FORD DIVISION • FORD MOTOR COMPANY

1960 FORD CAR

SHOP Manual

1960 Ford Car Shop Manual
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1960

FORD CAR

SHOP MANUAL

DEPARTMENT
DIVISION
OR COMPANY

COMPANY, DEARBORN, MICHIGAN

INDEX

FOREWORD

This manual provides information for the proper servicing of 1960 Ford Cars, Station Wagons, Courier, and Ranchero. The descriptions and specifications contained in this manual were in effect at the time the manual was approved for printing. The Ford Division of Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design, without notice and without incurring obligation.

SERVICE DEPARTMENT
FORD DIVISION
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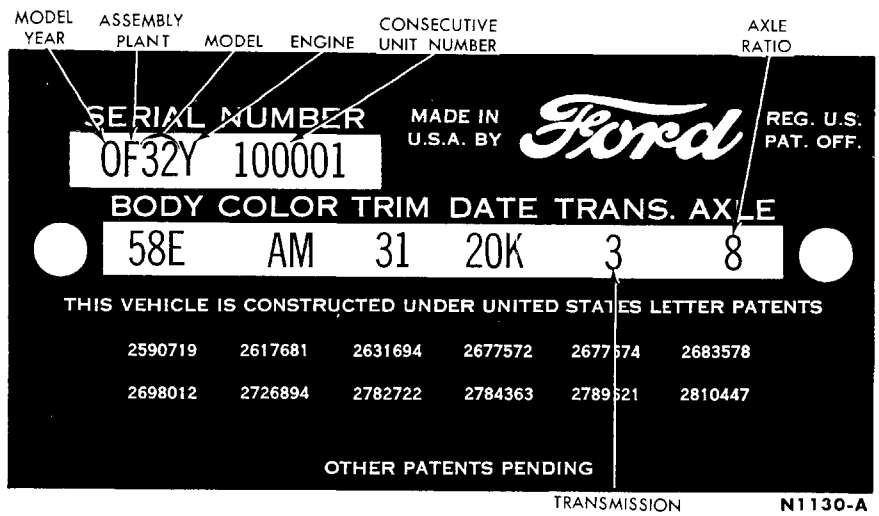
FORD CAR IDENTIFICATION



Car Patent Plate

The Car Patent Plate is attached to the left door front pillar.

MODEL YEAR

The number "0" designates 1960.

ASSEMBLY PLANT

A	Atlanta	D	Dallas
C	Chester	F	Dearborn
G	Chicago	K	Kansas City
H	Lorain	N	Norfolk
J	Los Angeles	S	Pilot Plant
U	Louisville	R	San Jose
E	Mahwah	P	Twin City

MODEL

The model code number identifies the product line series and the particular body style: the first of the two digits shows the product line, and the second digit shows a two-door style **by an odd number** or a four-door style **by an even number.**

Fairlane—Series 30

31 . . . . . 2 Door Club Sedan
32 . . . . . 4 Door Town Sedan
33 . . . . . 2 Door Business Sedan

Fairlane 500—Series 40

41 . . . . . 2 Door Club Sedan
. . . . . 4 Door Town Sedan

Starliner

53 . . . . . 2 Door Club Victoria

Sunliner

55 . . . . . Sunliner Convertible

Station Wagons—Series 60

61 . . . . . 2 Door Ranch Wagon
62 . . . . . 4 Door Ranch Wagon
64 . . . . . 4 Door 6-Passenger Country Sedan
66 . . . . . 4 Door 9-Passenger Country Sedan
68 . . . . . 4 Door 9-Passenger Country Squire
69 . . . . . 2 Door Courier (Commercial Ranch Wagon)

ENGINE

V . . . . . 6 Cylinder 223 Cubic Inch
W . . . . . 8 Cylinder 292 Cubic Inch (Dual)
X . . . . . 8 Cylinder 352 Cubic Inch (Dual)
Y . . . . . 8 Cylinder 352 Cubic Inch (4-barrel)
T . . . . . 8 Cylinder 292 Cubic Inch (Dual—Low Compression Export, 84 Octane)
G . . . . . 8 Cylinder 352 Cubic Inch (4-barrel Low Compression Export, 84 Octane)

CONSECUTIVE UNIT NUMBER

Each assembly plant, with each model year, begins with consecutive unit number 100001 and continues on for each car built.

FORD CAR IDENTIFICATION

BODY

Fairlane

64F . . . . . 2 Door Club Sedan
58E . . . . . 4 Door Town Sedan
64G . . . . . 2 Door Business Sedan

Fairlane 500

64A . . . . . 2 Door Club Sedan
58A . . . . . 4 Door Town Sedan

Galaxie

62A . . . . . 2 Door Club Sedan
54A . . . . . 4 Door Town Sedan
75A . . . . . 4 Door Town Victoria

Starliner

63A . . . . . 2 Door Club Victoria

Sunliner

76B . . . . . Sunliner Convertible

Station Wagons

59C . . . . . 2 Door Ranch Wagon
71H . . . . . 4 Door Ranch Wagon
71F . . . . . 4 Door 6-Passenger Country Sedan
71E . . . . . 4 Door 9-Passenger Country Sedan
71G . . . . . 4 Door 9-Passenger Country Squire
59E . . . . . 2 Door Courier (Commercial Ranch Wagon)

COLOR

Code	"M" Number	Color	Sales Name
A	M30J-1724	Black	Raven Black
C	M30J-1139	Light Aqua	Aquamarine
E	M30J-1225	Medium Blue Metallic	Belmont Blue
F	M30J-1226	Light Blue	Sky Mist Blue
G	M30J-1231	Yellow	Yosemite Yellow
H	M30J-1230	Beige Metallic	Beachwood Brown
J	M30J-1232	Red	Monte Carlo Red

Code	"M" Number	Color	Sales Name
K	M30J-1233	Turquoise Metallic	Sultana Turquoise
M	M30J-1238	White	Corinthian White
Q	M30J-1248	Lavender Metallic	Orchid Gray
T	M30J-1273	Medium Green Metallic	Meadow Vale Green
W	M30J-1274	Light Green	Adriatic Green
Z	M30J-1287	Light Gray Metallic	Platinum

TRIM

32 . . . . . Vinyl & Blue Broadcloth
33 . . . . . Vinyl & Green Broadcloth
31 . . . . . Vinyl & Gray Broadcloth
34 . . . . . Vinyl & Beige Broadcloth
62 . . . . . Vinyl & Blue Woven Plastic
63 . . . . . Vinyl & Green Woven Plastic
67 . . . . . Vinyl & Turquoise Woven Plastic
44 . . . . . Beige All Vinyl
45 . . . . . Red All Vinyl
37 . . . . . Vinyl & Turquoise Broadcloth
36 . . . . . Vinyl & Black Broadcloth
38 . . . . . Vinyl & Yellow Broadcloth
35 . . . . . Vinyl & Red Broadcloth
39 . . . . . Vinyl & Lavender Broadcloth
48 . . . . . Yellow All Vinyl
42 . . . . . Blue All Vinyl
47 . . . . . Turquoise All Vinyl
46 . . . . . Black All Vinyl
49 . . . . . Lavender All Vinyl
43 . . . . . Green All Vinyl

DATE

The code letters for the month are preceded by a numeral to show the day of the month when the car was completed.

	First Model Year	Second Model Year
January	A	N
February	B	P
March	C	Q
April	D	R
May	E	S
June	F	T
July	G	U
August	H	V
September	J	W
October	K	X
November	L	Y
December	M	Z

TRANSMISSION

1 . . . . . Standard
2 . . . . . Overdrive
3 . . . . . Fordomatic
4 . . . . . Automatic—Cruise-O-Matic

A number designates a conventional axle, while a letter designates an Equa-Lock differential.

1 . . . . . 3.56
2 . . . . . 3.89
3 . . . . . 3.10
4 . . . . . 3.78
6 . . . . . 3.22
8 . . . . . 2.91
9 . . . . . 3.70
A 3.56
B 3.89
C 3.10

1960 FORD CAR SHOP MANUAL

GROUP 1

ENGINES AND EXHAUST SYSTEMS

PART 1-1 GENERAL ENGINE SERVICE

This part covers engine trouble diagnosis, tune-up, and in-chassis tests and adjustments for all car engines. In addition, the cleaning, inspection, repair, and overhaul procedures are covered.

For engine removal, disassembly, assembly, and installation procedures, refer to Parts 1-2, 1-3, and 1-4.

1 ENGINE TROUBLE DIAGNOSIS

Engine performance complaints usually fall under one of the basic headings listed in the "Engine Trouble Diagnosis Guide." When a particular trouble can not be traced to a definite cause by a simple check, the possible items that could be at fault are listed in the order of their probable occurrence. Therefore, in most cases, the items should be checked in the order listed. For example, under Poor Acceleration, the ignition system is listed as a probable cause of the trouble. All the ignition system items that affect acceleration are listed. These items should all be checked before proceeding to the next probable cause listed.

ENGINE TROUBLE DIAGNOSIS GUIDE

ENGINE WILL NOT CRANK	The cause of this trouble is usually in the starting system. If the starting system is not at fault, check for a hydrostatic lock or a seized engine. Remove the spark plugs, then attempt to crank the engine with the starter. If the engine cranks, it indicates that water is leaking into the cylinders. Remove the cylinder head(s) and inspect the gasket(s) and/or head(s) for cracks. Examine the cylinder block for cracks.
ENGINE CRANKS NORMALLY, BUT WILL NOT START	Check the fuel supply. If there is sufficient fuel in the tank, the cause of the trouble probably lies in either the ignition or the fuel system. To determine which system is at fault, disconnect all the spark plug wires. Check the spark intensity of one wire at a time. Install a terminal adapter in the terminal of the wire to be checked. Hold the adapter approximately 3/16 inch from the exhaust manifold and crank the engine. **NO SPARK OR A WEAK SPARK AT THE SPARK PLUGS** The cause of the trouble is in the ignition system. To determine if the cause of the trouble is in the primary or the secondary circuit, remove the coil high tension lead from the top of the distributor and hold it approximately 3/16 inch from the cylinder head, then with the ignition on and

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ENGINE CRANKS NORMALLY, BUT WILL NOT START (Continued)

the engine turning over, check for a spark.

If the spark at the coil high tension lead is good, the cause of the trouble is probably in the distributor cap, rotor, or the spark plug wires.

If there is no spark or a weak spark at the coil high tension lead, the cause of the trouble is probably in the primary circuit, coil to distributor high tension lead, or the coil.

A GOOD SPARK AT THE SPARK PLUGS

If the spark is good at the spark plugs, check the spark plugs and the ignition timing. If the spark plugs or the ignition timing are not at fault, check the following items:

MANUAL CHOKE

Check the choke linkage for binding or damage. Make certain the choke plate closes when the choke knob on the instrument panel is pulled out and that the plate opens when the knob is pushed in.

AUTOMATIC CHOKE

Check the position of the choke plate. If the engine is hot, the plate should be open. If the plate is not open, the engine will load up due to the excessively rich mixture and will not start. If the engine is cold, the plate should be closed. If the plate is not operating properly, check the following items:

The choke linkage for binding.

The fast idle cam for binding.

Thermostatic spring housing adjustment.

Fast idle speed screw for proper adjustment.

FUEL SUPPLY AT CARBURETOR

Work the throttle by hand several times. Each time the throttle is actuated, fuel should spurt from the accelerating pump discharge nozzles.

If fuel is discharged by the accelerating pump, the engine is probably flooded, or there is water in the fuel system, or an engine mechanical item, is at fault.

If fuel is not discharged by the accelerating pump, disconnect the carburetor fuel inlet line at the carburetor. Use a suitable container to catch the fuel. Crank the engine to see if fuel is reaching the carburetor.

If fuel is not reaching the carburetor, check:

The fuel pump.

The carburetor fuel inlet line for obstructions.

The flexible fuel pump inlet line for a collapsed condition.

The fuel tank line to flexible fuel line for obstructions.

The fuel tank vent.

If fuel is reaching the carburetor, check:

The fuel inlet system including, the fuel inlet screen, the fuel inlet needle and seat assembly, and the float assembly.

Check for dirt in the carburetor, not allowing fuel to enter or be discharged from the idle system.

ENGINE STARTS, BUT FAILS TO KEEP RUNNING

FUEL SYSTEM

Idle fuel mixture needle(s) not properly adjusted.

Engine idle speed set too low.

The choke not operating properly.

Float setting incorrect.

Fuel inlet system not operating properly.

Dirt or water in fuel lines or carburetor.

Carburetor icing.

Fuel pump defective.

IGNITION SYSTEM

Breaker points not properly adjusted.

Defective spark plugs.

Leakage in the high tension wiring.

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ENGINE RUNS, BUT MISSES

Determine if the miss is steady or erratic and at what speed the miss occurs by operating the engine at various speeds under load.

MISSES STEADILY AT ALL SPEEDS

Isolate the miss by operating the engine with one cylinder not firing. This is done by operating the engine with the ignition wire removed from one spark plug at a time, until all cylinders have been checked. Ground the spark plug wire removed.

If the engine speed changes when a particular cylinder is shorted out, that cylinder was delivering power before being shorted out. If no change in the engine operation is evident, the miss was caused by that cylinder not delivering power before being shorted out, check the:

IGNITION SYSTEM

If the miss is isolated in a particular cylinder, perform a spark test on the ignition lead of the cylinder.

If a good spark does not occur, the trouble is in the secondary circuit of the system, check the:

Spark plug wire.

Distributor cap.

If a good spark occurs, check the spark plug. If the spark plug is not at fault, a mechanical component of the engine is probably at fault.

ENGINE

Perform a compression test to determine which mechanical component of the engine is at fault.

MISSES ERRATICALLY AT ALL SPEEDS

EXHAUST SYSTEM

Exhaust gas control valve inoperative or sticking.

Exhaust system restricted.

IGNITION SYSTEM

Breaker points not properly adjusted.

Defective breaker points, condenser, secondary wiring, coil, or spark plugs.

High tension leakage across the coil, rotor, or distributor cap.

FUEL SYSTEM

Choke not operating properly.

Float setting incorrect.

Fuel inlet system not operating properly.

Dirt or water in fuel lines or carburetor.

Restricted fuel filter.

COOLING SYSTEM

Check the cooling system for internal leakage and/or for a condition that prevents the engine from reaching normal operating temperature.

ENGINE

Perform a compression test to determine which mechanical component of the engine is at fault.

MISSES AT IDLE ONLY

FUEL SYSTEM

Idle fuel mixture needles not properly adjusted.

IGNITION SYSTEM

Defective coil, condenser, breaker points, rotor, ignition wiring, or spark plugs.

Excessive play in the distributor shaft.

Worn distributor cam.

VACUUM BOOSTER PUMP

Leaking pump, lines, or fittings.

ENGINE

Perform a compression test to determine which mechanical component of the engine is at fault.

MISSES AT HIGH SPEED ONLY

FUEL SYSTEM

Power valve clogged or damaged.

Low or erratic fuel pump pressure.

Fuel inlet system not operating properly.

Restricted fuel filter.

COOLING SYSTEM

Engine overheating.

FUEL SYSTEM

Engine idle speed set too low.

Idle fuel mixture needle(s) not properly adjusted.

Float setting incorrect.

Air leaks between the carburetor and the manifold and/or fittings.

Fuel leakage at the carburetor fuel bowl(s).

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ROUGH ENGINE IDLE (Continued)	Idle fuel system air bleeds or fuel passages restricted. Fuel bleeding from the accelerating pump discharge nozzle(s). Throttle plate(s) not closing. Improper secondary throttle plate stop adjustment (4 - barrel carburetor). **IGNITION SYSTEM** Improperly adjusted or defective breaker points. Fouled or improperly adjusted spark plugs. Incorrect ignition timing. Spark plug misfiring.	**EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking. **VACUUM BOOSTER PUMP** Leaking pump, lines, or fittings. **ENGINE** Loose engine mounting bolts or worn insulator. Cylinder head bolts not properly tightened. Valve lash set too tight (Mileage Maker Six and 292 V-8).
POOR ACCELERATION	**IGNITION SYSTEM** Incorrect ignition timing. Fouled or improperly adjusted spark plugs. Improperly adjusted or defective breaker points. Distributor not advancing properly. **FUEL SYSTEM** Inoperative accelerating pump inlet ball check. Inoperative accelerating pump discharge ball check. Accelerating pump diaphragm defective. Float setting incorrect. Throttle linkage not properly adjusted. Accelerating pump stroke not properly adjusted.	Leaky power valve, gaskets, or accelerating pump diaphragm. Dirt or corrosion in accelerating system. Distributor vacuum passages in the carburetor blocked. Restricted fuel filter. **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking. **BRAKES** Improper adjustment. **TRANSMISSION** Clutch slippage (manual - shift transmissions). Improper band adjustment (automatic transmissions). Converter One-Way Clutch (automatic transmission).
ENGINE DOES NOT DEVELOP FULL POWER, OR HAS POOR HIGH SPEED PERFORMANCE	**PRELIMINARY** Determine if the trouble exists when the engine is cold, at normal operating temperature, or at all engine temperatures. **ENGINE COLD** **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking. **FUEL SYSTEM** Clogged or undersize main jets d/or low float setting. Clogged or undersize secondary s (4-barrel carburetor). Power valve clogged or damaged.	Secondary throttle plates not opening (4-barrel carburetor). Fuel pump pressure incorrect. Distributor vacuum passage in the carburetor blocked. **COOLING SYSTEM** Thermostat inoperative or incorrect heat range. **ENGINE AT NORMAL OPERATING TEMPERATURE** **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking. **FUEL SYSTEM** Same items as for engine cold.

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ENGINE DOES NOT DEVELOP FULL POWER, OR HAS POOR HIGH SPEED PERFORMANCE (Continued)

ALL ENGINE TEMPERATURES

IGNITION SYSTEM

Ignition timing not properly adjusted.
Defective coil, condenser, or rotor.
Distributor not advancing properly.
Excessive play in the distributor shaft.
Distributor cam worn.
Fouled or improperly adjusted spark plugs or spark plugs of improper heat range.
Improperly adjusted or defective breaker points.

FUEL SYSTEM

Restricted air cleaner.
Restricted fuel filter.
Same items as for engine cold.

ENGINE

Perform an engine compression test to determine which mechanical component is at fault.
One or more camshaft lobes worn beyond wear limit.

EXHAUST SYSTEM

Restriction in system.

TRANSMISSION

Improper band adjustment (automatic transmissions).
Converter One-Way Clutch (automatic transmission).

EXCESSIVE FUEL CONSUMPTION

Determine the actual fuel consumption with test equipment installed in the car.
If the test indicates that the fuel consumption is not excessive, demonstrate to the owner how improper driving habits will affect fuel consumption.
If the test indicates that the fuel consumption is excessive, make a preliminary check of the following items before proceeding to the fuel and ignition systems.

PRELIMINARY CHECKS

CHASSIS ITEMS

Check:
Tires for proper pressure.
Front wheel alignment.
Brake adjustment.

EXHAUST SYSTEM

Check the exhaust gas control valve operation.

ODOMETER

Check calibration.

IGNITION SYSTEM

Check ignition timing.

FINAL CHECKS

FUEL SYSTEM

Check:
Fuel pump pressure.
Engine idle speed.
Idle fuel mixture needle(s) for proper adjustment.
Automatic choke for proper operation.
Fast idle speed screw for proper adjustment.
Accelerating pump stroke adjustment.
Anti-stall dashpot for proper adjustment.
Air cleaner for restrictions.
Float setting or fuel level.
Jets for wear and/or damage.
Power valve operation.
Air bleeds for obstructions.
Accelerating pump discharge nozzles for siphoning.

IGNITION SYSTEM

Check:
Ignition timing.
Spark plug condition and adjustment.
Distributor spark advance operation.

ENGINE

Perform an engine compression test to determine which mechanical component of the engine is at fault.

COOLING SYSTEM

Check thermostat operation and heat range.

TRANSMISSION

Check band adjustment (automatic transmissions).

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS (Continued)

ENGINE OVERHEATS	**TEMPERATURE SENDING UNIT AND GAUGE** Unit or gauge defective, not indicating correct temperature. **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking. Restriction in system. **ENGINE** Cylinder head bolts not properly tightened. Incorrect valve lash. (Mileage Maker Six and 292 V-8). Low oil level or incorrect viscosity oil used.	**COOLING SYSTEM** Insufficient coolant. Cooling system leaks. Drive belt tension incorrect. Radiator fins obstructed. Thermostat defective. Cooling system passages blocked. Water pump inoperative. **IGNITION SYSTEM** Incorrect ignition timing. **BRAKES** Dragging brakes.
ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE	**TEMPERATURE SENDING UNIT AND GAUGE** Unit or gauge defective, not indicating correct temperature.	**COOLING SYSTEM** Thermostat inoperative, incorrect heat range, or thermostat not installed.
LOSS OF COOLANT	**COOLING SYSTEM** Leaking radiator. Loose or damaged hose connections. Water pump leaking. Radiator cap defective. Overheating. **ENGINE** Cylinder head gasket defective.	Intake manifold to cylinder head gasket defective. Improper tightening of cylinder head or intake manifold bolts. Cylinder block core plugs leaking. Temperature sending unit leaking. Cracked cylinder head or block, or warped cylinder head or block gasket surface.
NOISY HYDRAULIC VALVE LIFTER	A noisy valve lifter can be located by operating the engine at idle speed and placing a finger on the face of the valve spring retainer. If the lifter is not functioning properly, a shock will be felt when the valve seats. Another method of identifying a noisy lifter is by the use of a piece of hose. With the engine operating at idle speed, place one end of the hose near the end of the valve stem and the other end to the ear and listen for a metallic noise. Repeat this procedure on each intake and exhaust valve until the noisy lifter(s) has been located. The most common causes of hydraulic valve lifter troubles are dirt, gum, varnish, carbon deposits, and air bubbles. Dirt in the lifter assembly can event the disc valve from seating, it may become lodged between e plunger and body surfaces. In her case, the lifter becomes inop- e due to failure to "pump-up," ecause the internal parts are no	longer free to function properly. When dirt is found to be responsible for lifter malfunction, remove the lifter assembly and thoroughly clean it. Recommended engine oil and filter change intervals should be followed to minimize lifter problems caused by dirt. Deposits of gum and varnish cause similar conditions to exist which may result in lifter malfunction. If these conditions are found to be present, the lifter should be disassembled and cleaned in solvent to remove all traces of deposits. Air bubbles in the lubricating oil, caused by an excessively high or low oil level, may likewise cause lifter malfunction. A damaged oil pick-up tube may allow air to be drawn into the lubricating system. To check for the presence of air, remove a valve rocker arm shaft cover and note the condition of the oil as it flows from the valve rocker arm shaft assembly. Perform corrective action as required to remove air from the lubricating oil.

2 TUNE-UP

The Tune-Up Schedule (Table 1) is applicable for either a minor or major tune-up. Refer to the "Maintenance Guide" in Group 18 for the recommended mileage interval.

Refer to that part of the manual which describes, in detail, the procedure to be followed. Perform the operations in the sequence listed.

TABLE 1—Tune-Up Schedule

Operation	Perform on		Recommended Procedure
	Minor	Major	
SPARK PLUGS Clean, adjust, and test.	X	X	Part 2-1
ENGINE COMPRESSION Take compression reading of each cylinder.		X	Part 1-1
INTAKE MANIFOLD Check and tighten bolts.	X*	X	Part 1-2, 1-3 or 1-4
DRIVE BELTS Check and adjust the tension of all drive belts.	X	X	Part 4-1
BATTERY Clean battery cables and terminals.		X	Part 12-1
Tighten cable clamps.		X	
Grease battery terminals.		X	
Check battery state of charge.	X	X	
Check generator regulator.		X	
Check generator output.		X	Part 12-1
Check starter motor current draw.		X	
Check coil output.		X	Part 2-1
Perform a primary circuit resistance test.		X	
Perform a spark intensity test of each spark plug wire.		X	
DISTRIBUTOR Check the condition of the breaker points.	X		Part 2-1
Replace the breaker points and the condenser.		X	
Check and adjust breaker arm spring tension.		X	
Lubricate the distributor cam. Oil the lubricating		X	
Check and adjust centrifugal advance (Dual Advance Distributor).		X	Part 2-1
Check and adjust vacuum advance.		X	
Clean distributor cap and rotor.	X	X	
FUEL SYSTEM Clean fuel pump sediment bowl.	X	X	Part 3-1
Replace fuel filter.		X	
Check fuel pump pressure and capacity.		X	
Clean carburetor fuel bowl(s) and adjust fuel level.		X	
ADJUSTMENTS Check and adjust ignition timing.	X	X	Part 2-1
Check and adjust engine idle speed.	X	X	Part 3-1
Adjust idle fuel mixture.	X	X	
Check and adjust valve lash (Mileage Maker Six and 292 V-8).	X	X	Part 1-1
EXHAUST Free the exhaust gas control valve.	X	X	Part 1-5
COOLING SYSTEM Inspect the radiator, hoses, and engine for leaks.		X	Part 4-1
Add rust inhibitor to radiator if water is used as coolant.		X	

*On all 352 V-8 engines.

3 TESTS AND ADJUSTMENTS—ENGINE INSTALLED

CAMSHAFT LOBE LIFT

1. On the Mileage Maker Six and 292 V-8, loosen the valve rocker arm adjusting screw serving the camshaft lobe to be checked. Slide the valve rocker arm to one side and secure it in this position.

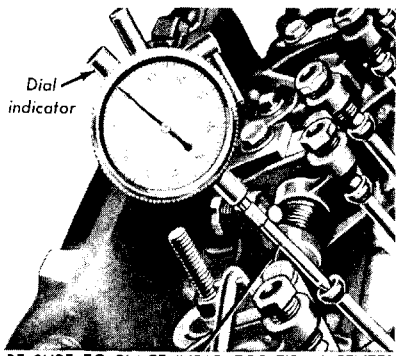


FIG. 1—Camshaft Lobe Lift—Mileage Maker Six or 292 V-8

On all 352 V-8 engines, remove the valve rocker arm shaft assembly and install a solid tappet-type push rod in the push rod bore of the camshaft lobe to be checked.

2. Make sure the push rod is in the tappet socket or the lifter push rod cup, then install a dial indicator in such a manner as to have the actuating point of the indicator in the push rod socket and in the same plane as the push rod movement (Fig. 1 or 2).

3. Rotate the crankshaft slowly in the direction of rotation until the tappet or lifter is on the base circle of the camshaft lobe. At this point, the push rod will be in its lowest position. Zero the dial indicator, then continue to rotate the damper slowly until the push rod is in the fully raised position. Compare the total lift recorded on the indicator with specifications.

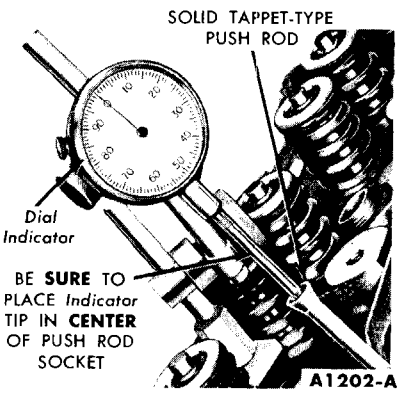


FIG. 2—Camshaft Lobe Lift—352 V-8 Engines

4. Continue to rotate the crankshaft until the indicator reads zero. This is a check on the accuracy of the original indicator reading.

VALVE LASH—MILEAGE MAKER SIX AND 292 V-8

Before a final valve lash adjustment is made, operate the engine for 30 minutes at 1200 rpm to stabilize engine temperatures. To accurately set the valve lash, use only a step-type feeler gauge ("go" and "no go").

It is very important that the valve lash be held to the correct specifications because:

If the lash is set too close, the valve will open too early and close too late, resulting in rough engine idle. Burning and warping of the valves will occur also because the valves cannot make firm contact

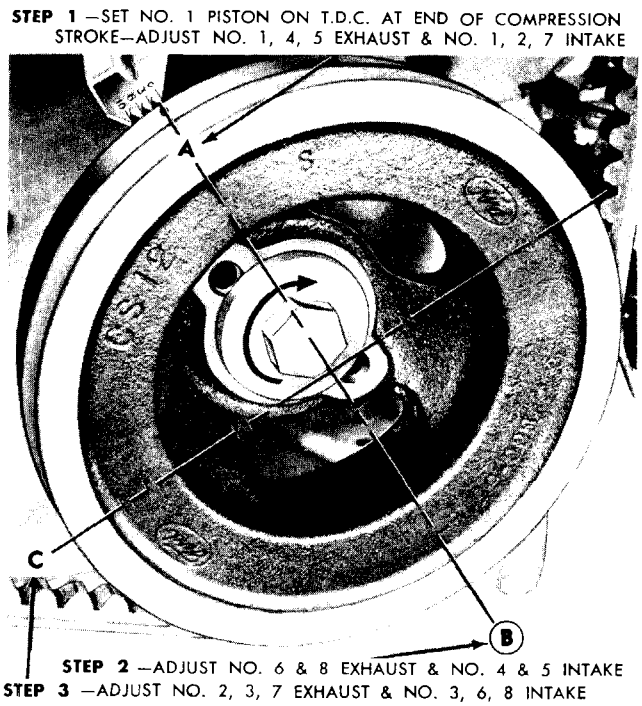
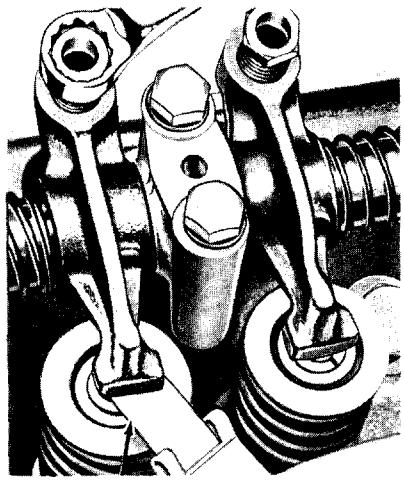


FIG. 4—Preliminary Valve Lash Adjustment—292 V-8



Step Type Feeler Gauge A1001-A

FIG. 5—Valve Lash Adjustment—Mileage Maker Six and 292 V-8

with the seats long enough to cool properly. If the lash is excessive, it will cause the valve to open too late and close too early causing valve bounce. In addition, damage to the camshaft lobe is likely because the tappet foot will not follow the pattern of the camshaft lobe causing a shock contact between these two parts.

If the valve rocker arm shaft assembly has been removed and installed, it will be necessary to make a preliminary (cold) valve lash adjustment before starting the engine. If the adjustment is made for an engine tune-up, follow the final adjustment procedure.

On the Mileage Maker Six, the cylinders are numbered from front to rear, 1-2-3-4-5-6 and the valves are arranged from front to rear, E-I-I-E-I-E-E-I-E-I-I-E.

On the 292 V-8, the cylinders are numbered from front to rear—right bank, 1-2-3-4; left bank, 5-6-7-8. The valves are arranged from front to rear on both banks, E-I-I-E-E-I-I-E.

PRELIMINARY ADJUSTMENT

First, turn all the valve adjusting screws until interference is noted, then check the torque required to turn the screw further. If the torque required to turn a screw is less than

Mileage Maker Six

1. Make two chalk marks on the crankshaft damper (Fig. 3). Space the marks approximately 120° apart so that with the timing mark, the damper is divided into three equal parts (120° represents 1/3 of the distance around the damper circumference).

2. Rotate the crankshaft until the No. 1 piston is near T.D.C. at the end of the compression stroke. The No. 1 piston is on T.D.C. at the end of the compression stroke when both valves are closed and the timing mark on the crankshaft damper is in line with the timing pointer.

3. Adjust the intake and exhaust valve lash for No. 1 cylinder (Fig. 5). The preliminary (cold) intake and exhaust valve lash should be set at 0.019 inch.

4. Repeat this procedure for the remaining set of valves, turning the crankshaft 1/3 turn at a time, in the direction of rotation, while adjusting the valves in the firing order sequence (1-5-3-6-2-4). This procedure requires two complete turns of the crankshaft.

292 V-8

1. Make three chalk marks on the crankshaft damper (Fig. 4). Space the marks approximately 90° apart so that with the timing mark, the damper is divided into four equal parts (90° represents 1/4 of the distance around the damper circumference). The preliminary (cold) intake and exhaust valve lash should be set at 0.019 inch.

2. Rotate the crankshaft until No. 1 piston is near T.D.C. at the end of the compression stroke, then adjust the following valves:

No. 1 Exhaust	No. 1 Intake
No. 4 Exhaust	No. 2 Intake
No. 5 Exhaust	No. 7 Intake

3. Rotate the crankshaft 180° or ½ turn (this puts No. 4 piston on T.D.C.), then adjust the following valves:

No. 6 Exhaust	No. 4 Intake
No. 8 Exhaust	No. 5 Intake

4. Rotate the crankshaft 270° or ¾ turn from 180° (this puts No. 3 piston on T.D.C.), then adjust the following valves:

No. 2 Exhaust	No. 3 Intake
No. 3 Exhaust	No. 6 Intake
No. 7 Exhaust	No. 8 Intake

FINAL ADJUSTMENT

1. Operate the engine for a minimum of **30 minutes at approximately 1200 rpm** to stabilize engine temperatures. **Be sure the engine is at normal operating temperature before attempting to set the valve lash.**

2. With the engine idling, set the valve lash (Fig. 5) **using a step-type feeler gauge only ("go" and "no go").** The final (hot) intake and exhaust valve lash should be 0.019 inch (Mileage Maker Six) and 0.018 inch 292 V-8).

To obtain the correct setting on the Mileage Maker Six, use a **step-type feeler gauge** of 0.018 inch ("go") and 0.020 inch ("no go") and on the 292 V-8 use a **step-type feeler gauge** of 0.017 inch ("go") and 0.019 inch ("no go"). The "go" step should enter, and the "no go" step should not enter. The resultant setting will be to the required specification.

VALVE CLEARANCE—ALL 352 V-8 ENGINES

A 0.060-inch shorter push rod (color coded white) or a 0.060-inch longer push rod (color coded yellow) are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Valve stem to valve rocker arm clearance should be 0.078- 0.218 inch with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease this clearance to the point that if not compensated for, the hydraulic valve lifter will cease to function. To determine whether a shorter push rod is necessary, make the following check:

1. Position the crankshaft as outlined in steps 2 and 3. Position the hydraulic lifter compressor tool on the rocker arm and slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Fig. 6). Hold the lifter in the fully collapsed position and insert the clearance gauge (Fig. 6) between the valve stem and the rocker arm of the valve being checked. If the first step of the gauge enters, the old push rod may be used. If the first step will not enter, replace the standard push rod with a shorter service push rod. If the second step of the gauge enters, the operating range of the lifter is

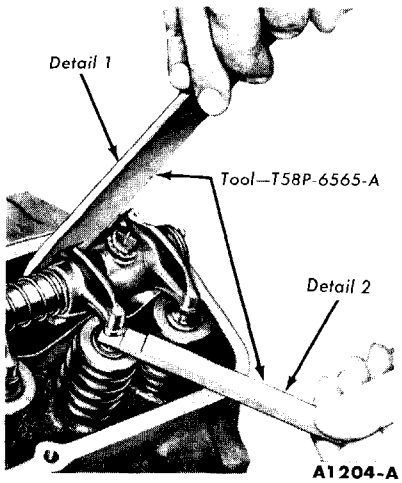


FIG. 6—Valve Clearance—352 V-8

excessive which indicates that the incorrect push rod has been installed or severe wear has occurred at the push rod ends, rocker arm, or valve stem. In this case, it will be necessary to determine the area of discrepancy and the incorrect or defective part(s) should be replaced. If all the valve train components except the push rod are within limits, install a 0.060-inch longer push rod.

2. Rotate the crankshaft until No. 1 piston is on T.D.C. at the end of the compression stroke. With No. 1 piston on T.D.C., check the following valves:

No. 1 Intake	No. 1 Exhaust
No. 3 Intake	No. 4 Exhaust
No. 7 Intake	No. 5 Exhaust
No. 8 Intake	No. 8 Exhaust

3. After these valves have been checked, position No. 6 piston on T.D.C. and check the following valves:

No. 2 Intake	No. 2 Exhaust
No. 4 Intake	No. 3 Exhaust
No. 5 Intake	No. 6 Exhaust
No. 6 Intake	No. 7 Exhaust

When compressing the valve spring to remove push rods, be sure the piston in the individual cylinder is below T.D.C. to avoid contact between the valve and the piston.

To replace a push rod, it will be necessary to remove the valve arm shaft assembly (Part 1-4). replacement of a valve

using the tool shown in Fig. 6 on the valve rocker arm and applying pressure in a direction to collapse the lifter.

MANIFOLD VACUUM TEST

A manifold vacuum test aids in determining the condition of an engine and also in helping to locate the cause of poor engine performance. To test manifold vacuum:

1. Operate the engine for a minimum of 30 minutes at 1200 rpm.

2. Install an accurate, sensitive vacuum gauge on the fuel pump end of the fuel pump vacuum line.

3. Operate the engine at recommended idle rpm, with the transmission selector lever in neutral.

4. Check the vacuum reading on the gauge.

TEST CONCLUSIONS

Manifold vacuum is affected by carburetor adjustment, valve timing, the condition of the valves, cylinder compression, and leakage of the manifold, carburetor, or cylinder head gaskets.

Because abnormal gauge readings may indicate that more than one of the above factors is at fault, exercise caution in analyzing an abnormal reading. For example, if the vacuum is low, the correction of one item may increase the vacuum enough so as to indicate that the trouble has been corrected. It is important, therefore, that each cause of an abnormal reading be investigated and further tests conducted where necessary in order to arrive at the correct diagnosis of the trouble.

Table 2 lists various types of readings and their possible causes.

Allowance should be made for the effect of altitude on the gauge reading. The engine vacuum will decrease with an increase in altitude.

COMPRESSION TEST

1. Be sure the battery is properly charged. Operate the engine for a minimum of 30 minutes at 1200 rpm. Turn the ignition switch off, then remove all the spark plugs.

2. Set the throttle plates (primary throttle plates only on the 4-barrel carburetor) and the choke plate in the wide open position.

3. Install a compression gauge in No. 1 cylinder.

4. Crank the engine several times and record the highest reading registered. Note the number of compression strokes required to obtain the highest reading.

5. Repeat the test on each cylinder, cranking the engine the same number of times for each cylinder as was required to obtain the highest reading on No. 1 cylinder.

TEST CONCLUSIONS

A variation of ∓20 pounds from specified pressure is satisfactory. However, the compression of all cylinders should be uniform within 10 pounds.

A reading of more than the allowable tolerance above normal indicates excessive deposits in the cylinder.

TABLE 2—Manifold Vacuum Gauge Readings

Gauge Reading	Engine Condition
18—All engines.	Normal.
Low and steady.	Loss of power in all cylinders caused possibly by late ignition or valve timing, or loss of compression due to leakage around the piston rings.
Very low.	Manifold, carburetor, or cylinder head gasket leak.
Needle fluctuates steadily as speed increases.	A partial or complete loss of power in one or more cylinders caused by a leaking valve, cylinder head or intake manifold gasket leak, a defect in the ignition system, or a weak valve spring.
Gradual drop in reading at engine idle.	Excessive back pressure in the exhaust system.
Intermittent fluctuation.	An occasional loss of power possibly caused by a defect in the ignition system or a sticking valve.
Slow fluctuation or drifting of the needle.	Improper idle mixture adjustment, carburetor or intake manifold gasket leak.

A reading of more than the allowable tolerance below normal indicates leakage at the cylinder head gasket, piston rings, or valves.

A low even compression in two adjacent cylinders indicates a cylinder head gasket leak. This should be checked before condemning the rings or valves.

To determine whether the rings or the valves are at fault, squirt the equivalent of a tablespoon of heavy oil into the combustion chamber, then crank the engine to distribute the oil and repeat the compression test. The oil will temporarily seal leakage past the rings. If approximately the same reading is obtained, the rings are satisfactory, but the valves are leaking. If the compression has increased 10 pounds or more over the original reading, there is leakage past the rings.

During a compression test, if the pressure fails to climb steadily and remains the same during the first two successive strokes, but climbs higher on the succeeding strokes, or fails to climb during the entire test, it indicates a sticking or stuck valve.

4 CLEANING, INSPECTION, AND RECONDITIONING

INTAKE MANIFOLD

Clean the manifold in a suitable solvent, then dry them with compressed air.

Inspect the manifold for cracks, leaks, or other defects that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. **Remove all filings and foreign matter that may have entered the manifold as a result of repairs.**

On the 352 V-8 engines, check the baffle plate on the underside of the manifold for looseness and be sure the maze screen is in place. Clean off any varnish accumulation.

EXHAUST MANIFOLD

Inspect the manifold(s) for cracks, leaks, or other defects that would make it unfit for further service.

On the right exhaust manifold of the 352 V-8 engines, make sure the air inlet and outlet holes are completely open and the cover does not leak. Blow out the automatic choke air heat tube with compressed air.

VALVE ROCKER ARM SHAFT ASSEMBLY

Clean all the parts thoroughly. Make sure that all oil passages are open.

Check the clearance between each rocker arm and the shaft by checking the I.D. of the rocker arm bore and the O.D. of the shaft. If the clearance between any rocker and the shaft exceeds the wear

radius. If the pad is grooved, replace the rocker arm. **Do not attempt to true this surface by grinding.**

Check for broken locating springs.

On the Mileage Maker Six and 292 V-8, check the rocker arm adjusting screws and the push rod end of the rocker arms for stripped or broken threads, and the ball end of the adjusting screw for nicks, scratches, or excessive wear. Inspect the oil tubes for cracks or sharp bends.

PUSH RODS

Check the ends of the push rods for nicks, grooves, roughness, or excessive wear.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator (Fig. 7). If the runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**

CLYINDER HEADS

CLEANING AND INSPECTION

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. **Be careful not to damage the cylinder head gasket surface.** After the valves are removed, clean the valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease, and other deposits.

Check the cylinder head for cracks, and the gasket surface for burrs and nicks. Replace the head if it is cracked. **Do not plane or grind more than 0.010 inch from the cylinder head gasket surface.** Remove all burrs or scratches with an oil stone.

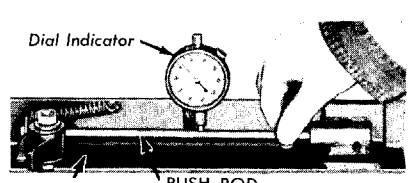


FIG. 7—Push Rod Runout

CYLINDER HEAD FLATNESS

Check the flatness of the cylinder head gasket surface (Fig. 8).

VALVE SEAT RUNOUT

Check the valve seat runout with an accurate gauge (Fig. 9). Follow

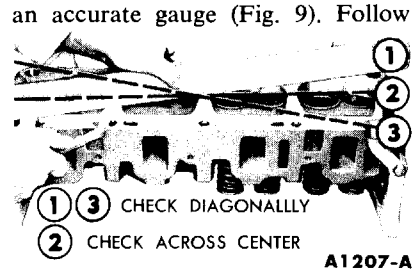


FIG. 8—Cylinder Head Flatness

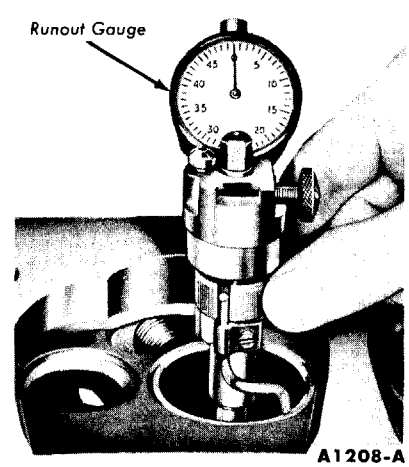


FIG. 9—Valve Seat Runout

the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat.

VALVE SEAT WIDTH

Measure the valve seat width (Fig. 10).

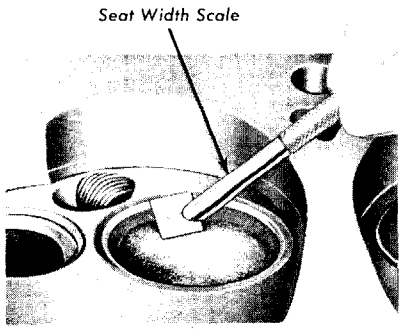
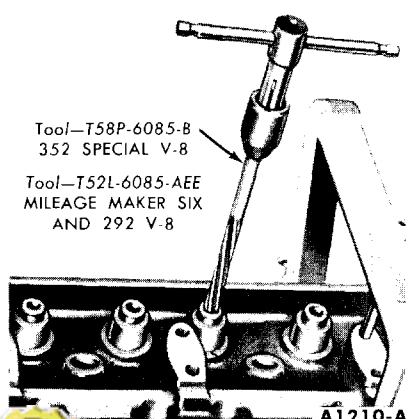


FIG. 10—Valve Seat Width

REAMING VALVE GUIDES

If it becomes necessary to ream a valve guide (Fig. 11) to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations; a 0.003-inch O.S. reamer with a standard diameter pilot, a 0.015-inch O.S. reamer with a 0.003-inch O.S. pilot, and a 0.030-inch reamer with a 0.015-inch O.S. pilot.



REFACING VALVE SEATS

Refacing of the valve seats should be closely co-ordinated with the refacing of the valve face so that the finished seat will match the valve face and be centered. This is important so that the valve and seat will have a good compression tight fit. Be sure that the refacer grinding wheels are properly dressed.

Grind the exhaust valve seats of all engines and the intake valve seats of the Mileage Maker Six and the 292 V-8 to a true 45° angle (Fig. 12). Grind the intake valve seat of the 352 V-8 to a true 30° angle (Fig. 13). Remove only enough stock to clean up pits, grooves, or to correct the valve seat runout. After the seat has been refaced, measure the seat width (Fig. 10). Narrow the seat, if necessary to bring it within limits.

If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specifications (Fig. 12 or 13).

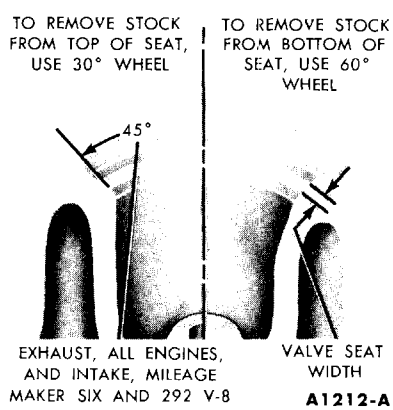


FIG. 12—Valve Seat Refacing—Exhaust All Engines and Intake Mileage Maker Six and 292 V-8

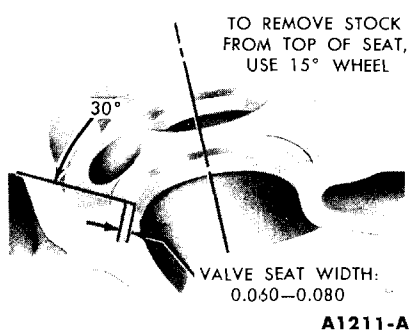


FIG. 13—Intake Valve Seat Refacing—352 V-8

On the exhaust valve seats of all engines and the intake valve seats of the Mileage Maker Six and 292 V-8, use a 60° angle grinding wheel to remove stock from the bottom of the seats (raise the seats) and use a 30° angle wheel to remove stock from the top of the seats (lower the seats).

On the intake valve seats of the 352 V-8 engines, use a 15° angle grinding wheel to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussian blue, then set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

VALVES

CLEANING AND INSPECTION

Remove all deposits from the valve with a fine wire brush or buffing wheel. The critical inspection points and tolerances of the valves are illustrated in Fig. 14.

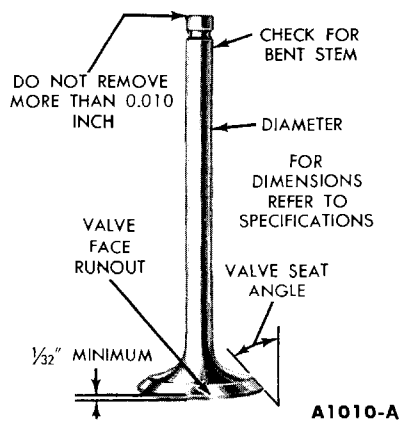


FIG. 14—Critical Valve Tolerances

Inspect the valve face and the edge of the valve head for pits, grooves, scores, or other defects. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage, and cracking. Defects, such as minor pits, grooves,

etc. may be removed. Discard valves that are severely damaged.

Inspect the valve springs, valve spring retainers, locks, and sleeves for defects. Discard any visually defective parts.

VALVE FACE RUNOUT

Check the valve face runout (Fig. 15). It should not exceed the wear limit.

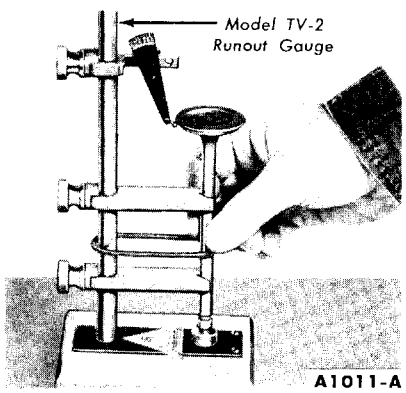


FIG. 15—Valve Face Runout

VALVE STEM CLEARANCE

Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Fig. 16 or its equivalent.

If the clearance exceeds the wear limit, try a new valve.

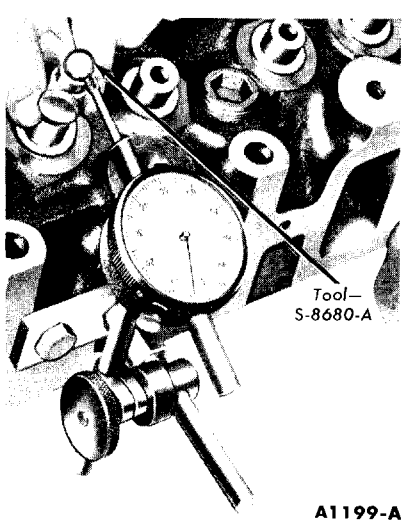


FIG. 16—Valve Stem Clearance

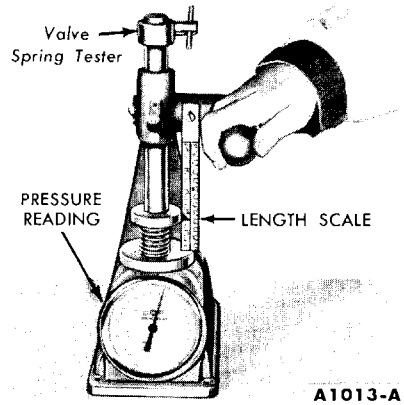


FIG. 17—Valve Spring Pressure

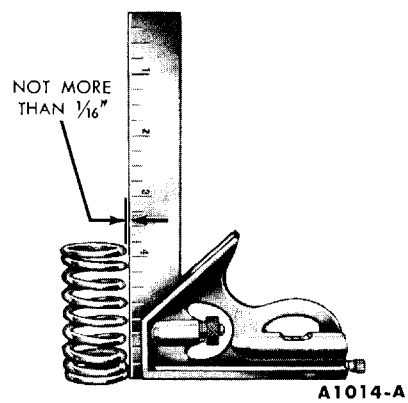


FIG. 18—Valve Spring Squareness

engine performance; therefore, if the pressure of any spring approaches the wear limit, replace the spring.

VALVE SPRING SQUARENESS

Check each spring for squareness, using a steel square and a surface plate (Fig. 18). Stand the spring and square on end on the surface plate. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. If the spring is out of square more than 1/16 inch, replace it.

REFACING VALVES

The valve refacing operation should be closely co-ordinated with the valve seat refacing operation so that the finished angle of the valve face will match the valve seat. This is important so that the valve and seat will have a good compression tight fit. Be sure that the refacer grinding wheels are properly dressed.

If the valve face runout is excessive and/or to remove pits and grooves, reface the exhaust valves of all engines and the intake valves of the Mileage Maker Six and 292 V-8 to a true 44° angle. Reface the intake valves of the 352 V-8 engines to a true 29° angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 1/32 inch after grinding, replace the valve as the valve will run too hot in the engine.

On the 352 V-8 engines, if the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine. Refer to Section 3 in this part.

SELECT FITTING VALVES

If the valve stem to valve guide clearance exceeds the wear limit, it is recommended that the valve guide be reamed for the next oversize valve stem. Valves with oversize stem diameters of 0.003, 0.015, and 0.030 inch are available for service. Refer to "Reaming Valve Guides."

HYDRAULIC VALVE LIFTERS—352 V-8 ENGINES

The lifter assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each lifter separately so as not to intermix the internal parts. **If any part of the lifter assembly needs replacing, replace the entire assembly.**

CLEANING AND INSPECTION

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint free cloth.

Inspect the parts and discard the entire lifter assembly if any part shows signs of pitting, scoring, galling, or evidence of non-rotation. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight.

Assemble the lifter assembly and check the assembly for freeness of operation by pressing down on the push rod cup. The lifter assemblies can also be tested with a hydraulic valve lifter tester to test the leak down rate. The leak down rate specification is 8-45 seconds. Follow the instructions of the test unit manufacturer.

TIMING CHAIN

Clean all parts in solvent and dry them with compressed air. Inspect the chain for broken links and the sprockets for cracks, and worn or

damaged teeth. It is recommended that all the components be replaced if any one item needs replacement.

CAMSHAFT

Clean the camshaft in solvent and wipe dry. Inspect the camshaft lobes for scoring, and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe. This pitting is not detrimental to the operation of the camshaft, therefore, the camshaft should not be replaced until the lobe lift loss has exceeded 0.005 inch.

The lift of camshaft lobes can only be checked with the camshaft installed in the engine. Refer to "Camshaft Lobe Lift" on page 1-9.

Check the distributor drive gear for broken or chipped teeth.

Remove light scuffs, scores, or nicks from the camshaft machined surfaces with a smooth oilstone.

CRANKSHAFT

CLEANING AND INSPECTION

Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces. Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

Inspect main and connecting rod journals for cracks, scratches, grooves, or scores. Dress minor imperfections with an oilstone. Refinish severely marred journals.

Measure the diameter of each journal in at least four places to determine out-of-round, taper, or undersize condition (Fig. 19).

If the journals exceed the wear limit, they should be refinished to size for the next undersize bearing.

REFINISHING JOURNALS

Refinish the journal to give the proper clearance with the next undersize bearing. If the journal will not "clean up" to give the proper clearance with the maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes, then polish the journal with a No. 320 grit polishing cloth and engine oil. Crocus cloth may be used also as a polishing agent.

CONNECTING RODS

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on the pin boss side of the piston usually indicates that a connecting rod is bent or the piston pin hole is not in proper relation to the piston skirt and ring grooves.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined crankpin, or a tapered connecting rod bore.

Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

CLEANING AND INSPECTION

Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution.** Blow out all passages with compressed air.

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced.

Check the piston pin to connecting rod bushing clearance. Replace the connecting rod if the bushing is so worn that it cannot be reamed or honed for an oversize pin.

Replace defective connecting rod nuts and bolts.

After the connecting rods are assembled to the piston, check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist is excessive, the connecting rod should be straightened or replaced.

PISTONS, PINS, AND RINGS

CLEANING AND INSPECTION

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.** Clean the ring grooves with a ring groove cleaner (Fig. 20). Make sure the oil ring slots (or holes) are clean.

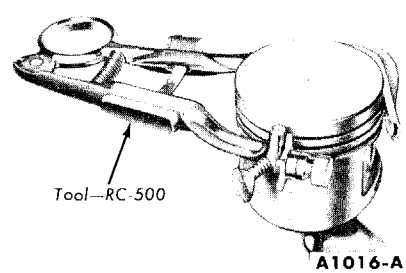


FIG. 20—Cleaning Ring Grooves

Carefully inspect the pistons for fractures at the ring lands, skirts, and pin bosses, and for scuffed, rough, or scored skirts. If the lower inner portion of the ring grooves have high steps, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation, or pre-ignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands, fractures, and/or damage from detonation or pre-ignition.

Check the piston to cylinder bore clearance with a tension scale and ribbon, following the procedure un-

der "Fitting Pistons." Check the ring side clearance following the procedure under "Fitting Piston Rings."

Replace piston pins showing signs of fracture or etching and/or wear. Check the piston pin fit in the piston and rod bushing.

Replace all rings that are scored, chipped, or cracked. Check the end gap and side clearance. It is good practice to always install new rings when overhauling the engine. **Rings should not be transferred from one piston to another regardless of mileage.**

FITTING PISTONS

Pistons are available for service in standard sizes and 0.020, 0.030, 0.040, and 0.060-inch oversize. Standard size pistons are divided into two sizes and are identified by a daub of red or blue paint. Refer to Part 1-6 for the available sizes and the piston to cylinder bore clearance.

If the clearance is greater than the maximum limit, recheck calculations to be sure that the proper size piston has been selected, check for a damaged piston, then try a new piston.

If the clearance is less than the minimum limit, recheck calculations before trying another piston. If none can be fitted, refinish the cylinder for the next size piston.

When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

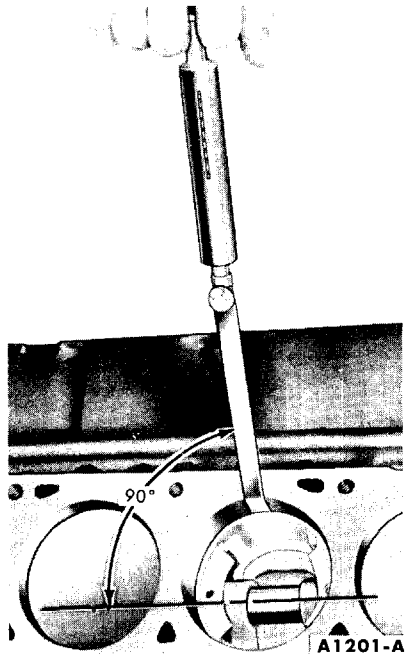


FIG. 21—Checking Piston Fit

If the taper and out-of-round conditions of the cylinder bore are within limits, new piston rings will give satisfactory service provided the piston clearance in the cylinder bore is within limits. If the new rings are to be installed in a used cylinder that has not been refinished, remove cylinder wall "glaze".

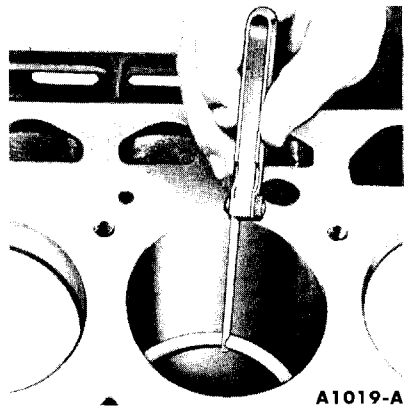


FIG. 22—Piston Ring Gap

To fit a piston:

1. Calculate the size piston to be used by taking a cylinder bore check (Fig. 28).

2. Select the proper size piston to provide the desired clearance.

3. Make sure the piston and cylinder block are at room temperature (70°F.). **After any refinishing operation, allow the cylinder bore to cool and make sure the piston and bore are clean and dry before the piston fit is checked.**

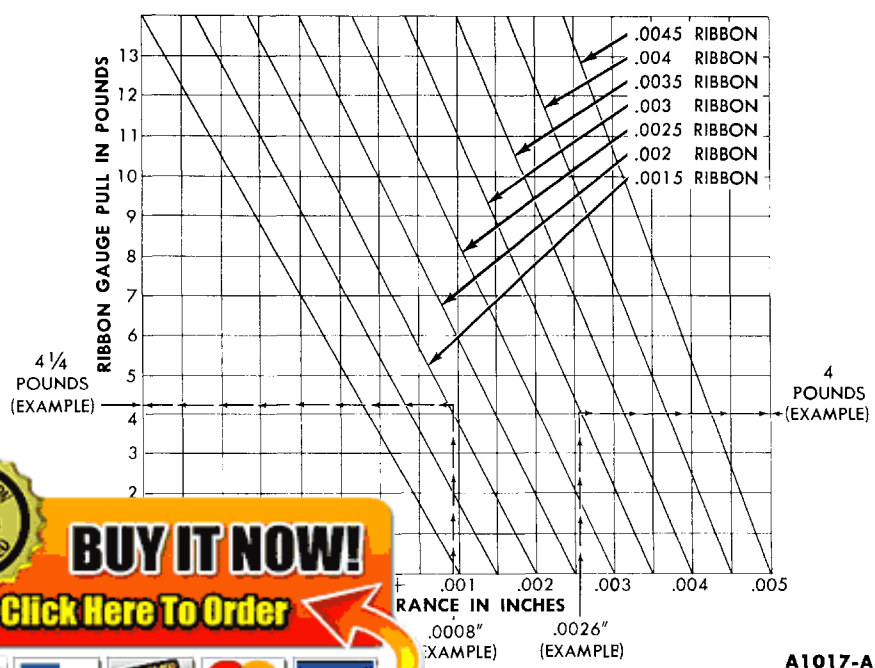
4. Attach a tension scale to the end of a feeler gauge ribbon that is free of dents or burrs. The feeler ribbon should be ½ inch wide and of one of the thicknesses listed in Table 3.

5. Position the ribbon in the cylinder bore so that it extends the entire length of the piston at 90° from the piston pin location.

6. Invert the piston and install it in the bore so that the end of the piston is about 1½ inches below the top of the cylinder block and the piston pin is parallel to the crankshaft axis.

7. Hold the piston and slowly pull the scale in a straight line with the ribbon, noting the pull required to

TABLE 3—Piston Clearance Chart



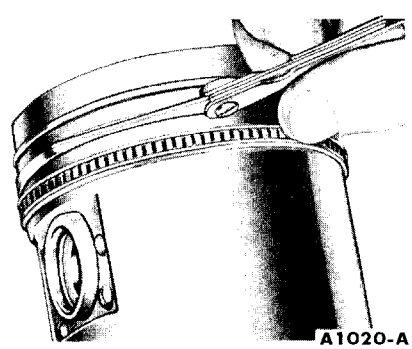


FIG. 23—Ring Side Clearance

remove the feeler ribbon (Fig. 21).

In Table 3, the diagonal lines represent feeler ribbons of various thicknesses, the horizontal lines represent the pounds pull, and the vertical lines represent the clearances. To determine the clearance, locate the line representing the pounds pull required to remove the feeler ribbon from the cylinder bore. Follow the horizontal line to the right until it intersects the diagonal line representing the feeler ribbon. Read down the vertical line for the clearance.

Example 1. If a 0.0015-inch feeler ribbon is used and it takes approximately 4¼ pounds pull to remove the feeler ribbon, the clearance is approximately 0.0008 inch. This is determined by locating the pounds pull (4¼) in Table 3 and following the line to the right until it intersects with the diagonal line representing the 0.0015-inch feeler ribbon. Read down the vertical line for the clearance (approximately 0.0008 inch).

Example 2. If a 0.003-inch feeler ribbon is used and it takes approximately 9 pounds pull to remove the ribbon, the resultant clearance is approximately 0.0015 inch.

Example 3. If a 0.003-inch feeler ribbon is used and it takes approximately 4 pounds pull to remove the feeler ribbon, the resultant clearance is approximately 0.0026 inch.

FITTING PISTON RINGS

1. Select the proper ring set for the size piston to be used.

2. Position the ring in the cylinder bore in which it is going to be used.

3. Push the ring down into the bore area where normal ring wear is not encountered.

4. Use the head of a piston to position the ring in the bore so that the ring is square with the cylinder wall. **Use caution to avoid damage to the ring or cylinder bore.**

5. Measure the gap between the ends of the ring with a feeler gauge (Fig. 22). If the ring gap is less than the recommended lower limit, try another ring set.

6. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Fig. 23). The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. **If the lower lands have high steps, the piston should be replaced.**

FITTING PISTON PINS

The piston pin fit should be a light thumb press fit at normal temperature (70°F). Standard piston pins are color coded green. Pins of 0.001-inch oversize (color coded blue) and 0.002-inch oversize (color coded yellow) are available.

If the pin hole in the piston must be reamed, use an expansion-type piloted reamer. Place the reamer in a vise and revolve the piston around the reamer. Set the reamer to the size of the pin bore, then expand the reamer slightly and trial ream the pin bore. Take a light cut. Use a pilot sleeve of the nearest size to maintain alignment of the bores.

Check the hole size, using the new piston pin. If the bore is small, expand the reamer slightly and make another cut. Repeat the procedure until the proper fit is obtained. Check the piston pin for fit in the respective rod bushing. If necessary, ream or hone the bushing to fit the pin.

Install the piston pin in the piston and rod. Install a new retainer at each end of the pin to hold it in place. Spiral the retainers into position with the fingers. Do not use pliers. Make sure the retainers are properly seated in their groove.

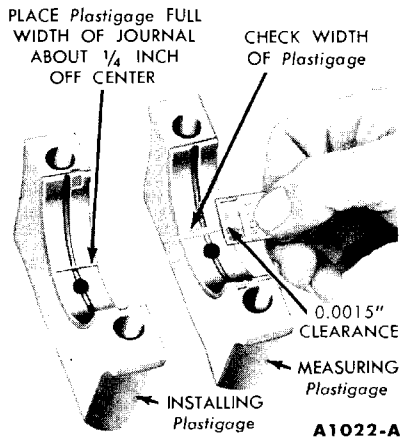


FIG. 25—Installing and Measuring Plastigage—Engine in Chassis

MAIN AND CONNECTING ROD BEARINGS

CLEANING AND INSPECTION

Clean the bearing inserts and caps thoroughly. Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of bearing failures and their causes are shown in Fig. 24. Check the clearance of bearings that appear to be satisfactory with Plastigage. Fit new bearings following the recommended procedure.

BEARING REPLACEMENT

The main and connecting rod bearing inserts are selective fit. **Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.**

Selective fit bearings are available for service in standard sizes only. Standard bearings are divided into two sizes and are identified by a daub of red or blue paint. Refer to Part 1-6 for the available sizes. **Red marked bearings increase the clearance; blue marked bearings decrease the clearance.** Undersized bearings, which are not selective fit, are available for use on journals that have been refinished.

Normally, bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal, be sure to fit the bearing to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter with minimum clearance, interference may result, causing an early failure. It is not recommended that bearings be fitted to a crankshaft journal which exceeds the maximum out - of - round specifications. **When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with two blue bearing halves.**

When checking the width of the Plastigage, check at the widest point in order to get the minimum clearance. Check at the narrowest point in order to get the maximum clearance. The difference between the two readings is the taper.

Main Bearings—Engine Installed

1. Replace one bearing at a time, leaving the other bearing securely fastened. Remove the main bearing cap to which new bearings are to be installed.

2. Insert the upper bearing removal tool (tool 6331) in the oil hole in the crankshaft.

3. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.

4. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block. Using tool 6331 in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

5. Replace the cap bearing.

6. Clean the crankshaft journal and bearing inserts.

7. Support the crankshaft so its weight will not compress the Plastigage and provide an erroneous reading. Position a small jack so it will bear against the counterweight adjoining the bearing which is being checked.

8. Place a piece of Plastigage on the bearing surface the full width of the bearing cap and about ¼ inch off center (Fig. 25).

9. Install the cap and tighten the bolts to specifications. **Do not turn the crankshaft while the Plastigage is in place.**

10. Remove the cap, then using Plastigage scale, check the width of the Plastigage.

If the clearance is less than the specified limits, try two red bearing halves or a combination of red and blue depending upon the condition. If the standard bearings do not bring the clearance within the desired limits, refinish the crankshaft journal, then install undersize bearings.

11. After the bearing has been checked and found to be satisfactory, apply a light coat of engine oil to the journal and bearings, then install the bearing cap. Tighten the cap bolts to specifications.

12. If the rear main bearing is replaced, replace the lower oil seal (in the seal retainer or rear main bearing cap) and the side seals. The upper oil seal (in the block) cannot be replaced with the crankshaft installed.

Main Bearings—Engine Removed

1. With the engine inverted on the workstand, remove the bearing inserts from the cap and the block from those bearings that are to be replaced.

2. Follow steps 4 thru 6 under "Main Bearings—Engine Installed."

3. Place a piece of Plastigage on the crankshaft journal the full width of the journal and about ¼ inch off center (Fig. 26).

4. Follow steps 9 thru 12 under "Main Bearings—Engine Installed."

Connecting Rod Bearings.

1. Install the new bearings in the connecting rod and cap.

2. Pull the connecting rod assembly down firmly on the crankshaft journal.

3. Place a piece of Plastigage on the lower bearing surface, the full width of the cap and about ¼ inch off center.

4. Install the cap and tighten the connecting rod nuts to specifications. **Do not turn the crankshaft while the Plastigage is in place.**

5. Remove the cap, then using the Plastigage scale check the width of the Plastigage.

If the clearance is less than the specified limits, try two red bearing halves or a combination of red and blue depending upon the condition. If the standard bearings do not bring the clearance within the desired limits, refinish the crankshaft journal, then install undersize bearings.

6. After the bearing clearance has been checked and found to be satisfactory, apply a light coat of engine oil to the journal and bearings, then install the connecting rod cap.

7. Repeat the procedure for the remaining connecting rods that require new bearings.

FLYWHEEL—MANUAL-SHIFT TRANSMISSIONS

INSPECTION

Inspect the flywheel for cracks, heat check, or other defects that would make it unfit for further service. Machine the friction surface of the flywheel if it is scored or worn. If it is necessary to remove more than 0.045 inch of stock from the original thickness, replace the flywheel.

Inspect the ring gear for worn, chipped, or cracked teeth. If the teeth are damaged, replace the ring gear.

With the flywheel installed on the crankshaft, check the flywheel face runout.

FLYWHEEL FACE RUNOUT

Install a dial indicator so that the indicator point bears against the flywheel face (Fig. 27). Turn the

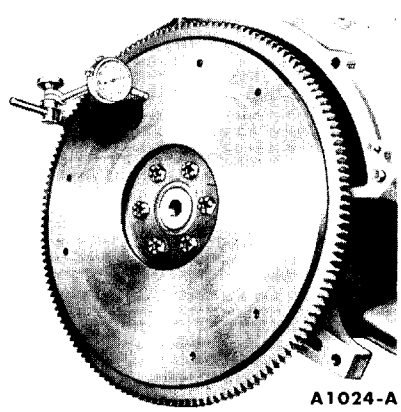


FIG. 27—Flywheel Face Runout

flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

RING GEAR REPLACEMENT

Heat the defective ring gear with a blow torch on the engine side of the gear, then knock it off the flywheel. **Do not hit the flywheel when removing the ring gear.**

Heat the new ring gear evenly until the gear expands enough to slip onto the flywheel. Make sure the gear is seated properly against the shoulder. **Do not heat any portion of the gear to a temperature higher than 500°F. If this limit is exceeded, the temper will be removed from the ring gear teeth.**

CYLINDER BLOCK

CLEANING AND INSPECTION

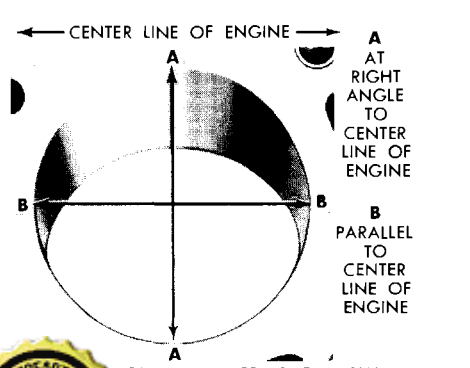
Thoroughly clean the block in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs which seal oil passages, then clean out all the passages. Blow out all passages, bolt holes, etc. with compressed air. Make sure the threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove any deposits.

After the block has been thoroughly cleaned, make a check for cracks. Minute cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

Check all machined gasket surfaces for burrs, nicks, scratches, and scores. Remove minor imperfections with an oil stone. Check the flatness of the cylinder block gasket surface following the procedure and specifications recommended for the cylinder head.

Replace all expansion-type plugs that show evidence of leakage.

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle, and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Fig. 28).



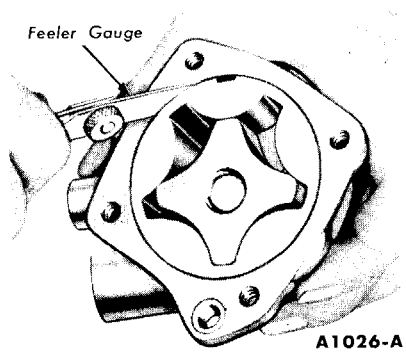


FIG. 29—Outer Race to Housing Clearance

Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceed the wear limits.

If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings providing the piston clearance is within limits. Use the finest grade of honing stone for this operation.

REFINISHING CYLINDER WALLS

Honing is recommended for refinishing cylinder walls only when the walls have minor imperfections, such as light scuffs, scratches, etc.

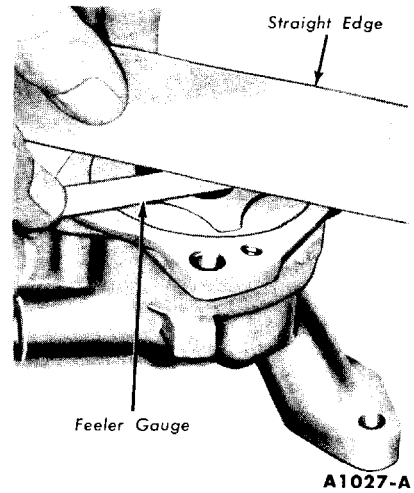


FIG. 30—Rotor End Play

The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

Refinish only the cylinder or cylinders that require it. **All pistons are the same weight, both standard and oversize; therefore, various sized pistons can be intermixed without upsetting engine balance.**

Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.0015 inch of the required oversize diameter. This will allow enough stock for the final step of honing so the correct surface finish and pattern are obtained. Use clean sharp hones of No. 220-280 grit for this operation.

For the proper use of the refinishing equipment follow the instructions of the manufacturer. Only experienced personnel should be allowed to perform this work.

After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly wash the cylinder walls with solvent to remove all abrasive particles, then thoroughly dry the walls. Check the piston fit. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons fitted, thoroughly clean the entire block to remove all particles from the bearing bores, oil passages, cylinder head bolt holes, etc. Coat the cylinder walls with oil.

OIL PAN AND OIL PUMPS

OIL PAN

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Be sure all foreign matter is removed from below the baffle plate.

Check the pan for cracks, holes, damaged drain plug threads, a loose baffle, and a nicked or damaged gasket surface.

Repair any damage, or replace the pan if repairs can not be made.

OIL PUMPS

Cleaning. Wash all parts in a solvent and dry them thoroughly. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and chips are removed.

On the gear-type oil pump, remove old gasket material from the pump body and cover.

Inspection. Check the inside of the pump housing and the outer race and rotor for damage or excessive wear.

Check the mating surface of the pump cover for wear. If the cover mating surface is worn, scored, or grooved, replace the cover.

Measure the outer race to housing clearance (Fig. 29).

With the rotor assembly installed in the housing, place a straight edge over the rotor assembly and the housing. Measure the clearance between the straight edge and the rotor and outer race (Fig. 30).

The outer race, shaft and rotor are replaceable only as an assembly.

Check the drive shaft to housing bearing clearance by measuring the O.D. of the shaft and the I.D. of the housing bearing.

Inspect the relief valve spring for a collapsed or worn condition.

Check the relief valve spring tension. If the spring tension is not within specifications and/or the spring is defective, replace the spring.

Check the relief valve piston for scores and free operation in the bore.

CRANKCASE VENTILATION SYSTEM MAINTENANCE

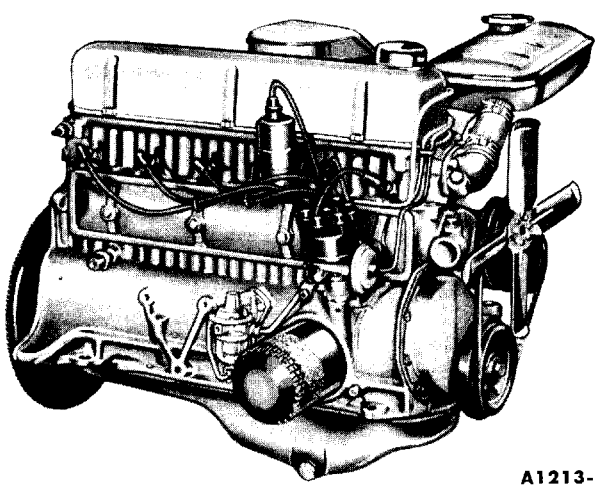
Refer to Group 18 for the correct mileage interval for maintenance.

The breather cap located on the oil filler tube should be cleaned with a solvent at the proper mileage interval. After cleaning, oil the mesh screen in the cap with light engine oil.

The road draft tube seldom requires cleaning except during a high mileage engine overhaul. However, if there is evidence of crankcase pressure, the tube should be checked for excessive sludge and cleaned out if necessary. In addition, on the 352 V-8 engines, the maze screen in the intake manifold baffle plate should be cleaned in solvent to remove any accumulation of sludge deposits.

PART 1-2 MILEAGE MAKER SIX

1 DESCRIPTION



A1213-A

FIG. 1—Mileage Maker Six

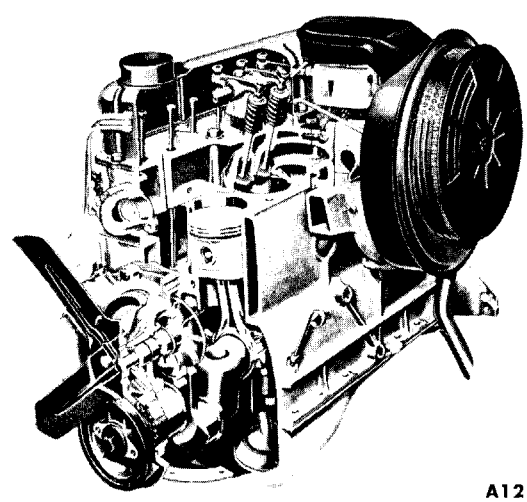


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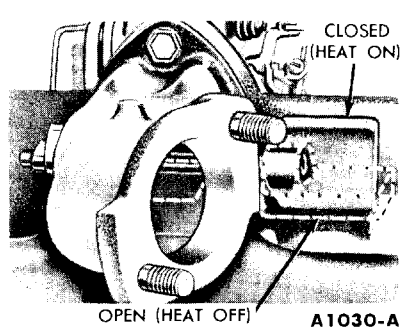
FIG. 2—Mileage Maker Six—Sectional

The Mileage Maker Six (Figs. 1 and 2) is a 6-cylinder engine with a piston displacement of 223 cubic inches and a compression ratio of 8.4:1. The engine is available in all car models. The patent plate indentification symbol is "A."

MANIFOLDS

...hamber (heat riser) is cast into ...ke manifold center section ...



A1030-A

FIG. 3—Exhaust Gas Control Valve

CYLINDER HEAD

The cylinder head carries the ...alves, valve rocker arm shaft as- ...embly, manifold assembly, ignition coil, the water outlet, and thermostat. Valve guides are cast integral in the head. The valves are arranged from front to rear E-I-I-E-I-E-E-I-E-I-I-E.

CYLINDER BLOCK

The cylinders are numbered from 1-6 starting at the front of the engine. The firing order is 1-5-3-6-2-4.

The distributor, located at the right front of the engine, drives the oil pump through an intermediate drive shaft.

The crankshaft is supported by four main bearings. Crankshaft end thrust is controlled by the flanges of the No. 3 main bearing.

The pistons have two compression rings and one oil control ring. The top compression ring is chrome-plated and the lower compression ring is phosphate - coated. The oil control ring assembly consists of a serrated spring and two chrome-plated steel rails.

VALVE TRAIN

The intake and exhaust valve assemblies are the rotating-type. The tappets are the solid steel, mushroom-type. Valve lash is maintained by self-locking adjusting screws.

The camshaft is supported by four bearings pressed into the block. It is driven by a sprocket and timing chain in mesh with a sprocket on the crankshaft. Camshaft thrust is controlled by a thrust plate located between the camshaft sprocket and the front journal of the camshaft. An eccentric, made integral with the camshaft, operates the fuel pump.

LUBRICATION SYSTEM

Oil from the oil pan sump is forced through the pressure-type lubrication system (Fig. 4) by a rotor oil pump. A spring loaded relief valve in the pump limits the maximum pressure of the system. Oil relieved by the valve is directed back to the intake side of the pump.

The engine has a full-flow filter which filters the entire output of the pump before the oil enters the engine. The filter has an integral relief valve and mounting gasket. The relief valve permits oil to bypass the filter if it becomes clogged, thereby maintaining an emergency supply of oil to the engine at all times. An anti-drain back diaphragm prevents a reverse flow of oil when the engine is stopped.

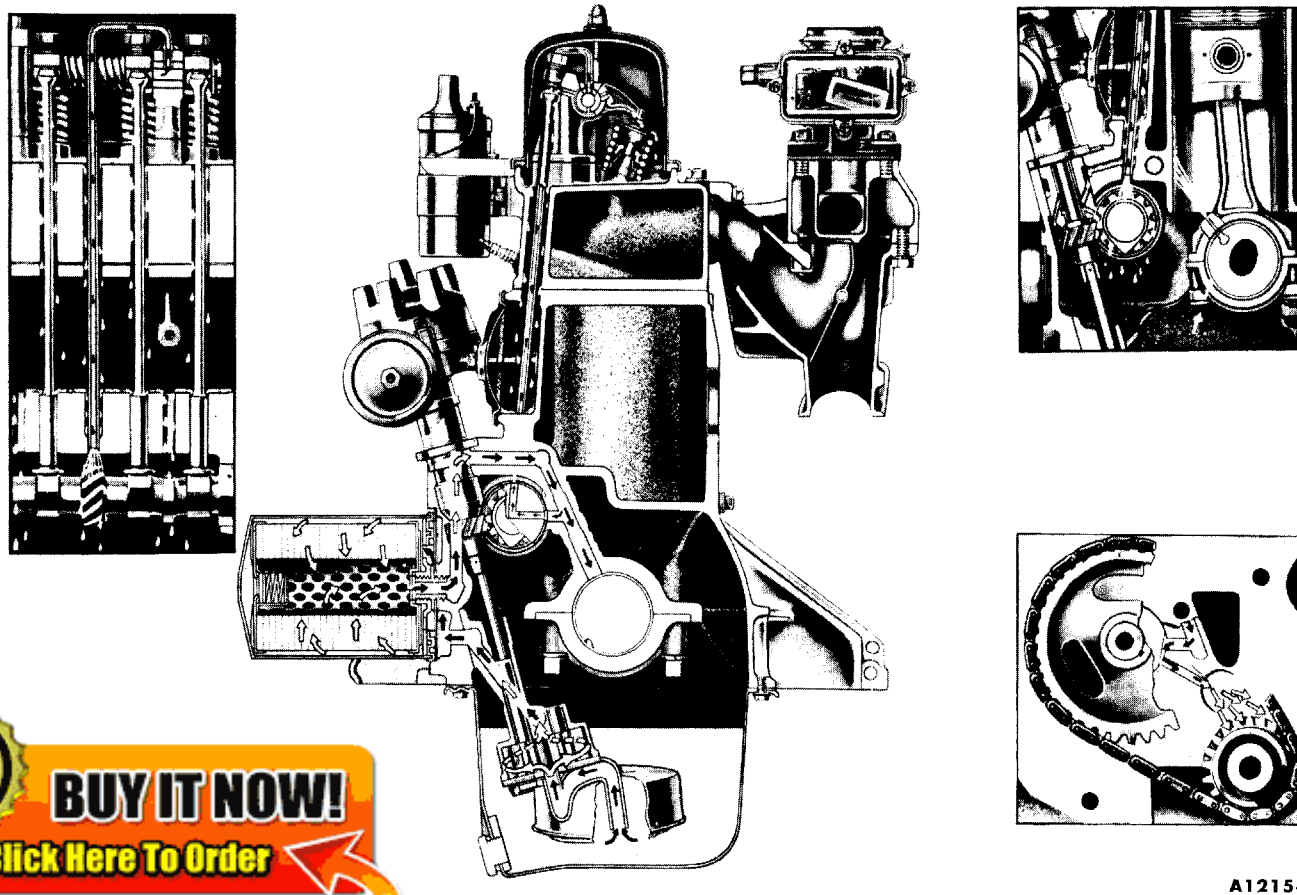
From the filter, the oil flows into the main oil gallery. The oil gallery supplies oil to all the camshaft and main bearings through a drilled passage in each main bearing web.

The timing chain and sprockets are lubricated through a flat on the No. 1 camshaft bearing.

Oil slingers prevent leakage by directing oil away from the crankshaft front and rear oil seals.

Cylinder walls, pistons, and piston pins are lubricated through a drilled hole in each connecting rod which indexes with a drilled hole in the connecting rod journal of the crankshaft.

Oil under reduced pressure lubricates the valve rocker arm shaft assembly. The oil is fed through a drilled passage in the cylinder block at the No. 3 camshaft bearing which indexes with a hole in the cylinder head. An oil inlet tube directs the oil into the hollow rocker shaft through the No. 6 valve rocker arm support. The oil from the shaft flows through drilled holes in each rocker arm to lubricate the rocker arm shaft bore and the valve and ball end of the rocker arm. Excess oil spirals down the rotating push rod and assists in lubricating the tappet and push rod seat. An oil outlet tube exhausts excess oil from the rocker shaft to lubricate the distributor lower bushing and distributor drive gear. The oil outlet tube is located at the No. 1 rocker arm support. The oil from each rocker arm drains into the push rod chamber through holes provided in the cylinder head.



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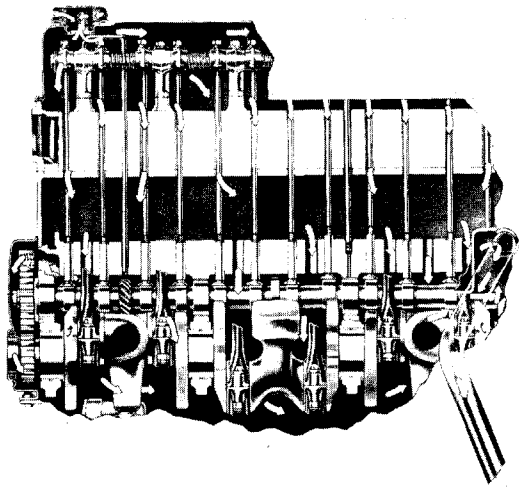

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FIG. 5—Ventilation System

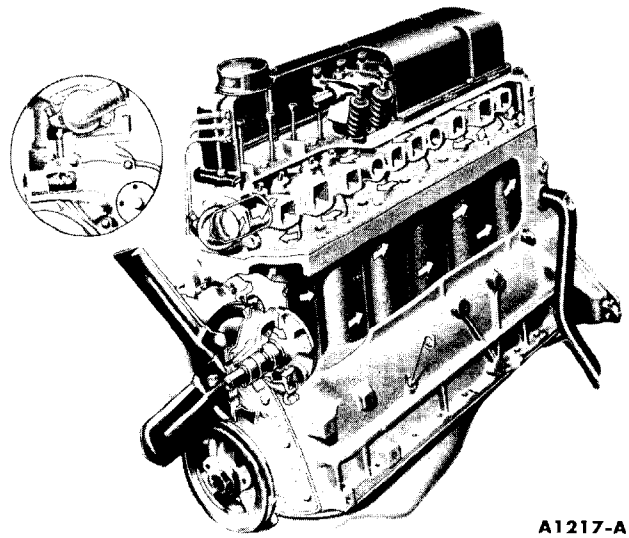

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FIG. 6—Cooling System

The oil in the push rod chamber drains back into the oil pan through an opening at the back of the block.

CRANKCASE VENTILATION

Ventilating air (Fig. 5) enters the engine through the oil filler cap located on the front of the valve rocker arm cover. The cap contains a maze filtering element.

Filtered air from the breather cap flows into the front section of the valve rocker arm shaft chamber. Here the air has a chance to normalize its temperature before contacting contaminating vapors originating in the crankcase. Warm ventilating air minimizes the formation of crankcase sludge. The ventilating air moves down past the push rods into the crankcase. Air is diverted from the front section of the crankcase through holes in the front of the cylinder block wall to ventilate the timing chain chamber. The air from the crankcase is then directed into the crankcase ventilation tube by the rotating action of the crankshaft.

COOLING SYSTEM

The coolant is drawn from the bottom of the radiator by the water pump which delivers the coolant to the cylinder block (Fig. 6).

As the coolant enters the block, it travels through cored passages to cool the entire length of each cylinder wall. Upon reaching the rear of the cylinder block, the coolant is directed upward into the cylinder head where it cools the combustion chambers, valves, and valve seats on its return to the front of the engine.

The coolant from the cylinder head flows past the water thermostat if it is open, into the radiator supply tank. If the thermostat is closed, a small portion of the coolant is returned to the water pump for recirculation. The entire system is pressurized to 13-15 psi.

2 ENGINE REMOVAL AND INSTALLATION

The engine removal and installation procedures are for the engine only without the transmission attached. The engine installation is shown in Fig. 7.

REMOVAL

1. Drain the cooling system and the crankcase.

2. Disconnect the battery ground cable at the battery, the heater hose [illegible] water pump and water outlet [illegible] the vacuum hose at the fuel [illegible] the water pump.

transmission, disconnect the transmission oil cooler lines at the radiator.

5. Remove the radiator. Remove the air cleaner.

6. Disconnect the accelerator retracting spring and the accelerator rod assembly at the carburetor. Disconnect the choke control cable at the carburetor.

7. On a car with an automatic transmission, remove the accelerator bracket from the intake manifold, then tie the bracket to the dash panel.

8. Disconnect the exhaust manifold from the muffler inlet pipe. Disconnect the generator wires at the generator, and the engine ground strap at the converter housing or flywheel housing.

9. Disconnect the primary wire at the coil, the oil pressure and temperature sending unit wires at the sending units, and the starter cable at the starter.

10. Remove the starter (and the automatic transmission fluid filler tube bracket). Remove the engine rear plate upper right bolt.

11. On a car with a manual - shift transmission, remove the flywheel inspection cover. Disconnect the clutch release spring and rod. Remove the clutch bracket from the rear of the engine block.

12. On a car with an automatic transmission, remove the converter housing access cover and cover assembly. Remove the flywheel to converter nuts, then secure the converter assembly in the housing. Remove the transmission oil cooler lines from the

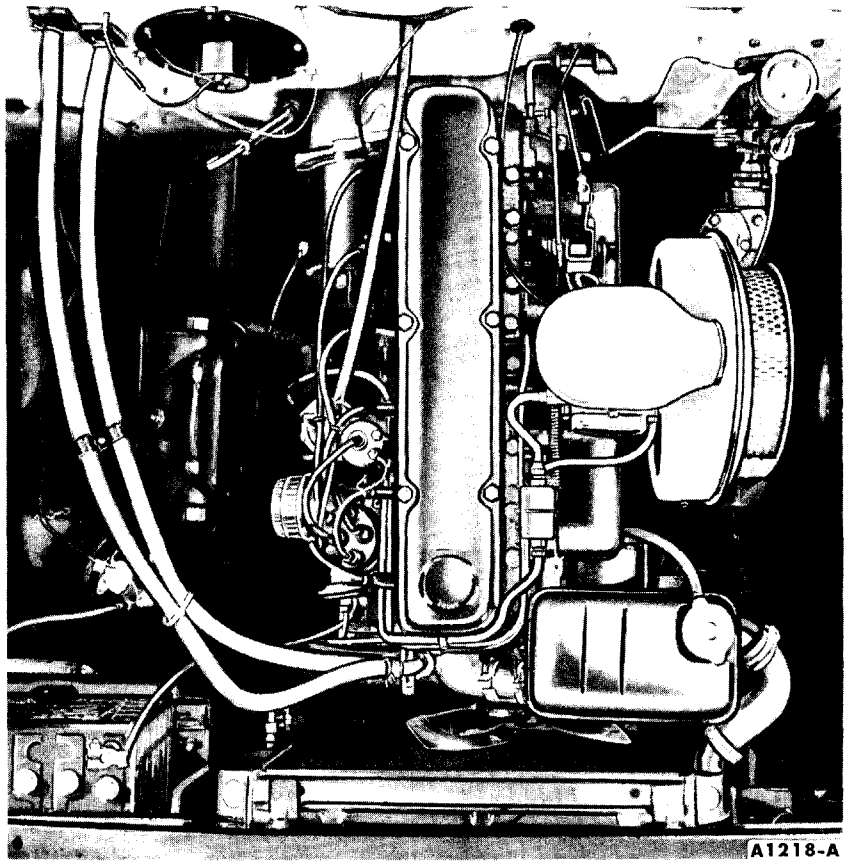
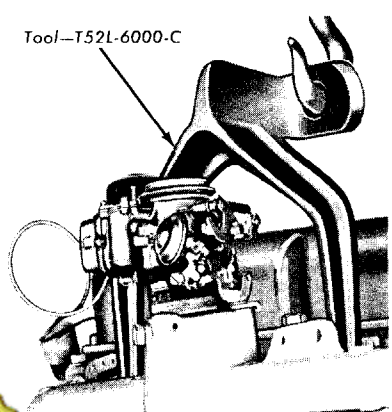


FIG. 7—Engine Installation

retaining clip at the engine and remove the clip from the engine right mount.

13. Remove the flywheel or converter housing to engine bolts. Support the transmission with a jack. Remove the remaining engine rear plate retaining bolts.



14. Remove the engine right and left support insulator to frame retaining nut.

15. Attach the engine lifting hook (Fig. 8). Raise the engine slightly, then carefully pull it from the transmission. Lift the engine out of the chassis, then install it on a work stand (Fig. 9).

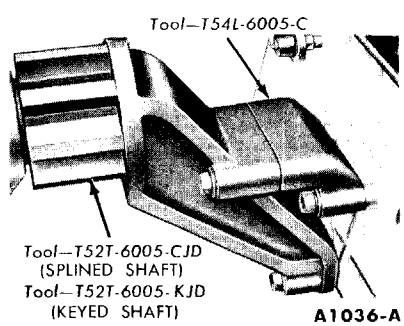


FIG. 9—Engine Mount

INSTALLATION

1. Place a new gasket over the exhaust manifold to muffler inlet pipe studs.

2. Lower the engine carefully into the chassis. Make sure the studs on the exhaust manifold are aligned with the holes in the muffler inlet pipe and the dowels in the block engage the holes in the flywheel or converter housing.

3. On a car with an automatic transmission, start the converter pilot into the crankshaft. Install the engine to flywheel housing bolts. Tighten the bolts to specifications. Remove the jack supporting the transmission. Remove the retainer securing the converter in the housing, then install the flywheel to converter nuts and tighten them to specifications. Install the converter housing access cover and the cover assembly and left rear splash shield.

4. On a car with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the position of the transmission with relation to the engine if the transmission input shaft will not enter the clutch disc. **If the engine "hangs up" after the shaft enters, turn the crankshaft slowly (with the transmission in gear) until the shaft splines mesh with the clutch disc splines.** Install the flywheel housing bolts and tighten them to specifications. Remove the jack supporting the transmission.

5. Install the converter or flywheel housing upper retaining bolts. Remove the engine lifting hook.

6. Install the engine left and right support insulator to engine retaining nuts (install the automatic transmission oil cooler lines bracket).

7. Install the remaining converter or flywheel housing retaining bolts. Install the engine rear plate lower retaining bolts.

8. Install the starter (and automatic transmission fluid filler tube bracket).

9. On a car with an automatic transmission, install the transmission oil cooler lines in the bracket at the engine block.

10. Install the exhaust manifold to muffler inlet pipe lockwashers and nuts, then tighten the nuts to specifications. Connect the engine ground strap, the generator wires, and the choke control cable.

11. On a car with an automatic transmission, install the accelerator bracket on the intake manifold.

12. On a car with a manual-shift transmission, connect the clutch release spring and rod. Adjust the

clutch pedal free travel. Install the flywheel housing inspection cover.

13. Connect the accelerator retracting spring and the accelerator rod assembly.

14. Connect the starter cable, the coil primary wire, the oil pressure and temperature sending unit wires, the vacuum hose and flexible fuel line, the heater hoses, and the battery ground cable.

15. Install the radiator. Connect the radiator upper hose to the water pump and the radiator lower hose to the radiator supply tank.

16. On a car with an automatic transmission, connect the oil cooler lines.

17. Fill and bleed the cooling system. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

18. On a car with an automatic transmission, adjust the transmission control linkage.

19. Install the air cleaner.

3 REPAIR OPERATIONS—ENGINE INSTALLED

ENGINE SUPPORTS

The front supports are located on each side of the crankcase (Fig. 10) and the rear support is located at the transmission extension housing. (Fig. 11).

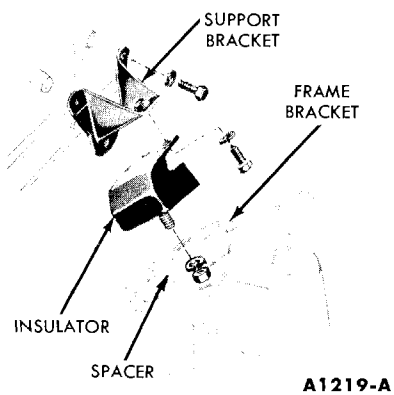


FIG. 10—Engine Front Support

ENGINE FRONT SUPPORT

The procedures given apply to either a right or left installation.

REMOVAL

1. Raise the engine with a jack and a wood block placed under the oil pan.

2. Remove the insulator to frame nut and lockwasher.

3. Remove the insulator to engine bolts and lockwashers and remove the insulator. If only one support is being removed, loosen the other support.

INSTALLATION

1. Position the insulator assembly. Lower the engine, then install, [illegible] to frame lockwasher

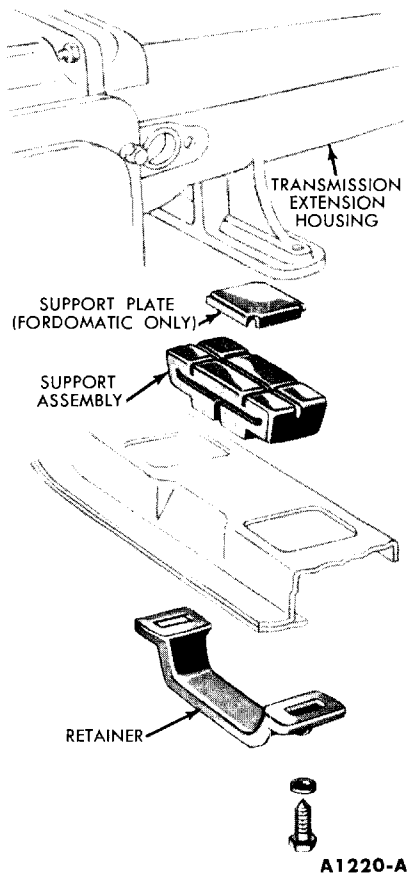


FIG. 11—Engine Rear Support

2. Raise the engine slightly to gain clearance at the transmission and remove the support assembly.

INSTALLATION

Position the support assembly. Install the support to extension housing flat washers, lockwashers, and bolts. Lower the engine.

MANIFOLDS

REMOVAL

1. Remove the air cleaner.

2. On a car with an automatic transmission, disconnect the throttle control rod and the accelerating assembly connecting link at the accelerator bracket. Disconnect the accelerator retracting spring at the block mounted bracket, and then remove the bracket.

3. On a car with a manual-shift transmission, disconnect the accelerator retracting spring and the accelerator rod assembly at the bell crank.

4. Disconnect the vacuum line at the intake manifold.

5. Disconnect the choke control cable.

6. Disconnect the fuel inlet line and the distributor vacuum line at the carburetor.

7. Disconnect the muffler inlet pipe from the exhaust manifold.

8. Remove the bolts fastening the manifold to the head (two manifold bolts retain the radiator supply tank mounting bracket). Lift the manifold assembly from the head. Remove the gaskets and sleeves.

9. To separate the manifolds, remove the nuts and bolt joining the intake and exhaust manifolds.

INSTALLATION

The manifold assembly is shown in Fig. 12.

1. If the intake and exhaust manifolds have been separated, place the intake manifold over the studs on the exhaust manifold. Install the lockwashers, nuts and bolt, then tighten them finger tight.

2. Install new intake manifold gaskets using new sleeves, if necessary, in the ports of the cylinder head.

3. Place a new exhaust manifold to muffler inlet pipe gasket over the studs on the exhaust manifold.

4. Coat the mating surfaces lightly with graphite grease. Place the manifold assembly in position against the head. **Make sure the port openings in the manifold assembly are aligned with the port openings in the cylin-**

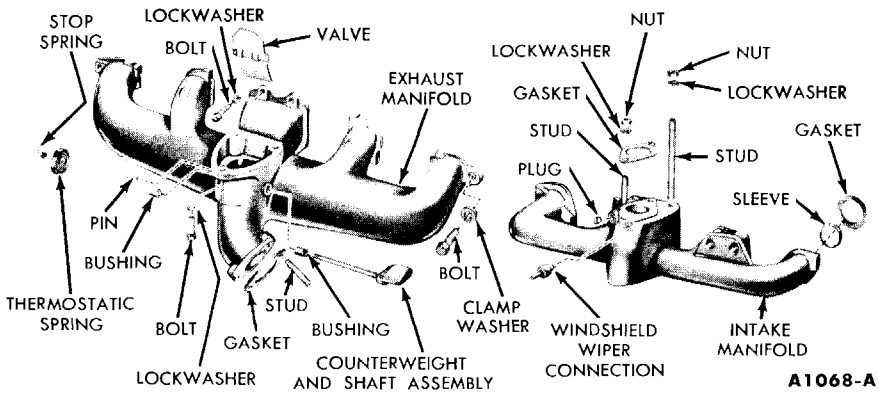


FIG. 12—Intake Manifold Assembly

der head and that none of the gaskets have become dislodged. Position the radiator supply tank bracket.

5. Install the attaching washers and bolts. Tighten the bolts to specifications, tightening from the center to the ends.

6. If the intake and exhaust manimolds were separated, tighten the bolt and nuts joining them.

7. Install the exhaust manifold to muffler inlet pipe lockwashers and nuts. Tighten the nuts to specifications.

8. Connect the vacuum line to the intake manifold. Connect the choke control cable. Connect the fuel inlet line and the distributor vacuum line at the carburetor.

9. On a car with an automatic transmission, install the accelerator retracting spring bracket. Connect the spring. Connect the accelerator assembly connecting link and adjust the transmission control linkage.

10. On a car with a manual-shift transmission, connect the accelerator retracting spring and the accelerator rod assembly.

11. Install the air cleaner.

EXHAUST GAS CONTROL VALVE REPLACEMENT

The exhaust gas control valve is located in the outlet of the exhaust manifold. Normally, it does not require replacement unless it becomes inoperative due to excessive corro-ion or damage.

valve plate. Remove the stop spring and thermostatic spring from the front end of the shaft.

3. Using an acetylene torch inside the manifold, cut the shaft on both sides of the valve plate. **Use caution to avoid damage to the shaft bearing bores.**

4. Remove the valve and shaft pieces.

5. Clean the bushings of corrosion and repair any damage that may have occurred. Replace the bushings if necessary.

6. When new bushings are installed, there should be a distance of 2⅜ inches from the inside edge of one bushing to the inside edge of the other bushing. The bushings should be equally spaced within the counterbores.

7. After installation, ream the bushings with a 5/16-inch reamer.

8. Lubricate the new shaft and bushings with a penerating oil and graphite mixture.

9. Insert the shaft through the bushings and valve plate.

10. Rotate the shaft in the valve plate until the counterweight is in the normal "up" (heat on) position (Fig. 3).

11. Tack weld the valve to the shaft. Move the assembly back and forth to check for a binding condition.

12. If there is no binding, weld the valve to the shaft in the original manner. The shaft and valve are stainless steel to minimize corrosion and/or damage by excessive heat.

13. Install the thermostatic spring in the shaft slot. Secure the spring by crimping the shaft at the slot. Wind the spring ¾ turn and hook the open end of the spring over the stop pin. The thermostatic spring should hold the valve in the closed (heat on) position (i.e. in the proper position to direct the flow of gases into the heat riser).

14. Install the stop spring.

15. Lubricate the shaft bushings while operating the valve manually to replace the original lubricant lost by the welding operation. Install the manifold assembly following the procedure under "Manifold Installation" on page 1-25.

CYLINDER HEAD

Cylinder head repair operations and checks, such as valve and valve seat refacing, cylinder heat flatness checks, etc., are covered in Part 1-1.

REMOVAL

1. Drain the cooling system. Remove the air cleaner.

2. Disconnect the radiator upper hose at the radiator and the heater hose at the water outlet housing.

3. Disconnect the oil pressure and water temperature sending unit wires at the sending units, and the battery ground cable at the cylinder head.

4. Disconnect the carburetor fuel inlet line and the vacuum line at the fuel pump, and the distributor vacuum line at the distributor.

5. Disconnect the fuel inlet line and the distributor vacuum line at the carburetor, and the vacuum line at the intake manifold, then remove the three lines as an assembly.

6. Disconnect the choke control cable at the carburetor.

7. Disconnect the accelerator retracting spring. Disconnect the accelerator rod assembly at the accelerator assembly.

8. Disconnect the high tension lead at the coil. Remove the coil from the head and move it to one side. Remove the distributor cap and the spark plug wires as an assembly. Remove the spark plugs.

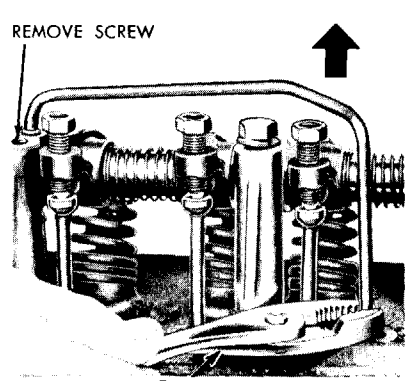


FIG. 13—Oil Inlet Line Removal

9. Disconnect the flexible fuel line at the fuel tank line.

10. Remove the valve rocker arm cover. Remove the cap screw and bracket from the No. 6 rocker arm support. Pull the oil inlet line out of the support, then pull it out of the block with pliers (Fig. 13). Be careful not to damage the line.

11. Remove the cap screw from the No. 1 rocker arm support, then remove the oil outlet line and bracket.

12. Loosen all rocker arm adjusting screws to remove the valve spring load from the rocker arms, then remove the valve rocker arm shaft assembly.

13. Remove the valve push rods in sequence and identify them so they can be installed in their original positions (Fig. 14).

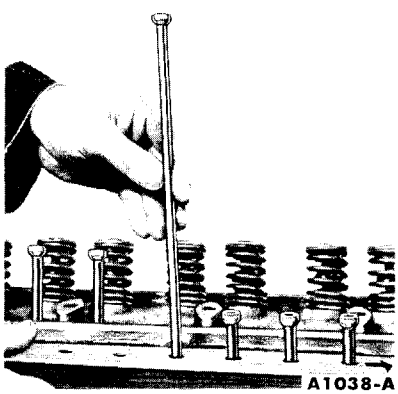


FIG. 14—Valve Push Rod Removal

14. Remove the manifold to cylinder head bolts (two manifold bolts retain the radiator supply tank mounting bracket). Pull the manifold assembly away from the cylinder head. Brace the assembly so that the muffler inlet pipe will not be damaged.

15. Disconnect the radiator supply tank support at the water pump and remove the supply tank.

16. Install the cylinder head holding fixtures for convenience in lifting the head and to protect the gasket surfaces (Fig. 15).

17. Remove all cylinder head bolts. Install the cylinder head guide studs (Fig. 16). Lift the cylinder head assembly off the engine. **Do not pry between the head and block as the gasket surfaces may become damaged.**

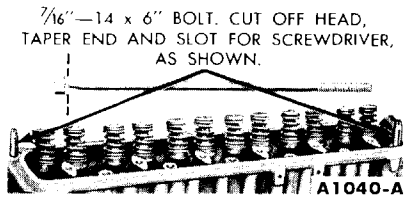


FIG. 16—Cylinder Head Guide Studs

INSTALLATION

1. Clean the head and block gasket surfaces.

2. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the head and block gasket surfaces (page 1-12).

3. Apply cylinder head gasket sealer to both sides of a new gasket. Use the brush furnished to spread the sealer evenly over the entire gasket surface.

4. Position the gasket over the guide studs on the cylinder block.

5. Lift the cylinder head over the guides and slide it down carefully.

6. Coat the threads of the bolts for the left side of the cylinder head with water resistant sealer. Install, but do not tighten, two bolts at opposite ends of the head to hold the head and gasket in position.

7. Remove the guides. Remove the cylinder head holding fixtures. Install the remaining bolts.

8. The cylinder head bolts are tightened in three progressive steps. Follow the sequence shown in Fig. 17. Tighten the bolts to 55 foot-pounds torque, then to 65 foot-pounds torque. Finally, tighten the bolts to 75 foot-pounds torque.

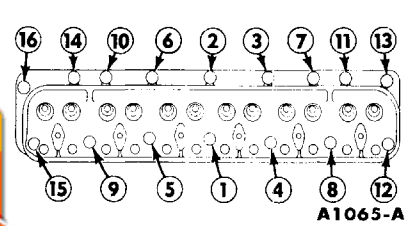


FIG. 17—Cylinder Head Bolt Tightening Sequence

9. Lubricate both ends of the push rods with engine oil. Install the push rods in their original bores, positioning the lower end of the rods in the tappet sockets.

10. Position the valve rocker arm shaft assembly on the head. **Be sure the oil holes in the shaft are facing downward.**

11. Install the oil outlet line, bracket, and retaining screw on the No. 1 support. Make sure the oil line enters the shaft locating hole.

12. Install a new O-ring seal on the lower end of the oil inlet line. Position the line in the No. 6 support. Make sure the O-ring seal is in the oil supply counterbore. Install the bracket and support bolt.

13. Tighten all the valve rocker arm shaft retaining bolts to specifications. Perform a preliminary valve lash adjustment (page 1-10).

14. Position the generator adjusting arm and radiator supply tank support and install the retaining bolt.

15. Clean the intake manifold gasket surfaces. Install new intake manifold gaskets using new sleeves, if necessary, in the ports of the cylinder head. Place the manifold assembly in position against the head. **Make sure the port openings in the manifold assembly are aligned with the port openings in the cylinder head and that none of the gaskets have become dislodged.** Install the manifold assembly retaining lockwashers and bolts (two manifold bolts retain the radiator supply tank mounting bracket). Tighten the bolts to specifications.

16. Connect and adjust the choke control cable.

17. Position the fuel inlet line and the two vacuum lines on the engine. Connect the distributor vacuum line and the carburetor fuel inlet line at the carburetor, and the manifold vacuum line at the manifold.

18. Connect the accelerator rod assembly and the accelerator retracting spring.

19. Install the ignition coil, spark plugs, and the distributor cap and spark plug wire assembly.

20. Connect the spark plug wires and the coil high tension lead.

21. Connect the carburetor fuel inlet line and the vacuum line at the fuel pump, and the distributor vacuum line at the distributor.

22. Connect the flexible fuel line. Connect the windshield wiper hose at the vacuum pump tube.

23. Connect the battery ground cable. Connect the oil pressure and water temperature sending unit wires.

24. Connect the radiator upper hose at the radiator. Connect the heater hose at the water outlet housing, but do not tighten the clamp.

25. Fill and bleed the cooling system.

26. Start the engine and operate it for **a minimum of 30 minutes at 1200 rpm** to stabilize engine temperatures. Check the valve lash (Part 1-1) with the engine idling and adjust the lash if necessary, using a step-type gauge ("go" and "no go"). Adjust the engine idle speed and idle fuel mixture (Part 3-1).

27. On a car with an automatic transmission, adjust the transmission control linkage.

28. Coat one side of the valve rocker arm cover gasket with oil resistant sealer. Lay the cemented side of the gasket in place in the cover. Install the cover, making sure that the gasket seats evenly all around the head.

29. Install the air cleaner.

CRANKSHAFT DAMPER

REMOVAL

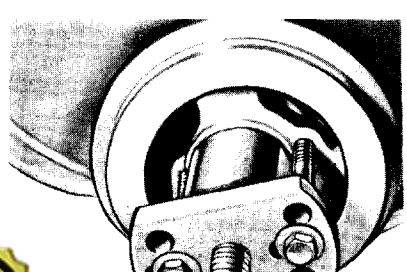
1. Drain the cooling system.

2. On a car with an automatic transmission, disconnect the transmission oil cooler lines at the radiator.

3. Disconnect the radiator upper hose at the radiator supply tank and the radiator lower hose at the water pump. Remove the radiator.

4. Remove the fan, drive belt, and pulley.

5. On a car with power steering, remove the power steering pump drive belt, and then remove the power steering pump pulley from the crankshaft damper.



6. Remove the cap screw and washer from the end of the crankshaft, then remove the damper (Fig. 18).

INSTALLATION

1. Lubricate the crankshaft with a white lead and oil mixture. Lubricate the front oil seal rubbing surface with grease.

2. Align the damper keyway with the key on the crankshaft, then install the damper on the crankshaft (Fig. 19).

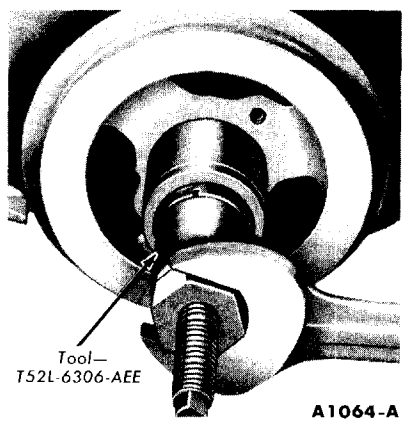


FIG. 19—Damper Installation

3. Install the lockwasher and cap screw, then tighten the cap screw to specifications.

4. On a car with power steering, install the power steering pump pulley on the crankshaft damper. Install and adjust the power steering pump drive belt.

5. Install the pulley, drive belt, and fan.

6. Install the radiator. Connect the radiator lower hose at the water pump and the radiator upper hose at the radiator supply tank.

7. On a car with an automatic transmission, connect the transmission oil cooler lines.

8. Fill and bleed the cooling system.

CYLINDER FRONT COVER AND TIMING CHAIN

REMOVAL

1. Remove the crankshaft damper and related parts by following the procedure under "Crankshaft Damper Removal."

2. Drain the crankcase.

3. Remove the oil pan and related parts by following the procedure under "Oil Pan Removal" page 1-32.

4. Disconnect the heater hose at the water pump and the generator adjusting arm at the water pump. Remove the water pump.

5. Remove the cylinder front cover and discard the gasket.

6. Remove the crankshaft front oil slinger. Crank the engine until the timing marks on the sprockets and chain are positioned as shown in Fig. 20.

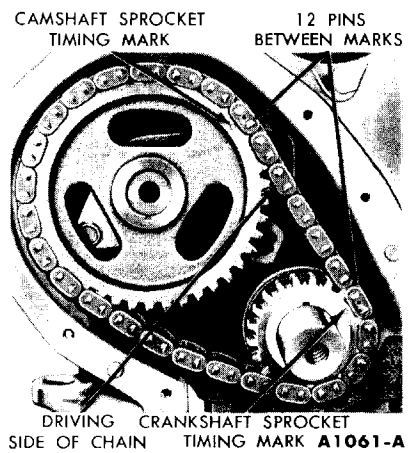


FIG. 20—Aligning Timing Marks

7. Remove the camshaft sprocket retaining bolt and washer. Slide both sprockets and timing chain forward and remove them as an assembly.

FRONT OIL SEAL REPLACEMENT

It is good practice to replace the oil seal each time the cylinder front cover is removed.

1. Drive out the old seal with a pin punch, then clean out the recess in the cover.

2. Coat a new seal with grease, then install the seal (Fig. 21). Drive the seal in until it is fully seated in the recess. After installation, check

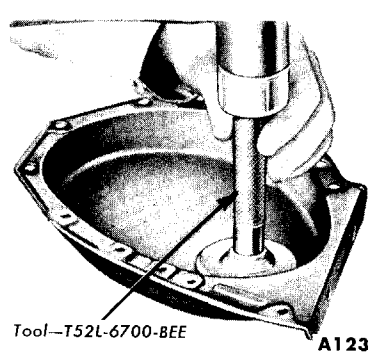


FIG. 21—Front Oil Seal Installation

to be sure the spring is properly positioned in the seal.

INSTALLATION

1. Place the keys in position in the slots on the camshaft and crankshaft.

2. Position the sprockets and timing chain on the camshaft and crankshaft. Be sure the timing marks on the sprockets and chain are positioned as shown in Fig. 20. Install the camshaft sprocket cap screw and washer.

3. Install the crankshaft front oil slinger.

4. Clean the cylinder front cover and the gasket surface of the cylinder block. Coat the gasket surface of the block and cover with sealer. Position a new gasket on the block.

5. Place the cover on the block and install the retaining screws.

6. Install the water pump. Connect the heater hose. Connect the generator adjusting arm.

7. Install the crankshaft damper and related parts following the procedure under "Crankshaft Damper Installation" (Page 1-28).

8. Install the oil pan and related parts following the procedure under "Oil Pan Installation" (Page 1-32).

9. Fill and bleed the cooling system. Fill the crankcase. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

CAMSHAFT

REMOVAL

1. Remove the crankshaft damper, cylinder front cover, and oil pan following the procedures in this section. Remove the grille.

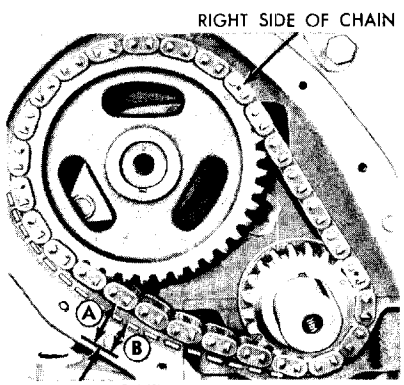
2. Remove the valve rocker arm cover and the valve rocker arm shaft assembly. Remove the valve push rods in sequence (Fig. 14).

3. Disconnect the primary wire and the high tension wire at the coil. Disconnect the vacuum line and primary wire at the distributor. Remove the distributor cap and spark wires as an assembly. Remove the distributor.

6. Remove the crankshaft front oil slinger. Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft sprocket retaining screw. Set the dial on zero. Position a large screwdriver between the camshaft sprocket and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with specifications. If the end play is excessive, check the spacer for correct installation before it is removed. If the spacer is correctly installed, replace the thrust plate when the camshaft is installed.

7. Remove the dial indicator. Rotate the crankshaft in a clockwise direction (as viewed from the front) to take up the slack on the left side of the chain.

8. Establish a reference point on the block and measure from this point to the chain (Fig. 22).



TAKE UP SLACK ON LEFT SIDE. ESTABLISH A REFERENCE POINT AND MEASURE DISTANCE **A**. TAKE UP SLACK ON RIGHT SIDE AND FORCE LEFT SIDE OUT WITH THE FINGERS AND MEASURE DISTANCE **B**. DEFLECTION IS **A** MINUS **B**.

A1062-A

FIG. 22—Timing Chain Deflection

9. Rotate the crankshaft in the opposite direction to take up the slack on the right side of the chain, then force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements.

10. If the deflection exceeds ½ inch, replace the timing chain and/or sprockets.

11. Remove the camshaft sprocket retaining bolt and washer. Slide both sprockets and the timing chain forward and remove them as an assembly.

12. Turn the camshaft until the tappets can be lifted with either a magnetic tappet lifter (Fig. 23), or the fingers. Raise the tappets clear of the camshaft lobes and secure them with spring-type clothes pins or window regulator spring clips (Figs. 23 and 24).

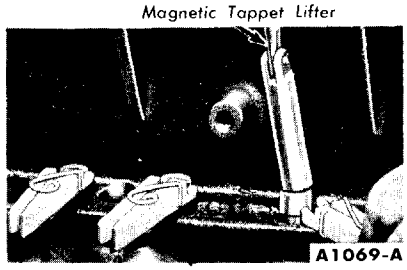


FIG. 23—Lifting and Securing Valve Tappets

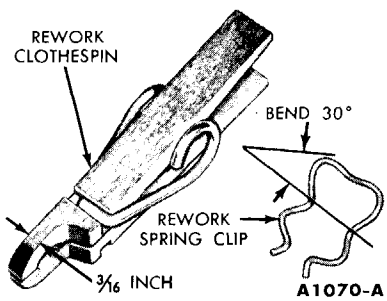


FIG. 24—Tappet Retainers

13. Remove the camshaft thrust plate and spacer. Carefully remove the camshaft by pulling it toward the front of the engine. **Use caution to avoid damaging the camshaft bearings.**

INSTALLATION

1. Oil the camshaft and apply Lubriplate to all the lobes. Carefully slide the camshaft through the bearings.

2. Install the camshaft spacer. **Be sure the chamfer on the spacer is to the rear or faces the camshaft journal.**

3. Install the thrust plate and tighten the retaining screws to specifications.

4. Position the sprockets and timing chain on the camshaft and crankshaft. Align the timing marks on the timing chain and sprockets as shown in Fig. 20. Install the camshaft sprocket cap screw and washer. Install the crankshaft front oil slinger.

5. Replace the crankshaft front oil seal. Install the cylinder front cover, the crankshaft damper, and related parts following the procedures in this section. Install the grille.