1988 model
New Car Features

TERCEL EZ/ SEDAN
TERCEL WAGON
COROLLA FX/FX16
MR2
CELICA
CAMRY
CRESSIDA
TOYOTA SUPRA
VAN
TRUCK/
4 RUNNER
LAND CRUISER

For More Effective Sales and Service Activities

TOYOTA

DIAGNOSTIC SYSTEM

The following engines have diagnostic functions that meet the on-board diagnostis requirements of the State of California.

Engine	Applicable Model
4A-GE	Corolla FX16, MR2
4A-GZE	MR2
3S-GE	Celica
7M-GE*	Toyota Supra
4Y-E	Van
22R-E	Truck / 4 Runner
3F-E	Land Cruiser

* Only California vehicles have been changed, and Federal vehicles have the same diagnostic system as on the 1987 models.

GENERAL

Some diagnostic details of the previous codes have been changed, and new diagnostic codes have been added.

Diagnostic codes by engine type

Code No.	Item	4A-GE	4A-GZE	3S-GE	7M-GE	4Y-E	22R-E	3F-E
		Corolla FX16 MR2	MR2	Celica	Toyota Supra	Van	Truck 4 Runner	Land Cruiser
11	ECU (+)	—	○	○	○	—	—	○
12	RPM Signal	•○	○	○	○	•○	○	○
13	PRM Signal	•○	○	○	○	•○	○	○
14	Ignition Signal	•○	○	○	○	•○	○	○
21	Oxygen Sensor and Oxygen Sensor Heater	•⊗	⊗	⊗	⊗	•⊗*1	⊗	⊗
22	Water Temp. Sensor Signal	•○	○	○	○	•○	○	○
24	Intake Air Temp. Sensor Signal	•○	○	○	○	•○	○	○
25	Air-fuel Ratio Lean Malfunction	●	●	●	■	●	●	●
26	Air-fuel Ratio Rich Malfunction	●	●	●	■	●	●	●
27	Sub-Oxygen Sensor and Sub-Oxygen Sensor Heater	—	—	—	■	●	—	—
28	No. 2 Oxygen Sensor and Oxygen Sensor Heater	—	—	—	—	—	—	●
31	Air Flow Meter Signal	•○	○	○	○	•○	○	○
32	Air Flow Meter Signal	—	○	○	○	—	—	○
35	HAC Signal	—	—	—	—	—	●*2	●
41	Throttle Position Sensor Signal	•○	○	○	○	•○	○	○
42	Vehicle Speed Sensor Signal	•○	○	○	○	•○	○	○
43	Starter Signal	•○	○	○	○	•○	○	○
51	Switch Signal	•○	○	○	○	•○	○	○
52	Knock Sensor Signal	—	○	—	○	—	○	—
53	Knock Control Signal	—	○	—	○	—	○	—
71	EGR System Malfunction	■	■	■	■	■	■	■

— Not applicable ⊗ Changed ■ California Vehicle only ○ Not Changed ● New • Code No. changed

*1 California Vehicle only *2 Chassis & Cab model with 22R-E engine and A/T only

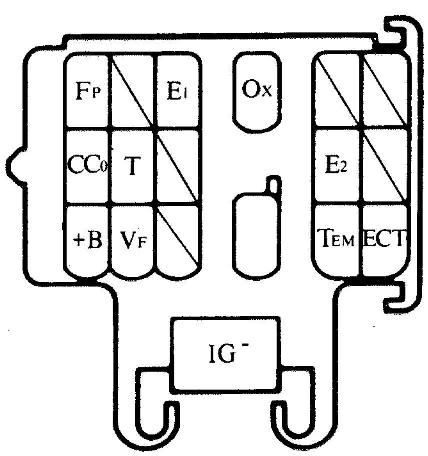
1. Check Connector for Diagnostic Code Inspection

Changes have been made to the check connector terminals in the Toyota Supra with 7M-GE engine for California and Land Cruiser.

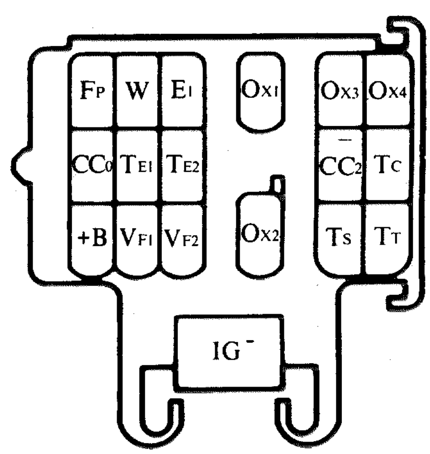
Changes	Terminal		
	Previous	→	New
Change in Name of Terminal	T	→	T_{E1}
	O_X	→	O_{X1}
	V_F	→	V_{F1}
	ECT	→	T_T
	TEM	→	T_S
Terminal added	T_{E2}		V_{F2}
	O_{X2}		CC_2
	O_{X3}		T_C
	O_{X4}		W
Terminal deleted	E_2		

TERMINAL LAYOUT

Together with changes in the terminal names and addition of terminals, the terminal layout has been changed as follows:



Previous

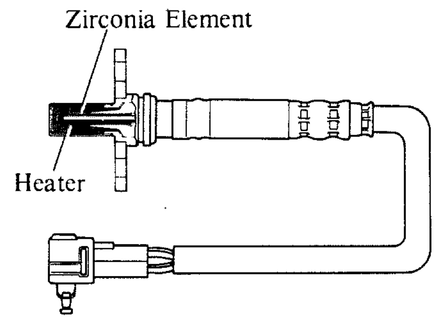


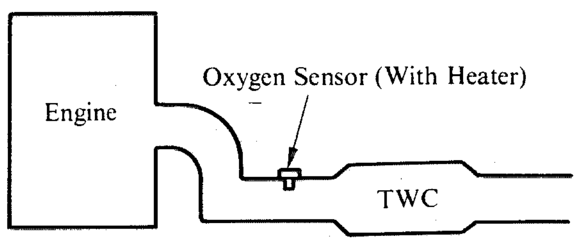
New

CONSTRUCTION AND OPERATION OF MAIN COMPONENTS

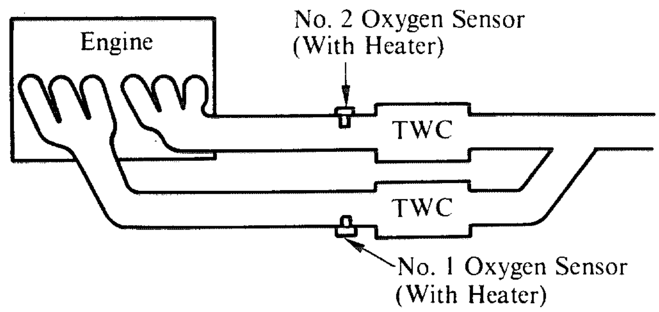
1. Oxygen Sensor

An oxygen sensor with a heater has been adopted. With this oxygen sensor, the temperature of the zirconia element under light engine loads can be maintained and the density of oxygen in exhaust gas can be detected precisely.
Operation is the same as for the previous oxygen sensor.
The 3F-E, 4Y-E and 7M-GE engines have two oxygen sensors each.

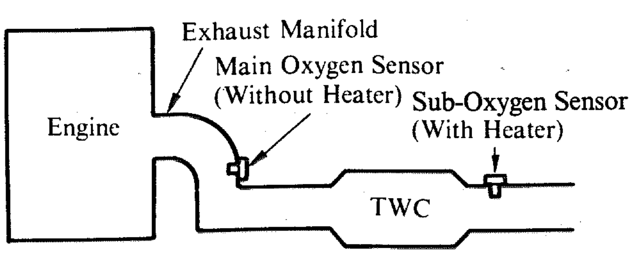




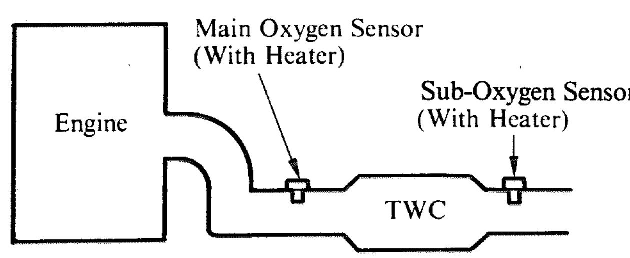
4A-GE, 4A-GZE, 3S-GE, 22R-E



3F-E



7M-GE (California Vehicle Only)



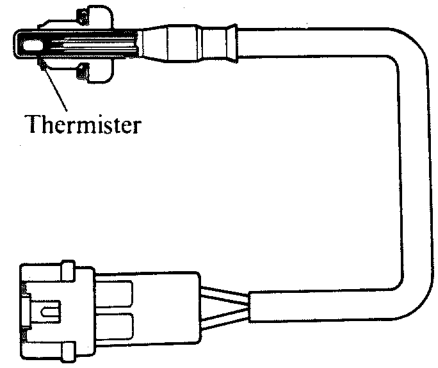
4Y-E

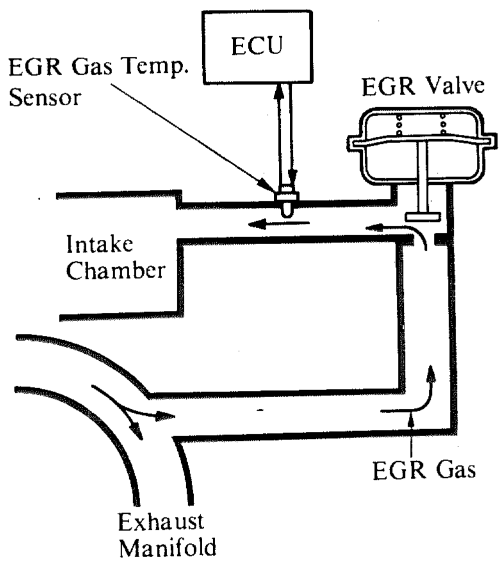
SUB-OXYGEN SENSOR

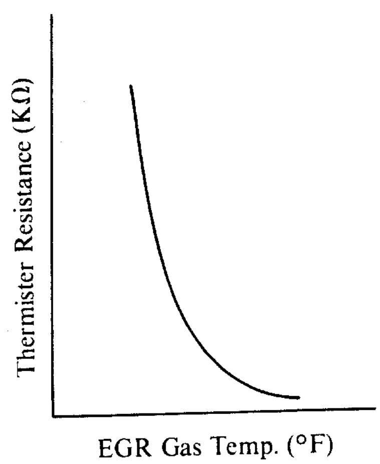
The sub-oxygen sensor on the 7M-GE (California vehicle) and 4Y-E engines rechecks the emission level after it is purified by the TWC (three-way catalytic converter) and feeds the result back to the main oxygen sensor. The feedback information of the main oxygen sensor is corrected accordingly so the air-fuel ratio is maintained as accurate as possible.
The sub-oxygen sensor is constructed and operates basically the same as the main oxygen sensor. The sub-oxygen sensor on the 7M-GE engine has a built-in heater.

2. EGR Gas Temperature Sensor

The EGR gas temperature sensor has a built-in thermistor which changes resistance considerably, according to the temperature, as shown in the graph on the right. The EGR gas temperature sensor is located between the EGR valve and the intake chamber. Since thermistor resistance changes according to the temperature of the EGR gas passing through the EGR valve, the voltage supplied from the ECU changes accordingly. The ECU uses this changing voltage as a signal.

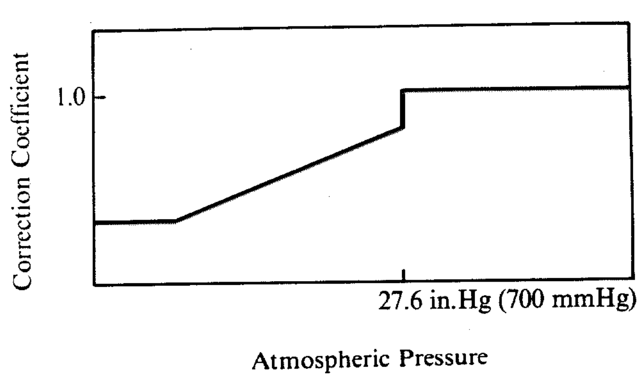






3. HAC (High Altitude Compensation) Sensor

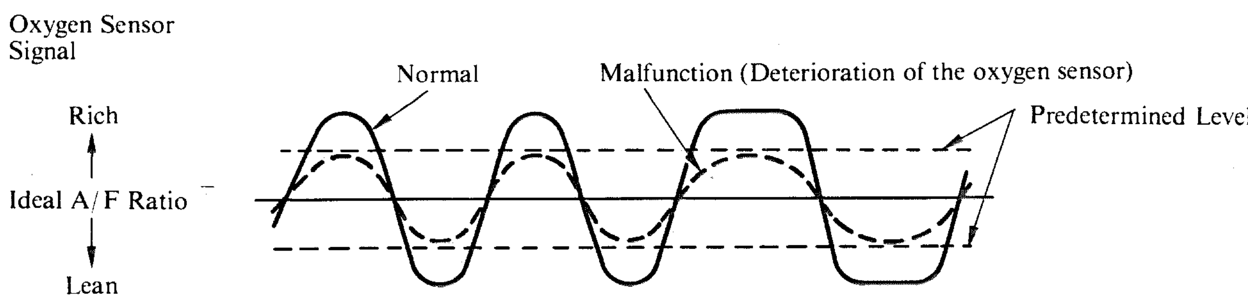
Oxygen in the atmosphere decreases as the altitude increases. If the fuel is injected in the same amount as at sea level, higher altitudes becomes too rich. The 3F-E engine has an altitude compensation sensor built into the ECU and the 22R-E engine (for the Truck-chassis & Cab with automatic transmission only) has an outside-fitted sensor. The HAC sensor sends signals to the ECU. The ECU adjusts signals from the air flow meter accordingly and determines an appropriate volume of fuel to be injected.
In case of the 22R-E engine, the signals from the HAC sensor are also used to prevent automatic trasmission gear shifting to OD (Overdrive) at high altitudes.



DESCRIPTION AND OPERATION

1. Oxygen Sensor and Oxygen Sensor Heater (Code Nos. 21, 28)

Code No. 21 of the previous diagnostic system indicated that the oxygen sensor signal was open. In the new diagnostic system, this code indicates that the oxygen sensor has deteriorated, or that the oxygen sensor heater is open or short-circuited.
Code No. 21 is indicated during air-fuel ration feedback whenever the amplitude of the oxygen sensor signal is less than a predetermined range, over a predetermined period of time, or when the oxygen sensor heater is open or short-circuited. Code No. 28 indicates the malfunction in the No. 2 oxygen sensor and oxygen sensor heater in the 3F-E engine. It functions the same as Code No. 21.



2. Sub-Oxygen Sensor (Code No. 27)

This code is for the 7M-GE and 4Y-E engines that have a sub-oxygen sensor behind the TWC. It functions the same as Code No. 21. On the 7M-GE engine, the sub-oxygen sensor has a heater but the main oxygen sensor does not.

3. Air-fuel Ratio Lean Malfunction (Code No. 25)

Code No. 25 is indicated under an air-fuel feedback correction condition when any of the malfunctions listed on page 15 have been detected.
Code No. 25 is considered to be caused by the open injector circuit, clogged injectors, low fuel pressure or misfire of the ignition system.

4. Air-fuel Ratio Rich Malfunction (Code No. 26)

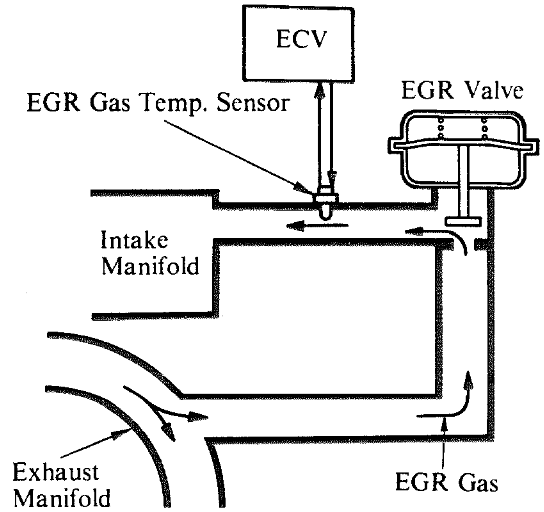
Code No. 26 is indicated in the same way as in the Code No. 25, but on the oxygen sensor signal output or air-fuel ratio feedback compensation value or adaptive control value of air-fuel ratio feedback, Code No. 26 is indicated when they have been detected that they continued at low limit (rich side) for a period of time.
Code No. 26 is considered to be caused by a short in the injector circuit, or a leak from the injector or cold start injector.

5. HAC Sensor (Code No. 35)

Code No. 35 is indicated when the signal from the HAC sensor has been open or short-circuited. This code is for the 3F-E enigne and 22R-E engine (Truck-chassis & Cab with automatic transmission) only.

6. EGR Valve System (Code No. 71)

The EGR gas temperature sensor has been added between the EGR valve and the intake manifold. It measures the temperature of the EGR gas to detect the condition of the EGR valve operation.
If the EGR valve becomes clogged during EGR operation, the exhaust gas is not recirculated and the temperature near the EGR gas temperature sensor drops below a predetermined level. This condition is detected by the ECU as an EGR valve system malfunction, and the ECU indicates Code No. 71.



DIAGNOSIS

The diagnostic items of each engine are detailed below.

○ : CHECK ENGINE lamp lights up when trouble is detected.
× : CHECK ENGINE lamp does not light up when trouble is detected.
● : CHECK ENGINE lamp lights up when trouble is detected on California vehicles.
— : Not applicable (N/A)

Code No.	Item	Diagnosis	Trouble Area	CHECK ENGINE Lamp Condition According to Engine Type						
				4A-GE	4A-GZE	3S-GE	7M-GE	4Y-E	22R-E	3F-E
11	ECU (+B)	Momentary interruption in power supply to ECU.	• IG switch circuit • IG switch • main relay circuit • Main relay • ECU	—	×	×	×	—	—	×
12	RPM Signal	No "Ne" or "G" signal to ECU within 2 seconds after engine has been cranked.	• Distributor circuit • Distributor • Igniter circuit* • Igniter* • Starter signal circuit • ECU * 4A-GE, 4Y-E and 22R-E only	—	○	○	○	—	—	○
		No "Ne" signal to ECU within 2 seconds after engine has been cranked.		○	—	—	—	○	○	—
		No "G" signal to ECU 2 times in succession when engine speed is between 500 rpm and 4000 rpm.		○	—	—	—	—	—	—
13	RPM Signal	No "Ne" signal to ECU when engine speed is above 1000 (1500*) rpm. * 4A-GE, 22R-E, 4Y-E	• Distributor circuit • Distributor • Igniter circuit* • Igniter* • ECU * 4A-GE, 4Y-E and 22R-E only	○	○	○	○	○	○	○
14	Ignition Signal	No "IGf" signal to ECU predetermined* times in succession. * 4A-GE: 4 4Y-E, 22R-E: 4~5 7M-GE, 3F-E: 6~8 4A-GZE, 3S-GE: 8~11	• Igniter and ignition coil circuit • Igniter and ignition coil • ECU	○	○	○	○	○	○	○
21	Oxygen Sensor	Detects deterioration of the Oxygen sensor.	• Oxygen sensor circuit • Oxygen sensor • ECU	○	○	○	○	○	○	○
	Oxygen Sensor Heater	Open or short circuit in oxygen sensor heater	• Oxygen sensor heater circuit • Oxygen sensor heater • ECU				—			

Code No.	Item	Diagnosis	Trouble Area	CHECK ENGINE Lamp Condition According to Engine Type						
				4A-GE	4A-GZE	3S-GE	7M-GE	4Y-E	22R-E	3F-E
22	Water Temp. Sensor Signal	Open or short circuit in water temp. sensor signal.	• Water temp. sensor circuit • Water temp. sensor • ECU	○	○	○	○	○	○	○
24	Intake Air Temp. Sensor Signal	Open or short circuit in intake air temp sensor signal.	• Intake air temp. sensor circuit • Intake air temp. sensor • ECU	●	●	●	●	●	●	●
25	Air-fuel Ratio Lean Malfunciton	*1 See Page 15.	• Injector circuit • Injector • Fuel line pressure • Oxygen sensor circuit • Oxygen sensor • Air flow meter • ECU	○	○	○	●	○	○	○
26	Air-fuel Ratio Rich Malfunction		• Injector circuit • Injector • Fuel line pressure • Cold start injector • Air-flow meter • ECU	○	○	○	●	○	○	○
27	Sub-oxygen Sensor	Open or short circuit in sub-oxygen sensor signal	• Sub-oxygen sensor circuit • Sub-oxygen sensor • ECU	—	—	—	●	○	—	—
	Sub-oxygen Sensor Heater	Open or short circuit in sub-oxygen senosr heater	• Sub-oxygen sensor heater circuit • Sub-oxygen sensor • ECU					—		
28	No. 2 Oxygen Sensor No. 2 Oxygen Sensor Heater	Same as Code No. 21	Same as Code No. 21	—	—	—	—	—	—	○
31	Air flow Meter Signal	Open circuit in Vc signal or short circuit between Vs and E_2 when idle contacts are closed.	• Air flow meter circuit • Air flow meter • ECU	—	○	○	○	—	—	○
		Short circuit between Vc and V_B, Vc and E_2, or Vs and Vc.		○	—	—	—	○	○	—
32	Air flow Meter Signal	Open circuit in E_2 or short circuit between Vc and Vs.	• Air flow meter circuit • Air flow meter • ECU	—	○	○	○	—	—	○
35	HAC (High Altitude Compensation) Sensor Signal	Open circuit in altitude compensation sensor signal	• HAC sensor circuit • HAC sensor • ECU	—	—	—	—	—	○	○
41	Throttle Position Sensor Signal	Open or short circuit in throttle position sensor signal.	• Throttle position sensor circuit • Throttle position sensor	●	●	●	●	●	●	●

Code No.	Item	Diagnosis	Trouble Area	CHECK ENGINE Lamp Condition According to Engine Type						
				4A-GE	4A-GZE	3S-GE	7M-GE	4Y-E	22R-E	3F-E
42	Vehicle Speed Sensor Signal	No "SPD" signal for *1 seconds when engine speed is between *2 rpm and *3 rpm and coolant temp. is below *4 °F 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 moving.	• IG switch circuit (starter) • IG switch • ECU	×	×	×	×	×	×	×
52	Knock Sensor Signal	Open or short circuit in knock sensor signal.	• Knock sensor circuit • Knock sensor • ECU	—	○	—	○	—	○	—
53	Knock Control signal in ECU	Knock control in ECU faulty	• ECU	—	○	—	○	—	○	—
71	EGR System Malfunction	EGR gas temp. below pre-determined level during EGR operation	• EGR system (EGR valve, EGR hose etc.) • EGR gas temp. sensor circuit • EGR gas temp. sensor • VSV for EGR • VSV for EGR circuit • ECU	●	●	●	●	●	●	●

Code 42 (values for *1 – *4):

Engine \ No.	*1	*2	*3	*4
4A-GE	8	2500	5500	176
4A-GZE	↑	2300	5000	↑
3S-GE	5	2500	6000	↑
7M-GE	↑	2500	4500	↑
4Y-E	8	1500	5000	↑
22R-E	5	above 2500		—
3F-E	8	2000	5000	176

Code No.	Item	Diagnosis	Trouble Area	CHECK ENGINE Diagnostic Light Condition According to Engine Type						
				4A-GE	4A-GZE	3S-GE	7M-GE	4Y-E	22R-E	3F-E
51	Switch Signal	No "IDL" signal or No "NSW" signal or "A/C" signal to ECU, with the check terminals E_1 and T (or T_{E1}) shorted.	• A/C switch circuit • A/C amplifire • Throttle position sensor circuit • Throttle position sensor • Neutral start switch circuit • Neutral start switch circuit • Neutral start switch • Accelerator pedal and cable • ECU	×	×	×	×	×	×	×

*1 Diagnosis conditions for each engine type

Diagnosis	4A-GE	4A-GZE	3S-GE	7M-GE	4Y-E	22R-E	3F-E
(1) When oxygen sensor signal continues at the upper (rich) of lower (lean) limit for a certain period of time during feedback condition.						○	
(2) When air-fuel ratio feedback compensation value or adaptive control value continues at the upper (lean) or lower (rich) limit for a certain period of time or adaptive control value is not renewed for a certain period of time.	○	○	○	○	○	○	○
(3) When air-fuel ratio feedback compensation value or adaptive control value feedback frequency is abnormally high during feedback condition.				○	○		○
(4) When marked variation is detected in engine revolutions for each cylinder during idle switch on and feedback condition.				○			

NOTE: For conditions (3) and (4), since neither a lean (Code No. 25) nor a rich (Code No. 26) diagnosis can be discriminated, both Code No. 25 and Code No. 26 are displayed consecutively.

LAND CRUISER

OUTLINE OF NEW FEATURES

The major changes in the minor changed Land Cruiser are the new 3F-E, 4-liter, 6-cylinder in-line OHV engine and A440F automatic transmission. These changes have created a high-performance and easy-to-drive 4WD vehicle. BJ70 and HJ60 vehicles for Canada have been discontinued.

1. 3F-E Engine

The 3F-E engine is based on the previous 2F engine but its total piston displacement has been reduced. The new engine incorporates TCCS (Toyota Computer-Controlled System) and all engine components have been reviewed and matched carefully for precise engine control and increased engine output.

2. A440F Automatic Transmission

The A440F, a 4-speed automatic transmission with a lock-up clutch and overdrive, is now used on all models. The manual transmission has been discontinued.

3. Transfer

The 2-speed transfer with an electrical H4 selector mechanism is used on all models.

4. Differential Locking System

The differential locking system, is now available as an option for all models. The system incorporates a differential locking mechanism in the front and rear differentials to give extra traction to get out of mud, etc.

5. Brake

A 7-inch and 8-inch tandem brake booster, as well as LSP & BV, are provided on all models to further enhance the braking performance.

6. Suspension

Low-pressure nitrogen gas-filled shock absorbers are used for all wheels.

7. Steering

The gear ratio is changed to further enhance the direct feeling.

8. New Body Electrical Systems

- Optional power windows
- Optional power door lock system
- Intermittent rear window wiper
- Two-stage rear heater blower.
- ETR (Electronic Tuning Radio) on all models

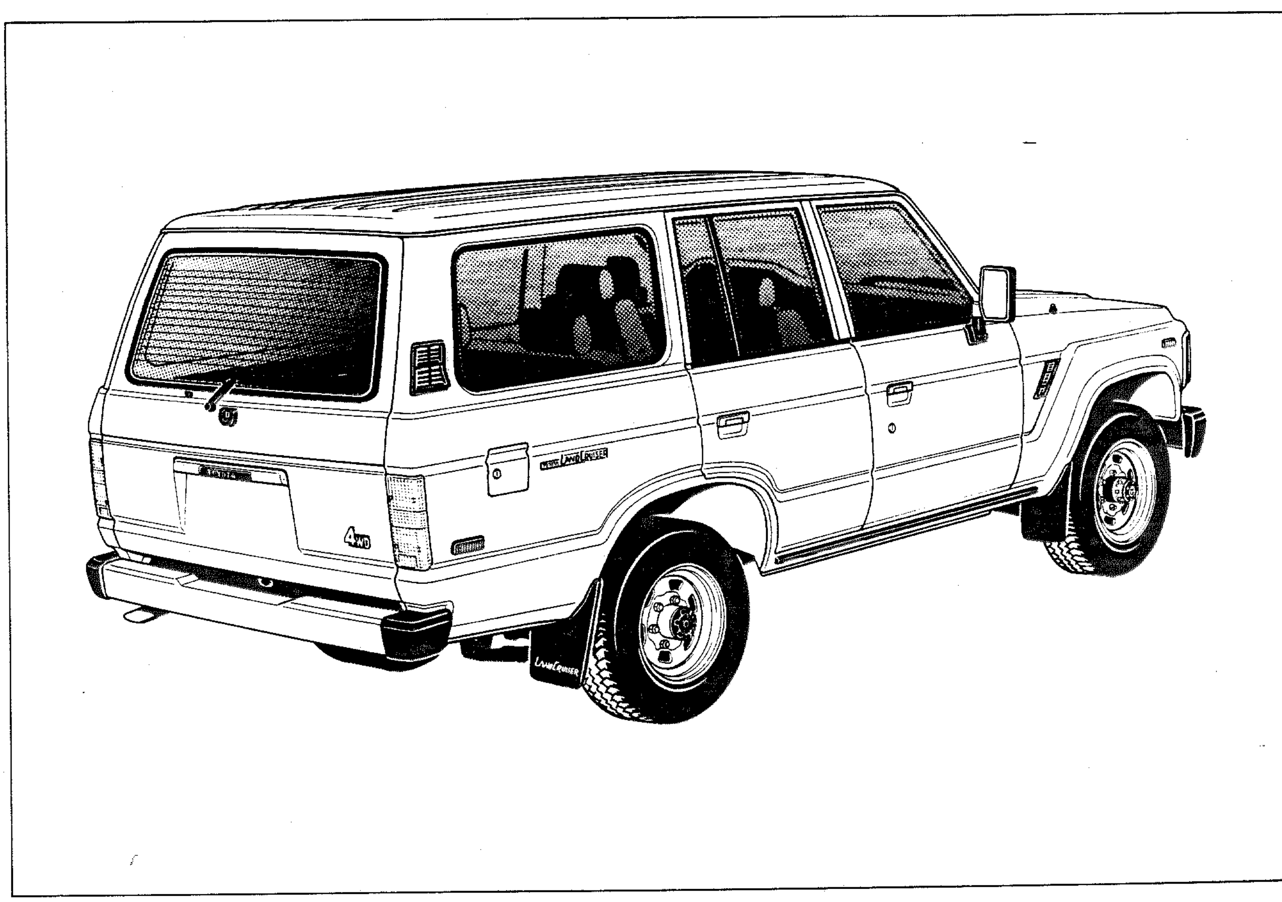
9. Redesigned Interior Equipment

- Instrument panel
- Steering wheel
- Headrests for rear seats
- Assist grips
- Fuel lid opener

10. Other Changes (see GENERAL 1988 FEATURES for detail)

- A one-step key less locking system is used on front doors.
- A three-point rear seat belt is used for rear seat.

EXTERIOR APPEARANCE



MODEL CODE

FJ62 L G—P N E A

BASIC MODEL CODE
FJ62: With 3F-E Engine

STEERING WHEEL POSITION
L : Left-hand Drive

BODY TYPE
G : Wagon
V : Van

GEAR SHIFT TYPE
P : 4-speed Automatic

GRADE
N : —

ENGINE SPECIFICATION
E : EFI

DESTINATION
A : U.S.A.
K : Canada

MODEL LINE-UP

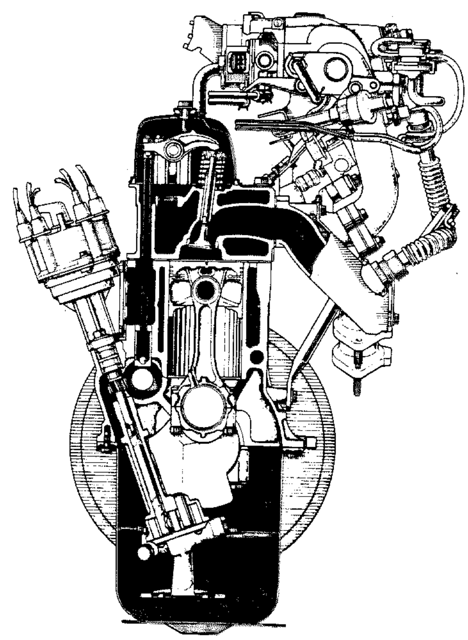
DESTINATION	ENGINE	BODY TYPE	GRADE	TRANSMISSION: 4-speed Automatic A440F
U.S.A.	3F-E	Wagon	—	FJ62LG-PNEA
		Van	—	FJ62LV-PNEA
Canada	3F-E	Wagon	—	FJ62LG-PNEK

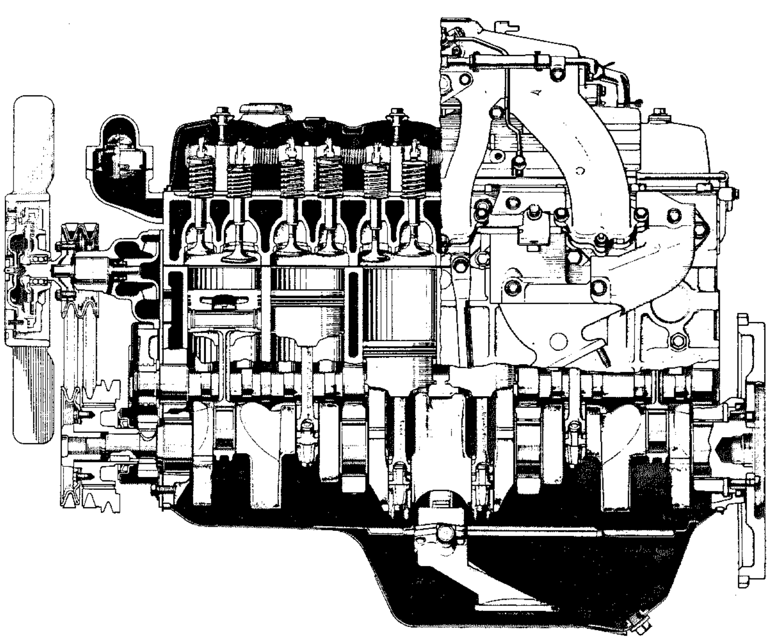
NEW FEATURES

3F-E ENGINE

1. Description

A newly-developed 3F-E engine is now used on all models. The 3F-E engine is based on the previous 2F engine but its total piston displacement has been reduced. It is equipped with TCCS (Toyota Computer-Controlled System) and the engine itself has been reduced in both size and weight and engine performance is improved.

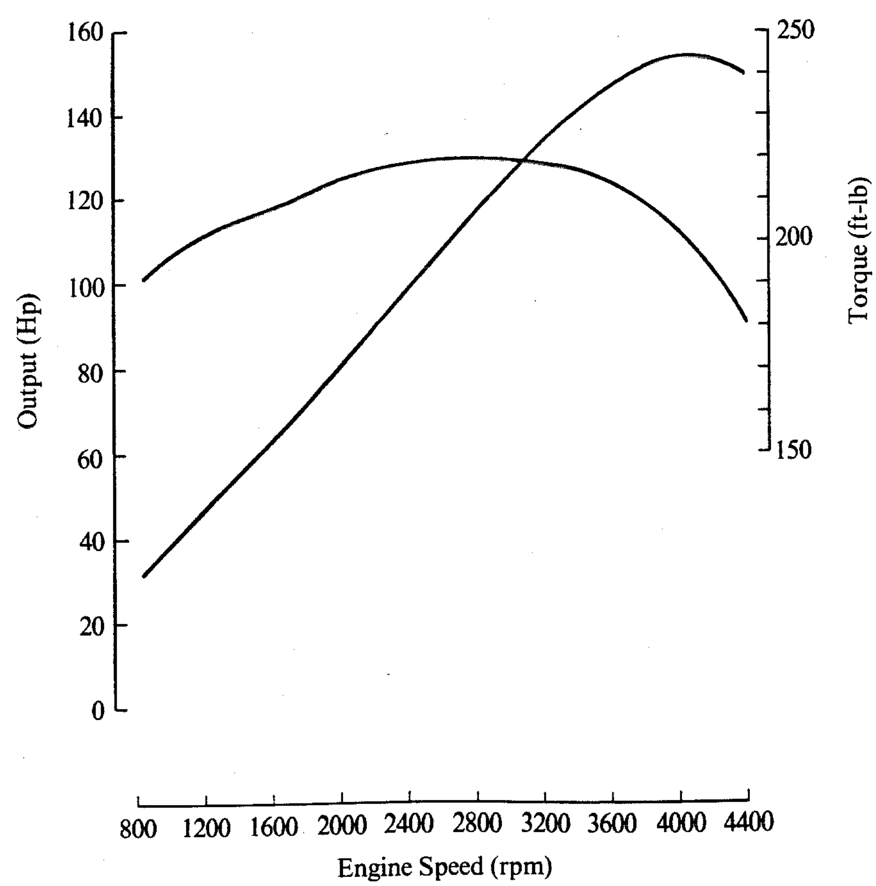




Specifications

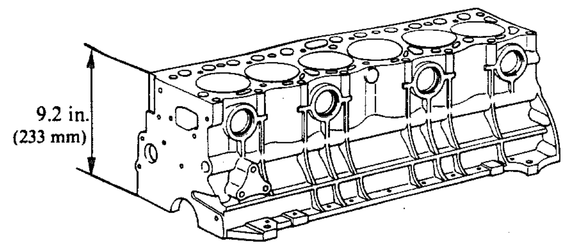
Item / Engine Type		3F-E	2F
No. of Cyls. & Arrangement		6-cylinder, In-line	←
Valve Mechanism		OHV, Gear Drive	←
Combustion Chamber		Wedge Type	←
Manifold		Counter-flow	←
Fuel Sytem		EFI	Carburetor
Displacement	cu.in. (cc)	241.3 (3955)	258.1 (4230)
Bore + Stroke	in. (mm)	3.70 × 3.74 (94 × 95)	3.70 × 4.40 (94 × 101.6)
Compression Ratio		8.1 : 1	7.8 : 1
Fuel Octane Number	RON	above 91	←
Max. Output	SAE-NET	155 HP @ 4000 rpm	125 HP @ 3600 rpm
Max. Torque	SAE-NET	220 ft-lb @ 3000 rpm	200 ft-lb @ 1800 rpm

Engine Performance Curve



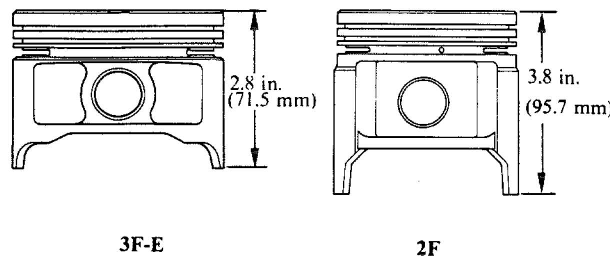
2. Cylinder Block

The total piston displacement of the engine has been reduced, the overall height of the cylinder block has been shortened [from 11.4 in. (289 mm) to 9.2 in. (233 mm)] and engine weight has also been reduced.



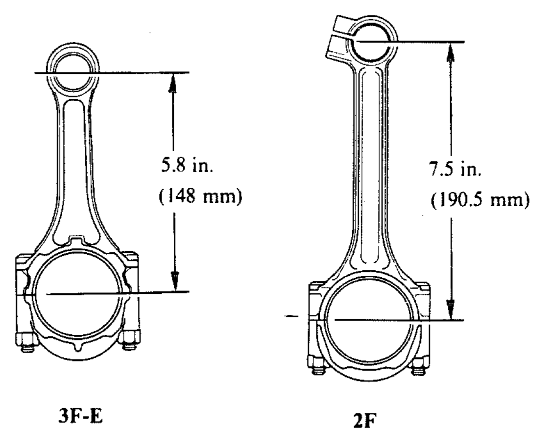
3. Piston and Piston Ring

To further increase engine performance, the piston has been made more compact by reducing the piston height.



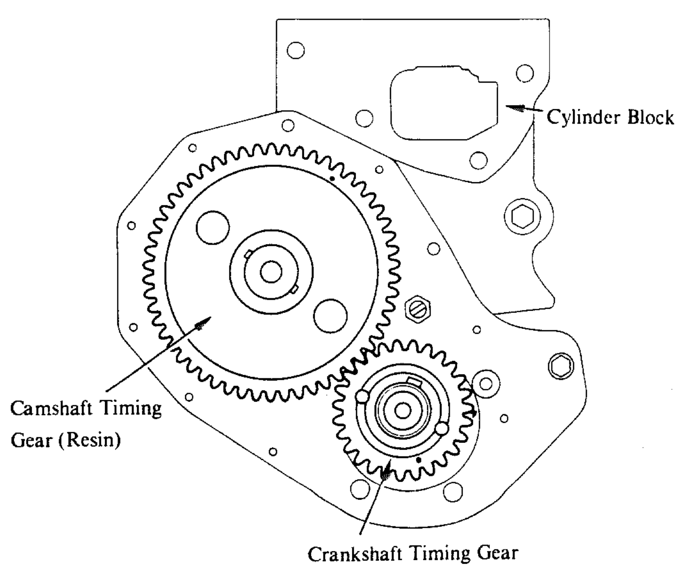
4. Connecting Rod

The overall length has been reduced. At the same time, the semi-floating type piston pin has been changed to a full-floating type. The diameter of the piston pin itself has also been reduced [from 0.98 in. (25.15 mm) to 0.87 in. (22 mm)].



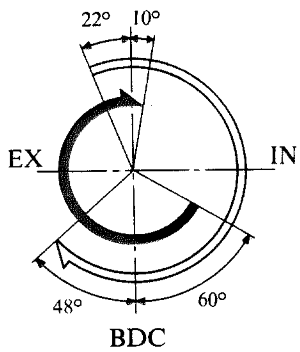
5. Camshaft Timing Gear

The steel camshaft timing gear has been replaced by a resin gear to reduce both weight and noise.

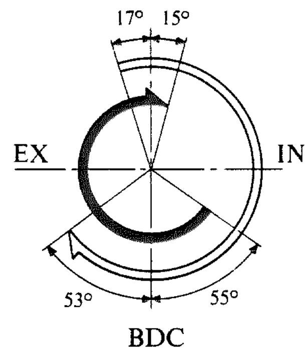


6. Camshaft

The valve timing has been changed as one of means of power increase.



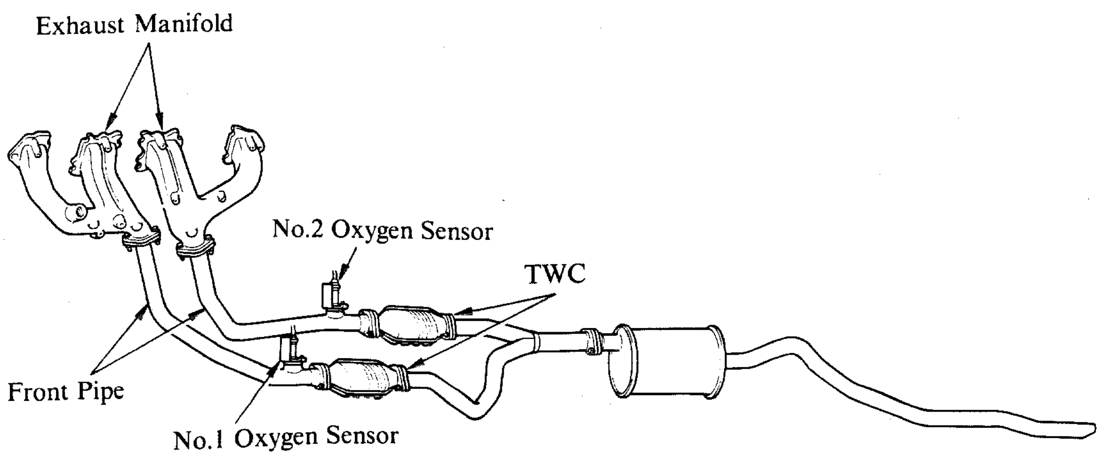
3F-E



2F

7. Exhaust System

To enhance exhaust efficiency, cylinders 1, 2 and 3, and cylinders 4, 5 and 6, have a separate exhaust manifold and front pipe, each incorporating a separate oxygen sensor and TWC (Three-Way Catalystic Converter).



8. TCCS (Toyota Computer-Controlled System)

GENERAL

The previous carburetor has been replaced by TCCS to control the engine more accurately. The TCCS has an ECU (Electronic Control Unit) with a built-in microprocessor. The ECU stores such data as the optimum fuel injection duration, ignition timing, and idling speed for various engine operating conditions. It also is programmed to determine what these parameters shall actually be, based upon the present running conditions as indicated by various sensors. The TCCS for 3F-E engine has the following functions;

1) EFI (Electronic Fuel Injection)

The ECU stores data on the optimum fuel injection duration for various engine operating conditions, and controls the fuel injection duration based upon data and signals from the sensors such as engine speed, intake air volume, coolant temperature, etc.

2) ESA (Electronic Spark Advance)

The ESA replaces the conventional mechanical governor advance and vacuum advance mechanisms. Optimum ignition timing data for each engine condition is stored in the memory of the ECU, which detects the various conditions by means of sensors. The ECU then selects an optimum ignition timing from memory for the current overall engine condition, and sends a signal to the igniter to generate the spark at the correct timing.

3) 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 based on coolant temperature to increase engine speed to fast idle.

4) Oxygen Sensor Heater Control

The ECU sends signals to the oxygen sensor to control the oxygen sensor heater operation based on intake air volume, engine speed and coolant temperature. The oxygen sensor heater is turned off when the intake air volume is higher than a predetermined level.
The oxygen sensor heater is used to maintain the oxygen sensor at a proper temperature during light engine loads. This helps to enhance the sensor accuracy.

5) EGR Control

The ECU sends signals to the EGR VSV to control its operation according to coolant temperature, throttle position, intake air volume or engine speed. EGR operation is turned off, for example, when the coolant temperature is low, when the accelerator pedal is released, when the intake air volume is low or high, or when the engine speed is high.
This ensures optimum operation of EGR based on the engine conditions so the amount of Nox emission is minimized.

6) AI (Air Injection) Control

The ECU sends signals to the AI VSV to control air injection based on coolant temperature, throttle position or engine speed. This ensures optimum air injection control and thus reduces the amount of CO and HC during warming-up and HC during deceleration.

7) Fuel Pressure Control

The ECU sends signals to the fuel pressure regulator VSV to increase fuel pressure based on intake air temperature, coolant temperaure and starting signal. By this system, engine restartability is maintained when the engine is hot.

8) Diagnosis

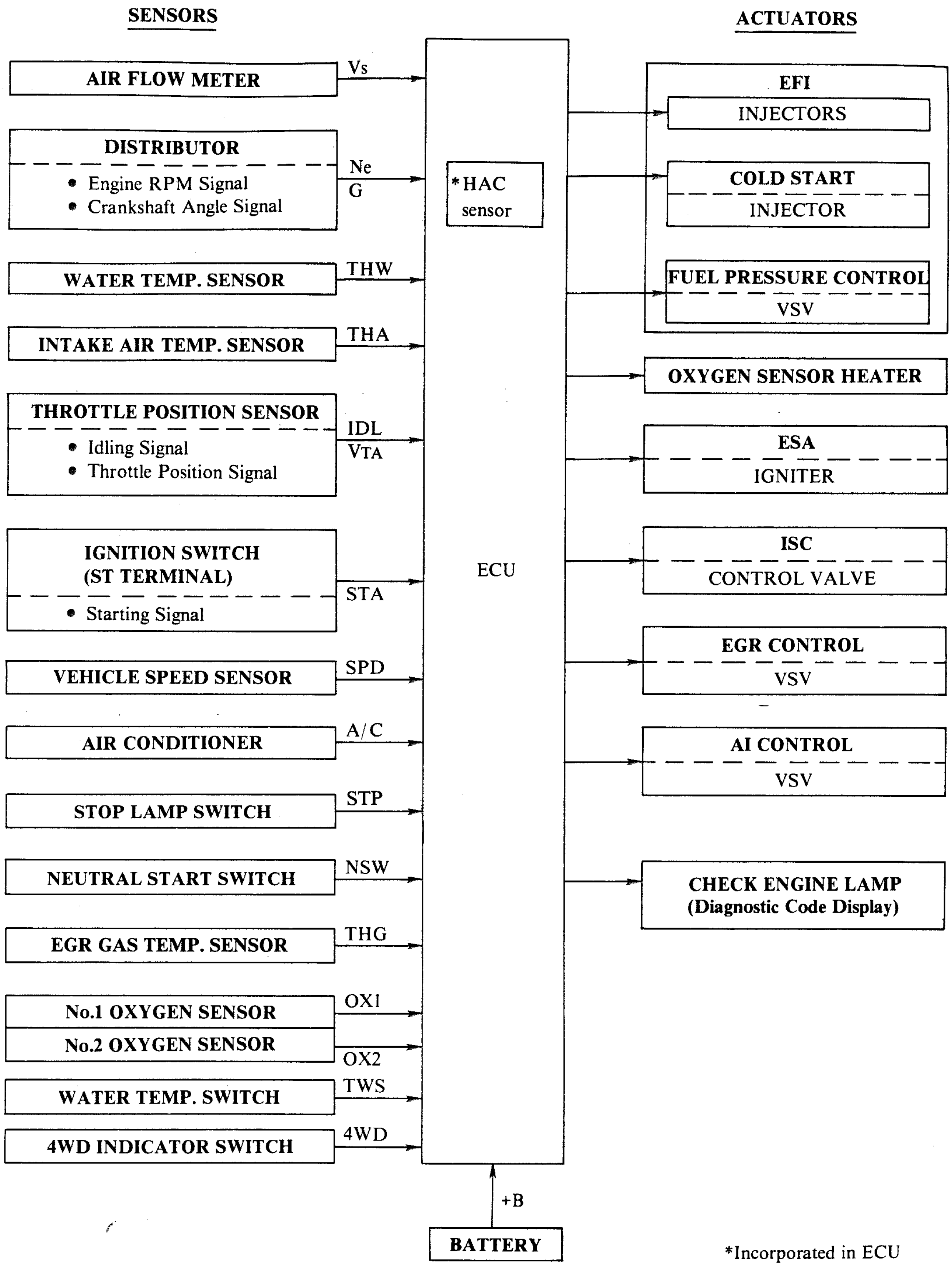
The ECU also contains a built-in self-diagnosis system and constantly monitors each sensor. Whenever it detects a malfunction, it warns the driver by turning on the CHECK ENGINE lamp on the meter panel. At the same time, it retains in its memory the particular sensor system in which it detected the malfunction. This information is not erased when the ignition switch is turned off, so the system that malfunctioned can be easily identified during are repair work by checking the contents of the memory.

9) Fail-Safe Function

If any of the sensors fail, it will send a "malfunction" signal to the ECU which will then determine, based upon its program whether to shut the engine off immediately, or whether to allow it to continue running.

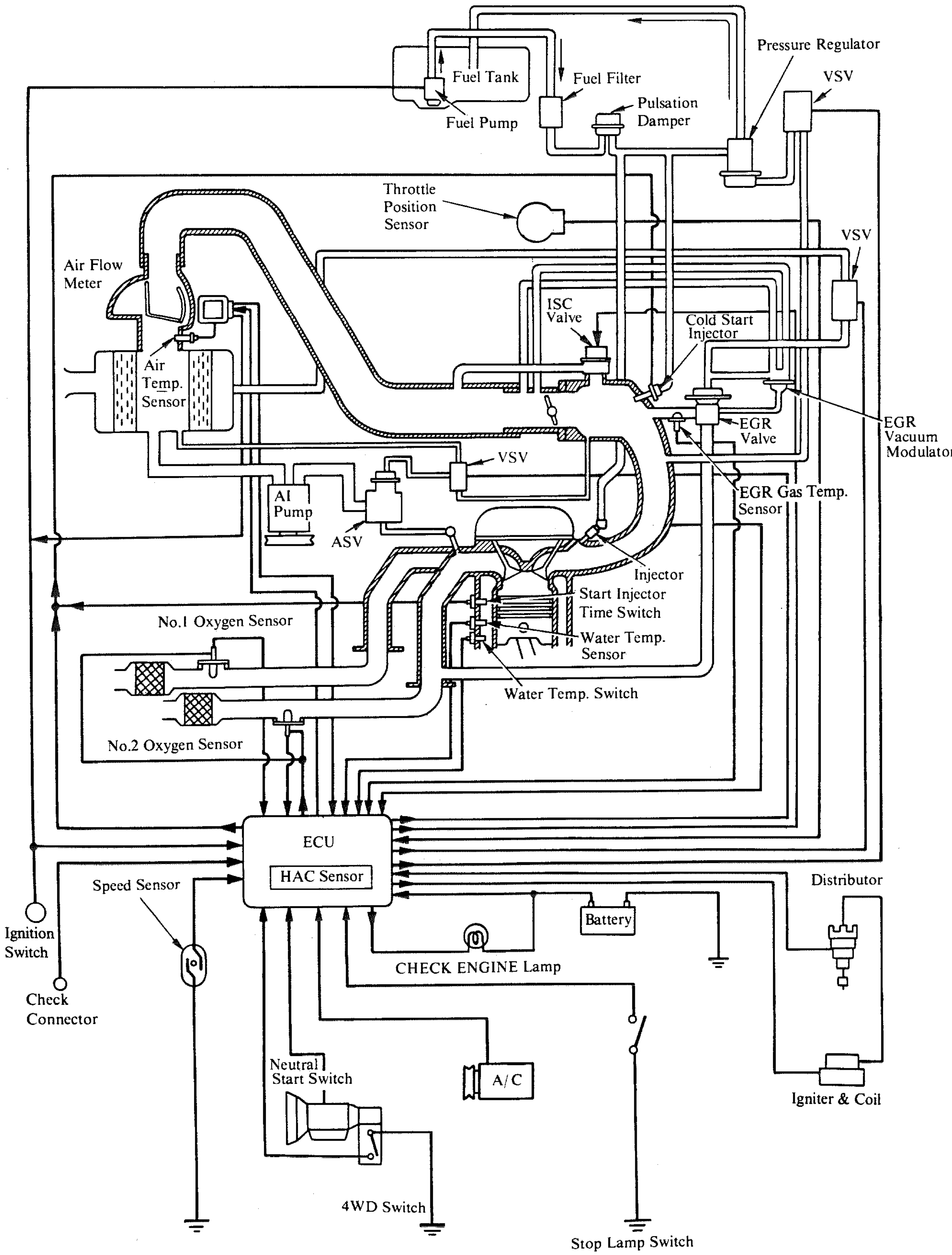
CONSTRUCTION

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

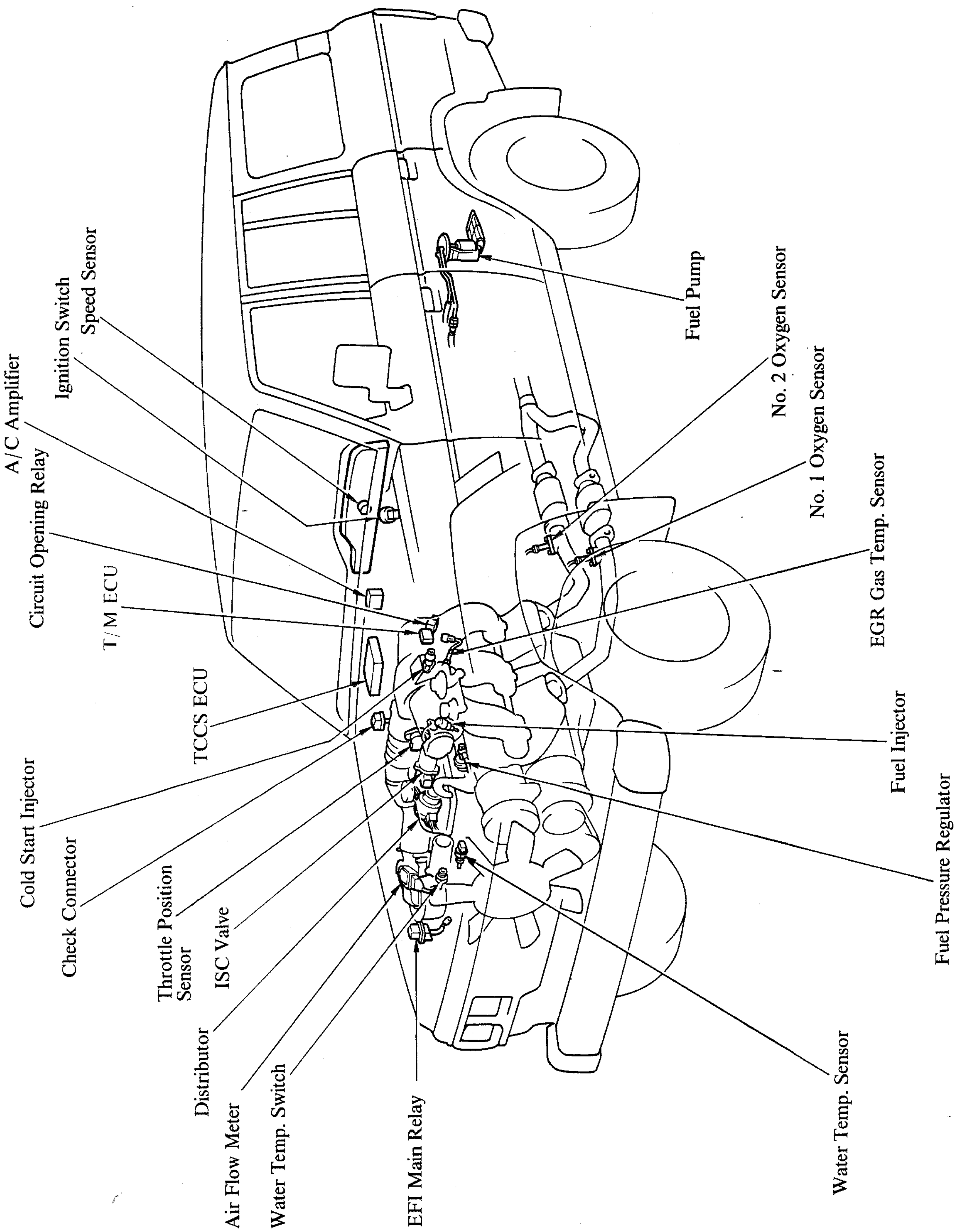


*Incorporated in ECU

TCCS SYSTEM DIAGRAM



ARRANGEMENT OF TCCS COMPONENTS



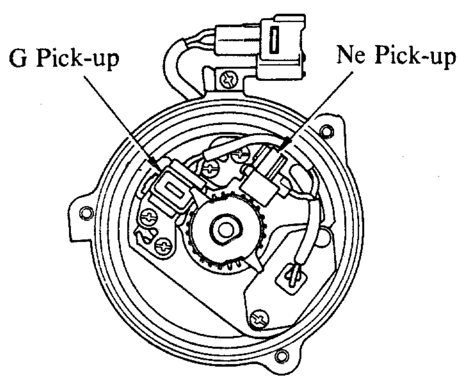
CONSTRUCTION AND OPERATION OF MAIN COMPONENTS

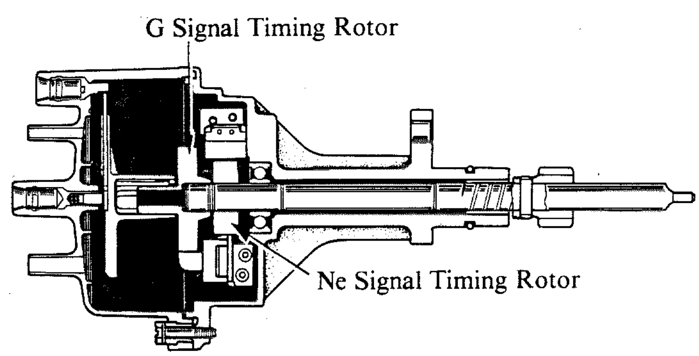
The following components are similar to and operate the same way as those in the models listed below;

Components	Engine (Model)
Air Flow Meter	7M-GE (Toyota Supra)
Throttle Position Sensor	7M-GE (Toyota Supra)
Oxygen Sensor	7M-GTE (Toyota Supra)
ISC Valve	7M-GE (Toyota Supra)
Cold Start Injector	7M-GE (Toyota Supra)
HAC Sensor (Incorporated in ECU)	7M-GTE (Toyota Supra)

1) Distributor

The conventional governor advnace 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 two pick-up coils (G 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.



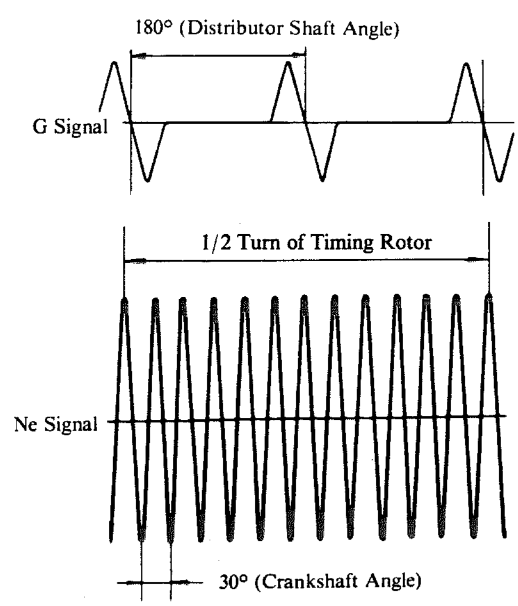


a. Crankshaft Angle Sensor (G Signal)

The G signal informs the ECU of the standard crankshaft angle, which is used to determine injection timing and ignition timing in relation to No.1 cylinder and No.6 cylinder TDC.

b. Engine RPM Sensor (Ne Signal)

The Ne signal is used by the ECU to detect the crankshaft angle and the engine speed.



EFI (Electronic Fuel Injection)

1) General

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

a. Fuel System

This is basically the same as that used with the conventional EFI system (7M-GE).
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 TCCS of the 3F-E engine, the cold start injector is controlled by the start injector time switch and ECU.

b. Air Induction System

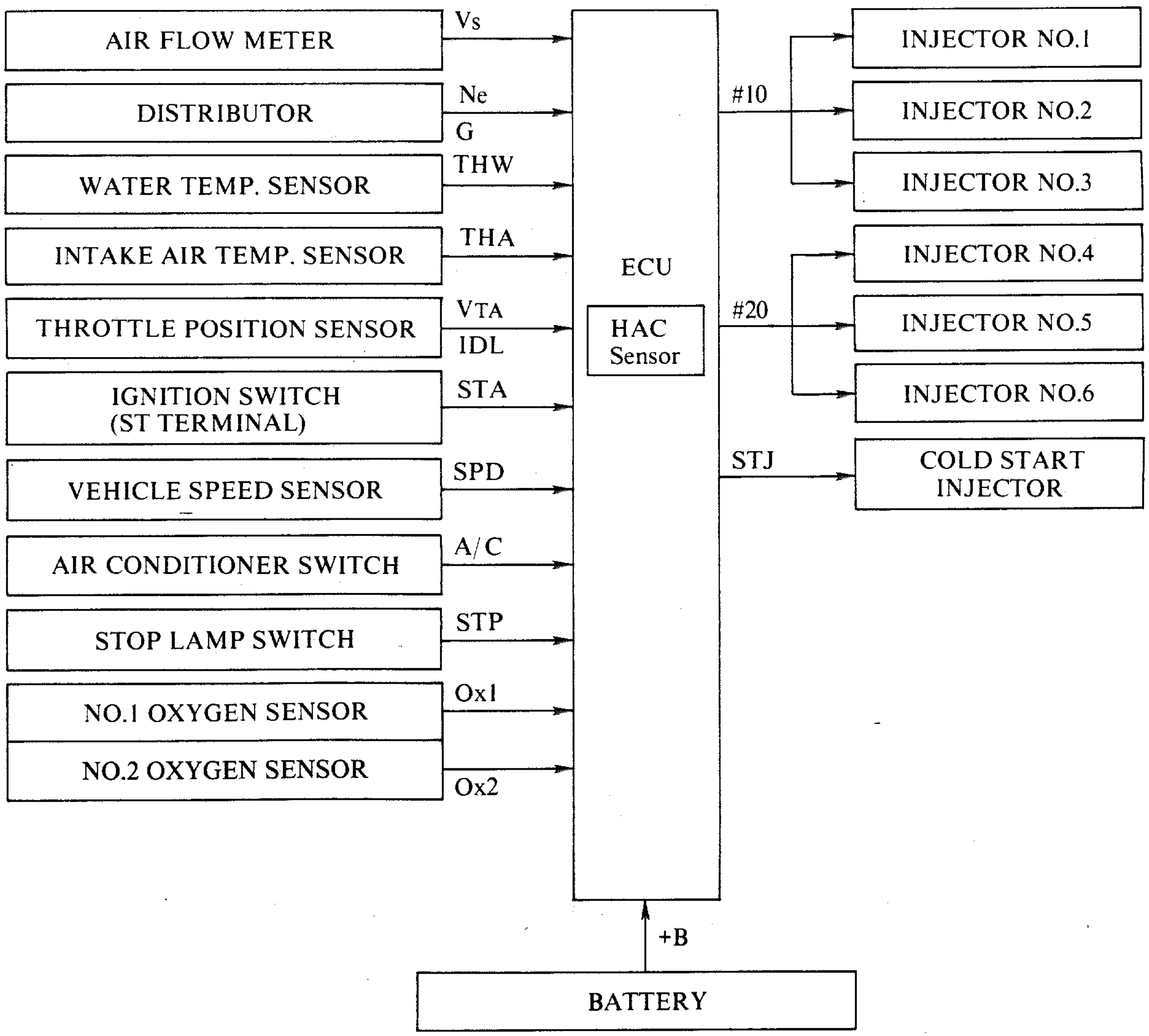
Intake air passes through the air flow meter, throttle body, intake chamber, intake manifold and flows to each intake port. The intake air volume is measured by the air flow meter and its signals are used by the ECU to determine the basic injection duration. In the 3F-E TCCS, the ISC valve, by adjustng the intake air volume which bypasses the throttle, automatically adjusts the engine idling speed and engine fast idle.

c. Electronic Control System

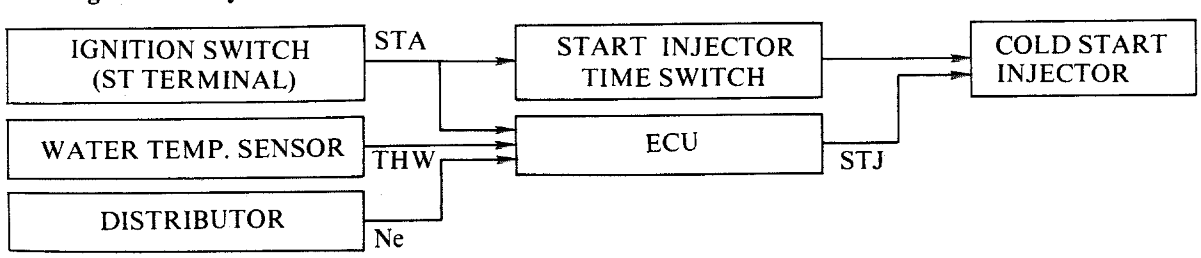
In the TCCS, the ECU controls the injection duration based on data stored in its memory and signal from the sensors.

2) **EFI Block Diagram**

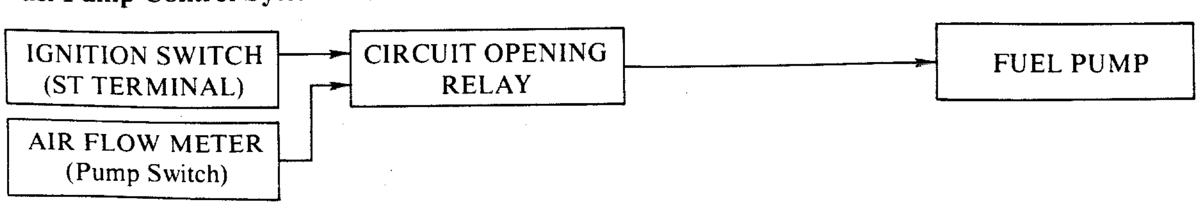
a. **Fuel Injection Duration Control System**



b. **Starting Control System**



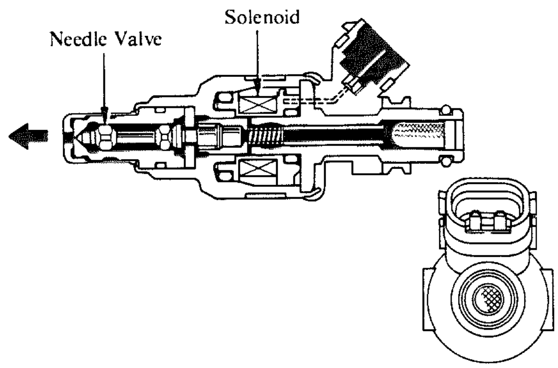
c. **Fuel Pump Control System**



3) Fuel System

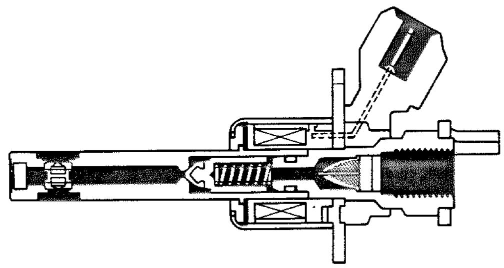
a. Fuel Injector

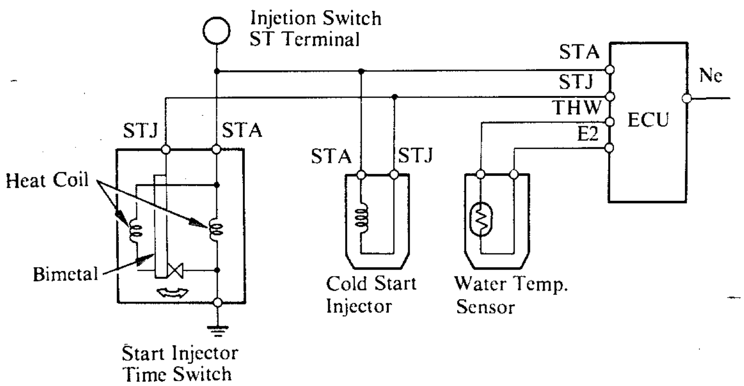
The fuel injector is a high-resistance type and separate resistor is no longer used. The cone type needle valve reduces the possibility of injector clogging. The injector has only one hole.



b. Cold Start Injector

The cold start injector is similar to the one used on the 7M-GE engine for Toyota Supra. The start injector time switch and the ECU controlling temperature have been changed. The operation time of the cold start injector is controlled by the start injector time switch and also by the ECU.

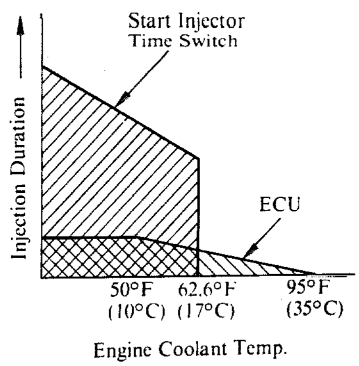




Cold Start Injector Control

When the engine coolant temperature is between 50°F (10°C) and 95°F (35°C), the ECU controls the injection duration according to the coolant temperature. When the temperature is below 50°F (10°C), the injection duration is maintained at a constant level.

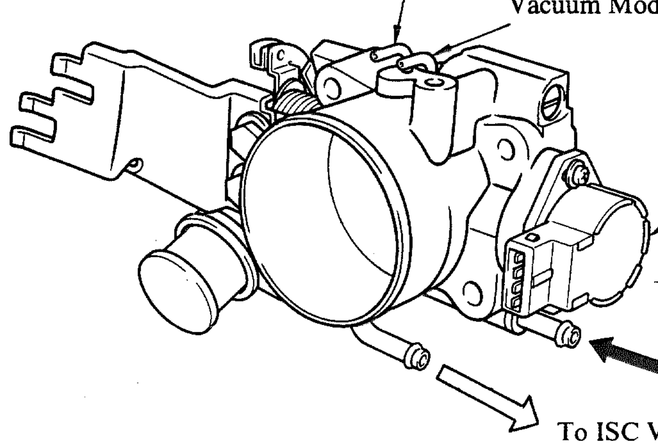
Injection is also controlled by the start injector time switch. When the coolant temperature is below 62.6°F (17°C), the injection duration varies according to the coolant temperature. Injection stops when the temperature rises above 62.6°F (17°C).

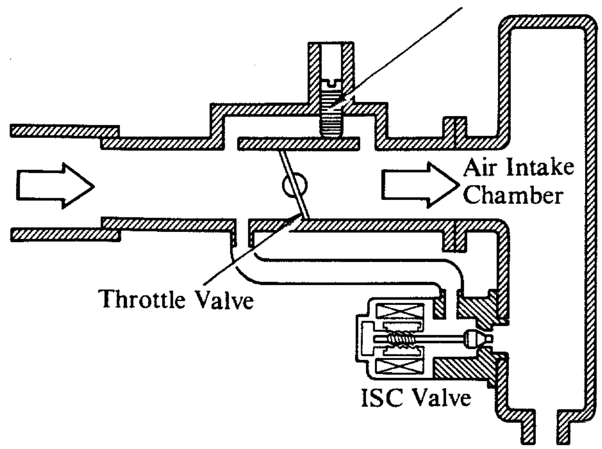


4) Air Induction System

Throttle Body

- A throttle valve is incorporated into the throttle body. The engine's output is controlled by controlling the intake air volume with the throttle valve.
- 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.





5) 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."

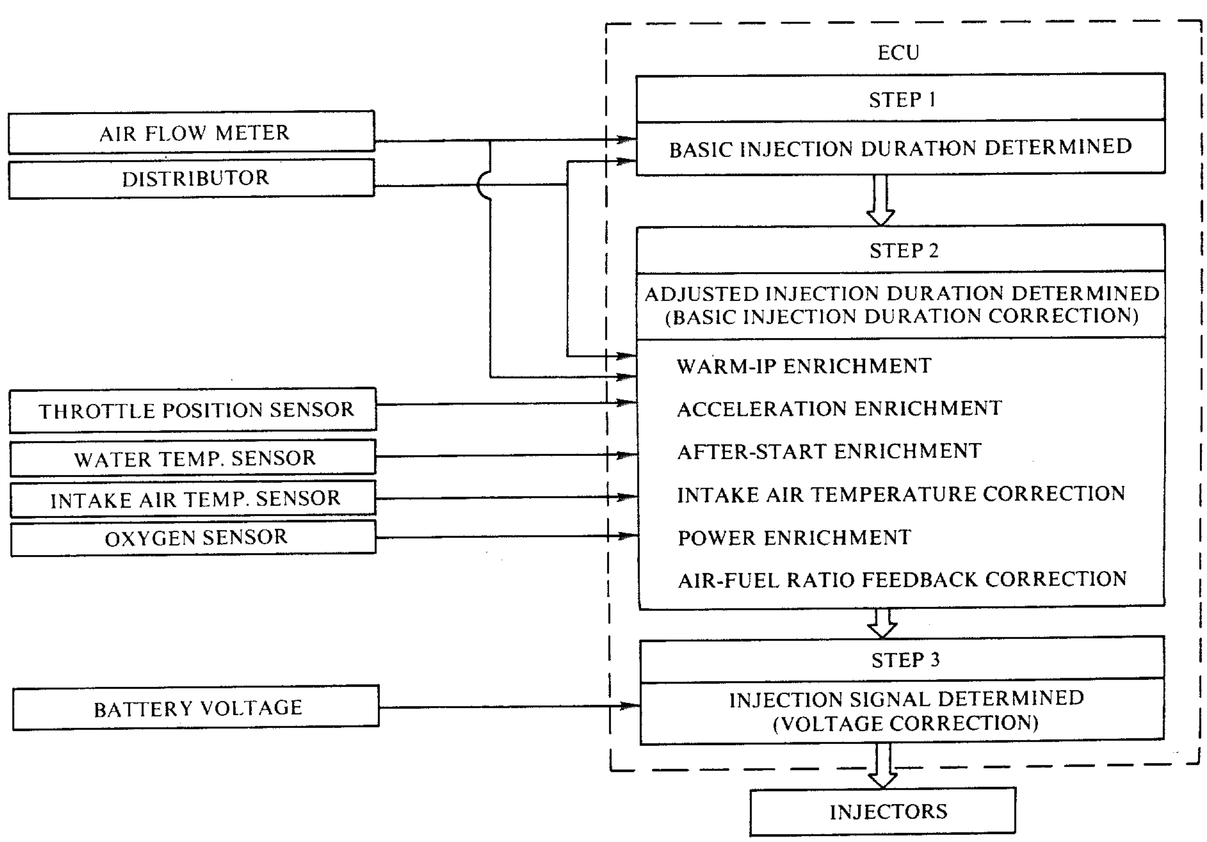
Step 2: Determination of Adjusted Duration of Injection

Under most engine conditions, the engine runs smoothly at an air-fuel mixture ratio of approximately 14.7 (this is called the "idle air-fuel ratio"). However, when the engine is still cold, or when an extra load is applied to the engine, a reduced air-fuel ratio is required (i.e., it must be richer). The ECU detects these engine conditions by means of the water temp. sensor, throttle position sensor and intake air temp. sensor, and continuosly corrects the basic injection duration to optimize it for the existing engine conditions.

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 14.7. This corrected time is called the "adjusted injection duration".

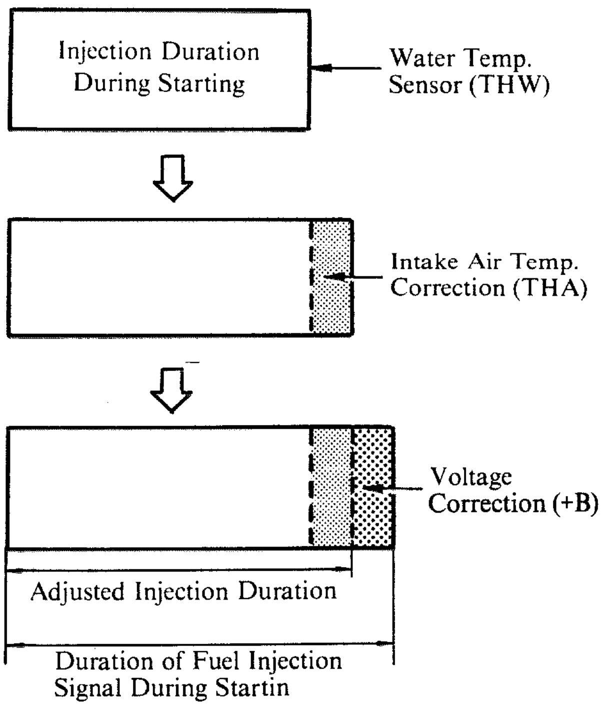
Step 3: Determination of Length of Injection Signal

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.



6) 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)
- Starter signal (STA)
- Battery voltage (+B)

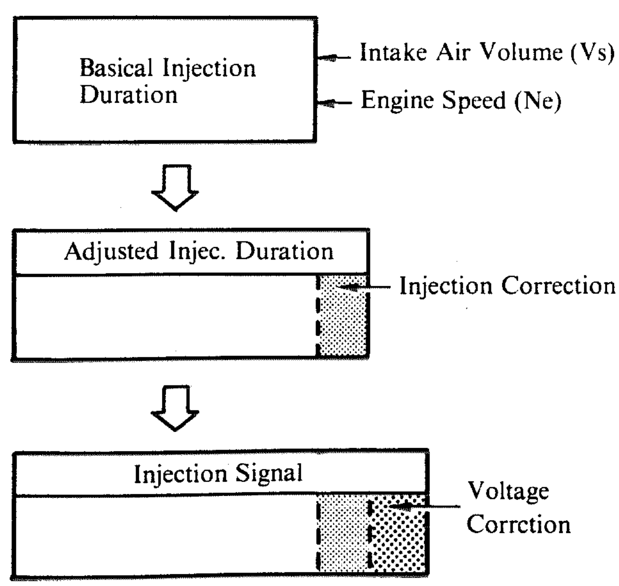
CONDITION
Engine speed below predetermined level, or STA on.

7) After-Start Injection Control

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

Injection Signal Duration
= Basic Injection Duration
× Injection Correction Coefficient*
+ Voltage Correction

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



a. 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

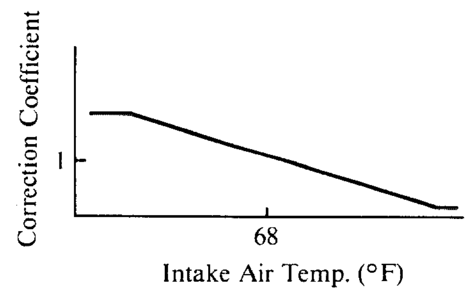
b. Injection Corrections

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

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 68°F (20°C) to be the "standard temperature" and increases or decreases the amount of fuel injected, depending upon whether the intake air temperature falls below or rises above this standard.

RELEVANT SIGNAL
Intake air temperature (THA)



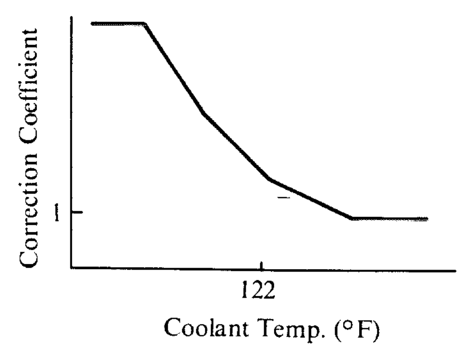
Warm-up Enrichment

When the engine is cold, a rich fuel mixture is needed to maintain drivability.

For this reason, when the coolant temperature is low, the water temp. sensor informs the ECU, which increases the amount of fuel injected.

As the coolant warms up, the amount of warm-up enrichment decreases, reaching zero (correction coefficient = 1.0) when the coolant reaches 122°F (50°C).

RELEVANT SIGNAL
Coolant temperature (THW)



After-start Enrichment

Immediately after starting (engine speed above predetermined level), the ECU supplies an extra amount of fuel for a certain period to aid in stabilizing engine operation.

This 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.

RELEVANT SIGNALS
- Engne speed (Ne)
- Coolant temperature (THW)

Acceleration Enrichment During Warm-up

The ECU injects extra fuel during acceleration when the engine is still warming up in order to aid drivability.
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 amount 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 176°F (80°C).
However, if any of the following occures the ECU stops calculating of extra fuel:
- Engine speed fails below predetermined level
- Fuel cut-off occures
- Intake air volume becomes smaller than a certain level

Power Enrichment

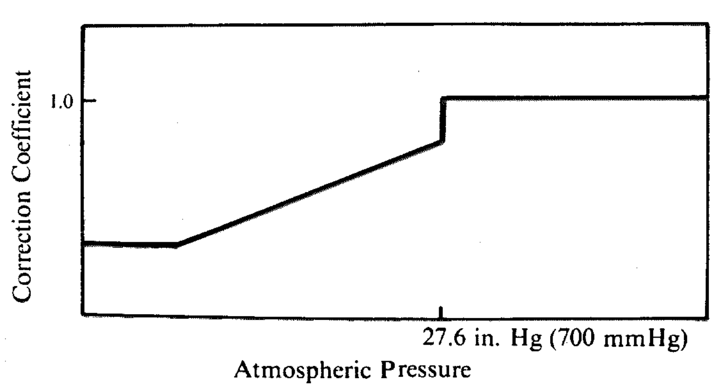
When the engine is operating under heavy load conditions, the injection volume is supplemented by a certain volume to maintain good drivability.
The correction volume is determined according to the intake air volume.

RELEVANT SIGNALS
- Throttle position (VTA)
- Air flow meter (Vs)
- Engine speed (Ne)

CONDITIONS
When any of the following conditions exist:
- Throttle valve opening angle above predetermined level
- Engine speed above predetermined level
- Intake air volume per engine speed is above predetermined level

HAC (High Altitude Compensator) Enrichment

The HAC sensor is incorporated in the ECU.
The density of oxygen in the atomsphere is smaller at high altitudes, the intake air volume metered by the air flow meter will be insufficient and the air-fuel mixture will be too rich. Because of this, the 3F-E engine uses an altitude compensation sensor. The ECU then, according to signals it receives from the altitude compensation sensor, adjusts signals from the air flow meter and determines the corresponding volume of fuel to be injected.

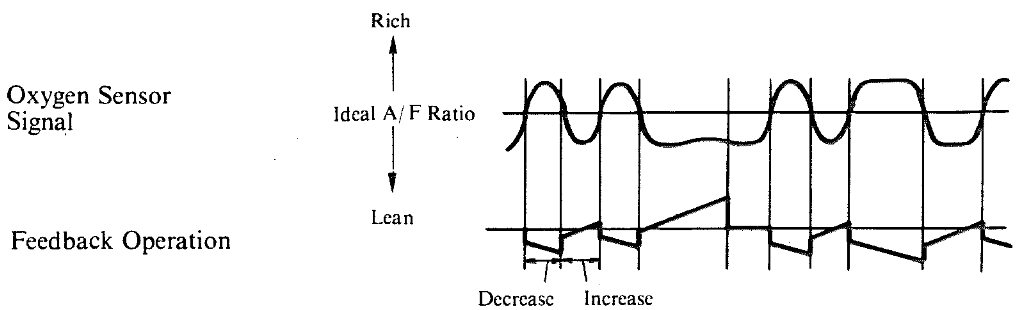


Air-fuel Ratio Feedback Correction

The ECU corrects the injection duration based on signals from the oxygen sensors to keep the air-fuel ratio within a narrow range near the ideal air-fuel ratio. (Closed loop operation)
However, under the following conditions, in order to prevent over heating of the catalyst and assure drivability the air-fuel ratio feedback operation does not work. (Open loop operation)

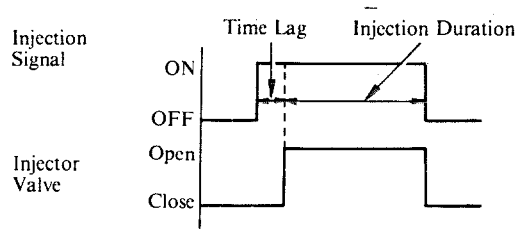
During engine starting
During power enrichment
During fuel cut-off
Coolant temperature above 104°F (40°C) and AI is ON

The ECU compares the voltage of the signals sent from the oxygen sensors with a reference voltage. If the voltage signal from the oxygen sensor 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 voltage signal is lower, it is judged that the air-fuel ratio is leaner than the ideal so the amount of fuel injected is increased.



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").
The 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.
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.



RELEVANT SIGNAL
Battery voltage (+B)

8) Fuel Cut-off

a. Fuel Cut-off During Deceleration

During deceleration at high engine speed with the throttle valve completely closed, the ECU cuts off fuel injection in order to prevent overheating of the catalyst due to misfiring and to improve fuel economy. When the engine speed drops or the throttle valve is opened, fuel injection is resumed.

RELEVANT SIGNALS
- Throttle position (IDL)
- Engine speed (Ne)
- Coolant temperature (THW)
- Stop lamp switch (STP)
- 4WD indicator swtich (4WD)

CONDITIONS
IDL contacts closed with engine speed above fuel cut-off speed

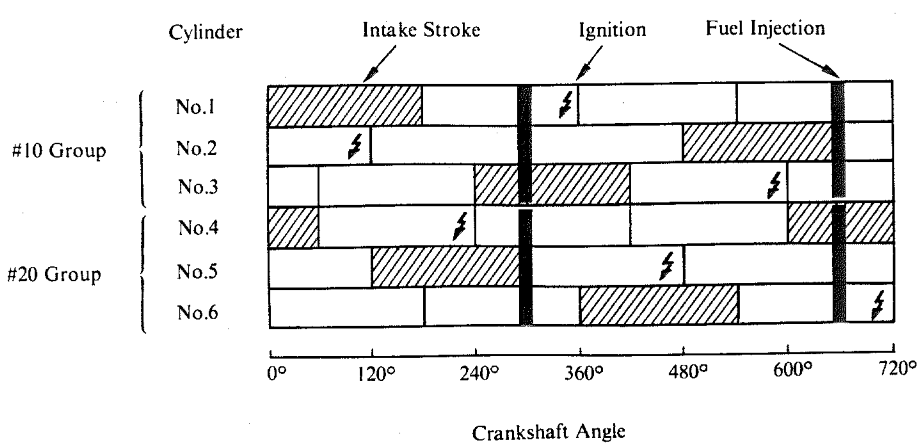
CONDITIONS FOR RESUMPTION OF FUEL INJECTION
Engine speed drops below fuel injection resumption speed, or IDL contacts open, however, the fuel injection resumption speed becomes higher than a predetermined level when the ECU is receiving an STP or 4WD signal.

b. Fuel Cut-off Due to High Engine Speed

To prevent engine over-run, fuel injection is cut if engine speed rises above 5000 rpm. Fuel injection is resumed when the engine speed falls below this value.

9) Fuel Injection Timing

The fuel injection system is a Two group injection system which injects fuel simultaneously into all cylinders once every one engine revolutions.



ESA (Electronic Spark Advance)

1) 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.

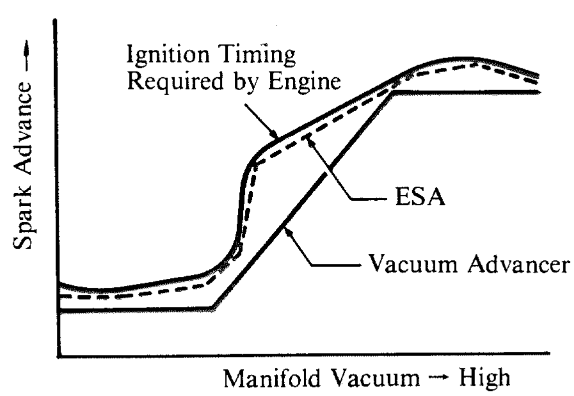
Actually, optimum ignition timing is affected largely by a number of factors, such as the shape of the combustion chamber and the temperature inside the combustion chamber in addition to the engine speed and the intake air volume.

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

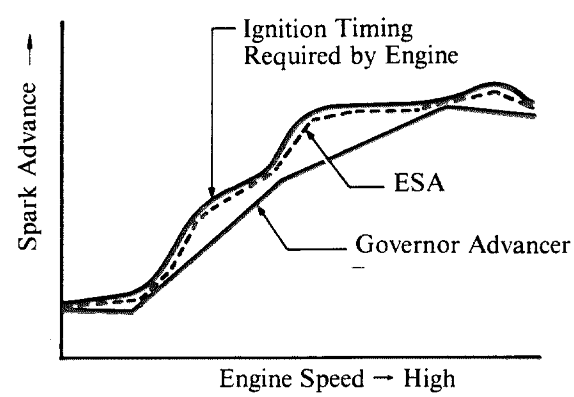
The ECU determines ignition timing from its internal memory containing optimum ignition timing data for each engine condition, based on signals detected by various sensors, and then sends signals to the igniter accordingly.

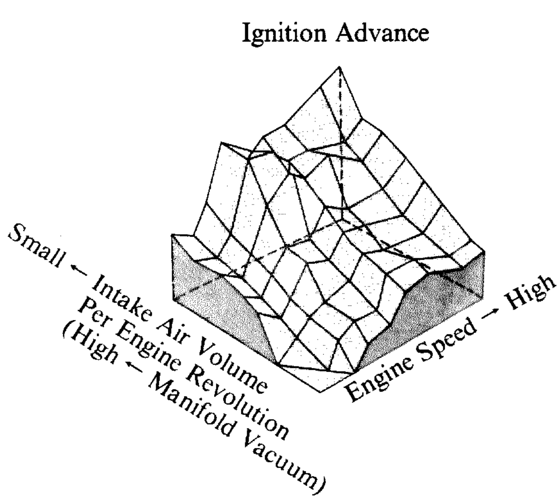
Since the ESA always gives optimum ignition timing, both fuel efficiency and engine power output are maintained at a good level.

Vacuum Advancing

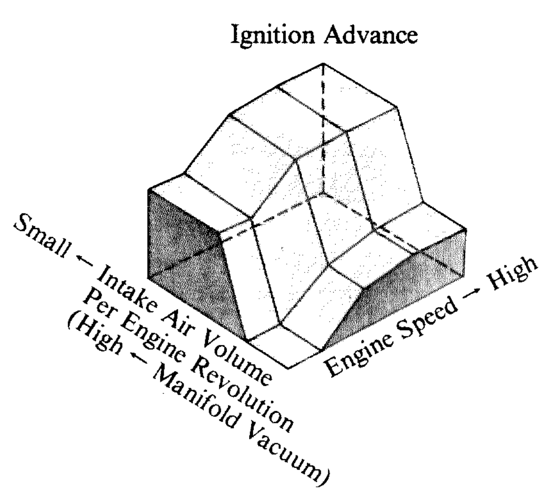


Governor Advancing



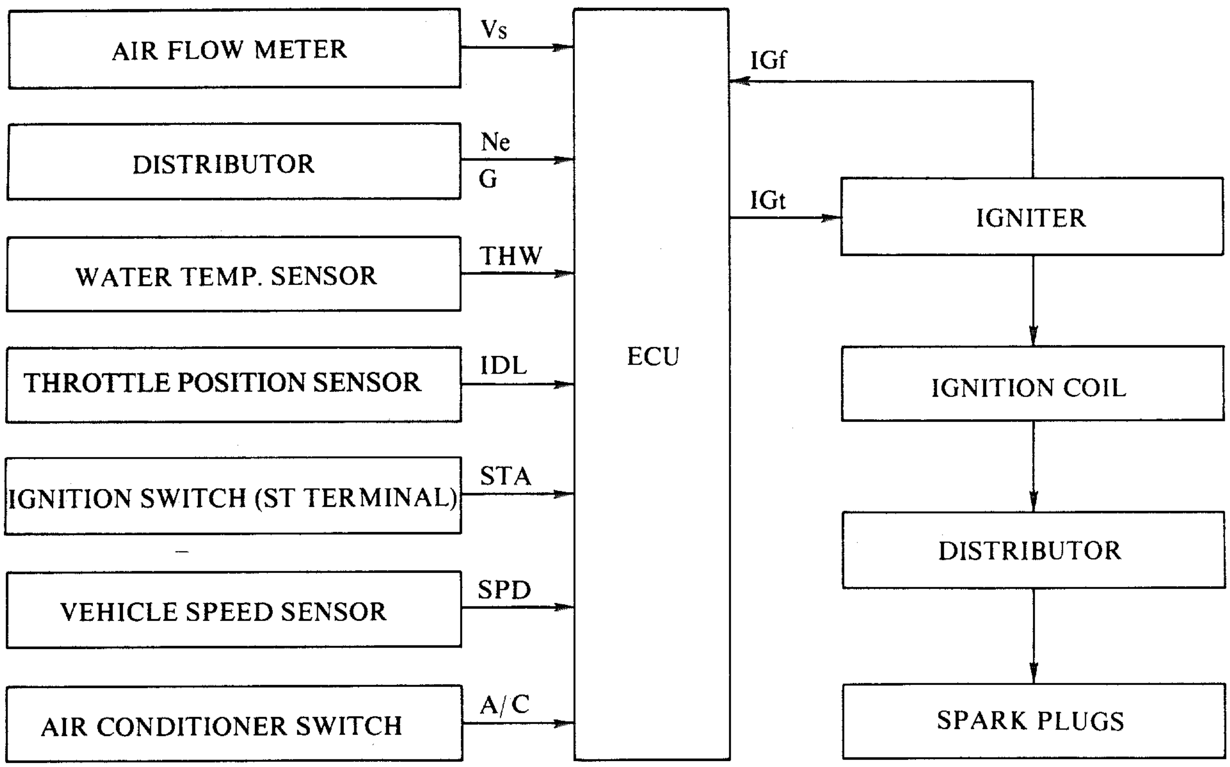


ESA



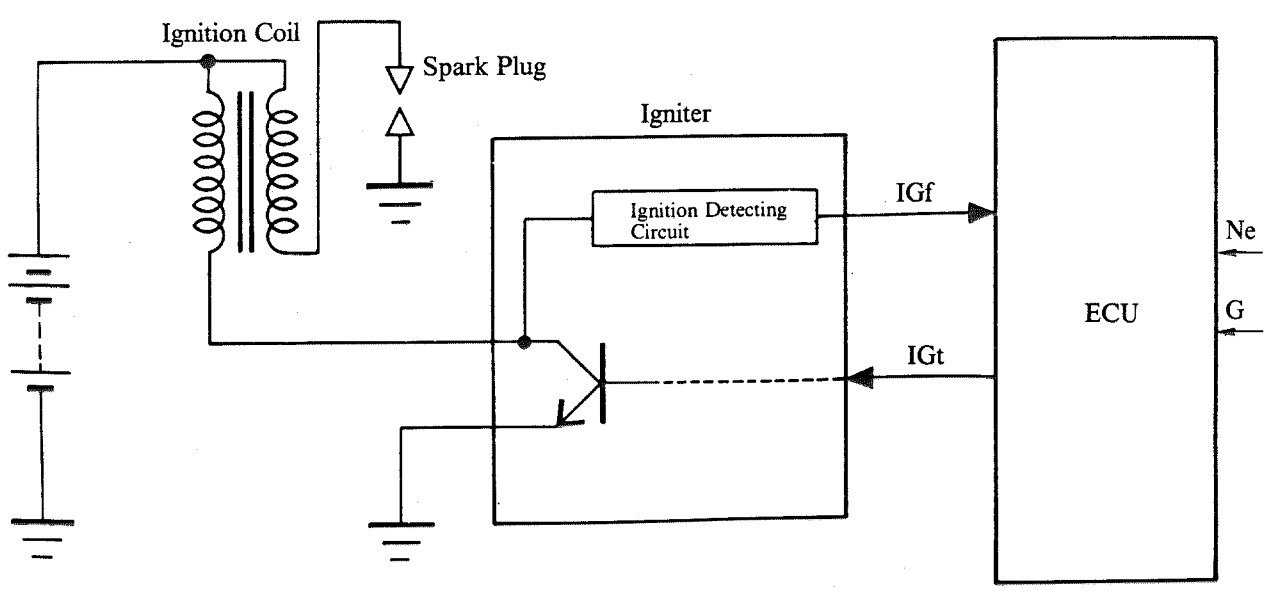
Conventional

2) ESA Block Diagram



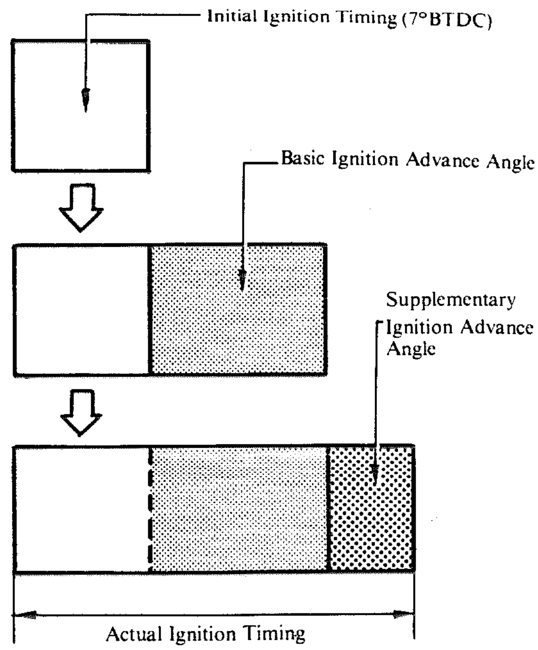
3) Igniter

In the TCCS, the power transistor is turned on and off by signals , 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.



4) 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. Whenever a G signal 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.



a. 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 7° BTDC in the ESA system.

Advance 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 7° BTDC until engine operation has been stabilized.

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

CONDITION
Engine speed below predetermined level, or STA on.

NOTE: During engine adjustment, etc., with the vehicle stopped, confirm the ignition timing by connecting the T_{E1} and E_1 terminals in the check connector with the throttle valve closed.
Under the above conditions, ignition advance should not be occurring timing should be the initial 7° BTDC.

b. Basic Ignition Advance Angle

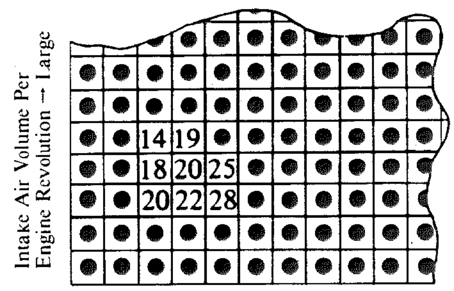
The memory in the ECU contains optimum advance angle data for the intake air volume per engine revolution and the engine speed. The ECU selects the basic ignition advance angle from memory according to the engine speed signals from the Ne pick-up coil in the distributor and the intake air volume signals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

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



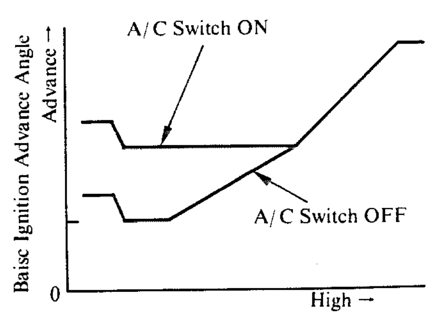
— ***REFERENCE*** —

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.

IDL Contacts Closed (ON)

When the IDL contacts close, the ignition timing is advanced.

RELEVANT SIGNALS
- Throttle position (IDL)
- A/C switch (A/C)
- Engine speed (Ne)



c. Supplementary Ignition Advance Angle

Warm-up Compensation

When the coolant temperature is low, the ignition timing advance angle is advanced to improve drivability.

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

Overheat Prevention

In order to prevent knocking or overheating of the catalyst, ignition timing is retarded when the coolant temperature is extremely high.

RELEVANT SIGNAL
- Coolant temperature (THW)

d. Maximum and Minimum Advance Angle Control

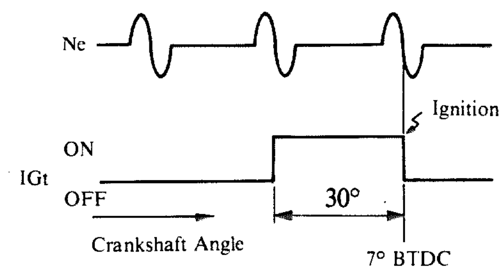
If the actual ignition timing (initial ignition timing +basic ignition advance angle +supplementary ignition advance angle) becomes abnormal, the engine will be adversely affected. To prevent this, the ECU controls the actual ignition timing so that the sum of the basic ignition and supplementary ignition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

Maximum advance angle: 40° BTDC
Minimum advance angle: −2° BTDC

e. Igniter Control

During Engine Starting and Immediately After Starting

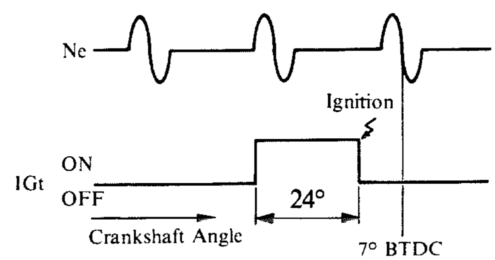
During engine starting and immediately after starting, the ECU sends the IGt signal to the igniter at given crank shaft angle before the initial ignition timing angle of 7° BTDC.



CONDITIONS
- STA on or engine speed below predetermined level.
- IDL on, service terminals E1 and T_{E1} shorted and vehicle speed is 0.

During Engine Running

During engine running, the ECU sends the IGt signal to the igniter at a given crank angle before the ignition point that it has just calculated.

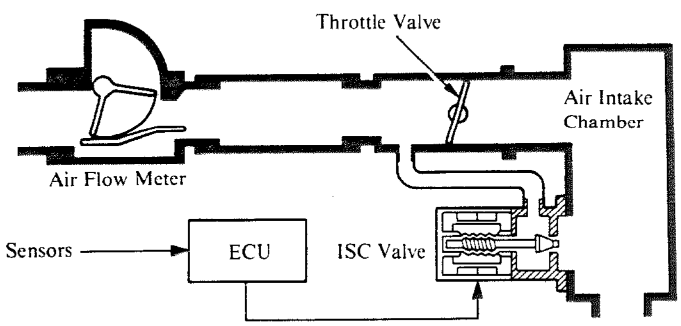


CONDITION
- Engine speed above the predetermined level.

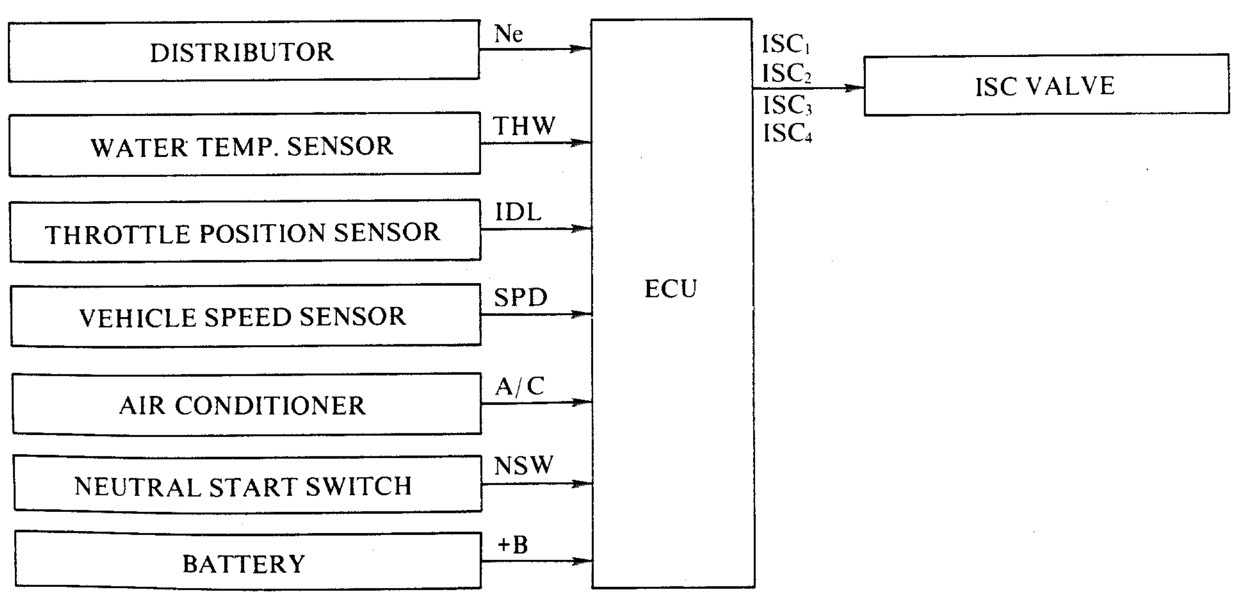
ISC (Idle Speed Control)

1) General

With the 3F-E TCCS, a target idling speed for each engine condition is stored in the ECU. The intake air volume bypassing the throttle valve is adjusted by the ISC valve according to the engine condition to maintain the target idling speed (However, the ISC valve does not control idle up of the power steering.).
When the engine is cold, the ISC valve opens depending on the coolant temperature and engine speed rises, causing fast idle.



2) ISC Block Diagram

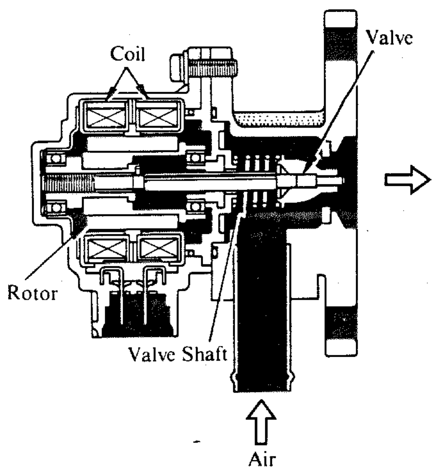


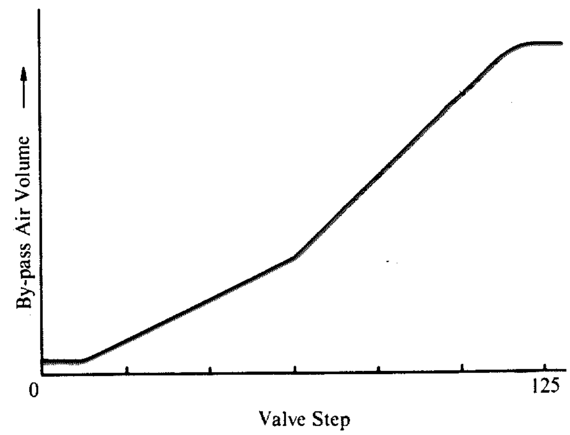
3) ISC Valve

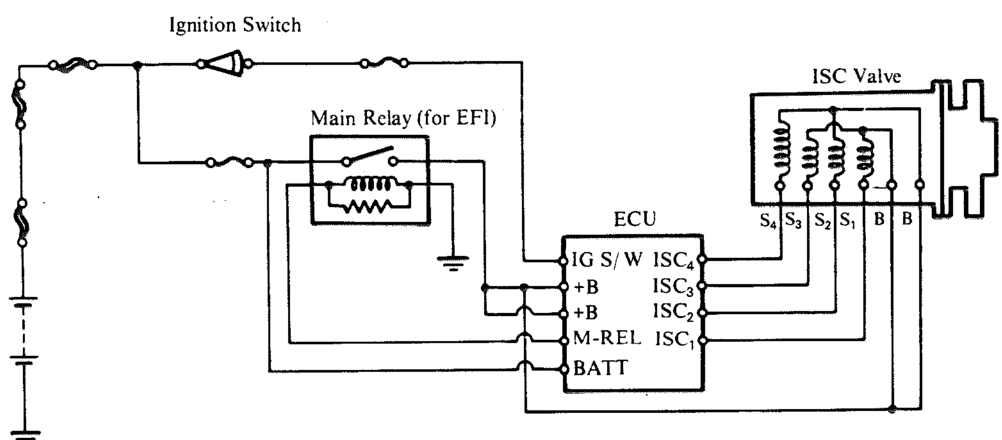
The ISC valve is mounted on the intake manifold and intake air bypassing the throttle valve is directed to the ISC valve through a hose.

The ISC valve operated by 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, 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.







4) 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.

a. Initial Set

When the engine is stopped, the ISC valve if fully open to the 125th step, giving the engine good restartability.

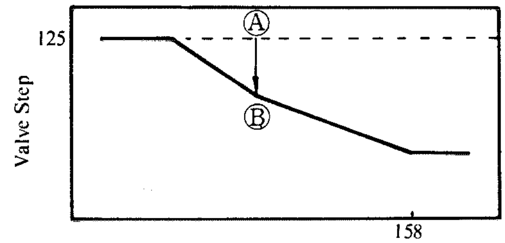
The Main Relay goes off after the ignition switchis turned off and initial set is completed.

RELEVANT SIGNAL
Engine speed (Ne)

CONDITION
Engine speed is zero and main relay ON.

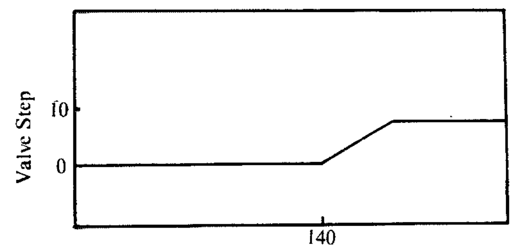
b. Start Control

If the engine is started and the ISC valve is in the initial set (fully open) condition, the engine speed will be too high. Therefore, immediately after the engine is started, the ISC valve moves to the step position which corresponds to the coolant temperature and intake air temperature.
The ISC valve opens more when the coolant temperature is lower or when the intake air temperature is higher.



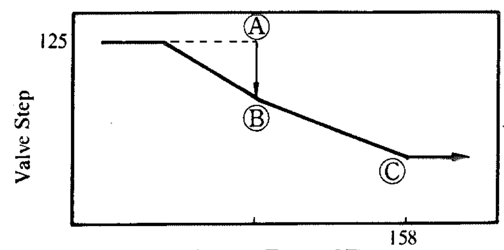
RELEVANT SIGNALS
- Engine speed (Ne)
- Coolant temperature (THW)
- Intake air temperature (THA)

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



c. Warm-up (Fast-idle) Control

When start control is ended, the fast idle speed is set by coolant temperature. As the coolant temperature rises, the ISC valve gradually closes and when the coolant temperature reaches 158°F (70°C), fast-idle control ends.



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

CONDITION
Engine speed above predetermined level

d. 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 that open or close the ISC valve in order to adjust the actual engine speed to match the target idling speed.

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 predetermined level and coolant temperature above 163°F (73°C).

Target Idling Speed

Air Conditioner Switch	Neutral Start Switch (Range)	Engine Speed
ON	ON (N.P)	900 rpm
	OFF (R.D. 3, 2, L)	750 rpm
OFF	ON (N.P)	650 rpm
	OFF (R.D. 3, 2, L)	600 rpm

e. Engine Speed Change Estimate Control

Immediately after the air conditioner switch or automatic transmission shift position is changed, the engine load changes, causing the engine speed to change. The ECU opens or closes the ISC valve to maintain a constant engine speed.

RELEVANT SIGNALS
- Engine speed (Ne)
- Air conditioner (A/C)
- Neutral start switch (NSW)

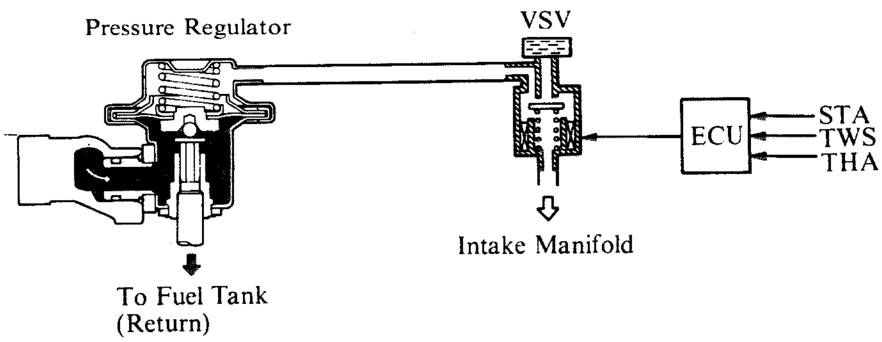
CONDITIONS
When air conditioner switch or neutral start switch turned on or off with engine speed above predetermined level.

OXYGEN SENSOR HEATER CONTROL

The oxygen sensor's heater operates when the load is light, maintaining sensor accuracy. If the intake air volume exceeds a predetermined level, the ECU switches off the heater.

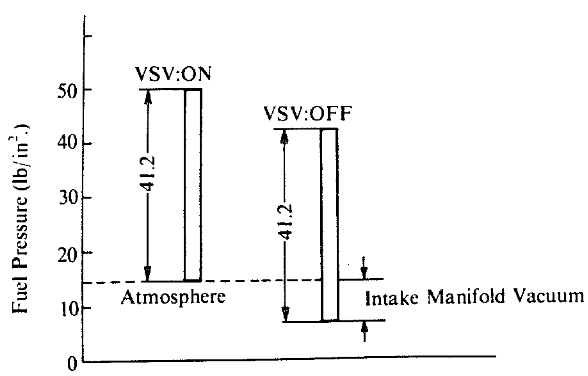
FUEL PRESSURE CONTROL

When restarting a hot engine, the ECU increases the fuel pressure above the normal level to reduce the fuel tendency to percolate. This helps restarting and also maintains the engine idle stability. The controlled fuel pressure is 41.2 lb/in². (2.9 kg/cm²).



Operation

When the coolant temperature switch is ON [above 221°F (105°C)] and the intake air temperature is 122°F (50°C) or higher, if the engine is cranked, the ECU turns on the VSV. As the VSV goes on, atmospheric air is introduced into the diagram chamber of the pressure regulator and the valve closes the passage. 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 several seconds.



DIAGNOSIS

1) General

The ECU contains a built-in self-diagnostic system which constantly monitors all sensors and lights the "CHECK ENGINE" lamp when it detects a malfunction 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.

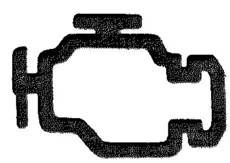
2) Check Engine Lamp

The diagnostic system monitors eighteen conditions, including the normal condition, listed in the chart on page 6 GENERAL 1988 FEATURES. Whenever a malfunction is detected in any one of these 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, the ECU does not light the lamp when a malfunction has been detected because a malfunction in those systems would not cause any major trouble such as engine stalling.

After a malfunction is corrected, or in the case of an intermittent problem, ceases to exist, 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 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.



Check Engine Lamp

- The lamp lights immediately if a TCCS problem occurs while the engine is running.
- If the problem is corrected, or in the case of an intermittent problem, ceases to exist, 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.

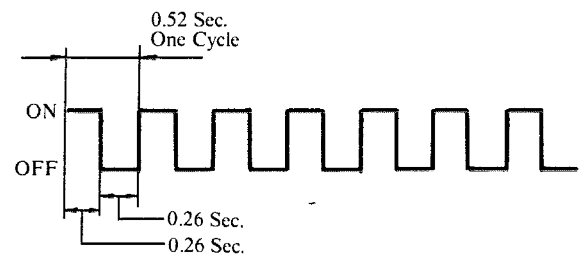
3) Diagnostic Codes

In the case of the 3F-E engine, TCCS problems can be diagnosed by fulfilling the following three conditions, then counting the number of times the CHECK ENGINE lamp flashes (see GENERAL 1988 FEATURES for detail):

CONDITIONS
- Ignition switch on
- Check terminals E_1 and T_{E1} connected
- IDL contacts on (throttle valve fully closed)

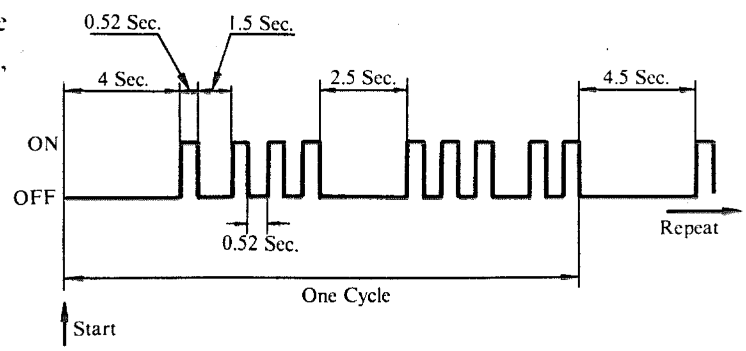
a. Normal

The lamp with flash continuously about 2 times per second.



b. Malfunction Present

When a malfunction code is in memory the lamp will blink the code(s). 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, will be retained in memory by the ECU from the time of detection until cancelled out.
- Once the malfunction is rectified, the "CHECK ENGINE" warning lamp will go out but the diagnostic code(s) will remain stored in the ECU memory (except for code 51).

FAIL-SAFE

1) 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.

a. Water Temp. Sensor and Air Temp. Sensor Malfunction

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

b. 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 consectively after each IGt signal, and will discontinue fuel injection.

c. HAC (High Altitude Compensator) Malfunction

When the HAC sensor built into the ECU sends signals exceeding predetermined levels, the air-fuel ratio is calculated by using a specific value stored in the ECU.

d. Throttle Position Sensor Malfunction

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

e. 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.
The injection duration is calculated from the starting signal (STA) and the throttle position signal (IDL). Also, the ignition timing is set to the initial ignition timing, 7° BTDC, regardless of engine speed.

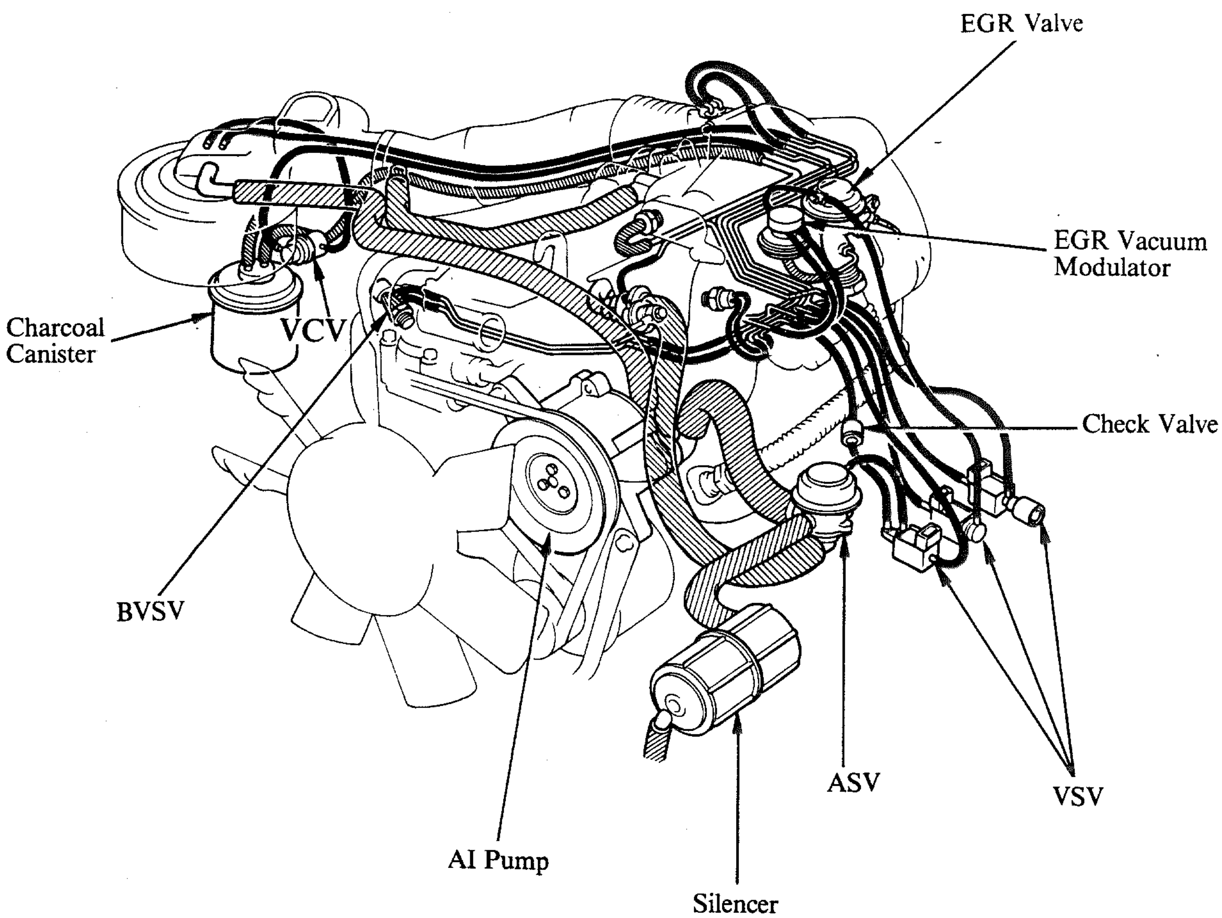
NOTE: When the engine is controlled by the back-up function, the CHECK ENGINE lamp lights up to warn the driver of the malfunction but no diagnostic code is output.

EMISSION CONTROL SYSTEM

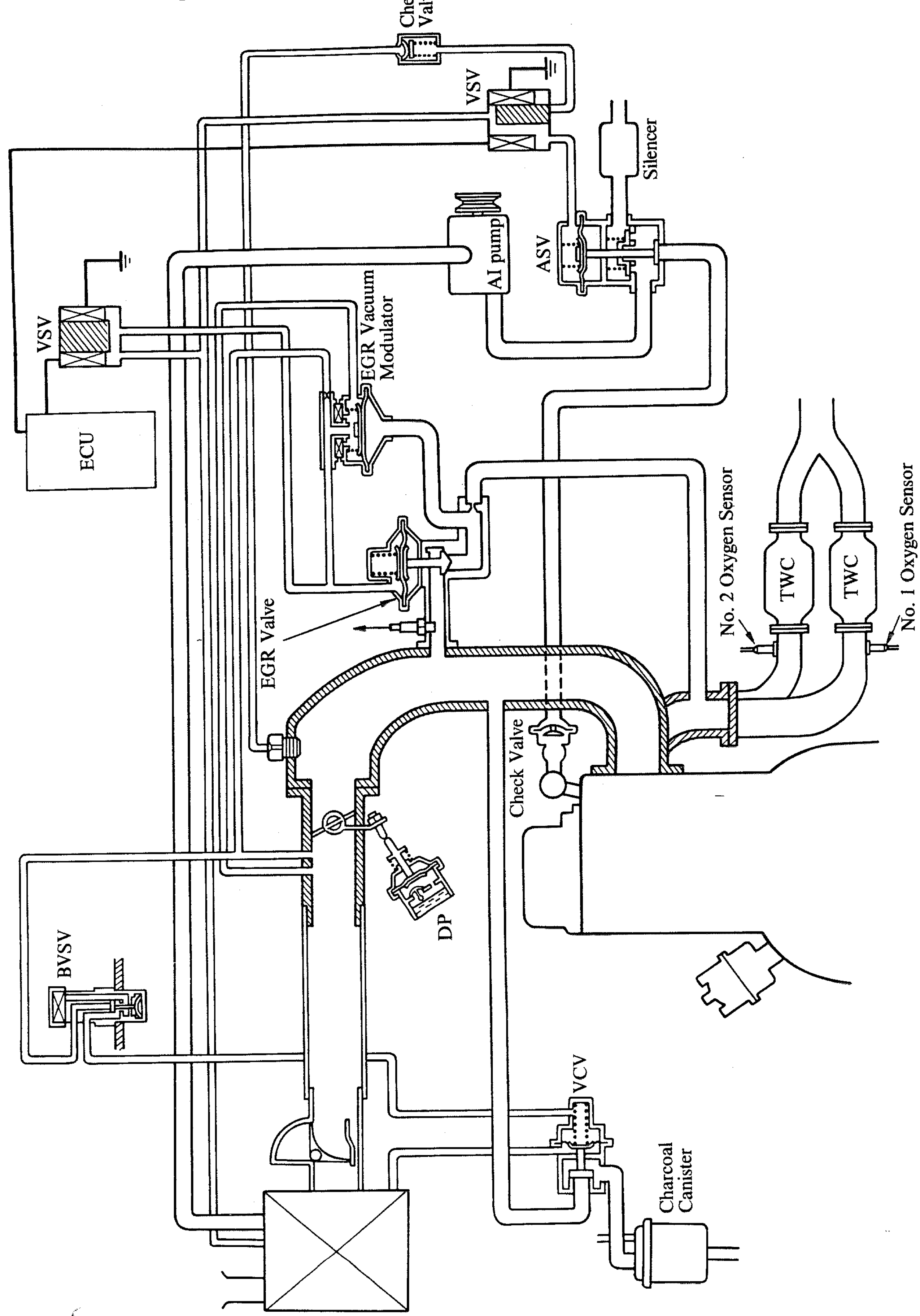
1) System Purpose

System	Abbreviaiton	Purpose
Positive crankcase ventilation	PCV	Reduces blow-by gas (HC)
Fuel evaporative emission control	EVAP	Reduces evaporative HC
Exhaust gas recirculation	EGR	Reduces NOx
Air injection	AI	Reduses HC and CO
Dash pot	DP	Reduces HC
Three-way catalyst	TWC	Reduces HC, CO and NOx
Electronic fuel injeciton	EFI	Regulates engine condition for reduction of exhaust emissions

2) Component Layout



3) Schematic Drawing



a. **EGR Control by ECU**

The ECU sends signals to the VSV, and the EGR is cut off by atmospheric air into the EGR valve pressure chamber, when:

- Coolant temperature is below 127° F (53°C).
- Throttle valve opening angle decreases.
- Intake air volume is smaller or larger than a predetermined range.
- Engine speed is above 3800 rpm.

b. **AI Control by ECU**

The ECU activates the VSV to turn air injection on when the following conditions shown under 1) and 2) below are met in addition to the following conditions;

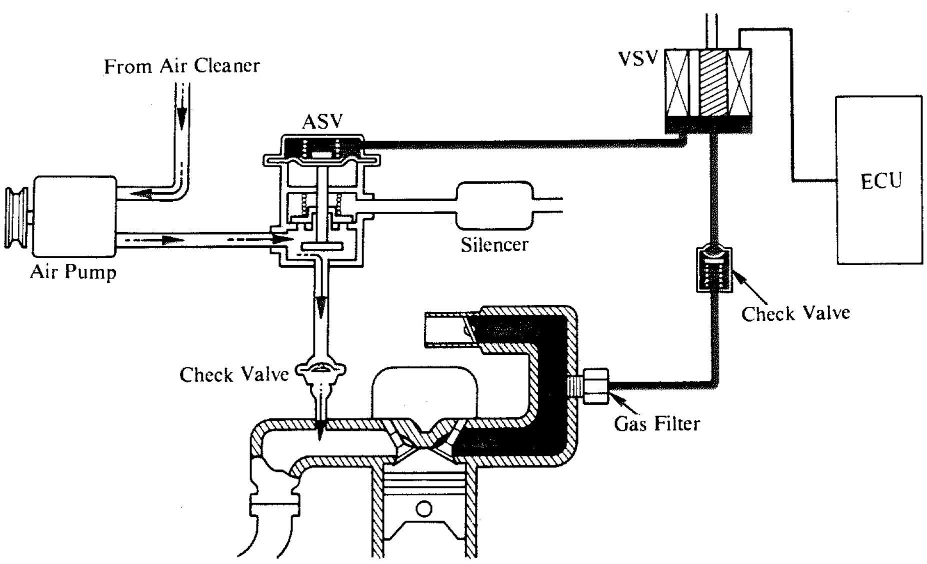
- Power enrichment deactivated

Air injection on cold engine

- Coolant temperature is between 59°F (15°C) and 104°F (40°C)

Air injection during deceleration

- Coolant temperature is above 104°F (40°C)
- IDL contacts are closed
- Engine speed below 2000 rpm and vehicle speed over 6 mph (10 km/h)



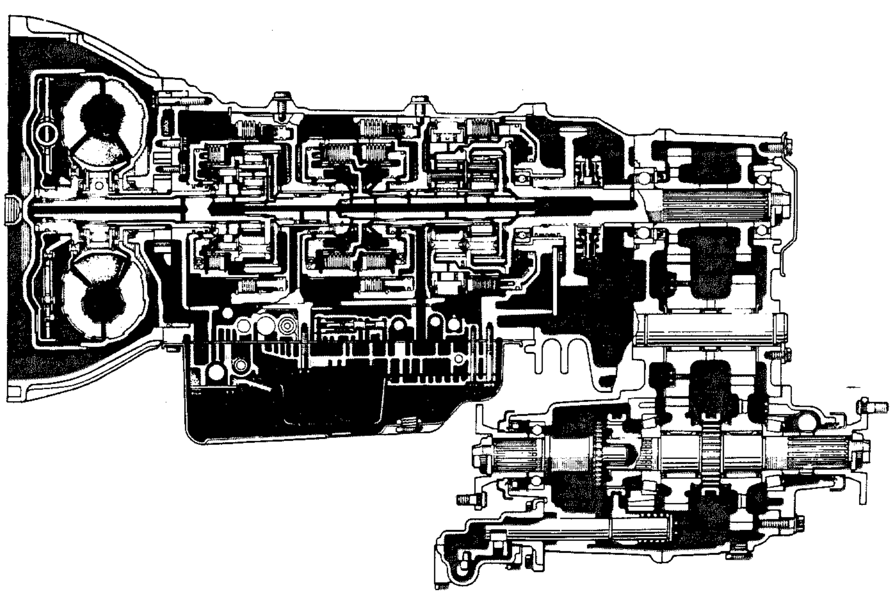
A440F AUTOMATIC TRANSMISSION

All models are now equipped with the A440F automatic transmission with a two-speed transfer. The A440F is a four-speed automatic transmission with a lock-up clutch and overdrive (OD). It has seven shift positions (P, R, N, D, 3, 2, L). The new range "3" covers 1st through 3rd gears and "D" range covers 1st through 4th (overdrive) gears. Range"2" is held on the 2nd gear.

- The following changes have been made to match the transmission to the 3F-E engine:

Major Changes

Purpose	Changed Parts	Content of Change
Powertrain performance	No.1 Governor Valve No.1 Governor Shaft	Governor Pressure Performance
	Torque Converter	Pump Blade and Shell Brazing
For greater engine protection during off-road driving	Oil Pan Protector	Oil Pan Protector added

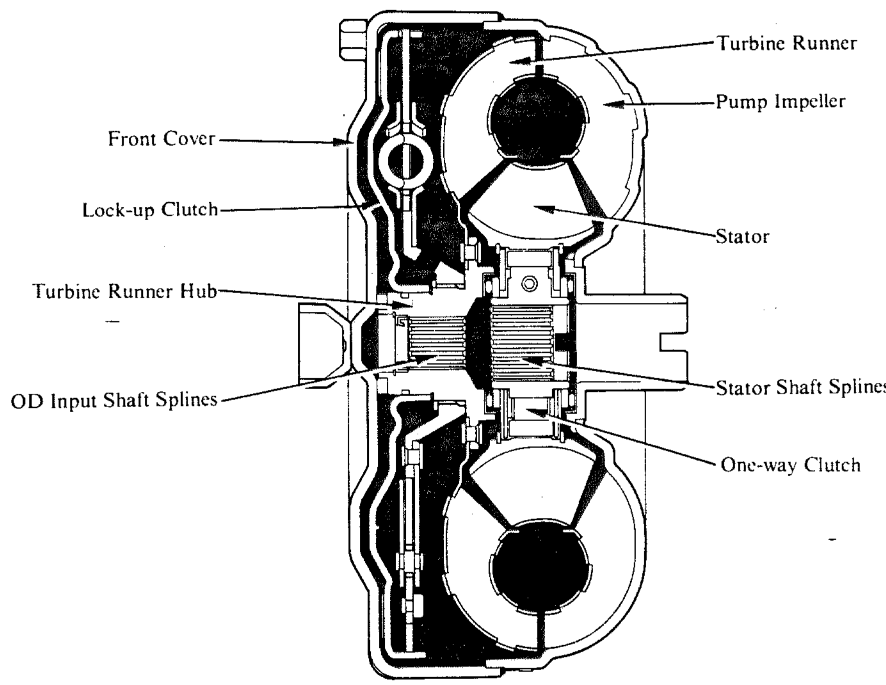


Specifications

Type of Transmission		A440F
Gear Ratio	1st	2.950
	2nd	1.530
	3rd	1.000
	4th (Overdrive)	0.717
	Reverse	2.678
Fluid Capacity		15.85 US qts (15 liters, 12.4 Imp.qts)
Type of Fluid		ATF Type DEXRON ® II

1. Torque Converter

The torque converter has a built-in hydraulically operated lock-up clutch which cuts power transmission losses due to slippage at medium and high speed, thus reducing fuel consumption. The torque converter is specially designed to optimally match the high power engine.

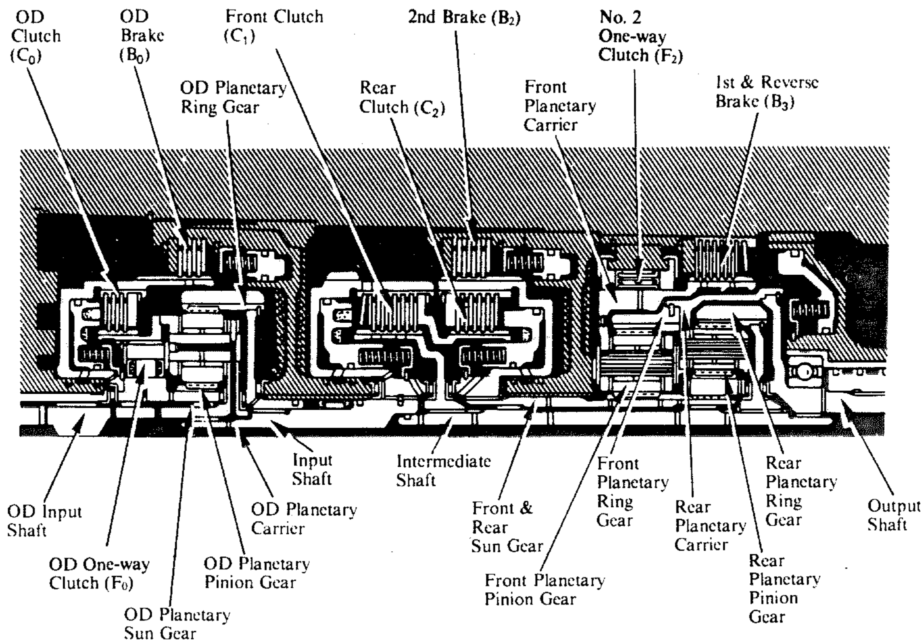


Operation of Lock-up Mechanism

The lock-up clutch is built and operates the same way as that in other automatic transmissions.

2. Planetary Gear Unit

Gears, brakes and clutches are arranged as shown below.

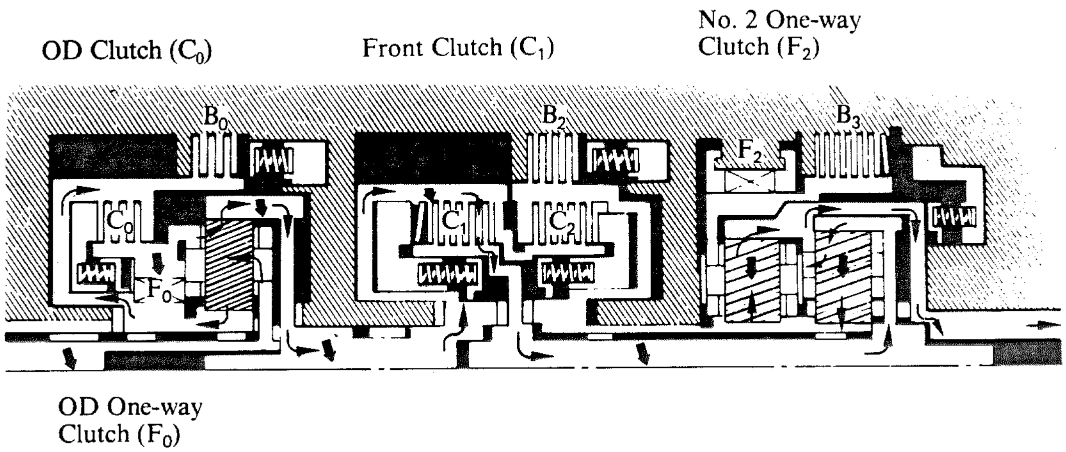


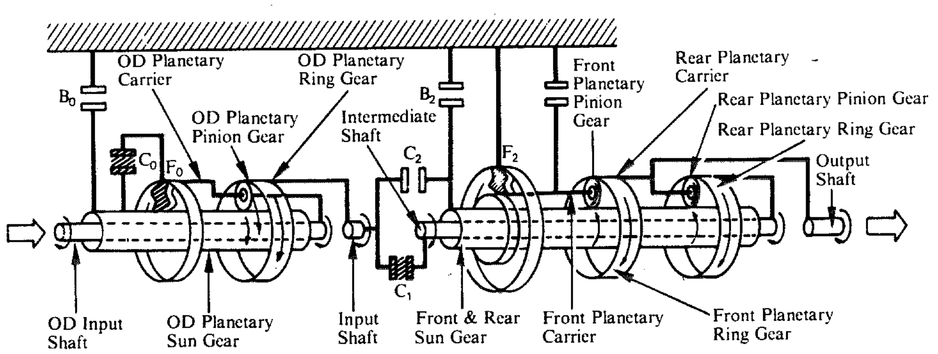
Functional Parts

Item			A440F
OD clutch	C_0	Number of discs	3
Front cluth	C_1		6
Rear clutch	C_2		5
OD brake	B_0		3
2nd brake	B_2		4
1st & reverse brake	B_3		6
OD one-way clutch	F_0	Number of sprags	22
No. 2 one-way clutch	F_2		46
OD planetary gear	Sun gear	Number of teech	35
	Pinion gear		27
	Ring gear		89
Front planetary gear	Sun gear		28
	Pinion gear		23
	Ring gear		75
Rear planetary gear	Sun gear		44
	Pinion gear		20
	Ring gear		83

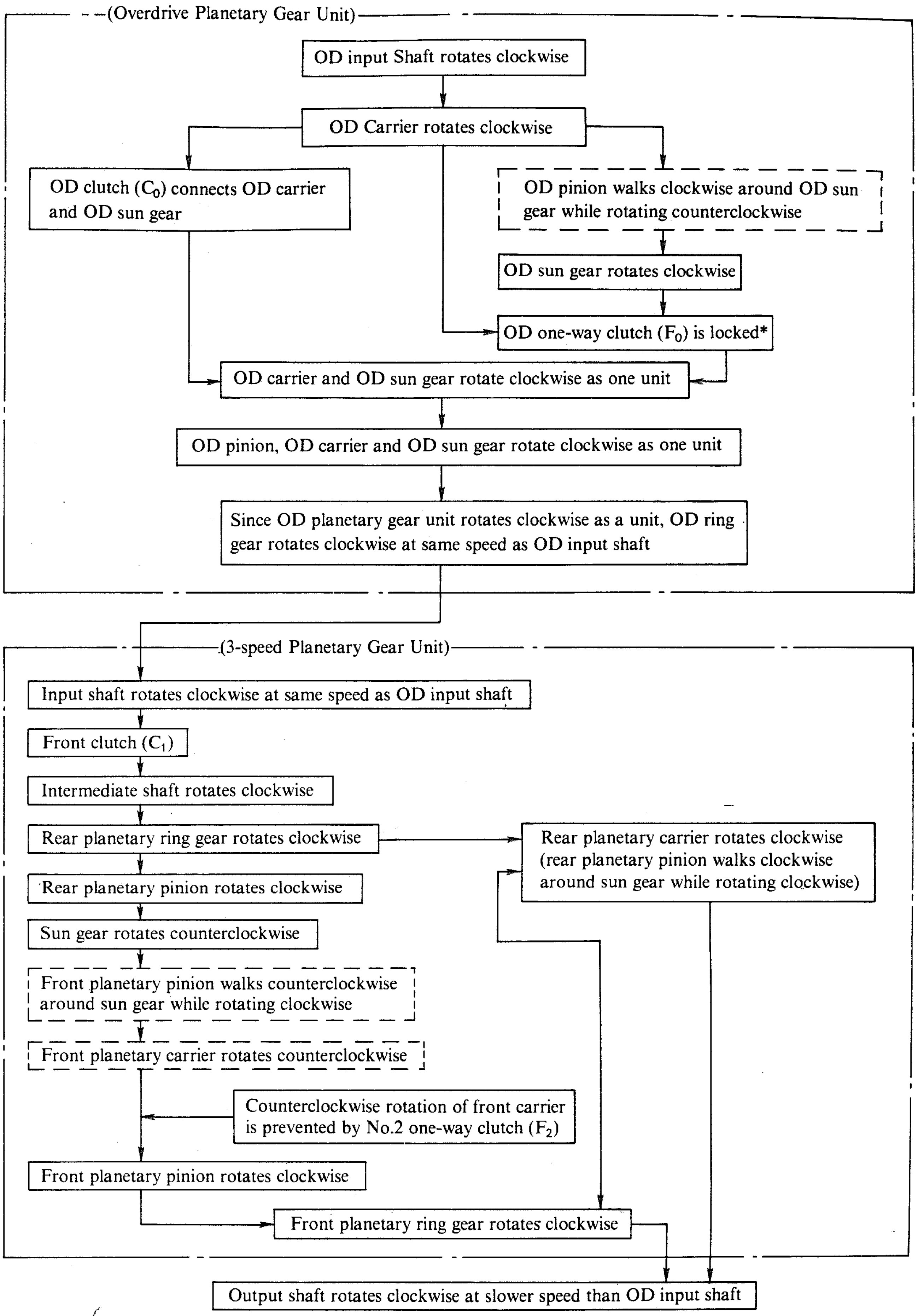
OPERATION

1) "D" or "3" Range (1st Gear)



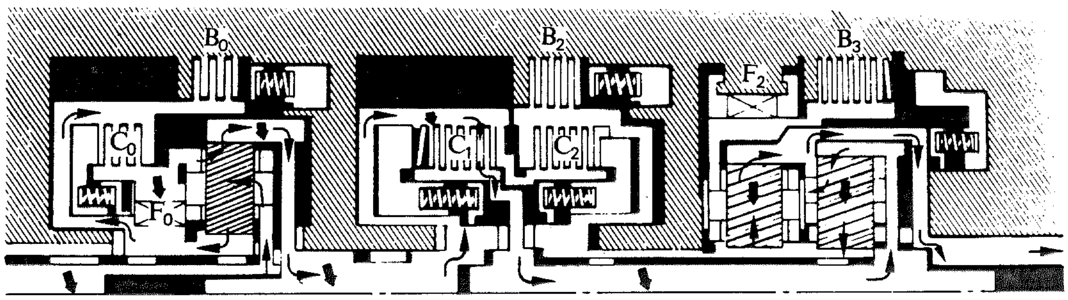


* The outer race of the OD one-way clutch (F_0) rotates clockwise as a unit with the OD planetary carrier, while the inner race rotates as a unit with the OD sun gear.
Since the inner race (OD sun gear) rotates faster than the outer race (OD carrier) by the amount of speed increment given to it by the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

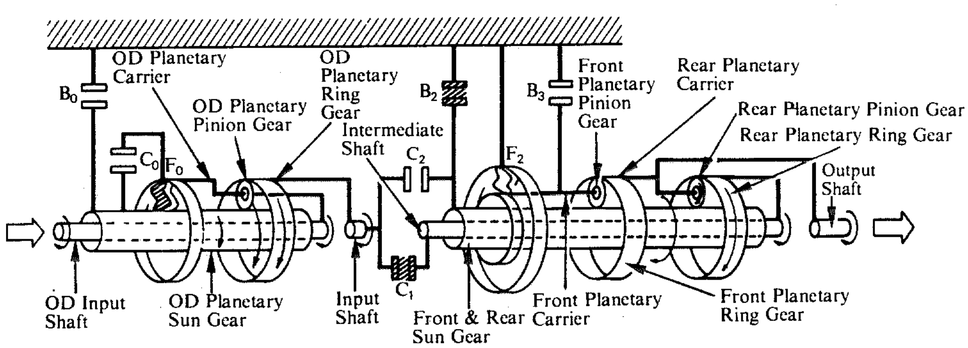

(Overdrive Planetary Gear Unit)
OD input Shaft rotates clockwise
OD Carrier rotates clockwise
OD clutch (C_0) connects OD carrier and OD sun gear
OD pinion walks clockwise around OD sun gear while rotating counterclockwise
OD sun gear rotates clockwise
OD one-way clutch (F_0) is locked*
OD carrier and OD sun gear rotate clockwise as one unit
OD pinion, OD carrier and OD sun gear rotate clockwise as one unit
Since OD planetary gear unit rotates clockwise as a unit, OD ring gear rotates clockwise at same speed as OD input shaft
(3-speed Planetary Gear Unit)
Input shaft rotates clockwise at same speed as OD input shaft
Front clutch (C_1)
Intermediate shaft rotates clockwise
Rear planetary ring gear rotates clockwise
Rear planetary carrier rotates clockwise (rear planetary pinion walks clockwise around sun gear while rotating clockwise)
Rear planetary pinion rotates clockwise
Sun gear rotates counterclockwise
Front planetary pinion walks counterclockwise around sun gear while rotating clockwise
Front planetary carrier rotates counterclockwise
Counterclockwise rotation of front carrier is prevented by No.2 one-way clutch (F_2)
Front planetary pinion rotates clockwise
Front planetary ring gear rotates clockwise
Output shaft rotates clockwise at slower speed than OD input shaft

2) "D" or "3" Range (2nd Gear)

Front Clutch (C_1)   2nd Brake (B_2)



OD One-way clutch (F_0)



(Overdrive Planetary Gear Unit)

OD input shaft rotates clockwise

OD carrier rotates clockwise

OD pinion walks counterclockwise around OD sun gear while rotating counterclockwise

OD sun gear rotates clockwise

OD one-way clutch (F_0) is locked

OD carrier and OD sun gear rotate clockwise as one unit

OD pinion, OD carrier and OD sun gear rotate clockwise as one unit

Since OD planetary gear unit rotates clockwise as a unit, OD ring gear rotates clockwise at same speed as OD input shaft

(3-speed Planetary Gear Unit)

Clockwise rotation of input shaft is transmited to rear planetary ring gear via front clutch (C_1) and intermediate shaft

Rear planetary ring gear rotates clockwise

When rear planetary pinion rotates clockwise, it attempts to turn sun gear counterclockwise at same time

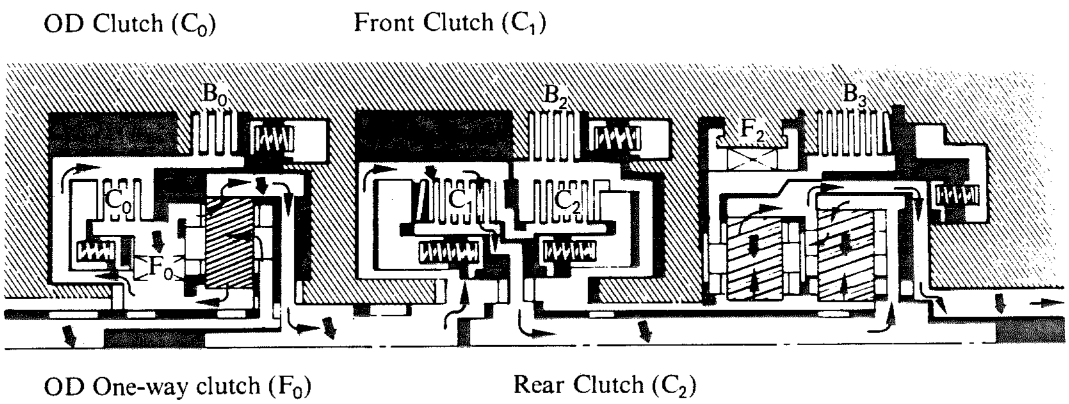
Counterclockwise rotation of sun gear is prevented by 2nd brake (B_2)

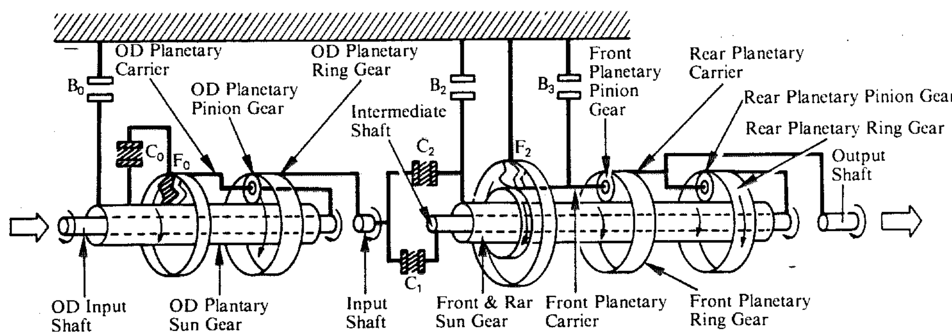
Rear planetary pinion walks clockwise around sun gear while rotating clockwise

Rear planetary carrier rotates clockwise

Output shaft rotates clockwise at slower speed than OD input shaft

3) "D" or "3" Range (3rd Gear)





OD Planetary gear unit (operates as in D range 1st gear)

↓

Input shaft rotates clockwise

Front clutch (C_1)	Rear clutch (C_2)
↓	↓
Intermediate shaft rotates clockwise	Sun gear rotates clockwise
↓	
Rear planetary ring gear rotates clockwise	

→ Rear planetary pinion is locked

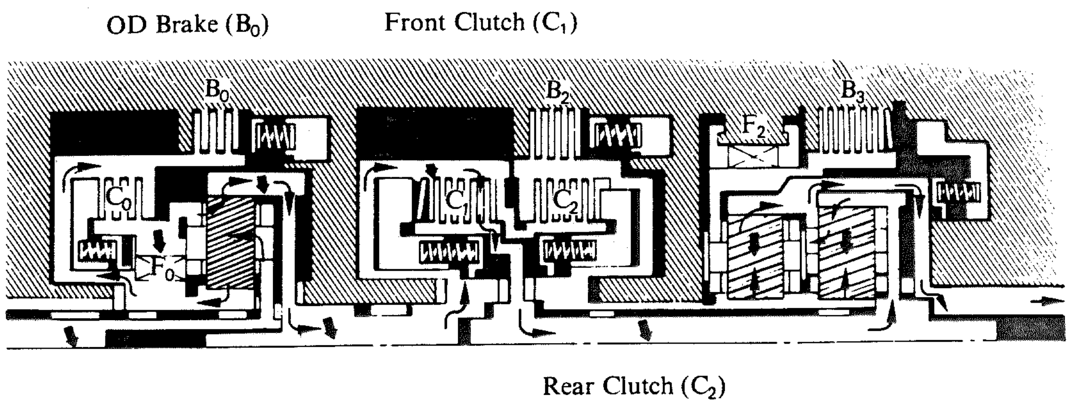
↓

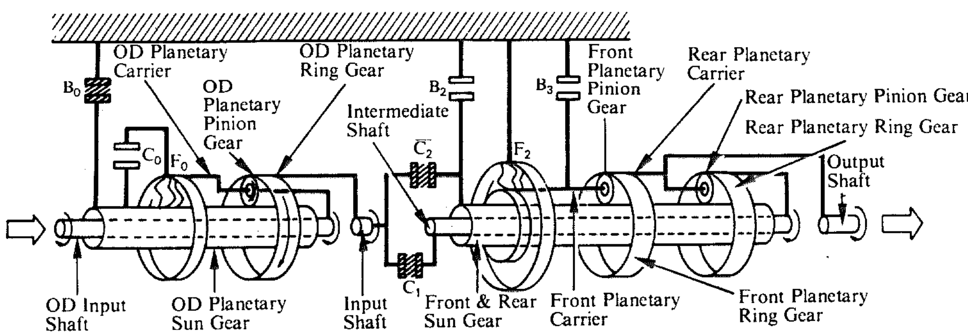
Rear planetary gear unit rotates clockwise as a unit

↓

Output shaft rotates clockwise at same speed as OD input shaft

4) "D" Range (Overdrive)





OD input shaft rotates clockwise

↓

OD planetary carrier rotates clockwise

↓

OD planetary pinion attempts to turn OD sun gear clockwise while rotating counterclockwise

Rotation of OD sun gear is prevented by OD brake (B_0)

↓

OD planetary pinion walks clockwise around OD sun gear while rotating clockwise

↓

OD ring gear rotates clockwise faster than OD input shaft by amount of speed increment given to it by clockwise rotation of OD planetary pinion

↓

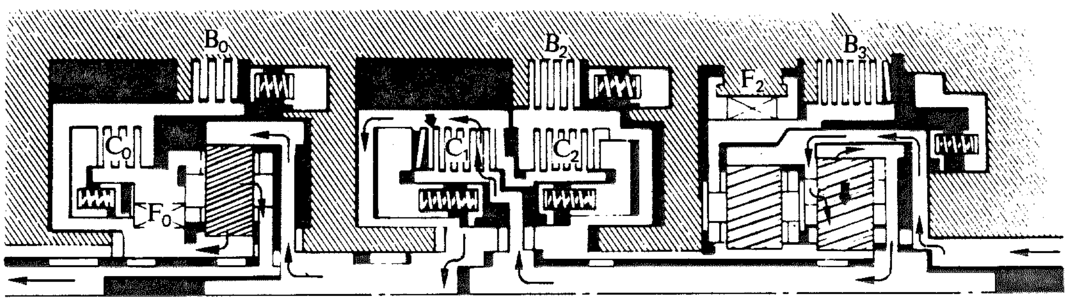
Clockwise rotation of OD ring gear is transmitted to output shaft via same route as in D range 3rd gear

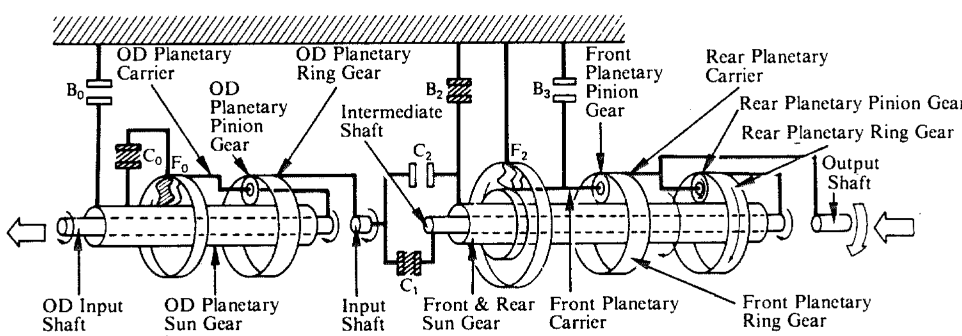
↓

Output shaft rotates clockwise at faster speed than OD input shaft

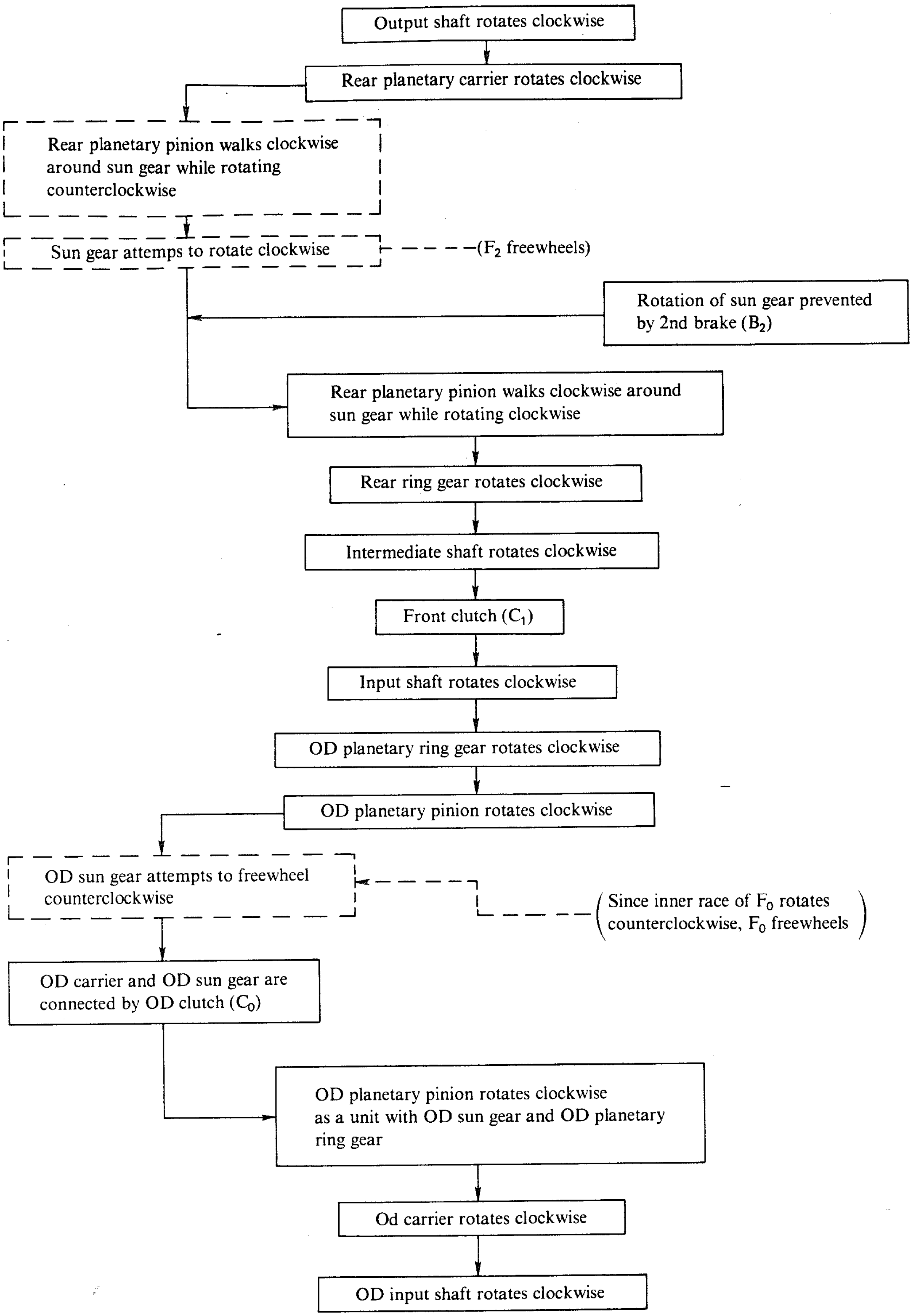
NOTE: Since the OD sun gear is held stationary by B_0, the inner race of F_0 does not rotate, but the outer race turns as a unit with the OD carrier. F_0 therefore freewheels when the vehicle is running in overdrive.

5) "2" Range (2nd Gear), Engine Braking

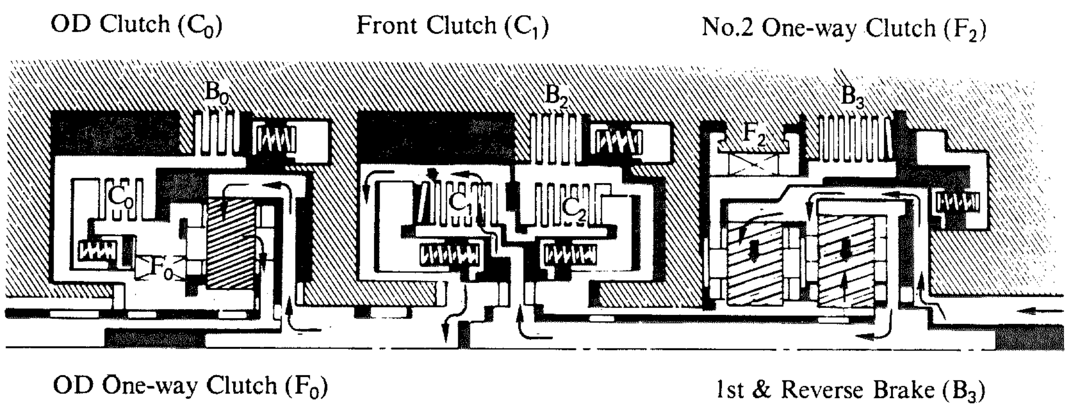


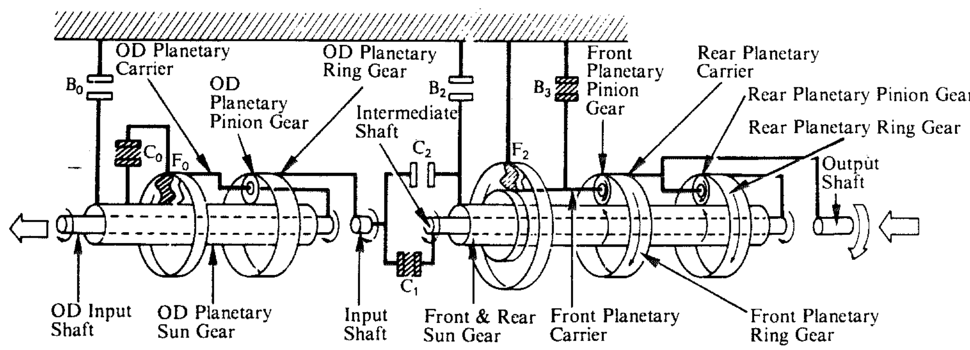


NOTE: When the vehicle is coasting in 2nd gear with the shift selector in "D" or "3", the OD clutch (C_0) does not function, so the engine will not brake. The clockwise rotation of the OD planetary ring gear likewise rotates the OD planetary pinion gear, making the OD planetary sun gear rotate counterclockwise. The OD one-way clutch cannot lock the OD sun gear, which therefore freewheels counterclockwise. Since the rotation of the OD ring gear is not transmitted to the OD planetary carrier, the driving force from the rear wheels is not transmitted to the OD input shaft. As a result, engine braking does not occur during coasting.


Output shaft rotates clockwise
Rear planetary carrier rotates clockwise
Rear planetary pinion walks clockwise around sun gear while rotating counterclockwise
Sun gear attemps to rotate clockwise
(F_2 freewheels)
Rotation of sun gear prevented by 2nd brake (B_2)
Rear planetary pinion walks clockwise around sun gear while rotating clockwise
Rear ring gear rotates clockwise
Intermediate shaft rotates clockwise
Front clutch (C_1)
Input shaft rotates clockwise
OD planetary ring gear rotates clockwise
OD planetary pinion rotates clockwise
OD sun gear attempts to freewheel counterclockwise
(Since inner race of F_0 rotates counterclockwise, F_0 freewheels)
OD carrier and OD sun gear are connected by OD clutch (C_0)
OD planetary pinion rotates clockwise as a unit with OD sun gear and OD planetary ring gear
Od carrier rotates clockwise
OD input shaft rotates clockwise

6) "L" Range (1st Gear), Engine Braking





Output shaft rotates clockwise

↓

Front planetary ring gear rotates clockwise

↓

Front planetary pinion walks clockwise around sun gear while rotating clockwise ← (F_2 freewheels)

Rotation of front carrier prevented by 1st & reverse brake (B_3)

Rear planetary carrier rotates clockwise

Front planetary pinion turns sun gear counterclockwise while rotating clockwise

↓

Sun gear rotates counterclockwise

↓

Rear planetary pinion walks clockwise around sun gear while rotating clockwise

↓

Rear planetary ring gear rotates clockwise

↓

Intermediate shaft rotates clockwise

↓

Front clutch (C_1)

↓

Operation of OD planetary gear unit is same as in 2 range 2nd gear during engine braking

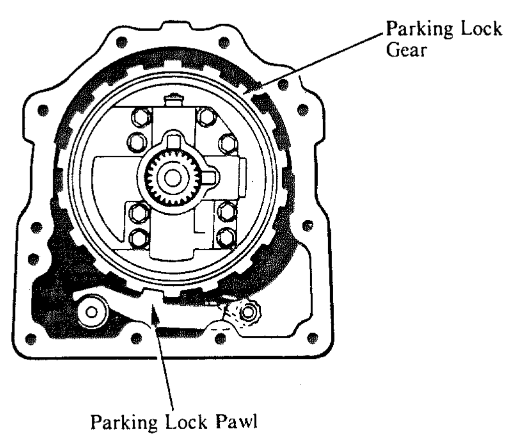
NOTE: When the vehicle is coasting in first gear with the shift selector in "D" or "3", the 1st & reverse brake (B_3) does not function, so engine braking will not occur. This is because the clockwise rotation of the output shaft likewise rotates the front planetary pinion gear, so the front planetary pinion gear rotates clockwise as it walks clockwise around the front & rear sun gear. As a result, the front planetary carrier also begins to rotate clockwise. Because one-way clutch No.2 does not prevent the front planetary carrier from rotating clockwise, the input from the output shaft is not transmitted to the front planetary pinion, to the front & rear sun gear, and to the rear planetary ring gear.

7) "N" or "P" Range

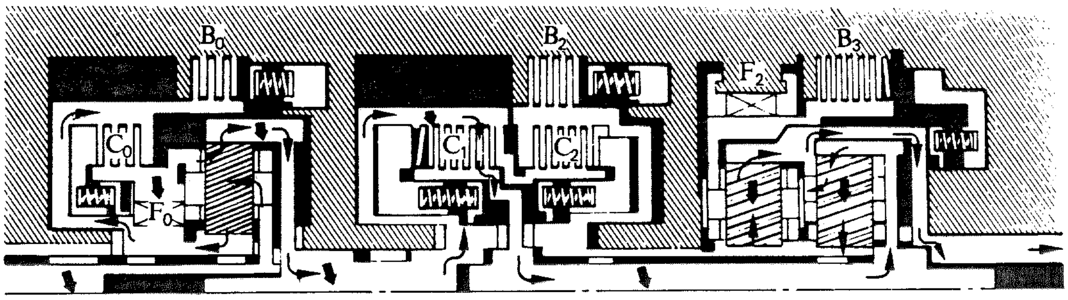
When the transmission is in the "N" or "P" range, the front clutch (C_1) and rear clutch (C_2) do not operate, so input from the input shaft is not transmitted to the output shaft.

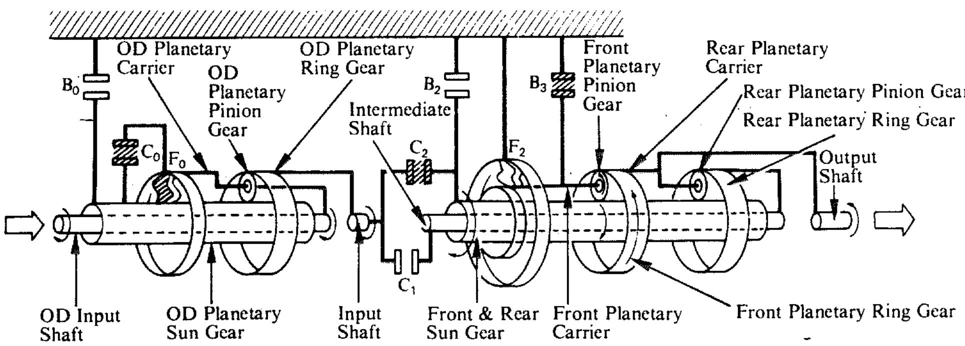
When the transmission is in "P", the parking lock pawl, which is mounted on the transmission case, meshes with the parking lock gear.

This gear is provided around the circumference of the governor body support, which is fixed to the output shaft. Therefore, when the pawl is engaged with the parking lock gear, the output shaft is locked, preventing the vehicle from moving.



8) "R" Range





OD planetary gear unit (operates as in D range 1st gear)

↓

Input shaft rotates clockwise

↓

Rear clutch (C_2)

↓

Sun gear rotates clockwise

↓

Front planetary pinion walks clockwise around sun gear while rotating counterclockwise

← Rotation of front carrier (axis of front planetary pinion) is prvented by 1st & reverse brake (B_3)

↓

Front planetary pinion rotates counterclockwise

↓

Front planetary ring gear rotates counterclockwise

↓

Output shaft rotates counterclockwise

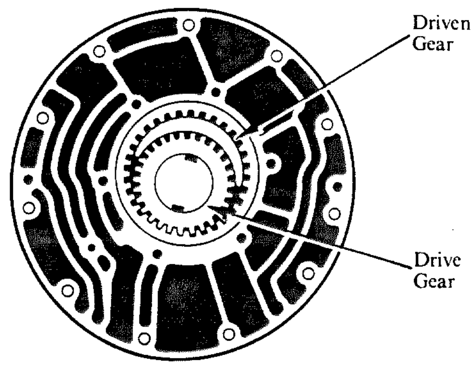
3. Hydraulic Control System

GENERAL

The hydraulic control system is composed of the oil pump, the valve body, the governor valve, the clutches, the brakes and the fluid passages which connect all of these. It automatically controls the fluid pressure of the planetary gear unit or in the case of the manual valve and throttle cam, allows this to be controlled manually.

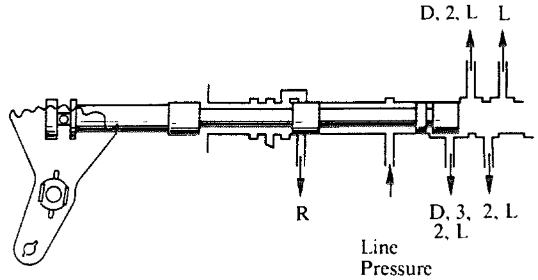
OIL PUMP

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.



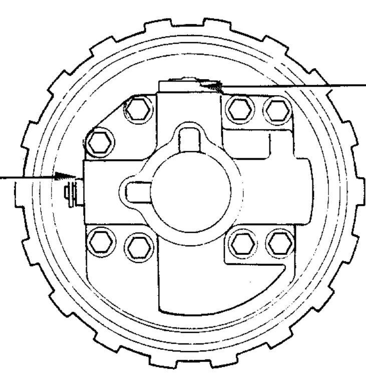
MANUAL VALVE

This valve serves to divert hydraulic fluid from one circuit to another. It is linked to the transmission shift lever and diverts the fluid to the "P", "R", "N", "D", "3", "2", or "L" circuit depending upon the lever position.



GOVERNOR VALVES

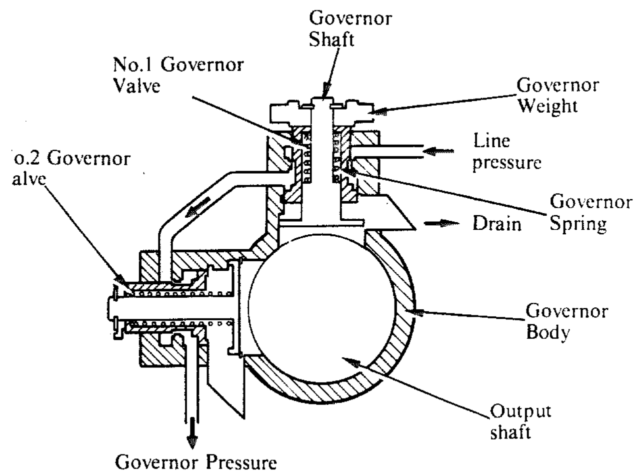
The A440F employ three-stage operation type governor valves, which are composed of the No.1 and No.2 governor valves. The governor valve body is mounted on the transmission output shaft and rotates as a unit with this shaft. The governor valve is able to sense the rotational speed of the output shaft (and thus the vehicle speed) due to changes in the centrifugal force that acts on the governor weight and governor valve. The governor valve then regulates the line pressure in accordance with the vehicle speed thus sensed changing this pressure into governor pressure.



1) Operation

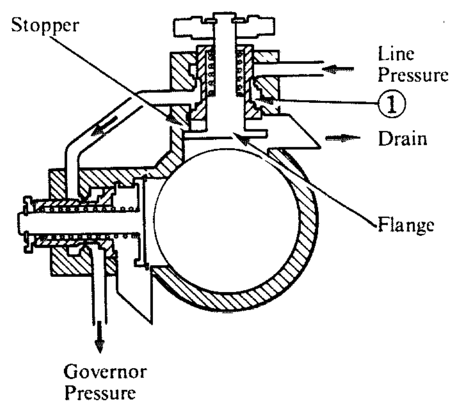
a. First Stage (Low Vehicle Speeds)

When the output shaft rotates, centrifugal force causes the No.1 governor valve, governor weight and governor shaft to move outward (away from the center of the rotation) as a unit. When this occurs, the hydraulic pressure passage, which has been closed up until this time, opens, feeding line pressure to the governor valve. This pressure becomes governor pressure and is regulated by the balance between the spring tension and the centrifugal force caused by the No.1 governor weight against the hydraulic pressure acting on the valve. The No.2 governor valve is completely opened by its own centrifugal force and the force of the spring during stage 1 and does not regulate governor pressure.



b. Second Stage (Medium Vehicle Speeds)

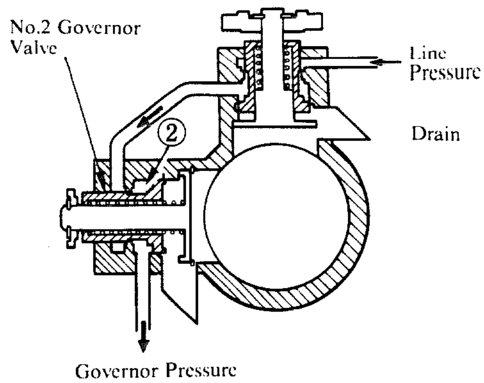
As the output shaft speed continues to increase, the flange of the governor shaft, which is joined to the governor weight and moves as a unit with it, moves outward and comes in contact with the governor body stopper. Thus, the governor weight and shaft are prevented from moving outward any further. From this point on, the centrifugal force acting on the governor shaft and weight ceases to have any effect upon the regulation of governor pressure, which is thereafter regulated by the No.1 governor valve and spring force.
At this time, when the No.1 governor valve opens due to its own centrifugal force and spring tension, the hydraulic pressure (originally line pressure) acts upon the No.1 governor valve at portion ①, causing the valve to move inward again, and the valve closes. The hydraulic pressure at ① then is sent to the No.2 governor valve as governor pressure.
The repetition of the above operation determines the 2nd stage pressure of the governor pressure.
As in stage 1, the No.2 governor valve does not regulate governor pressure in stage 2.

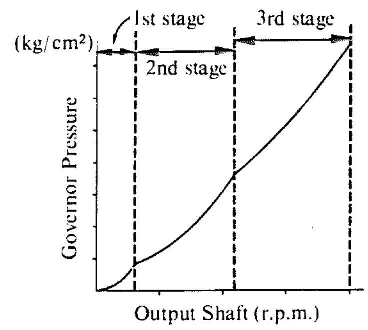


c. **Third Stage (High Vehicle Speeds)**

As long as the No.1 governor valve is regulating the governor pressure, the No.2 governor valve remains wide open.

As the output shaft speed rises, however, the No.1 governor valve eventually reaches a point where it can no longer prevent the governor pressure from rising. At this moment, the No.2 governor valve begins regulating the pressure. The governor pressure, already regulated somewhat by the No.1 governor valve, is further regulated by the No.2 governor valve, which closes (against centrifugal force and spring tension) in accordance with the governor pressure acting upon it at portion ②.

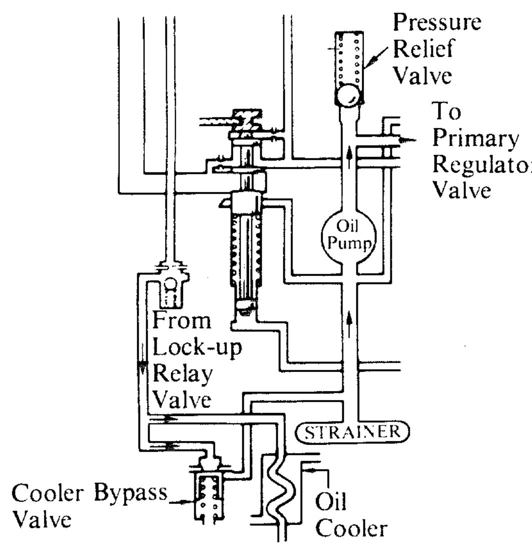




Governor Pressure Performance

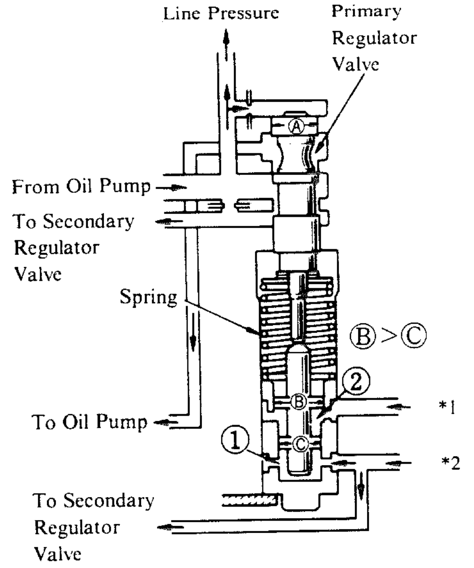
OIL COOLER BYPASS VALVE AND PRESSURE RELIEF VALVE

The pressure relief valve regulates the oil pump pressure so that it does not rise above a predetermined maximum value. The oil cooler bypass valve is a safety valve whose purpose is to lower the pressure of fluid that has been heated by the torque converter going to the cooler so that it does not rise above a certain value.



PRIMARY REGULATOR VALVE

The primary regulator valve adjusts the hydraulic pressure (line pressure) to each element in conformity with the throttle opening and vehicle speed to prevent engine power loss.
At the lower portion of the primary regulator valve, spring tension and hydraulic pressure (Ⓒ × No.1 throttle pressure), which act on portion ① , function as an upward force. At the upper portion, (Ⓐ × line pressure) acts as a downward force.
Line pressure is regulated by the balance of these two forces. When the vehicle is running in "2", "L" or "R", line pressure from the manual valve acts on portion ② , and force [(B) —(C) × line pressure] combines with force (Ⓒ × No.1 throttle pressure), (which acts on ①) to push the valve upward. This creates a line pressure that is higher than that occuring in "D".

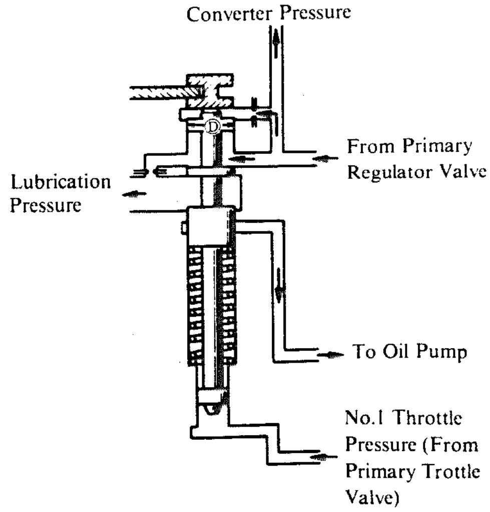


*1 Line pressure (fomr "L", "2" & "R" Range Manual Valve)

*2 No.1 Throttle Pressure (From Primary Trottle Valve)

SECONDARY REGULATOR VALVE

This valve regulates the converter pressure and lubrication pressure in conformity with the throttle opening and vehicle speed. Spring tension and No.1 throttle pressure acting on the lower portion of the valve act as an upward force, while (converter pressure × Ⓓ) acts as a downward force. The balance of these two forces regulates the converter pressure and lubrication pressure.

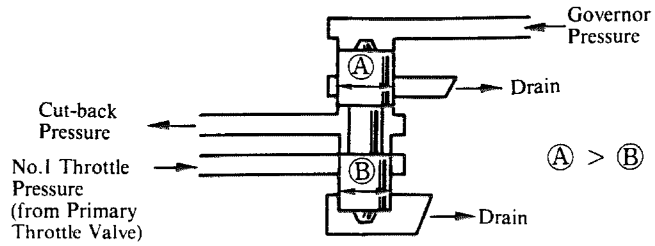


CUT-BACK VALVE

This valve regulates the cut-back pressure acting on the primary throttle valve, and is actuated by governor pressure and No.1 throttle pressure. By applying cut-back pressure to the primary throttle valve in this manner, the No.1 throttle pressure is lowered to prevent unnecessary power loss from the oil pump.

Governor pressure acts on the upper portion of the valve and as the valve is pushed downward, a passage from the throttle valve is opened and No.1 throttle pressure is applied. Because of the difference in the diameters of the valve pistons, the valve is pushed upward, and the pressure created by the balance between the downward force due to governor pressure and the upward force due to No.1 throttle pressure becomes the cut-back pressure.

However, when the No.1 throttle pressure is low, the valve is forced downward by governor pressure. Since this completely opens up the passage from the primary throttle valve, cut-back pressure is the same as No.1 throttle pressure under this condition (i.e., No.1 throttle pressure is not lowered).



PRIMARY THROTTLE VALVE

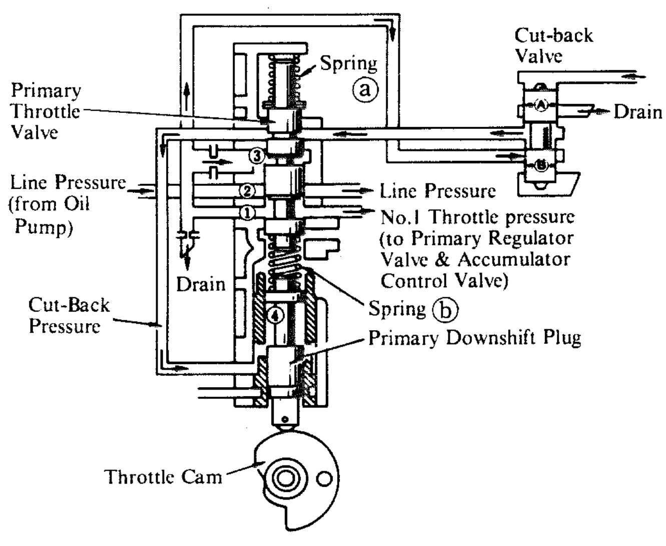
This valve regulates the No.1 throttle pressure supplied to the primary regulator valve, secondary regulator valve and accumulator control valve in response to changes in the throttle valve opening.

Pressing the accelerator pedal pulls the throttle cable, rotates the throttle cam counterclockswise, and pushes the primary downshift plug upward. This pressure on spring ⓑ above the plug is sufficient to push the primary throttle valve upward, thereby opening up passage ①.

At the same time, acting downward are cut-back pressure from the cut-back valve, which acts at portion ②, the No.1 throttle pressure, which acts at portion ③, and the force of spring ⓐ.

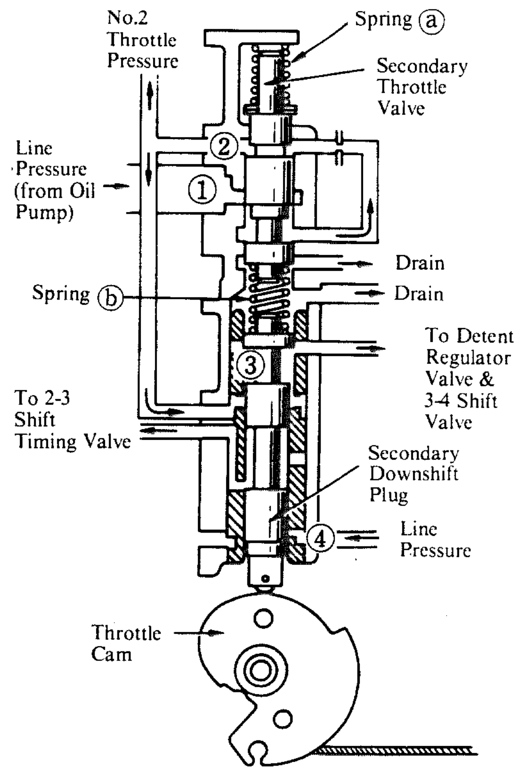
It is the balance between the force pushing upward and the forces pushing downward on the throttle valve that determines the No.1 throttle pressure.

The cut-back pressure always acts on portion ④ of the downshift plug, providing the force required to push the plug up when the throttle cam rotates counterclockwise. This arrangement makes the accelerator pedal much easier to depress as no great amount of force is needed.



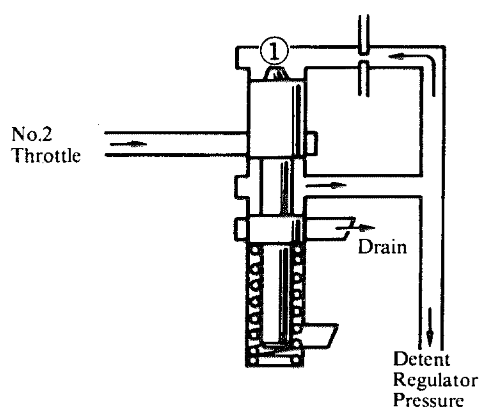
SECONDARY THROTTLE VALVE

This throttle valve adjusts the No.2 throttle pressure that shifts the 1-2, 2-3 and 3-4 shift valves in response to the throttle valve opening. Pressing the accelerator pedal pulls the throttle cable, rotates the throttle cam and pushes the secondary downshift plug upward. This pressure on spring ⓑ above the plug pushes the secondary throttle valve upward, thereby opening the valve at portion ①.
The hydraulic pressure passes through portion ① and, together with the force of spring ⓐ, attempts to push the throttle valve down. The balance between the forces pushing upward and downward on the throttle valve thus determines the No.2 throttle pressure.
The resultant No.2 throttle pressure also acts on portion ③ of the secondary downshift plug. During kickdown, the throttle cam rotates and pushes the plug up, thereby opening the plug at portion ③ to supply No.2 throttle pressure to the detent regulator valve and the 3-4 shift valve. When the transmission is in "D", "3", "2" or "L" range, the line pressure from the manual valve acts on portion ④.
When the throttle cam is almost fully returned (i.e., the throttle valve almost fully closed), the downshift plug drops, opening the line pressure passage at ④ to feed line pressure to the 2-3 shift timing valve.



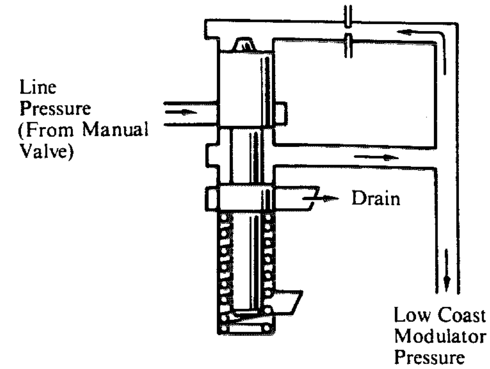
DETENT REGULATOR VALVE

During kickdown, the detent regulator valve keeps the hydraulic pressure acting on the 1-2 and 2-3 shift valves to a constant value. When the No.2 throttle pressure reaches portion ① of the valve, it attempts to push the valve downward against the spring. The detent regulator pressure is maintained by the balance of the two forces acting on the regulator valve.



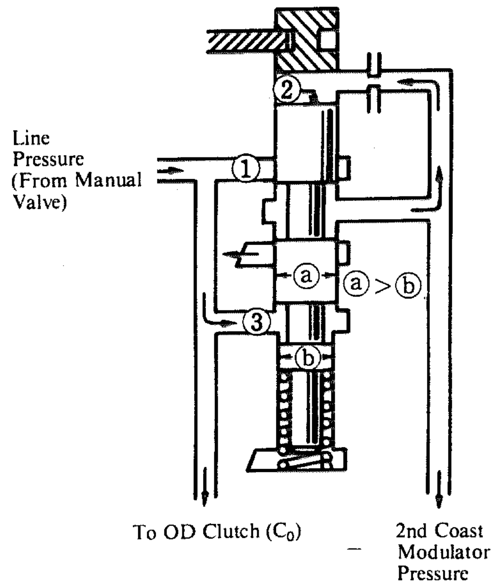
LOW COAST MODULATOR VALVE

This valve regulates the low coast modulator pressure which acts on the 1st & reverse brake (B_3). This pressure cushions the shifting shock that occurs when the manual valve is shifted to "L" range. The operation is the same as that of the detent regulator valve.



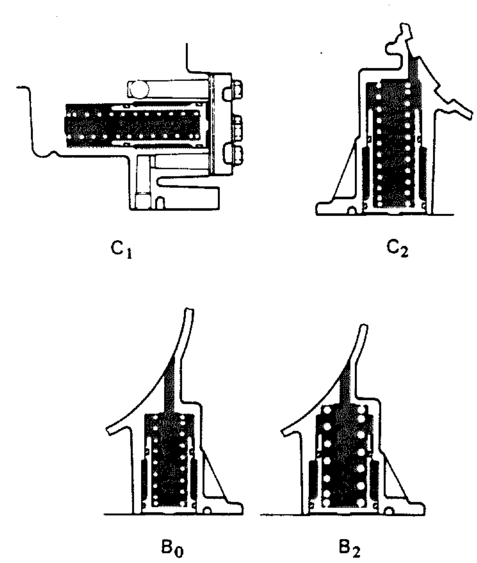
2ND COAST MODULATOR VALVE

This valve regulates the 2nd coast modulator pressure which acts on the 2-3 shift valve. Shifting the manual valve to "2" or "L" feeds the 2nd coast modulator pressure to portion ② via portion ①, pushing the valve down against the spring and the force [(a – b) × line pressure] acting on portion ③, both of which push the valve upward. The two forces balance to hold the modulator valve in the position shown in the figure. The valve then constantly moves up and down slightly in that position, adjusting the 2nd coast modulator pressure.



ACCUMULATORS

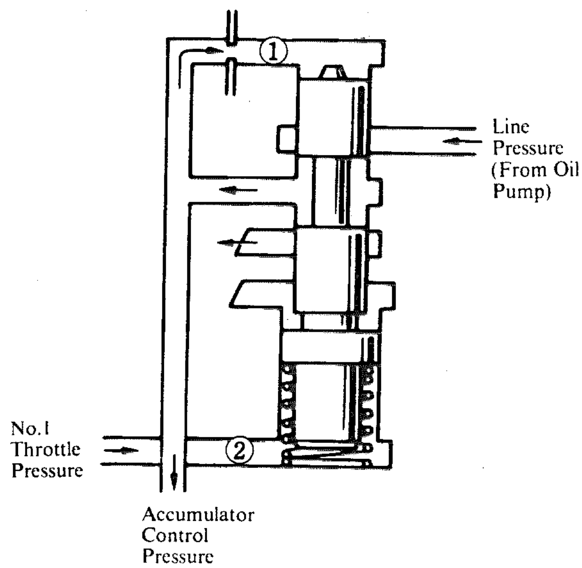
The accumulators cushion shifting shock. The A440F has four accumulators, for the front clutch (C_1), rear clutch (C_2), 2nd brake (B_2), and OD brake (B_0). The accumulator control pressure, which depends on the throttle valve opening, always acts on the C_2, B_0 and B_2 accumulator pistons. When line pressure is applied to the operating side, the piston is pushed slowly upward and shock is buffered as the fluid pressure used to operate the clutches and brakes gradually rises.



ACCUMULATOR CONTROL VALVE

When the throttle opening is small, this valve reduces the accumulator control pressure acting on the back-pressure side of the C_2, B_0 and B_2 accumulators so that the accumulators absorb the shifting shock effectively.

The accumulator control pressure acts on portion ①, pushing the control valve down against spring tension and the No.1 throttle pressure (which is generated by the primary throttle valve and which acts on portion ②), both of which forces attempt push the valve up. While the throttle opening is still small, these two forces regulate the accumulator control pressure. Beyond a certain throttle opening, however, the No.1 throttle pressure becomes large enough to push the valve all the way up so that the line pressure and accumulator control pressure becomes equal to prevent the clutches and brakes from slipping.

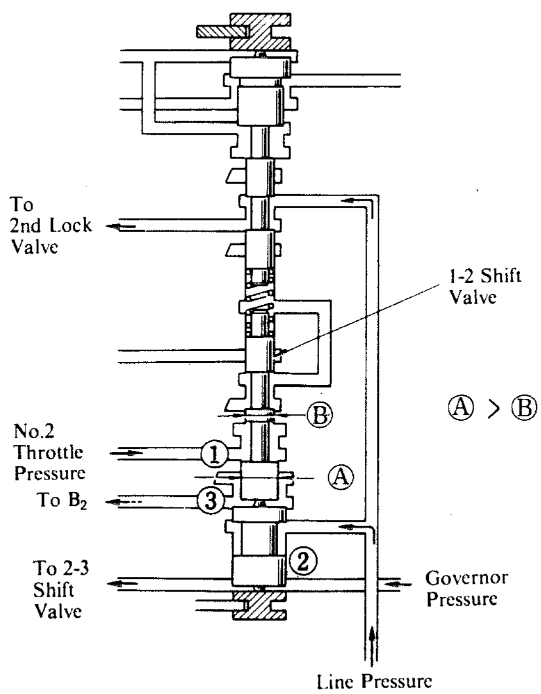


1-2 SHIFT VALVE

This valve automatically switches between 1st and 2nd gears in accordance with governor and No.2 throttle pressure.

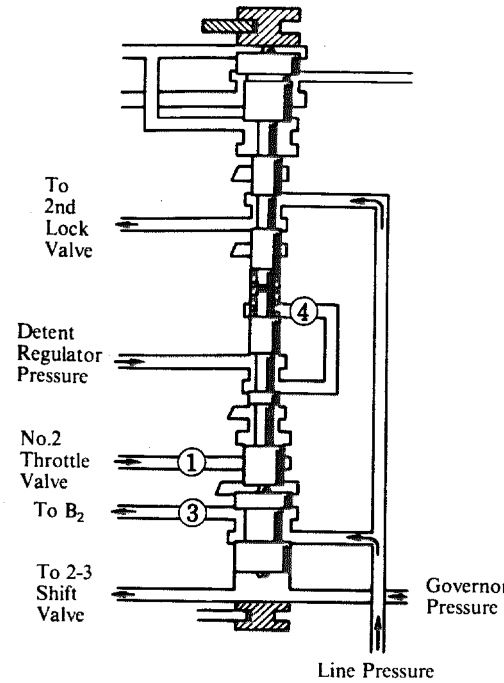
The No.2 throttle pressure from the secondary throttle valve acting on ① , along with the spring tension, pushes the valve down against the governor pressure acting on ② , which pushes the valve upward.

When the downward force is greater than the upward force, the 1-2 shift valve is pushed downward, causing the line pressure circuit to portion ③ to close. Since the line pressure does not reach the 2nd brake (B_2), the transmission remains in 1st gear.

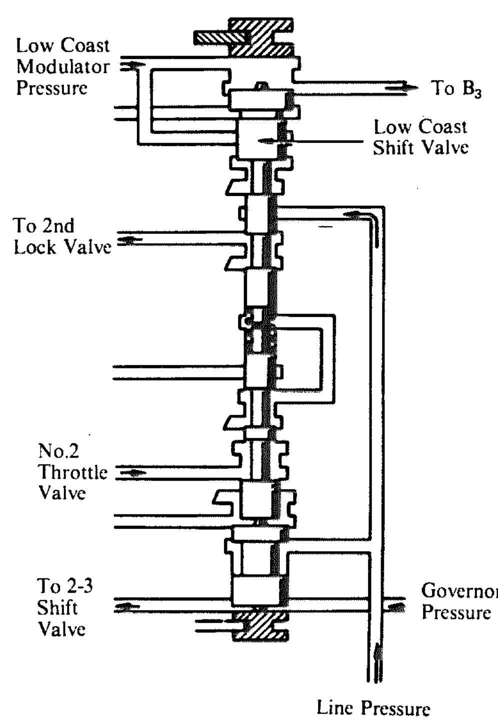


As the vehicle speeds up while in 1st gear, the governor pressure rises until the force pushing the valve up overcomes that pushing it down. The valve then moves up, opening the passage at portion ③ so that the line pressure passes through the 2-3 shift valve to the 2nd brake (B_2), shifting the transmission into 2nd gear. In this valve position, only the spring tension, and not the No.2 throttle pressure, acts on the 1-2 shift valve as a downward force. The vehicle speed at which the valve moves downward is therefore lower than that at which it moves upward, an effect which produces up/down shift hysteresis.

During kickdown, the detent regulator pressure acts on portion ④ to push the valve back down, shifting the transmission from 2nd to 1st gear.



When the transmission is in the "L" range, the low coast modulator pressure acts on the top of the low coast shift valve to force the valve down and thus keep the transmission in 1st gear.



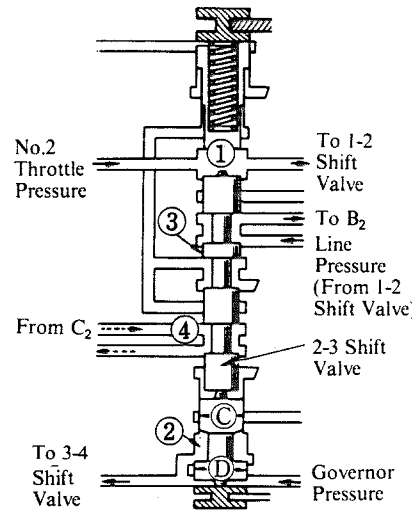
2-3 SHIFT VALVE

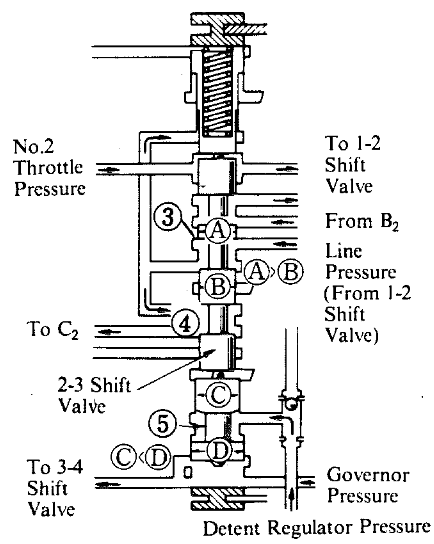
This valve shifts between 2nd and 3rd gears. The No.2 throttle pressure from the secondary throttle valve acts on portion ① to create a force pushing the valve downward, while the governor pressure acts on portion ② to create a force pushing the valve upward. When the vehicle is running in 2nd gear, the downward force overcomes the upward force, so the valve stays down, connecting the line pressure from the 1-2 shift valve to the 2nd brake. When the vehicle speeds up while in 2nd gear, the governor pressure rises until the corresponding force pushing the valve upward overcomes that pushing it down. The valve moves upward, releasing the line pressure previously acting on the 2nd brake (B_2) via the 2-3 shift timing valve. Instead, the line pressure passes through portion ④ to the rear clutch (C_2), shifting the transmission into 3rd gear. In this valve position, the upward force on the valve is no longer [Ⓒ × governor pressure] but [Ⓓ × governor pressure]. Since area Ⓓ is greater than Ⓒ , the vehicle speed at which the valve moves downward is lower than that at which it moves upward, an effect which produces the up/down shift hysteresis. If the throttle valve opening is predetermine level or less, the transmission shifts from 3rd to 1st gear. As long as the 1-2 shift valve is raised (transmission in 3rd gear), the line pressure from the 1-2 shift valve acts on portion ③ , producing an upward force [Ⓐ — Ⓑ × line pressure] on the valve. Thus, even if the governor pressure drops, the valve stays up to keep the transmission in 3rd gear. When the 1-2 shift valve drops, cutting off the line pressure, this force disappears, so the transmission shifts from 3rd to 1st.

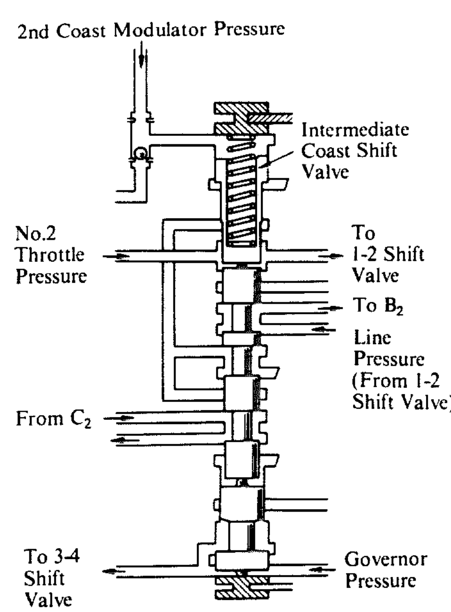
When the throttle is open more than predetermine level, throttle pressure is high. Therefore, if vehicle speed drops the 2-3 shift valve will move downward before the 1-2 shift valve, even if line pressure is acting on the area Ⓐ — Ⓑ , and the transmission will shift into 2nd gear.

During kickdown, however, the detent regulator pressure acts on portion ⑤ to push the valve downward so that the transmission shifts from 3rd to 2nd.

When the transmission is in the "2" range, the second coast modulator pressure acts on the upper part of the intermediate coast shift valve to block upshifting to 3rd gear.

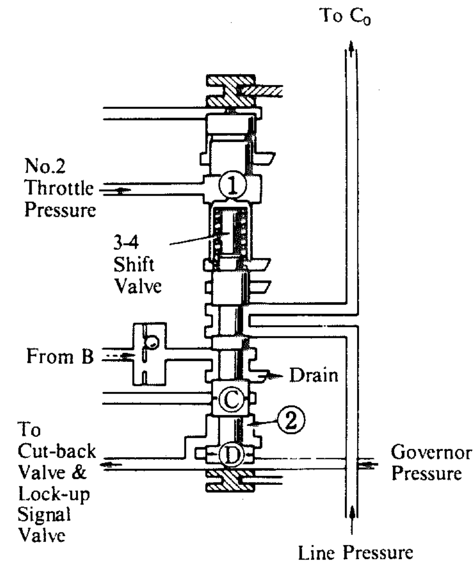




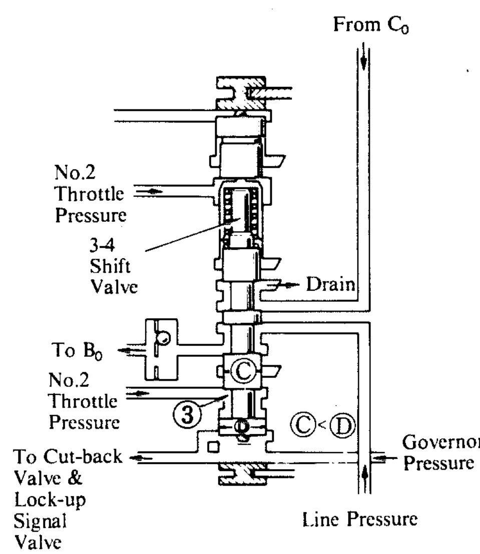


3-4 SHIFT VALVE

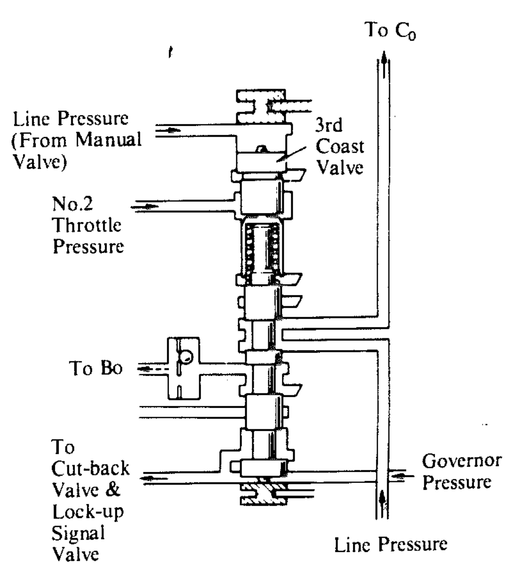
This valve shifts between 3rd gear and OD. The No.2 throttle pressure from the secondary throttle valve acts on portion ① against the spring to create a downward force on the valve.
The governor pressure from the governor valve, on the other hand, acts on portion ② to create an upward force. When the vehicle is running in 3rd gear, the downward force overcomes the upward one, pushing the valve downward and releasing the line pressure previously acting on the OD brake (B_0). The line pressure then goes to the OD clutch (C_0) to keep the transmission in 3rd.



When the vehicles speeds up while 3rd gear, the governor pressure rises until the corresponding upward force becomes strong enough to overcome the downward one, pushing the valve upward and releasing the line pressure previously acting on the OD clutch (C_0). The line pressure then goes to the OD brake (B_0), shifting the transmission into OD. The valve hysteresis between the 3rd and OD gears occurs in exactly the same way as in the 2-3 shift valve.
During kickdown, the No.2 throttle pressure from the secondary down-shift plug acts on portion ③ to push the valve downward and thus shift the transmission from OD to 3rd gear.



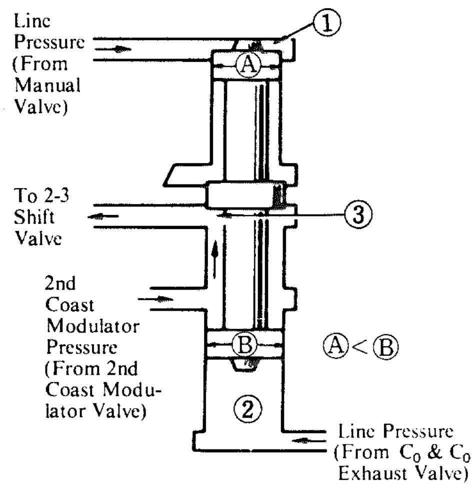
When the transmission is in the "3", "2", or "L" range, the line pressure from the manual valve acts on the top of the 3rd coast valve so that the valve stays down, effectively preventing shifting into OD.



D-2 DOWN-SHIFT TIMING VALVE

If the shift lever is shifted into the "2" range while the vehicle is running in overdrive, the transmission automatically shifts into 3rd gear for a moment before shifting into 2nd so as to avoid the severe shifting shock that would occur if the transmission were directly shifted from OD into 2nd gear.

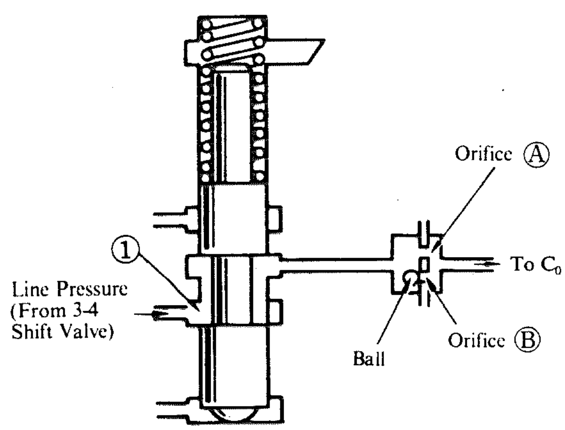
When the vehicle is running in overdrive, the line pressure from the manual valve acts on portion ①, pushing the valve downward. Manually shifting into the "2" range applies the line pressure from the manual valve to the 3rd coast valve, pushing down the 3-4 shift valve and thus shifting the transmission into 3rd gear. This causes the line pressure to act on portion ② through the C_0 exhaust valve. Since area Ⓑ is greater than Ⓐ , the valve shifts upward, opening up the passage to the 2-3 shift valve (③) which allows the 2nd coast modulator pressure from the modulator valve to act on the 2-3 shift valve, shifting the transmission down into 2nd gear. Note, however, that the OD clutch (C_0) itself requires time to shift, and that the line pressure must pass through an orifice in the C_0 circuit. As a result, the line pressure takes a certain period of time to reach and fully act on portion ②, and the valve gradually rises so that it takes some time to downshift from 3rd to 2nd gear.

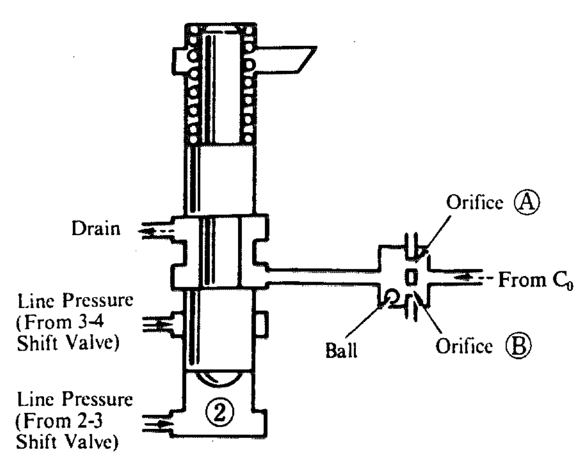


OVERDRIVE CLUTCH EXHAUST VALVE

This valve cushions the shock in shifting from 3rd to 2nd gear. When the vehicle is running in 3rd gear, the spring tension on the valve keeps it pushed down, opening up passage ① from the 2-3 shift valve and allowing the line pressure from that valve to pass through orifice Ⓐ to the OD clutch (C_0).

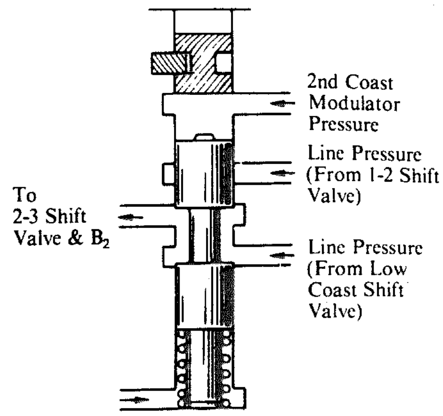
When the transmission shifts into 2nd gear, the line pressure from the 2-3 shift valve acts on portion ② to raise the valve, sealing off the line pressure passage to the OD clutch (C_0) circuit and draining the residual pressure in the OD clutch circuit via the two orifices (Ⓐ and Ⓑ). This speedy disconnection of the OD clutch (C_0) effectively cushions shift shock.



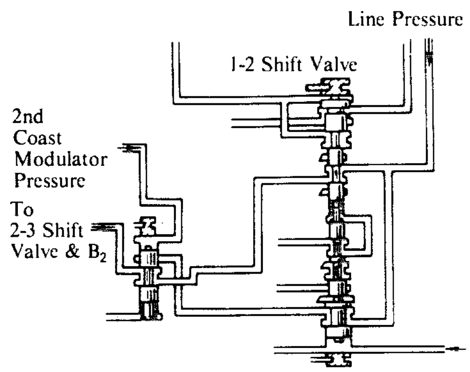


2ND LOCK VALVE

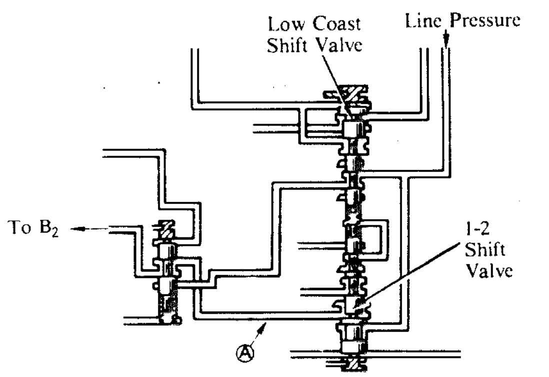
This valve keeps the transmission in 2nd gear while the transmission is in the "2" range. The 2nd coast modulator pressure from the modulator valve passes through the D-2 shift timing valve to act on the top of this valve and keep it pushed down. The line pressure from the low coast shift valve (1-2 shift valve) therefore passes through the 2-3 shift valve. Since the low coast shift valve remains in the upward position whatever the 1-2 shift valve position, the line pressure from the low coast shift valve acts on the 2nd brake (B_2) via the 2-3 shift valve, keeping the transmission in 2nd gear.



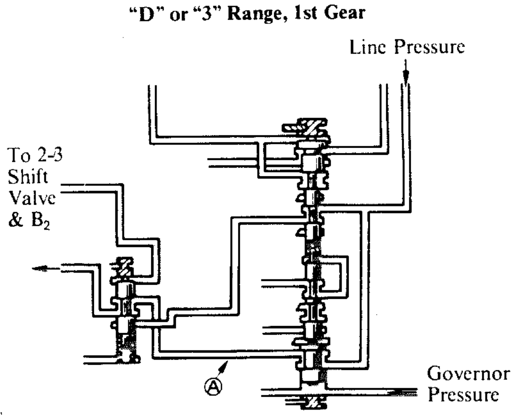
When the vehicle is running in the "D" or "3" range, the 2nd coast modulator pressure does not act on the top of the valve, so the spring tension forces the valve upward, cutting off the line pressure passage from the low coast shift valve to the 2nd brake (B_2). However, passage Ⓐ from the 1-2 shift valve to B_2 is not blocked off by the 2nd lock valve, so the feeding of line pressure to B_2 is determined by the up-and-down movements of the 1-2 shift valve. In other words, upshifting and downshifting are both possible.



"2" Range

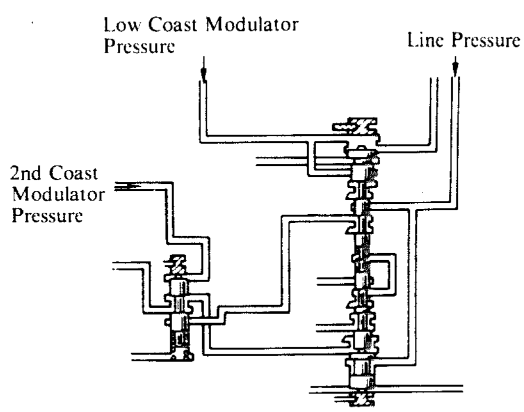


"D" or "3" Range, 1st Gear



"D" or "3" Range 2nd Gear

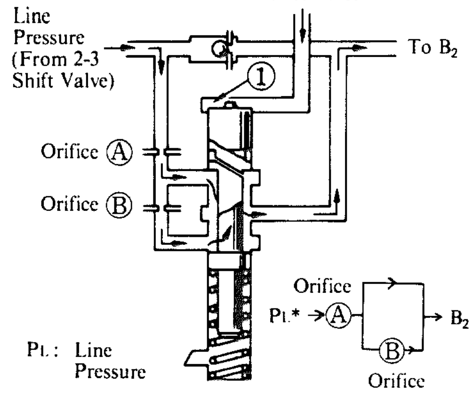
In the "L" range, both the 1-2 shift valve and the low coast shift valve are in the lower positions so that no line pressure reaches the 2nd lock valve.



"L" Range

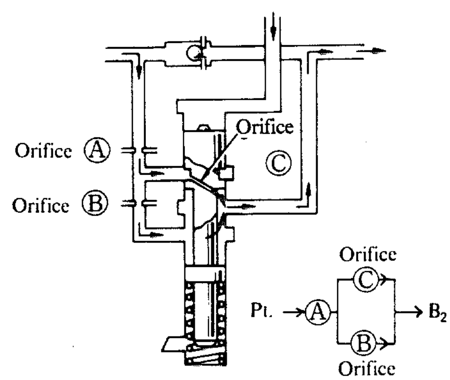
3-2 KICK-DOWN ORIFICE CONTROL VALVE

This valve cushions the shifting shock accompanying kickdown from 3rd to 2nd gear. It adjusts the time required to completely engage the 2nd brake (B_2) to match that required to completely disengage the rear clutch, a time that increases with vehicle speed.
The governor pressure from the governor valve acts on portion ① keeping the valve pushed downward against the spring tension. As the vehicle speeds up, the governor pressure rises, forcing the valve downward against the resistance of the spring. At a low vehicle speed, the valve assumes the position shown in the figure below. At this time, the line pressure from the 2-3 shift valve passes through the two orifices (Ⓐ and Ⓑ) controlling the flow rate to the 2nd brake (B_2). (See schematic below.)



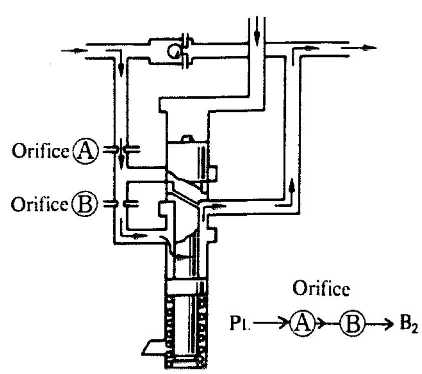
Low Vehicle Speed

At a medium speed, the valve assumes the position shown in the figure below. At this time, the line pressure from the 2-3 shift valve must pass through three orifices (Ⓐ , Ⓑ and Ⓒ) controlling its flow rate on its way to the 2nd brake valve (B_2). (See schematic below.) Since the flow rate is lower, the time required to completely connect the 2nd brake (B_2) at a medium speed is longer than at a lower speed.



Medium Vehicle Speed

At a higher speed, the valve assumes the position shown in the figure below. The line pressure from the 2-3 shift valve passes through two orifices (Ⓐ and Ⓑ) controlling the flow rate to the 2nd brake (B_2). (See schematic below.) The time required to completely connect the 2nd brake (B_2) at a higher speed becomes even longer than at a medium speed.



High Vehicle Speed

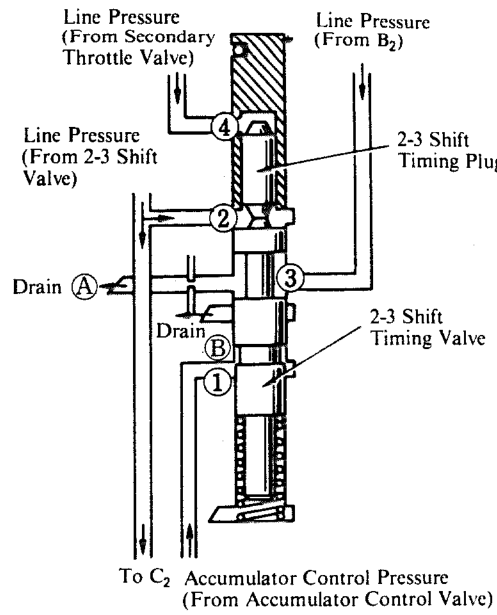
2-3 SHIFT TIMING VALVE

When the transmission shifts from 2nd to 3rd gear, this valve adjusts the timing between the disconnection of the 2nd brake (B_2) and the connection of the rear clutch (C_2) in order to cushion the shifting shock involved.

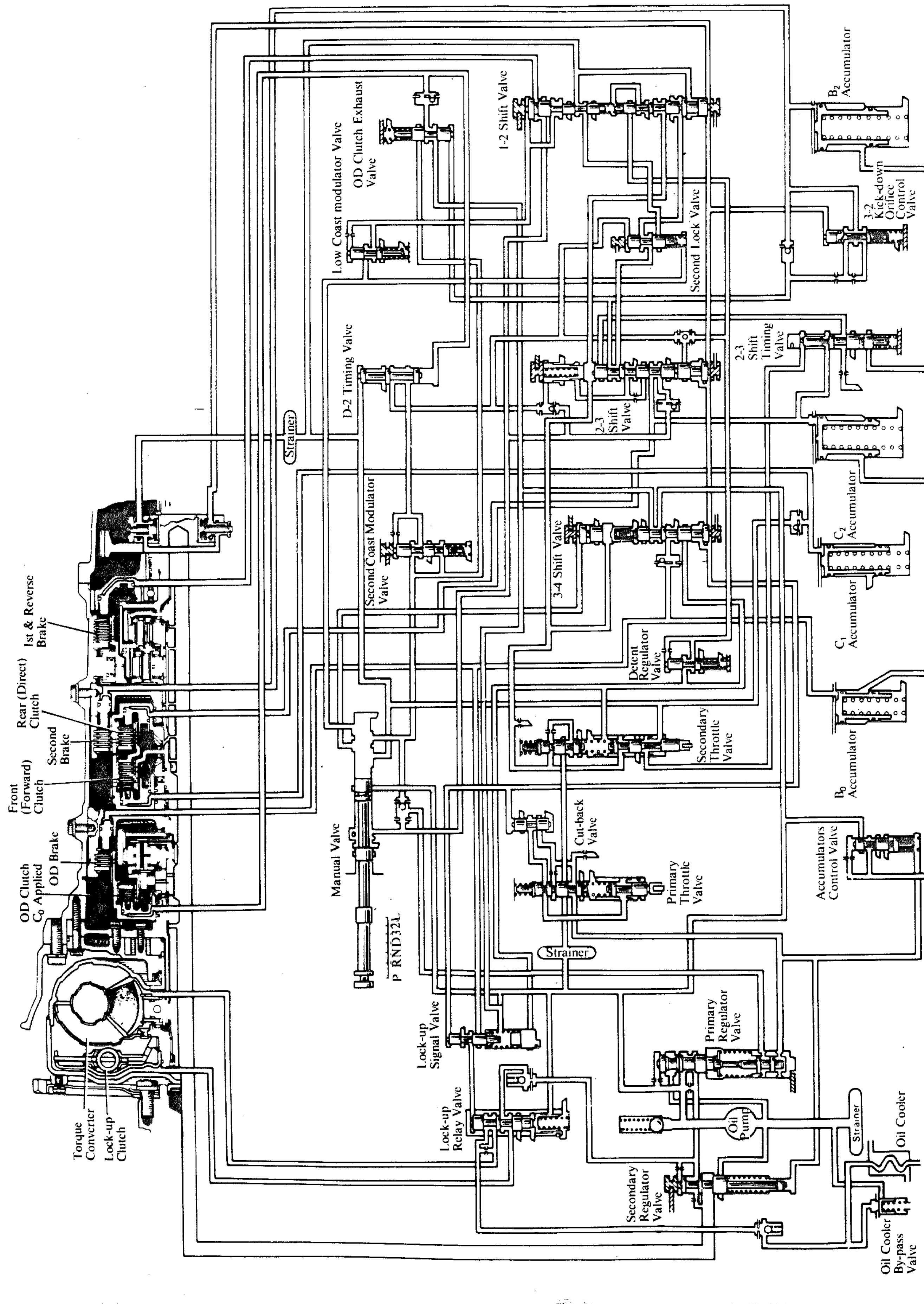
When the vehicle is running in 2nd gear, the accumulator control pressure acting on portion ① and the spring tension keep the valve raised. When the 2-3 shift valve moves upward, the C_2 line pressure from the 2-3 shift valve acts on portion ② to produce a small downward force. This line pressure rises as it acts on the rear clutch (C_2), so the force acting on portion ② gradually grows greater, thus opening drain Ⓑ of the valve slowly.

As the valve drops, the B_2 line pressure previously acting on the 2nd brake is first released through drain Ⓐ . Then the valve has dropped even further, drain Ⓑ opens, releasing the B2 line pressure much more quickly.

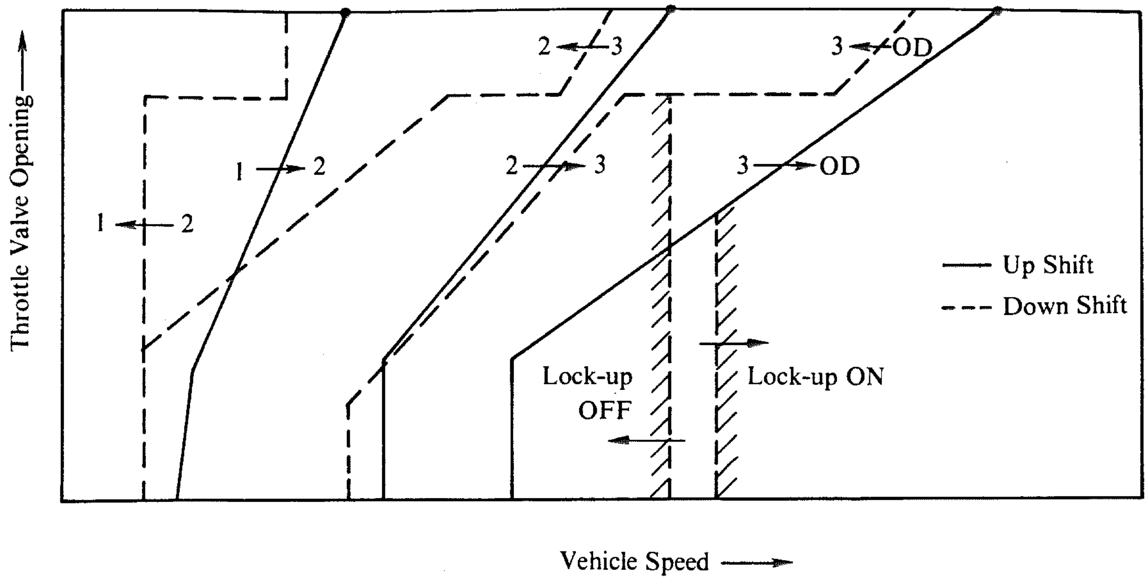
When the throttle valve opening is below a certain amount, the line pressure from the secondary throttle valve acts on portion ④ to depress the 2-3 shift timing plug, which then slightly depresses the timing valve as well. Since C_2 line pressure does not have to push the valve as far, less time is required to release the B_2 line pressure through drain Ⓑ .



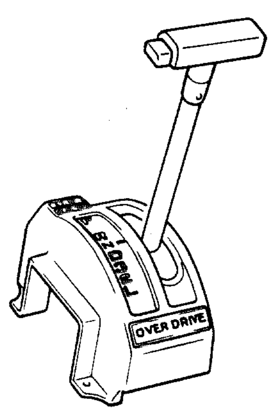
4. Hydraulic Circuit



5. Shift and Lock-up Pattern



The seven-position (P, R, N, D, 3, 2, L) shift lever allows a more accurate gear selection to suit the actual driving condition. The range "3" covers 1st through 3rd gears and "D" range covers 1st through overdrive (4th) gears. Range "2" is held on the 2nd gear to ease maneuvering on muddy or slippery terrain.

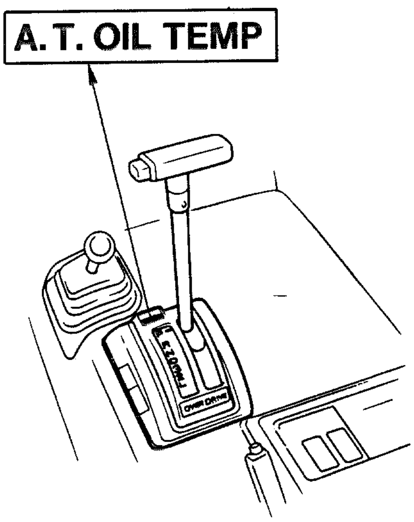


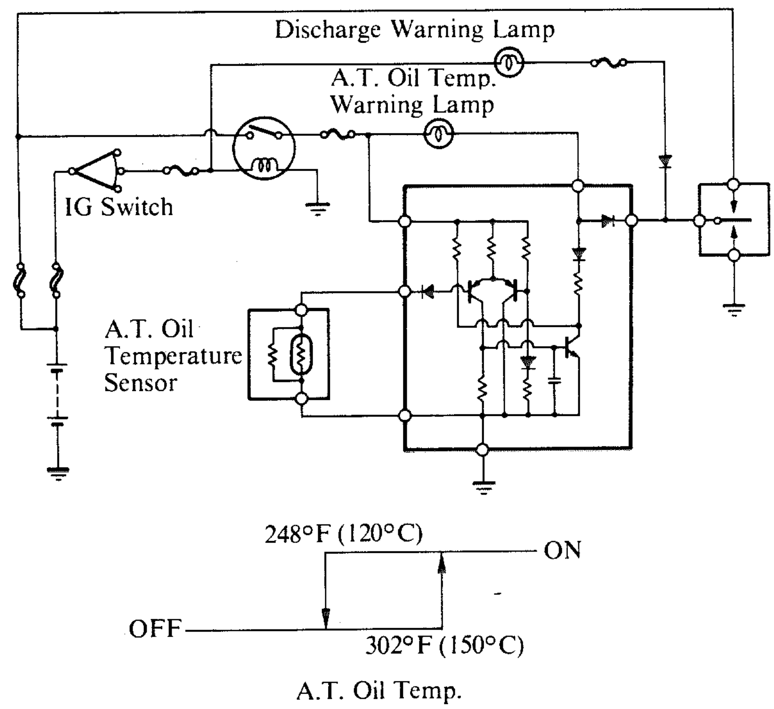
Shift Position	Shift and Lock-up Pattern
P	——
R	Reverse
N	——
D	1st ↔ 2nd ↔ 3rd ↔ OD*
3	1st ↔ 2nd ↔ 3rd
2	2nd
L	1st

* Lock-up clutch engageable

6. Automatic Transmission Fluid Temperature Warning System

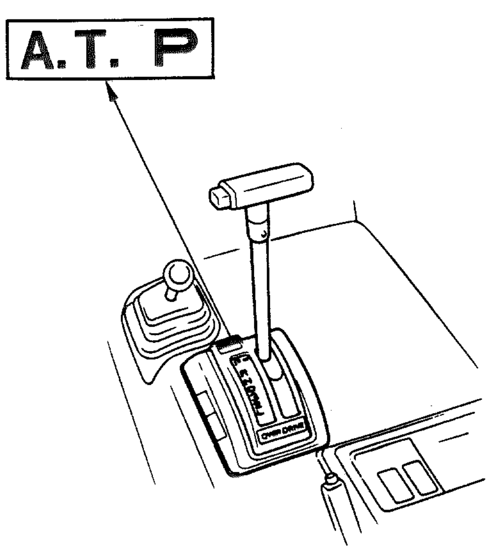
When the automatic transmission fluid temperature rises above a normal level, the driver is warned by the A.T. OIL TEMP warning lamp on the front side of shift indicator on the console. If this lamp goes on while driving, slow down and stop the vehicle, shift the selector lever in "P" and let the engine idle until the light goes off.

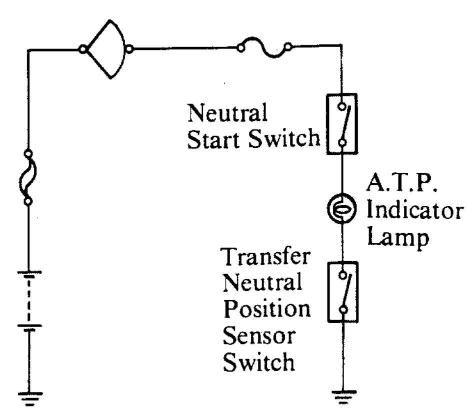




7. A.T.P. (Automatic Transmission Parking) Indicator

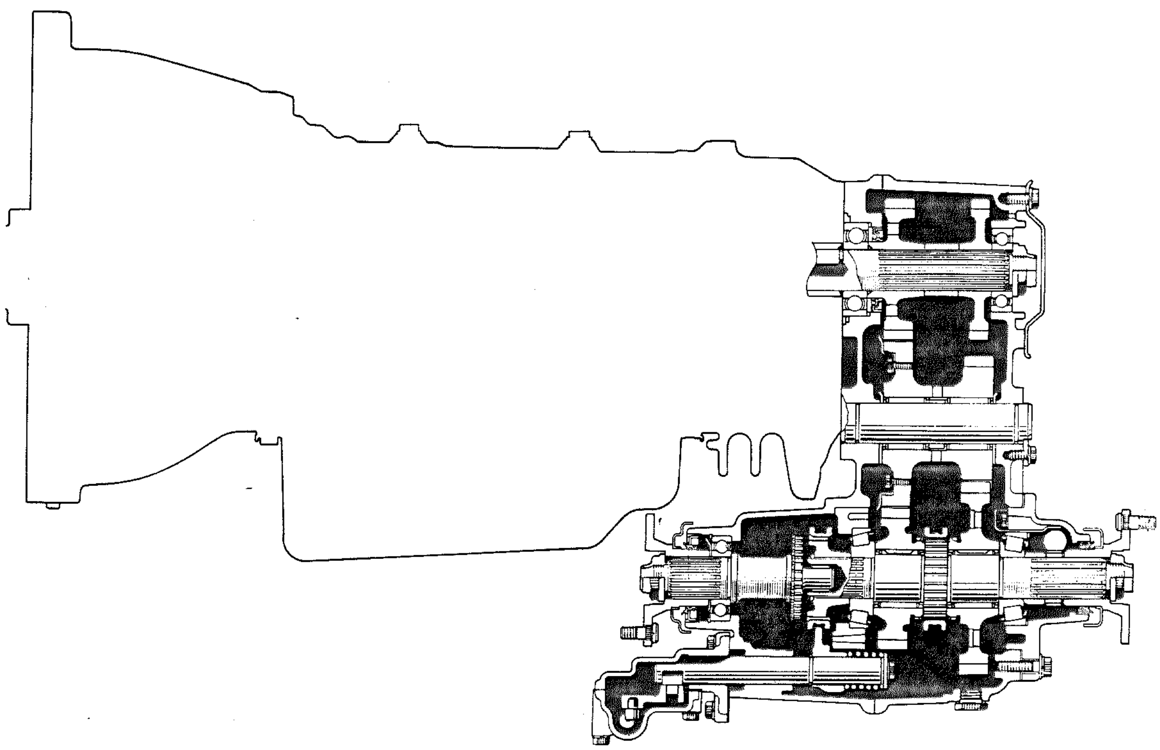
The propeller shaft and wheels are free even when the transmission shift lever is set to "P" as long as the transfer shift lever is in "neutral" position. The A.T.P. indicator lights up to warn the driver that the propeller shaft and wheels are not locked. If the A.T.P. indicator lamp goes on, the transfer shift lever should be shifted to H2 or L4 position.





TRANSFER

All models are now equipped with a transfer having an electrical H4 selector mechanism. A pushbutton selector switch is located on the instrument panel allowing shifting to either H2 or H4 driving. The transfer construction and operation in the same as previous type.



Specifications

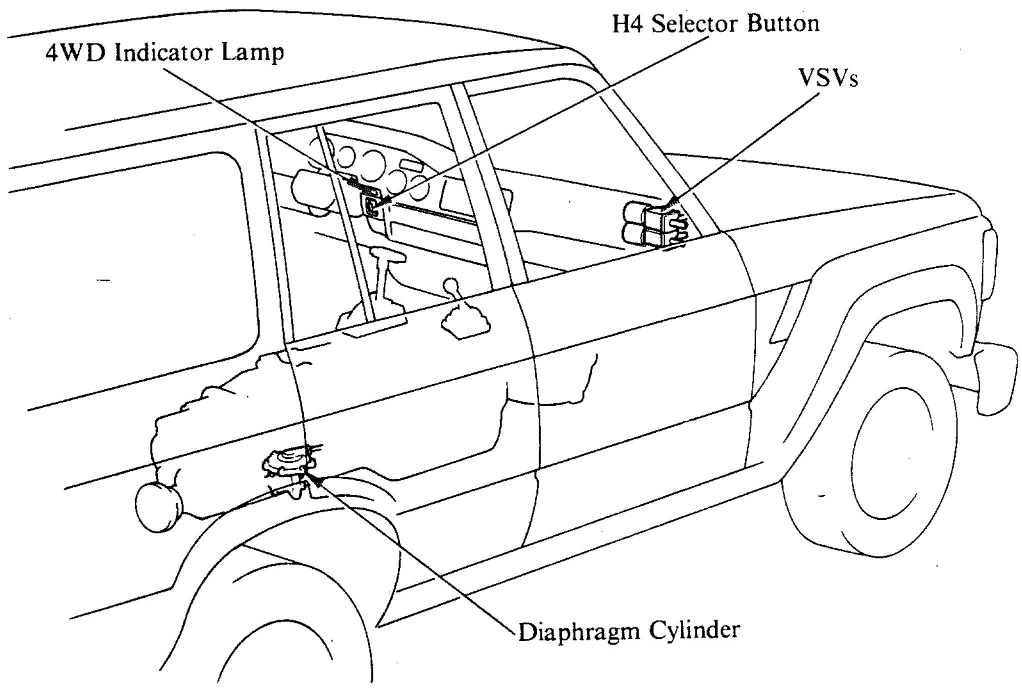
Item \ Model		New	Previous (FJ60 series)
Type of Transmission		A440F	H42
Type of Engine		3F-E	2F
Shift Control Link Type		Push-button Type	Remote Control Link Type
Gear Ratio	High	1.000	←
	Low	2.295	1.963
Oil Capacity		2.2US qts. (2.1liters, 1.8Imp.qts)	←
Type of Oil		SAE 90, API GL-4 or GL-5	←

1. Electrical H4 Selector Mechanism

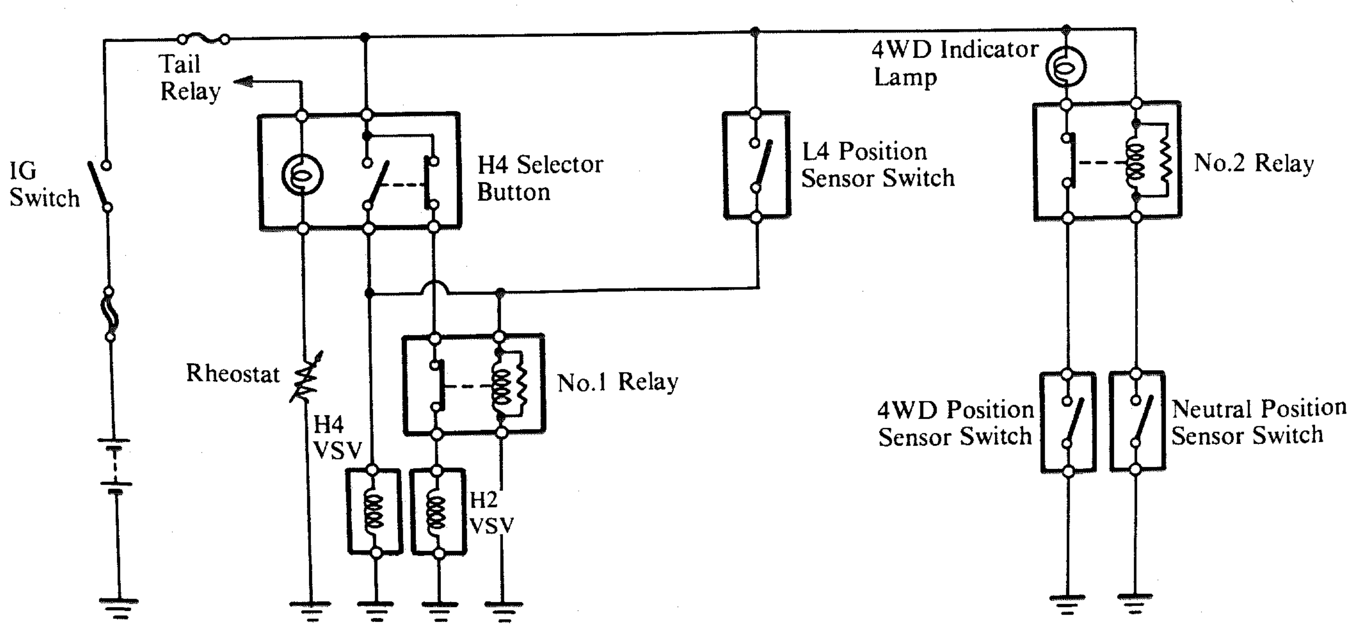
DESCRIPTION

The electrical H4 selector mechanism is designed to allow the driver to select either the H2 or H4 position simply by pushing the H4 selector button, rather than manually operating the transfer shift lever.

LOCATION OF SYSTEM COMPONENTS



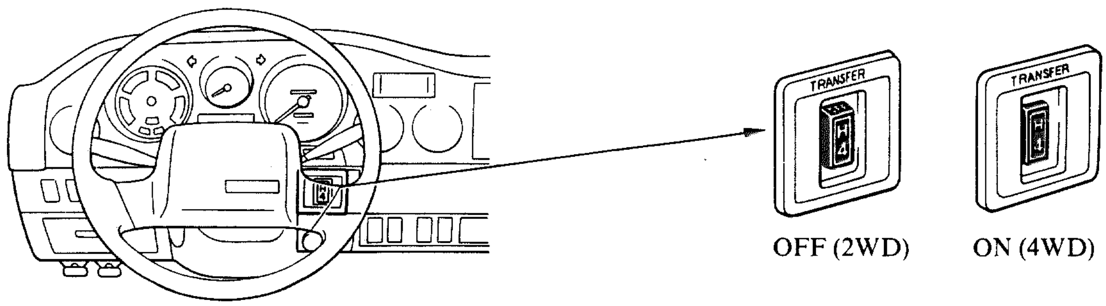
WIRING DIAGRAM



CONSTRUCTION AND OPERATION OF MAIN COMPONENT

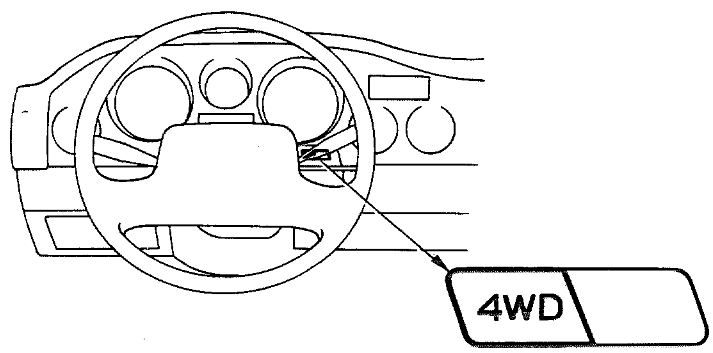
1) H4 Selector Button

This push-button switch is located on the instrument panel, and selects the H4 position when it is pushed in once, and H2 when it is pushed in again.



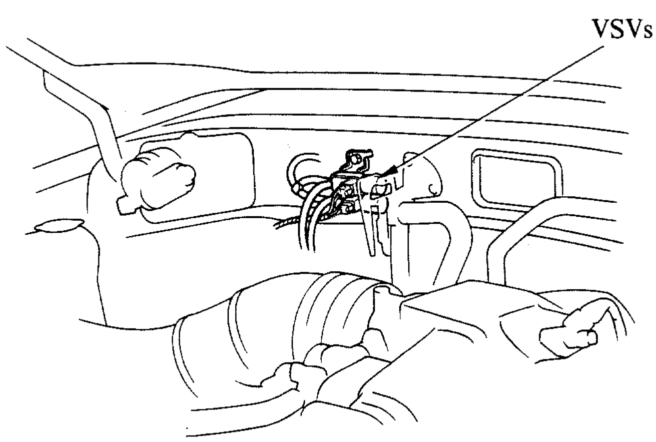
2) 4WD Indicator Lamp

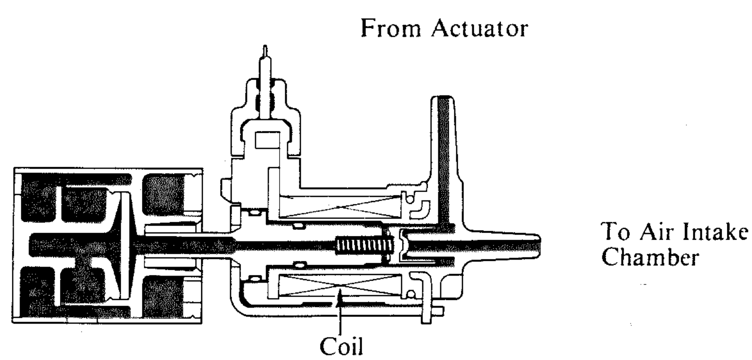
This indicator lamp is located on the instrument panel, and lights up when the transfer is shiftted to the four-wheel drive position (H4 or L4).



3) VSVs

Two VSVs (H2 VSV and H4 VSV) are used in the electrical H4 selector mechanism. They are located in the engine compartment. These valves are operated by the H4 selector button and relay to supply either vacuum or atmospheric air to the shift actuator.

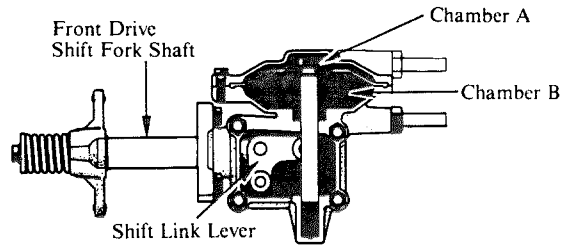




4) Vacuum Shift Mechanism

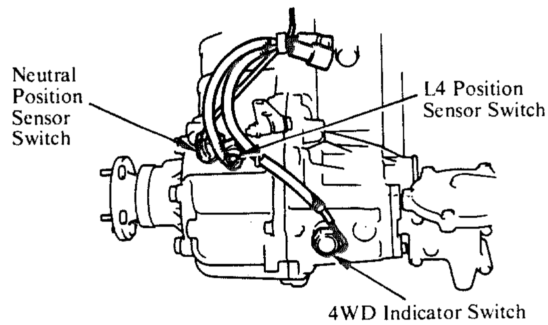
The diaphragm cylinder is fitted to the transfer case. When either vacuum or atmospheric air is supplied to chamber A or B, it moves the front drive shift fork shaft via linkage and thus switches 2WD or 4WD modes.

Chamber A	Chamber B	Transfer
Vacuum	Atmosphere	2WD (H2)
Atmosphere	Vacuum	4WD (H4, L4)



5) Transfer Indicator Switch

A 4WD position sensor switch is added to the transfer front case, and a neutral position sensor switch and L4 position sensor switch are located on the transfer rear case.

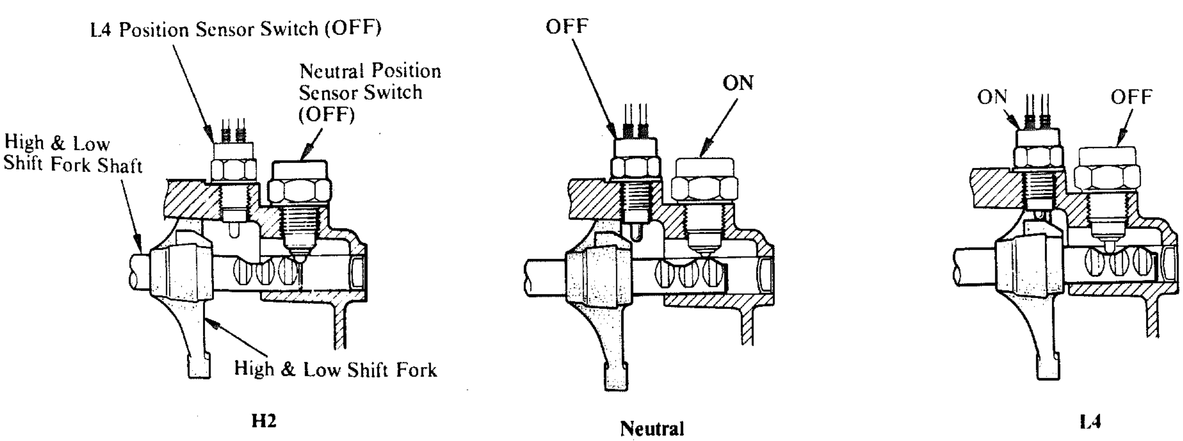


a. Neutral and L4 Position Sensor Switches

The neutral position sensor switch contacts the high and low shift fork shaft, and the L4 position sensor switch goes over the protrusion on the high and low shift fork.

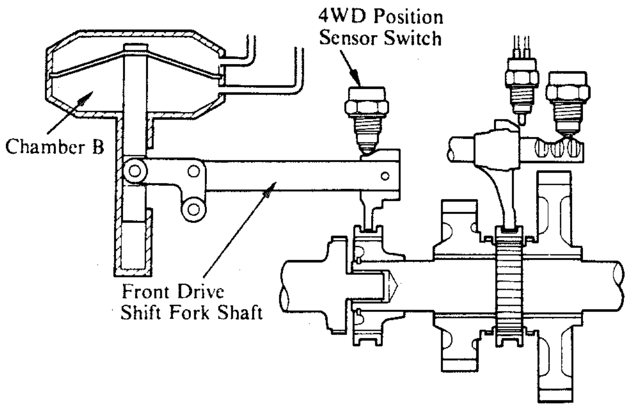
When the transfer shift lever is shifted into the neutral position, the neutral position sensor switch goes on and turns No.2 relay on. When the lever is shifted to L4 position, the L4 position sensor switch goes on and activates No.1 relay. At the same time, it also turns H4 VSV on.

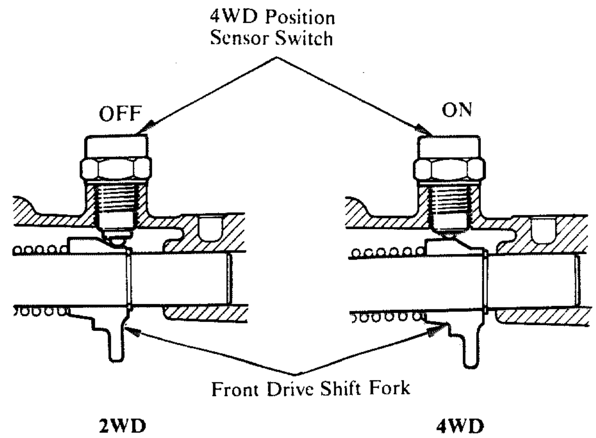
Transfer Shift Lever	Neutral Position Sensor Switch	L4 Position Sensor Switch
H2	OFF (Closed)	OFF (Open)
N	ON (Open)	OFF (Open)
L4	OFF (Closed)	ON (Closed)



b. 4WD Position Sensor Switch

When H4 VSV turns on, the front drive shift fork shaft moves and the front drive shift fork activates the 4WD position sensor switch turning on the 4WD indicator lamp.

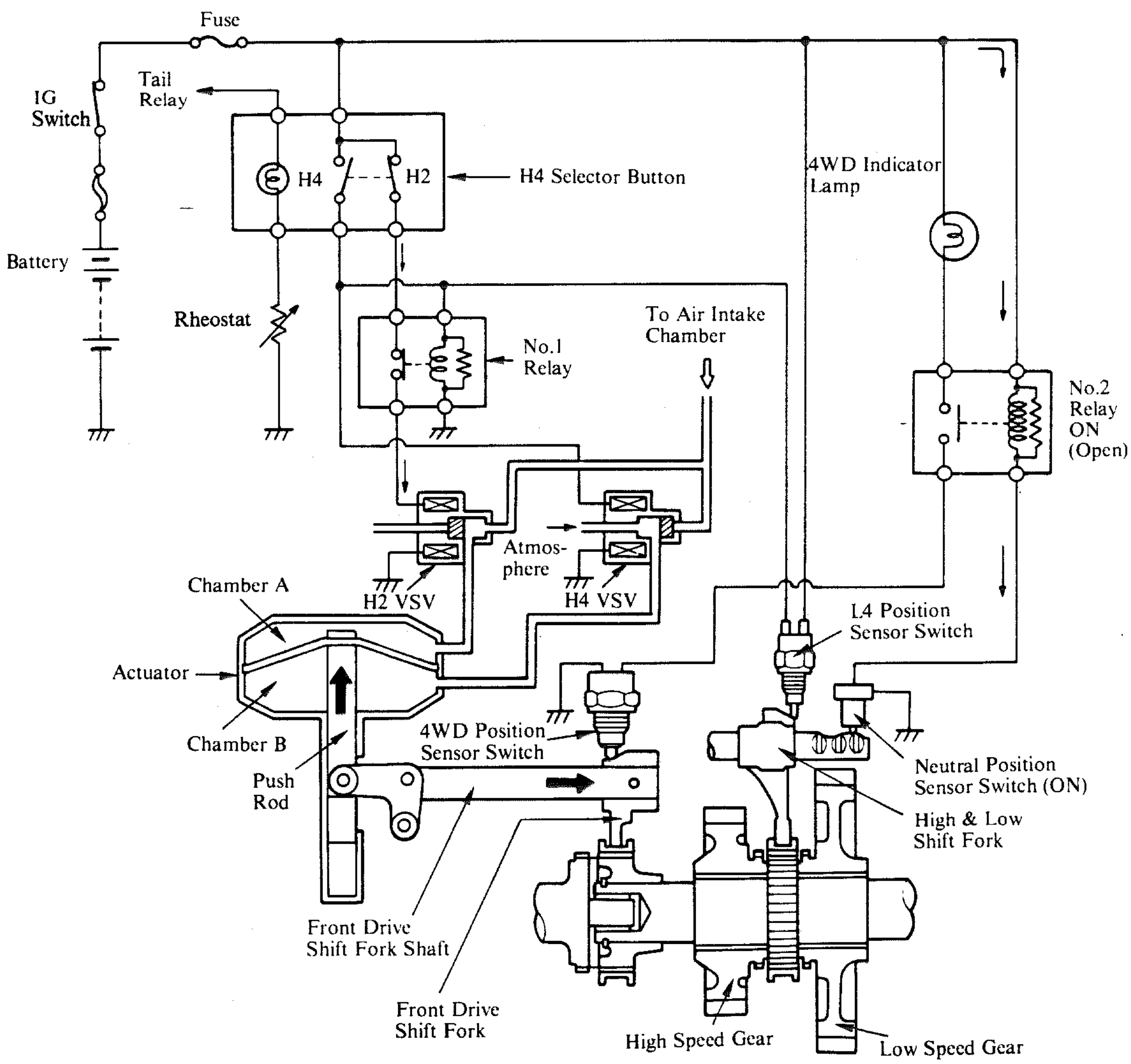




OPERATION

1) Neutral Position

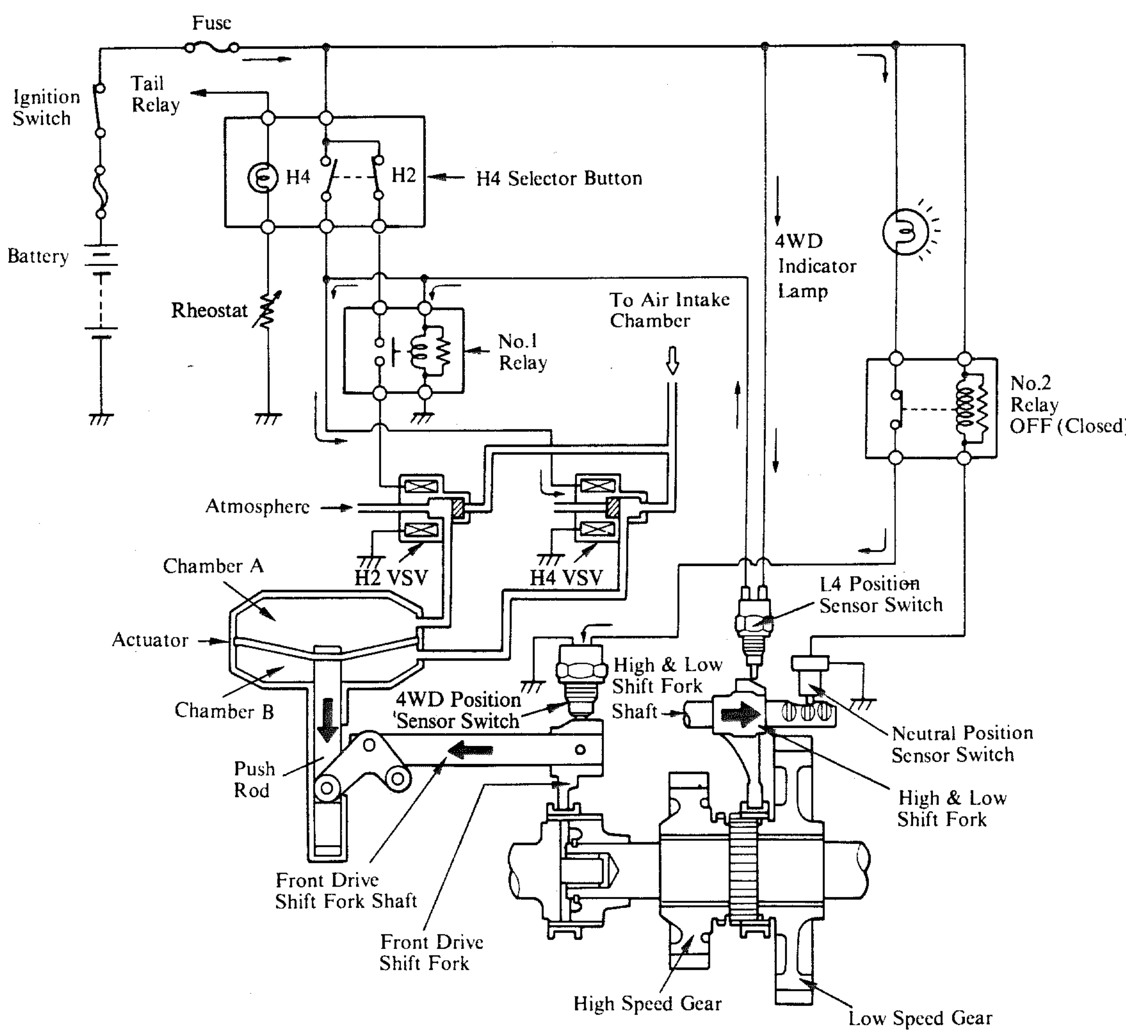
When the transfer shift lever is in the neutral position, the 4WD indicator lamp remains off even if the H4 button is pressed. Since the neutral position sensor switch is on when the transfer shift lever is in neutral position, No.2 relay becomes ON (open) and thus the 4WD indicator lamp does not go on. When the H4 selector button is operated, the VSV is activated and the front drive shift fork shaft moves, however, the 4WD indicator lamp remains off because No.2 relay is on.



2) L4 Position

When the transfer shift lever is shifted into L4 position, the high and low shift fork shaft and the high and low shift fork move over to the right. The L4 position sensor switch and H4 VSV go on as a result. No.1 relay also goes on (open) but H2 VSV remains off, and atmospheric air acts on chamber A and vacuum acts on chamber B. This moves the front drive shift fork shaft to the left to the L4 position. Then, the neutral position sensor switch goes off, the 4WD position sensor switch goes on, and No.2 relay goes off (closed). The 4WD indicator lamp goes on as a result.

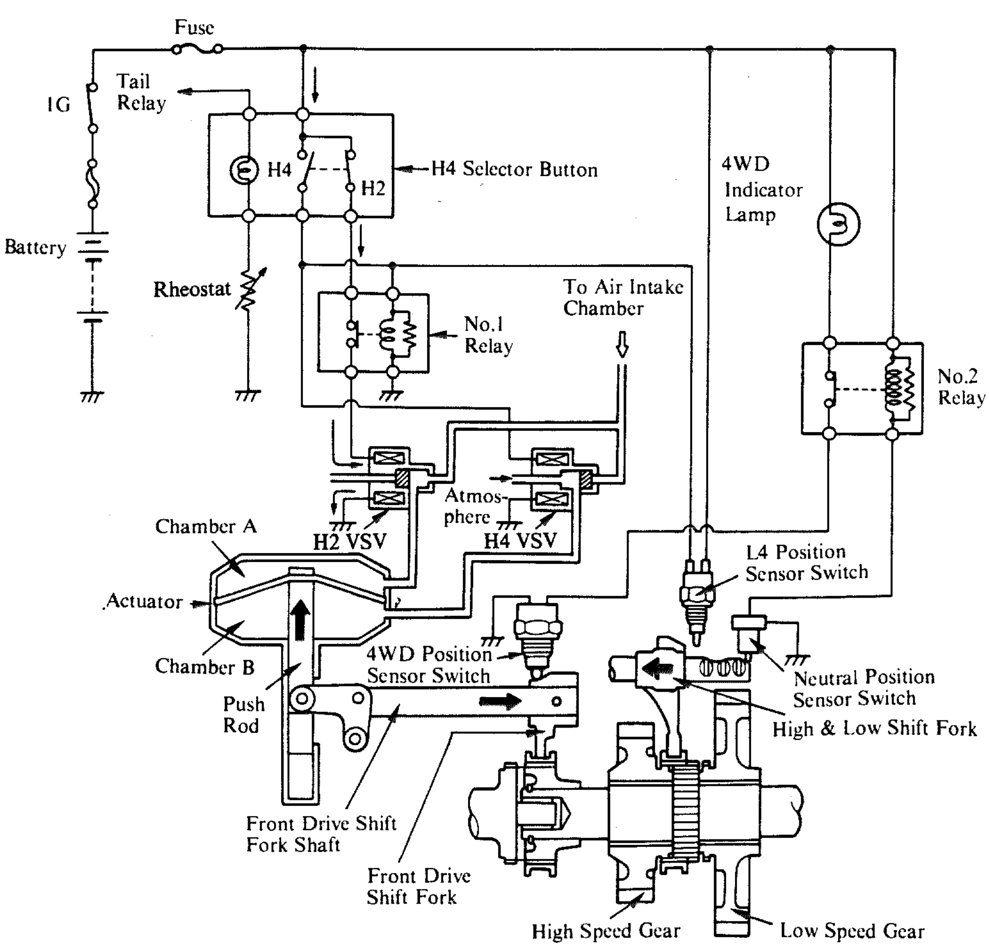
NOTE: The H4 selector button is inoperative when the transfer is in the L4 position, so the transfer cannot be shifted to the H2 or H4 position.



3) H2 Position (H4 Selector Button OFF)

When the transfer shift lever is shifted to H2 position, the high and low shift fork moves over to the left. The L4 position sensor switch and the H4 VSV go off and, at the same time, No.1 relay goes off and the H2 VSV goes on. Therefore, vacuum acts on chamber A and atmospheric air acts on chamber B, causing the front drive shift fork shaft to move to the right to the H2 position.
The 4WD indicator lamp does not go on since the neutral position sensor switch, 4WD position sensor switch and No.2 relay are off in this condition.

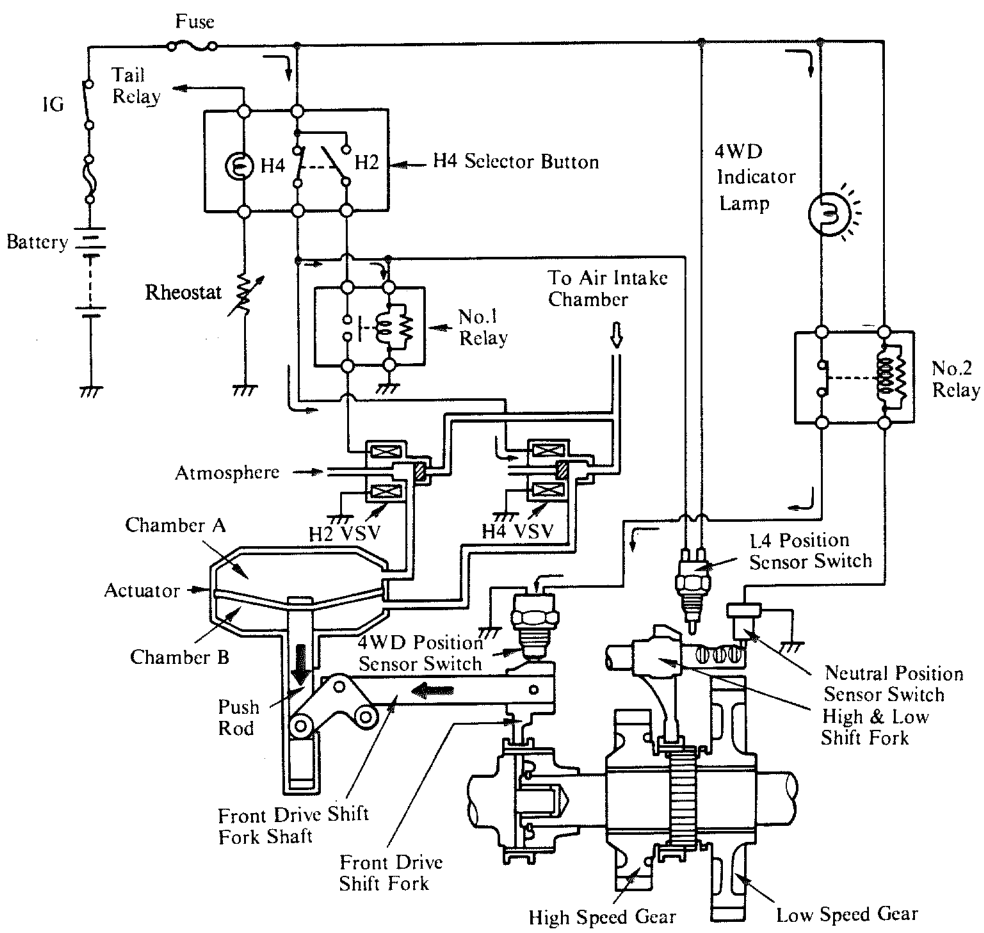
Transfer Shift Lever		H2	No.1 Relay	OFF (Closed)
H4 Selector Button		OFF	No.2 Relay	OFF (Closed)
VSV	H4	OFF	L4 Position Sensor Switch	OFF (Open)
	H2	ON	4WD Position Sensor Switch	OFF (Open)
Chamber	A	Vacuum	Neutral Position Sensor Switch	OFF (Open)
	B	Atmosphere		
4WD Indicator Lamp		Light OFF		
Transfer Gear		H2		



4) H2 Position (H4 Selector Button ON)

When the H4 selector button is pushed on, the H4 VSV goes on, No.1 relay goes on and the H2 VSV goes off. Then atmospheric air acts on chamber A and vacuum acts on chamber B, causing the front drive shift fork shaft to move to the left into the H4 position.
The 4WD indicator lamp goes on in this condition since the neutral position sensor switch and No.2 relay are off and 4WD position sensor switch is on.

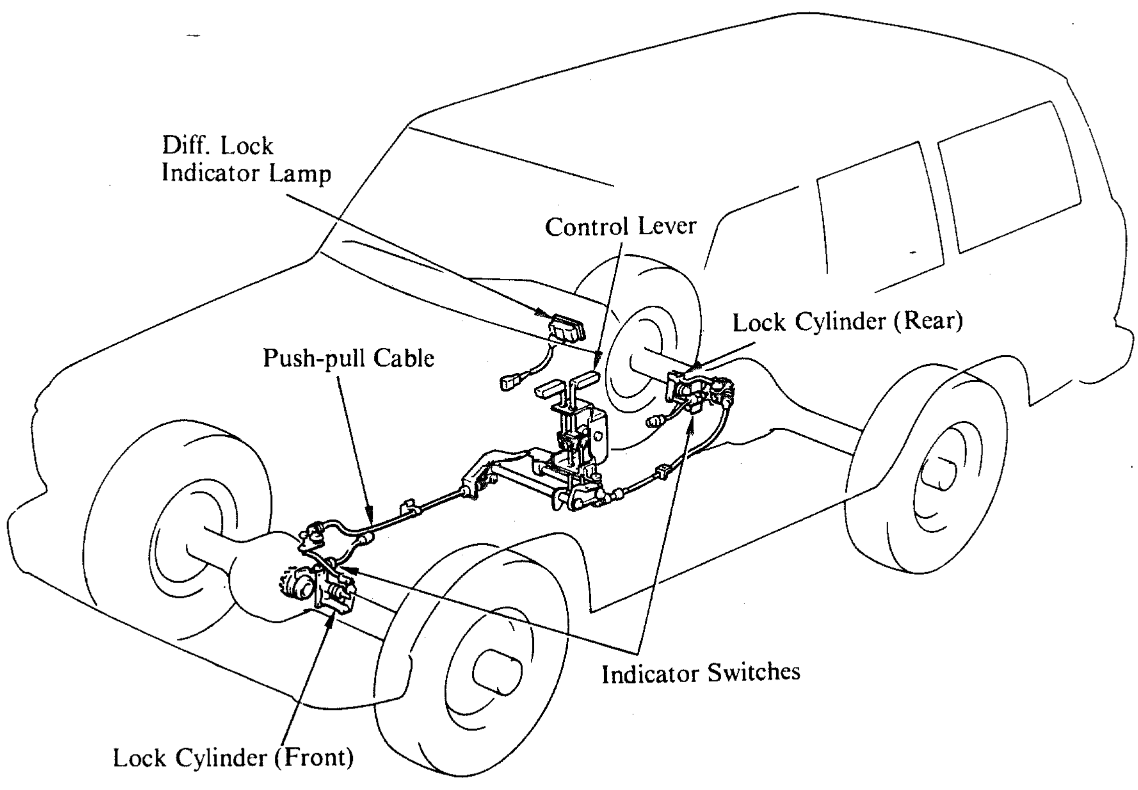
Transfer Shift Lever		H2	No.1 Relay	ON (Open)
H4 Selector Button		ON	No.2 Relay	OFF (Closed)
VSV	H4	ON	L4 Position Sensor Switch	OFF (Open)
	H2	OFF	4WD Position Sensor Switch	ON (Closed)
Chamber	A	Atmosphere	Neutral Position Sensor Switch	OFF (Open)
	B	Vacuum		
4WD Indicator Lamp		Light ON		
Transfer Gear		H4		



DIFFERENTIAL LOCKING SYSTEM

The differential locking system is available as an option for all models. This system locks the front and rear differentials to obtain traction power for emergency use.

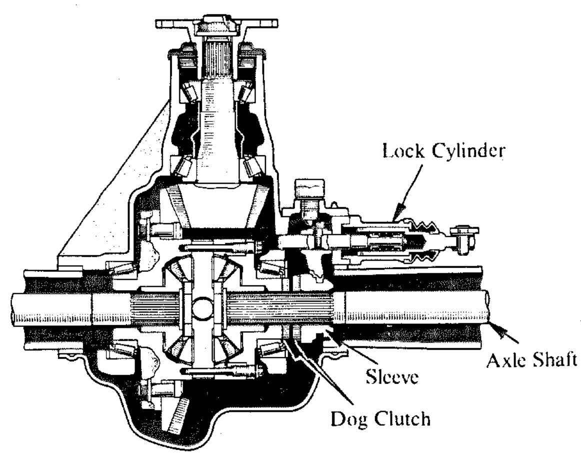
The differential locking system is operated by two control levers located at the driver's seat side. Push-pull cables are connected to the control levers to operate a lock cylinder fitted to the front and rear differentials and to lock the differential case and the axle shaft. When the differential case and the axle shaft are locked, the differential gear is deactivated so the power is transmitted directly to the left and right wheels equally. This gives extra traction needed to get out of mud or on slippery roads. It locks only the rear differential, or both the front and rear differentials.



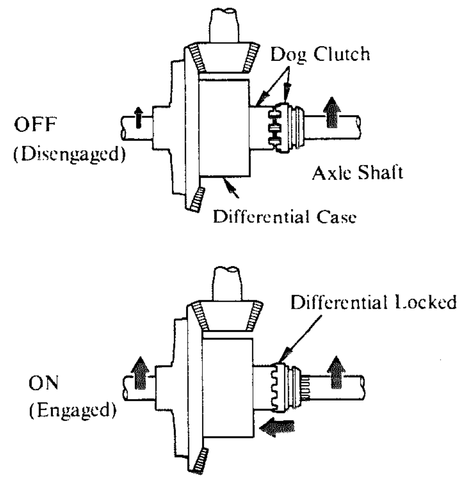
1. Contruction and Operation of Main Components

DIFFERENTIAL

A sliding sleeve and dog clutch are used to lock the right axle shaft to the differential case.
When a control lever, located at the driver seat side, is pulled, it causes the sleeve to slide via lock cylinder and become engaged with the dog clutch at the right end of the differential case. The left and right axle shafts then rotate as a unit.

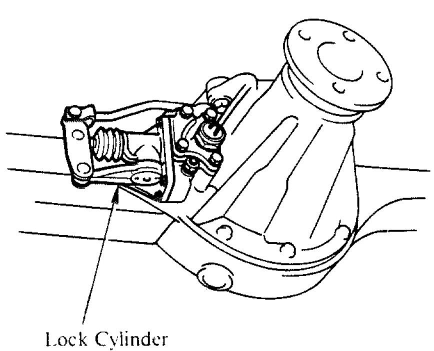


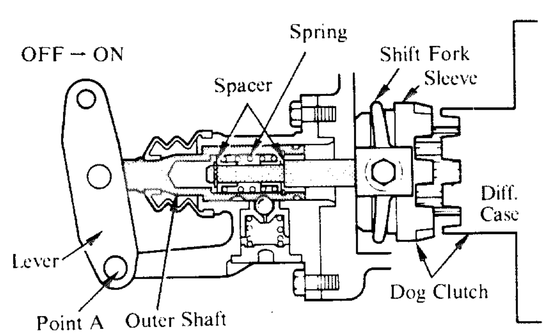
Differential (Rear)



LOCK CYLINDER

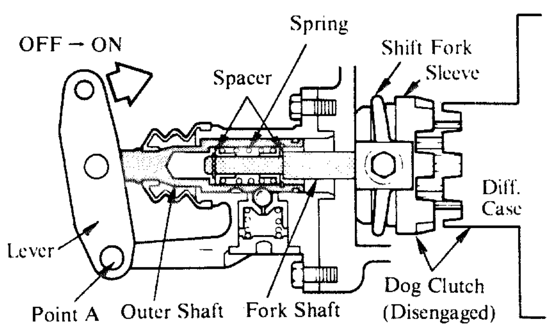
The lock cylinder is fitted to the differential carrier. Operating a control lever located at the driver seat side moves the sleeve to engage or disengage the dog clutch as needed.



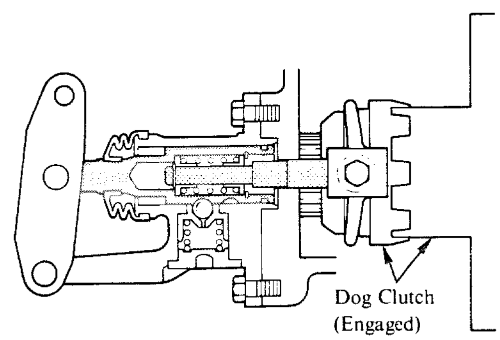


1) Operation

When a control lever by the driver's seat is pulled up (differential lock ON), the lever connected to the cylinder turns clockwise and pushes the outer shaft to the right. It causes, via spacers and a spring, the fork shaft to push to the right. Since the fork shaft is bolted to the shift fork, they move to the right as a unit and cause the sleeve to move to the right. Dog clutches of the sleeve and the differential case become engaged and the right and left differential cases and axle shafts are locked to each other. Therefore, both axle shafts rotate as a unit.

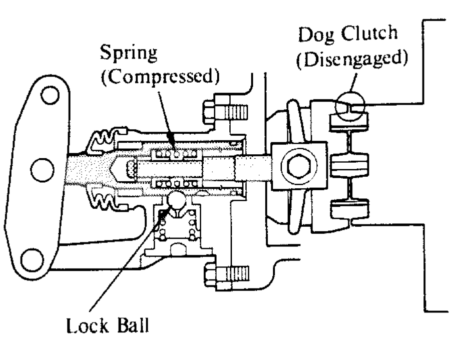


Diff. Lock OFF



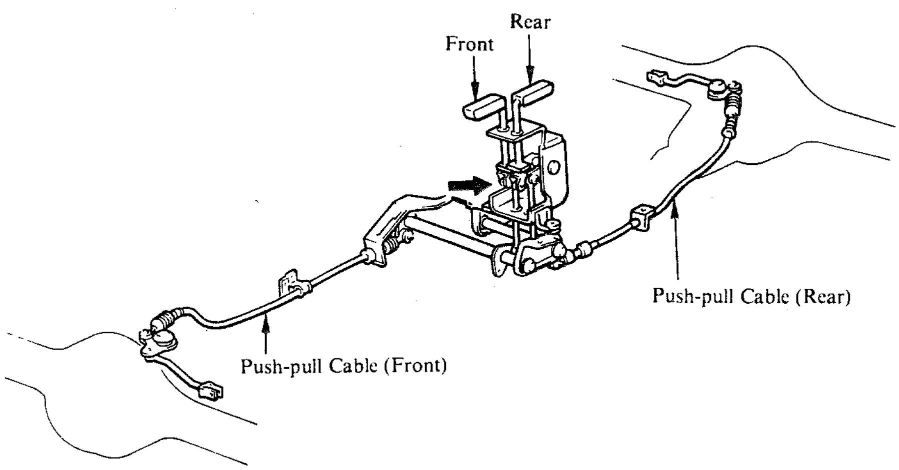
Diff. Lock ON

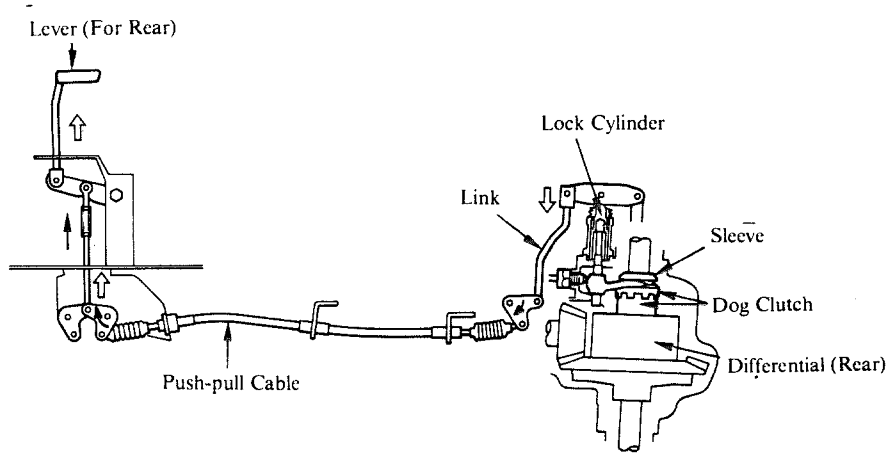
Sometimes, dog clutches of the differential case and the sleeve fail to engage each other when the control lever by the driver's seat is pulled up. This occurs because the fork shaft remains still at a position shown below as the dog clutches of the sleeve and the differential case are not engaged even after the lever and the outer shaft of the lock cylinder are moved to the right as above. In this condition, the spring is compressed via spacers by the outer shaft and the fork shaft. When a difference occurs btween the right and left wheel rotation, the sleeve is pushed to the right by the spring. Dog clutches are engaged and lock the differential as a result.
When the control lever by the driver's seat is operated once, the outer shaft moves and the locking ball falls in the groove on the outer side of the outer shaft. The ball thus locks the outer shaft in that position and retains the spring in a compressed condition even after the control lever is released.
Similarly, dog clutches sometimes remain engaged even when the control lever is operated to unlock. Dog clutches will disengage in the reverse manner.

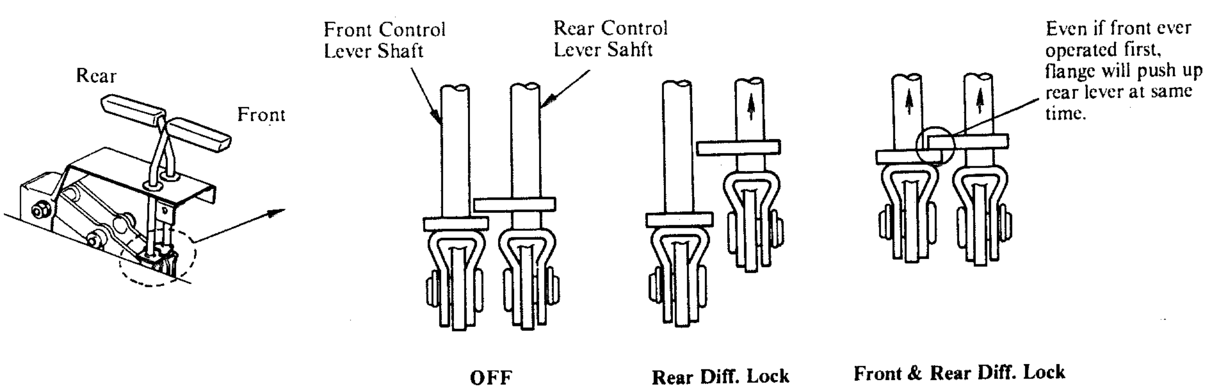


CONTROL LINK

The control link is of a mechanical type having a push-pull cable and manually locks the differentials in whichever of the two modes is selected. It locks only the rear differential or both the front and rear differentials.
Two control levers are located by the driver's seat, one for the front and the other for the rear differential. Pulling up a lever locks the differntial and pushing it down unlocks it.
The rear differential control lever must be operated first. Even of the front differential is attempted first, the rear differential control lever is pushed up simultaneously by a flange located under the lever. Similaly, the front differential must be unlocked before the rear differential.



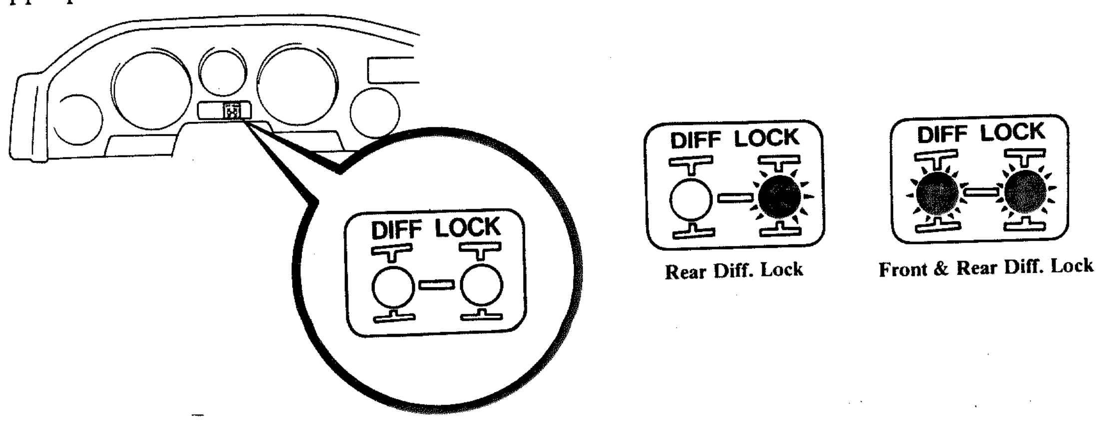




DIFFERENTIAL LOCK INDICATOR

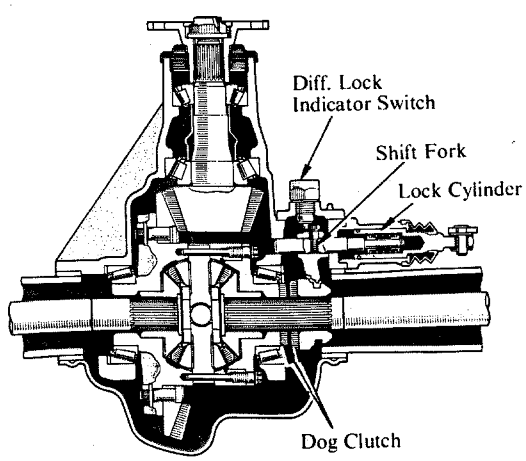
1) Differential Lock Indicator Lamps

The front and rear differential lock indicator lamps are located on the combination meter. When the dog clutches of the front or rear differential become engaged and the differential is locked, the appropriate indicator lamp goes on and indicates that the differential has been locked.

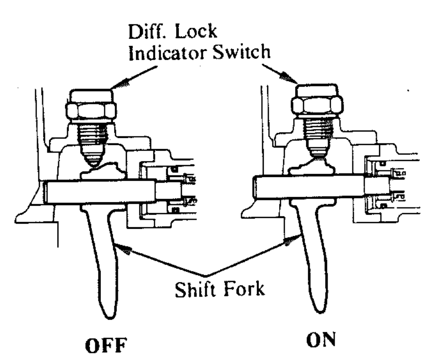


2) Differential Lock Indicator Switch

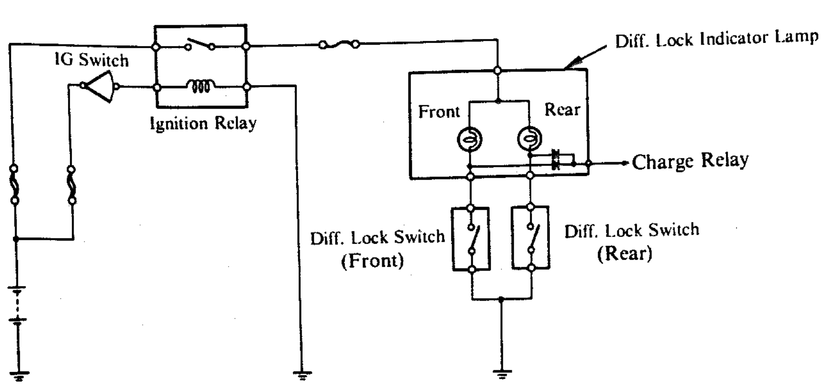
A differential lock indicator switch is fitted to the front and rear lock cylinders. It is turned on or off by a protrusion provided on the shift fork. When the control lever inside the cabin is operated, the indicator lamp may not go on until dog clutches in the lock cylinder are engaged, similarly, the indicator lamp remains lit when the control lever is oprated to unlock until the dog clutches become disengaged.



Differential (Rear)



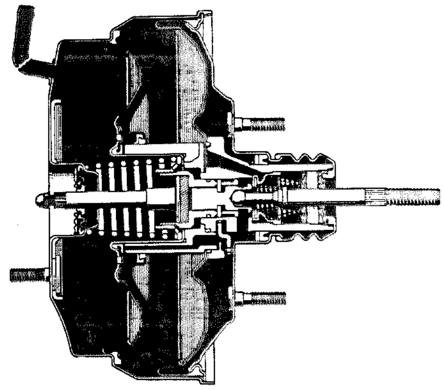
3) Wiring Diagram



BRAKE

1. Brake Booster

The previous 7.5 inch tandem type brake booster is replaced by a 7 plus 8 inch tandem type brake booster. The construction and operation of the new booster is the same way as the tandem type brake booster on the Toyota Supra.

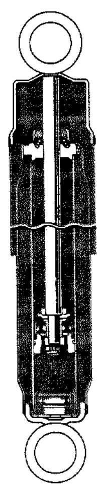


2. LSP & BV (Load Sensing Proportioning and Bypass Valve)

The previous P & B valve has been replaced with LSP & B valves on all models. They are built and operate the same way as those on the Trucks.

SUSPENSION

The suspension type itself has not been changed but the leaf spring, stabilizer bar, shock absorber bushings, etc. have been reviewed for better matching.
Low-pressure nitrogen gas-filled shock absorbers are used for the front and rear suspensions. They provide superior anti-cavitation and stable damping characteristics to enhance riding comfort and stability.
The tire size has been changed from HR78-15 to P225/75 R15.



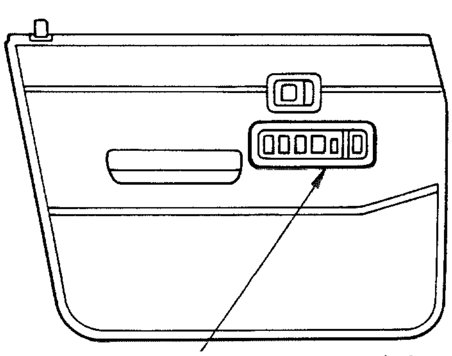
STEERING

The steering gear ratio has been changed (from 19.0 to 18.27) to obtain a better response at high speeds.

BODY ELECTRICAL SYSTEMS

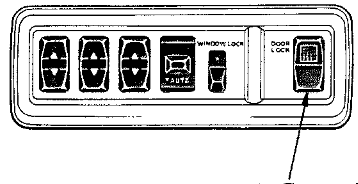
1. Power Windows

Power windows are available as an option on all models. A master switch is located on the driver side door. It has a "one-touch" control switch for the window so the driver does not need to keep the switch depressed until the window is fully open.



2. Power Door Lock System

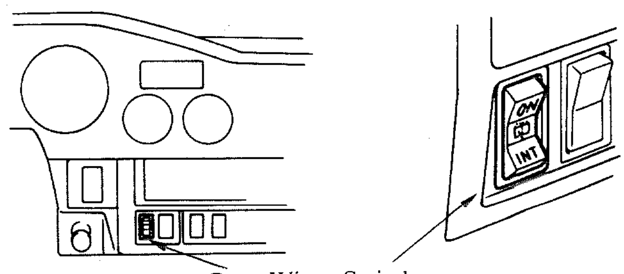
A power door lock system is available as an option on all models. A door lock control switch is located on the driver side door, together with the master control switch for power windows. The door lock control switch locks and unlocks all doors as well as the tail gate.



Door Lock Control Switch

3. Intermittent Rear Window Wiper

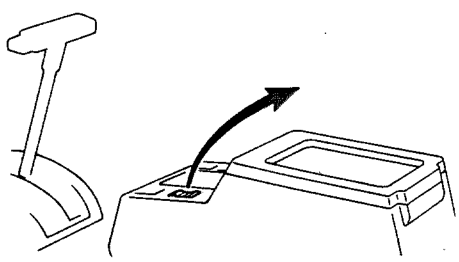
An intermittent rear window wiper is standard equipment on all models. It is operated by a rear wiper switch located on the instrument panel.

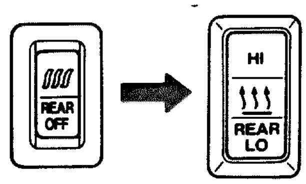


Rear Wiper Switch

4. Rear Heater

The previous single-mode rear heater has been replaced with a two-stage (high and low) type to enhance comfort for rear seat passengers.

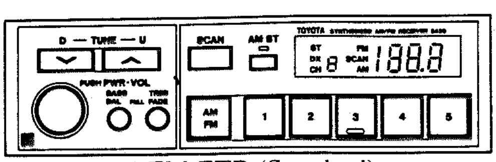




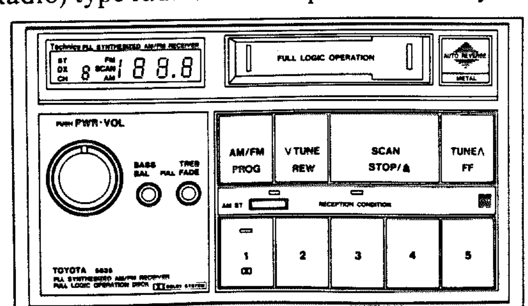
Previous New

5. Audio System

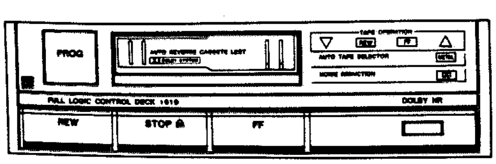
All models are equipped with an ETR (Electronic Tuning Radio) type radio. A four-speaker audio system is available as an option.



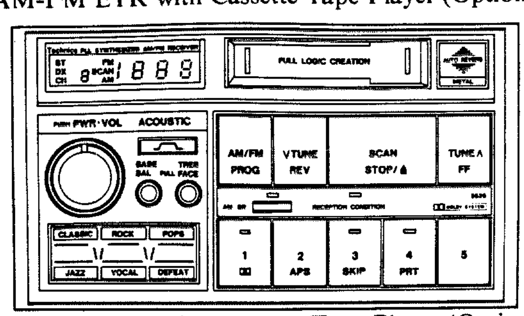
AM-FM ETR (Standard)



AM-FM ETR with Cassette Tape Player (Option)



Cassette Tape Player (Option)



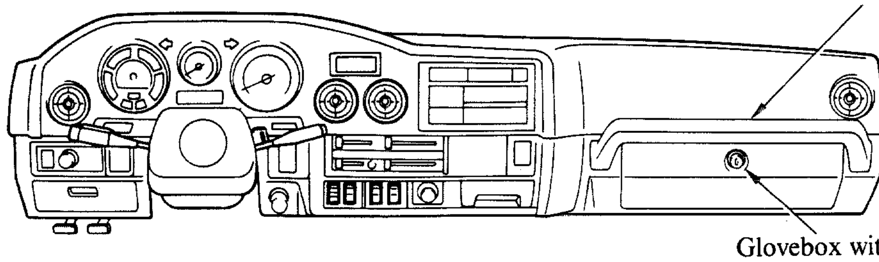
AM-FM ETR with Cassette Tape Player (Option) (with Acoustic Flavor)

REDESIGNED INTERIOR

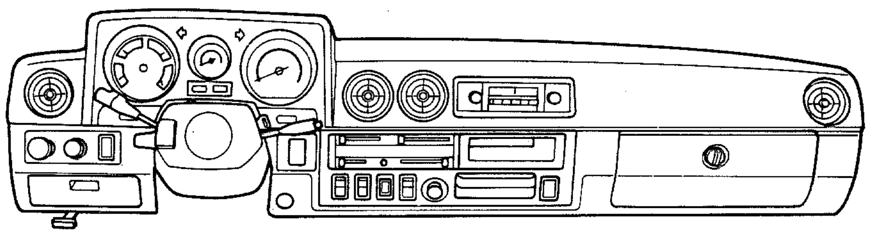
1. Instrument Panel

The instrument panel has been redesigned with a passenger car like larger and easy-to-see layout. A urethane assist grip and a glove-box with a key lock are also adopted.

New

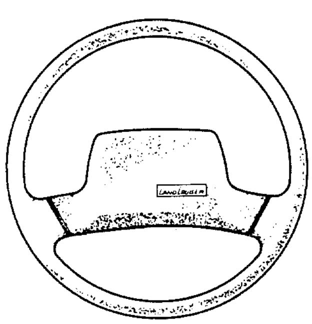


Previous
(FJ60 series)

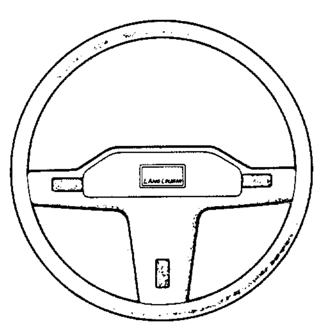


2. Steering Wheel

The steering wheel has been redesigned. The center pad material is changed to urethane.



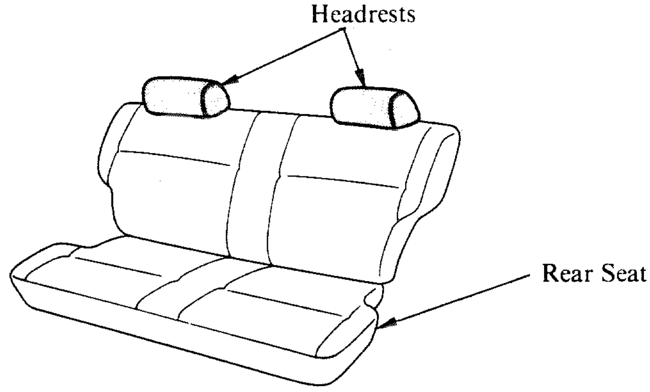
New



Previous

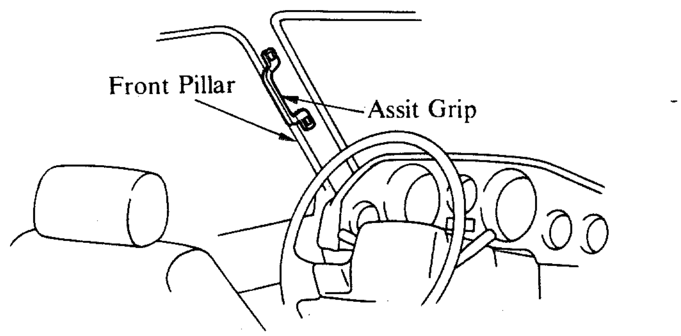
3. Rear Seat Headrests

A headrest has been added to each section of the rear seat to enhance riding comfort of rear seat passengers.



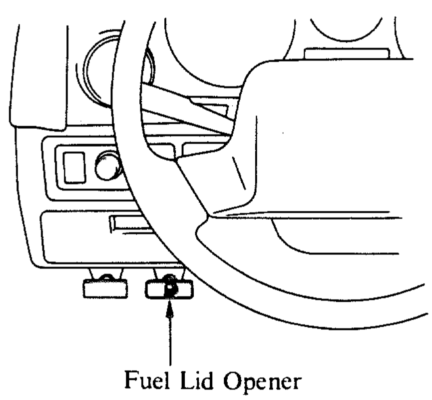
4. Assist grip

An assist grip is added to the front pillar near the driver's seat to allow for easier entry and exit.



5. Fuel Lid Opener

A fuel lid opener is standard equipment in all models.

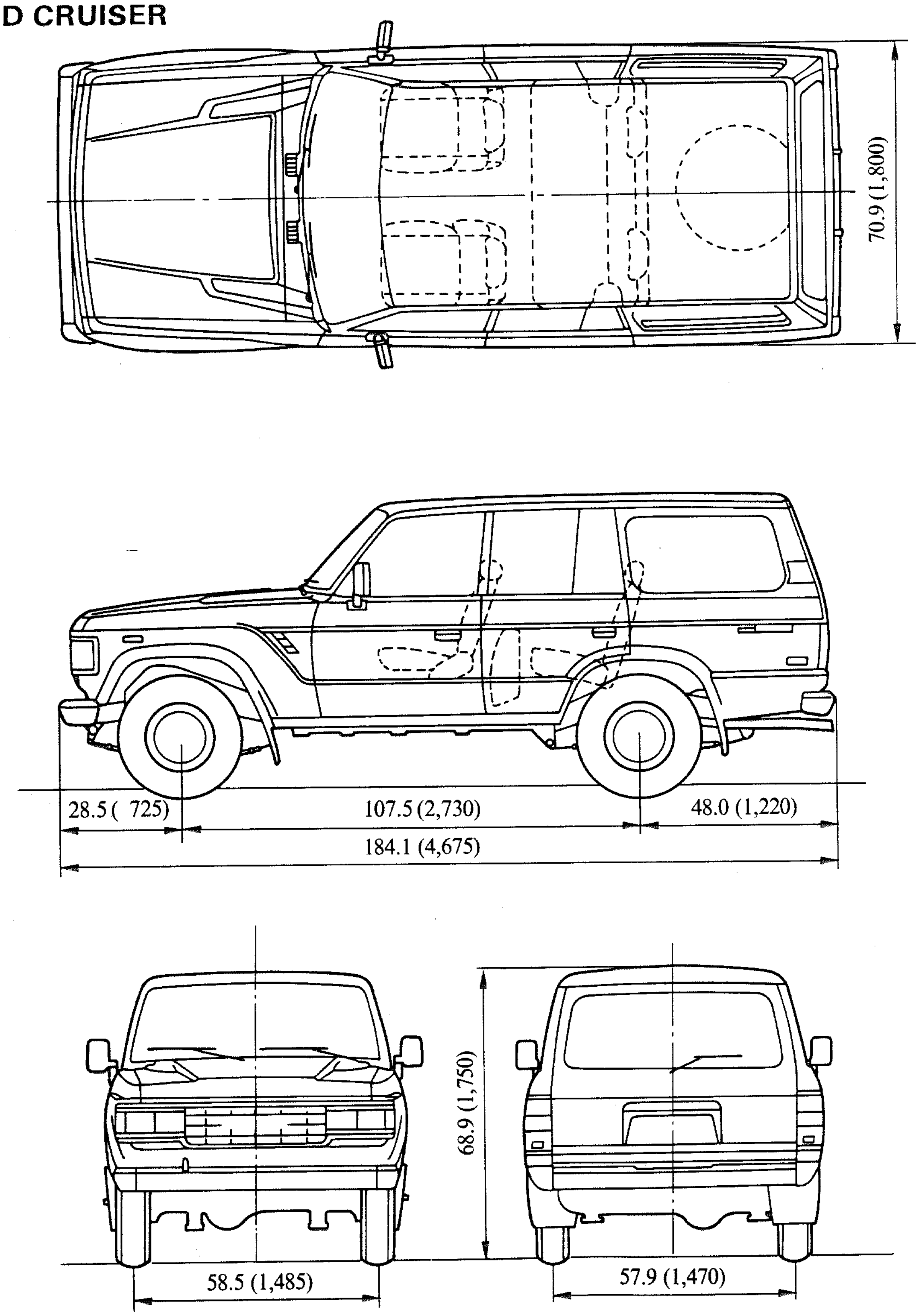


LAND CRUISER

Item			Area	USA		Canada
	Body Type			Van	Wagon	Wagon
	Vehicle Grade			—	—	—
	Model Code			FJ62LV-PNEA	FJ62LG-PNEA	FJ62LG-PNEK
Engine	Engine Type			3F-E	←	←
Engine	Valve Mechanism			2 Valves, OHV	←	←
Engine	Bore X Stroke		in. (mm)	3.70X3.74 (94X95)	←	←
Engine	Displacement		cc (cu.in.)	241.3 (3,955)	←	←
Engine	Compression Ratio			8.1 to 1	←	←
Engine	Carburetor Type			EFI	←	←
Engine	Reserch Octane No.		RON	91	←	←
Engine	Max. Output (SAE-NET)		HP@rpm (kW/rpm)	154 @ 4,000 (115/4,000)	←	←
Engine	Max. Torque (SAE-NET)		lb-ft@rpm (N·m/rpm)	220 @ 3,000 (299/3,000)	←	←
Engine Electrical	Battery Capacity (5HR)		Voltage & Amp. hr.	12-56	←	←
Engine Electrical	Alternator Output		Watts	960	←	←
Engine Electrical	Starter Output		kW	1.0	←	←
Performance	Max. Speed		rpm (km/h)	96 (155)	←	←
Performance	Max. Cruising Speed		rpm (km/h)	77 (124)	←	←
Performance	Max. Permissible Speed	1st Gear	km/h (mph)	34 (55)	←	←
Performance		2nd Gear	km/h (mph)	65 (105)	←	←
Performance		3rd Gear	km/h (mph)	87 (140)	←	←
Performance	—	4th Gear	km/h (mph)	—	—	
Performance	Turning Diameter (Outside Front)	Wall to Wall	ft. (m)	44.0 (13.4)	←	←
Performance		Curb to Curb	ft. (m)	40.7 (12.4)	←	←
Performance	Fuel Tank Capacity		— US.gal (l, Imp. gal)	23.8 (90, 19.8)	←	←
Chassis	Clutch Type			—	—	—
Chassis	Transmission Type			A440F	←	←
Chassis	Transmission Gear Ratio	In First		2.950	←	←
Chassis		In Second		1.530	←	←
Chassis		In Third		1.000	←	←
Chassis		In Fourth		0.717	←	←
Chassis		In Fifth		—	—	—
Chassis		In Reverse		2.678	←	←
Chassis	Transfer Gear Ratio H4/L4			1.000/2.296	←	←
Chassis	Differential Gear Size Front/Rear		in.	9.5″/9.5″	←	←
Chassis	Differential Gear Ratio Front/Rear			4.111/4.111	←	←
Chassis	Suspension Type	Front		Leaf Spring	←	←
Chassis		Rear		Leaf Spring	←	←
Chassis	Stabilizer Bar	Front		STD	←	←
Chassis		Rear		STD	←	←
Chassis	Brake Type	Front		Ventilated Disc	←	←
Chassis		Rear		L.T. Drum	←	←
Chassis	Parking Brake Type			L.T. Drum	←	←
Chassis	Brake Booster Type and Size		in.	Tandem, 7″+8″	←	←
Chassis	Proportioning Valve Type			LSPV	←	←
Chassis	Steering Gear Type			Recirculating Ball	←	←
Chassis	Steering Gear Ratio (Overall)			19.0	←	←
Chassis	Power Steering Type			Flapper Valve	←	←
Major Dimension & Vehicle Weight	Overall	Length	in. (mm)	184.1 (4,675)	←	←
Major Dimension & Vehicle Weight		Width	in. (mm)	70.9 (1,800)	←	←
Major Dimension & Vehicle Weight		Height	in. (mm)	68.9 (1,750)	←	68.9 (1,750), 72.0 (1,830)*[1]
Major Dimension & Vehicle Weight	Wheel Base		in. (mm)	107.5 (2,730)	←	←
Major Dimension & Vehicle Weight	Tread	Front	in. (mm)	58.5 (1,485)	←	←
Major Dimension & Vehicle Weight		Rear	in. (mm)	57.9 (1,470)	←	←
Major Dimension & Vehicle Weight	Effective Head Room	Front	in. (mm)	40.0 (1,015)	←	←
Major Dimension & Vehicle Weight		Rear	in. (mm)	—	40.4 (1,025)	←
Major Dimension & Vehicle Weight	Effective Leg Room	Front	in. (mm)	39.2 (995)	←	←
Major Dimension & Vehicle Weight		Rear	in. (mm)	—	34.6 (880)	←
Major Dimension & Vehicle Weight	Shoulder Room	Front	in. (mm)	59.5 (1,512)	←	←
Major Dimension & Vehicle Weight		Rear	in. (mm)	—	59.6 (1,515)	←
Major Dimension & Vehicle Weight	Cargo Space	Length	in. (mm)	—	—	—
Major Dimension & Vehicle Weight		Width	in. (mm)	—	—	—
Major Dimension & Vehicle Weight		Height	in. (mm)	—	—	—
Major Dimension & Vehicle Weight	Overhang	Front	in. (mm)	28.5 (725)	←	←
Major Dimension & Vehicle Weight		Rear	in. (mm)	48.0 (1,220)	←	←
Major Dimension & Vehicle Weight	Min. Running Ground Clearance		in. (mm)	9.1 (230)	←	←
Major Dimension & Vehicle Weight	Angle of Approach		degree	35°30′	←	←
Major Dimension & Vehicle Weight	Angle of Departure		degree	17°30′	←	←
Major Dimension & Vehicle Weight	Curb Weight	Front	lb (kg)	2,215 (1,005)	←	2,215 (1,005)
Major Dimension & Vehicle Weight		Rear	lb (kg)	2,265 (1,030)	←	2,225 (1,010)
Major Dimension & Vehicle Weight		Total	lb (kg)	4,480 (2,035)	←	4,440 (2,015)
Major Dimension & Vehicle Weight	Gross Vehicle Weight	Front	lb (kg)	—	—	—
Major Dimension & Vehicle Weight		Rear	lb (kg)	—	—	—
Major Dimension & Vehicle Weight		Total	lb (kg)	5,620 (2,550)	←	←
Major Dimension & Vehicle Weight	Luggage Compartment Capacity		cu.ft. (m^3)	—	6,116 (2,775)	←

*[1] With Roof Carrier

3. LAND CRUISER



Body Type	Station Wagon, Van
Model Code	FJ62LV-PNEA FJ62LG-PNEA FJ62LG-PNEK