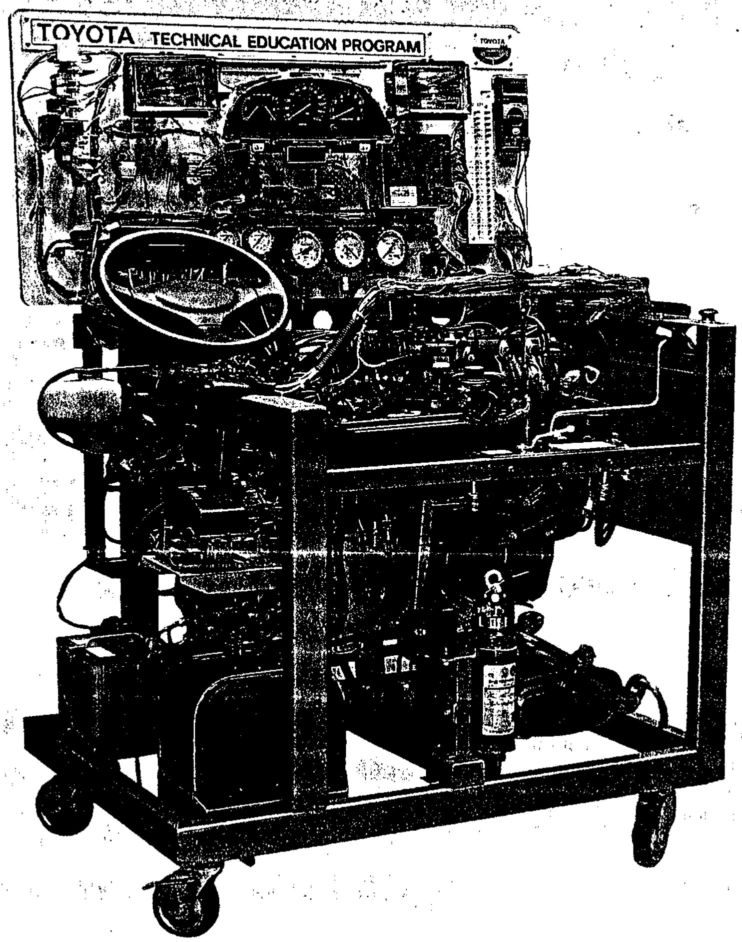
TOYOTA

ENGINE SIMULATOR

Training Manual



TECHNICAL EDUCATION PROGRAM

TOYOTA MOTOR CORPORATION

OVERSEAS SERVICE DIVISION

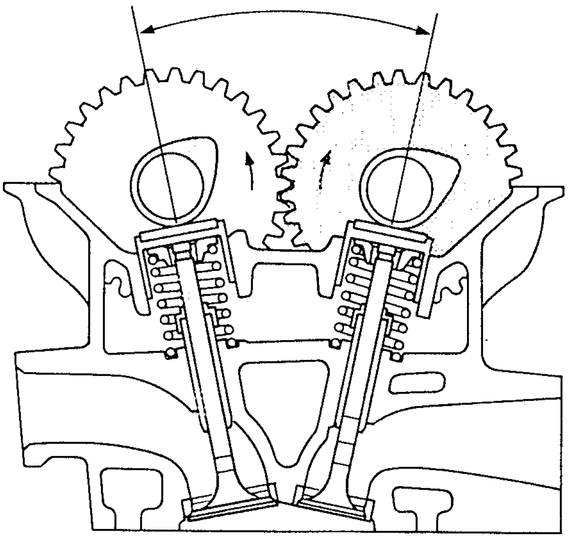
FOREWORD

- This training manual allows study of the basic features of the TCCS (Toyota Computer Controlled System) and its mechanisms. Utilizing the 4A-FE Engine Simulator and EFI System Cutaway Parts Kit explained in the Toyota Training Manual will facilitate a thorough understanding of this manual, permitting more effective training.

- **Some illustrations (bearing an asterisk at the bottom right) used in this manual are listed on the last page of this manual, and can be prepared as overhead transparency projections (OHP) for easy reference.**

- A large number of illustrations used in this manual are drawn in such a way so that students can add colors themselves for their better understanding.

EXAMPLE



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TOYOTA MOTOR CORPORATION

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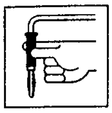
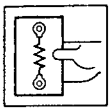
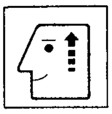
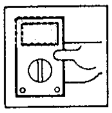
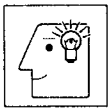
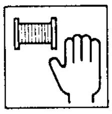
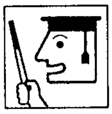
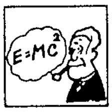
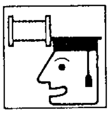
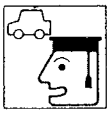
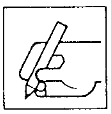
EXPLANATORY NOTES

SYMBOLS

Some or all of the following symbols are used in this manual.

NO	SYMBOL	MEANING
1		**Subject to be studied**
2		**Making a circuit**
3		**Practice piece (used in the electrical circuit following the symbol)**
4		**Practice**
5		**Inspection or measurement**
6		**Answer, result of measurement, etc.**
7		**Experiment**
8		**Comment, hint, etc.**
9		**Law, general principle, etc.**
10		**Explanation of actual operation**
11		**Explanation of actual use on vehicle**
12		**Quiz**

RELATED MATERIALS

The following related materials are also avaiable for use with the 4A-FE engine simulator:

1. TEAM Training manual:
   - EFI (Electric Fuel Injection) .... Pub. No. TTM205E
   - TCCS (Toyota Computer-Controlled System) .... Pub. No. TTM301E
2. Repair manual:
   - Electrical Wiring Diagram for Celica .... Pub. No. EWD071U

ABBREVIATIONS USED IN THIS MANUAL

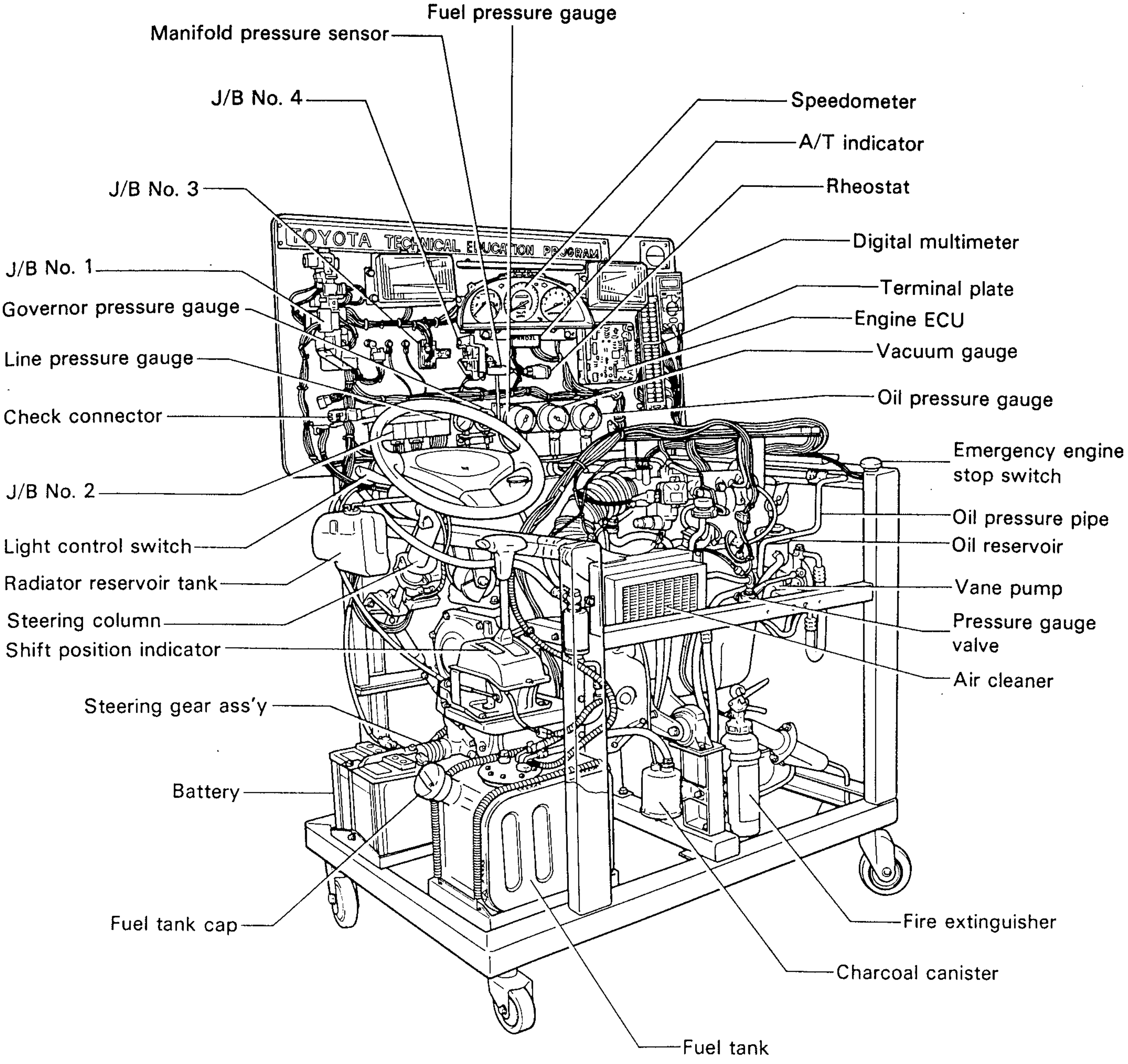
A/C	Air Conditioner	O/S	Oversized
ACV	Air Control Valve	PCV	Positive Crankcase Ventilation
A/T	Automatic Transmission	P/S	Power Steering
BTDC	Before Top Dead Center	STD	Standard
BVSV	Bi-metal Vacuum Switching Valve	SST	Special Service Tool
DP	Dash Pot	TCCS	Toyota Computer-Controlled System
ECU	Electronic Control Unit	TDC	Top Dead Center
EFI	Electronic Fuel Injection	TEMP.	Temperature
EGR	Exhaust Gas Recirculation	TWC	Three-Way Catalyst
ESA	Electronic Spark Advance	U/S	Undersized
FL	Fusible Link	VSV	Vacuum Switching Valve
IIA	Integrated Ignition Assembly	VTV	Vacuum Transmitting Valve
ISC	Idle Speed Control	w/	With
M/T	Manual Transmission	w/o	Without

CHEMICAL SYMBOLS

HC	Hydrocarbon	CO_2	Carbon dioxide
NOx	Oxides of nitrogen	N_2	Nitrogen
CO	Carbon monoxide	H_2O	Water

HOW TO USE 4A-FE ENGINE SIMULATOR

LAYOUT OF PARTS



SPECIFICATIONS OF MAIN COMPONENTS

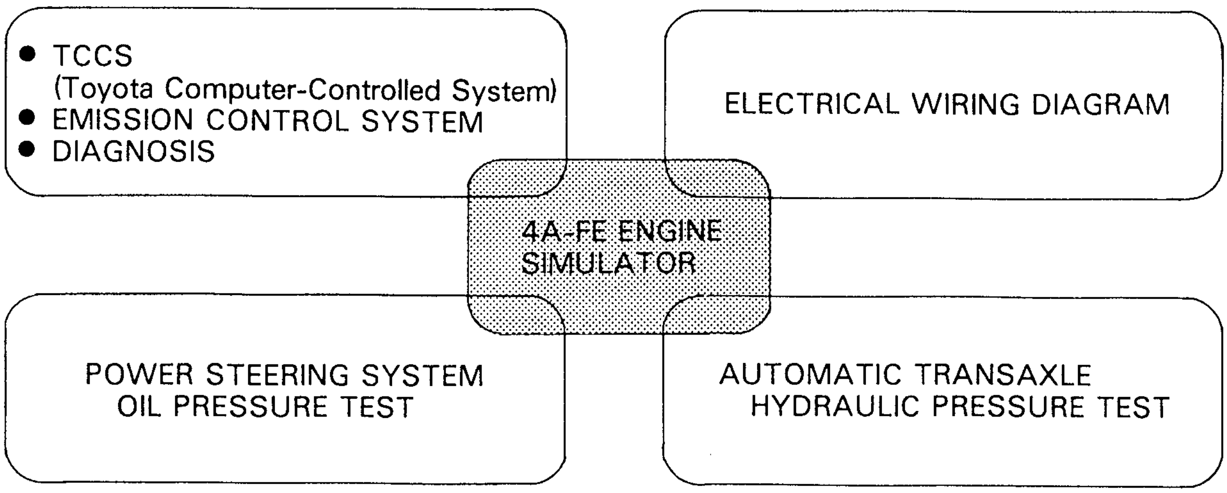
The simulator is comprised of components and parts that are primarily found on the Corolla and Celica, passenger cars with a solid reputation worldwide, and those found on other vehicles made by Toyota. The primary components, parts, and specifications are listed below.

MAIN COMPONENT	BASIC MODEL			DESTINATION	REFERENCE
	NAME	CODE	YEAR		
Engine	Celica	AT180L	'90	USA	California specifications
Transaxle assembly	Corolla	AE92L	'90	USA	A131L
PS vane pump	Celica	AT180L	'90	Europe	
Steering wheel	Celica	AT180L	'90	Europe	
Air cleaner	Carina II	AT171L	'90	Europe	ANNEX 23
Steering damper	Toyota Truck	RN10L	'89	USA	Other distimation Hilux
Charcoal canister	Coaster	RB20L	'83	General	
Sealed beam mounting ring	Cressida	GX71L	'85	G.C.C.	G.C.C.: Gulf Cooperation Council
A/T indicator lamp	Camry	SV21L	'89	USA	For ATM
Speedometer	Celica	AT180L	'90	USA	
Steering gear box	Corolla	AE92L	'90	USA	
Steering column	Celica	AT180L	'90	Europe	
Steering intermediate shaft no. 2	Celica	AT180L	'90	Europe	
Fuel filter	Cressida	GX71L	'85	General	
Starter	Celica	AT180L	'90	Europe	0.8 kW

MAIN FEATURES

The 4A-FE Engine Simulator has been designed based on the 1990 Celica (vehicle model code AT180L, US specifications) and has the following features:

1. The Toyota Computer-Controlled System (TCCS) can be easily studied.
2. Mounted wire harnesses and connectors are the same as those used on actual vehicles. This aids in learning how to read the Electrical Wiring Diagram (EWD) Manual, Pub. No. EWD071U.
3. A pressure gauge is inserted in the power steering oil pressure line, thus facilitating oil pressure measurement. Also, the operating condition of the PS system during the engine idle-up period, which places the steering wheel in a fully-locked position, can be experienced.
4. An oil pressure gauge inserted in the hydraulic circuitry of the automatic transmission facilitates the measurement of line pressure and governor pressure.
5. The emission control system equipped on the 4A-FE engine allows technicians to view system operating conditions.
6. The incoming or outgoing voltage, resistance, etc. to/from the Engine ECU can easily be measured on the built-in terminal plate.
7. Diagnostic skills can be practiced.



CAUTION ON USING SIMULATOR

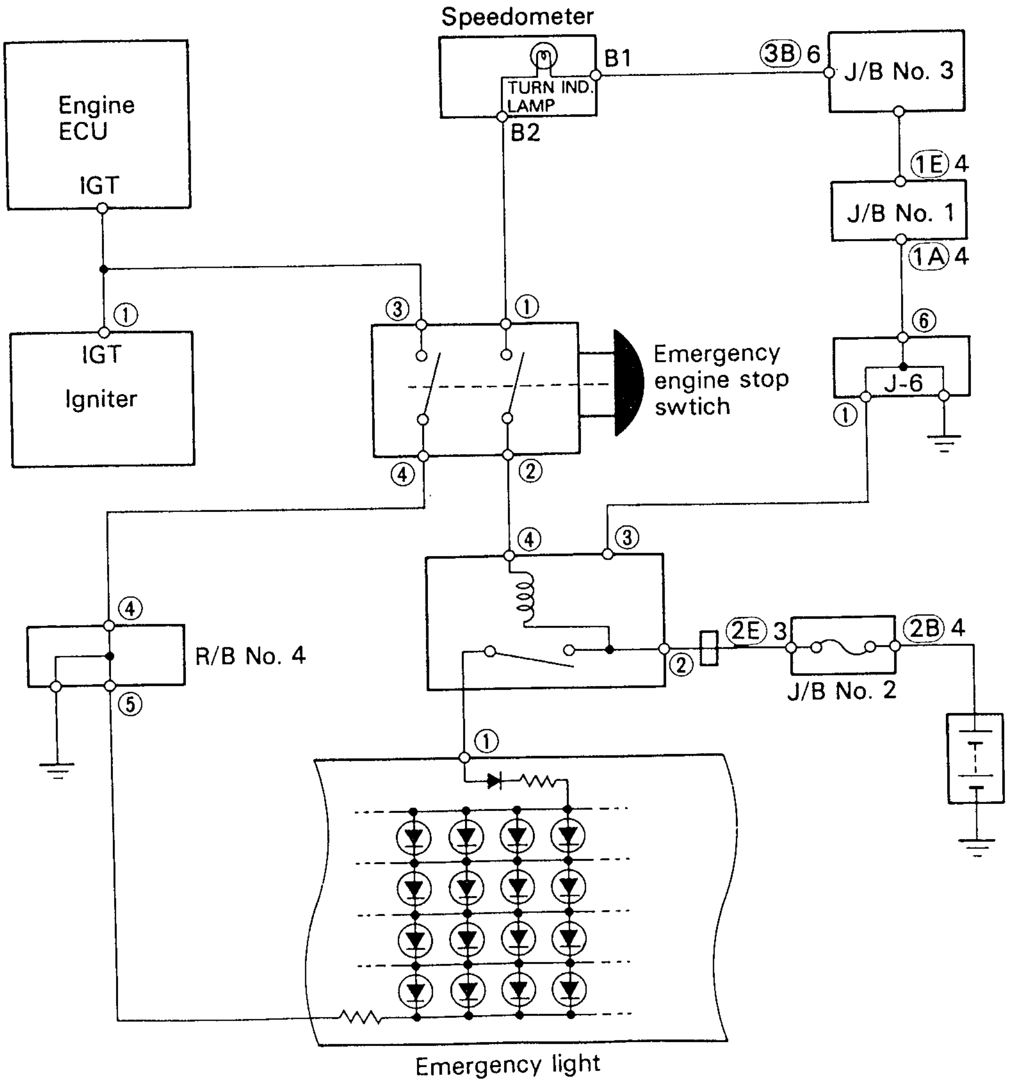
1. SPECIAL PARTS & CIRCUITS

The following special parts and circuits have been added to ensure the durability and usability of the simulator:

a. EMERGENCY ENGINE STOP SWITCH

When the emergency engine stop switch is pressed, the engine stops and the flasher relay operates, causing the emergency light to blink.
When the emergency engine stop switch is pressed again, the emergency light stops blinking, and the engine can be restarted (see wiring diagram below).

NOTICE:
Since the emergency engine stop switch stops the engine by grounding IGT between the igniter and the Engine ECU, diagnostic code 14 will be recorded in memory if the engine is stopped by this switch.



b. SHIFT SELECTOR LEVER

The shift selector lever has been modified so that it cannot be shifted to the "P" range.

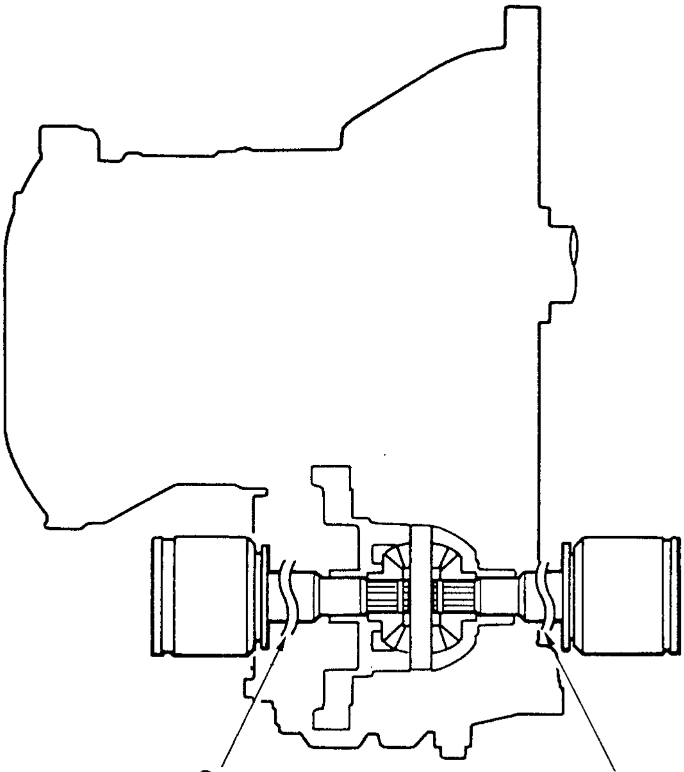
c. DRIVE SHAFTS

For safety reasons, the right and left front drive shafts are cut through at the entrance to the front axle housing. For this reason, the stall test cannot be performed.

— Reference —

Stall test:

The stall test checks the overall performance of the transmission and engine by measuring the maximum engine speeds in the "D" and "R" ranges.



4A-FE ENGINE

GENERAL

The 4A-FE engine is controlled by the TCCS (Toyota Computer-Controlled System) which uses the Engine ECU (Electronic Control Unit) with a built-in microprocessor.
The TCCS of the 4A-FE engine controls the following functions:

· EFI (Electronic Fuel Injection)

· ESA (Electronic Spark Advance)

· ISC (Idle Speed Control)

· Diagnosis

· Fail-safe function

· Emission control

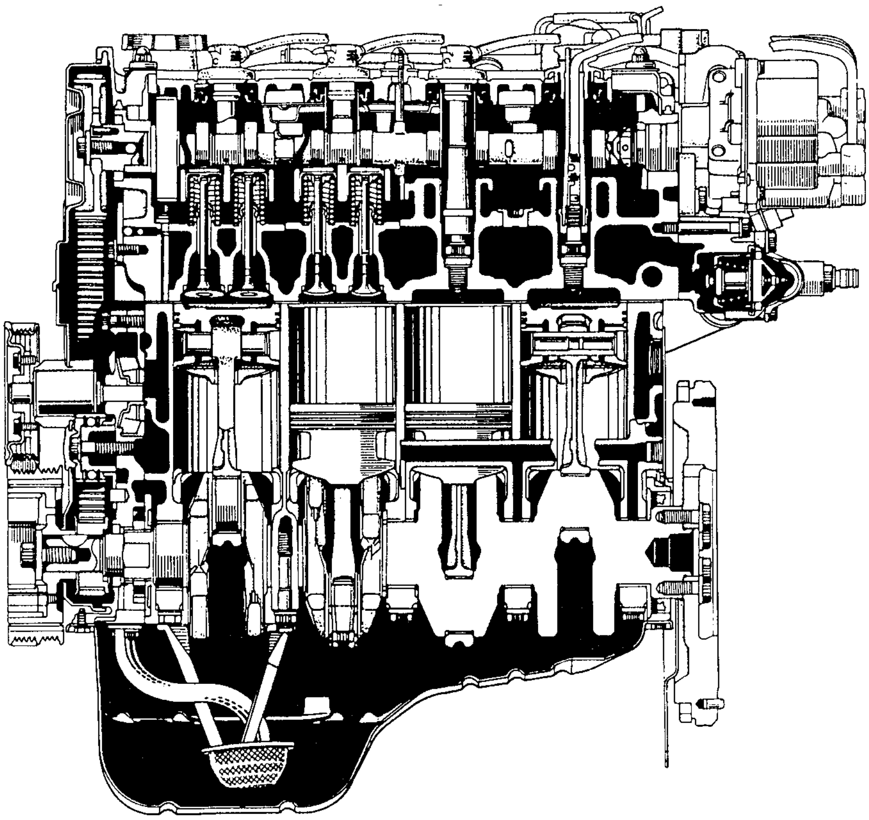
SPECIFICATIONS

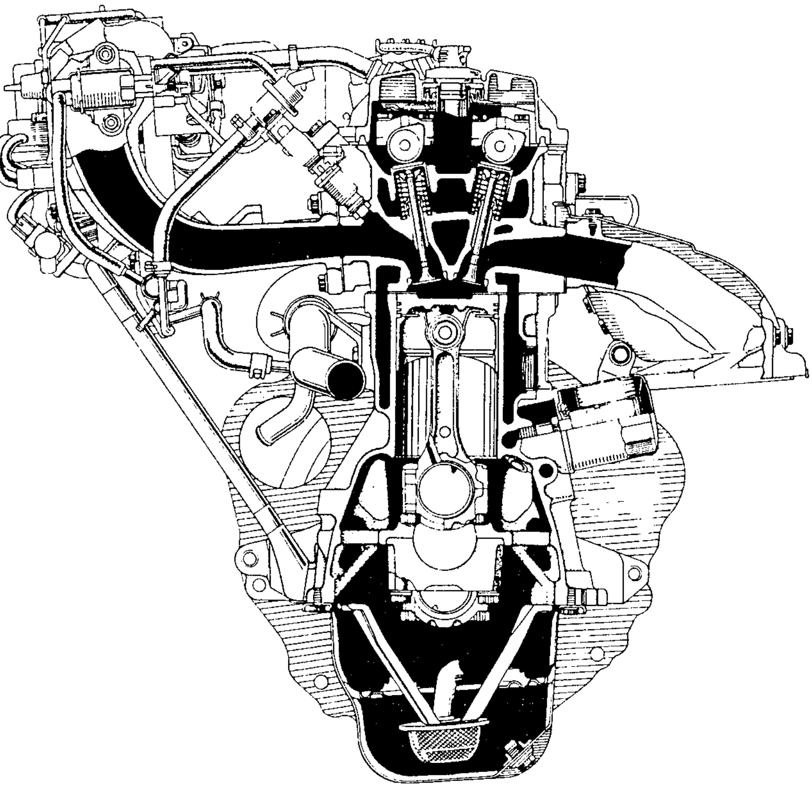
ITEM \ ENGINE		4A-FE
No. of cylinders & arrangement		4-cylinder, in-line
Valve mechanism		4 valves, DOHC, belt & gear drive
Combustion chamber		Pentroof type
Manifolds		Cross-flow
Displacement	cc (cu.in.)	1587 (96.8)
Bore X stroke	mm (in.)	81 X 77 (3.19 X 3.03)
Compression ratio		9.5 : 1
Max. output	(EEC) (SAE-NET)	77 kW @ 6,000 rpm 102 HP @ 5,800 rpm*
Max. torque	(EEC) (SAE-NET)	142 N·m @ 3,200 rpm 101 ft-lbs @ 4,800 rpm*

*Applicable only to California specification vehicles.

DESCRIPTION

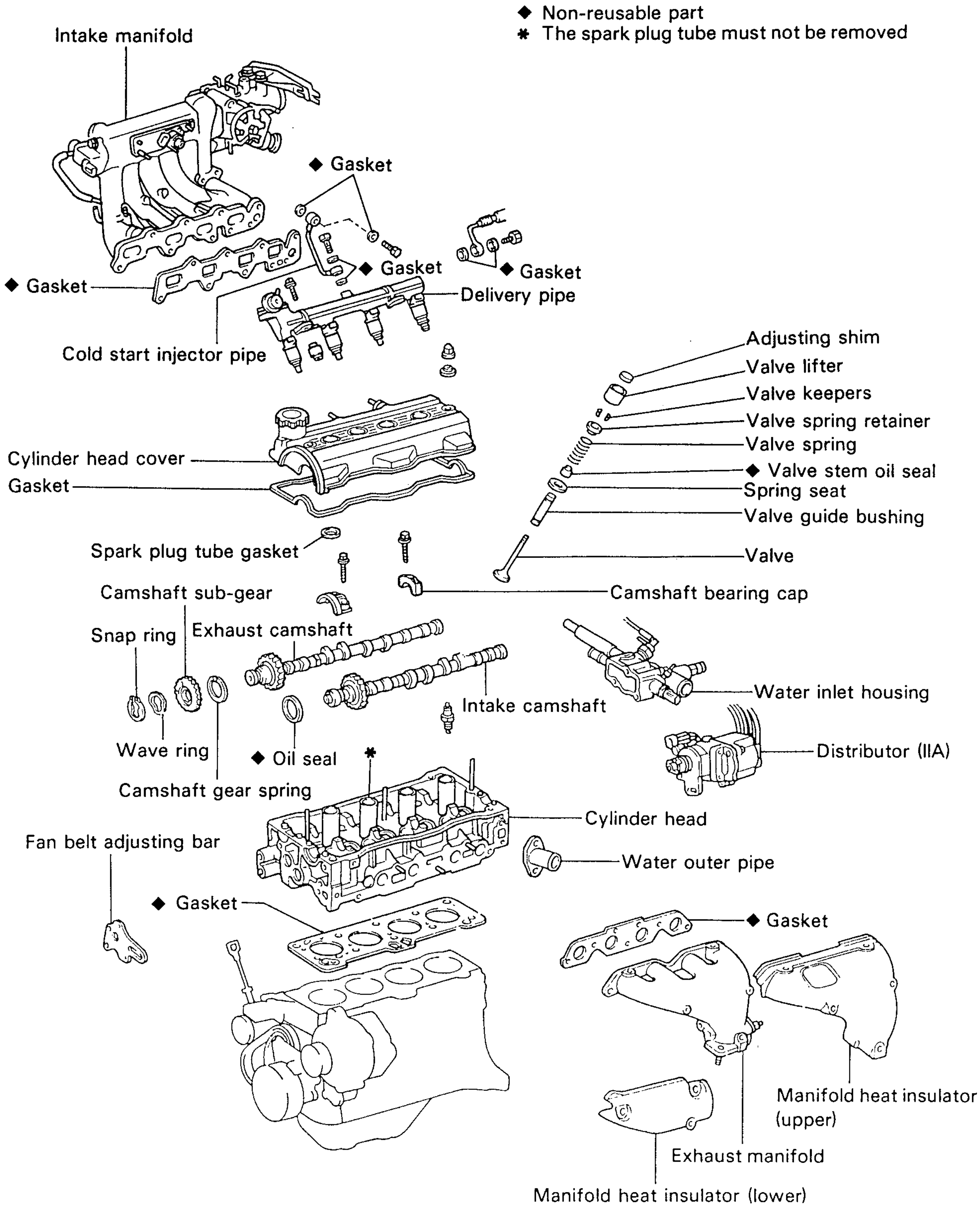
The 4A-FE engine is a dependable, lightweight and compact DOHC engine.





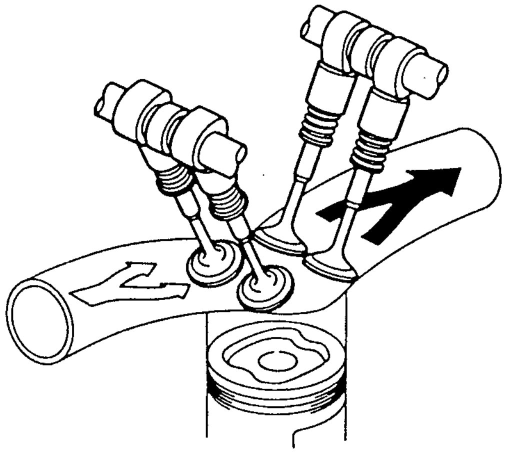
MAIN SERVICE POINTS

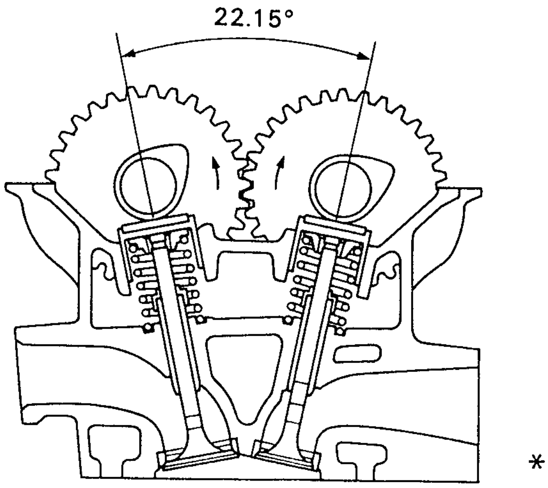
COMPONENTS



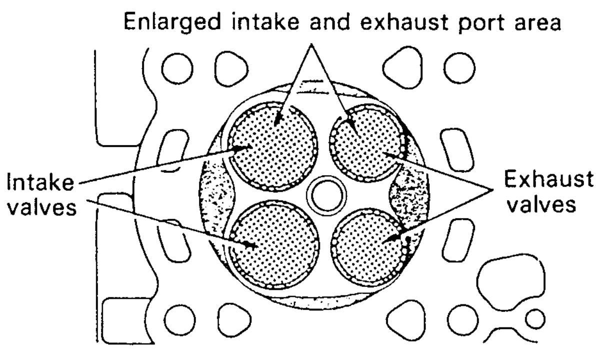
CYLINDER HEAD

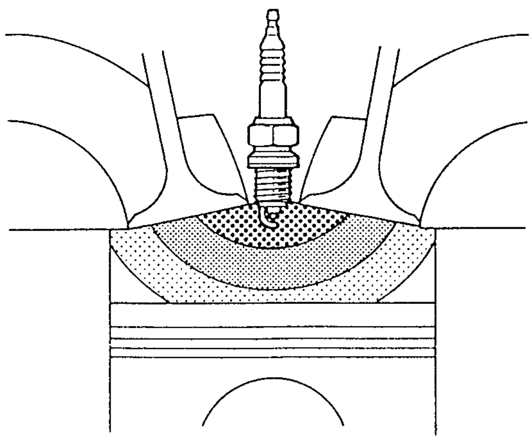
a. The cylinder head is made of a heat-conductive aluminum alloy.
b. Since the 4A-FE engine is a DOHC engine, the inlet and exhaust ports are laid out in a cross-flow arrangement, and each cylinder is provided with four valves.
c. To ensure a compact cylinder head design, the valve angle has been set to 22.15°. A train of gears transmits power from the exhaust to the intake camshaft.





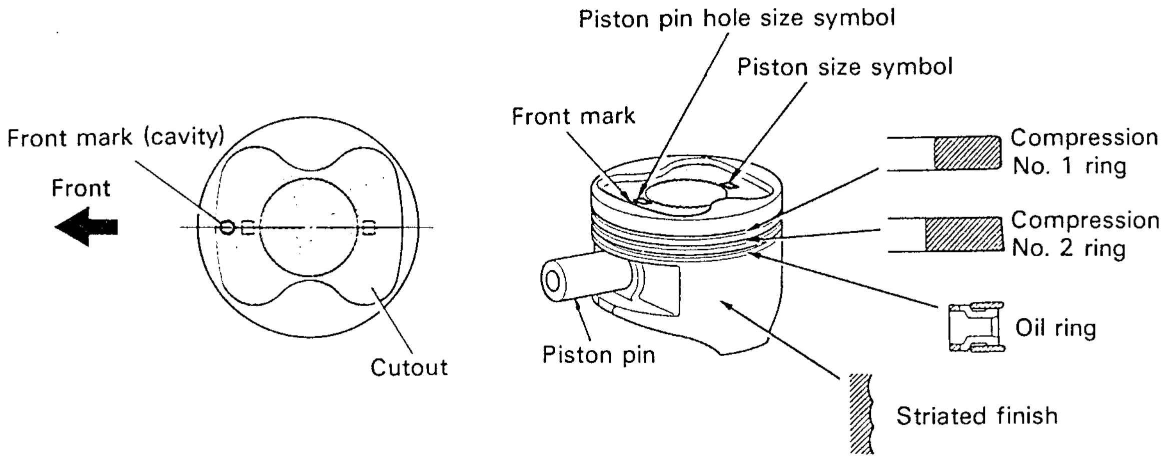
d. Inlet resistance has been decreased by enlarging the diameters of the valves and ports, resulting in an increase in intake efficiency.
e. The spark plug has been located at the center of each combustion chamber through the adoption of a pent-roof combustion chamber.
Faster and more even flame propagation has thus been made possible, and combustion efficiency has increased.





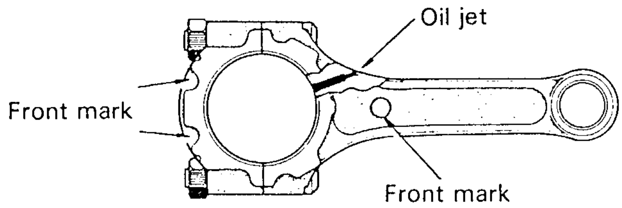
PISTON & PISTON RINGS

a. Each piston head is concave, with the space thus created forming a part of the combustion chamber. Cutouts are also provided to prevent interference between the valves and the top of the piston.
b. A semi-floating piston pin is used to link the piston and the connecting rod.
c. The skirt of each piston has a striated finish for an increase in anti-seizing properties.



CONNECTING RODS

The connecting rod has an oil jet for cooling the inside of the piston.



CONNECTING ROD BEARINGS

a. The connecting rod bearings are constructed of aluminum alloy.
b. The connecting rod bearings come in three standard sizes: 1, 2, and 3. An undersized type (U/S 0.25) is also available.

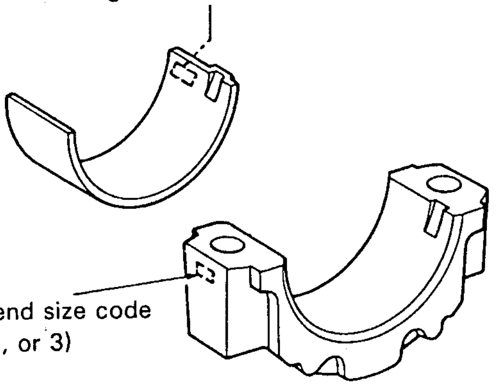
BEARING SIZE CODE	BEARING THICKNESS mm (in.)	PIN DIAMETER mm (in.)
1	1.486 ~ 1.490 (0.0585 ~ 0.0587)	
2	1.490 ~ 1.494 (0.0587 ~ 0.0588)	39.985 ~ 40.000 (1.5742 ~ 1.5748)
3	1.494 ~ 1.498 (0.0588 ~ 0.0590)	
U/S 0.25	1.607 ~ 1.613 (0.0633 ~ 0.0635)	39.745 ~ 39.755 (1.5648 ~ 1.5652)

STANDARD OIL CLEARANCE
STD 0.020 ~ 0.051 mm (0.0008 ~ 0.0020 in.)
U/S 0.25 0.019 ~ 0.065 mm (0.0007 ~ 0.0026 in.)

MAXIMUM OIL CLEARANCE
0.08 mm
(0.0031 in.)

CONNECTING ROD BEARING SELECTION

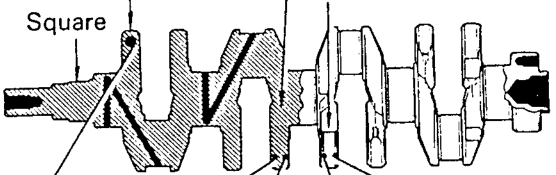
If the oil clearance of the connecting rod bearing exceeds the service limit (0.08 mm), replace the standard bearing or grind down the crank pin and use an undersized bearing.
The procedure for selecting standard-sized bearings during replacement is to select the same size as the existing one: choose a standard-sized bearing of which bearing size code (1, 2, or 3) is identical to the big end size code (1, 2, or 3) stamped on the bearing cap of the connecting rod.



STANDARD BEARING SIZE CODE = CONNECTING ROD BIG END SIZE CODE

CRANKSHAFT

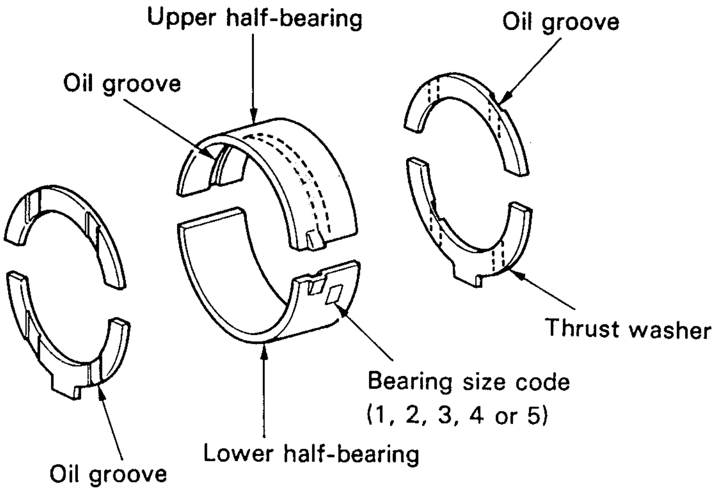
a. The crankshaft has five main journals and eight balance weights.
b. The front end of crankshaft has a square section for driving the oil pump drive gear.
c. A crankshaft journal size code (0, 1, or 2) is stamped on No. 1, No. 4 and No. 5 balance weights.



CODE	CRANKSHAFT JOURNAL SIZE
0	47.994 – 48.000 mm (1.8895 – 1.8898 in.)
1	47.988 – 47.994 mm (1.8893 – 1.8895 in.)
2	47.982 – 47.988 mm (1.8891 – 1.8893 in.)

CRANKSHAFT BEARINGS

a. The crankshaft bearings are constructed of aluminum alloy.
b. The upper half-bearing has an oil groove around its inside circumference but the lower half-bearing does not.
c. Thrust washers are used with the No. 3 (center) journal.
d. The crankshaft bearing come in five standard sizes: 1, 2, 3, 4 and 5. An undersized type (U/S 0.25) is also available.



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BEARING SIZE CODE	BEARING THICKNESS mm (in.)	CYLINDER BLOCK MAIN JOURNAL BORE mm (in.)
1	2.002 ~ 2.005 (0.0788 ~ 0.0789)	1) 52.025 ~ 52.031 (2.0482 ~ 2.0485) 2) 52.031 ~ 52.037 (2.0485 ~ 2.0487) 3) 52.037 ~ 52.043 (2.0487 ~ 2.0489)
2	2.005 ~ 2.008 (0.0789 ~ 0.0791)	
3	2.008 ~ 2.011 (0.0791 ~ 0.0792)	
4	2.011 ~ 2.014 (0.0792 ~ 0.0793)	
5	2.014 ~ 2.017 (0.0793 ~ 0.0794)	
U/S 0.25	2.121 ~ 2.127 (0.0835 ~ 0.0837)	

STANDARD OIL CLEARANCE

STD **0.015 ~ 0.033 mm**
(0.0006 ~ 0.0013 in.)

U/S 0.25 **0.018 ~ 0.056 mm**
(0.0007 ~ 0.0022 in.)

MAXIMUM OIL CLEARANCE

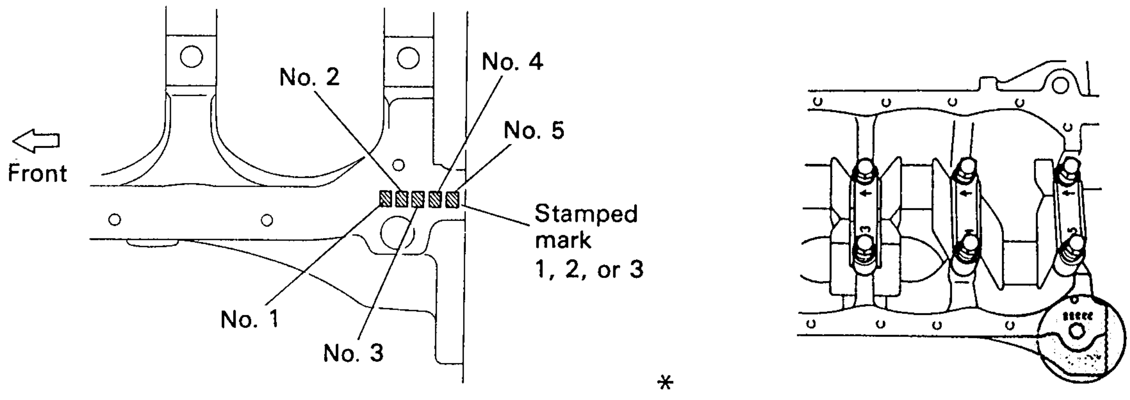
0.10 mm
(0.0039 in.)

CRANKSHAFT BEARING SELECTION

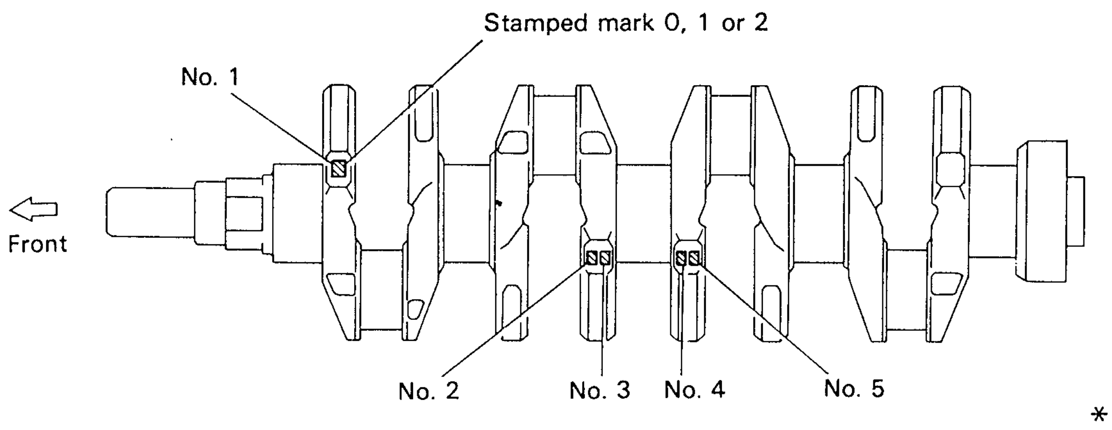
If the oil clearance of the crankshaft bearing exceeds the service limit 0.10 mm (0.0039 in.), replace the standard bearing or grind down the crankshaft main journal and use an undersized bearing.

1. LOCATION OF STAMPED SIZE CODE

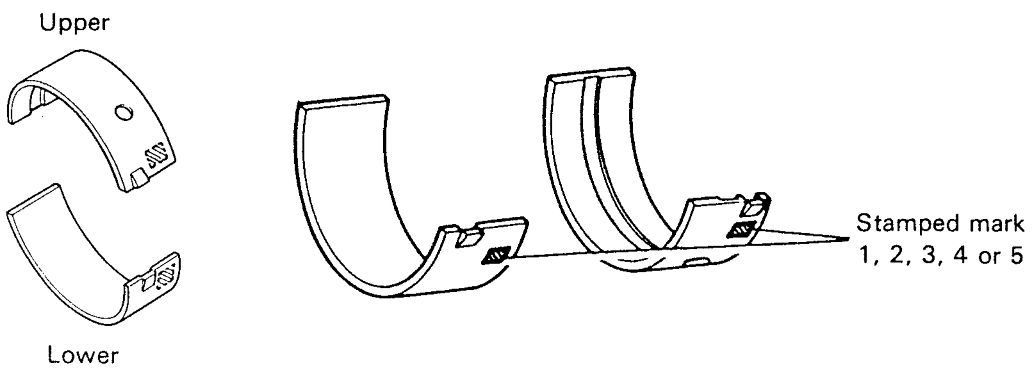
a. CYLINDER BLOCK MAIN JOURNAL BORE



b. CRANKSHAFT MAIN JOURNAL



c. CRANKSHAFT BEARING



2. BEARING SELECTION

The size code of the standard bearing to be selected is calculated by the following equation, or selected from the table below.

CYLINDER BLOCK MAIN JOURNAL BORE SIZE CODE	+	CRANKSHAFT JOURNAL SIZE CODE	=	STANDARD BEARING SIZE CODE

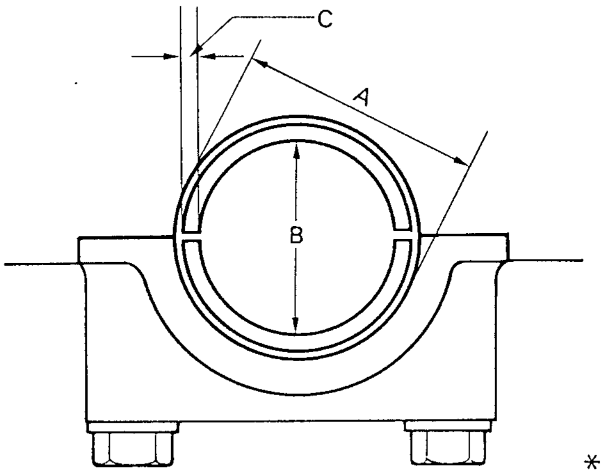
	NUMBER MARKED								
CYLINDER BLOCK MAIN JOURNAL BORE SIZE CODE	1			2			3		
CRANKSHAFT JOURNAL SIZE CODE	0	1	2	0	1	2	0	1	2
STANDARD BEARING SIZE CODE	1	2	3	2	3	4	3	4	5

3. PRACTICE

Fill in the size code and diameter or thickness in the blanks below.

	A		B		C
POSITION	CYLINDER BLOCK MAIN JOURNAL BORE		CRANKSHAFT JOURNAL		STANDARD BEARING
SIZE CODE	1	+	1	=	
DIAMETER OR THICKNESS					

=	OIL CLEARANCE



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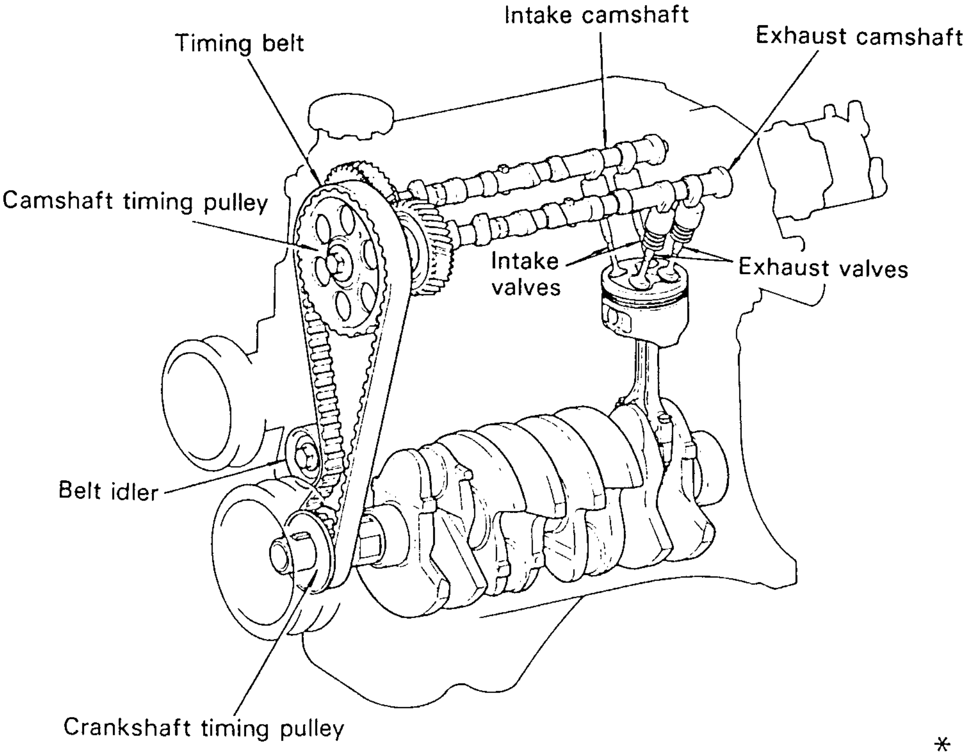
VALVE MECHANISM

1. GENERAL

a. The valves are directly operated by the two camshafts.
b. The exhaust camshaft is driven by a timing belt, while the intake camshaft is driven by the exhaust camshaft via a gear.
c. Each cylinder is equipped with two intake valves and two exhaust valves to allow a reduction in the weight of each valve. At the same time, intake and exhaust efficiency has been increased by enlarging the port area.



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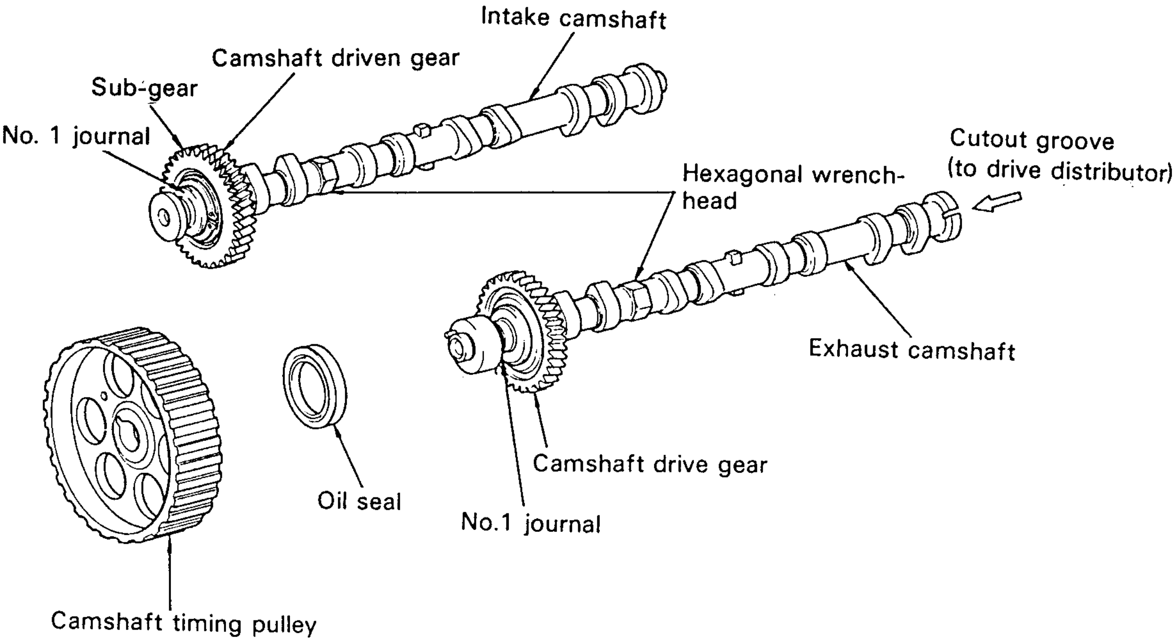
2. CAMSHAFT

a. Each camshaft has five journals, four of which are located between each cam. Thrust force is received by the thrust surface of the No. 1 journal.

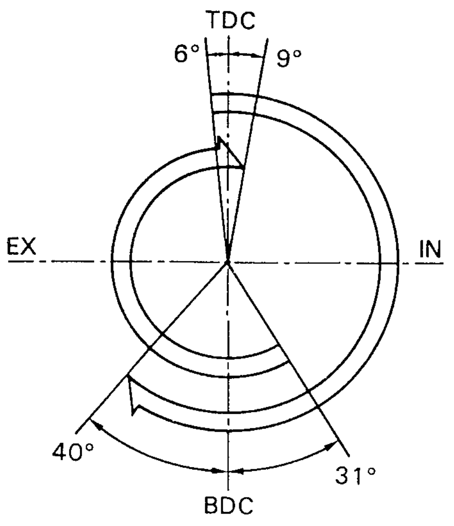
b. The intake camshaft is driven by a gear on the exhaust camshaft. A sub-gear mechanism has been adopted on the intake camshaft to control backlash and reduce gear noise.

c. The rear end of the exhaust camshaft has a cutout groove for transmitting power to the distributor.

d. Each camshaft has a hexagonal wrench-head that is used when removing or installing the camshaft or the camshaft timing pulley.



VALVE TIMING



VALVE OPENING ANGLE	
INTAKE	226°
EXHAUST	220°

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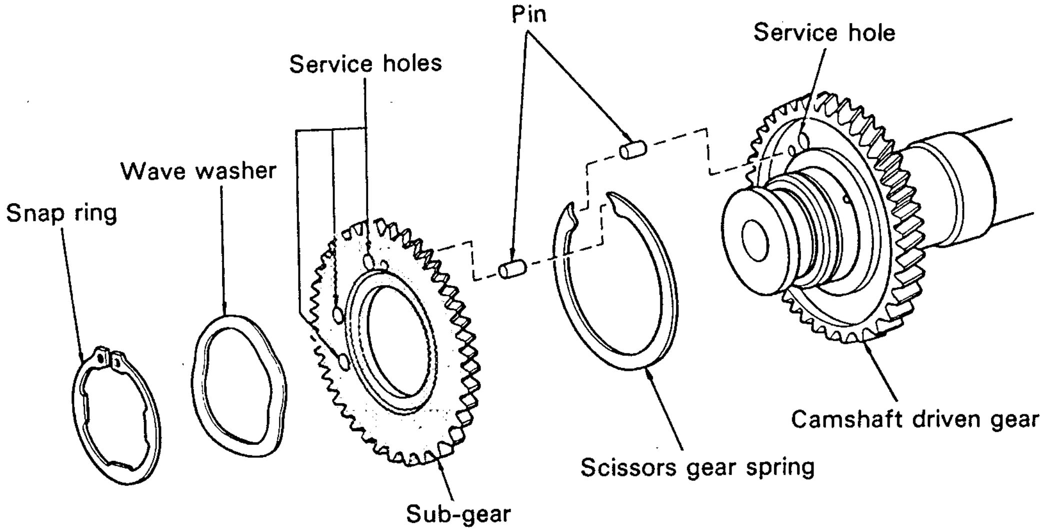
3. SUB-GEAR MECHANISM (Scissors Gear Mechanism)



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A pair of mating gears is usually provided with a clearance, called backlash, in order to protec the teeth from seizure or other damage. When the gears are subject to torque fluctuations, however, the backlash causes the gears to chatter.

To prevent such gear noise, the 4A-FE engine employs an additional sub-gear that eliminates the backlash of the intake camshaft driven gear.

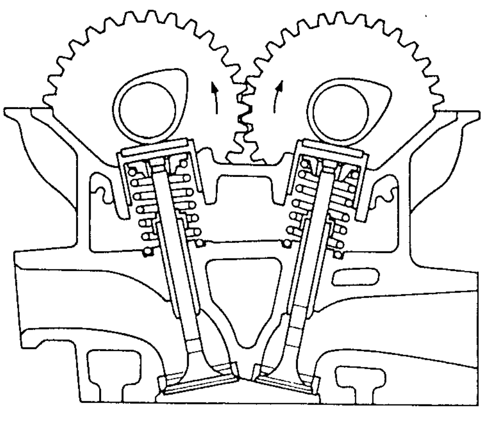
a. The camshaft driven gear, which is press-fitted onto the intake camshaft, is provided with a pin which holds one end of the scissors spring.

b. The sub-gear is secured to the intake camshaft by a snap ring and a wave washer. It has the same number of teeth as the camshaft driven gear. The pin on the sub-gear holds the other end of the scissors spring.

c. The scissors spring is located between the camshaft driven gear and the sub-gear, and its ends are held by the pins of these gears. The camshaft driven gear transmits torque in the direction of rotation to the sub-gear via the scissors spring.

d. Because this torque (which acts in the direction of sub-gear rotation) is applied by the scissors spring, the sub-gear lags approximately 20° (equivalent to a two-teeth lag) behind the camshaft driven gear.

The teeth on the driven and sub-gears are thus always engaged with the teeth of the drive gear so that the gear train is free of backlash.



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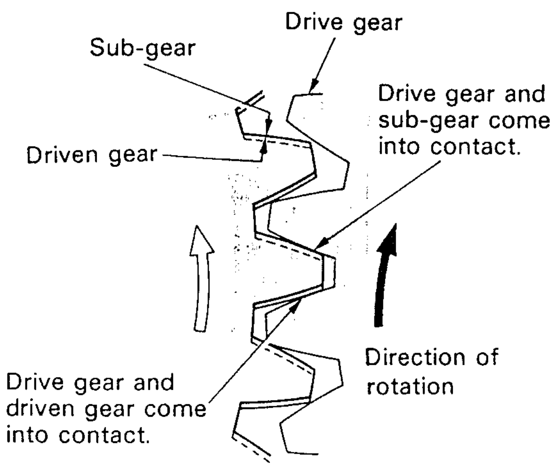

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4. REMOVAL AND INSTALLATION OF CAMSHAFTS

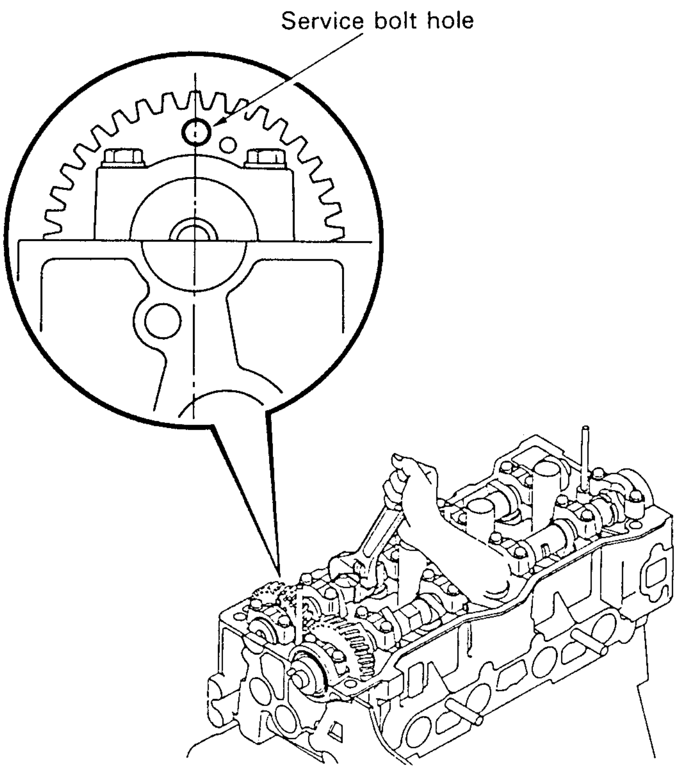
The thrust clearance of the camshafts is small, and the gears remain engaged at all times while the camshafts are installed in the cylinder head. For these reasons, when removing or installing the camshafts, pay attention to the points below:

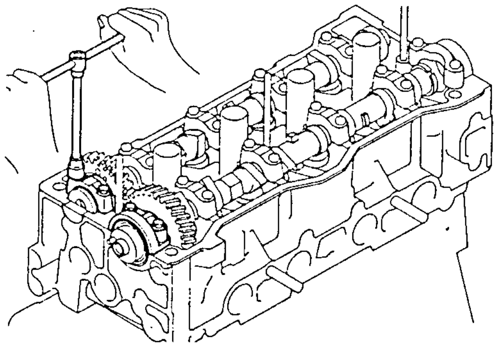
POINT 1 When removing or installing a camshaft bearing cap, set the corresponding camshaft beforehand so that the individual valve springs act evenly on it. The valve springs should lift the camshaft roughly parallel to the other camshaft when the cap is removed. This procedure prevents damage to the cylinder head (thrust surfaces).

POINT 2 The scissors gear spring transmits torque in the direction of sub-gear rotation. When removing or installing the camshafts, secure the sub-gear to the driven gear beforehand by setting the designated bolt into the service holes on the gears.

a. REMOVE INTAKE CAMSHAFT AND EXHAUST CAMSHAFT

1. Set the service bolt hole of the intake camshaft gear to the top. This helps the intake camshafts to be lifted levelly and evenly by pushing the No. 1 and No. 3 cylinder cam lobes of the intake camshaft against their valve lifters.
2. Remove the No. 1 IN and EX bearing cap bolts and then the caps.



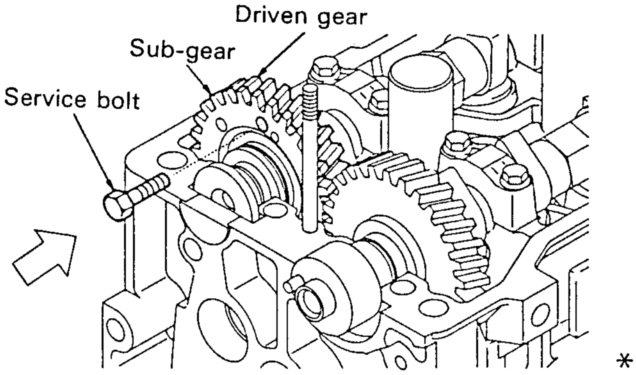


3. Secure the sub-gear to the driven gear of the intake camshaft with a service bolt.

– NOTES –

- **See Point 2.**
- **RECOMMENDED SERVICE BOLT**

Thread diameter	**6 mm**
Thread pitch	**1.0 mm**
Bolt length	**16 ~ 20 mm**



NOTE: When removing the camshaft, make certain that the torsional spring force of the sub-gear has been eliminated by the above operation.

4. Uniformly loosen each bearing cap bolt a little at a time and in the sequence shown in Fig. 1 below.
5. Remove the intake camshaft caps and camshaft.

CAUTION: Do not pry or attempt to force the camshaft with a tool or other object.

NOTE: If the camshaft cannot be lifted out straight and level, retighten the No. 3 bearing cap (see Fig. 2) and loosen the bolts of the bearing cap alternately a little at a time with the gear pulled up (do the same for the exhaust camshaft).

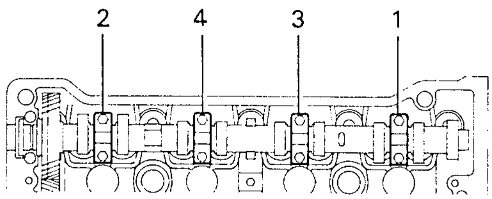


Fig. 1

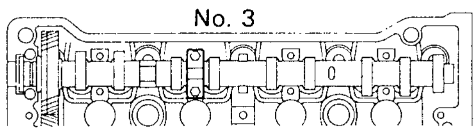


Fig. 2

6. Turn approx. 105° with the wrench.
   Set the knock-through pin as shown in Fig. 3 below.

NOTE: The above angle allows the No. 1 and No. 3 cylinder cam lobes of the exhaust camshaft to push their valve lifters evenly.

7. Uniformly loosen each bearing cap bolt a little at a time and in the sequence shown in Fig. 4 below.
8. Remove the exhaust camshaft bearing caps and camshaft.

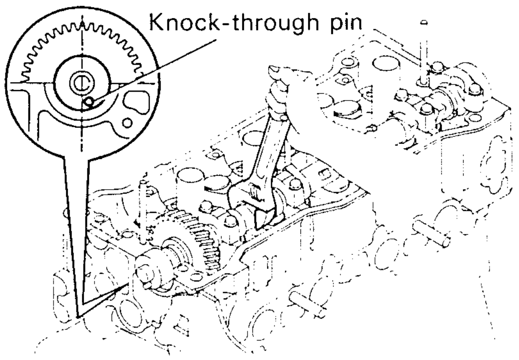


Fig. 3

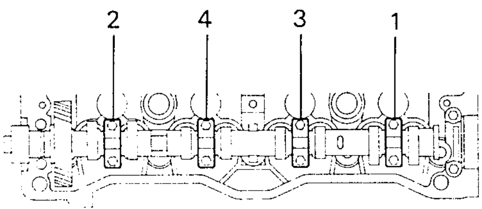


Fig. 4

b. INSTALL INTAKE CAMSHAFT AND EXHAUST CAMSHAFT

— NOTE —

See Point 1 in the previous section.

1. Apply new engine oil to all rotating surfaces.
2. Place the exhaust camshaft on the cylinder head as shown in Fig. 1 below.
3. Apply seal packing to the cylinder head as shown in Fig. 2 below.

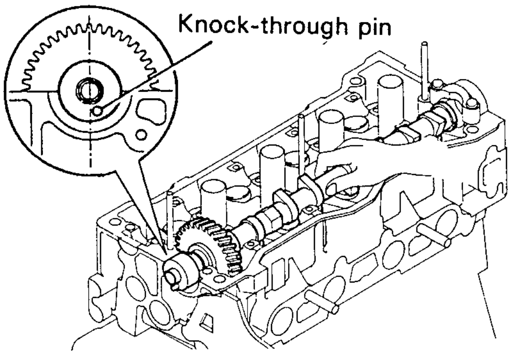


Fig. 1

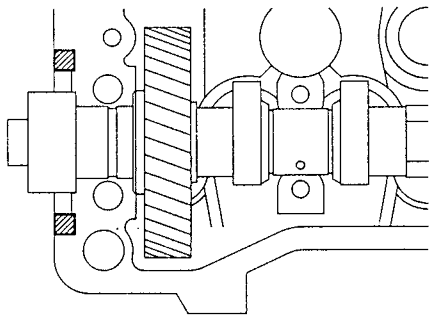


Fig. 2

4. Place the bearing caps on each journal with the arrows pointing toward the front, and install the bearing cap bolts.
5. Tighten the bearing cap bolts in several passes and in the order shown in Fig. 4 below.

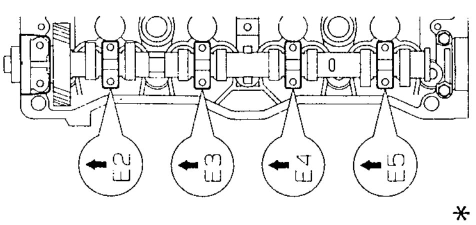


Fig. 3

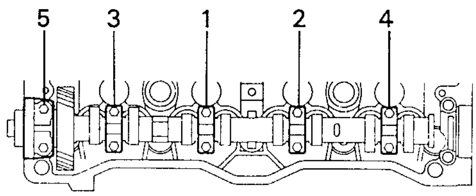
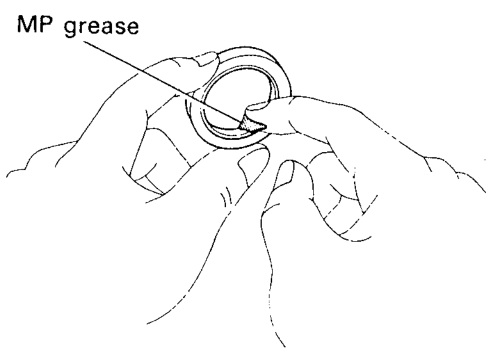
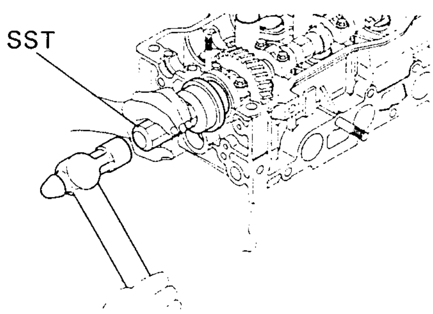


Fig. 4

6. Apply MP grease to the lip of a new camshaft oil seal.
7. Using a SST (SST 09223-46011), drive in the oil seal.





8. Set the knock-through pin of the exhaust camshaft as shown in Fig. 1 below.
9. Align the match marks stamped on the exhaust and intake camshaft gears, and engage the gears. Roll down the intake camshaft onto the cylinder head while engaging the gears with each other.

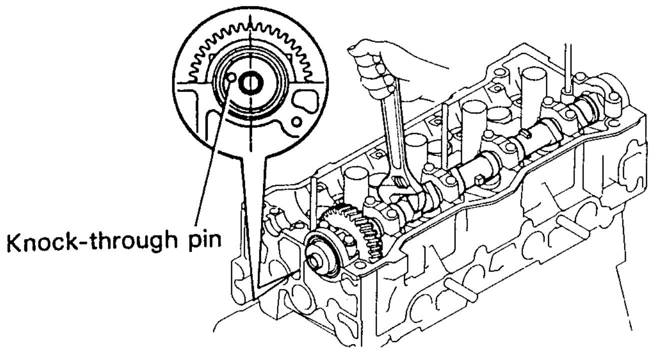


Fig. 1

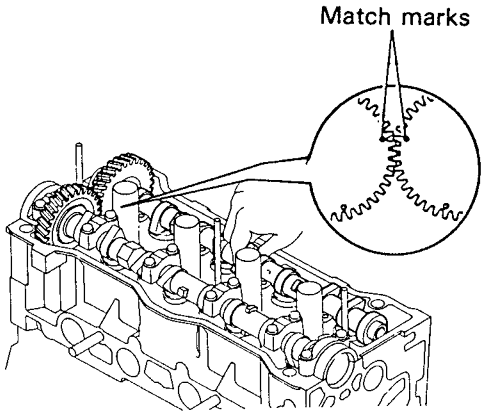


Fig. 2

10. Place the No. 2 through 5 bearing caps on each journal with the arrows pointing toward the front, and install the bearing cap bolts.
11. Tighten the bearing cap bolts in several passes and in the order shown in Fig. 4 below.

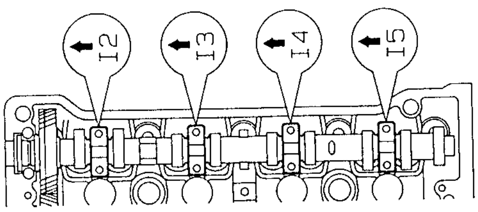


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Fig. 3

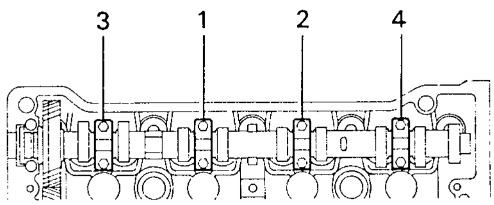
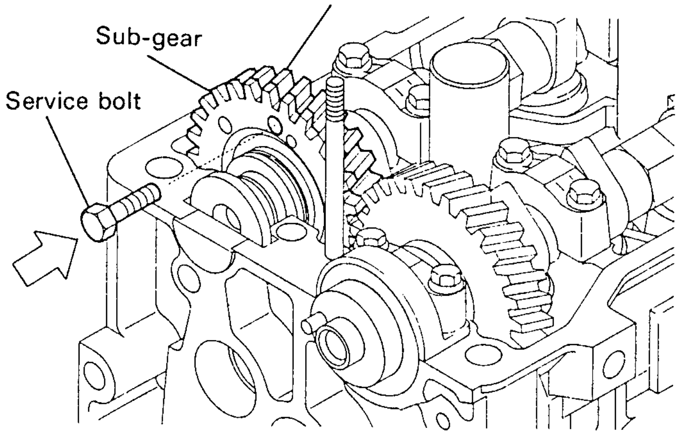


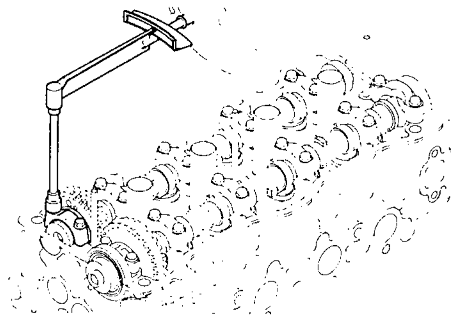
Fig. 4

12. Remove the service bolt securing the sub-gear to the driven gear.
13. Place the No. 1 bearing cap of the intake camshaft with the arrow pointing toward the front, and install the bearing cap bolts.
14. Tighten the bearing cap bolts in several passes.

– CAUTION –

If the No. 1 bearing cap does not fit properly, push the camshaft gear backwards by prying apart the cylinder head and camshaft gear with a screwdriver.





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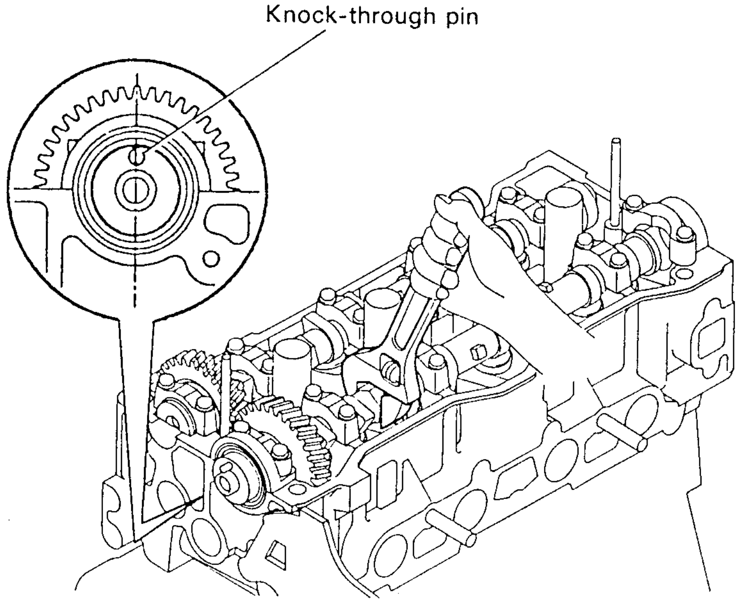
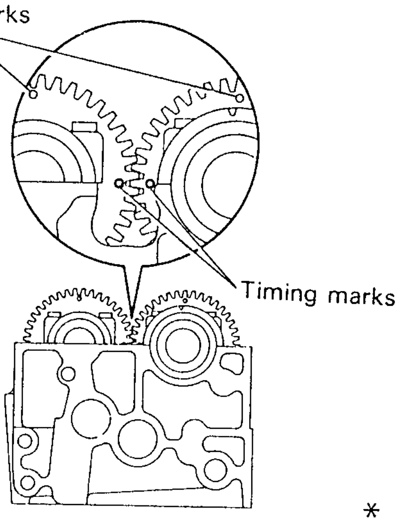
15. Turn the camshaft one revolution from TDC to TDC of the No. 1 cylinder.
16. Set the knock-through pin of the exhaust camshaft to the top.
17. Check that the timing marks (for TDC) are aligned.





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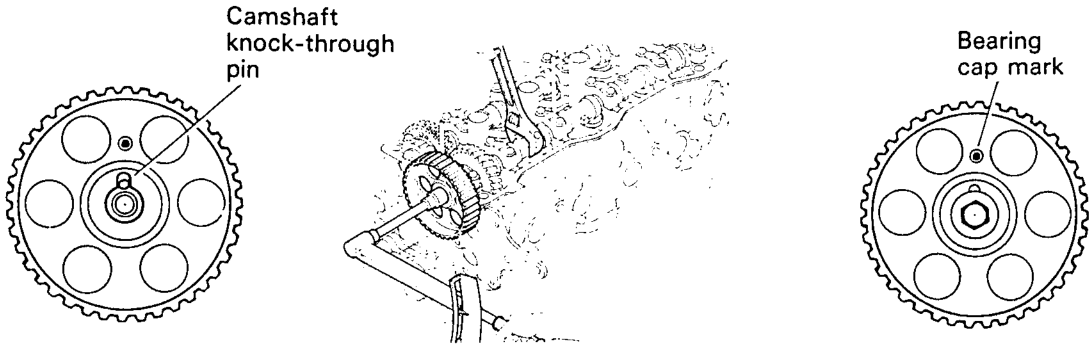
c. INSTALL CAMSHAFT TIMING PULLEY & BELT

1. Check that the camshaft bearing cap mark and the center of the small hole on the camshaft timing pulley are aligned.
2. Secure the camshaft, and tighten the camshaft timing pulley bolt.
3. Align the camshaft knock-through pin with the camshaft timing pulley as shown in the figure below.



4. Align the points marked during removal, and install the timing belt (see Fig. 1).
5. Loosen the timing belt idler pulley set bolt (see Fig. 2).
6. Turn the crankshaft two revolutions from TDC to TDC of the No. 1 cylinder.

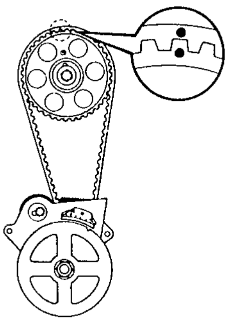


Fig. 1

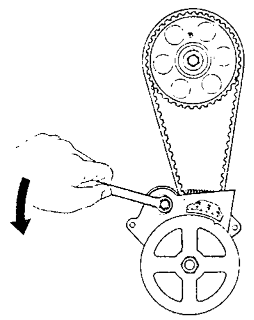


Fig. 2

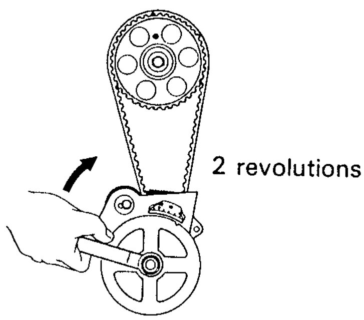


Fig. 3

7. Check the valve timing.
   Be sure that each pulley is aligned with its match mark as shown in Fig. 4 below.
8. Tighten the timing belt idler pulley set bolt.
9. Measure the timing belt tension as shown in Fig. 5 below.
10. If the measured value is not within standard, readjust with the idler pulley.

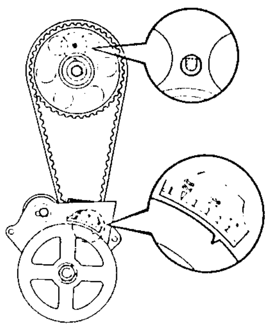


Fig. 4

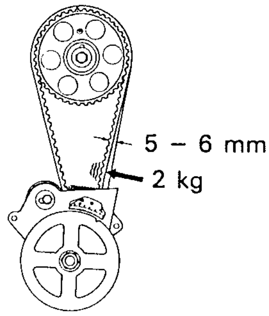


Fig. 5

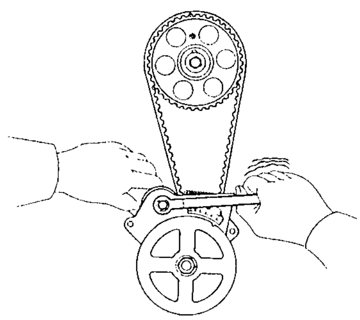
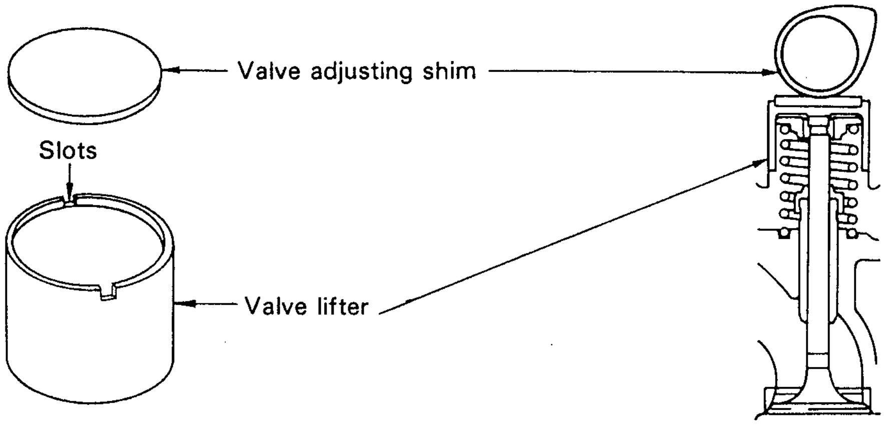


Fig. 6

5. VALVE LIFTER AND VALVE ADJUSTING SHIMS

a. The valve adjusting shims used are of an outer shim type and have been located on top of the valve lifters. This makes it unnecessary to remove the camshafts in order to replace the shims when the valve clearance is adjusted.

b. Seventeen different sizes of shims (increasing in size from 2.50 to 3.30 mm, in increments of 0.05 mm) are available.

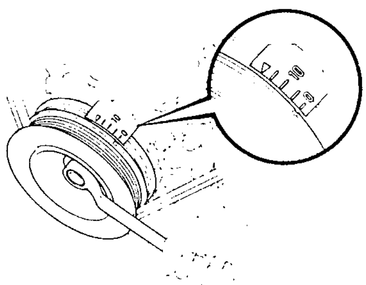


6. ADJUSTING OF VALVE CLEARANCE

a. MEASURE THE VALVE CLEARANCE

1. Set the No. 1 cylinder to TDC/compression.
2. Measure the clearance of half of the valves.

- Measure only those valves indicated as shown in Fig. 1 below.
- Record the measurements which are out of specification. They will be used later to determine the required replacement shims.



Valve clearance (cold):

Intake	**0.15 – 0.25 mm (0.006 – 0.010 in.)**
Exhaust	**0.20 – 0.30 mm (0.008 – 0.012 in.)**

3. Turn the crankshaft pulley one revolution, and measure the other valves.

- Turn the crankshaft pulley one revolution, and align the timing marks as stated in step 1 above.
- Measure only the valves indicated as shown in Fig. 2 below.

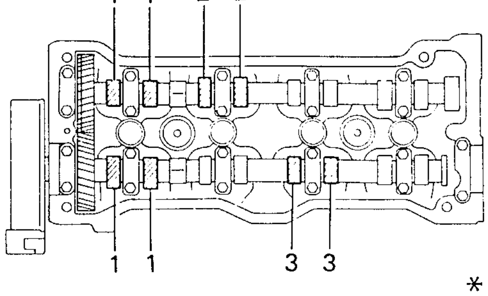


Fig. 1

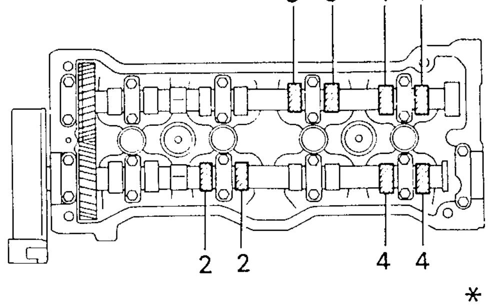
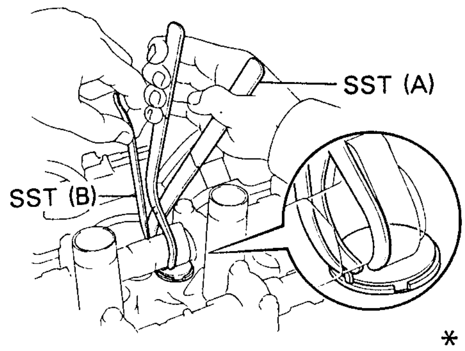
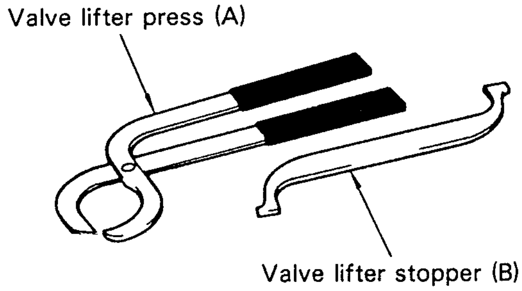


Fig. 2

b. ADJUST VALVE CLEARANCE

1. Press down the valve lifter with SST A, and hold the valve lifter down with SST B.
   SST: Valve clearance adjusting tool set 09248-55012
   Valve lifter press (A) 09248-05011
   Valve lifter stopper (B) 09248-05020





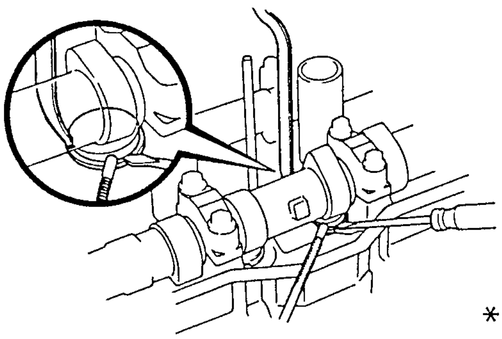
2. Remove the adjusting shim with a small screwdriver and magnetic finger.
3. Determine the replacement shim size using the following formula or the charts on the next two pages.

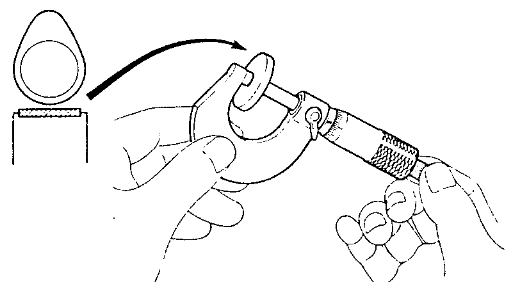
- Calculate the thickness of the new shim, so the valve clearance comes within the specified value.

T . . . . . Thickness of used shim
A . . . . . Measured valve clearance
N . . . . . Thickness of new shim

Intake side:
N = T + (A − 0.20 mm [0.008 in.])
Exhaust side:
N = T + (A − 0.25 mm [0.010 in.])

- Select a shim with a thickness that is as close as possible to the calculated values.





ADJUSTING SHIM SELECTION CHART

INTAKE VALVES

Measured clearance (mm)	Installed shim thickness (mm)																																																								
	2.500	2.525	2.550	2.575	2.600	2.620	2.625	2.640	2.650	2.660	2.675	2.680	2.700	2.720	2.725	2.740	2.750	2.760	2.775	2.780	2.800	2.820	2.825	2.840	2.850	2.860	2.875	2.880	2.900	2.920	2.925	2.940	2.950	2.960	2.975	2.980	3.000	3.020	3.025	3.040	3.050	3.060	3.075	3.080	3.100	3.120	3.125	3.140	3.150	3.160	3.175	3.180	3.200	3.225	3.250	3.275	3.300
0.000 - 0.009											02	02	02	04	04	04	04	04	06	06	06	08	08	08	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	26	26
0.010 - 0.025										02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	26	26
0.026 - 0.029									02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	26	26	28
0.030 - 0.040								02	02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	26	26	28
0.041 - 0.050								02	02	02	02	02	04	04	04	06	06	06	06	06	08	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	26	26	28
0.051 - 0.070						02	02	02	02	02	04	04	04	06	06	06	06	06	08	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	28	28
0.071 - 0.075					02	02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	28	28
0.076 - 0.090					02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	28	28	30
0.091 - 0.100					02	02	02	04	04	04	04	04	06	06	06	08	08	08	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	28	28	30
0.101 - 0.120				02	02	04	04	04	04	04	06	06	06	08	08	08	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	30	30
0.121 - 0.125			02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	30	30
0.126 - 0.140			02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	30	30	32
0.141 - 0.149			02	02	04	04	04	06	06	06	06	06	08	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	30	30	32
0.150 - 0.250																																																									
0.251 - 0.270	04	06	06	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34		
0.271 - 0.275	04	06	06	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34		
0.276 - 0.290	06	06	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34			
0.291 - 0.300	06	06	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34			
0.301 - 0.320	06	08	08	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34				
0.321 - 0.325	06	08	08	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34				
0.326 - 0.340	08	08	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34					
0.341 - 0.350	08	08	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34						
0.351 - 0.370	08	10	10	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34							
0.371 - 0.375	08	10	10	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34								
0.376 - 0.390	10	10	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34									
0.391 - 0.400	10	10	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34										
0.401 - 0.420	10	12	12	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34												
0.421 - 0.425	10	12	12	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34												
0.426 - 0.440	12	12	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34													
0.441 - 0.450	12	12	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34													
0.451 - 0.470	12	14	14	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34															
0.471 - 0.475	12	14	14	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																
0.476 - 0.490	14	14	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																	
0.491 - 0.500	14	14	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																		
0.501 - 0.520	14	16	16	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																				
0.521 - 0.525	14	16	16	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																				
0.526 - 0.540	16	16	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																					
0.541 - 0.550	16	16	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																					
0.551 - 0.570	16	18	18	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																							
0.571 - 0.575	16	18	18	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																								
0.576 - 0.590	18	18	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																									
0.591 - 0.600	18	18	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																										
0.601 - 0.620	18	20	20	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																												
0.621 - 0.625	18	20	20	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																												
0.626 - 0.640	20	20	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																													
0.641 - 0.650	20	20	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																													
0.651 - 0.670	20	22	22	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																															
0.671 - 0.675	20	22	22	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																
0.676 - 0.690	22	22	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																	
0.691 - 0.700	22	22	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																																		
0.701 - 0.720	22	24	24	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																																				
0.721 - 0.725	22	24	24	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																				
0.726 - 0.740	24	24	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																					
0.741 - 0.750	24	24	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34																																						
0.751 - 0.770	24	26	26	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																																							
0.771 - 0.775	24	26	26	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																								
0.776 - 0.790	26	26	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																									
0.791 - 0.800	26	26	28	28	30	30	30	32	32	32	32	32	34	34	34																																										
0.801 - 0.820	26	28	28	30	30	32	32	32	32	32	34	34	34																																												
0.821 - 0.825	26	28	28	30	30	32	32	32	32	34	34	34	34																																												
0.826 - 0.840	28	28	30	30	32	32	32	32	34	34	34	34																																													
0.841 - 0.850	28	28	30	30	32	32	32	34	34	34	34	34																																													
0.851 - 0.870	28	30	30	32	32	34	34	34	34	34																																															
0.871 - 0.875	28	30	30	32	32	34	34	34	34																																																
0.876 - 0.890	30	30	32	32	34	34	34	34																																																	
0.891 - 0.900	30	30	32	32	34	34	34																																																		
0.901 - 0.925	30	32	32	34	34																																																				
0.926 - 0.950	32	32	34	34																																																					
0.951 - 0.975	32	34	34																																																						
0.976 - 1.000	34	34																																																						
1.001 - 1.025	34																																																								

SHIM THICKNESSES mm (in.)

Shim No.	Thickness	Shim No.	Thickness
02	2.500 (0.0984)	20	2.950 (0.1161)
04	2.550 (0.1004)	22	3.000 (0.1181)
06	2.600 (0.1024)	24	3.050 (0.1201)
08	2.650 (0.1043)	26	3.100 (0.1220)
10	2.700 (0.1063)	28	3.150 (0.1240)
12	2.750 (0.1083)	30	3.200 (0.1260)
14	2.800 (0.1102)	32	3.250 (0.1280)
16	2.850 (0.1122)	34	3.300 (0.1299)
18	2.900 (0.1142)		

INTAKE VALVE CLEARANCE (COLD):
0.15 – 0.25 mm (0.006 – 0.010 in.)

EXAMPLE: A 2.800 mm shim is installed, and the measured clearance is 0.450 mm. Replace the 2.800 mm shim with shim No. 24 (3.050 mm).

ADJUSTING SHIM SELECTION CHART

EXHAUST VALVES

Measured clearance (mm)	Installed shim thickness (mm)																																																							
	2.500	2.525	2.550	2.575	2.600	2.620	2.625	2.640	2.650	2.660	2.675	2.680	2.700	2.720	2.725	2.740	2.750	2.760	2.775	2.780	2.800	2.820	2.825	2.840	2.850	2.860	2.875	2.880	2.900	2.920	2.925	2.940	2.950	2.960	2.975	2.980	3.000	3.020	3.025	3.040	3.050	3.060	3.075	3.080	3.100	3.120	3.125	3.140	3.150	3.160	3.175	3.180	3.200	3.225	3.250	3.275	3.300
0.000 – 0.009														02	02	02	02	02	04	04	04	06	06	06	06	06	08	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	24	24
0.010 – 0.025														02	02	02	02	04	04	04	06	06	06	06	06	08	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	24	26
0.026 – 0.040													02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	24	24	26
0.041 – 0.050												02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	24	24	26
0.051 – 0.070											02	02	02	04	04	04	04	04	06	06	06	08	08	08	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	26	26
0.071 – 0.090									02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	26	26	28
0.091 – 0.100								02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	26	26	28
0.101 – 0.120						02	02	02	02	02	04	04	04	06	06	06	06	06	08	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	28	28
0.121 – 0.140					02	02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	28	28	30
0.141 – 0.150					02	02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	28	28	30
0.151 – 0.170				02	02	04	04	04	04	04	06	06	06	08	08	08	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	30	30
0.171 – 0.190			02	02	04	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	30	30	32
0.191 – 0.199			02	02	04	04	04	06	06	06	06	08	08	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	30	30	32
0.200 – 0.300																																																									
0.301 – 0.320	04	06	06	08	08	10	10	10	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34		
0.321 – 0.325	04	06	06	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34		
0.326 – 0.340	06	06	08	08	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34			
0.341 – 0.350	06	06	08	08	10	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34			
0.351 – 0.370	06	08	08	10	10	12	12	12	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34				
0.371 – 0.375	06	08	08	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34				
0.376 – 0.390	08	08	10	10	12	12	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34					
0.391 – 0.400	08	08	10	10	12	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34					
0.401 – 0.420	08	10	10	12	12	14	14	14	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34							
0.421 – 0.425	08	10	10	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34								
0.426 – 0.440	10	10	12	12	14	14	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34									
0.441 – 0.450	10	10	12	12	14	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34										
0.451 – 0.470	10	12	12	14	14	16	16	16	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34												
0.471 – 0.475	10	12	12	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34												
0.476 – 0.490	12	12	14	14	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34													
0.491 – 0.500	12	12	14	14	16	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34													
0.501 – 0.520	12	14	14	16	16	18	18	18	18	18	20	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34															
0.521 – 0.525	12	14	14	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																
0.526 – 0.540	14	14	16	16	18	18	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																	
0.541 – 0.550	14	14	16	16	18	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																		
0.551 – 0.570	14	16	16	18	18	20	20	20	20	20	22	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																				
0.571 – 0.575	14	16	16	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																				
0.576 – 0.590	16	16	18	18	20	20	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																					
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0.601 – 0.620	16	18	18	20	20	22	22	22	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																							
0.621 – 0.625	16	18	18	20	20	22	22	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																								
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0.651 – 0.670	18	20	20	22	22	24	24	24	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																												
0.671 – 0.675	18	20	20	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																												
0.676 – 0.690	20	20	22	22	24	24	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																													
0.691 – 0.700	20	20	22	22	24	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																													
0.701 – 0.720	20	22	22	24	24	26	26	26	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																															
0.721 – 0.725	20	22	22	24	24	26	26	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																
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0.741 – 0.750	22	22	24	24	26	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																																		
0.751 – 0.770	22	24	24	26	26	28	28	28	28	28	30	30	30	32	32	32	32	32	34	34	34																																				
0.771 – 0.775	22	24	24	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																				
0.776 – 0.790	24	24	26	26	28	28	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																					
0.791 – 0.800	24	24	26	26	28	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																																					
0.801 – 0.820	24	26	26	28	28	30	30	30	30	30	32	32	32	34	34	34	34	34																																							
0.821 – 0.825	24	26	26	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																								
0.826 – 0.840	26	26	28	28	30	30	30	30	32	32	32	32	34	34	34	34																																									
0.841 – 0.850	26	26	28	28	30	30	30	32	32	32	32	32	34	34	34																																										
0.851 – 0.870	26	28	28	30	30	32	32	32	32	32	34	34	34																																												
0.871 – 0.875	26	28	28	30	30	32	32	32	32	34	34	34	34																																												
0.876 – 0.890	28	28	30	30	32	32	32	32	34	34	34	34																																													
0.891 – 0.900	28	28	30	30	32	32	32	34	34	34	34	34																																													
0.901 – 0.925	28	30	30	32	32	34	34	34	34																																																
0.926 – 0.950	30	30	32	32	34	34	34																																																		
0.951 – 0.975	30	32	32	34	34																																																				
0.976 – 1.000	32	32	34	34																																																					
1.001 – 1.025	32	34	34																																																						
1.026 – 1.050	34	34																																																							
1.051 – 1.075	34																																																								

SHIM THICKNESSES mm (in.)

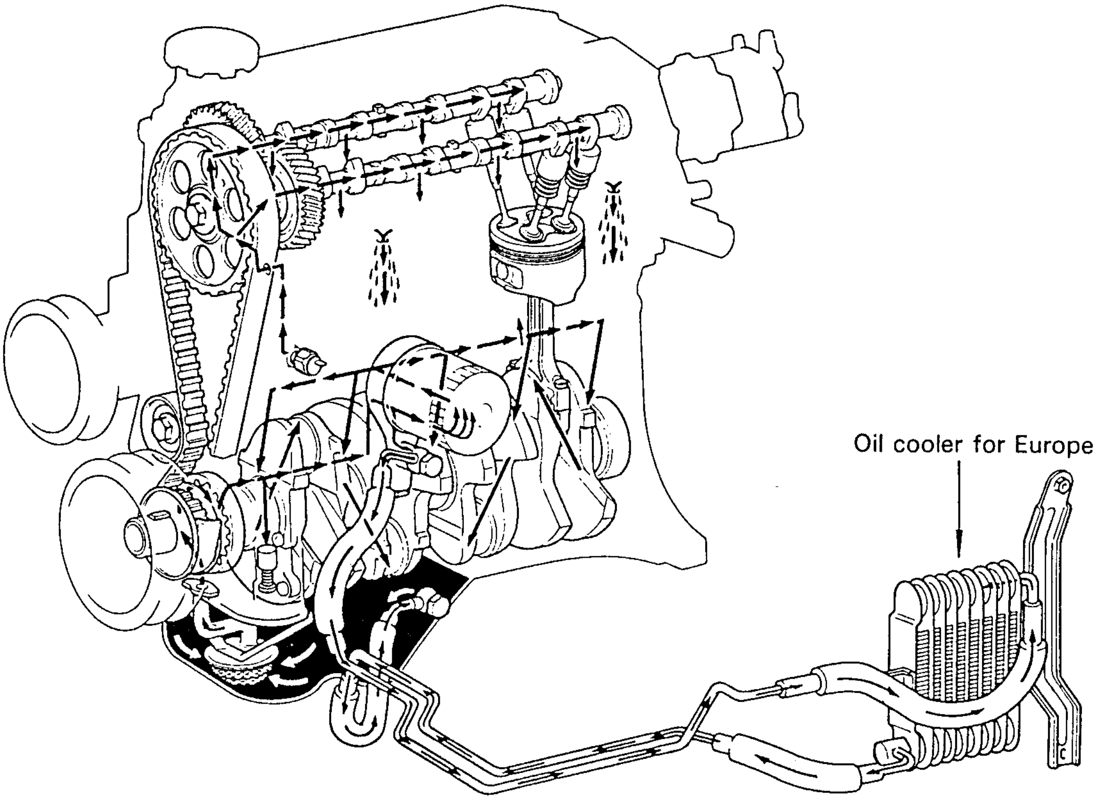
Shim No.	Thickness	Shim No.	Thickness
02	2.500 (0.0984)	20	2.950 (0.1161)
04	2.550 (0.1004)	22	3.000 (0.1181)
06	2.600 (0.1024)	24	3.050 (0.1201)
08	2.650 (0.1043)	26	3.100 (0.1220)
10	2.700 (0.1063)	28	3.150 (0.1240)
12	2.750 (0.1083)	30	3.200 (0.1260)
14	2.800 (0.1102)	32	3.250 (0.1280)
16	2.850 (0.1122)	34	3.300 (0.1299)
18	2.900 (0.1142)		

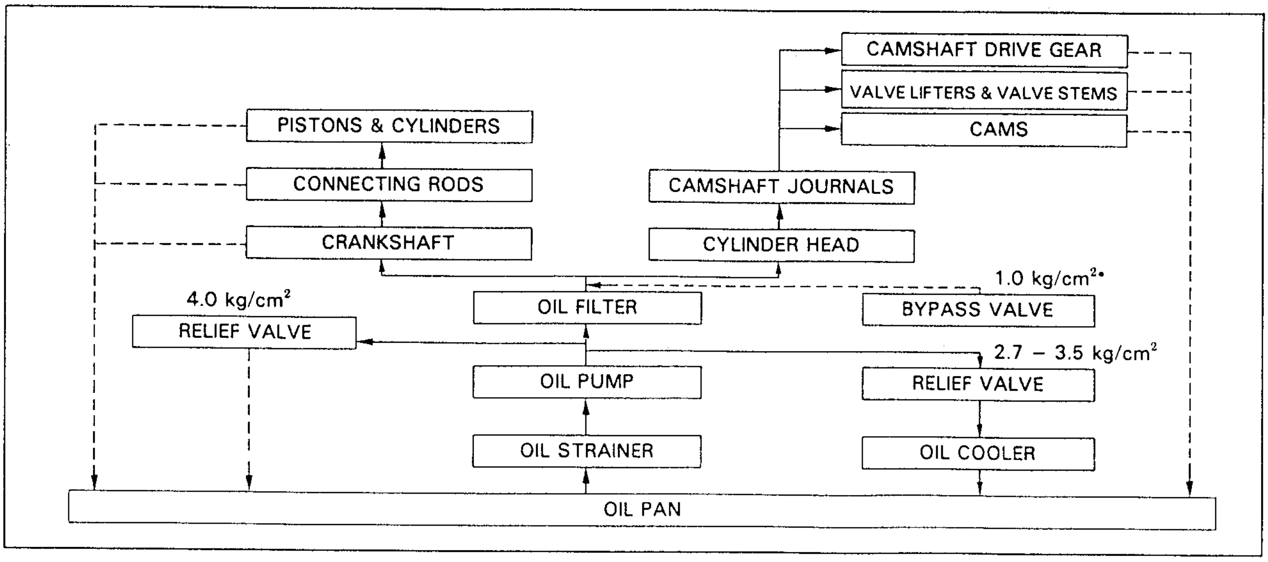
EXHAUST VALVE CLEARANCE (COLD):
0.20 – 0.30 mm (0.008 – 0.012 in.)

EXAMPLE: A 2.800 mm shim is installed and the measured clearance is 0.450 mm. Replace the 2.800 mm shim with shim No. 22 (3.000 mm).

LUBRICATION SYSTEM

a. The lubrication system is fully pressurized and all of the oil passes through an oil filter.
b. The oil pump is driven by the crankshaft directly.
c. The gasket used for the oil pan is FIPG (Formed-In-Place Gasket) liquid sealant.





* DIFFERENCE BETWEEN INLET AND OUTLET PRESSURE.

INTAKE SYSTEM

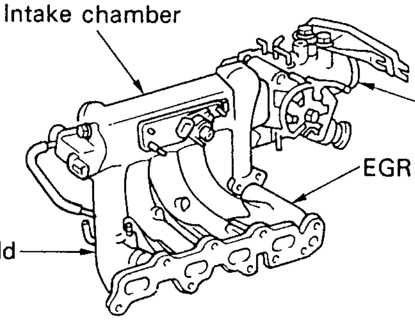
1. THROTTLE BODY

(See P.50)

2. INTAKE MANIFOLD

a. The intake manifold, intake chamber, and EGR port have been combined into one unit.

b. The intake manifold has four independent long ports, which use the inertial charging effect to increase the amount of air that can be drawn into the cylinders, thus increasing the torque generated by the engine at low and medium speeds.



IGNITION SYSTEM

1. GENERAL

A fully-transistorized ignition system is used, but ignition timing is controlled by the ESA (Electronic Spark Advance) system. ESA is one of the functions of the TCCS.

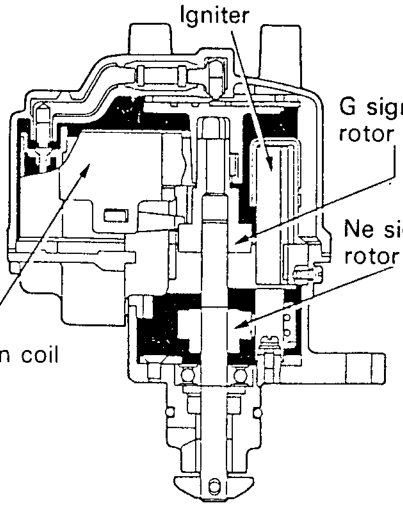
2. DISTRIBUTOR

a. The IIA (Integrated Ignition Assembly) incorporating the ignition coil and igniter in the distributor is installed on the cylinder head.

b. The crankshaft angle and engine rpm sensors are used with the ESA system in place of the conventional vacuum controller and governor mechanism.

– NOTE –

See p.56 for details on the distributor and ignitor, and p.72 for details on the ESA system.



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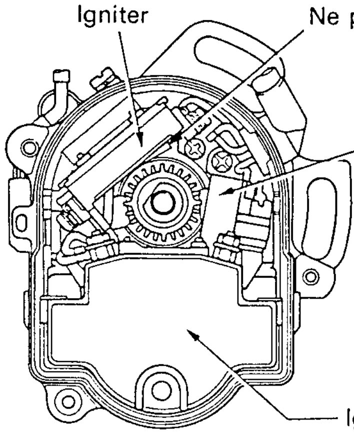
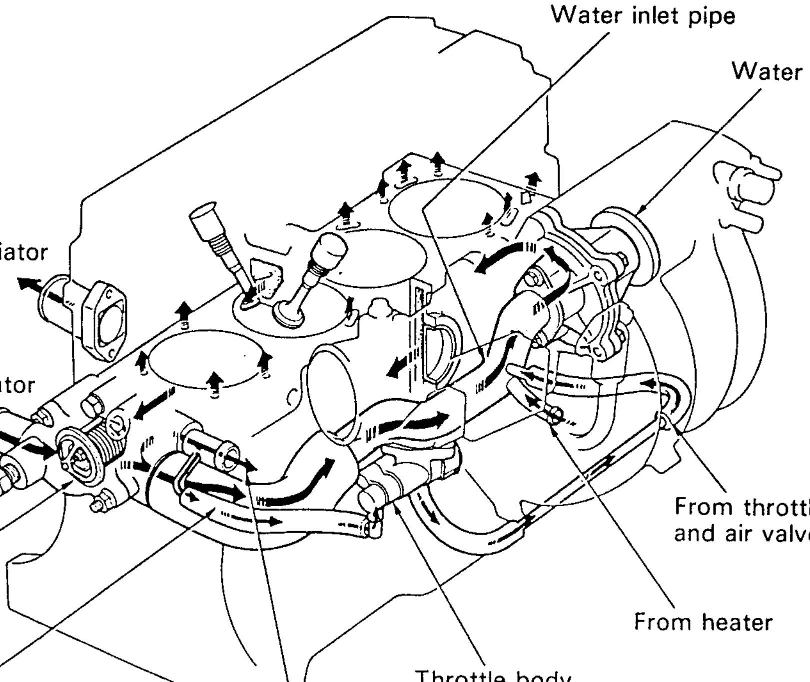


*

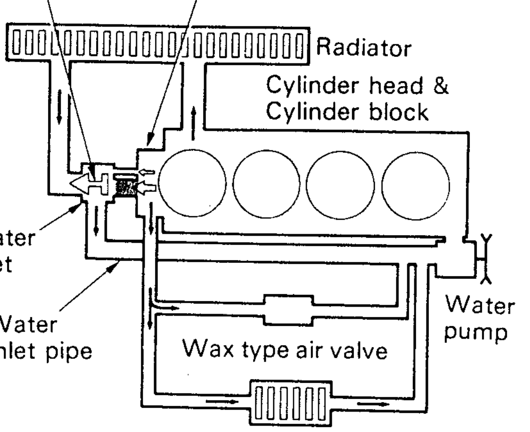
COOLING SYSTEM

There are two types of cooling systems, differentiated by the position where the thermostat is mounted. In one type, the thermostat is mounted in the water inlet, and in the other type, it is mounted in the water outlet. Cooling systems can also differ in whether or not a bypass valve for controlling the bypass circuit is included.

In recent engines, the most commonly used systems include a thermostat with a bypass valve.



- A wax type air valve is located between the water inlet housing and the water pump, and is installed in parallel with the heater circuit.



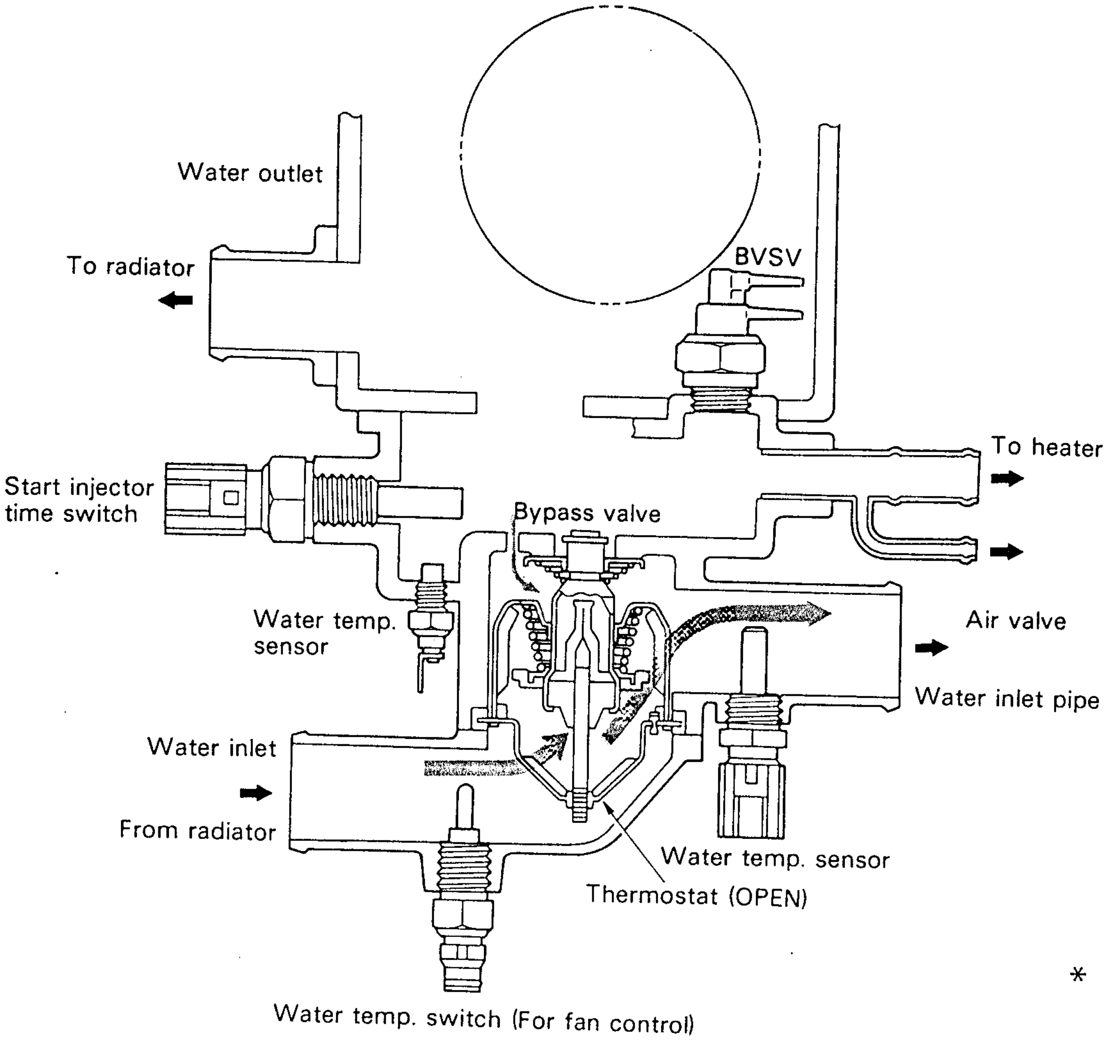
☐ : Coolant is always circulating while the engine is running.

■ : Coolant is always circulating while the engine warms up and the thermostat is open, but the volume of coolant circulating is greatly decreased.

☐ : Coolant circulates only when the engine is hot and the thermostat is open.

*

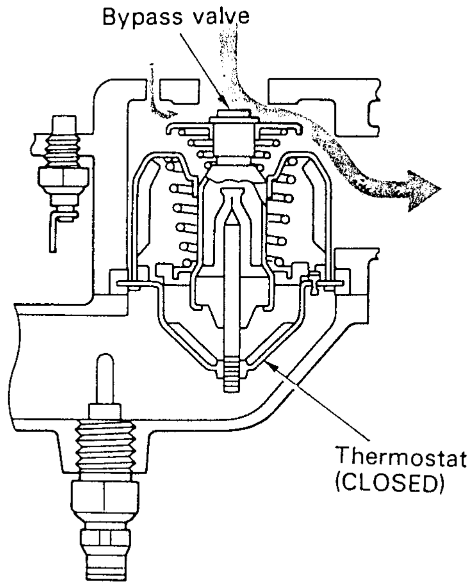
LAYOUT OF WATER INLET HOUSING



*

– CAUTION –

An engine equipped with a thermostat with a built-in bypass valve should not be run with the thermostat removed.
In engines with a bypass valve in the bypass circuit, the bypass circuit is wider than in the type without a bypass valve. If the engine is run with the thermostat with bypass valve removed, most of the coolant will flow through the bypass circuit, resulting in engine overheating. (This is because the radiator offers resistance to the flow of coolant, so it is easier for coolant to flow through the bypass circuit.)



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TCCS (Toyota Computer-Controlled System)

GENERAL

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

1. EFI (Electronic Fuel Injection)

The ECU determines the duration of fuel injection according to intake manifold pressure, engine speed, coolant temperature, and other signals and sends control signals to the fuel injectors. The fuel injection system in the 4A-FE engine is a simultaneous injection system.

2. ESA (Electronic Spark Advance)

The ECU determines the amount of ignition advance over the initial set timing of the distributor by the intake manifold pressure, engine speed, coolant temperature, and other signals and sends control signals to the igniters.

3. ISC (Idle Speed Control)

By means of engine speed signals and coolant temperature signals, the ECU sends control signals to the ACV (air control valve) so that the actual idle speed becomes the same as the target idle speed stored in the ECU.

4. DIAGNOSIS

The ECU is constantly monitoring signals from each sensor. If the ECU detects a malfunction signal, the CHECK ENGINE lamp on the combination meter lights up and informs the driver of the malfunction.

The nature of the malfunction is stored in code in the ECU memory, and when the TE1 and E1 terminals in the check connector are connected, the ECU outputs the malfunction code by flashing the CHECK ENGINE lamp.

5. FAIL-SAFE FUNCTION

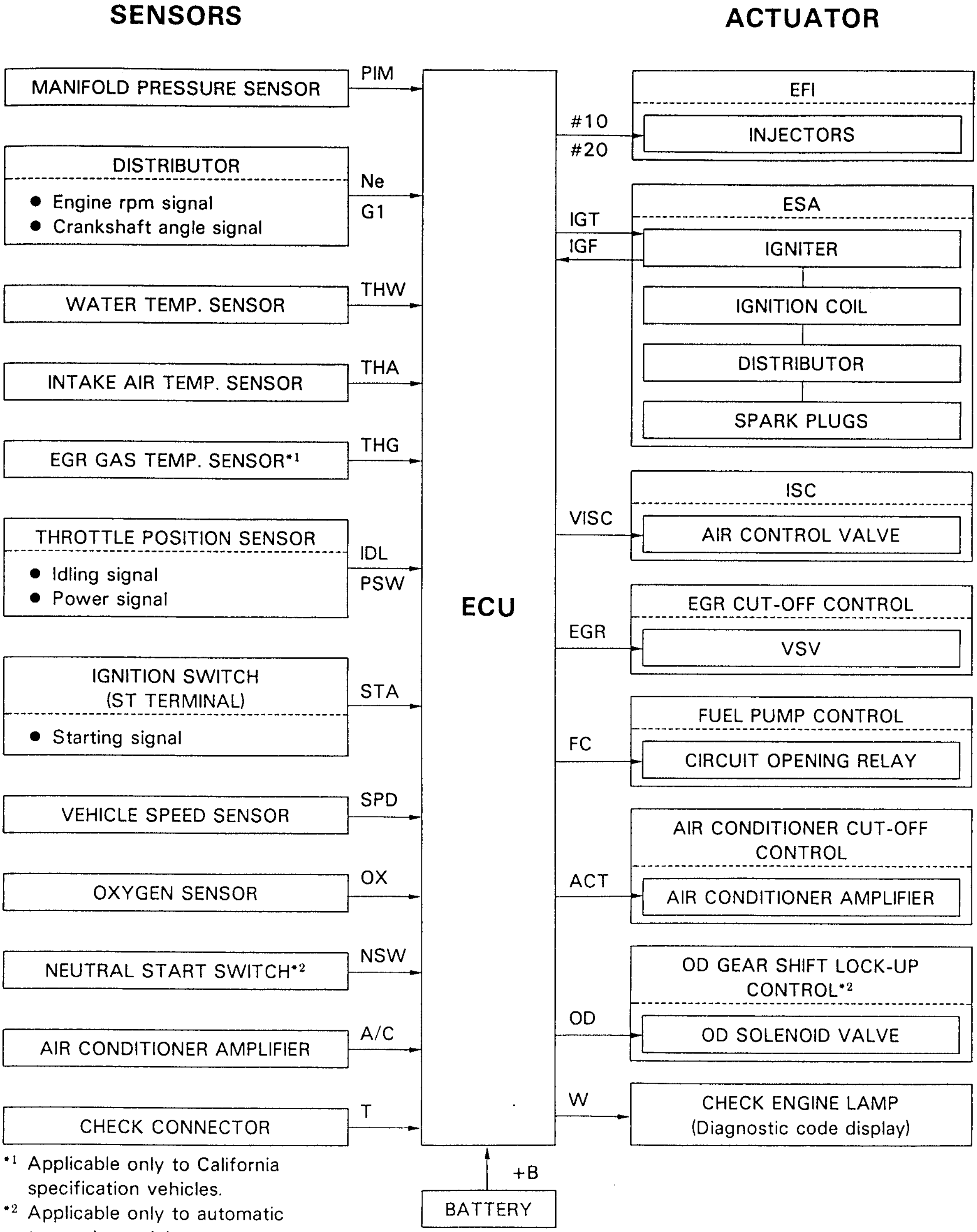
If the ECU judges from the signals from each sensor that there is a malfunction, it continues engine operation using its own data or it stops the engine.

6. EMISSION CONTROL

The ECU sends signals to the EGR VSV to cut the EGR bases on coolant temperature, engine speed, neutral start switch, or intake manifold pressure signals. This system maintains driveability at a low coolant temperature, under light or high load condition, or at high engine speed, etc.

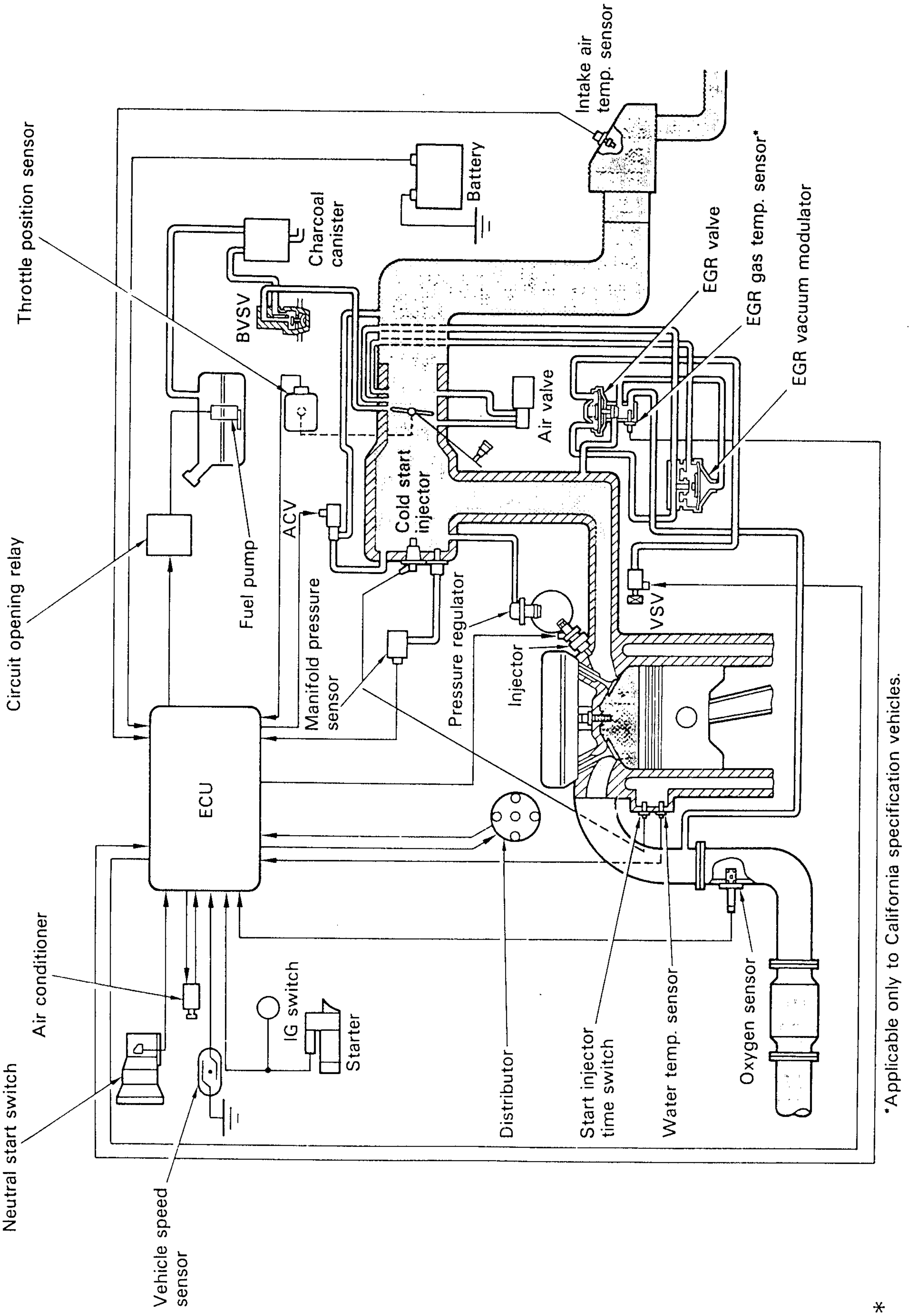
CONSTRUCTION

The engine control system can be divided into three groups: the sensors, ECU, and actuator.

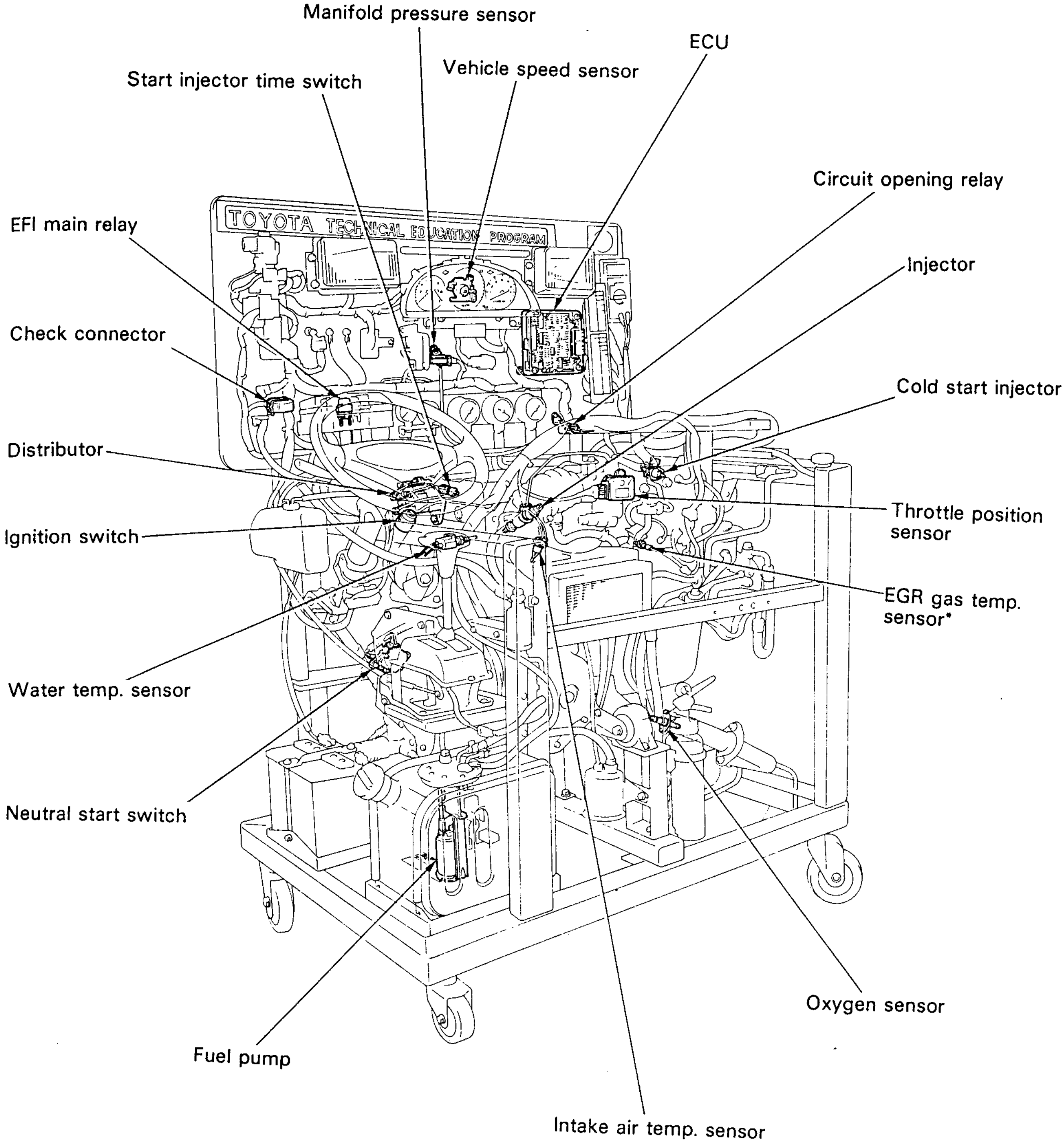


*1 Applicable only to California specification vehicles.
*2 Applicable only to automatic transaxle models.

TCCS DIAGRAM



ARRANGEMENT OF TCCS COMPONENTS

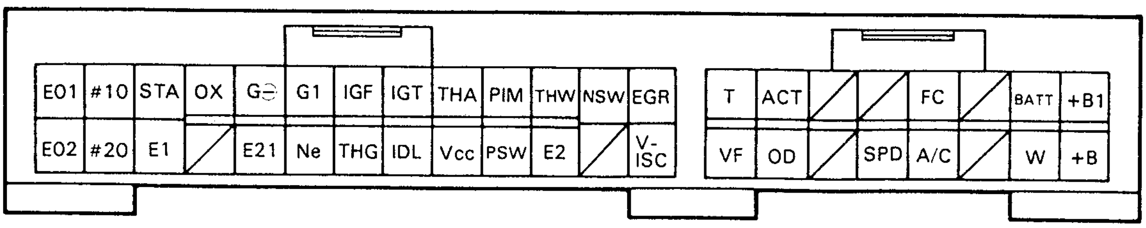


*Applicable only to California specification vehicles.

ECU CONNECTOR

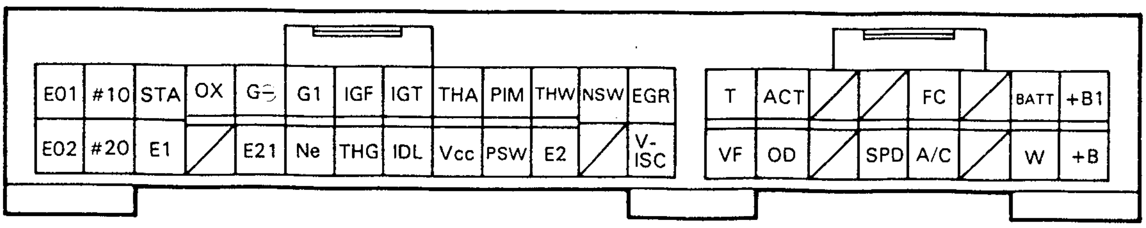
TERMINAL SYMBOL, NAME, AND CONNECTION (1)

SYMBOL	TERMINAL NAME [AND CONNECTION]	
#10	No Meaning	[Injectors]
#20	↑	↑
A/C	Air conditioner compressor signal	[Air con. magetic clutch, amplifier, etc.]
ACT	Air conditioner cut	[Air con. (acceleration cut) amplifier]
+B	Battery (power source for ECU)	[EFI main relay]
+B1	↑ ↑	↑
BATT	Battery (back-up power source for ECU)	[Battery]
E01	Earth (ground)	[Intake manifold]
E02	↑	↑
E1	↑	[Intake manifold, sensor, etc.]
E2	↑	[Sensors]
E21	↑	↑
EGR	Exhaust gas recirculation	[VSV for EGR control]
FC	Fuel pump control	[Circuit opening relay]
G1	Group No. 1	[Distributor]
G⊖	Group minus	↑



TERMINAL SYMBOL, NAME, AND CONNECTION (2)

SYMBOL	TERMINAL NAME	[AND CONNECTION]
IDL	Idle switch	[Throttle position sensor]
IGF	Ignition fail (confirmation) signal	[Igniter]
IGT	Ignition timing signal	↑
Ne	Number of engine revolutions	[Distributor]
NSW	Neutral start switch	[Ignition switch ST terminal and Neutral start switch]
OX	Oxygen sensor	[Oxygen sensor]
OD	Overdrive cut signal	OD solenoid
PSW	Power switch	[Throttle position sensor]
PIM	Pressure intake manifold	[Intake manifold pressure sensor]
SPD	Vehicle speed	[Vehicle speed sensor]
STA	Starter	[Ignition switch ST terminal or neutral start switch
T	Test terminal	[Check connector]
THA	Thermo intake air	[Intake air temp. sensor]
THG	Thermo exhaust gas	[Exhaust gas temp. sensor]
THW	Thermo water	[Water temp. sensor]
V-ISC	VSV type idle speed control	[VSV ACV for Idle speed control]
VF	Voltage feedback	[Check connector]
Vcc	Voltage constant control (5 V power source)	[Intake manifold pressure sensor]
W	CHECK ENGINE warning lamp	[CHECK ENGINE lamp]



EFI (Electronic Fuel Injection)

EFI is not one single system – the components and functions that make it up actually belong to three different systems: the fuel system, the air induction system, and the electronic control system.

1. FUEL SYSTEM

Fuel is pressurized by an electric pump (turbine type), then flows to the injectors through the filter. There is one injector for each cylinder, and it injects fuel whenever its valve is opened by the solenoid. 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.

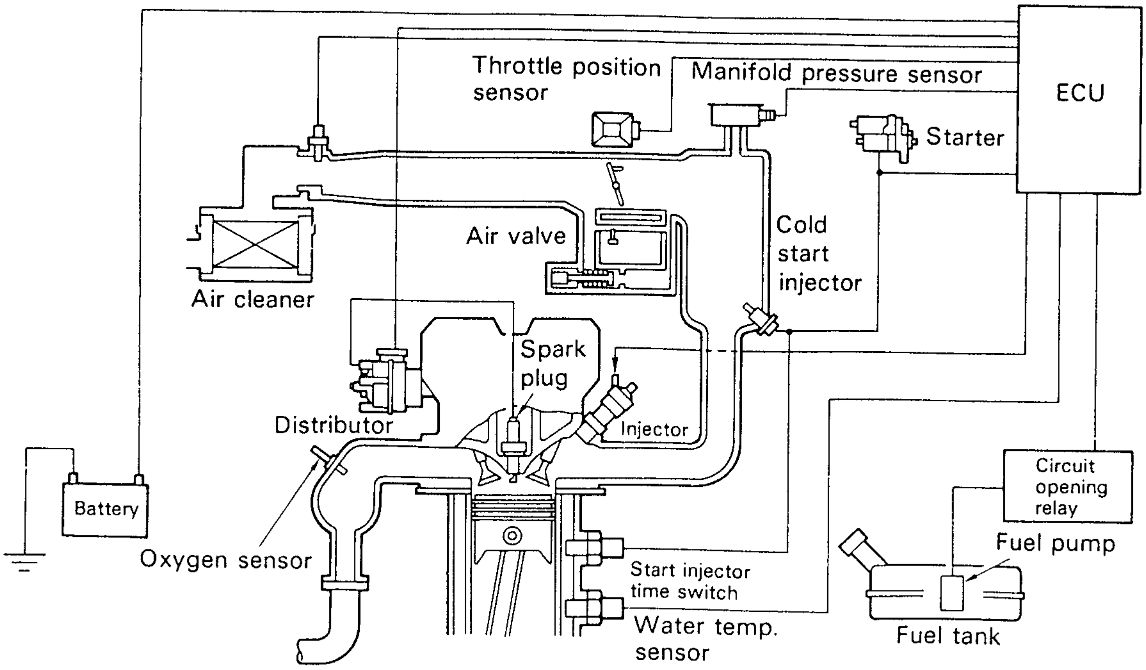
2. AIR INDUCTION SYSTEM

Intake air from the air cleaner is supplied to the engine through the throttle body and intake manifold, then flows to each intake port. The intake manifold pressure is measured by the manifold pressure sensor, and its signals are used by the ECU to determine the basic injection duration. Also there is an air valve for bypassing the throttle valve in order to increase engine idle speed when the engine is cold.

3. ELECTRONIC CONTROL SYSTEM

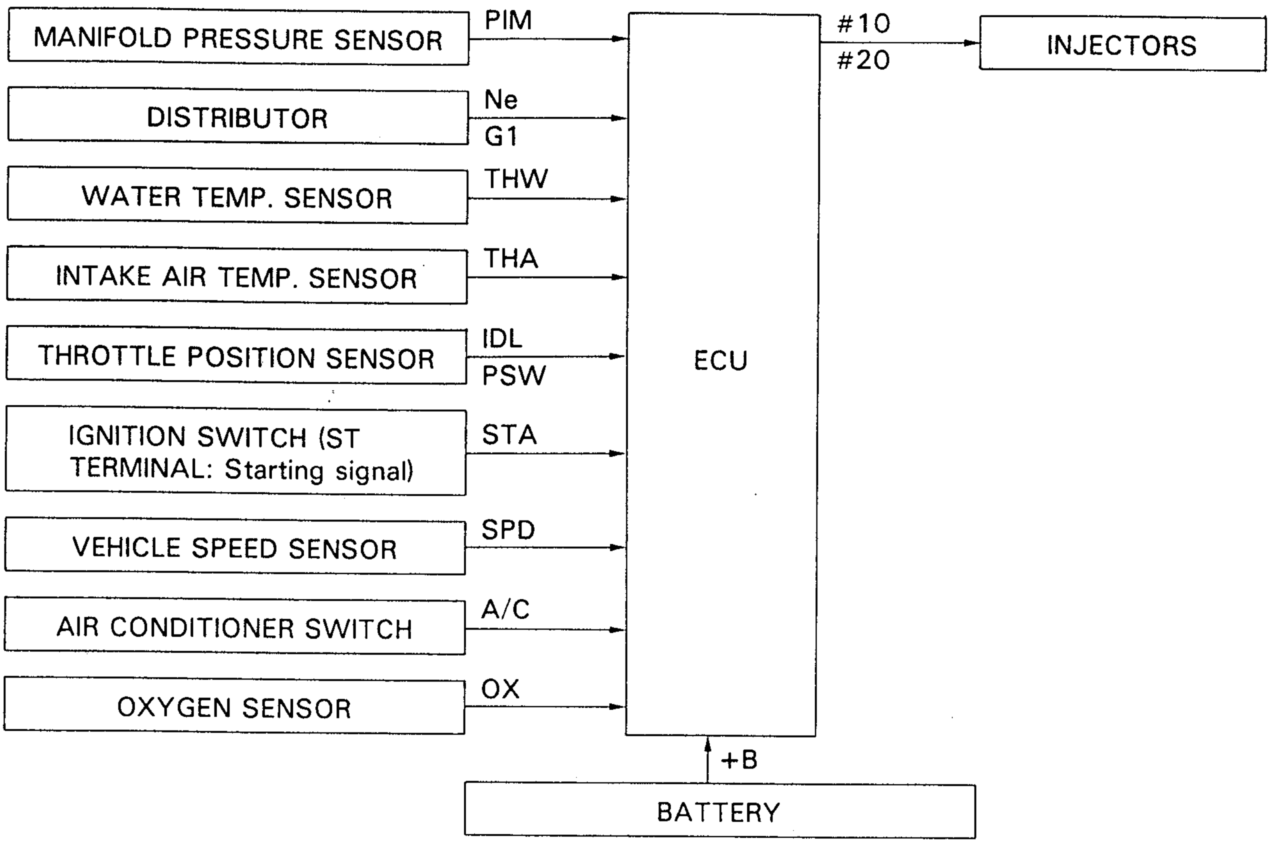
The ECU controls the injection duration based upon data stored in its memory and signals from the sensors.
This means that the 4A-FE engine is capable of controlling the fuel injection duration much more precisely.

4. FUNCTION OF ECU

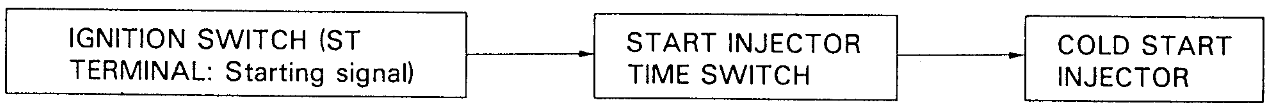


BLOCK DIAGRAM

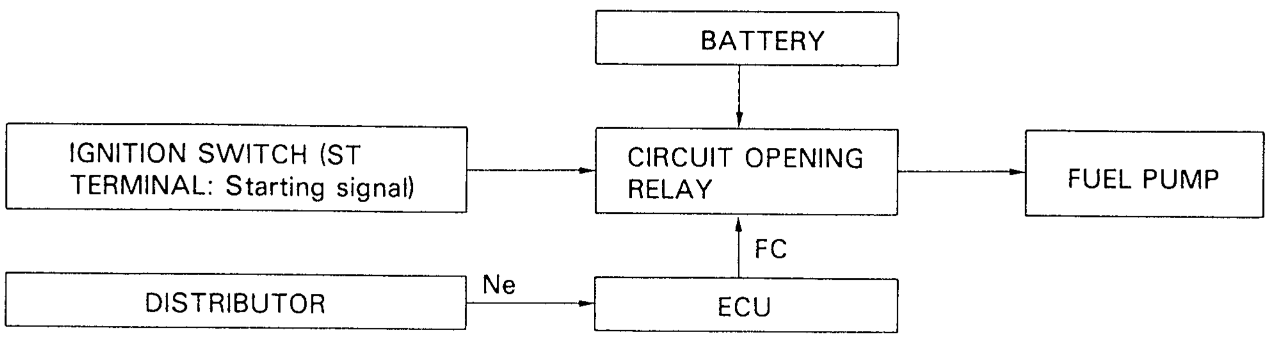
1. CONTROL OF FUEL INJECTION DURATION CONTROL



2. COLD START INJECTOR CONTROL



3. FUEL PUMP CONTROL



1. FUEL SYSTEM

FUEL PUMP

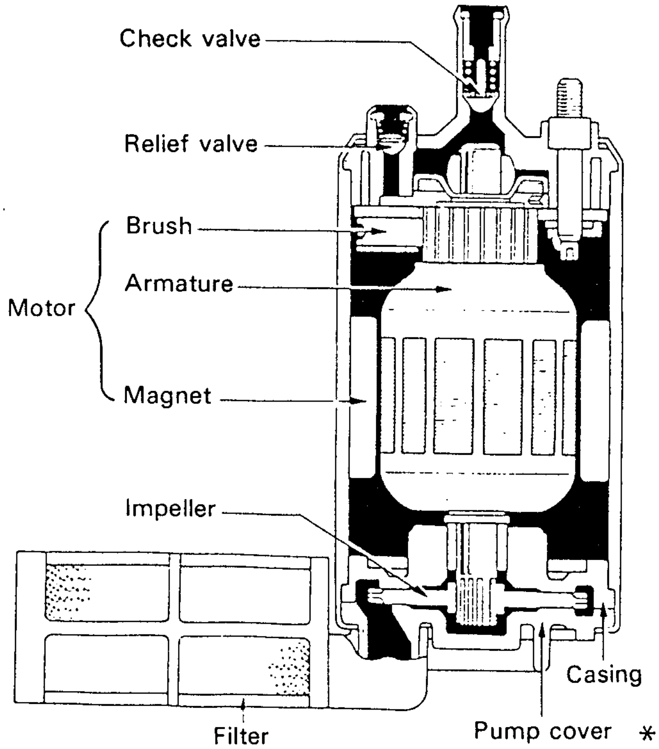
1. CONSTRUCTION & OPERATION

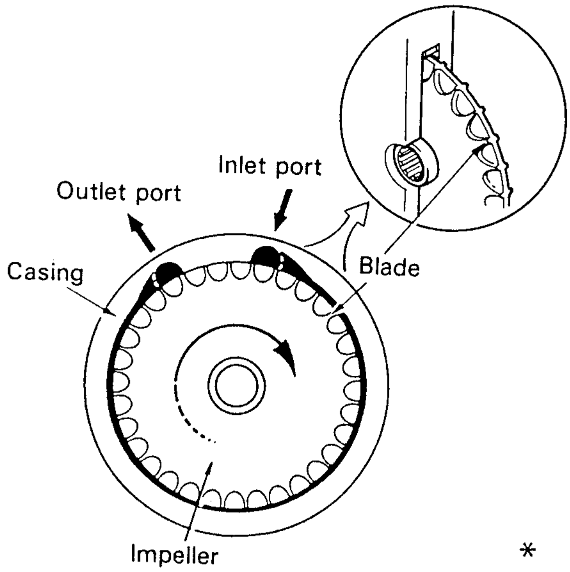
The pump is mounted inside the fuel tank. A turbine pump is used as it features little discharge pulsation of the fuel in the pump.

This pump consists of the motor and the pump itself, with a check valve, relief valve, and filter also incorporated into the unit.

2. TURBINE PUMP

The turbine pump consists of impellers, which are driven by the motor, and the casing and pump cover, which compose the pump unit. When the motor turns, the impellers turn along with it. Blades on the outer circumference of the impellers pull fuel from the inlet port to the outlet port. Fuel discharged from the outlet port passes around the motor and is discharged from the pump through the check valve.





3. RELIEF VALVE

The relief valve opens when the discharge pressure reaches 345.3 to 588.4 kPa (3.5 to 6.0 kgf/ cm^2 or 49.8 to 85.3 psi), and the highly-pressurized fuel is returned directly to the fuel tank. The relief valve prevents the fuel pressure from rising beyond that level.

4. CHECK VALVE

The check valve closes when the fuel pump stops. The check valve and pressure regulator both work to maintain residual pressure in the fuel line when the engine is stopped, thus facilitating restarting.

If there was no residual pressure, vapor lock could occur easily at high temperatures, making it difficult to restart the engine.

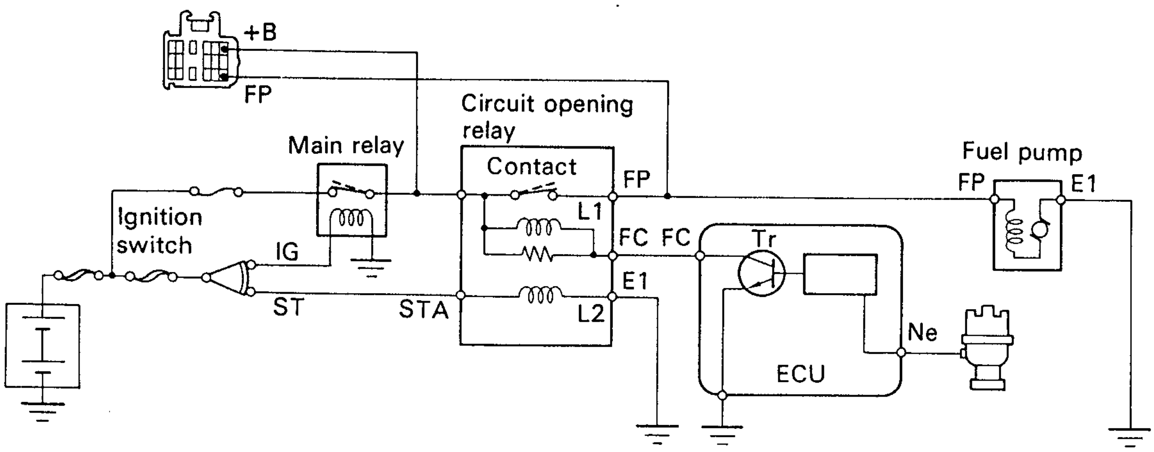
FUEL PUMP CONTROL

The fuel pump in a vehicle equipped with an EFI engine operates only when the engine is running. Even if the ignition switch is on, the fuel pump will not operate as long as the engine itself is not running. This is a safety feature.

OPERATION

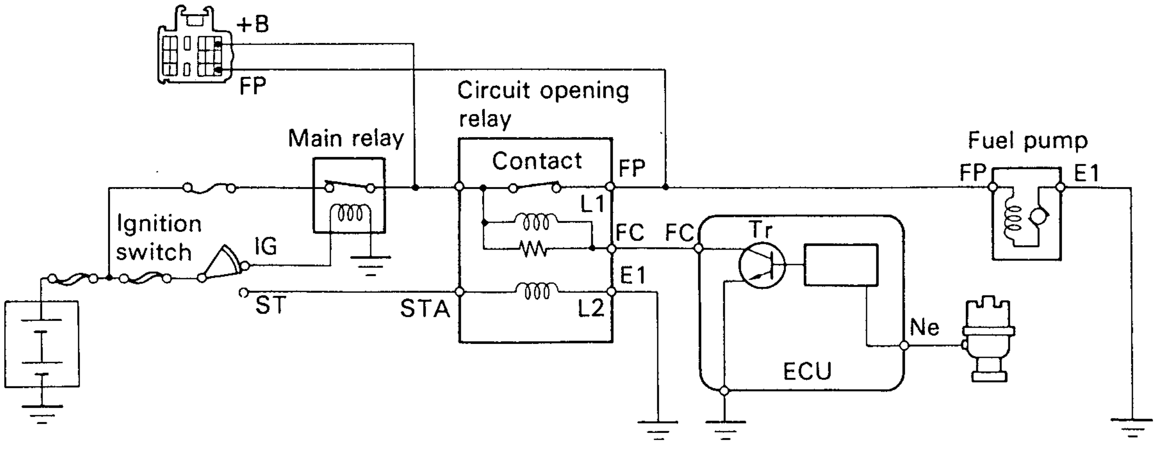
(1) DURING STARTING

When the engine starts, current flows through the L2 coil in the circuit relay to close the contact. The current then flows as shown in the diagram below to rotate the fuel pump.



(2) AFTER STARTING

When the ECU receives an "Ne" signal from the distributor, the internal transistor (Tr) goes on. As a result, current flows through the L1 coil of this relay and is kept on at all times while the engine is running.

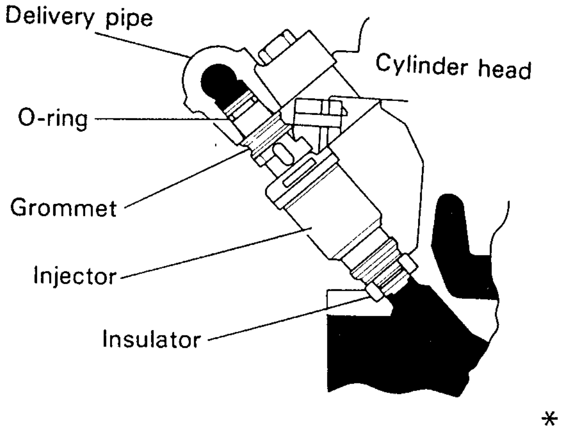


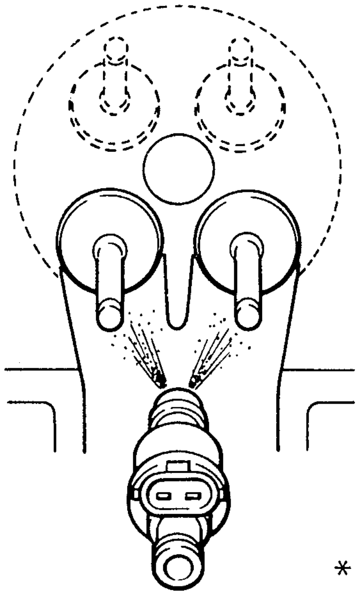
FUEL INJECTORS

The injector is an electromagnetically-operated nozzle which injects fuel in accordance with a signal from the ECU.

Two injection holes are provided at the tip of the injector to ensure good fuel atomization and even spraying of fuel near the two intake ports.

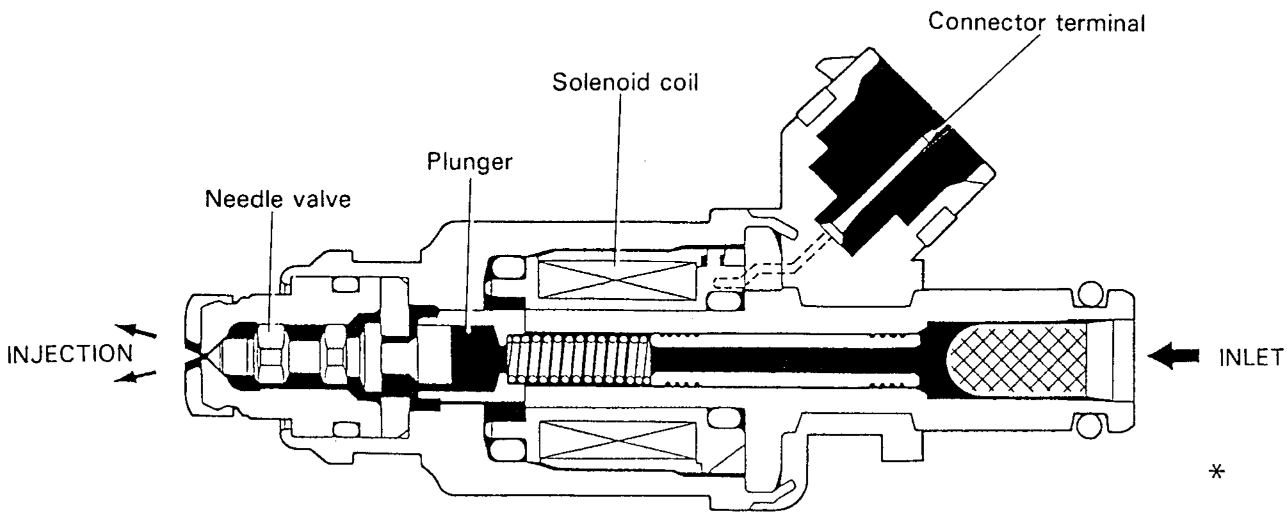
The injectors are installed with an insulator to the cylinder head near the cylinder head intake port, and are secured by the delivery pipe.



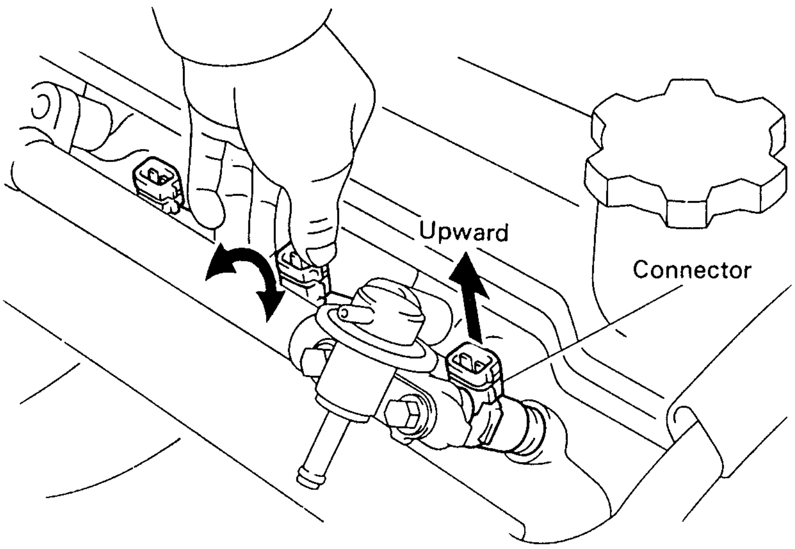


OPERATION

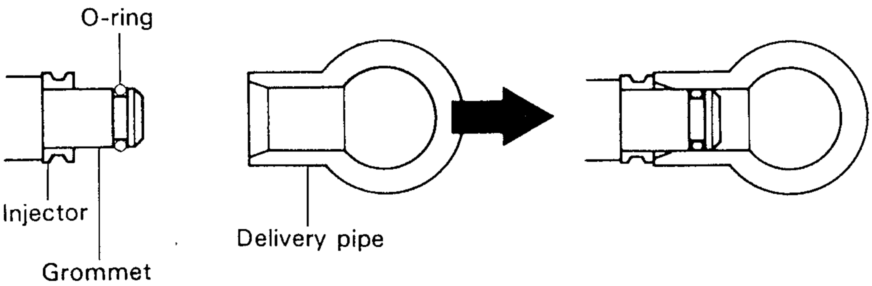
When a signal from the ECU is received by the solenoid coil, the plunger is pulled against spring tension. Since the needle valve and plunger are of a single unit, the valve is also pulled from its seat and fuel is injected as shown by the arrows in the illustration.
Fuel volume is controlled by the duration of the signal. Because the needle valve stroke is fixed, injection continues for as long as the needle valve is open.



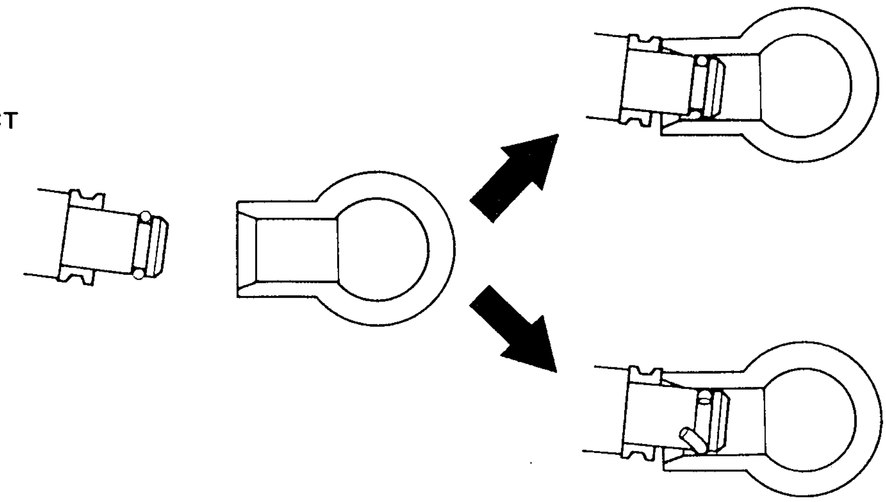
Injector installation is correct if the injector can be turned back and forth by hand smoothly. If the injector cannot be turned smoothly, there is usually something wrong with the way the O-ring is fitted.



CORRECT



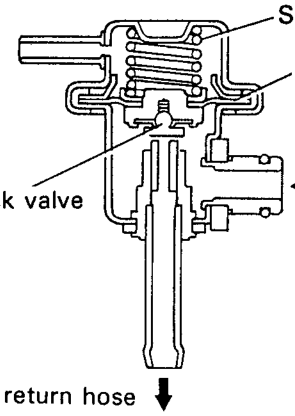
INCORRECT



PRESSURE REGULATOR

1. FUNCTION

The pressure regulator regulates the fuel pressure to the injectors. Fuel injection quantity is controlled by the duration of the signal applied to the injectors, so that a constant pressure to the injectors must be maintained. However, variations in the fuel pressure (due to injection) and changes in the manifold vacuum will cause the quantity of fuel injected to vary slightly even if the injection signal and fuel pressure are constant. Therefore, to obtain an accurate injection quantity, the sum of the fuel pressure A and intake manifold vacuum B must be maintained at 265 – 304 kPa (2.7 – 3.1 kgf/cm² or 38 – 44 psi).



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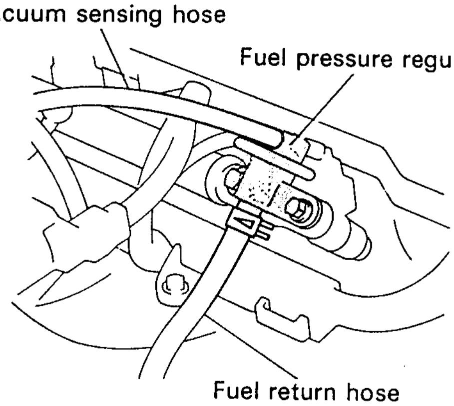
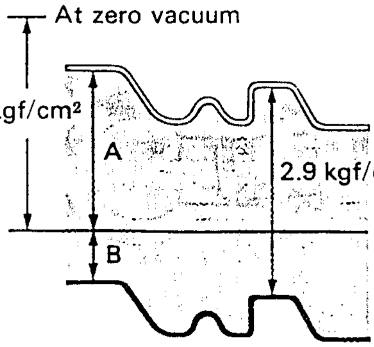


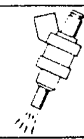
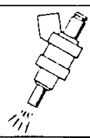
2. OPERATION

Pressurized fuel from the delivery pipe pushes on the diaphragm, opening the valve. Part of the fuel flows back to the fuel tank through the return pipe. The amount of fuel returned depends on the degree of diaphragm spring tension, and the fuel pressure varies according to the volume of returned fuel.

Intake manifold vacuum is applied to the chamber on the diaphragm spring side, weakening the diaphragm spring tension, increasing the volume of fuel return, and lowering the fuel pressure. In short, when intake manifold vacuum rises (less pressure), fuel pressure falls only to the extent of the decrease in pressure, so that the sum of the fuel pressure A and the intake manifold vacuum B is maintained at a constant value.

The valve is closed by the spring when the fuel pump stops. As a result, the check valve inside the fuel pump and the valve inside the pressure regulator maintain residual pressure inside the fuel line.

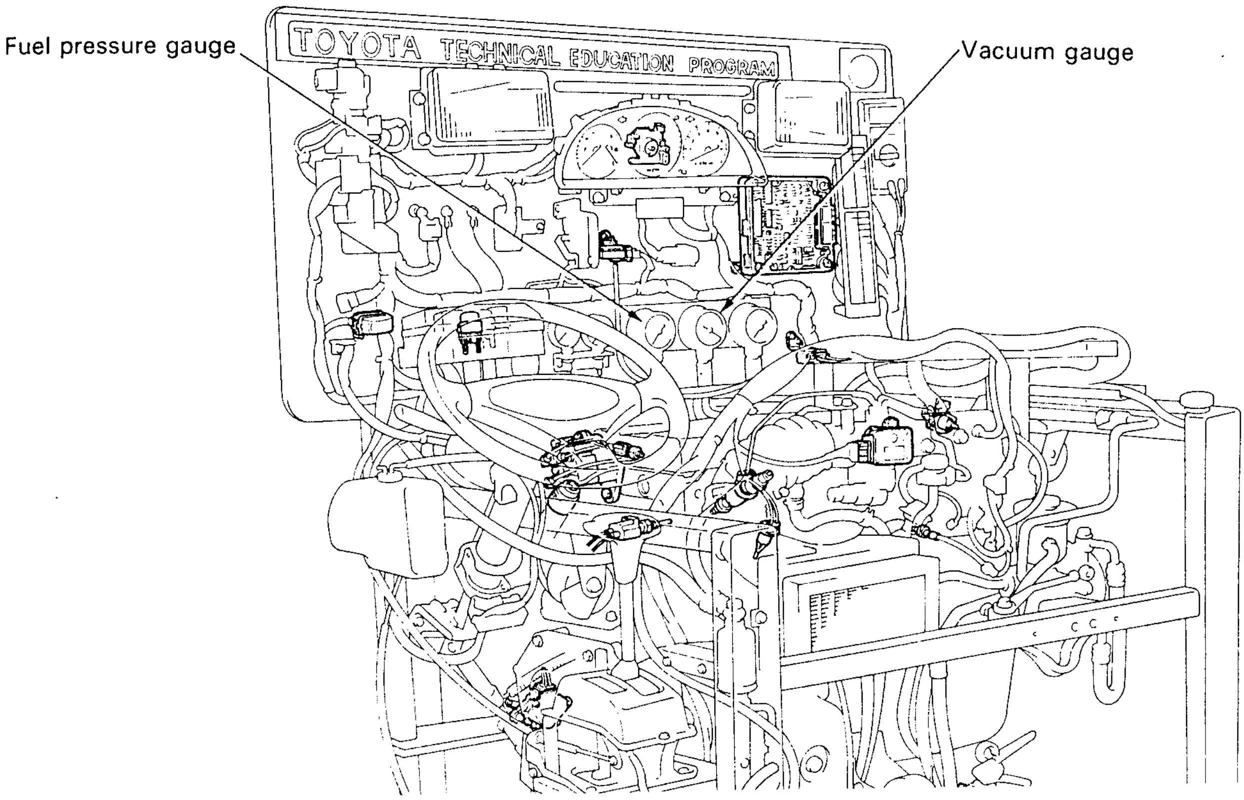


FUEL PRESSURE	LOW	HIGH
INTAKE MANIFOLD VACUUM	High (low pressure)	Low (high pressure)
INJECTION VOLUME	 SAME	 SAME

3. PRACTICE

Check the relationship between intake manifold vacuum and fuel pressure.

ENGINE CONDITION \ GAUGE		FUEL PRESSURE	INTAKE MANIFOLD VACUUM
During idling			
2000 rpm			
3000 rpm			
4000 rpm			
Under high load (during acceleration)			
After engine is stopped	1 minute after		
	5 minutes after		

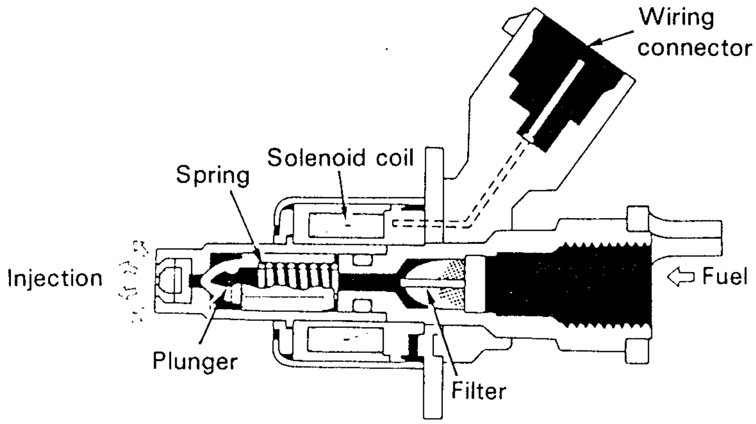


COLD START INJECTOR

The cold start injector, which is installed in the center of the air intake chamber, functions to improve cold engine starting.

1. CONSTRUCTION & OPERATION

The injector operates only during cranking (starting) when the coolant temperature is low. In addition, the maximum injection duration is limited by the start injector time switch to prevent flooding (wet spark plugs) resulting from continuous injection by the cold start injector.
A special design is used for the injector tip in order to improve the misting effect.
When the ignition switch is turned to ST, the current flows to the solenoid coil, and the plunger is pulled against spring tension.
Thus, the valve will open and fuel will flow over the plunger and through the injector tip.



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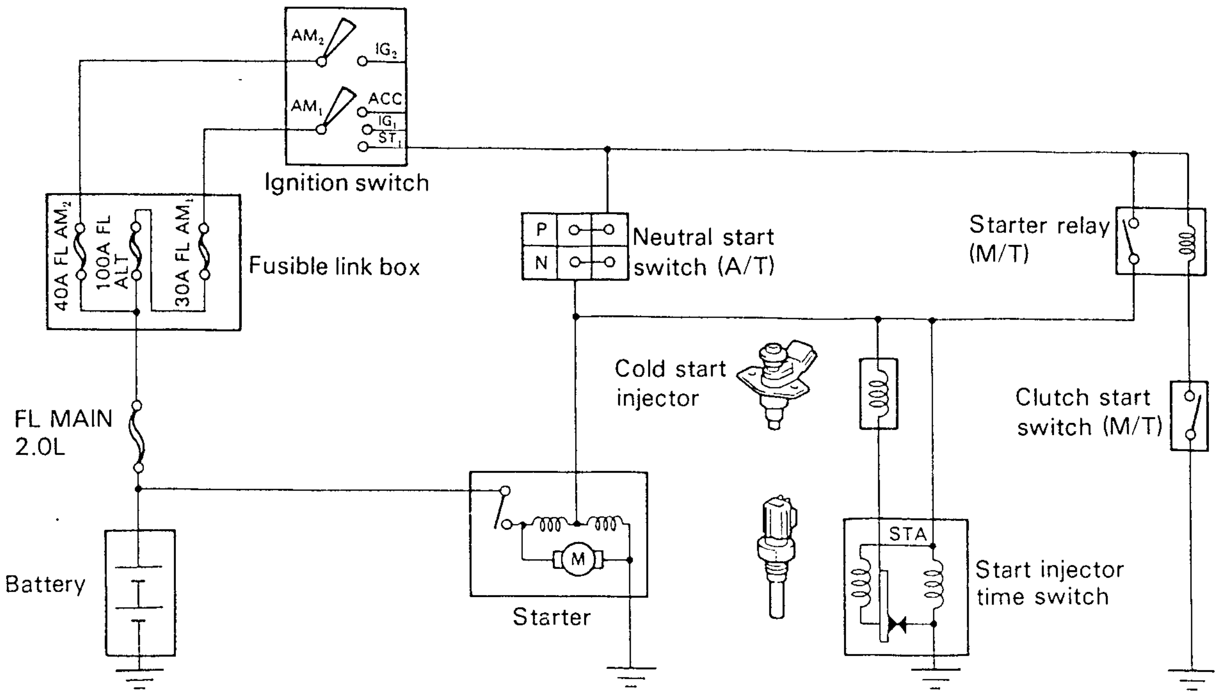
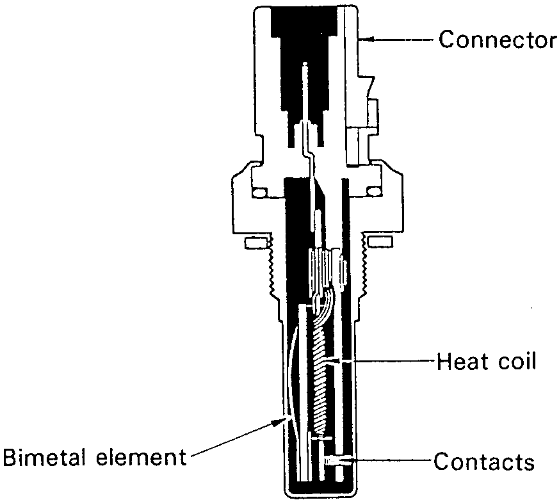
2. SYSTEM DIAGRAM

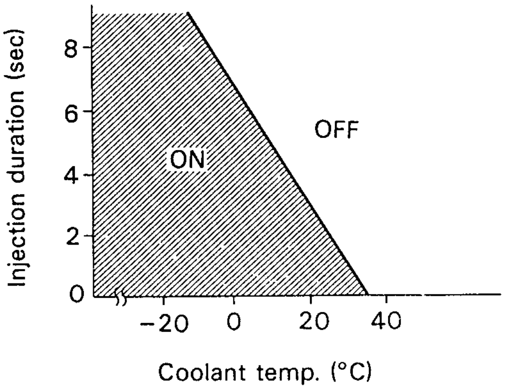
The diagram below shows the basic circuit of the cold start injection system.



START INJECTOR TIME SWITCH

The function of the start injector time switch is to control the maximum injection duration of the cold start injector.





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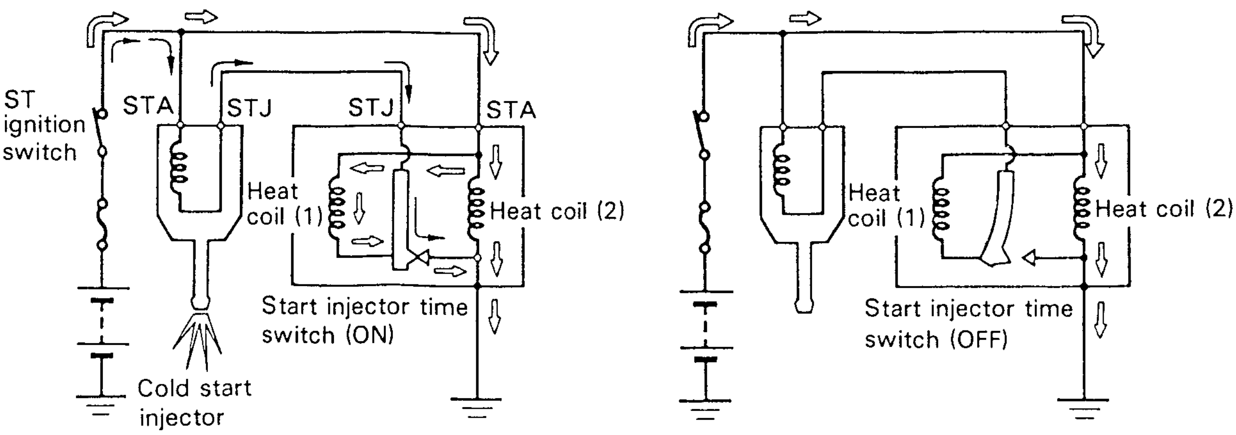
CONSTRUCTION & OPERATION

COLD START INJECTOR ELECTRICAL CIRCUITRY

a. When the coolant temperature is low, the contacts are closed. When the ignition switch is turned to ST, current flows as shown below and fuel is injected.

b. When the ignition is returned to ON after starting the engine, injection of the start injector is terminated.
If the starter motor is cranked for a prolonged period, there is a possibility of flooding (wet spark plugs). However, as current flows through heat coils (1) and (2), the bimetal element is heated and the contacts open, so there is no current flow to the cold start injector. Therefore, flooding is prevented if the engine is hard to start. The bimetal element is heated by heat coil (2) to keep the contacts from closing again, thus preventing flooding.



(a) (b)

2. AIR INDUCTION SYSTEM

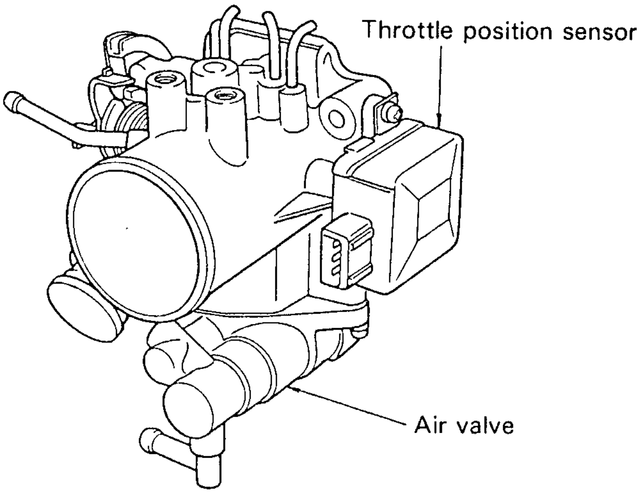
THROTTLE BODY

1. CONSTRUCTION

a. A throttle valve is incorporated into the throttle body. This valve controls engine output by controlling the volume of intake air drawn into the engine.

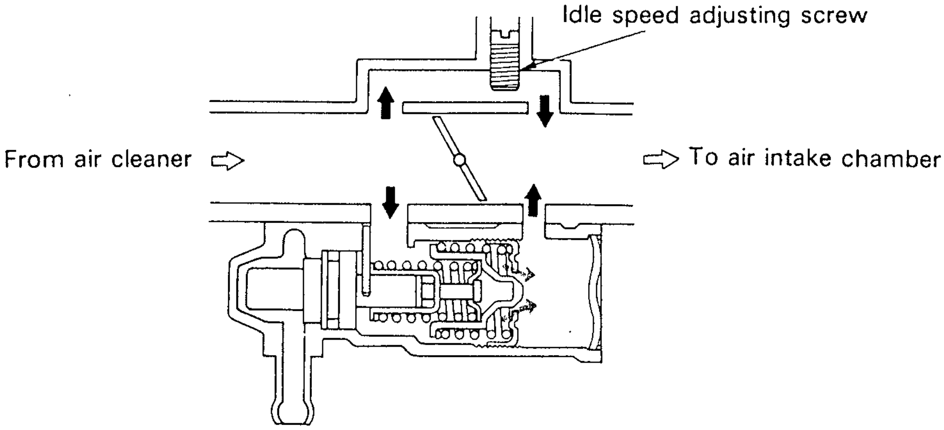
b. A throttle position sensor is mounted on the throttle valve shaft. This sensor senses the throttle valve opening angle and sends signals to the ECU.

c. A wax type air valve is integrated with the throttle body. This valve controls the engine idle speed in accordance with the coolant temperature, thus improving engine warm-up performance. The coolant also warms the throttle body in order to prevent icing.



2. IDLE SPEED ADJUSTING SCREW

During idling, the throttle valve is fully closed, which is not the case in engines equipped with a carburetor. As a result, intake air flows through the bypass passage into the air intake chamber. The engine speed during idling can be adjusted by adjusting the volume of air passing through this bypass passage: turning the idle speed adjusting screw (in the clockwise direction) will decrease the bypass flow and lower the engine speed, and loosening the screw (turning it counterclockwise) will increase the volume of air flowing through the bypass and raise engine speed.



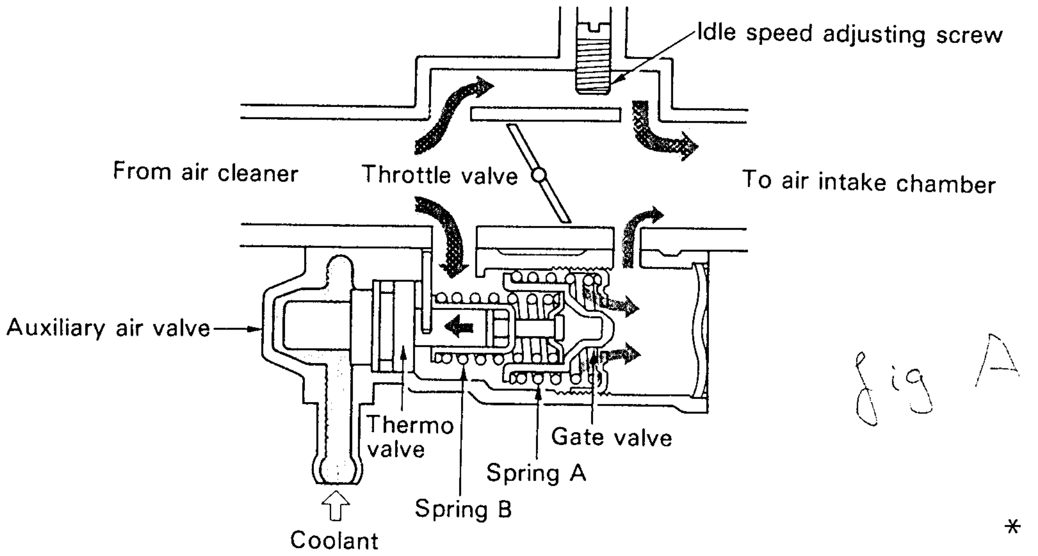
AIR VALVE

CONSTRUCTION AND OPERATION

(1) AT LOW TEMPERATURE

The wax type air valve is made up of a thermo valve, a gate valve, spring A, and another spring B. The thermo valve is filled with thermo wax, which expands and contracts in volume in accordance with changes in coolant temperature.

When the temperature is low, the thermo valve is contracted, and the gate valve is opened by spring A. This allows air to flow through the air valve, bypassing the throttle valve, into the air intake chamber.



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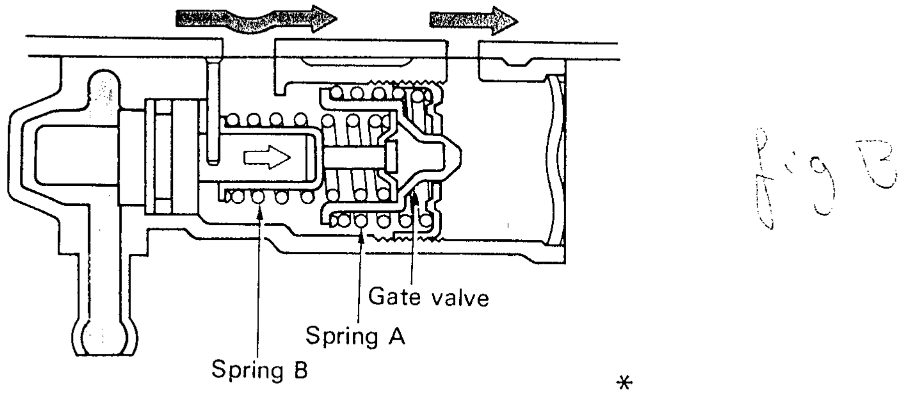
(2) AT HIGH TEMPERATURE

As the coolant temperature rises, the thermo valve expands causing spring B to close the gate valve. Since spring B is stronger than spring A, the gate valve is closed gradually, lowering the engine speed as it closes.

In this way, by the time the coolant temperature reaches 80°C, the gate valve is closed, and engine idle speed is normal.

If the coolant temperatuer rises higher, the thermo valve expands even more. This contracts spring B, increasing its spring force and keeping the gate valve closed.



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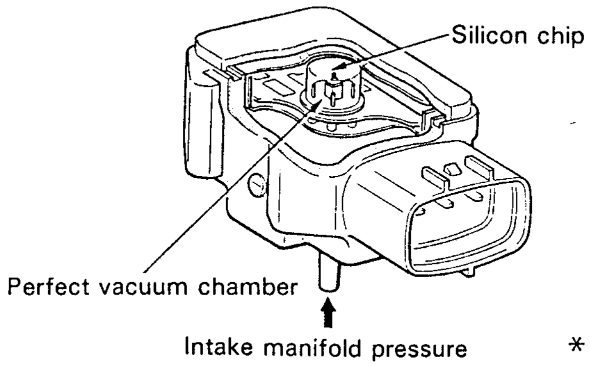
MANIFOLD PRESSURE SENSOR (VACUUM SENSOR)

This is an extremely important sensor, which senses the volume of intake air.
By means of a built-in IC sensor unit, the manifold pressure sensor senses the intake manifold pressure as a PIM signal. The ECU then determines the basic injection duration and basic ignition advance angle on the basis of this PIM signal.



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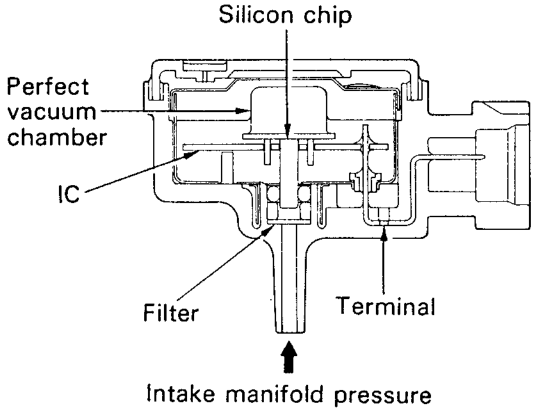

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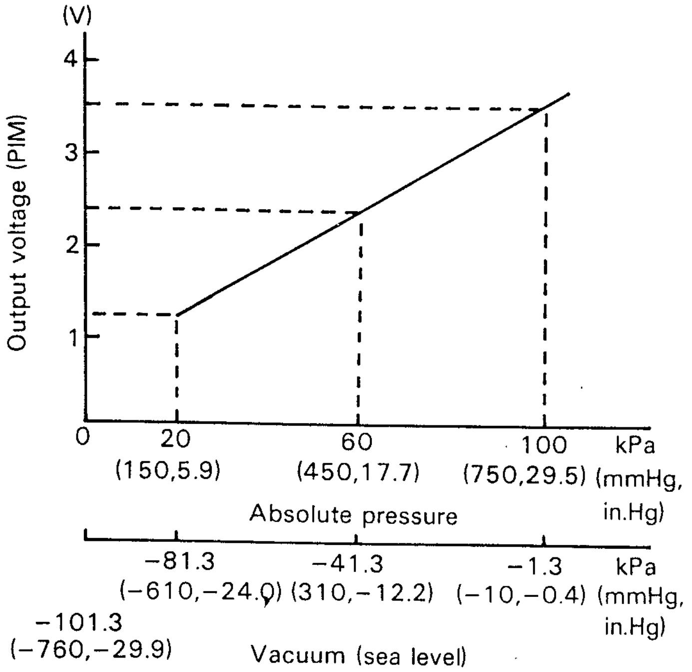
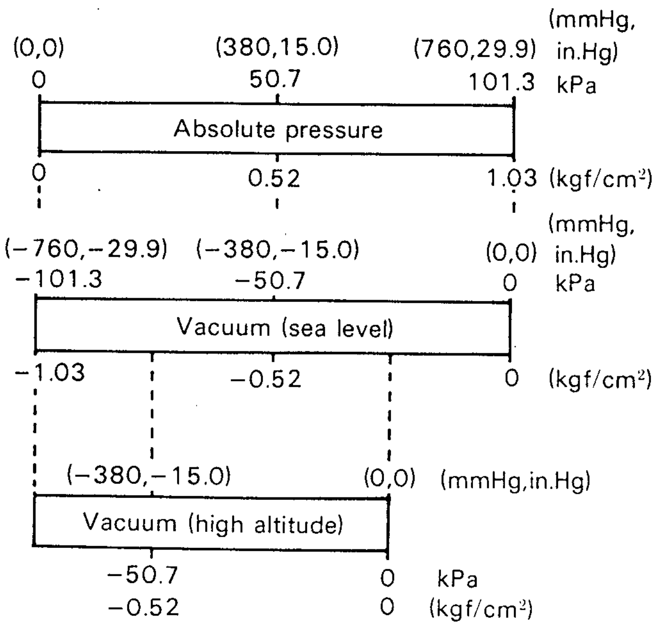
OPERATION & FUNCTION

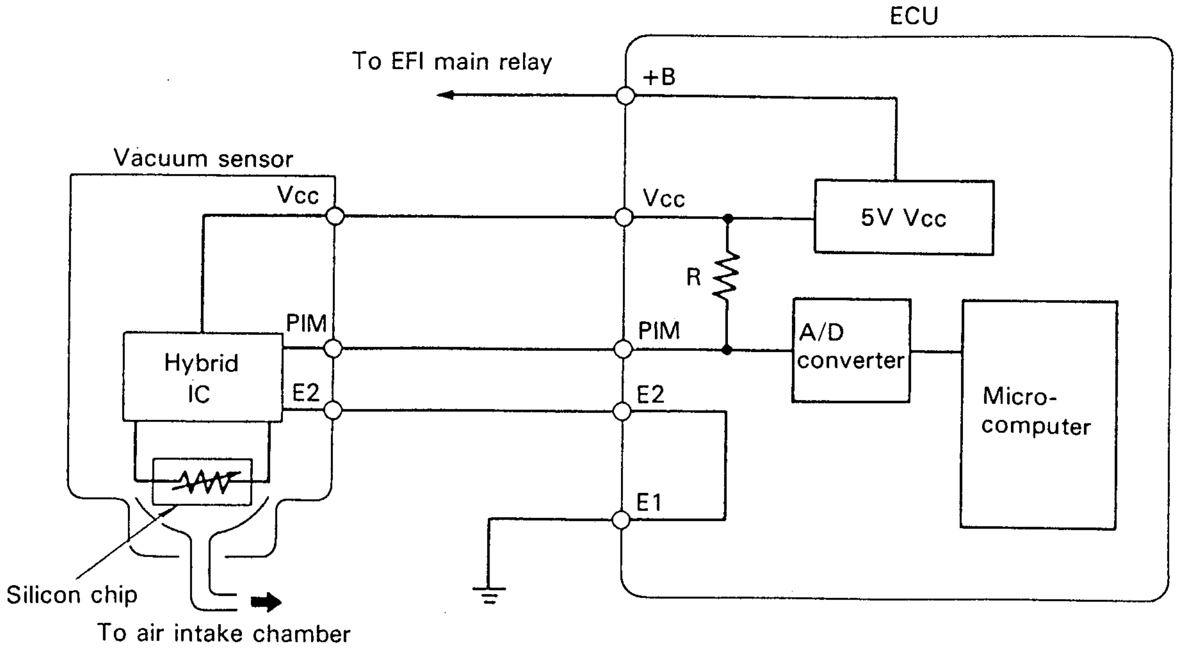
A silicon chip combined with a vacuum chamber is incorporated into the sensor unit, one side of the chip being exposed to intake manifold pressure and the other side to the internal perfect vacuum chamber.
A change in the intake manifold pressure causes the shape of the silicon chip to change, and the resistance value of the chip fluctuates in accordance with the degree of deformation. This fluctuation in the resistance value is converted to a voltage signal by the IC built into the sensor, and is then sent to the ECU from PIM terminal as an intake manifold pressure signal. The Vcc terminal of the ECU supplies constantly 5 volts as a power source for the IC.

– REFERENCE –
Since the manifold pressure sensor uses the perfect vacuum as a reference and senses the absolute pressure inside the intake manifold (the absolute pressure is 0 mmHg when there exists a perfect vacuum), it is not influenced by fluctuations in atmospheric pressure due to altitude.
This enables the air-fuel ratio to be maintained at the proper level at high altitudes.





The manifold pressure sensor is connected to the ECU as shown in the diagram below.



– NOTES –

1. IF RUBBER HOSE CONNECTED TO SENSOR IS DISCONNECTED (TCCS IS NORMAL).

Since the electrical circuit is normal, the voltage indicated at the PIM terminal is approximately 3.6 V at sea level (when the vacuum is 0 Pa).
Since the voltage at the PIM terminal is approximately 3.6 V, the ECU judges that the volume of intake air is large and lengthens the fuel injection duration accordingly. In the idle state, the air-fuel mixture will become too rich and the engine will stall.

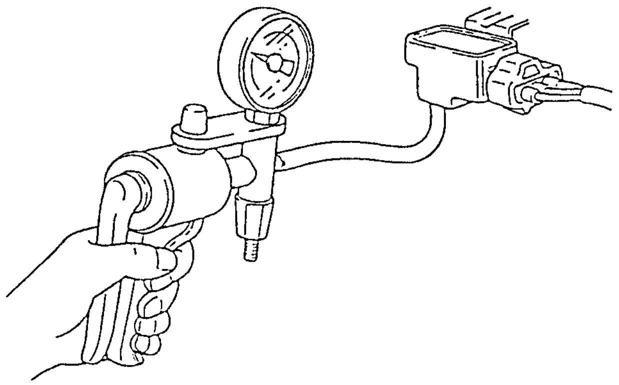
2. IF SENSOR'S CONNECTOR IS DISCONNECTED.

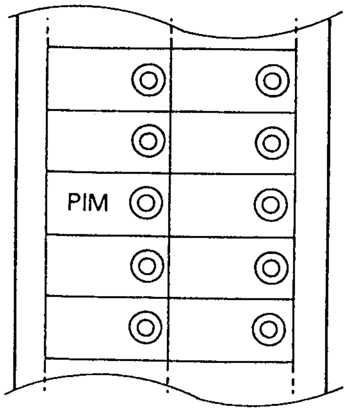
Since the voltage on the ECU side of the PIM terminal becomes 5 V due to resistor R in the ECU, the ECU judges that the manifold pressure sensor is abnormal and lights the CHECK ENGINE lamp. At the same time, the fail-safe function operates to determine the injection duration by the on and off switching of the IDL contacts, thus keeping the engine running. At this time, if the voltage at the PIM terminal is measured, it will read 4.5 V or lower due to resistor R (high resistance) in the ECU. The indicated voltage will vary according to the tester used.

2. PRACTICE

a. Change the vacuum applied to the intake manifold pressure sensor (vacuum sensor), and measure the voltage at the PIM terminal of the ECU.

VACUUM kPa (mmHg) (in.Hg)	0 (0) (0)	−15 (−112.5) (−4.43)	−30 (−225) (−8.87)	−45 (−337.5) (−13.30)	−60 (−450) (−17.73)	−75 (−562.5) (−22.16)
PIM (V)						
Voltage drop (V)	——					

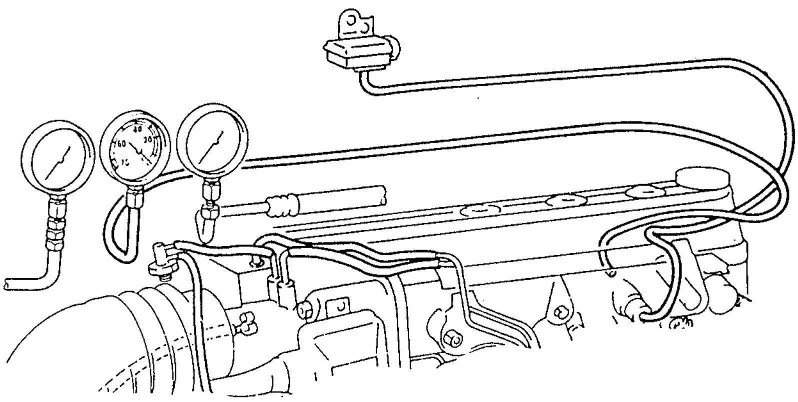




b. Measure the voltage at the PIM terminal of the ECU when the intake manifold pressure and engine rpm changed.

- The coolant temperature 80 − 85°C

ENGINE RPM	IDLING	2000 RPM	4000 RPM	THROTTLE VALVE FULLY OPEN
PIM (V)				
Manifold vacuum kPa (mmHg)				

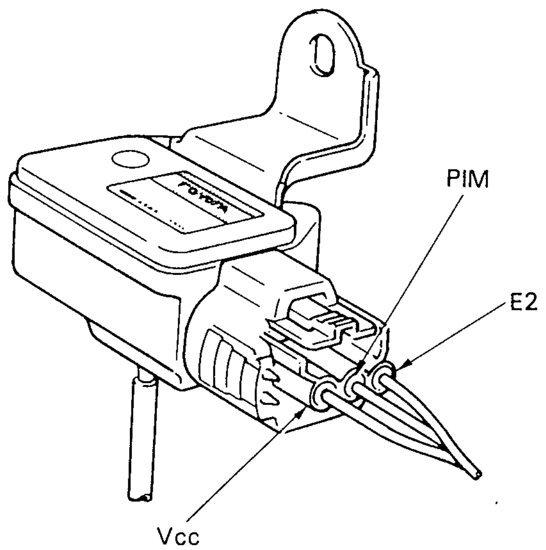


– REFERENCE –

a. The ECU senses the intake air volume by means of the PIM voltage. Therefore, if the PIM voltage is incorrect, the ECU cannot control the EFI and ESA correctly.

b. The fuel injection duration becomes longer as the PIM voltage rises.

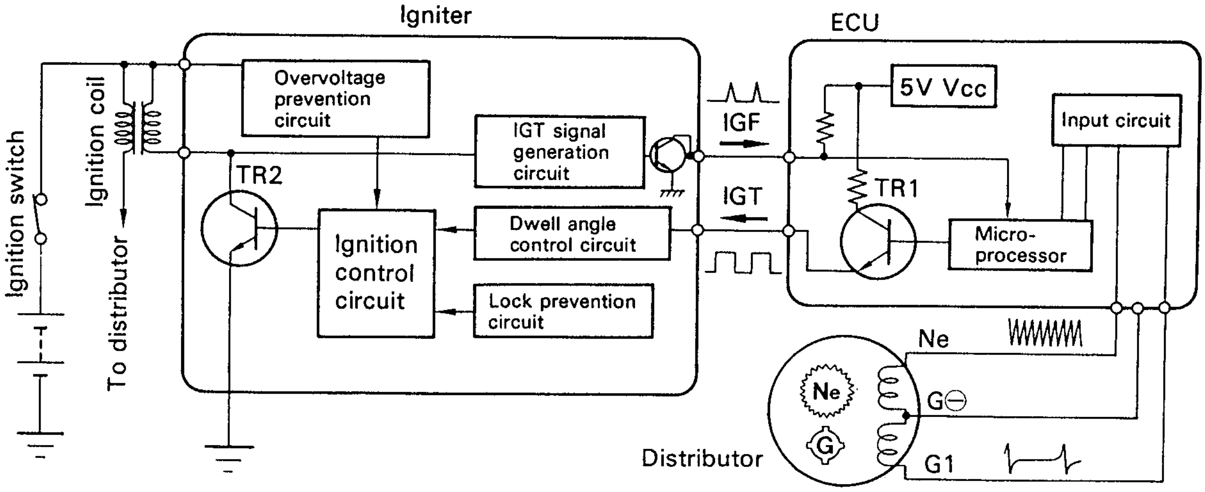
TERMINAL	CONDITION	PIM VOLTAGE	WARNING	DIAG. CODE	FAIL-SAF
Vcc	Open	5 V	◎	2	Backup mode
	Shorted	0 V	–	–	–
	If Vcc is shorted, the ECU's constant voltage circuit does not operate. Thereby the ECU will not operate. This causes the engine to stop (and in some models, the ECU could be damaged).				
PIM	Open	5 V	◎	2	Backup mode
	Shorted	0 V			
	Large resistance	Voltage drops (lean mixture)	–	–	–
E2	Open	5 V	◎	2	Backup mode
	Loose (poorly grounded)	The PIM voltage is raised by the amount represented by the poor contact at E2.	–	–	–
		The PIM voltage rises, and the air-fuel mixture becomes rich.			
+B	Voltage drop	There is no effect as long as the voltage does not drop below 5.1 V. .... (5 V constant voltage circuit)			



3. ELECTRONIC CONTROL SYSTEM

DISTRIBUTOR IIA (Integrated Ignition Assembly) Type

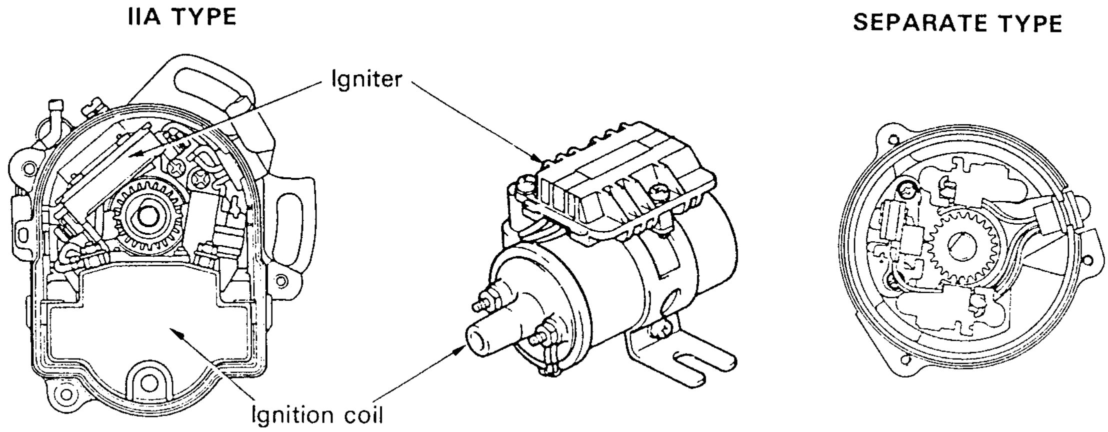
1. SYSTEM DIAGRAM



The microprocessor in the ECU determines the ignition timing according to signals from each sensor, using the crankshaft angle signals (G1 and Ne) as references. After determining the ignition timing, the ECU sends ignition timing signal (IGT) to the igniter.
When the IGT signal goes off, the primary current to the igniter is interrupted, causing a high voltage (approx. 20 to 35 kV) to be generated by the secondary coil and sparks to be generated by the spark plugs.

2. CONSTRUCTION

a. The IIA incorporating the ignition coil and igniter is located within the distributor.
b. The crankshaft angle and engine rpm sensors are installed along with the ESA system, and the vacuum controller and governor mechanism are eliminated.



3. G1 SIGNAL

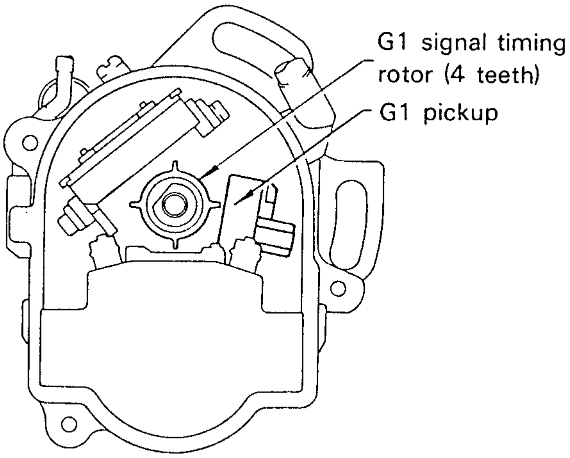
CRANKSHAFT ANGLE SENSOR

The G1 signal informs the ECU of the standard crankshaft angle, which is used to determine injection timing and ignition timing in relation to TDC of each cylinder.
The components of the distributor that are used to generate this signal are: (1) the G1 signal timing rotor, which is fixed to the distributor shaft and turns once for every two revolutions of the crankshaft, and (2) the G1 pickup coil, which is mounted in the distributor housing.

4. Ne SIGNAL

ENGINE RPM SENSOR

The G1 signal timing rotor is provided with four teeth which activate the G1 pickup coil four times with each revolution of the distributor shaft, generating the waveforms shown in the illustration below.
From this signal, the ECU detects when each piston is near its TDC.
The Ne signal is used by the ECU to detect the crankshaft angle and the engine speed. As with the G1 signal, the Ne signal is generated in the Ne pickup coil by the Ne signal timing rotor. The difference is that the timing rotor has 24 teeth.
Therefore, the Ne signal pulsates 24 times with each revolution of the distributor shaft.
From this signal, the ECU detects the engine speed as well as each 30° change in the crankshaft angle.



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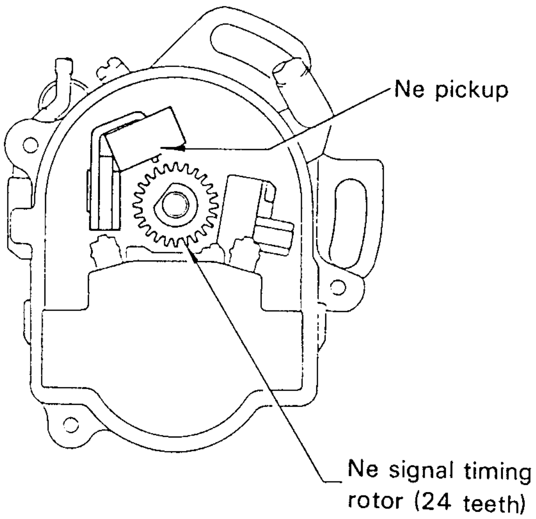

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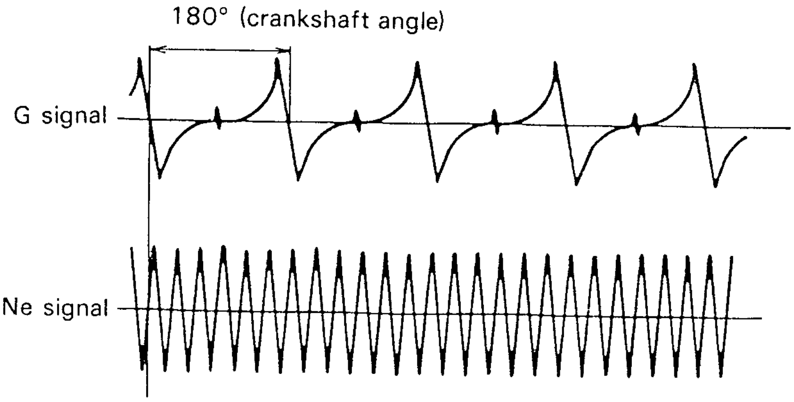

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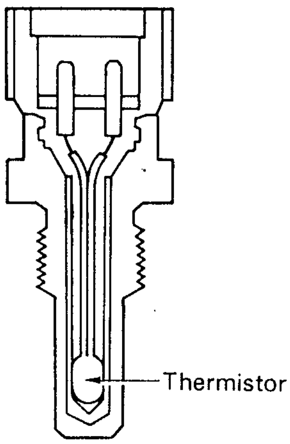
WATER TEMPERATURE SENSOR (THW)

This sensor senses the coolant temperature by means of an internal thermistor.
Vaporization of fuel is poor when the temperature is low, so a richer mixture is required. For this reason, when the coolant temperature is low, thermistor resistance increases, and a high-voltage THW signal is sent to the ECU.
Based on this signal, the ECU increases fuel injection volume to improve driveability during cold engine operation.
Conversely, when the coolant temperature is high, a low-voltage THW signal is sent to the ECU, decreasing fuel injection volume.



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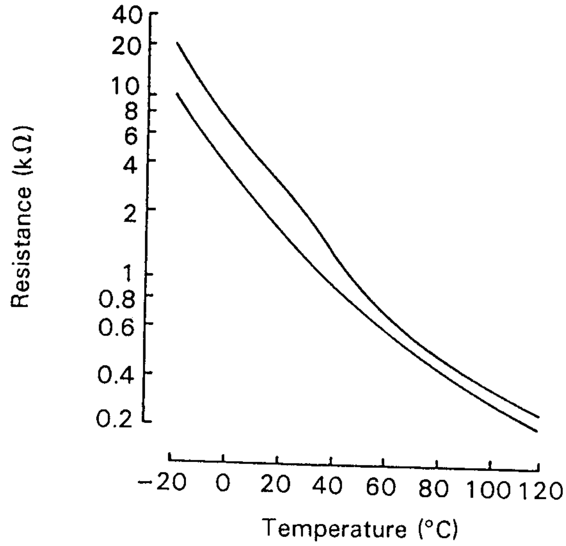
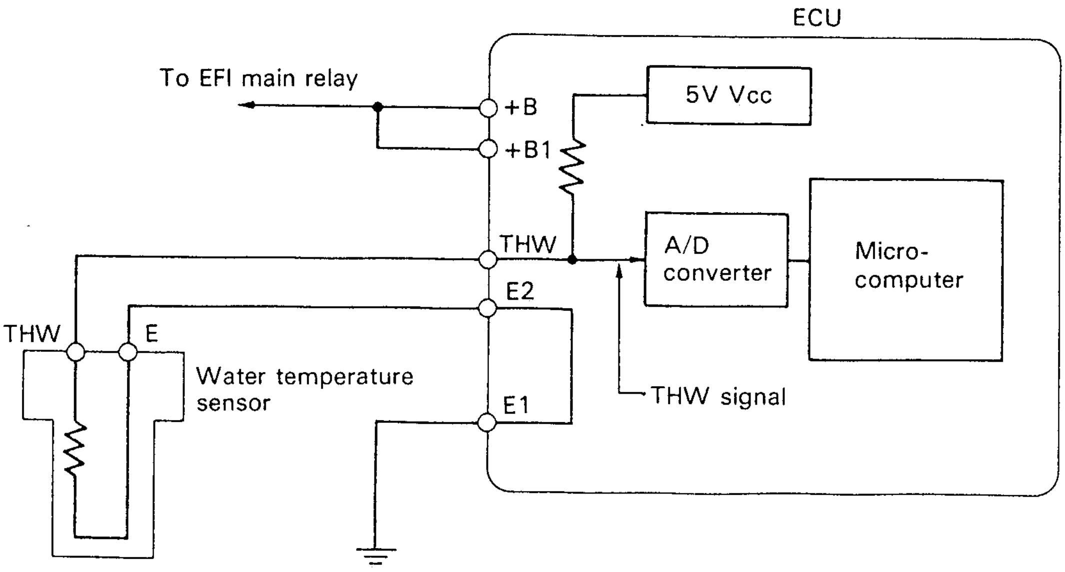


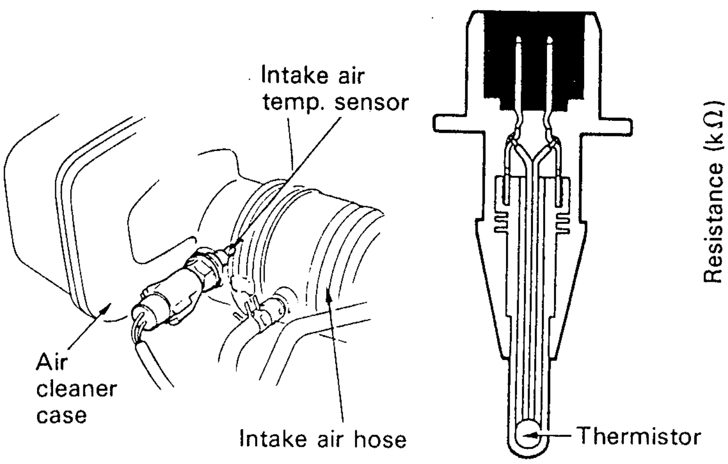
WATER TEMPERATURE SENSOR ELECTRICAL CIRCUITRY

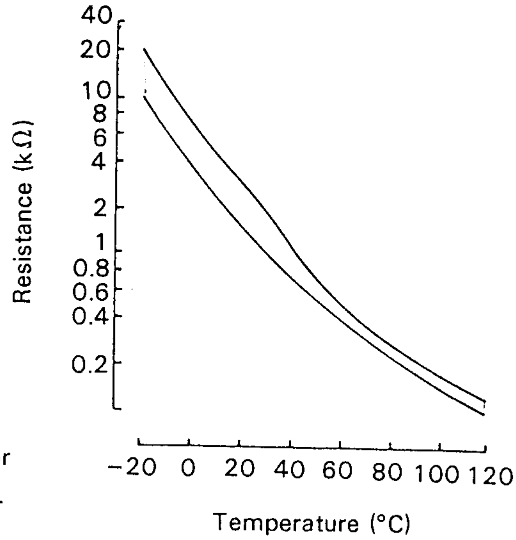
The water temperature sensor is connected to the ECU as shown in the diagram below.
Since resistor R in the ECU and the thermistor in the water temperature sensor are connected in series, the voltage of the THW signal changes when the thermistor's resistance value changes.



INTAKE AIR TEMPERATURE SENSOR

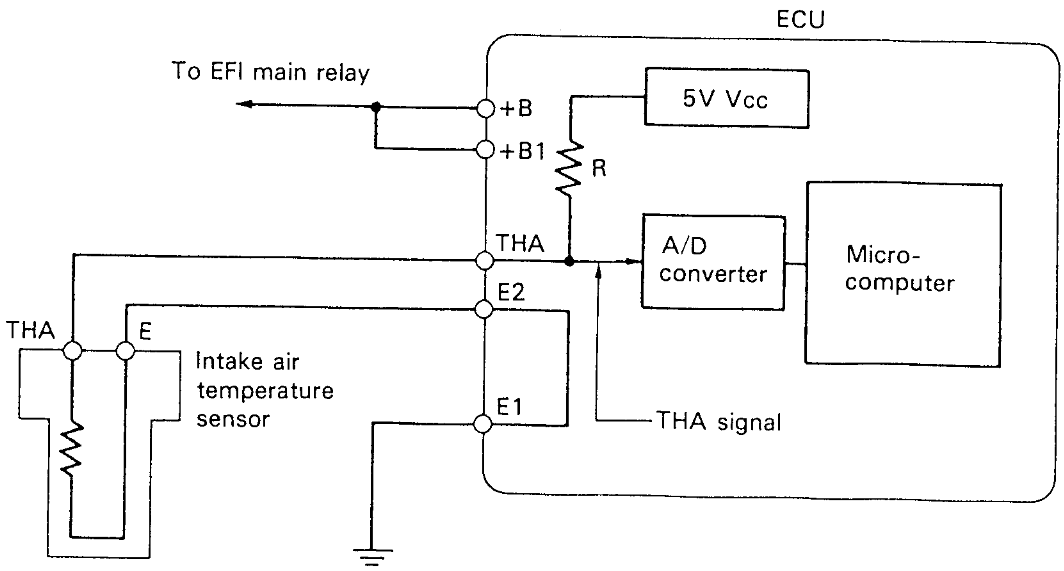
The intake air temperature sensor senses the temperature of the intake air. Like the water temperature sensor, it is composed of a thermistor and is mounted on the intake air hose. The pressure and density of air changes with the temperature. Therefore, even though the pressure of intake manifold measured by the manifold pressure sensor may be the same, the volume of injected fuel will vary with the temperature. The ECU uses a temperature of 20°C (68°F) as a standard, decreasing the injection volume when the temperature is higher than that, and increasing injection volume when the temperature is lower. In this manner, the proper air-fuel ratio is ensured regardless of the ambient temperature.





INTAKE AIR TEMPERATURE SENSOR ELECTRICAL CIRCUITRY

The characteristics of the intake air temperature sensor and its connections with the ECU are basically the same as those for the water temperature sensor.



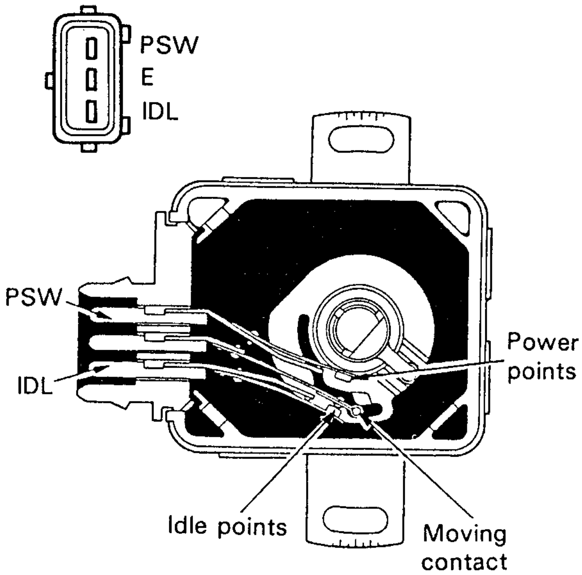
THROTTLE POSITION SENSOR

1. CONSTRUCTION & OPERATION

The throttle position sensor is mounted on the throttle body. It senses the throttle valve opening angle to detect engine load.

When the throttle valve is closed, the moving contact points and the IDL points make contact, informing the ECU that the engine is idling. This signal is also utilized to cut off fuel when decelerating.

When the throttle valve is opened more than 70° (from the closed position), the moving contact points and the PSW points make contact, informing the ECU that the engine is running under a full load. At all other timings, the moving contact points are in a neutral state, and no points are making contact.



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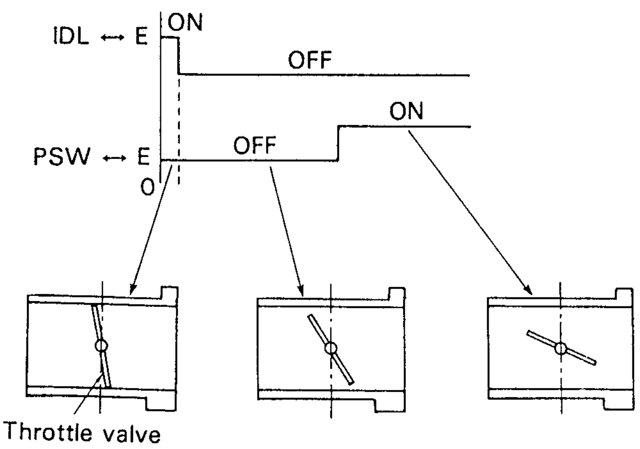
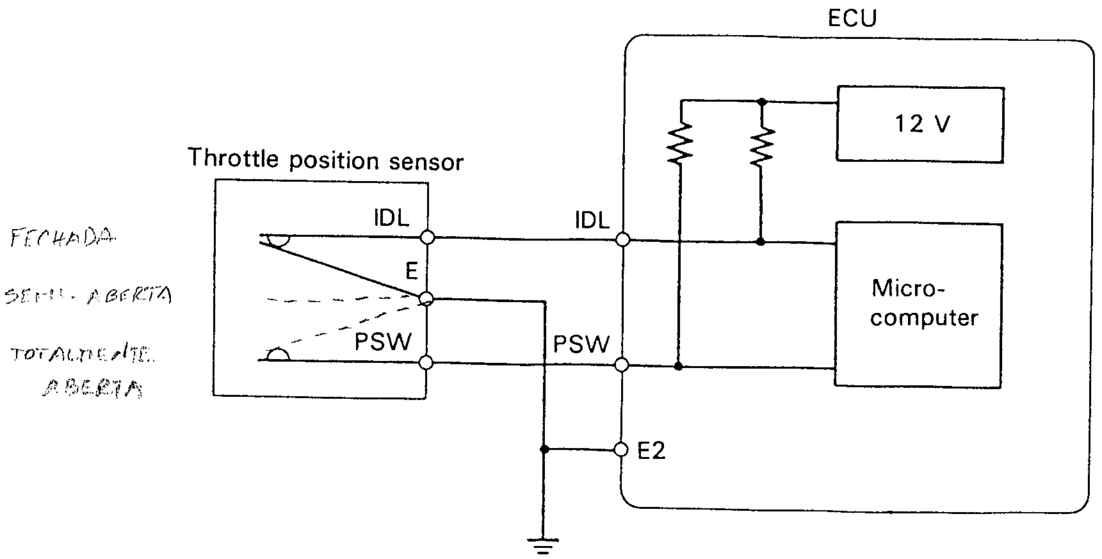


THROTTLE VALVE OPENING ANGLE *

The throttle position sensor and ECU are connected as shown in the diagram below.



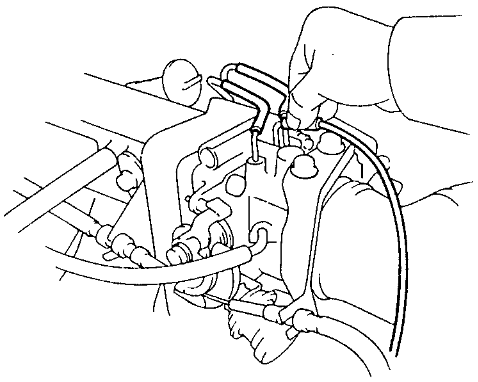
2. PRACTICE

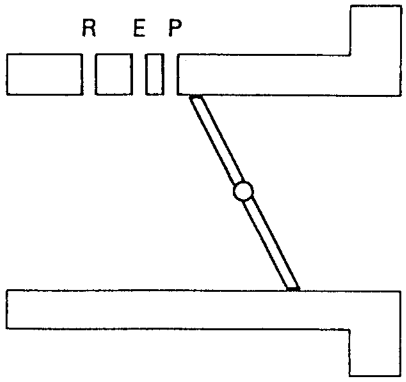
a. INSPECT THROTTLE BODY

Check the vacuum at each port.

1. Start the engine.
2. Check the vacuum with your finger.

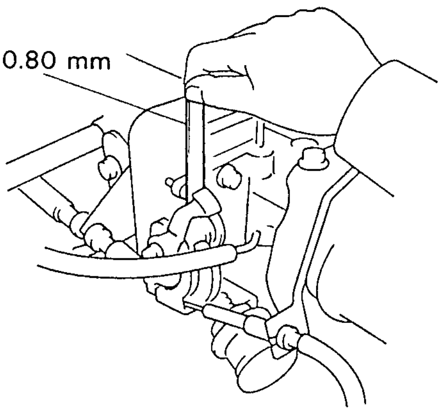
PORT NAME	AT IDLING	OTHER THAN IDLING
P	No vacuum	Vacuum
E	No vacuum	Vacuum
R	No vacuum	Vacuum

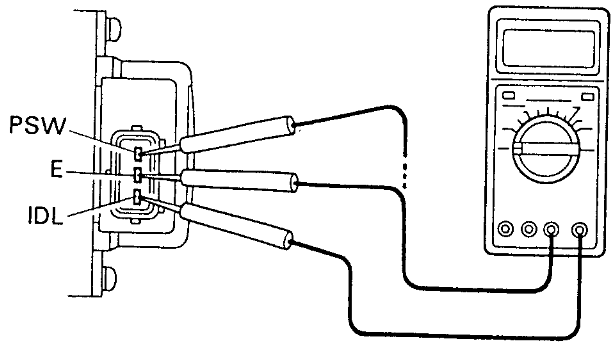




b. INSPECT THROTTLE POSITION SENSOR

1. Disconnect the sensor connector.
2. Insert a feeler gauge between the throttle stop screw and stop lever.
3. Using an ohmmeter, measure the resistance between terminals.



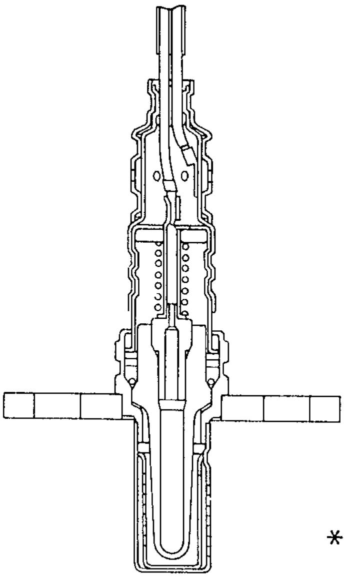


CLEARANCE BETWEEN LEVER AND STOP SCREW	CONTINUITY BETWEEN TERMINALS	
	IDL – E	PSW – E
0.60 mm (0.024 in.)	Continuity	No continuity
0.80 mm (0.031 in.)	No continuity	No continuity
Throttle valve fully opened	No continuity	Continuity

OXYGEN SENSOR

- In order for engines equipped with the TWC (three-way catalyst) to achieve their best exhaust emission purification performance, it is necessary for the air-fuel ratio to be kept within a narrow range near the theoretical air-fuel ratio.

  The oxygen sensor senses whether the air-fuel ratio is richer or leaner than the theoretical air-fuel ratio. The oxygen sensor is located in the exhaust pipe and consists of an element made of zirconium dioxide (ZrO_2, a kind of ceramic material). This element is coated both inside and outside with a thin layer of platinum. Ambient air is introduced into the sensor, and the outside of the sensor is exposed to exhaust gases.



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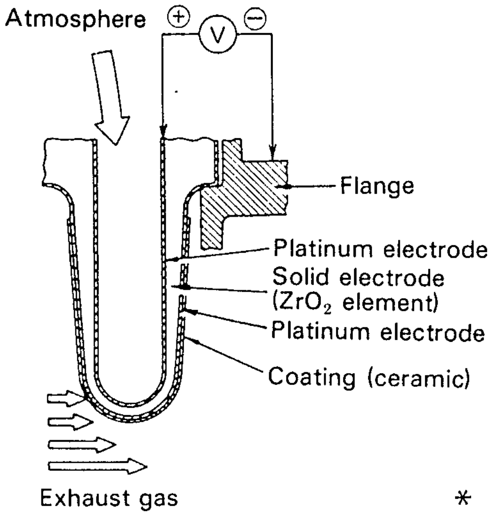

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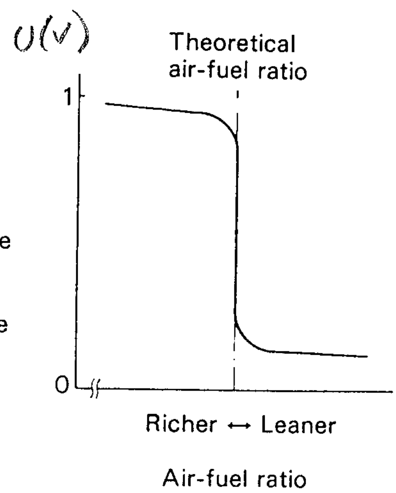
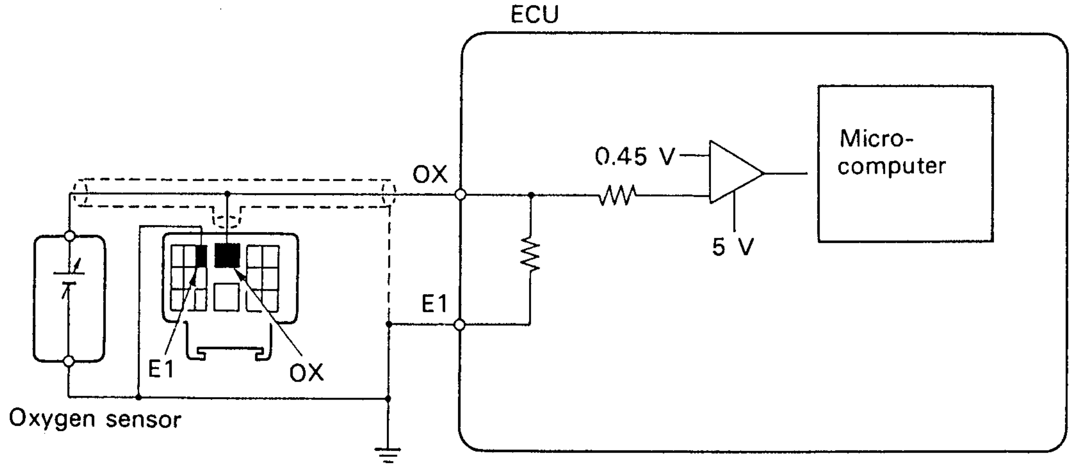


- If the oxygen concentration on the inside surface of the ZrO_2 element differs greatly from that on the outside surface at high temperatures (400°C [752°F] or higher), the ZrO_2 element generates a voltage. When the air-fuel mixture is lean, there is a lot of oxygen in the exhaust gas, so there is little difference between the oxygen concentration inside and outside the sensor element. Thus, the voltage generated by the ZrO_2 element is low (close to 0 V). Conversely, if the air-fuel mixture is rich, the oxygen in the exhaust gas almost disappears. This creates a large difference between the oxygen concentrations inside and outside the sensor, and the voltage generated by the ZrO_2 element is large (approximately 1 V).

  The platinum with which the element is coated acts as a catalyst, causing the oxygen in the exhaust gas to react with the CO. This decreases the oxygen volume and increases the sensitivity of the sensor.

  The ECU uses this OX signal to increase or reduce the injection volume to keep the air-fuel ratio at an even value near the stoichiometric air-fuel ratio.

The oxygen sensor is connected to the ECU as shown in the diagram below.



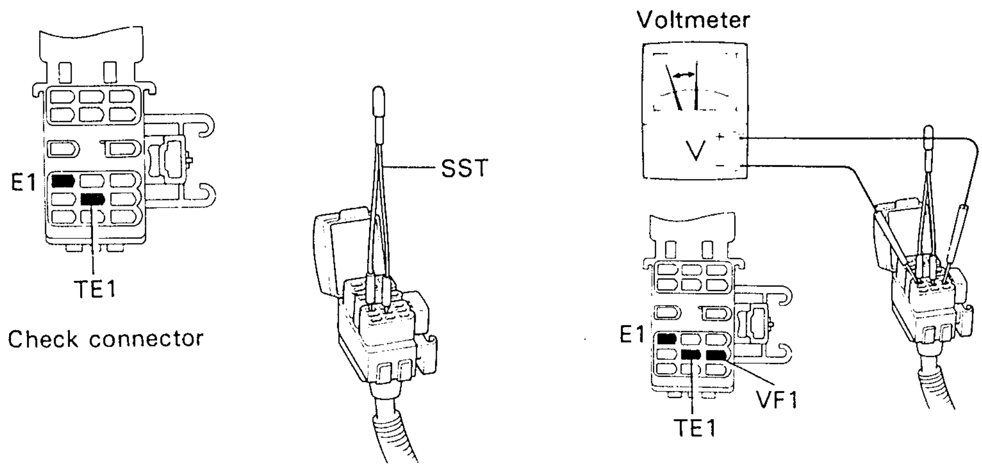
INSPECTION OF OXYGEN SENSOR

1. WARM UP ENGINE

Allow the engine to reach normal operating temperature.

2. INSPECT FEEDBACK VOLTAGE (VF)

a. Warm up the oxygen sensor with the engine at 2500 rpm for approx. 90 seconds.
b. Connect the positive (+) probe of a voltmeter to terminal VF1 of the check connector and the negative (−) probe to terminal E1.
c. Using the SST, connect terminals TE1 and E1 of the check connector.
   SST 09843-18020
   Maintain engine speed at 2500 rpm.
d. Check the number of times the voltmeter needle fluctuates in 10 seconds.
   - 8 times or more .... Normal
   - Less than 8 times .... Refer to repair manual.



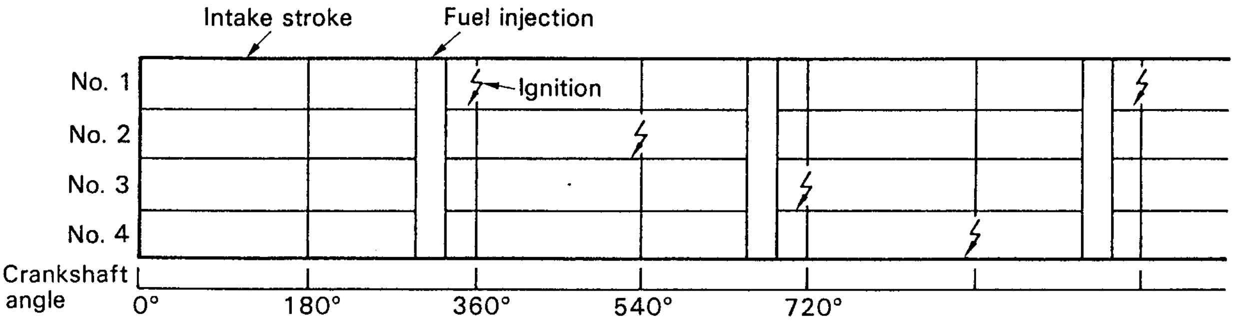
Check connector

4. ECU FUNCTIONS

The ECU first determines the basic injection duration based upon the intake manifold pressure signal and the engine rpm signal. It then determines the injection duration, actually required by the engine, by adjusting the basic injection according to the signals from the sensors that keep it informed of various engine operating conditions.
The ECU then causes the injectors to inject fuel into the intake port of each cylinder at the specific crankshaft angle calculated.

FUEL INJECTION METHOD

Fuel injection occurs once per crankshaft revolution for all cylinders.



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.

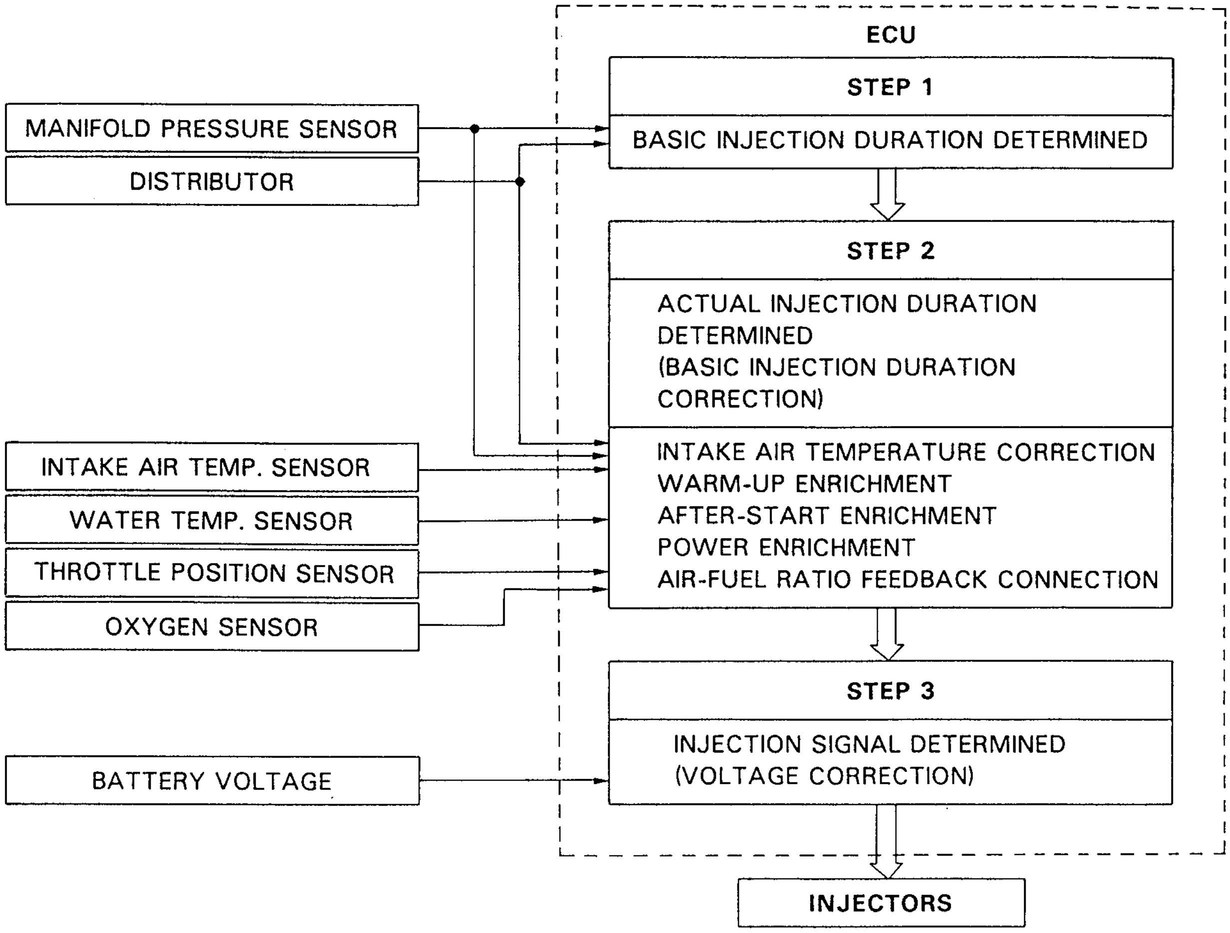
The ECU selects from the data stored in its memory an injection duration that is suitable for the intake manifold pressure (as detected by the manifold pressure sensor) and the engine rpm (as detected by the distributor). This injection duration is called the "basic injection duration."

Step 2: Determination of Duration of Actual Injection

Under most conditions, the engine runs smoothly at an air-fuel ratio of approximately 14.7:1. However, when the engine is still cold, or when an extra load is applied to the engine, the air-fuel ratio required by the engine falls below 14.7 (i.e., the engine requires a richer mixture).
The ECU detects these engine conditions by means of the water temperature sensor, throttle position sensor, and intake air temperature sensor, and corrects the basic injection duration to optimize it for the existing engine conditions. Also, in the 4A-FE engine with TWC (three-way catalyst), the injection duration is corrected even under normal engine conditions by the signals from the oxygen sensor to keep the air-fuel ratio within a narrow range near 14.7.
The corrected duration is called the "actual injection duration," which is the actual length of time during which the injector valve is open.

Step 3: Determination of Length of Injection Signal

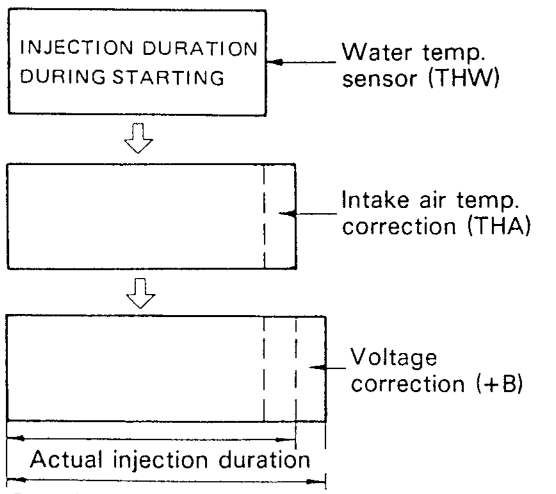
There is an operational delay between the sending of the ECU injection signal and the opening of the injector valve. This delay is greater the lower the battery voltage. The ECU accounts for this delay in the injection signal that it sends to the injector so that the actual length of time that the injector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



FUEL INJECTION DURATION CONTROL

1. STARTING INJECTION CONTROL

During engine starting, it is difficult for the manifold pressure sensor to accurately sense the intake manifold pressure 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 the intake manifold pressure. It then adds to this an intake air temperature correction and a voltage correction to obtain the injection duration.



Duration of fuel injection signal during starting

CONDITIONS

Engine speed below predetermined level or STA on.

RELEVANT SIGNALS

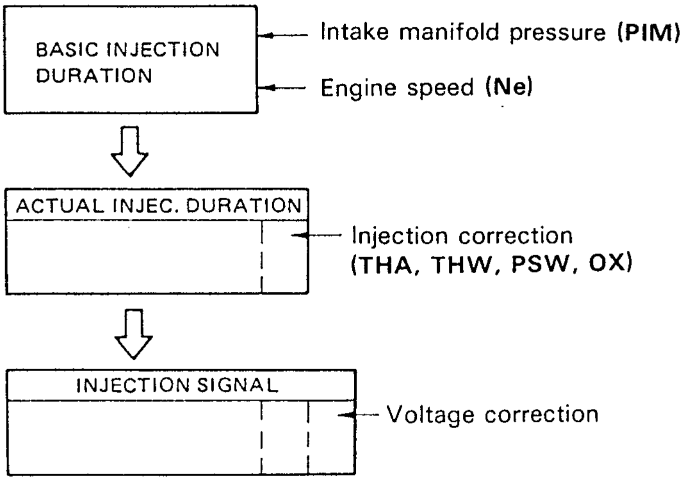
- **Engine speed (Ne)**
- **Coolant temperature (THW)**
- **Intake air temperature (THA)**
- **Ignition switch (STA)**
- **Battery voltage (+B)**

2. 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 x injection correction coefficient* + voltage correction

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



a. BASIC INJECTION DURATION

The basic injection duration is determined as the manifold pressure (PIM signal) and the engine speed (Ne signal). The internal memory of the ECU contains data of various basic injection durations for various manifold pressures and engine speeds.

— REFERENCE —

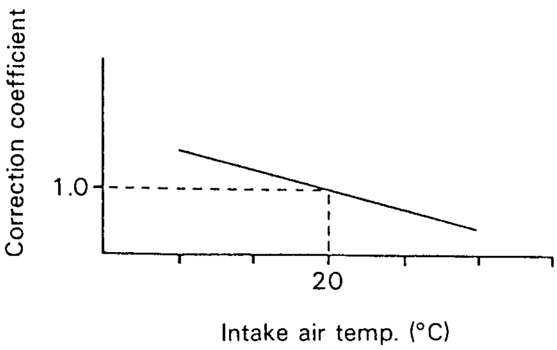
1. Since intake efficiency varies with the amount of valve clearance, the intake air volume varies even if the intake manifold pressure is the same.
   Therefore, when valve clearance varies, the ratio of the air-fuel mixture changes slightly.
   Since the 4A-FE engine corrects injection duration according to the air-fuel ratio feedback correction using an oxygen sensor (described later), the air-fuel ratio is always maintained at the optimum level.
2. Since the 4A-FE engine employs the EGR system, the amount of intake oxygen varies depending on whether the EGR valve is open or closed even if the intake manifold pressure is the same.
   The data stored in the ECU is for normal operation of the EGR system.
   If EGR system operation is not normal, the basic injection duration calculated by the ECU will not be correct, but the air-fuel ratio feedback correction constantly keeps the air-fuel ratio at the proper level as in 1 above.

b. INJECTION CORRECTIONS

The ECU is kept informed of the running conditions of the engine at each moment by means of signals from various sensors, and it makes various corrections in the basic injection duration based upon these signals.

1. 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 manifold pressure (by means of the manifold pressure sensor) and the intake air temperature (by means of the intake air temperature sensor) so that it can adjust the injection duration to maintain the air-fuel ratio currently required by the engine. For this purpose, the ECU considers 20°C to be the "standard temperature" and increases or decreases the amount of fuel injected by approximately 10 percent, depending upon whether the intake air temperature falls below or rises above this temperature.



RELEVANT SIGNAL

Intake air temperature (THA)

2. AFTER-START ENRICHMENT

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

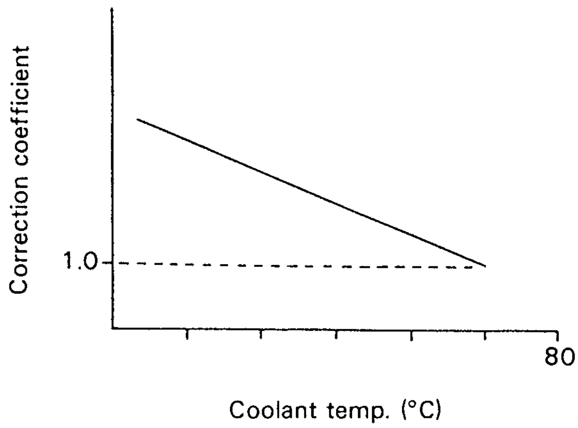
RELEVANT SIGNALS

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

3. WARM-UP ENRICHMENT

As fuel vaporization is poor when the engine is cold, driveability will deteriorate if a rich fuel mixture is not supplied.

For this reason, when the coolant temperature is low, the water temperature sensor so informs the ECU, which increases the amount of fuel injected to compensate. In extremely cold temperatures, the amount of fuel injected is approximately doubled.



RELEVANT SIGNAL

Coolant temperature (THW)

4. POWER ENRICHMENT

When the ECU determines from throttle position and intake manifold pressure that the injection duration is in the power range, it increases the injection volume by approximately 20 – 30 percent according to engine conditions at that time in order to maintain good driveability.

RELEVANT SIGNALS

- **Intake manifold pressure (PIM)**
- **Throttle position (PSW)**
- **Engine speed (Ne)**

5. AIR-FUEL RATIO FEEDBACK CORRECTION

The ECU corrects the injection duration based on the signals from the oxygen sensor to keep the air-fuel ratio within a narrow range near the ideal air-fuel ratio. (This is called a closed-loop operation.*) Furthermore, in order to prevent overheating of the catalyst and assure driveability, the air-fuel ratio feedback operation does not occur under the following conditions (open-loop operation):

- During engine starting
- During power enrichment
- When coolant temperature is below predetermined level
- When fuel cut-off occurs

* **Closed-Loop Operation**

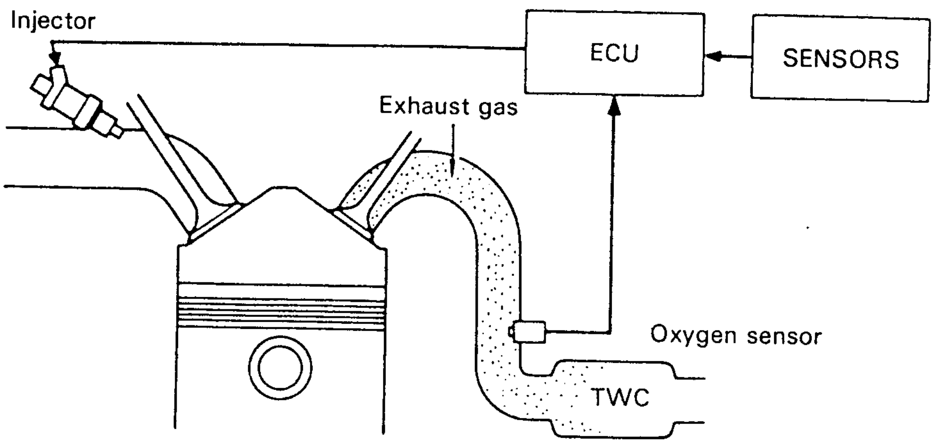
Engines with three-way catalyst (TWC) require an air-fuel ratio, which is kept within a narrow range near the theoretical value.

The ECU ensures the optimum fuel injector output by sending a control signal to the fuel injectors in response to signals from the various sensors that monitor the engine's condition.

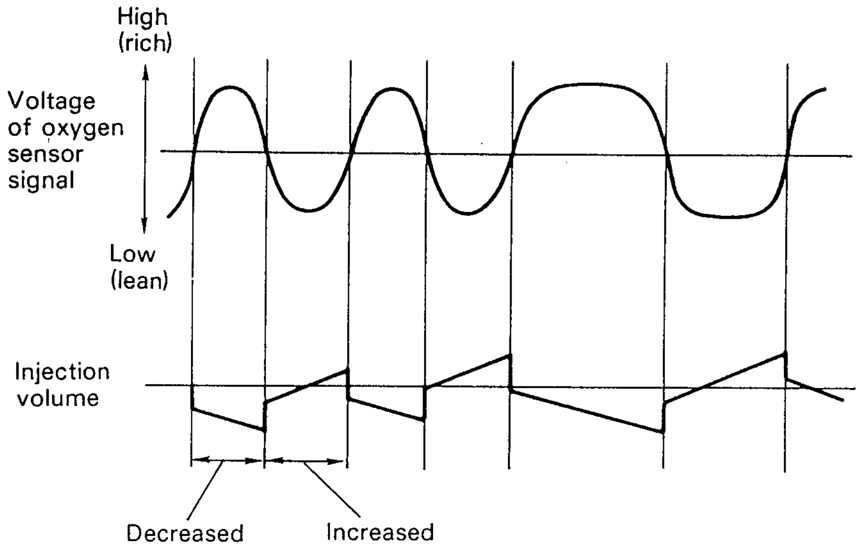
The oxygen sensor monitors the concentration of oxygen (O_2) in the exhaust gas and outputs voltage signals that tell the ECU whether the air-fuel ratio is higher (leaner) or lower (richer) than the theoretical value.

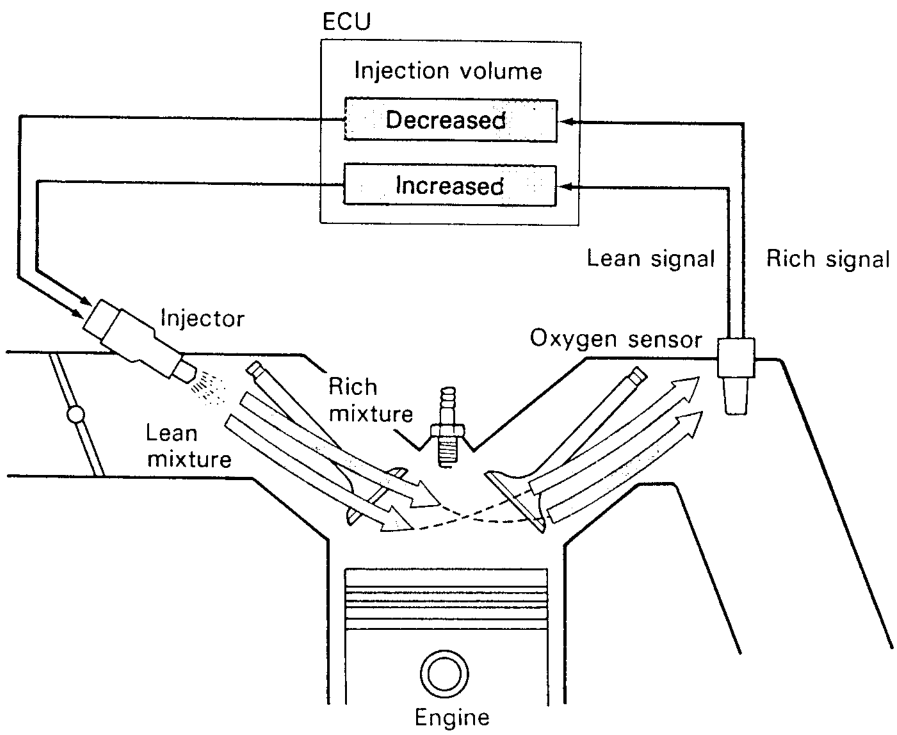
The ECU then, if necessary, corrects the length of the fuel injection duration signal before sending it to the fuel injectors.

This control process, in which the ECU adjusts the length of fuel injection duration signals that it feeds back to the injectors, based on its indirect monitoring of the oxygen sensor output, is referred to as "closed-loop operation."



The ECU compares the voltage of signals sent from the oxygen sensor with a predetermined voltage. If the voltage of a signal is higher than that voltage, it judges the air-fuel ratio to be richer than the ideal air-fuel ratio and reduces, at a constant rate, the amount of fuel injected. If the voltage of a signal is lower, it judges that the air-fuel ratio is leaner than the ideal, and increases the amount of fuel injected.



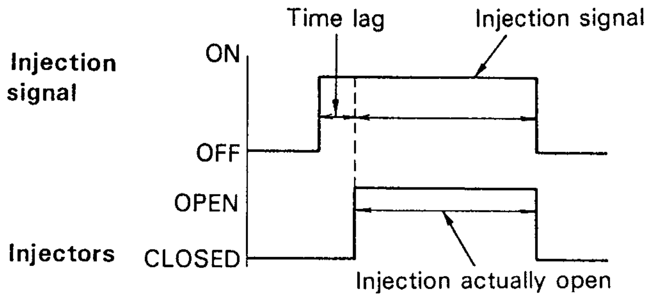


3. VOLTAGE CORRECTION

There is a slight delay between the time the ECU sends an injection signal to the injectors and the time the injectors actually open. This delay becomes longer the more the voltage of the battery drops. If this were not prevented by voltage correction, the length of time that the injection 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 of time 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)

FUEL CUT-OFF

1. FUEL CUT-OFF DURING DECELERATION

During deceleration from a high engine speed with the throttle valve completely closed, the ECU stops injection of fuel in order to improve fuel economy.

When the engine speed falls below a certain rpm or the throttle valve is opened, fuel injection is resumed.

CONDITION FOR RESUMPTION OF FUEL INJECTION

Engine speed drops below fuel injection resumption speed (IDL contacts go off).

CONDITION

IDL contacts of throttle position sensor on; engine speed above fuel cut-off speed.

RELEVANT SIGNALS

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

– NOTE –

Fuel cut-off and fuel injection resumption speeds vary depending upon coolant temperature.

2. FUEL CUT-OFF DUE TO HIGH ENGINE SPEED

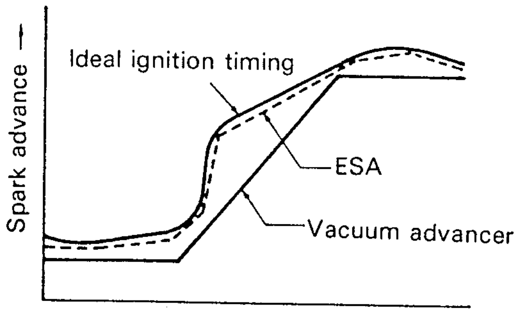
To prevent engine overrun, fuel injection is stopped if the engine speed rises above 6500 rpm. Fuel injection is resumed when the engine speed falls below 6500 rpm.

ESA (Electronic Spark Advance)

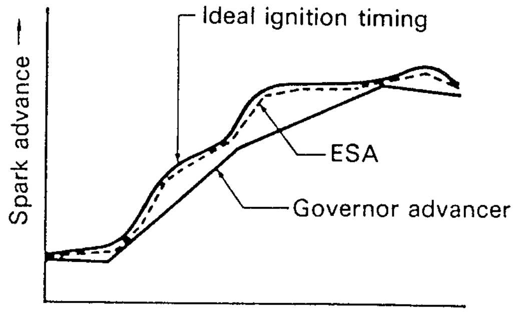
GENERAL

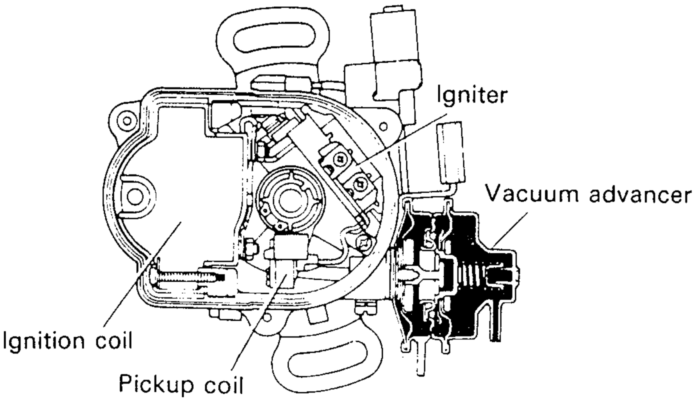
In order to maximize engine output efficiency, the air-fuel mixture must be ignited when the maximum combustion pressure occurs; that is, at about 10° after TDC.
However, the time from ignition of the air-fuel mixture to the development of maximum combustion pressure varies depending on the engine rpm and the manifold pressure; ignition must occur earlier when the engine speed is higher and later when it is lower. In a conventional ignition system, the timing is advanced by a governor advancer.
On the other hand, when the manifold pressure is low (high vacuum), ignition must also be advanced, and this is achieved by the vacuum advancer in the conventional ignition system.
Actually, optimum ignition timing is affected by a number of other factors besides engine speed and intake air volume: the shape of the combustion chamber, the temperature inside the combustion chamber, etc. Therefore, governor and vacuum advancers do not provide ideal ignition timing for the engine. However, with the ESA system, the engine is provided with nearly ideal ignition timing characteristics.
The ECU determines ignition timing from its internal memory, which contains optimum ignition timing data for each engine condition, and then sends the appropriate ignition timing signal to the igniter.
Since the ESA always ensures optimum ignition timing, both fuel efficiency and engine power output are maintained at optimum levels.

VACUUM ADVANCING



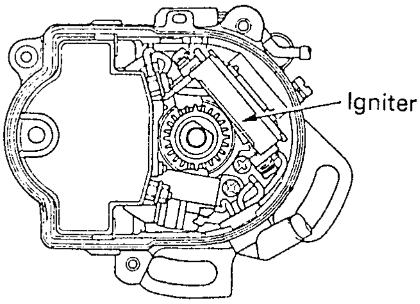
ADVANCING BY ENGINE RPM





IIA (CONVENTIONAL TYPE)

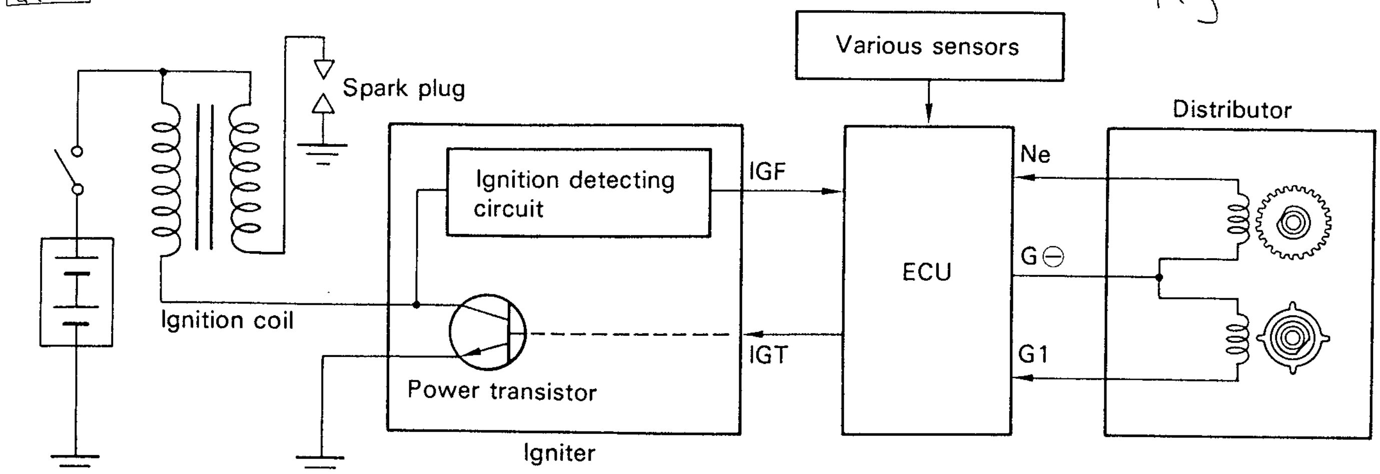
*



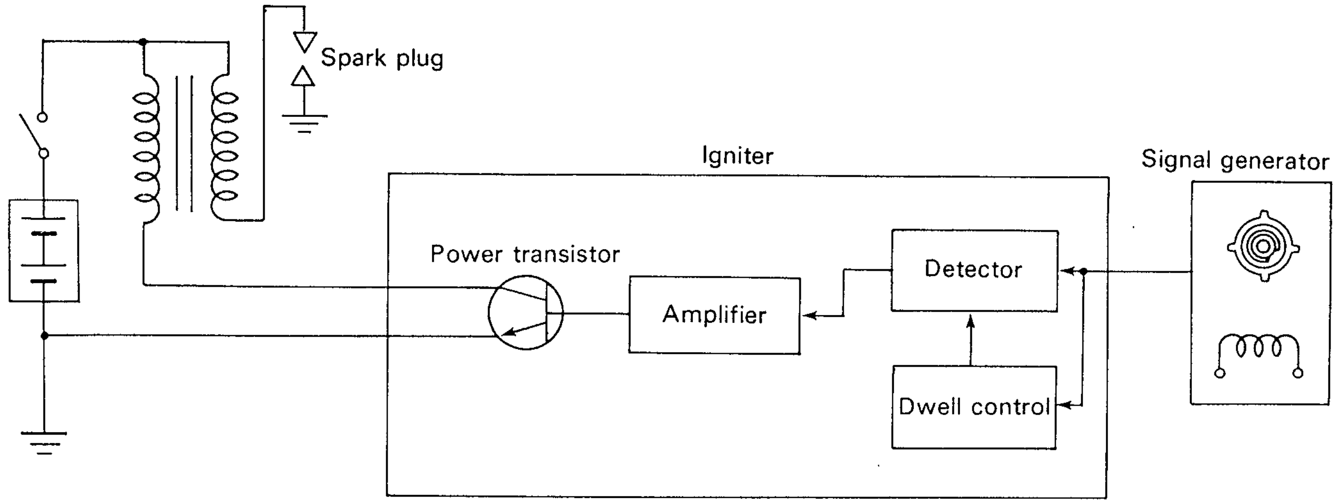
IIA (WITH ESA)

ESA SYSTEM DIAGRAM

Fig A

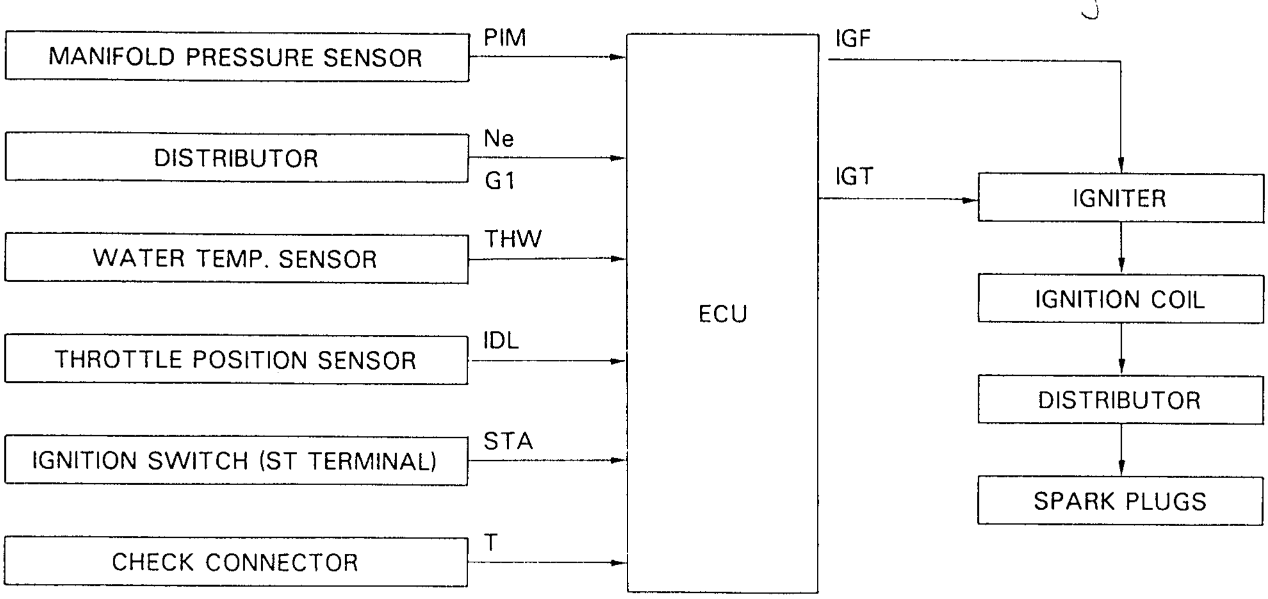


IGNITER CIRCUITRY (without ESA system)



ESA BLOCK DIAGRAM

Fig B



IGNITER

1. OPERATION

The microprocessor in the ECU determines the ignition timing according to signals from each sensor, using the crankshaft angle signals (G1 and Ne) as references. After determining the ignition timing, the ECU sends the ignition timing signal (IGT) to the igniter.
When the IGT signal goes off, the primary current to the igniter is interrupted, causing a high voltage (approx. 20 to 35 kV) to be generated by the secondary coil and sparks to be generated by the spark plugs.

2. INCORPORATED CIRCUITS

The igniter incorporates the following circuits so as to deliver a stable secondary voltage and assure system reliability.

a. DWELL ANGLE CONTROL CIRCUIT

The circuit controls the length of time during which TR2 (shown on page 75) is on so as to assure the proper secondary voltage.

b. IGNITION CONFIRMATION (IGF) SIGNAL GENERATION CIRCUIT

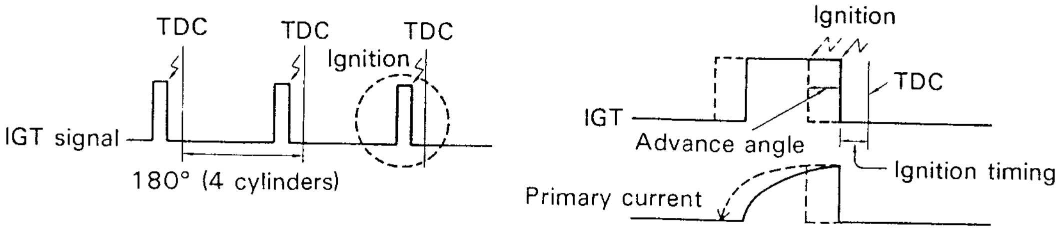
The counter-electromotive force that is generated when the primary current is interrupted causes this circuit to send an ignition confirmation (IGF) signal to the ECU.

c. LOCK PREVENTION CIRCUIT

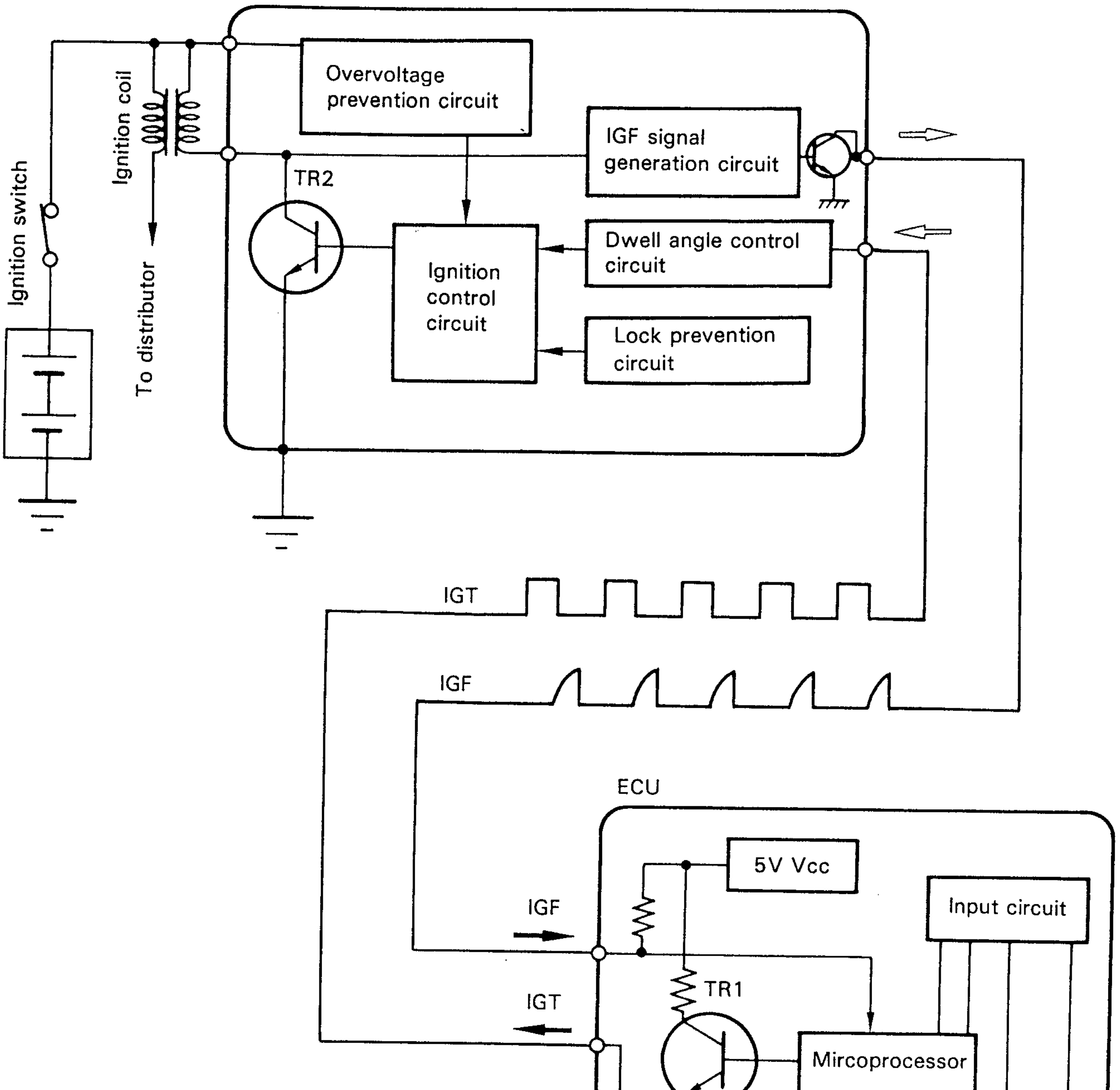
This circuit forces TR2 to go off if it locks up (that is, if current flows continuously for longer than a predetermined period) so as to protect the ignition coil and TR2.

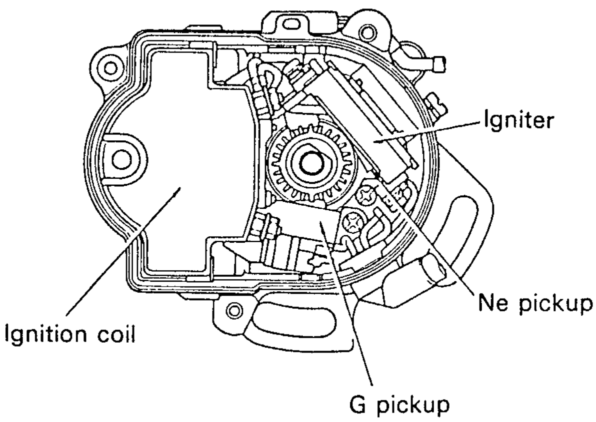
d. OVER VOLTAGE PREVENTION CIRCUIT

The circuit forces TR2 to go off if the power supply voltage becomes too high so as to protect TR2 and the ignition coil.



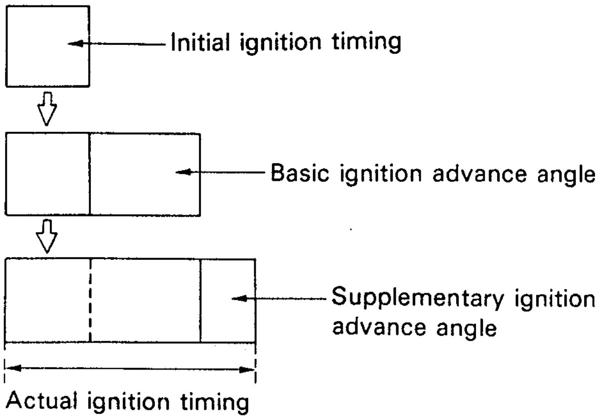
3. SYSTEM DIAGRAM





FUNCTIONS OF ECU

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



Whenever a G1 signal is input into the ECU, the ECU counts the number of Ne signals input (one Ne signal is generated for each 30° of revolution of the crankshaft). Each time the crankshaft rotates to the specified angle, the ECU sends an IGT (ignition) signal to the igniter.

1. INITIAL IGNITION TIMING

"Initial ignition timing" is the basic crankshaft angle at which ignition takes place when the electronic advance is not in operation.

ADVANCE CONTROL DURING STARTING

Since engine speed is unstable during and directly 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 until engine operation has been stabilized.

CONDITIONS

Engine speed below predetermined level or STA on.

RELEVANT SIGNALS

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

2. BASIC IGNITION ADVANCE ANGLE

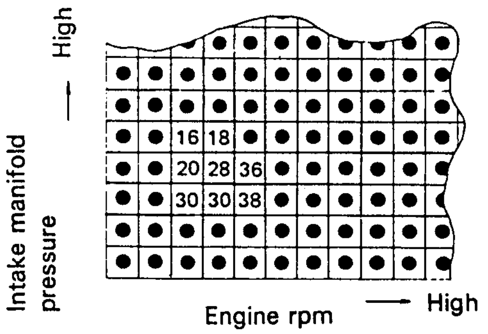
This corresponds to the vacuum advance or governor advance angle in a convertional engine. The memory in the ECU contains optimum advance angle data corresponding to the intake manifold pressure and the engine rpm.

The ECU selects the basic ignition advance angle from the memory according to the engine speed signals from the Ne pickup coil in the distributor and the intake manifold pressure signals from the manifold pressure sensor.

a. IDLE CONTACTS OPEN (OFF)

The ECU determines the basic ignition advance angle based upon data stored in its memory. This data can be shown in the form of a table, as shown below.

BASIC IGNITION ADVANCE ANGLE DATA



RELEVANT SIGNALS
- **Intake manifold pressure (PIM)**
- **Engine speed (Ne)**
- **Throttle position (IDL)**

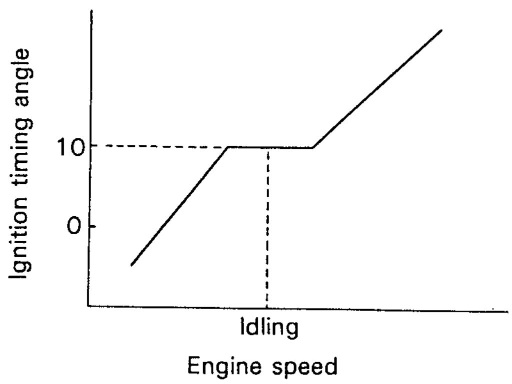
– REFERENCE –

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 manifold pressure.

It then carries out proportional calculations to find the optimal ignition timing for the given conditions.

b. IDL CONTACTS CLOSED (ON)

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



RELEVANT SIGNALS
- **Throttle position (IDL)**
- **Engine speed (Ne)**

3. SUPPLEMENTARY IGNITION ADVANCE ANGLE

a. WARM-UP COMPENSATION

When the coolant temperature is low, the ignition timing advance angle is advanced or retarded to improve driveability and warm-up.

b. STABLE IDLING CORRECTION

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

4. MAXIMUM AND MINIMUM ADVANCE ANGLE CONTROL

If the ignition timing (initial ignition timing + basic ignition advance angle + supplementary ignition advance or retard angle) becomes abnormal, engine operation will be adversely affected. To prevent this, the ECU controls the actual ignition angle (ignition timing) so that the sum of the basic ignition and supplementary ignition advance and retard angles cannot be greater or less than certain values.

These value are:

Ignition timing	ATDC 10° ~ BTDC 44°

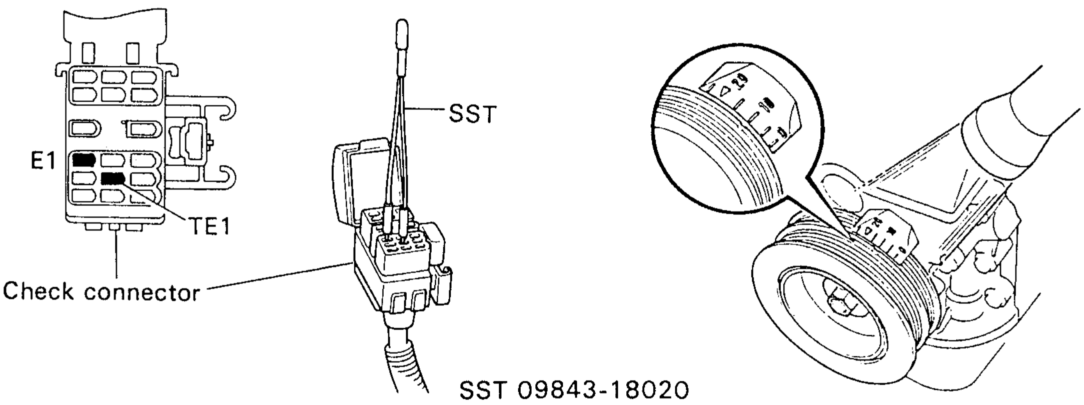
CHECKING AND ADJUSTING IGNITION TIMING

To check the ignition timing, short-circuit the TE1 and E1 service terminals with the IDL contacts closed. This will cause the ignition advance angle to be fixed so that it can be seen whether or not the ignition timing returns to the fixed ignition angle of 10° BTDC as it should. If it does not, it must be adjusted.

CONDITIONS

- **IDL contacts closed (on)**
- **TE1 and E1 short-circuit**

STANDARD IGNITION TIMING = INITIAL IGNITION TIMING + FIXED IGNITION ADVANCE
= 10° BTDC



— NOTES —

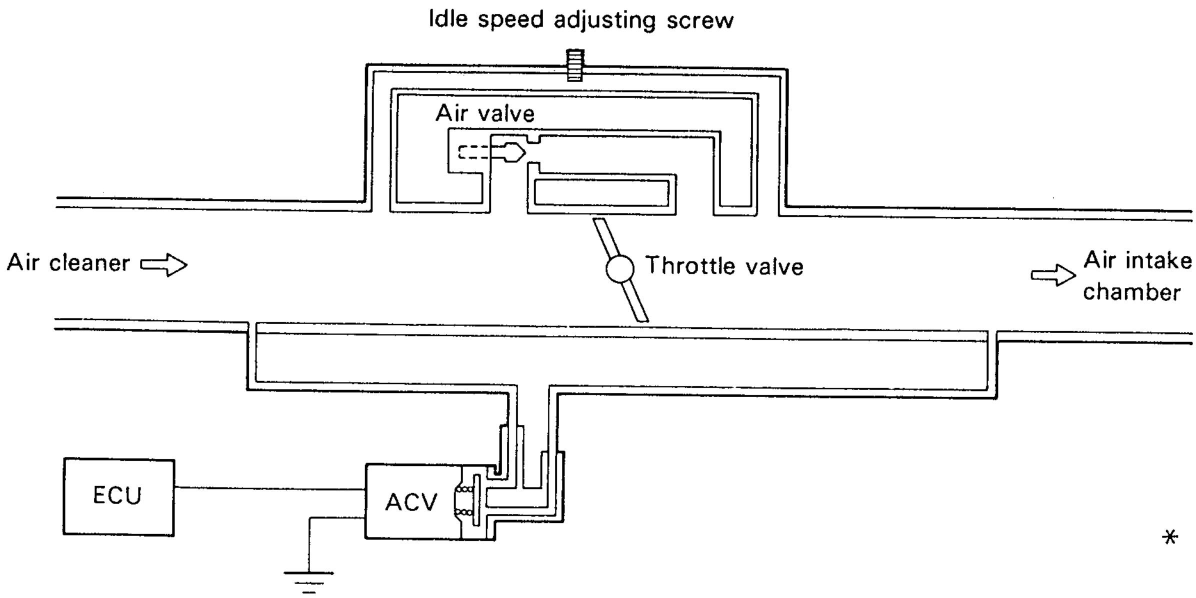
1. The ECU determines ignition timing by adding the basic ignition advance angle and supplementary ignition advance angle to the initial ignition timing.
   However, the initial ignition timing itself is not determined by the ECU but by the angle to which the distributor has been physically set. For this reason, it is very important to set the distributor to the appropriate angle if one wishes to obtain the correct ignition timing.
2. When the terminals TE1 and E1 are disconnected after adjusting the ignition timing correctly, ignition timing will be about 10° BTDC (varying by 5 – 15° by stable idling correction).
3. When the throttle valve is open (IDL contacts open [off]), the ignition timing will not be about 10° BTDC but will keep advancing.

ISC (Idle Speed Control)

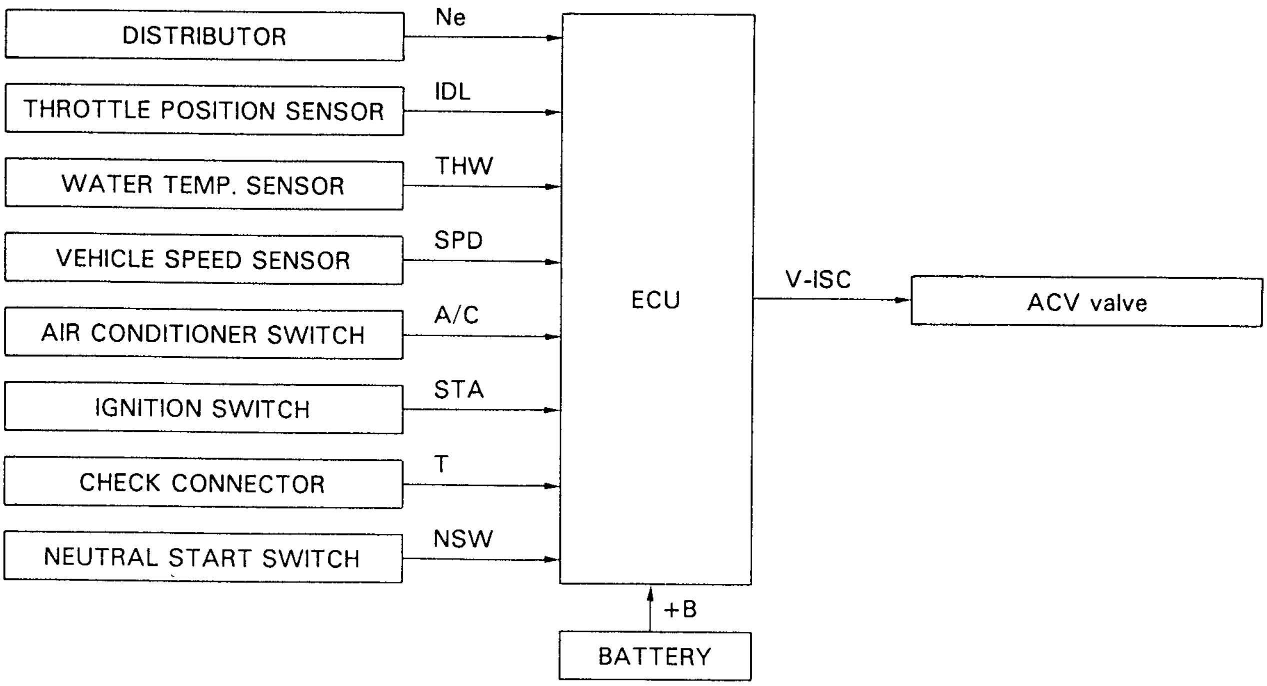
GENERAL

The 4A-FE engine is equipped with an ISC system which uses an ACV (air control valve) to maintain engine startability and idling stability.
Since the air volume controlled by this ACV is small, an air valve for controlling fast idle in the cold state and the idle-up mechanisms for power steering and the air conditioner are provided.

ISC SYSTEM DIAGRAM



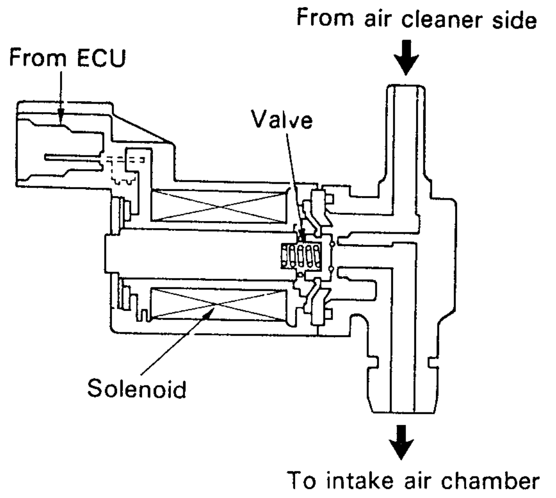
ISC BLOCK DIAGRAM

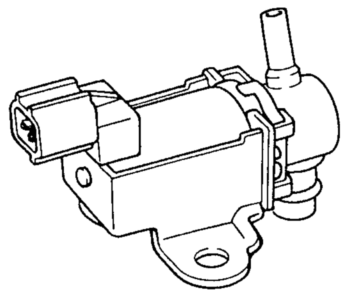


AIR CONTROL VALVE (ACV)

While current flows according to the signal from the ECU, the coil is excited and the valve moves. This changes the gap between the solenoid valve and the valve body, regulating the idle speed. However, the fast-idle speed is regulated using an air valve.

In actual operation, current to the coil is switched on and off every 100 msec., so the position of the solenoid valve is determined by the proportion of time the signal is on and the time it is off (i,e., by the duty ratio). That is, the valve opens wider the longer current flows to the coil.





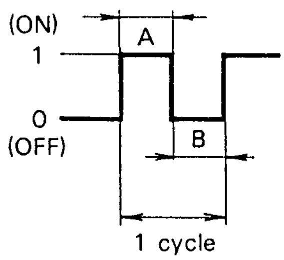
*

— REFERENCES —

DUTY RATIO

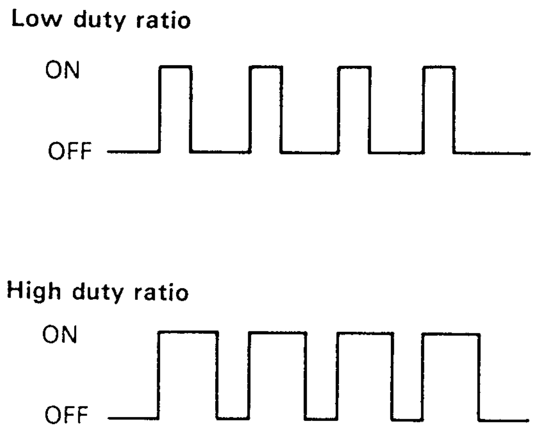
The duty ratio is the ratio of the interval during which current flows in one cycle of a signal. The figure below shows one cycle during which current flows and then does not flow.

A: Current flows
B: Current does not flow



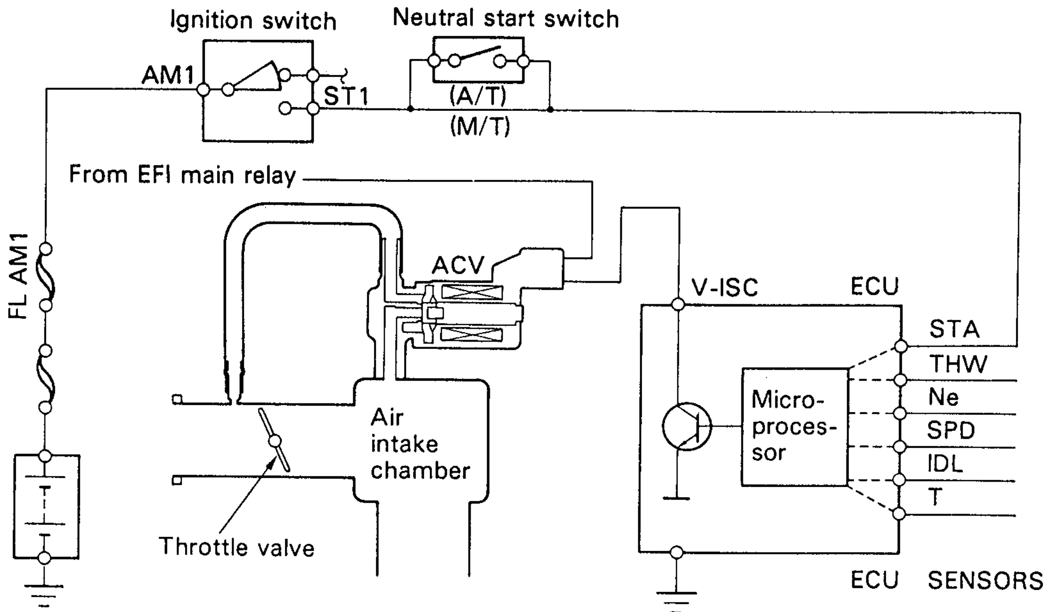
Duty ratio (%)

$$= \frac{A}{A + B} \times 100$$



FUNCTION OF ECU

The ACV controls the volume of air passing through the throttle valve by means of signals from the ECU (duty signal) and is mounted in the air intake chamber. The air flow volume is determined by the ratio of the times the air flow volume signal from the ECU is on and off (duty ratio).
If the idle speed changes any because of a mechanical failure or changes in electrical load, such as when the air conditioner switch or neutral start switch is operated, etc., the ACV regulates the volume of air by passing the throttle valve according to signal from the ECU, thus helping to stabilize the idle speed. During warm-up, the fast-idle speed is regulated by the air valve. Control is as explained below.



1. **CONTROL DURING CRANKING**

   To improve startability during cranking, switching the STA on causes the ACV to open fully.

2. **ENGINE SPEED CHANGE ESTIMATE CONTROL**

   The duty radio is changed when the air conditioner switch or neutral start switch is operated. This helps to limit the change in idle speed.

3. **CONSTANT DUTY CONTROL**

   The ECU maintains the ACV at a fixed opening angle when the IDL contacts are off or the air conditioner switch is on.

4. **FEEDBACK CONTROL**

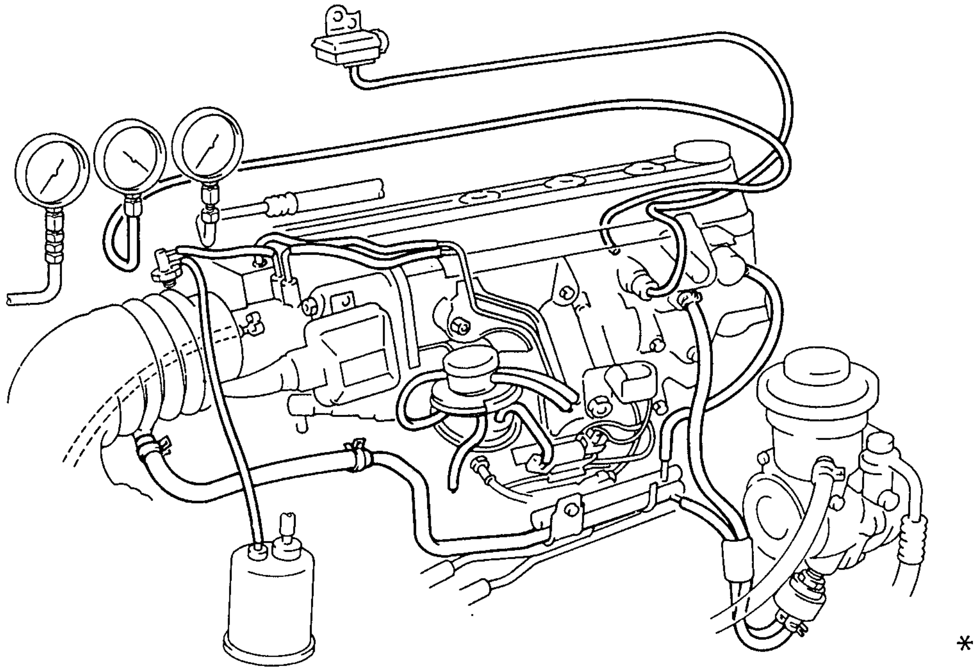
   The ECU changes the duty ratio of the V-ISC signal and maintains the idle speed in conditions other than those in 1, through 3.

   – NOTE –

   Connecting the TE1 and E1 terminals of the check connector causes the ECU to set the ACV opening angle at a fixed value regardless of engine operating conditions.

INSPECTION AND ADJUSTMENT OF IDLE SPEED

COMPONENT LAYOUT (Pipes & Hoses)

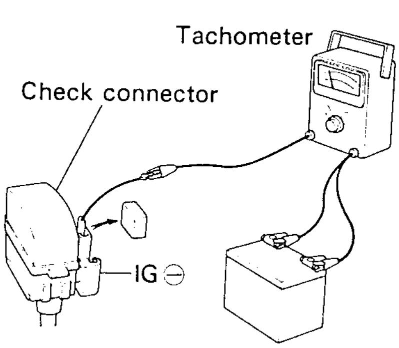


1. INITIAL CONDITIONS

a. Air cleaner installed
b. Normal engine operating temperature
c. All pipes and hoses of air induction system connected
d. All vacuum lines connected
e. All accessories switched off
f. EFI system wiring connectors fully plugged
g. Ignition timing set correctly
h. Transmission in "neutral" range

2. CONNECT TACHOMETER

Connect the test probe of a tachometer to terminal IG ⊖ of the check connector.



NOTES:

- **NEVER allow the tachometer probe terminal to touch ground as it could result in damage to the igniter and/or ignition coil.**
- **As some tachometers are not compatible with this ignition system, we recommend that you confirm the compatibility of your unit before use.**

3. INSPECT AIR VALVE OPERATION

a. Remove the air cleaner hose.

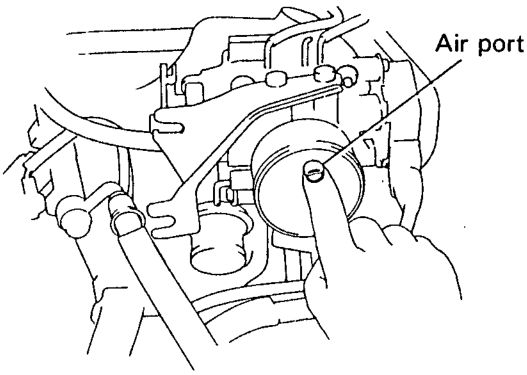
b. Check the engine rpm by closing the air port on the throttle body.

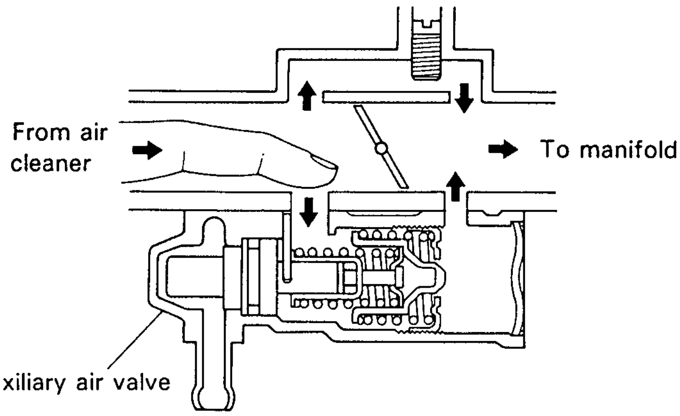
At low temp. (Coolant temp.: below 80°C (176°F))

- The engine rpm should drop.

After warm-up

- Check that engine rpm does not drop more than 100 rpm.



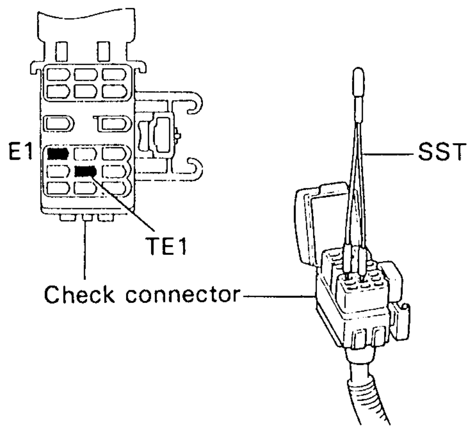


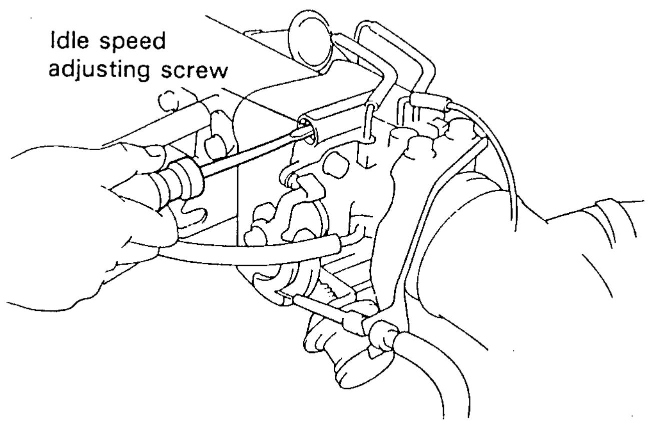
c. Install the air cleaner hose.

d. Using the SST, connect terminals TE1 and E1 of the check connector.

4. INSPECT AND ADJUST IDLE SPEED: 800 rpm (in "N" range w/ cooling fan off)

If not as specified, adjust the idle speed by turning the idle speed adjusting screw.





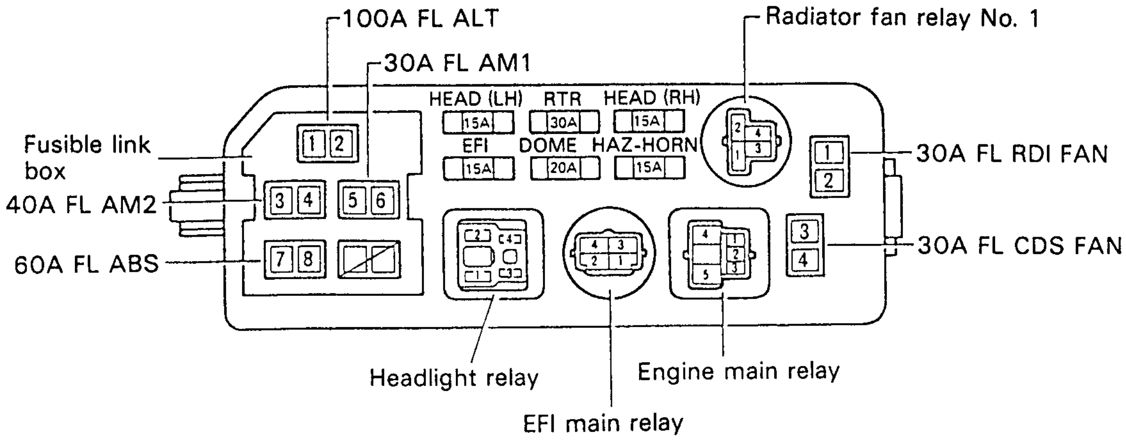
– NOTES –

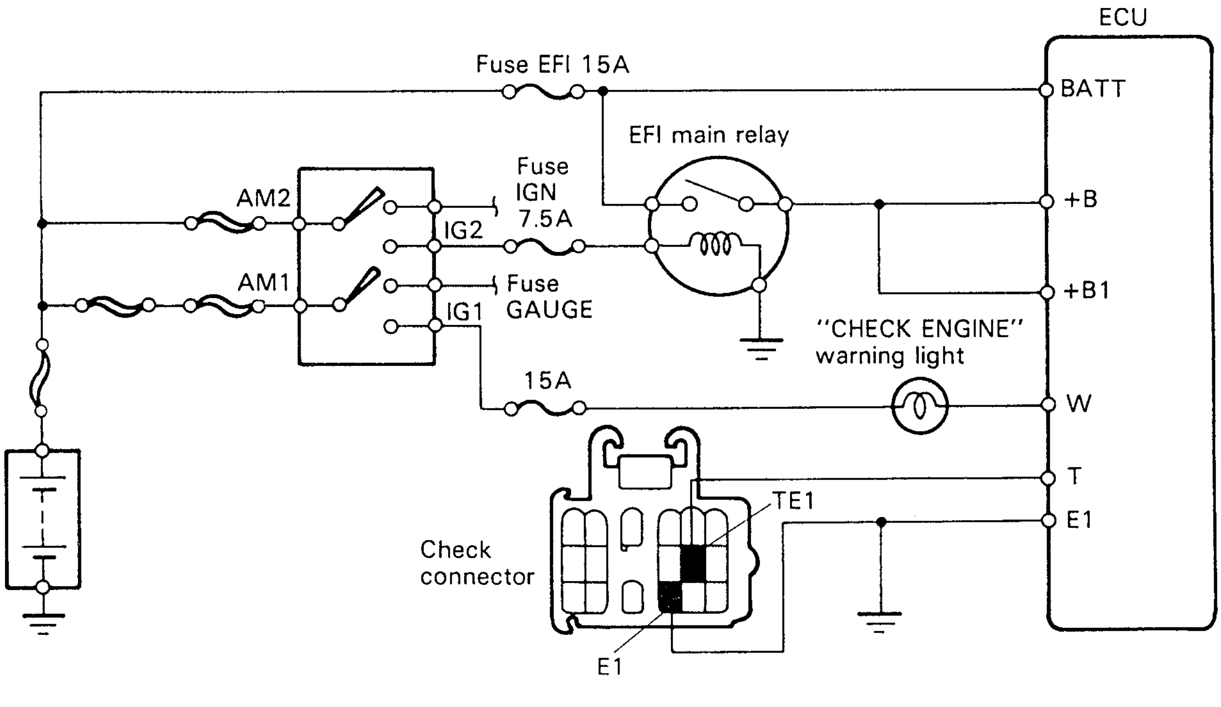
1. In actual vehicles, the idle speed in the "D" range is approximately 100 rpm lower than that of the "N" range.
2. In this simulator, the idle speeds in the "D" and "N" ranges are nearly the same because the driveshaft is free.
3. When the lever is shifted from "N" to "D", the engine rpm rises for approximately 2 seconds because the ISC is operating and the driveshaft is free.

DIAGNOSIS

GENERAL

The ECU contains a built-in self-diagnositc system. The ECU, which is constantly monitoring all sensors, lights the "CHECK ENGINE" lamp when it detects a problem in certain parts of the circuitry. At the same time, the ECU registers in its memory the system containing the malfunction. This information is retained in memory even after the ignition switch is turned off, and even after the malfunction has been corrected. When the vehicle is brought into the service workshop because of a problem in the TCCS, 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 15A fuse for more than 10 seconds with the ignition switch turned off.

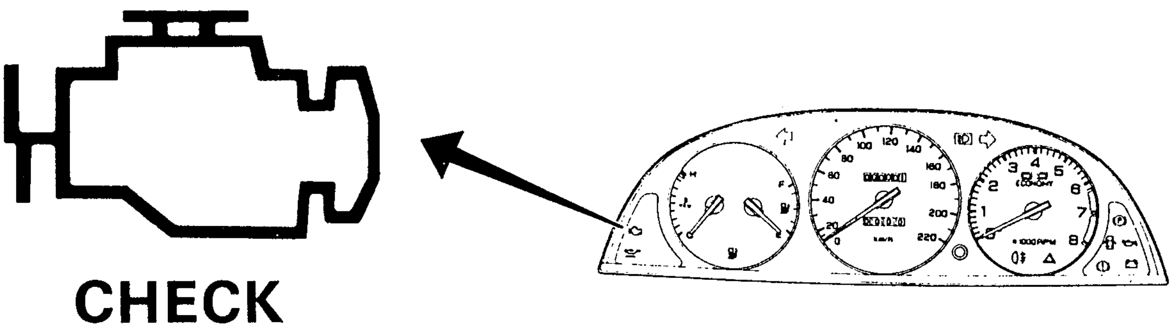




CHECK ENGINE LAMP

The diagnostic system monitors the fifteen conditions, including the normal condition, listed in the charts on pages 89. Whenever the ECU detects a major TCCS malfunction (that is, one of those marked with a circle in the CHECK ENGINE column of the table), it lights the CHECK ENGINE lamp to so inform the driver. For all of the systems not so marked, the ECU does not light the lamp when a malfunction is detected, because a malfunction in those systems would not cause any major problems such as engine stalling.

After a malfunction is corrected, the ECU turns off the CHECK ENGINE lamp, but until the fuse is removed, the ECU memory retains a record of the system that contained the malfunction.



1. OPERATION

a. 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.

b. The lamp lights immediately if a major TCCS problem occurs while the engine is running.

c. The lamp goes out five seconds after the problem is corrected.

d. 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.

2. CANCELLING DIAGNOSTIC CODE

After repair of trouble area, the diagnostic code retained in memory by the ECU must be cancelled out by removing the fuse EFI 15A, located in the junction block No. 2, for 10 seconds or more, depending on ambient temperature (the lower the temperature, the longer the fuse must be left out) with the ignition switch OFF.

– NOTES –

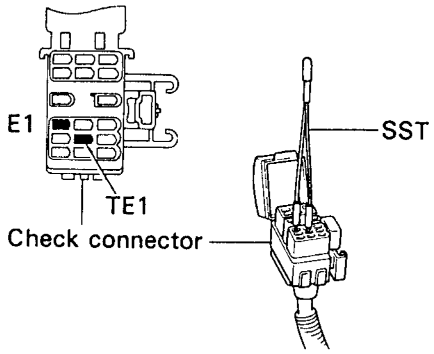
1. Cancellation can also be done by removing the battery negative (–) terminal, but in this case, other memory systems (clock, etc.) will also be cancelled out.
2. If the diagnostic code is not cancelled out, it will be retained by the ECU and appear along with a new code in the event of future trouble.
3. If it is necessary to remove the battery terminal, a check must first be made to see if a diagnostic code has been recorded.

DIAGNOSTIC CODES

In the 4A-FE engine, TCCS problems can be diagnosed by fulfilling the following three conditions, then counting the number of times the CHECK ENGINE lamp blinks (see the Table of Diagnostic Codes):

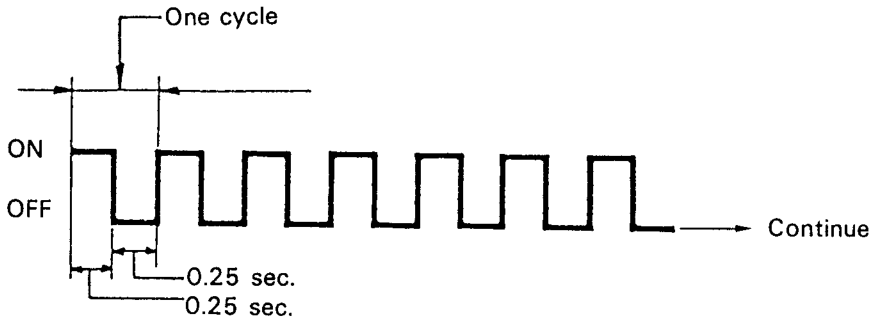
CONDITIONS

- **Ignition switch ON**
- **Check terminals E1 and TE1 connected**
- **IDL contacts on (throttle valve fully closed)**



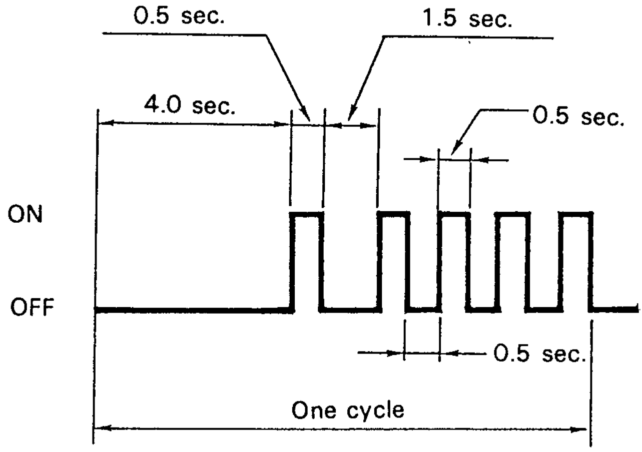
1. NORMAL

The lamp will blink once every 0.25 second as shown below.



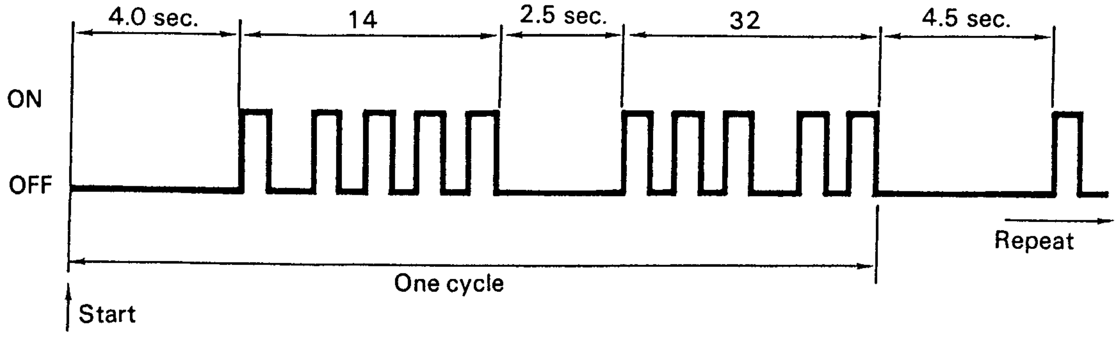
2. MALFUNCTION PRESENT

The appropriate diagnostic code will be indicated by the lamp as shown in the example below. In this case, code 14 is indicated.



– NOTES –

1. If two or more malfunctions are present at the same time, the lowest-numbered diagnostic code will be displayed first as shown in the example below. In this case, codes 14 and 32 are indicated.



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2. Diagnostic codes for all detected malfunctions, except code No. 51, will be retained in memory by the ECU from the time of detection until cancellation.
3. Once the malfunction is cleared, the "CHECK ENGINE" warning lamp will go out, but the diagnostic code(s) will remain stored in the ECU memory (except code No. 51) until the fuse is removed.

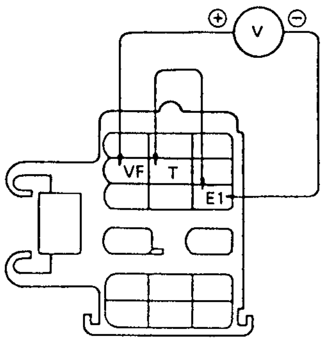
3. DIAGNOSIS USING VF OUTPUT TERMINAL VOLTAGE

In addition to the CHECK ENGINE lamp, the voltage from the VF terminal of the check connector may also be measured to diagnose fuel injection problems.

The ECU will output 5 V from the VF terminal if there are no problems but will stop outputting a voltage if there is problem. This allows the system to be diagnosed even if the CHECK ENGINE lamp is burned out.

The VF terminal can be checked for voltage when all of the following conditions are fulfilled:

CONDITIONS
- **Ignition switch on**
- **Check terminals TE1 and E1 short-circuited**
- **IDL contacts on (throttle valve fully closed)**



4. DIAGNOSTIC CODES

CODE NO.	"CHECK ENGINE" LIGHT BLINKING PATTERN	SYSTEM	DIAGNOSIS	TROUBLE AREA	"CHECK ENGINE" DIAGNOSTIC LIGHT
—	 ON OFF	Normal	This appears when none of the other codes is identified.	—	—
12		Rpm signal	No Ne or G1 signal to ECU within 2 seconds after engine has been cranked.	• Distributor circuit • Distributor • Starter signal circuit • ECU	○
13		Rpm signal	No Ne signal to ECU when engine speed is above 1,000 rpm.	• Distributor circuit • Distributor • ECU	○
14		Ignition signal	No IGF signal to ECU 4 times in succession.	• Igniter and ignition coil circuit • Igniter and ignition coil • ECU	○
21		Oxygen sensor signal	Detection of oxygen sensor deterioration.	• Oxygen sensor circuit • Oxygen sensor • ECU	○
		*Oxygen sensor heater circuit	During air-fuel ratio feedback correction, voltage output from the oxygen sensor does not exceed a set value on the lean side and the rich side continuously for a certain period.	• Oxygen sensor heater circuit • Oxygen sensor heater • ECU	○
22		Water temp. sensor signal	Open or short circuit in water temp. sensor signal (THW).	• Water temp. sensor circuit • Water temp. sensor • ECU	○
24		Intake air temp. sensor signal	Open or short circuit in intake air temp. sensor signal (THA).	• Intake air temp. sensor circuit • Intake air temp. sensor • ECU	●
25		Air-fuel ratio lean malfunction	• Lean signal sent by oxygen sensor for several seconds during air-fuel ratio feedback correction. • Open or short circuit for oxygen sensor (OX).	• Injector circuit • Injector • Oxygen sensor circuit • Oxygen sensor • ECU • Fuel line pressure • Air flow meter • Air intake system • Ignition system	○
26		Air-fuel ratio lean malfunction	Rich signal sent by oxygen sensor for several seconds during air-fuel ratio feedback correction.	• Injector circuit • Injector • Fuel line pressure • Cold start injector • Air flow meter • ECU	○
31		Vacuum sensor signal	Open circuit in Vcc signal or short circuit between Vcc and E2 when idle contacts are closed.	• Vacuum sensor circuit • Vacuum sensor • ECU	○

*Federal

DIAGNOSTIC CODES (Cont'd)

CODE NO.	"CHECK ENGINE" LIGHT BLINKING PATTERN	SYSTEM	DIAGNOSIS	TROUBLE AREA	"CHECK ENGINE" DIAGNOSTIC LIGHT
41		Throttle position sensor signal	The IDL and PSW signals are output simultaneously for several seconds.	● Throttle position sensor circuit ● Throttle position sensor ● ECU	●
42		Vehicle speed sensor signal	No SPD signal for 8 seconds when engine speed is between 2,600 rpm and 4,500 rpm and coolant temp. is below 80°C (176°F) except when racing the engine.	● Vehicle speed sensor circuit ● Vehicle speed sensor ● ECU	—
43		Starter signal	No STA signal to ECU unit when engine speed reaches 800 rpm with vehicle not moving.	● Ignition switch circuit ● Ignition switch ● ECU	—
•71		EGR malfunction	EGR gas temp. below predetermined level during EGR control.	● EGR system (EGR valve, EGR hose, etc.) ● EGR gas temp. sensor circuit ● EGR gas temp. sensor ● EGR control VSV ● EGR control VSV circuit ● ECU	●
51		Switch condition signal	No IDL signal while engine is running, neutral start signal, or A/C signal to ECU, with the check terminals TE1 and E1 connected.	● A/C switch circuit ● A/C amplifier ● Throttle position sensor circuit ● Throttle position sensor ● Accelerator pedal and cable ● ECU ● Neutral start switch	—

● California only

FAIL-SAFE

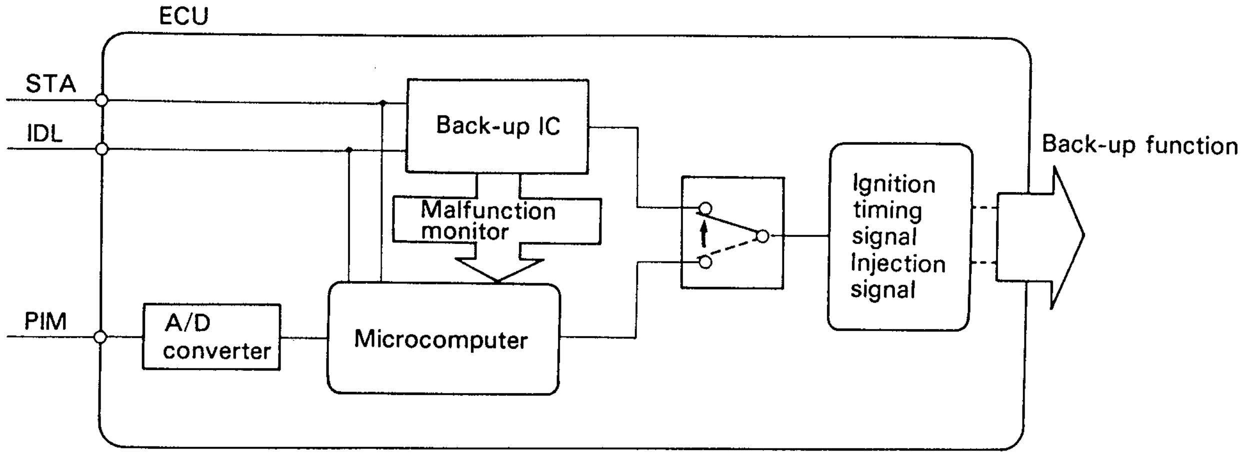
FAIL-SAFE FUNCTION

When a malfunction is detected by any of the sensors, there is a possibility of an engine or other malfunction occurring if the ECU were to continue to control the TCCS in the normal way. To prevent such a problem, the fail-safe function of the ECU either relies on the data stored in memory to allow the TCCS to continue operating, or stops the engine if a hazard is anticipated. The following table describes the problems, which can occur in the various circuits, and the responses of the fail-safe function.

CIRCUIT WITH ABNORMAL SIGNALS	NECESSITY OF FAIL-SAFE FUNCTION	FAIL-SAFE FUNCTION
Water temp. sensor signal (THW) circuit Intake air temp. sensor signal (THA) circuit	If an open or short circuit occurs in the water temperature or intake air temperature signal circuit, the ECU senses that the temperature is below −50°C or higher than 139°C. This results in the air-fuel ratio becoming too rich or too lean, which leads to engine stall or rough engine running.	Values for normal operation (standard values) are used. Standard values differ according to engine characteristics, but generally, a coolant temperature of 80°C and an intake air temperature of 20°C are used.
Ignition confirmation signal (IGF) circuit	If trouble occurs in the ignition system and ignition cannot take place (the ignition confirmation signal (IGF) does not reach the ECU), the catalyst could overheat due to misfiring.	Fuel injection is stopped.
Intake manifold pressure sensor signal (PIM) circuit	If an open or short circuit occurs in the intake manifold pressure sensor signal circuit, the basic injection duration cannot be calculated, resulting in engine stalling or inability to start the engine.	When the T terminal is off, the back-up mode is entered. If the T terminal is on, the standard values are used for the intake manifold pressure signal. The standard intake manifold pressure value is 225 mmHg.

1. BACK-UP FUNCTION

The back-up function is a system, which switches to the back-up IC for fixed signal control when trouble occurs with the microprocessor inside the ECU, allowing the vehicle to continue operating. This system assures the continuation of only basic functions, and normal performance cannot be maintained.



2. BACK-UP CONDITIONS

The ECU switches to the back-up mode when either of the following conditions is met:

① When the microprocessor stops outputting the ignition timing signal (IGT).

② When there is an open or short circuit in the intake manifold pressure signal circuit and the T terminal is off (D-type EFI only).

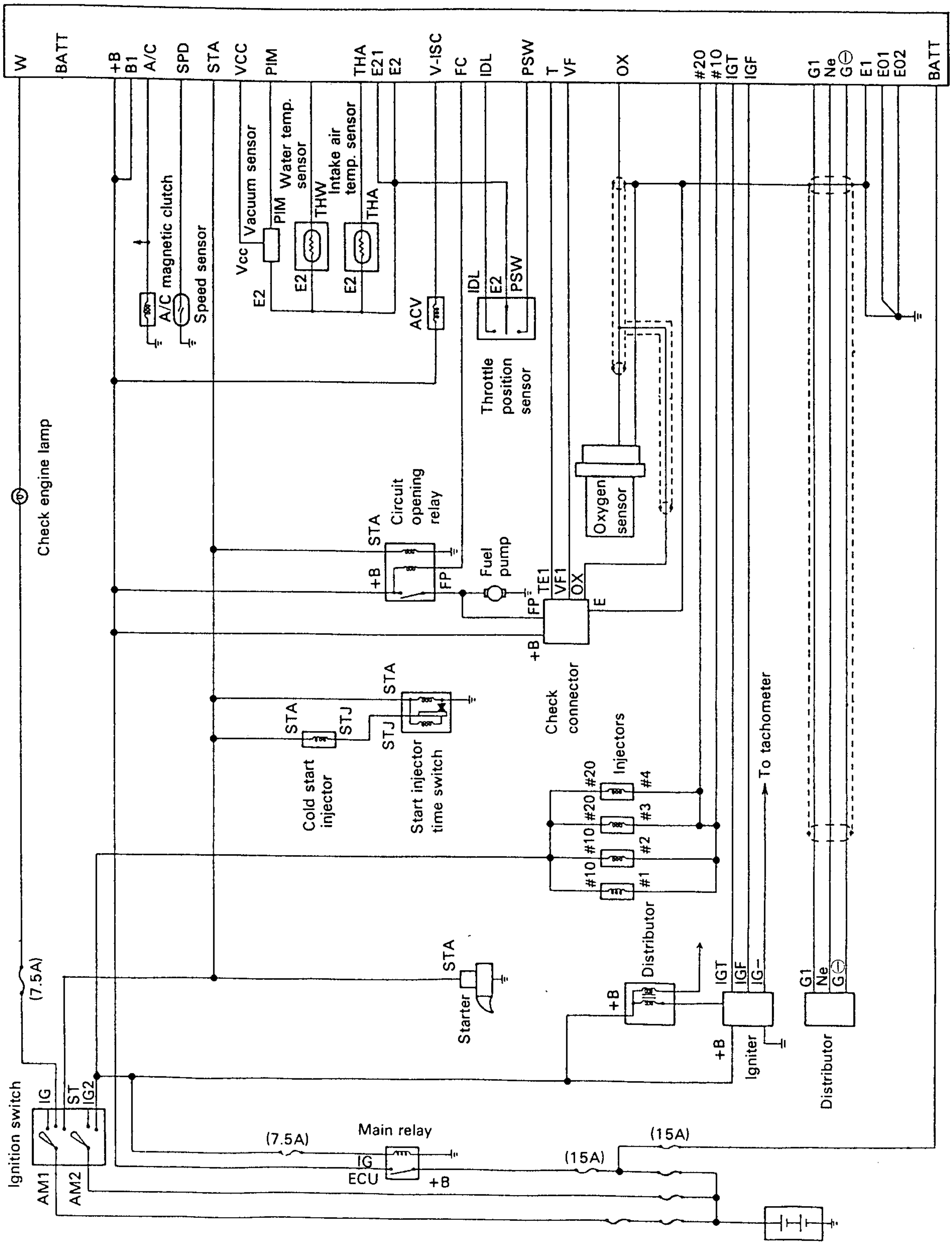
3. BACK-UP MODE

If either back-up condition is satisfied, fixed values are substituted for fuel injection duration and ignition timing, and engine operation is maintained. The back-up IC sets three fixed values according to the STA signal and IDL contact conditions. At the same time, the CHECK ENGINE lamp is lighted to inform the driver. (However, no code is output in the case of condition ① mentioned above, though a code is output in the case of condition ② .) Fixed values differ according to the engine model.

SUMMARY OF TCCS CONTROL

			SENSORS												
			Manifold pressure sensor	Throttle position sensor		Water temp. sensor	Intake air temp. sensor	Vehicle speed sensor	Distributor		Ignition switch	A/C magnet switch	Oxygen sensor	Battery	ECU
			PIM	IDL	PSW	THW	THA	SPD	G1	Ne	STA	A/C	OX	+B	
			Senses manifold pressure.	Senses when throttle valve is fully closed.	Informs ECU of whether or not vehicle is running under high load by sensing throttle valve opening angle.	Senses coolant temperature.	Senses intake air temperature.	Senses vehicle speed.	Senses crankshaft angles, which are basic data needed in determining injection and ignition timing.	Senses engine speed (rpm).	Senses when engine is starting.	Senses whether air conditioner is on or off.	Senses oxygen density in exhaust gas.		Determines injection duration and timing, ignition timing, idle speed, etc., based upon data from sensors and data stored in memory, and sends appropriate signals to control actuators.
	Injection timing								●	●					
	Starting injection					●	●			●	●			●	●
EFI	Basic injection		●							●					●
EFI	Correction	Intake air temp. correction					●								●
EFI	Correction	Warm-up enrichment				●									●
EFI	Correction	After-start enrichment				●				●					●
EFI	Correction	Air-fuel ratio correction during acceleration or deceleration	●	●		●				●					●
EFI	Correction	Power enrichment	●		●					●					●
EFI	Correction	Air-fuel ratio feedback correction	●	●	●	●				●	●		●		●
EFI	Correction	Voltage correction												●	●
EFI	Fuel cut-off			●		●		●		●					●
ESA	Start advance angle control									●	●				●
ESA	Basic advance angle control		●	●						●					●
ESA	Warm-up compensation		●			●									●
ESA	Overheat prevention					●									●
ESA	Maximum and minimum advance angle control														●
ESA	Igniter control			●					●	●	●				●
ISC				●				●		●	●	●			●

TCCS ELECTRICAL CIRCUITRY

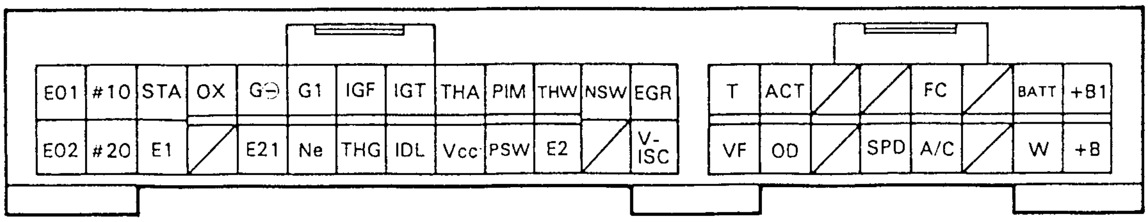


PRACTICE

MEASURE THE VOLTAGE

Measure the voltage at each of the terminals shown below under the specified conditions.

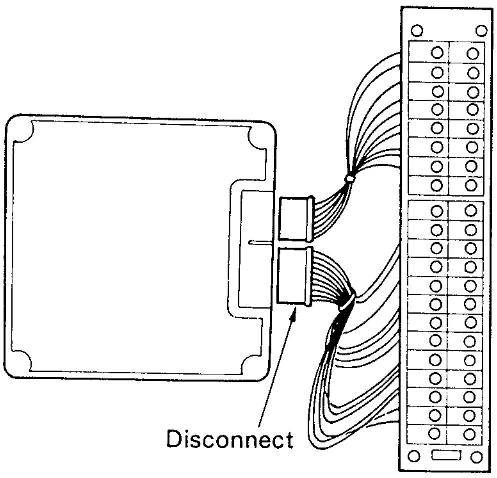
No.	TERMINAL	STD VOLTAGE (V)	CONDITION		(V)
1	+B +B1 – E1	10 – 14	Ignition switch on	+B	
				+B1	
2	BATT – E1	10 – 14	–		
3	IDL – E2	12	Ignition switch on	Throttle valve open	
				Throttle valve fully closed	
4	PSW – E2			Throttle valve open	
				Throttle valve fully closed	
5	No. 10 – E01 No. 20 – E02	10 – 14	Ignition switch on	No. 10	
				No. 20	
6	W – E1	10 – 14	No trouble ("CHECK ENGINE" warning light off) and engine running		
7	PIM – E2	3.3 – 3.9	Ignition switch on		
8	Vcc – E2	4.5 – 5.5			
9	THA – E2	1 – 3	Ignition switch on	Intake air temp. 20°C (68°F)	
10	THW – E2	0.1 – 1.0		Coolant temp. 80°C (176°F)	
11	STA – E1	6 – 14	Cranking		
12	IGT – E1	0.7 – 1.0	Idling		
13	T – E1	10 – 14	Check connector TE1 – E1 not connected		
		0.5 or less	Check connector TE1 – E1 connected		
14	NSW – E1	0 – 2	Neutral start switch "P" or "N" range		
		6 – 14	Ex. neutral start switch "P" or "N" range		
15	V-ISC – E1	10 – 14	Cranking for ten seconds after starting		

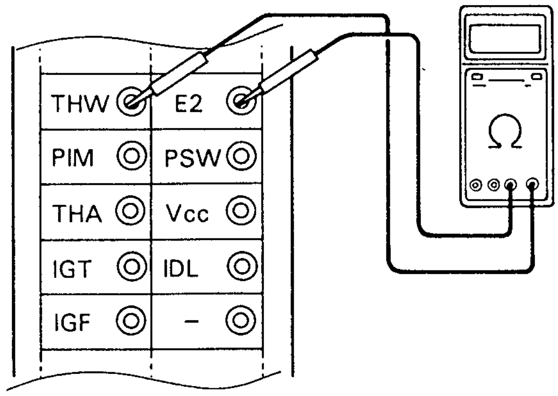


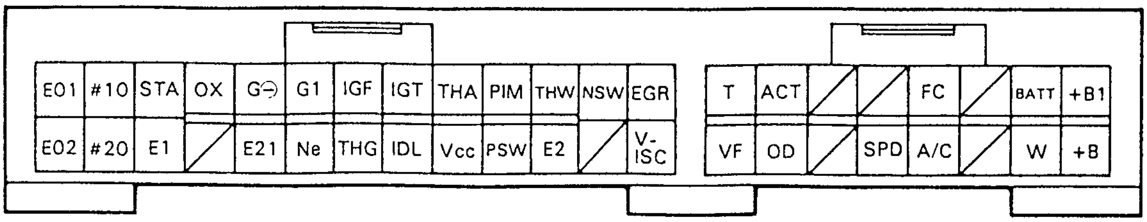
MEASURE THE RESISTANCE

- Disconnect the connectors from the ECU and measure the resistance between each of the terminals under the specified conditions.

No.	TERMINAL	STD RESISTANCE (Ω)	CONDITION		(Ω)
1	IDL – E2	Infinity	Throttle valve open		
		0	Throttle valve fully closed		
2	PSW – E2	0	Throttle valve fully open		
		Infinity	Throttle valve fully closed		
3	THA – E2	2,000 – 3,000	Intake air temperature 20°C (68°F)		
4	THW – E2	200 – 400	Coolant temperature 80°C (176°F)		
5	G1 / Ne – G⊖	200 – 260	—	G1	
				Ne	







EMISSION CONTROL SYSTEM

SYSTEM FUNCTION

SYSTEM	ABBREVIATION	FUNCTION
Positive crankcase ventilation	PCV	Reduces blow-by gas (HC)
Fuel gas recirculation	EVAP	Reduces evaporative HC
Exhaust gas recirculation	EGR	Reduces NOx
Three-way catalyst	TWC	Reduces HC, CO and NOx
Electronic fuel injection	EFI	Regulates all engine conditions for reduction of exhaust emissions.
Auxiliary system: Dash pot	DP	Reduces HC and CO

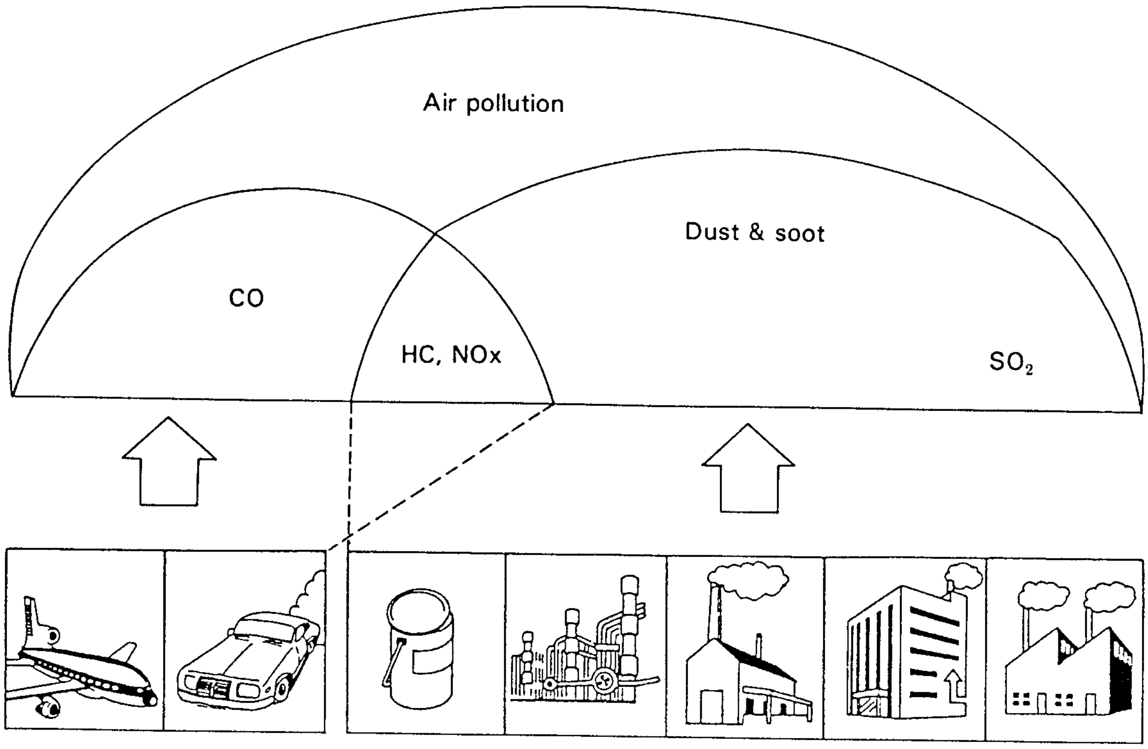
– REFERENCE –

AIR POLLUTION AND EXHAUST GAS FROM AUTOMOBILES

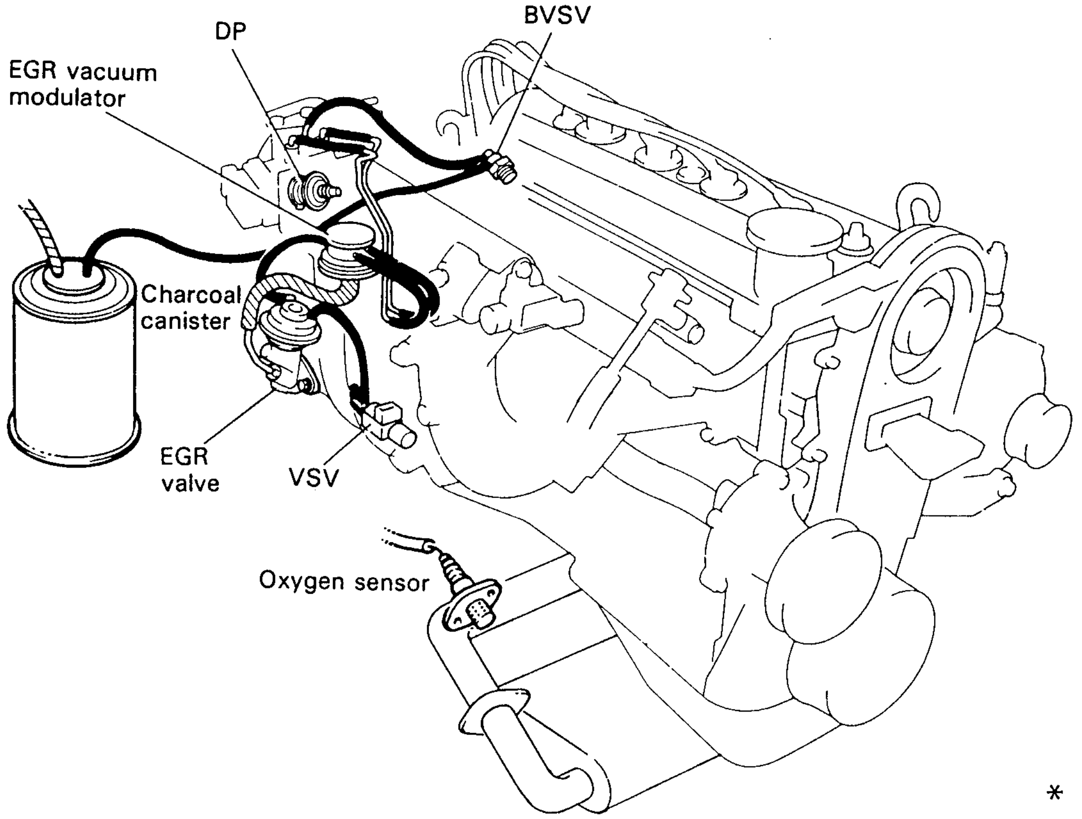
Air pollution is caused by sulfurous acid gases (SO_2), carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NOx), lead (Pb), soot, dust, etc., plus secondary products such as oxidants and sulfuric acid mists.

These are called pollutants and are often found in exhaust gases from automobiles, airplanes, and other vehicles, as well as in the smoke from industrial plants, thermal electric power plants, heaters for buildings, incinerators, and other stationary sources.

Among these air pollutants, the exhaust gases from automobiles consist mainly of carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx).



COMPONENT LAYOUT



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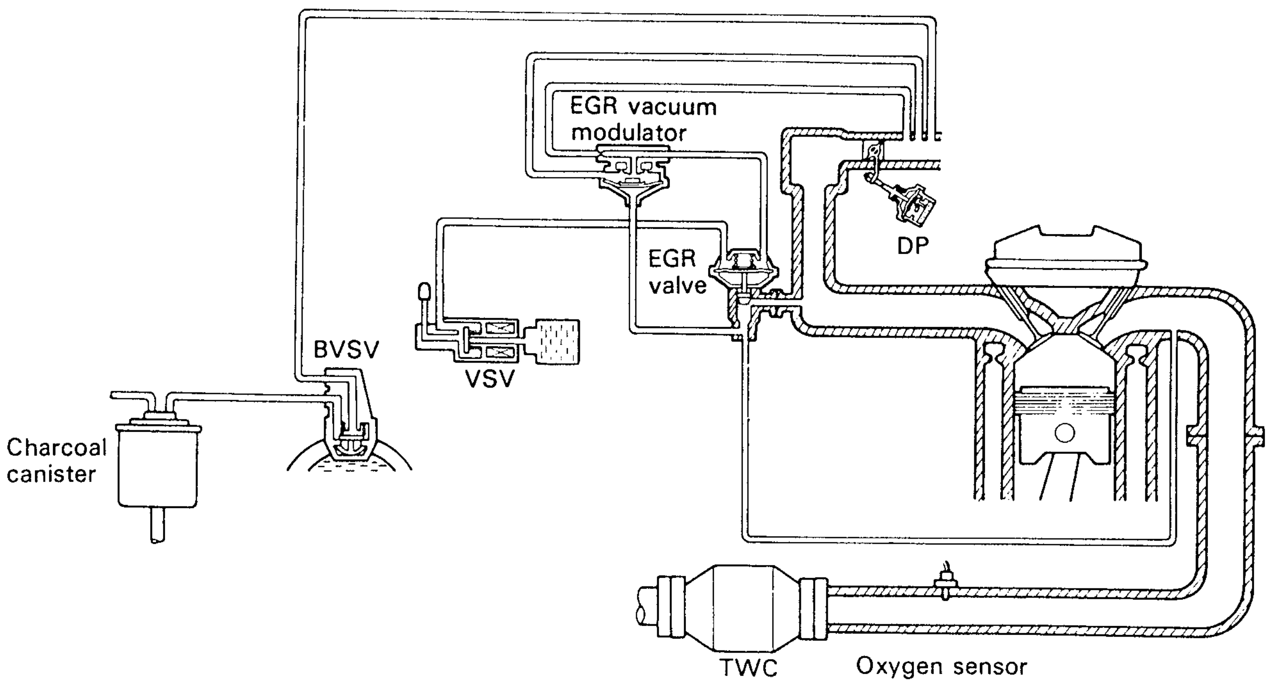
SCHEMATIC DRAWING



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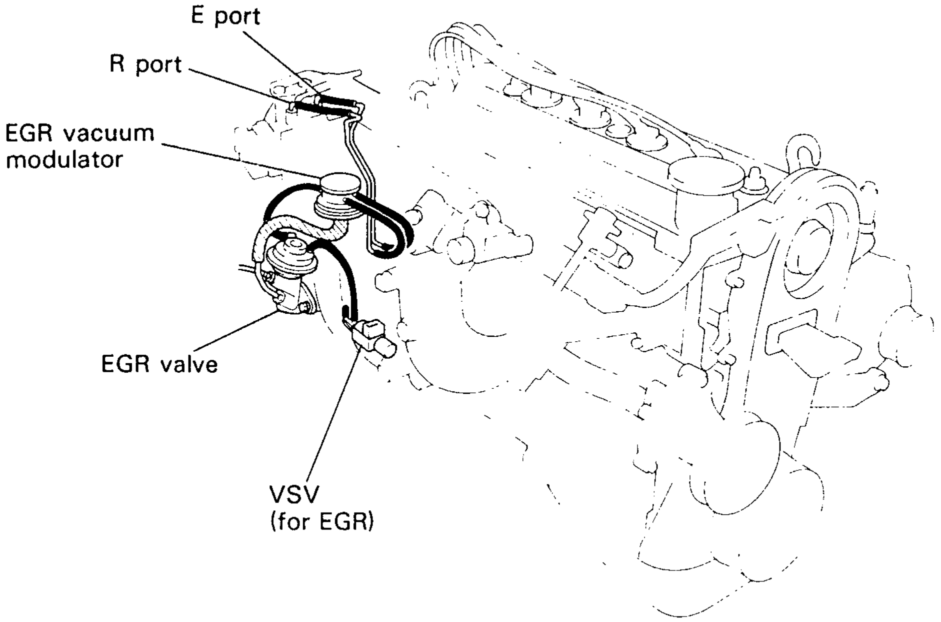
EXHAUST GAS RECIRCULATION (EGR) SYSTEM

To reduce NOx emissions by lowering the maximum combustion temperature, part of the exhaust gases are recirculated through the EGR valve to the intake manifold.

1. COMPONENT LAYOUT



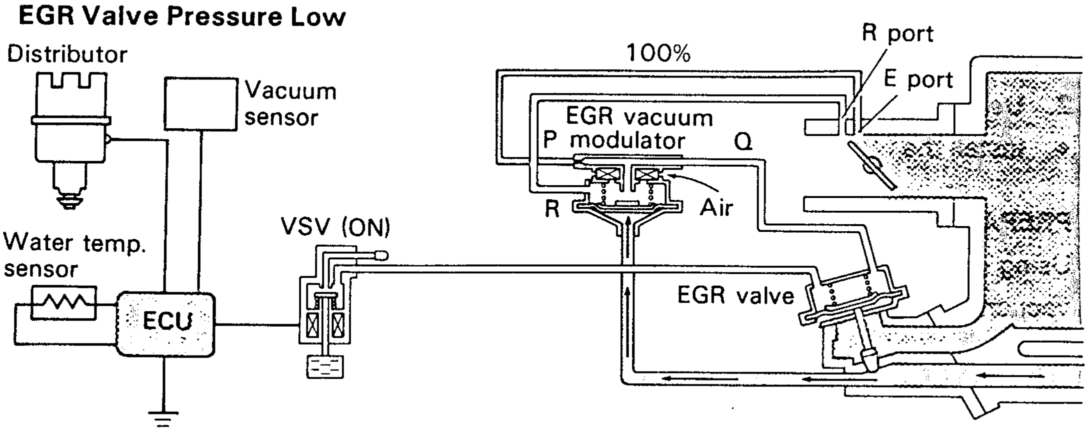
2. OPERATION

COOLANT TEMP.	ENGINE RPM	VSV	THROTTLE VALVE OPENING ANGLE	PRESSURE IN EGR VALVE PRESSURE CHAMBER		EGR VACUUM MODULATOR	EGR VALVE	EXHAUST GAS
Below 47°C (117°F)	–	••• OFF	–	–		–	CLOSED	Not recirculated
Above 53°C (127°F)	Above 1,100 rpm		–	–		–	CLOSED	Not recirculated
		••• ON	Positioned below E port	–		–	CLOSED	Not recirculated
			Positioned between E port and R port	(a) LOW	Pressure constantly alternating between low and high*	OPENS passage to atmosphere	CLOSED	Not recirculated
				(b) HIGH		CLOSES passage to atmosphere	OPEN	Recirculated
			Positioned above R port	(c) HIGH	**	CLOSES passage to atmosphere	OPEN	Increases
	Above 4,400 rpm	(d) OFF	–	–		–	CLOSED	Not recirculated

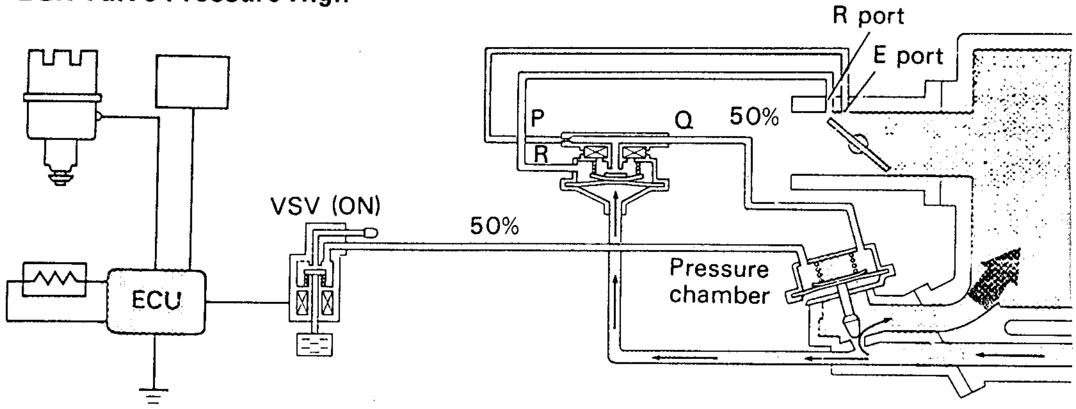
Remarks:
- * Pressure increase ⟶ Modulator closes ⟶ EGR valve opens ⟶ Pressure drops ⟶ Modulator opens ⟶ EGR valve closes ⟶ (Pressure increase)
- ** When the throttle valve is positioned above the R port, the EGR vacuum modulator will close the atmosphere passage and open the EGR valve to increase the EGR gas, even if the exhaust pressure is insufficiently low.
- *** VSV switches on when the product of engine rpm multiplied by the vacuum sensor valve pressure exceeds a specified value.
- **** If terminals TE1 and E1 of the check connector are connected, the VSV switches on.

3. OPERATION

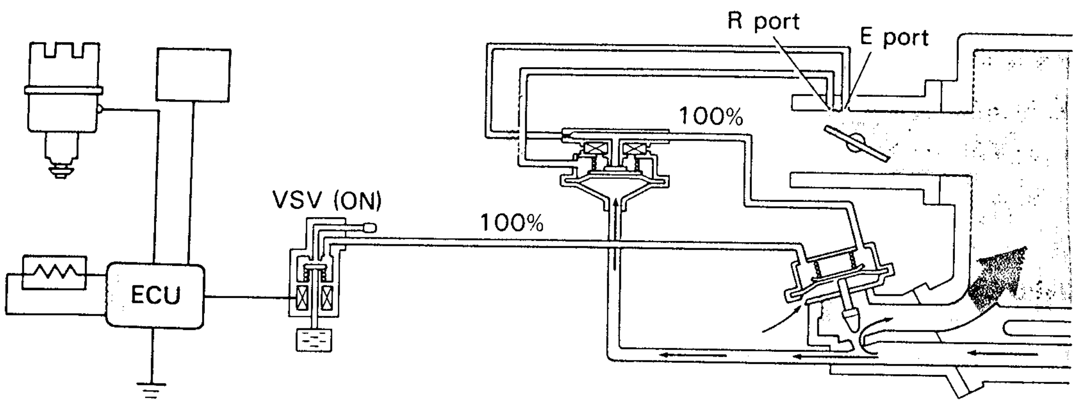
a. EGR Valve Pressure Low



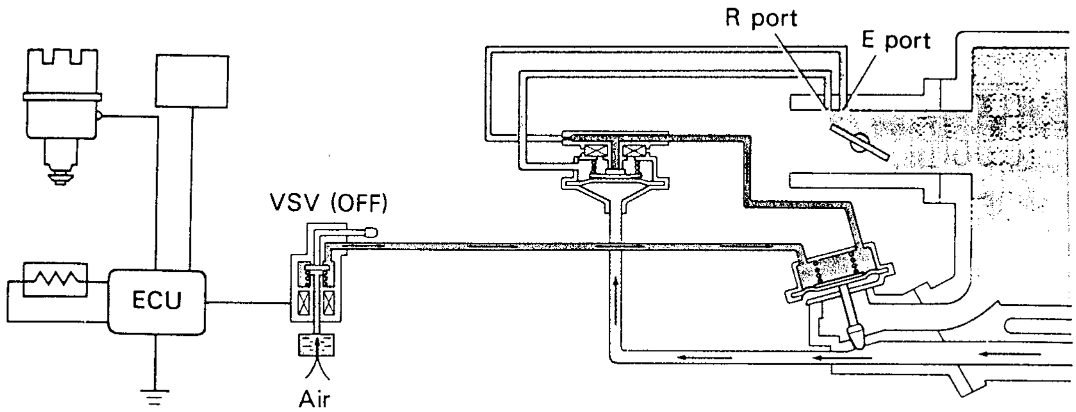
b. EGR Valve Pressure High



c. EGR Valve Pressure High



d. VSV Off



4. INSPECTION OF EGR SYSTEM

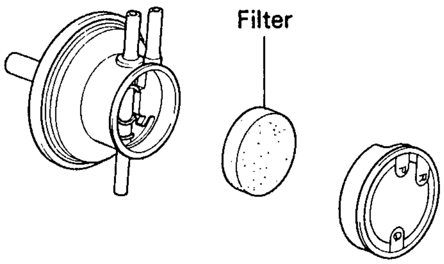
a. CHECK AND CLEAN FILTERS IN EGR VACUUM MODULATOR

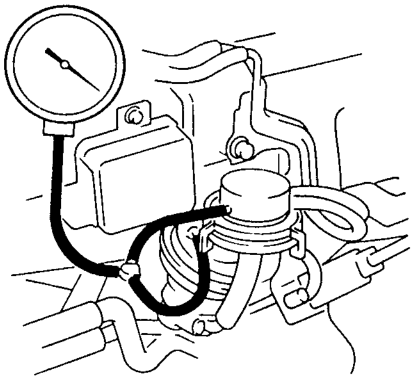
1. Check the filters for contamination or damage.
2. Using compressed air, clean the filters.

- Install the filters with the coarser surface facing the atmospheric side (outward).

b. PREPARATION

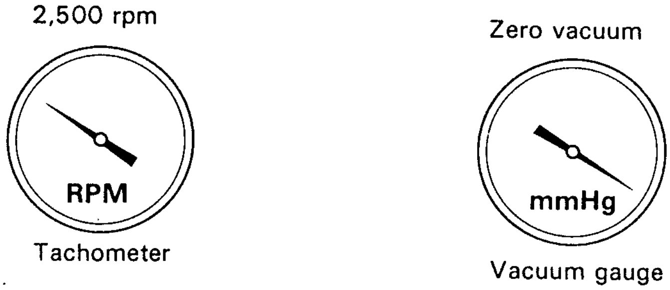
Using a 3-way connector, connect a vacuum gauge to the hose between the EGR valve and vacuum modulator.





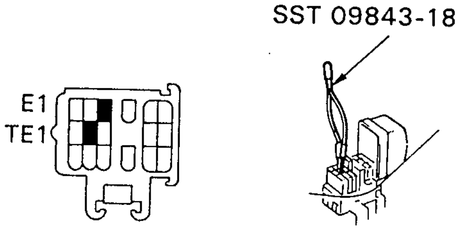
c. CHECK SEATING OF EGR VALVE & CHECK VSV

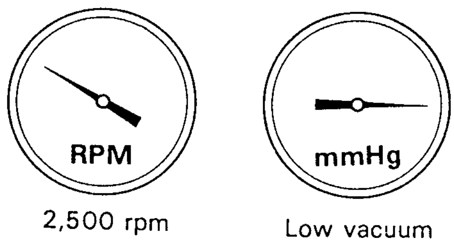
Check that the vacuum gauge indicates zero at 2,500 rpm.



d. CHECK VSV AND EGR VACUUM MODULATOR

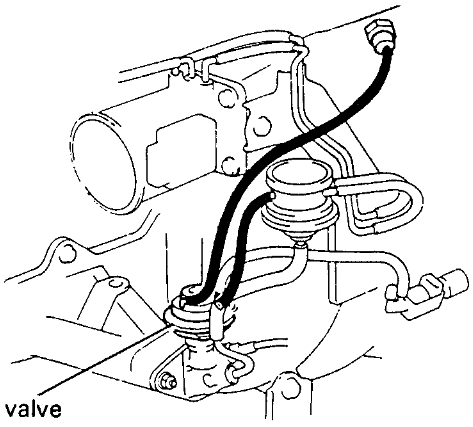
1. Using an SST, connect terminals TE1 and E1 of the check connector.
2. Check that the vacuum gauge indicates low vacuum at 2,500 rpm.





e. **CHECK EGR VALVE WITH TERMINALS TE1 AND E1 CONNECTED**

1. Apply vacuum directly to the EGR valve with the engine idling.
2. Check that the engine runs rough or stalls.
3. Reconnect the vacuum hoses to the proper locations.
4. Remove the SST.



5. INSPECTION OF VSV

a. **CHECK VSV FOR OPEN CIRCUIT**

Using an ohmmeter, check that there is continuity between the terminals.

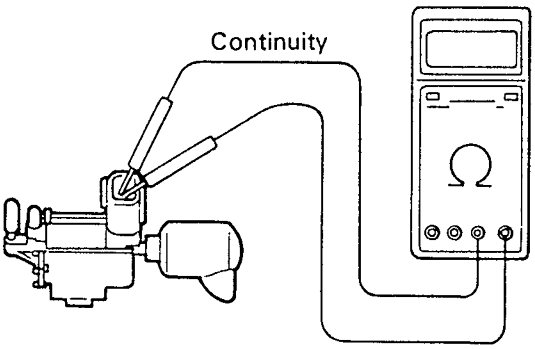
Resistance (cold): 37 – 44 Ω

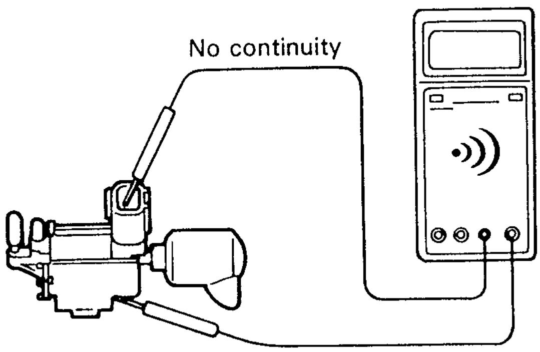
If there is no continuity, replace the VSV.

b. **CHECK VSV FOR GROUND**

Using an ohmmeter, check that there is no continuity between each terminal and the body.

If there is continuity, replace the VSV.

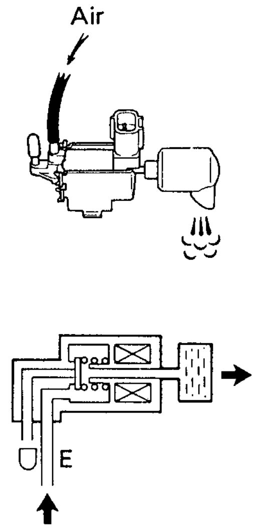


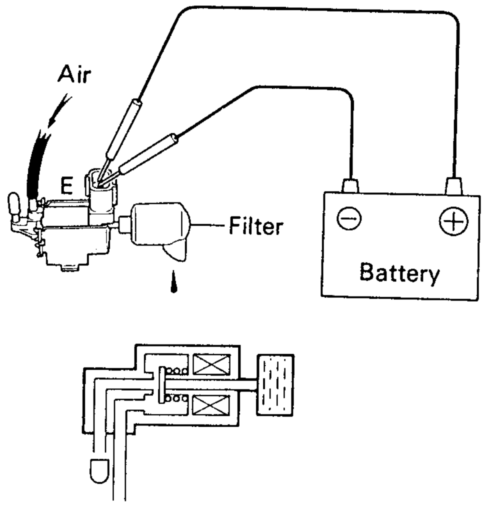


c. CHECK VSV OPERATION

1. Check that air flows from pipe E to the filter.
2. Apply battery voltage across the terminals.
3. Check that air does not flow from pipe E to the filter.

   If operation is not as specified, replace the VSV.



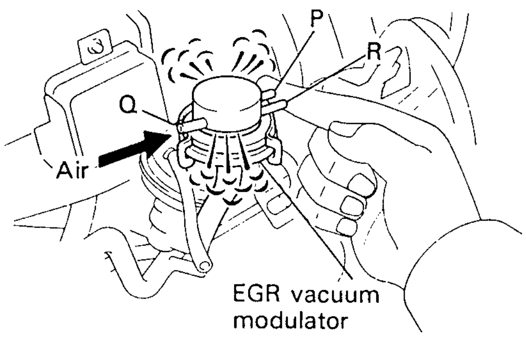


6. INSPECTION OF EGR VACUUM MODULATOR

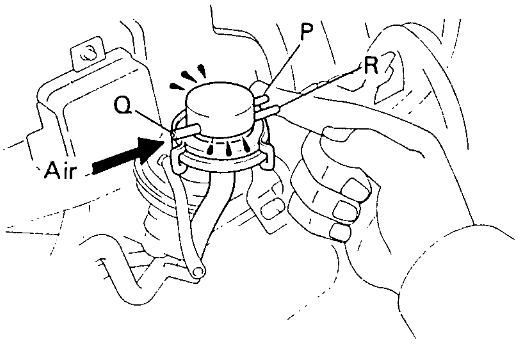
CHECK EGR VACUUM MODULATOR OPERATION

a. Disconnect the vacuum hoses from ports P, Q, and R of the EGR vacuum modulator.
b. Block ports P and R with your finger.
c. Blow air into port Q, and check that the air passes through to the air filter side freely.
d. Start the engine and maintain speed at 2500 rpm.
e. Repeat the above test. Check that there is a strong resistance to air flow.
f. Reconnect the vacuum hoses to the proper locations.

Engine stopped

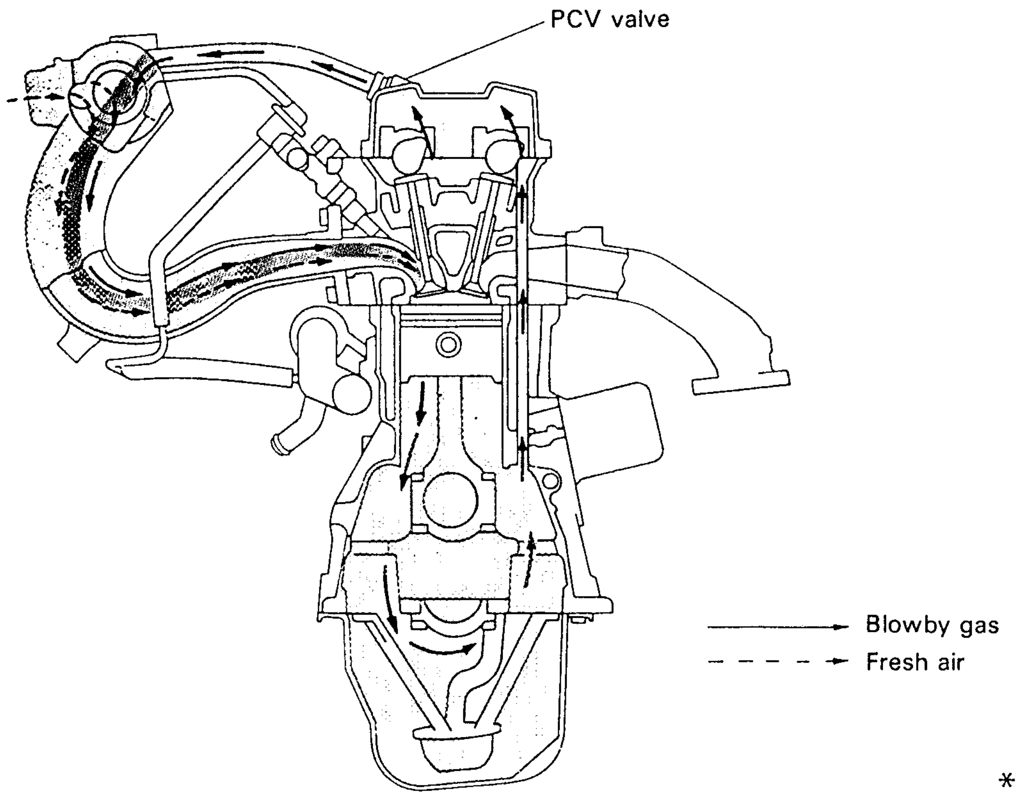


Engine at 2500 rpm



POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

To reduce HC emissions, crankcase blowby gas (HC) flows through the PCV valve to the air intake chamber for recombustion in the cylinders.



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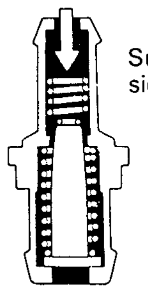
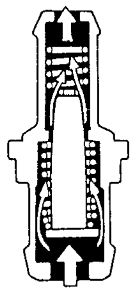
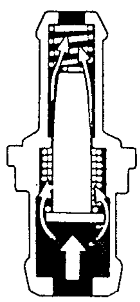
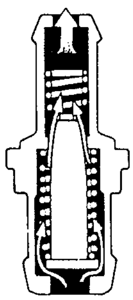
1. OPERATION

Engine not running or backfiring	Normal operation
 ○ PCV VALVE IS CLOSED.	 ○ PCV VALVE IS OPEN. ○ VACUUM PASSAGE IS LARGE.
Idling or decelerating	**Acceleration or high load**
 ○ PCV VALVE IS OPEN. ○ VACUUM PASSAGE IS SMALL.	 ○ PCV VALVE IS FULLY OPEN.

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2. INSPECTION OF PCV VALVE

a. REMOVE PCV VALVE

b. ATTACH CLEAN HOSE TO PCV VALVE

c. BLOW AIR FROM CYLINDER HEAD SIDE

Check that air passes through easily.

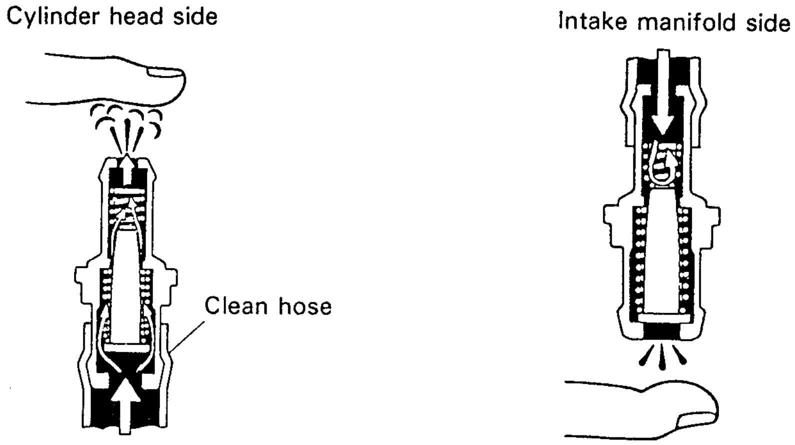
CAUTION: Do not suck air through the valve as you may breathe in harmful gasoline vapors.

d. BLOW AIR FROM INTAKE MANIFOLD SIDE

Check that air passes through with difficulty.

If the PCV valve fails either of the checks, replace it.

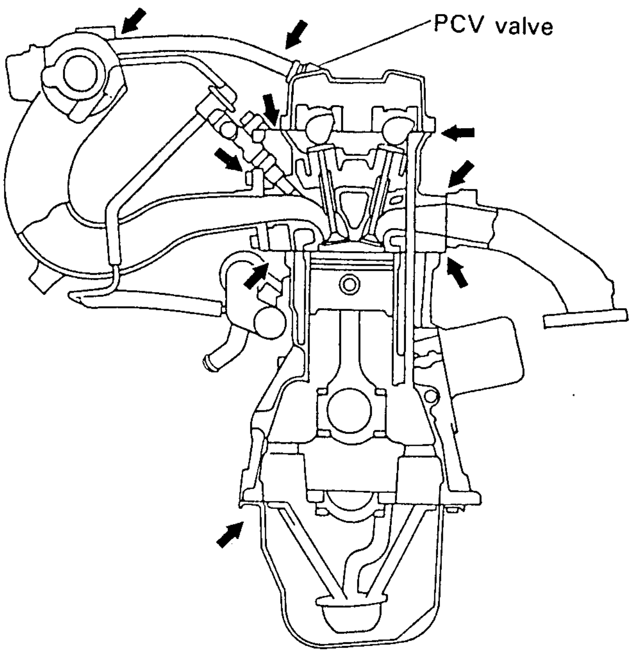
e. REINSTALL PCV VALVE



3. INSPECTION OF PCV HOSES AND CONNECTIONS

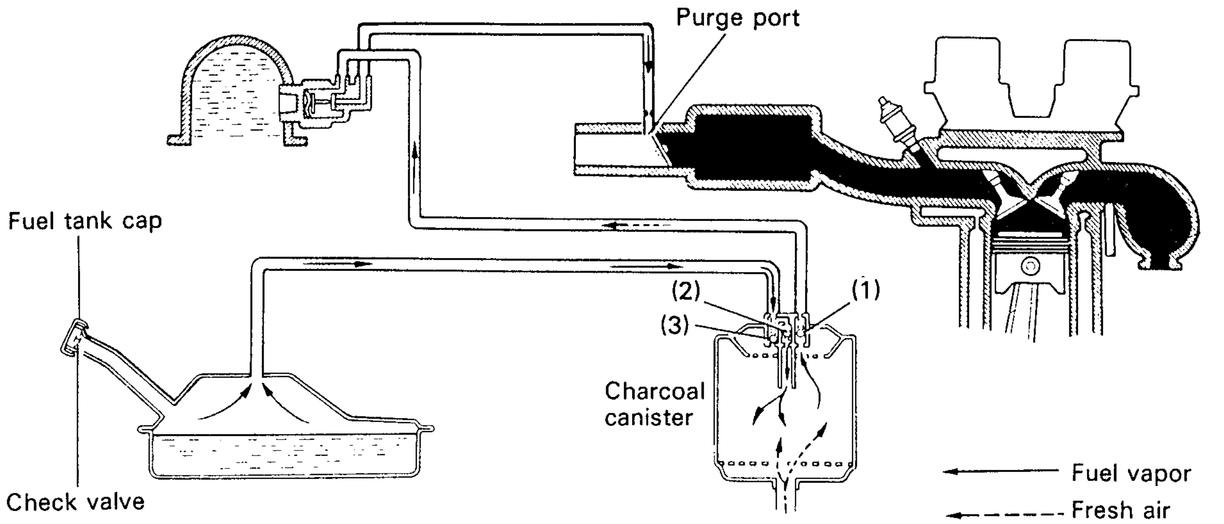
VISUALLY INSPECT HOSES, CONNECTIONS, AND GASKETS

Check for cracks or other damage.



FUEL EVAPORATIVE EMISSION CONTROL (EVAP) SYSTEM

To reduce HC emissions, evaporated fuel from the fuel tank is routed through the charcoal canister to the air intake chamber for combustion in the cylinders.



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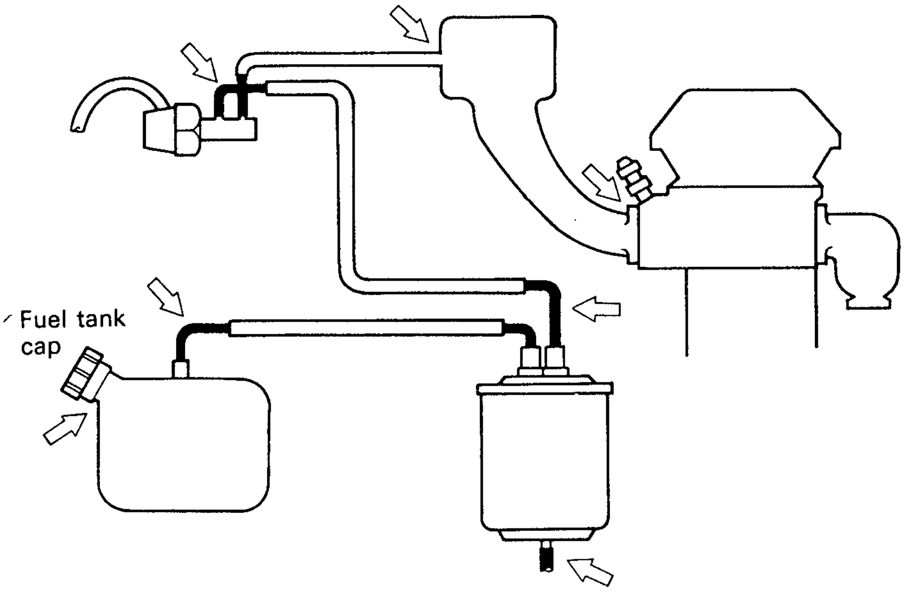
1. OPERATION

COOLANT TEMP.	BVSV	THROTTLE VALVE OPENING	CHECK VALVE (1)	CHECK VALVE (2)	CHECK VALVE (3)	CHECK VALVE IN CAP	EVAPORATED FUEL (HC)
Below 35°C (95°F)	CLOSED	–	–	–	–	–	HC from tank is absorbed into canister.
Above 54°C (129°F)	OPEN	Positioned below purge port	CLOSED	–	–	–	
		Positioned above purge port	OPEN	–	–	–	HC from canister is led into air intake chamber.
High pressure in tank	–	–	–	OPEN	CLOSED	CLOSED	HC from tank is absorbed into canister.
High vacuum in tank	–	–	–	CLOSED	OPEN	OPEN	Air is led into fuel tank.

2. INSPECTION OF FUEL VAPOR LINES, FUEL TANK, AND TANK CAP

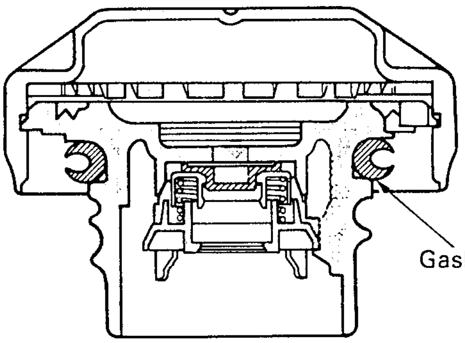
a. VISUALLY INSPECT LINES AND CONNECTIONS

Look for loose connections, sharp bends or damage.



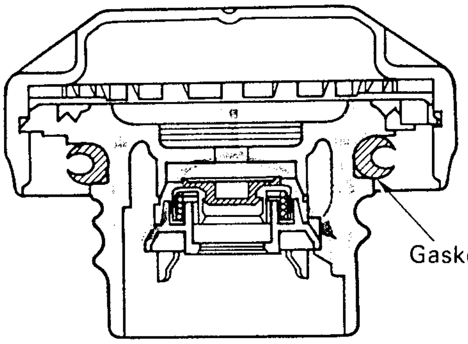
b. VISUALLY INSPECT FUEL TANK CAP

Check the cap and gasket for deformation or other damage.



Check valve (vacuum valve)

CLOSED



Check valve (vacuum valve)

OPEN

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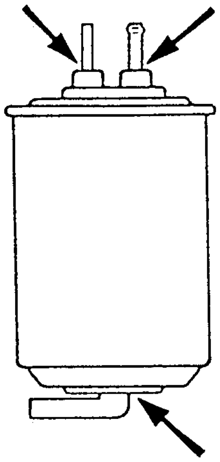
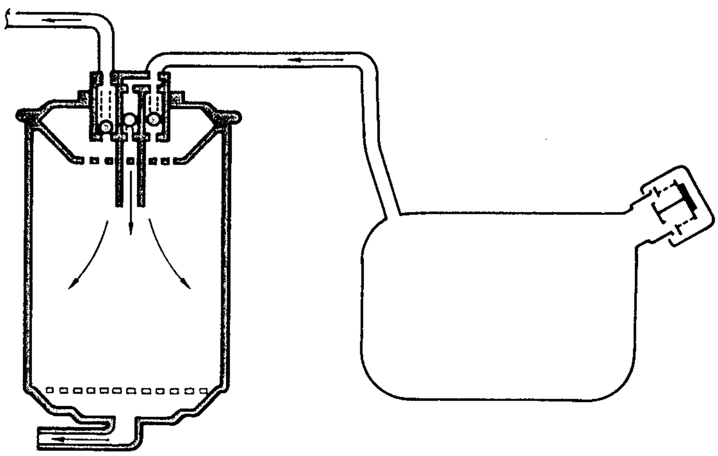
3. INSPECTION OF CHARCOAL CANISTER

a. VISUALLY INSPECT CHARCOAL CANISTER CASE

Lock for cracks or other damage.





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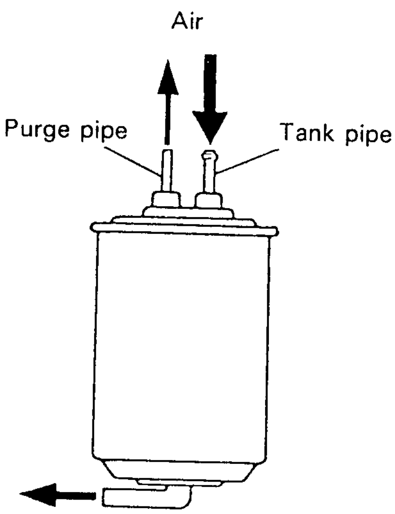
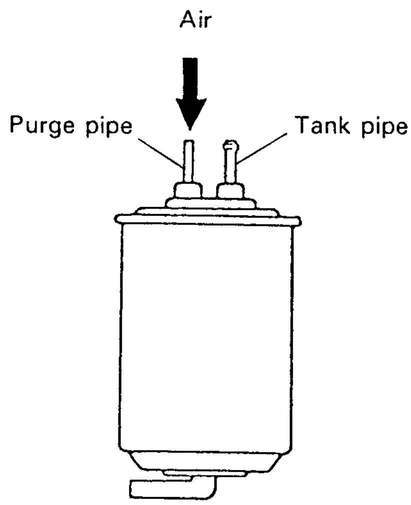
b. CHECK FOR CLOGGED FILTER AND STUCK CHECK VALVE

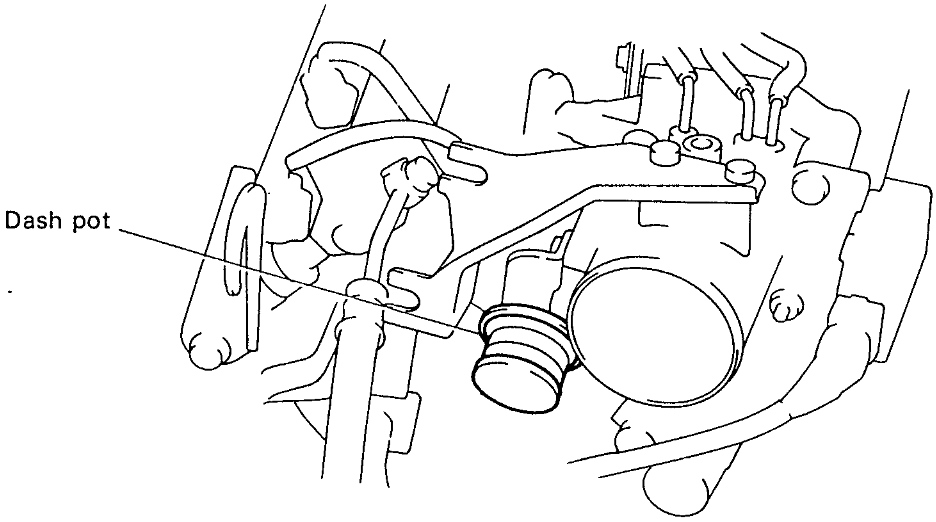
1. Blow low-pressure compressed air into the tank pipe, and check that air flows without resistance from the other pipe.
2. Blow air into the purge pipe, and check that air does not flow from the other pipe.





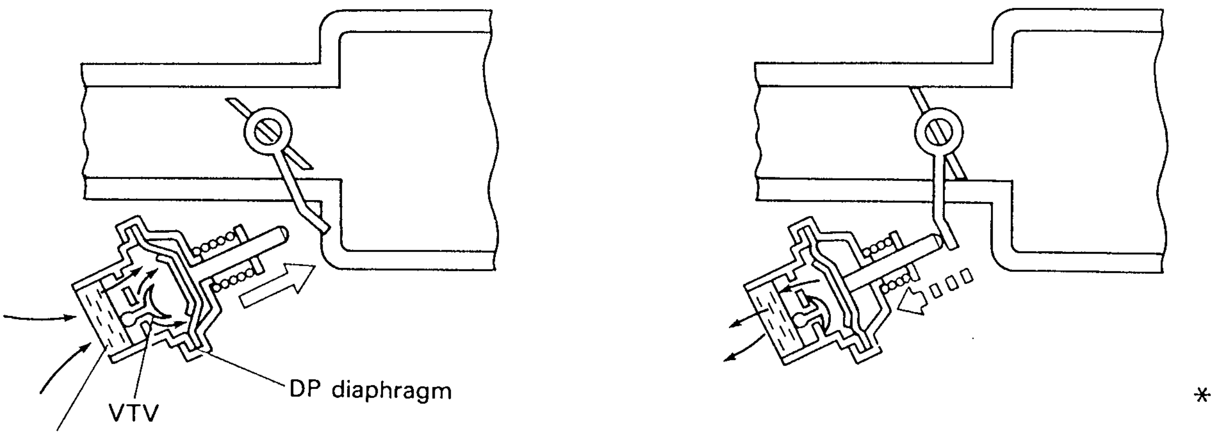
DASH POT (DP) SYSTEM

During deceleration, the dash pot opens the throttle valve slightly more than at idle. This reduces HC and CO emissions by causing the air-fuel mixture to burn completely.



1. OPERATION

Normal driving **Deceleration**



CONDITION	DIAPHRAGM	VTV	THROTTLE VALVE
Idling	Pushed in by return force of throttle valve	CLOSED	Idle speed position
Normal driving	Pushed out by diaphragm spring	OPEN	High speed position
Deceleration	Pushed in by return force of throttle valve	CLOSED	Opens slightly and then slowly closes to idle position.

2. INSPECTION & ADJUSTMENT OF DASH POT (DP) SYSTEM

a. WARM UP ENGINE

b. CHECK IDLE SPEED AND ADJUST, IF NECESSARY

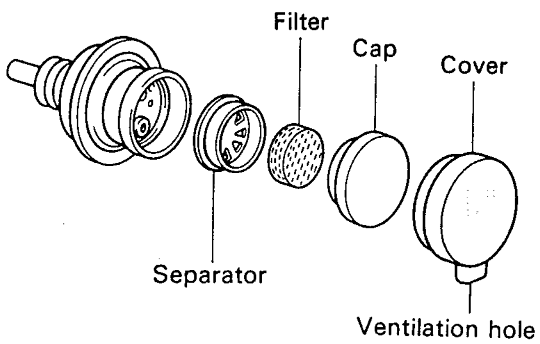
Idle speed: 800 rpm (w/cooling fan off)

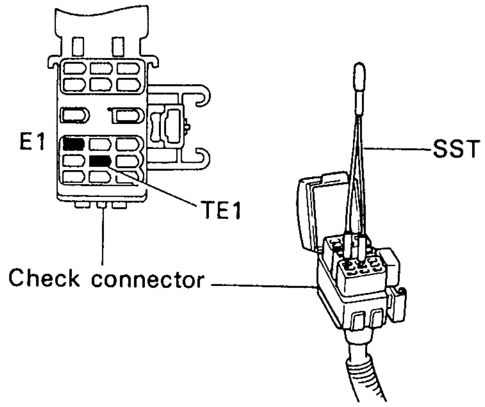
If not as specified, adjust the idle speed by turning the idle speed adjusting screw (see page 85).

c. REMOVE COVER, CAP, FILTER AND SEPARATOR FROM DP

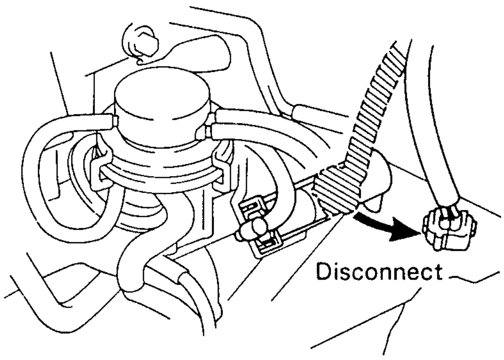
d. INSPECT AND ADJUST DP SET SPEED

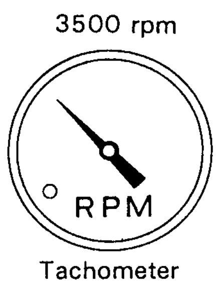
1. Using a SST, connect terminals TE1 and E1 of the check connector.

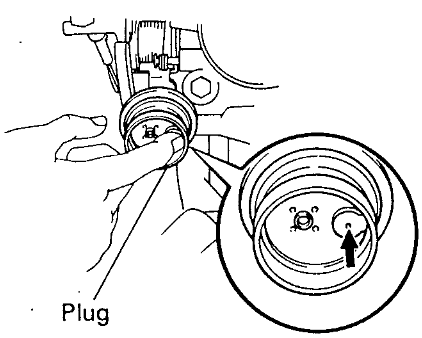




2. Disconnect the VSV connector.
3. Race the engine at 3500 rpm for a few seconds.
4. Plug the VTV hole with your finger.







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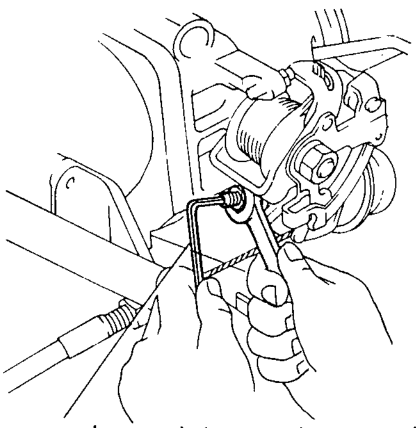
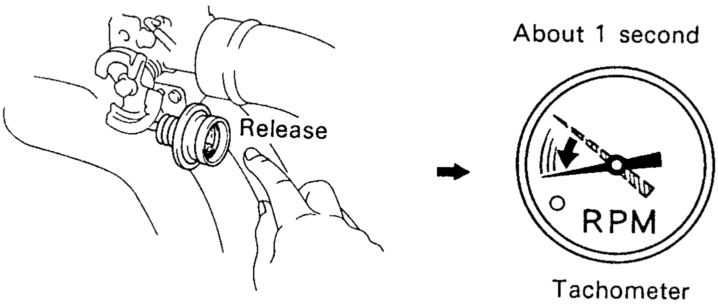
5. Release the throttle valve.
6. Check the DP set speed.
   DP set speed: A/T 2200 rpm (w/cooling fan off)
   - **IF NOT AS SPECIFIED, ADJUST WITH THE STOPPER SCREW**
7. Adjust the DP set speed by turning the DP adjusting screw.
8. Repeat steps (3) to (5), and recheck the DP set speed.
9. Release the blocked hole, and check that the engine returns to an idle in about 1 second.





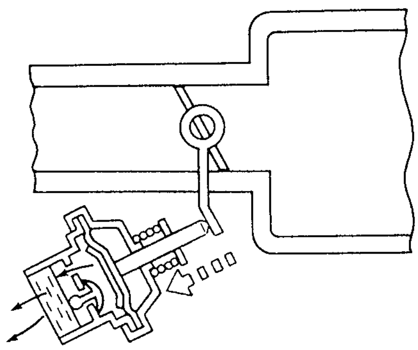
10. Connect the VSV connector.
11. Remove the SST from the check connector.

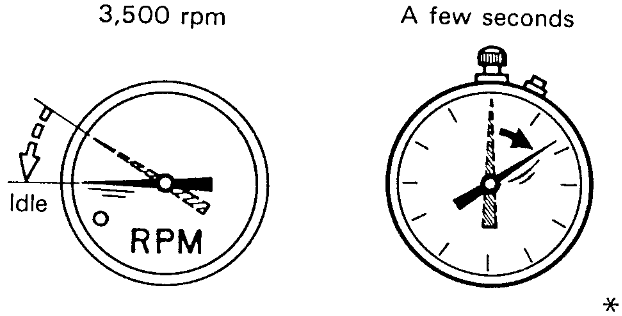
e. REINSTALL DP SEPARATOR, FILTER, CAP AND COVER

Install the cover with the ventilation holes facing downward.

f. CHECK VTV OPERATION

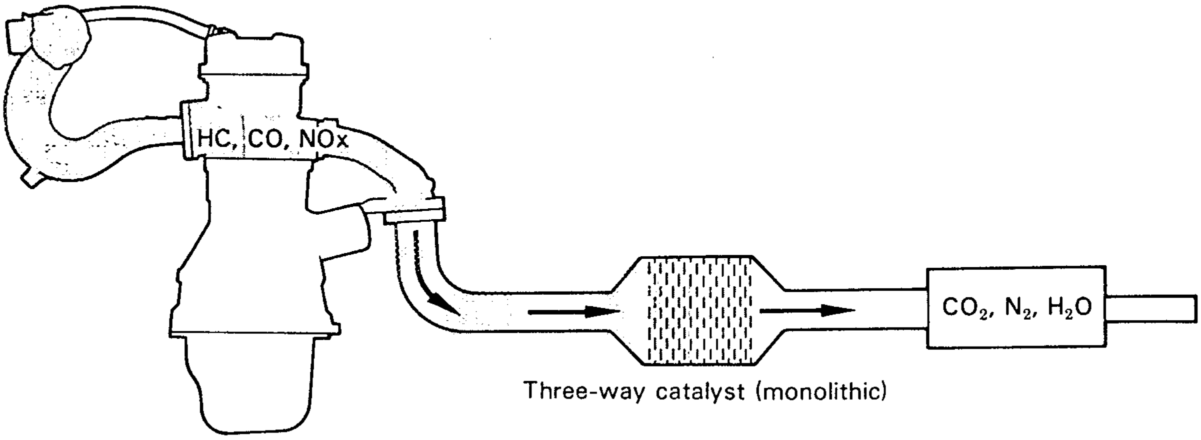
Race the engine at 3500 rpm for a few seconds, release the throttle valve and check that the engine returns to an idle in a few seconds.





THREE-WAY CATALYST (TWC) SYSTEM

To reduce HC, CO, and NOx emission, they are oxidized, reduced and converted to nitrogen (N_2), carbon dioxide (CO_2) and water (H_2O) by the catalyst.



Three-way catalyst (monolithic)

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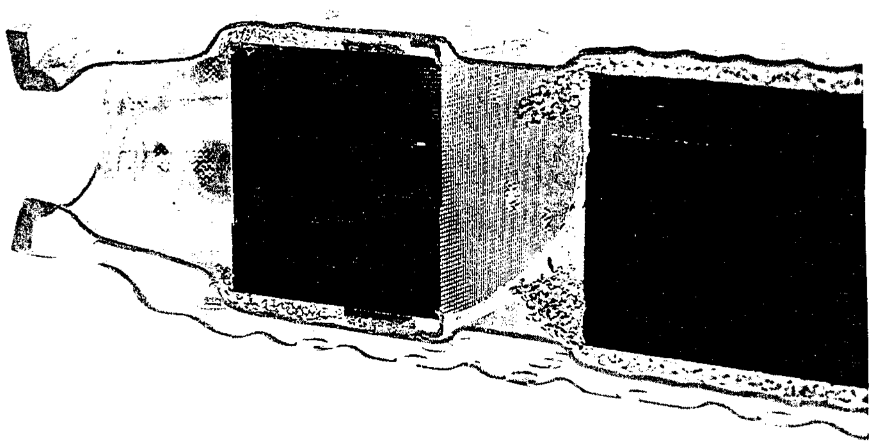
OPERATION

Exhaust Port		TWC		Exhaust Gas
HC, CO and NOx	→	Oxidation and reduction	→	CO_2 H_2O N_2

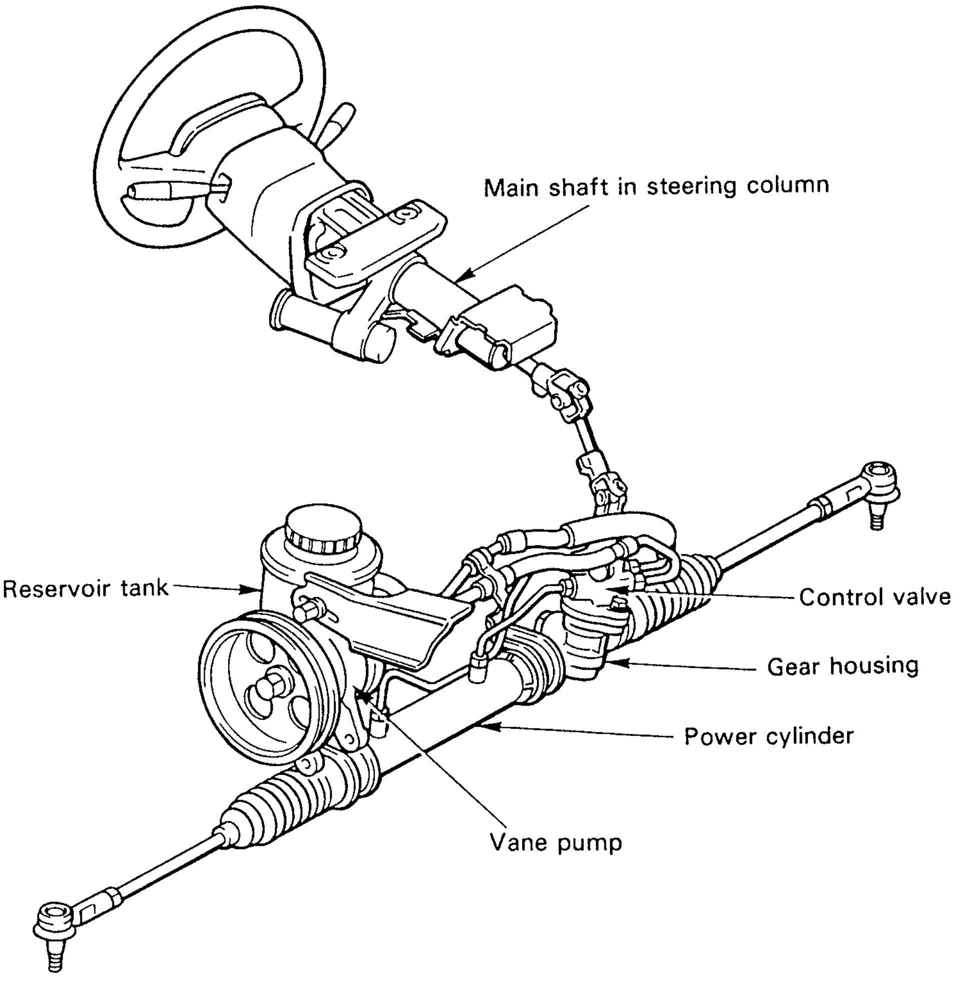


POWER STEERING (Engine Revolution Sensing Type Power Steering)

DESCRIPTION

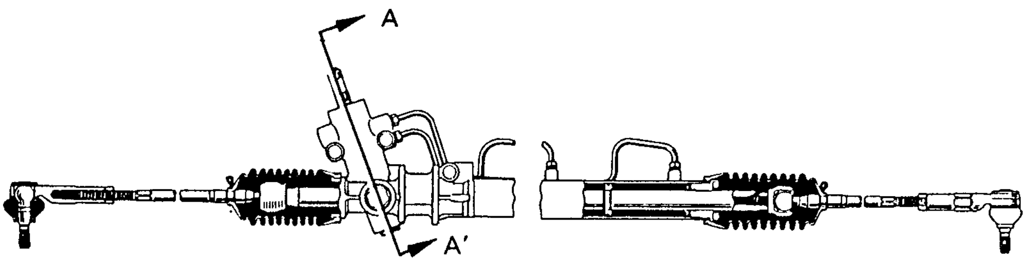
NECESSITY FOR POWER STEERING

To improve riding comfort, most modern automobiles have wide, low-pressure tires which increase the tire-to-road surface contact area. As a result of this, more steering effort is required.
Steering effort can be decreased by increasing the gear ratio of the steering gear. However, this will cause a larger rotary motion of the steering wheel when the vehicle is turning, making sharp turns impossible.
Therefore, to keep the steering agile and, at the same time, the steering effort small, some sort of a steering assist device becomes necessary: in other words, power steering.

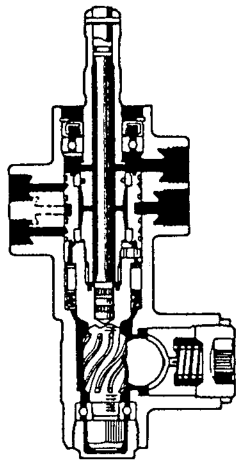


GENERAL

The engine revolution sensing type power steering requires a minimum effort at low speed and during stationary steering, and a larger and moderate effort at medium to high speeds. For these reasons, it gives a feeling of stable steering at all times.



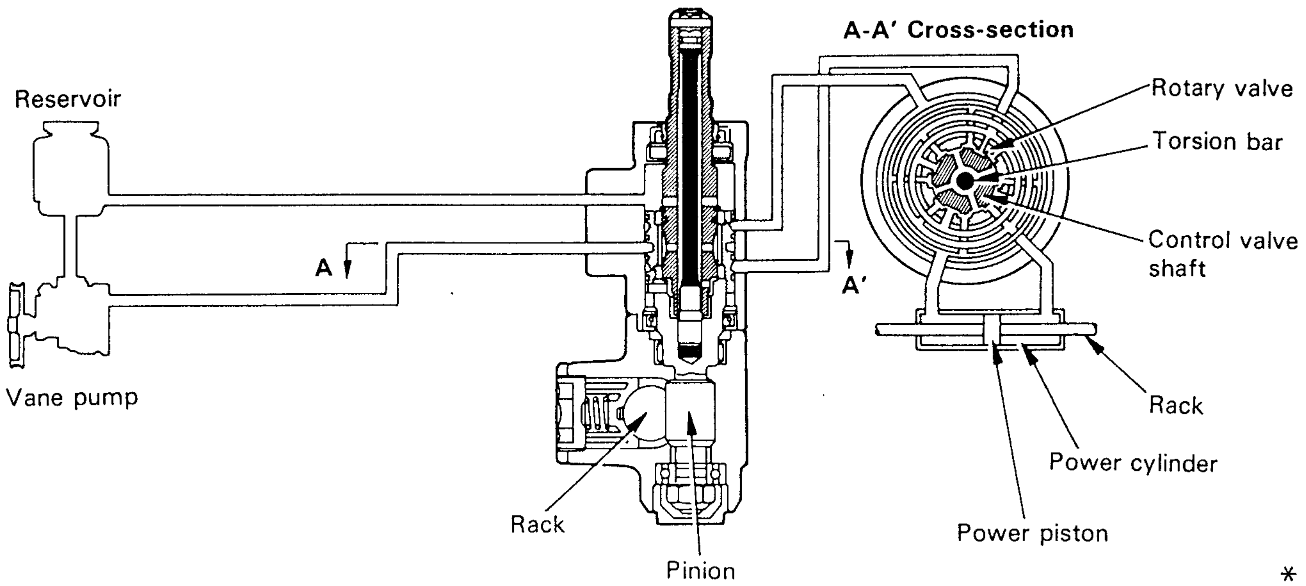
A-A' Cross-section



SPECIFICATIONS

MODEL / ITEM		LHD
Gear ratio (overall)		17.5 : 1
No. of turns lock to lock		3.0
Rack stroke	mm (in.)	124 (4.88)
Fluid volume	liters (US qts, Imp. qts)	0.8 (0.85, 0.70)
Type of fluid		ATF Type DEXRON® II

SYSTEM DIAGRAM



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STEERING GEAR CONTROL VALVE

The steering gear control valve consists of a torsion bar, control valve shaft and rotary valve. The passage of power steering fluid is switched by the control valve shaft and the rotary valve to reduce steering effort.

1. TORSION BAR

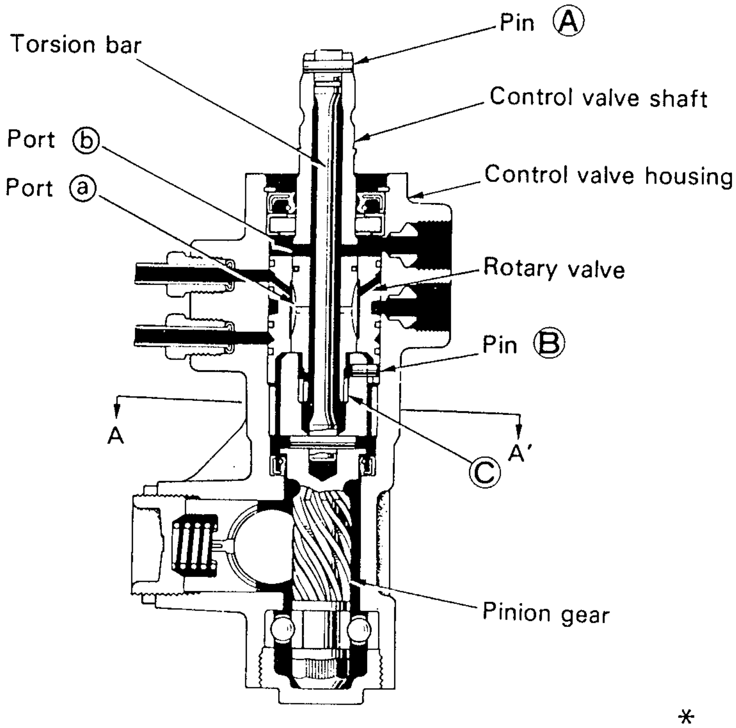
The upper end of the torsion bar is fixed with pin Ⓐ to the control valve shaft. The other end is press-fitted into the pinion gear and is caulked into place. In other words, the control valve shaft and the pinion gear are joined together by the torsion bar.

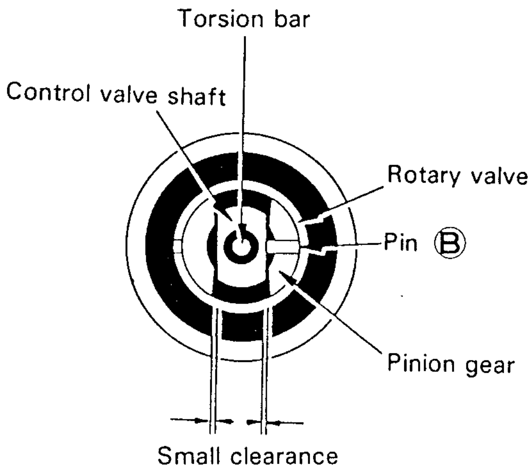
2. CONTROL VALVE SHAFT

The lower end of the control valve shaft is inserted into section Ⓒ of the pinion gear. A small clearance is provided between the control valve shaft and pinion gear as shown in the A-A' cross-section, so that the control valve shaft can turn by the amount of the clearance against the pinion gear when the steering wheel is turned to the right or left.

Even if the hydraulic circuit should fail for some reason, the rotation of the control valve shaft is transmitted directly to the pinion gear, making manual steering possible.

Eight longitudinal grooves are provided along the outer circumference of the control valve shaft. Front ports ⓐ are located in alternate grooves, connecting the outside and the inside of the shaft. Two ports ⓑ are also located right above the rotary valve, connecting the outside and the inside. Ports ⓐ and ports ⓑ are return ports for the power steering fluid. The fluid passed through the rotary valve is directed to the inside of the shaft through ports ⓐ and returned to the reservoir through ports ⓑ





A-A' Cross-section

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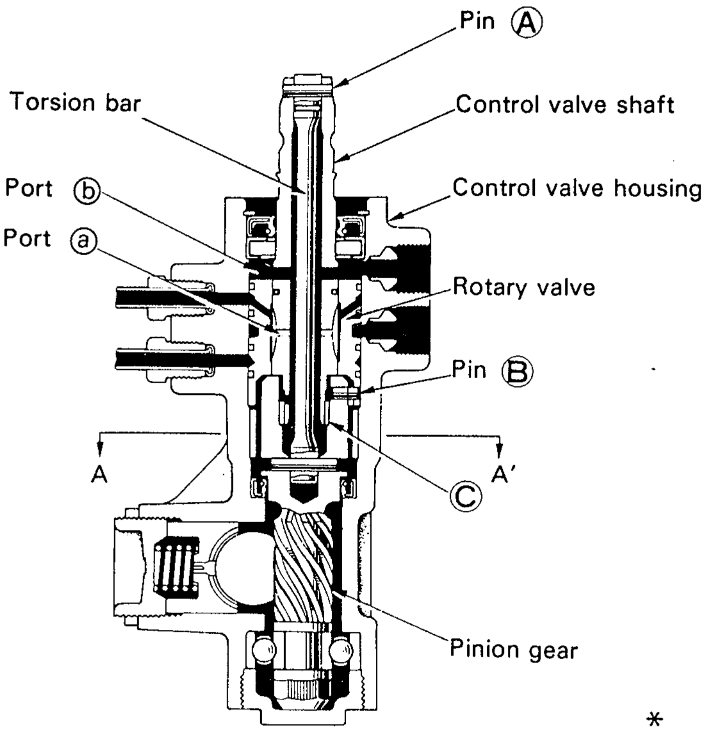
3. ROTARY VALVE

The lower end of the rotary valve is fixed to the pinion gear with pin Ⓑ, and rotates as one unit with the pinion gear. Four oil seals are fitted around the circumference of the rotary valve. These oil seals are in contact with the inner surface of the control valve housing, forming three fluid passages, ①, ② and ③. Grooves are machined in the inner surface of the rotary valve and form control grooves with the control valve shaft. There are three through ports (ⓒ, ⓓ and ⓔ) connecting inside the rotary valve with the fluid passages of the outer surface.



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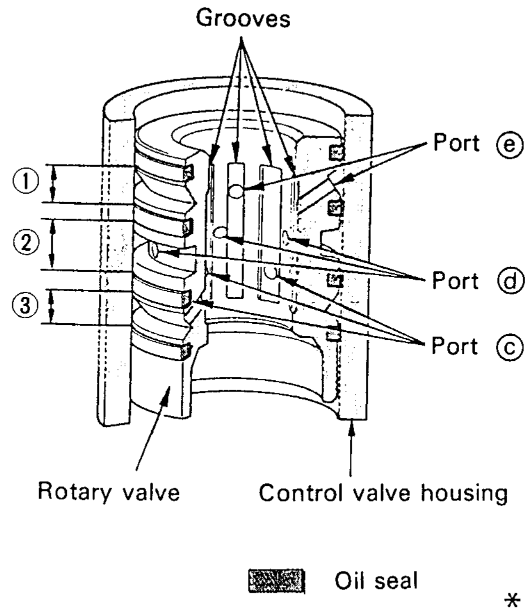

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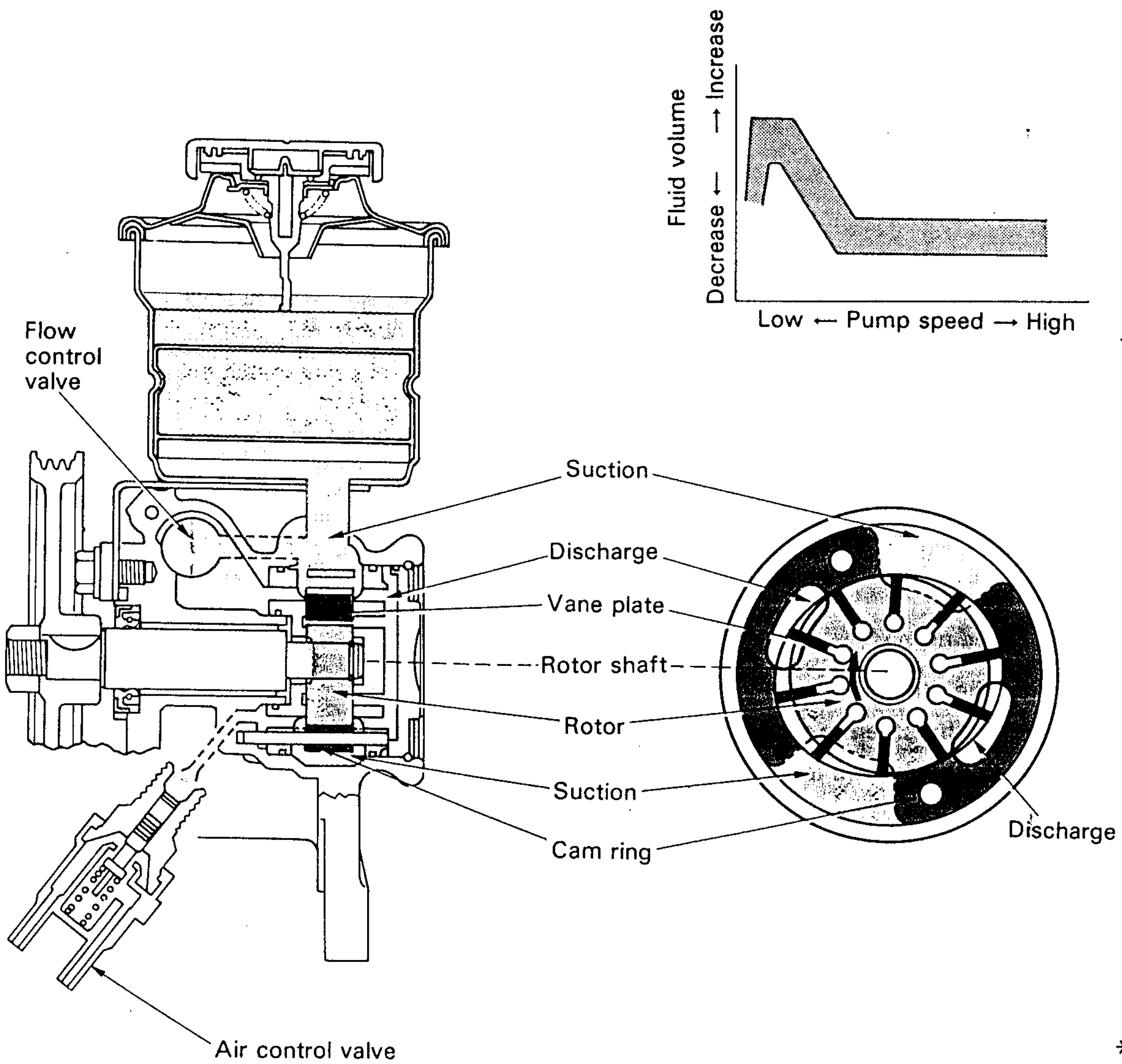
When the steering wheel is turned in either direction, the control valve shaft rotates the same angle as the steering wheel, while the torsion bar is twisted since road resistance is applied to the pinion gear. Due to this, the lower end of the torsion bar turns a smaller angle by the amount of twist than the upper end. As a result, the relative position of the rotary valve and the control valve shaft is shifted, and the fluid passage in the hydraulic circuit is changed. This causes a pressure difference in the right-hand and left-hand chambers of the power cylinder, and steering effort is reduced.

VANE PUMP

This is a lightweight and compact rpm-sensing vane pump. Fluid volume is controlled by the flow control valve and increases rapidly until the engine reaches a certain speed. After that, the fluid volume is maintained at a set amount by the flow control valve regardless of the engine speed.

OPERATION

A rotor rotates within a cam ring secured to the pump housing. There are grooves in the rotor and a vane plate built into the grooves. The outer circumference of the rotor is circular, but the inner surface of the cam ring is oval so there exists a clearance between the rotor and cam ring. The vane plate partitions off this clearance to form a fluid chamber.



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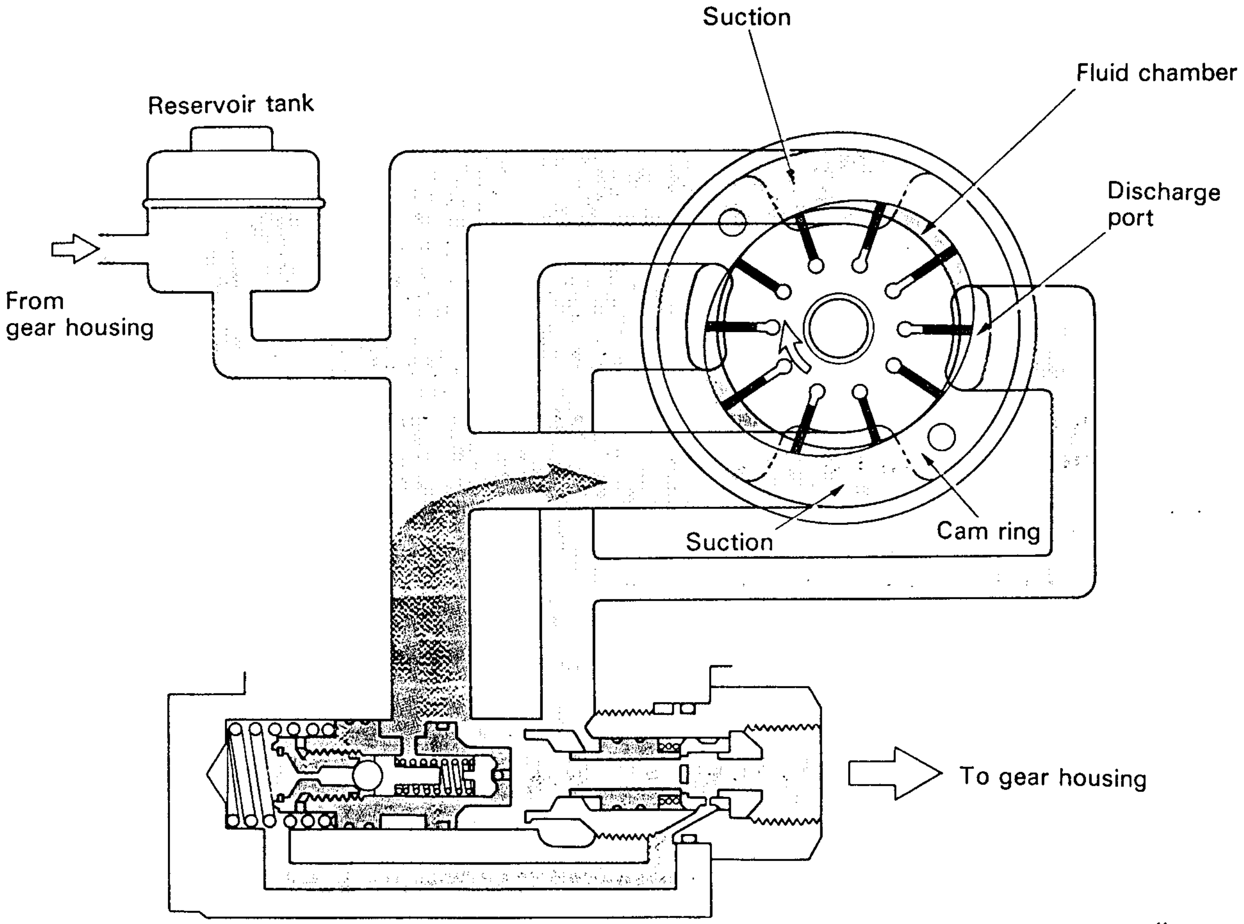
1. SUCTION

The vane plate is held against the inner surface of the cam ring by both centrifugal force and fluid pressure aganist the back of the vane plate, forming a seal so that when the pump produces fluid pressure, pressure leakage between the vane plate and cam ring is prevented.
The capacity of this fluid chamber is increased or decreased as the rotor rotates to operate the pump. In other words, the capacity of the fluid chamber increases at the suction port so that reservoir fluid is drawn into the fluid chamber from the suction port.

2. DISCHARGE

The volume of the fluid chamber is decreased on the discharge side, and when it reaches zero, the fluid previously drawn into the chamber is forced out through the discharge port. There are two suction and two discharge ports. Therefore, fluid is drawn in and discharged twice with each revolution of the rotor.



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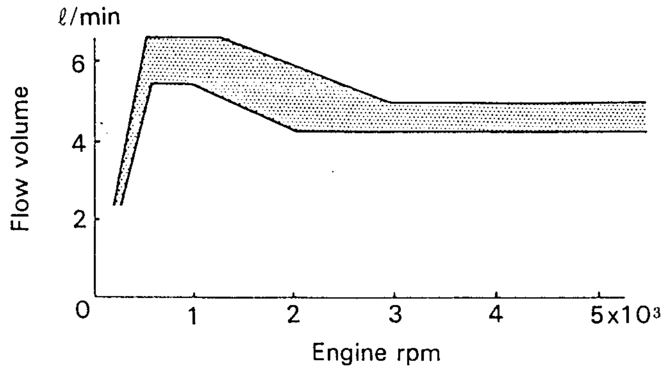
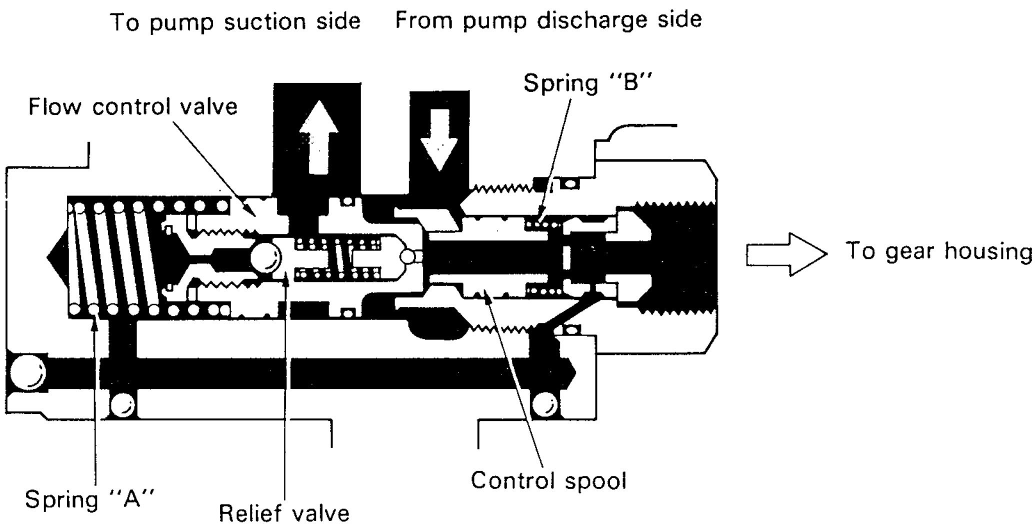
FLOW CONTROL VALVE & CONTROL SPOOL

The discharge volume of the vane pump increases proportionately as engine rpm rises. The amount of steering assist provided by the power piston of the gear housing is determined by the volume of fluid from the pump. As the pump rpm increases, the flow volume becomes greater, providing more steering assist and, consequently, less steering effort is required. In other words, the steering effort varies in accordance with the change in rpm, which is a disadvantage from the standpoint of steering stability.
Therefore, it is necessary to maintain a constant fluid flow volume from the pump regardless of the rpm, and this is the function of the flow control valve.
Normally, when the vehicle is moving at high speed, there is less tire resistance and, consequently, less steering effort is required. Therefore, with some power steering systems, there is less assist provided during high speed so that an appropriate steering effort can be obtained.



(This graph shows the no-load flow volume.)

In short, the flow volume from the pump to the gear housing is reduced during high-speed driving, and there is less power steering assist.
Discharge volume of the pump increases with a rise in pump rpm, but the flow volume of the fluid to the gear housing is reduced. This is referred to as rpm-sensing power steering, and it consists of a flow control valve with a built-in control spool.



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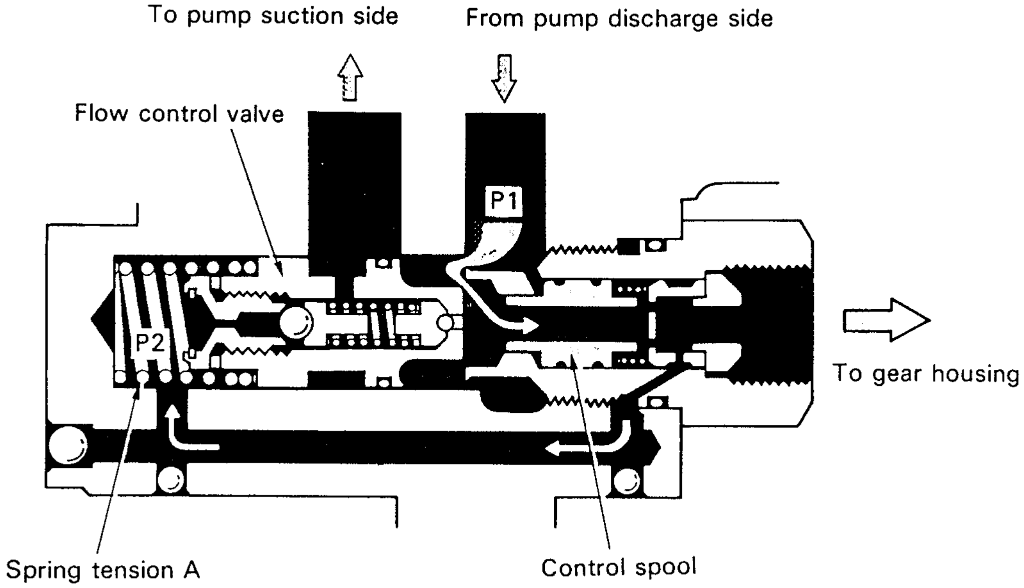
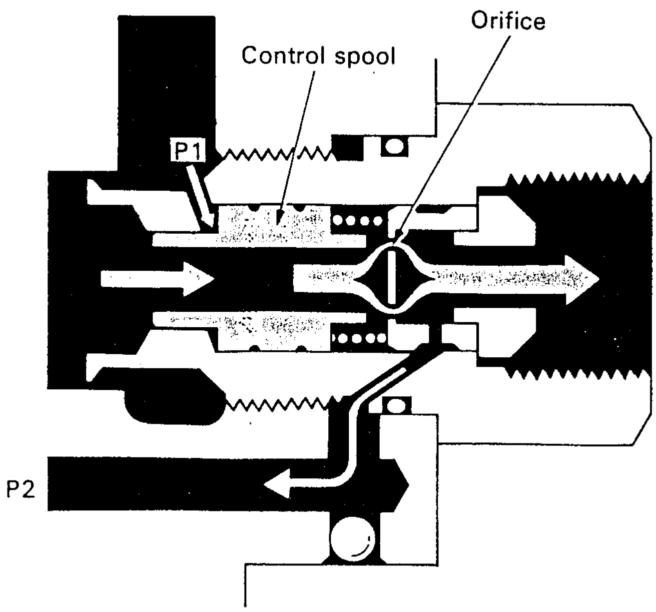
1. DURING LOW-SPEED DRIVING

(Pump speed: 650 – 1,250 rpm)

Pump discharge pressure P1 is applied to the right side of the flow control valve, and P2 is applied to the left side after passing through the orifices. The pressure difference between P1 and P2 becomes larger as the engine rpm increases. When the pressure difference between P1 and P2 overcomes the flow control valve spring tension (A), the flow control valve moves to the left. This opens the passage to the pump suction side so the fluid returns to the pump suction side. Fluid volume to the housing is controlled at 6.6 l/min. (3.88 x 10^{-3} cubic ft./sec.) in this manner.





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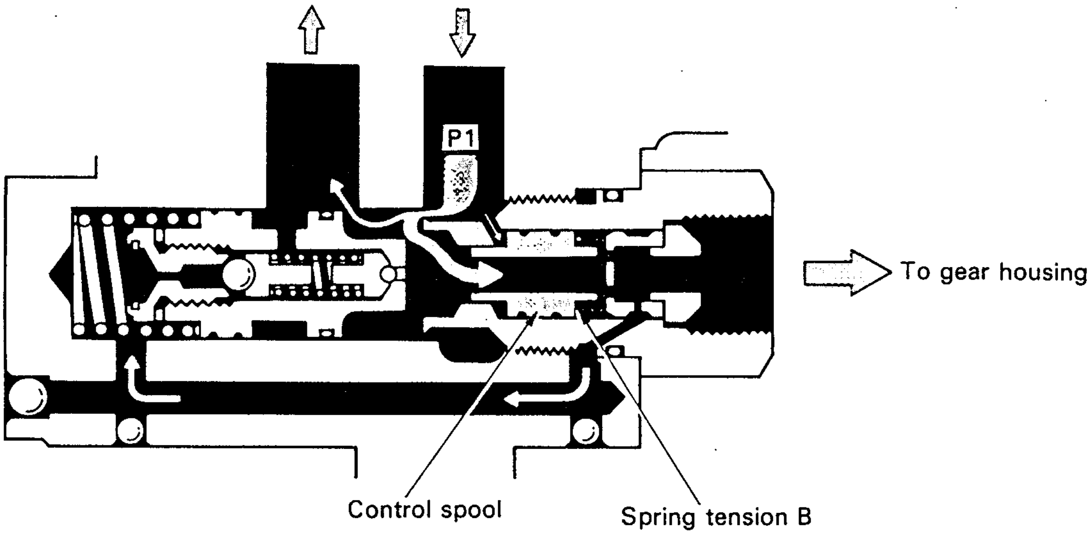
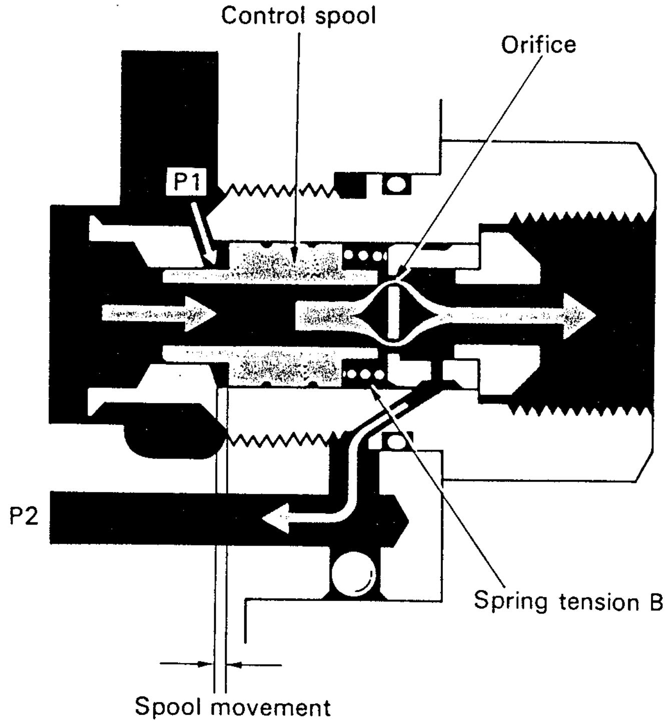
2. AT MEDIUM SPEED

(Pump speed: 1250 – 2500 rpm)



Pump discharge pressure P1 is applied to the left side of the control spool. When the pump is above 1250 rpm, pressure P1 overcomes the spring tension (B) and forces the control spool to the right, so the fluid volume passing through the orifices is decreased, causing a lowering of pressure P2. Consequently, the pressure difference between P1 and P2 increases. In this manner, the flow control valve moves toward the left so that the fluid returns to the pump suction side, reducing the fluid volume to the gear housing.

In other words, when the control spool moves to the right, decreasing the fluid volume passing through the orifices.



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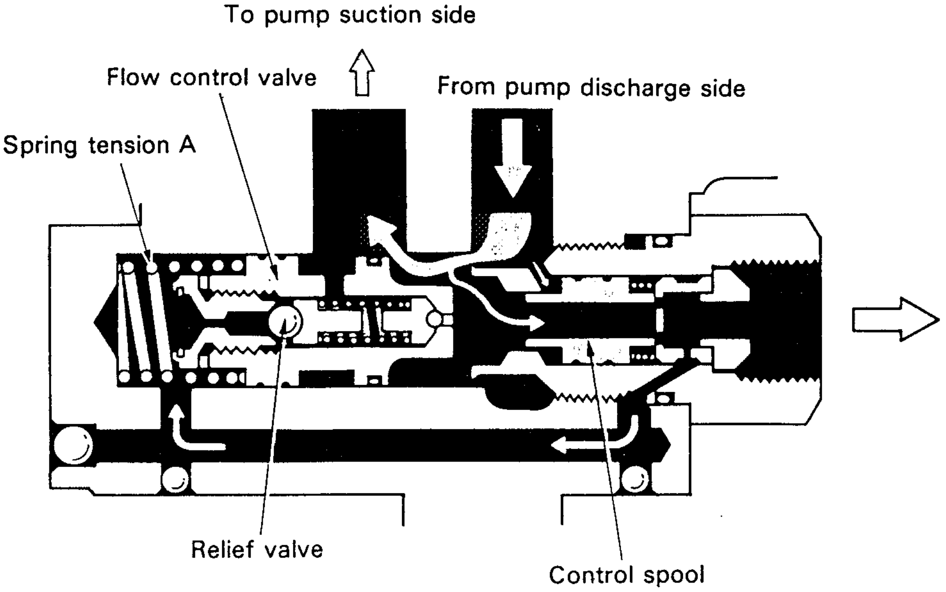
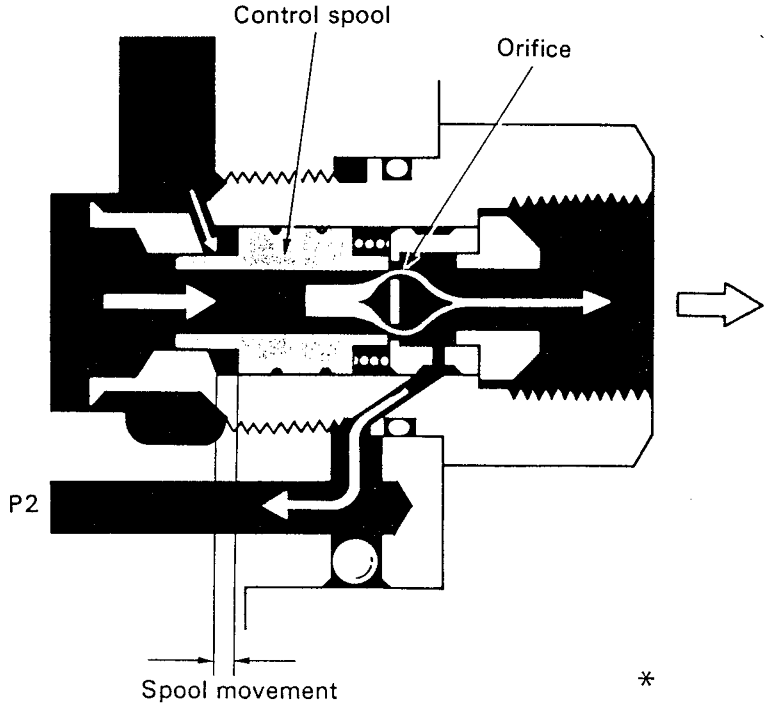
3. DURING HIGH-SPEED DRIVING

(Pump speed: Over 2500 rpm)

When pump speed exceeds 2500 rpm, the control spool is forced all the way to the right, half closing the orifices. At this time, pressure P2 is determined by only the amount of fluid passing through the orifices. Fluid volume to the gear housing is kept at 3.3 l/min. (1.94 x 10^{-3} cubic ft./sec.) in this manner.





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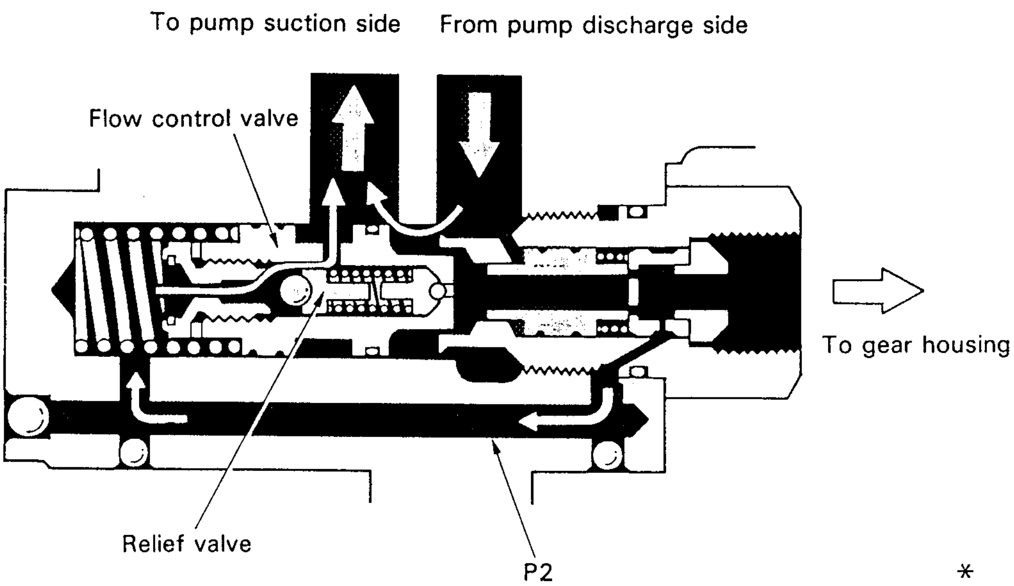
4. RELIEF VALVE

The relief valve is located in the flow control valve. When pressure P2 exceeds 7845 kPa, 80 kgf/cm[2] or 1138 psi (when turning the steering wheel fully), the relief valve opens to lower pressure.

When pressure P2 drops, the flow control valve is forced to the left and controls the maximum pressure.



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GEAR HOUSING

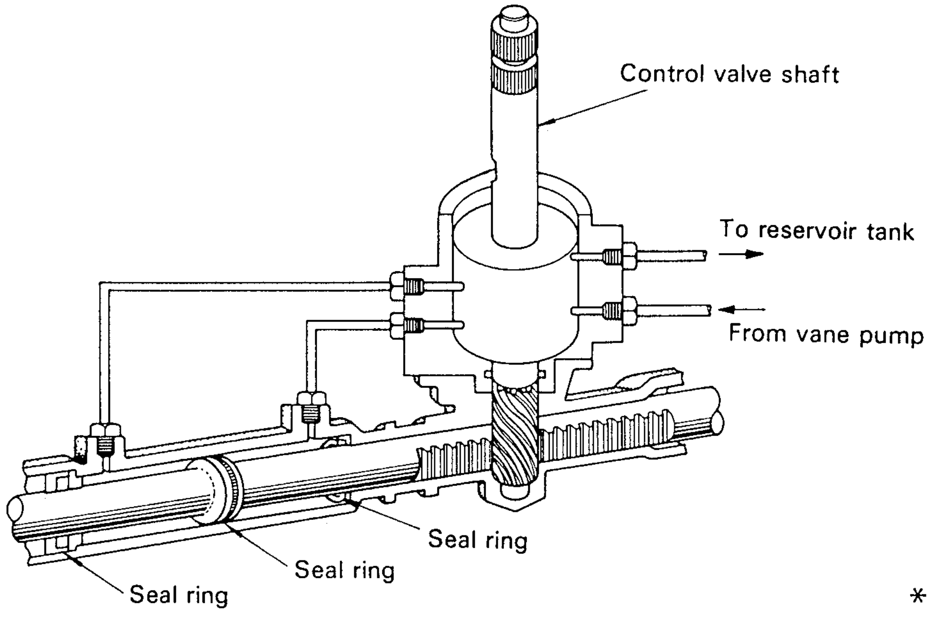
1. DESCRIPTION

The piston in the power cylinder is positioned on the rack, and the rack moves due to fluid pressurized by the vane pump acting on the piston in either direction. Fluid pressure leakage is prevented by a seal ring on the piston. Also, there is an oil seal on both sides of the cylinder to prevent external leakage of the fluid.

The control valve shaft is connected to the steering wheel. When the steering wheel is in the neutral (straight-ahead) position, the control valve is also in the neutral position, so the fluid from the vane pump does not act on either chamber but flows back to the reservoir tank. However, when the steering wheel is turned in either direction, the control valve changes the passage so the fluid flows into one of the chambers. The fluid in the opposite chamber is forced out and flows back to the reservoir tank by way of the control valve.

Currently, there are three different types of control valves which perform this changeover action of the passage: spool valve, rotary valve and flapper valve. All types have a torsion bar between the control valve shaft and pinion, and the control valve functions in accordance with the amount of twist applied to the torsion bar.

In the event that there is no fluid or fluid pressure and the torsion bar is twisted to a certain extent, the control valve shaft stopper turns the pinion directly and moves the rack. In other words, the same amount of steering wheel torque as with manual steering will be transmitted to the pinion via the control valve shaft.



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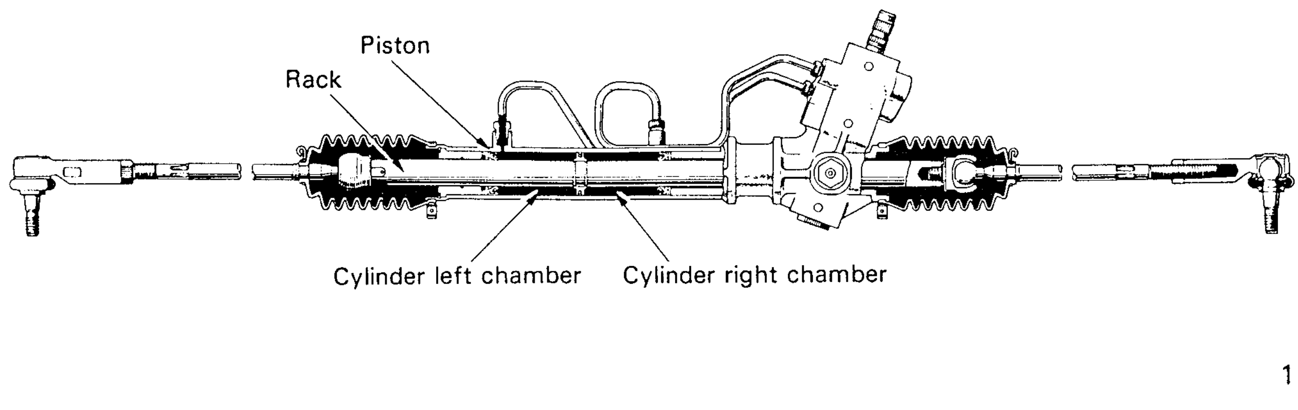
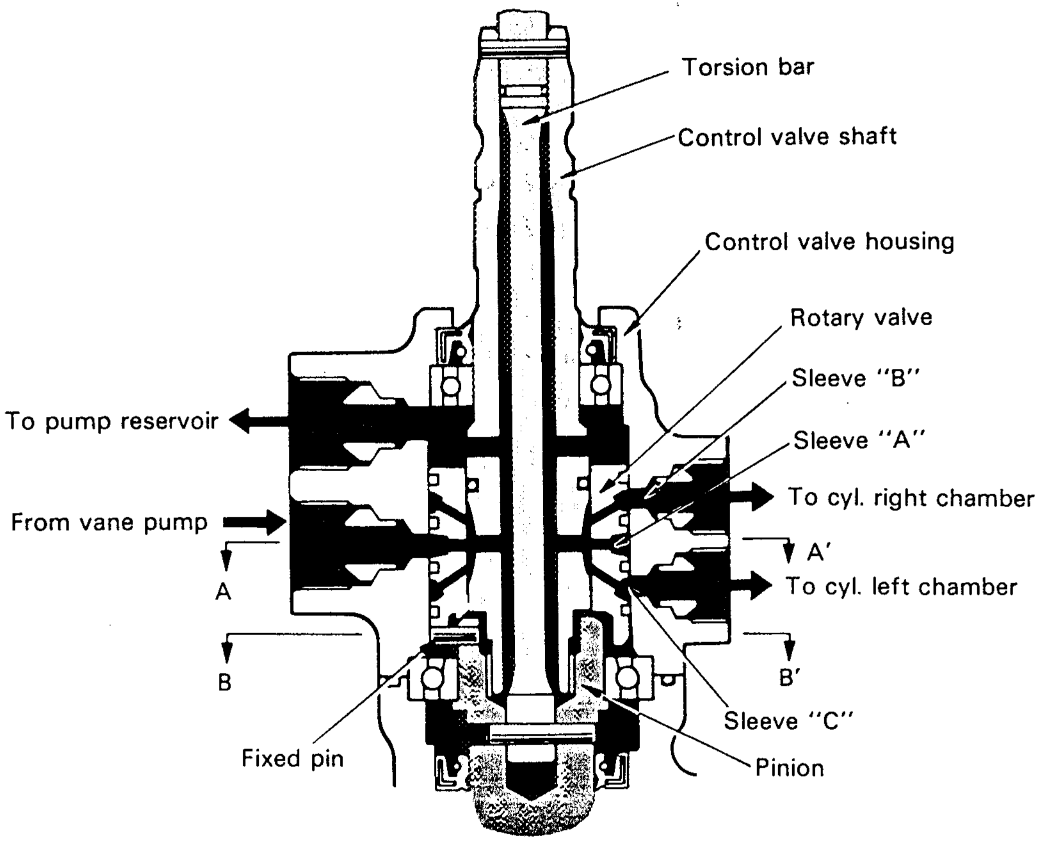


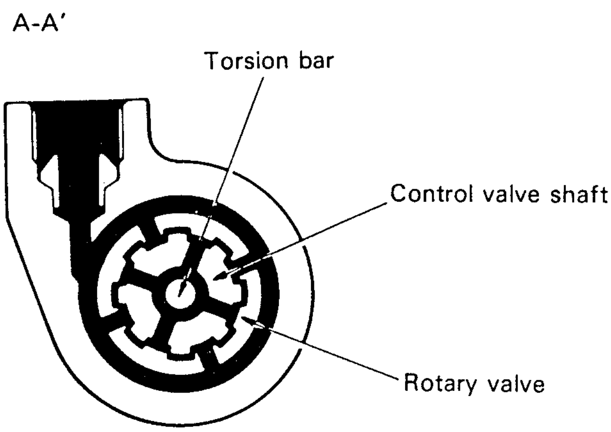
2. CONTROL VALVE

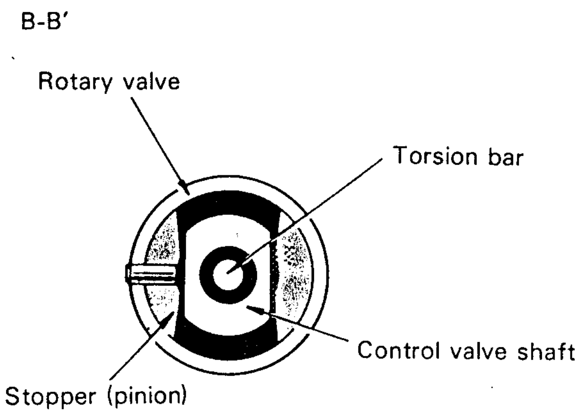
The control valve in the gear housing determines which chamber the fluid from the vane pump goes to. The control valve shaft (to which steering wheel torque is applied) and the pinion gear are connected by means of a torsion bar.

The rotary valve and pinion gear are secured by a pin and rotate integrally.

If no vane pump pressure is applied, the torsion bar is fully twisted, and the control valve shaft and pinion gear make contact at the stopper. Then the control valve shaft torque is applied directly to the pinion gear.

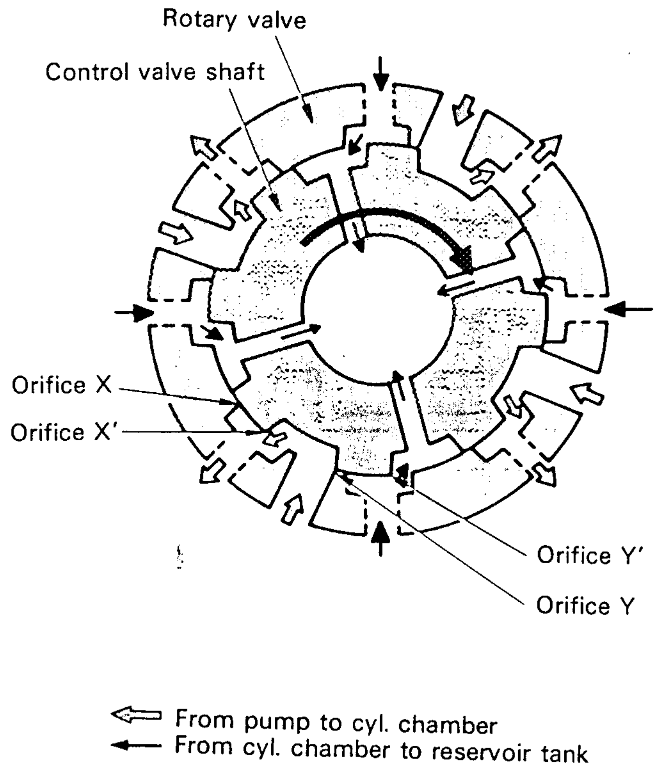


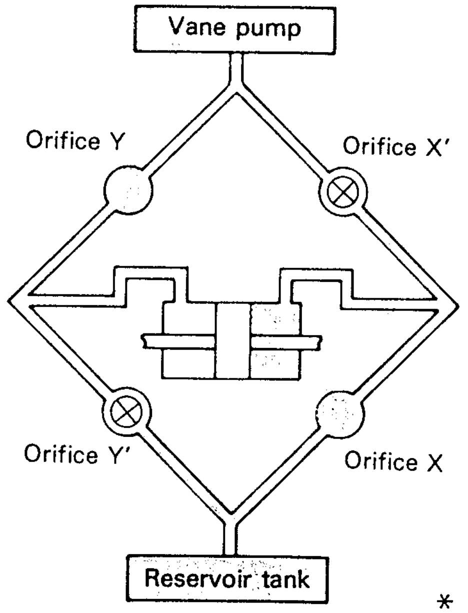




3. OPERATION (Fluid Circuit Control)

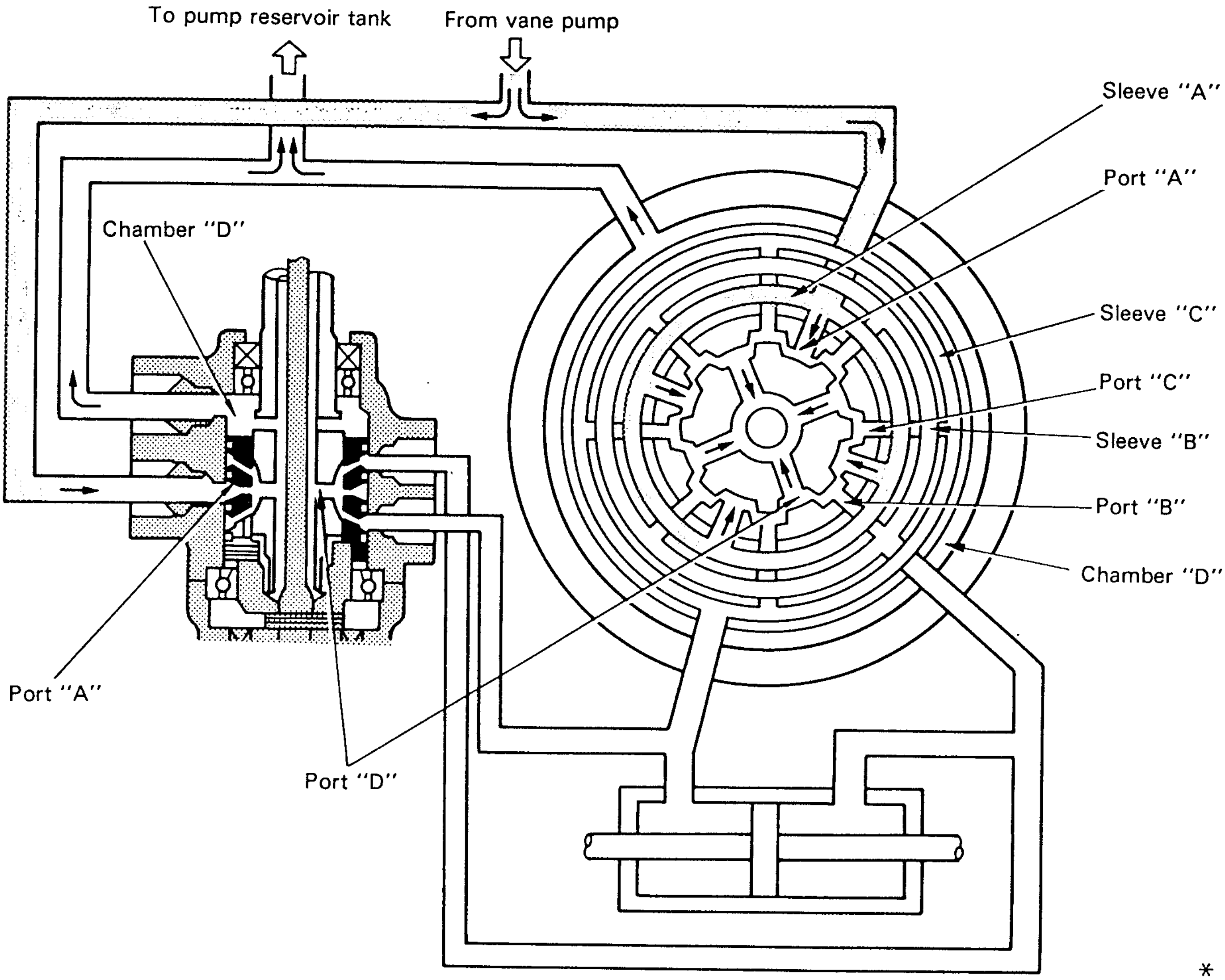
A restriction in the hydraulic circuit is formed by rotary movement of the control valve shaft in relation to the rotary valve. When the steering wheel is turned to the right, pressure is restricted at orifices X and Y. When it is turned to the left, a restriction is formed at X' and Y'.
When the steering wheel is turned, the control valve shaft rotates, turning the pinion gear via the torsion bar. In contrast to the pinion gear, as the torsion bar twists in proportion to road surface force at this time, the control valve shaft rotates only to the extent of the amount of twist and moves to the right or left in relation to the rotary valve. Thus orifices X and Y (or X' and Y') are formed, and a difference in hydraulic pressure between the right and left cylinder chambers is created.
In this manner, rotation of the control valve shaft directly performs changeover of the passages and regulates the fluid pressure.
The fluid from the vane pump enters from the outer circumference of the rotary valve, and the fluid returning to the reservoir tank passes between the torsion bar and the control valve shaft.

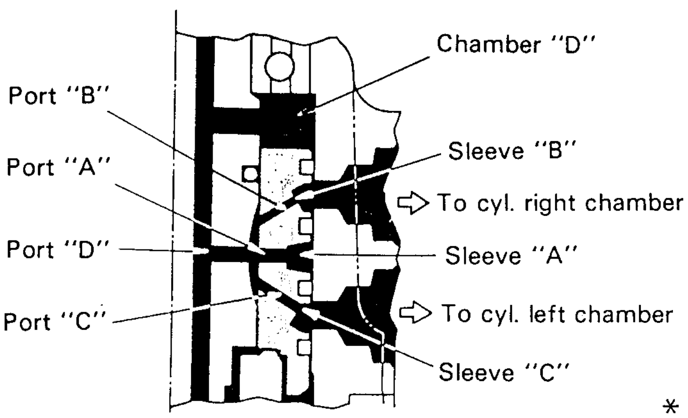


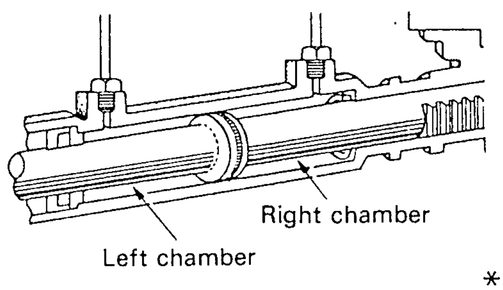


a. NEUTRAL POSITION

As the control valve shaft does not revolve, it is in a neutral position in relation to the rotary valve. Fluid supplied by the pump returns to the reservoir tank through port "D" and chamber "D". The right and left chambers of the cylinder are slightly pressurized, but as there is no pressure difference between the two, no power steering assist occurs.

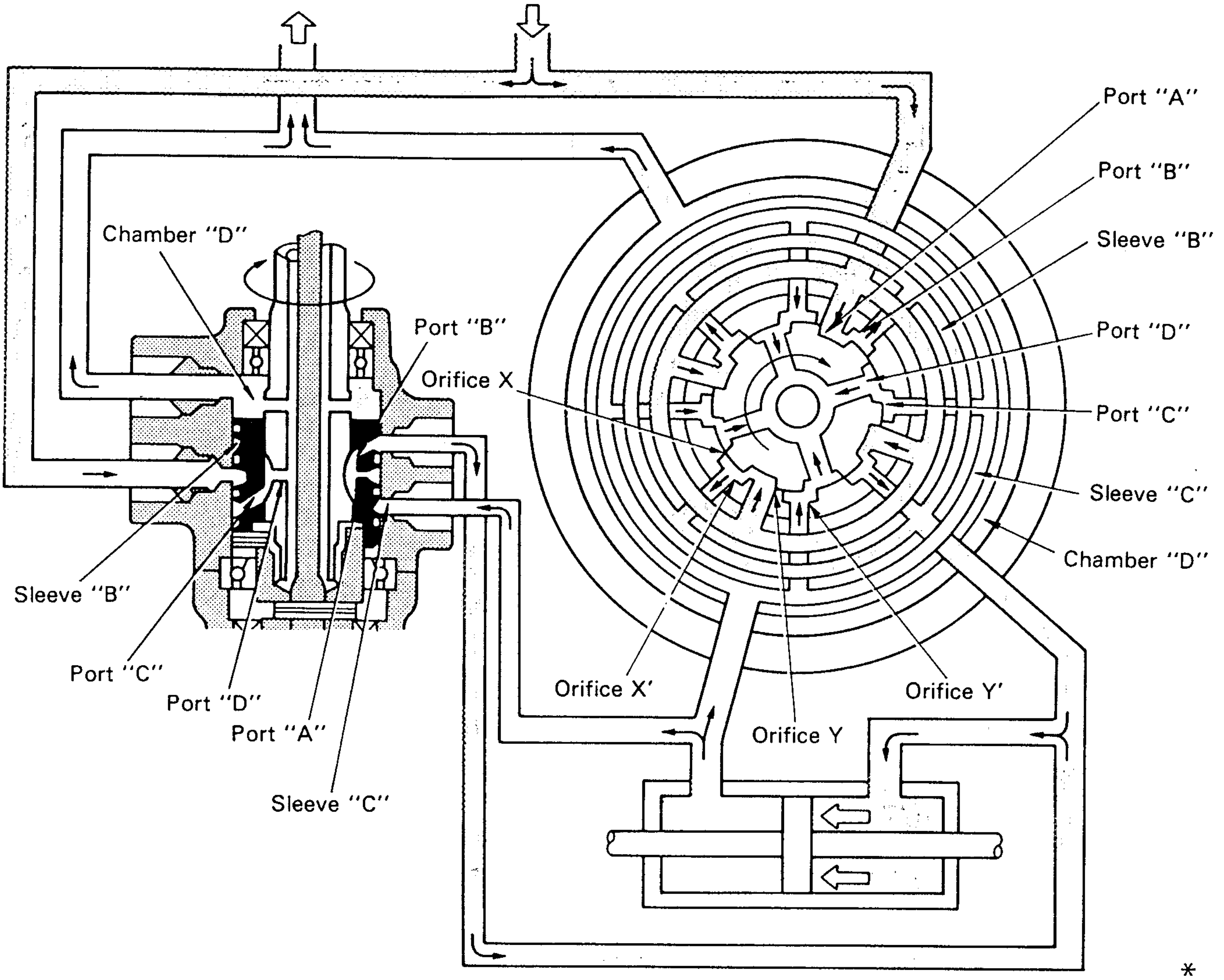






b. RIGHT TURN

When the vehicle makes a right turn, the torsion bar is twisted, and the control valve shaft revolves to the right accordingly. Fluid from the pump is constricted by orifices X and Y of the control edge in order to stop flow to ports "C" and "D". As a result, fluid flows from port "B" to sleeve "B" and then to the right cylinder chamber, causing the rack to move to the left and resulting in power steering assist. At the same time, the fluid in the left cylinder chamber flows back to the reservoir tank via sleeve "C" → port "C" → port "D" → chamber "D".



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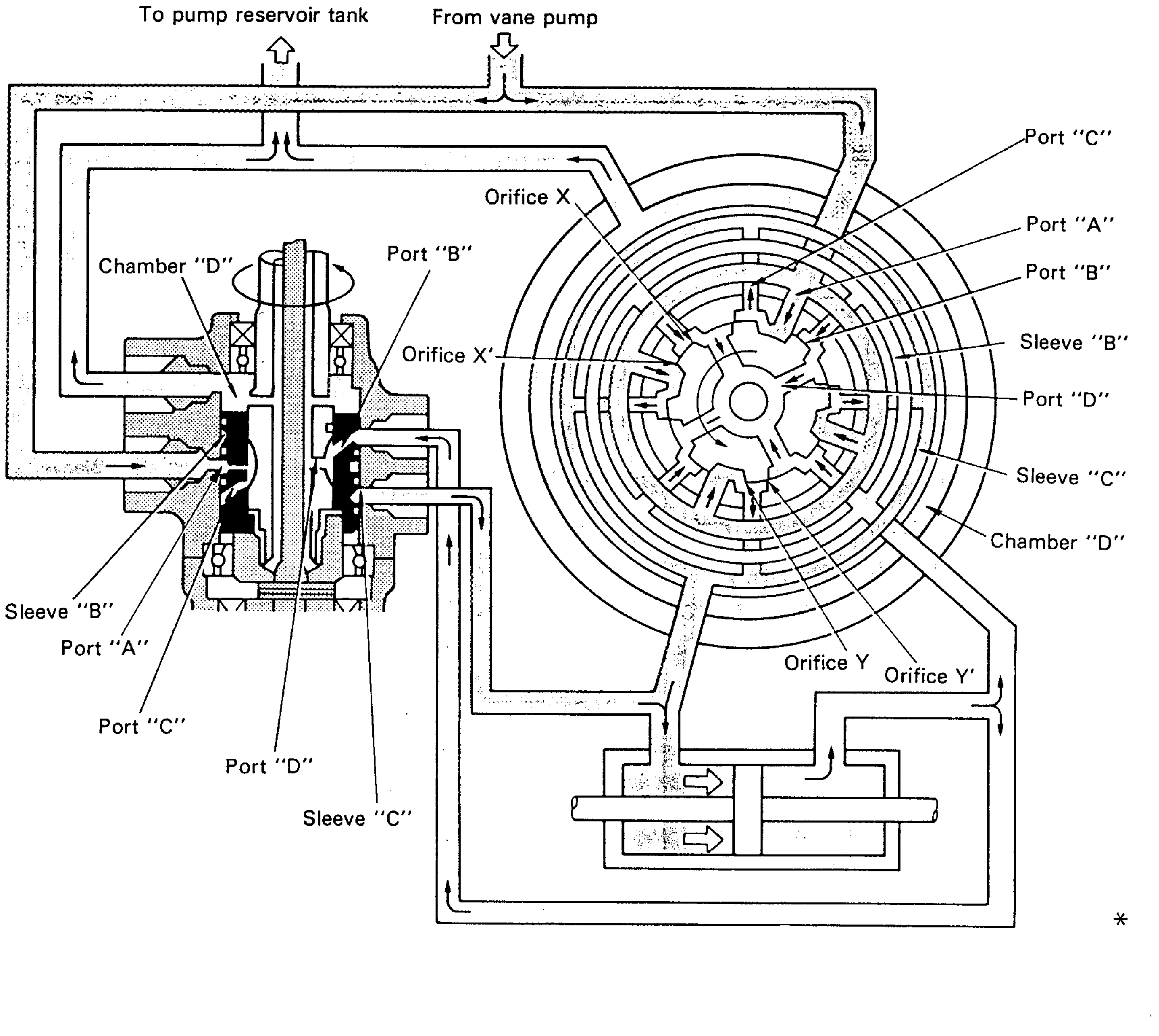
c. LEFT TURN

In the same manner as for a right turn, when the vehicle makes a left turn, the torsion bar is twisted, and the control shaft rotates to the left accordingly. The fluid sent from the pump is constricted by orifices X' and Y' of the control edge in order to stop flow to ports "B" and "D". As a result, fluid flows from port "C" to sleeve "C" and then to the left cylinder chamber, causing the rack to move to the right and resulting in power steering assist. At the same time, the fluid in the right cylinder chamber flows back to the reservoir tank via sleeve "B" → port "B" → port "D" → chamber "D".

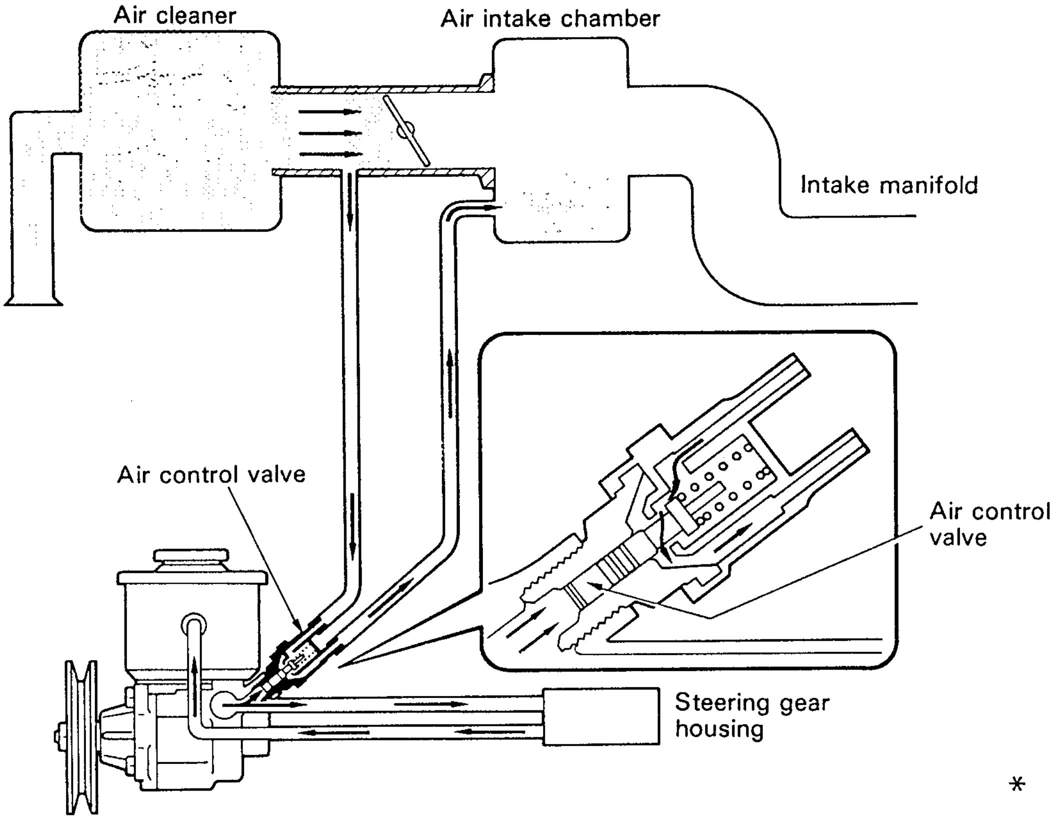


IDLE-UP DEVICE

The pump produces maximum fluid pressure when the steering wheel is turned fully to the right or left. At this time, there is maximum load on the pump, which causes a decrease in engine idle rpm. To solve this problem, almost all vehicles are equipped with an idle-up device, which acts to raise the engine idle rpm whenever there is a high load on the pump. The idle-up device functions to raise engine idle rpm when pump fluid pressure acts on the air control valve (installed on the pump body) to control the flow of air.

OPERATION

When the piston of the air control valve is pushed by fluid pressure, the air valve opens, and the volume of air bypassing the throttle valve is increased to regulate engine rpm.



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ON-VEHICLE (OR SIMULATOR) INSPECTION

1. FLUID LEVEL CHECK

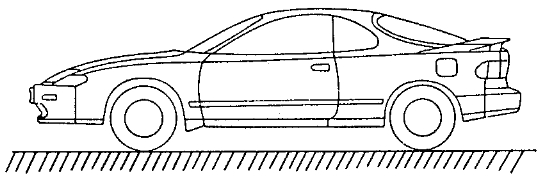
a. KEEP VEHICLE LEVEL

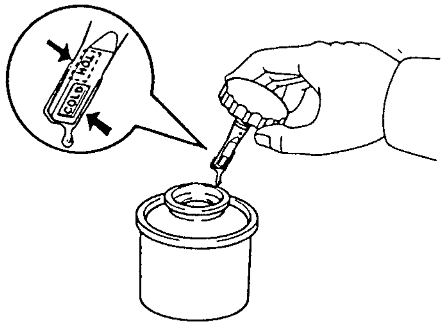
b. CHECK FLUID LEVEL IN RESERVOIR TANK

Check the fluid level and add fluid, if necessary.

Fluid: ATF DEXRON®II

Check that the fluid level is within the HOT level of the dipstick. If the fluid is cold, check that it is within the COLD level of the dipstick.





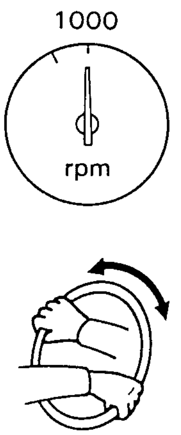
c. CHECK FOR FOAMING OR EMULSIFICATION

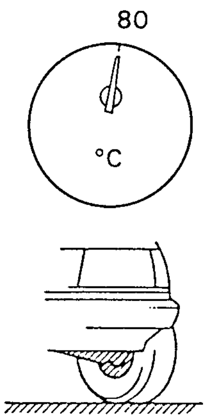
1. With the engine idling at 1000 rpm or less, turn the steering wheel from lock to lock several times to boost fluid temperature.

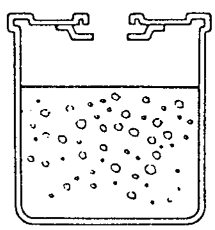
   Fluid temperature: Approximately 80°C (176°F)

2. Check for foaming or emulsification.

- Foaming and emulsification indicate either the existence of air in the system or that the fluid level is too low.





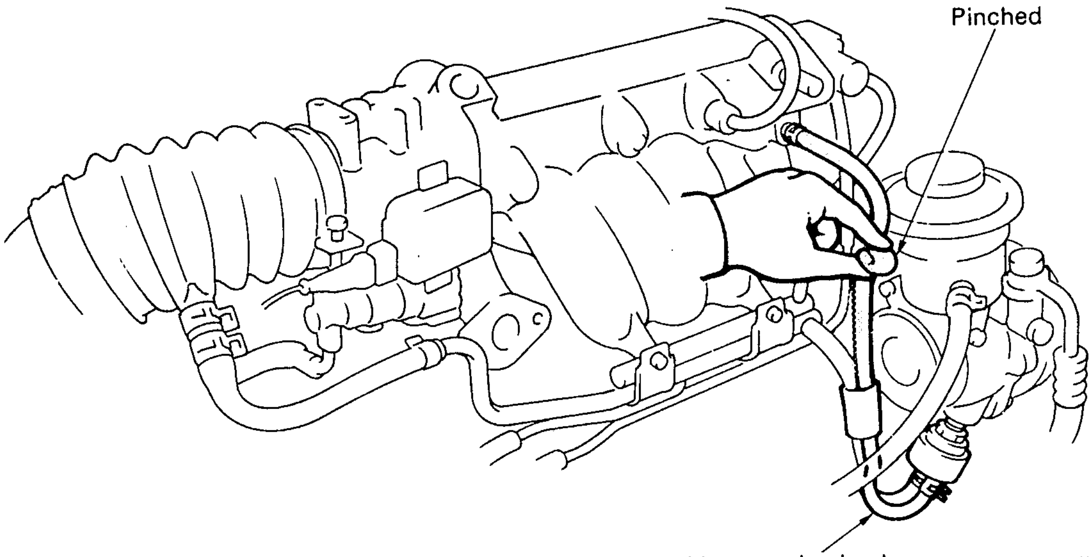


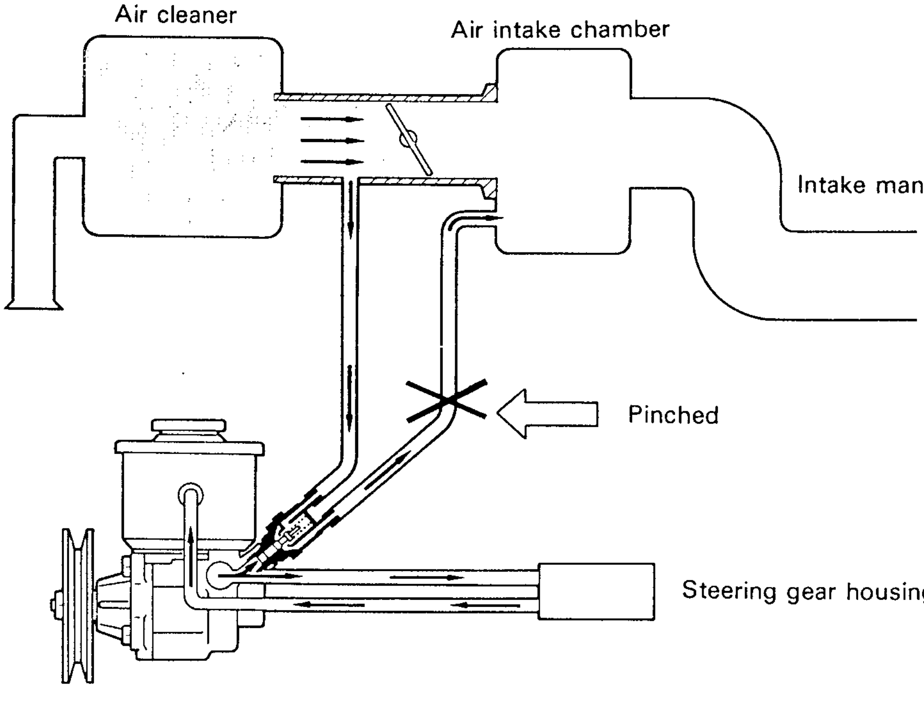
2. CHECK IDLE-UP

a. WARM UP ENGINE

b. CHECK IDLE-UP

1. Turn the steering wheel fully to the right or left.
2. Check that the engine rpm decreases when the air control valve hose is pinched.
3. Check that the engine rpm increases when the air control valve hose is released.



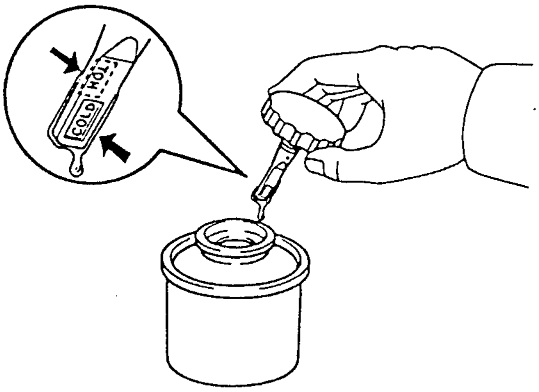


3. BLEEDING OF POWER STEERING SYSTEM

a. Check fluid level in reservoir tank and add fluid, if necessary.

Fluid: ATF DEXRON® II

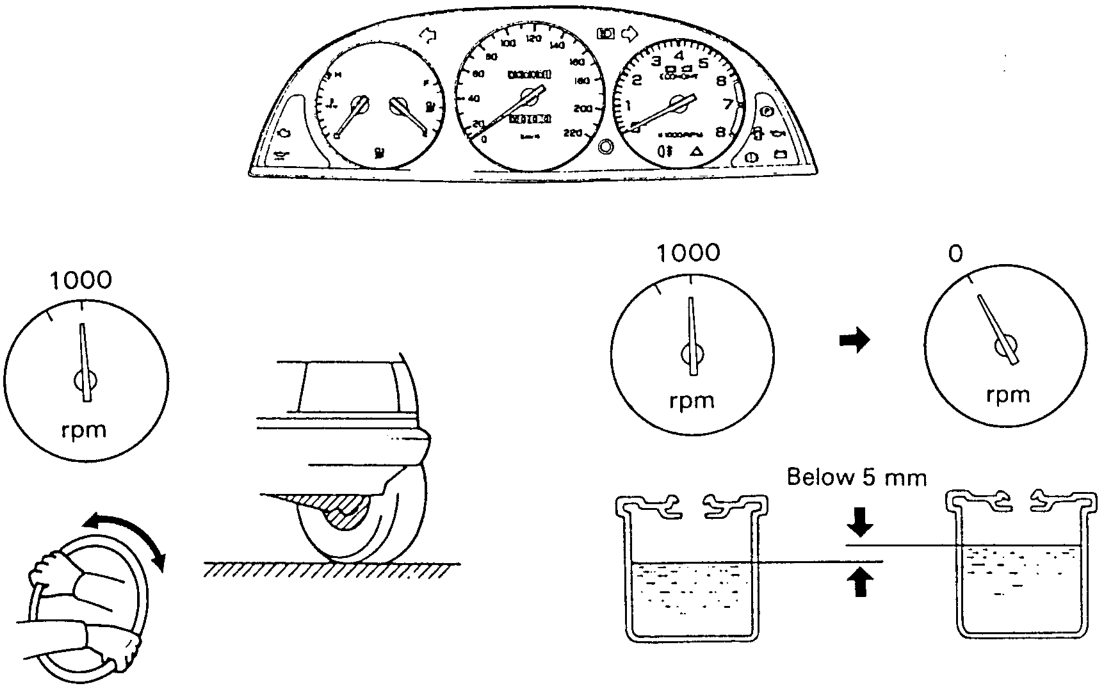
b. Check that the fluid level is within the HOT level of the dipstick. If the fluid is cold, check that it is within the COLD level of the dipstick.



c. With engine speed below 1000 rpm, turn the steering wheel fully to the right or left and keep it there for 2 – 3 seconds. Then turn the wheel to the reverse full-lock position and keep it there for 2 – 3 seconds.

d. Check that the fluid in the reservoir tank is not foamy or cloudy and does not rise above maximum when the engine is stopped.

Maximum rise: 5 mm (0.20 in.)



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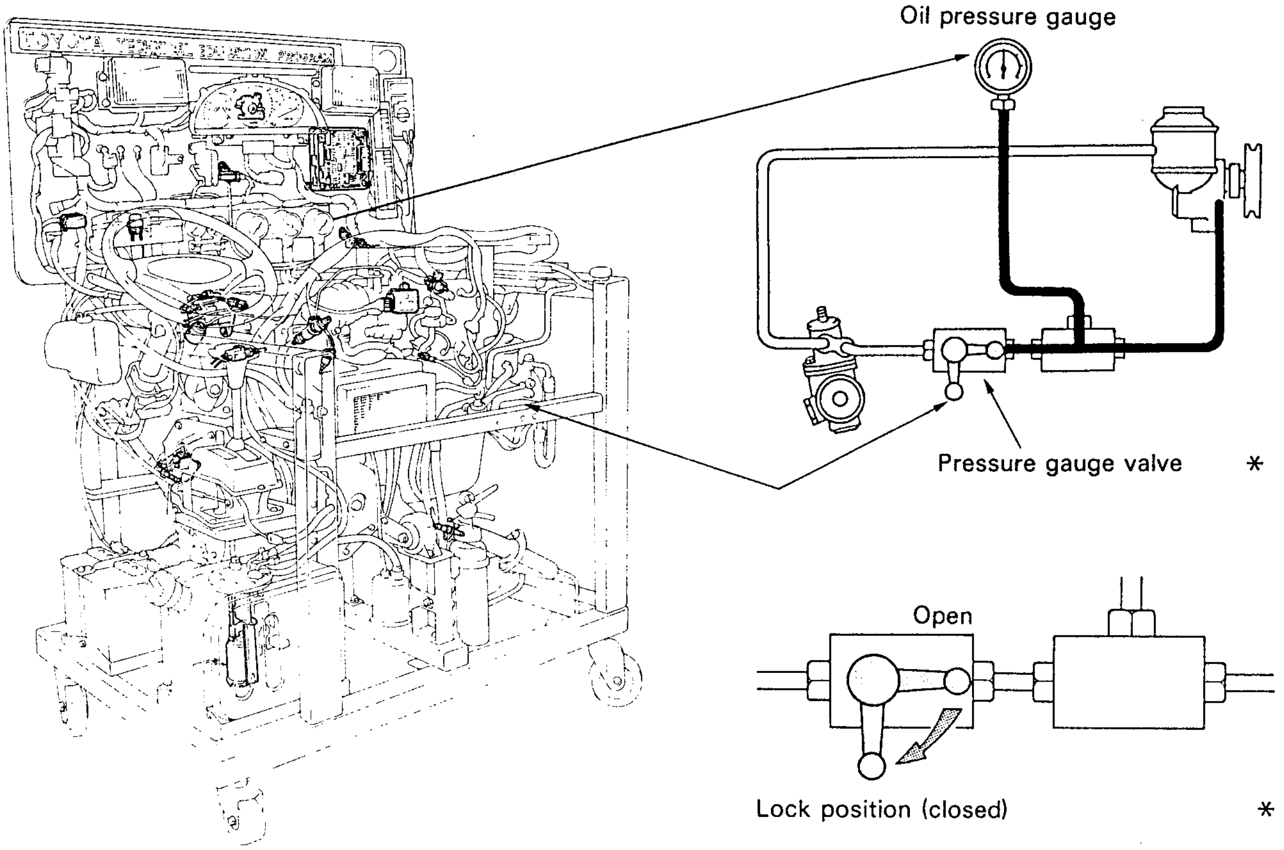
4. OIL PRESSURE CHECK



a. **CHECK FLUID PRESSURE READING WITH VALVE CLOSED**

Close the pressure gauge valve and observe the reading on the gauge.

Minimum pressure: 6,865 kPa (70 kgf/cm^2, 996 psi)

– NOTES –

1. Do not keep the valve closed for more than 10 seconds.

2. Do not let the fluid temperature become too high.

If pressure is low, repair or replace the PS pump.

b. **OPEN PRESSURE GAUGE VALVE FULLY**

c. **CHECK AND RECORD PRESSURE READING AT 1000 RPM**

d. **CHECK AND RECORD PRESSURE READING AT 3000 RPM**

Check that there is a difference of 490 kPa (5 kgf/cm^2, 71 psi) or less in pressure between the 1000 rpm and 3000 rpm checks.

If the difference is excessive, repair or replace the flow control valve of the PS pump.

e. **CHECK PRESSURE READING WITH STEERING WHEEL TURNED TO FULL LOCK**

Be sure the pressure gauge valve is fully opened in engine idling.

Minimum pressure: 6,865 kPa (70 kgf/cm^2, 996 psi)

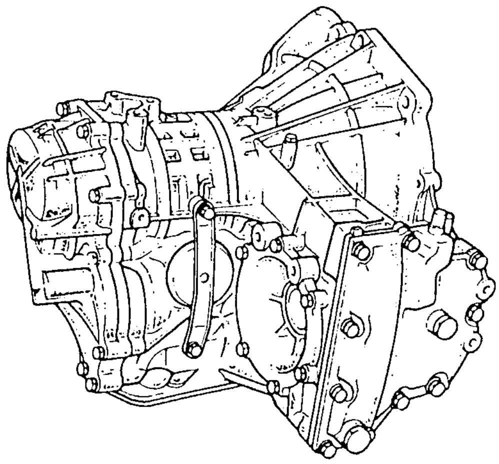
AUTOMATIC TRANSAXLE (Type A 131L)

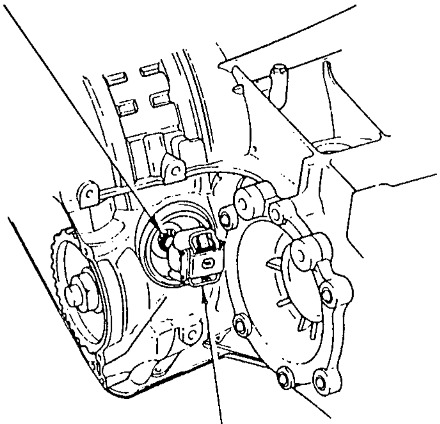
DESCRIPTION

The A131L transaxles are of a three-speed automatic transaxle which has been newly developed to be used in front-engine and front-drive (FF) type vehicles with transversely-mounted engines. The torque converter is equipped with a built-in lock-up clutch.

These transaxles use the following mechanisms to provide exceptional fuel economy, power performance and quietness:

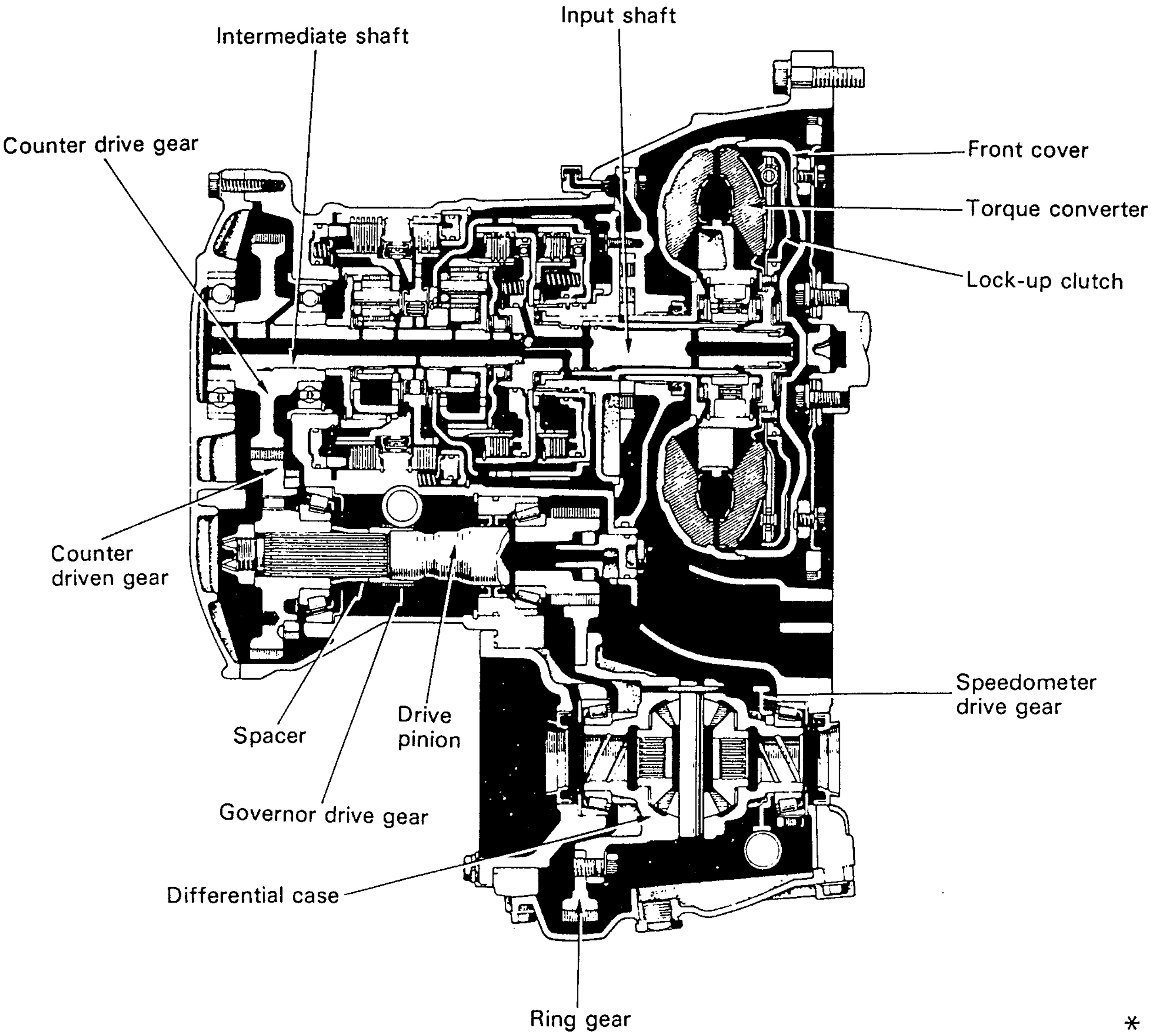
1. A highly efficient torque converter designed for vehicles
2. A three-speed automatic transmission with a wide gear ratio
3. A compact, high-precision valve body
4. A highly efficient compact oil pump
5. A lightweight and durable integral transaxle case
6. A governor valve that can be removed and replaced without removal of the transaxle





CONSTRUCTION

The transaxle case contains a torque converter, a three-speed planetary gear unit, a hydraulic control system and differential.



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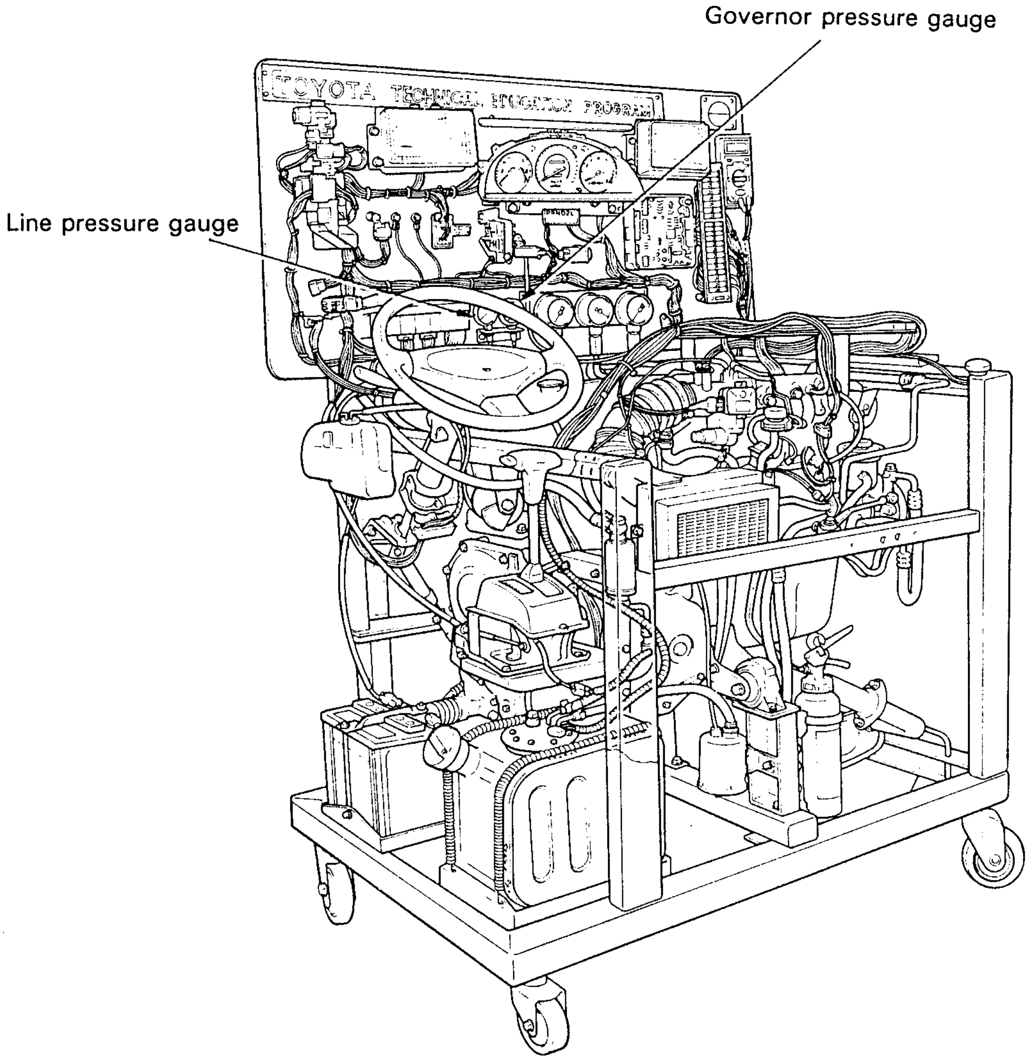
Specifications

Type of Transaxle		A131L
Type of Engine		4A-FE
Gear Ratio	1st Gear	2.810
	2nd Gear	1.549
	3rd Gear	1.000
	4th Gear	–
	Reverse	2.296
Counter Gear Reduction Ratio		0.945
Differential Gear Reduction Ratio		3.526
Fluid Capacity	Transmission	5.5 liters (5.8 US qts, 4.8 Imp. qts)
	Differential	1.4 liters (1.5 US qts, 1.2 Imp. qts)
Type of FLuid		ATF DEXRON® II

HYDRAULIC PRESSURE TEST



1. MEASURE LINE PRESSURE

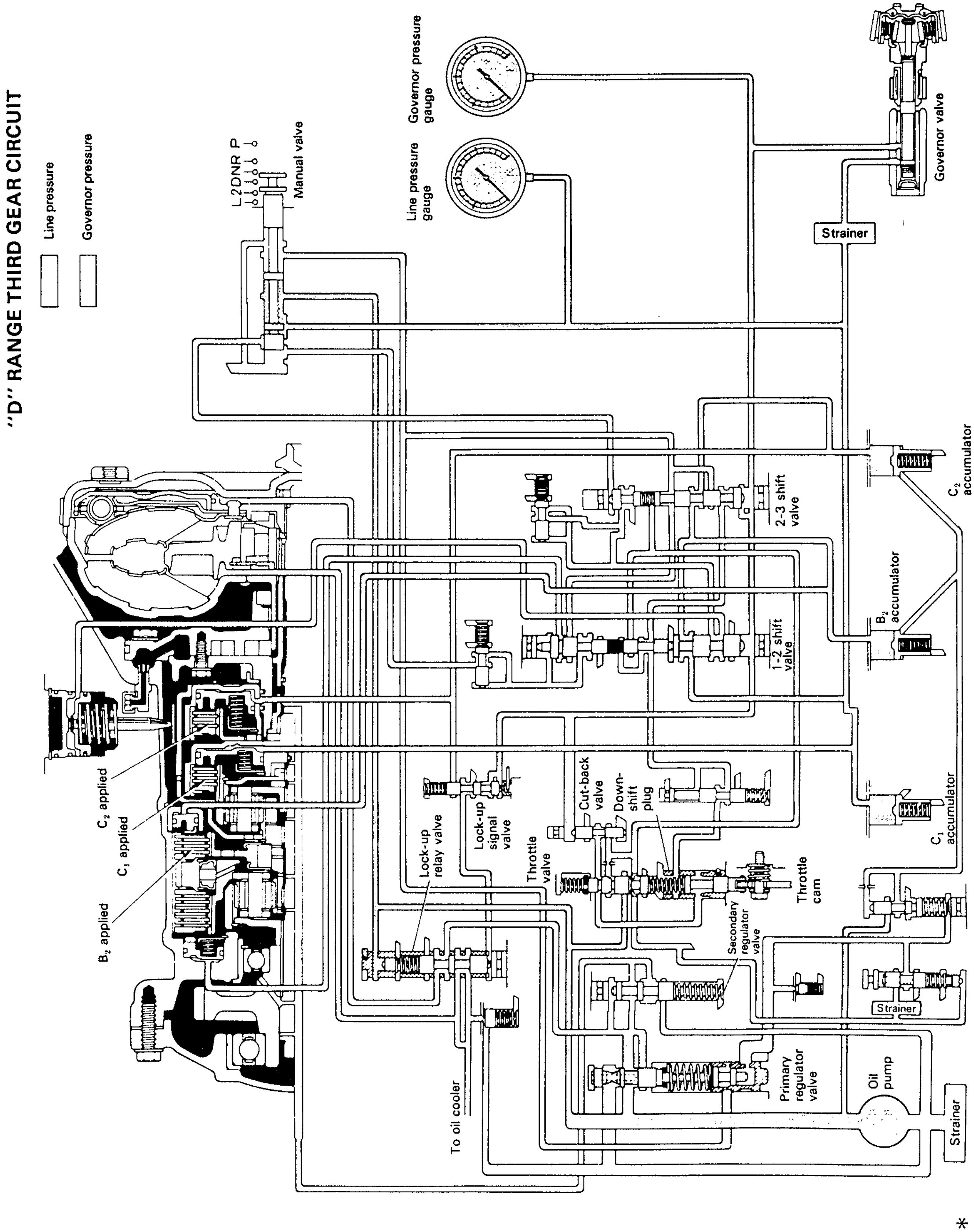
Warm up the transmission fluid.

A/T RANGE	"D"	"R"
ENGINE CONDITION	Idling	Idling
PRESSURE kPa (kgf/cm², psi)	363 – 422 (3.7 – 4.3, 53 – 61)	530 – 706 (5.4 – 7.2, 77 – 102)

2. MEASURE GOVERNOR PRESSURE

DRIVE PINION	VEHICLE SPEED (reference)	GOVERNOR PRESSURE
	A131L (4A-FE engine)	kPa (kgf/cm², psi)
1000 rpm	30 km/h (19 mph)	88 – 167 (0.9 – 1.7, 13 – 24)
1800 rpm	54 km/h (34 mph)	137 – 216 (1.4 – 2.2, 20 – 31)
3500 rpm	105 km/h (65 mph)	373 – 451 (3.8 – 4.6, 54 – 65)

3. HYDRAULIC CIRCUITRY & LOCATION OF HYDRAULIC PRESSURE GAUGE



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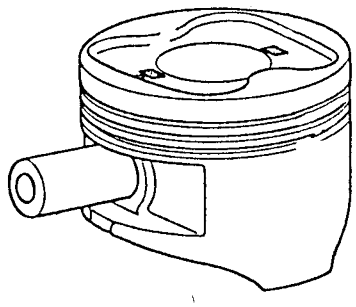
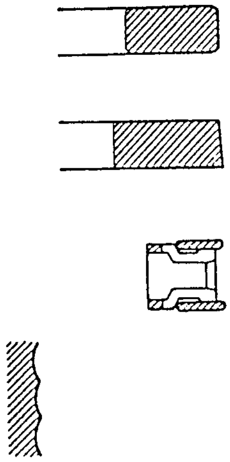
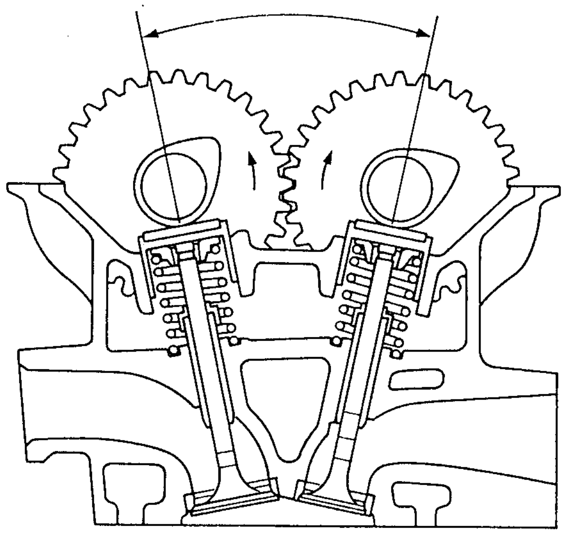
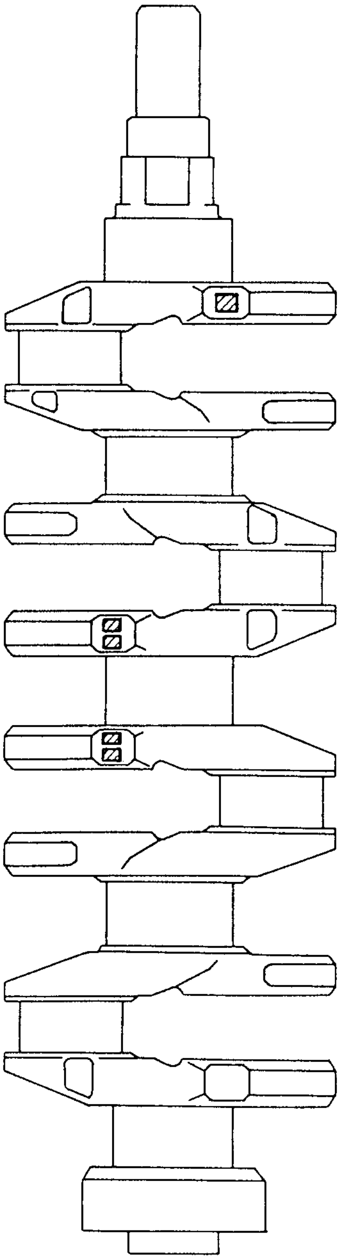
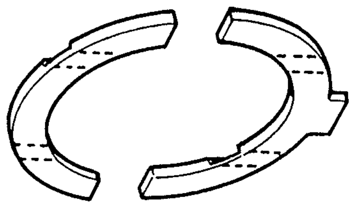
ILLUSTRATIONS

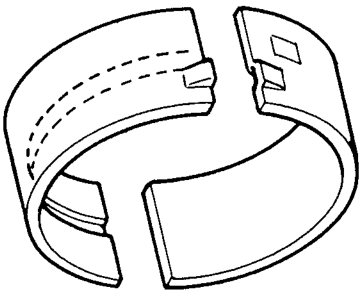


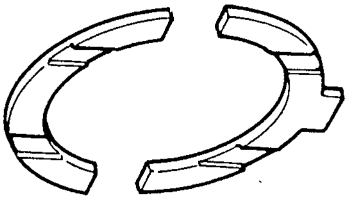


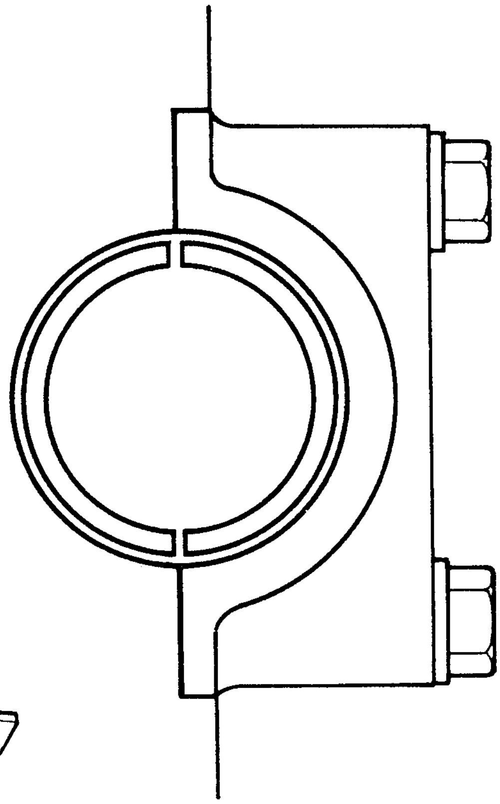


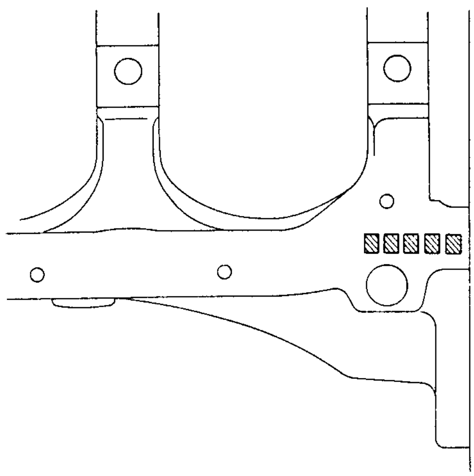


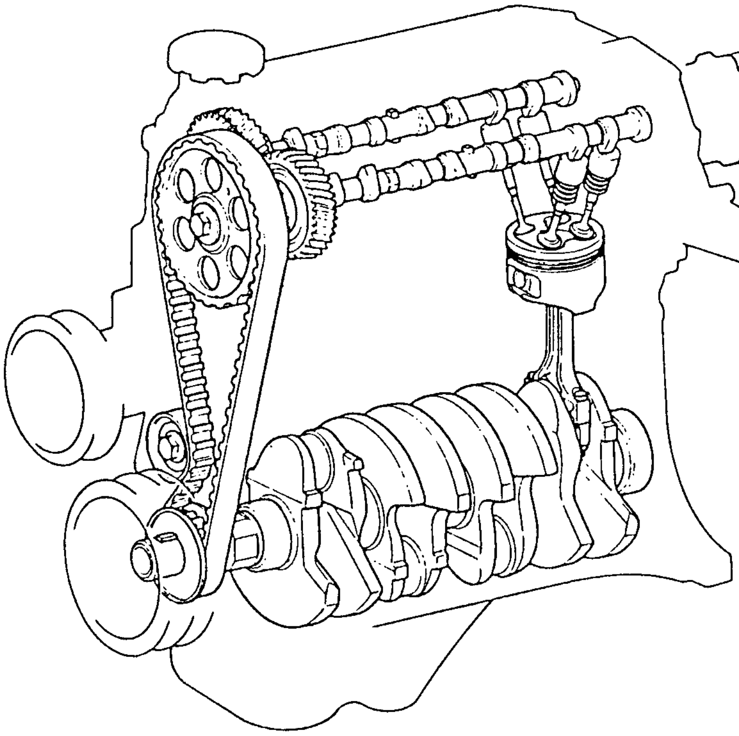


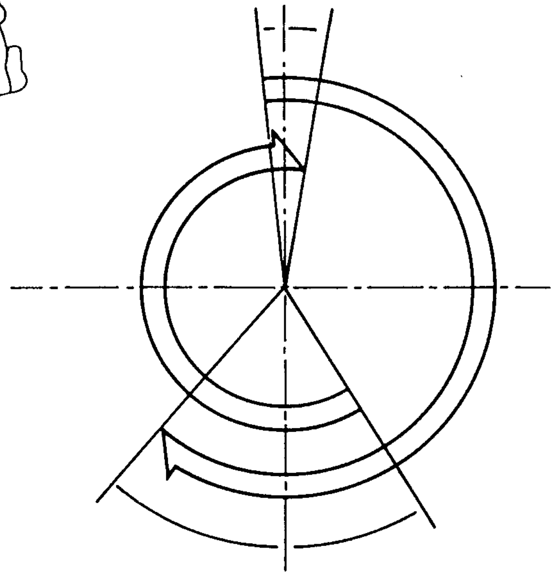


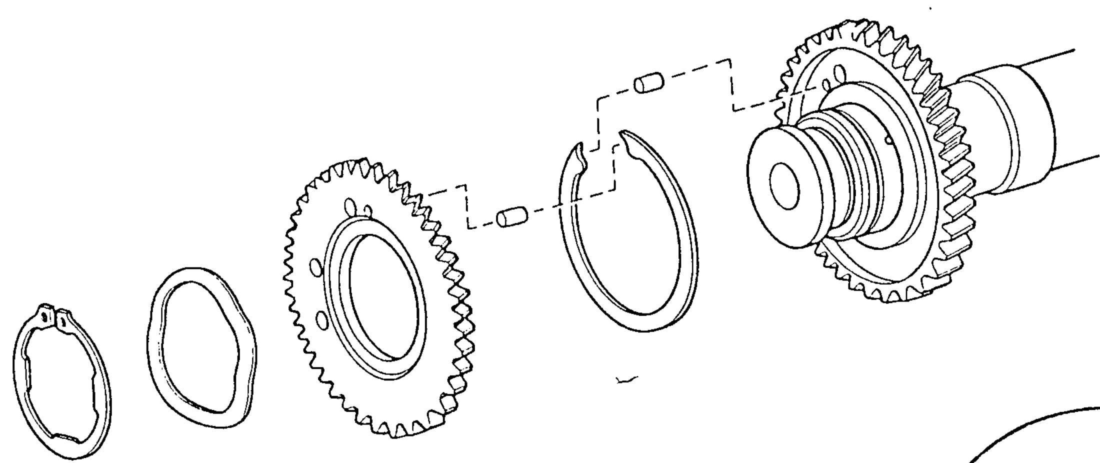


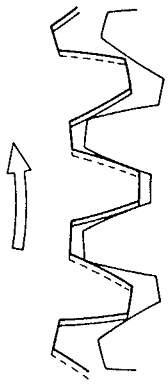


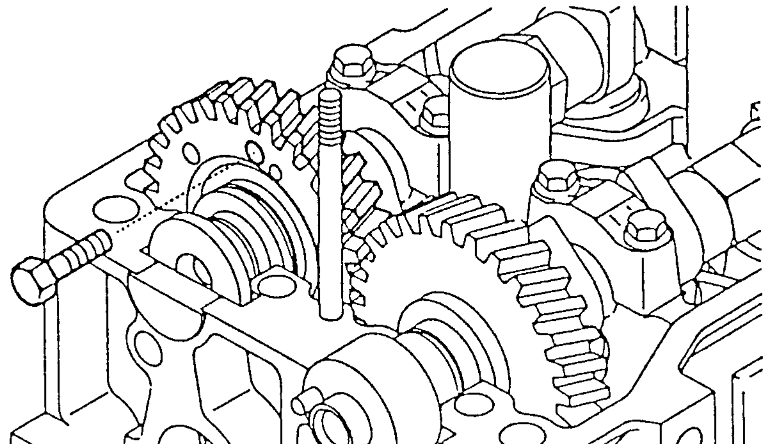


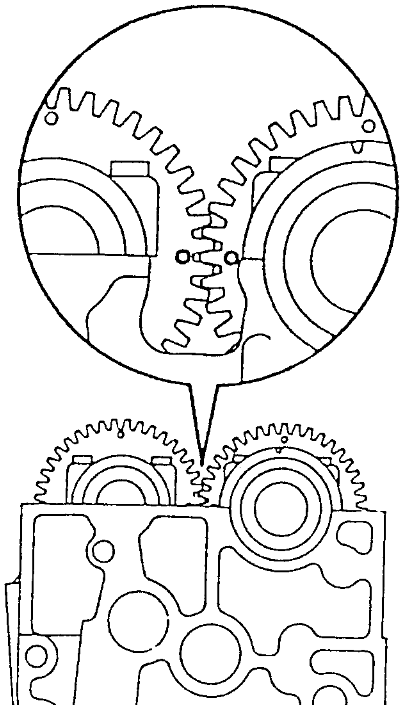


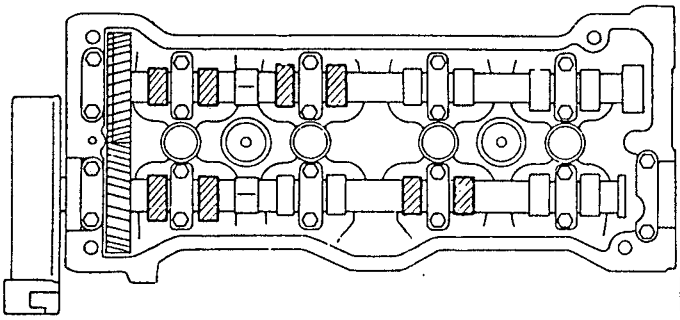


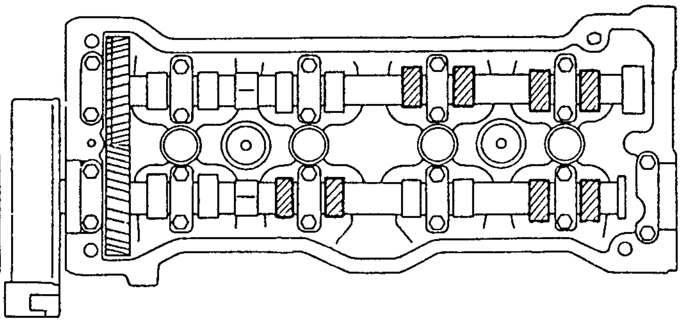


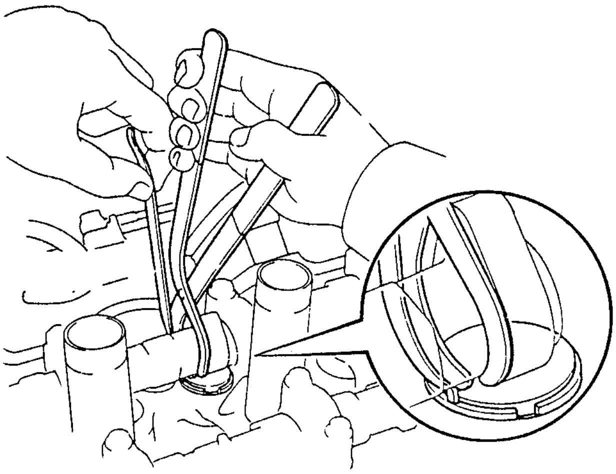


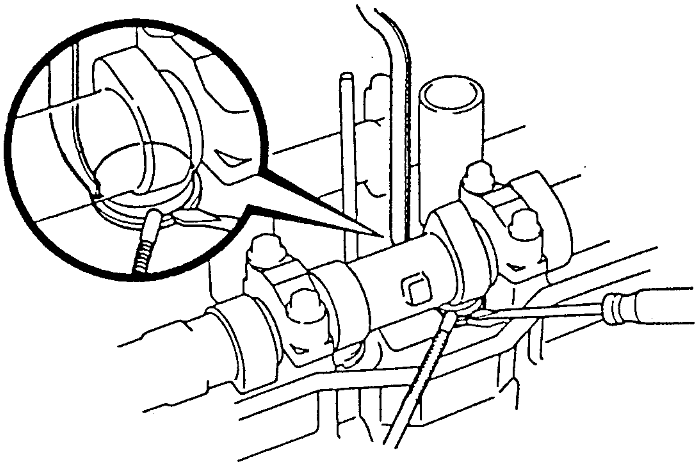


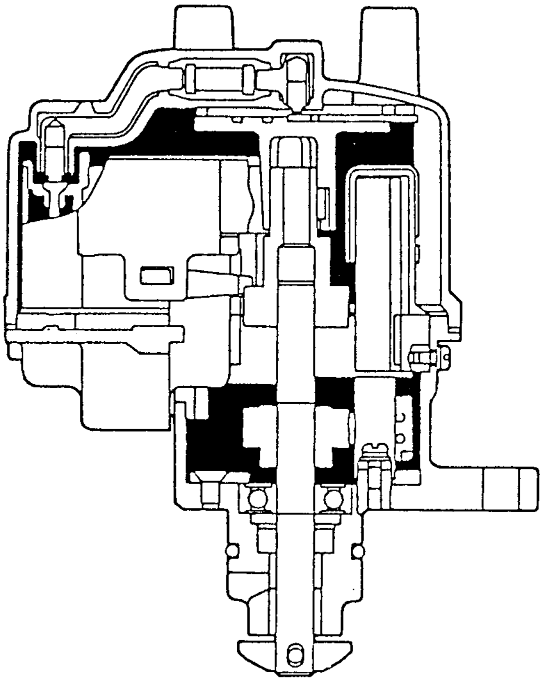


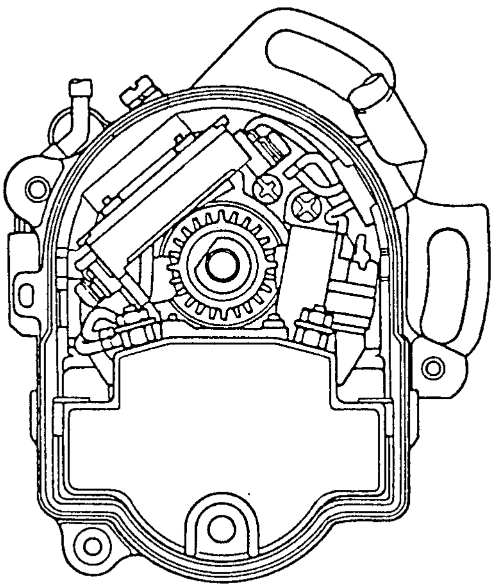


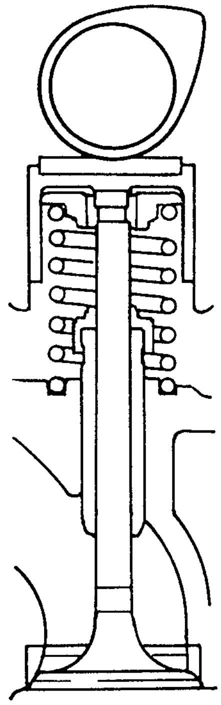


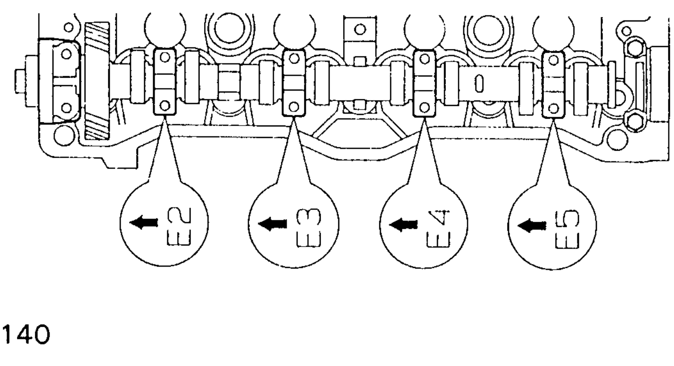








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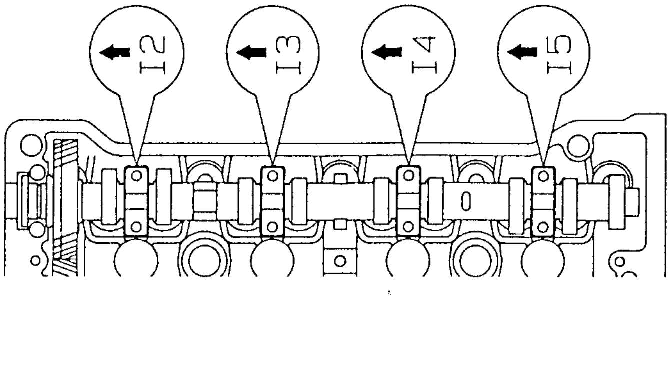
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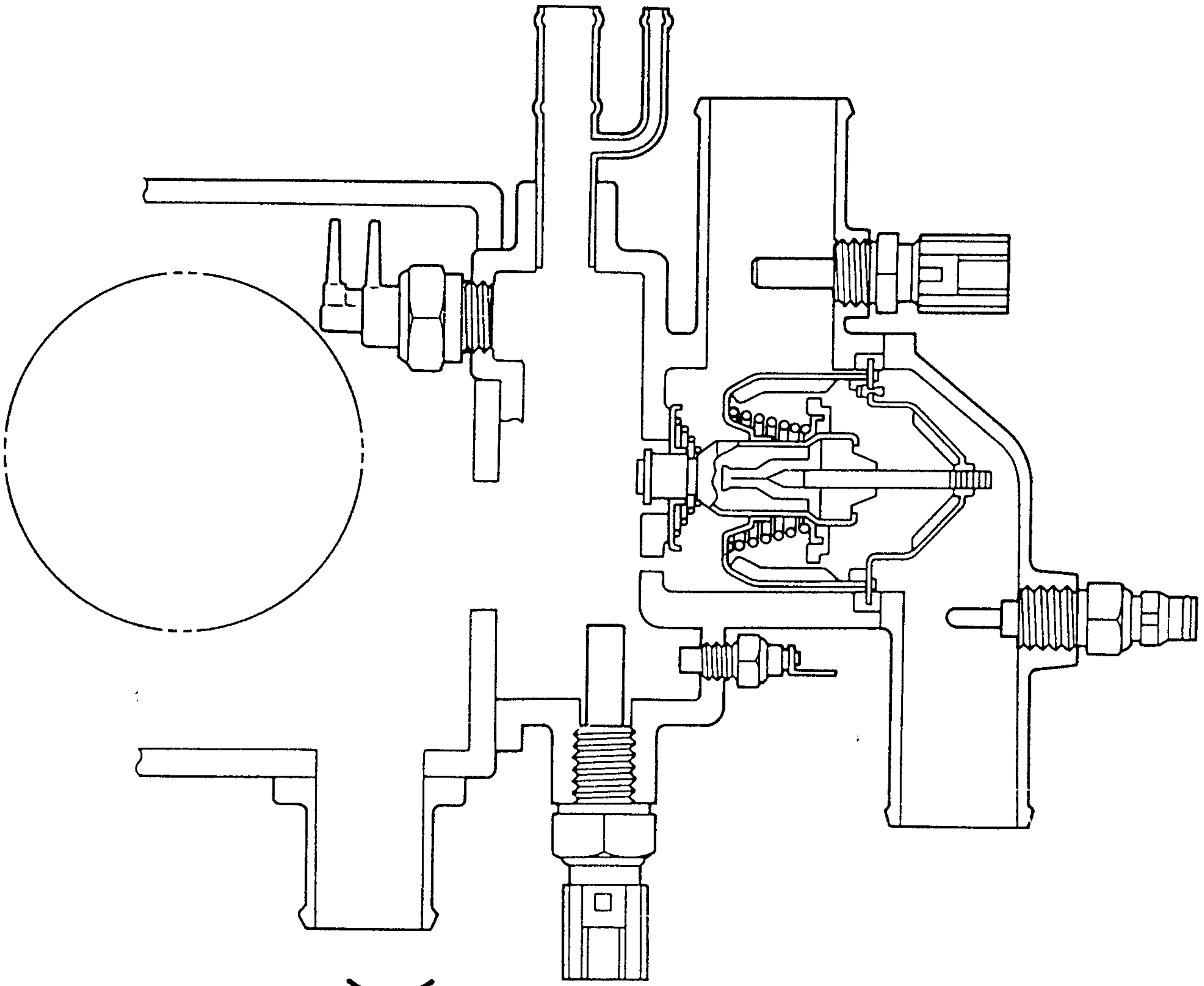

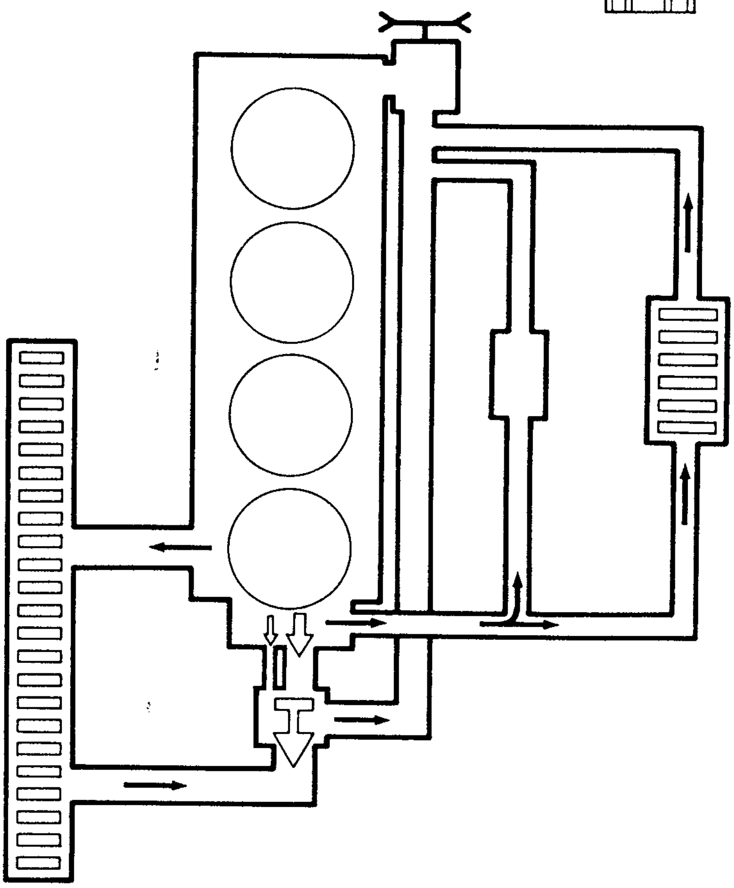

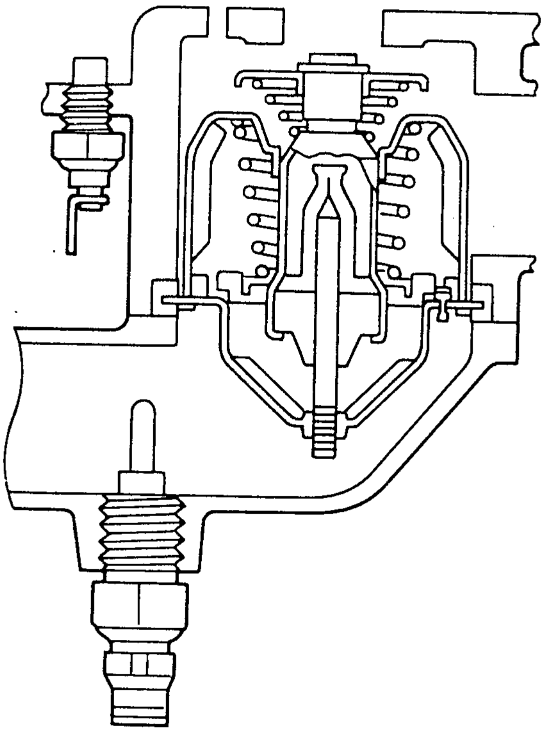

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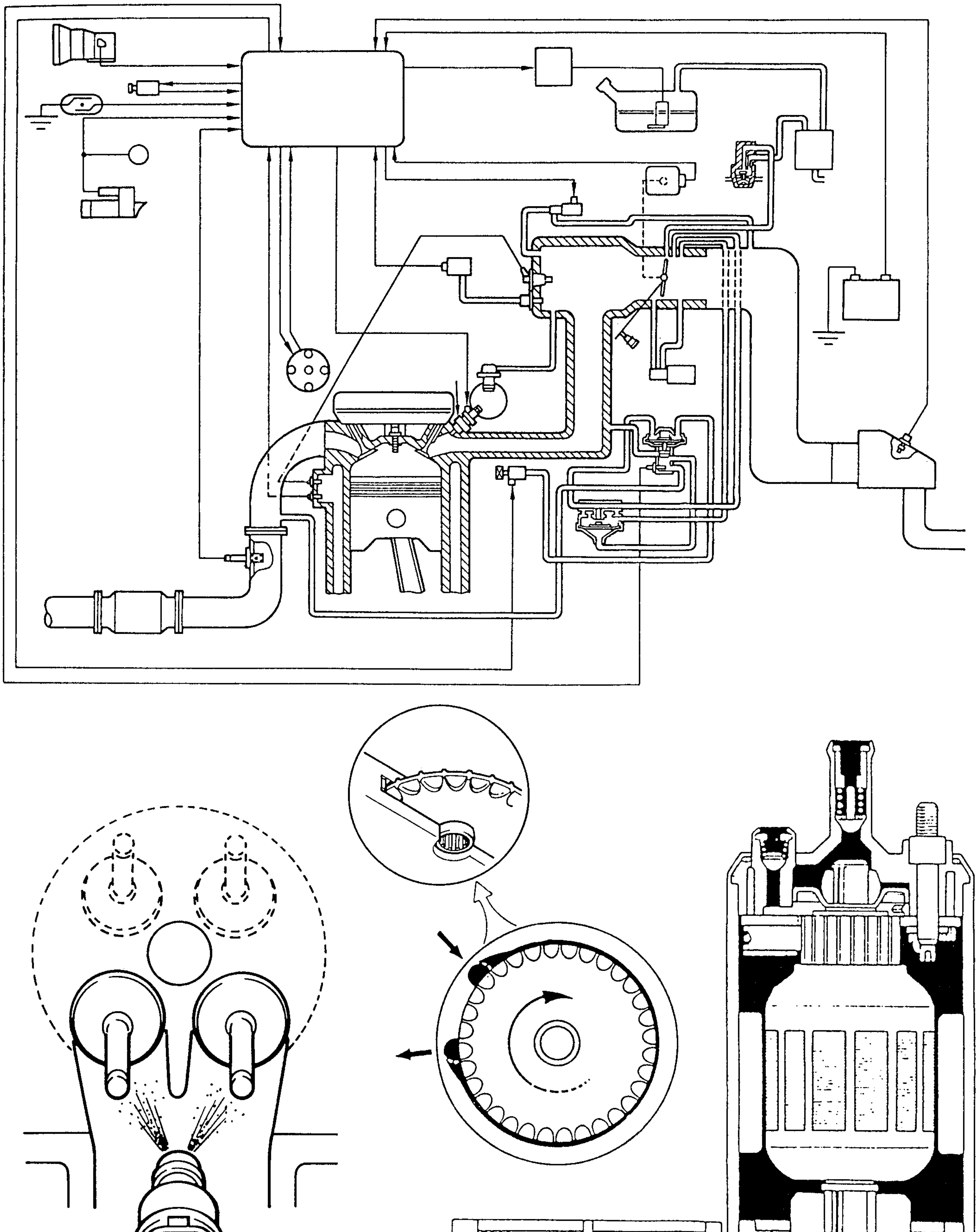

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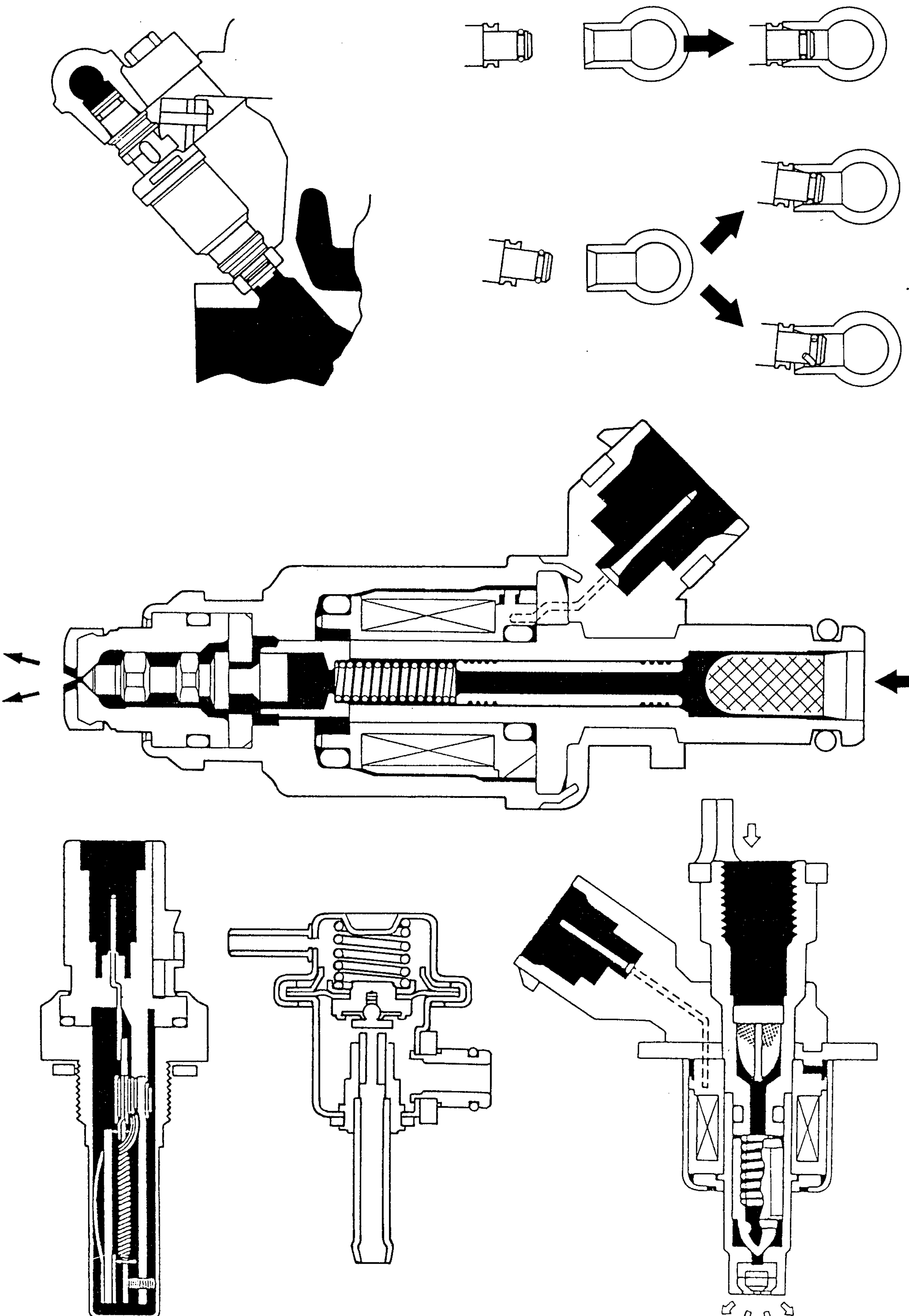

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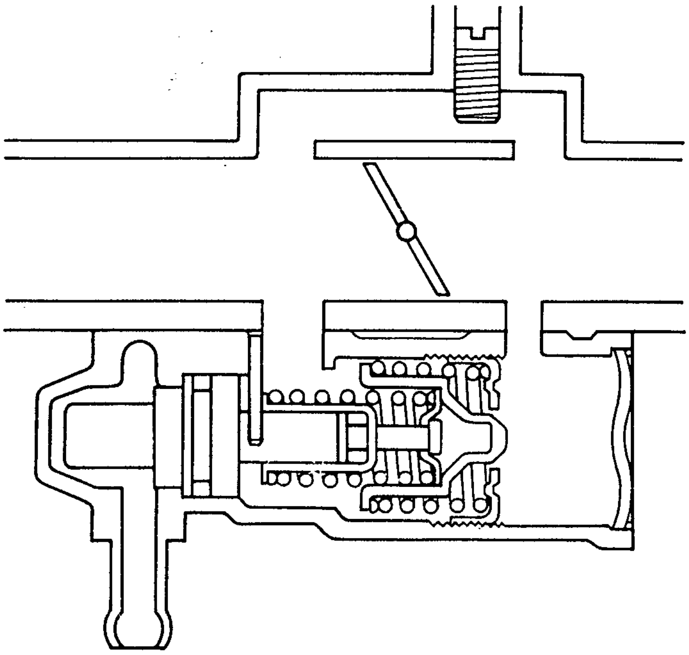
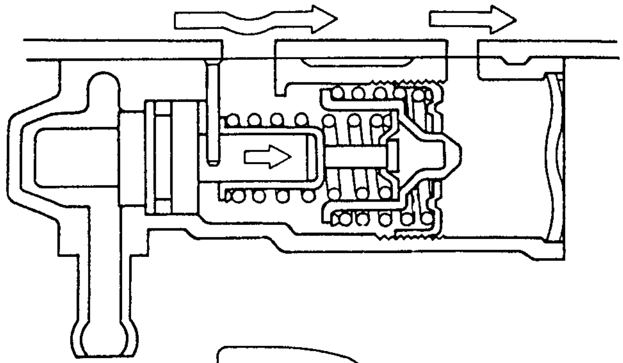
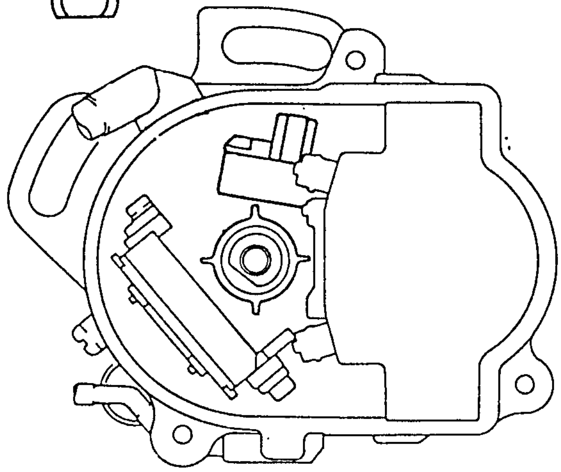
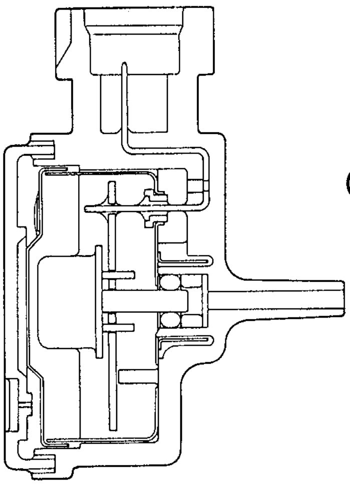
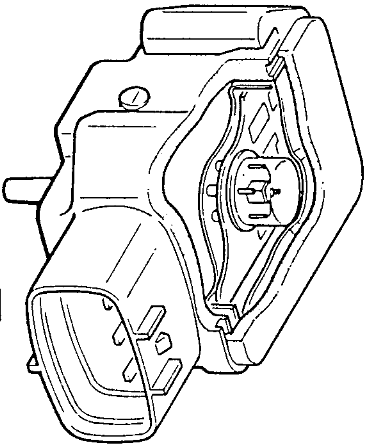
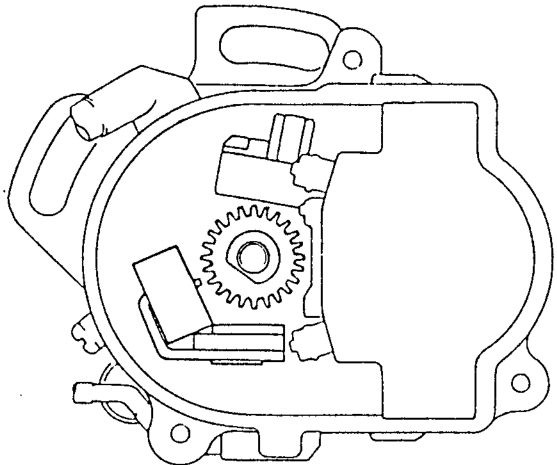
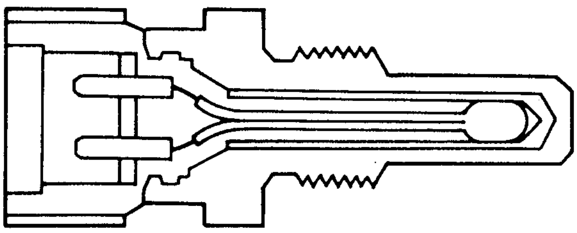
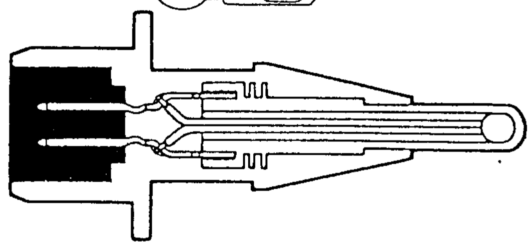
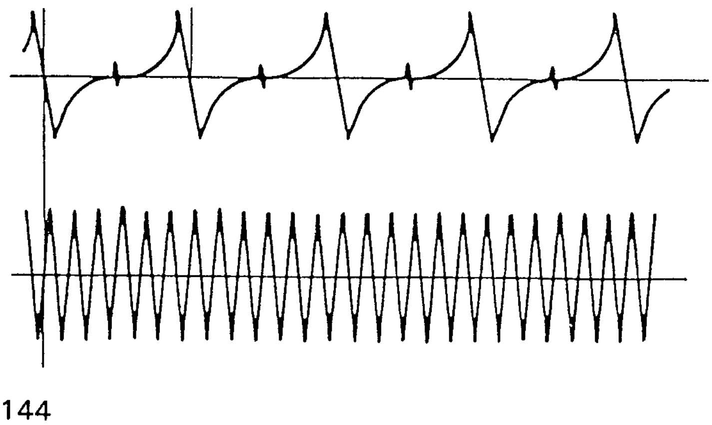
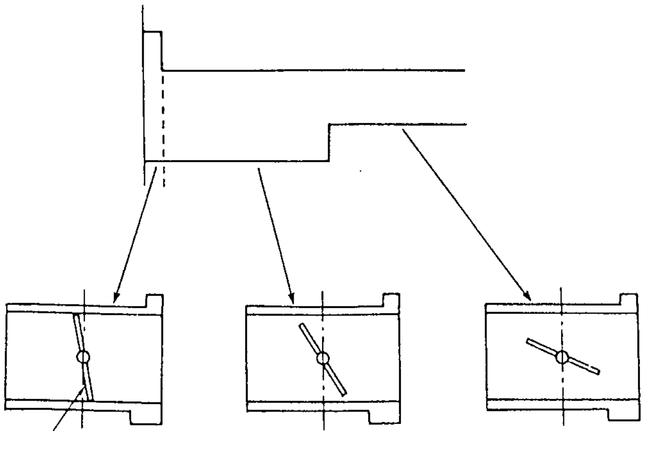

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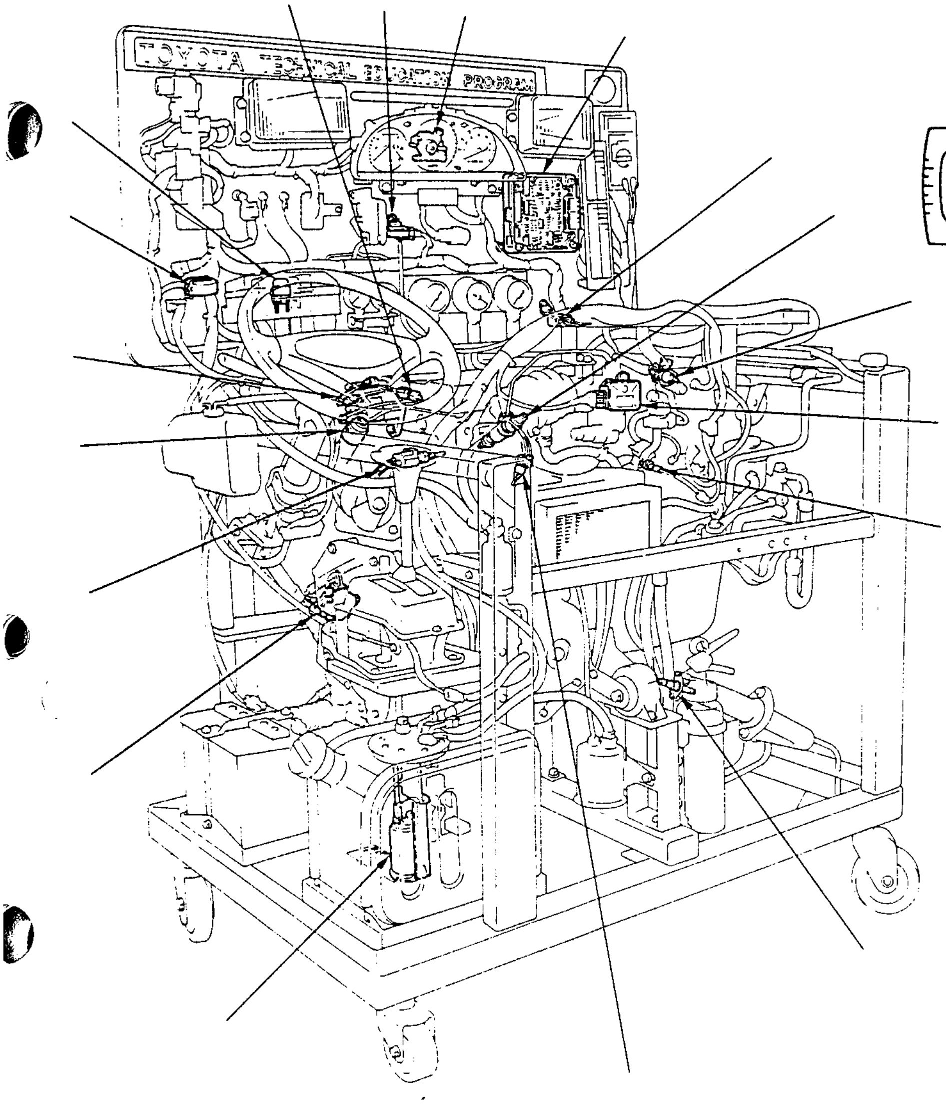

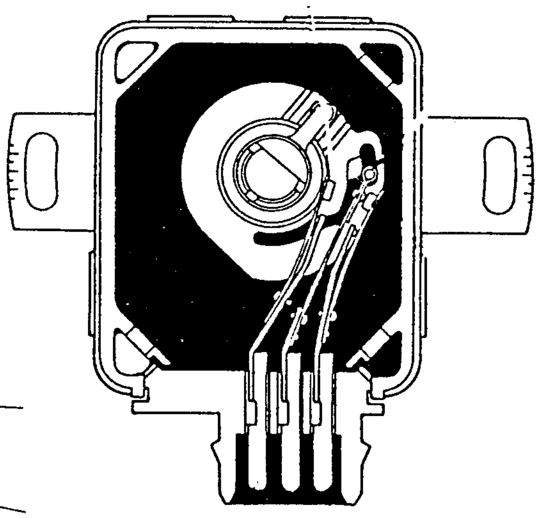

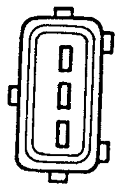

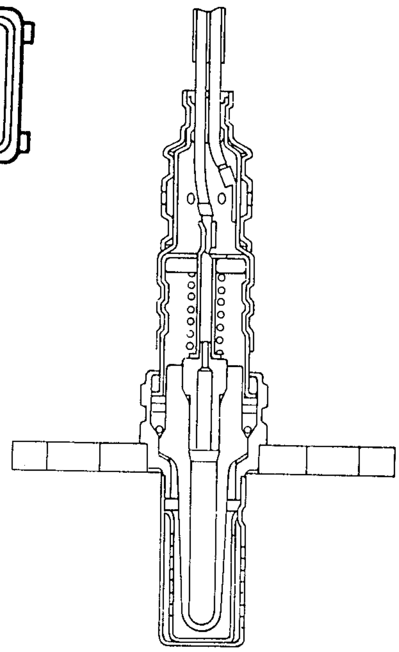

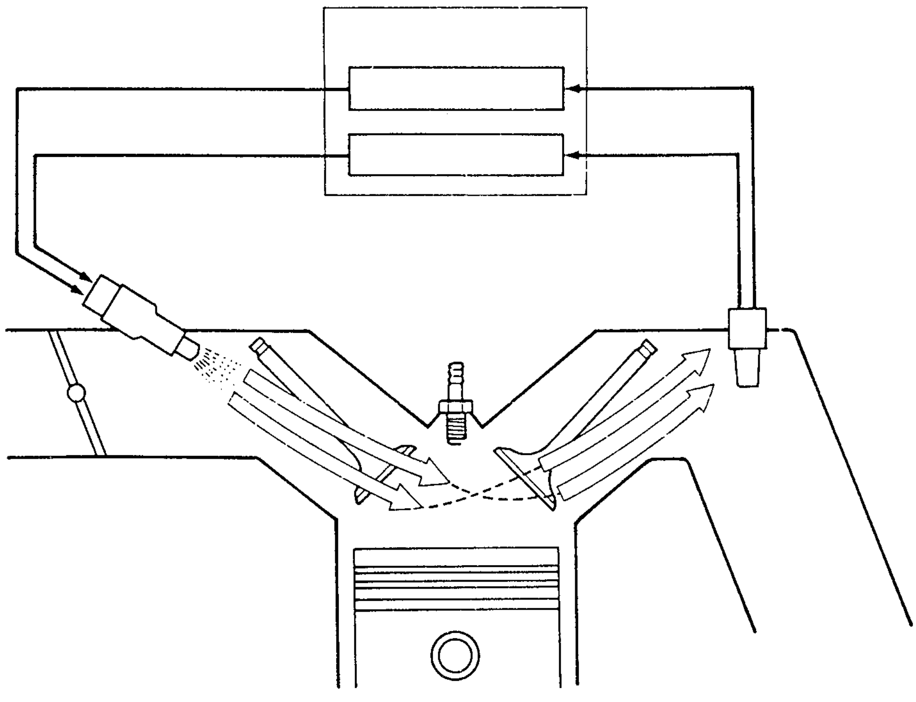

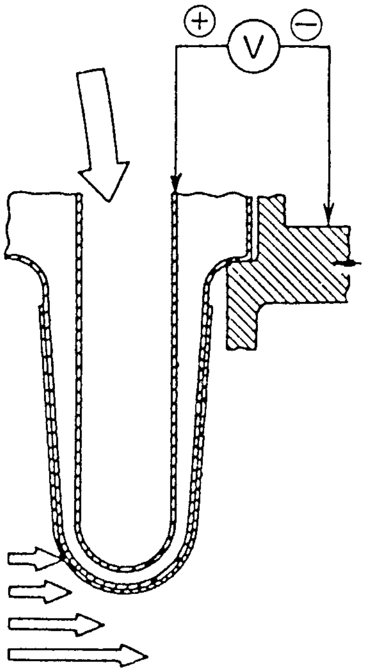

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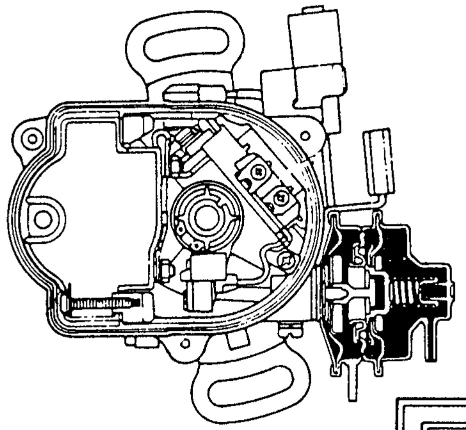

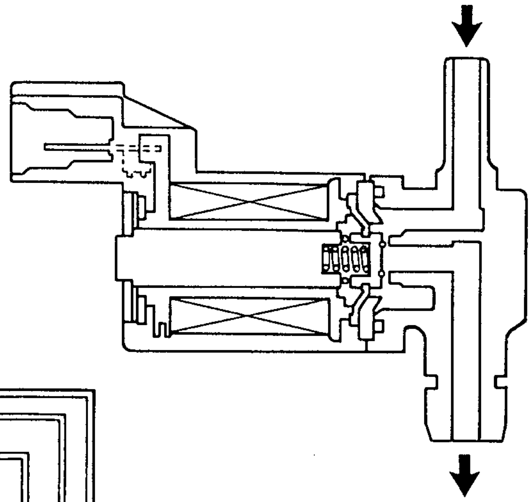

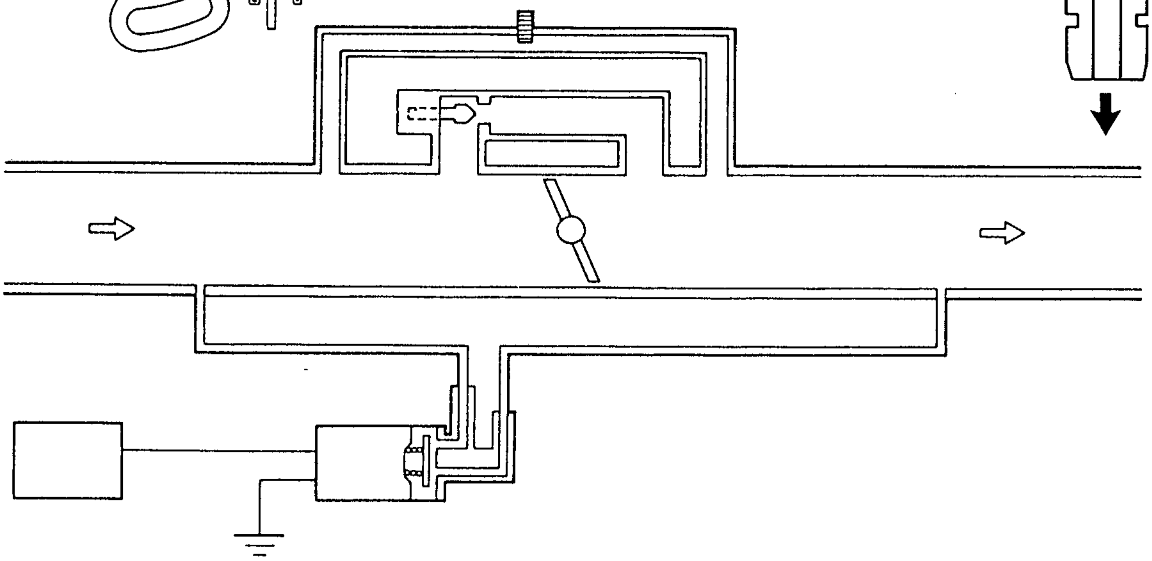

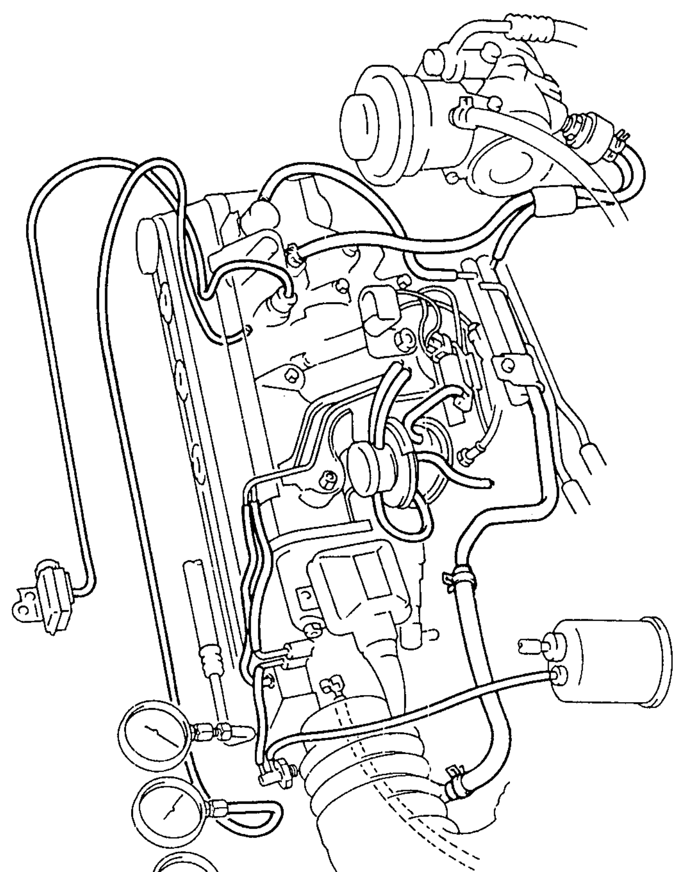

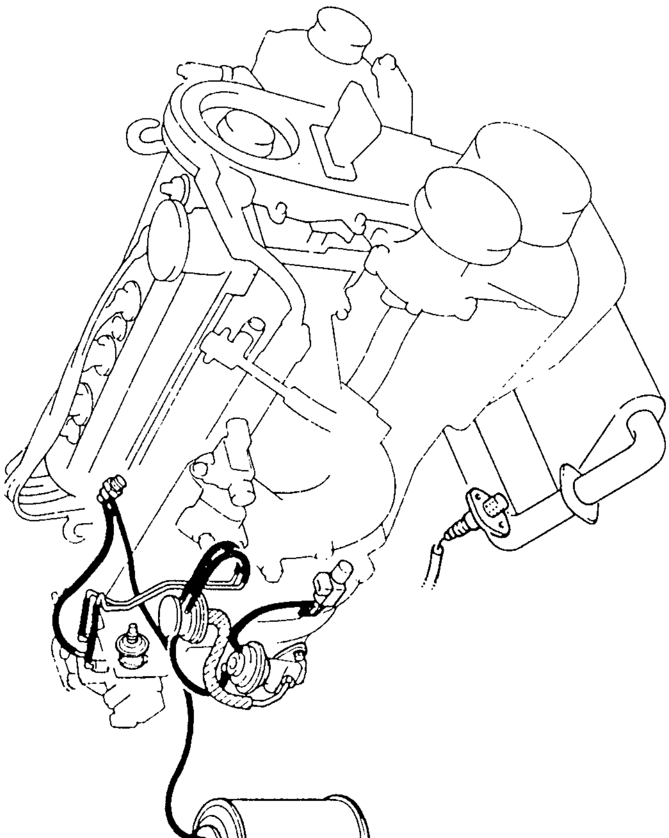

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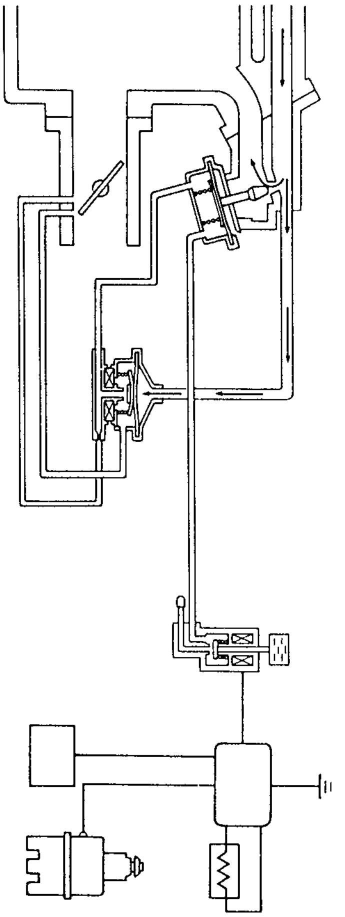

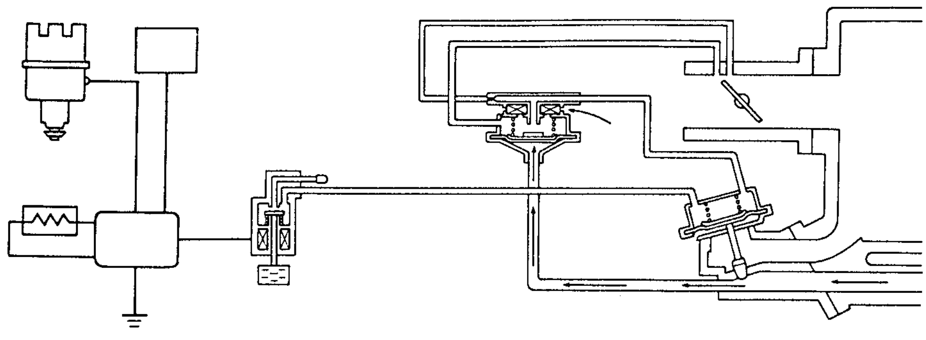

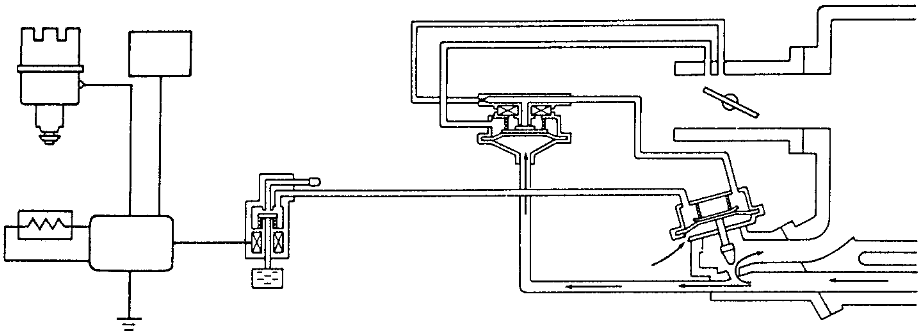

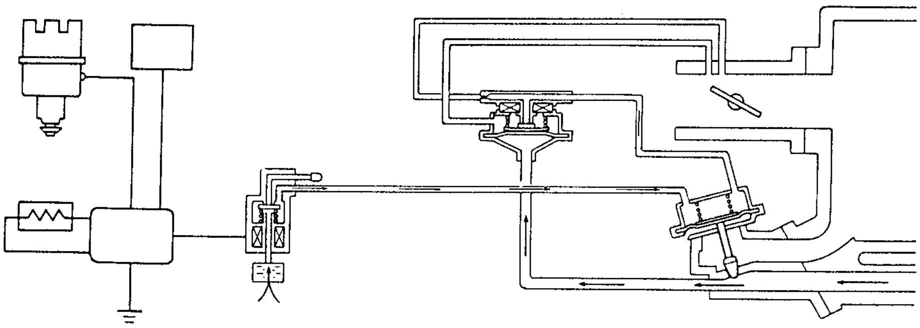

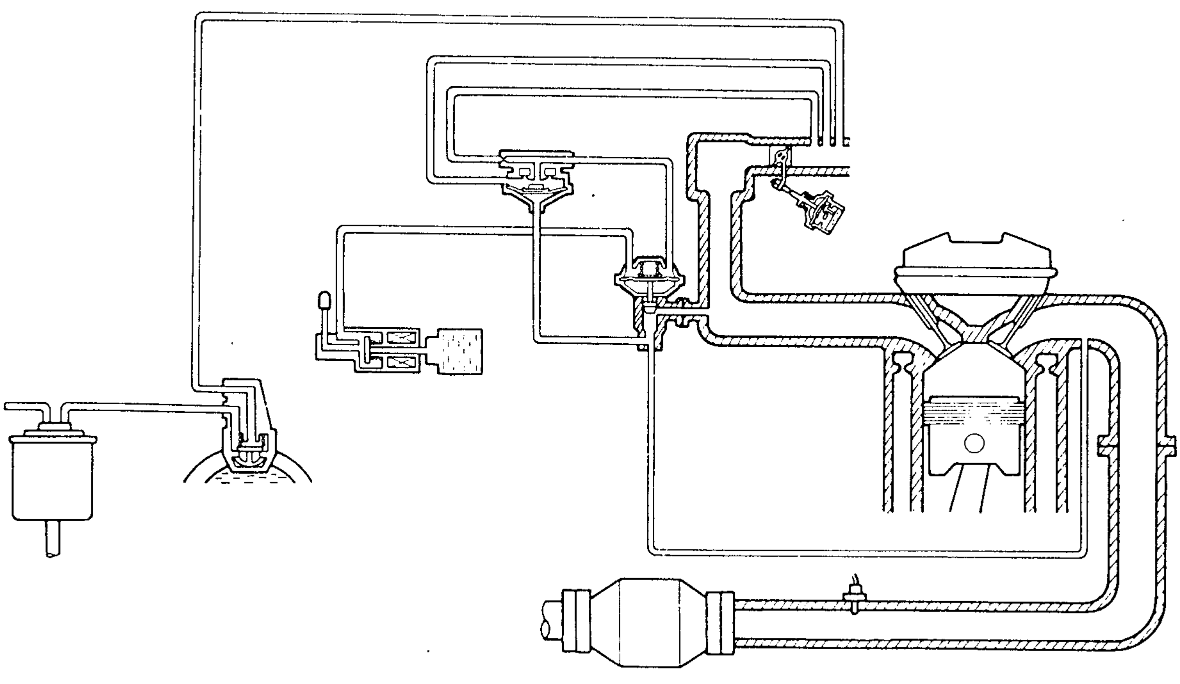

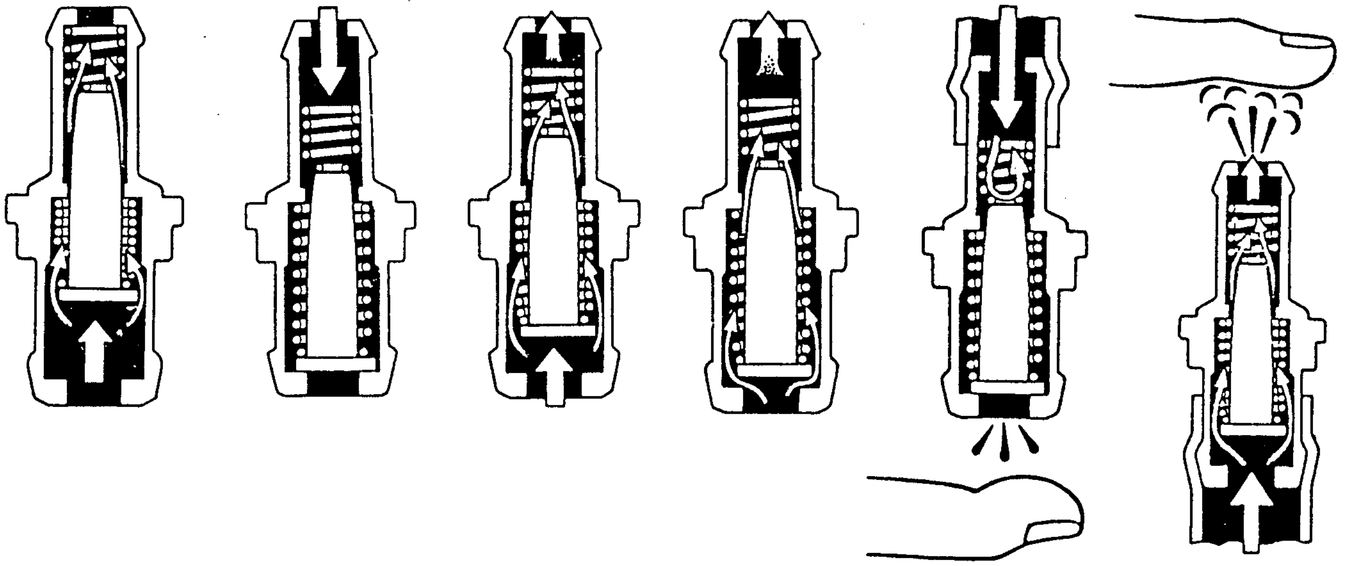

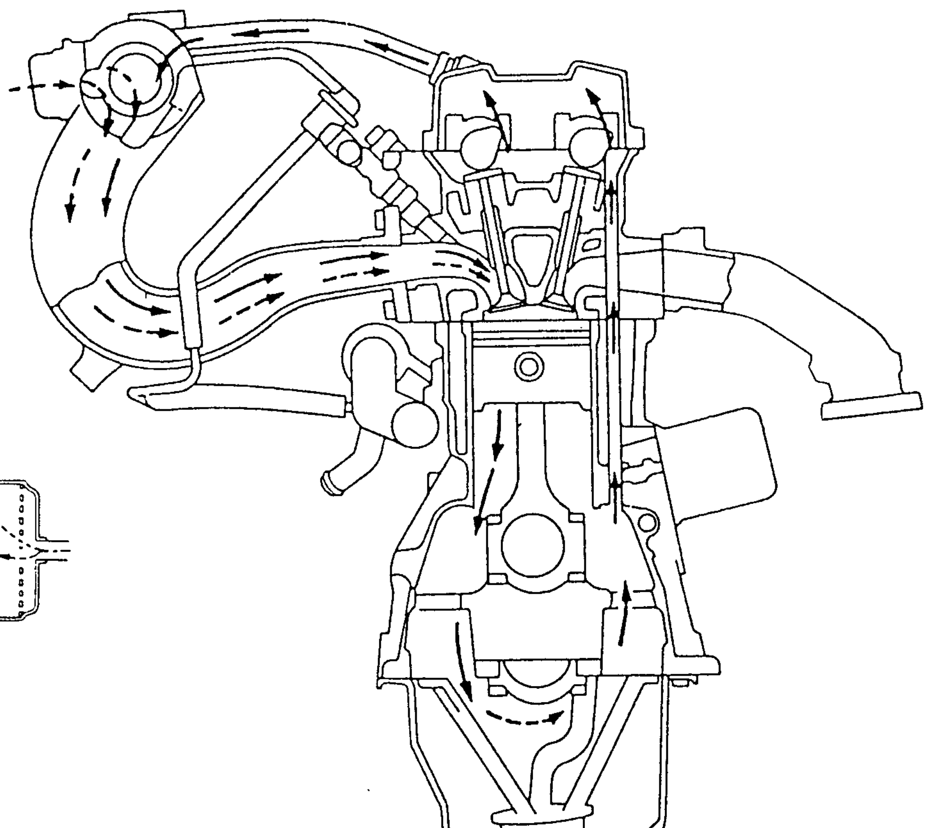

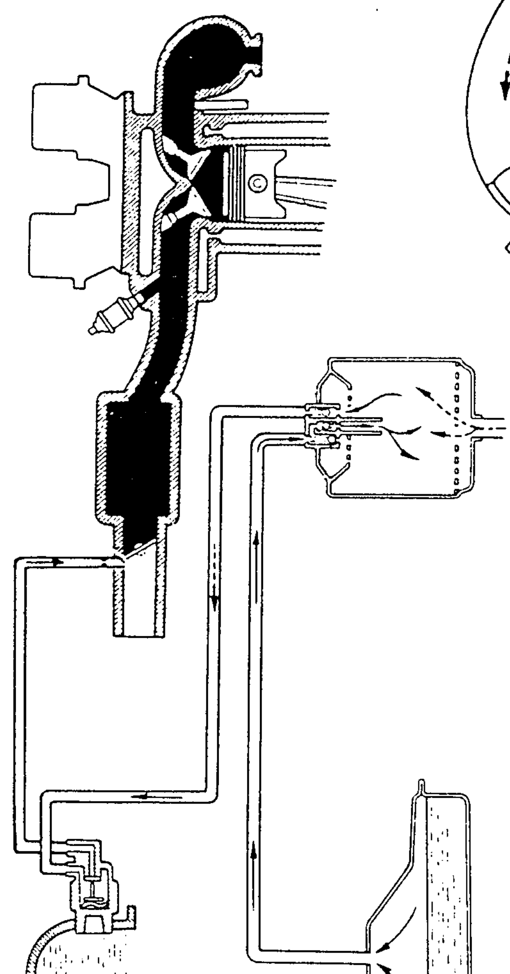

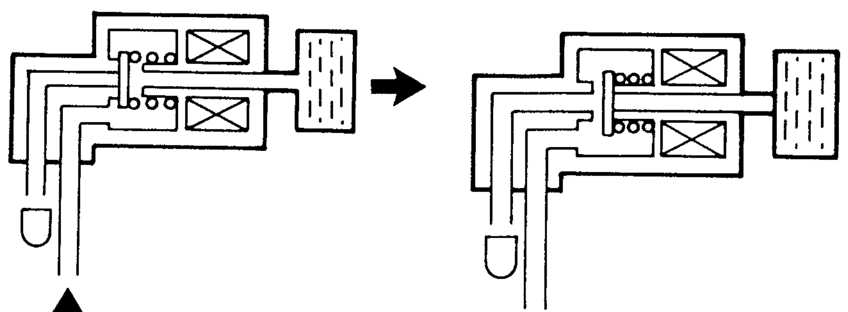

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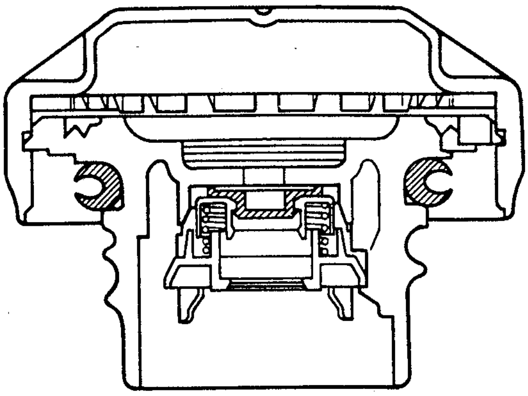

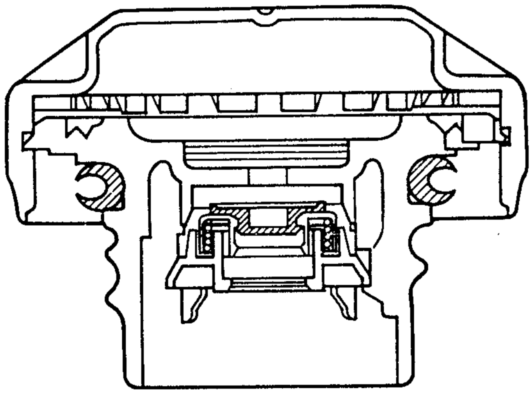

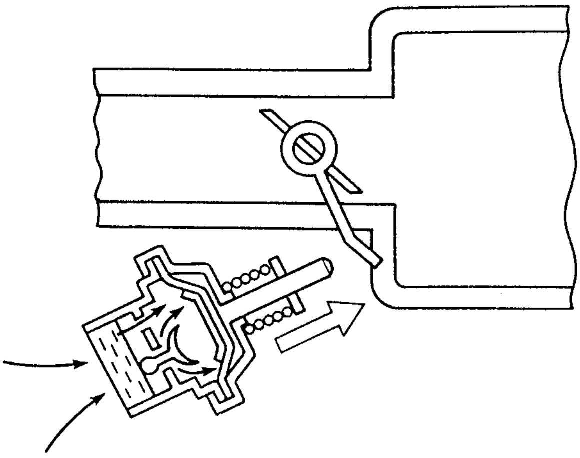

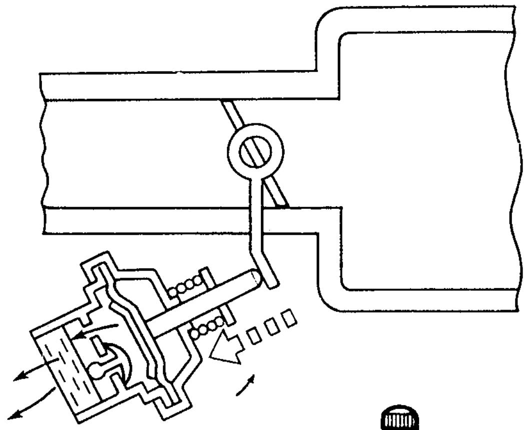

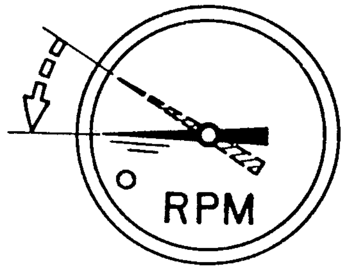
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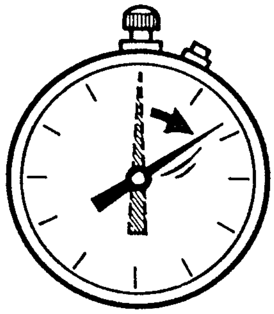

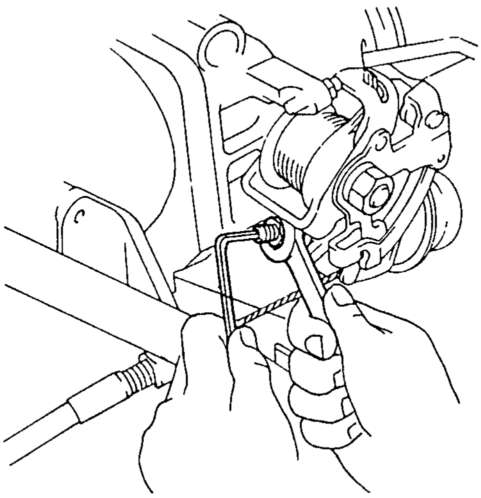

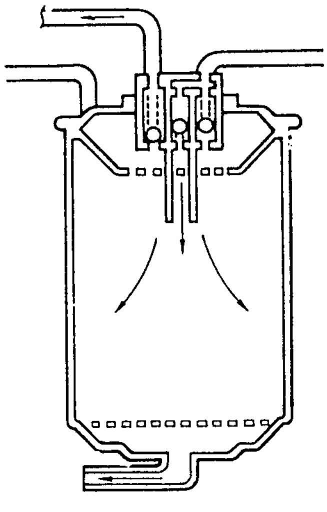

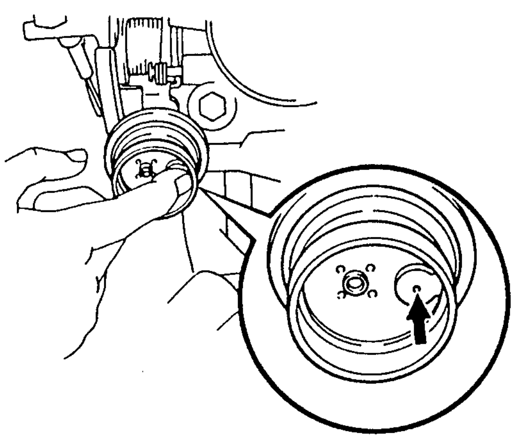

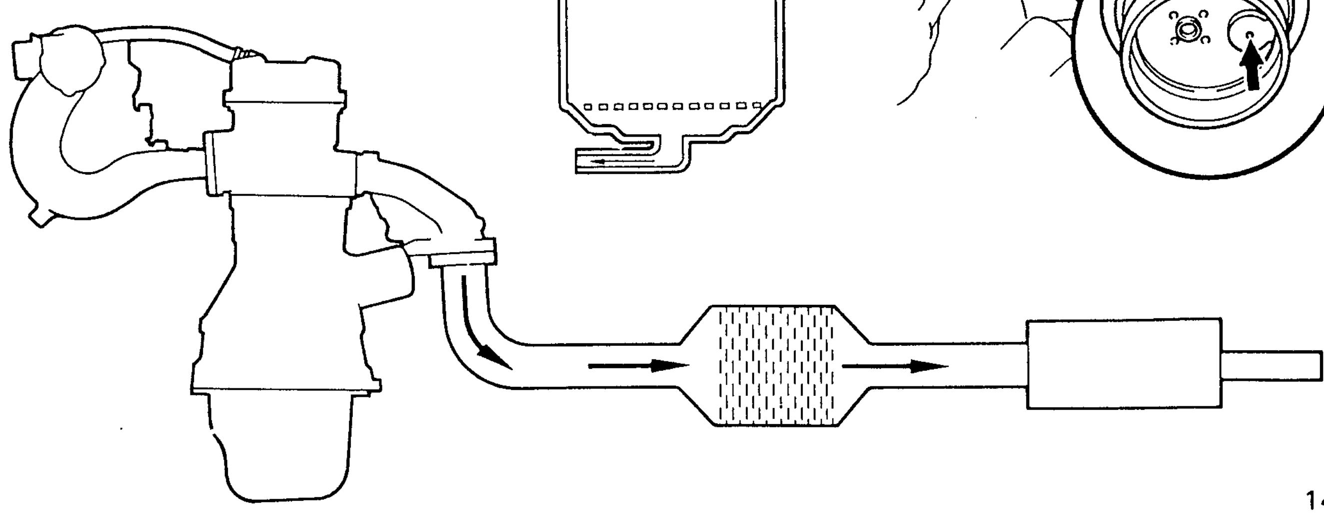

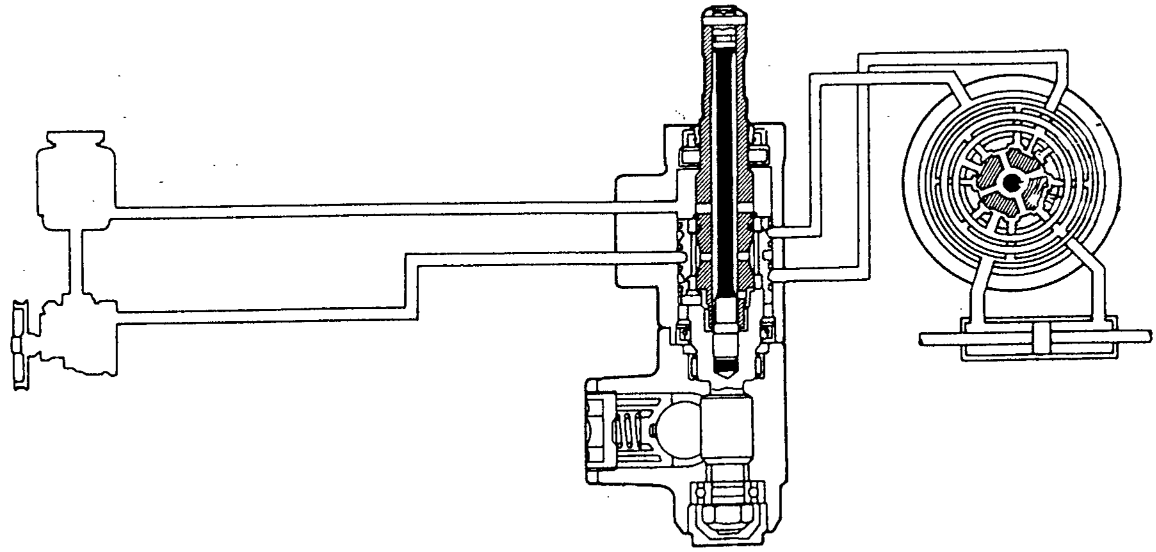

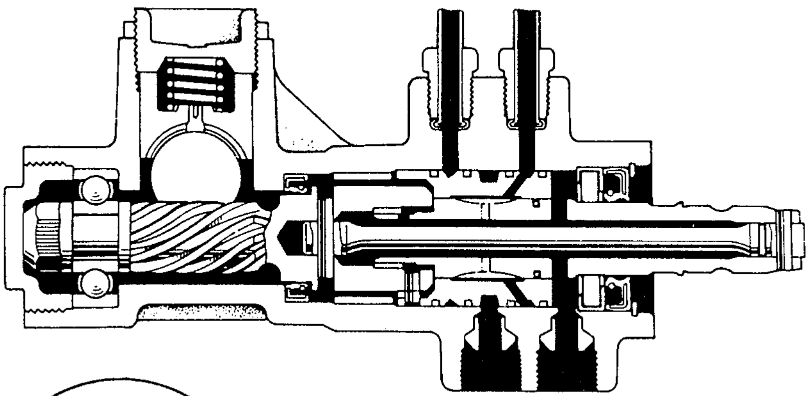

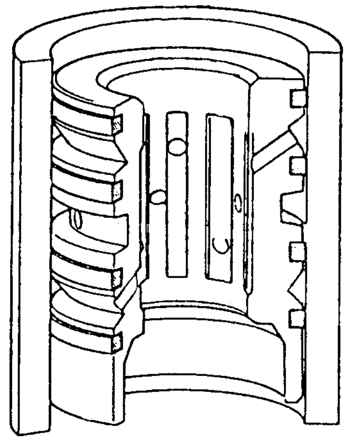

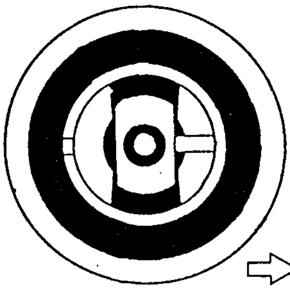

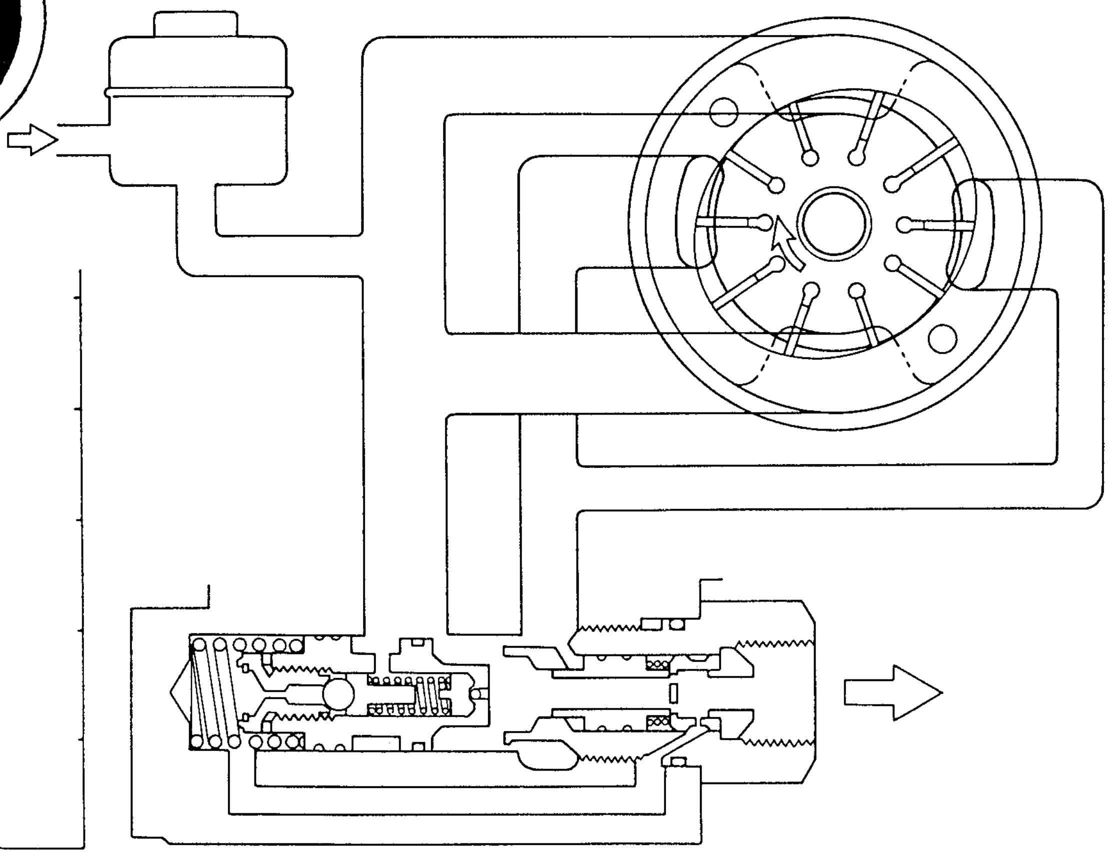

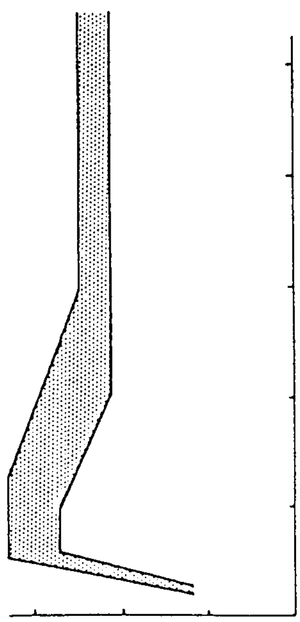

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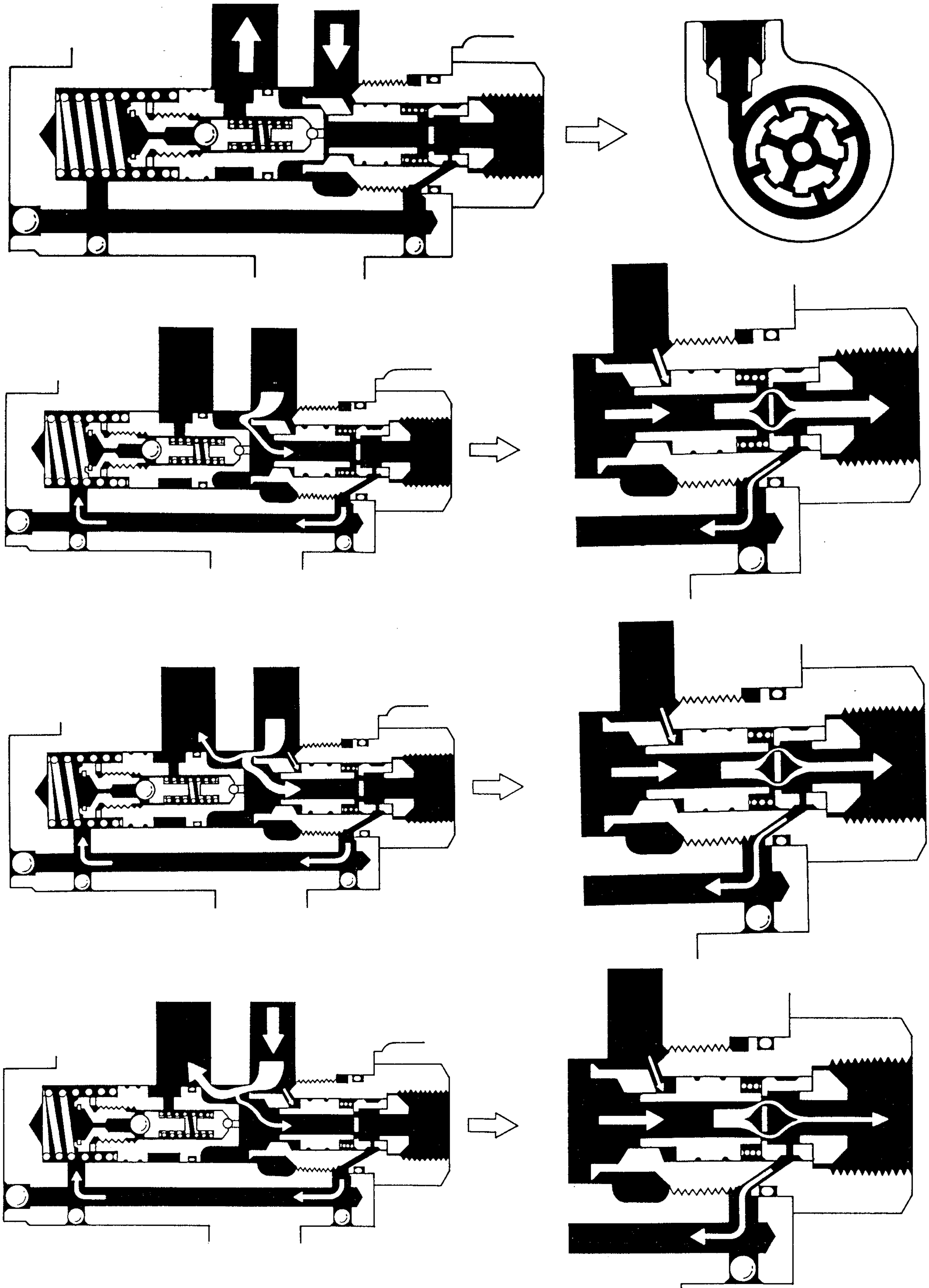

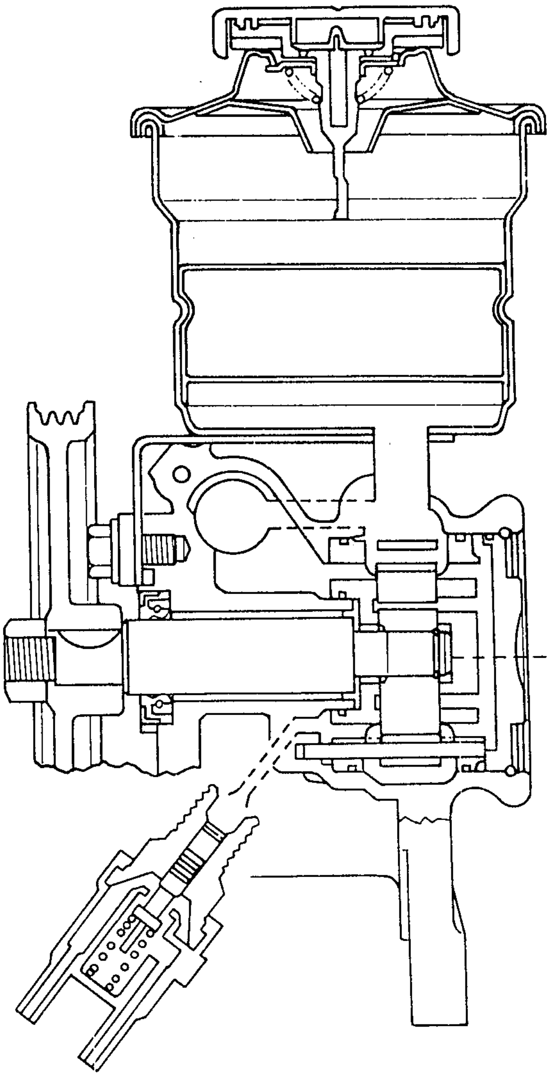

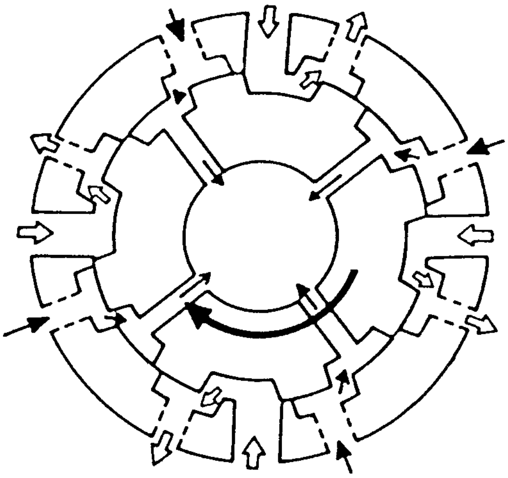

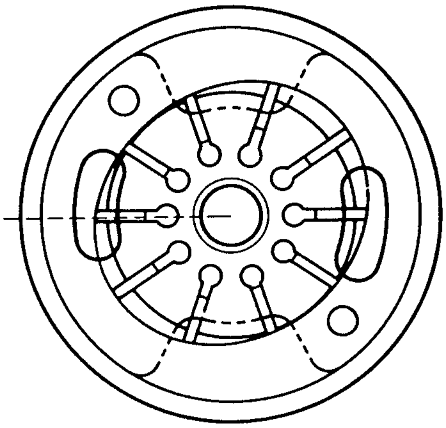

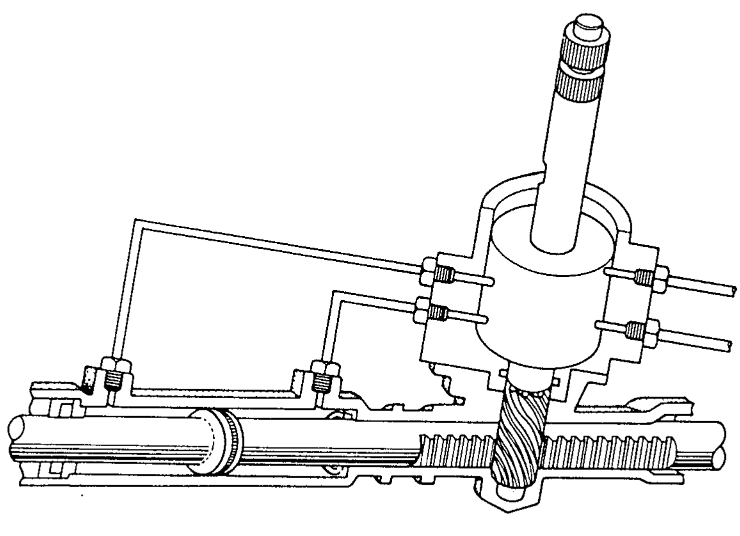

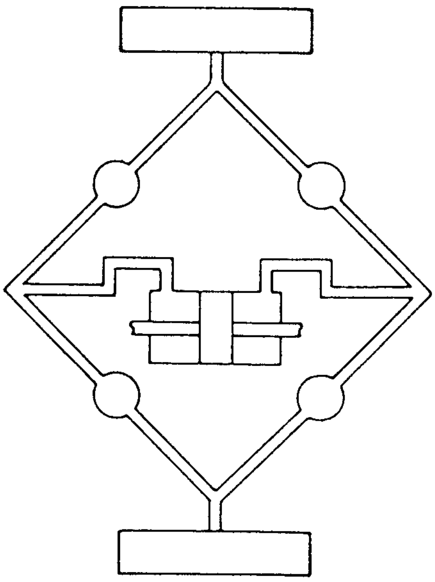

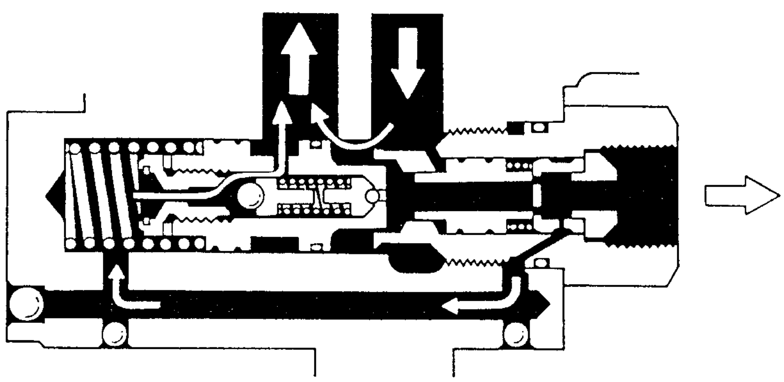

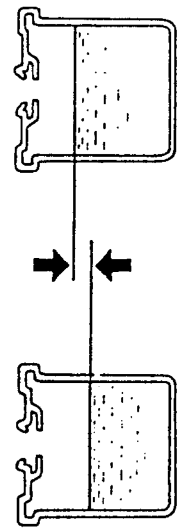

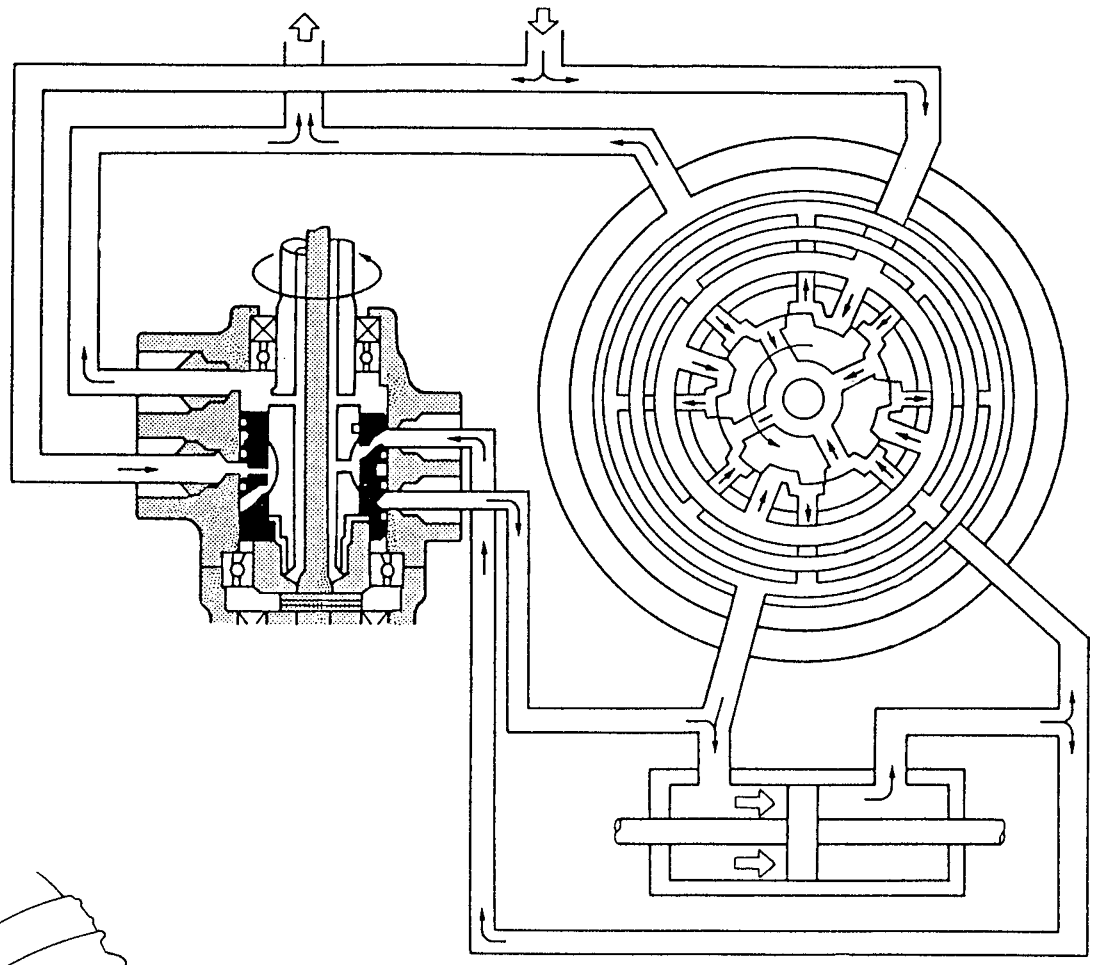

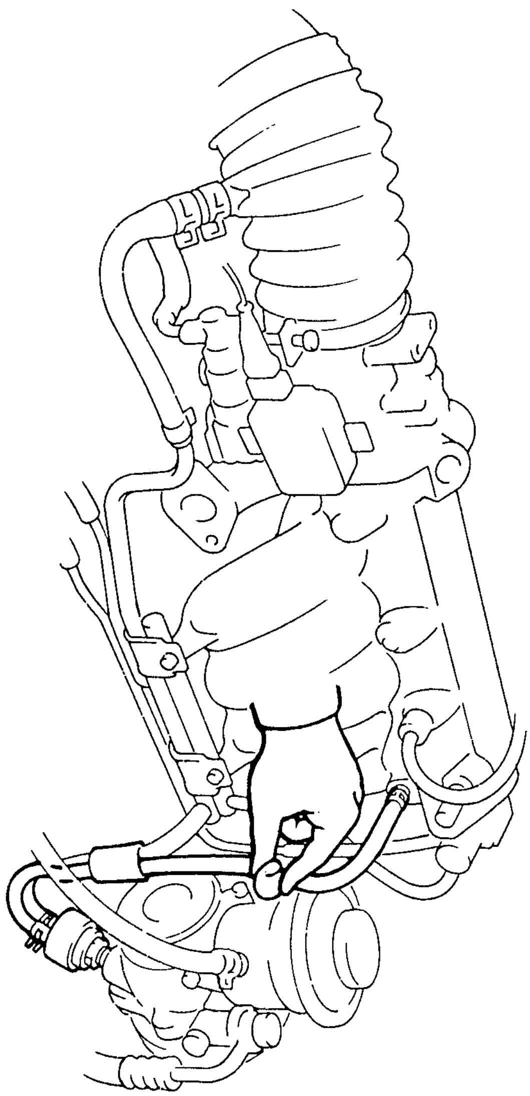

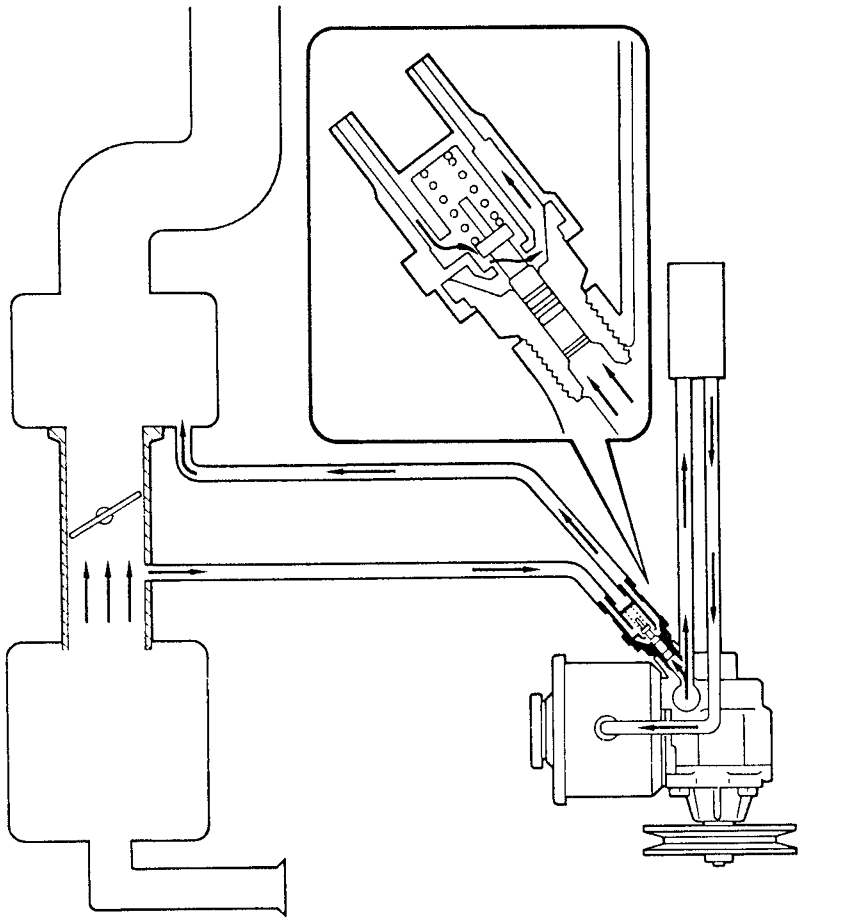

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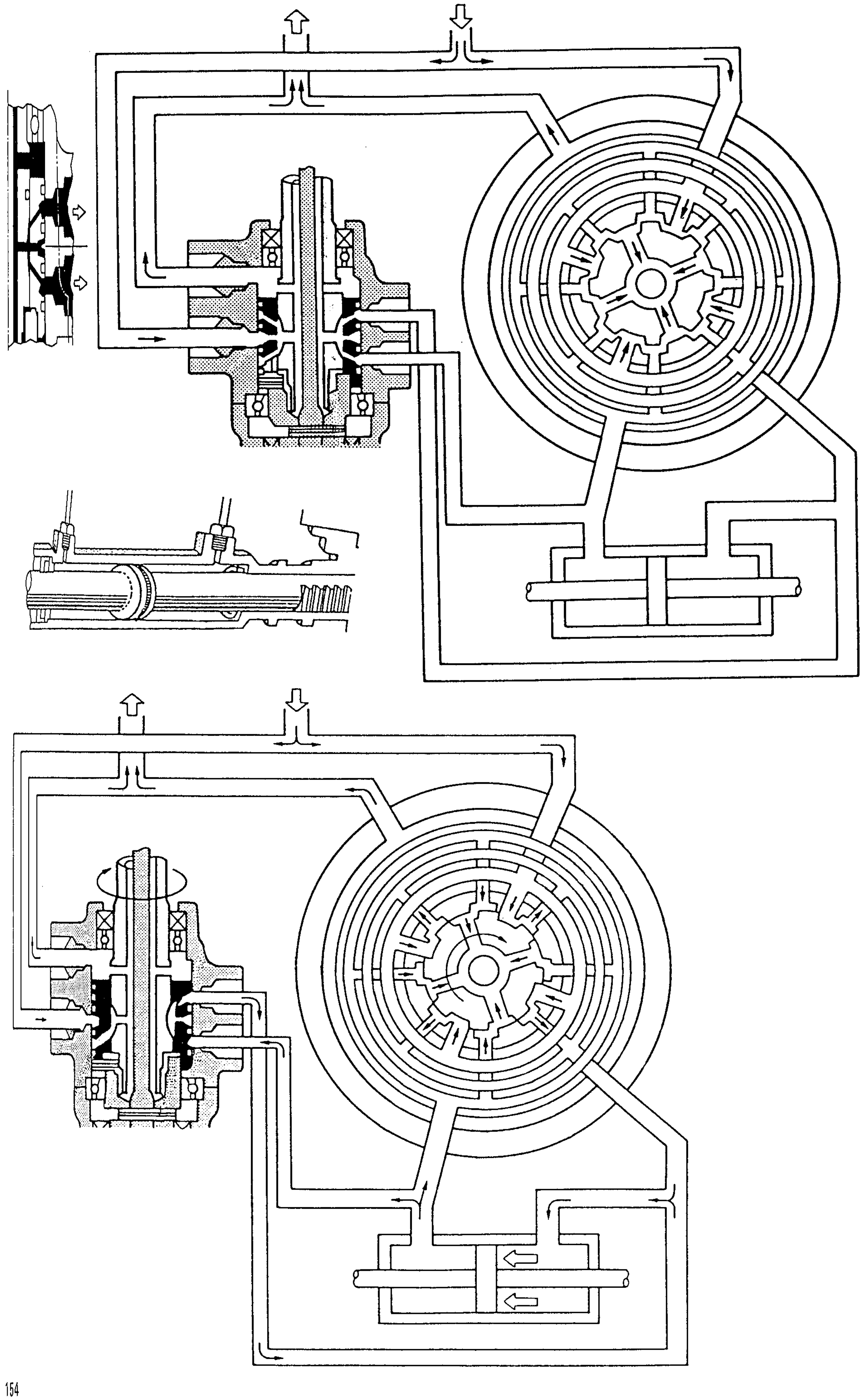

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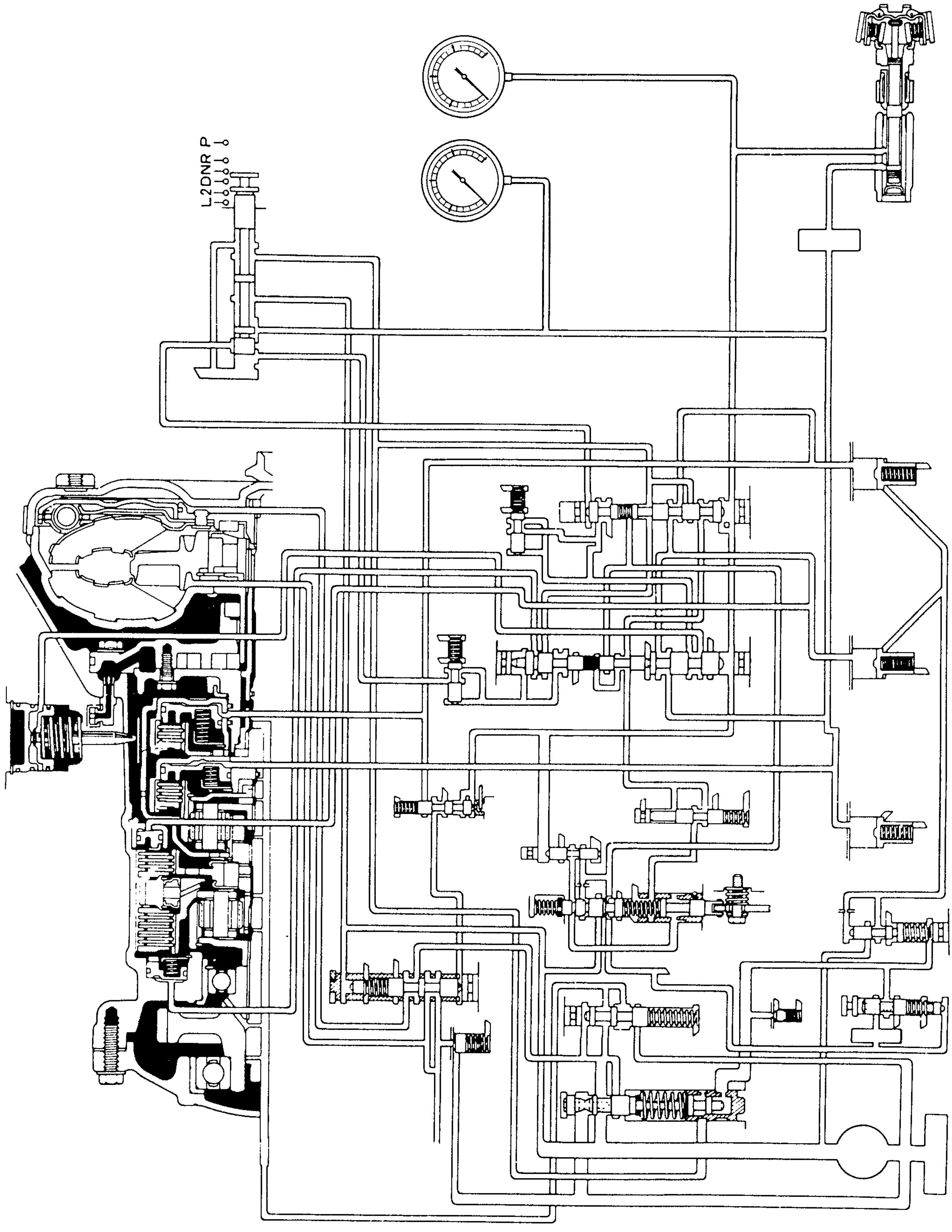
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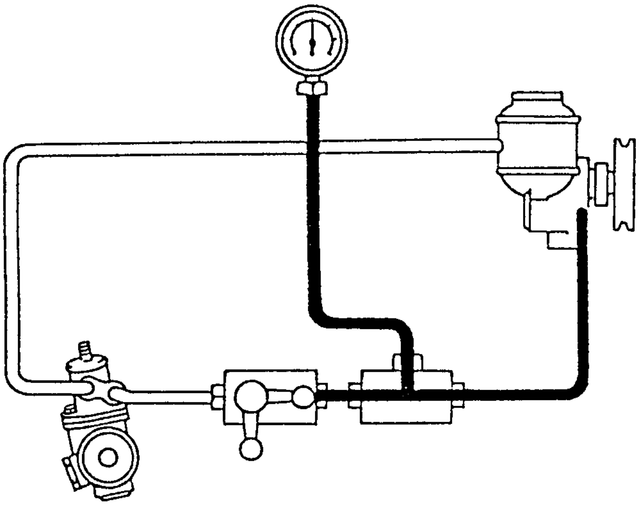

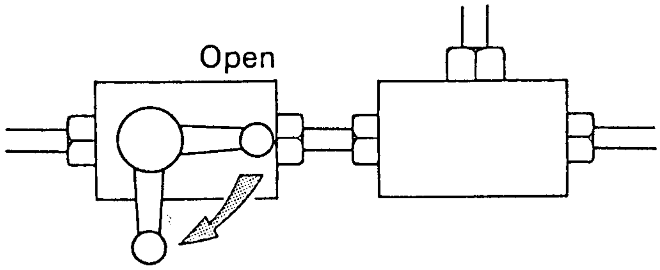

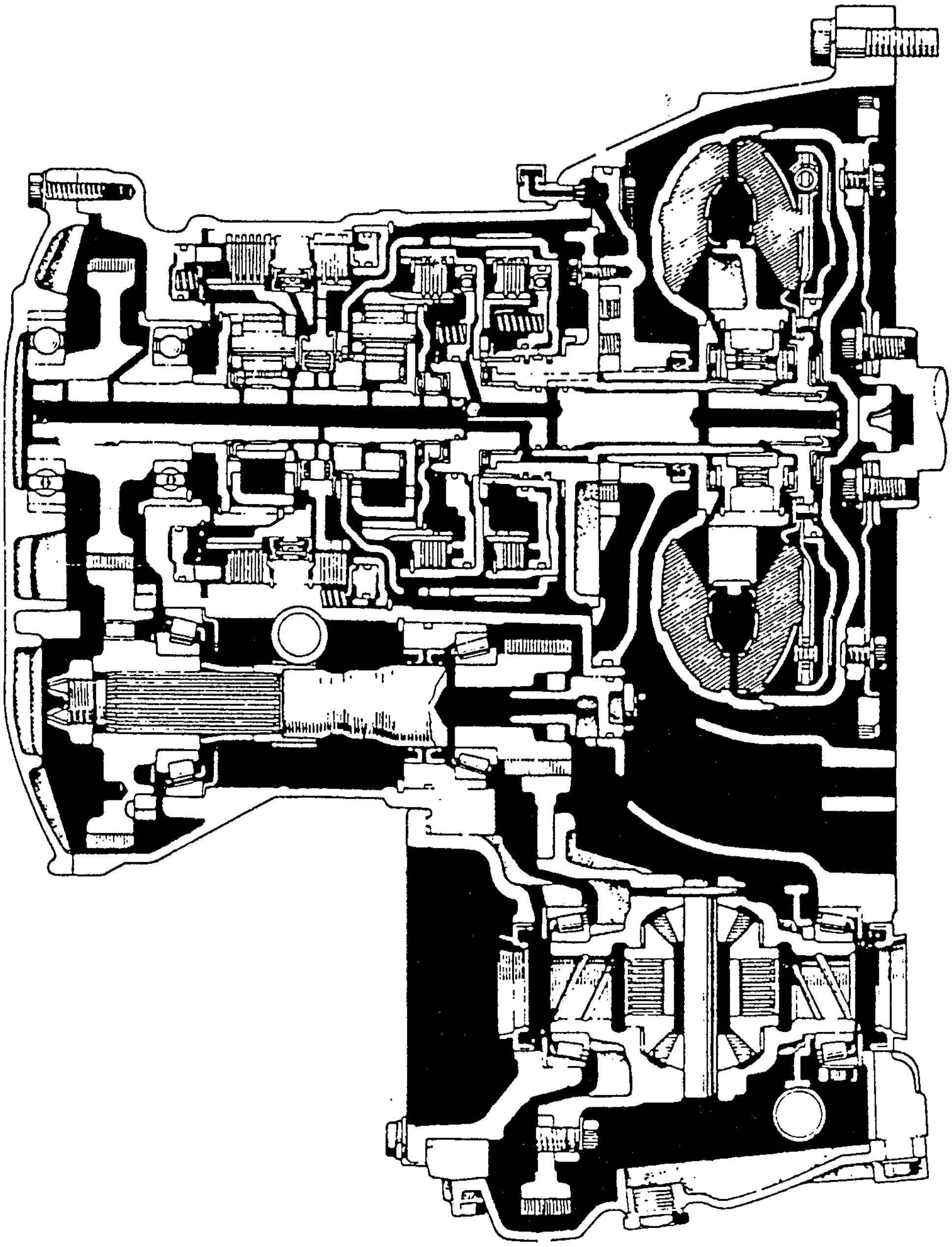

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ELECTRICAL WIRING DIAGRAM FOR 4A-FE ENGINE SIMULATOR