TO INDEX

F3 AUTOMATIC TRANSMISSION/AUTOMATIC TRANSAXLE

A4B
1 OUTLINE
1-1 DESCRIPTION

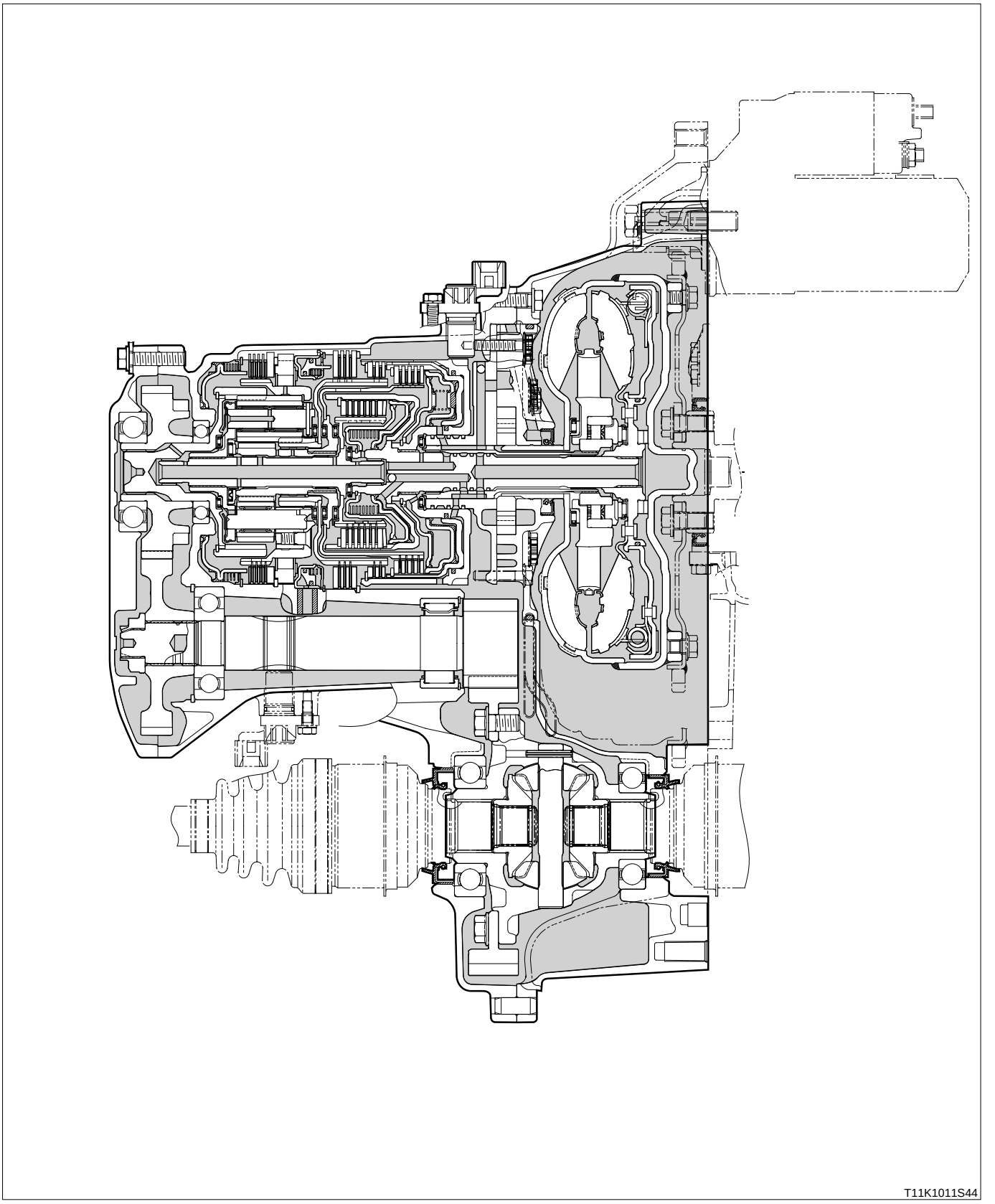
1.An automatic transaxle has been employed, which is of Type A4B－D electronic hydraulically-controlled planetary gear.In order to achieve a high transmitting efficiency and smooth gear shifting characteristics featuring a good response,this automatic transaxle has employed a direct pressure control for shifting control elements,high-level electronic control.

1-2 SPECIFICATION

Specifications of automatic transaxle

Driving method		2WD
Engine type		K3－VE
Transaxle type		A4B－D
Transaxle identification code (label)		8NN
Torque converter type		Three-element, one-stage, two-phase type(with lockup mechanism)
Stall torque ratio		2.0
Torque converter identification paint (reference)		Blue
Automatic gear shift		Four forward speeds, One reverse speed
Gear ratio	1st	2.731
	2nd	1.526
	3rd	1.000
	4th	0.696
	Reverse	2.290
Final reduction gear ratio		4.032
Number of planetary gear teeth	Front planetary sun gear	31
	Planetary long pinion	20
	Rear planetary sun gear	26
	Planetary short pinion	19
	Planetary ring gear	71
Shift control method		Electronic hydraulic pressure controlled planetary gear method
Shift control element		Wet type multiple clutch disc : 3sets Wet type multiple brake disc : 2sets One way clutch : 1set
Manual control pattern		P － R － N－ D－ 2－ L(with O/D OFF switch)
Lubrication fluid	Name	Dexron ® Ⅲ or Ⅱ
	Capacity ℓ	5.0
Oil cooling system		Water-cooled (radiator built-in type)

1-3 SECTIONAL VIEW



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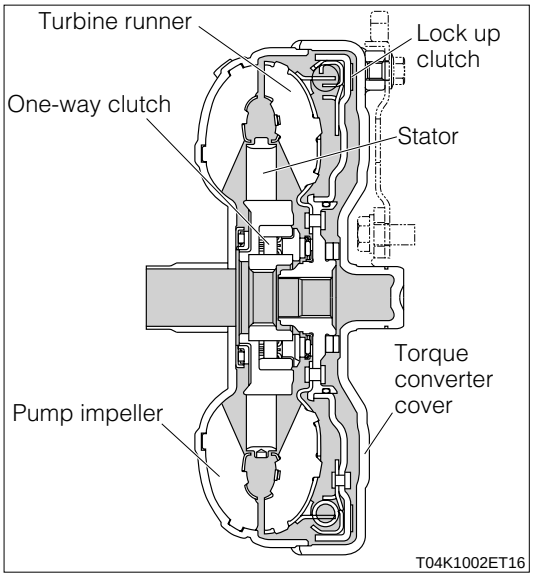
2 CONSTRUCTION AND OPERATION

2-1 TORQUE CONVERTER

2-1-1 OUTLINE

The torque converter has employed a three-elemennt, single-stage, two-phase type with lockup mechanism.

The torque converter is composed of a torque converter cover to which the drive plate is attached a pump impeller integral with the torque converter cover, an input shaft at the transmission side a turbine runner which is fit with the spline , a stator, a one-way clutch which supports the stator, a lock-up cluch and so forth.



2-1-2 LOCKUP MECHANISM

(1) Outline

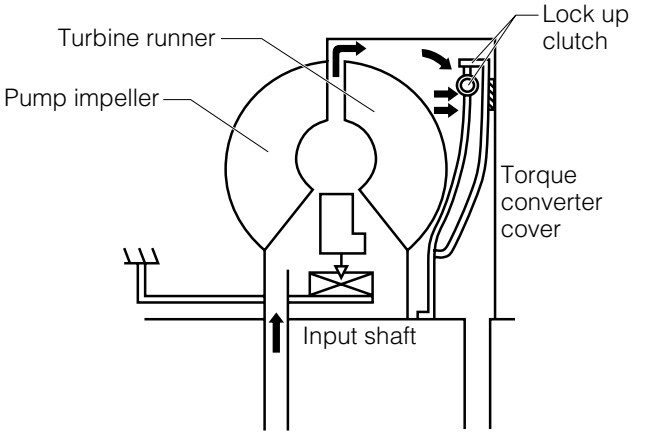
The lockup mechanism is a mechanism which provides a mechanical cluch between the torque converter cover and the turbine runner, thus connecting the pump impeller directly with the turbine runner.

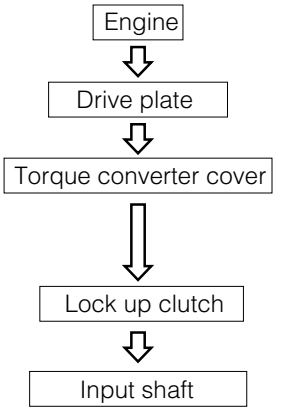
Refer to Page F5-7.

(2) When lockup clutch is operating

When the lockup clutch is operating, the transmission control computer controls the hydraulic pressure control mechanism so as to switch the fluid flow to the lockup clutch section in the torque converter, as shown in the figure below.

Consequently, the lockup clutch is pushed against the torque converter cover owing to the difference in hydraulic pressure between the right and the left sides.As a result,the lockup clutch rotates as a unit integral with the cover.





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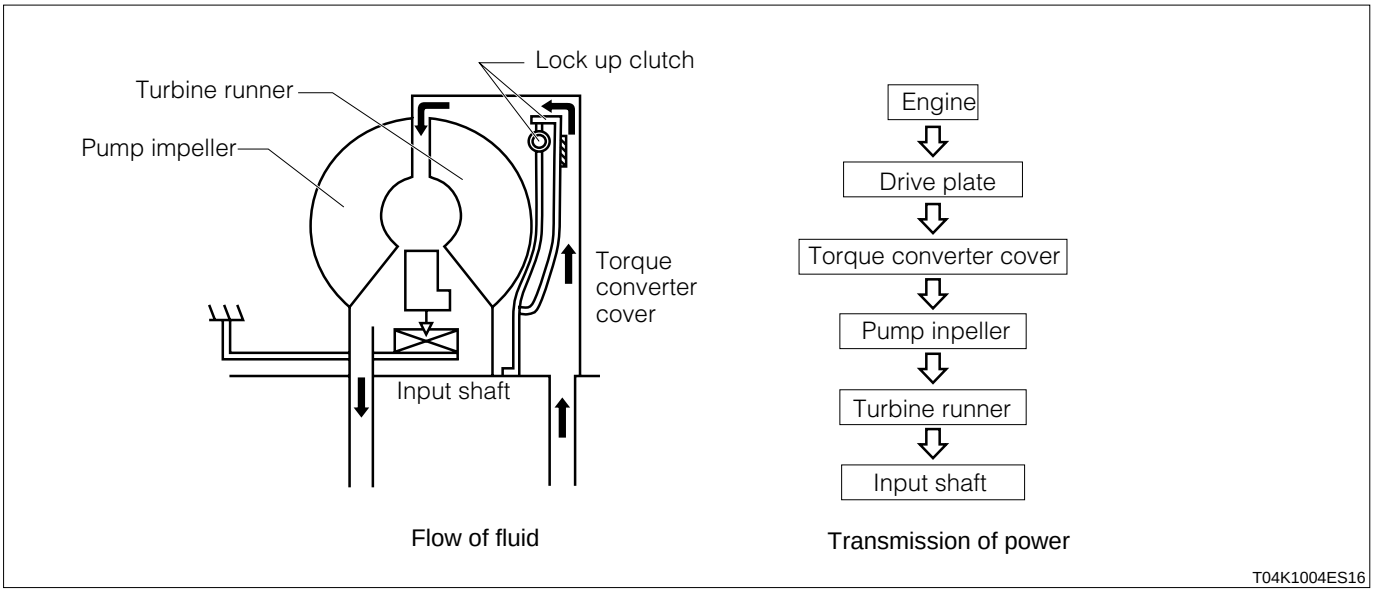
(3) When lockup clutch is not operating

When the lockup clutch is not operating, the transmission control computer controls the hydraulic pressure control mechanism so as to switch the fluid flow to the lockup clutch section in the torque converter, as shown in the figure below.

Hence, the lockup clutch is separated from the torque converter cover, thus transmitting the power as a normal torque converter.



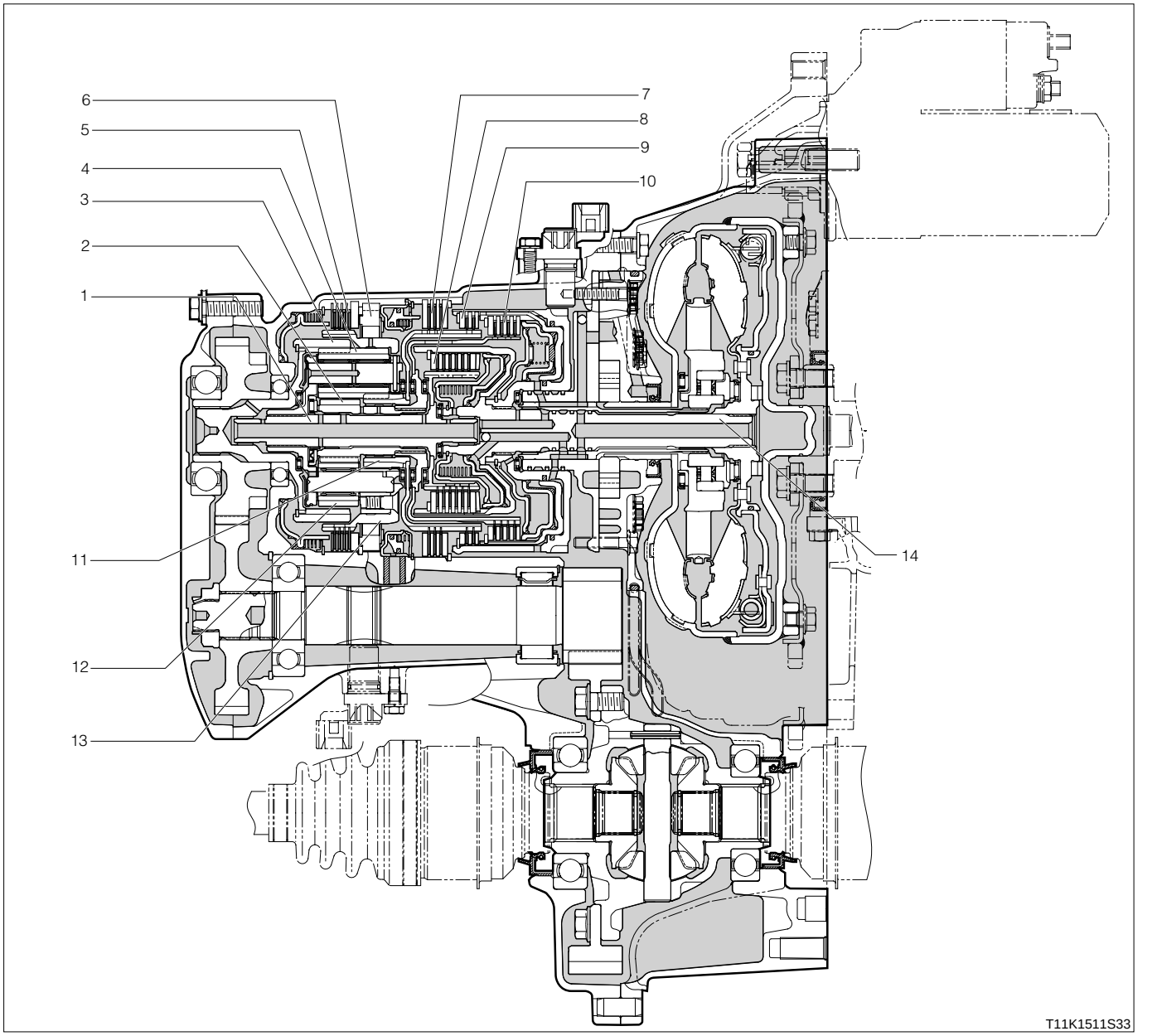
2-2 POWER TRAIN MECHANISM

2-2-1 DESCRIPTION

1.In the power train mechanism, the power transmitted from the engine to the input shaft of the transmission through the torque converter is transmitted from various clutches and brakes to the planetary gear. In this way, gear shifting takes place.

2.In order to achieve a compact size,the power train system has employed a Ravigneaux planetary gear.

3.For high precision hydraulic pressure control for the shifting control elements,the clutch piston has employed a centrifugal hydraulic pressure canceller.



1	Intermediate shaft	8	Rear clutch (C3)
2	Rear planetary sun gear	9	Reverse clutch (C1)
3	Planetary ring gear	10	Forward clutch (C2)
4	Planetary long pinion	11	Front planetary sun gear
5	1st& reverse break (B2)	12	Planetary short pinion
6	One-way clutch	13	Planetary carrier
7	2nd&4th break (B1)	14	Input shaft

2-2-2 PLANETARY GEAR

The Ravigneaux type planetary gear consists of the front planetary sun gear, rear planetary sun gear, planetary short pinion, planetary long pinion, planetary carrier, planetary ring gear, etc.

2-2-3 SHIFT CONTROL ELEMENT

(1) Description

1. The shifting control elements are composed of the three kinds of wet type multiple clutches, namely the reverse clutch (C1), forward clutch (C2) and rear clutch (C3); the two kinds of wet type multiple brakes, namely the 2nd & 4th brake (B1) and 1st & reverse brake (B2); and the one-way clutch (F).
2. In order to achieve precise hydraulic pressure control and smooth gearshift characteristics, a centrifugal hydraulic pressure canceller is provided for each clutch piston of the reverse clutch (C1), forward clutch (C2) and rear clutch (C3).
3. The following table shows functions of each gearshift control element.

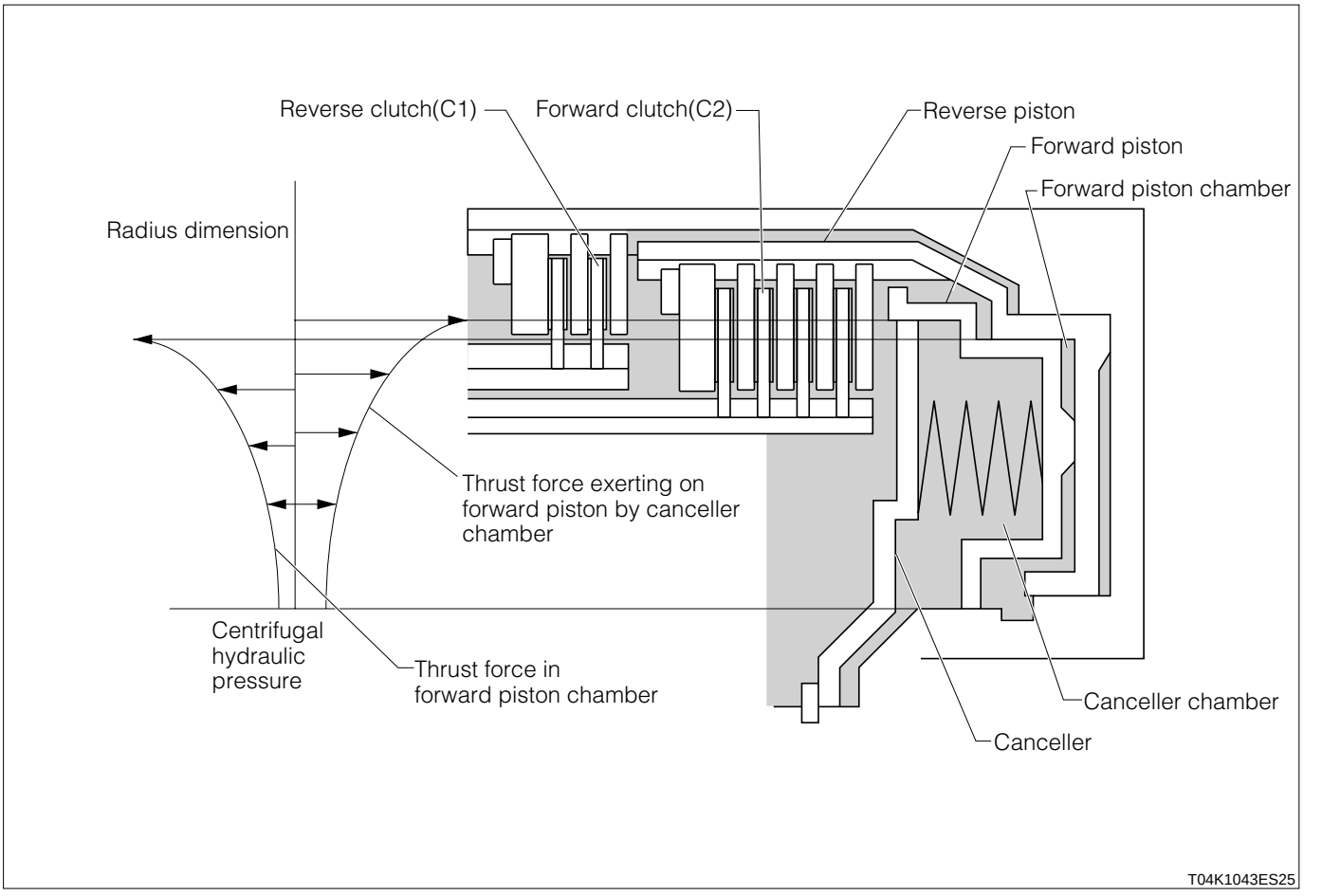
Function of each shift control element

Shift control element		FUNCTION
C1	Reverse clutch	The input shaft and front planetary sun gear are connected.
C2	Forward clutch	The input shaft and rear planetary sun gear are connected.
C3	Rear clutch	The input shaft and intermediate shaft (→ planetary carrier) are connected.
B1	2nd&4th break	The front planetary sun gear is locked.
B2	1st& reverse break	The rotation of the planetary carrier is locked.
F	One-way clutch	The counterclockwise rotation of the planetary carrier is locked.

(2) Centrifugal hydraulic canceller

As is the case with the reverse clutch and forward clutch, centrifugal hydraulic pressure of oil due to the rotation is applied to the piston that operates the clutch provided at the rotating section. Therefore, even when no hydraulic pressure is applied, the piston is operated by thrust force caused by the centrifugal hydraulic pressure. In this way, there are cases where shifting shocks occur.

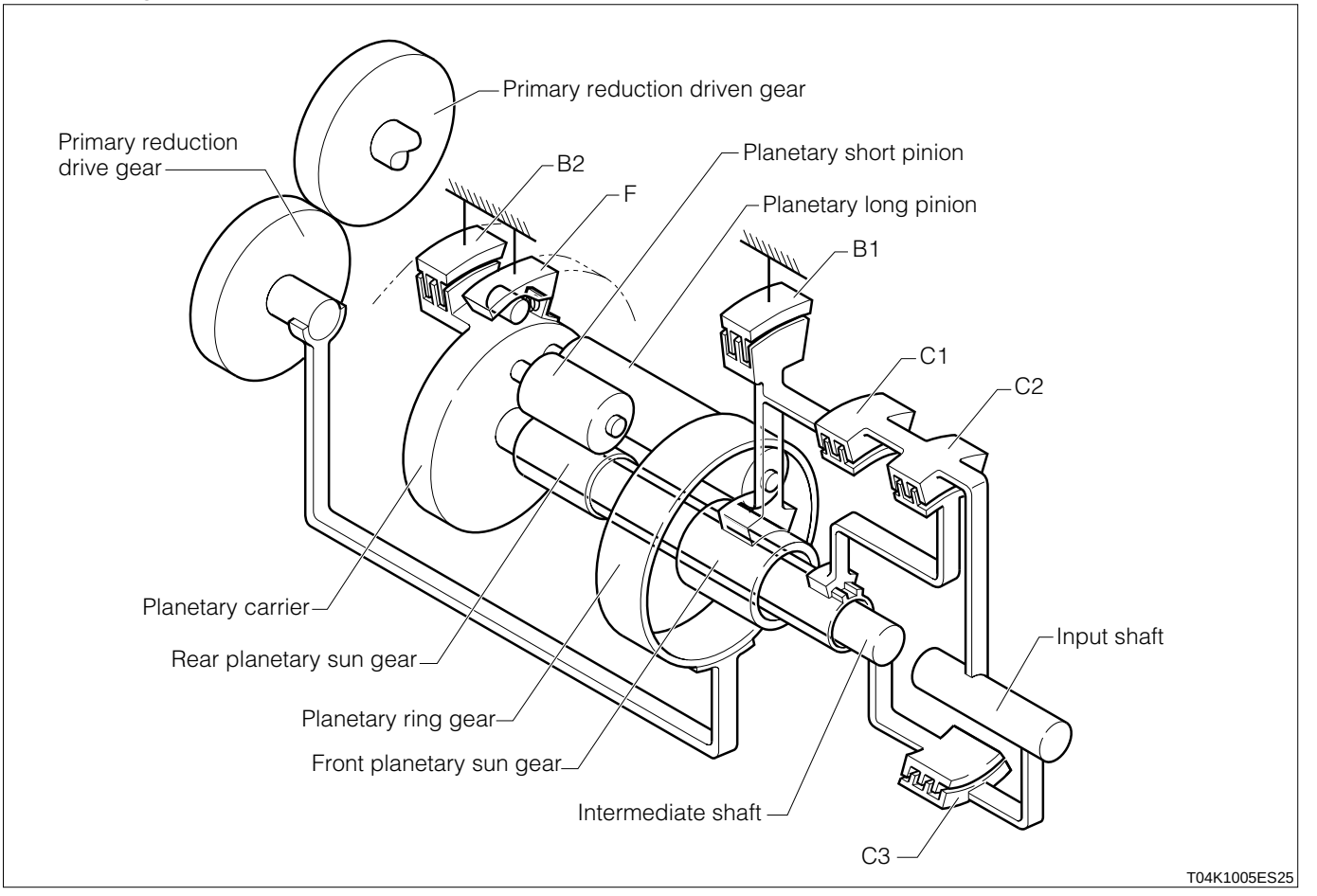
On this automatic transaxle, a cancel chamber is provided on each clutch piston of the reverse clutch (C1), forward clutch (C2) and rear clutch (C3), facing against the clutch hydraulic pressure chamber, as indicated in the figure below. Thus, in the centrifugal hydraulic canceller, the centrifugal hydraulic pressure which is generated at the clutch hydraulic pressure chamber is counteracted by the centrifugal hydraulic pressure which is generated at the cancel chamber. In this way, it becomes possible to attain precise timing control for engagement and disengagement without being affected by the centrifugal hydraulic pressure in the entire revolution zone. Consequently, smooth shifting characteristics have been realized.



2-2-4 POWER TRAIN ROUTE

(1) Description

With regard to power flow, there are the following three input routes. One is a route in which power flows from the input shaft via the C1 clutch to the front planetary sun gear. Another is a route in which power flows via the C2 clutch to the rear planetary sun gear. The other is a route in which power flows via the C3 clutch to the intermediate shaft (→ planetary carrier). As for the power output, there is one route in which power is transmitted from the planetary ring gear to the primary reduction drive gear and primary reduction driven gear.



Furthermore, the following table shows the functions of each shift control element according to each shift gear.

Table showing function of shift control element

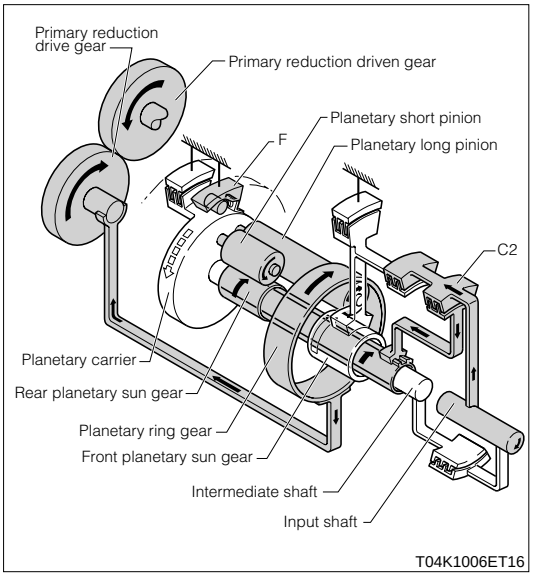
Gear position	C1	C2	C3	B1	B2	F
Reverse	○				○	
Neutral						
1st(Ⓓ·2)		○				○
2nd		○		○		
3rd		○	○			
4th			○	○		
1st(Ⓛ)		○			○	○

(2) Ⓓ·2 range 1st (without engine brake)

In the 1st gear of the Ⓓ·2 range, the forward clutch (C2) and one-way clutch operate. As a result, the reduction drive gear rotates clockwise at a gear ratio of 2.730.

As indicated in the figure on the right, the forward clutch (C2) is operating. Therefore, the turning force of the input shaft is transmitted directly to the rear planetary sun gear. Furthermore, a counterclockwise turning force is transmitted to the planetary short pinion.

On the other hand, the planetary long pinion, which is meshed with the planetary short pinion, receives a clockwise turning force, thus causing the planetary carrier to rotate counterclockwise. However, since the planetary carrier cannot rotate due to the operation of the one-way clutch (F), the planetary ring gear receives a clockwise turning force, thus causing the reduction drive gear to rotate clockwise.

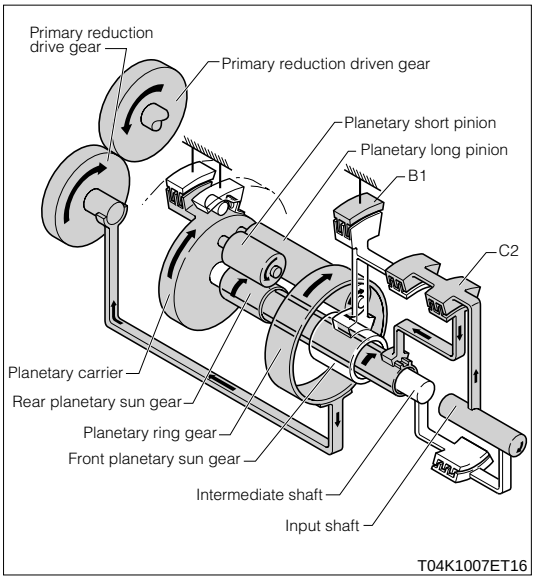


(3) 2nd

In the 2nd gear, the forward clutch (C2) and 2nd & 4th brake (B1) operate. As a result, the reduction drive gear rotates clockwise at a gear ratio of 1.526.

As indicated in the figure on the right, the forward clutch (C2) is operating. Therefore, the turning force of the input shaft is transmitted directly to the rear planetary sun gear. Furthermore, a counterclockwise turning force is transmitted to the planetary short pinion.

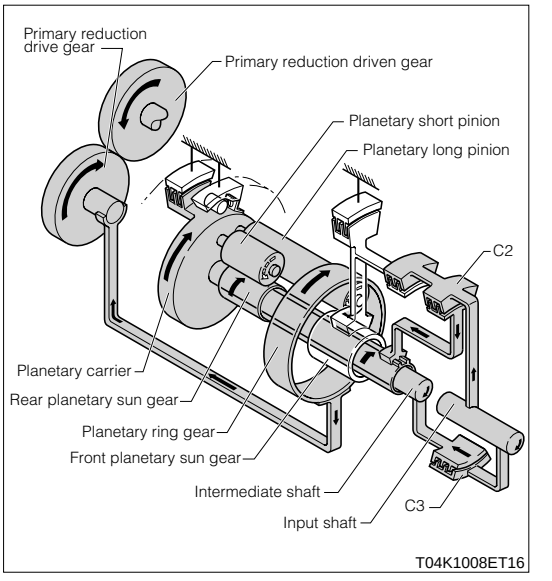
On the other hand, the front planetary sun gear is locked by the 2nd & 4th brake (B1). Consequently, the planetary long pinion, which is meshed with the planetary short pinion, receives a clockwise turning force and walks around the front planetary sun gear clockwise, while turning on its axis. Thus, a clockwise turning force is transmitted to the planetary ring gear. Next, the turning force of the planetary ring gear transmits a clockwise turning force to the reduction drive gear.



(4) 3rd

In the 3rd gear, the forward clutch (C2) and rear clutch (C3) operate. As a result, the reduction drive gear rotates clockwise at a gear ratio of 1.000.

As indicated in the figure on the right, the forward clutch (C2) and rear clutch (C3) are operating. Therefore, the input shaft, rear planetary sun and planetary carrier will turn in the same direction. Hence, the planetary short pinion and planetary long pinion will be locked. Consequently, the planetary ring gear receives a clockwise turning force and transmits a clockwise turning force to the reduction drive gear.



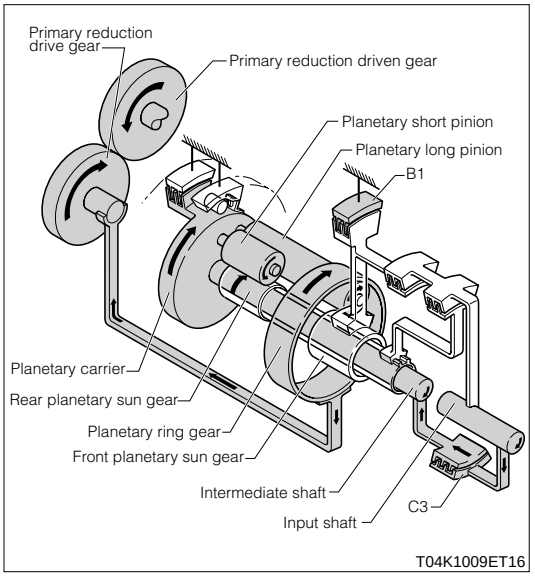
(5) 4th

In the 4th gear, the rear clutch (C3) and 2nd & 4th brake (B1) operate. As a result, the reduction drive gear rotates clockwise at a gear ratio of 0.696.

As indicated in the figure on the right, the rear clutch is operating. Therefore, the turning force of the input shaft is transmitted directly to the intermediate shaft, thus transmitting a clockwise turning force to the planetary carrier.

On the other hand, the front planetary sun gear is locked by the 2nd & 4th brake (B1). Consequently, the planetary long pinion, which is supported by the planetary carrier, receives a clockwise turning force and walks around the front planetary sun gear, while turning on its axis. Thus, the planetary ring gear is turned clockwise.

Next, the turning force of the planetary ring gear transmits a clockwise turning force to the reduction drive gear.



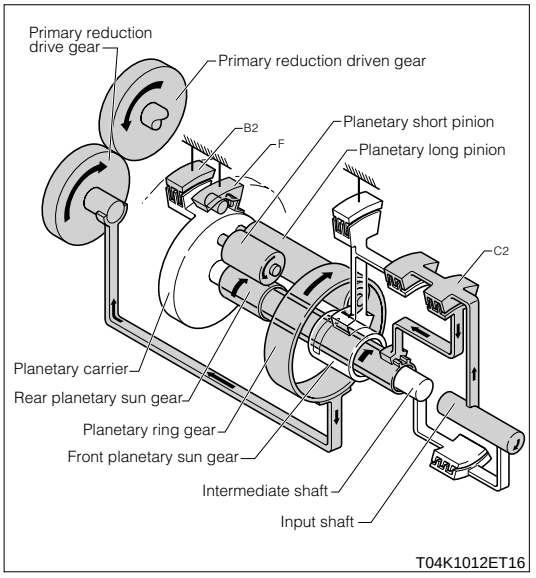
(6) [L] range 1st (with engine brake)

Rotation is transmitted in the same way as with the 1st gear ([D]·[2]) described above. However, the 1st & reverse brake (B2) prevents the planetary carrier from being turned clockwise during the engine braking period.

In other words, when the 1st gear ([D]·[2]) is driven, the counterclockwise turning of the planetary carrier is locked by the action of the one-way clutch (F), thereby transmitting the turning force to the planetary ring gear.

However, during the engine braking period, a reverse force is applied and the one-way clutch (F) is not working, thus causing the planetary carrier to idle.

In the case of the 1st gear of the [L] range, when the 1st & reverse brake (B2) is applied, the planetary carrier is fixed. In this way, it becomes possible to perform the engine braking.

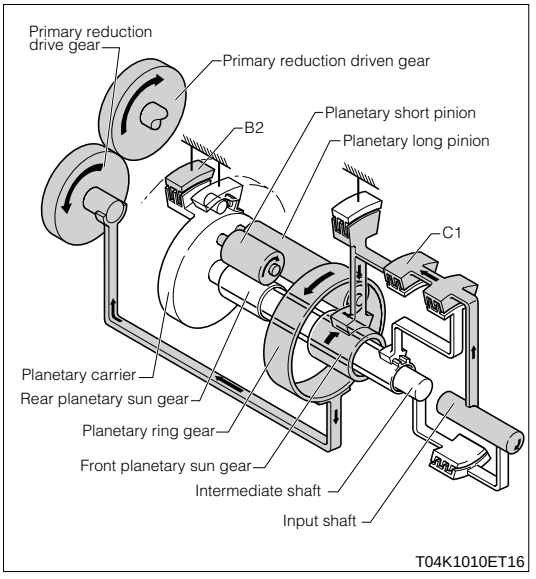


(7) [R] range

In the case of the [R] range, the reverse clutch (C1) and 1st & reverse brake (B2) are applied, and the reverse gear is set. As a result, the reduction drive gear rotates counterclockwise at a gear ratio of 2.290.

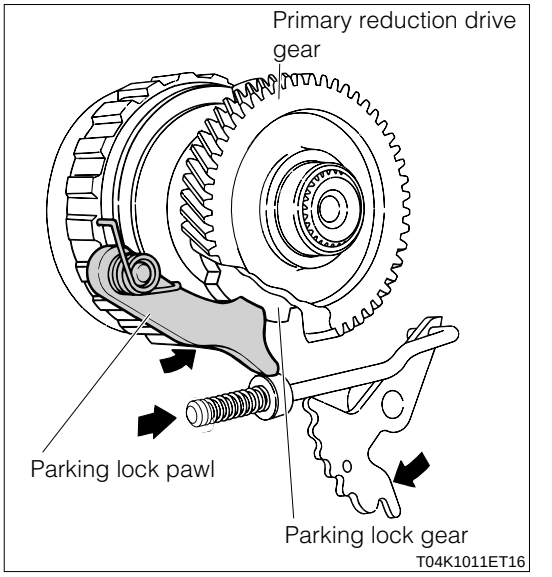
Since the reverse clutch (C1) operates, as shown in the figure on the right, the turning force of the input shaft is transmitted directly to the front planetary sun gear.

On the other hand, the planetary carrier is locked due to the action of the 1st & reverse brake (B2). Hence, the clockwise turning force transmitted to the front planetary sun gear will cause the planetary long pinion to turn on its axis counterclockwise, thus transmitting the counterclockwise turning force to the planetary ring gear. Therefore, the reduction drive gear, which is connected to the planetary ring gear, will rotate counterclockwise.



(8) Ⓟrange

When shifted to the Ⓟ range, the parking cam is pushed out through the parking rod. As a result, the parking cam pushes up the parking lock pawl. Consequently, the parking lock pawl is engaged with the parking lock gear and it becomes locked.



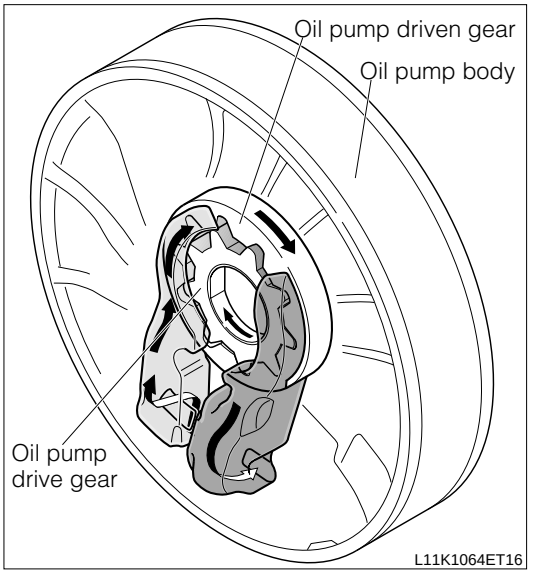
2-3 HYDRAULIC CONTROL SYSTEM

2-3-1 DESCRIPTION

1. Using the hydraulic pressure created by the oil pump, the hydraulic control system regulates and switches the hydraulic pressures acting on each gear shifting control element of the power train system according to the running conditions, and lubricates each part inside the transmission.
2. The hydraulic control system consists of an oil pump which generates hydraulic pressure and a valve body which controls the hydraulic pressure acting on each gear shifting control element, using the hydraulic pressure.
3. The control system has employed a direct pressure control to control directly the hydraulic pressure by the solenoid valve + control valve provided for each gear shifting control element (clutch and brake). As a result, it becomes possible to control precisely the pressure at the disengagement side and engagement side during the transient period of gear shifting (clutch-to-clutch control). Consequently, good response and smooth shift feeling have been achieved.

2-3-2 OIL PUMP

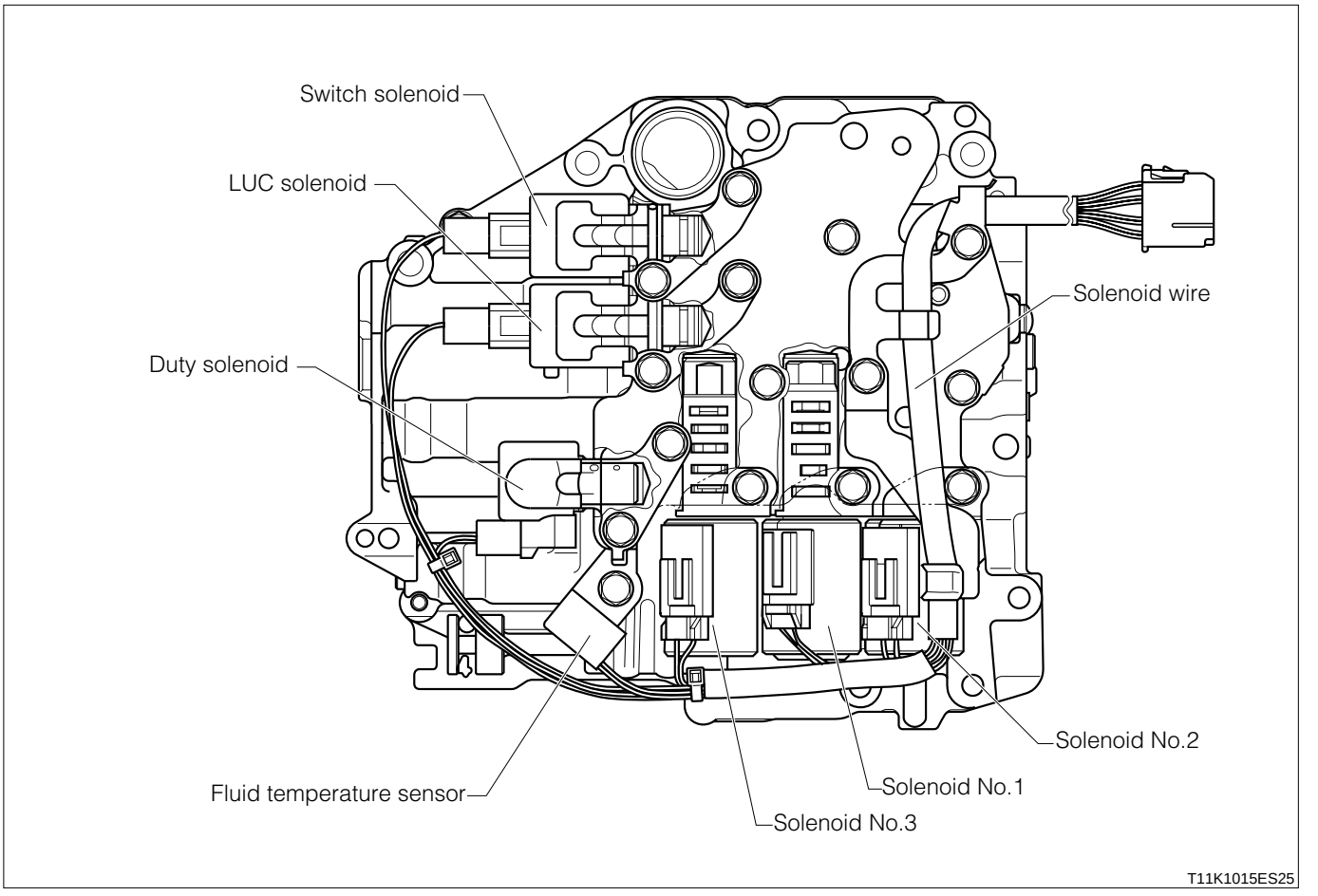
1. For enhanced efficiency, the oil pump has employed a crescentless type.
2. In the crescentless type, the crescent has been abolished and a small-sized driven gear has been employed. Consequently, the load during the oil pump driving period has been reduced.
3. The oil pump consists of an oil pump body, oil pump drive gear and oil pump driven gear. The oil pump drive gear is driven by the torque converter, thus driving the oil pump driven gear. Consequently, automatic transmission oil is sent to the hydraulic pressure control system in a pressurized condition.



2-3-3 VALVE BODY

(1) Description

The valve body is provided at the lower section of the transaxle case. The valve body consists of the following components: A regulator valve, which regulates the pressure generated at the oil pump to the line pressure; various solenoid valves, which convert the hydraulic pressure and switch the fluid passage based on the electric signal from the transmission control computer; control valve, which controls the hydraulic pressure applied to each gear shifting control element by the hydraulic pressure from the solenoid valve; and various valves, which switch the fluid passage by the line pressure.



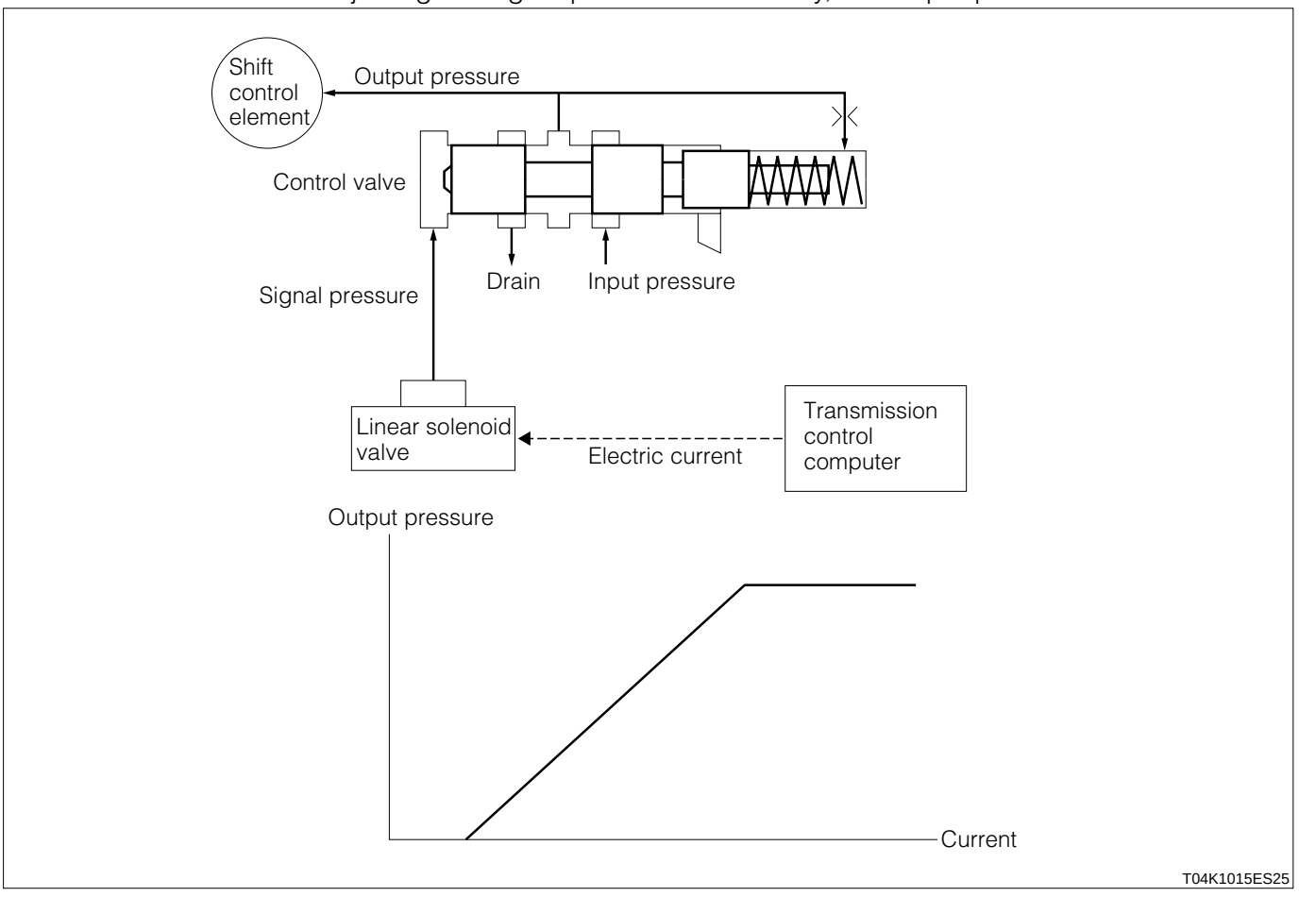
Functions of each solenoid valve

Nomenclature	FUNCTION
Solenoid No.1	Controlling oil pressure of B1 berak
Solenoid No.2	Controlling oil pressure of C2 clutch
Solenoid No.3	Controlling oil pressure of C3 clutch and B2 berak Controlling line pressure
Duty Solenoid	Controlling oil pressure of lock-up clutch
LUC Solenoid	Changing lock-up reley valve
Switch Solenoid	Changing solenoid reley valve

(2) Direct pressure control

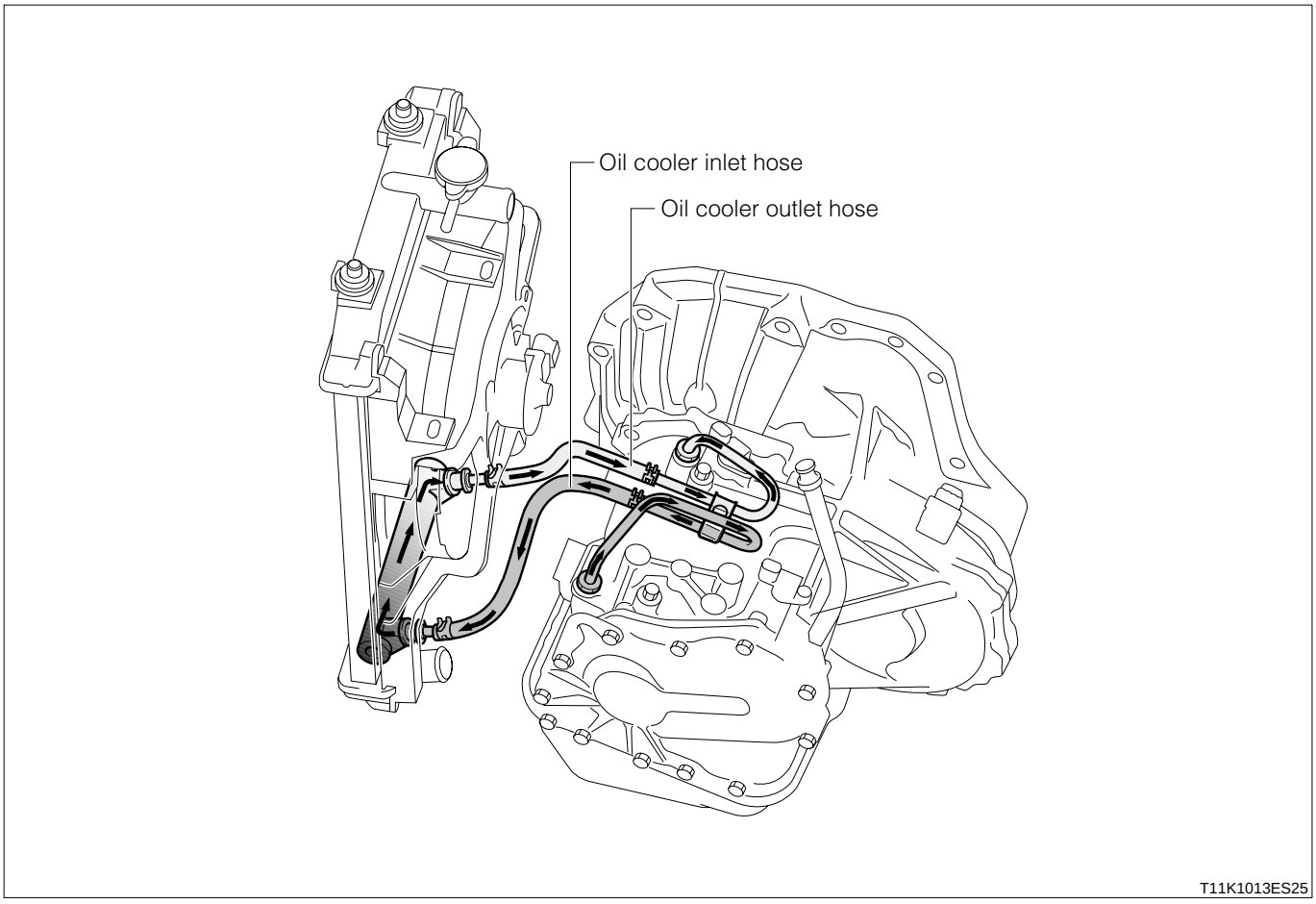
In the valve body of this automatic transaxle, each gearshift control element of B1, B2, C2 and C3 as well as each control valve are connected directly. Hence, the control valve controls the hydraulic pressure of each gear shifting control element and performs gear shifting. Furthermore, a linear solenoid valve, which generates a signal pressure to be applied to the control valve, is connected to each control valve, respectively.

The transmission control computer controls the hydraulic pressure by controlling the electric current of the linear solenoid valve and adjusting the signal pressure. In this way, the output pressure is controlled.



2-4 COOLING SYSTEM

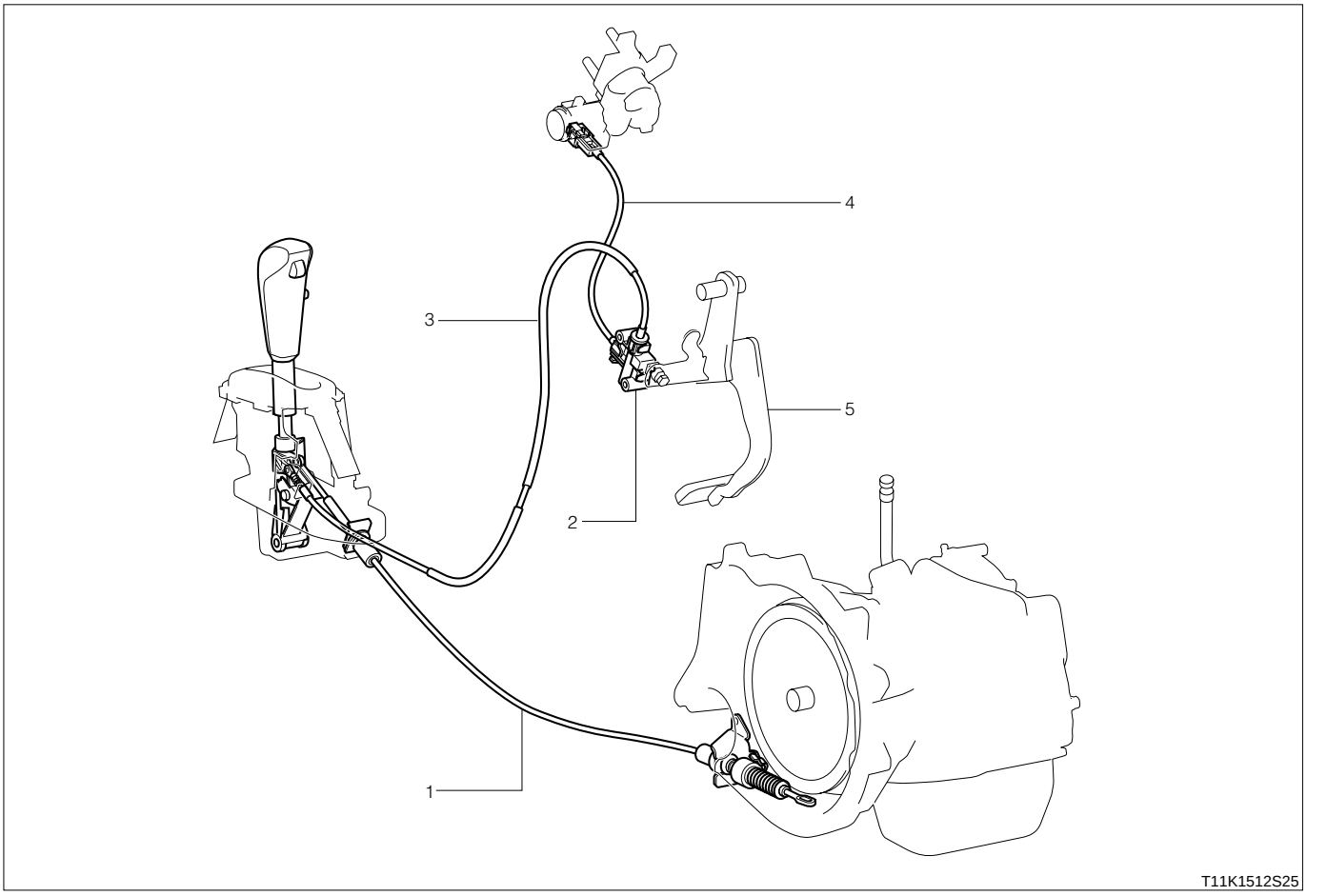
The automatic transmission fluid is cooled by the oil cooler incorporated in the radiator.



2-5 SHIFT CONTROL MECHANISM

2-5-1 DESCRIPTION

1.A six-position type (Ⓟ·Ⓡ·Ⓝ·Ⓓ·2·Ⓛ+O/D) floor shift has been employed.
2.The shift control mechanism has employed a remote control type by the push-pull cable.
3.The shift lock mechanism with key interlock has adopted a mechanical type, in which the shift locking and key interlock operation are controlled by means of the cable. (specification for Taiwan only)



1	Control cable	4	Key lock cable
2	Lock mechanism	5	Break pedal
3	Shift lock cable		

2-5-2 SHIFT LOCK MECHANISM

The shift lock mechanism is a mechanism which prevents the shift lever from moving from the Ⓟ range to any other position, unless the brake pedal is depressed (the brake pedal "ON") and the ignition key is set to the "ACC" or "ON" position.

(1) When the brake pedal is "OFF" or the ignition key is set to the "LOCK" position:

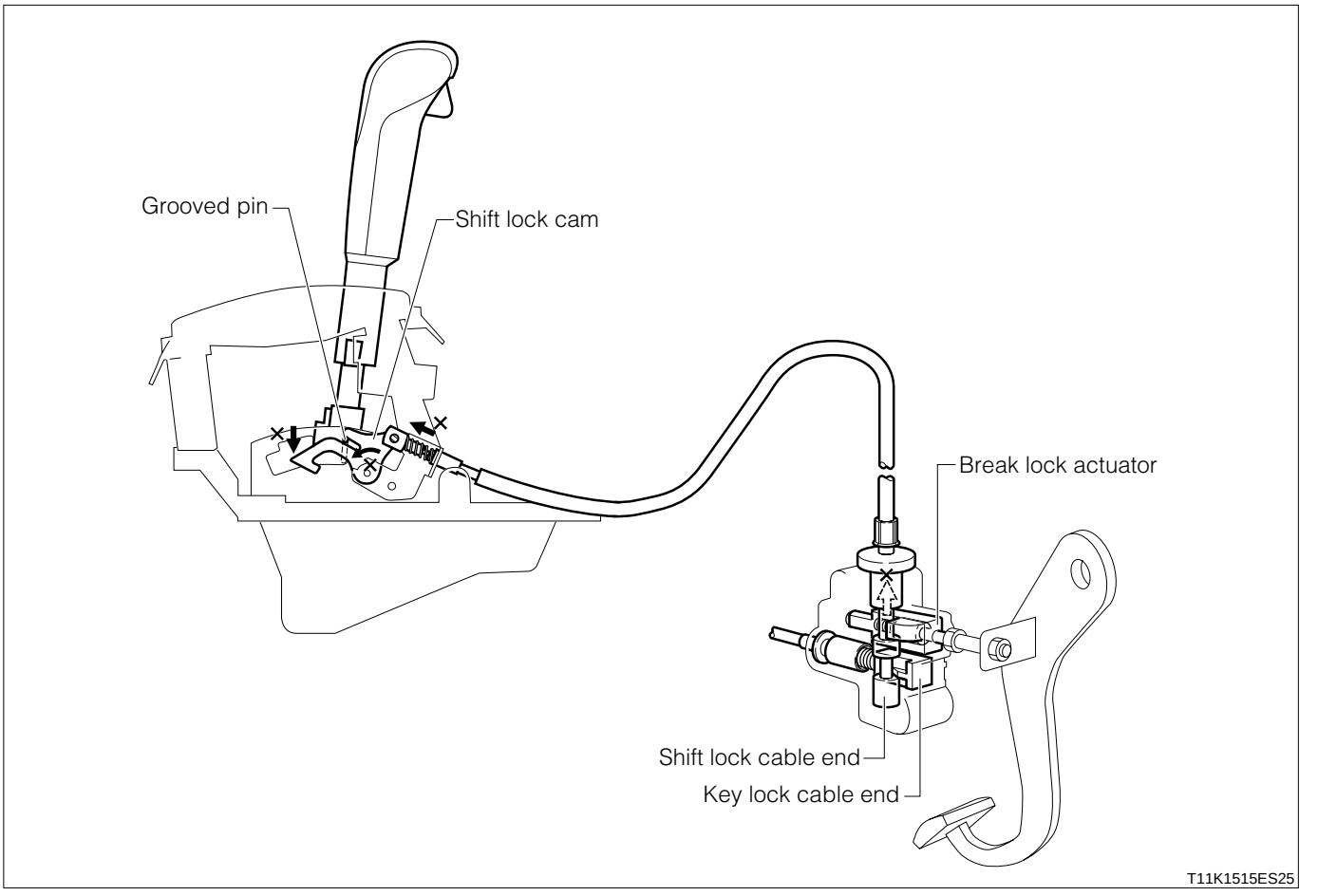
When the shift lever is shifted to the Ⓟ range, the shift lock cable end is located at the position indicated in the figure.

When the brake pedal is "OFF," the brake lock actuator is pushed toward the left side by the brake pedal. Therefore, the protruding section of the brake lock actuator locks the upward movement of the shift lock cable end.

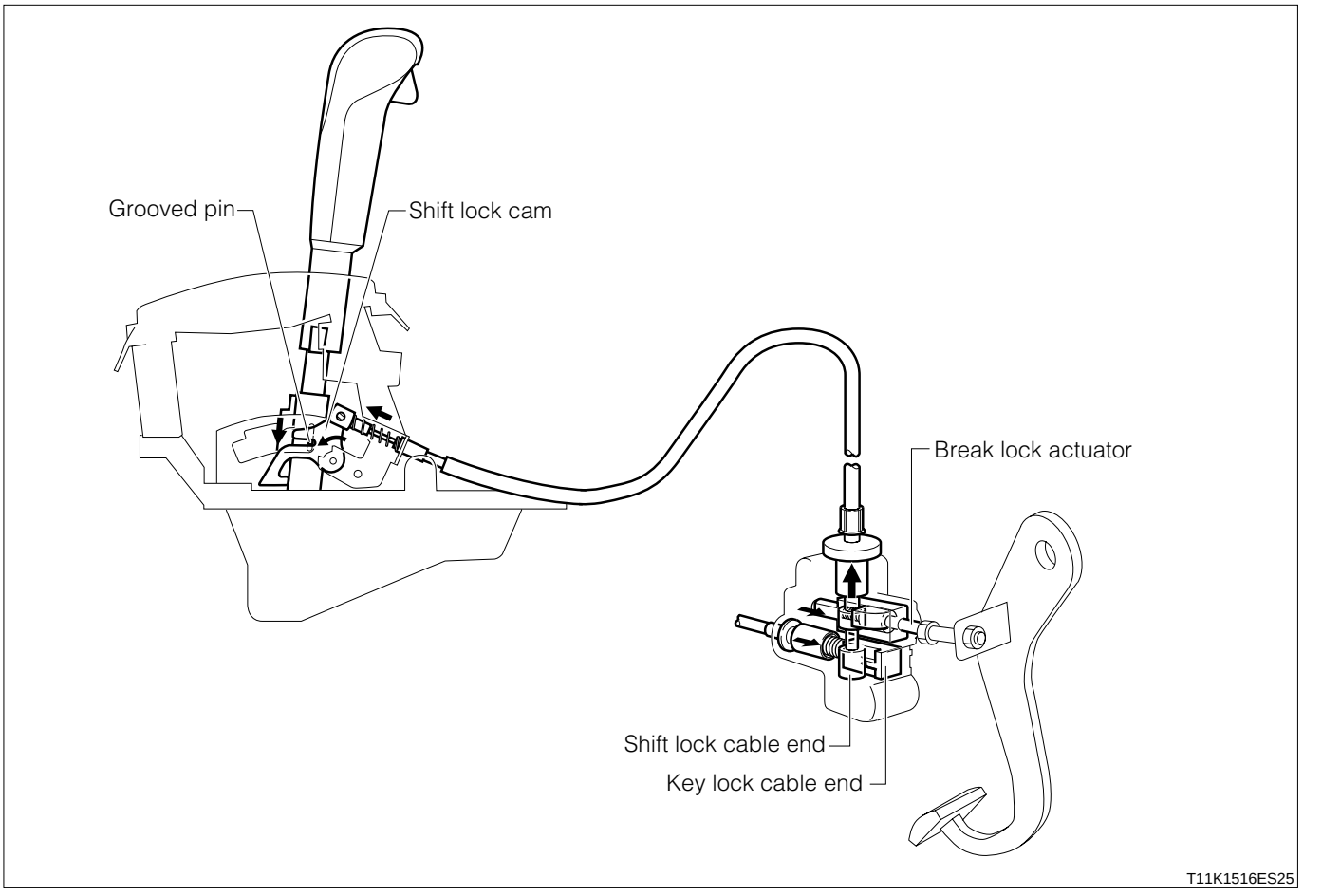
When the ignition key is set to the "LOCK" position, the key lock cable end is pulled and moved to the ignition switch side (the left side in the figure). (Refer to the section under "Key Interlock.") As a result, the protruding section of the key lock cable end locks the upward movement of the shift lock cable end.

The shift lock cable is connected to the shift lock cam which rotates, interlocking with the sliding of the grooved pin (which unlocks the shift lever by sliding downward, interlocking with the button) for unlocking the shift lever.

Therefore, when the shift lock cable is locked, the shift lever cannot be moved to any other range except the Ⓟ range.



(2) When the brake pedal is "ON" and the ignition key is set to the "ACC" or "ON" position:
When the brake pedal becomes "ON," the brake lock actuator jumps out due to the force of the spring (it moves toward the right side in the figure). As a result, the shift lock cable end is unlocked.
When the ignition key is turned from the "LOCK" position to the "ACC" or "ON" position, the key lock cable becomes free (Refer to the section under "Key Interlock."). As a result, the key lock cable moves due to the force of the spring (it moves toward the right side in the figure), thus unlocking the shift lock cable end. Consequently, the shift lock cable becomes free, thus enabling the shift lever to move to a range other than the Ⓟ range.



2-5-3 KEY INTERLOCK MECHANISM

The key interlock mechanism is a mechanism which prevents the ignition key from turning to the "LOCK" position when the shift lever is set to a position other than the Ⓟ range. As a result, the key cannot be pulled out.

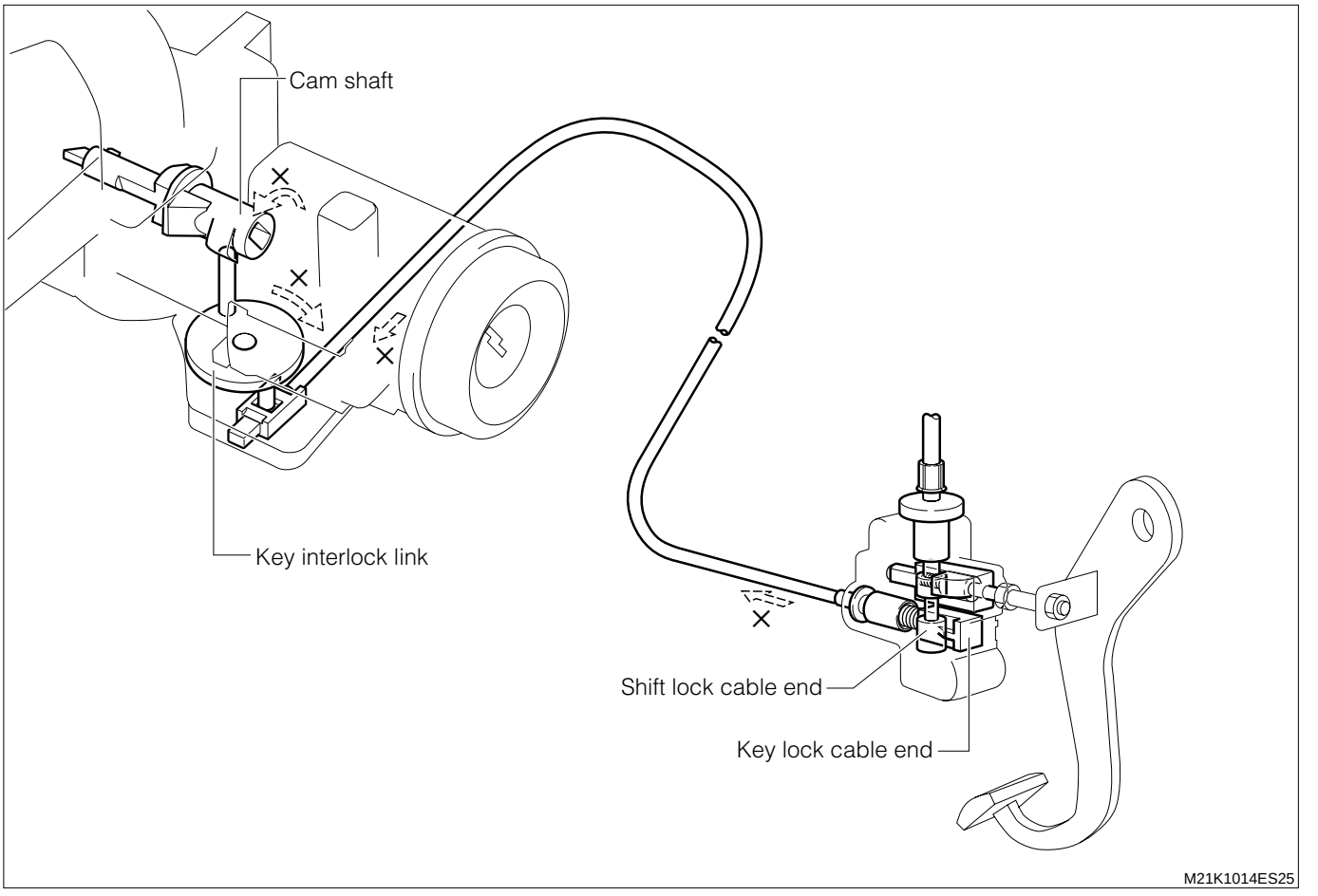
(1) When the shift lever is shifted to a position other than the Ⓟ range:

When the shift lever is shifted to a position other than the Ⓟ range, the shift lock cable end is located at a position indicated in the figure.

The key lock cable end is locked by the shift lock cable end so that it cannot move to the ignition switch side (the left side in the figure).

The key lock cable is connected to the key interlock link of the key cylinder. The key interlock link will rotate by the operation of the camshaft when the ignition key is turned to the "LOCK" position.

Consequently, when the key lock cable is locked, the key interlock link cannot rotate. As a result, the key cannot be turned to the "LOCK" position.



(2) When the shift lever is shifted to the Ⓟ range:

When the shift lever is shifted to the Ⓟ range (with the shift lever button not pushed), the shift lock cable end moves downward, thus unlocking the key lock cable end.

Consequently, the key lock cable becomes free (movable), enabling the key interlock link to rotate. As a result, the ignition key can be turned to the "LOCK" position.