FORD MOTOR COMPANY • DIVISION

1960 FORD TRUCK

SHOP MANUAL

1960 Ford Truck Shop Manual
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FOREWORD

This manual provides information for the proper servicing of 1960 Ford Trucks. Service procedures for the Courier are covered in the 1960 Ford Car Shop Manual. 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
FORD MOTOR COMPANY

FORD TRUCK IDENTIFICATION

MODEL DESIGNATIONS

Ford truck designations consist of two elements, a letter and a three or four digit number. The letter determines the type of truck and the number indicates the size, as follows:

F.....**Conventional Series**
C.....**Tilt Cab Series**
T.....**Tandem Axle Series**
B.....**School Bus Series**
P.....**Parcel Delivery Series**
H.....**Tilt-Cab, Tandem Series***

100, 250, 350, 400.....**Light Duty Models**
500, 550, 600.....**Medium Duty Models**
700, 750, 800, 850.....**Heavy Duty Models (except Tandem Models)**
950, 1000, 1100 and T-700 thru T-950.....**Extra-Heavy Duty Models**

*Special order only

For example: the F-350 is a Light Duty conventional model. The C-600 is a Medium Duty Tilt Cab model. The T-950 is an Extra Heavy Duty Tandem Axle model. The Courier model does not carry a letter or number designation.

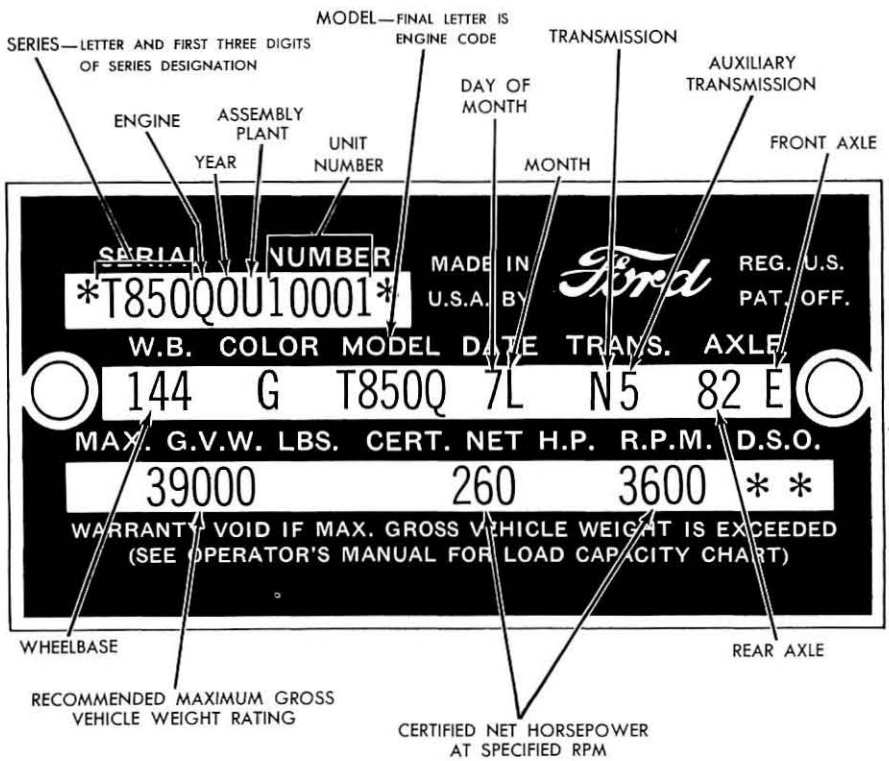

FIG. 1—Typical Truck Rating Plate

TRUCK REGISTRATION RATINGS

Series	Model	RATING GVW (lb)	RATING Nominal (ton)	Series	Model	RATING GVW (lb)	RATING Nominal (ton)	Series	Model	RATING GVW (lb)	RATING Nominal (ton)
F-100	F-100	5,000	½	F-350	F-350	9,800	1	F-700	F-700	21,000	2½
	F-101	4,000	½		F-351	7,700	¾		F-701	17,000	1¾
	F-102	5,000	½	F-500	F-500	15,000	1½		F-702	22,000	2½
	F-103	5,600	½		F-501	10,000	1		F-703	17,000	1¾
	F-104	4,000	½	F-600	F-600	17,000	2		F-704	25,000	3
	F-105	5,600	½		F-601	15,000	1½		F-705	20,000	2
	F-250	7,400	¾		F-602	19,500	2½		F-706	25,000	3
					F-603	21,000	2½	F-750	F-750	22,000	2½
					F-604	21,000	2½		F-751	17,000	1¾
					F-605	15,000	1½		F-752	25,000	3
									F-753	20,000	2
									F-754	25,000	3

CONTINUED ON NEXT PAGE

FORD TRUCK IDENTIFICATION

TRUCK REGISTRATION RATINGS (Continued)

Series	Model	RATING GVW (lb)	RATING Nominal (ton)
F-800	F-800	25,000	3
	F-801	20,000	2
	F-802	25,000	3
	F-803	27,000	3½
	F-804	27,000	3½
	F-805	20,000	2
	F-806	27,000	3½
	F-807	27,000	3½
F-850	F-850	25,000	3
	F-851	20,000	2
	F-852	25,000	3
	F-853	27,000	3½
	F-854	27,000	3½
	F-855	20,000	2
	F-856	27,000	3½
	F-857	27,000	3½
F-950	F-950	27,000	3½
	F-951	24,000	2
	F-952	27,000	3½
	F-953	29,000	4
	F-954	29,000	4
	F-955	31,000	5
	F-956	33,000	5
F-1000	F-000	31,000	5
	F-001	26,000	3
	F-002	33,000	5
	F-003	33,000	5
F-1100	F-010	36,000	5
	F-011	26,000	3
B-500	B-500	15,000	1½
	B-501	10,000	1
B-600	B-600	17,000	2
	B-601	15,000	1½
	B-602	19,500	2½
	B-603	19,500	2½
B-700	B-700	21,000	2½
	B-701	17,000	1¾
	B-702	22,000	2½
	B-704	22,000	2½
	B-706	22,000	2½
	100		

Series	Model	RATING GVW (lb)	RATING Nominal (ton)
C-550	C-550	18,000	1½
	C-551	10,000	1
C-600	C-600	19,500	2½
	C-601	15,000	1½
	C-602	21,000	2½
	C-603	15,000	1½
	C-604	21,000	2½
	C-605	15,000	1½
C-700	C-700	22,000	2½
	C-701	17,000	1¾
	C-702	23,000	2½
	C-703	17,000	1¾
	C-704	25,000	3
	C-705	17,000	1¾
	C-706	25,000	3
C-750	C-750	23,000	2½
	C-751	17,000	1¾
	C-752	25,000	3
	C-753	17,000	1¾
	C-754	25,000	3
C-800	C-800	27,000	3½
	C-801	20,000	2
	C-802	27,000	3½
	C-803	27,000	3½
	C-804	27,000	3½
	C-805	20,000	2
C-850	C-850	27,000	3½
	C-851	20,000	2
	C-852	27,000	3½
	C-853	27,000	3½
	C-854	27,000	3½
	C-855	20,000	2
C-950	C-950	30,000	4
	C-951	24,000	2
	C-952	30,000	4
	C-953	31,000	5
	C-954	31,000	5
	C-955	26,000	3
	C-956	33,000	5
	C-957	26,000	3
C-1000	C-000	31,000	5
	C-001	26,000	3
	C-002	33,000	5
	C-010	36,000	6
	C-011	30,000	4

Series	Model	RATING GVW (lb)	RATING Nominal (ton)
P-350	P-350	8,000	¾
	P-351	5,500	½
	P-352	8,000	¾
P-400	P-400	10,000	1
	P-401	7,700	¾
P-500	P-500	15,000	1½
	P-501	10,000	1
P-600†	P-600	17,000	2
	P-601	15,000	1½
	P-602	19,500	2½
T-700	T-700	28,000	3
	T-701	22,000	2
	T-702	29,000	3
	T-703	22,000	2
	T-704	32,000	3
	T-705	22,000	2
	T-706	33,000	3
	T-707	22,000	2
T-750	T-750	35,000	3½
	T-751	27,000	3
	T-752	37,000	3½
	T-753	27,000	3
T-800	T-800	39,000	3½
	T-801	30,000	3
	T-802	41,000	3½
	T-803	45,000	4
	T-804	43,000	4
	T-805	30,000	3
	T-806	45,000	4
	T-808	43,000	4
T-850	T-850	39,000	3½
	T-851	30,000	3
	T-852	41,000	3½
	T-853	45,000	4
	T-854	43,000	4
	T-855	30,000	3
	T-856	45,000	4
	T-858	43,000	4
T-950	T-950	46,000	5
	T-951	32,000	4
	T-952	48,000	5
	T-953	32,000	4
	T-954	51,000	5
	T-955	32,000	4

†Special order only.

FORD TRUCK IDENTIFICATION

ENGINE CODE

Code	Sales Designation	Service and Engineering Designation
B*	292 MD V-8	EEH, EEJ**—Dual
C	292 MD V-8	EEH, EEJ**—Dual
D	292 HD V-8	EEK—4-Barrel
E*	292 V-8	EEK—4-Barrel
F	332 HD V-8	ECT—4-Barrel
J	223 Six	EBR, EBS, EBT
N	302 HD V-8	ECS—4-Barrel
P	401 SD V-8	EDL—4-Barrel
Q	477 SD V-8	EDM—4-Barrel
R	534 SD V-8	EDN—4-Barrel

*Export only
**P-Series only

MONTHS CODE

Month	Code Letter	
	First Year	Second 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

TRANSMISSION CODE

Code	Type
A	3-Speed Standard
B	3-Speed Overdrive
C	Fordomatic
D	3-Speed M/D Warner T-89C
E	3-Speed H/D Warner T-87E
F	4-Speed Warner T-98A
G	H/D Cruise-O-Matic
H	6-Speed Transmatic
J	5-Speed M/D Clark 250 V (Direct)
K	5-Speed M/D Clark 251 VO (Overdrive)
L	5-Speed H/D Clark 265 V (Direct)
M	5-Speed H/D Clark 264 VO (Overdrive)
N	5-Speed EH/D Spicer 5652 (Direct)
P	5-Speed EH/D Spicer 5756B (Direct)
Q	5-Speed EH/D Spicer 6352 (Direct)
R	5-Speed EH/D Spicer 6852G (Direct)
S	5-Speed EH/D Spicer 6453A (Overdrive)
T	8-Speed Roadranger

COLOR CODE

Code	Color Name	Paint Spec. Number
A	Raven Black	M30J-1724
M	Corinthian White	M30J-1238
V	Academy Blue	M30J-1024
F	Sky Mist Blue	M30J-1226
L	Dark Green	M30J-1237
W	Adriatic Green	M30J-1274
J	Monte Carlo Red	M30J-1232
	Goldenrod Yellow	M30J-358
	Turquoise	M30J-556

ASSEMBLY PLANT CODE

Code	Plant Location
A	Atlanta
D	Dallas
E	Mahwah
G	Chicago
H	Lorain (Ohio)
K	Kansas City
N	Norfolk
P	Twin City (St. Paul)
R	San Jose
U	Louisville

AUXILIARY TRANSMISSION CODE

Code	Type
1	Spicer 5831C
2	Spicer 5831B
3	Spicer 7231B
4	Spicer 7231D
5	Spicer 8341A

FRONT AXLE CODE

Code	Type
A	3.92 Ratio (4-Wheel Drive)
B	4.55 Ratio (4-Wheel Drive)
C	6,000 lb.
D	7,000 lb.
E	9,000 lb.
F	11,000 lb.
G	15,000 lb.

FORD TRUCK IDENTIFICATION

REAR AXLE CODE

Code	Ratio
100, 250, 350, 400 Models	
OA*	3.73—3.3M
OB*	3.92—3.3M
OD*	4.56—5M
OF*	4.88—5M
01	3.70—3.3M
02	3.89—3.3M
03	4.11—3.3M
04	4.56—5M
05	4.86—7.2M
06	4.88—5M
07	5.14—7.2M
08	5.83—7.2M
500, 550, 600 Models	
B1	5.83—13M
22	6.20—11M
B2	6.20—13M
K2	6.20—14M
S2	6.20—15M
23	6.50—16M
24	6.80—11M
B4	6.80—13M
K4	6.80—14M
S4	6.80—15M
25	7.17—16M
S6	7.20—15M
500, 550, 600 Models (Continued)	
51	5.83/8.11—13M
E1	5.83/8.11—14M
N1	5.83/8.11—15M
E2	6.33/8.81—14M
N2	6.33/8.81—15M
53	6.50/9.04—16M
FCB 700-950	
C1	4.88—21M
32	5.57—18M
C2	5.57—21M
23	6.50—16M
33	6.50—18M
C3	6.50—21M
S4	6.80—15M
25	7.17—16M
35	7.17—18M
C5	7.17—21M
S6	7.20—15M
37	7.67—18M
N2	6.33/8.81—15M
53	6.50/9.04—16M
54	6.50/8.87—18M
E4	6.50/8.87—21M
55	7.17/9.77—18M
E5	7.17/9.77—21M
56	5.57/7.60—18M
E6	5.57/7.60—21M
E7	4.88/6.65—21M
FC—1000-1100	
41	4.88—23M
42	5.43—23M
43	6.17—23M
45	6.67—23M
D4	6.38—29M
D6	7.03—29M
61	4.88/6.33—23M
62	5.43/7.39—23M
63	6.14/8.36—23M
65	6.71/9.13—23M
F4	6.42/8.38—29M
F6	7.09/9.07—29M
T—700-850	
71	6.70—22M
G2	7.07—28M
73	7.79—22M
G3	7.79—28M
T—800-850	
81	4.56—34M
82	5.85—34M
83	6.69—34M
84	7.80—34M
85	8.60—34M
T-950	
92	5.57—38M
93	6.50—38M
94	7.60—38M
95	8.38—38M

*Limited slip

1960 FORD TRUCK 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 truck engines. In addition, the cleaning, inspection, repair, and overhaul procedures are covered.

For engine removal, disassembly, assembly, and installation, refer to Part 1-2, 1-3, 1-4, or 1-5.

1 ENGINE TROUBLE DIAGNOSIS

Engine performance complaints usually fall under one of the basic headings listed in the "Engine Trouble Diagnosis Guide." This guide lists procedures and checks to be performed to help isolate the cause of the trouble. 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 (Part 12-2). 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. Also examine the cylinder block for cracks.
	ck the fuel supply. If there is nt fuel in the tank, the cause trouble probably lies in either nition 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

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ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ENGINE CRANKS NORMALLY, BUT WILL NOT START (Continued)

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. Hold it approximately 3/16 inch from the cylinder head. With the ignition on and 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 the cause of the trouble, check the following items.

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.

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, such as valves, 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 (mechanical fuel pump).

The fuel tank line for obstructions.

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.

Float setting incorrect.

Fuel inlet system not operating properly.

…rt or water in fuel lines or …retor.

Carburetor icing.

Fuel pump defective.

IGNITION SYSTEM

Breaker points not properly adjusted.

Defective spark plugs.

Leakage in the high tension wiring.

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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 (223 Six and 292 MD V-8). Exhaust system restricted. **IGNITION SYSTEM** Breaker points not properly adjusted. Defective breaker points, condenser, secondary wiring, coil, or ugs. 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. **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 needle(s) 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. **COOLING SYSTEM** Engine overheating.

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ROUGH ENGINE IDLE	**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). 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 carburetors). Leaking fuel enrichment valve (4-barrel carburetors).	**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 (223 Six and 292 MD V-8). **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.
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 needles or balls. Accelerating pump diaphragm defective. Float setting incorrect. Throttle linkage not properly adjusted. Accelerating pump stroke not properly adjusted.	Leaking power valve, gaskets, or accelerating pump diaphragm. Leaking fuel enrichment valve (4-barrel carburetors). Dirt or corrosion in accelerating system. Distributor vacuum passages in the carburetor blocked (single-barrel, dual carburetors, and 534 SD V-8 4-barrel carburetor). **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking (223 Six and 292 MD V-8). **TRANSMISSION** Clutch slippage (manual-shift transmissions). Improper adjustment (automatic transmissions).
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 (223 Six and 292 MD V-8). **FUEL SYSTEM** Clogged fuel filter. Clogged or undersize main jets and/or low float setting. Clogged or undersize secondary jets (4-barrel carburetors). Power valve clogged or damaged. Secondary throttle plates not opening (4-barrel carburetors).	

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ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

ENGINE DOES NOT DEVELOP FULL POWER, OR HAS POOR HIGH SPEED PERFORMANCE (Continued)	Fuel pump pressure incorrect. Distributor vacuum passage in the carburetor blocked (single-barrel, dual carburetors, and SD V-8 4-barrel carburetors). **COOLING SYSTEM** Thermostat inoperative or of incorrect heat range. **ENGINE AT NORMAL OPERATING TEMPERATURE** **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking (223 Six and 292 MD V-8). **FUEL SYSTEM** Same items as for engine cold. **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. Same items as for engine cold. **VACUUM GOVERNOR (HD V-8 ENGINES)** Incorrect top speed adjustment. Valve shaft bent impairing operation of the valve sleeve (in governor controlling unit in the distributor). Incorrect governor spring and/or spring pin installed in wrong hole (in throttle actuating unit on carburetor). **VELOCITY GOVERNOR— 223 SIX OR 292 MD V-8** Incorrect adjustment. Throttle plate(s) in governor not completely opening. **MECHANICAL GOVERNOR— SD V-8 ENGINES** Incorrect adjustment. Governor defective. **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 adjustment (automatic transmissions).
EXCESSIVE FUEL CONSUMPTION	Determine the actual fuel consumption with test equipment installed in the truck. 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** **ITEMS** k: for proper pressure. Front wheel alignment. Brake adjustment. **EXHAUST SYSTEM** Check the exhaust gas control valve operation (223 Six and 292 MD V-8). **ODOMETER** Check calibration. **IGNITION SYSTEM** Check ignition timing. **FINAL CHECKS** **FUEL SYSTEM** Check: Fuel pump pressure.

CONTINUED ON NEXT PAGE

ENGINE TROUBLE DIAGNOSIS GUIDE (Continued)

EXCESSIVE FUEL CONSUMPTION (Continued)	Engine idle speed. Idle fuel mixture needle(s) for proper adjustment. 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. Fuel enrichment valve operation (4-barrel carburetors). 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).
ENGINE OVERHEATS	**TEMPERATURE SENDING UNIT AND GAUGE** Unit or gauge defective, not indicating correct temperature. **EXHAUST SYSTEM** Exhaust gas control valve inoperative or sticking (223 Six and 292 MD V-8). Restriction in system. **ENGINE** Cylinder head bolts not properly tightened. Incorrect valve lash. 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.
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. E der 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.

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 17 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	Minor	Major	Recommended Procedure
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	Part 1-7
DRIVE BELTS Check and adjust tension.	X	X	Part 4-1
BATTERY Clean cables and terminals.		X	Part 12-1
Tighten cable clamps.		X	
Grease battery terminals.		X	
Check battery state of charge.	X	X	
ELECTRICAL Oil generator rear bearing through oil cup (223 Six).		X	Part 12-1
Check generator output.		X	
Check starter motor current draw.		X	
Check coil output.		X	Part 2-1
Perform a primary circuit resistance test.		X	
Perform a secondary circuit continuity test.		X	
DISTRIBUTOR Check the condition of the breaker points.	X		Part 2-1
Replace the breaker points and the condenser.		X	
Check and adjust the breaker arm spring tension.		X	
Lubricate the distributor cam. Oil the lubricating wick (Centrifugal Advance and Dual Advance Distributors). Lubricate the distributor [illegible]g through the oil		X	

Operation	Minor	Major	Recommended Procedure
DISTRIBUTOR (Continued) Check and adjust centrifugal advance—Centrifugal Advance and Dual Advance Distributors.		X	Part 2-1
Check and adjust vacuum advance —Loadomatic and Dual Advance Distributors.		X	
Clean distributor cap and rotor.	X	X	
FUEL SYSTEM Clean fuel pump sediment bowl (mechanical fuel pump).	X	X	Part 3-1
Replace fuel pump sediment bowl filter (mechanical fuel pump).		X	
Check fuel pump pressure and capacity.		X	
Drain fuel system filter—HD and SD V-8.	X		
Replace fuel system filter element—HD and SD V-8.		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.	X*	X	Part 1-1
Check and adjust governor speed—HD and SD V-8.	X	X	Part 2-3
EXHAUST Free the exhaust gas control valve—223 Six and 292 MD V-8.	X	X	Part 1-6
COOLING SYSTEM Inspect the radiator, hoses, and engine for coolant leaks.		X	Part 4-1
Add rust inhibitor to radiator if water is used as coolant.		X	

*332 HD V-8.

3 TESTS AND ADJUSTMENTS—ENGINE INSTALLED

CAMSHAFT LOBE LIFT

1. Loosen the valve rocker arm adjusting screw.

2. Slide the rocker arm assembly to one side. Secure it in this position.

3. Make sure the push rod is in the tappet socket. Install a dial indicator in such a manner as to have the actuating point of the indicator in the push rod cup and in the same plane as the push rod movement (Fig. 1).

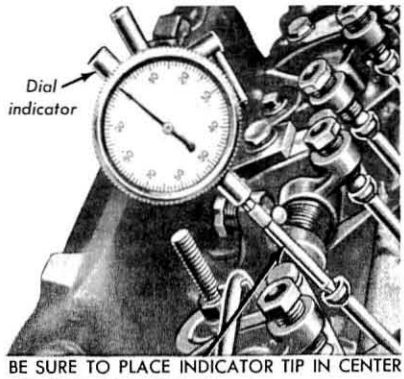
4. Turn the crankshaft damper slowly in the direction of rotation until the tappet is on the base circle of the camshaft lobe. At this point, the push rod will be in its lowest position.

5. Zero the dial indicator.

6. Continue to rotate the damper slowly until the push rod is in the fully raised position.

7. Compare the total lift recorded on the indicator with specifications.

8. To check the accuracy of the original indicator reading, continue to rotate the damper until the indicator reads zero.



BE SURE TO PLACE INDICATOR TIP IN CENTER OF PUSH ROD SOCKET A1000-A

FIG. 1—Camshaft Lobe Lift

VALVE LASH

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 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.

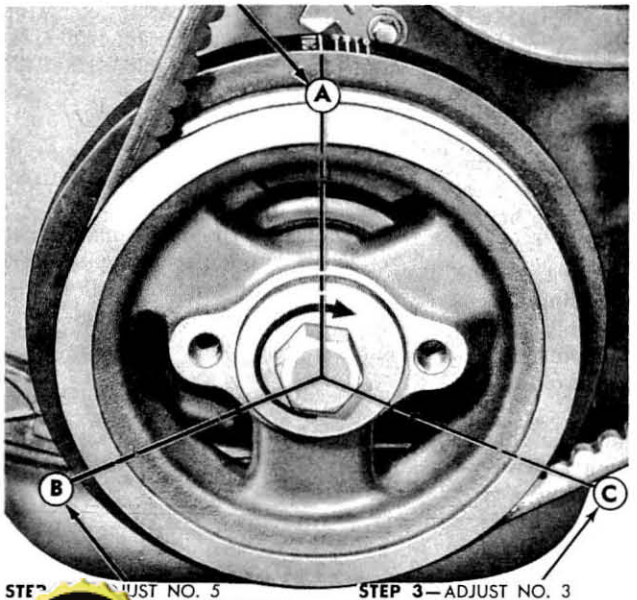
On the 223 Six, the cylinders are numbered from front to rear, 1-2-3-4-5-6 and the valves are arranged from front to rear E-I-I-E-I-E-E-I-E-I-I-E.

On the V-8 engines, the cylinders are numbered from front to rear—right bank, 1-2-3-4; left bank, 5-6-7-8.

On the MD and HD V-8 engines, the valves are arranged from front to rear on both banks, E-I-I-E-E-I-I-E.

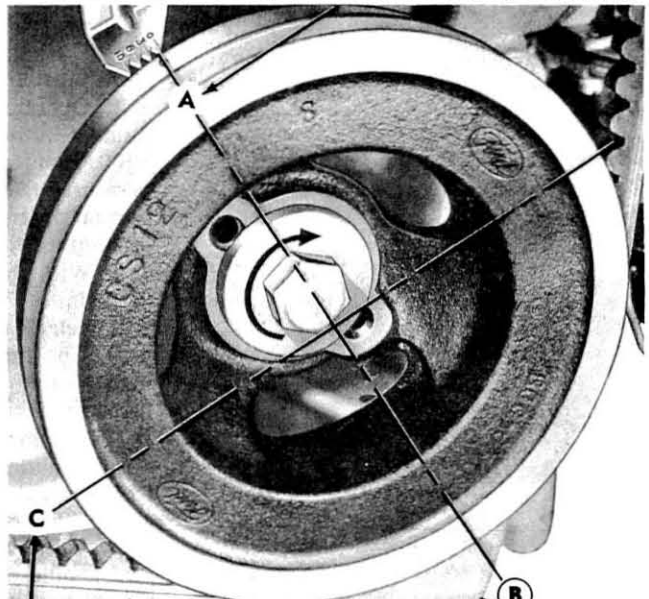
On the SD V-8 engines, the valves are arranged from front to rear on both banks, E-I-E-I-I-E-I-E.

STEP 1— SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE, ADJUST NO. 1 INTAKE AND EXHAUST
STEP 4— ADJUST NO. 6 INTAKE AND EXHAUST



STEP —ADJUST NO. 5 E AND EXHAUST
STEP 3—ADJUST NO. 3 INTAKE AND EXHAUST
NO. 4 AND EXHAUST
1421-A

STEP 1 —SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE—ADJUST NO. 1, 4, 5 EXHAUST & NO. 1, 2, 7 INTAKE



STEP 2 —ADJUST NO. 6 & 8 EXHAUST & NO. 4 & 5 INTAKE
STEP 3 —ADJUST NO. 2, 3, 7 EXHAUST & NO. 3, 6, 8 INTAKE
A1203-A

FIG. 3—Preliminary Valve Lash—V-8

PRELIMINARY ADJUSTMENT—223 SIX

1. 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 3 foot-pounds (36 inch-pounds), try a new self locking adjusting screw. If this is still unsatisfactory, replace the rocker arm and adjusting screw.

2. Make two chalk marks on the crankshaft damper (Fig. 2). 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).

3. 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.

4. Adjust the intake and exhaust valve lash for No. 1 cylinder. The valve lash setting is listed in Table 2. **Use a step-type feeler gauge ("go" and "no go") to adjust the valves.**

5. 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).

PRELIMINARY ADJUSTMENT—V-8

1. On the MD and HD V-8 engines, follow step 1 under the 223 Six engine (the SD V-8 engines do not have self-locking adjusting screws).

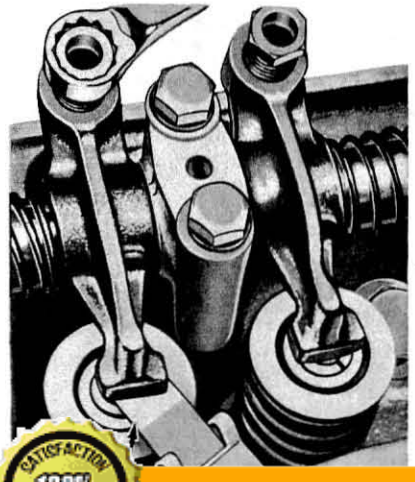


TABLE 2—Valve Lash Specifications

Engine	Preliminary (Cold)		Final (Hot)	
	Intake	Exhaust	Intake	Exhaust
223 Six	0.019	0.019	0.019	0.019
292 MD and HD V-8	0.019	0.019	0.018	0.018
302 and 332 HD V-8	0.020	0.022	0.020	0.020
All SD V-8	0.020	0.020	0.020	0.020

2. Make three chalk marks on the crankshaft damper (Fig. 3). 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 valve lash settings are listed in Table 2. **Use a step-type feeler gauge ("go" and "no go") to adjust the valves.**

3. 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

4. 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

5. 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. 4 or 5) **using a step-type feeler gauge only ("go" and "no go").** The final (hot) intake and exhaust valve lash specifications are listed in Table 2.

For example to obtain the correct setting on the 223 Six, use a **step-type feeler gauge** of 0.018 inch ("go") and 0.020 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 (0.019 inch).

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 manifold vacuum line or on the fitting in the intake manifold.

3. Operate the engine at recommended idle rpm.

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 intake 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 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 3 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.

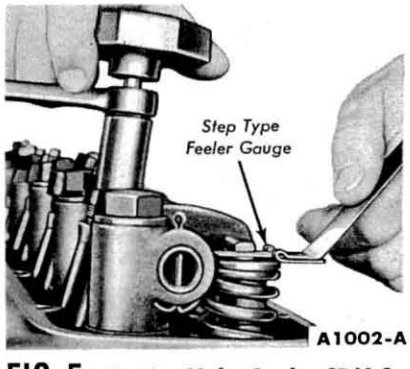


FIG. 5—Setting Valve Lash—SD V-8

TABLE 3—Manifold Vacuum Gauge Readings

Gauge Reading (Inches Hg)	Engine Condition
17 (302, 332 HD V-8, and SD V-8) 18 (223 Six, 292 MD and HD V-8)	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.

ENGINE 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 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 recorded. 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 the 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.

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. 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 valve.

4 CLEANING, INSPECTION, AND RECONDITIONING

INTAKE MANIFOLD

Clean the manifold in a suitable solvent, then dry it 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 intake manifold of the 223 Six and all MD and HD V-8 engines, scrape all carbon deposits from the center exhaust passage below the carburetor heat riser of the intake manifold. This carbon acts as a ... restricting the heating act... exhaust gases.

EX...

In...

leaks...

make it unfit for further service.

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 arm and the shaft exceeds the wear limit, replace the shaft and/or the rocker arm. Inspect the shaft and the rocker arm bore for nicks, scratches, scores, or scuffs. Dress up minor surface defects with a hone.

Inspect the pad at the valve end of the rocker arms for a grooved ...s. If the pad is grooved, re- ... the rocker arm. **Do not attempt ...e this surface by grinding.**

...eck 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.

Check for broken locating springs. Inspect the oil tubes (except SD V-8 engines) for cracks or sharp bends.

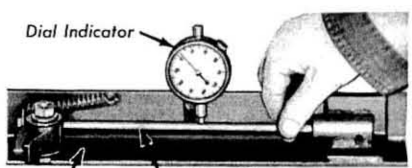


FIG. 6—Push Rod Runout

PUSH RODS

Check the cup end and the ball end of the push rods for nicks, grooves, roughness, or excessive wear.

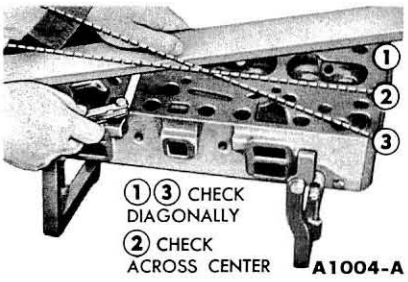


FIG. 7—Cylinder Head Flatness

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 between cup and ball centers with a dial indicator (Fig. 6). If the runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**

CYLINDER 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.

Check the valve seat insert for signs of excessive wear, cracks, or looseness (intake and exhaust on 302 and 332 HD V-8 and all SD V-8 engines, exhaust only on 292 HD V-8 engine).

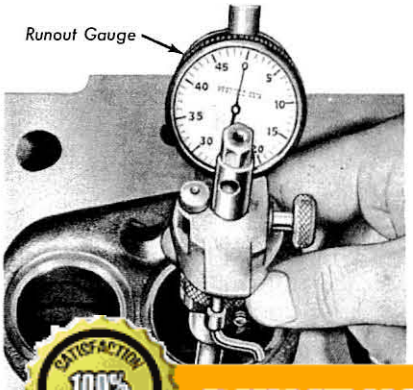


FIG.

CYLINDER HEAD FLATNESS

Check the flatness of the cylinder head gasket surface (Fig. 7).

VALVE SEAT RUNOUT

Check the valve seat runout with an accurate gauge (Fig. 8). Follow the instructions of the gauge manufacturer.

VALVE SEAT WIDTH

Measure the valve seat width (Fig. 9).

REAMING VALVE GUIDES

If it becomes necessary to ream a valve guide (Fig. 10) 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.

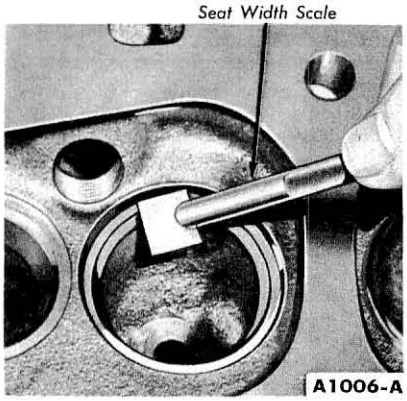


FIG. 9—Valve Seat Width

When going from a standard size valve to an oversize valve, always use the reamers in sequence. **Always reface the valve seat after the valve guide has been reamed.**

REFACING VALVE SEATS

Refacing of the valve seats should be closely coordinated with the refacing of the valve face so 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 and vacuum tight fit. Be sure that the refacer grinding wheels are properly dressed.

Grind the valve seat to a true 45° angle (Fig. 11). Remove only enough stock to clean up pits, grooves, or to ect the valve seat runout. After eat is ground, measure the seat n (Fig. 9). Narrow the seat, if ssary to bring it within limits.

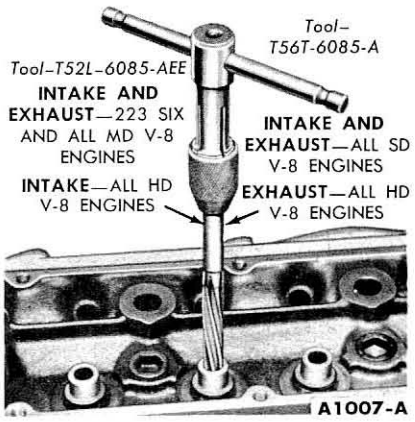


FIG. 10—Reaming Valve Guides

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. 11). Use a 60° angle grinding wheel to remove stock from the bottom of the seat (raise the seat). Use a 30° angle wheel to remove stock from the top of the seat (lower the seat).

The finished valve seat should contact the approximate center of the valve face. To determine where the valve seat contacts the face, 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.

After refacing the valve seat, it is good practice to lightly lap in the valve with a medium grade lapping compound. Remove all the compound from the valve and seat after the lapping operation.

VALVE SEAT INSERT REPLACEMENT—HD AND SD V-8 ENGINES

Exhaust valve seat inserts are

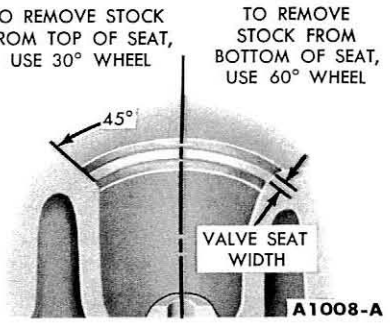


FIG. 11—Valve Seat Refacing

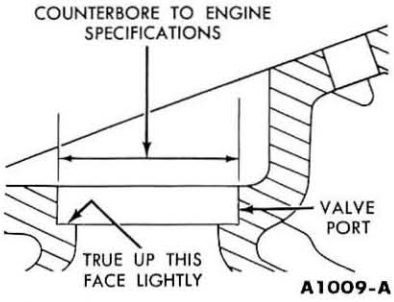


FIG. 12—Counterbore for Oversize Insert—HD and SD V-8

used in the 292 HD V-8. Intake and exhaust valve seat inserts are used in the 302 and 332 HD V-8 and in all SD V-8 engines. To replace the valve seat insert:

1. Invert the cylinder head.
2. Position a drift in the valve port.
3. Drive the insert out.
4. Counterbore the insert recess to specifications (Fig. 12). Cut slightly below the old counterbore depth to clean up this face (approximately 0.001-0.002 inch).
5. Clean out chips and oil from the recess.
6. Chill the oversize insert and the installation tool in dry ice for ½ hour. **The insert must be installed immediately upon removal from the dry ice. Protect the hands when handling the chilled insert and tool.**
7. Position the insert on the tool with the small radius on the outer edge facing outward.
8. Pilot the driving tool in the valve guide, then drive the insert into the counterbore until it is **fully** seated. Do not peen the area around the insert.
9. Reface the new insert.

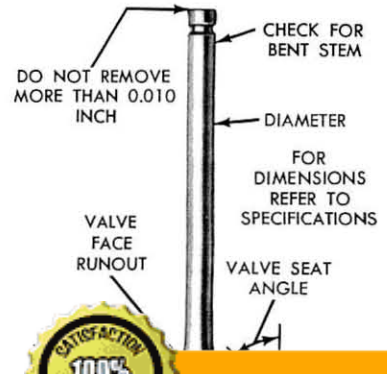


FIG.

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 valve are illustrated in Fig. 13.

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. **Do not discard sodium cooled valves (exhaust valves of all HD and SD V-8 engines) with other scrap metal in scrap bins. If a sodium cooled valve is accidentally broken**

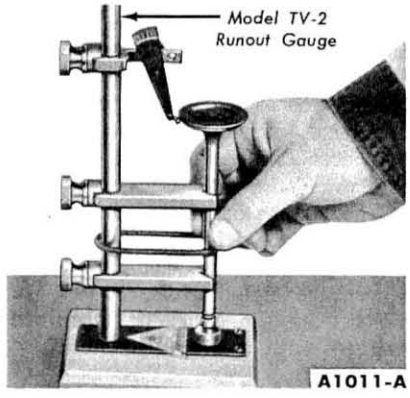


FIG. 14—Valve Face Runout

and the sodium exposed, it will react violently upon contact with water resulting in fire and explosion due to chemical action. Therefore, these valves should be handled with care and disposed of by being buried in the ground in an area not subjected to excavation, or dropped into deep natural water in a section not subjected to dredging.

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. 14). It should not exceed the wear limit.

VALVE STEM CLEARANCE

Check the valve stem to valve guide clearance of each valve in its ctive valve guide with the tool n in Fig. 15 or its equivalent. the clearance exceeds the wear try a new valve.

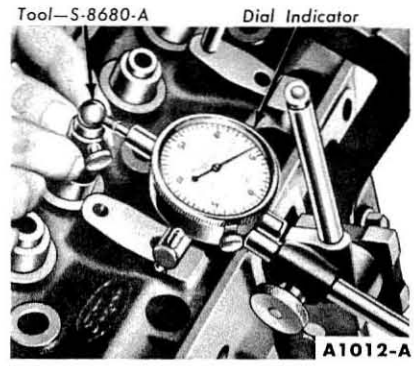


FIG. 15—Valve Stem Clearance

VALVE SPRING PRESSURE

Check the valve spring for proper pressure (Fig. 16). Weak valve springs cause poor performance; therefore, if the pressure of any spring exceeds the wear limit, replace the spring.

VALVE SPRING SQUARENESS

Check each spring for squareness using a steel square and a surface plate (Fig. 17). 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 coordinated 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, grind the valve to a true 44°

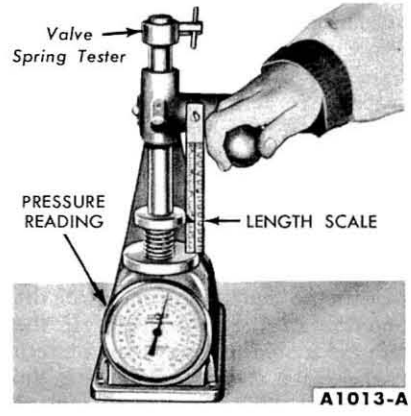


FIG. 16—Valve Spring Pressure

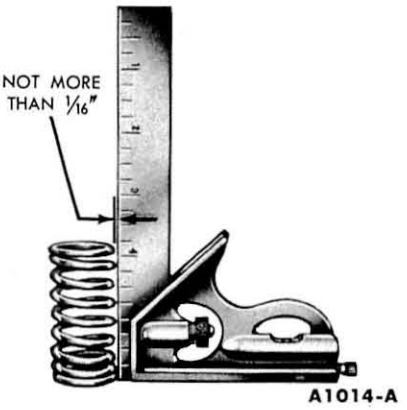


FIG. 17—Valve Spring Squareness

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 refacing, replace the valve as it will run too hot in the engine.

Remove all grooves or score marks from the end of the valve stem, then chamfer as necessary. Do not remove more than 0.010 inch from the stem.

After refacing the valves, it is good practice to lightly lap in the valves with a medium grade lapping compound to match the seats. Be sure to remove all of the compound from the valve and seat after the lapping operation.

SELECT FITTING VALVES

If the valve stem to the valve guide clearance exceeds the wear limit, it is recommended that the valve guide be reamed for the next oversized valve stem. Valves with oversize stem diameters of 0.003, 0.015, and 0.030 inch are available for service. **Always reface the valve seat when the valve guide is reamed.**

TIMING CHAIN—223 SIX, 292 MD AND HD V-8

Clean all parts in solvent and dry them with compressed air. Inspect the chain for broken links and the sprockets for cracks, worn or damaged teeth. It is recommended that all the components be replaced if any one item needs replacement.

TIMING GEARS—302, 332 HD, AND ALL SD V-8

Clean the gears in solvent. Note the condition of the gear teeth. If the

CAMSHAFT AND BEARINGS

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 nose portion of the lobe. This pitting is not detrimental to the operation of the camshaft, therefore, the camshaft should not be replaced until the camshaft lobe lift loss has exceeded 0.005 inch.

The lift of camshaft lobes can only be accurately checked with the camshaft installed in the engine. Refer to "Camshaft Lobe Lift" in Section 3 of this part.

Check the camshaft journal to bearing clearances by measuring the diameter of the journals and the I.D. of the bearings. If the clearance exceeds the wear limit, the camshaft journals should be ground for undersize bearings or the camshaft replaced, and/or the bearings should be replaced. Bearings are available pre-finished to size for standard and undersize journal diameters. Check the parts catalog for the undersizes available.

Check the distributor drive gear (and governor drive gear on SD V-8 engines) for broken or chipped teeth.

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

CRANKSHAFT

Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces.

CLEANING AND INSPECTION

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. Reface severely marred journals.

Measure the diameter of each journal in at least four places to determine out-of-round, taper, or undersize condition (Fig. 18).

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 may result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

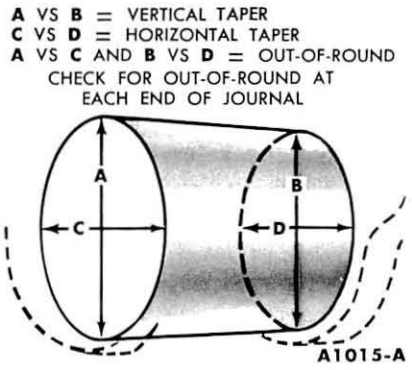


FIG. 18—Crankshaft Journal Measurements

After refinishing the journals, chamfer the oil hole, then polish the journal with a No. 320 grit polishing cloth and engine oil. Crocus cloth may also be used 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 journal, 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 maximum limit and/or if the 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 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 rod should be straightened or replaced.

PISTONS, PINS, AND RINGS

CLEANING AND INSPECTION

Remove deposits from the piston surfaces and from the underside of the piston head. 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. 19). Make sure the oil ring slots (or holes) are clean.

Carefully inspect the pistons for fractures at the ring lands, skirt, 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 piston top 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 (covered under "Fitting Pistons") and the ring side clearance (covered 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 0.003, 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 1-7 for the available sizes.

The piston to cylinder bore clearance should be from 0.0008-0.0026 inch (223 Six and MD and HD V-8 engines) or 0.0011-0.0029 inch (all SD V-8 engines). The wear limit is 0.005 inch.

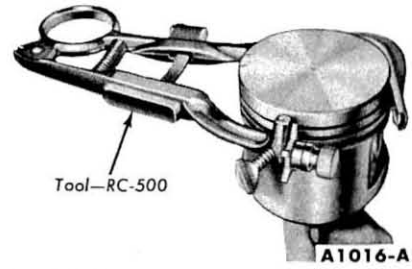


FIG. 19—Cleaning Ring Grooves

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.

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 the cylinder wall "glaze."

To fit a piston:

1. Calculate the size piston to be used by taking a bore check (Fig. 27).
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 the recommended thickness listed in Table 4.
5. Position the ribbon in the 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 pis-

TABLE 4—Piston Clearance Chart

ton 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 remove the feeler ribbon (Fig. 20).

In Table 4, the diagonal lines represent feeler ribbons of various thicknesses, the horizontal lines represent the pounds pull, and the vertical lines represent clearance. 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 4 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.

FIG. [illegible] ll the piston pin in the piston

4. Use the head of a piston to position the ring in the bore so 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. 21). 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. 22). 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.**

FIG. 21—Piston Ring Gap

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 [illegible] the proper fit is obtained. Check [illegible]itted piston pin for fit in the [illegible]ctive rod bushing. If necessary, [illegible] or hone the bushing to fit the

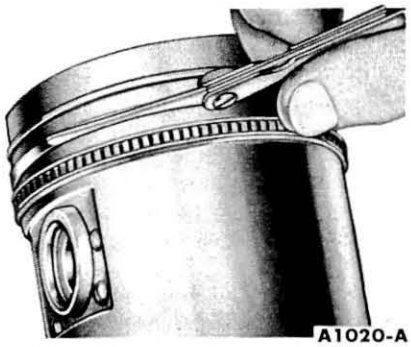


FIG. 22—Piston Ring Side Clearance

and rod. Install a new retainer at each end of the pin to hold it in place. When the retainers are installed, make sure they are properly seated in the grooves provided in the piston pin bore.

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. 23. 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 and do not require reaming to size upon installation. **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 1-7 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

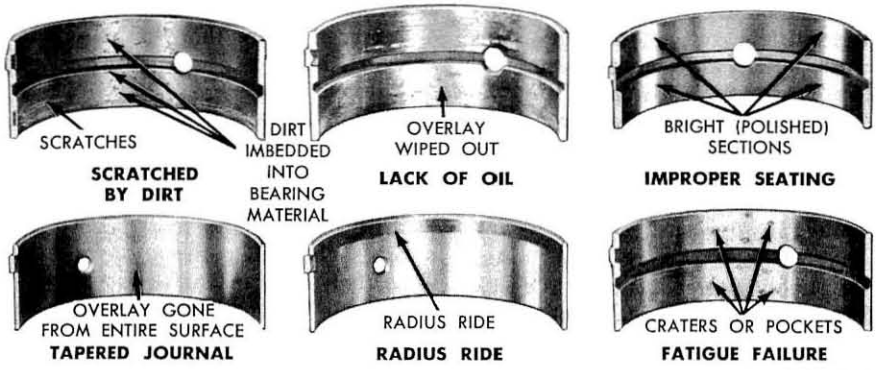


FIG. 23—Typical Bearing Failures

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.

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.

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 be[illegible]ts itself. Remove the tool. [illegible] the cap bearing.

[illegible]

we[illegible]

gag[illegible]

ing [illegible]

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. 24).

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 the Plastigage scale, check the width of the Plastigage.

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 of those bearings that are to be replaced.

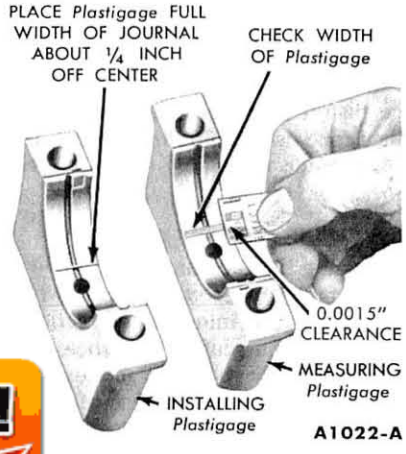


FIG. 24—Installing and Measuring Plastigage—Engine in Chassis

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. 25).

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.**

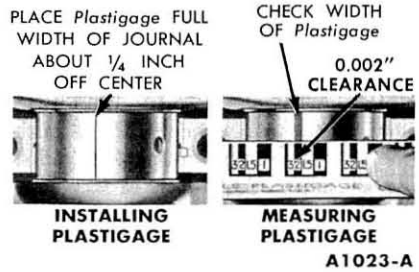


FIG. 25—Installing and Measuring Plastigage—Engine Removed

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

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

If the runout exceeds the maximum limit, remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft flywheel face if the mounting flange runout is excessive.

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

During the disassembly of the cylinder block for engine overhaul, closely inspect the wear pattern on all parts to help diagnose the cause of wear.

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.

FIG. 26 Flywheel face runout

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 denatured 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. 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. 27).

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. grade of hone to be used is rmined by the amount of metal e removed. Follow the instruc- of the hone manufacturer. If e stones are used to start the 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.

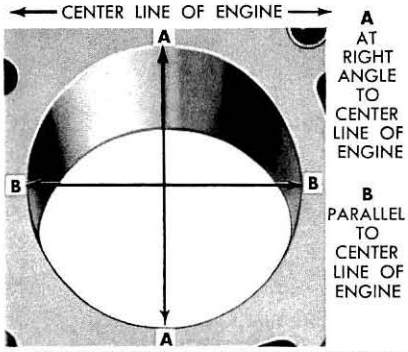
After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly wash the cylinder walls, with solvent to remove all abrasive particles, then thoroughly dry the walls. Check the piston fit. Mark the pistons to correspond to the cylinders in 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 PUMP

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



1. OUT-OF-ROUND = DIFFERENCE BETWEEN **A** AND **B**
2. TAPER = DIFFERENCE BETWEEN THE **A** MEASUREMENT AT TOP OF CYLINDER BORE AND THE **A** MEASUREMENT AT BOTTOM OF CYLINDER BORE

A1025-A

FIG. 27—Cylinder Bore Out-of-Round & Taper

baffle, and a nicked or warped 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 — V-8 Engines. 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. 28).

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. 29).

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 co[illegible]r worn condition.

[illegible]elief valve spring ten-
si[illegible]
sp[illegible]
def[illegible]
C[illegible]
scor[illegible]

Inspection—223 Six Engine. Inspect the pump body and the gear teeth for damage or wear. Check the gear end clearance with a dial indicator or Plastigage. The Plastigage method is as follows:

Position the gasket on the housing, then place the Plastigage on the gears and install the cover. Remove the cover and check the Plastigage reading.

Check the gears for freedom of rotation. Check the compression of the oil pressure relief valve spring and check the clearance of the relief valve in the valve chamber.

OIL COOLER—SD V-8

Clean the oil cooler as soon as possible after removing it from the engine, or soak it in cleaning solvent until ready to clean. This will prevent hardening and drying of accumulated foreign material.

Immerse the oil cooler in a commercial cleaning solvent and clean the outside of the plates with a stiff bristle brush.

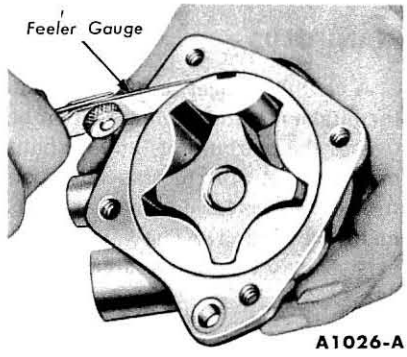


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FIG. 28—Outer Race to Housing Clearance

Pressure circulate a standard commercial solvent (at a pressure of approximately 20 psi) through the oil passages of the cooler in the reverse direction of normal flow. Normal flow is from the bottom hole (inlet) to the top hole (outlet). If a circulating pump is not available, soak the cooler in solvent for a few minutes and force the solvent through the oil passages with a plunger or piston-type hand pump. If the oil passages are severely clogged, use an oakite or alkaline solution. After cleaning, pressure flush the cooler with clean hot water.

[illegible]oroughly clean the passages in
[illegible]over and clean the relief valve
[illegible]nbly. Remove all old gasket
[illegible]r from the cover, oil cooler, and

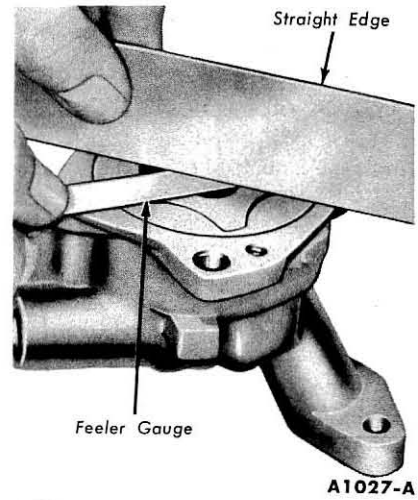

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FIG. 29—Rotor End Play

CRANKCASE VENTILATION SYSTEM MAINTENANCE

Refer to Group 17 for the correct mileage interval for maintenance.

223 SIX AND 292 V-8

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 ventilation 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.

302 AND 332 HD AND ALL SD V-8

The breather cap located on the valve push rod cover of the 302 and 332 HD V-8 engines should be serviced as indicated for the 223 Six and 292 MD and HD V-8.

A filter, located on each valve rocker arm cover of the SD V-8 engines, contains a paper element. This element should be replaced at the recommended mileage interval.

The lower portion of the ventilation tube on these engines contains a filtering element which is serviced as follows:

1. Remove the crankcase ventilation tube lower extension by loosening the retainer bolt and turning the tube to disengage the slot.
2. Remove the vent tube filter with pliers. **Do not attempt to drive it out as this will damage the filter.**
3. Clean the filter in solvent and dry it with compressed air.
4. Install the filter and crankcase ventilation tube lower extension.

PART 1-2 223 SIX ENGINE

1 DESCRIPTION

The 223 Six (Figs. 1 and 2) is a 6-cylinder engine with a piston displacement of 223 cubic inches. It has a compression ratio of 8.1:1. The engine is available in the F-100 thru 600, the B-500 and 600, and all P-Series trucks. The patent plate identification symbol for the engine is "J."

MANIFOLDS

A chamber (heat riser) is cast into the intake manifold center section between the carburetor and exhaust manifold. A thermostatically controlled valve is located in the exhaust manifold (Fig. 3). The valve directs exhaust gases into this area to provide the heat necessary to assist in vaporizing the incoming fuel mixture.

CYLINDER HEAD

The cylinder head carries the valves, valve rocker arm shaft assembly, manifold assembly, ignition coil, and the water outlet and ther-

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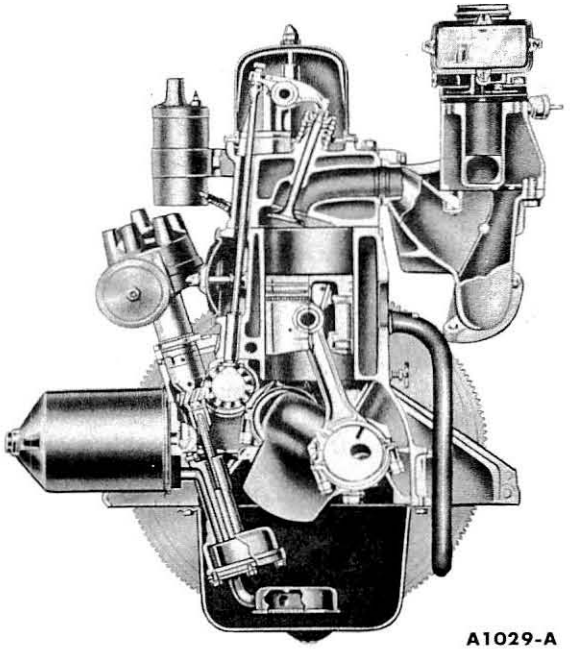

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FIG. 2—223 Six—Sectional

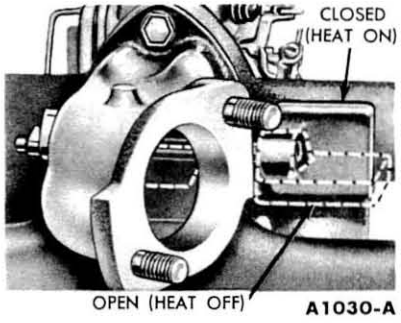


FIG. 3—Exhaust Control Valve

mostat. 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

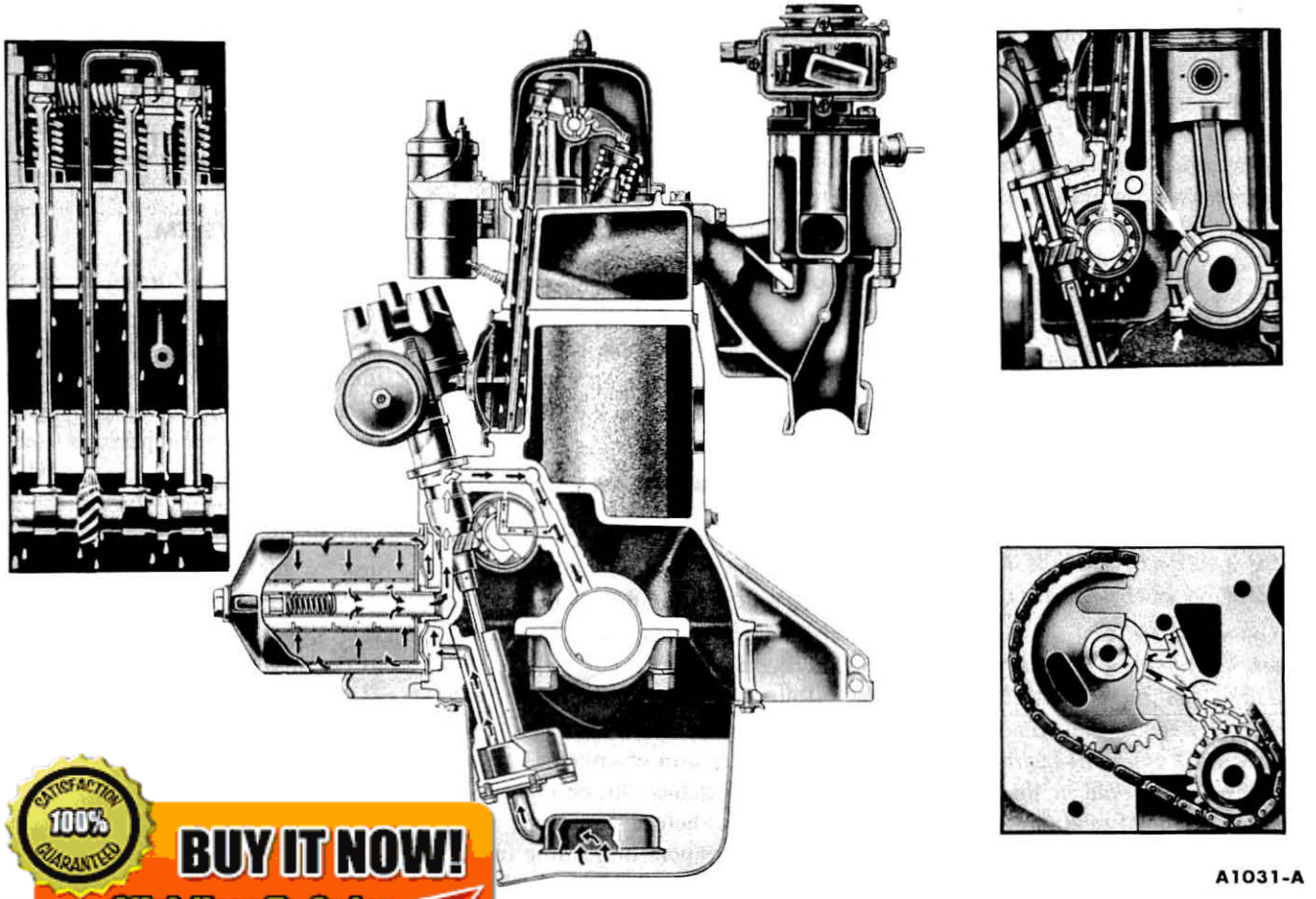
The intake and exhaust valve assemblies are the rotating-type. The tappets are the solid steel, mushroom-type. Valve lash is maintained by self locking adjusting screws.

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 feed lubrication system (Fig. 4) by a rotor oil pump which is mounted in the front of the crankcase. 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. A by-pass provides oil to the engine in case the filter element becomes clogged. The by-pass is located in the hollow center bolt of the filter and consists of a spring loaded valve. When the element is clean and oil will flow through it, the pressure difference between the inner and outer faces of the valve is not great enough to overcome the spring pressure behind the valve. Therefore, no oil flows through the by-pass. When the element is dirty and will not permit a sufficient flow of oil, the pressure



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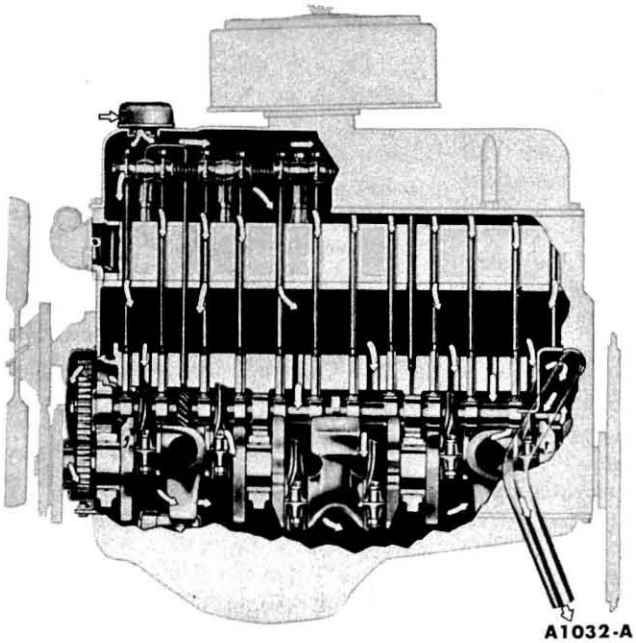

FIG. 5—Ventilation System

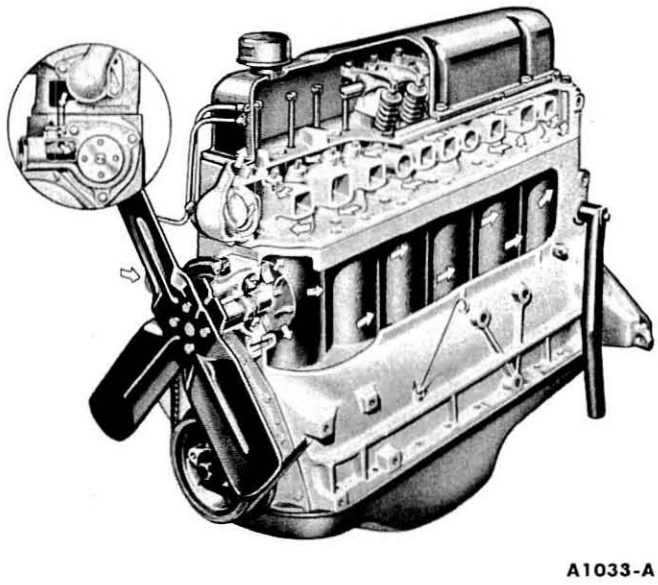

FIG. 6—Cooling System

acting on the inner face of the valve drops. If the pressure difference between the valve faces is great enough to overcome spring pressure, the valve will open. Oil then by-passes the element, maintaining an emergency supply of oil to the engine.

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 th... 3 camshaft bearing which i... a hole in the cylinder th... sh...

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.

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 chamber. Here the air has a chance to normalize its ...perature before contacting con...inating vapors originating in the ...nkcase. Warm ventilating air mini...es 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.

At this point, the coolant flows into the water outlet connection, past the thermostat if it is open, into the top of the radiator. 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 7 psi.

2 ENGINE REMOVAL AND INSTALLATION

The procedures are separated according to truck body styles.

B- AND F-SERIES

REMOVAL

A typical 223 Six engine installation is shown in Fig. 7.

1. Remove the hood.
2. Drain the cooling system and the crankcase.
3. Remove the radiator and shroud as an assembly.
4. Remove the air cleaner. Tape the carburetor air horn closed.
5. Disconnect the choke control cable at the carburetor. Disconnect the accelerator shaft to accelerator bellcrank rod at the bellcrank.
6. On a truck with an automatic transmission, disconnect the transmission throttle control rod at the bellcrank.
7. Remove the accelerator retracting spring.
8. Disconnect the flexible fuel line at the fuel tank line and install a cap on the fuel tank line.
9. Disconnect the generator wires at the generator.
10. Remove the engine ground strap at the flywheel housing (retained by the upper left flywheel housing to engine rear plate bolt).
11. Remove the upper right and the lower left engine rear plate to flywheel housing retaining bolt.
12. Remove the drive belt(s). Remove the fan, spacer, and pulley.
13. Disconnect the heater hoses at the engine.
14. Disconnect the water temperature and oil pressure sending unit wires at the sending units.
15. Disconnect the resistor wire and the battery wire at the coil.
16. Remove the starter.
17. Disconnect the exhaust manifold at the muffler inlet pipe. Remove the inlet pipe to engine bracket bolt.
18. On a truck with a manual-shift transmission, remove the flywheel housing inspection cover.
19. On a truck with an automatic transmission, remove the converter housing lower access cover and disconnect the converter from the flywheel. Secure the converter assembly in the housing. On all trucks except an F-100, disconnect the transmission oil cooler inlet and outlet lines at the engine.
20. Remove the remaining flywheel housing retaining bolts.
21. Attach the engine lifting hook (Fig. 8).
22. Remove the engine right and left front support to frame bracket bolts.
23. Carefully lift the engine out of the engine compartment.
24. Install the engine on a work stand (Fig. 9).

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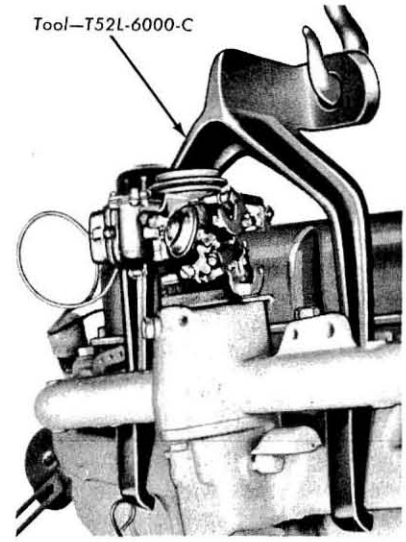


FIG. 8—Engine Lifting Hook

INSTALLATION

1. Place a new gasket over the exhaust manifold to muffler inlet pipe studs.
2. Position a floor jack under the transmission.
3. Carefully lower the engine into the chassis.

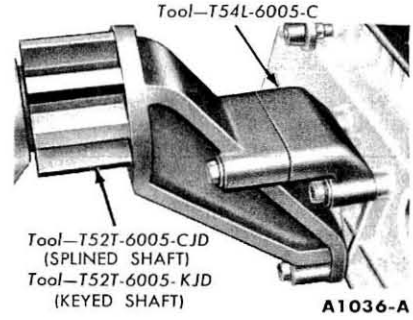


FIG. 9—Engine Mount

4. 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 housing.

5. On a truck with an automatic transmission, start the converter pilot into the crankshaft. Remove the retainer securing the converter. Attach the converter to the flywheel. Install two converter housing upper and lower retaining bolts. Remove the support from the transmission. Install the converter housing inspection cover. On all trucks except an F-100, connect the oil cooler inlet and outlet lines.

6. On a truck 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 in relation to the engine if the input shaft will not enter the clutch disc. **If the engine "hangs up" after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.** Install two flywheel housing upper and lower retaining bolts. Remove the support from the transmission. Install the flywheel housing cover.

7. Install the engine right and left front support bolt and nut. Tighten the nut to specifications. Remove the engine lifting hook and sling.

8. Position the engine ground strap. Install the remaining engine rear plate retaining bolts.

9. Install the exhaust manifold to muffler inlet pipe retaining lockwashers and nuts.

10. Install the inlet pipe to engine bracket bolt.

11. Connect the generator wires.

12. Remove the cap from the fuel tank line and connect the flexible fuel line.

13. Install the accelerator retracting spring.

14. On a truck with an automatic transmission, connect the transmission throttle control rod at the accelerator bellcrank.

15. Connect the accelerator shaft to bellcrank rod at the bellcrank and the choke control cable at the carbure

fa

be

17

18

frame

19. Connect the resistor wire and the battery wire to the coil.

20. Connect the oil pressure and water temperature sending unit wires. Connect the heater hoses.

21. Remove the tape from the carburetor air horn. Install the air cleaner.

22. Fill and bleed the cooling system.

23. Fill the crankcase with the proper grade and quantity of engine oil.

24. Install the hood.

25. Run the engine at fast idle and check all gaskets and hose connections for leaks.

26. On a truck with an automatic transmission, adjust the transmission control linkage.

P-SERIES

REMOVAL

1. Drain the cooling system and the crankcase.

2. Remove the driver's seat assembly, the master cylinder inspection cover, and the steering column cover plates.

3. Disconnect the accelerator pedal at the accelerator assembly, and the wires from the headlight beam selector switch.

4. Remove the left wheel house panel and the center floor plate.

5. Disconnect the right side of the engine rear cover panel from the right wheel house panel.

6. Disconnect the rear flange of the engine rear cover from the removable frame cross member and the center floor plate front bracket.

7. Loosen the air cleaner tube at the carburetor inlet elbow and at the air cleaner and remove the tube. Leave the air cleaner attached to the engine cover.

8. Wedge the right and left frame gussets open so the rear flange of the engine rear cover plate will clear the slots.

9. Remove the cover plate.

10. Remove the accelerator bracket assembly, and the accelerator retracting spring. Disconnect the choke control cable.

11. On a truck with an automatic mission, disconnect the throttle ol rod.

. Remove the carburetor.

Disconnect the exhaust mani- the muffler inlet pipe and remove the inlet pipe to engine bracket bolt.

14. Disconnect the generator wires at the generator.

15. Disconnect the flexible fuel line at the fuel tank line and install a cap on the fuel tank line.

16. Disconnect the engine temperature and oil pressure sending unit wires at the sending units.

17. Disconnect the resistor wire and the battery wire at the coil.

18. Disconnect the battery ground cable at the battery.

19. Remove the starter.

20. Remove the fan blade and bracket as an assembly.

21. Remove the radiator.

22. Remove the engine right and left front support to frame bracket bolts.

23. Remove the flywheel or converter housing cover.

24. Remove the flywheel housing or converter housing to engine block and engine rear plate retaining bolts.

25. Disconnect the converter assembly from the flywheel.

26. Loosen the engine right and left rear support capscrews.

27. Remove the engine crankcase ventilation tube.

28. On a truck with an automatic transmission, disconnect the transmission oil cooler inlet and outlet hoses at the engine. Remove the filler tube and drain the transmission.

29. Position a jack under the rear of the transmission and raise the transmission.

30. Attach the engine lifting hook. Swing the rear of the engine toward the right about 30° and manually lift the rear of the engine to clear the engine compartment. Remove the engine through the right door. Install the engine on a work stand.

INSTALLATION

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

2. Lower the engine carefully into the chassis through the right door. 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 converter or flywheel housing.

3. On a truck with an automatic transmission, start the converter pilot into the crankshaft. Remove the retainer securing the converter. Attach the converter to the flywheel. Install

the converter housing to engine block and engine rear plate retaining bolts. Install the converter housing cover plate. Install the automatic transmission filler tube. Connect the transmission oil cooler hoses.

4. On a truck 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 in relation to the engine if the input shaft will not enter the clutch disc. **If the engine "hangs up" after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.** Install the flywheel housing to engine block and engine rear plate retaining bolts. Remove the transmission support.

5. Install the engine front support to the frame bracket, then tighten the nuts to specifications.

6. Remove the engine lifting hook. Remove the jack from the transmission.

7. Tighten and safety wire the engine rear support bolts.

8. Install the fan and bracket. Install and adjust the drive belt.

9. Install the radiator.

10. Remove the cap from the fuel tank line and connect the flexible fuel line.

11. Install the exhaust manifold to muffler inlet pipe retaining lockwashers and nuts. Connect the inlet pipe to engine bracket.

12. Install the carburetor.

13. Install the accelerator bracket assembly and the accelerator retracting spring. Connect all the carburetor linkage and lines.

14. On a truck with a Fordomatic transmission, connect the throttle control rod.

15. Install the starter.

16. Connect the resistor wire and the battery wire to the coil.

17. Connect the engine temperature and oil pressure unit wires.

18. Connect the generator wires and the battery cable.

19. Install the crankcase ventilation tube.

20. Position the engine cover assembly and the engine rear panel assembly. Install the flange of the engine cover rear panel between the frame gussets and the cross member. Remove the wedges.

21. Connect the right side of the engine rear cover panel to the right wheel house panels.

22. Connect the rear flange of the engine rear cover to the frame cross member and the center floor plate front bracket.

23. Connect the headlight beam selector switch wires and the accelerator pedal.

24. Connect the carburetor air intake hose to the air cleaner and the air horn.

25. Install the engine left cover to wheel house panel, the steering column cover plates, and the master cylinder inspection cover.

26. Install the center floor plate over the transmission.

27. Install the driver's seat assembly.

28. Fill and bleed the cooling system.

29. Fill the crankcase with the proper grade and quantity of engine oil.

30. Operate the engine at fast idle and check for coolant and oil leaks.

31. On a truck with an automatic transmission, adjust the transmission control linkage.

3 ENGINE DISASSEMBLY—ENGINE REMOVED

MANIFOLDS

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

2. Remove the carburetor and gaskets.

3. Remove the bolts fastening the manifold assembly to the cylinder head. Lift the manifold assembly from the head. Remove the gaskets and sleeves.

FIG.

4. Remove the nuts and bolt joining the intake and exhaust manifolds, then separate the manifolds.

CYLINDER HEAD

1. Remove the fuel inlet line and the distributor vacuum line as an assembly.

2. Disconnect the high tension lead at the coil. Remove the coil from the cylinder head.

3. Remove the distributor cap and spark plug wires as an assembly.

4. Remove the spark plugs.

5. Remove the valve rocker arm cover.

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

Remove the cap screw from the valve rocker arm shaft support. ove the oil outlet line and et.

8. Loosen all valve rocker arm adjusting screws to remove the valve spring load from the rocker arms. Remove the valve rocker arm shaft assembly.

9. Remove the valve push rods in sequence and identify them so they can be installed in their original positions (Fig. 11).

10. Install the cylinder head holding fixtures for convenience in lifting

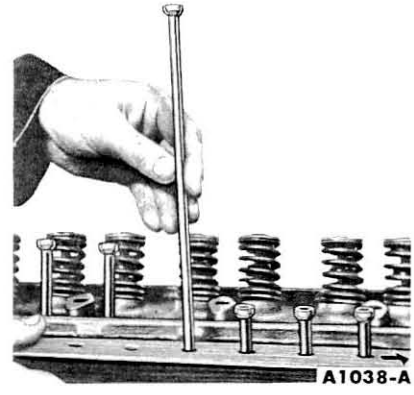


FIG. 11—Push Rod Removal

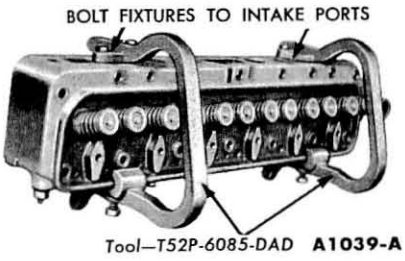


FIG. 12—Cylinder Head Fixtures

the head and to protect the gasket surfaces (Fig. 12).

11. Remove all cylinder head bolts.

12. Install the cylinder head guide studs (Fig. 13).

13. Lift the cylinder head assembly off the engine. **Do not pry between the head and block as the gasket surfaces may become damaged.**

OIL FILTER, FUEL PUMP, AND DISTRIBUTOR

1. Remove the filter assembly and gasket.

2. Remove the fuel pump and gasket.

3. Remove the distributor and intermediate drive shaft.

4. Remove the oil level dipstick. Remove the valve push rod cover.

FLYWHEEL

1. On a flywheel for a manual-shift transmission, mark the pressure plate cover so that it can be replaced in the same position. Remove the clutch pressure plate and cover assembly.

2. Remove the flywheel.

OIL PAN AND OIL PUMP

1. Invert the engine on the work stand.

2. Remove the oil pan. Discard the gasket.

3. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.

CYLINDER FRONT COVER

1. Loosen the generator mounting bolts and disconnect the generator adjusting arm at the water pump. Remove the drive belt(s).

2. Remove the fan and pulley.

3. Remove the generator.

4. Remove the water pump.

5. Remove the cap screw and washer from the end of the crankshaft. Install the puller on the crankshaft damper, then remove the damper (Fig. 14).

6. Remove the cylinder front cover. Discard the gasket.

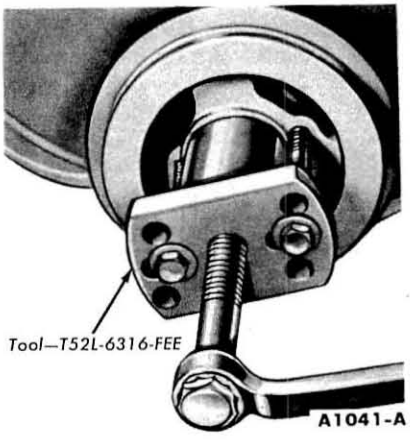


FIG. 14—Damper Removal

TIMING CHAIN AND SPROCKETS

1. Remove the crankshaft front oil slinger.

2. Remove the camshaft sprocket retaining bolt and washer.

3. Slide both sprockets and the timing chain forward and remove them as an assembly.

CONNECTING ROD ASSEMBLIES

1. Turn the engine on the work stand so that the front end is up.

2. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**

3. Make sure all bearing caps (main and connecting rod) are marked so they can be installed in their original locations.

4. Turn the crankshaft until the connecting rod being removed is shown.

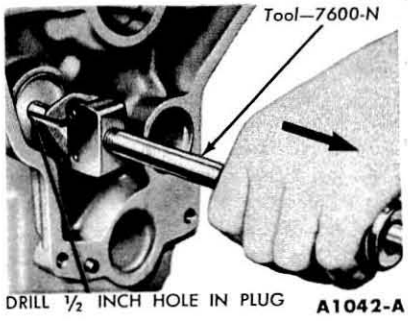


FIG. 15—Camshaft Rear Plug Removal

5. Remove the connecting rod cap.

6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankpin or the cylinder wall when removing the piston and rod.**

7. Remove the bearing inserts from the connecting rods and caps.

CRANKSHAFT

1. Remove the main bearing caps.

2. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**

3. Remove the rear journal oil seal from the block and rear main bearing cap. Remove the cap to block side seals.

4. Remove the main bearing inserts from the block and bearing caps.

CAMSHAFT

1. Turn the engine in the work stand so that the front end is up.

2. Pull all the tappets to the outside of the block to allow clearance for removal of the camshaft.

3. Remove the camshaft thrust plate and spacer.

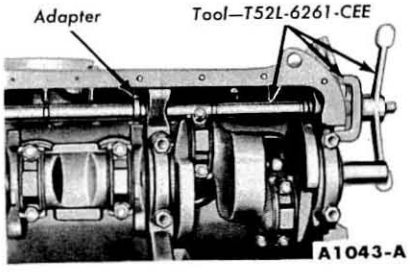


FIG. 16—Camshaft Bearing Replacement

4. Carefully remove the camshaft by pulling it toward the front of the engine. **Use caution to avoid damaging the journals and lobes.**

5. Remove all the tappets keeping them in order so that they can be installed in their original location.

CAMSHAFT BEARINGS

1. Drill a ½-inch hole in the camshaft rear bearing bore plug and remove the plug as shown in Fig. 15.

2. Remove the camshaft bearings (Fig. 16).

4 DISASSEMBLY AND ASSEMBLY OF COMPONENT PARTS

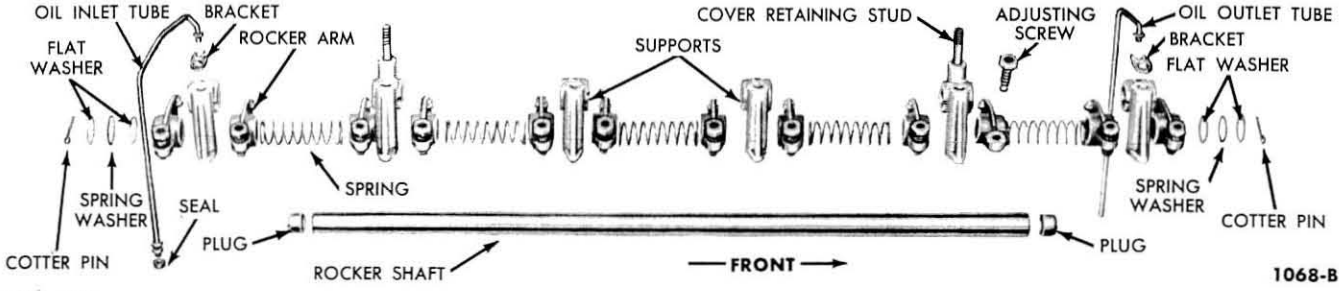


FIG. 17—Valve Rocker Arm Shaft Assembly

VALVE ROCKER ARM SHAFT

DISASSEMBLY

1. Remove the cotter pin from each end of the valve rocker arm shaft. Remove the flat washers and spring washers.

2. Slide the valve rocker arms, springs, and supports off the shaft. Be sure to identify the parts.

3. If it is necessary to remove the plugs from each end of the shaft, drill or pierce the plug on one end. Use a steel rod to knock out the plug on the opposite end. Working from the open end, knock out the remaining plug.

ASSEMBLY

1. Lubricate all parts with engine oil. Apply Lubriplate to the pad of the valve rocker arms.

2. If the plugs were removed from the ends of the shaft, use a blunt tool or large diameter pin punch and install a plug cup side out, in each end of the shaft.

3. Install a flat washer, spring washer, another flat washer, and a cotter pin on one end of the shaft.

4. Install the valve rocker arms, supports, and springs in the order shown in Fig. 17. **Be sure the oil holes in the shaft are facing downward.** Complete the assembly by installing the remaining two flat washers with the spring washers between them and install the cotter pin.

CYLINDER HEAD

DISASSEMBLY

1. Remove deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. **Be careful not to scratch the cylinder head gasket surface.**

2. Compress the valve springs (Fig. 18). Remove the valve retainer locks and release the spring.

3. Remove the sleeve, spring retainer, spring, stem seal, and valve. Discard the valve stem seals. Indentify all valve parts.

ASSEMBLY

1. Lubricate the valve guides and valve stems with engine oil. Apply Lubriplate to the tip of the valve stems.

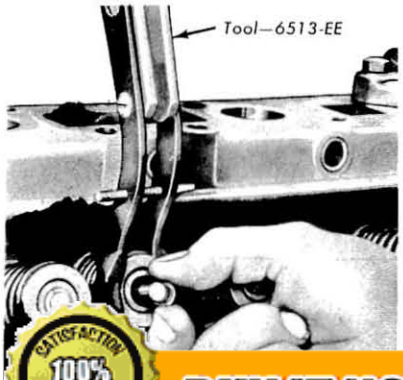
2. Install each valve (Fig. 19) in the valve guide from which it was removed or to which it was fitted. Install a new stem seal on the valve.

3. Install the valve spring assembly over the valve, then install the spring retainer and sleeve.

4. Compress the spring and install the retainer locks (Fig. 18).

5. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 20).

6. Check the dividers against a scale. If the assembled height is



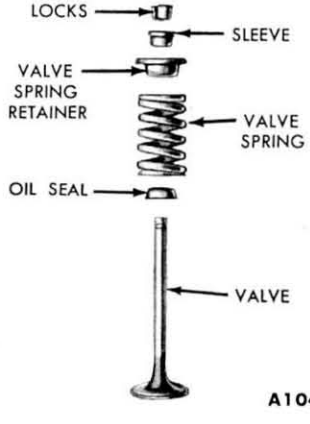


FIG. 19—Valve Assembly

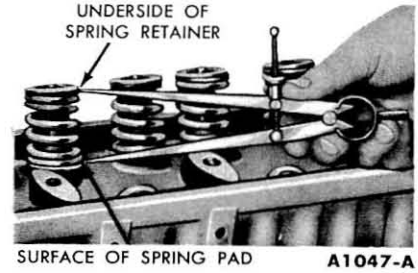


FIG. 20—Valve Spring Assembled Height

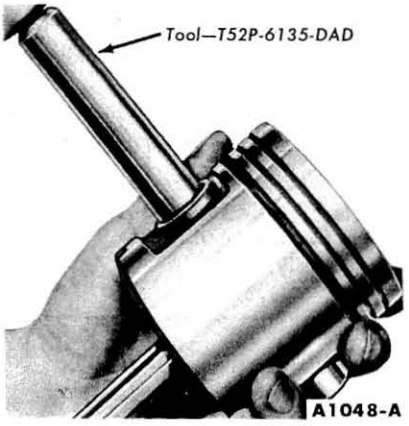


FIG. 21—Piston Pin Removal

greater than $1\frac{25}{32}$ inches, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension of $1\frac{3}{4}$-$1\frac{25}{32}$ inches. **Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs which will lead to excessive load loss and spring breakage.**

PISTONS AND CONNECTING RODS

DISASSEMBLY

1. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.

2. Remove the piston rings. Remove the piston pin retainers. Drive the piston pin out of the piston and rod (Fig 21). Discard the retainers.

ASSEMBLY

The piston, connecting rod, and related parts are shown in Fig. 22.

1. Lubricate all parts with light engine oil.

2. Position the connecting rod in the piston and push the pin into place. **Assemble the piston and connecting rod with the oil squirt hole in the rod and the indentation in the piston positioned as shown in Fig. 23.**

3. Insert new piston pin retainers by spiraling them into position with the fingers. Do not use pliers.

4. Follow the instructions contained on the piston ring package and install the piston rings.

5. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (step 6 under "Fitting Piston Rings" in Part 1-1).

6. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts may distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

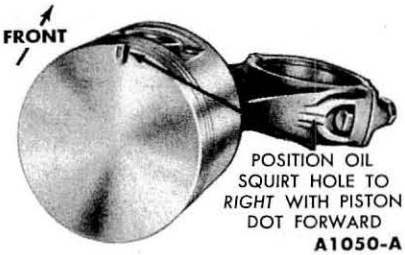


FIG. 23—Oil Hole Position

OIL PUMP

DISASSEMBLY

1. Remove the oil pump cover and the inlet tube assembly and gaskets from the oil pump.

2. Remove the snap wire retaining the screen in the inlet tube assembly and remove the screen.

3. Push the oil pump drive shaft and drive gear assembly from the pump housing. Remove the driven gear.

4. Remove the oil pressure relief

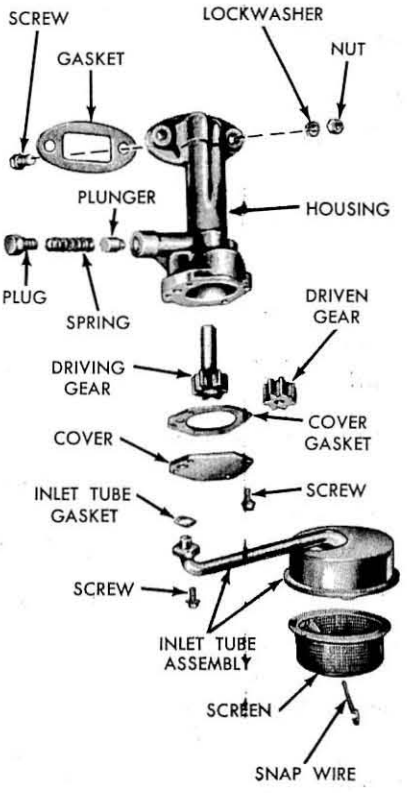


FIG. 24—Oil Pump Assembly

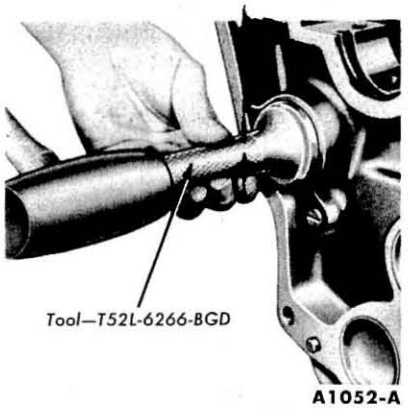


FIG. 25—Camshaft Rear Plug Installation

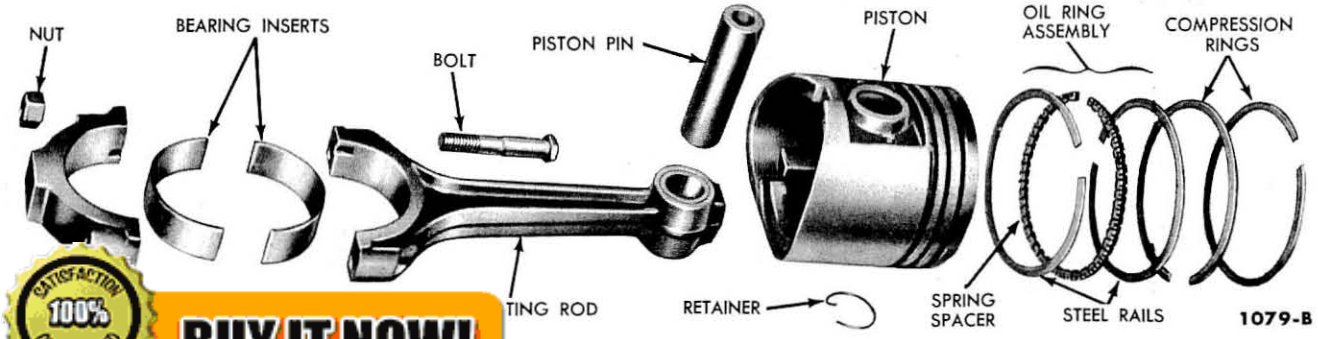


FIG.

valve chamber plug, spring, and plunger.

ASSEMBLY

The oil pump assembly is shown in Fig. 24.

1. Apply a light coat of engine oil to all moving parts.

2. Install the pressure relief valve plunger, spring, and plug. Tighten the plug to specifications.

3. Slide the drive gear and shaft assembly into the housing. Install the driven gear. Check the end play of the gear (Part 1-1).

4. Apply sealer to both sides of the oil pump cover gasket. Position the gasket on the oil pump. Install the oil pump cover.

5. Install the screen in the inlet tube assembly and secure it with the snap wire.

6. Install the inlet tube gasket, and the inlet tube assembly on the oil pump cover. Tighten the retaining screws to specifications. Rotate the pump shaft by hand to make sure it turns freely.

5 ENGINE ASSEMBLY—ENGINE REMOVED

CAMSHAFT BEARINGS

Camshaft bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters. Number 3 bearing is not interchangeable with the other bearings.

1. Position the new bearing at the bearing bore, and press it in place (Fig. 16). Align the oil holes in the bearings with the oil holes in the cylinder block when the bearings are installed. **Be sure the camshaft front bearing is installed 0.005-0.020 inch below the front face of the cylinder block.**

2. Clean out the camshaft rear bearing bore plug recess thoroughly.

3. Coat the flange of a new plug with water resistant sealer and install it with the flange facing out (Fig. 25).

4. Drive the plug in until it is flush or slightly below the casting surface.

TAPPETS

Dip the tappet foot in Lubriplate, then coat the remainder of each valve tappet with engine oil. Install the tappets in their original bores.

CAMSHAFT

The camshaft and related parts are shown in Fig. 26.

1. Oil the camshaft and apply Lubriplate to all lobes. Be sure all the valve tappets are seated. Carefully slide the camshaft through the bearings.

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

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

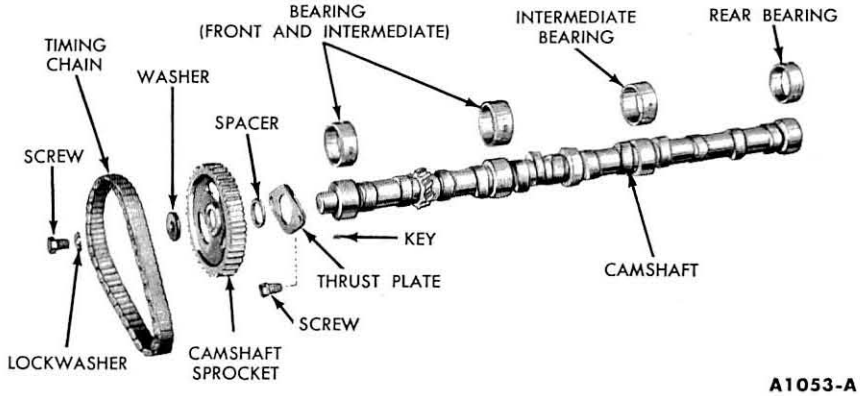
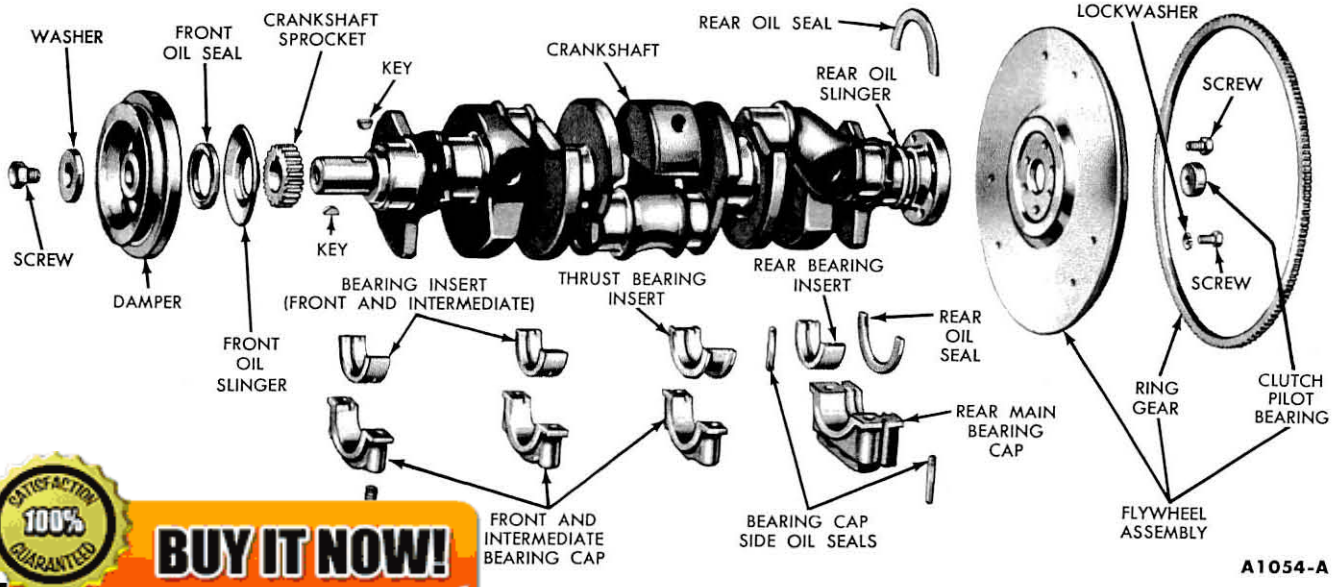


FIG. 26—Camshaft Assembly



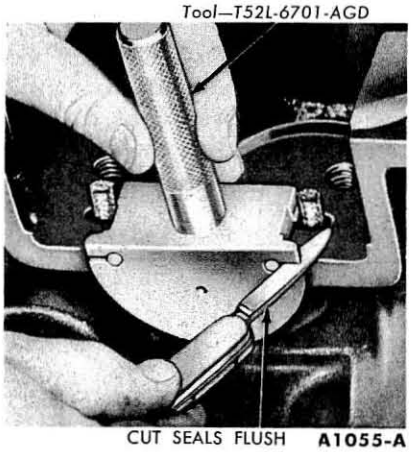


FIG. 28—Oil Seal Installation

4. Temporarily install the camshaft sprocket with the retaining screw tightened to specifications.

5. Push the camshaft toward the rear of the engine.

6. Install a dial indicator so that the indicator point is on the camshaft sprocket retaining screw. Set the dial on zero.

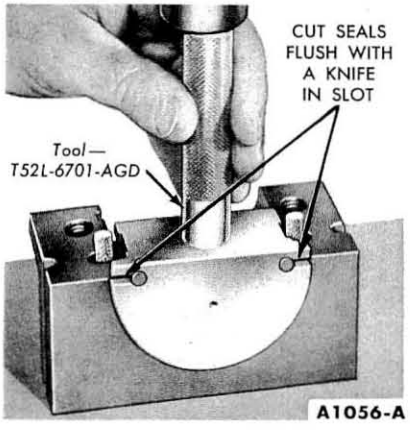


FIG. 29—Oil Seal Installation

7. 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.

8. If the end play is excessive, check the spacer for correct installation. Replace the thrust plate and/or spacer if necessary.

9. Remove the dial indicator and the camshaft sprocket.

CRANKSHAFT

The crankshaft and related parts are shown in Fig. 27.

1. Be sure that the rear journal oil seal grooves are clean. Install a new rear journal oil seal in the block (Fig. 28) and rear main bearing cap (Fig. 29). After installation, cut the ends of the seals flush.

2. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts may distort the bearing and cause a failure.

Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

3. Install the lower main bearing inserts in the bearing caps.

4. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**

5. Check the clearance of each main bearing following the procedure under "Main Bearing Replacement" in Part 1-1.

6. If the bearing clearances are satisfactory, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). **Main bearing caps are numbered 1 thru 4 starting at the front of the engine. The arrows on the cap should be pointed toward the front of the engine.** Tighten the bearing cap bolts to specifications.

7. Install the thrust bearing cap with the bolts finger tight.

8. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 30).

9. Hold the crankshaft forward and pry the thrust bearing cap to the rear (Fig. 30). This will align the thrust surfaces of both halves of the bearing.

10. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications (Fig. 30).

11. Force the crankshaft toward the rear of the engine.

12. Install a dial indicator so the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Fig. 31).

13. Set the dial on zero. Push the crankshaft forward and note the reading on the dial.

14. If the end play exceeds the wear limit, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or foreign matter. If the thrust faces are not defective, they probably were not aligned properly. Install the thrust bearing and align the faces following the recommended procedure (steps 7, 8, 9 and 10), then recheck the end play.

15. Dip the rear bearing cap side seals in light engine oil, then immediately install them in the grooves.

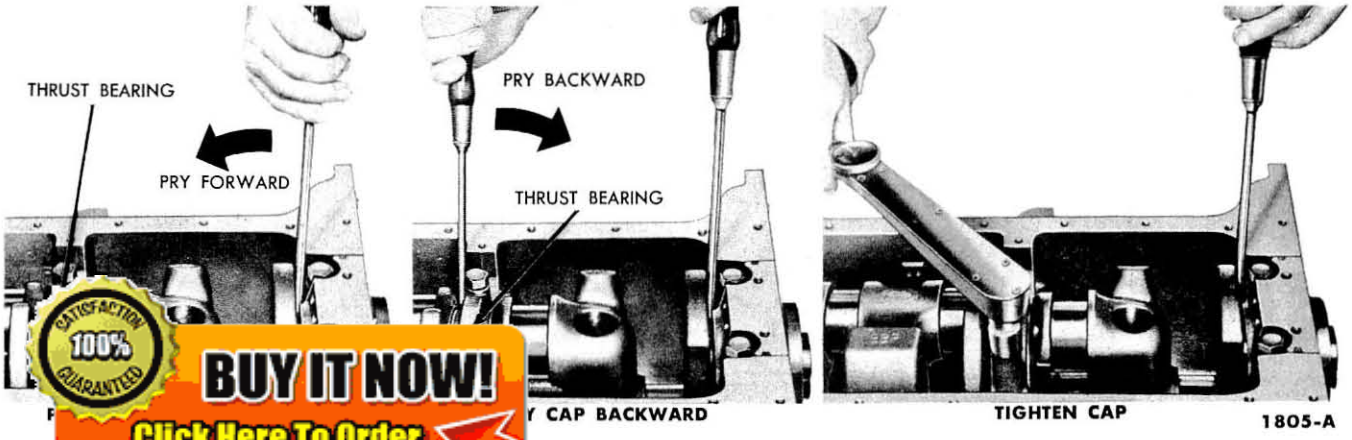


FIG. [illegible]

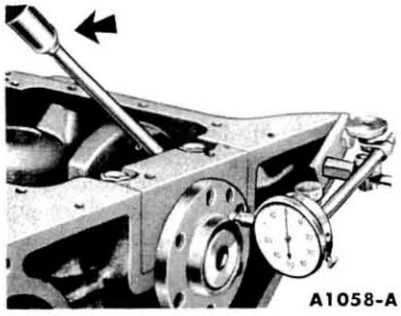


FIG. 31—Crankshaft End Play

Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion. It may be necessary to tap the seals into place for the last ½ inch of travel. Do not cut the seal projecting ends.

16. Check the rear bearing cap side seals for leaks by squirting a few drops of oil into the parting lines between the bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. **This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.**

CONNECTING ROD ASSEMBLIES

1. Turn the engine on the workstand so that the front end is up.

2. Oil the piston rings, pistons, and cylinder walls with light engine oil.

3. Be sure to install the pistons in the same cylinders from which they were removed, or to which they were fitted. The connecting rod and bearing cap are numbered from 1 to 6 beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

4. Make sure the ring gaps are properly spaced around the circumference of the piston.

5. Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 32). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. **Install the piston with the indentation in the piston head toward the front of the engine.**

FIG. 33—Checking Side Clearance

6. Check the clearance of each bearing following the procedure under "Connecting Rod Bearing Replacement" in Part 1-1.

7. If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearings.

8. Turn the crankshaft throw to the bottom of its stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

9. Install the connecting rod cap, then tighten the nuts to specifications.

10. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal (Fig. 33).

TIMING CHAIN AND SPROCKETS

1. Lubricate the timing chain and rockets with engine oil. Place the ys in position in the slots on the nkshaft and camshaft.

F

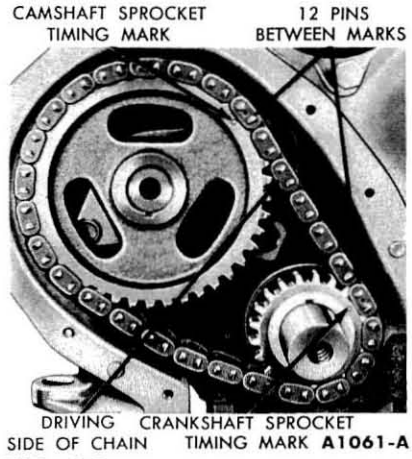


FIG. 34—Aligning Timing Marks

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. 34. There are 12 timing chain link pins between the timing marks on the sprockets.

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

4. Establish a reference point on the block and measure from this point to the chain (Fig. 35).

5. Rotate the crankshaft in the opposite direction to take up the slack on the right side of the chain. 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.

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

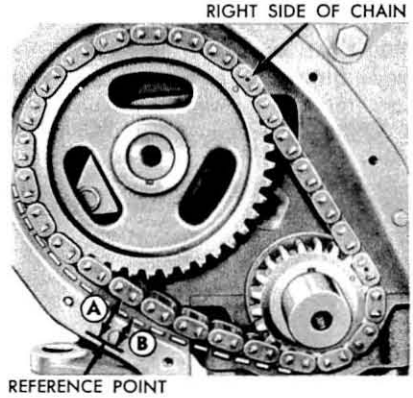


FIG. 35—Timing Chain Deflection

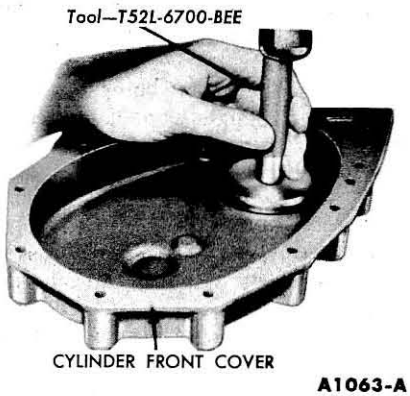


FIG. 36—Front Seal Installation

7. Install the camshaft sprocket cap screw and washers. Install the crankshaft front oil slinger.

CYLINDER FRONT COVER AND FRONT OIL SEAL

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. Clean out the recess in the cover.
2. Coat a new seal with grease. Install the seal (Fig. 36).
3. Drive the seal in until it is fully seated in the recess.
4. After installation, check to be sure the spring is properly positioned in the seal.

CYLINDER FRONT COVER INSTALLATION

1. Clean the cylinder front cover and the gasket surface of the cylinder block.
2. Coat the gasket surface of the block and the cover with sealer. Position a new gasket on the block.
3. Place the cover on the block and install the retaining screws. Tighten the screws to specifications.
4. Lubricate the crankshaft with a white lead and oil mixture and lubricate the oil seal rubbing surface with grease.
5. Line up the damper keyway with the key on the crankshaft.
6. Install the damper on the crankshaft (Fig. 37).
7. Install the water pump and generator.
8. Install the fan and pulley.
9. Install and adjust the drive belt.

OIL PAN AND OIL PUMP

1. Invert the engine on the work stand.
2. Place a new gasket on the oil pump retaining bolts. Slide the pump mounting flange over the retaining bolts and install the lockwashers and nuts.
3. Make sure the gasket surfaces of the block and oil pan are clean and free from burrs.
4. Coat the block surface and oil pan gasket surface with sealer and position the gasket on the block.
5. Position the oil pan on the block. Install the retaining screws, then tighten the screws from the center outward in each direction to specifications.

FLYWHEEL

1. Position the flywheel on the crankshaft and install the retaining bolts. Tighten the bolts to specifications.
2. On a flywheel for a manual-shift transmission, use tool 7563 to locate the clutch disc, then install the pressure plate. Tighten the retaining bolts to specifications.

OIL FILTER, FUEL PUMP, AND DISTRIBUTOR

1. Cement a new gasket to the valve push rod cover. Install the cover. Install the oil level dipstick.
2. Using a new gasket, install the fuel pump.
3. Rotate the crankshaft damper until No. 1 piston is on T.D.C. at the end of the compression stroke.
4. Position the distributor and intermediate drive shaft into the block ...e rotor at the No. 1 firing posi... ...nd the breaker points open. ... the hold down clamp. **...e sure the oil pump intermedi... ...ve shaft is properly seated in ... ...mp. It may be necessary to reposition the intermediate shaft in order to engage it in the oil pump.**
5. Make sure the two elongated holes in the oil filter anti-drain back diaphragm are in the up position.
6. Clean the cylinder block oil filter recess, then install a new gasket.
7. Install the oil filter assembly following the procedure under "Oil Filter Replacement" in Section 6.

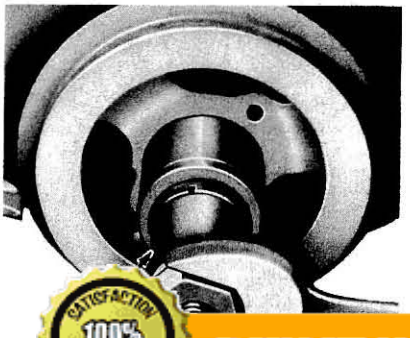


FIG. 3...

CYLINDER HEAD

1. Clean the head and block gasket surfaces.
2. Inspect the head for any damage and repair as necessary.
3. Apply cylinder head gasket sealer to both sides of a new gasket. Position the gasket over the guide studs on the cylinder block.
4. Lift the cylinder head over the guides and slide it down carefully.
5. Before installing the cylinder head bolts, coat the threads of the left bolts with a small amount of water resistant sealer.
6. 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, then install the remaining bolts.
8. Remove the cylinder head holding fixtures.
9. The cylinder head bolts are tightened in three progressive steps. Follow the sequence shown in Fig. 38. Tighten the bolts to 55 foot-pounds torque, then tighten them to 65 foot-pounds torque. Finally, tighten the bolts to 75 foot-pounds torque. **After the cylinder head bolts have been tightened to specifications, the bolts should not be disturbed.**
10. Lubricate both ends of the push rods with engine oil. Install the push rods in their proper sequence, positioning the lower end of the rods in the tappet sockets.
11. Position the valve rocker arm shaft assembly on the head. **Be sure the oil holes in the shaft are facing downward.**
12. Install the oil outlet line, bracket, and retaining screw on the

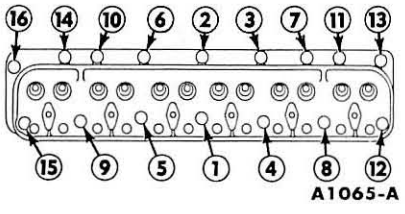


FIG. 38—Cylinder Head Bolt Tightening Sequence

No. 1 support. Make sure the oil line enters the shaft locating hole.

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

14. Tighten all the valve rocker arm shaft retaining bolts to specifications.

15. Perform a preliminary valve lash adjustment (Part 1-1). The final valve lash adjustment is made with the engine installed in the truck.

16. Install the spark plugs.

17. Install the distributor cap and spark plug wire assembly. Connect the spark plug wires.

18. Install the coil on the cylinder head and connect the coil high tension lead.

MANIFOLDS

1. Place the intake manifold over the studs on the exhaust manifold.

2. Install the lockwashers, nuts and bolt tightening them finger tight.

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

4. Coat the mating surfaces lightly with graphite grease.

5. 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.**

6. Install the attaching washers and bolts. Tighten the bolts to specifications, tightening them from the center to the ends. Tighten the bolt and nuts joining the intake and exhaust manifolds to specifications.

7. Position the carburetor gasket on the intake manifold. Install the carburetor.

8. Position the carburetor fuel inlet line and the distributor vacuum line on the engine. Connect the fuel inlet line at the fuel pump and at the carburetor. Connect the distributor vacuum line at the distributor and at the carburetor.

6 REPAIR OPERATIONS—ENGINE INSTALLED

ENGINE SUPPORTS

The engine front supports are located on each side of the crankcase (Fig. 39) and the engine rear supports are located on each side of the flywheel housing (Fig. 40).

ENGINE FRONT SUPPORTS

Removal

1. Remove the nut, washer, bolt, and lower insulator from each front support.

2. Raise the front of the engine and remove the upper insulators.

Installation

1. Place the upper insulator in position on each frame bracket. Lower the engine.

2. Install the lower insulator, bolt, washer, and nut on each side of the engine. Tighten the bolts to specifications.

ENGINE REAR SUPPORTS

Removal

1. Remove the nut, bolt, lower insulator, and spacer from each rear support.

2. Raise the rear of the engine, then remove the upper insulators.

Installation

1. Place a new upper insulator into position on each side of the engine. Lower the engine.

2. Install the spacer, the lower insulator, bolt, and nut on each side of the engine. Tighten the bolts to specifications.

MANIFOLDS

REMOVAL

1. Remove the air cleaner (and flex hose as an assembly on a P-Series truck). Then tape the carburetor air horn closed.

2. On a truck 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 truck with a manual-shift transmission, disconnect the accelerator retracting spring and the accelerator rod assembly at the bellcrank.

4. Disconnect the vacuum line at the intake manifold.

5. Disconnect the choke control ble.

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

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

8. Remove the bolts fastening the manifold to the head and lift the manifold assembly from the head. Remove the gaskets and sleeves.

9. Remove the nuts and bolt joining the intake and exhaust manifolds, then separate the manifolds.

INSTALLATION

The manifold assembly is shown in Fig. 41.

1. 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.

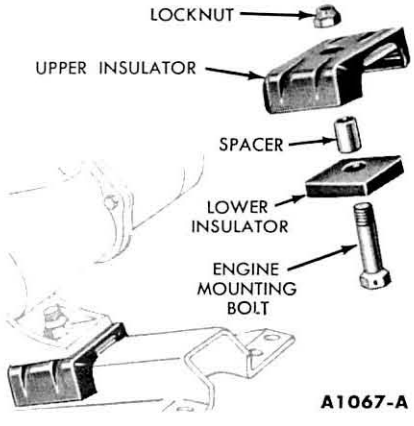


FIG. 40—Engine Rear Supports

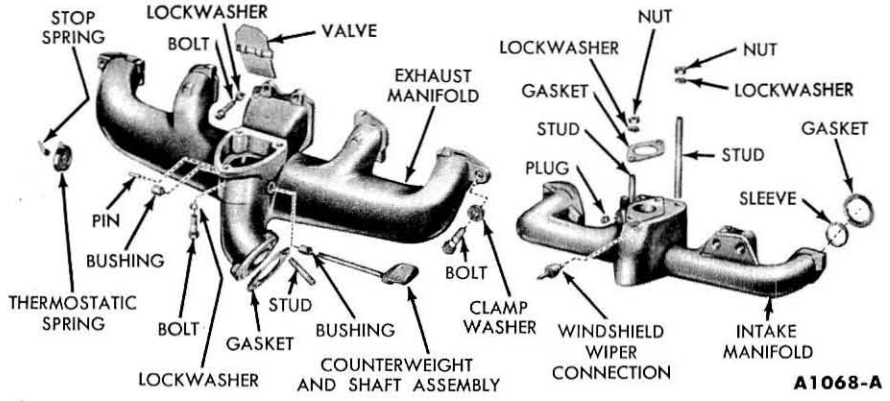


FIG. 41—Manifold Assembly

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 cylinder head and that none of the gaskets have become dislodged.**

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

6. Tighten the bolt and nuts joining the intake and exhaust manifolds.

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

8. Position the carburetor gaskets on the intake manifold. Install the carburetor.

9. Connect the vacuum line to the intake manifold. Connect the choke control cable.

10. Connect the fuel inlet line and and the distributor vacuum line to the carburetor.

11. On a truck with an automatic transmission, install the accelerator retracting spring bracket. Connect the spring. Connect the accelerator assembly connecting link and the throttle control rod. Adjust the transmission control linkage.

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

13. Remove the tape from the carburetor air horn. Install the air cleaner (and connect the flex hose on a P-Series truck).

EXHAUST GAS CONTROL VA[illegible]ACEMENT

loc[illegible]
man[illegible]

quire replacement unless it becomes inoperative due to excessive corrosion or damage.

1. Remove the manifold assembly following the procedure in this section. Separate the intake and exhaust manifolds.

2. Before removing the control valve assembly, note the position of the counterweight in relation to the 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 penetrating 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 [illegible] to check for a binding condition. [illegible]. If there is no binding, weld the [illegible] to the shaft in the original man[illegible] 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.

16. Install the manifold assembly following the procedure in this section.

CYLINDER HEAD

REMOVAL

1. Drain the cooling system. Remove the air cleaner (and flex hose as an assembly on a P-Series truck). Tape the carburetor air horn closed.

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

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

4. Remove the carburetor fuel inlet line and the distributor vacuum line as an assembly.

5. 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 spark plug wire assembly.

6. Remove the spark plugs.

7. On a truck with an automatic transmission, disconnect the throttle control rod and the accelerator assembly connecting link at the accelerator bracket. Disconnect the accelerator retracting spring at the block mounted bracket. Remove the bracket.

8. On a truck with a manual-shift transmission, disconnect the accelerator retracting spring and the accelerator rod assembly at the bellcrank.

9. Disconnect the flexible fuel line at the fuel tank line and install a cap on the fuel tank line.

10. Disconnect the choke control cable at the carburetor.

11. Remove the valve rocker arm cover. Remove the valve rocker arm shaft assembly.

12. Remove the valve push rods in sequence (Fig. 11).

13. Remove the manifold to cylinder head bolts. Pull the manifold assembly away from the cylinder head. Brace the assembly so the muffler inlet pipe will not be damaged.

14. Install the cylinder head holding fixtures for convenience in lifting the head and to protect the gasket surfaces (Fig. 12).

15. Remove all cylinder head bolts. Install the cylinder head guide studs (Fig. 13).

16. Lift the cylinder head assembly off the engine. **Do not pry between the head and block as the gasket surfaces may become damaged.**

INSTALLATION

1. Clean the head and block gasket surfaces.

2. Apply cylinder head gasket sealer to both sides of a new gasket. Position the gasket over the guide studs on the cylinder block.

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

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

5. Remove the guides, then install the remaining bolts. Remove the cylinder head holding fixtures.

6. The cylinder head bolts are tightened in three progressive steps. Follow the sequence shown in Fig. 38. Tighten the bolts to 55 foot-pounds torque, then tighten them to 65 foot-pounds torque. Finally, tighten the bolts to 75 foot-pounds torque.

7. 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.

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

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

10. Install a new O-ring seal on the l[illegible]nd of the oil inlet line. Po[illegible]e in the No. 6 support. M[illegible] o[illegible] bra[illegible]

1[illegible] arm[illegible]

tions. Perform a preliminary valve lash adjustment.

12. Connect the choke control cable.

13. 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.

14. On a truck with an automatic transmission, install the accelerator retracting spring bracket on the block. Connect the spring. Connect the throttle control rod and the accelerator assembly connecting link.

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

16. Install the ignition coil, spark plugs, and the distributor cap.

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

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

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

20. Connect the heater hose and the radiator upper hose. Fill and bleed the cooling system.

21. 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").**

22. 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.

23. On a truck with an automatic transmission, adjust the transmission control linkage.

24. Install the air cleaner (and connect the flex-hose on a P-Series truck).

CRANKSHAFT DAMPER

REMOVAL

1. Drain the cooling system. Remove the radiator.

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

[illegible] On a truck with power steering, [illegible]ve the power steering pump [illegible] belt. Remove the power steering [illegible]p pulley from the crankshaft [illegible]er.

4. Remove the cap screw and washer from the end of the crankshaft. Remove the damper (Fig. 14).

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. 37).

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

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

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

6. Install the radiator. Fill and bleed the cooling system.

CYLINDER FRONT COVER AND TIMING CHAIN

REMOVAL

1. Drain the crankcase. Remove the crankshaft damper and related parts as outlined in this section.

2. Disconnect the heater hose and the generator adjusting arm from the water pump. Remove the water pump.

3. Remove the oil level dip stick, crankcase ventilation tube, flywheel housing inspection cover, and the oil pan.

4. Remove the screws fastening the cylinder front cover to the block. Remove the cover and gasket.

5. Remove the crankshaft front oil slinger. Crank the engine until the timing marks on the sprockets and chain are positioned as shown in Fig. 34.

6. Remove the camshaft sprocket retaining bolt and washer.

7. Slide both sprockets and timing chain forward and remove them as an assembly.

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. 34.

3. Install the camshaft sprocket cap screw and washer.

4. Install the crankshaft front oil slinger.

5. Replace the crankshaft front oil seal.

6. Clean the cylinder front cover and the gasket surface of the cylinder block.

7. Coat the gasket surface of the block and cover with sealer. Position a new gasket on the block. Place the cover on the block and install the retaining screws.

8. Install the water pump.

9. Install the damper and related parts following the procedure in this section.

10. Install the oil pan, flywheel housing inspection cover, crankcase ventilation tube, and the oil level dip stick.

11. Connect the generator adjusting arm, heater hose, and battery ground wire.

12. 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 the timing chain and sprockets following the procedures in this section.

2. Remove the air cleaner. Tape the carburetor air horn closed.

3. Remove the valve rocker arm cover. Remove the valve rocker arm shaft assembly. Remove the valve push rods in sequence.

4. Disconnect the primary wire and the high tension wire at the coil.

5. Remove the vacuum line and primary wire at the distributor.

6. Remove the distributor cap and the spark plug wire assembly.

7. Remove the valve push rod cover.

8. Remove the fuel pump and the distributor.

9. Turn the camshaft until the tappets can be lifted with either a magnet (Fig. 42), or the finger. Raise the tappets clear of the camshaft lobes and secure them with spring-type clothes pins or window regulator spring clips (Figs. 42 and 43).

10. Carefully remove the camshaft by pulling it toward the front of the engine. **Use caution to avoid damaging the camshaft bearings.**

Magnetic Tappet Lifter

FI

INSTALLATION

1. Oil the camshaft and apply Lubriplate to all the lobes.

2. Carefully slide the camshaft through the bearings.

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

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

5. Install the timing chain and sprockets, cylinder front cover, and the crankshaft damper and related parts following the procedures in this section.

6. Install the oil pan, flywheel housing cover, crankcase ventilation tube, and the oil level dipstick.

7. Release the tappets. Install the push rods. Install the valve rocker arm shaft assembly.

8. Perform a preliminary valve lash adjustment.

9. Cement a new gasket to the valve push rod cover. Install the cover and ignition wiring clip.

10. Install the fuel pump and connect the fuel lines and vacuum line.

11. Crank the engine until the No. 1 piston is on T.D.C. after the compression stroke.

12. Position the distributor in the block with the rotor at the No. 1 firing position and the breaker points open. Install the distributor hold down clamp.

13. Connect the distributor primary wire and the vacuum line.

14. Install the distributor cap, and connect the spark plug wires and the coil high tension lead.

15. Remove the tape from the carburetor air horn.

16. Fill and bleed the cooling system. Fill the crankcase.

17. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

18. Make a final valve lash adjustment with the engine idling. Install valve rocker arm cover. Install air cleaner (and connect the flex on a P-Series).

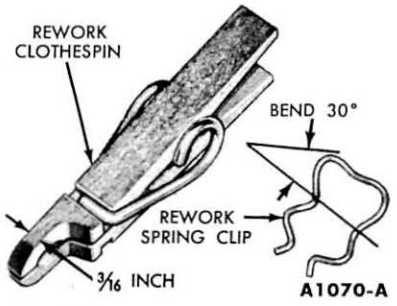


FIG. 43 – Valve Tappet Retainers

TAPPET REPLACEMENT

1. Remove the camshaft and related parts following the procedure in this section.

2. Remove and install one tappet at a time through the bottom of the block. Apply Lubriplate to each tappet foot, then coat the remainder of each tappet with engine oil before installation. A flexible-type holding tool can be used if desired. As each tappet is installed, secure it in the up position.

3. After the tappets are installed, install the camshaft and related parts.

FLYWHEEL

REMOVAL

1. Disconnect the transmission from the engine and slide it to the rear as outlined in Group 5 (manual-shift transmission) or Group 6 (automatic transmission).

2. On a manual-shift transmission, remove the pressure plate and cover assembly as outlined in Group 5.

3. Remove the flywheel retaining bolts and remove the flywheel.

INSTALLATION

1. Position the flywheel on the crankshaft flange and install the mounting bolts. Tighten the bolts in sequence across from each other to specifications.

2. On a manual-shift transmission, install the clutch disc and the pressure plate and cover assembly as outlined in Group 5.

3. Connect the transmission to the engine as outlined in Group 5 (manual-shift transmissions) or Group 6 (automatic transmissions).

OIL FILTER REPLACEMENT

The oil filter assembly is shown in Fig. 44.

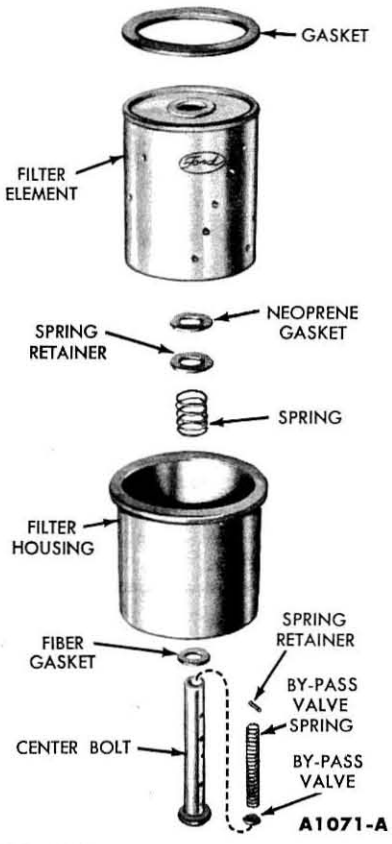


FIG. 44—Oil Filter Assembly

1. Place a drip pan under the filter. Remove the filter center bolt, then remove the filter assembly and gasket.
2. Remove the filter element, neoprene gasket, spring and seat, then remove the center bolt from the container and the fiber gasket from the bolt. Discard the filter element and all gaskets.
3. Wash all parts in solvent. Make sure all openings in the center bolt are clean.
4. Install the new filter element in the housing following the instructions furnished with the new element.
5. Make sure the two elongated holes in the oil filter anti-drain back diaphragm are in the up position (Fig. 45).
6. Clean the cylinder block filter recess, then install a new gasket.
7. Place the filter assembly in position, and thread the center bolt into the adapter finger-tight.
8. Rotate the filter assembly slightly, in each direction, to make sure the gasket is seated evenly.
9. Tighten the center bolt to specifications. **Do not over tighten the center bolt.**
10. Add oil to the crankcase if necessary. Operate the engine at fast idle and check for oil leaks.

OIL PAN AND OIL PUMP

OIL PAN REMOVAL

1. Drain the crankcase. Remove the oil level dipstick and the flywheel housing inspection cover. Remove the crankcase vent tube.
2. Remove the oil pan retaining screws and remove the pan and gasket.

OIL PUMP REMOVAL

1. Rotate the crankshaft to obtain the proper clearance between the crankshaft counterweights and the oil pump.
2. Identify the position of the distributor and rotor. Loosen the distributor and rotate it ¼ turn to disengage it from the oil pump.
3. Remove the two nuts and lockwashers retaining the oil pump to the cylinder block, then remove the pump and gasket.
4. Thoroughly clean the old gasket material from the mounting pad on the block and pump.

FIG. 45—Diaphragm Position

OIL PUMP INSTALLATION

1. Place a new gasket on the retaining bolts. Slide the pump mounting flange over the retaining bolts, and install the lockwashers and nuts. Tighten the nuts to specifications.
2. Using the identification marks as guides, install the distributor.

OIL PAN INSTALLATION

1. Make sure the gasket surfaces of the block and oil pan are clean and free from burrs. Coat the block surface and oil pan gasket surface with sealer. Position the gasket on the oil pan.
2. Hold the oil pan in place against the block and install a screw, finger tight, at each end of the oil pan. Install the remaining screws. Tighten the screws from the center outward in each direction to specifications.
3. Install the flywheel housing inspection cover, the oil level dipstick, and the crankcase vent tube.
4. Fill the crankcase with the proper grade and quantity of engine oil. Operate the engine and check for oil leaks.

PART 1-3 292 MD AND HD V-8 ENGINES

1 DESCRIPTION

The 292 MD (Medium Duty) and HD (Heavy Duty) V-8 engines (Figs. 1, 2, and 3) have the same basic design. The differences between the engine models and their applications are listed in Table 1.

MANIFOLDS

The intake manifold contains a passage through the center section and under the carburetor, through which hot exhaust gases are directed to assist in vaporizing the incoming fuel charge.

On the 292 MD V-8 engine, the exhaust gases are directed into the intake manifold by a thermostatically controlled exhaust valve (Fig. 4). The valve is located between the crossover pipe and the inlet of the right exhaust manifold. When the valve is in the closed (heat on) position, part of the exhaust gases are directed from the left exhaust manifold, through the heat riser passage, to the right exhaust manifold (Fig. 5). When the valve opens (heat off), more of the exhaust gases from the left manifold are permitted to flow directly out of the exhaust system in the normal manner.

The HD V-8 engine does not have an exhaust gas control valve.

The intake manifold has two sets of fuel passages, each with its own separate inlet connection to the carburetor (Fig. 6). The right barrel(s) of the carburetor feeds Nos. 2, 3, 5, and 8 cylinders, and the left barrel(s) feeds Nos. 1, 4, 6, and 7 cylinders.

The HD V-8 engine, when installed in a C-Series truck, has ram's horn exhaust manifolds. These mani-

FIG. 1—HD V-8 Engine

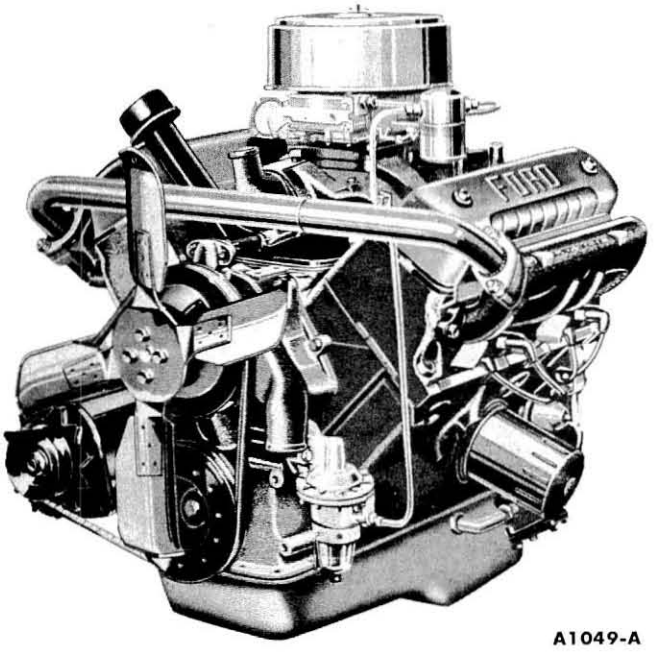


FIG. 2—HD V-8 Engine

TABLE 1—Engine Model Application

Patent Plate Code	Prefix	Engine	Compression Ratio	Carburetor	Governor	Distributor	Truck Model Application
C	EEH EEJ	292 MD V-8	7.9:1	2-Barrel	Velocity*	Dual Advance	C-550, 600; F-, B-, C-, T-700; P-Series; F-100 thru 600; B-500, 600*
D	EEK	292 HD V-8	7.6:1	4-Barrel	Vacuum	Centrifugal Advance	F-, B-, C-, T-700;* C-500,* 600;* F-, B-500,* 600*

*Optional.

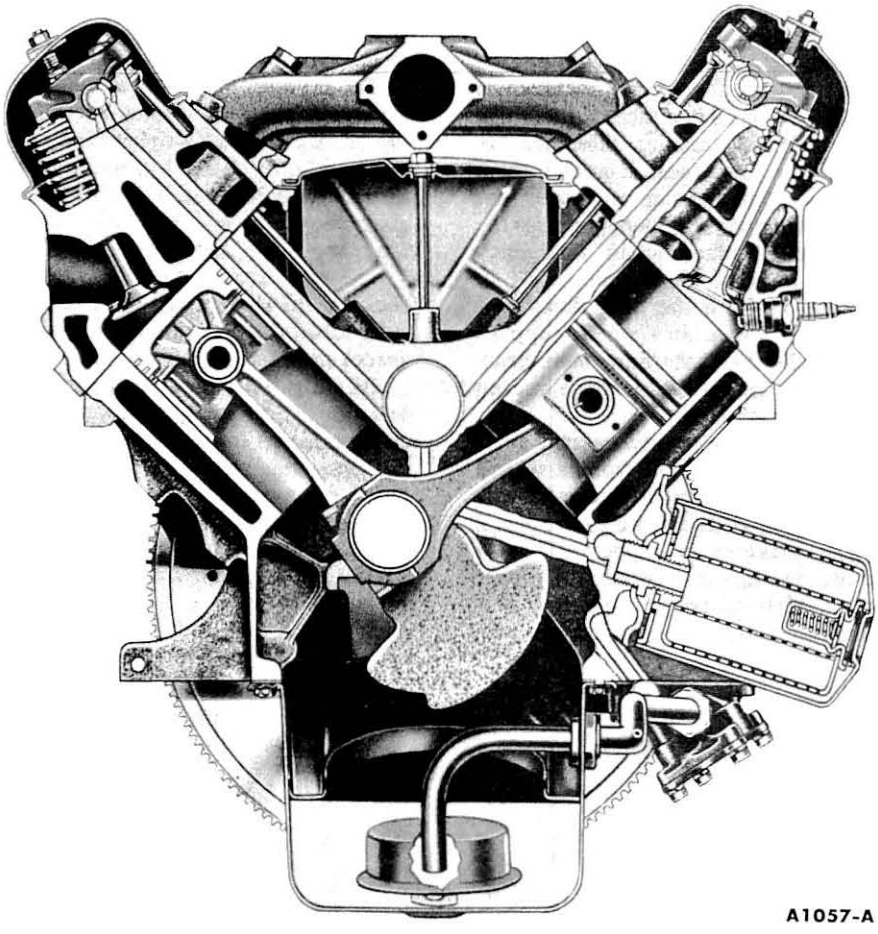


FIG. 3—Engine Sectional

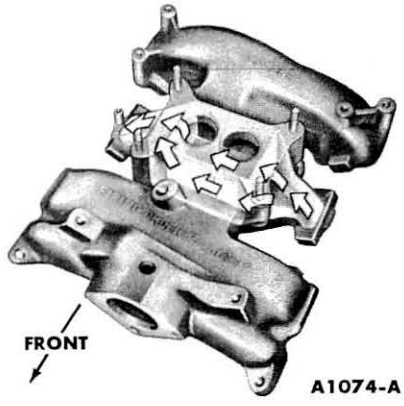


FIG. 5—Exhaust Gas Passage

CYLINDER BLOCK

The cylinders are numbered from front to rear on the right bank 1, 2, 3, 4 and on the left bank 5, 6, 7, 8. The firing order is 1-5-4-8-6-3-7-2.

The oil pump is mounted externally on the left rear of the block. The distributor is located on the top of the engine at the right rear. It drives the oil pump through an intermediate drive shaft.

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

folds are interchangeable between either side of the engine.

The HD V-8 engine when installed in a B-, F-, or T-Series truck has conventional exhaust manifolds.

CYLINDER HEADS

The cylinder head assemblies contain the valves and the valve rocker arm shaft assembly. Valve guides are integral part of the head. The exhaust valve seats of the HD V-8 engines are the insert type. The valves are arranged from front to rear on banks E-I-I-E-E-I-I-E.

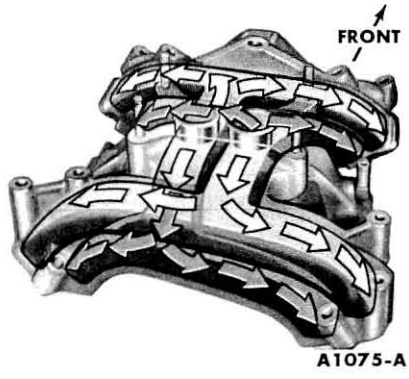


FIG. 6—Fuel Passages

The top compression ring of the piston 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 used in the MD V-8 engine and the intake valves of the HD V-8 engine are the rotating-type. Sodium cooled, free turning exhaust valves are used in the HD V-8 engine.

Easy maintenance of valve lash is afforded by self locking adjusting screws.

The camshaft is supported by five bearings pressed into the block.

The camshaft is driven by a sprocket and timing chain in mesh with a sprocket on the crankshaft. A single strand chain is used on the MD V-8 engine and a double strand chain is used on the HD V-8 engine.

LUBRICATION SYSTEM

Oil from the oil pan sump is forced through the pressure-feed lubrication system (Fig. 7) by a rotor 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.

A by-pass provides oil to the engine in case the filter element becomes clogged. The by-pass is located in the hollow center bolt of the filter and consists of a spring loaded valve. When the element is clean and oil will flow through it, the pressure difference between the inner and outer faces of the valve is not great enough to overcome the spring pressure behind the valve. Therefore, no oil flows through the by-pass. When the element is dirty and will not permit sufficient flow of oil, the pressure acting on the inner face of the valve drops. If the pressure difference between the valve faces is great enough to overcome spring pressure, the valve will open. Oil then by-passes the element, maintaining an emergency supply of oil to the engine.

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

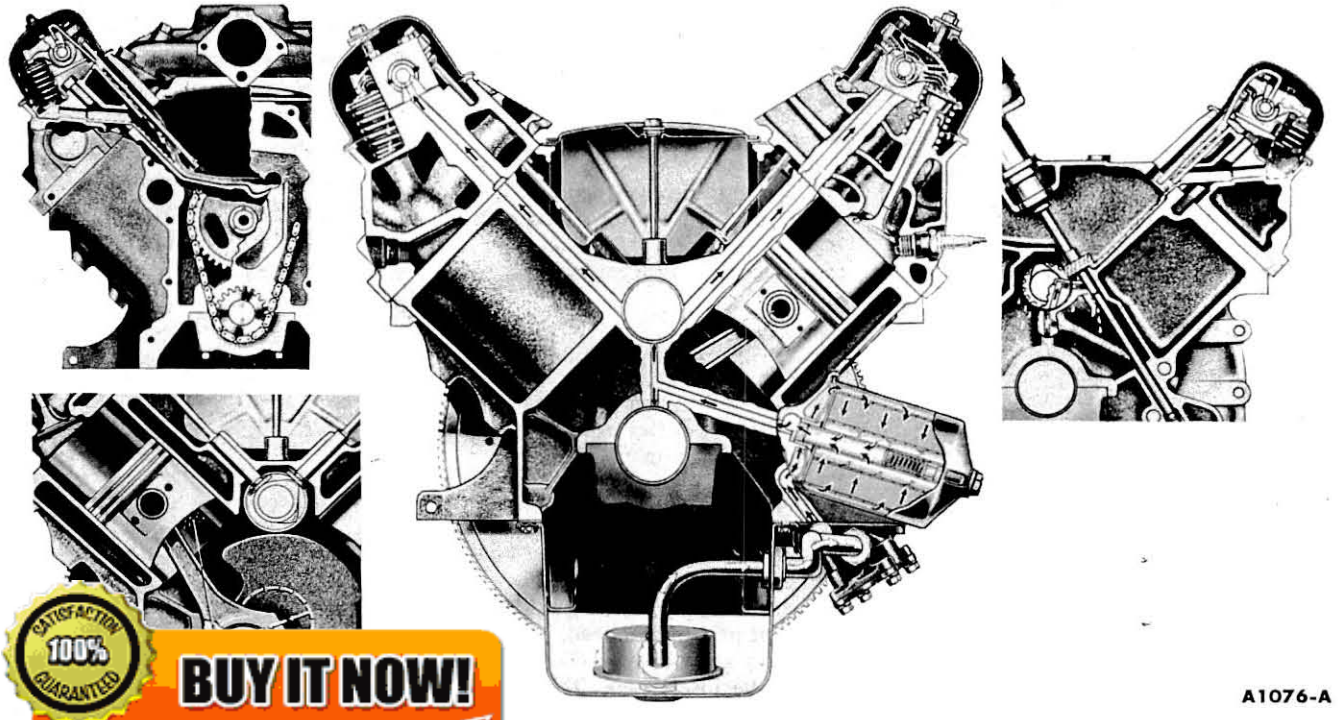
The right valve rocker arm shaft assembly receives oil from a drilled passage at the No. 3 camshaft bearing. The oil is directed into the No. 2 valve rocker arm support. The oil from the support flows into the rocker shaft. Metered holes in the shaft permit lubrication of each rocker arm shaft bore and the valve and ball joint ends of the rocker arms. The excess oil spirals down the rotating push rods. The left valve rocker arm shaft assembly is similarly lubricated from the No. 3 camshaft bearing via the No. 3 valve rocker arm support. The oil from each rocker arm drains into the push rod chamber through holes in the cylinder heads. In addition, each rocker arm shaft has an overflow tube which exhausts excess oil into the push rod chamber. The overflow tubes are located at the front of the right cylinder head and at the rear of the left cylinder head.

The oil from the left valve rocker arm shaft assembly drains back into the oil pan through a hole at the rear of the block. This oil lubricates the distributor drive gear. The distributor shaft bushing is lubricated by oil from the No. 5 camshaft bearing.

The oil from the right valve rocker arm shaft assembly overflow tube lubricates the timing chain and sprockets.

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

Connecting rod bearings are lubricated by passages drilled from the crankshaft main journals to the connecting rod journals of the crankshaft. Cylinder walls are lubricated by oil sprayed from a hole drilled in each connecting rod.



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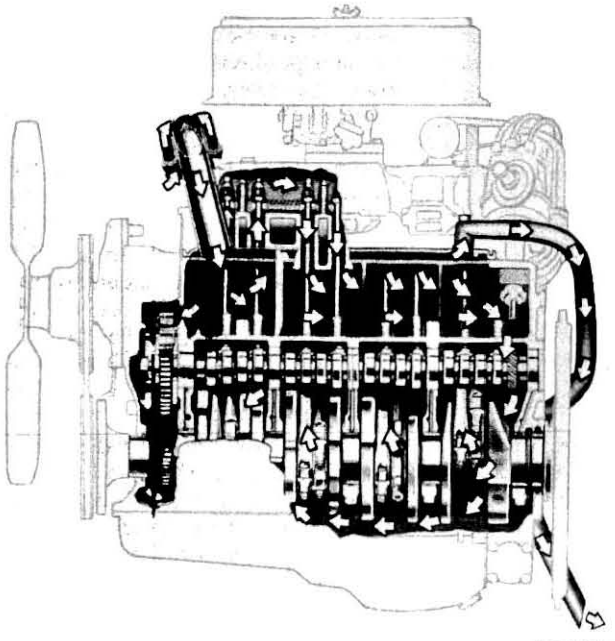

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FIG. 8—Crankcase Ventilation

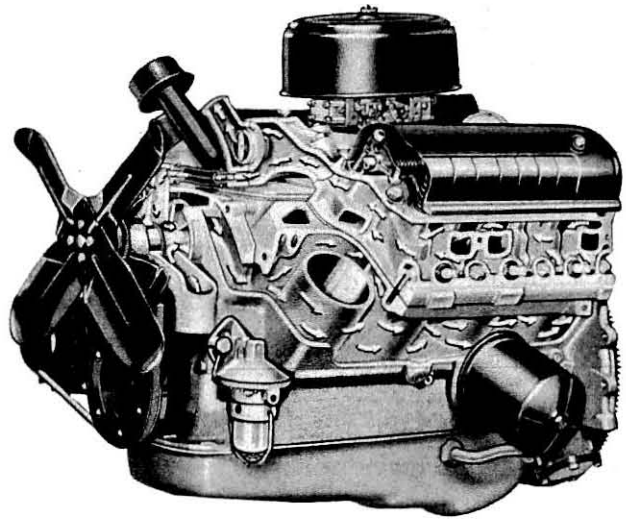

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FIG. 9—Cooling System

CRANKCASE VENTILATION

Ventilating air (Fig. 8) enters the engine through the oil filler cap located on the front of the valve push rod cover. The cap contains a maze filtering element.

Filtered air from the cap flows into the front section of the push rod chamber. Here, the air has a chance to warm up before contacting contaminating vapors originating in the crankcase. Warm ventilating air minimizes the formation of crankcase sludge.

The air is directed by a baffle, located on the push rod chamber cover, upward into the front of both valve rocker arm shaft chambers. The air is forced to the rear of the chambers and down into the rear section of the push rod chamber and through an opening in the block into the crankcase. Air is also diverted from the front section of the push rod chambers through holes in the front wall of the cylinder block to ventilate the timing chain.

The air from the crankcase is directed into the crankcase ventilation tube by the forward motion of the truck which creates a partial vacuum at the crankcase ventilation tube outlet.

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. 9).

The coolant 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 heads where it cools the combustion chambers, valves, and valve seats on its return to the front of the engine.

The coolant from each cylinder head flows through the water passages in the intake manifold, into the water outlet connection and past the water thermostat, if it is open, into the top of the radiator. 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 7 psi.

2 ENGINE REMOVAL AND INSTALLATION

Engine removal and installation procedures are separated according to truck body styles.

B-, F-, AND T-SERIES

A ical engine installation is s g. 10.

th

4. Remove the radiator and shroud as an assembly.
5. Remove the fan, spacer, and drive belt.
6. On a truck with an air compressor, open the air reservoir drain cock. Disconnect the compressor air lines.
7. Disconnect the heater hoses at engine. Disconnect the generator es.
8. Remove the starter and dust l.
9. Disconnect the muffler inlet s) from the exhaust manifold(s).
10. Disconnect the resistor wire and the battery wire at the coil. Disconnect the choke control cable at the carburetor.
11. Remove the engine front support insulator bolts.
12. Disconnect the water temperature and oil pressure sending unit wires at the sending units. Disconnect the engine ground strap.
13. Disconnect the fuel line. Disconnect the vacuum brake booster hose at the intake manifold (if applicable).

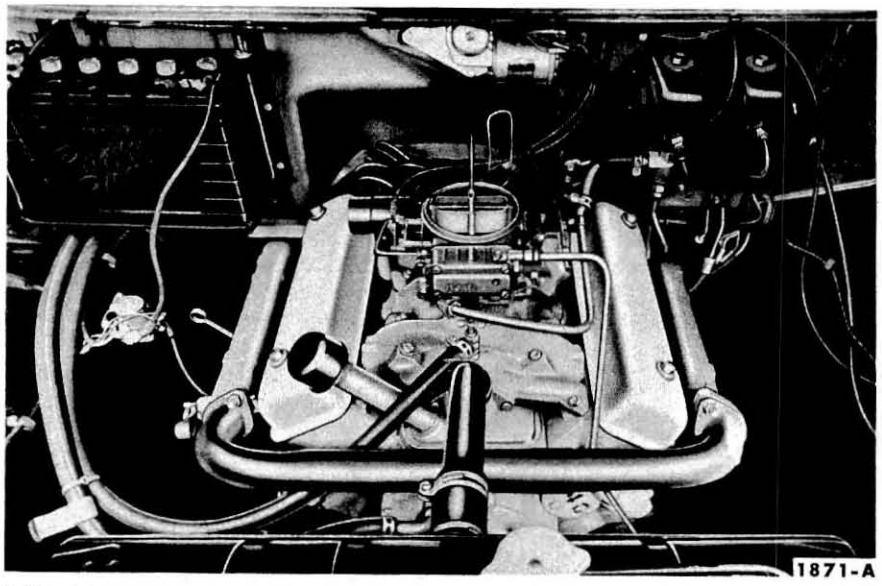

FIG. 10—MD V-8 Engine Installation—F-Series

14. On a truck with power steering, disconnect the power steering return line and the pump pressure line at the bracket on the frame left side member. Drain the oil into a suitable container. Disconnect the power steering return line at the pump reservoir and the pressure line at the pump housing.

15. Disconnect the throttle control cable at the carburetor. Remove the accelerator return spring.

16. On a truck with a manual-shift transmission and either the MD or HD V-8 engine, disconnect the accelerator rod assembly at the accelerator assembly. Remove the flywheel housing inspection cover. Remove the flywheel housing retaining bolts. On the HD V-8 engine, remove the clutch release lever retracting spring and the cable clamp at the governor.

17. On a truck with an automatic transmission, disconnect the throttle control rod and the accelerator connecting rod at the engine mounted bracket assembly. Remove the converter housing front cover and lower cover. Disconnect the converter from the flywheel. Remove the converter housing to cylinder block lower retaining bolts. Remove the floor mat. Disconnect the accelerator pedal at the accelerator assembly. Remove the transmission cover plate with the accelerator assembly. Disconnect the oil cooler water inlet tube at the cylinder h[illegible] Disconnect the transmissio[illegible] water inlet and outlet h[illegible] up[illegible] oil[illegible]

of the block. Tape the throttle rod out of the way.

18. Support the transmission and attach the engine lifting hooks (tool T53L-6000-B) and sling (tool T53L-300-A).

19. Remove the remaining flywheel or converter housing retaining bolts.

20. Raise the engine slightly. Carefully pull the engine out of the engine compartment.

21. Install the engine on a work stand (Fig. 11).

INSTALLATION

1. Attach the engine lifting hooks and sling.

2. Remove the engine from the work stand.

3. Place a new gasket over the muffler inlet pipe studs on the exhaust manifold(s).

4. Lower the engine carefully into the engine compartment. Make sure the exhaust manifold(s) are properly aligned with the muffler inlet pipe(s) and the dowels in the block engage the holes in the flywheel housing.

5. On a truck with an automatic transmission, start the converter pilot into the crankshaft. Position the transmission oil cooler outlet line and start two upper converter retaining bolts. Start the engine front support bolts and nuts. Tighten the converter upper retaining bolts to specifications. [illegible]er the engine and remove the en- lifting hooks. Install the con- [illegible]r housing lower retaining bolts. Attach the converter to the flywheel. Install the converter lower cover and front cover. Remove the transmission jack.

6. On a truck 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 in relation to the engine if the input shaft will not enter the clutch disc. **If the engine "hangs up" after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.** Install the flywheel housing lower retaining bolts. Remove the jack from the transmission. Start the engine front support bolts and nuts. Lower the engine and remove the engine lifting hooks. Install the flywheel housing upper bolts. Install the flywheel housing inspection cover.

7. Tighten the engine front support insulator bolts to specifications.

8. Connect the muffler inlet pipes and tighten the nuts to specifications.

9. Install the starter seal and starter.

10. On a truck with an automatic transmission, connect the oil cooler outlet line to the left side of the cylinder block. Connect the transmission oil cooler water outlet and inlet hoses. Remove the tape from the throttle rod. Install the transmission cover plate. Install the floor mat and connect the accelerator pedal.

11. Connect the choke control cable. Install the accelerator return spring. Connect the accelerator connecting rod. Connect the throttle control cable and adjust the length. Connect the throttle control rod.

12. Tighten the engine front support insulator bolts to specifications.

13. Connect the muffler inlet pipes and tighten the nuts to specifications.

14. Install the starter seal and starter.

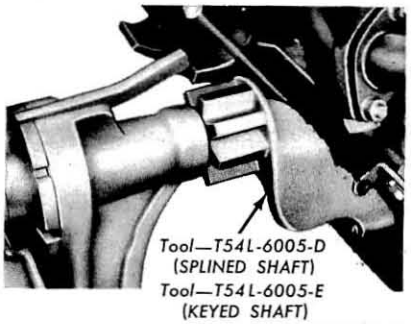

FIG. 11—Engine Mount

15. Connect the resistor wire and battery wire to the coil. Connect the generator wires, the engine ground strap, the oil pressure and water temperature sending unit wires, and the fuel line.

16. Connect the heater hoses. Install the radiator and shroud assembly. Install the drive belts, spacer, and fan. Adjust the tension of the drive belts.

17. On a truck with an air compressor, connect the reservoir to compressor line, and close the reservoir drain cock.

18. On a truck with power steering, connect the power steering return line to the pump reservoir and the pressure line at the pump housing. Connect the return line to the bracket on the frame left side member. Fill the power steering pump reservoir.

19. Fill the crankcase with the proper grade and quantity of engine oil.

20. Fill and bleed the cooling system.

21. Install the hood.

22. Run the engine at fast idle and check all gaskets and hose connections for leaks. Install the air cleaner.

23. On a truck with an automatic transmission, adjust the transmission control linkage.

C-SERIES

REMOVAL

1. Release the cab lock and tilt the cab forward.

2. Drain the cooling system and the crankcase.

3. Remove the clamps holding the throttle, choke, and accelerator cables, and the heater hoses to the radiator.

4. Remove the fan assembly and the drive belts.

5. Remove the radiator and shroud as an assembly.

6. Remove the air cleaner. Disconnect the heater hoses from the engine.

7. On a truck with an air compressor, open the air reservoir drain cock. Disconnect the air line at the front of the engine and place the line against the frame side rail.

8. Disconnect the fuel line. Install a cap on the fuel line.

9. Disconnect the oil pressure and

tro

ator cables at the carburetor, and the vacuum brake hose (if so equipped).

11. On the HD V-8 engine, remove the clutch release lever retracting spring.

12. Disconnect the resistor wire and the battery wire at the coil. Disconnect the generator wires.

13. Remove the starter.

14. Disconnect the radiator supply tank hose at the tank.

15. Remove the oil filler pipe assembly clamp at the coolant supply tank bracket.

16. Disconnect the muffler inlet pipes at the exhaust manifolds.

17. Support the transmission and remove the flywheel housing inspection cover and the flywheel housing to engine retaining bolts.

18. Remove the engine front support insulator bolts.

19. Attach the engine lifting hooks (tool T53L-6000-B) and sling (tool T53L-300-A). Remove the engine and lower the engine on blocks and remove the right exhaust manifold and gasket.

20. Remove the mount from the work stand and install it on the engine.

21. Install the engine on the work stand (Fig. 11).

INSTALLATION

1. Attach the engine lifting hooks and sling. Disconnect the mount from the work stand and lower the engine on blocks.

2. Remove the mount from the engine and install the right exhaust manifold and gasket.

3. Place a new gasket over the exhaust manifold studs.

4. Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes and the dowels in the block engage the holes in the flywheel housing.

5. Install the flywheel housing to engine retaining bolts. Install the engine front support insulator bolts. Remove the transmission support.

6. Install the flywheel housing inspection cover and the starter.

7. Connect the muffler inlet pipes.

8. Connect the radiator supply tank hose.

9. Connect the resistor wire and the battery wire to the coil. Connect the vacuum brake hose (if so

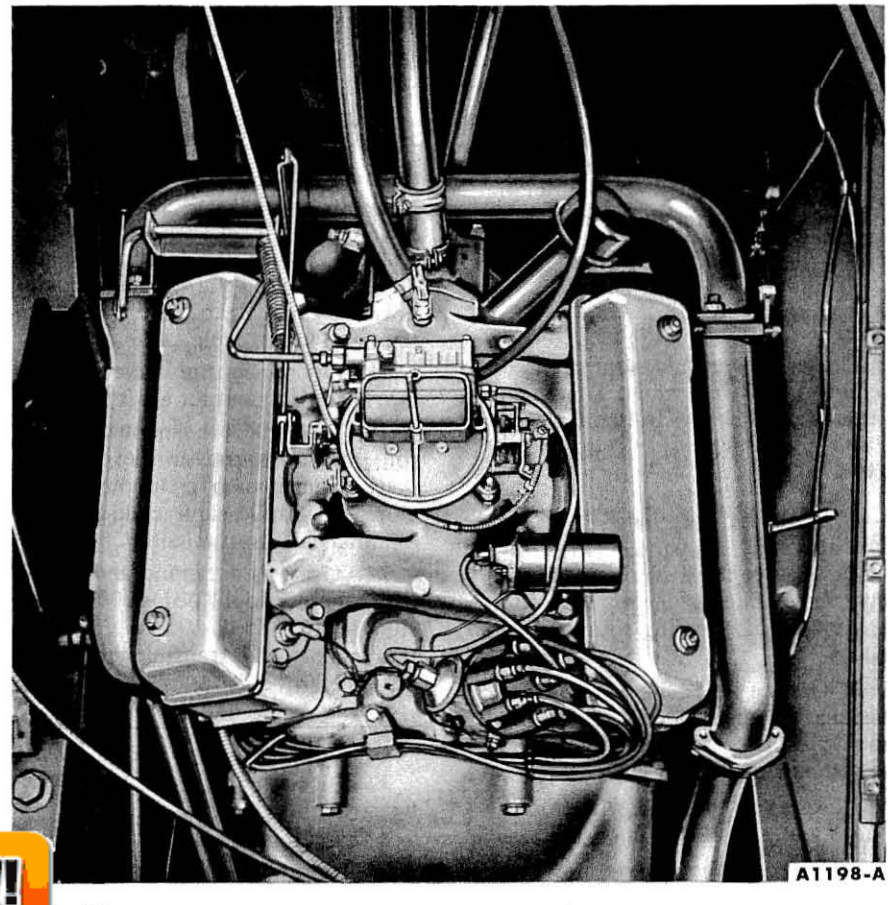

Fig. 12—MD V-8 Installation—P-Series

equipped). Connect the generator wires.

10. Install and adjust the drive belts. Install the oil filler pipe assembly clamp to the radiator supply tank bracket.

11. Connect the accelerator cable, choke control cable, and the throttle control cable.

12. Connect the oil pressure and the temperature sending unit wires.

13. Remove the fuel line cap and connect the fuel line.

14. On the HD V-8 engine, install the clutch release lever retracting spring.

15. Install the radiator and shroud as an assembly.

16. Connect the accelerator, choke and throttle control cables, and the heater hose to the radiator clamps.

17. Install the fan assembly and connect the heater hoses.

18. On a truck with an air compressor, connect the reservoir to compressor line and close the reservoir drain cock.

19. Fill the crankcase with the proper grade and quantity of engine oil. Fill the cooling system.

20. Operate the engine at fast idle and check all gaskets and hose connections for leaks.

21. Install the air cleaner.

22. On a truck with an automatic transmission, adjust the transmission control linkage.

P-SERIES

The engine and transmission are removed as an assembly. The engine installation is shown in Fig. 12.

REMOVAL

1. Drain the cooling system and the crankcase.

2. Remove the driver's seat assembly, the master cylinder inspection cover, and the steering column cover plates.

3. Disconnect the accelerator pedal at the accelerator assembly, and the wires from the headlight beam selector switch.

4. ...ve the left wheel house p... center floor plate ... t... pa...

6. ... tain...

rear cover to the removable frame cross member and the center floor plate front bracket.

7. Wedge the right and left frame gussets open so the rear flange of the engine rear cover plate will clear the slots.

8. Remove the removable cross member.

9. Remove the air cleaner. Disconnect the battery ground cable. Disconnect the water temperature and oil pressure sending unit wires at the sending units.

10. Disconnect the resistor wire and the battery wire at the coil. Disconnect the relay to starter cable at the starter, and the starter to frame cable at the starter.

11. Remove the radiator upper and lower hoses.

12. Remove the engine front support insulator bolts.

13. Disconnect the speedometer cable at the drive gear. Disconnect the generator wires.

14. Disconnect the brake vacuum hose at the intake manifold line.

15. Disconnect the flexible fuel line at the fuel tank line and install a cap on the tank line.

16. Disconnect the choke control cable at the carburetor.

17. Remove the right exhaust manifold to muffler inlet pipe retaining nuts.

18. Remove the carburetor air cleaner stud and the engine rear support retaining capscrews. Remove the hand brake cable and bracket.

19. Disconnect the universal joint to transmission output shaft flange.

20. Disconnect the manual control rods at the transmission lever (automatic transmission). Disconnect the clutch hydraulic slave cylinder hose (manual-shift transmission).

21. Using a floor crane, and engine lifting hooks (tool T53L-6000-B) and sling (tool T53L-300-A), remove the engine and transmission as an assembly.

INSTALLATION

1. Place a new gasket over the exhaust manifold studs.

2. Using a floor crane, and the en... lifting hooks and sling, position ... engine and transmission (as an ...mbly) in the chassis.

... Install the engine rear support ...ews. Safety wire the capscrews.

4. Install the engine front support to frame cross member bolts and nuts. Tighten the nuts to specifications.

5. Install the hand brake cable. Connect the generator wires and the brake vacuum hose.

6. Remove the cap from the fuel tank line and connect the flexible fuel line.

7. Connect the choke control cable. Connect the speedometer cable.

8. Connect the right exhaust manifold to the muffler inlet pipe. Tighten the muffler inlet pipe nuts to specifications.

9. Connect the radiator upper and lower hoses.

10. Connect the starter to frame cable and the relay to starter cable. Connect the resistor wire and the battery wire to the coil. Connect the water temperature and oil pressure sending unit wires, and the battery cable.

11. Install the frame cross member and connect the universal joint to transmission output shaft flange.

12. Connect the clutch hydraulic slave cylinder hose and bleed the cylinder (manual-shift transmission).

13. Position the engine cover assembly and the engine cover rear panel assembly.

14. Install the flange of the engine cover rear panel between the frame gussets and frame removable cross member. Remove the wedges.

15. Install the right side of the engine rear cover panel to the right wheel house panel.

16. Connect the headlight beam selector switch wires and the accelerator pedal.

17. Install the engine left cover to wheel house panel, the steering column cover plates, and the master cylinder inspection cover.

18. Install the driver's seat assembly.

19. Fill the crankcase with the proper grade and quantity of engine oil. Fill and bleed the cooling system.

20. Operate the engine at fast idle and check all gaskets and hose connections for leaks.

21. Install the air cleaner anchor screw and the air cleaner.

22. On a truck with an automatic transmission, adjust the transmission control linkage.

3 ENGINE DISASSEMBLY—ENGINE REMOVED

INTAKE MANIFOLD AND DISTRIBUTOR

1. Disconnect the fuel line at the carburetor and at the fuel pump and remove the line.
2. Disconnect the vacuum lines at the vacuum booster pump, intake manifold, and the distributor. Remove the lines.
3. Disconnect the high tension lead and the primary ignition wire from the coil.
4. Remove the distributor cap and the spark plug wires and brackets as an assembly.
5. Remove the distributor.
6. Slide the clamp on the coolant bypass hose toward the water pump.
7. Remove the intake manifold (and gaskets), carburetor, and coil as an assembly.
8. Clean the top of the valve push rod cover, then remove the cover.

CYLINDER HEADS

1. Remove the valve rocker arm covers and gaskets. Remove the oil level dipstick.
2. Release the spring tension on the valve rocker arms by loosening the adjusting screws. Remove the valve rocker arm shaft assembly.
3. Remove and identify the push rods so they can be replaced in their original positions (Fig. 13).
4. On the HD V-8 engine, remove the exhaust valve caps. Identify the caps for proper installation.
5. Remove the exhaust manifolds and the spark plugs.
6. Remove the cylinder head bolts. Install the cylinder head holding fixtures (Fig. 14).
7. Lift the cylinder head off the block. **Do not pry between the cylinder head and the block.** Remove the cylinder head gasket.

FIG. 13—Valve Push Rod Removal

OIL FILTER AND OIL PUMP

1. Loosen the filter center bolt, then remove the filter assembly and gasket.
2. Disconnect the oil inlet tube at the pump and remove the "O" ring seal. Loosen the oil inlet tube at the oil pan.
3. Remove the oil pump to block retaining screws, then remove the pump, intermediate shaft, and gasket.

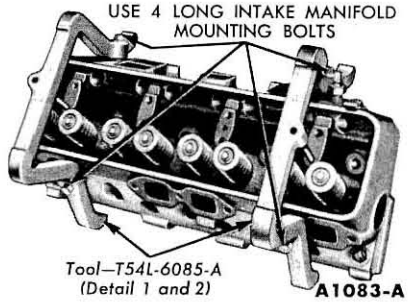

FIG. 14—Cylinder Head Fixtures

OIL PAN

1. Invert the engine on the work stand.
2. Remove the oil pan retaining screws and remove the oil pan. Discard the gasket.

FLYWHEEL

1. On a flywheel for a manual-shift transmission, mark the pressure plate cover so that it can be replaced in the same position, and remove the clutch pressure plate and cover assembly.
2. Remove the flywheel retaining bolts and remove the flywheel.

CYLINDER FRONT COVER

1. Disconnect the generator brackets from the cylinder front cover and the cylinder block. Remove the generator and brackets as an assembly.
2. Remove the drive belt(s), fan, spacer and pulley.
3. Remove the fuel pump and gasket.
4. Remove the water pump.
5. On engines with a separate power steering pulley, remove the pulley from the crankshaft damper.
6. Remove the cap screw and washer from the end of the crankshaft.
7. Install the puller on the crankshaft damper, then remove the damper (Fig. 15).

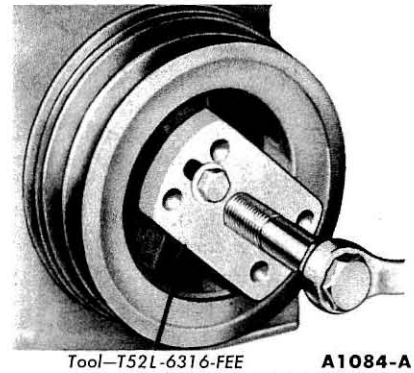

FIG. 15—Damper Removal

8. Remove the cylinder front cover and gasket.

TIMING CHAIN AND SPROCKETS

1. Remove the crankshaft front oil slinger.
2. Remove the camshaft sprocket retaining bolt and washer. Remove the fuel pump eccentric.
3. Slide both sprockets and the timing chain forward and remove them as an assembly. (Fig. 16).

CONNECTING ROD ASSEMBLIES

1. Turn the engine on the work stand so that the front end is up.
2. Remove any ridge and/or deposits from the upper end of the cylinder bores. Move the piston to the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the in-

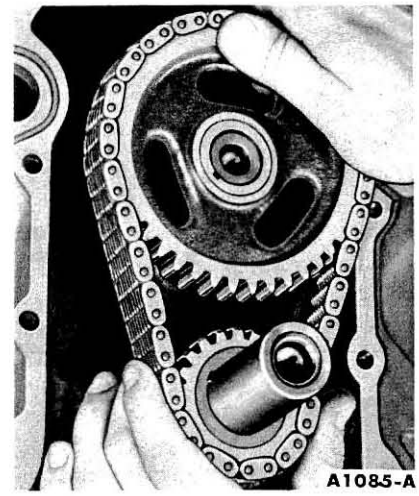

FIG. 16—Timing Chain Removal or Installation

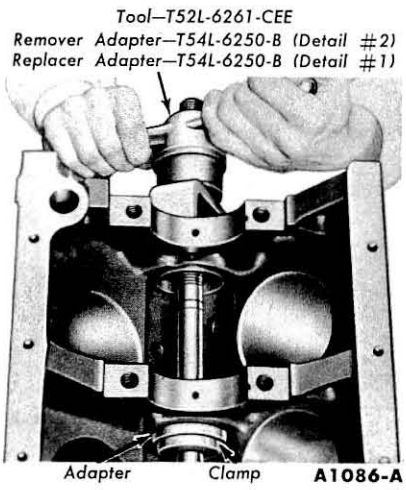

FIG. 17—Camshaft Bearing Replacement

structions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**

3. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.

4. Turn the crankshaft until the connecting rod being removed is down.

5. Remove the connecting rod cap.

6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and connecting rod.**

7. Remove the bearing inserts from the connecting rod and caps.

CRANKSHAFT

1. Remove the main bearing caps and the rear oil seal retainer.

2. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**

3. Remove the rear journal oil seal from the block and rear oil seal retainer. Remove the retainer to block side seals.

4. Remove the bearing inserts from the block and bearing caps.

CAMSHAFT

1. Pull all the tappets up to allow clearance for removal of the camshaft.

2. Remove the camshaft thrust plate and spacer.

3. Carefully remove the camshaft by pulling it toward the front of the engine. **Use caution to avoid damaging the journals and lobes.**

4. Remove all the tappets keeping them in order so that they can be installed in their original location.

CAMSHAFT BEARINGS

1. Drill a ½-inch hole in the camshaft rear bearing bore plug and use tool 7600-E to remove the plug.

2. Remove the camshaft bearings (Fig. 17).

4 DISASSEMBLY AND ASSEMBLY OF COMPONENT PARTS

VALVE ROCKER ARM SHAFT

DISASSEMBLY

1. Remove the cotter pin from each end of the valve rocker arm shaft. Remove the flat washers and spring washers.

2. Slide the rocker arms, springs, and the supports off the shaft. Be sure to identify the parts.

3. If it is necessary to remove the plugs from each end of the shaft, drill or pierce one plug. Insert a steel rod through the plug and knock out the plug on the opposite end. Working from the open end, knock out the remaining plug.

ASSEMBLY

1. Lubricate all parts with engine oil. Apply Lubriplate to the pad of the valve rocker arms.

2. If the plugs were removed from the ends of the shaft, use a blunt tool or a large diameter pin punch and install a plug, cup side out, in each end of the valve rocker arm shaft.

3. Install a flat washer, spring washer, another flat washer, and a cotter pin on one end of the shaft.

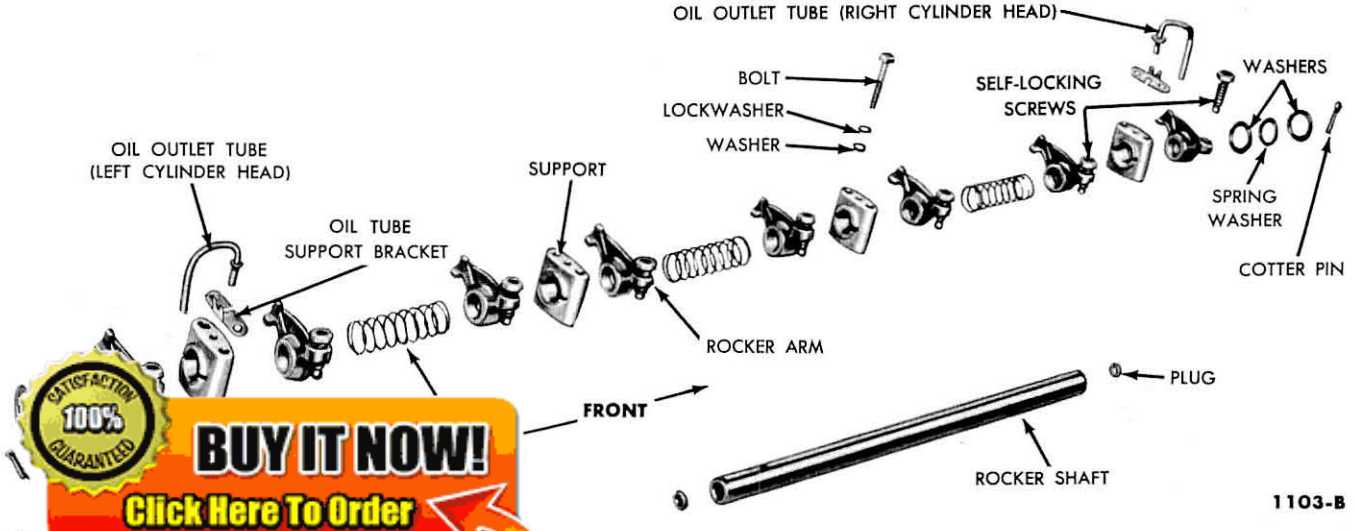

FIG. [illegible]—Valve Rocker Arm Shaft Assembly

4. Install the rocker arms, supports, and springs in the order shown in Fig. 18. **Be sure the oil holes in the shaft are facing downward.** Complete the assembly by installing the remaining two flat washers with the spring washer between them and install the cotter pin.

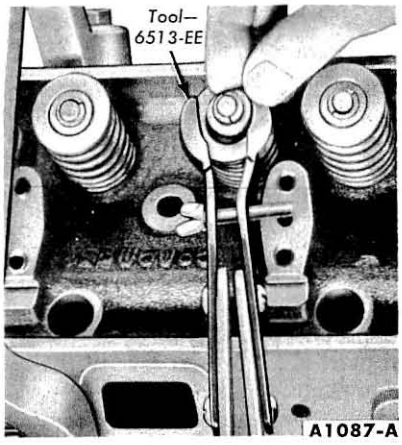

FIG. 19—Valve Spring Retainer Lock Removal or Installation

CYLINDER HEADS

DISASSEMBLY

1. Clean deposits from the cylinder head combustion chambers before removing the valves.
2. Compress the valve springs (Fig. 19), then remove the spring retainer locks, and release the spring.
3. Remove the sleeve, spring retainer, spring, stem seal, and valve. Discard the valve stem seals. Identify all valve parts.

WATER OUTLET CONNECTION

The cylinder head assemblies are interchangeable from one cylinder bank to the other. To interchange the

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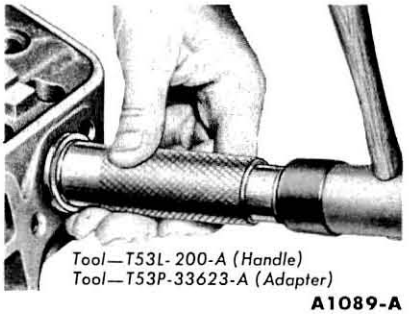


FIG. 21—Water Outlet Plug Installation

cylinder heads, it is necessary to install a plug in the water outlet at the rear of the right cylinder head and install a water temperature sending unit adapter in the water opening at the rear of the left cylinder head. Replacement cylinder heads do not have either the plug or adapter installed; therefore, they can be used for either right or left installations.

Water Outlet Plug. To remove the water outlet plug:

1. Drill a ½-inch hole in the center of the plug.
2. Remove the plug as shown in Fig. 20.

To install the plug:

1. Clean the plug recess thoroughly.
2. Coat the flange of the plug with water resistant sealer.
3. Install the plug with the flange facing out. Drive the plug in until the flange is flush or slightly below the casting surface (Fig. 21).

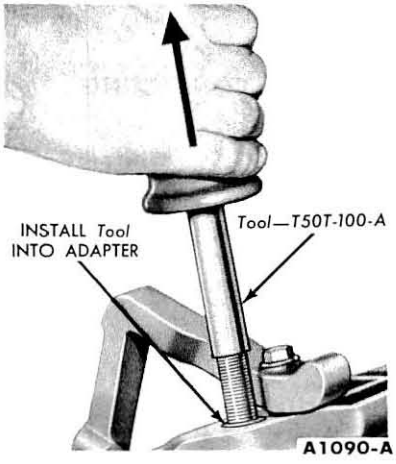


FIG. 22—Sending Unit Adapter Removal

ıding Unit Adapter. To remove
dapter:
Thread the impact hammer
e into the adapter.

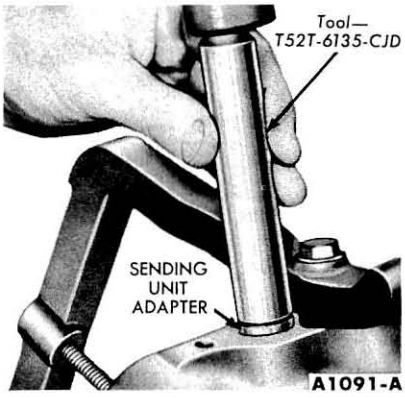


FIG. 23—Sending Unit Adapter Installation

2. Tighten the locknut against the adapter (Fig. 22).
3. Remove the adapter by using the slide hammer.

To install the sending unit adapter:

1. Clean the adapter recess thoroughly.
2. Coat the adapter with water resistant sealer.
3. Install the adapter with the undercut toward the inside of the cylinder head. Drive the adapter in until it is flush with the casting surface (Fig. 23).

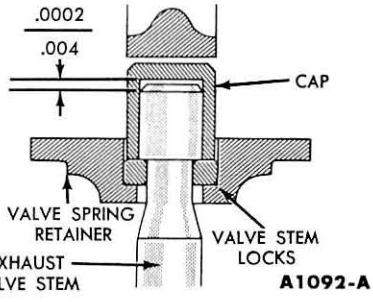


FIG. 24—Free Turning Valve Clearance

ASSEMBLY

1. On the exhaust valves of the HD V-8 engine, measure the clearance between the end of the valve stem and the inside of the cap (Figs. 24 and 25). The correct clearance is 0.0002-0.004-inch. The proper clearance is necessary so that the cap can

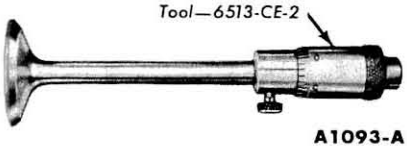


FIG. 25—Free Turning Valve Clearance Measurement

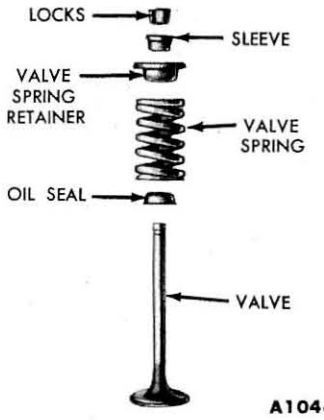


FIG. 26—Rotating Valve Assembly

carry the valve spring pressure permitting the valve to rotate. If the clearance is greater than 0.004 inch, reduce the clearance by lapping the open end of the cap on a smooth surface.

2. Lubricate the valve guides and valve stems with engine oil. Apply Lubriplate to the tip of all valve stems.

3. Position each valve in the guide from which it was removed or to which it was fitted (Fig. 26 or 27).

4. Install a new stem seal, cup side down on the valve.

5. Position the valve spring and retainer on the valve stem.

6. On the intake and exhaust valve of the MD V-8 and the intake of the HD V-8, position the sleeve in the valve stem.

7. Compress the spring and install the retainer locks (Fig. 19).

8. Measure the assembled height of the valve springs from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 28).

9. Check the dividers against a scale.

10. If the assembled height is greater than $1\frac{25}{32}$ inches, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension of $1\frac{3}{4}$-$1\frac{25}{32}$ inches. **Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs which will lead to excessive load loss and spring breakage.**

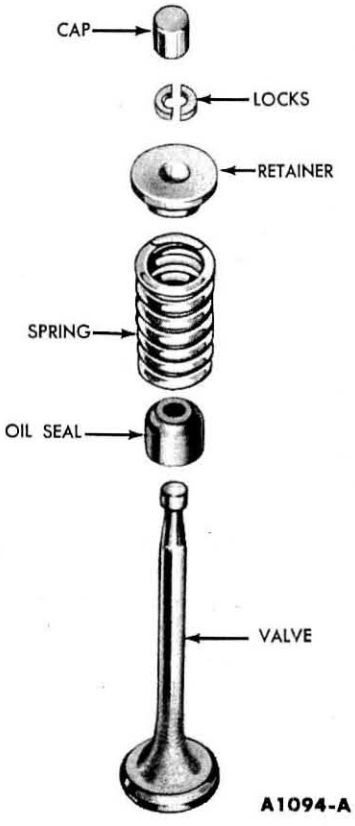


FIG. 27—Free Turning Valve Assembly

PISTONS AND CONNECTING RODS

DISASSEMBLY

1. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.

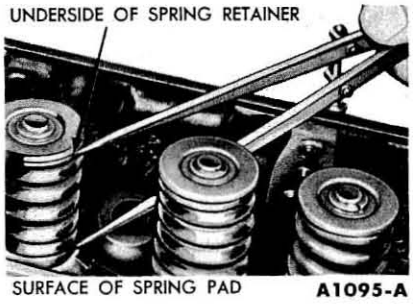


FIG. 28—Valve Spring Assembled Height

2. Remove the piston rings. Remove the piston pin retainers. Drive the pin out of the piston and rod (Fig. 29). Discard the retainers.

ASSEMBLY

The piston, connecting rod, and related parts are shown in Fig. 30.

1. Lubricate all parts with light engine oil.

2. Position the connecting rod in the piston and push the pin into place. **Assemble the piston and connecting rod with the oil squirt hole in the connecting rod and the indentation in the piston positioned as shown in Fig. 31.**

3. Insert new piston pin retainers by spiraling them into the piston with the fingers. Do not use pliers.

4. Follow the instructions con-

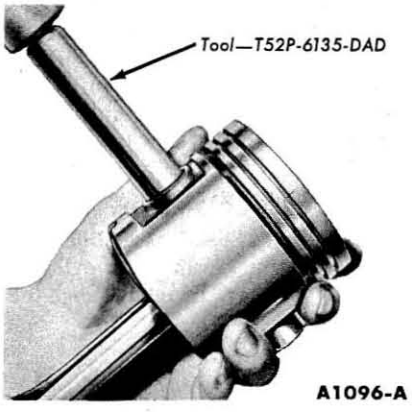


FIG. 29—Piston Pin Removal

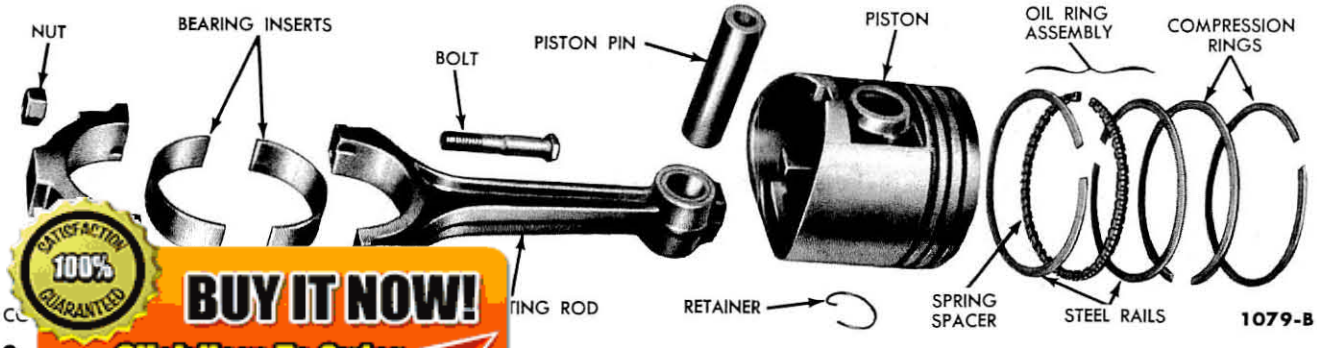


FIG.

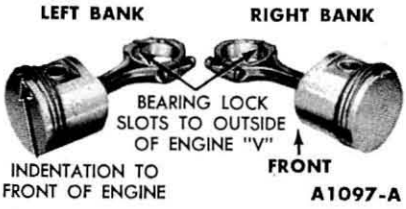


FIG. 31—Connecting Rod and Piston Assembly

tained on the piston ring package and install the piston rings.

5. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (step 6 under "Fitting Piston Rings" in Part 1-1).

6. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts may distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

OIL PUMP

The oil pump is shown in Fig. 32.

DISASSEMBLY

1. Remove the cover and O-ring seal. Remove the inner rotor and shaft, and the outer race.

2. Remove the oil pressure relief valve chamber plug, gasket, spring, and plunger.

ASSEMBLY

1. Oil all parts thoroughly.

2. Install the oil pressure relief valve plunger, spring, gasket, and plug.

3. Install the outer race, and the inner rotor and shaft assembly. **The inner rotor and shaft, and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.**

4. Install the O-ring seal in the groove on the pump body, and install the cover. Tighten the cover retaining screws to 12-15 foot-pounds torque.

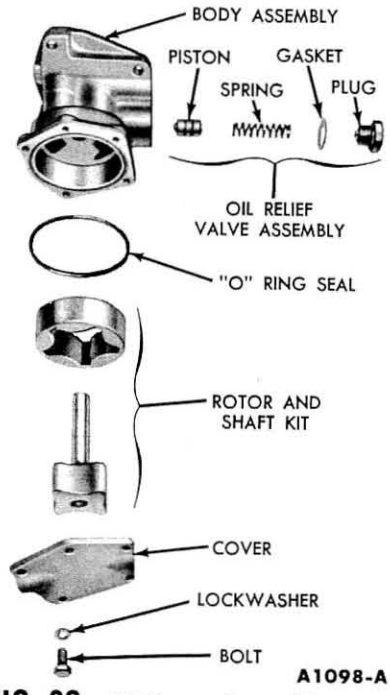


FIG. 32—Oil Pump Assembly

5 ENGINE ASSEMBLY—ENGINE REMOVED

CAMSHAFT BEARINGS

Camshaft bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters. Number 1 bearing is not interchangeable with the other bearings.

1. Position the new bearing at the bearing bore, and press it in place with the tool shown in Fig. 17. Align the oil holes in the bearings with the oil holes in the cylinder block when the bearings are installed. **Be sure the camshaft front bearing is installed 0.005-0.020 inch below the front face of the cylinder block.**

2. Clean the camshaft rear bearing bore plug recess thoroughly.

3. Coat the flange of a new plug with water resistant sealer and install it with the flange facing out (Fig. 33).

4. Drive the plug in until the flange is flush or slightly below the casting surface.

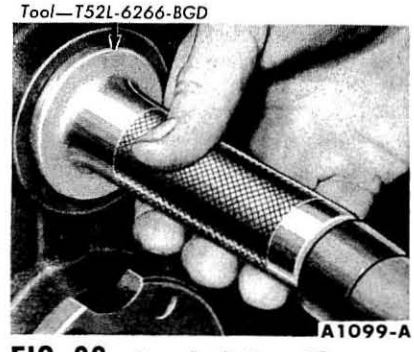
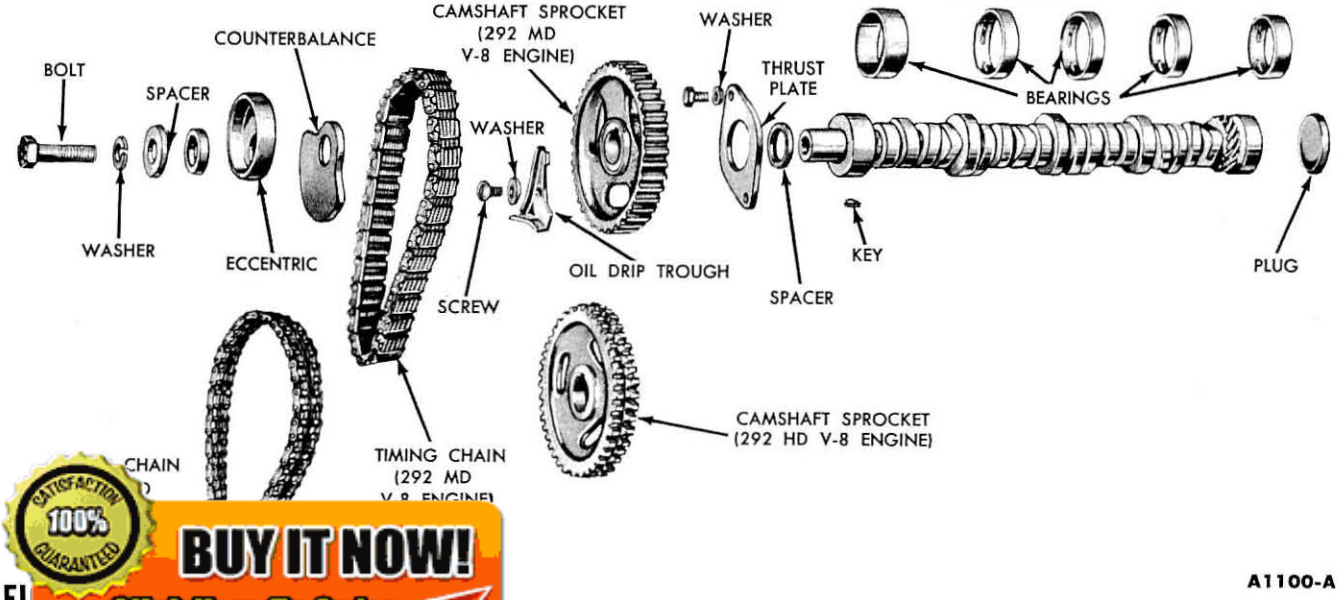
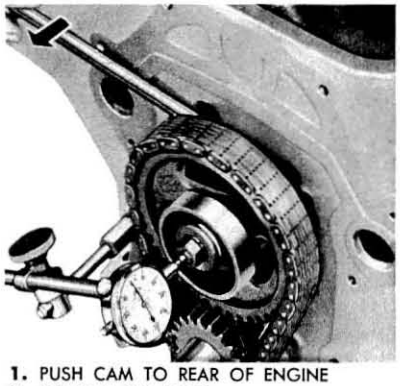


FIG. 33—Camshaft Rear Plug Installation





1. PUSH CAM TO REAR OF ENGINE
2. SET DIAL ON ZERO
3. PULL CAM FORWARD AND RELEASE

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FIG. 35—Camshaft End Play

CAMSHAFT

The camshaft and related parts are shown in Fig. 34.

1. Dip the tappet foot in Lubriplate. Coat the remainder of each valve tappet with engine oil.

2. Install the tappets in their original bores.

3. Oil the camshaft and apply Lubriplate to all lobes. Be sure all the valve tappets are seated. Carefully slide the camshaft through the bearings.

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

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

6. Temporarily install the camshaft sprocket, spacer, washer, and cap screw. Tighten the cap screw to specifications.

7. Push the camshaft toward the rear of the engine.

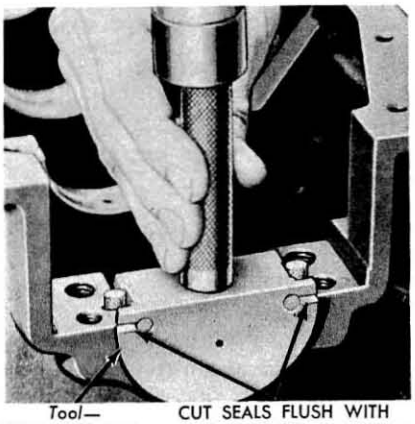
8. Install a dial indicator so that the indicator point is on the camshaft sprocket cap screw (Fig. 35).

9. Zero the dial indicator. 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.

10. If the end play is excessive, check the spacer for correct installation.

11. Replace the thrust plate and/or spacer if necessary.

12. Remove the dial indicator and the camshaft sprocket.



Tool—T52L-6701-AGD CUT SEALS FLUSH WITH *Knife* IN SLOT A1103-A

FIG. 37—Oil Seal Installation

CRANKSHAFT

The crankshaft and related parts are shown in Fig. 36.

1. Be sure that the rear journal oil seal grooves are clean. Install a new rear journal oil seal in the block (Fig. 37) and rear journal oil seal retainer (Fig. 38). After installation, cut the ends of the seals flush.

2. If the crankshaft main bearing

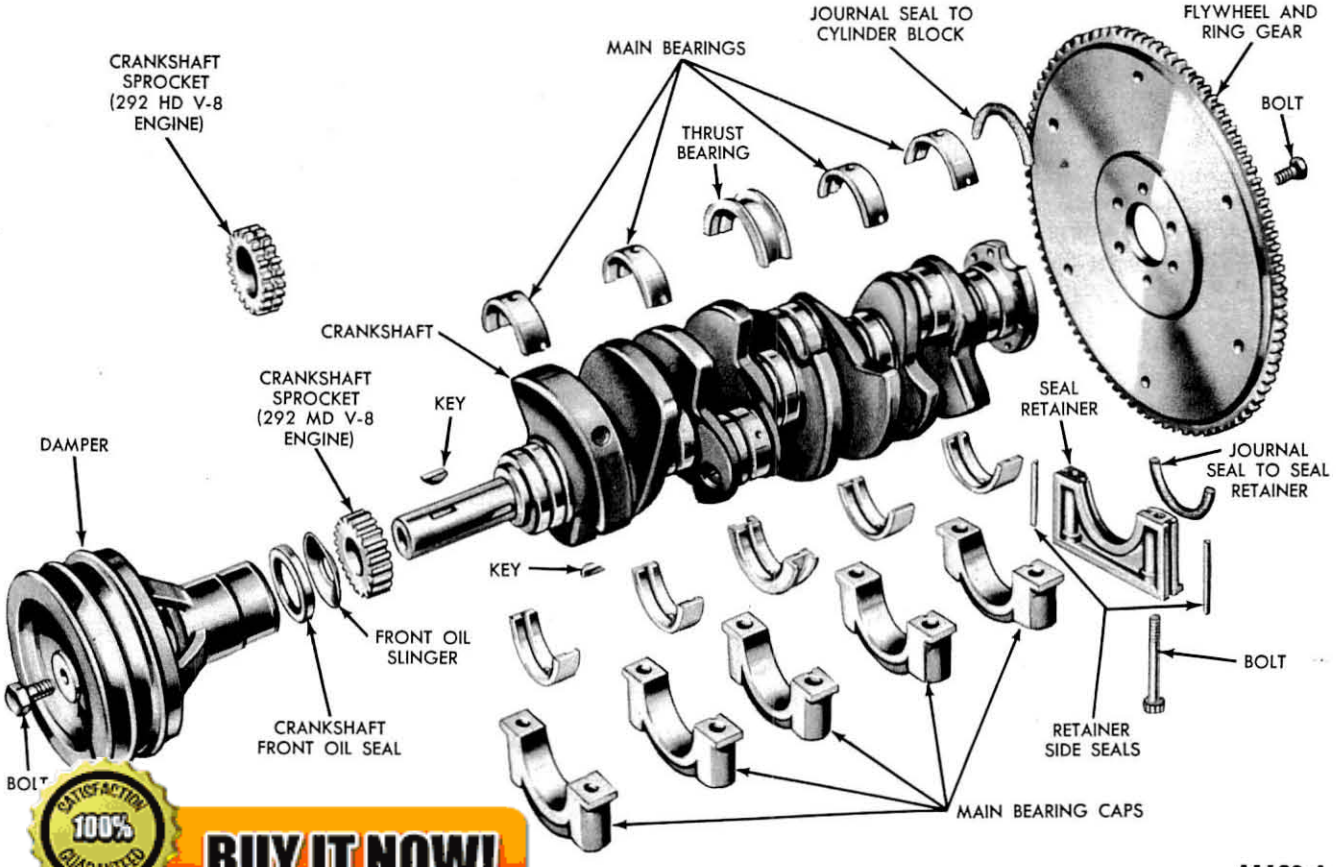


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FIG. 3