



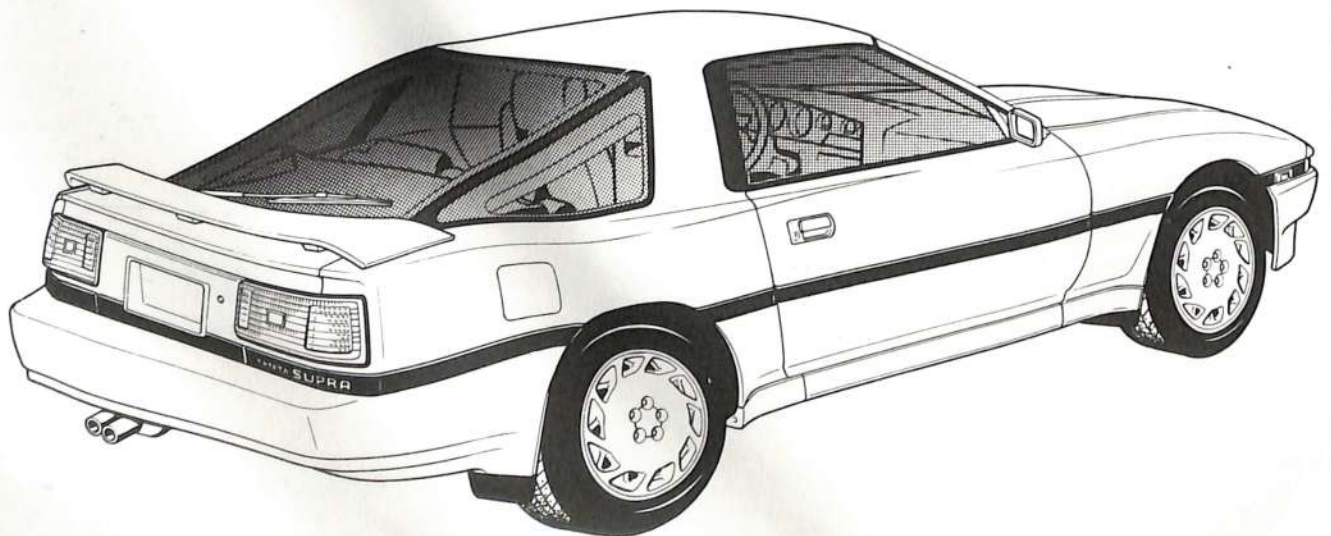
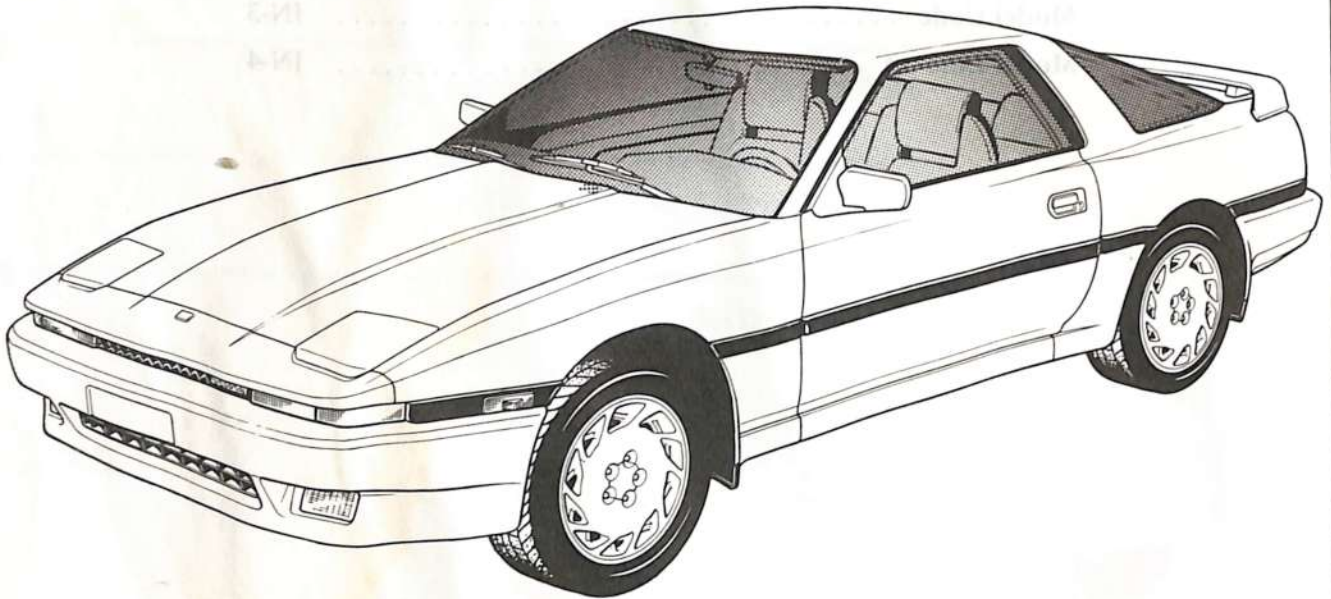
TOYOTA **SUPRA**

New Car Features
Jan., 1986

For More Effective Sales and Service Activities

TOYOTA

Exterior Appearance



Model Code

MA70 R-B L M V F Q

BASIC MODEL CODE

MA70: With 7M-GE Engine

STEERING WHEEL POSITION

L : Left-hand Drive
R : Right-hand Drive

MODEL NAME

B : Toyota Supra

BODY TYPE

L : Liftback

DESTINATION

Q : Australia
V : Gulf Countries*
N : South Africa
Blank: Other Countries

ENGINE SPECIFICATION

F : EFI and DOHC

GRADE

V : GT

GEARSHIFT TYPE

M : 5-speed Manual
P : 4-speed Automatic

* Saudi Arabia, Kuwait, Oman, U.A.E., Qatar and Bahrain

Model Line-up

Destination	Body Type	Grade	Engine	Transmission	
				W58 5-speed Manual	A340E 4-speed Automatic
Australia	Liftback	GT	7M-GE	MA70R-BLMVFQ	MA70R-BLPVFQ
Gulf Countries*				MA70L-BLMVFFV	MA70L-BLPVFFV
South Africa				MA70R-BLMVFN	
Other Countries				MA70 ^L _R -BLMVF	MA70 ^L _R -BLPVF

* Saudi Arabia, Kuwait, Oman, U.A.E., Qatar and Bahrain

New Model Highlights

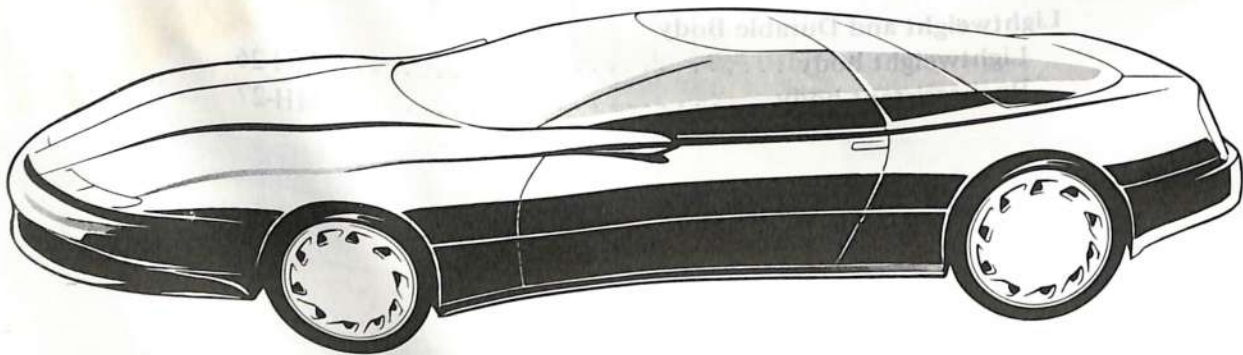
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Development Objectives

The Toyota Supra is Toyota's image leader car. The Supra has a good reputation, especially for its body styling and high performance. Market needs, however, have been shifting towards more luxurious and higher performance products. In response to this trend, Toyota has carried out a full model change to make the Toyota Supra a pioneer model engineered with Toyota's advanced technology as well as a real volume-sales sports car.

The new Toyota Supra has been developed with the following objectives in mind:

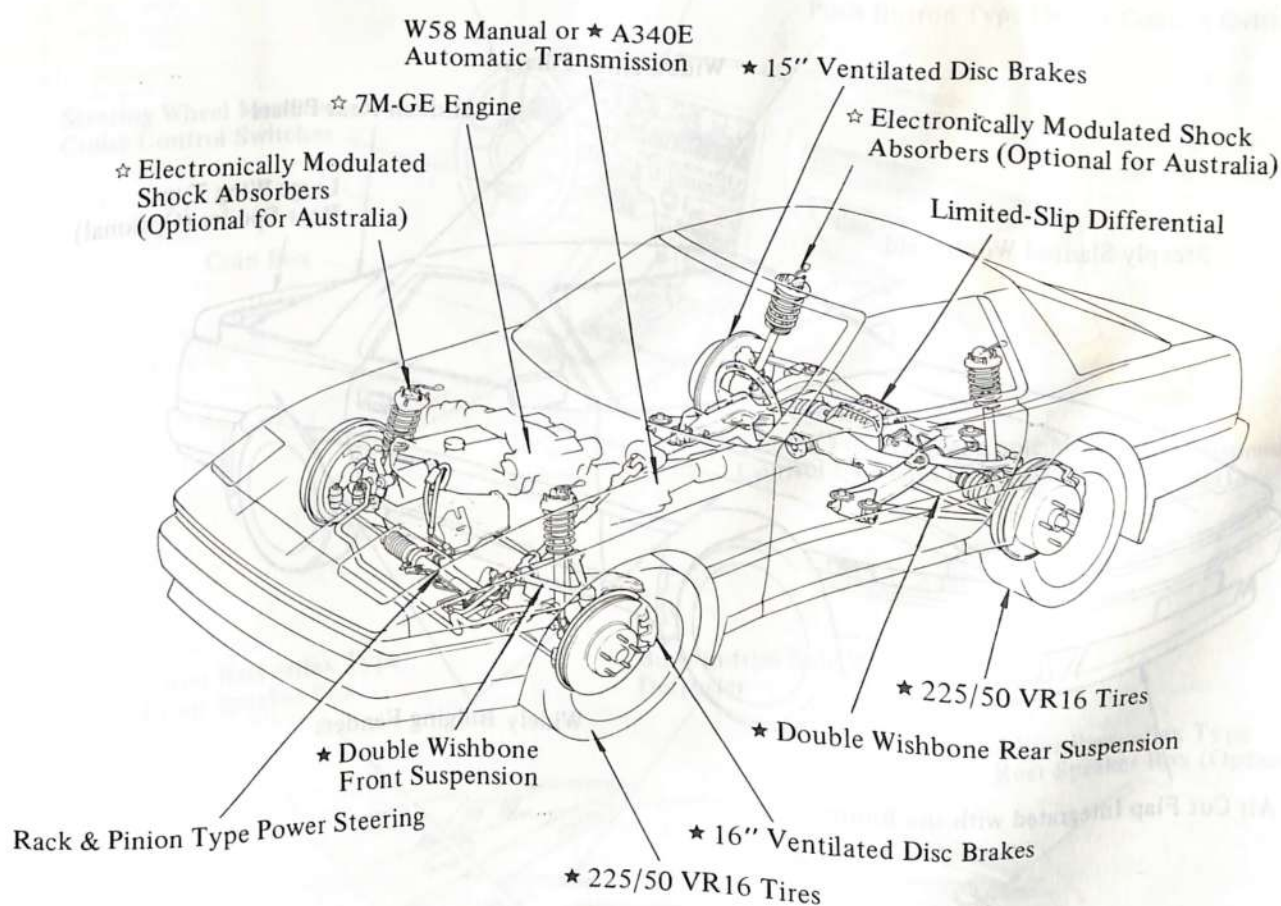
- ▶ High performance worthy of a real sports car
- ▶ Sporty and powerful exterior styling
- ▶ Sporty and high quality interior which gives the occupants a luxurious feeling
- ▶ Attractive new features and equipment



Outline

Driving Performance

- The engine is the newly developed high performance 3.0 liter DOHC 24 valve 7M-GE engine.
- A 4-wheel double wishbone suspension used on racing cars has been adopted. Also, for Australia, the TEMS (Toyota Electronic Modulated Suspension), which controls the damping force of the shock absorbers electronically in accordance with driving conditions, is offered as optional equipment.
- High performance 225/50 VR 16 tires, which are the most suitable for the new suspension, are provided. This is the first time that Toyota has adopted high speed type tires with an aspect ratio of 50%.

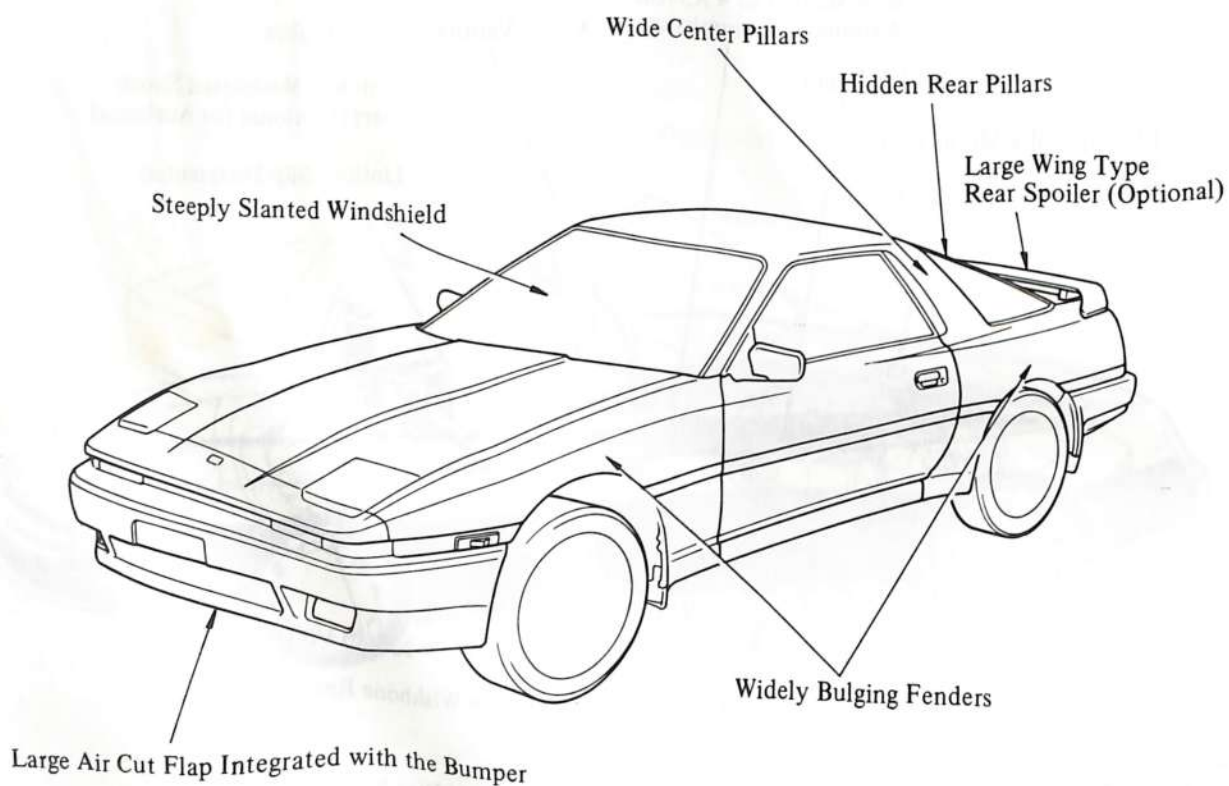


☆ : Newly Developed
 ★ : Newly Incorporated

Outline

Exterior

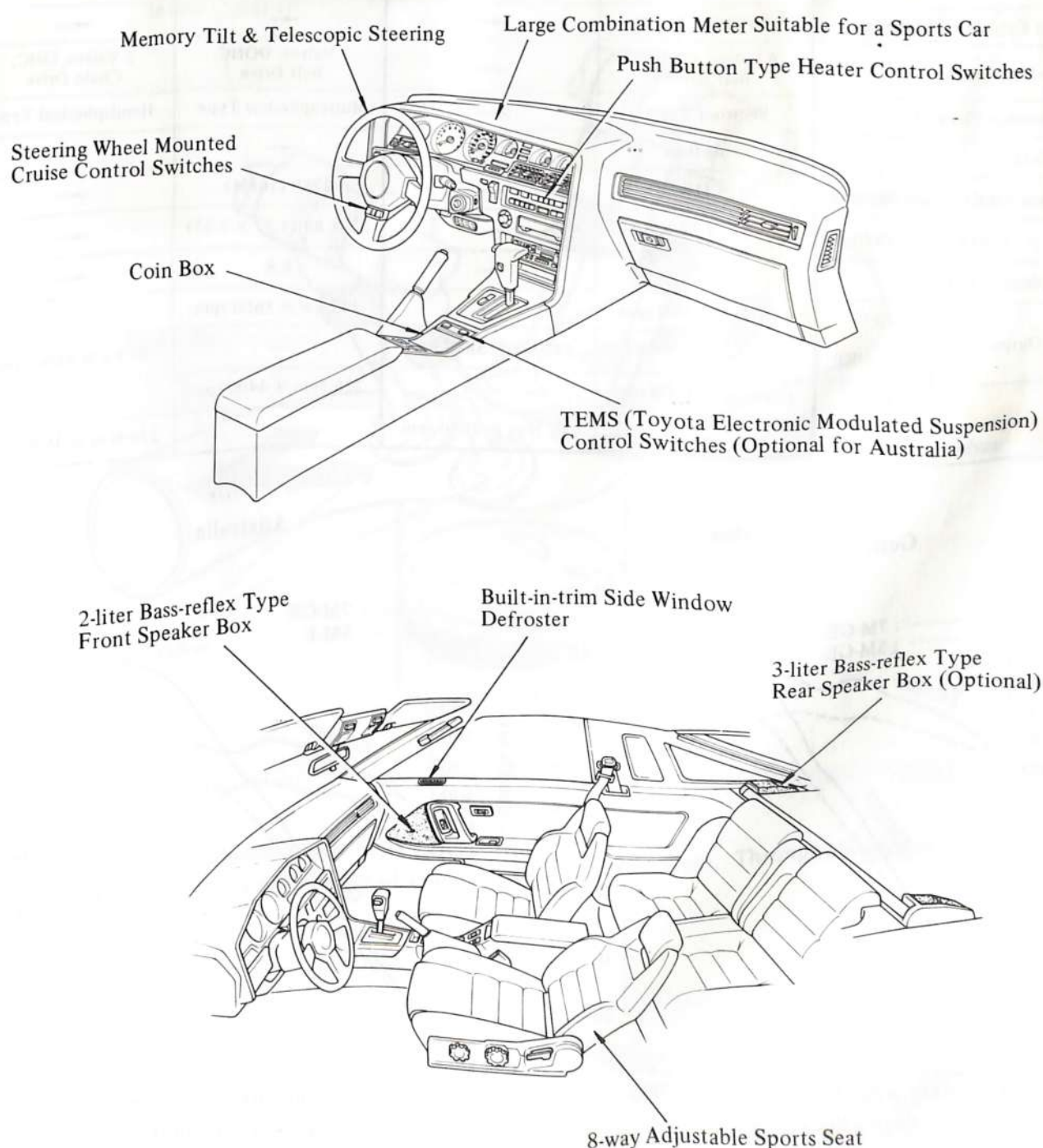
- Through the curved design and low overall height, the style has been made more sporty and aerodynamic.
- With its accentuated, widely bulging fenders, which envelop the wheels, the design is one which emphasizes the wide tread and gives a feel of stability.
- By shortening the overall length by about 40 mm (1.6 in.) compared with the previous Supra, by slanting the windshield steeply and by widening the center pillars, the wide cabin looks compact and the Supra's sportiness is emphasized.



Outline

Interior

- The interior is given a high class feel by the use of carefully designed color coordinates and soft materials.
- By adopting a large combination meter and grouping the switches around the steering wheel, a functional cockpit appropriate for a sports car is created.
- By the adoption of memory tilt and telescopic steering, the lengthening of the front seat sliding range by about 30 mm (1.2 in.) toward the rear, and by increasing the head clearance by about 40 mm (1.6 in.), even tall persons can sit in the optimum driving position.



High-power and Economical Engine

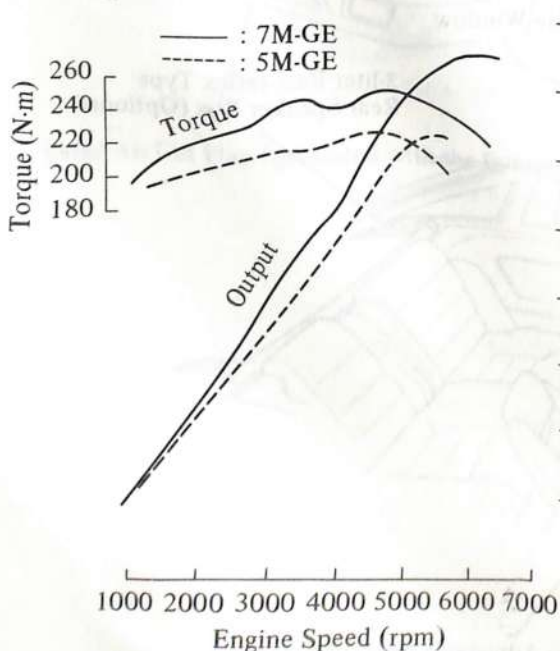
7M-GE Engine

 TD-2

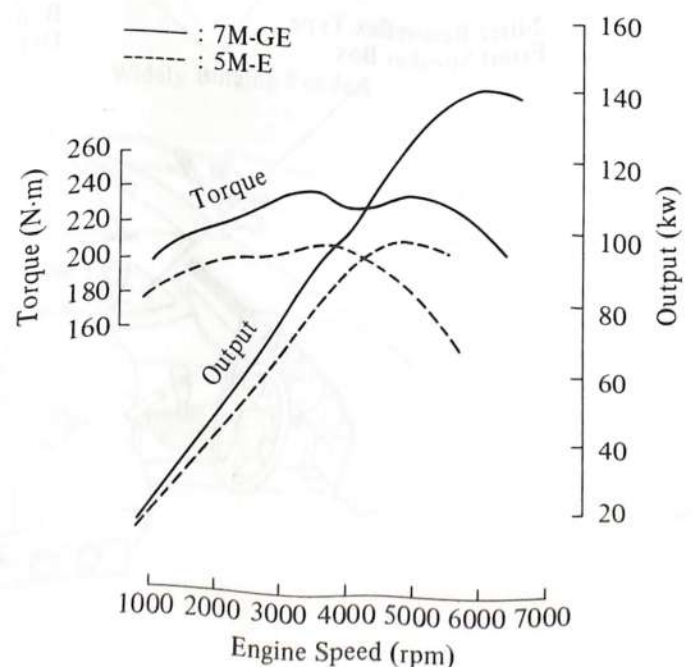
- The 7M-GE engine is a lightweight 3.0 liter DOHC engine which has been developed with the 5M-GE engine, mounted in the previous Supra for general countries and in the Cressida, as a base.
- This successor to the 5M-GE engine incorporates 4 valves per cylinder, a new type Intake Air Control System and the TCCS (Toyota Computer Controlled System) for a high output, super-responsive engine with good fuel economy.

Engine		7M-GE	7M-GE (Australia)	5M-GE	5M-E (Australia)
Item					
No. of Cyls. & Arrangement		6 Cylinder, In-line	←	←	←
Valve Mechanism		4 Valves, DOHC, Belt Drive	←	2 Valves, DOHC, Belt Drive	2 Valves, OHC, Chain Drive
Combustion Chamber		Pentroof Type	←	Multi-spherical Type	Hemispherical Type
Manifold		Cross-flow	←	←	←
Displacement	cc (cu.in.)	2954 (180.3)	←	2759 (168.4)	←
Bore × Stroke	mm (in.)	83 × 91 (3.27 × 3.58)	←	83 × 85 (3.27 × 3.35)	←
Compression Ratio		9.2	←	8.8	←
Max. Output	EEC	150 kw @ 6000 rpm	—	117 kw @ 5600 rpm	—
	SAE-NET	—	140 kw @ 5800 rpm	—	99 kw @ 4800 rpm
Max. Torque	EEC	254 N·m @ 4800 rpm	—	226 N·m @ 4400 rpm	—
	SAE-NET	—	245 N·m @ 4800 rpm	—	216 N·m @ 3600 rpm

General Countries



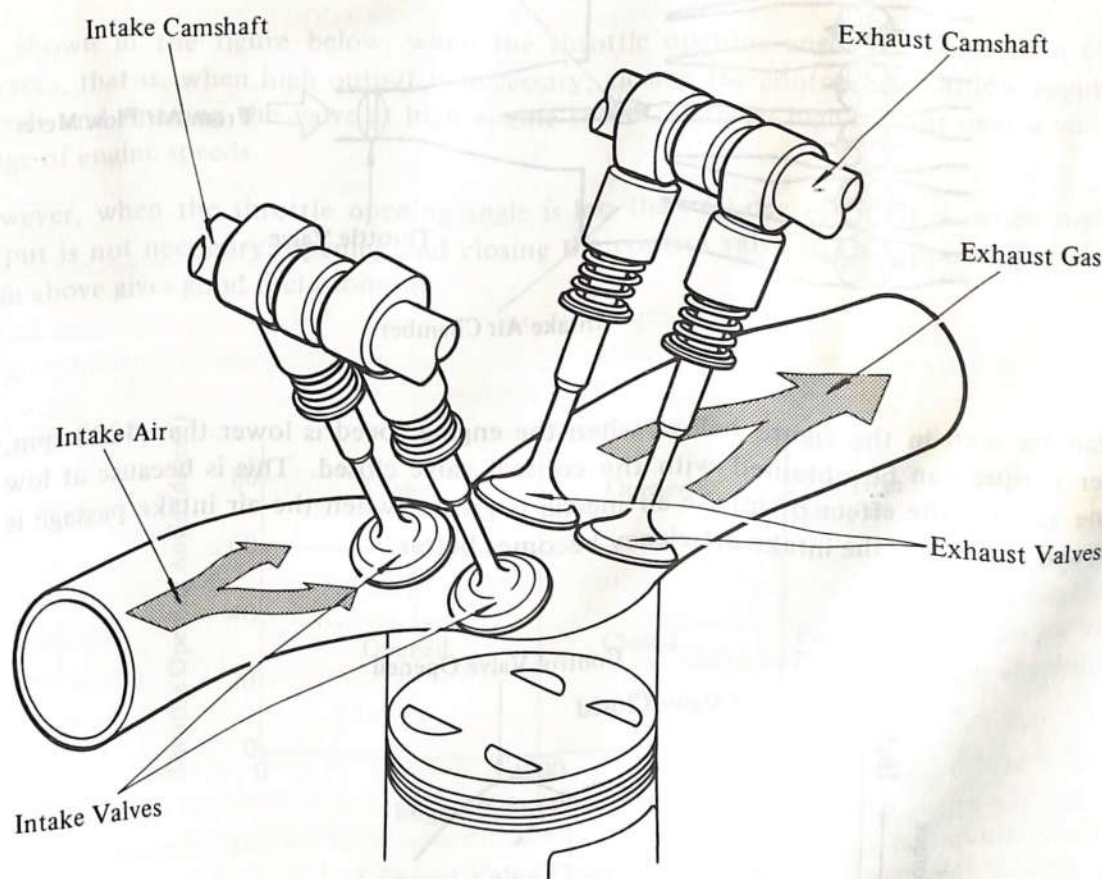
Australia



High-power and Economical Engine

1. High Output

- Through the adoption of 4 valves per cylinder (2 intake valves and 2 exhaust valves), the intake and exhaust surface area has been increased. As a result, intake and exhaust air resistance has been reduced, and efficiency, especially at high engine speeds, has been greatly improved.
- Since the camshafts operate the valves directly, the mass of the valve train is low. Through this means, precise valve motion all the way up to considerably high engine speeds has been made possible and high output has been obtained.

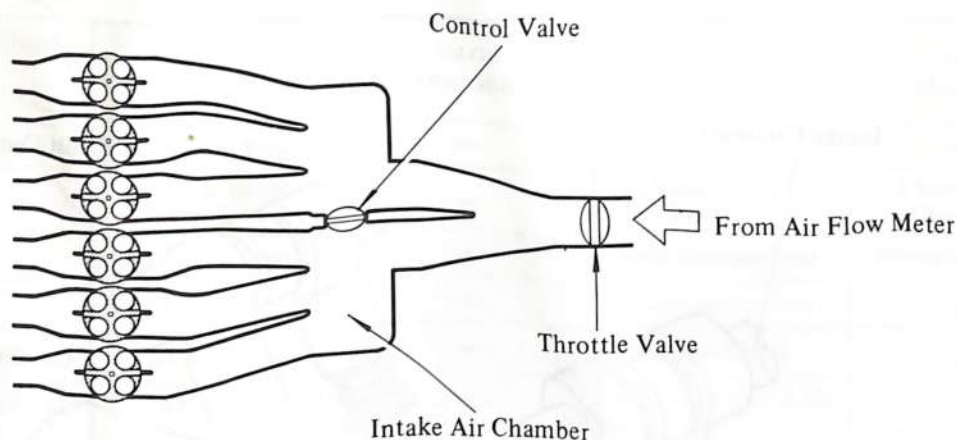


- The TCCS now includes a new type Intake Air Control System. Through its adoption, high output can be achieved over a wide range of engine speeds.

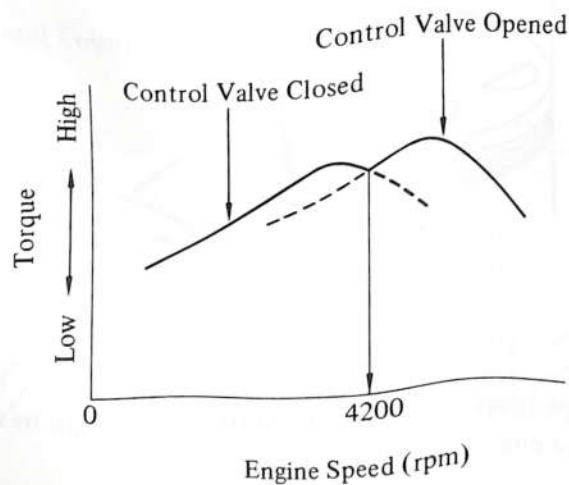
High-power and Economical Engine

What is the new type Intake Air Control System?

On the 7M-GE engine, a control valve is installed in the center of the intake air chamber, as seen in the figure below. This control valve opens and closes in accordance with the engine speed and the throttle opening angle and controls the air intake passage.



As can be seen in the figure below, when the engine speed is lower than 4200 rpm, higher torque can be obtained with the control valve closed. This is because at low engine speeds, the effect of intake air inertia is greater when the air intake passage is long, and therefore, the intake efficiency becomes better.

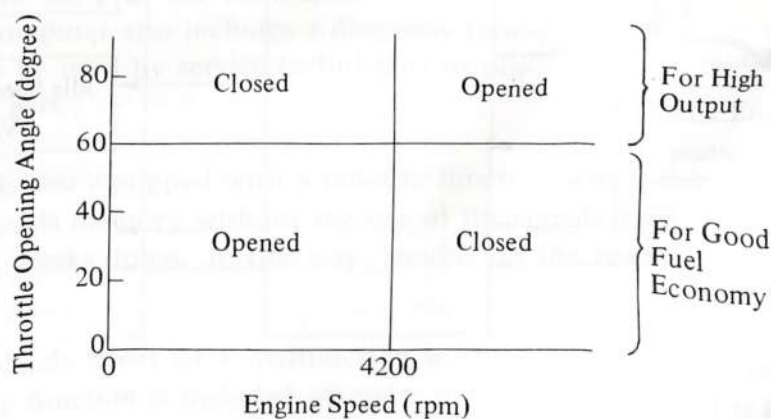


High-power and Economical Engine

On the other hand, when the engine speed is greater than 4200 rpm, higher torque can be obtained with the control valve open. This is because the intake air resistance is greater if the air intake passage is long, and as a result, intake efficiency drops.

As shown in the figure below, when the throttle opening angle is greater than 60 degrees, that is, when high output is necessary, closing the control valve at low engine speeds and opening the valve at high engine speeds, delivers high output over a wide range of engine speeds.

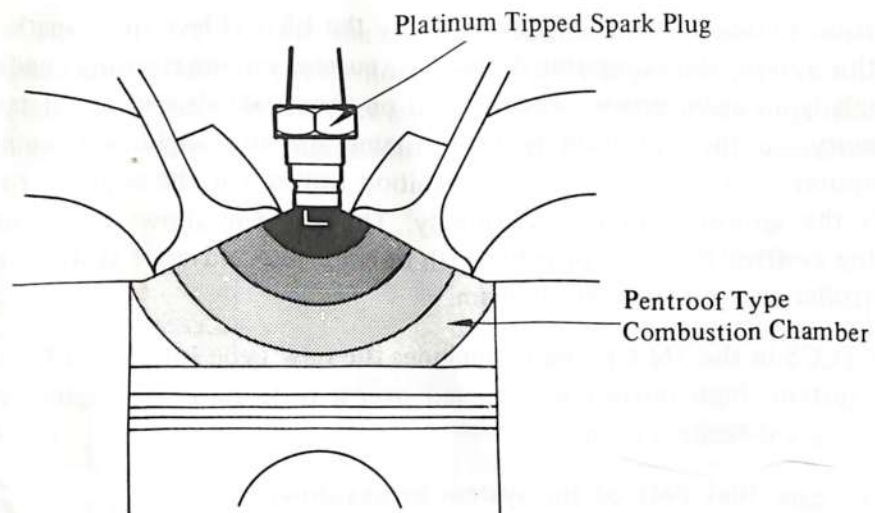
However, when the throttle opening angle is less than 60 degrees, that is, when high output is not necessary, opening and closing the control valve in the opposite pattern from above gives good fuel economy.



Control Valve Operation

High-power and Economical Engine

- By the use of platinum tipped spark plugs, ignition characteristics have been improved and more efficient combustion has been made possible (For Australia only).
- By adopting a pentroof type combustion chamber, the flame propagation distance has been shortened. This makes rapid, effective combustion possible.



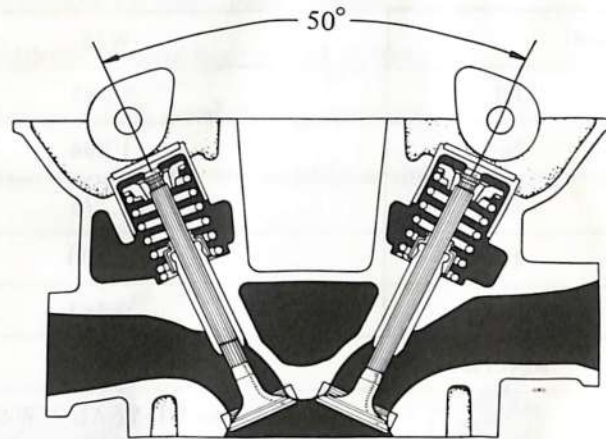
3. Super-response

- Through the use of a valve mechanism whereby the camshafts operate the valves directly, the valves' following characteristics have been improved.
- Through the adoption of a three group fuel injection system, as described before, even when the engine conditions change suddenly, extremely fine adjustments of the injected fuel amount and the injection timing have been made possible.
- The ignition timing can be precisely controlled by the ESA system.
- High performance fuel injectors, with good injected fuel atomization characteristics, have been adopted. Since the plunger in these injectors is small and lightweight, that is, since the moving parts have a low inertial mass, their response is outstanding.

High-power and Economical Engine

4. Others

- By narrowing the angle between the intake valves and the exhaust valves to 50 degrees, the cylinder head has been made compact.



- Since the maximum amount of fuel needed for a given period of time increases with higher performance engines, a fuel pump has been adopted which provides a high output capacity. With this system, when driving the car at high engine speeds with a heavy load, the output capacity increases. When driving under normal conditions, the output volume is decreased in order to reduce power consumption.

High-performance Drivetrain

Transmission

1. Manual Transmission

 TD-49

- The W58 manual transmission, which has been proven on the previous Supra, is used in the new Supra.

Manual Transmission		W58
Gear Ratio	1st	3.285
	2nd	1.894
	3rd	1.275
	4th	1.000
	5th	0.783
	Reverse	3.768
Type of Fluid		API GL-4 or GL-5 SAE 75W-90 or 80W-90
Fluid Volume		2.4 liters (2.1 Imp. qts.)

2. Automatic Transmission

 TD-50

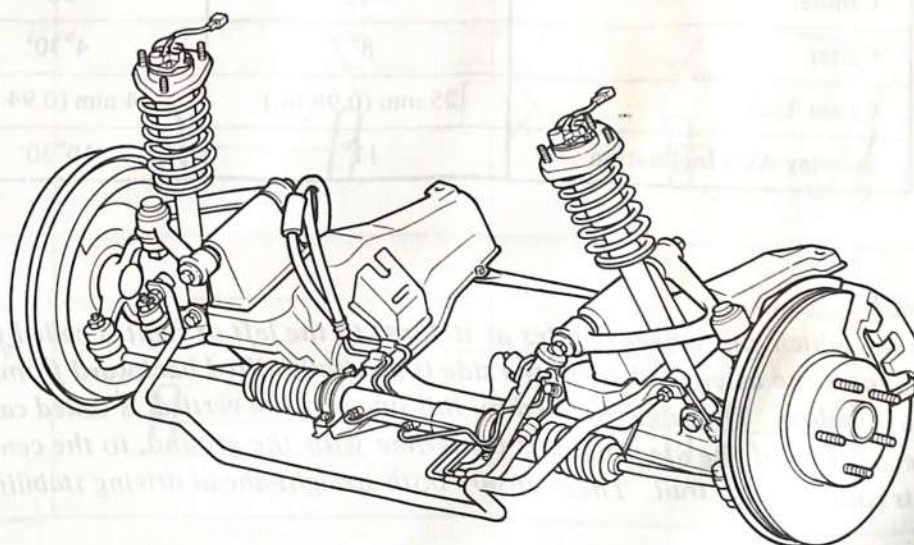
- The A340E automatic transmission is a 4-speed Electronically-Controlled Transmission (ECT) developed for use with high-performance engines such as the 22R-TEC, 6M-GE and new 7M-GE. A lock-up mechanism is built into the torque converter.

Automatic Transmission		A340E
Gear Ratio	1st	2.804
	2nd	1.531
	3rd	1.000
	4th (Overdrive)	0.705
	Reverse	2.393
Type of Fluid		ATF type DEXRON® II
Fluid Volume		7.2 liters (6.3 Imp. qts.)

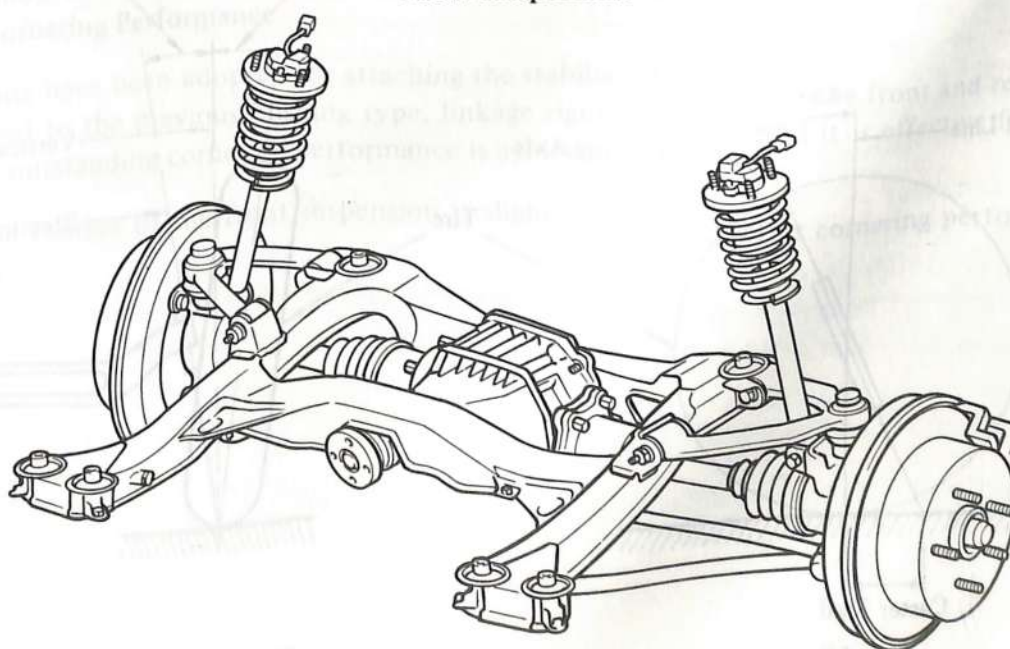
High-performance Chassis

Suspension

- A high performance suspension suitable for the new Supra as a high performance sports car has been developed with the following items as the chief aim. Also, for Australia, the TEMS (Toyota Electronic Modulated Suspension) has been adopted as optional equipment.
 - ▶ Good directional stability during high speed driving
 - ▶ Good cornering performance during high speed driving
 - ▶ High performance combined with good riding comfort
- Both the front and the rear suspensions are double wishbone type with a geometry designed specifically for the new Supra.



Front Suspension



Rear Suspension

High-performance Chassis

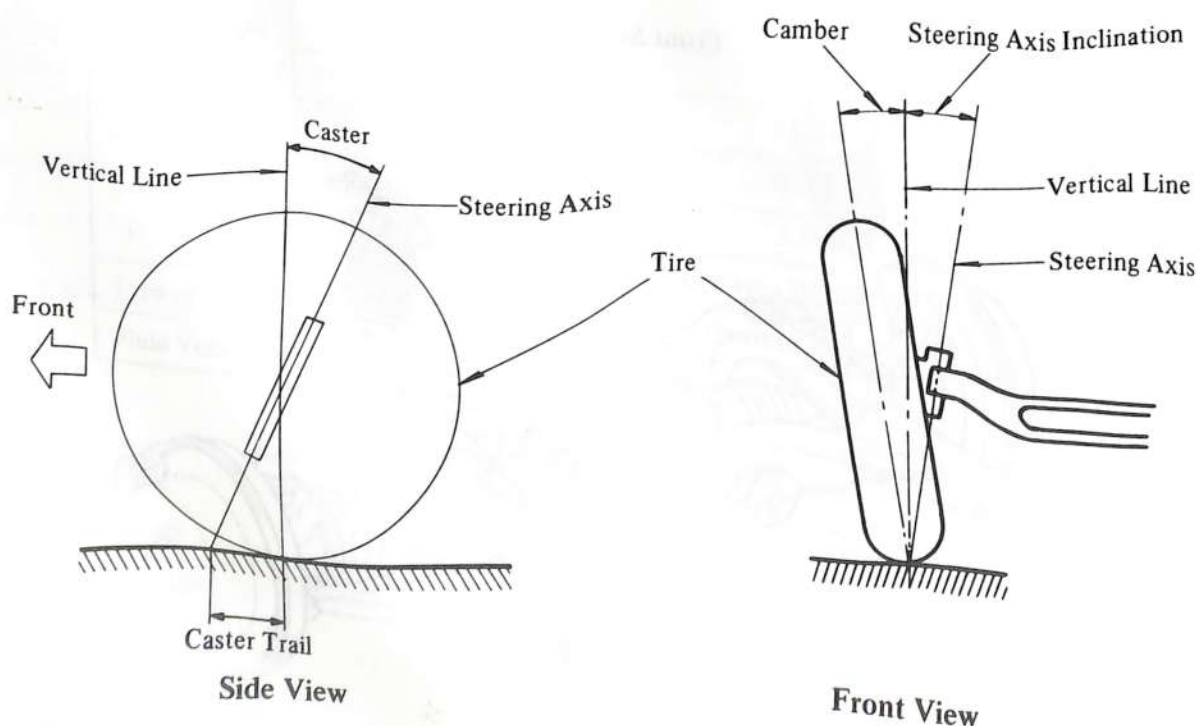
1. Good Directional Stability

- The lower arms on both the front and rear suspensions are of sufficient length, so the tread changes very little during bound and rebound. This makes for better directional stability.
- By adopting a large caster of 8 degrees on the front suspension, directional stability has been further improved. On the other hand, the caster trail has been optimized at 25 mm (0.98 in.), so a natural steering feeling is assured.

Item \ Model	New	Previous
Tread	1486 mm (58.50 in.)	1466 mm (57.72 in.)
Camber	-15'	30'
Caster	8°	4°30'
Caster Trail	25 mm (0.98 in.)	24 mm (0.94 in.)
Steering Axis Inclination	11°	10°30'

— REFERENCE —

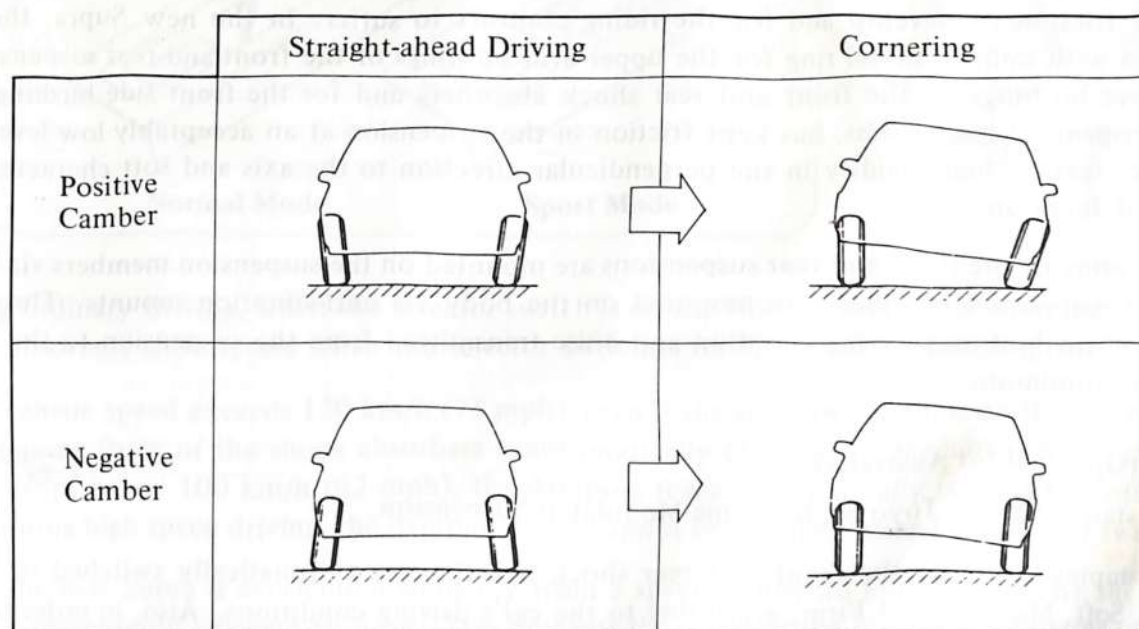
The axis around which the wheel rotates as it turns to the left or right is called the steering axis. The steering axis centerline as viewed from the side is generally tilted backward from the vertical as shown in the left figure below. The angle formed by this line and the vertical is called caster, and the distance from the intersection of the steering axis centerline with the ground, to the center of the tire-to-road contact area is called caster trail. These ensure both straight-ahead driving stability and wheel recovery after turning.



High-performance Chassis

The steering axis is also tilted inward as viewed from the front as shown in the right figure in the previous page. This is called *steering axis inclination*, and is measured in degrees of tilt from the vertical.

The wheels of the car are installed with their tops tilted outward or inward as shown in the right figure in the previous page. This is called *camber*, and is measured in degrees of tilt from the vertical. When the top is tilted outward, it is called *positive camber*. Conversely, inward tilt is called *negative camber*. Slightly negative camber provides better cornering performance by reducing the positive camber that occurs when the body of the car tilts during cornering, as shown in the figure below.



2. Good Cornering Performance

- Ball joints have been adopted for attaching the stabilizer bar in both the front and rear suspensions. Compared to the previous bushing type, linkage rigidity is high and it is effective for even minute rolls, so outstanding cornering performance is achieved.
- Since the camber of the front suspension is slightly negative, better cornering performance can be attained.

High-performance Chassis

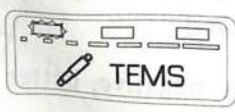
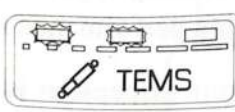
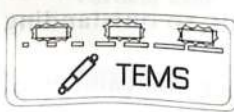
3. High Performance Combined with Good Riding Comfort

- Generally, during braking, the front of the body dives and the rear of the body rises, and during acceleration, the reverse, with the front of the body floating up and the rear of the body squatting, occurs. On the new Supra, the upper and lower arms of the front and rear suspension are placed in the optimum locations to reduce this phenomenon to the minimum.
- The front and rear suspension upper arms are made of aluminum and the front and rear stabilizer bars are hollow to reduce the unsprung weight. As a result, riding comfort is further improved.
- Generally, compared to the Macpherson strut type or the semi-trailing arm type, the double wish-bone suspension has a larger number of bushings and ball joints, so there is a tendency for a great deal of friction to develop and for the riding comfort to suffer. In the new Supra, the use of bushings with built-in metal ring for the upper arm bushings of the front and rear suspensions, for the lower bushings of the front and rear shock absorbers and for the front side bushings of the front suspension lower arms, has kept friction in the suspension at an acceptably low level. These bushings feature high rigidity in the perpendicular direction to the axis and soft characteristics in the axial direction.
- All the arms of the front and rear suspensions are mounted on the suspension members via bushings and the suspension members are mounted on the body via anti-vibration mounts. Through this double anti-vibration system, vibration and noise transmitted from the suspension to the body is kept to a minimum.

4. TEMS (Optional for Australia)

 TD-104

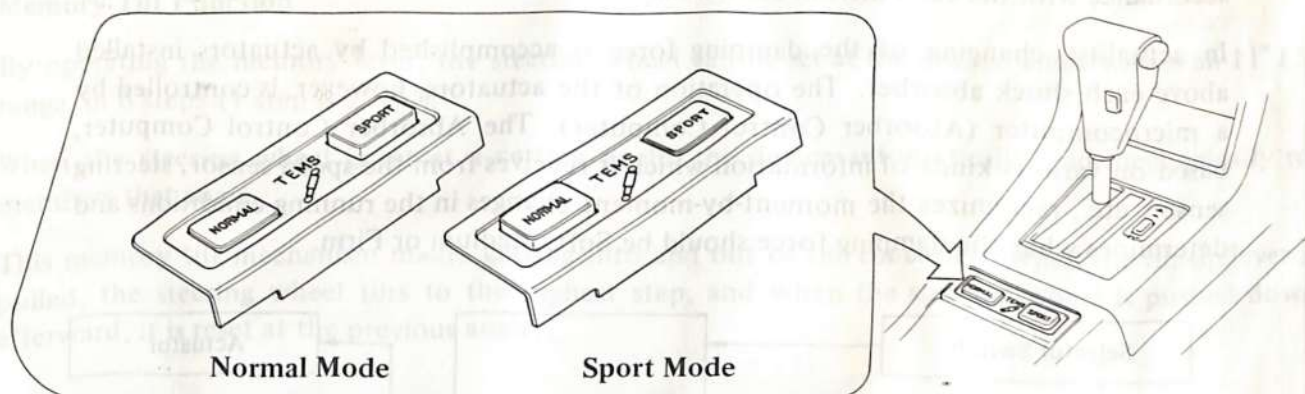
- TEMS stands for the Toyota Electronic Modulated Suspension.
- The damping force of the front and rear shock absorbers is automatically switched to one of 3 stages, Soft, Medium and Firm, according to the car's driving conditions. Also, in order to inform the driver of which of the 3 stages the damping force is currently set at, a TEMS indicator with the following type of display is provided in the combination meter.

Damping Force	Soft	Medium	Firm
TEMS Indicator			

High-performance Chassis

- The driver can select either of the 2 modes shown below by operating the selector switch located just in back of the shift lever.

- ▶ Emphasis on riding comfort ————— Normal Mode
- ▶ Enjoying a sporty ride ————— Sport Mode



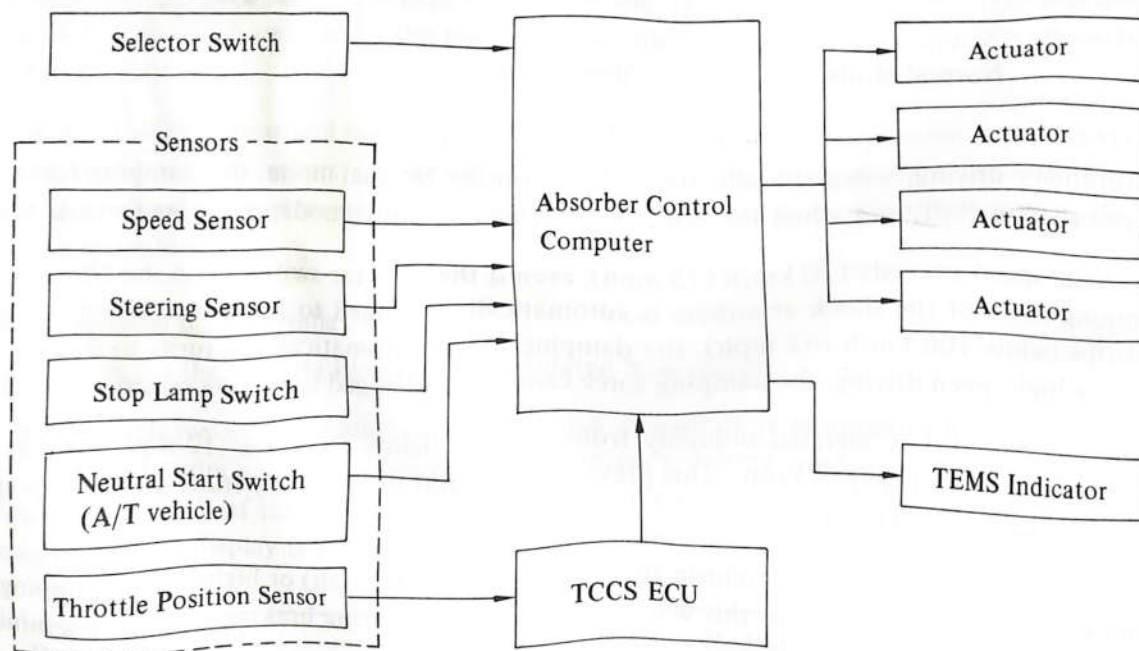
- During ordinary driving, when the selector switch is on the Normal mode, the damping force of the shock absorbers is Soft, and when the selector switch is on Sport mode, damping force is Medium.
- When vehicle speed exceeds 120 km/h (75 mph), even if the selector switch is on the Normal mode, the damping force of the shock absorbers is automatically changed to Medium. (When the vehicle speed drops below 100 km/h (62 mph), the damping force automatically returns to Soft.) Therefore, during high speed driving, the damping force cannot be changed using the selector switch.
- When the new Supra is accelerated suddenly from a speed below 20 km/h (12 mph), the damping force is temporarily changed to Firm. This prevents the front of the body from floating up and the rear of the body from squatting.
- If the brakes are applied when the vehicle speed is 60 km/h (37 mph) or higher, the damping force is temporarily changed to Firm. In this way, body nose dive during braking is kept to a minimum.
- In a sudden turn, the damping force temporarily becomes Firm, thus limiting body roll. Judgement of whether the vehicle is making a sudden turn is based on the turning angle of the steering wheel and the vehicle's speed at that time.
- On cars equipped with automatic transmissions, while the vehicle speed is less than 10 km/h (6 mph) with the shift lever in the "N" or "P" range, and for 5 seconds after the shift lever is then changed to any other range from that condition, the damping force is maintained on Firm. This prevents the rear of the body from squatting suddenly when the shift lever is taken out of the "N" or "P" range.

High-performance Chassis

How does the TEMS work?

In the TEMS (Toyota Electronic Modulated Suspension), as described earlier, the damping force of the shock absorbers is automatically changed to one of three stages in accordance with the car's driving condition.

In actuality, changing of the damping force is accomplished by actuators installed above each shock absorber. The operation of the actuators, however, is controlled by a microcomputer (Absorber Control Computer). The Absorber Control Computer, based on various kinds of information which it receives from the speed sensor, steering sensor, etc., recognizes the moment-by-moment changes in the running conditions and determines what the damping force should be Soft, Medium or Firm.



Then how is the damping force of the shock absorbers changed to 3 different stages? As is generally well known, the damping force of shock absorbers is obtained by the resistive force of a shock absorber fluid passing through narrow passages. If the passages are widened, the damping force will decrease and if they are constricted, the damping force will become greater. In the TEMS, this fluid passage is made narrower or wider in 3 stages, varying the damping force.

The fluid channel is changed by an electric actuator mounted on top of each shock absorber that drives a vertical rod to control a valve inside the shock absorber body.

Luxury Equipment

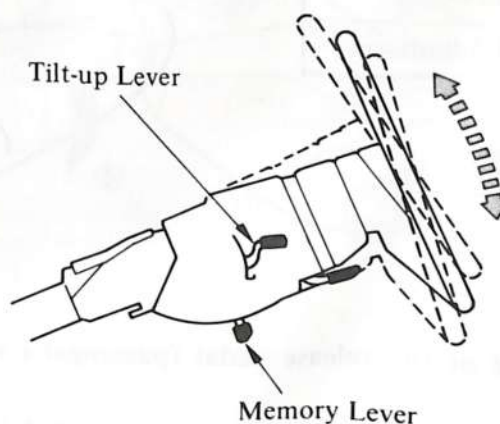
Memory Tilt and Telescopic Steering

 TD-117

- In addition to the previous tilt mechanism, a telescopic mechanism has been also adopted, making it possible to adjust the steering wheel to a more suitable position.

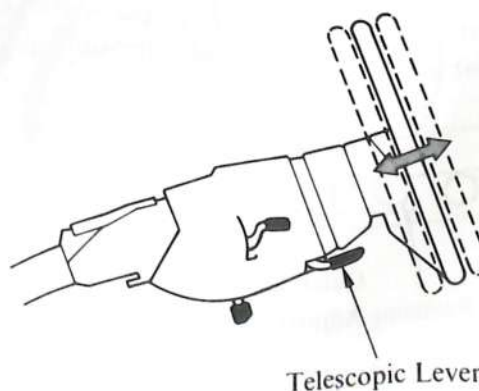
1. Memory Tilt Function

- By operating the memory lever, the steering wheel can be set at the desired angle within an $11^{\circ}15'$ range, in 6 steps (1 step is $2^{\circ}15'$).
- When the steering wheel is set at a certain angle, the device automatically and mechanically remembers that angle.
- This memory tilt mechanism makes getting into and out of the car easier. When the tilt-up lever is pulled, the steering wheel tilts to the highest step, and when the steering wheel is pushed down afterward, it is reset at the previous angle.



2. Telescopic Function

- By operating the telescopic lever, the steering wheel's longitudinal position can be adjusted to the desired position within a 40 mm (1.58 in.) range.



Seat

TD-137

A 6-way adjustable sports seat has been adopted. This seat allows the more suitable driving position.

Lumbar support and side support are power adjusted, so adjustment is extremely easy.

Adjustment Function

Forward-backward Slide
Quick Reclining
Stepless Reclining
Vertical Adjuster*
Power Lumbar Support*
Power Side Support*
Headrest Vertical Adjustment
Headrest Forward-backward Adjustment

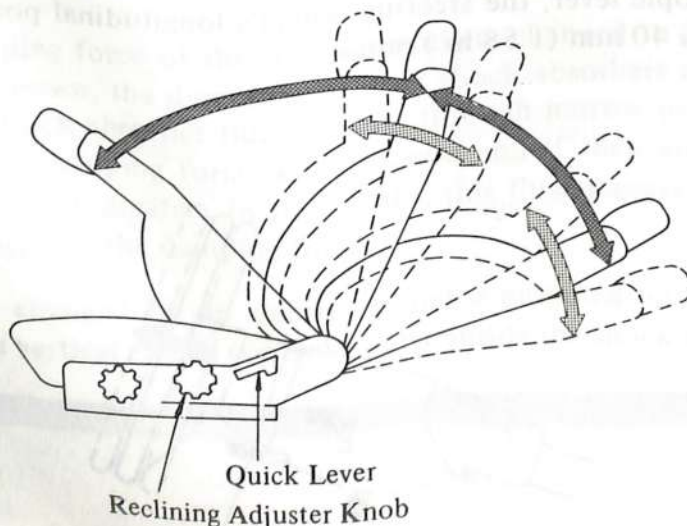
Driver's Seat Only



Reclining Function

By operating the quick lever or the release pedal (passenger's seat only), the seat back can be reclined forward or backward.

When the seat back is in the normal position or when it is reclined back, stepless adjustment within 30° range can be carried out by turning the reclining adjuster knob.



Luxury Equipment

2. Power Lumbar Support and Power Side Support

- The lumbar support and the side support can be steplessly adjusted by means of motors incorporated into the seat back.
- The lumbar and side support switch is located just in front of the console box where the driver can reach it in the normal driving posture, so adjustments can be made easily.



Cruise Control System

TD-149

- The cruise control system, which is extremely convenient when running continuously at a constant speed, is now standard equipment.
- The control switch is located on the steering wheel (see page MH-5), for outstanding ease of operation.

Audio System

TD-156

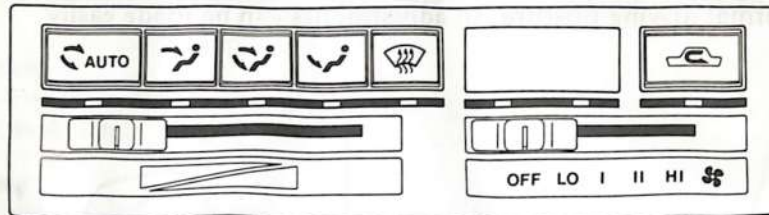
- Through the use of 2-liter Bass-reflex type front speakers and optional 3-liter Bass-reflex type rear speakers, full bass sounds are reproduced and sound with the feel of a concert hall can be enjoyed.

Luxury Equipment

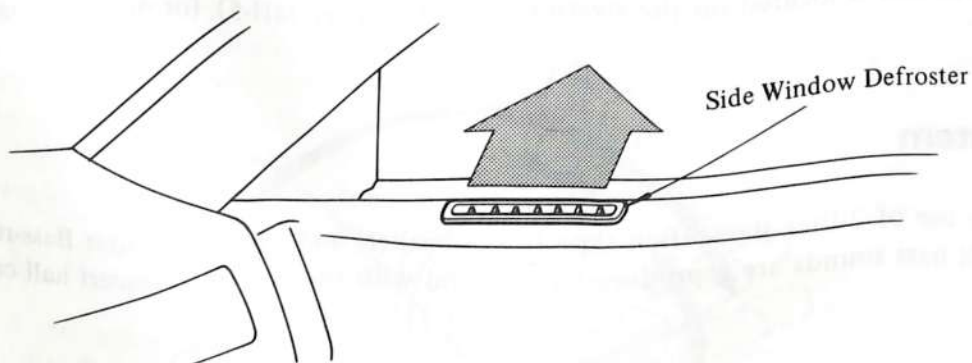
Air Conditioning System

 TD-157

- A push button type control switch is used, improving ease of operation. The mode position, now indicated by graphic symbols, is easier to identify at a glance.

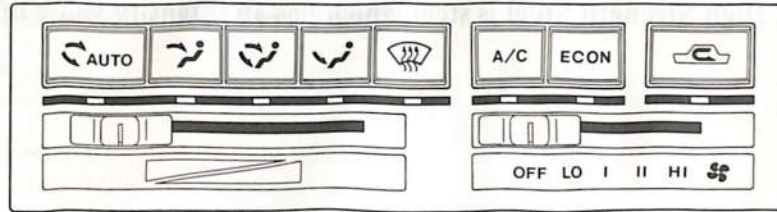


- The mode control switches now include an Auto mode, in which vents are automatically changed according to the position of the temperature control lever.
- When the Defroster mode is set, in order to improve the defrosting efficiency, the system will automatically switch to Fresh even if the Recirc switch is on.
- A cool air bi-level system has been adopted in which cool air can be blown out through the center ventilator during heating and defrosting. In this way, comfortable heating and defrosting, with the head cool and the feet warm, can be obtained.
- Even when the blower switch is off, if the Recirc switch is off, that is, if the setting is on Fresh, outside air will be brought in by dynamic pressure while the car is moving. At such a time, the outlet temperature and the vents can be controlled as usual.
- As shown in the figure below, side window defrosters are built into the door trim. This increases the window defrosting capacity.

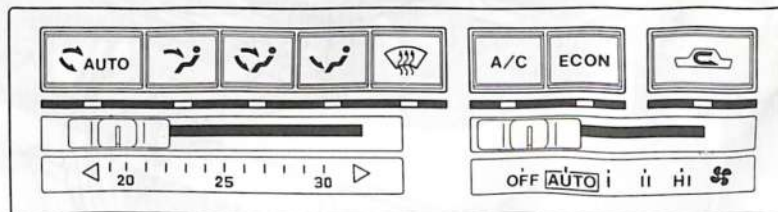


Luxury Equipment

- The air conditioner is offered as optional equipment for general countries and South Africa.



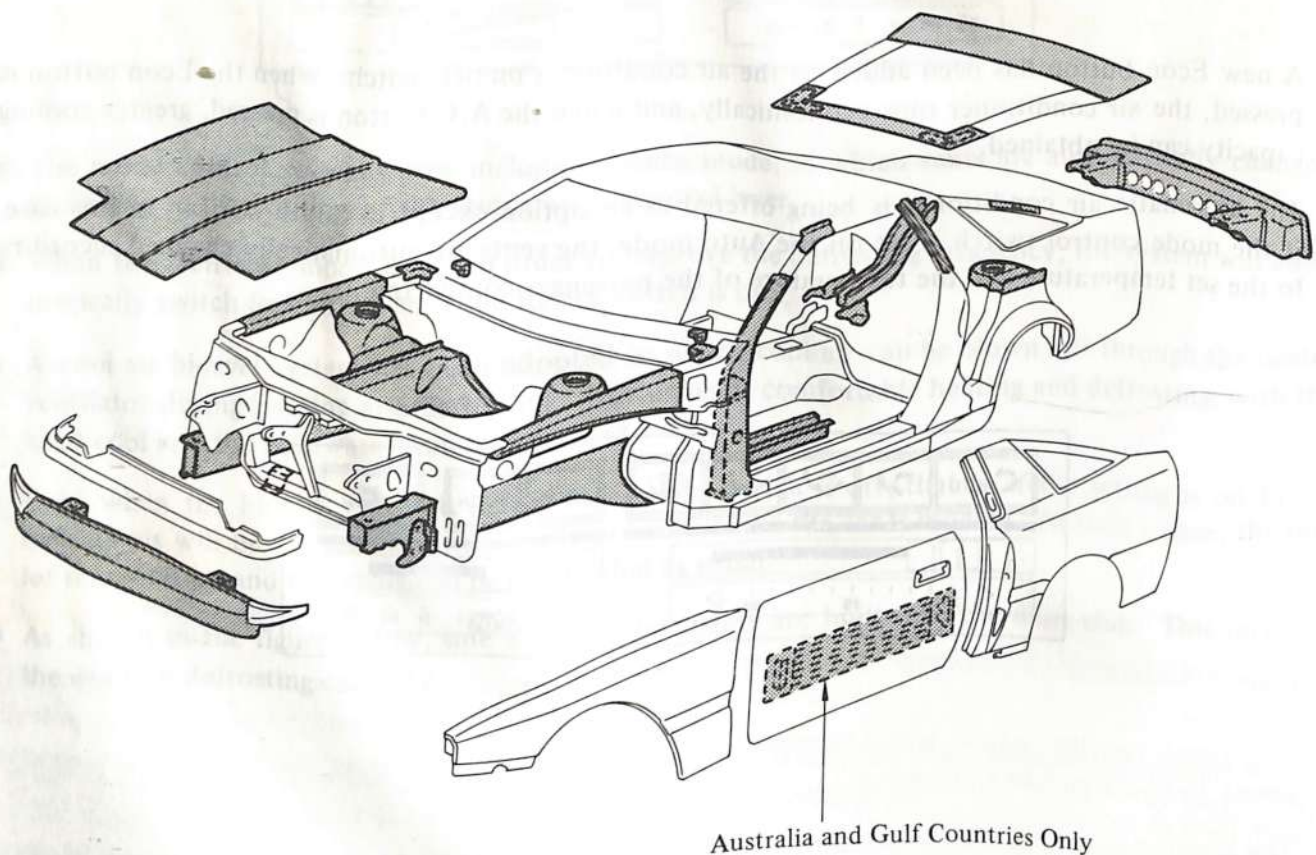
- A new Econ button has been added to the air conditioner on-off switch. When the Econ button is pressed, the air conditioner runs economically, and when the A/C button is pressed, greater cooling capacity can be obtained.
- The automatic air conditioner is being offered as an option except in South Africa. In this case, if the mode control switch is set on the Auto mode, the vents are automatically changed according to the set temperature and the temperature of the passenger compartment.



Lightweight and Durable Body

Lightweight Body

- High Strength Steel has been used extensively, making the body lighter while retaining its high strength. Generally, High Strength Steel is steel which has an intensity value of at least 35 kgf/mm².

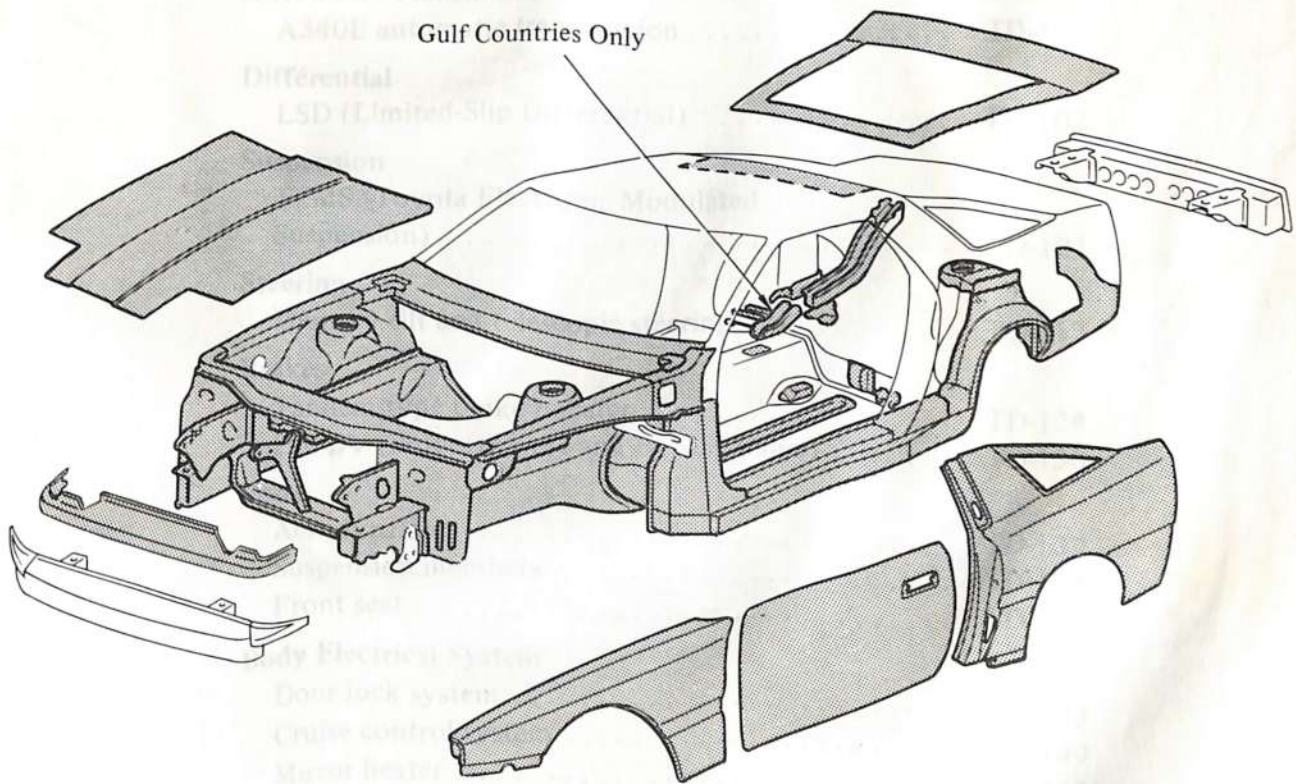


NOTE: The illustration shows only the main components. There are other components for which High Strength Steel is used. Total weight of High Strength Steel used is approximately 113 kg (249 lbs.).

Lightweight and Durable Body

Rust-resistant Body

- Rust-resistant Steel has been extensively used. 2 types of Rust-resistant Steel are used; Galvanized Steel Sheet and Electro Galvanized Steel Sheet.



NOTE: The illustration shows only the main components. There are other components for which Rust-resistant Steel is used.

1. The first part of the report deals with the general situation of the country and the progress of the work.

2. The second part of the report deals with the results of the work and the conclusions drawn from it.

3. The third part of the report deals with the financial situation and the budget for the next year.

4. The fourth part of the report deals with the personnel situation and the plans for the next year.

5. The fifth part of the report deals with the general conclusions and the recommendations for the future.

6. The sixth part of the report deals with the general conclusions and the recommendations for the future.

7. The seventh part of the report deals with the general conclusions and the recommendations for the future.

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9. The ninth part of the report deals with the general conclusions and the recommendations for the future.

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11. The eleventh part of the report deals with the general conclusions and the recommendations for the future.

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19. The nineteenth part of the report deals with the general conclusions and the recommendations for the future.

20. The twentieth part of the report deals with the general conclusions and the recommendations for the future.

Technical Description

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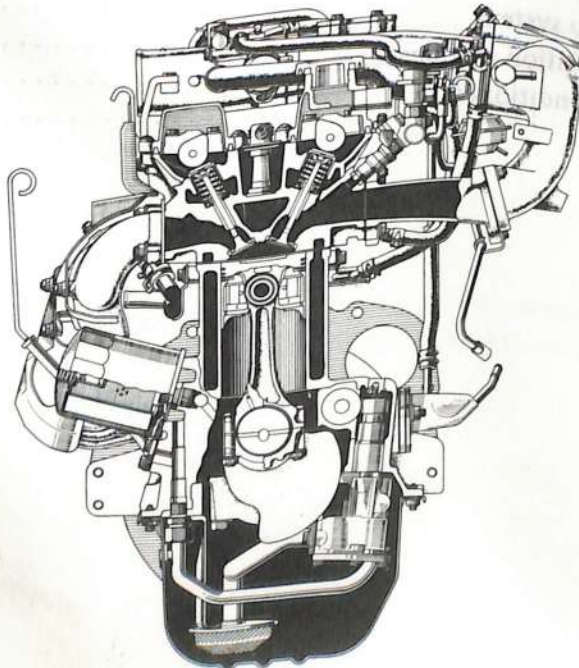
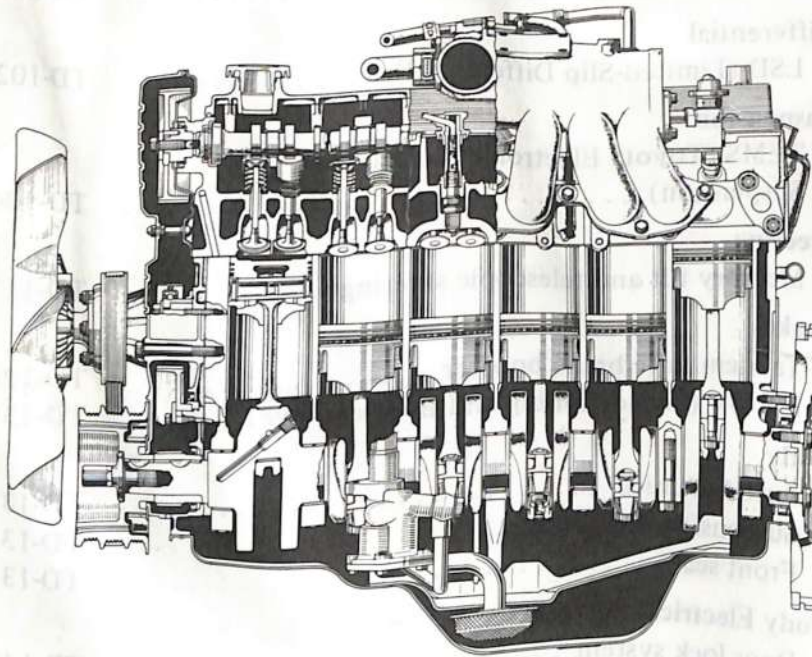
ENGINE

7M-GE ENGINE

DESCRIPTION

The 7M-GE engine is a 3.0 liter 4 valve DOHC engine that has been designed based on the 5M-GE engine (2.8 liter 2 valve DOHC engine).

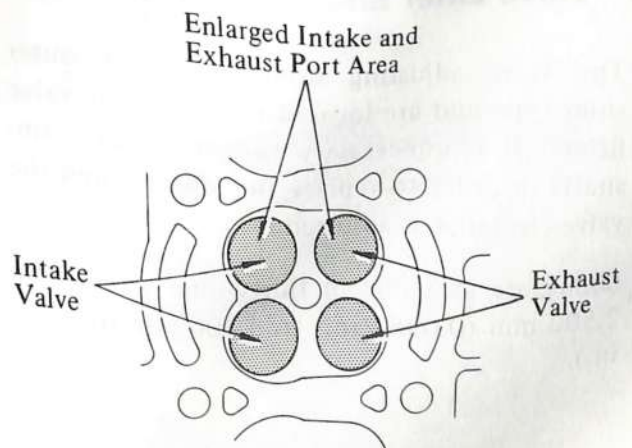
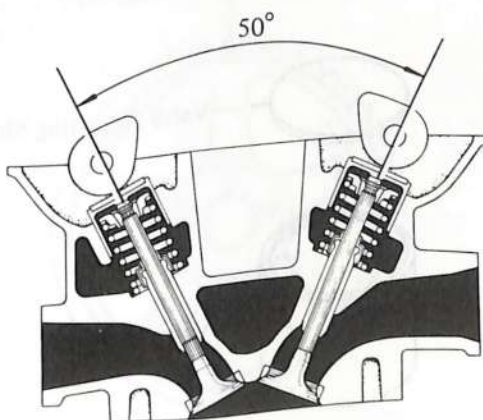
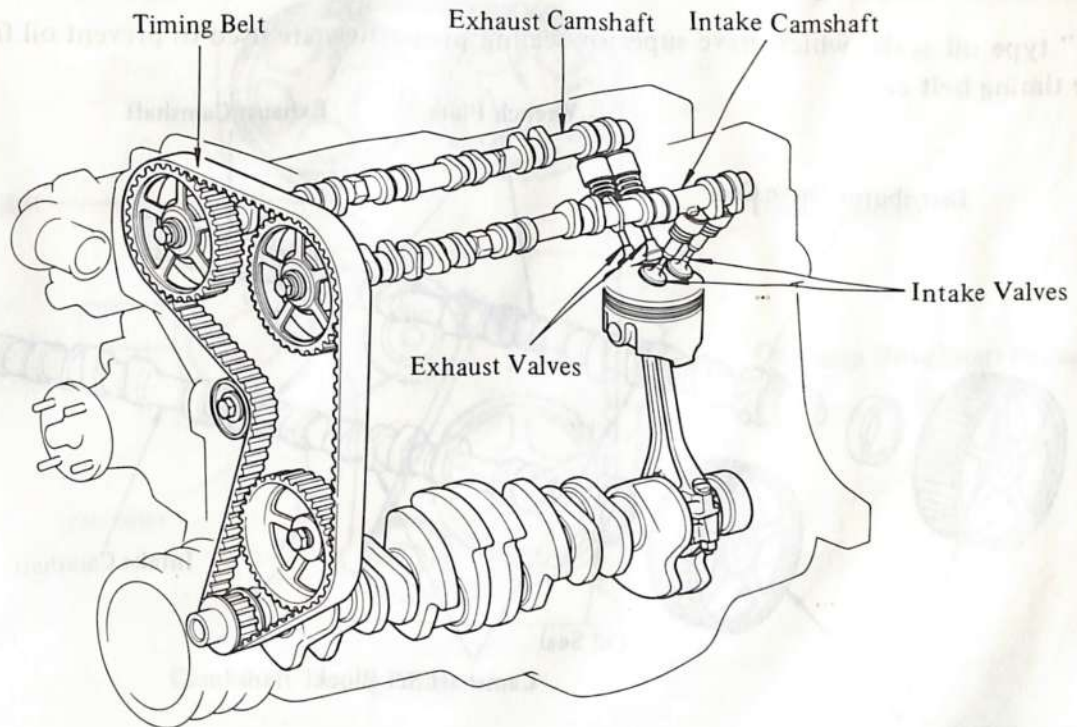
Fuel economy, maintainability, performance and reliability have all been improved by the use of four valves for each cylinder and the Intake Air Control System, as well as by the use of the TCCS (Toyota Computer Controlled System).



VALVE MECHANISM

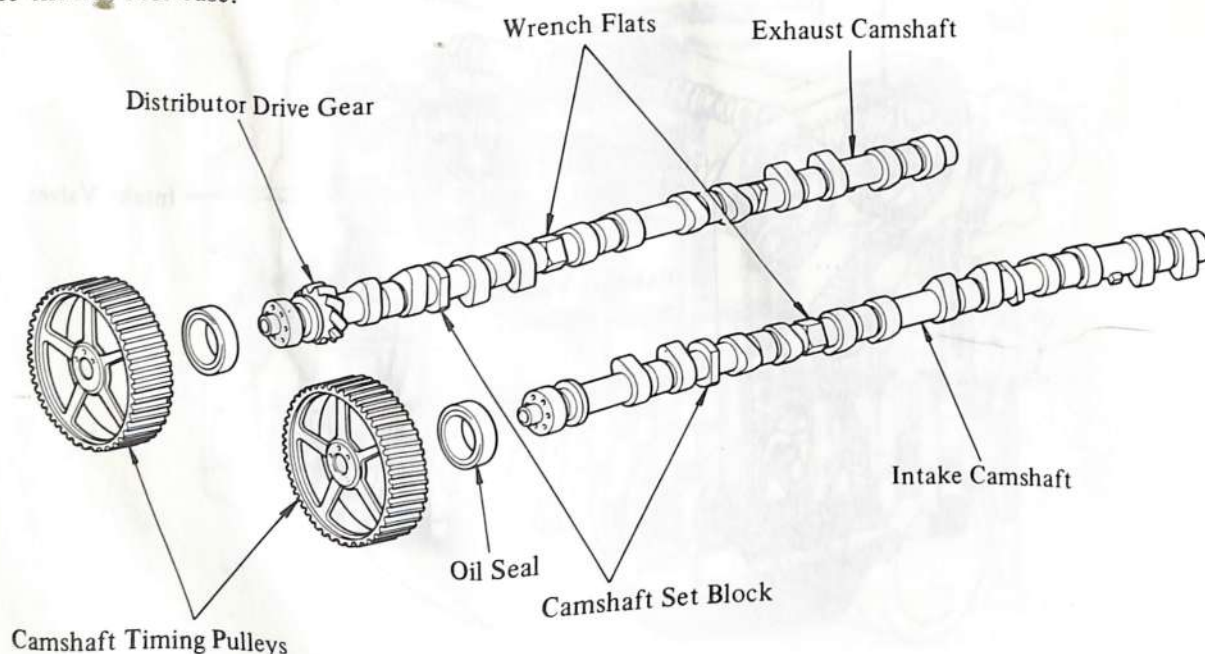
1. General

- Each cylinder is equipped with two intake valves and two exhaust valves so that the size and weight of each valve can be reduced. At the same time, intake and exhaust efficiency has been increased due to an overall increase in port area.
- The valves are directly opened and closed by the two belt-driven camshafts, even at high engine speeds.



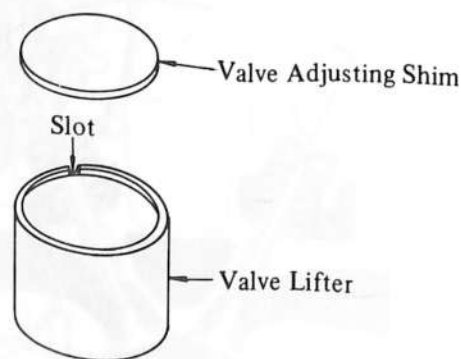
2. Camshafts

- Each camshaft has seven journals, six of which are located between the valve lifters. The thrust is taken up by the thrust surface of the No. 1 journal.
- The distributor is driven by a gear installed on the front of the exhaust camshaft.
- The two exhaust valves of each cylinder open and close together, as do the two intake valves.
- Each camshaft has been provided with hexagonal wrench flats so that the camshaft can be held immobile while the camshaft timing pulley is removed or installed.
- A block has been designed in for setting the camshaft at the No. 1 cylinder TDC compression.
- “T” type oil seals, which have superior sealing properties, are used to prevent oil from leaking into the timing belt case.



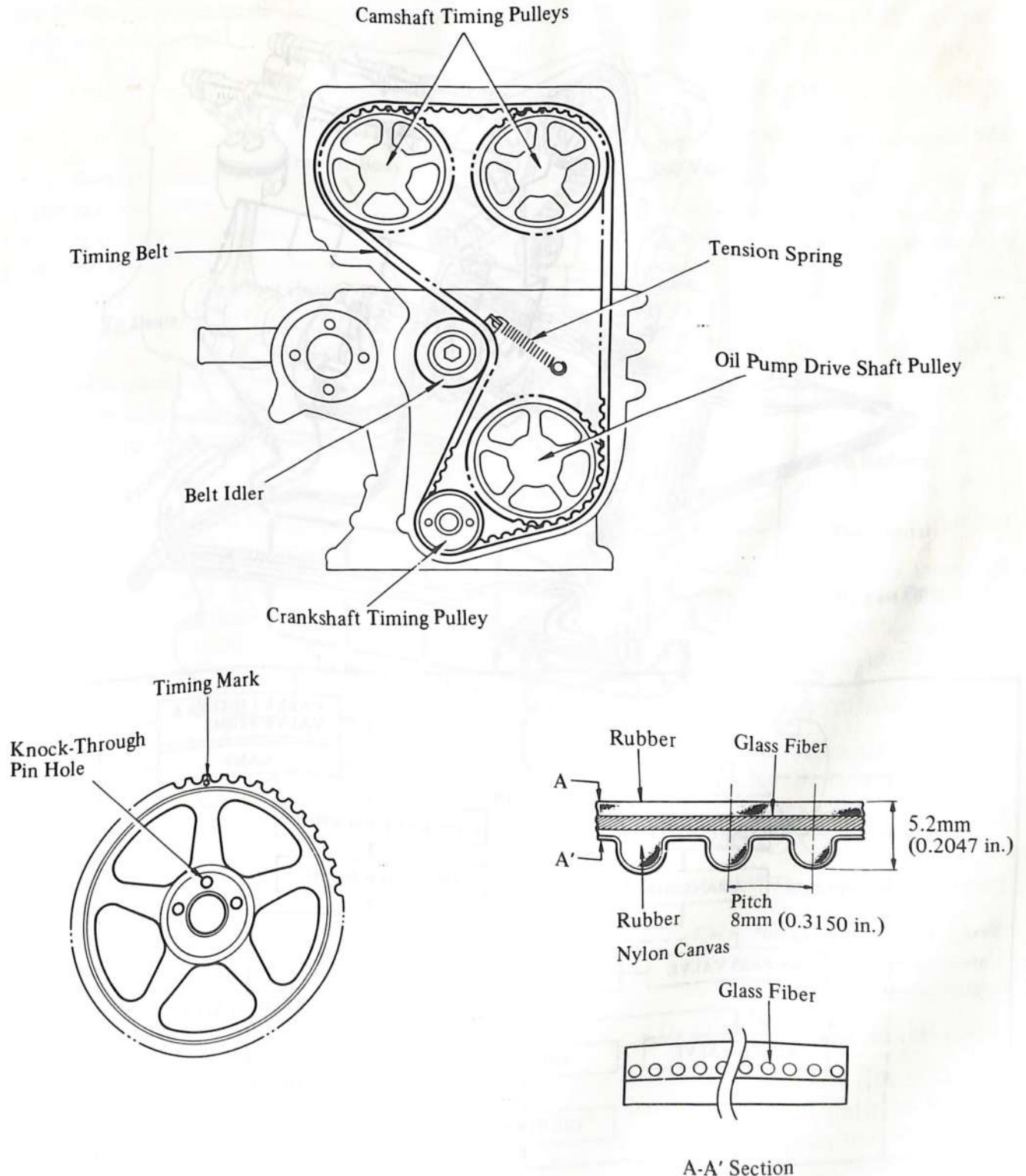
3. Valve Lifter and Valve Adjusting Shims

- The valve adjusting shims used are outer shim type and are located on top of the valve lifters. It is unnecessary to remove the camshafts in order to replace the shims when the valve clearance is adjusted.
- Shims are available in thirty-nine sizes from 2.500 mm (0.0984 in.) to 3.300 mm (0.1299 in.).



4. Timing Pulleys, Belt Idler and Timing Belt

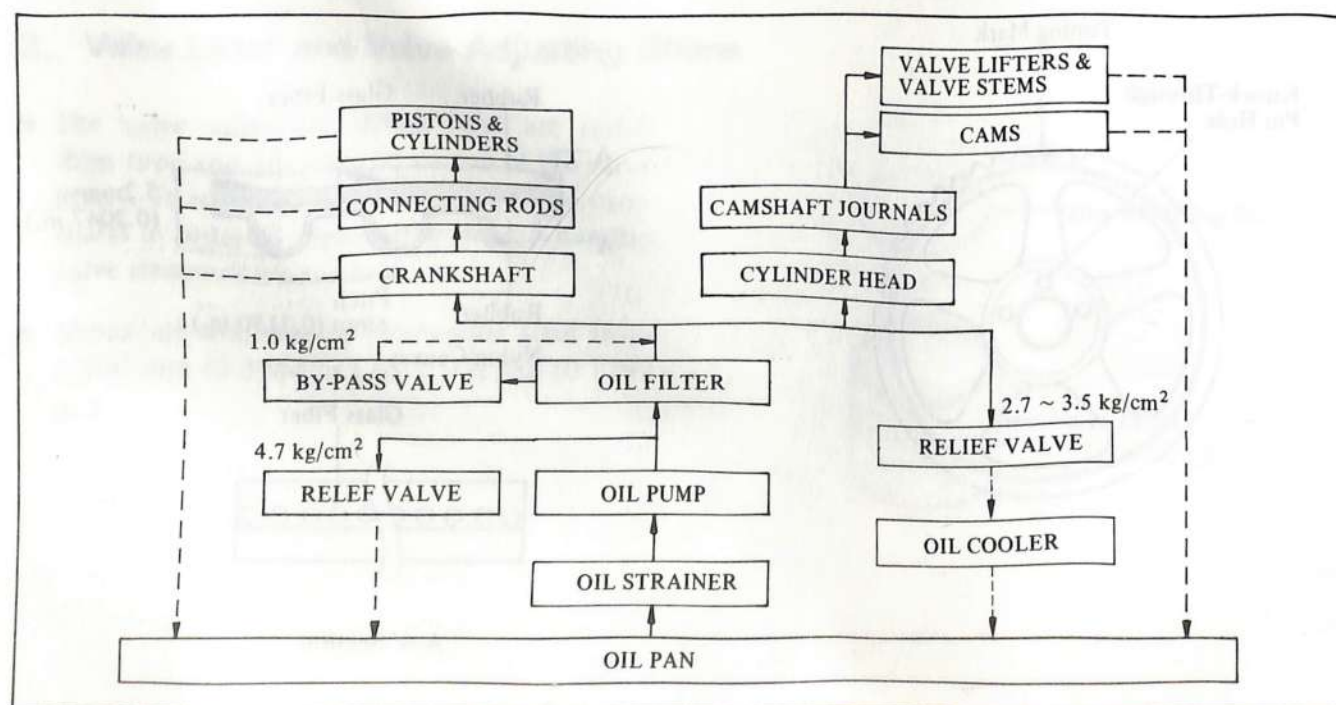
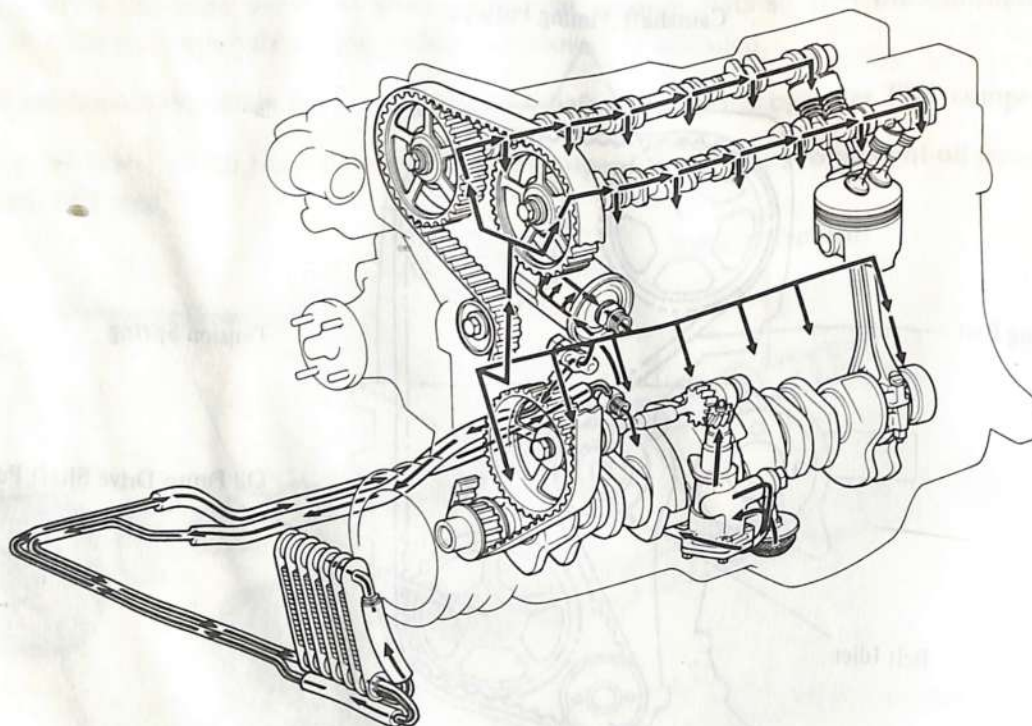
- The timing pulleys can be used interchangeably on either the exhaust or intake side.
- The timing belt idler is provided with a sealed-in-grease type ball bearing.
- A timing belt with rounded teeth is used to reduce noise.



LUBRICATION SYSTEM

Lubrication Circuit

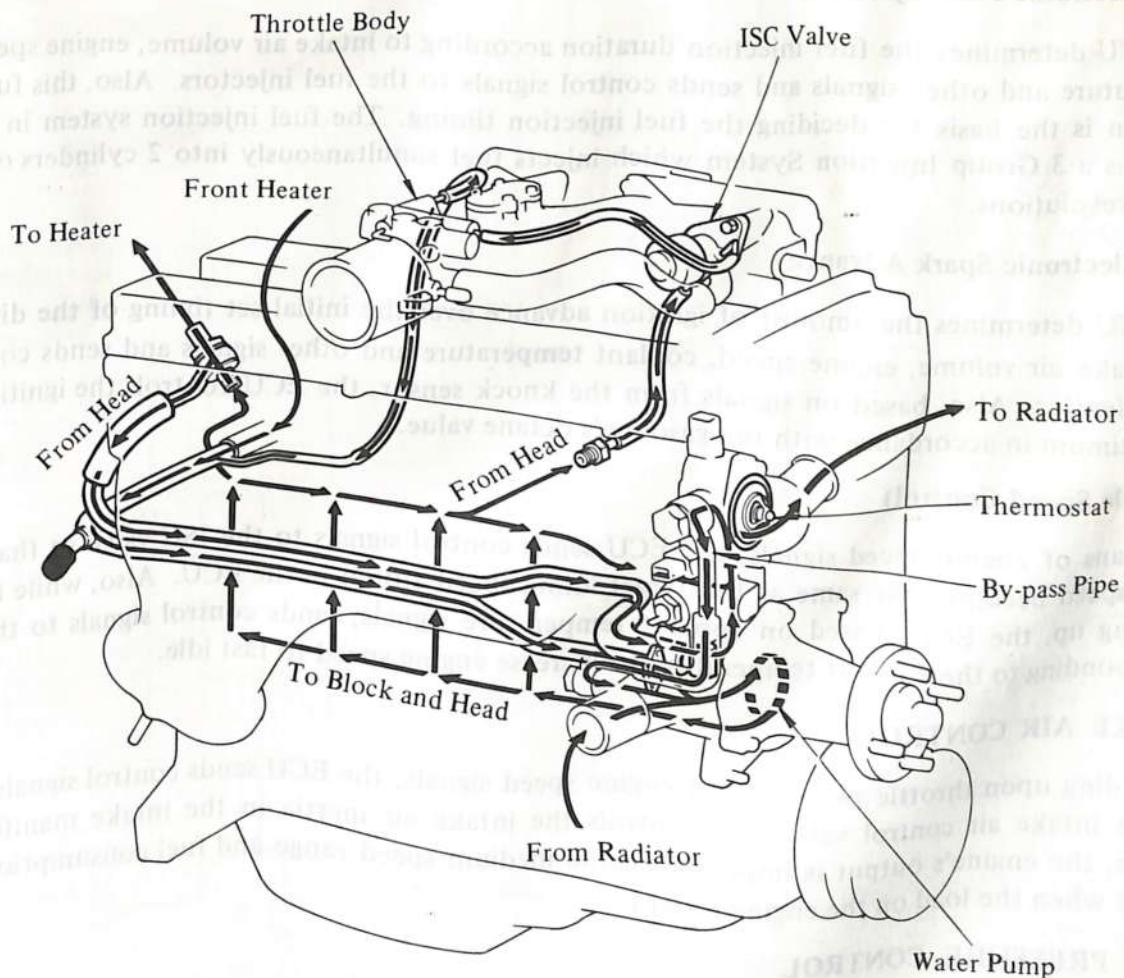
The lubrication circuit is fully pressurized and oil passes through an oil filter.



COOLING SYSTEM

Cooling Circuit

A pressurized, forced-circulation cooling system has been adopted. The water pump is driven by the belt and the thermostat is located at the water pump outlet side of the cooling circuit. Coolant not only cools the cylinder block and cylinder head, but also warms the ISC valve and throttle body, preventing icing.



TCCS (TOYOTA Computer-Controlled System)

1. General

The TCCS uses an ECU (Electronic Control Unit) with a built-in microprocessor. Stored inside the ECU is the data for fuel injection duration, ignition timing and idling speed, etc. which are matched with the various engine conditions as well as programs for calculation. The ECU utilizes these data and signals from the various sensors in the vehicle and makes calculations with the stored programs to determine fuel injection duration, ignition timing and idling speed, etc., and outputs control signals to the respective actuators which control operation.

The TCCS for the 7M-GE engine has the functions shown below:

EFI (Electronic Fuel Injection)

The ECU determines the fuel injection duration according to intake air volume, engine speed, coolant temperature and other signals and sends control signals to the fuel injectors. Also, this fuel injection duration is the basis for deciding the fuel injection timing. The fuel injection system in the 7M-GE engine is a 3 Group Injection System which injects fuel simultaneously into 2 cylinders once every 2 engine revolutions.

ESA (Electronic Spark Advance)

The ECU determines the amount of ignition advance over the initial set timing of the distributor by the intake air volume, engine speed, coolant temperature and other signals and sends control signals to the igniter. Also, based on signals from the knock sensor, the ECU controls the ignition timing at the optimum in accordance with the gasoline's octane value.

ISC (Idle Speed Control)

By means of engine speed signals, the ECU sends control signals to the ISC valve so that the actual idling speed becomes the same as the target idling speed stored in the ECU. Also, while the engine is warming up, the ECU, based on coolant temperature signals, sends control signals to the ISC valve corresponding to the coolant temperature to increase engine speed to fast idle.

INTAKE AIR CONTROL

Depending upon throttle position and engine speed signals, the ECU sends control signals to the VSV of the intake air control valve and controls the intake air inertia in the intake manifold. By this system, the engine's output is improved in the medium speed range and fuel consumption can be improved when the load on the engine is light.

FUEL PRESSURE CONTROL

Based on coolant temperature, intake air temperature and starting signals, the ECU sends control signals to the pressure regulator VSV and raises the fuel pressure. Through this system, restartability is improved when the engine is hot.

FUEL PUMP SPEED CONTROL

The ECU, based on intake air volume and engine speed signals, sends control signals to the fuel pump control relay to control the fuel pump speed. That is to say, when the engine requires a large volume of fuel, the fuel pump turns at high speeds and when only a small volume of fuel is required, the pump turns at low speeds.

DIAGNOSIS

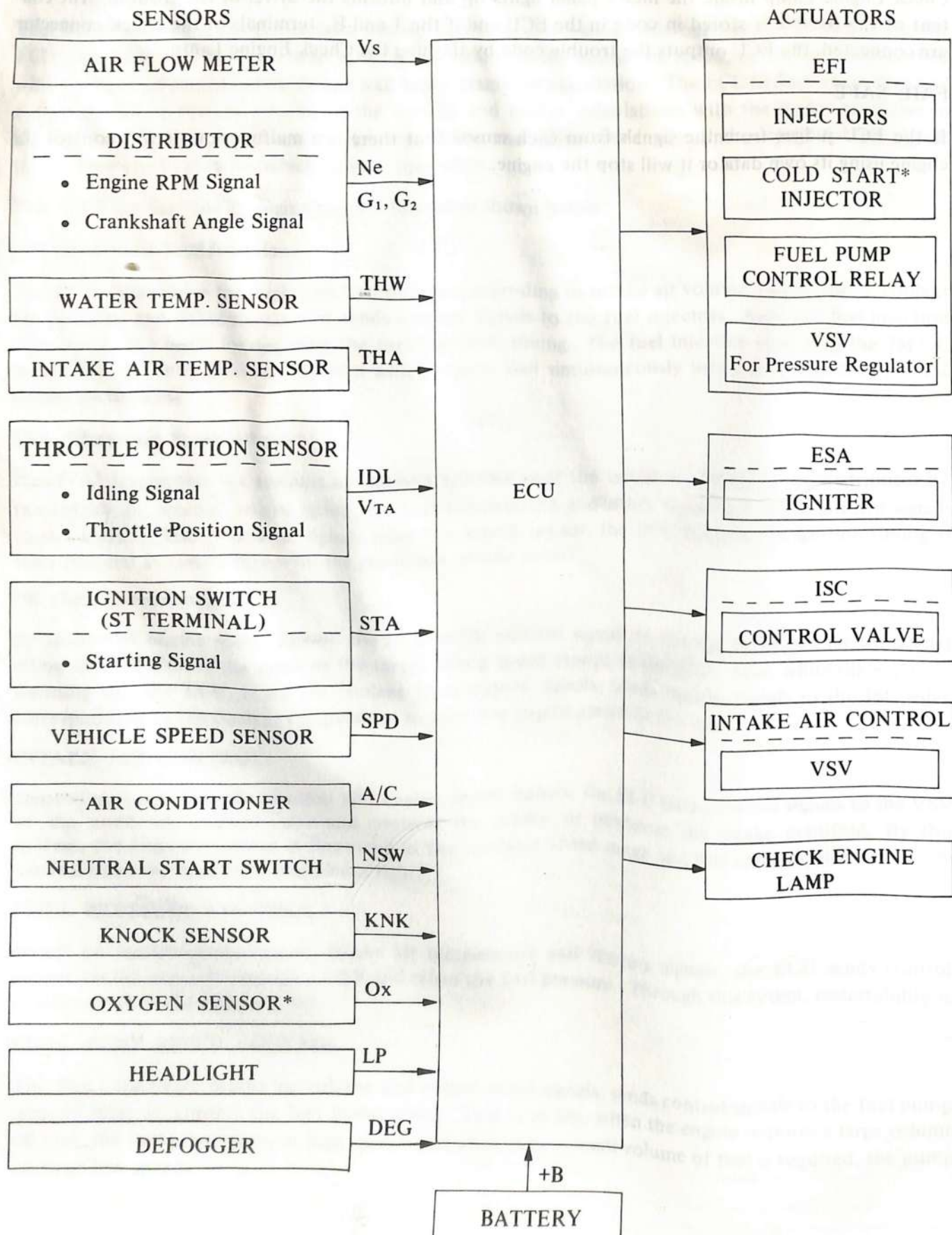
The ECU is constantly monitoring signals from each sensor. If trouble develops with the signals, the Check Engine Lamp inside the meter panel lights up and informs the driver of the trouble. The content of the trouble is stored in code in the ECU and if the T and E₁ terminals of the check connector are connected, the ECU outputs the trouble code by flashing the Check Engine Lamp.

FAIL SAFE

If the ECU judges from the signals from each sensor that there is a malfunction, it will control the engine using its own data or it will stop the engine.

2. Construction

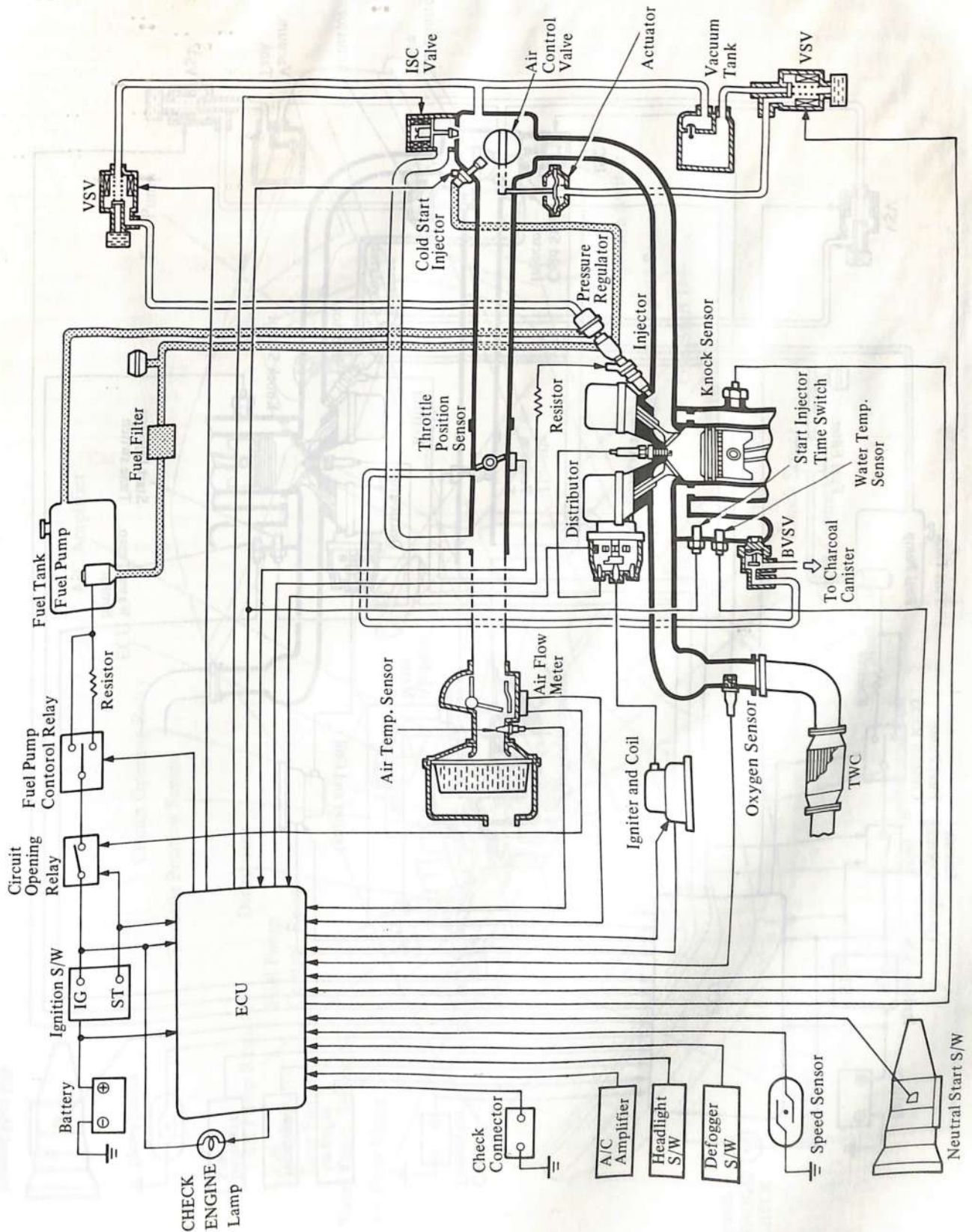
The TCCS can be broadly divided into three groups: the ECU, the sensors, and the actuators.



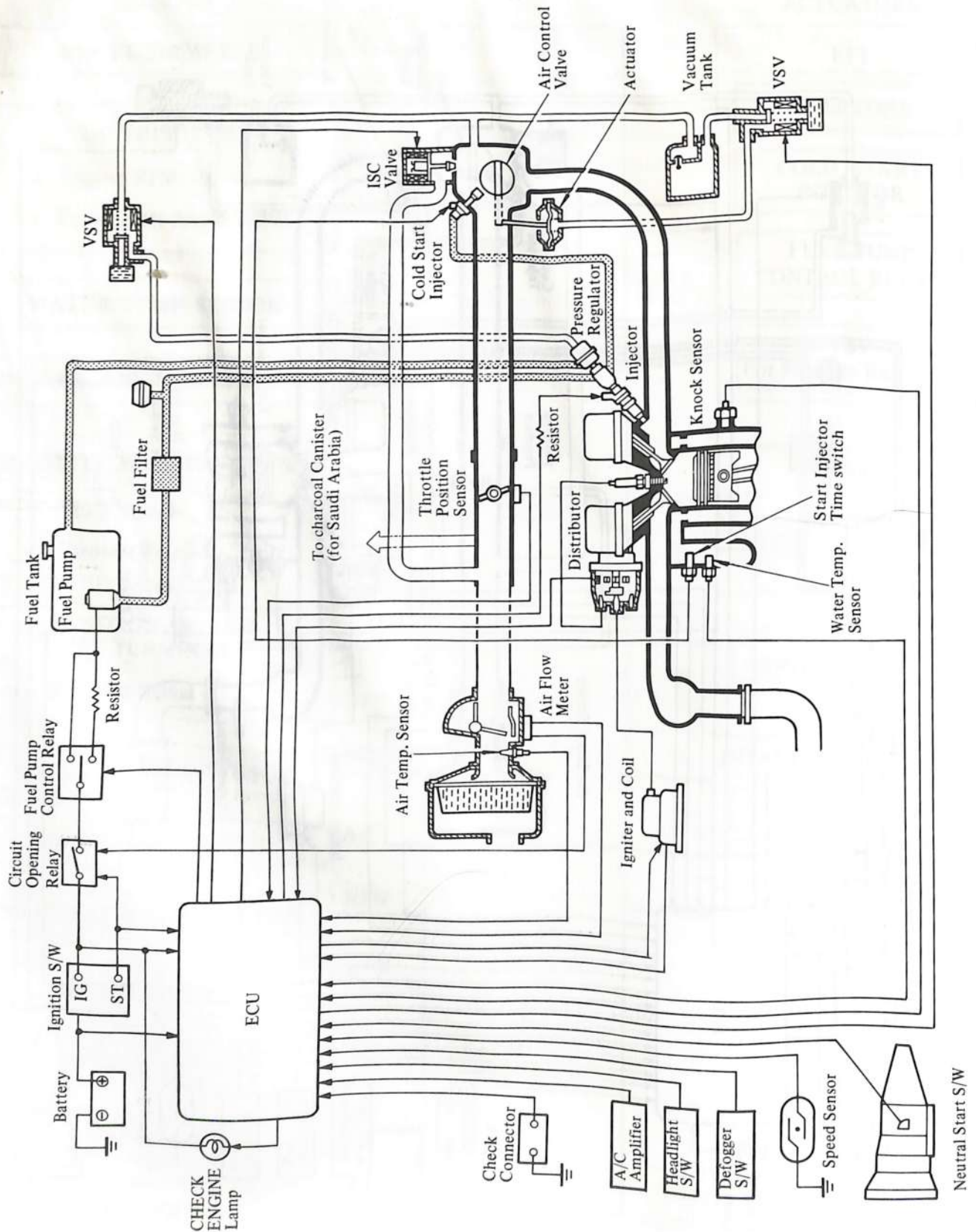
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3. TCCS System Diagram

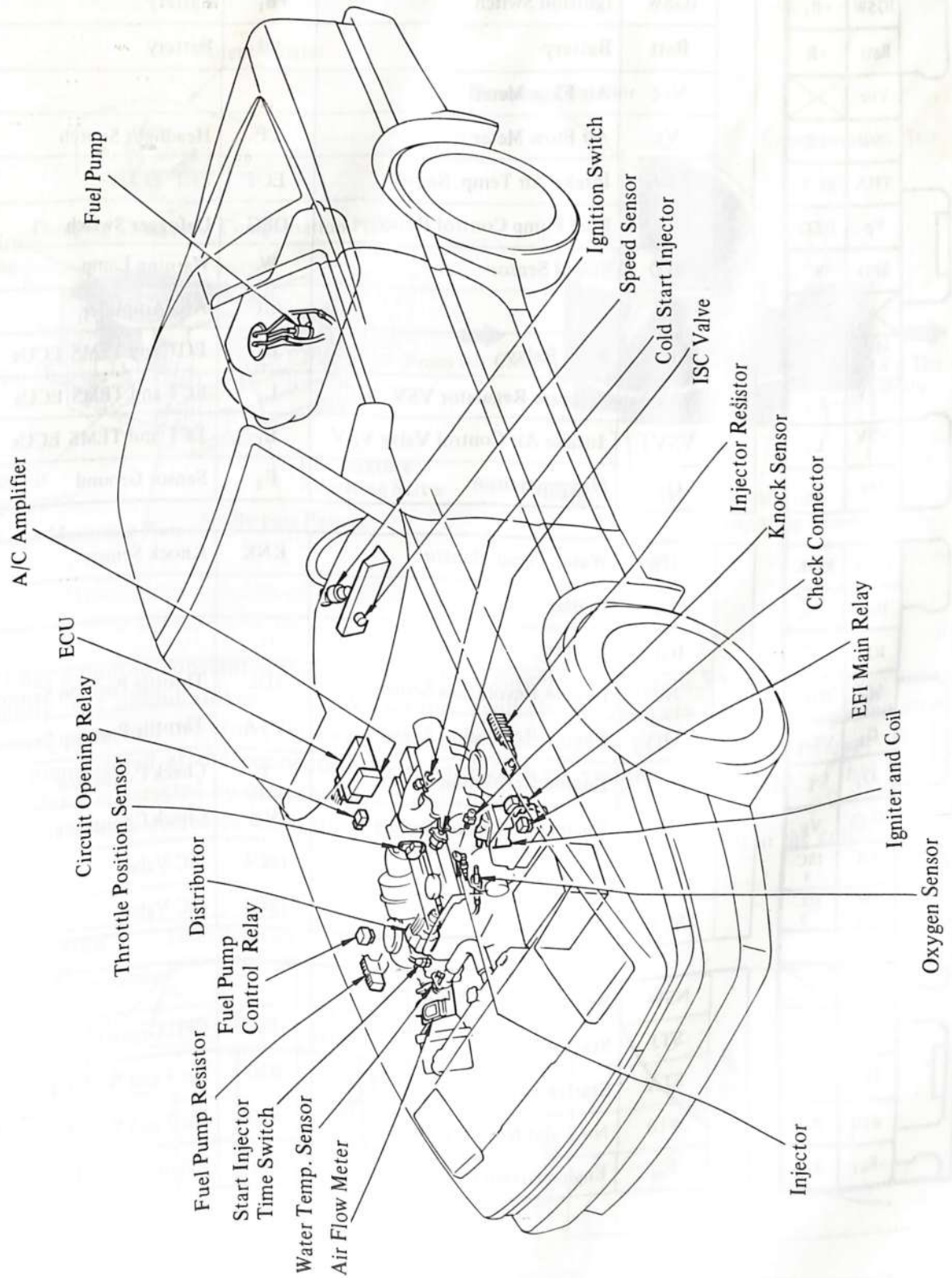
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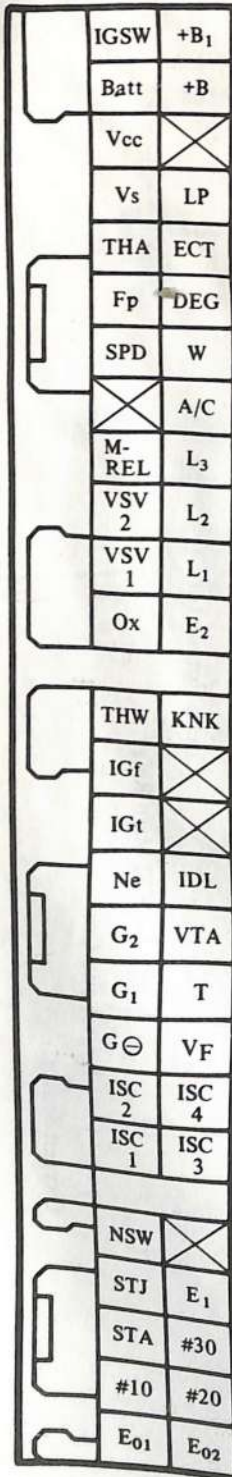
Except Australia



4. Arrangement of TCCS Components



5. ECU Connectors



	Symbol	Connection	Symbol	Connection
24 Pin	IGSW	Ignition Switch	+B ₁	Battery
	Batt	Battery	+B	Battery
	Vcc	Air Flow Meter		
	Vs	Air Flow Meter	LP	Headlight Switch
	THA	Intake Air Temp. Sensor	ECT	ECT ECU
	Fp	Fuel Pump Control Relay	DEG	Defogger Switch
	SPD	Speed Sensor	W	Warning Lamp
			A/C	A/C Amplifier
	M-REL	Main Relay	L ₃	ECT and TEMS ECUs
	VSV ₂	Pressure Regulator VSV	L ₂	ECT and TEMS ECUs
	VSV ₁	Intake Air Control Valve VSV	L ₁	ECT and TEMS ECUs
	Ox	Oxygen Sensor	E ₂	Sensor Ground

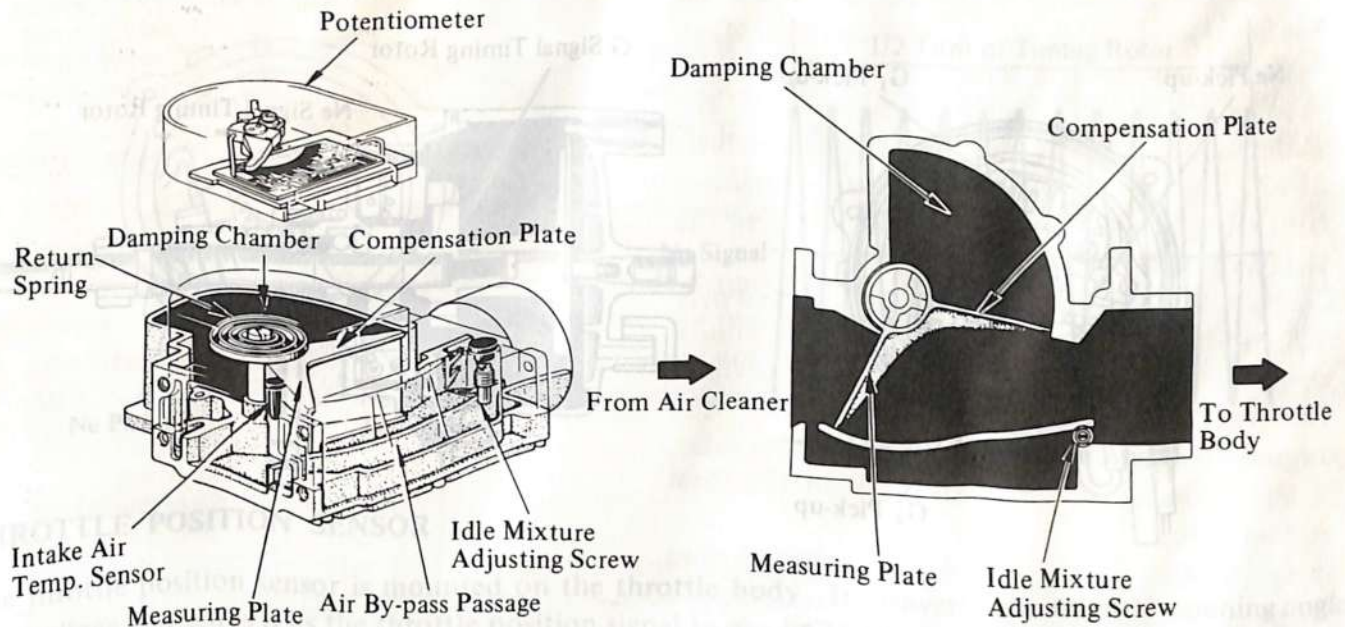
18 Pin	THW	Water Temp. Sensor	KNK	Knock Sensor
	IGf	Igniter		
	IGt	Igniter		
	Ne	Engine Revolution Sensor	IDL	Throttle Position Sensor
	G ₂	Engine Revolution Sensor	VTA	Throttle Position Sensor
	G ₁	Engine Revolution Sensor	T	Check Connector
	G ⊖	Engine Revolution Sensor	VF	Check Connector
	ISC ₂	ISC Valve	ISC ₄	ISC Valve
	ISC ₁	ISC Valve	ISC ₃	ISC Valve

10 Pin	NSW	Neutral Start Switch		
	STJ	Start Injector	E ₁	CPU Ground
	STA	Starter Switch	#30	No.3 and No.5 Injectors
	#10	No.1 and No.4 Injectors	#20	No.2 and No.6 Injectors
	E ₀₁	Engine Ground	E ₀₂	Engine Ground

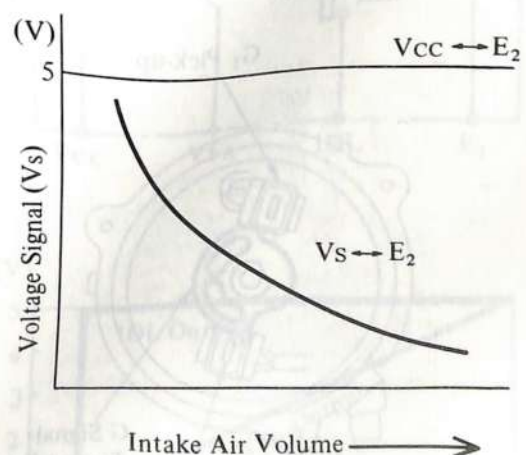
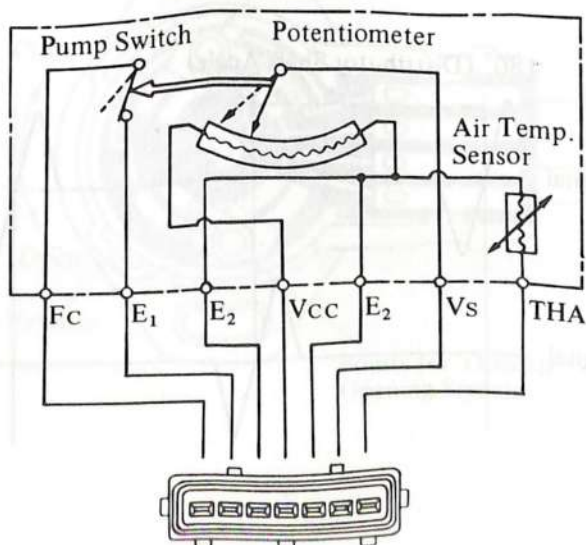
6. Construction and Operation of Main Components

AIR FLOW METER

Using a potentiometer, the air flow meter translates intake air volume into varying voltage. The ECU determines the basic injection duration and basic ignition advance angle on the basis of this voltage.

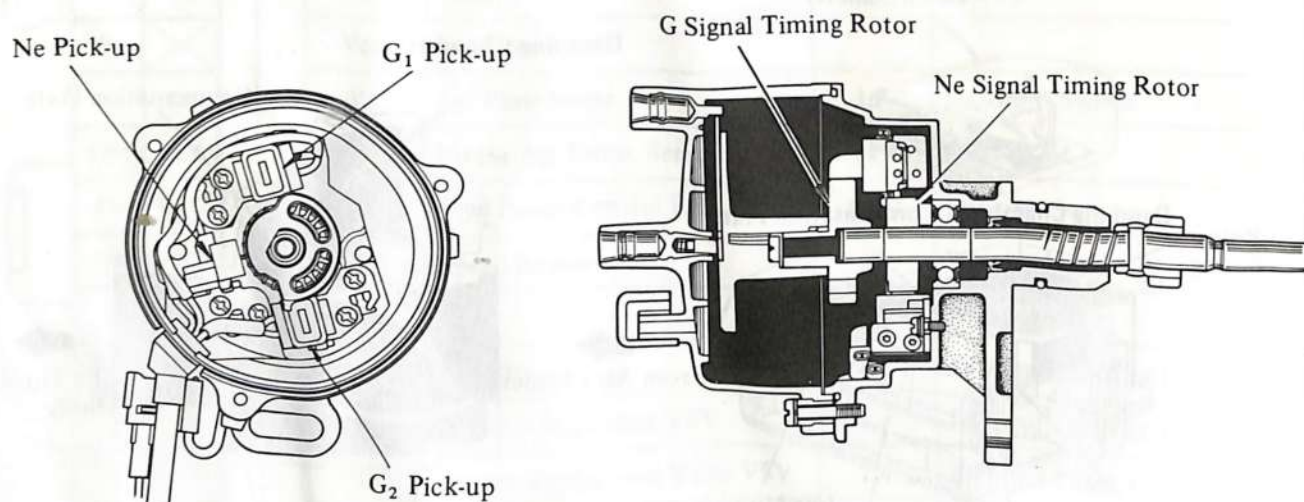


The ECU has a built-in constant-voltage circuit, which supplies a constant 5 volts to the V_{cc} terminal. Consequently, the output voltage at the V_s terminal will always indicate the exact opening angle of the measuring plate, and therefore, the exact intake air volume. The ECU memorizes the specific values which are premeasured at the connection between intake air volume and voltage, so that the exact intake air volume is detected by only the V_s output voltage. The V_s output voltage decreases when the intake air volume increases, as shown in the graph.



DISTRIBUTOR

The conventional governor advance and vacuum advance mechanisms have been eliminated in the TCCS distributor since spark advance is electronically controlled by the ECU. The distributor in the TCCS contains three pick-up coils (G_1 , G_2 and Ne), which are similar to those of the conventional fully-transistorized ignition unit. These coils are important sensors for the ECU, allowing it to detect engine rpm and crankshaft angle.



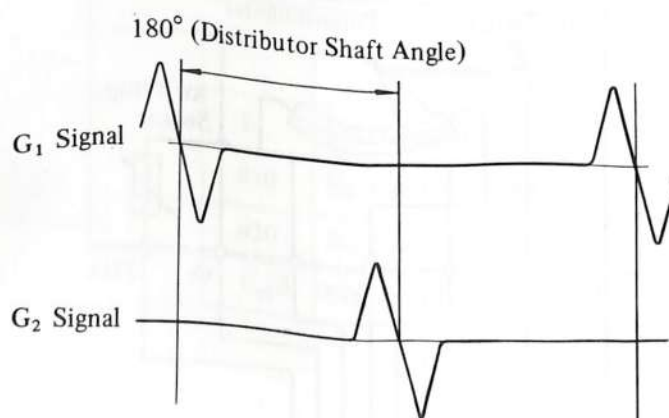
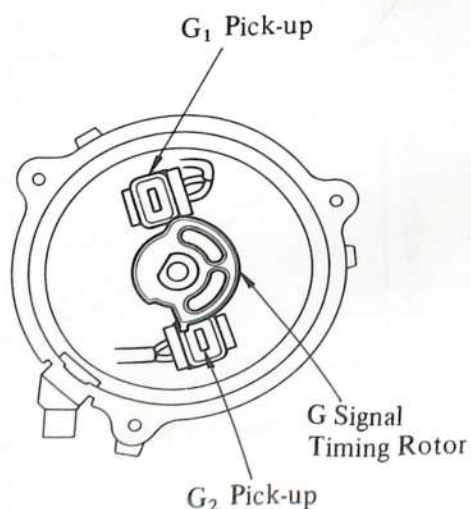
Crankshaft Angle Sensor (G_1 and G_2 Signal)

The G_1 signal informs the ECU of the standard crankshaft angle, which is used to determine injection timing and ignition timing in relation to No. 6 cylinder TDC; G_2 conveys the same information for No. 1 cylinder.

The components of the distributor that are used to generate these signals are:

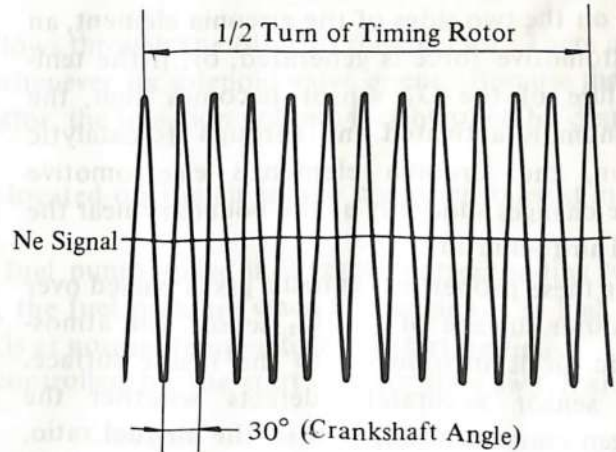
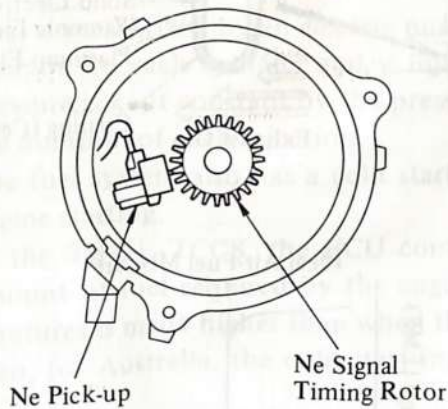
(1) the timing rotor, which is fixed to the distributor shaft and turns once for every two revolutions of the crankshaft; and (2) the two pick-up coils (the G_1 pick-up coil and the G_2 pick-up coil), which are mounted on the inside of the distributor housing.

The G_1 , G_2 timing rotor is provided with a projection or tooth which activates the G_1 and G_2 pick-up coils once each revolution of the distributor shaft, generating the waveforms shown in the chart. From these signals, the ECU detects when the No. 6 and No. 1 pistons are near their TDC.



Engine RPM Sensor (Ne Signal)

The Ne signal is used by the ECU to detect the crankshaft angle and the engine speed. Ne signals are generated in the pick-up coil by the timing rotor the same as with the G signal. The only difference is that the timing rotor for the Ne signal has 24 teeth. Therefore, 24 Ne signals are generated per engine cycle or once each turn of the distributor shaft. From these signals, the ECU detects the engine speed as well as each 30° change in the engine crankshaft angle.

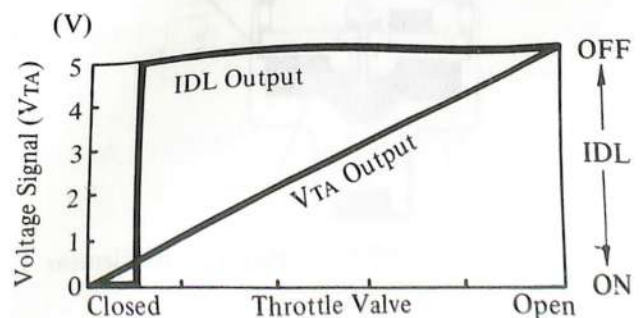
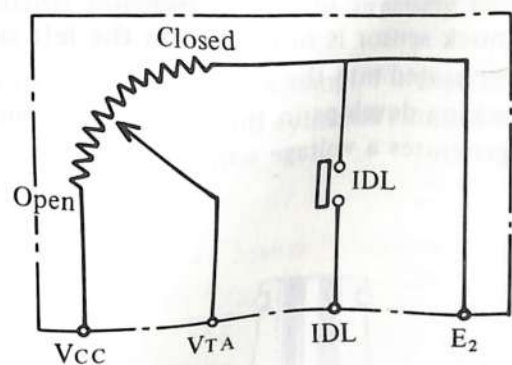
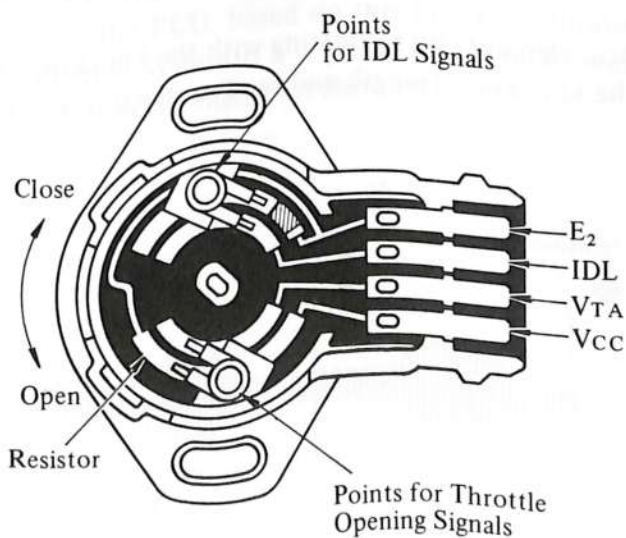


THROTTLE POSITION SENSOR

The throttle position sensor is mounted on the throttle body. It converts the throttle opening angle into voltage and sends it as the throttle position signal to the ECU.

A 5V constant voltage is applied to the Vcc terminal from the ECU. As the contact point slides along the resistor in accordance with the throttle valve opening angle, voltage is applied to the V_{TA} terminal in proportion to this angle.

When the throttle valve is closed completely, the contact points for the IDL signal connect between the IDL and E₂ terminals.



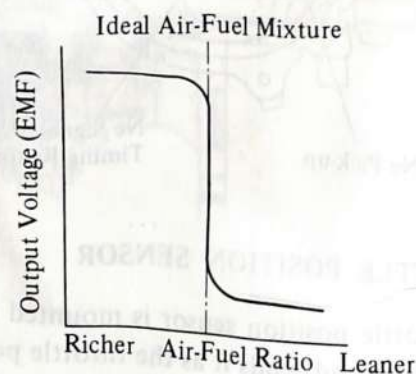
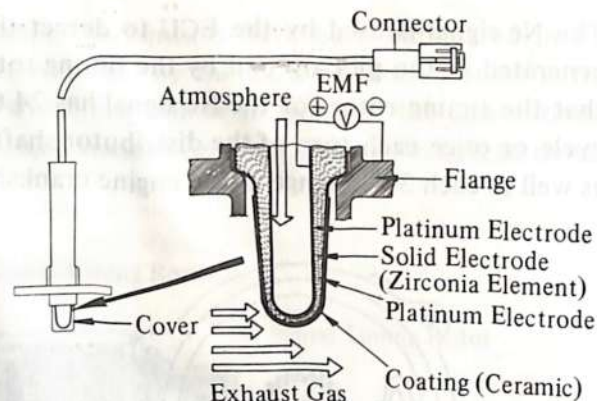
OXYGEN SENSOR (For Australia)

The O_2 sensor is composed of a test tube shaped zirconia element with a thin layer of platinum bonded to both sides. This sensor is mounted in the exhaust manifold and senses the oxygen concentration (air-fuel ratio) in the exhaust gas. If there is a difference in the oxygen concentration on the two sides of the zirconia element, an electromotive force is generated, or, if the temperature of the O_2 sensor becomes high, the platinum is activated and through its catalytic action, the zirconia element's electromotive force changes suddenly at the boundary near the ideal air-fuel ratio.

Using these properties, exhaust gas is passed over the outer surface of the O_2 sensor and atmospheric air is introduced to the inside surface. The sensor accurately detects whether the oxygen concentration, that is, the air-fuel ratio, is higher (rich) or lower (lean) than the ideal air-fuel ratio.

If the air-fuel ratio is more concentrated than the ideal air-fuel ratio, (rich), the electromotive force of the O_2 sensor becomes high and "rich" signals are sent to the computer.

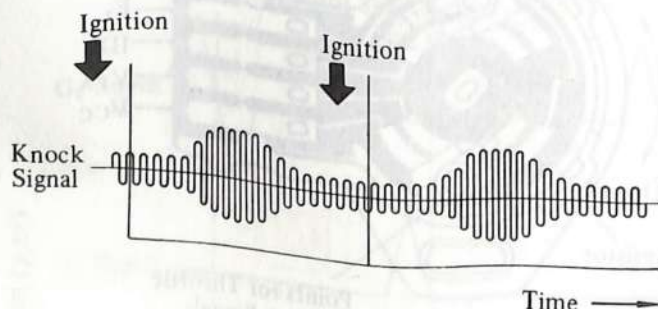
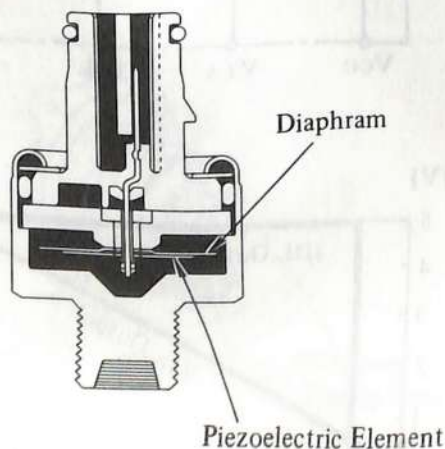
On the other hand, if the concentration of O_2 is low, the electromotive force of the O_2 sensor is low, and "lean" signals are sent to the computer.



KNOCK SENSOR

The knock sensor is mounted on the left side of the cylinder block. A piezoelectric ceramic element is incorporated into the sensor.

If knocking develops in the engine, this piezoelectric element, by resonating with the knocking vibration, generates a voltage which corresponds with the knocking strength and sends a signal to the ECU.



7. EFI (Electronic Fuel Injection)

GENERAL

The EFI can be broadly separated into three systems; the fuel system, the air induction system and electronic control system.

1) Fuel System

Fuel is pressurized by an electric pump, then flows through the filter to the injector. There is one injector for each cylinder and it injects fuel whenever its solenoid valve opens. Because the fuel pressure is kept constant by the pressure regulator, the injection volume is controlled by changing the duration of each injection.

The fuel system also has a cold start injector located on the air intake chamber to assist in cold engine starting.

In the 7M-GE TCCS, the ECU controls the fuel pump speed in 2 stages corresponding to the amount of fuel required by the engine. Also, the fuel pressure when the engine is at high temperatures is made higher than when the engine is at normal temperatures at starting time.

Also, for Australia, the cold start injector is controlled by the start injector time switch and the ECU.

2) Air Induction System

Intake air passes in order through the air flow meter, throttle body and intake manifold and flows to each intake port. The intake air volume is measured by the air flow meter and its signals are used by the ECU to determine the basic injection duration. In the 7M-GE TCCS, the ISC valve, by adjusting the intake air volume which bypasses the throttle, automatically adjusts the engine idling speed and engine fast idle. By opening and closing the air control valve in the intake manifold, the intake air intake efficiency is improved and the engine's output is increased.

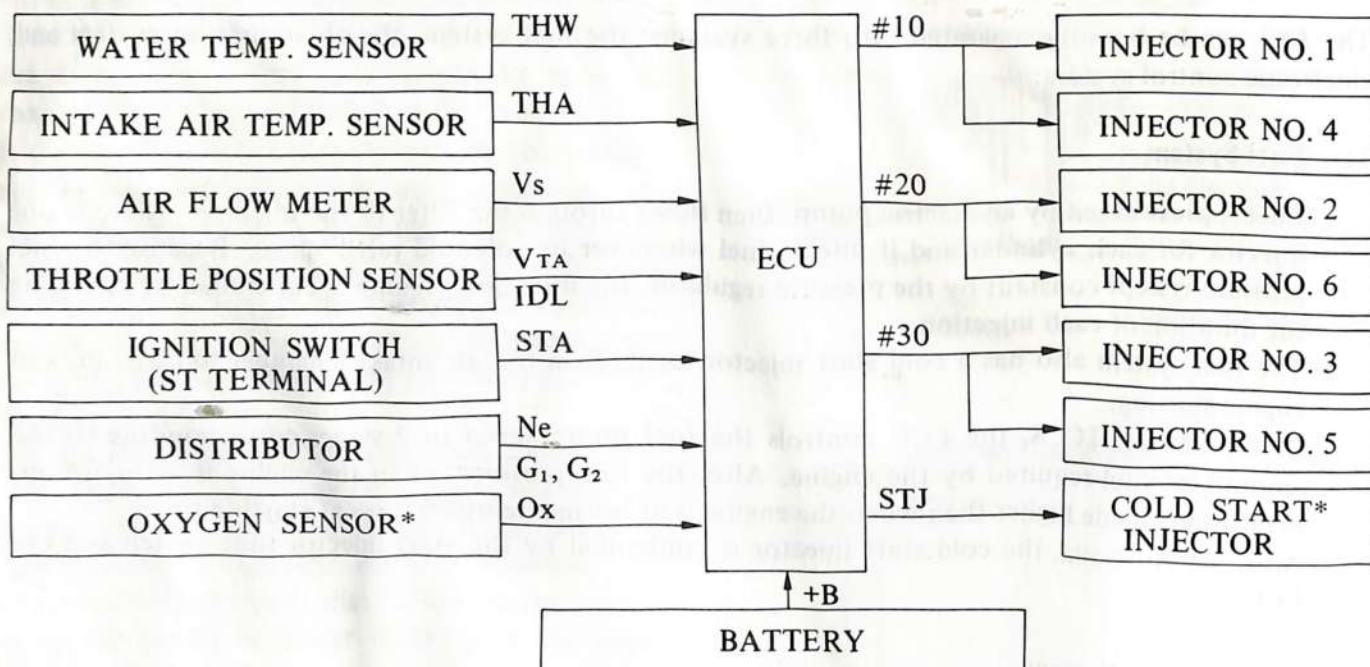
3) Electronic Control System

The ECU includes a built-in microprocessor. It controls injection duration precisely based on data stored in its memory and signals from the sensor.

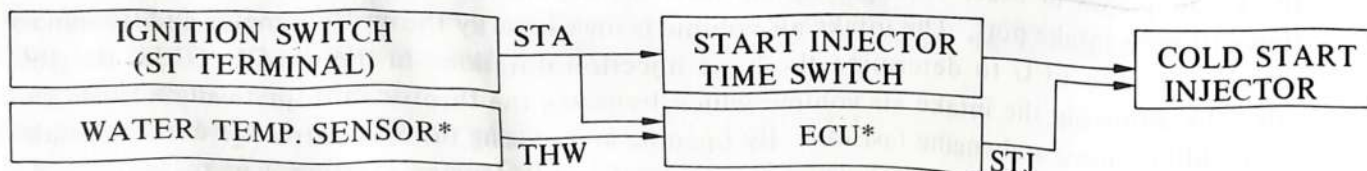
Also, the ECU, based on this injection duration, controls the injection timing. Further, the fuel injection system is a 3 group injection system which injects fuel into 2 cylinders simultaneously once every 2 engine revolutions.

EFI BLOCK DIAGRAM

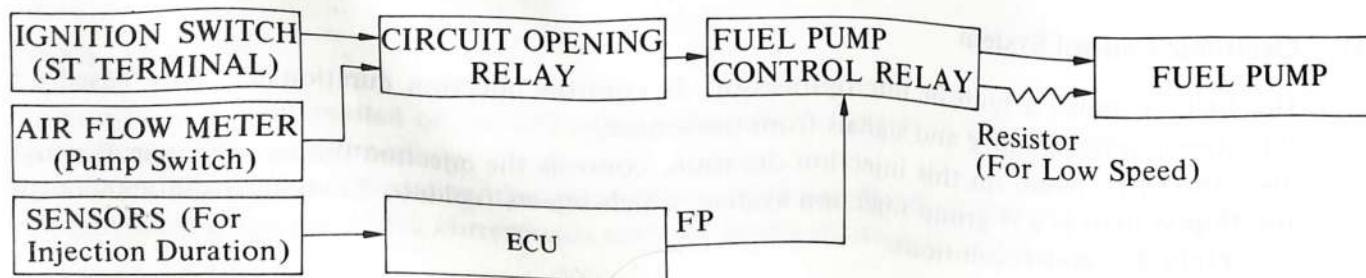
1) Fuel Injection Duration Control



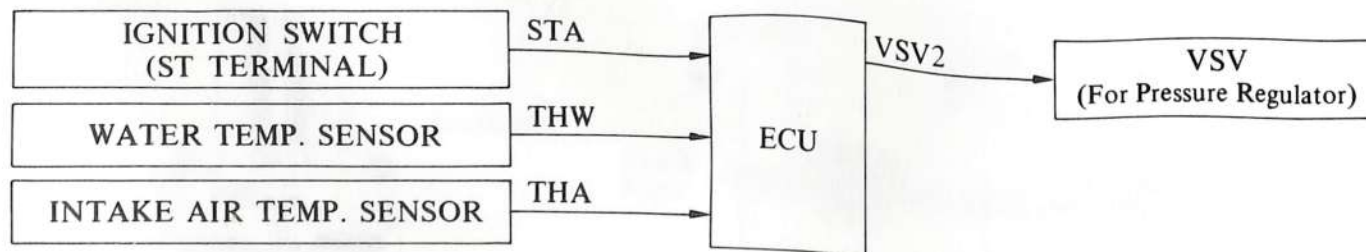
2) Starting Control



3) Fuel Pump Control



4) Fuel Pressure Control



*: Items with this mark apply to Australia.

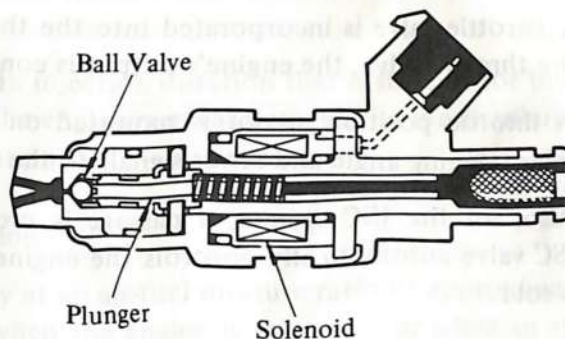
FUEL SYSTEM

1) Fuel Injector

Fuel is injected into the intake port of each cylinder in accordance with injection signals from the ECU.

In the end of the injector, there are 2 injection holes which match the 2 intake ports. The shape of the valve has been changed from the pintle type to the ball type to reduce the possibility of valve sticking.

The plunger has been made smaller and lighter in weight, and its response to signals from the ECU has been raised.

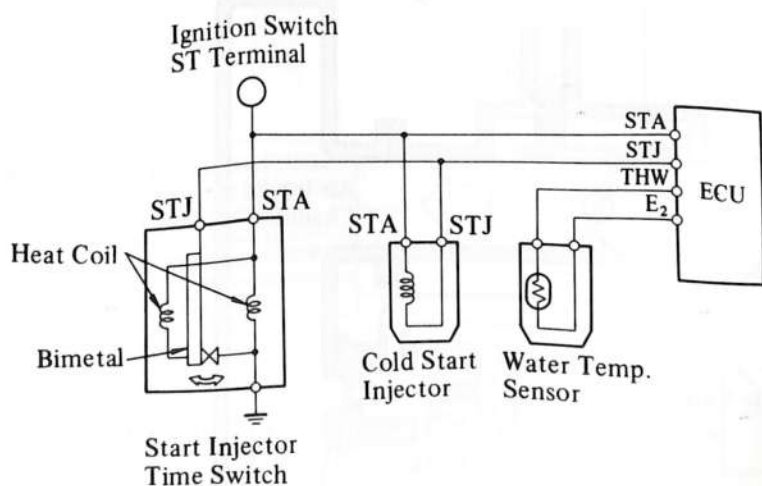
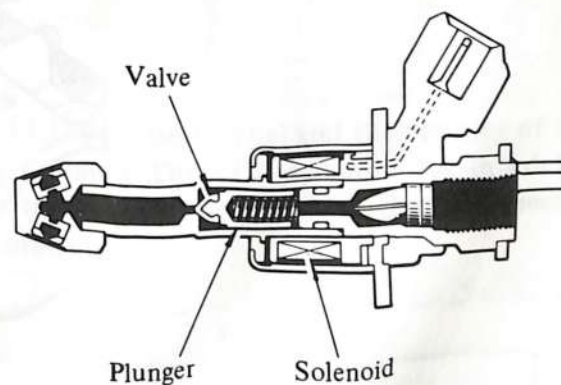


2) Cold Start Injector

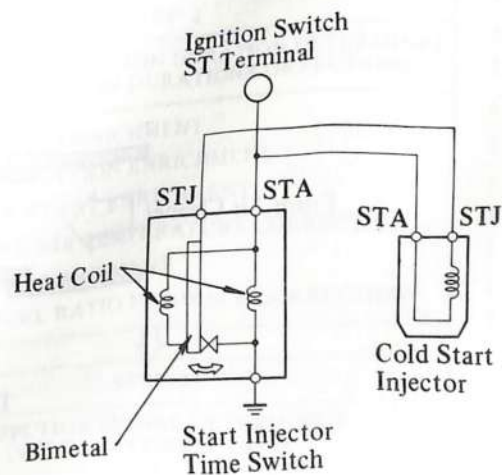
The cold start injector injects fuel into the intake air chamber during engine cranking to improve startability.

In starting the engine when the engine coolant temperature is 22°C (76°F) or lower, the cold start injector's operation time is controlled by the start injector time switch.

For Australia in starting the engine when the engine coolant temperature is between 22°C and 35°C (76°F and 95°F), the operation time of the cold start injector is controlled by the ECU.



Circuit for Australia.

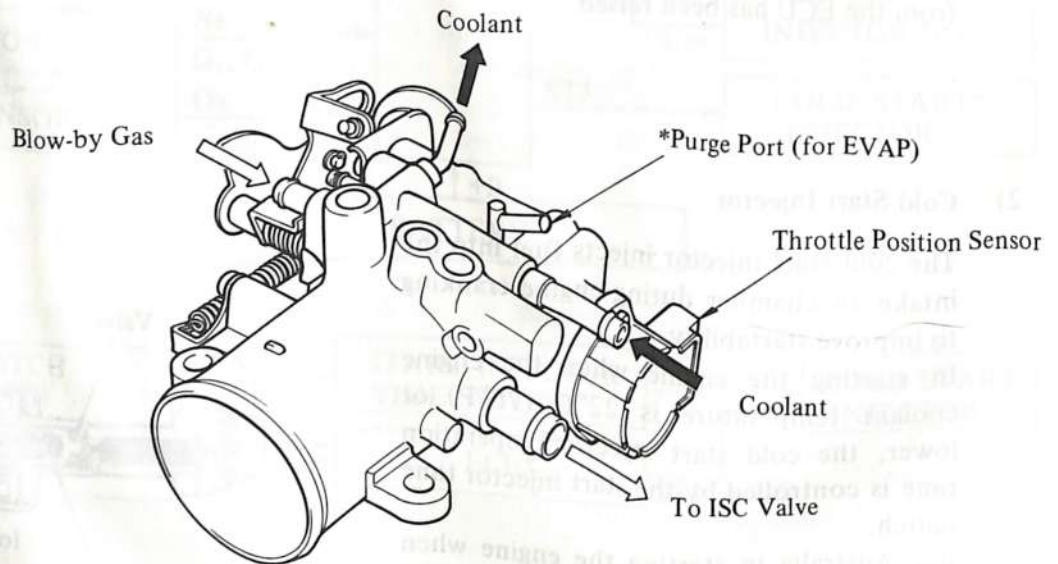


Circuit for Other Countries

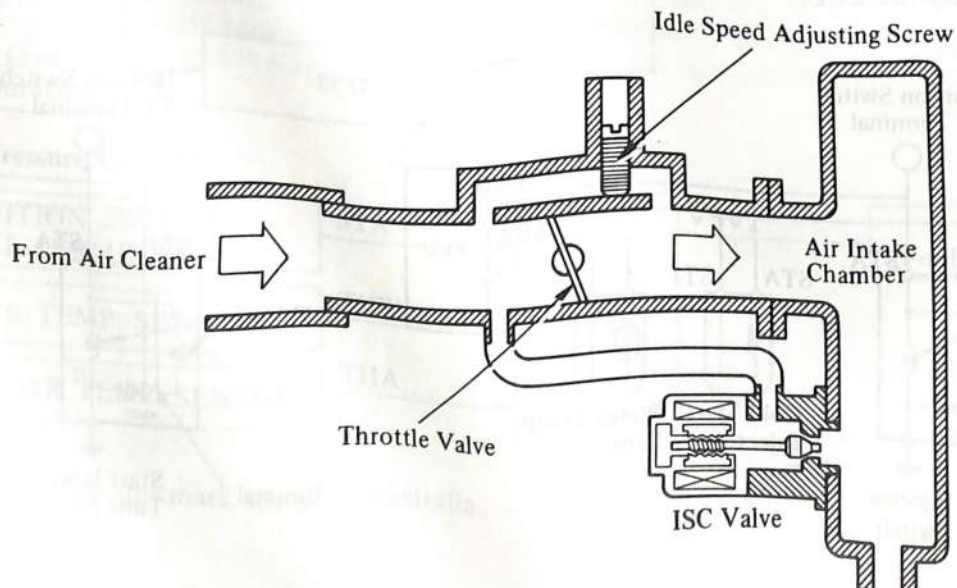
AIR INDUCTION SYSTEM

Throttle Body

- A throttle valve is incorporated into the throttle body. By controlling the intake air volume with the throttle valve, the engine's output is controlled.
- A throttle position sensor is mounted on the throttle valve shaft. This sensor senses the throttle valve opening angle and sends signals to the ECU.
- Also, for the ISC system, a passage is provided for intake air to bypass the throttle valve. This ISC valve automatically controls the engine idling speed and causes the engine to fast idle when it is cold.
- Engine coolant passes through the throttle body to prevent icing of the throttle valve.



*: Items with this mark apply to Australia and Saudi Arabia.



PRINCIPLE OF INJECTION DURATION CONTROL

The ECU determines the duration of each injection in the following steps:

Step 1: Determination of Duration of Basic Injection

The ECU selects, from the data stored in its memory, an injection duration that is suitable for the intake air volume (as detected by the air flow meter) and the engine rpm (as detected by the distributor). This injection duration is called the “basic injection duration.”

Step 2: Determination of Adjusted Duration of Injection

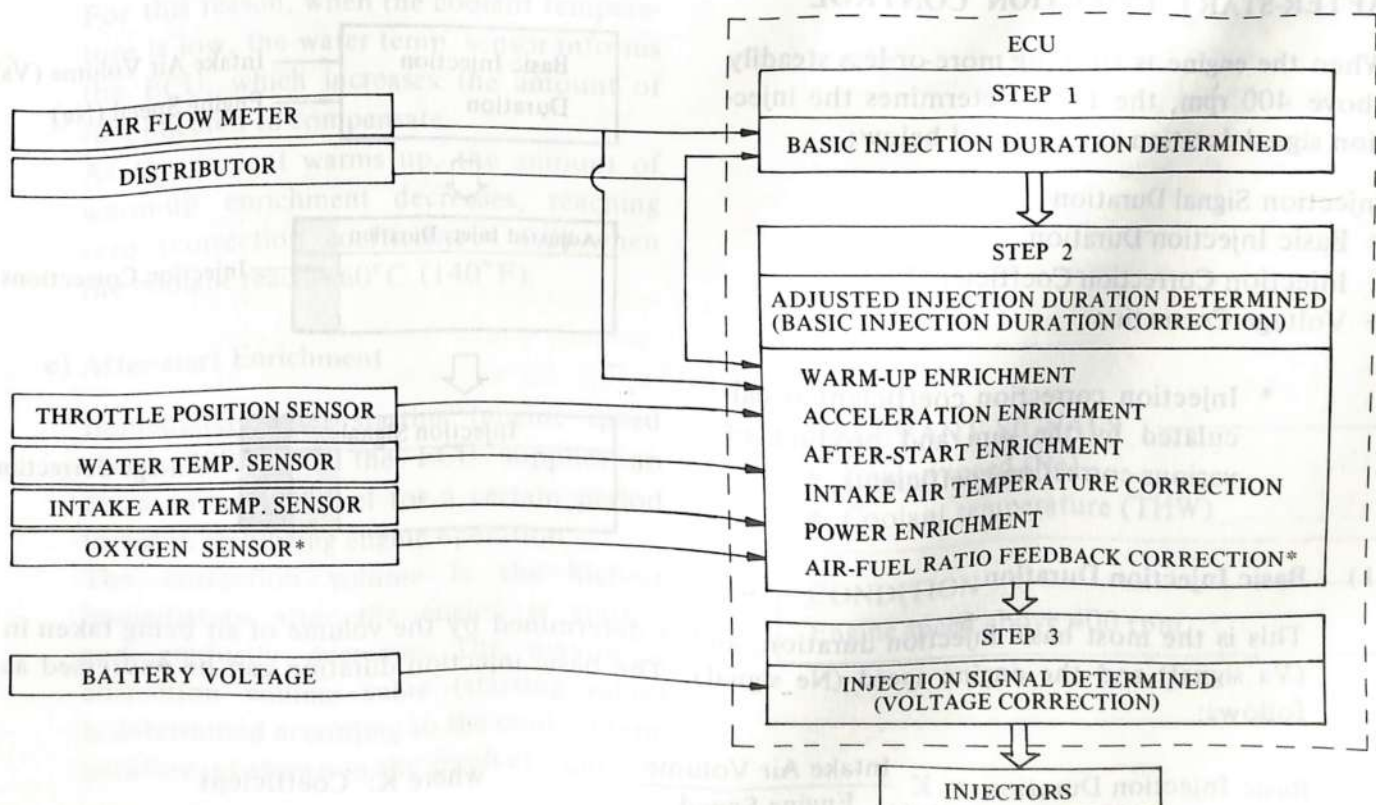
Under most engine conditions, the engine runs smoothly at an air-fuel mixture ratio of approximately 15 (this is called the “ideal air-fuel ratio”). However, when the engine is still cold, or when an extra load is applied to the engine, the air-fuel ratio is reduced to below 15 (i.e., it becomes richer). The ECU detects these engine conditions by means of the water temp. sensor, throttle position sensor and intake air temp. sensor, and corrects the basic injection duration to optimize it for the existing engine conditions.

The corrected time is called the “adjusted injection duration”.

Furthermore, in cars for Australia, even under normal engine conditions, the injection duration is corrected by the signals from the oxygen sensor to keep the air-fuel ratio within a narrow range near 15.

Step 3: Determination of Length of Injection Signal

There is an operational delay between the sending of the ECU injection signal and the opening of the injector valve. This delay is greater the lower the battery voltage. The ECU accounts for this delay in the injection signal that it sends to the injector so that the actual length of time that the injector valve is open is equal to the calculated adjusted injection duration.

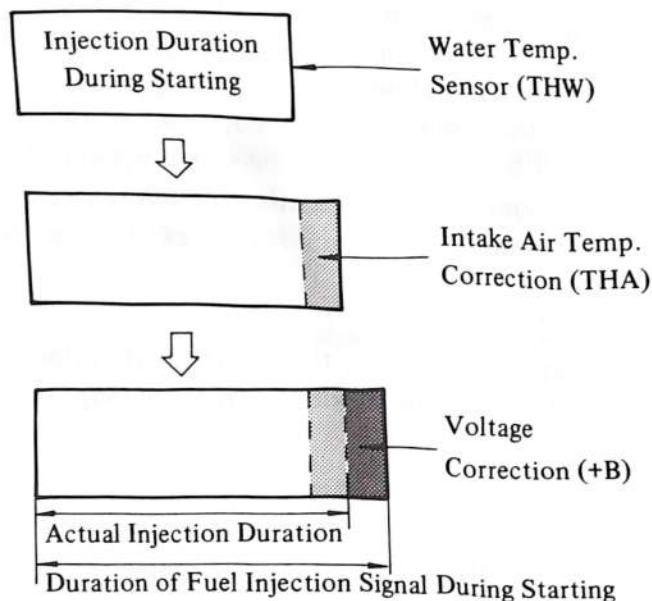


*: Items with this mark apply to Australia.

STARTING INJECTION CONTROL

During engine starting, it is difficult for the air flow meter to accurately sense the amount of air being taken in due to large fluctuations in rpm.

For this reason, the ECU selects from its memory an injection duration that is suitable for the coolant temperature, regardless of intake air volume or engine rpm. It then adds to this an intake air temperature correction and a voltage correction, to obtain the injection duration.

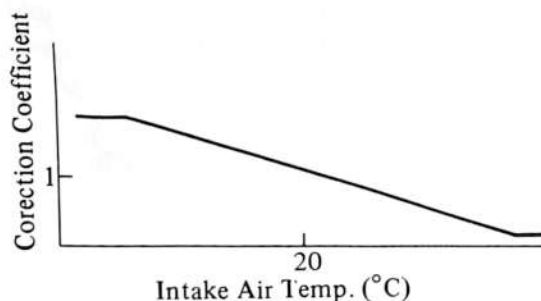


RELEVANT SIGNALS

- Engine speed (Ne)
- Coolant temperature (THW)
- Intake air temperature (THA)

CONDITIONS

Engine speed below 400 rpm.

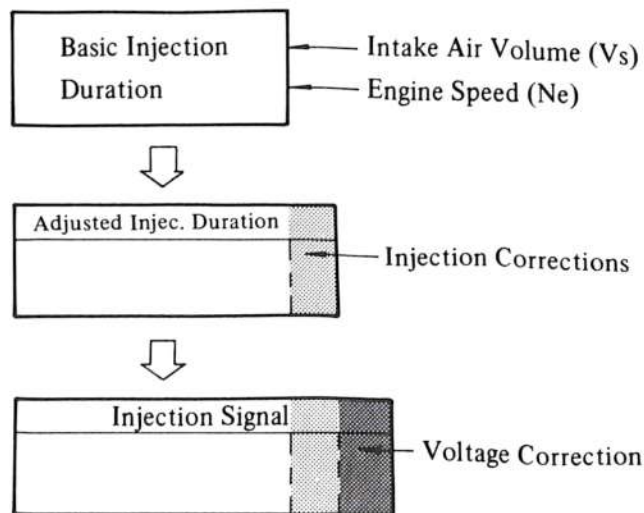


AFTER-START INJECTION CONTROL

When the engine is running more-or-less steadily above 400 rpm, the ECU determines the injection signal duration as explained below;

$$\begin{aligned} \text{Injection Signal Duration} &= \text{Basic Injection Duration} \\ &+ \text{Injection Correction Coefficient*} \\ &+ \text{Voltage Correction} \end{aligned}$$

* Injection correction coefficient is calculated by the sum and product of various correction coefficients.



1) Basic Injection Duration

This is the most basic injection duration, and is determined by the volume of air being taken in (Vs signal) and the engine speed (Ne signal). The basic injection duration can be expressed as follows:

$$\text{Basic Injection Duration} = K \frac{\text{Intake Air Volume}}{\text{Engine Speed}}$$

where K: Coefficient

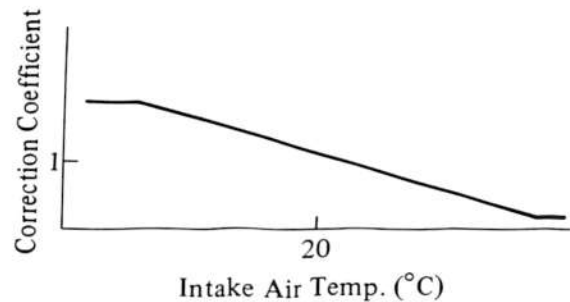
2) Injection Corrections

The ECU is kept informed of the moment-by-moment engine running conditions by signals from various sensors, and makes various corrections in the basic injection duration based on these signals.

a) Corrections Based on Intake Air Temperature

The density of the intake air will change depending upon its temperature. For this reason, the ECU must be kept accurately informed of both the intake air volume (by means of the air flow meter) and the intake air temperature (by means of the intake air temp. sensor) so that it can adjust the injection duration to maintain the air fuel ratio currently required by the engine. For this purpose, the ECU considers 20°C (68°F) to be the "standard temperature" and increases or decreases the amount of fuel injected, depending upon whether intake air temperature falls below or rises above this standard.

RELEVANT SIGNAL —
Intake air temperature (THA)



b) Warm-up Enrichment

As fuel vaporization is poor when the engine is cold, if a rich fuel mixture is not supplied, drivability will deteriorate. For this reason, when the coolant temperature is low, the water temp. sensor informs the ECU, which increases the amount of fuel injected to compensate. As the coolant warms up, the amount of warm-up enrichment decreases, reaching zero (correction coefficient = 1.0) when the coolant reaches 60°C (140°F).

RELEVANT SIGNAL —
Coolant temperature (THW)

c) After-start Enrichment

Immediately after starting (engine speed above 400 rpm), the ECU supplies an extra amount of fuel for a certain period to aid in stabilizing engine operation. The correction volume is the highest immediately after the engine is started and gradually decreases. The maximum correction volume value (starting value) is determined according to the coolant temperature, as shown in the graph at right.

RELEVANT SIGNALS —
• Engine speed (Ne)
• Coolant temperature (THW)

CONDITION —
Engine speed above 400 rpm

d) Acceleration Enrichment During Warm-up

The ECU injects extra fuel during acceleration when the engine is still warming up in order to aid driveability.

Through calculation of the amount of change in the intake air volume per engine revolution, the ECU detects the engine's acceleration or deceleration condition. The correction volume is determined according to the coolant temperature and the strength of acceleration or deceleration.

RELEVANT SIGNALS

- Air flow meter (Vs)
- Engine speed (Ne)
- Coolant temperature (THW)

CONDITIONS

Intake air volume per engine revolution changes (acceleration or deceleration) with coolant temperature below 80°C (176°F).

However, if any of the following occurs the ECU stops calculating this change, and halts the injection of extra fuel:

- Engine speed falls below 400 rpm
- Fuel cut-off occurs
- Intake air volume becomes smaller than a certain level

e) Power Enrichment

When the engine is operating under heavy load conditions, the injection volume is supplemented by a certain volume to maintain good driveability.

The correction volume is determined according to the intake air volume.

RELEVANT SIGNALS

- Throttle position (VTA)
- Air flow meter (Vs)

CONDITIONS

Throttle valve opening angle above 60° or intake air volume larger than a certain level.

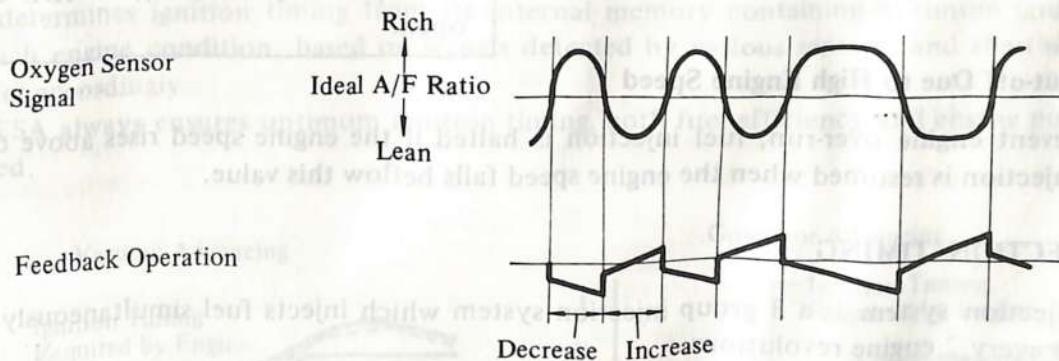
f) Air-fuel Ratio Feedback Correction (For Australia)

The ECU corrects the injection duration by the signals from the oxygen sensor to keep the air-fuel ratio within a narrow range near the ideal air-fuel ratio. (Closed loop operation)

Further, in order to prevent over heating of the catalyst and assure driveability, under the following conditions, the air-fuel ratio feedback operation does not work. (Open loop operation)

- During engine starting
- During power enrichment
- Fuel cut-off occurs

The ECU compares the voltage of the signals sent from the oxygen sensor with a reference voltage. As a result, if the voltage of the signal is higher, the air fuel ratio is judged to be richer than the ideal air-fuel ratio and the amount of fuel injected is reduced at a constant rate. If the point where the voltage of the signal is lower, it is judged that the air-fuel ratio is leaner than the ideal so the amount of fuel injected is increased.

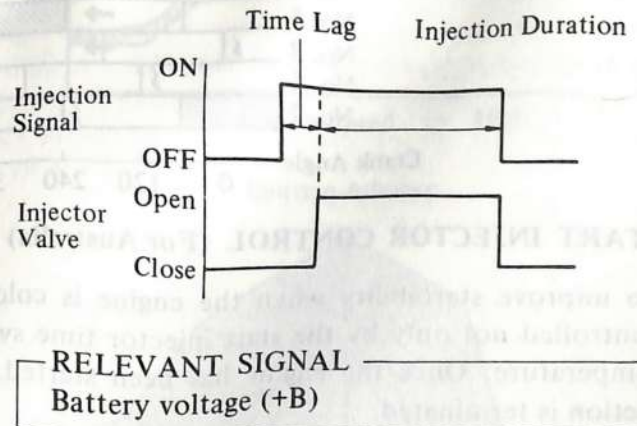


3) Voltage Correction

There is a slight delay between the time the ECU sends an injection signal to the injectors and the time the injectors actually open. This delay becomes longer the more the voltage of the battery drops (as, for example, when it becomes over-discharged, or "run down").

This means that the length of time that the injector valves remain open would become shorter than that calculated by the ECU, causing the actual air-fuel ratio to become higher (i.e., leaner) than that required by the engine, if this were not prevented by voltage correction.

In voltage correction, the ECU compensates for this delay by lengthening the injection signal by a period corresponding to the length of the delay. This corrects the actual injection period so that it corresponds with that calculated by the ECU.



FUEL CUT-OFF

1) Fuel Cut-off During Deceleration

During deceleration at high engine speed with the throttle valve completely closed, in order to improve fuel economy, the ECU cuts off fuel injection. When the engine speed becomes low or the throttle valve is opened, fuel injection is resumed.

RELEVANT SIGNALS

- Throttle position (IDL)
- Engine speed (Ne)
- Coolant temperature (THW)

CONDITIONS

IDL contacts closed with engine speed above fuel cut-off speed (NB).

CONDITIONS FOR RESUMPTION OF FUEL INJECTION

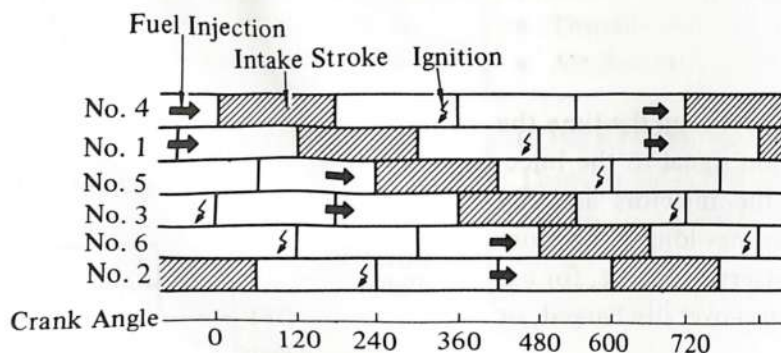
Engine speed drops below fuel injection resumption speed (NA), or IDL contacts open.

2) Fuel Cut-off Due to High Engine Speed

To prevent engine over-run, fuel injection is halted if the engine speed rises above 6,800 rpm. Fuel injection is resumed when the engine speed falls below this value.

FUEL INJECTION TIMING

The fuel injection system is a 3 group injection system which injects fuel simultaneously into 2 cylinders once every 2 engine revolutions.



START INJECTOR CONTROL (For Australia)

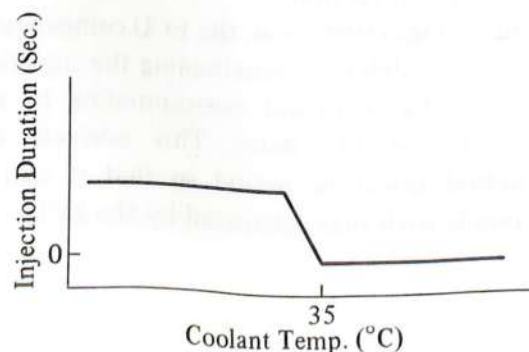
To improve startability when the engine is cold, the injection duration of the cold start injector is controlled not only by the start injector time switch but by the ECU in accordance with the coolant temperature. Once the engine has been started, current to the cold start injector is cut off and injection is terminated.

RELEVANT SIGNALS

- Coolant temperature (THW)
- Ignition switch (STA)
- Engine speed (Ne)

CONDITIONS

The engine is cranking and the coolant temperature is below 35°C (95°F).



8. ESA (Electronic Spark Advance)

GENERAL

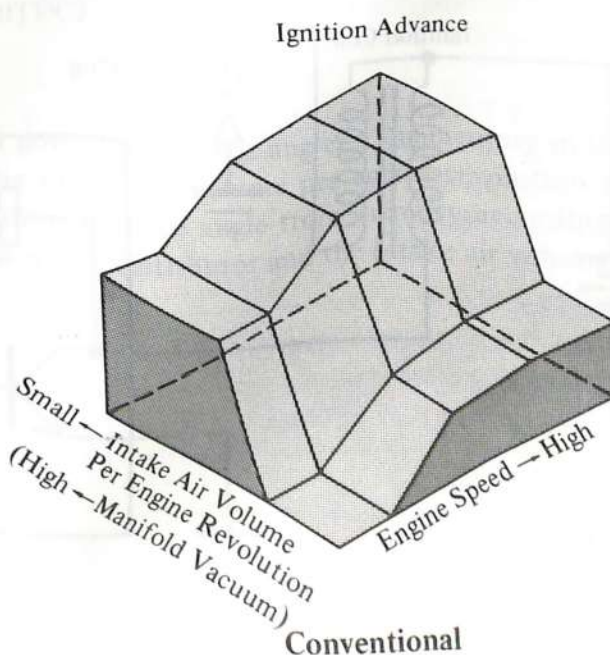
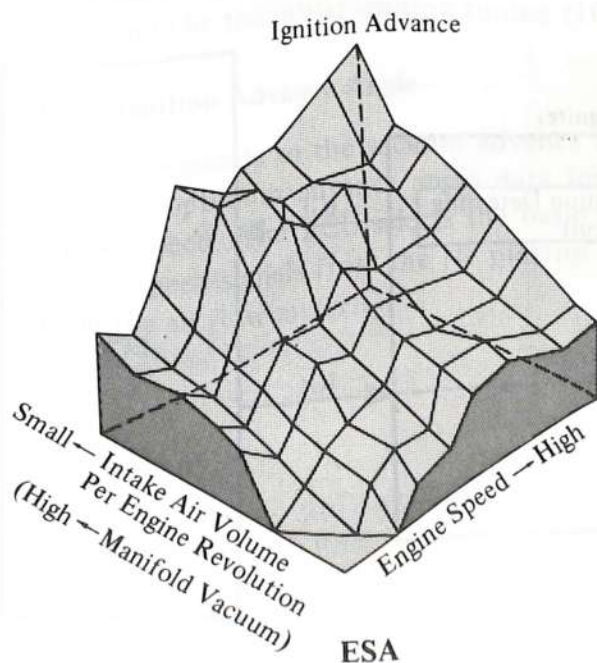
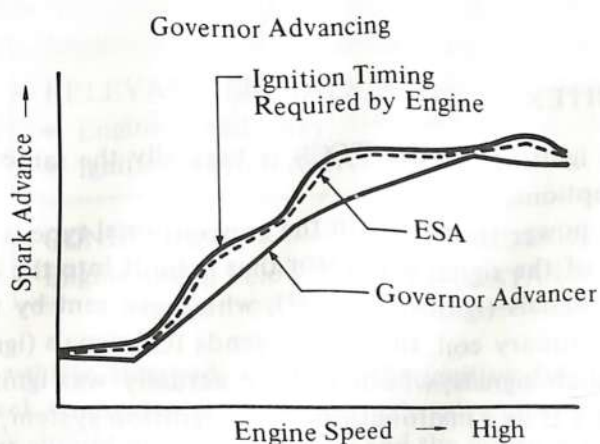
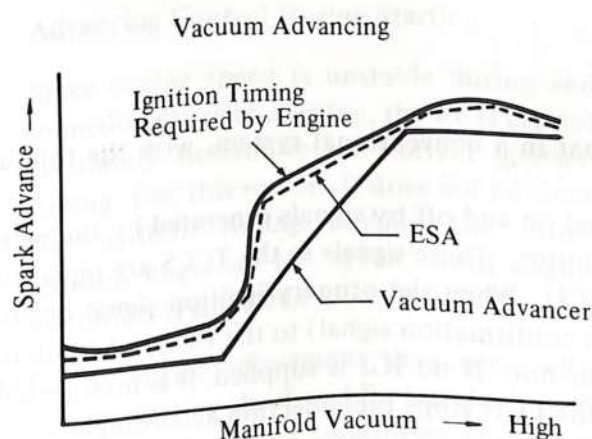
The air-fuel mixture must be ignited so that the combustion pressure will become maximum at 10° after TDC. However, the time from ignition of the air-fuel mixture to the maximum combustion pressure varies depending on the engine speed and the intake air volume. Ignition must occur earlier when the engine speed is faster. In the conventional system, the timing was advanced by the governor advancer. When the intake air volume per engine revolution is small (high vacuum), ignition must also be advanced, and this is achieved by the vacuum advancer in the conventional system.

Actually, optimum ignition timing is affected largely by a number of factors, such as the shape of the combustion chamber and the temperature inside the combustion chamber in addition to the engine speed and the intake air volume. Therefore the governor and vacuum advance do not provide ideal ignition timing for the engine.

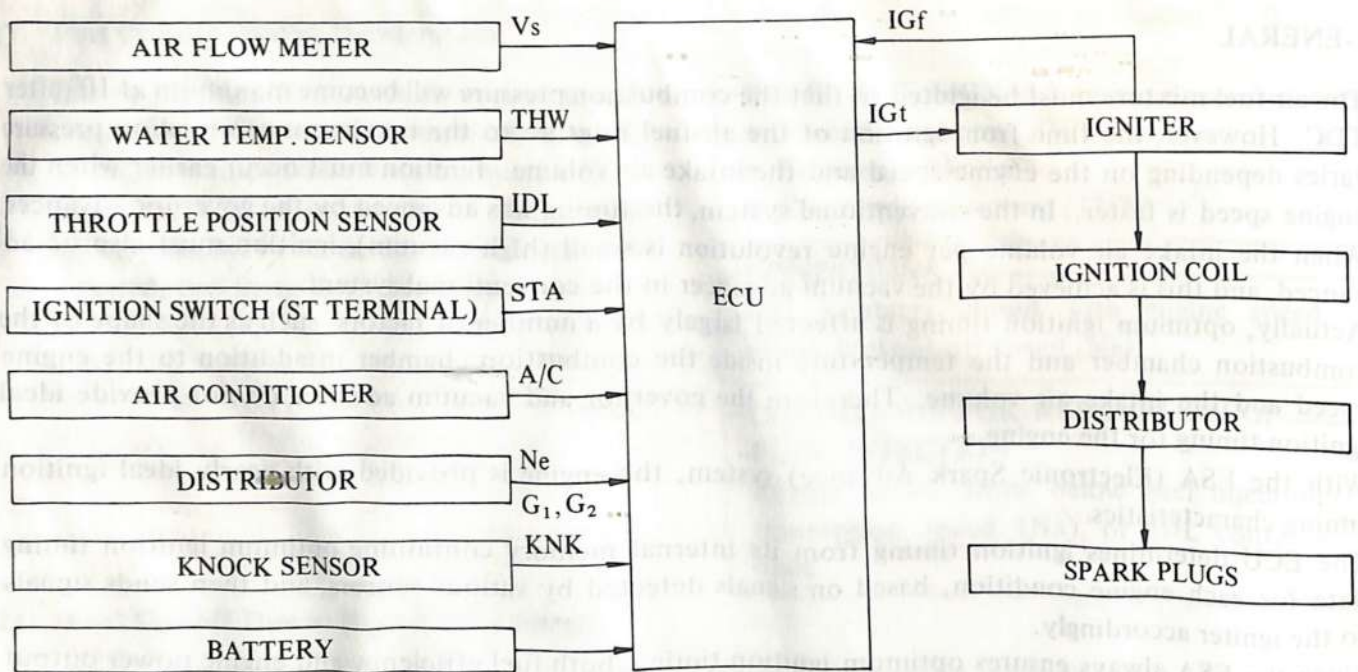
With the ESA (Electronic Spark Advance) system, the engine is provided with nearly ideal ignition timing characteristics.

The ECU determines ignition timing from its internal memory containing optimum ignition timing data for each engine condition, based on signals detected by various sensors, and then sends signals to the igniter accordingly.

Since the ESA always ensures optimum ignition timing, both fuel efficiency and engine power output are improved.



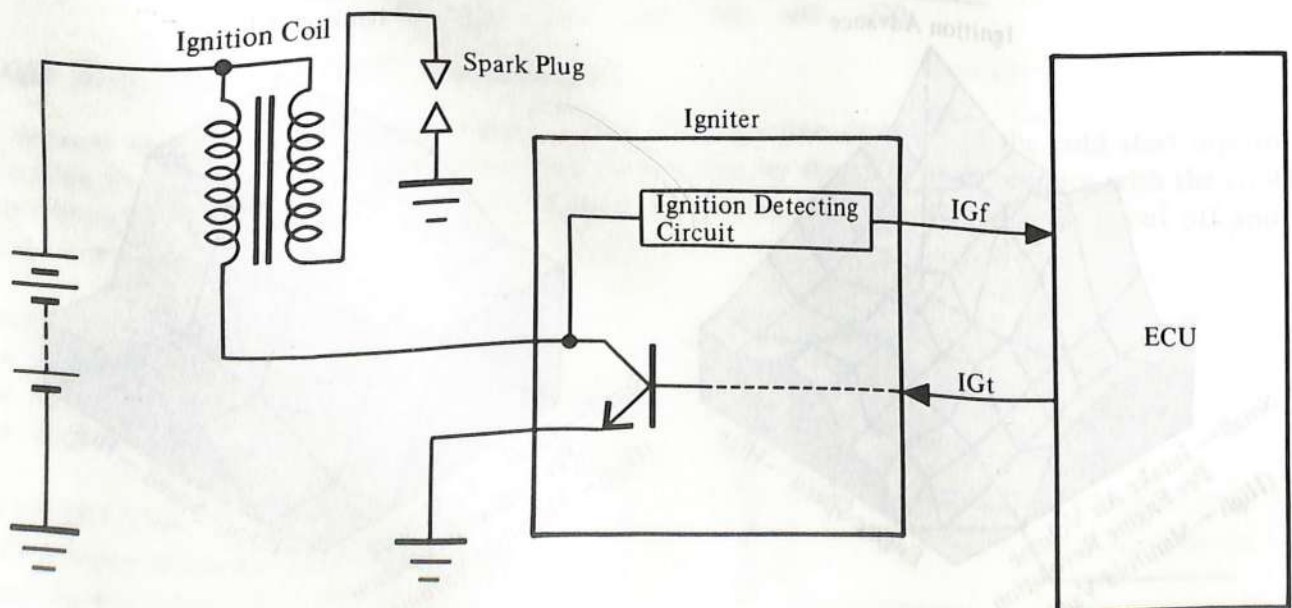
ESA BLOCK DIAGRAM



IGNITER

The ignition in the TCCS is basically the same as that in a conventional system, with the following exceptions.

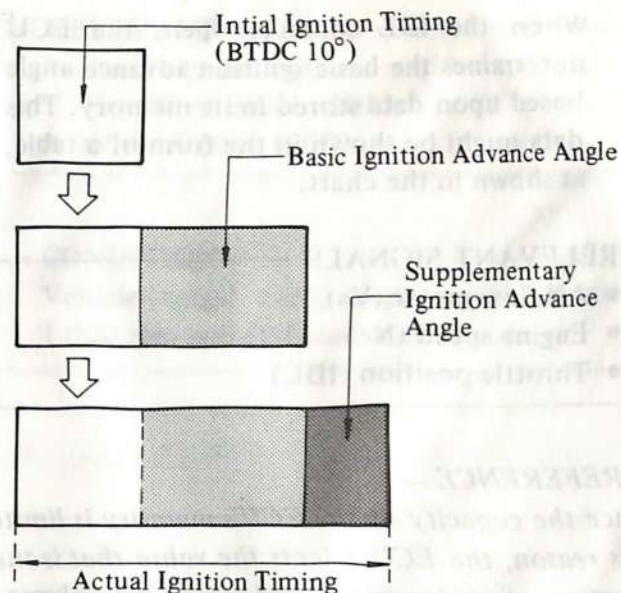
The power transistor in the conventional type is turned on and off by signals generated by the pick-up coil of the signal generator that is built into the distributor. These signals in the TCCS are replaced by IGt signals (ignition signal), which are sent by the ECU. When the primary ignition signal occurs in the primary coil, the igniter sends IGf signals (ignition confirmation signal) to the ECU, which detects, by such signals, whether there actually was ignition or not. If no IGf is supplied, it is interpreted by the ECU as a malfunction in the ignition system, and the ECU stops fuel injection accordingly.



FUNCTIONS OF ECU

The ECU detects various engine conditions from signals provided by the sensors, and determines the amount of advance angle required in excess of the initial ignition timing. The ignition timing in the ESA system is determined by the sum of the basic ignition advance angle and the supplementary ignition advance angles. The actual timing is therefore as shown in the chart on the right.

Whenever a G signal (either G_1 or G_2) is input into the ECU, the ECU counts the number of Ne signals input (One Ne signal is generated for each 30° revolution of the crankshaft). When the crankshaft rotates to the specified angle, the ECU sends an IGt (ignition) signal to the igniter.



1) Initial Ignition Timing

The initial ignition timing is the basic crankshaft angle at which ignition takes place when the electronic advance is not in operation. This initial timing is set at 10° BTDC in the ESA system.

Advancing Control During Starting

Since engine speed is unstable during and immediately after starting, the ECU cannot accurately determine the correct ignition timing. For this reason, it does not advance the ignition timing beyond the initial ignition angle of 10° BTDC until engine operation is stabilized.

RELEVANT SIGNALS

- Engine speed (Ne)
- Ignition switch (STA)

CONDITIONS

Engine speed below 400 rpm, or STA on.

NOTE: At engine adjustment time, etc., with the vehicle stopped, confirm the ignition timing by connecting the T and E_1 terminals in the check connector with the throttle valve closed. Under the above conditions, ignition advance should not be occurring and the ignition timing should be the initial ignition timing (10° BTDC)

2) Basic Ignition Advance Angle

This corresponds to the vacuum advance and governor advance angles. The memory in the ECU contains optimum advance angle data for the intake air volume per engine revolution and the engine speed. The ECU selects the basic ignition advance angle from memory according to the engine speed signals from the Ne pick-up coil in the distributor and the intake air volume signals from the air flow meter.

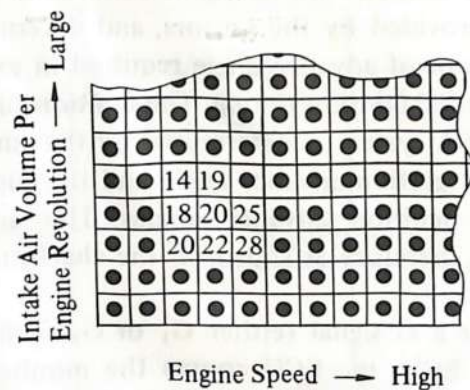
a) IDL Contacts Open (OFF)

When the IDL contacts open, the ECU determines the basic ignition advance angle based upon data stored in its memory. This data might be shown in the form of a table, as shown in the chart.

RELEVANT SIGNALS

- Air flow meter (Vs)
- Engine speed (Ne)
- Throttle position (IDL)

Basic Ignition Advance Angle Data



– REFERENCE –

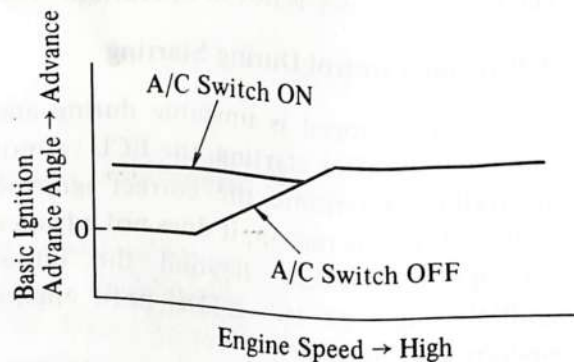
Since the capacity of the ECU's memory is limited, it cannot hold all possible advance angle data. For this reason, the ECU selects the value that is the closest to the required value for each particular combination of engine speed and intake air volume. It then carries out proportional calculations to find the optimum ignition timing for the given engine speed and the intake air volume.

b) IDL Contacts Closed (ON)

When the IDL contacts close, the ignition timing is advanced as shown in the graph.

RELEVANT SIGNALS

- Throttle position (IDL)
- A/C switch (A/C)
- Engine Speed (SPD)



3) Supplementary Ignition Advance Angle for Overheat Prevention

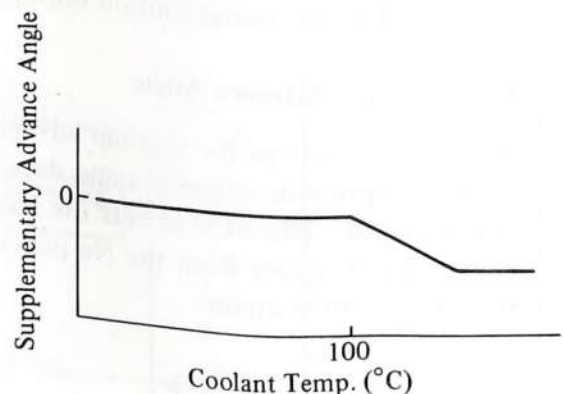
In order to prevent overheating, ignition timing is retarded when the coolant temperature rises above 100°C (212°F).

RELEVANT SIGNALS

- Coolant temperature (THW)
- Air flow meter (Vs)
- Engine speed (Ne)

CONDITIONS

Coolant temperature above 100°C (212°F) and the intake air volume per engine revolution above a certain level.



4) Supplementary Ignition Advance Angle for Stable Idling

When the engine speed changes at idle because of engine load changes, the ECU adjusts the ignition timing to stable engine speed.

The ECU is always calculating the average engine speed value. If the engine speed goes below a certain fixed speed, the ECU advances the ignition timing by a certain angle only. If the engine speed goes above the average engine speed, the ECU retards the ignition timing by a fixed angle only.

Furthermore this supplementary ignition angle varies within 0° and 3° .

RELEVANT SIGNALS

- Engine speed (Ne)
- Throttle position (IDL)
- Vehicle speed (SPD)

CONDITIONS

Vehicle speed zero, engine speed below 1,000 rpm and IDL contacts closed.

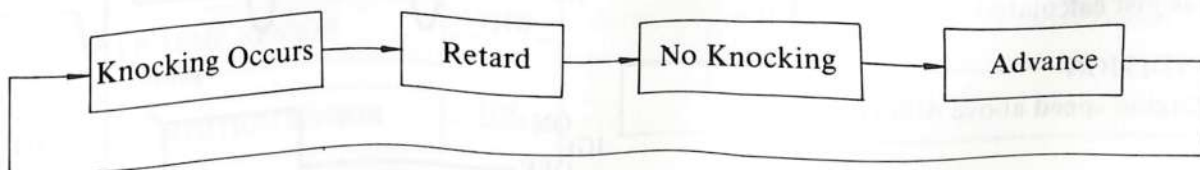
5) Supplementary Ignition Advance Angle for Knock Prevention

The ignition timing, at which engine knocking occurs, differs according to the gasoline's octane value. The ECU controls the ignition timing at the optimum timing to correspond to the gasoline octane value.

If engine knocking occurs, the knock sensor converts the vibration from the knocking into voltage signals and sends them to the ECU. The ECU judges whether the knocking strength is at one of 3 levels, strong, medium or weak, according to the strength of the knock signals and changes the supplementary ignition advance angle according to the strength. That is, if knocking is strong, the ignition timing is retarded a lot, and if it is weak, it is retarded a little.

When engine knocking stops, the ECU stops retarding the ignition timing and advances the ignition timing by fixed angles a little at a time.

If ignition timing advance continues and engine knocking recurs, ignition timing is again retarded. The ECU feeds back signals from the knock sensor to correct ignition timing as shown below.

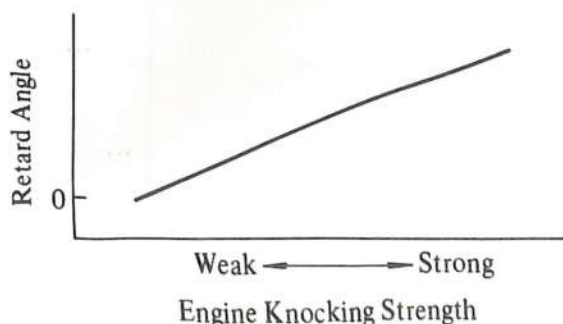


RELEVANT SIGNALS

- Engine speed (Ne)
- Intake air volume (Vs)
- Coolant temperature (THW)
- Engine knocking (KNK)

CONDITIONS

- Intake air volume per engine revolution larger than a certain level.
- Ignition timing not advanced with coolant temperature below 60°C (140°F).



7) Maximum and Minimum Advance Angle Control

If the actual ignition timing (initial ignition timing + basic ignition advance angle + supplementary ignition advance angle) becomes abnormal, the engine will be adversely affected. To prevent this, the ECU controls the actual ignition timing so that the sum of the basic ignition and supplementary ignition advance angles cannot be greater than a certain maximum value, nor less than a certain minimum value. These values are:

Maximum advance angle: 47° BTDC

Minimum advance angle: 5° BTDC

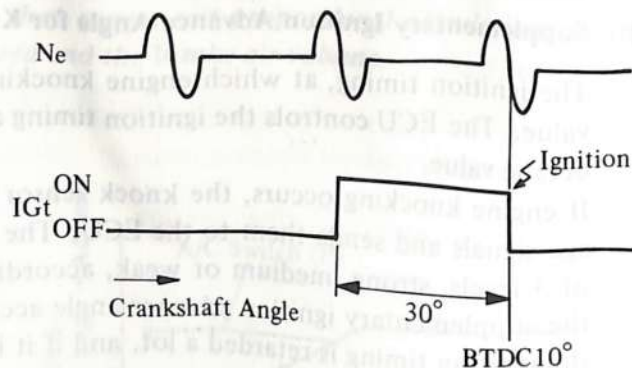
8) Igniter Control

a) During Engine Starting and Immediately After Starting

During engine starting and immediately after starting, the ECU begins sending the IGt signal to the igniter 30° crank shaft angle before the initial ignition timing angle (10° BTDC).

CONDITIONS

- STA on or engine speed below 400 rpm.
- IDL on and service terminals E₁ and T shorted.

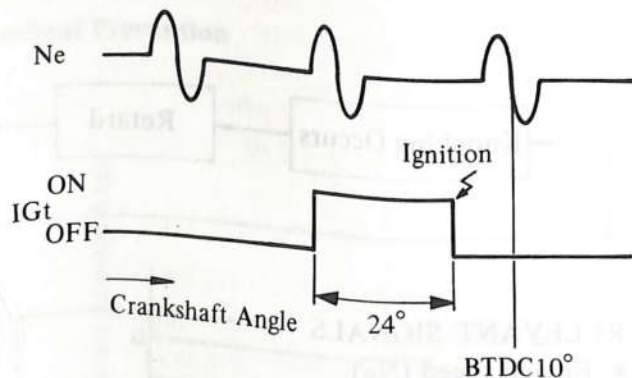


b) During Engine Running

During engine running, the ECU begins sending the IGt signal to the igniter 24° crank angle before the ignition point that it has just calculated.

CONDITION

- Engine speed above 400 rpm.



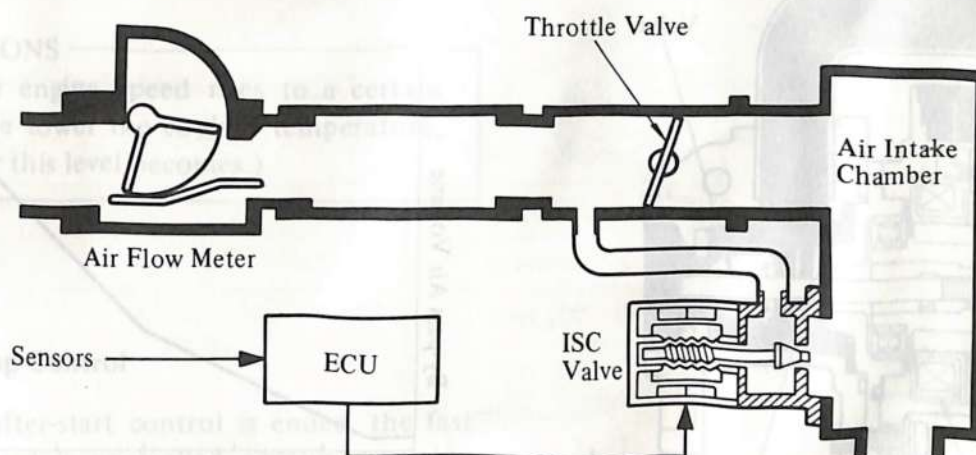
9. ISC (Idle Speed Control)

GENERAL

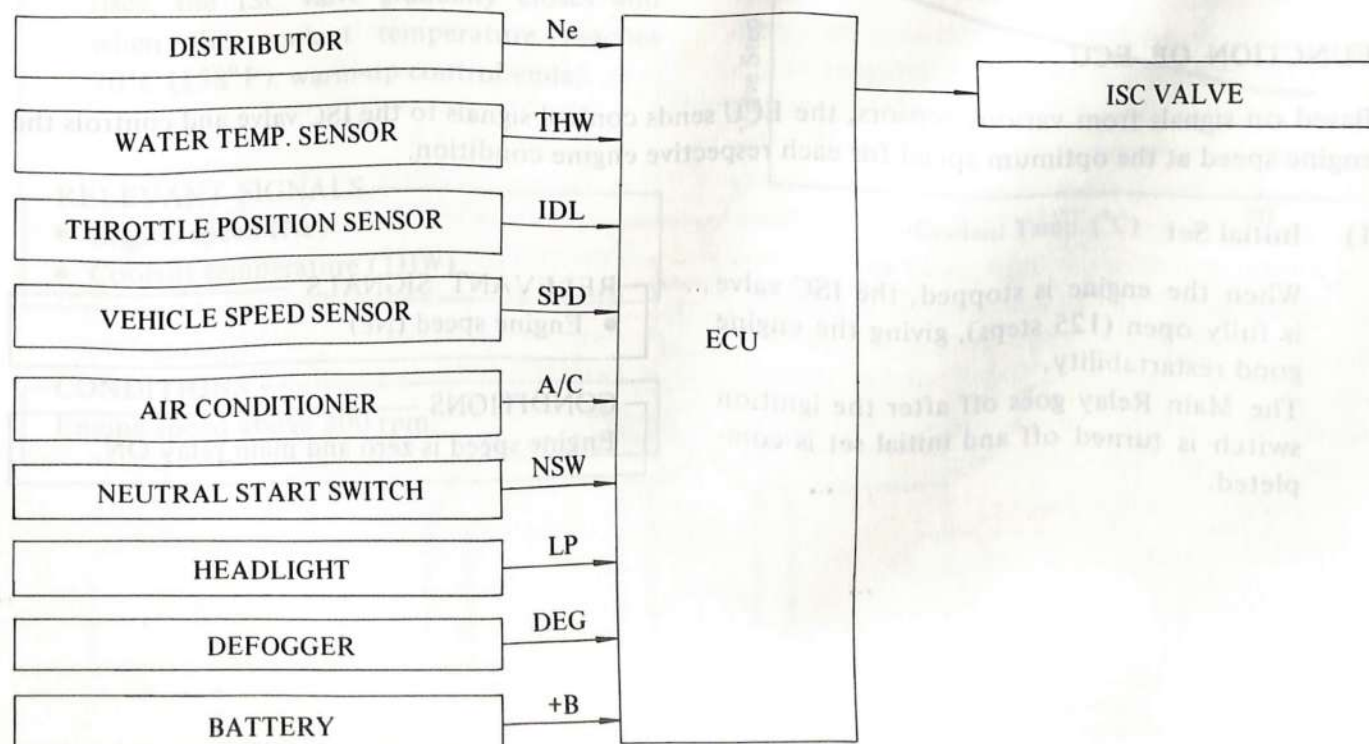
In previous engines, the volume of intake air bypassing the throttle valve is adjusted by the idle speed adjusting screw to adjust the idling speed. Afterward, as the idling speed changes over a period of time, it is readjusted by turning the idle speed adjusting screw.

Also, when the engine is cold, intake air bypasses the throttle valve through an air valve and the engine speed increases, causing fast idle. In addition, when the air conditioner is operated, the throttle valve is opened by a diaphragm and the idle speed is increased.

In the 7M-GE TCCS, a target idling speed for each engine condition is stored in the ECU and by adjusting the intake air volume bypassing the throttle valve according to each engine condition by the ISC valve, the idling speed is controlled so that it becomes the target idling speed. Also, when the engine is cold, the ISC valve is opened corresponding to the coolant temperature and the engine speed is increased, causing fast idle.



ISC BLOCK DIAGRAM

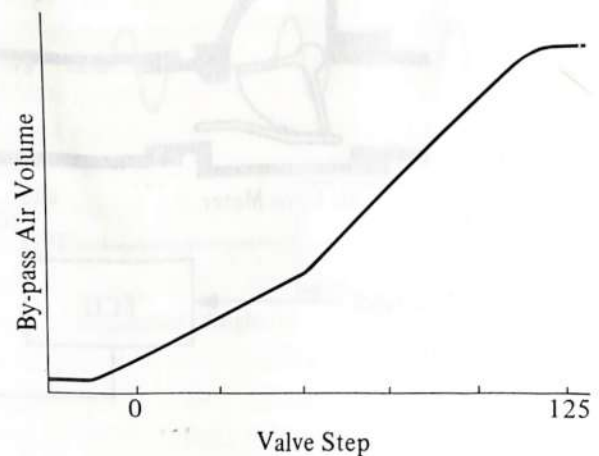
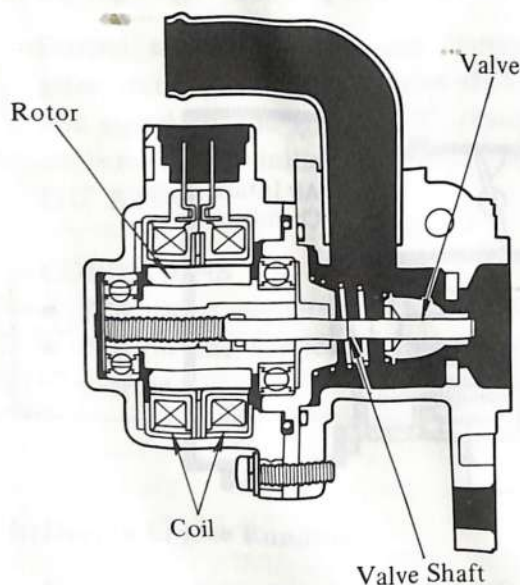


ISC VALVE

The ISC valve is mounted on the intake manifold and intake air bypassing the throttle valve is directed to the ISC valve through a hose.

The ISC valve operates according to signals from the ECU and controls the volume of intake air which bypasses the throttle valve.

The ISC valve is a step motor type. It consists of 4 coils, the magnetic rotor, valve shaft and valve. When current flows to the coils due to signals from the ECU, the rotor turns and moves the valve shaft forward or backward according to the signals, changing the gap between the valve and the valve body. In this way the intake air volume bypassing the throttle valve is changed, changing the engine speed. There are depending on the rotor stop position, 125 steps in the gap between the valve and the valve body.



FUNCTION OF ECU

Based on signals from various sensors, the ECU sends control signals to the ISC valve and controls the engine speed at the optimum speed for each respective engine condition.

1) Initial Set

When the engine is stopped, the ISC valve is fully open (125 steps), giving the engine good restartability.

The Main Relay goes off after the ignition switch is turned off and initial set is completed.

RELEVANT SIGNALS

- Engine speed (Ne)

CONDITIONS

Engine speed is zero and main relay ON.

2) After-start Control

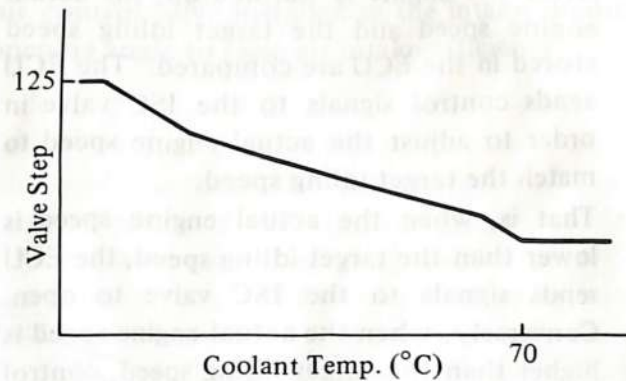
If the engine is started and the ISC valve is in the initial set (fully open) condition, the engine speed will become too high. Therefore, immediately after the engine is started, the ISC valve is adjusted to the step position which corresponds to the coolant temperature. This keeps the engine speed lower.

RELEVANT SIGNALS

- Engine speed (Ne)
- Coolant temperature (THW)

CONDITIONS

When the engine speed rises to a certain level. (The lower the coolant temperature, the higher this level becomes.)



3) Warm-up Control

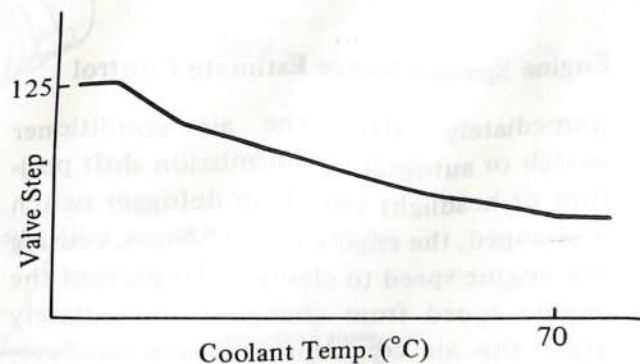
When after-start control is ended, the fast idle speed is controlled corresponding to the coolant temperature in order to warm up the engine. As the coolant temperature rises, the ISC valve gradually closes and when the coolant temperature reaches 70°C (158°F), warm-up control ends.

RELEVANT SIGNALS

- Engine speed (Ne)
- Coolant temperature (THW)

CONDITIONS

Engine speed above 300 rpm.



4) Feedback Control

After the engine is warmed up, the actual engine speed and the target idling speed stored in the ECU are compared. The ECU sends control signals to the ISC valve in order to adjust the actual engine speed to match the target idling speed.

That is, when the actual engine speed is lower than the target idling speed, the ECU sends signals to the ISC valve to open. Conversely, when the actual engine speed is higher than the target idling speed, control signals are sent to the valve to close.

RELEVANT SIGNALS

- Throttle position (IDL)
- Vehicle speed (SPD)
- Engine speed (Ne)
- Coolant temperature (THW)
- Air conditioner (A/C)
- Neutral start switch (NSW)

CONDITIONS

IDL contacts close, vehicle speed is zero, Engine speed above 300 rpm and coolant temperature above 70°C (158°F).

Target Idling Speed (Automatic Transmission)

Air Conditioner Switch	Neutral Start Switch	Engine Speed
ON	ON	900 rpm
	OFF	750 rpm
OFF	ON	700 rpm
	OFF	600 rpm

Target Idling Speed (Manual Transmission)

Air Conditioner Switch	Engine speed
ON	900 rpm
OFF	700 rpm

5) Engine Speed Change Estimate Control

Immediately after the air conditioner switch or automatic transmission shift position or headlight switch or defogger switch is changed, the engine load changes, causing the engine speed to change. To prevent the engine speed from changing, immediately after the air conditioner switch or automatic transmission shift position or headlight switch or defogger switch is changed, the ECU sends signals to the ISC valve to open or close by a fixed number of valve steps.

RELEVANT SIGNALS

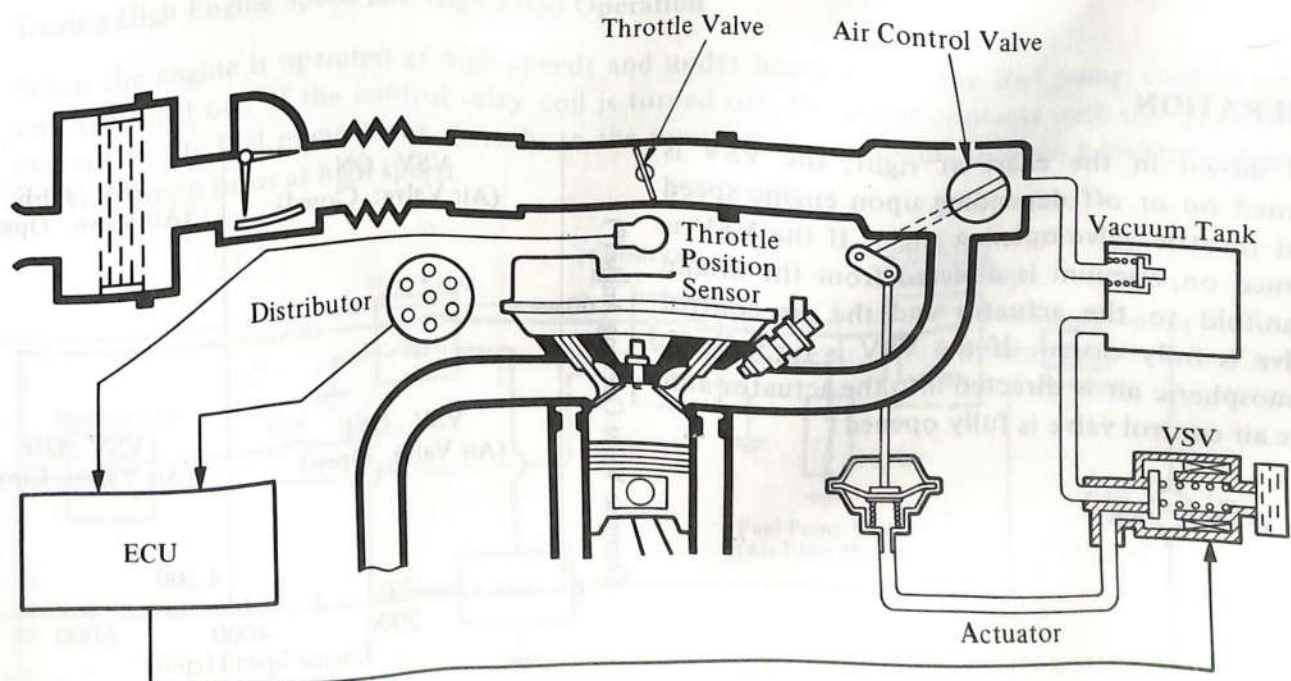
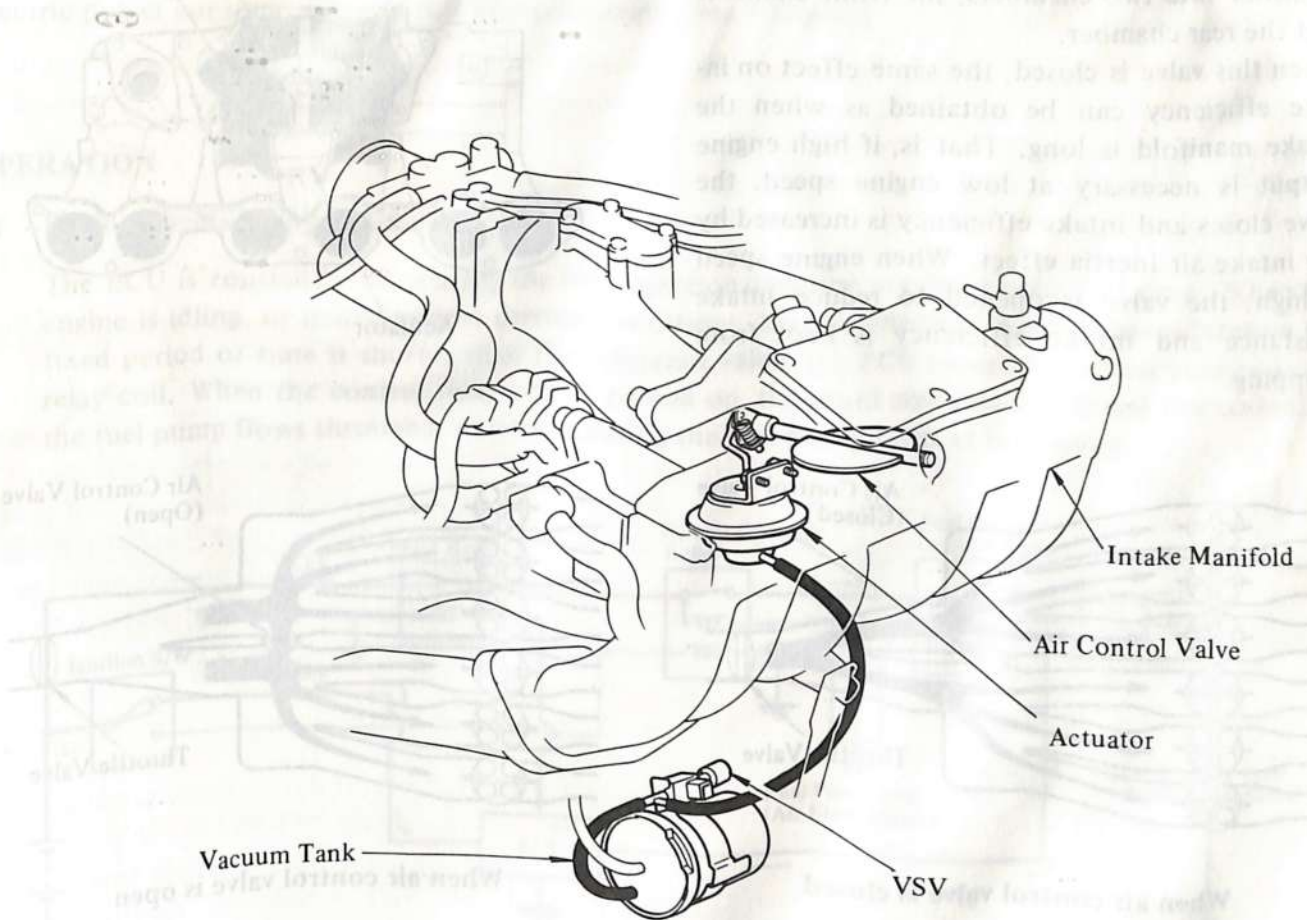
- Engine speed (Ne)
- Air conditioner (A/C)
- Neutral start switch (NSW)
- Headlight (LP)
- Defogger (DEG)

CONDITIONS

When air conditioner switch or neutral start switch or headlight switch or defogger switch turned on or off with engine speed above 300 rpm.

10. Intake Air Control System

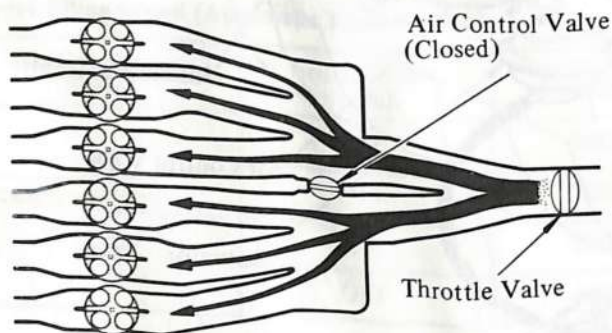
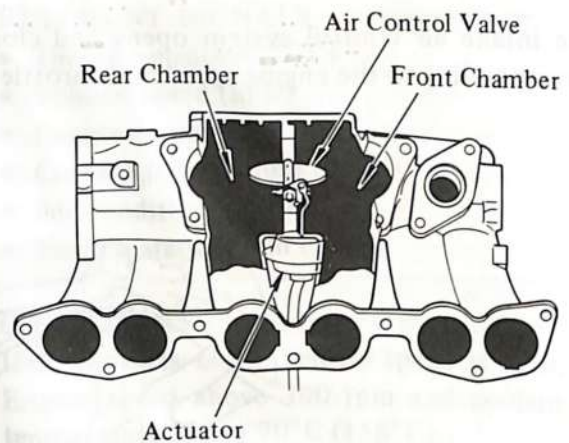
The intake air control system opens and closes an air control valve installed in the intake manifold corresponding to the engine speed and throttle valve opening angle to raise air intake efficiency.



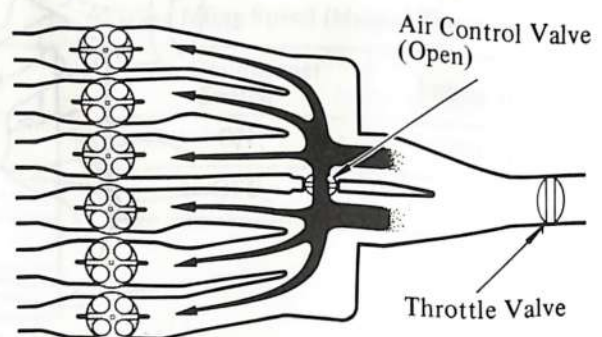
INTAKE MANIFOLD AND AIR CONTROL VALVE

An air control valve is built into the inside of the intake manifold, which divides the intake air chamber into two chambers, the front chamber and the rear chamber.

When this valve is closed, the same effect on intake efficiency can be obtained as when the intake manifold is long. That is, if high engine output is necessary at low engine speed, the valve closes and intake efficiency is increased by the intake air inertia effect. When engine speed is high, the valve is opened to reduce intake resistance and intake efficiency is kept from dropping.



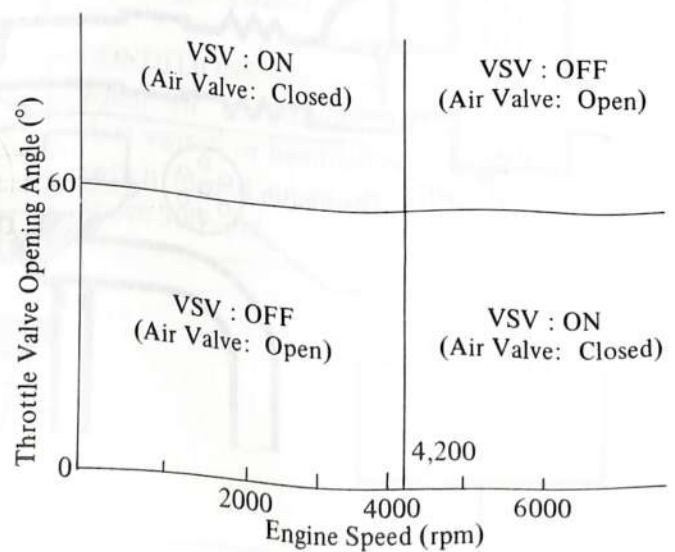
When air control valve is closed



When air control valve is open

OPERATION

As shown in the chart at right, the VSV is turned on or off depending upon engine speed and throttle valve opening angle. If the VSV is turned on, vacuum is directed from the intake manifold to the actuator and the air control valve is fully closed. If the VSV is turned off, atmospheric air is directed into the actuator and the air control valve is fully opened.



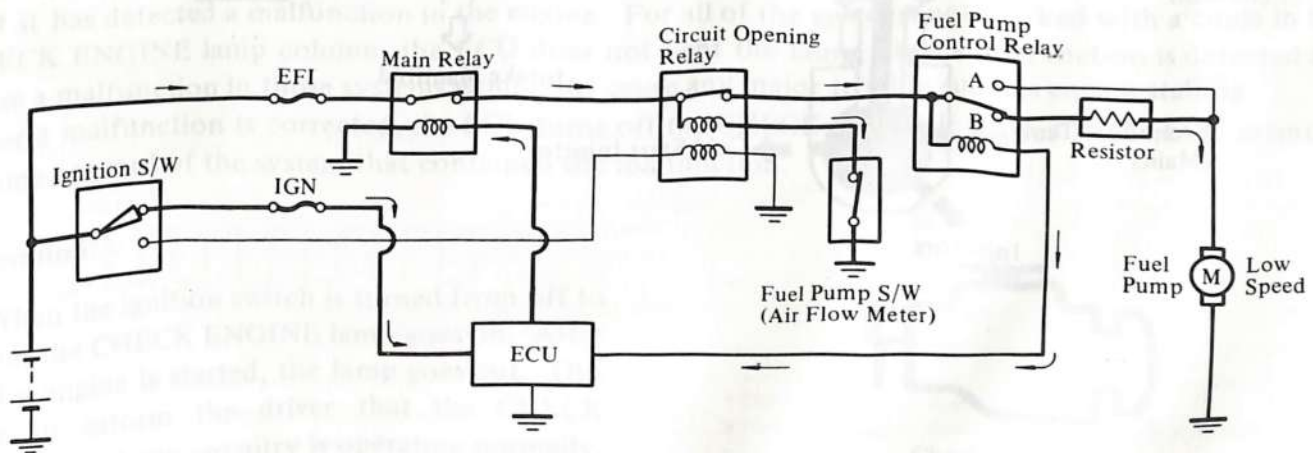
11. Fuel Pump Speed Control

A high output fuel pump has been adopted in the 7M-GE engine. The ECU changes the speed of the fuel pump in 2 stages corresponding to the amount of fuel required by the engine. With this system, electric power consumption and fuel pump durability are improved.

OPERATION

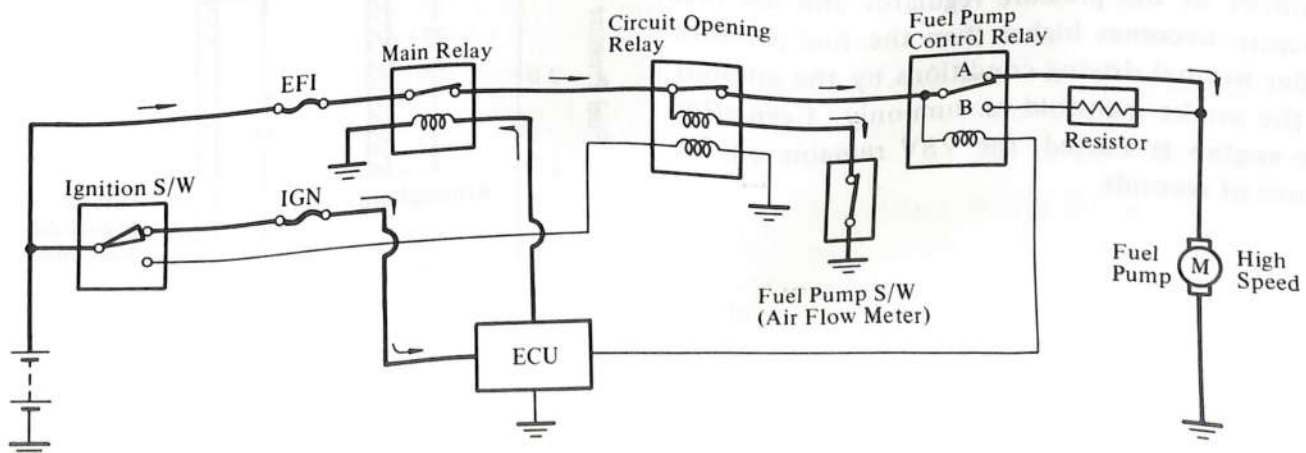
1) During Engine Idling or Cruising

The ECU is constantly calculating the fuel injection duration per fixed period of time. When the engine is idling, or under normal driving conditions, that is, when the fuel injection duration per fixed period of time is shorter than the reference value, the ECU turns on the fuel pump control relay coil. When the control relay coil is turned on, the point contacts side B and the current to the fuel pump flows through a resistor, causing the fuel pump turns at low speed.



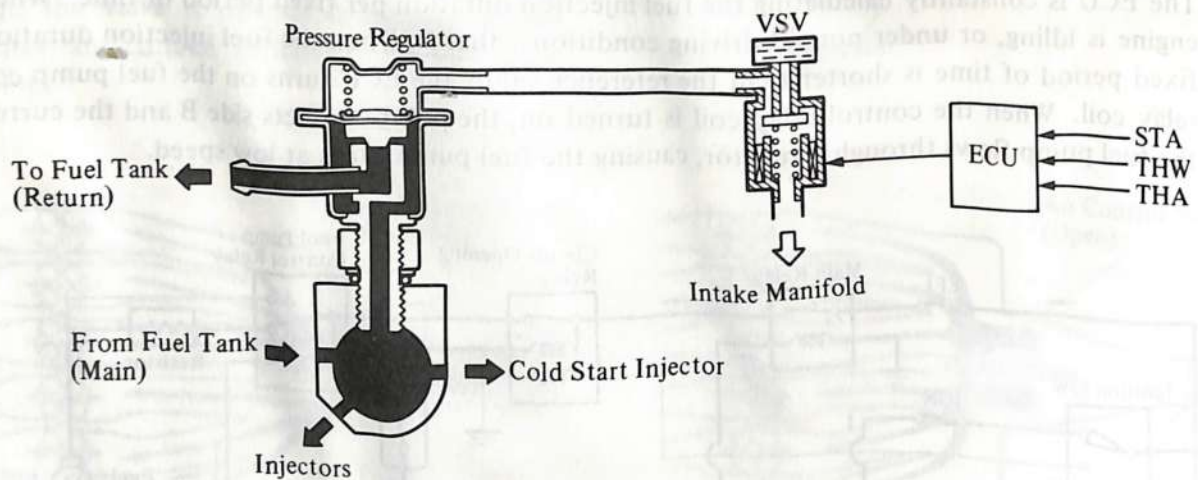
2) During High Engine Speed and High Load Operation

When the engine is operated at high speeds and under heavy loads, the fuel pump control relay coil is turned off. If the control relay coil is turned off, the point contacts with side A and the current to the fuel pump flows directly to the pump without passing through a resistor, causing the fuel pump turns at high speed.



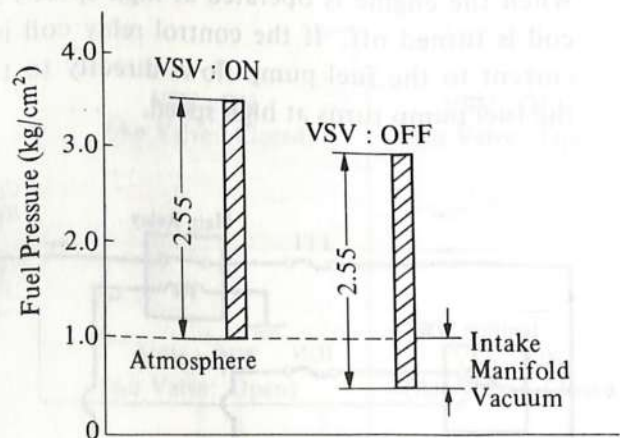
12. Fuel Pressure Control

When the engine is started with its temperature high, the fuel pressure is made higher than under normal driving conditions. When the fuel pressure is increased, the fuel's tendency to percolate is reduced, which improves engine restartability and idling stability.



OPERATION

When the coolant temperature is 100°C (212°F) or higher and the intake air temperature is 60°C (140°F) or higher, if the engine is cranked, the ECU turns on the VSV. As the VSV goes on, atmospheric air is introduced into the diaphragm chamber of the pressure regulator and the fuel pressure becomes higher than the fuel pressure under normal driving conditions by the amount of the intake manifold vacuum only. Even after the engine is started, the VSV remains on for scores of seconds.



13. Diagnosis

GENERAL

The ECU contains a built-in self-diagnostic system.

The ECU, which constantly monitors all sensors, lights the "CHECK ENGINE" lamp when it detects a problem in a sensor or its circuitry. At the same time, the ECU registers the system containing the malfunction in its memory. This information is retained in memory after the ignition switch is turned off, and even after the malfunction has been corrected. When the vehicle requires service because of a problem in the TCCS system, the contents of the memory may be checked to identify the malfunction. After the problem is repaired, the diagnostic system is cleared by removing the EFI fuse for more than 10 seconds with the ignition switch off.

CHECK ENGINE LAMP

The diagnostic system monitors sixteen conditions, including the normal condition, listed in the chart on page 45. Whenever a malfunction is detected in any one of the systems marked with a circle in the CHECK ENGINE lamp column, the ECU lights the CHECK ENGINE lamp to inform the driver that it has detected a malfunction in the engine. For all of the systems not marked with a circle in the CHECK ENGINE lamp column, the ECU does not light the lamp when a malfunction is detected because a malfunction in those systems would not cause any major trouble such as engine stalling. After a malfunction is corrected, the ECU turns off the CHECK ENGINE lamp, but the ECU memory retains a record of the system that contained the malfunction.

Operation

- When the ignition switch is turned from off to on, the CHECK ENGINE lamp goes on. After the engine is started, the lamp goes out. This is to inform the driver that the CHECK ENGINE lamp circuitry is operating normally.
- The lamp lights immediately if a TCCS problem occurs while the engine is running.
- If the problem is rectified, the lamp goes out five seconds after the problem is corrected.
- If the problem no longer exists at the time the TCCS is being checked by a technician (as, for example, if it is an intermittent problem), the CHECK ENGINE lamp will not light, even if the malfunction has been recorded in the memory of the ECU.



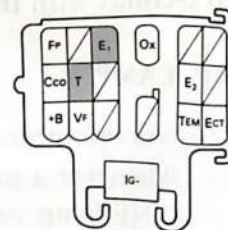
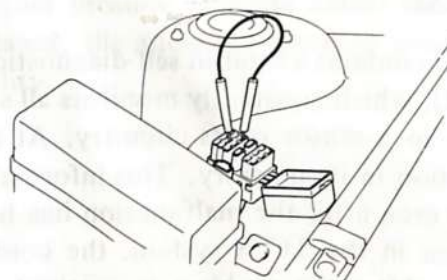
Check Engine Lamp

DIAGNOSTIC CODES

In the case of the 7M-GE engine, TCCS problems can be diagnosed by fulfilling the following three conditions, then counting the number of times the CHECK ENGINE lamp flashes (see the Table of Diagnostic Codes on the next page):

CONDITION

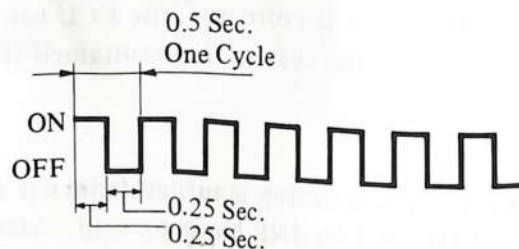
- Ignition switch on
- Check terminals E₁ and T connected
- IDL contacts on (throttle valve fully closed)



Check Connector

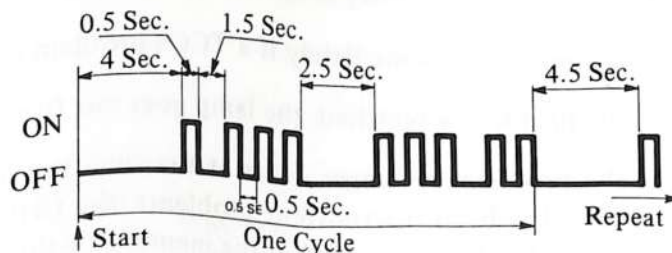
1) Normal

The lamp will flash 2 times per second as shown in the chart on the right.



2) Malfunction Present

The appropriate diagnostic code(s) will be indicated by the lamp as shown in the example on the right. In this case, codes 13 and 32 are indicated:



NOTE: • If two or more malfunctions are present at the same time, the lowest-numbered diagnostic code will be displayed first. However, no other code will appear along with code No. 11.

- All detected diagnostic codes, except 51 and 53, will be retained in memory by the ECU from the time of detection until cancelled out.
- Once the malfunction is cleared, the "CHECK ENGINE" warning lamp will go out but the diagnostic code(s) will remain stored in the ECU memory (except for code 51 and 53.)

Code No.	Item	Diagnosis	Trouble Area	"CHECK ENGINE" Diagnostic Light
	Normal			—
11	ECU (+B)	Momentary interruption in power supply to ECU.	• Ignition switch, main relay circuit • ECU	—
12	RPM Signal	No "Ne" or "G" signal to ECU within several seconds after engine is cranked.	• Distributor circuit • Crank position, starter signal circuit • Distributor • ECU	○
13	RPM Signal	No "Ne" signal to ECU when the engine speed is above 1,000 rpm.	↑	○
14	Ignition Signal	No "IGf" signal to ECU 6–8 times in succession	• Igniter circuit • Igniter • ECU	○
21*	Oxygen Sensor Signal	Open circuit in oxygen sensor signal (Ox)	• Oxygen sensor circuit • Oxygen sensor • ECU	○
22	Water Temp. Sensor Signal	Open or short circuit in water temp. sensor signal (THW)	• Water temp. sensor circuit • Water temp. sensor • ECU	○
24	Intake Air Temp. Sensor Signal	Open or short circuit in intake air temp. sensor signal (THA)	• Intake air temp. sensor circuit • Intake air temp. sensor • ECU	—
31	Air Flow Meter Signal	Open circuit in Vcc signal or short circuit between Vs and E ₂ when idle contacts are closed	• Air flow meter circuit • Air flow meter • ECU	○
32	Air Flow Meter Signal	Open circuit in E ₂ signal or short circuit between Vcc and Vs	↑	○
41	Throttle Position Sensor Signal	Open or short circuit in throttle position sensor signal (VTA)	• Throttle position sensor circuit • Throttle position sensor • ECU	—
42	Vehicle Speed Sensor Signal	No "SPD" signal for several seconds when engine speed is between 2,000 rpm and 4,500 rpm except when racing the engine	• Vehicle speed sensor circuit • Vehicle speed sensor • ECU	—
43	Starter Signal	No "STA" signal to ECU until engine speed reaches 800 rpm with vehicle not moved	• Starter signal circuit • Ignition switch, main relay circuit • ECU	—
51	Switch Signal	No "IDL" signal or No "NSW" signal or "A/C" signal to ECU, with the check terminals E ₁ and T shorted.	• A/C amplifier • A/C switch circuit • Neutral start switch • Neutral start switch circuit • Accelerator pedal and cable • Throttle position sensor • Throttle position sensor circuit • ECU	—
52	Knock Sensor Signal	Open or short circuit in knock sensor signal (KNK)	• Knock sensor circuit • Knock sensor • ECU	○
53	Knock Control CPU (ECU)	Knock control CPU faulty	• ECU	○

*: No. 21 applies to Australia.

14. Fail-Safe

FAIL-SAFE FUNCTION

When a malfunction is detected by any of the sensors, the fail-safe function of the ECU either relies on the data stored in its memory to allow the TCCS to continue operating or stops the engine.

1) Water Temp. Sensor and Air Temp. Sensor Malfunction

If an open circuit develops in the air or water temp. sensor, or in their circuitry, the affected sensor will send a signal informing the ECU that the temperature has fallen below -50°C (-58°F). On the other hand, if a short circuit develops, the sensor will send a signal informing the ECU that the temperature has risen above 140°C (284°F).

If the ECU receives either one of these abnormal signals, it ignores all input from the affected sensor and relies upon the standard air or coolant temperature value stored in memory. These values are 20°C (68°F) for intake air temperature and 80°C (176°F) for coolant temperature. This is to prevent stalling and poor idle.

2) Ignition System Malfunction

The ECU will detect a malfunction in the ignition system if no IGf signal is supplied to the ECU 3–5 times consecutively after each IGt signal, and will discontinue fuel injection. This is to prevent TWC from overheating due to no ignition.

3) Throttle Position Sensor Malfunction

If the throttle position sensor circuit is open or if there is a short, the ECU judges that the signals indicate a malfunction and controls the engine as if the throttle valve opening angle were 0° . This prevents engine stall or engine overrun.

4) Knock Sensor and Knock CPU Malfunction

If the knock sensor circuit becomes open or is shorted, or if trouble develops in the knock CPU in the ECU, the ECU, without ignition timing feedback control corresponding to the knock strength, sets the supplementary ignition advance angle to the maximum retard condition to prevent knocking. By thus preventing the ignition timing from advancing too far, the engine knock is suppressed.

5) Back-up Function

If there is trouble with the CPU in the ECU and the ignition signals (IGt) are not output, the ECU controls fuel injection and ignition timing at predetermined levels as a back-up function to make it possible to continue to operate the vehicle.

Furthermore, the injection duration is calculated from the starting signal (STA) and the throttle position signal (IDL). Also, the ignition timing is fixed at the initial ignition timing, 10° BTDC, without relation to the engine speed.

NOTE: If the engine is controlled by the back-up function, the CHECK ENGINE lamp lights up to warn the driver of the malfunction but the diagnostic code is not output.

EMISSION CONTROL SYSTEM

1. System Purpose

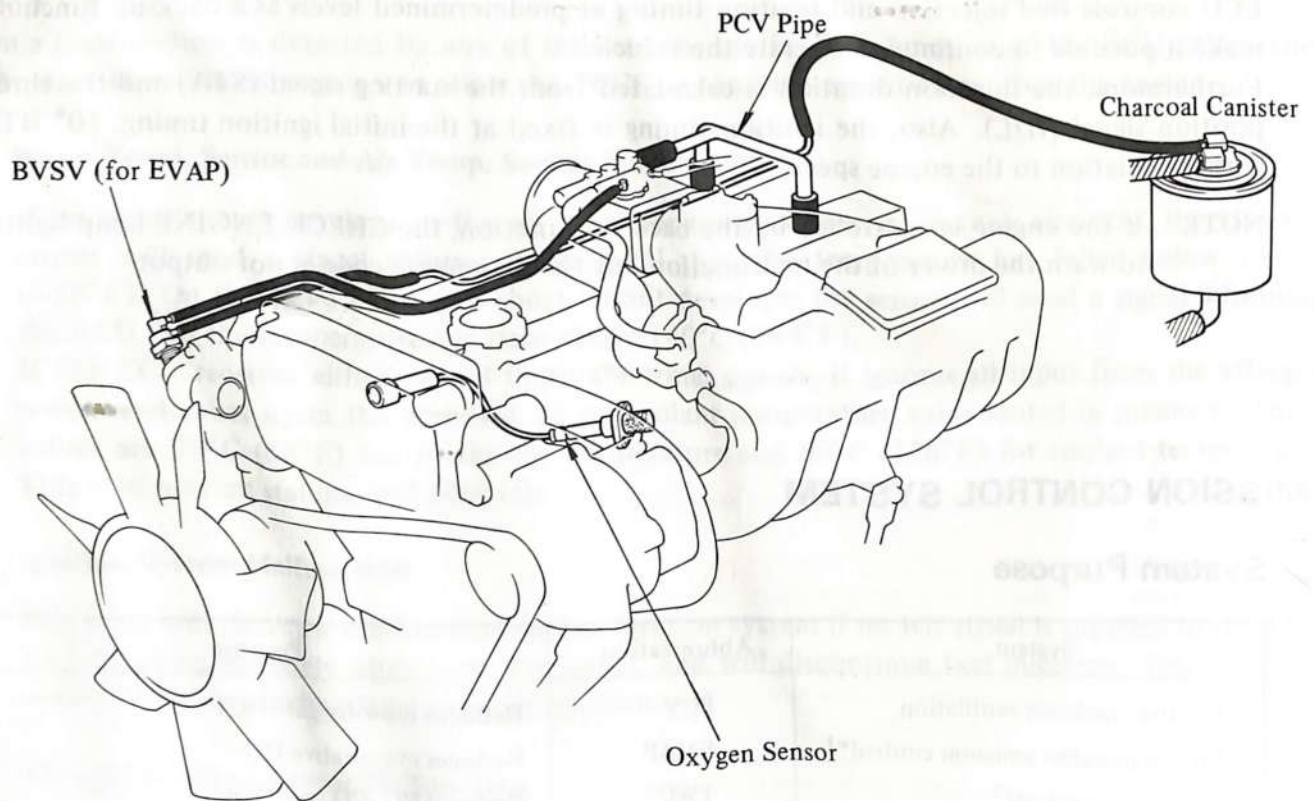
System	Abbreviation	Purpose
Positive crankcase ventilation	PCV	Reduces blow-by gas (HC)
Fuel evaporative emission control* ¹	EVAP	Reduces evaporative HC
Three-way catalyst* ²	TWC	Reduces HC, CO and NOx
Electronic fuel injection	EFI	Regulates all engine conditions for reduction of exhaust emissions

*¹: Items with this mark apply to Australia and Saudi Arabia.

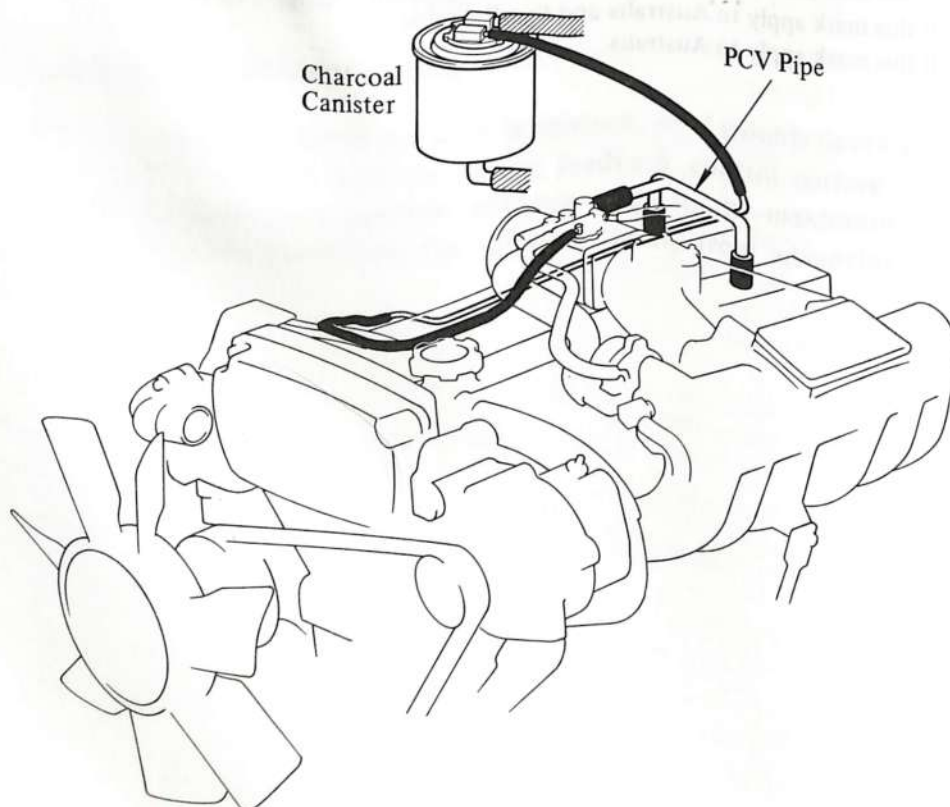
*²: Items with this mark apply to Australia.

2. Component Layout

For Australia



For Saudi Arabia

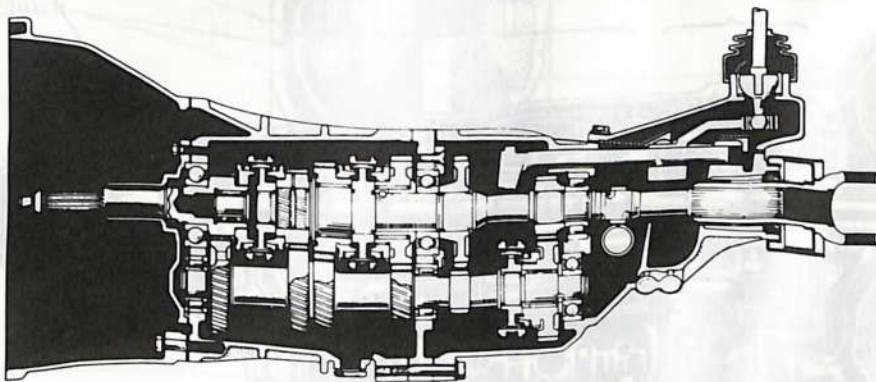


MANUAL TRANSMISSION

W58 MANUAL TRANSMISSION

The W58 manual transmission, which has been proven on previous models, is mounted in the new Supra.

The basic construction, operation and gear ratios of this transmission have not been changed.



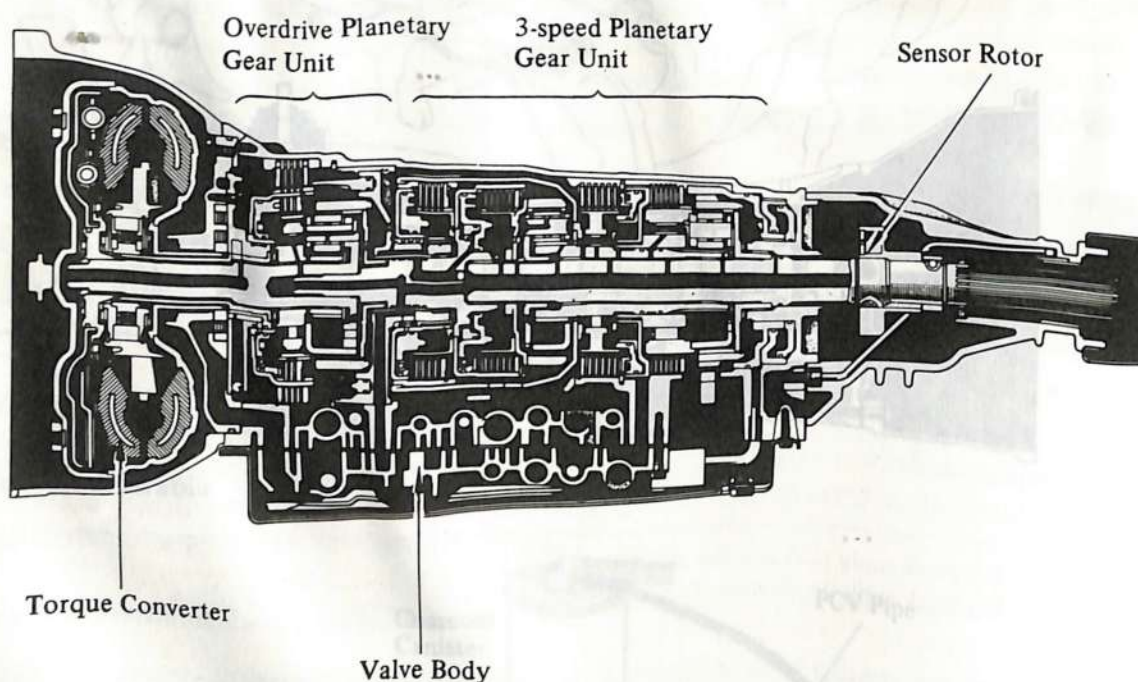
Specifications

Gear Ratio	1st	3.285
	2nd	1.894
	3rd	1.275
	4th	1.000
	5th	0.783
	Reverse	3.768
Fluid Volume	2.4 liters. (2.5 US qts., 2.1 Imp. qts.)	
Type of Fluid	API GL-4 or GL-5 SAE 75W-90 or 80W-90	

AUTOMATIC TRANSMISSION

A340E AUTOMATIC TRANSMISSION

The major components of the A340E Electronically-controlled Transmission (ECT) are the torque converter with lock-up clutch, the overdrive (OD) planetary gear unit, the 3-speed planetary gear unit, the hydraulic control system and the electronic control system.

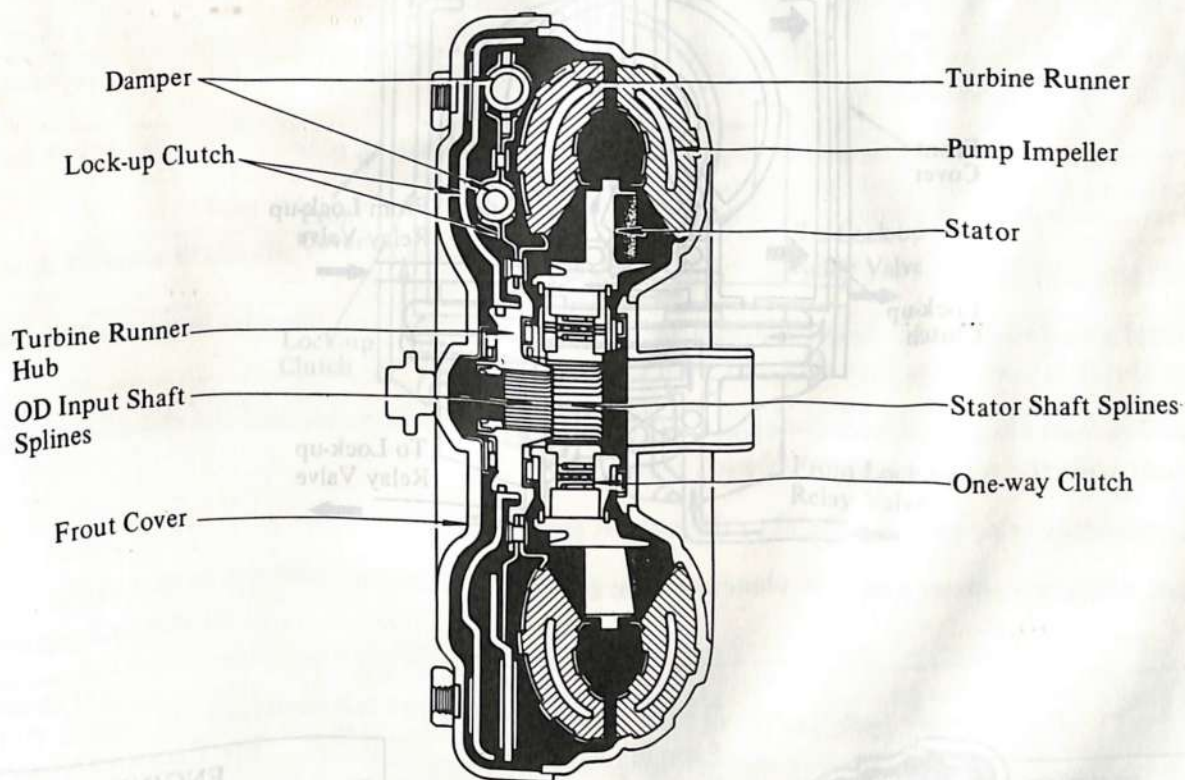


Specifications

Type of Transmission		A340E
Type of Engine		7M-GE
Gear Ratio	1st	2.804
	2nd	1.531
	3rd	1.000
	4th (Overdrive)	0.705
	Reverse	2.393
Fluid Volume		7.2 liters (6.3 Imp. qts.)
Type of Fluid		ATF type DEXRON® II

TORQUE CONVERTER WITH LOCK-UP CLUTCH

The torque converter of the A340E has a hydraulically controlled lock-up clutch which corresponds to a manual clutch. This prevents torque converter loss at medium and high speeds, and brings about better fuel economy.

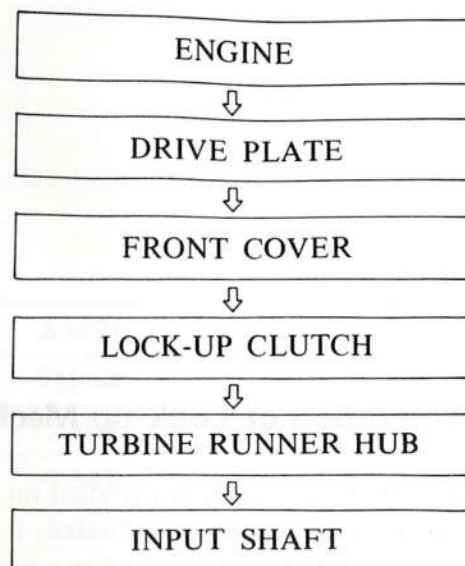
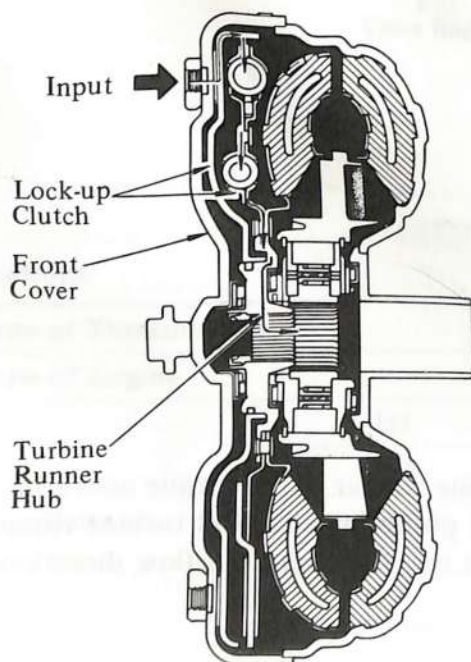
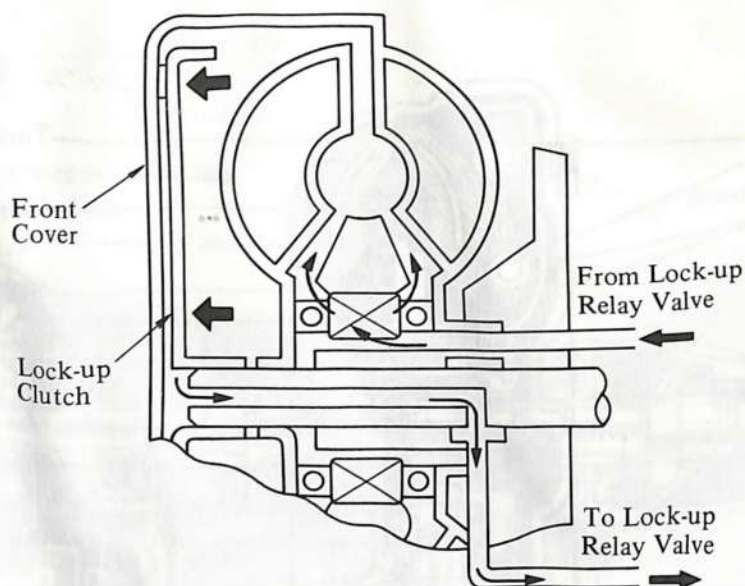


Operation of Lock-up Mechanism

The lock-up clutch is installed on the same axis as the turbine runner of the torque converter. When the lock-up clutch is actuated, it rotates together with the pump impeller and turbine runner. Engaging and disengaging of the lock-up clutch is determined by changes in the flow direction of the hydraulic fluid into the torque converter.

1) LOCK-UP CLUTCH ENGAGED

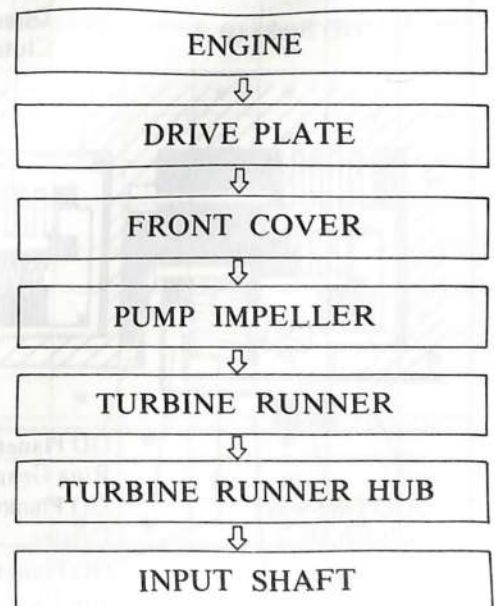
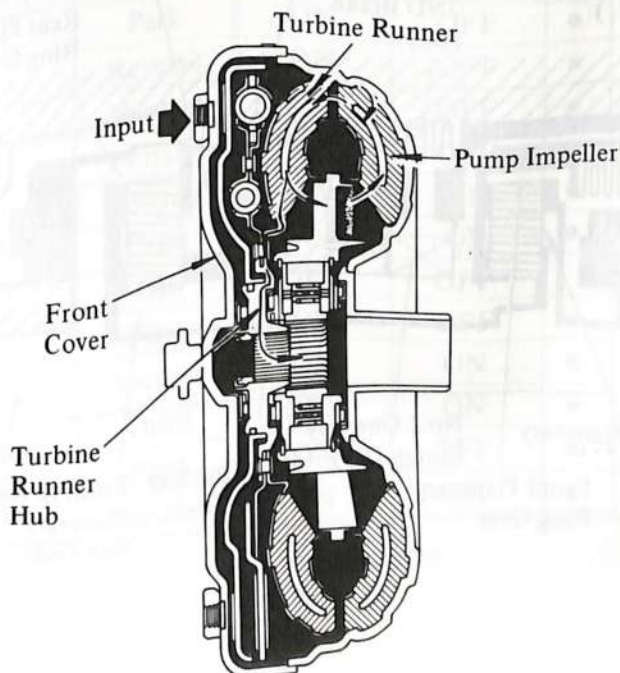
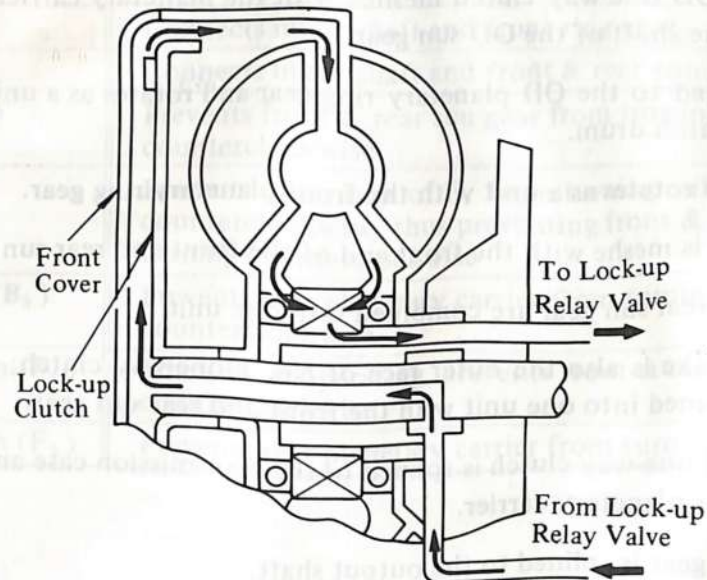
The flow of the fluid in the torque converter is as shown by the arrow in the figure below. This flow causes, the lock-up clutch to press against the front cover side by the left-right pressure differential, so it turns together with the front cover.



2) LOCK-UP CLUTCH DISENGAGED

The flow of the fluid is reversed at the point when the lock-up clutch is engaged, as shown in the figure at below. As a result, since the pressure on the left side is high, the lock-up clutch separates from the front cover.

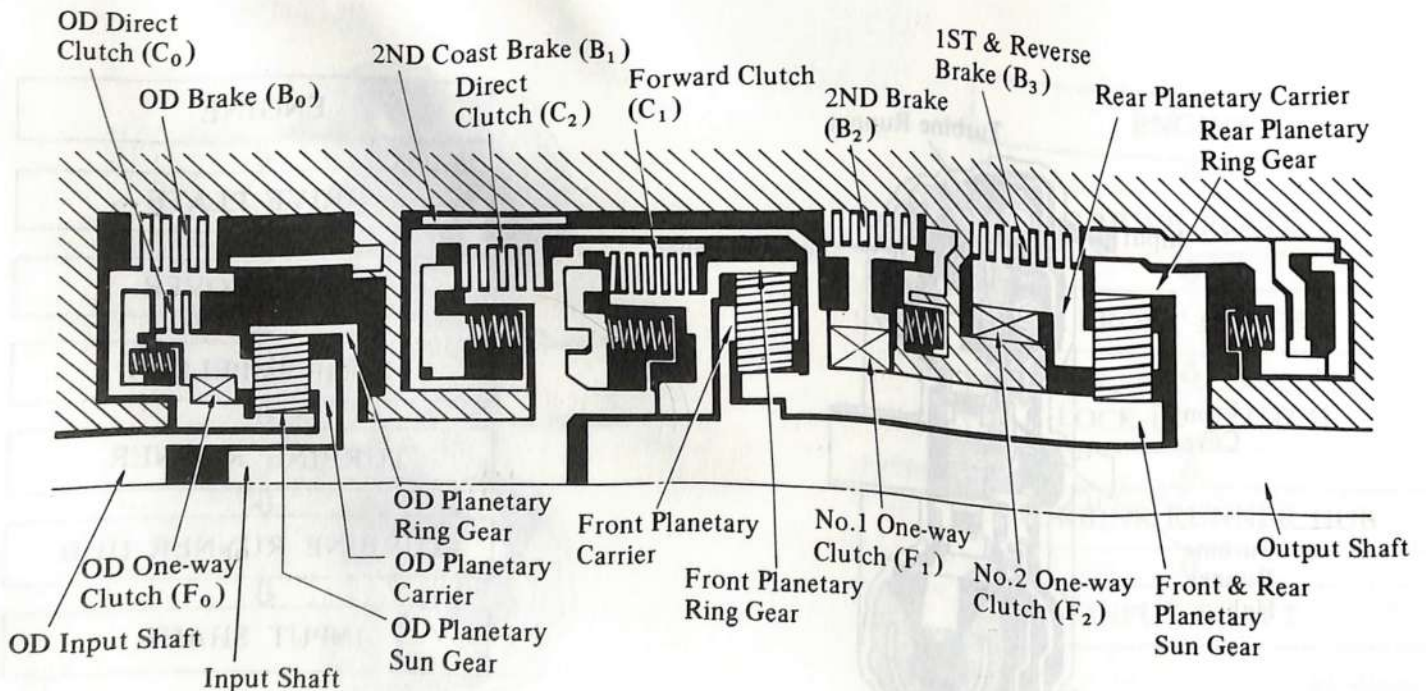
Therefore, since engine power is transmitted as it would be with an ordinary torque converter, a difference develops between the rotational speed of the pump impeller and the turbine runner.



PLANETARY GEAR UNIT

1. Construction

- The OD input shaft and OD planetary carrier rotate together as one unit.
- The OD sun gear has been combined with the OD direct clutch drum into one unit.
- The splines of the OD direct clutch are also the hub of the OD brake.
- The outer race of the OD one-way clutch meshes with the planetary carrier, while the inner race is permanently fixed to the shaft of the OD sun gear.
- The input shaft is splined to the OD planetary ring gear and rotates as a unit with the direct clutch hub and the forward clutch drum.
- The forward clutch hub rotates as a unit with the front planetary ring gear.
- The direct clutch drum is meshed with the front end of the front and rear sun gear.
- The front sun gear and rear sun gear are combined into one unit.
- The hub of the 2nd brake is also the outer race of No. 1 one-way clutch; the inner race of No. 1 one-way clutch is combined into one unit with the front and rear sun gear.
- The inner race of No. 2 one-way clutch is splined to the transmission case and the outer race rotates as one unit with the rear planetary carrier.
- The rear planetary ring gear is splined to the output shaft.
- The front planetary carrier and rear planetary ring gear rotate as a unit with the output shaft.



Operation of Each Element

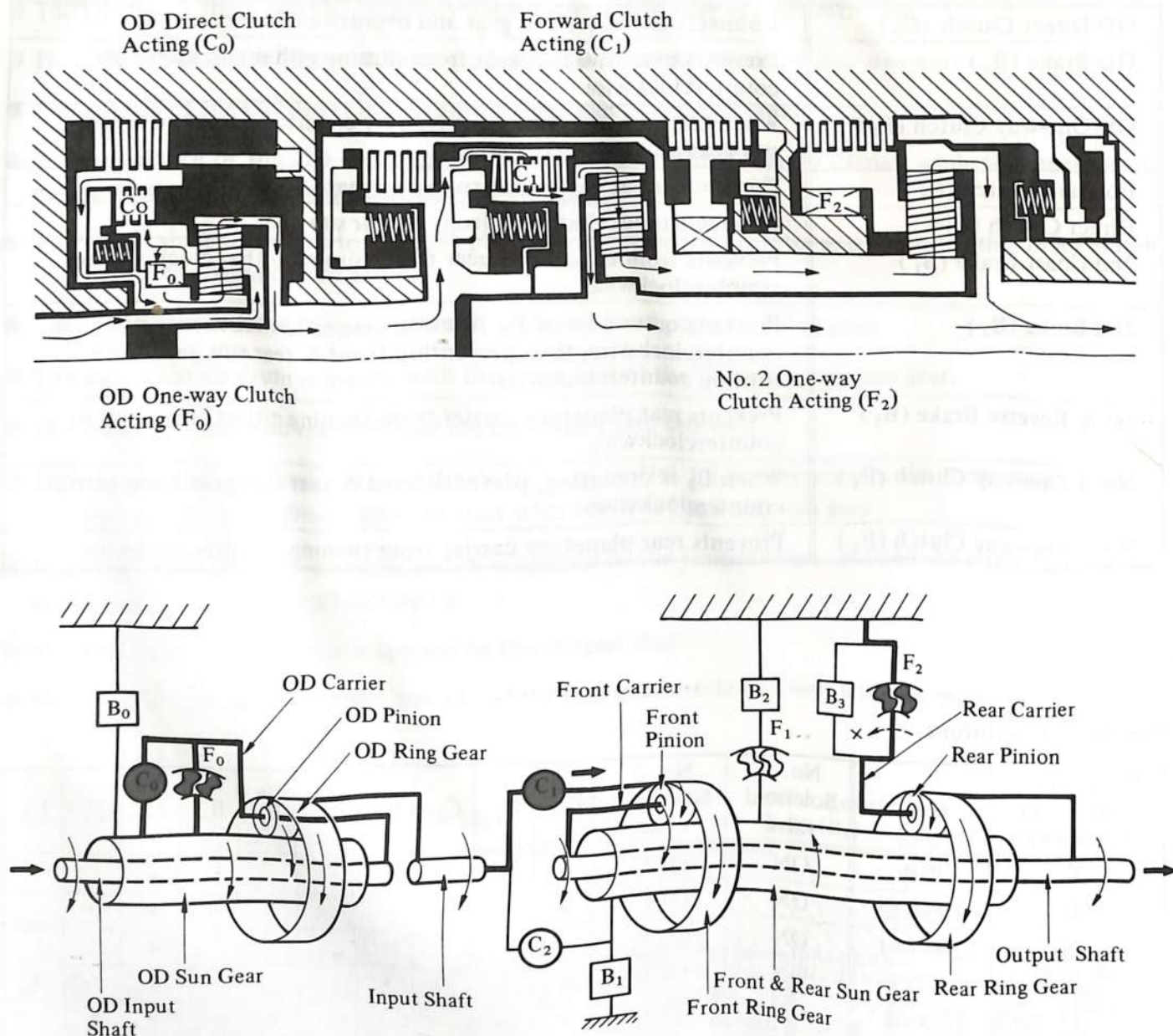
NOMENCLATURE	OPERATION
OD Direct Clutch (C_0)	Connects overdrive sun gear and overdrive carrier
OD Brake (B_0)	Prevents overdrive sun gear from turning either clockwise or counterclockwise
OD One-way Clutch (F_0)	When transmission is being driven by engine, connects overdrive sun gear and overdrive carrier
Forward Clutch (C_1)	Connects input shaft and front ring gear
Direct Clutch (C_2)	Connects input shaft and front & rear sun gear
2nd Coast Brake (B_1)	Prevents front & rear sun gear from turning either clockwise or counterclockwise
2nd Brake (B_2)	Prevents outer race of F_1 from turning either clockwise or counterclockwise, thus preventing front & rear sun gear from turning counterclockwise
1st & Reverse Brake (B_3)	Prevents rear planetary carrier from turning either clockwise or counterclockwise
No. 1 One-way Clutch (F_1)	When B_2 is operating, prevents front & rear sun gear from turning counterclockwise
No. 2 One-way Clutch (F_2)	Prevents rear planetary carrier from turning counterclockwise

Operating Conditions

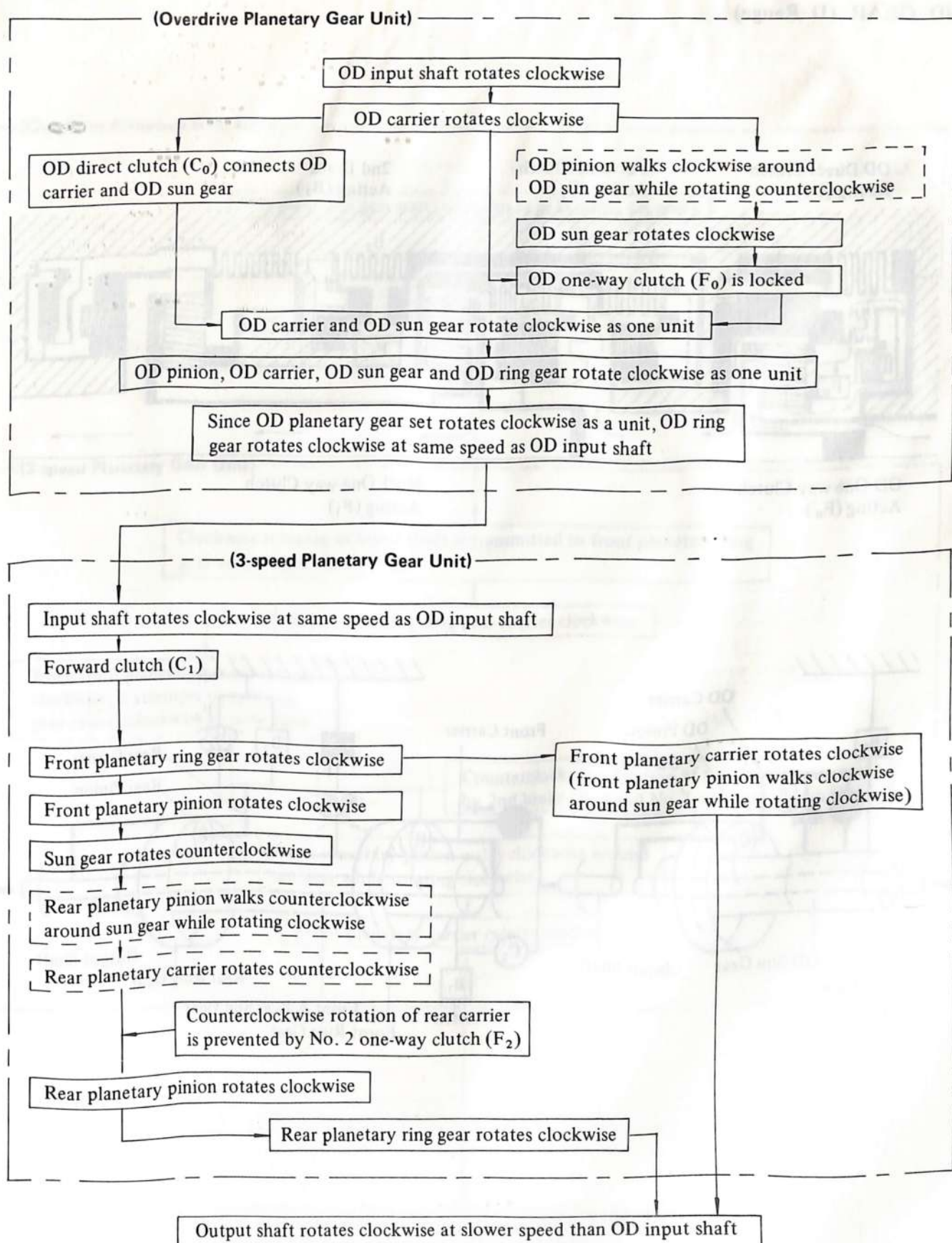
Range (i.e., Shift Lever Position)	Gear	No. 1 Solenoid valve	No. 2 Solenoid valve	C_0	C_1	C_2	B_0	B_1	B_2	B_3	F_0	F_1	F_2
P	Park	ON	OFF	•							•		
R	Reverse	ON	OFF	•		•				•	•		
N	Neutral	ON	OFF	•							•		
D	First	ON	OFF	•	•						•		•
	Second	ON	ON	•	•				•		•	•	
	Third	OFF	ON	•	•	•			•		•		
	OD	OFF	OFF		•	•	•		•				
2	First	ON	OFF	•	•						•		•
	Second	ON	ON	•	•			•	•		•	•	
	Third	OFF	ON	•	•	•			•		•		
L	First	ON	OFF	•	•					•	•		•
	Second	ON	ON	•	•			•	•		•	•	

•: Operates

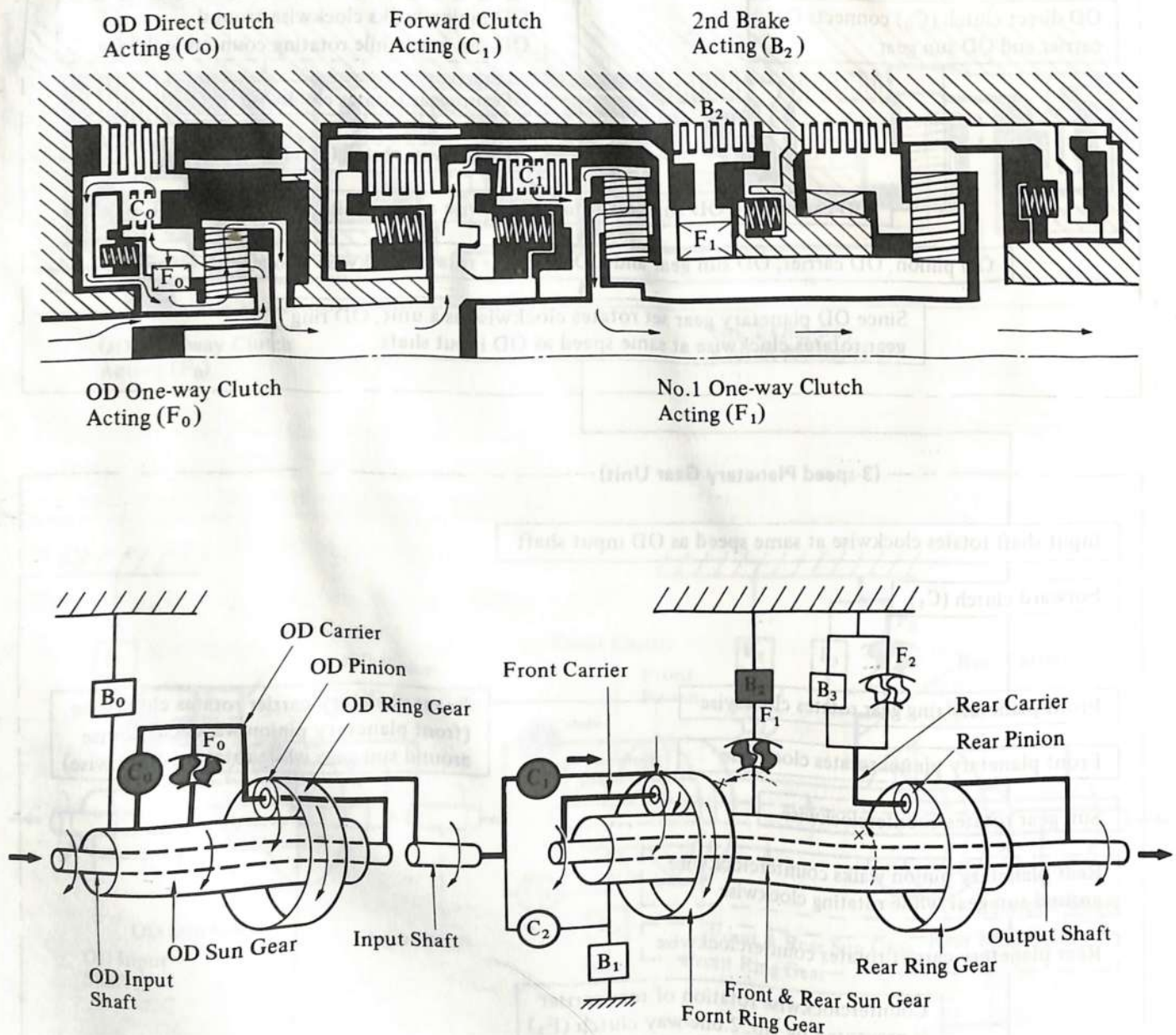
1ST GEAR (D or 2 Range)

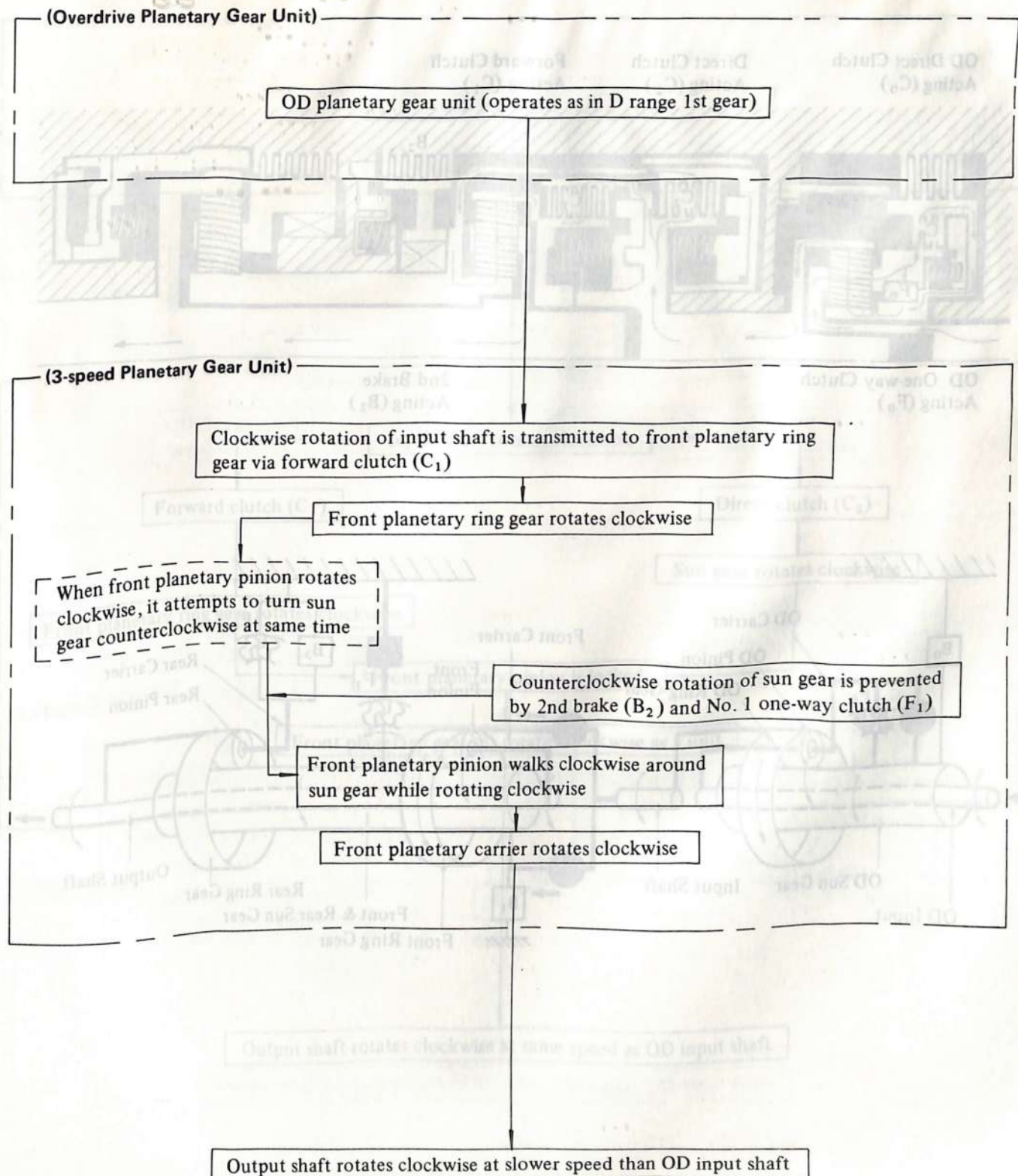


The outer race of the OD one-way clutch (F_0) rotates clockwise as a unit with the OD planetary carrier, while the inner race rotates as a unit with the OD sun gear. Since the inner race (OD sun gear) rotates faster than the outer race (OD carrier) by the amount of speed increment given to it by the counter clockwise-rotation of the OD pinion, the OD one-way clutch (F_0) is locked, and the OD carrier and OD sun gear turn as one unit.

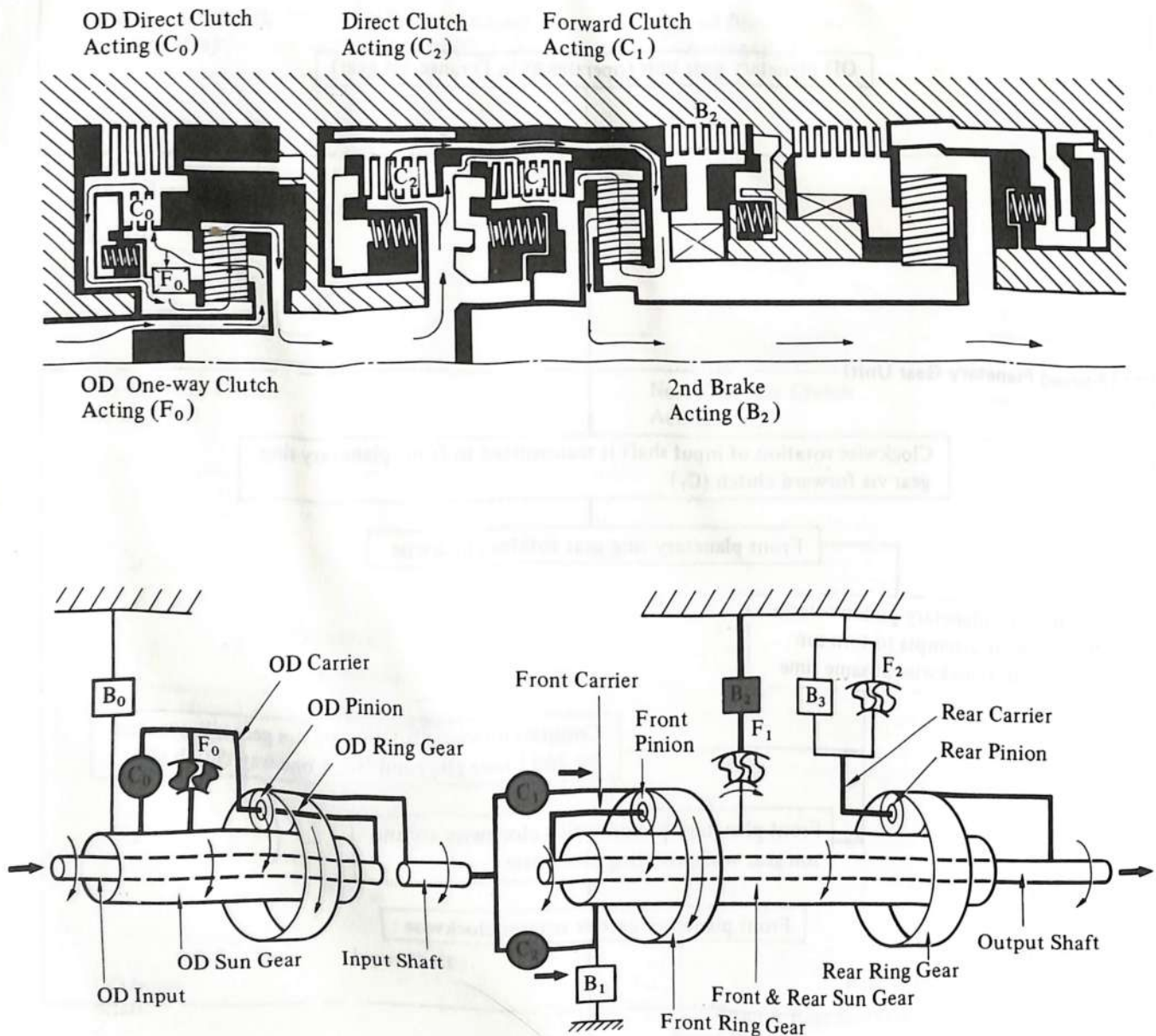


2ND GEAR (D Range)

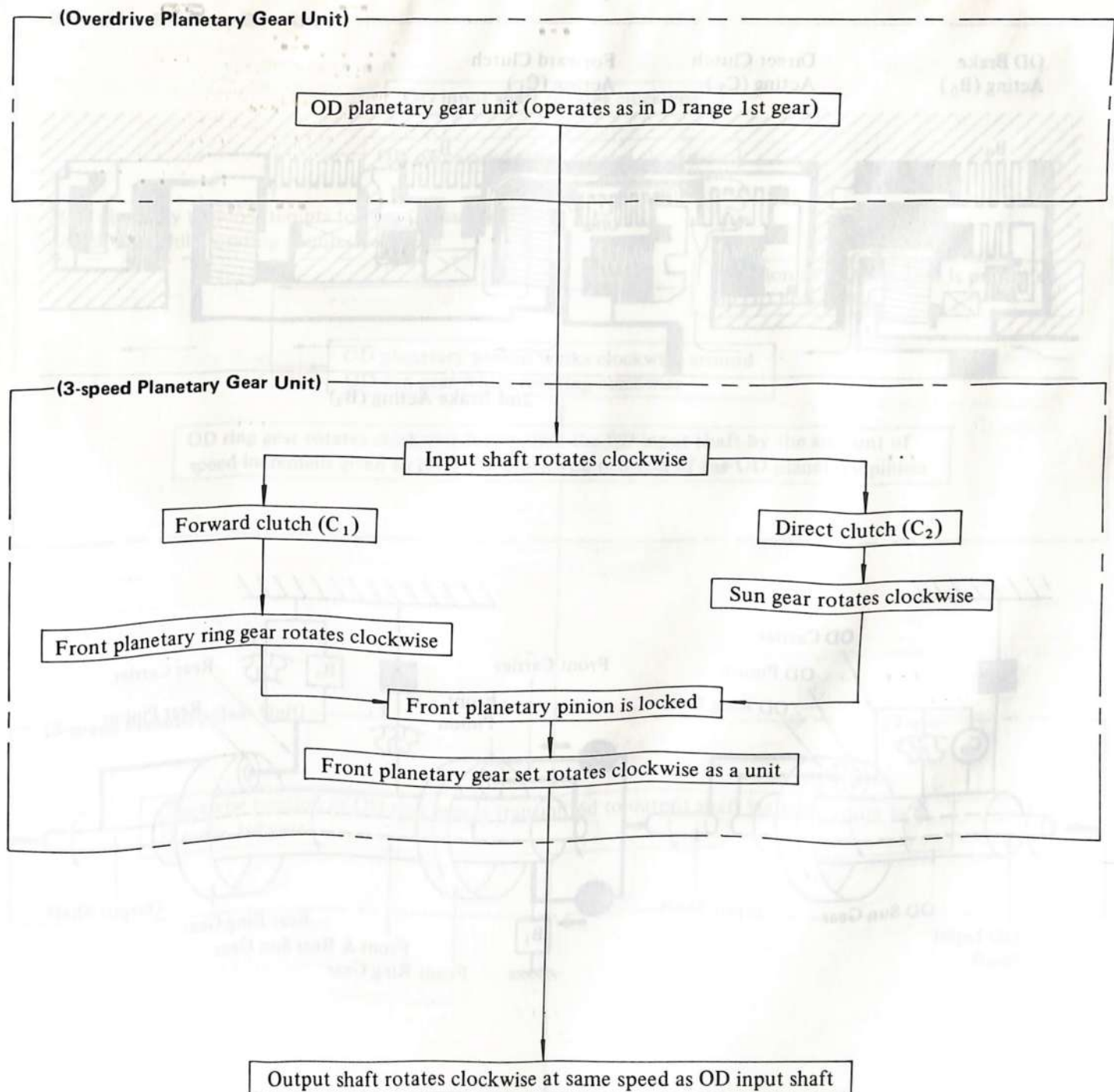




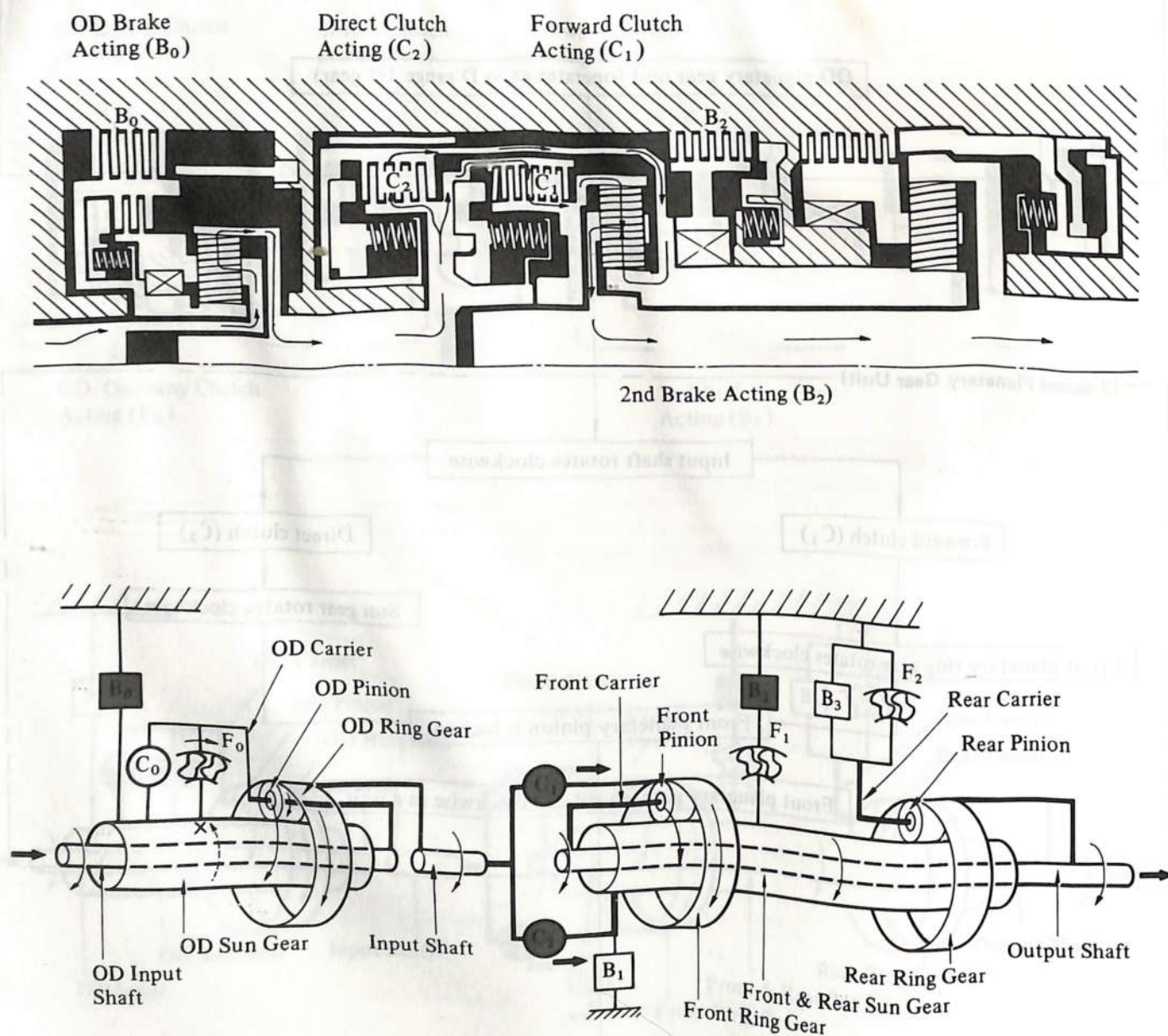
3RD GEAR (D or 2 Range)



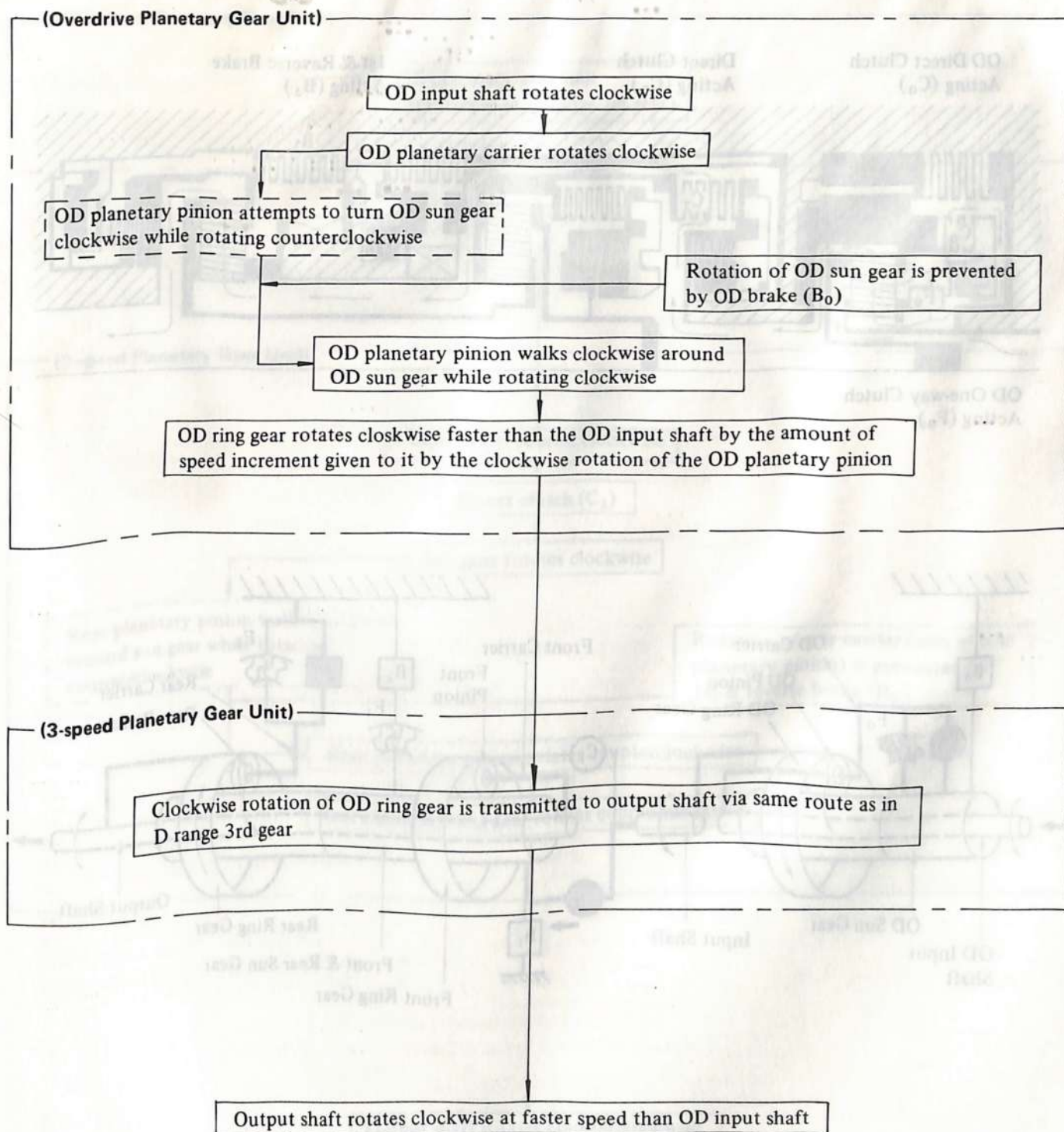
Though the 2nd Brake (B_2) acts in relation to the hydraulic system, since one-way clutch (F_1) free-wheels when the front and rear planetary sun gear rotates clockwise, the 2nd Brake (B_2) does not stop the front and rear planetary sun gear from rotating clockwise.



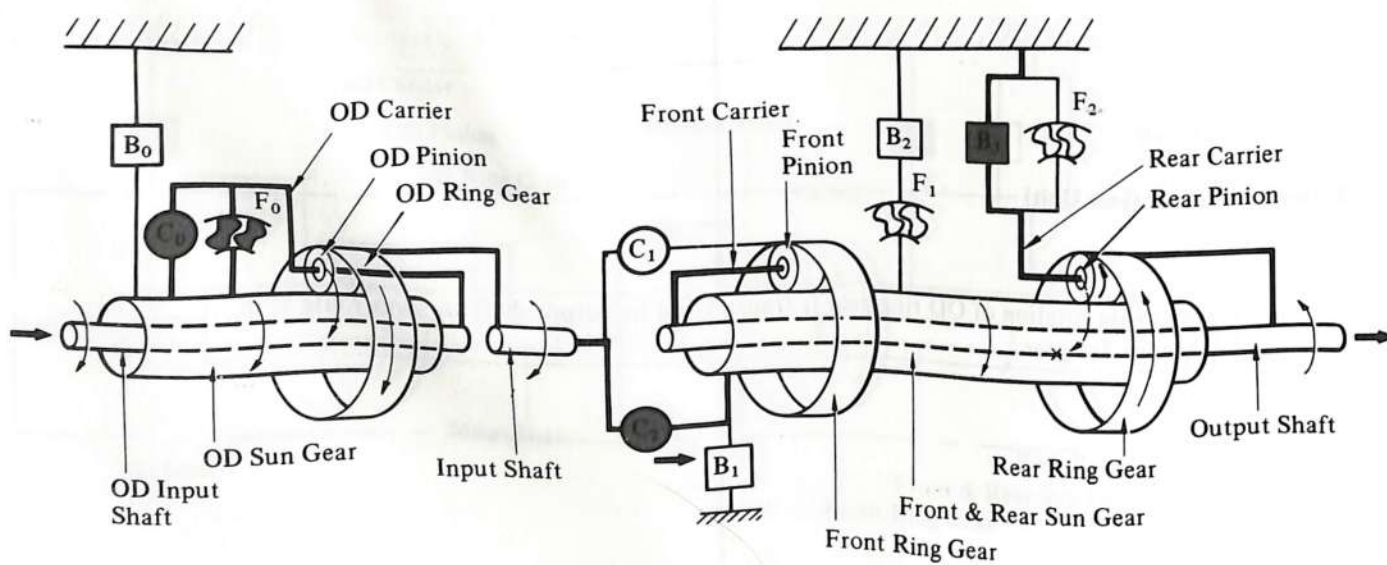
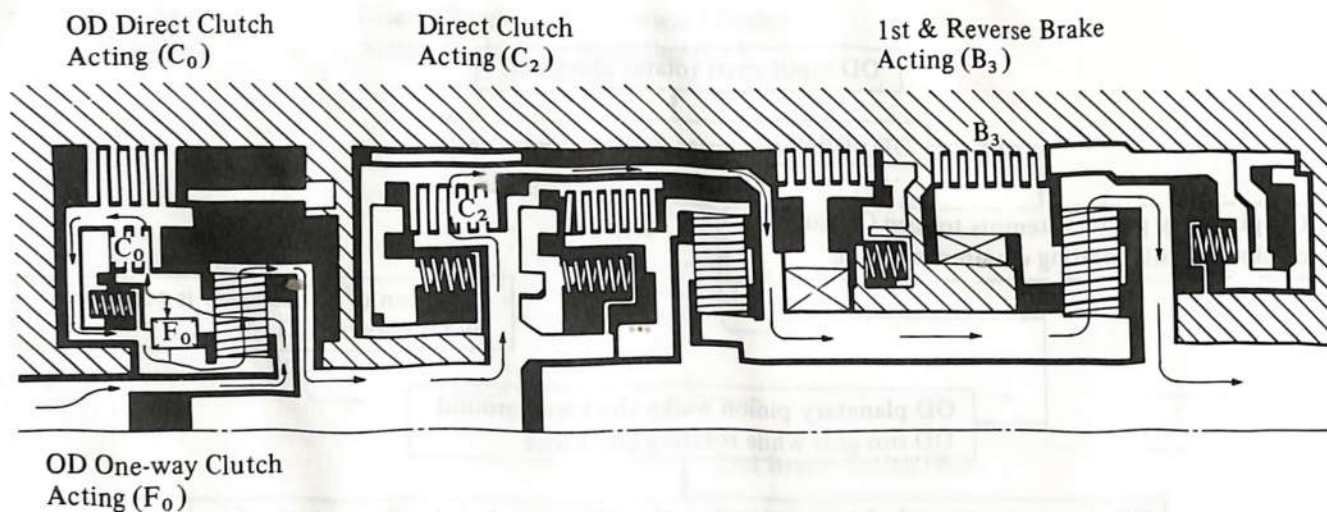
OVERDRIVE (D Range)

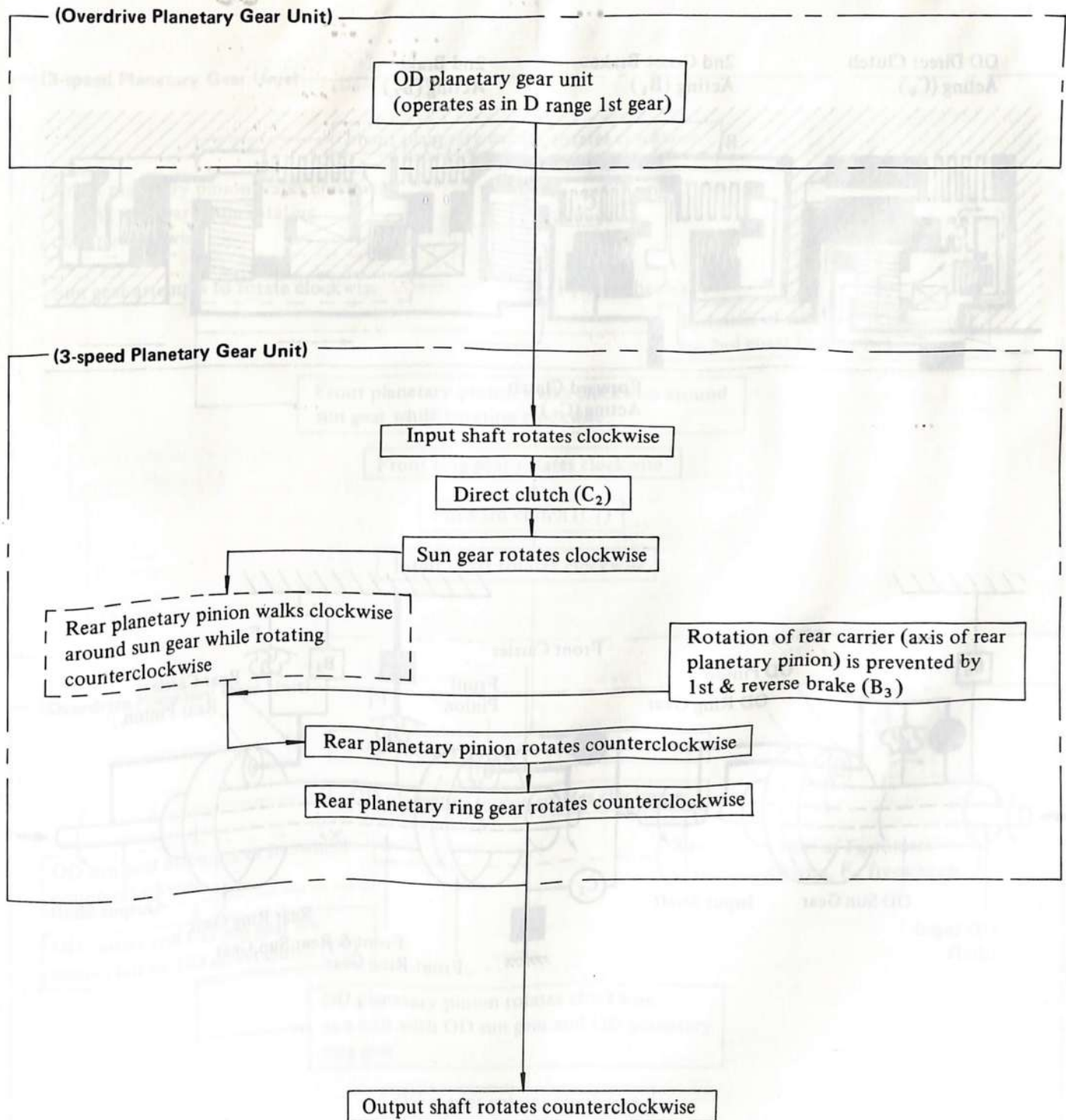


Since the OD sun gear is held stationary by B_0 , the inner race of F_0 does not rotate, but the outer race turns as a unit with the OD carrier. F_0 therefore freewheels when the vehicle is running in overdrive.

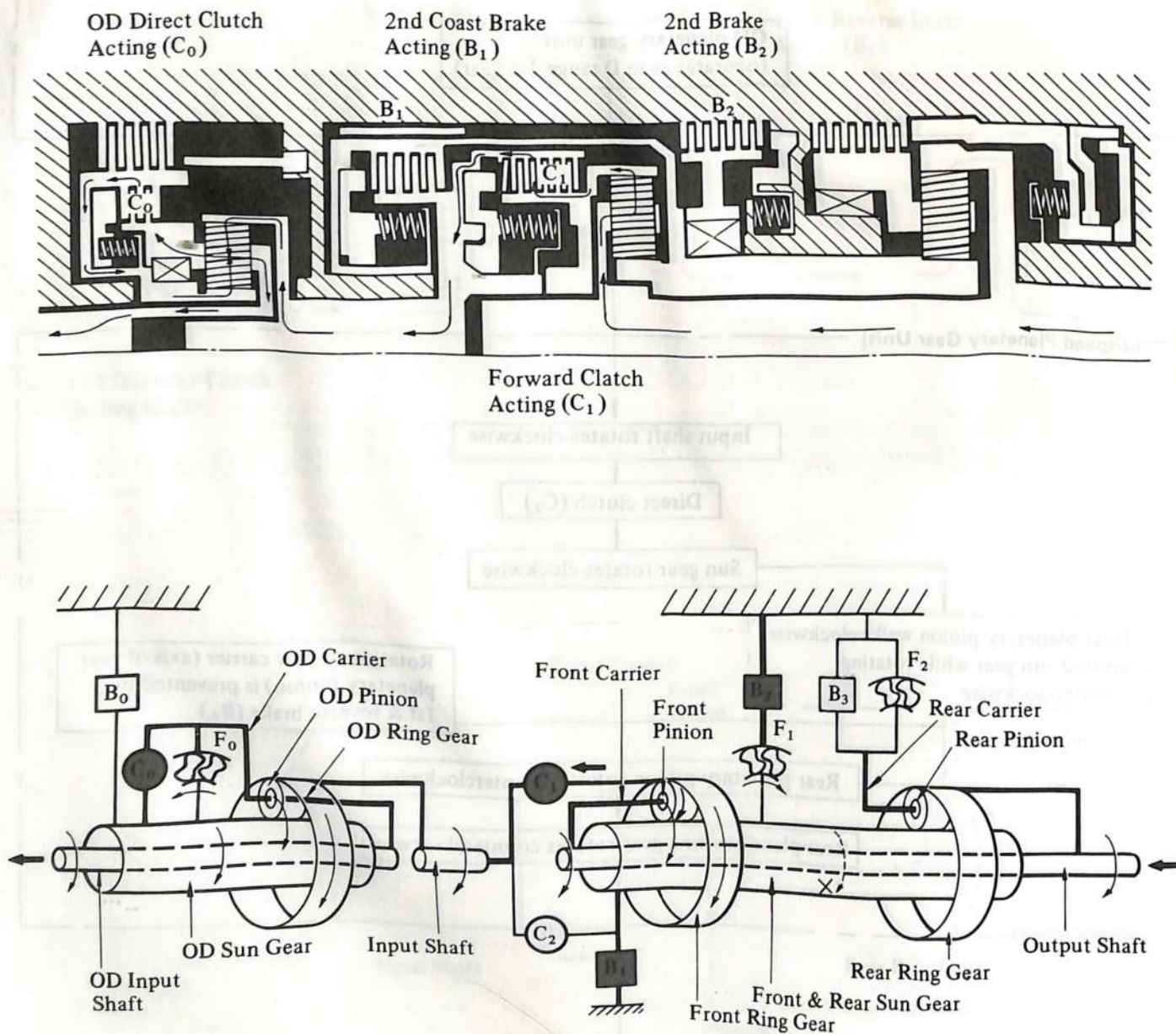


REVERSE GEAR

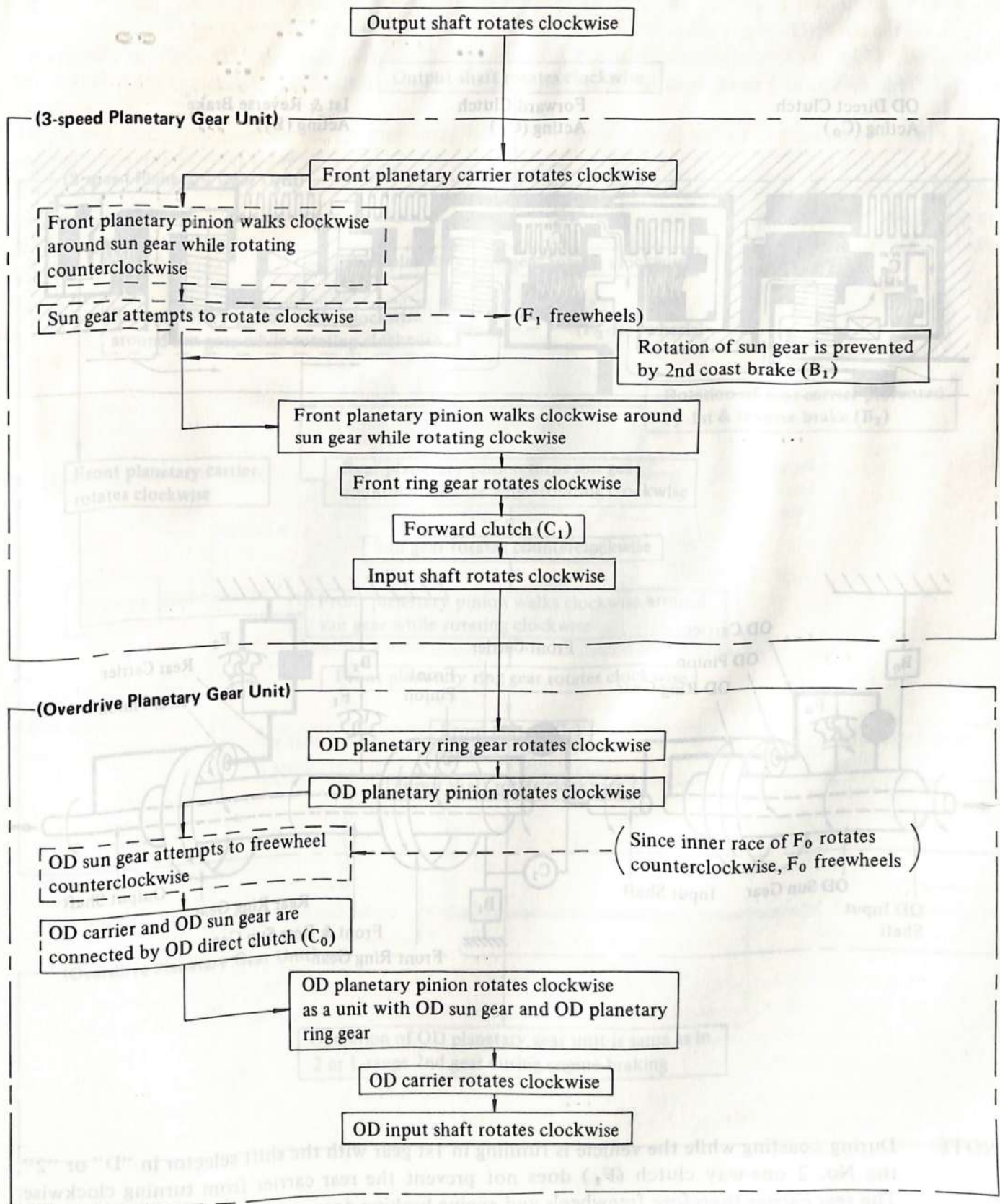




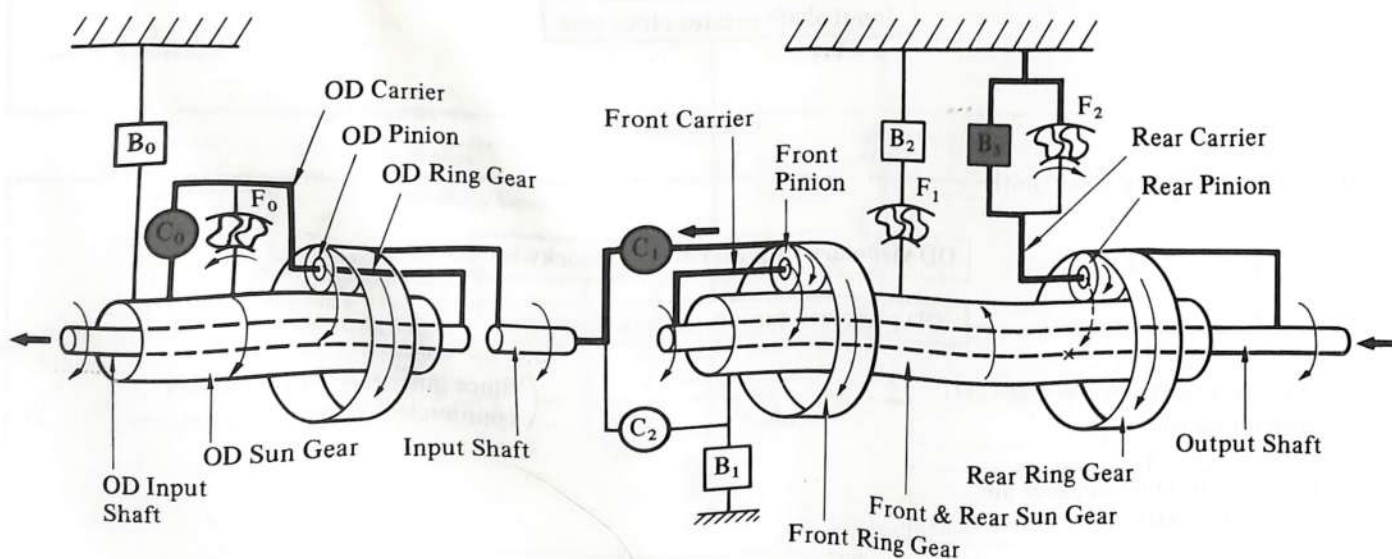
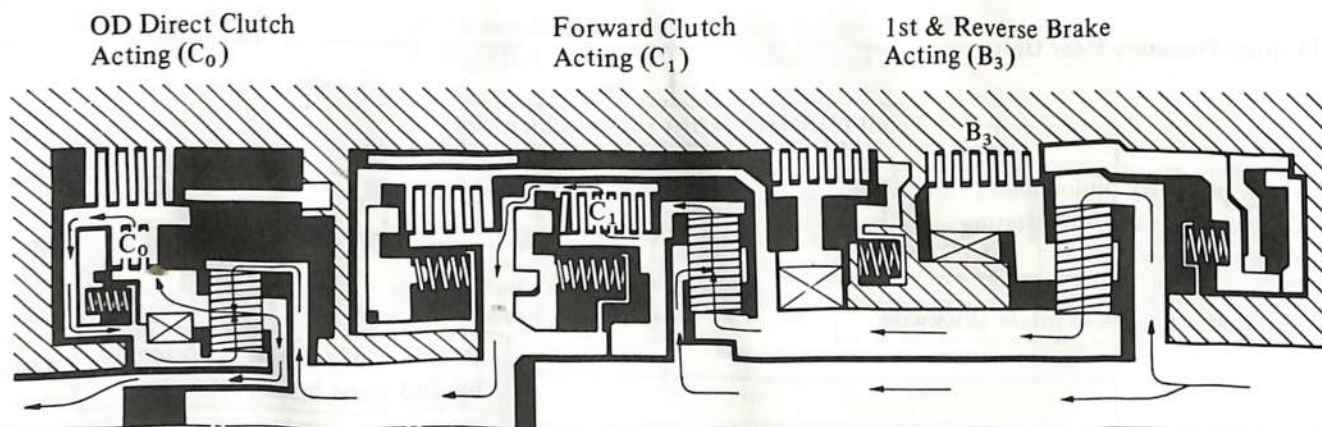
2ND GEAR (2 or L Range), ENGINE BRAKING



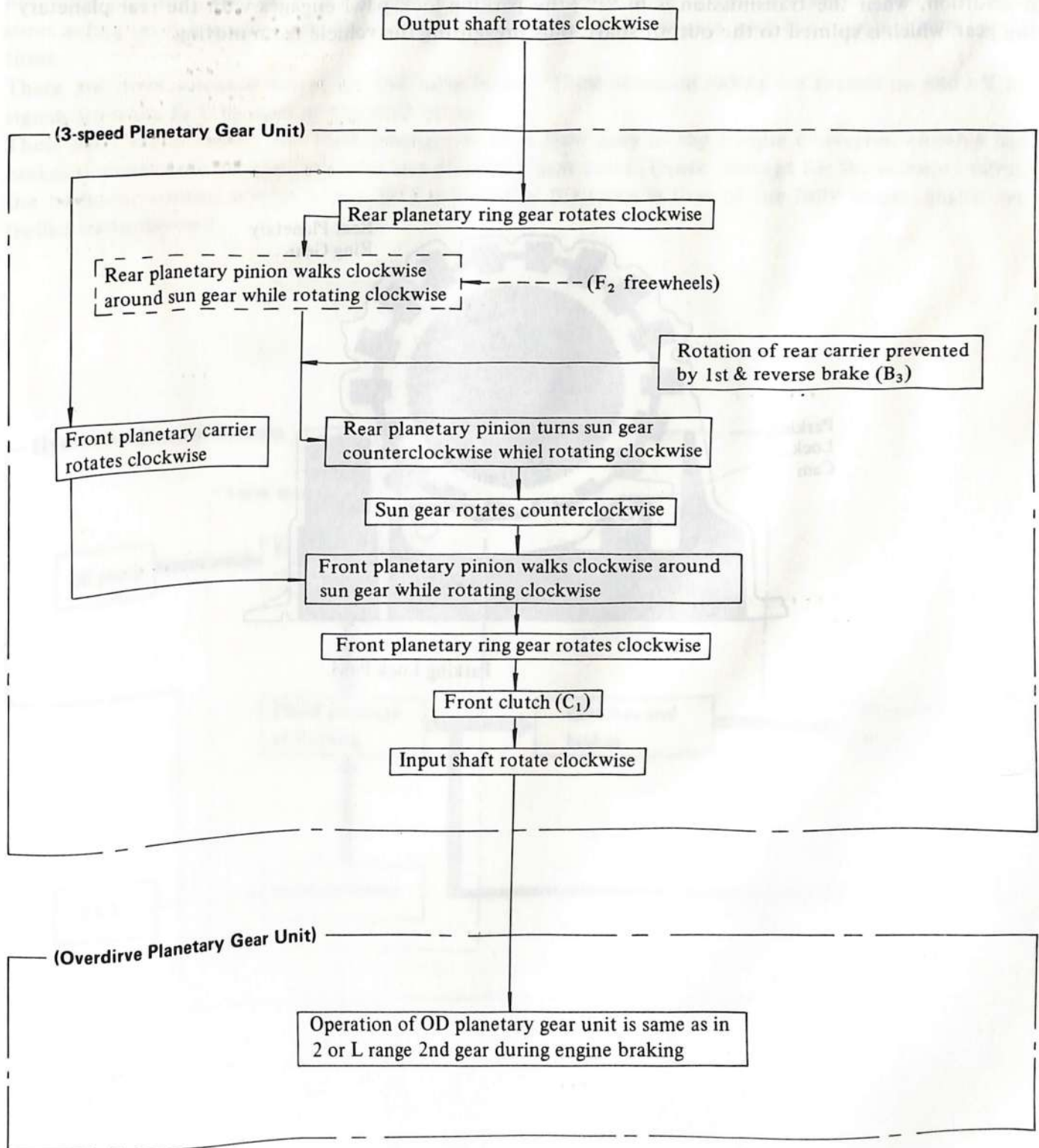
- The operation of the planetary gear sets when the transmission is being driven by the engine is 2 or L range 2nd gear is the same as in D range 2nd gear.
- During coasting while the vehicle is running in 2nd gear with the shift selector in "D", since the No. 1 one-way clutch (F_1) does not prevent the front & rear sun gear from turning clockwise, the sun gear freewheels and engine braking does not occur.



1ST GEAR (L Range), ENGINE BRAKING



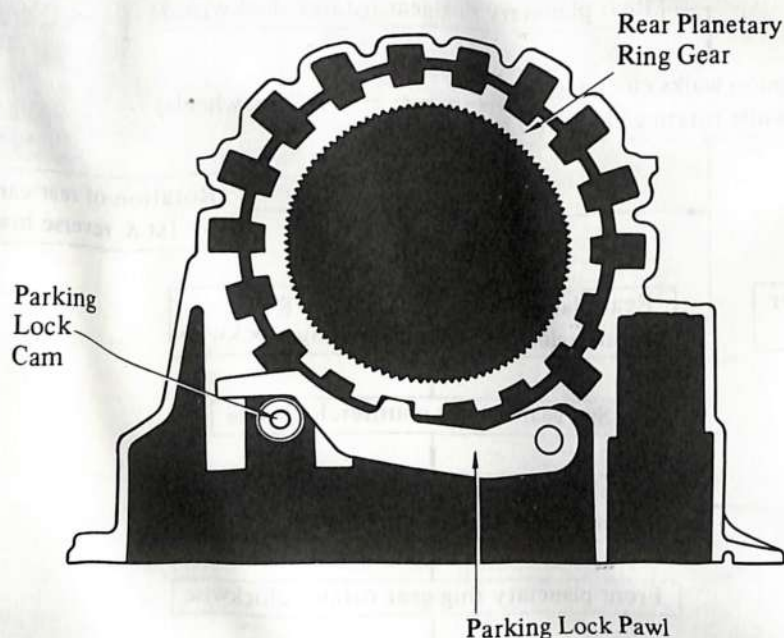
NOTE: During coasting while the vehicle is running in 1st gear with the shift selector in "D" or "2", the No. 2 one-way clutch (F₂) does not prevent the rear carrier from turning clockwise. The rear carrier therefore freewheels and engine braking does not occur.



N AND P RANGES

When the transmission is in “N” or “P”, the forward clutch (C_1) and direct clutch (C_2) do not act, so input from the overdrive input shaft is not transmitted to the output shaft.

In addition, when the transmission is in “P”, the parking lock pawl engages with the rear planetary ring gear, which is splined to the output shaft, thus preventing the vehicle from moving.

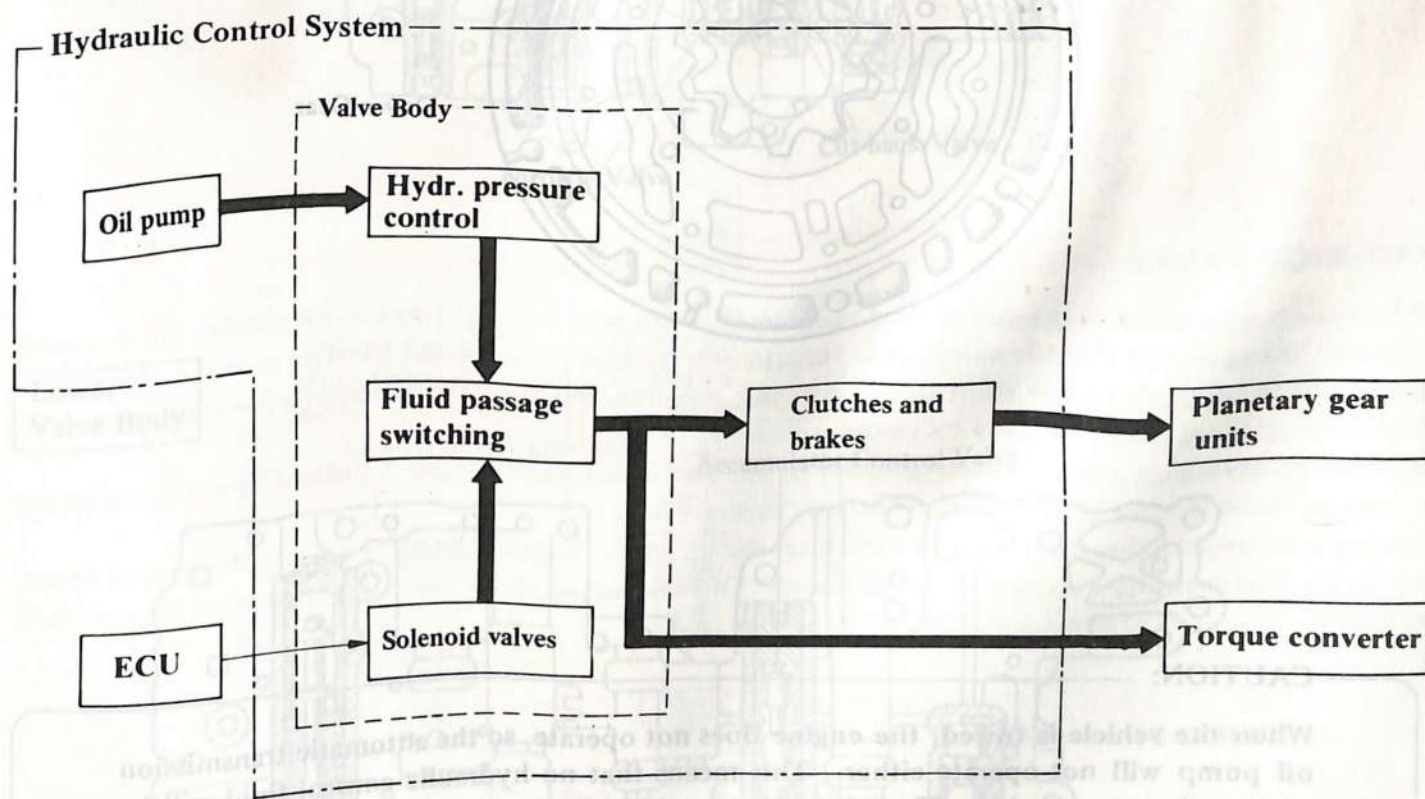


HYDRAULIC CONTROL SYSTEM

The hydraulic control system is composed of the oil pump, the valve body, the solenoid valves, and clutches and brakes, as well as the fluid passages which connect all of these components. Based on the hydraulic pressure created by the oil pump, the hydraulic control system governs the hydraulic pressures acting on the torque converter, clutches and brakes in accordance with the vehicle driving conditions.

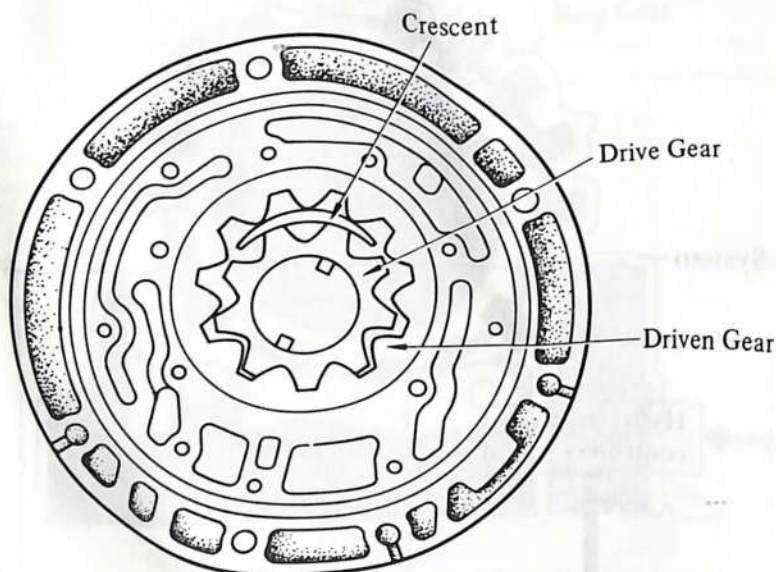
There are three solenoid valves on the valve body. These solenoid valves are turned on and off by signals from the ECU to operate the shift valves.

These shift valves switch the fluid passages so that fluid goes to the torque converter, clutches and brakes to control the torque converter and planetary gear units. (Note: Except for the solenoid valves, the hydraulic control system of the ECT is basically the same as that of the fully hydraulically-controlled transmission.)



1. Oil Pump

The oil pump is designed to send fluid to the torque converter, lubricate the planetary gear unit and supply operating pressure to the hydraulic control system. The drive gear of the oil pump is continually driven by the engine via the torque converter pump impeller. The pump has sufficient capacity to supply the necessary fluid pressure throughout all speed ranges, as well as in reverse.



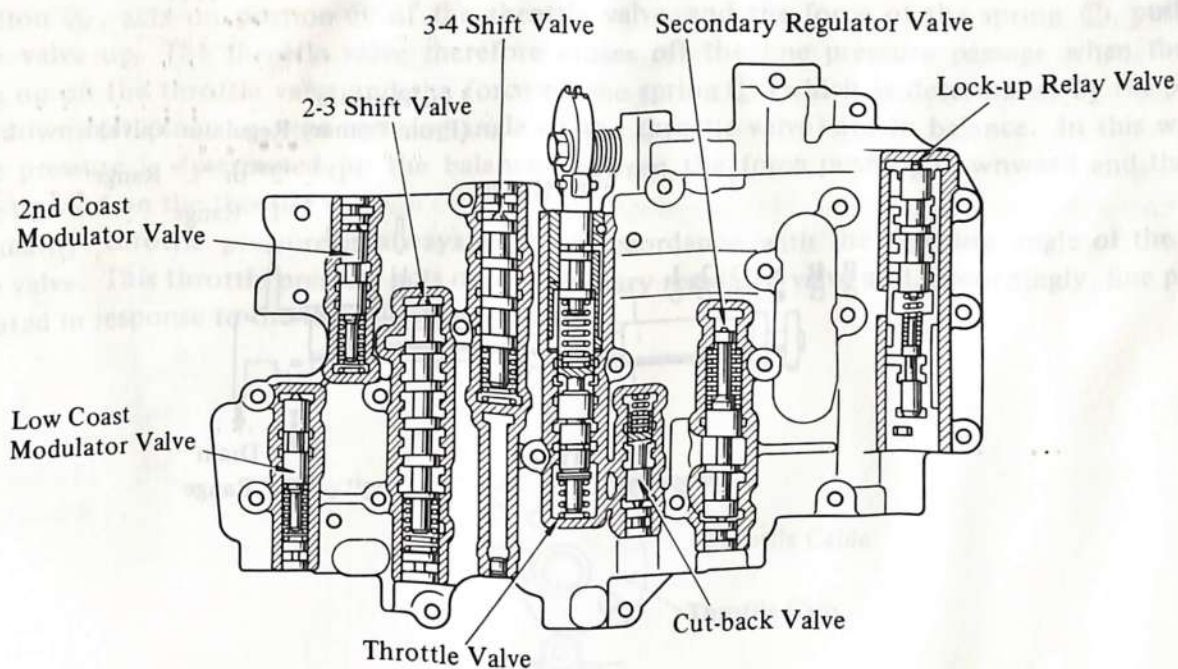
CAUTION:

When the vehicle is towed, the engine does not operate, so the automatic transmission oil pump will not operate either. This means that no hydraulic control fluid will be sent to the transmission. Therefore, if the vehicle is towed at high speeds or for long distances, the protective fluid film coating the various rotating parts of the transmission may disappear and cause the transmission to seize up. For this reason, the vehicle should be towed at a low speed (no more than 30 km/h) and no further than 80 km at one time. Furthermore, if the transmission itself malfunctions or begins leaking fluid badly, the vehicle should be towed with its drive wheels lifted clear of the ground or with the propeller shaft disconnected.

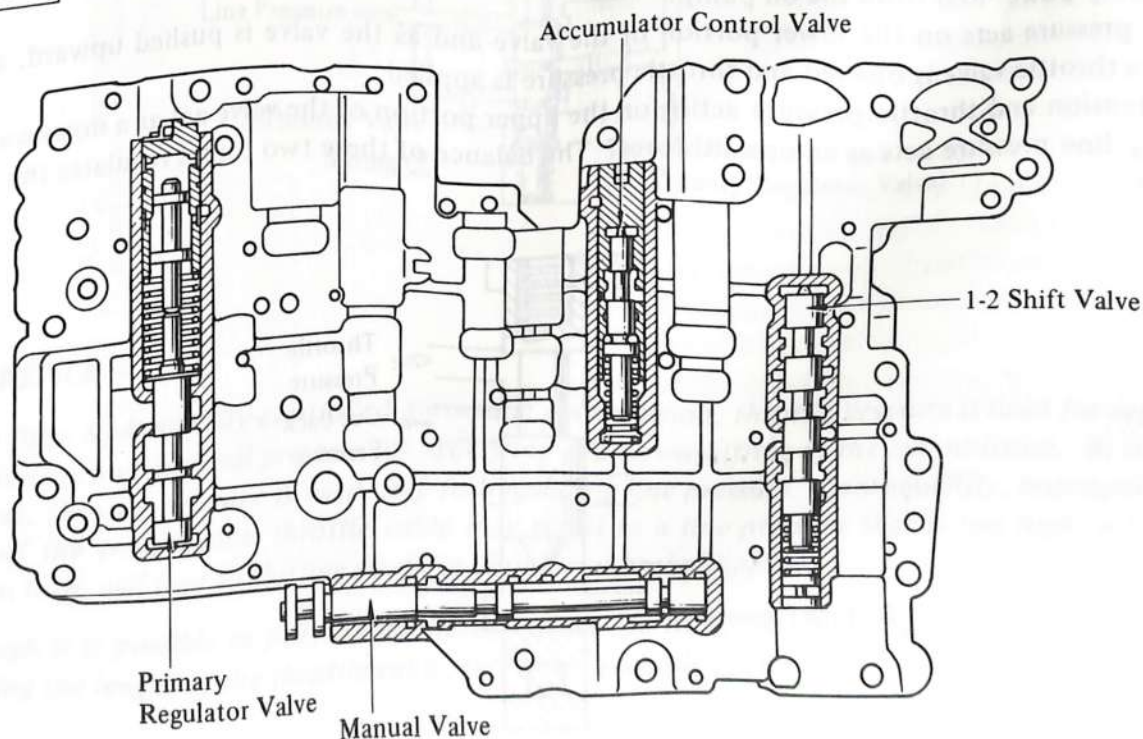
2. Valve Body

The valve body consists of an upper valve body and a lower valve body. The valve contained therein controls fluid pressure and functions to switch fluid from one passage to another.

Upper Valve Body

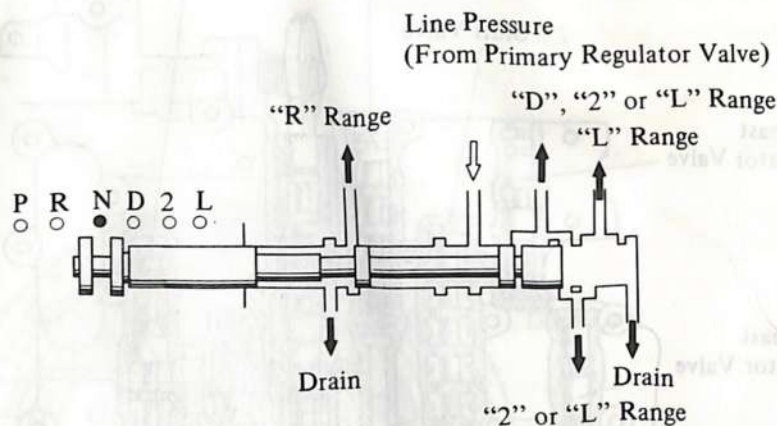


Lower Valve Body



MANUAL VALVE

This valve serves to divert hydraulic fluid from one circuit to another. It is linked to the transmission shift lever and depending upon the lever position diverts the fluid to the "P", "R", "N", "D", "2" or "L" circuit.

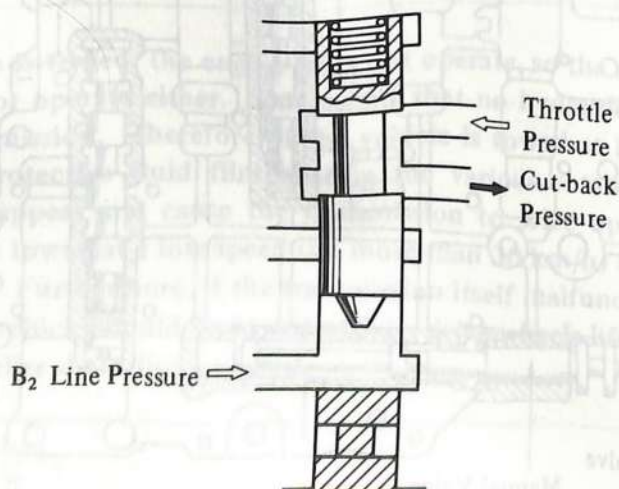


CUT-BACK VALVE

When the transmission is in any forward range and in any gear but 1st, this valve regulates the cut-back pressure acting on the throttle valve. It is actuated by B_2 line pressure and throttle pressure. By applying cut-back pressure to the throttle valve in this manner, the throttle pressure is lowered to prevent unnecessary power loss from the oil pump.

B_2 line pressure acts on the lower portion of the valve and as the valve is pushed upward, a passage from the throttle valve is opened and throttle pressure is applied.

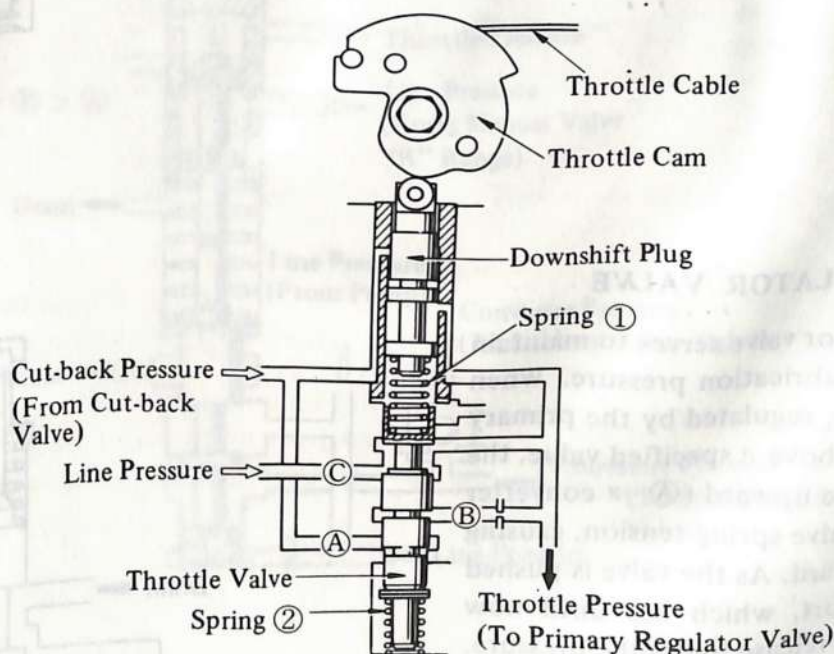
Spring tension and throttle pressure acting on the upper portion of the valve act as a downward force, while B_2 line pressure acts as an upward force. The balance of these two forces regulates the cut-back pressure.



THROTTLE VALVE

The throttle valve acts to produce throttle pressure in response to changes in the throttle opening or engine torque. When the accelerator pedal is depressed, the downshift plug is pushed downward via the transmission throttle cable and throttle cam. This pushes the throttle valve downward by the spring ①, thereby opening the pressure passage ③ for creation of throttle pressure. Meanwhile, this throttle pressure also together with the cut-back pressure from the cut-back valve, which acts on portion ④, acts on portion ⑤ of the throttle valve, and the force of the spring ②, pushes the throttle valve up. The throttle valve therefore closes off the line pressure passage when the force pushing up on the throttle valve and the force of the spring ① (which is determined by the position of the downshift plug, i.e., the opening angle of the throttle valve) are in balance. In this way, the throttle pressure is determined by the balance between the force pushing downward and the force pushing upward on the throttle valve.

Consequently, throttle pressure is always kept in accordance with the opening angle of the engine throttle valve. This throttle pressure acts on the primary regulator valve and, accordingly, line pressure is regulated in response to the throttle valve opening.

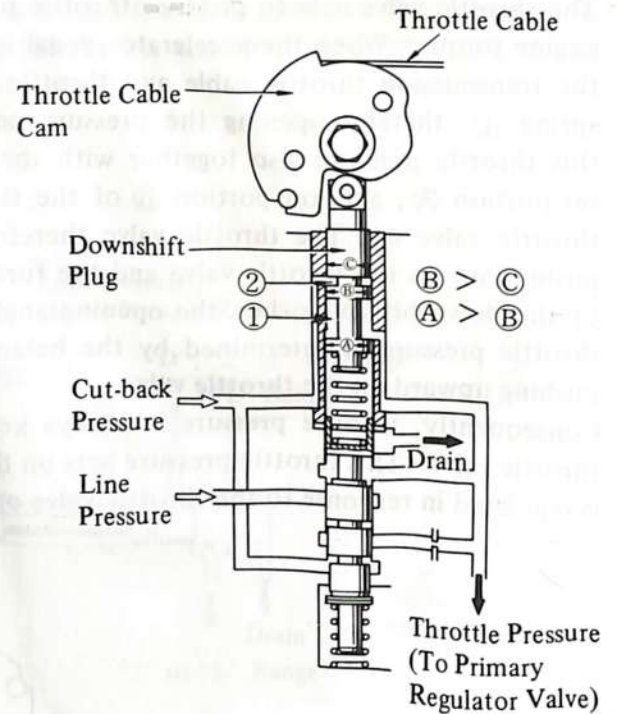


– REFERENCE –

- In the fully hydraulically-controlled automatic transmission, throttle pressure is used for regulating line pressure and as signal pressure for upshifting and downshifting of the transmission. In the ECT, however, throttle pressure is used only for regulating line pressure. Consequently, improper adjustment of the transmission throttle cable may result in a line pressure that is too high or too low. This, in turn, will lead to shifting shock or clutch and brake slippage.
- Although it is possible in fully hydraulically controlled transmissions to adjust the shift points by adjusting the length of the throttle cable, this is not possible in the ECT.

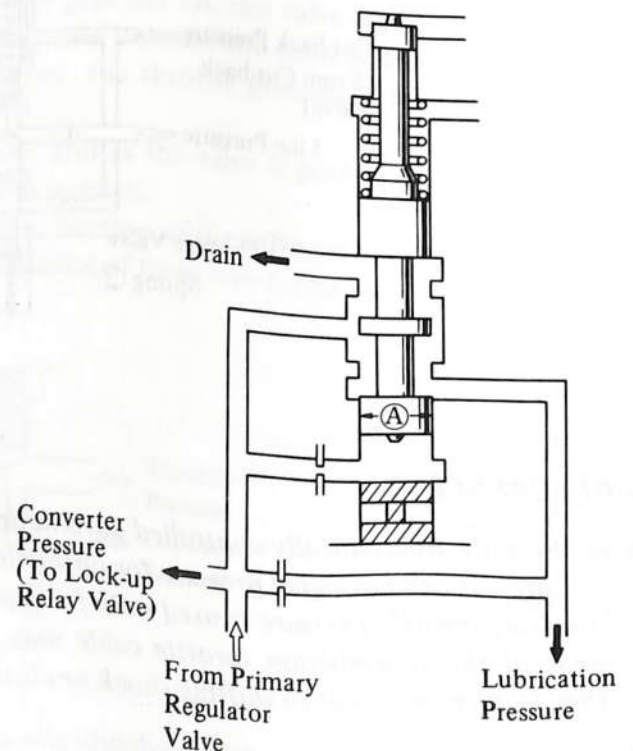
DOWNSHIFT PLUG

Throttle pressure acts on portion ① of the downshift plug, which is pushed downward by the force of $(A - B \times \text{throttle pressure})$ in order to lower the contact pressure on the throttle cam and downshift plug. If the opening angle of the throttle valve is small, cut-back pressure also acts on portion ② to further lower contact pressure and reduce the amount of force of the accelerator pedal. However, cut-back pressure does not act on the downshift plug if the transmission is in the "R" range or 1st gear.



SECONDARY REGULATOR VALVE

The secondary regulator valve serves to maintain stable converter and lubrication pressure. When the hydraulic pressure, regulated by the primary regulator valve, rises above a specified value, the force pushing the valve upward ($A \times \text{converter pressure}$) overcomes valve spring tension, causing the valve to move upward. As the valve is pushed upward, the drain port, which has until now been closed, opens to release hydraulic pressure. When this happens, spring tension now forces the valve back downward, again closing the drain port. It is by repetition of the foregoing operation that the secondary regulator valve maintains a stable converter pressure and lubrication pressure.



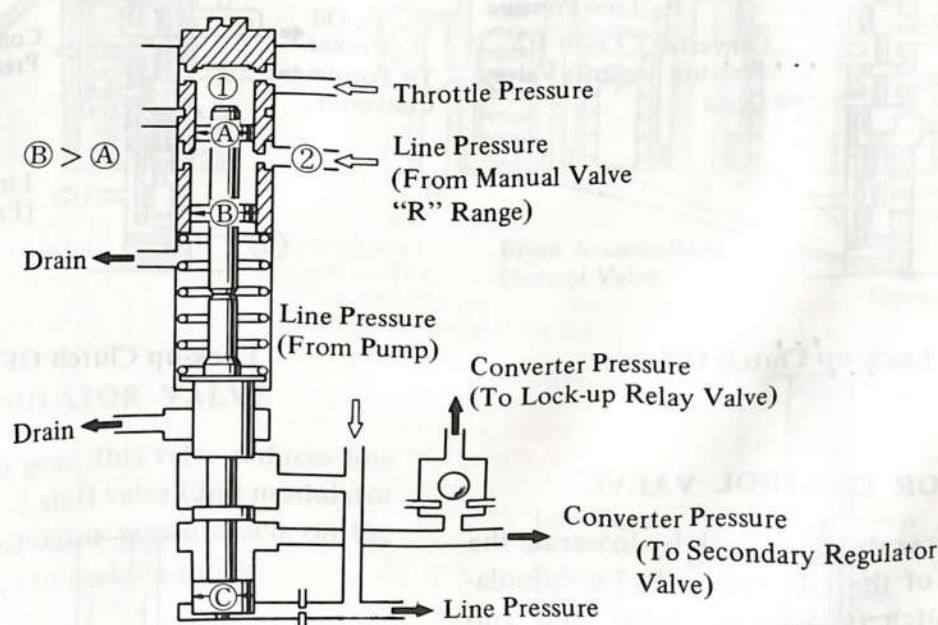
PRIMARY REGULATOR VALVE

The primary regulator valve uses throttle pressure to change the hydraulic pressure created by the oil pump into line pressure in accordance with the engine load. In other words, when there is a heavy load on the engine (throttle valve opening is large or throttle pressure is high), the primary regulator valve raises the line pressure to increase positive engagement of the clutches and brakes. On the other hand, when there is less of a load on the engine (small throttle valve opening or low throttle pressure), the line pressure is lowered to reduce shift shock and engine power loss.

In the upper portion of the primary regulator valve, spring tension and hydraulic pressure ($A \times$ throttle pressure) which acts on portion ①, function as a downward force.

In the lower portion, ($C \times$ line pressure) acts as an upward force. Line pressure is regulated by the balance of these two forces.

When the vehicle is running in reverse, line pressure from the manual valve acts on portion ②, and force $\{ (B - A) \times \text{line pressure} \}$ combines with force ($A \times$ throttle pressure) to push the valve downward. This creates a line pressure that is higher than that occurring in other ranges.



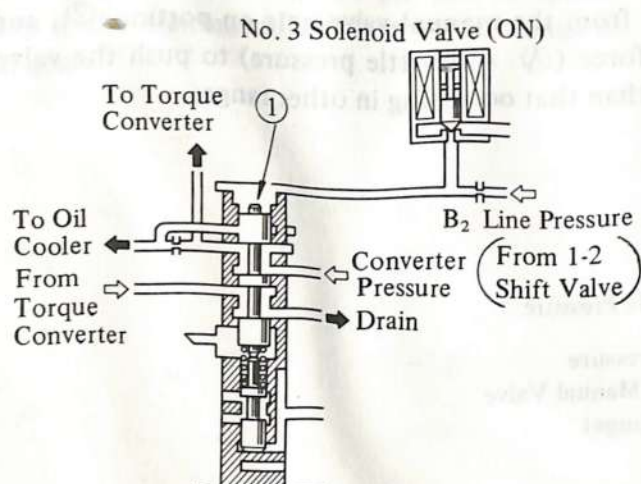
– REFERENCE –

LINE PRESSURE

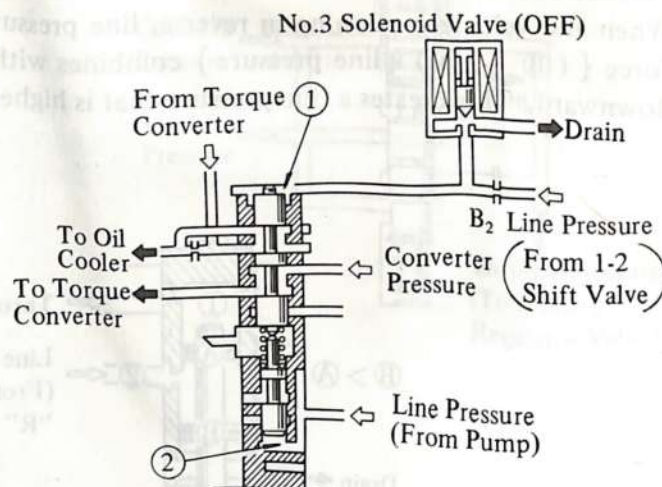
Line pressure is the most basic and important pressure used in the automatic transmission, because it is used to operate all of the clutches and brakes in the transmission. If the primary regulator valve does not operate correctly, line pressure will be either too high or too low. Line pressure that is too high will lead to shifting shock and consequent engine power loss due to the greater effort required of the oil pump; line pressure that is too low will cause slippage of clutches and brakes, which will, in extreme cases, prevent the vehicle from moving. Therefore, if either of these problems are noticed, the line pressure should be measured to see if it is within standard.

LOCK-UP RELAY VALVE

In accordance with a fluid pressure signal (B_2 line pressure) from No. 3 solenoid valve the lock-up relay valve reverses the fluid flow to the converter (lock-up clutch). When No. 3 solenoid valve comes on, B_2 line pressure from the 1-2 shift valve acts on portion ① of the lock-up relay valve, forcing it downward to engage the lock-up clutch. When No. 3 solenoid valve goes off, B_2 line pressure acting on portion ① of the valve is released. Therefore the lock-up relay valve is pushed upward by line pressure acting on portion ② and the force of the spring to disengage the lock-up clutch.



Lock-up Clutch ON



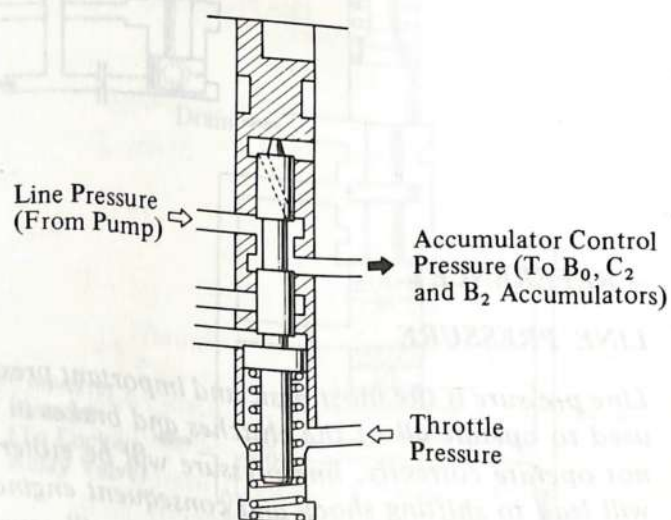
Lock-up Clutch OFF

ACCUMULATOR CONTROL VALVE

This valve reduces shifting shock by lowering the back pressure of the OD brake (B_0) accumulator, direct clutch (C_2) accumulator, and 2nd brake (B_2) accumulator when the throttle opening angle is small.

Since the torque produced by the engine is small if the throttle opening angle is small, accumulator back-pressure, and therefore the initial pressure used to operate the clutches and brakes, are both reduced, preventing the shock that would ordinarily occur when the brakes and clutches are connected.

Conversely, since the torque produced by the engine is large if the throttle angle is large, accumulator back-pressure is increased, thus preventing slippage from occurring when the clutches and brakes are engaged.



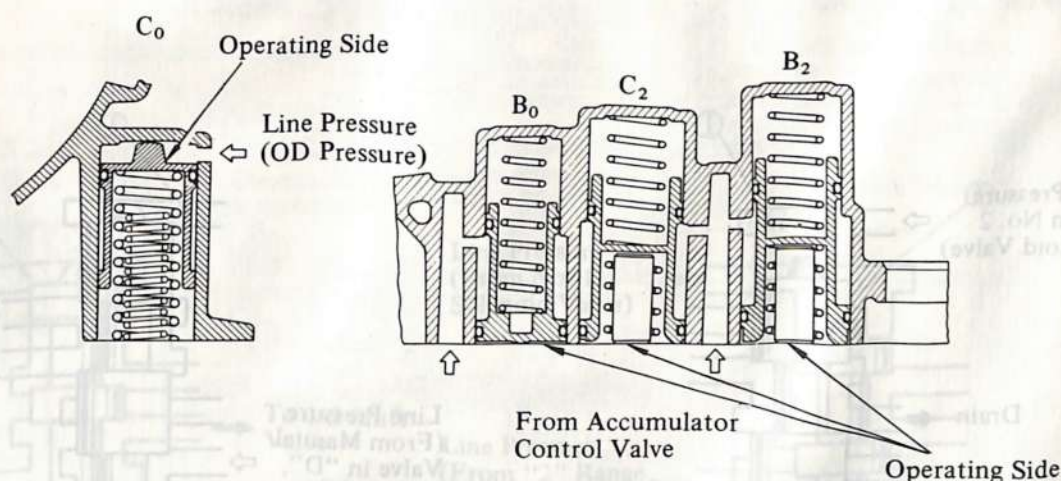
ACCUMULATORS

The accumulators act to cushion shifting shock. The A340E has four accumulators: one each for the OD direct clutch (C_0), OD brake (B_0), direct clutch (C_2) and 2nd brake (B_2).

Accumulator control pressure is always acting on the back pressure side of the B_0 , C_2 and B_2 accumulator pistons, and this pressure, along with spring tension, pushes down the pistons. This makes the movements of the accumulator pistons (caused by accumulator control pressure being made to act on the back-pressure chambers of the accumulators) the most suitable for the throttle opening angle (engine torque).

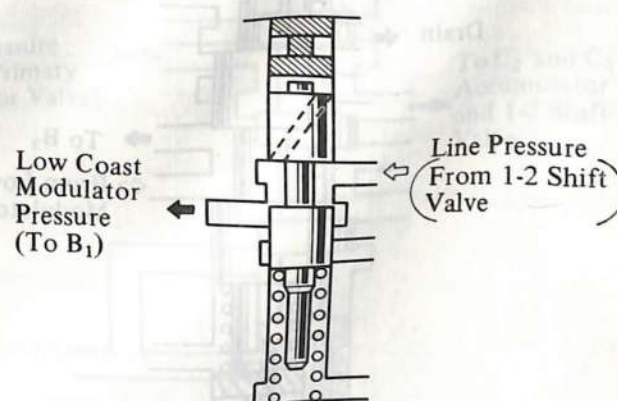
When line pressure is applied to the working chamber, the piston is pushed slowly upward and shock is buffered as the fluid pressure used to operate the clutches and brakes gradually rises.

Operation of the C_0 piston is basically the same as that for B_0 , C_2 and B_2 . However, the force pushing the pistons downward is spring tension only.



2ND COAST MODULATOR VALVE

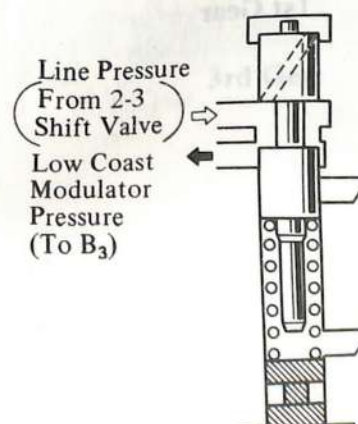
In the 2 range 2nd gear, this valve reduces line pressure from the 1-2 shift valve (2nd modulator pressure). 2nd modulator pressure acts on the 2nd coast brake (B_1) to cushion shock.



LOW COAST MODULATOR VALVE

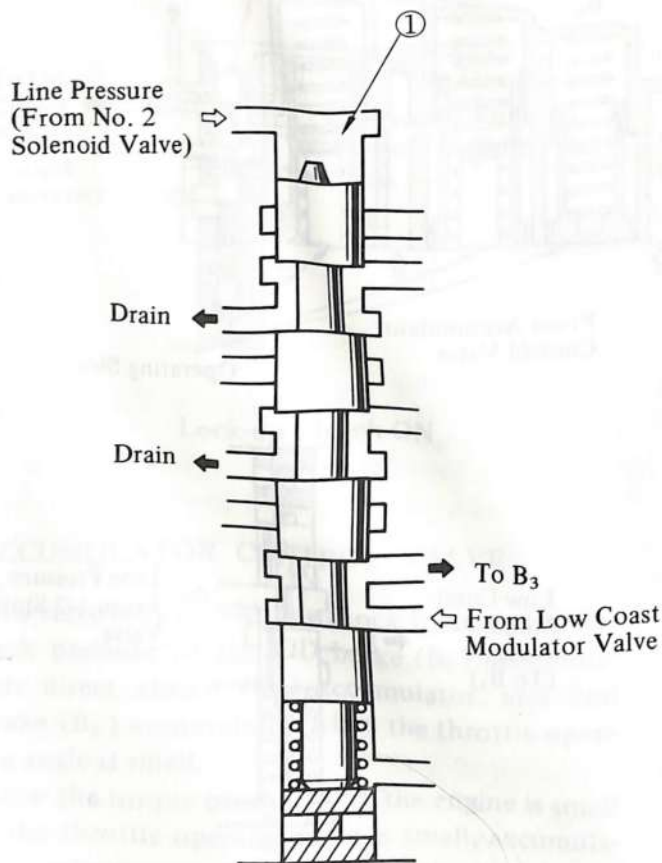
In the L range, the low coast modulator valve reduces line pressure from the 2-3 shift valve (low modulator pressure).

Low coast modulator pressure acts on the 1st & reverse brake (B_3) via the 1-2 shift valve to cushion shock.

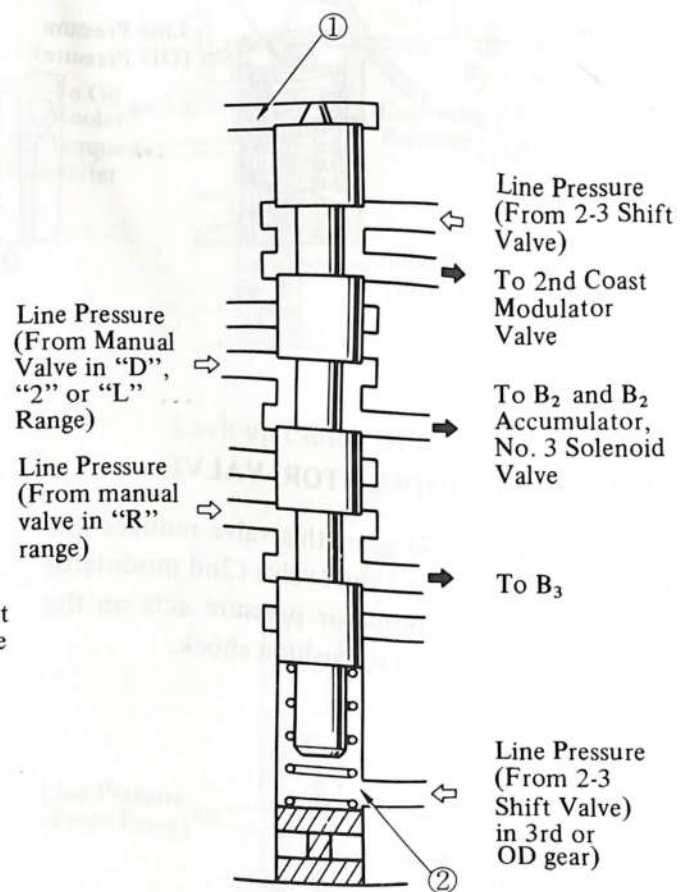


1-2 SHIFT VALVE

The 1-2 shift valve provides shifting between 1st and 2nd gears. When the ECU turns off No. 2 solenoid valve, line pressure will act on portion ① of the 1-2 shift valve, forcing it downward and shifting the transmission into 1st gear. When the ECU turns on No. 2 solenoid valve, the line pressure which has been acting on portion ① of the valve is released through the No. 2 solenoid valve drain port. Consequently, spring tension now forces the 1-2 shift valve back upward, shifting the transmission into 2nd gear. When the transmission is in overdrive, No. 2 solenoid valve is off, as when in 1st gear, and the line pressure is acting on portion ① of the valve. However, as line pressure from the 2-3 shift valve is acting on portion ② of the 1-2 shift valve, it remains pushed upward by spring tension.



1st Gear



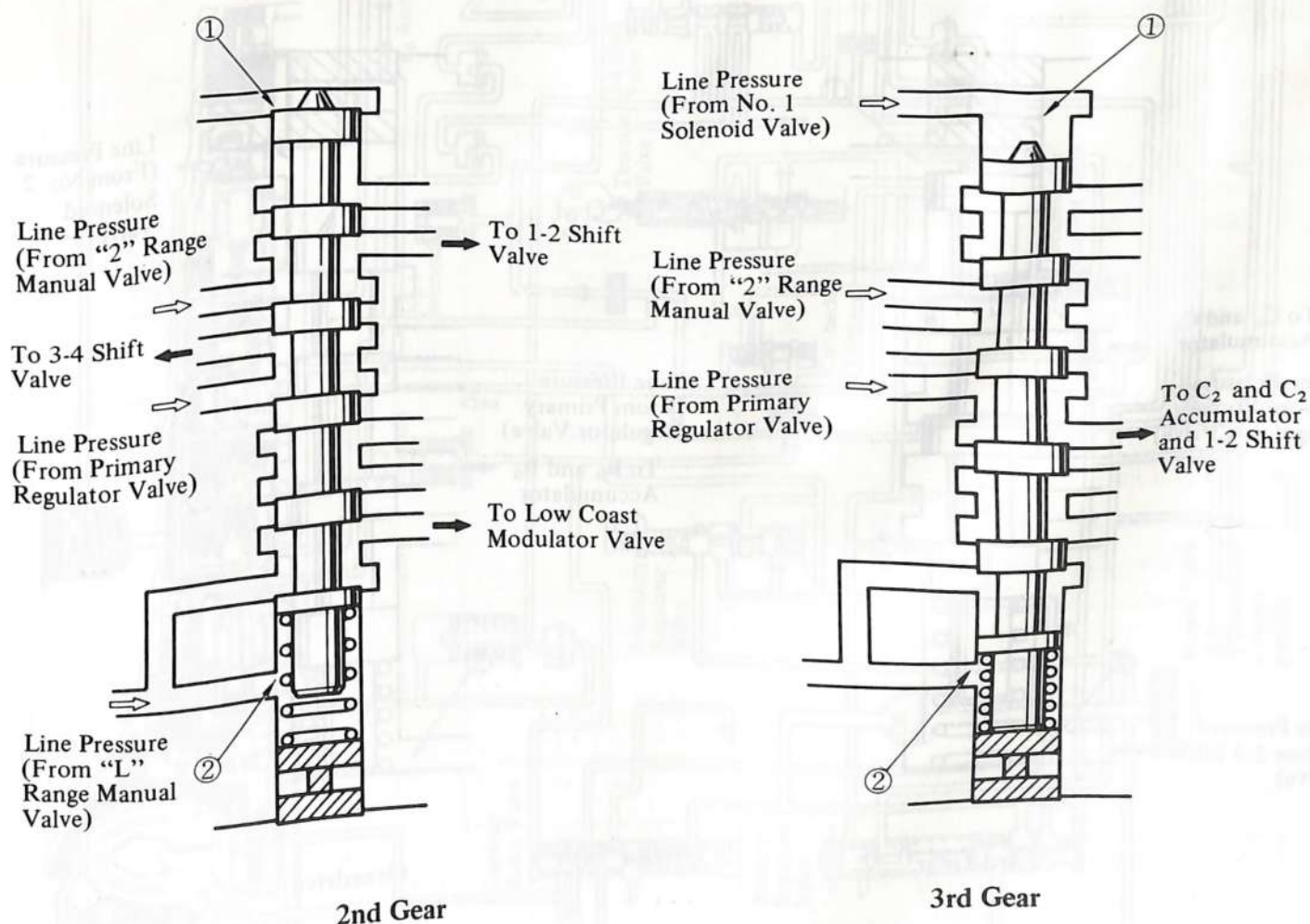
2nd Gear

2-3 SHIFT VALVE

The 2-3 shift valve provides shifting between 2nd and 3rd gears. When the ECU turns on No. 1 solenoid valve, the line pressure acting on portion ① of the 2-3 shift valve is released through the No. 1 solenoid valve drain port. Therefore, the 2-3 shift valve is forced upward by spring tension and the transmission is shifted into 2nd gear.

When the ECU turns off No. 1 solenoid valve, line pressure acts on portion ① of the valve, forcing it downward and shifting the transmission into 3rd gear.

When the transmission is in "L" range, however line pressure from the manual valve is acting on portion ② of the 2-3 shift valve, so it remains in an upward position and the transmission will not shift into 3rd gear.

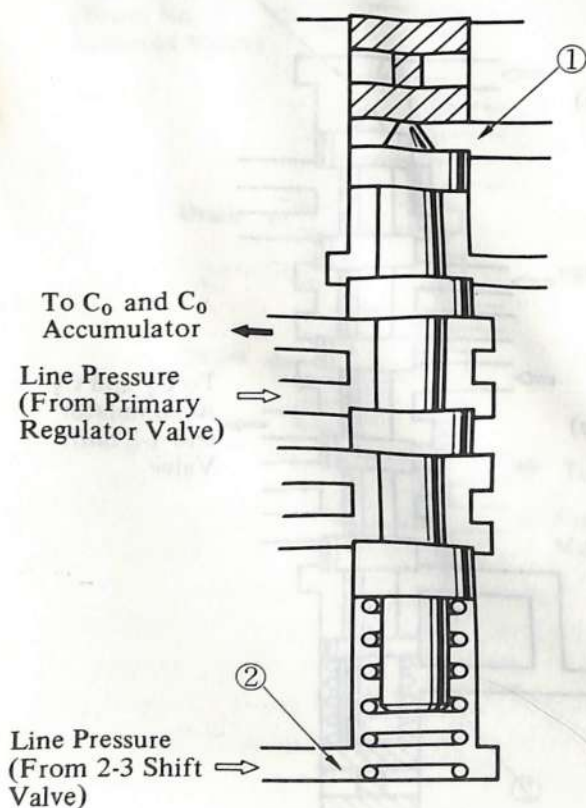


3-4 SHIFT VALVE

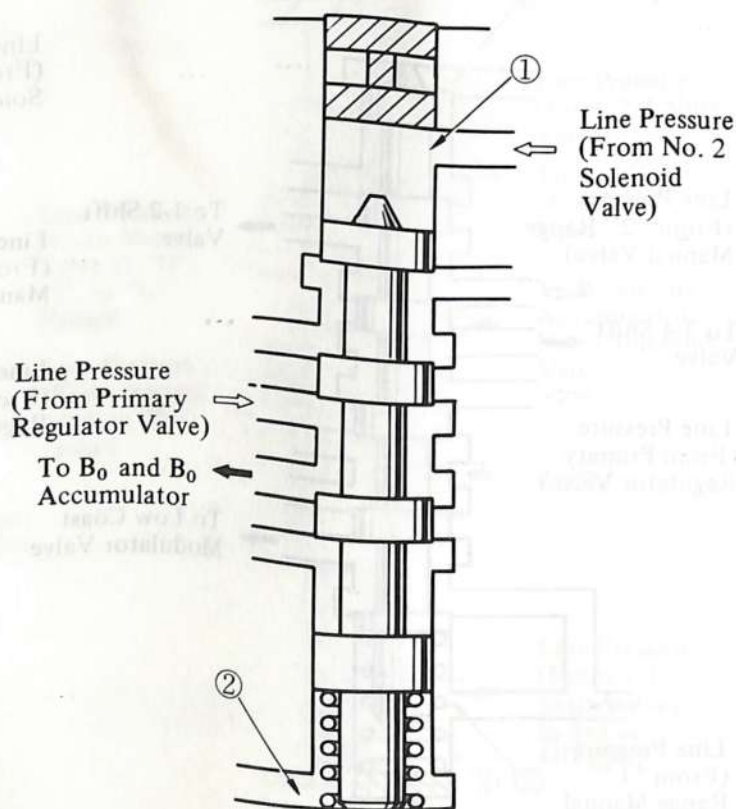
The 3-4 shift valve provides shifting between 3rd and OD gears. When the ECU turns on No. 2 solenoid valve, the line pressure acting on portion ① of the 3-4 shift valve is released through the No. 2 solenoid valve drain port. Therefore, the 3-4 shift valve is forced upward by spring tension and the transmission is shifted into 3rd gear.

When the ECU turns off No. 2 solenoid valve, line pressure acts on portion ① of the valve, forcing it downward and shifting the transmission into overdrive.

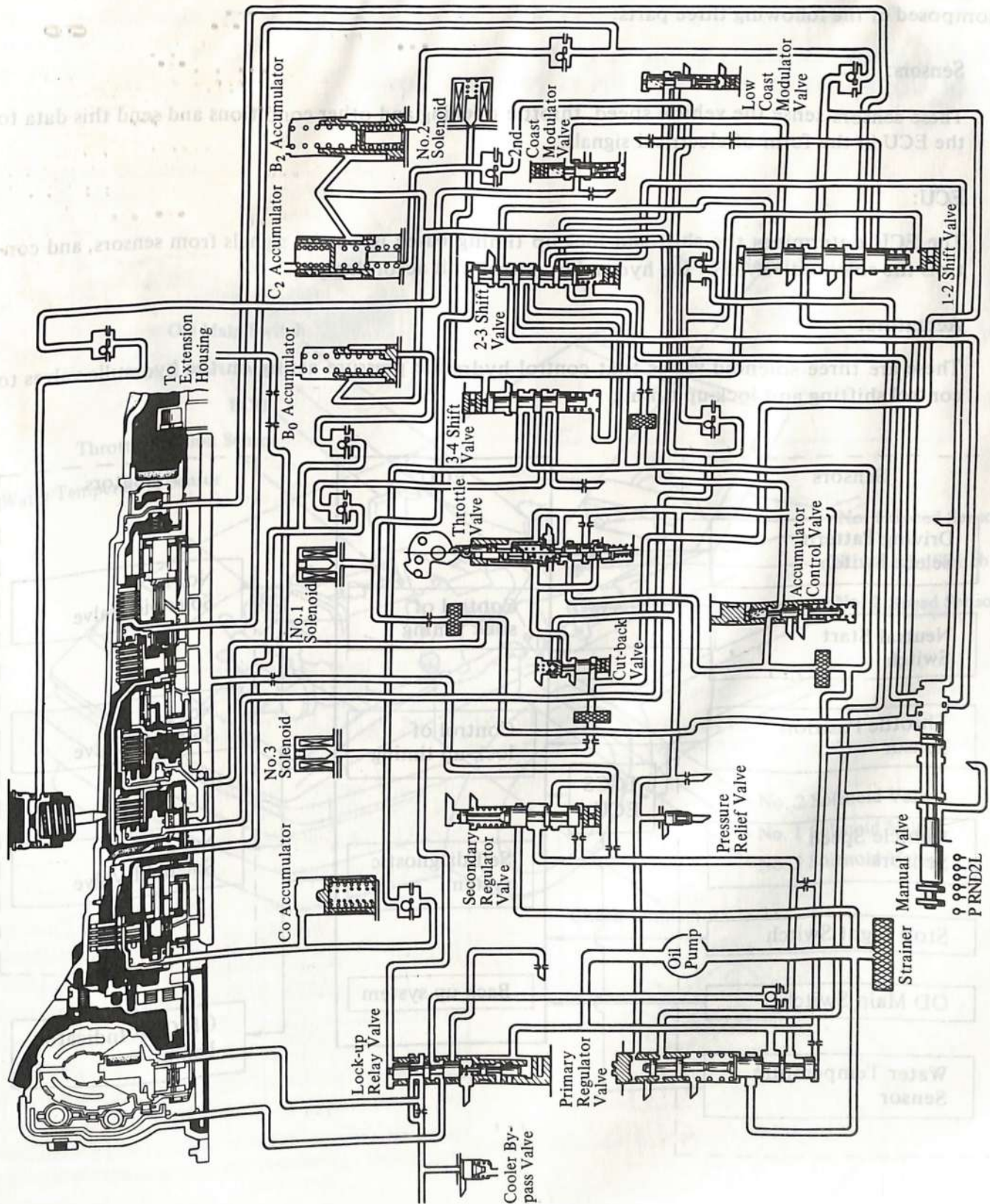
However when the transmission is in any gear of the “2” or “L” ranges or in 1st or 2nd gear of the “D” range, line pressure from the 2-3 shift valve is always applied to portion ② of the 3-4 shift valve, so it remains in an upward position and the transmission will not upshift to overdrive.



3rd Gear



Overdrive



ELECTRONIC CONTROL SYSTEM

The electronic control system for controlling the shift timing and the operation of the lock-up clutch is composed of the following three parts:

1. **Sensors:**

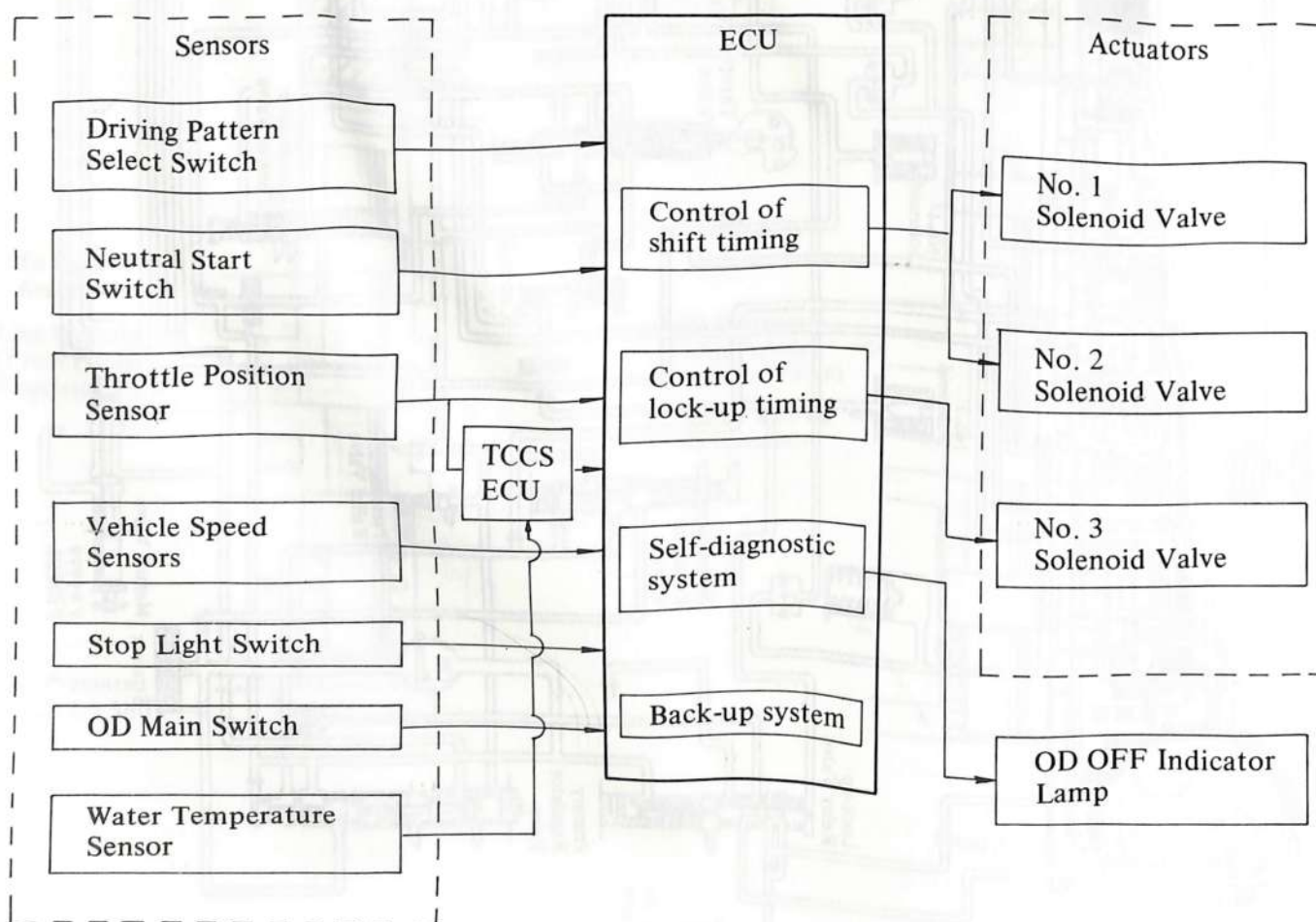
These sensors sense the vehicle speed, throttle opening and other conditions and send this data to the ECU in the form of electrical signals.

2. **ECU:**

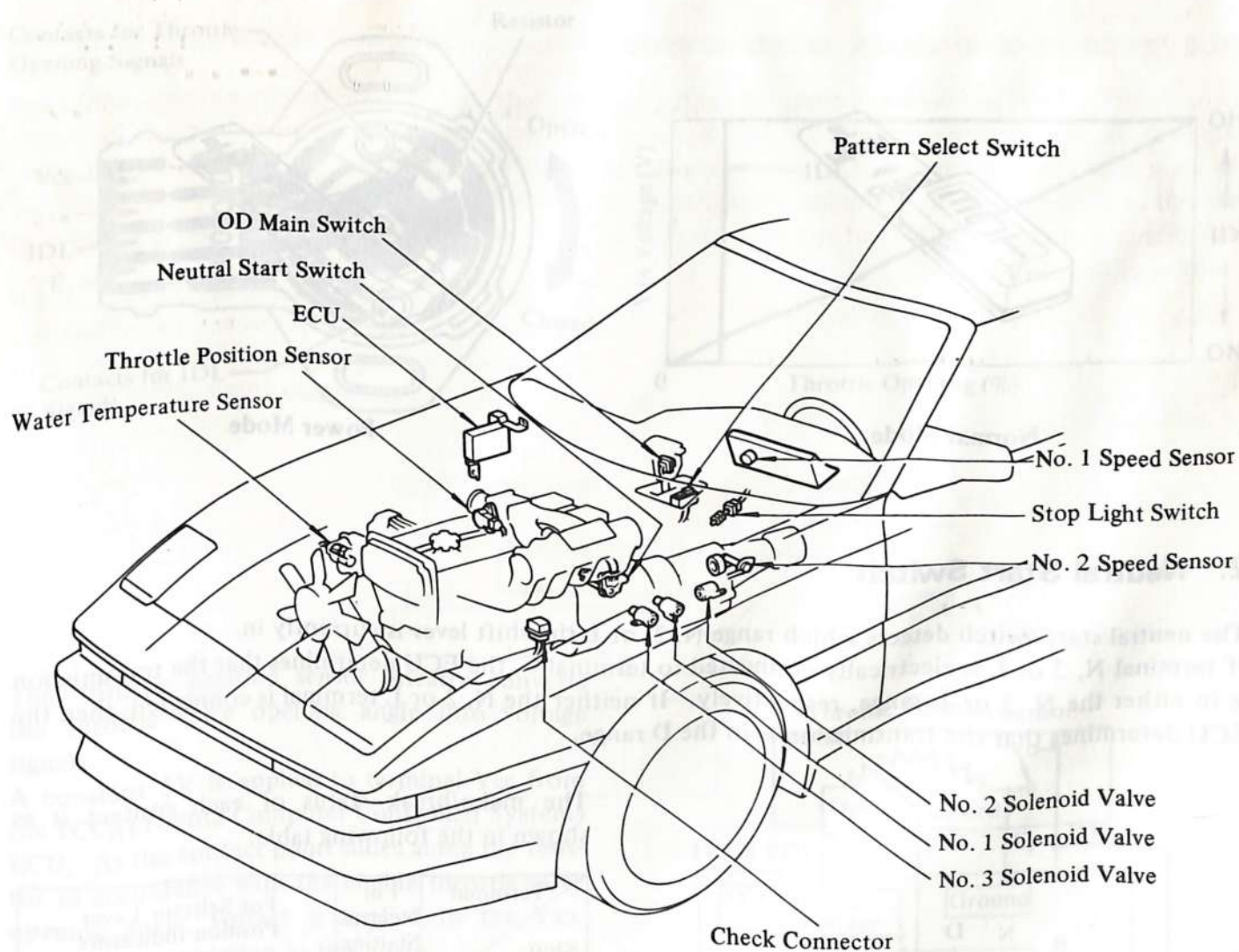
The ECU determines the shift and lock-up timing based upon the signals from sensors, and controls the solenoid valves of the hydraulic control unit accordingly.

3. **Actuators:**

These are three solenoid valves that control hydraulic pressure acting on the hydraulic valves to control shifting and lock-up timing.



Layout of System Components

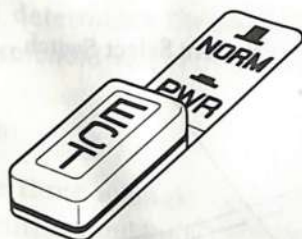


1. Driving Pattern Select Switch

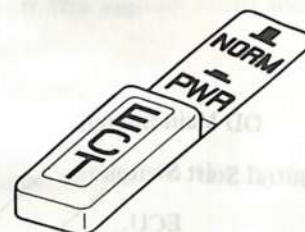
Two shift schedules are programmed into the ECU, the POWER and NORMAL modes. The mode used by the ECU is determined by the setting of the driving pattern select switch.

NORMAL MODE – WHEN THE BUTTON IS UP.

POWER MODE – WHEN THE BUTTON IS PRESSED DOWN.



Normal Mode

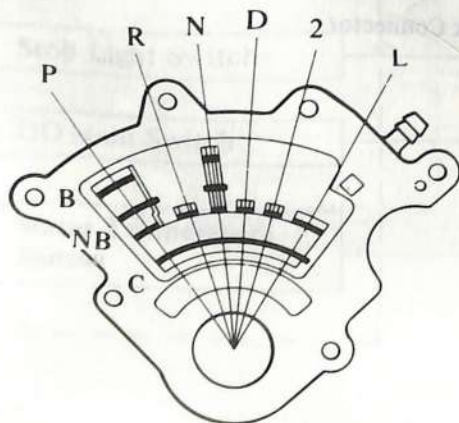


Power Mode

2. Neutral Start Switch

The neutral start switch detects which range N, 2, or L the shift lever is currently in.

If terminal N, 2 or L is electrically connected to terminal C, the ECU determines that the transmission is in either the N, 2 or L range, respectively. If neither the N, 2 or L terminal is connected, then the ECU determines that the transmission is in the D range.



The make/break status of each contact is as shown in the following table:

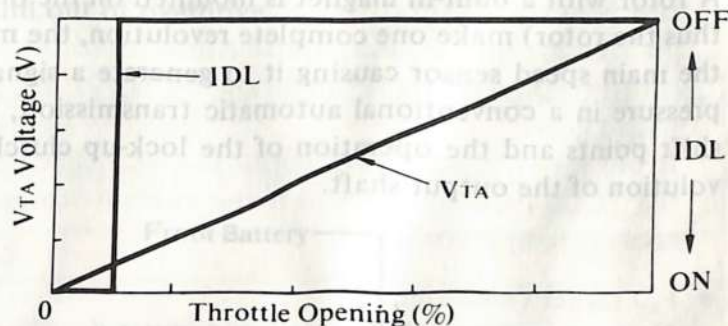
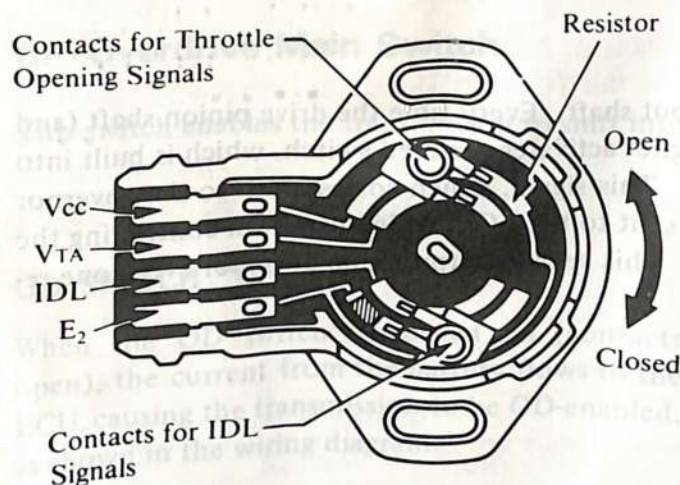
Shift Position	Terminal		For Neutral Starting		For Selector Lever Position Indicators						
	B	NB	C	P	R	N	D	2	L		
P	○	○	○	○							
R			○	○	○						
N	○	○	○			○					
D			○				○				
2			○					○			
L			○						○		

○ — ○ : Indicates that terminals are electrically connected.

NOTE: In the P, D and R ranges, the neutral start switch does not send signals to inform the ECU of the shift selector position.

3. Throttle Position Sensor

This sensor is mounted on the throttle body and electronically senses how far the throttle valve is open. It then sends this data to the TCCS and ECT ECUs to control shifting and lock-up in the transmission.

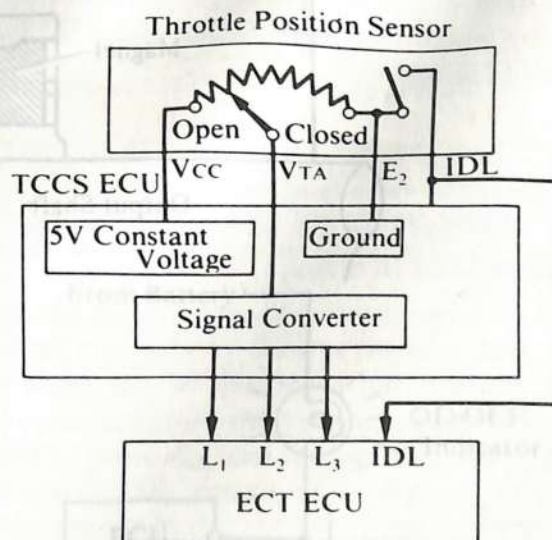


This throttle position sensor linearly converts the throttle valve opening angle into voltage signals.

A constant 5V is applied to terminal Vcc from the TCCS (Toyota Computer Controlled System) ECU. As the contact point slides along the resistor in accordance with the engine throttle valve opening angle, voltage is applied to the VTA terminal in proportion to this angle.

The TCCS ECU converts this "VTA" voltage into one of eight different throttle opening angle signals to inform the ECT ECU of the throttle opening.

When the throttle valve is closed completely, the contact points for the IDL signal connect the IDL and E₂ terminals, sending an IDL signal to the ECT ECU to inform it that the throttle is fully closed.

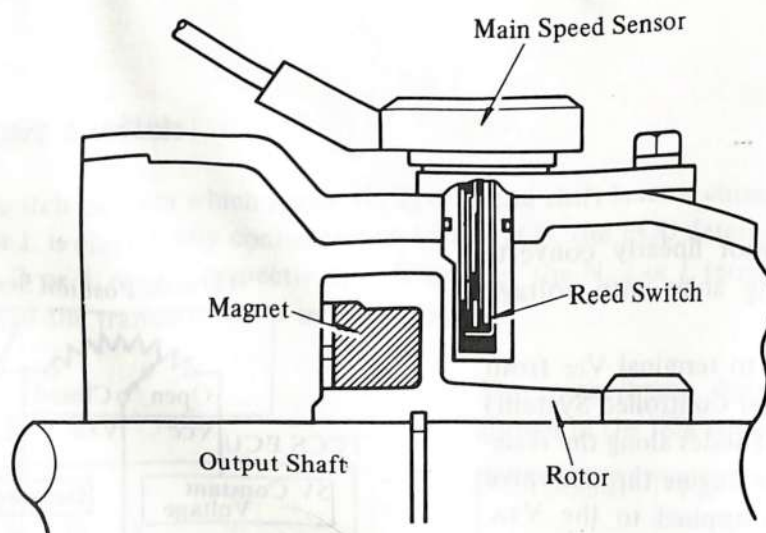


4. Speed Sensors

The speed sensors (No. 1 and No. 2) which replace the governor pressure of the hydraulically-controlled automatic transmission tell the ECU the vehicle speed. They are critical to ECU operation because the ECU determines the gear-shifting point using the throttle valve position signal from the above mentioned throttle position sensor and the signals from these speed sensors. The ECU normally determines the shift point using the signal from No. 2 speed sensor. It is programmed however, to automatically switch to No. 1 speed sensor, when No. 2 speed sensor fails.

NO. 2 SPEED SENSOR (MAIN SPEED SENSOR)

A rotor with a built-in magnet is mounted on the output shaft. Every time the drive pinion shaft (and thus the rotor) make one complete revolution, the magnet activates the reed switch, which is built into the main speed sensor causing it to generate a signal. This signal, which corresponds to the governor pressure in a conventional automatic transmission, is sent to the ECU, which uses it in controlling the shift points and the operation of the lock-up clutch. This sensor outputs one pulse for every one revolution of the output shaft.



NO. 1 SPEED SENSOR (BACK-UP SPEED SENSOR)

This sensor is built into the speedometer and operates in place of the main speed sensor if that sensor should happen to malfunction. It outputs four pulses for every one revolution of the speedometer cable.

5. Stop Light Switch

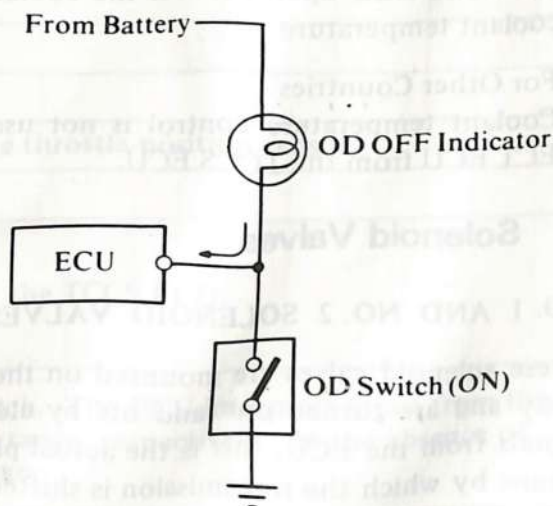
This switch is mounted on the brake pedal bracket. When the brake pedal is depressed, this switch sends a signal to the ECU, informing it that the brakes have been applied. The ECU then cancels operation of the lock-up clutch while braking is in progress to prevent the engine from stalling from rear wheel lock up.

6. Overdrive Main Switch

This switch enables the transmission to shift into and out of overdrive.

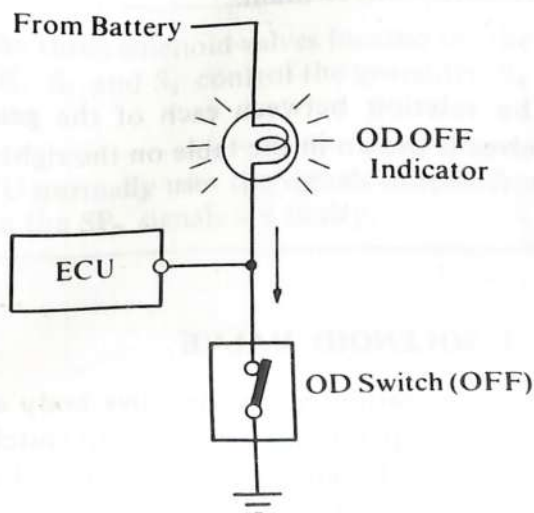
OD SWITCH "ON"

When the OD switch is turned on (contacts open), the current from the battery flows to the ECU, causing the transmission to be OD-enabled, as shown in the wiring diagram.



OD SWITCH "OFF"

When the OD switch is turned off (contacts closed), the current from the battery flows to ground as shown in the wiring diagram. Therefore, OD is disabled, i.e., the transmission is not permitted by the ECU to shift into overdrive. At the same time, the OD OFF indicator comes on.



7. Cruise Control Computer

If the actual vehicle speed drops to about 8 km/h (5 mph) below the set cruise control system (CCS) speed, the CCS computer sends a signal to the ECT ECU, ordering it to disengage the lock-up clutch, and to prevent the transmission from operating in overdrive.

8. Water Temperature Sensor

● For Australia

This sensor monitors the coolant temperature by means of a thermistor, converts coolant temperature into electrical signals, and sends these signals to the TCCS ECU. If the coolant temperature falls below 60°C (140°F), the TCCS ECU sends a signal to the ECT ECU OD₁ terminal, preventing the transmission from up-shifting into overdrive and the lock-up clutch from operating. Then, if the coolant temperature drops below 35°C (95°F), a signal is sent to the ECT ECU preventing shift up to 3rd gear.

If the water temperature sensor should happen to fail due to a short-circuit or disconnected wire, the TCCS ECU operates as if the coolant temperature were 80°C (176°F), regardless of the actual coolant temperature.

● For Other Countries

Coolant temperature control is not used. Therefore, signals are not sent to terminal OD₁ of the ECT ECU from the TCCS ECU.

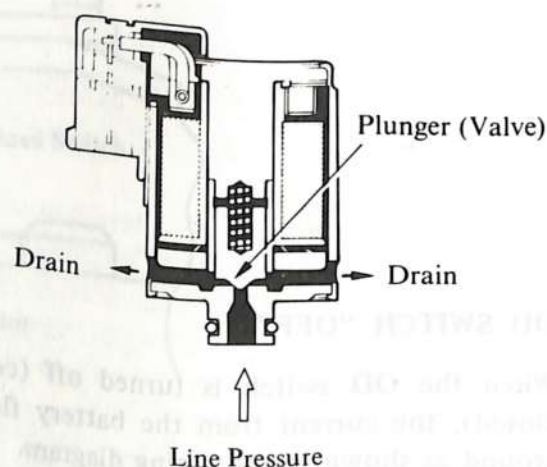
9. Solenoid Valves

NO. 1 AND NO. 2 SOLENOID VALVES

These solenoid valves are mounted on the valve body and are turned on* and off by electrical signals from the ECU; this is the actual physical means by which the transmission is shifted from one gear to another.

* “On” here means “Open” – the plunger of the solenoid valve is attracted upward by the coil, thus opening the valve and allowing line pressure fluid to drain.

The relation between each of the gears and valves is shown in the table on the right.



Solenoid Valve \ Gear	Gear			
	1st	2nd	3rd	OD
No. 1	On	On	Off	Off
No. 2	Off	On	On	Off

NO. 3 SOLENOID VALVE

This is also mounted on the valve body and is turned on and off by signals from the ECU, thus controlling the operation of the lock-up clutch.

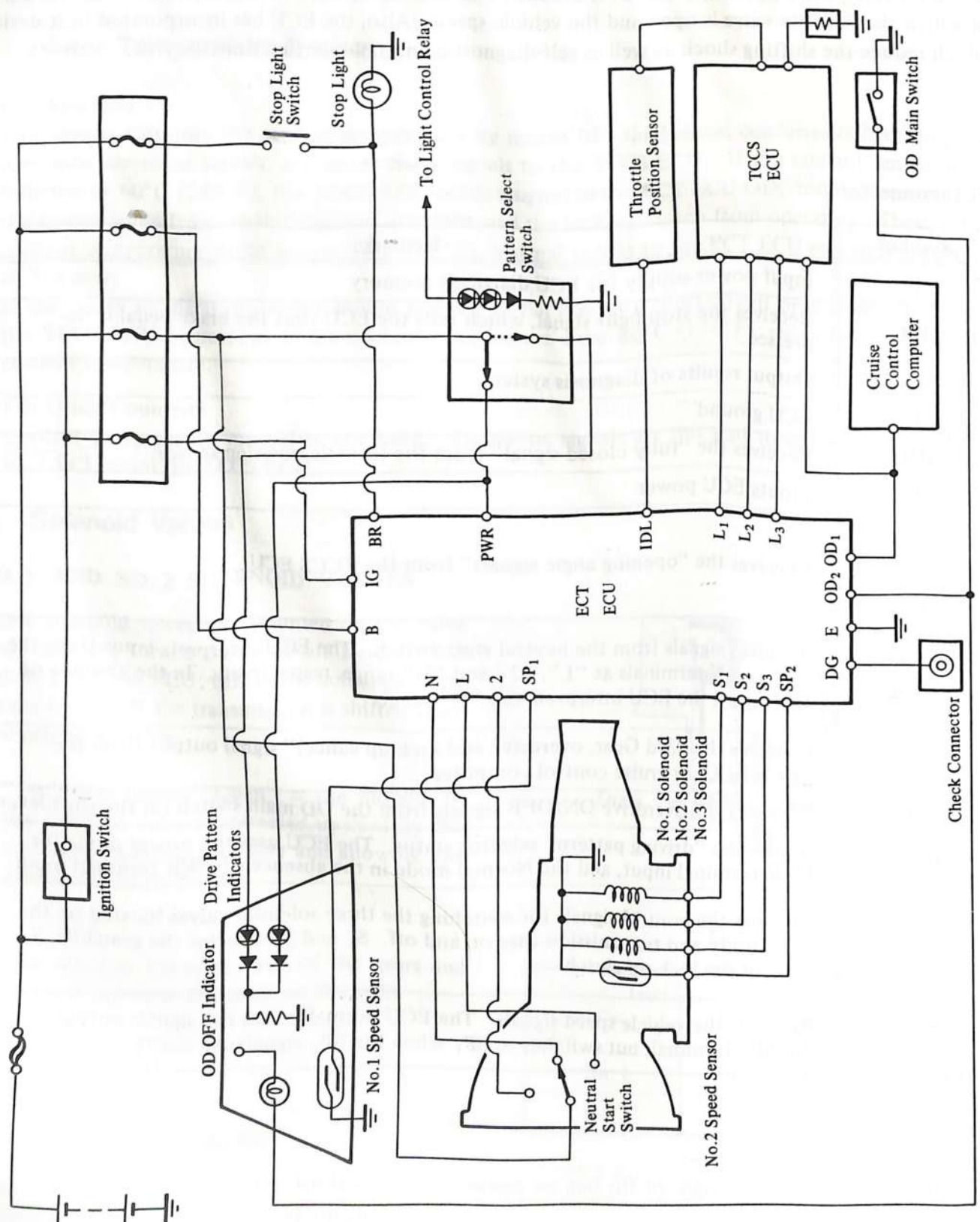
When the ECU sends a signal to No. 3 solenoid valve, causing it to come on. For this reason, line pressure acts on the top portion of the lock-up relay valve, causing the lock-up clutch to engage.

10. ECU (Electronic Control Unit)

Using the shift lever position (D, 2 or L range) and the driving mode (Power or Normal mode), the ECU selects a shift and lock-up pattern from among the shift and lock-up patterns stored in its memory. Based on this preset pattern, it controls the shift and lock-up operation in accordance with the degree in which the throttle valve is open and the vehicle speed. Also, the ECU has incorporated in it devices which reduce the shifting shock as well as self-diagnostic and fail-safe functions.

ECU-connector

Symbol	Remarks
B	Input power supply for ECU diagnosis memory
BR	Receives the stop light signal, which tells the ECU that the brake pedal is depressed.
DG	Output results of diagnosis system
E	ECU ground
IDL	Receives the “fully closed signal” from the throttle position sensor.
IG	Inputs ECU power
L ₁	Receives the “opening angle signals” from the TCCS ECU.
L ₂	
L ₃	
L	Receives signals from the neutral start switch. The ECU interprets input from the L, 2 and N terminals as “L”, “2” and “N” range, respectively. In the absence of any input, the ECU interprets the “D” range.
2	
N	
OD ₁	Receives the “3rd Gear, overdrive and lock-up cancel” signal output from the TCCS ECU, or cruise control computer.
OD ₂	Receives the overdrive ON/OFF signals from the OD main switch on the shift lever.
PWR	Inputs the “driving pattern” selector status. The ECU uses the power mode for PWR terminal input, and the Normal mode in the absence of PWR terminal input.
S ₁	Outputs the control signals for switching the three solenoid valves located on the valve body and transmission case on and off. S ₁ and S ₂ control the gearshift, S ₃ control the lock-up clutch.
S ₂	
S ₃	
SP ₁	Receives the vehicle speed signals. The ECU normally uses the signals output from the SP ₂ terminal, but switches to SP ₁ when the SP ₂ signals are faulty.
SP ₂	



SHIFT AND LOCK-UP PATTERN

As shown in the chart below, the ECU is programmed to select the shift and lock-up pattern depending upon the driving mode and shift lever position (range).

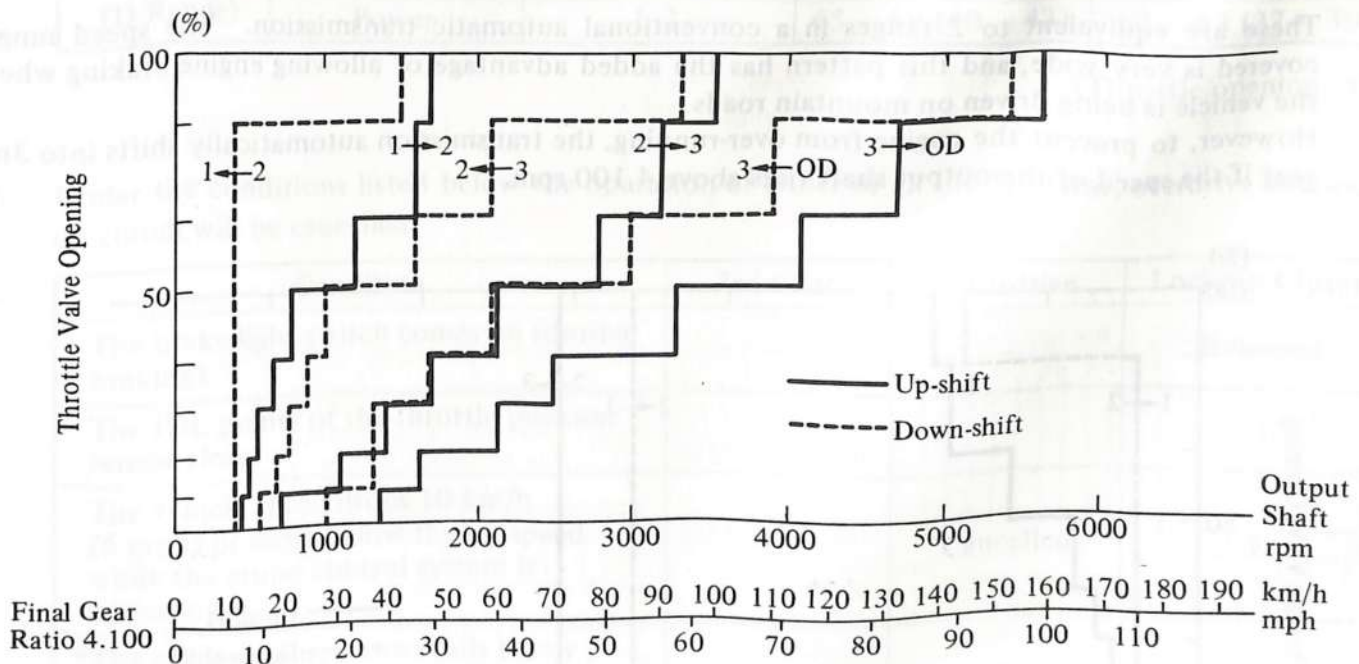
* See page TD-95

Driving Mode \ Range	"D" Range		"2" Range		"L" Range	
	Shift Pattern	Lock-up Pattern	Shift Pattern	Lock-up Pattern	Shift Pat Pattern	Lock-up Pattern
Normal	S-1	L-1	S-3	—	S-4	—
Power	S-2	L-2	↑	—	↑	—

NOTE: Lock-up is engaged in the 2nd, 3rd and OD gears of the D range. However, it will only begin to operate when the speed of the vehicle reaches the specified speed, which depends on the throttle opening.

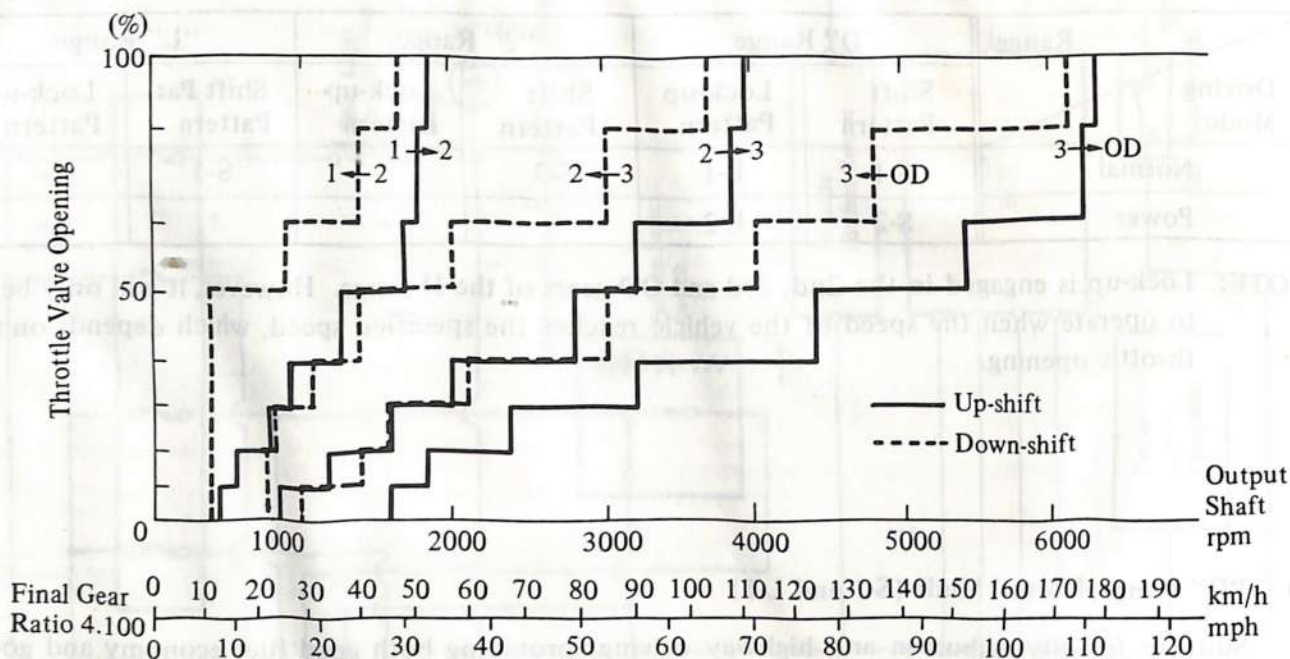
1) "D" Range, Normal Mode (S-1 and L-1)

Suitable for city, suburban and highway driving, providing both good fuel economy and good acceleration.



2) "D" Range, Power Mode (S-2 and L-2)

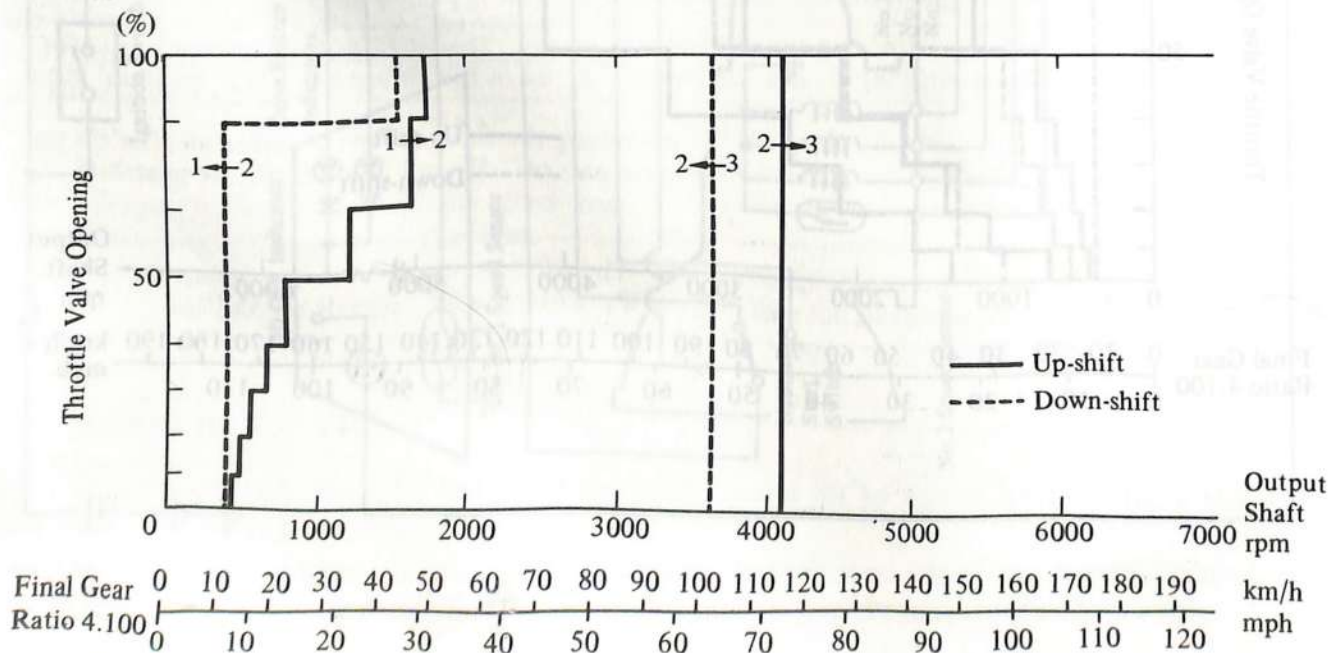
This is the best pattern for accelerating. For this reason, the speed at which the transmission up-shift or down-shift occur is higher than in the Normal mode.



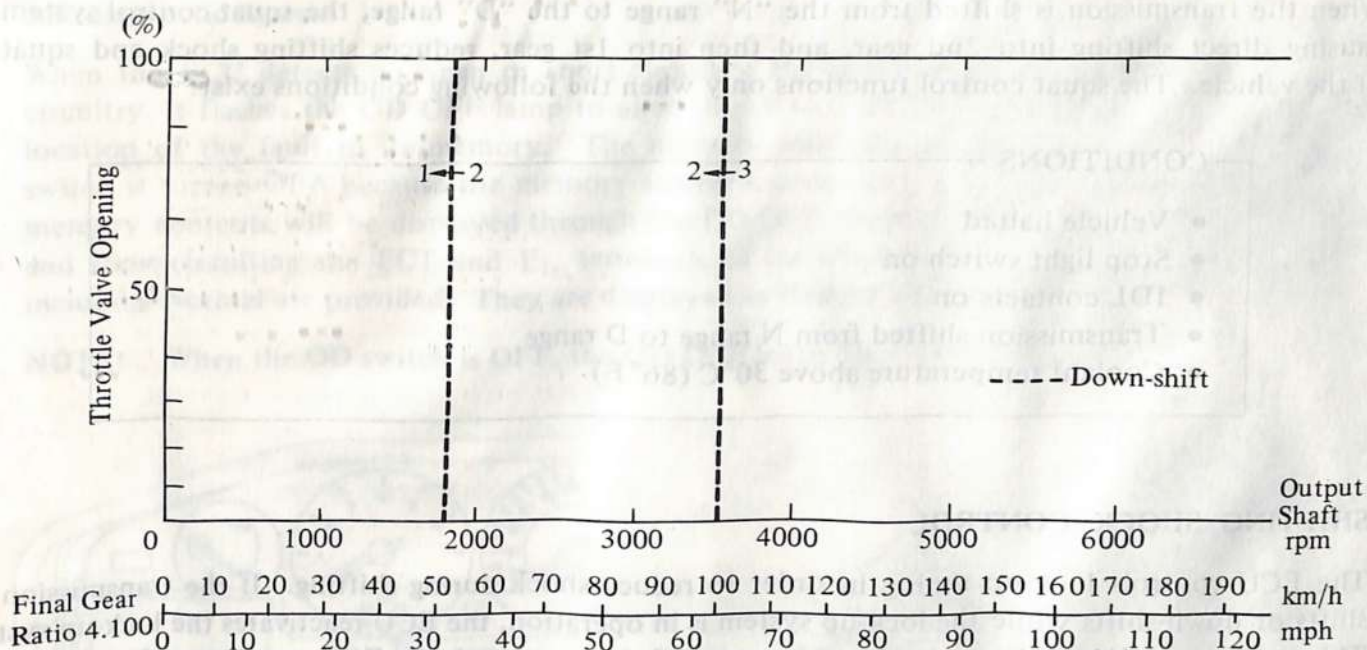
3) "2" Range, Normal or Power Mode (S-3)

These are equivalent to 2 ranges in a conventional automatic transmission. The speed range covered is very wide, and this pattern has the added advantage of allowing engine braking when the vehicle is being driven on mountain roads.

However, to prevent the engine from over-running, the transmission automatically shifts into 3rd gear if the speed of the output shaft rises above 4,100 rpm.



4) "L" Range, Normal or Power Mode (S-4)



– REFERENCE –

1. Lock-up Points

Gear	Driving Pattern	Lock-up Pattern	Lock-up km/h (mph)	
			Engaged	Disengaged
OD (D Range)	Normal	L-1	60 – 65 (37 – 40)	58 – 61 (36 – 38)
	Power	L-2	65 – 69 (40 – 43)	60 – 63 (37 – 39)

(Throttle opening: 5%)

2. Under the conditions listed below the operation of either or all the 3rd Gear, overdrive and lock-up clutch will be cancelled.

Condition	3rd Gear	Overdrive	Lock-up Clutch
The brake light switch comes on (during braking).	—	—	Released
The IDL points of the throttle position sensor close.	—	—	↑
The vehicle speed drops 10 km/h (6 mph) or more below the set speed while the cruise control system is operating.	—	Cancelled	↑
*The coolant temperature falls below 35°C (90°F) and the vehicle speed drives below 40 km/h (25 mph)	Cancelled	↑	↑
*The coolant temperature falls below 60°C (140°F) and the vehicle speed drives below 60 km/h (37 mph)	—	↑	↑

* Australia only.

“N” TO “D” SQUAT CONTROL

When the transmission is shifted from the “N” range to the “D” range, the squat control system, by causing direct shifting into 2nd gear, and then into 1st gear, reduces shifting shock and squatting of the vehicle. The squat control functions only when the following conditions exist:

CONDITIONS

- Vehicle halted
- Stop light switch on
- IDL contacts on
- Transmission shifted from N range to D range
- Coolant temperature above 30°C (86°F)

SHIFTING SHOCK CONTROL

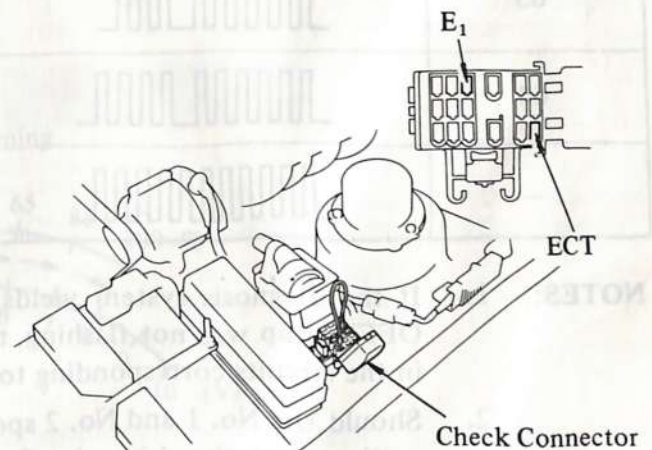
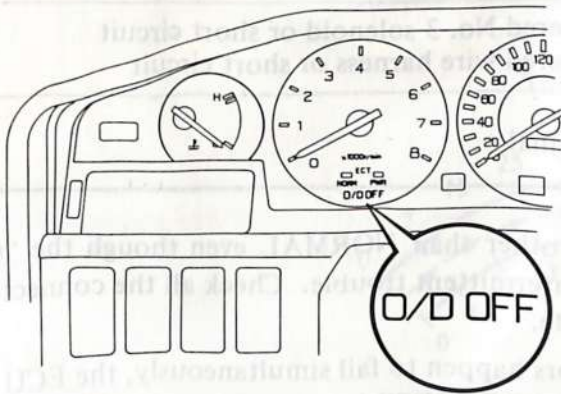
The ECU controls lock-up timing in order to reduce shock during shifting. If the transmission up-shifts or down-shifts while the lock-up system is in operation, the ECU reactivates the lock-up system. This helps to reduce shifting shock. After up-shift is completed, the ECU reactivates the lock-up system.

SELF-DIAGNOSTIC FUNCTIONS

1) Self-diagnostic System

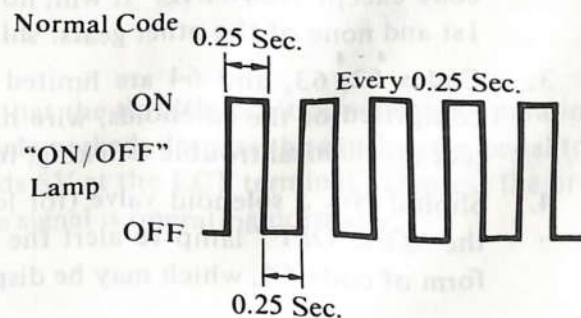
When the ECU detects an open or short circuit in the vehicle speed sensors or solenoid valves circuitry, it flashes the OD OFF lamp to alert the driver. At the same time, the ECU stores the location of the fault in its memory. The memory contents remain intact even if the ignition switch is turned OFF because the memory stored is protected by a back-up power supply. The memory contents will be displayed through the OD OFF lamp by turning the ignition switch ON and short-circuiting the ECT and E₁ terminals of the check connector. Six diagnostic codes, including Normal are provided. They are displayed as flashing patterns on the OD OFF lamp.

NOTE: When the OD switch is OFF, the OD OFF lamp does not blink.



a. Normal Code Indication

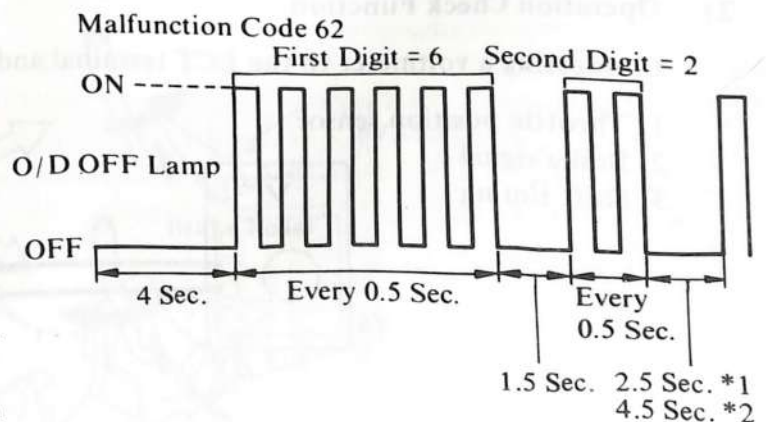
The lamp will blink every 0.25 seconds.



b. Malfunction Code Indication

First, the lamp will pause for 4 seconds. Thereafter, the number of times the lamp blinks every 0.5 seconds is the first figure of a code. Next, the number of times the lamp blinks every 0.5 seconds is the second figure of the code.

If there is more than one malfunction code, the code with the smallest number will appear first. Followed by a pause for 2.5 seconds, then the next code will appear in the same manner as described above. Finally, the entire procedure will be repeated. In the illustration, malfunction code 62 is indicated.



*1 When the other code is output.

*2 When the same code is output.

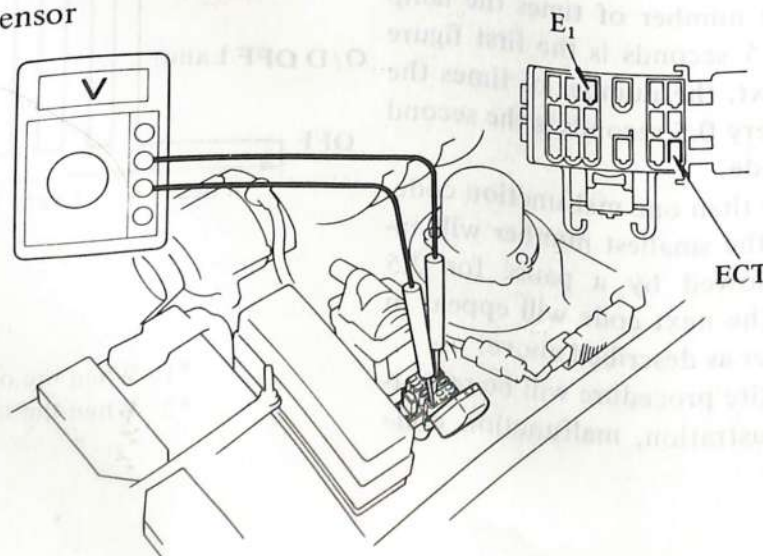
Code No.	Light Pattern	Diagnosis System
42	 ON OFF	Defective No. 1 speed sensor (in combination meter) Severed wire harness or short circuit.
61		Defective No. 2 speed sensor (in ATM) Severed wire harness or short circuit.
62		Severed No. 1 solenoid or short circuit Severed wire harness or short circuit
63		Severed No. 2 solenoid or short circuit Severed wire harness or short circuit
64		Severed No. 3 solenoid or short circuit Severed wire harness or short circuit
—		Normal

- NOTES:**
1. If the diagnosis system yields a code other than NORMAL even though the "O/D OFF" lamp was not flashing, there is intermittent trouble. Check all the connections in the circuits corresponding to that code.
 2. Should the No. 1 and No. 2 speed sensors happen to fail simultaneously, the ECU will neither alert the driver by flashing the "O/D OFF" lamp nor record any diagnostic code except NORMAL. It will, however, decide that the driver is allowed to use only 1st and none of the other gears: shifting upward will then be impossible.
 3. Codes 62, 63, and 64 are limited to short or open circuits in the electrical system comprised of the solenoids, wire harness, and connectors. The ECU is unable to detect mechanical trouble (sticking, for example) in the solenoid valves.
 4. Should No. 3 solenoid valve (for lock-up clutch control) fail, the ECU will not flash the "O/D OFF" lamp to alert the driver. It will, however, record the failure in the form of code 64, which may be displayed during troubleshooting.

2) Operation Check Function

Connecting a voltmeter to the ECT terminal and measuring the voltage enables you to check:

1. Throttle position sensor
2. Brake signal
3. Shift timing



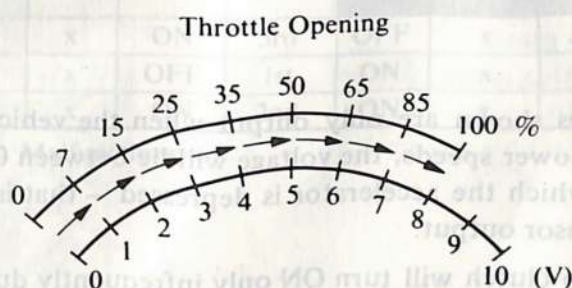
a. Checking the Throttle Position Sensor

With the ignition switch ON and the vehicle parked, gradually depress the accelerator pedal from the fully closed position to fully open position. If the voltage at the ECT terminal rises in 1 volt increments from 0V to 8V, the throttle position sensor is working normally.

NOTES: Do not touch the brake pedal during this check. Pressing the brake pedal will yield a zero reading for all accelerator positions.

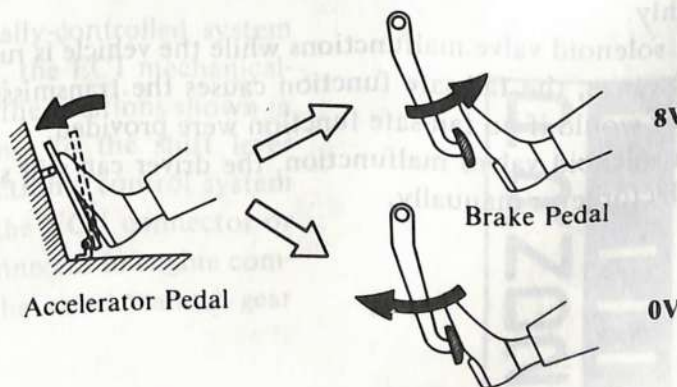
If the reading remains at 0V as the accelerator is depressed, the possible causes are:

- A brake signal remains ON.
- An IDL signal remains ON.
- Trouble in the ECU power supply circuit.
- Trouble in the ECU itself.



b. Checking the Brake Pedal

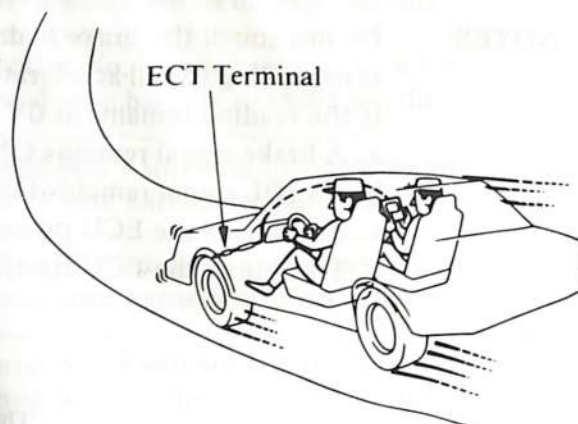
Before checking the brake signal, make sure that the throttle position sensor is operating normally. With the ignition switch ON and the vehicle parked, depress the accelerator pedal to the fully open throttle position so that the voltage reads 8V at the ECT terminal. Depress the brake pedal. If the voltage drops from 8V to 0V, the brake signal is operating normally.



c. Checking Shift Timing

Perform a road test with a voltmeter connected to the ECT terminal. The output voltage for each gear range should be as shown in the table below.

Gear	1st	2nd		3rd		OD	
lock-up	—	OFF	ON	OFF	ON	OFF	ON
ECT terminal voltage	0	2	3	4	5	6	7



- NOTES:**
1. The voltages shown are only output when the vehicle speed exceeds 10 km/h (6 mph). At lower speeds, the voltage will lie between 0V and 8V and depend on the degree to which the accelerator is depressed – that is, it will switch to the throttle position sensor output.
 2. The lock-up clutch will turn ON only infrequently during normal 2nd and 3rd gear operation. To trigger this action, press the accelerator pedal to 50% or more of its stroke. At less than 50%, the voltage may change in the sequence 2V-4V-6V-7V.
 3. If the gears fail to shift in response to the changes in the voltage readings, the possible cause of trouble is solenoid sticking or a malfunction in the automatic transmission body.

FAIL-SAFE FUNCTIONS

1) Solenoid Valve Back-up Function

If either No. 1 or No. 2 solenoid valve malfunctions, the ECU can still control the transmission by operating the remaining solenoid to put the transmission in a gear that will allow the vehicle to be operated smoothly.

For example, if No. 1 solenoid valve malfunctions while the vehicle is running in 1st gear with the transmission in the D range, the fail-safe function causes the transmission to shift into 3rd gear instead of into OD as it would if no fail-safe function were provided.

Furthermore, if both solenoid valves malfunction, the driver can still safely drive the vehicle by operating the shift selector lever manually.

Range	Normal		No. 1 Solenoid Malfunctioning			No. 2 Solenoid Malfunctioning			Both Solenoids Malfunctioning	
	Solenoid Valve		Gear	Solenoid Valve		Gear	Solenoid Valve		Gear	Gear when shift selector is manually operated
	No. 1	No. 2		No. 1	No. 2		No. 1	No. 2		
D	ON	OFF	1st	x	ON (OFF)	3rd (OD)	ON	x	1st	OD
	ON	ON	2nd	x	ON	3rd	OFF (ON)	x	OD (1st)	OD
	OFF	ON	3rd	x	ON	3rd	OFF	x	OD	OD
	OFF	OFF	OD	x	OFF	OD	OFF	x	OD	OD
2	ON	OFF	1st	x	ON (OFF)	3rd (OD)	ON	x	1st	3rd
	ON	ON	2nd	x	ON	3rd	OFF (ON)	x	3rd (1st)	3rd
	OFF	ON	3rd	x	ON	3rd	OFF	x	3rd	3rd
L	ON	OFF	1st	x	OFF	1st	ON	x	1st	1st
	ON	ON	2nd	x	ON	2nd	ON	x	1st	1st

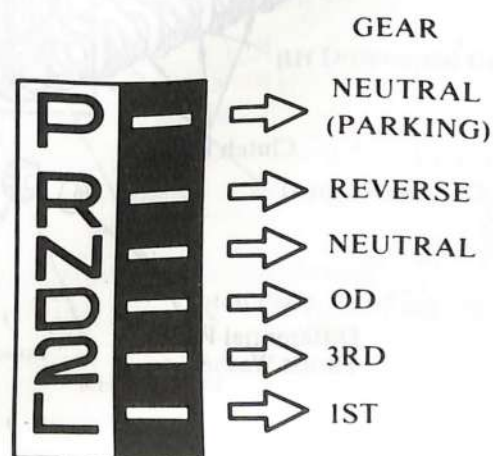
(): No fail-safe function x: Malfunctions

2) Back-up Speed Sensing Function

There are two vehicle speed sensors: a main sensor (No. 2), located on the transmission case, and a back-up sensor (No. 1), located in the speedometer. Consequently, even if the main sensor malfunctions for some reason, the ECU can continue to operate normally by keeping itself informed of the speed of the vehicle by the use of the signals from the back-up sensor. If both vehicle speed sensors No. 1 and No. 2 malfunction and no vehicle speed signal is sent to the ECU, the ECU is programmed to detect this as a vehicle speed of 0 km/h (0 mph) and cause the transmission to shift into 1st gear; no further upshifting is then possible.

3) Manual Operation Function

When the electronically-controlled system is totally deactivated, the ECT mechanically shifts the gears to the positions shown in the figure in response to the shift lever position. If the electronic control system fails, disconnecting the ECU connector or the ECT solenoid connector in engine compartment provides the same manual gear shifting.



DIFFERENTIAL .

LSD (Limited-Slip Differential)

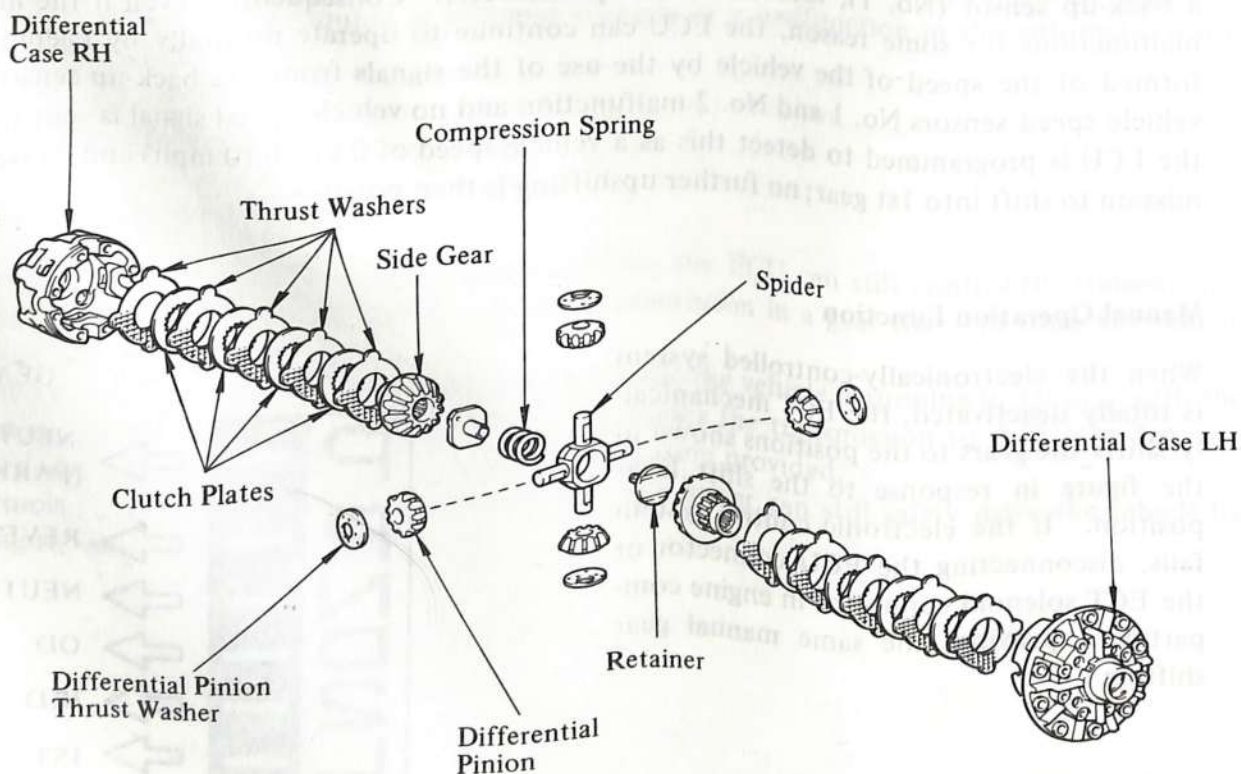
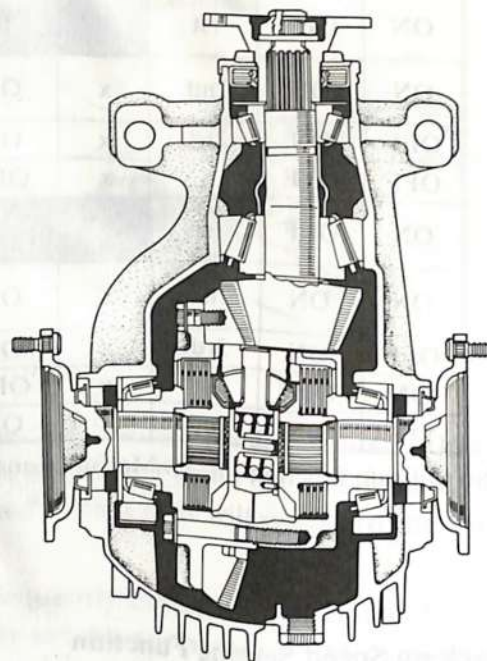
CONSTRUCTION

Thrust washers and clutch plates are mounted, in alternating sequence, between the side gears and the differential case.

Four projections of the thrust washers fit into the guide grooves of the differential case, and the clutch plates are splined to the side gears.

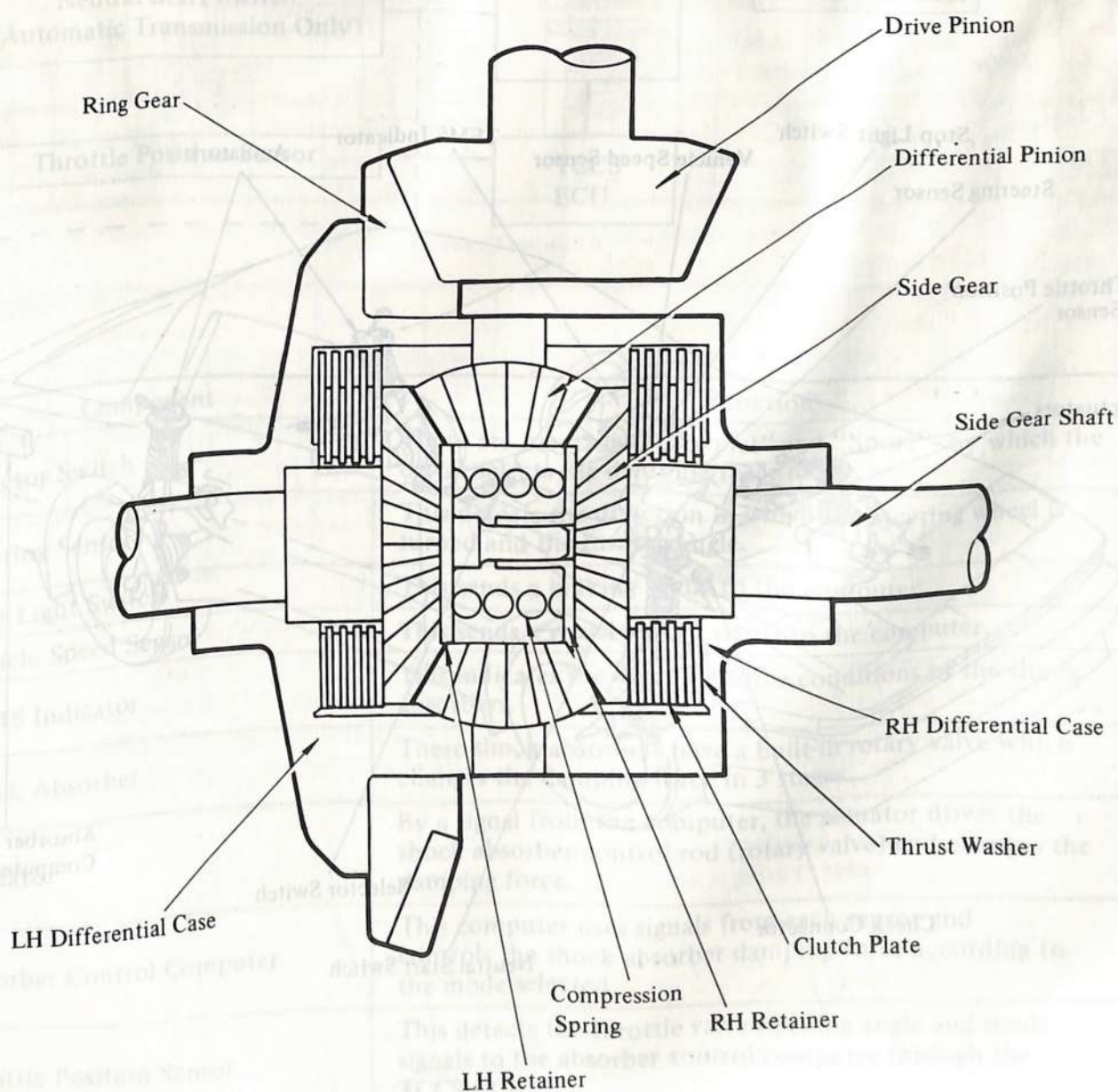
A barrel shaped compression spring is fitted between the left and right side gears to keep the thrust washers pressed up against the clutch plates via the retainers and side gears.

This means, in effect, that the side gears are kept pressed against the differential case (via the thrust washers and clutch plates) by the spring.



OPERATION

If there is a large difference in the rates at which the left and right wheels turn (as, for example, when the vehicle is cornering) a corresponding difference is produced in the rates at which the side gears and differential case turn. This difference would result in slippage between the thrust washers and clutch plates. Since these are pushed together by the spring, friction torque is created between the thrust washers and clutch plates (that is, between their surfaces, which are in direct contact with each other). This torque attempts to make the differential case and side gears rotate as a unit. This is called the "limited slip effect".



SUSPENSION

TEMS (For Australia Only)

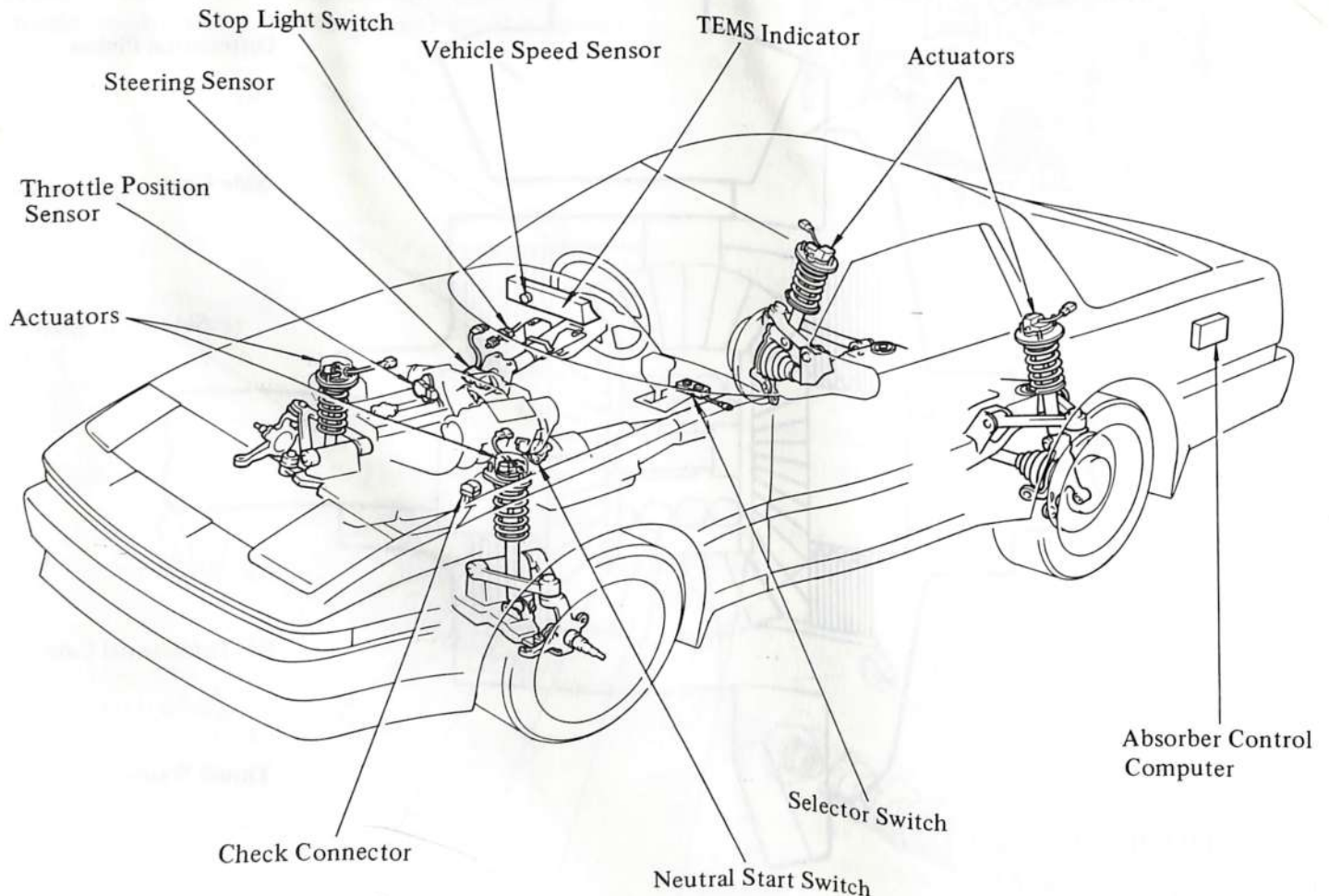
TEMS stands for the Toyota Electronic Modulated Suspension.

This is a system in which the damping force of the 4 shock absorbers is changed automatically depending on the driving conditions and which delivers superb riding comfort and better driving stability.

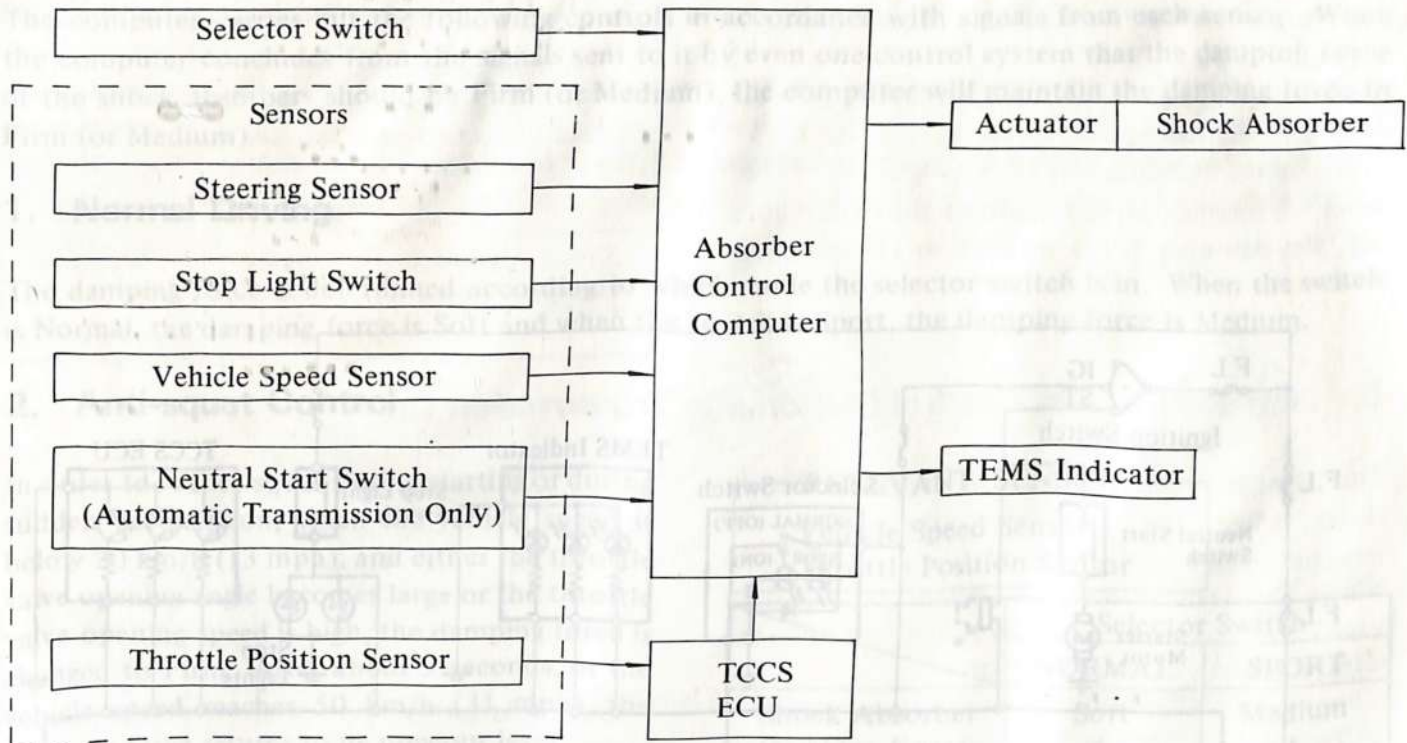
The shock absorbers' damping force changes in 3 stages.

Also, the driver can select 2 modes. A diagnosis system and fail-safe function are also included.

LOCATION OF SYSTEM COMPONENTS

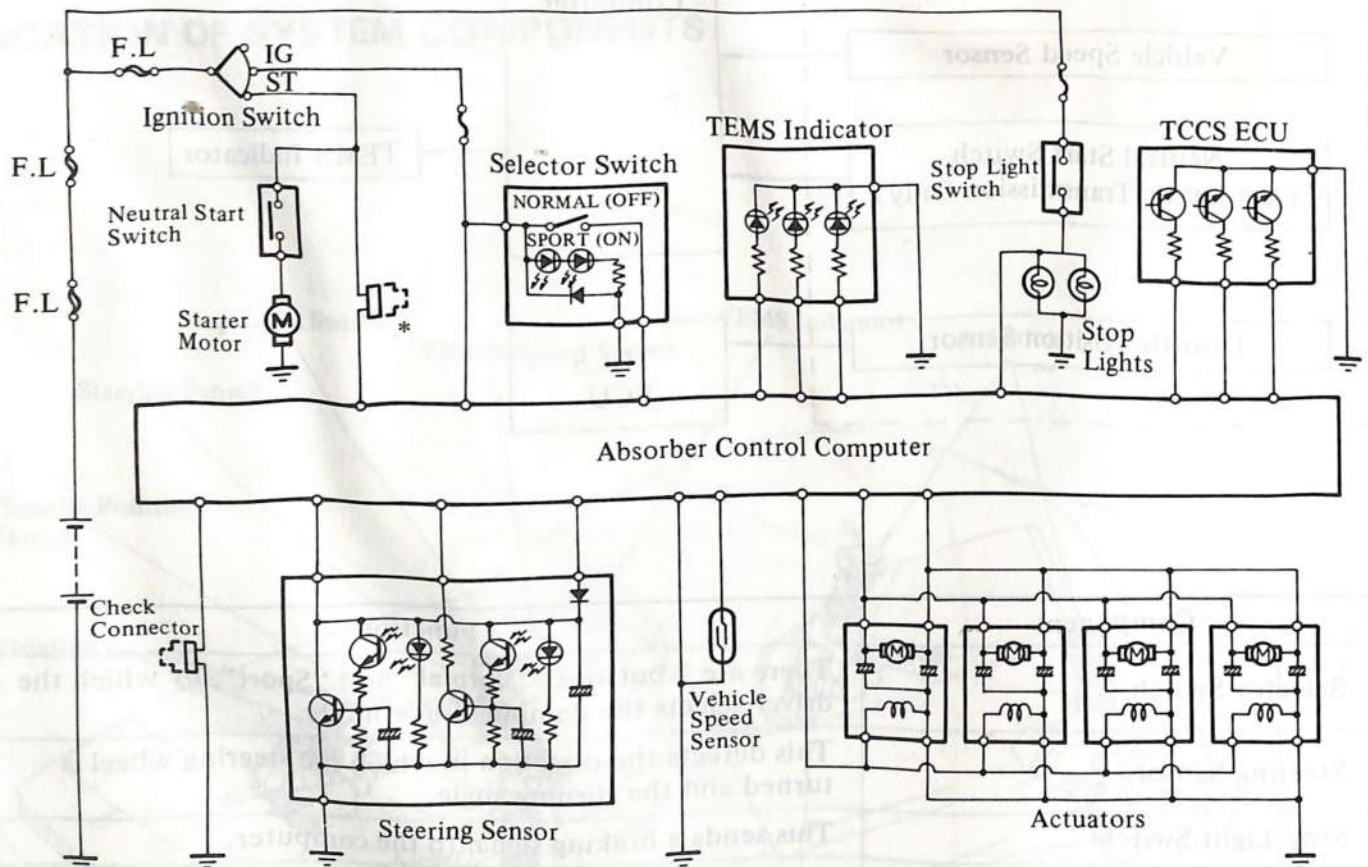


FUNCTION OF COMPONENTS



Component	Function
Selector Switch	There are 2 buttons, "Normal" and "Sport", by which the driver selects the damping force mode.
Steering Sensor	This detects the direction in which the steering wheel is turned and the turning angle.
Stop Light Switch	This sends a braking signal to the computer.
Vehicle Speed Sensor	This sends a vehicle speed signal to the computer.
TEMS Indicator	This indicates the damping force conditions of the shock absorbers.
Shock Absorber	These shock absorbers have a built-in rotary valve which changes the damping force in 3 stages.
Actuator	By a signal from the computer, the actuator drives the shock absorber control rod (rotary valve) and changes the damping force.
Absorber Control Computer	This computer uses signals from each sensor and controls the shock absorber damping force according to the mode selected.
Throttle Position Sensor	This detects the throttle valve opening angle and sends signals to the absorber control computer through the TCCS ECU.
Neutral Start Switch (Automatic Transmission only)	This sends signals to the computer that the shift position is the "N" or "P" range.

WIRING DIAGRAM



* M/T— Open
A/T— Short

CONTROL SYSTEM

The computer carries out the following controls in accordance with signals from each sensor. When the computer concludes from the signals sent to it by even one control system that the damping force of the shock absorbers should be Firm (or Medium), the computer will maintain the damping force in Firm (or Medium).

1. Normal Driving

The damping force is determined according to which mode the selector switch is in. When the switch is Normal, the damping force is Soft and when the switch is Sport, the damping force is Medium.

2. Anti-squat Control

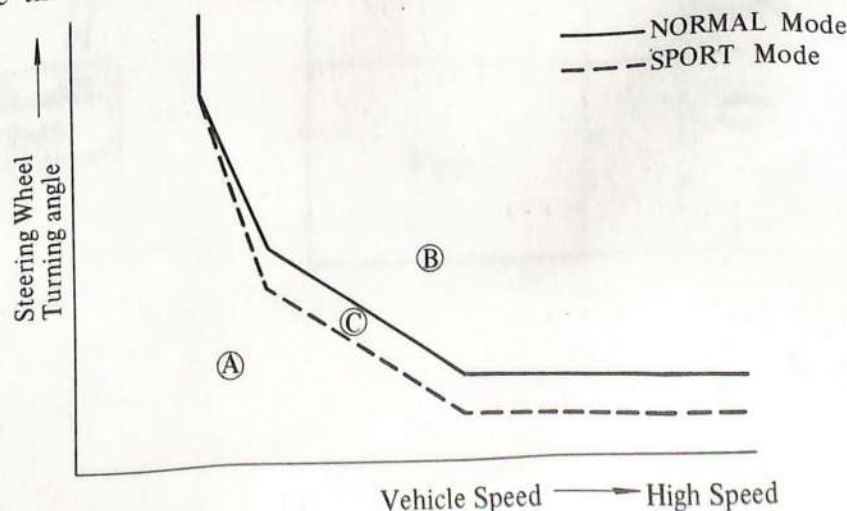
In order to reduce squat during starting or during sudden acceleration, when the vehicle speed is below 20 km/h (13 mph), and either the throttle valve opening angle becomes large or the throttle valve opening speed is high, the damping force is changed to Firm. After about 3 seconds, or the vehicle speed reaches 50 km/h (31 mph), the damping force returns to its previous level.

RELEVANT SENSOR		
Vehicle Speed Sensor Throttle Position Sensor		
	Selector Switch	
	NORMAL	SPORT
Shock Absorber Damping Force	Soft ↓ Firm	Medium ↓ Firm

3. Anti-roll Control

The control system works to check body roll when cornering or driving "S" curves. In the graph of vehicle speed and steering wheel turning angle below, when the speed and angle change line is crossed (when the speed and angle change from ① → ② with the selector switch in "Normal" or when they change from ① → ③ with the selector switch in "Sport"), the damping force changes to Firm. Then, about 2 seconds later, the damping force returns to the previous level. However, turning the steering wheel even more or turning the steering wheel sharply left and right while the damping force is Firm, lengthens the time the damping force is kept in Firm.

RELEVANT SENSOR		
Vehicle Speed Sensor Steering Sensor		
	Selector Switch	
	NORMAL	SPORT
Shock Absorber Damping Force	Soft ↓ Firm	Medium ↓ Firm



4. Anti-dive Control

This control system works to reduce nose dive during braking.

When the stop light switch (brake lights) goes on with the vehicle speed is above 60 km/h (37 mph), the damping force changes to Firm. About 2 seconds after the stop light switch goes off, the damping force returns to the previous level.

RELEVANT SENSOR		
Vehicle Speed Sensor Stop Light Switch		
	Selector Switch	
	NORMAL	SPORT
Shock Absorber Damping Force	Soft ↓ Firm	Medium ↓ Firm

5. Anti-shift Squat Control (Automatic Transmission Only)

This control system works to suppress vehicle squat when the automatic transmission is engaged from a standing start.

When the vehicle speed is below 10 km/h (6 mph) and the shift position is "N" or "P", the damping force changes to Firm.

Then about 5 seconds after the transmission is shifted out of "N" or "P", or when the vehicle speed reaches 15 km/h (9 mph), the damping force returns to the previous level.

RELEVANT SENSOR		
Vehicle Speed Sensor Neutral Start Switch		
	Selector Switch	
	NORMAL	SPORT
Shock Absorber Damping Force	Soft ↓ Firm	Medium ↓ Firm

6. High Speed Sensing Control

This control system works to raise stability when driving at high speeds. When the vehicle speed is above 120 km/h (75 mph), the damping force changes to Medium. Then when the vehicle's speed drops below 100 km/h (62 mph), the damping force returns to the previous level. When the Sport mode is used, the damping force does not change.

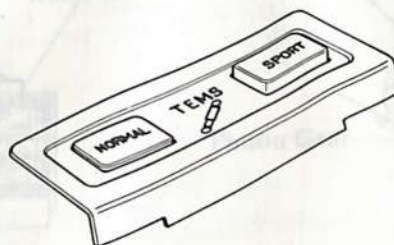
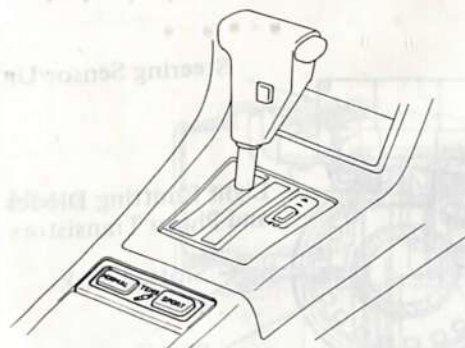
RELEVANT SENSOR		
Vehicle Speed Sensor		
	Selector Switch	
	NORMAL	SPORT
Shock Absorber Damping Force	Soft ↓ Medium	Medium

CONSTRUCTION AND OPERATION OF MAIN COMPONENTS

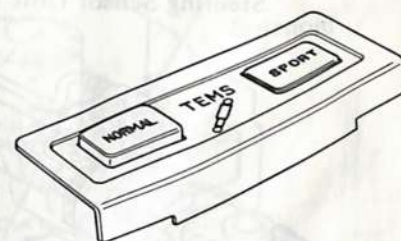
1. Selector Switch

The selector switch is installed in the center console and is used by the driver to select the damping force mode.

With this switch, two modes, Normal and Sport, can be selected.



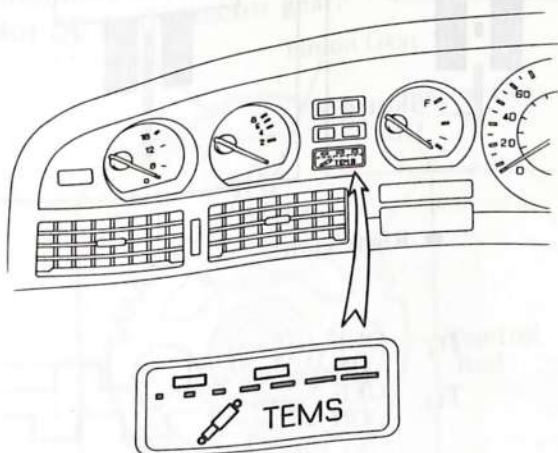
Normal Mode

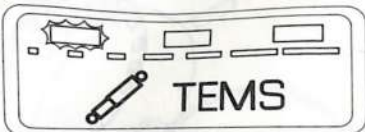
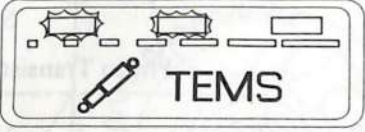
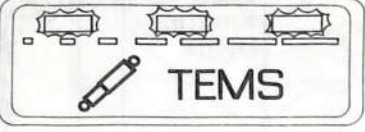


Sport Mode

2. TEMS Indicator

This indicator displays the shock absorber damping force condition, and is built into the combination meter. This indicator is also used as an indicator for the diagnosis and for the fail-safe function. For about 2 seconds after the ignition switch is turned on, all 3 indicator lamps light up as a check for burned out lamps.

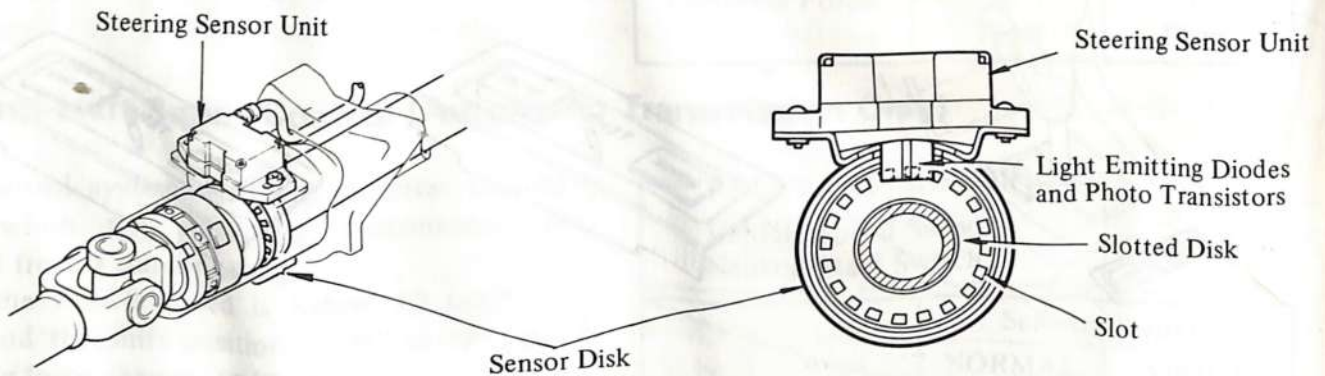


Shock Absorber Damping Force	TEMS Indicator
Soft	 TEMS
Medium	 TEMS
Firm	 TEMS

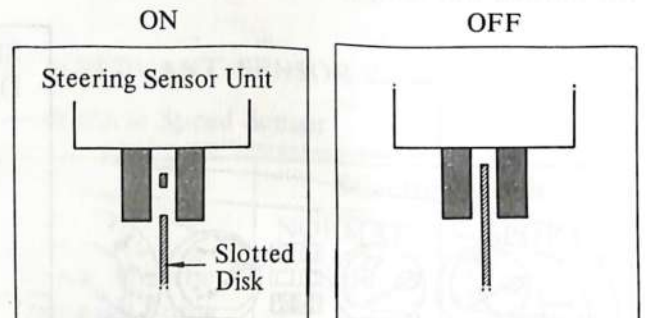
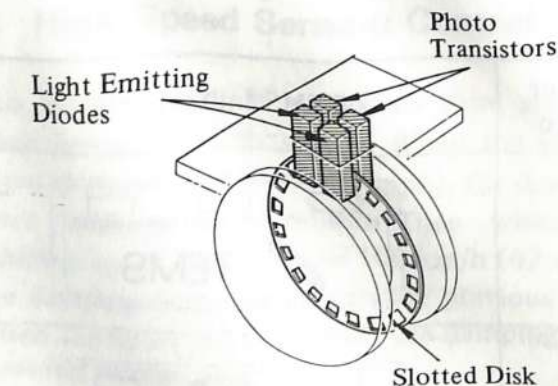
3. Steering Sensor

This sensor detects the steering wheel turning angle and the turning direction. It is composed of a steering sensor unit and a sensor disk. The steering sensor unit is fixed on the steering column tube and has two light emitting diodes and photo transistors. The sensor disk is fixed on the steering main shaft and turns with it.

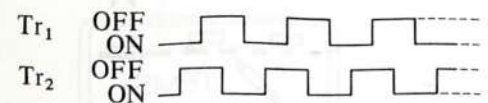
The sensor disk includes a slotted disk which has 20 slots around its circumference. The slotted portion of the disk lies between the two light emitting diodes and two photo transistors, of the steering sensor unit.



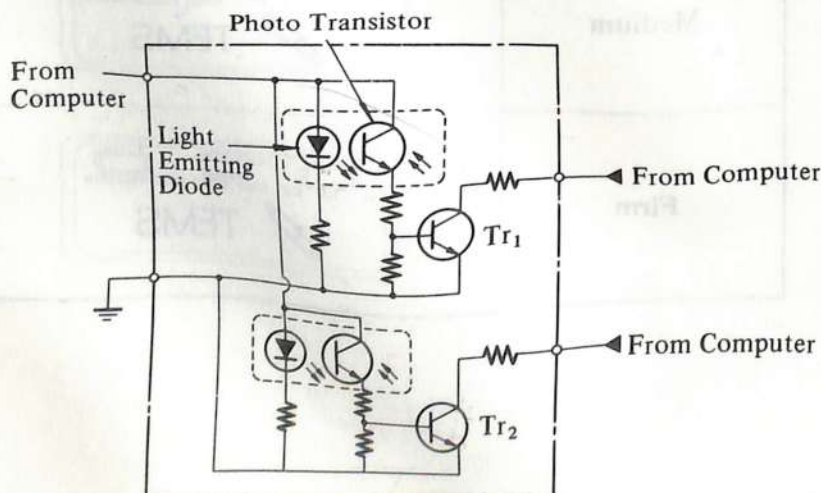
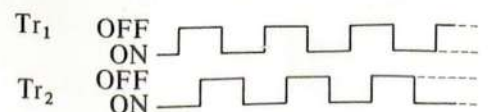
When the steering wheel is turned, the slotted disk in the sensor disk also turns. Light from the light emitting diodes is alternately cut off and passed as the slots pass by them. The photo transistors pick up the on and off light pattern and are turned on and off repeatedly, as shown in the graphs on the right below. The computer senses these on-off conditions, and the steering wheel turning angle and turning direction are detected.



● Right Turn

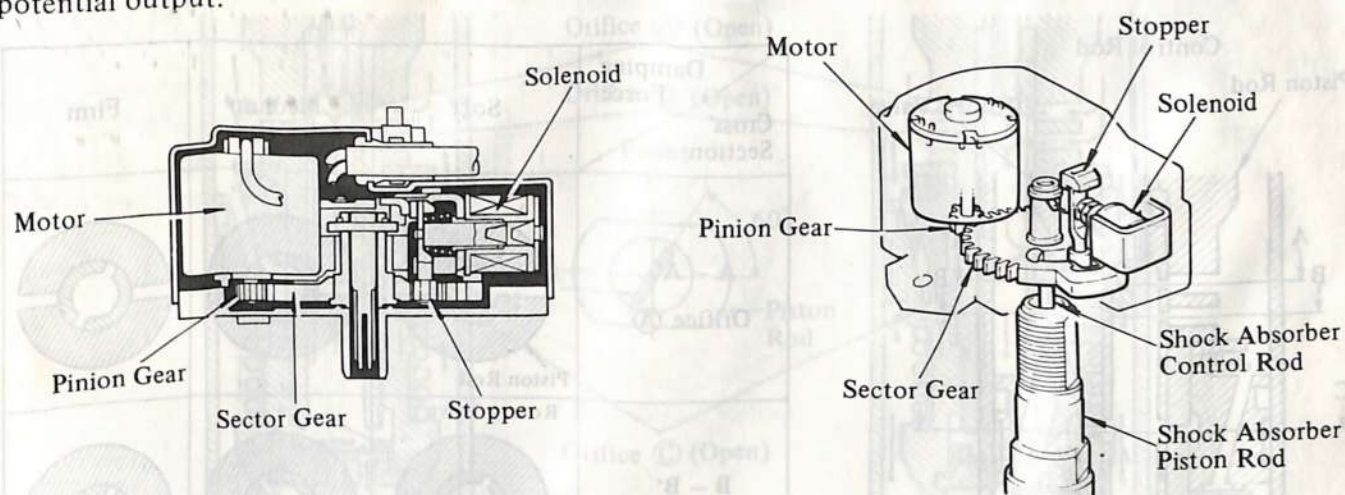


● Left Turn



4. Actuator

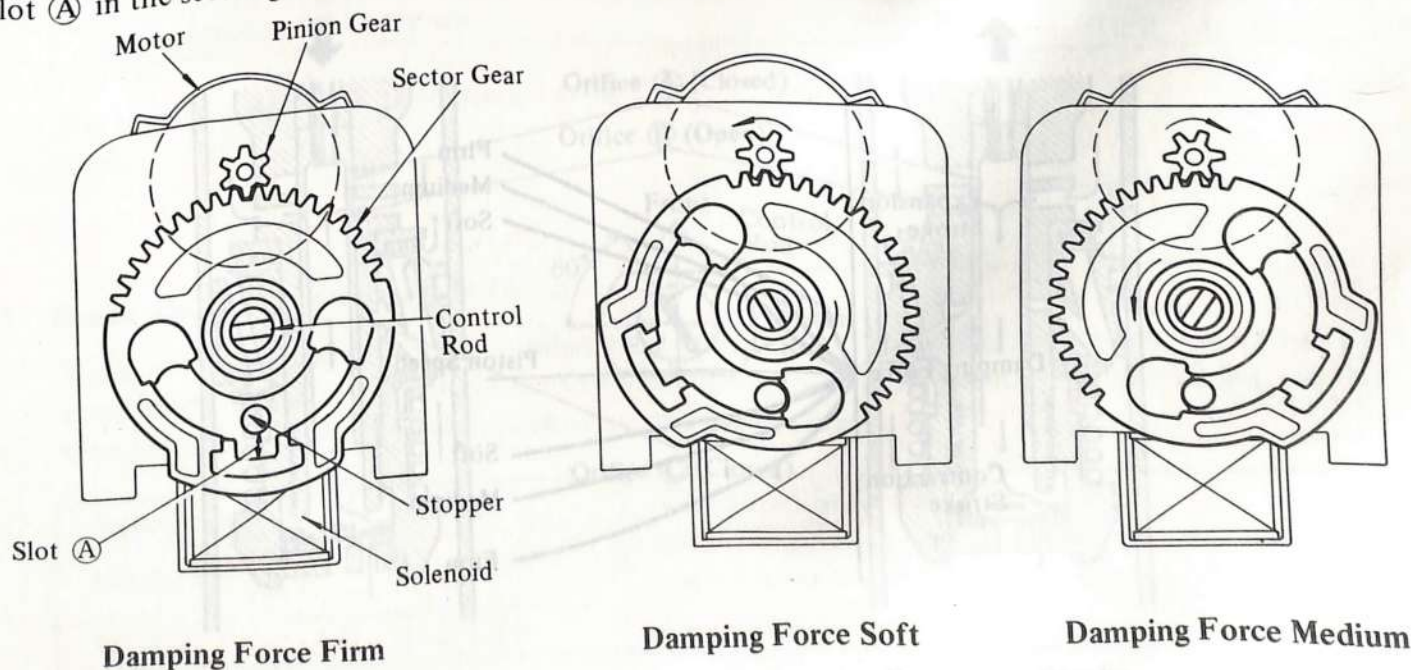
This device drives the control rod of the shock absorber by means of a motor and is installed on top of the shock absorber. The motor is a series motor which has a low starting current. This gives it very fast response to the signals from the absorber control computer, and makes it capable of repeated operation. The 4 motors, each installed on one of the shock absorbers, are connected in parallel and all four operate at the same time. The motors are activated by the computer for about 0.15 seconds at a time. Also, the computer controls the turning direction of the motors, by reversing its electric potential output.



OPERATION

When the motors are turned by current from the computer, the sector gear is turned by the pinion gear on the end of the motors. This causes the control rod of the shock absorber which is connected to the center of the sector gear, to turn changing the damping force of the shock absorber. When the damping force is changed to Medium or Soft, the sector gear is turned until it comes to the stopper.

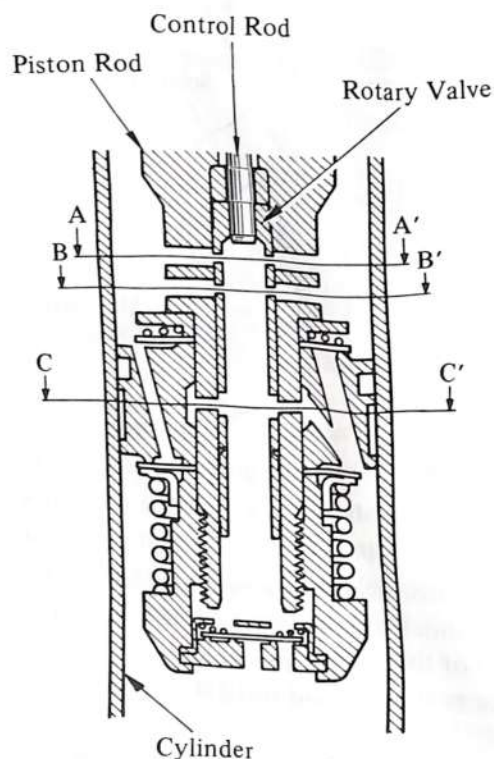
When the damping force is changed to Firm from Medium or Soft, the stopper is attracted by the solenoid, and the sector gear is turned and stopped at the position in which the stopper engages in slot (A) in the sector gear.



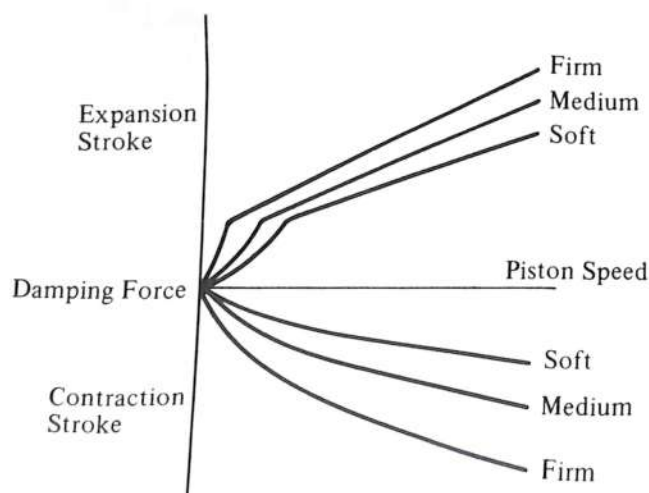
NOTE: The actuator as viewed from below.

5. Shock Absorber

The mechanism and operation of the shock absorber are basically the same as with the conventional type. It differs from ordinary shock absorbers in that the damping force can be regulated by opening and closing additional orifices. The piston rod and the rotary valve, which turns as one unit with the control rod, have the orifices at three levels, as shown in the figure below. By turning the rotary valve, the orifices are opened and closed, as shown in the chart below, and the damping force is changed in three stages.



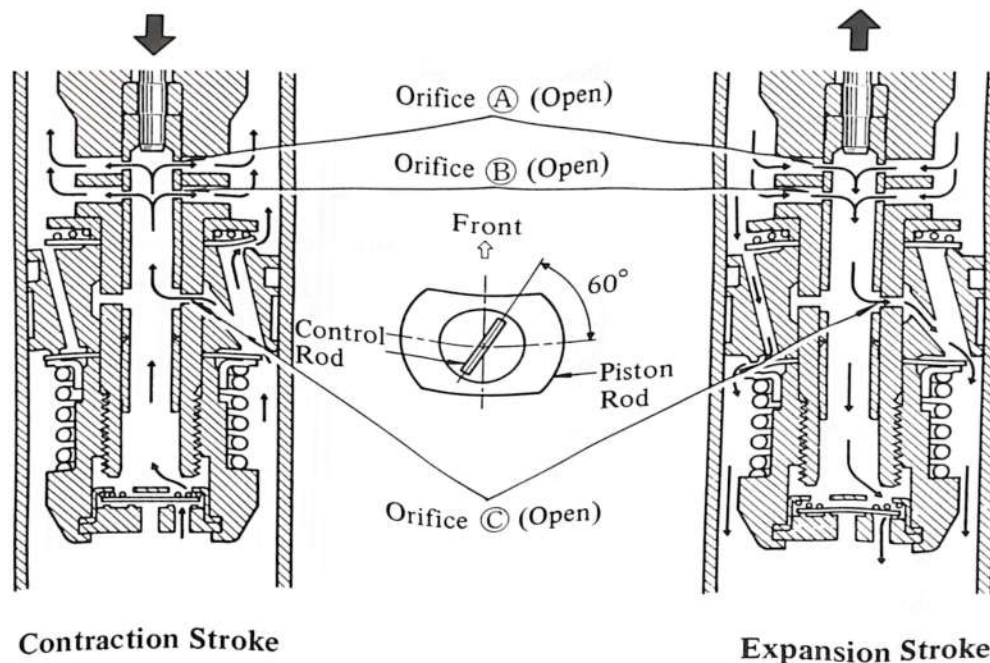
Damping Force Cross Section	Soft	Medium	Firm
A – A' Orifice (A)			
B – B' Orifice (B)			
C – C' Orifice (C)			



OPERATION

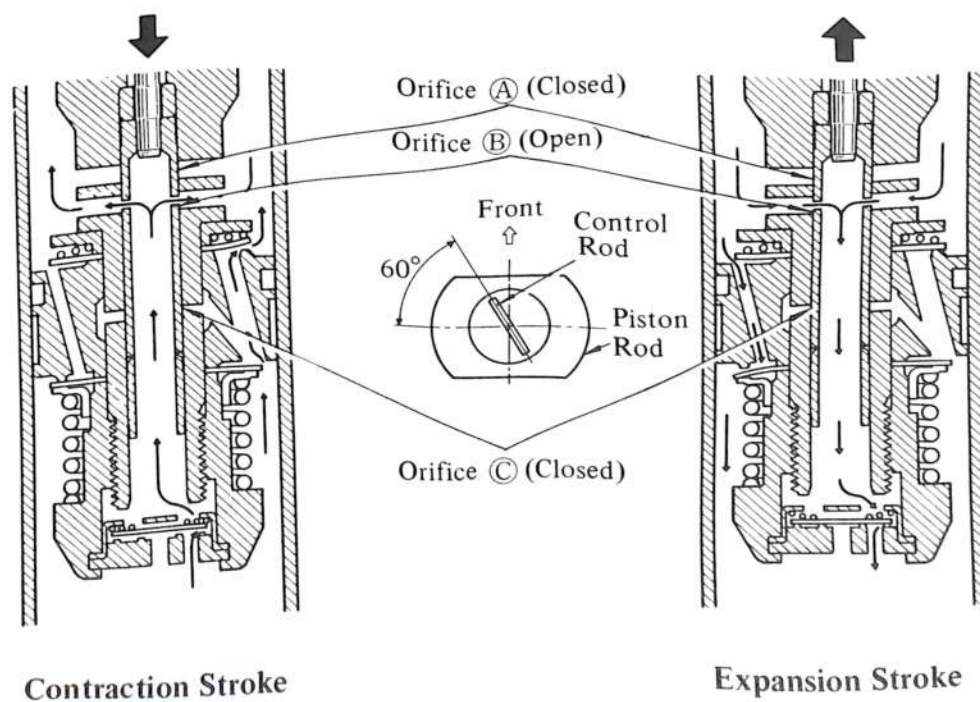
1) Soft Damping Force

All three orifices are open, and oil flow is as shown in the figure below.



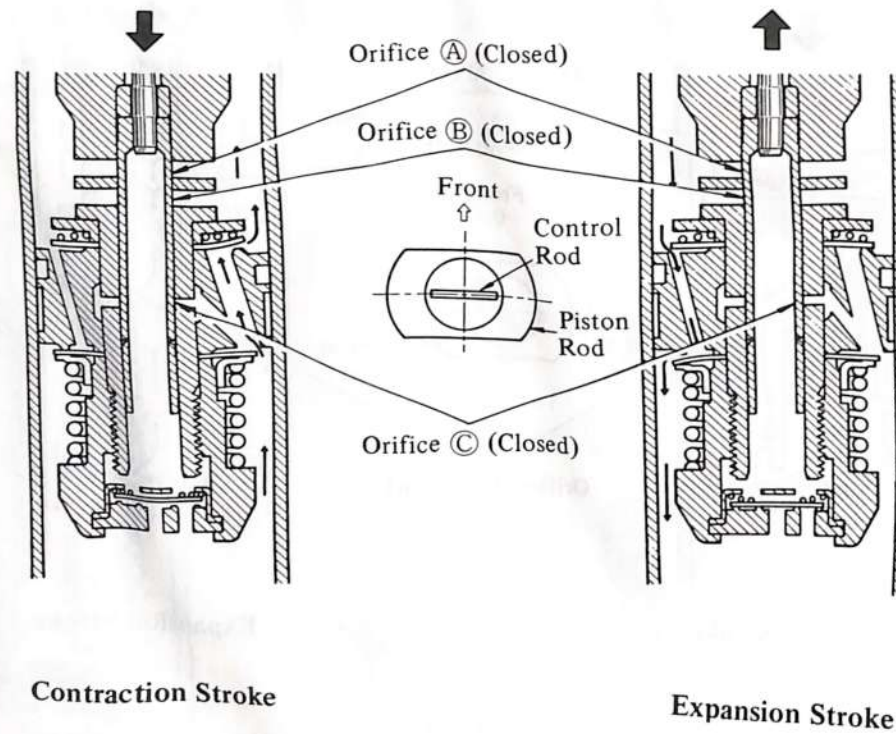
2) Medium Damping Force

Orifice (B) is open and orifices (A) and (C) are closed. Oil flow is as shown in the figure below.



3) Firm Damping Force

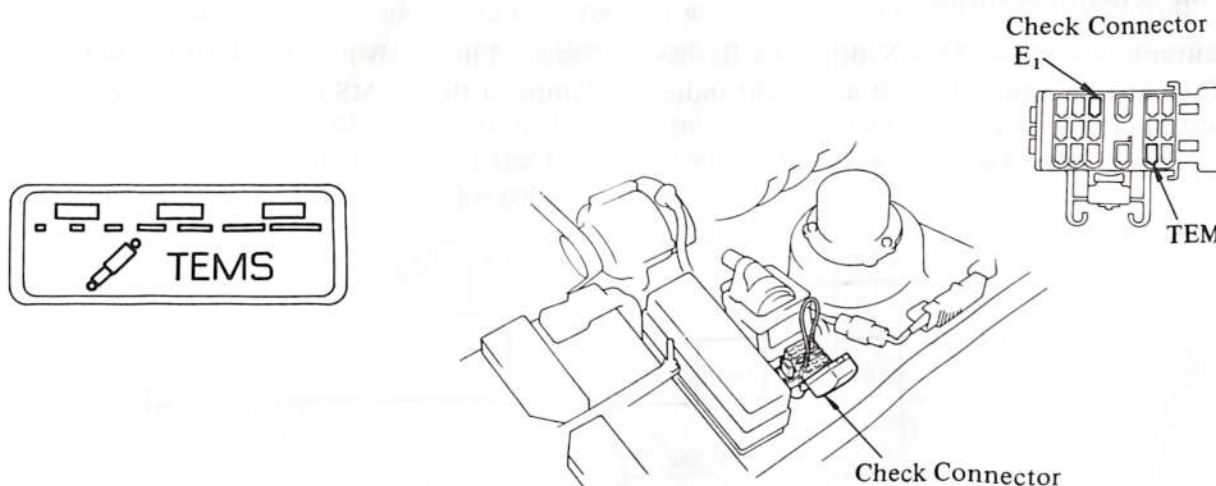
All three orifices are closed. Oil flow is as shown in the figure below.



6. Diagnosis

By connecting the TEM and E₁ terminals in the check connector, the steering sensor circuit and the damping force can be checked.

Results of the check are displayed on the TEMS indicator in the combination meter.

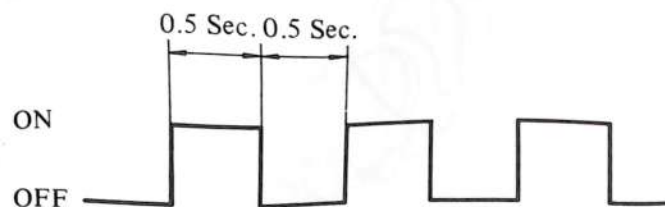


1) Steering Sensor Circuit Check System

With this check system, the steering sensor and steering sensor circuits' condition can be checked. When the Normal selector switch is pressed after the ignition switch is turned on, with the TEM and E₁ check terminals connected, if the following results are output in accordance with the steering wheel position, then the circuit is normal.

Steering Wheel Position	TEMS Indicator		
	Left	Center	Right
Turned to the left more than 45°.	Blink	OFF	OFF
Turned to the right more than 45°.	OFF	OFF	Blink
In the straight ahead position.	Blink	OFF	Blink

The indicator will blink once every 1.0 second.



2) Shock Absorber Damping Force Check

When the TEM and E₁ check terminals are connected and the ignition switch turned on, the actuators' position can be set at a Soft or Firm depending on the selector switch position. At this time, the damping force can be checked by rocking the body.

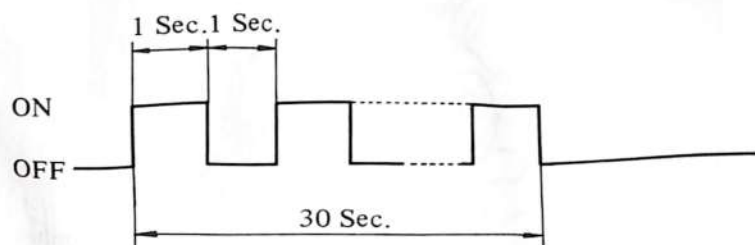
Selector Switch	Actuator	TEMS Indicator
NORMAL	Set at Soft	Differs depending on the steering wheel turning angle (Refer to the table in 1) above.)
SPORT	Set at Firm	All 3 lamps light up.

7. Fail-safe Function

If an abnormality occurs with the actuator circuit, current flowing to the actuators stops and the TEMS indicator comes on informing the driver that trouble has occurred.

- When the actuator is shorted.

The center lamp of the TEMS indicator flashes at 1 second intervals for about 30 seconds, then goes off. Then at that time, the left and right indicator lamps of the TEMS indicator go off.

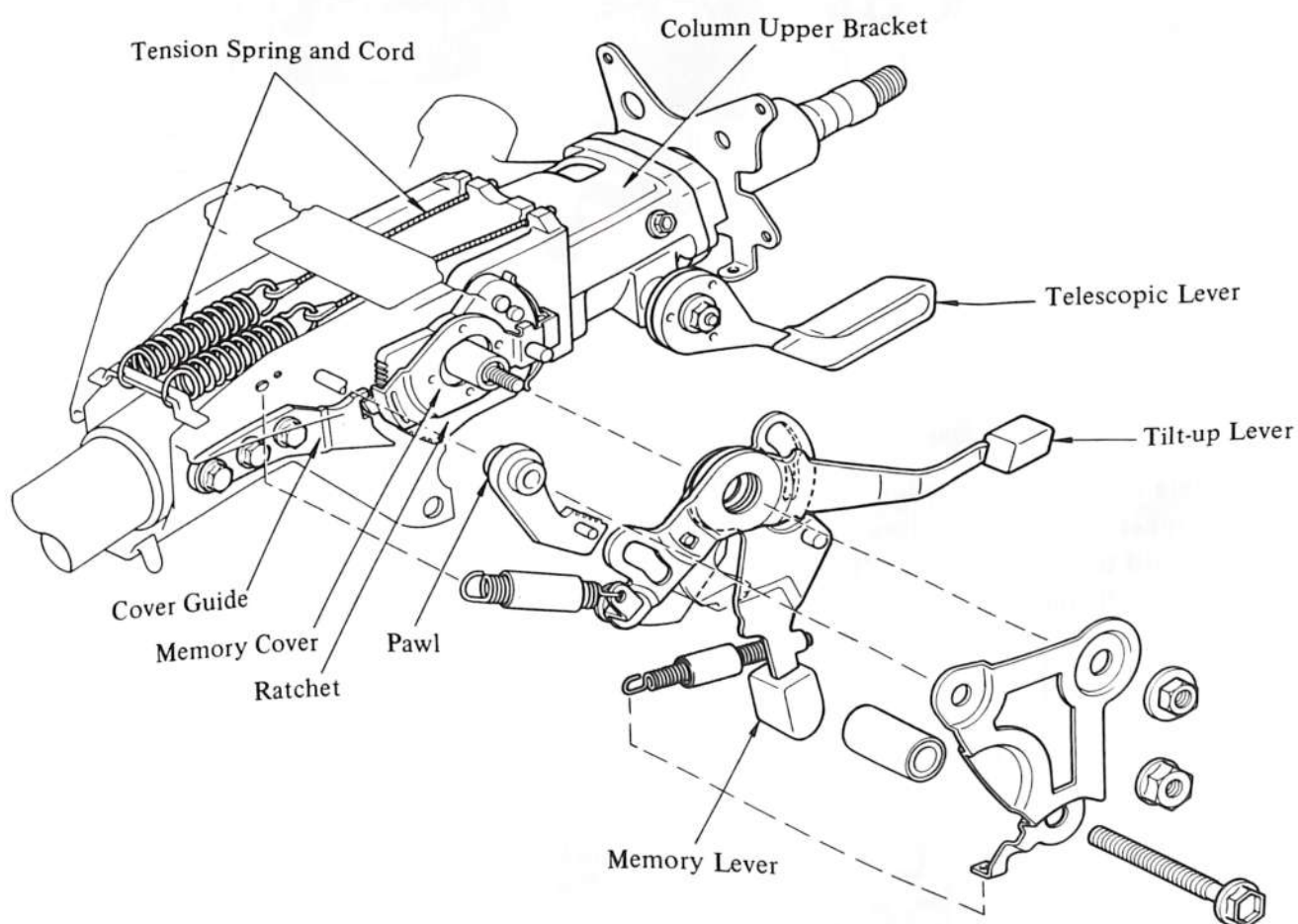


STEERING

MEMORY TILT AND TELESCOPIC STEERING

The memory tilt and telescopic steering system is composed of the tilt-up lever which tilts the steering wheel up, the memory lever, which sets the steering wheel in the desired vertical position, the telescopic lever, which sets the steering wheel in the desired forward-backward position, and other related components.

The main operation consists of the memory mechanism which locks the steering wheel in the original position after it has been tilted up, and the telescopic mechanism, which locks the steering wheel in the desired position in the forward-backward direction.

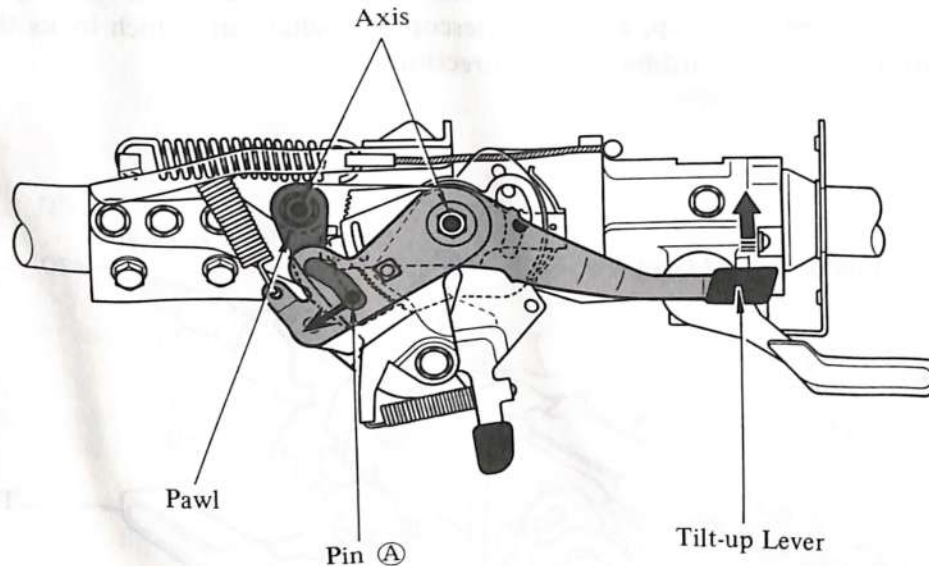


MEMORY MECHANISM

1. Tilt Mechanism

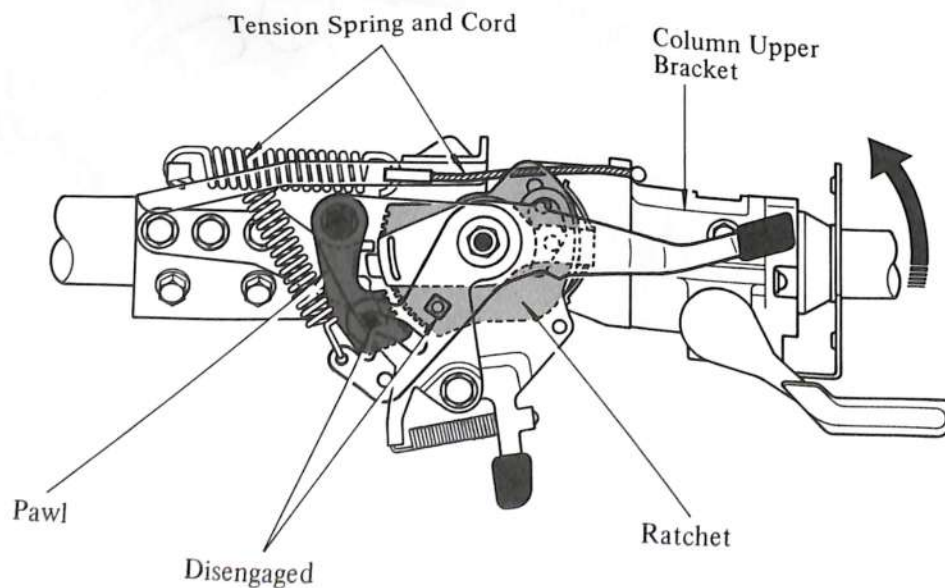
If the tilt-up lever is pulled up (turned counterclockwise), the cam hole of the tilt-up lever pushes pin ① toward the left (turned clockwise).

Since pin ① is installed on the top of the pawl, pin ① and the pawl move as a unit.

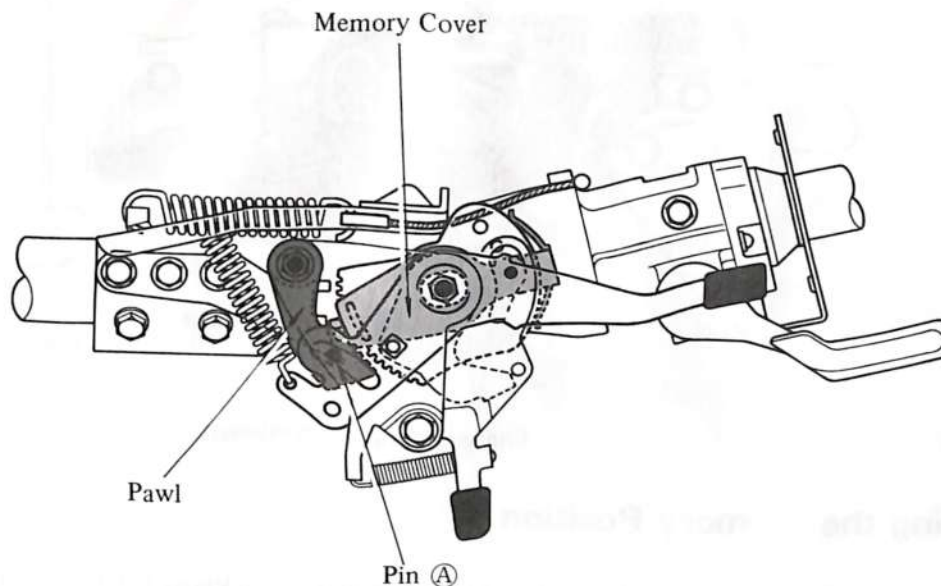


By pushing the pawl to the left side, (turning clockwise), the ratchet, which moves as a unit with the column upper bracket, disengages from the pawl (unlocks). As a result, the column upper bracket is tilted upward to the topmost step by the tension spring and cord.

At this time, the memory cover moves in accordance with the ratchet.

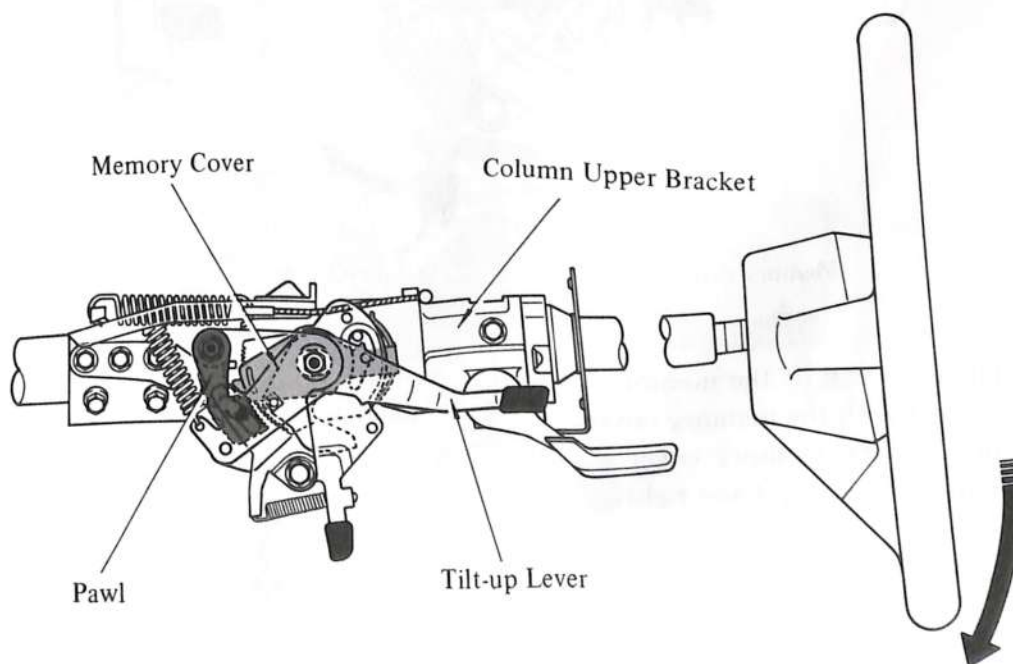


When the column upper bracket is tilted to the topmost step, if the tilt-up lever is released, pin ① on the pawl is moved by the cam hole of the tilt-up lever toward the right (turned counterclockwise), but since the claw of the ratchet is covered by the memory cover, the pawl stops when it is on top of the memory cover and it cannot engage with the ratchet. (lock cancel condition)

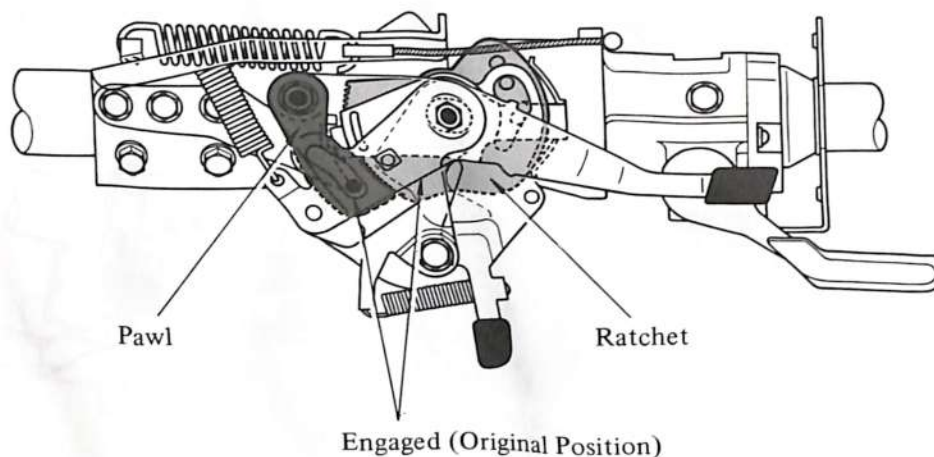


When the column upper bracket is lowered gradually from the topmost step, it drops down as long as the pawl is on the memory cover.

But when the range in which the pawl is on the memory cover is passed, the pawl is engaged with the ratchet by the cam hole of the tilt-up lever. (lock condition)

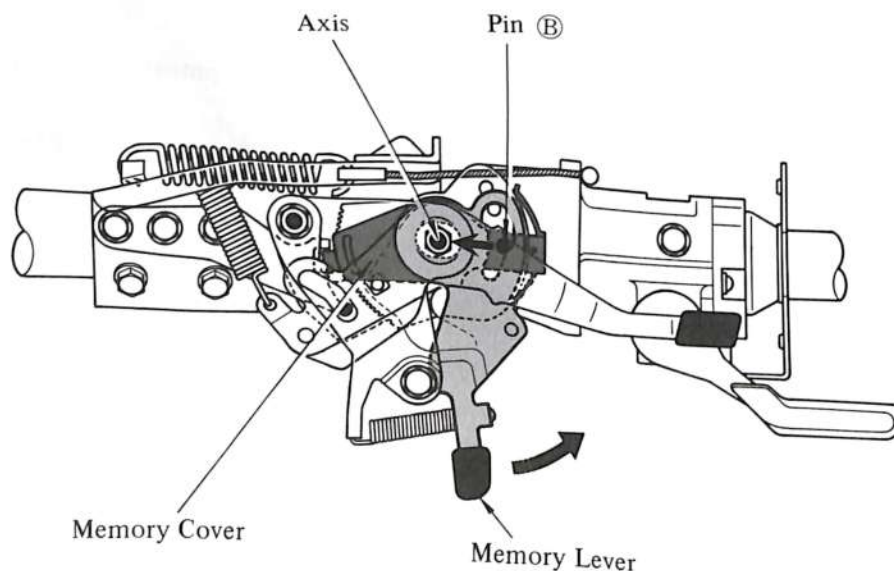


The position at which the pawl engages with the ratchet is the same position as before the column upper bracket was tilted up. (memory mechanism)

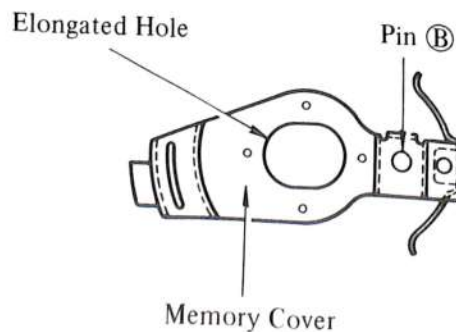


2. Changing the Memory Position

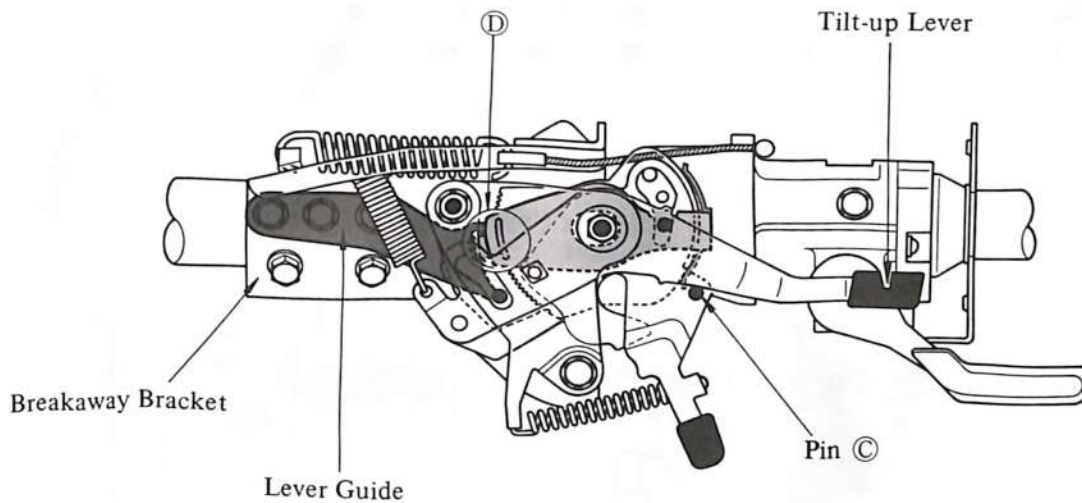
If the memory lever is pulled to the right (turned counterclockwise), the cam hole of the memory lever pushes pin ⑤ to the left.



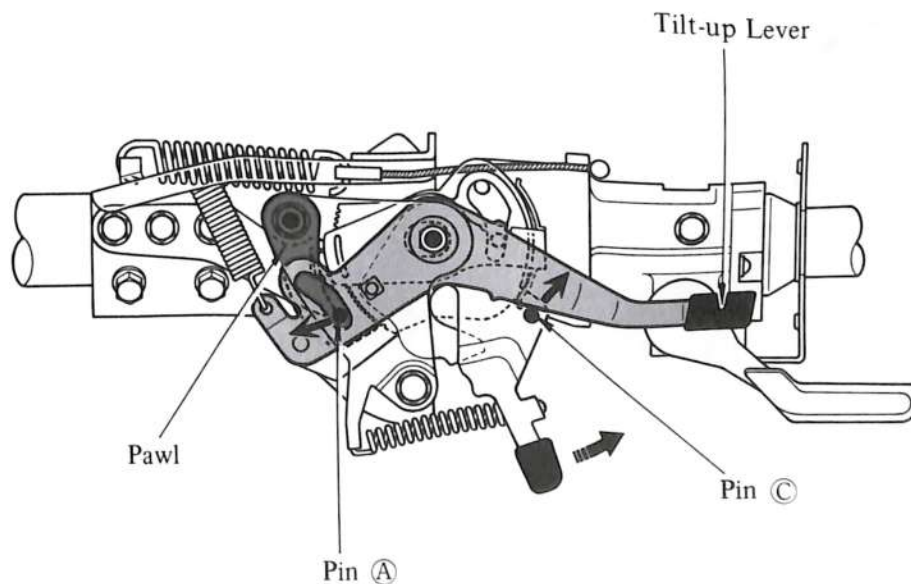
Pin ⑤ is installed on top of the memory cover, and moves as a unit with the memory cover. The center hole in the memory cover is elongated, and it can be moved left and right.



If pin ③ on the memory lever is pulled until it pushes lightly against the tilt-up lever, the memory cover slips into the notch in cover guide ④ fastened to the breakaway bracket and locks in place.

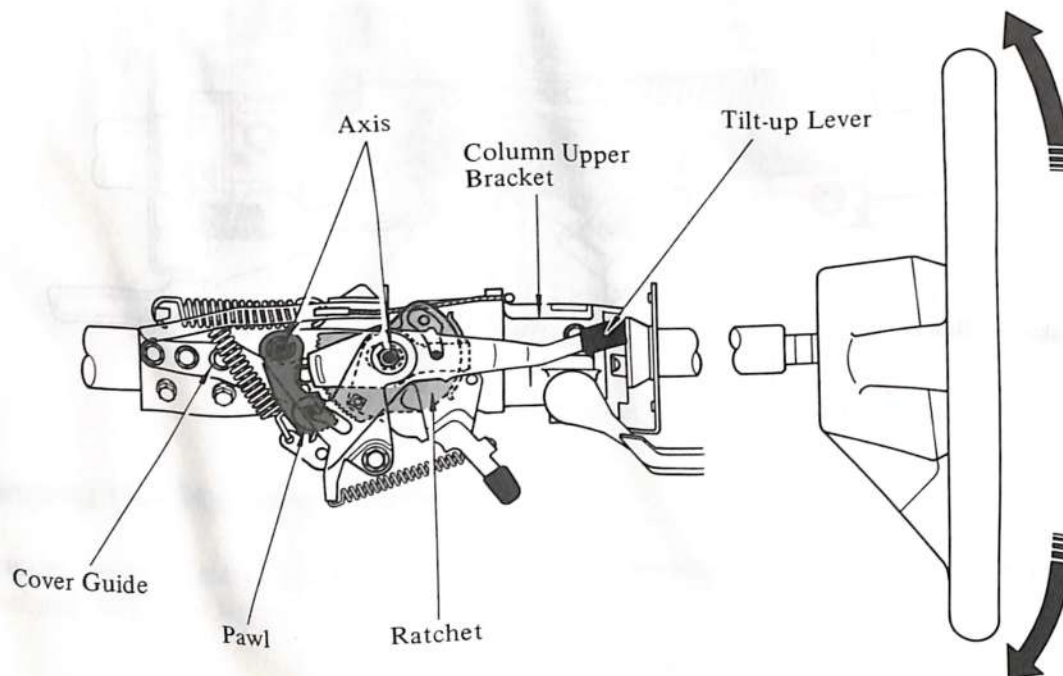


In this condition (with the memory cover locked into the cover guide), if the memory lever is pulled toward the right again (turned counterclockwise), the tilt-up lever is also pulled toward the right by pin ③ on the memory lever (turned counterclockwise). At this time, the cam hole of the tilt-up lever pushes pin ① on the pawl to the left (turns clockwise).

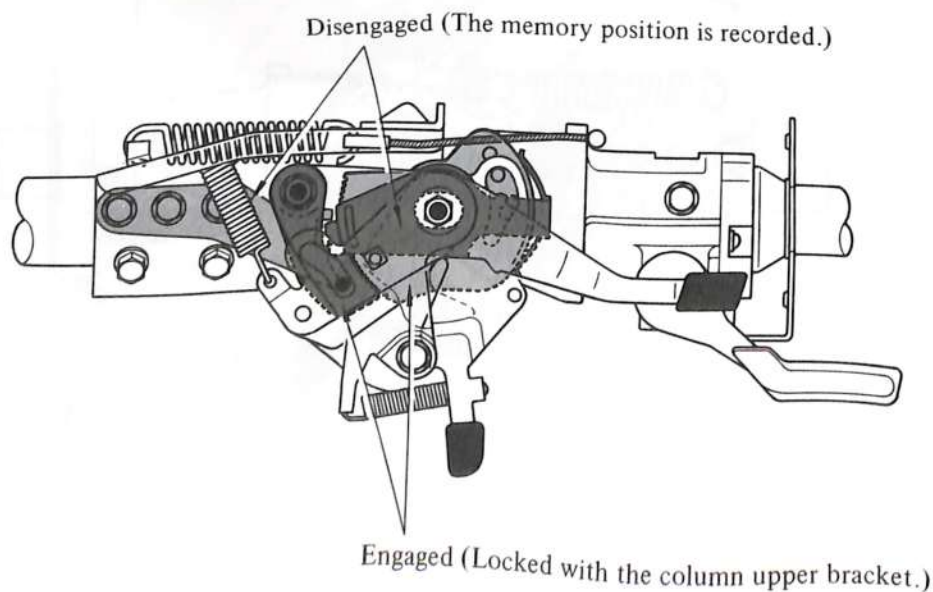


Since the pawl is pushed toward the left by the tilt-up lever (turned counterclockwise), the ratchet, which moves as a unit with the column upper bracket, is disengaged from the pawl. As a result, the column upper bracket can be moved to any position desired.

The memory position is changed by changing the relative positions of the ratchet and the memory cover (locked with the cover guide).



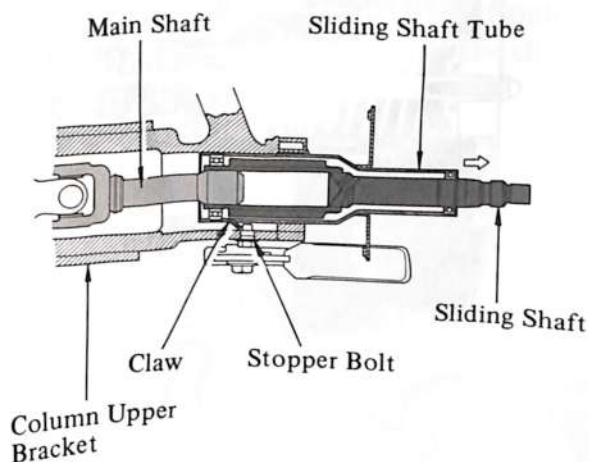
After aligning the column upper bracket (ratchet) in the desired position, if the memory lever is released, the column upper bracket is locked in place since the pawl engages with the ratchet. The memory cover comes out of the notch in the cover guide and returns to the original position. This movement is the recording of the memory position.



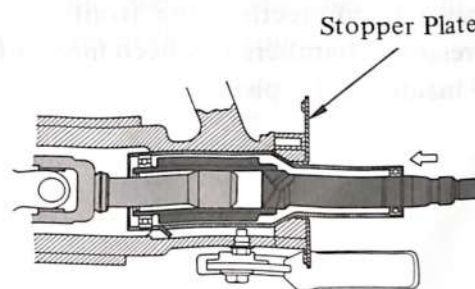
TELESCPIC MECHANISM

The sliding shaft is splined to the main shaft, and along with transmitting the turning of the steering wheel, it also slides on the main shaft. The sliding shaft is supported inside the sliding shaft tube by bearings and the shaft and tube slide together inside the column upper bracket.

In the pull out direction, the sliding range is up to the point where the claw on the sliding shaft tube contacts the stopper bolt and in the push in direction, it slides until the stopper plate contacts the column upper bracket.

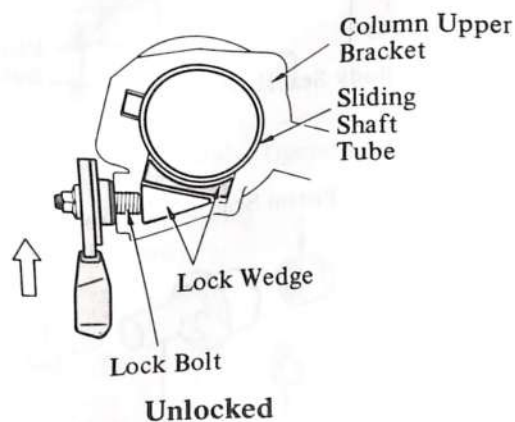
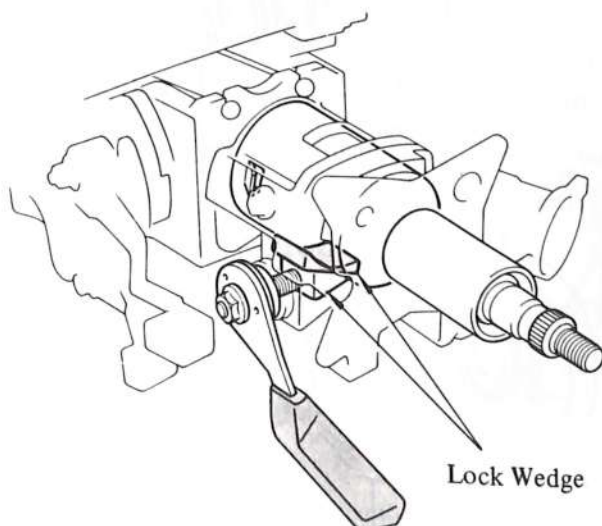


Pull out direction

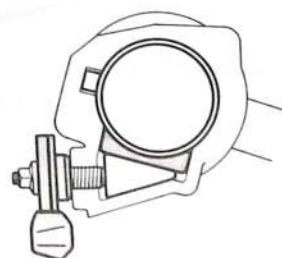


Push in direction

Locking the steering wheel in the forward-backward direction is accomplished by tightening the 2 wedge locks built into the column upper bracket against the outer surface of the sliding shaft tube with a lock bolt.



Unlocked



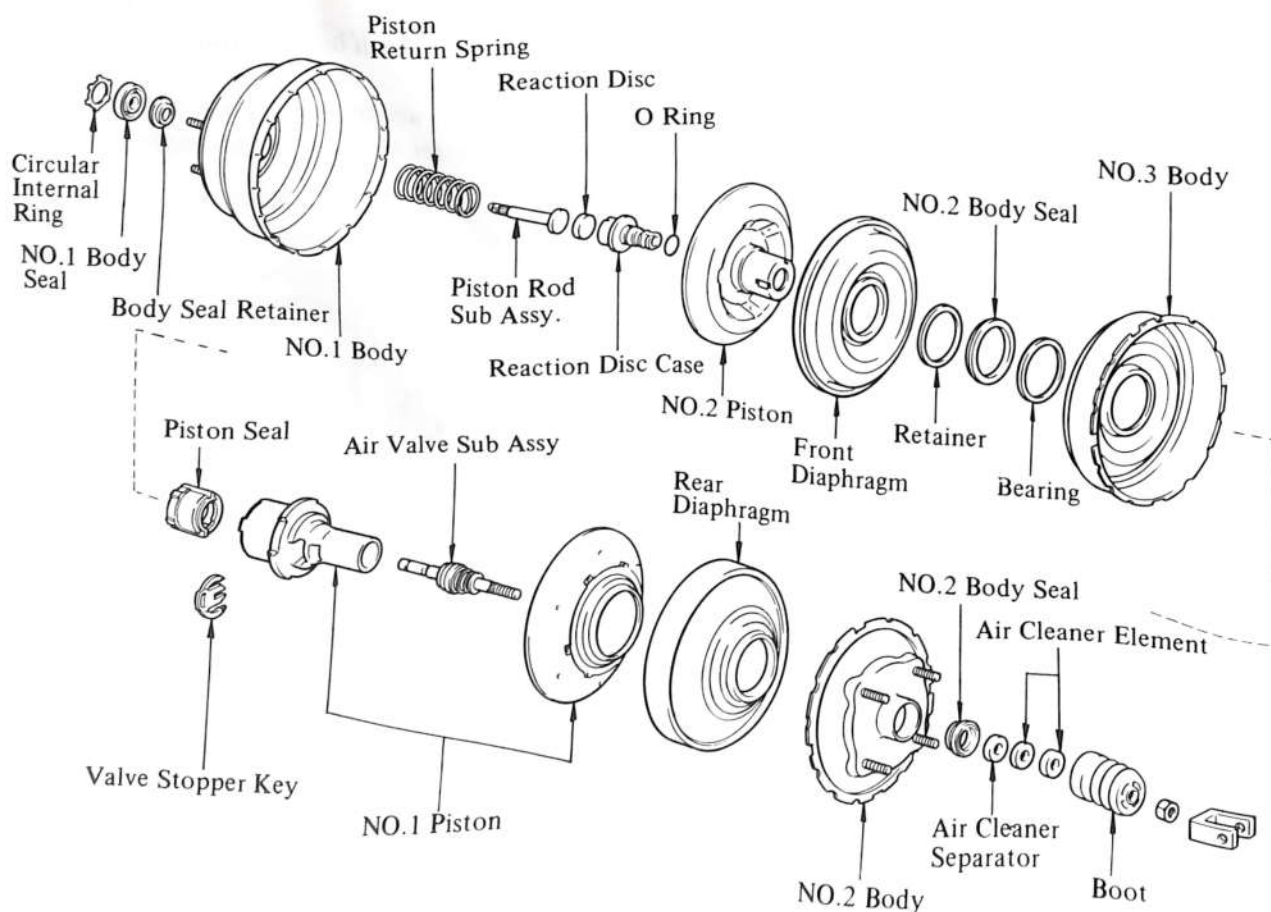
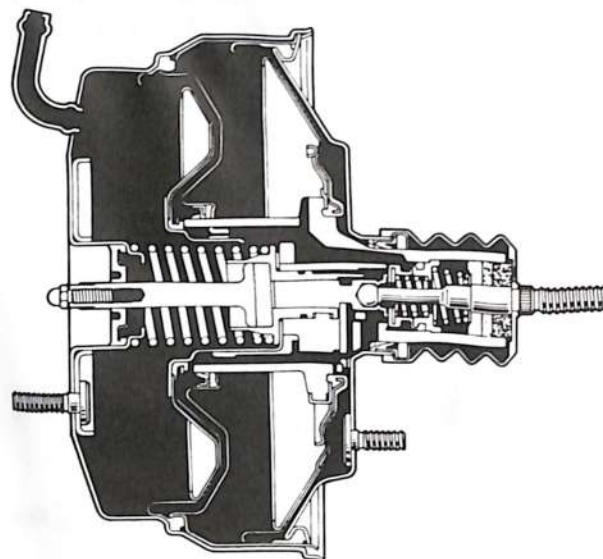
Locked

BRAKES

TANDEM TYPE BRAKE BOOSTER

The tandem type brake booster is a compact and extremely powerful unit having two vacuum chambers (8 inch diameter in the front, 9 inch diameter in the rear).

Basically, it is built and operates the same as the conventional 7.5-inch tandem type brake booster. The air passage connecting the front and rear variable pressure chambers has been moved from outside to inside of the piston.

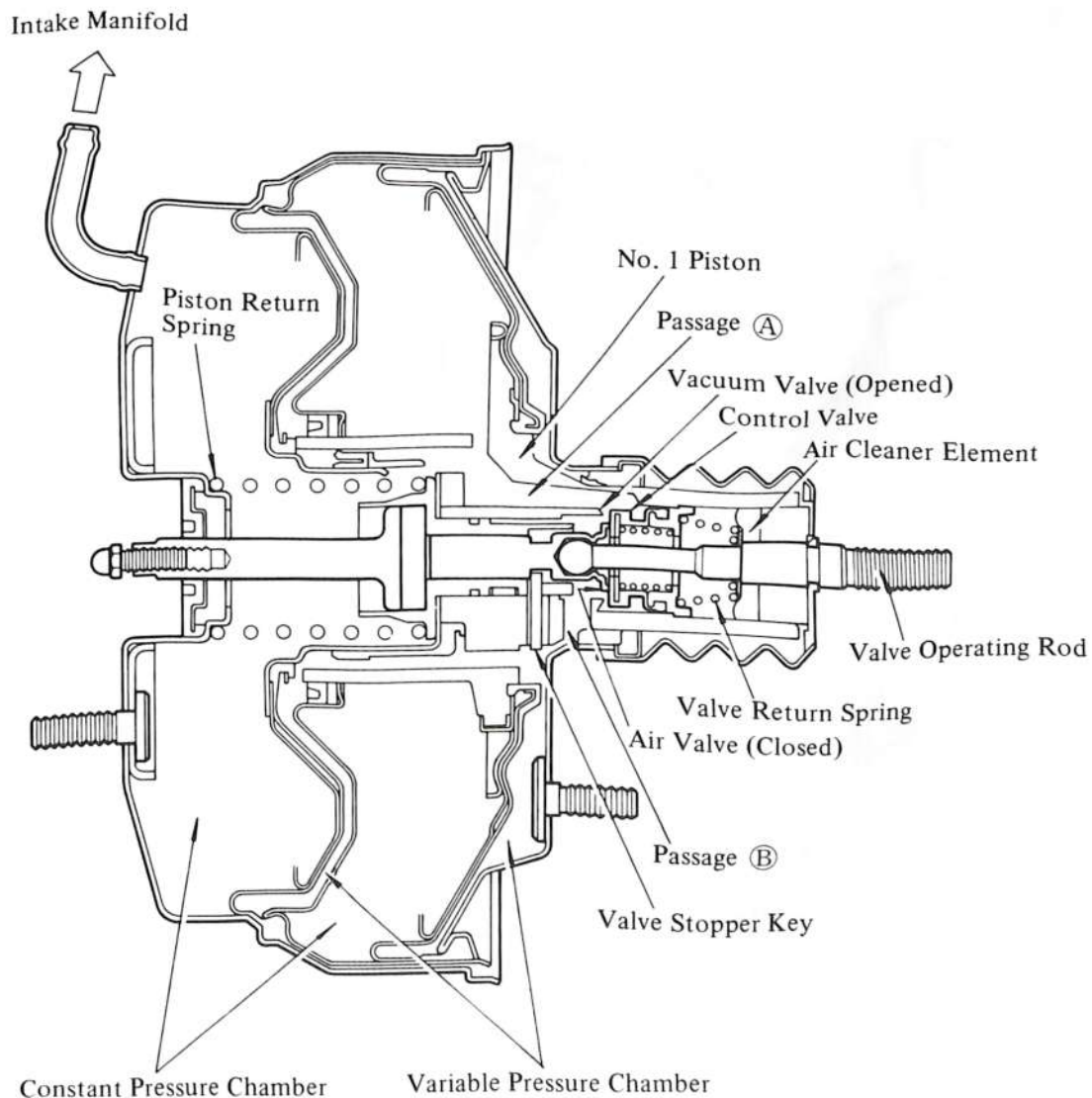


OPERATION

Non-operating State

When there is no force on the valve operating rod, the air valve and valve operating rod are pushed to the right by the tension of the valve return spring and stop when they make contact with the valve stopper key. At this time, since the air valve pushes the control valve back toward the right, the passage, through which atmospheric air from the air cleaner element enters the booster, is closed. On the other hand, the vacuum valve and the control valve are separated, so passage ① leads to passage ②.

Therefore, both the constant pressure chamber and the variable pressure chamber conduct air and there is no difference in the pressure in the chambers on both sides of the piston.

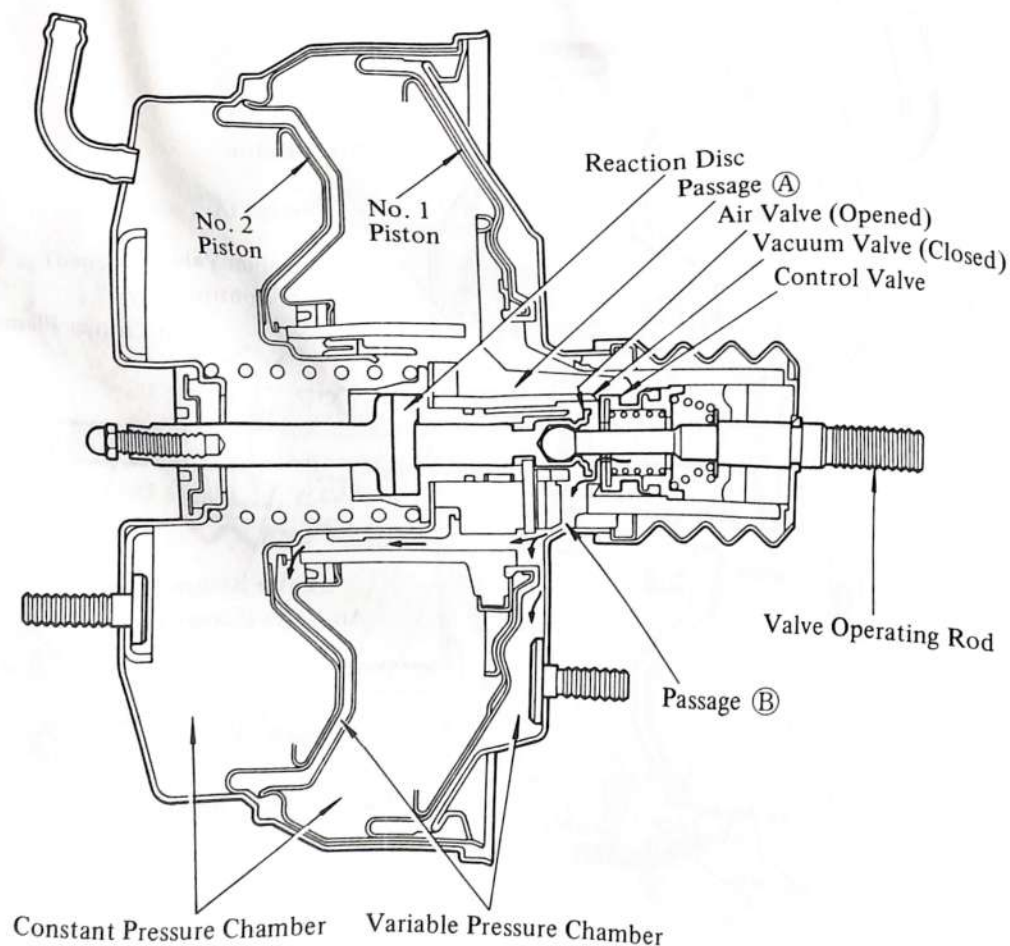


Operating State

When the brake pedal is depressed, the valve operating rod and air valve are pushed to the left together. As a result, first, the control valve and vacuum valve are in contact cutting off the continuity between passage ① and ② (the continuity between constant pressure chamber and variable pressure chamber).

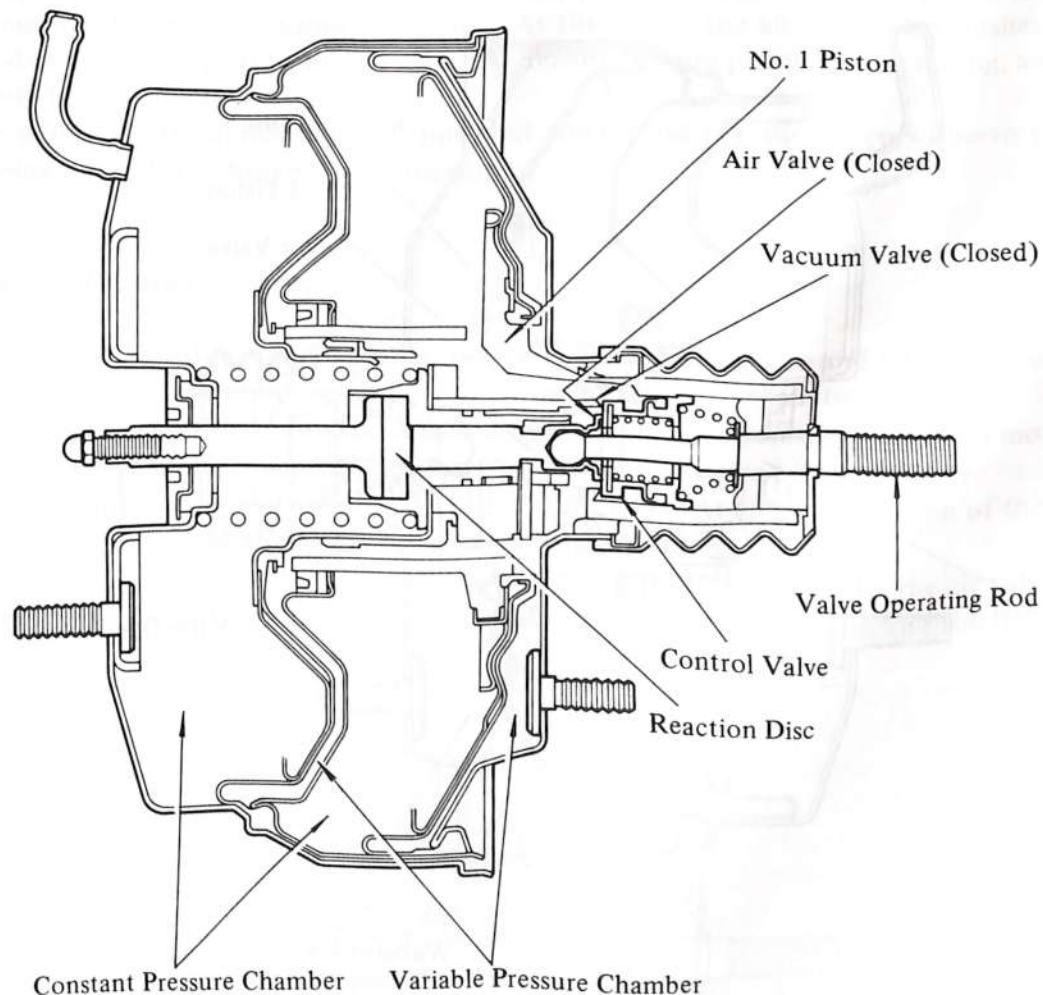
Next, the air valve is separated from the control valve and atmospheric air from the air cleaner element passes through passage ② and enters the variable pressure chamber. This generates a pressure difference between the variable pressure chamber and the constant pressure chamber and the pistons move to the left.

The piston force, occurring due to the pressure difference, is transmitted to the reaction disc via the reaction disc case. It is further transmitted to the master cylinder push rod and forms the booster output force. The pressure contact area of pistons No. 1 and No. 2, multiplied by the pressure difference between the constant pressure chamber and variable pressure chamber, equals the booster output force.



Holding State

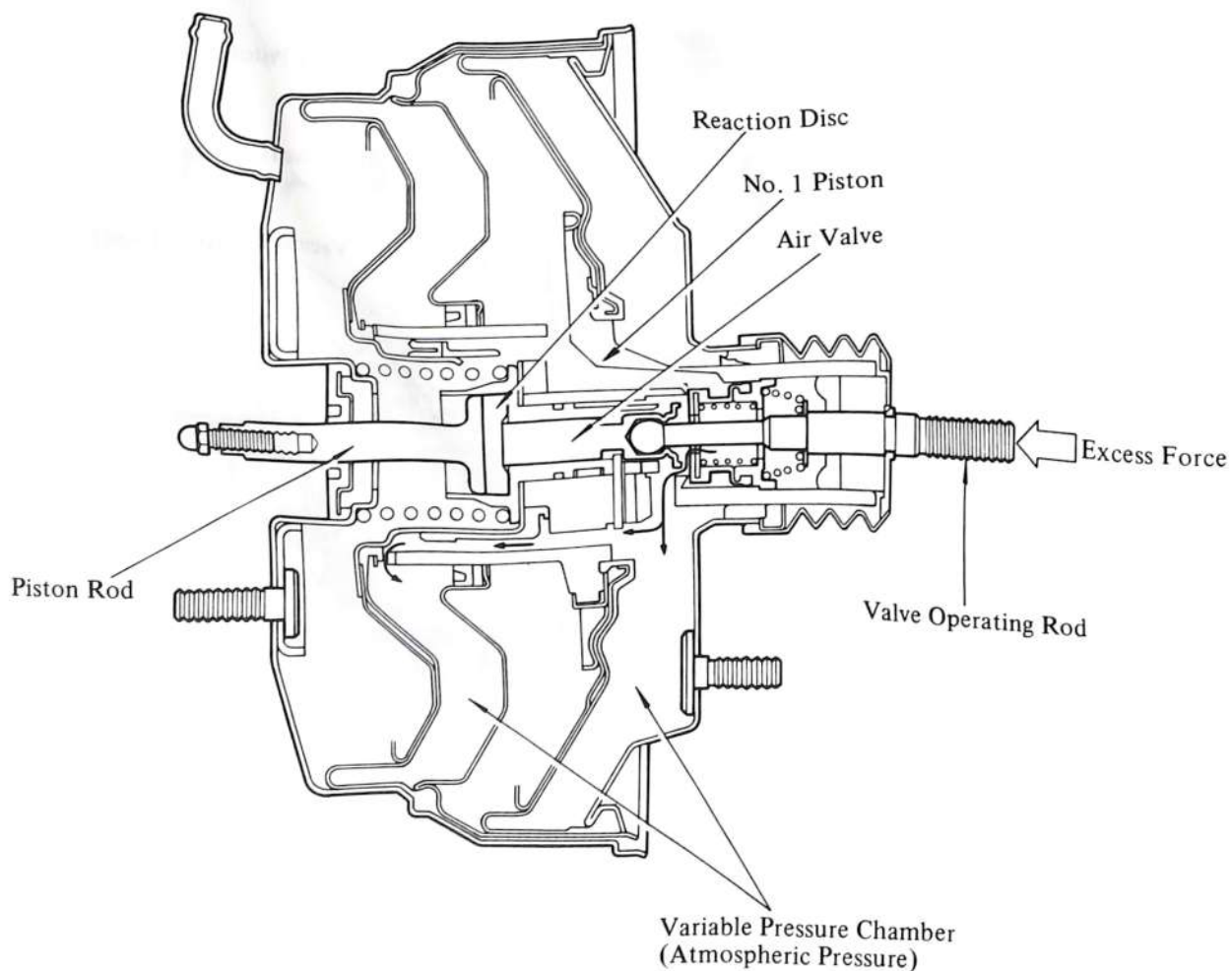
When the brake pedal is depressed, the force applied on the air valve via the valve operating rod and the force on the piston, resulting from the pressure difference (between the constant pressure chamber and variable pressure chamber) will push the reaction disc. Consequently, the central portion of the reaction disc (portion touching the air valve) is pushed back. If the air valve has a balanced pressure on it, the control valve will be making contact with the air valve and vacuum valve.



Maximum Boosting State

When a greater pressure is applied to the brake pedal, the variable pressure chamber will be fully supplied with atmospheric pressure and the pressure difference applied on the piston will be at maximum. Any force exceeding this will not have an effect on the piston operation.

If the brake pedal is depressed even further, there will no longer be a balance between the reaction disc and air valve, so the excess force will then be applied on the piston rod.



Released State

As pedal pressure is reduced, the reaction disc and air valve will no longer be balanced so the air valve will be pushed back toward the right, making contact with the control valve and shutting off the variable pressure chamber from entry of atmospheric air. At the same time, it will push back the control valve and open the vacuum valve.

Consequently, the air in the variable pressure chamber will be drawn into the constant pressure chamber, cancelling out the pressure difference between the two. The piston assembly will be pushed back to a non-operating state by the piston return spring.

No Vacuum Condition

In this case, both the constant pressure chamber and variable pressure chamber are supplied with atmospheric air.

If the brake pedal is depressed, the valve operating rod pushes the air valve and moves to the left, making contact with the reaction disc. The reaction disc pushes against the master cylinder push rod which, in turn, pushes the master cylinder piston. At this time, the air valve also pushes the valve stopper key fitted in the No. 1 piston, overcoming the tension of the piston return spring, and pushing the piston assembly toward the left.

Of course, there is no booster action at this time, but since fluid pressure occurs due to the master cylinder piston being pushed, the brakes will function.

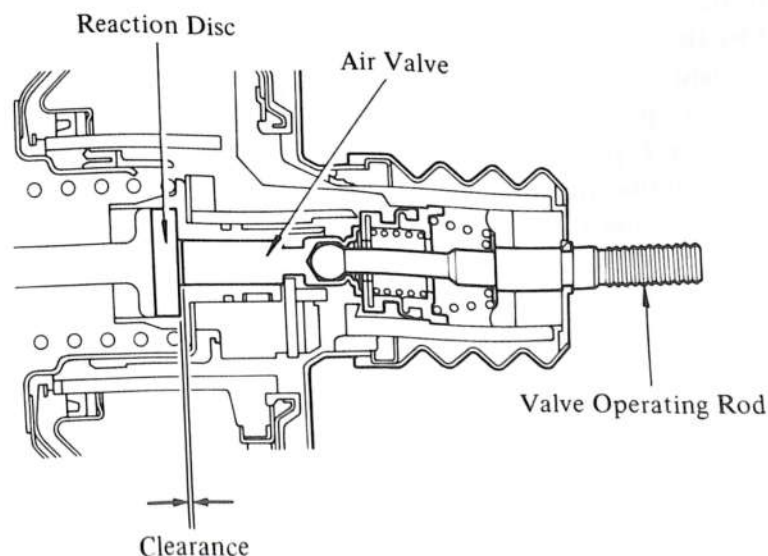
Dynamic Booster Action

During a non-operating state, due to a clearance between the reaction disc and air valve, booster output power will occur to a certain point, regardless of force on the valve operating rod.

In other words, the instant the vacuum valve closes and the air valve opens, No. 1 piston moves to the left, producing booster output force so that the force on the operating rod has no effect.

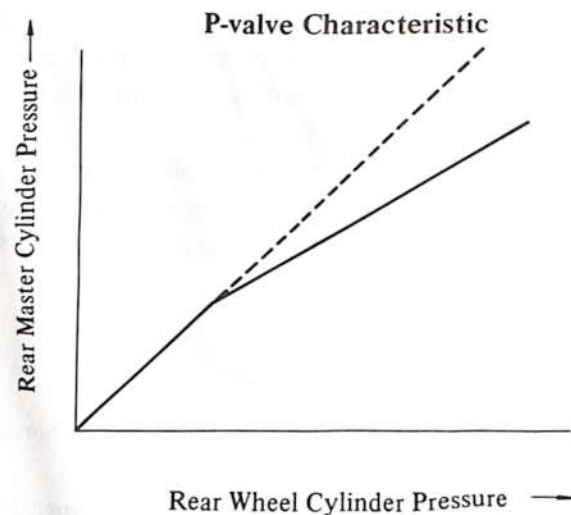
Consequently, there is little reaction force on the operating rod. At the termination of the dynamic action, the reaction disc and air valve are in contact with each other.

The force on the valve operating rod is transmitted to the reaction disc, through the air valve. Therefore, force on the piston rod is the sum of the assist force occurring in the piston and the force applied to the operating rod.



P&BV (Proportioning and Bypass Valve)

A single bore type P & BV has been adopted in place of the former two bore type. Opening of the bypass circuit conducted by the B valve piston in the two bore type is accomplished by the sleeve in the single bore type.



OPERATION

1. Normal Condition

- When the hydraulic pressure P_r from the master cylinder rear is low, the piston is pushed toward the left in the figure by the force F of the spring. This hydraulic pressure P_r is transmitted from chamber (A) to the rear wheel cylinder through the valve and chamber (B).

The forces acting upon the piston at this time are as follows.

Force pushing to the right = $P_r \times S_1$

Force pushing to the left = F

$F > P_r \times S_1$

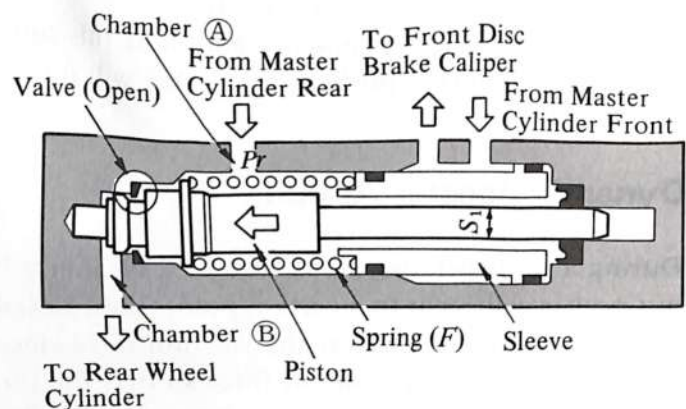
- If P_r rises and $P_r \times S_1$ become larger than F , the piston is pushed to the right and the valve closes. At that time, the hydraulic pressure P_w transmitted to the rear wheel cylinder will be that indicated by the point of deflection in the graph above right. While the valve is closed, the force $P_r \times S_1$ pushing the piston to the right and the force F pushing the piston to the left will be in equilibrium.

Once the valve is closed, the following forces are applied to the piston.

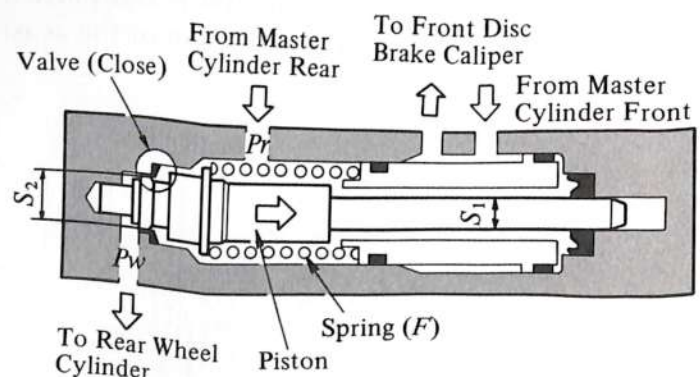
Force pushing to the right = $P_w \times S_2$

Force pushing to the left = $P_r \times (S_2 - S_1) + F$

$P_w \times S_2 = P_r \times (S_2 - S_1) + F \dots \dots \dots (1)$



* The "S#" means the area of these portion



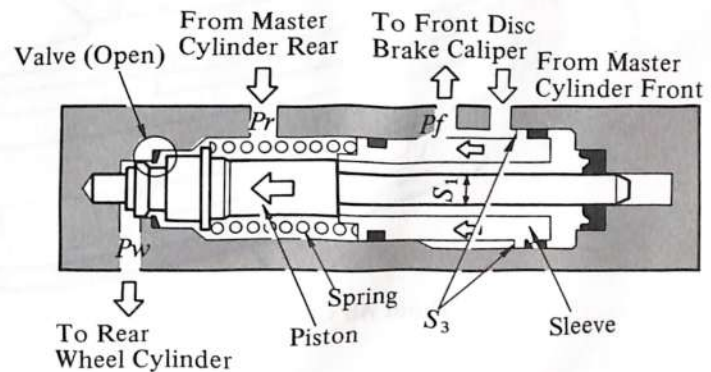
- When P_r is increased further, the piston is pushed again to the left side and the valve opens. If the valve opens, P_w increases, but before P_w and P_r equalize, the piston is pushed to the right and the valve closes.

Increase of P_w is smaller than that of P_r as explained above, and the following equation results from (1).

$$P_w = P_r \times \frac{S_2 - S_1}{S_2} + \frac{F}{S_2} \quad \left(\text{when } P_r \geq \frac{F}{S_1}\right)$$

2. When Front Brake Circuit Fails

- When the front brake circuit is operating normally, the hydraulic pressure P_r from the master cylinder is equal to P_f and the force pushing the sleeve to the right and the pressure pushing it to the left are in equilibrium, so the sleeve is pushed to the right by the spring.
- In the unlikely event that the front brake circuit should develop an abnormality and P_f should drop to zero, the hydraulic pressure acting on the sleeve S_3 , would drop so the sleeve would be pushed to the left, the piston would be pushed to the left and the valve would open. The hydraulic pressure P_r from the master cylinder, therefore, would be transmitted as is to the rear wheel cylinder. And at this time, the following forces are applied to the piston.
 Pushing the piston to the right = $P_r \times S_1$
 Pushing the piston to the left = $P_r \times S_3$



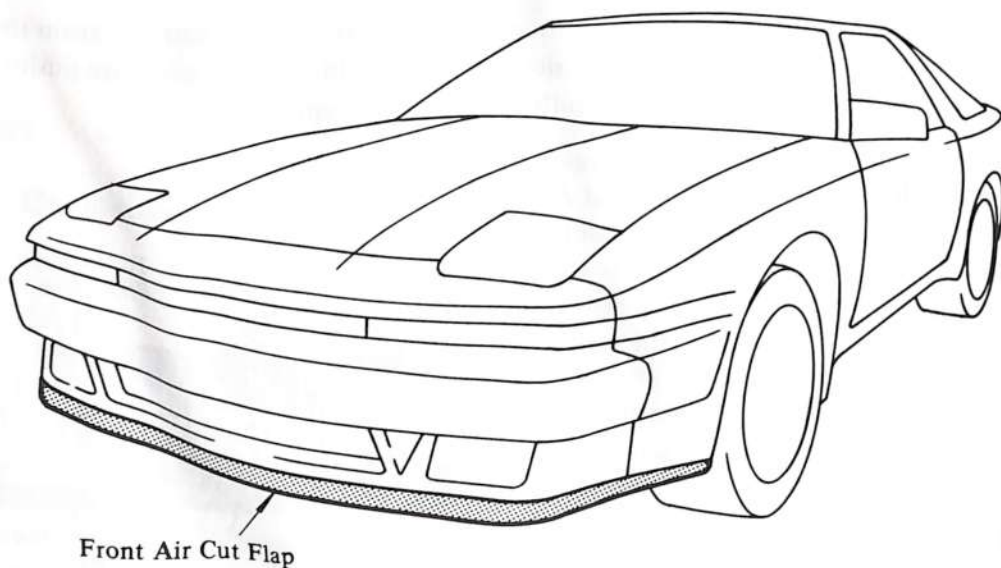
BODY

AERODYNAMICS

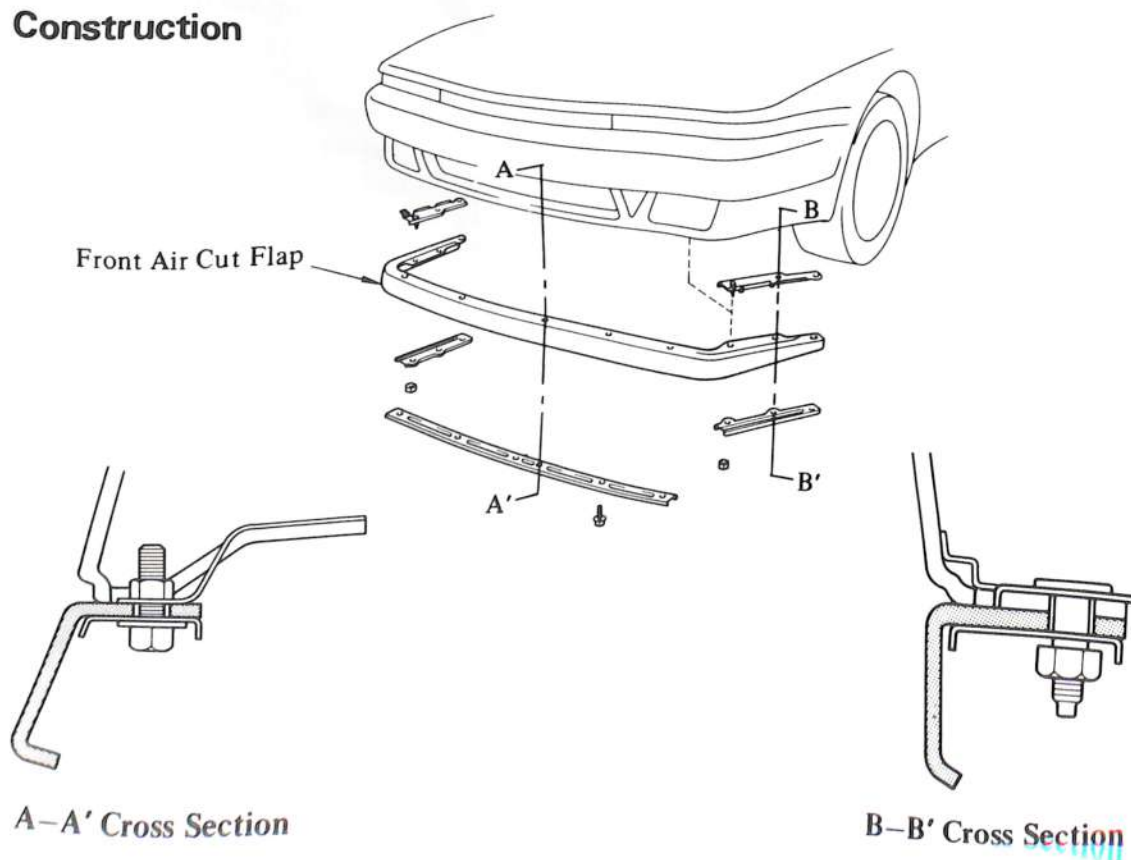
FRONT AIR CUT FLAP

1. Description

- An air cut flap is installed under the front bumper, further improving aerodynamic characteristics.
- The front air cut flap is made of Urethane.



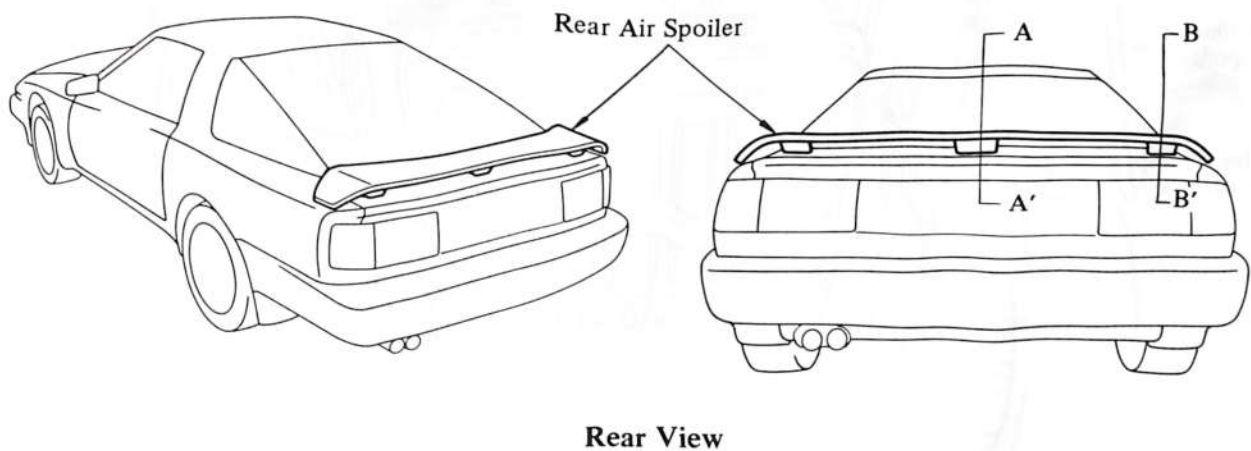
2. Construction



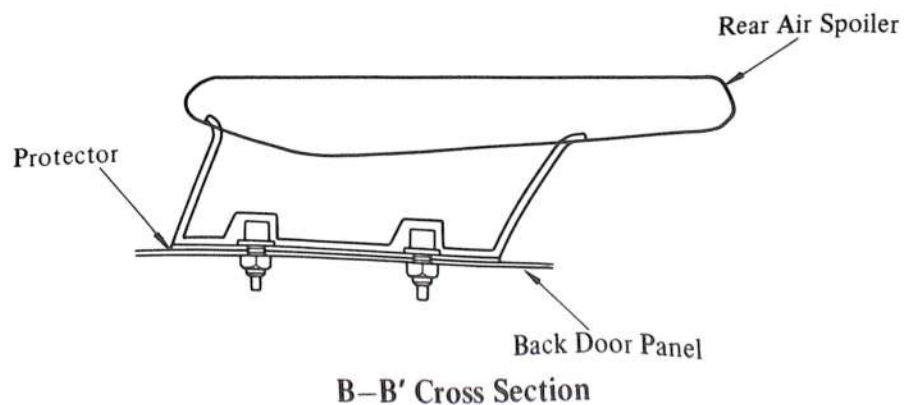
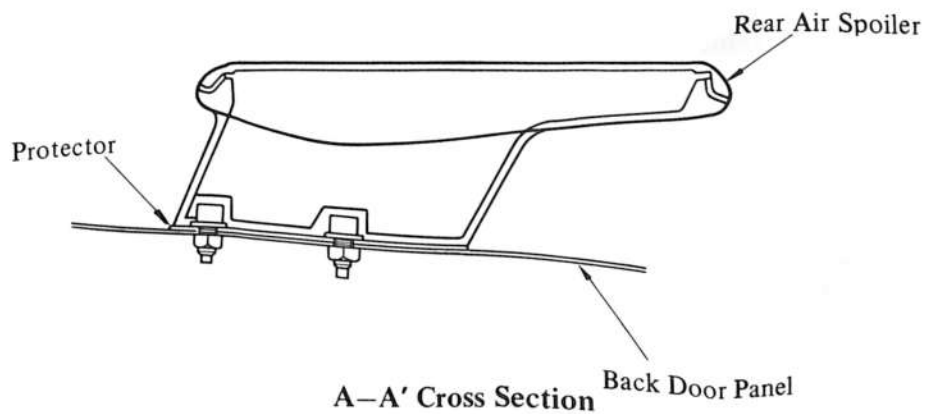
REAR AIR SPOILER

1. Description

- A large wing type rear air spoiler which improves aerodynamic characteristics is mounted on the rear of the back door.
- The rear air spoiler is made of FRP (Fiber Reinforced Plastic). Also, it is painted the same color as the body.



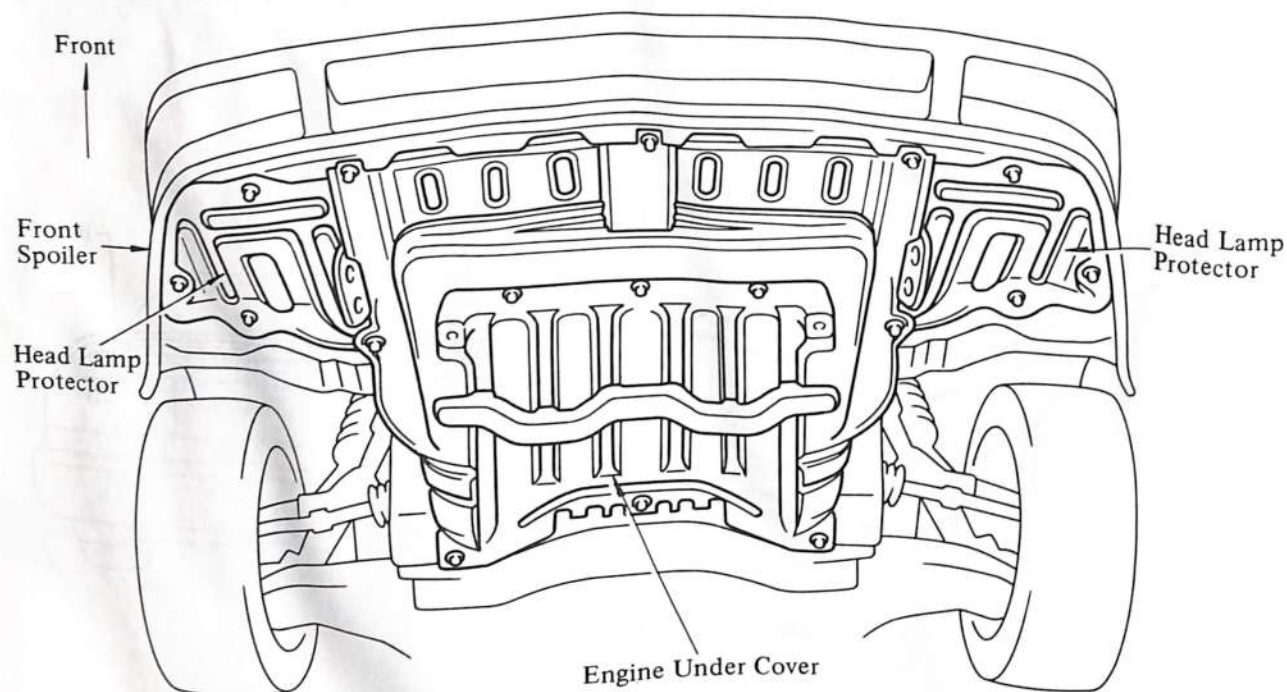
2. Construction



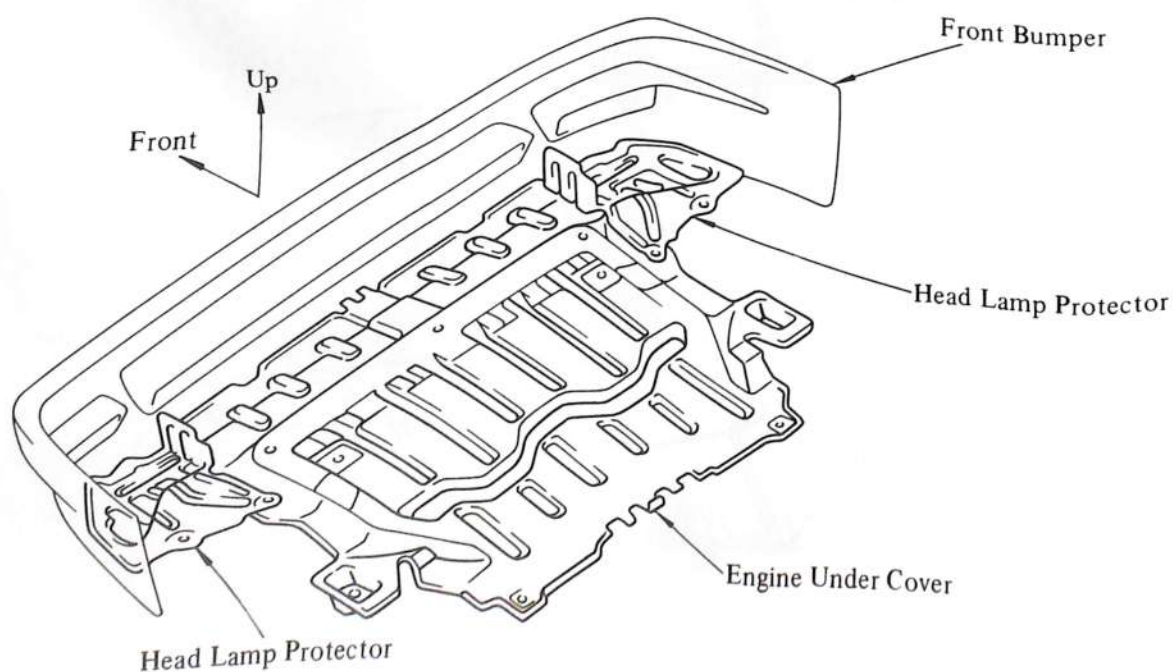
UNDER COVER

Through the installation of the spoiler under the front bumper, the engine under cover and the head lamp protectors, the air flow is smoother and aerodynamic characteristics are improved.

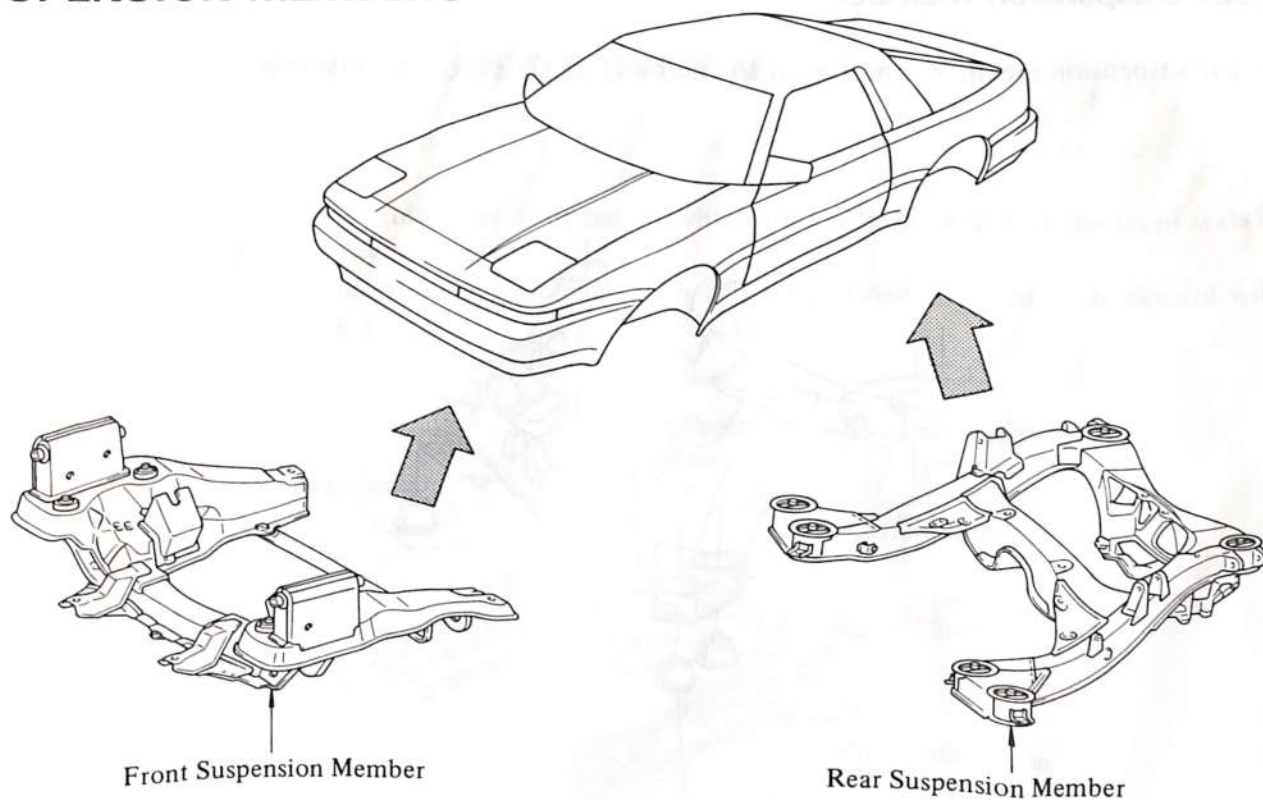
a. Viewed from underneath the vehicle



b. Viewed from inside the vehicle

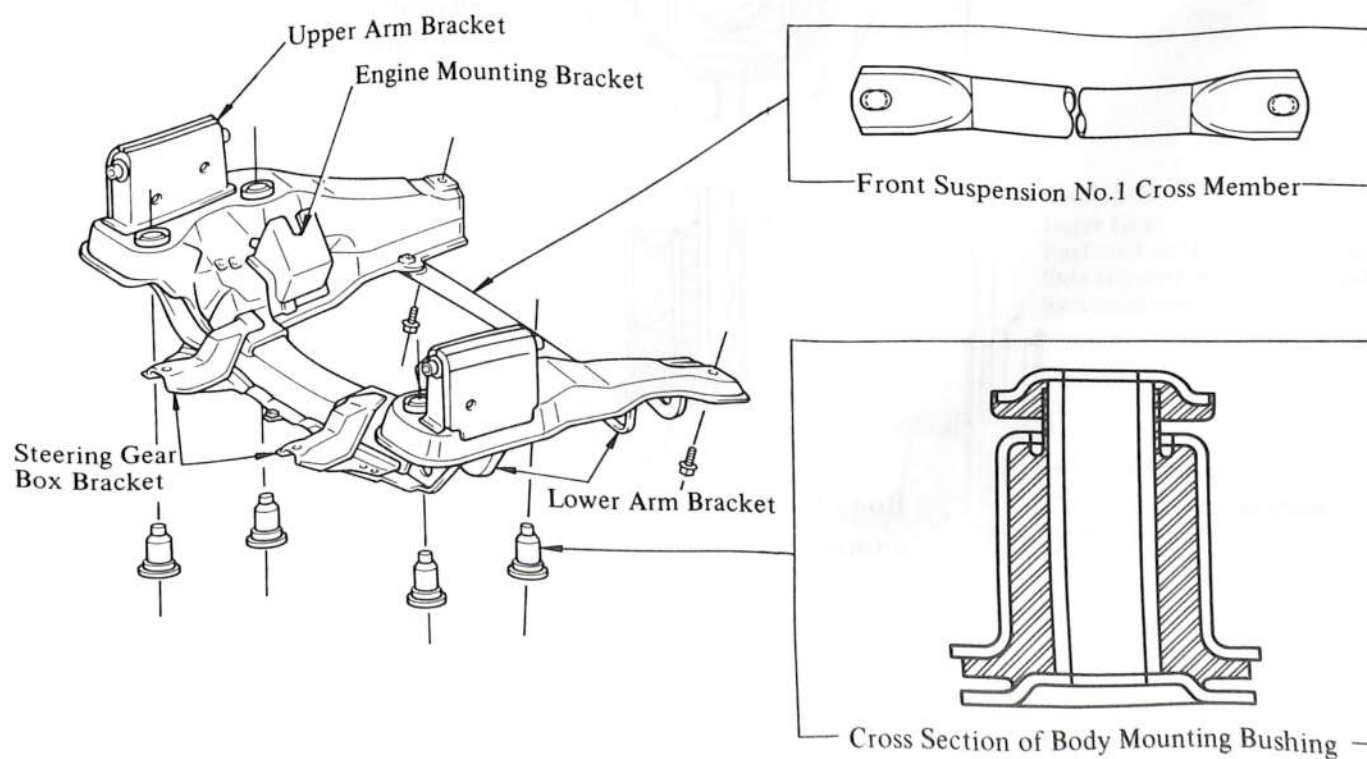


SUSPENSION MEMBERS



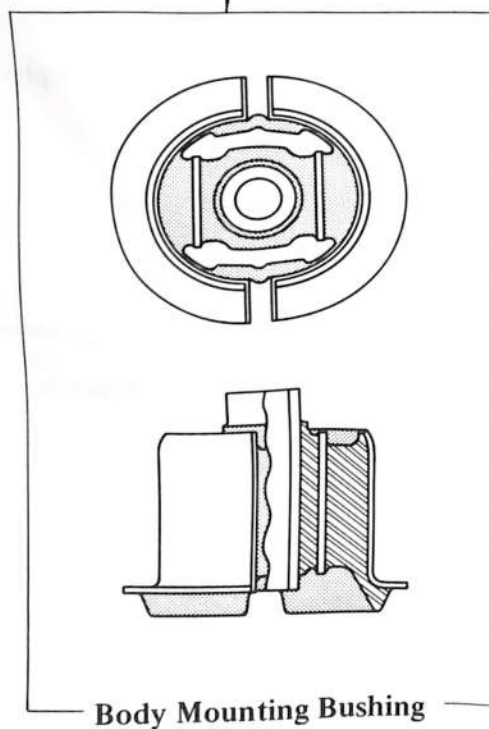
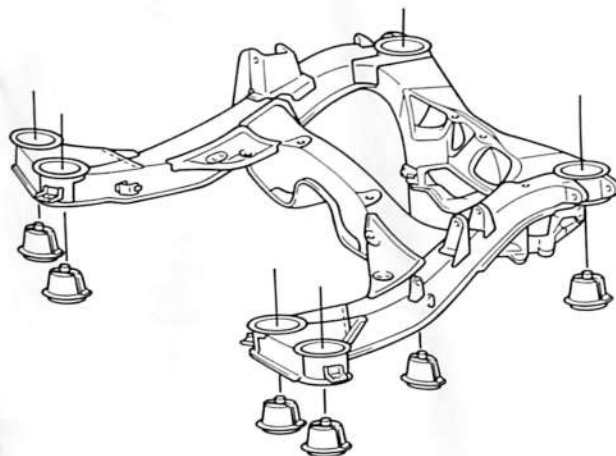
1. Front Suspension Member

- The front suspension member is mounted to the body at four places via bushings and two places via bolts.



2. Rear Suspension Member

- The rear suspension member is mounted to the body at six places via bushings.



Body Mounting Bushing

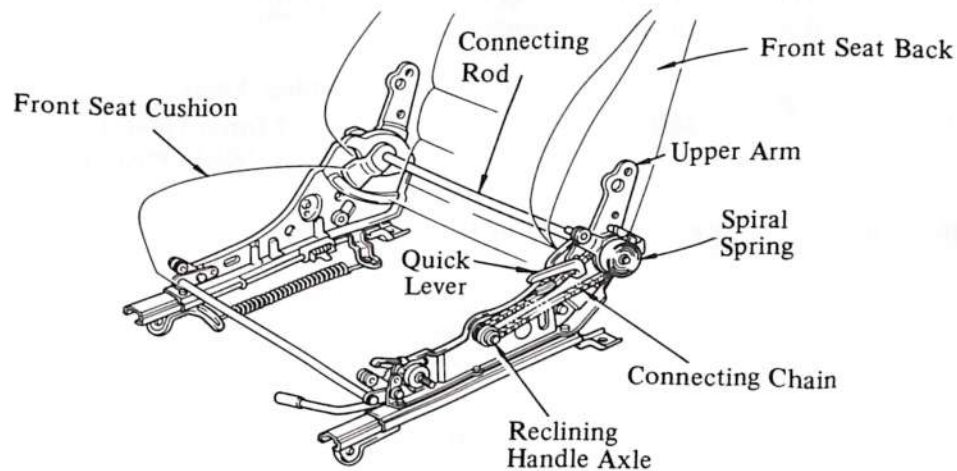
FRONT SEAT

STEPLESS RECLINING ADJUSTER SYSTEM

1. Description

A stepless reclining adjuster system was adopted in which the reclining angle of the front seats (driver and passenger) can be steplessly adjusted.

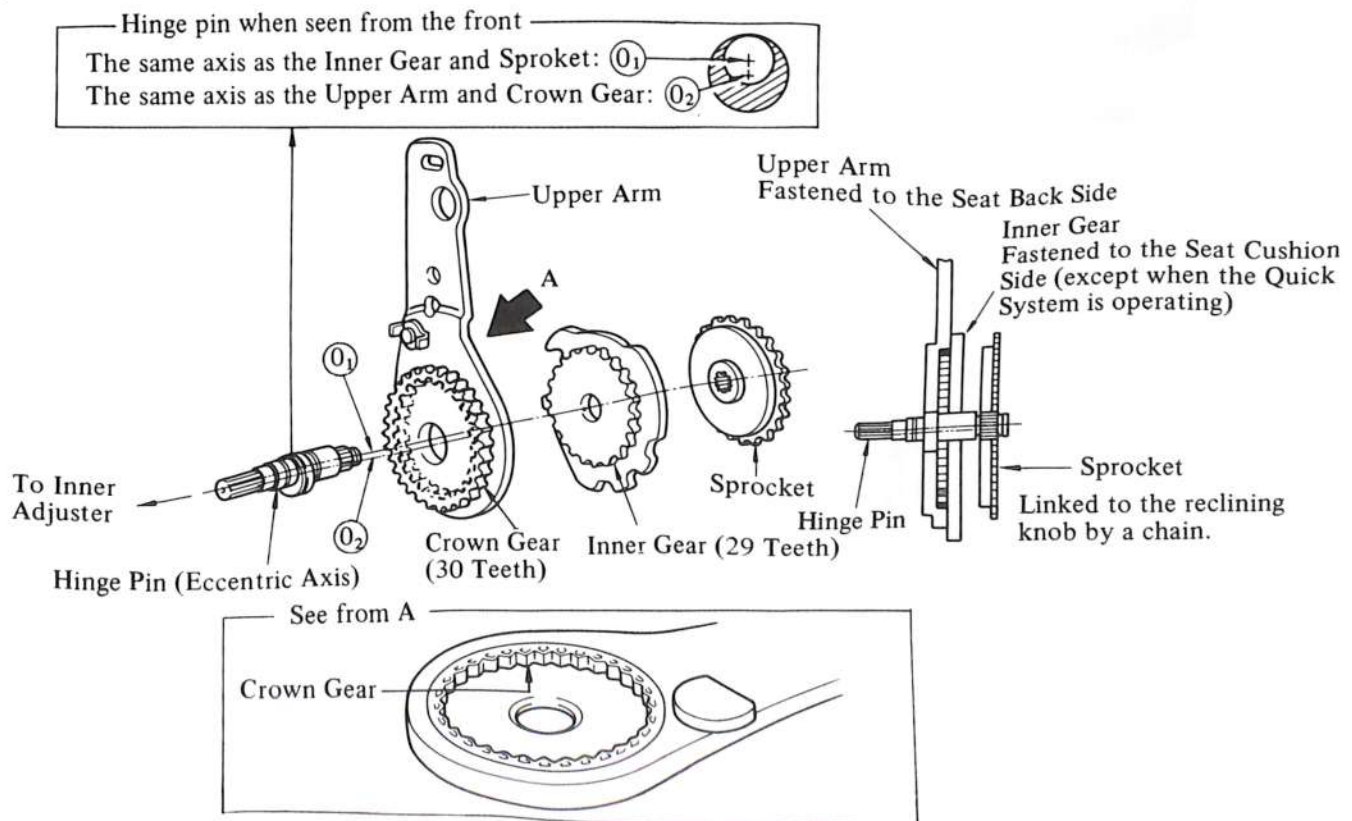
Also, a Quick System was adopted in which the seat can be reclined forward or backward with one touch by operating the Quick Lever.



2. Construction and Operation

STEPLESS RECLINING ADJUSTMENT

1) Construction



2) Operation

- If the reclining adjuster knob is turned, the sprocket, which is linked to the knob by a chain, and the hinge pin, which is linked to the sprocket by serrations, are turned.
- As the hinge pin rotates it raises the upper arm by sliding it against the inner gear.
- Since the inner gear is fastened to the seat cushion side, (except when the Quick System is operating), center O_2 of the upper arm crown gear fastened to the seat back turns with center O_1 of the inner gear as its axis.
- Therefore, the upper arm crown gear turns around the inner gear by the turning of the hinge pin. Furthermore, when the hinge pin has made N turns, the reclining angle of the seat back can be expressed by the following formula.

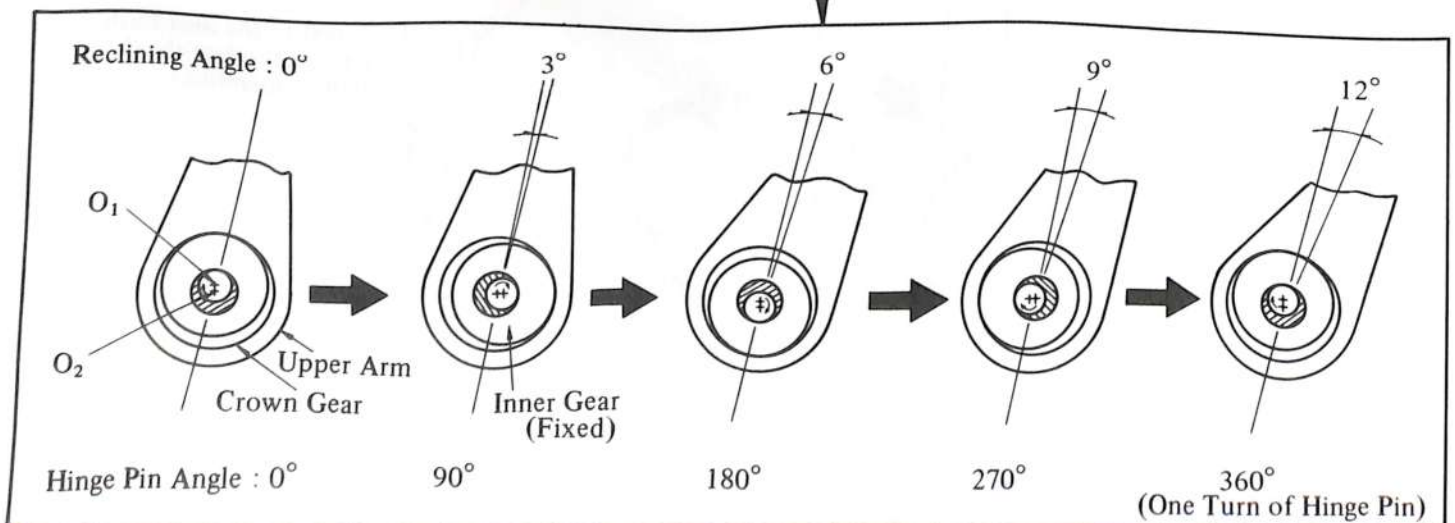
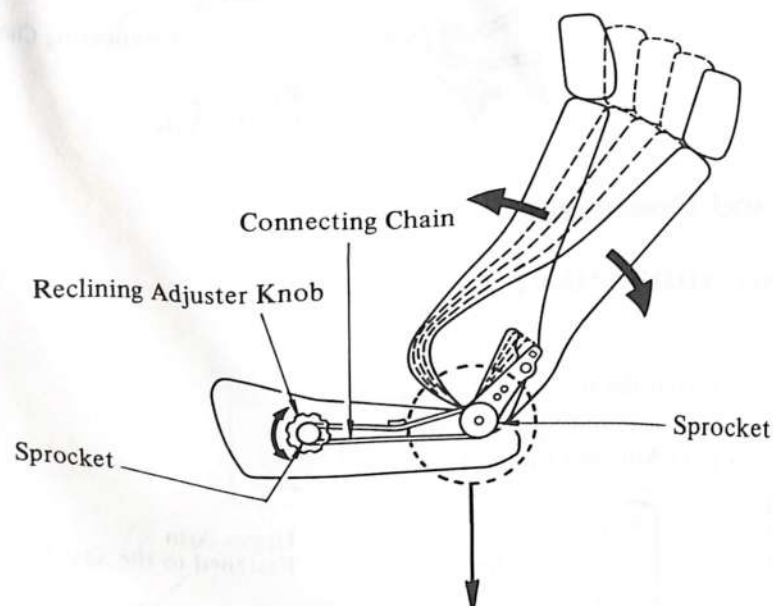
$$\alpha = N \times \frac{Z_2 - Z_1}{Z_2} \times 360^\circ$$

α : Reclining Angle, N : No. of Turns of Hinge Pin

Z_1 : No. of Inner Gear Teeth (29)

Z_2 : No. of Crown Gear Teeth (30)

Therefore, $\alpha = 12^\circ \times N$ and one turn of the hinge pin reclines the seat back 12° .

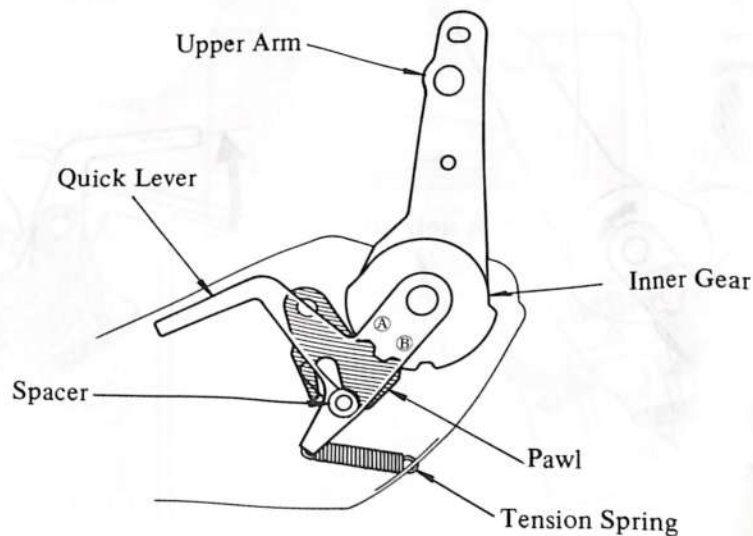


QUICK RECLINING ADJUSTMENT

1. Normal Position

The figure below shows the state where the seat back is locked in the normal position. At this time, the pawl is engaged in the latch on the outer circumference of the inner gear (A, B). Moreover, the spacer which moves as one with the quick lever is pressed by the tension spring on the back surface of the pawl and the pawl is locked with the latch of the inner gear.

Furthermore, in the normal position, the seat back can be steplessly reclined.

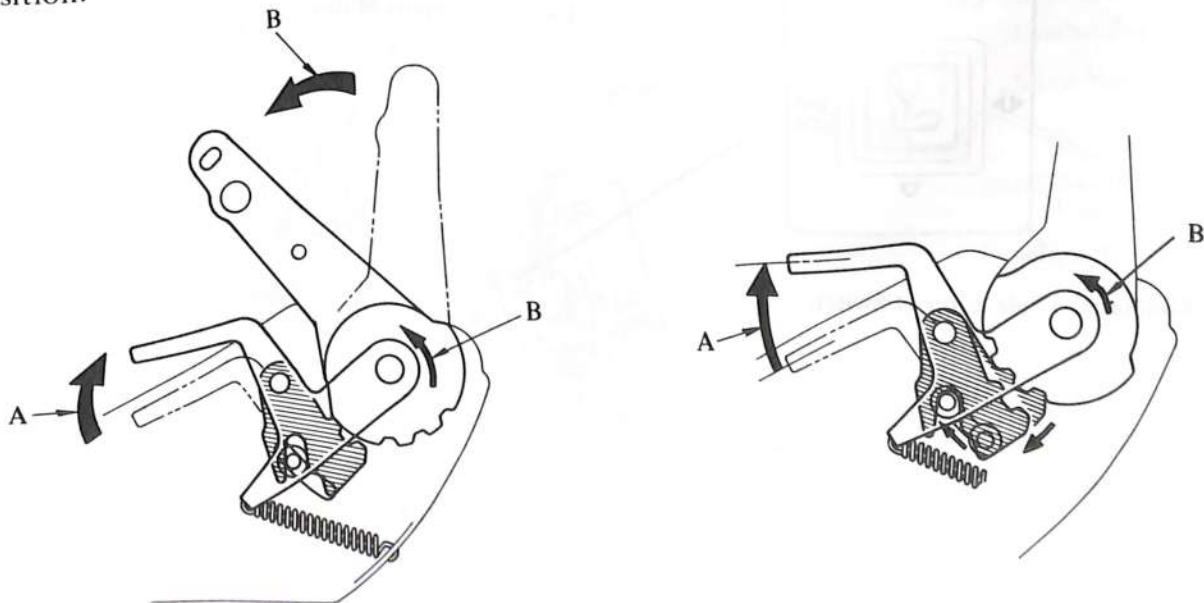


2. Forward Reclining Position

The figure below shows the seat back reclining forward. The quick lever is operated in direction A with the seat back in the normal position. At this time, the spacer releases from the pawl and the force of the pawl pressing on the latch is removed.

Therefore, with the hinge pin as the axis, the upper arm and the inner gear become one and the seat back reclines forward. (Direction B)

Also, even if the seat back returns to the normal position, it will return to the originally set reclining position.

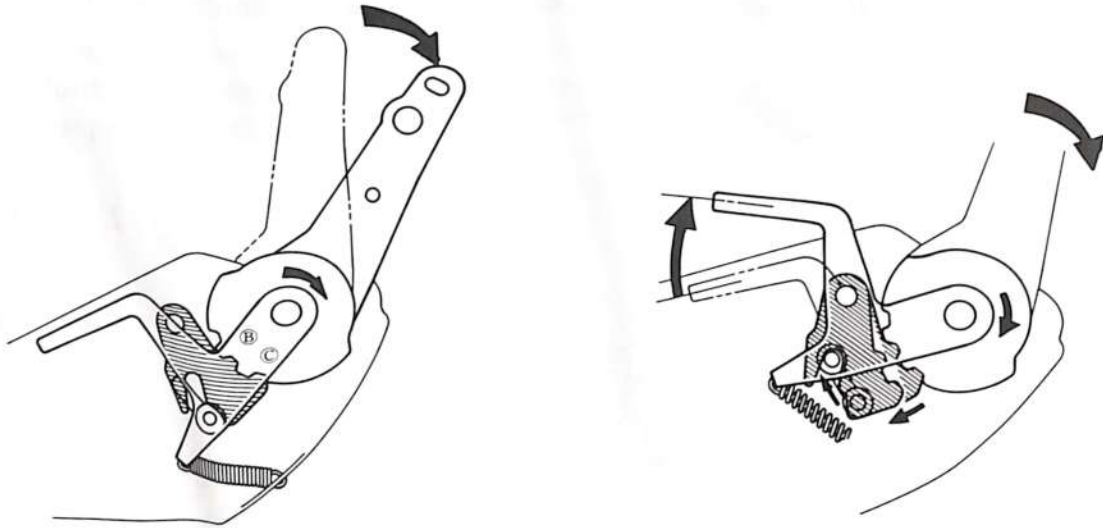


3. Backward Reclining Lock Position

The figure below shows the seat back reclined backward.

As with forward reclining, the quick lever is operated and the pawl releases from the latch of the inner gear. Next the seat back reclines and the pawl is locked with the latch (B, C) of the inner gear.

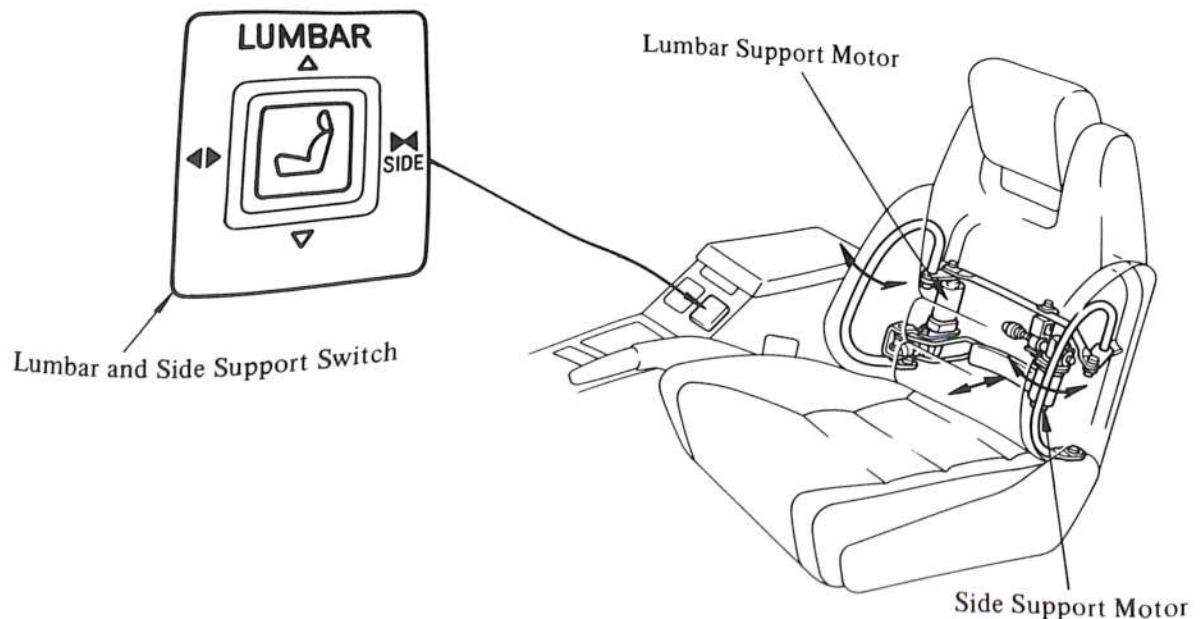
Further, in the backward reclining lock position, stepless reclining of the seat back can be done. Also, even if the seat back is returned to the normal position, it will return to the originally set reclining position.



POWER SIDE SUPPORT AND POWER LUMBAR SUPPORT

1. Description

The previous manual side support and lumbar support systems have been changed to electrical systems to improve their manipulability.

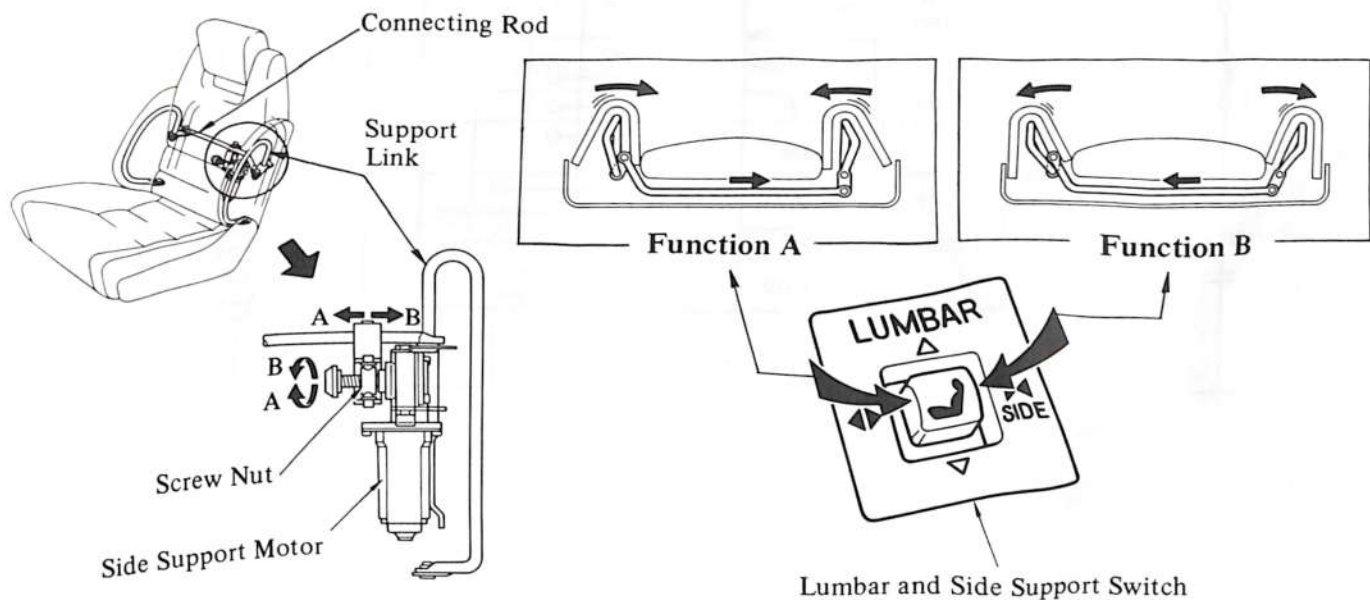


2. Construction and Operation

POWER SIDE SUPPORT ADJUSTMENT

Previously, by turning the adjustment knob on the side of the seat, the support link was moved to carry out side support adjustment.

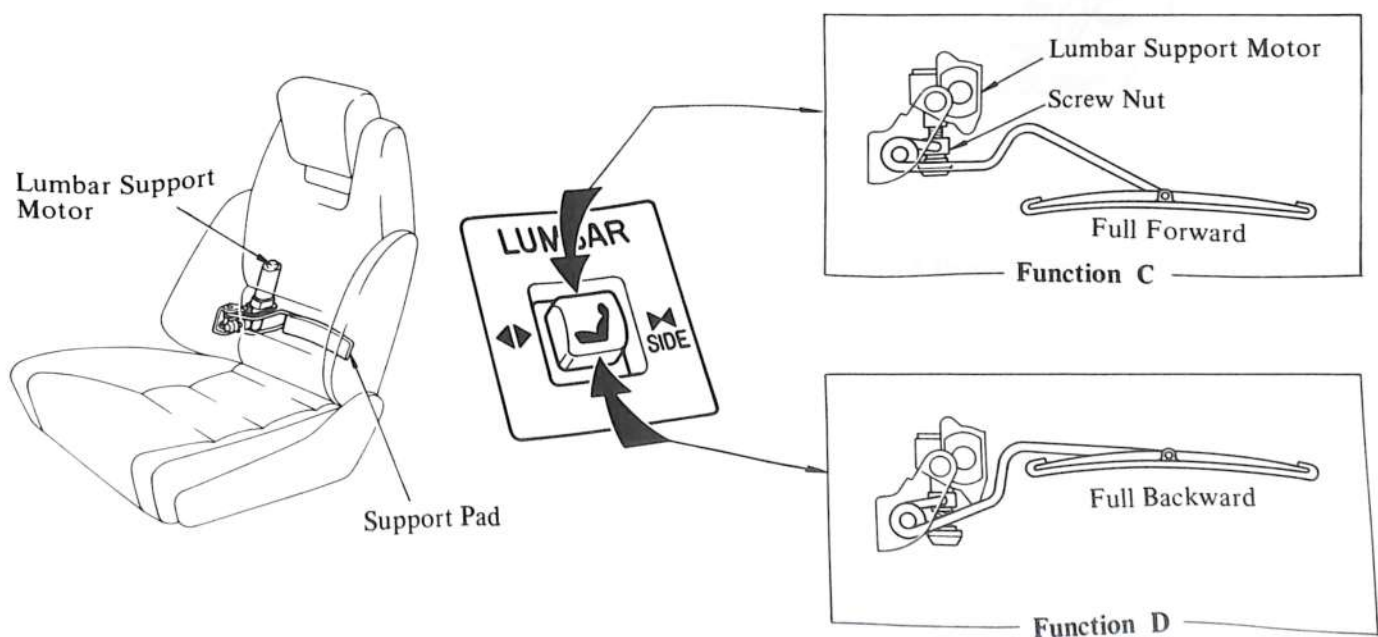
As opposed to this, with the power side support adjustment system, a connecting rod connected to a screw nut on the side support motor is moved left or right, moving the support link and adjusting the side support.



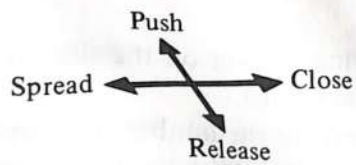
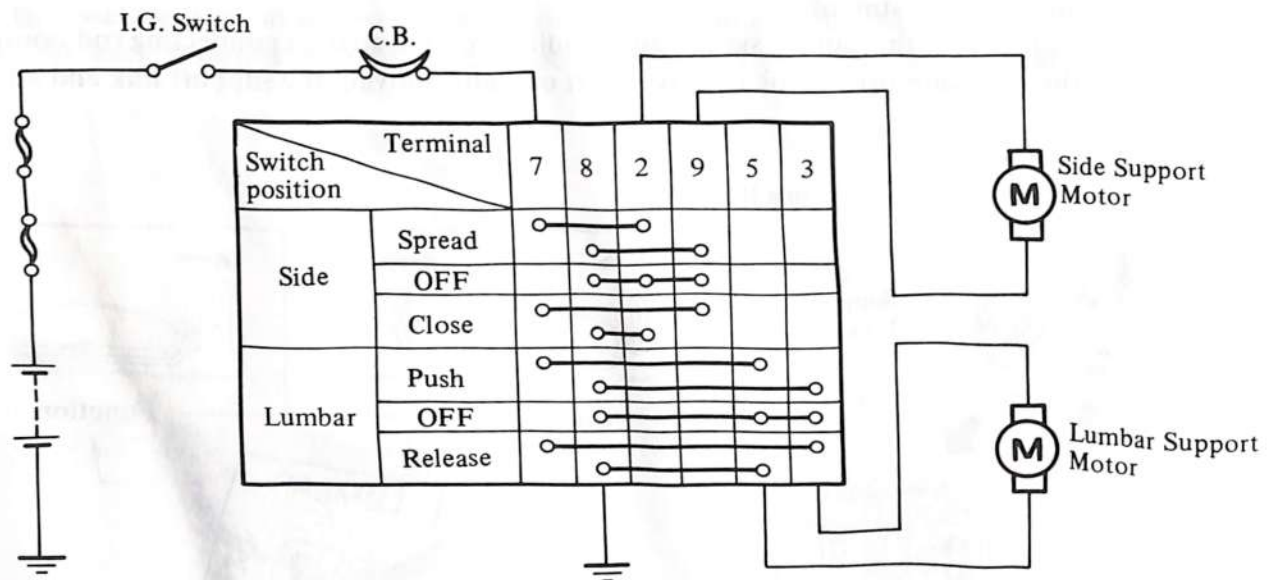
POWER LUMBAR SUPPORT ADJUSTMENT

Previously, lumbar support adjustment was accomplished by moving a lever on the side of the seat which moved the support pad linked to the torsion bar forward or backward.

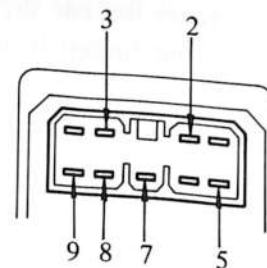
Now however, with power lumbar support adjustment, the screw nut on the lumbar support motor is moved and the torsion bar linked to it moves the support pad forward or backward, making stepless adjustment possible.



3. System Circuit



Lumbar and Side Support Switch



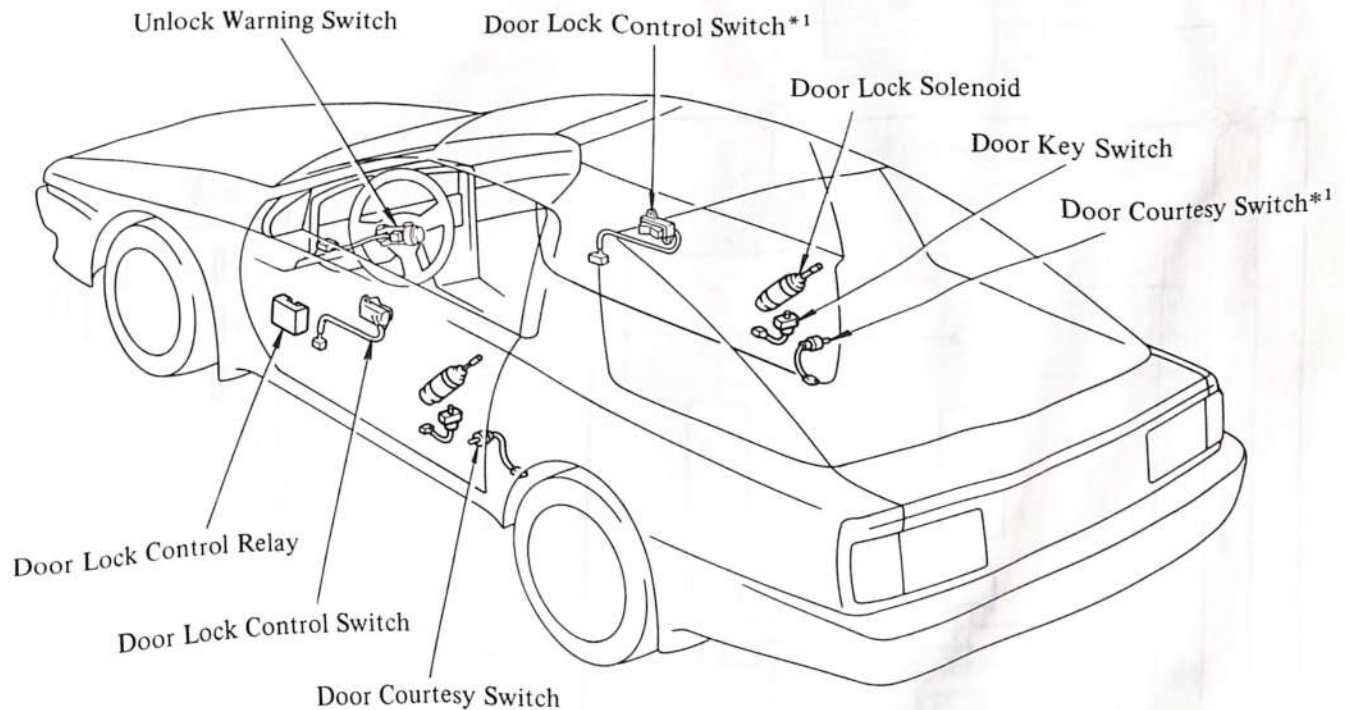
Connector for Lumbar and Side Support Switch

BODY ELECTRICAL SYSTEM

DOOR LOCK SYSTEM

DESCRIPTION

- A lock, unlock mechanism connected to the key was adopted.
- A key confine prevention mechanism was adopted.



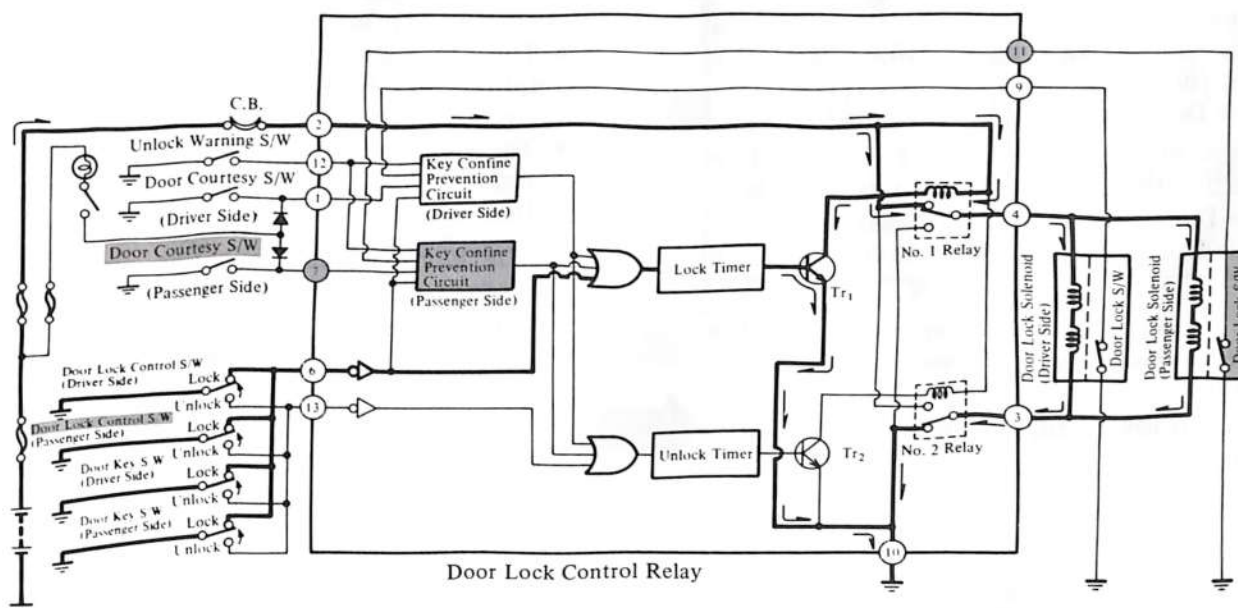
*1 : Models for Australia and Gulf Countries

COMPONENT	FUNCTION
Door Lock Control Switch	Through the operation of this switch, a lock signal or an unlock signal is sent to the door lock control relay.
Door Key Switch	This switch sends a lock signal or an unlock signal to the door lock control relay when the door key is operated from the outside.
Door Lock Solenoid	These are solenoids which lock or unlock the doors.
Door Lock Switch	This switch is incorporated into the door lock solenoid and detects when the door is locked.
Unlock Warning Switch	This switch detects when the key is inserted into the ignition key cylinder.
Door Courtesy Switch	This switch detects if the door is open.
Door Lock Control Relay	This relay sends current to the door lock solenoids in accordance with the signals from the switches. (Current is sent in opposite directions depending on whether the door is being locked or unlocked.)

OPERATION

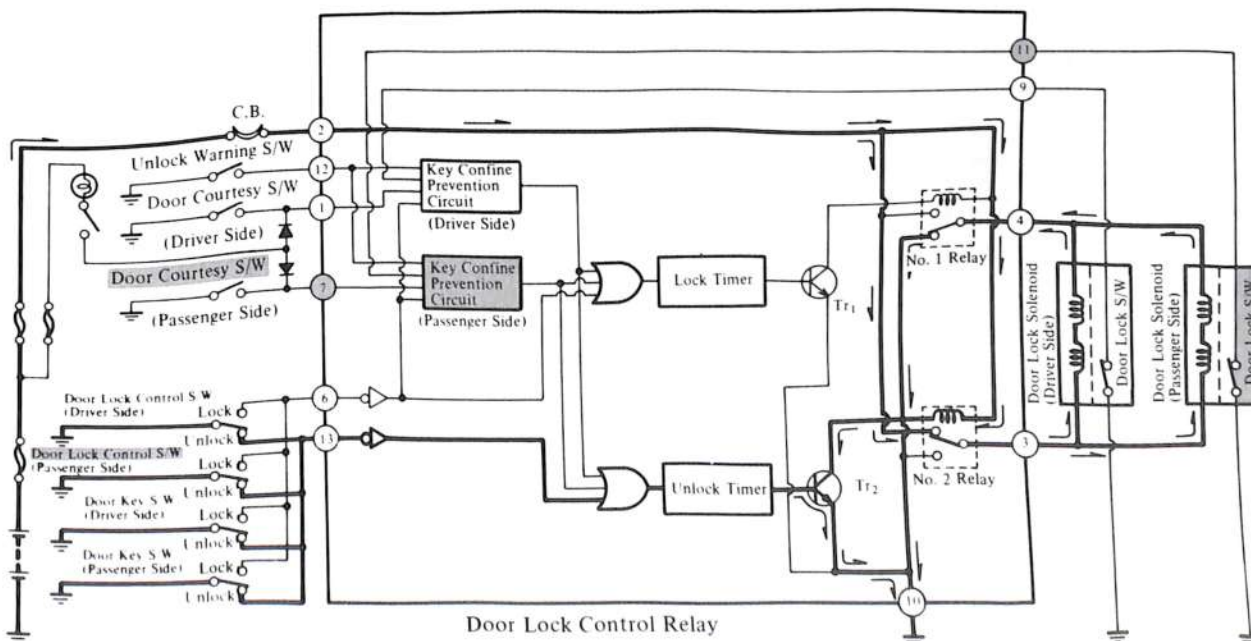
1. Door Lock Operation with the Door Lock Control Switch or the Key

If the door lock control switch is pushed to the lock side or the door key is turned in the lock direction (toward the front), the lock timer inside the door lock control relay operates and locks the doors on both sides.



2. Door Unlock Operation by the Door Lock Control Switch or the Key

If the door lock control switch is pushed to the unlock side or the door key is turned in the unlock direction (toward the rear), the unlock timer inside the door lock control relay operates and unlocks the doors on both sides.



3. Key Confine Prevention

If the door is locked while the key is inserted in the ignition key cylinder, the key confine prevention circuit operates inside the door lock control relay, and the door is not locked.

PATTERN 1 (DOOR LOCK LEVER LOCK OPERATION)

Condition Before the Door Lock Operation

- The key is inserted in the ignition key cylinder.
(The Unlock Warning Switch is ON.)
- The door is open.
(The Door Courtesy Switch goes ON.)

Lock Operation

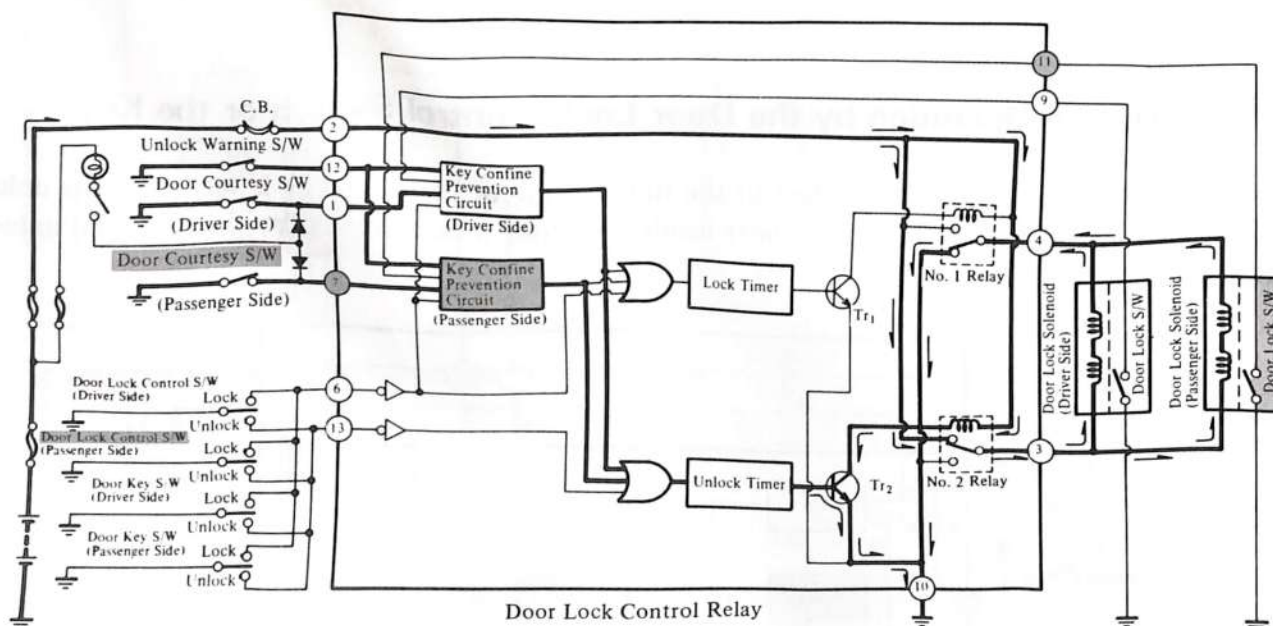
- The Door Lock Lever is pushed.
(The Door Lock Switch goes OFF.)

Door Lock Control Relay

- The ON signal goes from terminal ⑫ to the key confine prevention circuit.
- The ON signal goes from terminal ① or terminal ⑦ to the key confine prevention circuit.
- The OFF signal goes from terminal ⑨ or terminal ⑪ to the key confine prevention circuit.
- The key confine prevention circuit operates and the Unlock signal goes to the Unlock Timer.
- The Unlock Timer turns Tr_2 ON for 0.2 sec.
- Relay No. 2 goes ON.
- Power is output from terminal ③.

Solenoids

Current flows to the Unlock sides of both solenoids.



— REFERENCE —

If the door lock lever is pushed in and held for longer than 0.2 sec., then a keyless lock operation, with the outside handle raised, is carried out, after 0.9 sec., the door lock is released.

PATTERN 2 (LOCK OPERATION WITH THE DOOR LOCK CONTROL SWITCH)

Condition Before the Door Lock Operation

- The key is inserted in the ignition key cylinder.
(The Unlock Warning Switch is ON.)
- The door is open.
(The Door Courtesy Switch goes ON.)

Lock Operation

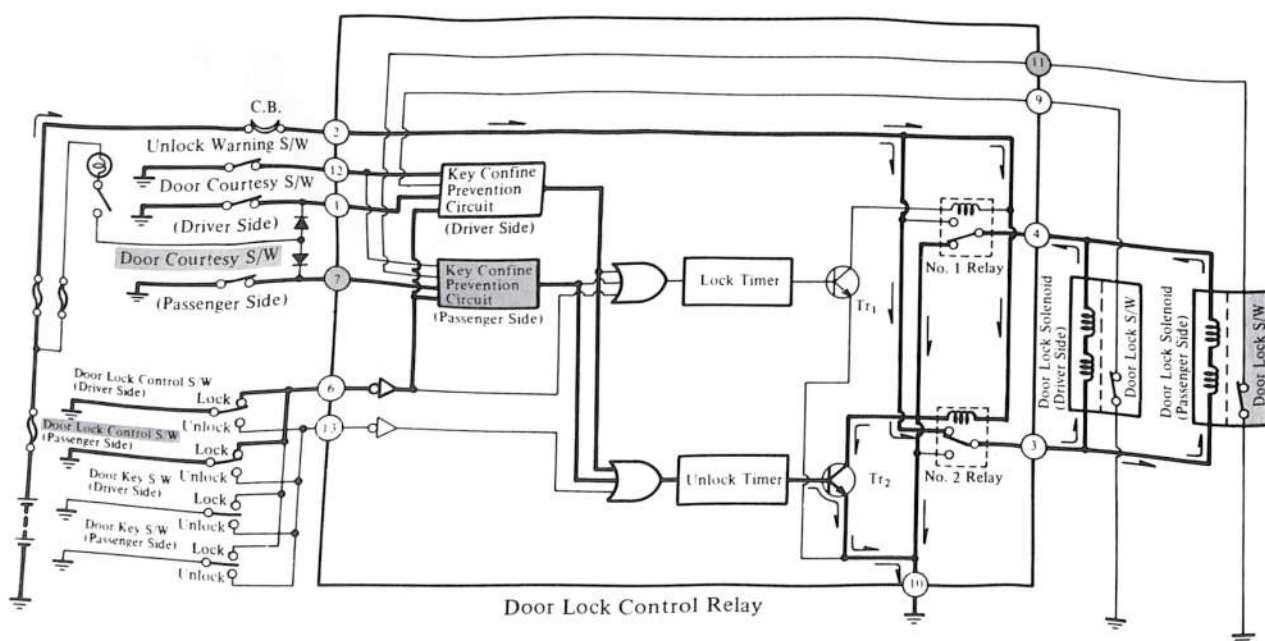
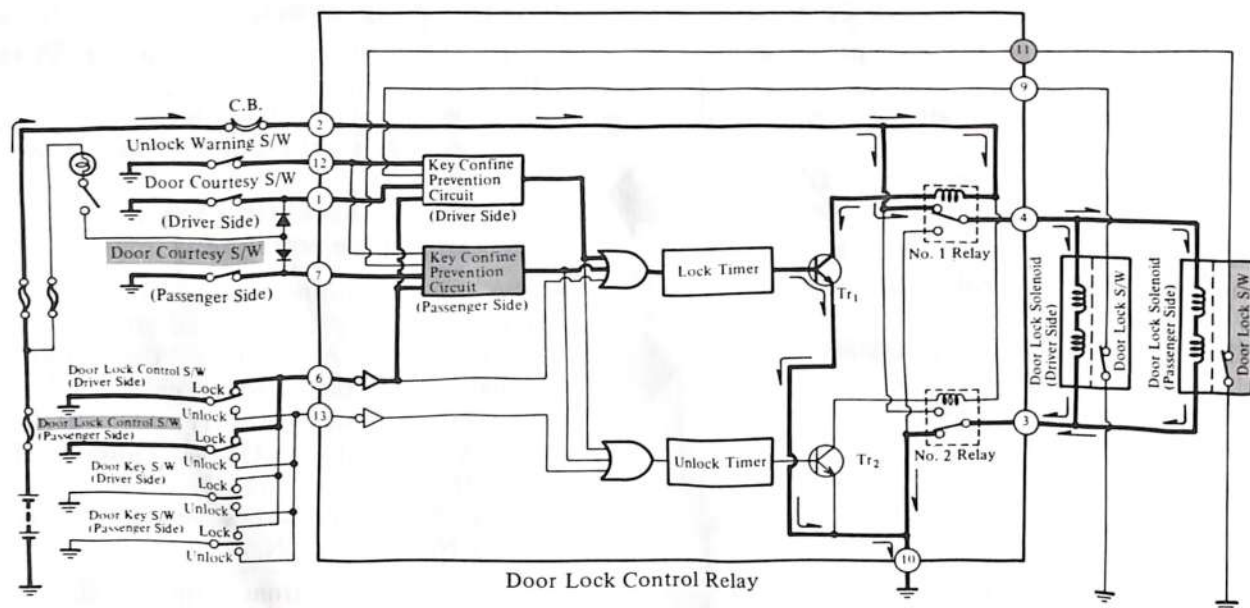
- The Door Lock Control Switch is pushed to the Lock side.
(The switch's Lock side point is grounded.)

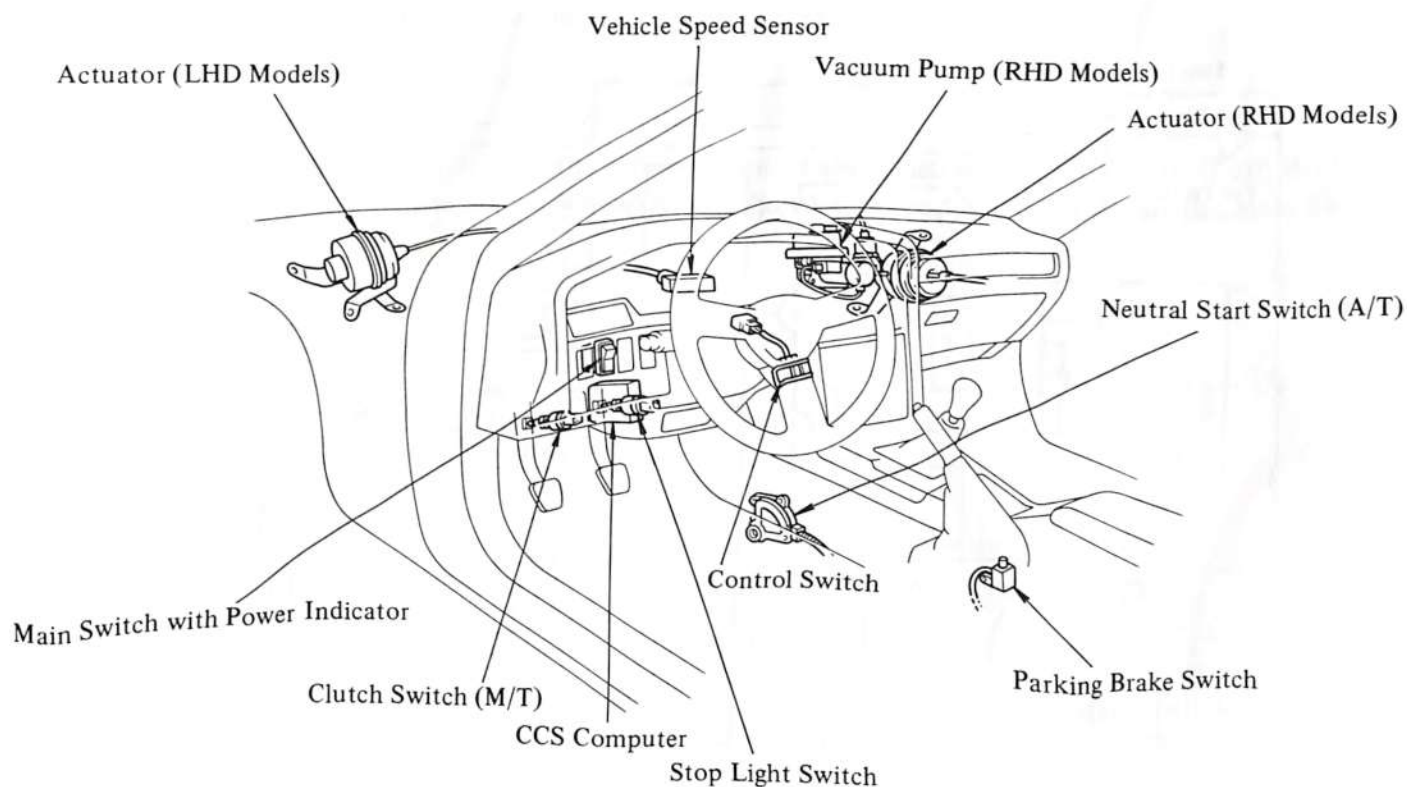
Solenoids

Current flows to the Lock sides of both solenoids and after that, to the Unlock sides.

Door Lock Control Relay

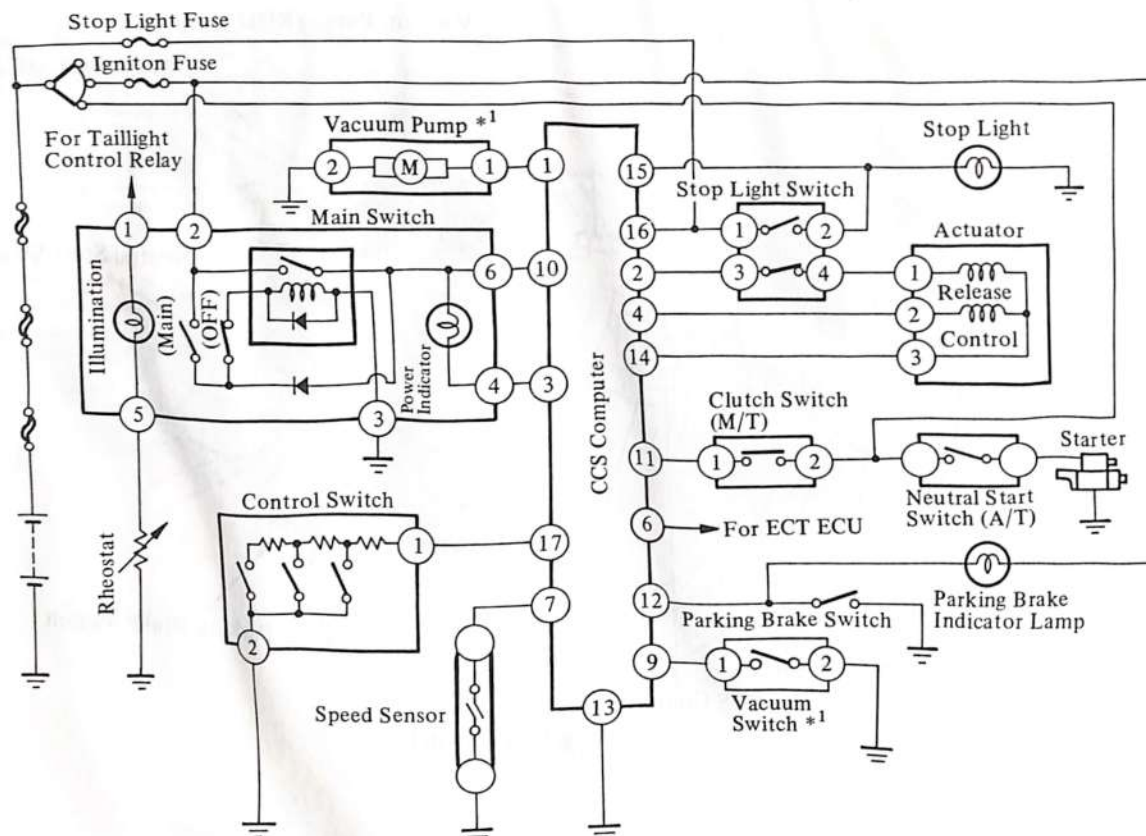
- The ON signal goes from terminal ⑫ to the key confine prevention circuit.
- The ON signal goes from terminal ① or terminal ⑦ to the key confine prevention circuit.
- The ON signal goes from terminal ⑥ to the key confine prevention circuit.
- The key confine prevention circuit works and the Lock signal goes to the Lock Timer. After that, the Unlock signal goes to the Unlock Timer.
- The Lock Timer turns Tr_1 ON for 0.2 sec. After that, the Unlock Timer turns Tr_2 ON for 0.2 sec.
- Relay No. 1 goes ON and after that Relay No. 2 goes ON.
- Power is output from terminal ④ and after that, power is output from terminal ③.



CRUISE CONTROL SYSTEM (CCS)

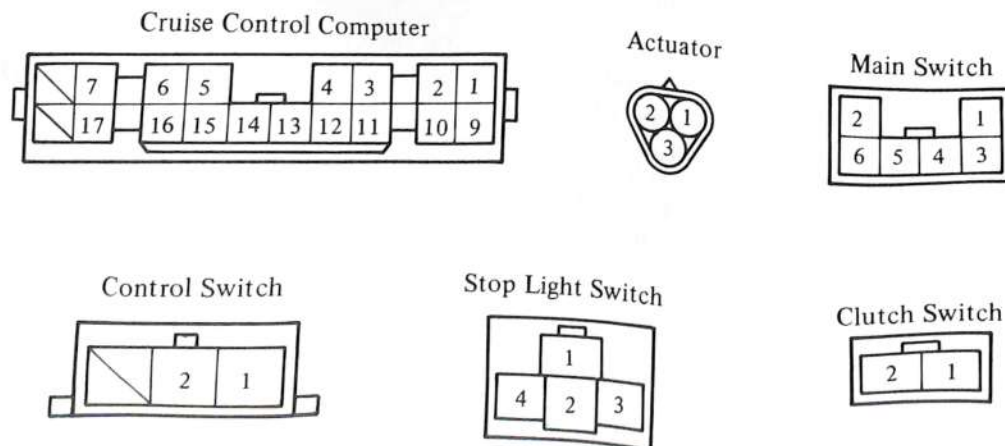
COMPONENT	FUNCTION
Vehicle Speed Sensor	This is mounted on the speedometer driven gear and produces pulse signals. The cruise control computer detects vehicle speed by sensing the pulse frequency.
CCS Computer	Receives signals from each sensor and controls total CCS functioning.
Actuator	This is controlled by the CCS computer, to increase or decrease the throttle valve opening angle.
Control Switch	This is used to control the CCS when setting the vehicle at a desired cruising speed or resetting it at another cruising speed, and to cancel the CCS.
Main Switch with Power Indicator	This is used to connect the CCS to the power source. Lights up when the main switch is ON, indicating that power is being supplied in the system.
Stop Light Switch	Output CCS release signals
Parking Brake Switch	
Clutch Switch (M/T)	
Neutral Start Switch (A/T)	
Vacuum Pump (RHD Models)	Supplies extra vacuum to the actuator when the vacuum in the manifold is not sufficient.

WIRING DIAGRAM



*1: Models with RHD

MAJOR CONNECTORS

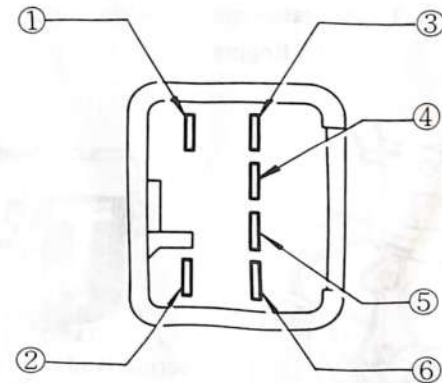
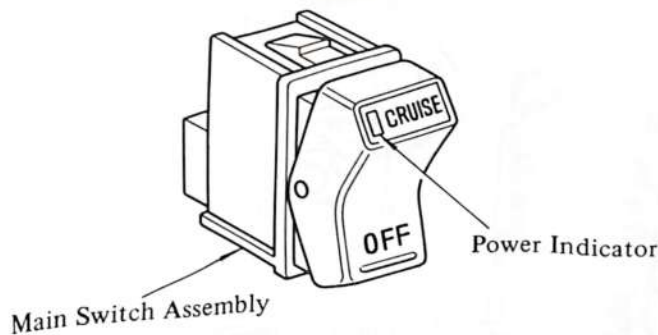


OPERATION

- The construction and operation of the cruise control system is the same as previous systems. (Basically, it is the same as that on the 1986 Celica ST 162 Series.)

Main Switch

- Even though the Main Switch is in the ON position, if the Ignition Switch is turned off, the Main Switch goes off at the same time. When the Ignition Switch is turned on again, the Main Switch remains off.

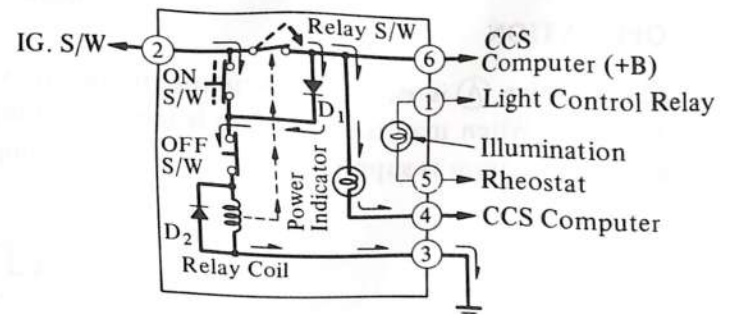


Connector for Main Switch

OPERATION

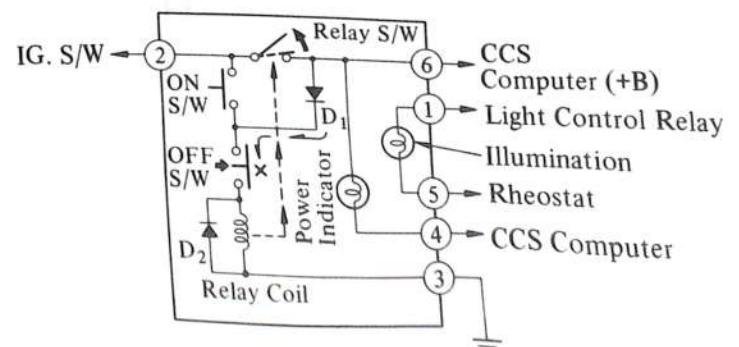
1) Main Switch ON

- With the Ignition Switch ON, if the Main Switch is turned ON, Terminal ③ is grounded by Terminal ② through the On Switch, Off Switch and Relay Coil.
 - The Relay Switch goes on and current flows to Terminal ⑥.
- Also, since current is flowing through the Relay Coil through D₁, even if the Relay Switch is separated from the On switch, it remains ON. (Self-hold Circuit) The Power Indicator Lamp Lights up.



2) Main Switch OFF

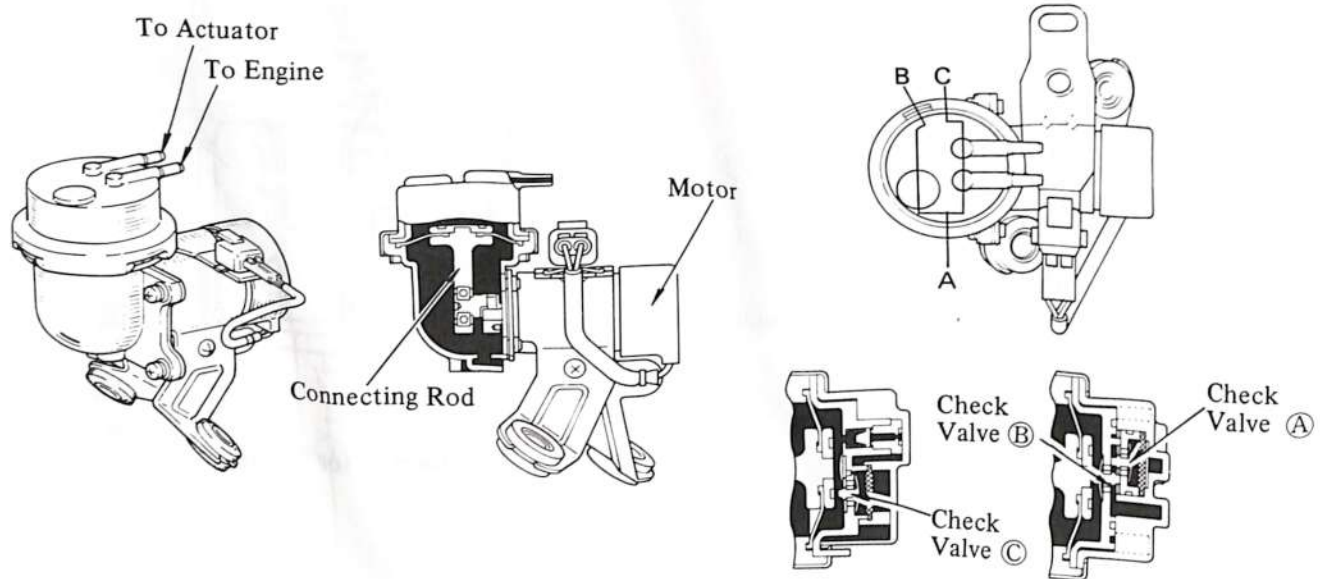
- When the Main Switch is ON, if the Off Switch is pressed, the current flowing from D₁ is cut off and the flow of current to the Relay Coil is stopped, causing the Main Switch goes off.
- Also, when the Ignition Switch is turned OFF, the Relay Coil is no longer charged and the Main Switch goes off.



2. Vacuum Pump (Models with RHD)

CONSTRUCTION

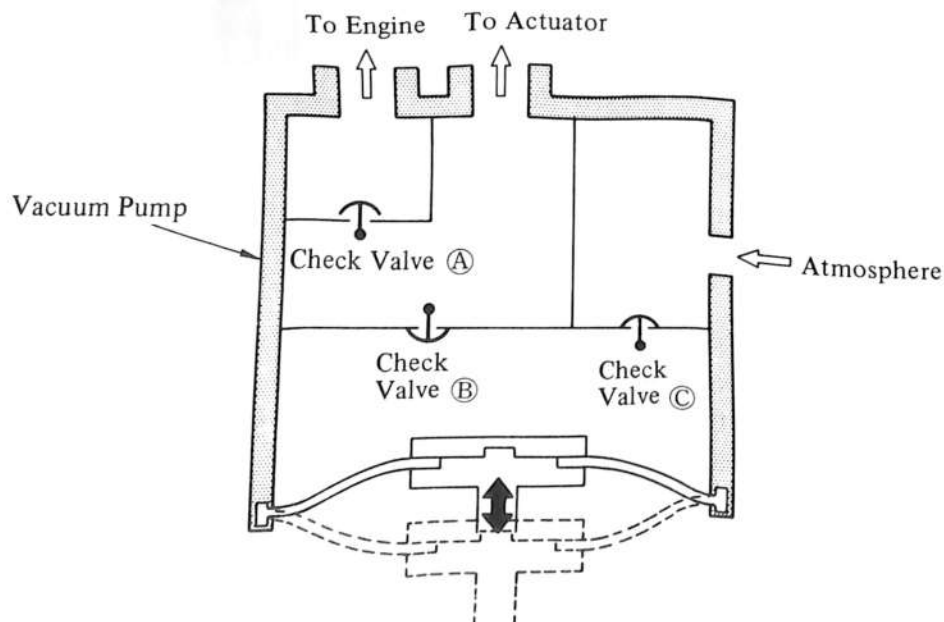
The vacuum pump is located between the vacuum outlet of the engine and the vacuum circuit of the actuator, and supplies extra vacuum to the actuator when the vacuum in the manifold is not sufficient (as when the vehicle is climbing a hill or during full acceleration).



A-B Cross Section A-C Cross Section

OPERATION

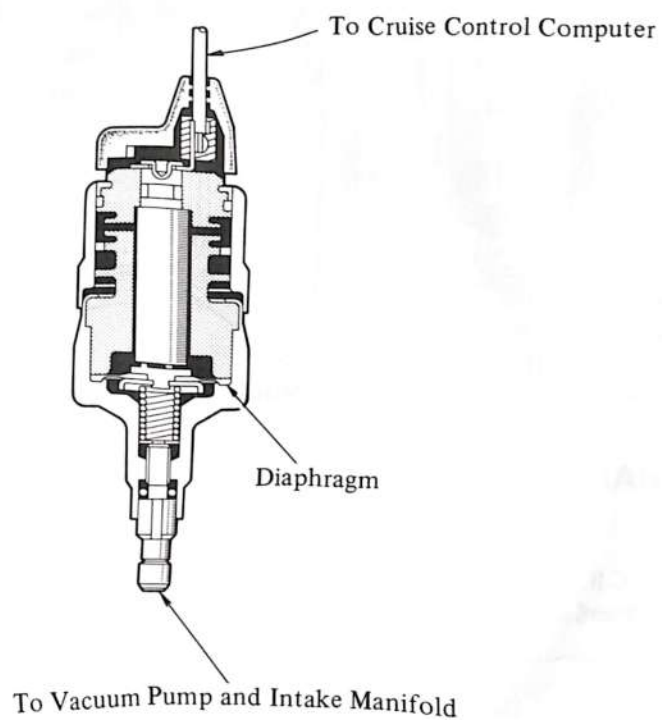
Check valve (A) is normally kept open due to vacuum in the manifold, and supplies vacuum to the actuator. When manifold vacuum is low, the computer sends a signal to turn the vacuum pump on. As a result, vacuum is supplied to the actuator through check valve (B).



3. Vacuum Switch

This switch detects vacuum in the intake manifold.

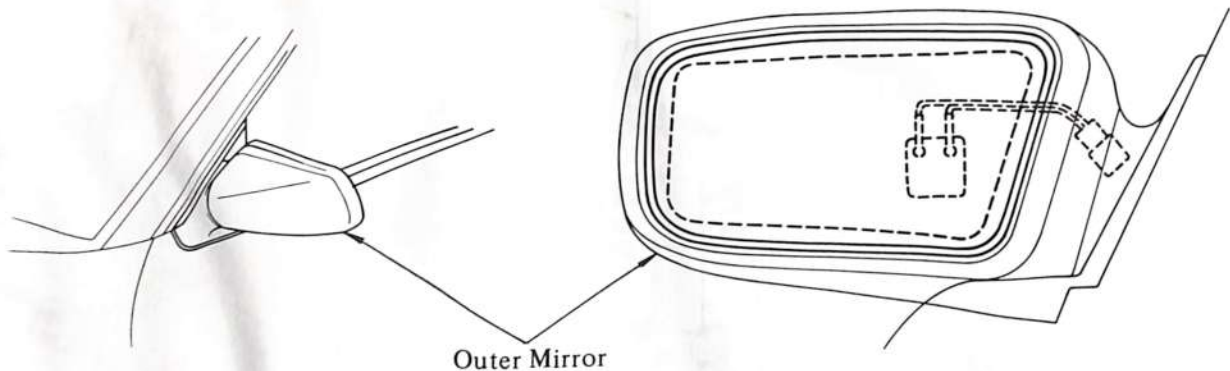
It turns on when this vacuum is 170 mmHg or lower, and sends an ON signal to the computer.



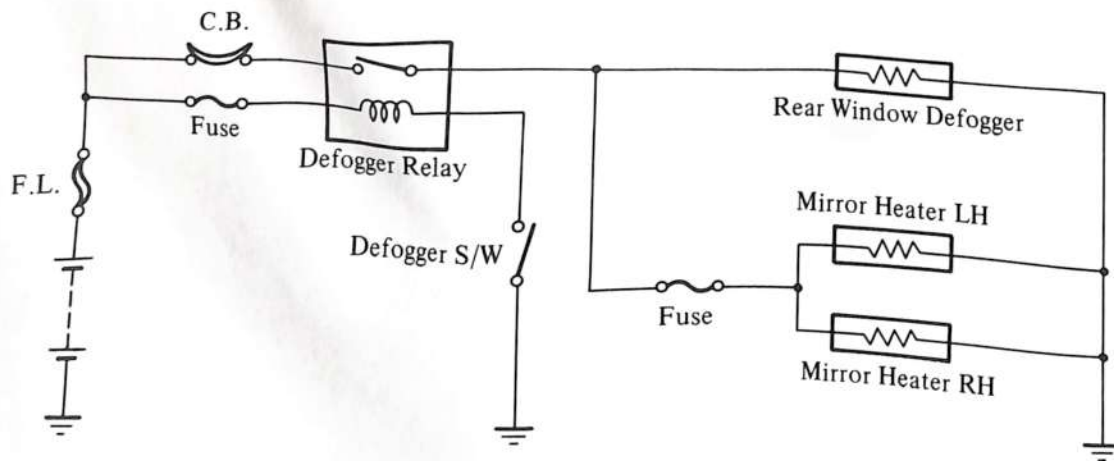
MIRROR HEATER

DESCRIPTION

- A heater (PTC heater) built into the Outer Mirror heats the surface of the mirror and evaporates any moisture or frost adhering to the surface of the mirror, assuring a clear rear view.
- The Mirror Heater is connected to the Rear Window Defogger and operates together with it.

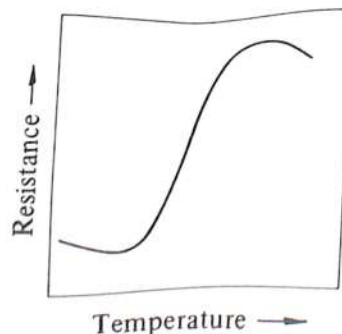


WIRING DIAGRAM

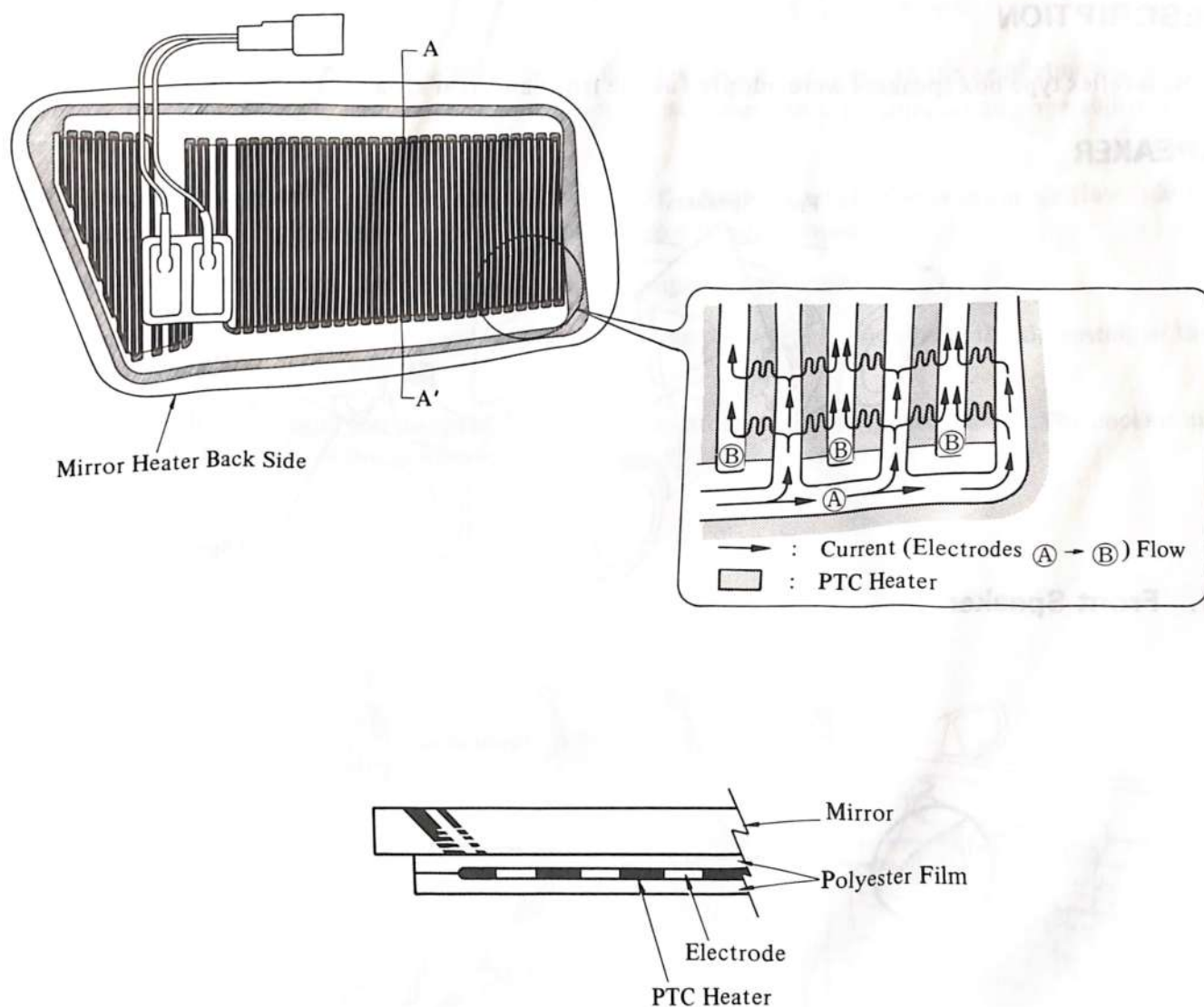


– REFERENCE –

PTC stands for Positive Temperature Coefficient. It is a thermally sensitive resistor element having a positive temperature characteristic, the resistance of which increases when the temperature rises to a certain level.



CONSTRUCTION



CAUTION

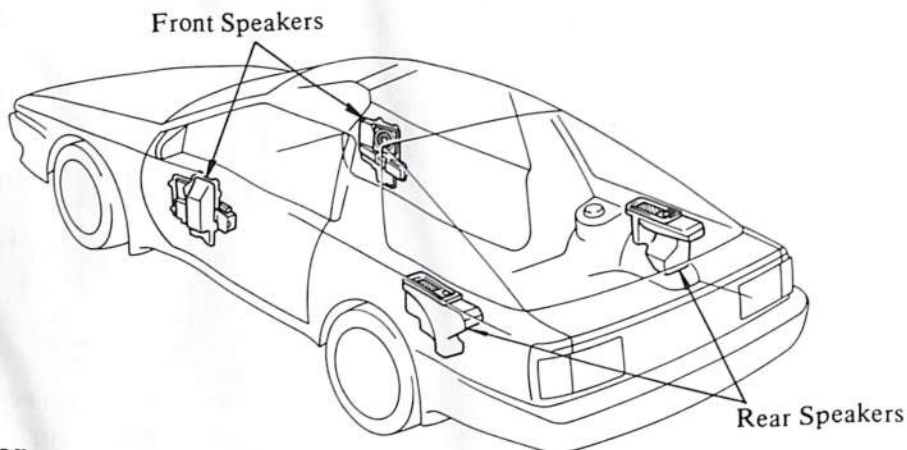
- When there is hardened ice or frost on the mirror surface, even when the Mirror Heater is operated, it takes time for evaporation to be completed. Before operating the Mirror Heater, please removed as much of the ice or frost from the mirror surface as possible.
- When the Mirror Heater is operated, the surface temperature of the mirror will rise to about 50°C (122°F) if the ambient temperature is normal. If the mirror surface is touched for a long period of time, it may cause a low temperature burn, so be careful not to touch the mirror surface.

AUDIO SYSTEM

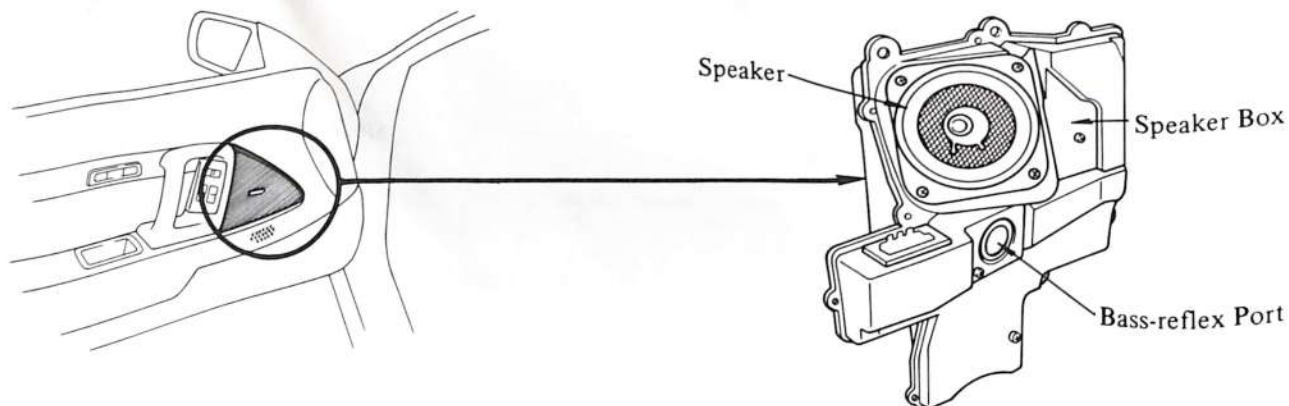
DESCRIPTION

- Bass-reflex type box speakers were adopted as the front and rear speakers.

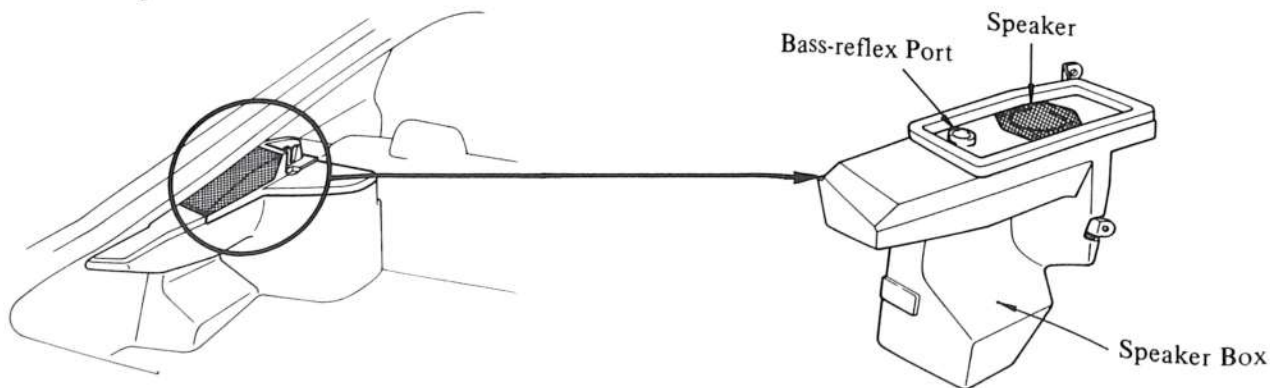
SPEAKER



1. Front Speaker



2. Rear Speaker



– REFERENCE –

Bass-reflex

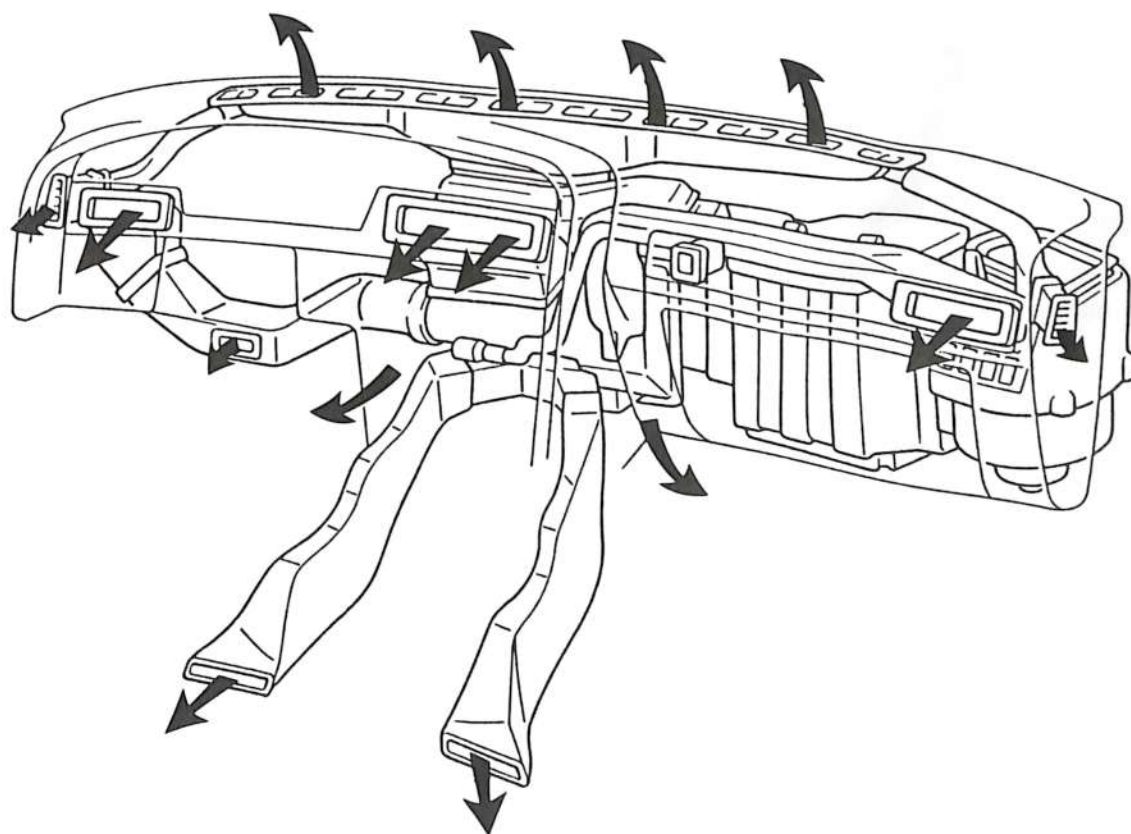
On the same surface of the speaker box as that to which the speaker is installed, a port (bass-reflex port) has been made and a cylinder has been mounted in this port. The bass sound emitted by the rear of the speaker's diaphragm is channeled to the front through this port. These ports work to reinforce sound emitted from the front of the speaker to produce sound with rich bass.

VENTILATION AND HEATER

DESCRIPTION

Compared to the previous Supra, the following points have been improved in the ventilation and heater system of the New Supra and through the adoption of new mechanisms, comfort and operability were improved.

- ▶ By reducing the resistance to air passing through the heater unit, the maximum air flow volume was increased and the dynamic ventilation performance was improved.
- ▶ A push-button type heater control was adopted to improve operability.
- ▶ Side defroster nozzles were mounted in the top of the door trims, improving the defrosting of the side window glass.
- ▶ A cool air bi-level system was adopted to increase comfort when the heater is on. The cool air bi-level system is the same as the system adopted in the ST162.AT160 series Celica.

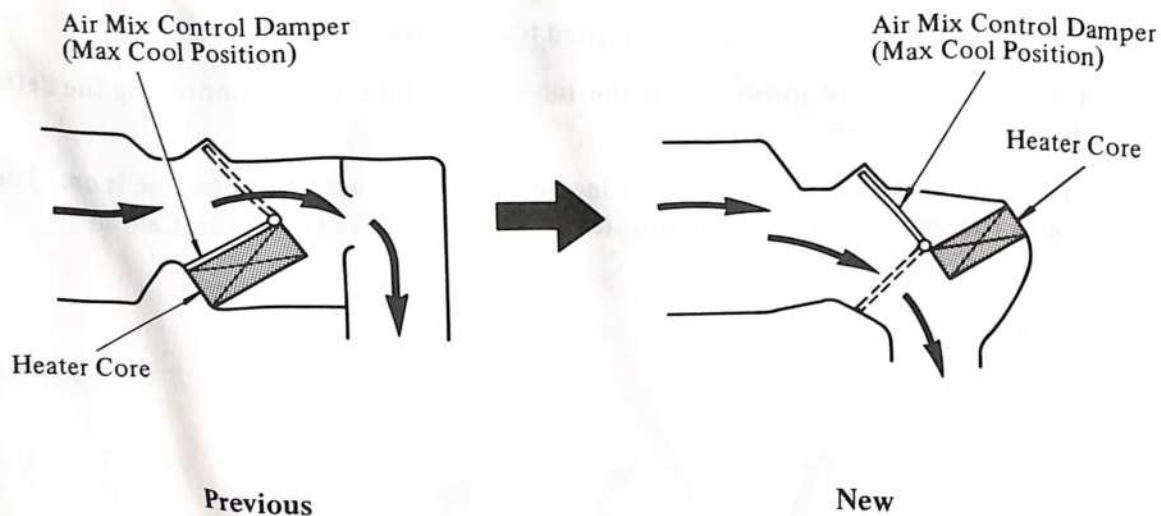


VENTILATION AND HEATER SYSTEM

1. Heater Unit and Air Duct

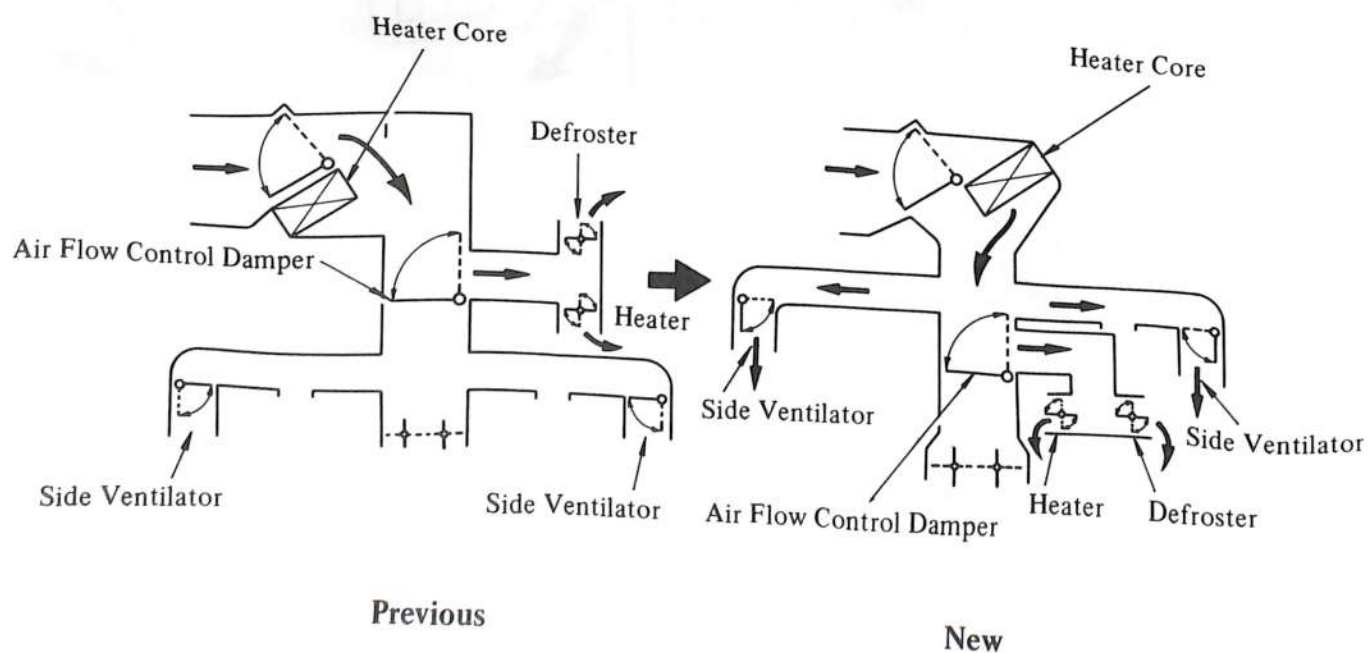
1) Short Pass System Heater Unit

- The location of the heater core was changed as shown in the following illustration, reducing resistance to air passing through the heater unit.



2) Blowing of Warm Air from the Side Ventilators

- By changing the location of the air flow control damper in the heater unit, even in the Heat mode or the Def mode, warm air is blown from the side ventilators.

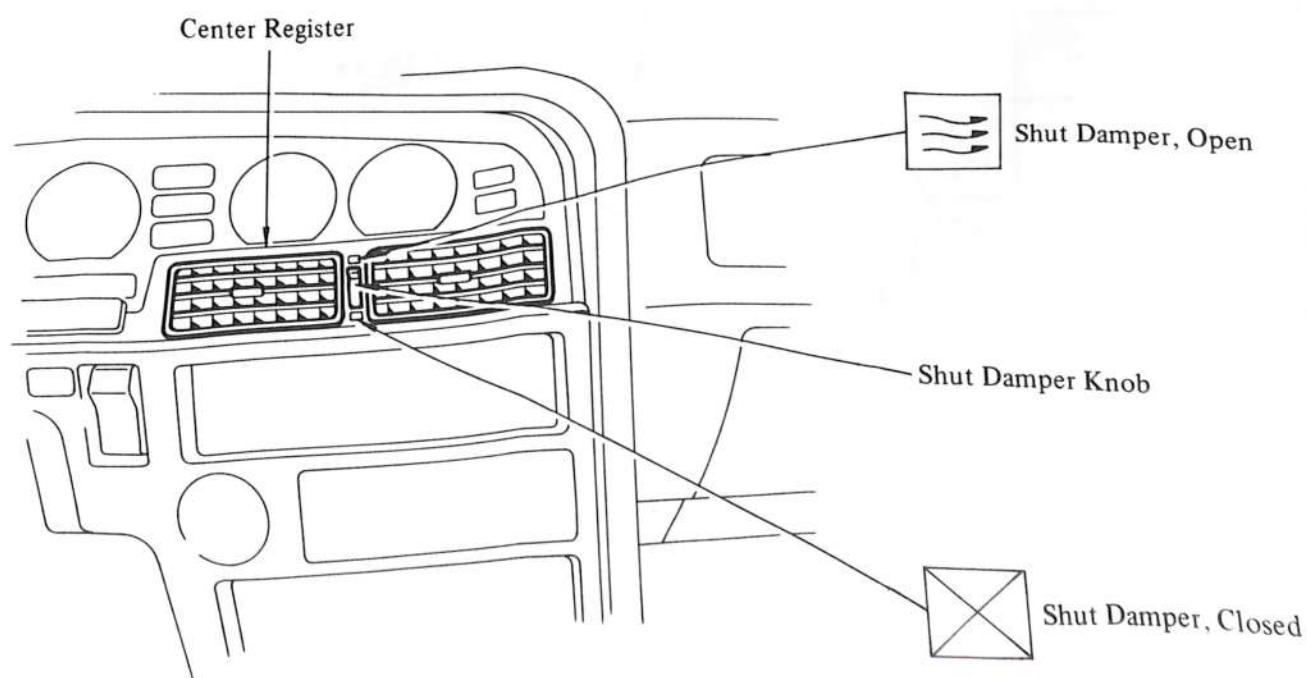
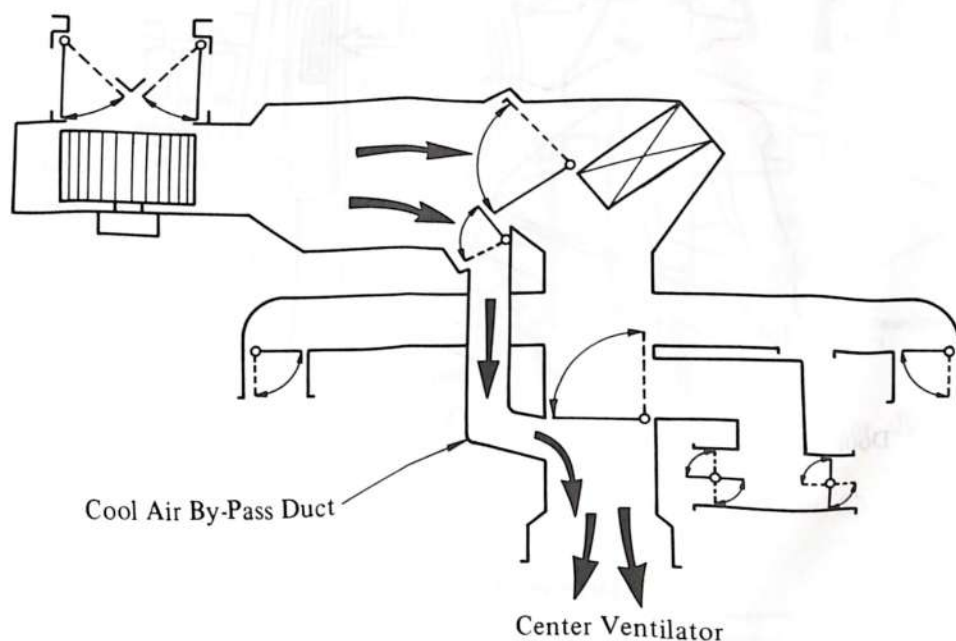


3) Cool Air Bi-level System

- A cool air bi-level system utilizing an air duct which by-passes the heater unit was adopted, permitting cool air to be blown directly from the center register. This eliminates discomfort to the face when the heater is being operated by providing a comfortable cool face warm feet heating system.

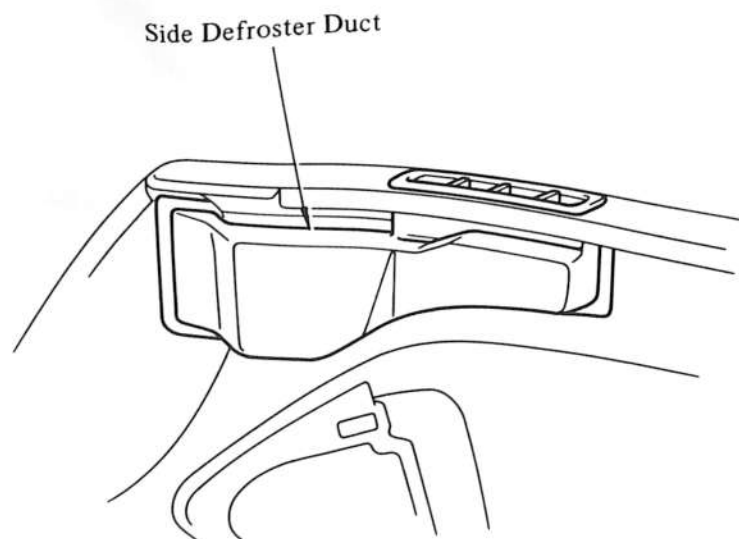
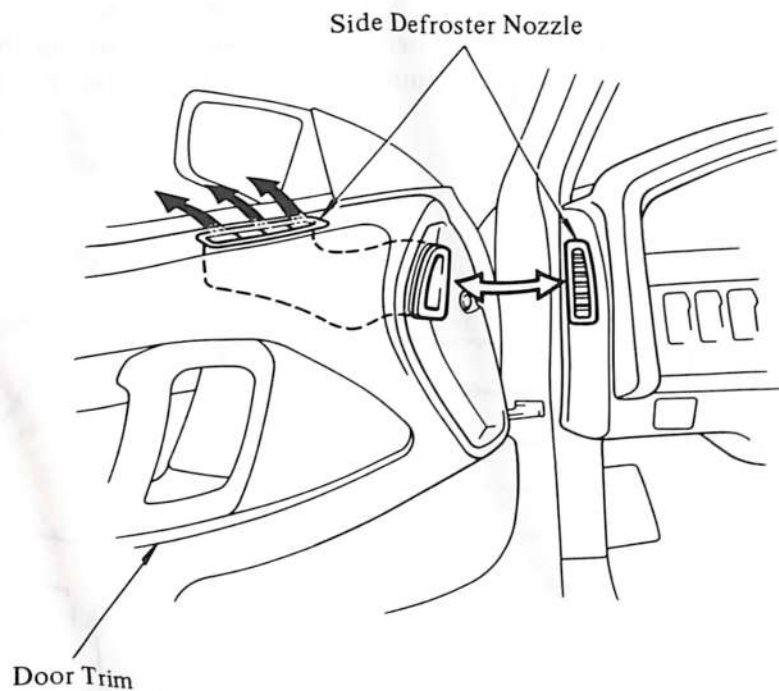
This system is connected to the air flow mode control switch and operates between the Heat mode and the Def mode.

When operation of the cool air bi-level system is unnecessary, moving the knob in the center register to the  position closes the shut damper and cutting off cool air.



4) Side Defroster Nozzle

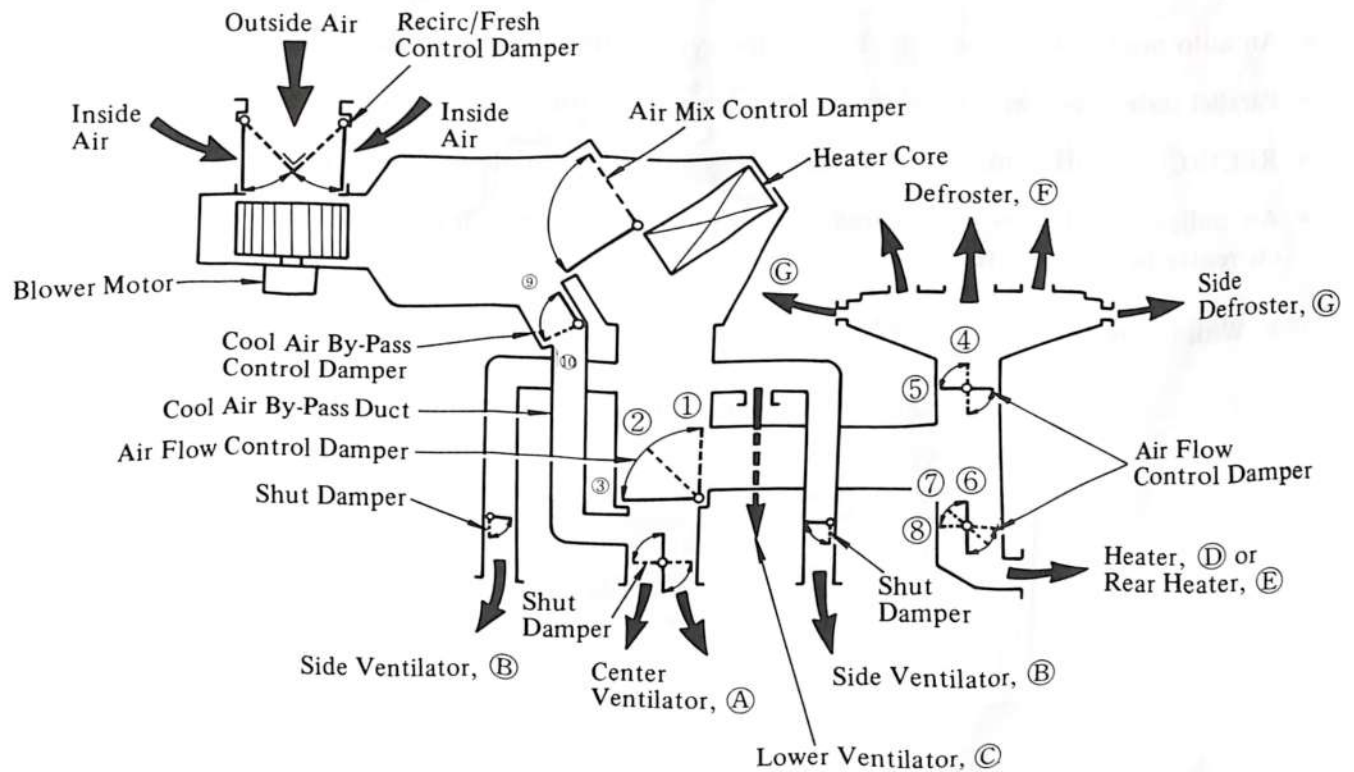
- The side defroster nozzle is located in the top of the door trim and improves the defrosting of the side window glass when the defroster is operated.



Inside of the Left Front Door Trim

5) Vent Position and Air Flow Volume Proportions

- The position of the air flow control damper and vents in use in the various modes as well as the proportion of the air flow in each mode are shown in the illustration and table below.



Mode	Air Flow Control Damper Position	Vent in Use and the Proportion of Air Flow to it* ¹					
		A	B	C	D, E	F	G
Vent	① ⑤ ⑧ ⑩				—	—	—
Bi-Level	② ⑤ ⑦ ⑩						
Heat	③ ⑤ ⑥ ⑨	* ²					
Def	③ ④ ⑧ ⑨	* ²					
Auto	Optional	By operating the temperature control switch, the vents connected to the switch are changed automatically between the Vent and Heat modes.* ³ Therefore, the air flow proportions are the same as those for Vent ~ Heat above.					

*¹: The size of the circle indicates the proportion of air flow.

*²: In the case where the cool air bi-level system is operated.

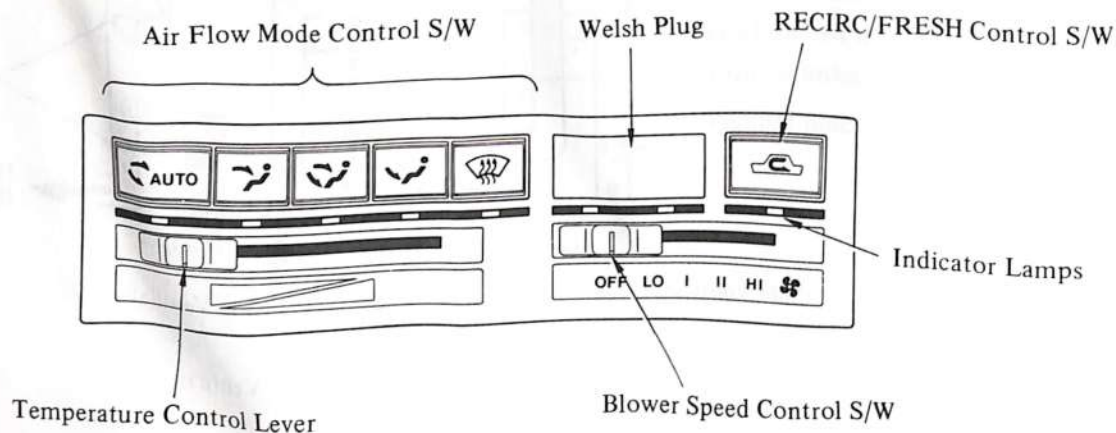
*³: In the case of models equipped with the automatic air conditioner, vent temperatures are automatically controlled and the air flow mode is automatically changed between the Vent and Heat modes.

2. Push Type Heater Control Panel

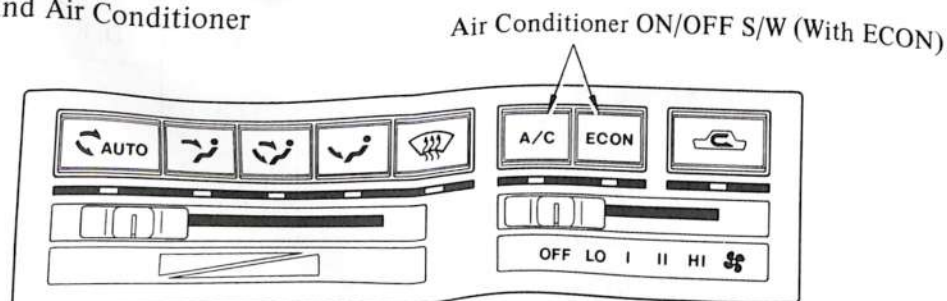
DESCRIPTION

- A push-button type heater control was adopted to improve operability. Also, by adopting the push type heater controls, the air damper control cables operating each air damper were eliminated, and in their place, the air dampers are controlled by servo motors.
- An auto mode switch, which changes the vents automatically, was adopted, improving operability.
- Parallel slide type switches were adopted for temperature control and for blower speed control.
- RECIRC/FRESH control was centralized in one switch to improve usability.
- An indicator lamp is placed under each push switch, which improves the visibility of the switch currently being operated.

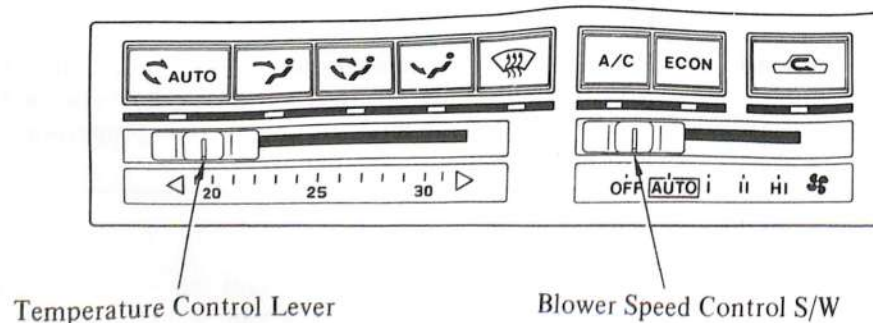
► With Heater



► With Heater and Air Conditioner



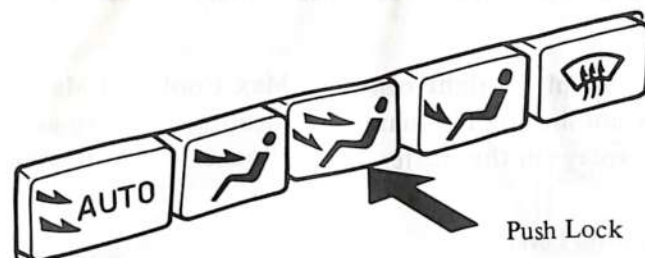
► With Heater and Automatic Air Conditioner



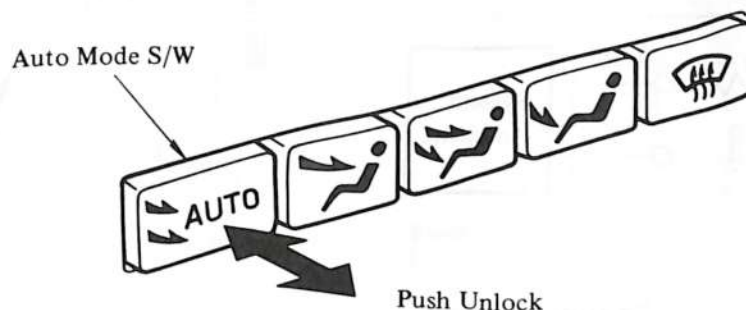
OPERATION

1) Air Flow Mode Control Switch

- If the Vent, Bi-Level, Heat or Def mode switch is pushed, the switch locks independently and the mode becomes fixed to that indicated by the switch.



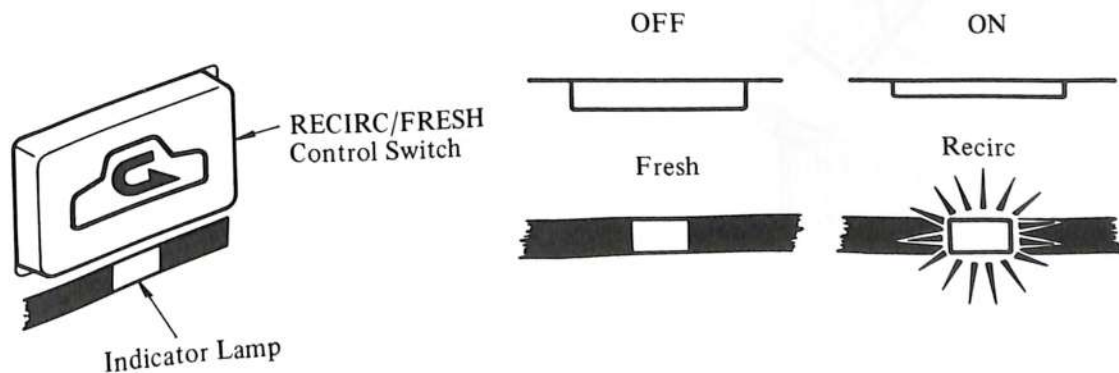
- An unlock switch was adopted for the auto mode switch and was made flush with all the other air flow mode control switches.



NOTE: Even at times when the auto mode switch is not "on", even if an air flow mode control switch is operated by mistake, if the switch becomes flush with the other air flow mode control switches, the system enters the auto mode.

2) RECIRC/FRESH Control Switch

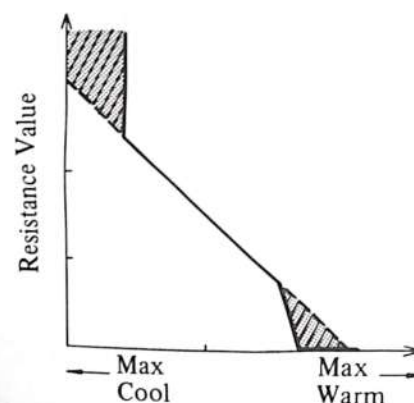
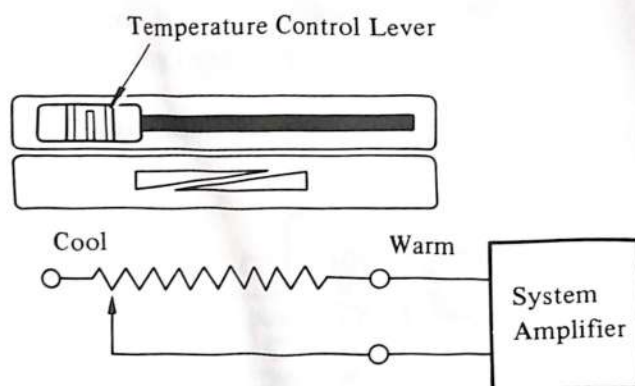
- When the switch is Off, fresh air is introduced and when the switch is ON, it changes to RECIRC and the indicator lamp goes on.



- In the RECIRC condition (when the switch is ON), if the DEF air flow mode control switch is turned on, the RECIRC/FRESH control switch automatically changes to FRESH and prevents fogging of the windows.

3) Temperature Control Lever

- A parallel slide type temperature control lever was adopted and a large notch is provided at the 25°C (77°F) center position.
- By sliding the temperature control lever, the set temperature is transmitted to a system amplifier converted into a resistance value. The resistance value becomes larger as the set temperature is set lower.
- Also, as shown in the graph at right below, a Max Cool and Max Warm zone are provided in which the maximum cooling or the maximum heating capacity are developed without relation to the temperature display on the heater control panel, to more greatly improve comfort.

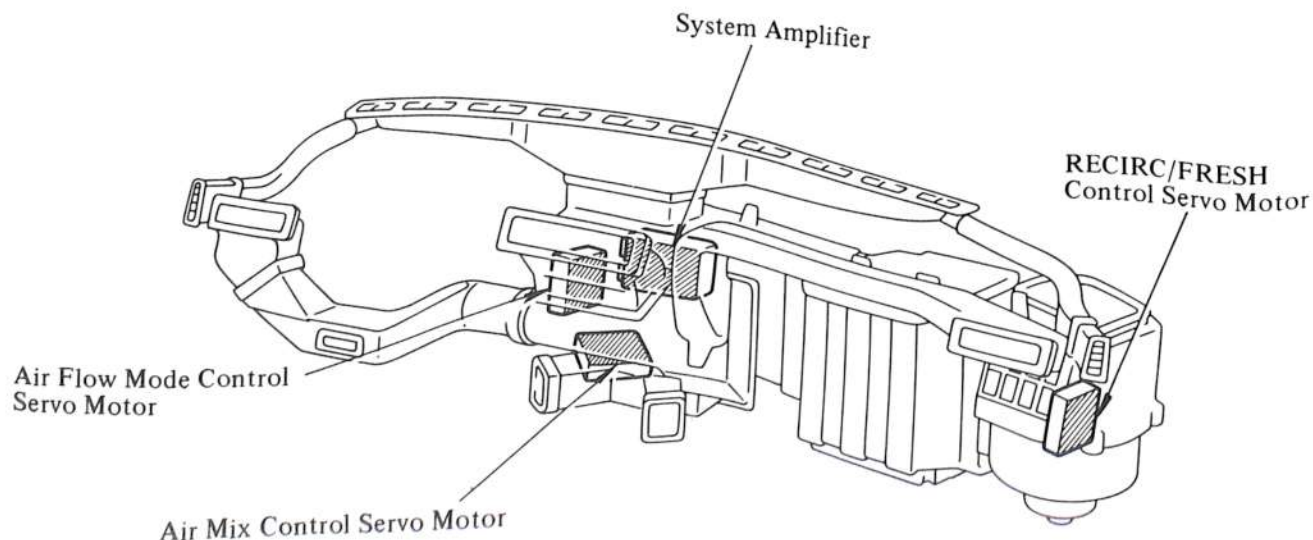


Resistance Characteristics

3. System Amplifier and Servo Motors

DESCRIPTION

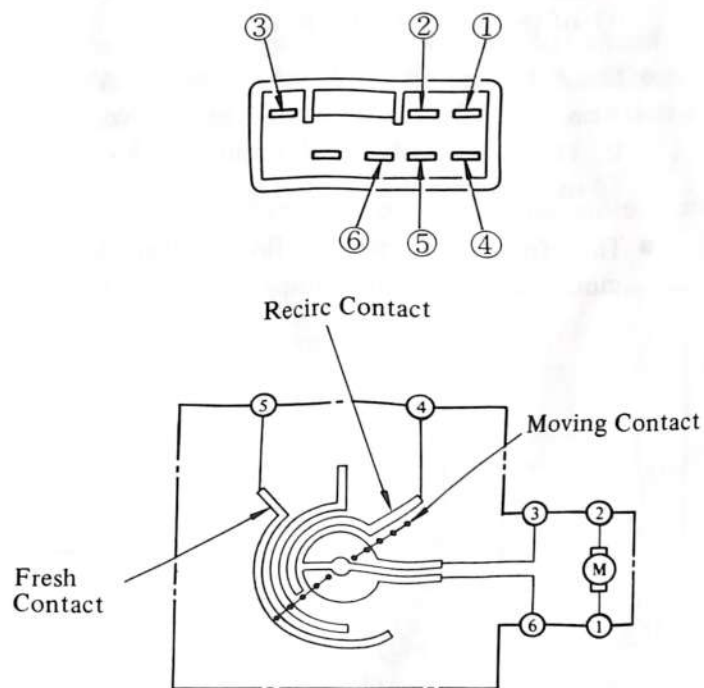
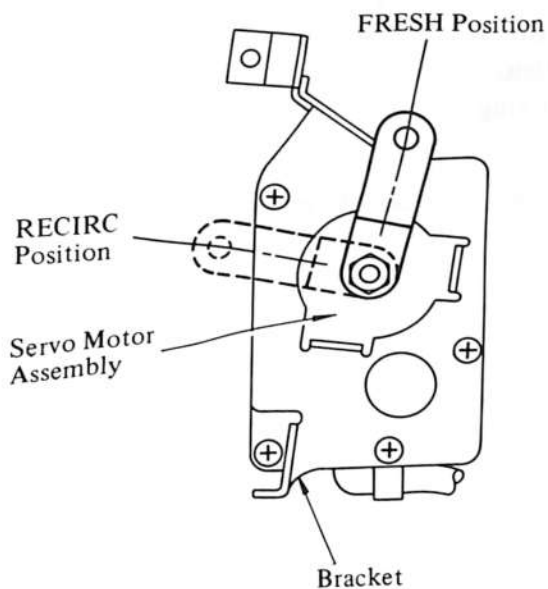
- Along with the adoption of push type heater controls, each air flow control damper is operated by a servo motor.
- Servo motors are installed in 3 places, for changing the air flow mode control damper, for changing the air mix control damper and for changing the RECIRC/FRESH control damper.
- The system amplifier controls the 3 servo motors.



OPERATION

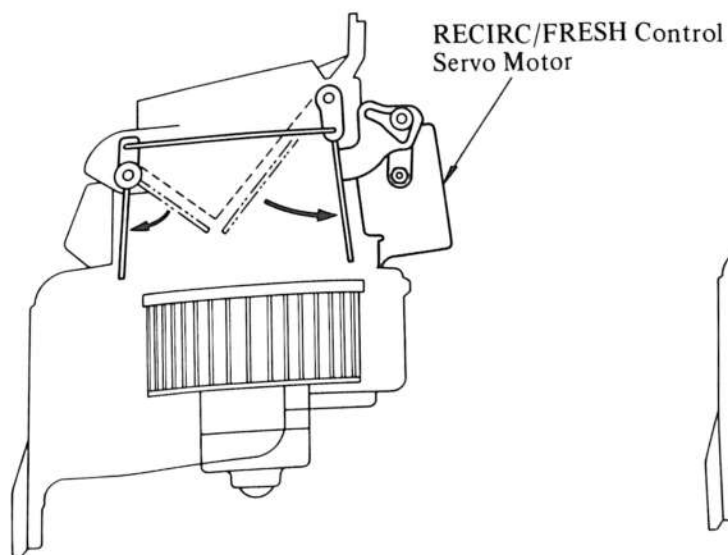
1) RECIRC/FRESH Control Servo Motor

If the RECIRC/FRESH control switch on the heater control panel is operated, the servo motor turns clockwise or counterclockwise according to signals from the system amplifier and changes the damper position via a link.

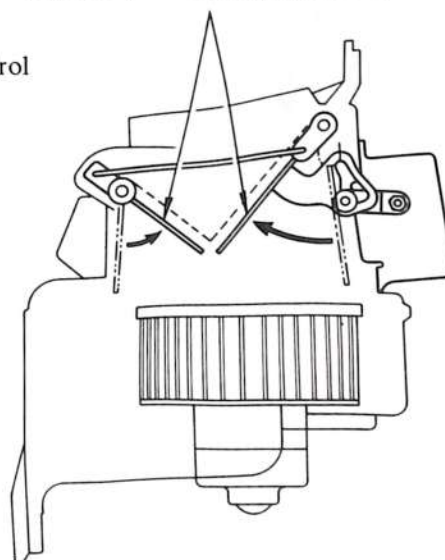


Servo Motor Internal Circuit

RECIRC/FRESH Control Dampers



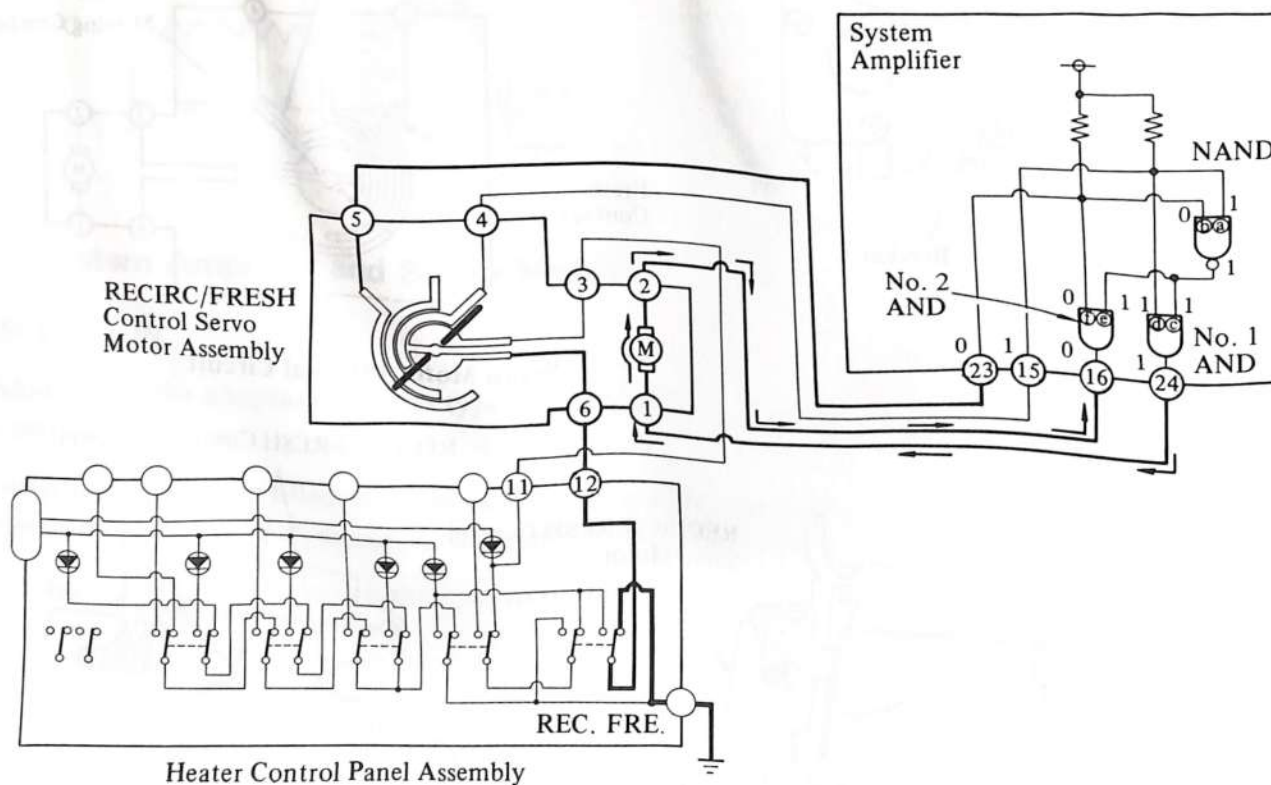
FRESH Position



RECIRC Position

a. When the RECIRC/FRESH Control Switch is on FRESH

- A grounded circuit can be completed by the System Amplifier, Terminal ②③ → Servo Motor, Terminal ⑤ → Servo Motor, Terminal ⑥ → Heater Control Panel, Terminal ⑫.
- Input to system amplifier terminal ②③ is 0 and input to terminal ⑫ is 1.
- Since there is a 1 at (a) of the NAND circuit and a 0 at (b) of the NAND circuit, the output of the NAND circuit becomes 1. Therefore, 1 is input to (c) of the No. 1 AND circuit and to (e) of the No. 2 AND circuit.
- Since 1 is input to (d) of the No. 1 AND circuit, the output of the No. 1 AND circuit is 1. Also, since 0 is input to (f) of the No. 2 AND circuit, the output of the No. 2 AND circuit is 0. Thus, the output of terminal ⑫④ of the system amplifier is 1 and the output of terminal ⑫⑥ of the system amplifier is 0.
- Therefore, the current flows from terminal ① to terminal ② of the servo motor, the motor turns and the damper is changed from RECIRC to FRESH.



– REFERENCE –

AND Circuit



If both inputs are "1", output will be "1"
 If either input is "0", output will be "0"

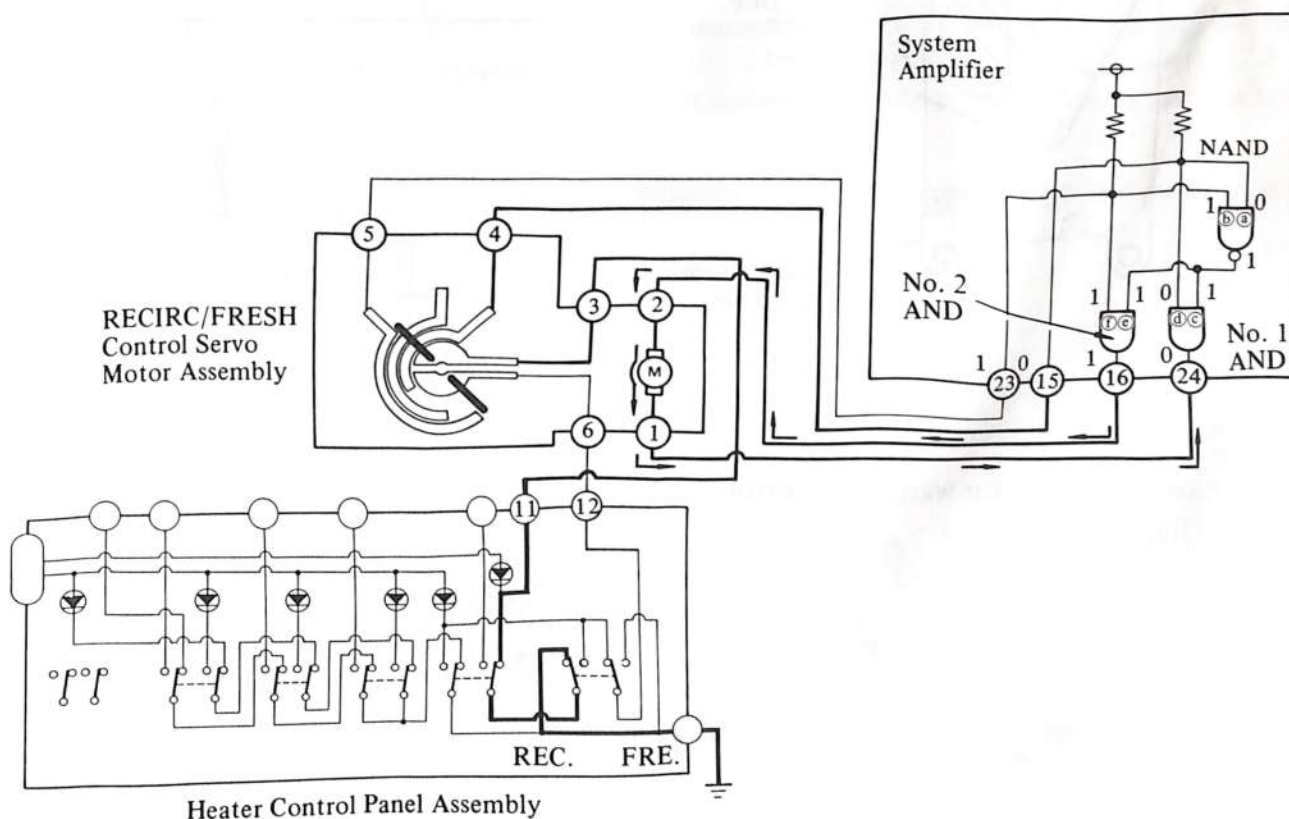
NAND Circuit



If both inputs are "1", output will be "0"
 If either input is "0", output will be "1"

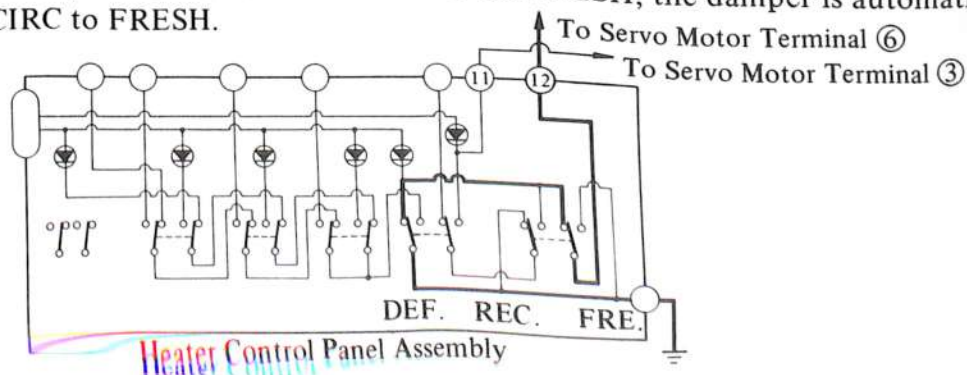
b. When the RECIRC/FRESH Control Switch is on RECIRC

- A grounded circuit can be completed by System Amplifier, Terminal ⑮ → Servo Motor, Terminal ④ → Servo Motor, Terminal ③ → Heater Control Panel, Terminal ⑪.
- The input to system amplifier terminal ⑮ is 0 and the input to terminal ⑲ is 1.
- ① of the NAND circuit is 0 and ② of the NAND circuit is 1, so the output of the NAND circuit is 1. The input to ③ of the No. 1 AND circuit and ④ of the No. 2 AND circuit is 1.
- Since 0 is input to ⑤ of the No. 1 AND circuit, the output of the No. 1 AND circuit is 0. Also, since the input at ⑥ of the No. 2 AND circuit is 1, the output of the No. 2 AND circuit is 1. Thus the output of terminal ⑲ of the system amplifier is 0 and the output of terminal ⑮ is 1.
- Therefore, current flows terminal ② to terminal ① of the servo motor, the motor turns and the damper is changed from FRESH to RECIRC.



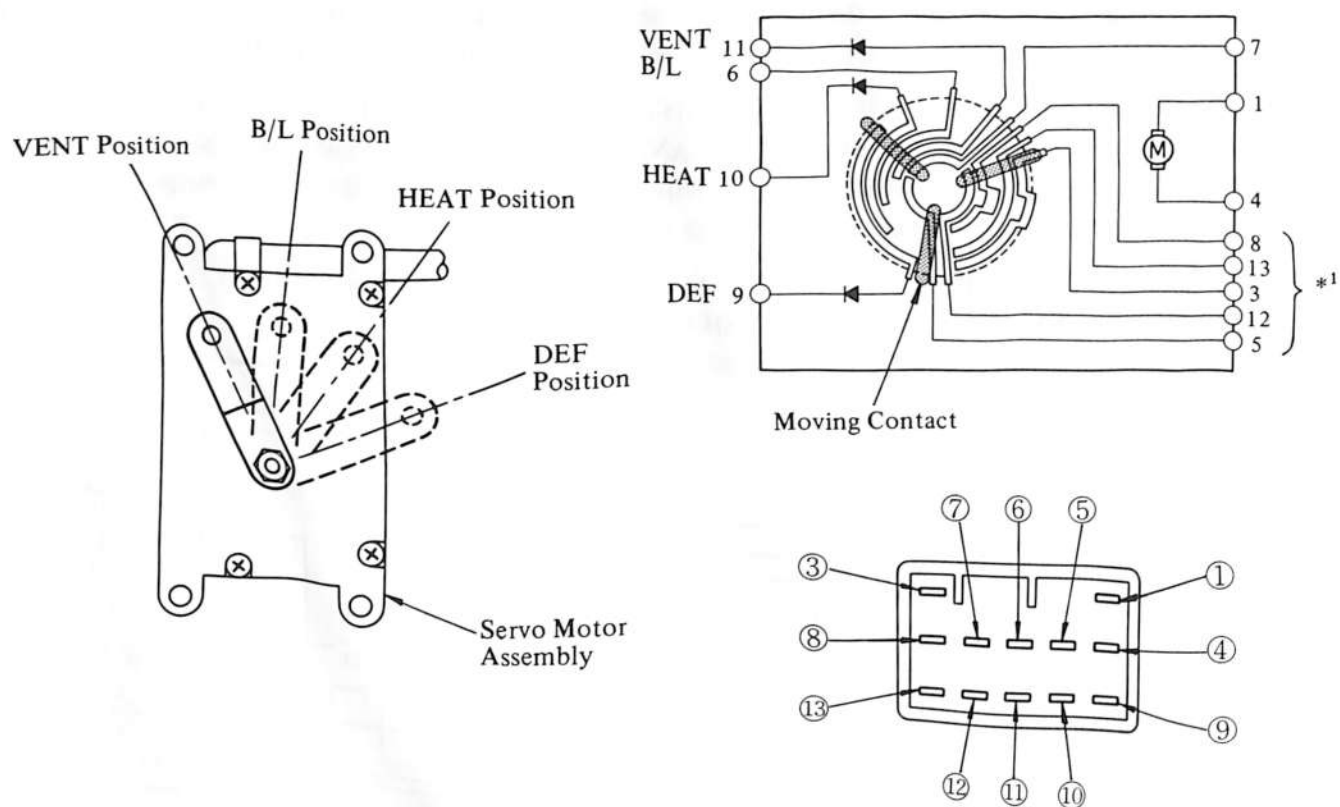
c. When the Air Flow Mode Control Switch is on DEF

- A grounded circuit can be completed by System Amplifier, Terminal ⑲ → Servo Motor, Terminal ② → Servo Motor, Terminal ⑥ → Heater Control Panel, Terminal ⑫. Therefore, just as when the RECIRC/FRESH control switch is set on FRESH, the damper is automatically changed from RECIRC to FRESH.

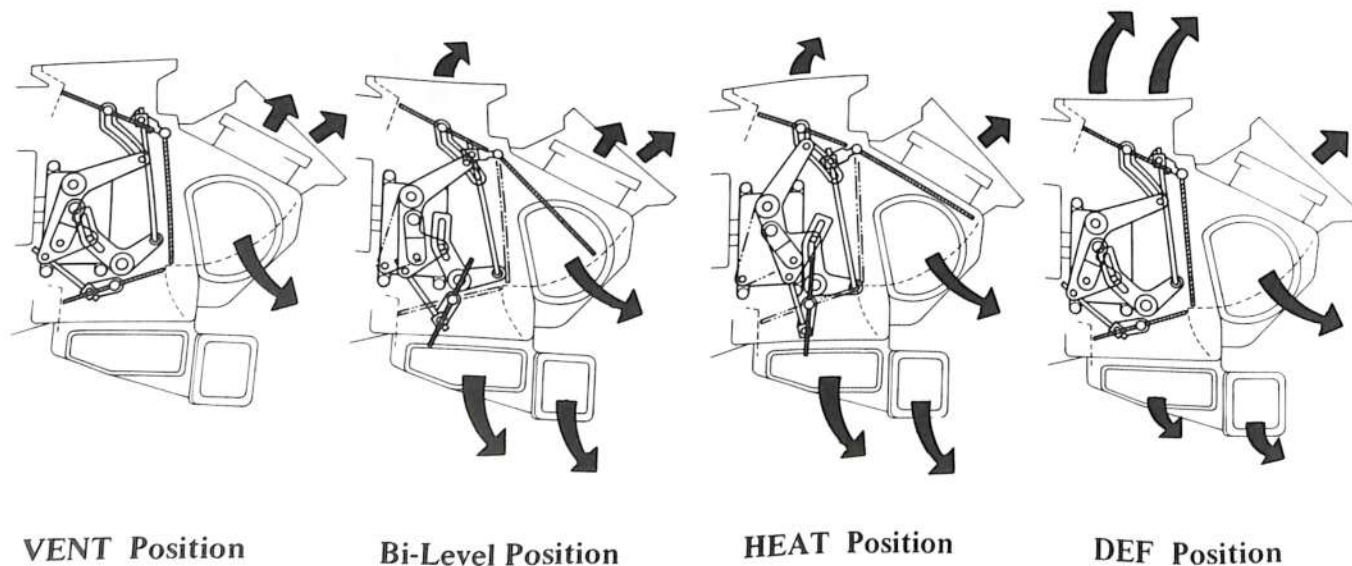


2) Air Flow Mode Control Servo Motor

If the air flow mode control switch on the heater control panel is operated, the servo motor turns clockwise or counterclockwise according to signals from the system amplifier and changes the damper position via a link. Also, in models equipped with the automatic air conditioner, a warm-up control switch circuit is also included.

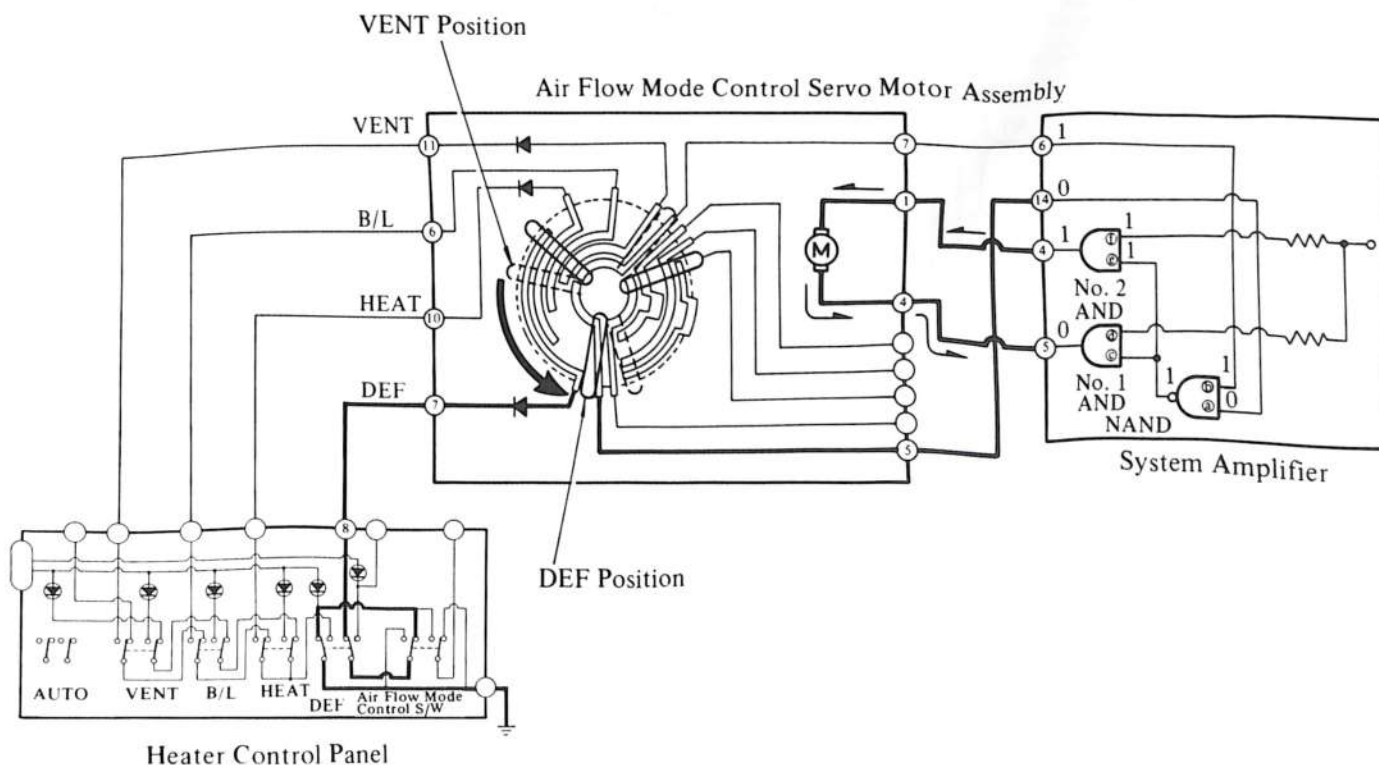


*1: Switch circuit for warm-up control
(Refer to TD-185.)



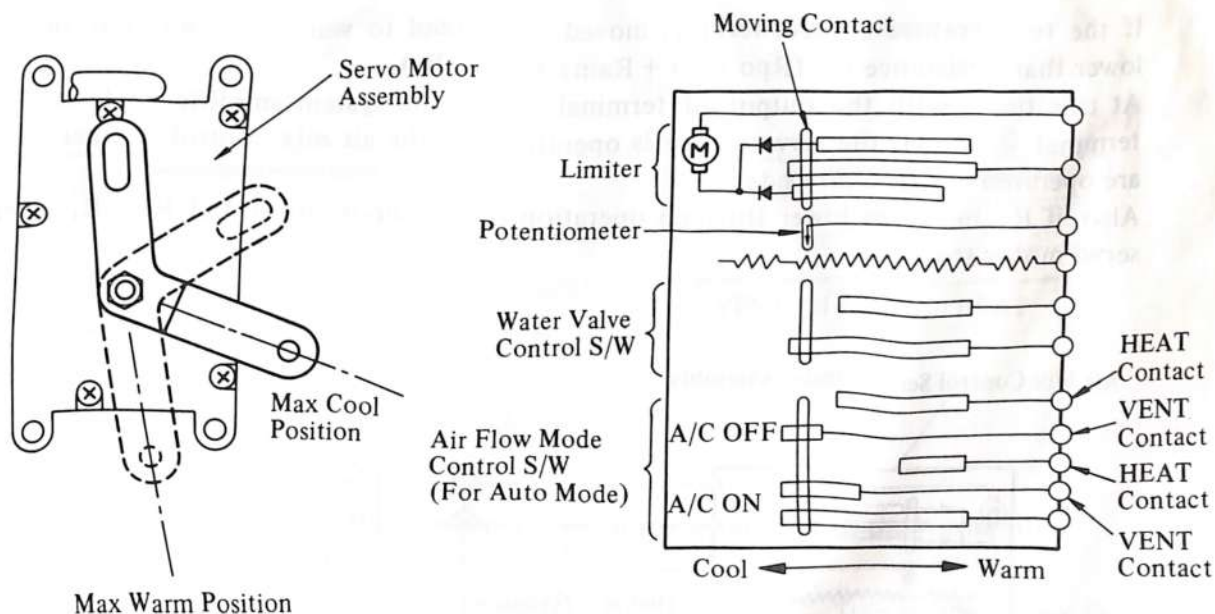
a. When the Air Flow Mode Control Switch is Changed from VENT to DEF

- The servo motor moving contacts are in the VENT position.
- If the air flow mode control switch is changed from VENT to DEF, the grounded circuit System Amplifier, Terminal ⑭ → Servo Motor, Terminal ⑤ → Servo Motor, Terminal ⑨ → Heater control Panel, Terminal ⑧, can be completed.
- The input to system amplifier terminal ⑭ is 0 and the input to terminal ⑥ is 1.
- Since the input to ④ of the NAND circuit is 0 and the input to ⑥ of the NAND circuit is 1, the output of the NAND circuit is 1 and the input to ③ of No. 1 AND circuit and to ⑤ of No. 2 AND circuit is 1.
- Since the input to ④ of No. 1 AND circuit is 0, the output of No. 1 AND circuit is 0. Also, since the input to ⑥ of No. 2 AND circuit is 1, the output of No. 2 AND circuit is 1. Thus the output of system amplifier terminal ⑤ is 1 and the output of terminal ④ is 1.
- Therefore, current flows from terminal ① to terminal ④ of the servo motor, the motor turns and the moving contacts move from the VENT position to the DEF position. At the point where contact with the DEF contacts is broken, the motor stops turning and the system is fixed in the DEF mode.
- The above operation is the same when changing from the Bi-Level or HEAT position to the DEF position.

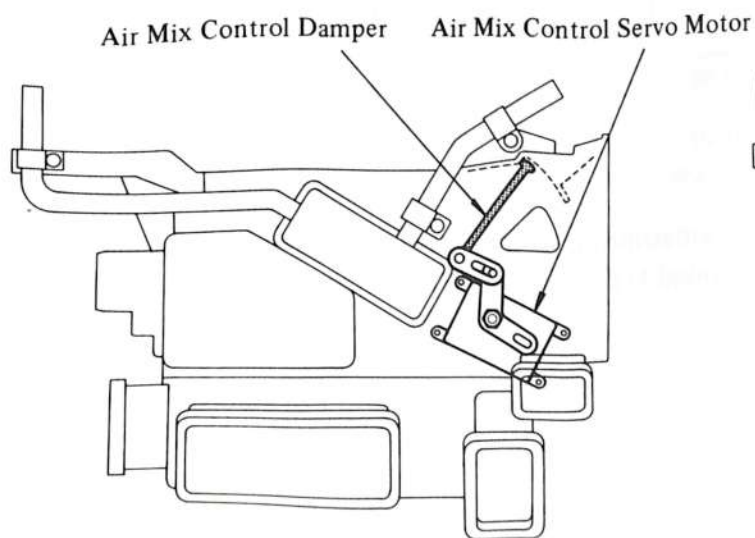


3) Air Mix Control Servo Motor

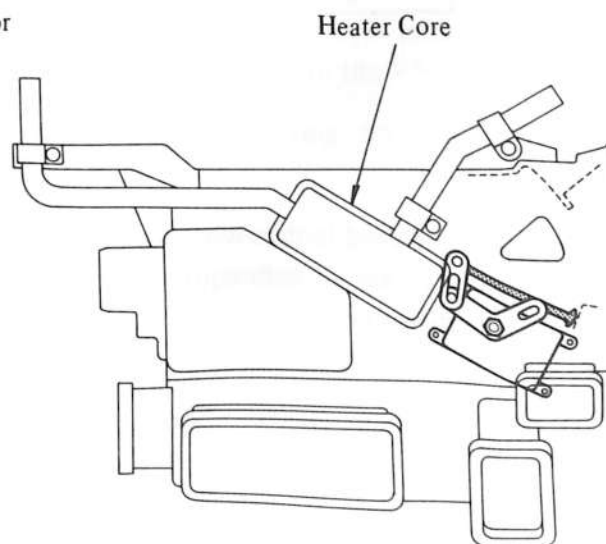
- This servo motor is mounted on the underside of the heater unit and is configured from a motor, potentiometer, air flow mode control switch, limiter and water valve control switch.
- By operating the temperature control lever on the heater control panel, the servo motor is turned clockwise or counterclockwise according to signals from the system amplifier, and at the same time as the resistance values of the potentiometer are changed, opening or closing of the air mix control damper and opening and closing of the water valve operated by the VSV (Vacuum Switching Valve) through the water valve control switch are carried out.



Servo Motor Internal Circuit



Max Cool Position



Max Warm Position

a. When the Temperature Control Lever is Changed from Warm to Cool

If the temperature control lever is moved from Warm to Cool, the set resistance R_2 (according to the position of the temperature control lever) becomes larger than resistance R_1 (potentiometer resistance R_{po} + In-Car temp. sensor resistance R_r + ambient temp. sensor resistance R_{am}) ($R_2 < R_1$).

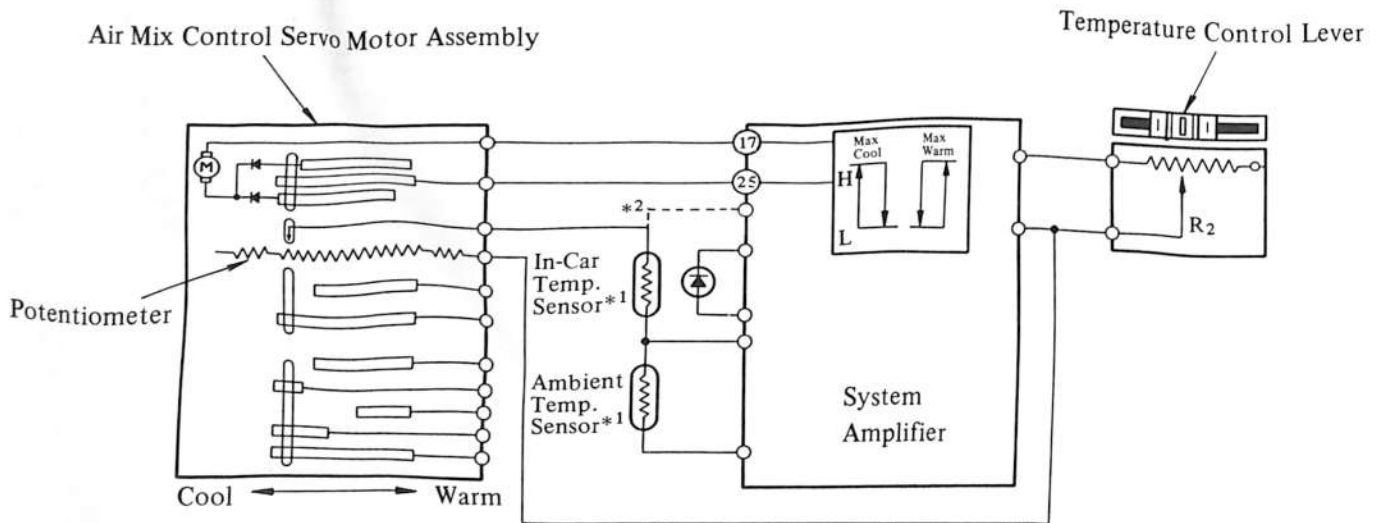
At this time, with the output of terminal ⑰ of the system amplifier as H and the output of terminal ②⑤ as low, the servo motor is operated and the air mix control damper and water valve are operated to the Warm side. If resistance R_1 becomes large by operating the motor and $R_2 = R_1$, operation of the servo motor stops.

b. When the Temperature Control Lever is Changed from Cool to Warm

If the temperature control lever is moved from cool to warm, the set resistance R_2 becomes lower than resistance R_1 ($R_{po} + R_r + R_{am}$). ($R_2 < R_1$)

At this time, with the output of terminal ⑰ or the system amplifier as L and the output of terminal ②⑤ as H, the servo motor is operated and the air mix control damper and water valve are operated to the warm side.

Also, if R_1 becomes lower through operation of the servo motor and $R_2 = R_1$, operation of the servo motor stops.



*1 : Not offered in cars with a manual type air conditioner

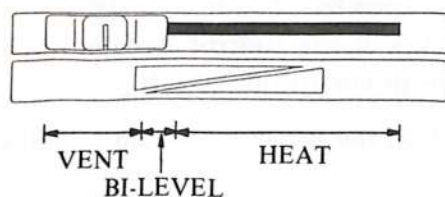
*2 : In the case of cars equipped with a manual type air conditioner or not equipped with an air conditioner

4. Air Flow Mode Automatic Control System

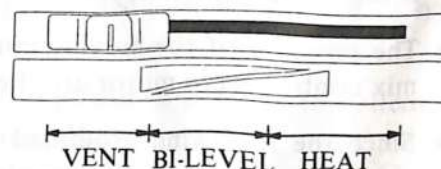
DESCRIPTION

- In cars which are not equipped with an air conditioner and those equipped with a manual air conditioner, by setting the air flow mode control switch to the AUTO mode, connection is made with the movement of the temperature control lever and the air flow vents are automatically changed between VENT, Bi-Level and HEAT.
- When the air conditioner is off, (including cars not equipped with an air conditioner), and when the air conditioner is on, the position of the air flow dampers changes in proportion to the operation of the temperature control lever.

Air Conditioner: OFF

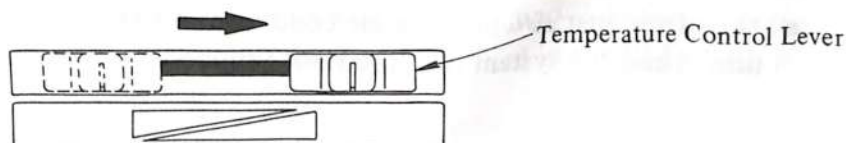


Air Conditioner: ON



OPERATION

- 1) When the Temperature Control Lever is Changed from the Cool Side to the Warm Side



- a. If the Air Conditioner is ON

- The moving contacts of the air flow mode control servo motor are in the VENT position.
- If the temperature control lever is slid to the Warm side, the moving contacts of the air mix control servo motor are moved to the Warm position.
- Since the air flow mode control switch on the heater control panel is in the AUTO mode, the following grounded circuit is completed and the input to system amplifier terminal ⑧ becomes 0.

<Grounded Circuit>

Heater Control Panel, Terminal ⑮ → Air Mix Control Servo Motor, Terminal ⑩ → Air Mix Control Servo Motor, Terminal ③ → System Amplifier, Terminal ⑧.

Also, since the air conditioner ON/OFF Switch is ON, the input to system amplifier terminal ⑩ is 1.

Therefore, the input to No. 1 NOT circuit is 0 and the output is 1, and the input to ⑩ of No. 1 NAND circuit is 1. Also, since the input to ③ of No. 1 NAND circuit is 1, the output of No. 1 NAND circuit is 0.

Therefore, the output of system amplifier terminal ① is 0.

- Since the output of system amplifier terminal ① is 0, the following grounded circuit is completed. Thus, the input to system amplifier terminal ⑭ is 0 and the input to terminal ⑥ is 1.

<Grounded Circuit>

System Amplifier, Terminal ① → Air flow Mode Control Servo Motor, Terminal ⑩ → Servo Motor, Terminal ⑤ → System Amplifier, Terminal ⑭.

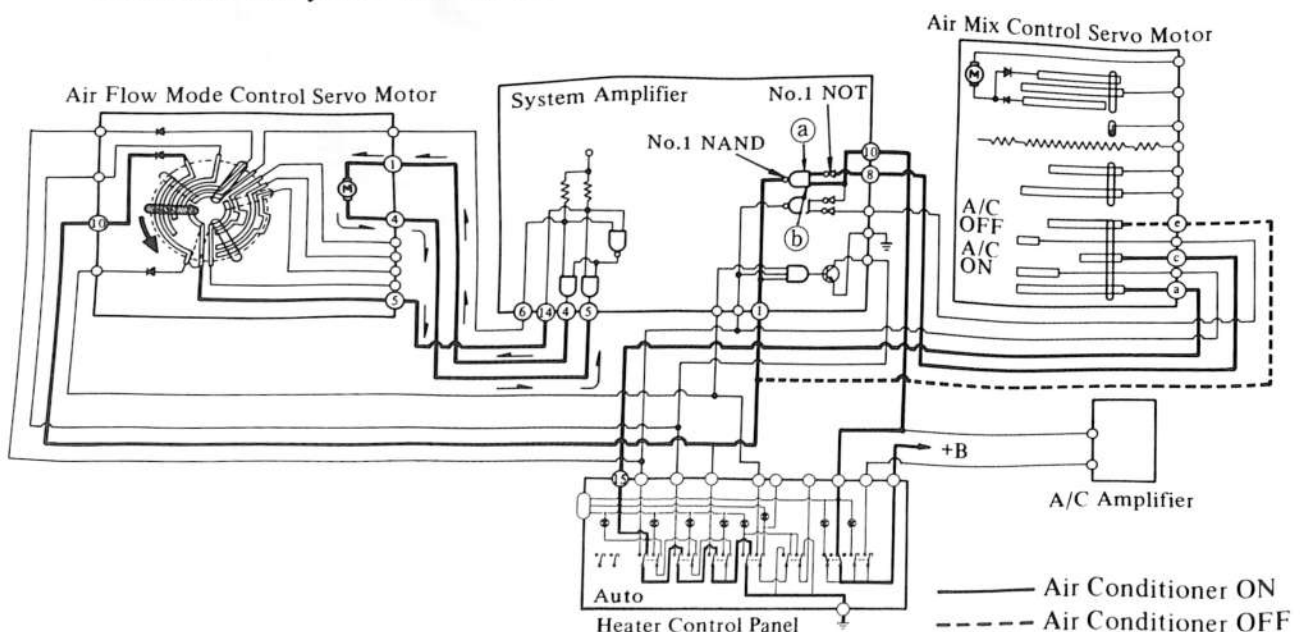
- In this way, the output of system amplifier terminal ④ is 1 and current flows from terminal ① to terminal ④ of the air flow mode control servo motor. The motor turns and the moving contacts move from the VENT position to the HEAT position. When contact with the VENT contacts is broken, the motor stops turning and the system is fixed in the HEAT mode.

b. If the Air Conditioner is OFF

- The position of the moving contacts of the air flow mode control servo motor and the air mix control servo motor are the same as when the air conditioner is ON.
- Since the following grounded circuit is completed, the input to system amplifier terminal ⑭ is 0 and the input to terminal ⑥ is 1.

<Grounded Circuit>

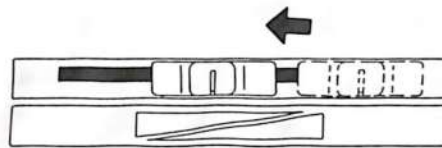
- Heater Control Panel, Terminal ⑮ → Air Mix Control Servo Motor, Terminal (a) → Air Mix Control Servo Motor, Terminal (e) → Air Flow Mode Control Servo Motor, Terminal ⑩ → Air Flow Mode Control Servo Motor, Terminal ⑤ → System Amplifier, Terminal ⑭.
- Therefore, just as when the air conditioner is ON, the air flow mode control servo motor is turned and the system is in the HEAT mode.



— REFERENCE —

NOT Circuit  Input signal will be reverses
 "1" input → "0" output
 "0" input → "1" output

2) Temperature Control Lever is Changed to Near the Center Position

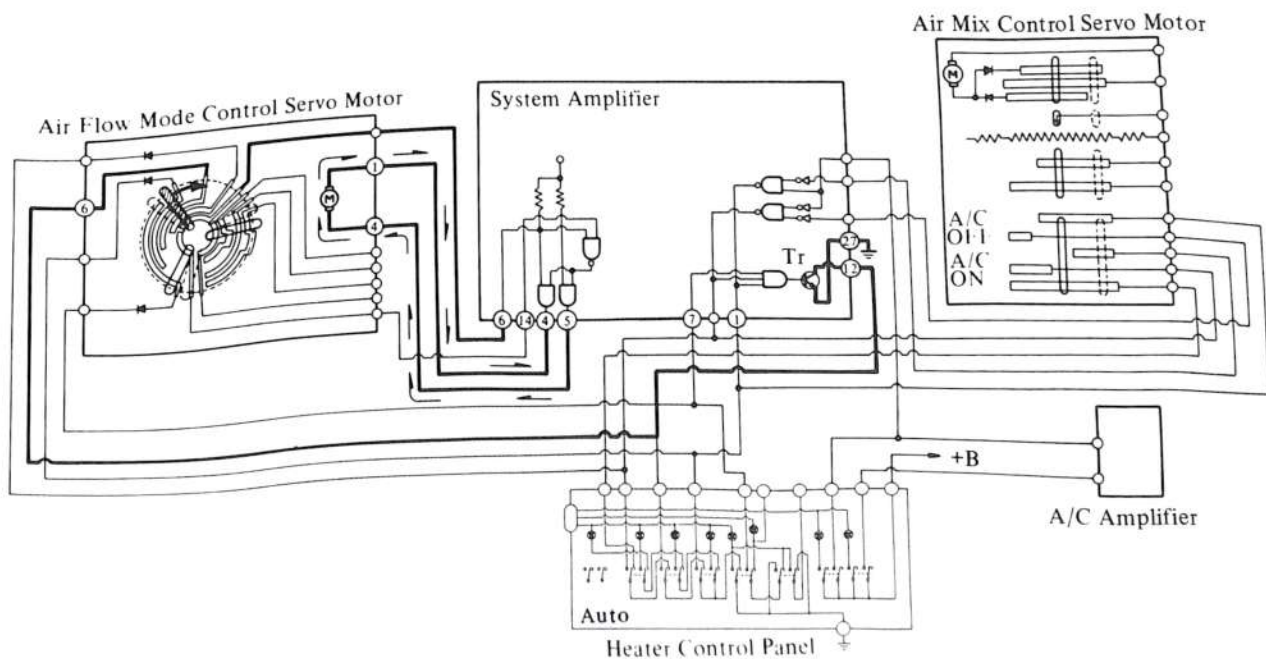


- Operation is the same whether the air conditioner is ON or OFF.
- The moving contacts of the air flow mode control servo motor are in the HEAT position.
- If the temperature control lever is slid to near the center position, the moving contacts of the air mix control servo motor move to a position midway between Cool and Warm.
- At this time, the input to terminals ⑦ and ① of the system amplifier is 1, the output of the AND circuit is 1 and since the transistor (Tr) is turned ON, the output of system amplifier terminal ⑫ becomes 0.
- Therefore, since the following grounded circuit is completed, 0 is input to system amplifier terminal ⑥ and 1 is input to system amplifier terminal ⑭.

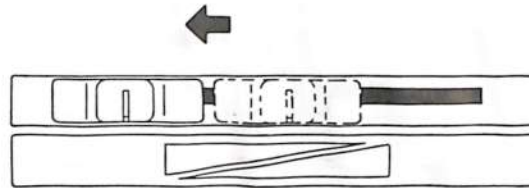
<Grounded Circuit>

System Amplifier, Terminal ⑭ → System Amplifier, Terminal ⑫ → Air Flow Mode Control Servo Motor, Terminal ⑥ → Air flow Mode Control Servo Motor, Terminal ⑦ → System Amplifier, Terminal ⑥.

- In this way, 1 is output to system amplifier terminal ⑤, current flows from terminal ④ to terminal ① of the air flow mode control servo motor, the motor turns and the moving contacts move from the HEAT position to the BI-LEVEL position. When contact with the HEAT contacts is broken, the motor stops turning and the system is fixed in the BI-LEVEL mode.



3) When the Temperature Control Lever is Changed from Mid Position to the COOL Side



a. If the Air Conditioner is ON

- The air flow mode control servo motor moving contacts are in the BI-LEVEL position.
- If the temperature control lever is slid to the Cool side, the air mix control servo motor moving contacts move to the Cool position.
- Since the air flow mode control switch on the heater control panel is in the AUTO mode, the following grounded circuit is completed making the input 0 to system amplifier terminal ⑥ and 1 to system amplifier terminal ⑭.

<Grounded Circuit>

Heater Control Panel, Terminal ⑮ → Air Mix Control Servo Motor, Terminal ① → Air Mix Control Servo Motor, Terminal ② → Air Flow Mode Control Servo Motor, Terminal ③ → Air Flow Mode Control Servo Motor, Terminal ④ → System Amplifier, Terminal ⑤.

- In this way, 1 is output to system amplifier terminal ⑤, current flows from terminal ④ to terminal ① of the air flow mode control servo motor, the motor turns and the moving contacts move from the BI-LEVEL position to the VENT position. When contact with the BI-LEVEL contacts is broken, the motor stops turning and the system is fixed in the VENT mode.

b. If the Air Conditioner is OFF

- The position of the moving contacts in the air flow mode control servo motor and the air mix control servo motor is the same as when the air conditioner is ON.
- Since the air flow mode control switch on the heater control panel is in the AUTO mode, the following grounded circuit is completed and the input to system amplifier terminal ③ is 0.

<Grounded Circuit>

Heater Control Panel, Terminal ⑮ → Air Mix Mode Control Servo Motor, Terminal ① → Air Mix Control Servo Motor, Terminal ② → System Amplifier, Terminal ③.

Also, since the air conditioner ON/OFF switch is OFF, 0 is input to system amplifier terminal ⑩.

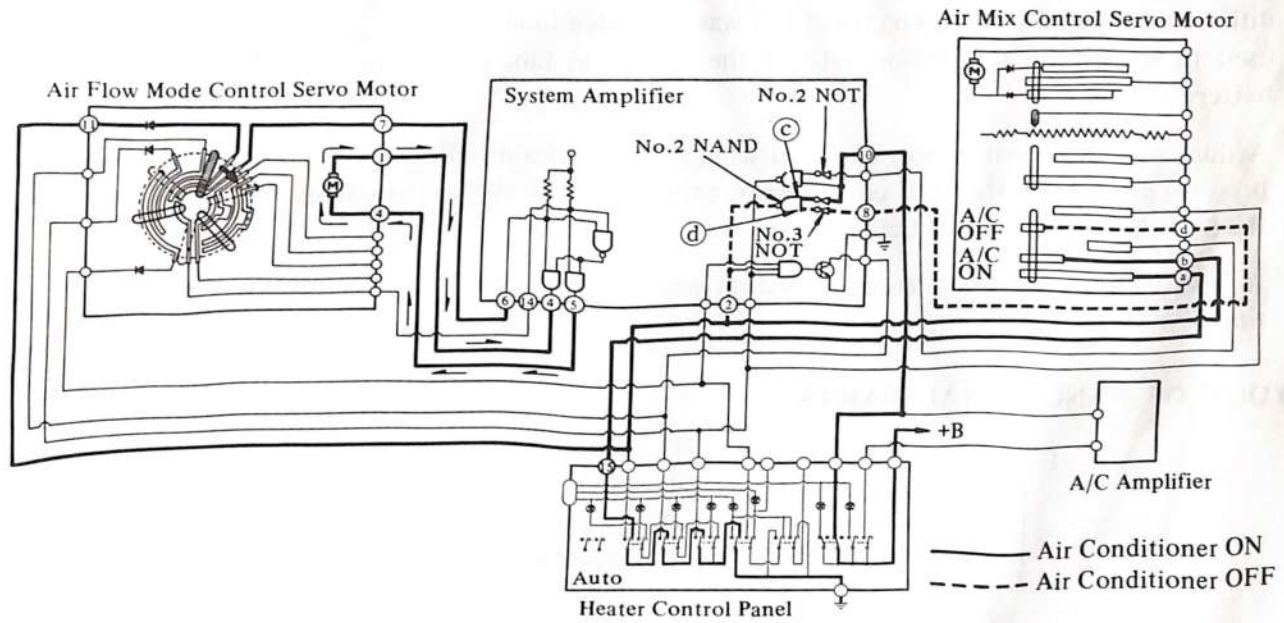
Therefore, 0 is input to No. 2 NOT circuit and No. 3 NOT circuit and their outputs both become 1. 1 is input to ③ and ④ of No. 2 NAND circuit and the output of No. 2 NAND circuit becomes 0.

- Since the output of system amplifier terminal ② is 0, the following grounded circuit is completed, 0 is input to system amplifier terminal ⑥ and 1 is input to system amplifier terminal ⑭.

<Grounded Circuit>

System Amplifier, Terminal ② → Air Flow Mode Control Servo Motor, Terminal ⑪ → Air Flow Mode Control Servo Motor, Terminal ⑦ → System Amplifier, Terminal ⑥.

- Therefore, just as when the air conditioner is ON, the air flow mode control servo motor turns and the system goes to the VENT mode.



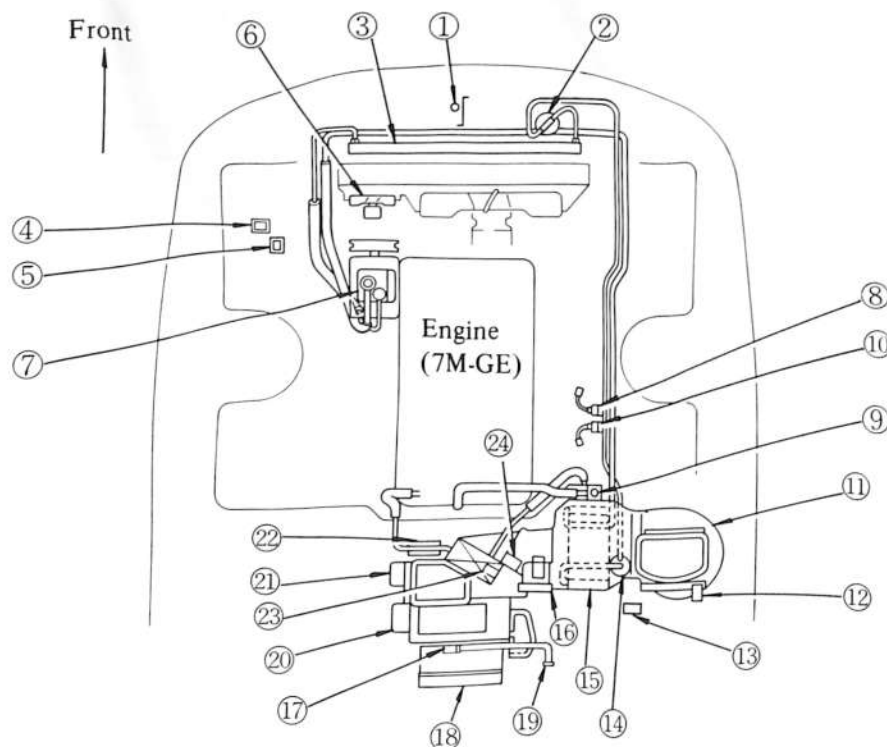
AIR CONDITIONER

DESCRIPTION

The air conditioner in the new Supra, compared to that in the previous Supra, includes the following improvements and new mechanisms which improve the system's comfort and usability.

- ▶ An automatic air conditioner is offered as an option on all models. (Not including South Africa)
- ▶ In order to assure the cooling performance of the cooler condenser and engine when the air conditioner is turned on, an electrical fan was provided in all models. Also, a high pressure switch is used to lower the utilization rate of the electrical fan, reduce noise and prevent running the battery down.
- ▶ A dual pressure switch was adopted which senses abnormalities in the refrigerant condensation pressure and stops the A/C compressor, protecting the compressor from damage. (The same as in the ST162, AT160 Series Celica)
- ▶ A 2-way air conditioner control system was adopted in all models equipped with an air conditioner.

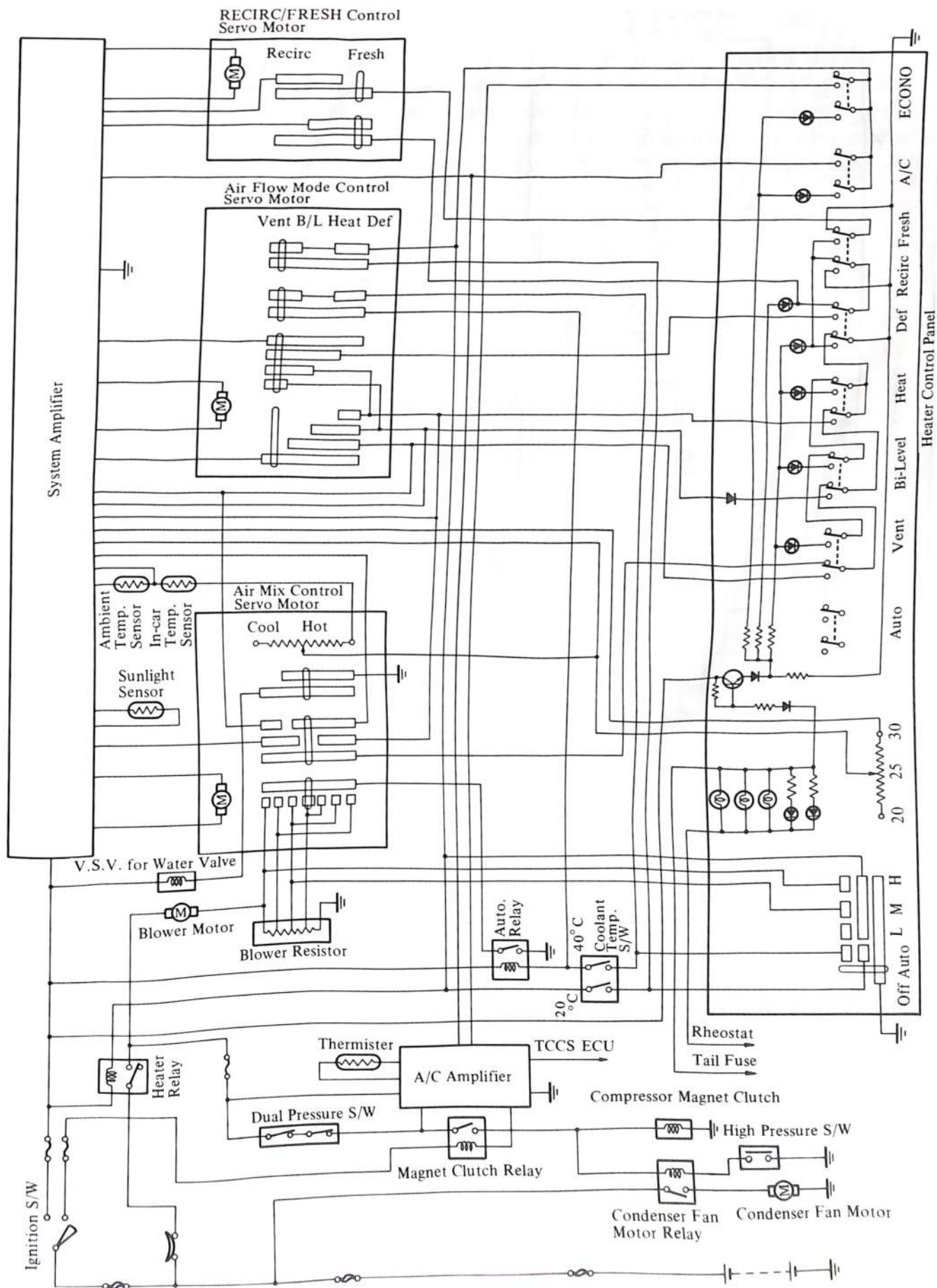
LAYOUT OF FUNCTIONAL PARTS



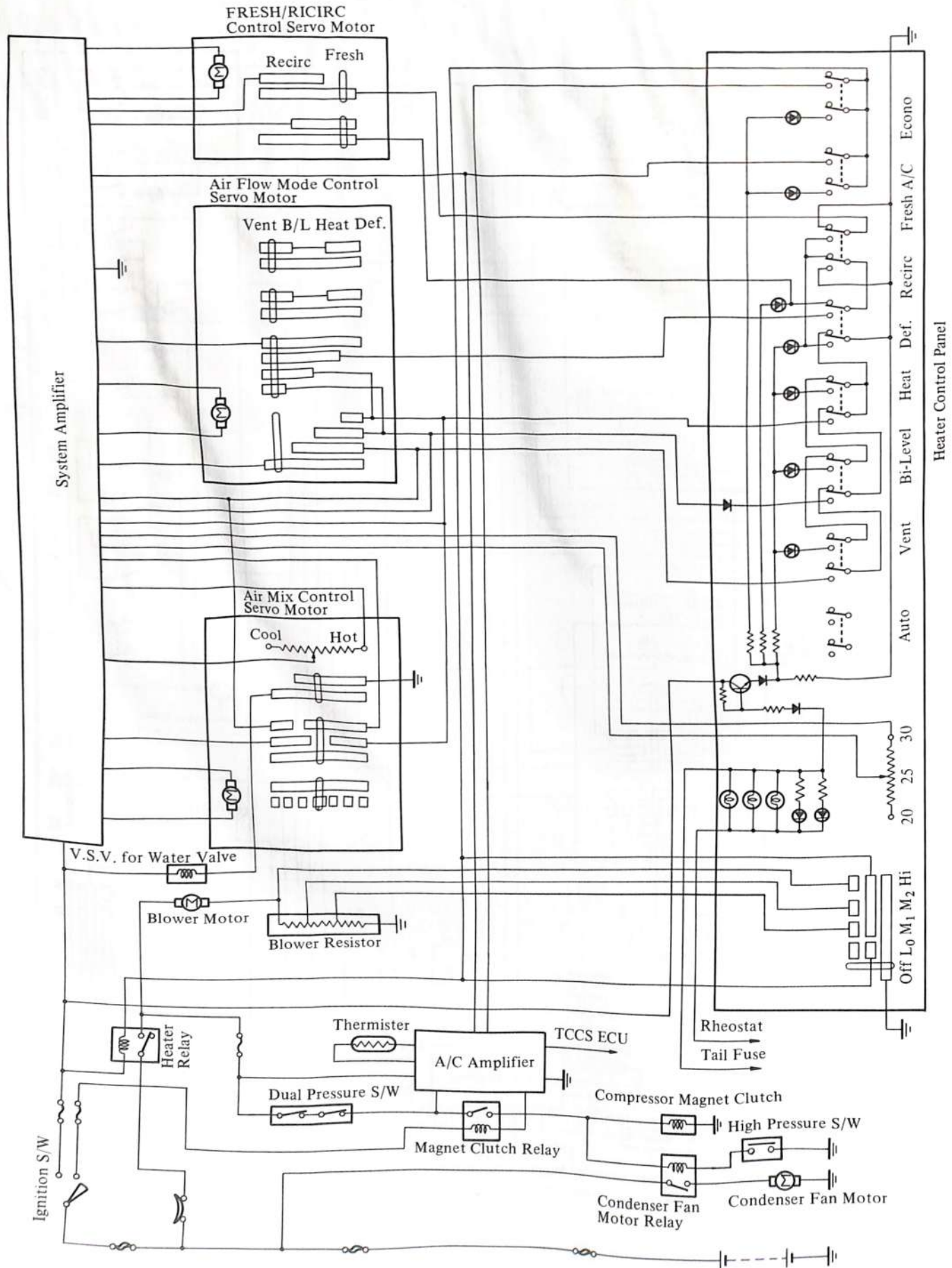
Engine Room	Interior	
① Ambient Temp. Sensor* ¹	⑪ Blower	⑳ Heater Unit
② Receiver Tank	⑫ RECIRC/FRESH Control Servo Motor	㉑ Air Flow Mode Control Servo Motor
③ Condenser	⑬ Sunlight Sensor* ¹	㉒ System Amplifier
④ Electrical Fan Relay	⑭ Expansion Valve	㉓ Coolant Temp. Switches* ¹
⑤ Magnet Clutch Relay	⑮ Cooling Unit	㉔ Air Mix Control Servo Motor
⑥ Electrical Fan	⑯ Program Switch* ¹	
⑦ Compressor	⑰ Aspirator* ¹	
⑧ Dual Pressure Switch	⑱ Heater Control Panel	
⑨ Water Valve	⑲ In-car Temp. Sensor* ¹	
⑩ High Pressure Switch		

*1: Only for Automatic Air Conditioner

WIRING DIAGRAM (for Automatic Air Conditioner)



WIRING DIAGRAM (for Manual Air Conditioner)



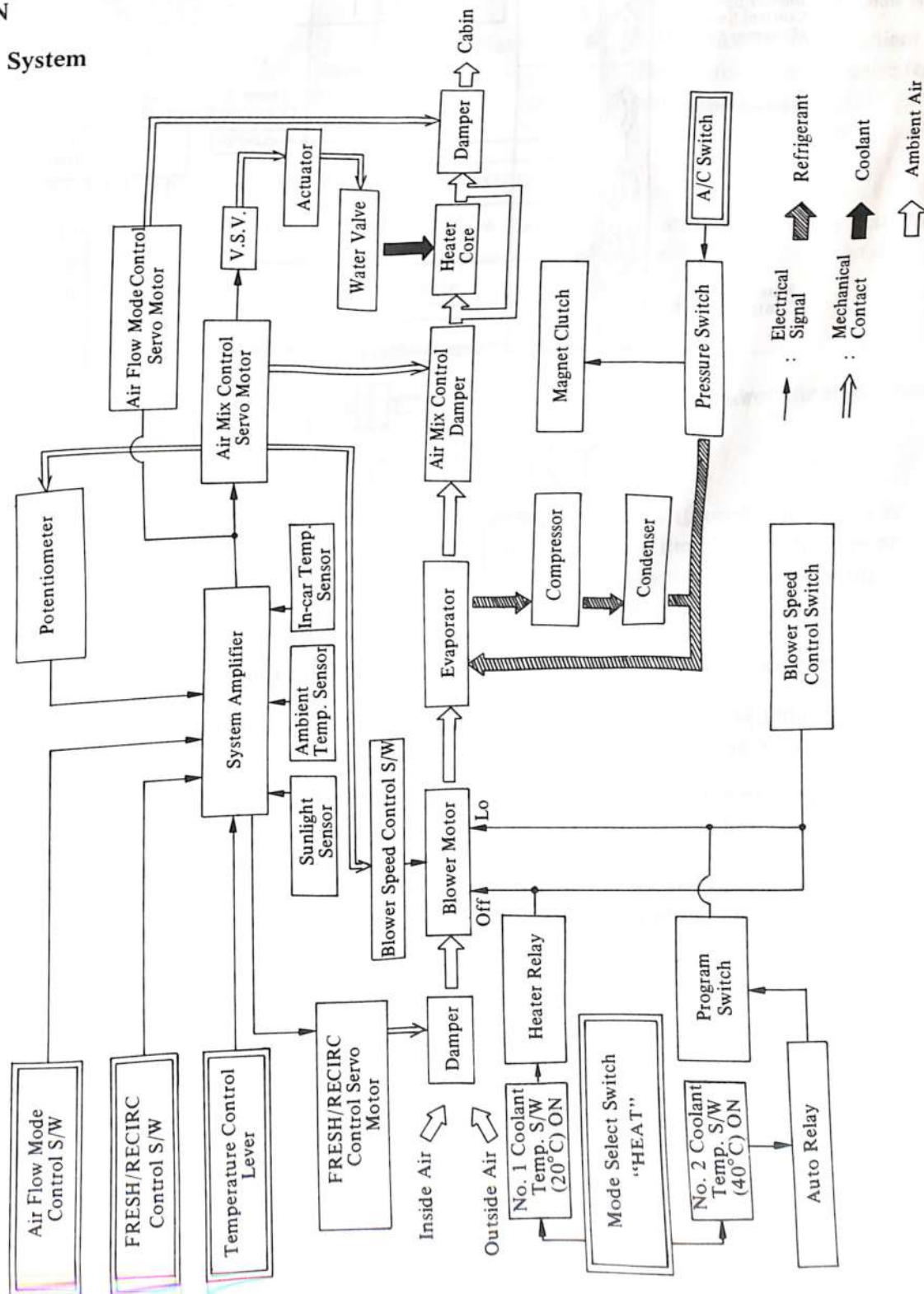
1. Automatic Air Conditioner

DESCRIPTION

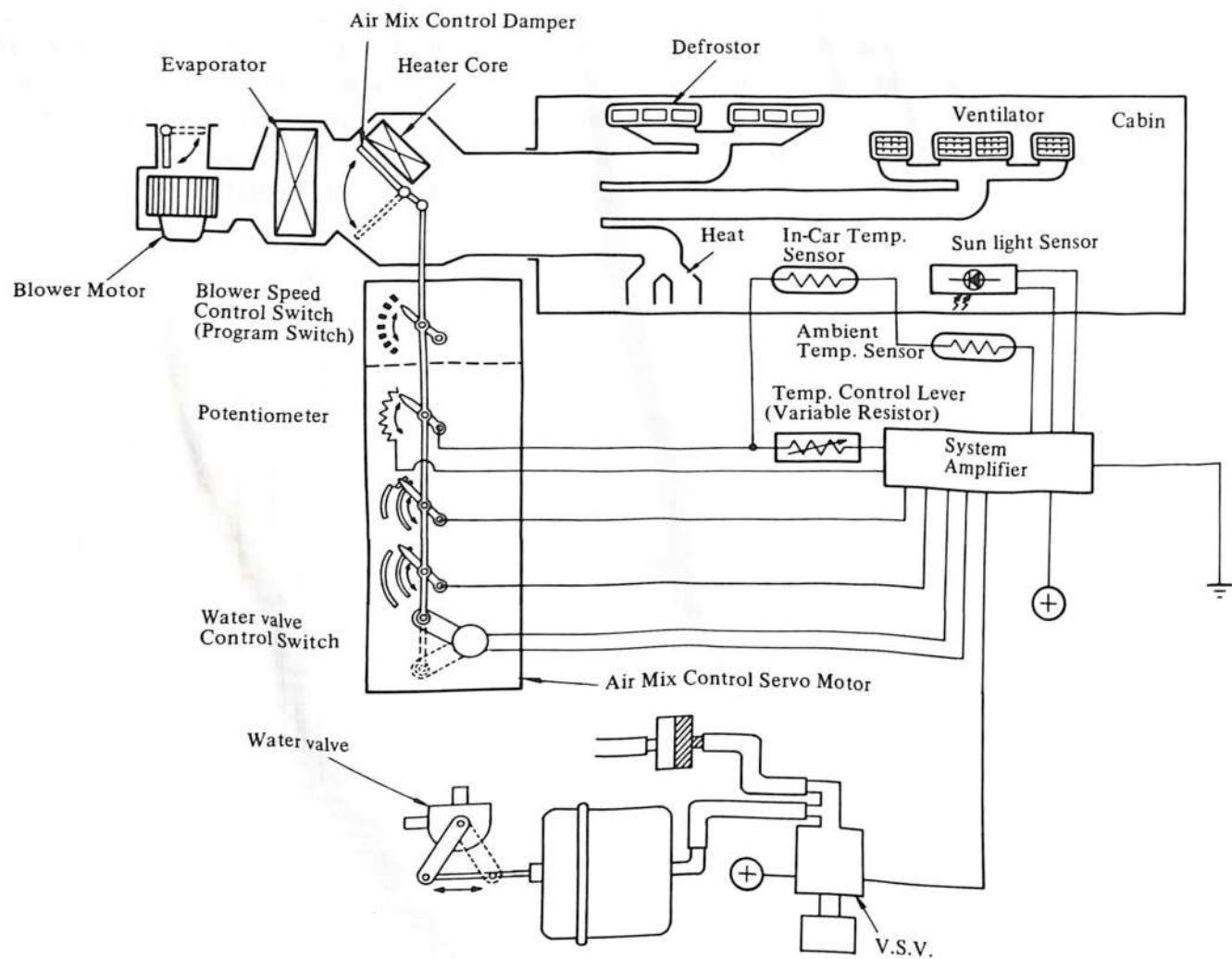
When the desired temperature is set on the auto air conditioner with the temperature control lever, the temperature of the air and the air volume are controlled by the computer, and regardless of the conditions inside and outside the car or the running conditions, the air conditioner works to keep the temperature inside the passenger compartment constant. Also, in the new Supra, control mechanisms are included which change the air vents in accordance with the air vent temperature (Vent—B/L—Heat), making this a mode auto system.

OPERATION

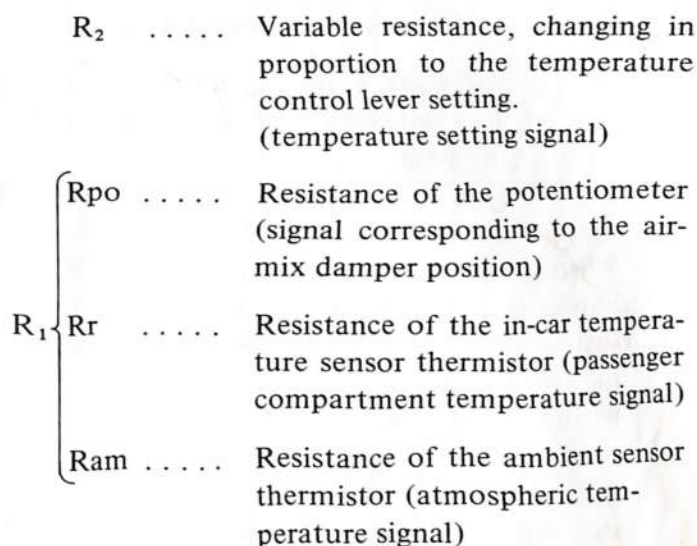
1) Control System



2) Temperature Control System



- The temperature control system is configured from the above system circuit.
- If the cabin temperature changes with respect to the temperature setting of the temperature control lever, resistance R_1 of the in-car temp. sensor or the ambient temp. sensor changes.
- The respective voltages at resistance R_1 and resistance R_2 , set by the temperature control lever, are changed and are input to the system amplifier.
- The system amplifier controls the turning of the air mix control servo motor according to the difference between these voltages.
- Along with opening or closing the air mix control damper, the air mix control servo motor operates the blower speed control switch, potentiometer and water valve control switch, operating to keep the cabin temperature constant.



In this situation, R_2 nearly equals R_1 ($R_{po} + R_r + R_{am}$), so the amplifier judges that the compartment temperature is being maintained at the preset temperature. For this reason, the servo motor does not operate.

This situation results when the inside temperature drops (R_r increases) and/or the in-car temperature is reset to a higher level (R_2 decreases).
In either case, R_2 becomes higher than R_1 .
As a result, the amplifier turns the servo motor on.
The air mix damper and water valve moves to allow more air to flow through the heater core.
The potentiometer is actuated in proportion to the movement of the air mix damper and water valve and as a result, resistance R_{po} decreases slowly. The servo motor stops operating when R_2 becomes equal to R_1 .

This situation results when the inside temperature rises (R_r decreases) and/or the in-car temperature is reset to a lower level (R_2 is increases).
In either case, R_2 becomes higher than R_1 .
As a result, the amplifire turns the servo motor on.
Therefore, the air mix damper and water valve move to allow less air to flow through the heater core.
As a result, the resistance of the potentiometer R_{po} increases. The servo motor stops when R_2 becomes equal to R_1 .

3) Blower Speed Automatic Control System

The blower speed is changed by the blower speed switch, shown below (Air Mix Control Servo Motor). It is switched by the position of the contact point that moves in proportion to the movement of the air mix damper and water valve.

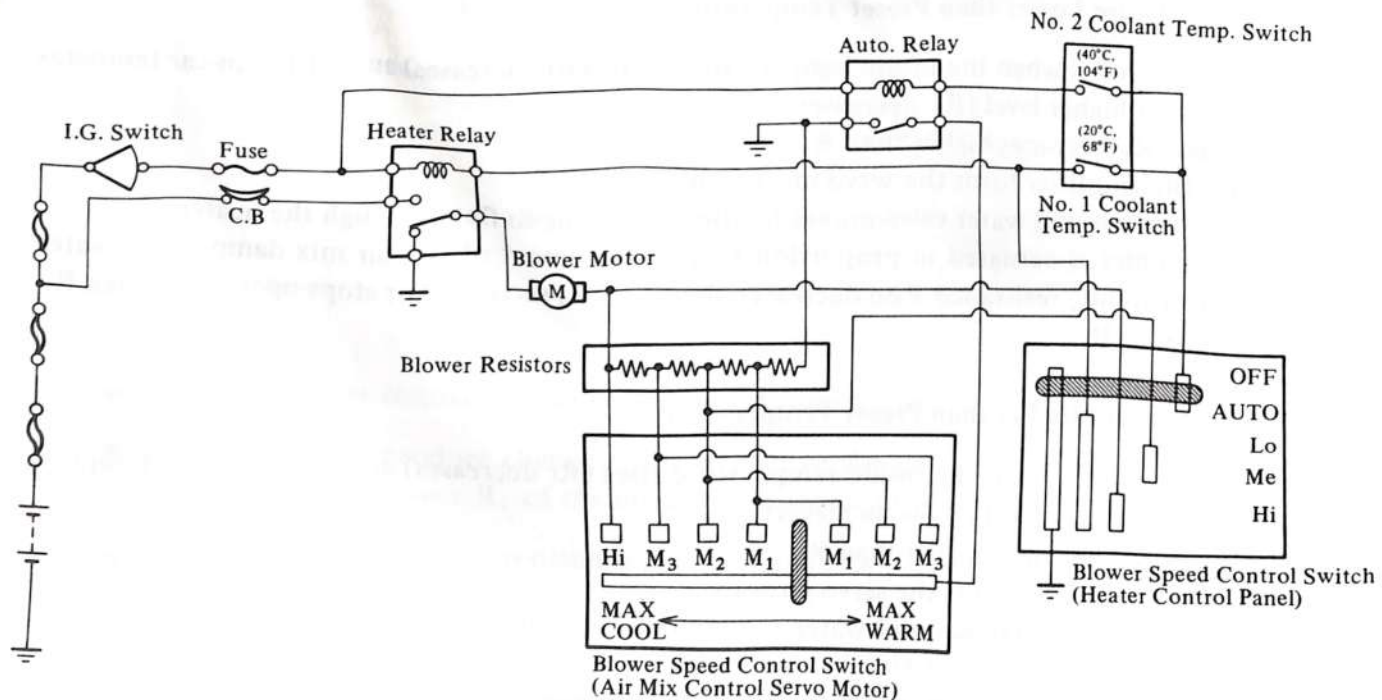
When the amount of movement of the servo motor shaft is large, the contact point of the blower speed switch is either at "MAX COOL" or "MAX WARM" and the blower speed increases.

When the contact point is at "MAX COOL", for example, electric current flowing through the blower motor goes from the blower motor to the "HIGH SPEED" contact of the blower speed switch, to the auto. control relay and to ground. Since all blower resistors are short-circuited, the blower runs at a high speed.

When the amount of movement of the servo motor shaft becomes smaller and the contact point comes closer to the center, a smaller number of resistors are short-circuited, and the blower speed decreases. When the contact point is at the Lo position, as shown below, all of the resistors are connected in series to the blower motor circuit. As a result, the blower speed becomes low. The automatic blower speed control becomes operative only when the blower switch assembly is set at "AUTO".

Otherwise, the blower speed remains at the speed to which it has been set.

Blower Speed Control Circuit



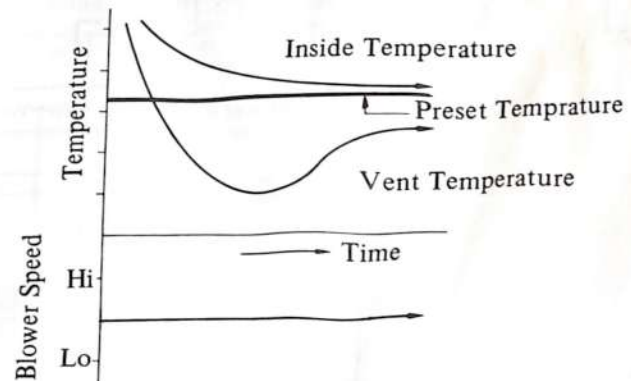
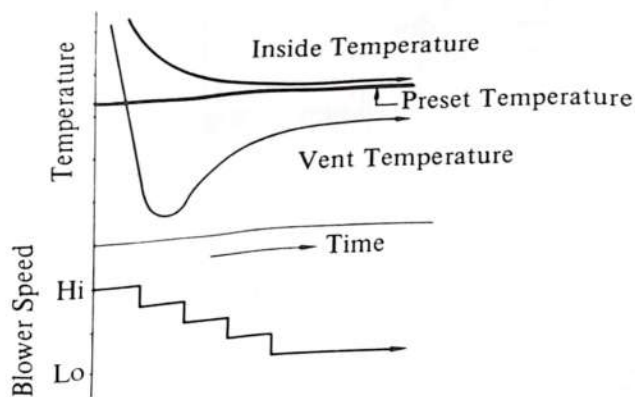
– REFERENCE –

If there is a large difference between the inside temperature and the preset temperature, the passenger compartment is cooled or heated at maximum capacity so that the temperature will become equal to the preset temperature in the shortest time possible.

The vent temperature is adjusted accordingly, and the blower speed is also set at high speed to achieve this.

The air flow rate is controlled in such a way that the blower speed is reduced as the two temperatures become closer.

If the blower speed was fixed at a particular speed, it would require a longer time until the cabin temperature becomes equal to the preset level as shown below.



4) Warm-up Control System

- ▶ The warm-up control is a system which controls the blower motor speed, when the outside temperature is low, according to the engine coolant temperature, providing optimum heating of the passenger compartment. Furthermore this system operates only when the air flow mode control switch is either the AUTO position or the HEAT position and the blower speed control switch is the AUTO position.

- ▶ The control system circuit is the same as the blower speed control system circuit.

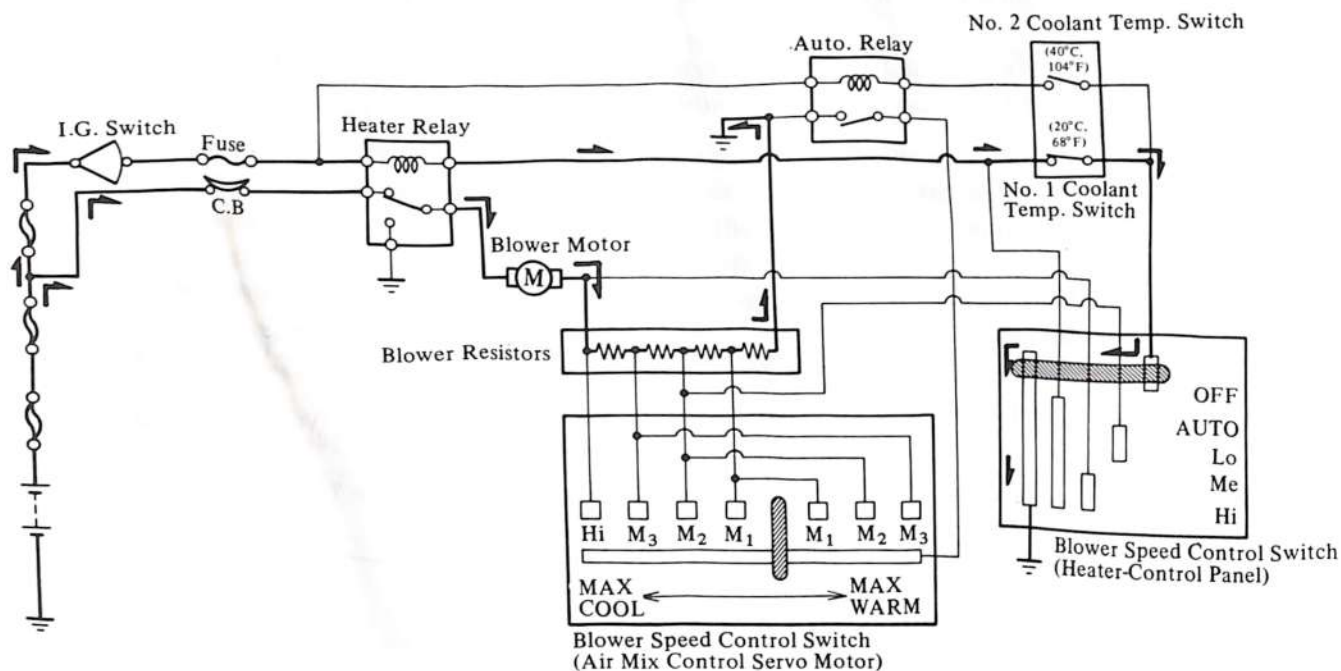
a. Coolant at 20°C (68°F) or Lower

When the blower speed control switch is set to "AUTO" position in the air flow mode control switch "HEAT" mode, the blower speed is controlled automatically according to the temperature of the engine coolant. Since No. 1 and No. 2 coolant temperature switches are off (contacts open), the blower control relay coil is not grounded, so the blower control relay is off. Current from the circuit breaker therefore does not flow to the blower motor, and the blower goes off.

b. Coolant between 20°C (68°F) and 40°C (104°F)

No. 1 coolant temp. switch (20°C, 68°F) is ON and the heater relay is turned ON, but since No. 2 coolant temp. switch (40°C, 104°F) is OFF, the auto relay remains OFF.

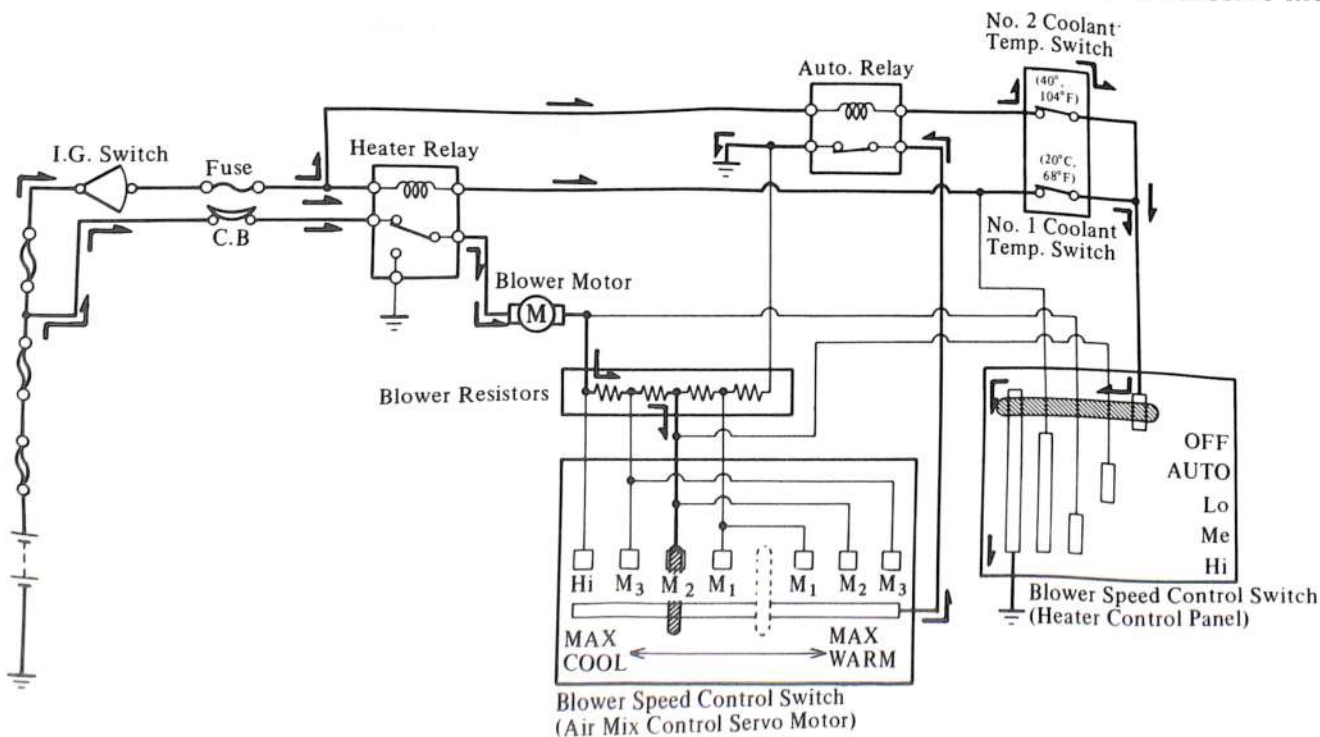
Therefore, the operating current to the blower motor passes through all blower resistors without relation to the position of the blower speed control switch in the air mix control servo motor, and the blower motor turns at L_0 speed.



c. Coolant Above 40°C (104°F)

Since No. 1 and No. 2 coolant temp. switches are ON, the heater relay and auto relay are turned ON.

Therefore, the operating current to the blower motor passes through the respective blower resistors and turning of the blower motor is controlled automatically at L_0 , M_1 , M_2 , M_3 or Hi according to the position of the blower speed control switch in the air mix control servo motor.



The diagram illustrates a vehicle's climate control system, showing the flow of air and refrigerant, and the electrical control system.

Refrigerant Cycle Components:

- Evaporator
- Air Mix Control Damper
- Heater Core
- Condenser
- Compressor

Air Flow and Distribution:

- Blower Motor
- Blower Speed Control Switch (Program Switch)
- Potentiometer
- Air Flow Mode Control Switch
- Water Valve Control Switch
- Air Flow Mode Control Servo Motor
- Air Mix Control Servo Motor
- Heat
- In-Car Temp. Sensor
- Sun light Sensor
- Ambient Temp. Sensor
- System Amplifier
- Temp. Control Lever (Variable Resistor)
- Ventilator
- Cabin

Other Components:

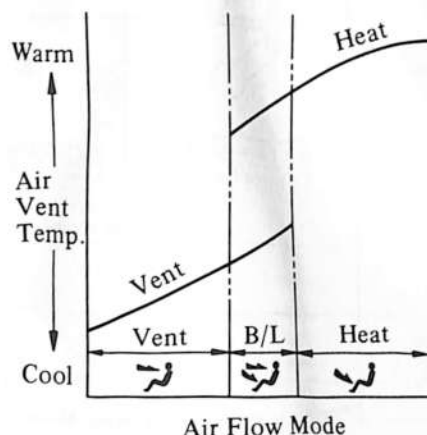
- Defroster
- Water Valve
- V.S.V. (Variable Speed Valve)

- The air flow mode automatic control system includes the air flow mode control servo motor with the temperature control system.
- The air flow mode automatic control system is configured from the above system circuit.
- If the cabin temperature or the ambient air temperature changes with respect to the temperature setting of the temperature control lever, the resistance of R_1 of the in-car temp. sensor or the ambient temp. sensor changes.
- The voltages at Resistor R_1 and Resistor R_2 , set by the temperature control lever, are changed and input to the automatic air conditioner amplifier.
- The automatic air conditioner amplifier controls the turning of the air mix control servo motor according to the difference in these voltages.
- Along with opening and closing the air mix control damper, the air mix control servo motor changes the air flow mode control switch built into it and inputs the switching signal from it to the system amplifier. The servo motor also operates the air flow mode control servo motor according to the output from the system amplifier and automatically controls the air flow mode in connection with the vent temperature.

– REFERENCE –

When the blower speed control switch and air flow mode control switch are set on "AUTO", the positions of the air flow mode control dampers (HEAT, VENT and DEF dampers) are controlled automatically according to the temperature of the air vent.

As shown in the graph by the automatically controlled air vent temperature, the air flow mode is changed to Vent $\leftrightarrow$ Bi-level $\leftrightarrow$ Heat.

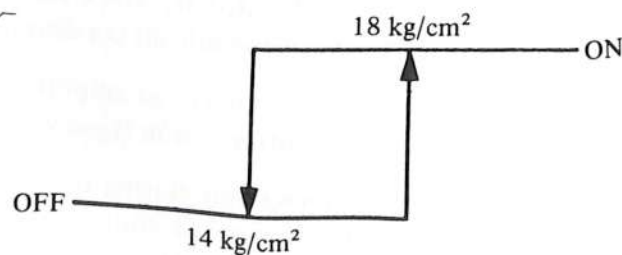
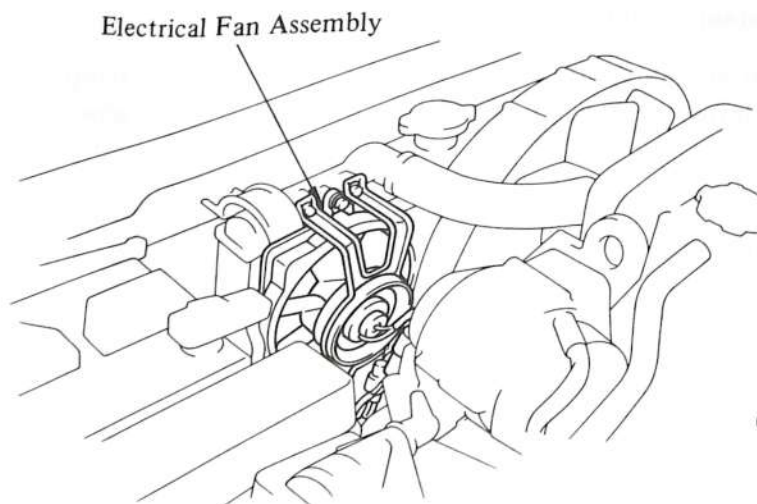
**Operation**

- Operation of the air flow mode automatic control system is basically the same as that of the air flow mode automatic control system explained in the VENTILATION and HEATER section. (Please refer to TD-173.)

2. Electrical Fan System

A suction type electrical fan has been mounted behind the radiator to improve the cooling performance of the cooler condenser and the radiator.

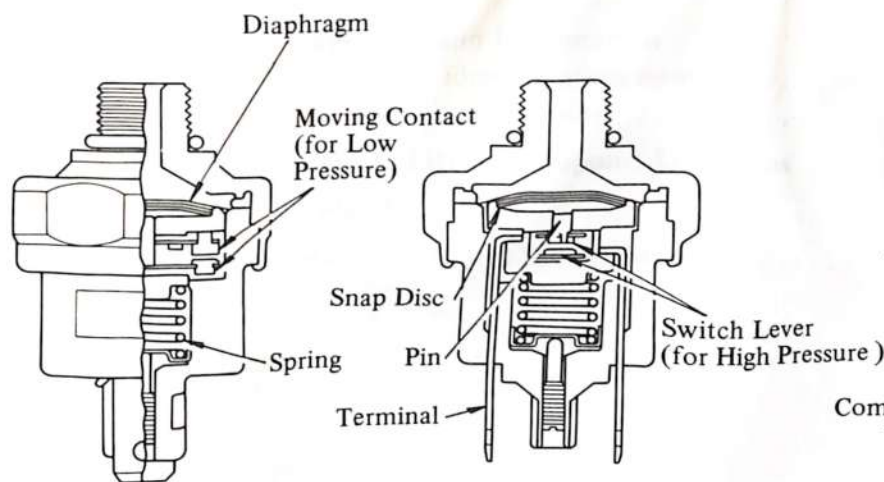
Also, a high pressure switch was installed. This switch lowers the utilization rate of the electrical fan, reduces noise and prevents the battery from running down.



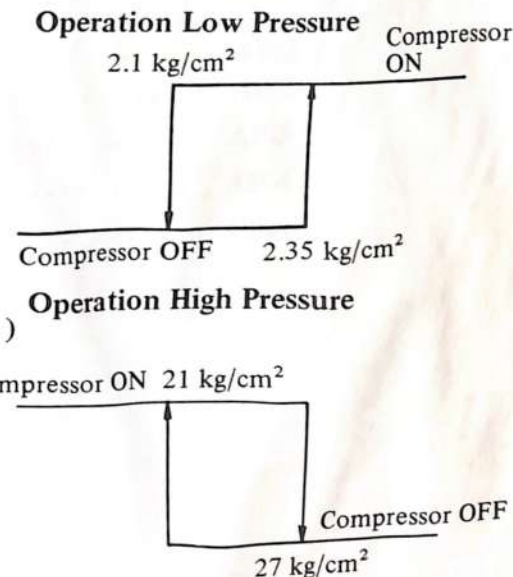
Operation of High Pressure Switch

3. Dual Pressure Switch

A dual pressure switch, which combines the functions of the high pressure cut pressure switch and the low pressure cut pressure switch (for detection of gas leakage) has been adopted. If a malfunction occurs in the cooling cycle, this switch stops the compressor.

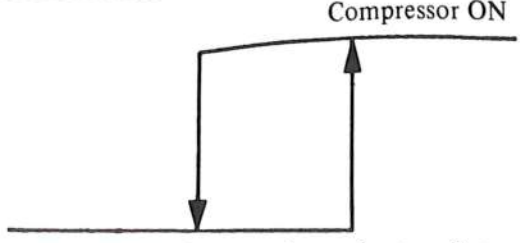
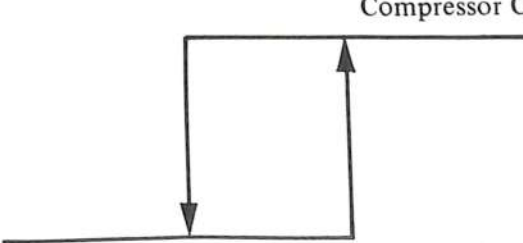


Dual Pressure Switch



4. 2-way Air Conditioner Control System

By pressing the "ECON" switch on the Air Conditioner the compressor is turned on or off by the thermistor (installed in the evaporator). This changes the temperature at which the compressor is turned off from 3°C (37.4°F) to 10°C (50.0°F) and saves power when driving with a light load.

NORMAL OPERATION (WITH A/C ON)	ECONOMY OPERATION (WITH ECONO ON)
	
Compressor ON  Compressor OFF 3°C (37.4°F) 4°C (39.2°F)	Compressor ON  Compressor OFF 10°C (50.0°F) 11°C (51.8°F)

Appendix

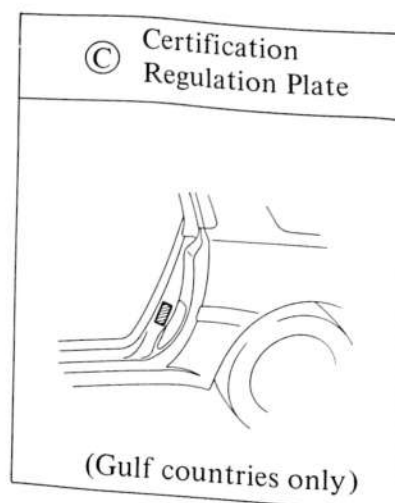
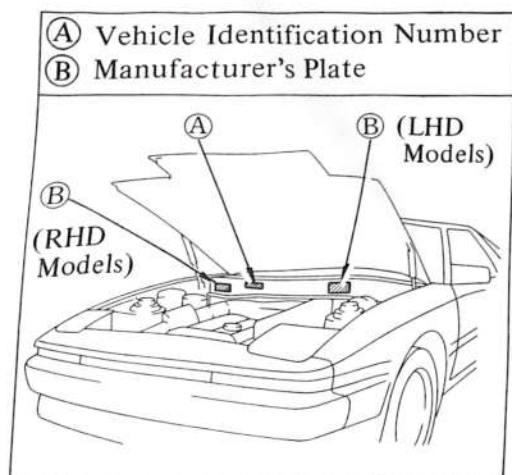
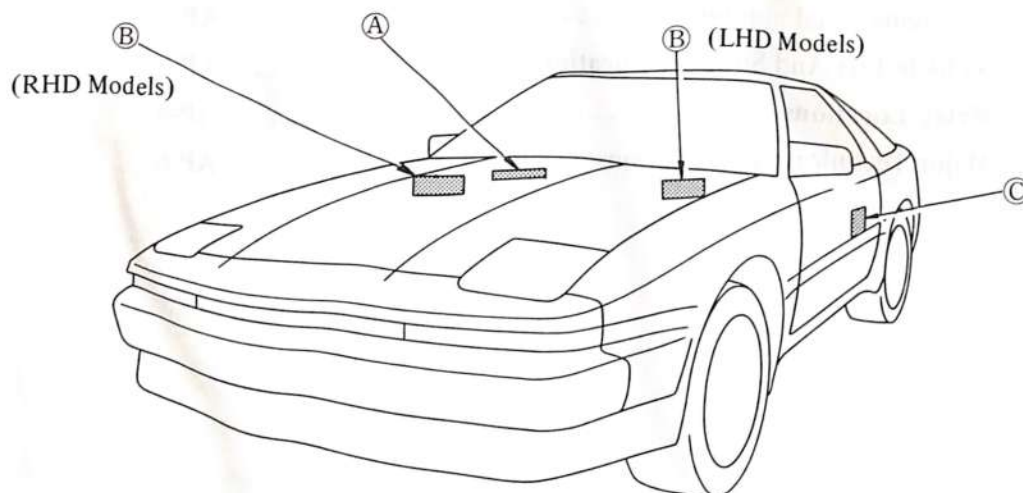
	Page
Identification Information	
Vehicle identification number	AP-2
Engine serial number	AP-2
Vehicle Lift And Support Locations	AP-3
Relay Locations	AP-4
Major Technical Specifications	AP-6

IDENTIFICATION INFORMATION

VEHICLE IDENTIFICATION NUMBER

The vehicle identification number is stamped on the cowl panel.

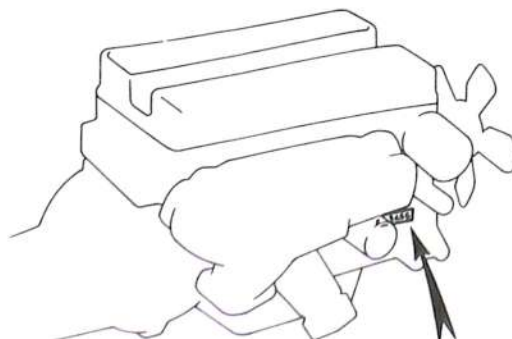
This number has also been stamped on the manufacturer's plate and certification regulation plate (Gulf countries only).



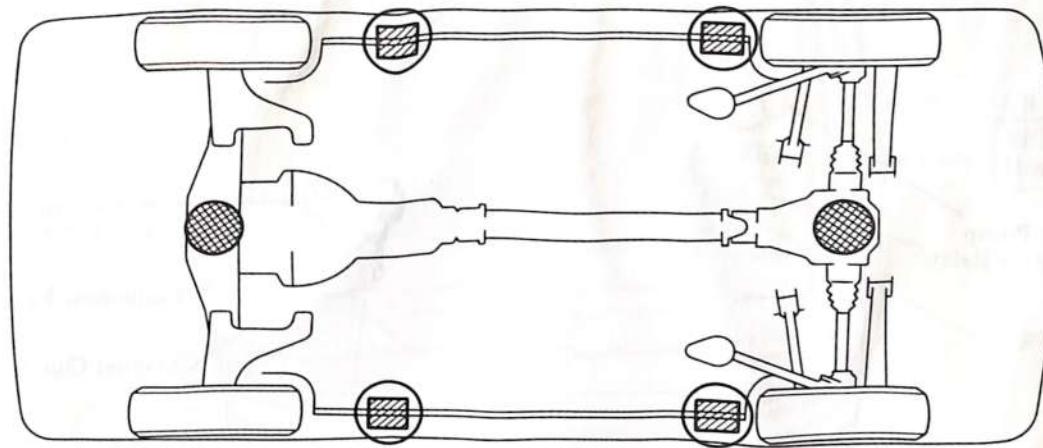
ENGINE SERIAL NUMBER

The engine serial number is stamped on the engine block as shown.

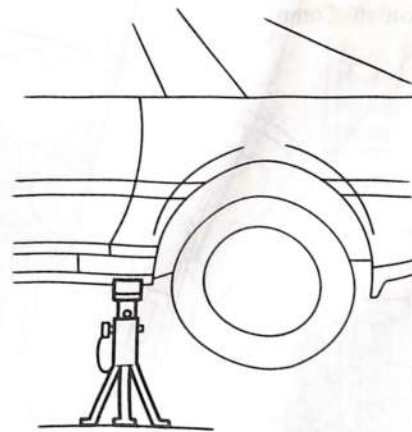
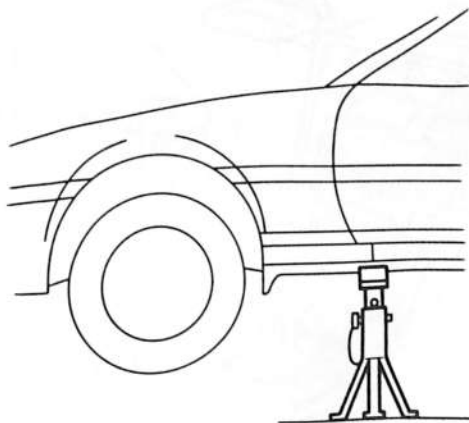
7M-GE Engine



VEHICLE LIFT AND SUPPORT LOCATIONS



← Front



JACK POSITION

Front Center of engine mounting center member
 Rear Jack up support of rear floor pan



PANTOGRAPH JACK POSITION

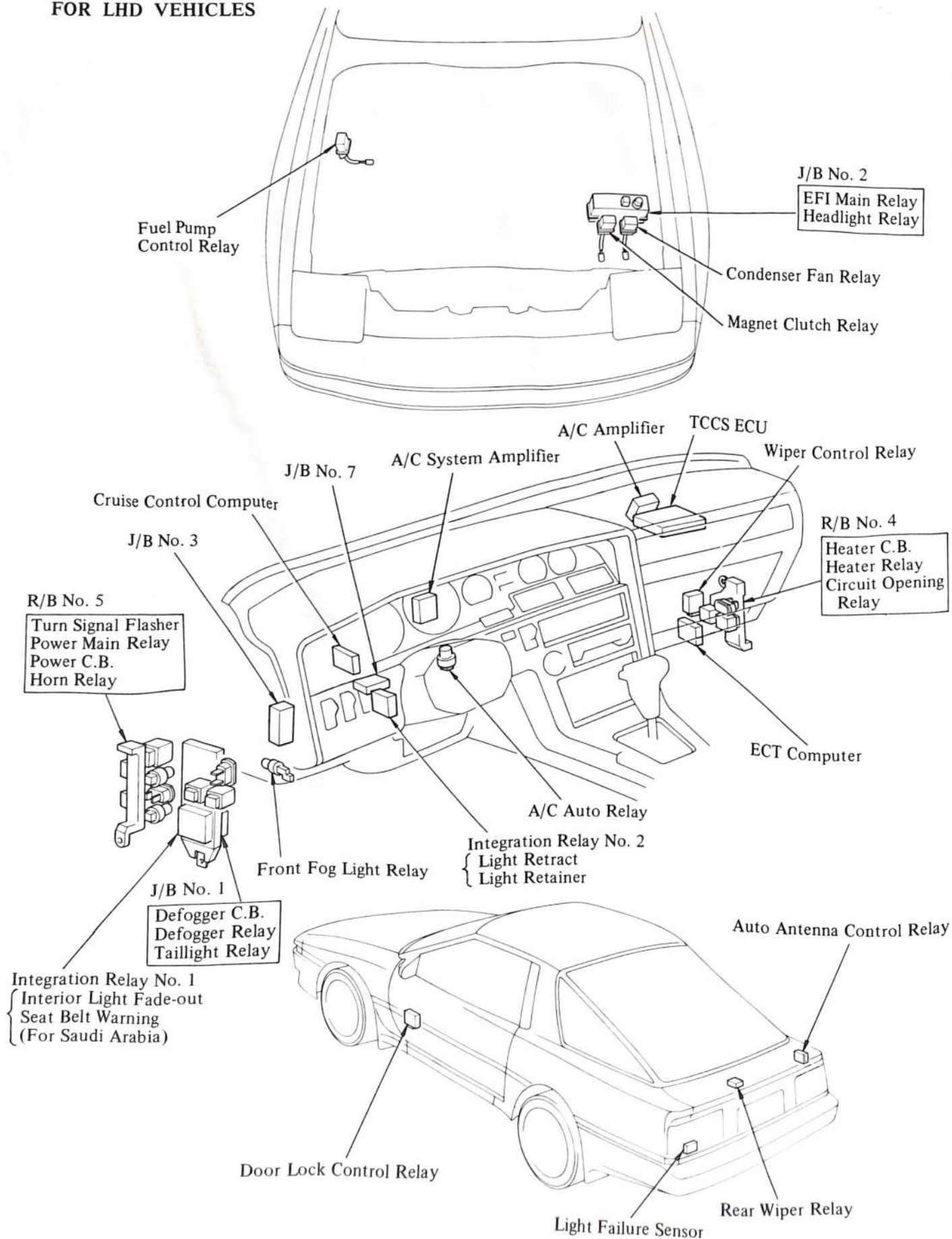
SUPPORT POSITION

Safety stand

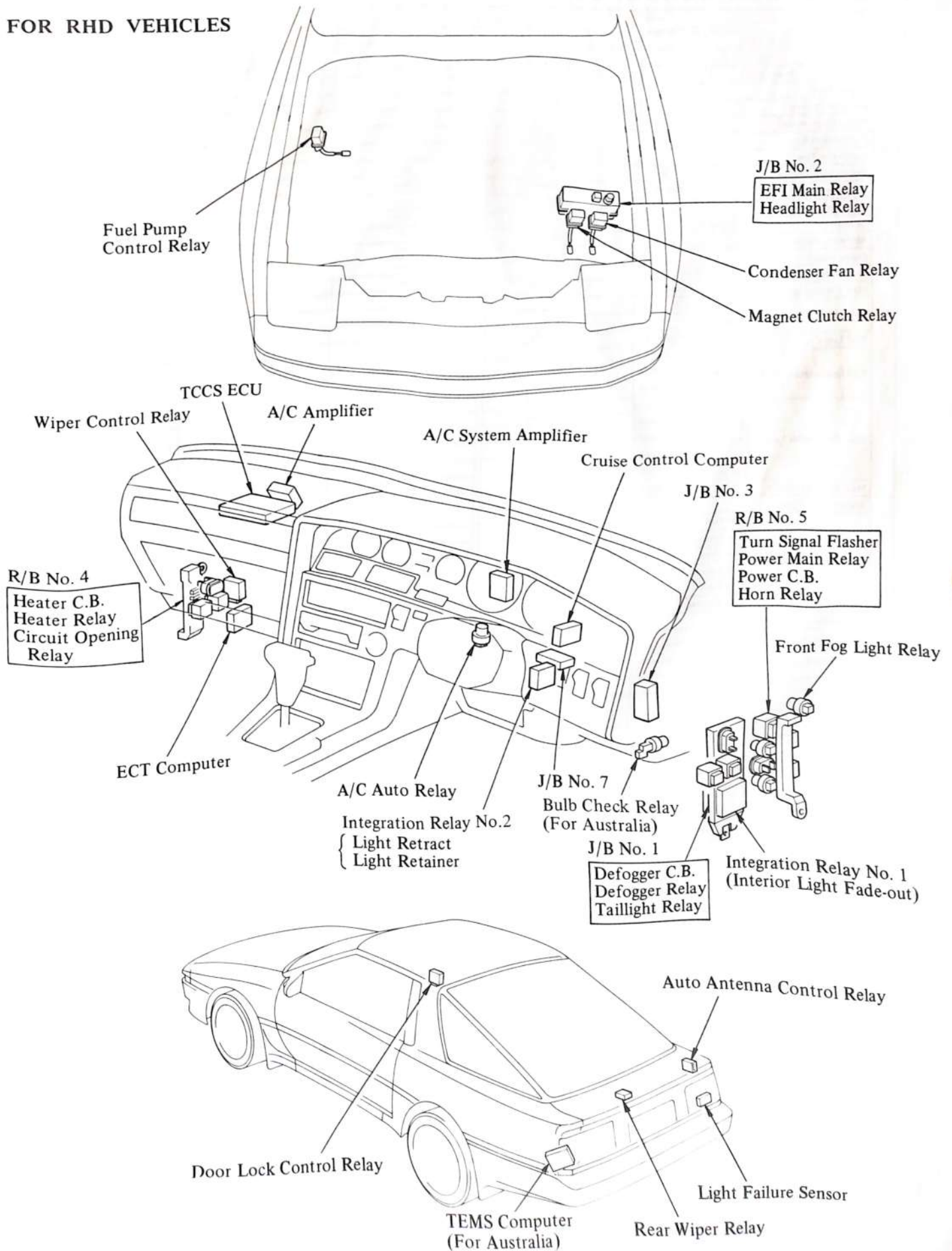


RELAY LOCATION

FOR LHD VEHICLES



FOR RHD VEHICLES



MAJOR TECHNICAL SPECIFICATIONS

Item			Area	General		Gulf Countries	
Body Type				Liftback			
Grade				GT			
Model Code				MA70L(R)-BLMVF	MA70L(R)-BLPVF	MA70L-BLMVFV	MA70L-BLPVFV
Engine	Engine Type			7M-GE	←	←	←
	Valve Mechanism			D.O.H.C.	←	←	←
	Piston Displacement cc (cu.in.)			2954 (180)	←	←	←
	Compression Ratio			9.2 to 1	←	←	←
	Carburetor Type			E.F.I.	←	←	←
	Fuel Octane Number RON			94	←	←	←
	Max. Output (EEC) Kw/rpm			150/6000	←	←	←
	Max. Torque (EEC) N-m/rpm			254/4800	←	←	←
Engine Electrical	Battery Voltage & Amp. hr.			12 – 60	←	←	←
	Alternator output Watts			840	←	←	←
	Starter output Kw			1.0	←	←	←
Performance	Max. Speed Km/h (mph)			220 (137)	←	←	←
	Max. Cruising Speed Km/h (mph)			175 (110)	←	←	←
	Acceleration	0 to 100 Km/h sec.		8.2	←	←	←
		0 to 400 m sec.		15.5	←	←	←
	Fuel Tank Capacity ℓ(Imp.gal)			70 (15.4)	←	←	←
	Fuel Consumption ECE	90 km/h ℓ/100km		7.9	7.5	7.9	7.5
		120 km/h ℓ/100km		9.8	9.4	9.8	9.4
		ECE mode ℓ/100km		—	—	—	—
	Max. Permissible Speed	1st gear Km/h (mph)		58 (36.0)	64 (39.7)	61 (37.9)	64 (39.7)
		2nd gear Km/h (mph)		101 (62.8)	117 (72.7)	106 (65.9)	117 (72.7)
		3rd gear Km/h (mph)		150 (93.2)	—	158 (98.2)	—
		4th gear Km/h (mph)		—	—	—	—
		5th gear Km/h (mph)		—	—	—	—
	Max. Grading Ability tan θ			0.49	0.58	0.45	0.56
	Chassis	Transmission Type			W58	A340E	W58
Transmission Gear Ratio		In First		3.285	2.804	3.285	2.804
		In Second		1.894	1.531	1.894	1.531
		In Third		1.275	1.000	1.275	1.000
		In Fourth		1.000	0.705	1.000	0.705
		In Fifth		0.783	—	0.783	—
		In Reverse		3.768	2.393	3.768	2.393
Differential Gear Size in.			8"	←	←	←	
Differential Gear Ratio			3.909	4.100	3.909	4.100	
Suspension Type		Front		Double Wishbone	←	←	←
		Rear		Double Wishbone	←	←	←
Brake Type		Front		Ventilated Disc	←	←	←
		Rear		Ventilated Disc	←	←	←
Brake Master Cylinder Type			Tandem	←	←	←	
Brake Booster Type & Size in.			Tandem, 8" + 9"	←	←	←	
Steering Gear Type			Rack & Pinion	←	←	←	
Steering Gear Ratio (Overall)			16.5	←	←	←	
Min. Turning Radius	Tire m (ft.)		5.4 (17.7)	←	←	←	
	Body m (ft.)		5.8 (19.0)	←	←	←	
Major Dimensions & Vehicle Weights	Overall	Length mm (in.)		4620 (181.9)	←	←	←
		Width mm (in.)		1745 (68.7)	←	←	←
		Height mm (in.)		1310 (51.6)	←	←	←
		Wheel Base mm (in.)		2595 (102.2)	←	←	←
	Tread	Front mm (in.)		1485 (58.5)	←	←	←
		Rear mm (in.)		1480 (58.3)	←	←	←
	Room	Length mm (in.)		1720 (67.7)	←	←	←
		Width mm (in.)		1400 (55.1)	←	←	←
		Height mm (in.)		1070 (42.1)	←	←	←
	Ground Clearance mm (in.)			155 (6.1)	←	←	←
	Overhang	Front mm (in.)		960 (37.8)	←	←	←
		Rear mm (in.)		1065 (41.9)	←	←	←
	Angle of Approach degree			14	←	←	←
	Angle of Departure degree			21	←	←	←
	Curb Weight (w/o OPT ~ Full OPT)	Front kg (lb)		770(1698)~810(1786), 805(1775)*2	785(1731)~825(1819), 820(1808)*2	790 (1742) ~ 825 (1819)	810 (1786) ~ 845 (1863)
		Rear kg (lb)		730(1609)~745(1642), 740(1631)*2	740(1631)~755(1665), 750(1654)*2	755 (1665) ~ 765 (1687)	760 (1676) ~ 770 (1698)
		Total kg (lb)		1500(3307)~1555(3428), 1545(3406)*2	1525(3362)~1580(3484), 1570(3462)*2	1545 (3406) ~ 1590 (3506)	1570 (3462) ~ 1615 (3561)
	Gross Vehicle Weight	Front kg (lb)		1000 (2205)	←	970	←
		Rear kg (lb)		1070 (2359)	←	1100	←
Total kg (lb)			2070 (4564)	←	←	←	
Luggage Compartment Capacity m³ (cu.ft.)			0.232 (8.19)	←	←	←	

*1: SAE-NET

*2: RHD Models

[illegible]



OVERSEAS SERVICE DEPARTMENT
TOYOTA MOTOR CORPORATION
Haruhi Center

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