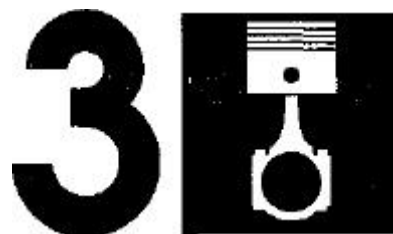


Engine and Engine Rebuilding



UNDERSTANDING THE ENGINE ELECTRICAL SYSTEM

The engine electrical system can be broken down into three separate and distinct systems—(1) the starting system; (2) the charging system; (3) the ignition system.

NOTE: See "Troubleshooting" for typical diagnosis procedures.

Battery and Starting System

The battery is the first link in the chain of mechanisms which work together to provide cranking of the automobile engine. In most modern cars, the battery is a lead-acid electrochemical device consisting of six two-volt (2 V) subsections connected in series so the unit is capable of producing approximately 12 V of electrical pressure. Each subsection, or cell, consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water. The two types of plates are of dissimilar metals. This causes a chemical reaction to be set up, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical appliance such as a lamp or motor. The continued transfer of electrons would eventually convert the sulfuric acid in the electrolyte to water, and make the two plates identical in chemical composition. As electrical energy is removed from the battery, its voltage output tends to drop. Thus, measuring battery voltage and battery electrolyte composition are two ways of checking the ability of the unit to supply power. During the starting of the engine, electrical energy is removed from the battery. However, if the charging circuit is in

good condition and the operating conditions are normal, the power removed from the battery will be replaced by the generator (or alternator) which will force electrons back through the battery, reversing the normal flow, and restoring the battery to its original chemical state.

The battery and starting motor are linked by very heavy electrical cables designed to minimize resistance to the flow of current. Generally, the major power supply cable that leaves the battery goes directly to the starter, while other electrical system needs are supplied by a smaller cable. During the starter operation, power flows from the battery to the starter and is grounded through the car's frame and the battery's negative ground strap.

The starting motor is a specially designed, direct current electric motor capable of producing a very great amount of power for its size. One thing that allows the motor to produce a great deal of power is its tremendous rotating speed. It drives the engine through a tiny pinion gear (attached to the starter's armature), which drives the very large fly-wheel ring gear at a greatly reduced speed. Another factor allowing it to produce so much power is that only intermittent operation is required of it. Thus, little allowance for air circulation is required, and the windings can be built into a very small space.

The starter solenoid is a magnetic device which employs the small current supplied by the starting switch circuit of the ignition switch. This magnetic action moves a plunger which mechanically engages the starter and electrically closes the heavy switch which connects it to the battery. The starting switch circuit consists of the starting switch contained within the ignition switch, a transmission neutral safety switch or clutch pedal

switch, and the wiring necessary to connect these with the starter solenoid or relay.

A pinion, which is a small gear, is mounted to a one-way drive clutch. This clutch is splined to the starter armature shaft. When the ignition switch is moved to the "start" position, the solenoid plunger slides the pinion toward the flywheel ring gear via a collar and spring. If the teeth on the pinion and flywheel match properly, the pinion will engage the flywheel immediately. If the gear teeth butt one another, the spring will be compressed and will force the gears to mesh as soon as the starter turns far enough to allow them to do so. As the solenoid plunger reaches the end of its travel, it closes the contacts that connect the battery and starter and then the engine is cranked.

As soon as the engine starts, the flywheel ring gear begins turning fast enough to drive the pinion at an extremely high rate of speed. At this point, the one-way clutch begins allowing the pinion to spin faster than the starter shaft so that the starter will not operate at excessive speed. When the ignition switch is released from the starter position, the solenoid is de-energized, and a spring contained within the solenoid assembly pulls the gear out of mesh and interrupts the current flow to the starter.

The Charging System

The automobile charging system provides electrical power for operation of the vehicle's ignition and starting systems and all the electrical accessories. The battery serves as an electrical surge or storage tank, storing (in chemical form) the energy originally produced by the engine-driven generator. The system also provides a means of regulating generator output to protect the battery from being overcharged and to avoid excessive voltage to the accessories.

The storage battery is a chemical device incorporating parallel lead plates in a tank containing a sulfuric acid-water solution. Adjacent plates are slightly dissimilar, and the chemical reaction of the two dissimilar plates produces electrical energy when the battery is connected to a load such as the starter motor. The chemical reaction is reversible, so that when the generator is producing a voltage (electrical pressure) greater than that produced by the battery, electricity is forced into the battery, and the battery is returned to its fully charged state.

The vehicle's generator is driven mechanically, through V belts, by the engine crankshaft. It consists of two coils of fine wire, one stationary (the "stator"), and one movable (the "rotor"). The rotor may also be known as the "armature," and consists of fine wire wrapped around an iron core which is mounted on a shaft. The electricity which flows through the two coils of wire (provided initially by the battery in some cases) creates an intense magnetic field around both rotor and stator, and the interaction between the two fields creates voltage, allowing the generator to power the accessories and charge the battery.

There are two types of generators; the earlier is the direct current (DC) type. The current produced by the DC generator is generated in the armature and carried off the spinning armature by stationary brushes contacting the commutator. The commutator is a series of smooth metal contact plates on the end of the armature. The commutator plates, which are separated from one another by a very short gap, are connected to the armature circuits so that current will flow in one direction only in the wires carrying the generator output. The generator stator consists of two stationary coils of wire which draw some of the output current of the generator to form a powerful magnetic field and create the interaction of fields which generates the voltage. The generator field is wired in series with the regulator.

Newer automobiles use alternating current generators or "alternators" because they are more efficient, can be rotated at higher speeds, and have fewer brush problems. In an alternator, the field rotates while all the current produced passes only through the stator windings. The brushes bear against continuous slip rings rather than a commutator. This causes the current produced to periodically reverse the direction of its flow. Diodes (electrical one-way switches) block the flow of current from traveling in the wrong direction. A series of diodes is wired together to permit the alternating flow of the stator to be converted to a pulsating, but unidirectional flow at the alternator output. The alternator's field is wired in series with the voltage regulator.

The regulator consists of several circuits. Each circuit has a core, or magnetic coil of wire, which operates a switch. Each switch is connected to ground through one or more resistors. The coil of wire responds directly to system voltage. When the voltage reaches the

required level, the magnetic field created by the winding of wire closes the switch and inserts a resistance into the generator field circuit, thus reducing the output. The contacts of the switch cycle open and close many times each second to precisely control voltage.

While alternators are self-limiting as far as maximum current is concerned, DC generators employ a current regulating circuit which responds directly to the total amount of current flowing through the generator circuit rather than to the output voltage. The current regulator is similar to the voltage regulator except that all system current must flow through the energizing coil on its way to the various accessories.

SAFETY PRECAUTIONS

Observing these precautions will ensure safe handling of the electrical system components, and will avoid damage to the vehicle's electrical system:

1. Observing these precautions will ensure safe handling of the electrical system components, and will avoid damage to the vehicle's electrical system:
2. Be *absolutely* sure of the polarity of a booster battery before making connections. Connect the cables positive to positive, and negative to negative. Connect positive cables first and then make the last connection to a ground on the body of the booster vehicle so that arcing cannot ignite hydrogen gas that may have accumulated near the battery. Even momentary connection of a booster battery with the polarity reserved will damage alternator diodes.
3. Disconnect both vehicle battery cables before attempting to charge a battery.
4. Never ground the alternator or generator output or battery terminal. Be cautious when using metal tools around a battery to avoid creating a short circuit between the terminals.
5. Never ground the field circuit between the alternator and regulator.
6. Never run an alternator or generator without load unless the field circuit is disconnected.
7. Never attempt to polarize an alternator.
8. Keep the regulator cover in place when taking voltage and current limiter readings.
9. Use insulated tools when adjusting the regulator.
10. Whenever DC generator-to-regulator wires have been disconnected, the generator

must be repolarized. To do this with an externally grounded, light duty generator, momentarily place a jumper wire between the battery terminal and the generator terminal of the regulator. With an internally grounded heavy duty unit, disconnect the wire to the regulator field terminal and touch the regulator battery terminal with it.

11. Never disconnect components with the ignition ON.

The Conventional Ignition System

MECHANICAL OPERATION

The distributor is geared to the camshaft of the engine, and in the case of a Chevrolet V-8, is also used to drive the engine oil pump in addition to its usual "spark sorting" duties. As the distributor shaft turns, the lobes of the distributor cam actuate the breaker point set, causing the points to open and close. The points are attached to the breaker plate, which on models using a vacuum advance system, is capable of rotating around the distributor shaft a small amount. This rotation of the breaker plate changes the relationship between the distributor shaft and the point set. The change in this relationship alters the time at which the points open, thereby changing the ignition timing. The amount of the ignition timing change, in degrees, is controlled by the vacuum advance diaphragm which senses the engine load through engine vacuum changes. The vacuum advance diaphragm is controlled by either "ported" or "manifold" vacuum. A ported vacuum source is one that is located above the throttle plates of the carburetor, whereas a manifold vacuum source is located below the carburetor throttle plates (or attached to a fitting directly on the intake manifold). At a given open throttle position, the vacuum signal to the distributor will be basically the same, whether it is from a ported or manifold vacuum source. During idle, however, manifold vacuum is high; ported is low. As vacuum to the advance unit is increased, the amount of degrees which the unit moves (advances) the breaker plate is also increased, and vice-versa (retard). It is because of this that you must disconnect the vacuum advance unit before adjusting the initial timing on engines which have a manifold vacuum source to the distributor. The most important function of the vacuum advance is to advance the ignition timing during cruise conditions for improved fuel

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economy. As engine load increases, engine vacuum drops, which allows the ignition timing to retard, thereby preventing detonation due to over-advanced timing. Some special high performance models such as the 427/L88 do not have vacuum advance systems. Fuel economy was not designed into such "off-road" engines.

NOTE: Do not remove the vacuum advance for street usage—fuel economy will suffer, along with engine performance if not set-up properly.

Another timing feature of the distributor is the centrifugal advance mechanism. This mechanism alters the ignition timing by rotating the distributor cam (a small amount) independent of the distributor shaft. Again, the relationship between the distributor shaft and the point opening is changed due to this rotation. The centrifugal advance mechanism consists basically of two small springs and two specially shaped weights attached to both the distributor cam and the shaft. These components are mounted underneath the ignition rotor. Instead of vacuum, this mechanism uses engine rpm as a guide for advancing the ignition timing. As engine rpm (and distributor shaft rpm) increases, the weights are moved gradually outward (against the spring tension) by centrifugal force. As the weights move outward, the distributor cam is moved to a more advanced timing position. When the engine rpm drops, the springs gradually pull the weights back to their low-speed position, thereby reducing the amount of tuning advance.

ELECTRICAL OPERATION

The point set, or breaker points as they are sometimes called, is the switching device of a conventional ignition system. The "primary" side of the ignition coil is connected to the battery, through the ignition switch, a resistor, and various wiring. When the ignition switch is in the "run" position, voltage from the ignition switch passes through a resistor, which lowers the battery voltage to the coil from 12V down to about 6-8V.

NOTE: If this resistor is defective, the full 12V from the battery will quickly burn the breaker point contacts and shorten the life of the ignition coil.

When the ignition switch is in the "start" position, the resistor is bypassed. This provides a full 12V to the ignition system to aid in starting the engine. Voltage flow after the resistor (or bypass

wire) is through the primary (low voltage) windings of the coil, to the breaker point set. When the points are closed (grounded), a magnetic field is produced within the primary windings of the ignition coil. When the points open, the coil voltage no longer has an easy path to ground. The magnetic field collapses and transfers the voltage from the primary windings (outer) of the coil to the "secondary" windings (inner) of the coil, through induction. Since the number of secondary windings in the ignition coil is much greater than the primary, the voltage is multiplied to roughly 20-25,000 volts. This high voltage then travels out of the center tower of the ignition coil, through the high tension lead (secondary coil wire) to the center tower of the distributor cap. The voltage is then distributed by the ignition rotor to the outer terminals of the distributor cap (in the "firing order"), through the plug wires and finally, the voltage jumps the gap of the spark plug, causing ignition of the air/fuel mixture in the cylinder.

The condenser, which is also attached to the breaker plate (grounded), acts as a temporary voltage storage unit when the points are closed. This helps to prevent arcing between the point contacts when the points are opened. Rapid metal transfer between the point contacts is indicative of a bad condenser.

The Breakerless Ignition Systems (Including H.E.I.)

Both the transistorized and H.E.I. systems operate in basically the same manner as the conventional ignition system, with the exception of the type of "switching device" used. As stated previously, the switching device of a conventional ignition system is the breaker point set. In the breakerless ignition systems, a toothed iron timer core is mounted on the distributor shaft. The timer core is mounted on the distributor shaft. The timer core rotates inside of an electronic pole piece. The pole piece has internal teeth (corresponding to those on the timer core) and contains a permanent magnet and pick-up coil (not to be confused with the ignition coil). The pole piece senses the magnetic field of the timer core teeth and sends a signal to the ignition module which electronically "calls the shots" concerning control of the primary coil voltage. The ignition coil operates in basically the same manner as a conventional ig-

ignition coil (though the ignition coils DO NOT interchange), but is controlled by the timer core, pole piece, and module; instead of the breaker points and condenser.

NOTE: H.E.I. ignitions use a condenser, but it is primarily used for radio interference purposes.

As far as the mechanical advance is concerned, the operation is also basically the same as a conventional ignition system, with the exception that the timer core rotates on the distributor shaft instead of the distributor cam used in conventional systems. The vacuum advance unit moves the breaker plate in the same manner as the conventional system, but the timing changes according to the position of the pole piece instead of the breaker points.

Appearance wise, the transistorized ignition distributor looks very much like a conventional distributor, with the exception of a two-wire lead (with a quick-disconnect plug) coming from the distributor. Also, the transistorized system uses both an externally mounted ignition coil and an ignition amplifier unit which is finned for heat dissipation.

CAUTION: Do not use a conventional ignition coil in place of an electronic ignition coil, or vice-versa. Component damage could result.

The H.E.I. distributor looks nothing like a conventional distributor. The components of an H.E.I. distributor are all contained within the distributor (pole piece, ignition coil, module, etc.).

Refer to Chapter 11 for detailed H.E.I. system troubleshooting. None of the electrical components used in either the transistorized or H.E.I. systems are adjustable. If a component is found to be defective, it must be replaced.

HEI SYSTEM PRECAUTIONS

Before going on to troubleshooting, it might be a good idea to take note of the following precautions:

Timing Light Use

Inductive pick-up timing lights are the best kind to use if your car is equipped with HEI. Timing lights which connect between the spark plug and the spark plug wire occasionally (not always) give false readings.

Spark Plug Wires

The plug wires used with H.E.I. systems are of a different construction than conventional

wires. When replacing them, make sure you get the correct wires, since conventional wires won't carry the voltage. Also, handle them carefully to avoid cracking or splitting them and never pierce them.

Tachometer Use

Not all tachometers will operate or indicate correctly when used on a H.E.I. system. While some tachometers may give a reading, this does not necessarily mean the reading is correct. In addition, some tachometers hook up differently from others. If you can't figure out whether or not your tachometer will work on your car, check with the tachometer manufacturer. Dwell readings, of course, have no significance at all.

H.E.I. System Testers

Instruments designed specifically for testing H.E.I. systems are available from several tool manufacturers. Some of these will even test the module itself. However, the tests given in the following section will require only an ohmmeter and a voltmeter.

ENGINE ELECTRICAL

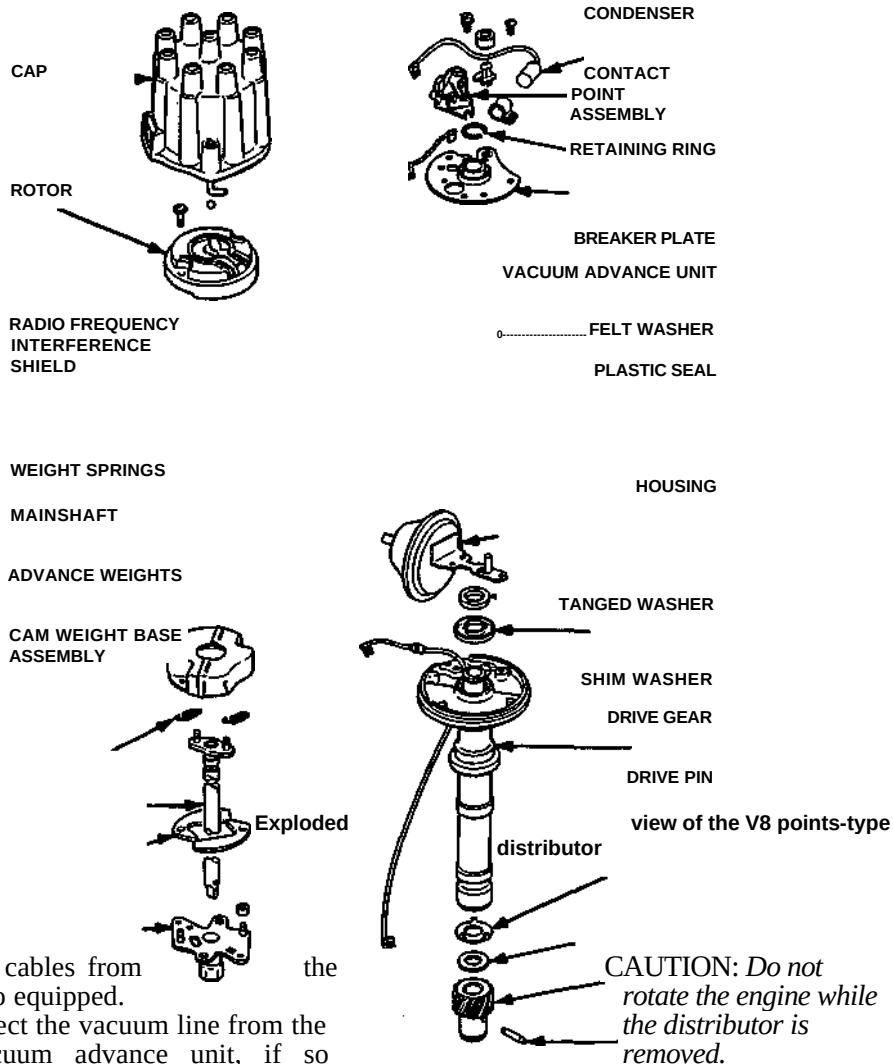
Distributor

REMOVAL

Conventional and Transistorized Systems

1. Rotate the engine until the timing mark on the crankshaft balancer is aligned with the top dead center mark (TDC or "0") on the timing tab scale. Remove the air cleaner assembly.
2. Remove the ignition shielding and disconnect the secondary (high tension) coil wire.
3. Release the distributor cap hold-down screws (push down and turn counterclockwise). Raise the distributor cap off of the distributor and check that the firing tip of the rotor is pointed at the #1 terminal of the distributor cap. If it is not; turn the engine one full revolution and again align the timing marks as previously stated. Recheck the rotor position.
4. Pull the plug wires out of the locating looms (if so equipped) and move the cap out of the way. Leave the plug wires attached to the cap.
5. Disconnect the battery cables at the battery.
6. Disconnect the tachometer and fuel

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injection drive cables from the distributor, if so equipped.

7. Disconnect the vacuum line from the distributor vacuum advance unit, if so equipped.

8. Mark the relationships between the following items:

- Rotor firing tip and distributor body
- distributor body and either the fire wall or the intake manifold

The combination of these marks will assure that the distributor gear is properly meshed with the camshaft and the ignition timing will be close enough to start the engine after the distributor is reinstalled.

9. On conventional ignitions, disconnect the distributor lead from the negative (—) terminal of the ignition coil. On transistorized systems, carefully release and pull apart the quick-disconnect of the two-wire distributor lead.

10. Remove the distributor hold-down bolt and plate.

11. Carefully pull the distributor from the engine. Note the rotation of the rotor as the distributor is pulled upward, caused by the angled distributor drive teeth.

12. Service the distributor as necessary.

H.E.I. Systems

1. Rotate the engine until the timing mark on the balancer is aligned with the top dead center mark (TDC or "O") on the timing tab scale.

2. Remove the air cleaner assembly and the ignition shielding.

3. With the ignition switch OFF, disconnect the feed, module, and tachometer wiring from the drivers side of the distributor cap. Do so by releasing the connector retaining tabs and pulling downward on the connectors. On 1981—84 models, also disconnect the four-wire connector installed in the wiring from the opposite side of the distributor.

CAUTION: Never allow the "Tach" terminal to touch ground.

4. Locate the locking tabs of the spark plug wire retaining ring (on the distributor cap). Move each of the two locking tabs outward to release the retaining ring. With the plug wires still attached to the ring, carefully remove the retaining ring from the distributor cap. Pull

Distributor Specifications

NOTE: The following specifications are given in degrees advance at crankshaft speed. Half degrees for distributor machine testing.

Year	Model	Distributor Part Number	Centrifugal Advance			Vacuum Advance	
			Start Degrees @rpm	Intermediate Degrees @rpm	End Degrees @rpm	Start Degrees @ In. Hg	End Degrees @ in. Hg
1963-64	All except fuel injection	1111024	0@700	11 @1600	24 @ 4600	0@8	15 @ 15.5
	Fuel injection	1111022	0@700	11 @700	24 @ 4600	0@8	15 @ 15.5
1965	Base engine	1111076	0@750	15 @ 1500	26 @ 4100	0@4	1 6.5 @ 8.2
	Special performance	1111069	0@800	NA	24 @ 2350	0@4	1 6.5 @ 8.2
	Fuel injection	1111070	0@800	NA	24 @ 2350	0@4	1 6.5 @ 8.2
	Base engine	1111087	0@750	15 @ 1500	30 @ 5100	0@4	1 6.5 @ 8.2
	Special performance w/transistor ign	1111060	0@800	NA	26 @ 2500	0@4	1 6.5 @ 8.2
	F.I. w/transistor ign	1111064	0@800	NA	26 @ 2500	0@4	1 6.5 @ 8.2
1966	300 hp	1111194	0@900	15 @ 1500	30 @ 5100	0@6	15 @12
	350 hp	1111438	0@950	20 @ 1800	30 @ 4700	0@8	15 @ 15.5
	390 hp	1111293	0@900	8 @ 1250	32 @ 5000	0@7	12 @12
	350 hp w/transistor ign	1111441	0@900	1 6.5 @ 1400	30 @ 4400	0@8	15 @ 15.5
	390 hp w/transistor ign	1111294	0@900	17 @ 2000	32 @ 5000	0@7	12 @12
	425 hp	1111170	0@900	17 @ 2000	32 @ 5000	0@7	12 @12
1967-68	300 hp	1111194	0@900	15 @ 1500	30 @ 51 00	0@6	15 @12
	350 hp	1111438	0@950	20 @ 1800	30 @ 4700	0@8	15 @ 15.5
	390 hp, 400 hp	1111293	0@900	17 @ 2000	32 @ 5000	0@7	12 @12
	435 hp	1111296	0@900	NA	30 @ 3800	0@8	15 @ 15.5
	430 hp L88	1111295	0@1200	18 @ 1900	30 @ 5000	—	—
	350 hp w/transistor ign	1111441	0 @ 900	1 6.5 @ 1400	30 @ 4400	0@8	15 @ 15.5
	390 hp, 400 hp	1111294	0@900	17 @ 2000	32 @ 5000	0@7	12 @12

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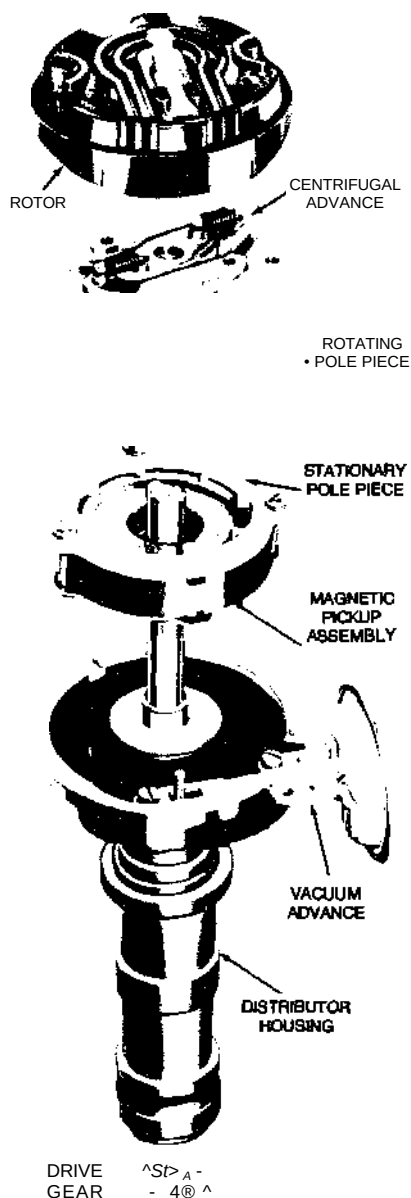
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Distributor Specifications (cont.)

NOTE: The following specifications are given in degrees advance at crankshaft speed. Half degrees for distributor machine testing.

Year	Model	Distributor Part Number	Centrifugal Advance			Vacuum Advance	
			Start Degrees @rpm	Intermediate Degrees @rpm	End Degrees @rpm	Start Degrees @ in. Hg	End Degrees @ in. Hg
1969	300 hp	1111490	0@900	15 @ 1500	30 @ 51 00	0@8	19@17
	350 hp	1111493	0@1000	10 @ 1700	26 @ 5000	0@7	15@12
	390 hp, 400 hp	1111926	0@900	17 @ 2000	26 @ 3800	0@7	12@12
	435 hp	1111928	0@900	2 @ 1100	30 @ 3800	0@8	15 @ 15.5
	430 hp L88	1111927	0@1200	16 @ 1900	29 @ 5000	—	—
1970	300 hp	1111490	0@900	15 @ 1500	30 @ 5100	0@8	19@17
	350 hp	1111493	0@1150	10 @ 1700	26 @ 5000	0@8	19@17
	370 hp	1111491	0@1000	NA	26 @ 5000	0@8	15 @ 15.5
	390 hp	1111464	0@1085	17 @ 21 00	22 @ 3200	0@7	12@12
	460 hp	1112026	0@1000	NA	21 @ 2300	0@7	12@12
1971	270 hp	1112050	0@1335	11 @2400	18 @ 4200	0@8	15 @ 15.5
	330 hp	1112038	0@1330	16 @ 2250	24 @ 5000	0@8	15 @ 15.5
	365 hp	1112051	0@1145	14 @ 2000	22 @ 3000	0@8	20@17
	425 hp w/manual trans	1112076	0@1300	25 @ 2350	31 @ 6000	0@7	12@12
	425 hp w/auto trans	1112053	0@1310	21 @ 2350	28 @ 5000	0@7	12@12
1972	200 hp	1112050	0@1335	11 @2400	18 @ 4200	0@8	15 @ 15.5
	255 hp	1112101	0@1200	14 @ 2000	28 @ 5000	0@8	15 @ 15.5
	270 hp	1112051	0@1145	14 @ 2000	22 @ 3000	0@8	20@17
1973	190 hp	1112098	0@1100	—	14 @ 4200	0@6	15@14
	250 hp	1112150	0@1200	—	20 @ 5000	0@6	15@12

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Exploded view of the transistorized distributor

the plug wires out of the locating looms (if so equipped) and move the ring (with the wires still attached) out of the way.

5. Release the distributor cap hold-down screws (push downward and turn counterclockwise) and lift the cap assembly off of the distributor. Check that the firing tip of the rotor is pointed at the #1 terminal of the distributor cap; if it is not, rotate the engine one

full revolution and again align the timing marks. Recheck the position of the rotor.

6. Disconnect the vacuum line from the distributor vacuum advance unit, if so equipped.

7. Follow steps 5, 7, 8, and 10-12 of the previous procedure, in that order to complete distributor removal.

INSTALLATION—ENGINE NOT DISTURBED

1. Clean the distributor and intake manifold mating surfaces and check the condition of the cork gasket. Replace the gasket if it is damaged.

2. Position the distributor in the engine without yet engaging it. Align the distributor housing-to-engine alignment marks which were made during removal. Position the rotor firing tip slightly counterclockwise of the corresponding distributor housing mark; remember, the rotor will turn slightly during installation.

3. Engage the distributor to the engine by moving it downward. The rotor should turn to its proper alignment position. If it does not, lift the distributor enough to disengage the drive gear, reposition the rotor and lower the distributor.

4. Install the distributor hold-down plate and just snug down the bolt.

5. Make sure that the rotor retaining screws are tight and install the distributor cap.

6. Connect the cables (tach, injection—if so equipped), wires, and vacuum line (if so equipped) to the distributor.

7. On conventional ignitions, reconnect the primary distributor lead to the coil. On models without H.E.I., reconnect the secondary coil wire.

8. On H.E.I. models, install the plug wire retaining ring. Press the ring downward until the two locking tabs engage. Make sure dial the plug wire terminals are firmly seated on the distributor cap terminals.

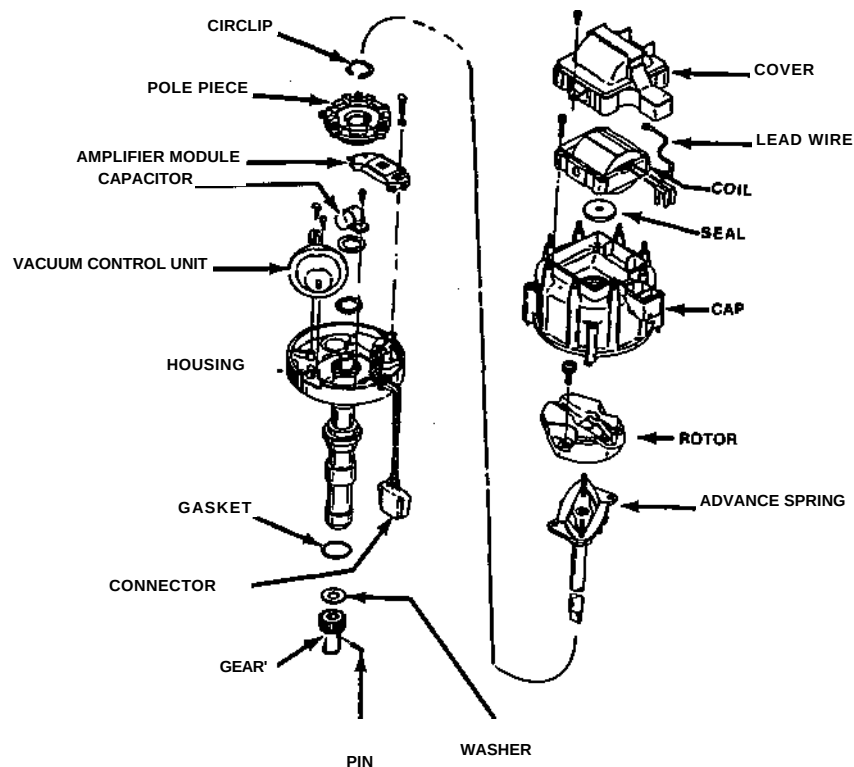
9. Reposition the plug wires into their locating looms, if so equipped.

10. Install the air cleaner and reconnect the battery cables.

11. Adjust the ignition timing as previously outlined and tighten the distributor hold-down bolt. Reinstall the ignition shield ing as necessary.

INSTALLATION—ENGINE DISTURBED

1. The piston of the #1 cylinder must be on its compression stroke and at the top of its



Exploded view of the HEI distributor. Engines with the computer emissions system do not have the vacuum advance unit.

travel (top dead center -TDC) in order to time the ignition system to the engine. There are several ways to determine when the piston is on its compression stroke. In any case, the #1 spark plug must be removed. The various methods are as follows:

a. Hold your finger over the spark plug hole and have an assistant turn the engine over slowly. When you feel compression, watch the timing marks. Stop turning the engine over as soon as the timing mark on the crankshaft balancer is aligned with the "0" mark on the timing tab scale.

b. Insert a rag into the spark plug hole (NOT into the cylinder). Turn the engine over slowly until the rag is blown out of the hole. Stop cranking the engine when this happens and check the timing marks. If necessary, "tap" the ignition key until the timing mark on the crankshaft balancer is aligned with the "0" mark on the timing tab scale.

c. Attach a compression gauge to the spark plug hole (preferably the screw-in type; eliminating the need for an assistant). Position the gauge dial so that it may be viewed while cranking the engine. Turn the engine over until the gauge needle reading

increases, indicating compression. Stop cranking the engine when this happens and check the timing marks. If necessary, "tap" the ignition key until the timing mark on the crankshaft balancer is aligned with the "0" mark on the timing tab scale. Remove the compression gauge. *NOTE: There are tools available commercially which screw into the #1 spark plug hole and register (more accurately than the above methods) when top dead center is reached. If one of these tools is used, follow the tool manufacturers instructions.*

2. Reinstall the #1 spark plug and connect the plug wire. With the distributor out of the vehicle and the distributor cap installed, locate the #1 distributor cap terminal and chalk mark its position on the distributor housing. Remove the distributor cap.

3. Position the distributor into the engine block with the:

a. vacuum advance unit in its proper position (see the Firing Order illustrations).

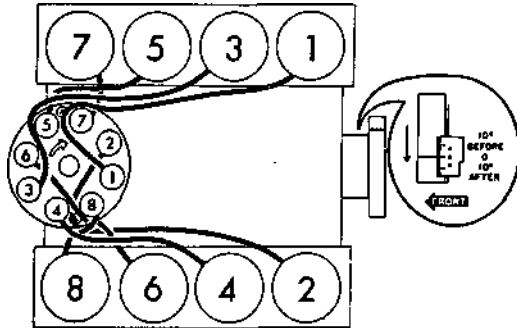
b. firing tip of the rotor pointing to the mark made during step 2.

4. As the distributor drive gear engages, the rotor will turn slightly. If the distributor

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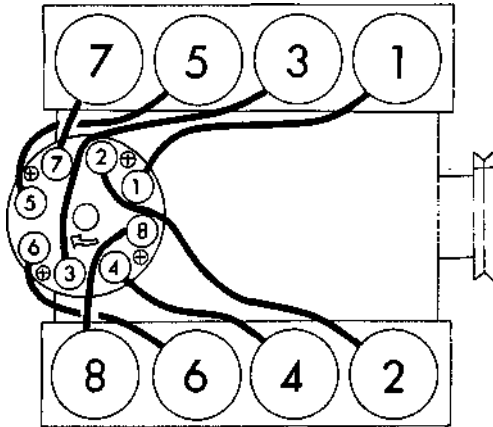
FIRING ORDER

To avoid confusion, replace spark plug wires one at a time.



1963-74 except HEI

ENGINE FIRING ORDER: 1-8-4-3-6-5-7-2
DISTRIBUTOR ROTATION: CLOCKWISE



1974-84 HEI

housing does not sit properly on the block, the oil pump shaft is not engaging with the distributor shaft. In this case, you can do one of two things:

a. Remove the distributor and turn the oil pump driveshaft with a long screw driver to align the pump driveshaft slot with the "blade" of the distributor shaft. This is done strictly by visual approximation.

b. Apply downward pressure on the distributor housing (NOT the rotor) and have someone "tap" the ignition key to slowly turn the engine over until the distributor falls into its proper position. After doing this, it is recommended that you recheck the timing by repeating steps 1 and 2.

5. On conventional ignitions, after proper positioning is assured, turn the distributor housing so that the points are just opening.

6. Install the distributor hold-down bolt and plate. Snug down the retaining bolt.

7. Connect the vacuum advance hose, tach drive cable, and injection drive cable, on vehicles equipped with these items.

8. Connect all wiring and adjust the ignition timing as previously outlined.

9. Install the ignition shielding.

H.E.S. COMPONENT REPLACEMENT

Distributor Cap

1. Disconnect the feed, module, and tachometer wiring from the drivers side of the distributor cap. Do so by releasing the wiring connector retaining tabs and carefully pulling downward on the connectors.

2. Locate the locking tabs of the spark plug wire retaining ring (on the distributor cap). Move each of the two locking tabs outward to release the retaining ring. With the plug wires still attached to the ring, pull the ring and wires off of the distributor cap and move the assembly out of the way.

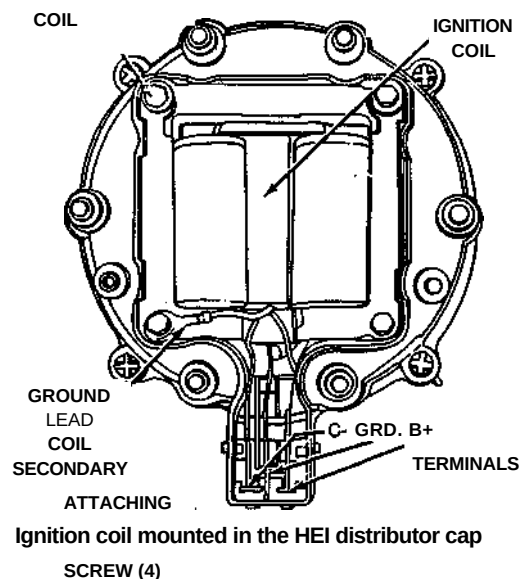
3. Release the distributor cap hold-down screws (push downward and counterclockwise) and lift the cap assembly off of the distributor.

4. Remove the coil cover from the distributor cap (4 fasteners).

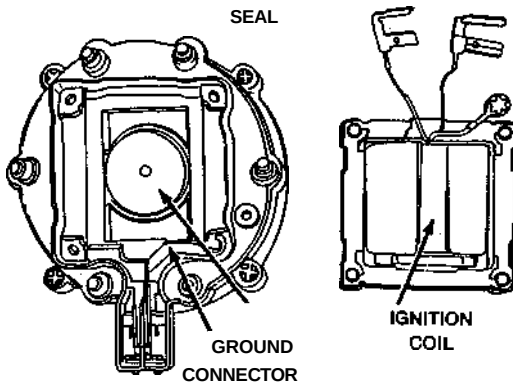
5. Push the spade terminals upward and out of the distributor cap.

6. Remove the four coil screws and lift the coil, spring, carbon contact, and rubber washer out of the distributor cap.

7. Reverse the previous steps to assemble, using a new cap. Lubricate the rubber washer with dielectric lubricant during assembly.



Ignition coil mounted in the HEI distributor cap



After removing the coil, check the condition of the arc seal (1981 shown, other years similar)

Ignition Coil

Perform steps 1, 2, 4, 5, and 6 of the previous distributor cap replacement procedure. Install the new coil, being sure to use the dielectric compound supplied with most coils to lubricate the rubber washer.

Ignition Rotor

Remove the distributor cap as previously outlined. Loosen the rotor retaining screws (most screws will stay attached to the rotor) and lift the rotor off of the mainshaft assembly. During installation, note the locations of the different locating "dowels" (2) on the underside of the rotor. These dowels help to prevent incorrect rotor installation by allowing the rotor to be installed in only one way.

Vacuum Advance Unit (if so equipped)

1. Remove the distributor cap and rotor as previously outlined.

2. Disconnect the hose from the vacuum advance unit.

3. Remove the two vacuum advance unit retaining screws and pull the unit outward.

4. Rotate the unit to disengage the operating rod from the distributor.

5. Reverse the previous steps to install.

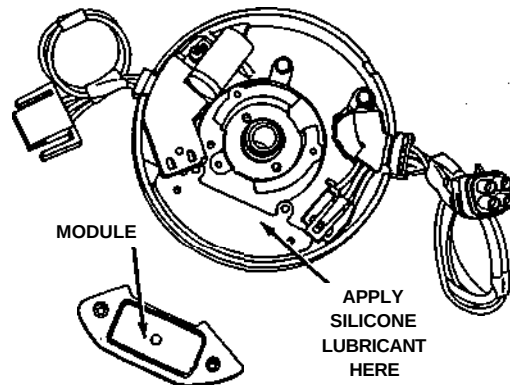
Module

1. Remove the distributor cap and rotor as previously outlined.

2. Carefully disconnect the wiring from the module.

3. Remove the two module retaining screws and lift the module out of the distributor housing.

4. Apply a light coating of silicone dielectric compound to the distributor housing in the module mounting area before installing the new module. The silicone compound is used to transfer heat from the module to the



Placement of silicone dielectric compound prior to HEI module installation—see text

EXTEND RETAINING TABS TO BE SURE OF POSITIVE LOCK IN CONNECTOR

WHITE WIRE

CONNECTOR REMOVED

A GREEN WIRE

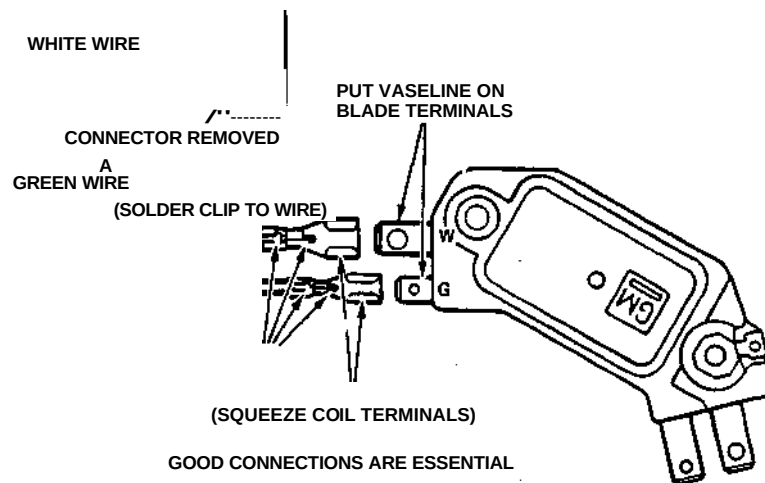
(SOLDER CLIP TO WIRE)

PUT VASELINE ON BLADE TERMINALS

(SQUEEZE COIL TERMINALS)

GOOD CONNECTIONS ARE ESSENTIAL

Proper HEI module electrical connections



70 ENGINE AND ENGINE REBUILDING

distributor housing. If the compound is not used, the module will overheat, causing failure of the ignition system.

NOTE: Silicone compounds are available strictly for this purpose—DO NOT use a regular silicone lubricant or sealer.

5. Install the new module, using the accompanying illustration as a guide to establish the best possible module connections.

NOTE: Many H.E.I. failures have been attributed to poor module connections. Inspect the wires, terminals, and connectors for damage and follow the accompanying illustration.

6. Install the rotor and distributor cap as previously outlined.

NOTE: Items previously listed are the only items of the H.E.I. distributor which are serviceable with the distributor installed. Other services will require distributor removal and disassembly.

DISASSEMBLY

Conventional Systems

1. Remove the distributor cap and the rotor.

2. Remove the two-piece radio interference shield (2 fasteners), if so equipped.

3. Remove the centrifugal advance springs and weights.

4. Drive the roll pin out of the distributor gear using a drift no larger than the roll pin.

5. Slide the distributor gear off of the shaft and remove the spacers and washers (note their arrangement for reinstallation).

6. Remove the tachometer drive gear.

7. Inspect the distributor shaft for burrs in the gear mounting area. If there are any burrs or nicks, carefully smooth them with a fine file. This should be done to prevent bushing damage as the distributor shaft is withdrawn from the housing.

8. Slide the distributor shaft assembly out of the housing.

9. Remove the vacuum advance unit (2 screws).

10. Carefully remove the breaker plate retaining ring and lift the breaker plate off of the distributor housing. DO NOT disassemble the breaker plate any further.

11. Remove the point set, condenser, and the condenser mounting bracket from the breaker plate. Remove the washer and seal from beneath the breaker plate.

Transistorized Systems

1. Remove the distributor cap and the rotor.

2. Remove the centrifugal advance springs and weights.

3. Remove the tachometer drive gear.

4. Support the distributor gear (to prevent damage to the magnetic pickup assembly) and drive the roll pin out of the gear, using a drift no larger than the roll pin.

5. Slide the distributor gear and washer off of the distributor shaft.

6. Inspect the distributor shaft for burrs in the gear mounting area. If there are any burrs or nicks, carefully smooth them with a fine file. This should be done to prevent bushing damage as the distributor shaft is withdrawn from the housing.

7. Remove the centrifugal advance weight support and timer core from the distributor shaft.

8. Disconnect the pickup coil lead connector.

9. Remove the retaining ring which secures the magnetic pickup assembly to the distributor housing.

10. Remove the entire magnetic pickup assembly from the distributor housing. DO NOT remove the three screws which secure the stationary pole piece to the pickup assembly.

11. Remove the washer and felt pad from the pickup mounting.

12. Remove the vacuum advance unit.

H.E.I. Systems

1. Remove the distributor cap assembly and rotor as previously outlined.

2. Remove the centrifugal advance springs and weights from the mainshaft, if so equipped.

3. Drive out the distributor gear roll pin using a drift.

4. Remove the distributor gear and washers. Note the location of the washers so that they may be reinstalled properly.

5. Slide the distributor shaft out of the housing.

6. Disconnect the electrical leads from the module and remove the module. Also remove the capacitor.

7. If the internal teeth of the pickup assembly are fully exposed; remove the pickup retaining ring and remove the pickup assembly from the distributor housing (Do not remove the three screws from the pickup as-

sembly). If the internal teeth of the pickup are not fully exposed; remove the magnetic shield from the pickup assembly (three attaching screws). Remove the pickup assembly retaining ring and remove the pickup components (magnet, pole piece, pickup coil). 8. Remove the vacuum advance unit, if so equipped.

ASSEMBLY

Assembly of the distributor is the reverse of its respective disassembly procedure.

When assembling the distributor, be sure to lubricate the distributor shaft bushings with a few drops of engine oil. Also be sure that the distributor shaft turns freely after it is installed. On conventional, point-type distributors, it is easier to install and gap the points while the distributor is removed.

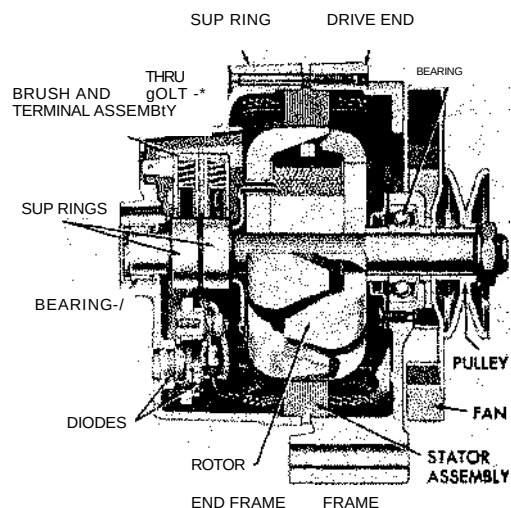
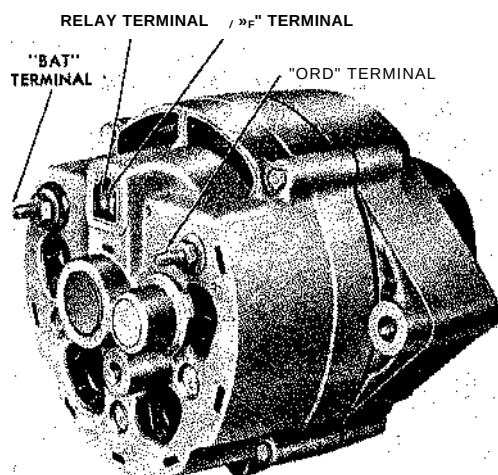
On H.E.I. systems, apply a light coating of silicone dielectric compound to the distributor housing in the module mounting area before installing the module. The silicone compound is used to transfer heat from the module to the distributor housing. If the compound is not used, the module will overheat, causing failure of the ignition system. NOTE: *Silicone compounds are available strictly for this purpose—DO NOT use a regular silicone lubricant or sealer.* Refer to the previous middle replacement procedure for additional module installation information.

Alternator

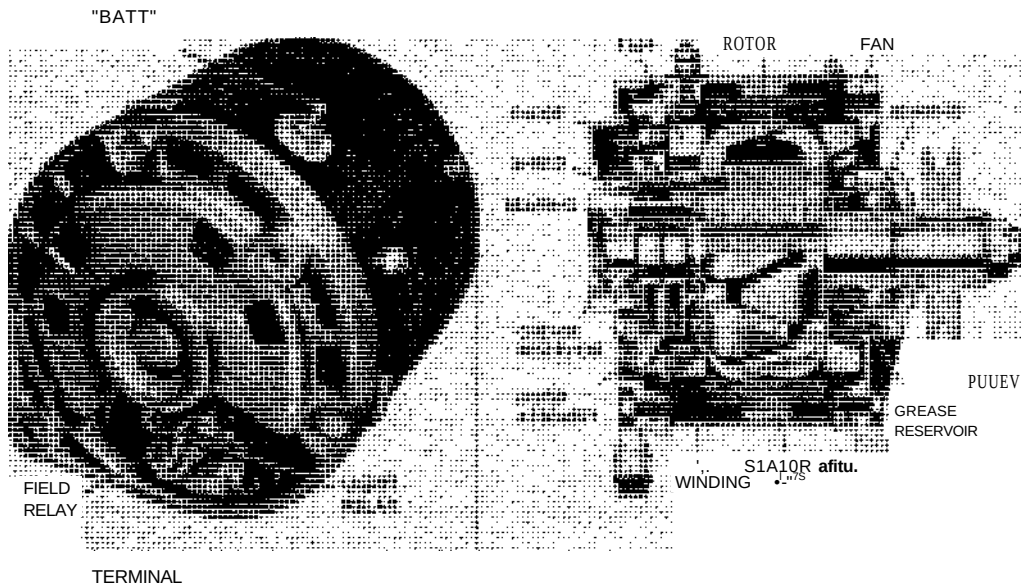
The alternating current generator (alternator) supplies a continuous amount of electrical energy at all engine speeds to keep the battery fully charged. The Corvette, as all other GM vehicles, uses a Delcotron alternator. Delcotron is a trade name of the Delco-designed alternator.

The alternator consists of four main assemblies: drive (pulley) end frame, slip ring (rear) end frame, stator, and rotor. The drive end frame houses a ball bearing which is used to support the front of the rotor and is large enough to withstand the side loads imposed on the rotor by the alternator belt. The slip ring end frame uses a small roller bearing which is used to support the rear of the rotor (The "perforated case" Delcotron uses a ball bearing in the rear, also). These bearings are lubricated during their assembly and need no additional lubrication. If you replace the bearings, try to obtain a fully sealed bearing for the front, to further increase bearing life.

The stator has a laminated core which is attached to the frame of the alternator. On "perforated case" models, the stator is serviced with the main case. A large number of windings cover the inside diameter of the stator, and it is within this circle that the rotor turns. Current passes from two brushes through the slip rings (of the rotor) and finally to the field coils which are wound in a manner concentric to the rotor shaft.



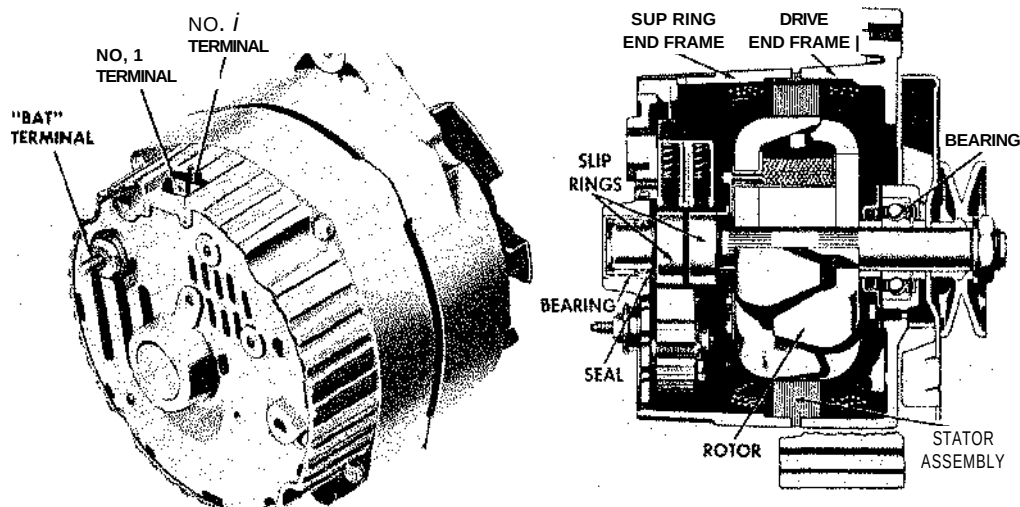
Externally regulated Delcotron—except "perforated case" models



Externally regulated, "perforated case" Delcotron

Both the internally and externally regulated Delcotrons use positive and negative diodes. These diodes are electrical check valves, meaning that they will allow current to pass freely in only one direction. The diodes perform the function of changing the alternating current (AC) developed within the stator windings to direct current (DC) which can be used by the 12VDC system. In the

externally regulated Delcotron (except the "perforated case" models), the negative diodes (3) are pressed into the slip ring end frame; the positive diodes (3) are pressed into an electrically insulated heat sink attached to the slip ring end frame. The diodes used in the "perforated case" Delcotron are pressed into removable heat sinks. The grounded heat sink contains the negative diodes; the insulated



Internally regulated Delcotron

contains the positive. Internally regulated Delcotron use a different type of diode arrangement. In these models, the negative diodes are permanently mounted in a rectifier bridge assembly. The rectifier bridge utilizes a finned aluminum heat sink for efficient diode cooling, and is mounted inside the slip ring end frame. A positive diode trio is used instead of separately mounted positive diodes. If a negative diode of the rectifier bridge fails, the rectifier bridge assembly must be replaced. Also, the positive diode trio can only be replaced as a unit.

Generally, internally and externally regulated alternators can easily be distinguished by the type of plug-in connector which is used at the alternator. External regulator models use a connector having two side-by-side vertical spade terminals, whereas the internal regulator type uses a connector having two side-by-side horizontal spade terminals. All "perforated case" Delcotron use external voltage regulators.

Adjustments can be made to the external type of regulator (covered later in this section). The internally mounted voltage regulator is non-adjustable—if it is defective, it must be replaced.

ALTERNATOR PRECAUTIONS

To prevent damage to the alternator and regulator, the following precautions should be taken when working with the electrical system.

1. Never reverse the battery connections.
2. Booster batteries for starting must be connected properly—positive-to-positive and negative-to-negative.
3. Disconnect the battery cables before using a fast charger; the charger has a tendency to force current through the diodes in the opposite direction for which they were designed. This burns out the diodes.
4. Never use a fast charger as a booster for starting the vehicle.
5. Never disconnect the voltage regulator while the engine is running.
6. Avoid long soldering times when replacing diodes or transistors. Prolonged heat is damaging to AC generators.
7. Do not use test lamps of more than 12 volts (V) for checking diode continuity.
8. Do not short across or ground any of the terminals on the AC generator.
9. The polarity of the battery, generator, and regulator must be matched and con-

sidered before making any electrical connections within the system.

10. Never operate the alternator on an open circuit. Make sure that all connections within the circuit are clean and tight.

11. Disconnect the battery terminals when performing any service on the electrical system. This will eliminate the possibility of accidental reversal of polarity.

12. Disconnect the battery ground cable if arc welding is to be done on any part of the car.

EXTERNALLY REGULATED ON-CAR CHARGING SYSTEM TESTS

Isolation Checks

These are quick checks that will allow the tester to isolate the general source of charging circuit difficulty in either the alternator, regulator, or wiring harness. Once the defective component has been singled out, further checks and repairs may be made using the procedures given in the alternator or regulator sections. Make these checks after looking for obvious problems such as a weak battery or loose fan belt.

Start the engine and bring the idle to between 1500-2000 rpm. Turn off all accessories, lights, radio, etc., and then disconnect the battery ground cable. If the engine stops, it is safe to assume that the alternator is at fault. If, however, the engine continues to operate, the problem lies with either the regulator or wiring harness.

Having eliminated the alternator from suspicion, the next step is to isolate the regulator from the harness and the easiest way is to substitute a known component. Remove the push-on wiring connector from the regulator and insert a regulator that is known to be good into the circuit, remembering to ground the regulator to the car. Idle the engine, remove the battery cable, and check the ammeter. If it indicates a discharge condition, then the possible problem is an open resistor or a shorted, positive diode. If the ammeter continues to indicate a charge, then it is the regulator that is defective.

Alternator Tests

Prepare the alternator for testing by disconnecting the battery ground terminal, the BAT, light relay, field, and GRD leads from the alternator terminals.

Check the positive diodes by connecting an ohmmeter between the R (or light relay) and

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BAT terminals, and noting the lowest range on the ohmmeter scale. It should indicate very low resistance. Reversing the connections should result in an infinitely high resistance indication.

If the ohmmeter reads low or high in both directions, the diodes are defective. A low reading could also indicate a grounded stator. To test for an open field, connect the ohmmeter between the F (or Field) and GRD terminals and check the low range scale for a reading between 7 and 20 ohms. A zero indication or one of excessively high resistance suggests a faulty alternator.

NOTE: *The 17SI alternator used on the 1984 Corvette uses delta stator windings and cannot be checked for an open circuit.*

Field Relay Tests

Fasten one voltmeter lead to the no. two regulator terminal and ground the other lead to the regulator. Idle the engine between 1500 and 2000 rpm. If the GEN light still burns, and a volt reading of 3.5 to 6.5 is present, then the regulator field relay is faulty.

Accessory Circuit Resistance Tests

A resistor is connected to the ACC terminal ignition switch. To check for an open resistor, connect the voltmeter to the no. 4 connection of the regulator and ground the other voltmeter lead to the regulator. A zero reading, with the ignition switch turned to the ACC notch, indicates an open resistor. The resistance wire is an integral part of the ignition harness and carries a rating minimum of 10 ohms, 6.25 watts. The wire is not solderable and must be crimp-connected.

INTERNALLY REGULATED SYSTEM TESTING

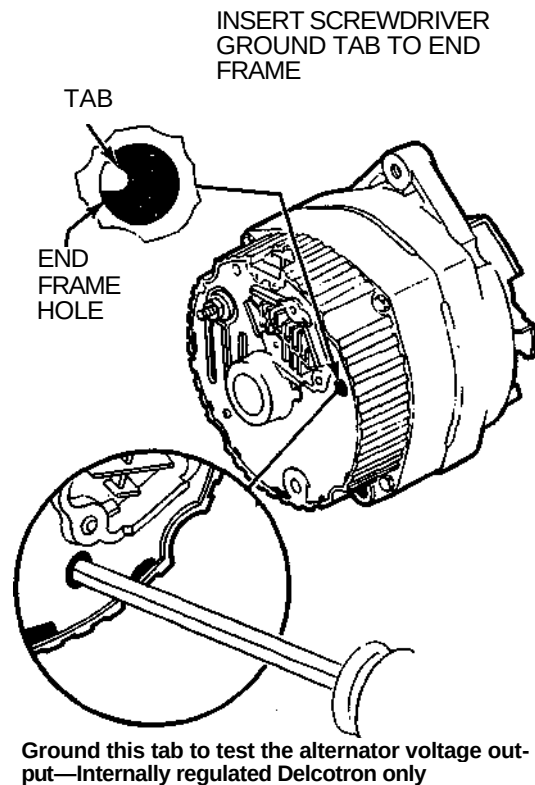
Alternator Output Test

1. Connect a test voltmeter, ammeter, and a 10-ohm, 6-watt resistor into the charging circuit. Do not connect the carbon pile to the battery posts at this time.
2. Increase alternator speed and observe the voltmeter—if the voltage is uncontrolled with speed and increases to 16 volts or more, check for a grounded brush lead clip as previously covered. If a brush lead clip is not grounded, the voltage regulator is faulty and must be replaced.
3. Connect the carbon pile load to the battery terminals.
4. Operate the alternator at moderate

speed and adjust the carbon pile to obtain maximum alternator output as indicated on the ammeter. If output is within 10% of rated output as stamped on the alternator frame, alternator is O.K. If output is not within specifications, ground the alternator field by inserting a screwdriver into the test hole in the end frame. If output now is within 10% of rating, replace the voltage regulator; if still not within specifications, check field winding, diode trio, rectifier bridge and stator, as described later.

Low Charging Rate Diagnosis

1. After battery condition, drive belt tension, and wiring terminals and connections have been checked, charge the battery fully and perform the following test:
2. Connect a test voltmeter between the alternator BAT terminal and ground, ignition switch on. Connect the voltmeter in turn to alternator terminals No. 1 and No. 2, the other voltmeter lead being grounded as before. A zero reading indicates an open circuit between the battery and each connection at the alternator. If this test discloses no faults in the wiring, proceed to Step 3.
3. Connect the test voltmeter to the alternator BAT terminal (the other test lead to



ground), start the engine and run at 1,500-2,000 rpm with all lights and electrical accessories turned on. If the voltmeter reads 12.8 volts or greater, the alternator is good and no further checks need be made. If the voltmeter reads less than 12.8 volts, ground the field winding by inserting a screwdriver into the test hole in the end frame.

CAUTION: *Do not force the tab more than % in. into the end frame.*

- a. If voltage increases to 13 volts or more, the regulator unit is defective;
- b. If voltage does not increase significantly, the generator is defective.

High Charging Rate Diagnosis

1. With the battery fully charged, connect a voltmeter between alternator terminal No. 2 and ground. If the reading is zero, No. 2 circuit from the battery is open.

2. If No. 2 circuit is OK, but an obvious overcharging condition still exists, proceed as follows:

- a. Remove the alternator and separate the end frames;
- b. Connect a low-range ohmmeter between the brush lead clip and the end frame (Test 1), then reverse the connections. If both readings are zero, either the brush lead clip is grounded or the regulator is defective. A grounded brush lead clip can be due to damaged insulating sleeve or omission of the insulating washer.

REMOVAL AND INSTALLATION

1. Disconnect the negative battery cable at the battery; this will prevent damaging the alternator diodes.

2. Disconnect the wiring from the rear of the alternator (bolt-on and push-in connectors).

3. Loosen the lower alternator bolt and remove the upper (adjustment) bolt. Slip the drive belt off of the pulley.

4. Remove the pivot bolt and lift the alternator out of its mounting brackets.

5. Installation of the alternator is the reverse of the previous steps. Adjust the drive belt to the proper tension.

DISASSEMBLY AND ASSEMBLY

Externally Regulated Type—Except "Perforated Case" Models

Remove the pulley by positioning a box-end wrench over the pulley retaining nut and inserting a $\frac{5}{16}$ in. allen wrench in the shaft to

prevent it from turning. Unbolt the retaining nut and slide it off the pulley. Disconnect the battery ground strap to prevent diode damage and remove the generator. On the 6.2 in. perforated case generator, remove the blade-connector retaining nuts and remove the connectors. Slip the indicator light relay from the terminal post, then back out the retaining screws, and remove the brush holder. Leave the capacitor attached to the generator. Remove the four, long, case bolts and separate the end frame and rotor assembly from the stator assembly. Cover the slip ring and bearing with tape to prevent contamination.

Remove the rotor from the end frame. Extract the retainer plate screws and remove the retainer plate and the end frame bearing. Remove the three attaching screws and separate the stator from the end frame. Remove the heat sink.

Wash all metal parts with the exception of the stator and rotor assemblies. The rotor slip rings may be cleaned with 400 grain polishing cloth. It is a good idea to rotate the rotor while doing this to guard against rubbing flat spots on the slip rings. Maximum out-of-round tolerance for slip rings is 0.001 in. Remove as little metal as possible when truing on a lathe. Polish with 400 grain cloth and blow dry. To assemble the alternator: Attach the slip-ring end frame to the stator assembly and position the diode connectors above the diode, relay, and stator leads. Tighten the terminal nuts, then slide the front end frame over the rotor. Slide on the spacer, pulley, washer, and nut, and torque the shaft to 50-60 ft. lbs. Attach the slip-ring end frame and stator to the rotor and drive end frame assembly and insert and tighten the thru-bolts.

Externally Regulated Type—"Perforated Case" Models

1. Mount the alternator in a vise, clamping the drive end mounting flange lengthwise.

2. Remove the two screws which secure the cover to the brush holder and remove the cover.

3. Remove the nut which retains the indicator light wire to the blade connector post. Disconnect the wire from the connector post.

4. Remove the two brush holder assembly attaching screws and remove the brush holder.

NOTE: *The capacitor lead is connected inside the alternator; the capacitor must stay*

with the alternator to avoid overstressing the lead wire.

5. Scribe alignment marks to indicate the relationships between the end frames and the main base. These components must be properly aligned during assembly.

6. Remove the slip ring (rear) end frame attaching bolts (3) and carefully pry the end frame off of the main case assembly. Pry around the circumference of the frame to avoid damaging the frame.

7. Remove the drive end frame attaching bolts (3).

8. Remove the end frame, rotor, and pulley as an assembly.

9. Remove the shaft nut, washer, pulley, and woodruff key from the rotor shaft and slide the rotor out of the end frame.

10. If you plan to test the diodes and stator, disconnect the stator leads from the diodes using either of the following methods.

a. Cut the leads between the stator windings and the diodes

b. Scrape the epoxy coatings from the leads and unsolder the leads from the diodes.

CAUTION: If you choose method "b", be sure to use a minimum amount of heat to avoid damage to the diodes.

11. Remove the heat sink retaining screws and remove the heat sinks. Remember that the insulated heat sink contains the positive diodes and that the insulated heat sink is the one with the "batt" terminal.

12. Testing and/or replacement of bearings or diodes should be performed at this time, if necessary.

Assembly of the alternator is the reverse of the previous steps. Note the following points during assembly:

a. Refer to the illustration which accompanies the "Brush and Holder Replacement" procedure for wiring information.

b. Solder the stator lead-to-diode connections, if separated during step 10.

c. Align the scribed marks made during disassembly.

d. Lightly clamp the pulley in a soft-jawed vise when installing the pulley nut. Torque the pulley nut to 50-60 ft. lbs.

e. When installing the brush holder, push each brush into the holder and retain with a straightened paper clip during installation. Remove the clip after the holder is installed.

Internally Regulated Type

1. Place alternator in a vise, clamped by the mounting flange only.

2. Remove the four through bolts and separate the slip ring end frame and stator assembly from the drive end and rotor assembly, using a screwdriver to pry the two sections apart. Use the slots provided for the purpose.

NOTE: Scribe matchmarks on the parts to aid in assembly.

3. Place a piece of tape over the slip ring end frame bearing to prevent entry of dirt; also tape shaft at slip ring end to prevent scratches.

4. Clean brushes, if they are to be reused, with trichloroethylene or carbon tetrachloride solvent. Use these solvents only in an adequately ventilated area.

5. Remove the stator lead nuts and separate the stator from the end frame.

6. Remove the screw that secures the diode trio and remove diode trio.

NOTE: At this point, test the rotor, rectifier bridge, stator and diode trio if these tests are necessary.

1. Remove the rectifier bridge hold-down screw and the BAT terminal screw, then disconnect condenser lead. Remove rectifier bridge from end frame.

8. Remove the two securing screws and brush holder and regulator assemblies. Note the insulating sleeves over the screws.

9. Remove the retaining screw and condenser from the end frame.

10. Remove the slip ring end frame bearing, if it is to be replaced, using the procedure given later in this section.

11. Remove the pulley nut, washer, pulley, fan and spacer from the rotor shaft, using a $\frac{5}{16}$ in. allen key to hold the shaft while loosening the nut.

12. Remove rotor and spacers from drive end frame assembly.

13. Remove drive end frame bearing retainer plate, screws, plate, bearing, and slinger from end frame, if necessary.

14. To assemble, reverse order of disassembly. Pulley nut must be tightened to 40-50 ft. lbs.

CLEANING AND INSPECTION

1. Clean all metal parts, except stator and rotor assemblies, in solvent.

2. Wipe off bearings and inspect them for pitting or roughness.

3. Inspect rotor slip rings for scoring. They may be cleaned with 400 grit sandpaper (not emery), rotating the rotor to make the rings concentric. Maximum out-of-true is 0.001 in. If slip rings are deeply scored, the entire rotor must be replaced as a unit.

4. Inspect brushes for wear; minimum length is $\frac{1}{4}$ in.

ALTERNATOR COMPONENT TESTING

Rotor *

Attach one lead of a 110 volt test lamp or an ohmmeter to either slip ring, and the other lead to the rotor shaft or poles. A lighted test lamp or low ohmmeter reading indicates grounded field windings.

Attach the lamp or ohmmeter connections to each slip ring. The windings are open if the lamp fails to light or the ohmmeter reading is high.

Connect a 12 volt battery and an ammeter in series with the slip rings to check for shorts. The windings are shorted if the reading exceeds 1.5 amps. An ohmmeter may be substituted for the same check and will show a resistance reading of less than 6 ohms if the windings are shorted.

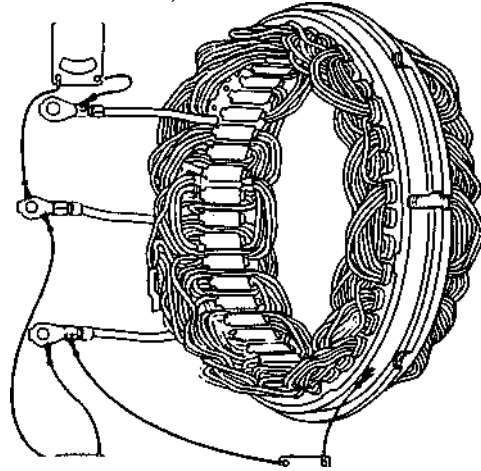
Stator

Attach the test lamp or ohmmeter to the stator frame and one of the stator leads. A lighted lamp or low resistance reading indicates grounded windings.

Successively connect the test equipment between each pair of stator leads. Open windings will produce a high resistance and prevent the test lamp from lighting.

Shorts require special test equipment. If

TESTING STATOR (CHECK FOR OPENS)



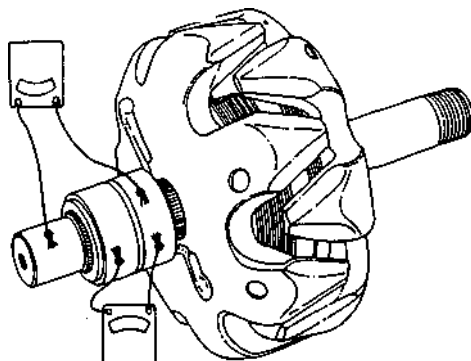
OHMMETER

OHMMETER
(CHECK FOR
OPENS)

OHMMETER
(CHECK FOR
GROUNDS)

Stator testing—except "perforated case" models

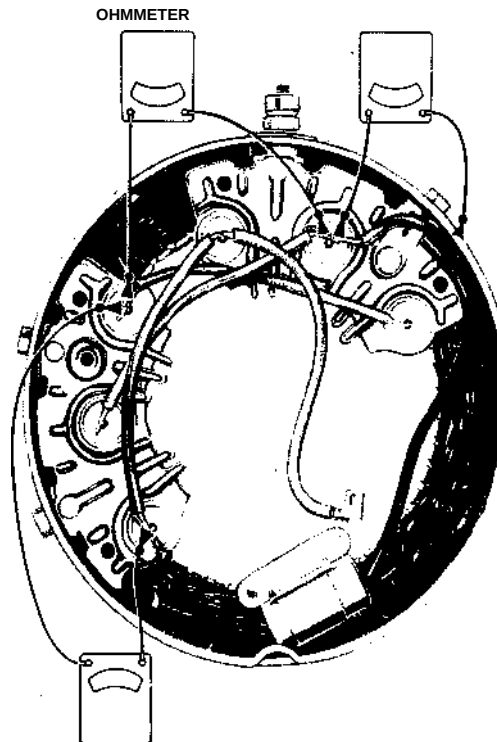
(CHECK FOR OPENS) TESTING ROTOR



OHMMETER
CHECK FOR OPENS

Rotor testing

(GROUNDSCOHHMMETER).



OHMMETER

OHMMETER

Stator testing—"perforated case" models

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all other tests fail to locate the problem, it is more than likely a short in the stator.

Separately Mounted Diodes (Pressed-in Type)

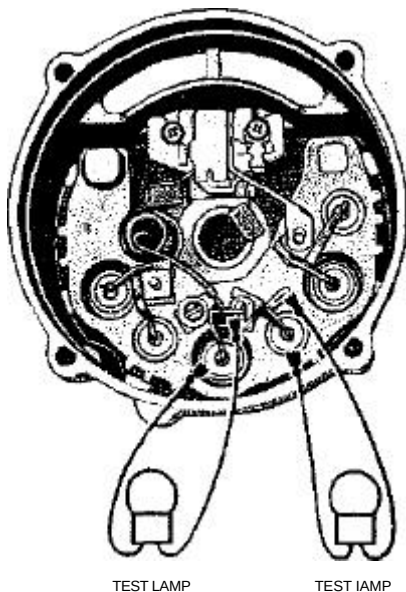
The diodes may be checked for shorts or opens by using an ohmmeter or a 12 volt test lamp.

CAUTION: Under no circumstances use a 110 volt test lamp.

Use a $V/2$ volt cell ohmmeter that has been adjusted to the lowest range scale. Attach one lead to the heat sink and the other to the diode lead. A good diode will show a high and a low reading depending on the connection switch. Two low or two high readings signal a faulty diode. Check the other diodes in the same manner. When servicing "perforated case" models, repeat this for the diodes in BOTH heat sinks.

Check the end-frame mounted diodes by connecting one test lead to the frame and the other to the diode lead. Reverse the connection and check the readings. The same diagnosis is true here as for the heat sink diodes.

If an ohmmeter is not available, substitute a 12 volt test lamp. Connect and switch connections in the same fashion as with the ohmmeter. The lamp will light in only one direction. If it lights or fails to light in both directions, the diode is bad.



Diode check

Diode Rectifier Bridge

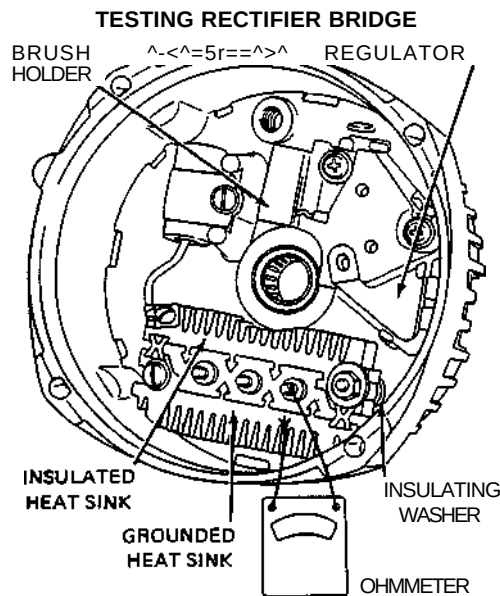
Refer to the accompanying illustration for component identification. Use a self-powered ohmmeter set on its lowest reading scale.

CAUTION: DO NOT use a 110 volt test lamp to test the rectifier bridge—use only a self-powered ohmmeter.

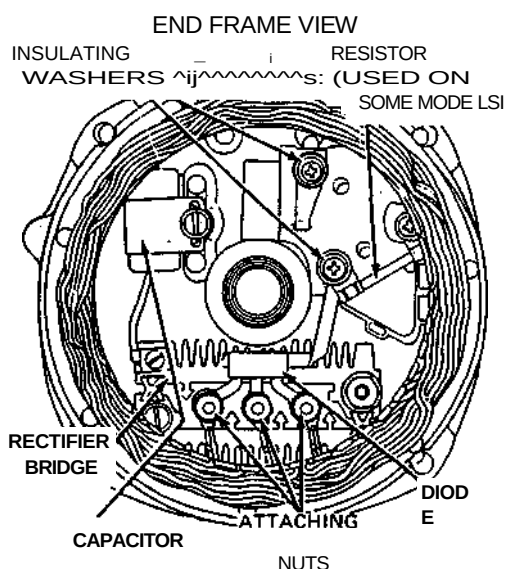
Connect one ohmmeter lead to the grounded heat sink. Connect the other lead to each of the three rectifier bridge terminals (one at a time) and note the ohmmeter readings (1st set). The readings at each of the bridge terminals should be virtually identical. Reverse the ohmmeter leads and repeat the test, again noting the meter readings (2nd set).

Connect one ohmmeter lead to the insulated heat sink. Connect the other lead to each of the three rectifier bridge terminals (one at a time) and note the ohmmeter readings (3rd set). Reverse the ohmmeter leads and repeat the test, again noting the meter readings (4th set).

Readings taken for any one full set should be virtually identical, conversely, if you get two different readings WITHIN the same set, replace the rectifier bridge assembly. When comparing readings between sets 1 and 2, one set should read high, the other low. When comparing readings between sets 3 and 4, again, one set should be high, the other low.



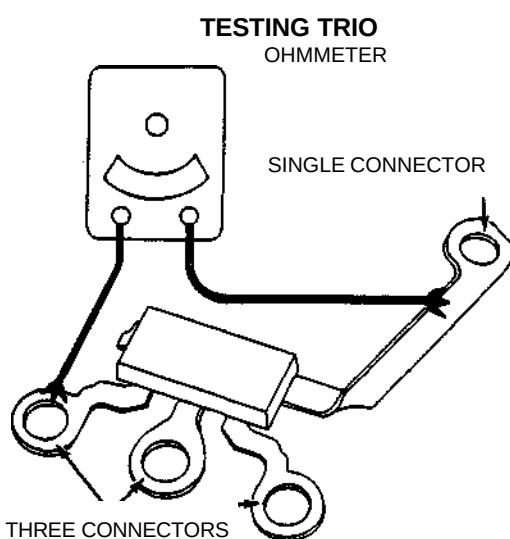
Rectifier bridge check



Location of diode trio

Diode Trio

CAUTION: DO NOT use a 110 volt test lamp to test the diode trio—use only a self-powered ohmmeter. Set the ohmmeter lead to the single terminal of the diode trio. Connect the other lead to each terminal (one at a time) of the three terminal grouping, and note the ohmmeter reading at each terminal (1st set). Reverse the ohmmeter leads and repeat the same test, again noting the ohmmeter readings (2nd set). Ohmmeter readings WITHIN one set should be virtually identical. When comparing readings BETWEEN each set, one set should be high, the other low.



Diode trio check

REPAIRS

Pressed-in Diode Replacement

Despite rumors to the contrary, diodes of this type may be replaced. It is not necessary to replace the entire generator assembly as some unscrupulous garage owners convinced their unwary customers in the introductory days of the AC generator.

Two types of diodes, positive and negative, are used in the AC generator. The heat sink contains the positive diodes and these are marked with red. End frame diodes are the negative ones and they have black markings. Do not attempt to drive a diode from its bore or the other diodes may be damaged.

Support the end frame in an arbor press, select a suitable removal spacer, and press the diode from the frame. Use the same method to install a replacement diode.

To replace heat sink diodes (which includes all of the diodes of "perforated case" models), it is necessary to separate the heat sink from the frame. Observe the stack-up closely to ensure correct reassembly of the BAT and GRD terminal bolts. Replace the diodes as described above, reassemble the bolt stack-ups and attach the heat sink to the end frame.

Bearing Replacement

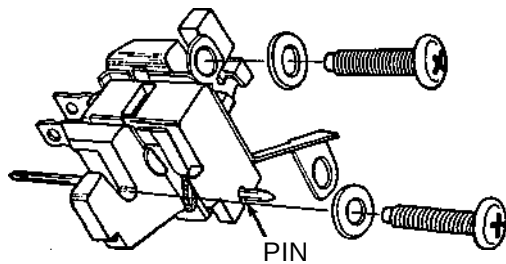
The drive end frame bearing is removed by detaching the retainer frame from the end plate and pressing the bearing out. Fill the bearing with full with multipurpose grease; do not overfill. Press the bearing into the end frame. Install the retainer plate.

The slip ring end frame bearing of the 6 in. "perforated-case" generator is pressed off the rotor shaft. The replacement is pressed over the rotor shaft by using an arbor press.

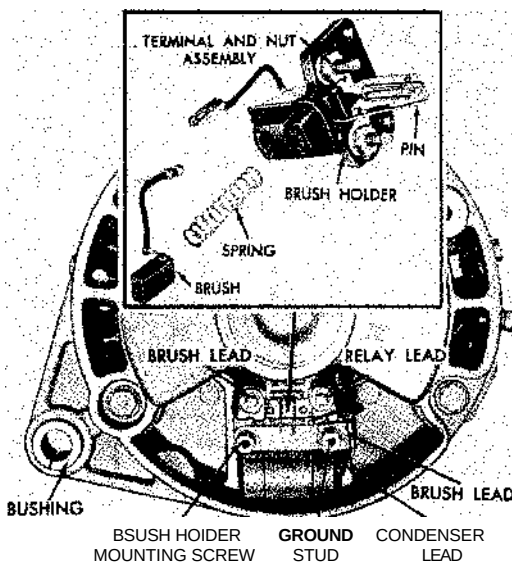
The 5.5 in. aluminum Delcotron slip-ring end bearing is replaced by pressing it out towards the inside of the case. To install the replacement, position a flat plate over the bearing and press it into the outside of the case. Press all bearings and diodes flush with their receptacles.

Brush and Holder Replacement

NOTE: It is always easier and worth the minimal extra cost to replace the brushes with their holder. For some models, brushes themselves are not serviced separately. For externally regulated models, except the "perforated case" Delcotron:



Brush holder—Externally regulated Delcotron, except "perforated case" models



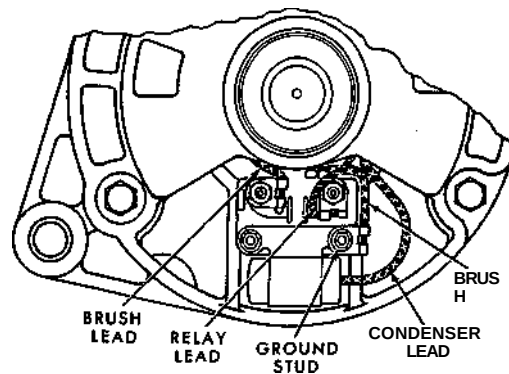
Brush holder—"perforated case" Delcotron

1. Remove the stator lead nut that also holds the relay terminal connector.
2. Remove the two mounting screws and the brush holder assembly.
3. When installing the new brush holder assembly, depress the brushes and insert a straightened paper clip through the holes provided in the holder for brush retention.
4. Install the brush holder assembly.
5. Remove the paper clip after the alternator is assembled.

For externally regulated models of the "perforated case" type:

If the alternator was disassembled according to the previous procedure, just install the new brush holder during assembly. If the alternator has not yet been disassembled, refer to steps 1—4 and 12e of the previous Disassembly and Assembly procedure to replace the brush holder. For internally regulated Delcotrons:

NOTE: This procedure also includes re-



Brush holder wiring—"perforated case" Delcotron

placement of the internal voltage regulator.

1. Remove two brush holder screws and stator lead to strap nut and washer, brush holder screws and one of the diode trio lead strap attaching screws.

NOTE: The insulating washers must be replaced in the same position on reassembly.

2. Remove brush holder and brushes. The voltage regulator may also be removed at this time, if desired.

3. Brushes and brush springs must be free of corrosion and must be undamaged and completely free of oil or grease.

4. Insert spring and brushes into holder, noting whether they slide freely without binding. Insert wooden or plastic toothpick into bottom hole in holder to retain brushes.

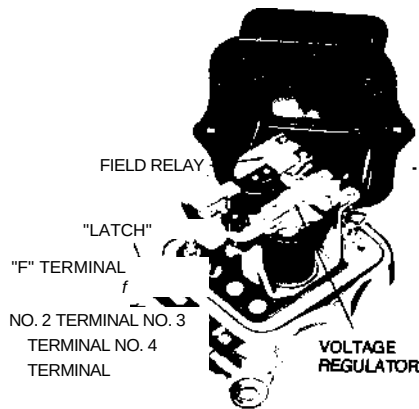
NOTE: The brush holder is serviced as a unit; individual parts are not available.

5. Reassemble in reverse order of disassembly.

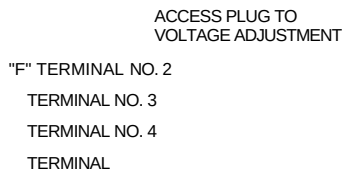
Voltage Regulator

Three types of voltage regulators have been used in the Corvette since 1963. The first type of regulator, hereafter referred to as Type One, is a double-contact model which is mounted externally, separately from the alternator. The Type One regulator was used on most 1963-68 and some 1969 Corvettes. This regulator is housed in a basically square, black metal case and has four electrical terminals.

The second type of regulator, hereafter called Type Two, is a transistorized model which was offered as an option with the transistorized ignition system in 1965. The Type Two regulator is externally mounted and uses: a) one transistor which assists in limiting the voltage to a preset value, and b) two diodes



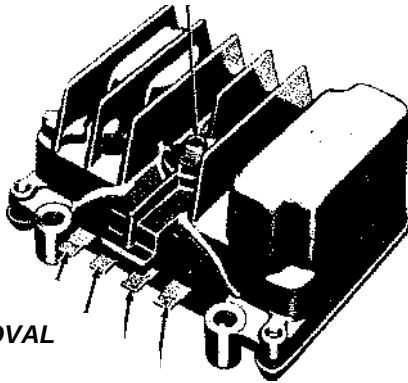
Type One voltage regulator



Type Two voltage regulator

which protect the system from transient voltage which may occur. The Type Two regulator is easily identified by the finned regulator casing.

The third type of regulator, hereafter called Type Three, is mounted inside of the Delcotron alternator. This electronic regulator, used in some 1969 and all later Corvettes, is non-adjustable and must be replaced if defective.



REMOVAL AND

INSTALLATION Types One and Two

1. Disconnect the negative battery cable at the battery.
2. Disconnect the wiring harness from the regulator.
3. Remove the regulator mounting screws and remove the regulator.
4. Installation is the reverse of the previous steps. Be sure that the regulator base is

properly grounded and do not overtighten the mounting screws, as this will cancel the cushioning effect of the rubber grommets.

Type Three

1. Remove the alternator from the vehicle as previously outlined.

2. Scribe a line on the alternator case from front-to-rear which will aid in attaining the proper relationships between components during assembly.

3. Remove the four through-bolts which join the end frame assemblies.

4. Separate the end frames by carefully prying between the drive (front) end frame and the stator. DO NOT pry between the slip ring (rear) end frame and the stator. The stator is wired to the rectifier bridge which is attached within the rear end frame.

5. Disconnect the three stator wire terminals at the rectifier bridge connections.

6. Remove the stator from the slip ring end frame. It may be necessary to carefully pry the stator from the frame.

7. Remove the three screws which retain the brush holder and regulator. Note the positions of the two screws which are equipped with plastic insulating washers—these screws MUST be installed in their original locations.

NOTE: Some alternators also have a resistor which is installed between the regulator and brush ground terminals. Note its position and reinstall it in the same manner.

8. Lift the brush holder and regulator out of the alternator frame.

9. The regulator is installed in the reverse of the previous steps. Before installing the brush holder, push the brushes into the holder and insert a straightened paper clip through the holes provided in the holder for brush retention. Remove the paper clip after the alternator is assembled.

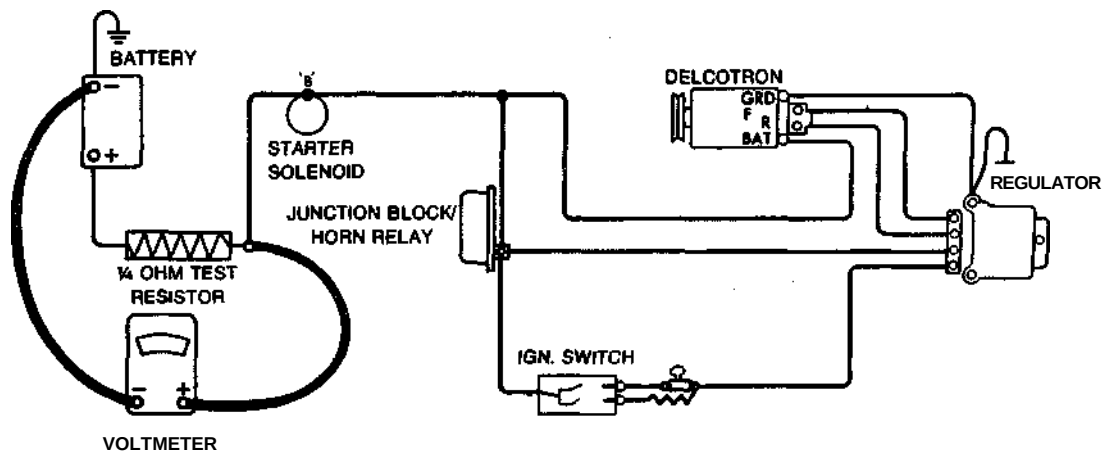
VOLTAGE ADJUSTMENT

Types One and Two Only

The adjustment procedure is the same for both types of regulators, except for the locations where the adjustment is made. On the Type One regulator, the adjustment screw is under the regulator cover; the Type Two regulator is adjusted externally after removing the alien screw from the adjustment screw access hole.

1. Insert a 10 ohm-25 watt fixed resistor into the charging circuit at the horn relay

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Schematic for testing the regulator voltage setting

junction block, as shown in the accompanying illustration.

2. Install a voltmeter as shown in the accompanying illustration.
3. Warm the engine by running it for about fifteen minutes at 1500 rpm or more.
4. Disconnect the regulator connector and reconnect it to cycle the regulator.
5. Read the voltage on the voltmeter. If the voltage reading is 13.5-15.2 volts, the regulator does not need adjustment or replacement. If the voltage is not within these limits, leave the engine running at 1500 rpm and proceed to step 6.
6. On Type One regulators, disconnect the regulator connector and remove the regulator cover. Reconnect the regulator connector. On Type Two regulators, remove the adjustment screw access plug from the regulator case (the plug is actually an alien screw).
7. Observe the voltmeter reading and turn the voltage adjustment screw until the voltmeter reads 14.2-14.6 volts.
8. On Type One regulators, disconnect

the regulator connector, install the cover and reconnect the regulator connector.

9. Continue running the engine at 1500 rpm to re-establish the internal temperature of the regulator (Type One only).

10. Again, cycle the regulator by disconnecting and reconnecting the regulator connector.

11. Recheck the voltmeter reading: If it is between 13.5 and 15.2 volts, the regulator is good; if not, replace the regulator.

CAUTION: On Type One regulators, always disconnect the regulator connector before removing the regulator cover, to prevent short circuits.

12. On Type Two regulators, If the voltmeter reading is okay, reinstall the access hole plug.

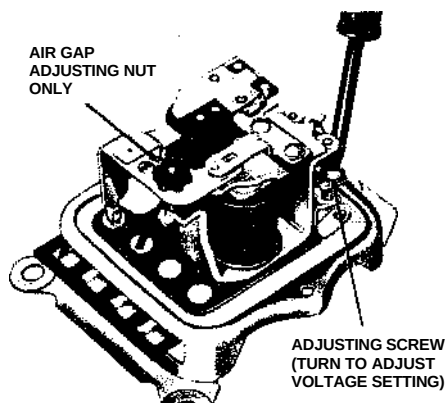
VOLTAGE TESTING

Type Three Regulator Only

Though other tests of the internal voltage regulator exist, the following test is quite accurate and requires a minimum of tools.

NOTE: The following test must be performed with the engine at normal operating temperature.

1. Attach one lead of a voltmeter to the "BAT" terminal of the alternator and the other lead to a good ground.
2. Start the engine and operate at about 1500 rpm.
3. Observe the voltmeter reading: If it is approximately 13.5-15.2 volts, the regulator is properly limiting the voltage to the battery. If the voltage is above about 15.2 volts, replace the voltage regulator as previously described. If the voltage is below 13 volts, locate the test hole in the rear end frame of



Type One voltage regulator—voltage adjustment

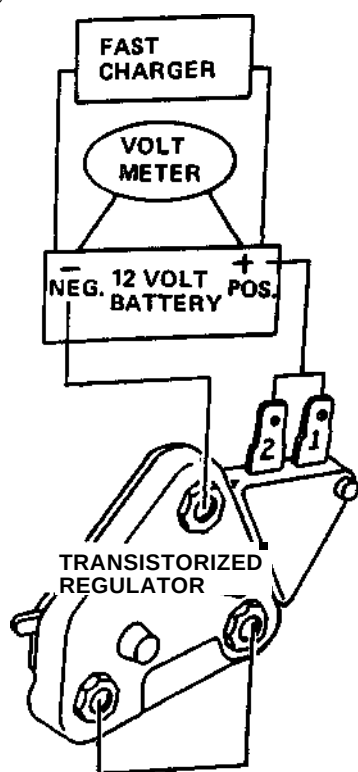
the alternator (refer to the illustration under Alternator Tests.) Insert a screwdriver into the test hole about $\frac{1}{2}$ " to depress the field grounding tab. Under no circumstances should you push the screwdriver further than 1" into the alternator. If the voltage reading increases as the screwdriver is put into the test hole, the alternator is functioning properly and the regulator must be replaced. If the voltage reading did not increase with the insertion of the screwdriver, the alternator must be disassembled and tested.

NOTE: If the test hole is not accessible, remove the alternator and test the following components: rotor, stator, rectifier bridge, diode trio, and brushes ($\frac{1}{2}$ " minimum length). Replace any component which may be defective. If these components are okay, replace the voltage regulator.

TESTING TYPE THREE REGULATOR OFF THE CAR

NOTE: This test requires the use of a fast charger.

1. Remove the voltage regulator from the alternator.
2. Connect voltmeter and fast charger to battery as shown.



TEST LIGHT Testing
voltage regulator on the bench

3. Connect regulator and test light as shown, observing battery polarity.

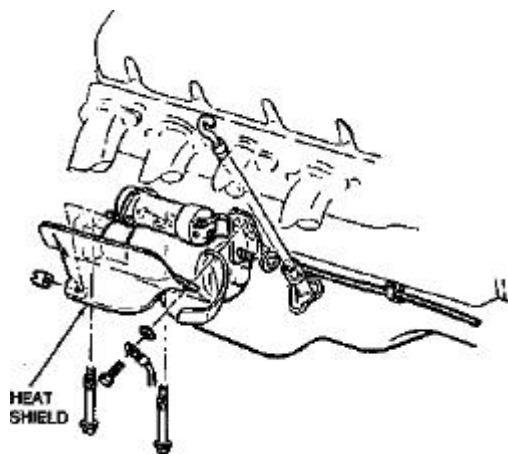
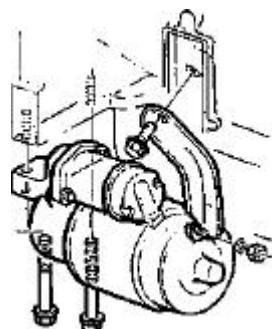
4. The test light should be on when connected.

5. Turn on the fast charger and slowly increase the charge rate. Check the voltmeter and make sure that the test light goes out at a minimum of 13.5 volts, and a maximum of 16.0 volts.

Starter

REMOVAL AND INSTALLATION

1. Disconnect the battery cables at the battery.
2. Raise the front of the vehicle to a convenient working height and support with jackstands.
3. Disconnect the wiring from the starter solenoid. Replace each connector nut as the terminals are removed as the thread sizes differ between connectors. Note or tag the wiring positions to avoid improper connections during installation.
4. Remove the front starter support bracket and the heat shield (if so equipped).



Starter mounting—small block (top) and big block (bottom)

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Alternator and Regulator Specifications

Alternator					Regulator						
Year	Model	Field Current Draw @12V	Output @ Generator RPM		Model	Field Relay			Regulator		
			2000	5000		Air Gap (in.)	Point Gap (in.)	Volts to Close	Air Gap (in.)	Point Gap (in.)	Volts at 125°
1963-64	1100628	1.9-2.3	27A	37A	1119512	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
1965-67	1100693	2.2-2.6	27A	37A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
	1100696	2.2-2.6	29A	42A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
1968	1100693	2.2-2.6	27A	37A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
	1100794	2.2-2.6	27A	37A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
	1100696	2.2-2.6	29A	42A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
1969	1100696	2.2-2.6	27A	37A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
1970	1100900	2.2-2.6	27A	37A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
	1100901	2.2-2.6	27A	37A	1119515	0.015	0.030	2.3-3.7	0.067	0.014	13.5-14.4
1971-72	1100544	4-4.5	®	®	1119515	0.015	0.030	1.5-3.2	0.067	0.014	13.8-14.8
	1100543,1100950	4-4.5	®	37A	1119515	0.015	0.030	1.5-3.2	0.067	0.014	13.8-14.8
	1100566	2.2-2.6	25A	35A	1119515	0.015	0.030	1.5-3.2	0.067	0.014	13.8-14.8

[illegible]

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5. Loosen the two main starter mounting bolts, support the starter and remove the bolts. Lower the starter front end first and remove the starter.

6. Reverse the previous steps to install the starter. Torque the two main starter mounting bolts to 25-35 ft. lbs.

STARTER OVERHAUL

Drive Replacement

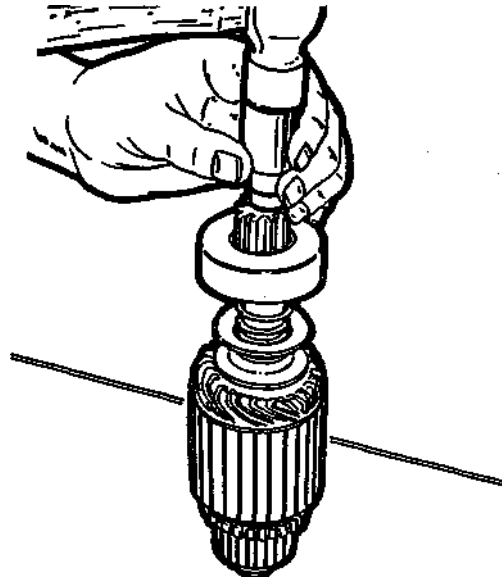
1. Disconnect the field coil straps from the solenoid.

2. Remove the two starter through bolts. Separate the commutator end frame, field frame, drive housing, and armature from each other.

3. Slide the two-piece thrust collar off of the end of the armature shaft.

4. Slide a $\frac{1}{2}$ " deep socket or a piece of pipe of suitable size over the drive end of the armature shaft and against the snap-ring retainer. Carefully tap the socket or pipe towards the armature to drive the retainer off of the snap-ring.

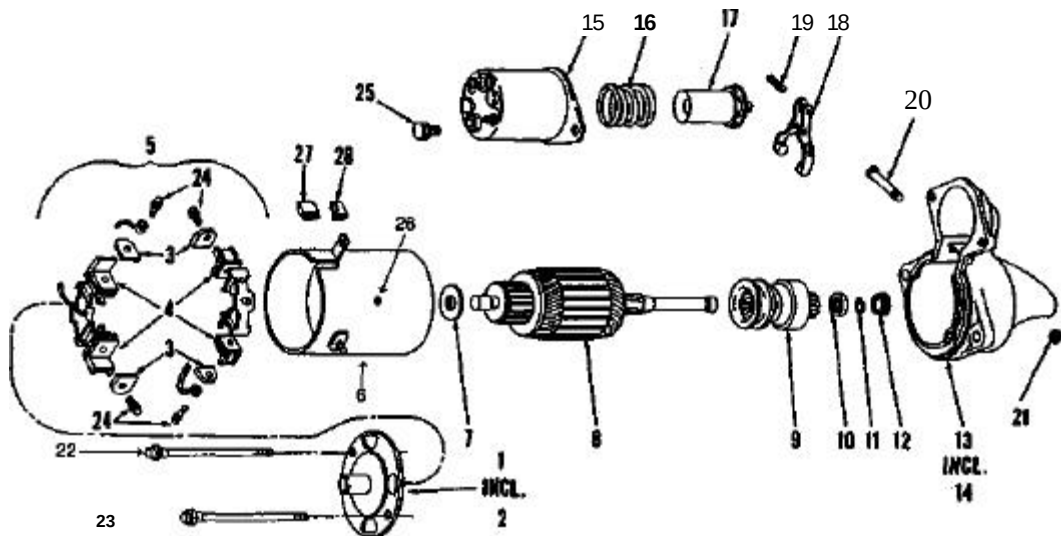
5. Remove the snap-ring from the armature shaft. Be careful, as the snap ring will



Use a piece of pipe to drive the retainer toward the snap-ring

distort rather easily. If the snap ring is distorted after removal, it must be replaced.

6. Slide the starter drive and retainer from the armature shaft.



1. Commutator end frame
2. Bushing (not pictured)
3. Brush
4. Brush holder
5. Brush and holder package
6. Field and frame assembly
7. Washer
8. Armature
9. Drive assembly
10. Retainer

11. Snap-ring
12. Thrust washer
13. Drive end housing
14. Bushing (not pictured)
15. Solenoid assembly
16. Plunger spring
17. Plunger
18. Lever
19. Roll pin
20. Lever pivot bolt

21. Lever bolt nut
22. Through bolt
23. Through bolt
24. Brush screw
25. Bolt
26. Field retaining screw
27. Plug
28. Grommet

Exploded view of the starter

7. To reassemble, lubricate the drive end of the armature shaft with silicone lubricant and slide the starter drive onto the shaft with the pinion gear facing away from the armature. Slide the retainer onto the shaft with the cupped portion facing away from the armature.

8. Support the armature assembly in a vertical fashion with the drive end pointing upward. Position the snap ring on the top of the shaft, and carefully place a block of wood on the snap ring. Keep the snap ring centered. Tap the block of wood to drive the snap ring onto the shaft. Using a deep socket that will fit around the shaft without interference and yet contact the snap ring, force the snap ring downward into its groove on the shaft.

9. Place the thrust washer on the shaft. Using two pairs of pliers as shown in the accompanying illustration, force the snap-ring retainer over the snap ring and engage it with the thrust washer.

10. Lubricate the drive housing bushing

with silicone lubricant. Install the armature and clutch assembly into the drive housing, engaging the solenoid shift lever with the clutch, and positioning the front end of the armature shaft into the drive housing bushing.

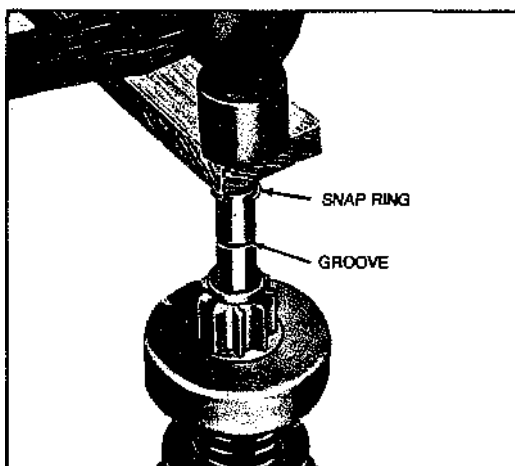
11. Apply a sealing compound (G.M. #1050026 or its equivalent) to the drive housing around the area where the field frame mates with the housing.

12. Slide the field frame assembly over the armature and guide the brushes over the armature commutator. Continue to push the field frame until the frame mates to the drive housing. Work slowly and carefully to prevent brush damage.

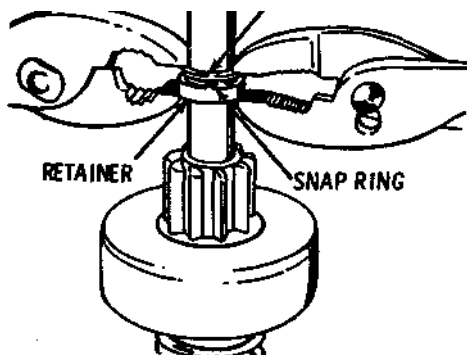
13. Lubricate the bushing in the commutator end frame with silicone lubricant, being careful not to get the lubricant on surrounding components.

14. Place the leather washer onto the armature shaft and slide the commutator end frame over the shaft and into position against the field frame. Line up the bolt holes, then install and tighten the two starter through bolts.

NOTE: If replacement of the starter drive fails to cure improper engagement of the starter pinion to the flywheel, there are probably defective parts in the solenoid and/or shift lever. In this case, it would probably be best to take the starter assembly (incl. solenoid) where a pinion clearance check can be made. If the pinion clearance is incorrect, disassemble the solenoid and shift lever. Inspect these parts and replace as necessary.



Forcing snap-ring over the armature shaft



Snap-ring installation

Brush Replacement

1. Disassemble the starter by following Steps 1 and 2 of the previous Drive Replacement procedure.

2. Replace the brushes one at a time to avoid having to mark the wiring. For each brush: Remove the brush retaining screw and remove the old brush. Install the new brush in the same direction (large end towards the end of the field frame). Position the wire connector on the top of the brush, line up the holes and reinstall the screw. Make sure the screw is snug enough to ensure good contact.

3. Reassemble the starter according to Steps 10—14 of the previous procedure.

Solenoid Replacement

1. Remove the screw and washer from the motor connector strap terminal.

General Engine Specifications

Year	Engine Displacement (CM in.)	Fuel Delivery System	Horsepower (ffirpmn	Torque @ rpm (ft. lbs.)«	Bore and Stroke (in.)	Compres-sion Ratio	CH Pressure @2000 rpm
1963-64	327	4bbl	250 @ 4400	350 @ 2800	4.00 x 3.25	10.5:1	45
	327	4bbl	300 @ 5000	360 @ 2800	4.00 x 3.25	10.5:1	45
1963	327	4bbl	340 @ 6000	344 @ 4000	4.00 X 3.25	11.25:1	45
	327	Fuel Inj	360 @ 6000	352 @ 5000	4.00 x 3.25	11.0:1	45
1964	327	4bbl	365 @ 6200	360 @ 3600	4.00 x 3.25	11.0:1	45
	327	Fuel Inj	375 @ 6200	350 @ 4000	4.00 x 3.25	11.0:1	45
1965	327	4bbl	250 @ 4400	350 @ 2800	4.00 x 3.25	10.5:1	45
	327	4bbl	300 @ 5000	360 @ 3200	4.00 x 3.25	10.5:1	45
	327	4bbl	350 @ 5800	360 @ 3800	4.00 x 3.25	11.0:1	45
	327	4bbl	375 @ 6200	350 @ 4000	4.00 x 3.25	11.0:1	45
	327	Fuel Inj	365 @ 6200	350 @ 4600	4.00 x 3.25	11.0:1	45
	396	4bbl	425 @ 6400	41 5 @ 4000	4.094 x 3.76	11.0:1	45
1966	327	4bbl	300 @ 5000	360 @ 3200	4.00 x 3.25	10.5:1	45
	327	4bbl	350 @ 5800	360 @ 3600	4.00 x 3.25	11.0:1	45
	427	4bbl	390 @ 5200	460 @ 3600	4.25 x 3.76	10.25:1	60
	427	4bbl	425 @ 5600	460 @ 4000	4.25 x 3.76	11.0:1	60
1967-68	327	4 bbl	300 @ 5000	360 @ 3400	4.00 x 3.25	10.0:1	45
	327	4bbl	350 @ 5800	360 @ 3600	4.00 x 3.25	11.0:1	45
	427	4bbl	390 @ 5400	460 @ 3600	4.25 x 3.76	10.25:1	65
	427	3-2 bbl	400 @ 5400	460 @ 3600	4.25 x 3.76	10.25:1	65
	427	3-2 bbl	435 @ 5800	460 @ 4000	4.25 X 3.76	11.0:1	65
	4 27®	4 bbl	430 @ 5200	450 @ 4400	4.25 x 3.76	12.0:1	65
1969	350	4 bbl	300 @ 4800	380 @ 3200	4.00 x 3.48	10.25:1	45
	350	4 bbl	350 @ 5600	380 @ 3200	4.00 x 3.48	11.0:1	45

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General Engine Specifications (cont.)

Year	Engine Displacement (cu In.)	Fuel Delivery System	Horsepower @rpmB	Torque @ rpm (ft. lbs.)e	Bore and Stroke (in.)	Compression Ratio	Oil Pressure @2000 rpm
1979	350	4bbl	195 @ 4000	285 @ 3200	4.000 x 3.480	8.2:1	45
	350	4bbl	225 @ 5200	270 @ 3600	4.000 x 3.480	8.9:1	45
1980	305	4bbl	180 @ 4200	255 @ 2000	3.736 x 3.480	8.5:1	45
	350	4bbl	190 @ 4400	280 @ 2400	4.000 x 3.480	8.5:1	45
	350	4bbl	230 @ 5200	275 @ 3600	4.000 x 3.480	9.0:1	45
1981	350	4bbl	190 @ 4200	280 @ 1600	4.000 x 3.480	8.2:1	45
1982	350	TBI®	200 @ 4200	285 @ 2800	4.000 x 3.480	9.0:1	45
1984	350	TBI®	205 @ 4300	290 @ 2800	4.000 x 3.480	9.0:1	45

•Beginning 1972, horsepower and torque are SAE net figures. They are measured at the rear of the transmission with all accessories installed and operating. Since the figures vary when a given engine is installed in different models, some are representative rather than exact. ® Limited production engine L88, for special purposes © Not available in California <D Throttle body fuel injection

Valve Specifications

Year	Engine Displacement (cu in.)	Seal Angle (deg)	Face Angle (deg)	Spring Test Pressure (lbs. @ in.)	Spring Installed Height (in.)	Stem to Guide Clearance (in.)		Stem Diameter (in.)	
						Intake	Exhaust	Intake	Exhaust
1963-64	327	46	45	175 @ 1.26	1.66	0.0010-0.0027	0.0016-0.0033	0.3404-0.3417	0.3410-0.3417
	327 (High Pert)	46	45	175 @ 1.26	1.66	0.0010-0.0027	0.0016-0.0033	0.3404-0.3417	0.3410-0.3417
1965-66	327	46	45	175 @ 1.26	1.66	0.0010-0.0027	0.0016-0.0033	0.3404-0.3417	0.3410-0.3417
	327 (350 hp)	46	45	175 @ 1.26	1.66	0.0010-0.0027	0.0016-0.0033	0.3410-0.3417	0.3410-0.3417
	327 (fuel inj)	46	45	175 @ 1.26	1.66	0.0010-0.0027	0.0016-0.0033	0.3410-0.3417	0.3410-0.3417
	396	46	45	315 @ 1.38	1%	0.0005-0.0024	0.0012-0.0029	0.3715-0.3722	0.3713-0.3720
	427	46	45	315 @ 1.38	1.88	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3720
	427 (425 hp)	46	45	315 @ 1.38	1.88	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3720
	427 (425 hp)	46	45	315 @ 1.38	1.88	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3720
1967	327 (300 hp)	46	45	200 @ 1.25	1% ²	0.0010-0.0027	0.0015-0.0032	0.3410-0.3417	0.3410-0.3417
	327 (350 hp)	46	45	200 @ 1.25	1 ⁻ /32	0.0010-0.0027	0.0015-0.0032	0.3410-0.3417	0.3410-0.3417
	427 (390, 400 hp)	46	45	NA	NA	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3720
	427 (435 hp)	46	45	315 @ 1.38	1 ⁻ /8	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3720
1968	327 (exc 350 hp)	46	45	198 @ 1.25	1.70	0.0010-0.0027	0.0017-0.0027	0.3410-0.3417	0.3410-0.3417
	327 (350 hp)	46	45	198 @ 1.25	1.70	0.0010-0.0027	0.0017-0.0027	0.3410-0.3417	0.3410-0.3417
	427 (exc 435 hp)	46	45	315 @ 1.38	1.88	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3722
	427 (435 hp)	46	45	315 @ 1.38	1.88	0.0010-0.0027	0.0015-0.0032	0.3715-0.3722	0.3713-0.3722
1969	350	46	45	200 @ 1.25	1.70	0.0010-0.0027	0.0010-0.0027	0.3410-0.3417	0.3410-0.3417
	350 (350 hp)	46	45	200 @ 1.25	1.70	0.0010-0.0027	0.0010-0.0027	0.3410-0.3417	0.3410-0.3417
	427 (390, 400 hp)	46	45	312 @ 1.38	1.88	0.0010-0.0027	0.0010-0.0027	0.3715-0.3722	0.3713-0.3722
	427 (435 hp)	46	45	312 @ 1.38	1.88	0.0010-0.0027	0.0010-0.0027	0.3715-0.3722	0.3713-0.3722
1970	350	46	45	80 @ 1.70	1 ⁻ ^ 3 2	0.0010-0.0037	0.0010-0.0047	0.3414	0.3414
	454	46	45	75 @ 1.88®	1%	0.0010-0.0037	0.0010-0.0047	0.3718	0.3817
	454®	46	45	75 @ 1.88®	1%	0.0010-0.0037	0.0010-0.0047	0.3718	0.3718

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Crankshaft and Connecting Rod Specifications (cont.)

All measurements are given in inches

Year	Engine	Crankshaft				Connecting Rod		
		Main Big Journal Dia	Main Big Oil Clearance	Shaft End-Play	Timist on No.	Journal Diameter	Oil Clearance	Side Clearance
1972	454 (425 hp)	2.7481-2.7490®	0.0013-0.0025®	0.006-0.010	5	2.1985-2.1995	0.0009-0.0025	0.019-0.025
	350	2.4484-2.4493®	0.0008-0.0020®	0.002-0.006	5	2.0990-2.1000	0.0013-0.0035	0.008-0.014
	350 (255 hp)	2.4484-2.4493®	0.0013-0.0025®	0.002-0.006	5	2.0990-2.1000	0.0013-0.0035	0.008-0.014
	454 (270 hp)	2.7485-2.7494©	0.0013-0.0025®	0.006-0.010	5	2.1990-2.2000	0.0009-0.0025	0.015-0.021
1973-74	350	2.4502©	0.0013-0.0025®	0.002-0.006	5	2.0990-2.1000	0.0013-0.0035	0.008-0.014
	454	2.7504®	0.0007-0.0019®	0.006-0.010	5	2.1990-2.2000	0.009-0.0025	0.015-0.021
1975-76	350	2.4502®	0.0013-0.0025®	0.002-0.006	5	2.0990-2.1000	0.0013-0.0035	0.008-0.014
1977-84	305, 350	2.4484-2.4493®	0.0008-0.0020®	0.002-0.006	5	2.0988-2.0998	0.0013-0.0035	0.008-0.014

® Nos. 3, 4—2.7481 -2.7490; No. 5—2.7478-2.7488

2.7478-2.7488

2.4479-2.4488

0.0006-0.001 8; No. 5—0.0008-0.0023

0.0023; No. 5—0.001 7-0.0033

Nos. 1 , 5—2.7499 ©No. 5—0.0029-0.0045

® Nos. 2, 3, 4—2.4481 -2.4490; No. 5—2.4479-2.4488 ® No. 5—

® No. 5 —0.0023-0.0033; with auto, trans. No. 1 —0.001 9-0.0031 ® No. 5—

® Nos. 2, 3, 4—0.001 3-0.0025; No. 5—0.001 9-0.0035 ® Nos. 2, 3, 4—

® Nos. 2, 3, 4—2.7481 -2.7490; No. 5—2.7478-2.7488 ® Nos. 2, 3, 4—0.001 1 -

© No. 5—2.4508 ® No. 5—0.0024-0.0040

®

Ring Gap Specifications

All measurements are given in inches

Year	Engine Displacement (cu. in.)	Top Compression	Bottom Compression	Oil Control	Displacement Year (cu. in.)	Advertised Horsepower	piston-to-Mo-Dore Clearance (in.) [®]
1963-68	327	0.013-0.023	0.013-0.025	0.015-0.065	SMALL-BLOCK ENGINES		
1969-71	350	0.010-0.020 [®]	0.013-0.025 [®]	0.015-0.065	1963-327	all 80	0.0005-0.0025
1965-74	396, 427, 454	0.010-0.020	0.010-0.020	0.010-0.040	305, 350 (exc. '69 350 hp, LT1 or L82 engs.)	various	0.0007-0.0027
1973-76	350	0.010-0.020	0.013-0.025 [®]	0.015-0.065	350 (1969 only)	350	0.0020-0.0036
1977	350	0.010-0.020	0.010-0.023 [®]	0.015-0.065	350 (LT1 & L82)	various	0.0036-0.0061
1978-84	305, 350	0.010-0.020	0.010-0.023 [®]	0.015-0.065	1981-350	all	0.0046-0.0061
					1982-84	all	0.0025-0.0045

® 250, 300 hp 350 cu in.

Top—0.013-0.023

2nd—0.013-0.025

® 250, 255 hp 350 cu in.—0.013-0.023 ®

180 hp—0.013-0.025 ® 185, 195 hp—0.010-0.025

Ring Side Clearance Specifications

All measurements are given in inches

Year	Engine Displacement (cu. in.)	Top Compression	Bottom Compression	Oil Control
63-68	327	0.0012-0.0032 [®]	0.0012-0.0027 [®]	0.000-0.0050
69-77	305, 350	0.0012-0.0032	0.0012-0.0027	0.000-0.0050 [®]
78-84	305, 350	0.0012-0.0032	0.0012-0.0032	0.002-0.0080
65-74	396, 427, 454	0.0017-0.0032	0.0017-0.0032	0.005-0.0065

©250, 275hp327cu. in.:

Top—0.0012-0.0027

2nd—0.0012-0.0032

© For 1969-73 engines only

2. Remove the two solenoid retaining screws.

3. Twist the solenoid clockwise to remove the solenoid flange key from the keyway in the housing. Remove the solenoid.

4. To reinstall the unit, place the return spring on the plunger and place the solenoid body on the drive housing. Push the solenoid inward and turn counterclockwise to engage

Engine

BIG-BLOCK ENGINES

1965-74	396	425	0.0036-0.0065
	427	390, 400	0.0024-0.0045
	430 [®]		0.0058-0.0080
		435	0.0040-0.0065
	454	245, 275, 345, 360, 390	0.0018-0.0035
		460	0.0040-0.0065

CD Range is from production minimum to service maximum © Limited production L88 engines only

the flange key. Install and tighten the solenoid retaining screws and the screw and washer which secure the strap terminal.

ENGINE MECHANICAL

Design

The success of the Corvette is largely due to the lengthy option lists that permit an owner to literally tailor his car to a specific type of driving or competition. For this reason, the engines that power the 1963-1984 models

Torque Specifications

All readings are given in ft. lbs.

Year	Engine Displacement (cu in.)	Cylinder Head Bolts	Connecting Rod Cap Bolts	Main Bearing Cap Bolts	Crankshaft Balancer Bolts	Flywheel-To-Crankshaft Bolts	Manifold	
							Intake	Exhaust
1963-67	327	60-70	35	80	60®	60	30	18-22
1968-76	327, 350	60-70	45	75®	60®	60	30	18-22
1977-84	305, 350	65	45	80®	60	60	30®	20®
1965	396	80	50	115	85	65	30	20
1966-76	427, 454	80®	50®	100®	85	65	30	20

© Aluminum heads—short bolts 65; long bolts 75

® Engines with 4-bolt mains—outer bolts 65

® Engines with 4-bolt mains—short bolts 95; long bolts 105

®^{7/16}

© Where applicable

© Outer bolts—High Pert.—70 ft. lbs.

® Inboard bolts—30 ft. lbs.

© Also torque the throttle body plate bolts to 20-34 ft. lbs. (1982 only)

have been offered in six internal displacements and approximately 14 performance levels.

Induction systems for these engines are varied and range from a single four-barrel configuration to "Tri-Power" (three Holley two-barrels), Rochester fuel injection, and the new "Cross-Fire Injection" which consists of two opposed throttle body fuel injection units.

The 327 cubic inch V8 was offered from 1963 through 1968 and spanned a horsepower range of 250 to 375; the latter figure being obtained with fuel injection. The 327, in addition to fuel injection, has used the Carter WCFB and AFB, Holley, and Rochester Quadrajet carburetors.

The stroke of the 327 was lengthened in 1969 and this brought the displacement to 350 cu in. The 350 as found in the 1969 through 1979 Corvettes has been available in horsepower ratings from 165 to 370. It is offered with either a single, four-barrel Rochester or Holley carburetor. The 305 engine used in 1980 California Corvettes only, has the same stroke as a 350 but the cylinder bore is a smaller 3.736". The 305, 327 and 350 engines are collectively referred to as the small block Corvette engines.

The 327 engine was derived from the earlier 265 and 283 Corvette engines, but featured many improvements. The block was a completely new casting and provided stronger main bearing webs. The bottom ends of the cylinders were relieved to clear the longer stroke crankshaft. All 327 and 350 cubic inch engines, except base power plants, are

equipped with forged crankshafts. Main bearing diameters were increased from 2.30 to 2.45 inches in 1968.

The large block engines were introduced to provide more torque and more flexible horsepower than the peakier small blocks. The cylinder block is quite conventional, the heads are where the innovation lies. Intake and exhaust valves are canted away from each other for optimum gas flow and port configuration. The seemingly strange angles at which the valves point gave rise to the nickname of "Porcupine" which was applied to these heads when they first appeared on NASCAR racing Chevrolets in 1963.

The large block Corvette engine was introduced in 1965 with an initial offering of 396 cubic inches and 425 hp. The 396 was enlarged to 427 cubic inches with a bore increase in 1966, although the top rated horsepower remained at 425. The 427, optional from 1966 through 1969, was offered in 390, 400, 425, 430, and 435 horsepower versions. Carburetors used on the large blocks included four-barrel Holley and Rochester carburetors and three, two-barrel carburetors. The 427 received a stroke increase in 1970 and became the 454. The "big-block" reached its highest performance rating in 1970 with horsepower output listed at 460 for the rare LS7 engine. Details are scarce as to whether this engine was ever installed in a production vehicle.

Generally speaking, the small and large block Corvette engines are of the same basic design. They feature eight cylinders ar-

ranged in a vee configuration. The cylinders are numbered front to rear with cylinders 1, 3, 5, and 7 on the left bank and 2, 4, 6, and 8 on the right, when viewed from the rear. Firing order for both engines is 1-8-4-3-6-5-7-2. Both the crankshaft and camshaft are supported by five bearings. Viewed from the front, crankshaft rotation is clockwise. Lubrication is full pressure, and a gear type oil pump feeds the system through a full flow oil filter. Both the oil pump and the distributor are driven by the camshaft. The main oil gallery pressurizes the bearings via the crankshaft and camshaft. The valve lifter oil gallery provides oil to the lifters which, in turn, feed the rocker arms through the hollow push-rods.

The standard bearer of Corvette high performance models was established, with the 1967 introduction of the 430 horsepower L-88 limited production option engine. This unit was furnished with a Tuft-ridged and cross-drilled heavy duty crankshaft, magnafluxed and shotpeened connecting rods with $\frac{7}{16}$ inch connecting rod bolts, forged pistons with pop-up domes, and aluminum cylinder heads (open-chambered in 1969).

The peak of large block development was reached in 1969 with the ZL-1 engine. This was the basic L-88 engine but with an aluminum cylinder block.

Engine Removal

This procedure is basically the same for all models regardless of which engine is used. Certain pieces of optional equipment require minor specific changes, but overall, the operation remains the same.

1. Mark the relationship between each hood hinge and the hood. Remove the hood.
2. Disconnect the battery cables at the battery.
3. Remove the air cleaner assembly and cover the carburetor. Mark any disconnected hoses so that they may be reinstalled properly.
4. Raise the front of the vehicle and support it with jackstands.
5. Locate and remove the engine coolant drain plugs. There is a drain plug on each side of the engine block, just above the top of the oil pan.
6. Loosen the radiator drain petcock and allow the coolant to drain from the radiator.
7. Remove the radiator hoses and the heater hoses.

8. Remove the radiator fan shroud, radiator, engine cooling fan(s) and fan clutch (if so equipped).

9. Drain the engine oil.

10. Remove the ignition shielding and release the distributor cap hold-down screws. Move the distributor cap (with wires still in tact) out of the way (away from the firewall).

11. During this step, mark the location and/or connection point of each item so that these items may be properly reinstalled/reconnected.

a. Disconnect the wiring from the starter, ignition coil, and distributor (primary wiring).

b. Disconnect the wiring from the alternator.

c. Disconnect the wires from both the water temperature sender and oil pressure sender. If the vehicle has a mechanical oil pressure gauge, disconnect the gauge tube at the engine block.

d. Disconnect the tachometer drive and fuel injection drive cables at the distributor, if so equipped.

e. Disconnect the engine ground wires.

f. Disconnect the wiring from the idle solenoid, if so equipped.

g. Disconnect the wiring from the various emission control items, as applicable (e.g.-TCS switch, oxygen sensor, barometric sensor, air control valve, etc.)

h. Disconnect the accelerator and transmission linkage (or cables, on late models) at the carburetor, fuel injection unit, or Throttle Body Injection (TBI) unit. If equipped with cables, unbolt the cable brackets from the engine.

i. Disconnect the fuel supply and evaporative emission lines at the fuel pump. On TBI equipped models, disconnect the flexible hoses which connect the frame-mounted lines to the engine-mounted lines. In either case, plug the fuel supply line to prevent fuel siphoning from the tank.

j. Disconnect any vacuum lines which run from a body-mounted item to an engine-mounted item (e.g.-power brake unit, cruise control, etc.)

12. Remove the drive belts from both the power steering pump and the air conditioning compressor, if equipped with these items. Unbolt the pump and compressor from their respective mounting brackets and tie these units out of the way (with lines still attached—DO NOT disconnect the refrigerant lines from the A/C compressor).

98 ENGINE AND ENGINE REBUILDING

13. Disconnect the cruise control chain or cable from the engine, if so equipped.

14. Disconnect the exhaust pipes from the exhaust manifold flanges. If the vehicle is equipped with side exhaust, it may be wise to remove the pipe and muffler units completely to get them out of the way, thereby protecting them from damage.

15. Remove the starter and solenoid as an assembly.

16. Remove the flywheel splash shield or convertor underpan, as applicable.

17. On automatic transmission equipped vehicles, remove the torque convertor-to-flywheel attaching bolts. Also, on these models, remove the transmission dipstick and tube.

18. On manual transmission equipped models, disconnect the linkage from each of the two levers of the clutch cross shaft. Loosen the outer ball stud nut and slide the stud out of the bracket slot. Move the cross shaft as required to clear the inboard ball stud. Remove the cross shaft from the vehicle.

19. Unless you have a suitable plug to prevent the transmission from draining after the driveshaft is removed, drain the transmission. On automatics without drain plugs it will be necessary to carefully remove the transmission pan, drain the fluid, and reinstall the pan. Using chain or heavy wire, secure the torque convertor to the transmission so that the convertor will not fall out as the engine is removed (auto, trans, only).

20. Matchmark the driveshaft to the rear axle flange (to prevent a driveshaft imbalance condition if the shaft was installed improperly), unbolt the universal joint straps from the flange and remove the driveshaft assembly.

21. Support the transmission using a floor jack and remove the transmission-to-engine mounting bolts (auto, trans.) of the bellhousing-to-engine mounting bolts (man. trans.).

22. Remove the engine mount "through" bolts (one per side, positioned front-to-back).

23. Attach the engine lifting devices to the engine lifting brackets. Most engines are equipped with these brackets bolted to the intake manifold. If your engine does not have these brackets, remove the valve covers and the center head bolt from each cylinder head. Attach the lifting apparatus to the cylinder heads and secure with the cylinder head bolts.

CAUTION: Be absolutely sure that the chain which you are using has a weight rating greater than the weight of the engine. If possible, use chain rated at least at 1000

lbs. Avoid using chains with a lesser rating; serious injury could result if you use an inferior chain.

24. Move the engine forward, enough to disengage the engine from the transmission. Raise the engine enough to clear the front of the car and carefully move the engine over and away from the nose of the vehicle.

25. Service the existing engine as necessary, or install a replacement.

CAUTION: Do not allow the engine to hang from the engine hoist for an extended period of time. Never work on the engine when it is attached to the hoist. Support the engine safely on the floor or on an engine stand.

Engine Installation

Installation of the engine is the reverse of the removal procedure. Make note of the following points before installing the engine:

1. Be sure that all wires, lines, etc., are connected as they originally were.

2. Be absolutely sure that the fuel lines are tightened properly and the throttle return springs are installed properly before attempting to start a new or rebuilt engine.

3. Follow all available bolt torque specifications.

4. Be sure to fill the engine, transmission, and cooling system with the correct quantities and qualities of fluids.

5. If a new camshaft was installed in the engine, the engine should be run for at least one hour after started at a minimum of 1500 rpm to properly "break-in" a new cam. If the cam manufacturers instructions differ, follow their recommendations.

6. Even though most head gasket manufacturers state that their gaskets require no "hot retorque", it is good practice to retorque the head bolts after the engine has been run for a couple of hours.

7. During engine installation, it is wise to replace "disposable" items such as radiator hoses, heater hoses, belts, and flexible fuel lines to prevent annoying (and possibly dangerous) post-installation problems associated with these items (e.g.-coolant leaks, fuel leaks, overheating, etc.).

8. Adjust all belts to the proper tension. If the belts are new, recheck their tension after about a 1/2 hour of running time (with a new cam, do this after the cam "break-in" period). Note that a belt is considered "used"

ENGINE OVERHAUL

Most engine overhaul procedures are fairly standard. In addition to specific parts replacement procedures and complete specifications for your individual engine, this chapter also is a guide to accepted rebuilding procedures. Examples of standard rebuilding practice are shown and should be used along with specific details concerning your particular engine.



Competent and accurate machine shop services will ensure maximum performance, reliability and engine life. Procedures marked with the symbol shown above should be performed by a competent machine shop, and are provided so that you will be familiar with the procedures necessary to a successful overhaul.

In most instances it is more profitable for the do-it-yourself mechanic to remove, clean and inspect the component, buy the necessary parts and deliver these to a shop for actual machine work.

On the other hand, much of the rebuilding work (crankshaft, block, bearings, pistons, rods, and other components) is well within the scope of the do-it-yourself mechanic.

Tools

The tools required for an engine overhaul or parts replacement will depend on the depth of your involvement. With a few exceptions, they will be the tools found in a mechanic's tool kit (see Chapter 1). More in-depth work will require any or all of the following:

- a dial indicator (reading in thousandths) mounted on a universal base
- micrometers and telescope gauges
- jaw and screw-type pullers
- scraper
- valve spring compressor
- ring groove cleaner
- piston ring expander and compressor
- ridge reamer
- cylinder hone or glaze breaker

- Plastigage®
- engine stand

Use of most of these tools is illustrated in this chapter. Many can be rented for a one-time use from a local parts jobber or tool supply house specializing in automotive work.

Occasionally, the use of special tools is called for. See the information on Special Tools and the Safety Notice in the front of this book before substituting another tool.

Inspection Techniques

Procedures and specifications are given in this chapter for inspecting, cleaning and assessing the wear limits of most major components. Other procedures such as Magnaflux and Zyglo can be used to locate material flaws and stress cracks. Magnaflux is a magnetic process applicable only to ferrous materials. The Zyglo process coats the material with a fluorescent dye penetrant and can be used on any material. Check for suspected surface cracks can be more readily made using spot check dye. The dye is sprayed onto the suspected area, wiped off and the area sprayed with a developer. Cracks will show up brightly.

Overhaul Tips

Aluminum has become extremely popular for use in engines, due to its low weight. Observe the following precautions when handling aluminum parts:

- Never hot tank aluminum parts (the caustic hot-tank solution will eat the aluminum)
- Remove all aluminum parts (identification tag, etc.) from engine parts prior to hot-tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never over-torque bolts or spark plugs, especially in aluminum threads.

Stripped threads in any component can be repaired using any of several commercial repair kits (Heli-Coil, Microdot, Keenserts, etc.)

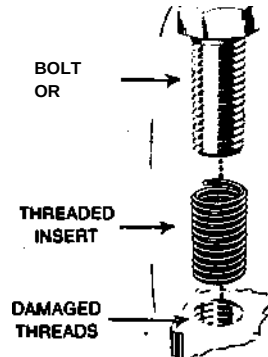
When assembling the engine, any parts that will be in frictional contact must be pre-lubed to provide lubrication at initial start-up. Any product specifically formulated for this purpose can be used, but engine oil is not recommended as a pre-lube.

When semi-permanent (locked, but removable) installation of bolts or nuts is desired, threads should be cleaned and coated with Loctite® or other similar, commercial non-hardening sealant.

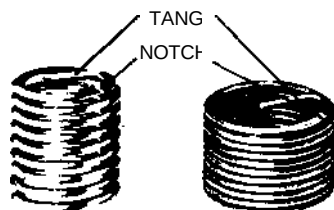
Repairing Damaged Threads

Several methods of repairing damaged threads are available. Heli-Coil® (shown here), Keenserts® and Microdot® are among the most widely used. All involve basically the same principle—drilling out stripped threads, tapping the hole and installing a pre-wound insert—making welding, plugging and oversize fasteners unnecessary."

Two types of thread repair inserts are usually supplied—a standard type for most Inch Coarse, Inch Fine, Metric Coarse and Metric Fine thread sizes and a spark plug type to fit most spark plug port sizes. Consult the individual manufacturer's catalog to determine exact applications. Typical thread repair kits will contain a selection of pre-wound threaded inserts, a tap (corresponding to the outside diameter threads of the insert) and an installation tool. Spark plug inserts usually differ because they require a tap equipped with pilot threads and a combined reamer/tap section. Most manufacturers also supply blister-packed thread repair inserts separately in addition to a master kit containing a variety of taps and inserts plus installation tools.

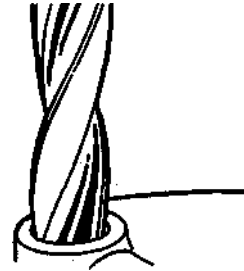


Damaged bolt holes can be repaired with thread repair inserts

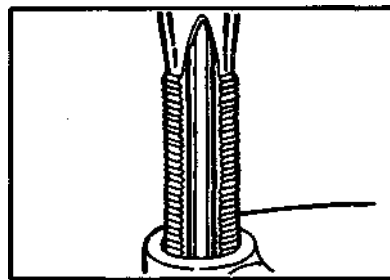


Standard thread repair insert (left) and spark plug thread insert (right)

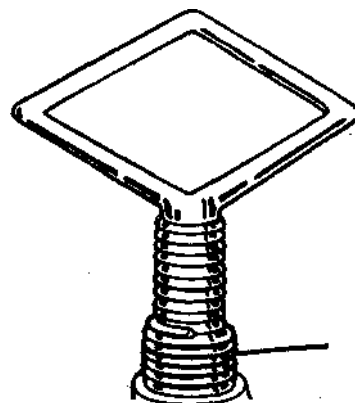
Before effecting a repair to a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads; the offending item can be removed with locking pliers or with a screw or stud extractor. After the hole is clear, the thread can be repaired, as follows:



Drill out the damaged threads with specified drill. Drill completely through the hole or to the bottom of a blind hole



With the tap supplied, tap the hole to receive the thread insert. Keep the tap well oiled and back it out frequently to avoid clogging the threads



Screw the threaded insert onto the installation tool until the tang engages the slot. Screw the insert into the tapped hole until it is $\frac{1}{4}$ turn below the top surface. After installation break off the tang with a hammer and punch

Standard Torque Specifications and Fastener Markings

In the absence of specific torques, the following chart can be used as a guide to the maximum safe torque of a particular size/grade of fastener. • There is no torque difference for fine or coarse threads. • Torque values are based on clean, dry threads. Reduce the value by 10% if threads are oiled prior to assembly. • The torque required for aluminum components or fasteners is considerably less.

U.S. Bolts

SAE Grade Number	1or2			5			6or7		
Number of lines always 2 lets than the grade number.				©			©		
Bolt Size (IncrwsMTiread)	Maximum Torque			Maximum Torque			Maximum Torque		
	R./Lbs.	Kgm	Nm	R./Lbs.	Kgm	.Nm	R./Uis.	Kgm	Nm
%— 20 — 28	5 0.8	0.7 6	6.8 8.1	8 1.4	1.1 10	10.8 13.6	10	1.4	13.5
⁹ / ₁₆ — 18 — 24	11 13	1.5 1.8	14.9 17.6	17 19	2.3 ^6	23.0 25.7	19	2.6	25.8
%— 16 — 24	18 2.75	2.5 20	24.4 27.1	31 35	4.3 4.8	42.0 47.5	34	4.7	46.0
⁷ / ₁₆ — 14 — 20	28 30	3.8 4.2	37.0 40.7	49 55	6.8 7.6	66.4 74.5	55	7.6	74.5
Vi— 13 — 20	39 41	5.4 5.7	52.8 55.6	75 85	10.4 11.7	101.7 115.2	85	11.75	115.2
⁹ / ₁₆ — 12 — 18	51 55	7.0 7.6	69.2 74.5	110 120	15.2 16.6	149.1 162.7	120	16.6	162.7
%— 11 — 18	83 95	11.5 13.1	112.5 128.8	150 170	20.7 23.5	203.3 230.5	167	23.0	226.5
%— 10 — 16	105 115	14.5 15.9	142.3 155.9	270 295	37.3 40.8	366.0 400.0	280	38.7	379.6
%— 9 — 14	160 175	22.1 24.2	216.9 237.2	395 435	54.6 60.1	535.5 589.7	440	60.9	596.5
1— 8 — 14	236 250	32.5 34.6	318.6 338.9	590 660	81.6 91.3	799.9 849.8	660	91.3	894.8
Metric Bolts									
Relative Strength Marking	4.6, 4.8			8.8					
Markings	l\$%7' lgp			vS2E/					
Bolt Size Thread Size i Fitch (mm)	Maximum Torque			Maximum Torque					
	Ft./Lbs.	Kgm	Nm	a/Lbs.	Kgm	Nm			
6x1.0	2-3	.2-.4	3-4	3-6	.4-.8	5-8			
8x1.25	6-8	.8-1	8-12	9-14	1.2-1.9	13-19			
10 x 1.25	12-17	1.5-2.3	16-23	20-29	2.7-4.0	27-39			
12x1.25	21-32	2.9-4.4	29-43	35-53	4.8-7.3	47-72			
14 x 1.5	35-52	4.8-7.1	48-70	57-85	7.8-11.7	77-110			
16x1.5	51-77	7.0-10.6	67-100	90-120	12.4-16.5	130-160			
18x1.5	74-110	10.2-15.1	100-150	130-170	17.9-23.4	180-230			
20 x 1.5	110-140	15.1-19.3	150-190	190-240	26.2-46.9	160-320			
22x1.5	150-190	22.0-26.2	200-260	250-320	34.5-44.1	340-430			
24x1.5	190-240	26.2-46.9	260-320	310-410	42.7-56.5	420-550			

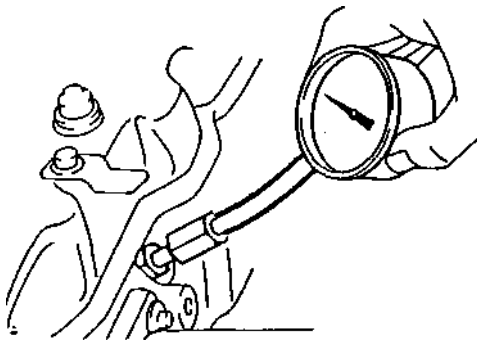
CHECKING ENGINE COMPRESSION

A noticeable lack of engine power, excessive oil consumption and/or poor fuel mileage measured over an extended period are all indicators of internal engine wear. Worn piston rings, scored or worn cylinder bores, blown head gaskets, sticking or burnt valves and worn valve seats are all possible culprits here. A check of each cylinder's compression will help you locate the problems.

As mentioned in the "Tools and Equipment" section of Chapter 1, a screw-in type compression gauge is more accurate than the type you simply hold against the spark plug hole, although it takes slightly longer to use. It's worth it to obtain a more accurate reading. Follow the procedures below for gasoline and diesel-engined cars.

Gasoline Engines

1. Warm up the engine to normal operating temperature.
2. Remove all spark plugs.



The screw-in type compression gauge is more accurate

3. Disconnect the high-tension lead from the ignition coil.
4. On carbureted cars, fully open the throttle either by operating the carburetor throttle linkage by hand or by having an assistant "floor" the accelerator pedal. On fuel-injected cars, disconnect the cold start valve and all injector connections.
5. Screw the compression gauge into the No. 1 spark plug hole until the fitting is snug.

NOTE: Be careful not to crossthread the plug hole. On aluminum cylinder heads use extra care, as the threads in these heads are easily ruined.

6. Ask an assistant to depress the accelerator pedal fully on both carbureted and fuel-injected cars. Then, while you read the compression gauge, ask the assistant to crank the engine two or three times in short bursts using the ignition switch.

7. Read the compression gauge at the end of each series of cranks, and record the highest of these readings. Repeat this procedure for each of the engine's cylinders. Compare the highest reading of each cylinder to the compression pressure specifications in the "Tune-Up Specifications" chart in Chapter 2. The specs in this chart are maximum values.

A cylinder's compression pressure is usually acceptable if it is not less than 80% of maximum. The difference between each cylinder should be no more than 12-14 pounds.

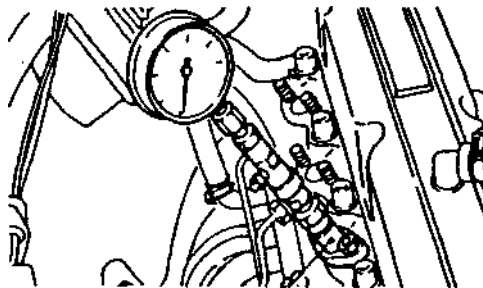
8. If a cylinder is unusually low, pour a tablespoon of clean engine oil into the cylinder through the spark plug hole and repeat the compression test. If the compression comes up after adding the oil, it appears that that cylinder's piston rings or bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder. If compression in any two adjacent cylinders is low, and if the addition of oil doesn't help the compression, there is leakage past the head gasket. Oil and coolant water in the combustion chamber can result from this problem. There may be evidence of water droplets on the engine dipstick when a head gasket has blown.

Diesel Engines

Checking cylinder compression on diesel engines is basically the same procedure as on gasoline engines except for the following:

1. A special compression gauge adaptor suitable for diesel engines (because these engines have much greater compression pressures) must be used.
2. Remove the injector tubes and remove the injectors from each cylinder.

NOTE: Don't forget to remove the washer underneath each injector; otherwise, it may get lost when the engine is cranked.



Diesel engines require a special compression gauge adaptor

3. When fitting the compression gauge adaptor to the cylinder head, make sure the bleeder of the gauge (if equipped) is closed.
4. When reinstalling the injector assemblies, install new washers underneath each injector.

after just 5 minutes of running time, and additional belt stretch will usually occur.

9. ALWAYS check for coolant, fuel, and oil leaks after the engine is started. If there is leakage, turn off the engine, determine the source of leakage and fix the problem before restarting the engine.

10. Adjust the ignition timing after the engine is started.

Cylinder Heads

REMOVAL AND INSTALLATION

1. Disconnect the battery cables at the battery.

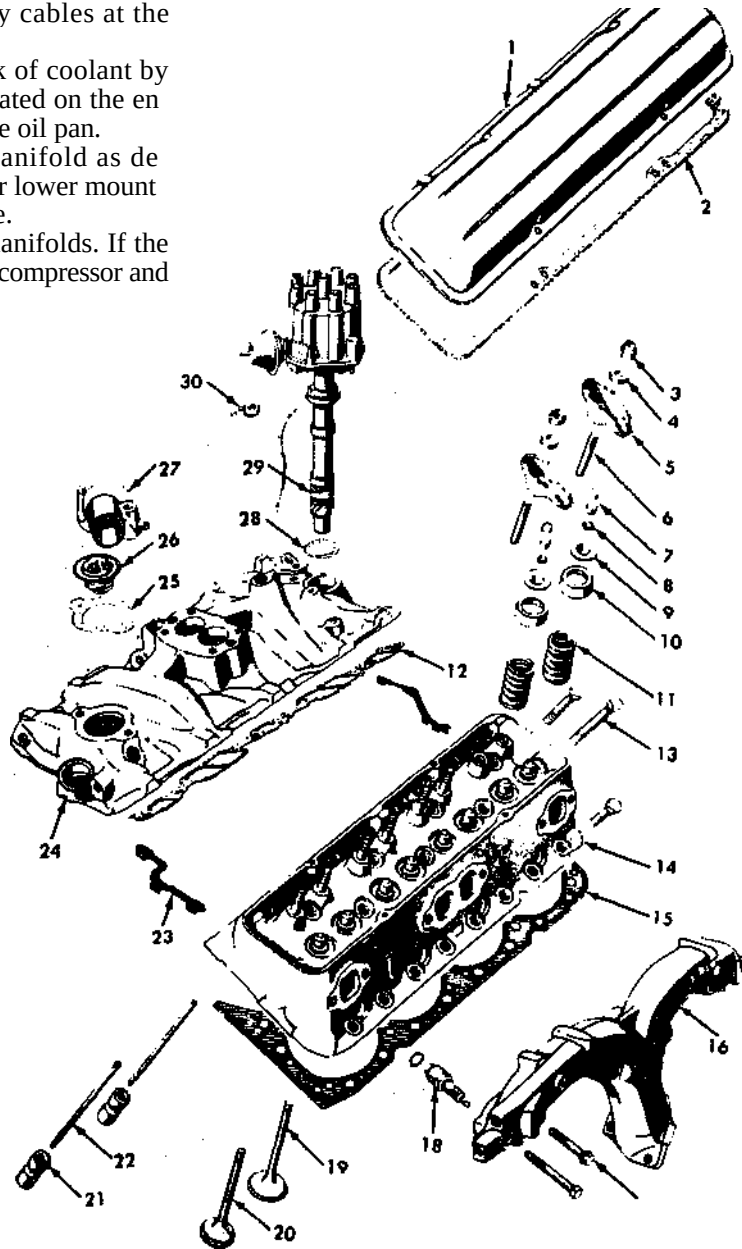
2. Drain the engine block of coolant by removing the drain plugs located on the engine block above the top of the oil pan.

3. Remove the intake manifold as described. Remove the alternator lower mounting bolt, and lay the unit aside.

4. Remove the exhaust manifolds. If the vehicle has A/C, dismount the compressor and

1. Rocker arm cover
2. Gasket
3. Nut
4. Ball
5. Rocker arms
6. Rocker arm studs
7. Valve keeper locks
8. O-ring seals
9. Valve spring cap
10. Shield
11. Spring
12. Gasket
13. Bolts
14. Cylinder head
15. Head gasket

16. Exhaust manifold
17. Bolts
18. Spark plug and gasket
19. Intake valve
20. Exhaust valve
21. Hydraulic lifters
22. Push rods
23. Intake manifold gaskets
24. Intake manifold
25. Gasket
26. Thermostat
27. Thermostat housing
28. Gasket
29. Distributor
30. Clamp



position it out of the way. Do not disconnect the refrigerant lines.

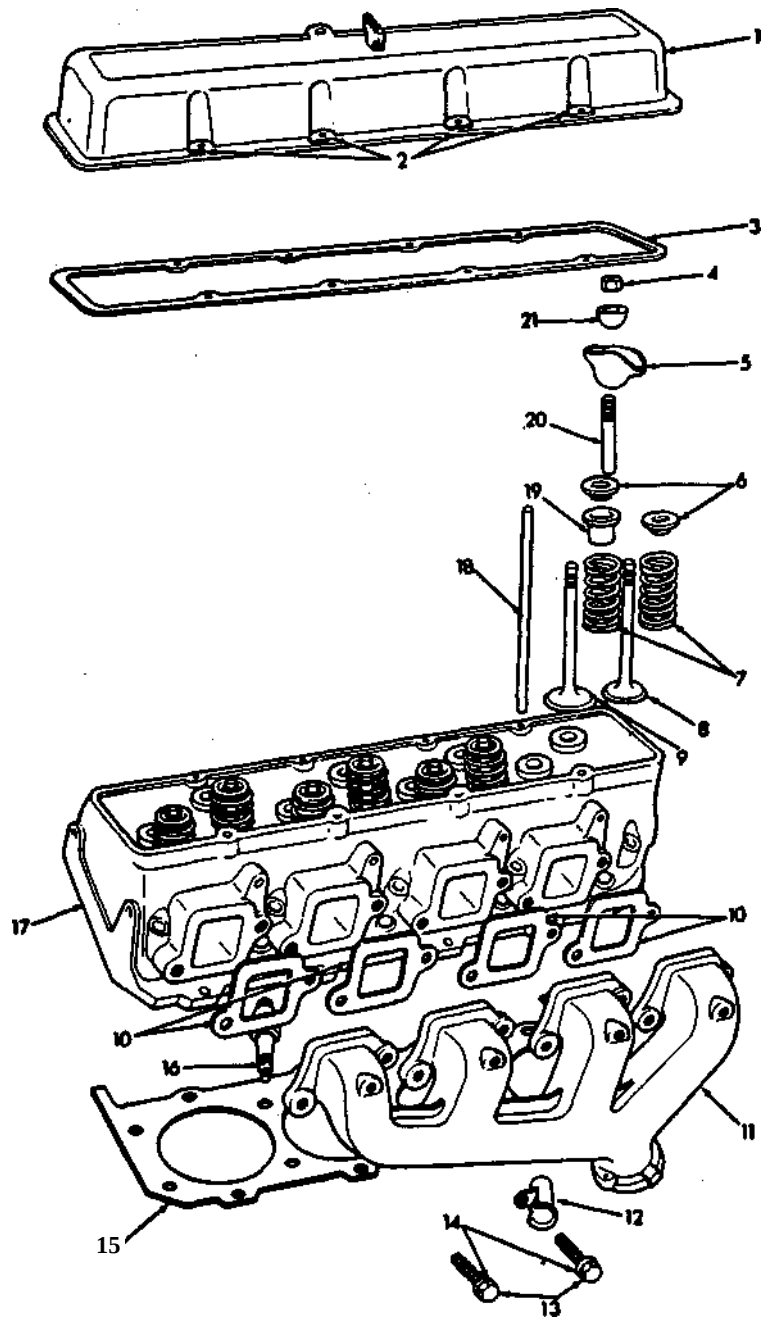
5. Back off the rocker arm nuts and pivot the rocker arms out of the way so that the pushrods can be removed. Identify the pushrods so that they can be reinstalled in their

original locations.

6. Remove the cylinder head bolts and cylinder heads.

7. Install using new gaskets. The head gasket is installed with the bead up.

Exploded view of the small-block cylinder head

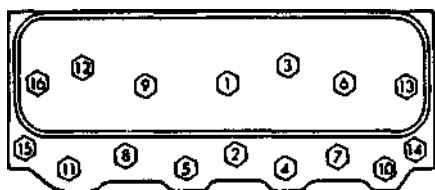


- | | | |
|--------------------------|-----------------------|---------------------|
| 1. Valve cover | 8. Exhaust valve | 15. Head gasket |
| 2. Screw reinforcements | 9. Intake valve | 16. Spark plug |
| 3. Gasket | 10. Gasket | 17. Cylinder head |
| 4. Adjusting nut | 11. Exhaust manifold | 18. Pushrod |
| 5. Rocker arm | 12. Spark plug shield | 19. Spring shield |
| 6. Valve spring retainer | 13. Bolt | 20. Rocker arm stud |
| 7. Valve spring | 14. Washer | 21. Rocker arm ball |

Exploded view of the big-block cylinder head

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Small block V8 cylinder head bolt tightening sequence



Big block V8 cylinder head bolt tightening sequence

NOTE: Coat a steel gasket, thinly and evenly, on both sides with sealer. If a steel asbestos gasket is used, do not apply sealer. Clean the bolt threads, apply sealing compound and install the bolts finger tight.

8. Tighten the head bolts a little at a time in the sequence illustrated to the specified torque.

9. Install the exhaust and intake manifolds.

10. Adjust the valves.

OVERHAUL

1. With cylinder head removed, remove valve rocker arm nuts, balls and rocker arms (if not previously done).

2. Using Tool J-15062, or equivalent, compress the valve springs and remove stem keys. Release the compressor tool and remove rotators or spring caps, oil shimmers, springs and damper assembly, then remove oil seals and valve spring shims.

3. Remove valves from cylinder head and place them in a rack in their proper sequence so that they can be assembled in their original positions. Discard any bent or damaged valves.

4. Clean all carbon from combustion chambers and valve ports using 2 wire brush.

5. Thoroughly clean the valve guides using a suitable wire bore brush.

6. Clean all carbon and sludge from push rods, rocker arms and push rod guides. Discard bent push rods.

7. Clean valve stems and heads on a buffing wheel.

8. Clean carbon deposits from head gas-

ket mating surface. Be careful not to score the machined gasket surface while cleaning.

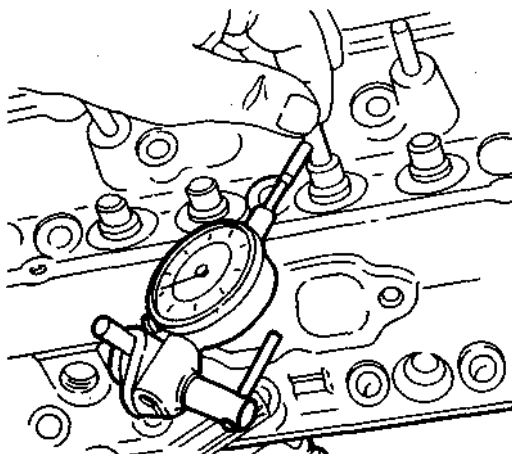
9. Inspect the cylinder head for cracks in the exhaust ports, combustion chambers, or external cracks to the water chamber.

10. Inspect the valves for burned heads, cracked faces or damaged stems.

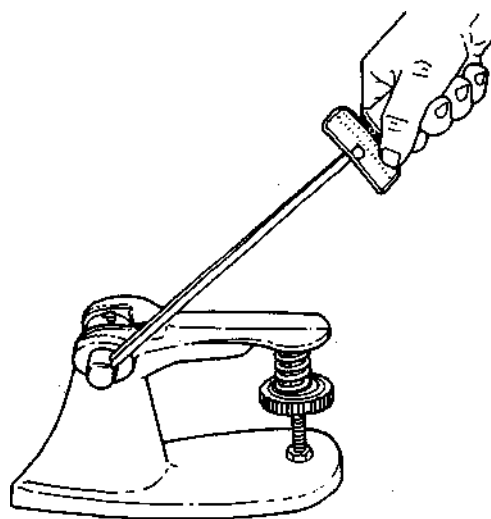
NOTE: Excessive valve stem to bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness.

11. Measure valve stem clearance as follows:

- Clamp a dial indicator on one side of the cylinder head rocker arm cover gasket rail.
- Locate the indicator so that move-



Measuring valve stem clearance with dial gauge



Checking valve spring tension—typical

ment of the valve stem from side to side (crosswise to the head) will cause a direct movement of the indicator stem. The indicator stem must contact the side of the valve stem just above the valve guide.

c. Drop the valve head about $\frac{1}{16}$ in. off the valve seat.

d. Move the stem of the valve from side to side using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves.

NOTE: See "Valve Guide and Seat Service" for detailed overhaul procedures.

12. Check valve spring tension with a suitable spring tester. Springs should be compressed to the specified height and checked against the specifications chart. Springs should be replaced if not within 10 lbs. (44N) of the specified load (without dampers).

13. Inspect rocker arm studs for wear or damage.

14. Check the cylinder head for warpage with a straightedge. If warpage exceeds .003 in. in a 6 in. span, or .006 in. over the total length, the cylinder head must be resurfaced (which is akin to planing a piece of wood). Resurfacing can be performed at most machine shops.

NOTE: When resurfacing the cylinder heads(s) of V8 engines, the intake manifold

mounting position is altered, and must be corrected by machining a proportionate amount from the intake manifold flange.

15. Insert a valve in the proper port.

16. Assemble the valve spring and related parts as follows:

a. Set the valve spring shim, valve spring, damper assembly, oil shedder and valve cap or rotator in place.

b. Compress the spring with Tool J-8062, or equivalent.

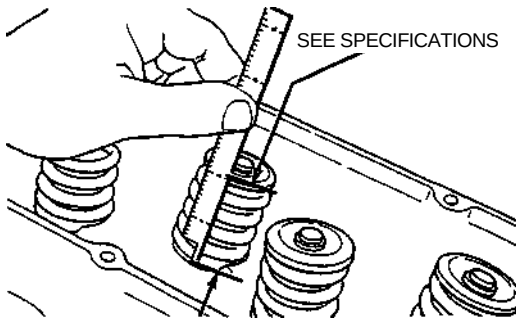
c. Install oil seal in the lower groove of the stem, making sure that the seal is flat and not twisted.

d. Install the valve and release the compressor tool making sure that the valve stems seat properly in the upper groove of the valve stem. Grease may be used to hold the locks in place while releasing the compressor tool.

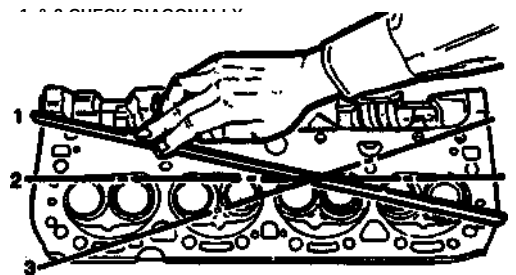
17. Install the remaining valves, repeating assembly sequence.

18. Check each valve stem oil seal by placing a Leak Detector Tool J-23994, or equivalent, over the end of the valve stem and against the cap (or rotator). Operate the vacuum pump and make sure no air leaks past the seal.

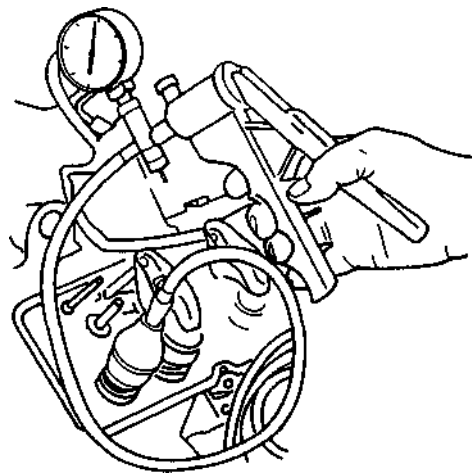
19. Check the installed height of the valve springs, using a narrow thin scale. A cutaway scale will help. Measure from the top of the shim or the spring seat to the top of the oil shedder. If this is found to exceed the specified height, install a valve spring seat shim approximately $\frac{1}{16}$ in. (1.6mm) thick. At no time should the spring be shimmed to give an installed height under the minimum specified.



Measuring valve spring installed height



Checking, cylinder head for warpage—typical



Checking valve stem oil seals with vacuum tester

Valve Guide and Seat Service

The small-block engines (305,327,350) do not have separate valve guides and seats. The small-block head is basically a one-piece casting; the valves move inside guide bores and seal against seats which are machined into the cylinder head.

All big-block (396,427,454) cylinder heads use separately pressed-in valve guides. Chevrolet does not sell replacement valve guides nor do they publish a factory recommended procedure for replacing the guides. They (the guides) can be replaced, but this can be performed only by a professional automotive machine shop. Valve seats of cast-iron big-block heads are machined into the cylinder head; they cannot be replaced. These seats, as those of the small-block, can be machined during a valve job to provide optimum sealing between the valve and the seat. Aluminum big-block cylinder heads use hardened steel valve seat inserts pressed into the cylinder heads. As in the case with big-block valve guides, Chevrolet does not sell replacement valve seats nor have they published a factory recommended procedure for replacing the seats. Due to the extremely high cost of replacement aluminum heads (\$600.00 + each at the time of this printing) be absolutely sure that the machine shop you chose has a noteworthy reputation for precision work.

Whether you have a small or big-block engine, valve guides are most accurately repaired using the bronze-wall rebuilding method. In this operation, "threads" are cut into the bore of the valve guide and bronze wire is turned into the threads. The bronze "wall" is then reamed to the proper diameter. This method is well received for a number of reasons: a) relatively inexpensive b) offers better valve lubrication (the wire retains oil) c) less valve friction (d) preserves the original valve guide-to-seat relationship.

Another method of repairing worn guides is to have the guides "knurled". The knurling process entails cutting into the bore of the

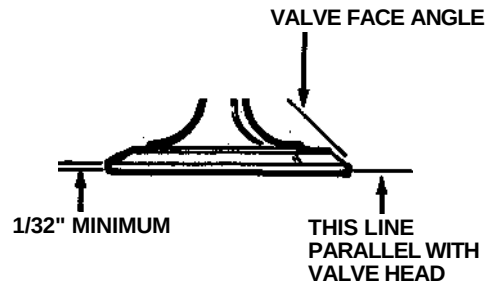
FOR DIMENSIONS,
REFER TO
SPECIFICATIONS

Proper
Up
Pattern
FirtM Rotation Tip Pattern
Rotator
CHECK FOR,
BENT STEM
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rotation

Typical valve stem wear patterns

DIAMETER.

valve guide with a special tool. The cutting action "raises" metal off of the guide bore which actually narrows the I.D. of the bore,



Critical valve dimensions

thereby reducing the clearance between the valve guide bore and the valve stem. This

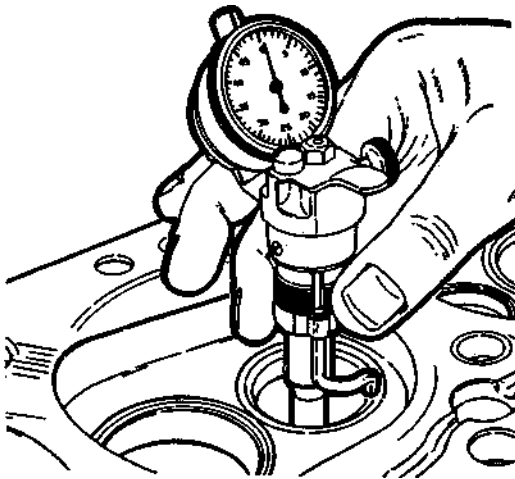


method offers the same advantages as the bronze wall method, but will generally wear faster.

Either of the above services must be performed by a professional machine shop which has the specialized knowledge and tools necessary to perform the service.

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Cutaway view of knurled valve guide

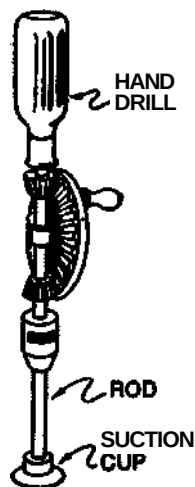


Checking valve seat concentricity with run-out gauge

LAPPING THE VALVES

When valve faces and seats have been re-faced and re-cut, or if they are determined to be in good condition, the valves must be "lapped in" to ensure efficient sealing when the valve closes against the seat.

1. Invert the cylinder head so that the combustion chambers are facing up.
2. Lightly lubricate the valve stems with clean oil, and coat the valve seats with valve grinding compound. Install the valves in the head as numbered.
3. Attach the suction cup of a valve lapping tool to a valve head. Moisten the suction cup to securely attach the tool to the valve.
4. Rotate the tool between the palms, changing position and lifting the tool often to prevent grooving. Lap the valve until a



Fabricated valve lapping tool



Lapping the valve and seat by hand—typical

smooth, polished seat is evident (you may have to add a bit more compound after some lapping is done).

5. Remove the valve and tool, and remove ALL traces of grinding compound with solvent-soaked rag, or rinse the head with solvent.

NOTE: Valve lapping can also be done by fastening a suction cup to a piece of drill rod in a hand "eggbeater" type drill. Proceed as above, using the drill as a lapping tool. Due to the higher speeds involved when using the hand drill, care must be exercised to avoid grooving the seat. Lift the tool and change direction of rotation often.

Valve Springs and Seals

Small-block engines use only one type of valve stem oil seal. The small-block seal is simply an O-ring which is installed on the lower groove of the valve stem and seals against the lower inside portion of the valve spring retainer.

Big-block engines have used four types of seals over the years. The first type is a rubber "umbrella" seal which is installed on the valve guide boss of the cylinder head and wipes the valve stem as the valve moves within the seal. The second type of seal is a nylon "umbrella" seal which is integral with the valve spring retainer. The third type is also nylon and is integral with the spring retainer, but, is no longer serviced. If defective, the third type must be replaced with the second type. Both the second and third types seal against the top of the valve stem and divert any oil which may seep through. The fourth type is of the

same design and arrangement as the small-block type.

REMOVAL

NOTE: The following Removal and Installation procedures apply to cylinder heads installed on the vehicle. Access to an air compressor and the purchase of certain special tools is required.

1. Remove the valve cover (both of the covers if all of the springs and/or seals are to be replaced).

2. Remove the spark plug from the cylinder which is to be serviced.

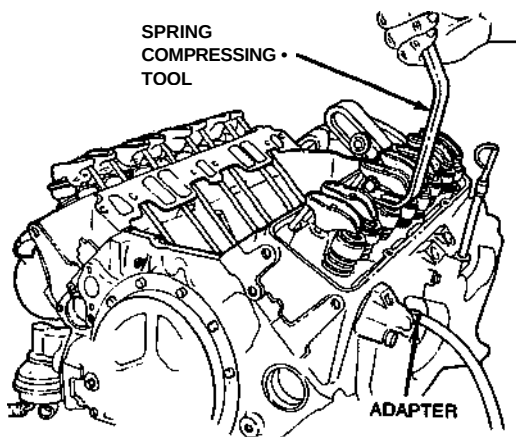
3. Install an air line adaptor in place of the spark plug and attach the air line from the air compressor to the adaptor. The compressed air is used to hold the valves in place when the valve springs are compressed. If either of the valves of the cylinder to be serviced are open, attach the air line after step 4.

4. Remove the rocker arm, ball and pushrod of the valve to be serviced.

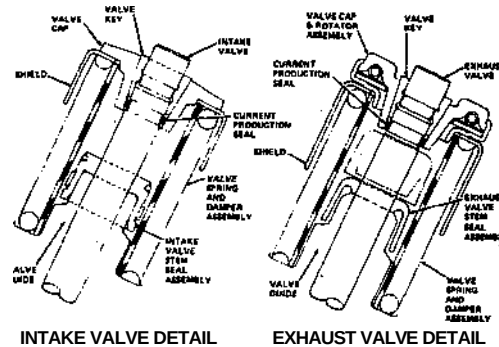
5. Install a special valve spring compressing tool to the rocker arm stud and retain the tool with the rocker arm nut.

6. Lever the tool handle towards you to compress the spring. Remove the two valve locks (split keys) and release the pressure on the tool handle slowly. Remove the tool, valve spring, and related components.

NOTE: If the valve does not stay in its uppermost position as the spring is compressed, the valve and/or valve seat are probably burned. A burned valve or seat will allow the compressed air to leak out of the cylinder. Cylinder head should be removed and overhauled.



Replacing the valve seals using compressed air and a special valve spring compressing tool—small block shown, big block similar



INTAKE VALVE DETAIL

EXHAUST VALVE DETAIL

O-ring type valve seal placement. Note the optional seal types are shown as dotted lines.

INSTALLATION

1. If a rubber "umbrella" type seal is used (big-block only), install the seal over the valve stem and seat it onto the valve guide boss.

2. Install the valve spring(s) and retainer over the valve and install the valve compressing tool. Compress the spring enough to expose the grooves of the valve stem.

NOTE: On big-block models using the nylon seal, the seal must be attached to the retainer prior to installation.

3. If O-ring type seals are used, position the O-ring into the lower groove of the valve stem, install the locks (retain with grease), and release the spring compressing tool. If the integral nylon seals are used, merely install the locks and release the spring compressing tool.

4. Visually check that the locks are positioned properly in the retainer.

5. Install the pushrod, rocker arm, and pivot ball. Tighten the rocker arm nut until it seems to be positioned the same as an undisturbed rocker nut.

6. Disconnect the compressed air line, remove the air line adaptor, and reinstall and connect the spark plug.

7. Adjust the valve as previously outlined and reinstall the valve cover(s).

Valve Lifters

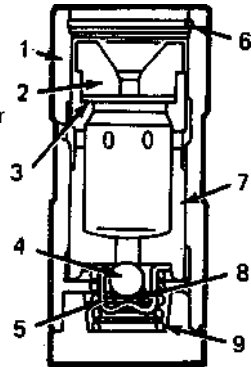
NOTE: Hydraulic valve lifters very seldom require attention. The lifters are extremely simple in design, readjustments are not necessary, and servicing of the lifters requires only that care and cleanliness be exercised in the handling of parts.

REMOVAL AND INSTALLATION

1. Remove intake manifold as previously outlined.

110 ENGINE AND ENGINE REBUILDING

1. Lifter Body
2. Push Rod Seat
3. Metering Valve
4. Check Ball
5. Check Ball Retainer



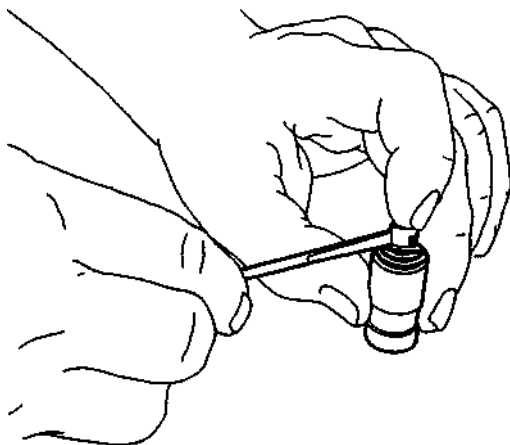
6. Push Rod Seat Retainer
7. Plunger
8. Check Ball Spring
9. Plunger Spring

Typical hydraulic valve lifter showing internal components

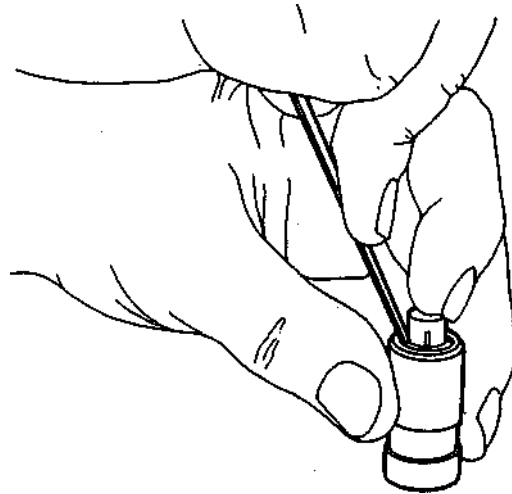
2. Remove valve rocker arms and pushrods.
3. Remove valve lifters. Place valve lifters, rocker arms and pushrods in order so that they may be installed in original location.
4. Coat foot of valve lifters with Molvorkote® or its equivalent and install valve lifters. Make sure lifter foot is convex. A suitable hydraulic lifter removal and installation tool makes the job easier.
5. Reassemble in reverse of removal procedures. Check valve adjustment.

OVERHAUL

1. Hold the plunger down with a push rod, and using the blade of a small screw driver, remove the push rod seat retainer.



Removing ball check valve from lifter body



Installing ball check valve into lifter body

2. Remove the push rod seat and metering valve.
3. Remove the plunger, ball check valve assembly and the plunger spring.
4. Remove the ball check valve and spring by prying the ball retainer loose from the plunger with the blade of a small screw driver.
5. Thoroughly clean all parts in cleaning solvent, and inspect them carefully. If any parts are damaged or worn, the entire lifter assembly should be replaced. If the lifter body wall is scuffed or worn, inspect the cylinder block lifter bore. If the bottom of the lifter is scuffed or worn, inspect the camshaft lobe. If the push rod seat is scuffed or worn, inspect the push rod. An additive containing EP lube, such as EOS, should always be added to crankcase oil for run-in when any new camshaft or lifters are installed. All damaged or worn lifters should be replaced.

NOTE: For proper lifter rotation during engine operation, lifter foot must be convex.

6. Place the check ball on small hole in bottom of the plunger.
7. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on the ball. Carefully press the retainer into position in plunger with the blade of a small screw driver.
8. Place the plunger spring over the ball retainer and slide the lifter body over the spring and plunger, being careful to line up the oil feed holes in the lifter body and plunger.
9. Fill the assembly with SAE 10 oil, then insert the end of a Vs in. drift pin into the plunger and press down solid—do not at-

tempt to force or pump the plunger. At this point, oil holes in the lifter body and plunger assembly will be aligned.

10. Insert a Vie in. drift pin through both oil holes to hold the plunger down against the lifter spring tension.

11. Remove the Ya in. drift pin, refill as sembly with SAE 10 oil.

12. Install the metering valve and push rod seat.

13. Install the push rod seat retainer, press down on the push rod seat and remove the Vie in. drift pin from the oil holes. The lifter is now completely assembled, filled with oil and ready for installation. Before installing lifters, coat the bottom of the lifter with Molykote® or its equivalent.

Rocker Arms and Studs

REMOVAL AND INSTALLATION

NOTE: Some engines are assembled using RTV silicone sealant in place of rocker arm cover gasket. If the engine was assembled using RTV, never use a gasket when reassembling. Conversely, if the engine was assembled using a rocker arm cover gasket, never replace it with RTV. When using RTV, an Vs inch bead is sufficient. Always run the bead on the inside of the bolt holes.

Rocker arms are removed by removing the adjusting nut. Be sure to adjust valve lash after replacing rocker arms. When replacing an exhaust rocker, move an old intake rocker to the exhaust rocker arm stud and install the new rocker arm on the intake stud.

Rocker arm studs that have damaged threads or are loose in the cylinder heads may be replaced with new studs available in 0.003 in. and 0.013 in. oversize or the bores may be tapped and screw-in repkement studs used. Do not attempt to install an oversize stud without reaming the stud bore. Studs are press-fit. Mark IV (big block V8) and kte high performance small-block engines use screw-in studs and pushrod guide plates. NOTE: If engine is equipped with the

A.I.R. exhaust emission control system, the interfering components of the system must be removed. Disconnect the lines at the air injection nozzles in the exhaust manifolds.

Intake Manifold

REMOVAL AND INSTALLATION

NOTE: When servicing late model vehicles, be absolutely sure to mark vacuum hoses and wiring so that these items may be properly reconnected during installation. Also, when disconnecting fittings of metal lines (fuel, power brake vacuum), always use two flare nut (or line) wrenches. Hold the wrench on the large fitting with pressure on the wrench as if you were tightening the fitting (clockwise), THEN loosen and disconnect the smaller fitting from the larger fitting. If this is not done, damage to the line will result.

1. Remove the air cleaner assembly.
2. Disconnect the battery cables at the battery.

3. Raise and support the front of tibe ve hicle.

4. Remove the coolant drain plugs from the lower portion of the engine block and al low the coolant to drain.

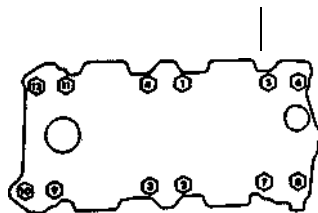
5. Reinstall and tighten the drain plugs and lower the vehicle.

NOTE: When servicing 1963-81 models, continue with the following step andfollow through to step 16. When servicing 1982 and later models, skip to step 17 andfollow through to step 32.

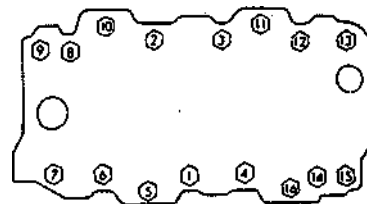
6. On single-carburetor models, discon nect the fuel line at the carburetor. On models equipped with three-two barrel carburetors, disconnect the fuel feed line from the three-way junction block at the front carburetor.

7. On 1963-67 models, remove the ac celerator rod which connects the carburetor linkage to the accelerator linkage at the fire wall. On 1968-81 models, disconnect the ac celerator cable at the carburetor.

8. On 1968-72 models, unbolt the accel-



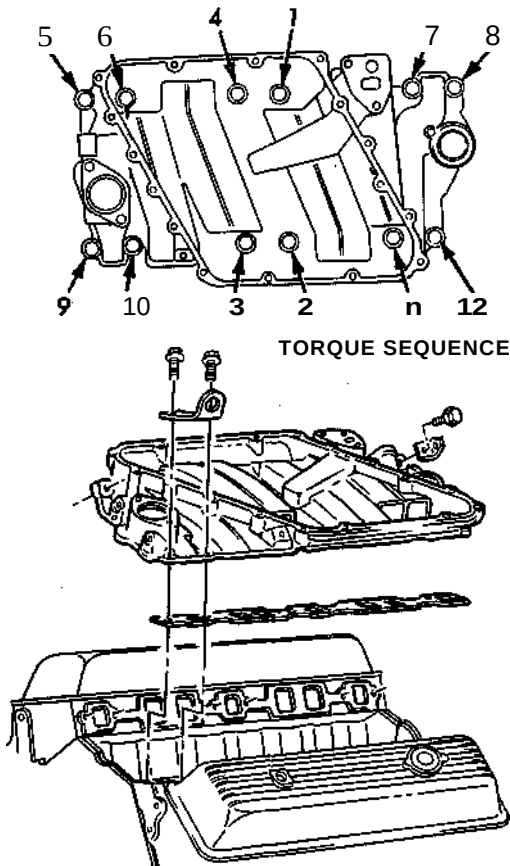
FRONT



FRONT

Intake manifold bolt torque sequence—1963-81 (small block, left side; big block, right side)

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1982 and later intake manifold installation and torque specifications

erator cable from the bracket and tie the cable out of the way. On 1973—81 models, unbolt the accelerator cable bracket from the carburetor and tie the cable and bracket assembly out of the way.

9. Disconnect the transmission linkage (or cable) and/or cruise control cable at the carburetor.

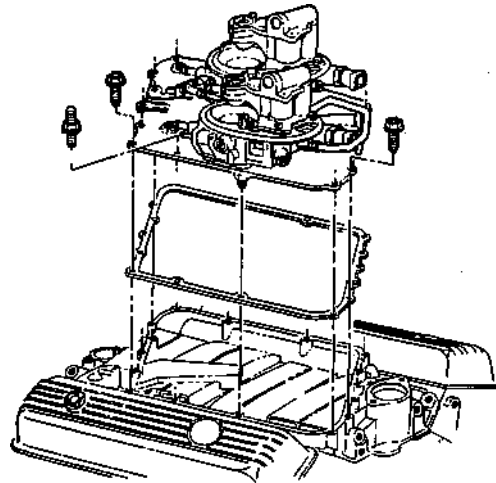
10. Disconnect the vacuum hoses from the distributor and power brake unit, if so equipped. If the power brake line uses a flex hose connected to an engine-mounted metal line, disconnect the flex hose at the metal line.

11. Disconnect the ignition coil and temperature sending switch wiring (if the switch is mounted on the intake manifold instead of the cylinder head).

12. Mark and disconnect any remaining vacuum lines which will interfere with the removal of the intake manifold and carburetor assembly.

13. Remove the distributor as previously outlined.

14. If the upper alternator or air condi-



1982 and later TBI plate installation

tioning compressor mounting brackets are mounted to the intake manifold, remove the brackets.

15. Disconnect the heater hose(s) at the manifold and the upper radiator hose at the thermostat housing.

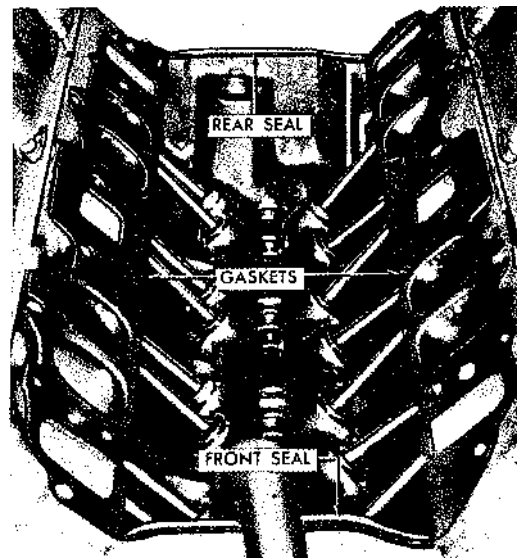
16. Remove the intake manifold and carburetor as an assembly.

NOTE: The following steps apply only to 1982 and later models.

17. Disconnect the fuel inlet line at the front Throttle Body Injection (TBI) unit.

18. Remove the exhaust gas recirculation (EGR) solenoid.

19. Disconnect the wiring from the idle air motors, injectors, and the throttle position sensor (TPS).



Intake manifold gasket and seal placement

20. Disconnect the fuel return line at the rear TBI unit.

21. Remove the power brake booster line.

22. Disconnect the accelerator and cruise control cables, unbolt the cable bracket from the manifold and tie the cable and bracket assembly out of the way.

23. Disconnect the air injection hose at the check valve and the air control valve.

24. Unbolt the air injection pump and move it out of the way.

25. Disconnect the positive crankcase ventilation valve hose at the manifold and move the hose aside.

26. Mark and disconnect any vacuum hoses which will interfere with removal of the manifold.

27. If you plan on removing the TBI units from the upper manifold plate, remove the fuel balance tube (connecting the units) at this time.

28. Remove the bolts which attach the upper manifold plate (or TBI plate) to the intake manifold. Lift the TBI and plate assembly off of the intake manifold.

29. Remove the distributor as previously outlined.

30. Disconnect the upper radiator hose from the thermostat housing.

31. Disconnect the heater hose from the intake manifold.

32. Remove the intake manifold-to-cylinder head bolts and lift the intake manifold assembly off of the engine.

33. Installation is the reverse of removal procedures. Note the following points when installing the manifold:

a. Components originally sealed with RTV sealer must be resealed with RTV. Conversely; if no RTV was used originally, it is not necessary to use during assembly.

b. It IS NOT necessary to remove all old RTV before applying the new RTV; just remove the loose pieces and seal over the remaining RTV. If the RTV must be applied around bolt holes, run the bead of RTV on the inside of the holes.

c. If available, use sealing tape on the threads of male fuel line fittings during assembly.

d. Replenish the cooling system with the proper amount and quality of coolant.

e. Before starting the engine, make sure that the throttle return springs are connected properly and the linkage does not bind in any way.

f. If disturbed during manifold re-

moval, adjust the drive belt(s) to recommended tension.

g. After the engine is started, check for leaks and readjust the ignition timing, if necessary.

Exhaust Manifold

REMOVAL AND INSTALLATION

1. If equipped with an air injection manifold attached to the exhaust manifold, remove the air injection manifold according to the procedure outlined in the Emission Control section.

2. Raise the front of the vehicle and support it safely with jackstands.

3. Soak the exhaust manifold flange studs with penetrating lubricant and remove the flange nuts. Lower the exhaust pipe from the manifold and tie the pipe out of the way.

NOTE: On later models equipped with a Y pipe, it may be necessary to unbolt the pipe from both manifolds. 4t, Lower the vehicle.

5. Remove the spark plug radio interference shielding, if so equipped. Mark and disconnect the spark plug wires from the plugs and remove the spark plugs and plug heat shields. Disconnect the oxygen sensor, if equipped. Do not allow penetrating oil to contaminate sensor.

6. Unbolt the manifold, working from the outer bolts towards the inner bolts to prevent manifold warpage.

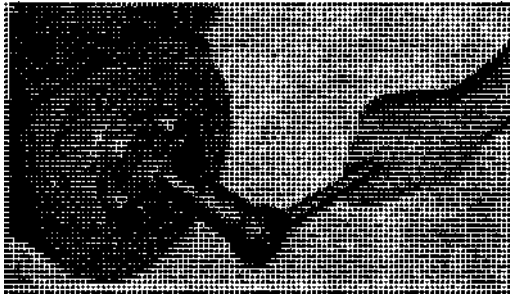
NOTE: On some 1974-76 models, it may be necessary to raise the right side of the engine to remove the right hand exhaust manifold. To do this, unbolt the fan shroud (but do not remove it), remove the right side engine mount through-bolt, and raise the right side of the engine using a jack with a block of wood between the jack and the oil pan.

Installation is the reverse of the previous steps. If the engine used gaskets between the exhaust manifold and the cylinder head, replace the gaskets. Replace the manifold-to-exhaust pipe seal(s). Be sure that all of the mating surfaces are clean. If the threads of the exhaust manifold studs are rusted, use a thread chaser on the studs before installing the manifold.

Timing Chain Cover

REMOVAL

1. Disconnect the battery cables at the battery.



Removing the vibration damper using a puller

2. Remove the radiator and fan shroud as outlined in the Engine Cooling section.

3. Remove the drive belts, cooling fan (engine-mounted only), and fan pulley.

4. Remove the cooling system drain plugs from the engine block and allow the coolant to drain.

5. Disconnect the brackets and hoses from the water pump and remove the water pump.

6. Remove the pulley, from the crankshaft damper. Also remove the center bolt from the damper, if so equipped.

7. Using a puller, remove the crankshaft damper.

CAUTION: To prevent damage to the damper, the puller used must attach to the hub of the damper. DO NOT use a jaw-type puller to grasp the outside of the damper.

8. On 1974 and earlier small-block models only, remove the oil pan as outlined in the Engine Lubrication section.

9. Remove the timing cover retaining bolts and remove the timing cover.

INSTALLATION

1. Clean the gasket mating surfaces of the water pump, timing cover, engine block, and oil pan.

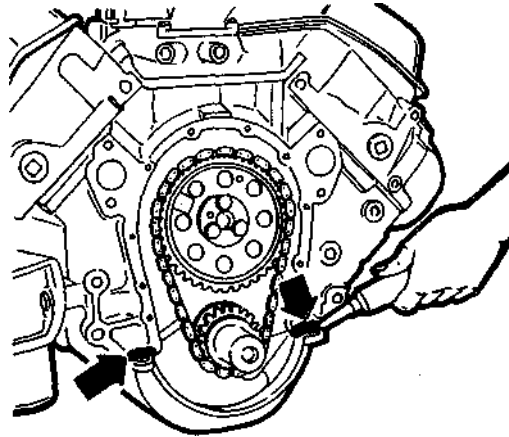
NOTE: Perform steps 2 and 3 only if the oil pan was not removed.

2. Using a sharp knife, cut the protruding oil pan gasket material flush with the front of the engine block.

3. Apply a W bead of RTV sealer to the oil pan-to-engine block front junctions (where the excess gasket was previously removed).

4. Coat the new timing cover-to-oil pan seal and lightly coat the lower portion of the seal with engine oil.

5. Install the timing cover (with gasket and seal). If the oil pan is installed, press downward on the cover to position the cover



Apply sealer to the front pads at the area shown (V8)

over the engine block dowel pins. Don't force the cover over the pins.

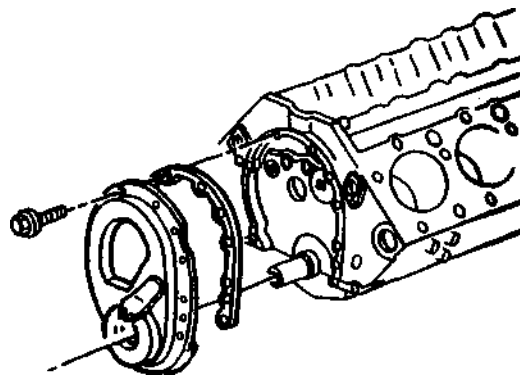
6. Install and tighten the cover retaining bolts. If the oil pan is installed, visually check that the cover gasket and seal did not distort after the bolts were tightened. Also check that the sealer applied during step 3 compressed, indicating a good seal.

7. Install the oil pan at this point, if it was removed previously. Be sure to apply a small amount of sealer where the oil pan side gaskets meet the front and rear seals.

8. Oil the crankshaft seal and clean both the crankshaft snout and the bore of the damper.

9. Lightly oil the damper bore and the crankshaft snout. Install the damper, using a tool that will pull the damper onto the crankshaft. It is not recommended to hammer the crankshaft into place.

10. The remainder of the assembly is performed in the reverse of steps 1-6 of the Removal procedure. Be sure to fill the cooling



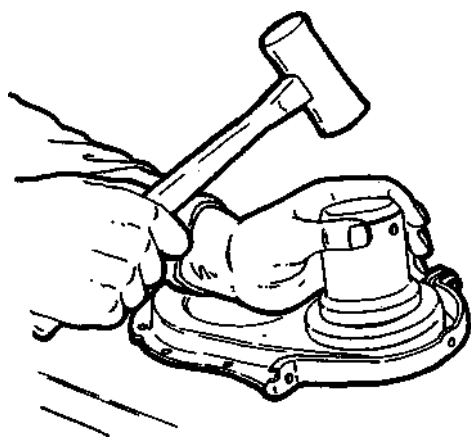
Timing cover and gasket—typical

system, adjust the tension of the drive belts, and check for leaks after the engine is started.

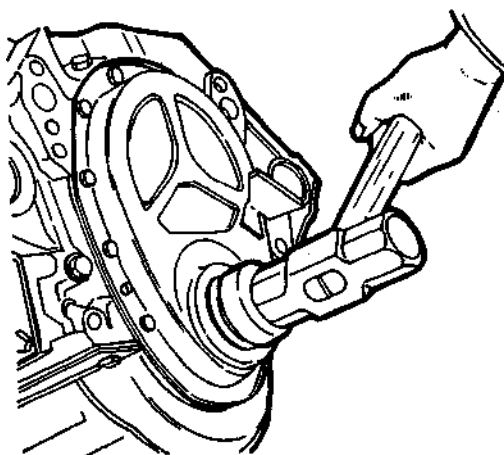
Timing Cover Oil Seal

REPLACEMENT

The timing cover oil seal may be replaced without removing the timing cover. Follow steps 1, 2, 6 and 7 of the Timing Cover Removal procedure to gain access to the cover. Pry the old seal out of the cover, being careful not to damage the cover itself. Install the new seal so that the open end of the seal is toward the inside of the cover. Drive the seal into place using a seal driver. If the seal is to be replaced with the cover removed, support the rear of the cover while driving the seal into place.



Seal installation with the cover removed

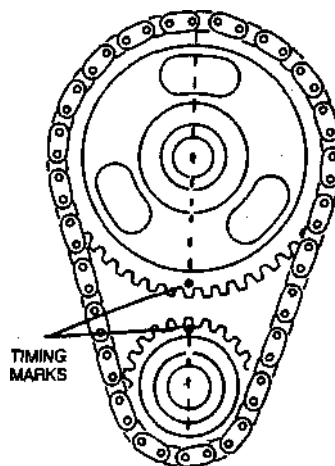


Seal installation with the cover installed

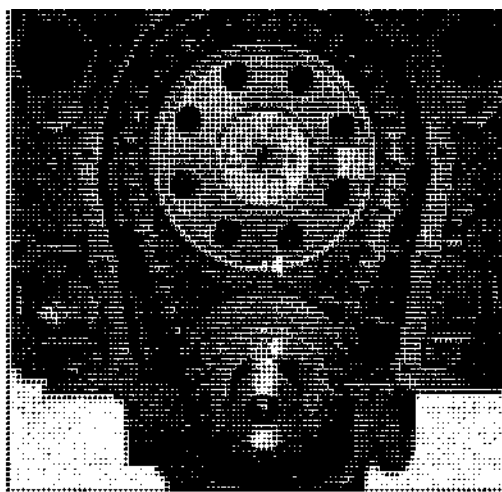
Timing Chain

REMOVAL AND INSTALLATION

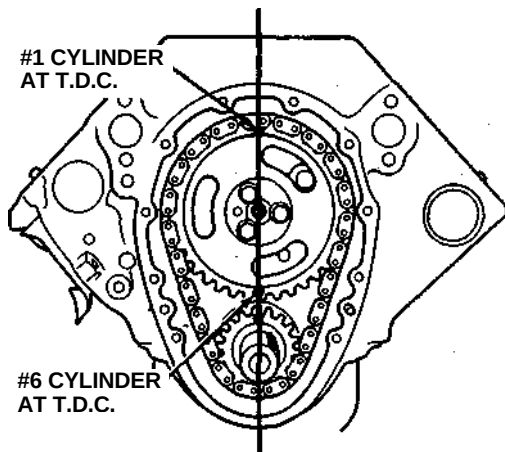
1. Set the engine to top dead center with the number one cylinder on its compression stroke (both valves closed).
2. Remove the timing cover as previously outlined.
3. Remove the three bolts from the camshaft sprocket and pull the sprocket off of the camshaft. Lower the sprocket and remove the camshaft sprocket and chain.
4. Check the camshaft and crankshaft sprockets for wear. It is best to replace the timing set (chain and sprockets) together. If you do not have a puller to remove the crankshaft sprocket, replacement of only the camshaft sprocket and chain will usually result in a sat-



1963-79 timing mark alignment—with steel camshaft gear



1963-79 timing mark alignment—with nylon timing gear



1980 and later timing mark alignment

isfactory repair. Remember that the total deflection of the chain (installed) should not exceed about $\frac{1}{4}$ in.

Most engines are equipped with the nylon-toothed camshaft sprocket. If you drive the car hard, or if the original sprocket failed prematurely, it may be wise to replace the nylon-toothed sprocket with the hardened-iron sprocket available through Chevrolet dealers. Make sure that you explain your intentions when purchasing the timing components, so that the chain and gears are properly matched. An all-metal cam gear produces a little more noise than the nylon-toothed gear, but will last considerably longer.

When installing the new timing components, be sure to align the timing marks of both the cam gear and crank gear. DO NOT rotate the engine while the timing chain is removed. Torque the camshaft sprocket bolts to 20 ft. lbs. and install the timing cover as previously outlined.

Camshaft

REMOVAL AND INSTALLATION

Remove the radiator and shroud. Remove the fan and fan pulley. Use a gear puller to remove the harmonic balancer. Remove the oil pan, water pump, and the timing chain cover.

On the top of the engine, remove the battery cables, carburetor(s)/fuel injection unit, (on 1982 and later models, remove the TBI units and the TBI mounting plate as an assembly), distributor shielding, and distributor. Be sure to mark the distributor so that it will not be necessary to retune the engine.

When the intake manifold has been cleared of obstructions, remove it to expose the valve

lifters. Cover the open area and remove the fuel pump and push rod.

Remove the rocker arm covers and rocker arms and withdraw the pushrods and lifters. Keep the pushrods and lifters in order so that they can be returned to their original positions. Remove the grille, timing chain, and camshaft sprocket. Loosen the engine side mount through bolts and jack up the front of the engine slightly. This is necessary for the camshaft to clear the radiator brace. Run two $\frac{5}{16}$ -18x4 in. bolts into the camshaft from the engine. Do not rotate the crankshaft until the camshaft has been replaced and the sprocket and chain correctly installed and aligned. Alignment procedures are the same as those shown within the previous Timing Chain replacement procedure.

Reverse the operation to complete the replacement. Lubricate the cam and lifters with E.O.S. additive before installation. Make an initial and final valve adjustment as previously described.

INSPECTION

Completely clean the camshaft with solvent, paying special attention to cleaning the oil holes. Visually inspect the cam lobes and bearing journals for excessive wear. If a lobe is questionable, have the cam checked at a reputable machine shop; if a journal or lobe is worn, the camshaft must be reground or replaced. Also have the camshaft checked for straightness on a dial indicator.

NOTE: If a cam journal is worn, there is a good chance that the bushings are worn.

Camshaft Bearings

REMOVAL AND INSTALLATION

If excessive camshaft wear is found, or if the engine is being completely rebuilt, the camshaft bearings should be replaced. A special puller tool is necessary.

NOTE: The front and rear bearings should be removed last, and installed first. Those bearings act as guides for the other bearings and pilot.

1. Drive the camshaft rear plug from the block.
2. Assemble the removal puller tool with its shoulder on the bearing to be removed. Gradually tighten the puller nut until the bearing is removed.
3. Remove the remaining bearings, leaving the front and rear for last. To remove these, reverse the position of the puller, so

as to pull the bearings towards the center of the block. Leave the tool in this position, pilot the new front and rear bearings on the installer, and pull them into position.

4. Return the puller to its original position and pull the remaining bearings into position.

NOTE: Ensure that the oil holes align when installing the bearings. This is very important! You can make a simple tool out of a piece of $\frac{1}{2}$ in. brass rod to check alignment.

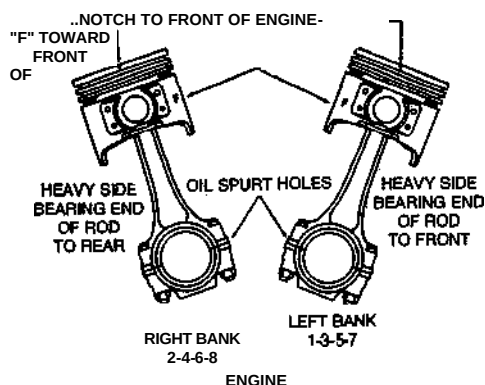
5. Replace the camshaft rear plug, and stake it into position.

Piston and Ring Servicing

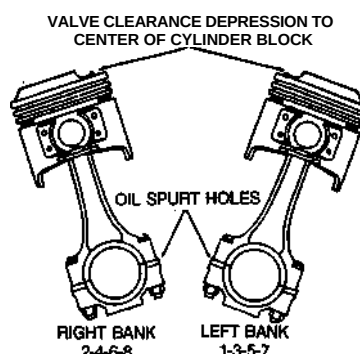
Corvette pistons are made of aluminum alloy and should not be exposed to careless treatment. Never use a wire brush to clean these pistons. Use cleaning solvent to remove varnish or carbon. Clean the ring grooves with a groove cleaner tool. Be sure the oil holes in the grooves are clear. Check for cracks, scuff marks, etc., and replace any piston that is suspect. Check the piston skirt measurement with a micrometer and compare to specifications.

Piston pins are matched to an individual piston and should be replaced with the piston as a set, not separately. Clean the pin with solvent and with a micrometer, check the pin external size and the piston pin bore size. Replace both if wear tolerance exceeds the specifications by 0.001 in.

Two compression rings and an oil ring assembly are used on Corvette pistons. The compression rings are marked on their top side and should always be assembled to the piston with this mark upward. Before assembling the rings to the piston, they should be fitted to their individual cylinder bore.



Correct piston/connecting rod positioning for 305,



Correct piston/connecting rod positioning for 396, 427, and 454 cu in. engines

The second ring is identified by a chamfer or step on its lower edge. The top compression ring has a chamfer on its upper edge and is chrome faced. Corvette rings are furnished in oversizes of 0.020 in., 0.030 in., and 0.040 in.

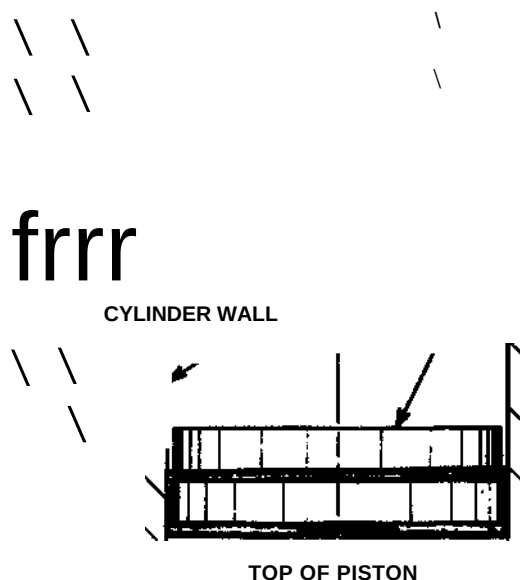
Pistons and Connecting Rods

REMOVAL AND INSTALLATION

Before removing the pistons, the top of the cylinder bore must be examined for a ridge. A ridge at the top of the bore is the result of normal cylinder wear, caused by the piston rings only travelling so far up the bore in the course of the piston stroke. The ridge can be felt by hand; it must be removed before the pistons are removed.

A ridge reamer is necessary for this operation. Place the piston at the bottom of its stroke, and cover it with a rag. Cut the ridge away with the ridge reamer, using extreme care to avoid cutting too deeply. Remove the

RIDGE CAUSED BY CYLINDER WEAR



327, and 350 engines

Wear ridge must be removed before piston removal

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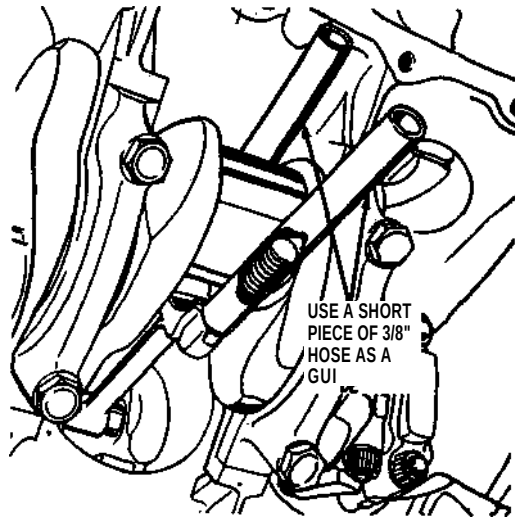
rag, and remove the cuttings that remain on the piston with a magnet and a rag soaked in clean oil.

NOTE: Make sure the piston top and cylinder bore are absolutely clean before moving the piston.

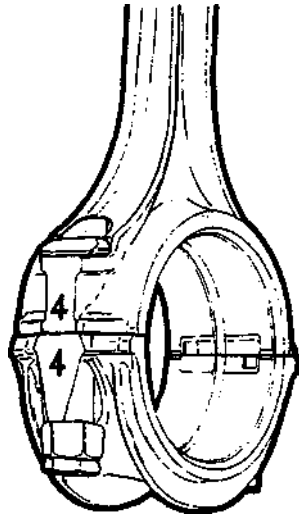
4. Match-mark the connecting rod cap to the connecting rod with a scribe; each cap must be reinstalled on its proper rod in the proper direction. Remove the connecting rod bearing cap and the rod bearing. Number the top of each piston with silver paint or a felt-tip pen for later assembly.

5. Cut lengths of $\frac{3}{8}$ in. diameter hose to use as rod bolt guides. Install the hose over the threads of the rod bolts, to prevent the bolt threads from damaging the crankshaft journals and cylinder walls when the piston is removed.

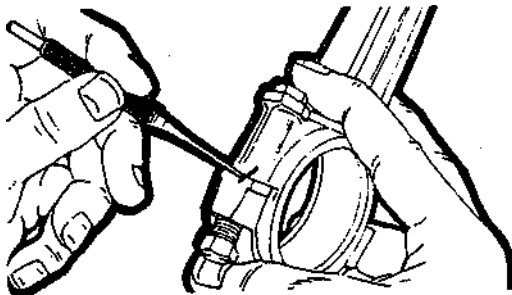
6. Squirt some clean engine oil onto the cylinder wall from above, until the wall is



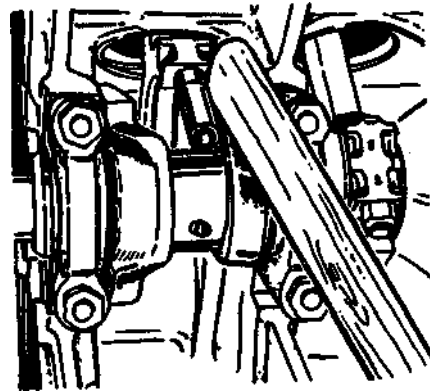
Fabricate rod bolt guides out of rubber hose to prevent damage to crankshaft journals when removing or installing pistons



Stamped number matchmarks on connecting rod and cap



Scribe a matchmark on the connecting rod and cap



Carefully tap the piston and rod assembly out of the cylinder bore with a wooden hammer handle

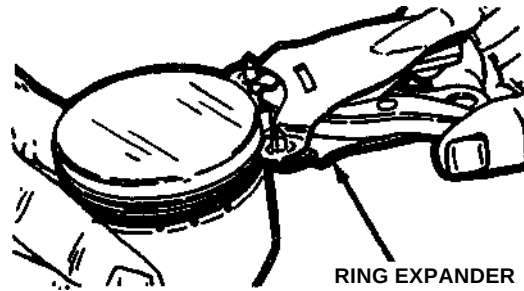
coated. Carefully push the piston and rod assembly up and out of the cylinder by tapping on the bottom of the connecting rod with a wooden hammer handle.

7. Place the rod bearing and cap back on the connecting rod, and install the nuts temporarily. Using a number stamp or punch, stamp the cylinder number on the side of the connecting rod and cap; this will help keep the proper piston and rod assembly on the proper cylinder.

NOTE: On all V8s, starting at the front the right bank cylinders are 2-4-6-8 and the left bank 1-3-5-7.

8. Remove remaining pistons in similar manner. On all engines, the notch on the piston will face the front of the engine for assem-

bly. The chamfered corners of the bearing caps should face toward the front of the left bank and toward the rear of the right bank, and the boss on the connecting rod should face toward the front of the engine for the right bank and to the rear of the engine on the left bank. On various engines, the piston compression rings are marked with a dimple, a letter "T," a letter "O," "GM" or the word "TOP" to identify the side of the ring which must face toward the top of the piston.



Removing the piston rings with expander tool

Piston Ring and Wrist Pin

REMOVAL AND INSPECTION

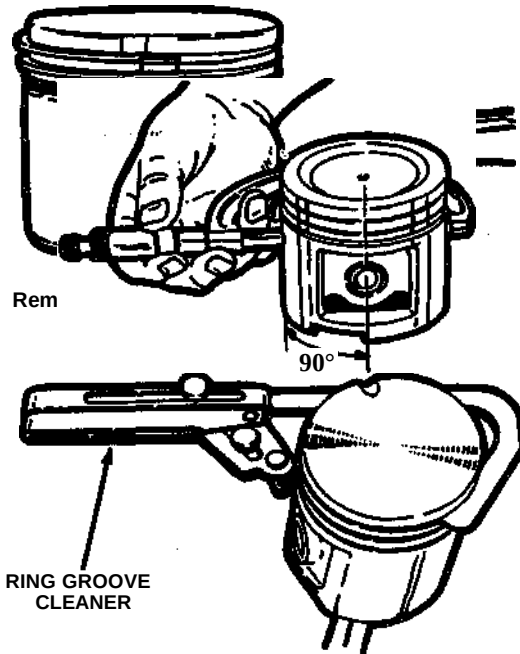
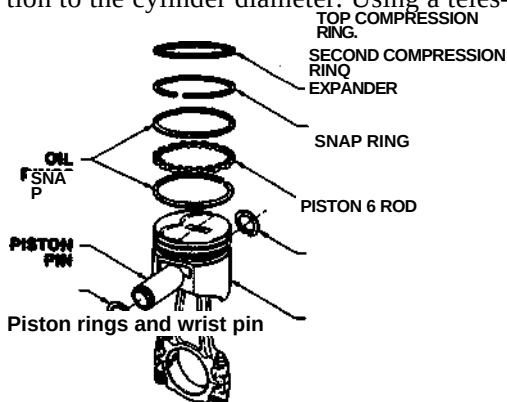
Some of the engines covered in this guide utilize pistons with pressed-in wrist pins; these must be removed by a special press designed for this purpose. Other pistons have their wrist pins secured by snap rings, which are easily removed with snap ring pliers. Separate the piston from the connecting rod.

A piston ring expander is necessary for removing piston rings without damaging them; any other method (screwdriver blades, pliers, etc.) usually results in the rings being bent, scratched or distorted, or the piston itself being damaged. When the rings are removed, clean the ring grooves using an appropriate ring groove cleaning tool, using care not to cut too deeply. Thoroughly clean all carbon and varnish from the piston with solvent.

CAUTION: Do not use a wire brush or caustic solvent (acids, etc.) on pistons.

Inspect the pistons for scuffing, scoring, cracks, pitting, or excessive ring groove wear. If these are evident, the piston must be replaced.

The piston should also be checked in relation to the cylinder diameter. Using a tele-

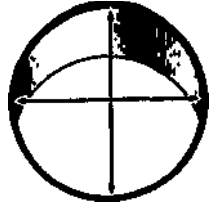


Clean the piston ring grooves with a suitable tool

Measure the piston with a micrometer

coping gauge and micrometer, or a dial gauge, measure the cylinder bore diameter perpendicular (90°) to the piston pin, 2 1/4 in. below the cylinder block deck (surface where the block mates with the heads). Then, with the

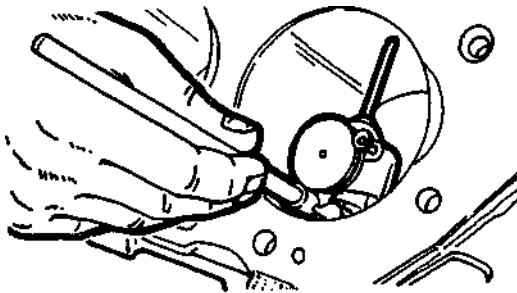
-CENTERLINE OF ENGINE-



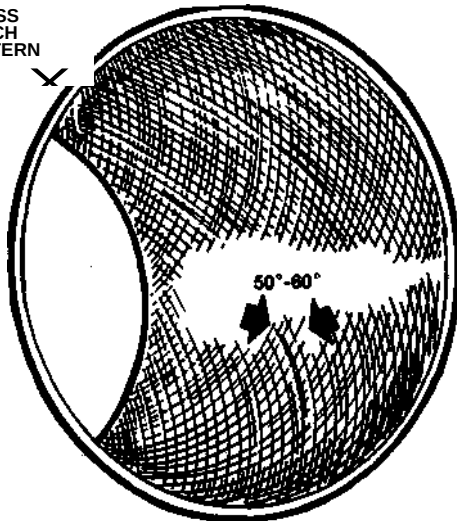
A—AT RIGHT ANGLE TO
CENTERLINE OF ENGINE
B—PARALLEL TO
CENTERLINE OF ENGINE

Cylinder bore measuring points

Correct cylinder bore honing pattern



Measure cylinder bore with dial gauge

CROSS
HATCH
PATTERN

micrometer, measure the piston perpendicular to its wrist pin on the skirt. The difference between the two measurements is the piston clearance. If the clearance is within specifications or slightly below (after the cylinders have been bored or honed), finish honing is all that is necessary. If the clearance is excessive, try to obtain a slightly larger piston to bring clearance to within specifications. If this is not possible obtain the first oversize piston and hone (or if necessary, bore)

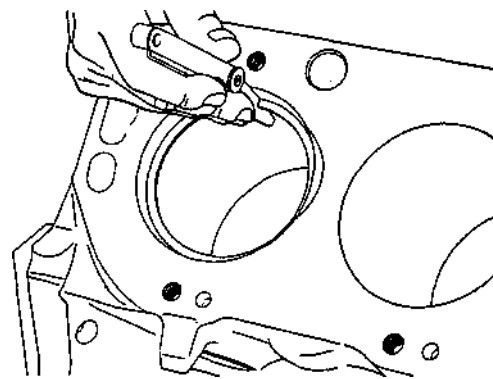
the cylinder to size. Generally, if the cylinder bore is tapered .005 in. or more or is out-of-round .003 in. or more, it is advisable to rebore for the smallest possible oversize piston and rings. After measuring, mark pistons with a felt-tip pen for reference and for assembly.

NOTE: *Cylinder block boring should be performed by a reputable machine shop with the proper equipment. In some cases, "clean-up" honing can be done with the cylinder block in the car, but most excessive honing and all cylinder boring must be done with the block stripped and removed from the car.*

CHECKING RING END GAP

Piston ring end gap should be checked while the rings are removed from the pistons. Incorrect end gap indicates that the wrong size rings are being used; *ring breakage could occur.*

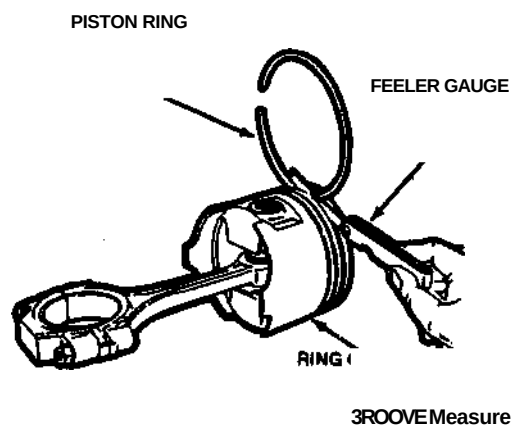
Compress the piston rings to be used in a cylinder, one at a time, into that cylinder. Squirt clean oil into the cylinder, so that the rings and the top 2 inches of cylinder wall are coated. Using an inverted piston, press the rings approximately 1 in. below the deck of the block (on diesels, measure ring gap clearance with the ring positioned at the *bottom* of ring travel in the bore). Measure the ring end gap with a feeler gauge, and compare to the "Ring Gap" chart in this chapter. Carefully pull the ring out of the cylinder and file the ends squarely with a fine file to obtain the proper clearance.



Measure piston ring end gap with feeler gauge

INSTALLATION AND SIDE CLEARANCE MEASUREMENT

Check the pistons to see that the ring grooves and oil return holes have been properly

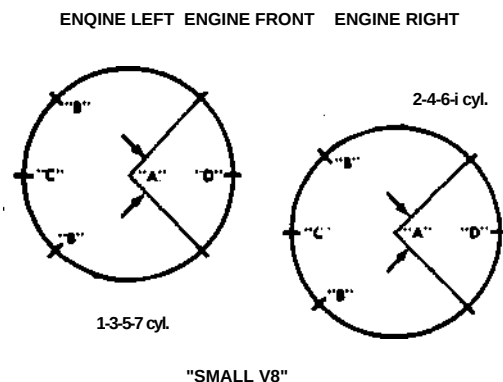


piston ring side clearance with feeler gauge

cleaned. Slide a piston ring into its groove, and check the side clearance with a feeler gauge. Make sure the feeler gauge is inserted between the ring and its lower land (lower edge of the groove), because any wear that occurs forms a step at the inner portion of the lower land. If the piston grooves have worn to the extent that relatively high steps exist on the lower land, the piston should be replaced, because these will interfere with the operation of the new rings and ring clearances will be excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

Install the rings on the piston, *lowest ring first*, using a piston ring expander. There is a high risk of breaking or distorting the rings, or scratching the piston, if the rings are installed by hand or other means.

Position the rings on the piston as illus-



"A" OIL RING SPACER SAP (Tang In Hole or Slot within Arc)

"B" OIL RING RAIL GAPS "C" 2ND

COMPRESSION RING CAP "D" TOP

COMPRESSION RING GAP Piston ring gap

location—all engines

trated; *spacing of the various piston ring gaps is crucial to proper oil retention and even cylinder wear*. When installing new rings, refer to the installation diagram furnished with the new parts.

Connecting Rod Bearings

Connecting rod bearings for the engines covered in this guide consist of two halves or shells which are interchangeable in the rod and cap. When the shells are placed in position, the ends extend slightly beyond the rod and cap surfaces so that when the rod bolts are torqued the shells will be clamped tightly in place to insure positive seating and to prevent turning. A tang holds the shells in place.

NOTE: *The ends of the bearing shells must never be filed flush with the mating surface of the rod and cap.*

If a rod bearing becomes noisy or is worn so that its clearance on the crank journal is excessive, a new bearing of the correct undersize must be selected and installed since there is no provision for adjustment.

CAUTION: *Under no circumstances should the rod end or cap be filed to adjust the bearing clearance, nor should shims of any kind be used.*

Inspect the rod bearings while the rod assemblies are out of the engine. If the shells are scored or show flaking, they should be replaced. If they are in good shape check for proper clearance on the crank journal (see below). Any scoring or ridges on the crank journal means the crankshaft must be replaced, or reground and fitted with undersized bearings.

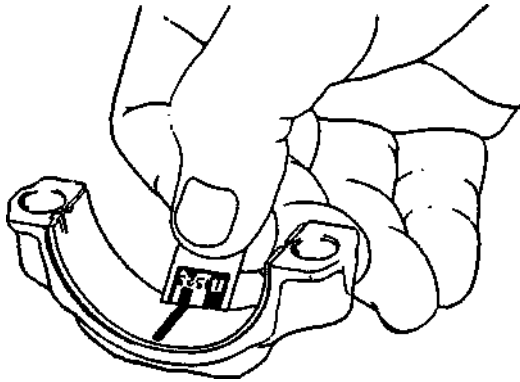
NOTE: *If journals are deeply scored or ridged the crankshaft must be replaced, as regrounding will reduce the durability of the crankshaft.*

ROD BEARING INSPECTION AND REPLACEMENT

NOTE: *Make sure connecting rods and their caps are kept together, and that the caps are installed in the proper direction.*

Replacement bearings are available in standard size, and in undersizes for reground crankshafts. Connecting rod-to-crankshaft bearing clearance is checked using Plastigage® at either the top or bottom of each crank journal. The Plastigage® has a range of .001 in. to .003.

1. Remove the rod cap with the bearing shell. Completely clean the bearing shell and



FLATTENED
GAGING PLASTIC

Check rod bearing clearance with Plastigage or equivalent



Undersize marks are stamped on the bearing shells. The tang fits in the notch on the rod and cap

the crank journal, and blow any oil from the oil hole in the crankshaft; Plastigage® lengthwise along

UNDERSIZE STAMP
IN THOUSANDS

the bottom center of the lower bearing shell, then install the cap with shell and torque the bolt or nuts to specification. **DO NOT** turn the crankshaft with Plastigage® in the bearing.

3. Remove the bearing cap with the shell. The flattened Plastigage® will be found sticking to either the bearing shell or crank journal. *Do not remove it yet.*

4. Use the scale printed on the Plastigage® envelope to measure the flattened material at its widest point. The number within the scale which most closely corresponds to the width of the Plastigage® indicates bearing clearance in thousandths of an inch.

5. Check the specifications chart in this

chapter for the desired clearance. It is advisable to install a new bearing if clearance exceeds .003 in.; however, if the bearing is in good condition and is not being checked because of bearing noise, bearing replacement is not necessary.

6. If you are installing new bearings, try a standard size, then each undersize in order until one is found that is within the specified limits when checked for clearance with Plastigage®. Each undersize shell has its size stamped on it.

7. When the proper size shell is found, clean off the Plastigage®, oil the bearing thoroughly, reinstall the cap with its shell and torque the rod bolt nuts to specification.

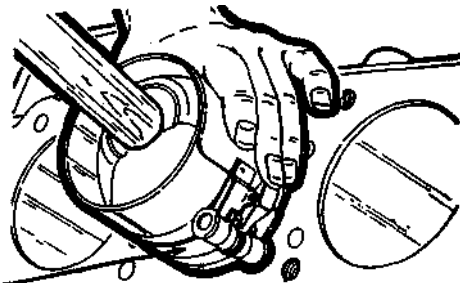
NOTE: With the proper bearing selected and the nuts torqued, it should be possible to move the connecting rod back and forth freely on the crank journal as allowed by the specified connecting rod end clearance. If the rod cannot be moved, either the rod bearing is too far undersize or the rod is misaligned.

PISTON AND CONNECTING ROD ASSEMBLY AND INSTALLATION

Install the connecting rod to the piston, making sure piston installation notches and any marks on the rod are in proper relation to one another. Lubricate the wrist pin with clean engine oil, and install the pin into the rod and piston assembly, either by hand or by using a wrist pin press as required. Install snap rings if equipped, and rotate them in their grooves to make sure they are seated. To install the piston and connecting rod assembly:

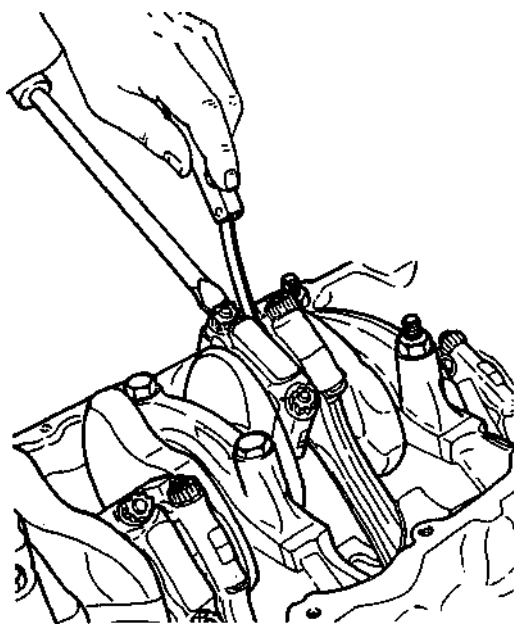
1. Make sure connecting rod big-end bearings (including end cap) are of the correct size and properly installed.

2. Fit rubber hoses over the connecting rod bolts to protect the crankshaft journals, as in



RING COMPRESSOR

Install piston ring compressor, then tap the piston into the cylinder bore carefully. Make sure the piston front marks are correctly positioned when installing



Check the connecting rod side clearance with a feeler gauge. Use a small pry bar to carefully spread the rods to specified clearance

the "Piston Removal" procedure. Coat the rod bearings with clean oil.

3. Using the proper ring compressor, insert the piston assembly into the cylinder so that the notch in the top of the piston faces the front of the engine (this assumes that the dimple(s) or other markings on the connecting rods are in correct relation to the piston notch(s)).

4. From beneath the engine, coat each crank journal with clean oil. Pull the connecting rod, with the bearing shell in place, into position against the crank journal.

5. Remove the rubber hoses. Install the bearing cap and cap nuts and torque to specification.

NOTE: When more than one rod and piston assembly is being installed, the connecting rod cap attaching nuts should only be tightened enough to keep each rod in position until all have been installed. This will ease the installation of the remaining piston assemblies.

6. Check the clearance between the sides of the connecting rods and the crankshaft using a feeler gauge. Spread the rods slightly with a small prybar to insert the gauge. If clearance is below the minimum tolerance, the rod may be machined to provide adequate clearance. If clearance is excessive, substitute an unworn rod, and recheck. If clearance is still outside specifications, the

crankshaft must be welded and reground, or replaced.

7. Replace the oil pump, if removed, and the oil pan.

8. Install the cylinder head(s) and intake manifold, as previously described.

Crankshaft Servicing

Crankshaft servicing literally makes or breaks any engine; especially a high performance one such as the Corvette.

The most critical maintenance operation is the replacement of the crankshaft main bearings. These bearings are of the precision insert design and do not require adjustment through shims. They are offered in under-sizes of 0.001 in., 0.002 in., 0.009 in., 0.010 in., 0.020 in., and 0.030 in.

Despite the advent of these inserts and accompanying precision machine work, it does happen that sizing mistakes are made and no crankshaft should be installed in a block without checking clearances. One of the simplest means of doing so is to use Plastigage®. This is a wax-like plastic material that is formed into precision threads. It will compress evenly between two surfaces, without damage, and when measured, will indicate the actual clearance.

It is easiest to check bearing clearance with the engine removed from the car and the block inverted. This ensures that the crank is resting against the upper bearing shells. If Plastigage is to be used on an engine still in the vehicle, it will be necessary to support the crankshaft at both ends so that clearance between the crankshaft and the upper bearing shells is eliminated.

REMOVAL

1. Drain the engine oil and remove the engine from the car. Mount the engine on a work stand in a suitable working area. Invert the engine, so the oil pan is facing up.

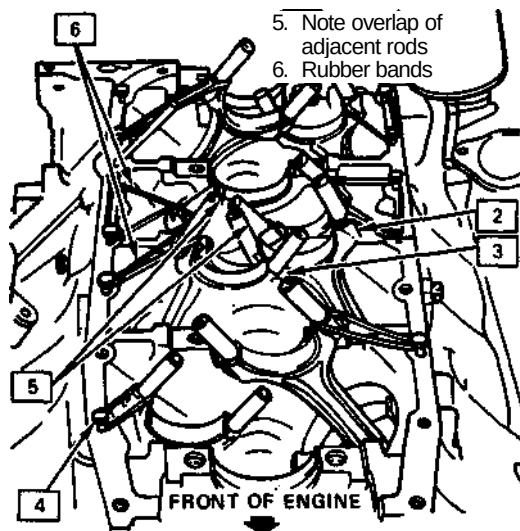
2. Remove the engine front (timing) cover.

3. Remove the timing chain and gears.

4. Remove the oil pan.

5. Remove the oil pump.

6. Stamp the cylinder number on the machined surfaces of the bolt bosses of the connecting rods and caps for identification when reinstalling. If the pistons are to be removed eventually from the connecting rod, mark the cylinder number on the pistons with silver paint or felt-tip pen for proper cylinder identification and cap-to-rod location.



1. Rubber hose
2. #4 rod
3. #3 rod
4. Oil pan bolt

Support the connecting rods with rubber bands and install rubber rod bolt caps when crankshaft is removed

7. Remove the connecting rod caps. Install lengths of rubber hose on each of the connecting rod bolts, to protect the crank journals when the crank is removed.

8. Mark the main bearing caps with a number punch or punch so that they can be reinstalled in their original positions.

9. Remove all main bearing caps.

10. Note the position of the keyway in the crankshaft so it can be installed in the same position.

11. Install rubber bands between a bolt on each connecting rod and oil pan bolts that have been reinstalled in the block (see illustration). This will keep the rods from banging on the block when the crank is removed.

12. Carefully lift the crankshaft out of the block. The rods will pivot to the center of the engine when the crank is removed.

MAIN BEARING INSPECTION

Like connecting rod big-end bearings, the crankshaft main bearings are shell-type inserts that do not utilize shims and cannot be adjusted. The bearings are available in various standard and undersizes; if main bearing clearance is found to be excessive, a new bearing (both upper and lower halves) is required.

NOTE: Factory-undersized crankshafts are marked, sometimes with a "9" and/or a large

spot of light green paint; the bearing caps also must have the paint on each side of the undersized journal.

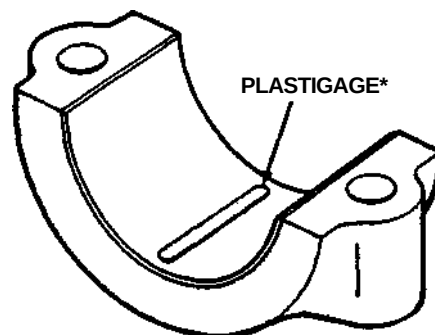
Generally, the lower half of the bearing shell (except No. 1 bearing) shows greater wear and fatigue. If the lower half only shows the effects of normal wear (no heavy scoring or discoloration), it can usually be assumed that the upper half is also in good shape; conversely, if the lower half is heavily worn or damaged, both halves should be replaced. *Never replace one bearing half without replacing the other,*

MEASURING MAIN BEARING CLEARANCE

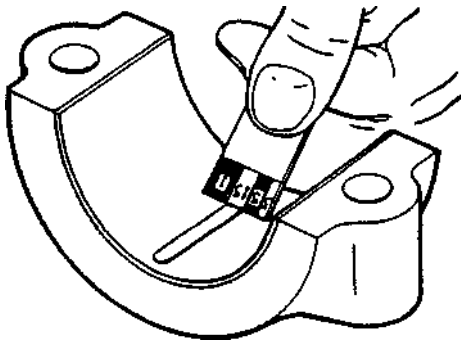
Main bearing clearance can be checked both with the crankshaft in the car and with the engine out of the car. If the engine block is still in the car, the crankshaft should be supported both front and rear (by the damper and to remove clearance from the upper bearing. Total clearance can then be measured between the lower bearing and journal. If the block has been removed from the car, and is inverted, the crank will rest on the upper bearings and the total clearance can be measured between the lower bearing and journal. Clearance is checked in the same manner as the connecting rod bearings, with-plastigage®.

NOTE: Crankshaft bearing caps and bearing shells should NEVER be filed flush with the cap-to-block mating surface to adjust for wear in the old bearings. Always install new bearings.

1. If the crankshaft has been removed, install it (block removed from car). If the block is still in the car, remove the oil pan and oil pump. Starting with the rear bearing cap, re-



Plastigage installed on main bearing caps correctly



Measure main bearing clearance by comparing flattened strip to Plastigage scale as shown

move the cap and wipe all oil from the crank journal and bearing cap.

2. Place a strip of Plastigage® the full width of the bearing, (parallel to the crankshaft), on the journal.

NOTE: Plastigage® is soluble in oil; therefore, oil on the journal or bearing could result in erroneous readings. CAUTION: Do not rotate the crankshaft while the gaging material is between the bearing and the journal.

3. Install the bearing cap and evenly torque the cap bolts to specification.

4. Remove the bearing cap. The flattened Plastigage® will be sticking to either the bearing shell or the crank journal.

5. Use the graduated scale on the Plastigage® envelope to measure the material at its widest point. *If the flattened Plastigage® tapers toward the middle or ends, there is a difference in clearance indicating the bearing or journal has a taper, low spot or other irregularity. If this is indicated, measure the crank journal with a micrometer.*

6. If bearing clearance is within specifications, the bearing insert is in good shape. Replace the insert if the clearance is not within specifications. *Always replace both upper and lower inserts as a unit.*

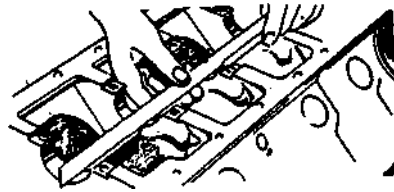
7. Standard, .001 in. or .002 in. undersize bearings should produce the proper clearance. If these sizes still produce too sloppy a fit, the crankshaft must be reground for use with the next undersize bearing. Recheck all clearances after installing new bearings.

8. Replace the rest of the bearings in the same manner. After all bearings have been checked, rotate the crankshaft to make sure there is no excessive drag. When checking the No. 1 main bearing, loosen the accessory drive belts (engine in car) to prevent a tapered reading with the Plastigage®.

MAIN BEARING REPLACEMENT

Engine Out of Car

1. Remove and inspect the crankshaft.
2. Remove the main bearings from the bearing saddles in the cylinder block and main bearing caps.
3. Coat the bearing surfaces of the new, correct size main bearings with clean engine oil and install them in the bearing saddles in the block and in the main bearing caps.
4. Install the crankshaft. See "Crankshaft Installation."



Check main bearing saddle alignment with straight-edge

Engine in Car

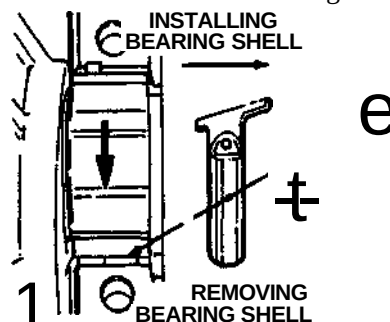
1. With the oil pan, oil pump and spark plugs removed, remove the cap from the main bearing needing replacement and remove the bearing from the cap.

2. Make a bearing roll-out pin, using a bent cotter pin as shown in the illustration. Install the end of the pin in the oil hole in the crankshaft journal.

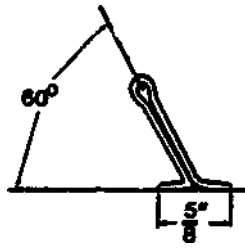
3. Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll the upper bearing out of the block.

4. Lube the new upper bearing with clean engine oil and insert the plain (unnotched) end between the crankshaft and the indented or notched side of the block. Roll the bearing into place, making sure that the oil holes are aligned. Remove the roll pin from the oil hole.

5. Lube the new lower bearing and install



Use a roll-out pin as illustrated to remove bearing shells



Fabricate a roll-out pin as illustrated, if necessary

the main bearing cap. Install the main bearing cap, making sure it is positioned in proper direction with the matchmarks in alignment.

6. Torque the main bearing cap bolts to specification.

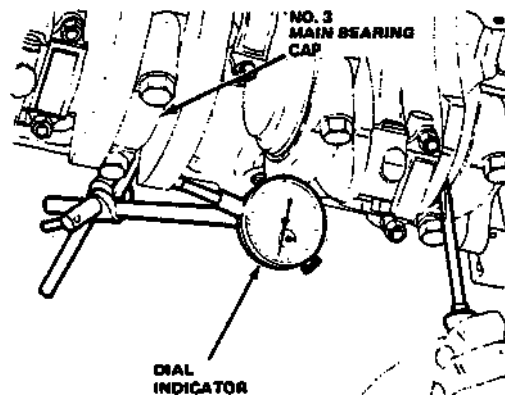
NOTE: *The thrust bearing must be aligned before torquing cap bolts.*

CRANKSHAFT INSTALLATION

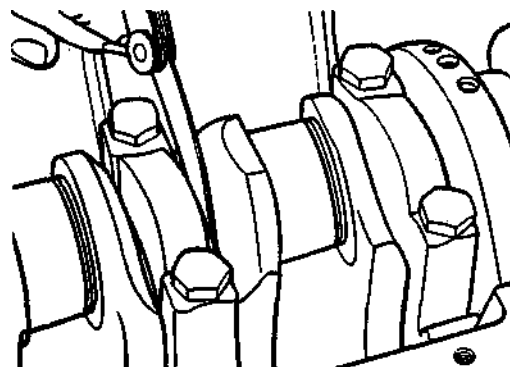
When main bearing clearance has been checked, bearings examined and/or replaced, the crankshaft can be installed. Thoroughly clean the upper and lower bearing surfaces, and lube them with clean engine oil. Install the crankshaft and main bearing caps.

Dip all main bearing cap bolts in clean oil, and torque all main bearing caps, excluding the thrust bearing cap, to specifications (see the "Crankshaft and Connecting Rod" chart in this chapter to determine which bearing is the thrust bearing). Tighten the thrust bearing bolts finger tight. To align the thrust bearing, pry the crankshaft the extent of its axial travel several times, holding the last movement toward the front of the engine. Add thrust washers if required for proper alignment. Torque the thrust bearing cap to specifications.

To check crankshaft end-play, pry the crankshaft to the extreme rear of its axial travel, then to the extreme front of its travel. Using a feeler gauge, measure the end-play at the front of the rear main bearing. End play may also be measured at the thrust bearing.



Measure crankshaft end play with a dial indicator



Use a feeler gauge to check crankshaft end play during assembly

Install a new rear main bearing oil seal in the cylinder block and main bearing cap. Continue to reassemble the engine in reverse of disassembly procedures.

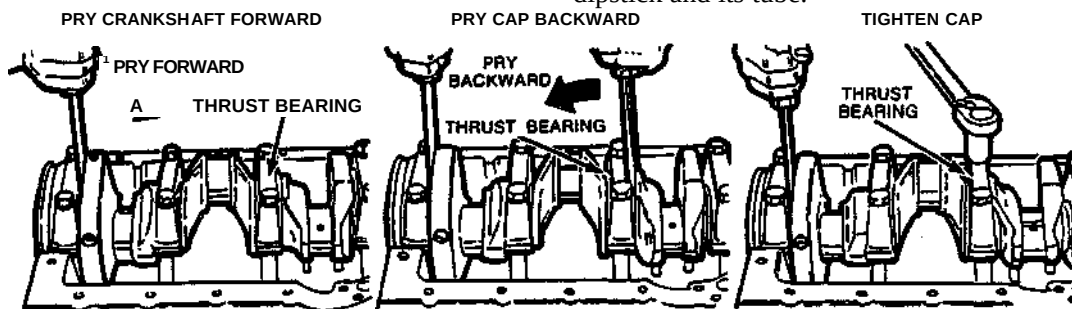
ENGINE LUBRICATION

Oil Pan

REMOVAL AND INSTALLATION All

Models

1. Disconnect the battery and remove the dipstick and its tube.



Align thrust bearing as illustrated. Torque caps to specifications

2. Raise the car and support the front on stands. Drain the engine oil.
3. Remove the starter and flywheel shield.
4. Disconnect the steering idler arm and lower it out of the way.
5. Remove the oil pan and discard the side gaskets and end seals.
6. On high performance engines, the oil splash shield must be removed before further operations can be carried out.
7. Glue the side gaskets and end seals to the oil pan.
8. Install the pan on the engine and tighten the bolts in a criss-cross pattern. Do not over-tighten these bolts.
9. Refill the crankcase with the proper engine oil.

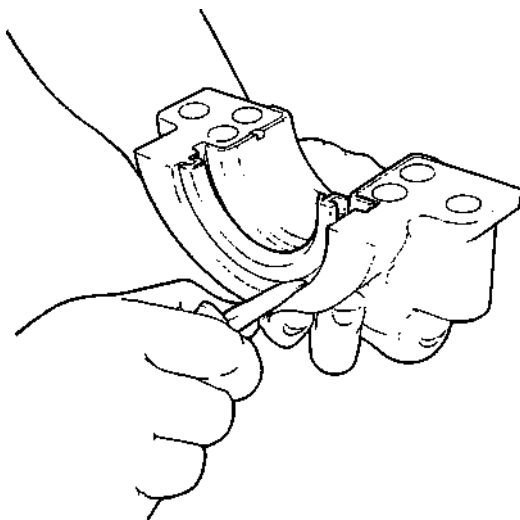
Rear Main Oil Seal

REMOVAL AND INSTALLATION

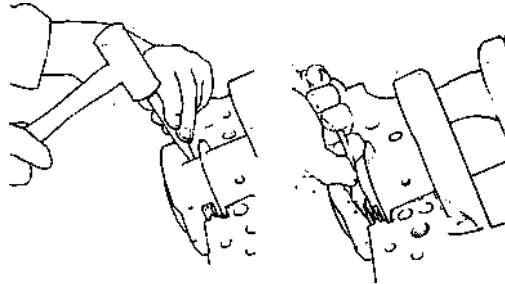
The rear main bearing seal may be replaced without removing the crankshaft. Both upper and lower seals must be replaced at the same time.

NOTE: Extreme care should be exercised when installing this seal to protect the sealing bead located in the channel on the outside diameter of the seal. An installation tool can be used to protect the seal bead when positioning seal.

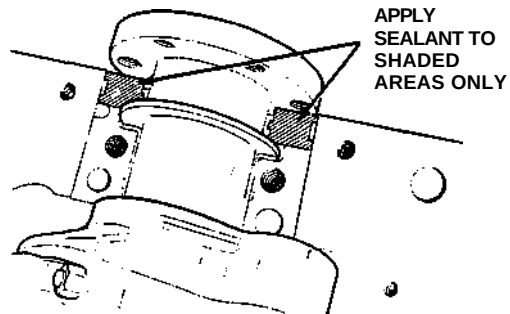
1. Remove the oil pan and oil pump.
2. Remove the rear main bearing cap, and pry the seal out from the bottom with a small screwdriver.
3. Remove the upper seal with a small hammer and a brass pin punch. Tap on one



Removing the lower half of the rear main oil seal



Before installing the rear bearing cap, apply sealer to the rear main seal as indicated
Removing the upper half of the rear main oil seal indicated



end of the seal until the opposite end can be gripped with pliers.

4. Clean the bearing cap and crankshaft.
5. Coat the lips and bead of the seal with a light engine oil. Do not get oil on the seal ends.
6. Insert the new seal into the bearing cap, rolling it into place with your finger and thumb. Press lightly on the seal, so that the seal tangs on the cap don't cut the bead on the back of the seal.
7. Lubricate the lip of the new oil seal and slowly push it into place while turning the crankshaft. Make sure that the seal tangs don't cut the bead on the back of the seal.
8. Install the main bearing cap and torque to specifications.

Oil Pump

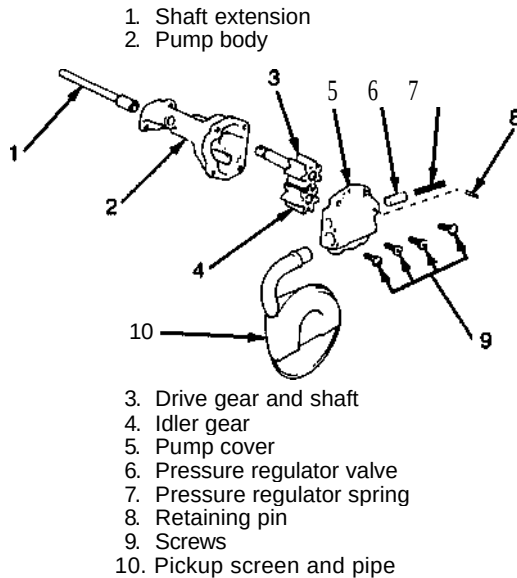
The oil pump is a two-piece housing containing a pressure regulator valve and the two pump gears. It is driven by the distributor shaft, which is in turn driven off the camshaft.

128 ENGINE AND ENGINE REBUILDING

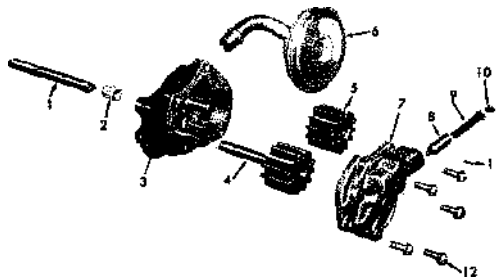
REMOVAL

1. Drain and remove the oil pan.
2. Remove the oil pump-to-rear main bearing cap bolt. Remove the pump and the extension shaft.
3. Remove the cotter pin, spring and pressure regulator valve.

NOTE: Place your thumb over the pressure regulator bore before removing the cotter pin, as the spring is under pressure.



Exploded view of small block oil pump



Exploded view of big block oil pump

OVERHAUL

1. Remove the pump cover attaching screws and the pump cover.

2. Mark gear teeth so they may be reassembled with the same teeth indexing. Remove the idler gear and the drive gear and shaft from the pump body.

3. Remove the pressure regulator valve retaining pin, pressure regulator valve and related parts, if not done.

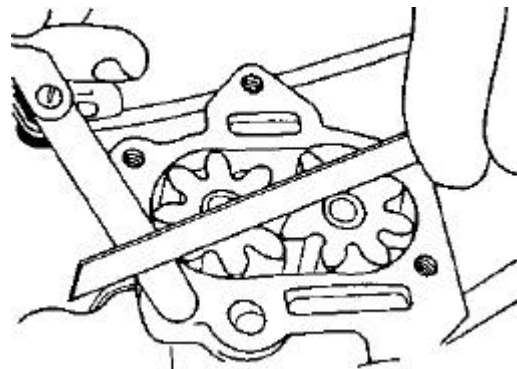
4. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump. Do not disturb the pickup screen on the pipe. This is serviced as an assembly.

5. Wash all parts in cleaning solvent and dry with compressed air.

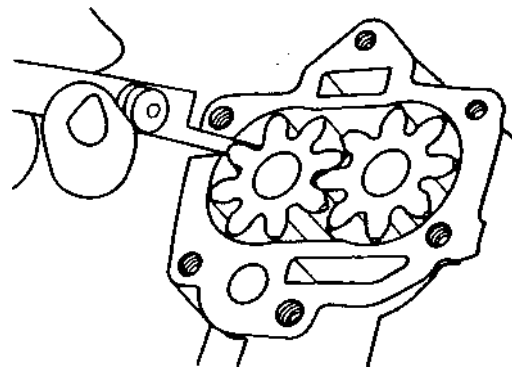
6. Inspect the pump body and cover for cracks or excessive wear. Inspect pump gears for damage or excessive wear.

NOTE: The pump gears and body are not serviced separately. If the pump gears or body are damaged or worn, replacement of the entire oil pump assembly is necessary.

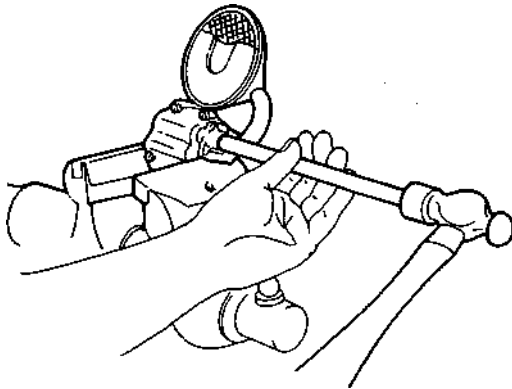
7. Check the drive gear shaft for loose-



Measure oil pump end clearance with feeler gauge and straightedge



Measure oil pump side clearance with a feeler gauge



Install oil pump screen by tapping lightly

ness in the pump body. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.

8. Inspect the pickup screen and pipe assembly for damage to screen, pipe or relief grommet.

9. Check the pressure regulator valve for fit.

10. If the pickup screen and pipe assembly was removed, it should be replaced with a new part. Loss of press fit condition could result in an air leak and loss of oil pressure. Mount the pump in a soft-jawed vise, apply sealer to end of pipe, and use a suitable tool to tap the pipe in place.

NOTE: Be careful of twisting, shearing or collapsing pipe while installing in pump. Do not use excessive force.

11. Install the pressure regulator valve and related parts.

12. Install the drive gear and shaft in the pump body.

13. Install the idler gear in the pump body with the smooth side of gear towards pump cover opening.

NOTE: Pack the inside of the pump completely with petroleum jelly. DO NOT use engine oil. The pump MUST be primed this way or it won't produce any oil pressure when the engine is started.

14. Install the pump cover and torque attaching screws to specifications.

15. Turn drive shaft by hand to check for smooth operation.

INSTALLATION

1. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.

NOTE: When assembling the drive shaft

extension to the drive shaft, the end of the extension nearest the washers must be inserted into the drive shaft.

2. Insert the drive shaft extension through the opening in the main bearing cap and block until the shaft mates into the distributor drive gear.

3. Install the pump onto the rear main bearing cap and install the attaching bolts. Torque the bolts to specifications.

4. Install the oil pan and fill the crankcase with engine oil.

Flywheel and Ring Gear

REMOVAL AND INSTALLATION

The ring gear is an integral part of the flywheel and is not replaceable.

1. Remove the transmission.

2. Remove the six bolts attaching the flywheel to the crankshaft flange. Remove the flywheel.

3. Inspect the flywheel for cracks, and inspect the ring gear for burrs or worn teeth. Replace the flywheel if any damage is apparent. Remove burrs with a mill file.

4. Install the flywheel. The flywheel will only attach to the crankshaft in one position, as the bolt holes are unevenly spaced. Install the bolts and torque to specification. Tighten bolts in crisscross pattern.

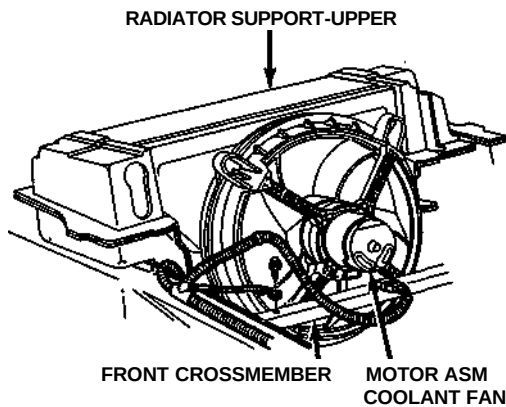
ENGINE COOLING

The cooling system consists of a radiator, expansion tank, viscous drive fan, thermostat, and mechanical water pump. Small block and certain special-performance large block Corvettes use an aluminum cross-flow radiator. Most large block Corvettes utilize a larger capacity radiator of conventional copper-brass alloy. The viscous drive fan restricts operation at 1500 rpm in cold weather and 3500 rpm during warmer temperatures. This fan requires less horsepower to drive during high rpm operation and reduces under-hood noise. Corvettes equipped with aluminum radiators demand certain precautions during normal operation and maintenance. Caution is advised when removing and replacing the filler cap, to avoid denting or scratching the sealing surfaces of the filler neck. Do not use replacement filler caps that use brass in their construction. Extended use will damage the radiator and necessitate extensive repair or replacement. The same precautionary mea-

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sure should be taken with replacement drain cocks. A V₈ in. cast iron plug may be substituted only for an extremely short period of time. Use only antifreezes and cleaners that are recommended for aluminum cooling systems.

1984 and later models use an electric, single-speed cooling fan mounted directly to the radiator shroud. Fan operation is determined by coolant temperature, operating only enough to maintain engine coolant at or below a preset maximum temperature. The cooling fan is energized through a relay controlled by a sending unit located in the right cylinder bank. The fan only operates when road speed is below 35 mph.



Thermostatically controlled cooling fan—1984 and later

Radiator

REMOVAL AND INSTALLATION

1963-68

1. Drain the radiator and cylinder block.
2. Remove upper and lower hoses and expansion tank hose.
3. Remove radiator shroud(s).
4. Remove retaining clamps and carefully pull radiator up and out of vehicle.
5. Reverse this procedure to install the radiator. Be sure that the two rubber cushions are correctly seated under the radiator before tightening.
6. Refill the cooling system and check for leaks.

1969-74

1. Drain the radiator.
2. Raise the hood and insert a bolt in the hole of the hood support. Remove the hood.
3. Remove the radiator inlet and outlet

hoses and, if applicable, the transmission coolant hoses.

4. If applicable, remove the supply tank hose at the radiator connection.

5. Remove the shroud to radiator support bracket screws (the L88 engine does not have a fan shroud).

6. Remove the shroud to radiator baffle bracket screws and let the shroud rest on the fan.

7. Remove the radiator upper support bracket screws and carefully *lift* the radiator from the car.

8. Install in the reverse order of removal.

1975-76

1. Drain the radiator and disconnect the battery ground cable. Disconnect cooler lines on automatic transmission models.

2. Remove the hood. This is a two-man job.

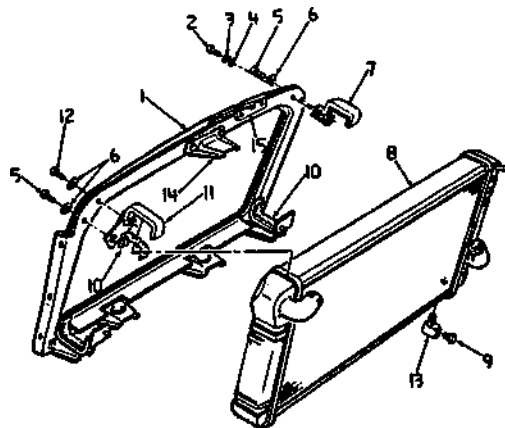
3. Remove the radiator support brackets attached to the fan shroud.

4. Remove the two front hood hinge bolts.

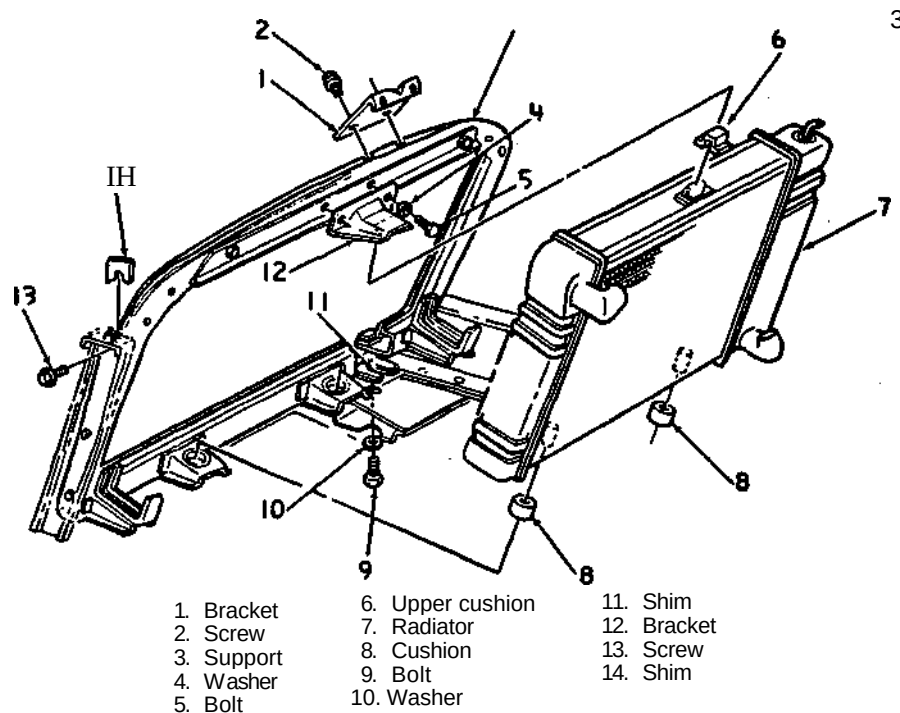
5. From inside the wheel well, remove the six radiator side support bolts.

6. Remove the two bottom radiator support bolts and the center brace.

7. Pull the radiator support forward and use a clamp to retain it to the right hood hinge.



Big block and H.O. small block radiator mounting. Most later models use this type of mounting regardless of whether a H.D. radiator is used



Standard duty small block radiator mounting—typical

8. Disconnect the two radiator hoses and the overflow hose.
9. Carefully lift the radiator out of the car.
10. If replacing the radiator, remove the shrouds and mount them on the new unit.
11. Installation is the reverse of removal.

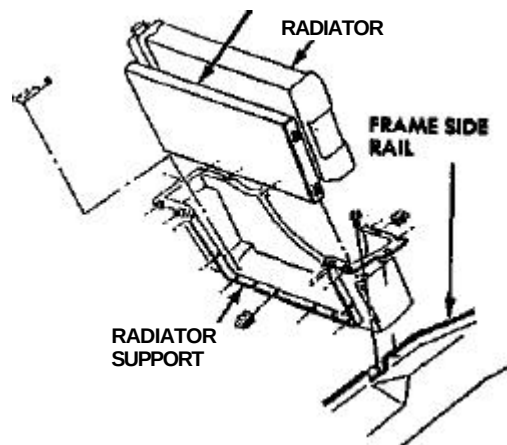
1977-82

1. Disconnect the negative battery cable at the battery.
2. Drain the cooling system.
3. If necessary remove the air cleaner snorkel.
4. Raise the front of the vehicle and support it with jack stands.
5. Disconnect the fan shroud from the radiator support bracket.
6. If so equipped disconnect the automatic transmission cooler lines from the radiator.
7. Remove the radiator support brackets.
8. Disconnect the radiator upper and lower hoses and the overflow tube from the radiator.
9. Remove the radiator.
10. Installation is the reverse of removal. When installing the radiator make sure it is seated in the mounting pads. When replacing

ing the radiator cap make sure the arrows line up with the overflow tube.

1984 and Later

1. Disconnect negative battery cable.
2. Drain cooling system.
3. Remove upper radiator hose.
4. Remove lower radiator hose.
5. Remove overflow hose at radiator.
6. Remove A/C accumulator and move aside.



Radiator mounting—1984 and later

CONDENSER

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7. Remove transmission cooler line.
8. Remove fan wires from fan and shroud.
9. Remove fan to gain access to lower cooler line.
10. Remove transmission cooler line at fitting.
11. Remove upper shroud bolts.
12. Remove upper shroud.
13. Remove radiator.
14. Installation is the reverse of removal.

Water Pump

REMOVAL AND INSTALLATION

1963-82

1. Drain the radiator.
2. Remove the fan.
3. Loosen the alternator mounting, rotate the alternator, and remove the fan belt. Remove power steering belt, A.I.R. belt, and idler belt, if so equipped.
4. Disconnect radiator and heater hoses.
5. Remove the water pump retaining bolts and remove the pump.
6. Reverse this procedure to install.

1984 and Later

1. Disconnect battery negative cable.
2. Drain cooling system.
3. Remove serpentine drive belt.
4. Remove water pump pulley.
5. Remove AIR pump pulley.
6. Remove air management valve adapter.
7. Remove AIR pump.
8. Disconnect fuel inlet and return lines.
9. Remove rear A/C compressor braces.
10. Remove lower A/C compressor mounting bolt.
11. Remove A/C compressor and idler pulley bracket nuts.
12. Disconnect A/C compressor wires.
13. Slide mounting bracket forward and rear A/C compressor bolt.
14. Remove A/C compressor.
15. Remove right and left AIR hoses at check valve.
16. Remove AIR pipe at intake and power steering reservoir bracket.
17. Remove power steering reservoir bracket including top alternator bolt.
18. Remove lower AIR bracket on water pump.
19. Remove lower radiator and heater hose at water pump.
20. Remove water pump.
21. Installation is the reverse of removal.

NOTE: *If installing new water pump, transfer heater hose fitting from old unit.*

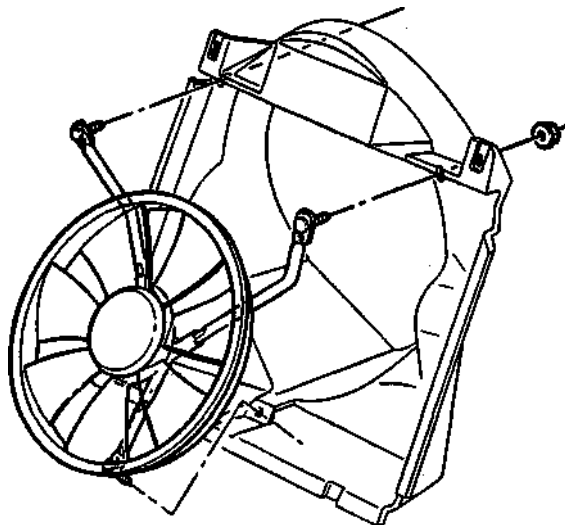
Thermostat

REMOVAL AND INSTALLATION

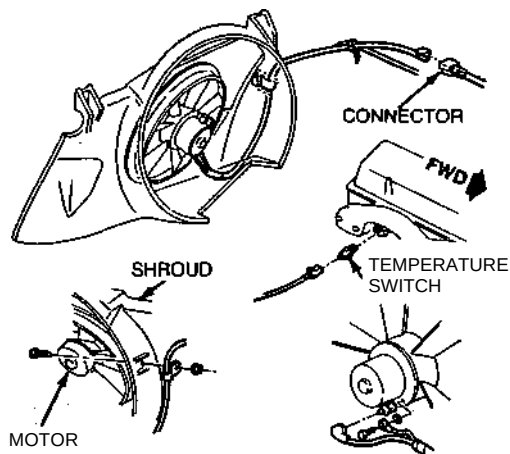
1. Drain enough coolant from the radiator to bring the level below the thermostat.
2. Remove the two bolts retaining the water neck to the manifold.
3. Lift the water neck (with radiator hose attached) and remove the thermostat.
4. Reverse this procedure to install, using a new gasket.

Auxiliary Engine Cooling Fan

Most 1979-82 Corvettes equipped with the heavy duty cooling system option use an auxiliary electric cooling fan. The auxiliary fan is used to supplement the engine-mounted fan during conditions of very high engine temperatures. The auxiliary fan circuit is energized anytime the ignition switch is in the RUN position, though the fan itself will not operate until the engine coolant temperature reaches 238°F., as sensed by the cylinder head-mounted coolant temperature sensor. When the coolant temperature decreases to approximately 201°F., the fan will turn off. **CAUTION:** *Keep hands, tools, clothing, etc. clear of the auxiliary fan. The fan can come on automatically even when the engine is not running.*



Auxiliary electric cooling fan used on most 1979-84 models



Electric cooling fan and related wiring

REMOVAL AND INSTALLATION

1. Disconnect the battery cables at the battery.
2. Remove the fresh air scoop.
3. Remove the engine-mounted cooling fan.
4. Remove the upper radiator shroud screws.
5. Remove the three fan bracket-to-shroud fasteners, remove the fan and motor assembly and disconnect the wire from the fan motor.
6. Installation is the reverse of the previous steps.