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# **MANUAL TRANSMISSION AND DIFFERENTIAL 6-SPEED (6MT)**

## GENERAL

### MANUAL TRANSMISSION AND DIFFERENTIAL

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#### 1. General

The six-speed manual transmission has been newly developed to exploit the full potential of the STi model's engine and enable the model to have a surpassing driving performance.

The major features of this new transmission are as follows:

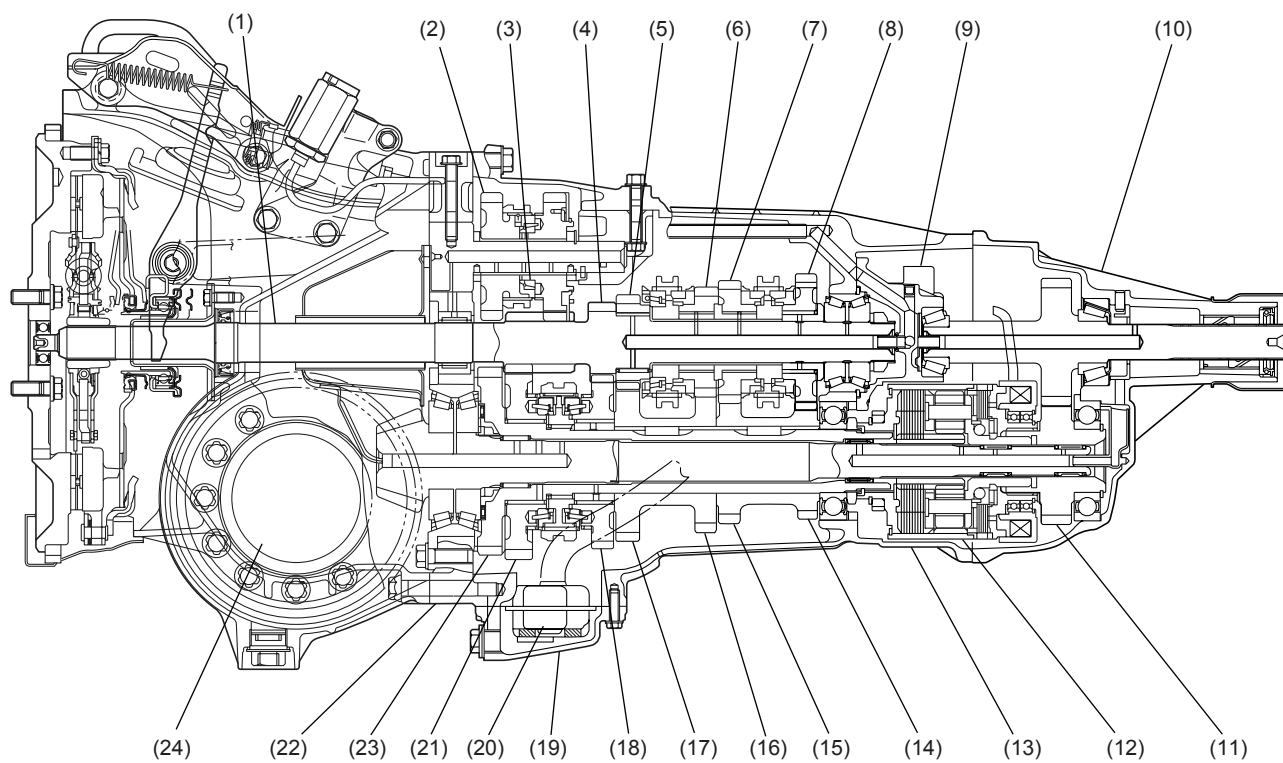
- The driver can make a gear shift with a smaller force than with conventional transmissions owing to the double-cone synchronizers employed for the 1st, 3rd and reverse gears and the triple-cone synchronizer employed for the 2nd gear. In addition, the synchronizing elements of the 2nd to 6th gears have splines with asymmetric chamfers in order to prevent generation of undesirable loads that would cause simultaneous engagement of two gears ("double meshing") as well as to ensure improved gear shift feeling.
- The reverse idler gear is a constant-mesh type with a new sub gear.
- The shift/select mechanism is of a parallel link design. It has shift rods each supported by a slidable ball bearing and provided with a detent mechanism that uses a plunger with a ball inside.
- The reverse check mechanism prevents unintended engagement of the reverse gear when the driver makes a shift into the 5th or 6th gear.
- The transmission case is split into three pieces lateral direction like that of the automatic transmission used in the standard model. It is highly rigid owing to appropriately arranged ribs.
- The oil pump incorporated in the transmission case ensures improved lubricating and cooling performance.
- An APTRAC type limited slip differential has been introduced for the front differential.
- The center differential uses a driver-controllable center differential which controls the drive power distribution to the front and rear wheels according to driving and road conditions.

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## CROSS SECTIONAL VIEW

MANUAL TRANSMISSION AND DIFFERENTIAL

### 2. Cross Sectional View



MT-00981

- |                        |                                   |                                  |
|------------------------|-----------------------------------|----------------------------------|
| (1) Main shaft         | (9) Transfer driven gear          | (17) 3rd driven gear             |
| (2) Reverse idler gear | (10) Extension case               | (18) 2nd driven gear             |
| (3) 1st drive gear     | (11) Transfer drive gear          | (19) Oil pan                     |
| (4) 2nd drive gear     | (12) Center differential assembly | (20) Oil strainer                |
| (5) 3rd drive gear     | (13) Transmission case            | (21) 1st driven gear             |
| (6) 4th drive gear     | (14) 6th driven gear              | (22) Adapter plate               |
| (7) 5th drive gear     | (15) 5th driven gear              | (23) Reverse driven gear         |
| (8) 6th drive gear     | (16) 4th driven gear              | (24) Front differential assembly |

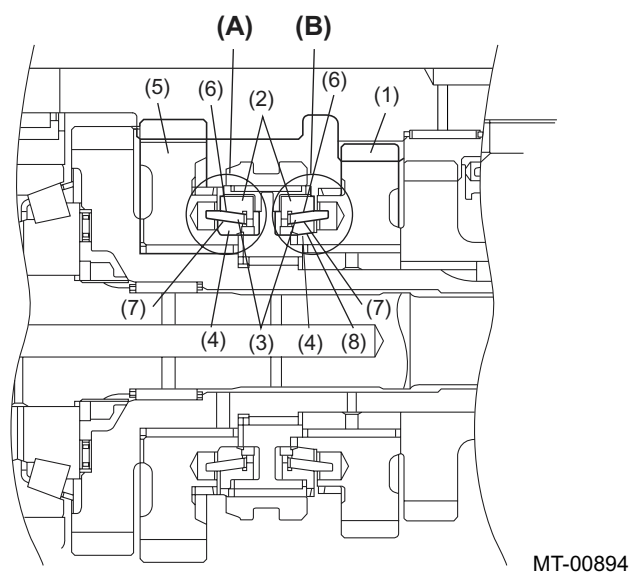
## TRIPLE-CONE SYNCHRONIZER

MANUAL TRANSMISSION AND DIFFERENTIAL

### 3. Triple-cone Synchronizer

#### A: CONSTRUCTION

The triple-cone synchronizer has three frictional interfaces - in addition to the two coaxial interfaces between the synchronizer cone and the inner and outer balk rings (which are same as those with a double-cone synchronizer), it has a third frictional interface between the inner surface of the inner balk ring and the cone on the 2nd driven gear. Thanks to an increased friction force, the triple-cone type produces larger synchronizing power than a double-cone type synchronizer. The main components of the triple-cone synchronizer are the outer balk ring, synchronizer cone, inner balk ring, and 2nd driven gear's cone.



MT-00894

(A) Double-cone synchronizer

(B) Triple-cone synchronizer

(1) 2nd driven gear

(2) Outer balk ring

(3) Synchronizer cone

(4) Inner balk ring

(5) 1st driven gear

(6) Cone surface 1

(7) Cone surface 2

(8) Cone surface 3

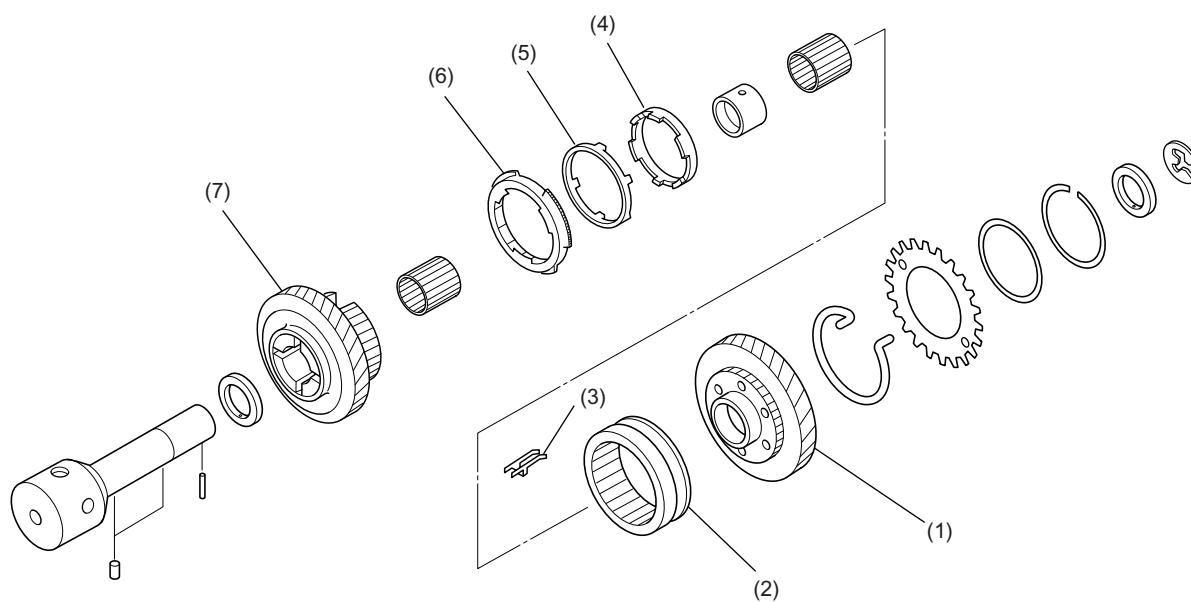
## REVERSE IDLER GEAR ASSEMBLY (WITH SYNCHRONIZING MECHANISM)

MANUAL TRANSMISSION AND DIFFERENTIAL

### 4. Reverse Idler Gear Assembly (with Synchronizing Mechanism)

- A constant-mesh type reverse gearing is used in the six-speed manual transmission.
- The reverse idler gear assembly is provided with a double-cone synchronizer.

Soon after disengagement of the clutch, the reverse gear remains rotating by an inertial force. If the driver makes a shift while the reverse gear is still rotating, an undesirable “gear clash” would occur. The double-cone synchronizer prevents this by synchronizing the speed of the No. 2 reverse idler gear with that of the reverse sleeve. It also allows the driver to make a smooth shift into the reverse gear.



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- (1) No. 1 reverse idler gear
- (2) Reverse sleeve
- (3) Insert key

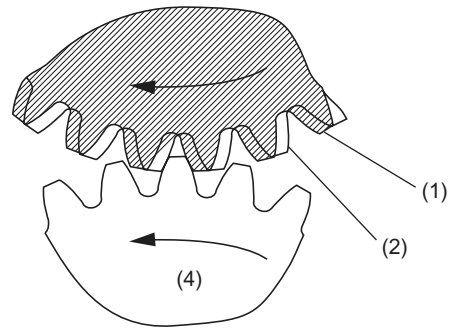
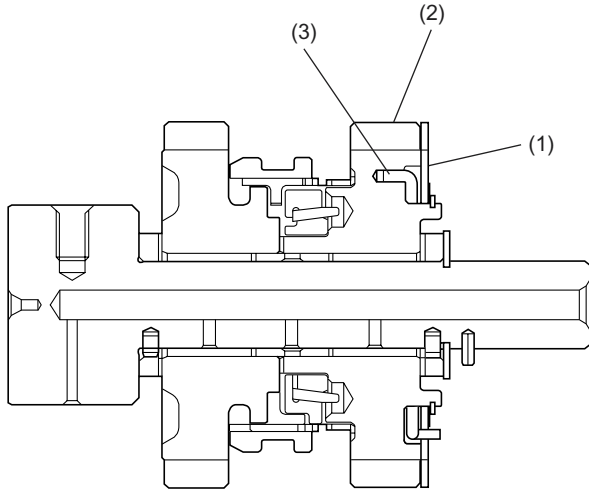
- (4) Inner balk ring
- (5) Synchronizer cone
- (6) Outer balk ring

- (7) No. 2 reverse idler gear

# REVERSE IDLER GEAR ASSEMBLY (WITH SYNCHRONIZING MECHANISM)

## MANUAL TRANSMISSION AND DIFFERENTIAL

● To prevent rattling noise that may occur with the constant-mesh type reverse gearing, No.1 reverse idler gear is fitted with a sub gear that has the same number of teeth as the No. 1 reverse idler gear. The sub gear is preloaded in the rotating direction by a spring so that it functions to reduce backlash between gear teeth and consequent rattling noise when the No. 1 reverse gear meshes with the reverse drive gear.



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- (1) Sub gear
- (2) No. 1 reverse idler gear

- (3) Spring
- (4) Reverse drive gear

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## SHIFT AND SELECT MECHANISM

MANUAL TRANSMISSION AND DIFFERENTIAL

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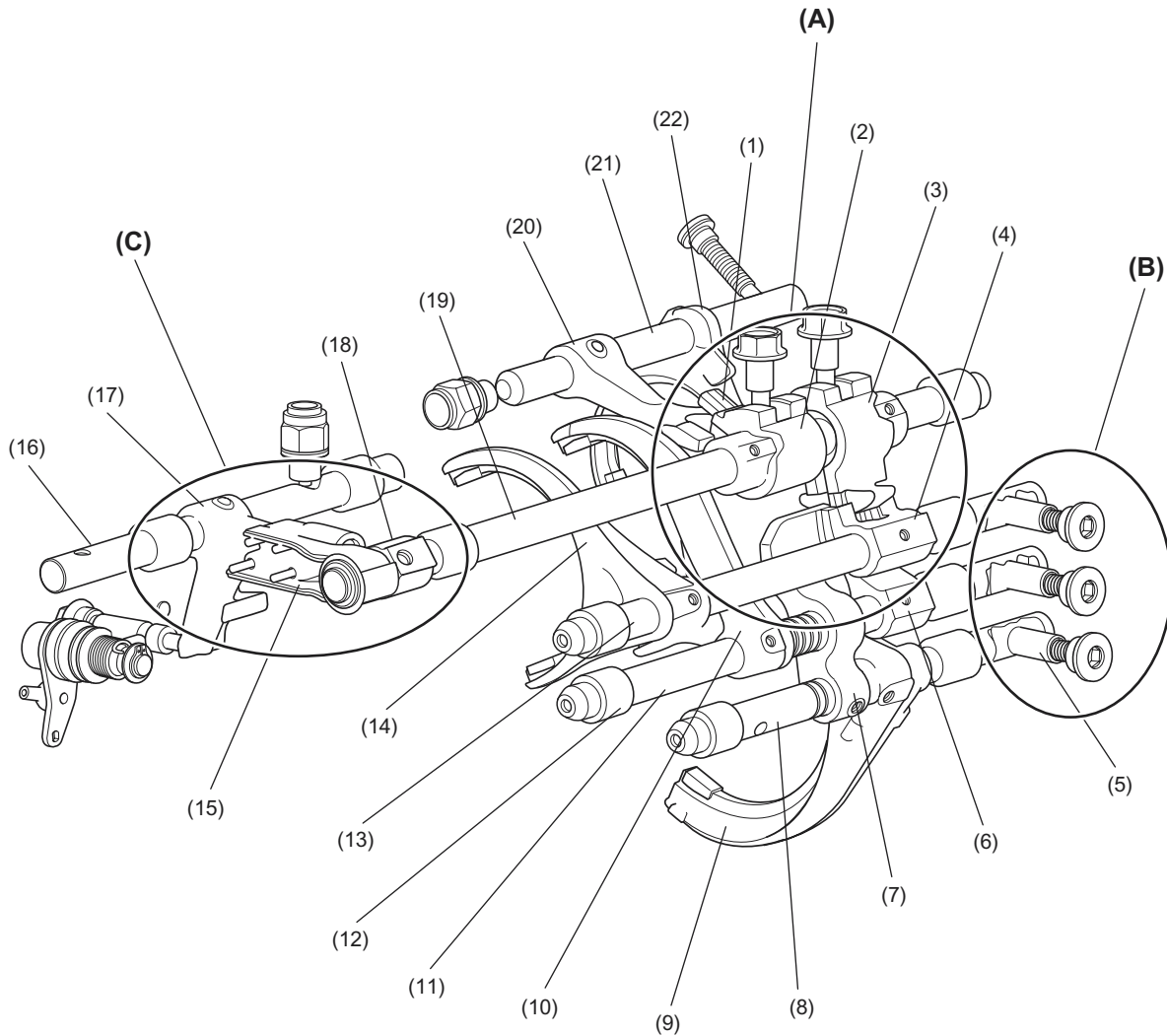
### 5. Shift and Select Mechanism

- The shifter fork and fork rods have a detent mechanism using a plunger with a ball in it and is supported with a slidable ball bearing. The detent mechanisms give the driver distinctive detent feeling and the slidable ball bearings help reduce the shift lever operating force.
- All shifter forks are made of aluminum die casting and the shifter arm shaft is formed as a hollow type to minimize the overall weight of the transmission.
- Gear double meshing is prevented by a mechanism that uses interlock blocks.
- The select return mechanism (which returns the selector lever to the neutral position) uses a U-shaped leaf spring.

# SHIFT AND SELECT MECHANISM

## MANUAL TRANSMISSION AND DIFFERENTIAL

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- |                                    |                          |                           |
|------------------------------------|--------------------------|---------------------------|
| <b>(A)</b> Interlock mechanism     | (6) 3rd-4th shifter arm  | (15) Neutral set spring   |
| <b>(B)</b> Shift detent mechanism  | (7) 1st-2nd shifter arm  | (16) Shifter arm shaft    |
| <b>(C)</b> Select return mechanism | (8) 1st-2nd shift fork   | (17) No. 1 selector arm   |
| (1) Interlock arm                  | (9) 1st-2nd shift fork   | (18) No. 2 selector arm   |
| (2) Reverse interlock block        | (10) 3rd-4th shift fork  | (19) Striking rod         |
| (3) Interlock block                | (11) 3rd-4th shifter rod | (20) Reverse shifter arm  |
| (4) 5th-6th shifter arm            | (12) Slidable bearing    | (21) Reverse fork rod     |
| (5) Shifter plunger                | (13) 5th-6th fork rod    | (22) Reverse shifter fork |
|                                    | (14) 5th-6th shift fork  |                           |



# SHIFT AND SELECT MECHANISM

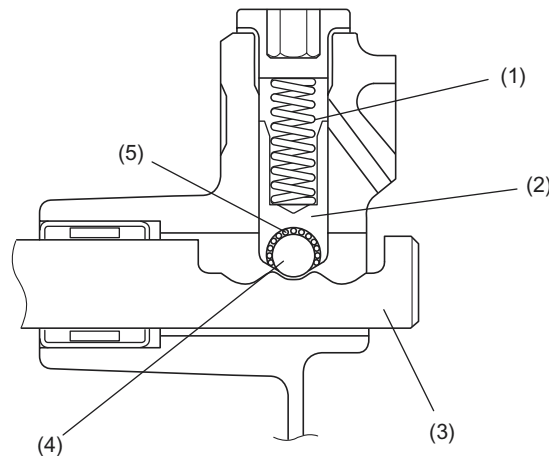
MANUAL TRANSMISSION AND DIFFERENTIAL

## A: MECHANISM

### 1. SHIFT DETENT MECHANISM

The shift detent mechanism allows the driver to distinctively feel the shift into a gear. The mechanism also prevents the transmission from jumping out of gear.

The shift detent mechanism uses a plunger with a check ball in it. The check ball is held under a small bowl which has the function of reducing friction during a shift and with the detent mechanism on the fork rod, generating a force to retain a gear in the selected position.



MT-00898

- (1) Spring
- (2) Plunger
- (3) Fork rod

- (4) Check ball
- (5) Bowl

# SHIFT AND SELECT MECHANISM

MANUAL TRANSMISSION AND DIFFERENTIAL

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## 2. SELECT RETURN MECHANISM

The select return mechanism allows the shift lever to return to the neutral position.

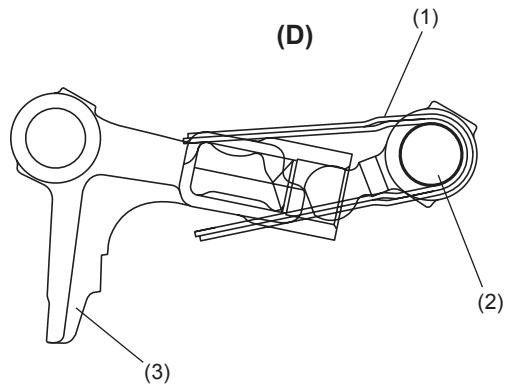
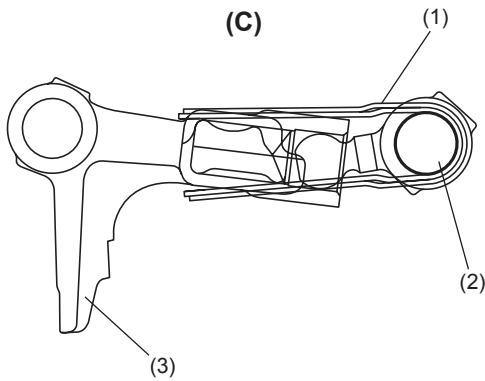
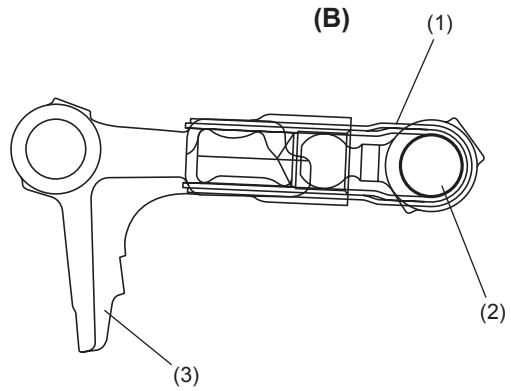
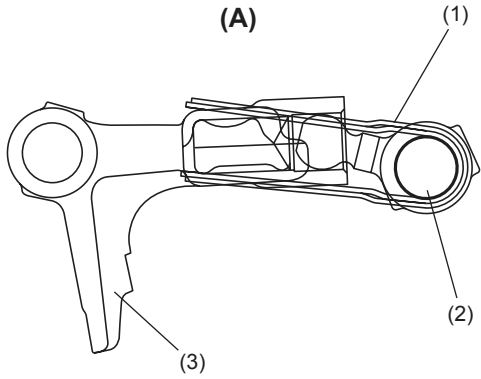
The neutral set spring pinches between its two arms the four convex portions on the No. 1 selector arm to hold the shift lever always in the neutral position. When the driver moves the shift lever in a select direction, the No. 1 and No. 2 selector arms turn about their axes, changing their relative angle.

This causes a pair of diagonally opposing convex portions on the No. 1 selector arm to open the neutral set spring. When the driver then releases the shift lever, the opened neutral set spring pushes by its returning force the convex portions to bring the selector arms back to the neutral position.

# SHIFT AND SELECT MECHANISM

MANUAL TRANSMISSION AND DIFFERENTIAL

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- (1) Neutral set spring
- (2) No. 2 selector arm
- (3) No. 1 selector arm

- (A) 1st-2nd
- (B) Neutral/3rd-4th
- (C) 5th-6th
- (D) Reverse

# SHIFT AND SELECT MECHANISM

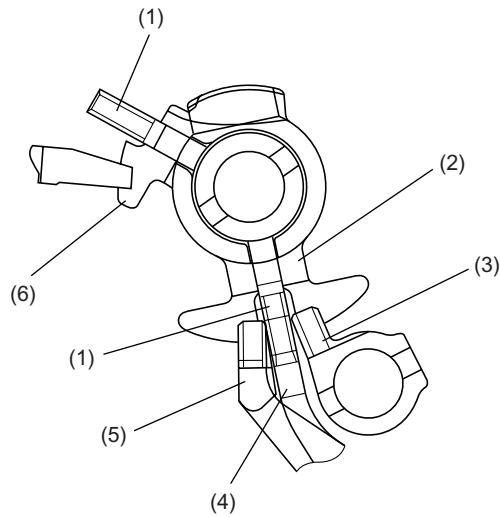
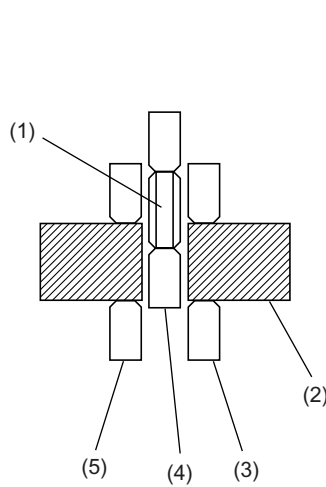
## MANUAL TRANSMISSION AND DIFFERENTIAL

### 3. INTERLOCK MECHANISM (DOUBLE-MESHING PREVENTION MECHANISM)

The interlock mechanism makes it impossible to shift the transmission into two gears at once. When the interlock arm selects the shifter arm corresponding to the gear into which the driver is going to make a shift, the interlock blocks also move in the same select direction, preventing the other shifter arms from being selected.

The gap between the two blocks is adjusted such that only one shifter arm can enter it, so the interlock blocks prevent the other two shifter arms from being selected even if the driver operates the shift lever in a way that otherwise would cause simultaneous engagement of two gears.

- **When shift lever is properly operated**



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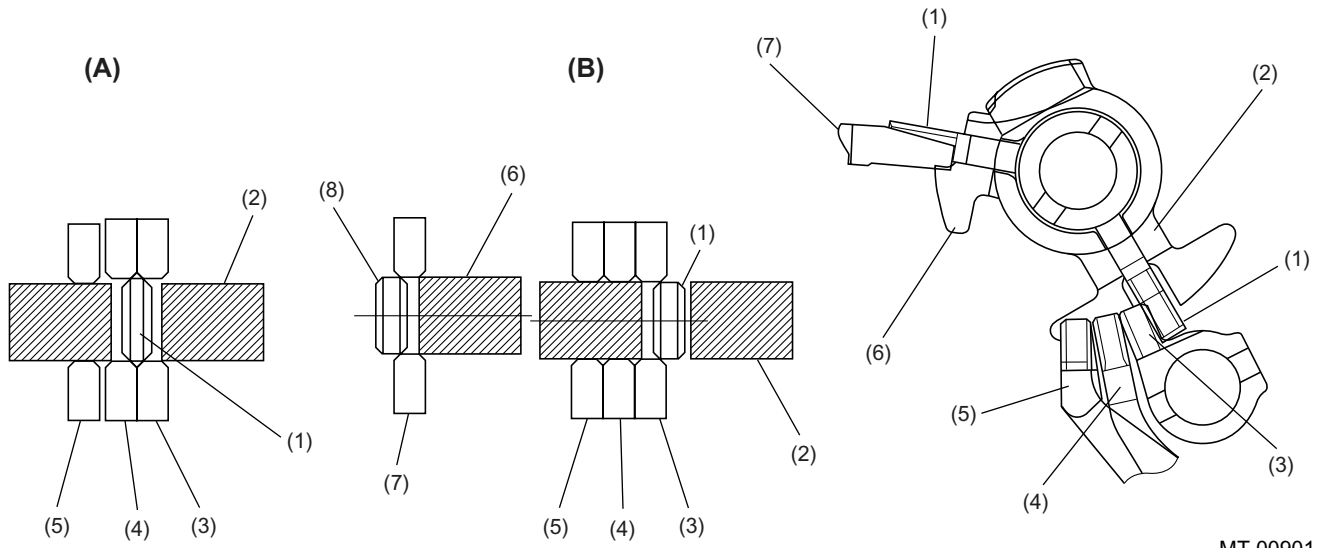
- (1) Interlock arm
- (2) Interlock block
- (3) 5th–6th shifter arm

- (4) 3rd–4th shifter arm
- (5) 1st–2nd shifter arm
- (6) Reverse interlock block

# SHIFT AND SELECT MECHANISM

MANUAL TRANSMISSION AND DIFFERENTIAL

## • When “double meshing” is prevented



### (A) Preventing 3rd and 5th double meshing

- (1) Interlock arm
- (2) Interlock block
- (3) 5th-6th shifter arm
- (4) 3rd-4th shifter arm

### (B) Preventing 6th and reverse double meshing

- (5) 1st-2nd shifter arm
- (6) Reverse interlock block
- (7) Reverse shifter arm
- (8) Reverse interlock block

## REVERSE CHECK MECHANISM

MANUAL TRANSMISSION AND DIFFERENTIAL

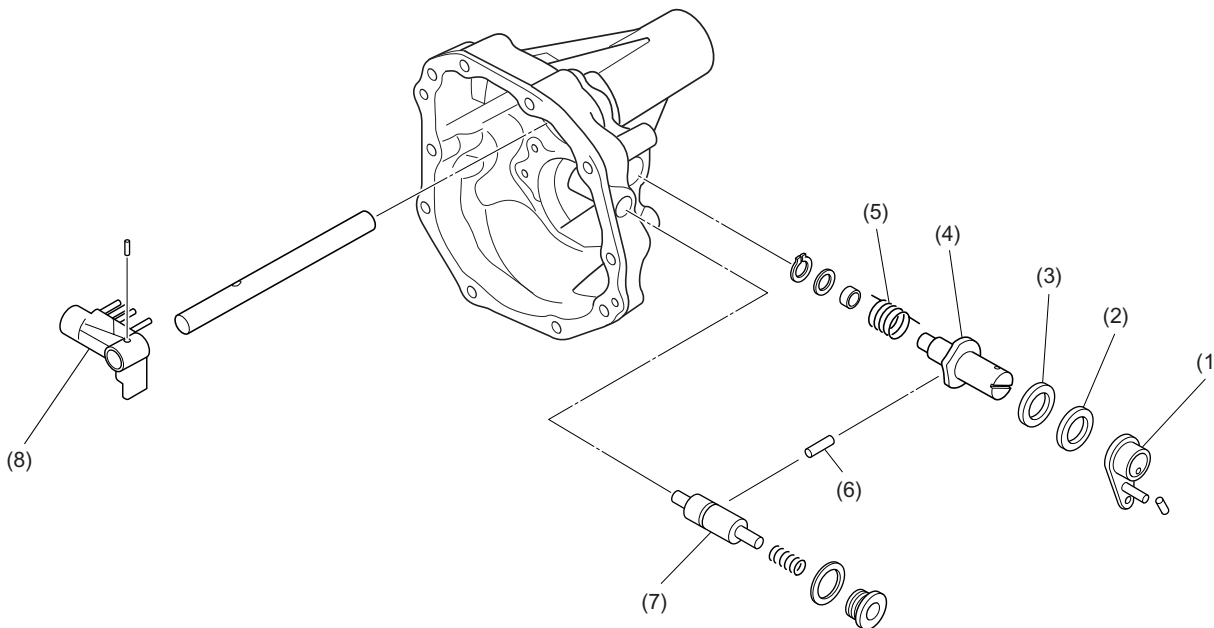
### 6. Reverse Check Mechanism

The reverse check mechanism prevents the reverse gear from being accidentally engaged when the driver makes a shift into the 5th or 6th gear. This mechanism is provided with a fail-safe function which enable shifting into reverse if the reverse check cable should be broken.

#### A: CONSTRUCTION

The reverse check mechanism is located inside the extension case.

It consists of a reverse check lever, oil seal, bearing, reverse check shaft, spring, plug and reverse check plug.



MT-00902

- |                         |                           |
|-------------------------|---------------------------|
| (1) Reverse check lever | (5) Spring                |
| (2) Oil seal            | (6) Interlock plunger     |
| (3) Bearing             | (7) Reverse check plunger |
| (4) Reverse check shaft | (8) No. 1 selector arm    |

# REVERSE CHECK MECHANISM

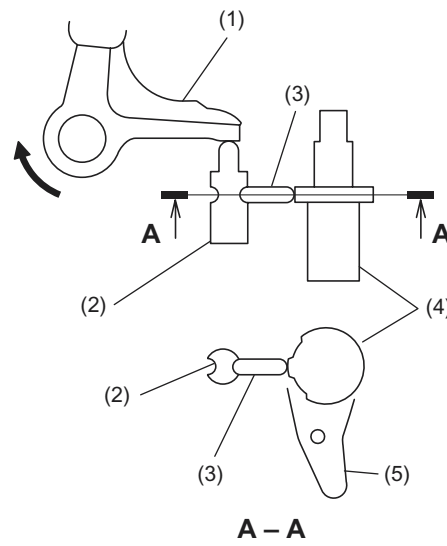
MANUAL TRANSMISSION AND DIFFERENTIAL

## B: OPERATION

### 1. MAKING SHIFT INTO 5TH/6TH

When the shift lever is moved into the 5th or 6th position, the No. 1 selector arm comes into contact with the reverse check plunger, trying to move the reverse check plunger.

However, one end of the interlock plunger is in contact with the cam lobe on the reverse check shaft and the other end is held in the groove in the reverse check plunger, so the selector arm cannot move in the reverse gear selecting direction.



MT-00903

- (1) No. 1 selector arm
- (2) Reverse check plunger
- (3) Interlock plunger

- (4) Reverse check shaft
- (5) Reverse check lever

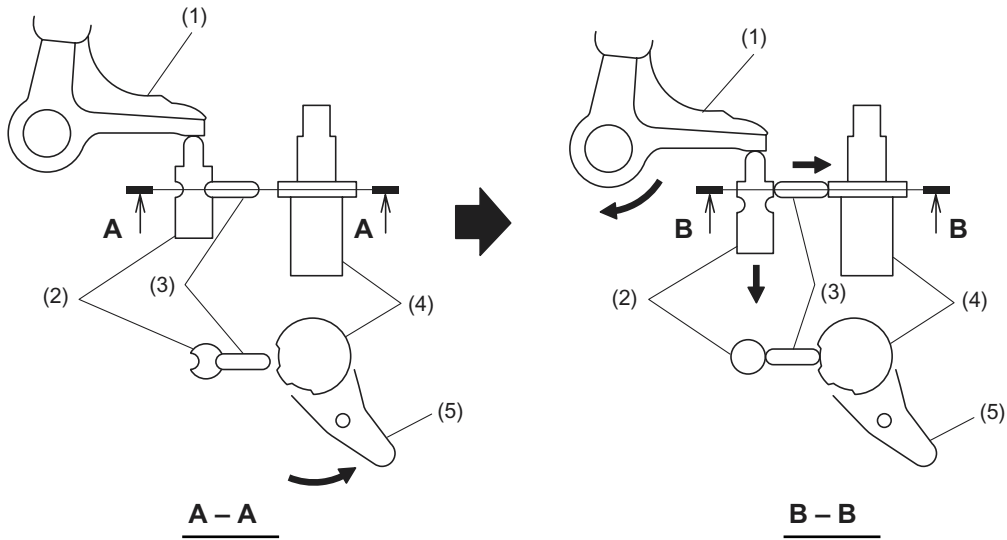
# REVERSE CHECK MECHANISM

## MANUAL TRANSMISSION AND DIFFERENTIAL

### 2. MAKING SHIFT INTO REVERSE

When making a shift into reverse, the driver lifts the slider on the shift lever. The upward movement of the slider causes, via the reverse check cable, the reverse check shaft to turn such that the cam lobe on the reverse check shaft becomes clear of the interlock plunger.

The interlock plunger can now move toward the reverse check shaft, allowing the selector arm to turn in the reverse gear selecting direction.



MT-00904

- (1) Selector arm
- (2) Reverse check plunger
- (3) Interlock plunger

- (4) Reverse check shaft
- (5) Reverse check lever

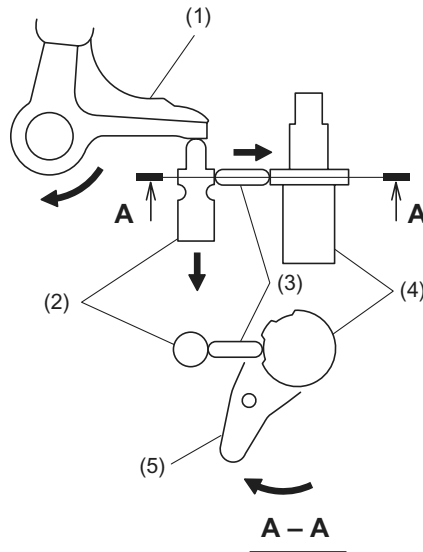


# REVERSE CHECK MECHANISM

MANUAL TRANSMISSION AND DIFFERENTIAL

## 3. FAIL-SAFE OPERATION

Should the reverse check cable be broken, the reverse check shaft turns clockwise by a spring force, making the plunger get clear of the cam lobe of the reverse check shaft. The plunger can now move toward the reverse check shaft, allowing the selector arm to turn in the reverse gear selecting direction.



MT-00905

- |                           |                         |
|---------------------------|-------------------------|
| (1) Selector arm          | (4) Reverse check shaft |
| (2) Reverse check plunger | (5) Reverse check lever |
| (3) Interlock plunger     |                         |

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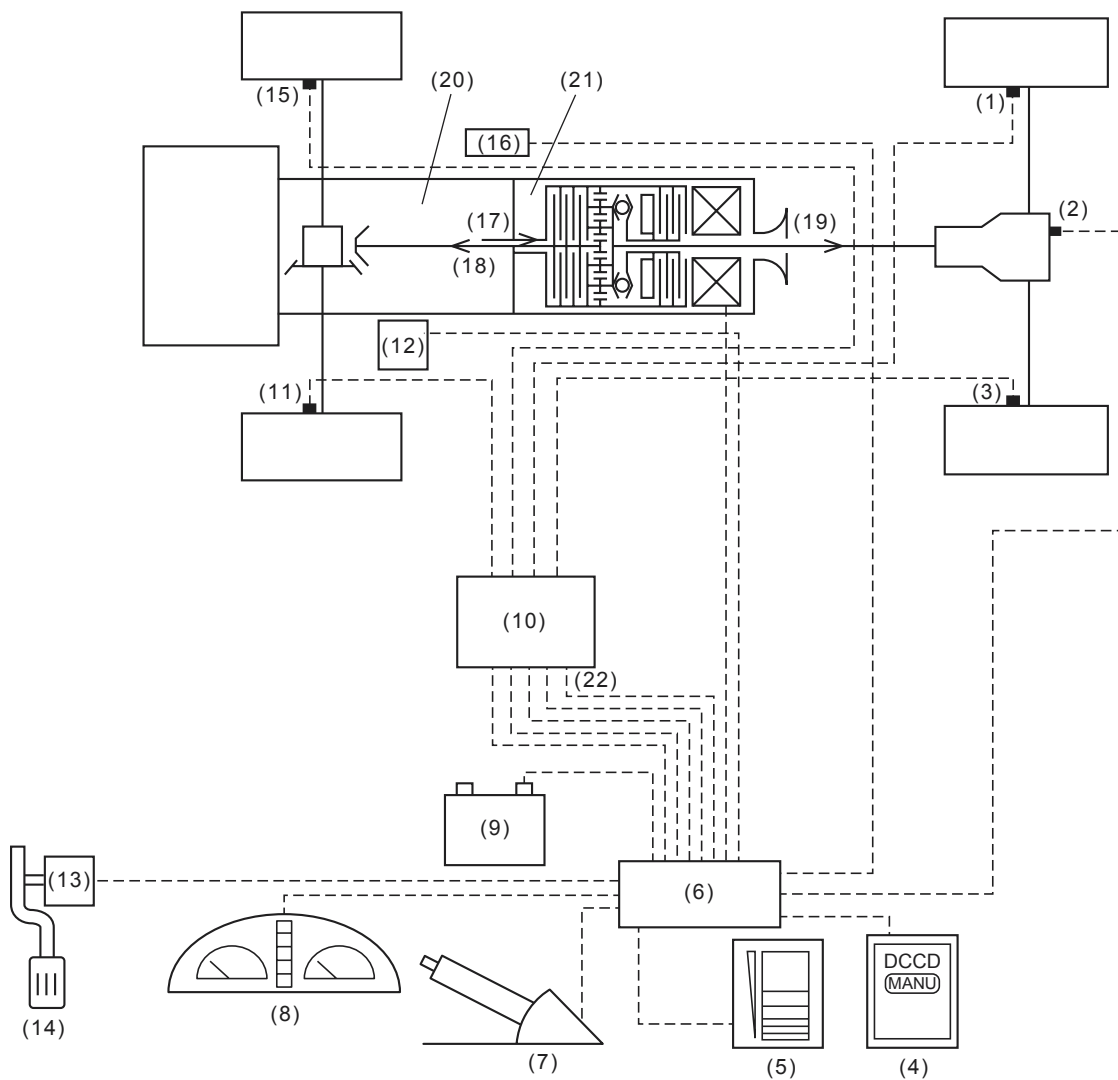
## DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

### 7. Driver-controllable Center Differential System

#### A: FEATURES

- The driver-controllable center differential system consists of a planetary gear set and electromagnetically engaged variably controlled multi plate clutches, distributing the drive torque to the front and rear wheels at a ratio of 35 : 65. The driver can optionally change the locking rate of the center differential.
- The system optimally controls the restricting action of the center differential using a computer and works together with the ABS control.



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# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

- (1) Wheel speed sensor (RR)
- (2) Rear differential oil temperature switch
- (3) Wheel speed sensor (RL)
- (4) Manual mode switch
- (5) Control dial
- (6) Driver-controllable center differential unit
- (7) Parking brake switch
- (8) Driver-controllable center differential indicator light
- (9) Battery
- (10) ABSCU & H/U
- (11) Wheel speed sensor (FL)
- (12) Brake light switch
- (13) Throttle position sensor
- (14) Accelerator pedal
- (15) Wheel speed sensor (FR)
- (16) Lateral G sensor
- (17) Input from main reduction gear
- (18) Front output
- (19) Rear output
- (20) Transmission assembly
- (21) Center differential
- (22) ABS monitor signal

Control	Auto mode	Manual mode
Hand brake control	yes	yes
Brake control	yes	yes
Center differential control	yes	yes
Fail-safe control	yes	yes
ABS control	yes	yes
Throttle respondent torque control	yes	yes
Slip control	yes	no
Tight cornering control	yes	yes
Volume control	no	yes
Cornering control	yes	no
Rear differential oil control	yes	yes

## ● Hand brake control

When the hand brake is operated, the current to the coil is lowered to forcibly free the center differential.

## ● Brake control

Controls the center differential restriction torque toward the free state in response to brake switch input.

## ● Center differential control

Based on throttle respondent torque control and slip control as basic controls, the differential restriction torque of the center differential is controlled between the free state and locked state through PWM control. Also, information received from other various switches and sensors are used in correcting the instruction torque for center differential control.

## ● Fail-safe control

If a failure such as breakage of the coil drive element is detected, the coil driving power is turned off and warning indication is given on the meter cluster at a 1 Hz cycle to call attention of the driver. If a failure occurs in any of the sensors, a fixed value is substituted for the value from the failed sensor to maintain control as usual, while activating a warning indication on the meter at a 1 Hz cycle to call attention of the driver.

## ● ABS control

When the ABS operates, the ABSCU & H/U outputs an activating signal to the center differential control unit to decrease the differential restriction torque of the driver-controllable center differential.

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL

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- Throttle respondent torque control

Controls the restriction torque of the center differential in response to the throttle opening. The restriction torque of the center differential calculated for each mode is corrected using particular values, however, basically toward the locked state when the throttle is wide open or toward the free state when the throttle is fully closed.

- Slip control

Controls the restriction torque of the center differential based on the amount of slip derived from the speed of four wheels.

- Tight cornering control

A correction value is calculated from the left and right wheel speed ratio and applied to the restriction torque of center differential, which is derived from the throttle respondent, slip control, etc.

- Volume control

By operating the control dial, the driver can optionally control the restriction torque of the center differential.

- Cornering control

The restriction torque of center differential is controlled based on a value derived from the throttle opening, lateral G sensor, four wheel speeds, etc.

- Rear differential oil control

When the rear differential oil temperature rises and the oil temperature switch activates, the center differential restriction torque is controlled toward the free state.

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

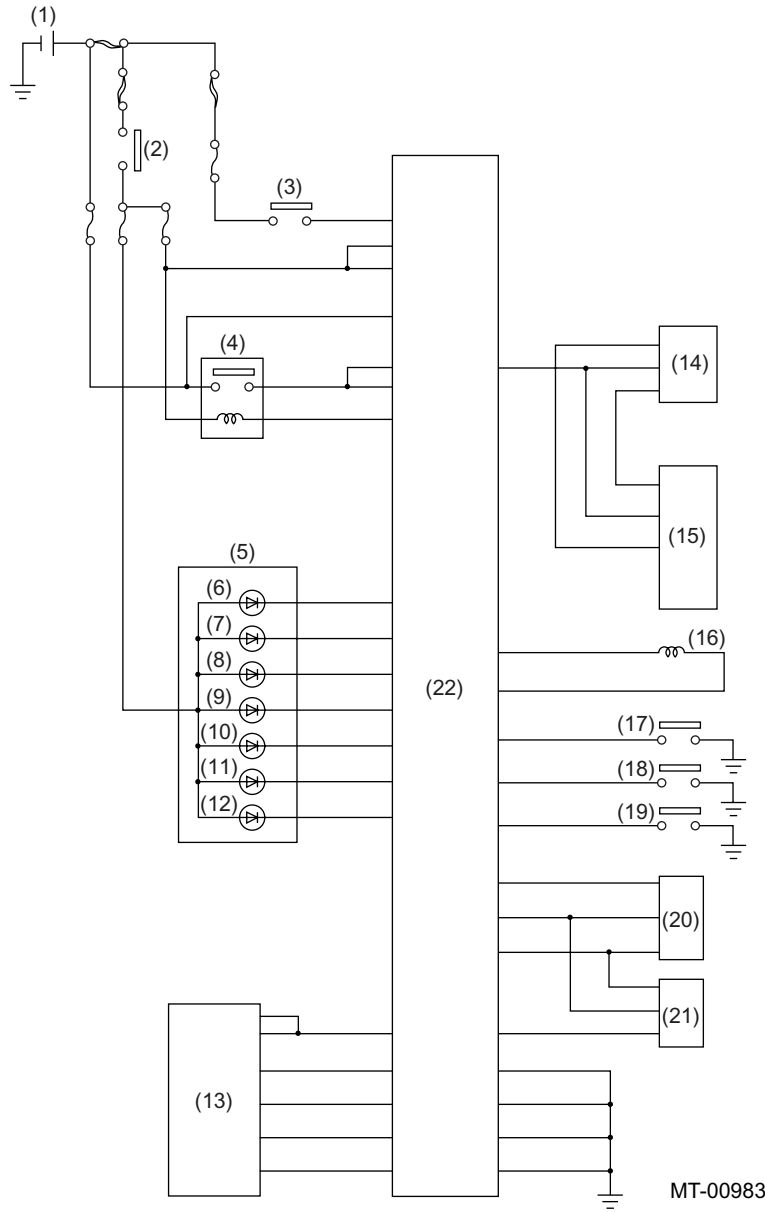
MANUAL TRANSMISSION AND DIFFERENTIAL

## B: INPUT AND OUTPUT SIGNALS

Name	Function
Driver-controllable center differential	In response to the signal from the driver-controllable center differential control unit, the current is varied to change the transmitting torque of the multi-plate clutch and control the differential torque.
Driver-controllable center differential control unit	Processes the signals from various sensors and switches and controls the current to the driver-controllable center differential.
Lateral G sensor	Sends information on acceleration of the vehicle in lateral directions to the driver-controllable center differential control unit.
Driver-controllable center differential indicator light	Indicates the locking rate of the center differential in a range from 0% to 100%.
Manual mode switch	Switches the driver-controllable center differential control mode between auto and manual.
Control dial	Enables to manually select the locking rate of the center differential in a range from 0% to 100%.
Rear differential oil temperature switch	Sends a signal to the driver-controllable center differential control unit if the rear differential oil temperature rises abnormally.
Parking brake switch	Sends information on the parking brake operational status to the driver-controllable center differential control unit.
Stop light switch	Sends information on the brakes' operational status to the driver-controllable center differential control unit.
Throttle position sensor	Sends information on the throttle valve opening to the driver-controllable center differential control unit.
ABSCU & H/U	Sends ABS monitor signals to the driver-controllable center differential control unit.

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL



# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

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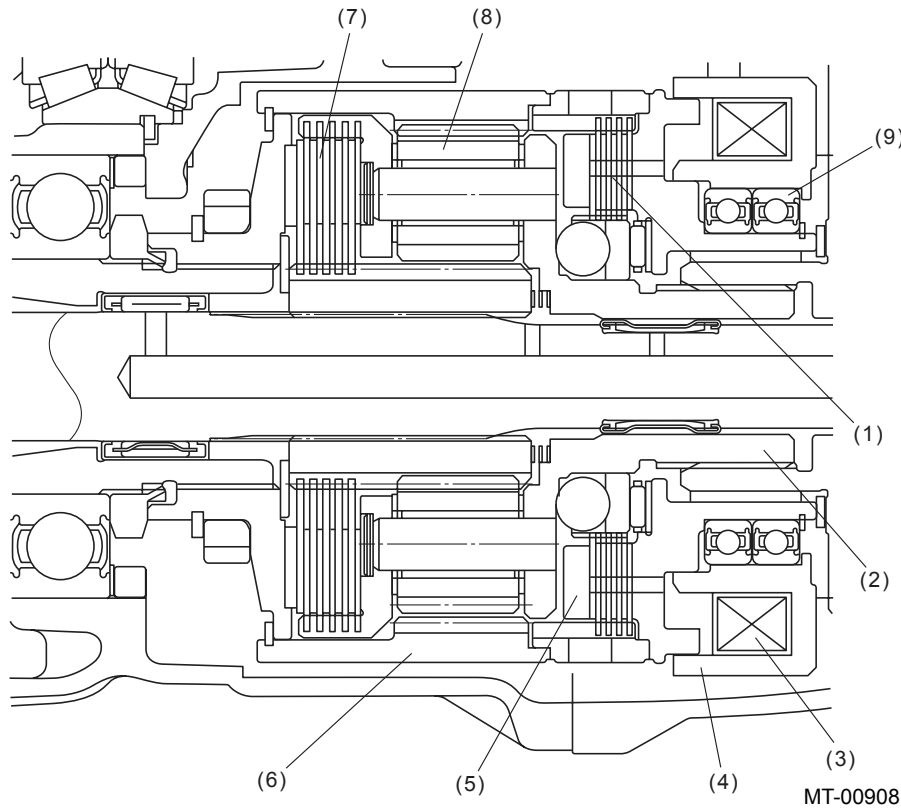
- |   |   |
|---|---|
| (1) Battery   | (12) Indicator light                                      |
| (2) Ignition relay  | (13) ABSCU & HU   |
| (3) Stop light switch   | (14) Throttle position sensor                             |
| (4) Driver-controllable center differential relay                             | (15) Engine control unit                                  |
| (5) Combination meter   | (16) Driver-controllable center differential              |
| (6) Driver-controllable center differential indicator light<br>(0% locked)    | (17) Parking brake switch                                 |
| (7) Driver-controllable center differential indicator light<br>(15% locked)   | (18) Manual mode switch                                   |
| (8) Driver-controllable center differential indicator light<br>(35% locked)   | (19) Rear differential oil temperature switch             |
| (9) Driver-controllable center differential indicator light<br>(65% locked)   | (20) Control dial   |
| (10) Driver-controllable center differential indicator light<br>(85% locked)  | (21) Lateral G sensor                                     |
| (11) Driver-controllable center differential indicator light<br>(100% locked) | (22) Driver-controllable center differential control unit |

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL

### C: DRIVER-CONTROLLABLE CENTER DIFFERENTIAL

- The driver-controllable center differential consists of a differential case, planetary carrier, planetary gears, electro-magnetic coils, armature, main clutch (multi-plate clutch), pilot clutch, and ball bearings.
- The engine torque enters the differential case from the transmission's driven shaft. The torque from the differential case is divided into front and rear directions at the planetary carrier; the torque to the front is transferred from the planetary carrier through the planetary gears to the sun gear, while the torque to the rear is transferred from the transfer drive gear (integrated with the planetary carrier) through the driven gear to the propeller shaft.
- If either of the front or rear wheels spins, the driver-controllable center differential controls the differential action between the front and rear wheels.



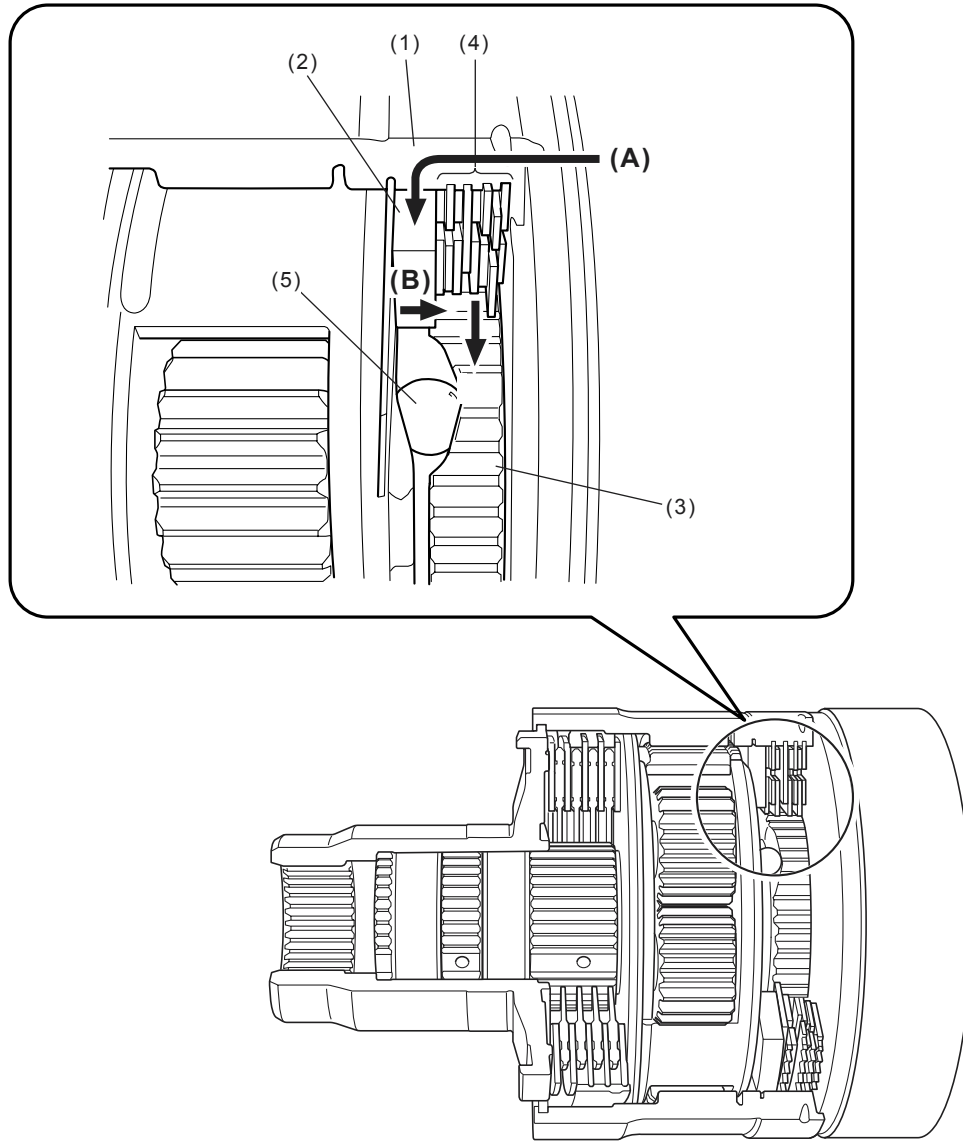
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|---------------------------|-----------------------|
| (1) Pilot clutch          | (6) Differential case |
| (2) Planetary carrier     | (7) Main clutch       |
| (3) Electro-magnetic coil | (8) Planetary gear    |
| (4) Electro-magnet        | (9) Ball bearing      |
| (5) Armature              |                       |



# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

- When current flows through the electromagnetic coils, magnetism is generated at components in the following sequence: electromagnet, differential case, armature (A). The armature is moved to the right (B) by this magnetism causing the pilot clutch to engage, and a magnetic field is formed in the area from the electromagnet, differential case, armature, and to the pilot clutch. The pilot clutch locks the differential case side and cam 1 side together, thus the rotational speed of the cam 1 and differential case are synchronized. The engagement of the pilot clutch is controlled by adjusting the current flowing through the electromagnetic coils.



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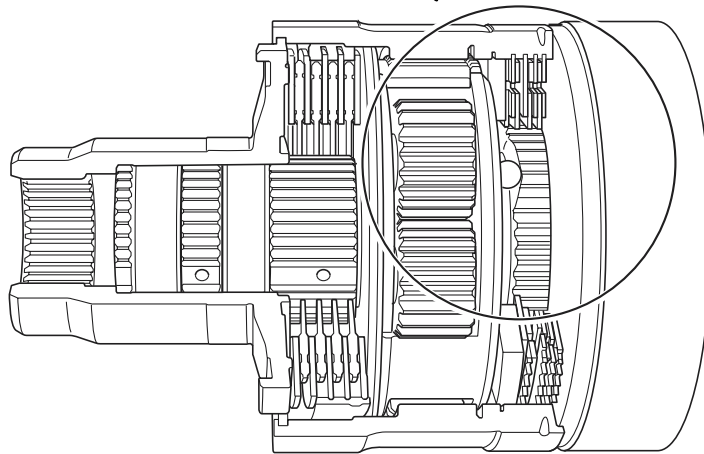
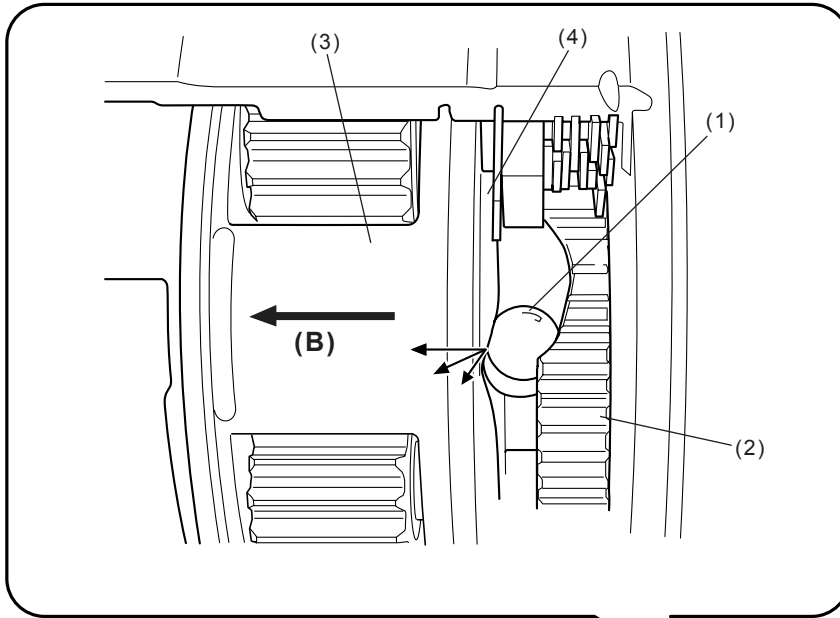
- (1) Differential case
- (2) Armature
- (3) Cam 1

- (4) Pilot clutch
- (5) Steel ball

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL

- When a speed difference occurs, a force (B) pushing the cam 2 to the left is generated at the steel balls sandwiched between cam 1 and cam 2, pushing the planetary carrier to the left.



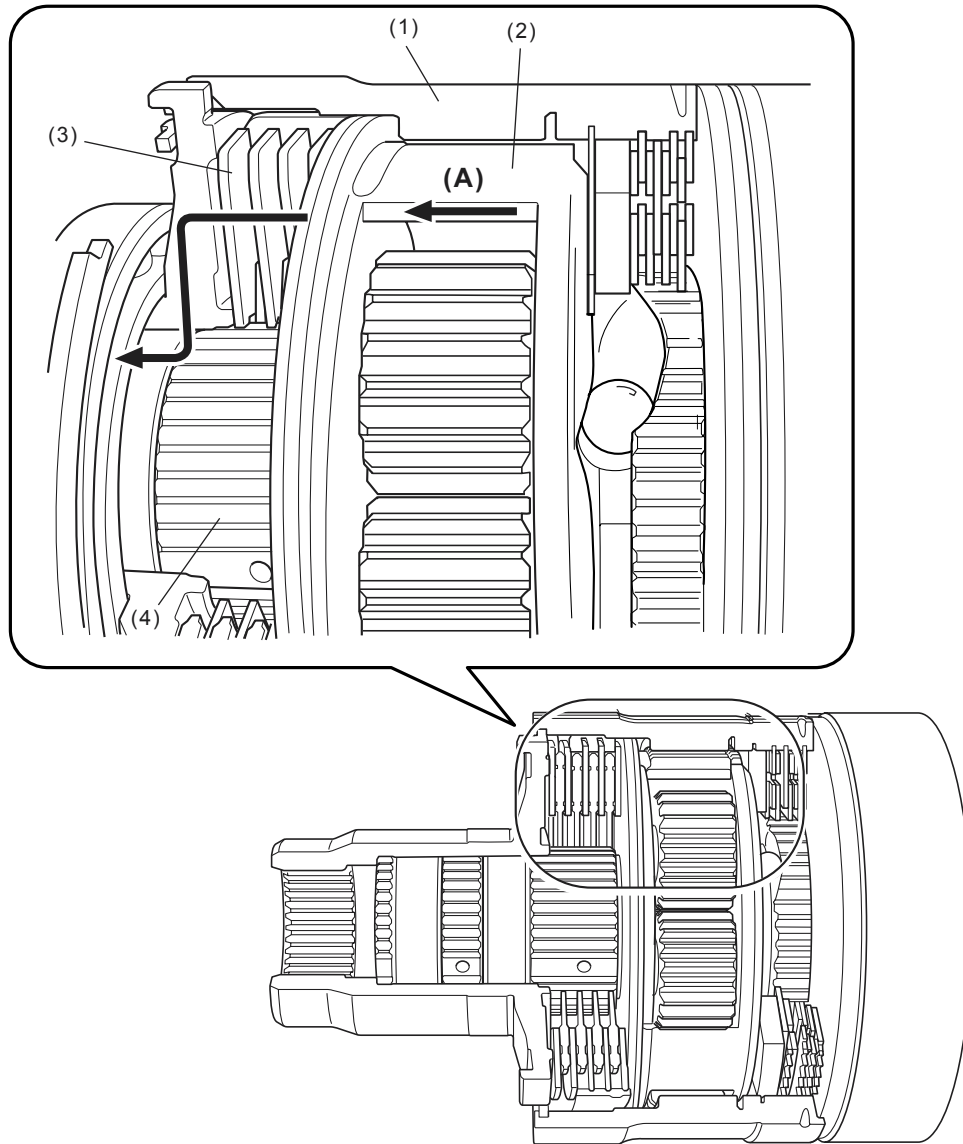
MT-00934

- (1) Steel ball
- (2) Cam 1
- (3) Planetary carrier
- (4) Cam 2

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

- When the planetary carrier moves to the left (A), the main clutch is engaged. The main gear locks the planetary gears and the sun gear together to generate a differential action restriction torque.



MT-00935

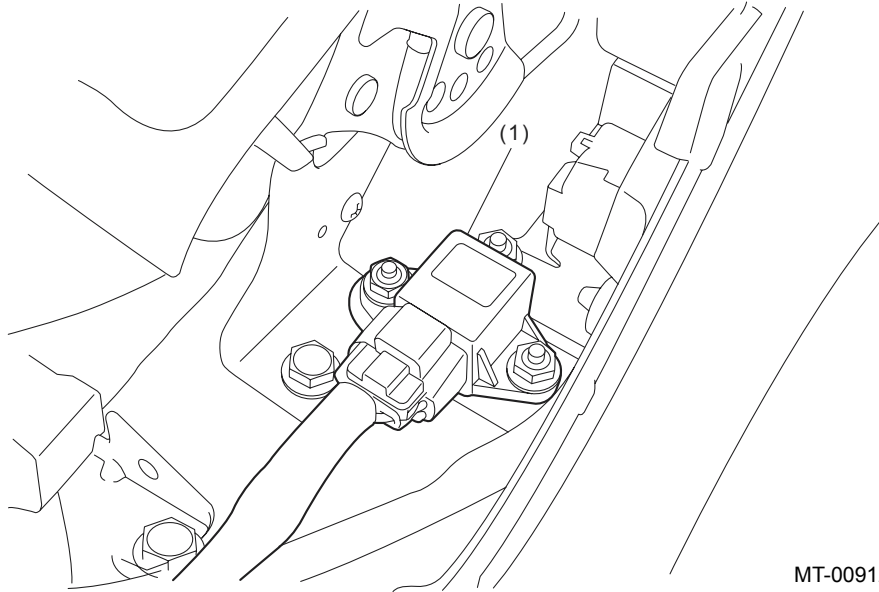
- (1) Differential case
- (2) Planetary carrier
- (3) Main clutch
- (4) Sun gear

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL

### D: LATERAL G SENSOR

A lateral G sensor is installed to the body at inside the console. The lateral G sensor detects the acceleration of the vehicle in the lateral direction and controls the differential action restriction torque.



MT-00912

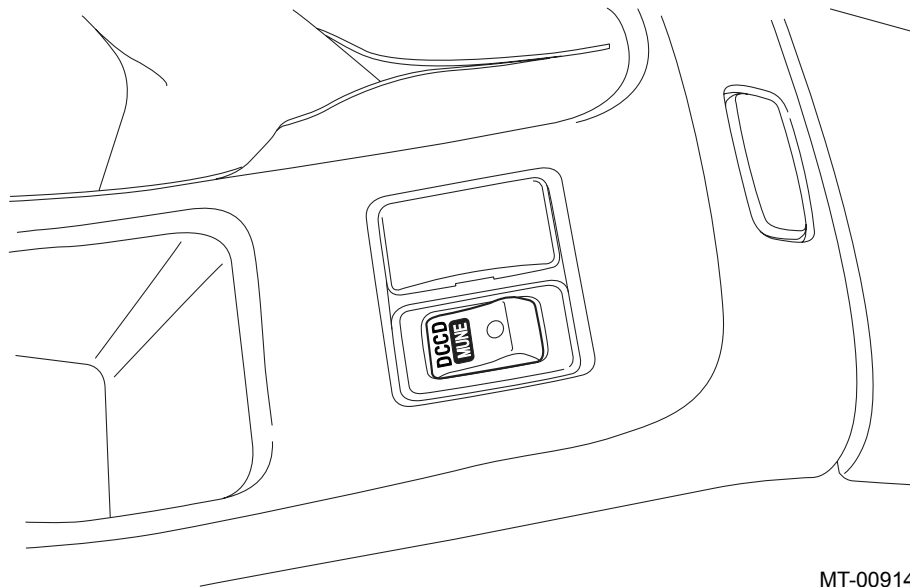
(1) Lateral G sensor

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

## E: MANUAL MODE SWITCH

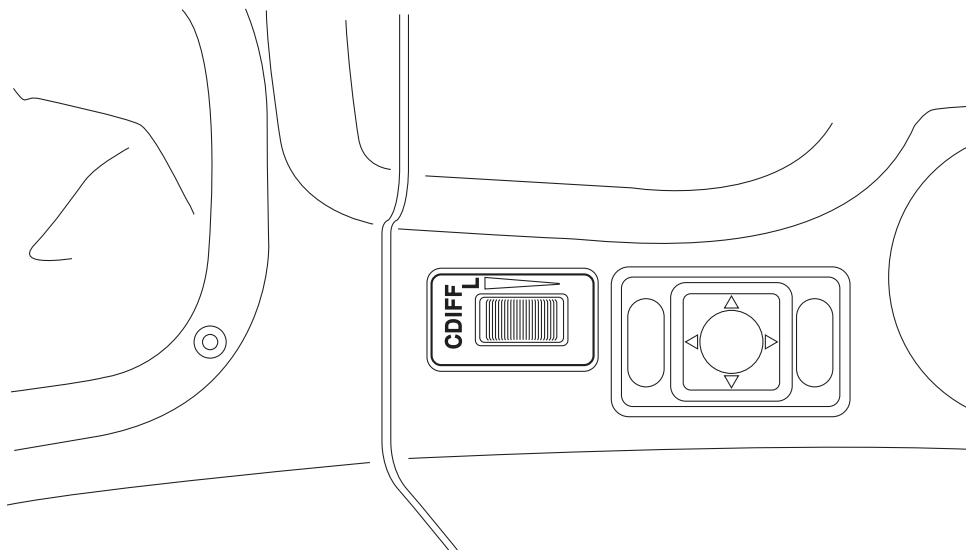
The manual mode switch enables the driver to select the mode (auto mode or manual mode) by pressing the switch each time.



MT-00914

## F: CONTROL DIAL

A rotary type switch is provided on the center console enabling the driver to optionally set the front-rear differential action restricting torque in the range between locking rate 0% (free) to 100% (locked). Also, detents are provided between free and locked positions.



MT-00915

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL

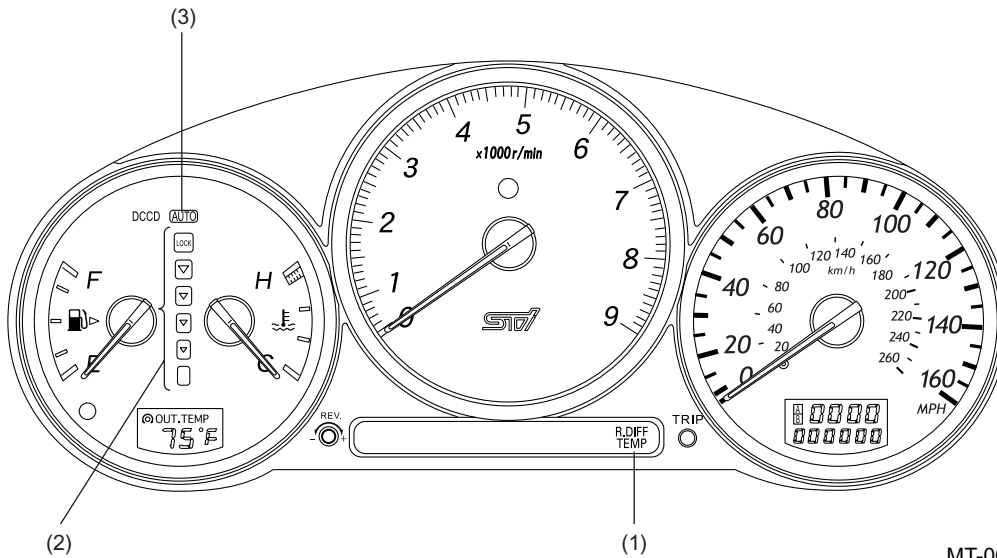
### G: DRIVER-CONTROLLABLE CENTER DIFFERENTIAL INDICATOR LIGHT

Driver-controllable indicator lights which indicate the locking rate of the center differential are provided in the meter cluster.

When the driver-controllable center differential is in the auto mode the “AUTO” at the upper part of the meter cluster illuminates, and when in manual mode and the differential restriction torque is varied manually the driver-controllable center differential indicator lights illuminate.

If the control unit detects a fault in a component or unit during self diagnosis, the driver-controllable center differential indicator lights flash until the ignition switch is turned OFF.

Faulty components or units can be identified by reading diagnostic trouble codes (DTC), and faults which occurred in the past can be retrieved from the memory.



MT-00977

- (1) Rear differential oil temperature warning light
- (2) Driver-controllable center differential indicator light
- (3) Driver-controllable differential auto mode indicator light

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

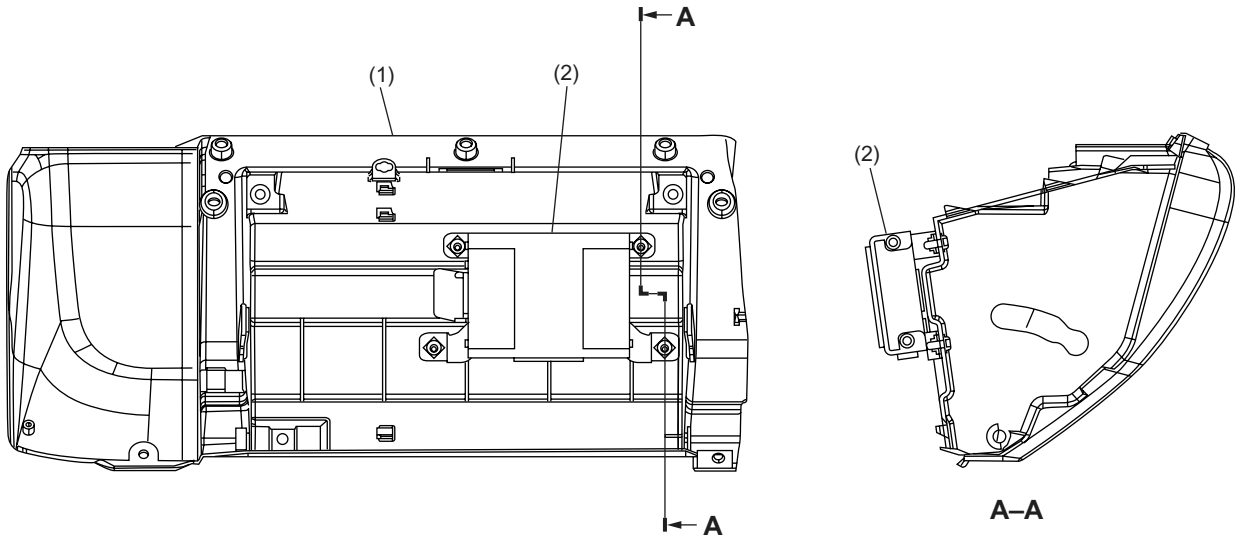
MANUAL TRANSMISSION AND DIFFERENTIAL

## H: DRIVER-CONTROLLABLE CENTER DIFFERENTIAL CONTROL UNIT

The control unit is located behind the glove box at the front passenger's side.

If the control unit detects a fault in a component or unit during self diagnosis, the driver-controllable center differential indicator light (FREE light at the bottom) flashes until the ignition switch is turned OFF.

Faulty components or units can be identified by reading diagnostic trouble codes (DTC), and faults which occurred in the past can be retrieved from the memory. The differential restriction torque of the driver-controllable center differential is controlled based on signals from various sensors and switches, ABS monitor signals and ABS wheel speed signals (from four wheels) from the ABSCU & H/U, and by taking into account the conditions of the road surface and the vehicle.



MT-00978

- (1) Glove box
- (2) Driver-controllable center differential control unit

# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

## MANUAL TRANSMISSION AND DIFFERENTIAL

### I: OPERATION

- When the vehicle is braked (A) while running:

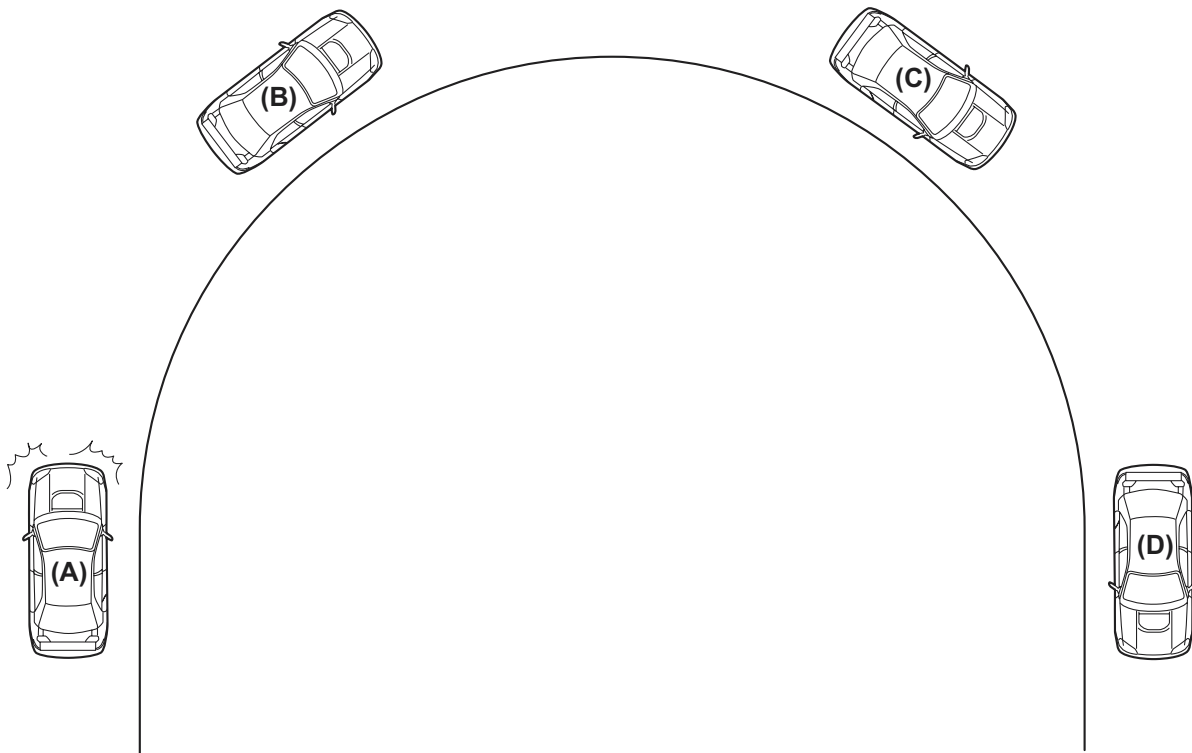
To enhance safety of the vehicle during braking the restriction force of the center differential is controlled toward the free state.

- When the vehicle is in between the turn-in point (B) and clipping point (C):

When the vehicle is running from the turn-in point toward the clipping point, the throttle opening increases (vehicle accelerates) and a signal from the lateral G sensor is input. Accordingly the center differential restriction torque is gradually increased to improve the cornering ability.

- When the vehicle is in between the clipping point (C) and exit point (D):

When the vehicle is running past the clipping point toward the exit point, the input from the lateral G sensor decreases. Accordingly the control interprets this as the vehicle is tracking out from the corner and increases the restricting force of the center differential toward the locked state to maintain traction.



MT-00922

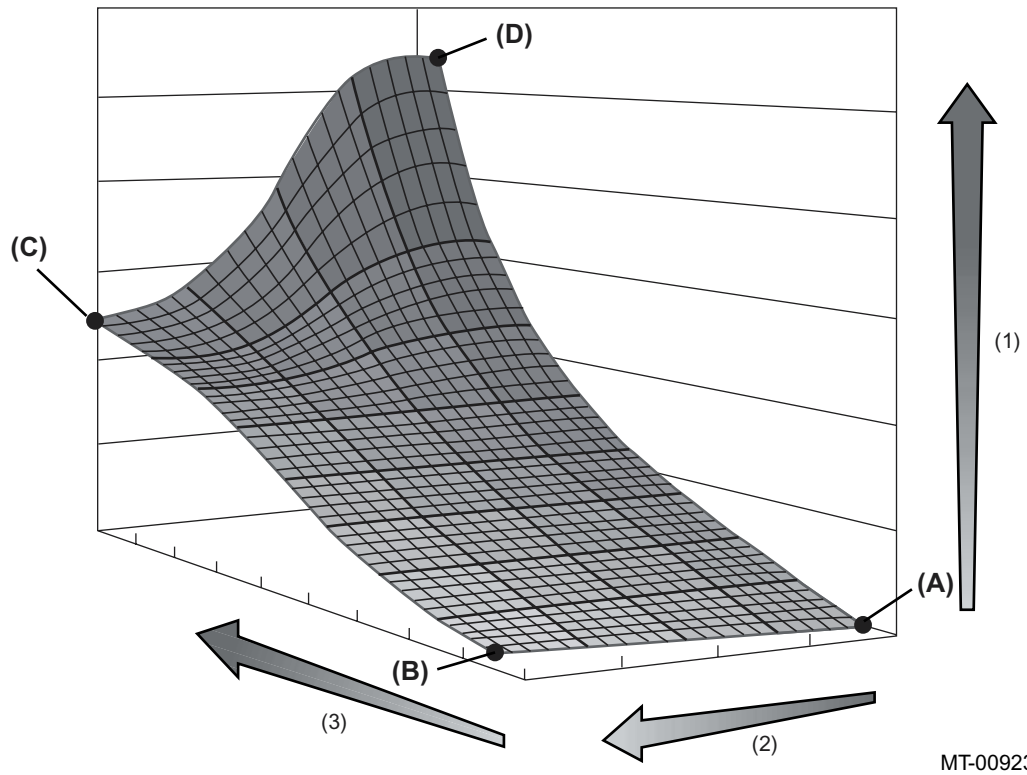
- (A) Braking
- (B) Turn-in point
- (C) Clipping point
- (D) Exit point



# DRIVER-CONTROLLABLE CENTER DIFFERENTIAL SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

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MT-00923

- (A) Braking
- (B) Turn-in point
- (C) Clipping point
- (D) Exit point

- (1) Center differential restriction torque
- (2) Lateral G
- (3) Throttle opening

## OIL PUMP

### MANUAL TRANSMISSION AND DIFFERENTIAL

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## 8. Oil Pump

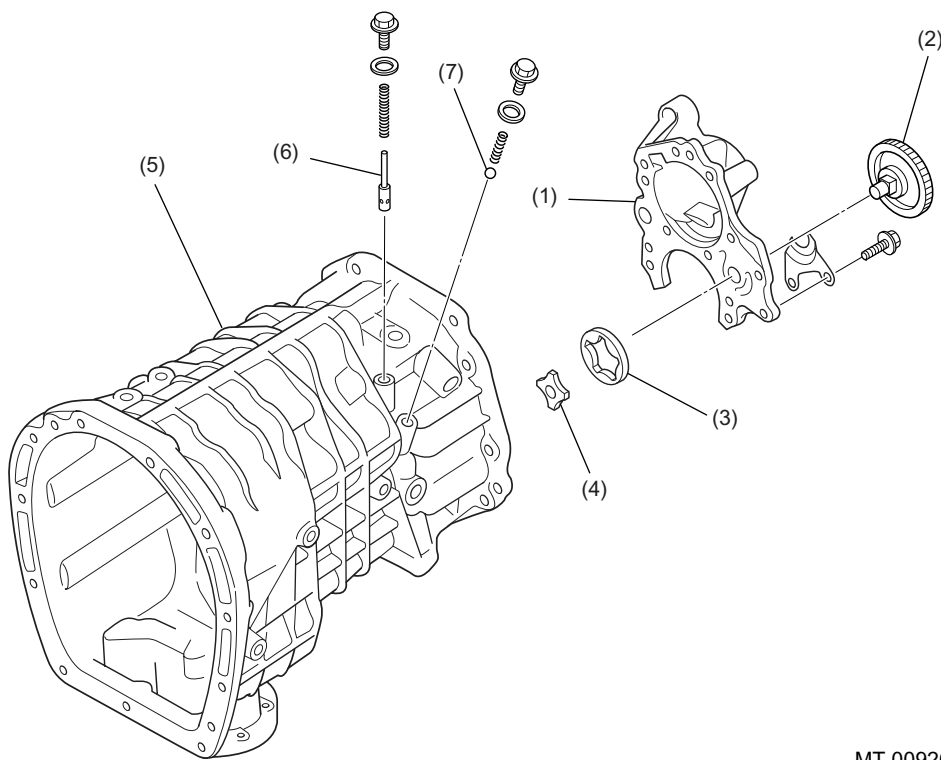
### A: CONSTRUCTION

The lubricating oil pump incorporated in the transmission case is of a trochoid type.

The pump consists of an inner rotor having four teeth, outer rotor having five teeth, oil pump cover and oil pump driven gear, which are all located at the rear of the transmission case.

The pump is driven by the drive gear located on the center differential, so the delivery rate varies with the speed of the center differential.

There are a pressure regulator valve and pressure relief valve on the delivery side of the pump.



MT-00926

- |                          |                              |
|--------------------------|------------------------------|
| (1) Oil pump cover       | (5) Transmission case        |
| (2) Oil pump driven gear | (6) Pressure regulator valve |
| (3) Outer rotor          | (7) Pressure relief valve    |
| (4) Inner rotor          |                              |

## LUBRICATION SYSTEM

MANUAL TRANSMISSION AND DIFFERENTIAL

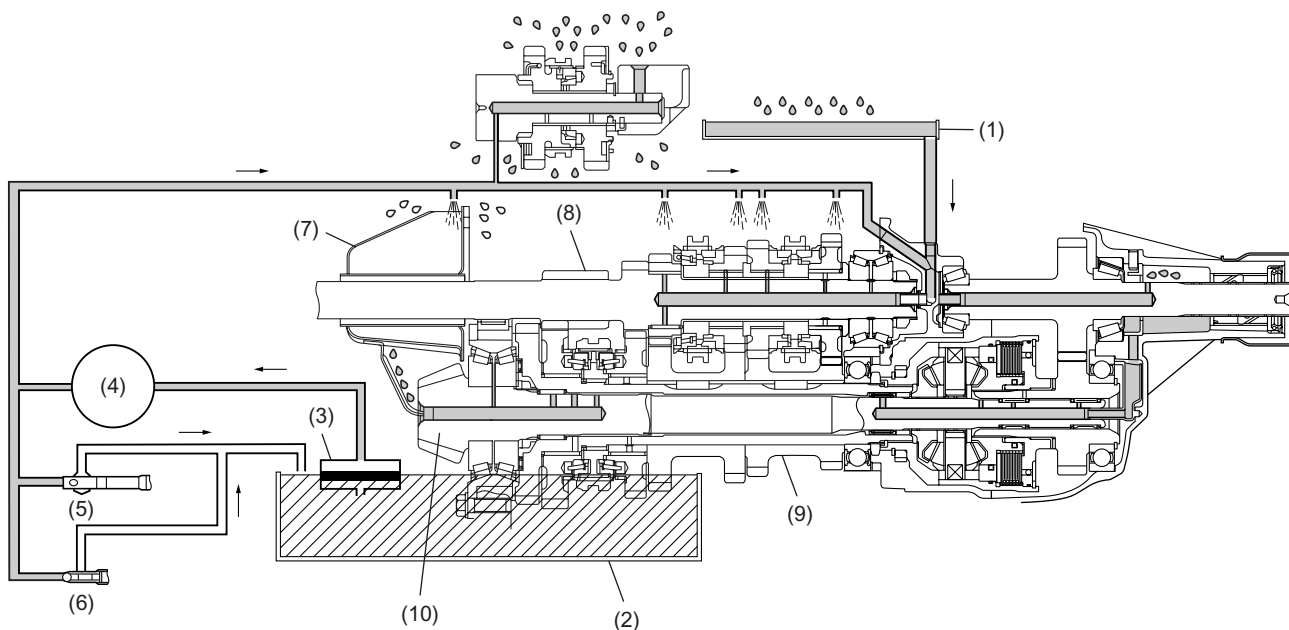
### 9. Lubrication System

A forced lubrication system using an oil pump has been employed to ensure adequate supply of oil to the components of the six-speed transmission.

The oil (gear oil) from the oil pump is distributed to the oil chamber, main shaft, drive pinion shaft, transfer gears, and other components.

The oil chamber has functions of accumulating oil and supplying with oil the central oil passage in the drive pinion shaft uninterruptedly.

In a conventional transmission without an oil chamber, the oil level is typically maintained at a height corresponding to the midpoint of the driven gear assembly. Such a large amount of gear oil (which has a relatively high viscosity) inflicts considerable frictional resistance on the gears when the transmission is operating. The use of the oil chamber can lower the oil level and thus reduce the friction between gears and oil by temporarily storing oil and supplying gears with it in an adequate amount.



MT-00927

- |                              |                           |
|------------------------------|---------------------------|
| (1) Oil guide                | (6) Pressure relief valve |
| (2) Oil pan                  | (7) Oil chamber           |
| (3) Oil strainer             | (8) Main shaft            |
| (4) Oil pump                 | (9) Driven gear assembly  |
| (5) Pressure regulator valve | (10) Drive pinion shaft   |

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## **FRONT DIFFERENTIAL (APTRAC TYPE LIMITED SLIP DIFFERENTIAL)**

MANUAL TRANSMISSION AND DIFFERENTIAL

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### **10.Front Differential (APTRAC Type Limited Slip Differential)**

#### **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**

In the APTRAC differential, there is a set of hexagonally-shaped cam followers placed between and kept in contact with the left and right face cams (which correspond to the side gears in a conventional differential).

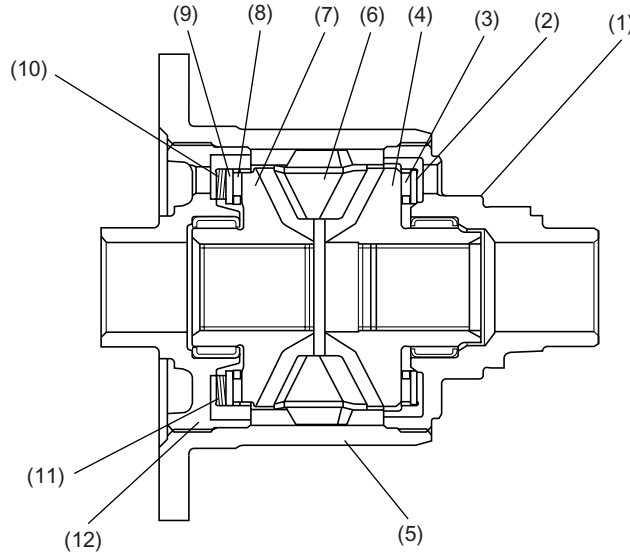
The cam followers engage at their outer ends with the slots that are cut on the inner surface of the cage in the axial direction, so they can slide laterally in the slots but must rotate together with the cage. Since the cam followers push the face cams as the cage rotates, the input torque to the cage is transmitted to the axle shafts.

There are a needle bearing and thrust washer pair between the face cam on each side and cage. Moreover, there is a Belleville spring between one of the needle bearing and thrust washer pairs to give preloading, thus ensuring proper initial friction between the cam followers and face cams.

# FRONT DIFFERENTIAL (APTRAC TYPE LIMITED SLIP DIFFERENTIAL)

MANUAL TRANSMISSION AND DIFFERENTIAL

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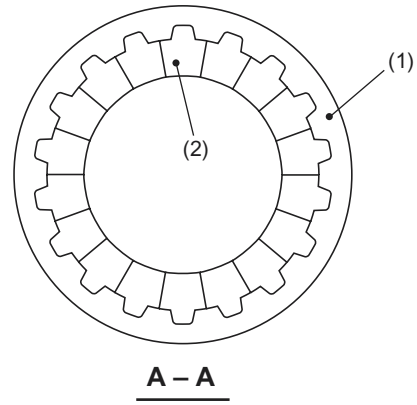
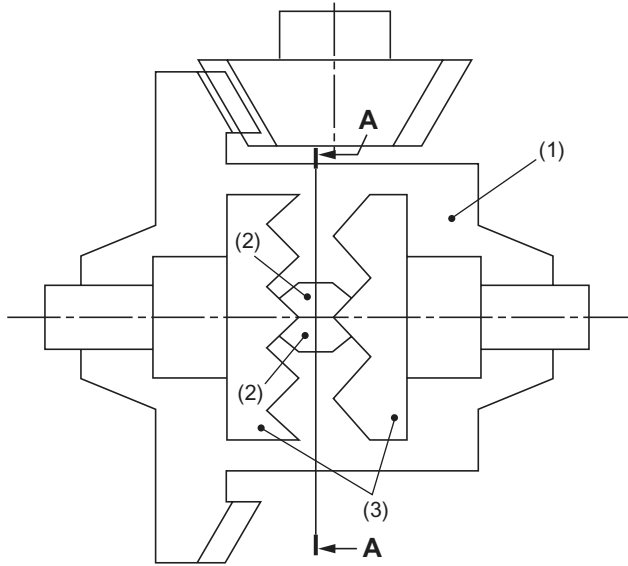


MT-00928

- |                    |                    |                        |
|--------------------|--------------------|------------------------|
| (1) Hub            | (5) Cage           | (9) Thrust washer      |
| (2) Thrust washer  | (6) Cam follower   | (10) Belleville spring |
| (3) Thrust bearing | (7) Face cam       | (11) Shim              |
| (4) Face cam       | (8) Thrust bearing | (12) Hub               |

# FRONT DIFFERENTIAL (APTRAC TYPE LIMITED SLIP DIFFERENTIAL)

MANUAL TRANSMISSION AND DIFFERENTIAL



MT-00929

- (1) Cage
- (2) Cam follower
- (3) Face cam

# FRONT DIFFERENTIAL (APTRAC TYPE LIMITED SLIP DIFFERENTIAL)

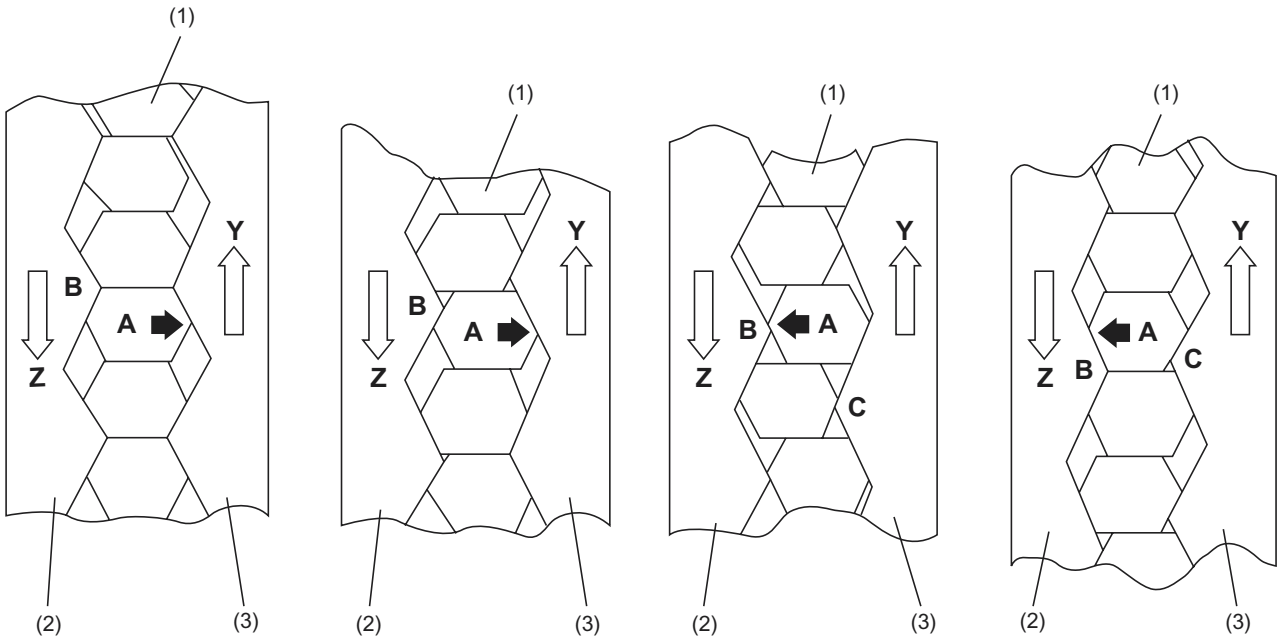
MANUAL TRANSMISSION AND DIFFERENTIAL

## C: OPERATION

### 1. WHEN RIGHT AND LEFT WHEELS ROTATE AT DIFFERENT SPEEDS

If the left and right wheels move relative to each other in the direction of arrow Z and in the direction of arrow Y, respectively, the cam follower A is pushed by the slope B of the left face cam, moving to the right. Then the cam follower A is pushed by the slope C of the right face cam, now moving to the left.

Likewise, all the other cam followers also repeat rightward and leftward movements as long as the right and left wheels continue rotating at different speeds, so the vehicle can turn a corner smoothly.



MT-00930

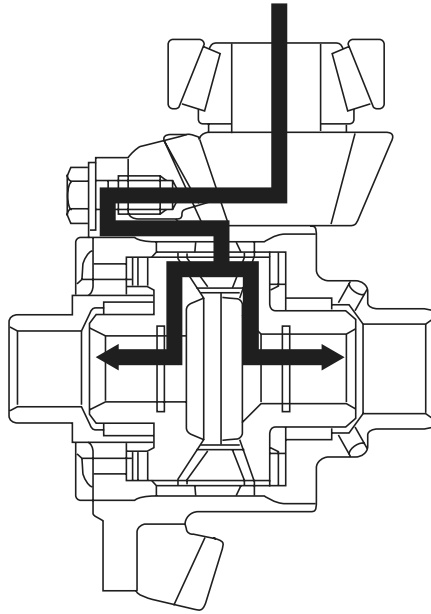
- (1) Cam follower
- (2) Left face cam
- (3) Right face cam

# FRONT DIFFERENTIAL (APTRAC TYPE LIMITED SLIP DIFFERENTIAL)

MANUAL TRANSMISSION AND DIFFERENTIAL

## 2. 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 cage and cam followers rotate together, just as in conventional differentials. As a result, driving torque is distributed equally to the right and left side gears.



MT-00931



# FRONT DIFFERENTIAL (APTRAC TYPE LIMITED SLIP DIFFERENTIAL)

MANUAL TRANSMISSION AND DIFFERENTIAL

## 3. WHEN TRACTION IS DIFFERENT BETWEEN RIGHT AND LEFT WHEELS

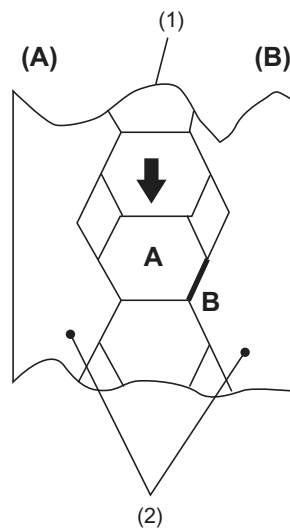
For example, if the left wheel spins on a slippery surface and loses traction, the left face cam starts rotating at a speed faster than the right wheel.

Like when the right and left wheels rotate at different speeds mentioned earlier, the cam follower A starts moving to the left.

This time, however, as the right wheel has traction, the drive torque pushes the cam follower A strongly against the right face cam when it makes the cam follower get over the slope B of the face cam, generating a large friction force between the contacting surfaces (shown by a thick line in the drawing).

This large friction force allows the drive torque to be transmitted to the right wheel.

In this way, the APTRAC differential can keep the drive torque distributed to a wheel with traction even when the other wheel spins and loses traction.



MT-00932

(1) Cam follower

(2) Face cam

(A) High speed rotation

(B) Low speed rotation

## D: SERVICE PROCEDURES FOR LSD

It is not recommended to disassemble this LSD assembly as components of this LSD assembly are not available individually.

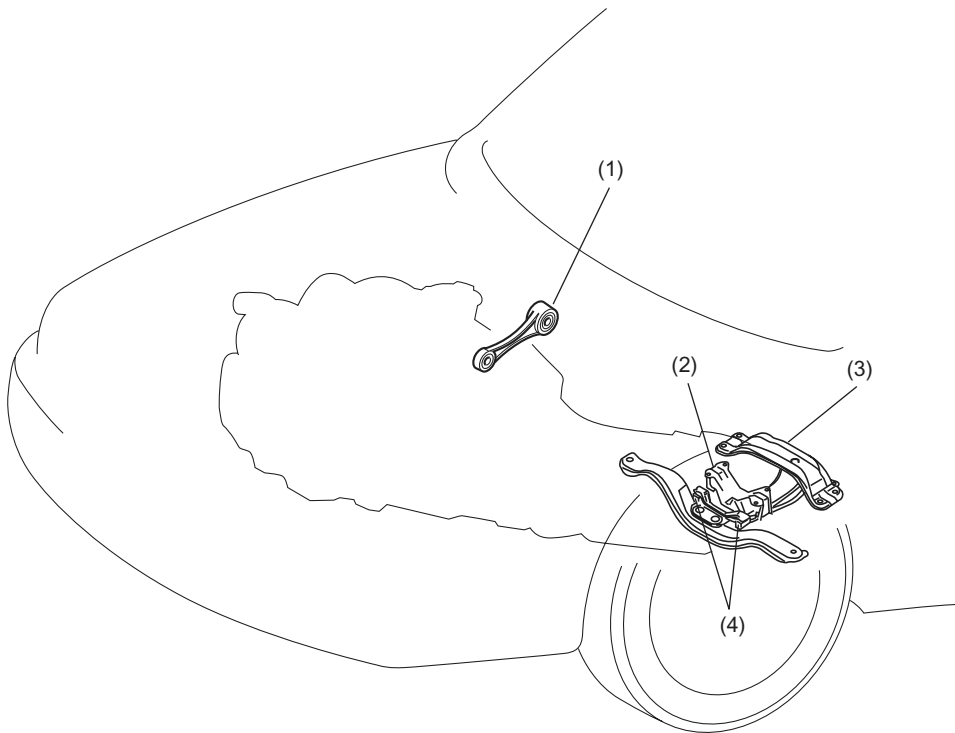
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## TRANSMISSION MOUNTING

MANUAL TRANSMISSION AND DIFFERENTIAL

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### 11. Transmission Mounting



MT-00933

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