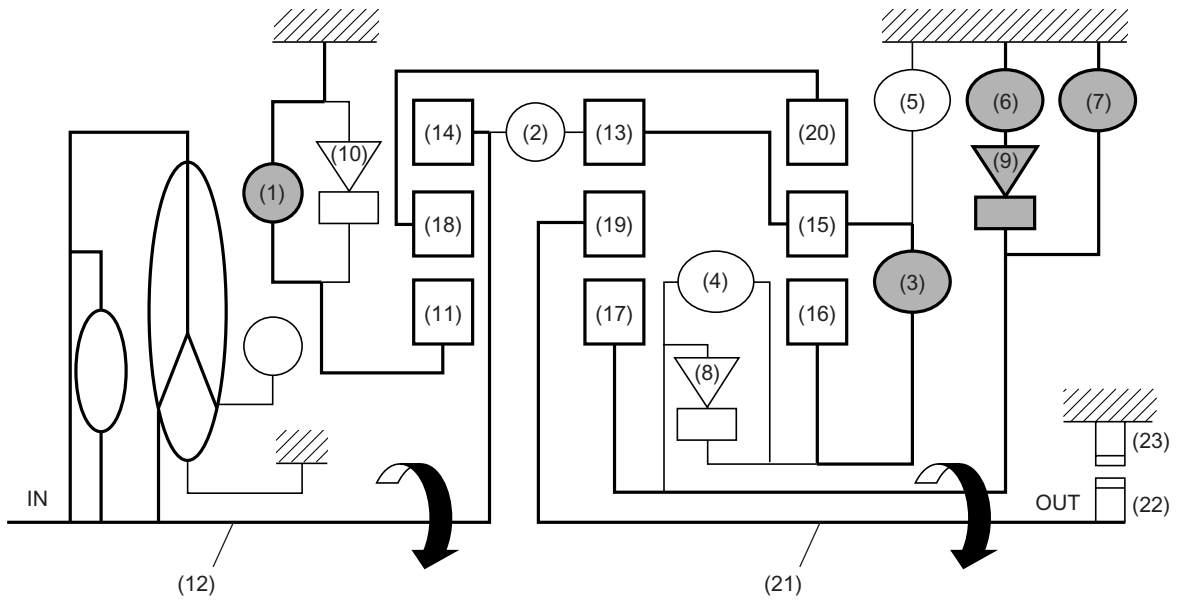
Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨
Rear internal gear ⇨ Rear carrier ⇨ Mid internal gear ⇨
Mid carrier ⇨ Output shaft

AT-01939

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

7. 2nd SPEED GEAR OF MANUAL MODE

- The front brake operates to hold the front sun gear.
- The forward brake and forward one-way clutch operates to control the reverse rotation of the mid sun gear.
- The direct clutch engages to connect the rear carrier and rear sun gear.
- The low coast brake operates to hold the mid sun gear.
- During deceleration, the low coast brake controls the reverse rotation of the mid sun gear and engine braking effect will be available.



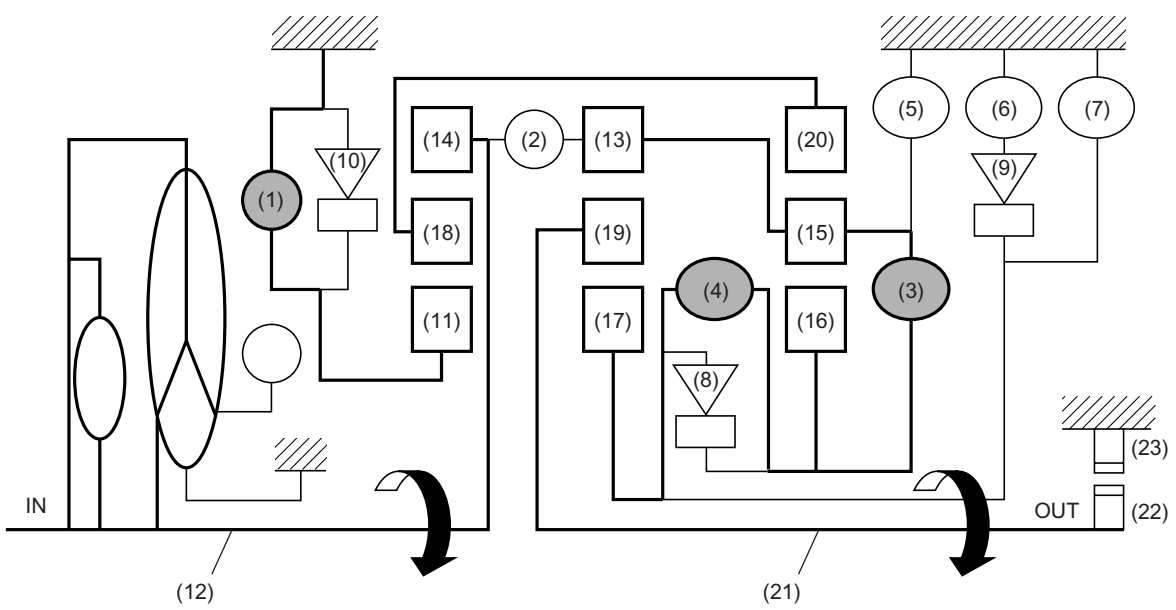
Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨
Rear internal gear ⇨ Rear carrier ⇨ Mid internal gear ⇨
Mid carrier ⇨ Output shaft

AT-01944

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

8. 3rd SPEED GEAR OF D RANGE OR MANUAL MODE

- The front brake operates to hold the front sun gear.
- The direct clutch engages to connect the rear carrier and rear sun gear.
- The high and low reverse clutch engages to connect the mid sun gear and rear sun gear.



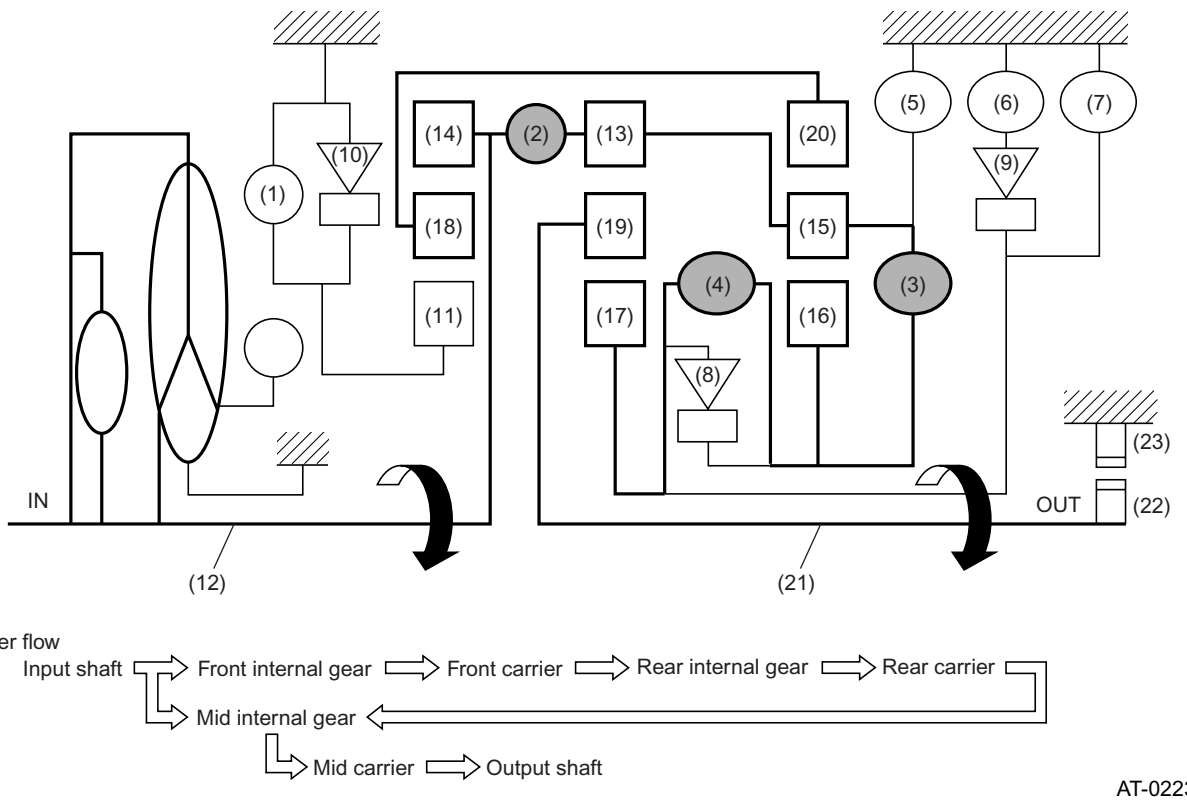
Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨
Rear internal gear ⇨ Rear carrier ⇨ Mid internal gear ⇨
Mid carrier ⇨ Output shaft

AT-01949

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

9. 4th SPEED GEAR OF D RANGE OR MANUAL MODE

- The direct clutch engages to connect the rear carrier and rear sun gear.
- The high and low reverse clutch engages to connect the mid sun gear and rear sun gear.
- The input clutch engages to connect the front internal gear and mid internal gear.
- Drive power is transmitted to the front internal gear, mid internal gear and rear carrier; the three planetary gears turn together as a unit in the normal direction.

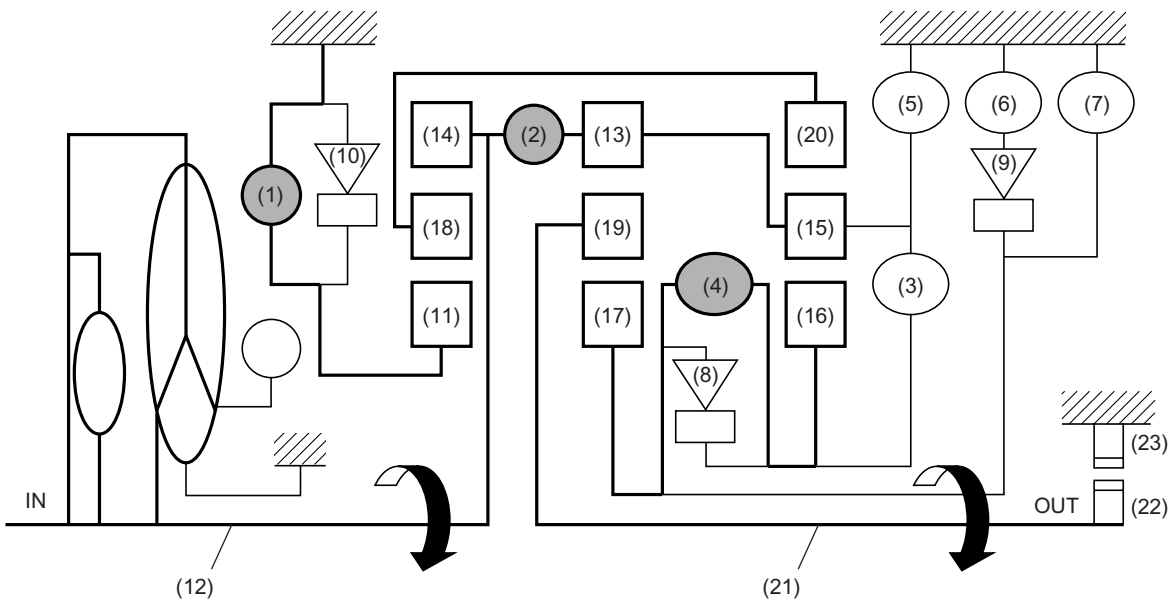


AT-02231

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

10. 5th SPEED GEAR OF D RANGE OR MANUAL MODE

- The front brake operates to hold the front sun gear.
- The input clutch engages to connect the front internal gear and mid internal gear.
- The high and low reverse clutch engages to connect the mid sun gear and rear sun gear.



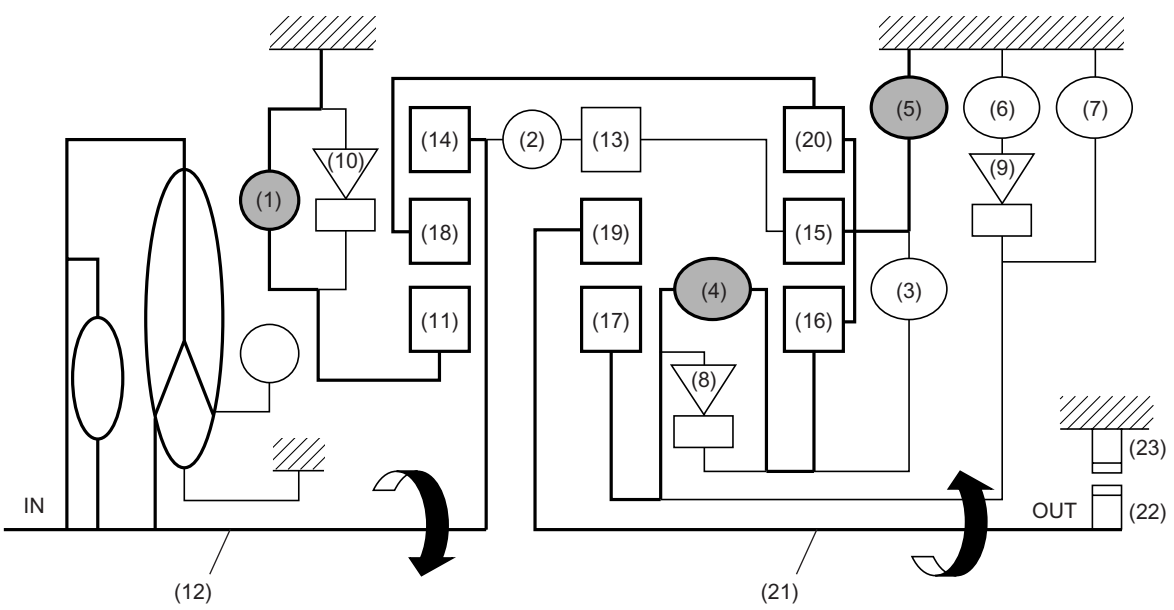
Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨ Rear internal gear
Input shaft ⇨ Mid internal gear ⇨ Rear carrier ⇨ Rear sun gear ⇨
Mid sun gear ⇨ Mid carrier ⇨ Output shaft

AT-02236

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

11. R RANGE

- The front brake operates to hold the front sun gear.
- The high and low reverse clutch engages to connect the mid sun gear and rear sun gear.
- The reverse brake operates to hold the rear carrier.



Power flow
Input shaft ⇨ Front internal gear ⇨ Front carrier ⇨ Rear internal gear ⇨
Rear sun gear ⇨ Mid sun gear ⇨ Mid carrier ⇨ Output shaft

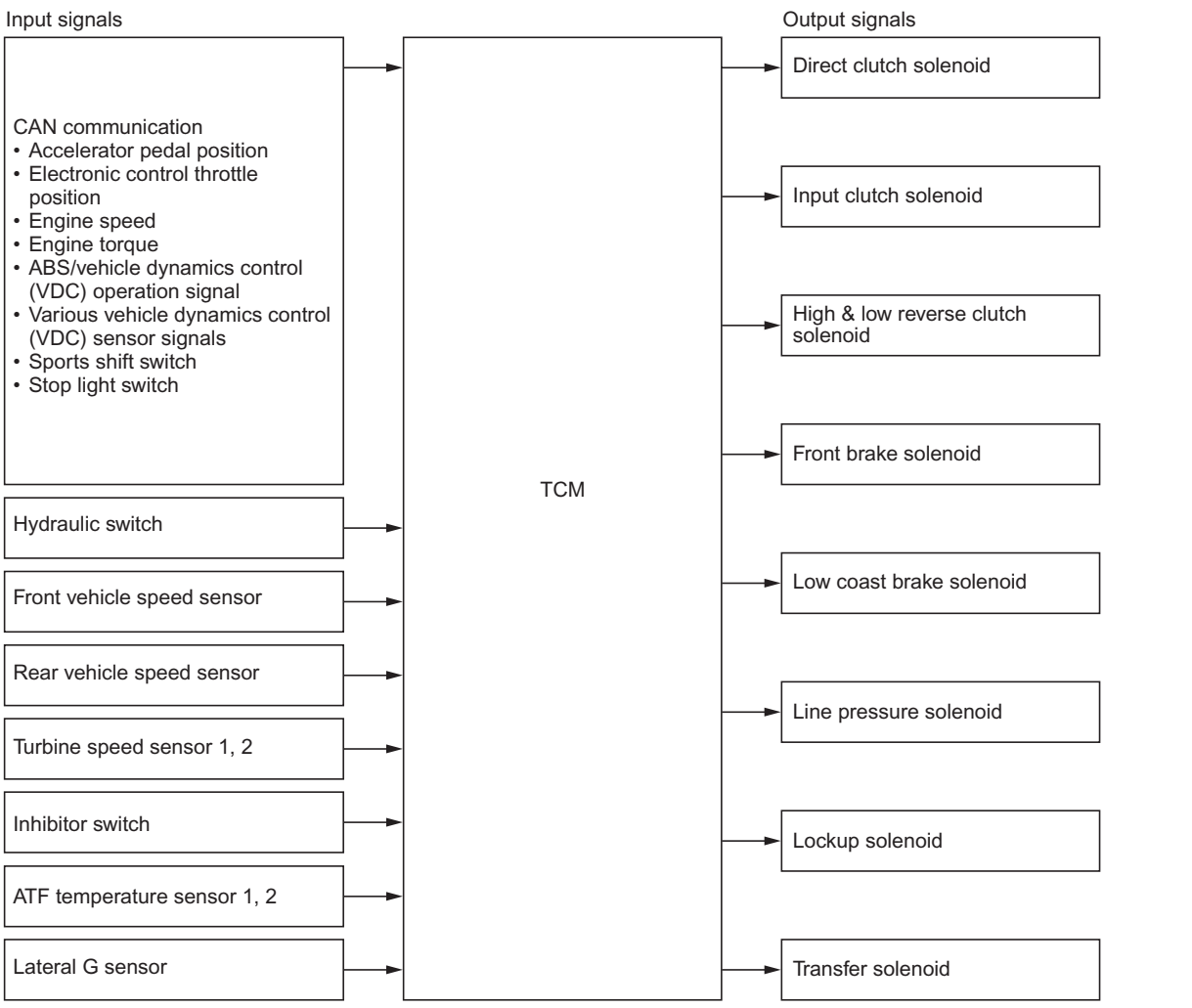
AT-02241

(1) Front brake
(2) Input clutch
(3) Direct clutch
(4) High and low reverse clutch
(5) Reverse brake
(6) Forward brake
(7) Low coast brake
(8) 1st one-way clutch
(9) Forward one-way clutch
(10) 3rd one-way clutch
(11) Front sun gear
(12) Input shaft
(13) Mid internal gear
(14) Front internal gear
(15) Rear carrier
(16) Rear sun gear
(17) Mid sun gear
(18) Front carrier
(19) Mid carrier
(20) Rear internal gear
(21) Output shaft
(22) Parking gear
(23) Parking pawl

14.Electro-hydraulic Control System

A: DESCRIPTION

The electro-hydraulic control system for the transmission and transfer consists of various sensors and switches, TCM, and the control valves including solenoid valves. The system controls the automatic transmission operation, including gear shifting, lockup clutch operation, line pressure, pilot pressure, 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 (front brake solenoid, low coast brake solenoid, input clutch solenoid, high and low reverse clutch solenoid, direct clutch solenoid, lockup solenoid, line pressure solenoid, and transfer solenoid) by sending appropriate signals to them.



AT-02246

B: CONTROL ITEMS

Control items			Description of control
Transmission hydraulic control	Shifting control	Shift pattern selection	Upshift points and downshift points are set for each range and shift pattern selected by switch operation, according to throttle position and vehicle speed. <Ref. to 5AT section, Transmission Control Module (TCM).>
		Control of linear solenoid for each shift clutch	The linear solenoid for each shift clutch is directly controlled in accordance with the target gear speed. Supported by the learning control and real time feedback functions, control values are corrected any time when necessary to improve shift quality and eliminate errors due to aging.
		Engine braking control	In manual mode, the low coast brake ON-OFF solenoid is controlled to make engine braking available in 1st and 2nd speeds.
	Lockup control	Base lockup control	Lockup engagement and disengagement points are set for each range and shift pattern selected by switch operation, according to throttle position and vehicle speed, and the lockup solenoid is controlled in accordance with these points to engage or disengage the lockup clutch inside the torque converter.
		Smooth control	When the lockup clutch is engaged, the pressure is gradually changed to ensure a smooth engagement.
	Line pressure control	Ordinary control	Line pressure is properly regulated according to information such as the electronic control throttle position, engine torque value, engine speed, vehicle speed, and range position.
		Control during engine braking	Line pressure is regulated in accordance with the vehicle speed while engine braking is used.
		Line pressure control in during shifting	Line pressure is regulated to the necessary value during gear shifting.
		Line pressure control when ATF temperature is low	Hydraulic pressure is controlled to a higher value than normal when the ATF temperature is low.
AWD center differential 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		LSD pressure is regulated according to the torque input to the transfer. Compared to normal control, the control pressure is raised to prevent slip.
	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 increased.
	Control while ABS/vehicle dynamics control (VDC) in operation		When ABS/vechicle dynamics control (VDC) operation signal is received, the LSD pressure is adjusted to the set level.
	Base brake control		When the brake switch is ON and throttle valve is fully closed, the LSD pressure is lowered.

C: CONTROL OF HYDRAULIC PRESSURE FOR SHIFTS

● Control of linear solenoid for each shift clutch
The linear solenoid for each shift clutch is directly controlled by means of electrical current in accordance with the target gear speed. The control current value is corrected any time when necessary by the learning control and real time feedback functions to improve shift quality and eliminate errors due to aging.

● Engine braking control
In manual mode, the low coast brake solenoid is controlled to make engine braking available in 1st and 2nd speeds.

D: LOCKUP CONTROL

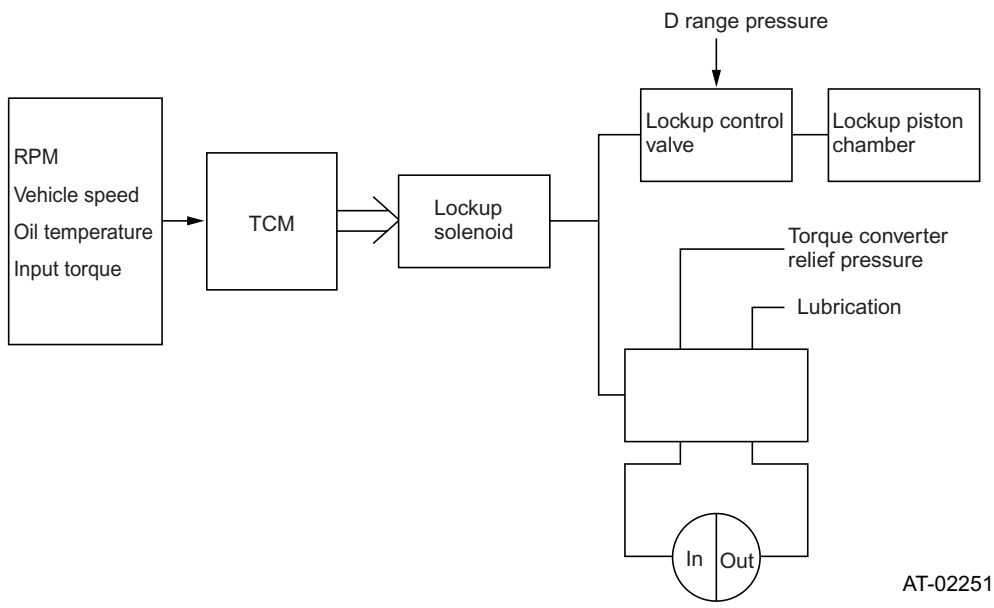
● By engaging the lockup clutch in the torque converter, the slip in the torque converter is eliminated and power is transmitted more effectively.

● Based on signals from the TCM, the lockup solenoid is controlled in order to let the lockup control valve operate and adjust apply pressure/release pressure, to consequently vary the lockup clutch engagement force.

Lockup operation conditions

Select lever	Gear position	Full lockup
D range	3	Δ
	4	Δ
	5	○
Manual mode	3	○
	4	○
	5	○

Δ: When the hill climbing mode is selected according to driving conditions, or when high ATF temperature is detected.



1. LOCKUP DISENGAGED STATE

When lockup is disengaged, the lockup solenoid causes the lockup control valve to open the clutch disengaging port, and the lockup operating pressure is added to the disengaging circuit. In the meantime, the lockup clutch control valve opens the lockup clutch engaging port and allows the hydraulic fluid in the circuit to flow to the ATF cooler, thus lowering the pressure in the engaging circuit. As a result, the lockup clutch is disengaged due to difference in pressure between both circuits. This operation is performed in all speed gears.

2. LOCKUP ENGAGED STATE

When lockup is engaged, the lockup solenoid puts the lockup control valve in the lockup state and builds up lockup operating pressure.

The lockup 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 lockup clutch and the clutch is engaged.

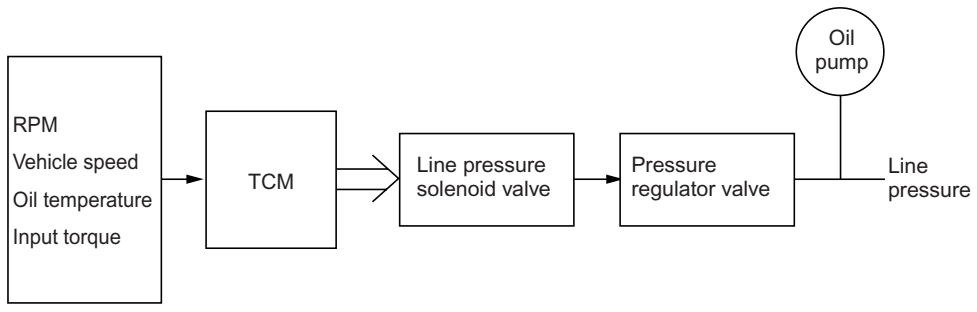
This operation is performed in all speed gears, and the lockup engages in response to the vehicle speed when the 5th gear is selected in the D range.

3. SMOOTH LOCKUP CONTROL

During the transition period from the lockup (disengaged) state to the lockup engaged state, the TCM controls the current output to the lockup solenoid. By changing the current output to the lockup solenoid and gradually raising the lockup clutch pressure, the lockup clutch piston is first put in a partially engaged state and its pressure is gradually increased to reduce shock.

E: LINE PRESSURE CONTROL

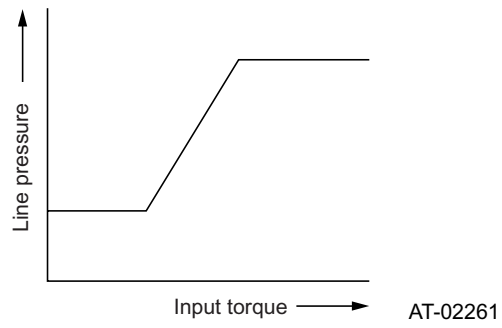
When torque signals corresponding to the engine drive power is sent from the ECM to the TCM, the TCM controls the line pressure solenoid. Using the line pressure solenoid pressure as a signal pressure, the pressure regulator valve is controlled, and the ATF discharged from the oil pump is regulated to an optimum level corresponding to the vehicle's running conditions.



AT-02256

1. LINE PRESSURE CONTROL IN NORMAL CONDITIONS

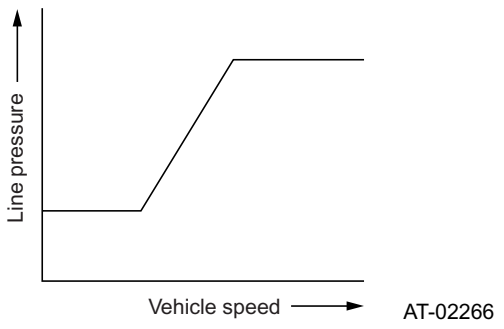
The line pressure which engages shift clutches to create 1st to 4th speeds, is regulated to a pressure required at each clutch according to the input torque.



AT-02261

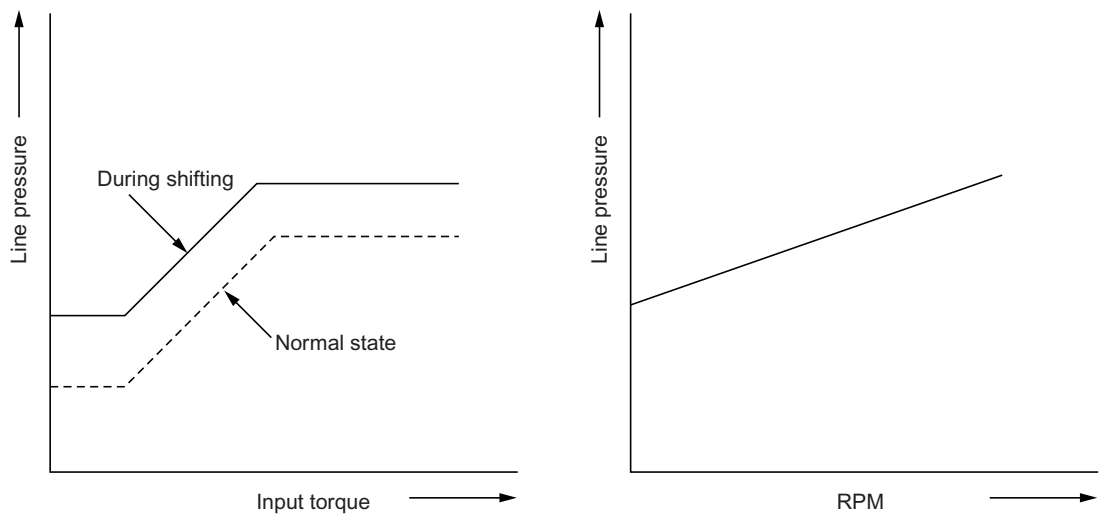
2. LINE-PRESSURE CONTROL DURING ENGINE BRAKING IN SPORTS MODE

When engine braking is used to let the transmission downshift, the line pressure is regulated in accordance with the vehicle speed.



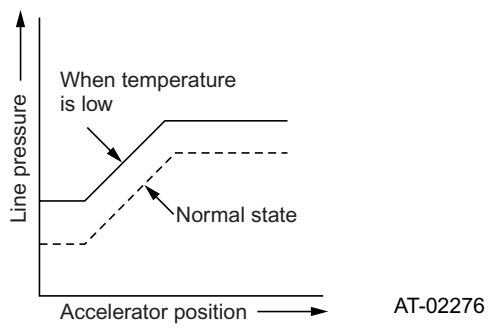
3. LINE-PRESSURE CONTROL DURING SHIFTING

During shifting, the line pressure is set to a level suitable for the input speed, input torque and the difference between the required and current gear speed.



4. LINE PRESSURE CONTROL WHEN ATF TEMPERATURE IS LOW

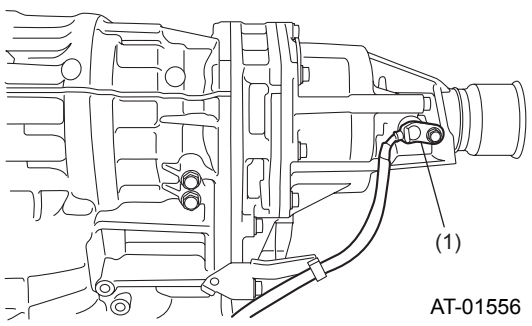
When the ATF temperature is low, the line pressure control characteristics is set higher than normal so that the clutches and brakes will operate at an earlier stage.



15.Sensor Systems

A: REAR VEHICLE SPEED SENSOR

This vehicle speed sensor is a Hall element type sensor and 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 pulse signals (22 pulses per rotation) to the TCM.

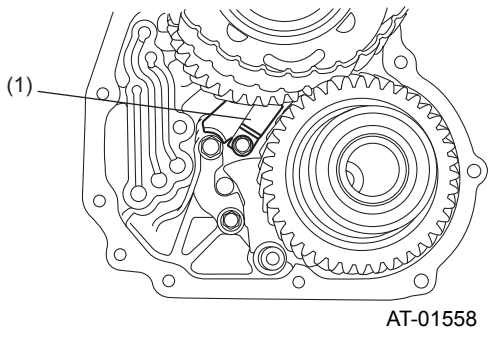


(1) Rear vehicle speed sensor

B: FRONT VEHICLE SPEED SENSOR

This vehicle speed sensor is a Hall element type sensor and is mounted on the inside of the transmission case. It detects the drive pinion shaft speed and sends pulse signals (16 pulses per rotation) to the TCM.

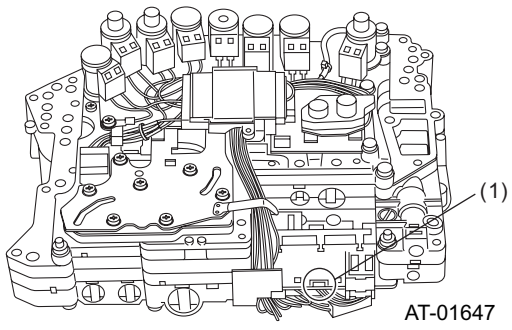
Signals from the front and rear vehicle speed sensors are used to calculate controlling vehicle speed, which is in turn used for gear shift control.



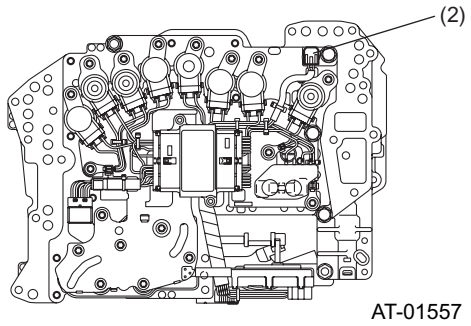
(1) Front vehicle speed sensor

C: ATF TEMPERATURE SENSOR 1, 2

These temperature sensors are thermistors and each of them is mounted on the control valve body. ATF temperature sensor 1 detects the ATF temperature in the oil pan, and ATF temperature sensor 2 detects the ATF temperature at the torque converter outlet; each sensor outputs electrical resistance signals.



AT-01647



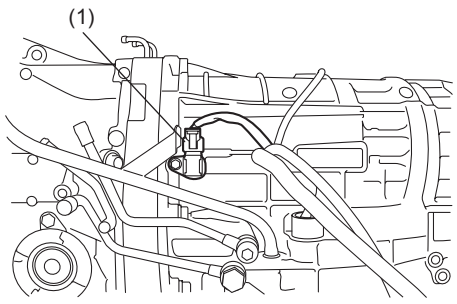
AT-01557

(1) ATF temperature sensor 1

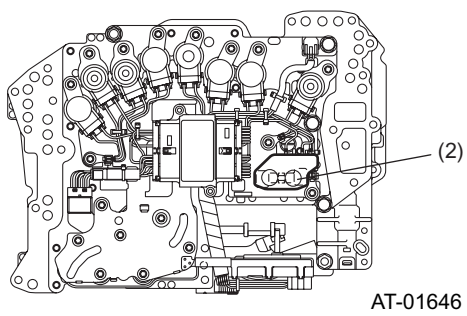
(2) ATF temperature sensor 2

D: TURBINE SPEED SENSOR 1, 2

Wheel speed sensors are hall element type sensors. Turbine speed sensor 1 detects the speed of the front sun gear, and turbine sensor 2 detects the speed of the front carrier. Each sensor sends pulse signals (60 pulses per rotation) to the TCM. From these two speed values, the TCM calculates the turbine speed and uses it for shifting control.



AT-01559



AT-01646

(1) Turbine speed sensor 1

(2) Turbine speed sensor 2

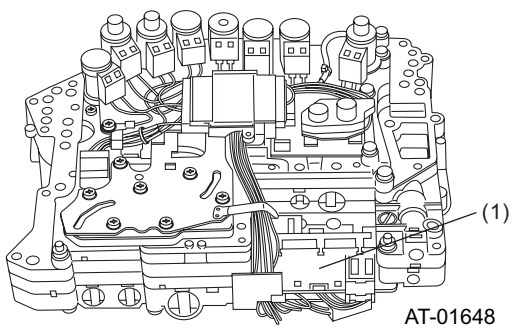
E: INHIBITOR SWITCH

The inhibitor switch is installed in the control valve and is connected to the TCM with 4 signal lines. The TCM uses this signal to detect range positions and to perform various controls. Relation between signals from the 4 lines (INH1 to 4) and range positions are as shown below:

	INH1	INH2	INH3	INH4
P				
R	○			○
N	○	○		
D	○	○	○	○

When the range position is detected as P or N as shown above, the TCM sends a signal (PN signal) allowing operation of the starter. On the other hand, in R or D range, starter operation is inhibited to ensure safety.

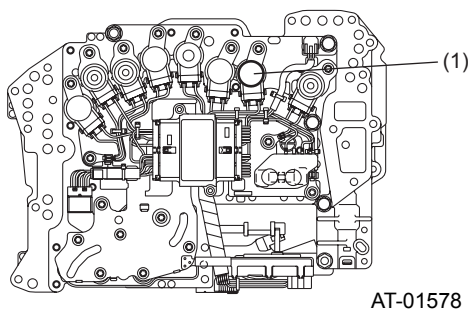
Additionally, when the range position is detected as R, the TCM turns the backup light relay output to ON and lets the backup lights illuminate.



(1) Inhibitor switch

F: LINE PRESSURE SOLENOID

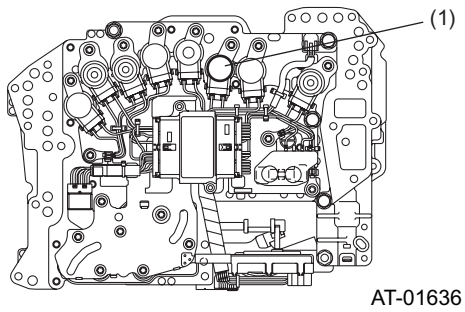
The line pressure solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. This controls the pressure modifier valve and accumulator control valve A to adjust the line pressure to an optimum pressure level suitable for operating conditions.



(1) Line pressure solenoid

G: LOCKUP SOLENOID

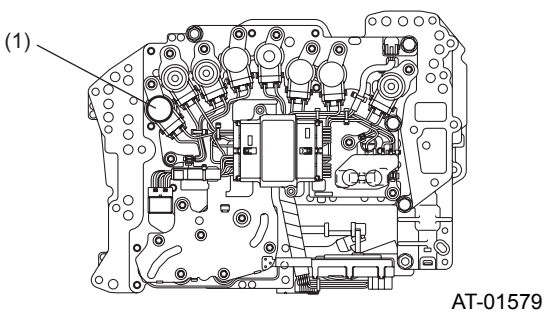
The lockup solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. It then controls the lockup control valve to provide smooth engagement and disengagement. It also enables stable slip lockup control while supported by learning control and real time feedback functions.



(1) Lockup solenoid

H: FRONT BRAKE SOLENOID

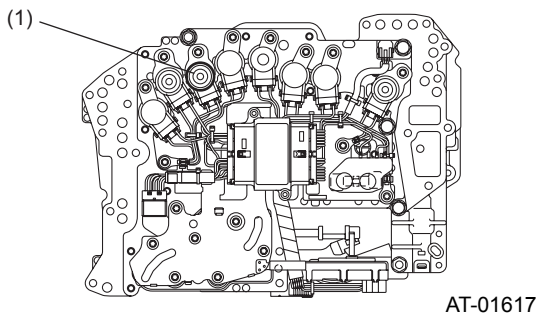
The front brake solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. This solenoid is activated when the front brake is to be engaged. Control values are corrected any time when necessary by the learning control and real time feedback functions to improve shift quality and eliminate errors due to aging.



(1) Front brake solenoid

I: INPUT CLUTCH SOLENOID

The input clutch solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. This solenoid is activated when the input clutch is to be engaged. Control values are corrected any time when necessary by the learning control and real time feedback functions to improve shift quality and eliminate errors due to aging.

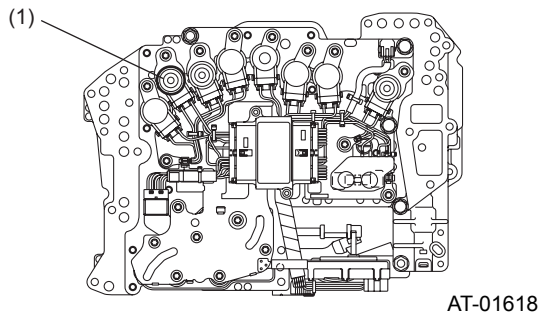


(1) Input clutch solenoid

J: DIRECT CLUTCH SOLENOID

The direct clutch solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. This solenoid is activated when the direct clutch is to be engaged. Control values are corrected any time when necessary by the learning control and real time feedback functions to improve shift quality and eliminate errors due to aging.

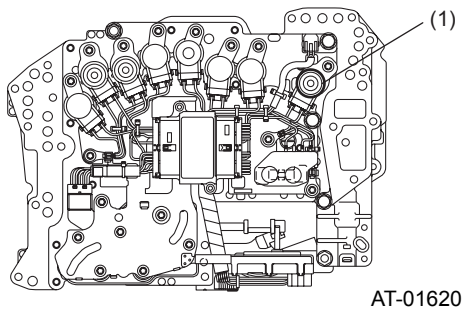
The direct clutch pressure can be switched to two range pressures with the direct clutch piston switch valve.



(1) Direct clutch solenoid

K: HIGH AND LOW REVERSE CLUTCH SOLENOID

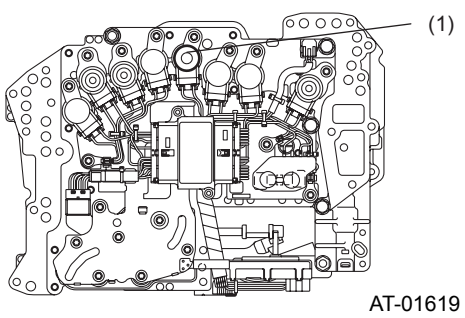
The high and low reverse clutch solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. This solenoid is activated when the high and low reverse clutch is to be engaged. Control values are corrected any time when necessary by the learning control and real time feedback functions to improve shift quality and eliminate errors due to aging.



(1) High and low reverse clutch solenoid

L: LOW COAST BRAKE SOLENOID

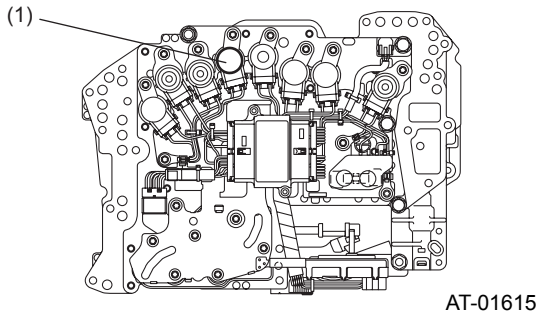
The low coast brake solenoid is mounted on the control valve and is directly controlled by ON/OFF instructions from the TCM. This solenoid is activated when the low coast brake is to be engaged during usage of engine braking in 1st or 2nd speed in manual mode.



(1) Low coast brake solenoid

M: TRANSFER SOLENOID

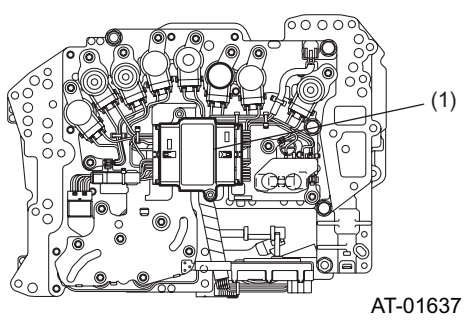
The transfer solenoid is mounted on the control valve and is directly controlled by electrical current instructions from the TCM. This ensures optimum AWD control in accordance with the varying road conditions by engaging/releasing the transfer clutch.



(1) Transfer solenoid

N: MEMORY BOX

The memory box is mounted on the control valve and stores hydraulic correction values and learned values for the initial shifting pressures for each solenoid, based on its hydraulic characteristics at the time delivered from the factory. The TCM acquires data from this memory box and performs correction based on these data to control each solenoid. This ensures high quality shifting from the time the vehicle was delivered from the factory.



(1) Memory box

16.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, lockup operation data, and transfer clutch torque data.

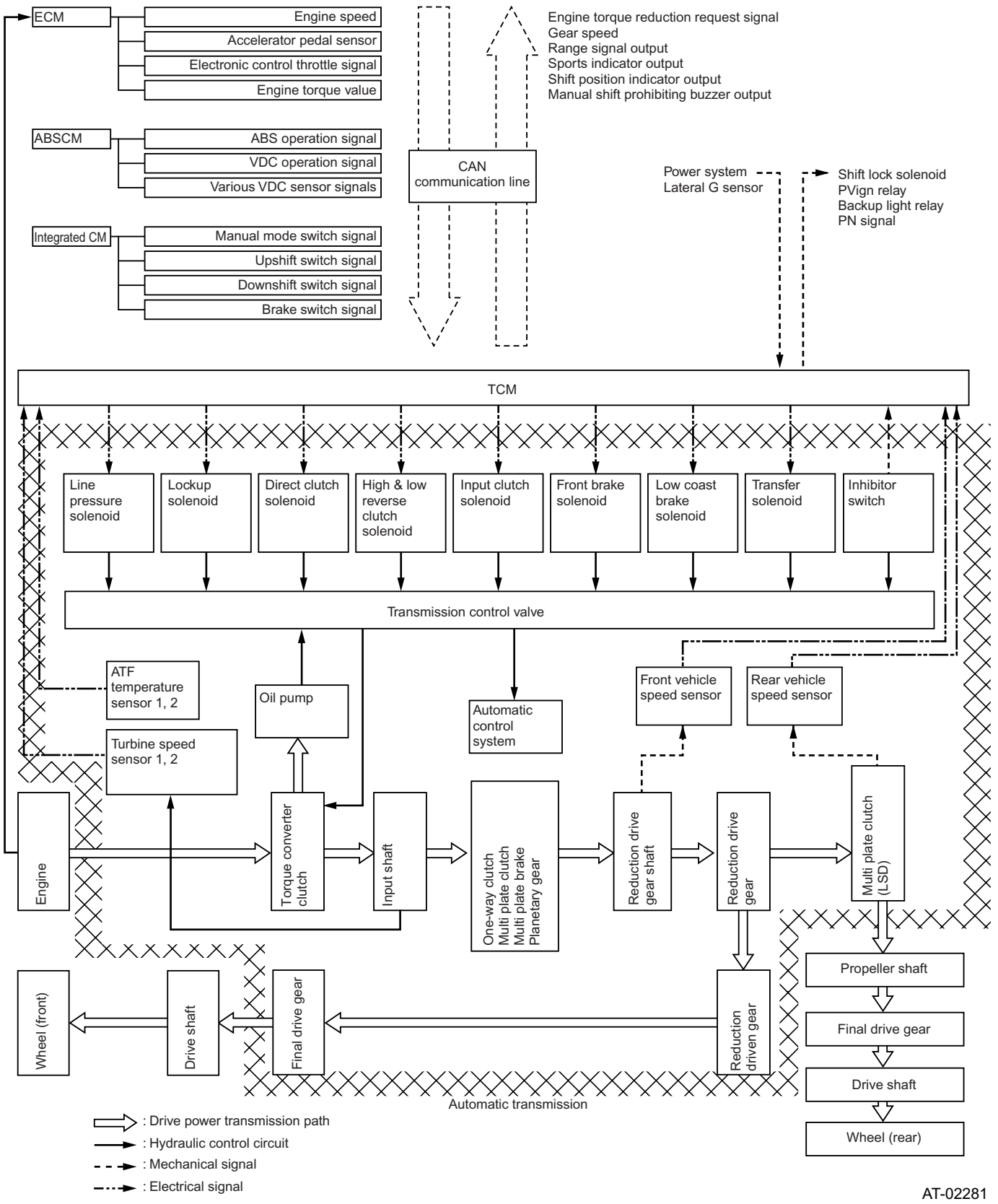
A: CONTROL SYSTEM

Control items		Input signals
Shifting control	Ordinary shift control	Accelerator pedal position signal Engine torque signal Engine speed Front vehicle speed signal Rear vehicle speed signal Turbine sensor 1, 2 signal Range signal
	Engine cooperative control	Front vehicle speed signal Rear vehicle speed signal Various engine information
	ABS cooperative control	Front vehicle speed signal Rear vehicle speed signal ABS operating signal Brake switch signal
	Control at high oil temperatures	ATF temperature sensor 1 signal ATF temperature sensor 2 signal
	Control when ATF or coolant temperature is low	ATF temperature sensor 1 signal ATF temperature sensor 2 signal Coolant temperature information
	Control when cruise control in operation	Cruise control switch signal Cruise control set signal

Control items			Input signals
Shift pattern selection control	Adaptive control	Shift pattern automatic switching control	Accelerator pedal position signal Engine speed Engine torque signal Front vehicle speed signal Rear vehicle speed signal Range signal Lateral G sensor signal Sports mode switch signal
		Accelerator pedal quick depressing control	Accelerator pedal position signal Front vehicle speed signal Rear vehicle speed signal Range signal
		Accelerator pedal quick return control	Accelerator pedal position signal Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal
		Braking control	Accelerator pedal position signal Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal Brake switch signal
		Control during cornering	Accelerator pedal position signal Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal Lateral G sensor signal
	Sports mode control		Accelerator pedal position signal Engine torque signal Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal
	Manual mode control		Engine speed Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal Upshift switch signal Downshift switch signal ATF temperature sensor 1 signal ATF temperature sensor 2 signal
Shift pattern selection control	2nd hold control (in Manual mode)		Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal Upshift switch signal Downshift switch signal
	Steering sports shift control		Engine speed Front vehicle speed signal Rear vehicle speed signal Range signal Sports mode switch signal Upshift switch signal Downshift switch signal ATF temperature sensor 1 signal ATF temperature sensor 2 signal Lateral G sensor signal

Control items		Input signals
Lockup control	Ordinary lockup control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed Range signal ATF temperature signal
	Slip lockup control	Front vehicle speed signal Rear vehicle speed signal Range signal Engine speed Turbine speed signal ATF temperature signal
Oil pressure control	Ordinary pressure control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed Range signal ATF temperature signal
	Shifting control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Engine speed Turbine speed signal Range signal ATF temperature signal
AWD center differential	Ordinary transfer control	Throttle position signal Rear vehicle speed signal Front vehicle speed signal Inhibitor switch ATF temperature signal Turbine speed signal Engine torque signal
	Slip detection control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Brake switch
	Steering control	Accelerator pedal position signal Rear vehicle speed signal Front vehicle speed signal Steering angle signal
	Control while ABS/vehicle dynamic control (VDC) in operation	ABS operating signal Vehicle dynamic control (VDC) operating signal Rear vehicle speed signal Front vehicle speed signal Brake switch
	Braking control	Accelerator pedal position signal Front vehicle speed signal Brake switch
	Start control	Engine torque signal Rear vehicle speed signal Front vehicle speed signal Turbine speed signal

B: SCHEMATIC DIAGRAM



C: SHIFTING CONTROL

1. ORDINARY SHIFT CONTROL

The TCM controls each solenoid based on input signal information such as inhibitor switch signals, vehicle speed signals and accelerator pedal position signals, to automatically select the optimum gear position from the shifting map.

2. ENGINE COOPERATIVE CONTROL

During shifting, the TCM outputs a torque-down requirement signal, and the ECM receives this to retard the ignition timing of each cylinder to temporary decrease the output torque from the engine. Simultaneously with this control, the TCM constantly monitors the shift sequence through vehicle speed sensors and the turbine speed sensor to perform feedback control and optimize gear shifts. Because of this control, a smooth and comfortable gear shifting is ensured under all conditions.

3. ABS COOPERATIVE CONTROL

When the ABS is operating, the optimum gear speed for the vehicle speed is selected by cooperative operation with the ABSCM to prevent degrading the operation of the ABS.

4. CONTROL AT HIGH OIL TEMPERATURES

If the ATF temperature becomes extremely high, shifting control is performed by automatically switching to a shifting map that is less likely to cause temperature rise.

5. CONTROL WHEN ATF OR ENGINE COOLANT TEMPERATURE IS LOW

When the ATF temperature or engine coolant temperature is extremely low at engine start, etc., shifting control is performed by automatically switching to a shifting map that causes temperature rise easier.

6. CONTROL WHEN CRUISE CONTROL IN OPERATION

When the cruise control is operating, shifting control is performed by automatically switching to a shifting map that is suitable for cruise control.

MEMO

D: SHIFT PATTERN SELECTION

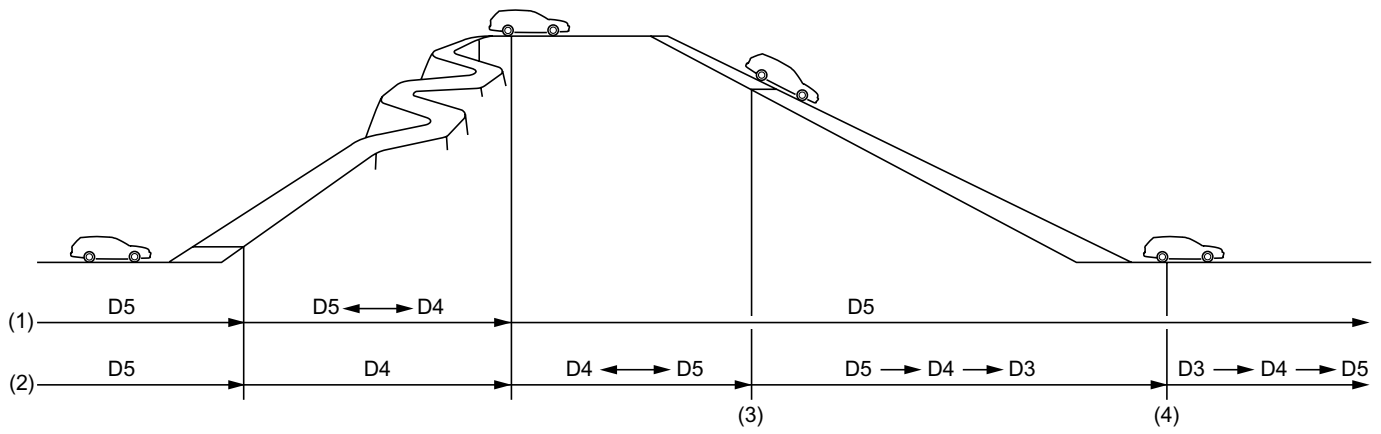
1. ADAPTIVE CONTROL

This control is performed to improve the drivability of the vehicle by optimizing gear shifts in accordance with the driver's intention to accelerate or decelerate, and driving conditions such as hill climbing, winding road driving, etc.

● Shift pattern automatic switching control
This control enables selection of the optimum gear speed by automatically switching the shift pattern by estimating driver's intentions and driving conditions through sensor information such as driving resistance, engine speed, acceleration, vehicle speed, and also from calculated values.
Any of the three patterns NORMAL, SPORTS, and SLOPE are continuously and automatically selected under the following conditions.

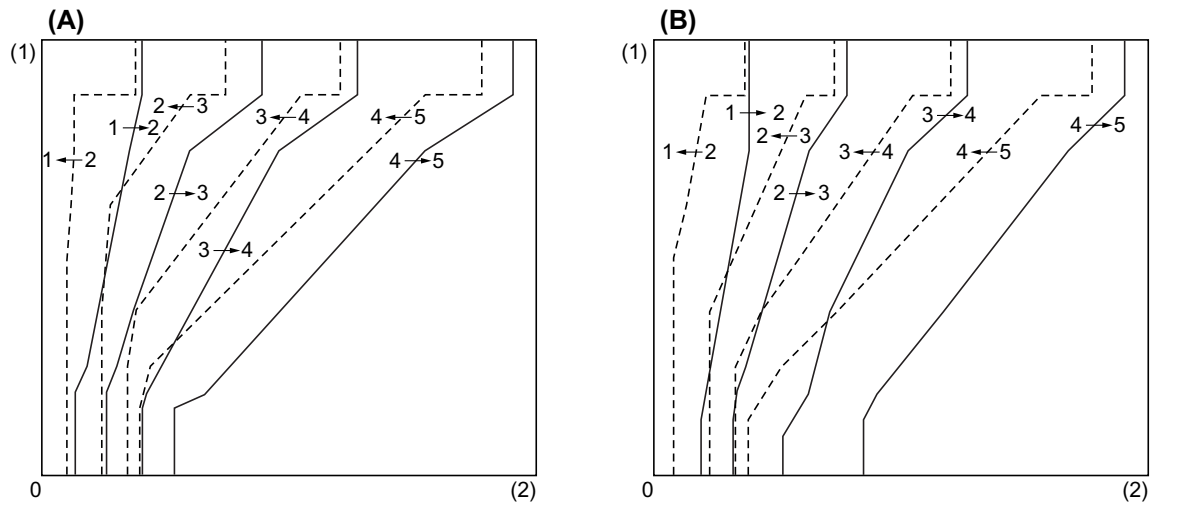
D range
NORMAL⇔SPORTS⇔SLOPE
D range, in sports mode
SPORTS⇔SLOPE

Normal pattern: covers a wide range from normal driving to high speed driving.
Sports pattern: a shift pattern suitable for driving conditions requiring deep accelerator pedal positions, such as winding road driving.
Slope pattern: this shift pattern controls upshifting to prevent too frequent gear shifting during climbing or descending hills. By combining braking control (in sports mode only) (explained later), automatic engine braking will be available when descending hills.



AT-01731

(1) Without climb/descend control
(2) With climb/descend control
(3) Brake pedal ON
(4) Re-acceleration



AT-01730

(A) Base pattern
(1) Accelerator pedal position
(B) Grade control pattern
(2) Vehicle speed

● Accelerator pedal quick depressing control
When the accelerator pedal is quickly depressed, the TCM interprets this as acceleration is required, and the transmission is downshifted earlier to obtain a greater drive force.

● Accelerator pedal quick return control
When the accelerator pedal is quickly released, the TCM interprets this as deceleration is required, and upshift is prohibited in order to hold the transmission in the current gear speed to prevent frequent shifting and to maintain engine braking effect (operates in sports mode only).

● Braking control
According to the braking force (deceleration) during braking, downshifts are hastened to ensure engine braking effect and obtain a larger driving power for accelerating after braking (operates in sports mode only).

● Control during cornering
When the system interprets that the vehicle is turning a corner by the lateral acceleration and the change rate in vehicle speed, it prevents unwanted upshifts to maintain a stable drive force and cornering performance.

2. SPORTS MODE CONTROL

When the shift lever is moved toward the manual gate side in D range, the SPORT light in the combination meter illuminates and the system enters the Sports mode. Gearshift timings are set at higher vehicle and engine speeds to make more use of low speed gears. The full lockup vehicle speed in 5th is also set higher than in the normal mode.

3. MANUAL MODE CONTROL

By operating the “+” or “–” switch on the select lever or steering wheel in D range with the sports mode switch ON (in sports mode), the system switches to manual mode. In this mode, operating the “+” switch causes upshifting while operating the “–” switch causes downshifting; manual shifting is enabled and the selected gear position is held while driving.

However, at certain vehicle speeds or ATF temperatures, the following inhibiting control is performed.

- Upshift inhibiting and auto downshift control

The gear upshifts each time the “+” switch is operated, however, when the vehicle speed is too low for the selected gear speed, the TCM inhibits further upshifting.If the vehicle speed becomes too slow for the current gear speed, a downshift will be made automatically to prevent engine stall. When the vehicle comes to a stop, the transmission will always be controlled to shift to 1st speed unless the vehicle was in manual 2nd hold control.

- Downshift inhibiting control

The gear downshifts each time the “–” switch is operated, however, when the vehicle speed is too low for the selected gear speed, the TCM inhibits further shifting. A manual shifting inhibiting buzzer will sound to warn the driver.

- Control when oil temperature is low

When the ATF temperature is low as in cases such as immediately after start in winter, upshifting to 5th is inhibited to quicken warm up.

- Engine over speed prevention control

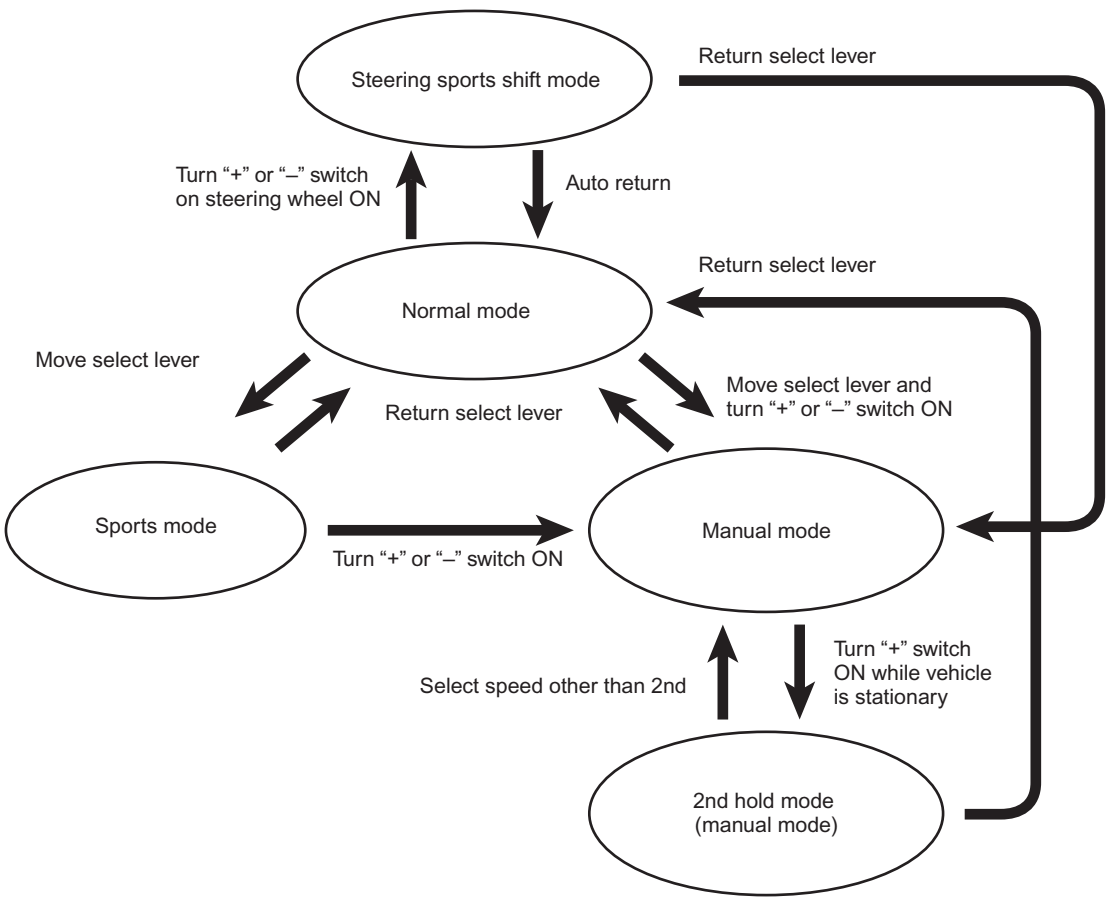
If the engine speed exceeds the preset value during accelerating, the fuel supply is cut to prevent over-revving of the engine.

4. 2nd HOLD CONTROL (IN MANUAL MODE)

When the “+” switch is operated when the vehicle is in manual mode and not moving, the transmission shifts to 2nd speed enabling start in 2nd.This status is held unless the manual mode is canceled, or a speed other than 2nd is selected with the “–” switch.Also, the transmission is held in 2nd when the vehicle is stopped.

5. STEERING SPORTS SHIFT CONTROL

By operating the “+” or “–” switch on the steering wheel in D range during Normal mode, the system can be temporary switched to manual mode to perform manual shift operations. In this mode, the mode automatically returns to the previous mode when the next operation is not performed within a specified time or when the vehicle is put in the straight forward accelerating state.



AT-02970

6. ILLUMINATION CONTROL OF VARIOUS INDICATORS

Illuminations of the various indicators on the combination meter are controlled in accordance with the shift pattern selection as shown below.

Indicator / Status	D ●	SPORT	▲▼	1	Operation mode
Normal D range	D ●	SPORT	△▽	(extinguished)	Normal mode
In sports mode	D ●	SPORT	△▽	(extinguished)	Sports mode
Manual mode	D ○	SPORT	▲▼	1 — 5	Manual mode
When engine oil temperature is high and high engine speed is maintained	D ○	SPORT	△▽	—	Manual mode (at high oil temperature)
In steering sports shift	D ○	SPORT	▲▼	1 — 5	Semi sports shift mode
When engine oil temperature is high and high engine speed is maintained (upper row: first 2 seconds, lower row: thereafter)	D ●	SPORT	△▽	—	Normal mode (at high oil temperature)
	D ●	SPORT	△▽	(extinguished)	Normal mode (at high oil temperature)

NOTE:
• Indicators printed in solid black show their illuminated status.
• ATF TEMP indicator illuminates to inform of high ATF temperature.

AT-02882

E: CONTROL VALVE HYDRAULIC PRESSURE CORRECTION CONTROL AND LEARNING CONTROL

● Control valve hydraulic pressure correction control
During this control, the TCM acquires the hydraulic pressure correction data stored for each control valve in the memory box installed on the control valves, and then correctively controls the instruction current to each solenoid based on the data. This ensures stable shifting quality irrespective of variance between units.

● Learning control of shifting hydraulic pressures
To constantly ensure excellent shift quality regardless of the variance between friction material and aging, learning control of shifting hydraulic pressures is used.
Learning takes place for every normal shifting under certain conditions, and the learned values are saved in the flash ROM of the TCM. The values are not cleared even when the power is turned OFF (or the battery's negative terminal disconnected).

F: AWD CENTER DIFFERENTIAL CONTROL

1. CONTROL DESCRIPTION

Engagement of the multi-plate clutch (LSD) in the center differential is controlled according to the torque input to the transfer. It selects a map according to driving conditions and use it as the control basis.

2. NORMAL CONTROL

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

3. START CONTROL

When the vehicle speed is 0 km/h (0 MPH), the TCM increases the engaging force of the multi-plate clutch to a higher level compared to that of normal control.

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

4. TURNING CONTROL

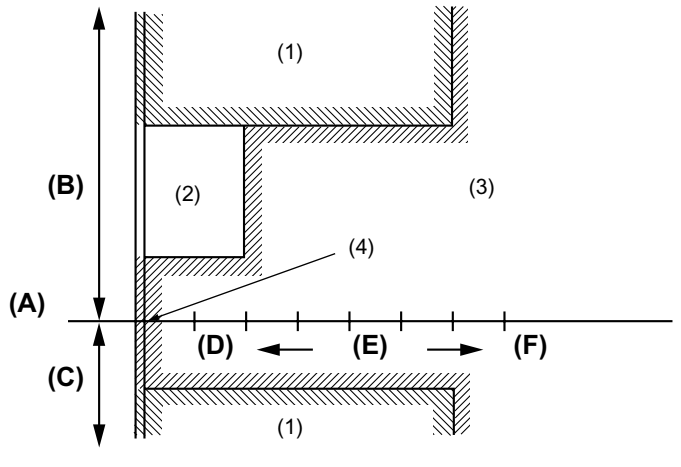
The TCM makes a correction such that the engagement force of the multi-plate clutch is reduced as the steering angle increases.

This function is performed to improve 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.



AT-00737

(A) Front and rear wheel speed ratio
(B) Front wheel slip
(C) Rear wheel slip
(D) Low
(E) Vehicle speed
(F) High

(1) Slip control
(2) Turning control
(3) Normal control
(4) Start control

6. ABS CONTROL

When the TCM receives an ABS operation signal from the ABSCM, it adjusts the differential action limiting torque to the predetermined level.

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.

G: RANGE LOCK CONTROL

This control prevents the select lever from being moved to the R position when the vehicle is running. Thus damage to components such as the reverse clutch is prevented.

When the specified speed is exceeded the TCM turns off the shift lock solenoid for the select lever.Therefore the range lock control works to inhibit operation from N range to R range, preventing the transmission from put into reverse.

17.On-board Diagnostics System

A: FUNCTION

● The on-board diagnosis system detects and indicates a fault by generating a code corresponding to each fault location. The engine malfunction indicator light (SPORTS indicator light) on the combination meter indicates occurrence of a fault or abnormality.

● When the engine malfunction indicator light comes on as a result of detection of a fault by the TCM, the corresponding diagnostic trouble code (DTC) is stored in the TCM.

● On OBD-II available vehicles, it is necessary to connect the SUBARU Select Monitor (SSM) to the data link connector in order to check the DTC.

● To provide various functions and to facilitate fault isolation, a diagnosis system compatible with the SSM is used.

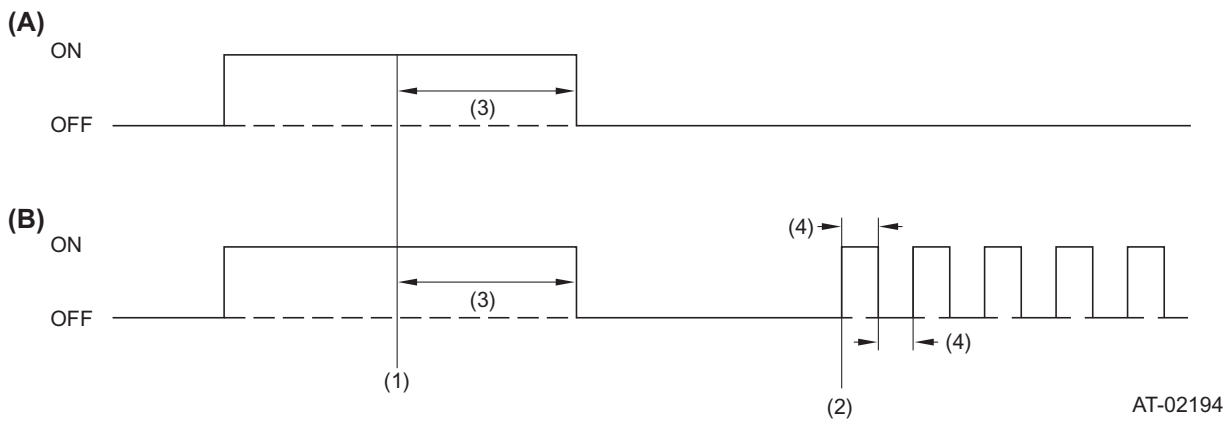
● The on-board diagnostics system detects the following electrical system faults or abnormalities in the system.

ATF temperature sensor 1, 2	Inhibitor switch
Turbine speed sensor 1, 2	CAN communication system
Front and rear wheel speed sensors	Interlock decision
Lockup solenoid (circuit, function)	1st engine brake abnormal
Line pressure solenoid (circuit)	Range lock solenoid (circuit)
Front brake solenoid (circuit, function)	PN signal output
Input clutch solenoid (circuit, function)	PVign power circuit (PVign relay)
High and low reverse clutch solenoid (circuit, function)	Backup light relay output circuit
Direct clutch solenoid (circuit, function)	TCM data communication abnormal
Low coast brake solenoid (circuit, function)	Lateral G sensor
Transfer solenoid (circuit)	Brake switch
Front brake hydraulic switch	Sports mode switch
Input clutch hydraulic switch	Engine speed signal
High and low reverse clutch hydraulic switch	1, 2, 3, 4, 5, R gear ratios
Direct clutch hydraulic switch	

If a fault is detected, the system tells the fault by causing the SPORTS indicator light to blink.

B: OPERATION OF SPORTS INDICATOR LIGHT

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



(A) When normal
(B) Abnormal

(1) Engine cranking
(2) Abnormality detected
(3) 2 seconds
(4) 0.25 seconds

18.Fail-safe Function

● Front and rear vehicle speed sensors, rear wheel speed sensor abnormal
If a fault is detected in either or both of the front vehicle speed sensor and rear vehicle speed sensor, the vehicle speed information received from the ABS unit via CAN communication is substituted for control. This enables normal quality shifting.

● Inhibitor switch abnormal
If an input of other than the specified pattern is entered to the TCM, the select position indicator lights in the combination meter are turned off, the starter is disabled, the reverse light is disabled, the transmission is fixed in D range, and manual mode is inhibited.

● PN signal abnormal
The output is turned OFF (starter inhibited) if an abnormality is detected in the PN signal output. However, if the ECM is receiving range signals through the backup of CAN communication, the starter can be used in P and N ranges.

● AT interlock decision
If an AT interlock decision is made, the vehicle's minimum mobility is maintained by fixing the transmission in 2nd, 4th or 5th speeds in accordance with the engaging pattern detected by the hydraulic switch. Relation between the hydraulic switch detection pattern and fixed gear speeds are as shown in the following table.

● Engine braking in 1st abnormal decision
If 1st engine braking abnormal decision is made, the low coast brake solenoid is deactivated to cancel the engine braking effect.

● Line pressure solenoid abnormal
The solenoid is deactivated and the line pressure set at maximum, 5th speed is inhibited. Except for this, the system is controlled normally.

● Lockup solenoid abnormal
The solenoid is deactivated and lockup is inhibited.

● Low coast brake solenoid abnormal
If the solenoid is failed and stuck in its ON state (electrically or mechanically) the transmission is fixed in 2nd speed, and when the solenoid is failed and stuck in its OFF state (electrically or mechanically) the solenoid is constantly turned OFF. (Engine braking is made not available in 1st and 2nd speeds.)

● Input clutch solenoid abnormal
If the solenoid is failed and stuck in its ON or OFF state (electrically or mechanically) the transmission is fixed in 4th speed to maintain mobility.

● Direct clutch solenoid abnormal
If the solenoid is failed and stuck in its ON or OFF state (electrically or mechanically) the transmission is fixed in 4th speed to maintain mobility.

● Front brake solenoid abnormal
If the solenoid is failed and stuck in its ON state (electrically or mechanically) the transmission is fixed in 5th speed, and when the solenoid is failed and stuck in its OFF state (electrically or mechanically) the transmission is fixed in 4th speed to maintain mobility.

● High and low reverse clutch solenoid abnormal
If the solenoid is failed and stuck in its ON or OFF state (electrically or mechanically) the transmission is fixed in 4th speed to maintain mobility.

● Transfer clutch solenoid abnormal
If the solenoid is failed and stuck in its ON or OFF state, the transfer solenoid output is constantly turned OFF.

● Turbine sensor 1, 2 abnormal
Shifting control is performed without using turbine sensor values to maintain minimum mobility. 5th speed and manual mode are inhibited.

● TCM data communication abnormal
If communication with the memory box on the control valves fails, backup values stored in the TCM are used for controlling the solenoids.

● CAN communication abnormal
If an abnormality occurs in CAN communication, data received via CAN communication are fixed to preset values to perform shift control and maintain minimum mobility. Lockup and manual mode are inhibited.

		Oil pressure switch output						Clutch pressure output pattern in failsafe mode						
Gear position		Input clutch switch	High& low reverse clutch switch	Direct clutch switch	Front brake switch	Low coast brake switch	Fail safe	Input clutch solenoid	High & low reverse clutch solenoid	Direct clutch solenoid	Front brake solenoid	Low coast brake solenoid	Lockup solenoid	Transfer solenoid
Interlock engaging pattern	1	×	○	–	○	○	Fixed in 4th	ON	ON	ON	OFF	OFF	OFF	ON
		–	○	×	–	○	Fixed in 4th	ON	ON	ON	OFF	OFF	OFF	ON
	2	–	×	○	–	○	Fixed in 4th	ON	ON	ON	OFF	OFF	OFF	ON
		×	–	○	○	–	Fixed in 4th	ON	ON	ON	OFF	OFF	OFF	ON
	3	–	○	○	–	×	Fixed in 2nd	OFF	OFF	ON	OFF	OFF	OFF	ON
		×	–	○	○	–	Fixed in 4th	ON	ON	ON	OFF	OFF	OFF	ON
	4	–	○	○	–	×	Fixed in 2nd	OFF	OFF	ON	OFF	OFF	OFF	ON
		○	–	○	×	–	Fixed in 5th	ON	ON	OFF	ON	OFF	OFF	ON
	5	○	○	–	○	×	Fixed in 2nd	OFF	OFF	ON	OFF	OFF	OFF	ON
		○	–	×	○	–	Fixed in 4th	ON	ON	ON	OFF	OFF	OFF	ON

× : Abnormal
○ : Normal

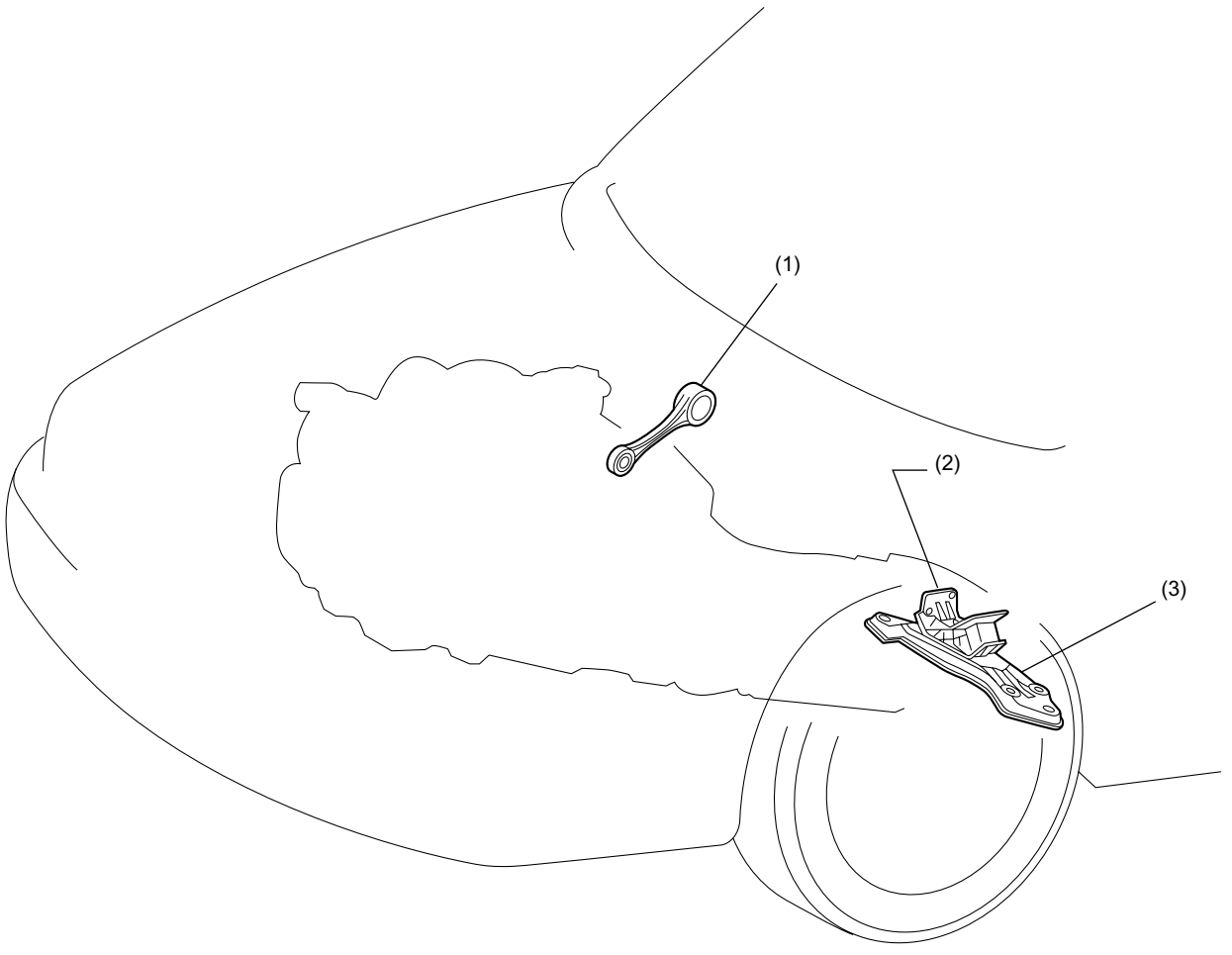
AT-02300

19.Transmission Mounting

A: GENERAL

The transmission mounting consists of a pitching stopper, cushion rubber, and a cross member.

In addition to support the transmission, these components absorb noise and vibration caused by the transmission.



AT-00438

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

MANUAL TRANSMISSION AND DIFFERENTIAL

1. General

The 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 has five forward speeds and one reverse speed, and all gears are provided with inertia lock type synchronizers.

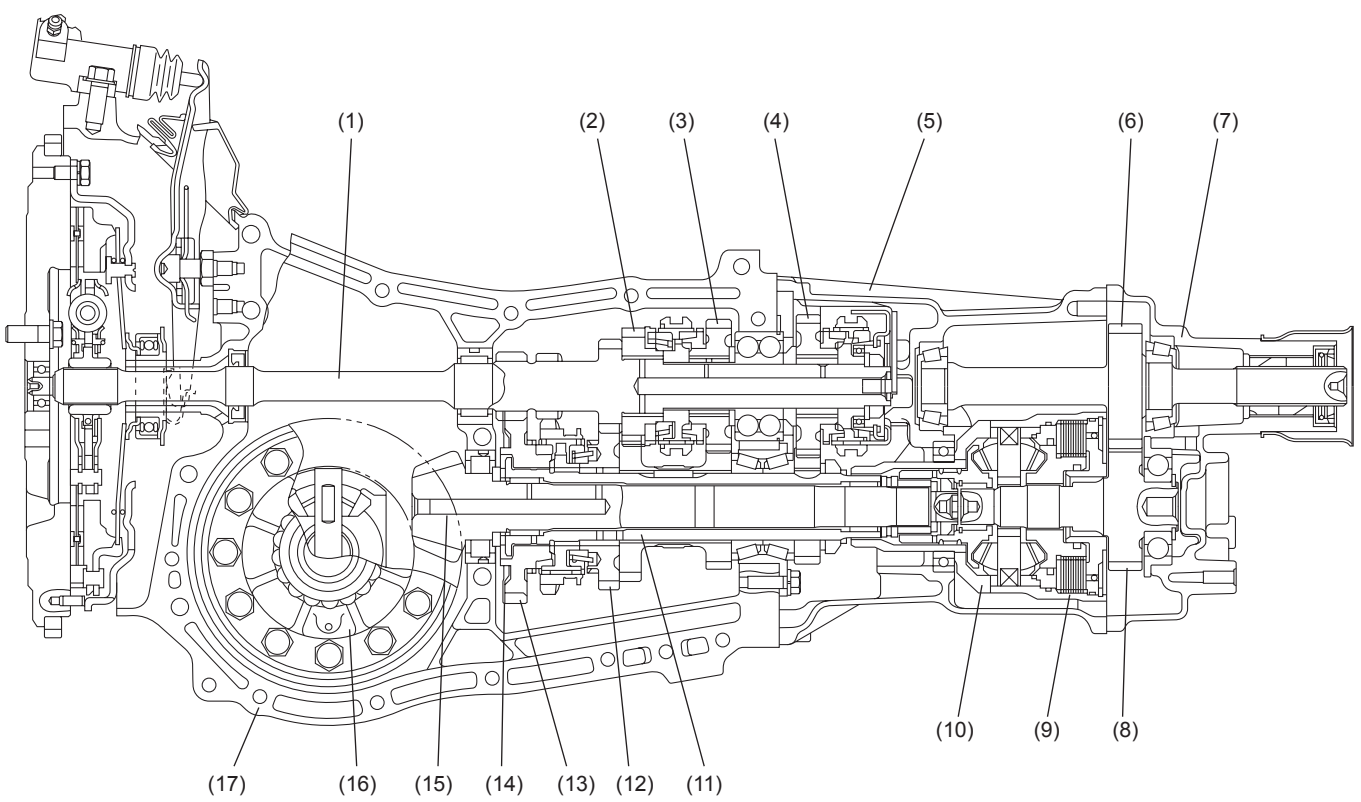
The transmission and front differential are housed in an aluminum case, which is split into right and left halves and constitutes also a clutch housing. Located at the rear and joined each other are the transfer case and extension case which house the transfer gears and center differential as well as 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 propeller shaft. The viscous coupling functions as a differential-action-limiting element.



MT-01225

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

2. Gearshift Mechanism

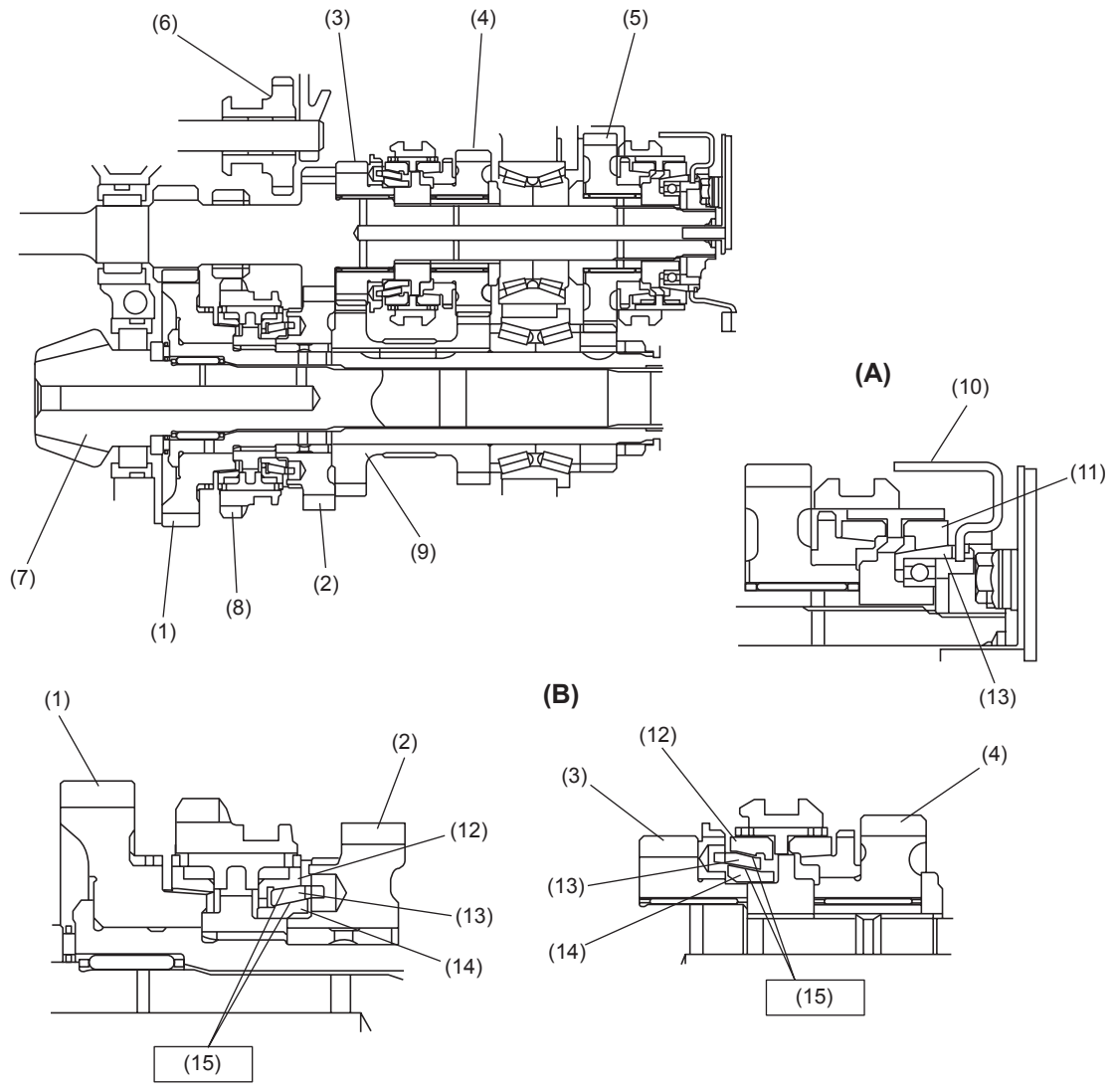
A: CONSTRUCTION

● Helical gears are used for forward speed gears. Reverse speed is achieved by making the drive gear to mesh with the main shaft while making the driven gear and reverse idler gear to mesh with the 1st-2nd synchronizer sleeve of the drive pinion, in order to reverse the rotating direction.

● The synchromesh mechanism for 1st and 2nd speeds are placed at the drive pinion side, while the mechanism for 3rd, 4th, 5th and reverse speeds are placed at the main shaft side.

● On non-turbo models, a double cone synchromesh mechanism is used for 2nd and 3rd speed gears.

● On turbo models, a double cone synchromesh mechanism is used for 1st, 2nd and 3rd speed gears.



MT-01034

(1) 1st gear
(2) 2nd gear
(3) 3rd gear
(4) 4th gear
(5) 5th gear
(6) Reverse idler gear
(7) Drive pinion shaft
(8) Reverse gear
(9) 3rd-4th driven gear
(10) Stopper
(11) Balk ring
(12) Outer balk ring
(13) Synchronizer cone
(14) Inner balk ring
(15) Cone surface

(A) <Reverse synchronizer>
(B) Torque <2nd and 3rd double-cone synchronizer>

3. Reverse Check Mechanism

Located in the transfer case, the reverse check mechanism prevents a direct 5th-to-reverse shift by using a selector arm and cam combination, which allows the gear to be shifted into the reverse only after it has been returned once to 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 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 can rotate and move axially on the shaft but its leftward movement is restricted by a step formed on the sleeve inner wall.

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

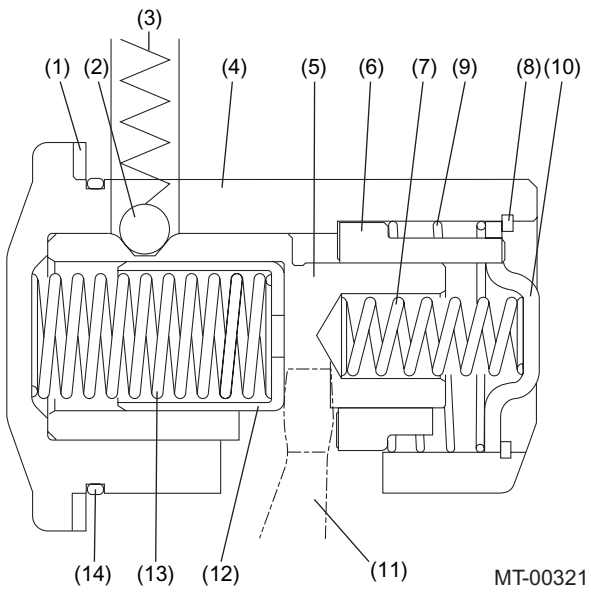
Around the check cam is the reverse check spring whose left end applies simultaneous leftward and rotational forces to the cam.

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

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

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

REVERSE CHECK MECHANISM

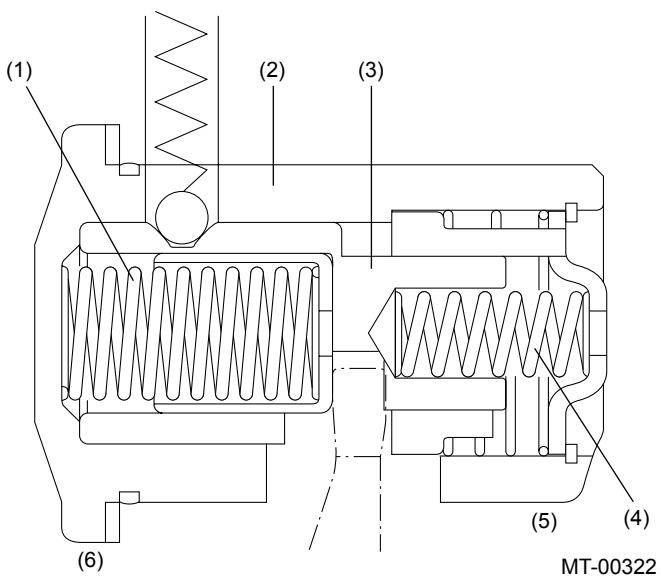


(1) Select adjust shim
(2) Detent ball
(3) Reverse accent spring
(4) Reverse check sleeve
(5) Reverse accent shaft
(6) Reverse check cam
(7) Reverse return spring
(8) Snap ring
(9) Reverse check spring
(10) Reverse check plate
(11) Selector arm
(12) Spring cap
(13) 1st return spring
(14) O-ring

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.

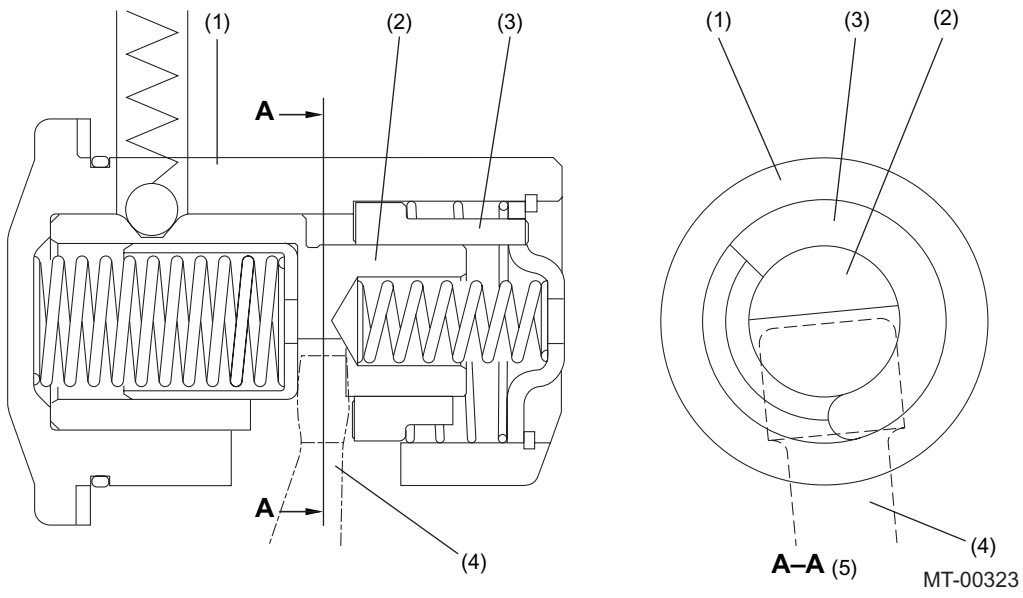
The following explanation describes how the selector arm and reverse check mechanism operate when the driver selects the 5th gear and then selects the reverse gear.



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

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

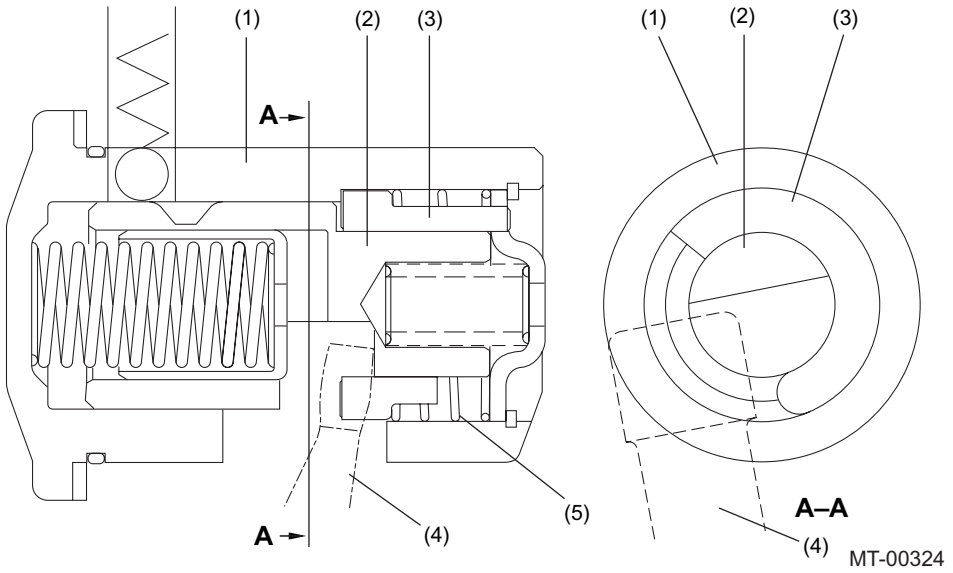
The selector arm moves rightward while pushing both the reverse accent shaft and reverse check cam simultaneously.



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

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 pressure and returns to its original position by the force of the reverse check spring.

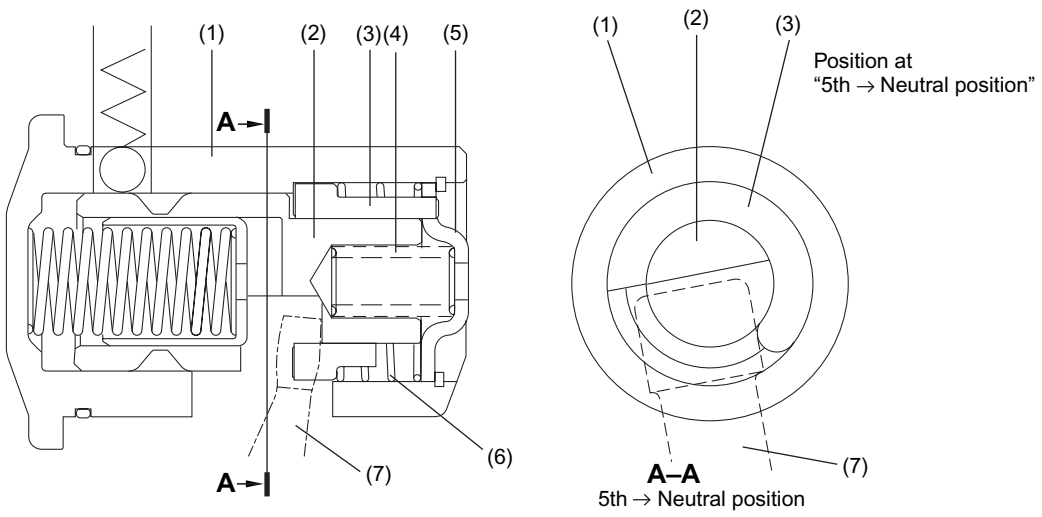


(1) Reverse check sleeve
(2) Reverse accent shaft
(3) Reverse check cam
(4) Selector arm
(5) Reverse check spring

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.

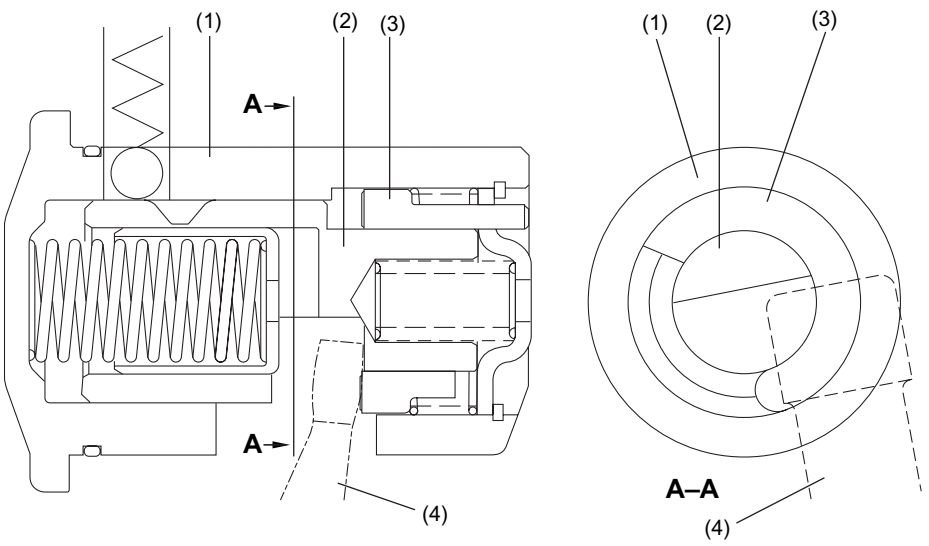


MT-00325

(1) Reverse check sleeve
(2) Reverse accent shaft
(3) Reverse check cam
(4) Reverse return spring
(5) Reverse check plate
(6) Reverse check spring
(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.



MT-00326

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

4. Center Differential

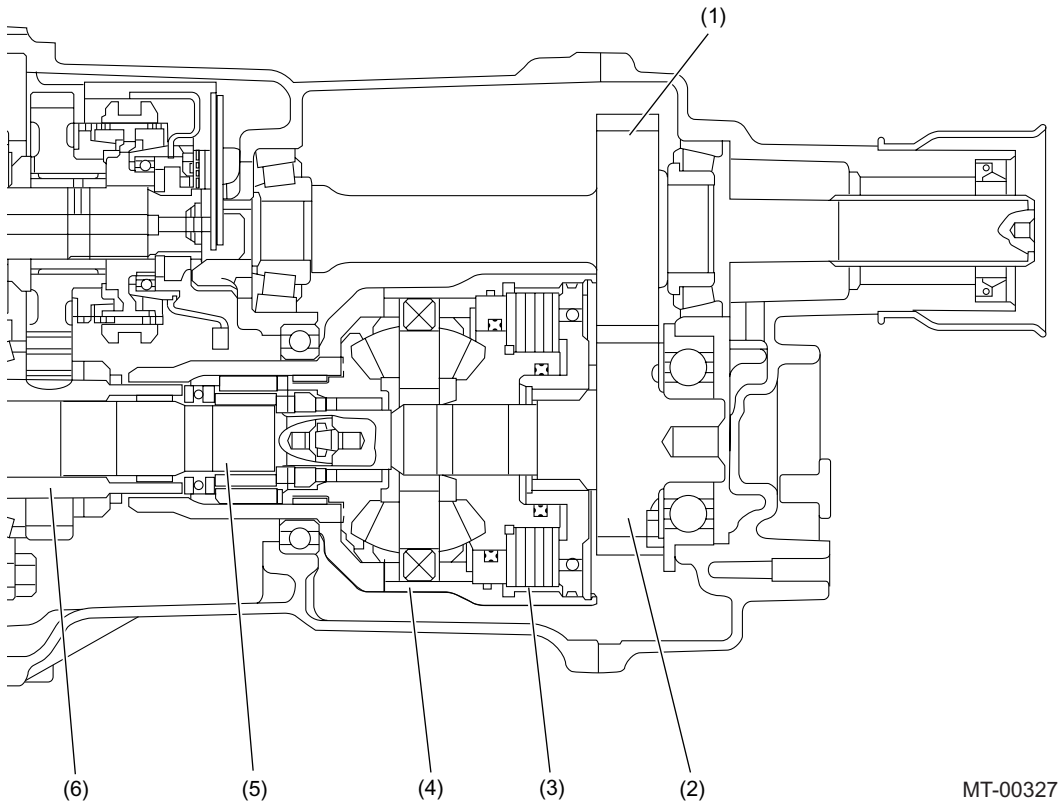
A: CONSTRUCTION

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

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

The engine torque enters the center differential case from the transmission's driven shaft. The 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.

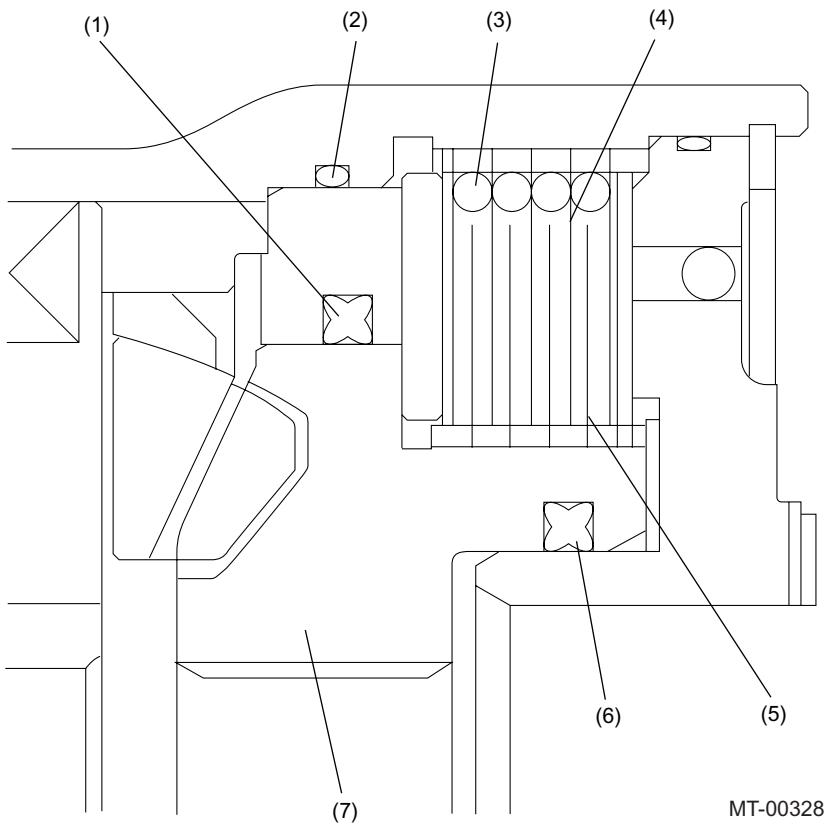
The viscous coupling limits the differential action of the bevel gear set when either front or rear wheels spin so that adequate torques are transmitted to the front and rear wheels and proper traction is obtained.



(1) Transfer driven gear
(2) Transfer drive gear
(3) Viscous coupling
(4) Center differential (with viscous coupling)
(5) Drive pinion shaft
(6) Drive 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 rings 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 pressurized due to large difference in front and rear axle speeds.

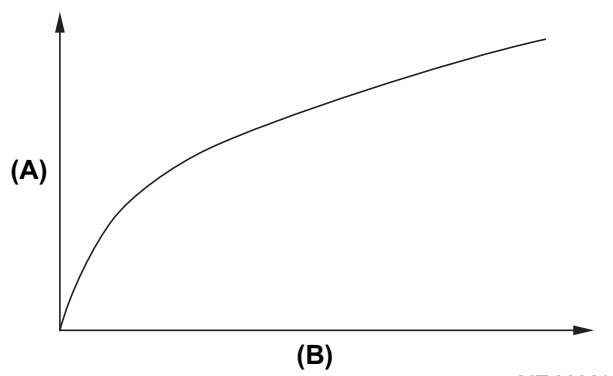


(1) X-section ring
(2) O-ring
(3) Spacer ring
(4) Outer plate
(5) Inner plate
(6) X-section ring
(7) Side gear (rear)

1. TORQUE CHARACTERISTICS

When a speed difference occurs between the center differential case and the rear side gear, a shear 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 shear 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.



MT-00329

(A) Driving torque
(B) Speed difference

2. HUMP PHENOMENON

Silicone oil is heated and expanded as differential action continues. The oil in the viscous coupling expands and compresses the inside air to cause direct plate-to-plate contact or 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 shear torque transmitting operation. (The hump phenomenon does not occur under normal operating conditions.)

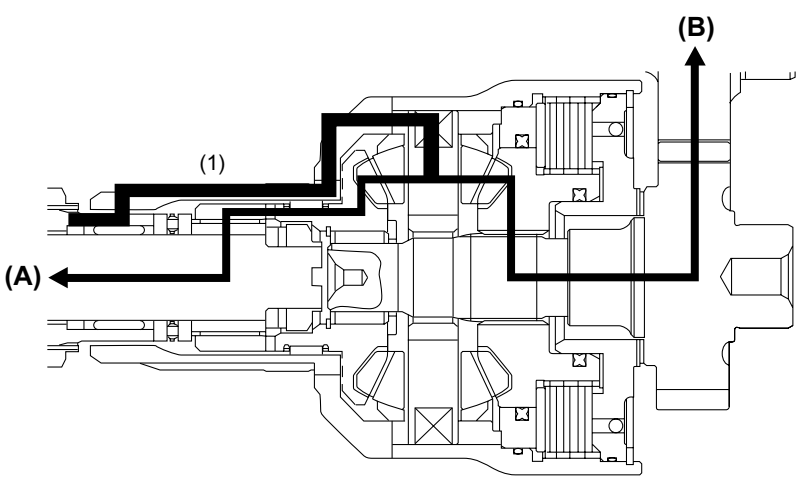
C: FUNCTION

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 shear torque because there is no relative movements between the inner and outer plates.



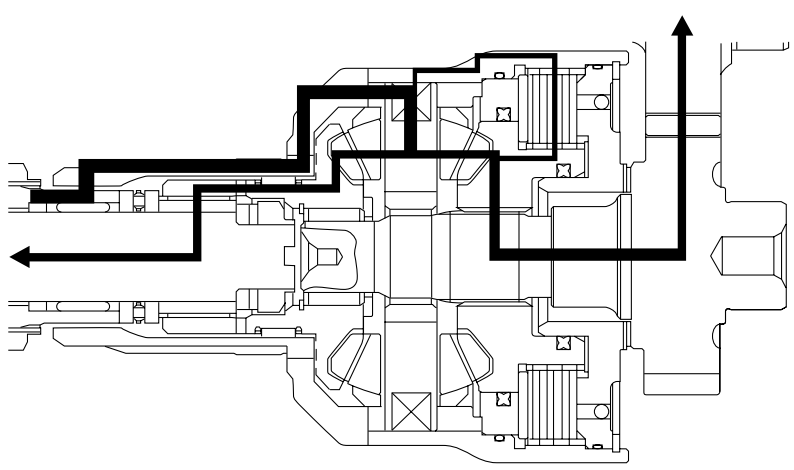
MT-00330

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

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.

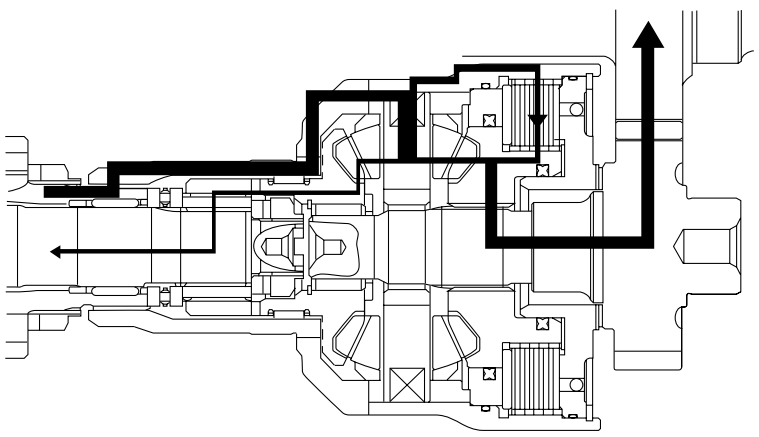
Although the speed difference is small under this condition, operation of the viscous coupling causes more torque to be transmitted to the rear than to the front.



MT-00331

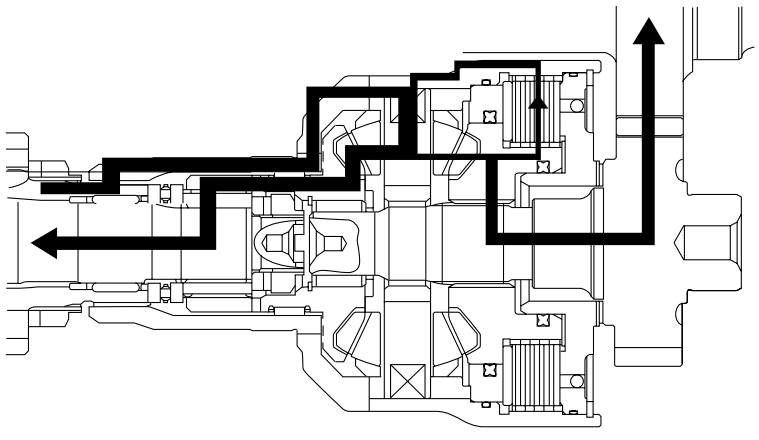
3. DRIVING ON ROUGH OR SLIPPERY ROADS

● 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 shear 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.



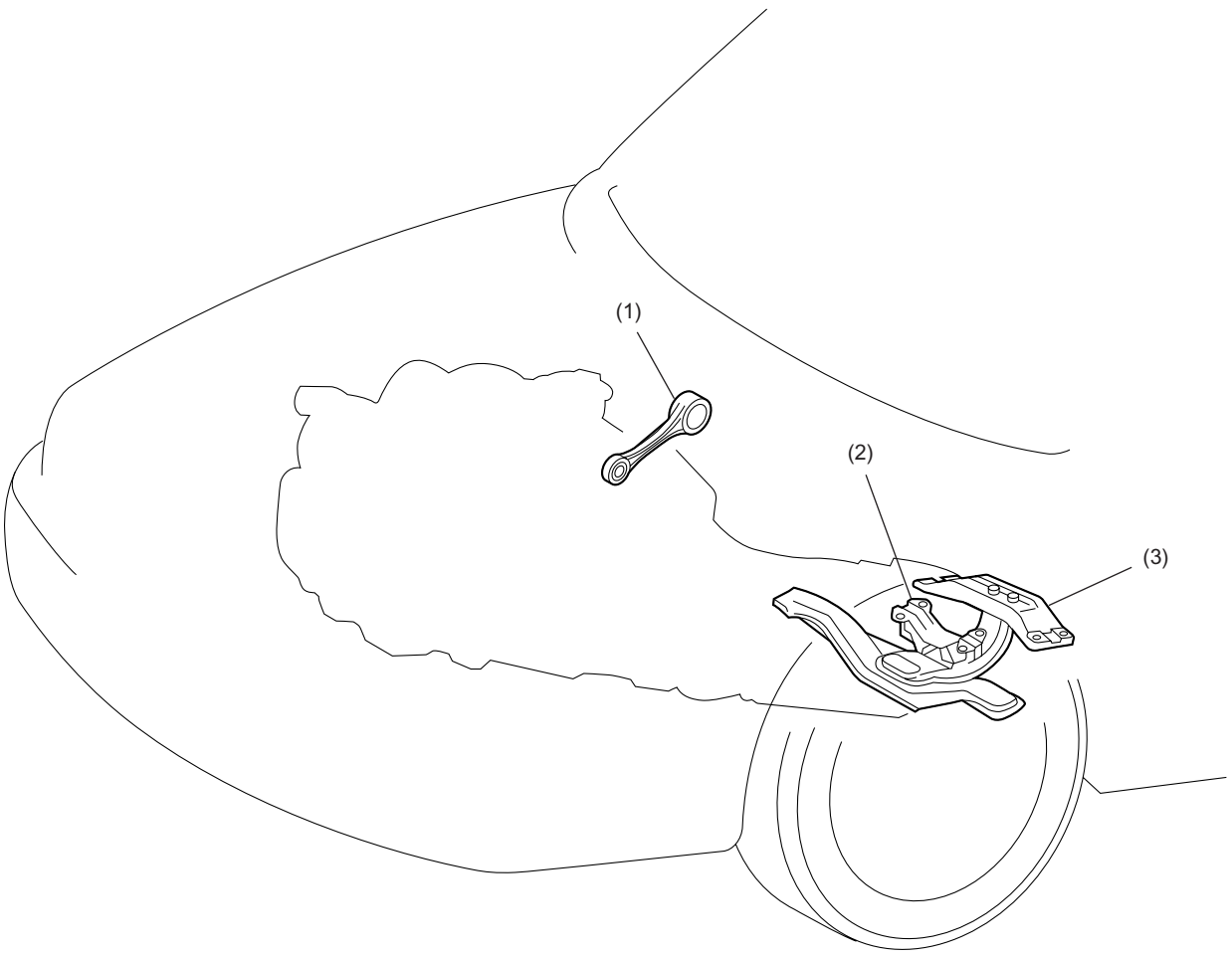
MT-00332

● 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 shear 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-00333

5. Transmission Mounting



MT-00334

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

AIRBAG SYSTEM

1. Airbag System

A: GENERAL

1. SRS AIRBAG

The SRS airbags supplement the seat belts which restrain the body if the driver or passenger is endangered by a severe impact to the front of the vehicle.

If an impact whose magnitude exceeding the preset value is applied to the vehicle, the airbags inflate immediately to prevent the driver and front seat passenger being hit against the steering wheel, instrument panel or windshield.

A two-staged inflator whose airbag inflation speed is changed according to the magnitude of the impact is used.

2. SRS SIDE AIRBAG

The SRS side airbag supplements the seat belts which restrain the body if the driver or passenger is endangered by a severe impact to the side of the vehicle.

If an impact whose magnitude exceeding the preset value is applied to the side of the vehicle, the side airbags inflate immediately to soften the impact to the driver or front seat passenger especially at their chest area.

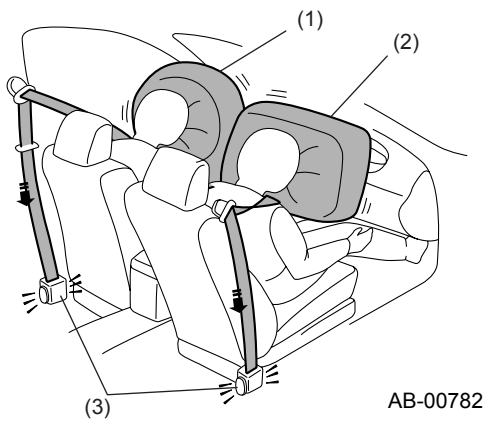
3. SRS CURTAIN AIRBAG

The SRS curtain airbag supplements the seat belts which restrain the body if the driver or passenger is endangered by a severe impact to the side of the vehicle.

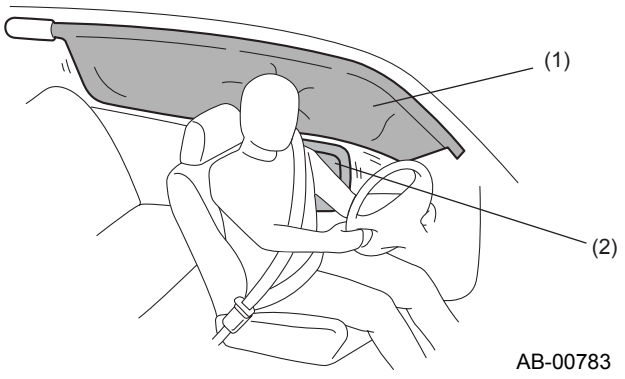
If an impact whose magnitude exceeding the preset value is applied to the side of the vehicle, the curtain airbag inflates immediately to soften the impact to the passengers especially at their head area.

4. SEAT BELT PRETENSIONER

The seat belt pretensioner improves efficiency of body restraint by retracting the seat belt immediately if the driver or passenger is endangered by a severe impact to the front of the vehicle.



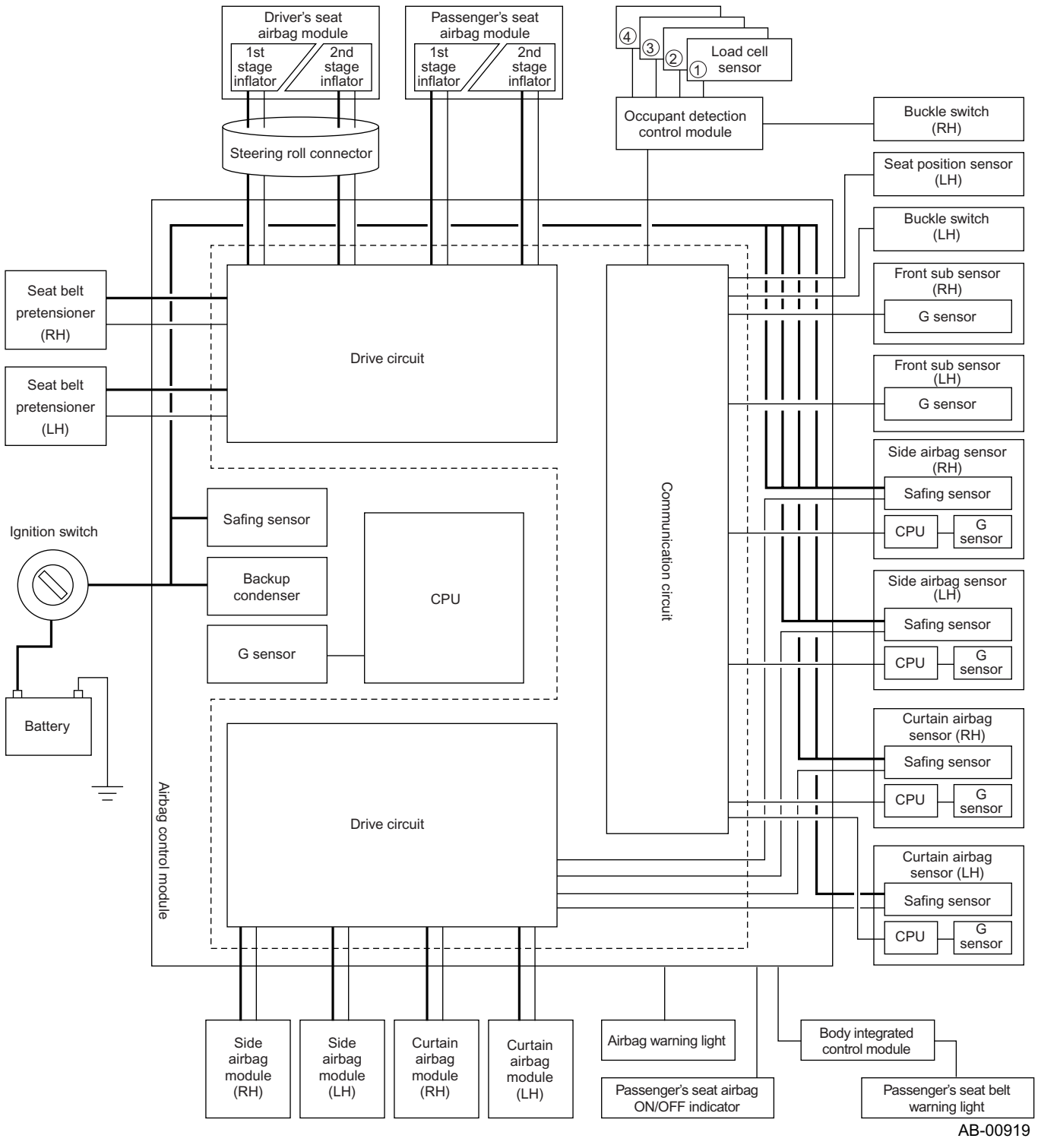
(1) Driver's seat SRS airbag
(2) Passenger's seat SRS airbag
(3) Retractor with pretensioner



(1) SRS curtain airbag
(2) SRS side airbag

2. System Components and Operation

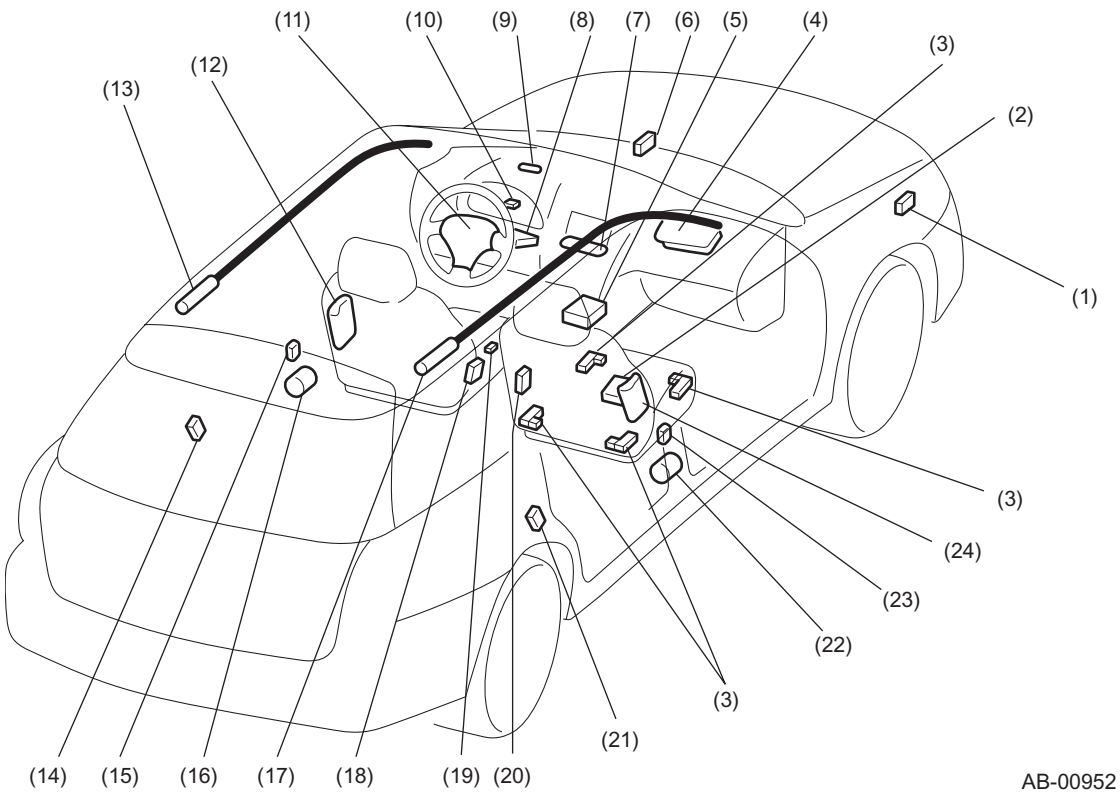
A: SYSTEM COMPONENTS



AB-00919

B: COMPONENTS

Name	Major function	Location
Airbag control module	• Senses impact and judges its magnitude by means of a safety sensor and G sensor built inside. • Serves as supplementary power supply if the battery voltage is lowered for some reason. • Directs airbags to inflate. • Performs self diagnosis of the airbag system.	Inside center console.
Driver's seat airbag module	Protects the driver's head and upper body to minimize injury in an event of frontal collision.	Stowed inside the pad at the center of the steering wheel.
Passenger's seat airbag module	Protects the passenger's head and upper body to minimize injury in an event of frontal collision.	Stowed inside the instrument panel at the front passenger's side.
Driver's seat side airbag module	Protects the driver's upper body to minimize injury in an event of side collision.	Stowed inside the driver's seat backrest.
Passenger's seat side airbag module	Protects the front passenger's upper body to minimize injury in an event of side collision.	Stowed inside the front passenger's seat backrest.
Curtain airbag module	Deploys together with the side airbag to protect the driver's or passenger's head and minimize injury in an event of side collision.	Stowed inside at left and right sides from the A pillars through the upper part of C pillars.
Steering roll connector	Provides electrical connection between the vehicle side airbag harness and steering wheel.	Between the combination switch and steering wheel.
Seat belt pretensioner	Retracts the seat belt immediately to restrain the body of front seat passengers in an event of a frontal collision.	Lower part of left and right B pillars.
Front sub sensor	Detects the impact in an event of a frontal collision and outputs a deceleration signal to the control module.	In front of left and right front frames.
Side airbag sensor	• Senses impact and judges its magnitude in an event of a side collision by means of a safety sensor and G sensor built inside. • Performs self diagnosis of the airbag system.	Inside the left and right B pillars.
Curtain airbag sensor	• Senses impact and judges its magnitude in an event of a side collision by means of a safety sensor and G sensor built inside. • Performs self diagnosis of the airbag system.	In front of rear left and right wheel arches.
Airbag warning light	• Indicates whether the system is normal or abnormal. • Displays diagnostic trouble codes.	Inside the combination meter.
Occupant detection control module	• Decides whether an adult, child, or is nobody is sitting in the seat, based on the occupant detection sensor output. • Performs self diagnosis of the occupant detection system.	Beneath the passenger's seat cushion.
Loadcell sensor	Detects the load on the seat applied by the passenger.	On the passenger's seat slide rail.
Passenger's seat airbag ON/OFF indicator	Indicates whether the deployment of the passenger's seat airbag is allowed or not, based on the decision of the occupant detection system.	Center of the instrument panel at the clock area.
Buckle switch	Detects whether the seat belt is fastened or not.	At the seat belt buckle.
Seat position sensor (LH)	Detects the fore-aft position of the driver's seat and distinguishes the passenger.	On the driver's seat slide rail.



AB-00952

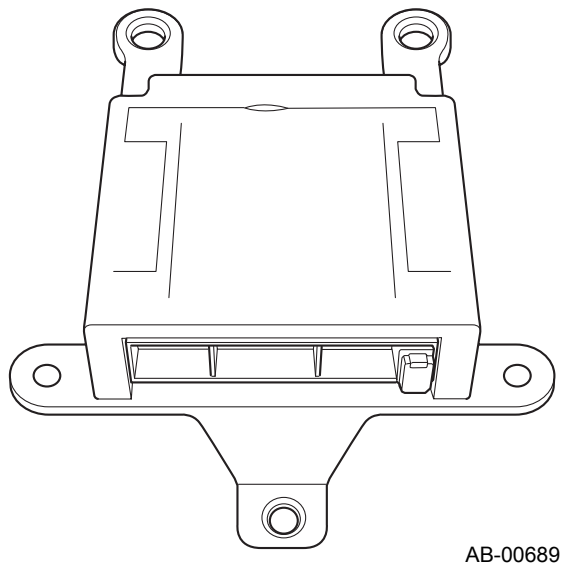
(1) Front sub sensor RH
(2) Occupant detection control module
(3) Load cell sensors
(4) Passenger's seat airbag module
(5) Airbag control module
(6) Front sub sensor LH
(7) Passenger's airbag ON/OFF indicator light
(8) Body integrated control module
(9) Passenger's seat belt warning light
(10) Airbag warning light
(11) Driver's seat airbag module
(12) Side airbag module LH
(13) Curtain airbag module LH
(14) Curtain airbag sensor LH
(15) Side inside airbag sensor LH
(16) Pretensioner LH
(17) Curtain airbag module RH
(18) Buckle switch LH
(19) Seat position sensor LH
(20) Buckle switch RH
(21) Curtain airbag sensor RH
(22) Pretensioner RH
(23) Side airbag sensor RH
(24) Side airbag module RH

1. AIRBAG CONTROL MODULE

The airbag control module is installed inside the center console and contains a safety sensor, G sensor, ignition judgment circuit, and a backup power supply, etc.

The control module receives electric signals from the safety sensor and electric sensor inside the module and also from the front sub sensor to detect the deceleration of the vehicle and judge whether the airbag and pretensioners should be ignited or not. It also has a self diagnosis function which lights up the airbag warning light in the combination meter if a fault occurs in the system. Diagnostic trouble codes generated by the self diagnosis function are stored in the memory in the module.

To prepare for battery voltage fall in an event of an accident, the control module is provided with a backup power supply.



AB-00689

- **Safety sensor**

Inside of the sensor there is a mass weight, which works as a pendulum; if the sensor detects an impact acceleration exceeding a certain limit, the mass weight in the sensor moves to close the contacts and turn the switch ON.

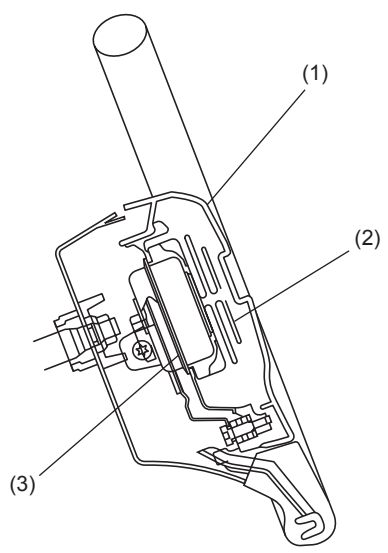
- **G sensor**

Inside of the sensor there are comb-teeth shaped electrodes; in case of a collision the distance between the electrodes varies by the impact to enable detection of the impact acceleration.

2. DRIVER'S SEAT AIRBAG MODULE

The driver's seat airbag module is built in the steering wheel pad.

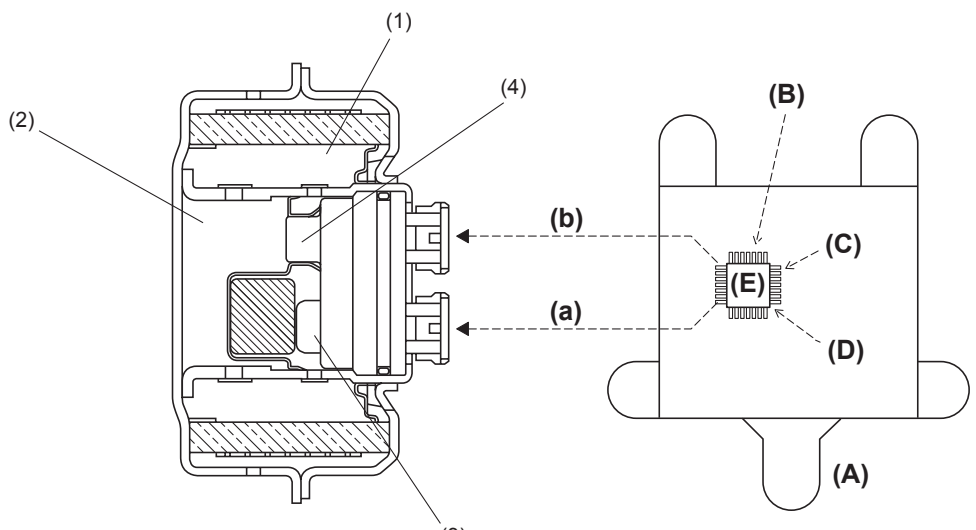
The SRS airbag module assembly cannot be disassembled. The driver's seat airbag module assembly consists of an inflator and airbag, and a steering wheel pad.



AB-00692

(1) Steering wheel pad
(2) Airbag
(3) Inflator

The inflator houses igniters and gas generating agents in a metal container. Igniters and gas generating agents are placed at two locations, and a 2-stage inflator which controls the airbag inflating speed according to the magnitude of impact at a collision is used. If the impact detected by the airbag sensor is equivalent to the level detected at a high speed, sudden collision, the two gas heating agents are ignited simultaneously. If the event of a collision at low or mid speed, the ignition of the 2nd stage gas generating agent is delayed to reduce the output of the inflator. Thus the inflator outputs power suitable for the severity of collision and relieves the impact to the passenger's head or upper body.



(1) 1st stage gas generating agent
(2) 2nd stage gas generating agent
(3) 1st stage igniter
(4) 2nd stage igniter

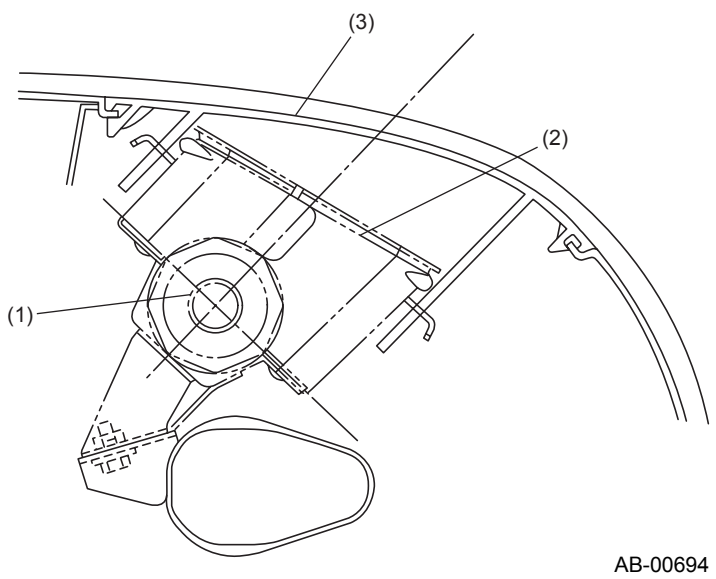
(a) 1st stage ignition signal
(b) 2nd stage ignition signal

(A) Airbag control module
(B) Front sub sensor
(C) Safety sensor
(D) G sensor
(E) CPU

3. PASSENGER'S SEAT AIRBAG MODULE

The front passenger's seat SRS airbag module assembly is built in the instrument panel at the front passenger's side.

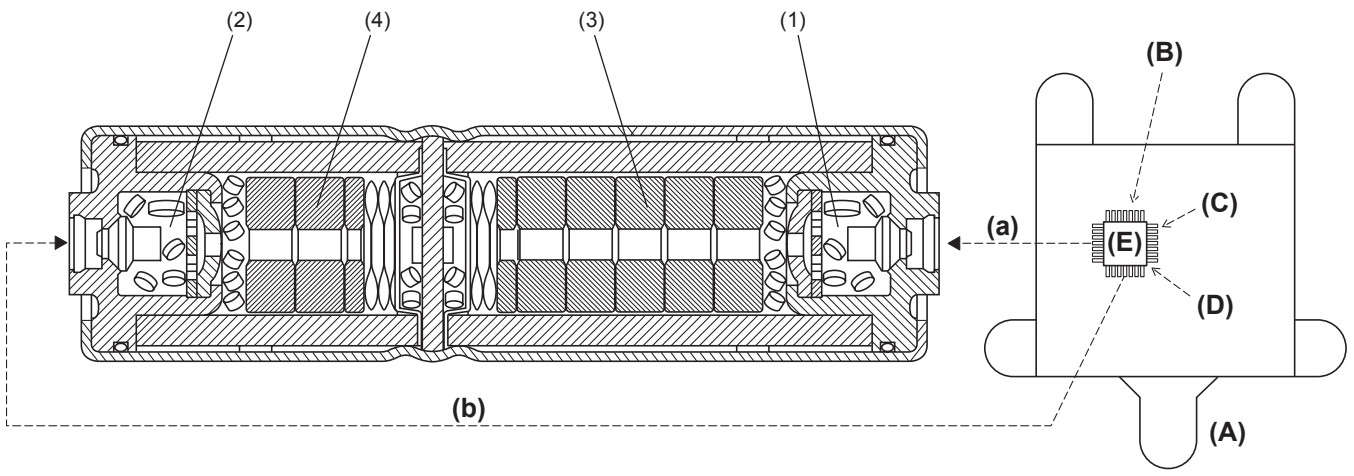
The SRS airbag module assembly cannot be disassembled. The front passenger's seat airbag module is fixed to the steering support beam, and consists of an inflator and an airbag.



AB-00694

(1) Inflator
(2) Airbag
(3) Lid

The inflator houses igniters and gas generating agents with a metal container. Igniters and gas generating agents are placed at two locations, and a 2-stage inflator which controls the airbag inflating speed according to the magnitude of impact at a collision is used. If the impact detected by the airbag sensor is equivalent to the level detected at a high speed, sudden collision, the two gas generating agents are ignited simultaneously. If the event of a collision at low or mid speed, the ignition of the 2nd stage gas generating agent is delayed to reduce the output of the inflator. Thus the inflator outputs power suitable for the severity of collision and relieves the impact to the passenger's head or upper body.



AB-00954

(1) 1st stage igniter
(2) 2nd stage igniter
(3) 1st stage gas generating agent
(4) 2nd stage gas generating agent

(a) 1st stage ignition signal
(b) 2nd stage ignition signal

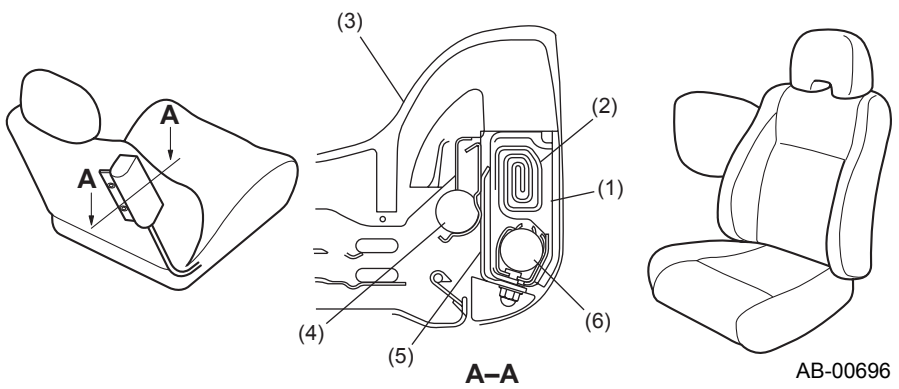
(A) Airbag control module
(B) Front sub sensor
(C) Safety sensor
(D) G sensor
(E) CPU

4. SIDE AIRBAG MODULE

The side airbag modules are built in the backrest of left and right front seats (at the door side).

The SRS side airbag module assembly cannot be disassembled. The side airbag module is fixed to the seat frame with a bracket, and consists of an inflator, airbag, and a case.

If a side-on collision occurs, the inflator produces a certain amount of gas to inflate the airbag in a very short time in response to the ignition signal from the side impact sensor.



(1) Case
(2) Airbag
(3) Seat upholstery
(4) Seat frame
(5) Bracket
(6) Inflator

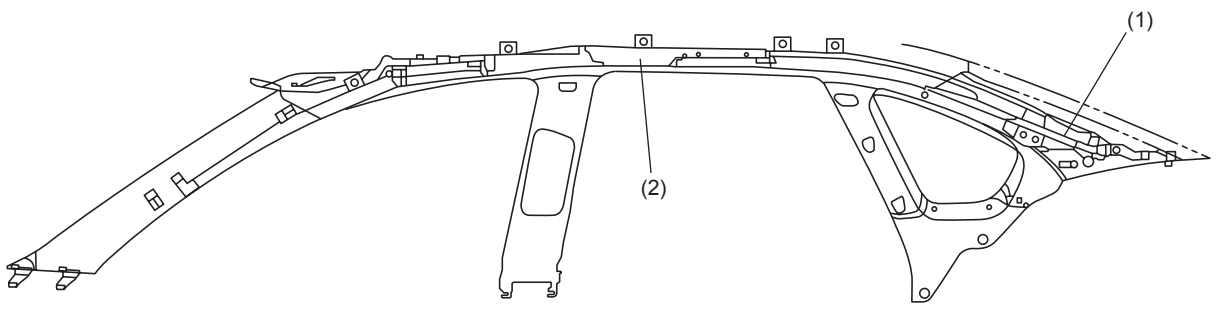
5. CURTAIN AIRBAG MODULE

The curtain airbag modules are placed at the front pillars, roof sides, and the rear pillars.

The SRS curtain airbag module cannot be disassembled. The curtain airbag modules are fixed to the vehicle body with a bracket and clips, and consists of an inflator and an airbag.

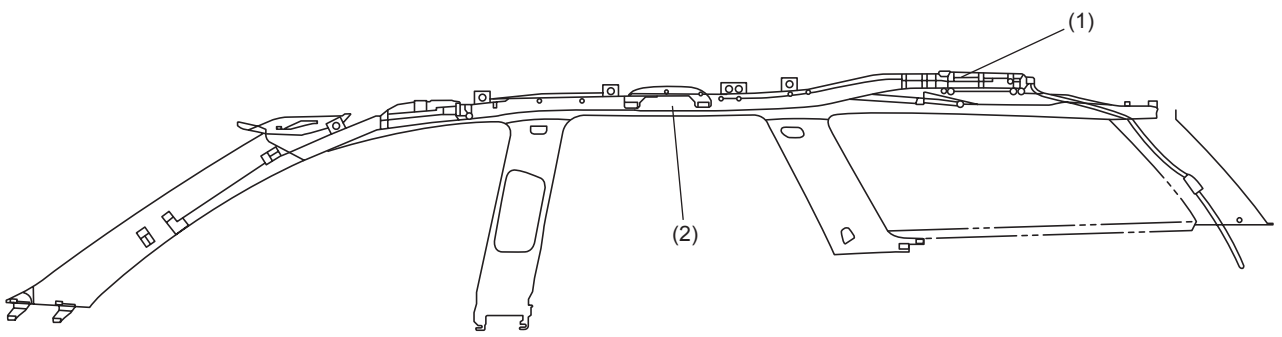
If a side-on collision occurs, the inflator produces a certain amount of gas to inflate the airbag in a very short time in response to the ignition signal from the side airbag sensor and curtain airbag sensor.

Sedan models



AB-00697

Wagon models



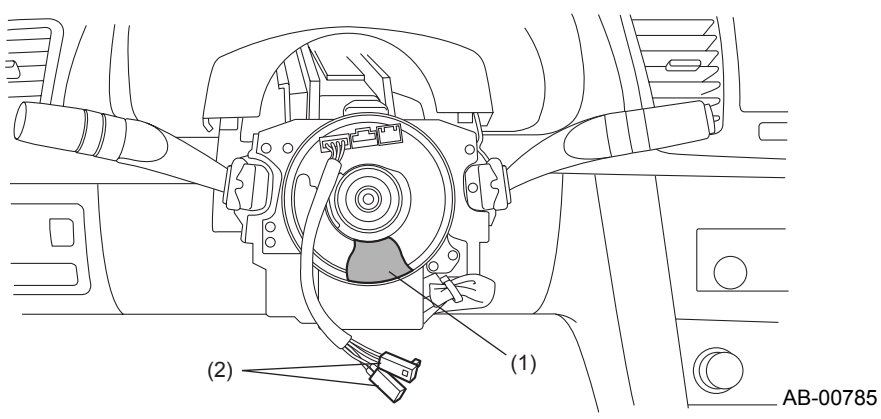
AB-00698

(1) Inflator
(2) Airbag

6. STEERING ROLL CONNECTOR

The steering roll connector is in between the steering column and the steering wheel, and contains a spirally wound flat cable.

The flat cable maintains connection between the airbag module on the steering wheel and the airbag harness even when the steering wheel is turned. Ignition signal from the airbag control module is sent through the roll connecter to the driver's seat airbag module.



(1) Flat cable

(2) Airbag module connecgtor

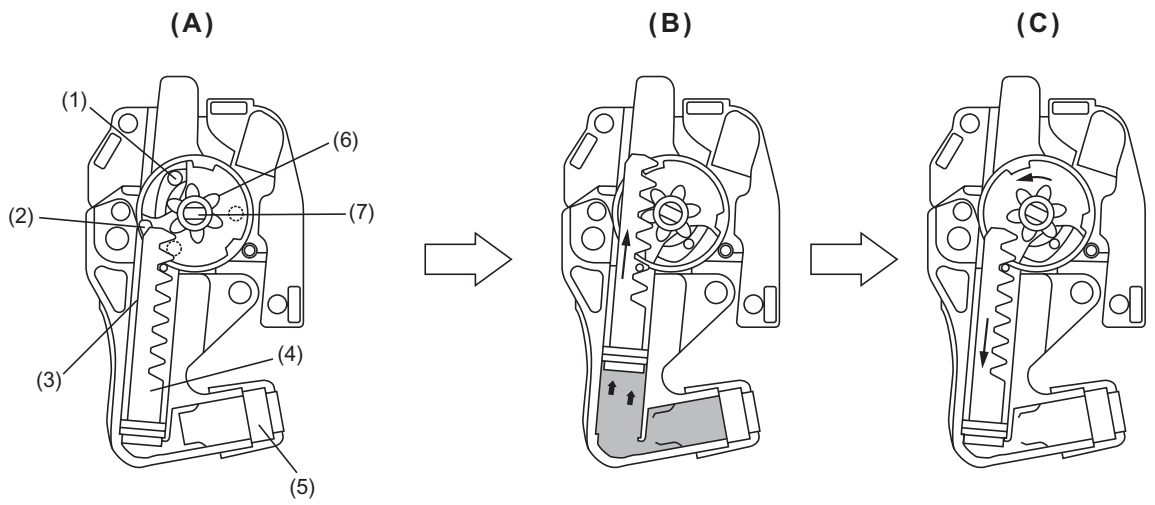
7. SEAT BELT PRETENSIONER

The driver's and front passenger's seat belt retractors contain a seat belt pretensioner.

The airbag control module controls the operation of the seat belt pretensioner. If the front sub sensor and the sensors inside the airbag control module detect an impact exceeding a specified level, the driver's seat and front passenger's seat airbags are deployed almost simultaneously. Upon receiving signals from the airbag control module the gas generator inside the pretensioners are ignited and the gas pressure retracts the seat belts in a very short time to improve the passenger restraint effect.

If the load placed on a seat belt exceeds the predetermined level, the torsion bar is twisted to allow the seat 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.



SB-00058

(A) Initial state
(1) Roller
(2) Shear rib
(3) Shear pin

(B) Pretensioner operates
(4) Piston
(5) Gas generator
(6) Pinion

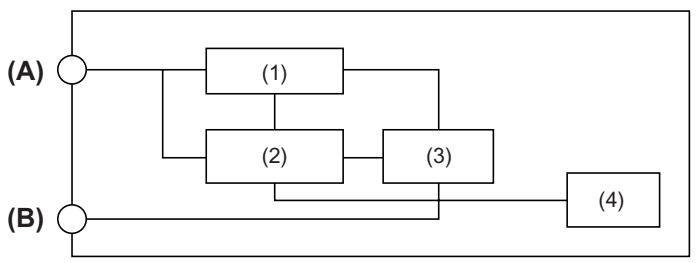
(C) Load limiter
(7) Sleeve

8. FRONT SUB SENSOR

The front sub sensor is installed to the tip of the front side frame.

If it detects an impact exceeding the specified level from the front, it sends a signal which is used for airbag system deployment judgment to the airbag control module.

To judge the impact to the front of the vehicle more precisely, the sensor is changed from the conventional pendulum type mechanical sensor to an electronic sensor.



AB-00700

(A) Power supply/communication terminal
(B) GND

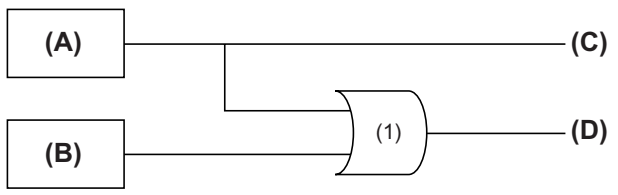
(1) 5 V power
(2) Current communication circuit
(3) G sensor
(4) Oscillator

9. SIDE IMPACT SENSOR

The side impact sensors (side airbag sensor, curtain airbag sensor) are installed at the bottom of the center pillars and the rear quarter pillars.

If the sensor in the side impact sensor detects an impact exceeding the specified level from the side, it sends a signal which is used for airbag system deployment judgment to the airbag control module.

Signals from the side airbag sensors are effective for both the side airbags and curtain airbags, while signals from the curtain airbag sensors detect impact to the rear seat sides and let only the curtain airbags deploy.

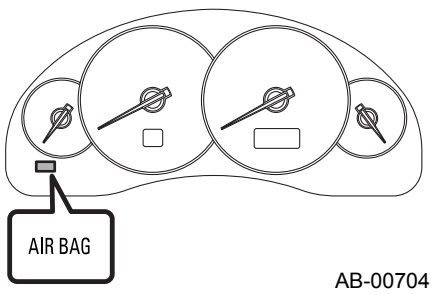


AB-00702

(A) Side airbag sensor
(B) Curtain airbag sensor
(C) Side airbag
(D) Curtain airbag
(1) OR

10. 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 6 seconds later.



AB-00704

11. WIRING HARNESS

The airbag harnesses are integrated into the body harness as follows:

- Front sub sensor harness: integrated into the front harness.
- Airbag main harness: integrated into the bulkhead harness.
- Pretensioner and side airbag harnesses: integrated into the rear harness.

3. Airbag Connectors

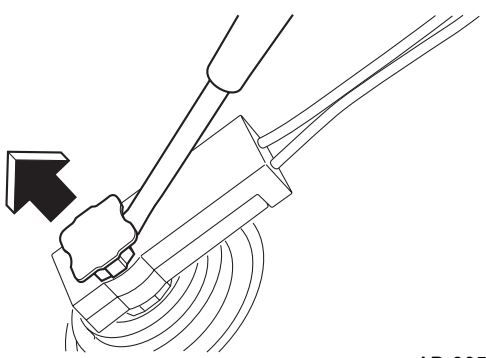
A: GENERAL

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.

1. DRIVER'S SEAT AIRBAG MODULE-TO-SEAT BELT PRETENSIONER CONNECTOR

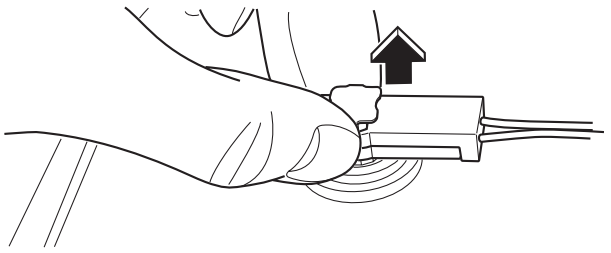
Disconnection:

1) Lift the lock button using a thin tipped tool like a miniature screwdriver.



AB-00529

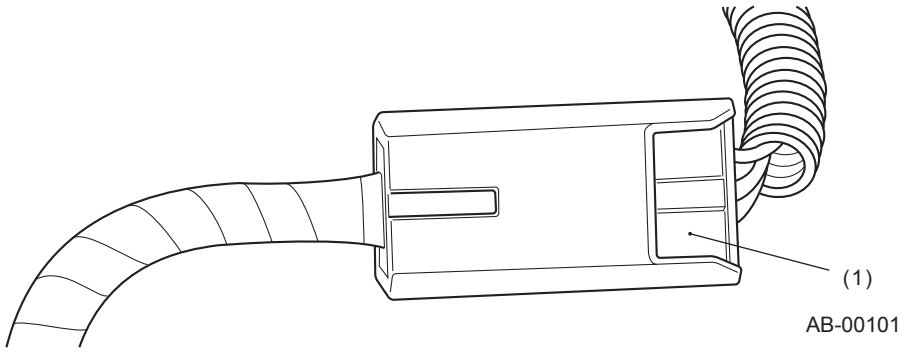
2) Pull the connector out from the airbag module.



AB-00528

Connection:
Carefully insert the connector into the airbag module. Push the connector until a "click" is heard from the lock button.

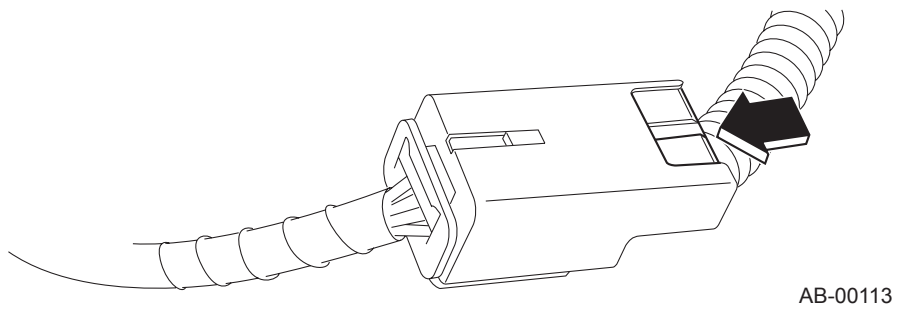
2. AIRBAG MAIN HARNESS-TO-ROLL CONNECTOR, AND PASSENGER'S SEAR AIRBAG MODULE CONNECTOR



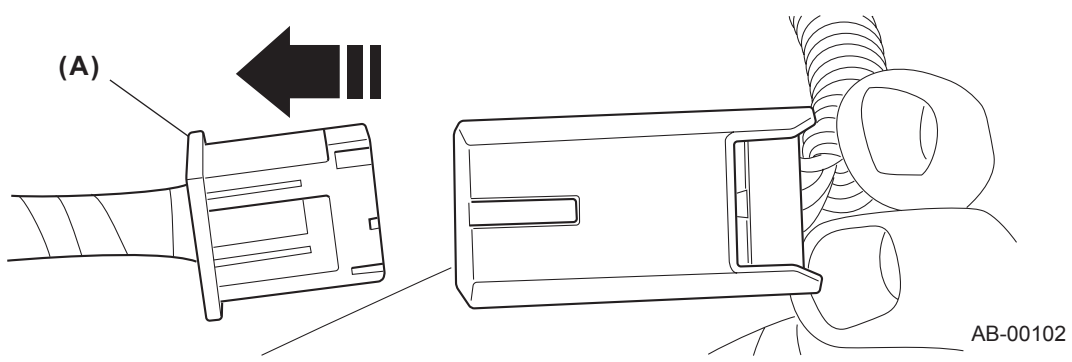
(1) Slide lock

Disconnection:

1) Press the slide lock inwards.

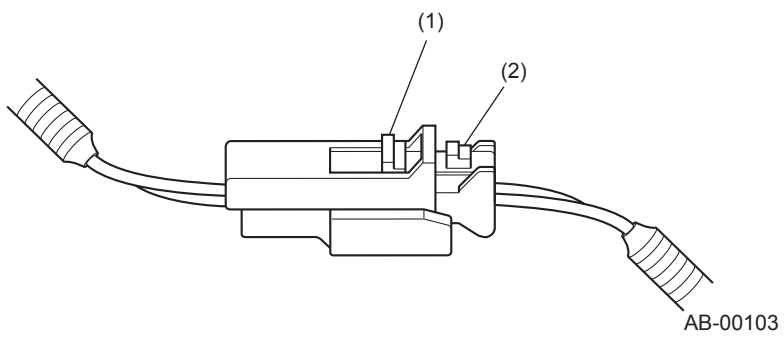


2) While the slide lock pressed in, disconnect the connector (A).



Connection:
Insert the female side connector half into the other until a "click" is heard.

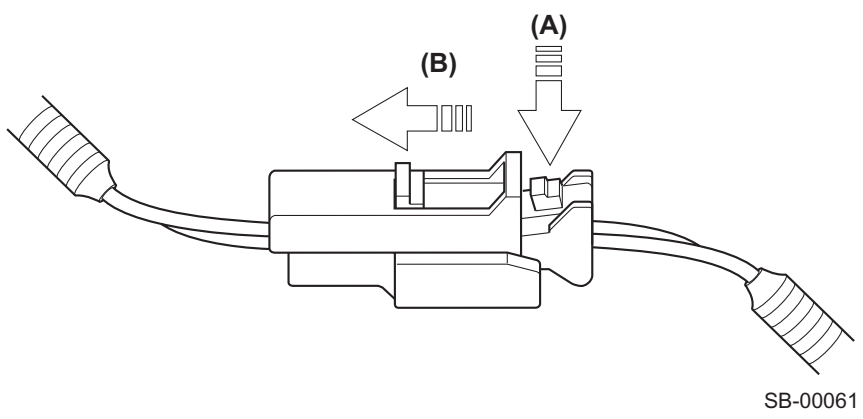
3. SIDE AIRBAG MODULE AND CURTAIN AIRBAG MODULE CONNECTORS



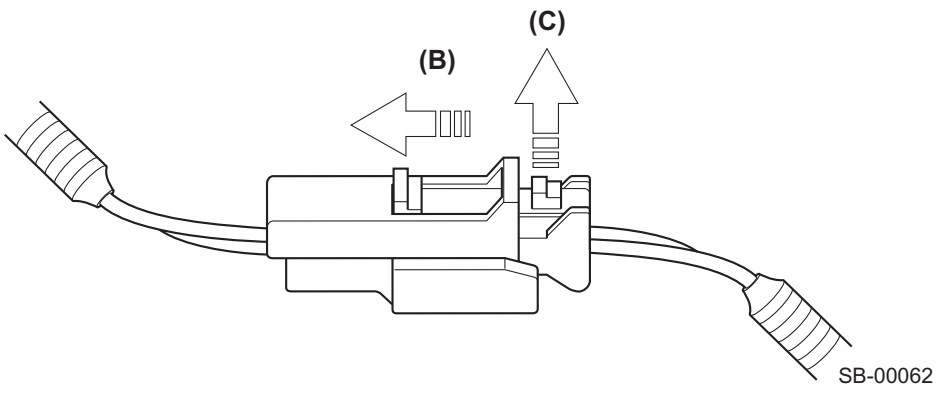
(1) Slide lock
(2) Lock arm

Disconnection:

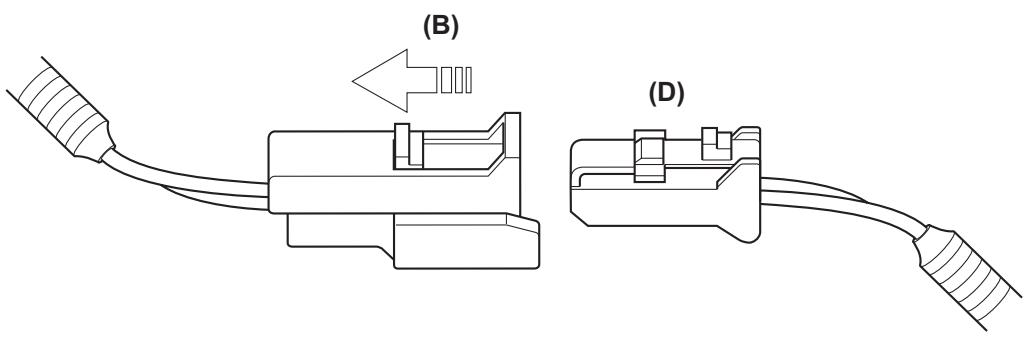
1) Push in and hold the lock arm (A), then pull the slide lock (B).



2) While the slide lock pulled and held (B), release the lock arm (C).



3) While the slide lock pulled and held (B), disconnect the connector (D).



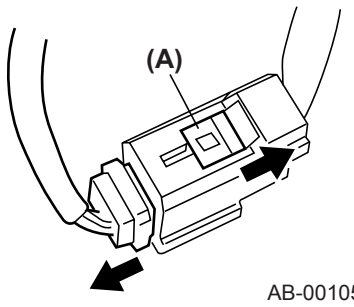
SB-00063

Connection:
Insert the female side connector half into the other until a “click” is heard.

4. AIRBAG HARNESS-TO-BODY HARNESS, OCCUPANT DETECTION CONTROL MODULE-TO-BODY HARNESS, AND SEAT BELT BUCKLE SWITCH CONNECTORS

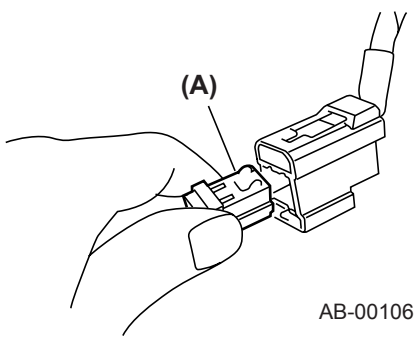
Disconnection:

Hold slide lock (A) moved in the direction of the arrow, then pull the female connector in the direction of the arrow.



AB-00105

Connection:
Push the connector (A) into the male connector carefully until a “click” is heard.

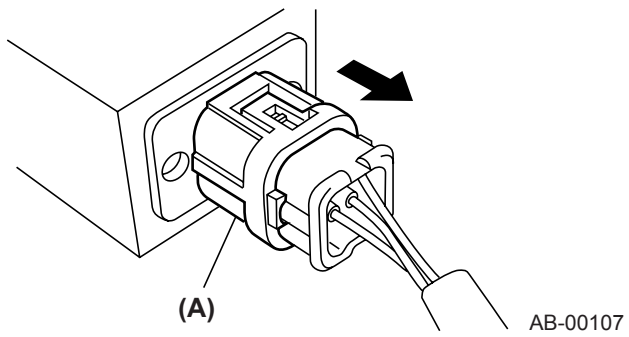


AB-00106

5. FRONT SUB SENSOR, SIDE AIRBAG SENSOR, CURTAIN AIRBAG SENSOR, AND SEAT POSITION SENSOR (LH) CONNECTORS

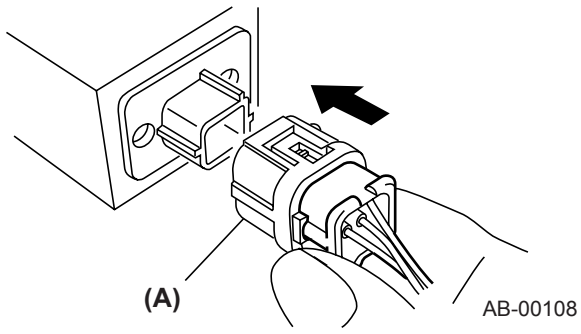
Disconnection:

Holding the outer part (A), pull the connector in the direction of the arrow.



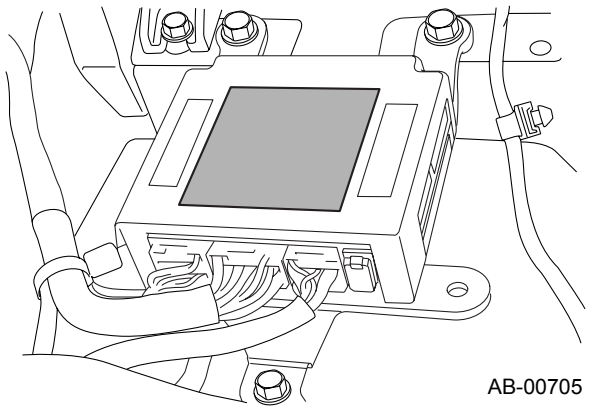
Connection:

Holding the inner part, push the connector into the socket carefully until a “click” is heard. Do not hold the outer part (A) as it moves back during connection of the connector.



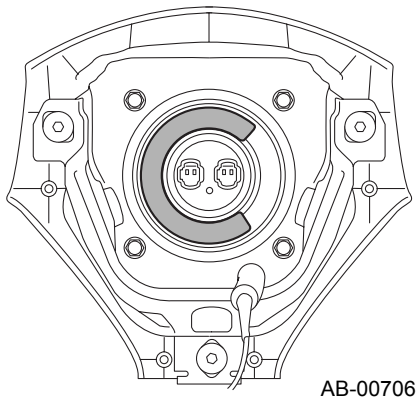
4. Locations of Warning and Caution Labels

1. AIRBAG CONTROL MODULE



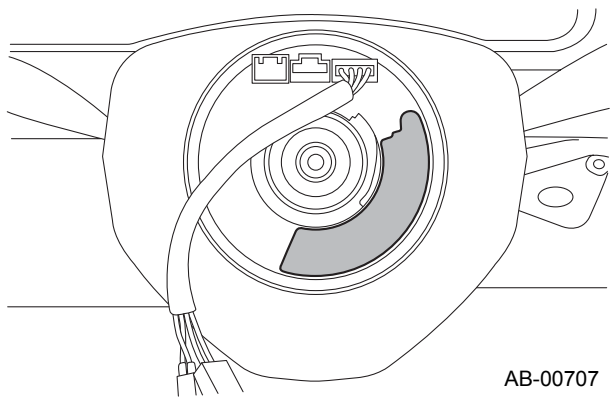
AB-00705

2. DRIVER'S SEAT AIRBAG MODULE



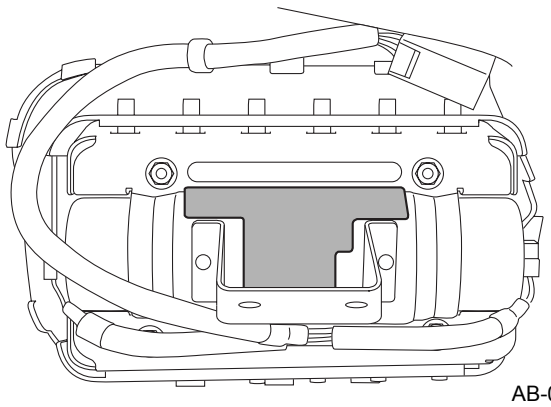
AB-00706

3. STEERING ROLL CONNECTOR



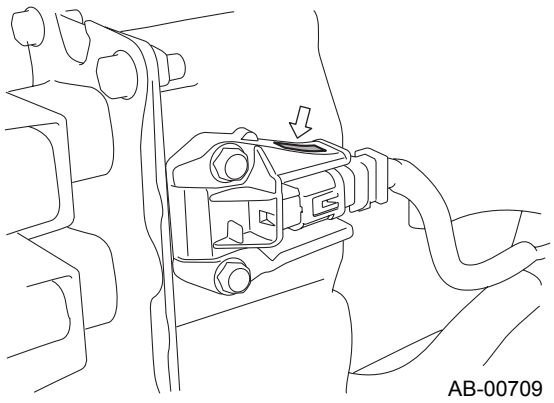
AB-00707

4. PASSENGER'S SEAT AIRBAG MODULE



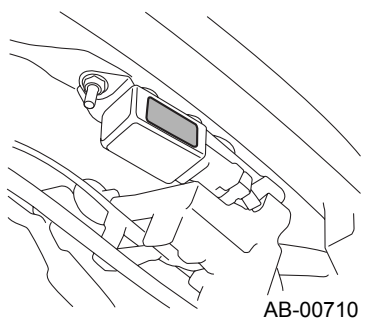
AB-00708

5. FRONT SUB SENSOR



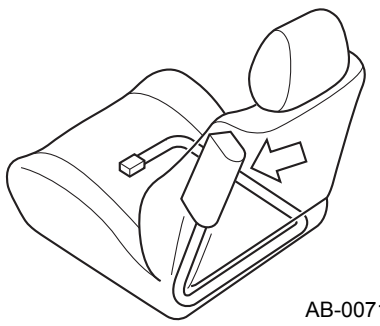
AB-00709

6. SIDE IMPACT SENSOR



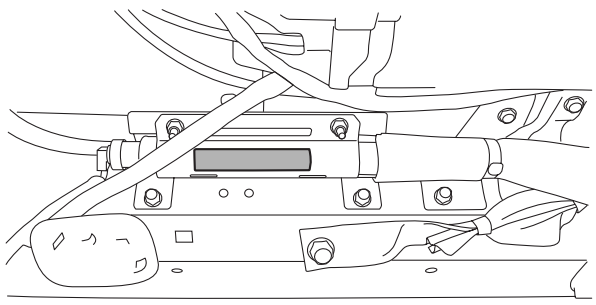
AB-00710

7. SIDE AIRBAG MODULE



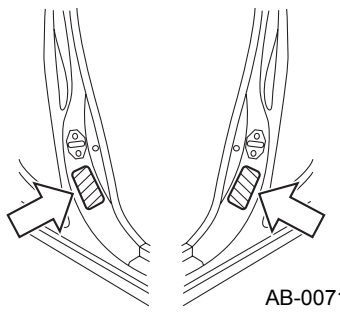
AB-00711

8. CURTAIN AIRBAG MODULE



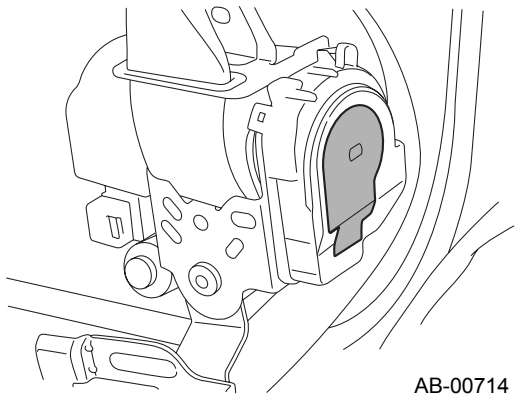
AB-00712

9. CENTER PILLAR LOWER AREA



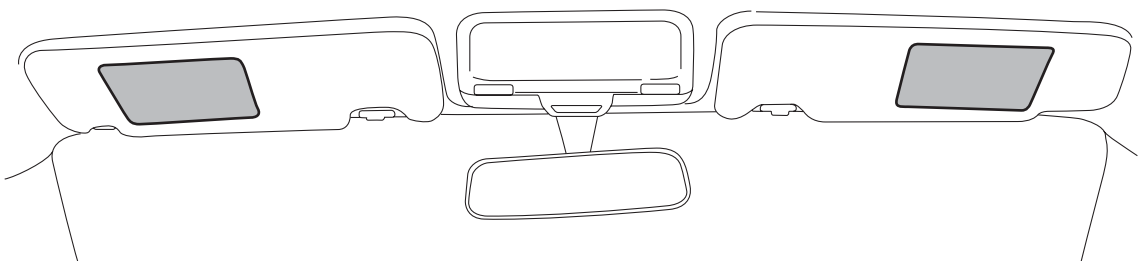
AB-00713

10. SEAT BELT PRETENSIONER



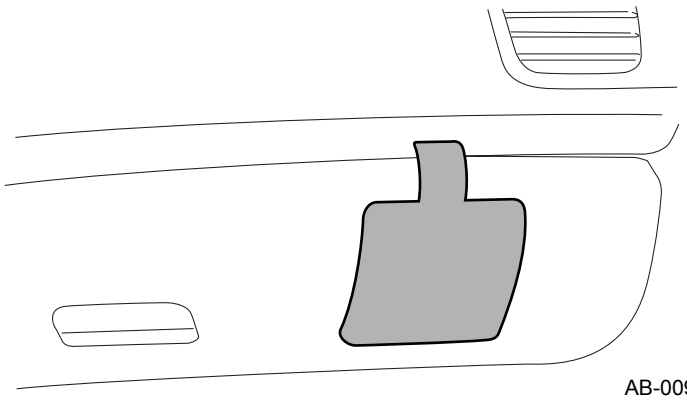
AB-00714

11. SUN VISOR



AB-00950

12. INSTRUMENT PANEL



AB-00951

ABS

1. Anti-lock Brake System (ABS)

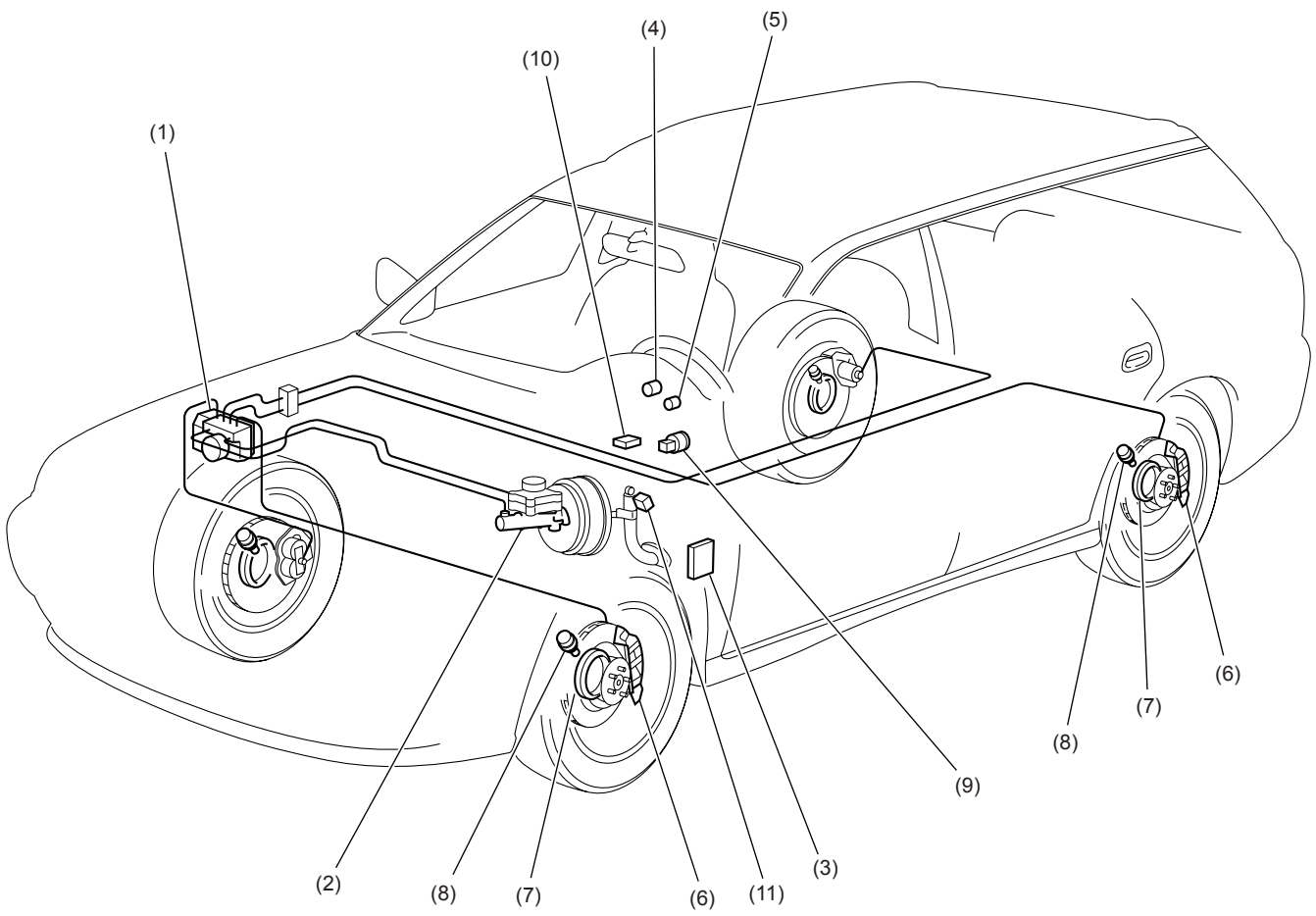
A: FEATURES

● To reduce the size and weight, this ABS 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).

● 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 system is a four-wheel independent control type, which controls each of the wheel brakes individually.



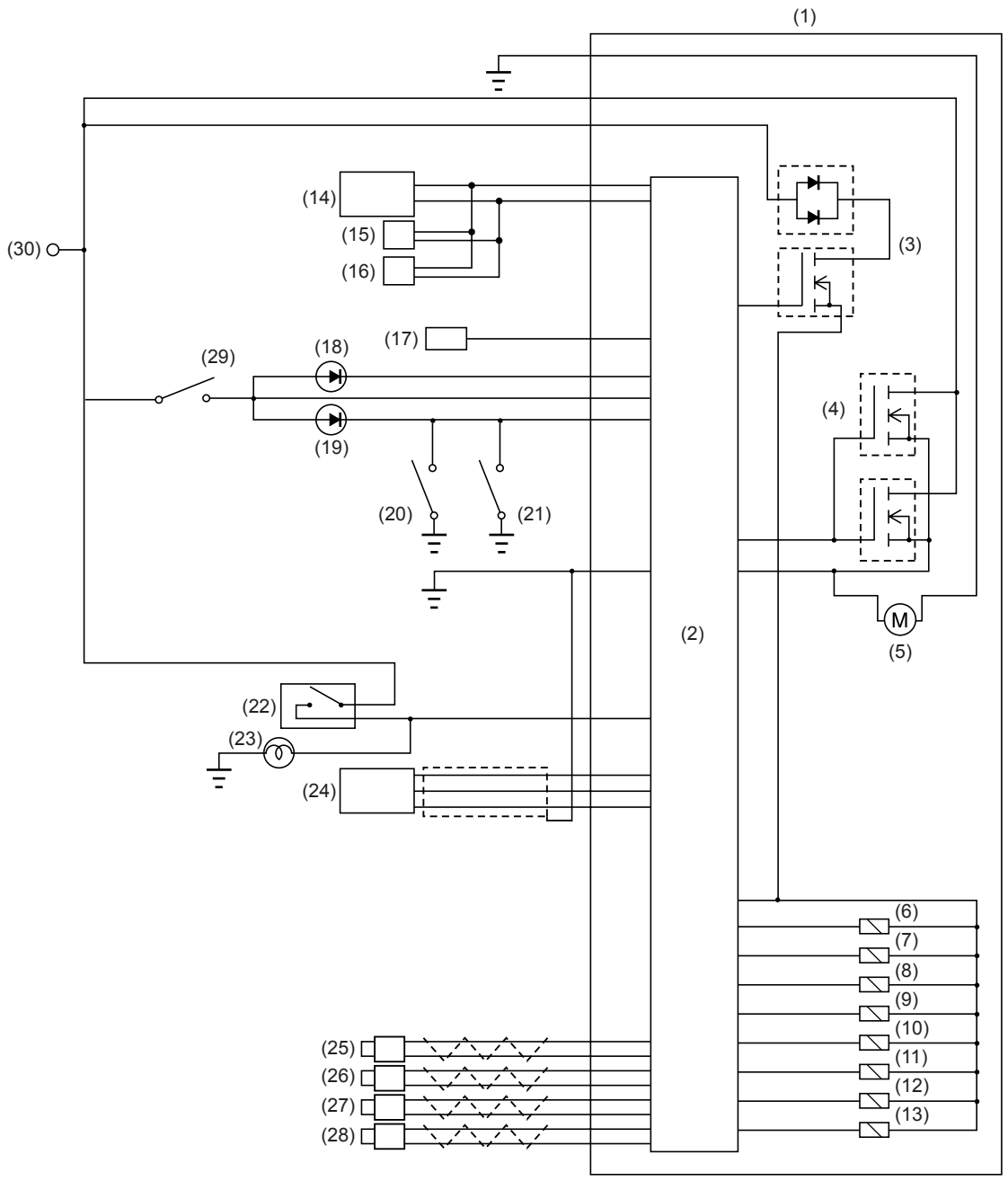
ABS00575

(1) ABS control module and hydraulic control unit (ABSCM & H/U)
(2) Master cylinder
(3) Transmission control module (AT models only)
(4) ABS warning light
(5) Brake & EBD warning light
(6) Wheel cylinder
(7) Magnetic encoder
(8) ABS wheel speed sensor
(9) G sensor
(10) Data link connector (for SUBARU select monitor)
(11) Stop light switch

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. 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 wheel speed sensor		Detects speed of each wheel and sends to the ABSCM.
Magnetic encoder		Incorporated with the hub unit bearing and causes the ABS wheel speed sensor to generate electrical signals.
G sensor		It detects a change in acceleration in the longitudinal direction of the vehicle and outputs it to the ABSCM as a voltage signal.
Stop light signal		Detects ON-OFF status of the brake pedal and sends to the ABSCM. The ABSCM uses it to determine ABS operation.
ABS warning light		It alerts the driver to an ABS fault.
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.
Brake warning light		It alerts the driver to an EBD fault. This warning light is also used for parking brake warning and brake fluid level warning.

MEMO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M

ABS00576

(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) Body integrated unit
(16) Engine control module
(17) Data link connector
(18) ABS warning light
(19) Brake warning light
(20) Parking brake warning light switch
(21) Brake fluid level switch
(22) Stop light switch
(23) Stop light
(24) G sensor
(25) Front left ABS wheel speed sensor
(26) Front right ABS wheel speed sensor
(27) Rear left ABS wheel speed sensor
(28) Rear right ABS wheel speed sensor
(29) IGN
(30) Battery

C: PRINCIPLE OF ABS CONTROL

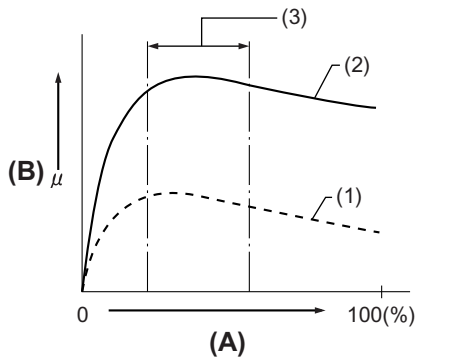
When the brake pedal is depressed during driving, the wheel speed decreases and the vehicle speed does as well. The decrease in the vehicle speed, however, is not always proportional to the decrease in the wheel speed. The non-correspondence between the wheel speed and vehicle speed is called “slip” 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 × 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 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 to maintain the slip ratio within this range.



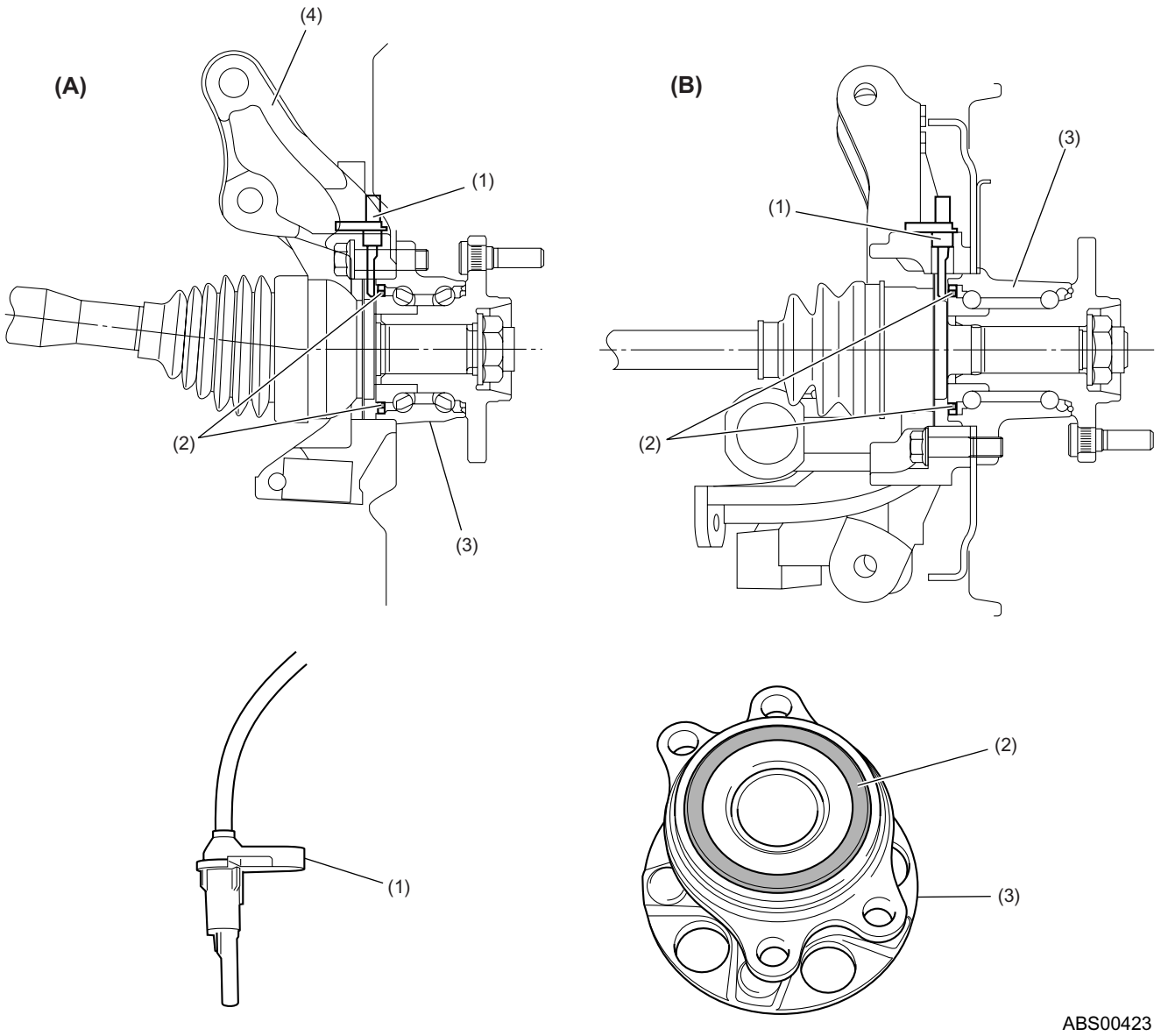
ABS00007

(A) Slip ratio
(B) Coefficient of friction between tire and road surface

(1) Icy road
(2) Asphalt-paved road
(3) Control range by ABS

D: ABS WHEEL SPEED SENSOR

Each of the ABS wheel speed sensors detects the speed of the corresponding wheel. The sensor consists of a sensor body and a magnetic encoder. The magnetic encoder is a permanent magnet with N poles and S poles arranged alternately, and when this turns together with the wheel the magnetic field at the sensing area of the sensor body changes. The sensor body has a hall element and outputs signals at a frequency proportional to the wheel speed.



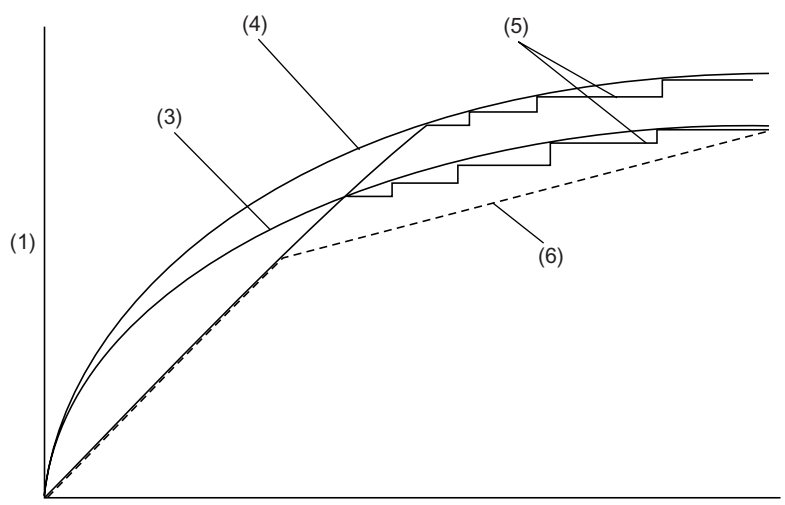
(A) Front
(B) Rear
(1) Sensor body
(2) Magnetic encoder
(3) Hub unit bearing
(4) Housing

E: EBD (ELECTRONIC BRAKE FORCE DISTRIBUTION)

The EBD system utilizes the function of the conventional ABS. This system prevents premature locking of the rear wheels by using electronic control instead of a proportioning valve. The system provides a feature to optimize the brake force distribution to the front and rear wheels according to change in loading conditions or displacement of the center of gravity during deceleration.

The ABSCM calculates the optimum brake force distribution from the difference in speed between the front and rear wheels. Based on the results, the ABSCM controls the rear wheel brake pressure through the ABS hydraulic unit (H/U) to achieve the optimum brake force distribution suitable for the driving condition.

The proportioning valve is disused on EBD equipped vehicles.



ABS00019

(1) Brake force to rear wheels
(2) Brake force to front wheels
(3) Optimum brake force distribution for light loaded conditions
(4) Optimum brake force distribution for heavy loaded conditions
(5) EBD controlled brake force distribution
(6) PCV controlled brake force distribution (reference)

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

● ABS control module section (ABSCM)

The ABSCM contains two micro control modules (MCMs) which communicate with each other. Both the MCMs process the same program and each MCM monitors the other's outputs. If a mismatch occurs between their outputs, the ABSCM cuts off the system and activate the fail-safe function.
The ABSCM can store a maximum of 3 diagnostic trouble codes (DTC) in a ROM. If more than 3 faults have occurred, only the 3 most recent failures are stored and others are erased. Trouble diagnostic 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 wheel speed 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 fluid pressure to each of the four wheels independently.

● 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 diagnostic trouble codes
- To read out data showing conditions under which a trouble code has been stored (freeze frame data)
- To initiate ABS sequence control pattern

● Indication functions

Under the control of the ABSCM, the ABS warning light provides the following two indication functions:
- ABS fault alerting
- 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 valve relay controls power supply to the solenoid valves in response to a command from the ABSCM. In normal (IG ON) condition, the relay is closed to supply power to the solenoid valves. 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.

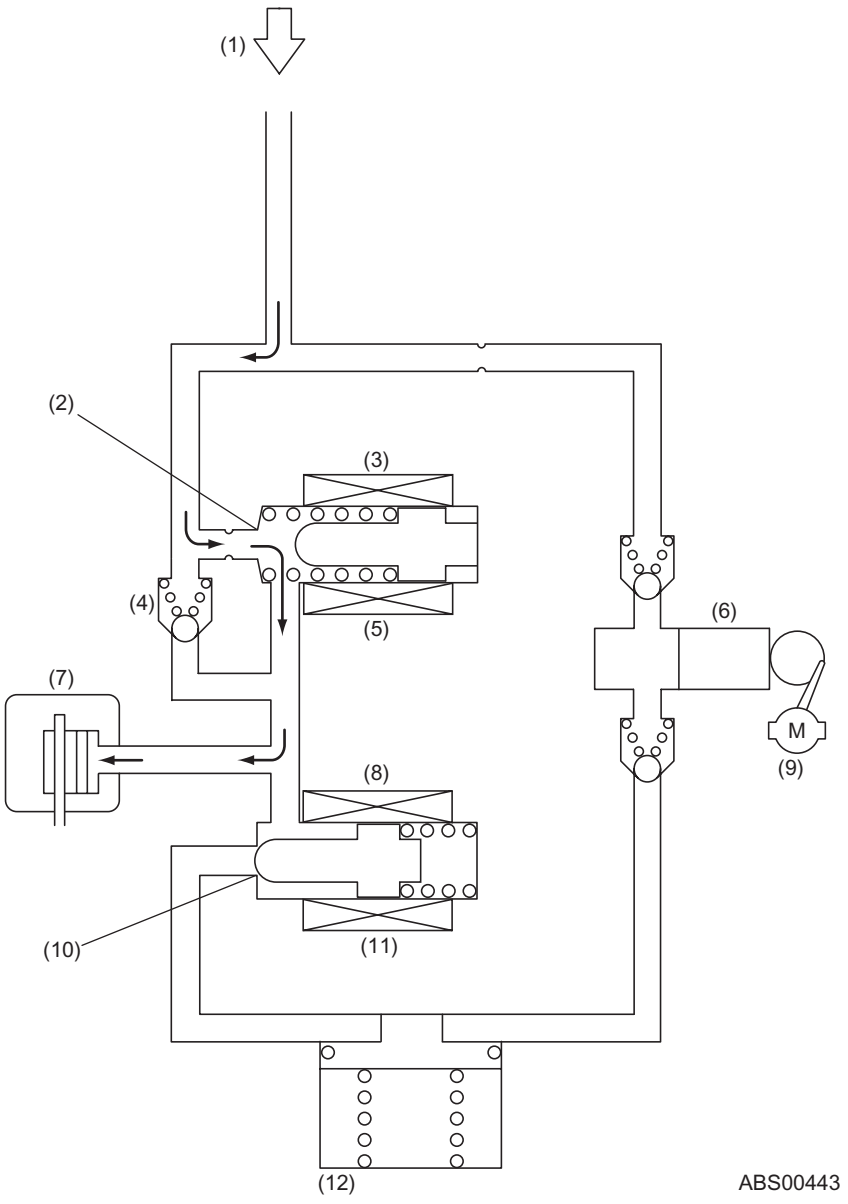
● The H/U has four operating modes; normal mode (non-ABS mode), and three ABS active modes, i.e., “increase”, “hold” and “decrease” modes.

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) Inlet port open
(3) Inlet solenoid valve
(4) Check valve
(5) Deenergized
(6) Pump
(7) Wheel cylinder
(8) Outlet solenoid valve
(9) Motor
(10) Outlet port closed
(11) Deenergized
(12) Reservoir

2. PRESSURE “DECREASE” CONTROL (ABS ACTIVE)

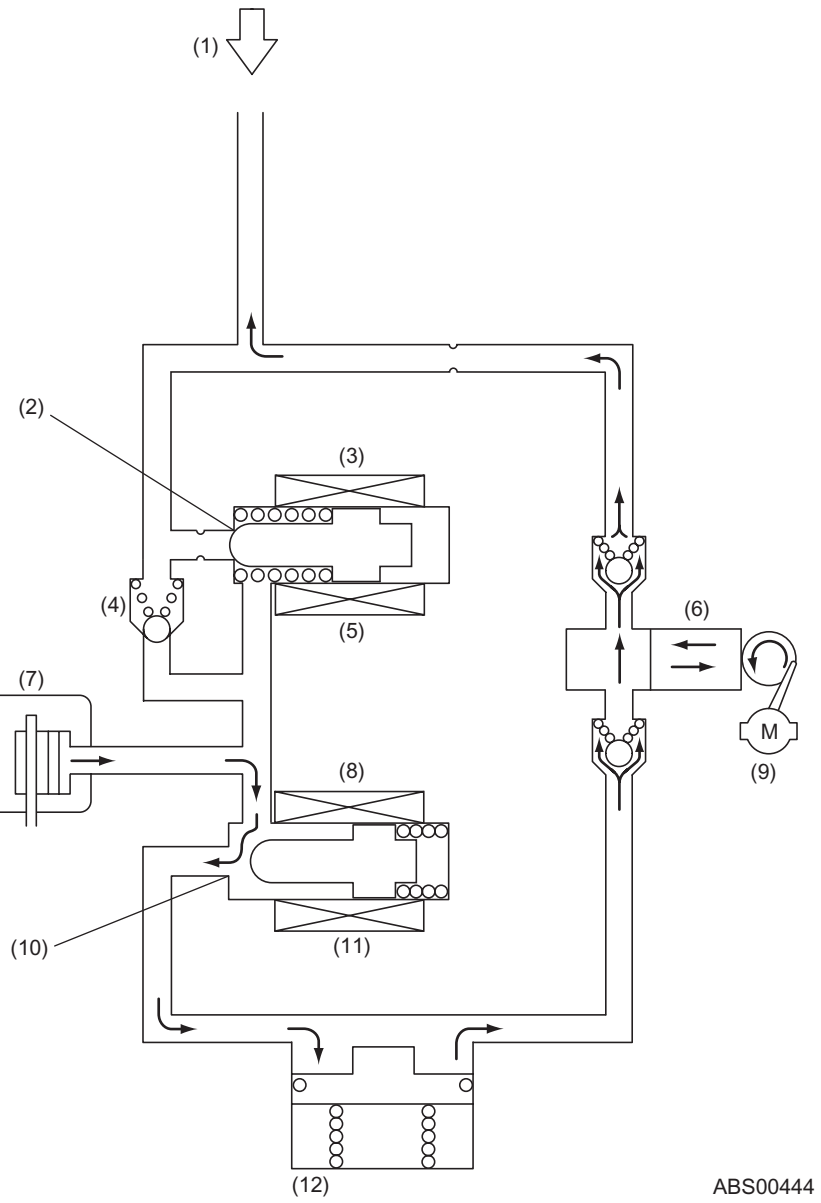
Both the inlet and outlet solenoid valves are energized, which means that the inlet port is closed and the outlet port is open.

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 H/U is represented by operation of a single wheel circuit.



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

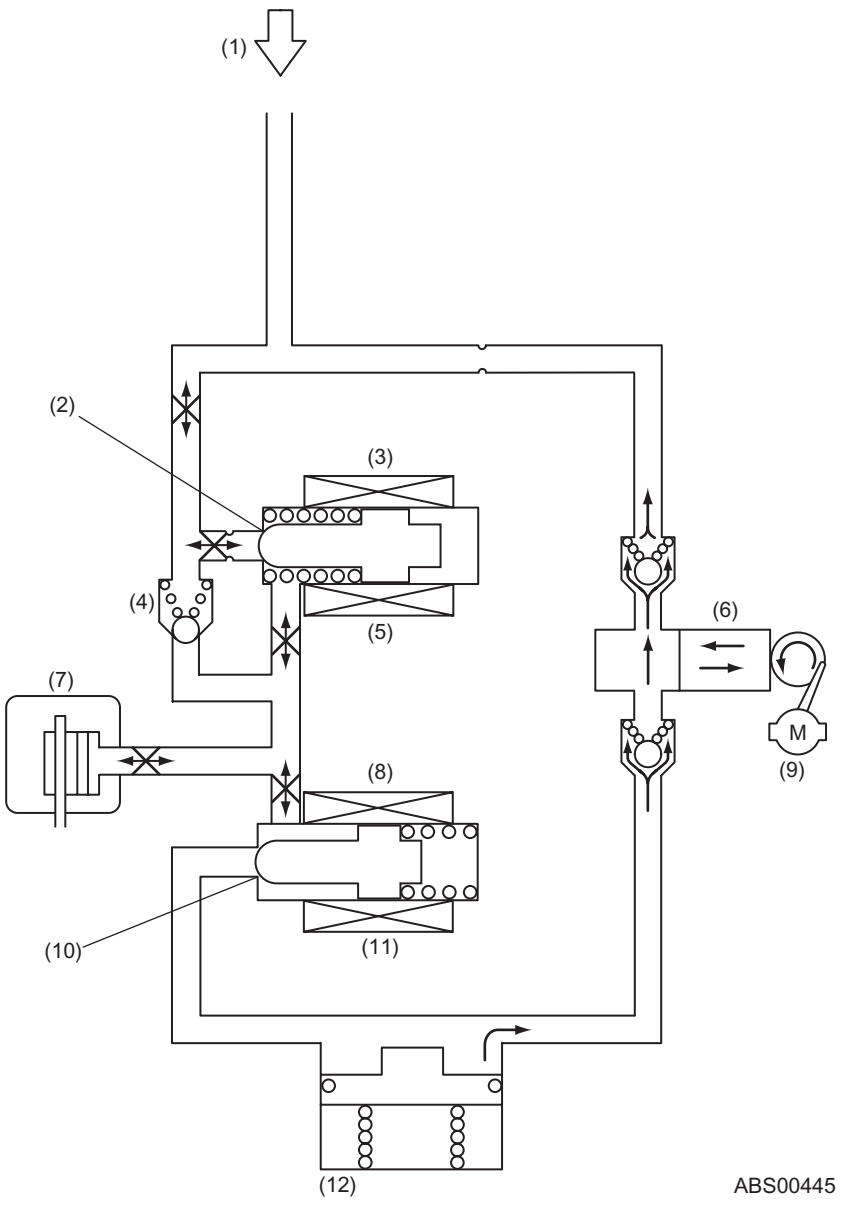
3. PRESSURE “HOLD” CONTROL (ABS ACTIVE)

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 H/U is represented by operation of a single wheel circuit.



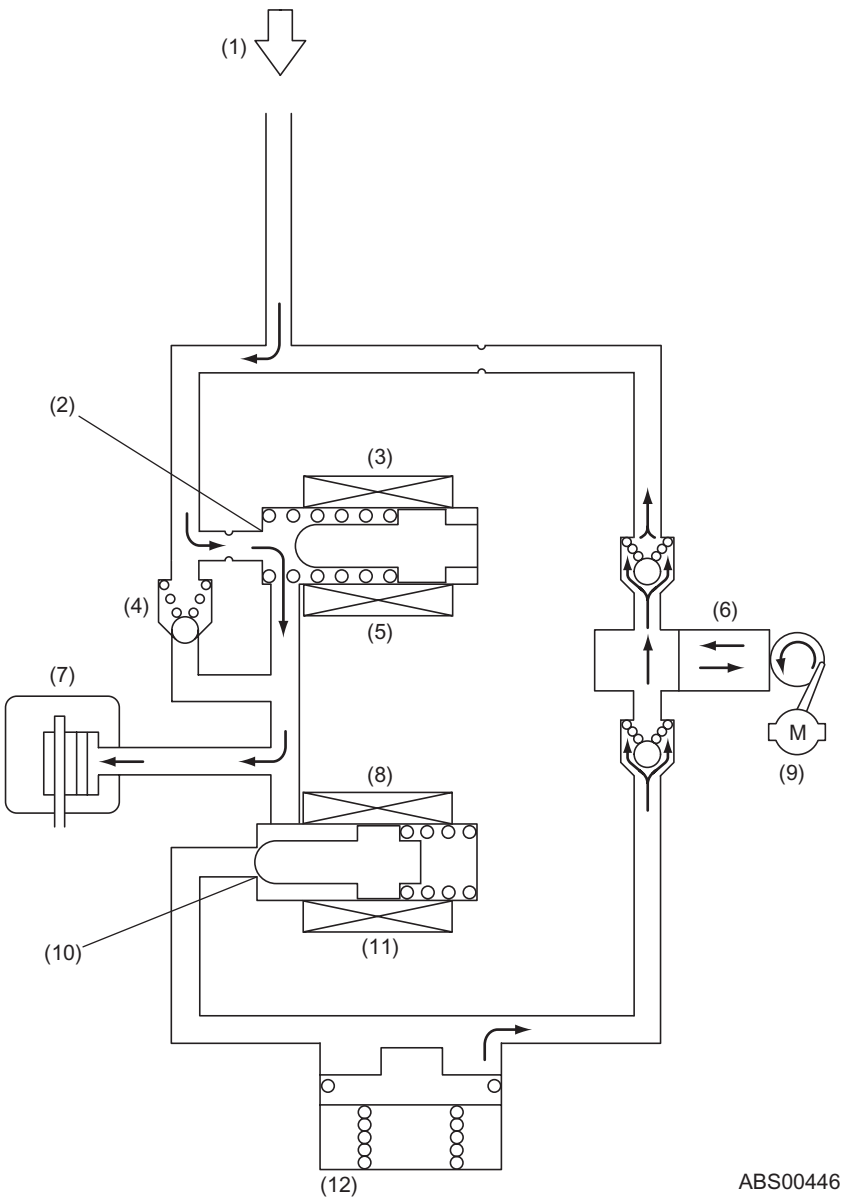
(1) From master cylinder
(2) Inlet port closed
(3) Inlet solenoid valve
(4) Check valve
(5) Energized
(6) Pump
(7) Wheel cylinder
(8) Outlet solenoid valve
(9) Motor
(10) Outlet port closed
(11) Deenergized
(12) Reservoir

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 H/U is represented by operation of a single wheel circuit.



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

G: ABS CONTROL CYCLE CURVES

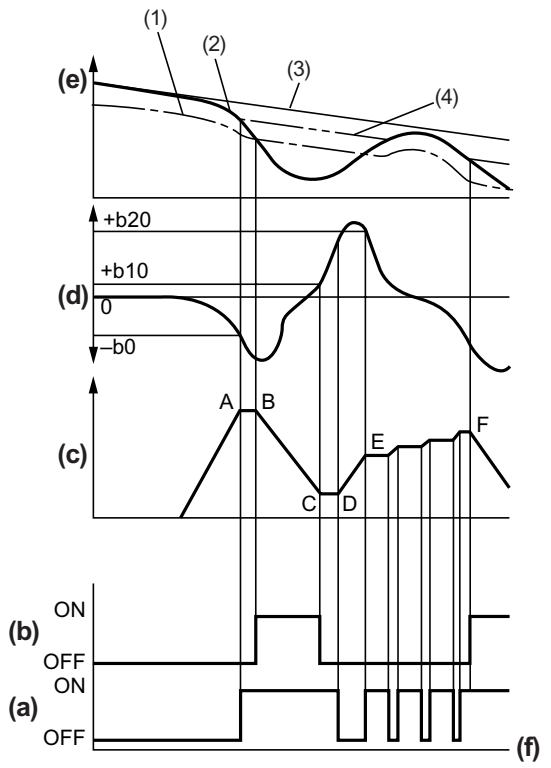
Depressing the brake pedal increases the brake fluid pressure in each wheel cylinder, which in turn decreases the wheel speed (or increases the wheel deceleration rate). When the brake fluid pressure is increased to a level of point “A” of the brake fluid pressure curve in the diagram (at which the wheel 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 solenoid valve
(b) Outlet solenoid valve
(c) Brake fluid pressure
(d) Wheel acceleration/deceleration
(e) Speed
(f) Time

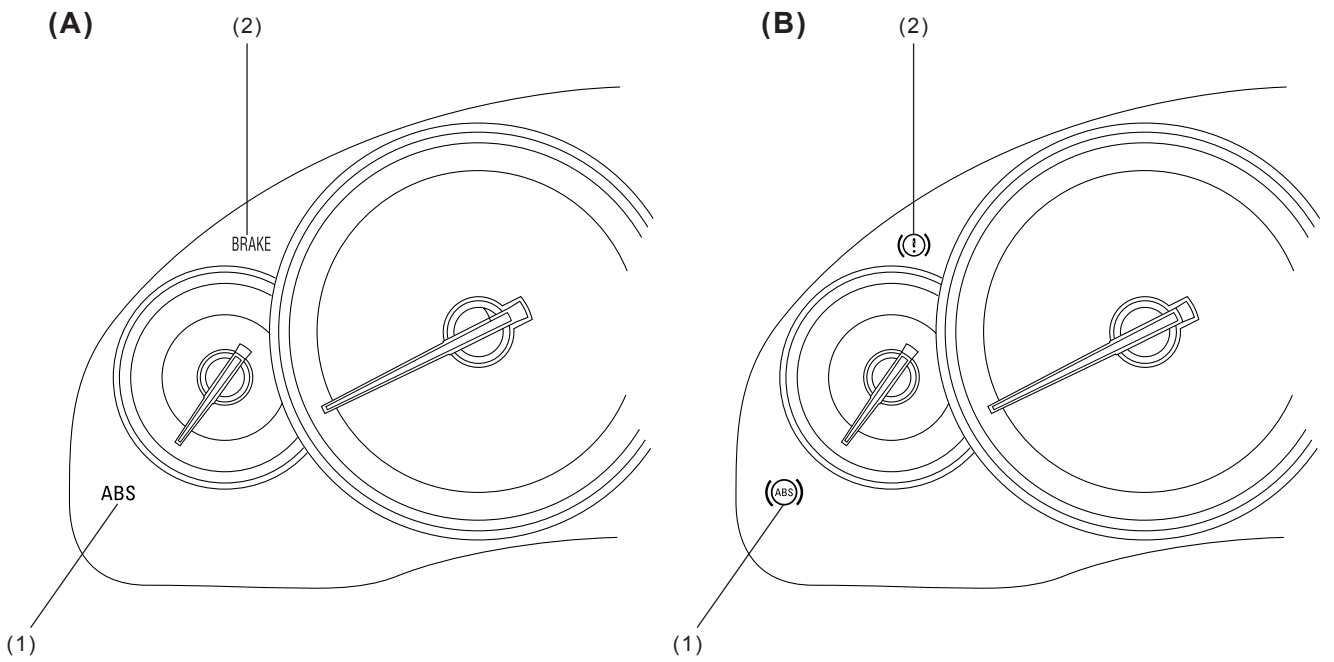
(1) Slip ratio setting
(2) Wheel speed
(3) Vehicle speed
(4) Dummy vehicle speed

Brake fluid pressure	Inlet solenoid valve	Outlet solenoid valve
Increase	OFF	OFF
Hold	ON	OFF
Decrease	ON	ON

H: ABS WARNING LIGHT AND BRAKE WARNING LIGHT (ALSO FUNCTIONS AS EBD WARNING LIGHT)

When a fault occurs in the signal transmission system or the ABSCM, the ABS warning light and brake warning light in the combination meter come on. At the same time, the current to the hydraulic control unit is interrupted. The brake system then functions in the same manner as a system without ABS.

If the warning light comes on, one or more diagnostic trouble codes should be stored in the ABSCM. To identify these codes, use a Subaru select monitor.



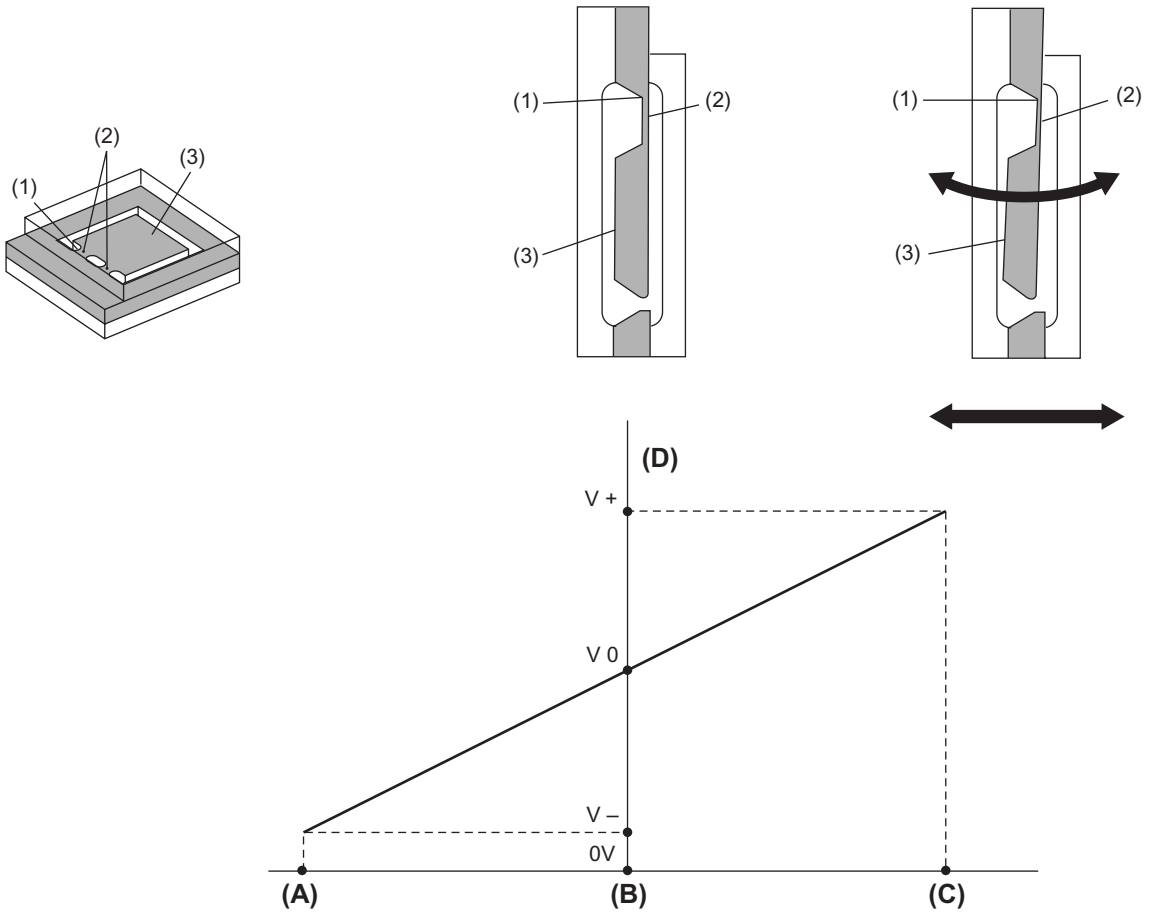
ABS00577

(A) U.S. spec. vehicle
(B) Canada spec. vehicle
(1) ABS warning light
(2) Brake warning light (also functions as EBD warning light)

I: G SENSOR

The G sensor detects changes in the vehicle's acceleration/deceleration rate in the longitudinal direction.

A piezo-resistor is formed on the beam. When the mass area moves during acceleration and deceleration, the beam distorts causing the resistance of the piezo-resistor to change. This change is converted into change in voltage and sent to the ABSCM.



ABS00322

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

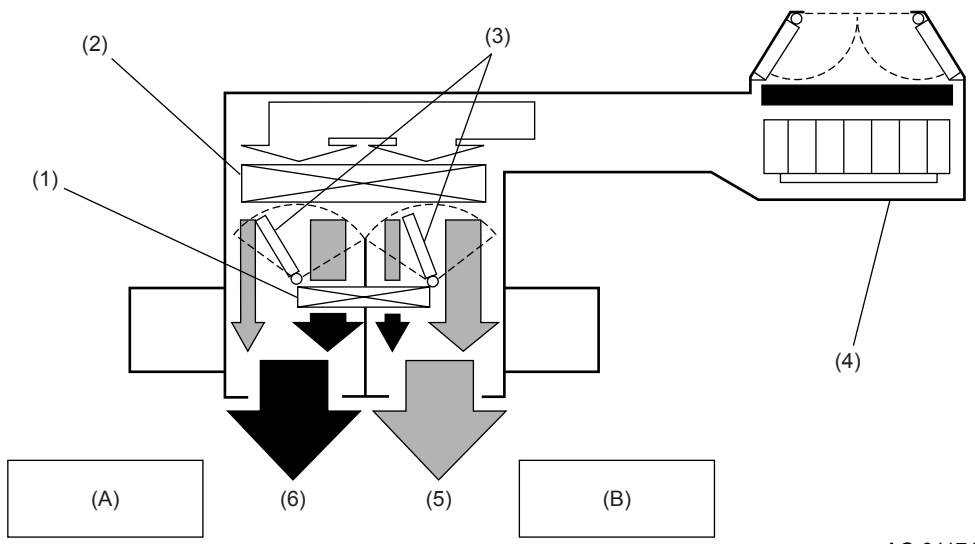
HVAC SYSTEM
(HEATER, VENTILATOR AND AC)

1. Heater System

A: GENERAL

● A semi-center type integrated air conditioning unit is used, where a high performance heater core and an evaporator core are placed in front and rear of the unit. While ensuring sufficient leg space at the front passengerís seat, resistance to air flow in the air passage is reduced, and the air conditioning system offers a low noise and comfortable environment in all seasons through its functions such as heating, air conditioning, ventilating and defrosting.

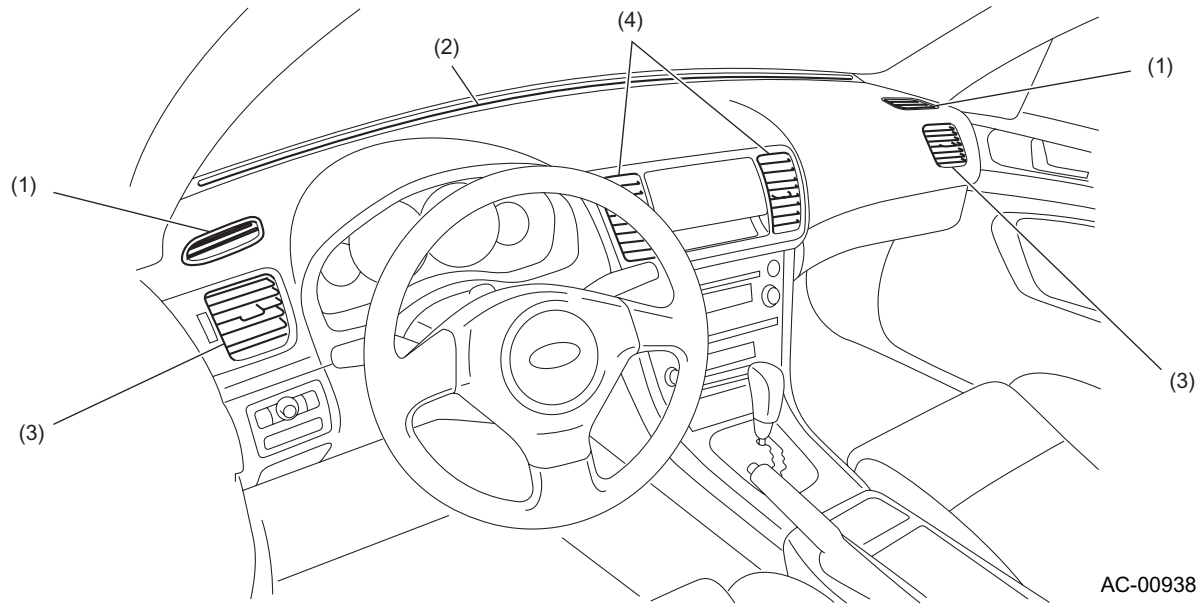
● On models with automatic air conditioning, a left/right independent temperature control system is introduced to enable the driver and passenger choose a desirable temperature setting individually.



AC-01171

(A) Driver's seat
(B) Passenger's seat
(1) Heater core
(2) Evaporator
(3) Air mix door
(4) Blower unit
(5) Cool air
(6) Warm air

● There are four ventilation grilles in the dashboard; two large size grilles at the center and a side grille at each side. To improve the defrosting performance, air is always sent out from the side grilles.

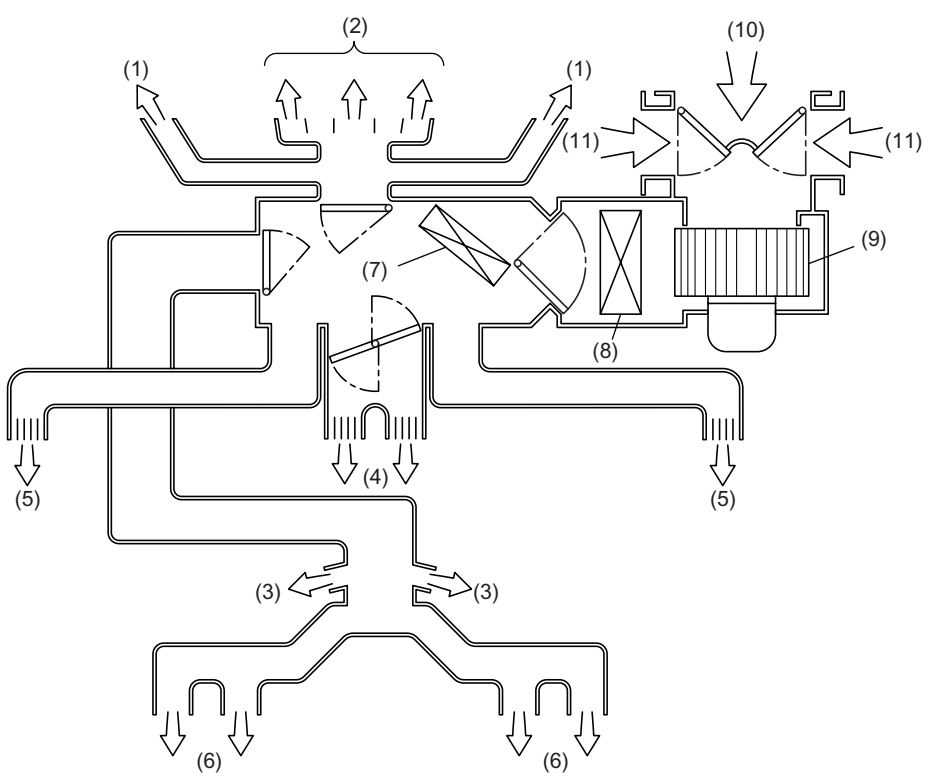


(1) Side defroster
(2) Front defroster
(3) Side ventilation grille
(4) Center ventilation grille

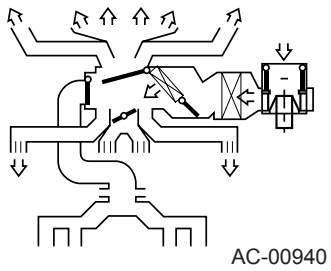
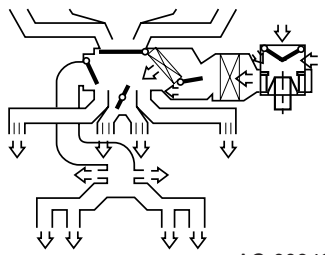
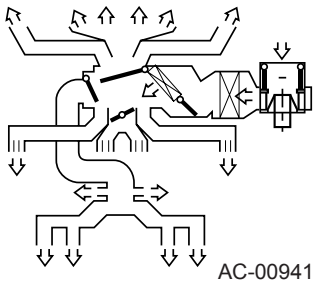
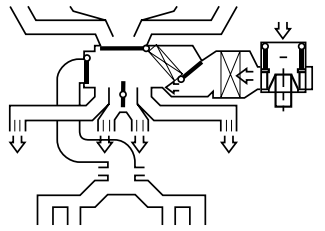
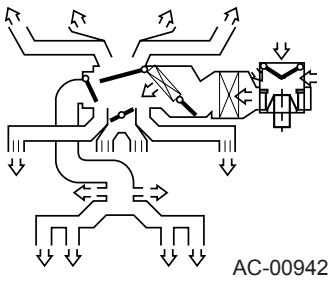
1. SPECIFICATIONS

Heating type	Heating performance (W)	Blower power consumption (W)	Maximum blower capacity (m^3/h)		
			VENT	HEAT	DEF
Outside air mixing type (“full-air-mix” type)	5200	220 or less	460	320	300

B: AIR FLOW MODES



(1) Side defroster
(2) Front defroster
(3) Foot duct
(4) Center vent duct
(5) Side vent duct
(6) Rear heater duct
(7) Heater core
(8) Evaporator
(9) Blower motor
(10) Outside air
(11) Cabin air

Switch position		Heater unit door operation	Switch position		Heater unit door operation
Air flow control	**DEF** AC-00119	 AC-00940	Air flow control	**BILEVEL** AC-00122	 AC-00943
	DEF/FOOT AC-00837	 AC-00941		**FACE** AC-00839	 AC-00944
	FOOT AC-00838	 AC-00942	FRESH/RECIRC switching	AC-00124	This switch allows selecting either of cabin-air-recirculation or fresh-air-introduction modes. FRESH/RECIRC is changed each time the switch is pressed. Indicator ON: cabin air recirculation Indicator OFF: fresh air introduction

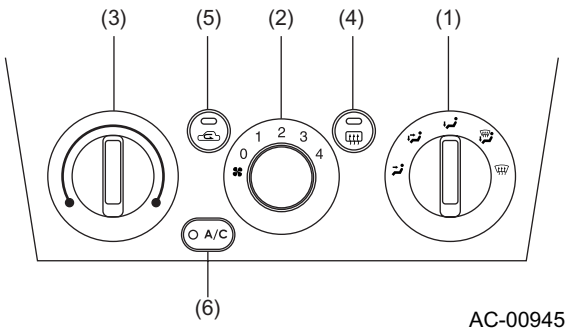
C: CONTROL PANEL

● The control panel is incorporated into the center panel. To improve the appearance of the interior, the panel is integrated with the audio panel except for models with some audio equipment variations.

● A rear window defogger switch is located in the control panel.

1. MODELS WITH MANUAL AIR CONDITIONING

● The control panel uses three large-diameter, dial type switches for easy operation and good visual recognition.



AC-00945

(1) Air flow control dial:
This switch allows selecting any of the five air flow modes.

AC-00127

(2) Fan speed control dial:
This switch allows turning on/off the blower and selecting any of the four blower speeds.

0 1 2 3 4

AC-00126

(3) Temperature control dial:
This switch allows step-less adjusting of the temperature of air delivered through ventilators.

(4) Rear window defogger switch:
This switch activates the rear defogger. When the switch is left on, a timer keeps the defogger activated for 15 minutes and then turns it off automatically.

(5) FRESH/RECIRC switch:
This switch allows selecting either cabin-air-recirculation or fresh-air-introduction.

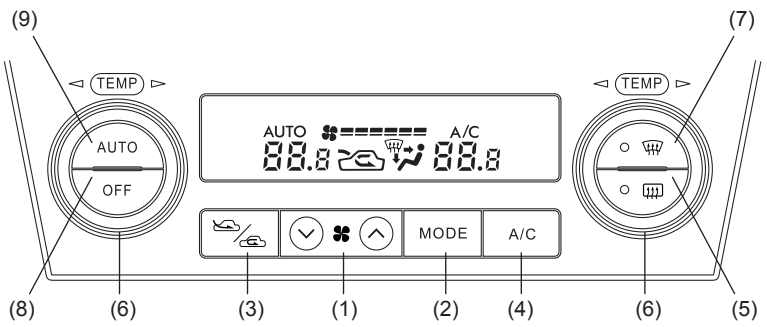
(6) Air conditioning switch:
This switch turns on or off the air conditioning compressor.

2. MODELS WITH AUTOMATIC AIR CONDITIONING

● A motor driven actuator is used for air outlet switching, driver and passenger side temperature control, and FRESH/RECIRC switching.

● A large sized LCD panel which excels in visibility is used for the control panel.

● To eliminate errors due to heat, the cabin temperature sensor is moved from the control panel to the console side panel.



AC-01122

(1) Fan speed control switch:
In automatic air conditioning mode, the system controls the blower speed automatically in accordance with sensor signals.
In manual air conditioning mode, this switch allows selecting any of the six blower speeds.

(2) Air flow control switch:
This switch allows selecting any of the four air flow modes.

AC-00130

(3) FRESH/RECIRC switch:
This switch allows selecting either cabin-air-recirculation or fresh-air-introduction.

(4) A/C switch:
This switch turns on or off the air conditioning compressor.

(5) Rear window defogger switch:
This switch activates the rear defogger. When the switch is left on, a timer keeps the defogger activated for 15 minutes and then turns it off automatically.

(6) Temperature control dial (left: driver's seat, right: passenger's seat):
By turning the left or right dial the temperature of air delivered through ventilators can be adjusted individually at the driver's side and passenger's side. When the dial is turned clockwise the temperature setting rises, and when the dial is turned counterclockwise the setting becomes lower.
Temperature setting can be changed in a range between 18 and 32°C in 0.5°C steps.

(7) Defroster switch:
When this switch is turned ON the system enters the defroster mode.

(8) OFF switch:
All functions are disabled.

(9) AUTO switch:
When this switch is turned ON the system enters auto air conditioning mode and automatically controls the blower fan speed, air outlet, fresh/recirculation switching, and compressor operation.

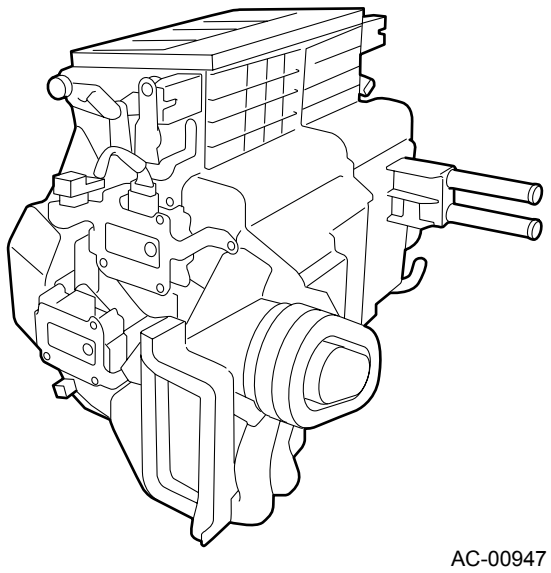
D: HEATER AND COOLING UNIT

● Having an evaporator core at the front and a heater core at the rear, this single unit combines both heating and cooling functions.

● The heater and cooling unit incorporates mode doors for creating different air flow modes and an air mix door for mixing heated air and outside air.

● On models with automatic air conditioning, the inside of the heater and cooling unit is separated into left and right parts so that the driver and passenger can individually control the temperature.

● In models with an automatic air conditioning, the mode doors and air mixing door are moved by electric-motor-driven actuators.
In models with a manual air conditioning system, the air mix door is moved by a linkage cable.



AC-00947

1. SPECIFICATIONS

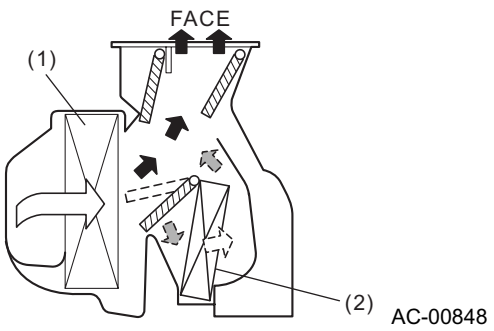
Heater core size	Heat output
264 × 110 × 27	5200 W

2. DESIGN FEATURES FOR EACH AIR FLOW MODE

1) Ventilation (FACE) mode

● The passage leading air from the evaporator to the ventilation duct is made straight to reduce air flow resistance.

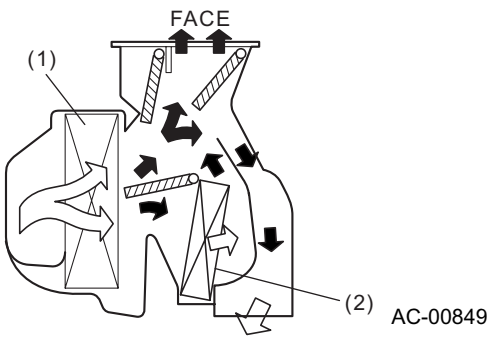
● When the air temperature is necessary to be adjusted, heated air is blown at right angles against the flow of cool air from the evaporator. This allows the airs to mix thoroughly.



(1) Evaporator
(2) Heater core

2) Foot/face (BILEVEL) mode

● The air that has flown through the evaporator is divided into two directions. Part of this air flows through the heater core and becomes warm air. The rest of the air goes to the outlet as cool air, however, this is mixed with the warm air from the heater core. The mixed air then flows to the ventilation and heater ducts.



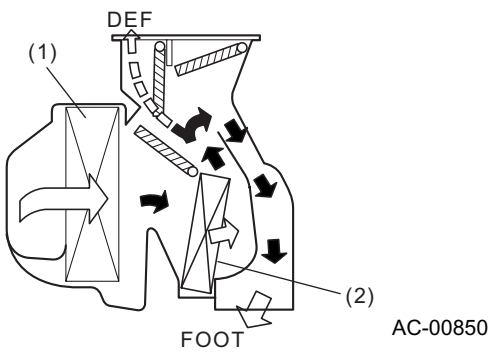
(1) Evaporator
(2) Heater core

3) Heating (FOOT) mode

● The air that has flown through the evaporator is heated at the heater core and then flows to the heater ducts.

● To defog the windshield, the defroster door is slightly open and warm air is also sent to the defroster (DEF) duct.

● The side ventilation grills ventilate air always.



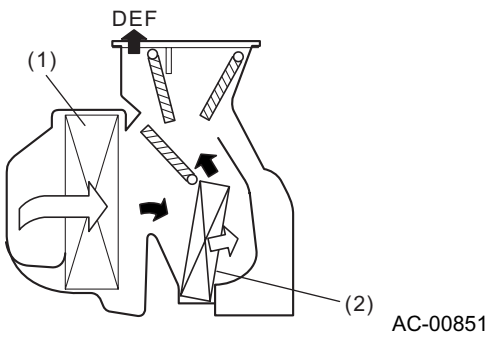
(1) Evaporator
(2) Heater core

4) Defroster (DEF) mode

● Air passages are designed in such a way that air flow resistance is minimized and defrosting performance is maximized.

● The air passages toward the defroster (DEF) outlet is long enough to ensure a same airflow rate at all defroster outlets.

● The side ventilation grills ventilate air always.



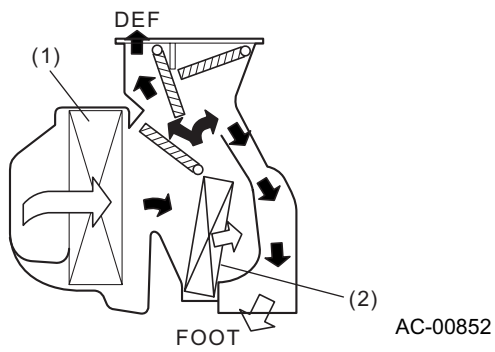
(1) Evaporator
(2) Heater core

5) Defroster (DEF) /Heating (FOOT) mode

● The air from the evaporator flows through the heater core and the warmed air flows to the defroster (DEF) duct and foot duct to defog the windshield while sending warm air to the legs.

● The air directed to the defroster duct flows out from the front and side defroster ducts to defog the windows.

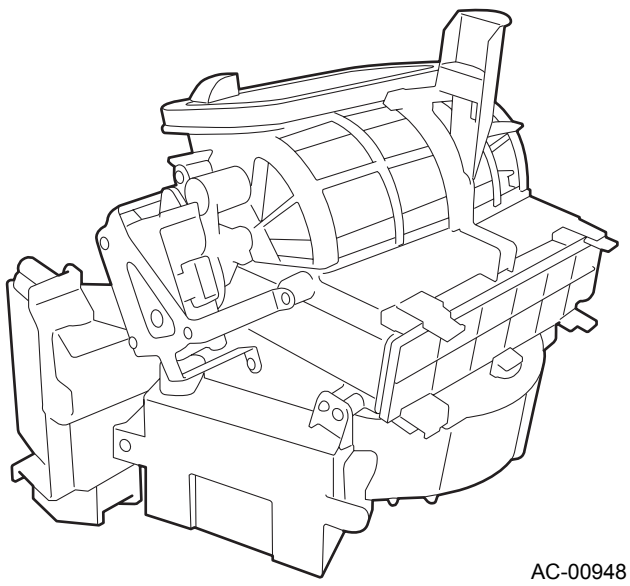
● The side ventilation grills ventilate air always.



(1) Evaporator
(2) Heater core

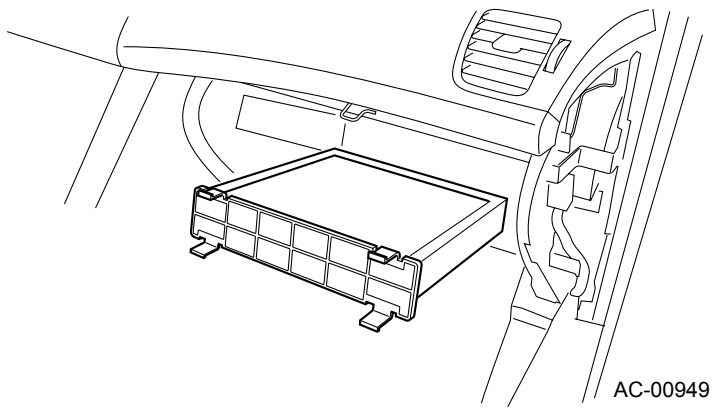
E: BLOWER UNIT

● The blower unit uses a low-noise-type motor.



F: FILTER

● Clean air filters are available for all models as dealer option. They can remove dust, cigarette smoke particles and other similar impurities in the air.

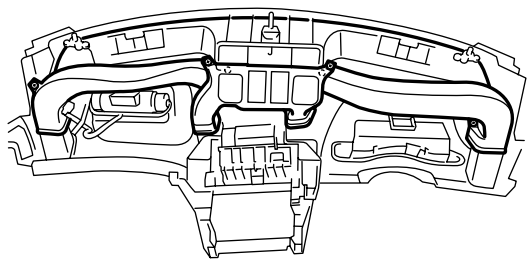


AC-00949

G: DUCT

● The ventilation duct and defroster duct are located behind the instrument panel. Both the ducts have been modified in the shape to reduce air flow resistance.

● Defrosting air flow is divided at the center, so that air can flow out evenly through a wide center defroster as well as right and left side defrosters.

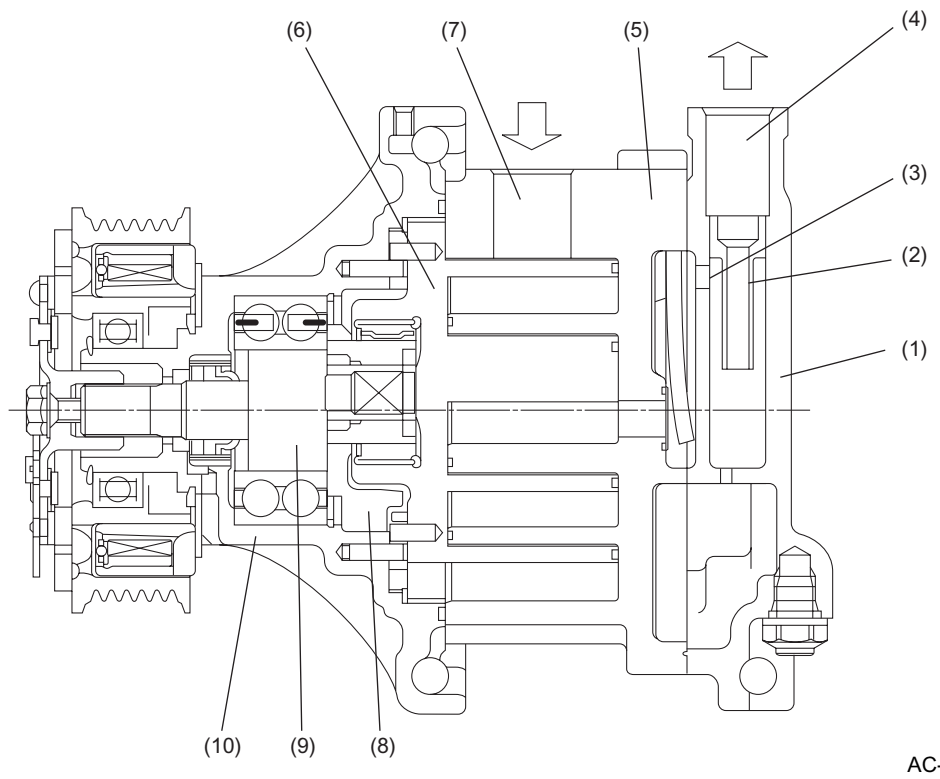


AC-00950

2. Cooling System

A: COMPRESSOR

As two scrolls (one movable and other fixed) are engaged, a crescent chamber is formed between multiple contact points. The movable scroll cannot rotate on its own axis but orbits instead, so the operating chamber moves inwards while its capacity is reduced. Intake, compression and discharge take place simultaneously at multiple operation chambers, and compressed refrigerant is sent from the discharge hole at the center to the oil separator and then separated in to refrigerant gas and oil before it is output from the discharge port.



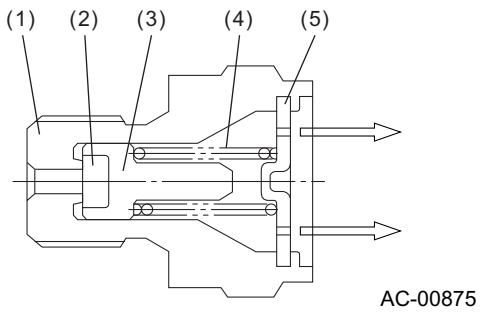
AC-00874

(1) Rear housing
(2) Oil separator
(3) Discharge hole
(4) Discharge port
(5) Shell: fixed scroll
(6) Rotor: movable scroll
(7) Suction port
(8) Balancer
(9) Shaft
(10) Front housing

1. PRESSURE RELIEF VALVE

This valve opens if the pressure of the high-pressure refrigerant gas rises to a dangerously high level to release part of refrigerant into the atmosphere, thus protecting the compressor. The valve is designed to limit the amount of released gas to the necessary minimum.

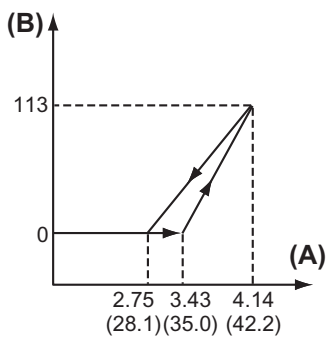
- Valve opening pressure: above 3.43 MPa (35.0 kgf/cm^2)
- Valve closing pressure: above 2.75 MPa (28.1 kgf/cm^2)
- Valve wide open pressure: below 4.14 MPa (42.2 kgf/cm^2)



AC-00875

(1) Housing
(2) Valve
(3) Holder
(4) Spring
(5) Plate

Operating characteristics



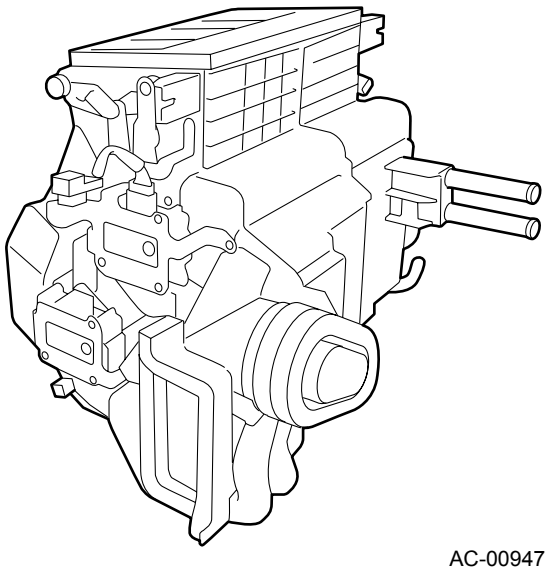
AC-00876

(A) Pressure MPa (kgf/cm^2)
(B) Leakage ℓ/min

B: COOLING UNIT

The heater unit and cooling unit are integrated into a single heater and cooling unit.

The cooling section components of this unit include an evaporator, expansion valve, and case.



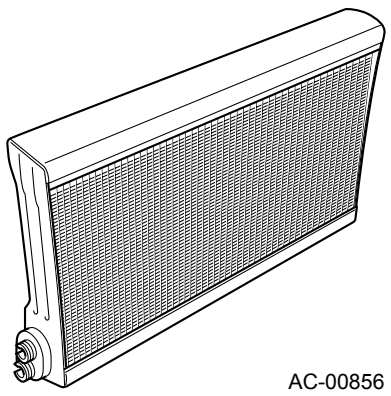
AC-00947

1. EVAPORATOR

The evaporator is a laminated type.

When a low-pressure, low-temperature refrigerant is sprayed by the expansion valve into the evaporator, it evaporates and cools the evaporator surfaces.

The cabin air is drawn by the blower and cooled down as it flows over the evaporator. The cooled air then flows passing through the heater unit and delivered into the cabin through vent outlets.



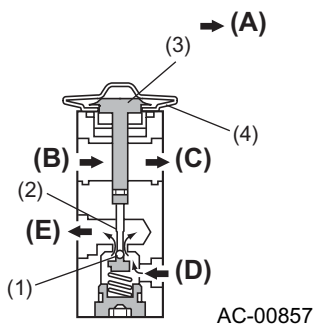
AC-00856

2. EXPANSION VALVE

The expansion valve regulates the flow of refrigerant such that heat exchange takes place optimally.

The expansion valve performs two functions; it sprays the high-pressure refrigerant from the condenser using a throttle valve, and it regulates the amount of the spray by changing opening of the throttle valve.

The expansion valve consists of such main components as a heat sensing cylinder, diaphragm, ball valve, spring, and adjusting screw.



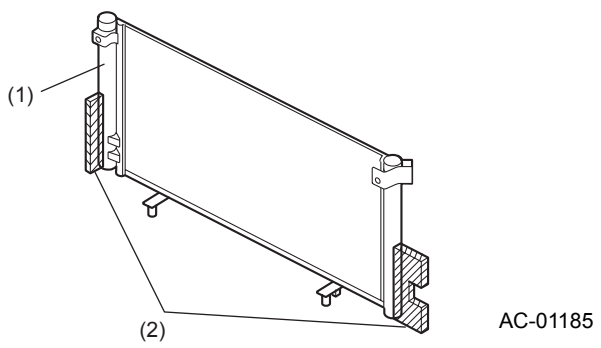
(1) Ball valve
(2) Shaft
(3) Heat sensing cylinder
(4) Diaphragm

(A) Refrigerant flow
(B) From evaporator (low-pressure side)
(C) To compressor
(D) To liquid tank
(E) To evaporator (high-pressure side)

The heat (temperature) sensing cylinder is held in contact with the evaporator outlet pipe so that a pressure corresponding to the sensed temperature may be applied to the chamber above the diaphragm. There is a pressure equalizing hole which communicates with the chamber below the diaphragm to transmit changes in the refrigerant pressure to the chamber. The ball valve is linked with the diaphragm and moves according to changes in the balance between the force applied to the diaphragm and the tension of the spring.

C: CONDENSER

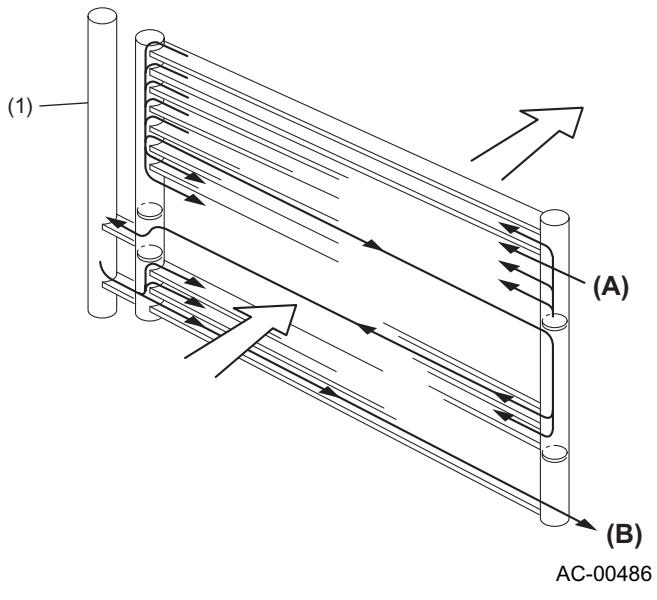
The condenser is a newly developed subcooling condenser that integrates a multi-flow type condenser and a modulator (gas-liquid separator) into a single unit. The condenser has a high heat-exchange efficiency.



(1) Liquid tank
(2) Urethane

1. SUBCOOLING CONDENSER

The new subcooling condenser has a subcooling section where part of the refrigerant that remains in gas form is cooled and reduced into liquid form. This enables almost 100% of the refrigerant to be re-liquefied.



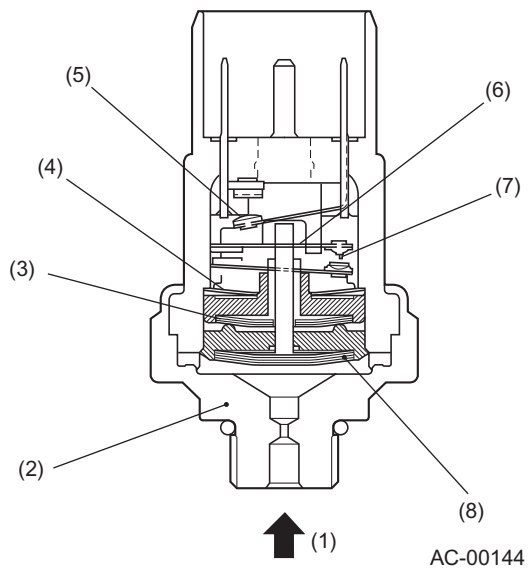
(1) Liquid tank
(A) Suction
(B) Discharge

D: PRESSURE SWITCH

The pressure switch is a high-pressure side component of the refrigeration cycle (cooling cycle). It consists of a diaphragm that receives refrigerant gas pressure, a snap plate, a rod, contacts that open both when the gas pressure is too low and when it is too high, and a switch that operates at mid-pressure.

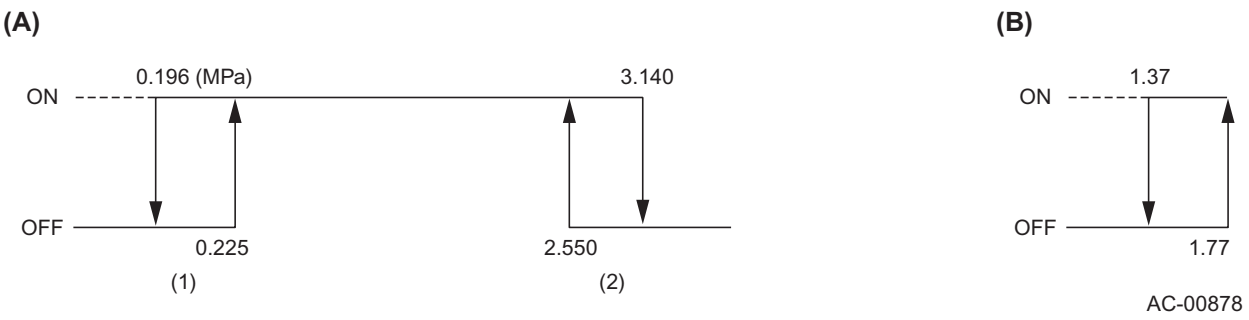
The pressure switch plays the following roles:

- Prevents “no-gas” operation due to leakage (when gas pressure is too low)
- Protects the system against abnormally high refrigerant pressure (when gas pressure is too high)
- Detects compressor load (mid pressure contact: electric cooling fan output control)



(1) Pressure
(2) Housing
(3) Diaphragm (high pressure)
(4) Diaphragm (low pressure)
(5) Mid-pressure switch
(6) Lever (high-pressure)
(7) High and low pressure switch
(8) Diaphragm (mid pressure)

ON-OFF pressures



(A) High and low pressure switch
(1) Low pressure
(B) Mid-pressure switch
(2) High pressure

1. SPECIFICATIONS

High/low pressure switch (compressor ON/OFF control)

Low pressure switch	ON→OFF	0.196 MPa (2.00 kgf/cm^2)
	OFF→ON	0.255 MPa (2.60 kgf/cm^2)
High pressure switch	ON→OFF	3.140 MPa (32.0 kgf/cm^2)
	OFF→ON	2.550 MPa (26.0 kgf/cm^2)

Mid pressure switch (electric cooling fan output control)

Compressor at low load	ON→OFF	1.37 MPa (13.9 kgf/cm^2)
Compressor at high load	OFF→ON	1.77 MPa (18.0 kgf/cm^2)

3. Manual Air Conditioning

A: GENERAL

1. SPECIFICATIONS

Item	Specifications			Remarks
Air conditioning	"Full-air-mix" type			
Cooling performance	Cooling capacity (W)		5300	
	Air flow rate (m^3/h)		460	
Refrigerant quantity	HFC-134a (g)		400±30	
Compressor	Type		Scroll	Denso SCSA08C
	Capacity (cm^3/rev)		74.5	
	Maximum permissible speed (rpm)		9000	
	Lubricant (amount contained in compressor in g)		Denso oil 8 (70)	
Magnetic clutch	Type		Dry, single disc	
	Power consumption (W)		35	
	Pulley ratio		1:1.43 (crankshaft pulley diameter: 133 mm; compressor pulley diameter: 125 mm)	
	Belt		Polyurethane V-belt with four ribs	
Condenser	Type		Multi-flow type (with built-in liquid tank for subcooling)	
	Fan	Type	Electric-motor-driven axial flow fan	
		Fan diameter	300 mm (7+5 blades)	
		Power consumption (W)	90 × 2	
Evaporator	Type		Laminated	
	Expansion valve		External pressure equalizing type	
	Temperature control		Thermo AMP (amplifier)	
Other controls	Fast idle control system		Engine control module (ECM)	
	High and low pressure limit control		Low pressure switch: Turns off compressor at a pressure lower than 0.196 MPa High-pressure switch: Turns off compressor at a pressure higher than 3.140 MPa	
	High-speed limit control		Performed by ECM	
	Radiator and condenser fan control		Performed by ECM	

2. CONTROL PANEL

<Ref. to AC-6, MODELS WITH MANUAL AIR CONDITIONING, CONTROL PANEL, Heater System.>

3. THERMO AMP (AMPLIFIER)

The thermo AMP detects the temperature at the evaporator outlet to turn off the magnetic clutch circuit when the evaporator temperature drops to a certain level in order to prevent frost from forming on the evaporator.

4. Automatic Air Conditioning

A: GENERAL

When the AUTO mode is selected, the automatic air conditioner controls the air temperature and air flow rate automatically.

1. SPECIFICATIONS

Item	Specifications			Remarks
Air conditioning	"Full-air-mix" type			
Cooling performance	Cooling capacity (W)		5300	
	Air flow rate (m^3/h)		460	
Refrigerant (g)	400±30			
Compressor	Type		Scroll	Denso SCSA08C
	Capacity (cm^3/rev)		74.5	
	Maximum permissible speed (rpm)		9000	
	Lubricant (amount contained in compressor in g)		Denso oil 8 (70)	
Magnetic clutch	Type		Dry, single disc	
	Power consumption (W)		35	
	Pulley ratio		1:1.43 (crankshaft pulley diameter: 133 mm; compressor pulley diameter: 125 mm)	
	Belt		Polyurethane V-belt with four ribs (H4) or six ribs (H6)	
Condenser	Type		Multi-flow type (with built-in liquid tank for subcooling)	
	Fan	Type	Electric-motor-driven axial flow fan	
		Fan diameter	H4: 300 mm Turbo and H6: 320 mm (7+5 blades)	
		Power consumption (W)	H4: 90 × 2, H6: 160 × 2, Turbo: 120 × 2	
Evaporator	Type		Laminated	
	Expansion valve		External pressure equalizing type	
	Temperature control sensor		Thermistor	
Automatic control system	Temperature control		"Full-air-mix" system	
	Fan speed control		Automatic control: stepless Manual control: six steps	
	Air introduction selection		Manual (inside air recirculation/fresh air introduction)	
	Air outlet selection		Manual (ventilation, bi-level, heater, defroster and heater/defroster)	
Other controls	Fast idle control system		Engine control module (ECM)	
	High and low pressure limit control		Low-pressure switch: Turns off compressor at a pressure higher than 0.196 MPa High-pressure switch: Turns off compressor at a pressure higher than 3.140 MPa	
	High-speed limit control		Performed by ECM	
	Radiator and condenser fan control		Performed by ECM	
Diagnosis function	The auto A/C control module has a sensor and actuator diagnosis function.			
Other controls	Manual adjustment possible at maximum heating and maximum cooling positions			

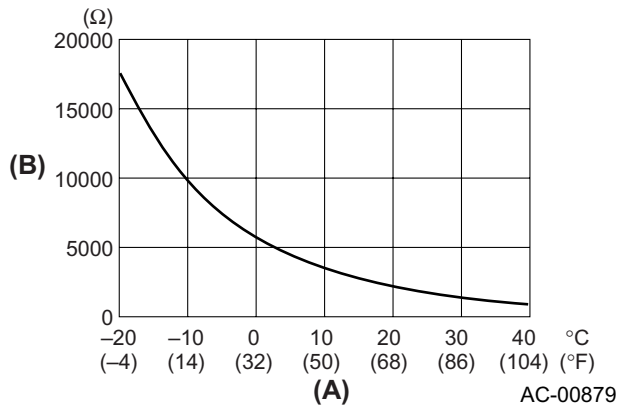
B: CONTROL PANEL

<Ref. to AC-7, MODELS WITH AUTOMATIC AIR CONDITIONING, CONTROL PANEL, Heater System.>

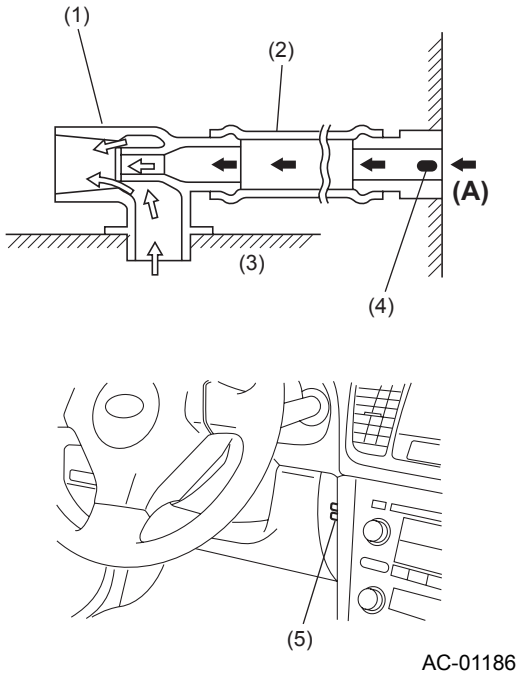
C: IN-VEHICLE SENSOR

The in-vehicle sensor detects the cabin temperature and sends an electric signal corresponding to the temperature to the A/C control module.

This sensor consists of an aspirator and a thermistor, the resistance of which changes in inverse proportion to the temperature. The aspirator operates by a vacuum generated in the heater unit (only when the blower unit is turned on).



(A) Temperature
(B) Resistance



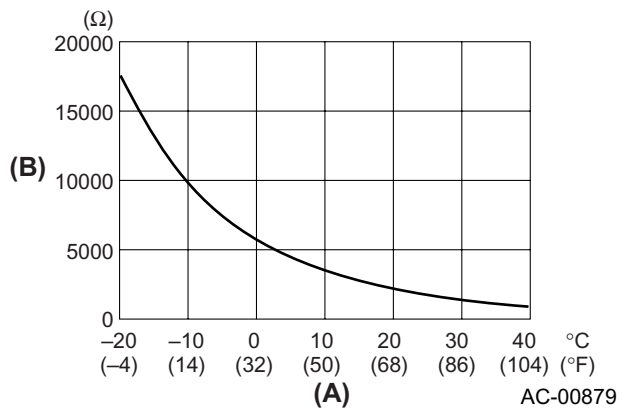
AC-01186

(1) Aspirator
(2) Aspirator duct
(3) Heater unit
(4) In-vehicle sensor
(5) Cabin air inlet
(A) Cabin air

D: AMBIENT SENSOR

The ambient sensor uses a thermistor to detect the ambient temperature and outputs a signal corresponding the detected temperature to the auto A/C control module.

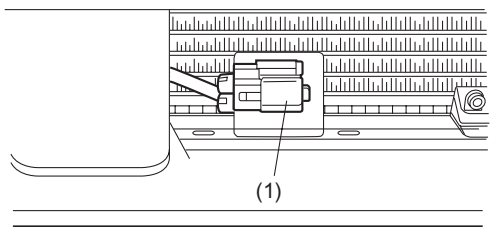
The thermistor is covered with a plastic molding to increase its thermal capacity, thus preventing it from being too sensitive to rapid changes in the temperature and enabling the sensor to output an average ambient temperature.



(A) Temperature

(B) Resistance

The ambient sensor is attached to the radiator lower panel at the portion where the radiator panel is located in such a way that it is exposed to outside air most efficiently.

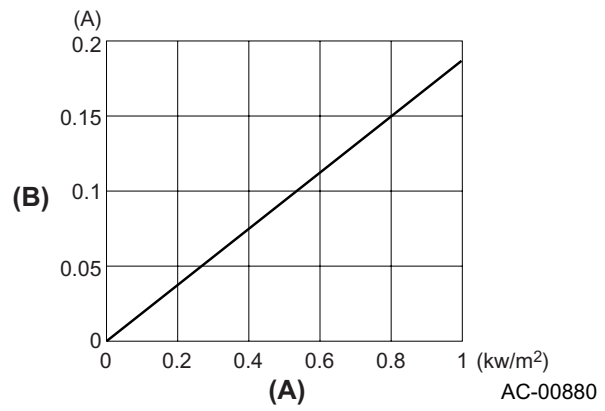


(1) Ambient sensor

E: SUN-LOAD SENSOR

The sun-load sensor uses a photodiode which can convert change in the intensity of solar radiation into change in the electric current. The output signal of the sensor is sent to the auto A/C control module.

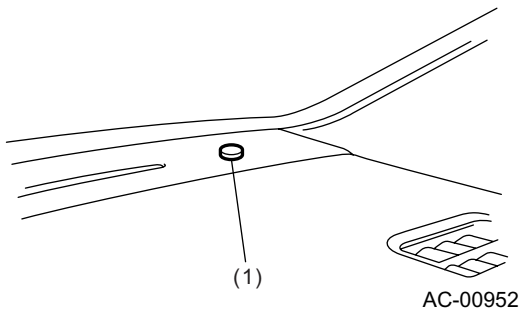
Sun-load sensor characteristic



(A) Solar radiation

(B) Photoelectric current

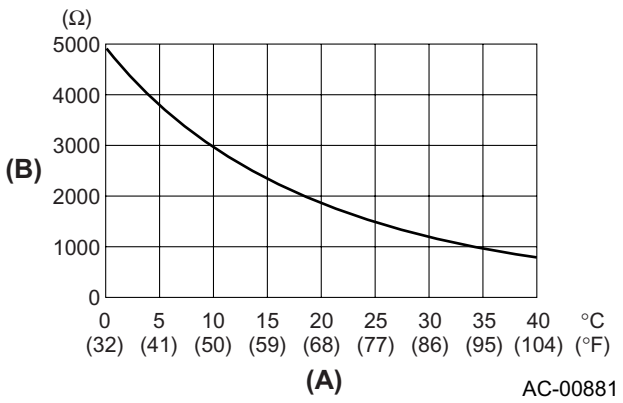
The sun-load sensor is attached to the front defroster grill.



(1) Sun-load sensor

F: EVAPORATOR SENSOR

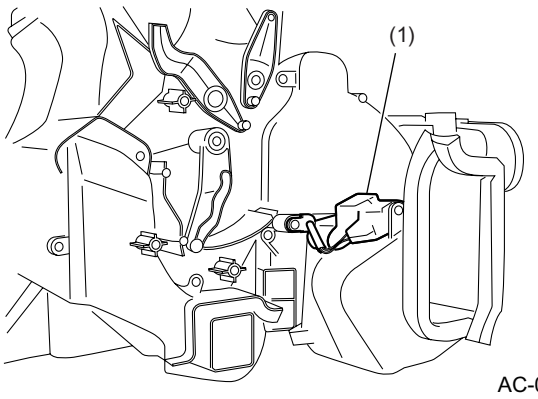
The evaporator sensor detects the temperature of the air that has passed over the evaporator and transmits a signal corresponding to the temperature to the auto A/C control module.



AC-00881

(A) Temperature

(B) Resistance

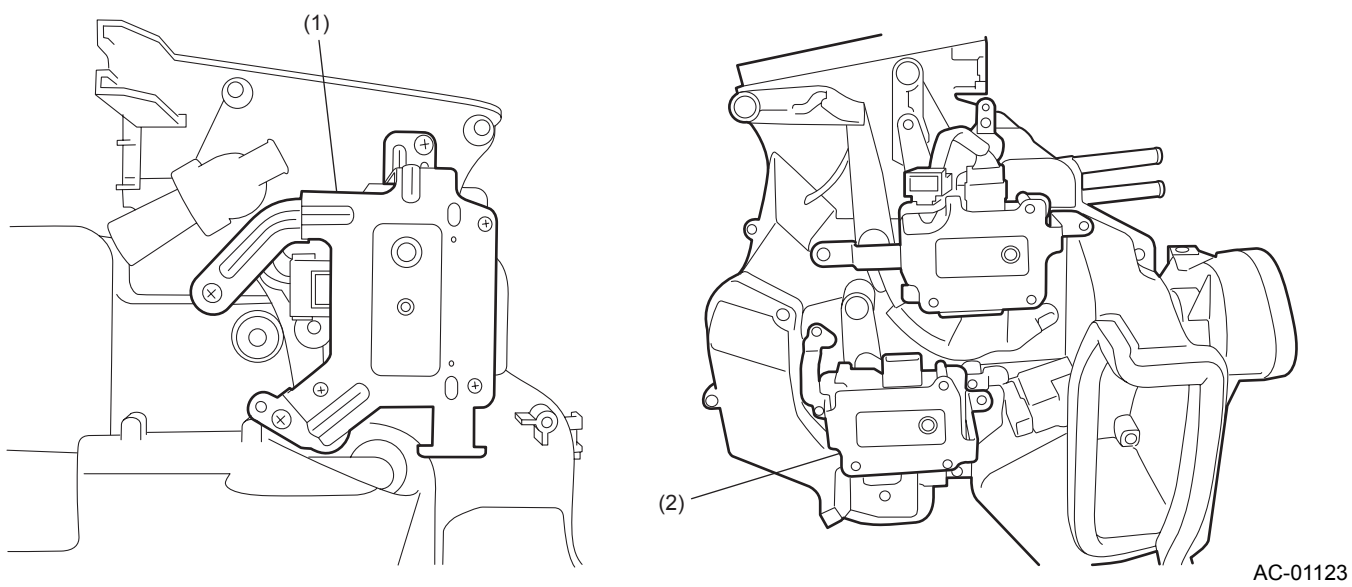


AC-00953

(1) Evaporator sensor connector

G: AIR MIX DOOR ACTUATOR

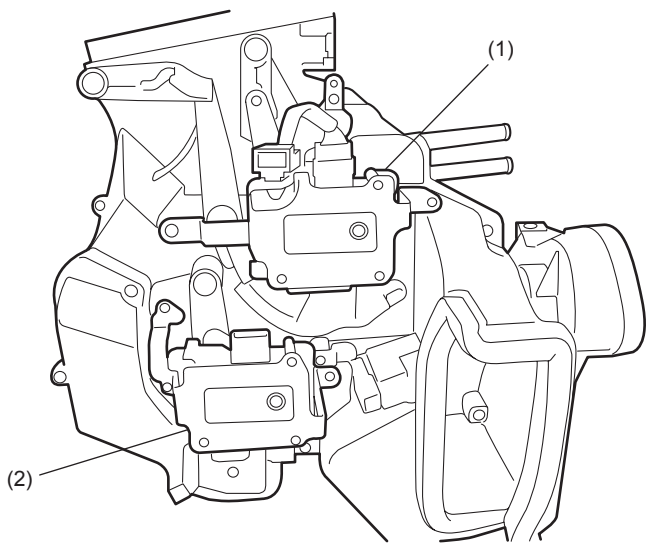
Air mix door actuators are installed at left and right of the heater and cooling unit, and they move the left and right air mix doors independently to the proper position in response to signals from the auto A/C control module. This enables the driver and passenger to control the temperature individually.



(1) Air mix door actuator (driver's seat)
(2) Air mix door actuator (passenger's seat)

H: MODE DOOR ACTUATOR

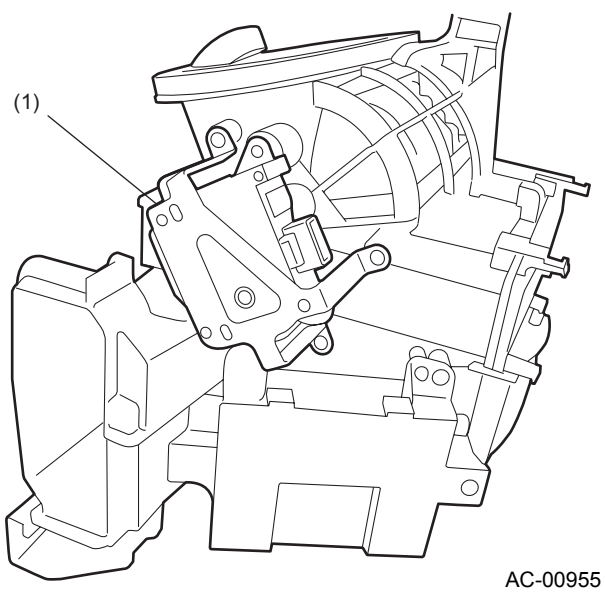
The mode door actuator incorporates an electric motor which turns in one or the other direction in response to signals from the auto A/C control module. The motion of the electric motor is transmitted to each mode door via a linkage and moves the door to the position appropriate for the selected air flow mode.



(1) Mode door actuator
(2) Air mix door actuator

I: FRESH/RECIRC DOOR ACTUATOR

The FRESH/RECIRC door actuator incorporates an electric motor which turns in one or the other direction in response to a signal from the auto A/C control module. The motion of the electric motor is transmitted to the FRESH/RECIRC door via a linkage to move the door to the outside-air introduction or cabin-air-recirculation position.



AC-00955

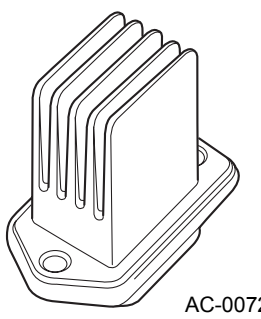
(1) FRESH/RECIRC door actuator

J: FAN CONTROL AMPLIFIER

The fan control amplifier uses a MOS* type field effect transistor. This amplifier steplessly regulates the blower motor voltage (in the range between approximately 3V and 12V) in response to gate voltage signals issued by the auto A/C control module.

Since this fan control amplifier features very small voltage drop, it can handle the maximum voltage for the maximum blower speed without need for a high-voltage relay.

*MOS = metal oxide semiconductor



AC-00720

BRAKE

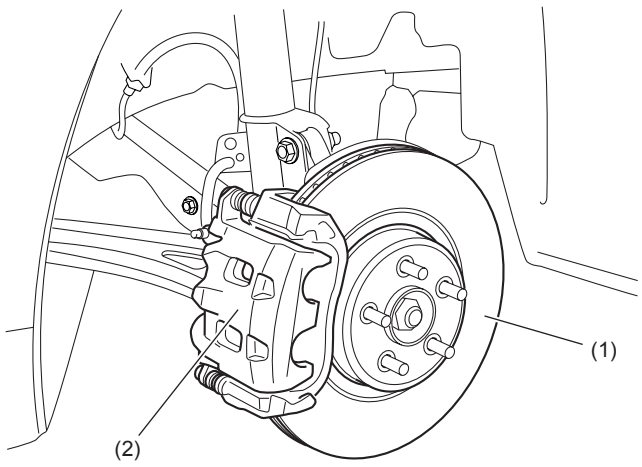
1. Front and Rear Disc Brakes

● Each of the front and rear disk brakes consist of a brake caliper, brake pads, and a brake disk rotor.

● The front disc brakes are of a ventilated disc type which features high heat dissipation and superb braking stability. The rear disk brakes are either a ventilated disk type or a solid disk type.

● 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 brake pads have a wear indicator which gives a warning when the pad is worn down to the limit.

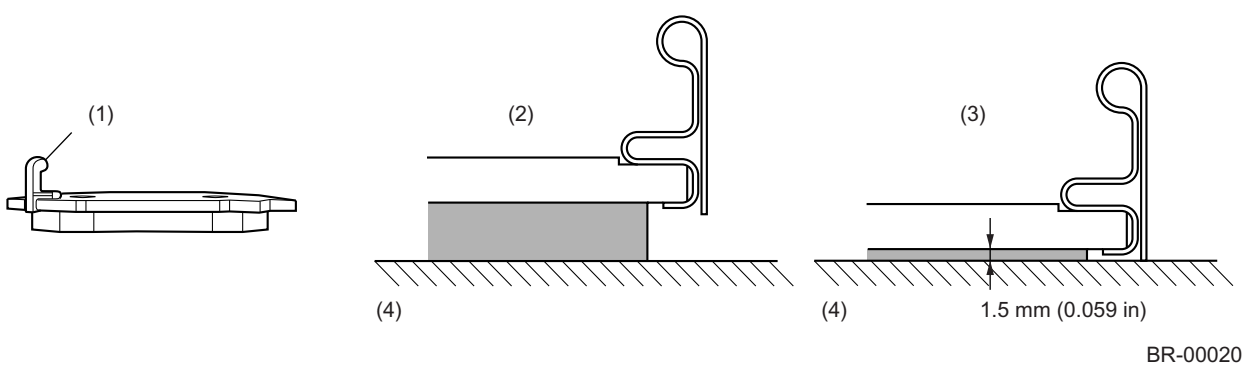


BR-00352

(1) Disc rotor
(2) Caliper body

A: PAD WEAR INDICATOR

A wear indicator is provided on the inner disc brake pads. When the pad wears down to 1.5 mm (0.059 in) the tip of the wear indicator comes into contact with the disc rotor, and makes a squeaking sound as the wheel rotates. This alerts the driver to the situation.



(1) Wear indicator
(2) New pad
(3) Worn pad
(4) Disc rotor

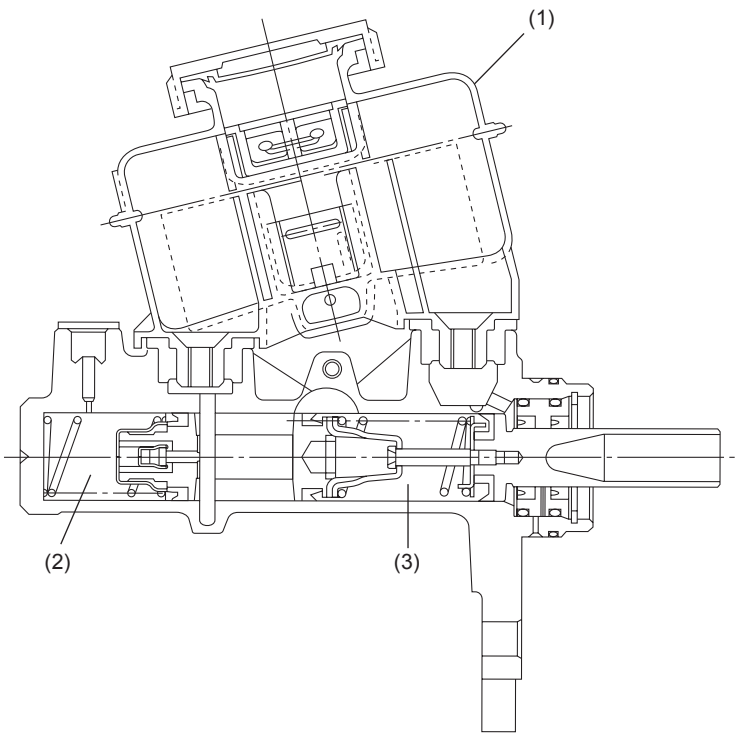
B: FRICTIONAL MATERIAL OF BRAKE PADS

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

2. Master Cylinder

● The master cylinder consists of a brake fluid reservoir chamber that stores brake fluid, and a hydraulic chamber section that converts the force applied to the brake pedal into hydraulic pressure.

● The hydraulic pressure generated in each of the two hydraulic chambers are sent to the brake caliper of each wheel through the 2 diagonally split brake circuits.



BR-00366

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

A: BRAKE FLUID LEVEL SWITCH

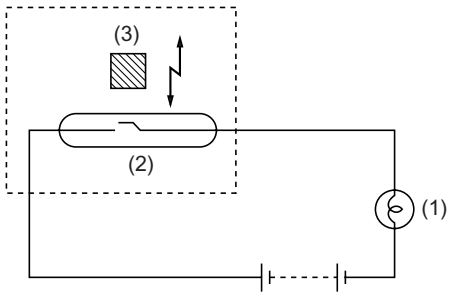
The brake fluid level switch is located inside the brake fluid reservoir tank and causes the brake system warning light on the combination meter to come on when the fluid level has dropped below the predetermined level.

The switch assembly consists of a reed switch (normally open) and a permanent magnet that is incorporated in a float.

When the brake fluid level is normal, the float is far above the reed switch, so the force of the magnet is unable to act on the reed switch. The warning light circuit, therefore, remains open.

When the brake fluid level drops to a level approximately 20 mm (0.79 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

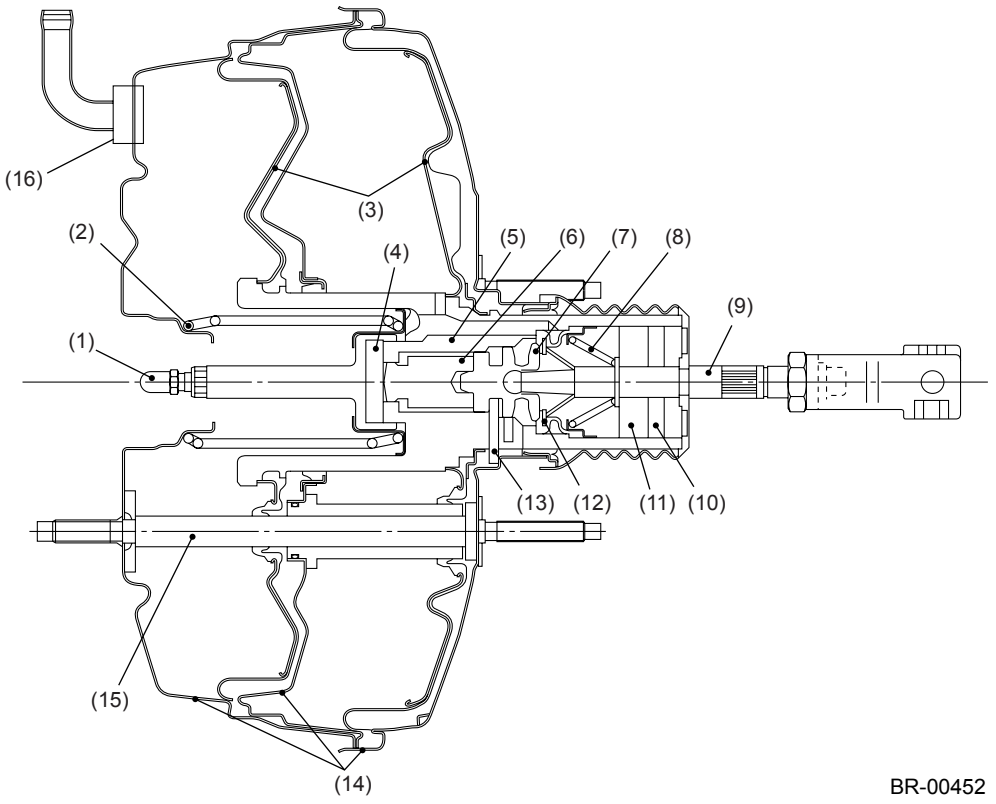
(1) Warning light
(2) Reed switch
(3) Permanent magnet

3. Brake Booster

The brake booster is a tandem type that uses two diaphragms.

By utilizing the differential pressure between the intake manifold vacuum and atmospheric pressure, a high braking force can be obtained even when the pedal depressing effort is small.

The brake booster is installed between the brake pedal and master cylinder. This contributes to improve the response to the brake pedal. If it fails, the brake servo effect is lost requiring a larger pedal effort, however, the braking force is still maintained.

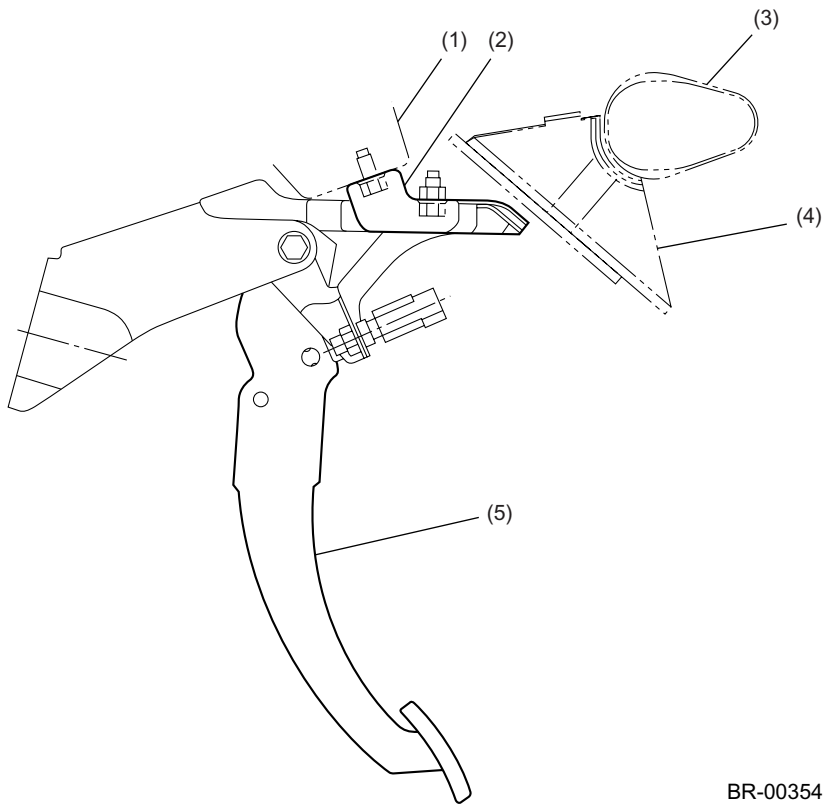


BR-00452

(1) Output rod
(2) Return spring
(3) Diaphragm
(4) Reaction disc
(5) Control housing
(6) Piston
(7) Plunger valve
(8) Valve spring
(9) Input rod
(10) Silencer
(11) Filter
(12) Poppet seal
(13) Stop plate
(14) Shell
(15) Tie-rod (through bolt)
(16) Check valve

4. Brake Pedal

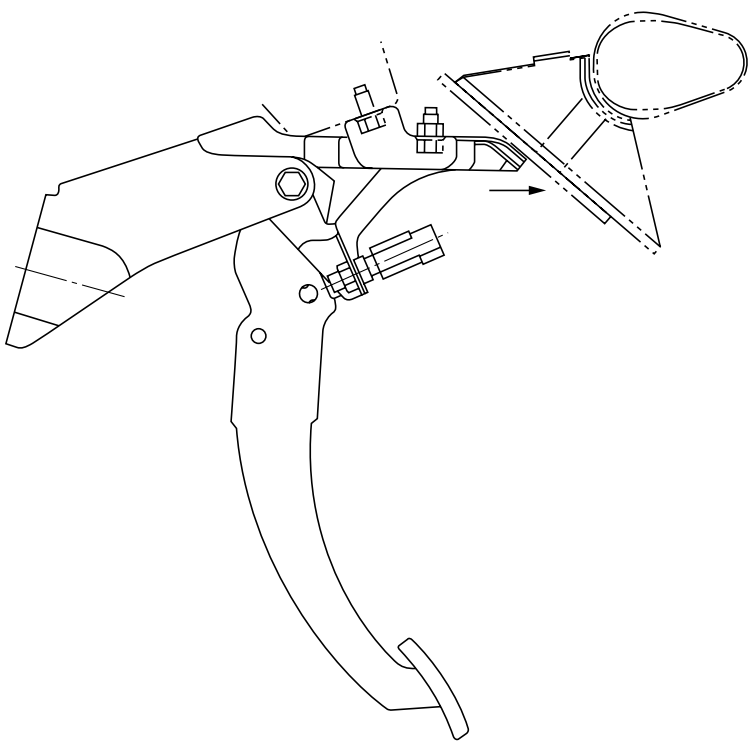
The brake pedal is provided with a mechanism to control movement to the rear in case of a frontal collision to minimize injury to the driver's legs.



(1) Mounting bracket at body side
(2) Bracket at brake pedal side
(3) Steering support beam
(4) Brake pedal catcher
(5) Brake pedal assembly

BRAKE PEDAL

If the brake pedal is pushed rearwards in case of a frontal collision, the brake pedal comes in contact with the catcher.

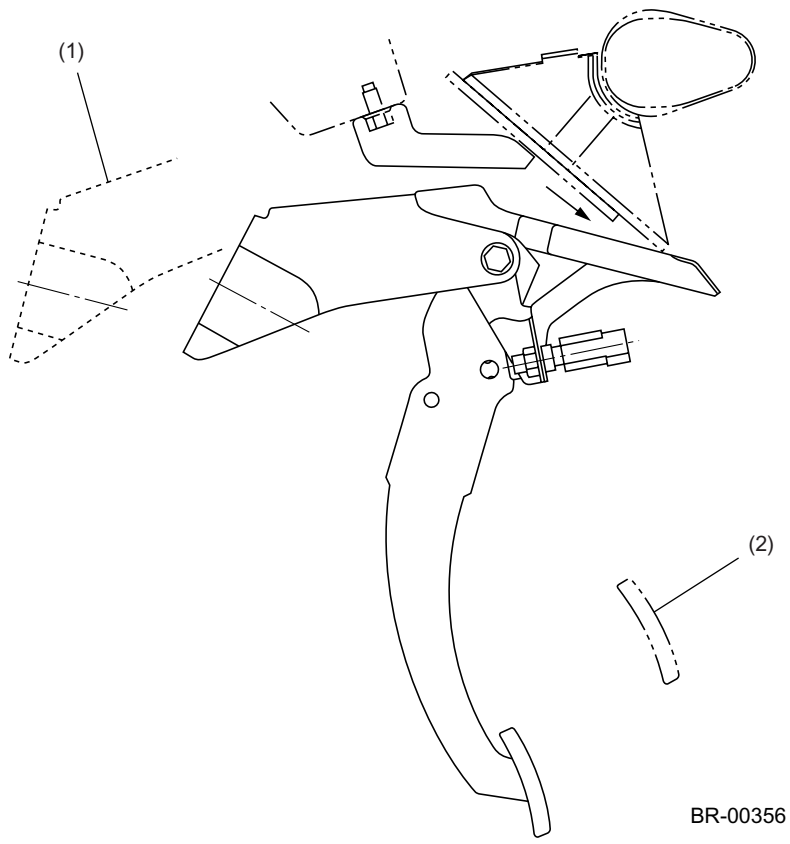


BR-00355

If the brake pedal is pressed further, the brake pedal will come apart from the pedal side bracket.

The brake pedal will move along the brake catcher.

By letting the brake pedal to move down along the catcher, the rearward movement of the brake pad is controlled.



(1) Mounted position before collision

(2) Brake pedal pad position after a collision on a vehicle without a rearward movement control mechanism

CRUISE CONTROL SYSTEM

1. Cruise Control

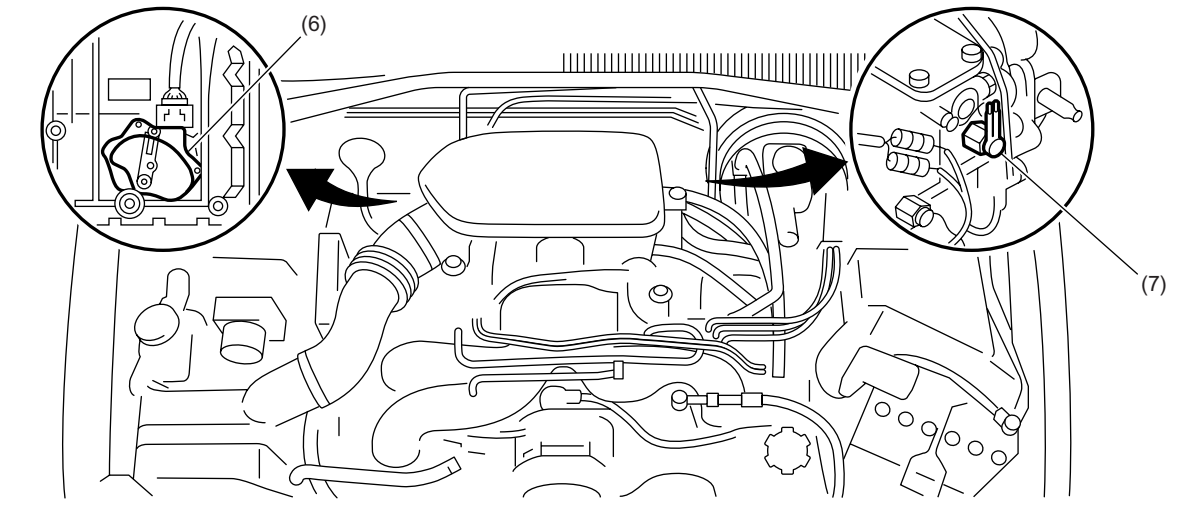
A: OPERATION

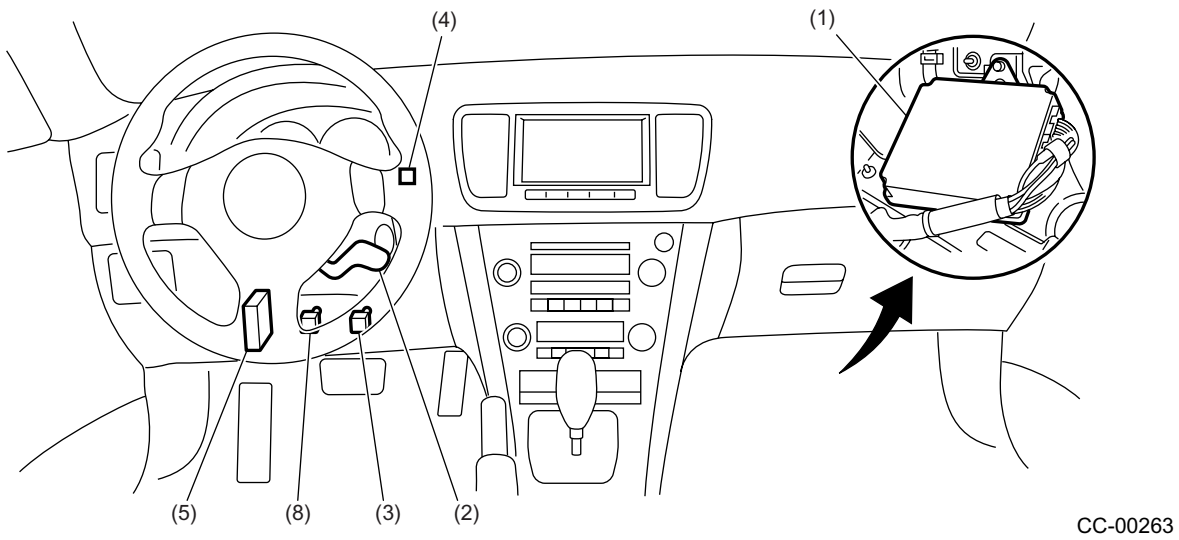
● The cruise control system automatically controls the vehicle speed. It allows the vehicle to run at a constant speed without need for the driver to keep the accelerator pedal depressed.

● The cruise control system is controlled by the engine control module (ECM).

● When the driver has activated the system and made a desired speed setting, the engine control module (ECM) compares the actual vehicle speed detected by the speed sensor with the preset speed in the engine control module (ECM) memory, and then generates a signal according to the difference between the two speeds.
This signal is transmitted to the electronic control throttle.
The electronic control throttle operates the throttle valve as necessary to keep the preset vehicle speed.

B: LOCATION OF COMPONENTS





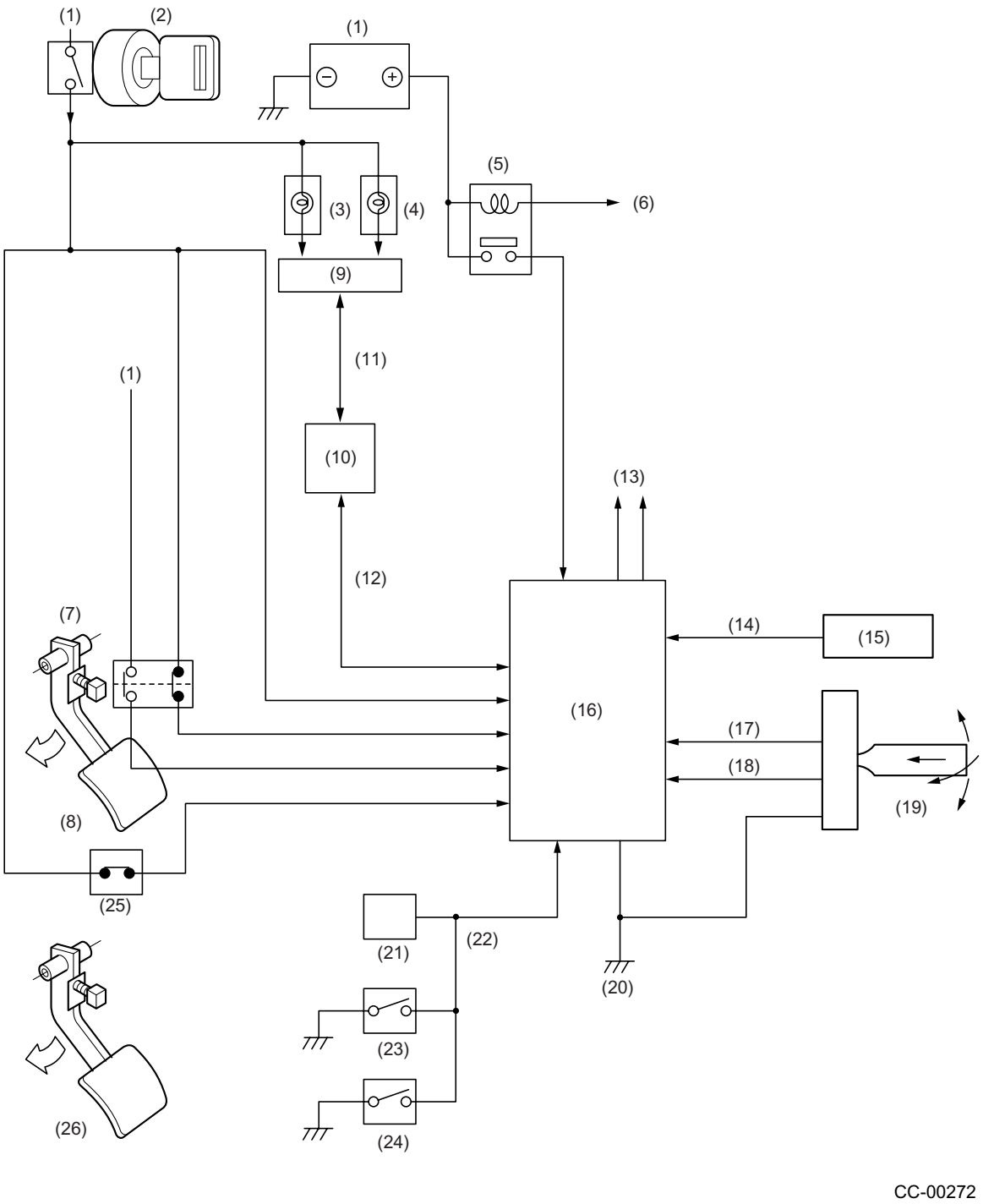
(1) Engine control module (ECM)
(2) Cruise control command switch (with built-in MAIN switch)
(3) Stop light and brake switch
(4) Cruise indicator light and cruise set indicator light
(5) Transmission control module (TCM) (AT)
(6) Inhibitor switch (AT)
(7) Neutral position switch (MT)
(8) Clutch switch (MT)

C: CONTROL AND OPERATION

Vehicle speed control	When the actual vehicle speed is higher than the set speed, the throttle valve of the electronic control throttle moves in the closing direction by the amount corresponding to the difference between the two speeds. When the actual vehicle speed is lower than the set speed, the throttle valve of the electronic control throttle moves in the opening direction by the amount corresponding to the difference between the two speeds.
Speed set function (SET function)	When the SET/COAST switch is pressed while the vehicle is running at a speed greater than 40 km/h (25 MPH) and the MAIN switch is ON, the cruise control is set at the current vehicle speed (this speed becomes the “memorized speed”) and the vehicle maintains this speed thereafter.
Resume control function (RESUME function)	When the RESUME/ACCEL switch is turned ON after the cruise control is temporarily cancelled, the vehicle speed returns to the memorized speed, which was stored just before the cruise control was 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 memorized speed is cleared. (1) Ignition switch is turned OFF (2) MAIN switch is turned OFF (3) Abnormality in the system is detected
Deceleration control function (1) (COASTING function)	When the SET/COAST switch is pressed for a prolonged time while the vehicle is governed by the cruise control, the memorized vehicle speed of the cruise control is changed to the vehicle speed value reached at the moment the switch is released after slowing down. However, the cruise control is cancelled when the vehicle speed becomes lower than the lower limit of the speed setting range.
Deceleration control function (2) (TAP DOWN function)	When the SET/COAST switch is pressed for a short time while the vehicle is governed by the cruise control, the cruise control subtracts a certain amount from the memorized speed to obtain a new value. However, when the actual vehicle speed largely differs from the memorized speed, the actual speed becomes the new memorized speed of the cruise control.
Acceleration control function (1) (ACCELERATING function)	When the RESUME/ACCEL switch is pressed for a prolonged time while the vehicle is governed by the cruise control, the memorized speed of the cruise control is changed to the vehicle speed value reached at the moment the switch is released after accelerating. However, when the vehicle speed is higher than the upper limit of the speed setting range, the upper limit becomes the memorized speed of the cruise control.
Acceleration control function (2) (TAP UP function)	When the RESUMU/ACCEL switch is pressed for a short time while the vehicle is governed by the cruise control, the cruise control adds a certain amount to the memorized speed to obtain a new value.However, when the actual vehicle speed largely differs from the memorized speed, the cruise control maintains the former memorized speed.
Cruise control cancel function	When any of the following conditions is met, the cruise control is cancelled. (1) Stop light switch ON (brake pedal depressed) (2) Brake switch OFF (brake pedal depressed) (3) Clutch switch ON (clutch pedal depressed) (4) Neutral switch ON (shift lever moved to neutral) (5) CANCEL switch ON (command switch pulled) (6) Ignition switch OFF (7) MAIN switch OFF (8) Transmission gear in 1st or reverse (9) Actual vehicle speed drops below 32 km/h (20 MPH) (10) Abnormality in the system is detected

MEMO

D: SCHEMATIC



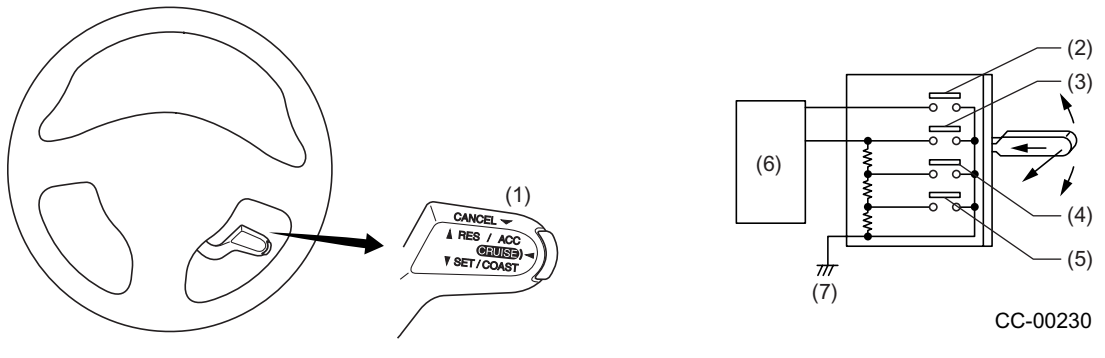
CC-00272

(1) Battery
(2) Ignition switch
(3) Cruise indicator light
(4) Cruise set indicator light
(5) Main relay
(6) Starter
(7) Stop light and brake switch
(8) Brake pedal
(9) Combination meter microprocessor
(10) Body integrated unit
(11) Low speed CAN communication
(12) High speed CAN communication
(13) Electronic control throttle
(14) Vehicle speed signal
(15) ABS control module/vehicle dynamic control (VDC) control module
(16) Engine control module (ECM)
(17) MAIN switch signal
(18) RESUME/ACCEL switch signal
CANCEL switch signal
SET/COAST switch signal
(19) Cruise control command switch
(20) Ground
(21) AT control module (5AT)
(22) Neutral signal
(23) Inhibitor switch (4AT)
(24) Neutral position switch (MT)
(25) Clutch switch (MT)
(26) Clutch pedal (MT)

E: COMMAND SWITCH (CRUISE CONTROL LEVER)

● When the vehicle is driven with the cruise control activated, the command switch controls its operation. It inputs MAIN signal, SET/COAST signal, RESUME/ ACCEL signal or CANCEL signal to the engine control module (ECM).

● When the cruise control MAIN switch is turned ON, the cruise indicator light in the combination meter illuminates. Also, when the cruise control is set, the cruise set indicator light in the combination meter illuminates.



(1) Command switch
(2) MAIN
(3) CANCEL
(4) SET/COAST
(5) RESUME/ACCEL
(6) Engine control module (ECM)
(7) Ground

● 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. MAIN SWITCH

When the switch is pushed once the cruise control system turns ON and becomes ready to set the cruise control. When the switch is pushed again the cruise control turns OFF.

2. CANCEL, RESUME/ACCEL AND SET/COAST SWITCH

Each switch contact is held closed as long as the lever is kept pressed in the relevant direction (except the CANCEL switch which should be pulled), and resulting current is applied as a signal to the engine control module (ECM).

F: CANCEL SIGNAL

A cancel signal deactivates the cruise control function. Operating any of the following switches results in generation of a cancel signal. On receiving a signal, the engine control module (ECM) cancels the cruise control function.

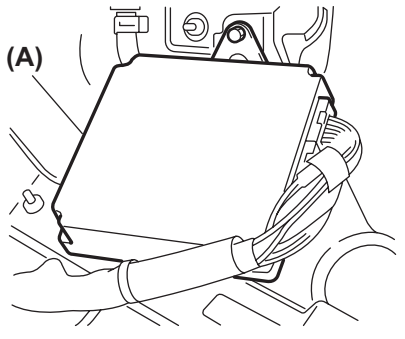
- Stop light switch
- Brake switch
- Clutch switch (MT)
- Inhibitor switch (AT)
- Neutral position switch (MT)
- MAIN switch (OFF operation)
- Command switch (CANCEL position)
- Ignition switch (OFF operation)

G: VEHICLE SPEED SIGNAL

Vehicle speed signals are sent from the ABS control module or vehicle dynamic control (VDC) control module to the engine control module (ECM), which uses the signals in controlling the cruise control function.

H: ENGINE CONTROL MODULE (ECM)

- Based on signals from the related switches and sensors, the engine control module (ECM) 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; electronic control throttle control
- The engine control module (ECM) (A) is located at the legroom of the front passenger's seat.



CC-00274

I: 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

● 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 light, clutch, neutral position and inhibitor switches) is activated. 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.

● When the ignition switch is turned ON while any of the command switches is in the ON position, the cruise control system is deactivated. 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 electric circuits. The system deactivation function is retained until the ignition switch is turned OFF.

● Abnormality of the command switch is detected.

● Abnormality of the stop light switch and brake switch is detected.

● Abnormality of the inhibitor switch is detected. (AT)

● Abnormality of the neutral position switch is detected. (MT)

● Abnormality of the ignition switch is detected.

● Change in vehicle speed signal is detected.

● Abnormality in any of the engine related sensors is detected.

● Abnormality of the brake switch input circuit in the engine control module (ECM) is detected.

● The MAIN switch and command switch were already ON when the ignition switch is turned ON.

3. CRUISE CONTROL CANCEL FUNCTION

When any of the following conditions is met, the cruise control is cancelled.

To set the cruise control again, the vehicle speed must be returned to within the speed setting range and necessary conditions must be met.

● Abnormal engine speed acceleration is detected.

● The vehicle speed has dropped below the lower control limit during cruise control driving.

● The vehicle has been running at speed higher than the set speed for an abnormally long time during cruise controlled driving.

● The set speed became impossible to be maintained for some reason (steep upgrade, hand brake operation, abnormal engine power drop, etc.).

CLUTCH

1. General

- The clutch is of a dry, single plate type with a diaphragm spring.
- The clutch is a push type clutch. When the pedal is depressed, the release bearing will press the center of the diaphragm spring to disengage the contact between the pressure plate and clutch.
- The clutch control is hydraulic and operates the release lever using the hydraulic pressure generated in the master cylinder when the pedal is depressed.
- A conventional type flywheel is used on non-turbo models, while a dual mass type flywheel is used on turbo models.
- The clutch start system enables the driver to start the engine only when the clutch pedal is fully depressed.

2. Clutch

● The clutch is a push type clutch. When the pedal is depressed, the self-aligning release bearing is caused to slide on a guide pressing the center of the diaphragm spring. The diaphragm spring is warped and the force having pressed the pressure plate is released, causing the flywheel, clutch disk and pressure plate to be disengaged from each other, and the transmission of drive force is interrupted. The action point of the clutch is located at the tip of each diaphragm spring fingers, which press the pressure plate against the clutch disc.

● A clutch using a diaphragm spring has the advantage of little variation in push load even when the clutch disc is worn. The diaphragm spring is located inside the clutch cover.

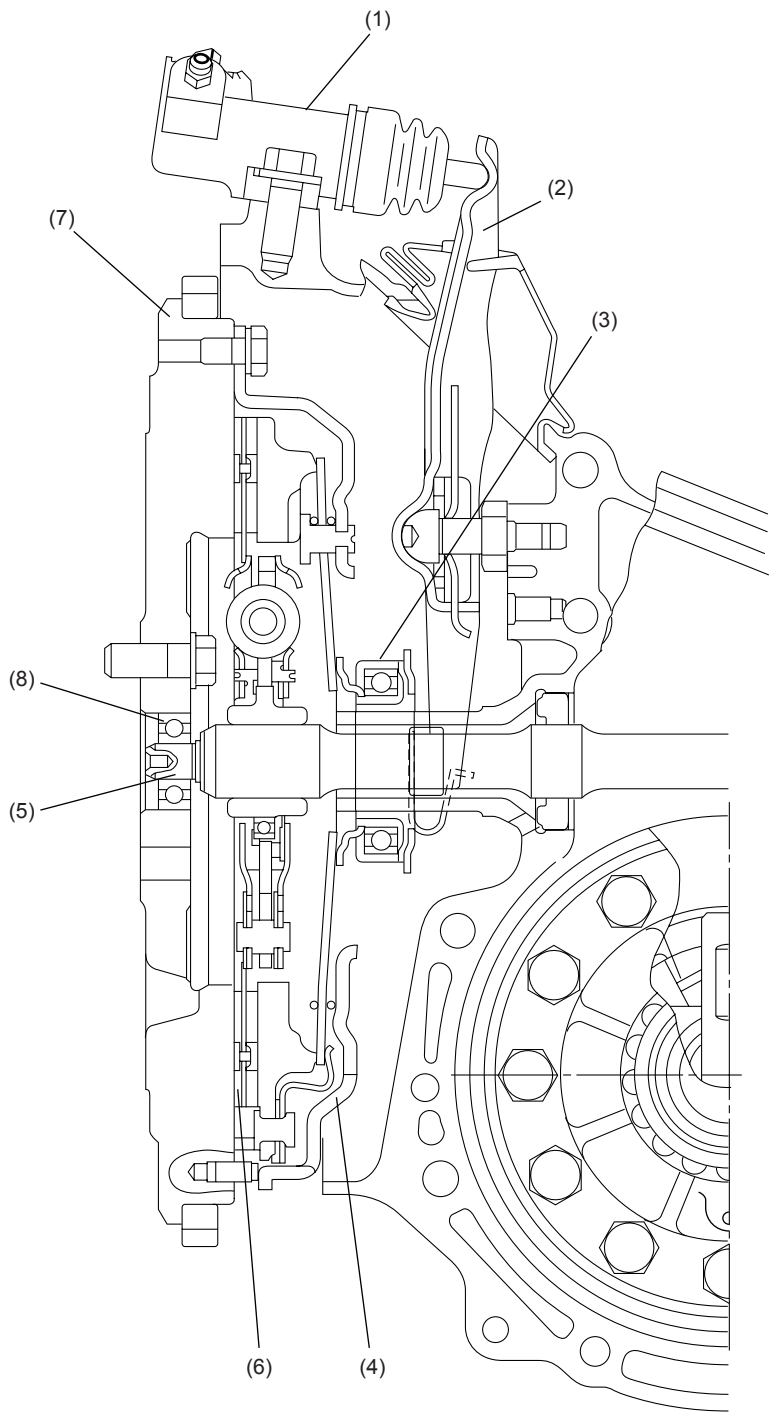
● The clutch disk for both of the non-turbo and turbo models has damper springs and is placed in between the flywheel and the pressure plate.

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

● The clutch control is hydraulic and the master cylinder is of the conventional type. The cylinder diameter of the master cylinder for turbo models are made larger. Also, on both the non-turbo and turbo models, the pedal depressing effort is optimized and a damper is attached to reduce vibration of the clutch pedal.

CLUTCH

A: NON-TURBO MODELS

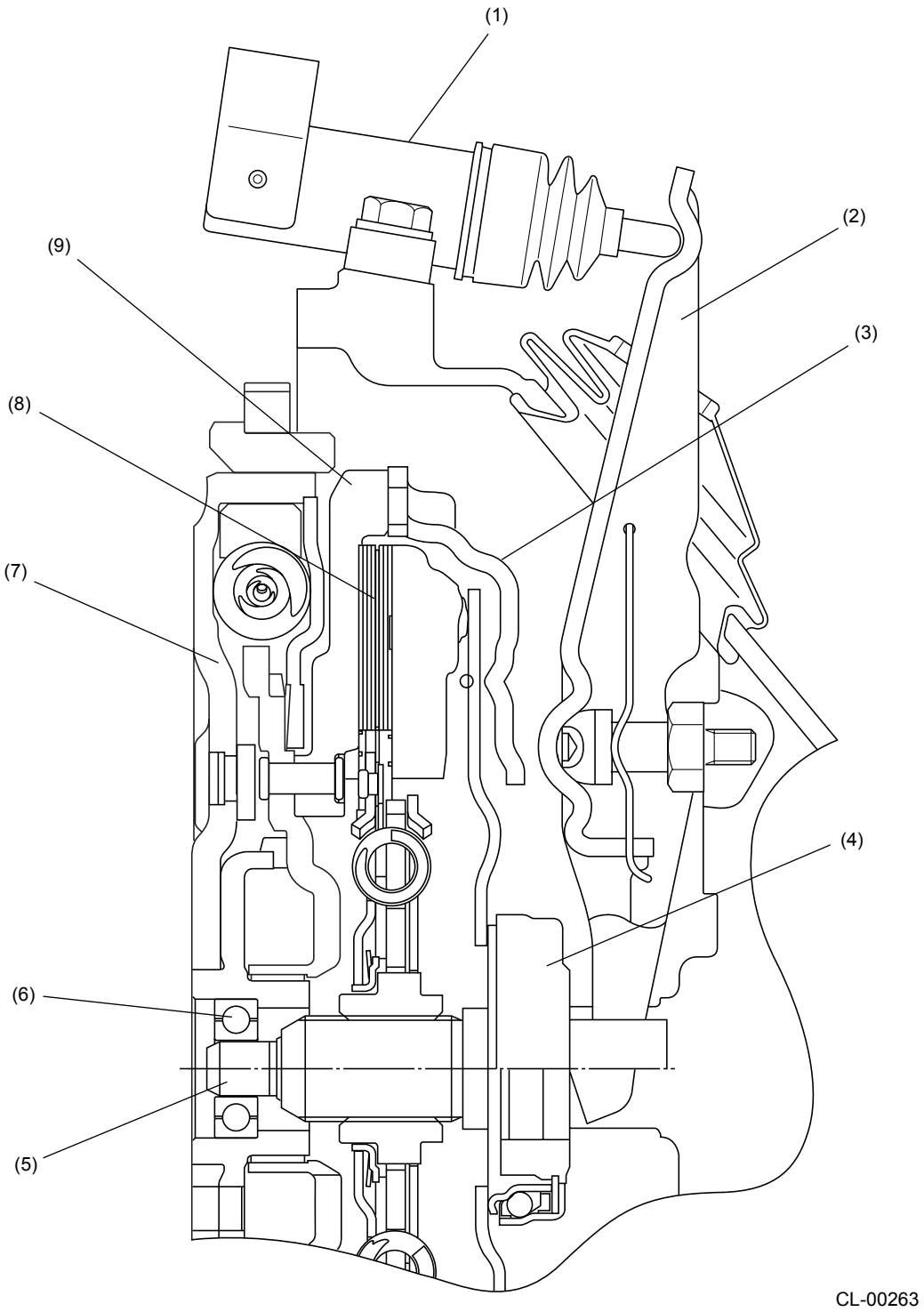


CL-00347

CLUTCH

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

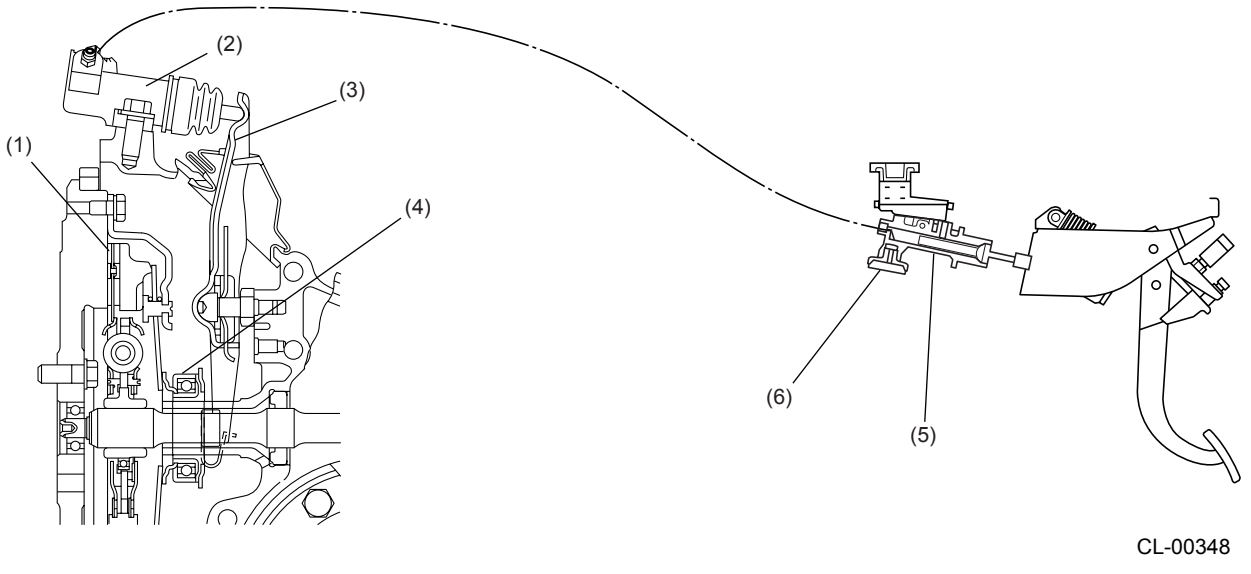
B: TURBO MODELS



(1) Operating cylinder
(2) Release lever
(3) Clutch cover
(4) Release bearing
(5) Main shaft
(6) Pilot bearing
(7) Primary flywheel
(8) Clutch disc
(9) Secondary flywheel

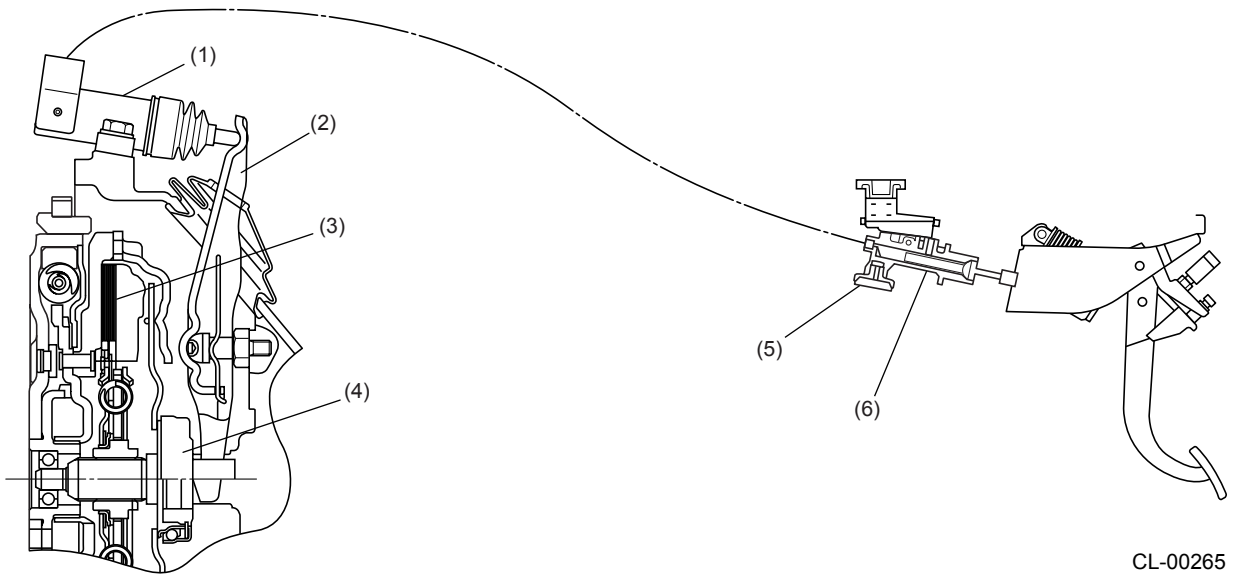
C: CLUTCH CONTROL SYSTEM

- Non-turbo models



(1) Clutch disc
(2) Operating cylinder
(3) Release lever
(4) Release bearing
(5) Clutch master cylinder
(6) Damper

- Turbo models



(1) Operating cylinder
(2) Release lever
(3) Clutch disc
(4) Release bearing
(5) Damper
(6) Clutch master cylinder

3. Flywheel

A: GENERAL

1. NON-TURBO MODELS

The flywheel is directly connected to the crankshaft. The mass of the flywheel absorbs the fluctuations in crankshaft rotation, and the flywheel transmits the engine torque to the clutch disc.

2. TURBO MODELS

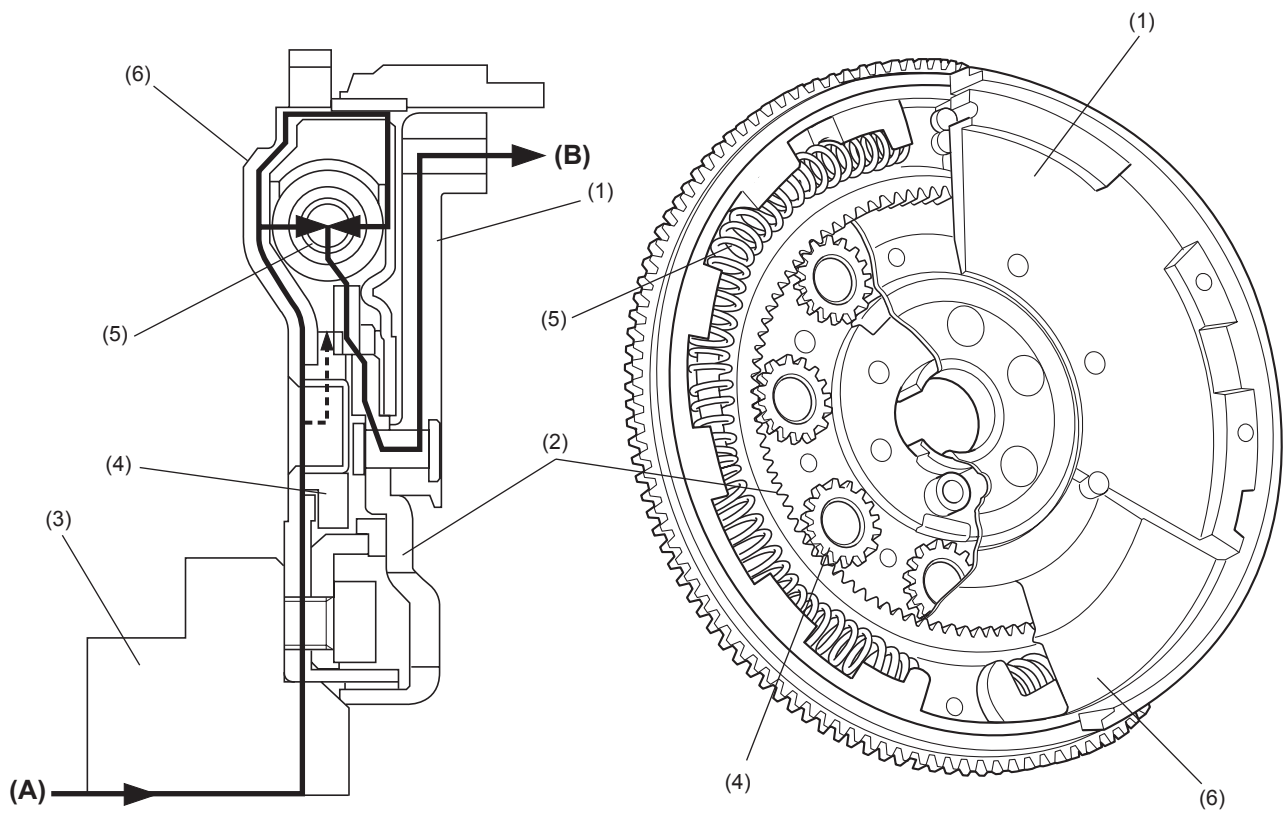
● The flywheel is of a dual mass type, which consists of a primary flywheel, damper spring, ring gear, planetary gears, and a secondary flywheel.

● The damper spring is attached to the periphery of the primary flywheel.

● The engine power flows from the primary flywheel through the damper spring, ring gear and planetary gears to the secondary flywheel, and then is transmitted to the transmission via the clutch. Torque fluctuation in this power train is dampened by lowering the rigidity of the power train using a two piece flywheel with a damper spring, ring gear and planetary gears in between, which helps reduce vibration and noise from the power unit.

B: CROSS SECTIONAL VIEW AND TORQUE FLOW

- Turbo models



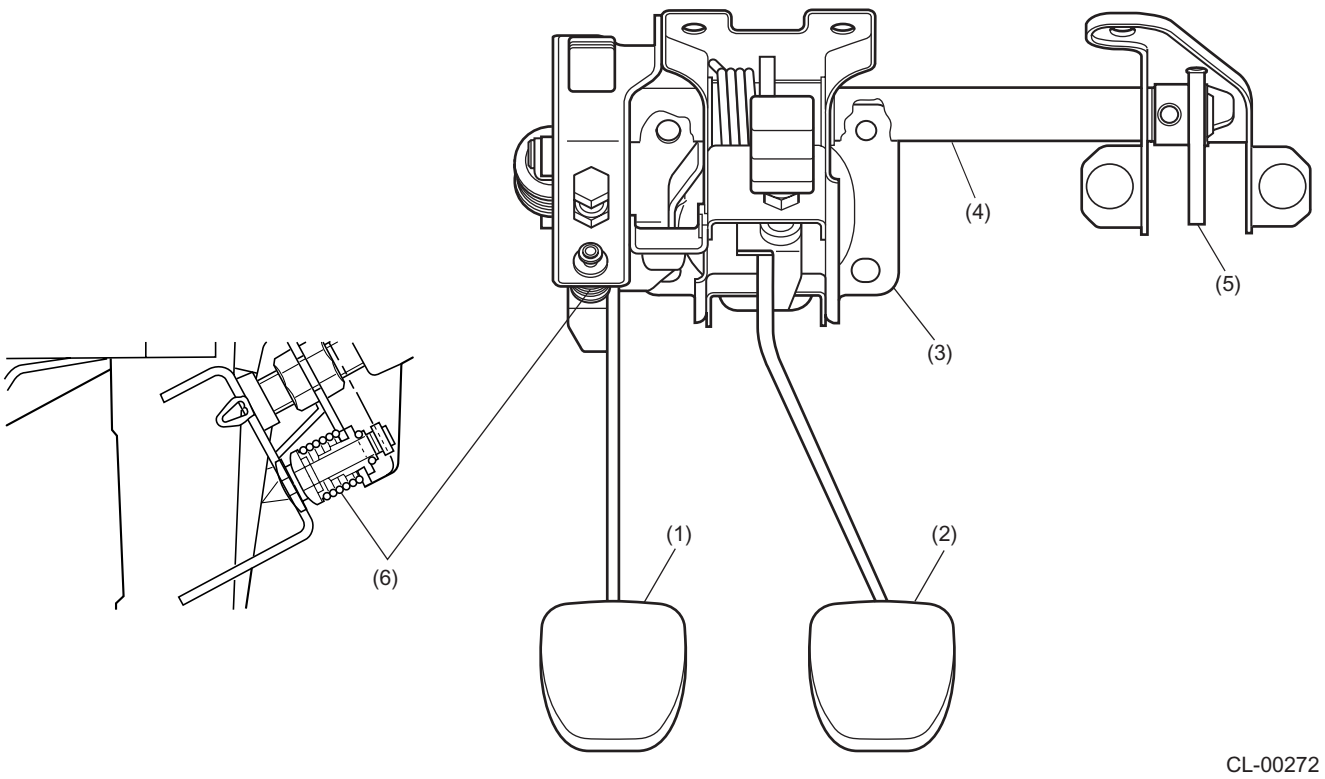
CL-00266

(1) Secondary flywheel
(2) Ring gear
(3) Crankshaft
(4) Planetary gear
(5) Damper spring
(6) Primary flywheel
(A) Input
(B) Output

4. 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.



CL-00272

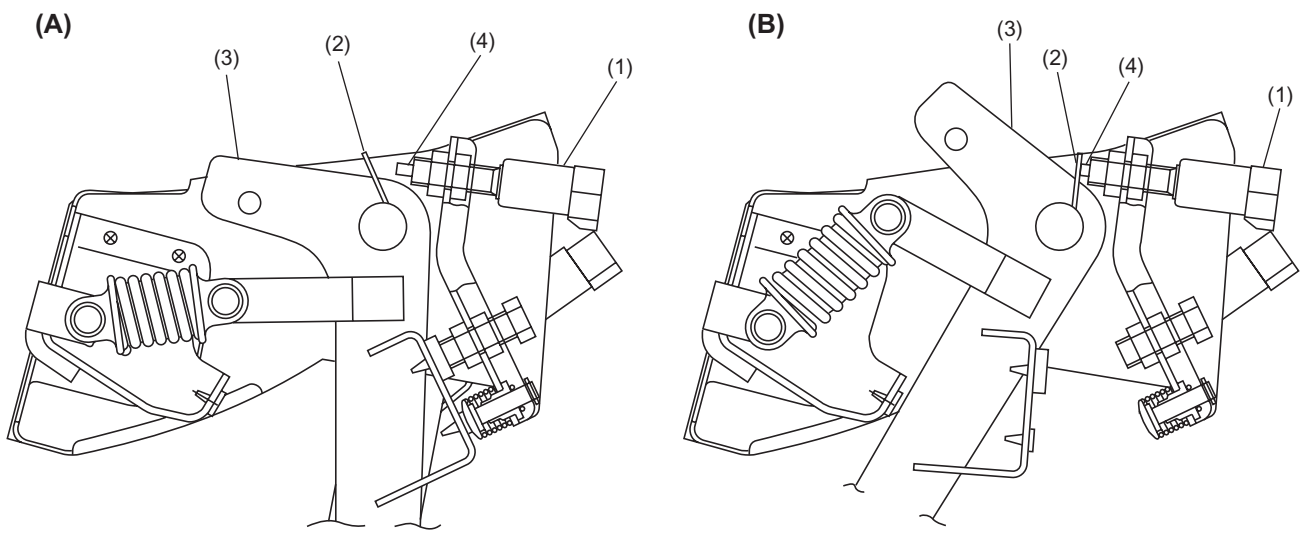
(1) Clutch pedal
(2) Brake pedal
(3) Brake and clutch pedal bracket
(4) Rod
(5) Lever
(6) Initial pedal effort reducing mechanism

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.



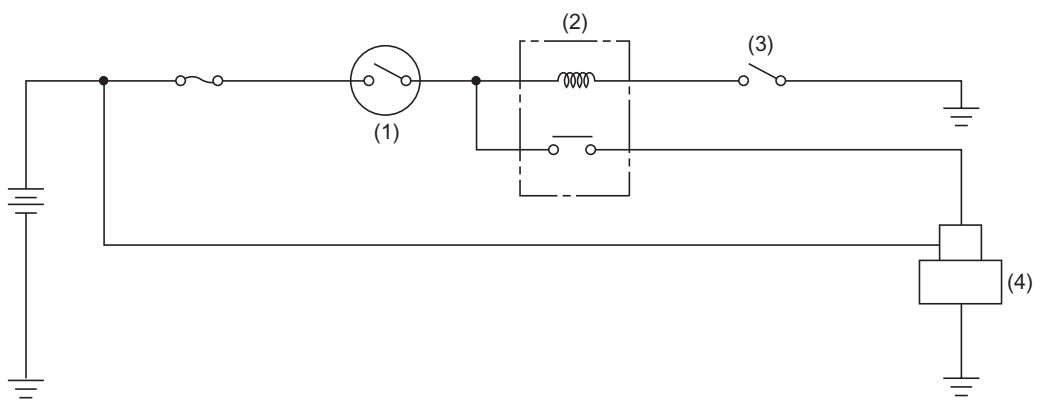
CL-00138

(A) When clutch switch is OFF
(1) Clutch switch
(2) Stopper

(B) When clutch switch is ON
(3) Clutch pedal
(4) Pushrod

HYDRAULIC CLUTCH PEDAL SYSTEM

- Schematic drawings



CL-00137

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

COOLING
(H4DOTC)

1. General

● The engine cooling system consists of a down-flow radiator which features high heat-dissipation performance, an electric-motor-driven fan, a water pump, a thermostat, and an engine coolant temperature sensor.

● The reservoir tank is made of translucent resin and enables easy confirmation of the coolant level. Also, coolant should be added to the reservoir tank when replenishment is necessary.

● The ECM controls the operation of the radiator main fan and sub fan depending on the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch.

2. Cooling Circuits

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

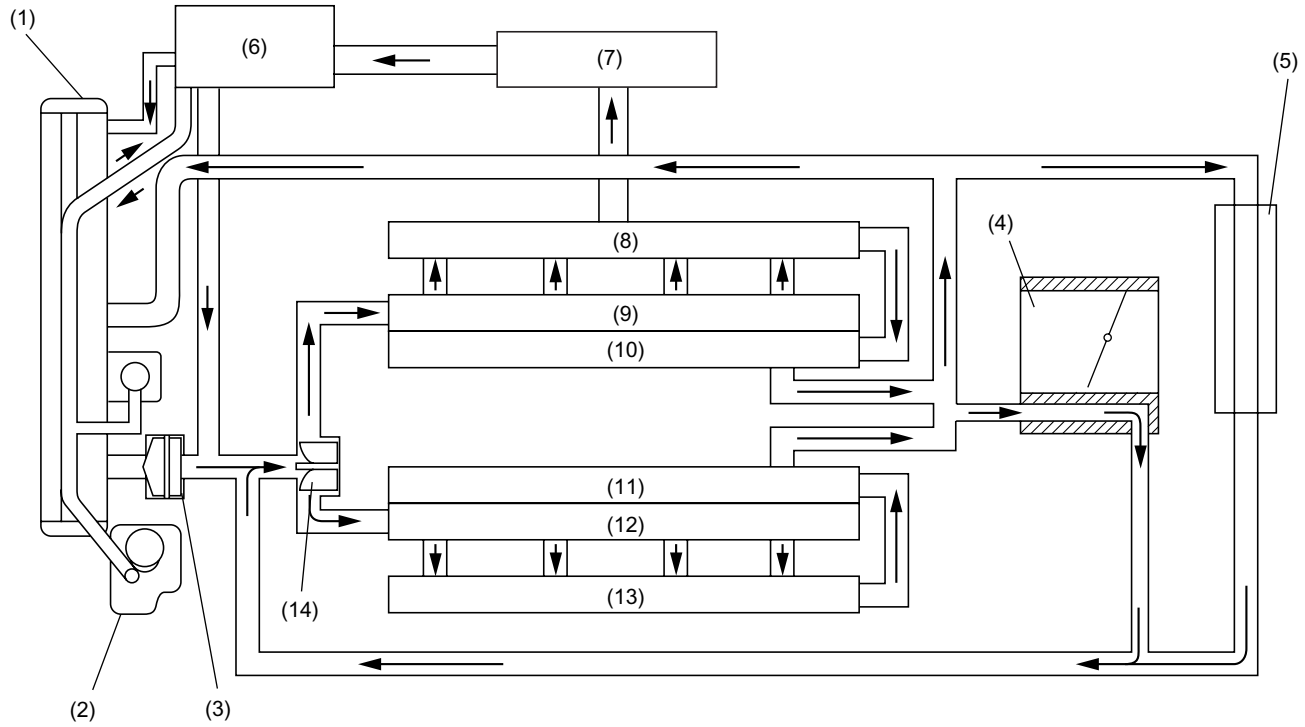
● 1st phase (thermostat closed)
When the engine coolant temperature is below the preset temperature, the thermostat remains closed. The coolant flows through the heater circuit. This permits the engine to warm up quickly.

● 2nd phase (thermostat open)
When the engine coolant temperature becomes higher than the preset temperature, 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 bocomes hotter than the preset value, the ECM receives signals from the engine coolant temperature sensor and causes the radiator fan(s) to operate. When the engine is stopped after high-speed operation, vapor produced in the turbocharger cooling section flows from the coolant filler tank to the reservoir tank where it condenses back into water. Water is then absorbed by the coolant filler tank as the engine cools down.

NOTE:
Refer to the Service Manual for preset engine coolant temperature values for each stage.

COOLING CIRCUITS

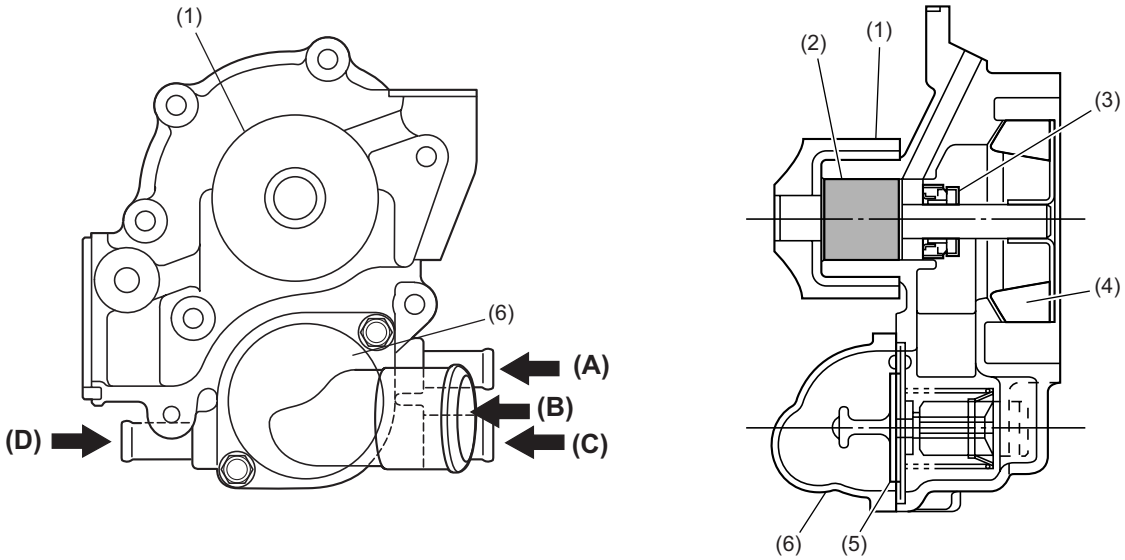


CO-02023

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

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.



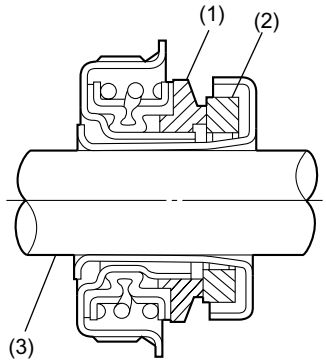
CO-02117

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

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

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.

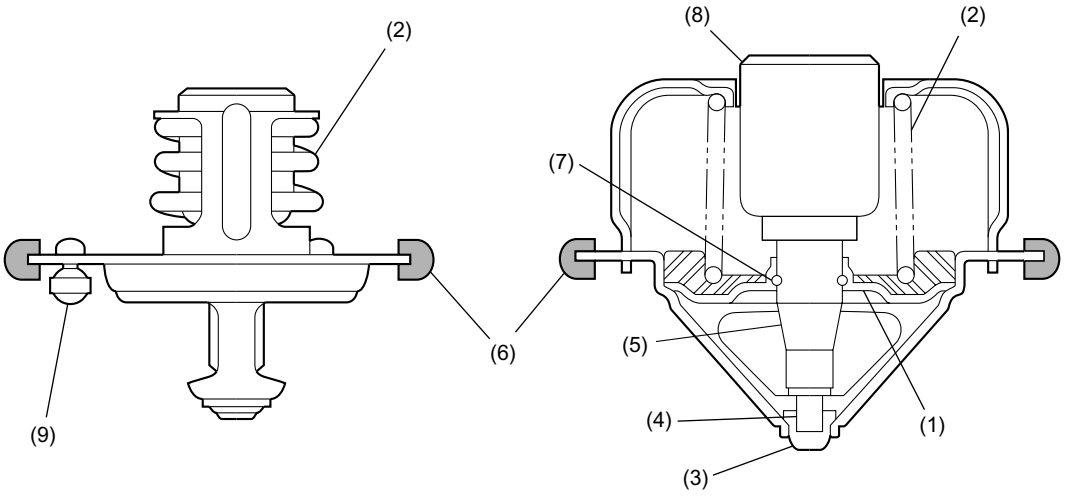


CO-00058

(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.

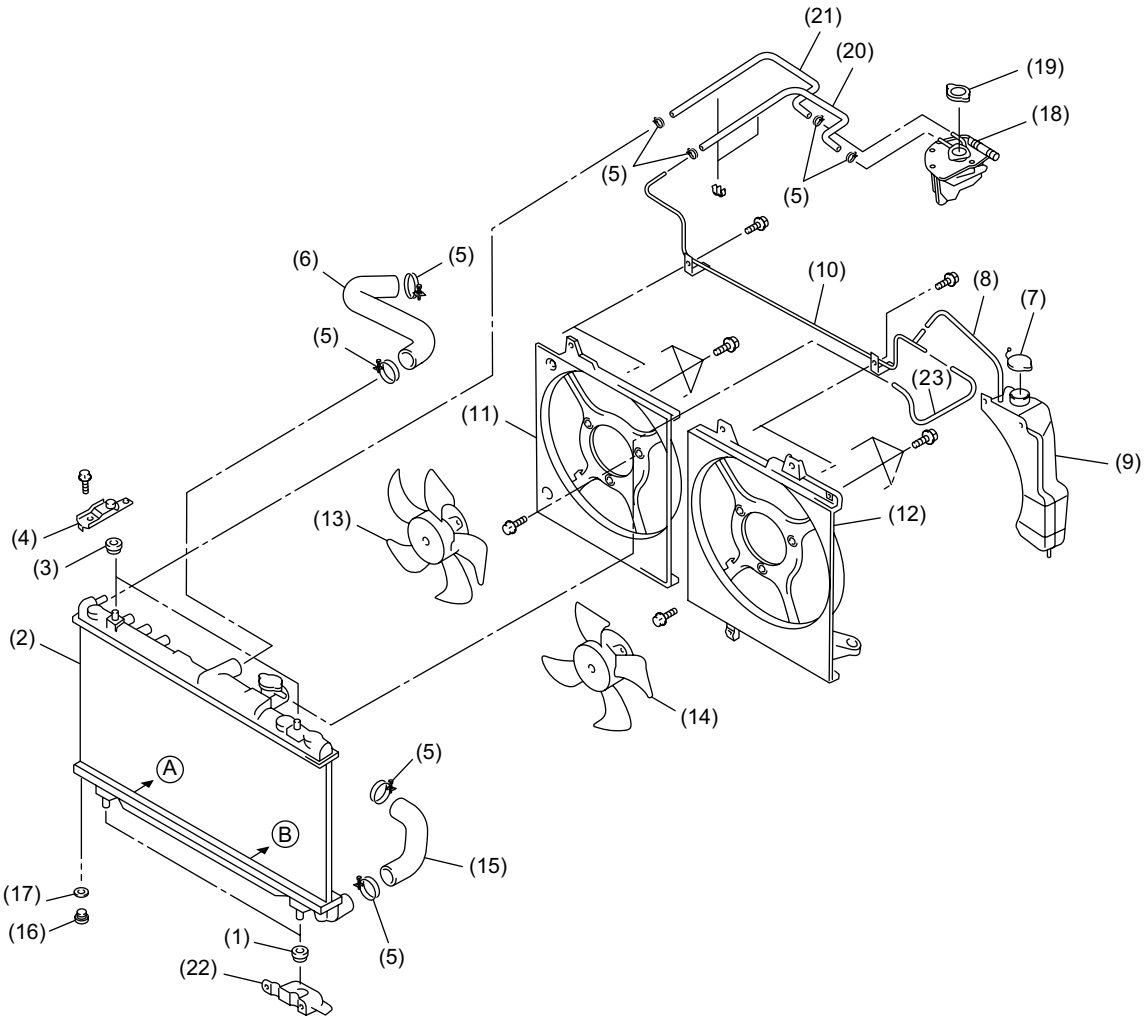


(1) Valve
(2) Spring
(3) Stopper
(4) Piston
(5) Guide
(6) Rubber packing
(7) Stop ring
(8) Wax element
(9) Jiggle valve

6. Radiator Fan

A: DESCRIPTION

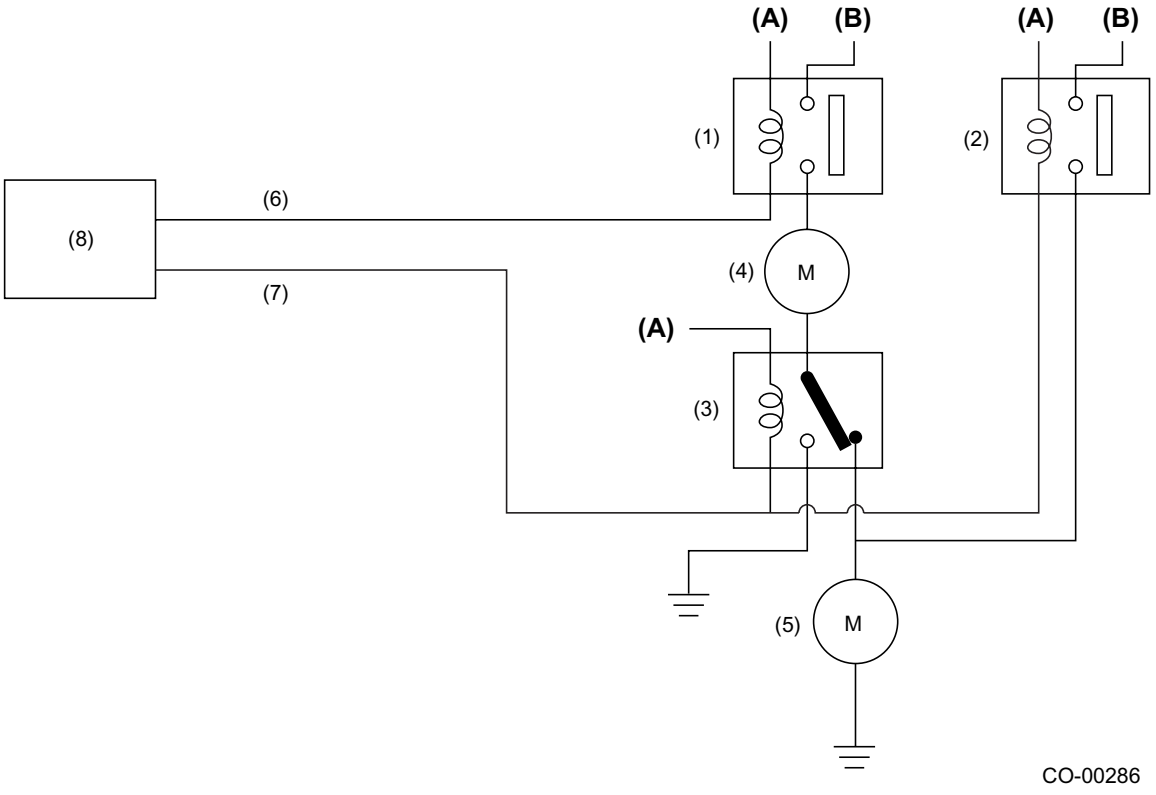
Each radiator fan is made of plastic. It is driven by an electric motor which is retained on a shroud.



CO-02118

(1) Radiator lower cushion
(2) Radiator
(3) Radiator upper cushion
(4) Radiator upper bracket
(5) Clamp
(6) Radiator hose A
(7) Engine coolant reservoir tank cap
(8) Overflow hose A
(9) Engine coolant reservoir tank
(10) Overflow pipe
(11) Radiator main fan shroud
(12) Radiator sub fan shroud
(13) Radiator main fan assembly
(14) Radiator sub fan assembly
(15) Radiator hose B
(16) Radiator drain plug
(17) O-ring
(18) Engine coolant filler tank
(19) Radiator cap (engine coolant filler tank cap)
(20) Engine overflow hose
(21) Engine air breather hose
(22) Radiator lower bracket
(23) Overflow hose B

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



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

B: FUNCTION

The ECM receives signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch, and based on these signals, the ECM controls the radiator fan speed to high or low.

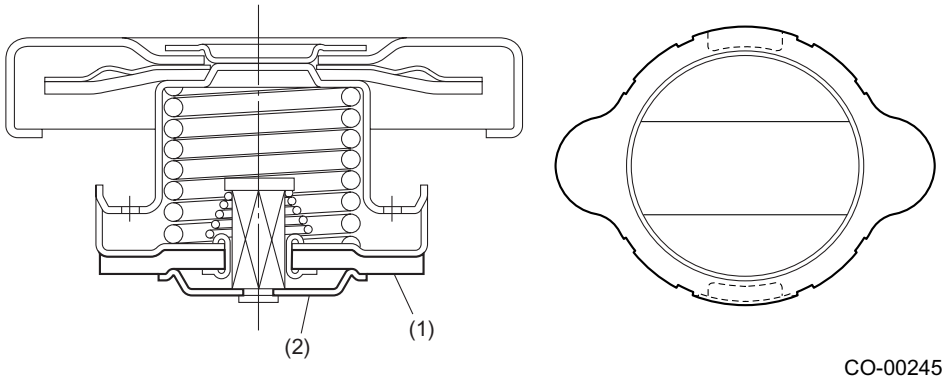
NOTE:
Refer to the Service Manual for operation of each model.

Operation example:

Vehicle speed	A/C compressor load	Engine coolant temperature		
		Rising: below 94°C (201°F) Lowering: below 91°C (196°F)	Rising: between 95 and 96°C (203 and 205°F) Lowering: between 92 and 94°C (198 and 201°F)	Rising: over 97°C (207°F) Lowering: over 95°C (203°F)
		Operation of radiator fans	Operation of radiator fans	Operation of radiator fans
When accelerating: below 19 km/h (12 MPH) When decelerating: below 10 km/h (6 MPH)	OFF	OFF	Low-speed	High-Speed
	Low	Low-Speed	Low-Speed	High-Speed
	High	High-Speed	High-Speed	High-Speed
When accelerating: between 20 and 69 km/h (12 and 43 MPH) When decelerating: between 11 and 64 km/h (7 and 40 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	High-Speed	High-Speed	High-Speed
	High	High-Speed	High-Speed	High-Speed
When accelerating: between 70 and 105 km/h (43 and 65 MPH) When decelerating: between 65 and 100 km/h (40 and 62 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	High-Speed	High-Speed	High-Speed
	High	High-Speed	High-Speed	High-Speed
When accelerating: over 106 km/h (66 MPH) When decelerating: over 101 km/h (63 MPH)	OFF	OFF	High-Speed	High-Speed
	Low	High-Speed	High-Speed	High-Speed
	High	High-Speed	High-Speed	High-Speed

7. Radiator Cap

The radiator cap at the coolant filler tank side has a pressure valve and a vacuum valve. When the radiator inner pressure becomes higher than specified, the pressure valve opens to send coolant to the reservoir tank. Also, when the radiator inner pressure becomes lower than the atmospheric pressure during the cooling down phase, the vacuum valve opens to send back coolant from the reservoir tank to the radiator. These functions prevent damage to the radiator components.



CO-00245

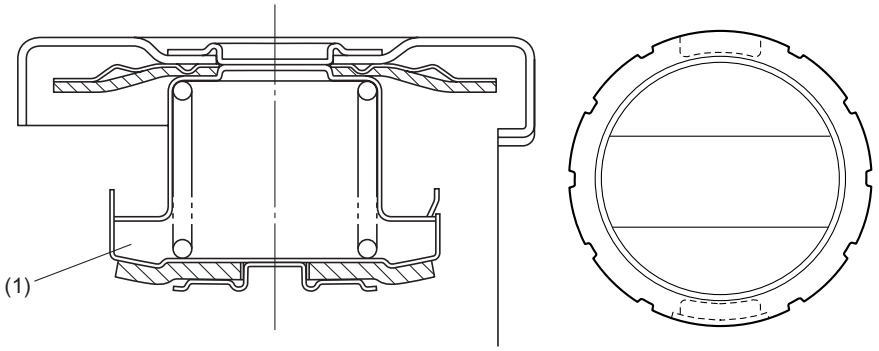
(1) Pressure valve

(2) Vacuum valve

8. Relief Valve Cap

The relief valve cap at the radiator side has a pressure valve. When the radiator inner pressure becomes higher than specified, the pressure valve opens to send coolant to the reservoir tank. This function prevents damage to the radiator components.

CAUTION:
Due to the difference in construction, the relief valve cap cannot be used in place of the radiator cap at the coolant filler tank side. If the relief valve cap is fit on the coolant filler tank, overheating may occur.



CO-00246

(1) Pressure valve

1. General

Specifications for SOHC U5 models are the same as those for SOHC models.<Ref. to CO(H4SO) section.>

COOLING
(H4SO)

1. General

● The engine cooling system consists of a down-flow radiator featuring high heat-dissipation performance, an electric-motor-driven fan, a water pump, a thermostat, and an engine coolant temperature sensor.

● The reservoir tank is made of translucent resin and enables easy confirmation of the coolant level. Also, coolant should be added to the reservoir tank when replenishment is necessary.

● The ECM controls the operation of the radiator main fan and sub fan depending on the signals from the engine coolant temperature sensor, vehicle speed sensor and A/C switch.

2. Cooling Circuits

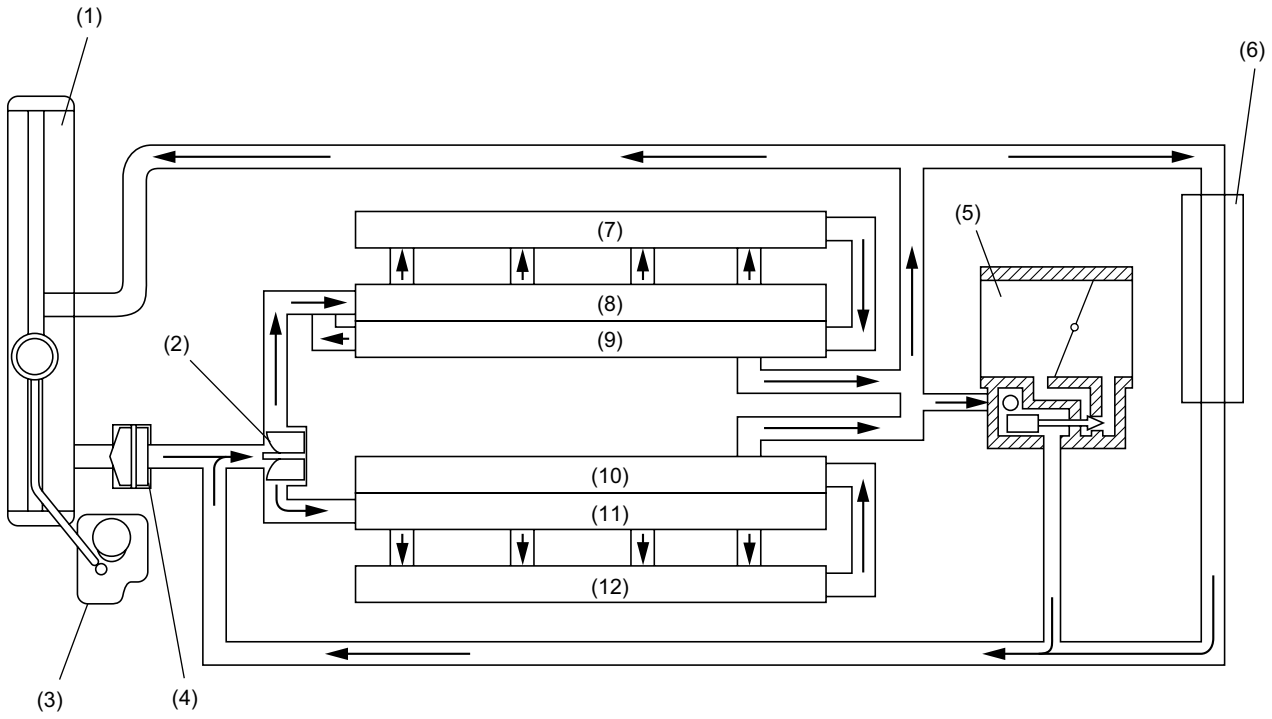
The cooling system operates in three different phases depending on the temperature of the engine coolant.

● 1st phase (thermostat closed)
When the engine coolant temperature is lower than the preset value, the thermostat remains closed. The coolant flows through the heater circuit. This permits the engine to warm up quickly.

● 2nd phase (thermostat open)
When the engine coolant temperature reaches the preset value, 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 becomes higher than the preset value, the ECM receives a signal from the engine coolant temperature sensor and causes the radiator fan(s) to operate.

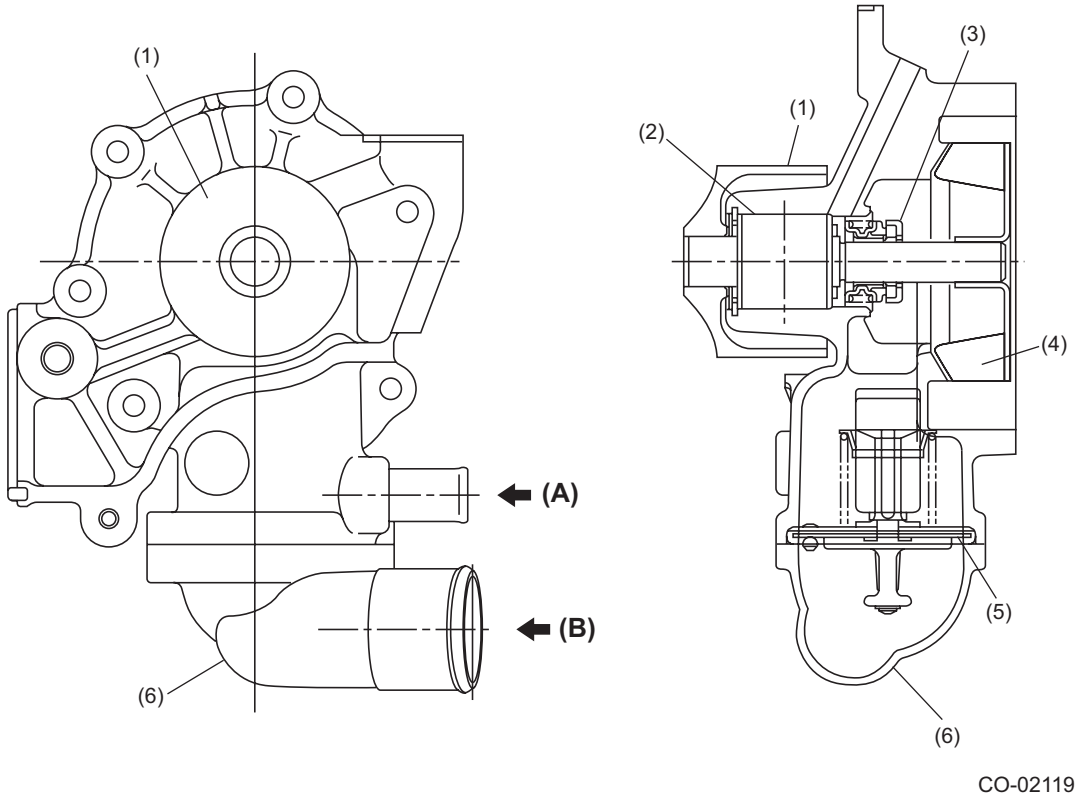
NOTE:
Refer to the Service Manual for preset engine coolant temperature values for each stage.



CO-02110

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

3. Water Pump

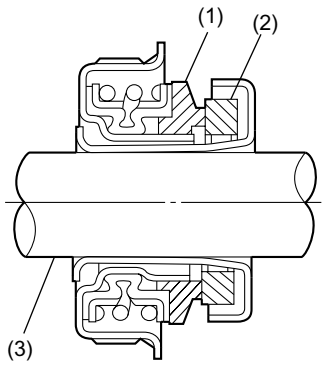


(A) From heater circuit
(B) From radiator

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

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.

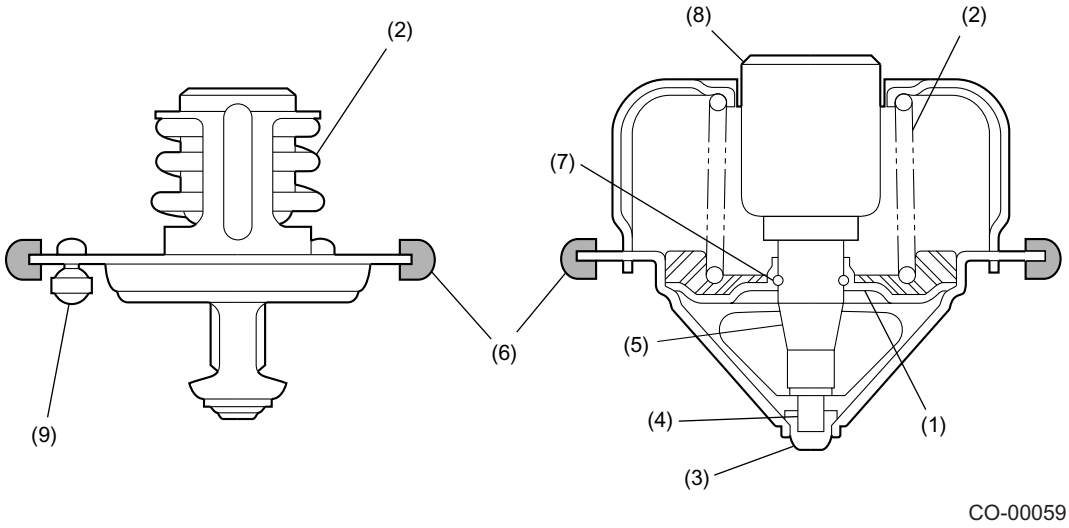


CO-00058

(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.

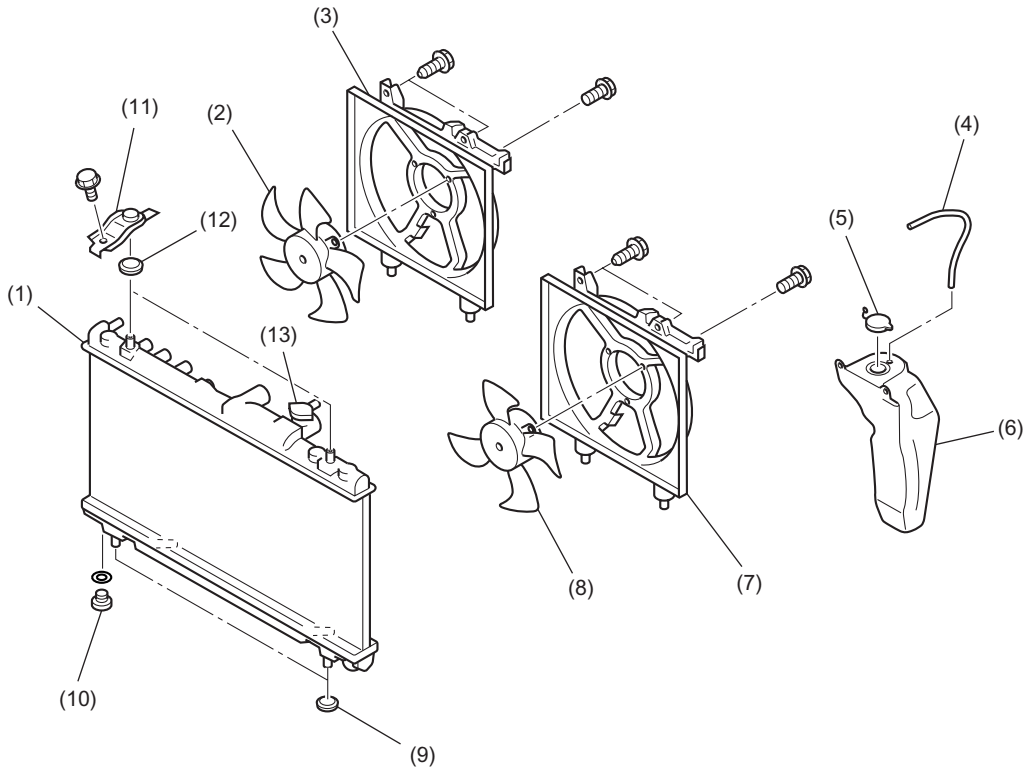


(1) Valve
(2) Spring
(3) Stopper
(4) Piston
(5) Guide
(6) Rubber packing
(7) Stop ring
(8) Wax element
(9) Jiggle valve

6. Radiator Fan

A: DESCRIPTION

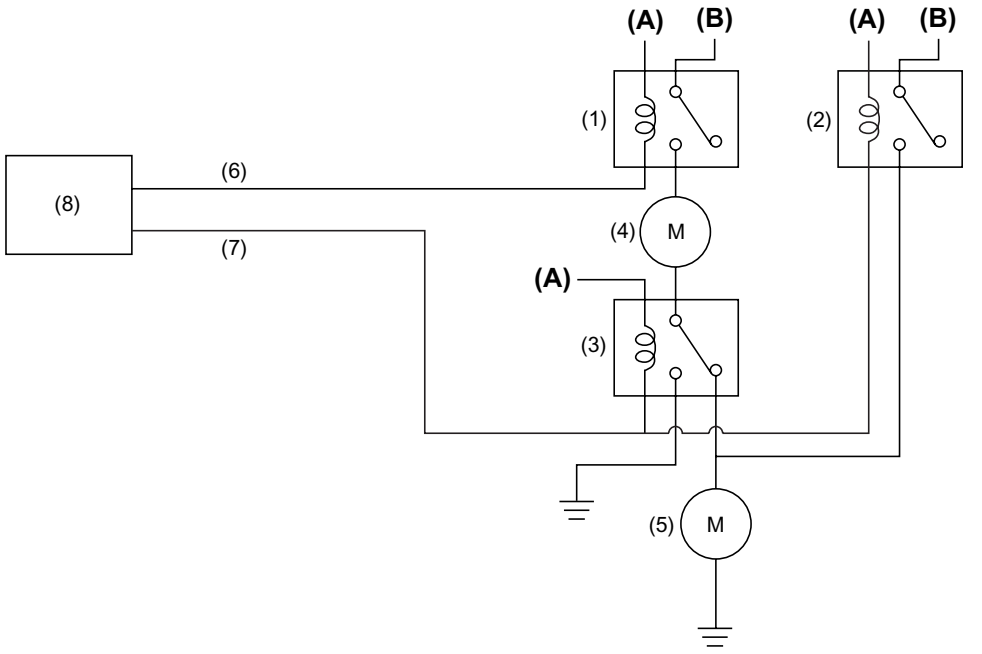
Each radiator fan is made of plastic. It is driven by an electric motor, which is retained on a shroud.



CO-00282

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

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



CO-00060

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

B: FUNCTION

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

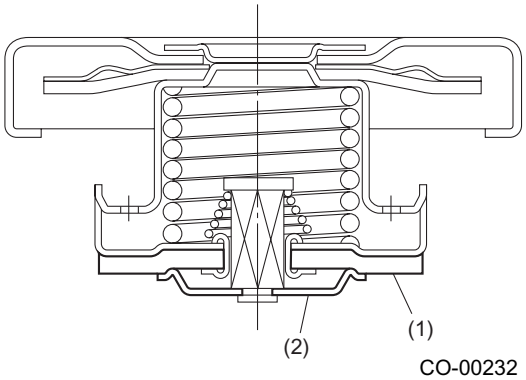
NOTE:
Refer to the Service Manual for operation of each model.

Operation examples:

Vehicle speed	A/C compressor load	Engine coolant temperature		
		Rising: below 95°C (203°F) Lowering: below 92°C (198°F)	Rising: between 96 and 99°C (205 and 210°F) Lowering: between 93 and 94°C (199 and 201°F)	Rising: over 100°C (212°F) Lowering: over 95°C (203°F)
		Operation of radiator fans	Operation of radiator fans	Operation of radiator fans
When accelerating: below 19 km/h (12 MPH) When decelerating: below 10 km/h (6 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	Low-Speed	Low-Speed	High-Speed
	High	High-Speed	High-Speed	High-Speed
When accelerating: between 20 and 69 km/h (12 and 43 MPH) When decelerating: between 11 and 64 km/h (7 and 40 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	High-Speed	High-Speed	High-Speed
	High	High-Speed	High-Speed	High-Speed
When accelerating: between 70 and 105 km/h (43 and 65 MPH) When decelerating: between 65 and 103 km/h (40 and 64 MPH)	OFF	OFF	Low-Speed	High-Speed
	Low	OFF	Low-Speed	High-Speed
	High	Low-Speed	High-Speed	High-Speed
When accelerating: over 106 km/h (66 MPH) When decelerating: over 104 km/h (64.6 MPH)	OFF	OFF	OFF	High-Speed
	Low	OFF	Low-Speed	High-Speed
	High	OFF	Low-Speed	High-Speed

7. Radiator Cap

The radiator cap has a pressure valve and a vacuum valve. When the radiator inner pressure becomes higher than specified, the pressure valve opens to send coolant to the reservoir tank. Also, when the radiator inner pressure becomes lower than the atmospheric pressure during the cooling down phase, the vacuum valve opens to send back coolant from the reservoir tank to the radiator. These functions prevent damage to the radiator components.

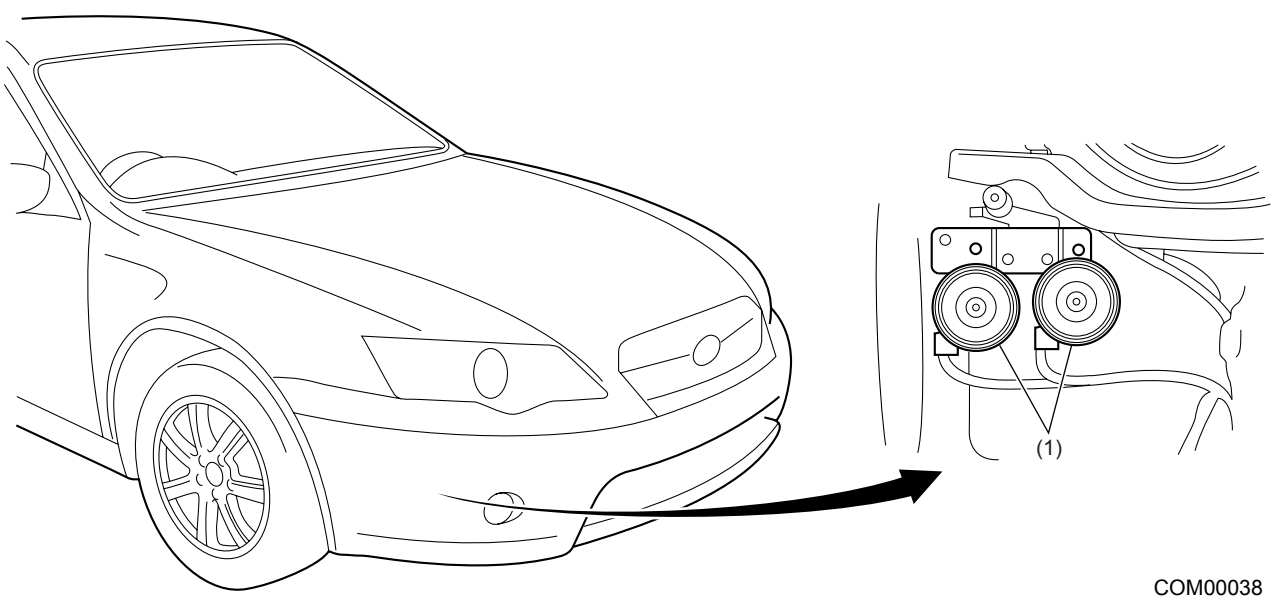


(1) Pressure valve
(2) Vacuum valve

COMMUNICATION SYSTEM

1. Horns

A: GENERAL



(1) Horns

- Two horns (high and low tone) are installed behind the front bumper under the RH headlight.
- By positioning the horns at behind the front bumper and under the RH headlight, repair cost for damage due to light collision can be minimized.

CONTROL SYSTEM
(AUTOMATIC)

1. Select Lever

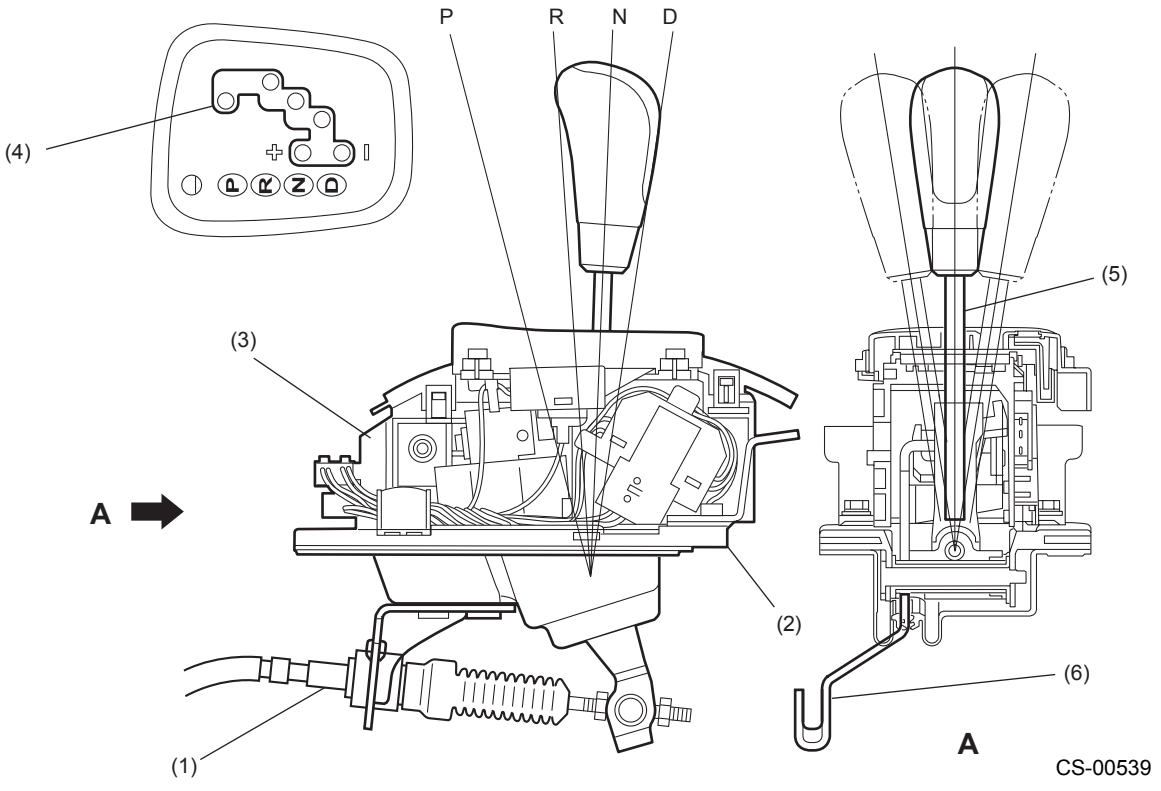
● The automatic transmission select lever can be moved to any of the 4 ranges and the transmission enters sports mode when the lever is moved laterally from D range, and further switches to sports shift mode (manual mode) when the lever is moved forward (“+” direction) or rearward (“–” direction).

● 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.

● 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).

● To transmit movements of the select lever to the transmission, a select cable is used.

● The select lever mechanism has a detent spring. It ensures more precise positioning of the select lever.

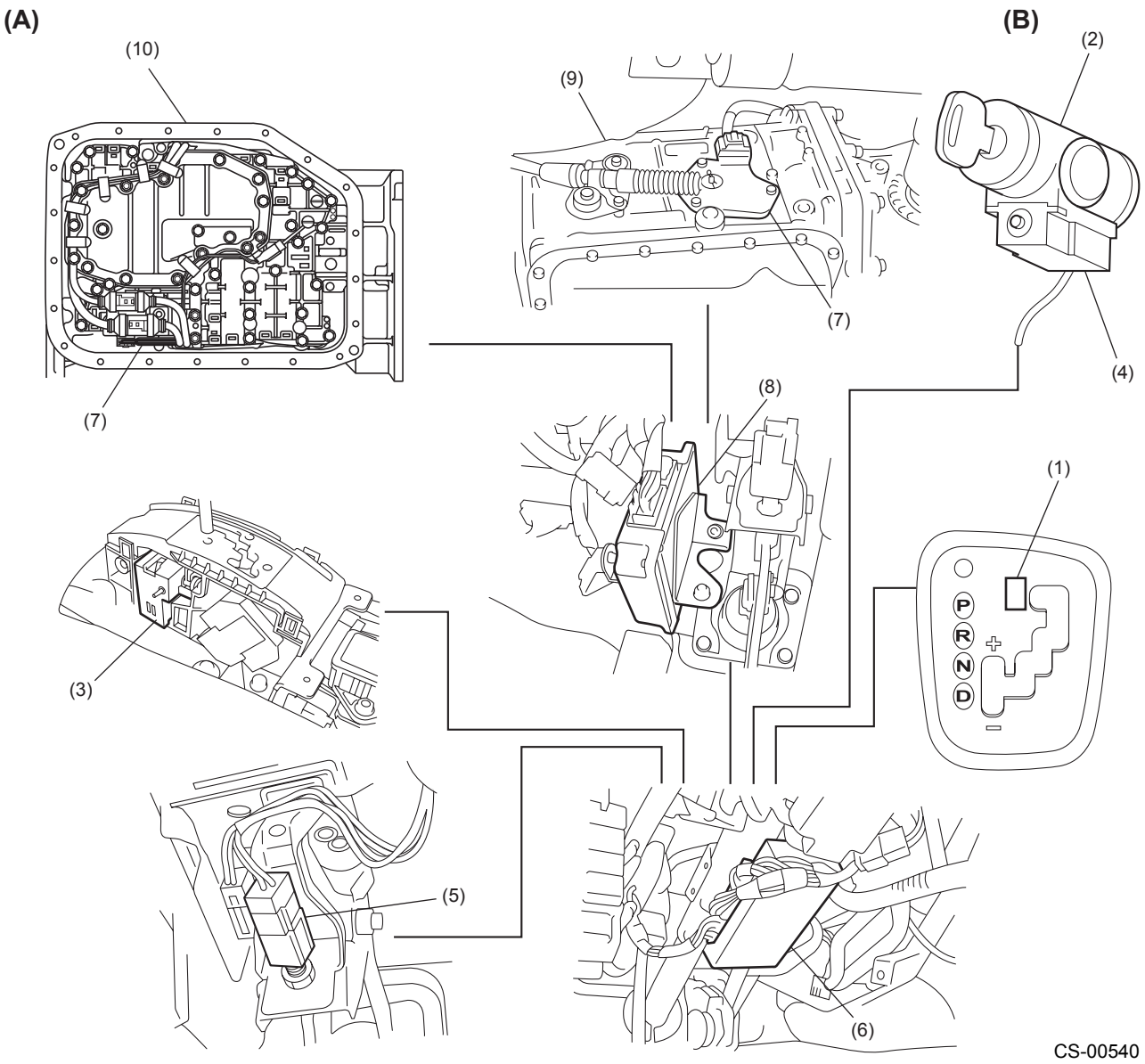


(1) Select cable
(2) Base plate, lower
(3) Base plate, upper
(4) Gate
(5) Select lever
(6) Arm
(A) View A

2. 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.



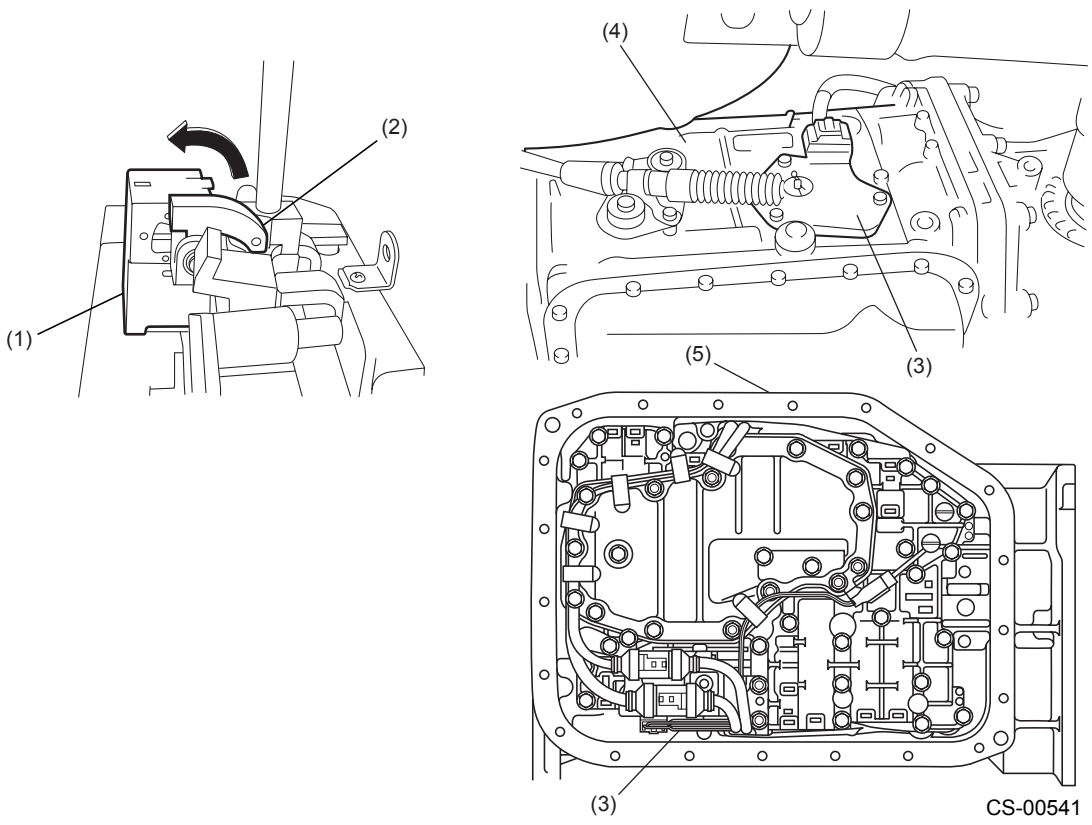
CS-00540

(A) Shift lock system
(1) “P” position switch
(2) Key cylinder
(3) Shift lock solenoid
(4) Key lock solenoid
(5) Brake pedal switch

(B) Key interlock system
(6) Body integrated unit
(7) Inhibitor switch
(8) TCM
(9) 4AT
(10) 5AT

B: SHIFT LOCK SYSTEM OPERATION

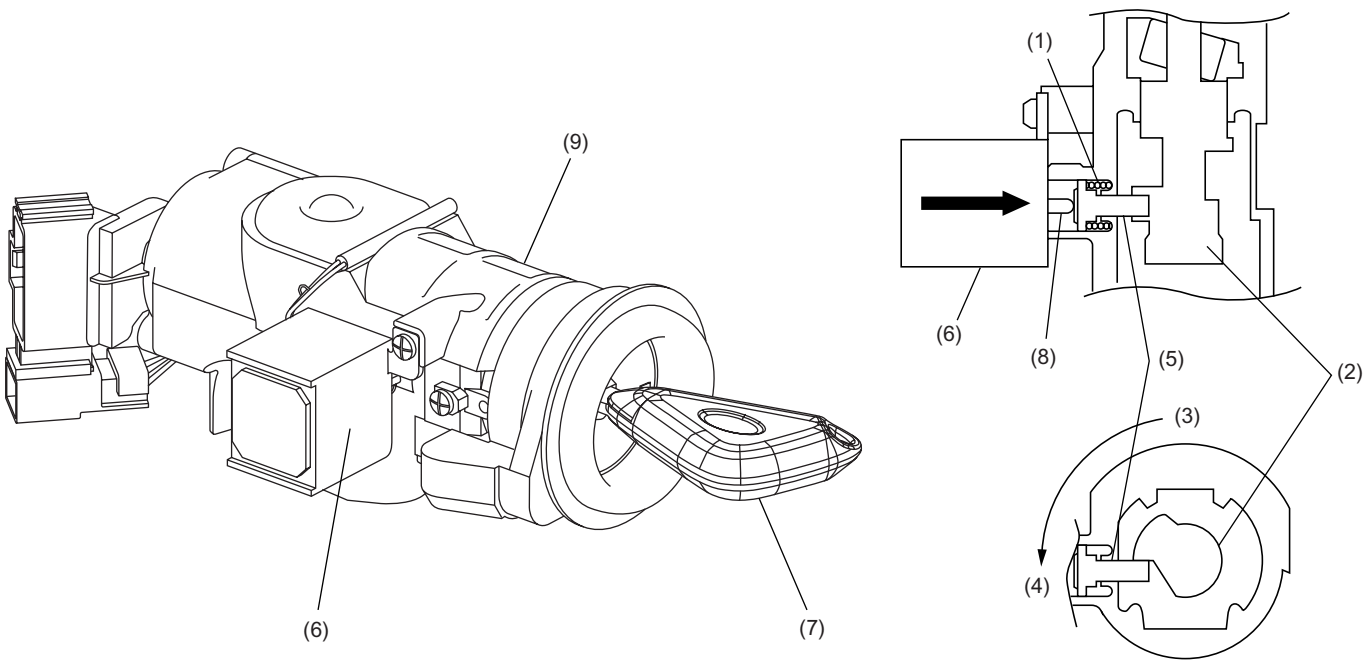
The shift lock system has a solenoid-operated plunger (1). With the select lever in the P position, the plunger remains extended, holding the lock arm (2) in its pushed out (locking) position. When the brake pedal is depressed with the ignition switch in either the ON or START position, the solenoid is energized and the plunger is retracted. This causes the lock arm to lift 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) Lock arm
(3) Inhibitor switch
(4) 4AT
(5) 5AT

C: KEY INTERLOCK FUNCTION

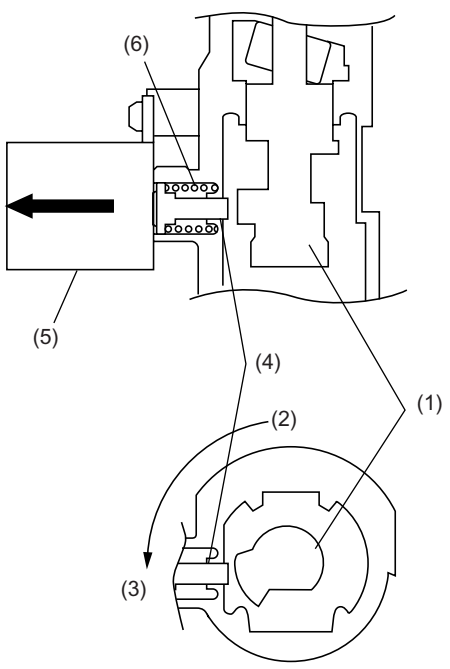
● When the select lever is at any position other than P, the solenoid is energized and its guide pin extends to hold the lock pin in its pushed out position. Held in its extended position, the lock pin interferes with the stopper portion of the rotator which turns together with the ignition key. Thus, the ignition key cannot be rotated to the “LOCK” position.



CS-00360

(1) Return spring
(2) Rotator
(3) START position
(4) LOCK position
(5) Lock pin
(6) Solenoid
(7) Key
(8) Guide pin
(9) Key cylinder

● When the select lever is moved to “P”, the “P” position switch in the select lever assembly operates, deenergizing the solenoid. As the push force of the guide pin is removed, the return spring moves the lock pin toward the solenoid and the lock pin becomes clear of the rotator stopper. Then the key can be rotated to the LOCK position and removed from the ignition switch.



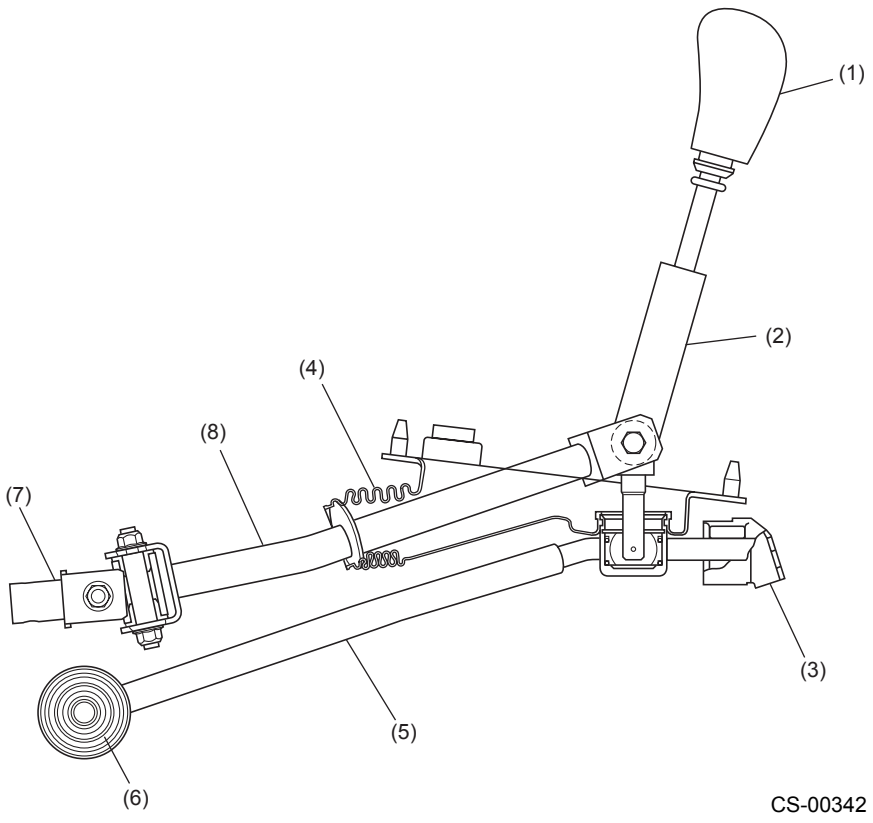
CS-00361

(1) Rotator
(2) START position
(3) LOCK position
(4) Lock pin
(5) Solenoid
(6) Return spring

CONTROL SYSTEM
(MANUAL)

1. 5MT Gear Shift Lever

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



CS-00342

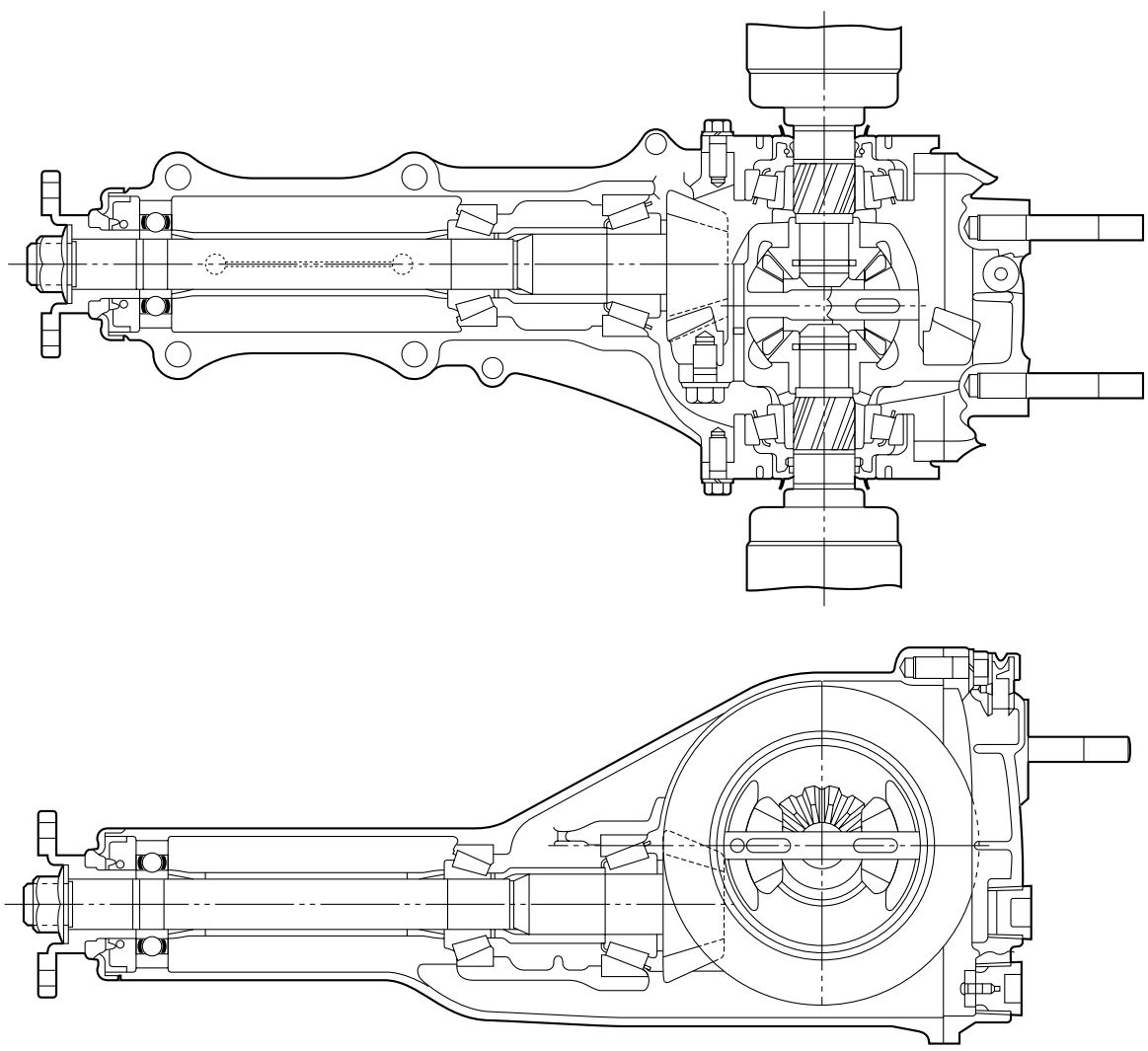
(1) Knob
(2) Lever
(3) Cushion rubber
(4) Boot
(5) Stay
(6) Bushing B
(7) Joint
(8) Rod

DIFFERENTIALS

1. Rear Differential

A: T-TYPE

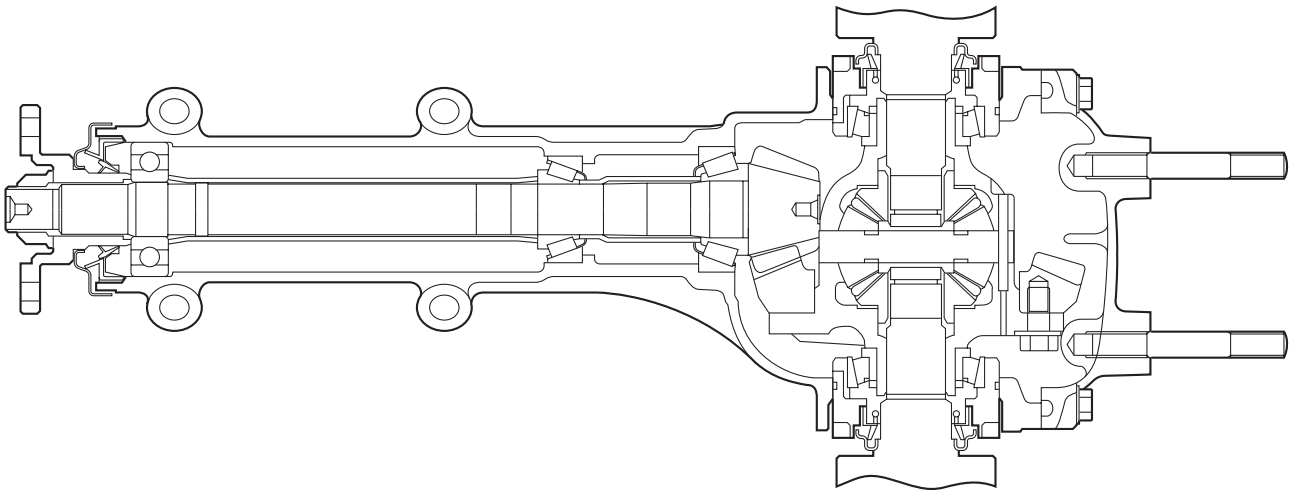
The drive gear is a hypoid gear with nominal diameter of 160 mm (6.30 in). The drive pinion shaft is supported by three bearings. The bearing preload is adjusted by selecting a spacer and washer combination of a proper thickness. The drive pinion height is adjusted by properly selecting the thickness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



DI-00231

B: VA 1 TYPE

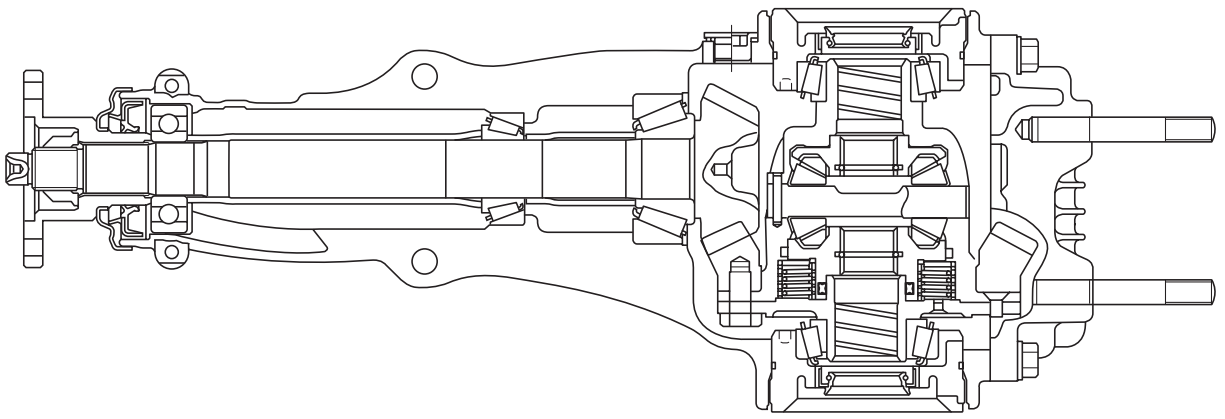
The drive gear is a hypoid gear with nominal diameter of 152 mm (5.98 in). The drive pinion shaft is supported by three bearings. The bearing preload is adjusted by selecting a spacer and washer combination of a proper thickness. The drive pinion height is adjusted by properly selecting the thickness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

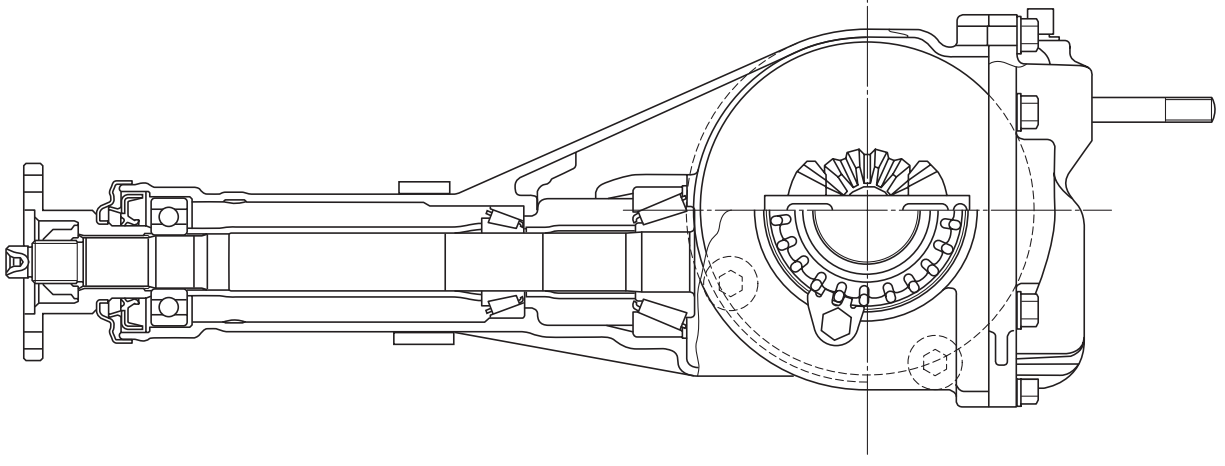


DI-00305

C: VA 2 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 a dummy shaft and gauge. The hypoid gear has uniform height teeth.





DI-00388

2. Limited Slip Differential (LSD) (Viscous Coupling Type)

A: GENERAL

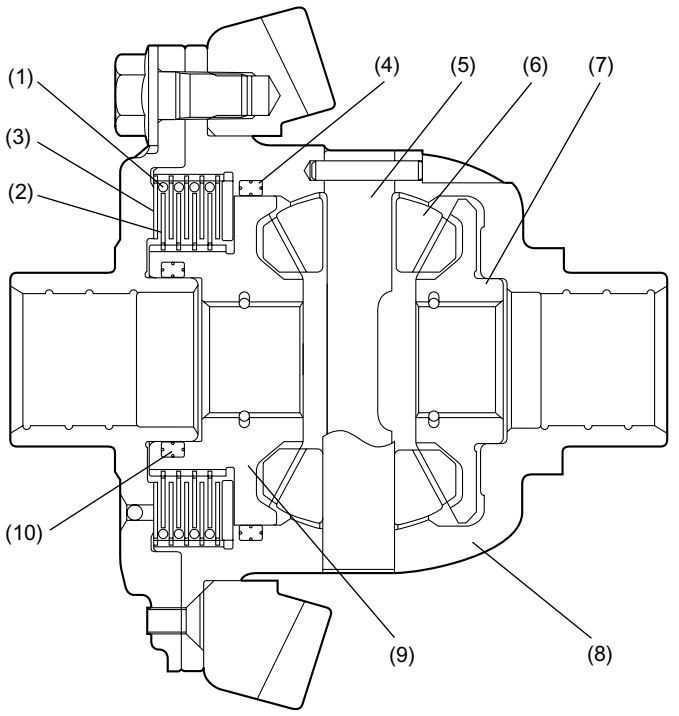
The limited slip differential (LSD) automatically limits the differential action and distributes torque to the left and right wheels adequately to enhance driving stability when the left and right wheels are rotating at speeds different from each other during driving on a slippery road (muddy, snow-covered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

B: CONSTRUCTION

The V/C (viscous coupling) 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.



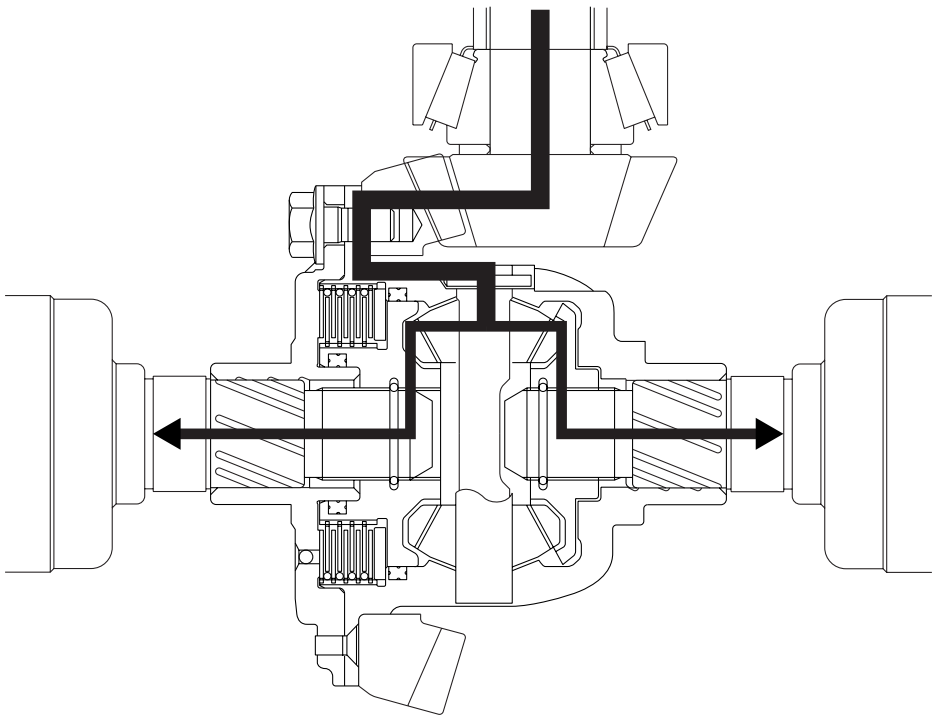
DI-00295

(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

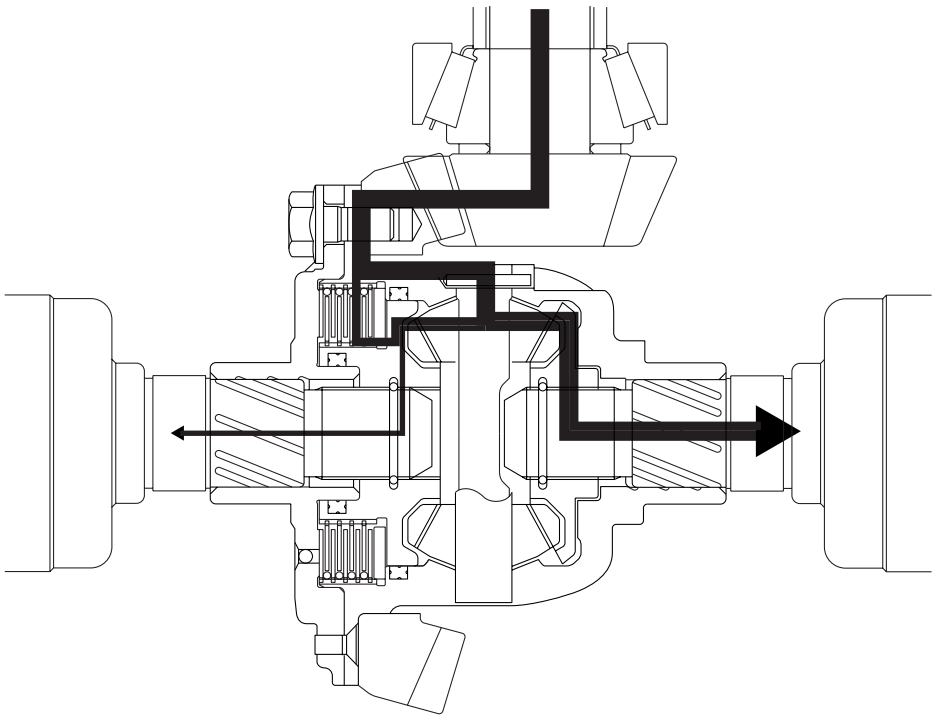
2. WHEN RIGHT AND LEFT WHEELS ROTATE AT DIFFERENT SPEEDS

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 shear 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.

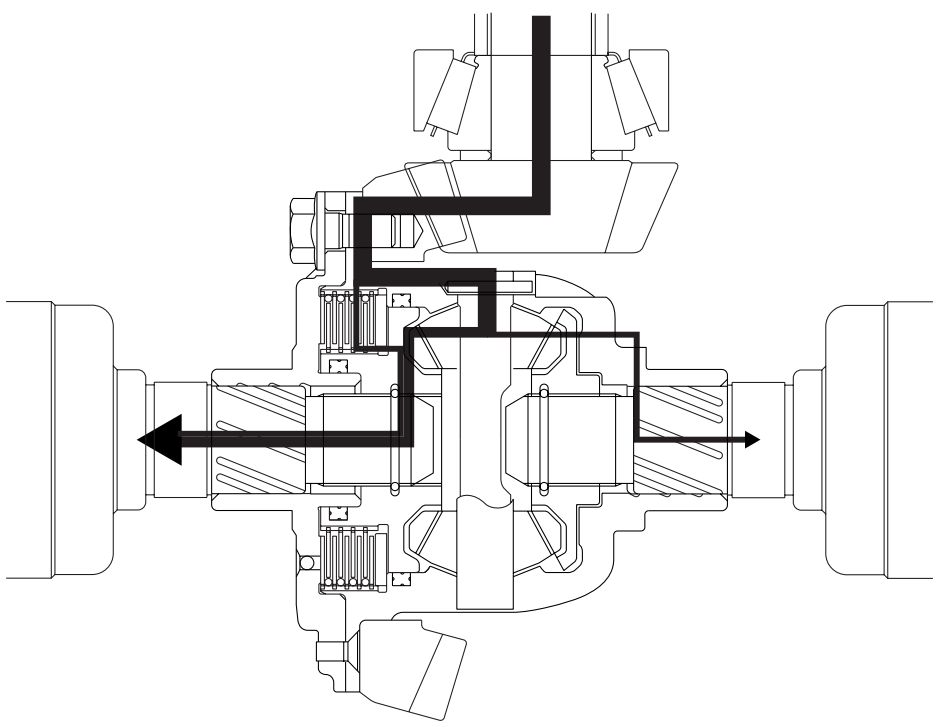
When the right wheel spins, the differential torque is transferred from the right wheel to the left wheel. Also in this case, a torque greater by the differential torque than the torque to the spinning wheel is transmitted to the wheel rotating at the lower speed.

When left wheel spins



DI-00297

When right wheel spins



DI-00298

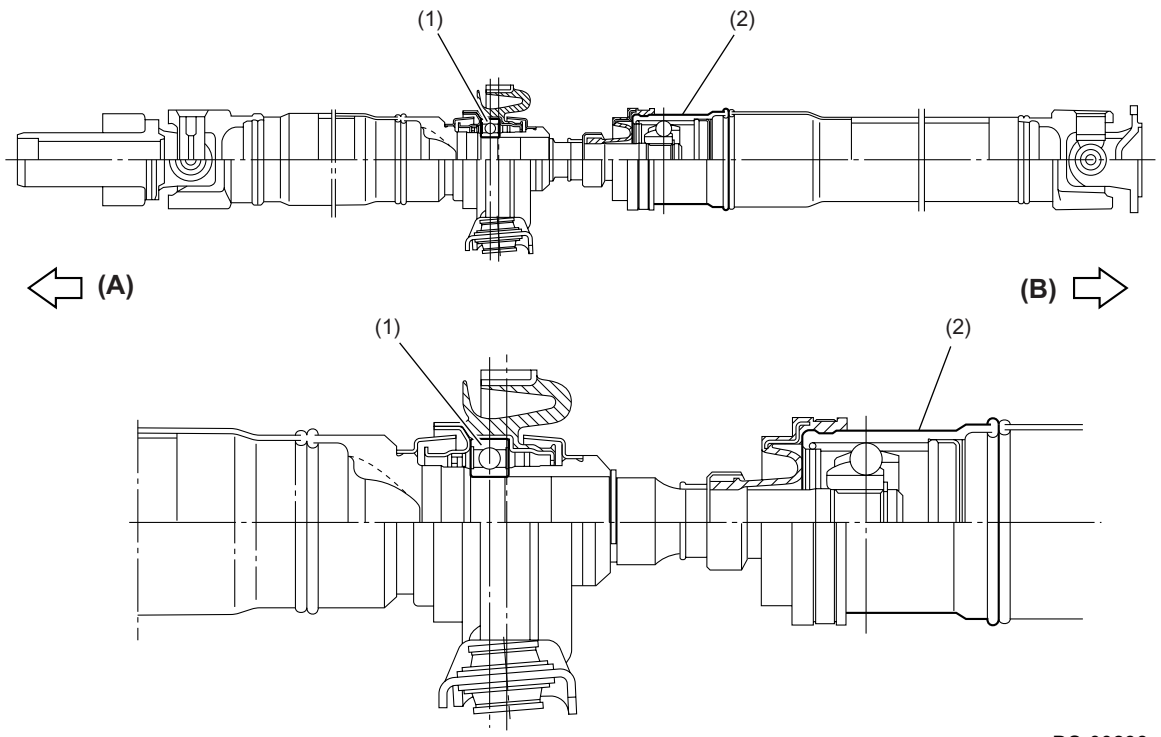
D: SERVICE PROCEDURES FOR LSD

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

DRIVE SHAFT SYSTEM

1. Propeller Shaft

To reduce noise, constant velocity joints are used on the propeller shafts. The center joint is a compact and small EDJ (High Efficiency Compact Double Offset Joint) type that can extend and retract in axial directions.



DS-00238

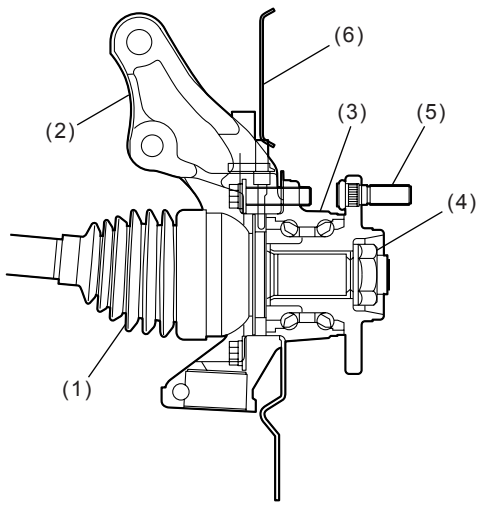
(1) Center bearing
(2) EDJ

(A) Transmission side
(B) Rear differential side

2. Front Axle

A: GENERAL

- A double-rowed angular type ball bearing that features small rolling friction is used.
- The bearing is structured as a hub unit bearing where one of its bearing inner race is integrated with the hub, and features light weight and high rigidity.
- Also, the oil seal is integrated with the bearing.
- The hub unit, housing and the disk cover, which is sandwiched between them are held together with four bolts.
- To reduce noise from the front drive shafts, the transmission side drive axle shaft and joint are integrated. PTJ (Pillow Tripod Joint) type constant velocity joints are newly used at the transmission side, and light and compact EBJ (High Efficiency Compact Ball Fixed Joint) type joints are used at the wheel side.
- The EBJ's spindle is splined to the hub unit and is fastened with an axle nut which is clinched.



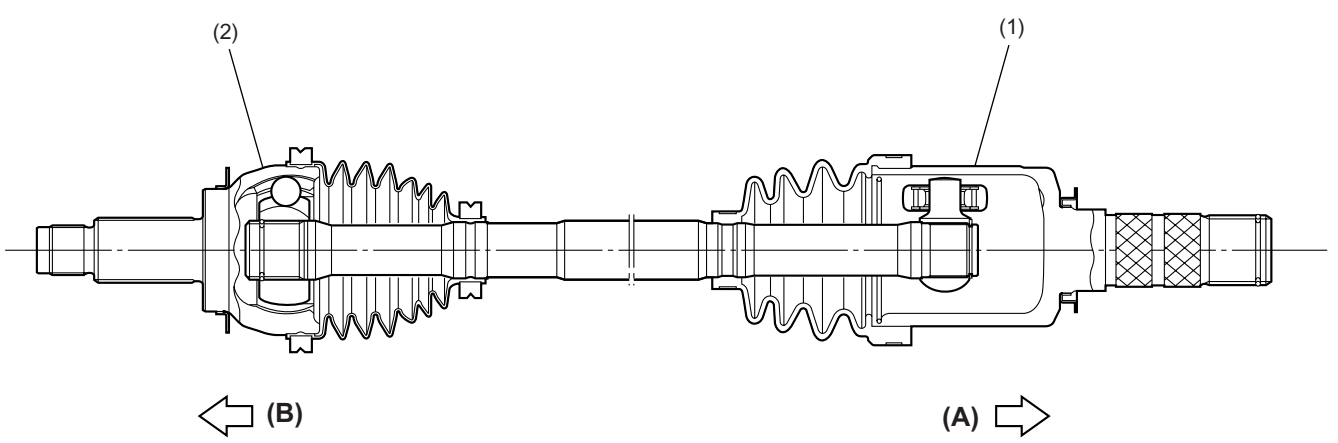
DS-00256

(1) EBJ
(2) Axle housing
(3) Hub unit bearing
(4) Axle nut
(5) Hub bolt
(6) Disc cover

B: FRONT DRIVE SHAFT

● The spline connection between the transmission side axle drive axle shaft and joint is abolished and changed to an integrated structure. PTJ (Pillow Tripod Joint) type joints are newly used at the transmission side, and light and compact EBJ (High Efficiency Compact Ball Fixed Joint) type joints are used at the wheel side.

● The rollers in the PTJ will not change its attitude even when the joint is angled, as they will slide while rolling in axial directions. The rollers will not be effected by the operating angle and will move smoothly inside in axial directions to reduce friction.



DS-00245

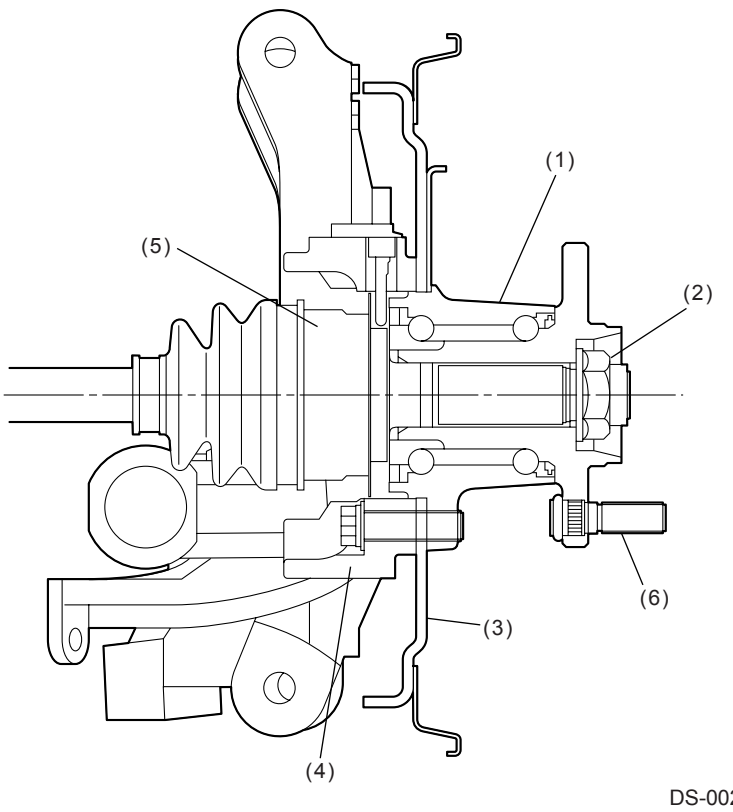
(1) PTJ
(2) EBJ

(A) Transmission side
(B) Wheel side

3. Rear Axle

A: GENERAL

- A double-rowed angular type ball bearing that features small rolling friction is used.
- The bearing is structured as a hub unit bearing where one of its bearing inner race is integrated with the hub, and features light weight and high rigidity.
- Also, the oil seal is integrated with the bearing.
- The hub unit, rear arm and the brake backing plate, which is sandwiched between them are held together with four bolts.
- The drive shaft's spindle is splined to the hub unit and is fastened with an axle nut which is clinched.
- The disc rotor is held in position by the hub bolts and wheel nuts together with the wheel.

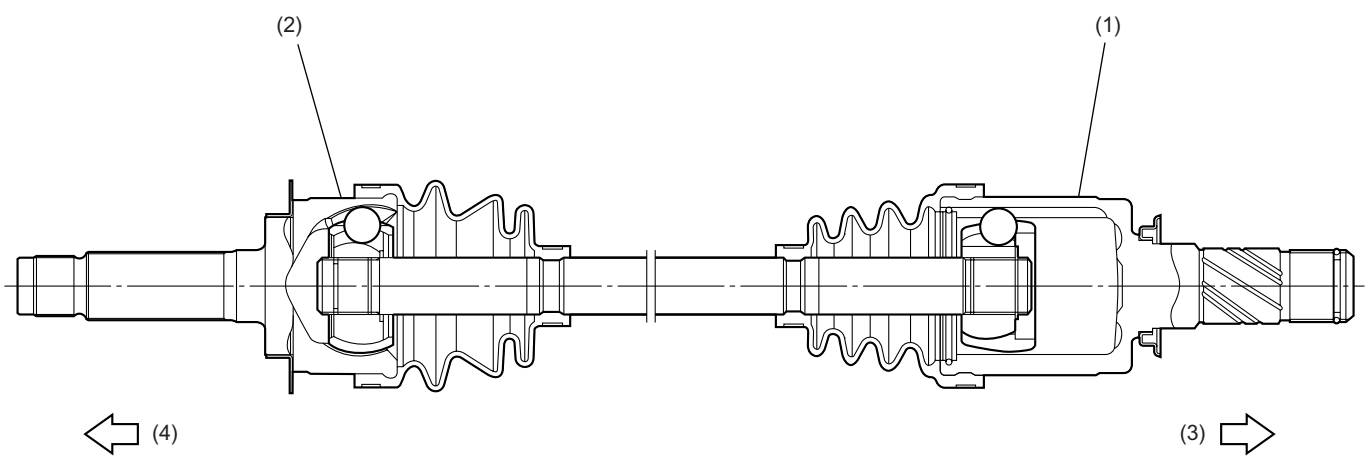


DS-00257

(1) Hub unit
(2) Axle nut
(3) Brake backing plate
(4) Rear arm
(5) Drive shaft
(6) Hub bolt

B: REAR DRIVE SHAFT

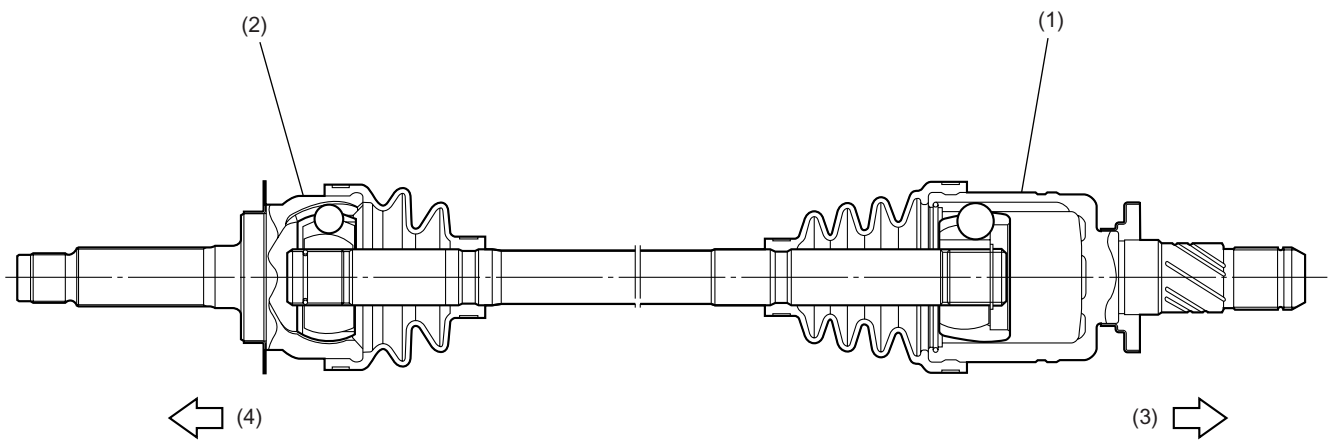
- A double offset joint (DOJ) is used on the differential side of each rear drive shaft.
- A bell joint (BJ) or a high efficiency compact ball fixed joint (EBJ) is used on the wheel side of each drive shaft.
- Rear drive shaft with BJ and DOJ joints



DS-00243

(1) DOJ
(2) BJ
(3) Differential side
(4) Wheel side

- Rear drive shaft with EBJ and DOJ joints



DS-00244

(1) DOJ
(2) EBJ
(3) Differential side
(4) Wheel side

EXTERIOR BODY PANELS

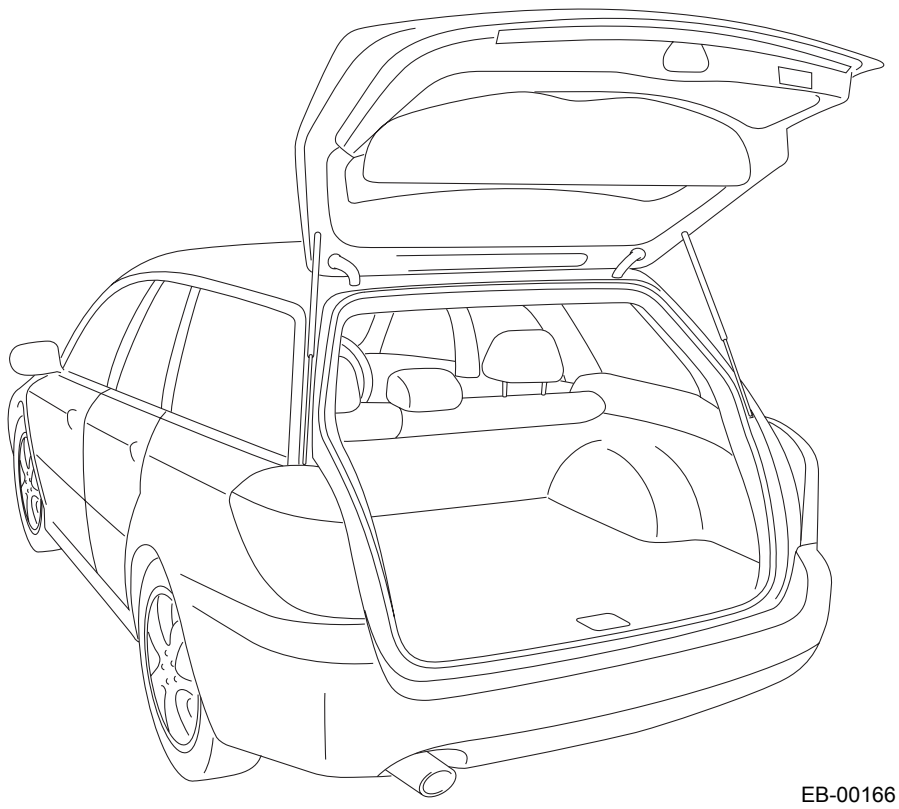
1. Front Hood

An aluminum hood is used on all models to reduce weight.

2. Rear Gate Panel

An aluminum rear gate panel is used on all models.

By changing the material to aluminum, the weight is reduced and the opening and closing of the rear gate is facilitated.

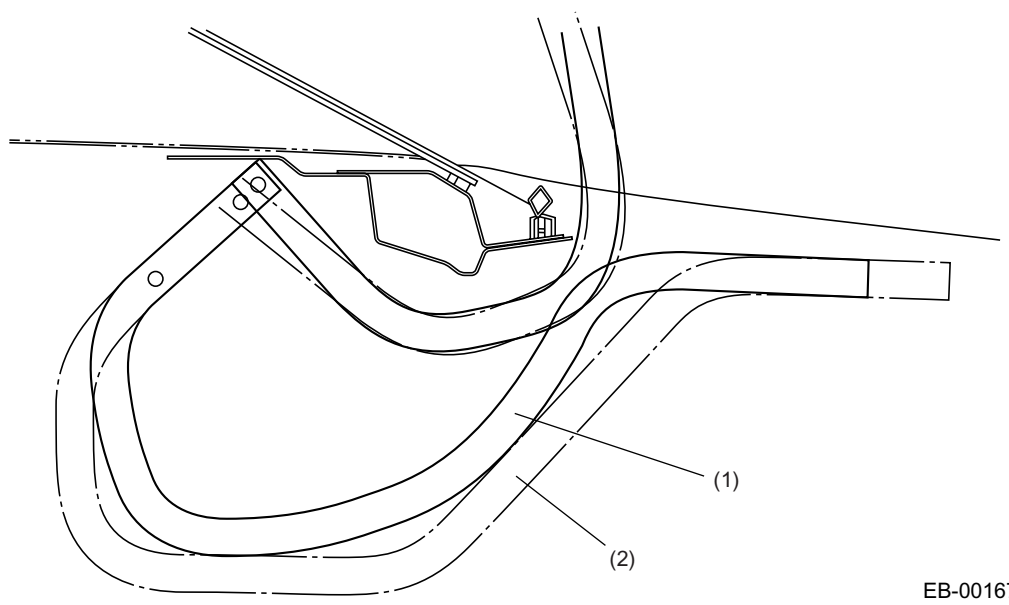


EB-00166

3. Trunk Lid

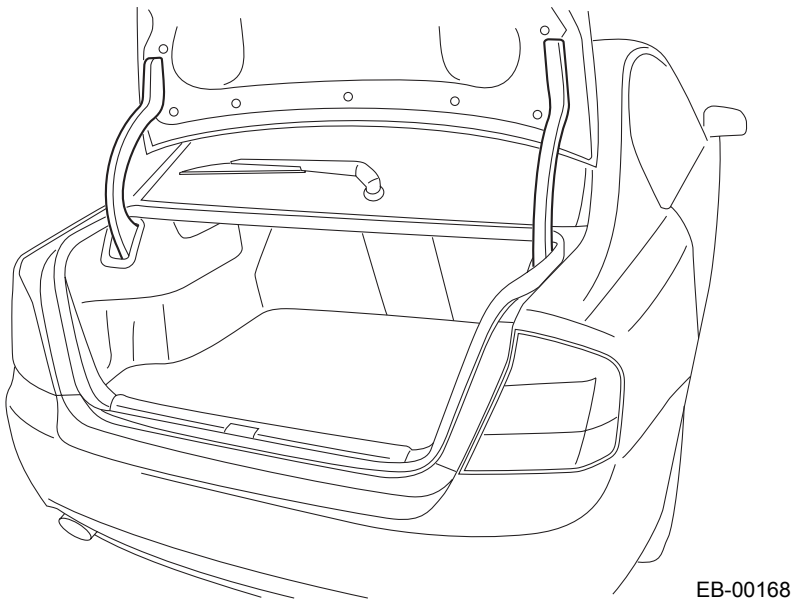
A: TRUNK LID ARM

By minimizing the size of the trunk lid arm, the traveling radius of the arm is made smaller to acquire a wider cargo space.



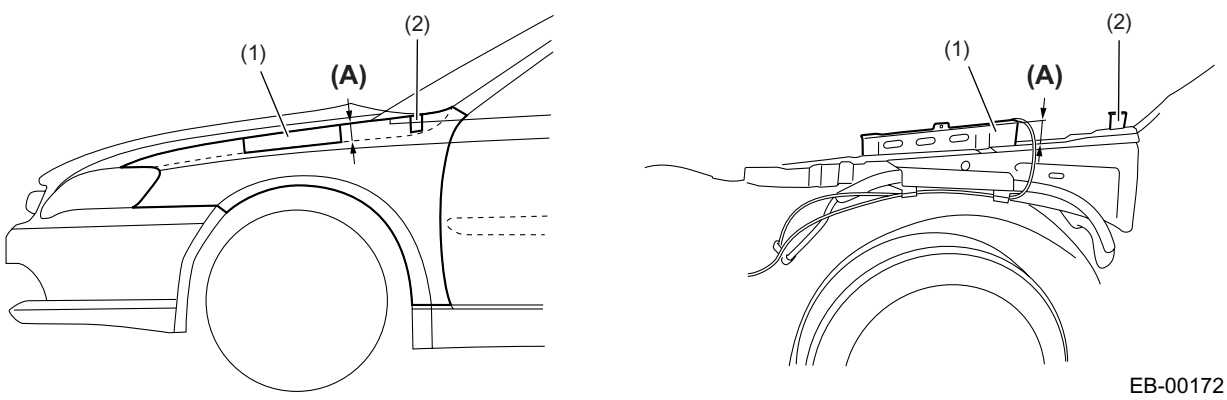
(1) New type (2) Former type

The trunk lid arm is stored inside the trunk trim when the trunk lid is closed.
This prevents the luggage from interfering with the arm when closing the trunk.



4. Front Fender Panel

By providing a clearance (A) between the wheel apron upper area and the fender upper area, the impact absorbing capacity and pedestrian protection is enhanced.



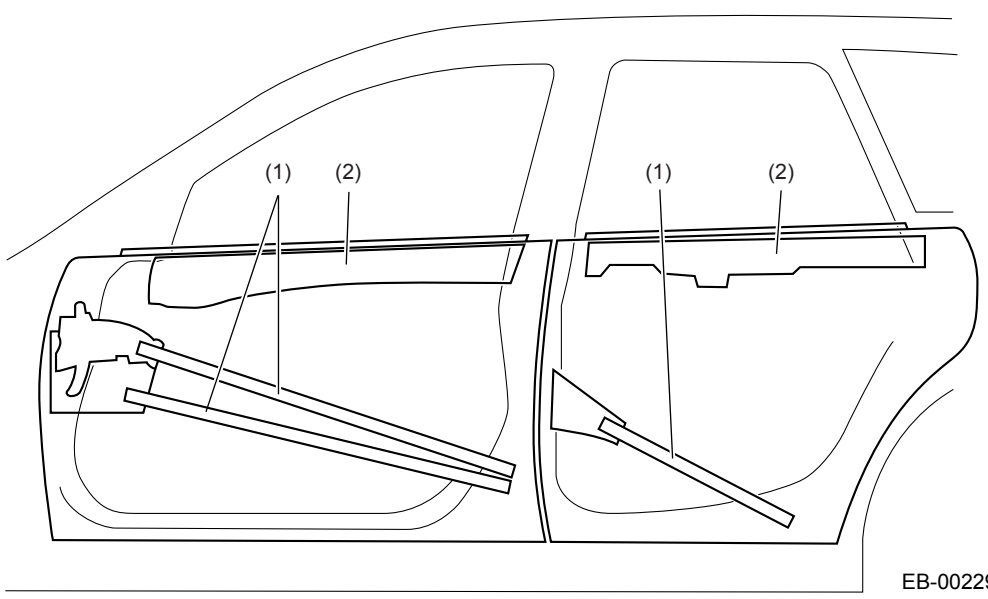
(1) Fender extension, front

(2) Fender extension, rear

5. Door

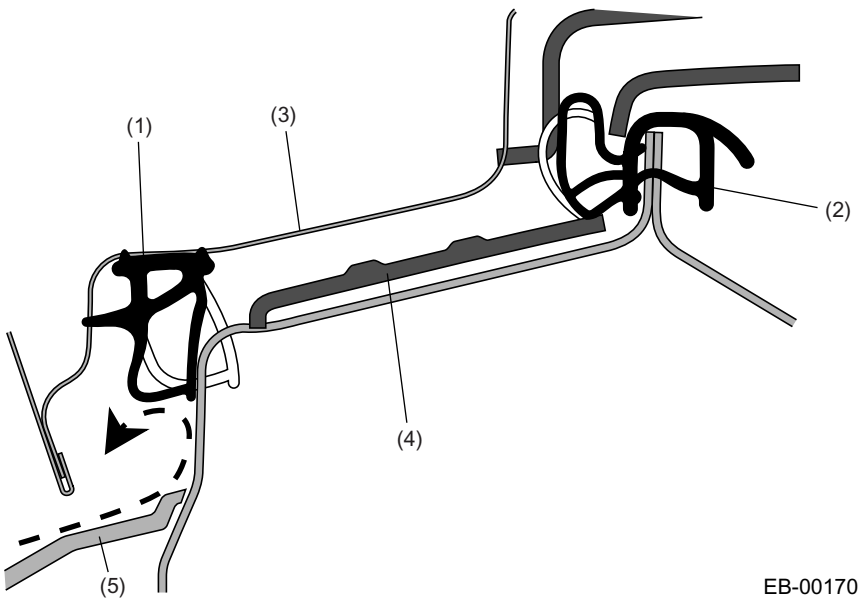
A: DOOR CONSTRUCTION

● The front and rear doors have in their inside a side door beam and a window shoulder area reinforcement.



(1) Side door beam
(2) Window shoulder area reinforcement

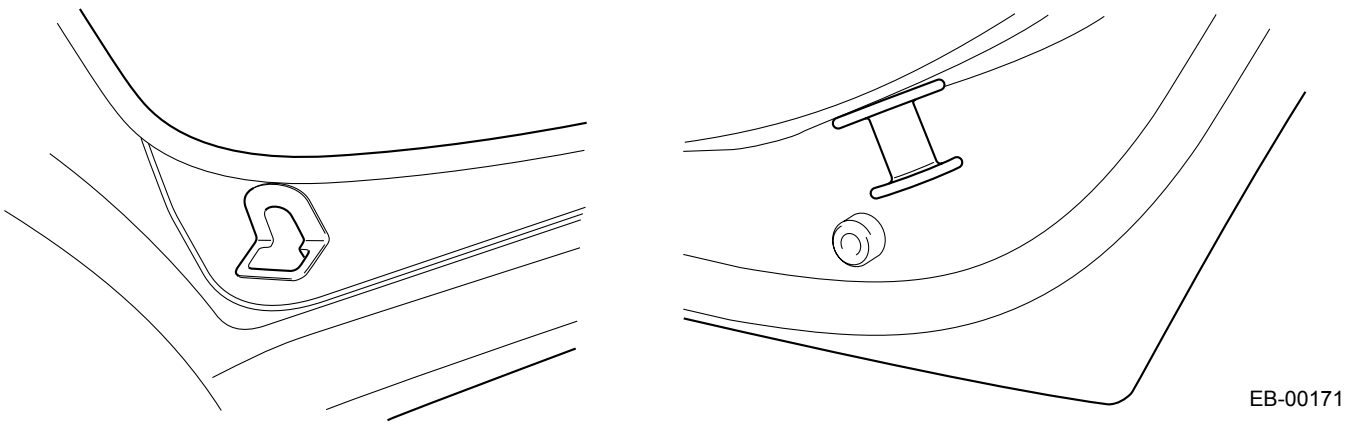
● Tight closure of each door is ensured by the double weather strip at the bottom which also reduces intruding noise.



(1) Outer weather strip
(2) Inner weather strip
(3) Door panel
(4) Scuff plate
(5) Side sill spoiler

B: REAR DOOR CATCHER

This prevents the rear door from deflecting into the cabin in case of a side collision.



EMISSION CONTROL
(AUX. EMISSION CONTROL DEVICES)
(H4DOTC)

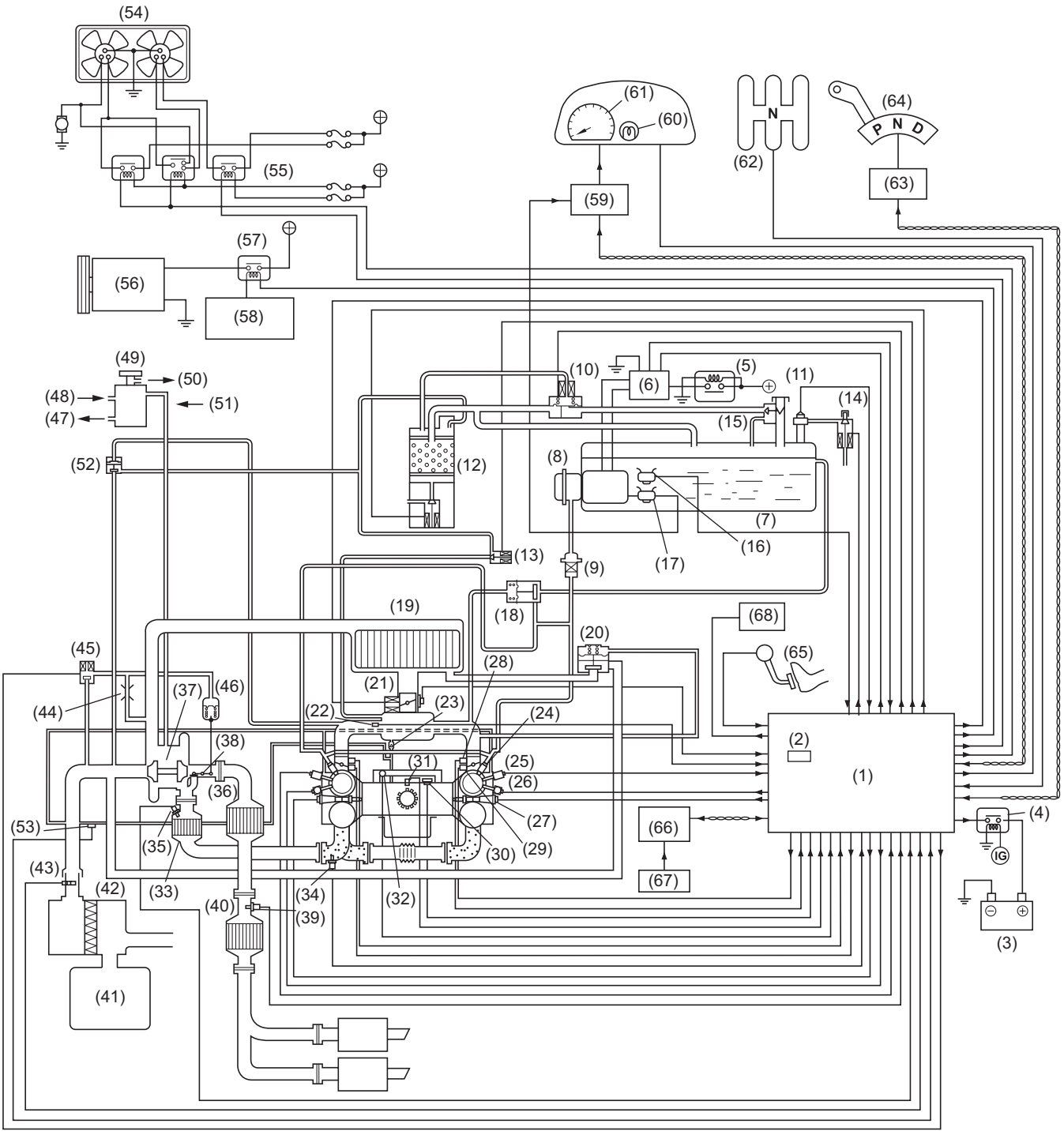
1. System Overview

There are three emission control systems, which are as follows:

- Crankcase emission control system
- Exhaust emission control system
  - Catalytic converter
  - 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 burn 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	Catalytic converter	Pre	Catalytic converter	Oxidizes HC and CO contained in exhaust gases as well as reducing NOx.
		Front		
		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 density of oxygen contained exhaust gases.
			Rear oxygen sensor	Detects density of oxygen contained in exhaust gases.
			Throttle position sensor	Detects throttle opening.
			Manifold absolute pressure sensor	Detects absolute pressure of intake manifold.
			Mass air flow and intake air temperature sensor	Detects amount of intake air.
				Detects intake air temperature at air cleaner case.
	Ignition control system		ECM	Receives various signals, compares signals with basic data stored in memory, and emits a signal for optimal control of ignition timing.
			Crankshaft position sensor	Detects engine speed (revolution).
			Camshaft position sensor	Detects reference signal for combustion cylinder discrimination.
			Engine coolant temperature sensor	Detects coolant temperature.
			Knock sensor	Detects engine knocking.
Evaporative emission control system			Canister	Absorbs evaporative gas that accumulates in fuel tank when engine stops, and releases it to combustion chambers for a complete burn when the 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	Closes the port to the canister when the fuel tank is full of fuel.
			Drain valve	Closes the evaporation line by receiving a signal from ECM to check the evaporation gas leak.

2. Schematic Diagrams



EC-02111

(1) Engine control module (ECM)
(2) Atmospheric pressure sensor
(3) Battery
(4) Ignition relay
(5) Fuel pump relay
(6) Fuel pump control unit
(7) Fuel tank
(8) Fuel pump
(9) Fuel filter
(10) Pressure control solenoid valve
(11) Fuel tank pressure sensor
(12) Canister
(13) Purge control solenoid valve
(14) Fuel tank sensor control valve
(15) Shut-off valve
(16) Fuel temperature sensor
(17) Fuel level sensor
(18) Pressure regulator
(19) Intercooler
(20) Air bypass valve
(21) Electronic control throttle
(22) Manifold absolute pressure sensor
(23) PCV valve
(24) Fuel injector
(25) Intake camshaft position sensor
(26) Intake oil flow control solenoid valve
(27) Ignition coil and igniter assembly
(28) Tumble generator valve position sensor
(29) Tumble generator valve actuator
(30) Knock sensor
(31) Crankshaft position sensor
(32) Engine coolant temperature sensor
(33) Front catalytic converter
(34) Front oxygen (A/F) sensor
(35) Exhaust temperature sensor
(36) Pre-catalytic converter
(37) Turbocharger
(38) Wastegate valve
(39) Rear oxygen sensor
(40) Rear catalytic converter
(41) Chamber
(42) Air cleaner element
(43) Mass air flow and intake air temperature sensor
(44) Orifice
(45) Wastegate control solenoid valve
(46) Wastegate actuator
(47) To water pump
(48) From radiator
(49) Engine coolant filler tank
(50) To reservoir tank
(51) From turbocharger
(52) Purge valve
(53) PCV hose assembly
(54) Radiator fan
(55) Fan control relay
(56) A/C compressor
(57) A/C relay
(58) A/C control module
(59) Body integrated unit
(60) Engine warning light
(61) Tachometer
(62) Neutral switch (MT models)
(63) Transmission control module (AT models)
(64) Neutral switch (AT models)
(65) Accelerator pedal position sensor
(66) ABS/VDC control module
(67) Vehicle speed signal
(68) Data link connector

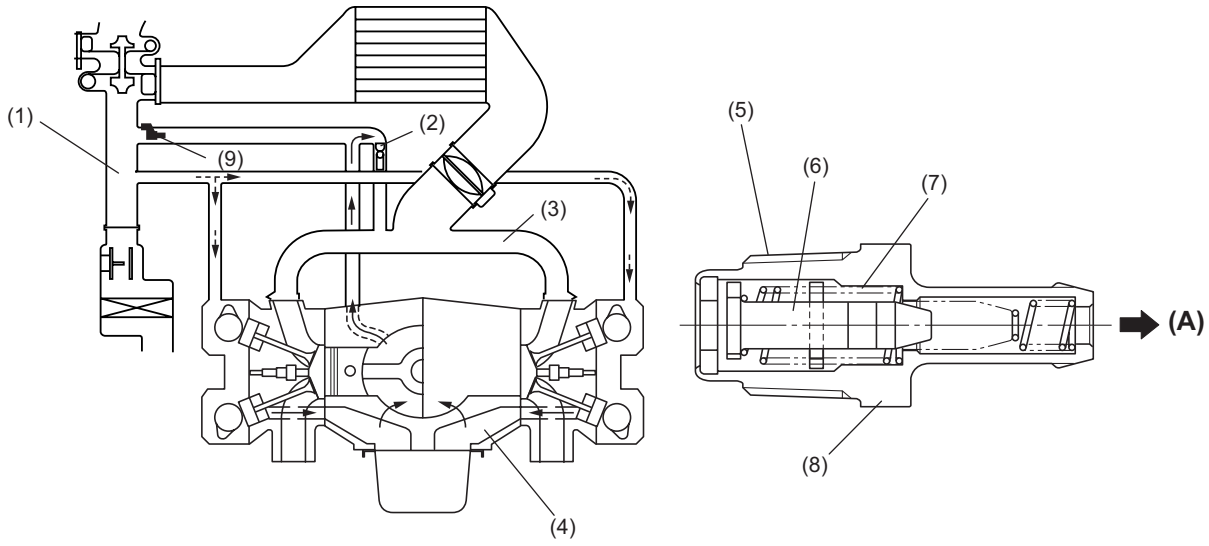
3. Crankcase Emission Control System

● The positive crankcase ventilation (PCV) system prevents air pollution that 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.

● The PCV hose is provided with a leak detection function.



EC-02112

(1) Intake duct
(2) PCV valve
(3) Intake manifold
(4) Crankcase
(5) Case
(6) Valve
(7) Spring
(8) PCV valve
(9) PCV hose assembly

(A) To intake manifold

4. Catalytic Converter

● The basic materials of the three-way catalytic converter are 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 catalytic converter, only unleaded gasoline should be used.

● The catalytic converter 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. Air/fuel (A/F) Control System

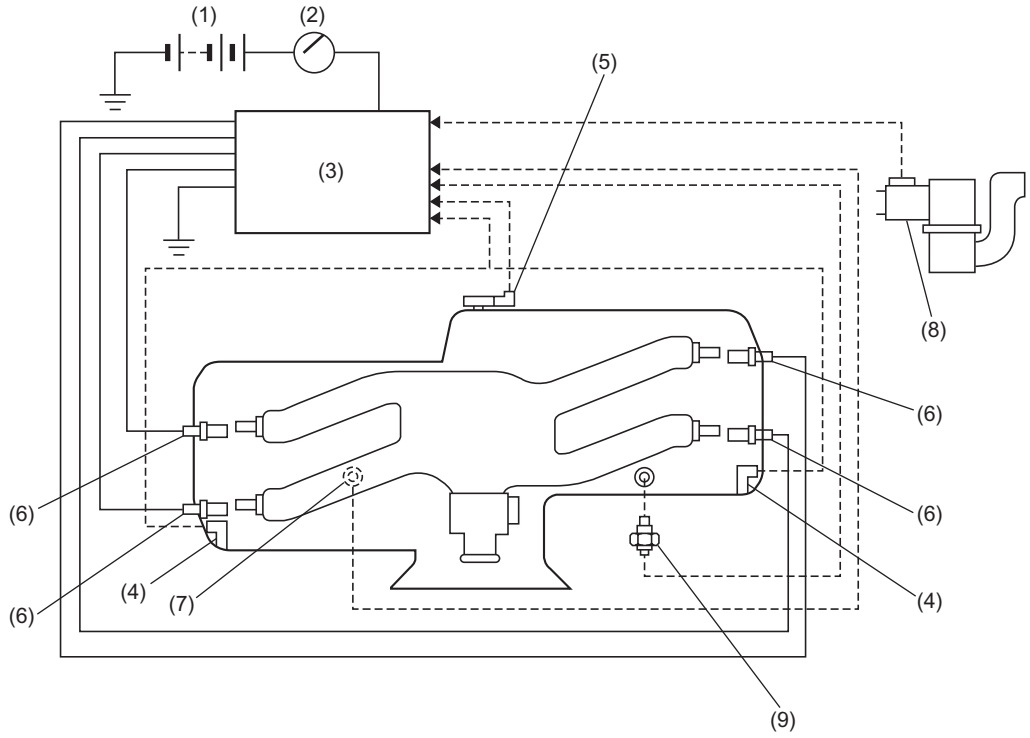
● The air/fuel (A/F) control system makes a correction to the basic fuel injection duration in accordance with the signals from the front oxygen (A/F) sensor and the rear oxygen sensor so that the stoichiometric ratio is maintained, thus ensuring most effective exhaust gas purification by the three-way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

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



EC-00247

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

7. Evaporative Emission Control System

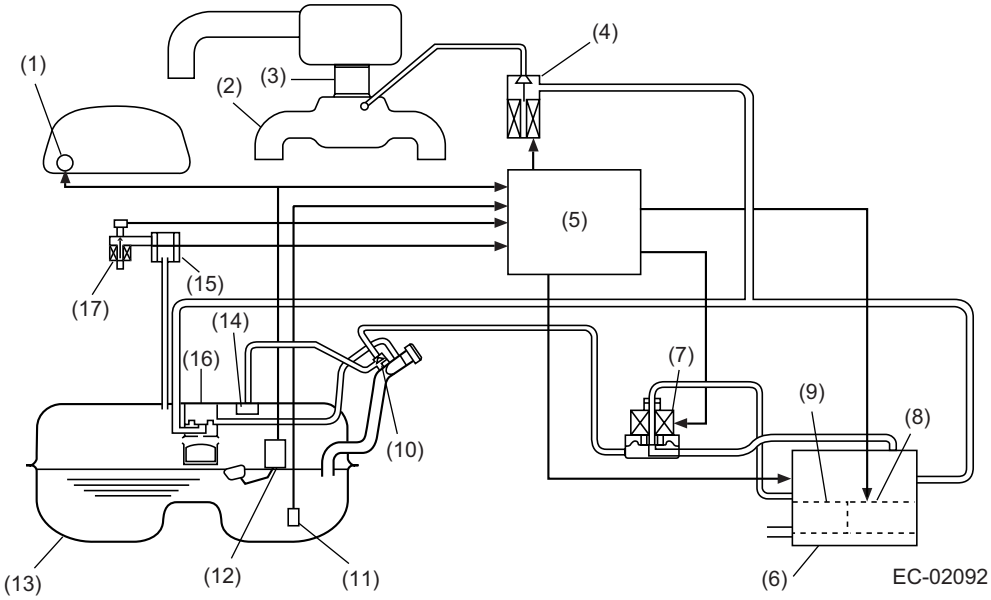
A: GENERAL

● The evaporative emission control system prevents fuel vapors from escaping into atmosphere.This system includes a canister, purge control solenoid valve, fuel cut valve, and the lines connecting them.

● Fuel vapors in the fuel tank is introduced into the canister through the evaporation line, and are absorbed by activated carbon in it.The fuel cut valve is also incorporated in the fuel tank line.

● The purge control solenoid valve is controlled optimally by the ECM according to the engine condition.

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

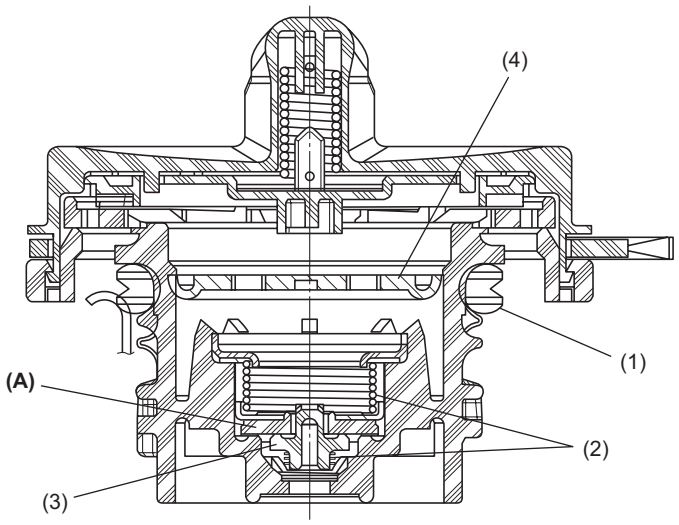
B: FUEL CUT VALVE

The fuel cut valve is incorporated in 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.

C: FUEL TANK CAP

- The fuel tank cap is of a quick lock type and can be opened or closed in 1/4 of a full turn.
- The fuel tank cap has a relief valve, which prevents development of vacuum in the fuel tank in the event of a problem with the fuel vapor line.

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



EC-02109

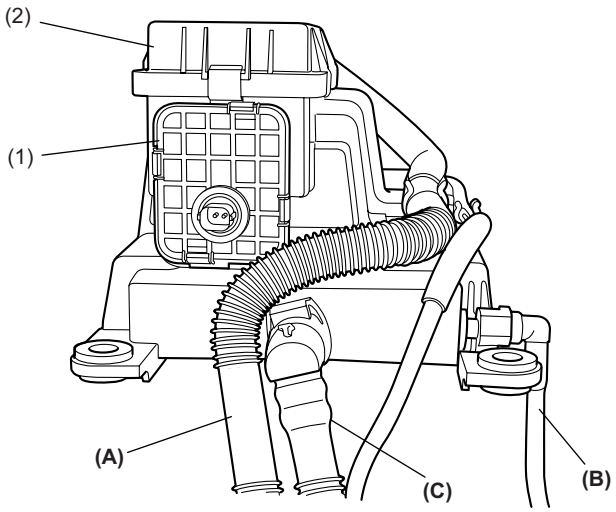
(1) Seal
(2) Spring
(3) Valve
(4) Filter

D: CANISTER

The canister incorporates a drain valve and a drain filter.

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.

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.



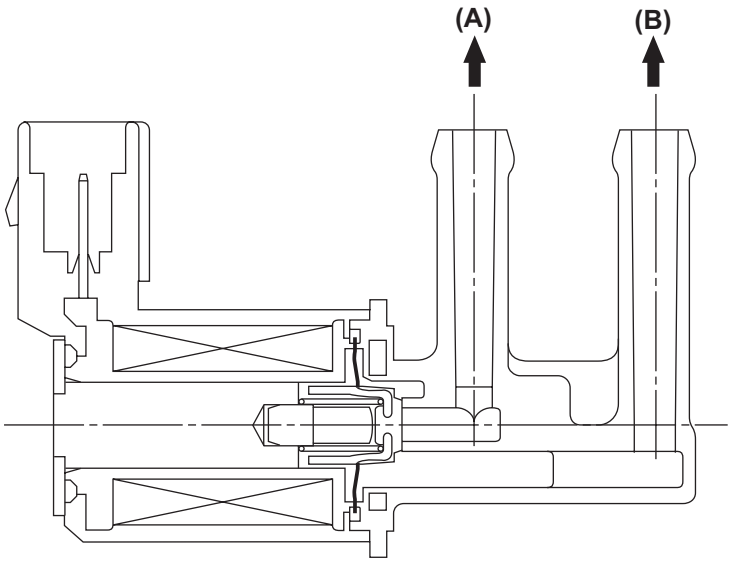
EC-02093

(1) Drain valve
(2) Drain filter

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

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 under the intake manifold and lets the evaporative gas absorbed by the canister be drawn into the intake manifold.



EC-02001

(A) To canister

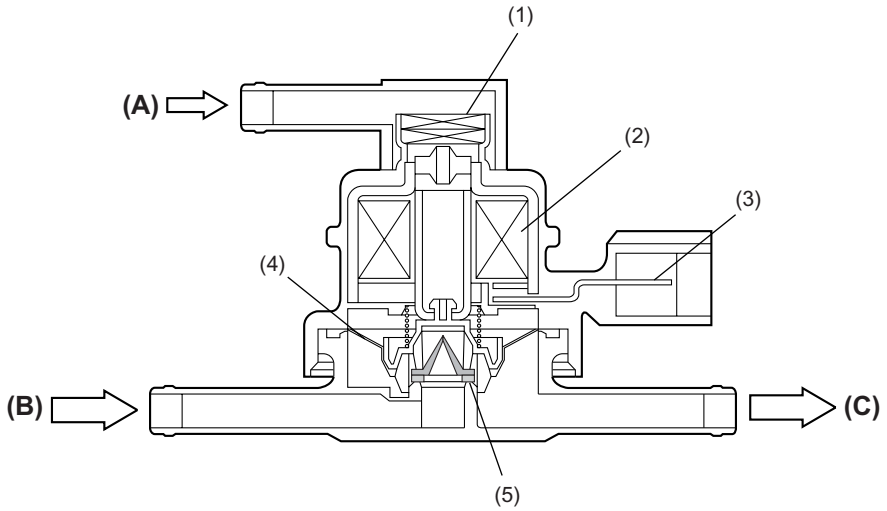
(B) To intake manifold

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. 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.



EC-00026

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

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

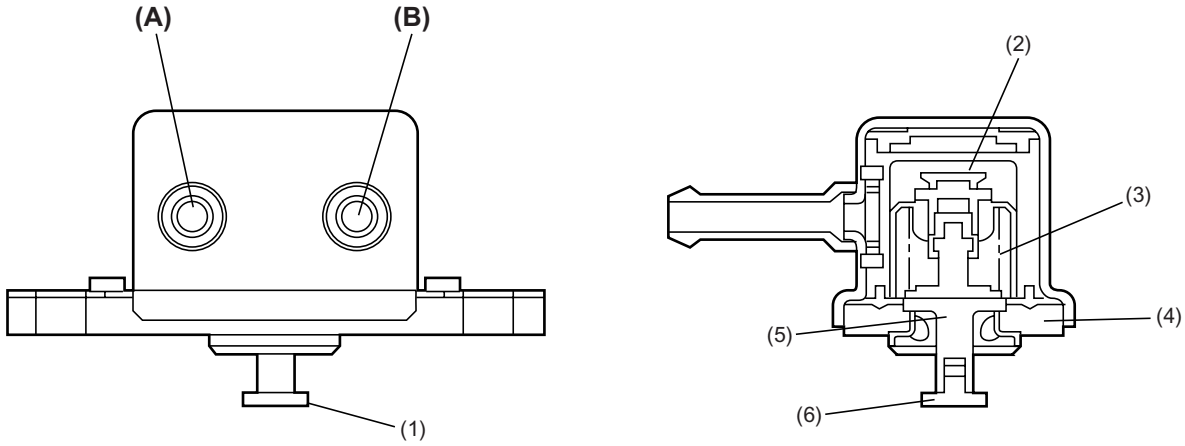
G: VENT VALVE

The vent valve is located inside of 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.

H: 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.



EC-00029

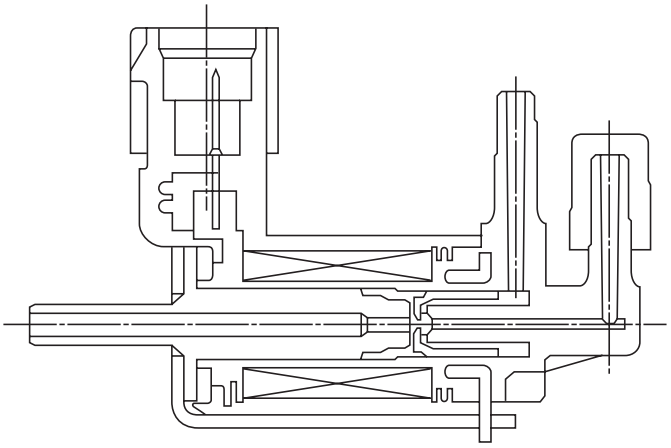
(1) Pin
(2) Valve
(3) Spring
(4) Plate
(5) Shaft
(6) Pin

(A) To canister
(B) To fuel tank

I: FUEL TANK SENSOR CONTROL VALVE

The fuel tank sensor control valve is installed on the top of the fuel tank and its one end is connected to the fuel tank pressure sensor while its other end is open to the atmosphere.

Normally the passage to the fuel tank pressure sensor is open to the atmosphere, however, the passage is closed when the ECM sends a signal to make a diagnosis of the evaporative emission control system.

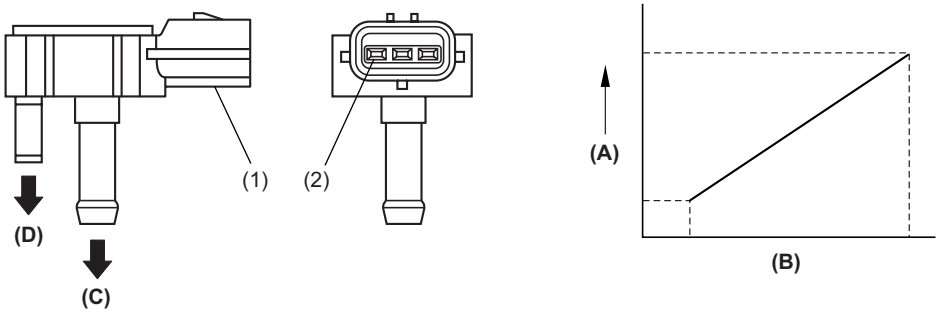


EC-00031

J: FUEL TANK PRESSURE SENSOR

The fuel tank pressure sensor is installed on the top of the fuel tank and measures the pressure in the fuel tank.

The measured pressure is converted into an electrical signal and sent to the ECM for diagnosis of the evaporative emission control system.



EC-02110

(1) Connector
(2) Terminal

(A) Output voltage
(B) Input pressure
(C) To fuel tank
(D) To fuel tank sensor control valve

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

A: GENERAL

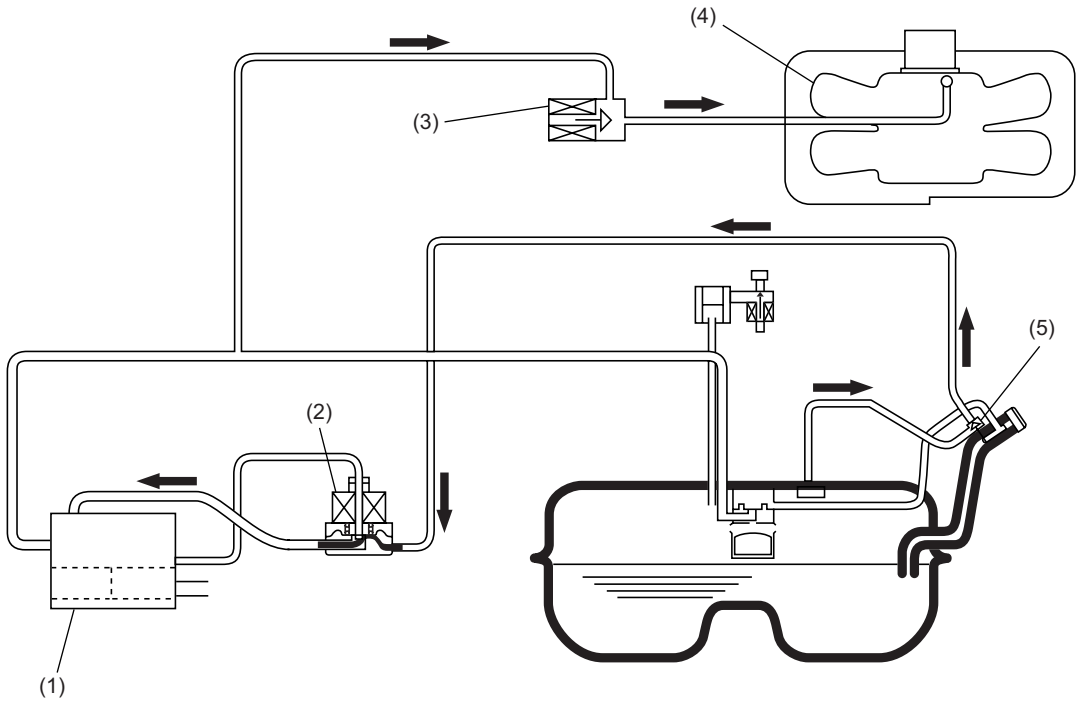
The on-board refueling vapor recovery system allows the fuel vapors in the fuel tank to be introduced directly into the canister through the vent valve when the fuel tank inside pressure increases as a result of refueling.

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.

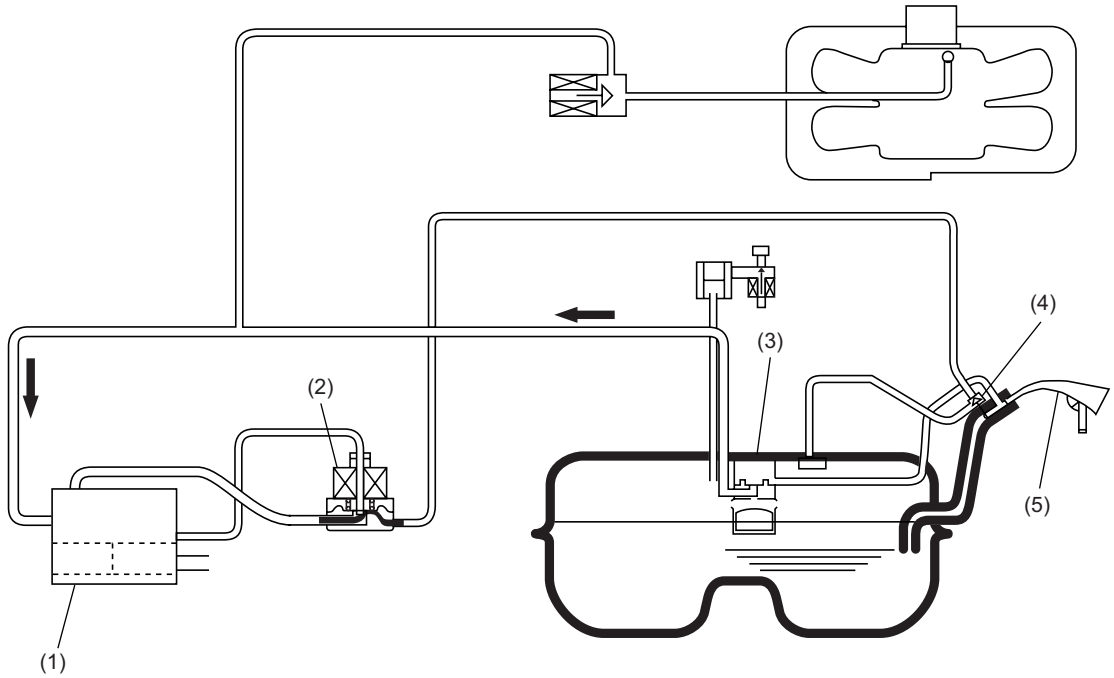


EC-02094

(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.

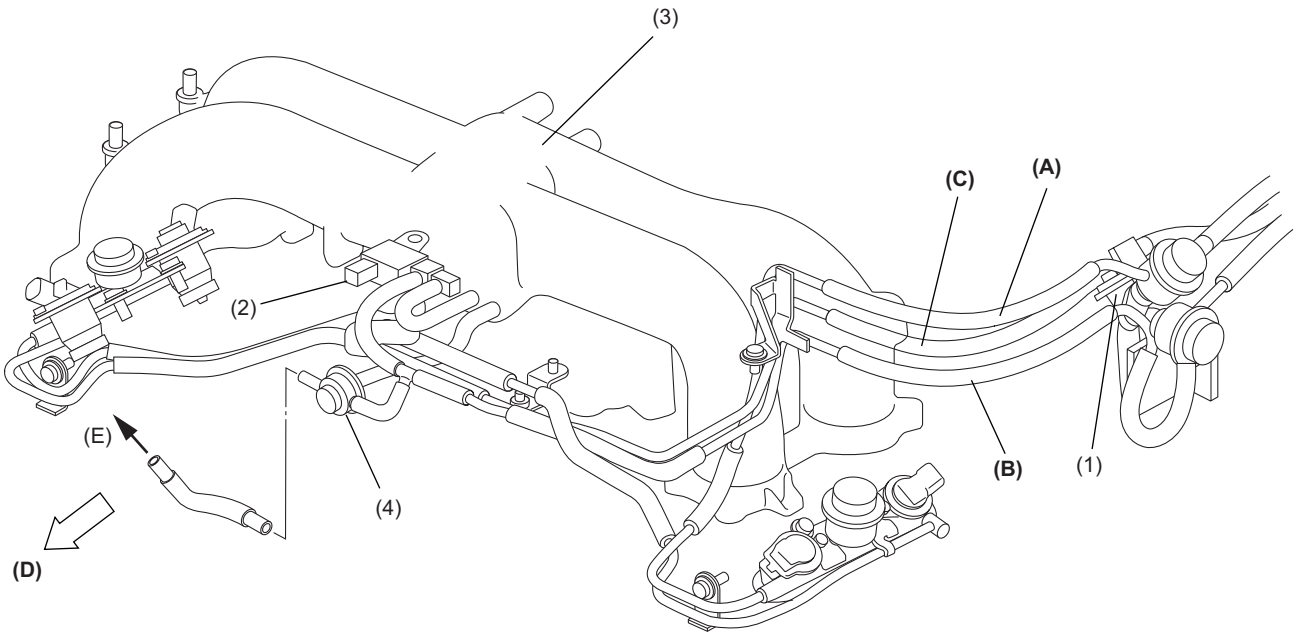


EC-02095

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

9. Vacuum Connections

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



EC-02113

(1) Pressure regulator
(2) Purge control solenoid valve
(3) Intake manifold
(4) Purge valve

(A) Delivery pipe
(B) Return pipe
(C) Evaporation pipe
(D) Front of vehicle
(E) To intake duct

1. General

Specifications for SOHC U5 models are included in EC(H4SO) models. <Ref. to EC(H4SO) section.>

EMISSION CONTROL
(AUX. EMISSION CONTROL DEVICES)
(H4SO)

1. System Overview

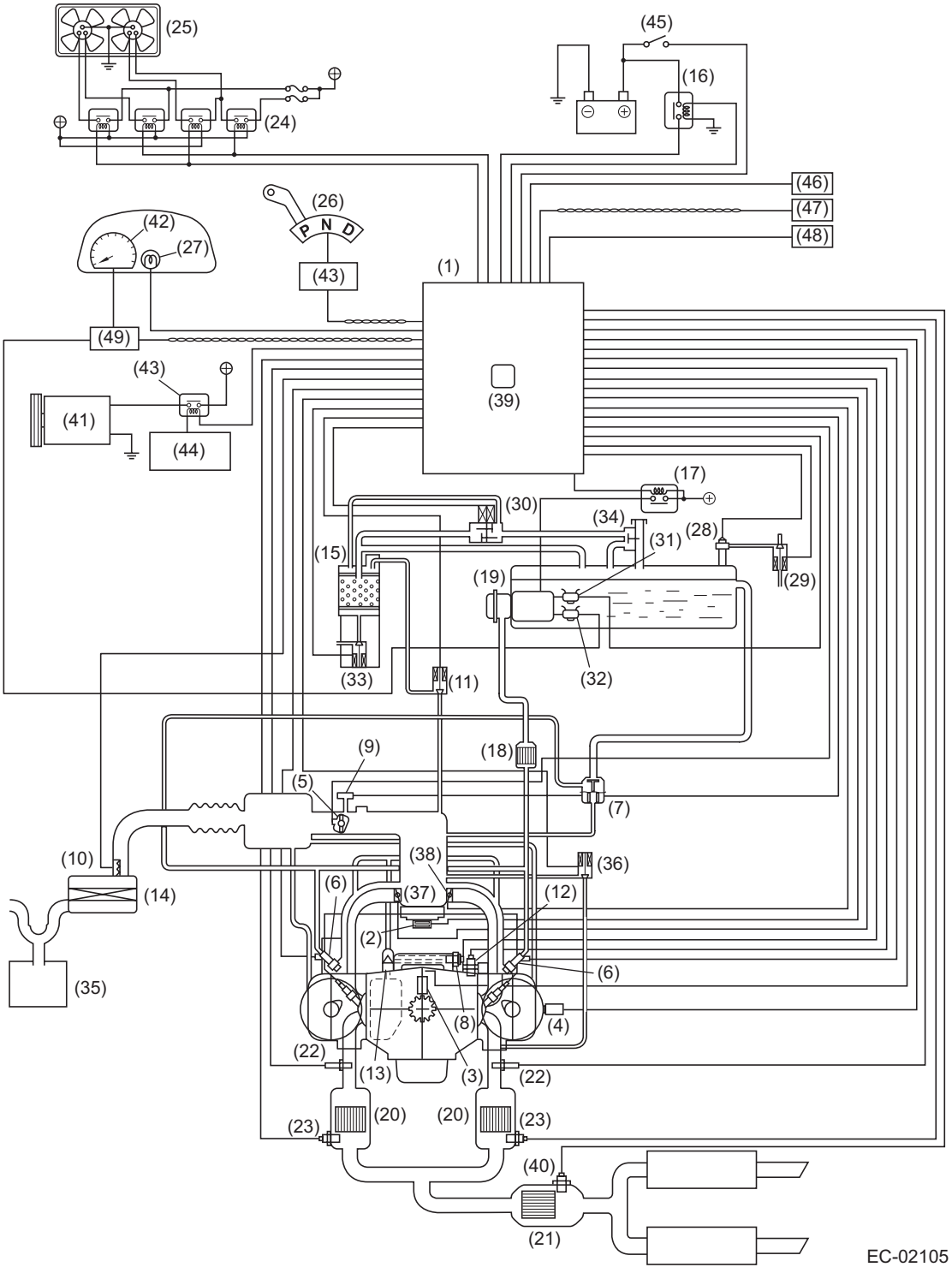
There are three emission control systems, which are as follows:

- Crankcase emission control system
- Exhaust emission control system
  - Catalytic converter
  - Air/fuel (A/F) control system
  - Ignition control system
  - Exhaust gas recirculation 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 burn 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	Catalytic converter	Front	Catalytic converter	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 density of oxygen contained exhaust gases.
			Front oxygen sensor Rear oxygen sensor	Detects density of oxygen contained in exhaust gases.
			Throttle position sensor	Detects throttle opening.
			Manifold absolute pressure sensor	Detects absolute pressure of intake manifold.
			Mass air flow and intake air temperature sensor	Detects amount of intake air.
				Detects intake air temperature at air cleaner case.
	Ignition control system		ECM	Receives various signals, compares signals with basic data stored in memory, and emits a signal for optimal control of ignition timing.
			Crankshaft position sensor	Detects engine speed (revolution).
			Camshaft position sensor	Detects reference signal for combustion cylinder discrimination.
			Engine coolant temperature sensor	Detects coolant temperature.
			Knock sensor	Detects engine knocking.
	Exhaust gas recirculation system		EGR valve	Adjusts the amount of exhaust gas flowing back to the intake pipe.
Evaporative emission control system			Canister	Absorbs evaporative gas that accumulates in fuel tank when engine stops, and releases it to combustion chambers for a complete burn when the 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 the fuel tank.
			Drain valve	Closes the evaporation line by receiving a signal from ECM to check the evaporation gas leak.

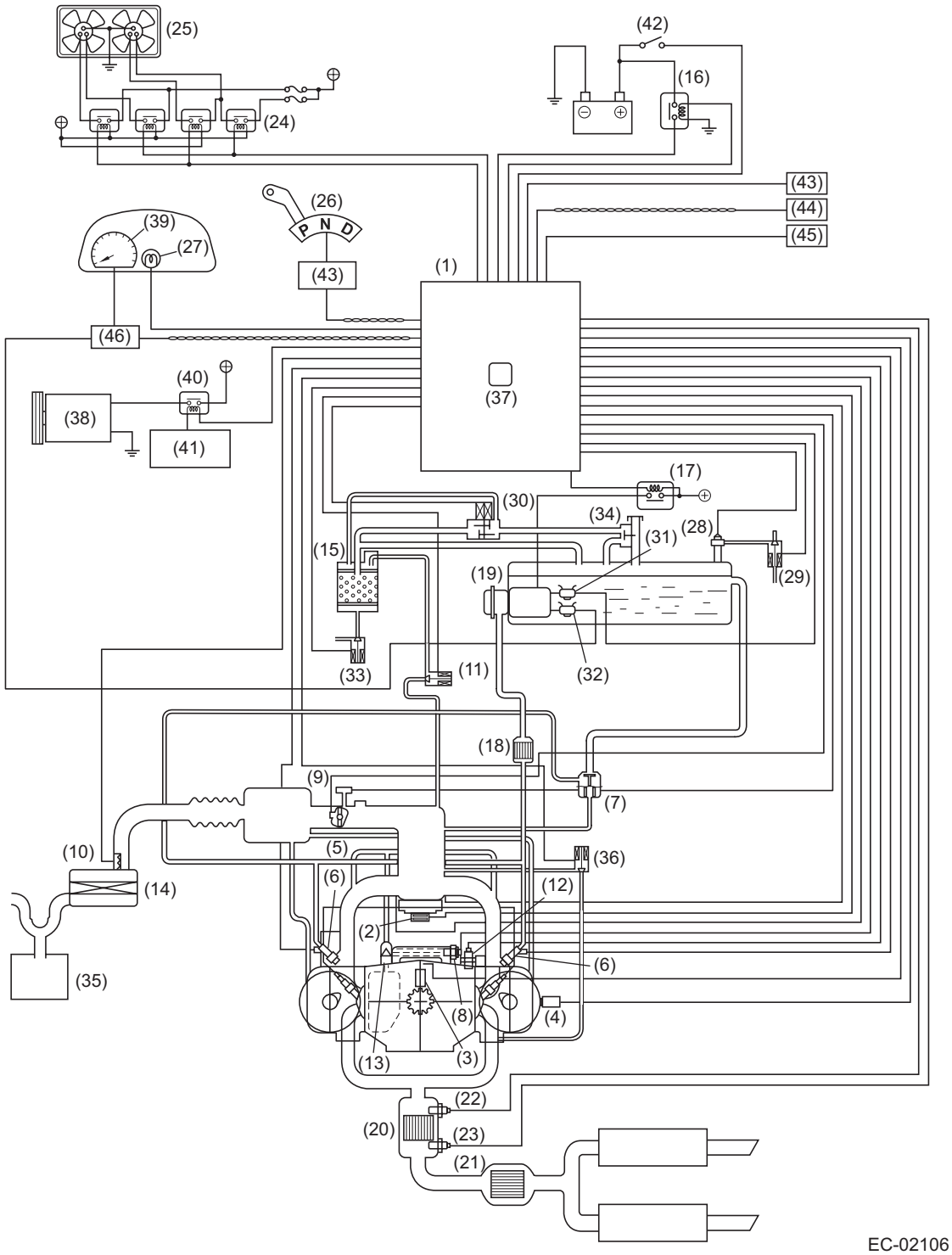
2. Schematic Diagrams

- Type 1



(1) Engine control module (ECM)
(2) Ignition coil and igniter assembly
(3) Crankshaft position sensor
(4) Camshaft position sensor
(5) Electronic control throttle
(6) Fuel injector
(7) Pressure regulator
(8) Engine coolant temperature sensor
(9) Manifold absolute pressure sensor
(10) Mass air flow and intake air temperature sensor
(11) Purge control solenoid valve
(12) Knock sensor
(13) PCV valve
(14) Air cleaner element
(15) Canister
(16) Main relay
(17) Fuel pump relay
(18) Fuel filter
(19) Fuel pump
(20) Front catalytic converter
(21) Rear catalytic converter
(22) Front oxygen (A/F) sensor
(23) Front oxygen sensor
(24) Radiator fan relay
(25) Radiator fan
(26) Inhibitor switch (AT models only)
(27) Engine warning light
(28) Fuel tank pressure sensor
(29) Fuel tank sensor control valve
(30) Pressure control solenoid valve
(31) Fuel temperature sensor
(32) Fuel level sensor
(33) Drain valve
(34) Shut-off valve
(35) Resonator chamber
(36) EGR valve
(37) Tumble generator valve actuator
(38) Tumble generator valve position sensor
(39) Atmospheric pressure sensor
(40) Rear oxygen sensor
(41) A/C compressor
(42) Tachometer
(43) A/C relay
(44) A/C control module
(45) Ignition switch
(46) Transmission control module (TCM) (AT models only)
(47) ABS control module (ABSCM)
(48) Data link connector
(49) Body integrated unit

- Type 2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EC-02106

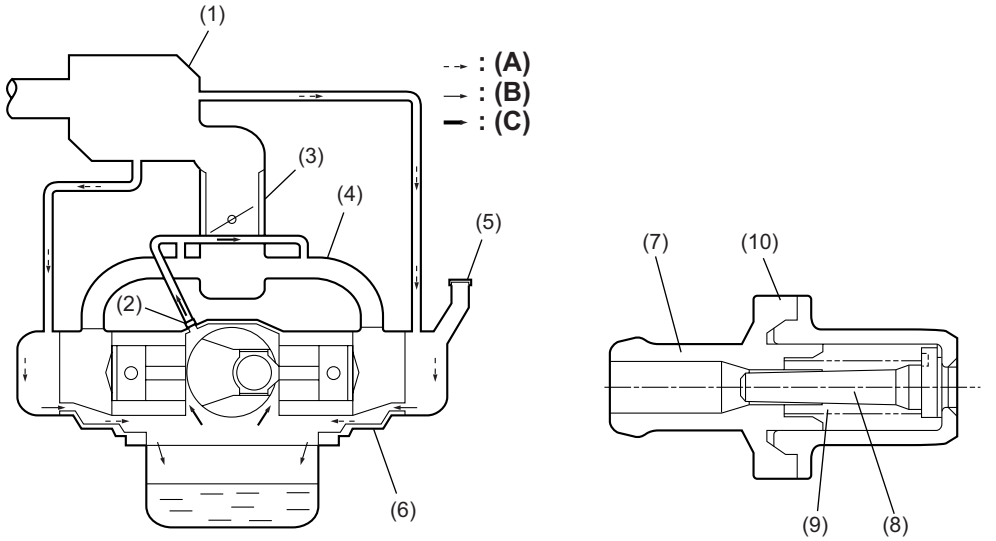
(1) Engine control module (ECM)
(2) Ignition coil and igniter assembly
(3) Crankshaft position sensor
(4) Camshaft position sensor
(5) Electronic control throttle
(6) Fuel injector
(7) Pressure regulator
(8) Engine coolant temperature sensor
(9) Manifold absolute pressure sensor
(10) Mass air flow and intake air temperature sensor
(11) Purge control solenoid valve
(12) Knock sensor
(13) PCV valve
(14) Air cleaner element
(15) Canister
(16) Main relay
(17) Fuel pump relay
(18) Fuel filter
(19) Fuel pump
(20) Front catalytic converter
(21) Rear catalytic converter
(22) Front oxygen (A/F) sensor
(23) Rear oxygen sensor
(24) Radiator fan relay
(25) Radiator fan
(26) Inhibitor switch (AT models only)
(27) Engine warning light
(28) Fuel tank pressure sensor
(29) Fuel tank sensor control valve
(30) Pressure control solenoid valve
(31) Fuel temperature sensor
(32) Fuel level sensor
(33) Drain valve
(34) Shut-off valve
(35) Resonator chamber
(36) EGR valve
(37) Atmospheric pressure sensor
(38) A/C compressor
(39) Tachometer
(40) A/C relay
(41) A/C control module
(42) Ignition switch
(43) Transmission control module (TCM) (AT models only)
(44) ABS control module (ABSCM)
(45) Data link connector
(46) Body integrated unit

3. Crankcase Emission Control System

● The positive crankcase ventilation (PCV) system prevents air pollution that will be caused by blow-by gas being emitted from the crankcase. The system consists of a sealed oil filler cap, rocker covers with fresh air inlet, connecting hoses, a PCV valve and an air intake duct.

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

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



EC-02107

(1) Air intake chamber
(2) PCV valve
(3) Throttle body
(4) Intake manifold
(5) Oil filler cap
(6) Crankcase
(7) Case
(8) Valve
(9) Spring
(10) PCV valve

(A) Outside air
(B) Mixture of air and blow-by gas
(C) Blow-by gas

4. Catalytic Converter

● The basic materials of the three-way catalytic converter are 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 catalytic converter, only unleaded gasoline should be used.

● The catalytic converter 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. Air/fuel (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 catalytic converter. 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.

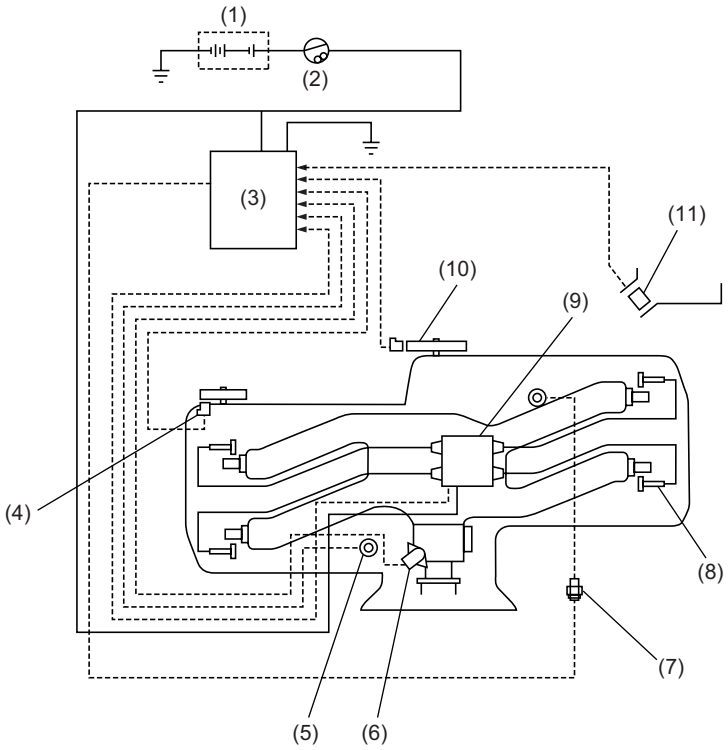
MEMO

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 igniter, 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.

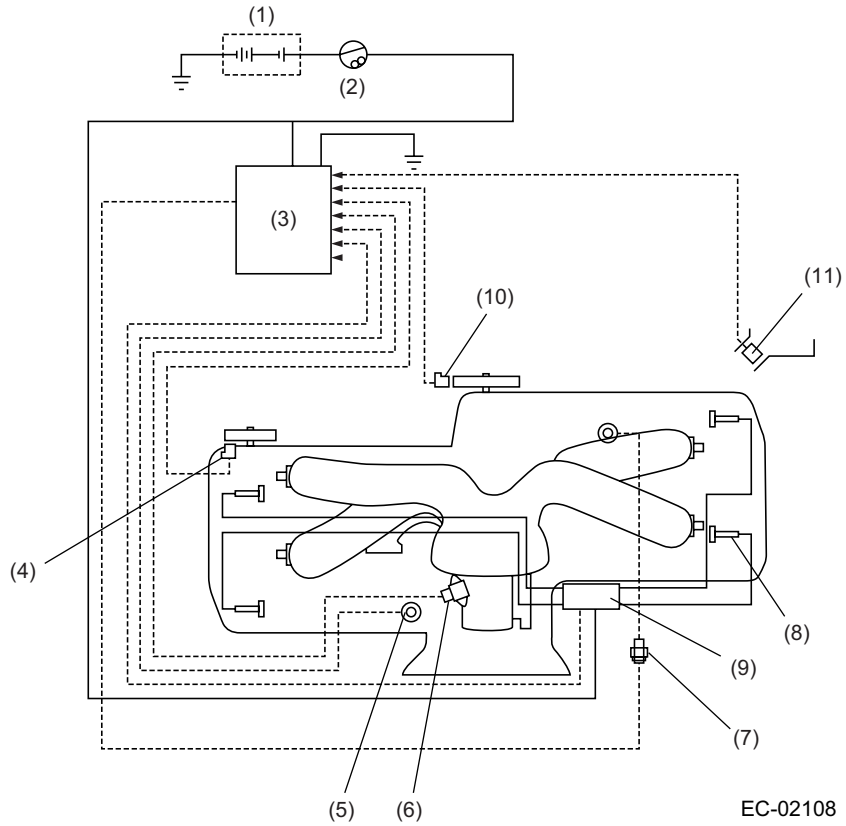
● Type 1



EC-02091

(1) Battery
(2) Ignition switch
(3) ECM
(4) Camshaft position sensor
(5) Knock sensor
(6) Manifold absolute pressure sensor
(7) Engine coolant temperature sensor
(8) Spark plug
(9) Ignition coil and igniter assembly
(10) Crankshaft position sensor
(11) Mass air flow and intake air temperature sensor

- Type 2



(1) Battery
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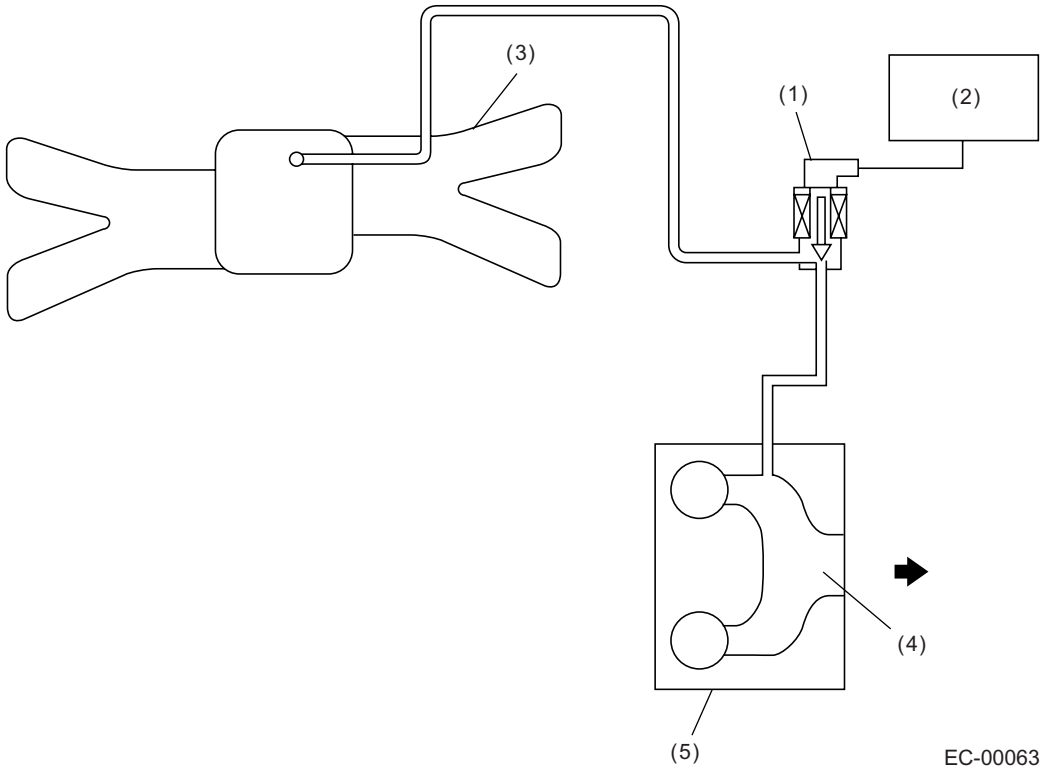
(6) Manifold absolute pressure sensor
(7) Engine coolant temperature sensor
(8) Spark plug
(9) Ignition coil and igniter assembly
(10) Crankshaft position sensor
(11) Mass air flow and intake air temperature sensor

7. Exhaust Gas Recirculation (EGR) System

1. 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

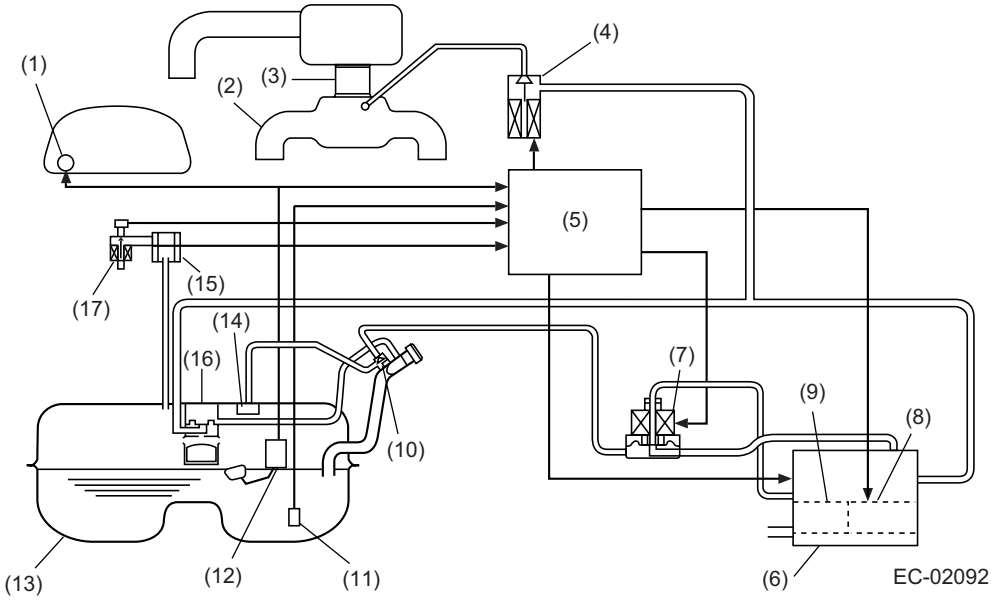
A: GENERAL

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

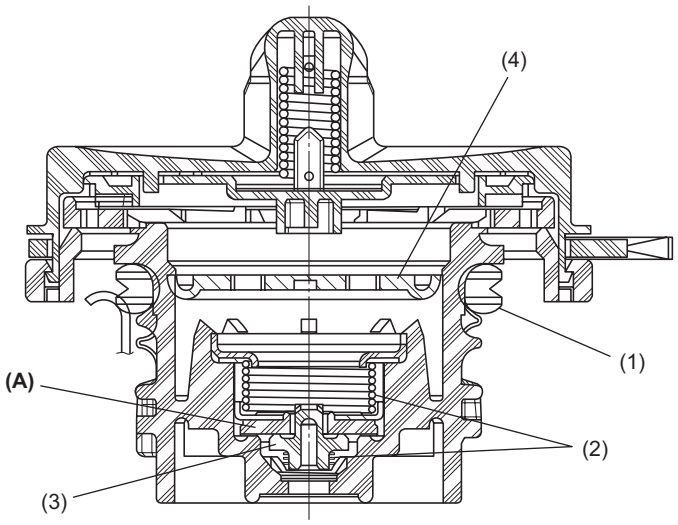
B: FUEL CUT VALVE

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

C: FUEL TANK CAP

- The fuel tank cap is of a quick lock type and can be opened or closed in 1/4 of a full turn.
- The fuel tank cap has a relief valve, which prevents development of vacuum in the fuel tank in the event of a problem with the fuel vapor line.

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



EC-02109

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

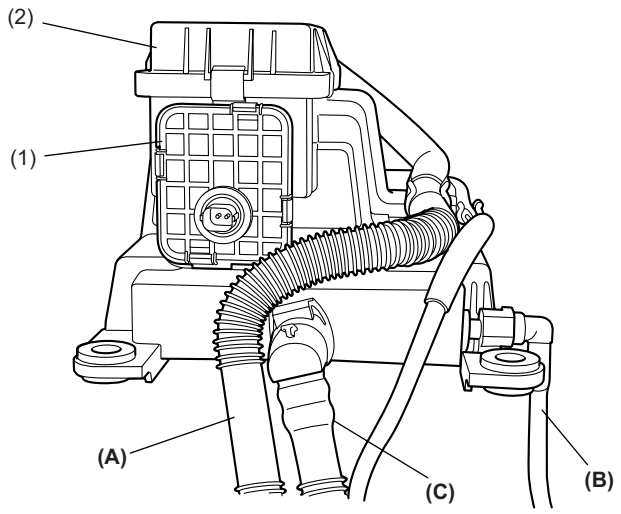
D: CANISTER

The canister incorporates a drain valve and a drain filter.

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.

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.

The drain valve is located just below the drain filter.



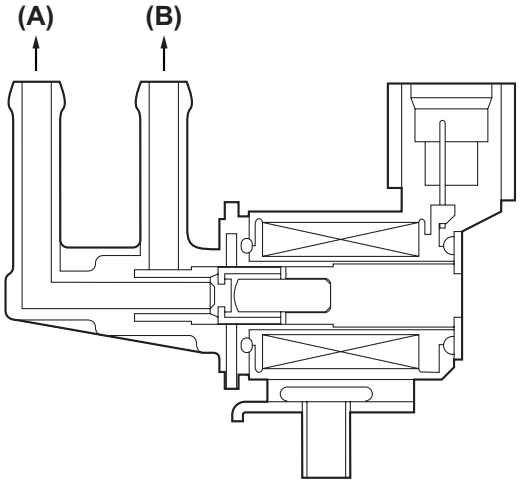
EC-02093

(1) Drain valve
(2) Drain filter

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

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 under the intake manifold.



EC-00237

(A) To intake manifold

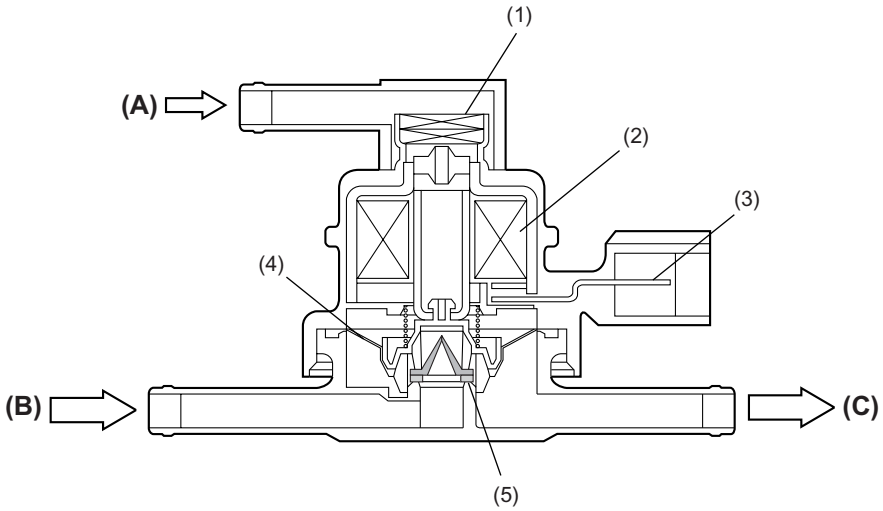
(B) To canister

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.



EC-00026

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

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

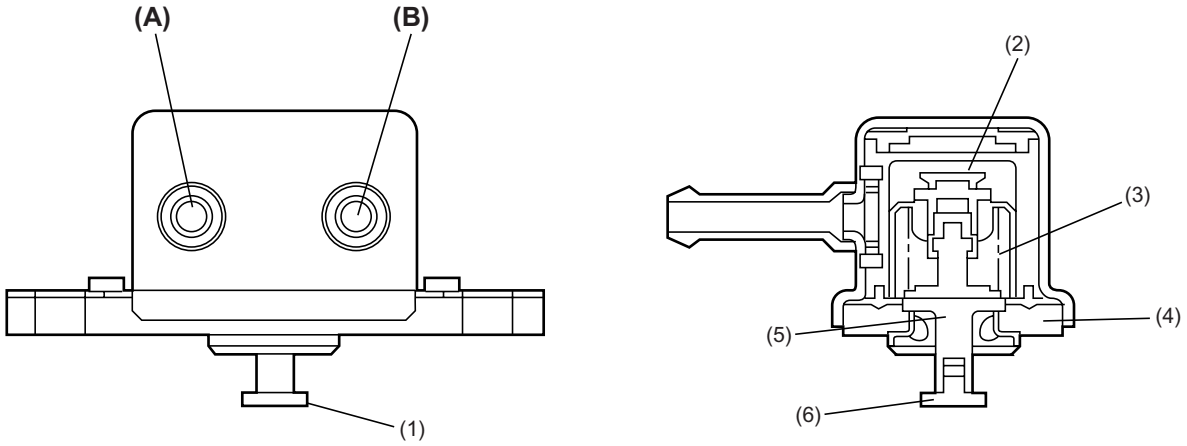
G: VENT VALVE

The vent valve is incorporated 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.

H: 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.



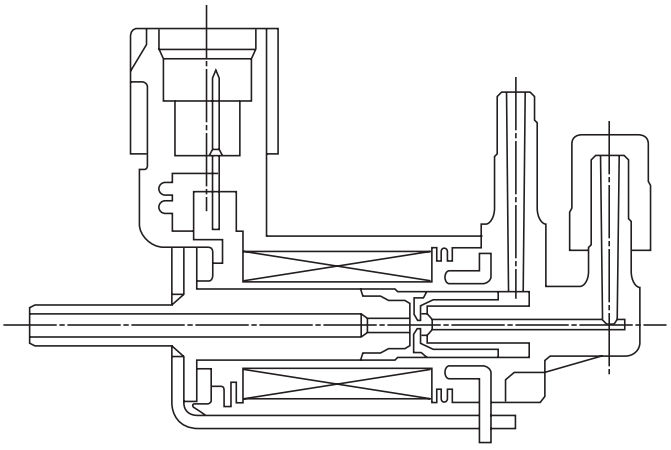
EC-00029

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

(A) To canister
(B) To fuel tank

I: FUEL TANK SENSOR CONTROL VALVE

The fuel tank sensor control valve is installed on the top of the fuel tank and its one end is connected to the fuel tank pressure sensor while its other end is open to the atmosphere.

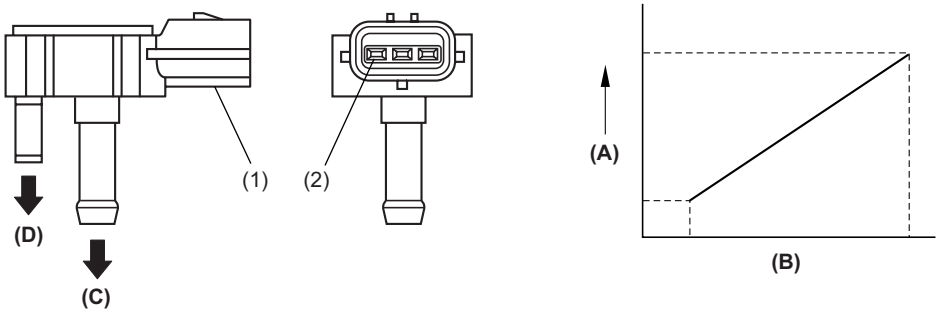


EC-00031

J: FUEL TANK PRESSURE SENSOR

The fuel tank pressure sensor is installed on the top of the fuel tank and measures the pressure in the fuel tank.

The measured pressure is converted into an electrical signal and sent to the ECM for diagnosis of the evaporative emission control system.



EC-02110

(1) Connector
(2) Terminal

(A) Output voltage
(B) Input pressure
(C) To fuel tank
(D) To fuel tank sensor control valve

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

A: GENERAL

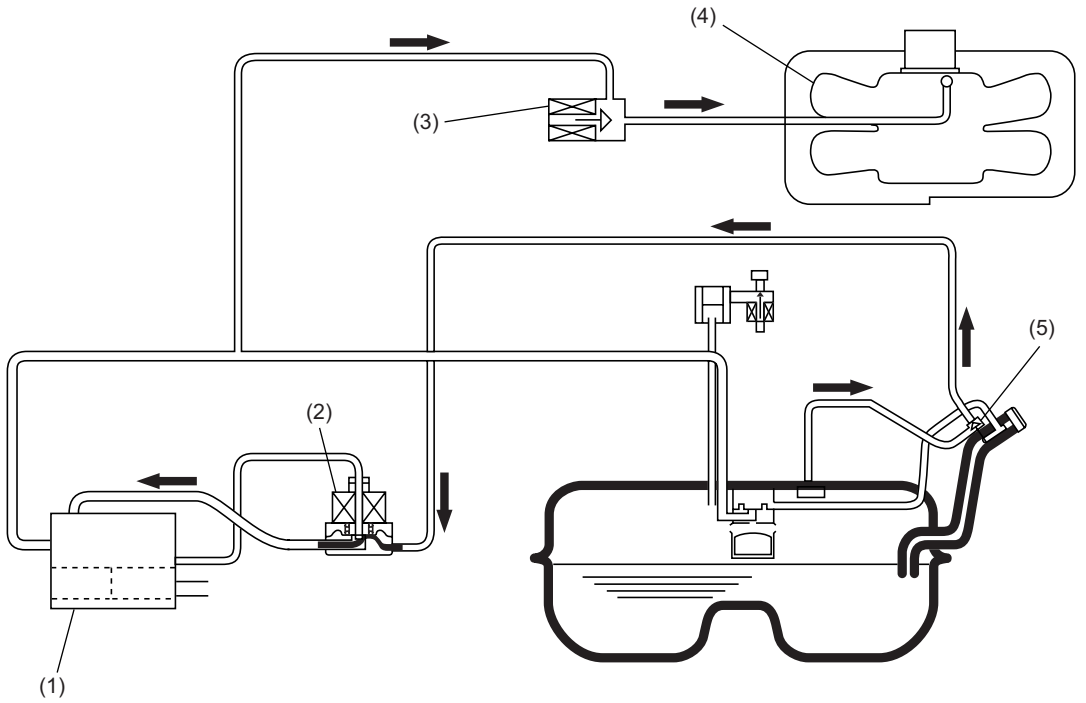
The on-board refueling vapor recovery system allows the fuel vapors in the fuel tank to be introduced directly into the canister through the vent valve when the fuel tank inside pressure increases as a result of refueling.

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.

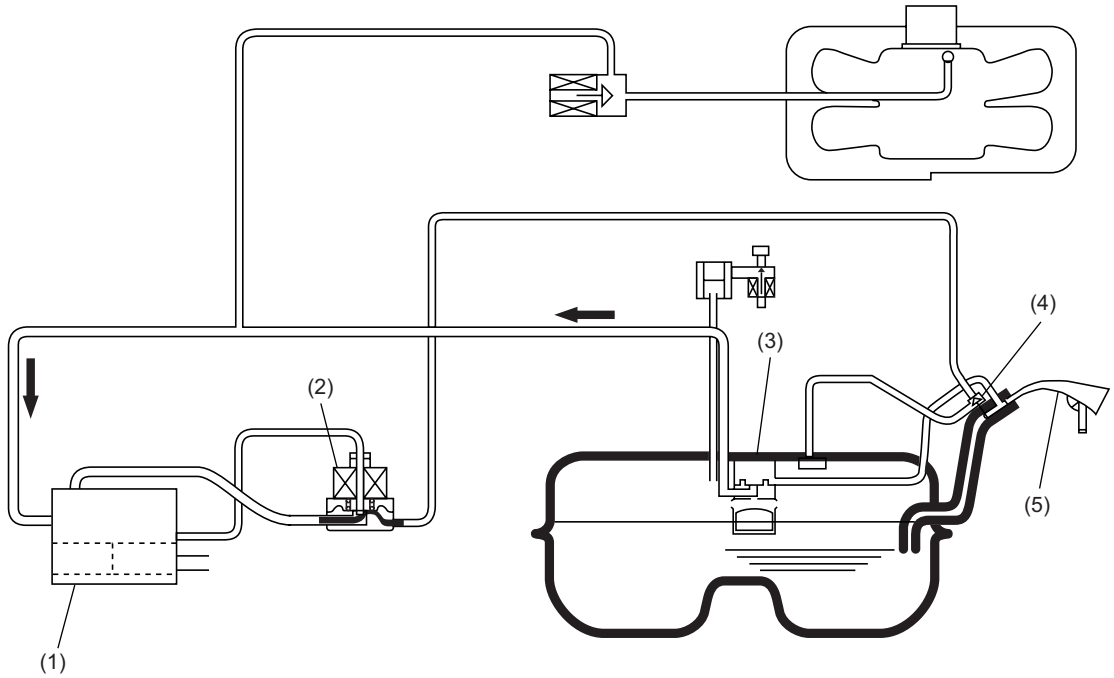


EC-02094

(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.

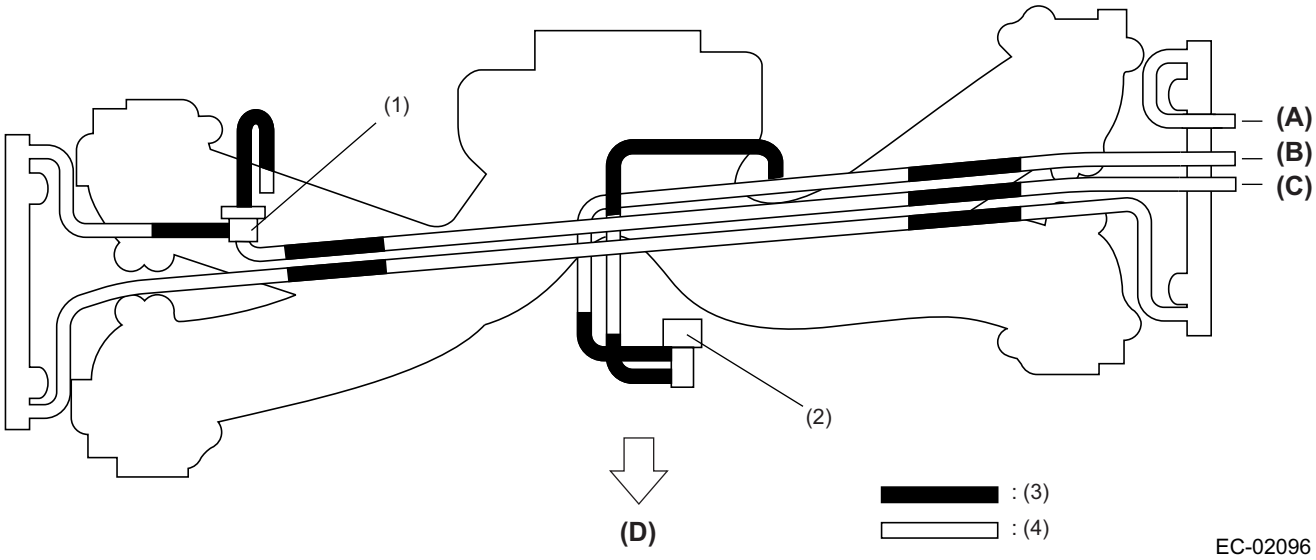


EC-02095

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

10.Vacuum Connections

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



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

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

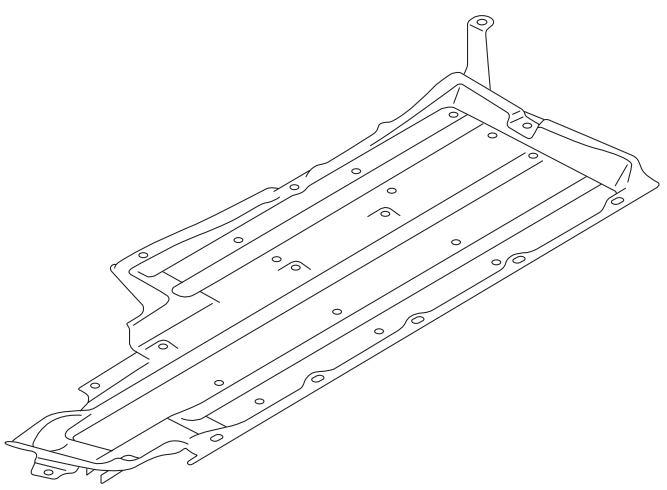
EXTERIOR / INTERIOR TRIM

1. Under Cover

A: FLOOR UNDER COVER

● A floor under cover is installed to both sides of the vehicle's floor part to improve the aerodynamic characteristics at the underside of the vehicle.

● Taking recycling reasons into account, polypropylene (PP) material is used.

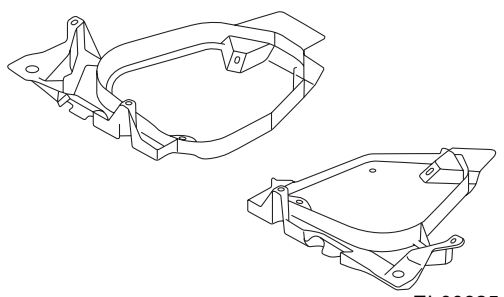


EI-00824

B: FUEL TANK PROTECTOR

● A fuel tank protector is installed to prevent damage to the fuel tank by flying stones etc. during driving.

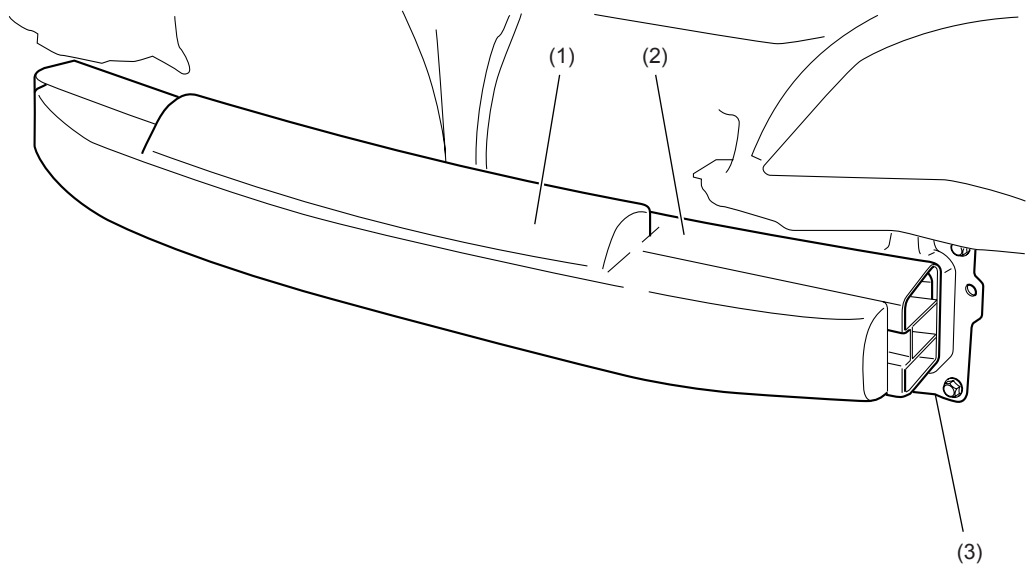
● Taking recycling reasons into account, polypropylene (PP) material is used.



EI-00825

2. Front Bumper Beam

A bumper beam assembly is placed inside the front bumper. The beam assembly is fastened to the chassis frame and absorbs the shock energy in case of a front collision to enhance safety of the vehicle.



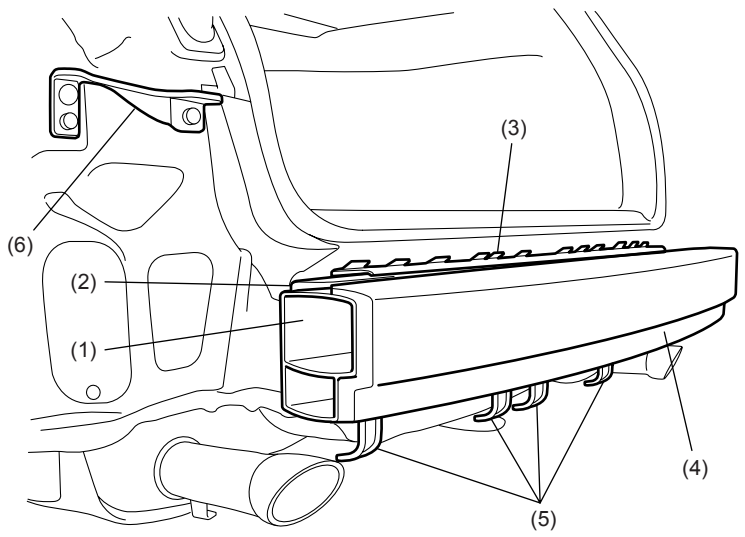
EI-01034

(1) Energy absorber foam
(2) Bumper beam reinforcement
(3) Bumper beam bracket

3. Rear Bumper Beam

● A bumper beam assembly is placed inside the rear bumper. The beam assembly is fastened to the chassis frame and absorbs the shock energy in case of a rear collision, etc. to reduce damage to the vehicle.

● The rear bumper assembly consists of a bumper face bracket, main beam, main beam bracket, and energy absorber foam made of PP foam.

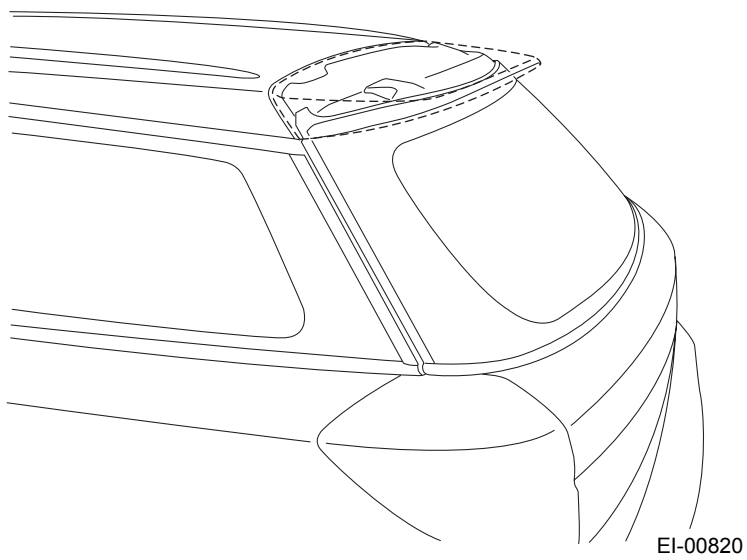


EI-01035

(1) Main beam
(2) Main beam bracket
(3) Beam upper rear
(4) Energy absorber foam
(5) Lower bracket
(6) Corner bracket

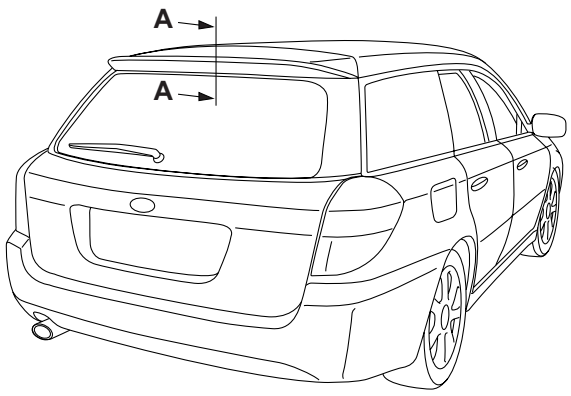
4. Roof Spoiler (Wagon Models)

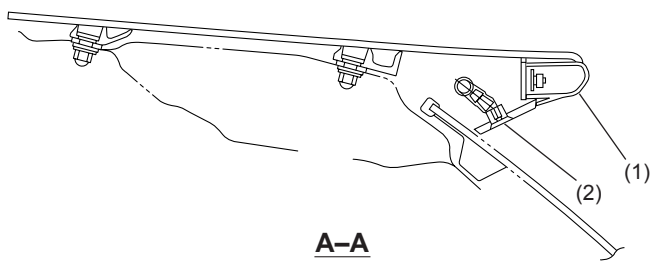
● The spoiler is built into the rear gate and is provided as standard equipment.



EI-00820

● In connection with providing the spoiler on all models, the high mount stop light and rear washer nozzle are incorporated in the roof spoiler.





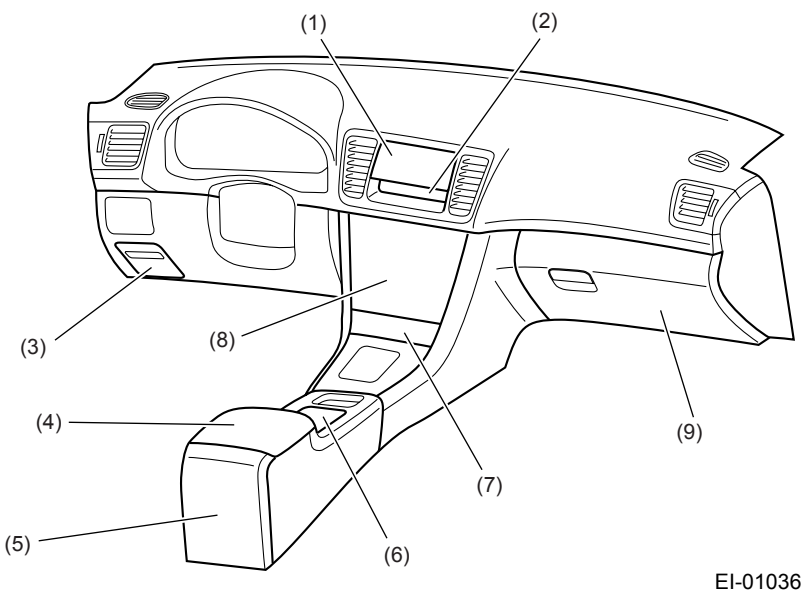
EI-00821

(1) High mount stop light

(2) Rear washer nozzle

5. Instrument Panel

- By modularizing the panel with the steering support beam, a sufficient rigidity is obtained, its quality is stabilized, and maintainability is improved.
- By tilting the center panel toward the driver, its operability and visibility is improved.
- There is no longer a split line between the passenger's airbag module lid and the instrument panel, contributing to a better appearance.
- Taking recycling reasons into account, PP resin is used for the main body. The entire upper part of the instrument panel is covered with urethane foam material with a soft surface skin. This material feels soft while it also contributes to protect passengers.
- An insulator is installed to the backside of the instrument panel. The insulator absorbs noise from the engine room and contributes to improve the quietness in the cabin.
- The panel is upholstered as far as the leg area of front passenger to improve the feel of material.

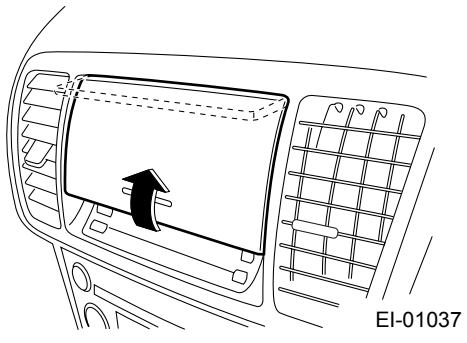


EI-01036

(1) Center pocket
(2) Clock
(3) Fuse box cover
(4) Console box
(5) Cup holder for rear seat passengers
(6) Cup holder for front seat passengers
(7) Ashtray and cigarette lighter
(8) Center panel
(9) Glove box

A: CENTER POCKET

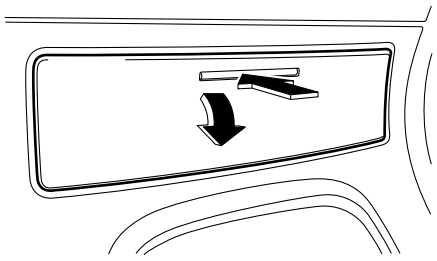
- A pocket with a lid is provided at the center of the instrument panel.
- Night illumination, which operates in connection with the lighting system, is provided.



EI-01037

B: ASHTRAY AND CIGARETTE LIGHTER FOR FRONT SEAT PASSENGERS

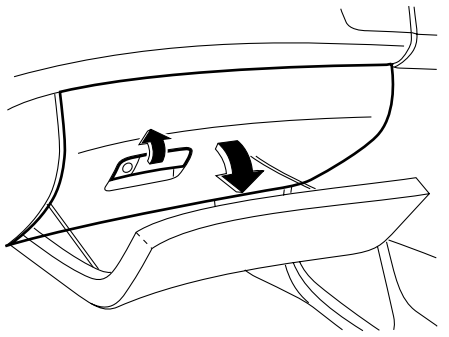
- These are located at the lower part of the center panel and can be opened in one-push action.
- The ashtray and cigarette lighter are provided with night illumination, which operates in connection with the lighting system.



EI-00685

C: GLOVE BOX

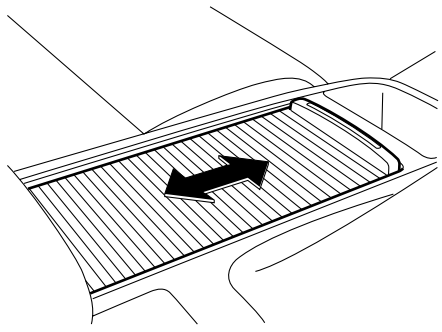
- The glove box is provided with a damper that controls the glove box lid to open slowly.
- It is also provided with night illumination that operates in connection with the lighting system.



EI-01068

D: CUP HOLDER FOR FRONT SEAT PASSENGERS

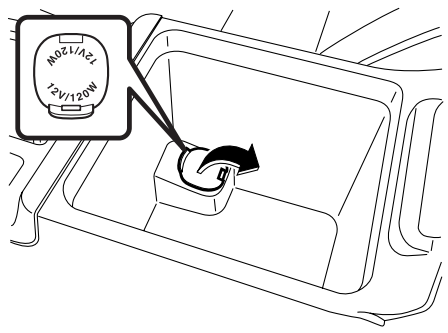
- Provided with a shutter type lid that can be closed when the cup holder is not used.
- The cup holder can hold a container up to a 500 cc size plastic bottle or an L size paper cup.



EI-00688

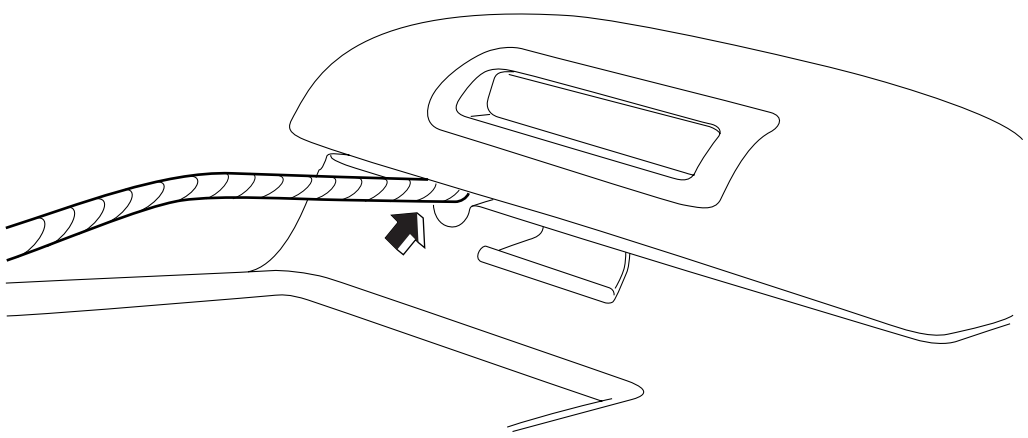
E: CONSOLE BOX

- An accessory socket is provided in the console box.



EI-01069

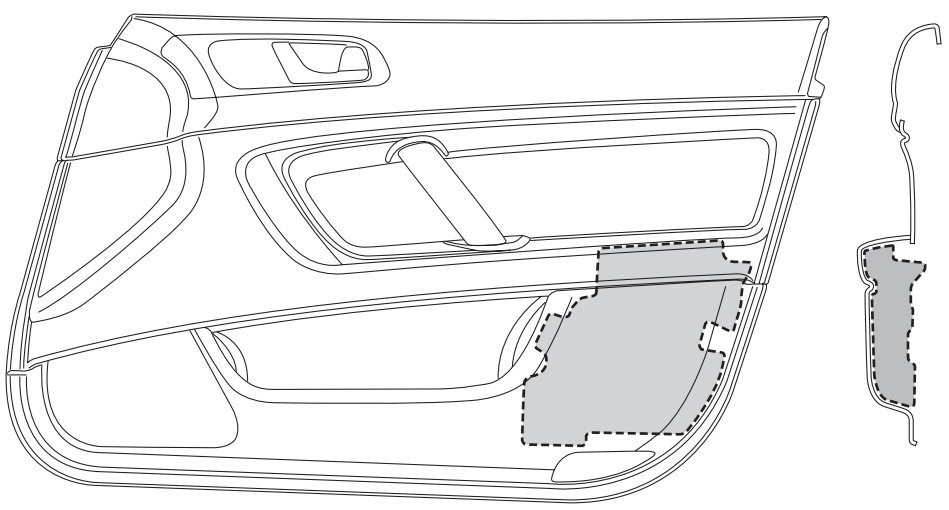
- When using the socket, the cable can be routed out from the front of the console box so that the cable will not be trapped even when the console lid is closed.



EI-01038

6. Door Trim

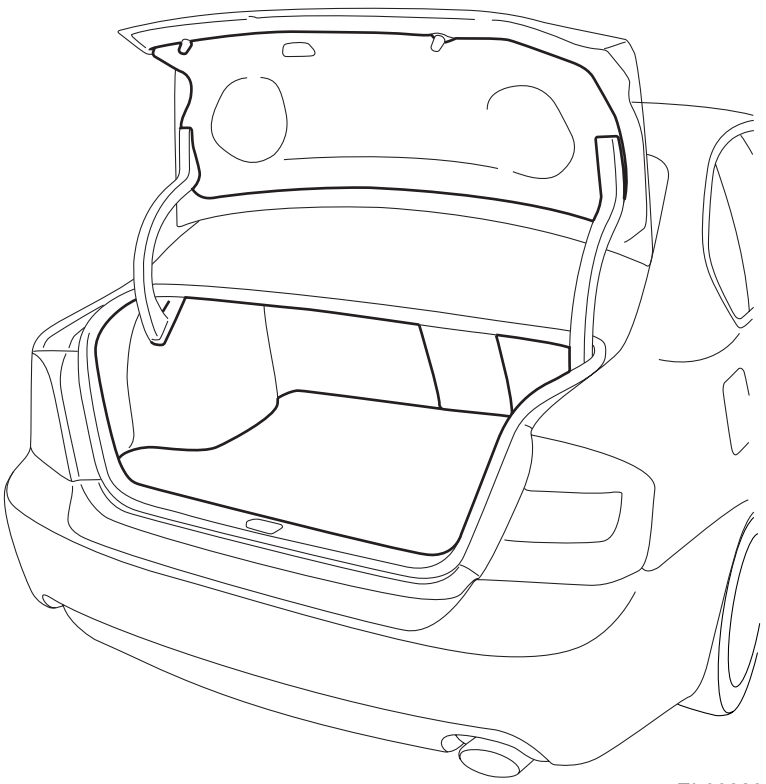
Shock absorbing pads installed to the backside of the front and rear door trims attenuate the impact due to a secondary collision.



EI-00826

7. Trunk Room Trim

Trunk lid trims and trunk lid arm covers are used to improve the feel of material.



EI-00823

ENTERTAINMENT SYSTEM

1. Audio System

A: GENERAL

1. AUDIO

Three types are provided.

● Audio sets of all grades are shaped in a non-standard form to make them fit the contour of the instrument panel.

● All grades are CD-R/RW compatible*.

● The highest grade audio system is also compatible with CD-R/CD-RWs* containing MP3 files.

● The audio unit for automatic air conditioning equipped models has a built-in CD changer.
Up to six CDs can be loaded.

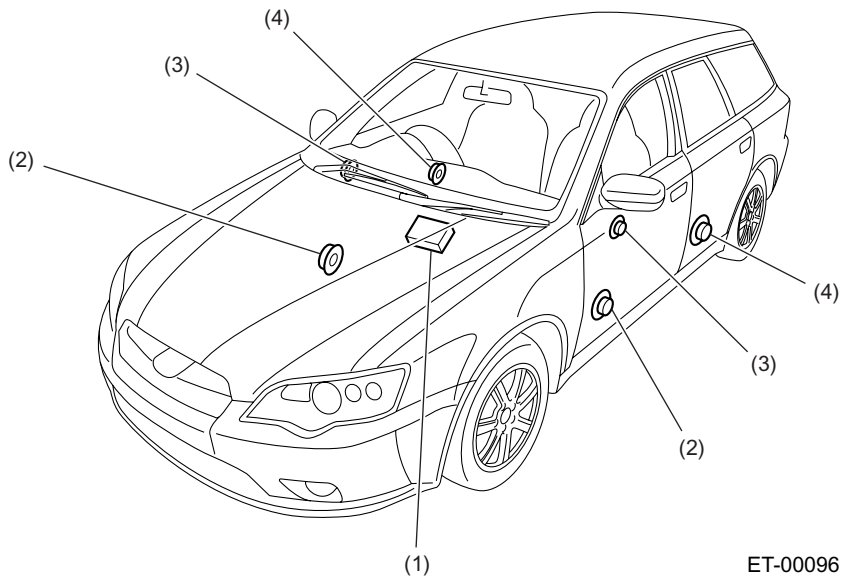
*: Some CD-R/RW discs with particular characteristics, scratches or dirty spots may not be usable.

2. SPEAKERS

● On models with six speakers, a full-range speaker is installed to each door and a tweeter is installed to each front door.

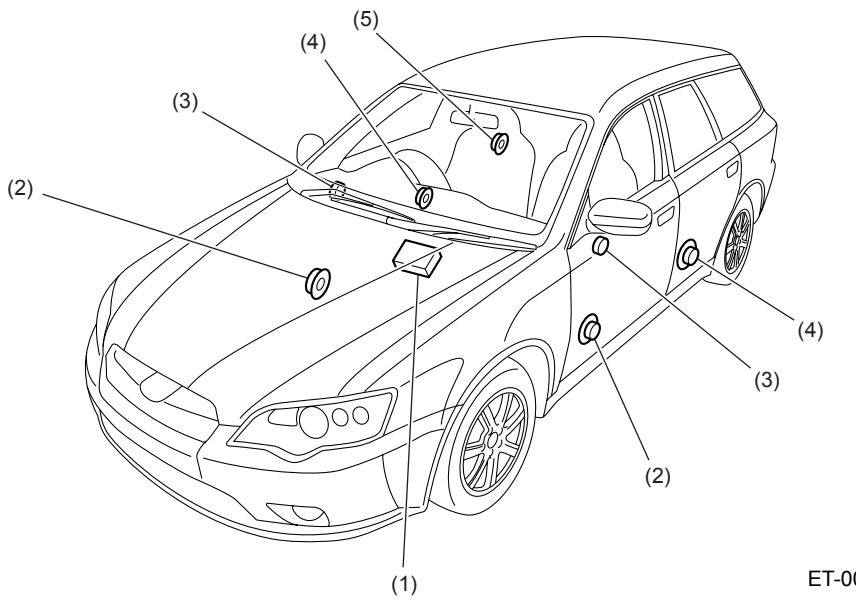
● On models with seven speakers, a full-range speaker is installed to each door and a tweeter and sub woofer are installed to each front door. The sub woofer is mounted on the rear right quarter trim (wagons).

Models with the 6 speaker system



(1) Audio unit
(2) Front speaker
(3) Tweeter
(4) Rear speaker

Models with the seven speaker system



ET-00152

(1) Audio unit
(2) Front speaker
(3) Tweeter
(4) Rear speaker
(5) Woofer (wagons)

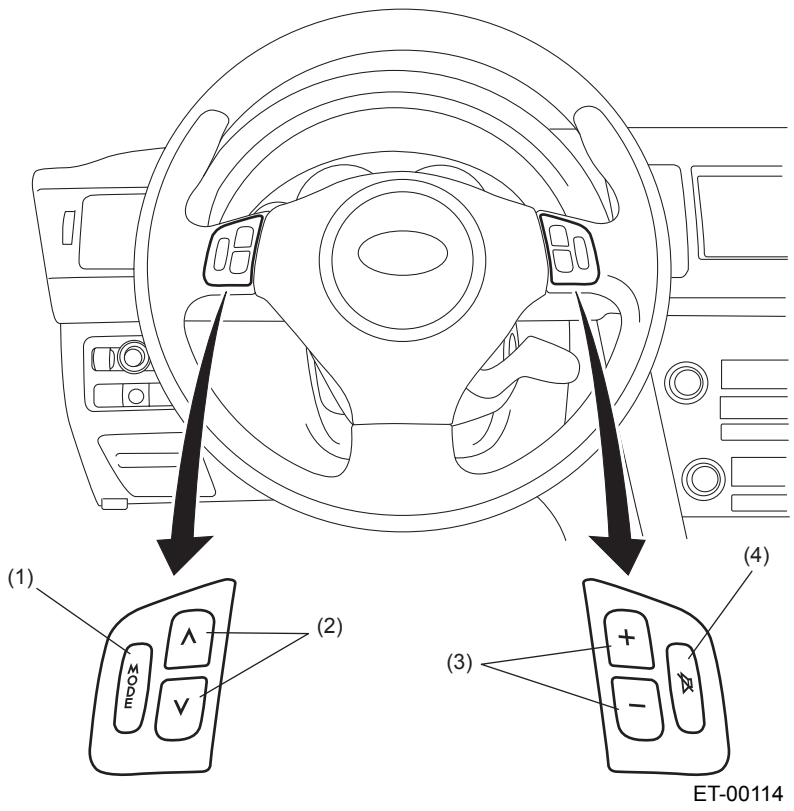
3. ANTENNA

- An on-glass antenna system is equipped on all models.
- The antenna amplifier is installed at the upper part of the rear left pillar on sedan models or at the upper center part of the rear gate on wagon models.

2. Satellite Switches

A: GENERAL

The driver can operate the audio system without releasing the hand from the steering wheel, Illumination is provided for nighttime visibility.



(1) Mode switch
(2) ∧ ∨ (Up/down) switch
(3) + – (volume) switch
(4) Mute switch

SATELLITE SWITCHES

1. MODE SWITCH

The mode of the audio system can be changed.

2. ∧ ∨ (UP/DOWN) SWITCH

- When receiving radio or TV waves, the frequency can be changed upwards or downwards. When the receiver is tuned to a radio or TV station during the upward or downward seek, the seek stops. (seek up/seek down)
- While listening to a CD, the next track or previous track can be selected. (track up/track down)

3. + – (VOLUME) SWITCH

The sound level can be turned up or down.

4. MUTE SWITCH

The sound can be temporarily muted. When this switch is operated, “MUTE” is indicated on the audio display. The sound level is resumed when the switch is pushed again.

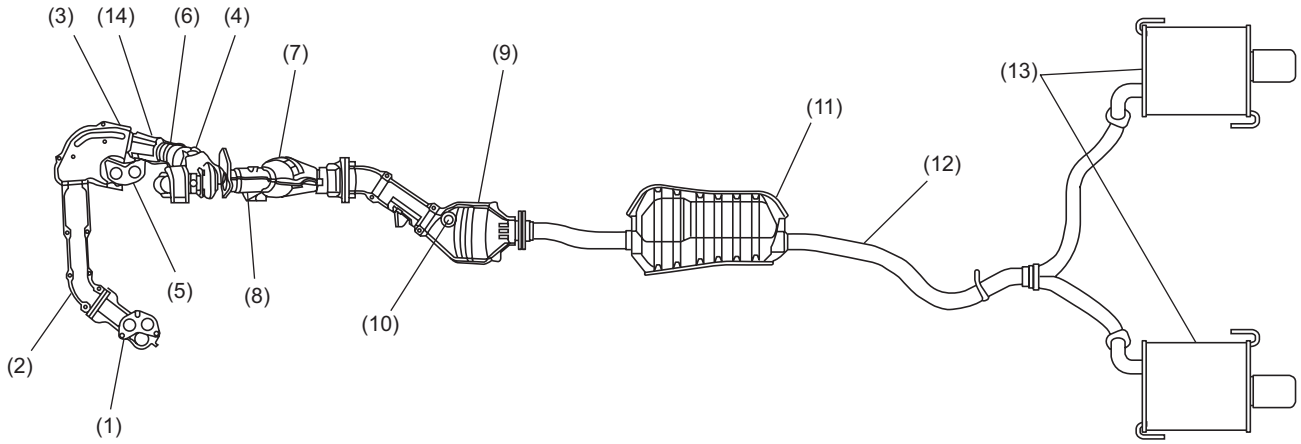
EXHAUST
(H4DOTC)

1. General

● The exhaust system consists of left and right exhaust manifolds, a front joint pipe, a turbocharger joint pipe, a center exhaust pipe, a rear exhaust pipe and a muffler. The pre catalytic converter is incorporated in the turbocharger joint pipe, the front catalytic converter is incorporated in the center exhaust pipe, and the rear catalytic converter is incorporated in the rear exhaust pipe.

● The exhaust system features an excellent sound suppression design; the rear exhaust pipe has a chamber in addition to a large capacity muffler.

2. Construction



EX-02079

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

EXHAUST
(H4SO U5)

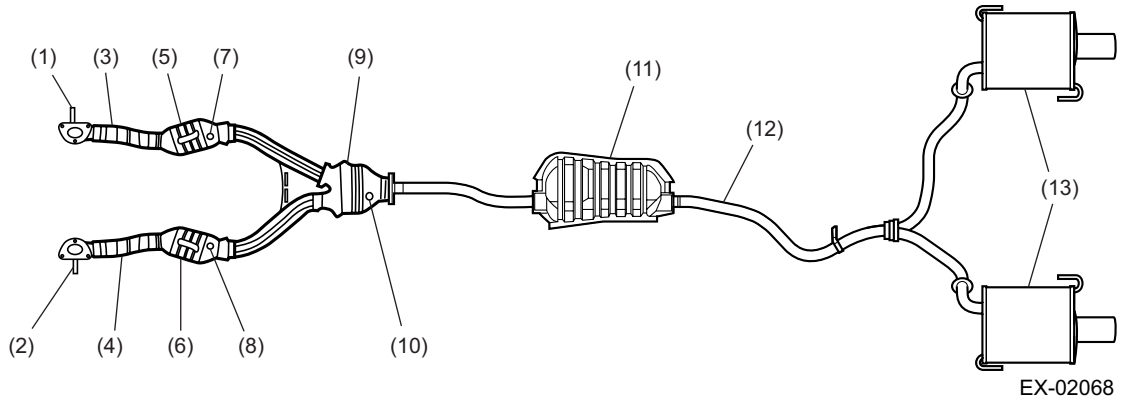
1. General

● The exhaust system consists of front exhaust pipes, three-way catalytic converters, a rear exhaust pipe and a muffler.

● The front exhaust pipe assembly consists of a front exhaust pipe (RH), which incorporates the front catalytic converter (RH), and a front exhaust pipe (LH), which incorporates the front catalytic converter (LH) and the rear catalytic converter.

● The exhaust system features an improved sound suppression design and has a chamber in addition to the muffler. Also, a twin-muffler system is used to reduce gas flow resistance.

2. Construction



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

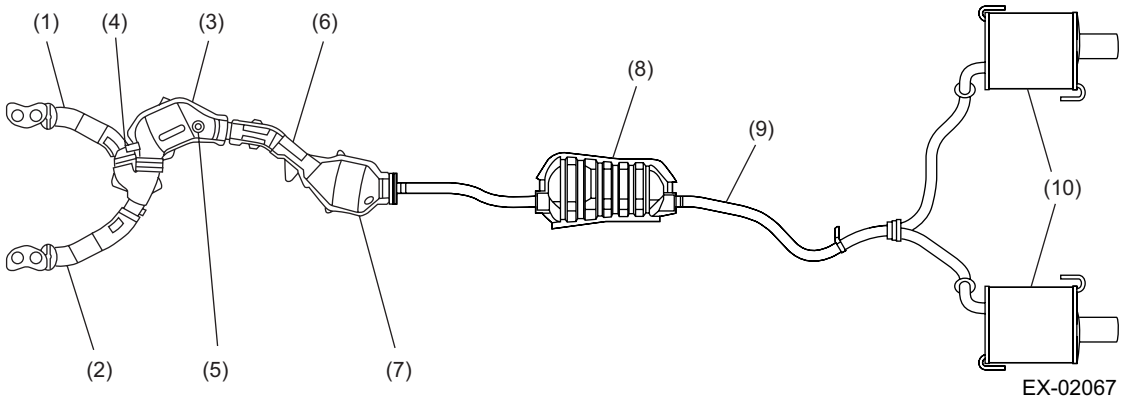
EXHAUST
(H4SO)

1. General

● The exhaust system consists of front exhaust pipes, three-way catalytic converters, a center exhaust pipe, a rear exhaust pipe and a muffler. The front catalytic converter and rear catalytic converter are incorporated in the center exhaust pipe.

● The exhaust system features an improved sound suppression design and has a chamber in addition to the muffler. Also, a twin-muffler system is used to reduce gas flow resistance.

2. Construction



(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) Chamber
(9) Rear exhaust pipe
(10) Muffler

MEMO

FRONT SUSPENSION

1. Front Suspension

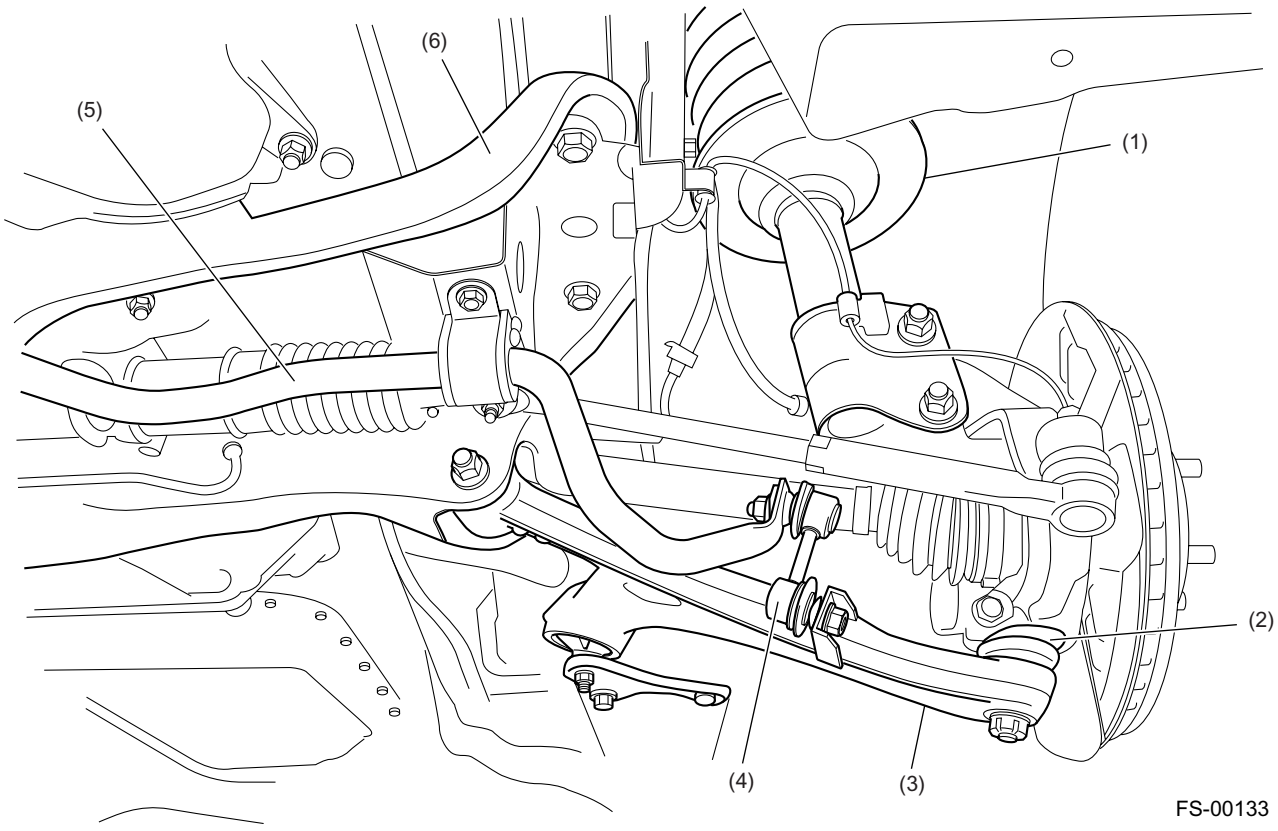
A: GENERAL

The front suspension is a McPherson strut-type independent suspension which have coil springs and dampers. The suspension on each side consists of a front arm, stabilizer, and a strut assembly.

The front arm is an “L” shaped arm. The outer end of the front arm is fixed to the front axle through a ball joint. The front of the arm’s inner end is fitted to the front cross member while the rear of the inner end is fixed to the vehicle body.

The front cross member is bolted to the vehicle body.

The front cross member bears the front arm, steering gearbox, and stabilizer.



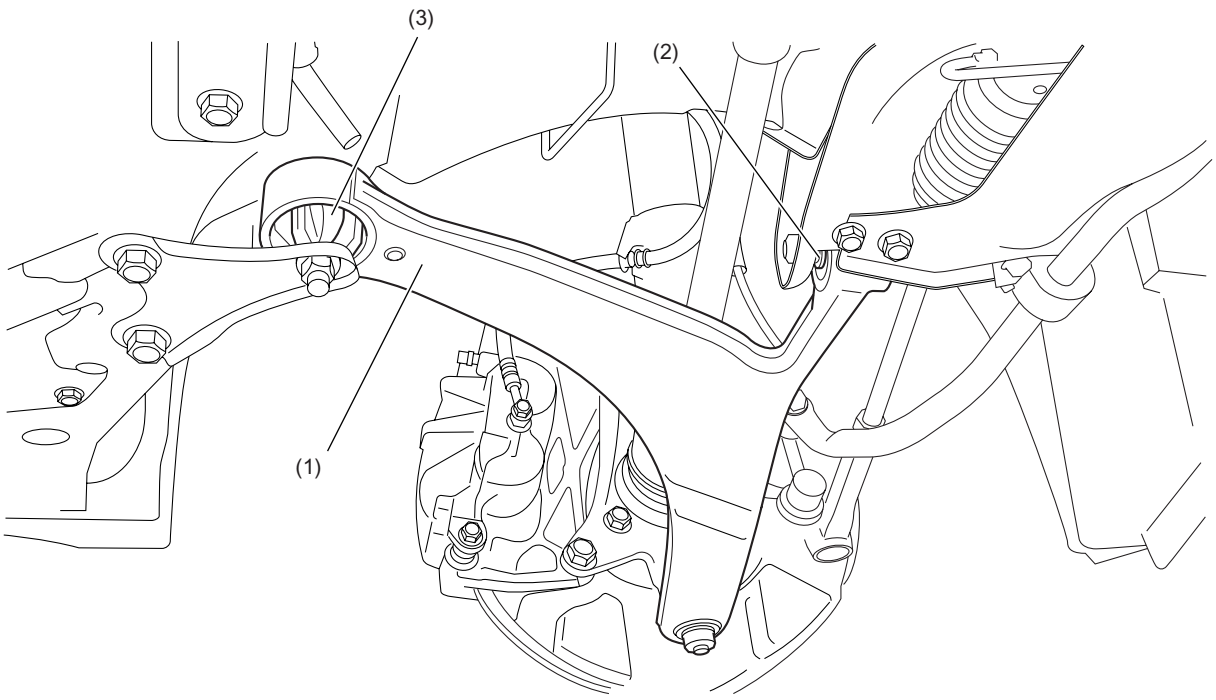
(1) Strut
(2) Ball joint
(3) Front arm
(4) Stabilizer link
(5) Stabilizer bar
(6) Front cross member

B: CONSTRUCTION

1. FRONT ARM

● By optimizing the shape of the front arm, a high strength and light weight are simultaneously achieved.

● The arm has a maintenance-free ball joint fitted by a castle nut at its outer end.
A rubber bushing is used at the front, and a hollowed bushing is used at the rear.



FS-00134

(1) Front arm
(2) Front bushing
(3) Rear bushing

2. STRUT

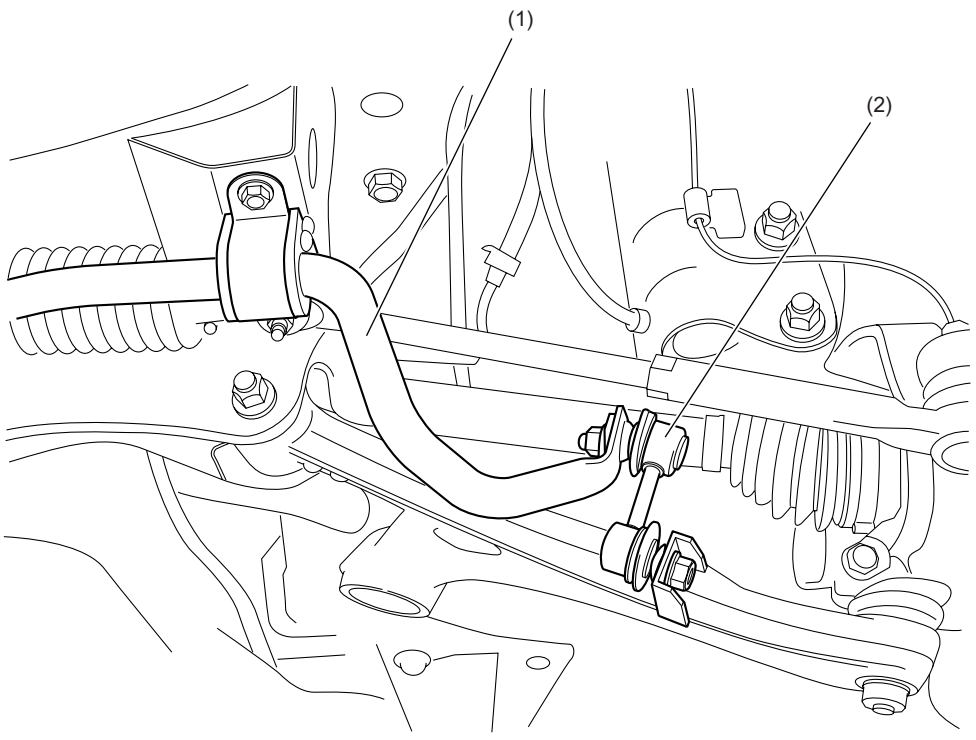
● The strut consists of a cylindrical double-acting low pressure gas filled damper that attenuates shock from the road surface.

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

3. STABILIZER

● The solid round rod stabilizer is attached to the front cross member through rubber cushions and its right and left ends are connected to the front arm through ball joints.

● The attitude change of the vehicle during a turn is controlled by the bar's torsional resistance.



FS-00135

(1) Stabilizer bar
(2) Stabilizer link

FUEL INJECTION
(FUEL SYSTEMS)
(H4DOTC)

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

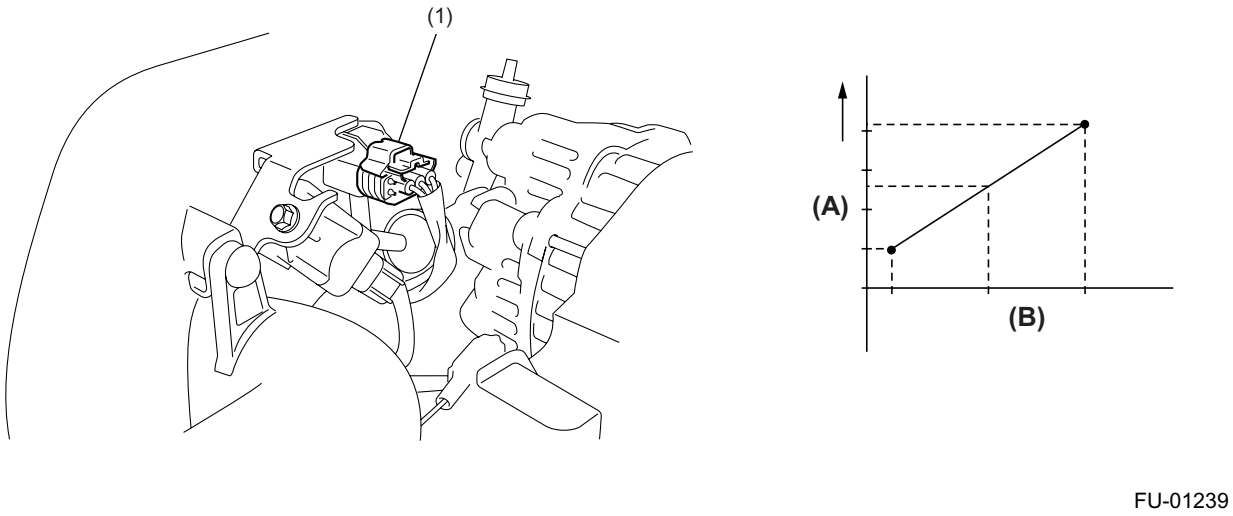
2. Air Line

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.

B: MANIFOLD ABSOLUTE PRESSURE SENSOR

The manifold absolute pressure sensor is attached to the intake manifold, 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-01239

(1) Manifold absolute pressure sensor

(A) Output voltage

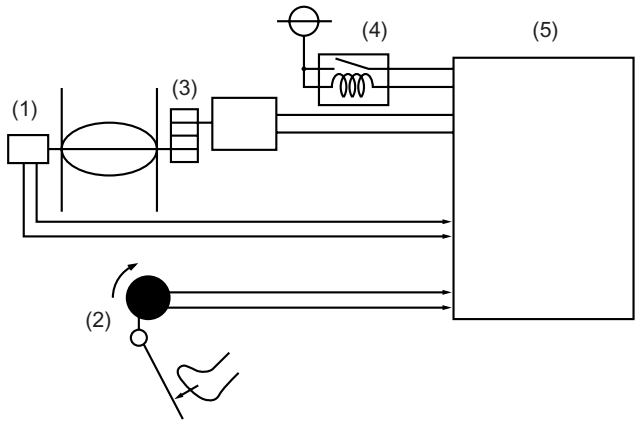
(B) Absolute pressure

C: ELECTRONIC CONTROL THROTTLE SYSTEM

● The electronic control throttle system consists of an accelerator pedal position sensor mounted on the accelerator pedal, a throttle position sensor and a throttle motor mounted on the throttle body, and the ECM which controls these devices.

● The movement of the accelerator pedal is converted into electrical signals by the accelerator pedal position sensor and sent to the ECM. Based on these signals the ECM controls the throttle motor to open and close the throttle valve.

● Idling control is now performed by the electronic control throttle system in place of the idle air control solenoid valve.



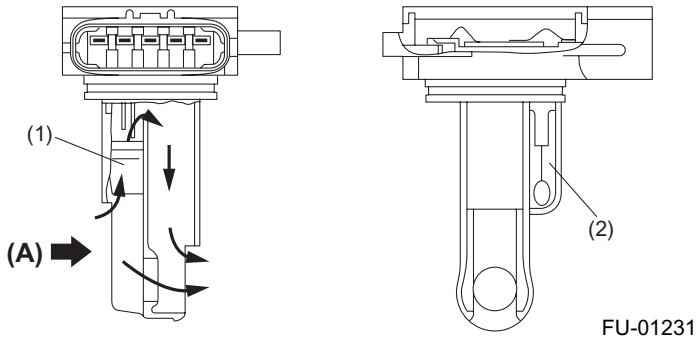
FU-01230

(1) Throttle position sensor
(2) Accelerator pedal position sensor
(3) Electronic control throttle assembly
(4) Electronic control throttle relay
(5) ECM

D: MASS AIR FLOW AND INTAKE AIR TEMPERATURE SENSOR

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

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

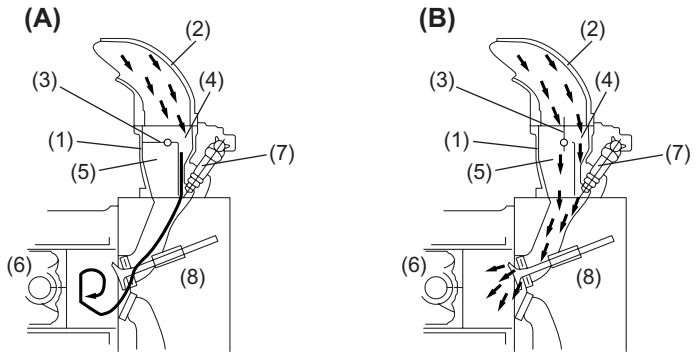


(1) Mass air flow sensor
(2) Intake air temperature sensor
(A) Air

E: TUMBLE GENERATOR VALVE

● A tumble generator valve is provided on each engine bank, between the intake manifold and intake air ports. The right bank tumble generator valve has butterfly valves for the #1 and #3 cylinders and the left bank tumble generator valve has those for the #2 and #4 cylinders. The two butterfly valves in each tumble generator valve are fitted on a single shaft that is driven by an actuator.

● The tumble generator valves are controlled by the ECM according to the coolant temperature and the time elapsed after start of the engine. When the engine is started, the butterfly valves are moved to the closing ends. In this state, the intake air flows at very high speeds passing through narrowed passages in the directions determined by the individual intake air ports in the cylinder head. This creates tumbling air motions in the cylinders, which enables lean mixtures to be ignited and thus harmful exhaust emissions to be reduced during engine start. The tumble generator valves are fully open when the engine is operating at an ordinary driving speed, allowing intake air to flow without being changed in direction and velocity.



FU-01232

(A) When closed
(B) When wide open
(1) Tumble generator housing
(2) Intake manifold
(3) Tumble generator valve
(4) Tumble generating air passage
(5) Intake main air passage
(6) Piston
(7) Injector
(8) Cylinder head

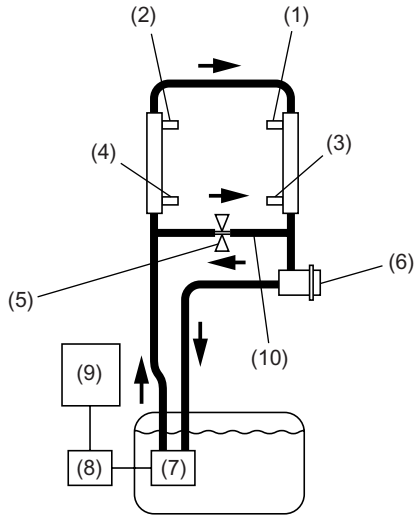
3. Fuel System

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.

● On some models, the fuel bypass return passage connected between the fuel pump and engine prevents excessive fuel to be supplied to the engine and lowers the fuel temperature after return, to reduce the generation of evaporative gas.

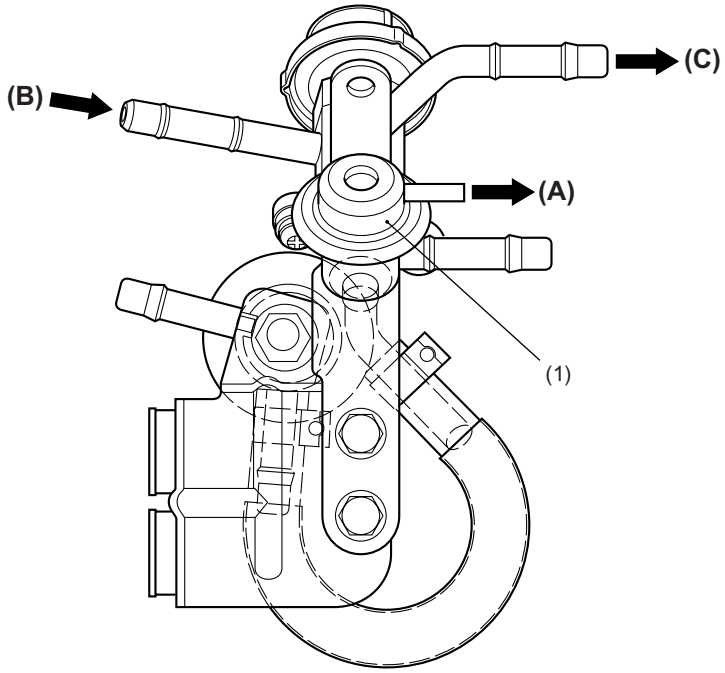


FU-02027

(1) #1 fuel injector
(2) #2 fuel injector
(3) #3 fuel injector
(4) #4 fuel injector
(5) Orifice
(6) Pressure regulator
(7) Fuel pump
(8) Fuel pump control unit
(9) ECM
(10) Fuel return passage

B: PRESSURE REGULATOR

The pressure regulator is installed in 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 to precisely control the amount of injected fuel.



FU-02028

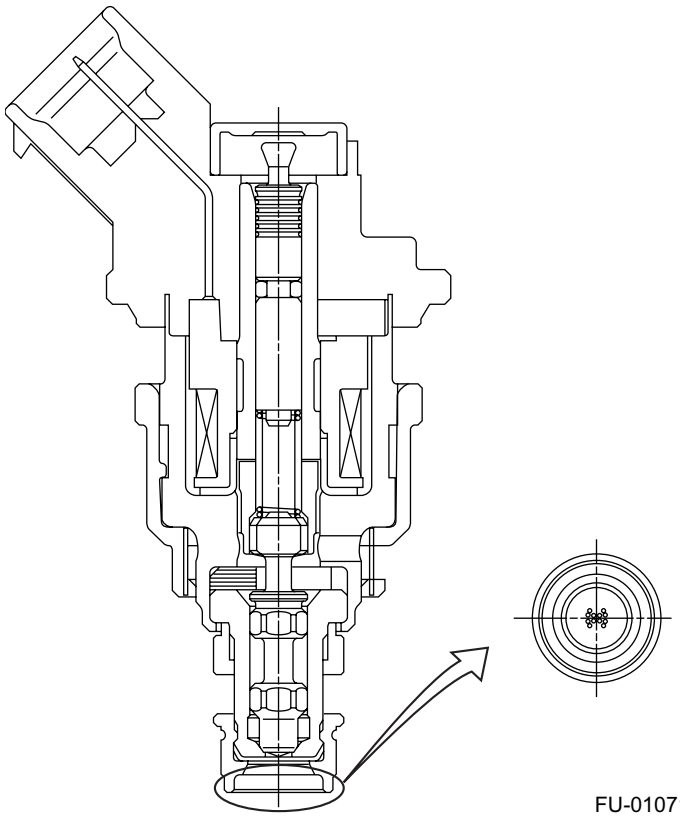
(1) Pressure regulator
(A) To intake manifold
(B) Fuel IN
(C) Fuel OUT

C: FUEL INJECTOR

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

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

- The injector injects fuel according to the valve open signal from the ECM. The needle valve is lifted by the solenoid which is energized on arrival of the valve open signal.
- Since the injector's nozzle hole area, the lift of valve and the fuel pressure are kept constant, the amount of fuel injected is controlled only by varying the duration of the valve open signal from the ECM.
- The multi-hole nozzle makes it possible for the injector to produce fine fuel particles, which enhances the combustion efficiency and output performance of the engine.

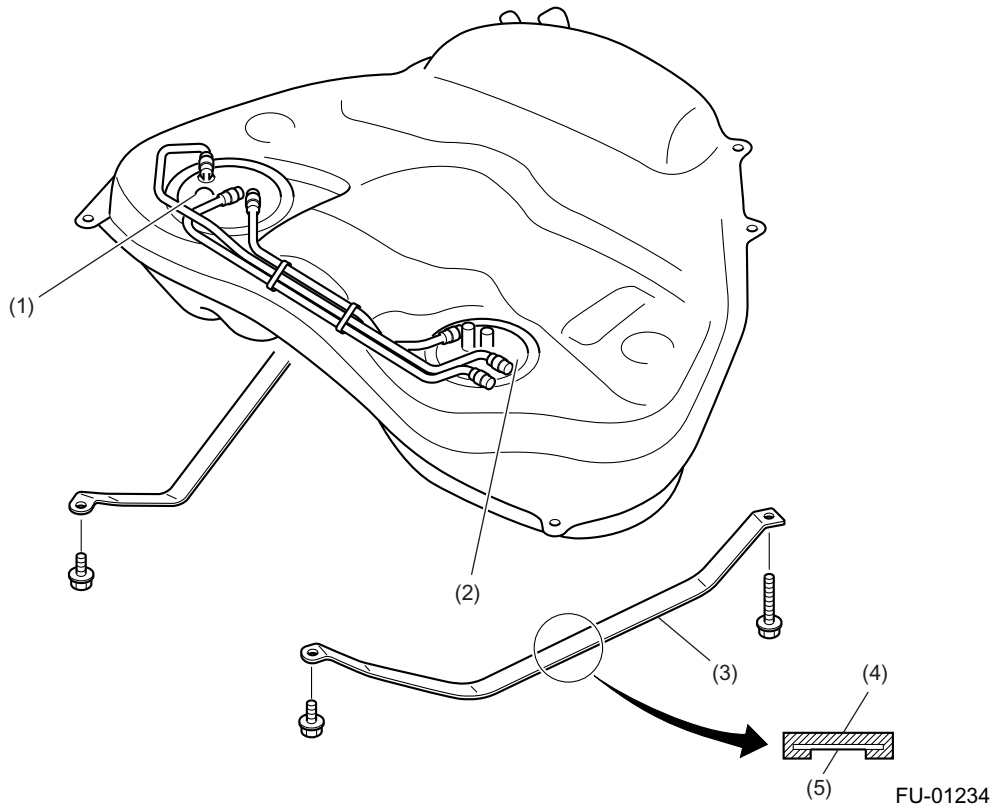


FU-01071

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
(2) Fuel sub level sensor
(3) Band
(4) Cushion
(5) Steel

E: FUEL PUMP AND FUEL LEVEL SENSOR ASSEMBLY

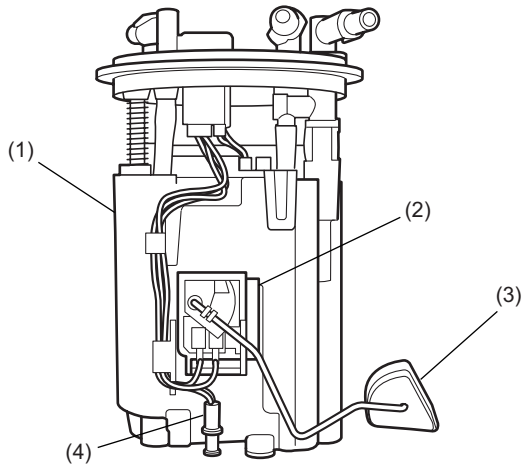
1. FUEL PUMP

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

- 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, the check valve closes 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.



FU-02519

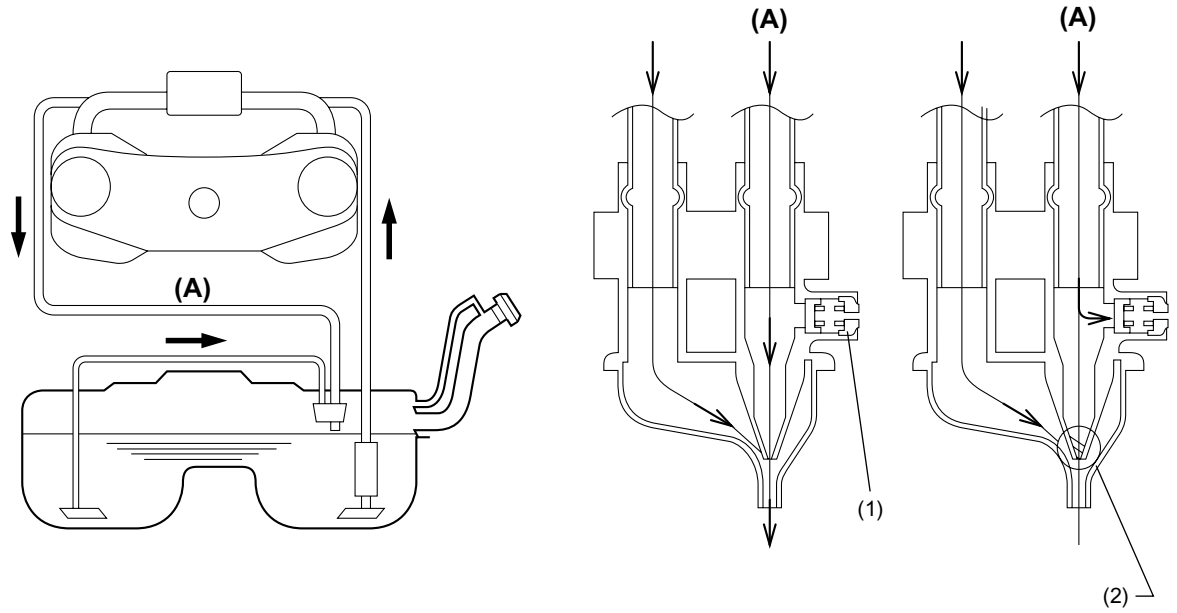
(1) Fuel pump assembly
(2) Fuel level sensor
(3) Float
(4) Fuel temperature sensor

3. JET PUMP

● The jet pump utilizes the velocity of fuel returning from the engine to produce vacuum in it.

● Using the pumping effect produced by the vacuum, the jet pump transfers fuel from the sub side and main side of the fuel tank to the fuel pump.

● When the return line nozzle is clogged, the fuel sent back through the return line flows back into the fuel tank via the relief valve.



FU-00226

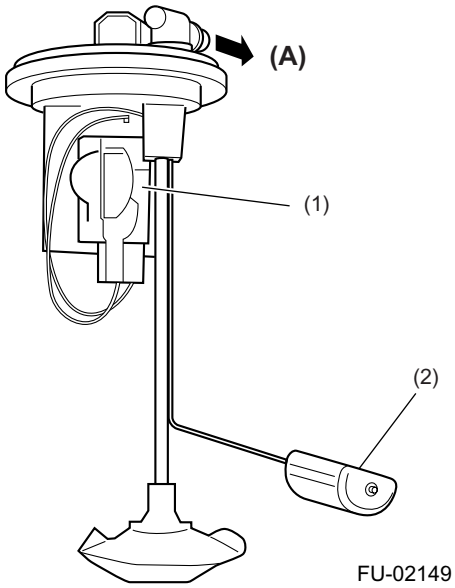
(1) Relief valve
(2) Nozzle
(A) Return line

4. FUEL FILTER

The fuel filter is integrated with the fuel pump assembly which is located in the fuel tank.

F: SUB-COMPARTMENT FUEL LEVEL SENSOR

This sensor detects the level of the fuel in the sub side (the side in which the fuel pump is not located) of the fuel tank. Also, when the jet pump is operating, fuel in the sub side is drawn up and transferred to the fuel pump.



(1) Fuel level sensor
(2) Float

(A) To jet pump

4. Sensors and Switches

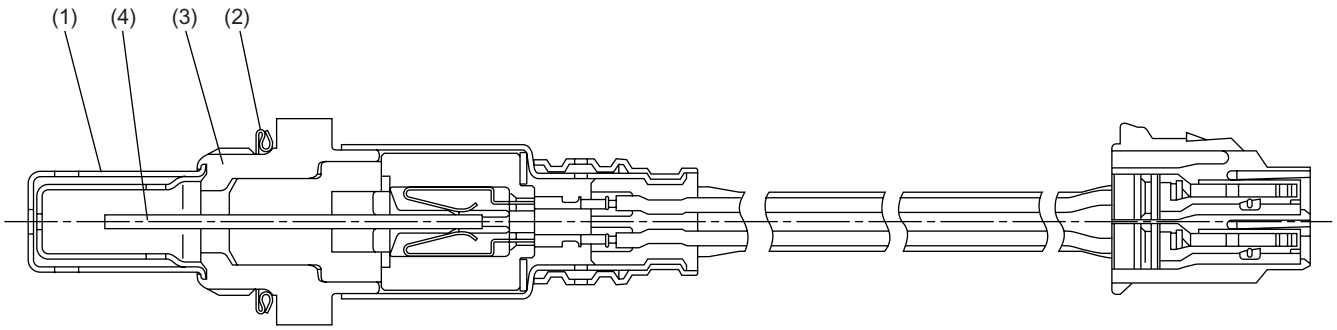
A: FRONT OXYGEN (A/F) SENSOR

● 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.



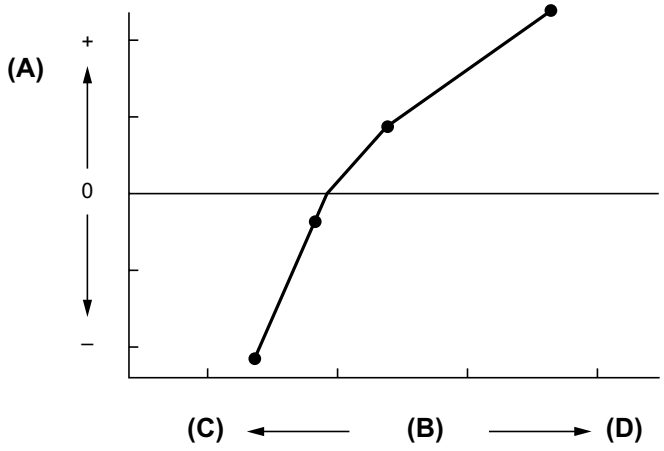
FU-02163

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

● 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-02015

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

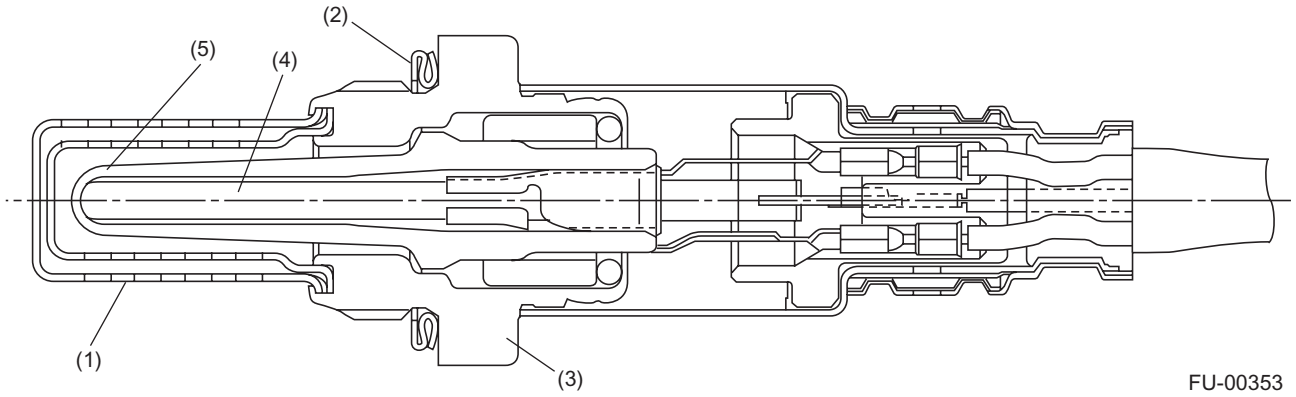
B: REAR OXYGEN SENSOR

● 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.

● By detecting the oxygen concentration in the exhaust gas using the oxygen sensor makes it possible to determine whether the air-fuel ratio is leaner or richer than the stoichiometric ratio.

● 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.

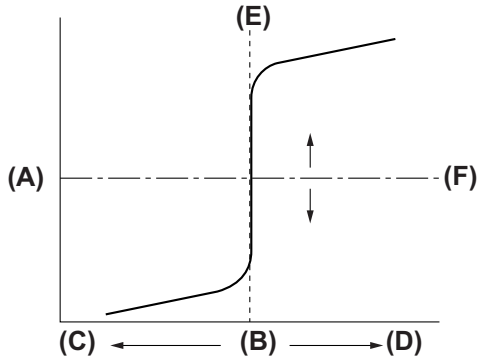


(1) Protection tube
(2) Gasket
(3) Sensor housing
(4) Ceramic heater
(5) Zirconia tube

● 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 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).

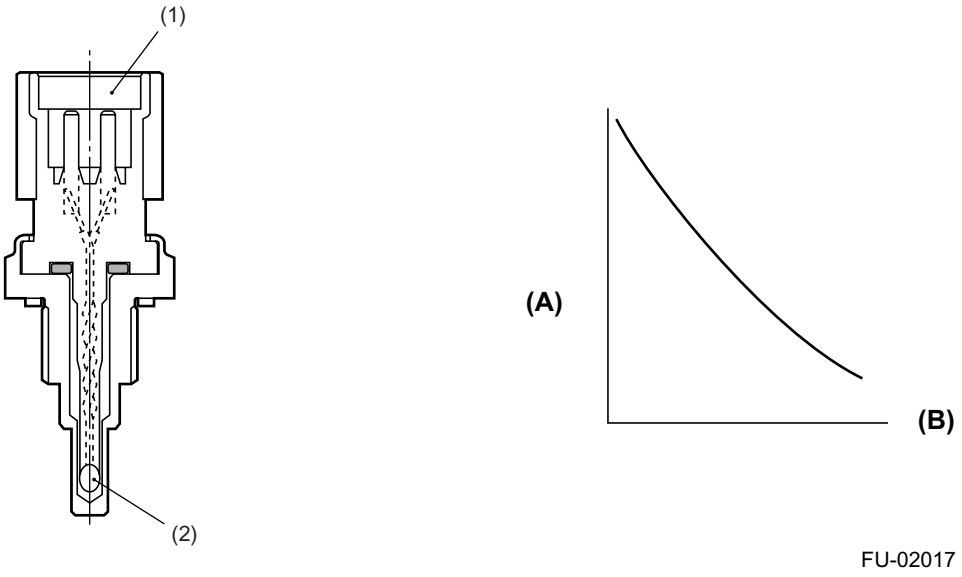


FU-02016

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



(1) Connector
(2) Thermistor element
(A) Resistance (kΩ)
(B) Temperature °C (°F)

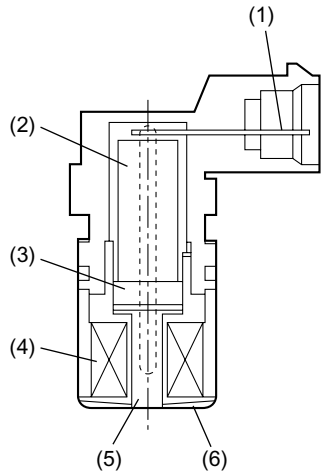
D: EXHAUST GAS TEMPERATURE SENSOR

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

E: CRANKSHAFT POSITION SENSOR

● The crankshaft position sensor is installed on the oil pump which is located in the front center portion of the cylinder block. The sensor generates a pulse when one of the teeth on the perimeter of the crankshaft sprocket (rotating together with the crankshaft) passes in front of it. The ECM determines the crankshaft angular position by counting the number of pulses.

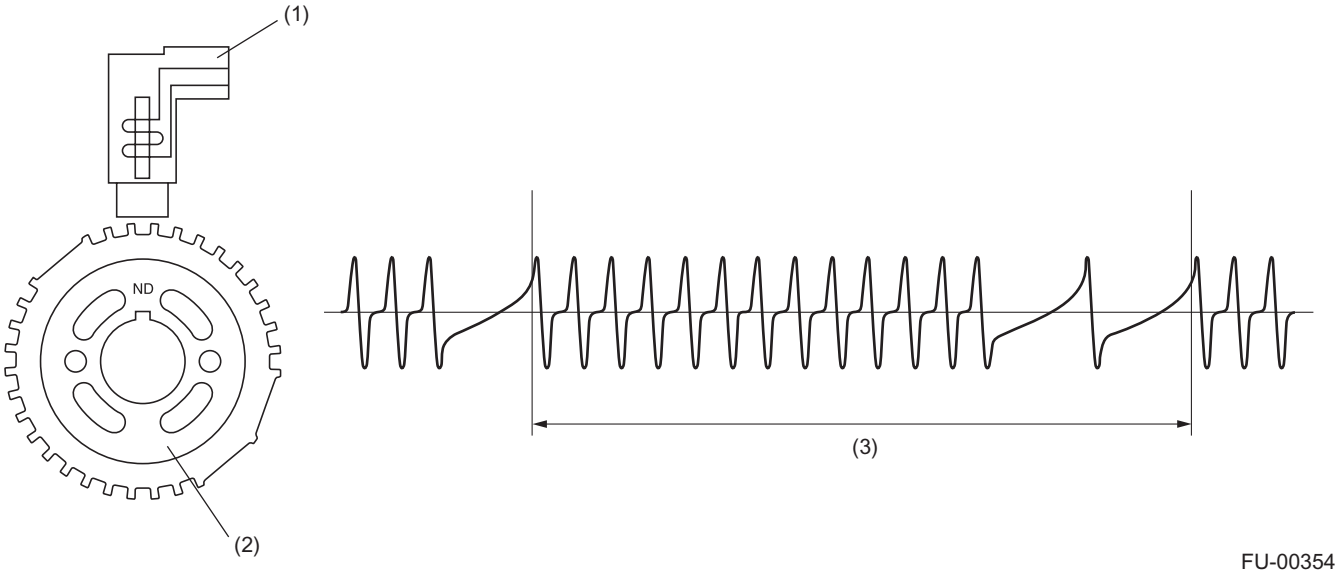
● The crankshaft position sensor is a magnet pickup type and is molded with components such as a magnet, core, coil, and terminal, etc.



FU-00234

(1) Terminal
(2) Yoke core
(3) Magnet
(4) Coil
(5) Core
(6) Cover

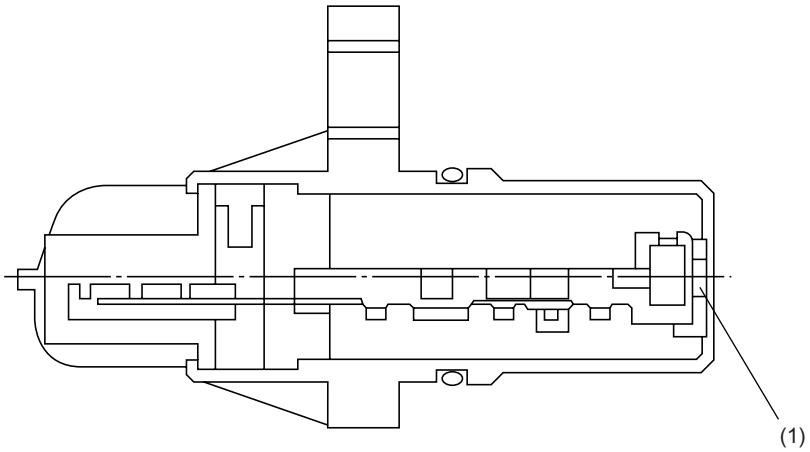
● As the crankshaft rotates, each tooth aligns with the crankshaft position sensor. At that time, the magnetic flux in the sensor's coil changes since the air gap between the sensor pickup and the sprocket changes. This change in magnetic flux induces a voltage pulse in the sensor and the pulse is transmitted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



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

F: CAMSHAFT POSITION SENSOR

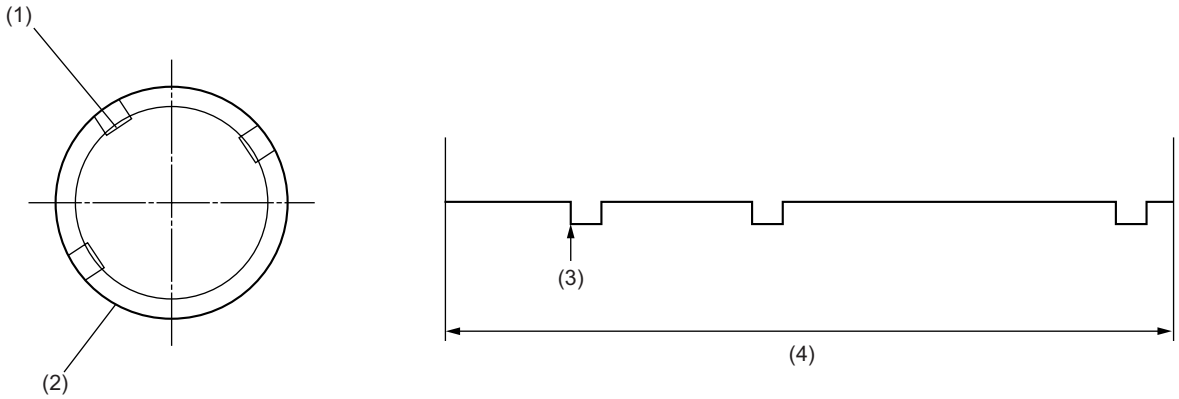
- The camshaft position sensor is located on the cylinder head.
- A hall element is used in this sensor and its construction is as shown below.



FU-02029

(1) Hall element

● The sensor generates a pulse when one of the slots in the camshaft passes in front of the sensor. The ECM detects the camshaft position by measuring the pulse.
Three slots are provided on the camshaft as shown below.



FU-01151

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

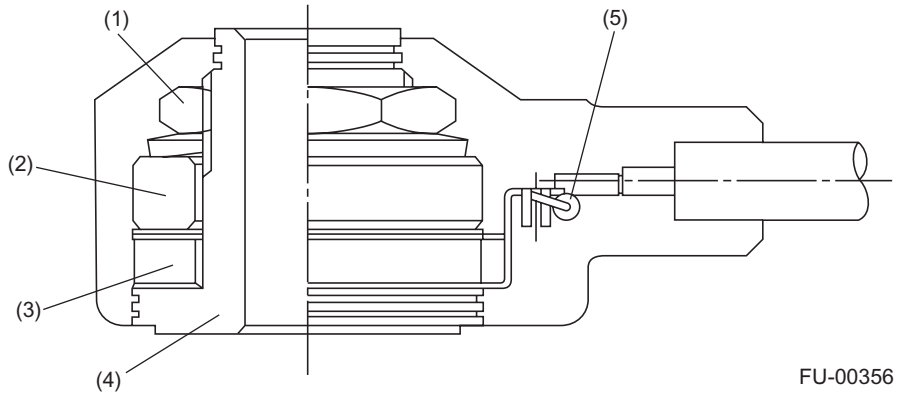
G: KNOCK SENSOR

● The knock sensor is installed on the cylinder block, and senses knocking that occurs in the engine.

● The sensor is a piezo-electric type which converts vibration resulting from knocking into electric signals.

● In addition to a piezo-electric element, the sensor has a weight and case as its components. If knocking occurs in the engine, the weight in the case moves causing the piezo-electric element to generate a voltage.

● The knock sensor harness is connected to the engine harness.



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

H: VEHICLE SPEED SENSOR

Vehicle speed signals are sent from the vehicle speed sensor to the ABS and VDC control modules.

The signals are sent to the ECM via CAN communication. For details, refer to the LAN section. <Ref. to LAN section.>

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

*1: Canister purge control is described under EC(H4DOTC) — Emission Control (Aux. Emission Control Devices) Evaporative Emission Control System. <Ref. to EC(H4DOTC) section, Evaporative Emission Control System.>

*2: Radiator fan control is described under CO(H4DOTC) — COOLING. <Ref. to CO(H4DOTC) section.>

B: INPUT AND OUTPUT SIGNALS

Signal	Unit	Function
Input signals	Manifold absolute pressure sensor	Detects the pressure (measures the absolute pressure) of intake air .
	Mass air flow and intake air temperature sensor	Detects the temperature and amount of intake air.
	Throttle position sensor	Detects the throttle valve position.
	Front oxygen (A/F) sensor	Detects the density of oxygen in exhaust gases at the upstream of the front catalytic converter.
	Rear oxygen sensor	Detects the density of oxygen in exhaust gases at the downstream of the front catalytic converter.
	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.
	Accelerator position sensor	Detects the position of the acccelerator pedal.
	Exhaust gas temperature sensor	Detects the exhaust gas temperature.
	Fuel temperature sensor	Detects the temperature of the fuel in the fuel tank.
	Fuel tank pressure sensor	Detects the evaporation gas pressure in the fuel tank.
	Ignition switch	Detects operation of the ignition switch.
	Starter switch	Detects the condition of engine cranking.
	Neutral position switch (MT)	Detects that the gear is in neutral.
	Inhibitor switch (AT)	Detects shift positions.
	A/C switch	Detects ON-OFF operation of the A/C switch.
	Power steering switch	Detects the steering condition.
Output signals	Fuel injector	Activates an injector.
	Ignition signal	Turns the primary ignition current ON or OFF.
	Electronic control throttle	Controls motor output to the electronic control throttle.
	Oil flow control solenoid valve	Controls oil pressure for oil flow control solenoid valve.
	Fuel pump control unit	Controls the fuel pump.
	A/C control relay	Turns ON or OFF the A/C control relay.
	Radiator fan control relay	Turns ON or OFF the radiator fan control relay.
	Wastegate control solenoid valve	Controls supercharging pressure
	Engine malfunction indicator light (MIL)	Indicates existence of abnormality.
	Purge control solenoid valve	Controls purge of evaporative gas absorbed by the canister.
	Tumble generator valve actuator	Operates the tumble generator valve.
	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.
	Oil flow control solenoid valve	Controls advance and retard angles of the intake valves.
	Heater circuit of front and rear oxygen sensors	Controls the heater of the front and rear oxygen sensors.
	Electronic control throttle motor cut relay	Turns ON-OFF the electronic control throttle motor relay.
	Power supply	Controls ON/OFF of the main power supply relay.

C: FUEL INJECTION CONTROL

● The ECM receives signals from various sensors and based on them, it determines the amount of fuel injected and the fuel injection timing. It performs the sequential fuel injection control over the entire engine operating range except during start-up of the engine.

● The amount of fuel injected depends upon the length of time the injector stays open. The fuel injection duration is determined according to varying operating condition of the engine. For the purpose of achieving highly responsive and accurate fuel injection duration control, the ECM performs a new feedback control that incorporates a learning feature as detailed later.

● The fuel injection control is performed such that fuel is injected accurately at the time when the maximum efficiency can be achieved for each cylinder.

1. FUEL INJECTION DURATION

Fuel injection duration is basically determined as indicated below:

● While cranking the engine:
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 air flow 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:

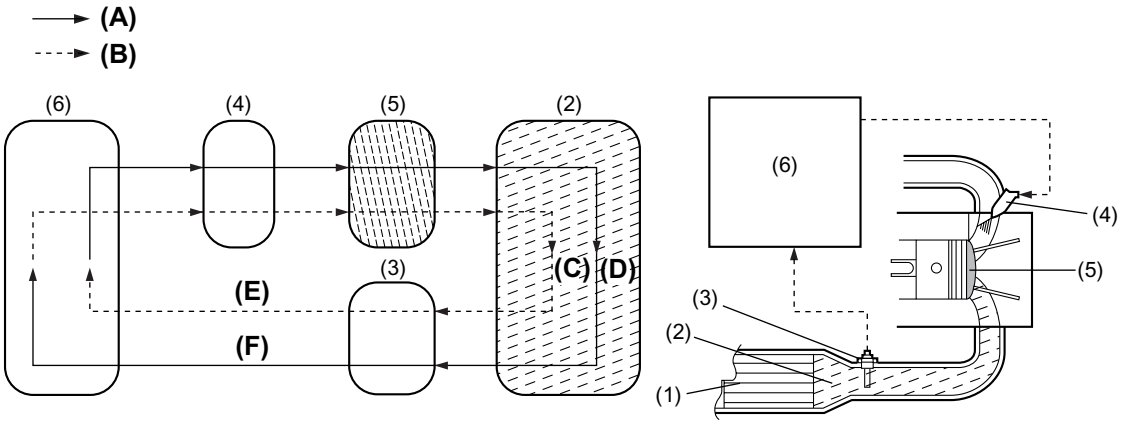
This factor is used to increase the fuel injection duration depending on the relationship between the throttle position sensor signal and air flow sensor signal.

- 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 is high, the air-fuel ratio is leaner than the stoichiometric ratio. The ECM then makes the fuel injection duration longer by modifying the factor. When the signal is low showing that the mixture is rich, the ECM modifies the factor to make the injection duration shorter. In this way, the air-fuel ratio is maintained at a level close to the stoichiometric ratio at which the three-way catalytic converter acts most effectively.



FU-00240

(1) Front catalytic converter
(2) Exhaust gases
(3) Front oxygen (A/F) sensor
(4) Fuel injector
(5) Combustion chamber
(6) ECM

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

4. LEARNING FEATURE

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

● In the air-fuel ratio feedback control, the ECM calculates the necessary amount of correction based on data from the front oxygen (A/F) sensor and adds the result to the basic duration (which is stored in the ECMs 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.

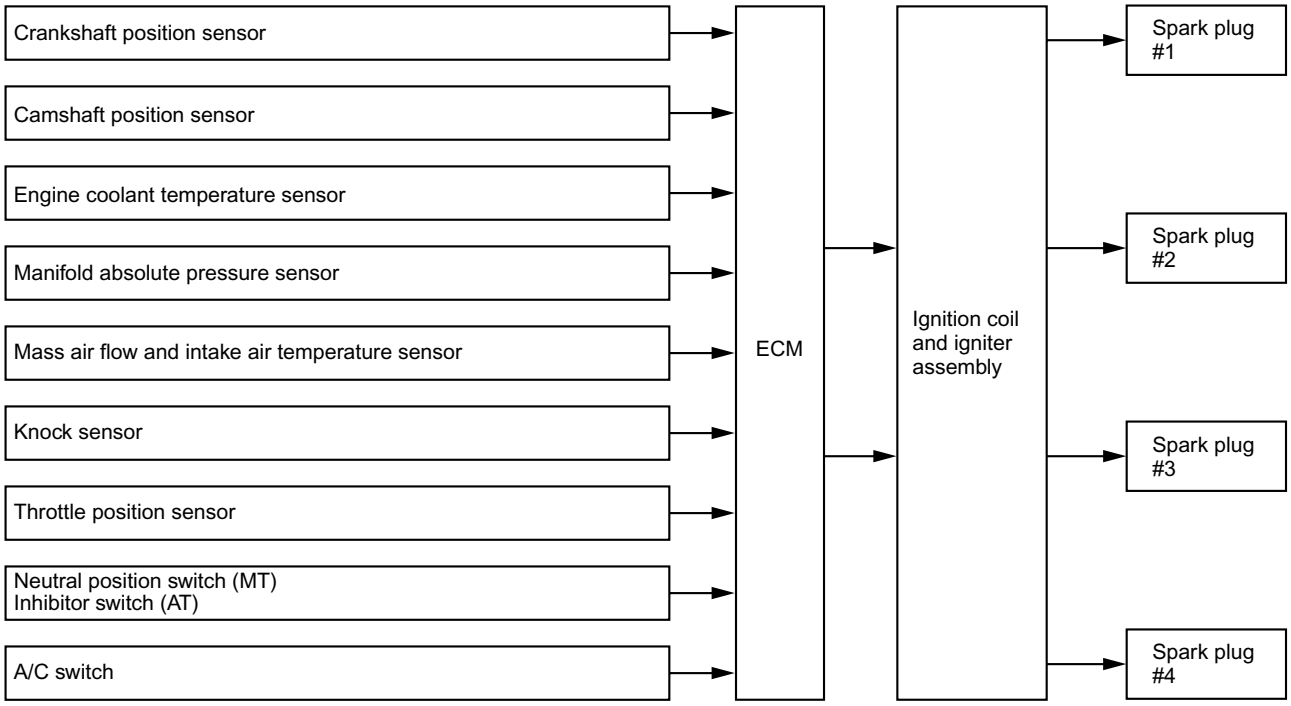
D: IGNITION CONTROL

● The ECM determines operating condition of the engine based on signals from the manifold absolute pressure sensor, engine coolant temperature sensor, intake air temperature sensor, crankshaft position sensor and other sources. The ECM then selects the ignition timing most appropriate for the condition thus determined from those stored in its memory and outputs at that timing a primary current OFF signal to the igniter 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.

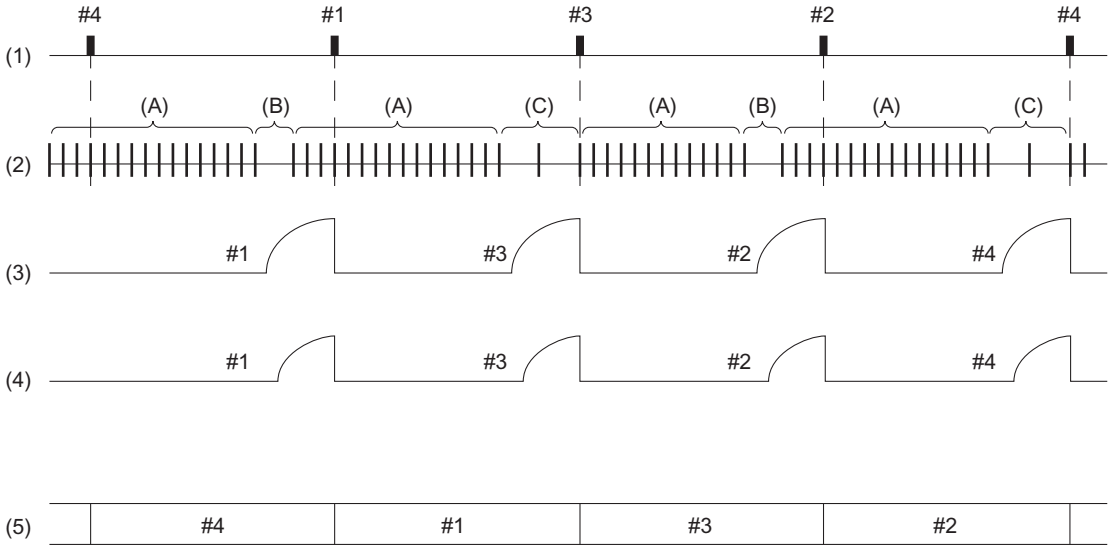
● Thus, the ECM can always perform optimum ignition timing taking into account the output, fuel consumption, exhaust gas, and other factors for every engine operating condition.

● 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-02164

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

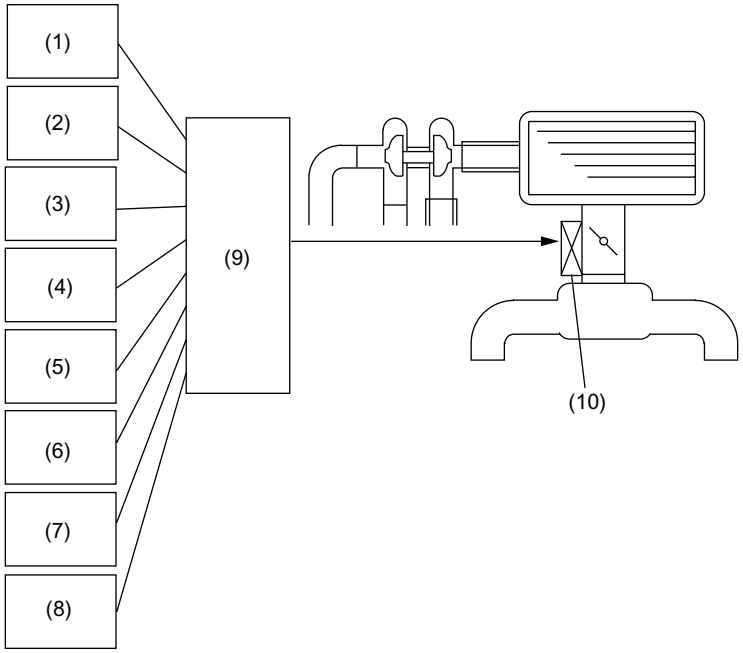


FU-00358

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

E: IDLE AIR CONTROL

● The ECM controls the electronic control throttle based on signals from the crankshaft position sensor, engine coolant temperature sensor, air flow sensor, manifold absolute pressure sensor and A/C switch so that the proper idle speed for each engine load is achieved.



FU-00359

(1) Crankshaft position sensor
(2) Camshaft position sensor
(3) Throttle position sensor
(4) Engine coolant temperature sensor
(5) Vehicle speed sensor
(6) Ignition switch
(7) A/C switch
(8) Neutral position switch
(9) ECM
(10) Electronic control throttle

F: FUEL PUMP CONTROL

The ECM controls the operation of the fuel pump through the fuel pump control unit, based on signals from the crankshaft position sensor. To improve safety, a “fuel pump stop signal” is sent from the ECM to the fuel pump control unit to stop the fuel pump if the engine stalls while the ignition switch is ON.

Ignition switch ON	Fuel pump
A certain period of time after ignition switch is turned ON	Operates
While cranking the engine	Operates
While engine is operating	Operates
When engine stops	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 engine malfunction indicator light on the combination meter indicates occurrence of a fault or abnormality.

● When the malfunction indicator light comes on as a result of detection of a fault by the ECM, the corresponding diagnostic trouble code (DTC) and freeze frame data indicating the 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 for DTCs.

● The SSM and GST can be used for erasing DTCs. These 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 drivability.

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. General

Specifications for the SOHC U5 models are included in FU(H4SO). <Ref. to FU(H4SO) section.>

FUEL INJECTION
(FUEL SYSTEMS)
(H4SO)

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

● Improves fuel efficiency

● Increased engine output

● Quick response to accelerator and brake pedal operation

● Superior start ability and warm-up performance in cold weather due to corrective controls made according to coolant and intake air temperatures

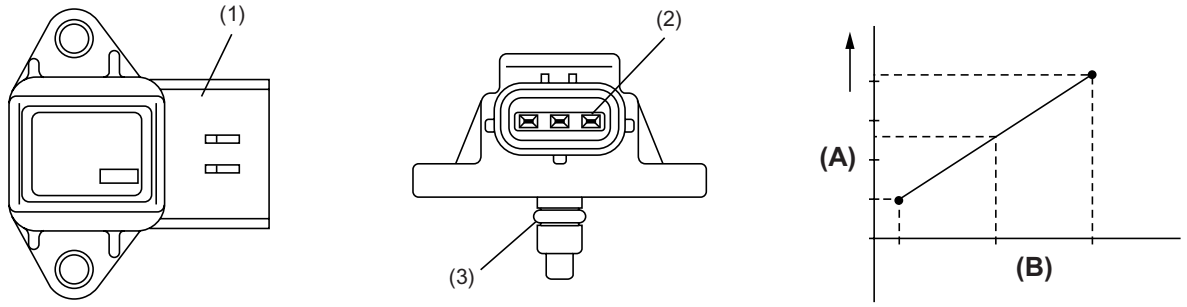
2. Air Line

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.

B: MANIFOLD ABSOLUTE PRESSURE SENSOR

The manifold absolute 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-02010

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

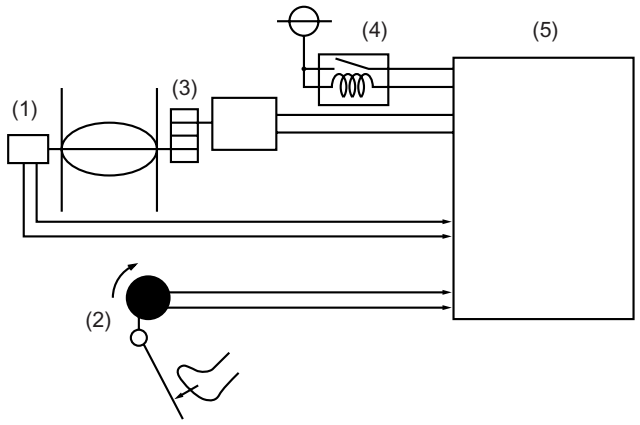
(A) Output voltage
(B) Absolute pressure

C: ELECTRONIC CONTROL THROTTLE SYSTEM

● The electronic control throttle system consists of an accelerator pedal position sensor mounted on the accelerator pedal, a throttle position sensor and a throttle motor mounted on the throttle body, and the ECM, which controls these devices.

● The movement of the accelerator pedal is converted into electrical signals by the accelerator pedal position sensor and sent to the ECM. Based on these signals the ECM controls the throttle motor to open and close the throttle valve.

● Idling control is now performed by the electronic control throttle system in place of the idle air control solenoid valve.



FU-01230

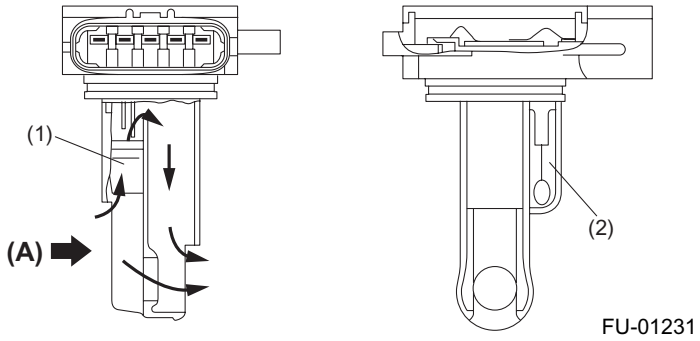
(1) Throttle position sensor
(2) Accelerator pedal position sensor
(3) Electronic control throttle assembly
(4) Electronic control throttle relay
(5) ECM

D: MASS AIR FLOW AND INTAKE AIR TEMPERATURE SENSOR

NOTE:
Not installed on some models.

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

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



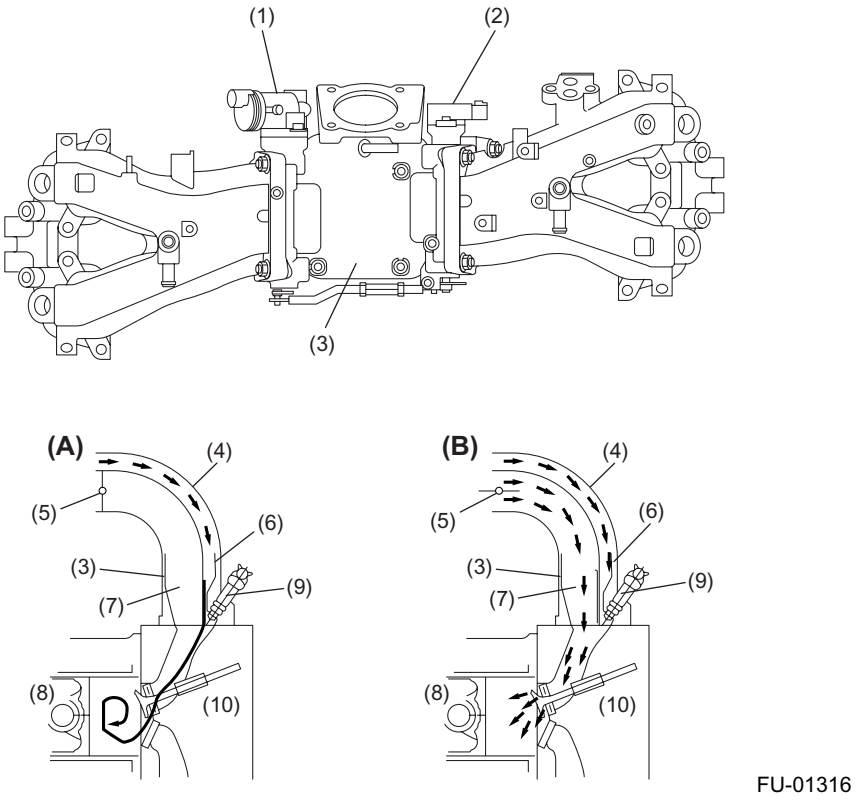
(1) Mass air flow sensor
(2) Intake air temperature sensor
(A) Air

E: TUMBLE GENERATOR VALVE

NOTE:
This is not installed on some models.

● A tumble generator valve is provided on the intake manifold of each engine bank. The right bank tumble generator valve has butterfly valves for the #1 and #3 cylinders and the left bank tumble generator valve has those for the #2 and #4 cylinders. The two butterfly valves in each tumble generator valve are fitted on a single shaft that is driven by an actuator.

● The tumble generator valves are controlled by the ECM according to the coolant temperature and the time elapsed after start of the engine. When the engine is started, the butterfly valves are moved to the closing ends.In this state, the intake air flows at very high speeds passing through narrowed passages in the directions determined by the individual intake air ports in the cylinder head. This creates tumbling air motions in the cylinders, which enables lean mixtures to be ignited and thus harmful exhaust emissions to be reduced during engine start. The tumble generator valves are fully open when the engine is operating at an ordinary driving speed, allowing intake air to flow without being changed in direction and velocity.



FU-01316

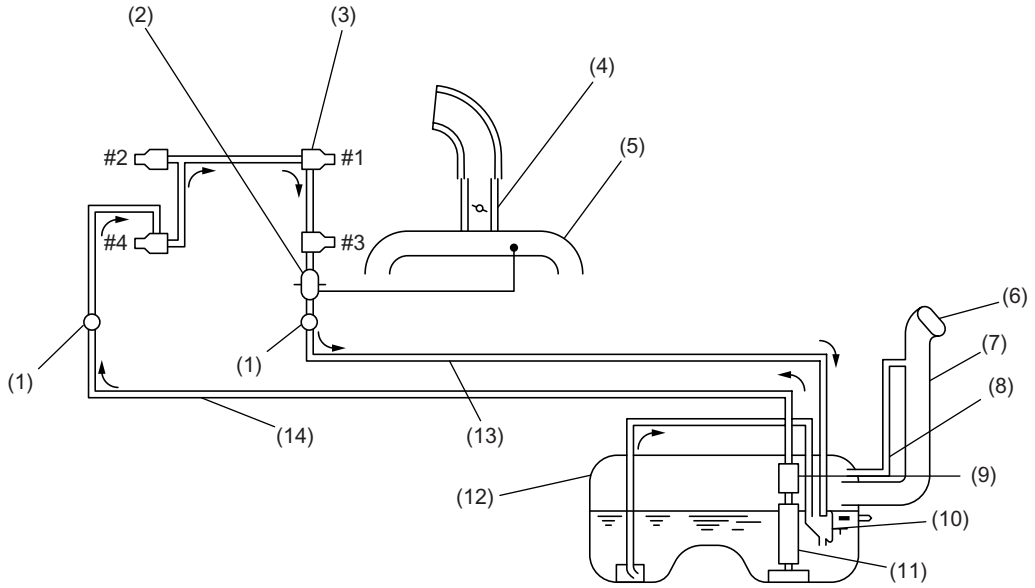
(A) Activated
(B) Not activated
(1) Actuator
(2) Tumble generator valve position sensor
(3) Tumble generator housing
(4) Intake manifold
(5) Tumble generator valve
(6) Tumble generating air passage
(7) Main intake air passage
(8) Piston
(9) Injector
(10) Cylinder head

3. Fuel System

A: GENERAL

● The fuel pressurized by the fuel tank inside pump is delivered to each fuel injector through the fuel filter. Fuel injection pressure is regulated to an optimum level by the pressure regulator.

● Each injector injects fuel into the intake port of the corresponding cylinder where the fuel is mixed with air. The mixture then enters the cylinder. Fuel injection amount and timing are regulated by the ECM.

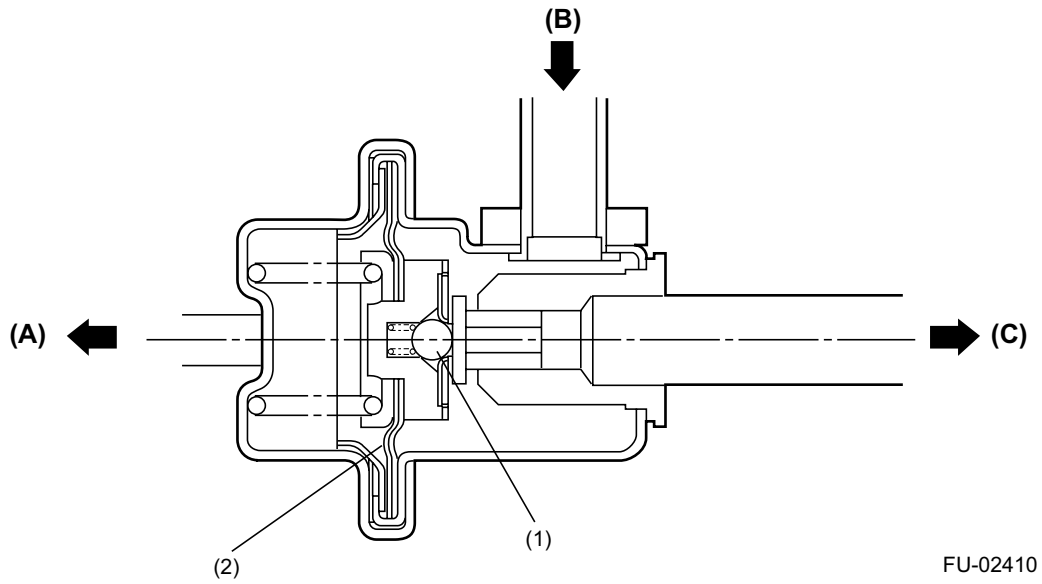


FU-02409

(1) Fuel damper valve
(2) Pressure regulator
(3) Fuel injector
(4) Throttle body
(5) Intake manifold
(6) Filler cap
(7) Filler pipe
(8) Air vent pipe
(9) Fuel filter
(10) Jet pump
(11) Fuel pump
(12) Fuel tank
(13) Fuel return line
(14) Fuel delivery 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 to precisely control the amount of injected fuel.

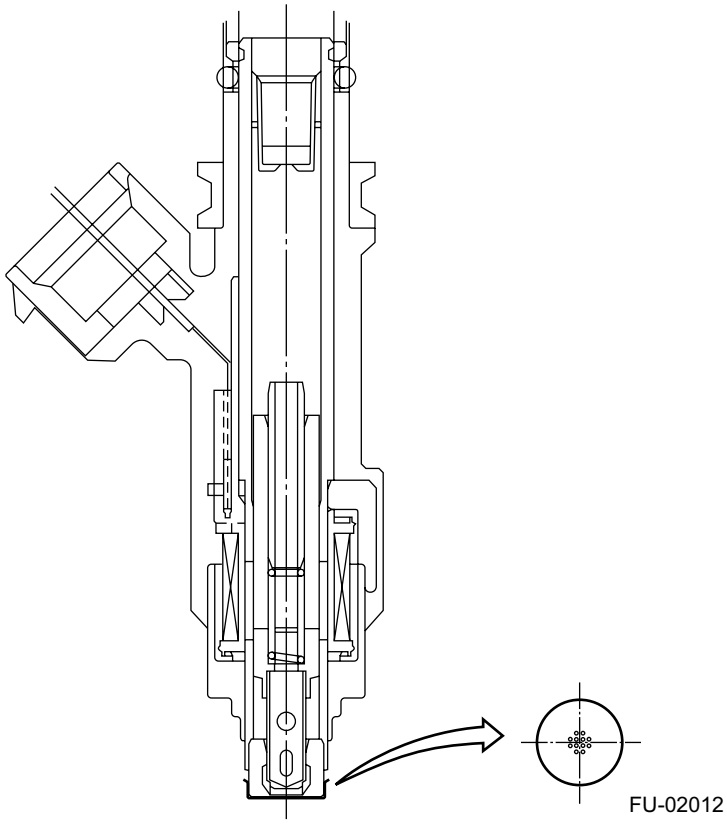


(1) Relief valve
(2) Diaphragm

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

C: FUEL INJECTOR

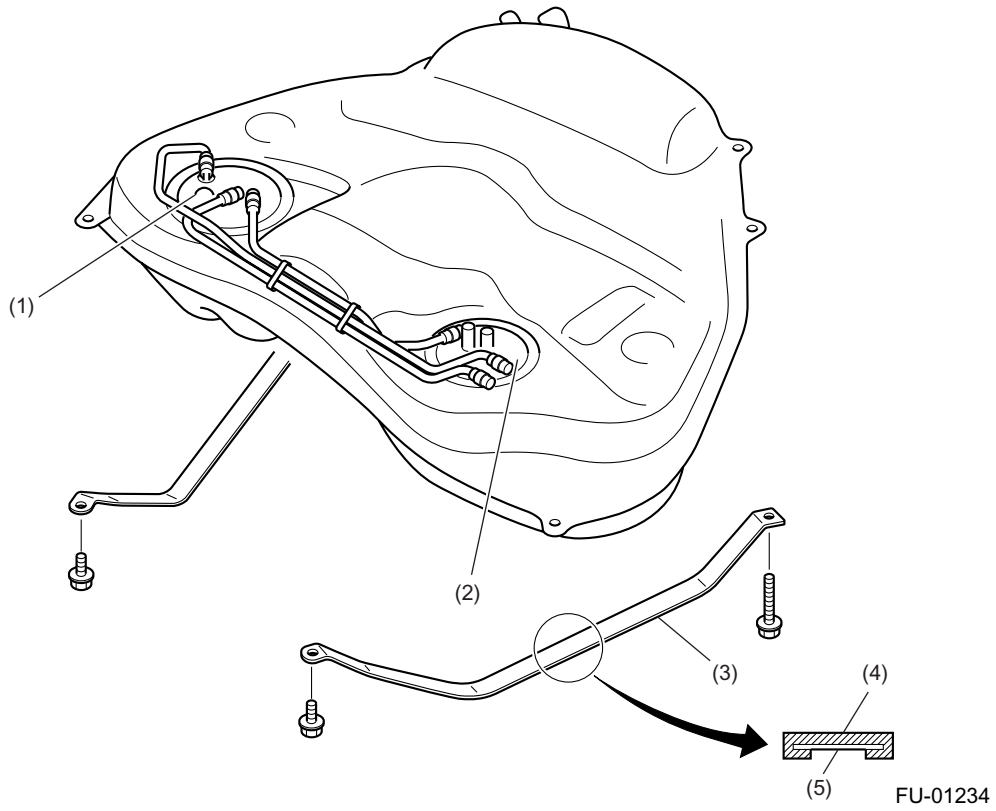
- The MFI system employs top feed type fuel injectors.
- Each injector is installed in the fuel pipe in such a way that the injector is cooled by fuel.
- The features of this type of fuel injector are as follows:
  1) High heat resistance
  2) Low driving noise
  3) Easy to service
  4) Small size
-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


FU-02012

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
(2) Fuel sub level sensor
(3) Band
(4) Cushion
(5) Steel

E: FUEL PUMP AND FUEL LEVEL SENSOR ASSEMBLY

1. FUEL PUMP

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

● 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.

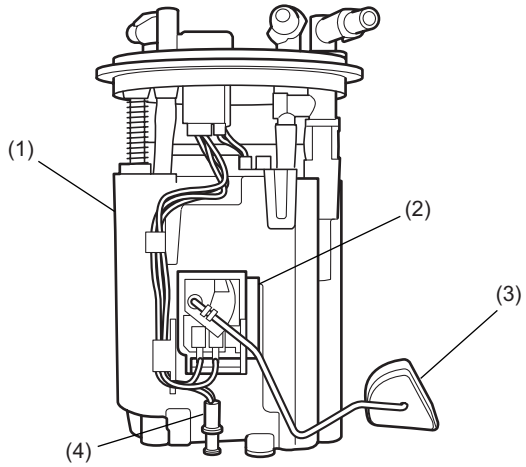
● The fuel pushed up by rotation of the impeller then passes through the clearance between the armature and the magnet of the motor and is discharged through the check valve.

● 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, check valve operates 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.



FU-02519

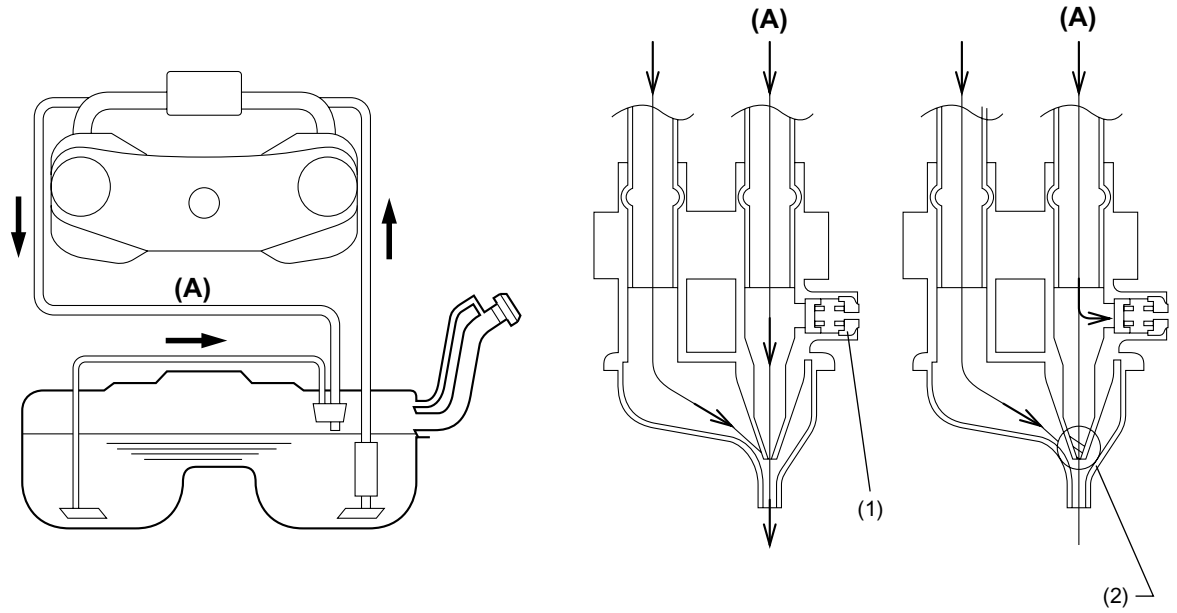
(1) Fuel pump assembly
(2) Fuel level sensor
(3) Float
(4) Fuel temperature sensor

3. JET PUMP

● The jet pump utilizes the velocity of fuel returning from the engine to produce vacuum in it.

● Using the pumping effect produced by the vacuum, the jet pump transfers fuel from the sub-compartment and main compartment of the fuel tank to the fuel pump.

● When the return line nozzle is clogged, the fuel sent back through the return line flows back into the fuel tank via the relief valve.



FU-00226

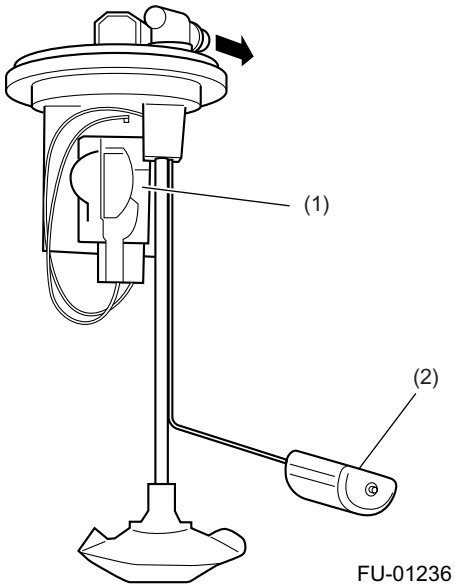
(1) Relief valve
(2) Nozzle
(A) Return line

4. FUEL FILTER

The fuel filter is integrated with the fuel pump assembly, which is located in the fuel tank.

F: SUB-COMPARTMENT FUEL LEVEL SENSOR

This sensor detects the level of the fuel in the sub side (the side without a fuel pump) of the fuel tank. Also, when the jet pump is operating, fuel in the sub side is drawn up and transferred to the fuel pump.



(1) Fuel level sensor
(2) Float

(A) To jet pump

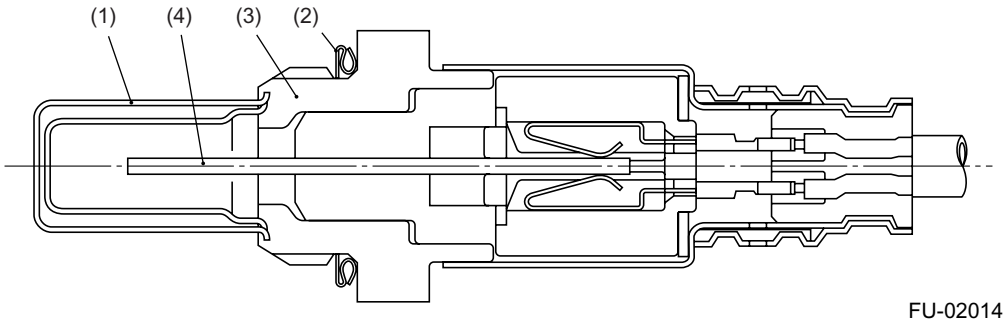
4. Sensors and Switches

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 sensor incorporates a ceramic heater to improve its performance at low temperatures.



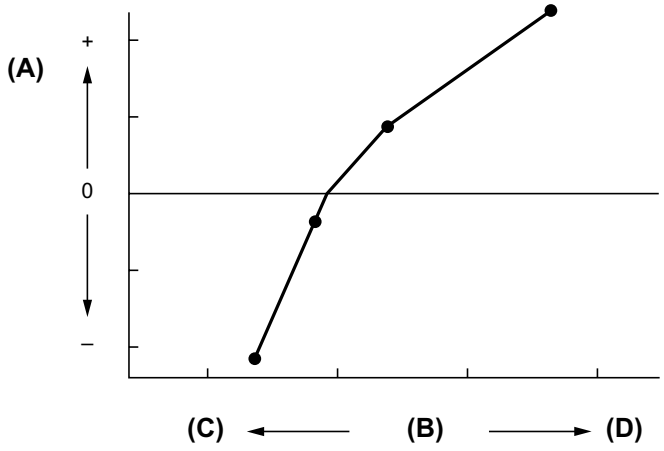
FU-02014

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

● 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 zirconium 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-02015

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

B: FRONT OXYGEN SENSOR AND REAR OXYGEN SENSOR

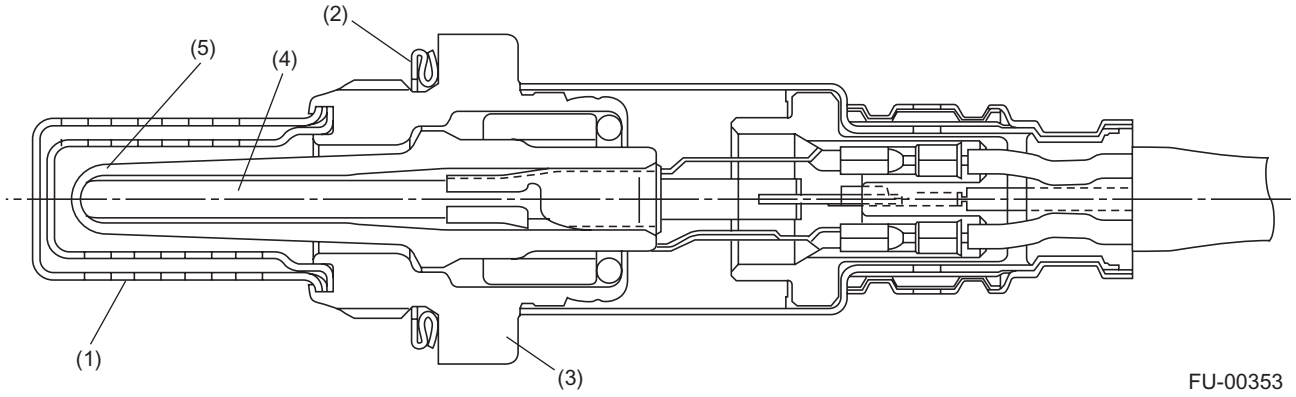
NOTE:
The front oxygen sensor is not installed on some models.

● The front oxygen sensor and rear oxygen sensor are 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 front oxygen sensor and rear oxygen sensor makes it possible to determine whether the air-fuel ratio is leaner or richer than the stoichiometric ratio.

● The front oxygen sensor and the rear oxygen sensor have a zirconium 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 zirconium 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.

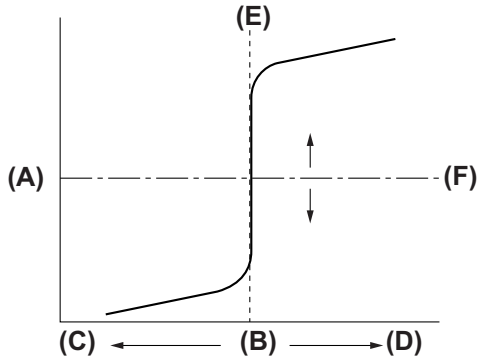


(1) Protection tube
(2) Gasket
(3) Sensor housing
(4) Ceramic heater
(5) Zirconium tube

● 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 zirconium 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).

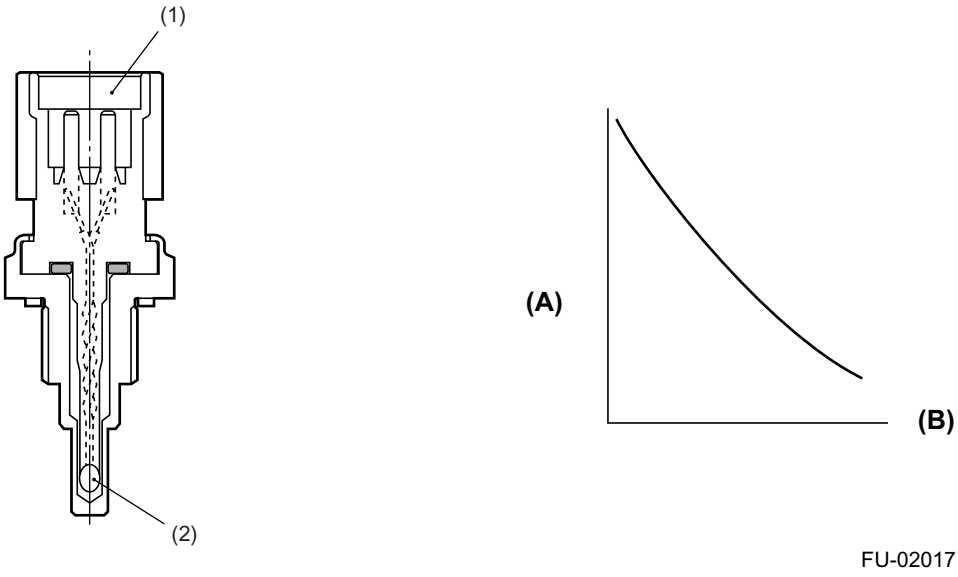


FU-02016

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



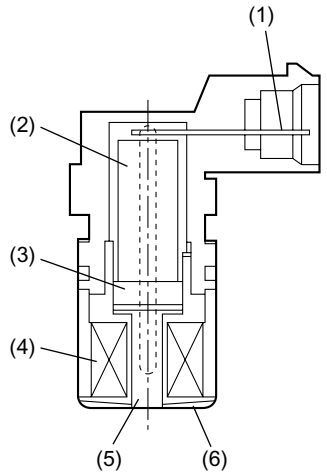
(1) Connector
(2) Thermistor element

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

D: CRANKSHAFT POSITION SENSOR

● The crankshaft position sensor is installed on the oil pump, which is located in the front center portion of the cylinder block. The sensor generates a pulse when one of the teeth on the perimeter of the crankshaft sprocket (rotating together with the crankshaft) passes in front of it. The ECM determines the crankshaft angular position by counting the number of pulses.

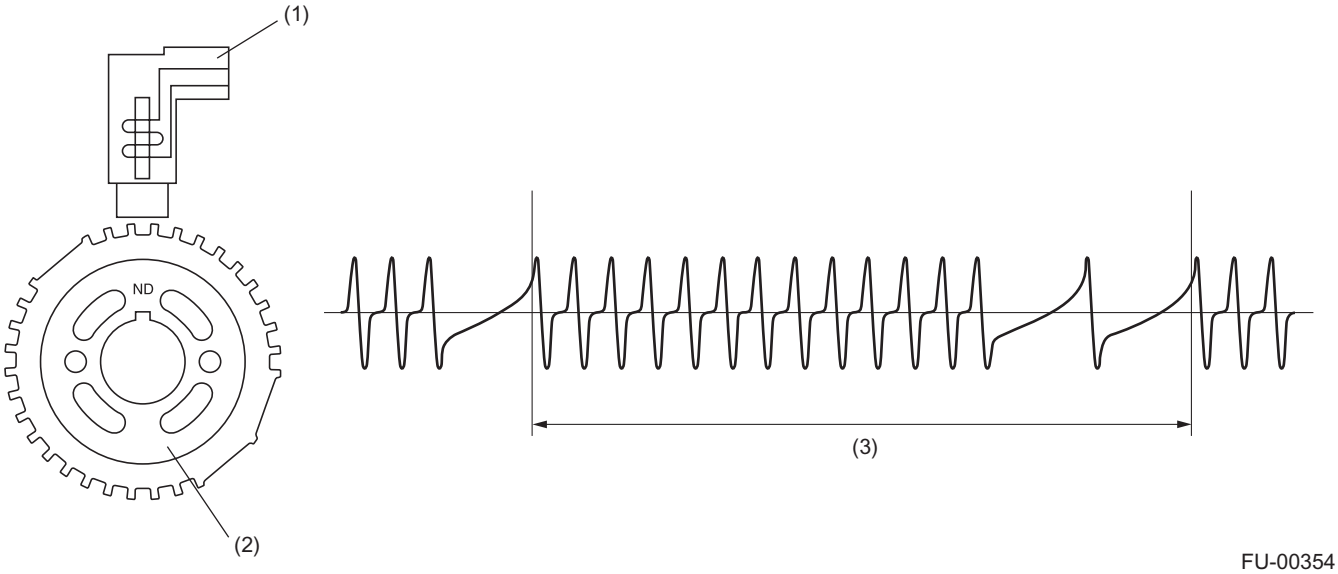
● The crankshaft position sensor is a molded type, which consists of a magnet, core, coil, terminals and other components as illustrated below.



FU-00234

(1) Terminal
(2) Yoke core
(3) Magnet
(4) Coil
(5) Core
(6) Cover

● 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.

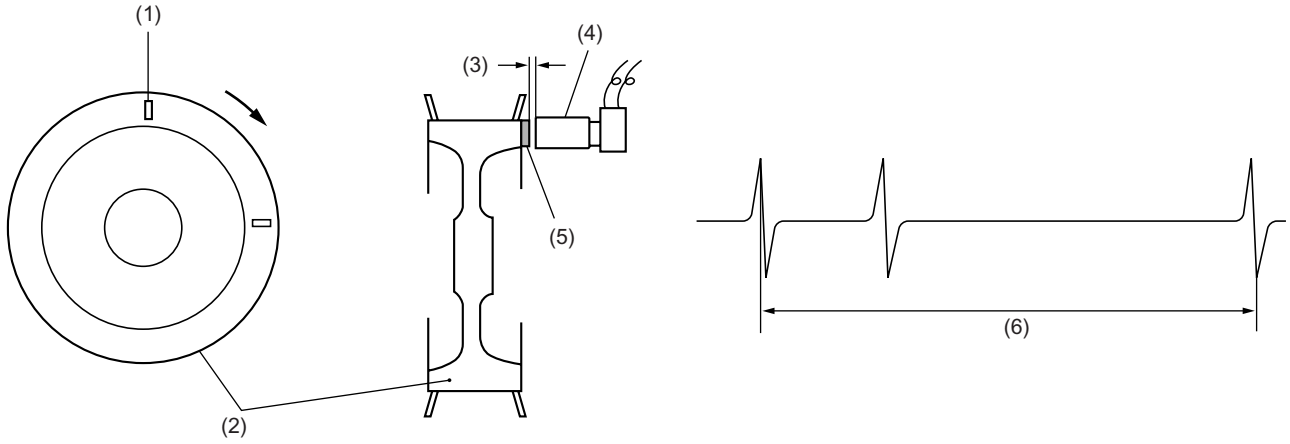


(1) Crankshaft position sensor
(2) Crankshaft sprocket
(3) Crankshaft half rotation

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.

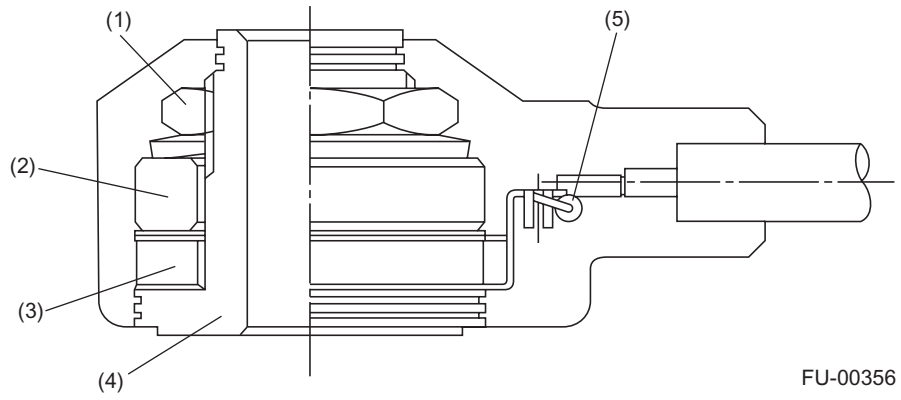


FU-02018

(1) Boss
(2) Cam 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 occur 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.



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

G: VEHICLE SPEED SENSOR

Vehicle speed signals are sent from the vehicle speed sensor to the ABS and VDC control modules.

The signals are sent to the ECM via CAN communication. (For details, refer to the LAN section.) <Ref. to LAN section.>

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 follows:

- Fuel injection control
- Ignition 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) — Evaporative Emission Control System. <Ref. to EC(H4SO) section.>

*2: Radiator fan control is described under CO(H4SO). <Ref. to CO(H4SO) section.>

B: INPUT AND OUTPUT SIGNALS

Signal	Unit	Function
Input signals	Manifold absolute pressure sensor	Detects the pressure of intake air (measures the absolute pressure).
	Mass air flow and intake air temperature sensor	Detects the temperature and amount of intake air.
	Throttle position sensor	Detects the throttle valve position.
	Front oxygen (A/F) sensor	Detects the density of oxygen in exhaust gases at the upstream of the front catalytic converter.
	Front oxygen sensor 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.
	Accelerator pedal position sensor	Indicates the accelerator pedal position.
	Ignition switch	Detects operation of the ignition switch.
	Starter switch	Detects the condition of engine cranking.
	Neutral position switch (MT)	Detects that the gear is in neutral.
	Inhibitor switch (AT)	Detects shift positions.
	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.
	A/C mid pressure switch	Detects operation of the A/C mid pressure switch.
	Wiper switch	Detects ON-OFF operation of the wiper switch.
	Power steering switch	Detects operation of the power steering switch.
	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.

Signal	Unit	Function
Output signals	Fuel injector	Activates an injector.
	Ignition signal	Turns the primary current to the ignition coil ON or OFF.
	Electronic control throttle	Controls motor output for the electronic control throttle.
	Fuel pump relay	Turns ON or OFF the fuel pump relay.
	A/C control relay	Turns ON or OFF the A/C control relay.
	Radiator fan control relay	Turns ON or OFF the radiator fan control relay.
	Tumble generator valve actuator	Operates the tumble generator valve.
	Engine warning light	Indicates existence of abnormality.
	Purge control solenoid valve	Controls purge of evaporative gas absorbed by the canister.
	EGR valve	Adjusts the exhaust gas circulating flow to the intake pipe.
	Heater circuit of front and rear oxygen sensors	Controls heater of front and rear oxygen sensors.
	Pressure control solenoid valve	Controls evaporation pressure in the fuel tank.
	Drain valve	Closes the evaporation line between the fuel tank and canister to detect leakage of evaporation gas.
	Power supply	Controls ON/OFF of the main power supply relay.

C: FUEL INJECTION CONTROL

● The ECM receives signals from various sensors and based on them, it determines the amount of fuel injected and the fuel injection timing. It performs the sequential fuel injection control over the entire engine operating range except during start-up of the engine.

● The amount of fuel injected depends upon the length of time the injector stays open. The fuel injection duration is determined according to varying operating condition of the engine. For the purpose of achieving highly responsive and accurate fuel injection duration control, the ECM performs a new feedback control that incorporates a learning feature as detailed later.

● The sequential fuel injection control is performed such that fuel is injected accurately at the time when the maximum air intake efficiency can be achieved for each cylinder (i.e., fuel injection is completed just before the intake valve begins to open).

1. FUEL INJECTION DURATION

Fuel injection duration is basically determined as indicated below:

● While cranking the engine:
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 air flow 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 start ability.

● 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 becomes the increment.

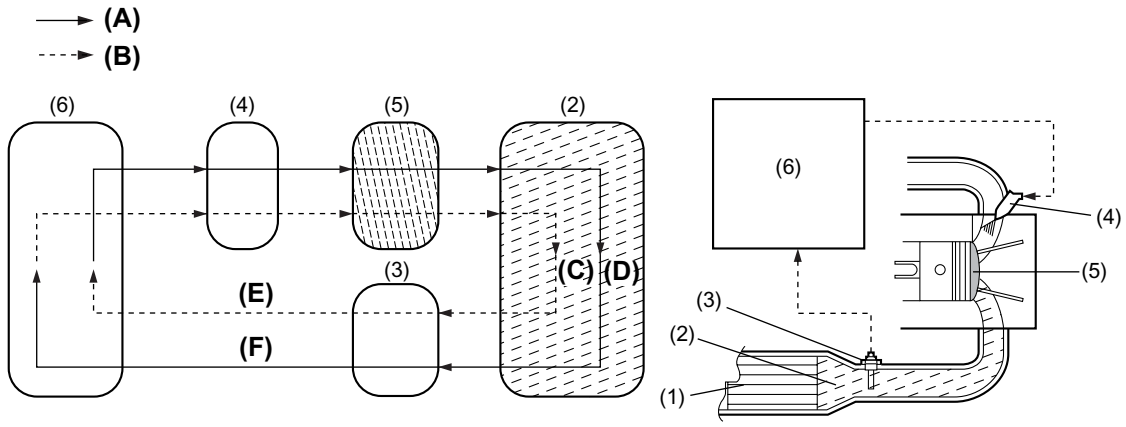
● After-start increment factor:
  ● This factor is used to increase the fuel injection duration for a certain period immediately after start of the engine to stabilize engine operation.
  ● The increment depends on the coolant temperature at the start of the engine.

● 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 air flow 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 is high, the air-fuel ratio is leaner than the stoichiometric ratio. The ECM then makes the fuel injection duration longer by modifying the factor. When the signal is low showing that the mixture is rich, the ECM modifies the factor to make the injection duration shorter. In this way, the air-fuel ratio is maintained at a level close to the stoichiometric ratio at which the three-way catalytic converter acts most effectively.



FU-00240

(1) Front catalytic converter
(2) Exhaust gases
(3) Front oxygen (A/F) sensor
(4) Fuel injector
(5) Combustion chamber
(6) ECM

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

4. LEARNING FEATURE

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

● In the air-fuel ratio feedback control, the ECM calculates the necessary amount of correction based on data from the front oxygen (A/F) 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 takes it into account with 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.

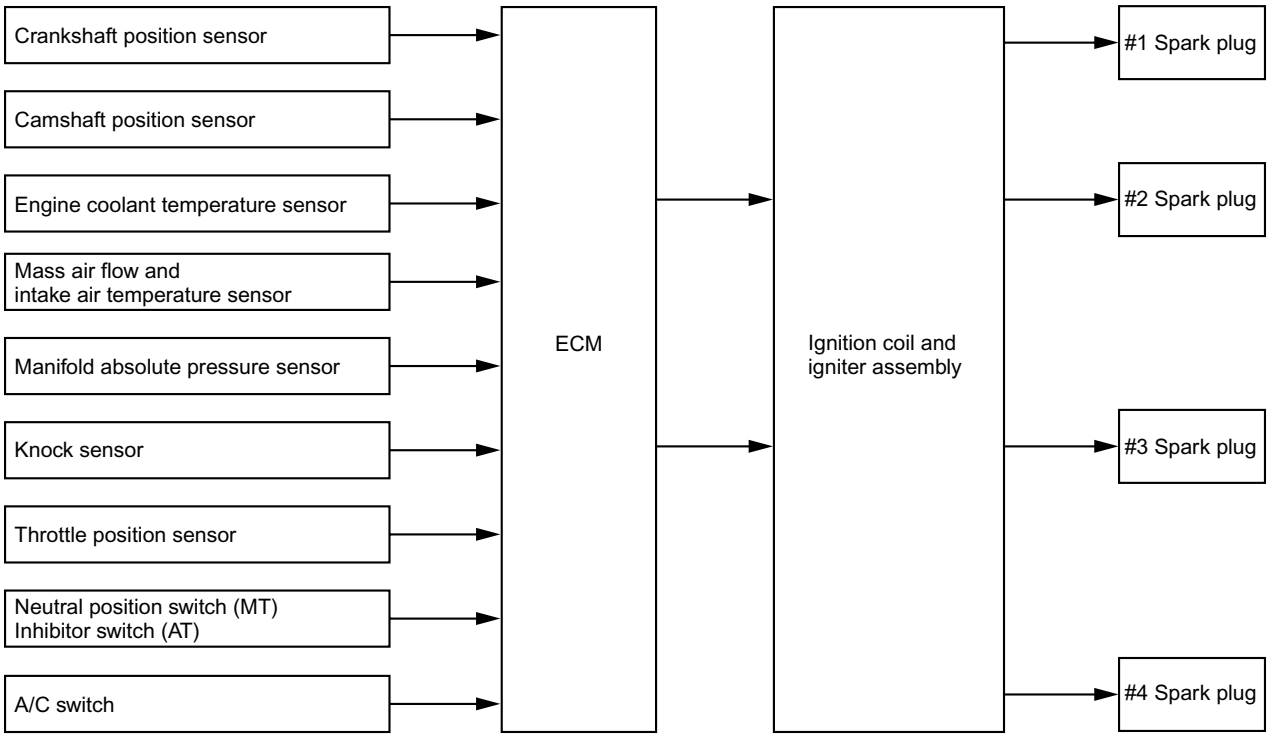
D: IGNITION CONTROL

● The ECM determines operating condition of the engine based on signals from the manifold absolute pressure sensor, engine coolant temperature sensor, intake air temperature sensor, crankshaft position sensor and other sources. The ECM then selects the ignition timing most appropriate for the condition thus determined from those stored in its memory and outputs at that timing a primary current OFF signal to the igniter 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 efficiency, exhaust gas, and other factors for every engine operating condition.

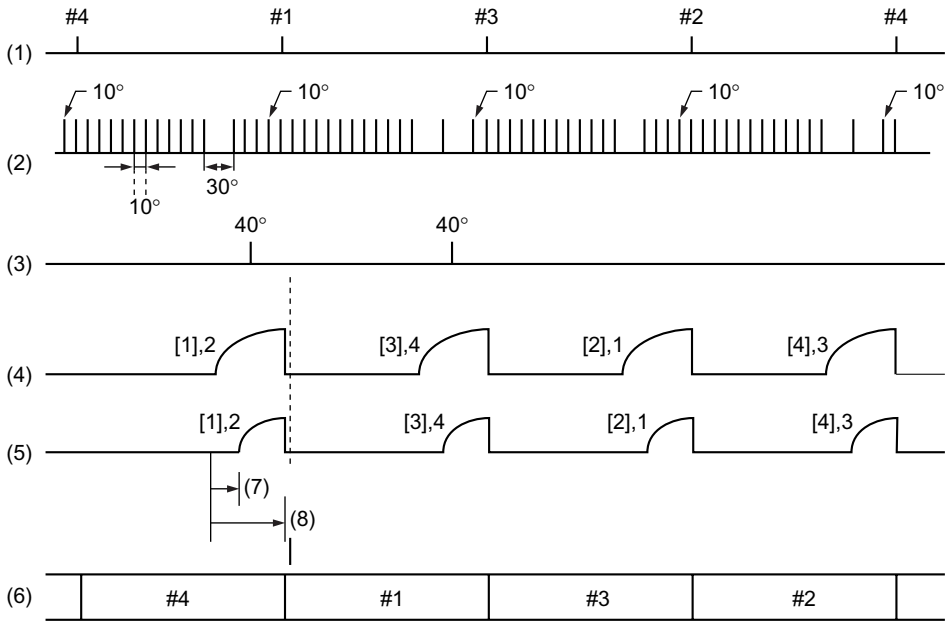
● Ignition control during start-up
Engine speed fluctuates during start of the engine, so the ECM cannot control the ignition timing. During that period, the ignition timing is fixed at 10° BTDC by using the 10° signal from the crankshaft position sensor.



FU-02412

● Ignition control after start of engine

From the time to receive crank angle signals indicating 180° of a turn, 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.

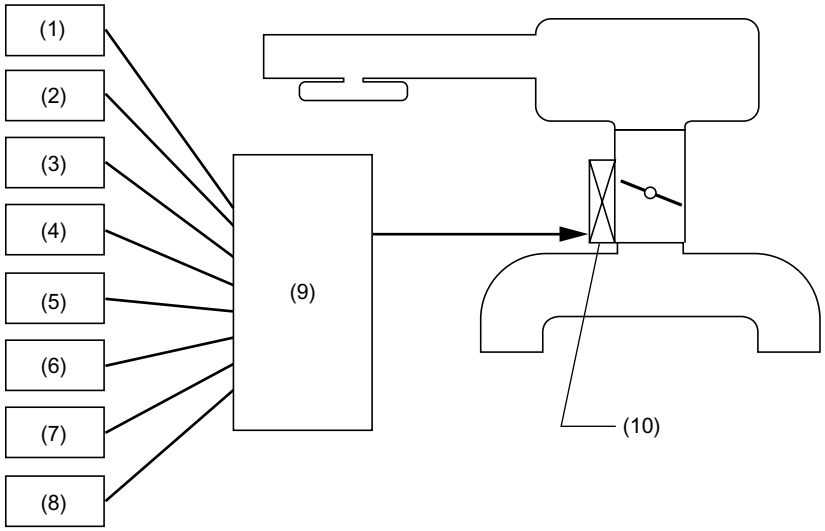


FU-02019

(1) Cylinder number
(2) Crank angle pulse (BTDC)
(3) Cam angle pulses (BTDC)
(4) Ignition timing at starting
(5) Ignition timing under normal conditions
(6) Cylinder at combustion
(7) Dwell set
(8) Ignition

E: IDLE AIR CONTROL

● The ECM controls the electronic control throttle based on signals from the crankshaft position sensor, engine coolant temperature sensor, manifold absolute pressure sensor and A/C switch so that the proper idle speed for each engine load is achieved.



FU-01238

(1) Crankshaft position sensor
(2) Camshaft position sensor
(3) Throttle position sensor
(4) Engine coolant temperature sensor
(5) Manifold absolute pressure sensor
(6) Ignition switch
(7) A/C switch
(8) Neutral position switch (MT), inhibitor switch (AT)
(9) ECM
(10) Electronic control throttle

F: FUEL PUMP CONTROL

Using the signal from the crankshaft position sensor, the ECM controls operation of the fuel pump by turning its reley 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 light on the combination meter indicates occurrence of a fault or abnormality.

● When the malfunction indicator light 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 be used for erasing DTCs. These 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 drivability.

B: FAIL-SAFE FUNCTION

For a sensor or switch that has been judged to be faulty by the on-board diagnosis, the ECM generates a pseudo signal to keep the vehicle operational. (The control becomes degraded.)

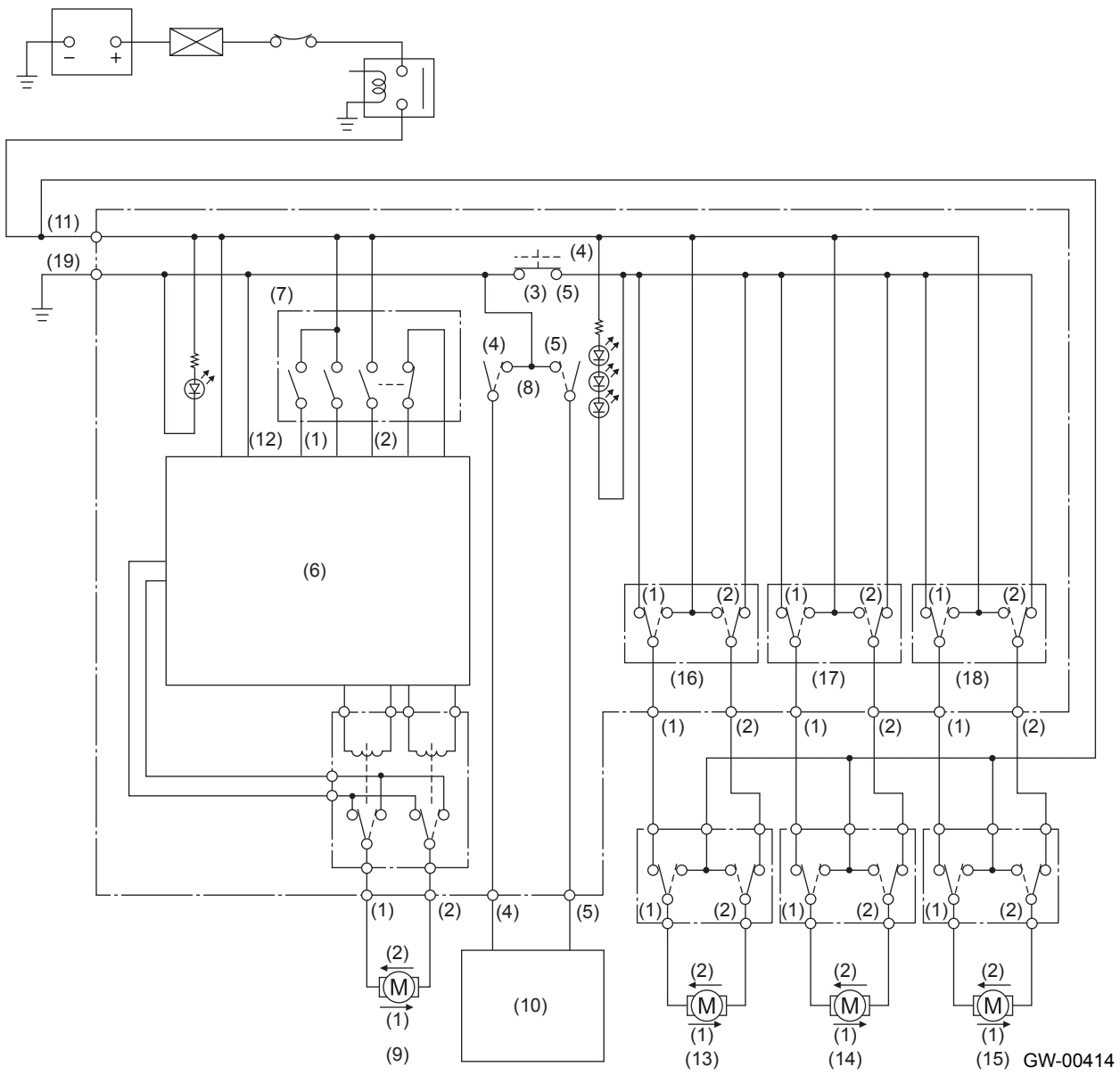
GLASS / WINDOWS / MIRRORS

1. Power Window

A: CONSTRUCTION

- The power window system consists of regulator motors and switches for individual doors, relays and a circuit breaker unit.
- Each door window can be opened/closed by pushing down/pulling up the switch.
- Only the driver's door window switch has a 2-stage mechanism:
  - When the switch is pushed down or pulled up lightly and held, the window continues to lower or raise until the switch is released.
  - When the switch is pushed down fully, the window opens to the end position automatically.

B: SCHEMATIC DRAWINGS



(1) Raise
(2) Lower
(3) Power window lock switch
(4) Lock
(5) Unlock
(6) Controller
(7) Power window driver's seat switch
(8) Door lock switch
(9) Driver's seat side
(10) Door lock controller
(11) Ignition
(12) Auto
(13) Passenger's seat
(14) Rear right
(15) Rear left
(16) Power window passenger's seat switch
(17) Power window rear right seat switch
(18) Power window rear left seat switch
(19) Ground

2. Door Mirrors

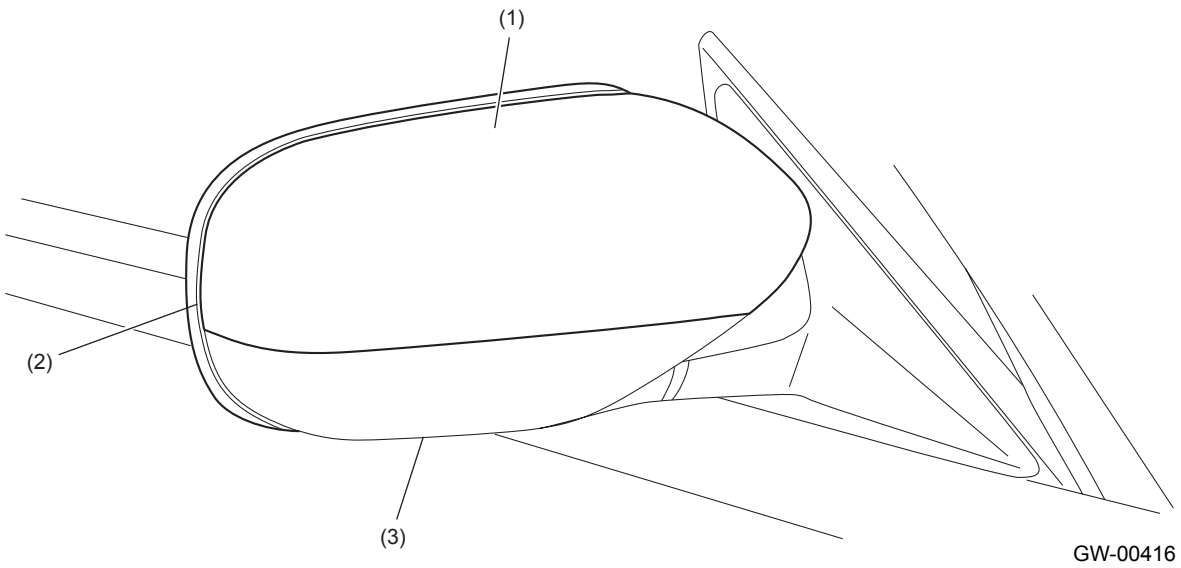
A: GENERAL

● Door mirrors are powered and remote controllable, and on some models each mirror has a side turn signal light built in it.

● The mirror body is structured as a scalp cap. The portion that may be damaged easier (scalp cap part and the side turn signal lamp part) can be replaced, contributing to reduce repair cost.

● Water drops cannot easily adhere to the mirror surface or front door glass while driving in rain.

● Mirror heaters are used on some models.



GW-00416

(1) Scalp cap
(2) Groove
(3) Side turn signal light

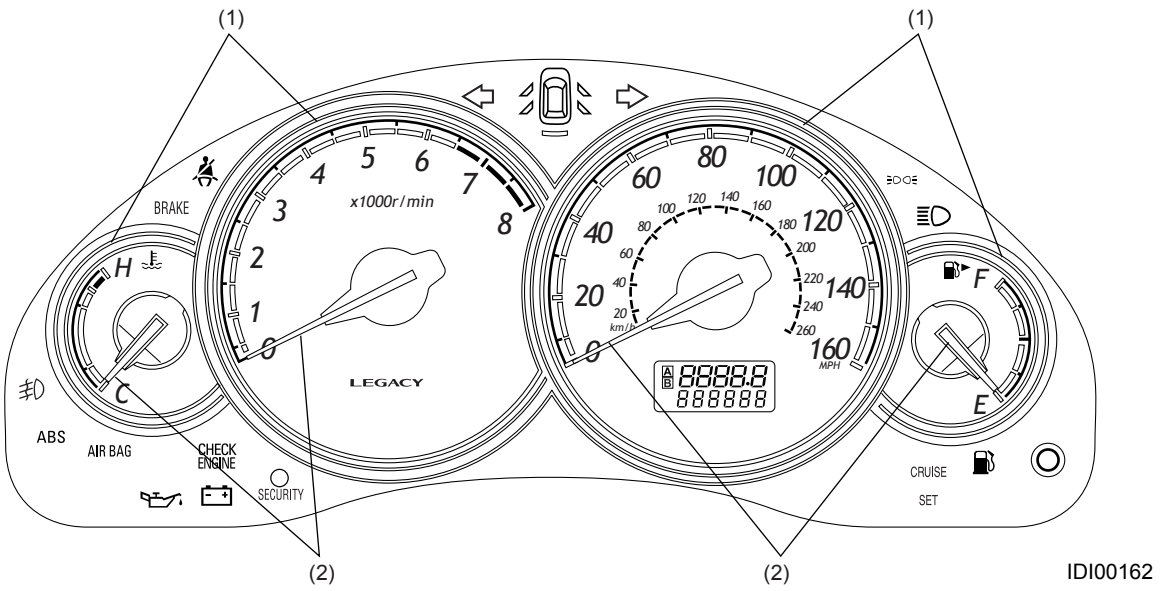
INSTRUMENTATION/DRIVER INFO

1. Combination Meter

A: ELECTRO-LUMINESCENT METER

To increase desirability and visibility of the meter, an electro-luminescent meter is used on some models.

- Red LEDs are used for meter rings and needles illumination.
- The brightness of the meter display area can be properly adjusted to meet various conditions.
- An indicator that illuminates when the lighting switch is turned to the next position from OFF is provided.



(1) Meter ring

(2) Needle

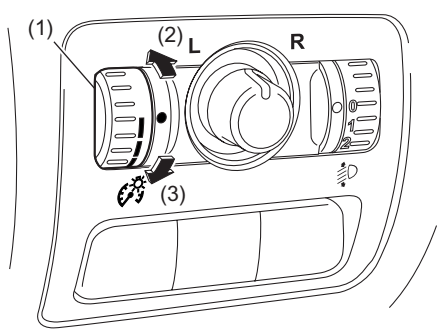
B: ILLUMINATION AND NEEDLES

1. INITIAL OPERATION

● Electro-luminescent meter
When the ignition switch is turned ON, the meter rings are illuminated first, and the needles are lit next. Then the needle moves from the minimum reading to the maximum reading, and then returns to the minimum reading. Finally the dial illumination and LCD turn on.

● Standard meter
When the ignition switch is turned ON, the meter needle moves from the minimum reading to the maximum reading and then returns to the minimum reading.

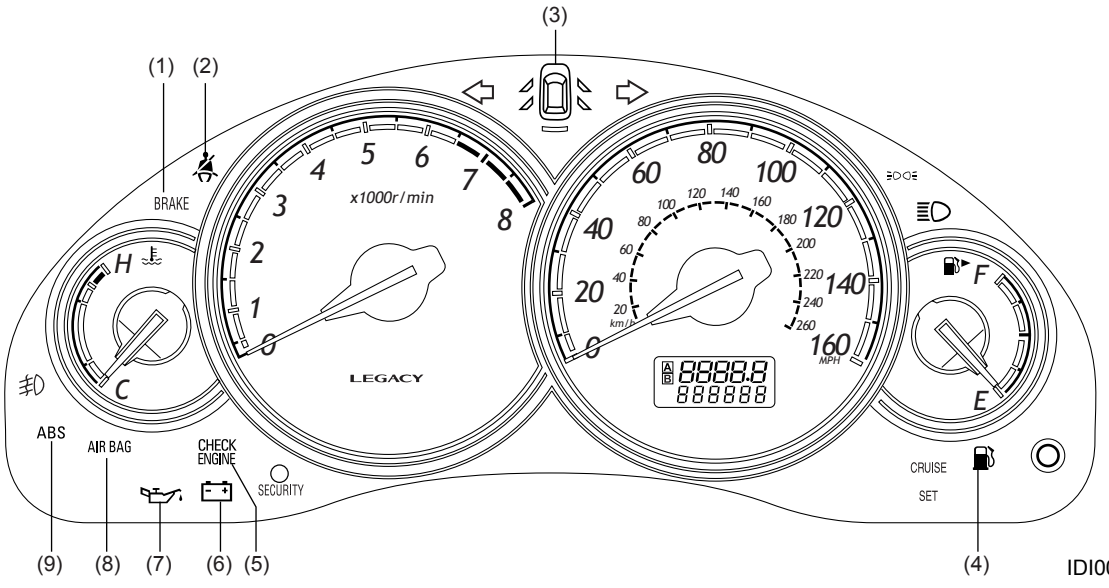
The illumination brightness can be adjusted by selecting any of the six steps of the instrument panel dial. (Adjustment is possible only when the lighting switch is ON for the standard meter.)



IDI00107

(1) Adjustment dial (2) Brighter (3) Darker

C: WARNING AND INDICATOR LIGHTS



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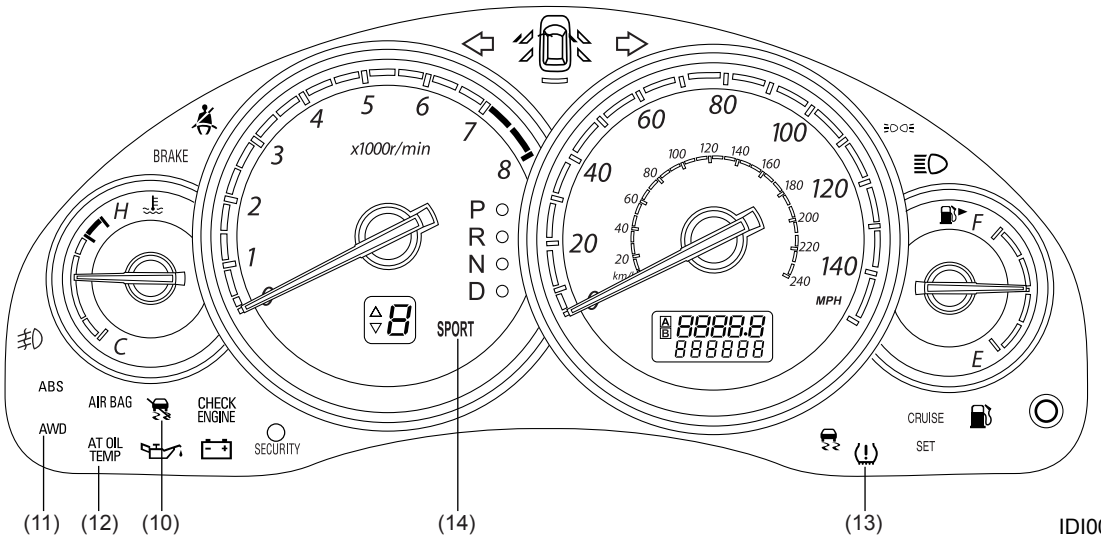


IDI00164

(1) Brake fluid level warning/parking brake indicator light
This light illuminates if the fluid level in the brake reservoir tank lowers below the specified level and/or when the parking brake is applied.

(2) Seat belt warning light
This warning light illuminates when the ignition switch is turned ON, and goes out when the seat belt is fastened.

(3) Door open warning light
This warning light illuminates when one or more doors and/or rear gate are not completely closed.

(4) Low fuel warning light
This warning light comes ON when the quantity of the fuel remaining in the tank has decreased to 9 ℓ (2.4 US gal, 2.0 Imp gal) or less.

(5) Engine malfunction indicator light
This light illuminates if a fault occurs in the MFI (Multiple point Fuel Injection) system.

(6) Charge warning light
This warning light illuminates when a fault occurs in the charging system while the engine is running.

(7) 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).

(8) AIR BAG system warning light
This warning light illuminates if a fault occurs in the airbag system.

(9) ABS warning light
This warning light illuminates if a fault occurs in any electrical component of the ABS (Anti-lock Brake System).

(10) Vehicle dynamics control warning light and vehicle dynamics control OFF indicator light
This light illuminates when a fault occurs in any electrical component of the vehicle dynamics control. It also illuminates when the vehicle dynamics control OFF switch is pressed.

(11) AWD warning light (AT)
This warning light illuminates if the vehicle is driven with front and rear tire sizes different from each other. On 4AT models, this indicator illuminates when the drive mode is changed from AWD to FWD (with the fuse installed in the FWD switch).

(12) AT oil temperature warning light (AT)
This warning light illuminates when the ATF temperature exceeds 150°C (302°F).

(13) Tire pressure warning light
This warning light illuminates when the air pressure in either of the tires drops below the specified value while traveling, and flashes when a fault occurs in the tire pressure monitoring system.

(14) Sports mode indicator (AT)
This indicator illuminates when the AT selector lever is put in the sports mode position, and blinks if a fault occurs in the AT control system.

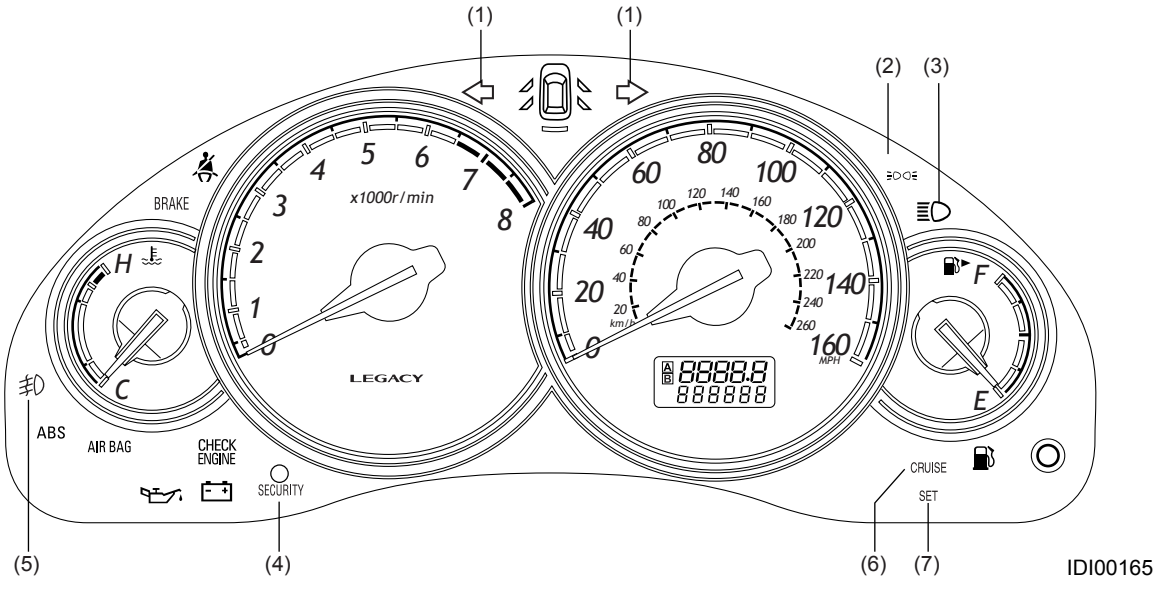
When everything is normal, the warning and indicator lights should be ON or OFF as shown below according to ignition switch positions.

Warning/Indicator light			Ignition switch position			
			LOCK/ACC	ON	ST	While engine is running
(1)	Brake fluid level / parking brake		OFF	ON	ON	*1
(2)	Seat belt		OFF	*2	*2	*2
(3)	Door or rear gate open	● Open	ON	ON	ON	ON
		● Closed	OFF	OFF	OFF	OFF
(4)	Low fuel level		OFF	*3	*3	*3
(5)	Engine malfunction indicator		OFF	ON	ON	OFF
(6)	Charge		OFF	ON	ON	OFF
(7)	Oil pressure		OFF	ON	ON	OFF
(8)	AIR BAG		OFF	*4	*4	*4
(9)	ABS		OFF	*5	*5	*5
(10)	Vehicle dynamics control		OFF	ON	ON	OFF
(11)	AWD		OFF	*6	*6	*6
(12)	AT oil temperature		OFF	ON	ON	OFF
(13)	Tire pressure		OFF	*5	*5	*5
(14)	Sports mode		OFF	OFF	OFF	*7

*1: This warning light illuminates when the parking brake is applied.
*2: This warning light flashes after the ignition switch is turned ON until the drivers seat belt is fastened.
*3: This warning light illuminates when the quantity of the fuel remaining in the tank has decreased to 9 ℓ (2.4 US gal, 2.0 Imp gal) or less.
*4: This warning light illuminates for about 6 seconds, and then goes out.
*5: This warning light illuminates for about 2 seconds, and then goes out.
*6: This warning light illuminates if the front and rear tire sizes are different from each other. This also illuminates when the drive mode is changed from AWD to FWD (4AT models).
*7: This light illuminates when the AT selector lever is moved to the sports mode position.

MEMO

D: TELLTALE LIGHT



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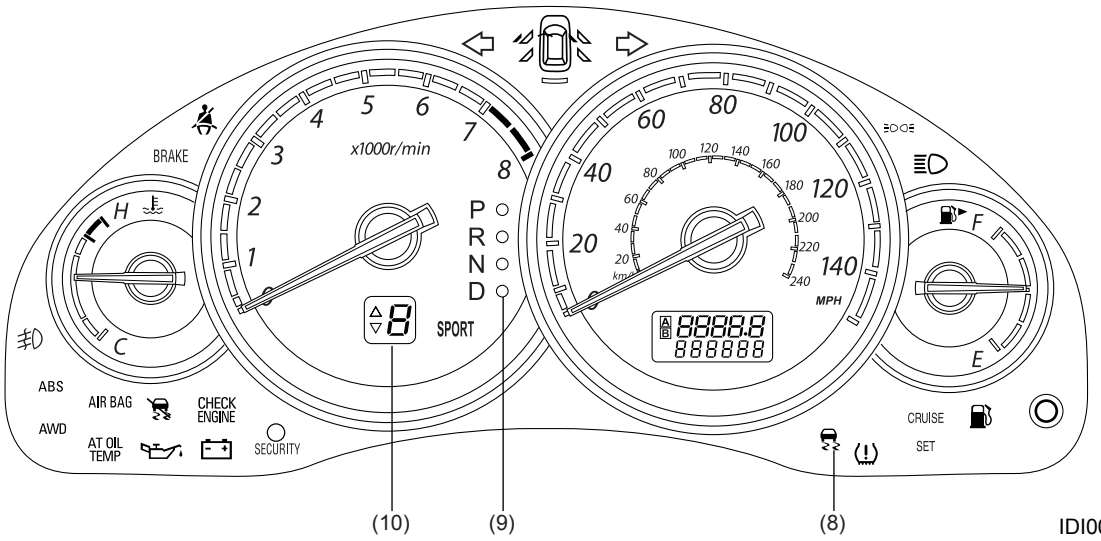


IDI00166

(1) Turn signal indicator light
This light blinks in unison with the corresponding turn signal lights when the turn signal switch is operated.

(2) Lighting switch indicator light
Turns on when the lighting switch is turned to the next position from OFF.

(3) Headlight beam indicator
This light illuminates when the headlights are in the high-beam position.

(4) Immobilizer indicator
This light illuminates when the immobilizer systems are armed.

(5) Front fog light indicator light
This light illuminates when the front fog lights are ON.

(6) CRUISE indicator light
This light illuminates when the cruise control main switch is turned ON.

(7) SET indicator light
This light illuminates when the cruise control main switch is turned ON and the SET/COAST switch on the command switch is turned ON.

(8) Vehicle dynamics control function indicator light
This light blinks when the vehicle dynamics control is operating.

(9) AT selector lever position indicator (AT)
The indicator corresponding to the present AT select lever position illuminates when the ignition switch is in any position other than ACC and LOCK.

(10) Sports shift indicator (AT)
Indicates the current gear position when sports shift is selected.

When everything is normal, the telltales should be ON, OFF or in other states as shown below according to ignition switch position.

Telltale light			Ignition switch position			
			LOCK/ACC	ON	ST	While engine is running
(1)	Turn signal		OFF	Blink	Blink	Blink
(2)	Lighting switch		OFF	*1	*1	*1
(3)	Headlight beam	• High beam	OFF	ON	ON	ON
		• Low beam	OFF	OFF	OFF	OFF
(4)	Immobilizer		*2	OFF	OFF	OFF
(5)	Front fog light	Front fog light ON	OFF	ON	ON	ON
(6)	CRUISE		OFF	OFF	OFF	ON
(7)	SET		OFF	OFF	OFF	*3
(8)	Vehicle dynamics control		OFF	*4	ON	OFF
(9)	AT selector lever position		OFF	ON	ON	ON
(10)	Sports shift indicator		OFF	*5	OFF	*5

*1: Turns on when the lighting switch is turned to the next position from OFF.
*2: This light illuminates when the immobilizer system is armed.
*3: This light illuminates when the SET/COAST switch is turned ON while driving at 40 km/h (25 MPH) or higher.
*4: This light illuminates for about 2 seconds, and then goes out.
*5: Indicates the current gear position when sports shift is selected. It also illuminates for about 2 seconds when the ignition switch is turned ON.

E: SPEEDOMETER

1. GENERAL

● The speedometer system is an electrical type that uses electric signals from the ABS or vehicle dynamics control (VDC) control module.

● Since the system does not use mechanical components such as rotating cable, there are no opportunities of occurring such problems as meter needle vibration and cable disconnection. Also, it does not constitute any means of mechanical noise transmission.

● The odometer and trip meter readings appear on a liquid crystal display (LCD).

● At the trip meter display, the illumination level and the following trouble information (abnormality of various control modules, communication system, vehicle speed signals, etc.) are shown in addition to the trip meter reading.

Indication	Indicated fault
“Er --”	High speed and low speed CAN communication failed simultaneously
“Er HC”	High speed CAN communication failure
“Er LC”	Low speed CAN communication failure
“Er IU”	Body integrated unit failure inside
“Er EG”	Engine control module communication counter failure
“Er tC”	Transmission control module communication counter failure
“Er Ab”	ABS/VDC control module communication counter failure
“Er SP”	Vehicle speed signal abnormal (ABS/VDC diagnostic trouble code information)
“Er SS”	Vehicle speed signal abnormal (wheel speed signal abnormal)

2. OPERATION

The ABS or VDC control module calculates the vehicle speed based on signals from the four wheel speed sensors and sends vehicle speed signals (4 pulses per rotation of wheel) to the speedometer drive circuit and odometer/trip meter drive circuit in the speedometer.

NOTE:
Signals from the ABS or VDC control module are also used by the engine control module, automatic transmission control module, etc.

3. SPECIFICATIONS

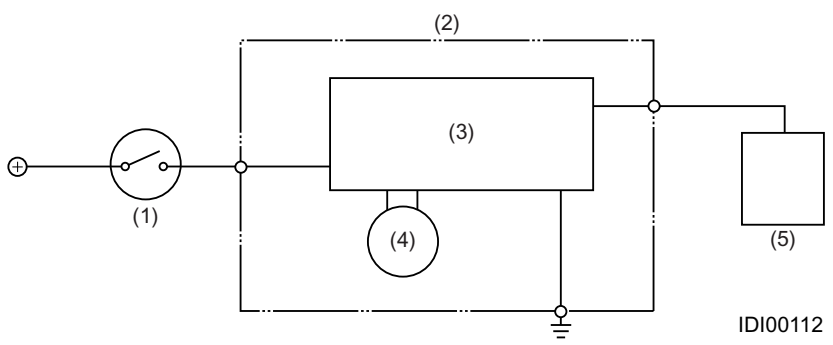
Speedometer	Type		Electric pulse type
	Indication	km/h	The needle points to 60 km/h (37.3 MPH) when 2,548 pulses are input per minute.
		MPH	The needle points to 60 MPH (95 km/h) when 4,104 pulses are input per minute.
Odometer	Type		Pulse count type
	Display		LCD/6 digits; 0 to 999,999 km (miles)
	Indication		Counts up 1 km per 2,548 pulses. (4,104 pulses per mile)(Count down is impossible.)
Trip meter	Type		Pulse count type
	Display		LCD/4 digits; 0 to 999.9 km (miles) and 1000 to 9999 km (miles).
	Indication		Counts up 1 km per 2,548 pulses. (4,104 pulses per mile)(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.)

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.



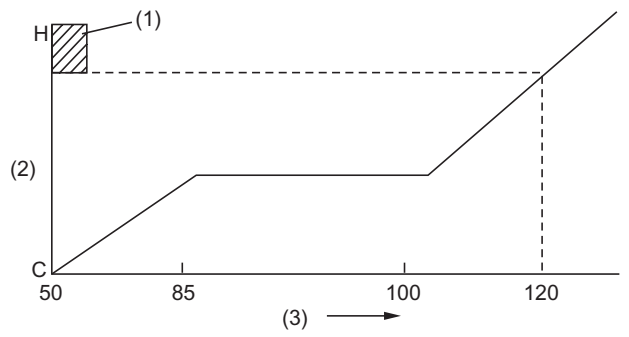
(1) Ignition switch
(2) Combination meter
(3) Microprocessor
(4) Tachometer
(5) Engine control module

G: WATER TEMPERATURE GAUGE

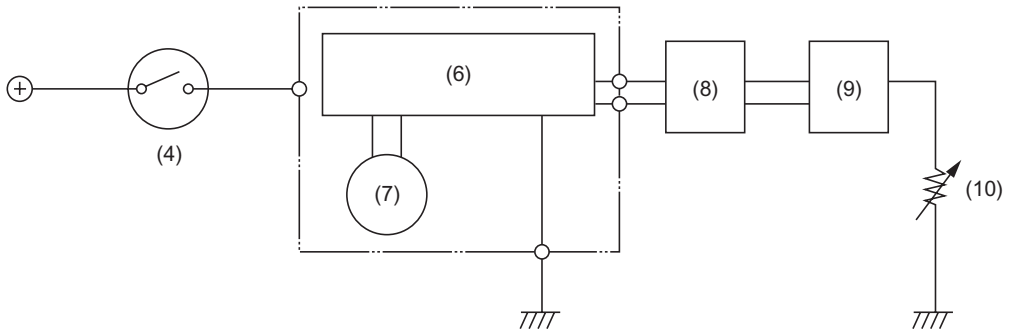
● Water temperature signals are generated at the engine coolant temperature sensor on the engine, and after converted into digital signals, these signals are sent via the body integrated unit to the combination meter.

● The resistance of the engine coolant temperature sensor changes according to the engine coolant temperature. Therefore, the signals sent to the water temperature gauge also changes according to the engine coolant temperature. As the change in signals causes the magnetic force of the step motor to change, the gauge needle moves according to the engine coolant temperature.

● When the coolant is at a normal operating temperature of approx. 85 to 100°C (158 to 212°F), the gauge needle stays in the middle of the indication range as shown below.



(5)



IDI00113

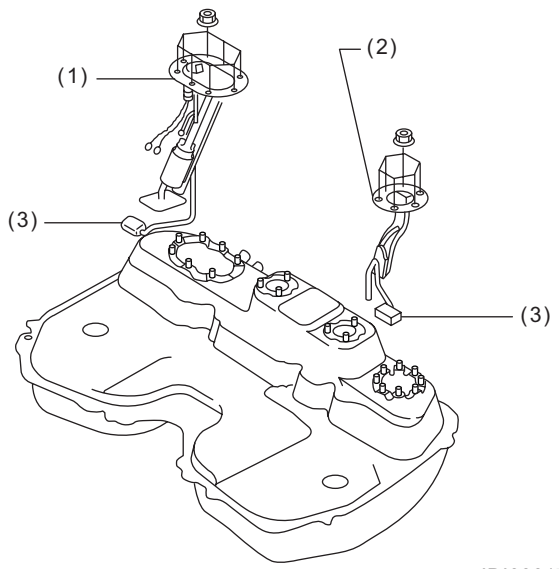
(1) Red zone
(2) Indication
(3) Temperature (°C)
(4) Ignition switch
(5) Combination meter
(6) Microprocessor
(7) Water temperature gauge
(8) Body integrated unit
(9) Engine control module
(10) Engine coolant temperature sensor

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 when the ignition switch is in the ON position. When the trip knob is pushed, the fuel gauge illumination comes ON and the fuel level registered just before the ignition switch was turned OFF is indicated, even when the ignition switch is in the OFF position.

● All models are equipped with two fuel level sensors. These sensors are installed in the fuel tank, one on the right side and the other on the left side. Two sensors are necessary because the fuel tank is divided into main and sub tank compartments.



IDI00017

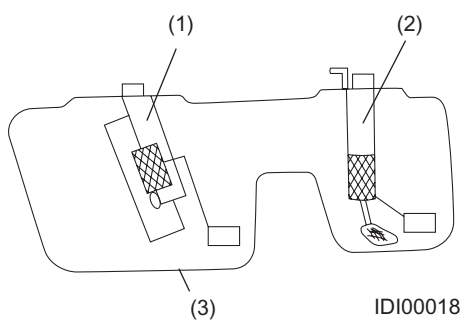
(1) Main fuel level sensor
(2) Fuel sub level sensor
(3) Float

2. OPERATION

The low fuel warning light operates as follows:

The signal from the fuel level sensor is converted into a digital signal at the body integrated unit, and then sent to the combination meter. The combination meter microprocessor continually monitors this signal. It turns on the low fuel warning light in the combination meter if a resistance value corresponding to the critical fuel level is detected for a certain time while driving.

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) Fuel sub level sensor
(3) Fuel tank

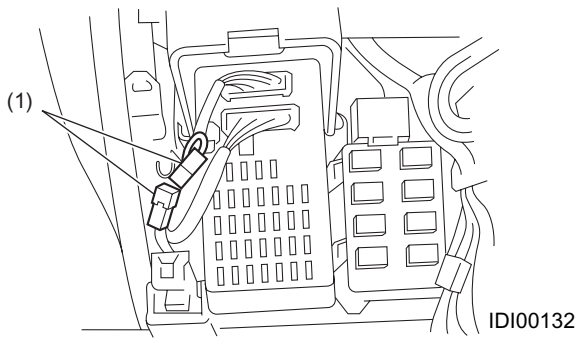
3. SPECIFICATIONS

	Fuel level	Resistance
Main fuel level sensor	Full	1.0 — 3.0Ω
	Empty	30.9 — 32.9Ω
Fuel sub level sensor	Full	1.0 — 3.0Ω
	Empty	61.1 — 63.1Ω

I: DIAGNOSIS MODE

1. GENERAL

The combination meter is provided with a self diagnosis function and a diagnostic trouble code display function which indicate DTCs for the engine, transmission and ABS/VDC control modules. To enter diagnosis mode, the diagnosis connector located near the fuse box under the right side of the driver's seat is used.



(1) Diagnosis connector

2. PROCEDURE

● Entering diagnosis mode

1) Connect the diagnosis connector.

2) Turn ON the ignition switch.

3) During initial operation of the meter and while the needle is moving, push the trip knob once to enter diagnostic trouble code display mode, or push the knob twice to enter self diagnosis mode.

NOTE:
If the vehicle is driven while in diagnosis mode (vehicle speed signals input), diagnosis mode is cancelled.

● To exit diagnosis mode

Turn OFF the ignition switch and disconnect the diagnosis connector to exit diagnosis mode.

3. FUNCTION

● Self diagnosis mode

When self diagnosis mode is activated, the system switches to warning lights, indicators, needle movement, illumination or buzzer check mode (sports shift) each time the trip knob is pushed.

● Diagnostic trouble codes display mode

When diagnostic trouble code display mode is activated, the display switches to indicate engine control module, transmission control module, or ABS/VDC control module diagnostic trouble codes each time the trip knob is pushed. In addition to the type of control module, the display will show whether the diagnostic trouble codes are now being received, present, or not. If CAN communication is failed, "-----" is displayed.

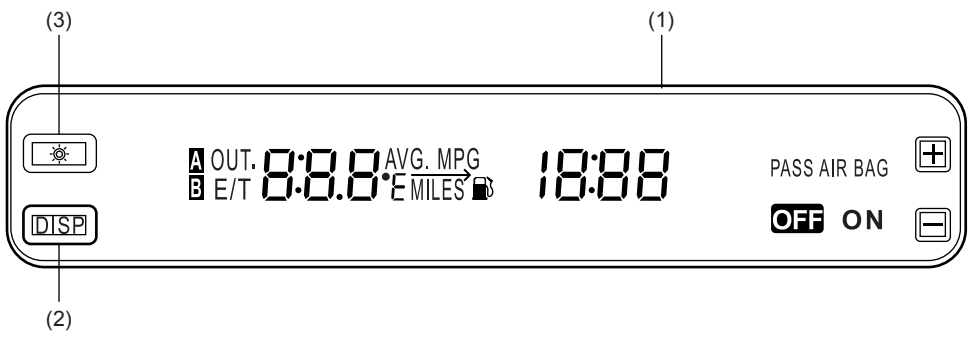
Control module	Status	Indication
Engine control module	Receiving diagnostic trouble codes	Trip "A" + "P (blink)"
	Diagnostic trouble codes present	Trip "A" + "P xxxx"
	No failure exists	Trip "A" + "P ----"
Transmission control module	Receiving diagnostic trouble codes	Trip "B" + "P (blink)"
	Diagnostic trouble codes present	Trip "B" + "P xxxx"
	No failure exists	Trip "B" + "P ----"
ABS/VDC control module	Receiving diagnostic trouble codes	Trip "A" + "C (blink)"
	Diagnostic trouble codes present	Trip "A" + "C xxxx"
	No failure exists	Trip "A" + "C ----"
CAN communication error	—	"-----"

2. Clock Unit

A: GENERAL

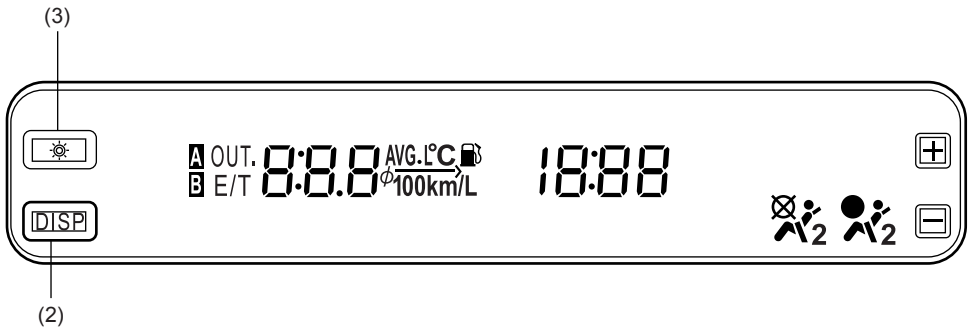
The clock unit display can be switched to indicate outside air temperature, fuel efficiency, remaining travel distance or continuous driving time, by operating a button. The DISP button is used for switching the display, and the indicated information switches in the following sequence each time the button is pressed: outside temperature → fuel efficiency at the instant → average fuel efficiency → remaining travel distance → continuous driving timeThese data are sent from the combination meter by means of digital communication. This clock unit is provided with a function to automatically display a failure; if the accessory power circuit is open it displays “Acc”, and if the ignition power circuit is open it displays “ign”.If an abnormality is detected in the communication between the combination meter and clock unit or in the received data, “Err” is displayed.If no data can be received, “Err” will always be displayed even when the indication is switched with the DISP button, but when only a specific data is not received, “Err” will be displayed only when the indication is switched to display that data. For example, if outside temperature data is not received “Err” will be displayed only when the thermometer feature is selected, and other indications such as the fuel efficiency meter will be displayed normally.

(A)



IDI00167

(B)



IDI00172

(A) For U.S.
(1) Clock unit
(2) DISP button

(B) For Canada
(3) BRIGHT button

B: OPERATION

1. CLOCK DISPLAY

The clock shows time when the ignition switch is turned to ACC or further from OFF.

2. INSTANT FUEL EFFICIENCY, AVERAGE FUEL EFFICIENCY, REMAINING TRAVEL DISTANCE AND CONTINUOUS DRIVING TIME DISPLAY

The combination meter microprocessor performs calculations based on vehicle speed signals from the ABS/VDC control module, remaining fuel signals from the body integrated unit, fuel efficiency signals from the engine control module, and engine start signals, and then sends the data to the clock unit.

- Average fuel efficiency

The value is calculated from the distance and total amount of consumed fuel since the trip meter has been reset the last time.

- Instant fuel efficiency

The value is calculated during driving, based on the traveled distance and amount of consumed fuel recorded for a certain period.

- Remaining travel distance

The value is calculated from the average fuel efficiency in recent 30 km (18.8 miles) and the amount of remaining fuel.

- Continuous driving time

Indicates the total time since the engine has been started.

3. OUTSIDE AIR TEMPERATURE DISPLAY

The body integrated unit performs calculations based on outside air temperature signals from the ambient sensor and vehicle speed signals from the ABS/VDC control module, and then sends the data via the combination meter to the clock unit.

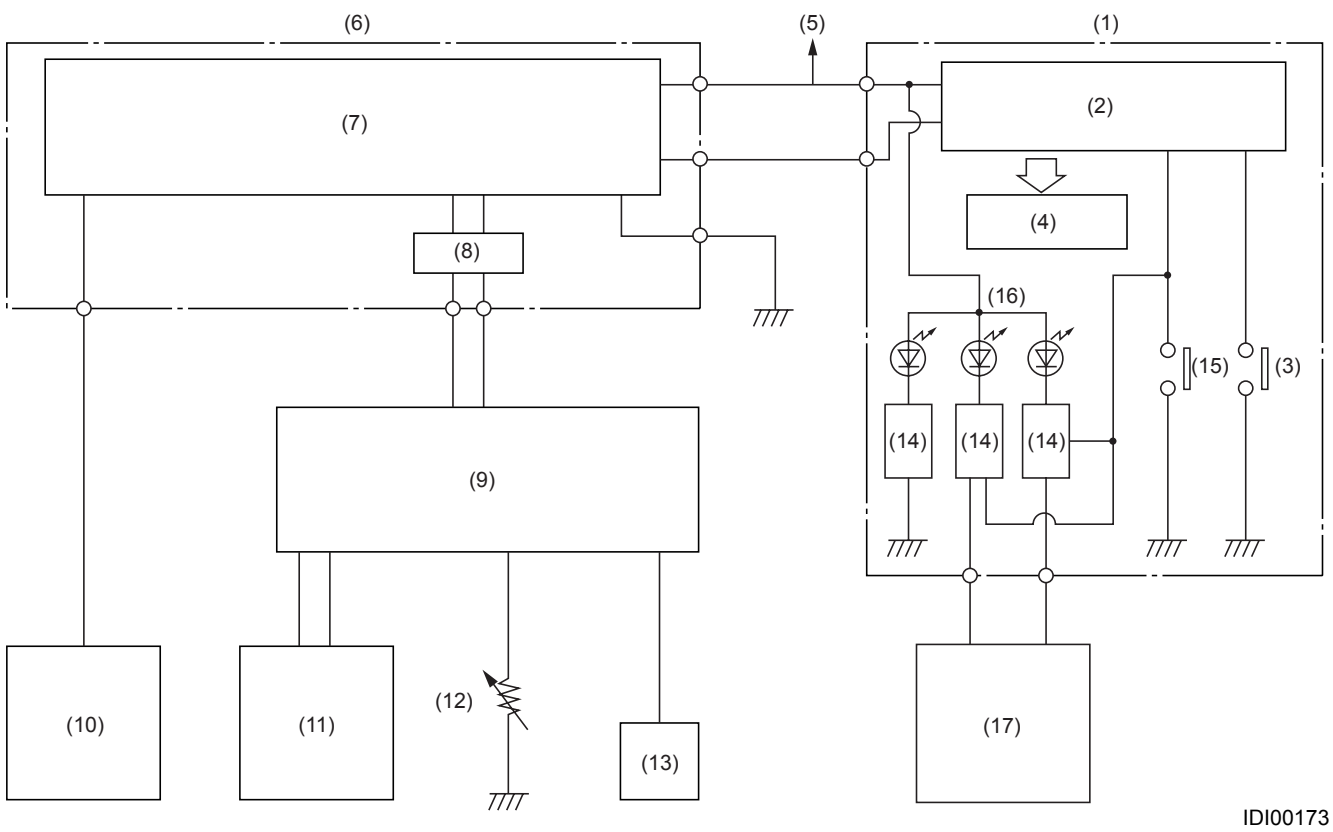
4. BRIGHT (DIMMER CANCELING) FUNCTION

The dimmer can be cancelled by pushing the BRIGHT button when the lighting switch is ON. The lights returns to the dimmed state when the button is pushed again.

5. PASSENGER'S SEAT AIRBAG INDICATOR

When this indicator (a mark on vehicles for Canada) is ON, the passenger's seat airbag will deploy in case of a front collision that should cause the airbag system to activate. When the indicator (a mark on vehicles for Canada) is OFF the passengers seat airbag will not deploy.

C: SCHEMATIC DRAWINGS



IDI00173

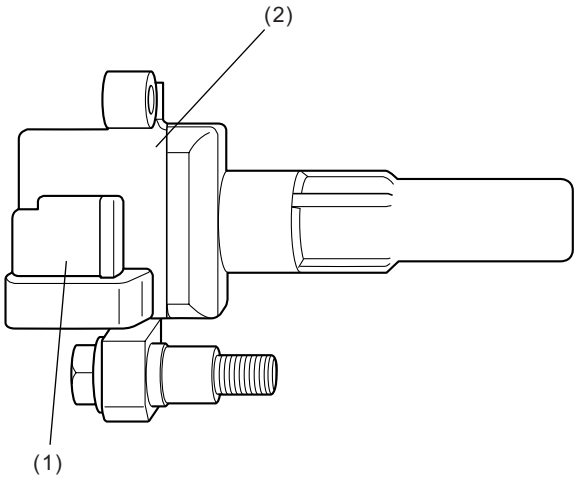
(1) Clock unit
(2) Microprocessor
(3) DISP button
(4) Display
(5) Ignition switch
(6) Combination meter
(7) Microprocessor
(8) CAN transmitter and receiver
(9) Body integrated unit
(10) ABS or VDC control module
(11) Engine control module
(12) Fuel level sensor
(13) Ambient sensor
(14) Dimmer canceling circuit
(15) BRIGHT button
(16) Passenger's seat airbag indicator
(17) Airbag control module

IGNITION
(H4SO)

1. Ignition Coil

The engine uses a direct ignition system with one ignition coil mounted for each cylinder.

The secondary terminal of the ignition coil is in contact with the spark plug terminal. Since no spark plug cable is used, secondary voltage drop, short circuit at connections, or other problems that are inherent in a system using spark plug cables do not occur. The result is high reliability.



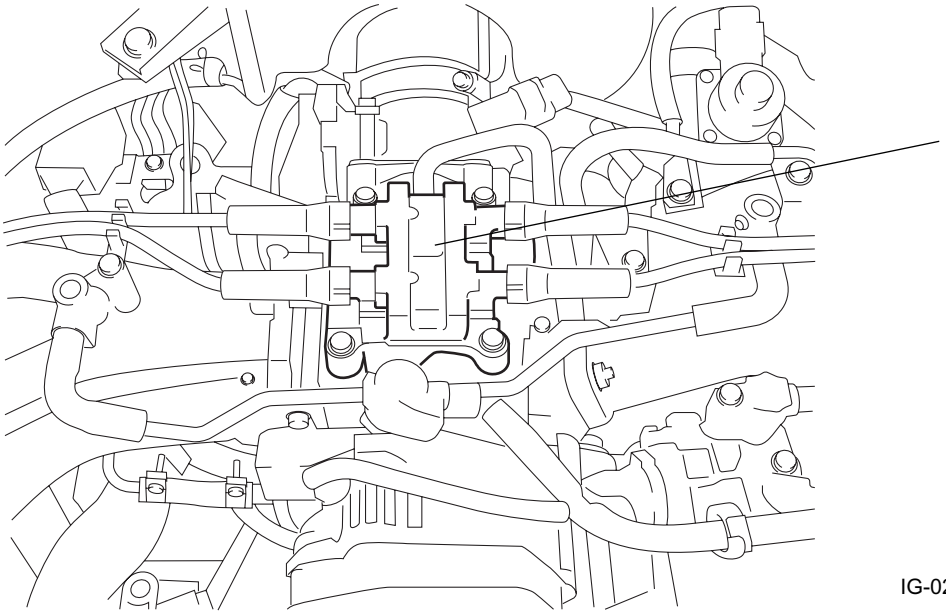
IG-00040

(1) Connector
(2) Ignition coil

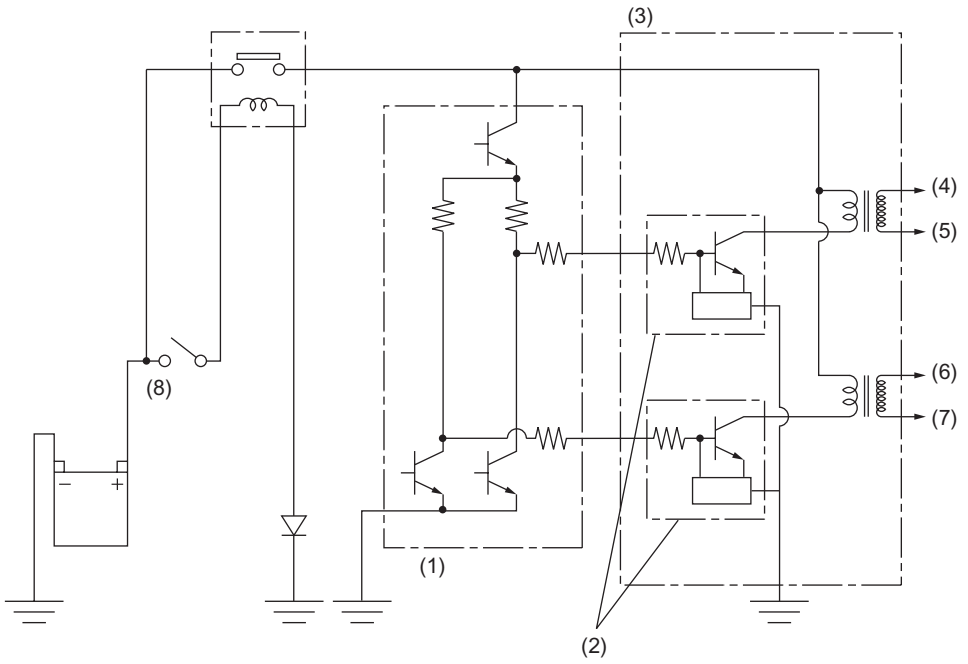
IGNITION
(H4SO U5)

1. Ignition Coil

Ignition coils are made integral with an igniter. 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 igniter assembly

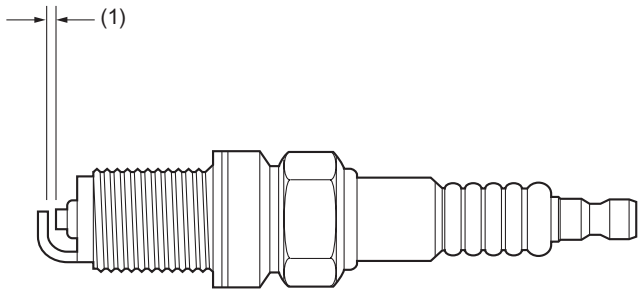


IG-00103

(1) ECM
(2) Igniter
(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).



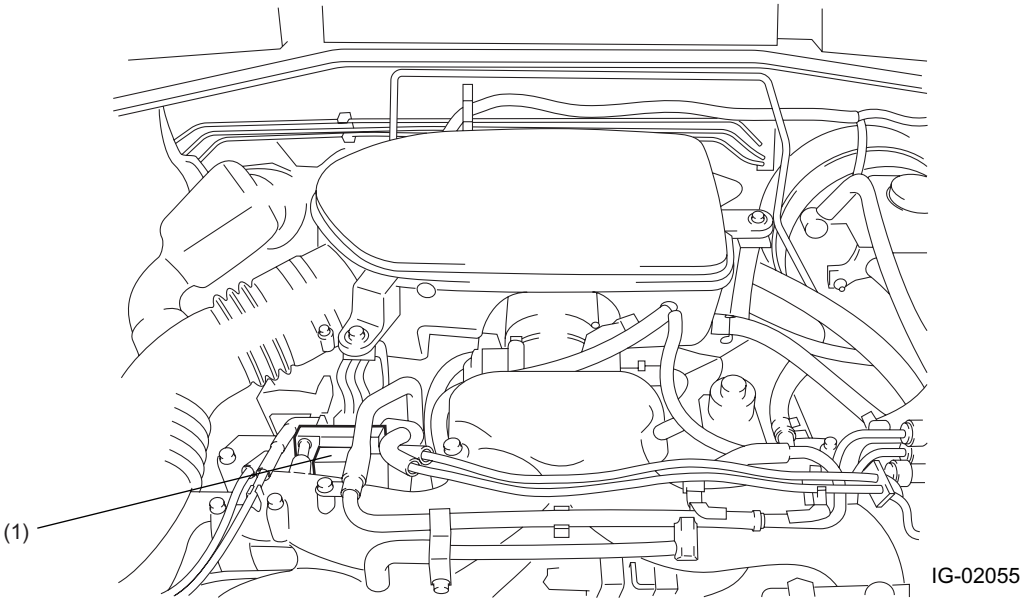
IG-00035

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

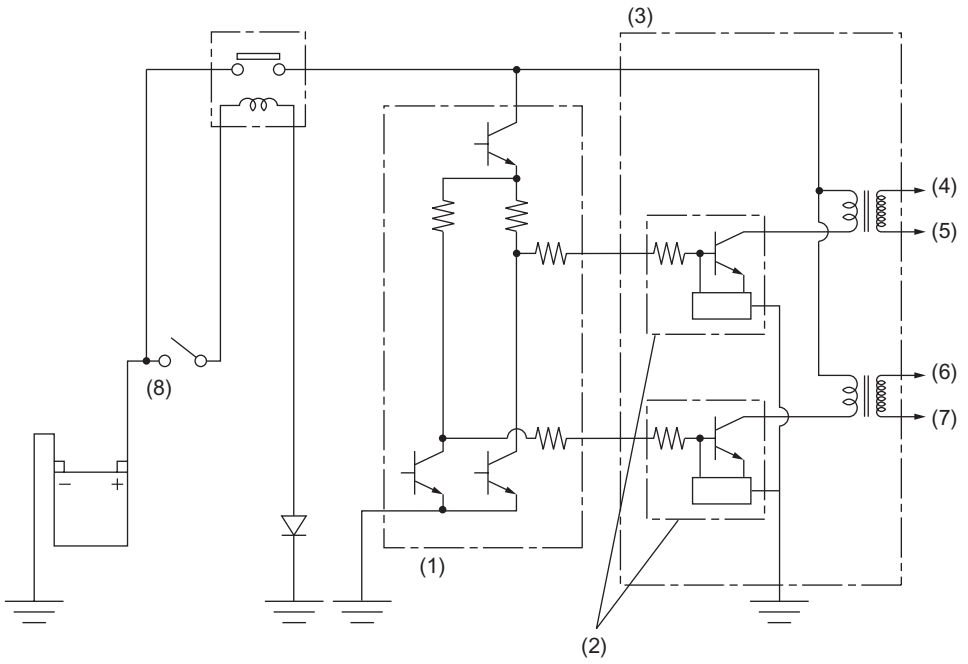
IGNITION
(H4SO)

1. Ignition Coil

Ignition coils are made integral with an igniter. 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 igniter assembly

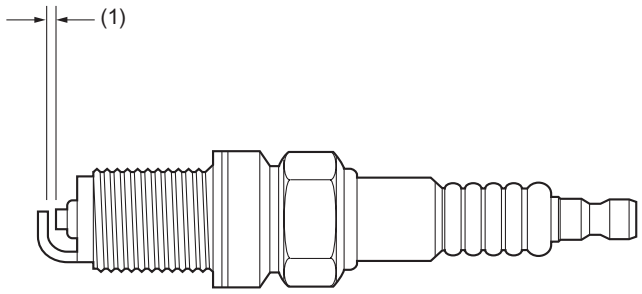


IG-00103

(1) ECM
(2) Igniter
(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

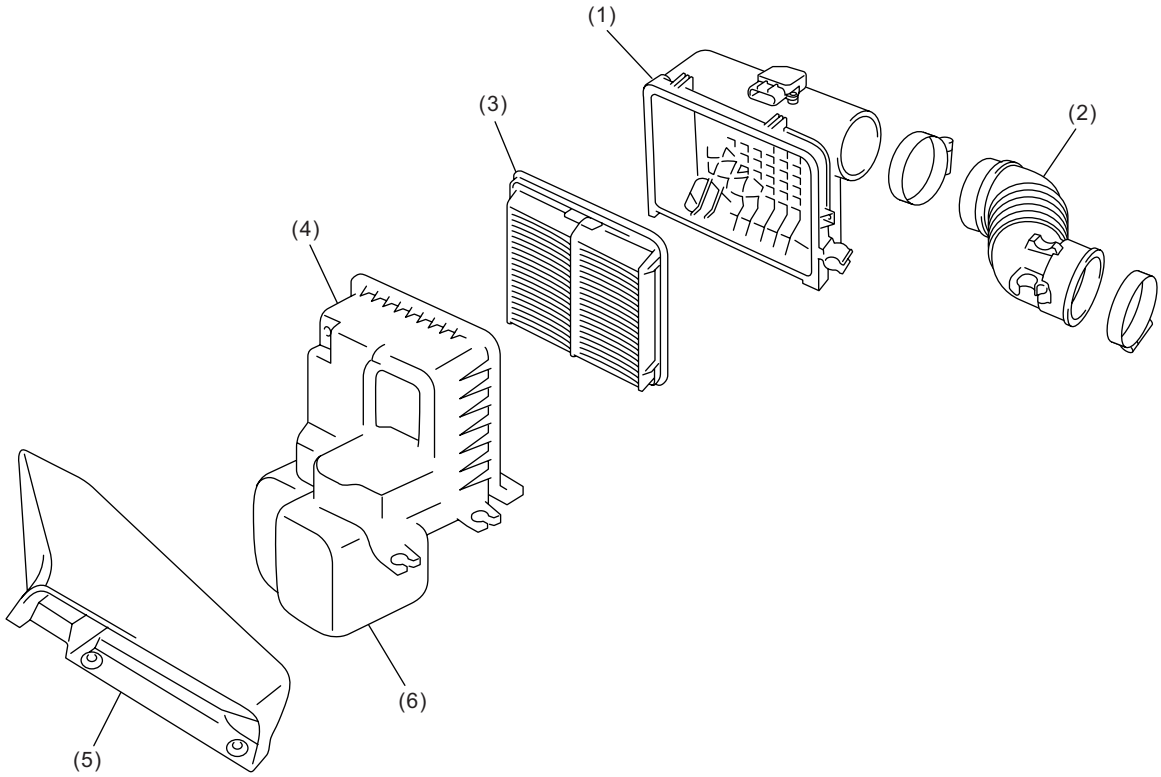
(1) Gap: 1.0 — 1.1 mm (0.039 — 0.043 in)

INTAKE (INDUCTION)
(H4DOTC)

1. Intake System

A: GENERAL

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



IN-02098

(1) Air cleaner rear case
(2) Air intake boot
(3) Air cleaner element
(4) Air cleaner front case
(5) Air intake duct
(6) Resonator chamber

2. Turbocharger System

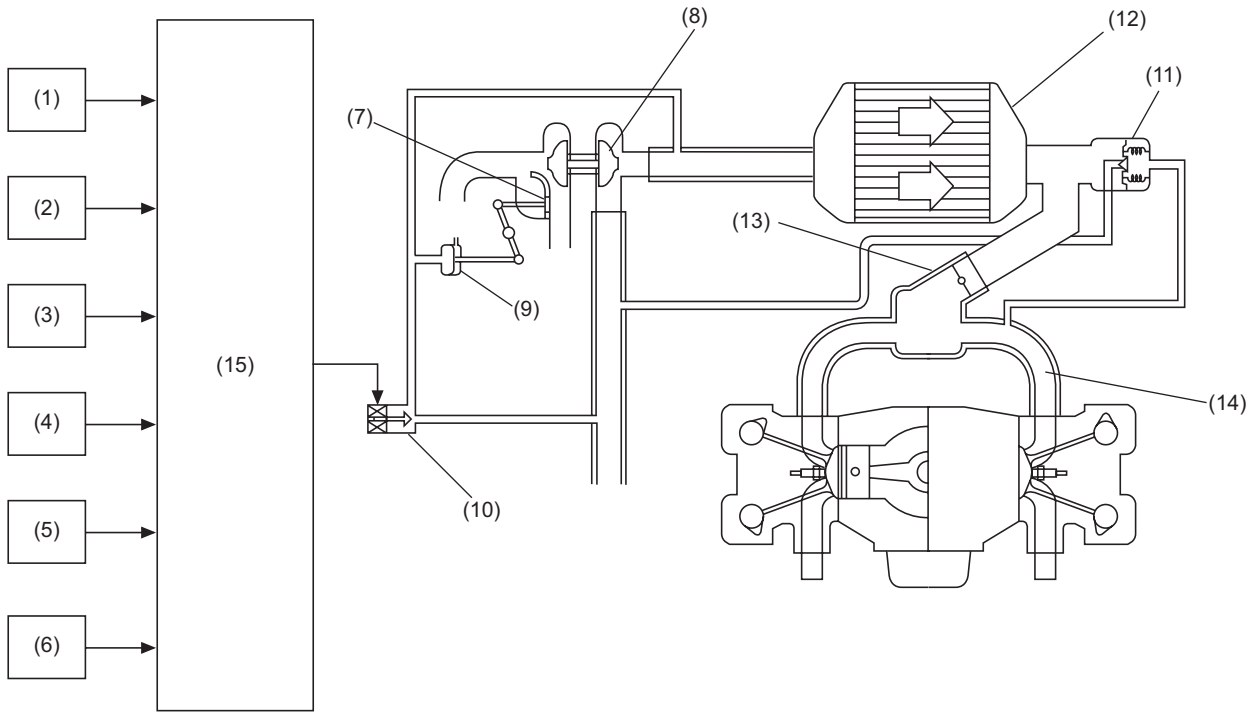
A: GENERAL

● The turbocharger system consists of a water-cooled turbocharger, air-cooled intercooler, wastegate control solenoid valve, etc.

● The turbine rotated by exhaust gas pressure rotates the compressor.

● As a result, the intake air is compressed by the compressor before it is delivered to the intake manifold.

● This turbocharger system controls the supercharging pressure according to changes in the atmospheric pressure. Even at a high altitude, therefore, the system offers stable performance without being affected by variations in atmospheric pressure.

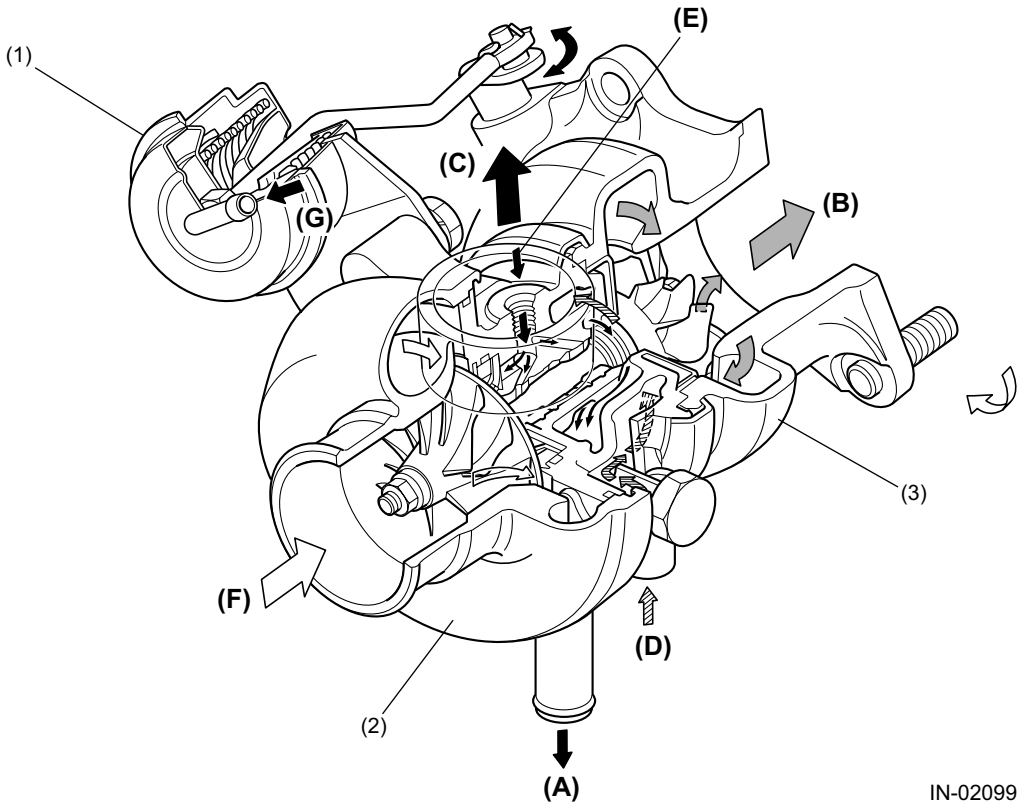


IN-00234

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

B: TURBOCHARGER UNIT

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

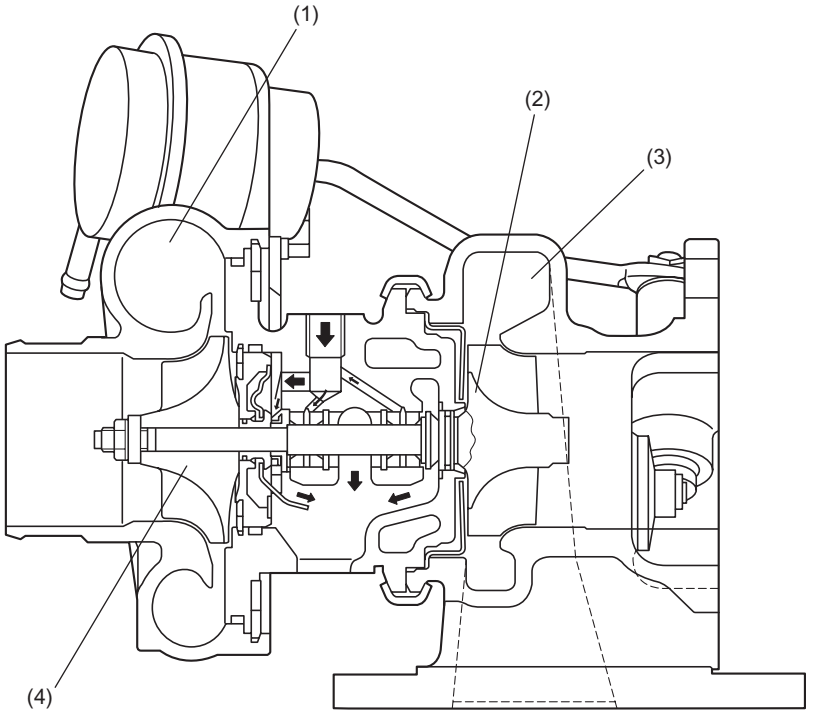


(1) Wastegate controller
(2) Compressor housing
(3) Turbine housing
(A) Lubricating oil outlet
(B) Exhaust gas outlet
(C) Air outlet port
(D) Coolant inlet
(E) Lubricating oil inlet
(F) Air inlet
(G) Wastegate valve operation pressure

C: LUBRICATION OF TURBOCHARGER

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

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



IN-00048

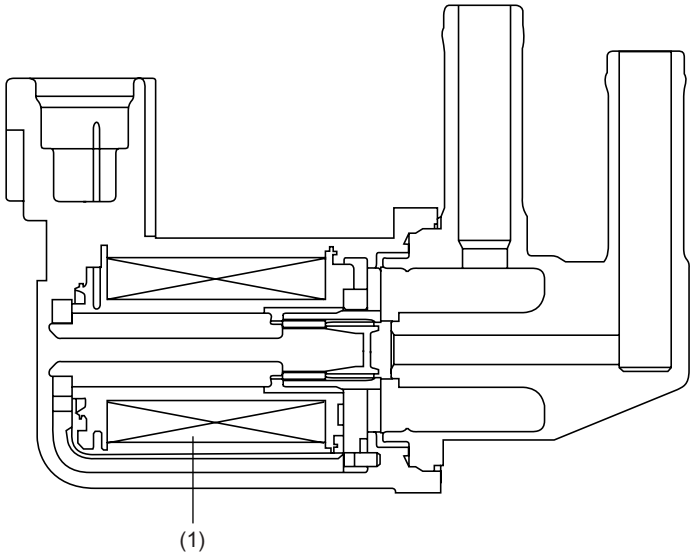
(1) Compressor housing
(2) Turbine wheel
(3) Turbine housing
(4) Compressor impeller

D: COOLING OF TURBOCHARGER

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

E: WASTEGATE CONTROL SOLENOID VALVE

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



IN-02001

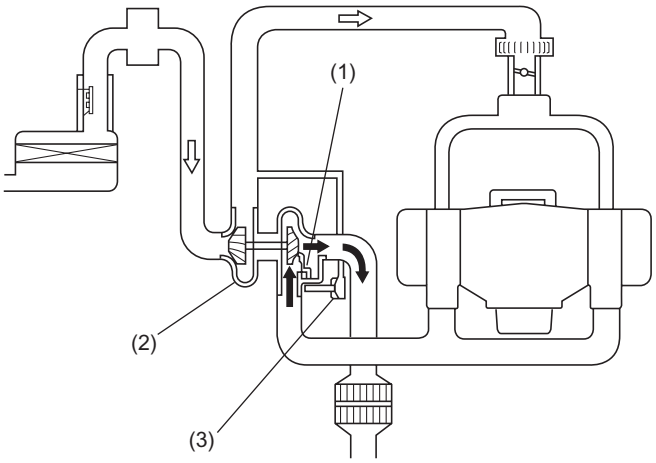
(1) Coil

F: REGULATION OF SUPERCHARGING PRESSURE

1. BASIC FUNCTION OF THE WASTEGATE VALVE

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

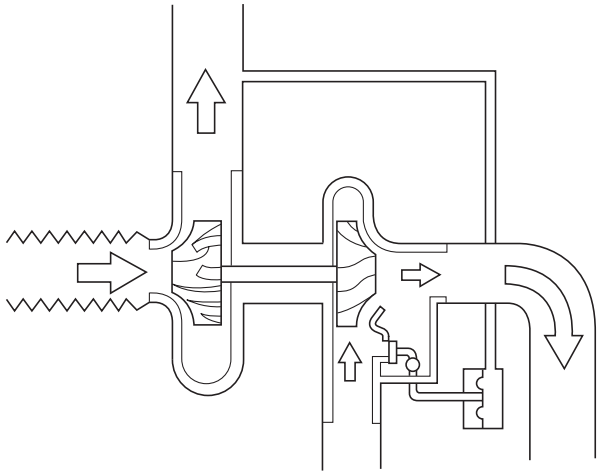
If the resultant supercharging pressure is extremely high, however, it may cause knocking and an excessively high thermal load on such engine components as pistons. In the worst case, the engine may be damaged or broken. To prevent this, the waste gate valve and its controller are provided. By sensing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



IN-00049

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

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



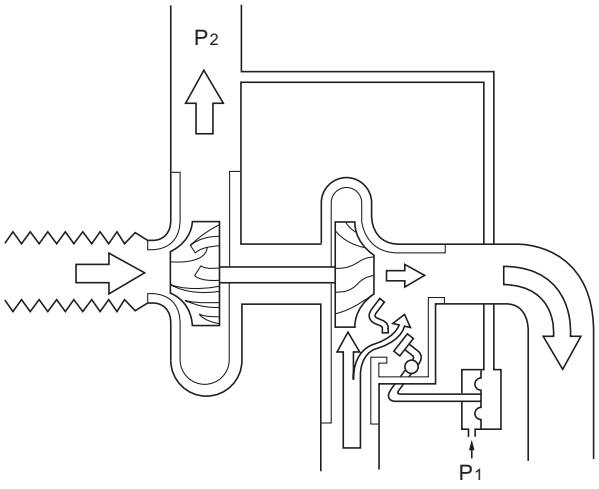
IN-00050

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

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

- It means $P_2 - P_1$ = constant.

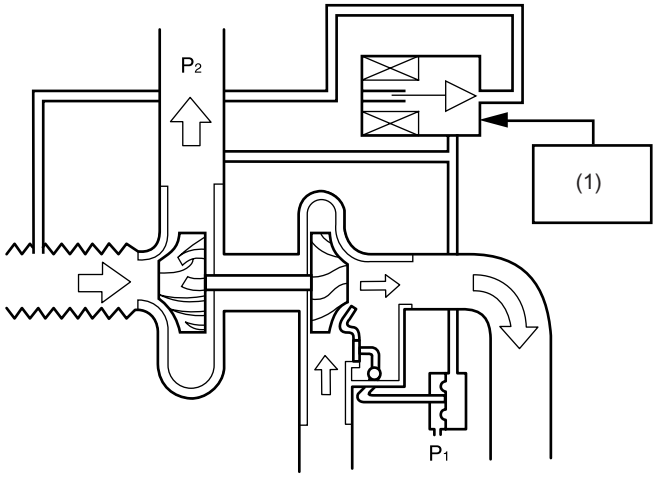
P_1: Atmospheric pressure
P_2: Supercharging pressure



IN-00051

2. CONCEPT OF THE WASTEGATE VALVE CONTROL

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



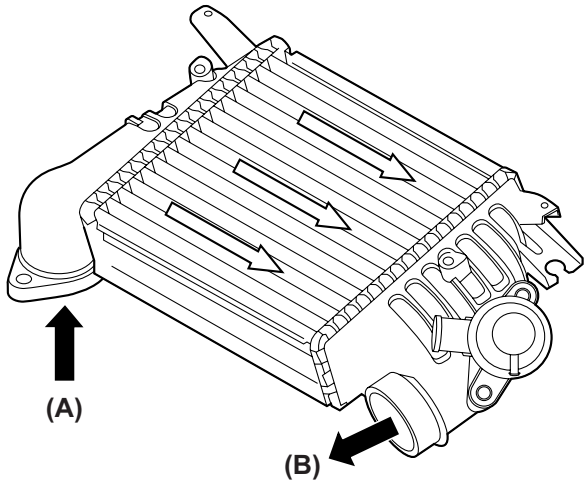
IN-02002

(1) ECU

G: INTERCOOLER

● Since the intake air having passed through the turbocharger unit is heated to a very high temperature, the air itself expands, resulting in a lower supercharging charging efficiency.The intercooler is provided just before the throttle body to cool down the intake air and improve the boosting efficiency.

● The intercooler is an air cooled type.The air delivered from the air intake duct provided at the engine hood flows through the core and cools the intake air passing through the intercooler.



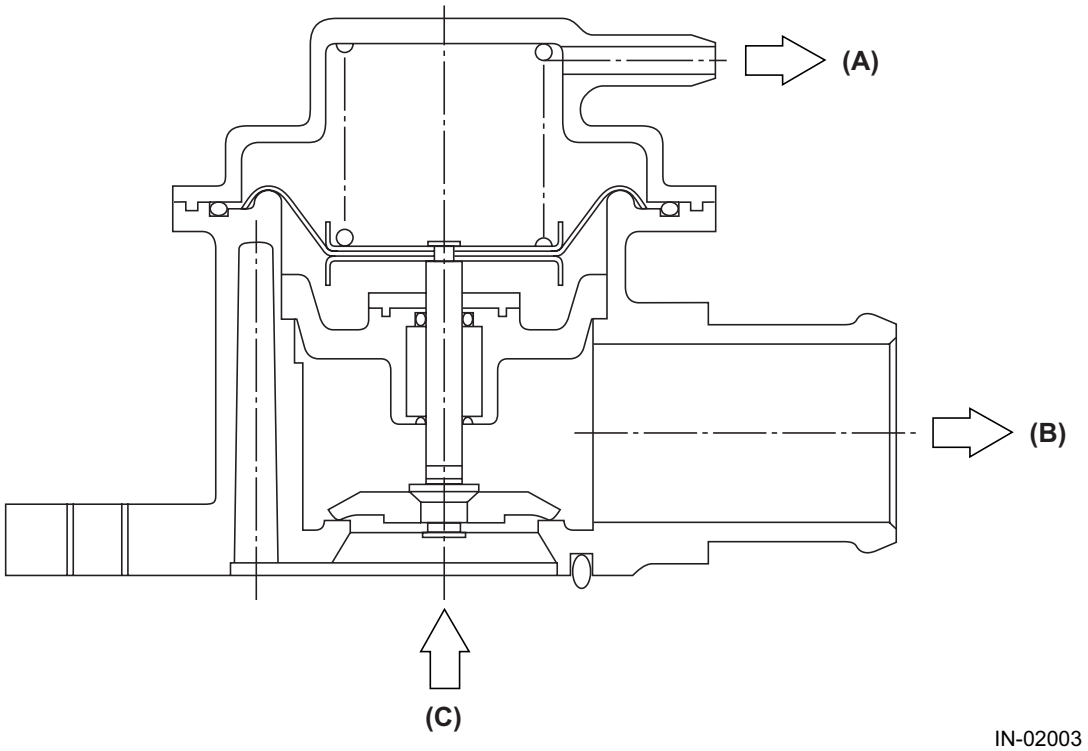
IN-02100

(A) From turbocharger

(B) To throttle body

H: AIR BYPASS VALVE

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



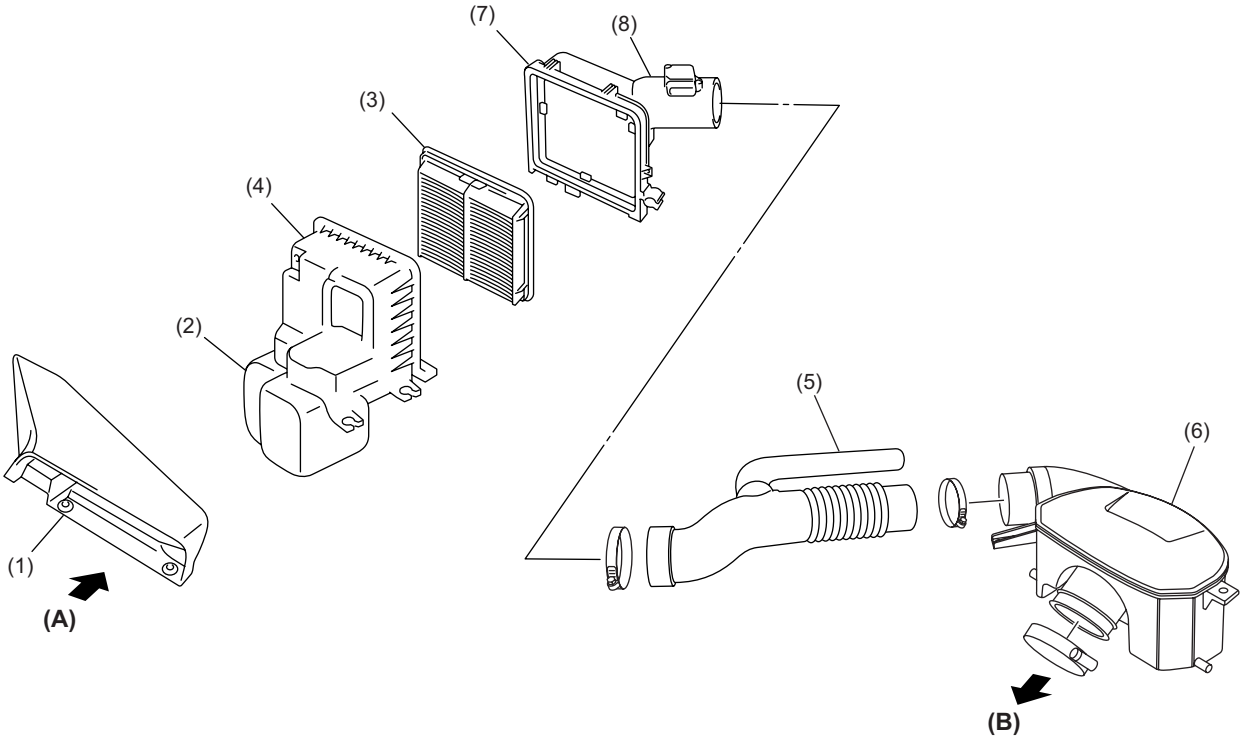
IN-02003

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

INTAKE (INDUCTION)
(H4SO U5)

1. General

The intake system consists of an intake duct, a resonator chamber, and an air cleaner element housed in its case. The resonator chamber effectively reduces the intake noise level. The air cleaner case is provided with a hydrocarbon adsorbing filter.



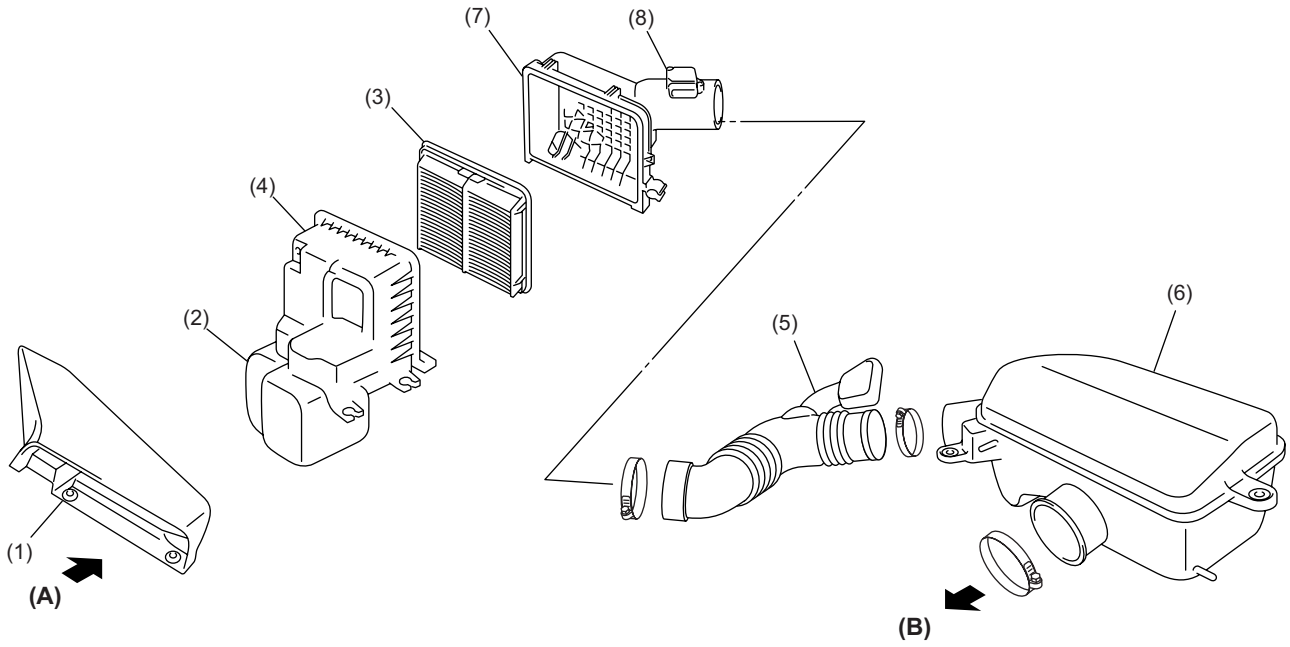
(1) Air intake duct
(2) Resonator
(3) Air cleaner element
(4) Air cleaner case (front)
(5) Intake duct
(6) Air intake chamber
(7) Air cleaner case (rear)
(8) Mass air flow and intake air temperature sensor

(A) Outside air
(B) To throttle body

INTAKE (INDUCTION)
(H4SO)

1. General

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



IN-02086

(1) Air intake duct
(2) Resonator
(3) Air cleaner element
(4) Air cleaner case (front)
(5) Intake duct
(6) Air intake chamber
(7) Air cleaner case (rear)
(8) Mass air flow and intake air temperature sensor

(A) Outside air
(B) To throttle body

LAN SYSTEM

1. General

A: LAN

● The LAN system*[1] enables data sharing among computers, that otherwise are left to function as independent systems, by connecting them via communications lines.

● Introduction of the LAN*[1] system has improved equipment and functions while reducing the weight of the vehicle by eliminating a considerable amount of harnesses.

● Data transmission/reception is via CAN *[2], which offers high-speed communication and also ensures a high level of reliability.

● Depending on control requirements, two transmission rates are used: high-speed CAN running at 500 Kbps, which is an ISO 11898 and manages power-related units; and low-speed CAN running at 125 Kbps, which is an ISO 11519-2 and manages body-related functions.

● Networks running at different transmission rates usually cannot share data between them, however, the body integrated unit with a gateway (hookup) function enables data sharing between different-rate networks.

NOTE:
*[1]: LAN (Local Area Network). A system where multiple computers (units) are linked via serial communication for data sharing.
*[2]: CAN (Controller Area Network). A serial communications protocol in compliance with ISO 11898 and ISO 11519-2.

B: CAN

● CAN is a serial communications protocol in compliance with relevant ISO standards.

● With its high bit rates, CAN enables quick, large-volume data transmission/reception.

● Based on continuous change in bus level (logical signals: low “0” and high “1”) stemming from voltage difference between CAN_High and CAN_Low, data and other frames are configured for message identification.

● If an error is detected, CAN’s fault confinement feature prevents the error from impacting units.

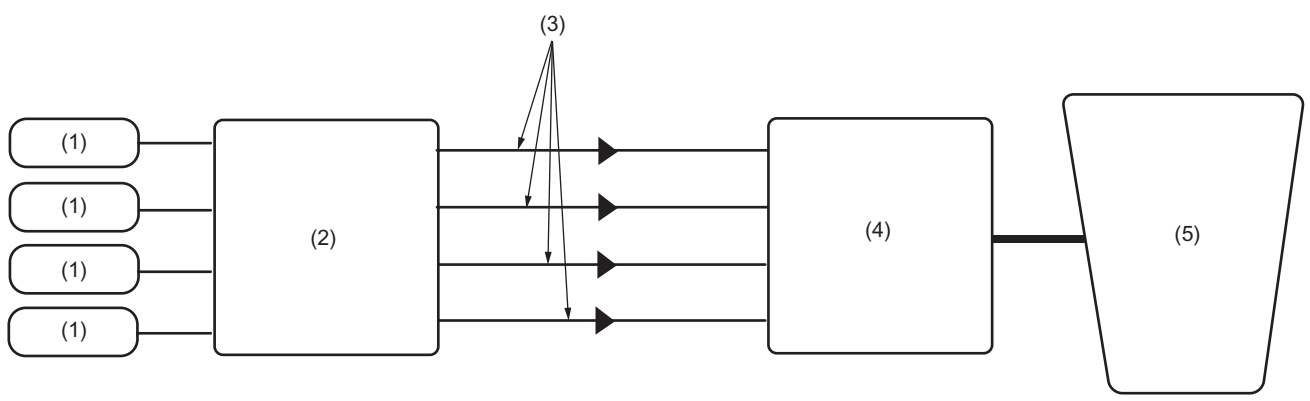
● If an error is detected, an error frame (notification that an error has been detected) is sent to units, telling them not to perform control based on data including errors.

● Depending on the status of the error detected, transmission/reception of the relevant data will be aborted.

C: COMPARISON BETWEEN CAN AND CONVENTIONAL DATA COMMUNICATION

- With conventional data communication, each sensor relies on its dedicated wiring for message to be sent between units. As data volume grows, so does the volume of wiring.
- CAN uses only one twisted-pair cable to connect between units for shared communication.

1. CONVENTIONAL COMMUNICATION

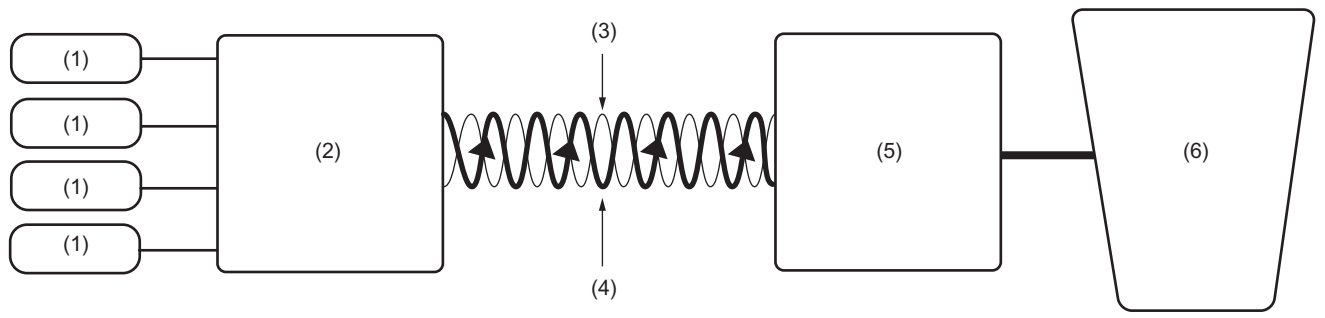


LAN00045

(1) Sensor
(2) ECM
(3) Communication wiring
(4) TCM
(5) Transmission

NOTE:
Conventional data communication needs as many data transmission lines as sensors used. (parallel signals)

2. CAN COMMUNICATION



LAN00046

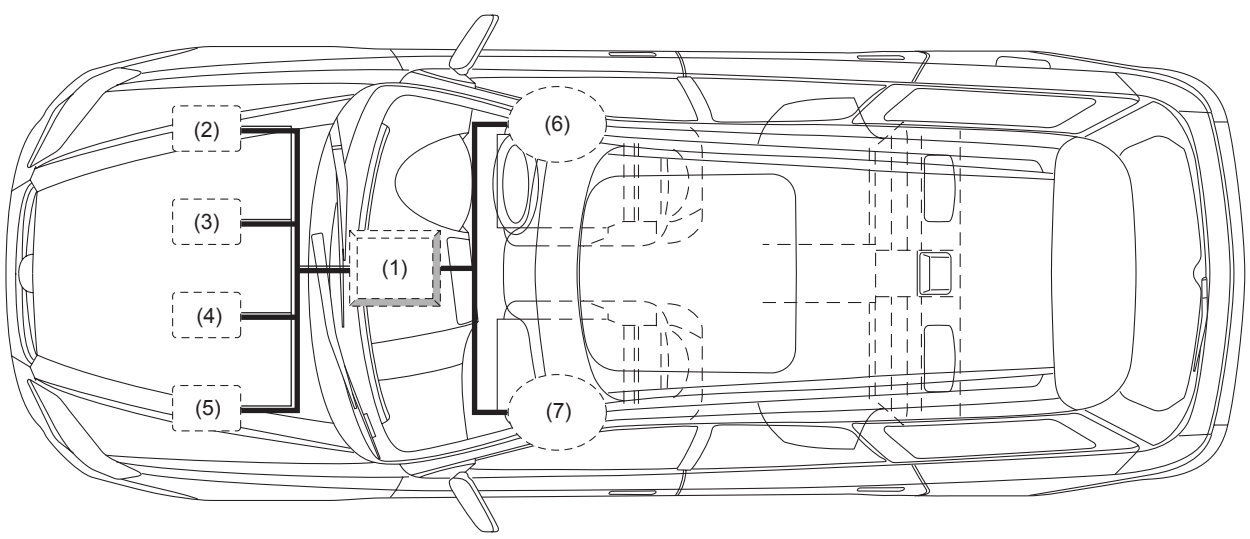
(1) Sensor
(2) ECM
(3) CAN line (LO)
(4) CAN line (HI)
(5) TCM
(6) Transmission

NOTE:

- With CAN, one twisted-pair cable (2 wires) manages transmission of all data. (serial communication)
- The main wire runs between the terminal resistor on the ECM and that on the ABSCM or vehicle dynamics control (VDC) CM & H/U. Other units are connected, in parallel, to the main wire via branch wires.

2. LAN Configuration

A: NETWORK ARCHITECTURE



LAN00131

(1) Body integrated unit
(2) ECM
(3) TCM
(4) ABSCM or VDCCM & H/U
(5) Steering angle sensor (vehicles with VDC)
(6) Combination meter
(7) A/C ECM (vehicles with automatic A/C)

(A) High-speed bus (500 Kbps)
(B) Low-speed bus (125 Kbps)
(C) High-speed system units
(D) Body integrated unit
(E) Low-speed system units

NOTE:

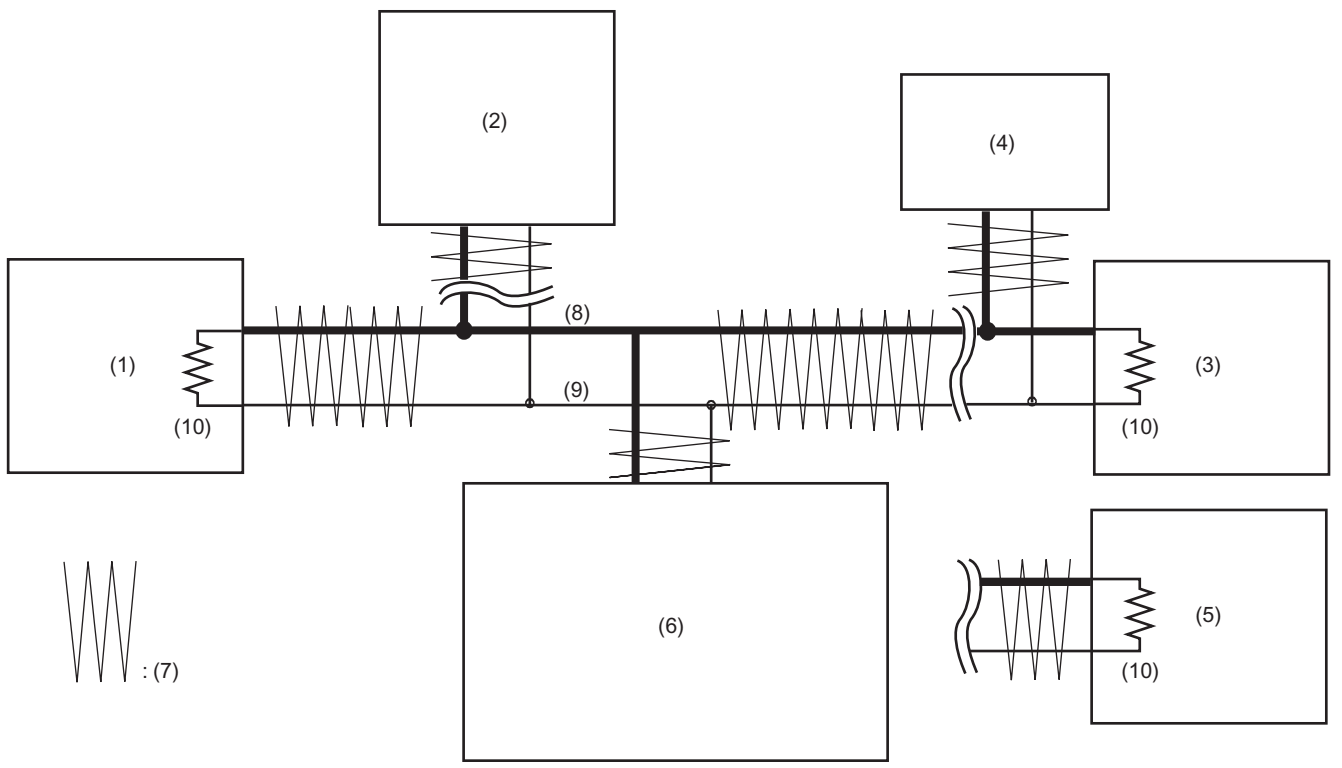
- Bit rate 500 Kbps: The bit rate of 500 Kbps means that 500,000 bits of data are transmitted per second.
- Bit rate 125 Kbps: The bit rate of 125 Kbps means that 125,000 bits of data are transmitted per second.

B: LAN CONNECTED UNITS

1. UNITS CONNECTED VIA HIGH-SPEED LAN

Vehicle type	Sedan				Wagon			
Transmission	MT		AT		MT		AT	
Vehicles with ABS/VDC	ABS	Vehicles with VDC	ABS	Vehicles with VDC	ABS	Vehicles with VDC	ABS	Vehicles with VDC
ECM	○	○	○	○	○	○	○	○
TCM			○	○			○	○
ABSCM & H/U	○		○		○		○	
VDCCM & H/U		○		○		○		○
Steering angle sensor unit		○		○		○		○
Body integrated unit	○	○	○	○	○	○	○	○

○: Installed units



LAN00048

(1) ECM
(2) TCM (AT models)
(3) VDCCM & H/U (vehicles with VDC)
(4) Steering angle sensor (vehicles with VDC)
(5) ABSCM & H/U (vehicles without VDC)
(6) Body integrated unit
(7) Twisted-pair cable
(8) CAN_HI
(9) CAN_LO
(10) Terminal resistor

NOTE:

● Terminal resistors built into the ECM and VDCCM & H/U stabilize traffic on the bus, and enables signals distinction from the voltage difference between the two bus lines (CAN_High and CAN_Low). These bus lines are called the main lines. Other units are connected in parallel to the main lines. These wires are called branch lines.

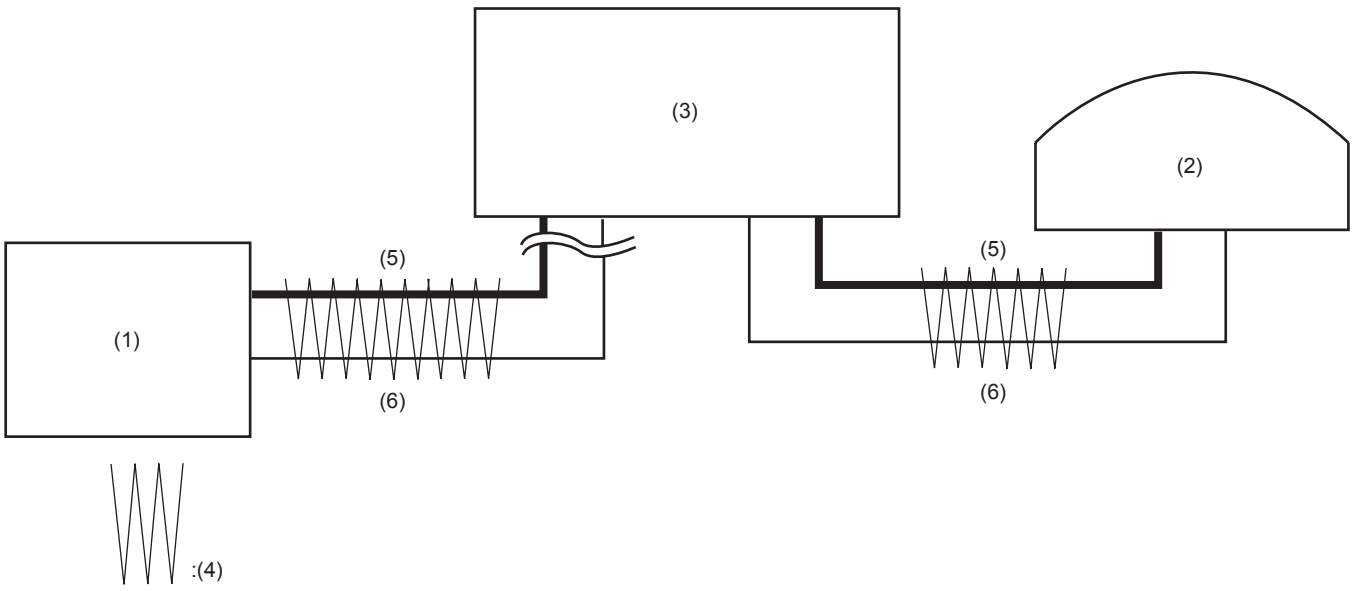
● If one bus line of the main lines becomes open, this is detected as an error and communication becomes no longer possible.

● If one bus line of a pair of branch lines becomes open, communication with the unit connected to the branch line becomes no longer possible, however, communication with other units remain intact. (The error will be displayed.)

2. UNITS CONNECTED VIA LOW-SPEED LAN

Vehicle type	Sedan								Wagon							
Navigation system	Yes		No		Yes		No		Yes		No		Yes		No	
A/C unit (vehicles with auto A/C)	○		○		○		○		○		○		○		○	
Combination meter	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Body integrated unit	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

○: Installed units



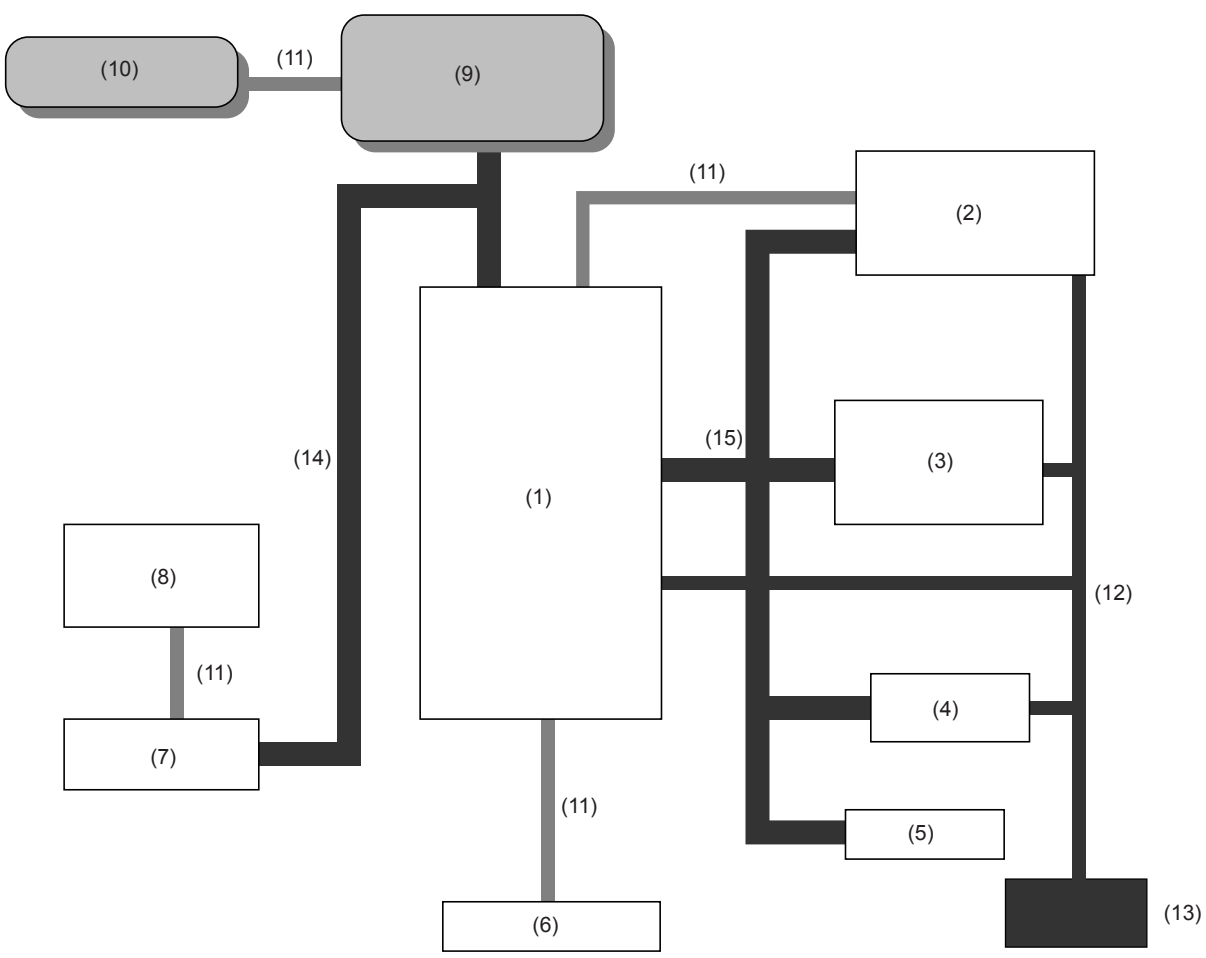
LAN00132

(1) Auto A/C ECM (vehicles with auto A/C)
(2) Combination meter
(3) Body integrated unit
(4) Twisted-pair cable
(5) CAN_HI
(6) CAN_LO

NOTE:
In low-speed CAN, the system still allows communication even if one of the twisted-pair cable wires becomes open. (Errors will be detected.)

The high- and low-speed LANs described above, and the IE_Bus, dedicated communication lines, and select monitor communication, etc. comprise the vehicle's data communication system.

LAN CONFIGURATION



(1) Body integrated unit
(2) ECM
(3) TCM
(4) ABSCM or VDCCM
(5) Steering angle sensor
(6) Keyless entry receiver
(7) A/C ECM (vehicles with auto A/C)
(8) Audio and A/C control panel
(9) Combination meter
(10) Clock
(vehicles without monitor screen)
(11) Dedicated communication line
(12) Select monitor communication wiring
(13) Select monitor
(14) Low-speed CAN
(body control system)
(15) High-speed CAN
(driving control system)

3. What is CAN?

A: FEATURES

● Some of the basic specifications of CAN, intended to ensure smooth multiplex data communication, are described below.

1. MULTIMASTER

● When the bus (communication line) is free, any unit may start to transmit a message.

2. MESSAGE TRANSFER

● All messages on CAN bus are sent in fixed formats.

● When the bus (communication line) is free, any unit connected to the bus may start to transmit a message.

● If two or more units start to transmit messages at the same time, these messages are prioritized using the identifier.

● The identifier does not indicate the destination of the message, but it signifies message priority for bus access.

● If two or more units start to transmit messages at the same time, bitwise (smallest-unit) arbitration is performed over the identifiers carried by the messages. The unit that has won the arbitration as carrying a higher-priority message continues to send the message while the unit that has a lower priority stops sending the message, and starts sending the message again after waiting for a while.

3. SYSTEM FLEXIBILITY

● As units connected to the bus do not have unique information like an address, other units can be added to the bus without changing the software, hardware, or application of the units.

4. BIT RATE

● The bit rate can be set to suit the applications of the communication network.

● The bit rate of all units connected to the same network (bus) must be uniform. Connecting units of different bit rates to the same bus will cause communication disturbances.

5. ERROR SIGNALING AND COMMUNICATION RECOVERY

● Error signaling: Any unit connected to a bus can detect an error, and upon detecting an error, the unit notifies all other units of the error.

● Communication recovery: If a unit detects an error while sending a message, the unit will abort the message and keep retransmitting the message until it is successfully sent. (communication recovery)

6. FAULT CONFINEMENT

● In CAN, there are two types of errors: temporary alteration of data on the bus caused by external noise or other disturbances; and permanent alteration of data on the bus caused by faulty units, failed drivers, open wire, or other failures. Causal units will be cut off from the bus to prevent such disturbances/failures from affecting other units.

7. CONNECTION ENVIRONMENTS

● The CAN bus accommodates connections of a number of units to it.

● There are no limitations on the number of units that can be connected to the CAN bus, however, if the bus length needs to be longer or the bit rate needs to be higher, the number of units needs to be smaller. On the other hand, if the bus length is relatively short or a relatively slower bit rate can be accepted, a greater number of units can be connected.

● As signals are distinguished with the voltage difference between the two bus lines (CAN_High and CAN_Low), the main lines and branch lines must be properly connected.

4. Fault Detection

A: COMMUNICATION ERROR INDICATIONS

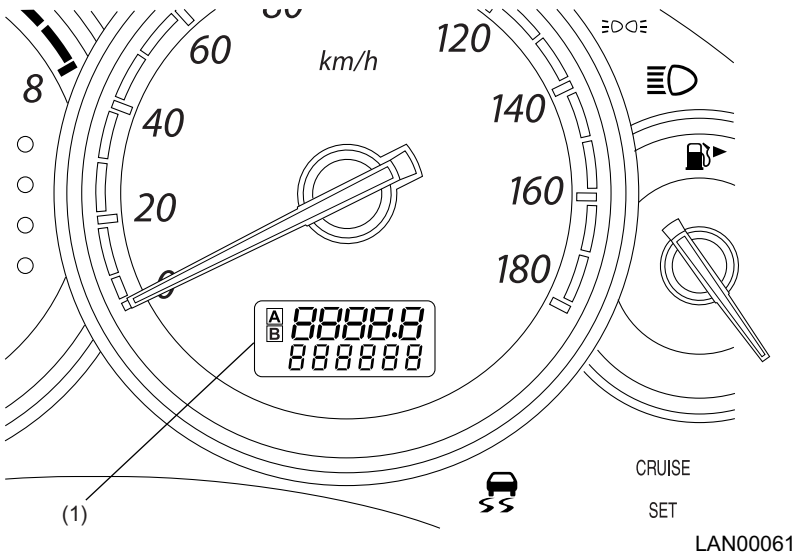
● If a fault occurs in the body integrated unit or LAN system (in any unit or the communication circuit), a communication error indication is given at the trip information display area on the combination meter.

● The indication differs by the type of fault, and related indicators such as the CHECK ENGINE light illuminate.

● If a communication error indication is given, one or more diagnostic trouble codes are stored in the body integrated unit. To read out diagnostic trouble codes, use a Subaru select monitor.

● If more than one diagnostic trouble code is stored, indication is given in the following order of priority: (1) High-speed CAN (2) Low-speed CAN (3) integrated unit (4) EGI (5) TCM (6) VDC

NOTE:
The indication returns to the normal trip display when the trip reset switch is pushed.



(1) Communication error indication area (trip meter)

CAUTION:

● IInformation registered in the body integrated unit must coincide with the vehicle's equipment and specifications for normal operation and diagnosis.

● If the body integrated unit is brand-new or put in factory mode, the key ring illumination blinks to indicate that equipment setting is not completed.

Types of communication error indications

Communication error indication	Description	Location of fault
Er --	High-speed CAN and low-speed CAN failed	Abnormality is found in both the high-speed and low-speed CAN communication systems.
Er HC	High-speed CAN failed	Abnormality is found in the high-speed CAN system.
Er LC	Low-speed CAN failed	Abnormality is found in the low-speed CAN system.
Er IU	Integrated unit failed	Abnormality is found in the integrated ECM or in its related parts.
Er EG	EGI communication data abnormal	Abnormality is found in the EGI ECM or in its communication system.
Er tC	TCM communication data abnormal	Abnormality is found in the TCM ECM or in its communication system.
Er Ab	ABS/VDC communication data abnormal	Abnormality is found in the ABSCM/VDCCM & H/U unit or in its communication system.

B: SUBARU SELECT MONITOR

1. READING DIAGNOSTIC TROUBLE CODES

● Diagnostic trouble codes can be read with a Subaru select monitor set in its body integrated unit mode.

2. READING CURRENT DATA

● Use a Subaru select monitor to read analog and digital data. (Confirm necessary items when customizing.)

3. MEMORY CLEAR MODE

● Use a Subaru select monitor to erase diagnostic trouble codes.

4. CUSTOMIZING (SETTING FUNCTIONS)

● Use a Subaru select monitor to perform detailed setting of body control related functions.

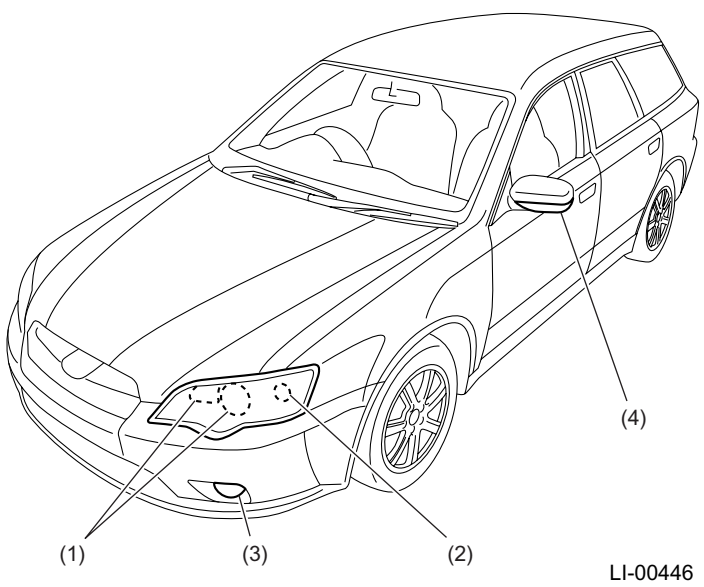
● When replacing immobilizer related components, registration of the immobilizer may be necessary.
(Refer to the immobilizer registering manual.)

CAUTION:
When customizing, do not change the factory mode resetting function to factory mode. If you do this, settings stored in the body integrated unit will be reset to initial values and the unit will not operate normally. In this case, perform registration of the body integrated unit from the very beginning.

LIGHTING SYSTEM

1. Front

A: GENERAL



(1) Headlight
(2) Front turn signal/parking, front side marker light
(3) Front fog light
(4) Side turn signal light

● The headlight of all models consists of four halogen bulbs, and projector type low beam lights are used.

● The front turn signal/hazard warning light, parking/front side marker light and the front side reflex reflector are incorporated into the headlight.

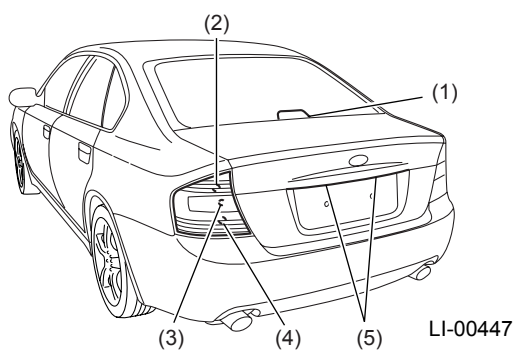
● The fog light is either of a projector type or a large sized multiple reflector type.

● On some models, the side turn signal lights are built into the lower part of the door mirrors to improve visibility. Also, LEDs (light emitting diodes) are used for light source to improve the durability.

2. Rear

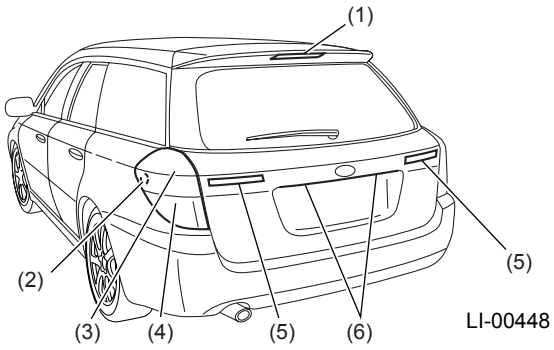
A: GENERAL

Sedan models



(1) High mount stop light
(2) Turn signal/hazard warning light
(3) Backup light
(4) Stop/tail/rear side marker light
(5) License plate light

Wagon models



(1) High mount stop light
(2) Rear side marker light
(3) Stop/tail light
(4) Turn signal/hazard warning light
(5) Backup light
(6) License plate light

● On sedan models, the rear turn signal/hazard warning light, stop/tail/rear side marker light, and the backup light are incorporated into the rear combination light. On wagon models, the rear turn signal/hazard warning light, stop/tail light, and the rear side marker light are incorporated into the rear combination light. On both the sedans and wagons, the rear reflex reflector and the rear side reflex reflector are incorporated into the rear combination light. On wagons, the backup lights are built in the rear gate garnish.

● The high mount stop light is installed to the bottom inside of the rear window on sedans, and to the rear of the roof spoiler on wagons.

● By using LEDs (light emitting diodes) as light source for the high mount stop light on wagon models, space is saved, efficiency is improved, and power consumption is reduced while the durability is improved.

LUBRICATION
(H4DOTC)

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.

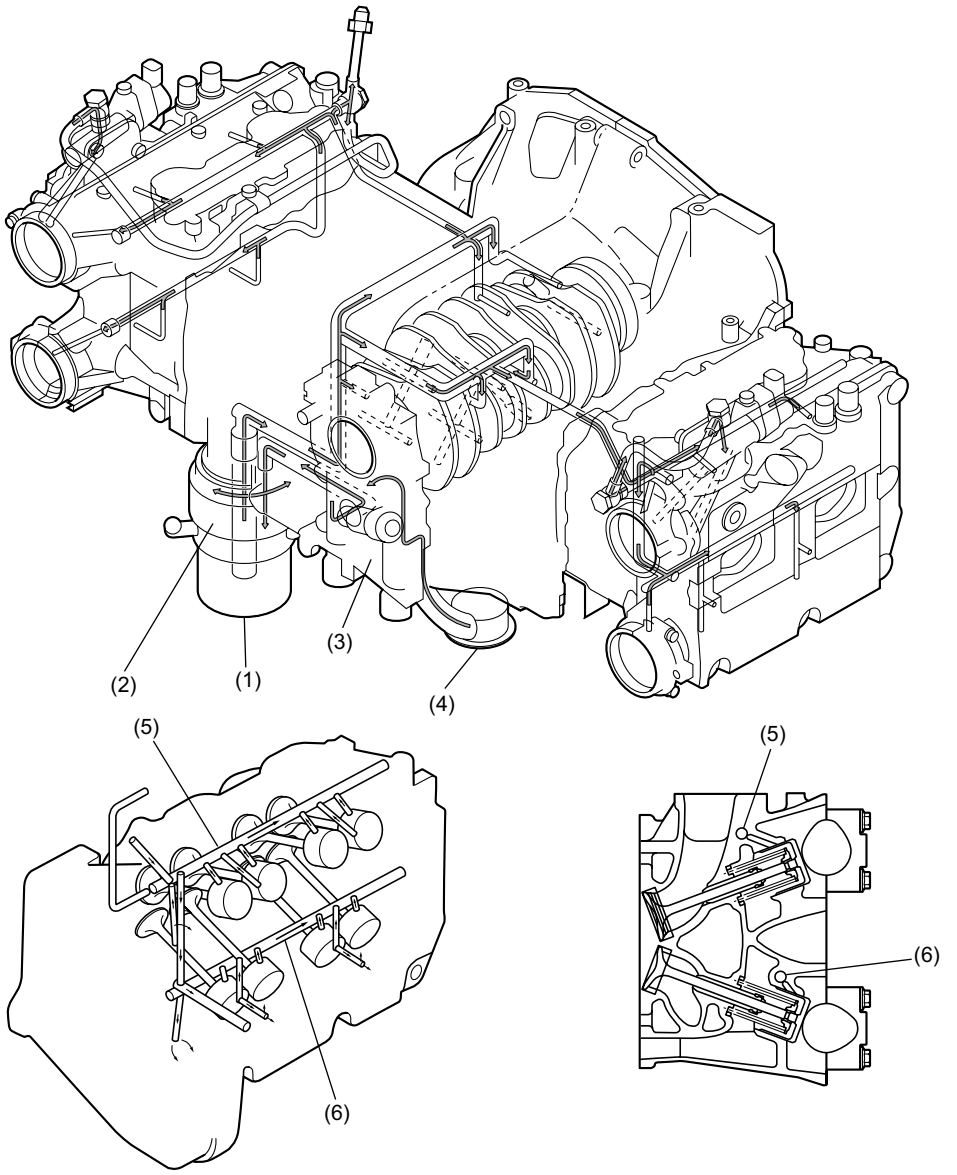
● The engine oil is cleaned by a full-flow, paper element type oil filter. The filter has a bypass valve which allows the engine oil to flow bypassing the filter if it is clogged.

● 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.

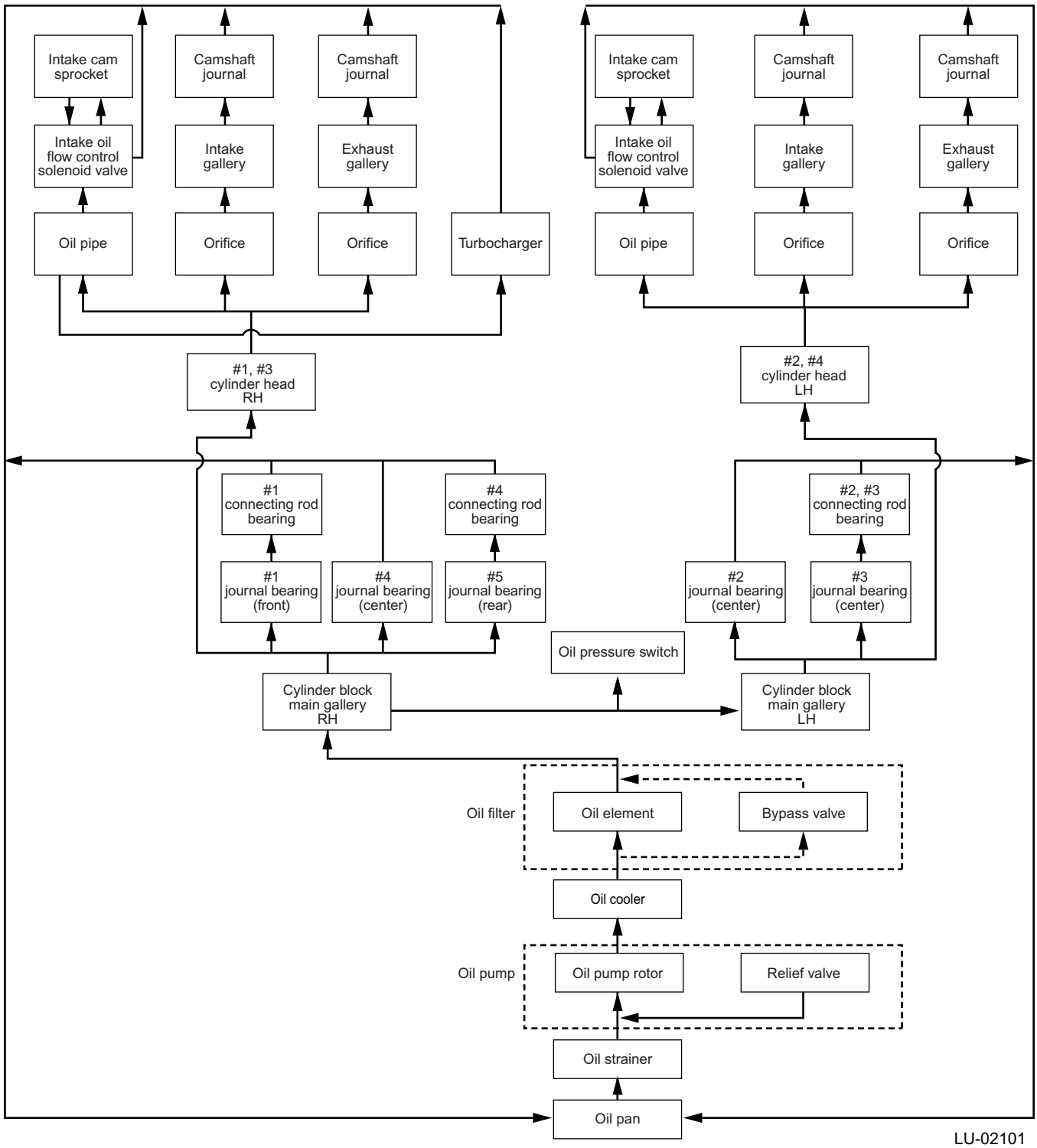
● An oil cooler is installed to keep the engine oil in an optimum temperature range and prevent degradation of lubrication performance.



LU-00212

(1) Oil filter
(2) Oil cooler (water cooled)
(3) Oil pump
(4) Oil strainer
(5) Intake gallery
(6) Exhaust gallery

2. Engine Oil Flow



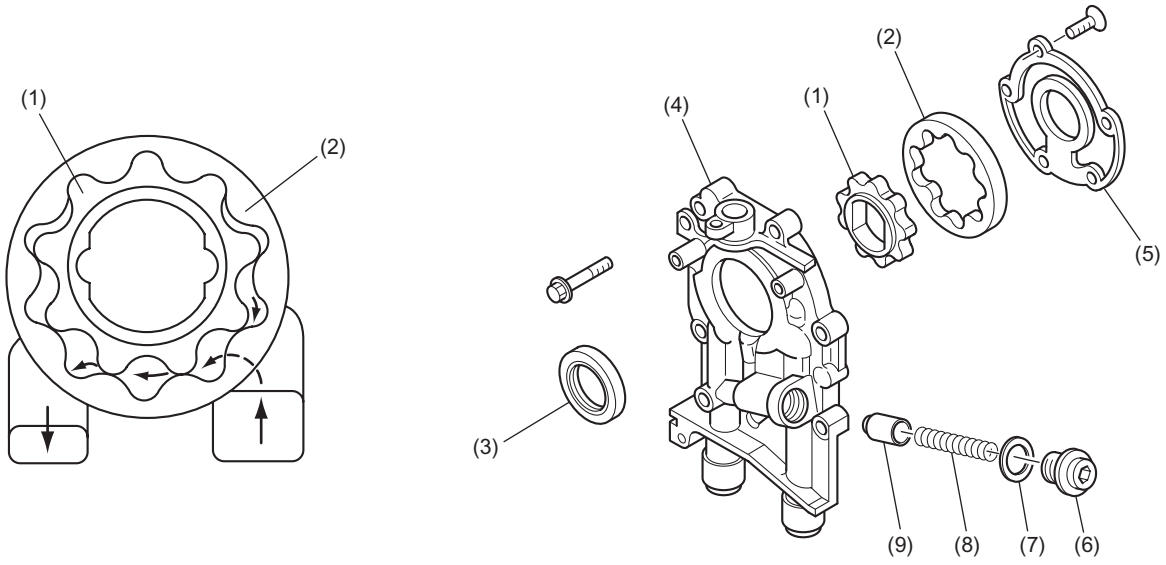
LU-02101

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 carried from the inlet port 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.

● A relief valve is built in the oil pump at its discharge side. When the oil pressure becomes higher than the preset value, the relief valve regulates the pressure by sending excessive oil back to the inlet side.

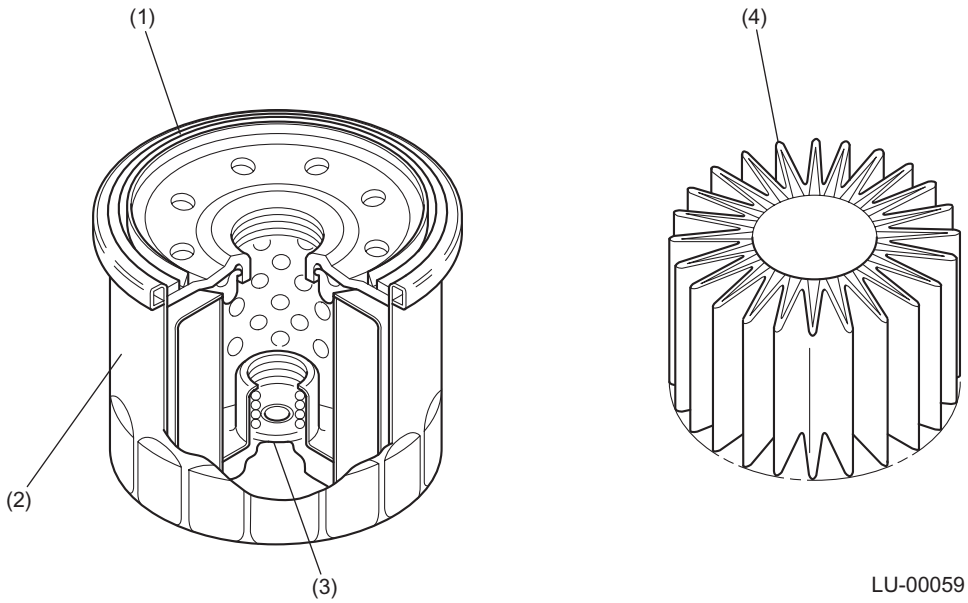


LU-00058

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

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. If the filter gets clogged causing the oil pressure to exceed the preset value, the bypass valve opens and detours the engine oil to flow around the filter. The filter element has a special pleat design to increase the effective filtering area.

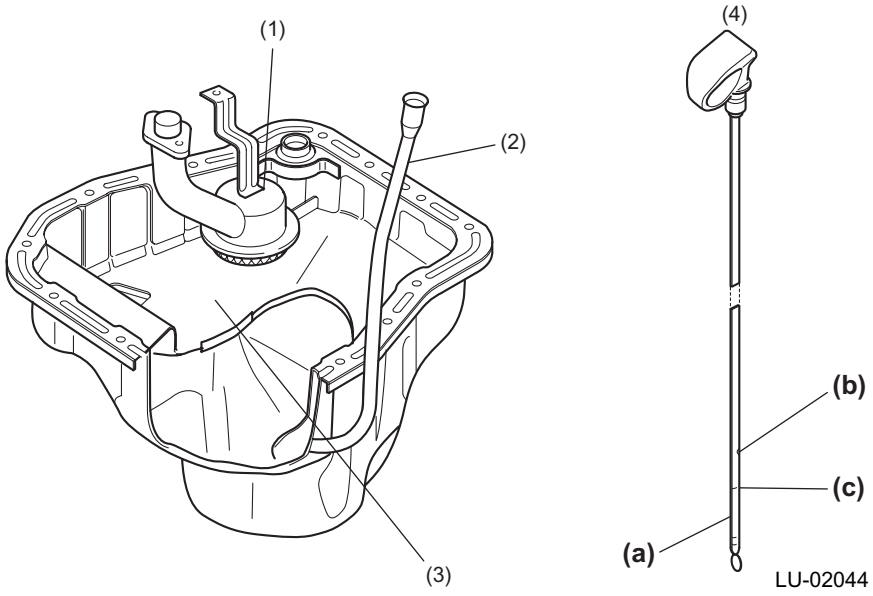


(1) Oil seal
(2) Filter body
(3) Bypass valve
(4) Pleated element

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 inside the oil pan. It stabilizes the oil level and reinforces the oil pan.

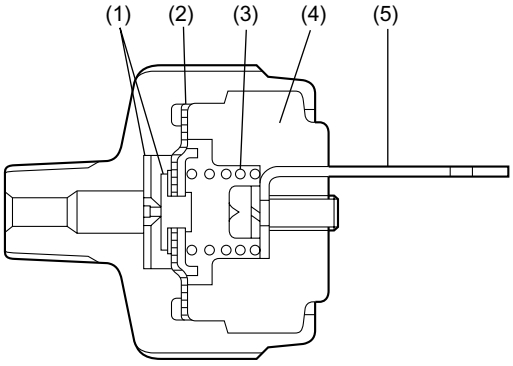


(1) Oil strainer
(2) Level gauge guide
(3) Baffle plate
(4) Oil level gauge

(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

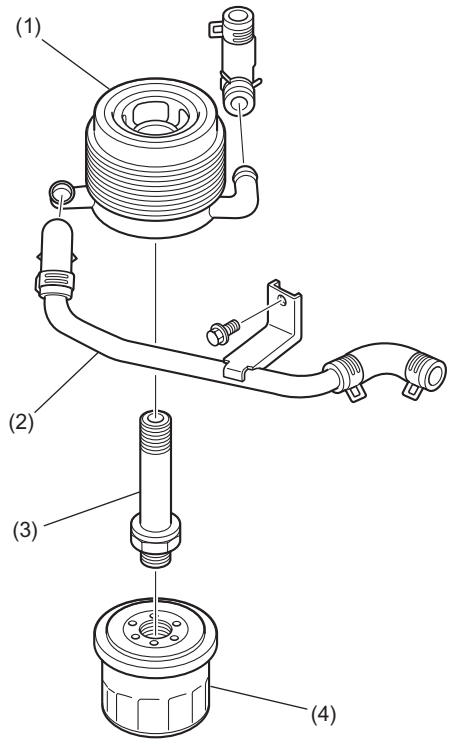
(1) Contact
(2) Diaphragm
(3) Spring
(4) Molded portion
(5) Terminal

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, the oil pressure pushes the diaphragm against the spring force.This opens the contact points and the oil pressure warning light goes out.

7. Oil Cooler

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



LU-00067

(1) Oil cooler
(2) Water pipe
(3) Connector
(4) Oil filter

1. General

Specifications for SOHC U5 models are same as those for SOHC models. <Ref. to LU(H4SO) section.>

LUBRICATION
(H4SO)

1. General

● The lubrication system forcibly circulates engine oil throughout the engine using an oil pump. The oil pressure is regulated by the relief valve built into the oil pump.

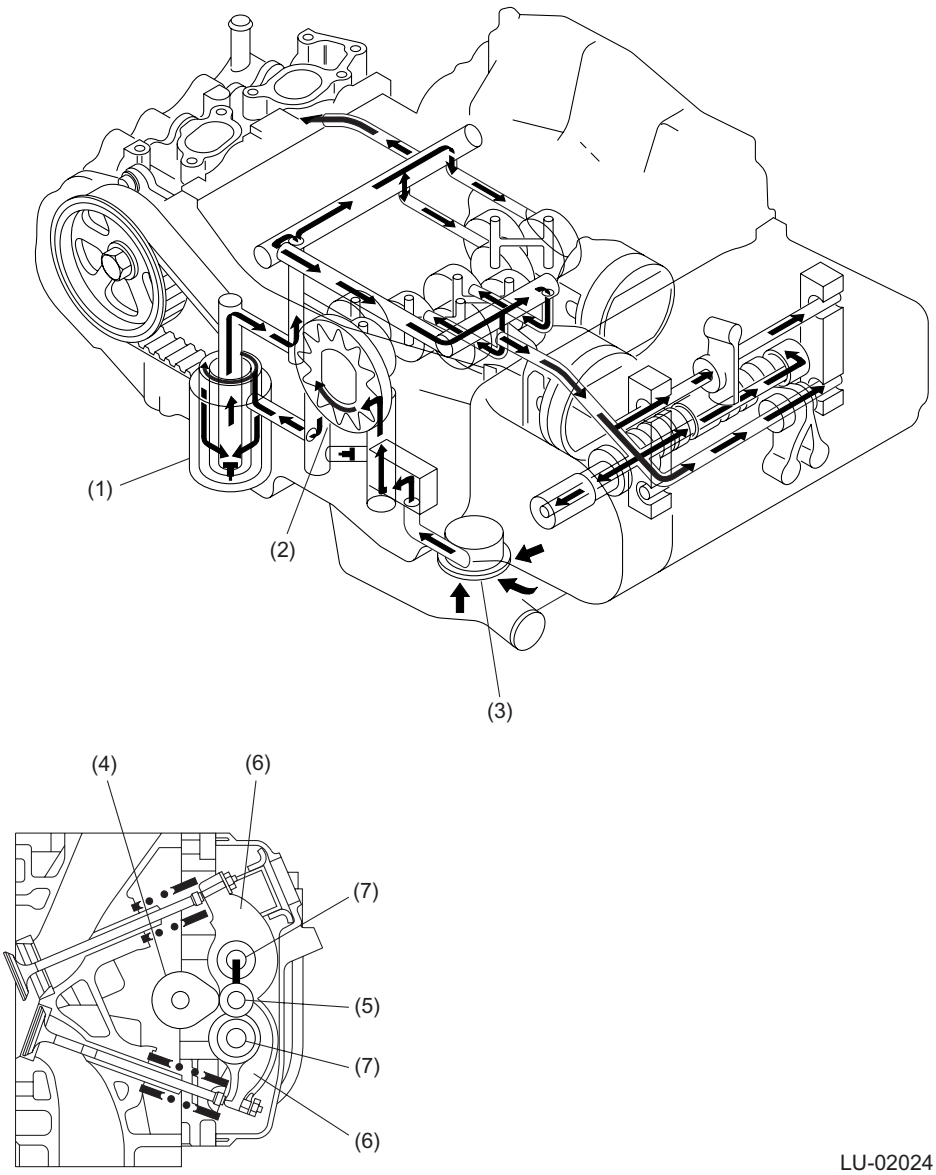
● The oil pump is a thin, large-diameter trochoid rotor type which can accommodate the engine's high output. The pump is directly driven by the crankshaft.

● 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 through the oil filter, vertical passage in the right bank of the cylinder block, and the oil galleries in the right and left banks of the cylinder block.

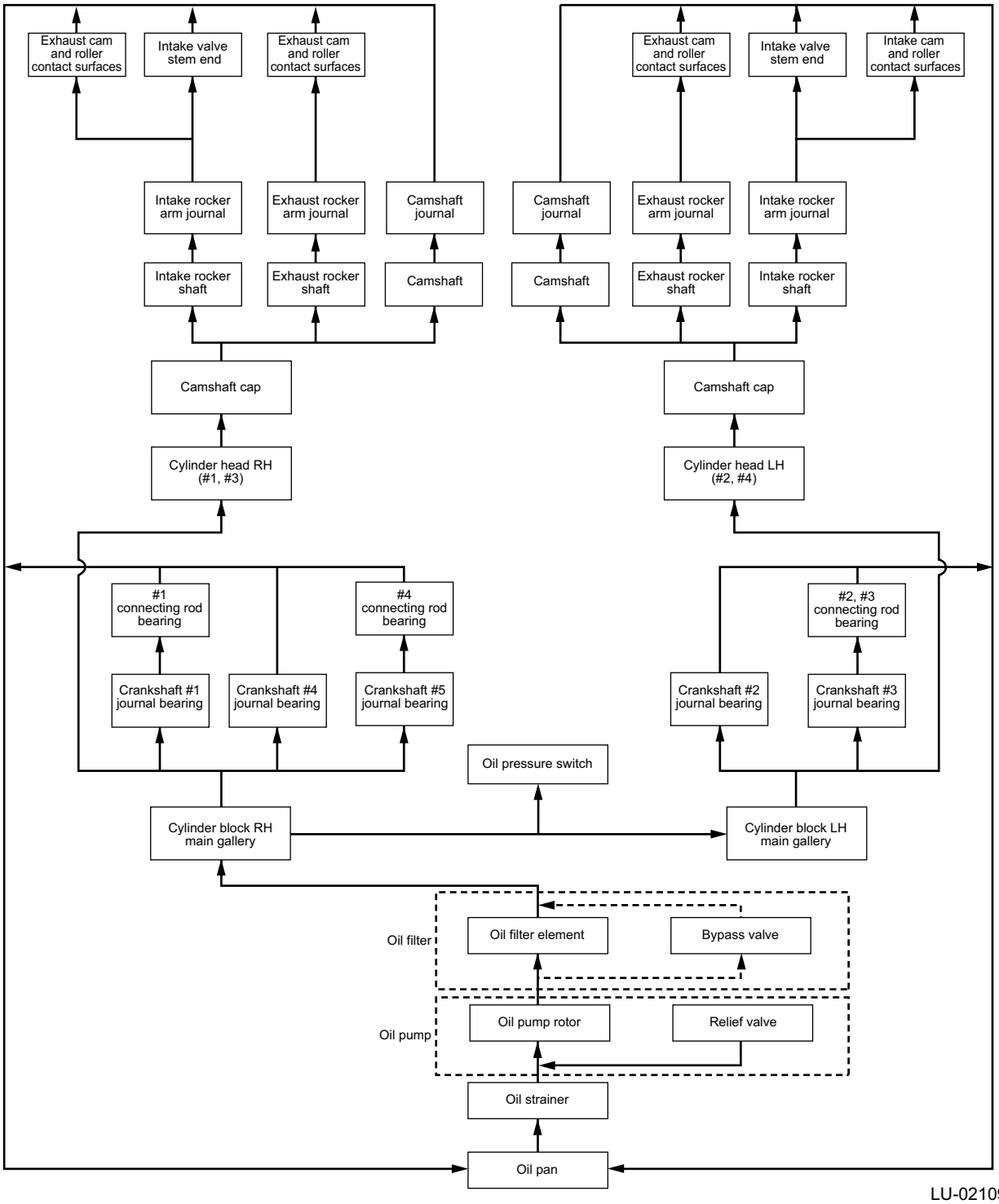
● The engine oil is also distributed to each cylinder head valve mechanism at a proper flow rate achieved by metering by the orifice provided in each oil gallery.



LU-02024

(1) Oil filter
(2) Oil pump
(3) Oil strainer
(4) Camshaft
(5) Roller
(6) Rocker arm
(7) Rocker shaft

2. Engine Oil Flow

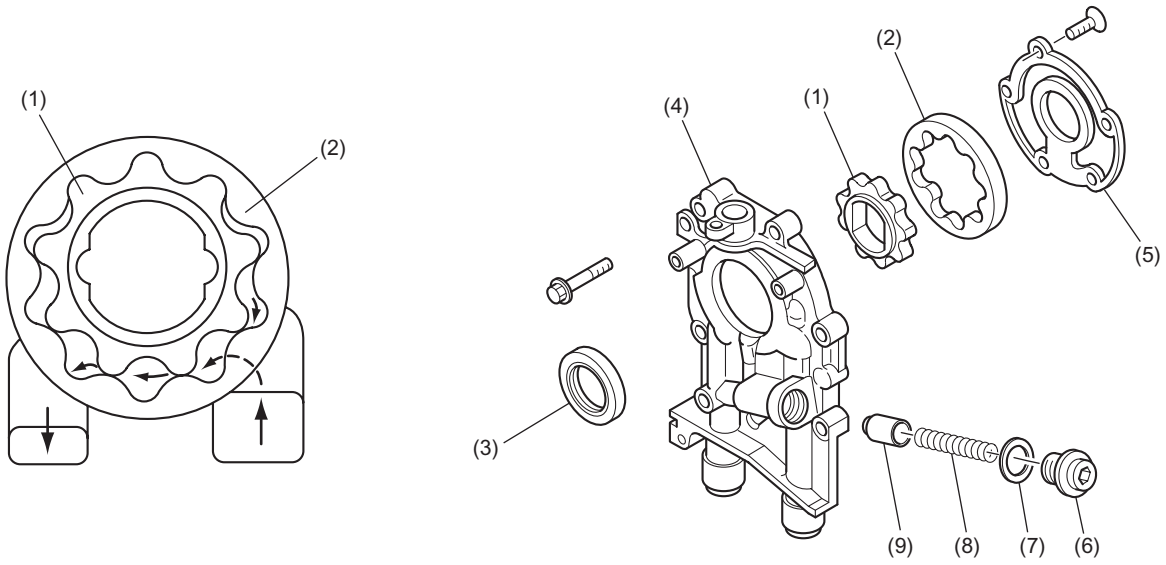


LU-02109

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 carried from the inlet port to the discharge port. As the pump rotates, the space carrying the oil becomes smaller, thus the oil is pressurized and discharged from the discharge port. A relief valve is built in the oil pump at its discharge side. When the oil pressure becomes higher than the preset value, the relief valve regulates the pressure by sending excessive oil back to the inlet side.

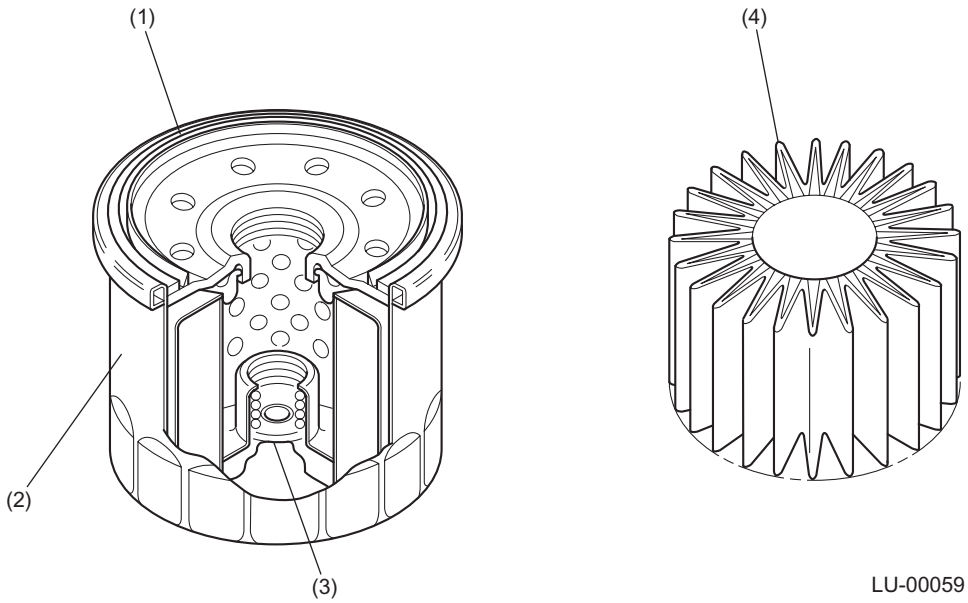


LU-00058

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

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. If the filter gets clogged causing the oil pressure to exceed the preset value, the bypass valve opens and detours the engine oil to flow around the filter. The filter element has a special pleat design to increase the effective filtering area.

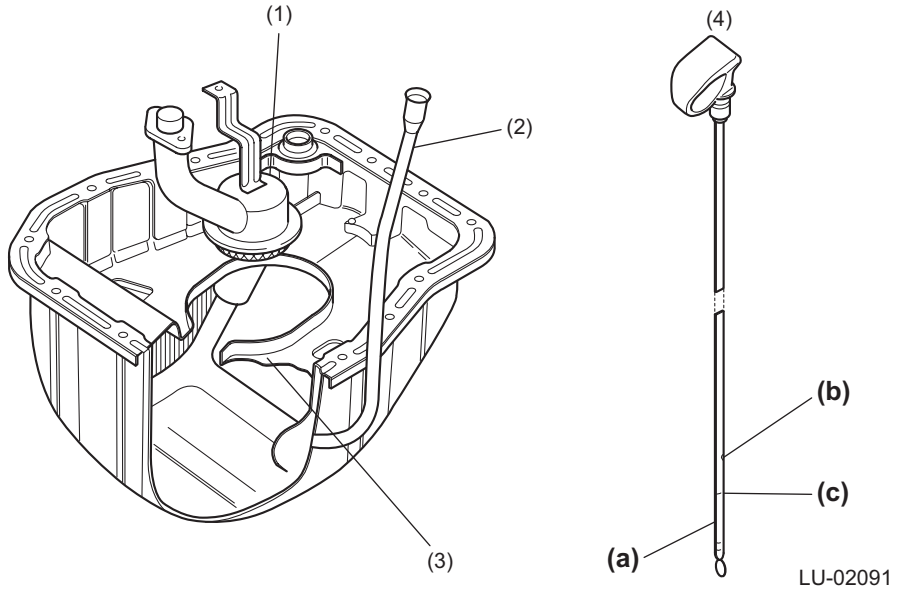


(1) Oil seal
(2) Filter body
(3) Bypass valve
(4) Pleated element

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 inside the oil pan. It stabilizes the oil level and reinforces the oil pan.

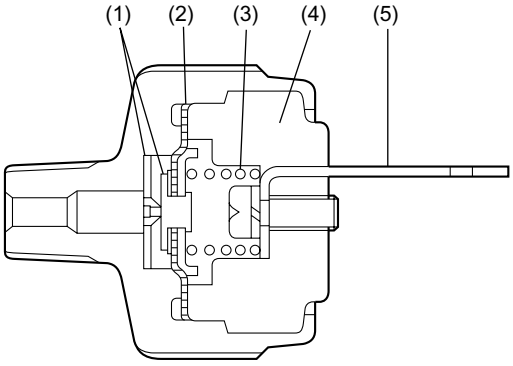


(1) Oil strainer
(2) Level gauge guide
(3) Baffle plate
(4) Oil level gauge

(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
(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, the oil pressure pushes the diaphragm against the spring force. This opens the contact points and the oil pressure warning light goes out.

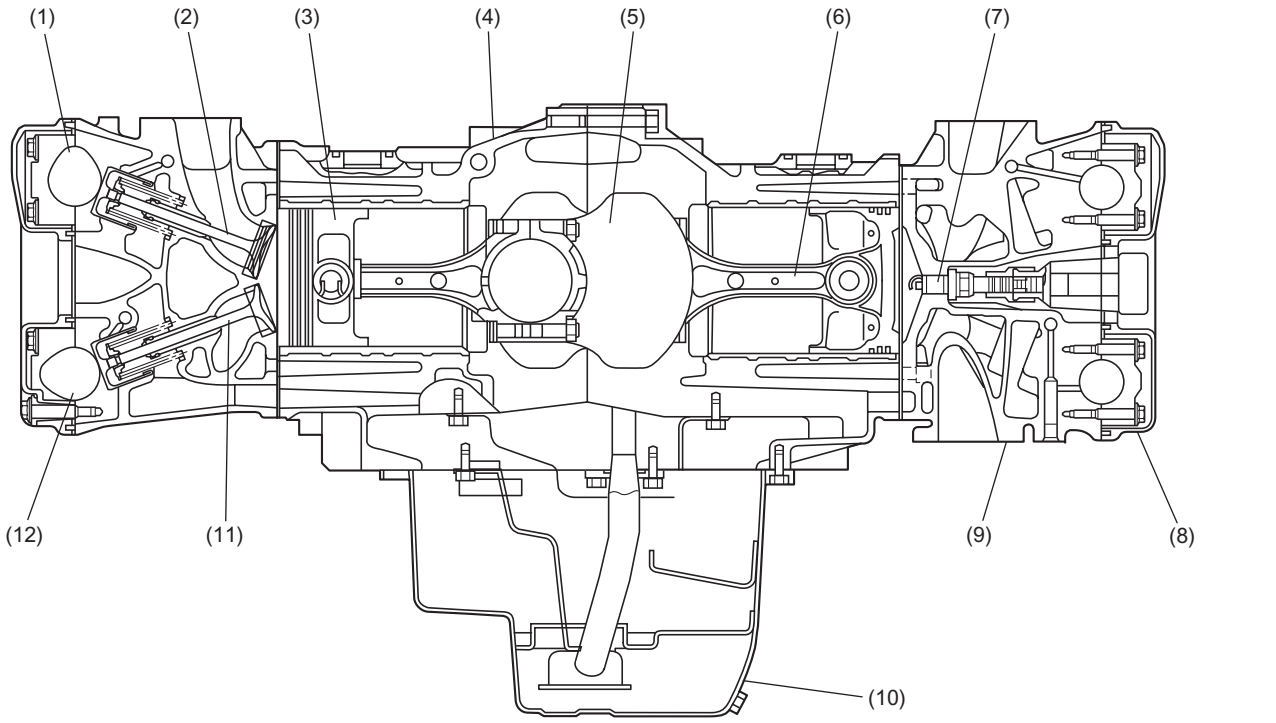
MECHANICAL
(H4DOTC)

1. General

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

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

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



ME-00828

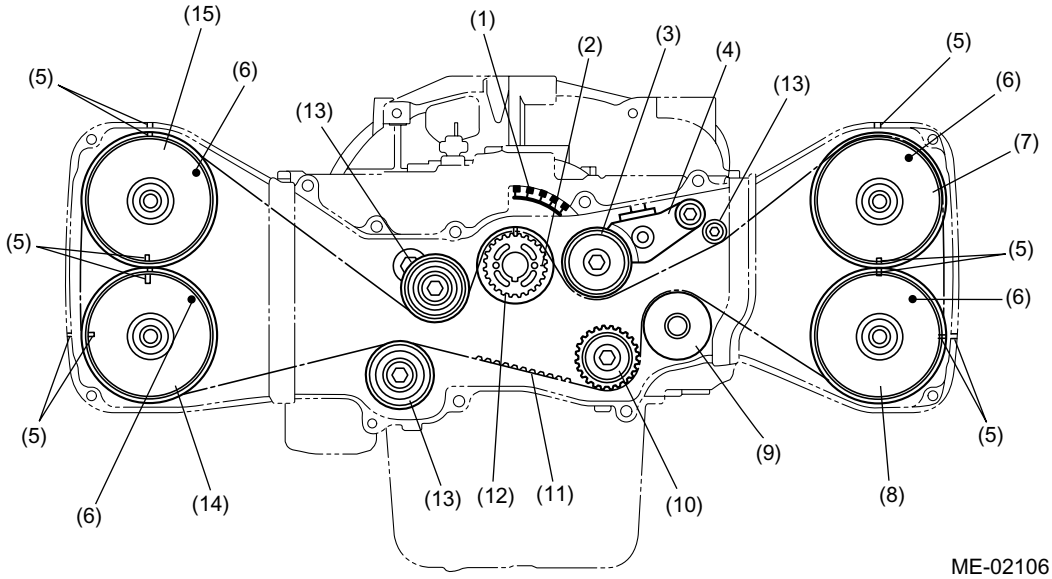
(1) Intake camshaft
(2) Intake valve
(3) Piston
(4) Cylinder block
(5) Crankshaft
(6) Connecting rod
(7) Spark plug
(8) Valve rocker cover
(9) Cylinder head
(10) Oil pan
(11) Exhaust valve
(12) Exhaust camshaft

2. Timing Belt

● A single timing belt drives four camshafts (intake and exhaust camshafts on each bank). The belt also drives the water pump by its non-toothed side.

● The timing belt teeth have a specially designed round profile which contributes to quiet operation.The timing belt is made of strong and inflexible core cords, wear-resistant canvas and heat-resistant rubber material.

● A hydraulic automatic belt tension adjuster always keeps the belt taut to the specified tension. Any manual belt tension adjustment is unnecessary.



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

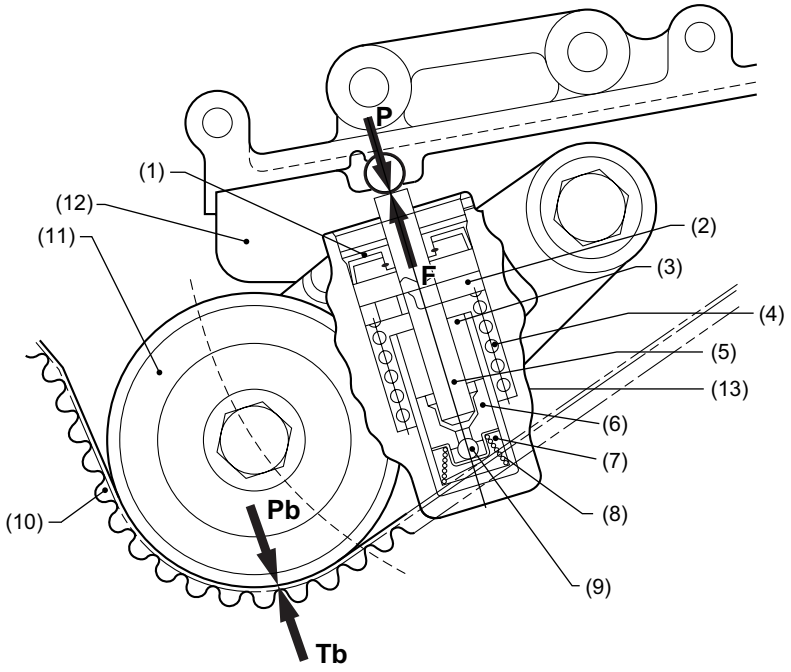
NOTE:
*: The #1 piston is set at the top dead center (TDC) when the piston-position mark on the crankshaft sprocket is aligned with the mark on cylinder block.
**: The #1 piston is set at TDC on the compression stroke when the piston-position mark on the camshaft sprocket is facing directly upward.

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.

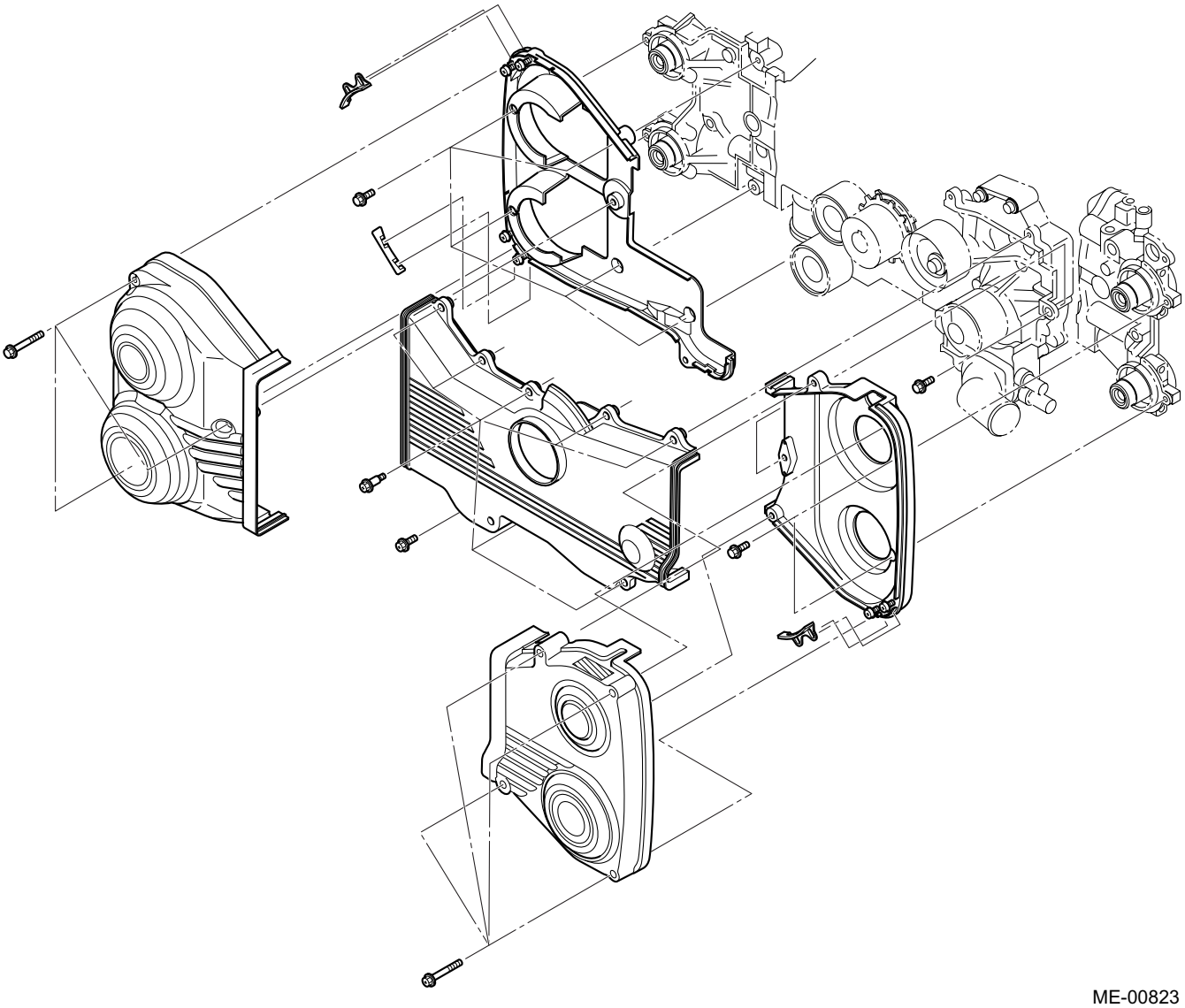
● Over-tension correction action
If the tension of the timing belt increases excessively, the force P becomes larger than the thrust force F and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force P balances again with the thrust force F. Thus 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.



ME-00823

5. Camshaft

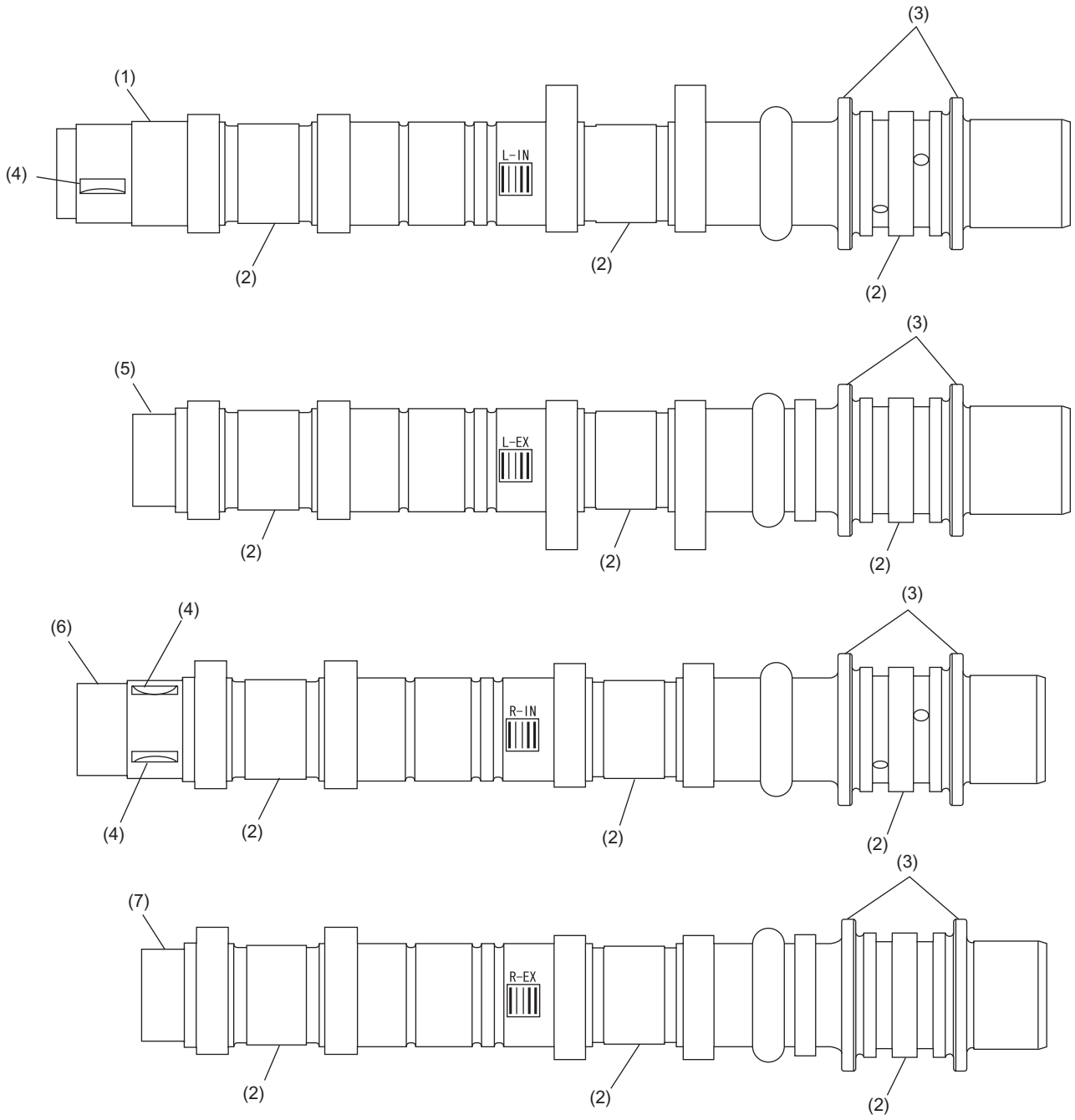
The DOHC engine uses four camshafts in all; intake and exhaust camshafts on each of the right and left banks.

The camshafts are of a composite material type using sintered steel for cam lobes and carbon steel for pipe part.

The sintered steel cams are very high in the resistance to wear, which enables the cam lift to be increased. In addition, use of a hollow pipe material contributes to reduction in weight.

Each camshaft is supported at its three journals and held in position by three camshaft caps. The two flanges on each camshaft supports thrust forces to limit the end play of the camshaft within the tolerance.

For DOHC turbo model engines, slots (notches) for variable valve timing position sensors are provided at the intake side.

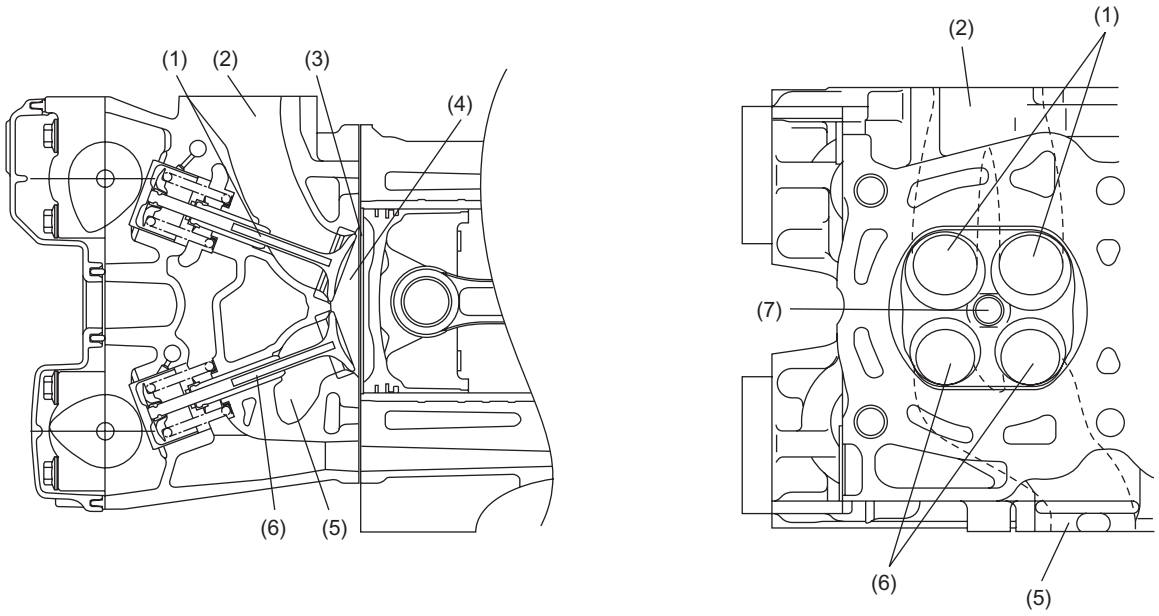


ME-00790

(1) Intake camshaft LH
(2) Journal
(3) Flange
(4) Slot (notch) for variable timing position sensor
(5) Exhaust camshaft LH
(6) Intake camshaft RH
(7) Exhaust camshaft RH

6. Cylinder Head

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



ME-00793

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

7. Cylinder Block

● The cylinder block is made of aluminum die casting. A semi-closed deck structure is used to obtain a higher rigidity to hold the cylinder liners.

● The cylinder liners are made of cast iron. As they are of a dry type, their outer surfaces are entirely in contact with the cylinder block.

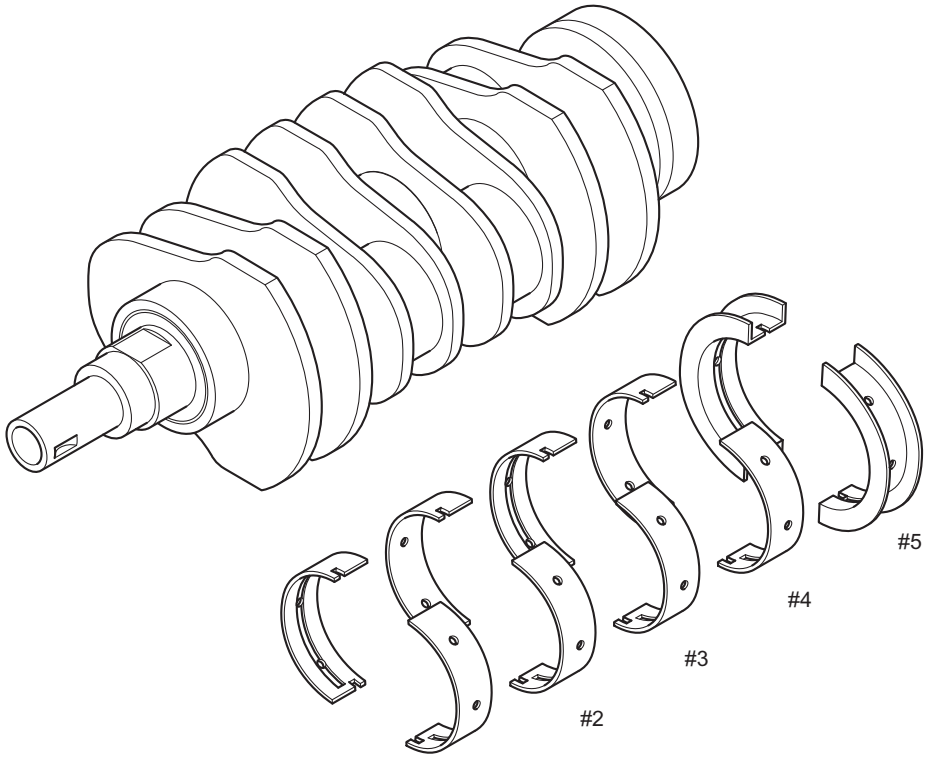
● The cylinder block supports the crankshaft at its five journals. The journal supporting portions are designed such that sufficient stiffness and quiet operation are ensured.

● Sintered material is fit in the casting at the #5 journal to achieve further quietness.

● The oil pump is located in the front center of the cylinder block and the water pump is located at the front of the left-cylinder bank. At the rear of the right-cylinder bank is an oil separator which removes oil mist contained in blow-by gas.

8. Crankshaft

The crankshaft is supported in the cylinder block at five journals. 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.



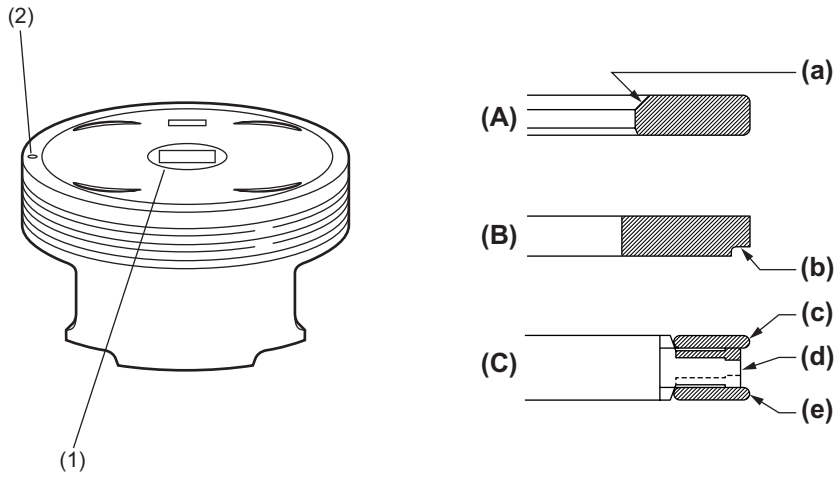
9. Piston

● The pistons are of a slipper skirt design for reduced weight and friction. The piston is also a thermal flow type whose oil control ring groove is provided with round oil drain holes.

● The piston pin is offset toward the thrust side (No. 1 and No. 3 downwards, No. 2 and No. 4 upwards) to reduce piston slap noises.

● The piston head has recesses to prevent interference with the intake and exhaust valves. It also has engraved marks to identify the piston size and the direction of installation. All the pistons are common in their design.

● Three piston rings are used for each piston; two compression rings and one oil control ring. The top piston ring has inner bevels and the second piston ring has a cut on the bottom outside to reduce oil consumption.



ME-00791

(1) Identification mark
(2) Location mark (engine front side)

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

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

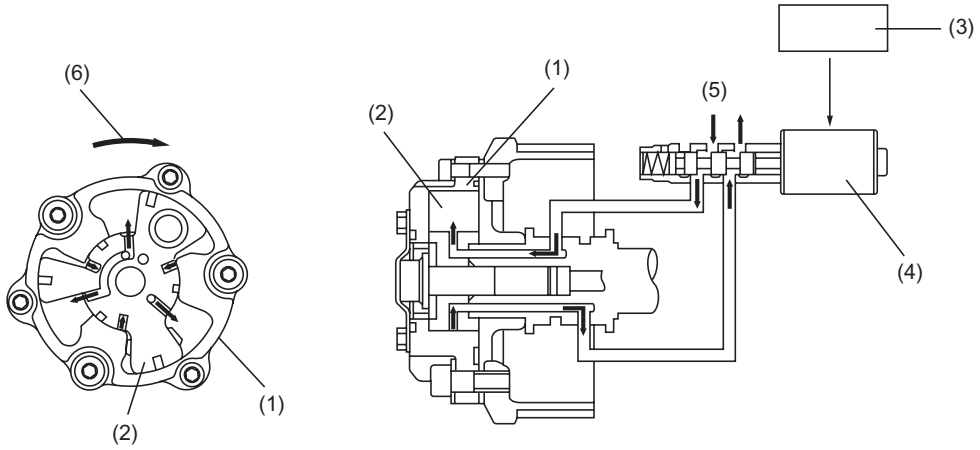
10.Variable Valve Timing System

This engine has a variable valve timing system, which adjusts the opening and closing timings of the valves optimally by continuously changing the phase angle of the camshaft sprocket relative to the camshaft.

- The ECM determines the optimal cam angle relative to the crank angle by making reference to the engine speed, vehicle speed, throttle opening and other relevant parameters.
- Under the control of the ECM, the oil flow control solenoid valve moves its spool to switch the hydraulic passage to/from the advance and retard chambers that are formed in the camshaft sprocket to change continuously the phase angle between the camshaft sprocket and camshaft.

A: PHASE ANGLE ADVANCES

In response to an advance signal from the ECM, the oil flow control solenoid valve moves its spool such that hydraulic pressure is applied to the advance chamber in the camshaft sprocket. The sprocket is then turned in the direction in which its phase angle advances relative to the camshaft.

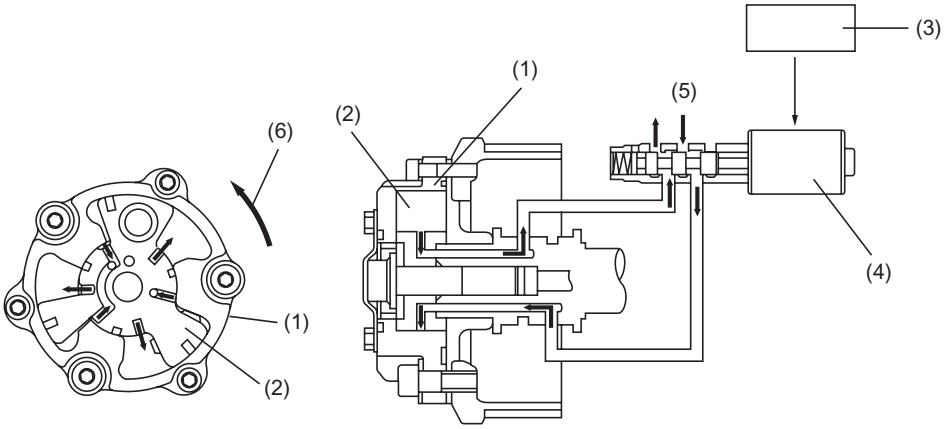


ME-00825

(1) Variable valve timing controller (attached to camshaft sprocket)
(2) Vane (attached to camshaft)
(3) ECM
(4) Oil flow control solenoid valve
(5) Oil pressure
(6) Turns in advance direction

B: PHASE ANGLE RETARDS

In response to a retard signal from the ECM, the oil flow control solenoid valve moves its spool such that hydraulic pressure is applied to the retard chamber in the camshaft sprocket. The sprocket is then turned in the direction in which its phase angle retards relative to the camshaft.

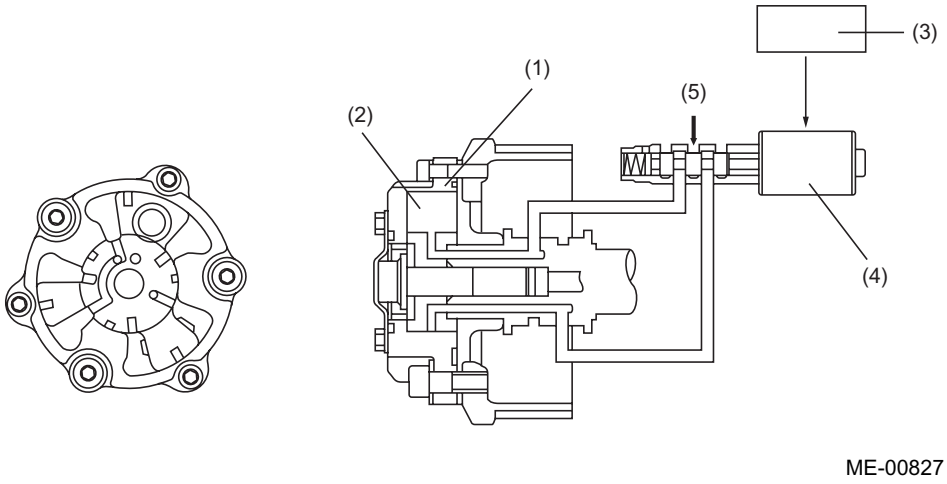


ME-00826

(1) Variable valve timing controller (attached to camshaft sprocket)
(2) Vane (attached to camshaft)
(3) ECM
(4) Oil flow control solenoid valve
(5) Oil pressure
(6) Turns in retard direction

C: A CERTAIN PHASE ANGLE IS RETAINED

When the ECM issues a signal to keep the phase angle unchanged, the oil flow control solenoid valve moves its spool to the position at which the hydraulic pressures to/from both the chambers are blocked. The pressures in the chambers are thus maintained, so the phase angle does not change and the intake valves' opening and closing timings also remain unchanged.

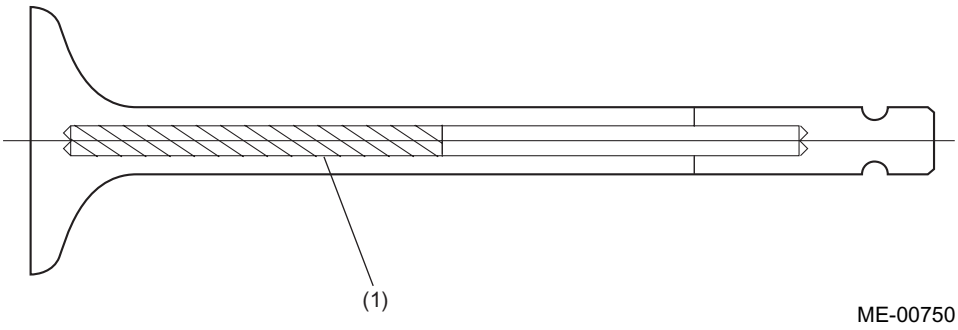


(1) Variable valve timing controller (attached to camshaft sprocket)
(2) Vane (attached to camshaft)
(3) ECM
(4) Oil flow control solenoid valve
(5) Oil pressure

11.Sodium-filled Exhaust Valves

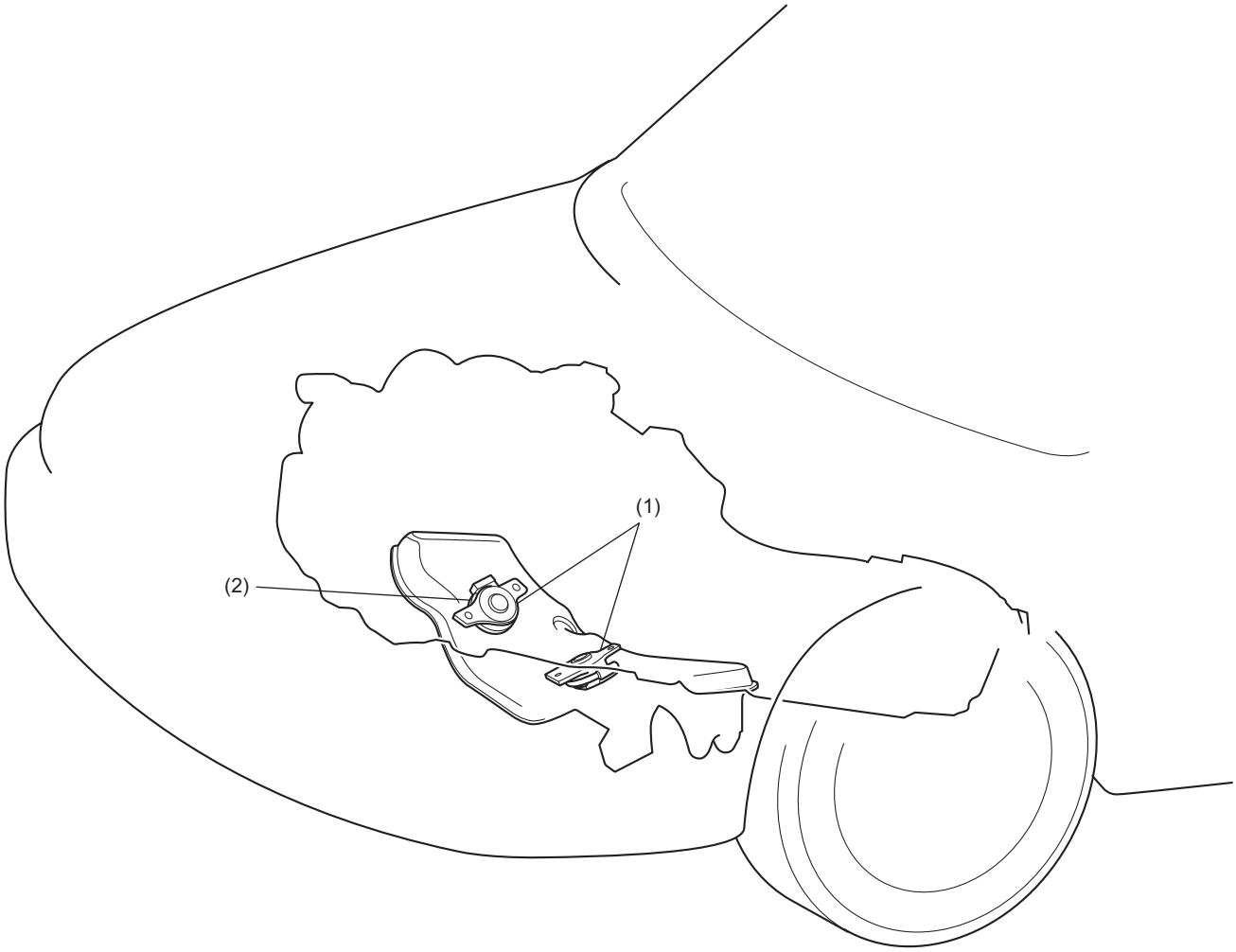
Each exhaust valve contains pure sodium in its hollow stem.Sodium has high thermal conductivity.

The entrapped sodium will liquefy at high temperatures and move inside the stem as the valve is operated. Thus the sodium will effectively transfer heat from the valve head to the valve stem, contributing to cooling down the valve head faster.



(1) Pure sodium

12.Engine Mounting



ME-02441

(1) Cushion rubber
(2) Engine mounting cover

1. General

Specifications for the SOHC U5 models are included in ME (H4SO). <Ref. to ME(H4SO) section.>

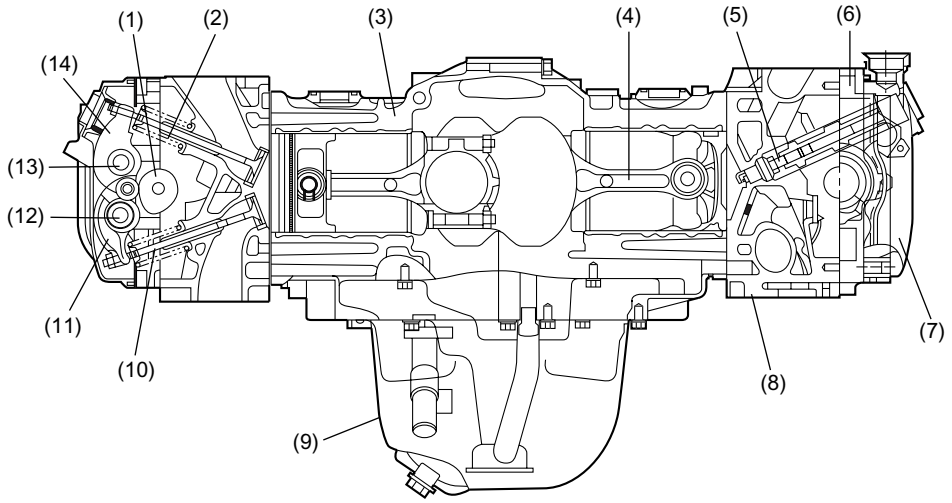
MECHANICAL
(H4SO)

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 pent roof 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 water pump on the left bank. A belt tension adjuster automatically adjusts the belt tension and eliminates the need for manual adjustments.
- The crankshaft is supported at five journals with high rigidity and strength.
- The cylinder block is made of aluminum die-casting, and cast iron cylinder liners are cast in.



ME-00312

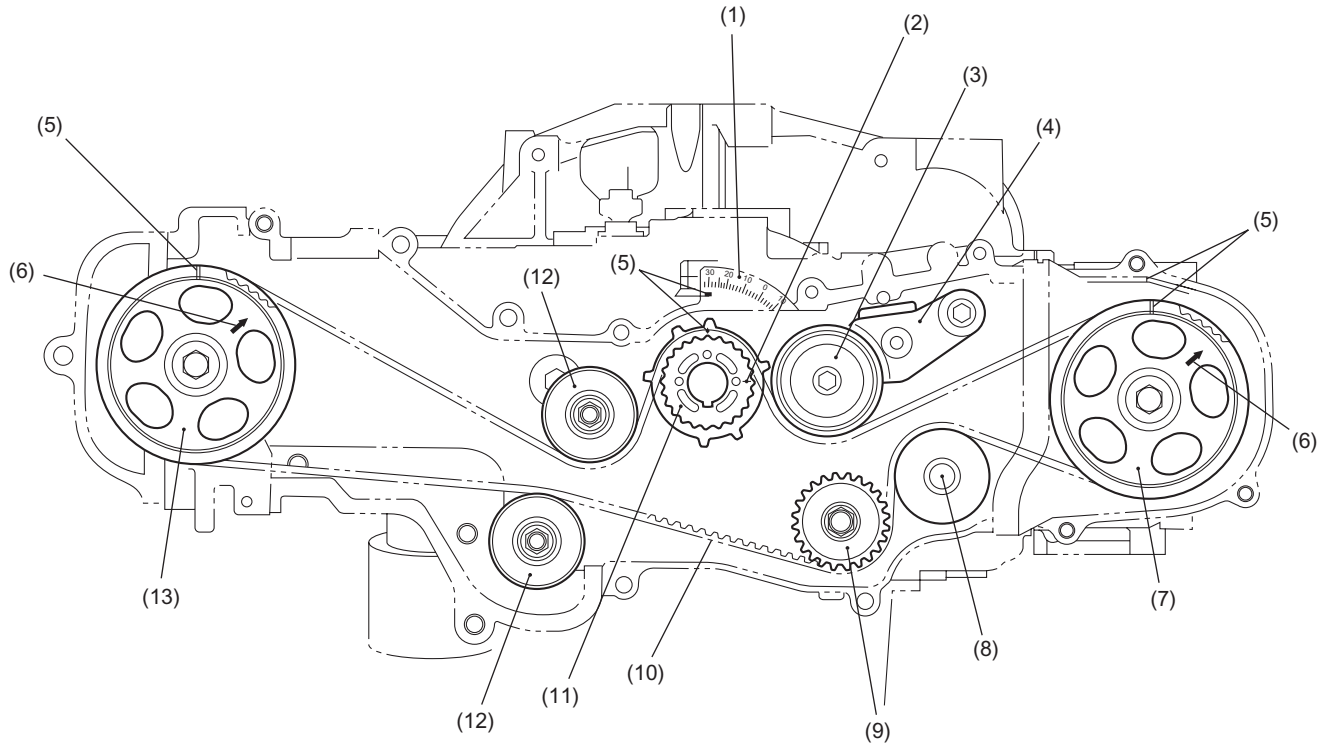
(1) Camshaft
(2) Intake valve
(3) Cylinder block
(4) Connecting rod
(5) Spark plug
(6) Camshaft cap
(7) Valve rocker cover
(8) Cylinder head
(9) Oil pan
(10) Exhaust valve
(11) Exhaust rocker arm
(12) Exhaust rocker shaft
(13) Intake rocker shaft
(14) Intake rocker arm

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

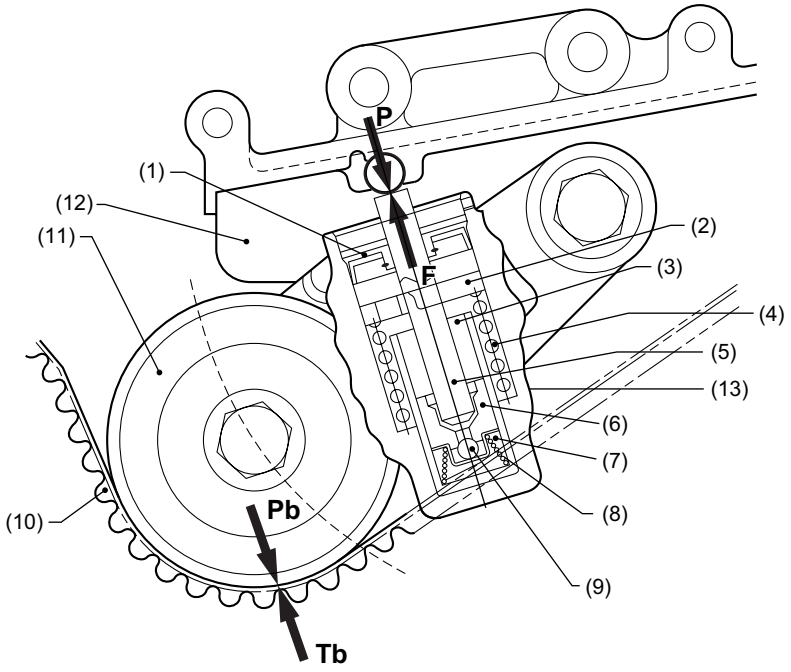
NOTE:
*: The #1 piston is at TDC when the piston position mark on the crankshaft sprocket is aligned with the timing mark on the cylinder block.
**: The #1 piston is at TDC on the compression stroke when the piston position mark on the camshaft sprocket is aligned with the timing mark on the belt cover.

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.

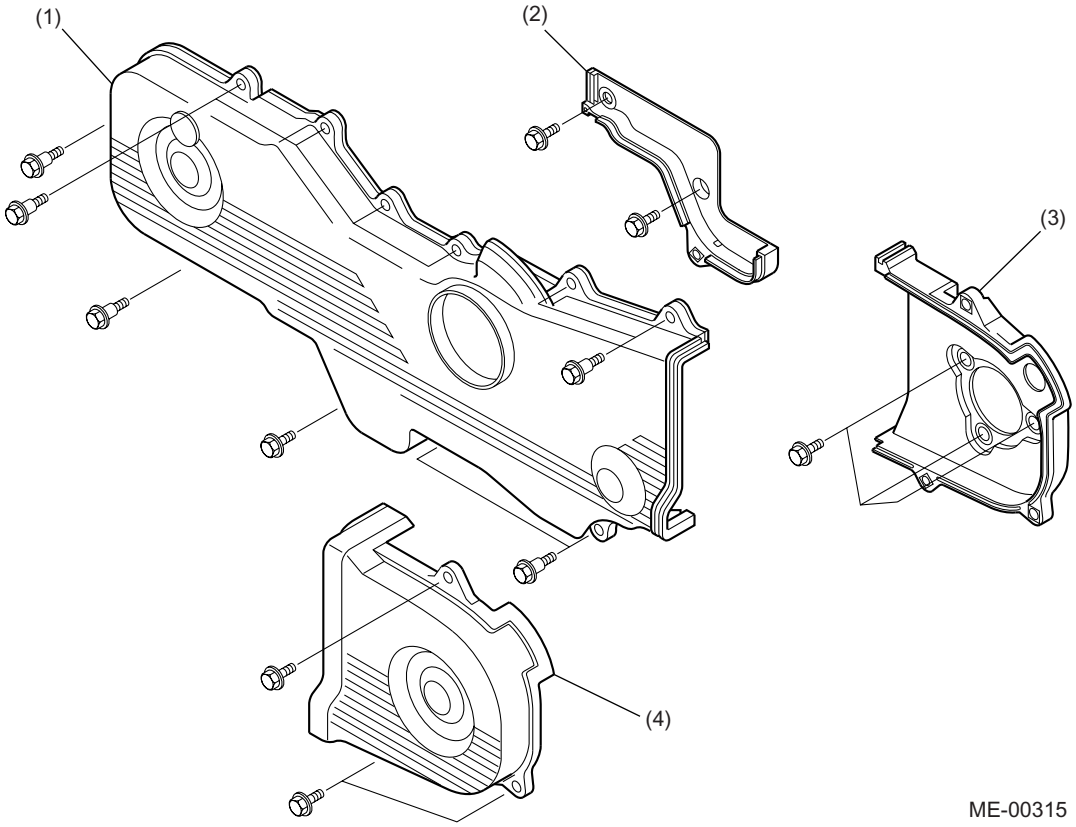
● Over-tension correction action
If the tension of the timing belt increases excessively, the force P becomes larger than the thrust force F and silicone oil is returned from the oil pressure chamber to the reservoir chamber little by little until the force P balances again with the thrust force F. Thus 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)

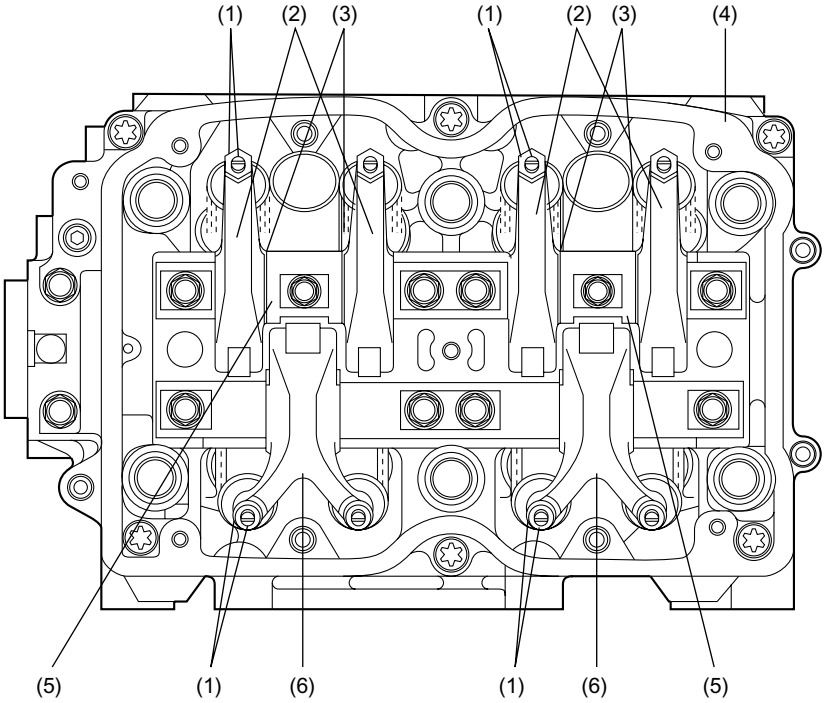
5. Valve Rocker Assembly

● 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.

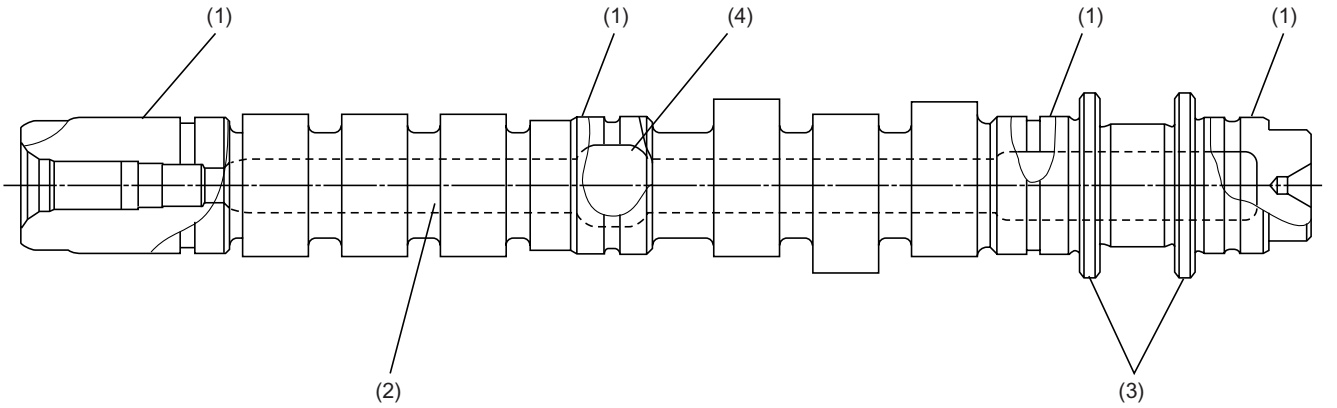


ME-00316

(1) Valve rocker adjusting screw and nut
(2) Intake valve rocker arm
(3) Wave washer
(4) Camshaft cap
(5) Supporter
(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. The oil passage is formed by casting (hollowed in varying inner diameter) to reduce the weight.

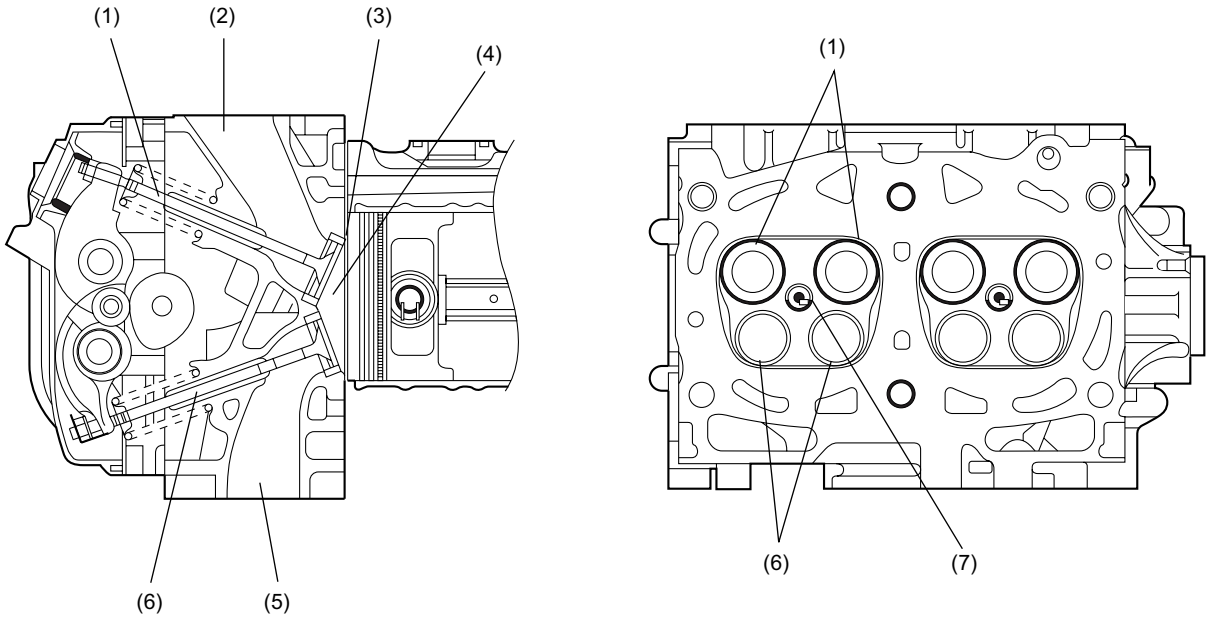


ME-02102

(1) Journal
(2) Oil passage
(3) Shaft flange
(4) Hollowed in varying inner diameter

7. Cylinder Head

- The cylinder head is made of low pressure cast aluminum.
- Each combustion chamber in the cylinder head is a compact, pent roof 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.
- As a design feature, the exhaust port of adjacent cylinders are joined to a single port, aiming at decreasing heat dissipation and accelerate activation of the catalytic converter.
- The cylinder head gasket is a metallic gasket. The gasket is highly resistant to heat and maintains high level of sealing performance for a long period.



ME-00318

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

8. Cylinder Block

● The cylinder block is made of aluminum die casting. Its open-deck design provides it with such advantageous features as relatively small weight, high rigidity and excellent cooling efficiency.

● The cylinder liners are made of cast iron. As they are of a dry type, their outer surfaces are entirely in contact with the cylinder block.

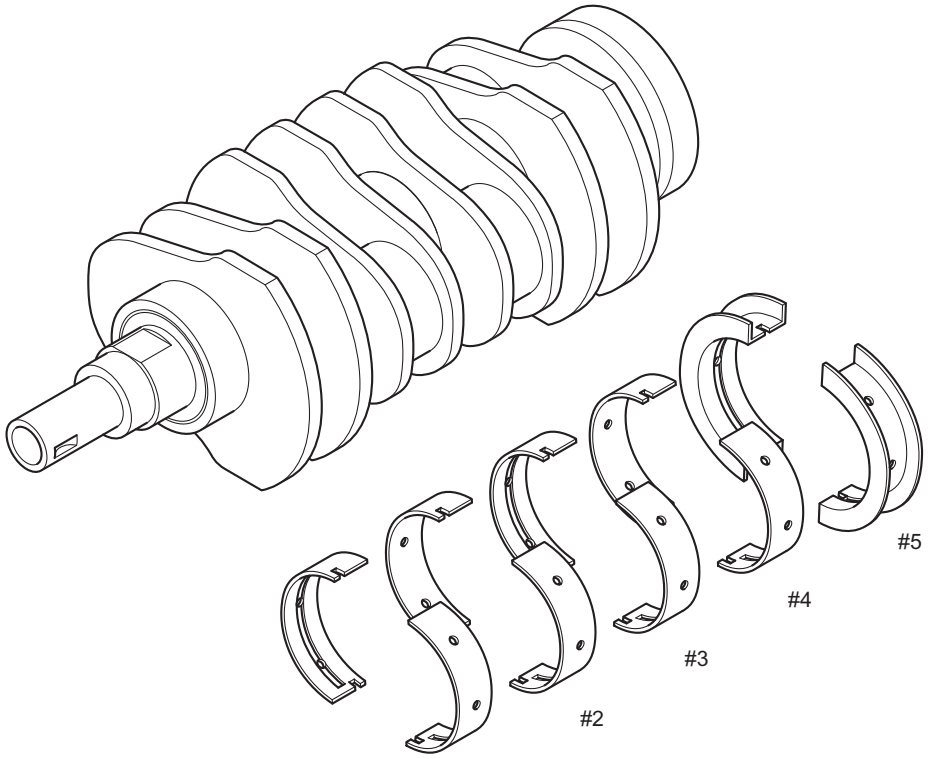
● The cylinder block supports the crankshaft at its five journals. The journal supporting portions are designed such that sufficient stiffness and quiet operation are ensured.

● Sintered material is fit in the casting at the #5 journal to achieve further quietness.

● The oil pump is located in the front center of the cylinder block and the water 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 at five journals. 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.



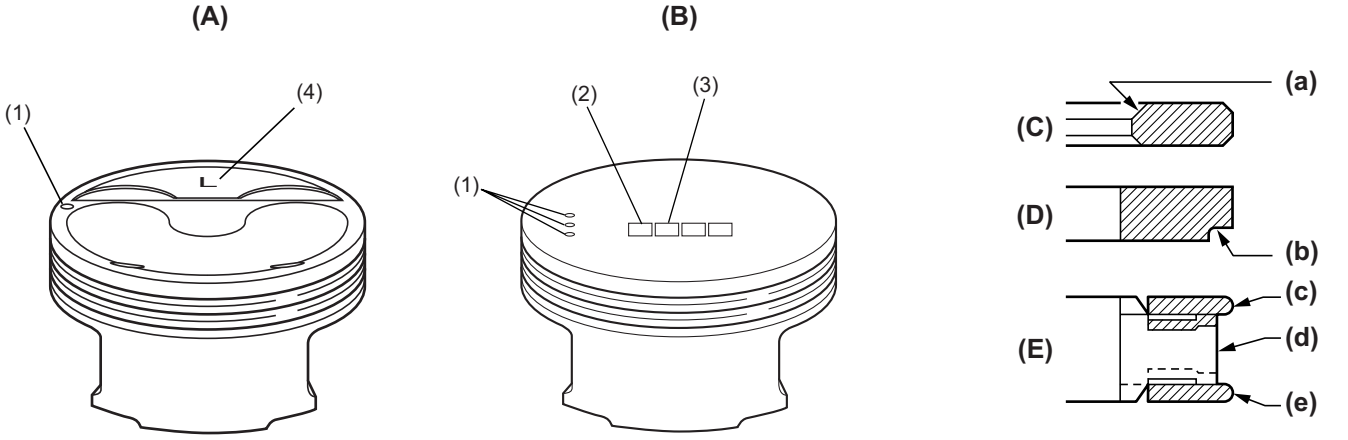
10.Piston

● The pistons are of a slipper skirt design for reduced weight and friction. The piston is also a thermal flow type whose oil control ring groove is provided with round oil drain holes.

● The piston pin is offset toward the thrust side (No. 1 and No. 3 pistons downwards, No. 2 and No. 4 pistons upwards) to reduce piston slap noises.

● 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. On type I models, the piston heads are concaved at the entire exhaust side to gather the tumble flow around the spark plug and improve combustion. Only on the type I models the pistons are distinguished left or right.

● 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.



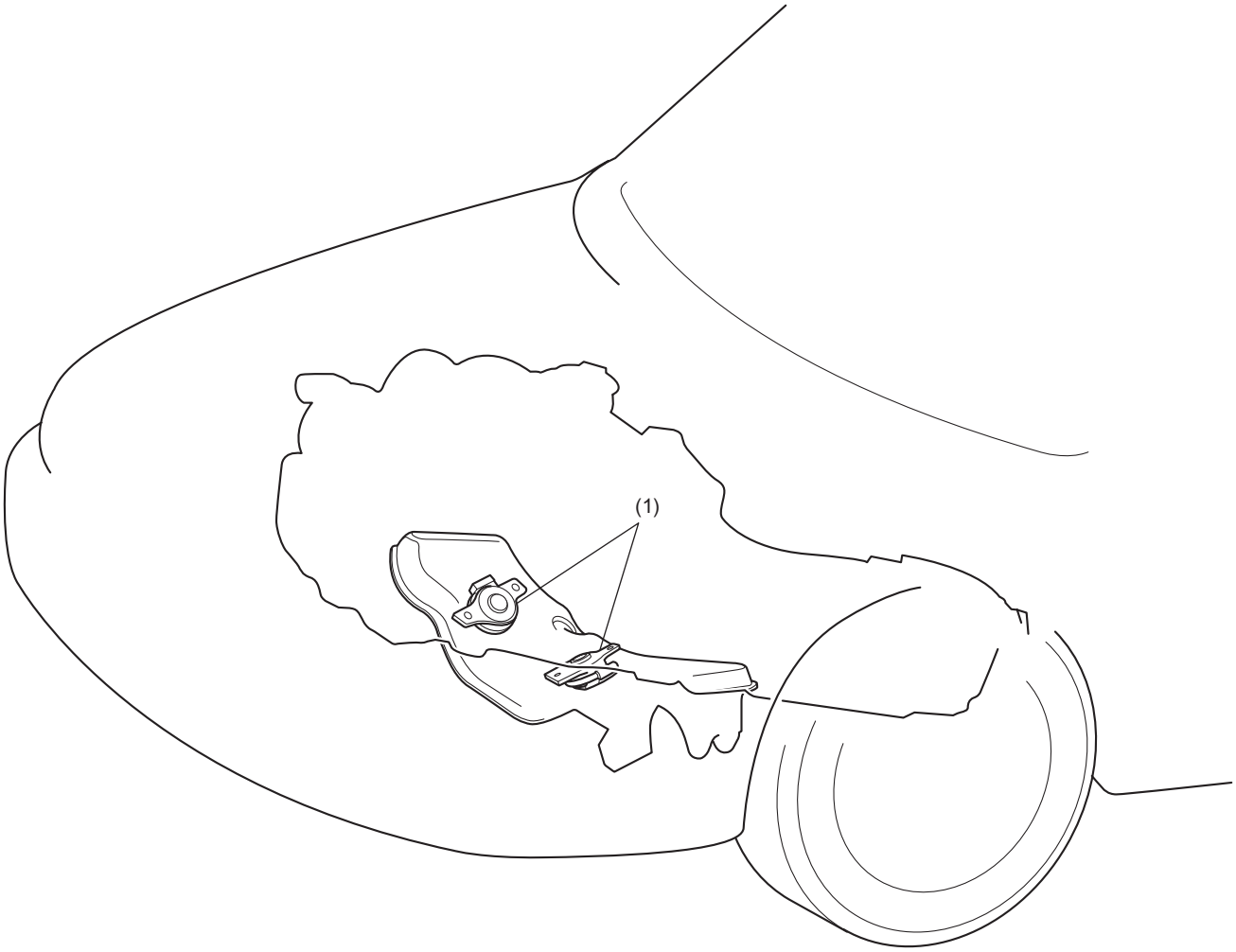
ME-02393

(1) Location mark (engine front side)
(2) Identification mark (piston size)
(3) Engine displacement
(4) Identification mark (left or right)

(A) Type I models
(B) Type II models
(C) Top ring
(D) Second ring
(E) Oil ring

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

11.Engine Mounting



ME-00434

(1) Cushion rubber

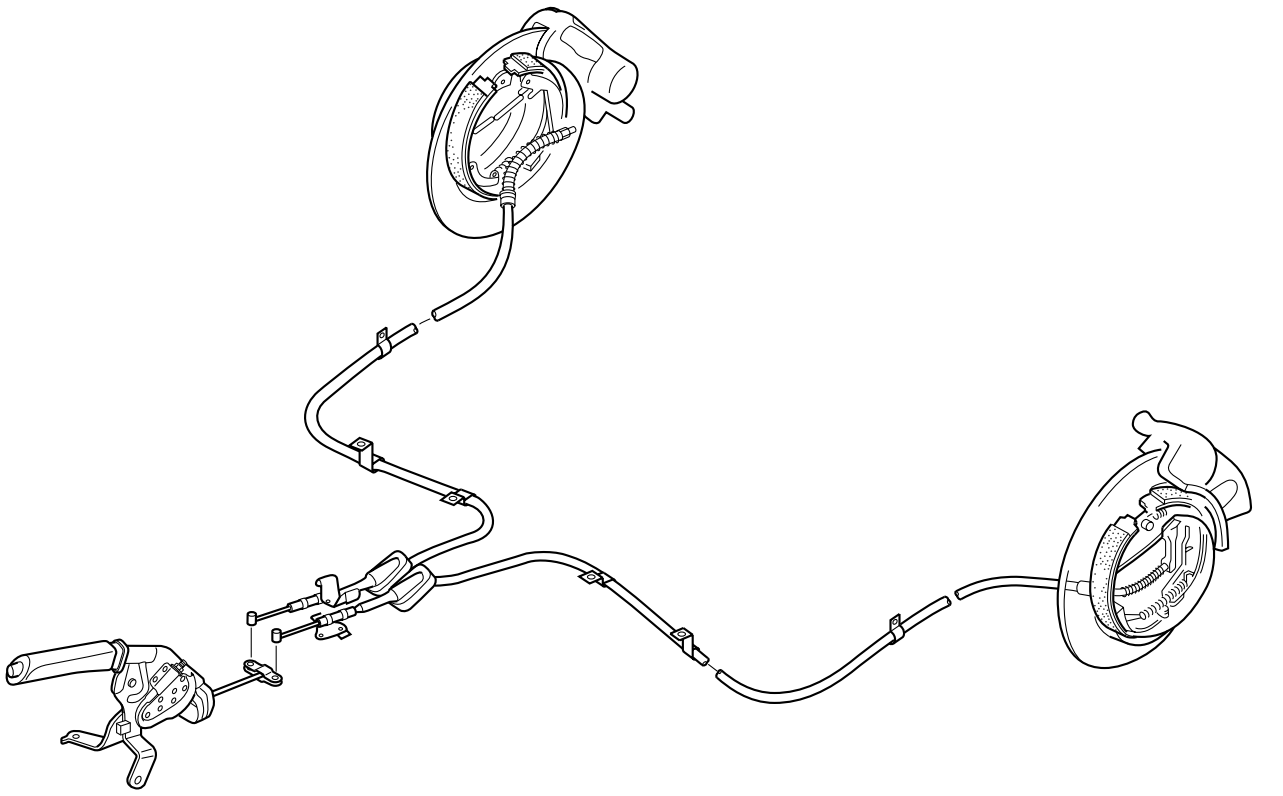
MEMO

PARKING BRAKE

1. Parking Brake

The parking brakes are applied by manually operating the lever to mechanically control the rear wheels through a cable.

Each rear disc brake rotor contains a drum brake mechanism which is used exclusively for the parking brake.



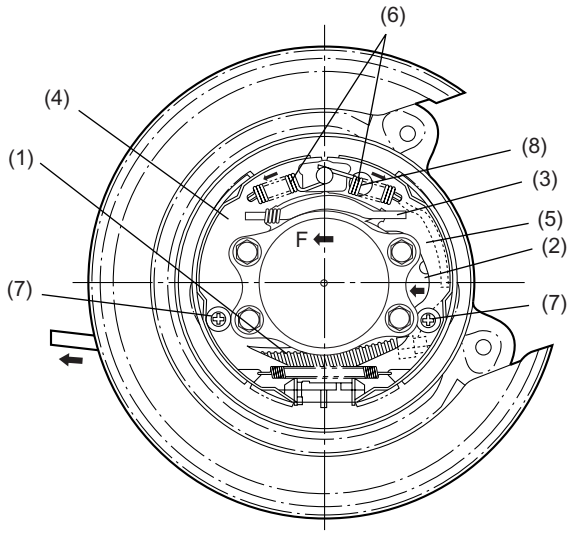
PB-00055

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.

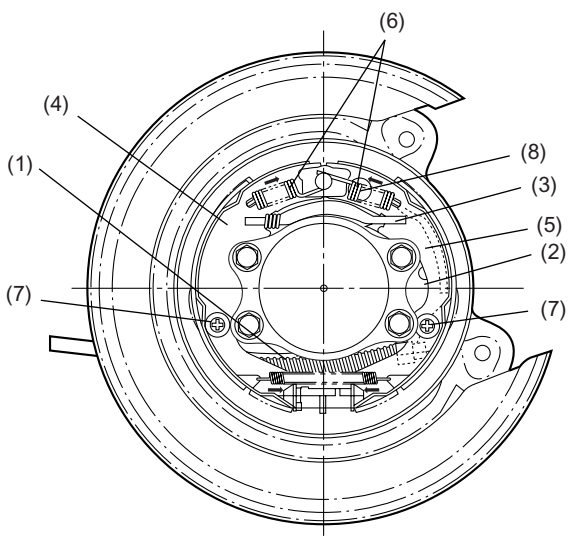


PB-00051

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

2. RELEASING

When the parking brake lever is returned to the release position and the parking brake cables are slackened, the brake shoes A and B are moved back to their original positions by the tension of return springs, so that the parking brake is released.



PB-00052

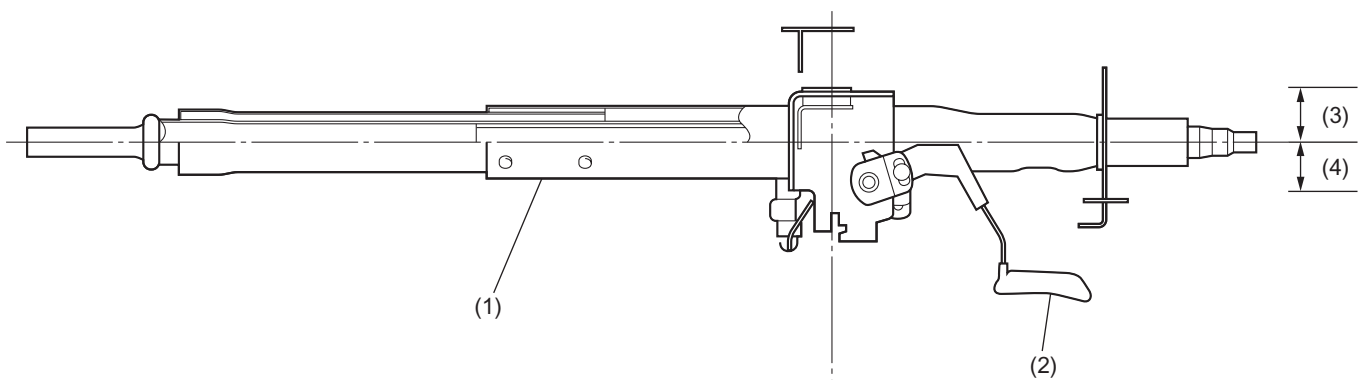
(1) Parking brake cable
(2) Lever
(3) Strut
(4) Brake shoe A
(5) Brake shoe B
(6) Shoe return spring
(7) Shoe hold down pin
(8) Point “P”

POWER ASSISTED SYSTEM (POWER STEERING)

1. Tilt Steering Column

A: TILT MECHANISM

● The steering wheel vertical position can be adjusted within a 38 mm (1.50 in) range by using the tilt lever to unlock the steering column and lock it again at the desired position.



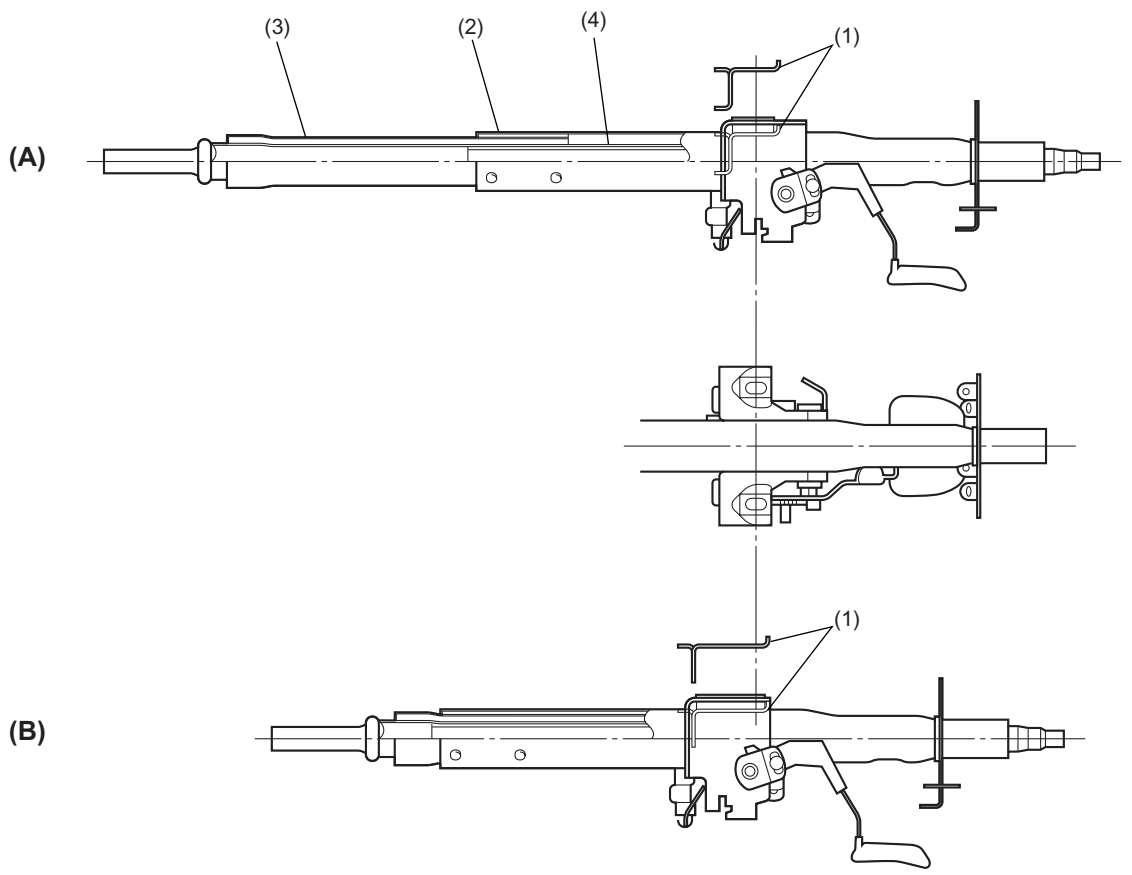
PS-00470

(1) Tilt steering column
(2) Tilt lever
(3) 23 mm (0.91 mm)
(4) 15 mm (0.59 in)

B: ENERGY-ABSORBING MECHANISM

● To absorb the backward movement energy generated in the engine compartment in the event of a frontal collision, a press-fitted pipes type steering column jacket has been adopted.
When an impact load exceeding a certain level is applied to the steering column, jacket A slides on jacket B.
Since jacket B is press-fitted in jacket A, friction generated between them absorbs the impact.
The column bending load is supported by the press-fitted jackets.

● 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.

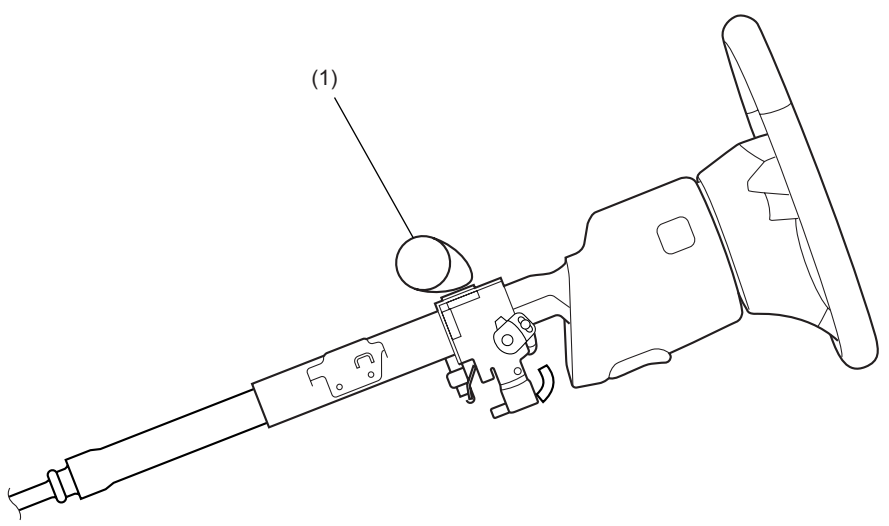


(A) Before absorption of impact energy
(B) After absorption of impact energy
(C) Before ripping
(D) After ripping

(1) Ripping plate
(2) Jacket A
(3) Jacket B
(4) Shaft

C: STEERING SUPPORT BEAM

● The steering column is held in position by a support beam, which is installed crosswise in the vehicle body at a level close to the steering wheel to reduce the overhang distance of the steering wheel from the supporting point of the column. The steering shaft upper bearing is also located close to the steering wheel to increase supporting efficiency as well as to minimize vibration of the steering wheel.



PS-00475

(1) Steering support beam

2. Power Steering System

A: HYDRAULIC SYSTEM

● The fluid pump is directly driven by the engine through a belt.

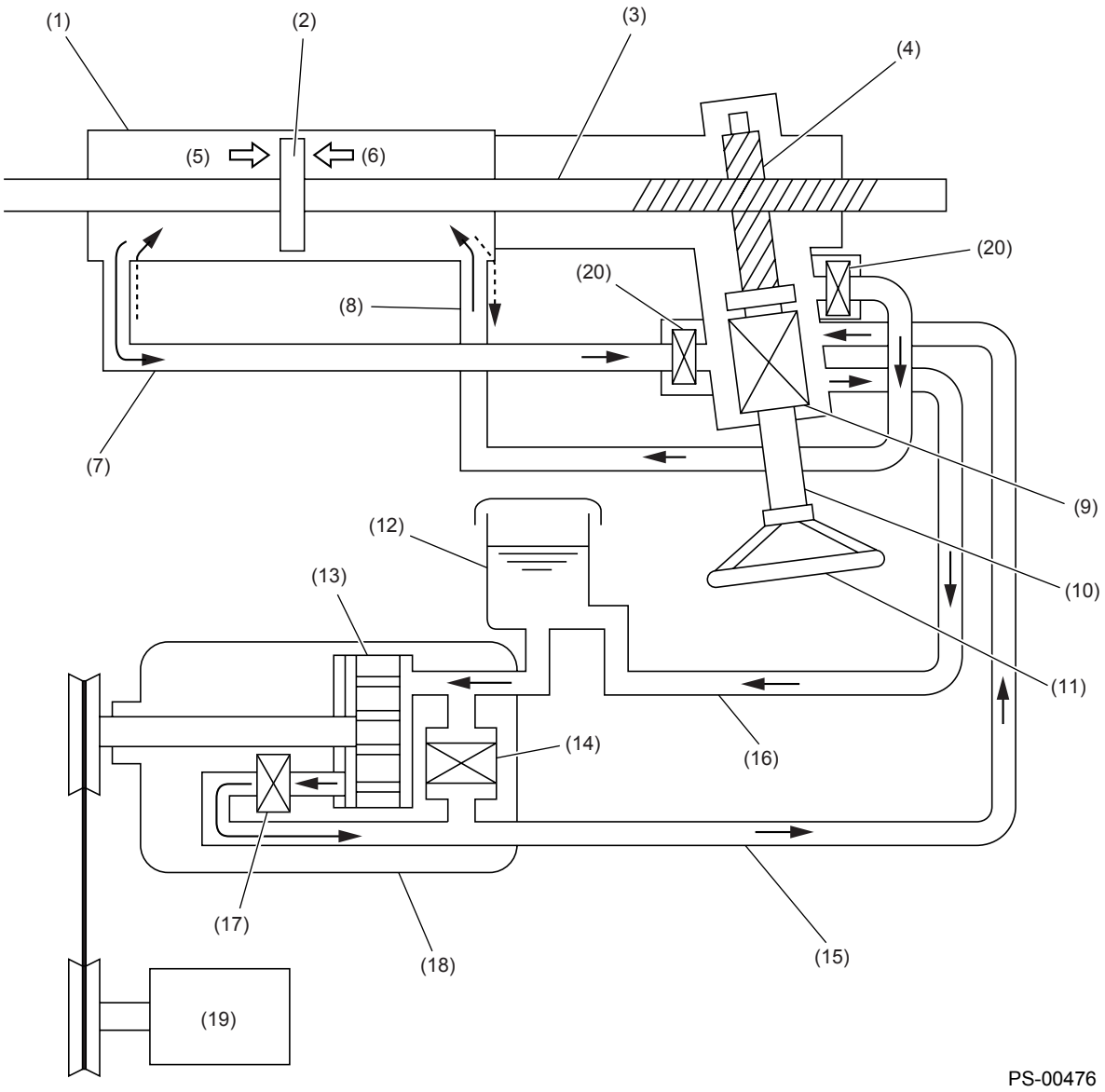
● The fluid flow is maintained almost constant regardless of change in the engine speed by the function of the flow control valve. The flow-regulated fluid is delivered to the control valve through hose A.

● When the steering wheel is turned, the rotary control valve connected to the pinion shaft opens the hydraulic circuit corresponding to the direction in which the steering wheel is turned. The fluid then flows into chamber A or B via pipe A or B.

● The fluid pressure in chamber A or B acts on the rack piston in the same direction as the rack shaft is moved by rotation of the steering wheel. This helps reduce the effort required of the driver to operate the steering wheel.

● Movement of the rack piston causes the fluid in the other chamber to return to the reservoir tank via pipe A or B, control valve, and hose B.
  ● As the steering shaft is connected to the pinion shaft mechanically via the rotary control valve, the steering system can operate as a manual system even if the hydraulic system becomes inoperative.
  ● To control the maximum fluid pressure, a relief valve is built into the fluid pump to prevent build-up of excessive fluid pressure.

● Since a damper valve is provided in the fluid passage, the steering stability in straight forward direction is improved and kickback is reduced.



PS-00476

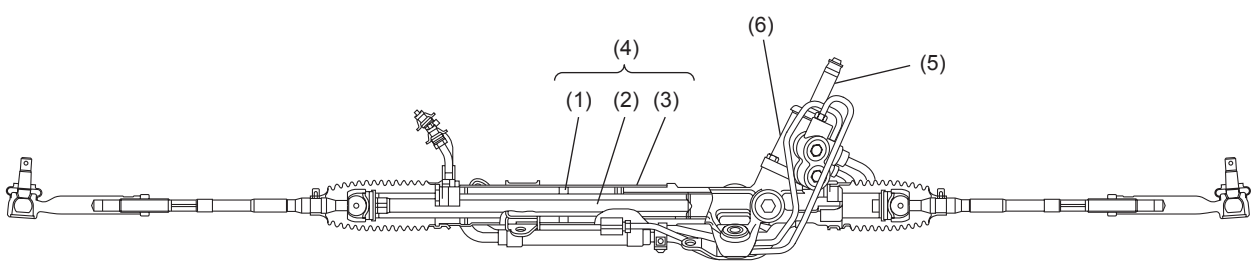
(1) Power cylinder
(2) Rack piston
(3) Rack shaft
(4) Pinion shaft
(5) Chamber A
(6) Chamber B
(7) Pipe A
(8) Pipe B
(9) Control valve
(10) Steering shaft
(11) Steering wheel
(12) Tank
(13) Vane pump
(14) Relief valve
(15) Hose A
(16) Hose B
(17) Control valve
(18) Fluid pump
(19) Engine
(20) Damper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

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 hydraulic fluid pipes.



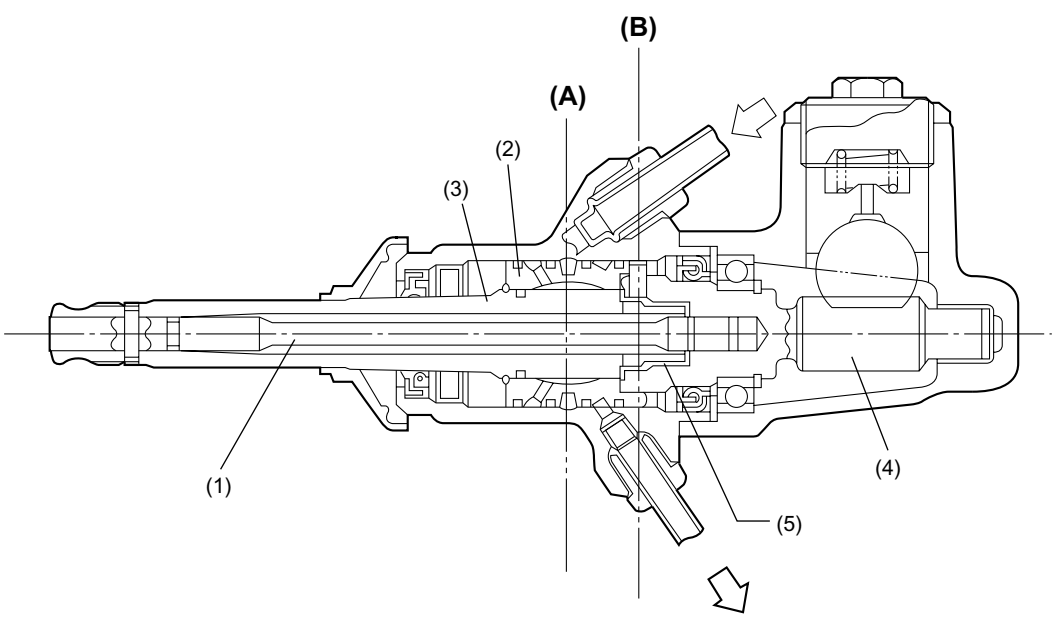
PS-00626

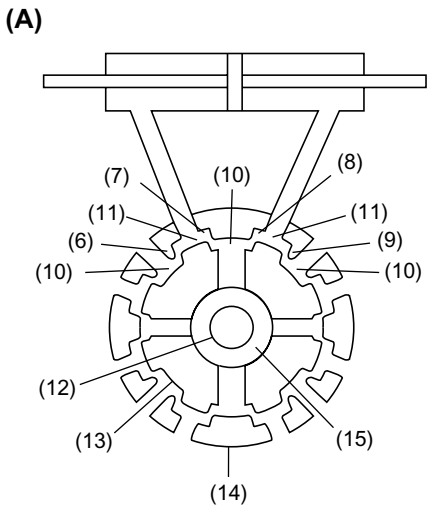
(1) Piston
(2) Rack shaft
(3) Cylinder
(4) Power cylinder
(5) Pinion shaft
(6) Control valve

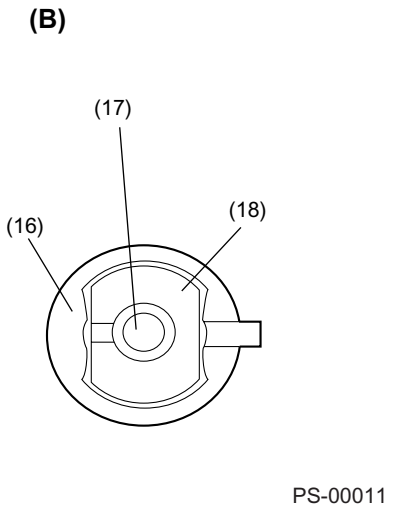
2. ROTARY CONTROL VALVE

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).







PS-00011

(1) Torsion bar
(2) Sleeve
(3) Rotor
(4) Pinion
(5) Pinion-to-rotor engagement (fail-safe feature)
(6) Fluid passage V_1
(7) Fluid passage V_2
(8) Fluid passage V_3
(9) Fluid passage V_4
(10) Groove C
(11) Groove D
(12) Torsion bar
(13) Rotor
(14) Sleeve
(15) Fluid return line (to reservoir tank)
(16) Pinion
(17) Torsion bar
(18) Rotor

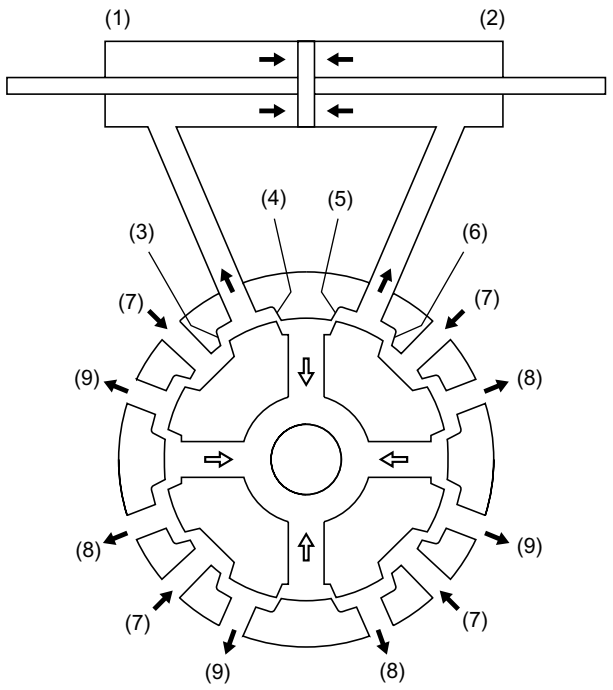
(A) Cross-sectional view A (fluid passage switching circuit)
(B) Cross-sectional view B (pinion-to-rotor engagement)

● Principle of operation

When the torsion bar is twisted by a rotational force applied to the steering wheel, the relative position between the rotor and sleeve changes. This changes the cross-sectional area of fluid passages V_1, V_2, V_3 and V_4. The fluid passages are thus switched and the fluid pressure is controlled in accordance with the operation of the steering wheel.

● When no steering force is applied:

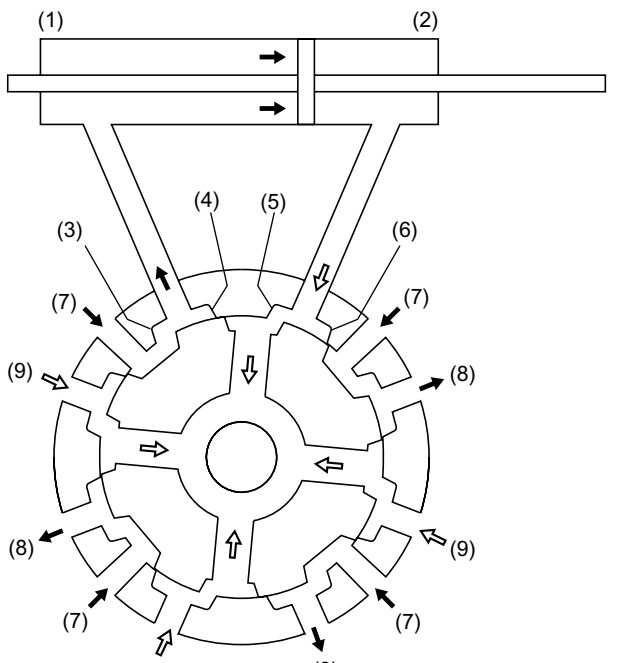
The rotor and sleeve are held at the neutral position. Fluid passages V_1, V_2, V_3 and V_4, which are formed by grooves C and D are open equally. Under this condition, the fluid from the pump returns to the reservoir tank so that neither fluid pressure builds up nor the rack piston moves in the power cylinder.



PS-00012

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

● 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.



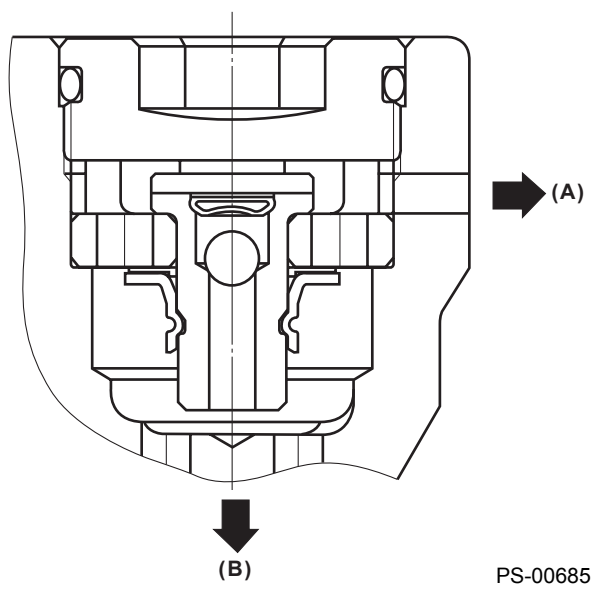
PS-00013

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

● Fail-safe function
If fluid pressure fails to build up due to, for example, a broken fluid pump drive belt, the steering wheel rotating torque is transmitted from the valve rotor to the pinion through mechanical engagement between them.

3. DAMPER VALVE

The damper valve is incorporated in the control valve body and is placed in the fluid passage at between the rotary control valve and the power cylinder chamber. Since the damper valve limits rapid flow of fluid caused by external force, the steering stability in straight forward direction is improved and kickback is reduced.



PS-00685

(A) To control valve
(B) To chamber A or B

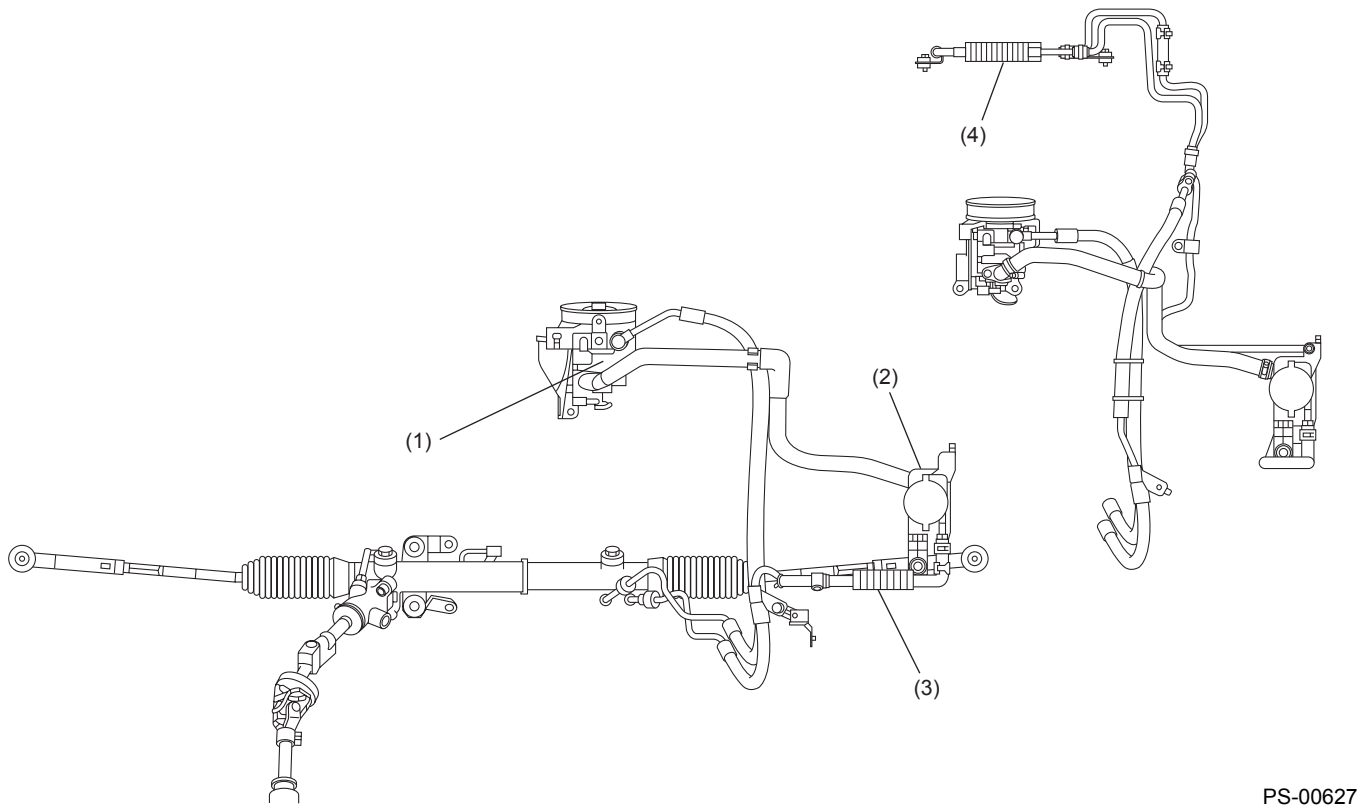
C: FLUID PUMP AND RESERVOIR TANK

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

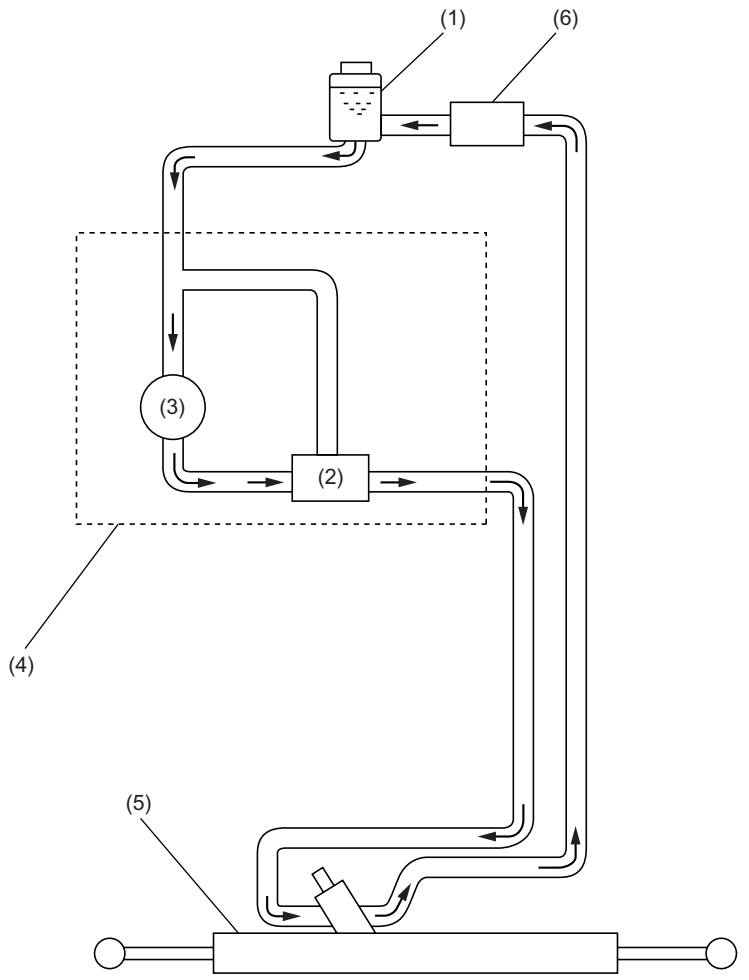
The reservoir tank is mounted on the vehicle body.

The fluid pump incorporates the flow control valve and relief valve, each performing the following functions:

- The flow control valve regulates the flow rate of discharged fluid to a constant level irrespective of the engine speed.
- The relief valve protects the system from excessively high pressures that may occur, for example, when the steering wheel is turned all the way.
- To stabilize the fluid temperature, an oil cooler is installed between the reservoir tank and gearbox.



(1) Fluid pump
(2) Reservoir tank
(3) Oil cooler (H4 models)
(4) Oil cooler (H6 models)

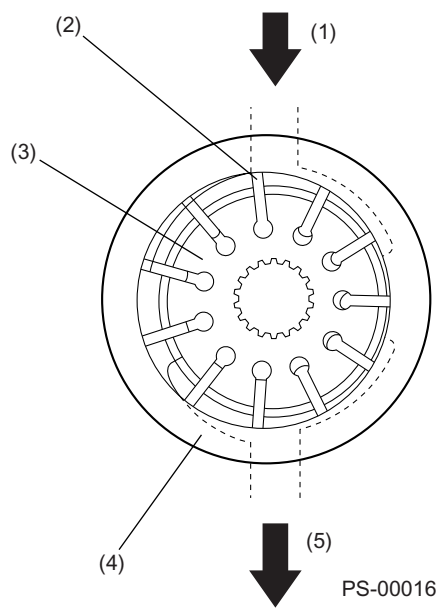


PS-00504

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

● The fluid pump is belt-driven by the engine. The fluid flow is controlled according to the engine speed so that an adequate steering resistance is given during high-speed operation.
The fluid pump is a variable capacity type vane pump whose delivery rate per rotation decreases as the engine speed increases. The pump is integral with a pump control valve and relief valve.

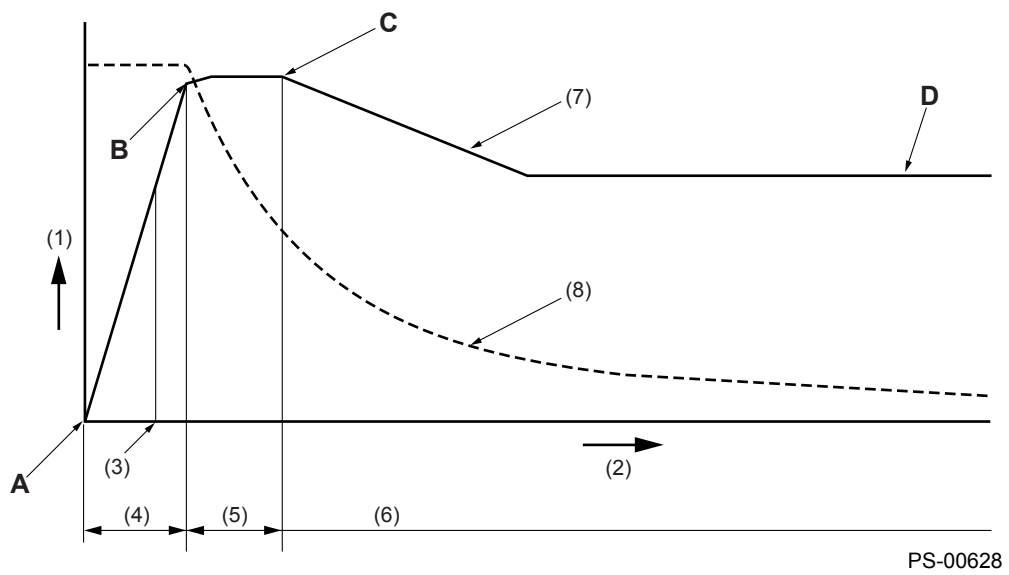
● The vane pump consists of a rotor, a cam ring, and 11 vanes.
When the rotor rotates, the vane in each slot of the rotor is moved out by centrifugal force in radial directions and pressed against the cam ring. The fluid from the suction port is confined in chambers formed between two adjacent vanes and carried to the discharge port. Since the cam ring is movable in relation to the rotor, the volume of each chamber is variable. This enables the delivery rate per rotation of the pump to be changed.



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

● **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).



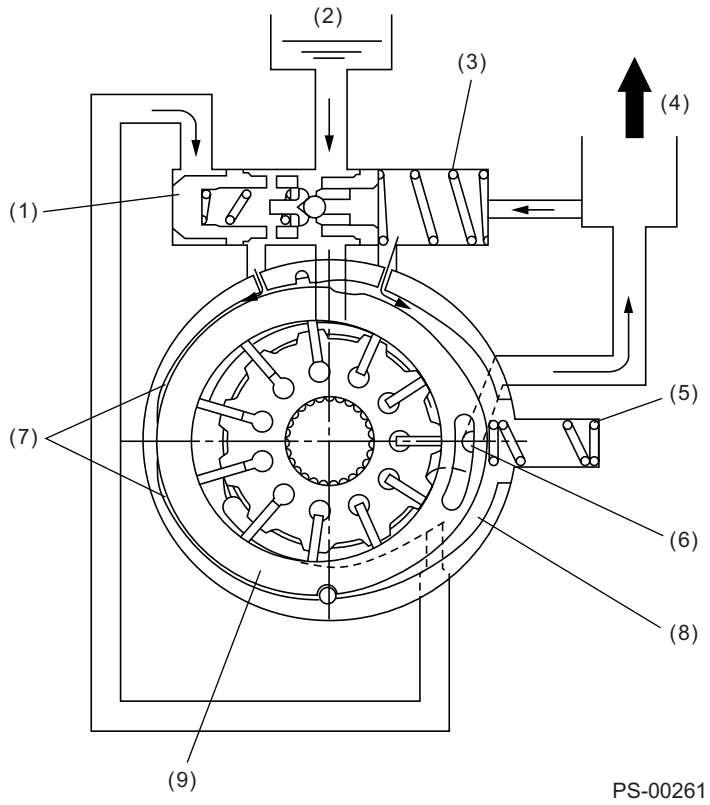
(1) Fluid flow
(2) Pump speed
(3) Idling
(4) Low-speed
(5) Mid-speed
(6) High-speed
(7) Delivery rate per unit time
(8) Delivery rate per rotation of pump

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 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 becomes a maximum.



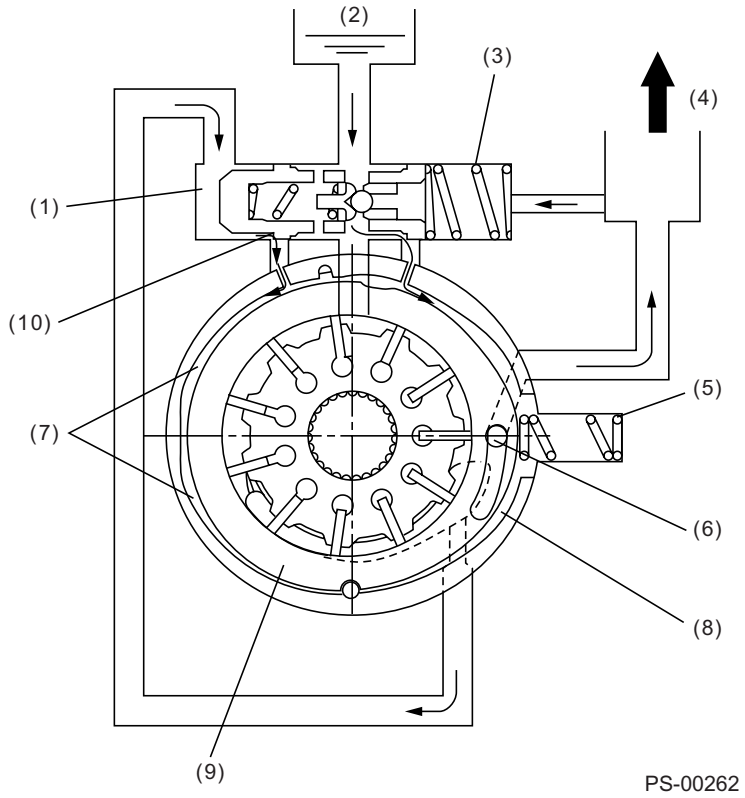
(1) Control valve
(2) Reservoir tank fluid
(3) Control valve spring
(4) Gear box
(5) Cam ring spring
(6) Variable orifice
(7) Pressure chamber A
(8) Pressure chamber B
(9) Cam ring

Mid- to high-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.

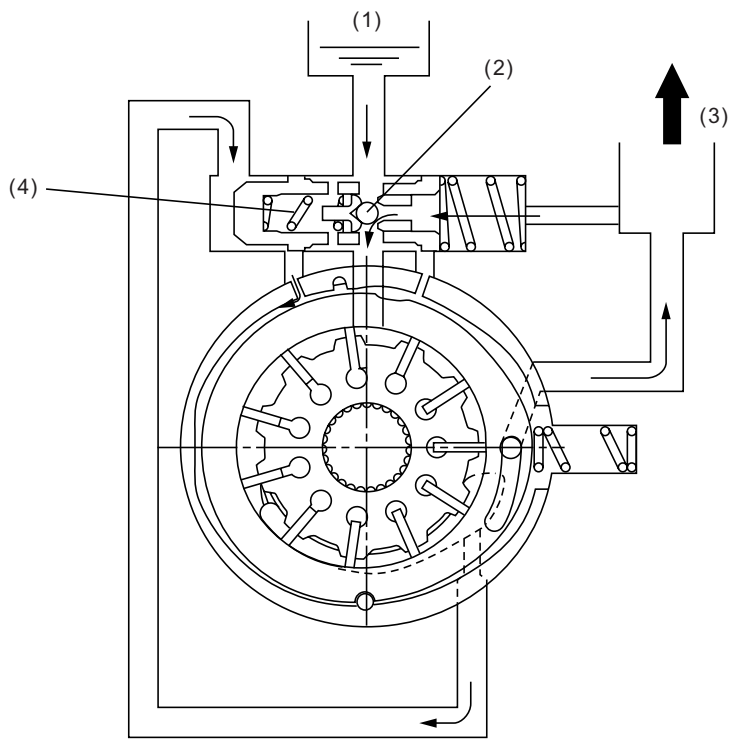
* The “necessary pressure” for chamber A is a pressure required to move the cam ring to the position corresponding to each predetermined flow rate (pump delivery rate). The pressure is obtained by changing the port opening area appropriately through displacement of the control valve. The displacement 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
(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
(10) Opening area

Maximum pressure control

When the overall delivery rate of the pump exceeds a preset value, the relief valve opens to allow part of the discharged fluid to flow toward the suction side of the pump, thereby controlling the maximum pressure.



PS-00263

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

REAR SUSPENSION

1. Rear Suspension

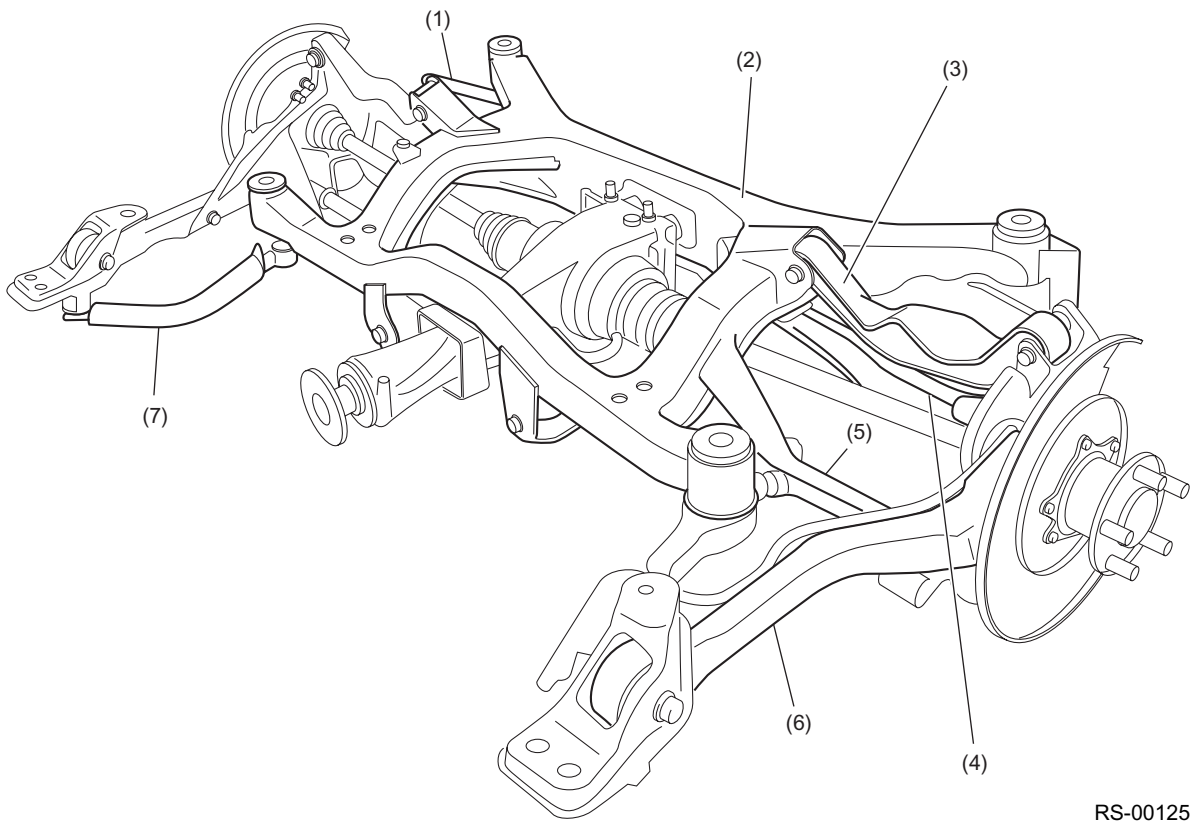
A: GENERAL

The rear suspension is a multilink type.

The suspension on each side consists of a rear arm, front link, upper link, rear link, sub frame support arm, shock absorber, and a coil spring.

The front link, rear link, and upper link are all attached to a sub frame which in turn is installed to the vehicle body through bushings.

This type of suspension is characterized by small changes in camber and toe-in against external input of vertical, longitudinal and lateral forces.



(1) Rear stabilizer
(2) Rear sub frame
(3) Upper link
(4) Rear link
(5) Front link
(6) Rear arm
(7) Sub frame support arm

B: CONSTRUCTION

1. REAR ARM

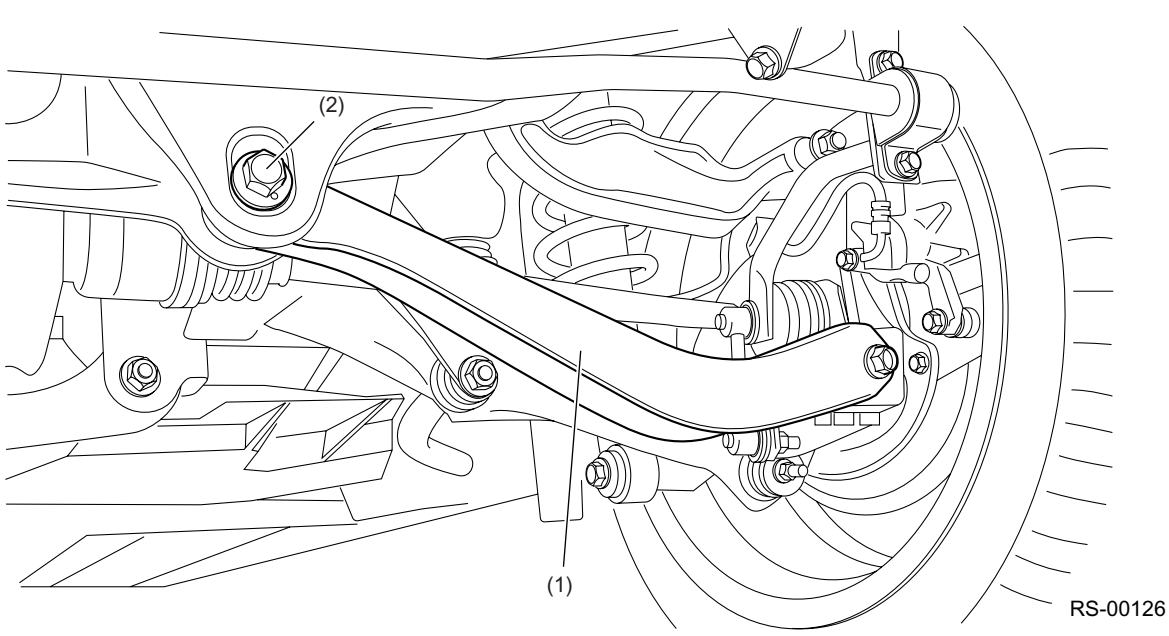
- Acts mainly on longitudinal loads.
- The rear arm bears the rear brake system and rear axle bearing unit.

2. FRONT LINK

- Acts on lateral loads.
- The link is made of steel pressed in a “U” section form, and the left and right ends of the link are connected to the rear sub frame and rear arm through rubber bushings.

3. REAR LINK

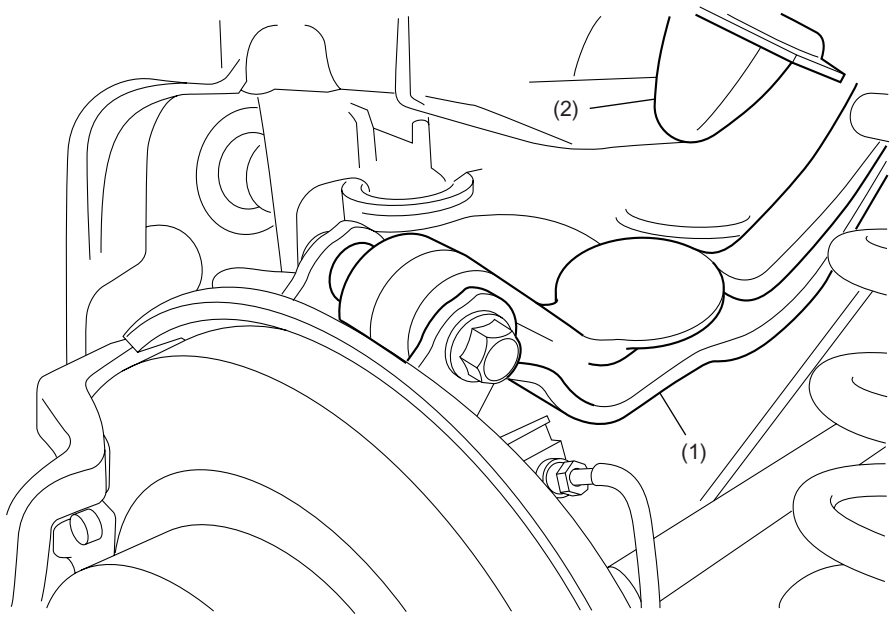
- Acts on lateral loads.
- The link is made of steel pressed in a “U” section form, and the link is connected to the rear sub frame and rear arm.
- A toe-in adjustment mechanism, which uses eccentric bolts, is provided at the joint between the rear link and rear sub frame.



(1) Rear link
(2) Eccentric bolt

4. UPPER LINK

- Acts on lateral loads.
- The left and right ends of the link are connected to the rear sub frame and rear arm through rubber bushings.
- This also supports the helper and prevents bottoming of the suspension.



RS-00127

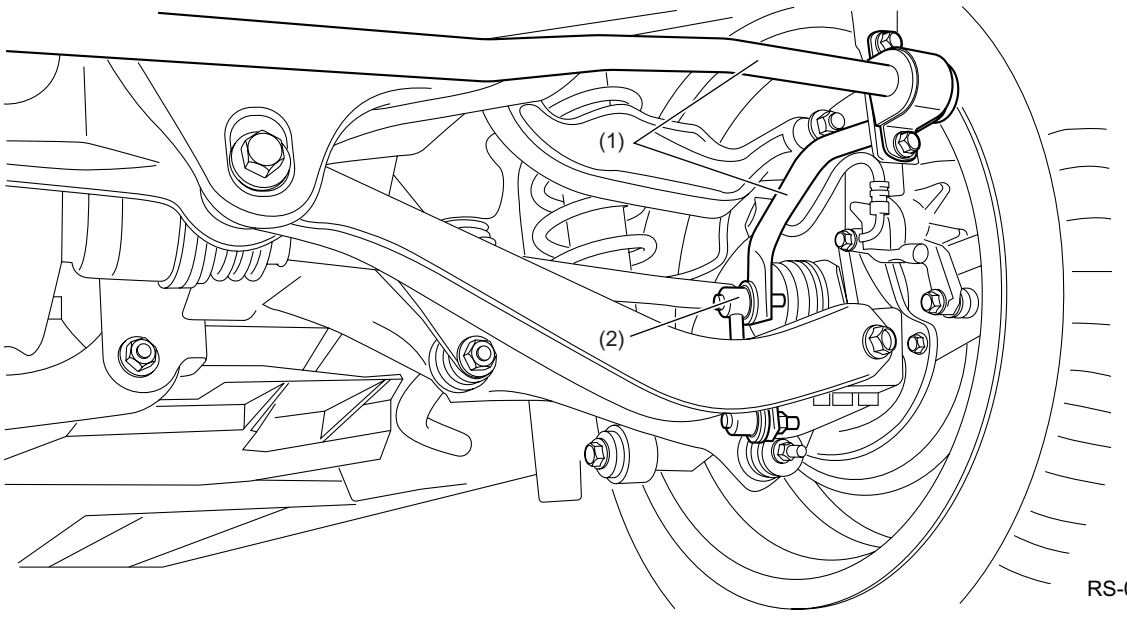
(1) Upper link
(2) Helper

5. SHOCK ABSORBER

- Acts on vertical loads together with the coil spring.
- The shock absorber is a cylindrical double-acting low pressure gas filled type and it attenuates shock from the road surface.

6. STABILIZER

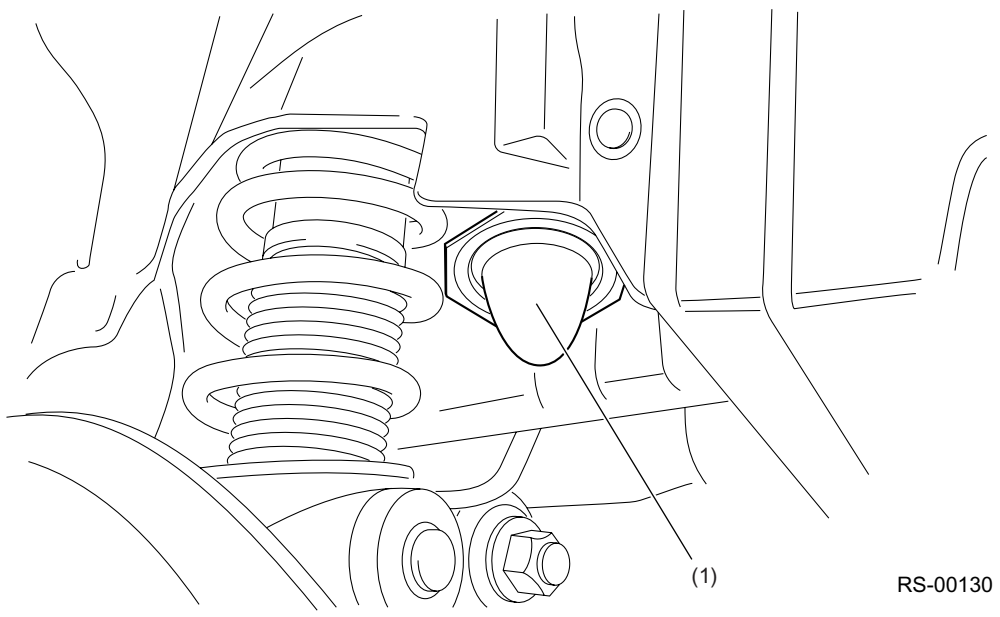
- The solid round rod stabilizer is attached to the rear sub frame through rubber bushings and its right and left ends are connected to the rear arm through ball joints of the stabilizer link.
- The attitude change of the vehicle during a turn is controlled by the bar's torsional resistance.



(1) Stabilizer bar
(2) Stabilizer link

7. HELPER

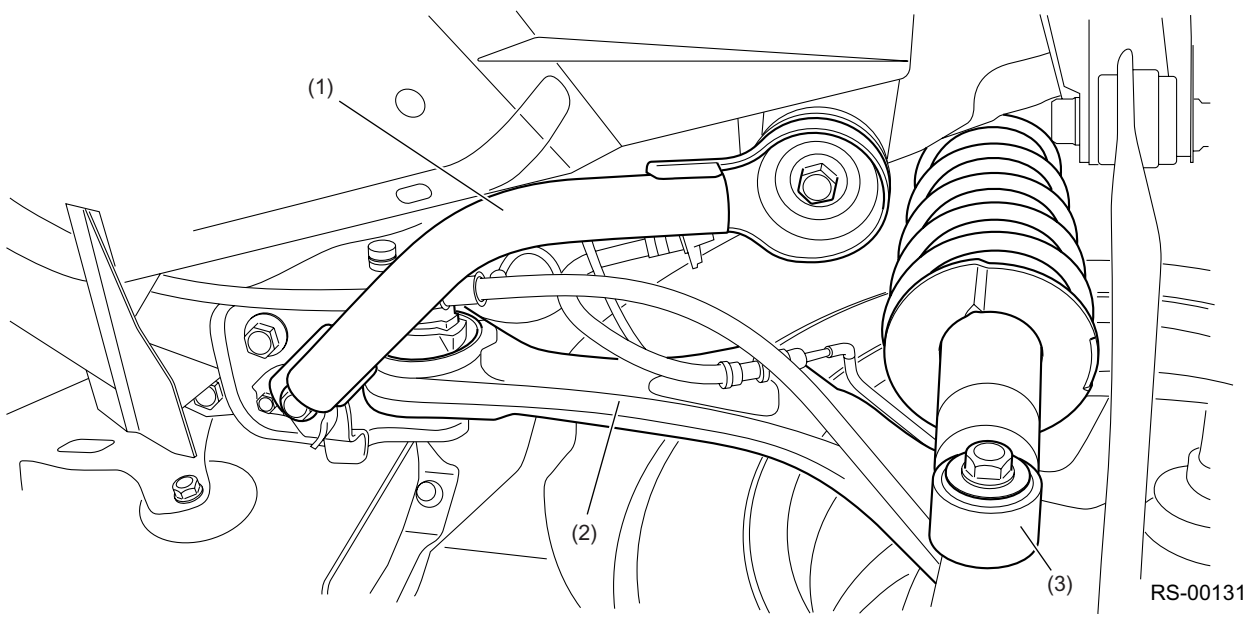
● The helper acts as a bump stopper together with the upper link by limiting the shock absorber stroke when the vehicle encounters a bump.



(1) Helper

8. SUB FRAME SUPPORT ARM

- Made of steel pipe whose both ends fixed to the rear arm bracket and rear sub frame.
- Restricts the twist between the rear sub frame and vehicle body.



(1) Sub frame support arm
(2) Rear arm
(3) Rear shock absorber

SEAT BELT SYSTEM

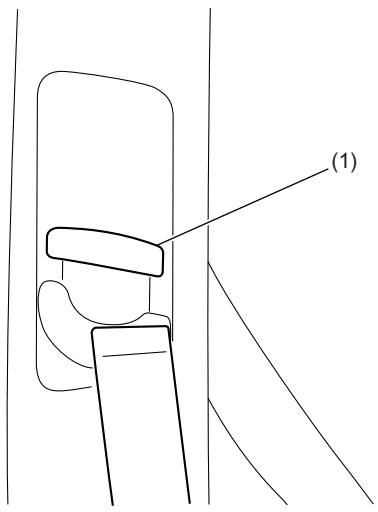
1. Seat Belt

A: ADJUSTABLE SHOULDER BELT ANCHOR

1. FRONT

Each front seat belt system has an adjustable shoulder belt anchor, which allows the occupant to select the most appropriate anchor height from among the five positions in a 90 mm (3.54 in) range.

The sash guide is put inside the pillar trim to improve the appearance.



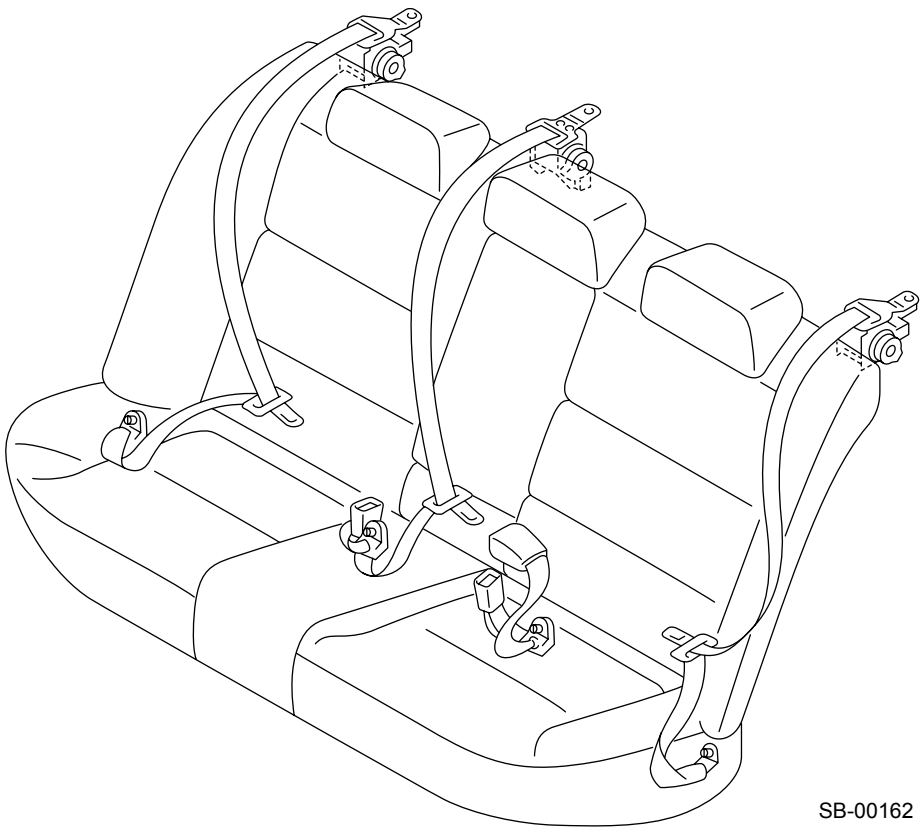
SB-00161

(1) Height adjuster button

B: REAR SEAT BELT

1. SEDAN MODELS

- A three-point type seat belt is provided on all seats.
- The retractor for the seat belt is installed on the rear shelf behind the seating position.

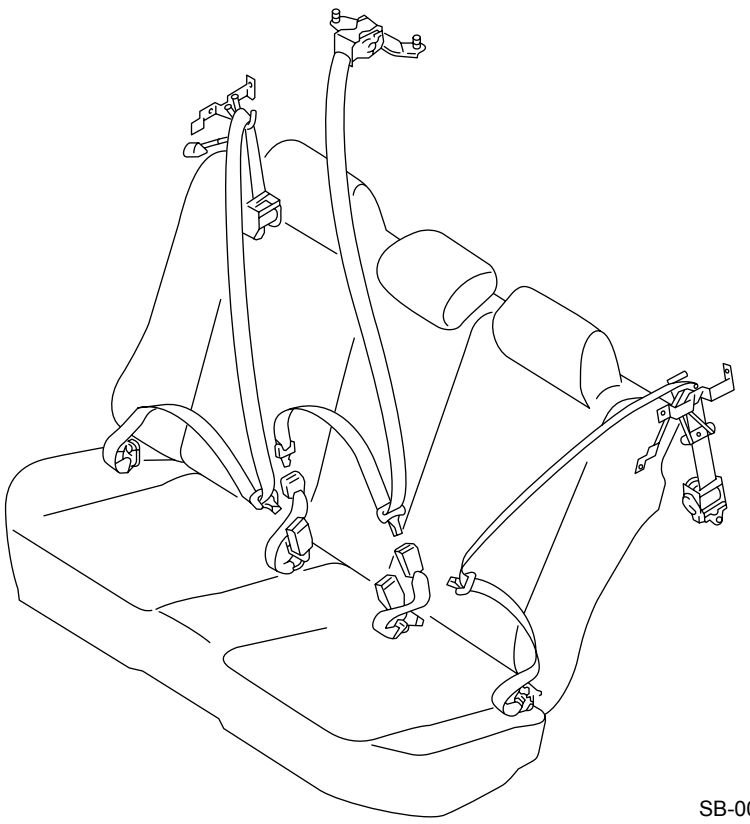


SB-00162

2. WAGON MODELS

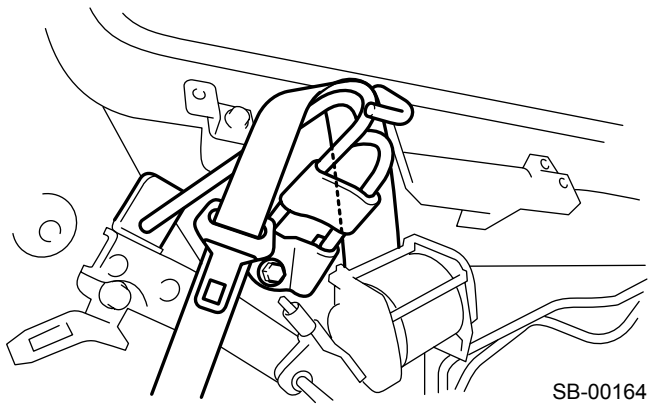
● A three-point type seat belt is provided on all seats.

● The seat belt for the center seat is installed to the rear right corner of the roof and can be detached at its connector to save the luggage space.



SB-00163

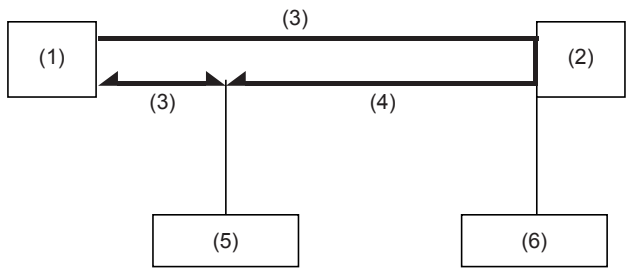
● Seat belts for the outer seats are provided with a new belt folding bracket at inside of the rear quarter trim to improve the appearance.



SB-00164

C: AUTOMATIC RETRACTOR (CHILD RESTRAINT SYSTEM FIXING FEATURE)

When any of the rear seat belts is 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-00169

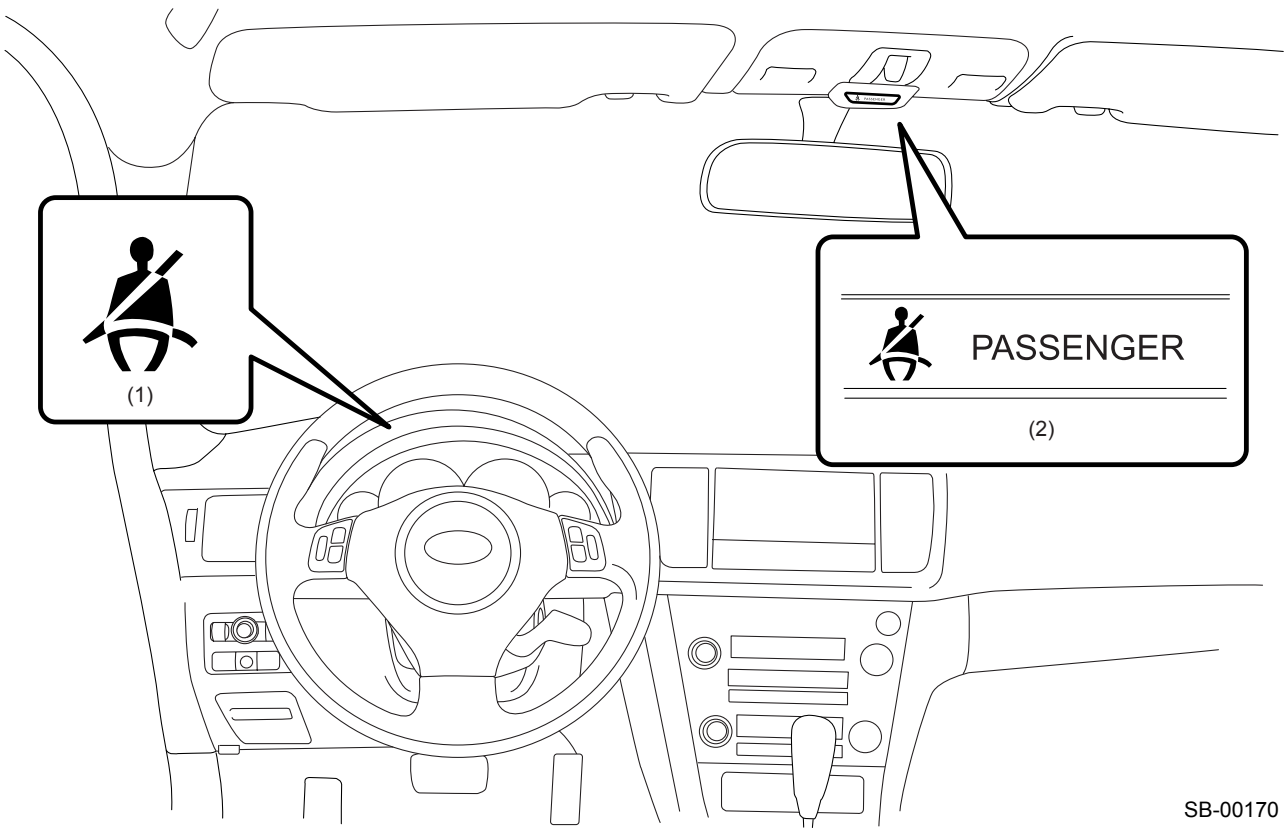
(1) Fully retracted
(2) Fully extended
(3) Normal mode (belt can be retracted and pulled out)
(4) Automatic lock mode (belt can be retracted but cannot be pulled out)
(5) Automatic locking mode to normal mode changeover
(6) Normal locking mode to automatic locking mode changeover

2. Seat Belt Light

A: SEAT BELT WARNING LIGHT

A seat belt warning light is provided for the front seats to warn the passengers to fasten the seat belt.

The driver's seat warning light is located in the combination meter, and the front passenger's seat belt warning light and rear seat belt fastening indicator are located at the center of the map light lens.



(1) Driver's seat warning light

(2) Passenger's seat warning light

B: SEAT BELT ALARM SYSTEM

1. GENERAL

When the ignition switch is turned ON, the seat belt warning light in the combination meter illuminates for 6 seconds and the warning buzzer sounds to warn the driver to fasten the seat belt. The seat belt warning light turns off and the buzzer ceases when the seat belt tongue plate is inserted into the seat belt buckle.

If the driver starts the vehicle without fastening the seat belt, the warning light illuminates or blinks and the buzzer sounds to warn the driver to fasten the seat belt. The seat belt warning light turns off and the buzzer ceases when the seat belt tongue plate is inserted into the seat belt buckle.

The passenger's seat side is also provided with a seatbelt alarm system, which turns ON the passenger's seat belt warning light when it detects a passenger through the passenger sensor (load cell sensor). If the driver starts the vehicle without fastening the seat belt, the seat belt warning light illuminates or blinks and the buzzer sounds to warn the passenger to fasten the seat belt.

2. SYSTEM STATUS TRANSITION

Alarms that are given with the seat belt warning light and buzzer vary in accordance with the vehicle speed and seat belt fastened/unfastened state. (The alarm system can warn the driver and the passenger individually, however, if both seat belts are not fastened, the buzzer will give priority to warn the driver.)

1) When the ignition switch is turned ON (with the seat belt not fastened), the seat belt warning light flashes for 6 seconds. If the seat belt is not fastened within this period, an alarm is given with a buzzer sound*.

*: The buzzer sounds only when the driver's seat belt is not fastened.

2) After 6 seconds since the ignition switch is turned ON, the seat belt warning light starts to illuminate or flash for every 15 seconds, and the buzzer will sound if the warning light is flashing.

3) If the seat belt is unfastened again when the vehicle speed is at or over 15 km/h (9 MPH), the seat belt warning light repeats illuminating or flashing, and the buzzer will sound if the warning light is flashing.

3. CUTOFF FUNCTION

The warning given after 6 seconds since the ignition switch is turned ON, and the warning function that activates when the seat belt is unfastened while driving can be optionally cut off. The cutoff function is common for both the driver's seat and passenger's seat, and can be set with the driver's seat buckle switch.

Temporary (TEMP) cutoff

1) How to cut: Repeat fastening and unfastening the driver's seat belt for 3 times within 6 seconds after turning the ignition switch ON. (The setting is changed for both the driver's seat and passenger's seat.)

2) Setting lasts: While the ignition switch is turned ON until it is turned OFF. (The cutoff function is canceled when the ignition switch is once turned OFF.)

Permanent cutoff

1) How to cut: Repeat fastening and unfastening the driver's seat belt for 20 times within 30 seconds after turning the ignition switch ON. Enabling and disabling cutting is done with the same operation. (The setting is changed for both the driver's seat and passenger's seat.)

2) Setting lasts: Until the microprocessor is reset*.

The cutoff function is reset when the battery is removed (battery positive terminal disconnected) or when the body integrated unit is removed. The cutting function may also be reset when the engine is cranked with low battery voltage.

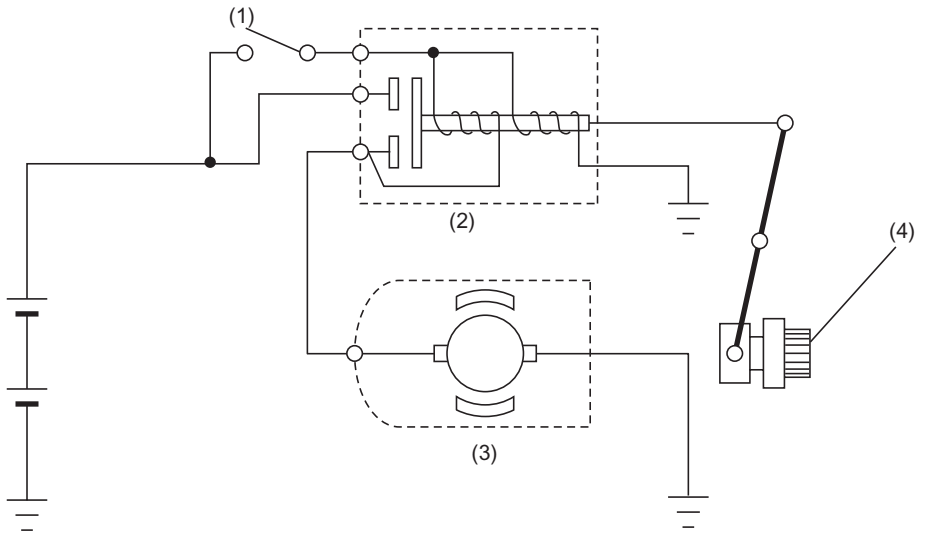
1. General

Specifications for DOHC turbo models are the same as those for SOHC models. <Ref. to SC(H4SO) section.>

STARTING/CHARGING SYSTEMS (H4SO)

1. Starter

The starter is of a reduction type.



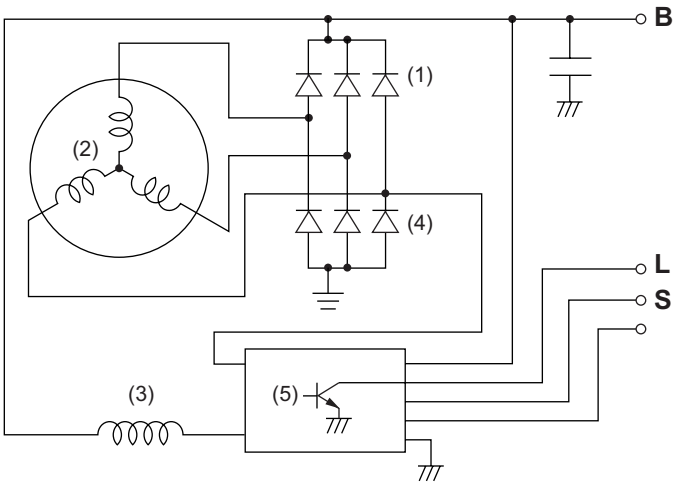
(1) Starter switch
(2) Magnet switch
(3) Starter
(4) Pinion

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 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 light illuminates.
(1) No voltage generation
Brush wear exceeds specified wear limits, field coil circuit is broken, etc.
(2) Excessive output
Output voltage is greater than 16 volts (approx.)
(3) Terminal B disconnection
Harness is disconnected from generator terminal B.
(4) Terminal S disconnection
Harness is disconnected from generator 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.



SC-02093

(1) Positive side diodes (3 pcs.)
(2) Stator coil
(3) Field coil
(4) Negative side diodes (3 pcs.)
(5) 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.

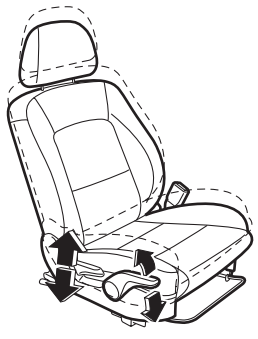
SEAT

1. Front Seat

A: ADJUSTMENT

Adjustment ranges are expanded to fit a wider variety of body types.

- The height of each headrest is adjustable to any of the 3 positions available.
- The uppermost position of the backrest is 11° rearwards from the perpendicular; the reclining angle is widened.
- A “towel bar” type seat slide lever is used for easier operation.
- The seat lifter mechanism has been changed from a system that lifts only the cushion to a system that lifts the entire seat.



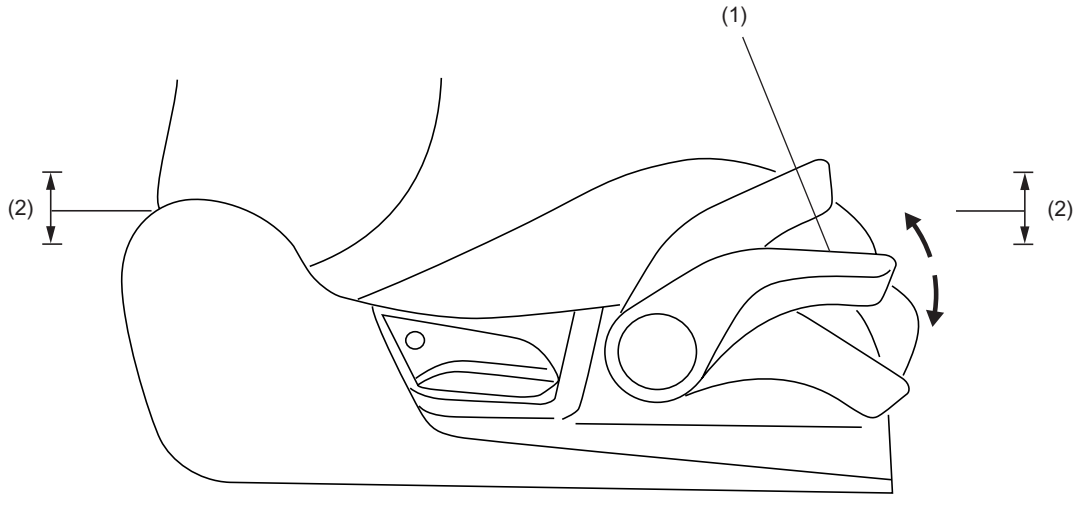
SE-00419

SE-00420

B: HEIGHT ADJUSTER

The driver's seat is provided with a height adjuster. Both the seat cushion and backrest rise every time the lifter lever is pulled up; they lower every time the lever is pushed down.

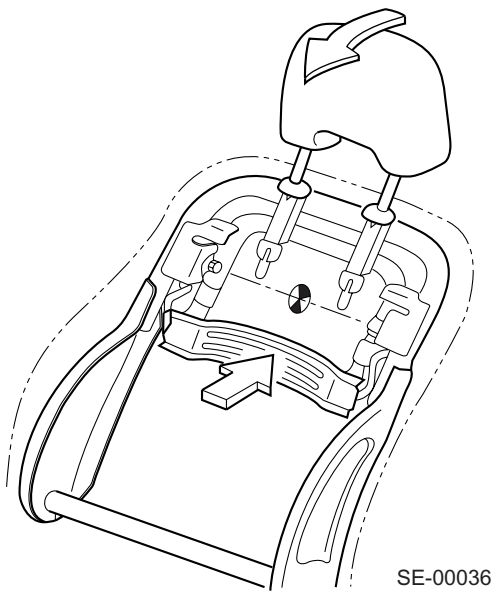
The lever is enlarged for easier operation.



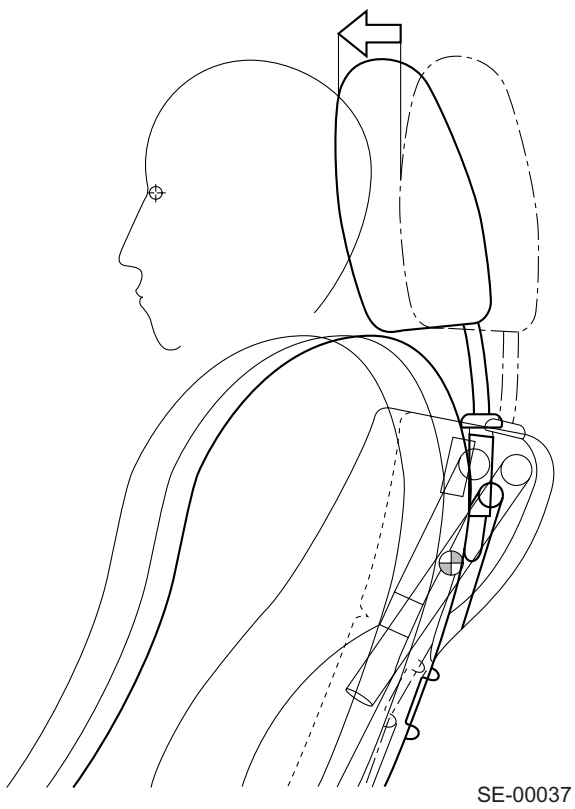
(1) Lifter lever
(2) Seat height adjustment range

C: ACTIVE HEADREST

In case of rear-end collision, the headrest moves forward to immediately support the passenger's head to reduce the possibility of injury to the neck.



SEAT



SE-00037

1) In case of rear-end collision, the passenger's body will move rearward by the impact.

2) When the body moves rearward, the thrust receiving plate inside the seat is pressed in.

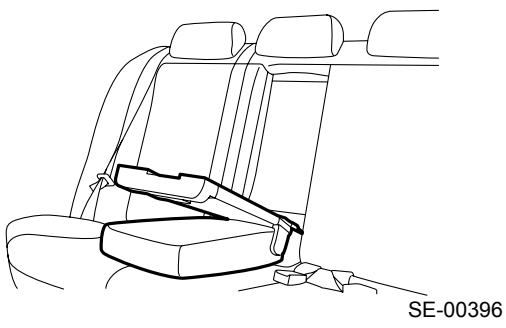
3) When the thrust receiving plate is pressed in, the headrest moves forward due to a levering action.

2. Rear Seat

A: OPERATION

1. SEDAN MODELS

The backrest has an armrest. It is also featured with a “center through” function.

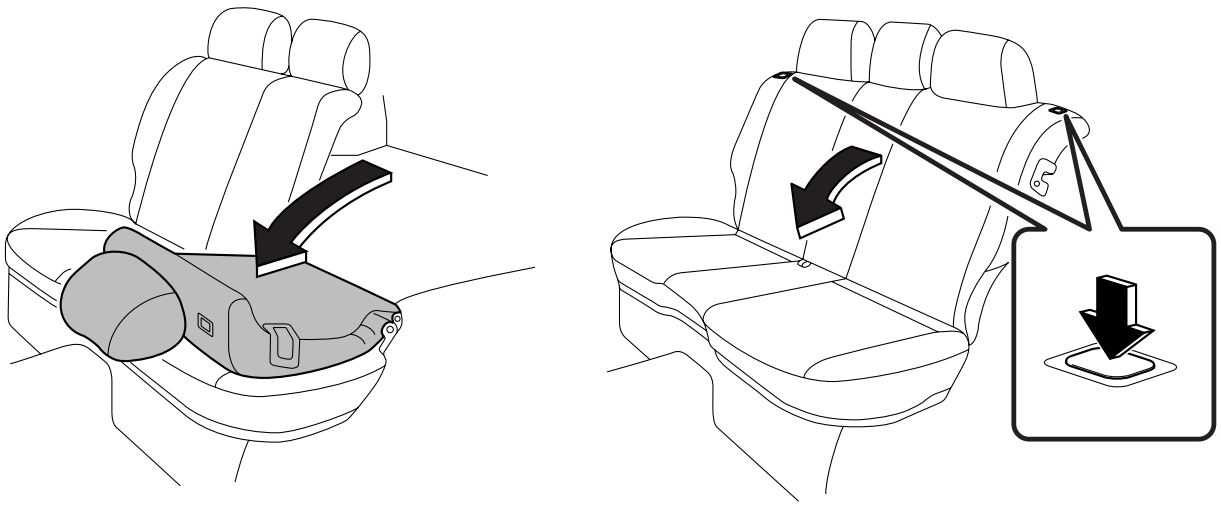


SE-00396

2. WAGON MODELS

● Unlock the backrest by pushing the release button and then fold the backrest forwards.

● The backrest and shoulder portions are separated to improve support of the rear passenger’s body. The backrest is also provided with a single-action folding feature, which contributes to form a flat luggage room by folding only the backrest forwards.



SE-00377

3. Occupant Detection System

A: GENERAL

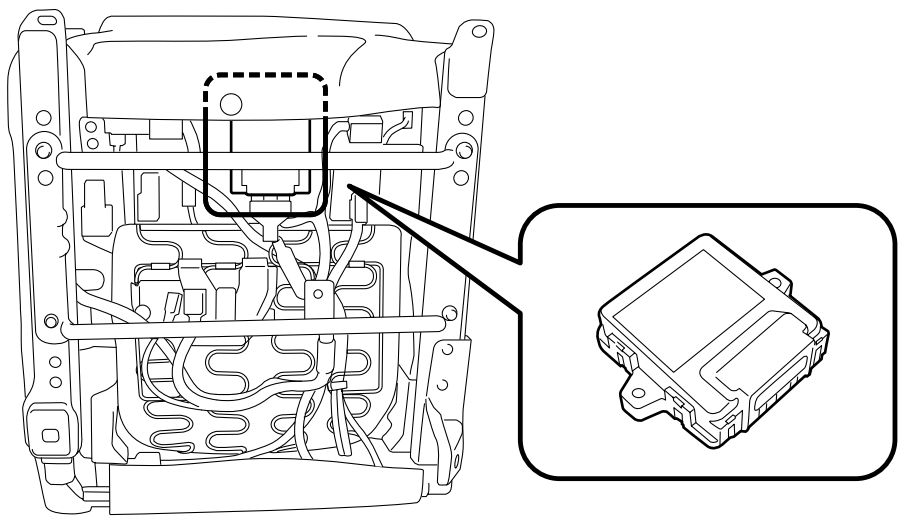
The passenger's seat is equipped with an occupant detection system, which consists of an occupant detection control module and four loadcell sensors, etc.

The occupant detection system sends signals to control the deployment of the passenger's seat airbag when a child or small person is sitting in the passenger's seat.

B: SYSTEM CONFIGURATION

The components of the occupant detection system are integrated as a seat cushion frame assembly; the assembly cannot be disassembled and the components cannot be replaced separately.

1. OCCUPANT DETECTION CONTROL MODULE

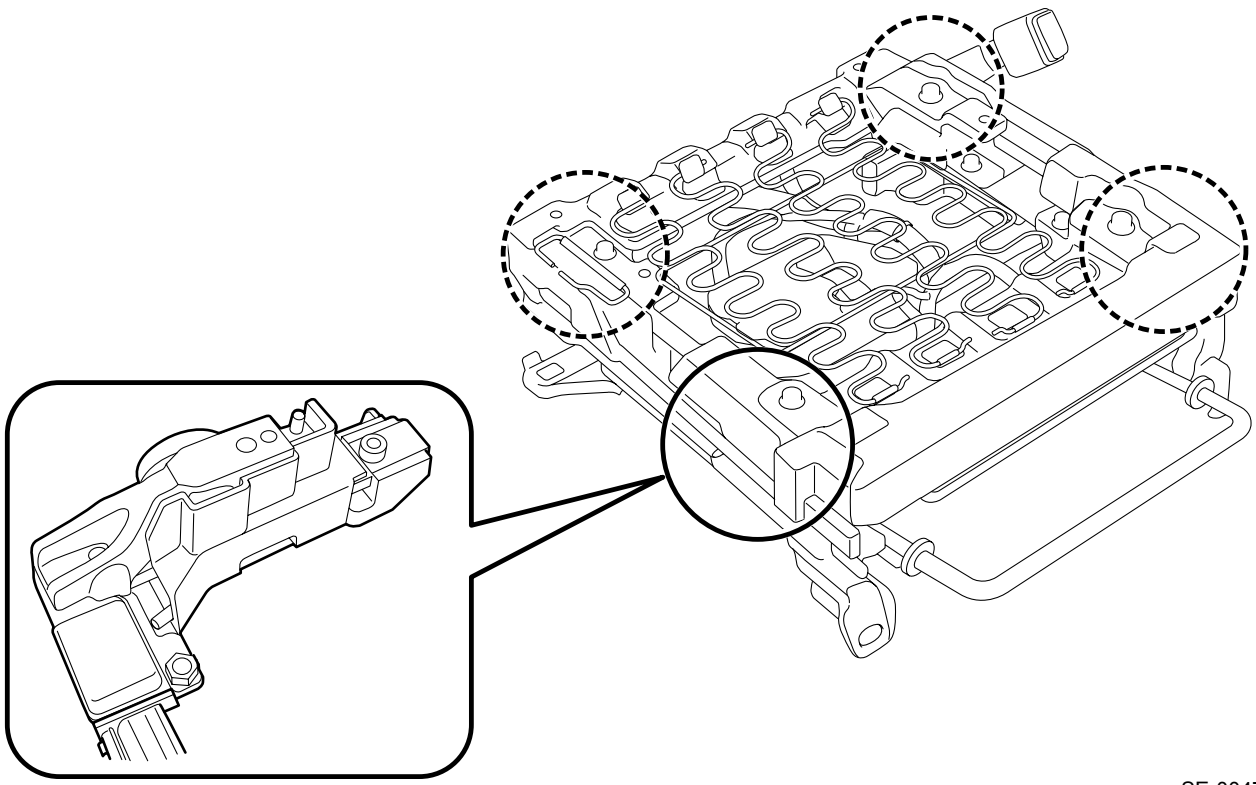


SE-00475

The occupant detection control module is installed under the passenger's seat and detects the presence/absence and physique of the person sitting in the passenger's seat based on signals sent from the loadcell sensors to send signals to the airbag control module.

If there is any abnormality in the occupant detection control module, the airbag warning light in the combination meter illuminates to warn the driver of system abnormality. Diagnostic trouble codes can be read by using a Subaru select monitor.

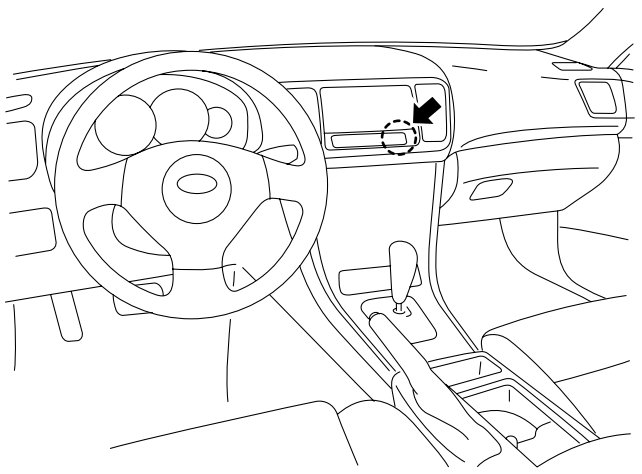
2. LOADCELL SENSOR



SE-00476

Four loadcell sensors are installed on the passenger's seat and each sensor measures the load to send signals to the load occupant detection control module.

3. PASSENGER'S SEAT AIRBAG INDICATOR



SE-00477

The passenger's seat airbag indicator light is built in the center part of the instrument panel. The light indicates the result judged by the occupant detection control module.

Depending on the occupant detection control module's decision, the passenger's seat airbag may not deploy even in case of a frontal collision, however, the driver's seat airbag will deploy and the driver/passenger seat belt pretensioners are controlled to activate. Also, the driver/passenger seat side airbags and the left/right curtain airbags are controlled to activate.

For initial check of the occupant detection system, both the ON (will deploy) and OFF (will not deploy) indicators will illuminate for about 6 seconds after the ignition switch is turned ON, and then turns OFF simultaneously for 2 seconds.

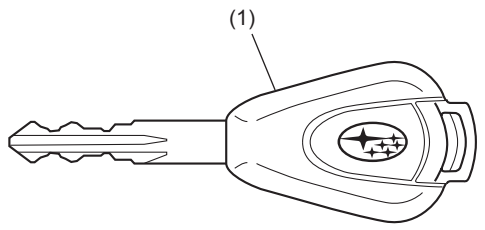
SECTION 9
MECHANISM AND FUNCTION

SECURITY AND LOCKS

1. Ignition Key

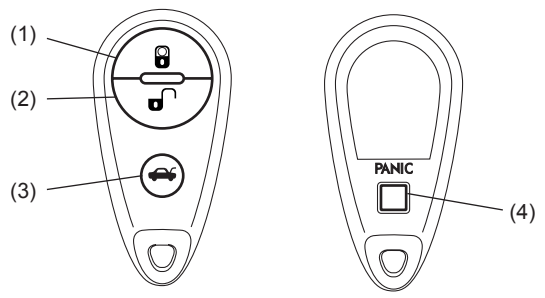
A: GENERAL

● A keyless entry system with a keyfob type transmitter is introduced. On models with immobilizer system, a transponder is assembled in the key.



SL-00388

(1) Transponder built-in



SL-00389

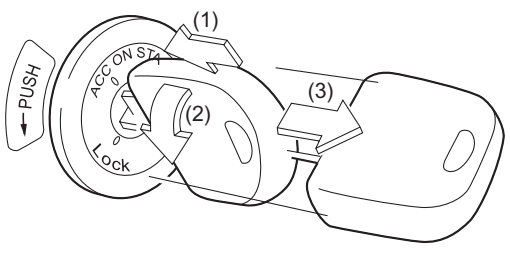
(1) Lock button
(2) Unlock button
(3) Trunk or rear gate button
(4) Panic button

2. Ignition Switch

A: GENERAL

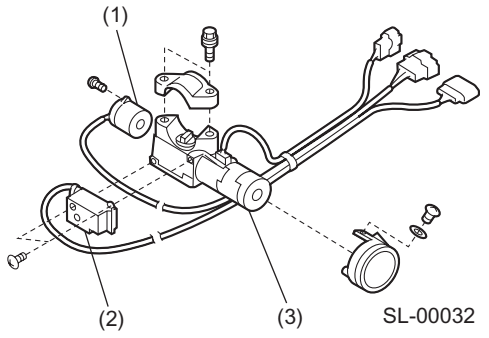
1. IGNITION SWITCH

● 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 key for AT models can be turned to the LOCK position only when the select lever is in the P position.



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 turned to the IGN position or removed from the ignition switch.

3. IGNITION SWITCH ILLUMINATION

The ignition switch illumination is lit for 3 seconds and then gradually darkens and turns off after the driver’s door is closed. If the ignition switch is turned to the ON position while the ignition switch illumination is ON, the ignition switch illumination turns OFF immediately. The body integrated unit controls the delayed off function.

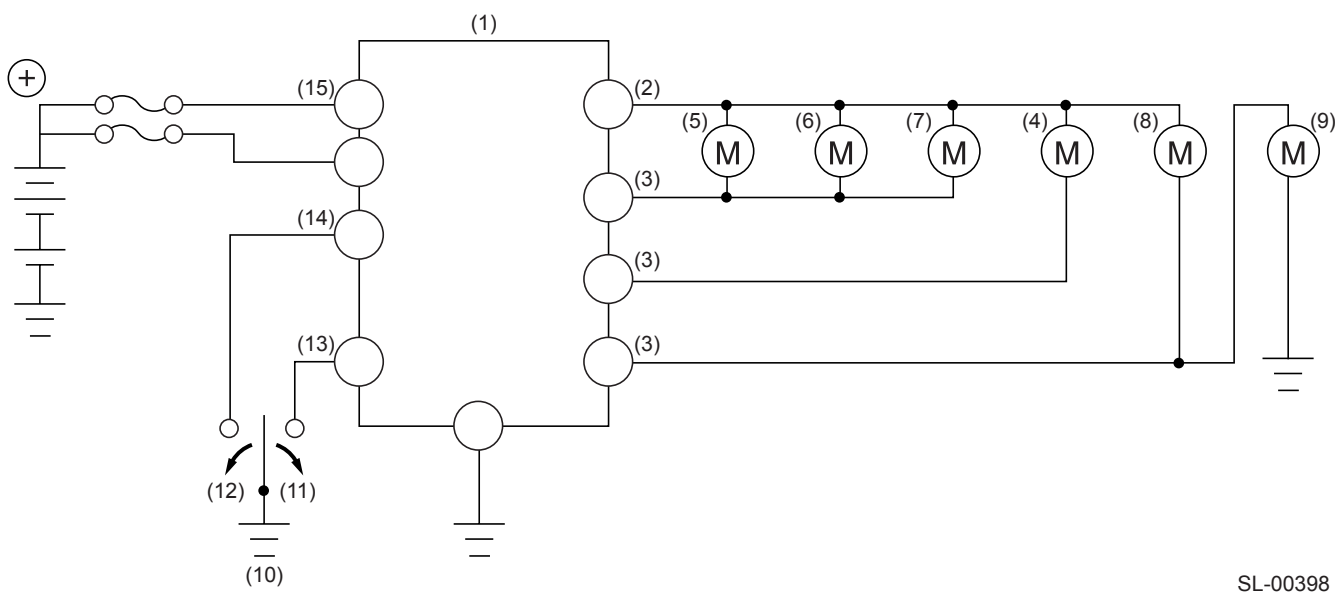
3. Power Door Lock

A: CONSTRUCTION

● The power door lock system consists of a body integrated unit, drivers door lock switch, 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: SCHEMATIC DRAWINGS



SL-00398

(1) Body integrated unit
(2) Lock output
(3) Unlock output
(4) Front LH actuator
(5) Front RH actuator
(6) Rear LH actuator
(7) Rear RH actuator
(8) Rear gate lock actuator (wagons)
(9) Trunk opener actuator (sedans)
(10) Door lock switch
(11) Unlock
(12) Lock
(13) Unlock switch
(14) Lock switch
(15) Battery

4. Keyless Entry System

A: CONSTRUCTION

● The keyless entry system consists of a transmitter, keyless entry control unit (with a built-in antenna), body integrated unit, door lock actuators, door switches, hazard warning lights, buzzer, and the interior light.

● The keyless entry system operates on a radio frequency, so the transmitter can be used in almost all directions relative to the vehicle. However, in some radio wave conditions the system may not operate properly.

NOTE:
The customizing function enables selection of coupled operation with the hazard warning lights. <Ref. to SL-12, Customizing Function.>

B: FUNCTION

1. DOOR LOCKING

1) Push the LOCK button on the transmitter 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 15 seconds and then fades out. (However, if a door locking procedure is performed again during this period, the lights will go out immediately.) The extinguishing time can be changed with the customizing function.

3) Check that the buzzer sounds twice and the hazard warning lights flash twice.

3. DOOR UNLOCKING (ALL DOORS)

1) Push the UNLOCK button on the transmitter 2 times within 5 seconds.

2) All doors are unlocked.

3) Check that the buzzer sounds twice and the hazard warning lights flash twice.

NOTE:

● When the unlock button is pushed while any of the doors (except rear gate or trunk) is open, all door locks are unlocked.

● When pushing the UNLOCK button on the transmitter twice to unlock all doors, the system may not respond if the interval between the 1st time and 2nd time is too short.

4. OPENING THE TRUNK

1) Push the TRUNK button on the transmitter for more than 1 second.
2) The trunk lid opens.
3) Check that the buzzer sounds twice and the hazard warning lights flash twice.

5. UNLOCKING THE REAR GATE LOCK

1) Push the TRUNK button on the transmitter once.
2) The rear gate lock is unlocked.
3) Check that the buzzer sounds twice and the hazard warning lights flash twice.

6. SELF POSITION DETECTION FUNCTION

1) Push the LOCK button on the transmitter 3 times within 5 seconds.
2) Check that the horn sounds once and the hazard warning lights flash 3 times.

7. PANIC ALARM

1) Push the panic button on the transmitter.

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.

8. ANSWER BACK (BUZZER SIGNALING) ON/OFF SELECTION

1) Push the UNLOCK button on the transmitter.

2) Push the LOCK and UNLOCK buttons on the transmitter simultaneously for more than 2 seconds to deactivate the answer back function. The function is armed again when the same operation is repeated.

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.

9. DOOR OPEN WARNING FUNCTION

The buzzer sounds five times and the hazard warning lights flash five times if the LOCK button on the transmitter is pressed with any door, the rear gate, or the trunk lid open.

10. TRANSMITTER REGISTRATION

- Up to 4 transmitters per vehicle can be registered.
- For the transmitter registration method, see Service Manual.

5. Alarm System (Burglar Alarm System)

A: FEATURES

● The alarm system protects the vehicle from a theft action (unauthorized entry into the vehicle). Upon detection of such an action, it gives alarm by causing the horn to sound and the hazard warning lights to flash.

● Unauthorized entry is monitored through the switches on the doors, rear gate, and trunk lid. If any of the switches is turned ON, the system interprets it as an attempt of unauthorized entry and gives alarm warning.

● Unauthorized entry is also monitored by the impact sensor (dealer option). The system operates in the same manner as mentioned above whenever the sensor senses an abnormal impact on the vehicle.

1. WARNING

● When activated, the alarm system causes the hazard warning lights to flash and the horn to sound intermittently. In addition to this, the security indicator light in the combination meter lights up.

● 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 unlocking with the keyless entry transmitter. (When the system is set, 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. (Only vehicles with an impact sensor, which is available as dealer option.)

● On vehicles with an impact sensor, the alarms are activated even if electrical wirings for these equipment are cut.

NOTE:

● For information regarding the impact sensor, refer to their installation and operating instructions.

2. HOW TO SET THE SYSTEM

1) Remove the key from the ignition switch.

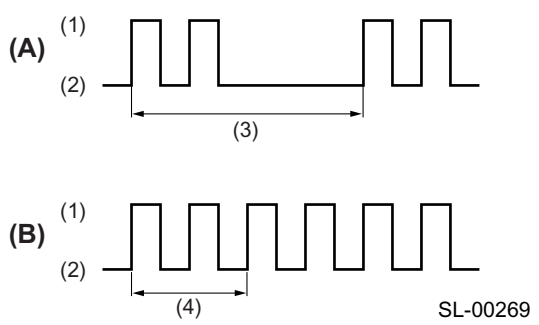
2) Close all the windows. Close and all doors, rear gate, and the trunk lid.

3) Push the LOCK button on the transmitter.

4) The keyless buzzer will sound once and the hazard warning lights flash once.

NOTE:
The system can be set even if the windows are open.

5) Check that the security indicator light flashes. If any of the doors or the rear gate is not closed properly, lock operation will not be accomplished when the LOCK button on the transmitter is pushed and therefore the keyless buzzer will not sound nor the hazard warning lights will not flash. When setting the alarm system, activation of the keyless entry system must be confirmed by the sound of keyless buzzer and flashing of the hazard warning lights. When the door, rear gate or trunk lid is closed, they will be automatically locked and the alarm system starts working. The indicator light blinks when the system is set and starts monitoring, and continues to blink until the system is disarmed. When the security indicator lamp is blinking as (B), the system is not ready yet and the alarm will not activate when a door is opened.



(A) Monitoring delay set to 0 seconds

(B) Monitoring delay set to 30 seconds (After 30 seconds has elapsed the system enters blinking status (A).)

(1) ON

(2) OFF

(3) 2 seconds

(4) 1 seconds

3. HOW TO UNSET THE SYSTEM

1) Push the UNLOCK button on the transmitter.

2) The keyless buzzer will sound twice and the hazard warning lights flash twice.

3) The security indicator light turns OFF.

4) The interior light illuminates for maximum 30 seconds and then fades out. (However, if a system is set during this period, the interior light will turn OFF.)

- Insert the key into the door key cylinder and turn the key in the unlocking direction.

4. HOW TO STOP ALARMS

- Push a button on the transmitter. (Either of the LOCK, UNLOCK, or TRUNK buttons will work)
- Insert the key into the ignition switch and turn the key to the ON position. However, the alarm will not cease unless a registered key is used. (models with immobilizer)
- Insert the key into the ignition switch and repeat switching OFF to ON for three times. (models without immobilizer)
- Insert the key into the door key cylinder and turn the key in the unlocking direction.

6. Immobilizer System

A: CONSTRUCTION

The immobilizer system consists of the following components: combination meter, body integrated unit, engine control module (ECM), transponder inside the ignition key, and an antenna fitted to the key cylinder.

The antenna receives a vehicle ID code emitted from the transponder when the key is inserted into the key cylinder.

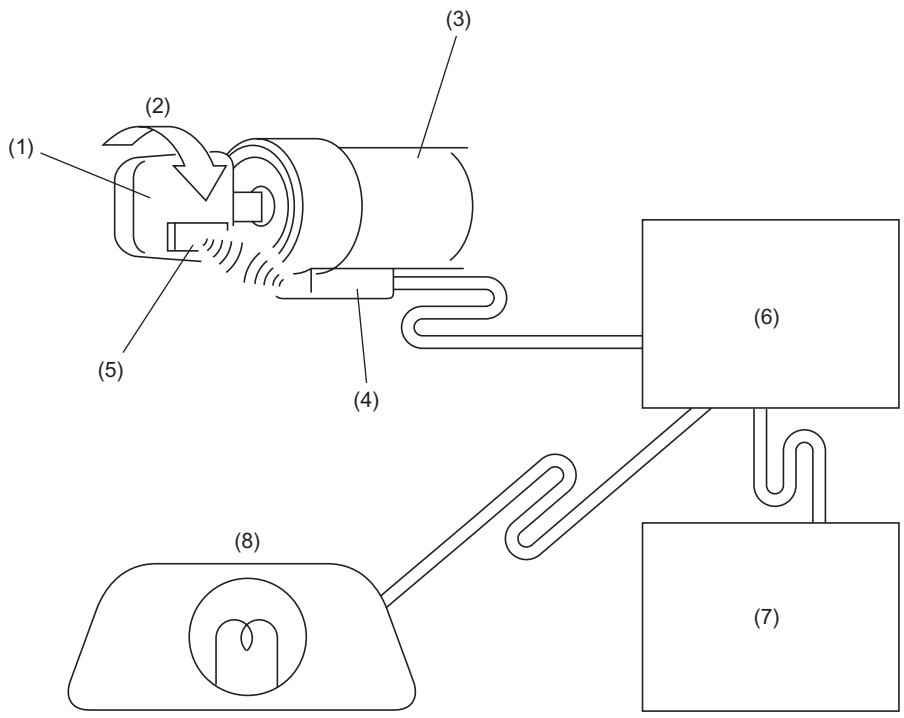
The ID code is transmitted to the body integrated unit. The body integrated unit compares the code with a one that has been registered in it. The body integrated unit also compares the ID code with the ECM and the combination meter. If these ID codes match with each other, the system allows the engine to be started. The engine may be able to start when the key is inserted even if the codes do not match. The engine, however, will automatically stop after a few seconds.

The immobilizer function is activated automatically when the key is removed from the key cylinder and when 60 seconds have passed after the ignition switch was turned to the “ACC” or “OFF” position.When the function is activated, the indicator light on the combination meter flashes at intervals of 0.2 seconds ON and 2.8 seconds OFF. (When security system is not set)

This indicator light flashing indicates to the thief that the system is ready to function.

If the immobilizer system fails, an incorrect key is used or an incorrect ECM is installed, the immobilizer indicator light will illuminate when the key is inserted into the key cylinder or when the ignition switch is turned ON.

NOTE:
To heighten the anti-theft performance of the immobilizer system, the system is designed in a way that the immobilizer cannot be deactivated by simply reconnecting the wiring or by replacing parts. Therefore, care must be taken when replacing or repairing the related components.



SL-00053

(1) Key
(2) Ignition switch ON
(3) Key cylinder
(4) Antenna
(5) Transponder
(6) Body integrated unit
(7) Engine control module
(8) Combination meter (immobilizer indicator light)

B: REGISTRATION

Registration is a procedure that must be carried out when an additional key is purchased or when either a key, ECM or combination meter is replaced. The procedure includes initialization of the system and re-registration of the ID code. Once initialized, the system loses the ID code it has retained so far and has no code until a new code is registered. ID codes for up to four keys (transponders) can be registered with a body integrated unit.

To prevent a copied key to be used, any set of keys (four maximum) can be registered only with one body integrated unit. Therefore, if a body integrated unit is replaced with a new one, the keys having been used with the old body integrated unit cannot be used with the new body integrated unit. The keys must be replaced simultaneously with the body integrated unit.

Registration is carried out by an authorized person using a select monitor and a special program. Access to the program is strictly controlled for reasons of security. The security ID (kept by customer) is required for registration. As the ID code for all registered keys are cleared when registration is started, registration must be performed will all keys including spares handed from the customer.

7. Customizing Function

A: GENERAL

- The following system can be customized by using a SUBARU select monitor.

System name			Initial setting	Customized settings
Room light (delayed extinguishment)	Illuminating time after door closed		5 seconds	0 seconds (OFF)
				3 seconds (short)
				8 seconds (long)
	Illuminating time after keyless unlock operation		20 seconds	0 seconds (OFF)
				10 seconds (short)
				30 seconds (long)
Keyless entry system	Answer back buzzer	Existence setting	Yes	No
		ON/OFF	ON	OFF
	Hazard answer back		ON	OFF
Alarm system	Warning	ON/OFF	ON	OFF
		Monitoring delay setting	30 seconds	0 seconds
	Impact sensor	Existence setting	No	Yes
		ON/OFF	OFF	ON
	Passive arming switching		OFF	ON
Rear defogger timer			OFF after 15 minutes	Operates for 15 minutes or continuously
Wiper deicer			OFF after 15 minutes	Operates for 15 minutes or continuously
Lockout prevention			ON	OFF
Battery drain prevention			ON	OFF

*:Setting is possible only with SUBARU select monitor.

NOTE:
Items above must be set to coincide with the vehicle’s equipment and specifications for normal operation and diagnosis.

1. General

Specifications for DOHC turbo models are the same as those for SOHC models. <Ref. to SP(H4SO) section.>

1. General

Specifications for SOHC U5 models are the same as those for SOHC models.<Ref. to SP(H4SO) section.>

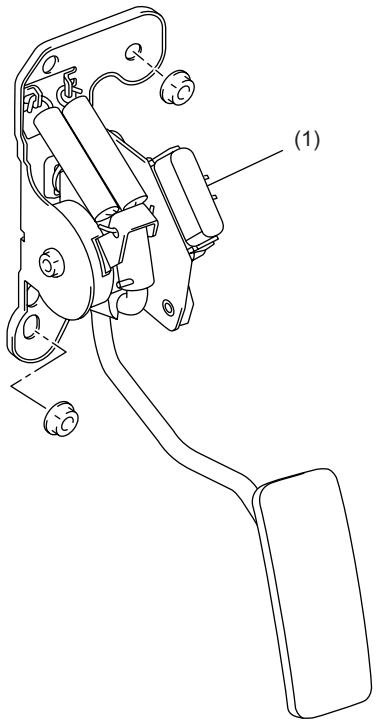
SPEED CONTROL SYSTEMS (H4SO)

1. General

An electronically controlled throttle is adopted.

The movement of the accelerator pedal is converted into electrical signals by the accelerator pedal position sensor and these signals are sent to the ECM.

The ECM controls the operation of the throttle body based on the signals from the accelerator pedal position sensor and on other driving conditions.



SP-02029

(1) Accelerator pedal position sensor

SPECIFICATIONS

1. Impreza

A: DIMENSIONS

Model			Sedan	Wagon	OUTBACK	STi
Overall length		mm (in)	4,415 (173.8)			
Overall width		mm (in)	1,740 (68.4)	1,695 (66.7)	1,710 (67.3)	1,740 (68.1)
Overall height (at C.W.)		mm (in)	1,440 (56.7)	1,485 (58.5)	1,495 (58.9)	1,430 (56.3)
Compartment	Length	mm (in)	1,890 (74.4)	1,845 (72.6)		1,890 (74.4)
	Width	mm (in)	1,380 (54.3)			
	Height	mm (in)	1,180 (46.5), 1,125 (44.3)*2	1,200 (47.2), 1,150 (45.3)*2	1,200 (47.2), 1,150 (45.3)*2	1,180 (46.5)
Wheelbase		mm (in)	2,525 (99.4)			2,540 (100.0)
Tread	Front	mm (in)	1,485 (58.5)	1,465 (57.7)	1,460 (57.5)	1,490 (58.7)
	Rear	mm (in)	1,475 (58.1), 1,480 (58.3)*1	1,455 (57.3)	1,455 (57.3)	1,485 (58.5)
Minimum road clearance		mm (in)	150 (5.9), 155 (6.1)*1	150 (5.9), 155 (6.1)*1	160 (6.3)	145 (5.7)

*1: WRX
*2: With sun roof

B: ENGINE

Model	Turbo 2.0 L	2.5 L	STi
Engine type	Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine		
Valve arrangement	Overhead camshaft type		
Bore × Stroke mm (in)	92 × 75 (3.62 × 2.95)	99.5 × 79 (3.92 × 3.11)	
Displacement cm^3 (cu in)	1,994 (121.67)	2,457 (149.9)	
Compression ratio	8.0±0.2	10.0±0.2	8.2±0.2
Firing order	1 — 3 — 2 — 4		
Idle speed at Park/Neutral position rpm	750±100	MT: 650±100 AT: 700±100	700±100
Maximum output kW (HP)/rpm	169 (227)/6,000	123 (165)/5,600	224 (300)/6,000
Maximum torque N· m (kgf-m, ft-lb)/rpm	294 (30.0, 217)/4,000	226 (23.0, 166)/4,000	407 (41.5, 300)/4,000

C: ELECTRICAL

Model		Turbo 2.0 L	2.5 L	STi
Ignition timing at idling BTDC		12° ±10°	MT: 10° ±8° AT: 15° ±8°	17° ±10°
Spark plug	Type and manufacturer	NGK: PFR6G	CHAMPION: RC10YC4 (standard) NGK: BKR5E-11 NGK: BKR6E-11	NGK : IFLR6B
Generator		12 V — 75 A		12 V — 90 A
Battery	Type and capacity (5HR)	MT: 12 V — 48 AH (55D23L) AT: 12 V — 52 AH (65D23L)	MT: 12 V — 48 AH (55D23L) AT: 12 V — 52 AH (75D23L)	12 V — 48 AH (55D23L)

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D: TRANSMISSION

Model			Turbo 2.0 L		2.5 L		STi
Transmission type			5MT	4AT	5MT	4AT	6MT
Clutch type			DSPD	TCC	DSPD	TCC	DSPD
Gear ratio		1st	3.454	2.785	3.454	2.785, 3.027*1	3.636
		2nd	1.947	1.545	2.062	1.545, 1.619*1	2.375
		3rd	1.366	1.000	1.448	1.000	1.761
		4th	0.972	0.694	1.088	0.694	1.346
		5th	0.738	—	0.780	—	0.971
		6th	—	—	—	—	0.756
		Reverse	3.333	2.272	3.333	2.272	3.545
		Dual range	—	—	—	—	—
Reduction gear (Front drive)	1st reduction	Type of gear	—	Helical	—	Helical	—
		Gear ratio	—	1.000	—	1.000	—
	Final reduction	Type of gear	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid
		Gear ratio	3.900	4.111	3.900, 4.111*1	4.111, 4.444*1	3.900
Reduction gear (Rear drive)	Transfer reduction	Type of gear	Helical	—	Helical	—	Helical
		Gear ratio	1.100	—	1.000	—	1.000
	Final reduction	Type of gear	Hypoid	Hypoid	Hypoid	Hypoid	Hypoid
		Gear ratio	3.545	4.111	3.900, 4.111*1	4.111, 4.444*1	3.900

5MT: 5-forward speeds with synchromesh and 1-reverse
4AT: Electronically controlled fully-automatic, 4-forward speeds and 1-reverse
6MT: 6-forward speeds with synchromesh and 1-reverse
DSPD: Dry Single Plate Diaphragm
TCC: Torque Converter Clutch
*1: Sedan model

E: STEERING

Model			TS	RS, OUTBACK, WRX	STi
Type			Rack and Pinion		
Turns, lock to lock			3.2	3.0	2.7
Minimum turning circle	m (ft)	Curb to curb	10.2 (33.5)	10.8 (35.4)	
		Wall to wall	11.1 (36.3)	11.7 (38.3)	

F: SUSPENSION

Front	Macpherson strut type, Independent, Coil spring
Rear	Dual-link type, Independent, Coil spring

G: BRAKE

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

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H: TIRE

Model	TS	RS, OUTBACK, WRX	STi
Rim size	15 × 6JJ	16 × $6^1/_2$JJ	17 × $7^1/_2$JJ
Tire size	P195/60R15 87H	P205/55R16 89V	225/45R17 90W
Type	Steel belted radial, Tubeless		

I: CAPACITY

Model			Turbo 2.0 L		2.5 L		STi
			5MT	4AT	5MT	4AT	6MT
Fuel tank		ℓ (US gal, Imp gal)	60 (15.9, 13.2)				
Engine oil	Total capacity	ℓ (US qt, Imp qt)	4.5 (4.8, 4.0)		4.0 (4.2, 3.5)		4.5 (4.8, 4.0)
	Engine oil amount for refill	ℓ (US qt, Imp qt)	Approx. 4.5 (4.8, 4.0)		Approx. 4.0 (4.2, 3.5)		Approx. 4.5 (4.8, 4.0)
Transmission gear oil		ℓ (US qt, Imp qt)	3.5 (3.7, 3.1)	—	3.5 (3.7, 3.1)	—	4.1 (4.3, 3.6)
ATF		ℓ (US qt, Imp qt)	—	9.3 (9.8, 8.2)	—	9.3 (9.8, 8.2)	—
Front differential gear oil		ℓ (US qt, Imp qt)	—	1.2 (1.3, 1.1)	—	1.2 (1.3, 1.1)	—
Rear differential gear oil		ℓ (US qt, Imp qt)	0.8 (0.8, 0.7)				1.0 (1.1, 0.9)
Power steering fluid		ℓ (US qt, Imp qt)	0.7 (0.7, 0.6)				
Engine coolant		ℓ (US qt, Imp qt)	7.7 (8.1, 6.8)	7.6 (8.0, 6.7)	7.0 (7.4, 6.2)	6.9 (7.3, 6.1)	7.7 (8.1, 6.8)

J: WEIGHT

1. FOR U.S. MODEL

Sedan

Model			2.5 L		Turbo 2.0L		
			RS		WRX		
			5MT	4AT	5MT		
Curb weight (C.W.)	Front	kgf (lb)	778 (1,715)	803 (1,770)	826 (1,820)	832 (1,834)	833 (1,836)
	Rear	kgf (lb)	567 (1,250)	567 (1,250)	573 (1,265)	586 (1,292)	588 (1,297)
	Total	kgf (lb)	1,345 (2,965)	1,370 (3,020)	1,399 (3,085)	1,418 (3,126)	1,421 (3,133)
Gross axle weight (G.A.W.)	Front	kgf (lb)	939 (2,070)	939 (2,070)	998 (2,200)	998 (2,200)	998 (2,200)
	Rear	kgf (lb)	907 (2,000)	907 (2,000)	916 (2,020)	916 (2,020)	916 (2,020)
	Total	kgf (lb)	1,778 (3,920)	1,778 (3,920)	1,837 (4,050)	1,837 (4,050)	1,837 (4,050)
Option	Power window		❍	❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍	❍
	ABS		❍	❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍	❍
	Cold W package		—	—	—	❍	❍
	Sun roof		—	—	—	❍	❍
	Dual airbag		❍	❍	❍	❍	❍
	Side airbag		—	—	❍	❍	❍
	Rear spoiler		—	—	—	❍	❍
	Seat in pure hide		—	—	—	—	❍
	Front LSD		—	—	—	—	—
	Aluminum wheel	Gold color	—	—	—	—	—
		Silver color	—	—	—	—	—

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Model			Turbo 2.0 L			Turbo 2.5 L	
			WRX			STi	
			4AT			6MT	
Curb weight (C.W.)	Front	kgf (lb)	850 (1,875)	857 (1,889)	858 (1,891)	863 (1,903)	863 (1,903)
	Rear	kgf (lb)	574 (1,265)	586 (1,292)	588 (1,297)	613 (1,351)	613 (1,351)
	Total	kgf (lb)	1,424 (3,140)	1,443 (3,181)	1,446 (3,188)	1,476 (3,254)	1,476 (3,254)
Gross axle weight (G.A.W.)	Front	kgf (lb)	998 (2,200)	998 (2,200)	998 (2,200)	1,030 (2,271)	1,030 (2,271)
	Rear	kgf (lb)	916 (2,020)	916 (2,020)	916 (2,020)	920 (2,028)	920 (2,028)
	Total	kgf (lb)	1,837 (4,050)	1,837 (4,050)	1,837 (4,050)	1,880 (4,145)	1,880 (4,145)
Option	Power window		❍	❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍	❍
	ABS		❍	❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍	❍
	Cold W package		—	❍	❍	—	—
	Sun roof		—	❍	❍	—	—
	Dual airbag		❍	❍	❍	❍	❍
	Side airbag		❍	❍	❍	❍	❍
	Rear spoiler		—	❍	❍	—	—
	Seat in pure hide		—	—	❍	—	—
	Front LSD		—	—	—	❍	❍
	Aluminum wheel	Gold color	—	—	—	❍	—
		Silver color	—	—	—	—	❍

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Wagon

Model			2.5 L		2.5 L	
			TS		OUTBACK	
			5MT	4AT	5MT	4AT
Curb weight (C.W.)	Front	kgf (lb)	778 (1,715)	801 (1,765)	783 (1,725)	805 (1,775)
	Rear	kgf (lb)	603 (1,330)	605 (1,335)	601 (1,325)	603 (1,330)
	Total	kgf (lb)	1,381 (3,045)	1,406 (3,100)	1,384 (3,050)	1,408 (3,105)
Gross axle weight (G.A.W.)	Front	kgf (lb)	939 (2,070)	939 (2,070)	939 (2,070)	939 (2,070)
	Rear	kgf (lb)	953 (2,100)	953 (2,100)	953 (2,100)	953 (2,100)
	Total	kgf (lb)	1,833 (4,040)	1,833 (4,040)	1,833 (4,040)	1,833 (4,040)
Option	Power window		❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍
	ABS		❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍
	Cold W package		—	—	—	—
	Sun roof		—	—	—	—
	Dual airbag		❍	❍	❍	❍
	Side airbag		—	—	—	—
	Rear spoiler		—	—	—	—
	Seat in pure hide		—	—	—	—
	Roof rail		❍	❍	❍	❍

Model			Turbo 2.0 L			
			WRX			
			5MT		4AT	
Curb weight (C.W.)	Front	kgf (lb)	826 (1,820)	826 (1,820)	851 (1,875)	851 (1,875)
	Rear	kgf (lb)	610 (1,345)	610 (1,345)	610 (1,345)	610 (1,345)
	Total	kgf (lb)	1,436 (3,165)	1,436 (3,165)	1,461 (3,220)	1,461 (3,220)
Gross axle weight (G.A.W.)	Front	kgf (lb)	998 (2,200)	998 (2,200)	998 (2,200)	998 (2,200)
	Rear	kgf (lb)	953 (2,100)	953 (2,100)	953 (2,100)	953 (2,100)
	Total	kgf (lb)	1,901 (4,190)	1,901 (4,190)	1,901 (4,190)	1,901 (4,190)
Option	Power window		❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍
	ABS		❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍
	Cold W package		—	❍	❍	—
	Sun roof		—	—	—	—
	Dual airbag		❍	❍	❍	❍
	Side airbag		❍	❍	❍	❍
	Rear spoiler		—	—	—	—
	Seat in pure hide		—	—	—	—
	Roof rail		❍	❍	❍	❍

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2. FOR CANADA MODEL

Sedan

Model			2.5 L		Turbo 2.0 L		
			RS		WRX		
			5MT	4AT	5MT		
Curb weight (C.W.)	Front	kgf (lb)	780 (1,720)	805 (1,775)	825 (1,820)	832 (1,834)	833 (1,836)
	Rear	kgf (lb)	570 (1,256)	570 (1,256)	576 (1,270)	586 (1,292)	588 (1,297)
	Total	kgf (lb)	1,350 (2,976)	1,375 (3,031)	1,401 (3,090)	1,418 (3,126)	1,421 (3,133)
Gross axle weight (G.A.W.)	Front	kgf (lb)	939 (2,070)	939 (2,070)	998 (2,200)	998 (2,200)	998 (2,200)
	Rear	kgf (lb)	907 (2,000)	907 (2,000)	916 (2,020)	916 (2,020)	916 (2,020)
	Total	kgf (lb)	1,778 (3,920)	1,778 (3,920)	1,837 (4,050)	1,837 (4,050)	1,837 (4,050)
Option	Power window		❍	❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍	❍
	ABS		❍	❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍	❍
	Cold W package		—	—	—	—	—
	Sun roof		—	—	—	❍	❍
	Dual airbag		❍	❍	❍	❍	❍
	Side airbag		—	—	❍	❍	❍
	Rear spoiler		❍	❍	❍	❍	❍
	Seat in pure hide		—	—	—	—	❍
	Front LSD		—	—	—	—	—
	Aluminum wheel	Gold color	—	—	—	—	—
		Silver color	—	—	—	—	—

Model			Turbo 2.0 L			Turbo 2.5 L	
			WRX			STi	
			4AT			6MT	
Curb weight (C.W.)	Front	kgf (lb)	851 (1,875)	857 (1,889)	858 (1,891)	866 (1,909)	866 (1,909)
	Rear	kgf (lb)	576 (1,270)	586 (1,292)	588 (1,297)	618 (1,363)	618 (1,363)
	Total	kgf (lb)	1,427 (3,145)	1,443 (3,181)	1,446 (3,188)	1,484 (3,272)	1,484 (3,272)
Gross axle weight (G.A.W.)	Front	kgf (lb)	998 (2,200)	998 (2,200)	998 (2,200)	1,030 (2,271)	1,030 (2,271)
	Rear	kgf (lb)	916 (2,020)	916 (2,020)	916 (2,020)	920 (2,028)	920 (2,028)
	Total	kgf (lb)	1,837 (4,050)	1,837 (4,050)	1,837 (4,050)	1,880 (4,145)	1,880 (4,145)
Option	Power window		❍	❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍	❍
	ABS		❍	❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍	❍
	Cold W package		—	—	—	—	—
	Sun roof		—	❍	❍	—	—
	Dual airbag		❍	❍	❍	❍	❍
	Side airbag		❍	❍	❍	❍	❍
	Rear spoiler		❍	❍	❍	—	—
	Seat in pure hide		—	—	❍	—	—
	Front LSD		—	—	—	❍	❍
	Aluminum wheel	Gold color	—	—	—	❍	—
		Silver color	—	—	—	—	❍

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Wagon

Model			2.5 L		2.5 L	
			TS		OUTBACK	
			5MT	4AT	5MT	4AT
Curb weight (C.W.)	Front	kgf (lb)	778 (1,715)	801 (1,765)	783 (1,725)	805 (1,775)
	Rear	kgf (lb)	603 (1,330)	605 (1,335)	601 (1,325)	603 (1,330)
	Total	kgf (lb)	1,381 (3,045)	1,406 (3,100)	1,384 (3,050)	1,408 (3,105)
Gross axle weight (G.A.W.)	Front	kgf (lb)	939 (2,070)	939 (2,070)	939 (2,070)	939 (2,070)
	Rear	kgf (lb)	953 (2,100)	953 (2,100)	953 (2,100)	953 (2,100)
	Total	kgf (lb)	1,833 (4,040)	1,833 (4,040)	1,833 (4,040)	1,833 (4,040)
Option	Power window		❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍
	ABS		❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍
	Cold W package		—	—	—	—
	Sun roof		—	—	—	—
	Dual airbag		❍	❍	❍	❍
	Side airbag		—	—	—	—
	Rear spoiler		—	—	—	—
	Seat in pure hide		—	—	—	—
	Roof rail		❍	❍	❍	❍

Model			Turbo 2.0 L			
			WRX			
			5MT			4AT
Curb weight (C.W.)	Front	kgf (lb)	826 (1,820)	832 (1,834)	833 (1,836)	851 (1,875)
	Rear	kgf (lb)	610 (1,345)	620 (1,367)	622 (1,372)	610 (1,345)
	Total	kgf (lb)	1,436 (3,165)	1,452 (3,201)	1,455 (3,208)	1,461 (3,220)
Gross axle weight (G.A.W.)	Front	kgf (lb)	998 (2,200)	998 (2,200)	998 (2,200)	998 (2,200)
	Rear	kgf (lb)	953 (2,100)	953 (2,100)	953 (2,100)	953 (2,100)
	Total	kgf (lb)	1,901 (4,190)	1,901 (4,190)	1,901 (4,190)	1,901 (4,190)
Option	Power window		❍	❍	❍	❍
	Power door lock		❍	❍	❍	❍
	Cruise control		❍	❍	❍	❍
	ABS		❍	❍	❍	❍
	Air conditioner		❍	❍	❍	❍
	Cold W package		—	—	—	—
	Sun roof		—	❍	❍	—
	Dual airbag		❍	❍	❍	❍
	Side airbag		❍	❍	❍	❍
	Rear spoiler		—	—	—	—
	Seat in pure hide		—	—	❍	—
	Roof rail		❍	❍	❍	❍

SUNROOF T-TOP
CONVERTIBLE TOP
(SUNROOF)

1. Sunroof

A: SEDAN MODELS

1. DESCRIPTION

The sunroof operates on an automatic opening/closing system including tilt and slide mechanisms.

● A motor with a built-in microprocessor is used for the sunroof motor, which provides one-touch automatic opening and closing functions with a jamming prevention feature. (The system operates in auto mode when the switch is pushed for more than 0.3 seconds.)

● Reduced thickness of the sunroof provides extra overhead clearance in the passenger compartment.

● The frame, glass lid and mechanism parts are refined to reduce considerable amount of weight.

2. FUNCTION

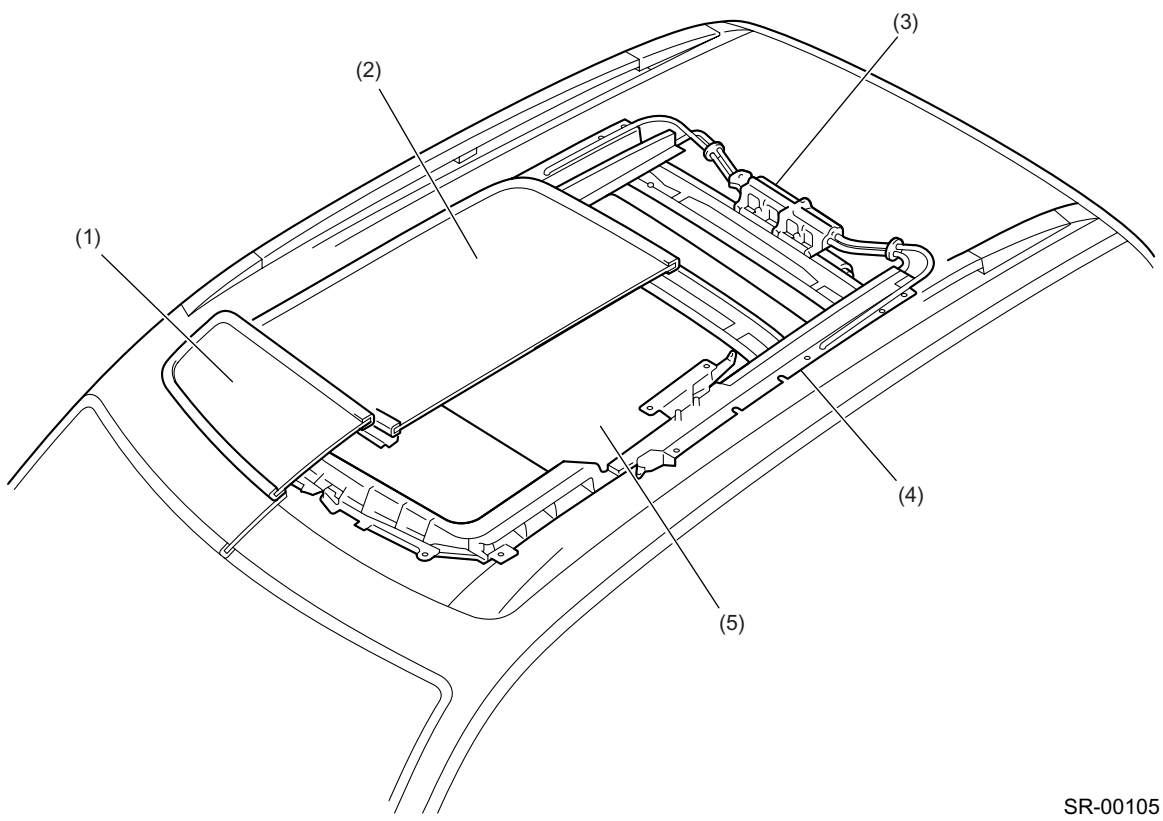
● **Sunroof tilting and sliding operation**
  ● With the glass lid fully closed, pushing the rear side of the tilt switch causes the rear end of the glass lid to rise by 30 mm (1.18 in). Pushing then the front side of the switch causes the lid to lower to the original position.
  ● Pushing the OPEN/CLOSE switch rearward causes the glass 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 sunshade can be opened or closed manually when the glass lid is closed.
  ● The sunshade moves rearward together with the glass lid when the OPEN side of the OPEN/CLOSE switch is pushed. (When closed, only the glass lid moves.)

B: WAGON MODELS

1. DESCRIPTION

The sunroof operates on an automatic opening/closing system, and the joined opening area consists of a tilting front glass lid and a sliding rear glass lid.



(1) Front glass lid
(2) Rear glass lid
(3) Motor
(4) Frame
(5) Sunshade

- The sunroof openings are joined to form a single, wide opening (720 mm (28.35 in) long and 600 mm (23.62 in) wide), aiming to improve the “open and free” feeling to a great extent.
- A motor with a built-in microprocessor is used for the sunroof motor, which provides one-touch automatic opening and closing functions with a jamming prevention feature. (The system operates in auto mode when the switch is pushed.)
- The frame, glass lid and mechanism parts are refined to reduce considerable amount of weight.
- The contour and tilt-up angle of the front glass lid are refined to enhance the effect as a deflector and reduce the wind blowing into the cabin when the sunroof is open. Also, the edge shape of the front glass lid is optimized to minimize unpleasant wind shearing noise.

2. FUNCTION

- **Open and close operations**
  - When the switch is pushed rearwards, the rear edge of the front glass lid tilts up by 45 mm (1.77 in).
  - When the switch is pushed forwards, the front glass lid tilts down to the fully closed position and then stops.
  - When the sunroof switch is pushed rearwards while the front glass lid is fully closed, the rear end of the front glass lid stops at a position ready for tilting up. When the switch is pushed again, the rear end of the front glass lid further tilts up to a position of 70 mm (2.76 in), and the rear glass lid slides and opens to a position 410 mm (16.14 in) from the rear end of the front glass lid and stops. When the sunroof switch is pushed again, the rear glass lid opens to the wide-open position [550 mm (21.65 in) from the front glass lid rear end].
  - When the sunroof switch is pushed forwards while the rear glass lid is at its wide-open position, the rear glass lid moves forward, and then comes to a stop when its front end reaches a position 150 mm (5.91 in) from the rear end of the front glass lid. When the sunroof switch is pushed again, the rear glass lid moves to the fully closed position, and the front glass lid closes until it reaches its tilted up position. When the sunroof switch is pushed once more, the front glass lid tilts down to the fully closed position.
- **Sunshade operation**
  - When the front glass lid tilts up, the shade opens at its front edge by 20 mm (0.79 in) in connection with the lid, to improve ventilation. However, when tilting down the shade will not move in connection with the front glass lid so the shade must be manually closed.
  - The sunshade automatically opens or closes together with the rear glass lid. However, when completely closing the sunroof, the sunshade will come to a stop at a position 170 mm (6.69 in) before the fully closed position even when the front glass lid is completely tilted down. Close the shade manually after the glass lid is completely closed.

TRANSFER CASE

1. Center Differential

Regarding the construction and operation of the center differential, refer to 5MT section. <Ref. to 5MT section.>

2. AWD Transfer System

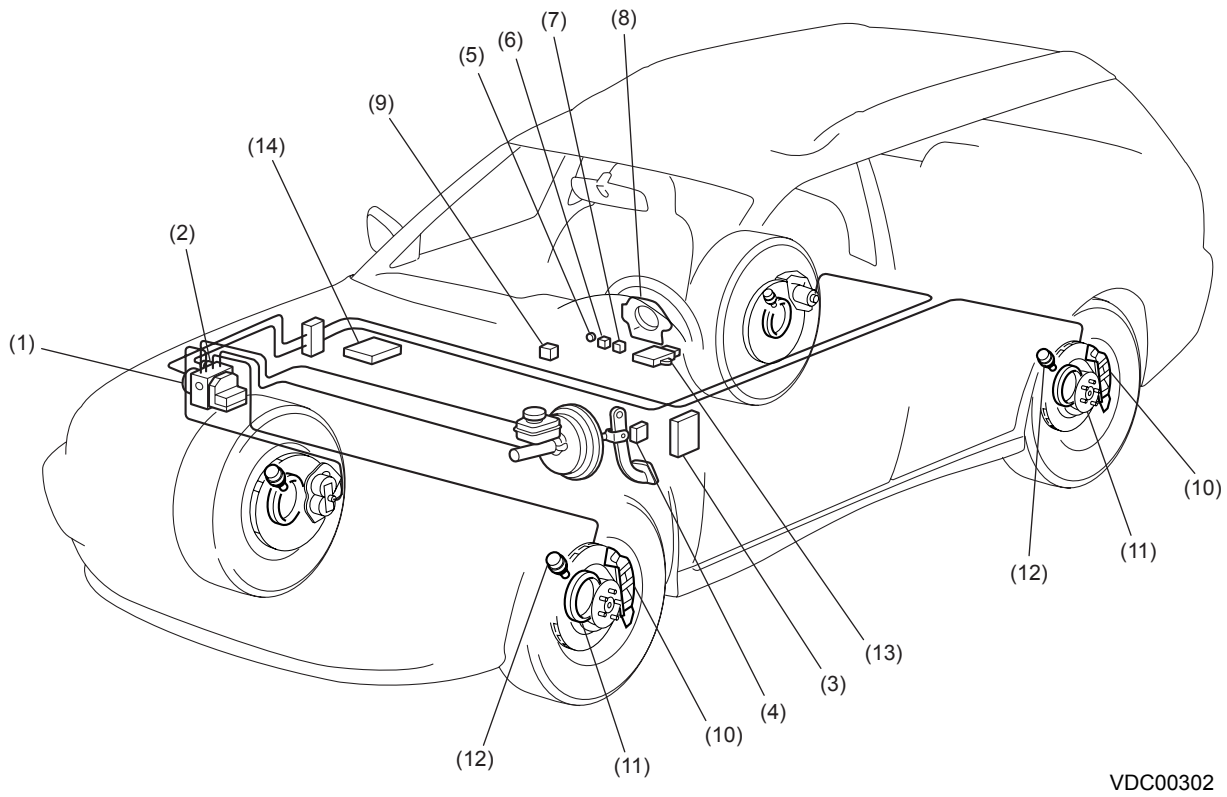
Regarding the construction and operation of the AWD transfer system, refer to 4AT or 5AT section. <Ref. to 4AT section, AWD Transfer System.> <Ref. to 5AT section, AWD Transfer System.>

VEHICLE DYNAMICS CONTROL SYSTEM (VDC)

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.

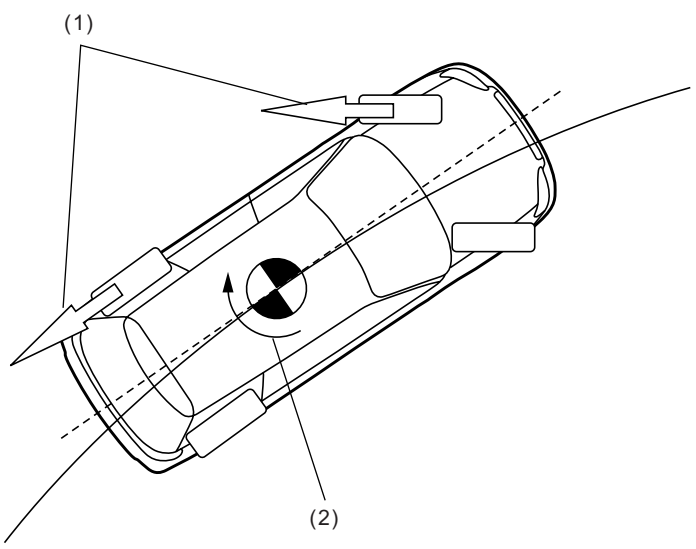


(1) Vehicle dynamics control (VDC) control module
(2) Pressure sensor
(3) Automatic transmission control module
(4) Stop light switch
(5) ABS warning light
(6) Vehicle dynamics control (VDC) operation indicator light
(7) Vehicle dynamics control (VDC) warning light and vehicle dynamics control (VDC) OFF indicator light
(8) Steering angle sensor
(9) Vehicle dynamics control (VDC) OFF switch
(10) Wheel cylinder
(11) Magnetic encoder
(12) ABS wheel speed sensor
(13) Yaw-rate and lateral G sensor
(14) Engine control module

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.

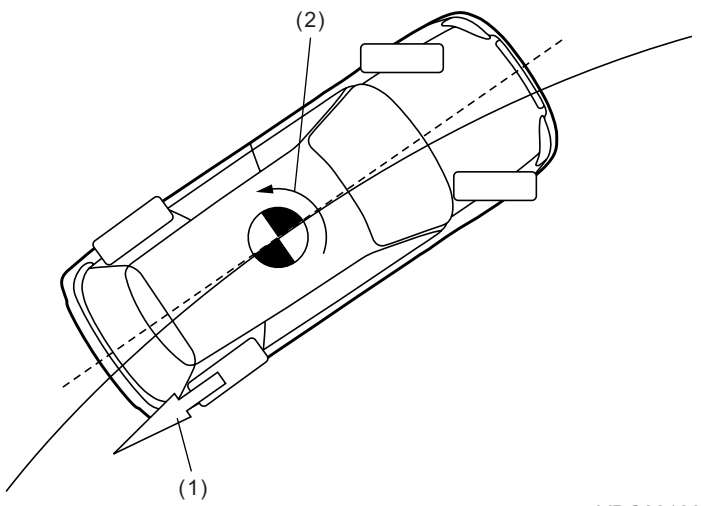


VDC00105

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

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.



VDC00106

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

C: FUNCTIONS USED IN VEHICLE'S BEHAVIOR STABILIZATION CONTROL

Vehicle dynamics control (VDC) function	The vehicle dynamics control (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 vehicles actual behavior from the data provided by the yaw-rate sensor, lateral G sensor, ABS wheel speed 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 sends commands to the engine control module. The engine control module compares the target engine output with the current engine output. Based on the comparison, the throttle opening or fuel injection is controlled. The targeted engine output is then achieved.

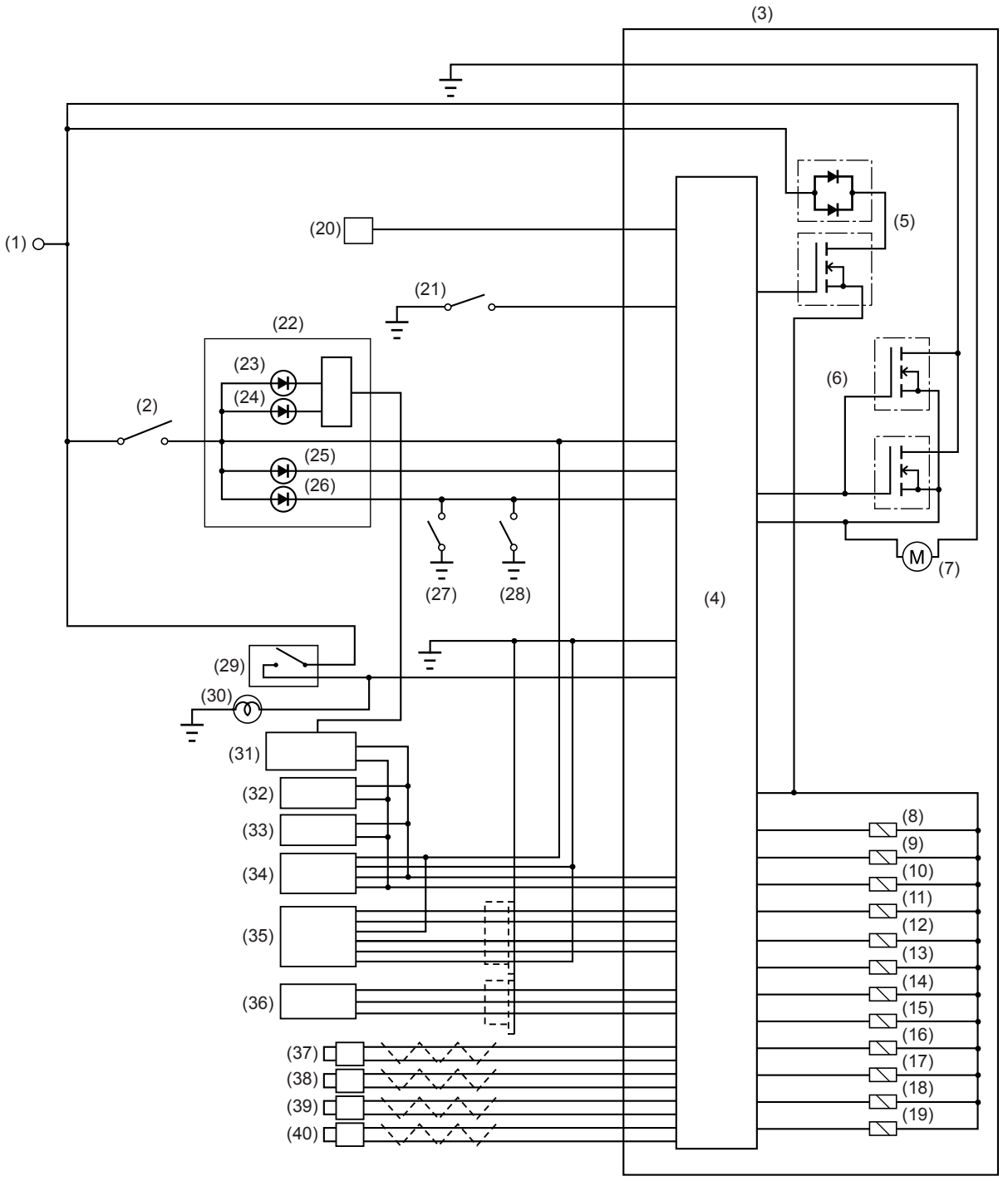
● "AWD control" is effected by the VDCCM as follows:
When necessary, the VDCCM sends a command to the automatic transmission control module. According to the command, the transmission control module controls the transfer clutch so that the torque is distributed between the front and rear axles optimally.

D: SYSTEM COMPONENTS AND FUNCTIONS

VDCCM	• Determines the vehicle's running condition from various sensor signals and, based on the result, controls the vehicle dynamics control (VDC) hydraulic unit, ABS and TCS as required. • Performs CAN communication with the engine control module, automatic transmission control module and the steering angle senso. • 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.
Vehicle dynamics control (VDC) hydraulic 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 CAN line.
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 wheel speed sensor	Detects the speed of each wheel and outputs it to the VDCCM.
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 etc. to the VDCCM.
Automatic transmission control module	Controls the transfer clutch in response to commands from the VDCCM during vehicle dynamics control (VDC) control, ABS control or TCS control so that torque is distributed optimally between the front and rear axles.
ABS warning light	Alerts the driver to an ABS fault.
Vehicle dynamics control (VDC) warning light and vehicle dynamics control (VDC) OFF indicator light	• Alerts the driver to a vehicle dynamics control (VDC) or TCS fault. • Illuminates to tell the driver that the vehicle dynamics control (VDC) and TCS are inactive. (when system is not failed)
Brake warning light	Alerts the driver to an EBD fault. This warning light is also used for parking brake warning and brake fluid level warning.
Vehicle dynamics control (VDC) operation indicator light	Blinks when the vehicle dynamics control (VDC) is operating or lights steadily when the TCS is operating.
Vehicle dynamics control (VDC) OFF switch	• Allows the driver to temporarily disengage the vehicle dynamics control (VDC). • In "temporarily disengaged" status, the vehicle dynamics control (VDC) OFF indicator light illuminates.

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

MEMO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VDC00276

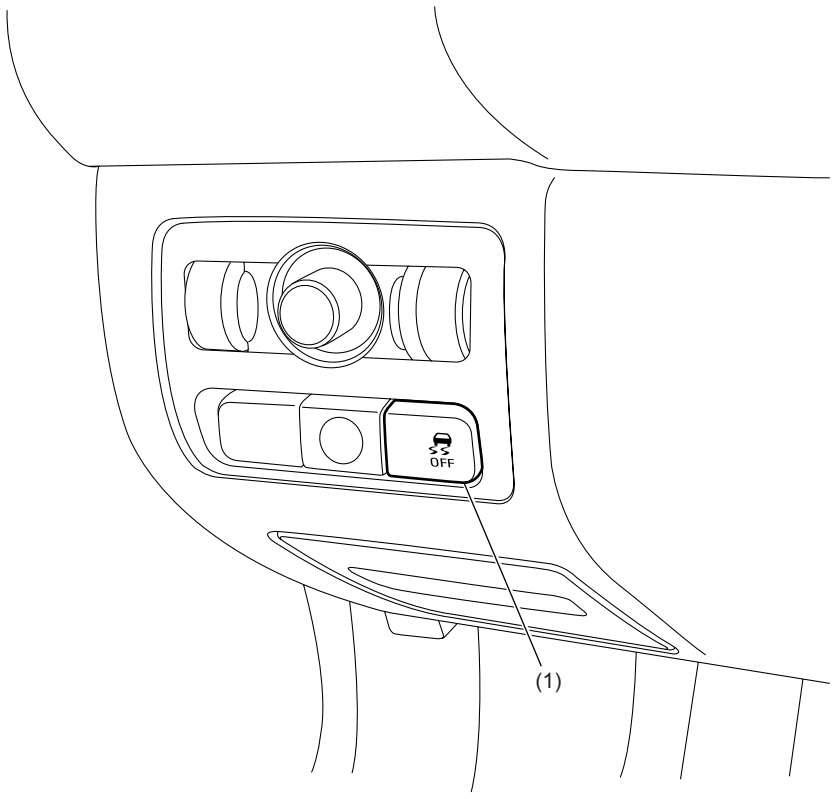
(1) Battery
(2) Ignition switch
(3) Vehicle dynamics control (VDC) control module and hydraulic unit (VDCCM & H/U)
(4) Vehicle dynamics control (VDC) control module
(5) Valve relay
(6) Motor relay
(7) Pump motor
(8) Front left inlet solenoid valve
(9) Front left outlet solenoid valve
(10) Front right inlet solenoid valve
(11) Front right outlet solenoid valve
(12) Rear left inlet solenoid valve
(13) Rear left outlet solenoid valve
(14) Rear right inlet solenoid valve
(15) Rear right outlet solenoid valve
(16) Primary suction solenoid valve
(17) Primary cut solenoid valve
(18) Secondary suction solenoid valve
(19) Secondary cut solenoid valve
(20) Data link connector
(21) Vehicle dynamics control (VDC) OFF switch
(22) Combination meter
(23) Vehicle dynamics control (VDC) warning light and vehicle dynamics control (VDC) OFF indicator light
(24) Vehicle dynamics control (VDC) operation indicator light
(25) ABS warning light
(26) Brake warning light
(27) Parking brake switch
(28) Brake fluid level switch
(29) Stop light switch
(30) Stop light
(31) Integrated unit
(32) Engine control module
(33) Transmission control module
(34) Steering angle sensor
(35) Yaw-rate and lateral G sensor
(36) Pressure sensor
(37) Front left ABS wheel speed sensor
(38) Front right ABS wheel speed sensor
(39) Rear left ABS wheel speed sensor
(40) Rear right ABS wheel speed sensor

E: VDC OFF SWITCH

A switch which allows the driver to temporarily disengage VDC control.

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.)
- 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) Vehicle dynamics control (VDC) OFF switch

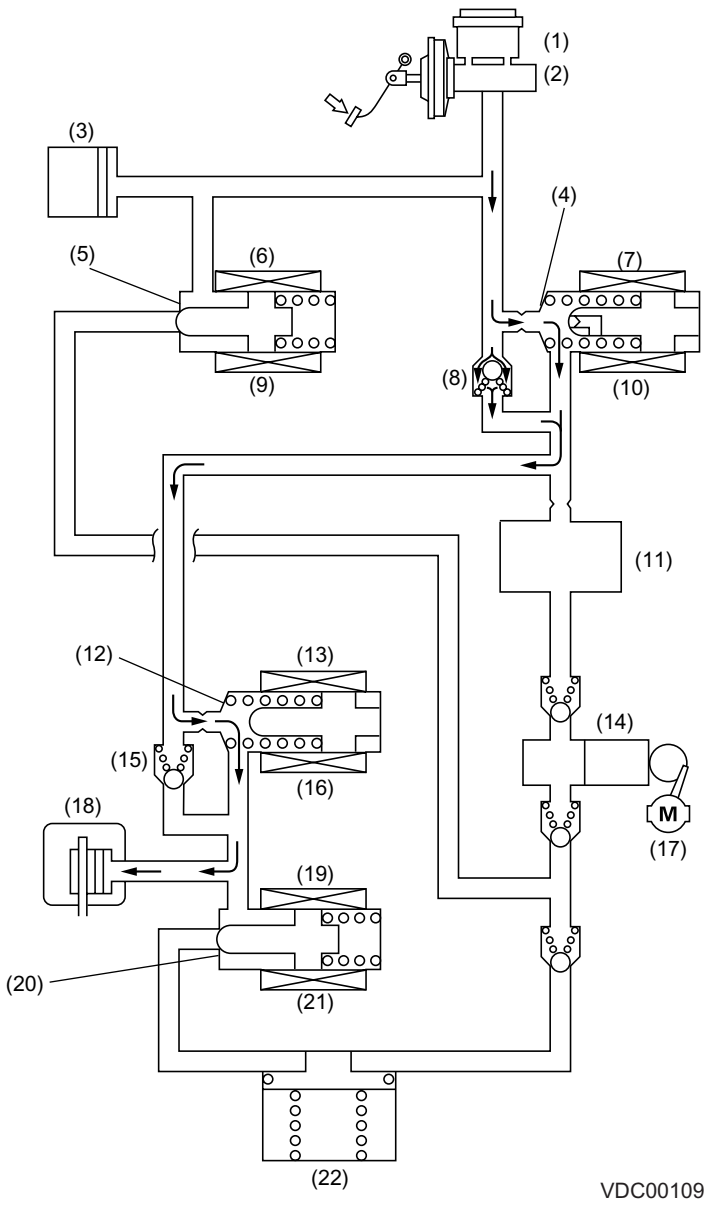
F: OPERATION OF VDC HYDRAULIC UNIT (VDC H/U)

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 unit is represented by operation of a single wheel circuit.



VDC00109

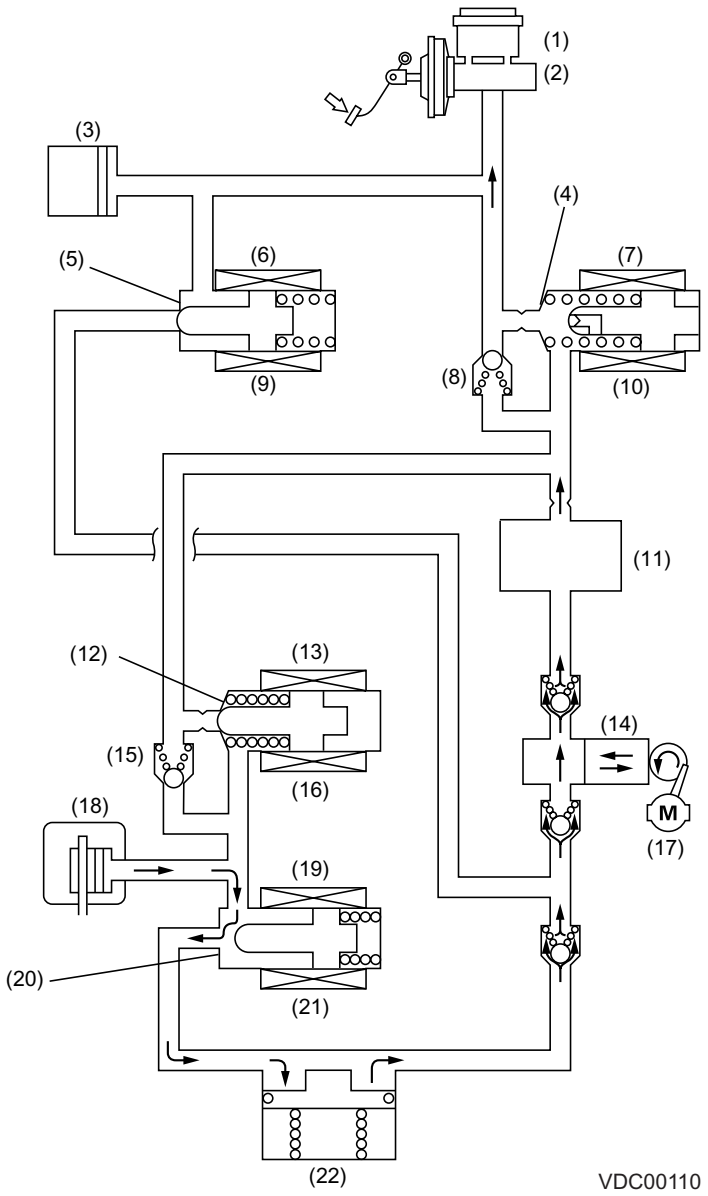
(1) Reservoir tank
(2) Master cylinder
(3) Pressure sensor
(4) Port open
(5) Port closed
(6) Suction solenoid valve
(7) Cut solenoid valve
(8) Check valve
(9) Deenergized
(10) Deenergized
(11) Damping chamber
(12) Port open
(13) Inlet solenoid valve
(14) Pump
(15) Check valve
(16) Deenergized
(17) Motor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

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 unit is represented by operation of a single wheel circuit.



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

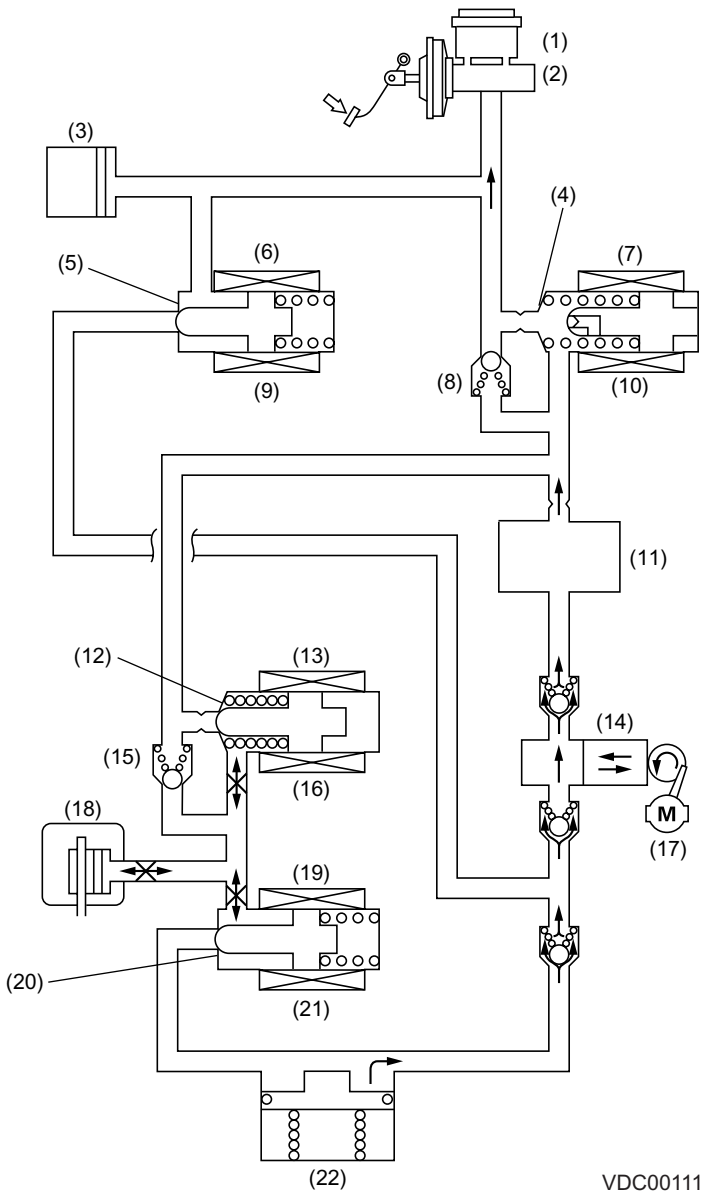
3. PRESSURE “HOLD” CONTROL WITH BRAKE PEDAL DEPRESSED

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 unit is represented by operation of a single wheel circuit.



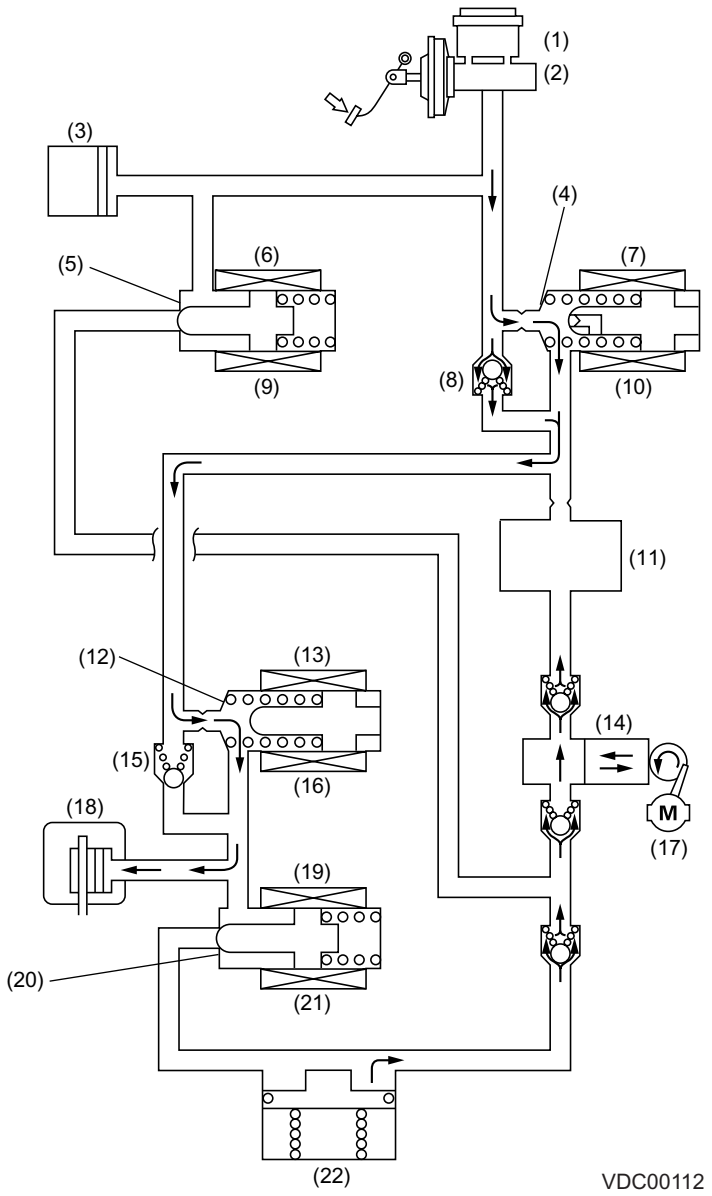
(1) Reservoir tank
(2) Master cylinder
(3) Pressure sensor
(4) Port open
(5) Port closed
(6) Suction solenoid valve
(7) Cut solenoid valve
(8) Check valve
(9) Deenergized
(10) Deenergized
(11) Damping chamber
(12) Port closed
(13) Inlet solenoid valve
(14) Pump
(15) Check valve
(16) Energized
(17) Motor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

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 unit is represented by operation of a single wheel circuit.



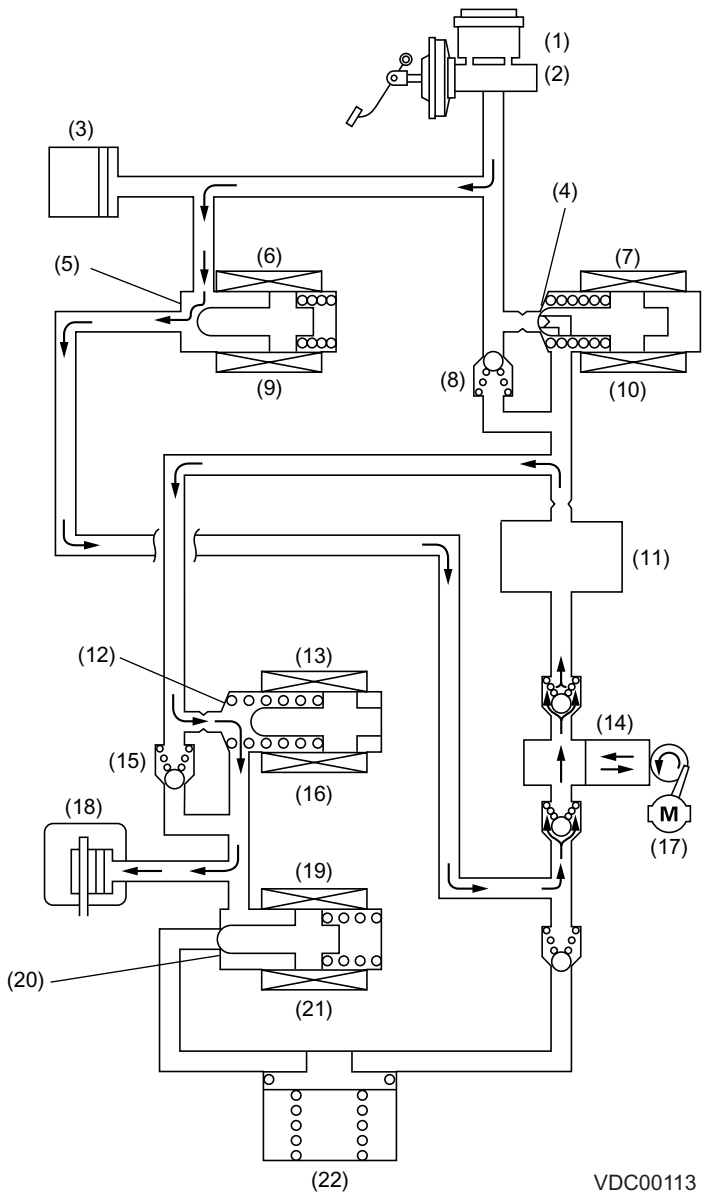
(1) Reservoir tank
(2) Master cylinder
(3) Pressure sensor
(4) Port open
(5) Port closed
(6) Suction solenoid valve
(7) Cut solenoid valve
(8) Check valve
(9) Deenergized
(10) Deenergized
(11) Damping chamber
(12) Port open
(13) Inlet solenoid valve
(14) Pump
(15) Check valve
(16) Deenergized
(17) Motor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

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 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) Energized
(11) Damping chamber
(12) Port open
(13) Inlet solenoid valve
(14) Pump
(15) Check valve
(16) Deenergized
(17) Motor
(18) Wheel cylinder
(19) Outlet solenoid valve
(20) Port closed
(21) Deenergized
(22) Reservoir

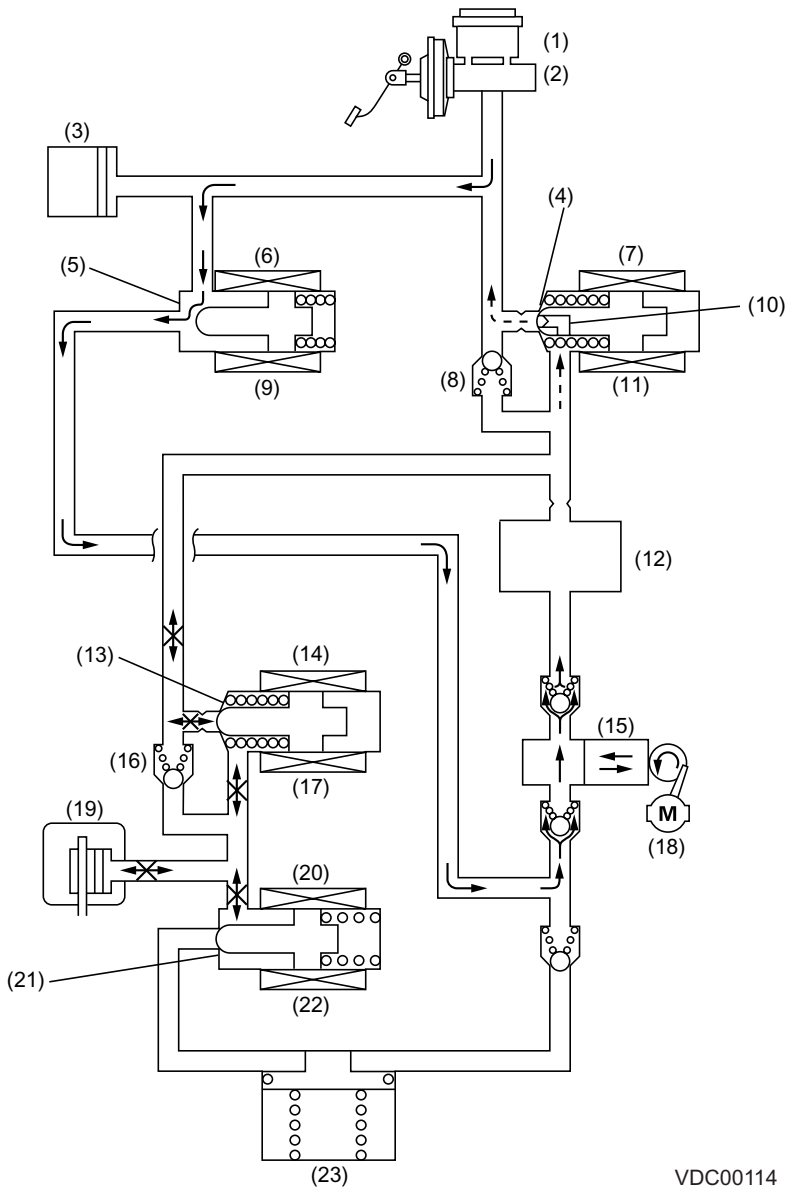
6. PRESSURE “HOLD” CONTROL WITH BRAKE PEDAL NOT DEPRESSED

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 unit is represented by operation of a single wheel circuit.



VDC00114

(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) Damping 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 closed
(22) Deenergized
(23) Reservoir

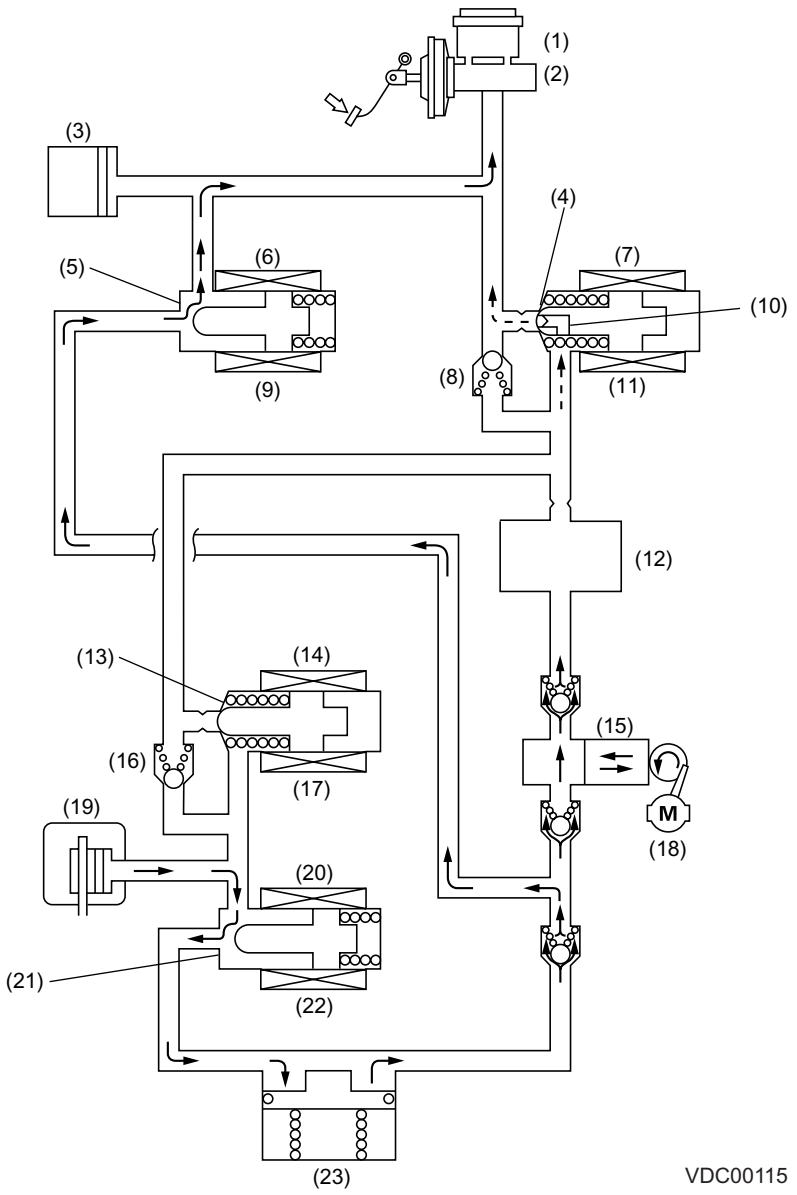
7. PRESSURE “DECREASE” CONTROL WITH BRAKE PEDAL NOT DEPRESSED

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 unit is represented by operation of a single wheel circuit.



VDC00115

(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) Damping 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

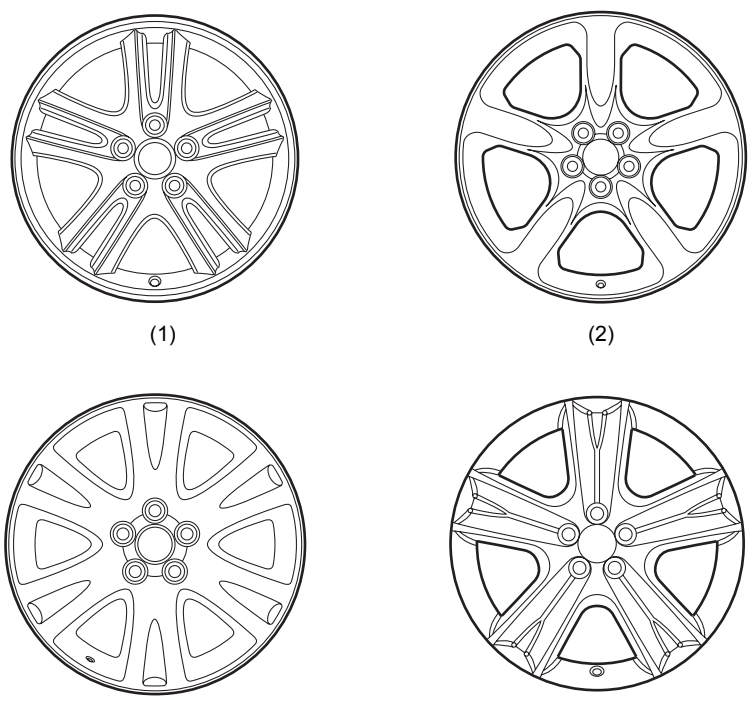
WHEEL AND TIRE SYSTEM

1. Wheel & Tire

A: STANDARD TIRE

Aluminum wheels are provided with a center cap.

The following four types of disk wheels are provided for model grades.

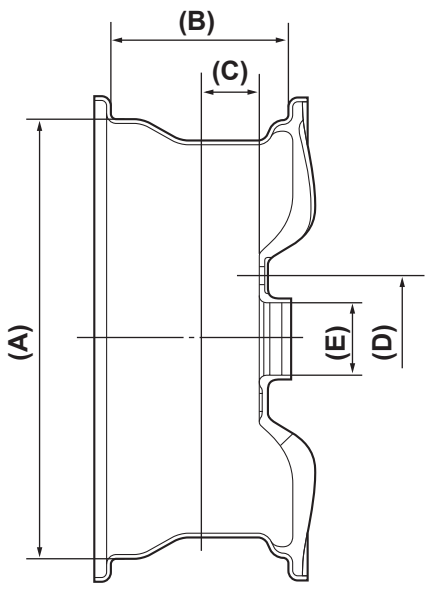


(1) (2)

(3) (4)

WT-00074

Disc wheel	Size	Rim diameter	Rim width	Offset	P.C.D.	Bolt holes	Center hole diameter	Tire size
		mm (in)	mm (in)	mm (in)	mm (in)		mm (in)	mm (in)
(1)	16 × 6 1/2JJ	ϕ405.6 (16.0)	165.5 (6.5)	55 (2.2)	ϕ100 (3.9)	5	ϕ56 (2.2)	P205/55R 16 89H
(2)	17 × 7JJ	ϕ436.6 (17.2)	178.0 (7)	55 (2.2)	ϕ100 (3.9)	5	ϕ56 (2.2)	215/45ZR 17
(3)	16 × 6 1/2JJ	ϕ405.6 (16.0)	165.5 (6.5)	48 (1.9)	ϕ100 (3.9)	5	ϕ56 (2.2)	P225/60R 16 97H
(4)	17 × 7JJ	ϕ436.6 (17.2)	178.0 (7)	48 (1.9)	ϕ100 (3.9)	5	ϕ56 (2.2)	P225/55R 17 95V

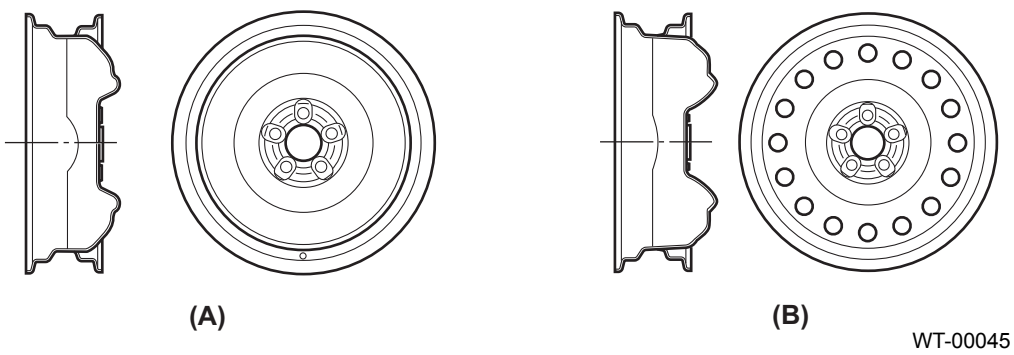


(A) Rim diameter
(B) Rim width
(C) Offset
(D) P.C.D.
(E) Center hole diameter
(F) Aluminum wheel

B: SPARE TIRE

A light and compact temporary type spare tire is equipped on some models.

Specifications	Tire size	Rim size
T-type tire	T135/70D17 102M T155/70D17 110M	17 × 4T
	T135/80R16 101M	16 × 4T

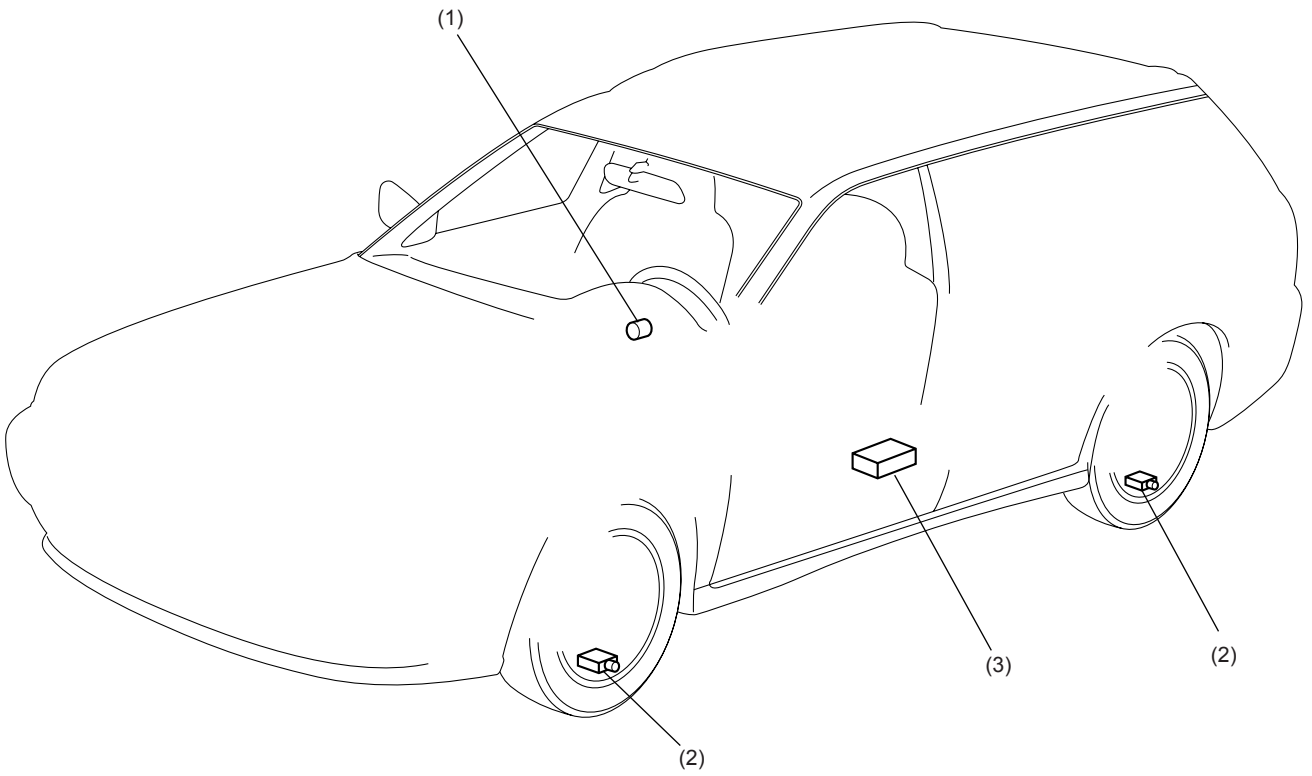


(A) 16 × 4T
(B) 17 × 4T

2. Tire Pressure Monitoring System

A: GENERAL

To comply with the requirements of FMVSS No. 138, a direct detecting type tire pressure monitoring system, which consists of four transmitters (each integrated with a tire air valve) and a receiver (installed under the driver's seat) is introduced.



WT-00075

(1) Indicator lights
(2) Transmitter
(3) Receiver

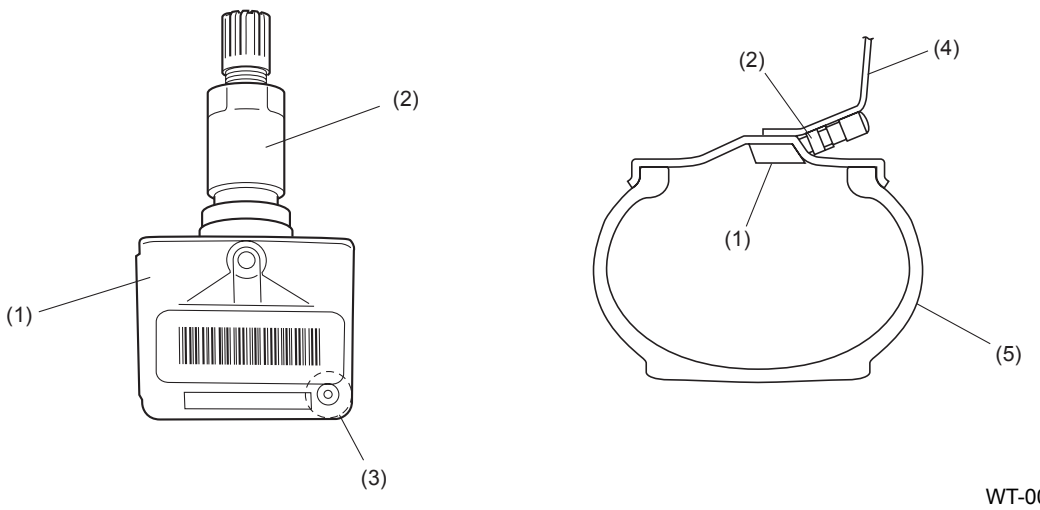
B: TRANSMITTER (TIRE PRESSURE SENSOR)

Detects the tire pressure with the sensor built inside the transmitter, which is integrated with the tire air valve.

The sensor contains a battery as a power source.

The battery life is 10 years or 160,000 km (100,000 miles).

The battery cannot be replaced separately; when the battery becomes weak the whole sensor assembly must be replaced.



WT-00076

(1) Transmitter (tire pressure sensor)
(2) Nut
(3) Tire pressure sensor built-in part
(4) Wheel
(5) Tire

When the vehicle speed increases to 11 — 32 km/h (7 — 20 MPH), the roll switch built in the sensor turns ON, and the sensor starts to transmit pressure data*1 together with the ID code*2 and function code*3.

When the switch is turned ON, the transmitter takes measurement once in every 30 seconds, and sends the result once in every minute.

When the vehicle is stopped for 15 minutes or more, the sensor enters sleep mode to minimize battery consumption.

*1: Detected tire pressure data
*2: ID code allocated to each transmitter
*3: A code indicating the current transmitter mode

The transmitter switches its mode according to its condition as follows.

These condition information are referred to as “function codes”.

Function codes

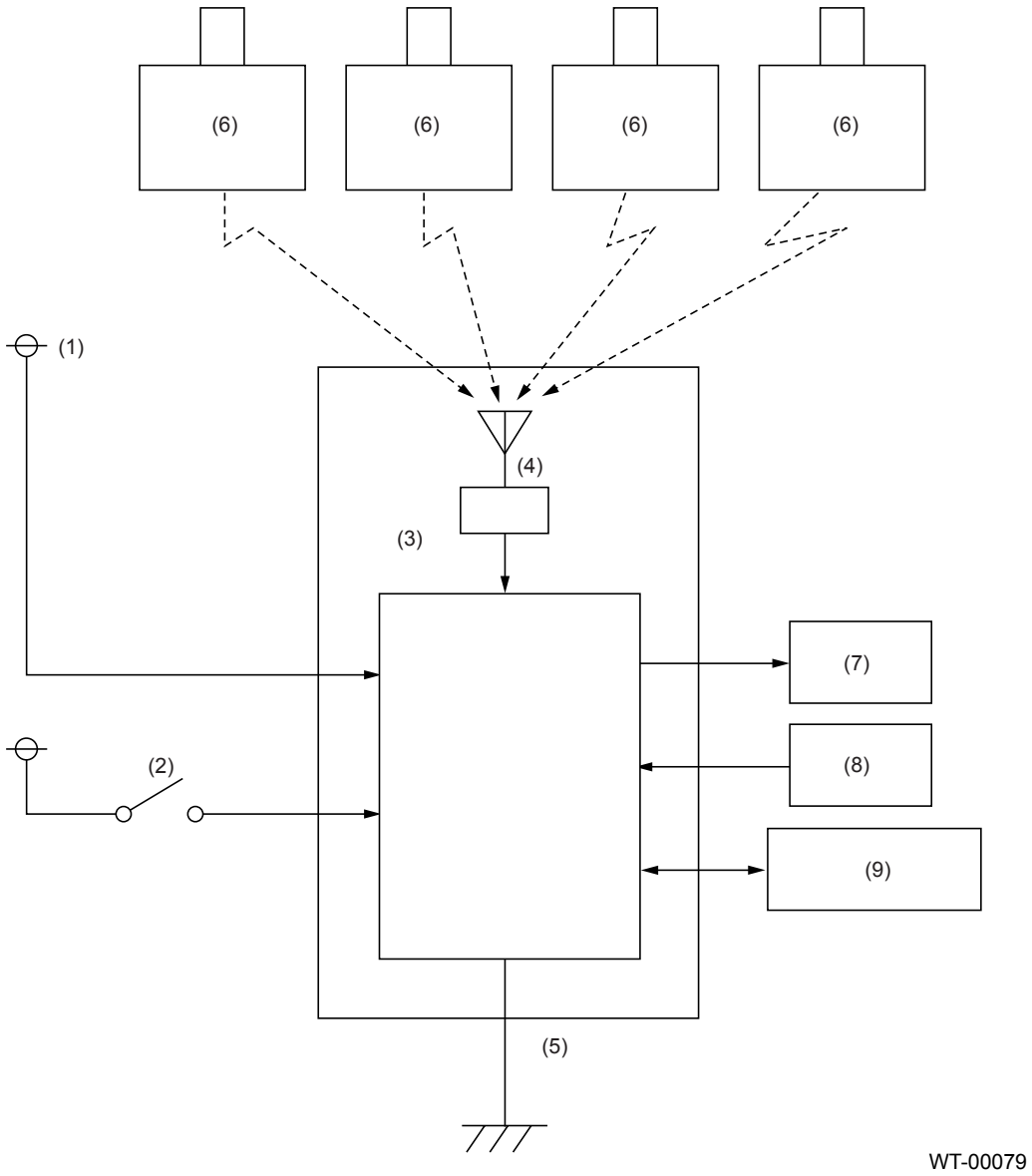
Mode	Code	Function
Learn mode	000	This is the initial mode when the transmitter is turned ON using a transmission activation tool (ST).
Low battery mode	001	Enters this mode when the transmitter battery voltage drops. This code is transmitted when the transmitter voltage becomes low.
OFF mode	010	Transmitter is OFF (no pressure detection, no data transmission).
Re-measure mode	011	This code is transmitted if the detected pressure differs by 8.4 kPa (0.086 kgf/cm^2, 1.218 psi) or more compared with the previous data. (sudden change in pressure due to tire burst, tire pressure adjustment, etc.)
Wake mode	101	This code is transmitted when the condition changes from vehicle stopped (transmitter roll switch OFF and data not transmitted) to vehicle running (transmitter roll switch turns ON and data transmission starts).
Normal pressure mode	111	This code is transmitted when the condition is none of the above; vehicle normally running or stopped (within 15 minutes after stopped).

C: RECEIVER

The receiver has a built-in antenna.

The receiver collects tire pressure data from the transmitters, and turns on the indicator to warn the driver when it concludes that the tire pressure has dropped below a certain value.

The receiver is provided with a system fault diagnosis function.



(1) Power supply
(2) Ignition switch
(3) Receiver
(4) Antenna
(5) Ground
(6) Transmitter
(7) Integrated unit
(8) Vehicle speed
(9) Subaru select monitor

1. RECEIVER FUNCTIONS

● Receiving function: Receives data from the transmitters and decides whether the data is valid or not.

● Pressure judgment function: The indicator turns ON to warn the driver if the tire pressure drops below the preset value (180 kPa, 1.835 kgf/cm^2, 26.11 psi). At the same time, a diagnostic trouble code is stored in the memory inside the receiver to identify which tire has low pressure. (low pressure detection turns ON at 180 kPa (1.835 kgf/cm^2, 26.11 psi), turns OFF at 200 kPa (2.039 kgf/cm^2, 29.01 psi))

● Diagnosis function: The indicator flashes and a diagnostic trouble code is stored in the memory inside the receiver if a system abnormality such as data reception failure, bad received data, or bad transmitter condition is detected.

2. CONDITIONS JUDGED AS A FAILURE

The receiver decides that the system has failed when any of the following conditions is met.

● EEPROM abnormal: The written data does not coincide with the loaded data when the ID is registered.

● Data reception failure: Transmitter data could not be received for 10 minutes or more while driving at a speed exceeding 40 km/h (24.9 MPH).

● Function code abnormal: “Re-measure” function code is received for 5 times in series, though the pressure change compared to the last data was within 7 kPa (0.071 kgf/cm^2, 1.02 psi) while driving at a speed exceeding 40 km/h (24.9 MPH).

● Air pressure data abnormal: “FFH”* pressure data has been received for 5 times in series while driving at a speed exceeding 40 km/h (24.9 MPH).

● Low battery: Function code for the “low battery” mode has been received for 20 times or more in series.

● Vehicle speed sensor abnormal: Function code for the “wake” mode has been received while the vehicle speed signal is 6 km/h (3.7 MPH) or lower.

*FFH is transmitted when the pressure data exceeds the upper limit (352kPa, 3.59 kgf/cm^2, 51.05 psi) of pressure detection.

If the indicator comes ON due to low tire pressure, the indicator will turn OFF when the under-inflated tire is inflated to normal pressure.

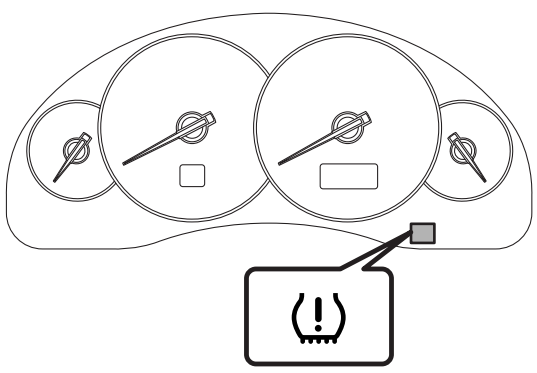
D: SUBARU SELECT MONITOR

The Subaru Select Monitor (SSM) enables the user to perform the following operations.

- Transmitter ID registration: The new ID can be registered when the transmitter is replaced due to battery life, etc.
- Data monitoring: The status of the function code, tire pressure, vehicle speed, indicator illuminating pressure, or I/O signal can be displayed.
- ID data display: The registered four IDs and the currently received data for each ID can be displayed.
- Diagnostic trouble codes display: Stored diagnostic trouble codes can be read.
- Erasing diagnostic trouble codes: Diagnostic trouble codes can be erased after repair work is completed.

E: INDICATOR LIGHT

The indicator light warns the driver when the tire pressure drops or a failure occurs in the system.



WT-00078

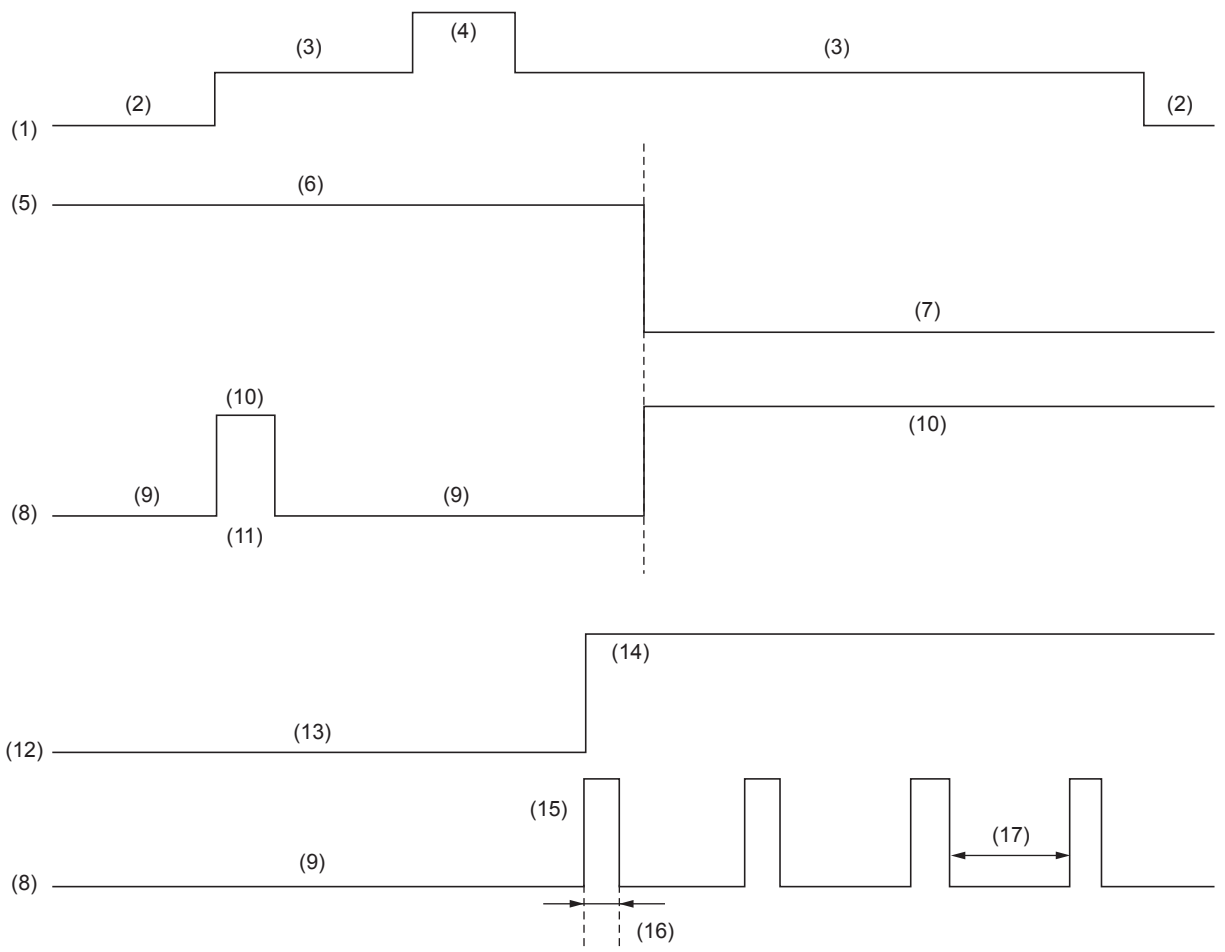
(1) Tire pressure monitoring indicator light

1. FAULT DISPLAY PATTERNS

When normal: indicator turns OFF at 2 seconds after the ignition switch has been turned ON

When low pressure is detected: illuminates

When system abnormality is detected: flashes (3 seconds OFF, 1 second ON)



WT-00077

(1) Ignition switch
(2) OFF
(3) ON
(4) Start
(5) Tire pressure
(6) Within standards
(7) 180 kPa (1.835 kgf/cm^2, 26.11 psi) or less
(8) Tire pressure warning light
(9) OFF
(10) Illuminates
(11) 2 seconds
(12) System status
(13) Normal
(14) Abnormal
(15) Flash
(16) 1 second
(17) 3 seconds

WIPER AND WASHER SYSTEM

1. Wiper and Washer Systems

A: GENERAL

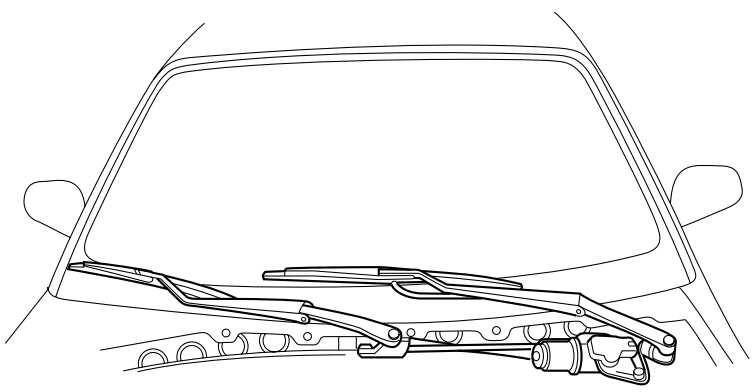
1. FRONT WIPER

1) The front wiper is of a tandem type featuring a 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.

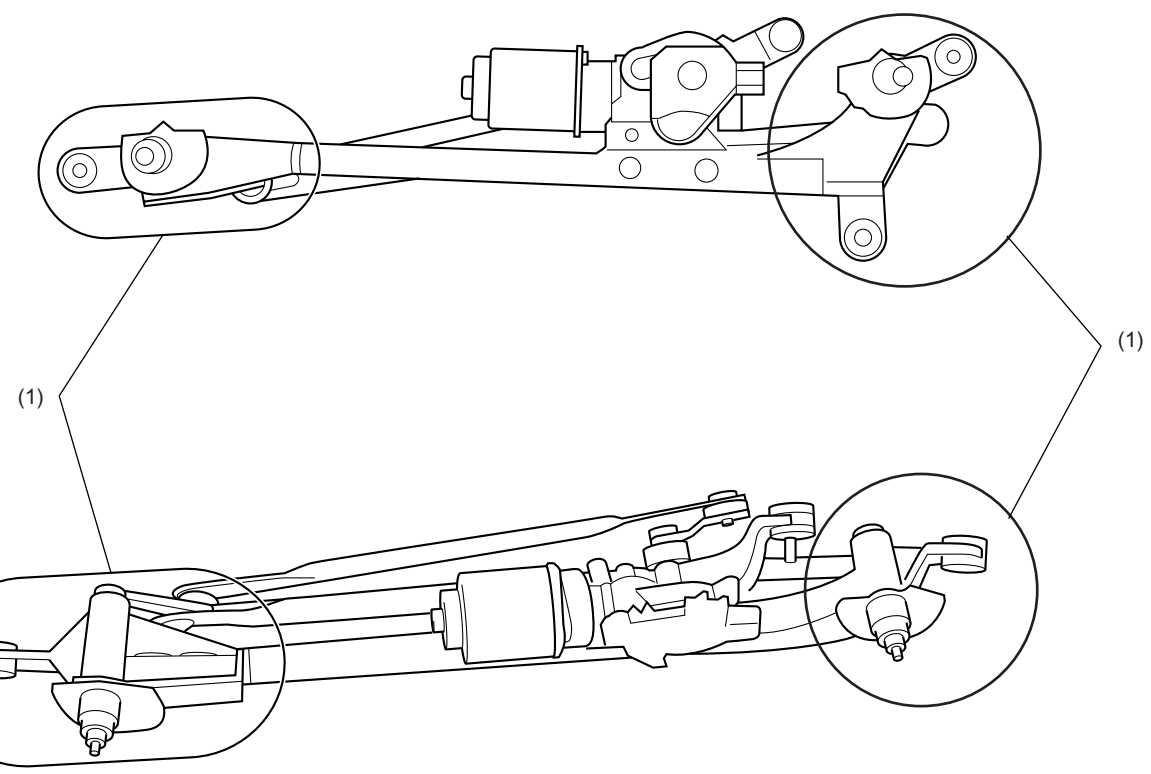
4) The front wiper system uses a modular construction in which the wiper motor forms an integral part of the linkage. The motor is installed on the body through rubber mounting.



WW-00159

5) The size of the motor is minimized by changing the stator shape, coil windings and the magnet.

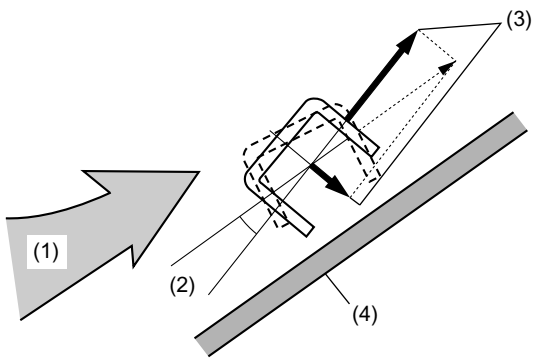
6) The mounting bracket is modified. The bracket of the wiper link assembly bracket area breaks if it receives a force exceeding a certain level to absorb the impact in case of a traffic accident, etc.



WW-00228

(1) Bracket

7) The driver's side wiper arm is angled to disperse the force applied to the wiper arm by the airflow. A part of the dispersed force acts to press the wiper blade against the windshield helping to prevent the wiper blade being lifted up.



WW-00043

(1) Airflow
(2) Angle of twist
(3) Dispersed force
(4) Windshield

8) When wiper arms are raised in cases such as washing the car, always raise the driver's seat side wiper arm first and then raise the passenger's seat side wiper arm. If the passenger's seat side wiper arm is raised first, this will obstruct the way for the driver's side wiper arm. If forcibly raised in the wrong way, the passenger's side wiper arm may be damaged. When lowering the wiper arms, lower the passenger's side arm first.

2. FRONT WASHER SYSTEM

1) The front washer system consists of a washer tank, motor and pump unit, and a pair of nozzles.

2) The washer tank is installed behind the front bumper under the left headlight.

3) The washer motor and pump unit is installed at the bottom of the washer tank.

4) The washer nozzles are installed to the front hood at its rear end and from the under side. Each nozzle has a spray hole.

5) Each washer nozzle has a check valve at a location approximately 100 mm (3.94 in) from the nozzle.

6) The washer tank is filled to its specified capacity when the fluid level is at the “FULL” mark on the filling pipe. Do not fill washer fluid until its level exceeds the “FULL” mark. The fluid may spill during driving or when replacing the head light bulb.

3. SPECIFICATIONS

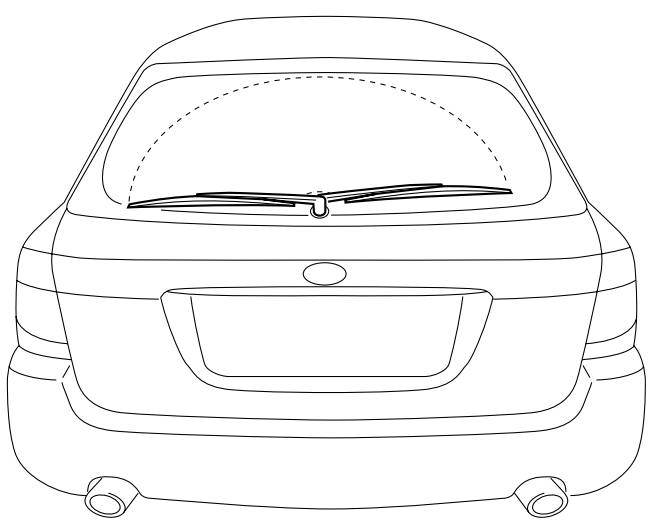
Washer tank	Capacity			4.0 ℓ (4.2 US qt, 3.5 Imp qt)
Wiper motor	Rated voltage			12 V
	No-load current			4 A or less
	Speed [at 2.0 N·m (20 kg-cm, 17 in-lb)]		HIGH	56 — 68 rpm
			LOW	35 — 45 rpm
	Motor characteristics when bound	HIGH	Torque	25.5 N·m (260 kg-cm,1.88 ft-lb) or more
			Current	33 A or less
		LOW	Torque	31.4 N·m (320 kg-cm, 2.31 ft-lb) or more
			Current	29.0 A or less
Wiper blade	Length	Driver side		600 mm (23.62 in)
		Passenger side		450 mm (17.72 in)

2. Rear Wiper and Washer

A: GENERAL

1. REAR WIPER

1) The rear wiper operates over an angle of 168°.



WW-00291

2) The rear wiper operates intermittently as shown in the following table only when the wiper switch is in the INT position on AT models.

Selector lever position (AT models only)	Vehicle speed km/h (MPH)	Interval (sec)
		Wagon
Reverse (R)	—	Continuous operation
Other than reverse (R)	0 — 20 (0 — 12.4)	12
	20 — 50 (12.4 — 31.1)	9
	50 — 80 (31.1 — 49.7)	6
	over 80 (49.7)	3

2. REAR WASHER SYSTEM

1) The front and rear washers share the same washer tank.

2) The washer motor and pump unit is installed at the bottom of the washer tank.

3) The washer nozzle is installed to the lower part of the roof spoiler. The nozzle has two spray holes.

4) The washer nozzle is provided with a check valve, which is located just below it.

3. SPECIFICATIONS

Wiper motor	Rated voltage		12 V
	No-load current		2 A or less
	Speed [at 0.5 N·m (5 kg-cm, 4.3 in-lb)]		25 rpm or more
	Motor characteristics when bound	Torque	8.8 N·m (0.90 kgf-m, 6 ft-lb)or more
		Current	13 A or more
Wiper blade	Length		350 mm (13.78 in)