The **condenser** in the distributor prevents excessive arcing at the contacts. When the contacts first open, the current tends to continue flowing across the gap. The condensor absorbs this current until it becomes fully charged; but by this time, the contacts have opened far enough to prevent the current flow. If there were no condenser in the circuit, the current would continue to flow and cause an arc that would soon burn the contacts. The capacity of the condenser is designed to be large enough to prevent arcing and burning of the contacts and small enough to reduce the transfer of material from one contact to the other.

The **cam** is designed so that the breaker points remain closed for a certain number of degrees so as to give the coil a given length of time to build up or become energized. This is called the cam angle, as shown below:

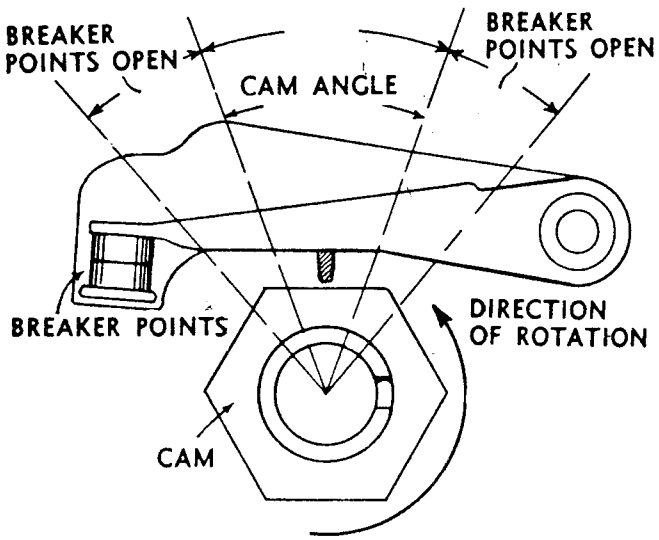


Figure 96 — Diagram illustrating cam angle

The cam is further designed to open the breaker points at a given speed in relation to cam travel to obtain proper point and condensor action. It is therefore important that the breaker points be adjusted to .020 gap so that proper cam angle is obtained.

DISTRIBUTOR MAINTENANCE — The distributor operation is vital to the operation of the engine and the following items should be carefully inspected every 250 hours of normal operation; however, dirt, dust, water and high speed operation may cause more rapid wear and necessitate more frequent inspections:

1 — **Remove Distributor Cap** — (without removing wires) — Clean cap and examine for cracks, carbon runners, corroded terminals or if the vertical faces of the inserts are burned — install a new cap.

If the horizontal faces of the inserts are burned — replace the cap and rotor as this is due to the rotor being too short.

2 — **Check Centrifugal Advance Mechanism** — for "freeness" by turning the breaker cam in the direction of rotation and then releasing it. The advance springs should return the cam to its original position.

3 — **Inspect Breaker Points and Gap** — if points are pitted, burned or worn to an unserviceable condition, install a new set of points. Badly pitted points may be caused by a defective or improper condenser capacity.

If the condenser capacity is too high, the crater (depression) will form in the positive contact; and, *if condenser is too low,* the crater will form in the negative contact as shown on the following sketch.

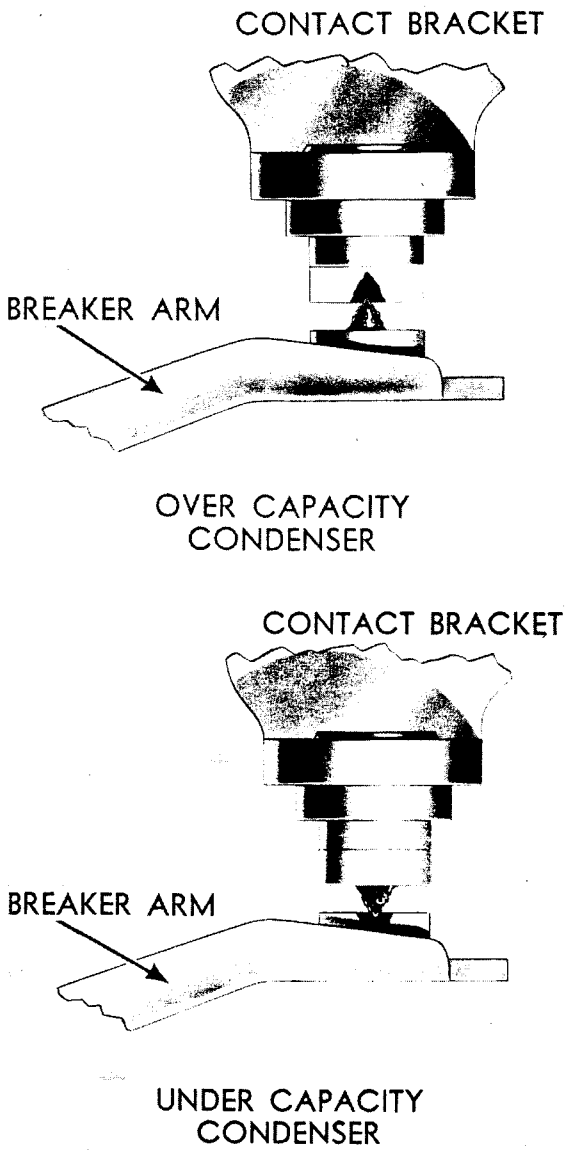


Figure 97 — Badly pitted breaker points caused by arcing due to incorrect condensor capacity

If the points are servicable, they should be dressed down with a fine-cut stone or point file. The file must be clean and sharp — never use emery cloth to clean contact points.

After filing, check the point gap and reset to .020 — the breaker arm must be resting on the high point of the cam during this operation.

When replacing points, make sure they are aligned and that they make full contact. Bend the stationary arm to obtain proper alignment — do not bend the breaker arm.

4 — **Lubrication** — is required at the shaft, advance mechanism, breaker cam and pivot. The shaft may be either oil or grease cup lubricated and should be given attention every oil change. Make sure the breaker arm moves freely on its hinge and apply a drop of light oil. A trace of ball bearing lubricant such as Mobilgrease Special (with Moly) should be used sparingly on the breaker cam unless lubricated by a felt wick with a few drops of oil.

CAUTION:
AVOID EXCESSIVE LUBRICATION — AS THE EXCESS MAY GET ON THE CONTACT POINTS AND CAUSE BURNING.

SPARK PLUGS — A spark plug consists of two electrodes; one grounded to the outer shell of the plug and the other well insulated with a core of porcelain or other heat resistant material. The space between these two electrodes is called the gap which should be set at .025 on standard plugs, and .035 on resistor type plugs for Continental L-Head Engines. Correct and uniformity of the gaps of all spark plugs in the engine is important for smooth running.

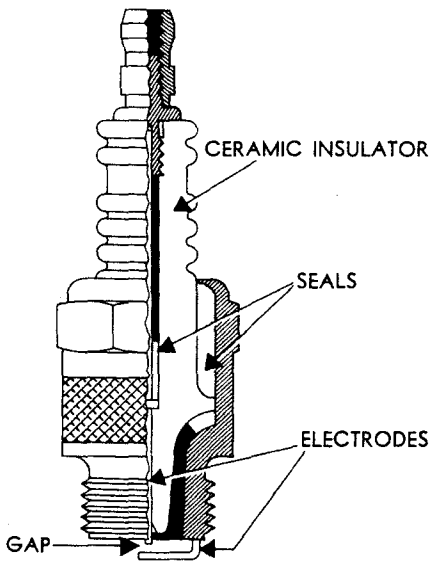


Figure 98 — Sectional view of spark plug

Spark plug gaps are best checked with a wire gauge unless the points are dressed to obtain a correct reading with a flat gauge. The adjustment should always be made on the side electrode and never on the center electrode which may cause a broken porcelain.

"Gapping" the electrode tip is more easily done with proper tools.

GAPPING THE SPARK PLUG. This illustration shows the use of the gapping tool which both measures and adjusts the electrode gap.

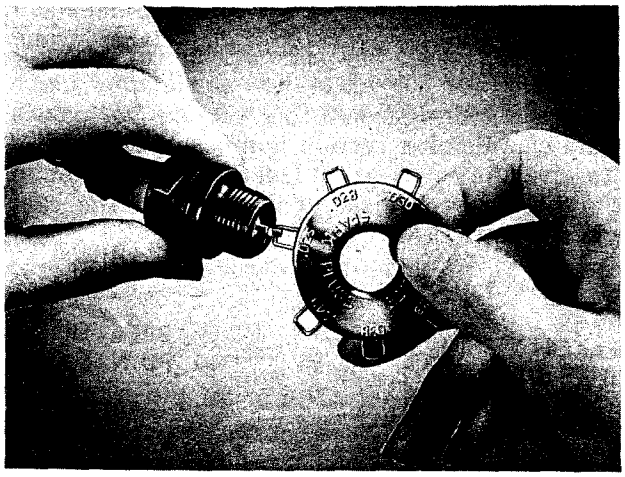


Figure 99 — Checking spark gap

Spark Plugs must operate within a certain temperature range to give good performance — not too hot and not too cold. The ability of a spark plug to conduct heat away from the center electrode and porcelain is controlled by the design of the shell and insulator — so varying the length of the insulator below the gasket shoulder controls the temperature.

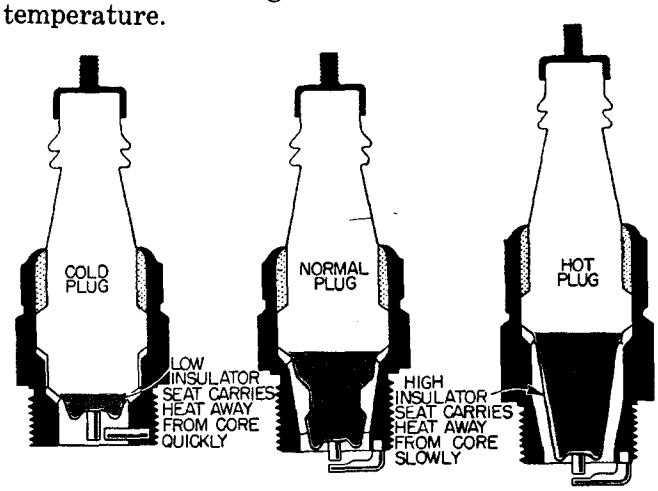


Figure 100 — Cold — Normal — Hot Spark Plugs

Cold-Normal-Hot Spark Plugs

Examination of a used spark plug will show if it is in the correct heat range for the operating conditions. If the plug runs too hot, the insulator will blister or crack and the electrodes burn away rapidly. If the plug remains too cool — soot and carbon will deposit on the insulator causing fouling and missing.

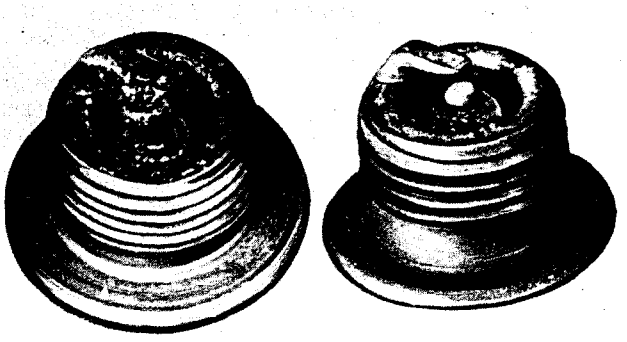


Figure 101 — Faulty spark plugs. Left: cold plug used in an engine that should have a hot plug. Right: hot plug used in an engine that should have a cold plug.

Spark plug electrodes will wear in the course of time and present day fuels have a tendency to form rusty-brown oxide deposits on the insulator tip. Therefore it is necessary to periodically clean the plugs with a plug cleaner and to reset the gaps to specifications.

Spark plugs must be correctly installed in order to obtain good performance from them. It is a simple but important matter to follow the following procedure when installing plugs:

1. Clean the spark plug seat in the cylinder head.
2. Use new seat gasket and screw plug in by hand.
3. Tighten all 18mm plugs to 35# torque with socket wrench of correct size.

DISTRIBUTOR — IGNITION TIMING
With Timing Light

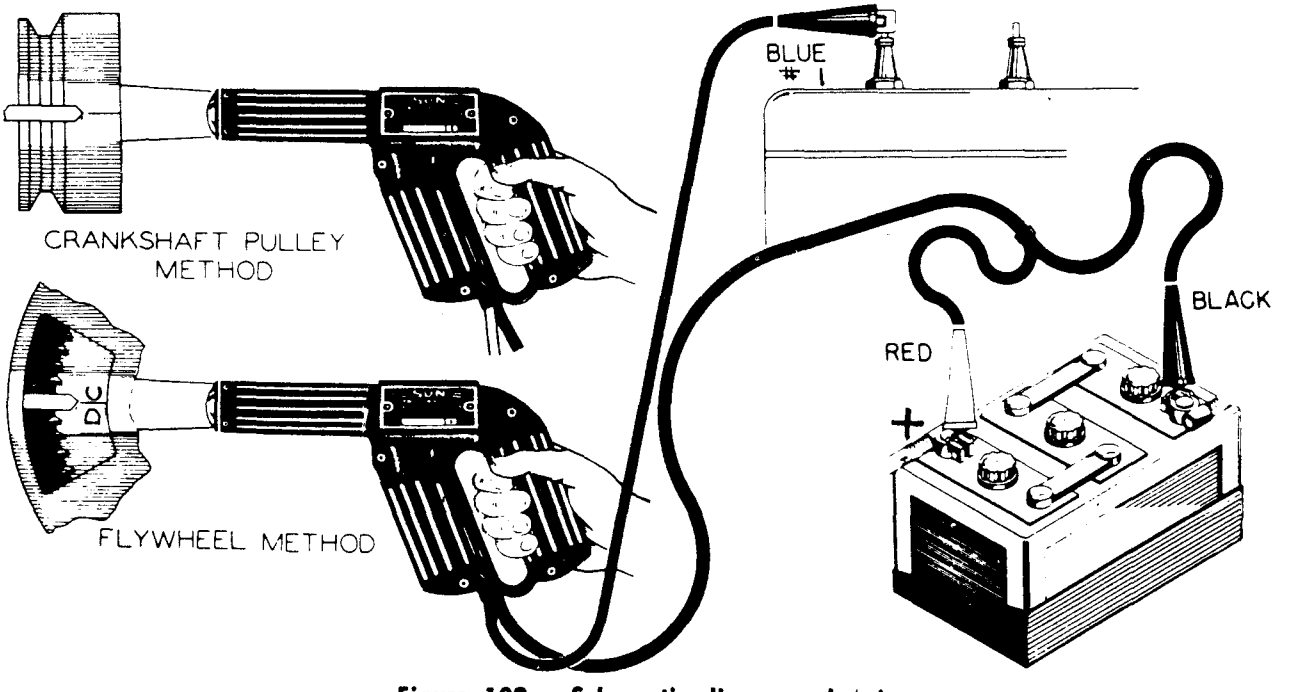


Figure 102 — Schematic diagram showing timing light hookup

Normally Continental L-Head engines with distributor-ignition are timed to have the distributor points start to open when #1 cylinder is on compression stroke and the flywheel mark "DC" (top-dead-center) lines up with the pointer in the bell housing.

There are two methods of checking ignition timing — *with or without a timing light.*

The *preferred method* is to use a timing light in following sequence:

Paint a line on the flywheel (or in some cases, on the front pulley) so the timing mark will be more legible under the timing light.

1. Clip blue secondary lead of light to the #1 spark plug — leave spark plug wire on plug.
2. Connect primary positive lead (red) to positive terminal of battery.
3. Connect primary negative lead (black) to negative battery terminal.

Figure 103 — Checking flywheel timing with timing light

4. Start engine and run at idle speed, 400 RPM or lower, so the automatic advance of the distributor is completely retarded. *THIS IS VERY IMPORTANT TO OBTAIN CORRECT TIMING.*

5. Direct timing light on the crankshaft pulley or on the flywheel through opening in bell housing and note timing marks as light flashes.

6. Timing is normally at "D.C." unless specified otherwise on your engine specification sheet.

7. To advance timing, turn distributor body clockwise. To retard timing, turn distributor body counter-clockwise.

8. When timing is correct, tighten distributor clamp screw securely. Then recheck timing again with light.

9. This operation is best performed in **shaded** area, so timing light is visible.

DISTRIBUTOR IGNITION TIMING
Without Timing Light
(Emergency Method)

An alternative method without timing light, is as follows:

1. Remove #1 Spark Plug — put your thumb over the spark plug hole and crank engine by hand until air is exhausting.

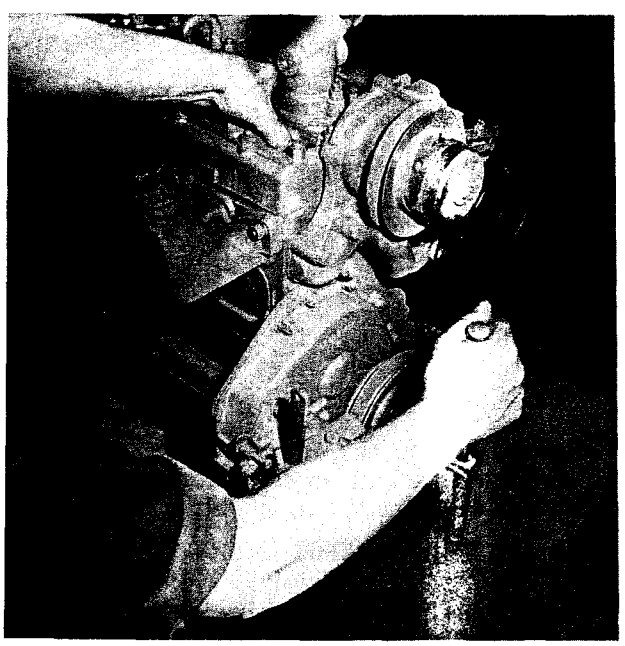


Figure 104 — Checking No. 1 Cylinder on Compression Stroke

2. Set piston on top-dead-center by slowly cranking until "DC" mark on flywheel (or crankshaft pulley) will line up with the pointer in bell housing (or gear cover).

Note: Some special applications may be timed several degrees before top dead center (BTDC).

Figure 104A — Flywheel timing marks

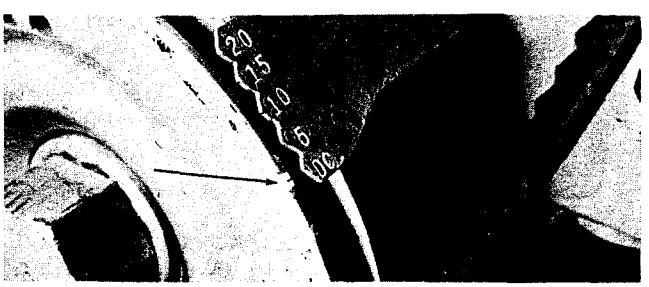


Figure 104B — Crank pulley timing mark

3. Loosen the distributor clamp bolt and rotate the distributor body until the contact points just *Start to Open.*

This may be more accurately checked by means of a test lamp connected between the distributor primary lead and the negative terminal of the battery — when the points are closed the light will be ON and as soon as the points break the light will go OFF.

4. Tighten distributor mounting bolts.

In high altitudes there is less tendency for spark ping as well as low altitudes with premium gasolines. In such cases, improved performance may be obtained by advancing the spark **not to exceed** 4 degrees ahead of specified setting.

CAUTION: *WHEN ENGINE SPECIFICATIONS HAVE SPECIAL TIMING OTHER THAN TOP-DEAD-CENTER — THEY MUST BE FOLLOWED IN ORDER TO OBTAIN SATISFACTORY SERVICE IN SPECIAL APPLICATIONS OR HIGHER ALTITUDES.*

MAGNETO - IGNITION

Magneto-Ignition is furnished on Continental L-Head engines on special applications to provide a complete ignition system without requiring a battery. The smaller engines are easily hand-cranked so that the starters and generators are not furnished in many of these applications.

The magneto comprises all the parts of the battery-ignition system with the exception of the battery, and in addition, means for generating current impulses directly in the primary winding — which is in effect a spark coil.

The advantage of the magneto is this self-contained character. All the elements of the ignition system are in one compact unit, from which it only requires a low-tension cable to the ignition switch and high-tension cables to the spark plugs.

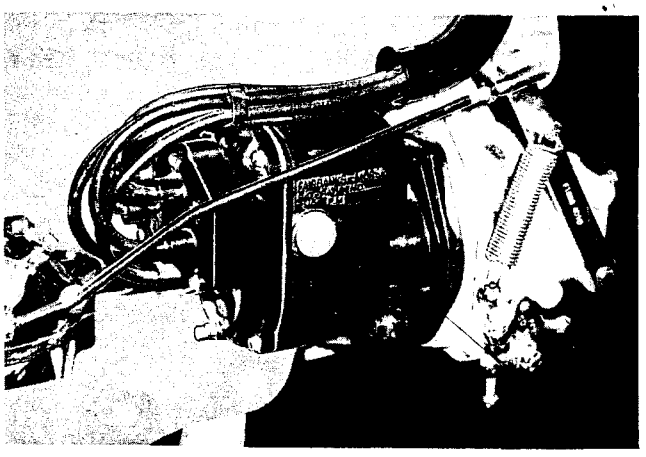


Figure 104C — Magneto installation

Operation

Magnetos are of the rotating magnet type with jump-spark distributor and are flange mounted to an accessory timing gear drive.

The rotation of the magnetic rotor sets up an alternating magnetic flux which cuts the primary winding each time it rises and falls. This induces electric currents, alternating in direction, to flow in the primary circuit during the intervals the breaker points are closed.

The current in the primary winding of the coil establishes a magnetic field which interlocks the turns of the coil secondary winding, this field reaching its maximum simultaneously with the primary current. Breaker point action at the instant of maximum primary current and field, opens the primary circuit so the primary current can't flow — causing the immediate and complete collapse of the magnetic field existing in the coil.

Schematic drawing of magneto ignition

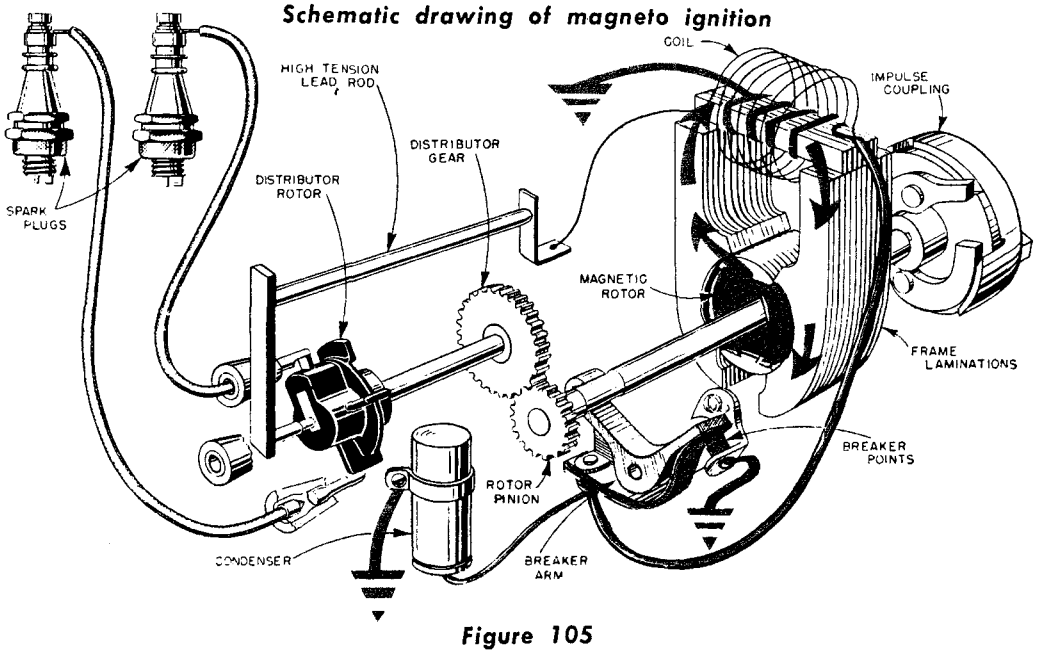


Figure 105

The ratio of turns in the coil secondary winding to those of the primary is very high so the induced voltage in the secondary winding is also very high.

The self-induced voltage occurring in the primary winding, as a result of the quick break of the primary circuit, is absorbed by the condenser wh is shunted across the breaker points. This act promotes a more rapid collapse of the primary fi and at the same time reduces contact point bu ing caused by arcing.

IMPULSE COUPLING

All magnetos have an impulse coupling which assists starting by automatically retarding the ignition spark during the starting operation and at the same time producing an intense, hot spark — which would otherwise be impossible at very low engine speeds.

This device prevents the rotor of the magneto from turning during the starting operation until the engine piston is about at top-dead-center, at which instant the rotor is snapped forward at very high speed, producing an intense spark which is automatically retarded to prevent back-firi Since the point at which the release occurs can controlled in the coupling construction — it is p sible to provide an automatic retard of the igniti spark during the starting period.

Basically the impulse coupling consists of shell and a hub, connected together by a stro spring. One half of the coupling (shell) is fitted a drive member on the engine drive shaft — whi the other half (hub) is keyed to the magneto rot shaft.

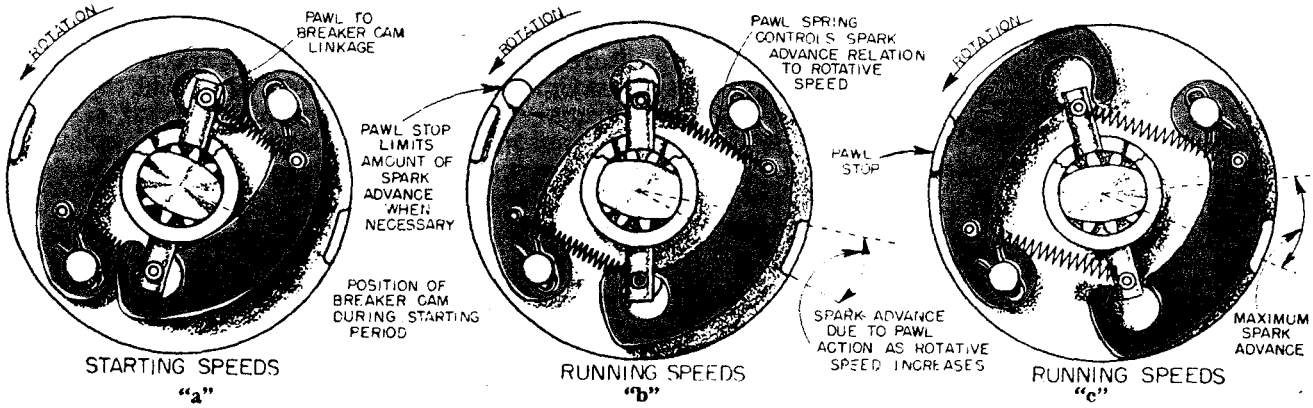


Figure 106 — Operation of Automatic Spark Advance Rotor

AUTOMATIC SPARK ADVANCE

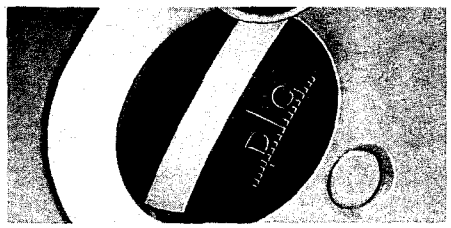
In slow speed operation, a pawl on the magneto half of the coupling engages a stop pin mounted on the magneto frame — which prevents further movement of the rotor. The engine half of the coupling continues to rotate and the relative change in position winds up the connecting spring.

When the desired point of ignition spark is reached, the pawl is released and the drive spring snaps the magneto rotor forward at high speed through its firing position.

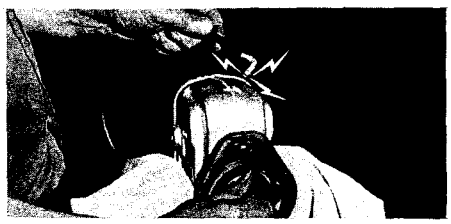
As the engine speed increases, the centrifugal force acting on the pawls — withdraws them to a position not engaging the coupling stop pin — the impulse coupling then acts as a solid drive member.

TIMING MAGNETO TO ENGINE

1. Remove rear spark plug (#4 on four cylinder and #6 on six cylinder engines.)

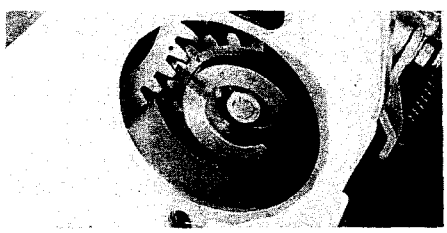


2. Set piston on top-dead-center by slowly cranking until "DC" mark on flywheel (or crankshaft pulley) will line up with the pointer in the flywheel housing (or gear cover).

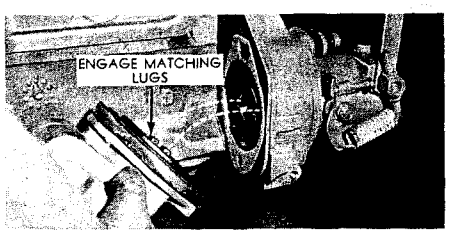


3. With magneto removed from the engine — put it firmly in a vise lined with soft cloths and turn drive lugs of impulse coupling until lead to rear plug (#4 or #6) fires.

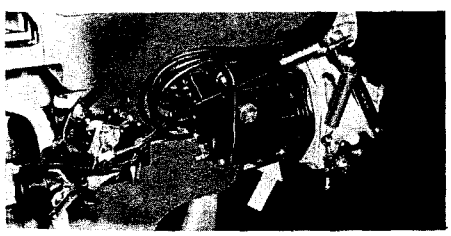
Bosch and Wico magneto indicate #1 lead so rear plug is directly opposite — F. M. magnetos are not marked, but rear plug lead is at 5 o'clock position when facing distributor end.



4. Check front end governor drive and make certain that punch-marked tooth of timing gear is meshing between the two punch-marked teeth of the governor drive gear.



5. Turn back magneto drive lugs of impulse coupling counter-clockwise about ¼ turn so as to mesh with the driving slots of the engine drive member.



6. Position magneto on engine and tighten mounting bolts moderately and connect wires to spark plugs.

7. Start and idle engine 600 R.P.M. and using a timing light connected to rear plug and battery source — check to see if timing is directly at "IGN-M" indicated by pointer.

If not, rotate magneto assembly until timing is correct, then tighten magneto mounting bolts.

IMPORTANT: Engine specifications require magnetos with the correct amount of "Built-in Lag" — which permits timing the magneto to the engine correctly as outlined.

Do not substitute other magnetos.

CHARGING CIRCUIT

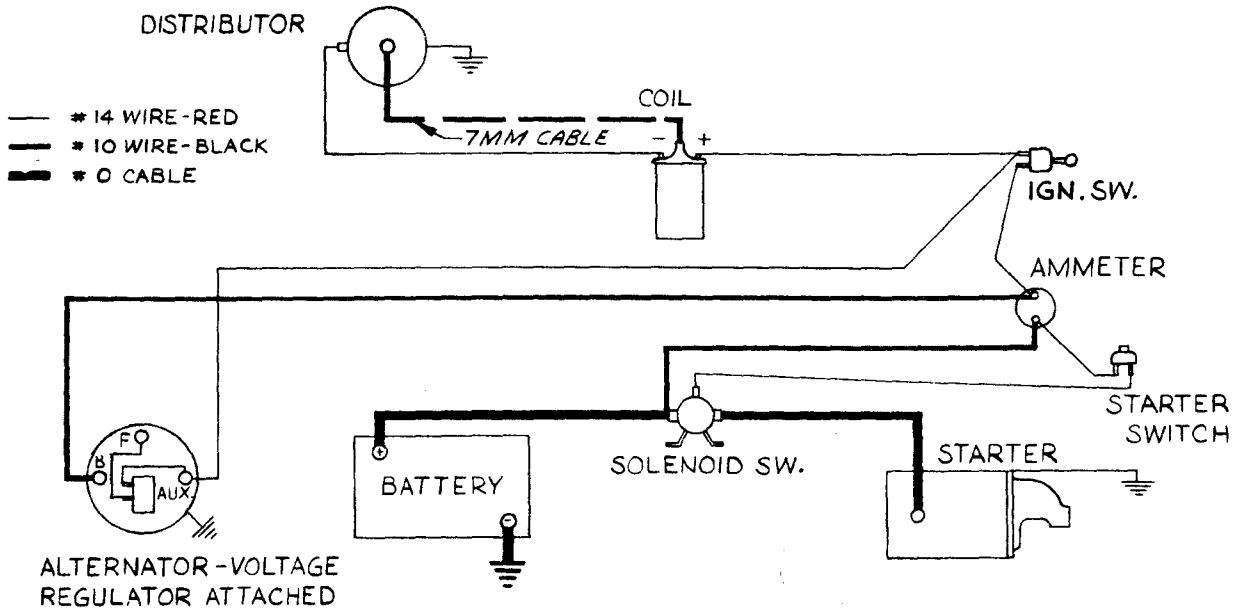


Figure 108 — Wiring Diagram (Prestolite)

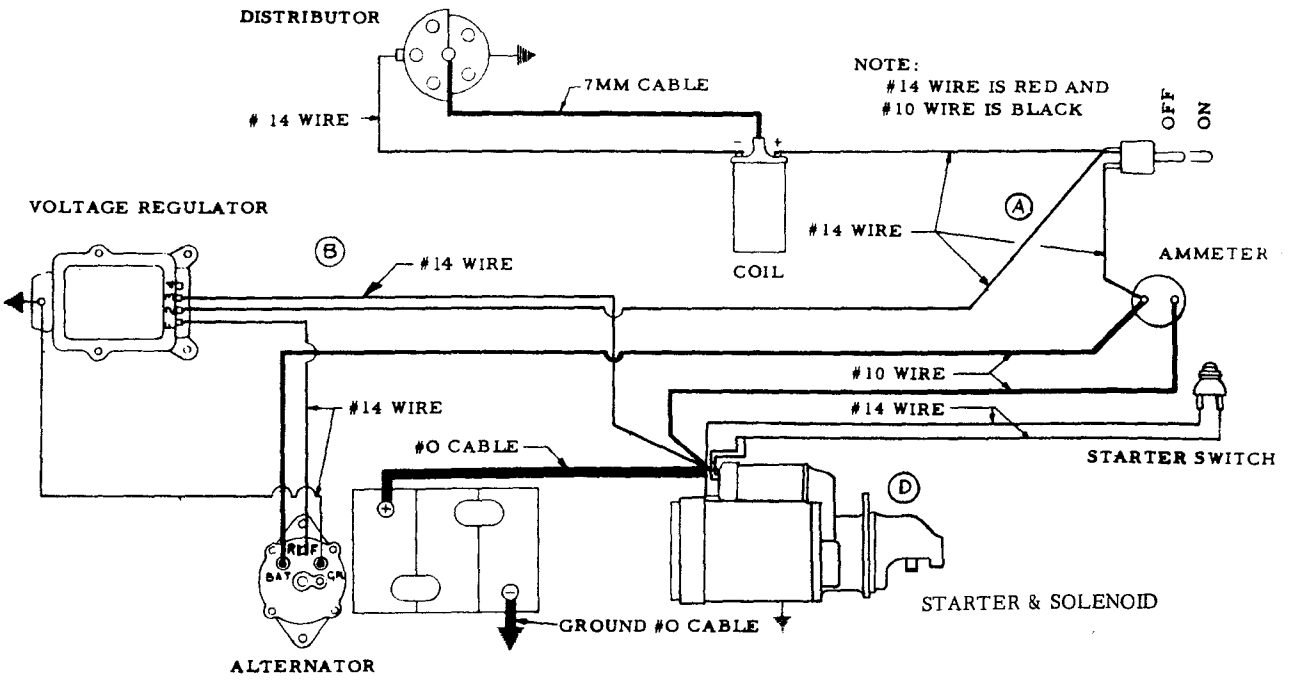


Figure 109 — Wiring Diagram (Delco)

The charging circuit consists primarily of a generator, regulator, battery and wiring. When analyzing the charging circuit, the components should be checked in the following order:

I. **Wiring**

Wiring in the charging circuit should be carefully inspected for frayed insulation or other damage, and replace any wiring that is defective. Also inspect all connections to the generator, regulator and battery (including all ground connections), and clean and tighten as required.

II. **Battery**

The lead-acid storage battery, used on automotive and industrial applications, is an electrochemical device for converting chemical energy into electrical energy.

It has three major functions:

1. It provides a source of current for starting the engine.
2. It acts as a stabilizer to the voltage in the electrical system.
3. It can, for a limited time, furnish current when the electrical demands of the unit exceed the output of the generator.

There are two types of batteries with which we are concerned: The DRY charged and the WET charged.

The DRY charged is shipped from the factory with charged plates, and the electrolyte is added when the battery is ready to be activated.

The WET charged battery is shipped from the factory with the electrolyte already added. This type must be recharged periodically, while in storage, to keep it ready for service.

Battery Testing

Visual Test — The battery should be inspected visually, checking the level of the electrolyte and the outside of the battery for damage and abuse.

The "In-Vehicle" Light Load Test

1. First, if the electrolyte level is low, adjust it to the proper level by adding water.
2. Then place a load in the battery by holding the starter switch "ON" for three seconds, or until the engine starts. If the engine starts, turn off ignition immediately. This removes the surface charge.
3. Then, turn the headlights on low-beam. The headlights must be turned on for one minute before starting the light load test and then left on during the test.
4. If any cell reads 1.95 volts or more and the difference between the highest and lowest is less than .05 volt, the battery is good.

The "Out-of-Vehicle" Light Load Test

This test is conducted in the same way as the "In-Vehicle" test.

To check the electrical condition of battery cells:

1. Place a 150 ampere load on battery for three seconds, using a high rate load tester, to remove surface charge.
2. Then, place a ten ampere load on battery for one minute before starting the Light Load Test. The difference in voltage readings between the individual cells can be interpreted in the same way as indicated under the "In-Vehicle" Light Load Test.

Specific Gravity Cell Comparison Test

This test should be used only on batteries having one-piece cell covers. Measure the specific gravity of each cell, regardless of state of charge, and interpret results as follows:

If the maximum difference between cell readings is less than .050 (50 points) and the lowest cell reading is 1.200 or above, the battery is good.

Full Charge Hydrometer Test

This test is given to fully charged batteries. If cell readings range between 1.230 and 1.310 specific gravity, the battery is ready for use.

NOTE: Add 4 points (.004) to the reading for every 10°F electrolyte temperature above 80°F, and subtract four (4) points for every 10°F electrolyte temperature below 80°F.

Selecting A Replacement Battery

When selecting a replacement battery it should be noted that battery power shrinks while the need for engine cranking power increases with falling temperatures. (See Chart)

BATTERY POWER	TEMPERATURE	ENGINE CRANKING POWER NEEDED
100%	80°	100%
68%	32°	165%
46%	0°	250%
30%	-20°	350%

Installing Batteries

The following points are important to properly install a battery:

1. Be sure the battery carrier is clean and that the new battery rests level when installed.
2. Tighten the hold-down evenly until snug. Do not draw down tight enough to distort or crack battery case.
3. Be sure the cables are in good condition and the terminal clamps are clean. Grease battery terminals lightly before attaching cable clamps. Make sure the ground cable is clean and tight at engine block or frame.
4. Check polarity to be sure battery is not reversed with respect to the generating system.
5. Connect "grounded" terminal of the battery last to avoid short circuits which will damage the battery.

Servicing Batteries

The following points are important to properly service a battery:

1. Check the level of the electrolyte regularly. Add water if necessary but do not overfill.
2. Keep the top of the battery clean. When necessary, wash with baking soda solution and rinse with clear water. Do not allow soda solution to enter cells.
3. Inspect cables, clamps and hold down bracket regularly. Replace if necessary.
4. Use the light load test as your regular service test to check battery condition.
5. Check the electrical system if the battery becomes discharged repeatedly.

CAUTION

Sparks or Flames Near a Battery that is Being Charged May Ignite Explosive Gases Causing a Dangerous Explosion.

III. Alternator

The alternator differs from the conventional D.C. shunt generator in that the armature is the stationary member and is called the stator; while the field is the rotating member and is called the rotor. Alternating current is rectified (changed to direct current) by means of diode rectifiers rather than mechanically with brushes coming into contact with the various segments of the rotating armature on the generator. With this construction, the higher current values involved in the armature or stator may be conducted to the external circuit through fixed leads and connections rather than through the rotating commutator and brushes as in D.C. generator. The comparatively small values of current supplied to the field may be conducted without difficulty through small brushes and rotating slip rings.

The alternator is somewhat lighter and more compact in design than the conventional D.C. generator of comparable electrical size and is equally as simple to service and test.

Each bearing is prelubricated which eliminates the need for periodic lubrication.

PRECAUTIONS TO BE OBSERVED WHEN TESTING OR SERVICING THE ALTERNATOR SYSTEM.

1. DISCONNECT THE BATTERY, before connecting or disconnecting test instruments (except voltmeter) or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and/or wiring.

2. TO AVOID DAMAGE TO THE REGULATOR, DO NOT, AT ANY TIME, CONNECT BATTERY TO THE REGULATOR FIELD TERMINAL.

3. THE FIELD CIRCUIT MUST NEVER BE GROUNDED, ON THIS SYSTEM, BETWEEN THE ALTERNATOR AND THE REGULATOR. Grounding of the field terminal either at the alternator or regulator will damage the regulator.

4. IF IT IS NECESSARY TO SOLDER ANY LEAD TO A RECTIFIER LEAD, use a pair of pliers as a heat dam between the solder joint and the rectifier.

5. THE ALTERNATOR MUST NOT BE OPERATED ON OPEN CIRCUIT WITH THE ROTOR WINDING ENERGIZED.

6. DO NOT ATTEMPT TO POLARIZE THE ALTERNATOR. No polarization is required. Any attempt to do so may result in damage to the alternator, reglator, or circuits.

7. GROUNDING OF THE ALTERNATOR OUTPUT TERMINAL MAY DAMAGE THE ALTERNATOR AND/OR CIRCUIT AND COMPONENTS.

8. REVERSED BATTERY CONNECTIONS MAY DAMAGE THE RECTIFIERS, WIRING OR OTHER COMPONENTS OF THE CHARGING SYSTEM. Battery polarity should be checked with a voltmeter before connecting the battery.

9. IF A BOOSTER BATTERY OR FAST CHARGER IS USED, ITS POLARITY MUST BE CONNECTED CORRECTLY TO PREVENT DAMAGE TO THE ELECTRICAL SYSTEM COMPONENTS. (POSITIVE TO POSITIVE, NEGATIVE TO NEGATIVE).

IV. **Regulator**

Some regulators are fully transistorized and completely sealed. These can not be adjusted or repaired, and it can be assumed that this type regulator will outlive the other components in the charging system.

Other regulators are adjusted and repaired in accordance with the manufacturer's instructions.

Installation of Regulator for Alternator

To insure proper operation and to protect the alternator and regulator, the following steps should be observed during installation.

1. Make sure regulator is of the same voltage and polarity as the alternator and battery.

2. Disconnect battery cable at battery terminal.

3. Make sure the mounting area of the alternator and regulator base are clean and make a good tight connection.

4. Connect alternator in accordance with the manufacturer's instructions.

5. Do not flash field or ground terminals of the regulator.

6. Reconnect battery cable.

7. Start engine and observe ammeter. A "High" charge rate is normal for the first few minutes, but will decrease as the regulator warms up.

NOTE: When servicing the charging system, never remove a unit until tests have shown it to be defective. Reference always should be made to the manufacturer's maintenance manuals for a complete trouble shooting story.

SECTION VIII
ENGINE REPAIR AND OVERHAUL

This section includes instructions for repairs and overhaul of the component units of Continental Red Seal L-Head engines.

Provide a clean place to work and clean the engine exterior before you start disassembling — dirt causes engine failures. Many shop tools have been developed to save time and assure good workmanship; these should be included in your equipment.

Use only genuine Red Seal parts in Continental engines since years of development and testing have gone into these specifications to assure maximum life and performance.

CYLINDER HEAD

The cylinder head is an important part of the engine assembly since it contains the complete combustion chamber and cored passage for water flow. Remove the cylinder head in the following sequence:

1. Drain water from engine and disconnect radiator or heat exchanger outlet hose.

2. Loosen and remove the nuts holding the cylinder head to the block.

3. Lift the cylinder head off the engine and carry to a clean bench for further disassembly.

4. Remove all carbon from combustion areas using a scraper and wire brush.

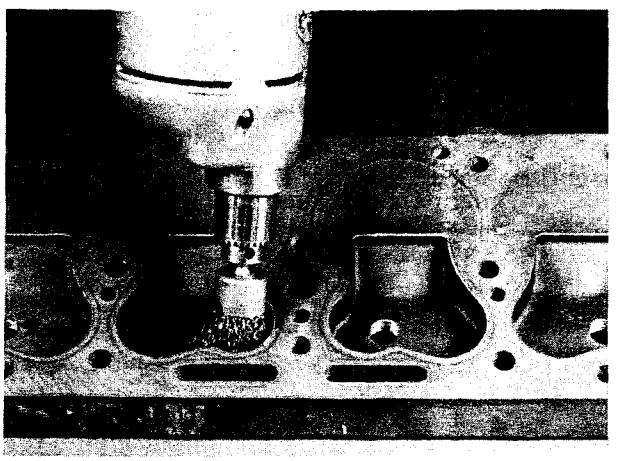


Figure 110 — Cleaning carbon from combustion chamber

5. Clean the cylinder head thoroughly with a solvent or degreasing solution and blow it off with air pressure.

6. Make sure that gasket contact surfaces on the head and block are clean, smooth and flat.

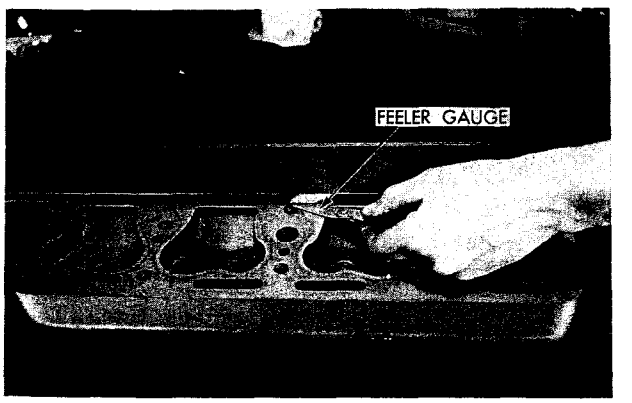


Figure 111 — Checking cylinder head flatness lengthwise.

7. Check out-of-flatness with straight edge and feeler gauge: maximum permissible is .00075 inches per inch of width or length. Thus, for a cylinder head 16″ long, maximum permissible lengthwise out-of-flatness is .012″. Out-of-flatness should vary gradually and uniformly from end to end and side to side. Localized depressions or high spots should not exceed .003.

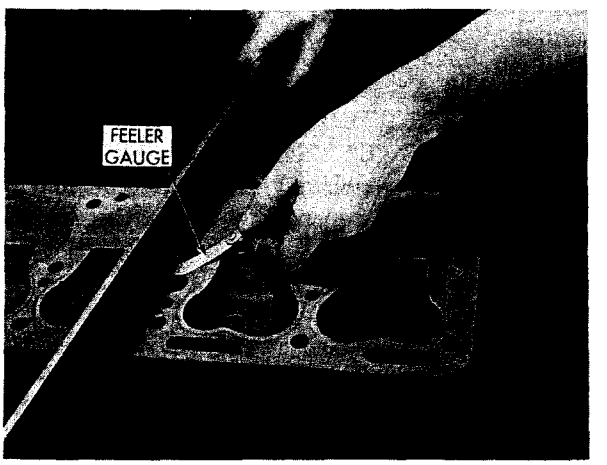


Figure 112 — Checking cylinder head flatness crosswise.

CYLINDER BLOCK

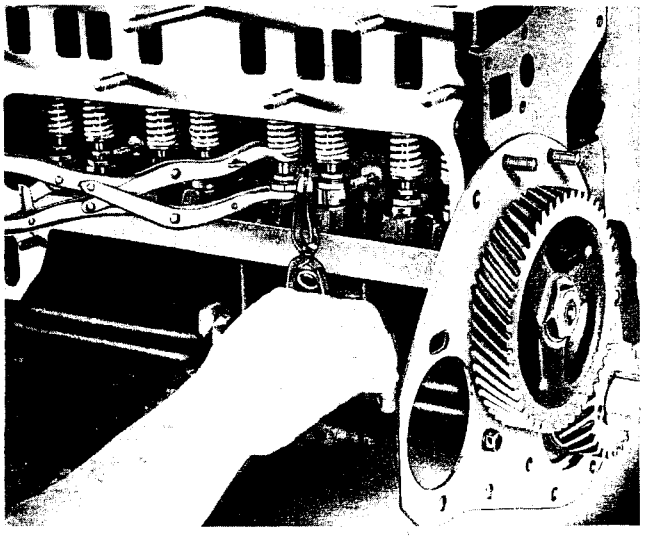


Figure 113 — Valve Removal

1. With a valve spring lifter, compress the springs and remove the locks or pins from the valve stems which are in a closed position. Close the other valves by rotating the crankshaft and remove the locks (or pins) from these valves in the same manner. Remove all valves and place in order in a rack, with holes numbered for both intake and exhaust valves so they will not be mixed in handling.

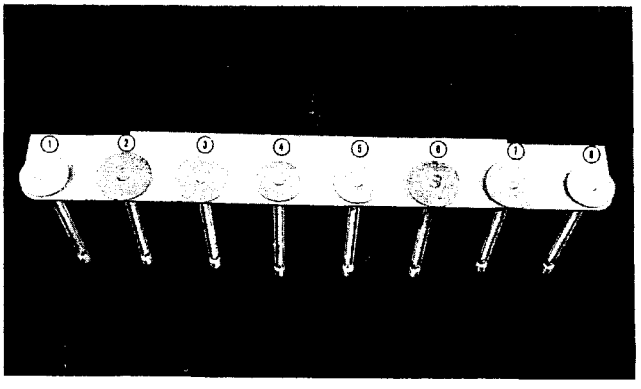


Figure 114 — Valves in rack

VALVE GUIDES

1. Clean the valve stem guides, removing lacquer or other deposits by running a valve guide cleaner or wire brush through the guides.

2. Check guides for wear by using "Go and No-Go" plug gage or a telescope gage and 1" micrometer. Replace all guides that are worn bell-mouthed and have increased .0015 in diameter. See Limits and Clearance Section for maximum diameter permissible to determine actual amount the diameter has increased. Remove all valve guides when necessary by using an arbor press and pressing them out from the combustion chamber side with a driver slightly smaller than the O.D. of the valve guide.

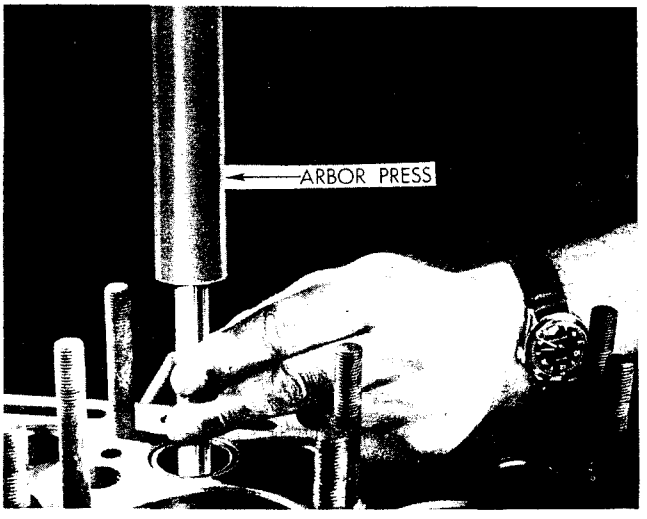
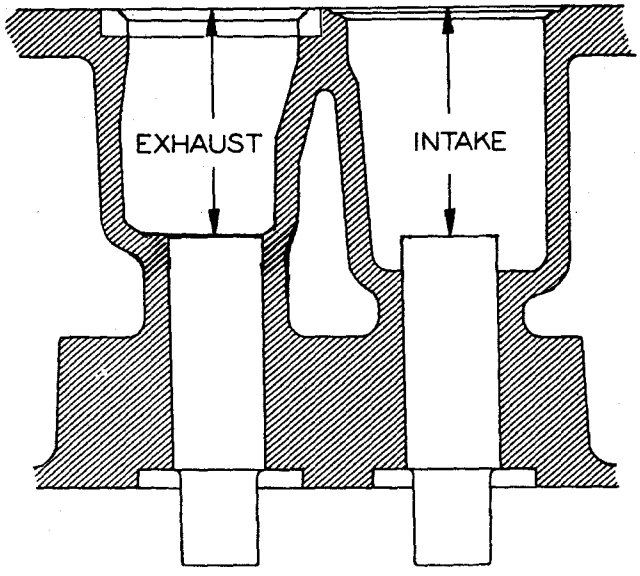


Figure 115 — Removing valve guides

3. Replace worn guides as required by using a suitable driver and an arbor press from the combustion side to the correct depth below the valve seat as given in the Limits and Clearance Chart.



Engine	Distance from Block Face to Top of Guide	
	Intake	Exhaust
N56, N62	25/32	25/32
Y69, Y91, Y112	7/8	7/8
F-4 , F-6 Series	1 13/32	1 13/32
M271, M290 M330, M363	1 1/4	1 9/16
B371, B427	1 7/8	1 5/16

Figure 116 — Diagram and chart showing valve guide location

CAUTION: When replacing guides that are ferrox coated do not ream since these are all pre-reamed before being ferrox coated — any further reaming will remove the coating.

VALVE SEAT INSERTS

1. The exhaust valve seat insert is held in plac by a shrink fit.

Inspect all exhaust valve inserts in the block an replace any that are loose, cracked or otherwis damaged. Use puller for removing faulty insert a shown in illustration.

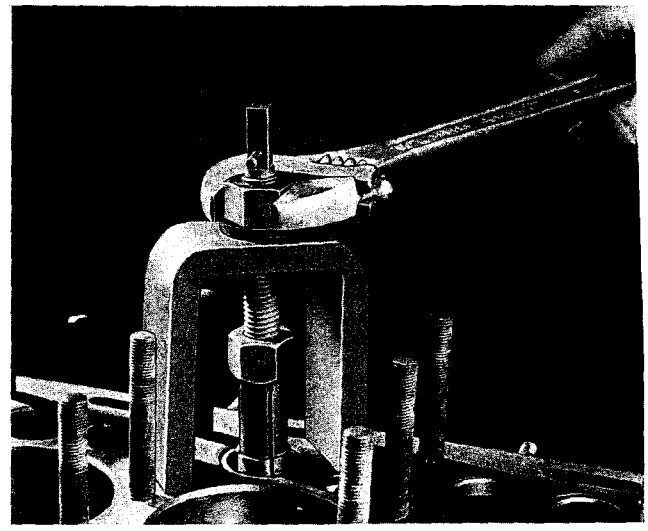


Figure 117 — Removing exhaust valve seat insert

2. When required to replace with new insert, clean and counterbore for .010 larger insert using counterbore tool with correct fitting pilot.

When machining the counterbore, be sure to go deep enough with the tool to clean up the bottom so that the insert will have full contact to carry away the heat.

Continental does not recommend installing new inserts having the same outside diameter as the one removed. The following chart shows the dimensions of Standard Inserts and counterbores:

DIMENSIONS OF STANDARD INSERTS AND COUNTERBORES

Engine Model	Outside Dia. of Insert (A)	Inside Dia. of Counterbore (B)	Press Fit
N-56 N-62	1.068-1.067	1.063-1.062	.004-.006
Y-69 Y-91 Y-112	1.1295-1.1285	1.1255-1.1245	.003-.005
F124 F135 F140 F163 F244 F245 F162	1.3485-1.3475	1.3445-1.3435	.003-.005
F-186 F-209 F-226 F-227	1.442-1.441	1.438-1.437	.003-.005
M-271 M-290 M-330 M-363	1.692-1.691	1.688-1.687	.003-.005
B-371 B-427	1.8785-1.8775	1.8755-1.8745	.003-.005

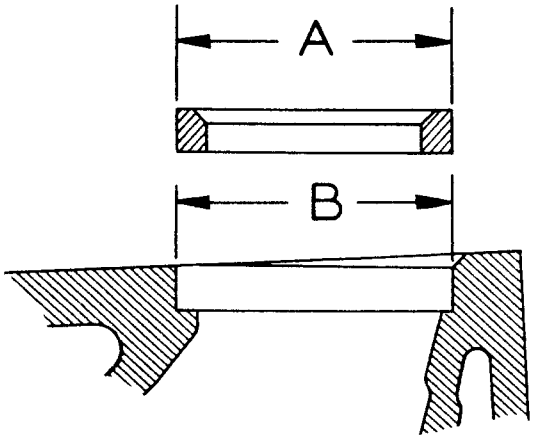


Figure 117-A — Insert and counterbore

When OVERSIZE inserts are used, dimensions of the insert and counterbore increase proportionately (.010, .020 — depending on the oversize).

New insert installation should have a press fit. Chill insert in container with dry ice for 20 minutes before assembling.

Insert may then be installed in the counterbore using a piloted driver, tapping in place with very light hammer blows, without the possibility of shearing the side walls. This assures it being seated firmly on the bottom of the counterbore.

Figure 118 — Installing valve seat insert with an arbor press

3. Grind the intake and exhaust valve seats in the block in accordance with instructions in the limits and clearance chart and before removing the arbor, indicate the seat. Total indicator reading of the run-out must not be more than .002". Use a pilot having a solid stem with a long taper, as all valve seats must be ground concentric and square with either new or worn valve stem guide holes.

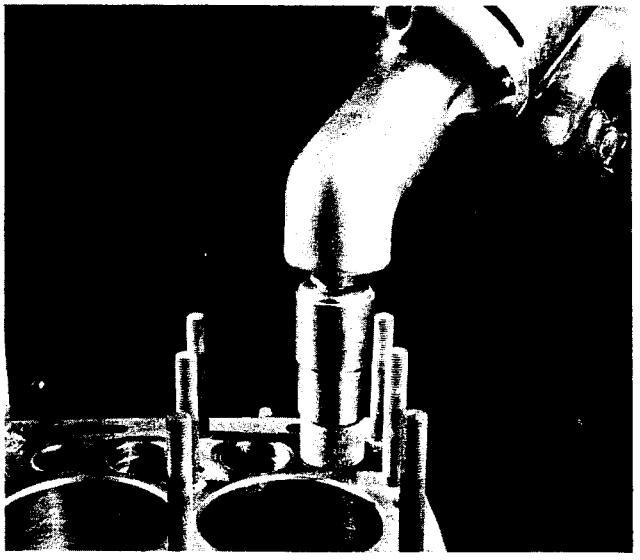


Figure 119 — Grinding Valve Seat

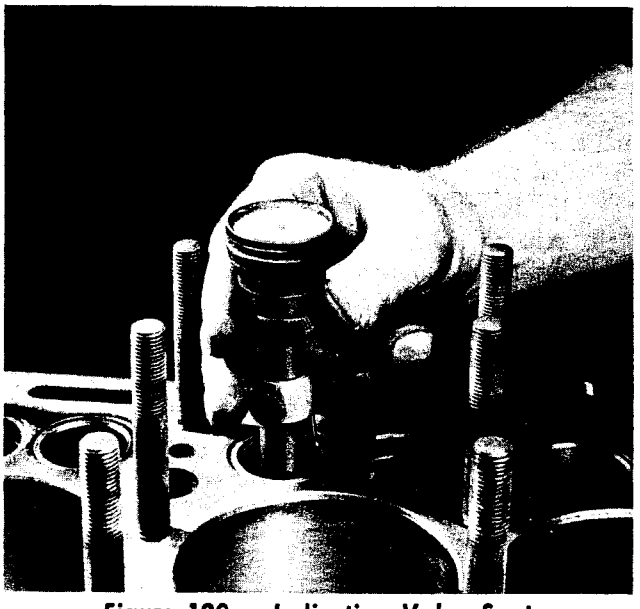


Figure 120 — Indicating Valve Seat

VALVES

1. Inspect valves for condition and replace any that are "necked", cracked or burned, also any on which valve stems are bent or worn more than .002 over the maximum allowable limits. Reface or replace all valves.

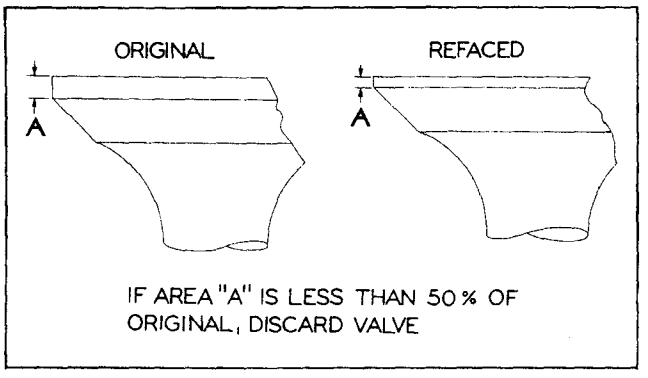


Figure 121 — Allowable head thickness of refaced valves

2. All valves having less than 50% margin thickness (outer edge of valve head) after refacing has been completed must be replaced. To check this dimension, compare the refaced valve with a new valve.

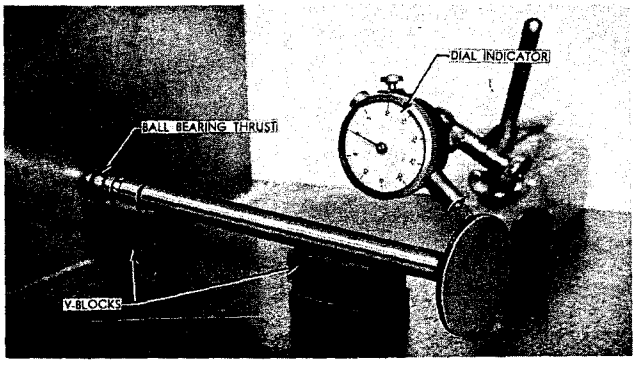


Figure 122 — Checking valve face in "V" blocks

3. Check all refaced or new valves in V-blocks with indicator to determine if the contact face is true with the stem within .002. If not, repeat the refacing operation.

4. After the valves and seats have been refaced and reground, coat the seat lightly with Prussian blue and drop the valve into position, oscillating it slightly to transfer the blue pattern to the valve face. This should show a contact width of 1/16" to 3/32" and should fall well within the width of the valve face, leaving at least 1/64" on either side where the blue does not show. If the contact is over 3/3 wide, the seat in the head may be narrowed using a 15° stone to reduce the outside diameter using a 60° or 75° stone to increase the insi diameter.

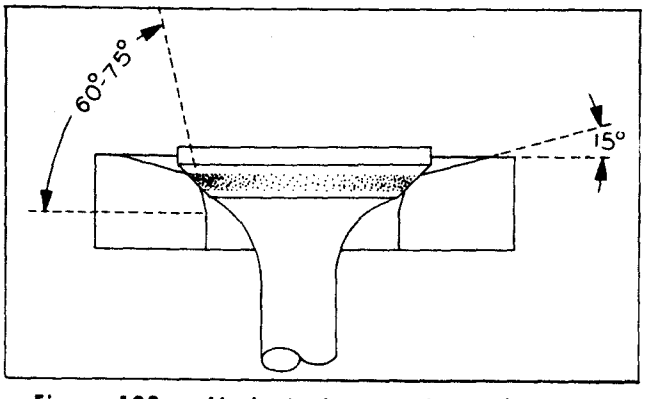


Figure 123 — Method of narrowing valve seats

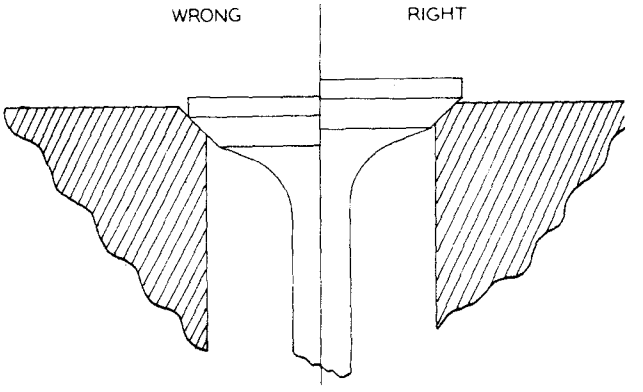


Figure 124 — Valve position in block

Never allow valves to set down inside the sea

After the narrowed-down seat is brought withi specifications, the seat should be retouched lightl with the original stone to remove burrs or feath ered edge.

> **"A poor valve grinding job cannot be corrected by valve lapping."**

5. Coat the valve stem with a light film of en gine oil.

VALVE SPRINGS

1. Check all valve springs on a spring tester tc make sure they meet specifications regarding weight and length. Springs, when compressed tc the "valve open" or "valve closed" length, must fall within the specifications shown on the chart when new, and must not show more than 10% loss to re-use.

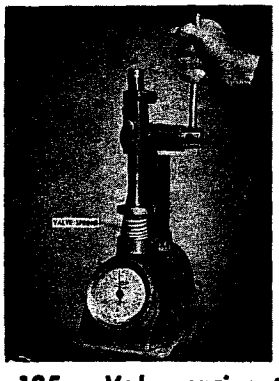


Figure 125 — Valve spring tester

2. Reassemble the valves and springs in the block with the retainer and retainer lock.

CHECKING BORE WEAR

1. Clean the ring of carbon from around the top of the cylinder bore formed above the travel of the top ring.

2. Determine the original diameter of the cylinder barrel by checking this unworn area with a pair of inside micrometers at intervals of approximately 45°.

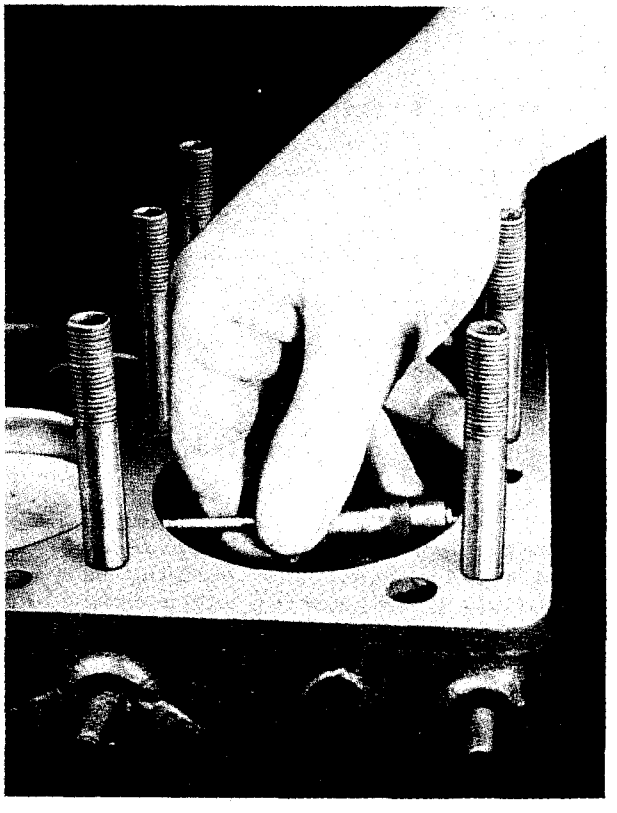


Figure 126 — Measuring original bore diameter above ring travel

3. Check in same manner the top of the ring travel area approximately ¼" below the shoulder.

4. The maximum difference in the above checks, indicates the amount of cylinder bore wear. If less than .008, re-ringing will be suitable and if over .008 re-boring is recommended.

PREPARING CYLINDER WALLS FOR RE-RINGING OR REBORING

1. Ridge ream the cylinders to remove the unworn area at the top so that the new rings when assembled will not bump and distort both themselves and the piston lands.

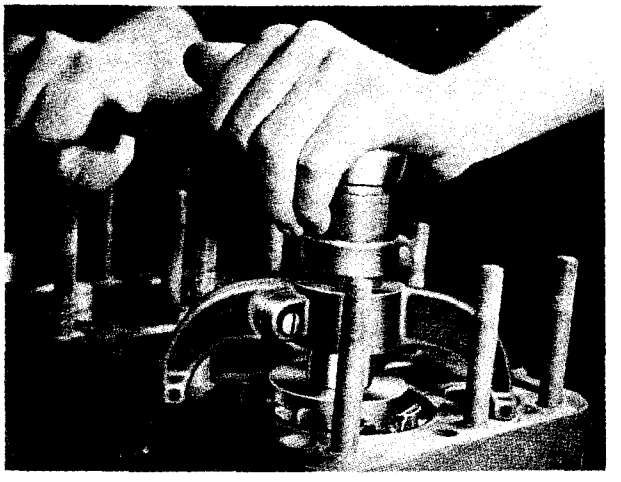


Figure 127 — Ridge reaming top of cylinder bore

Several good makes of ridge reamers are available which will ream the top of the bore in direct relation to the worn area so that should the worn area be off center slightly there will be no partial ridge remaining.

2. Drain the crankcase and remove the oil pan.

3. Remove the cap screws holding the connecting rod caps to the rod. *Keep the cap and bolts in numerical order so that when the pistons and rods are removed from the engine, the cap can be reassembled and kept with its mating part.*

4. Push the pistons and connecting rods up through the top of the cylinder, carrying with them all the carbon and metal chips left from the cleaning and ridge reaming operation. *When doing this, every precaution must be taken to prevent damage to cylinder bores by the sharp corners and rough edges of the connecting rods and bolts.*

5. To get the correct cross hatch pattern with a cylinder hone, use a top quality electric drill with a speed of 500 RPM or less.

It is important to remove the glaze on the cylinder bores by using a cylinder hone, with an adjustable stone tension, (see illustration), in order to assure quick seating of the new piston rings. **If the cylinder glaze is not removed, you will have no assurance as to when the rings will begin to function properly and control the oil; this is especially true when chrome rings are used.**

The following step by step procedure is recommended:

a. Cover the entire crankshaft with a clean, slightly oily cloth to prevent abrasives and dirt from getting on the crankshaft.

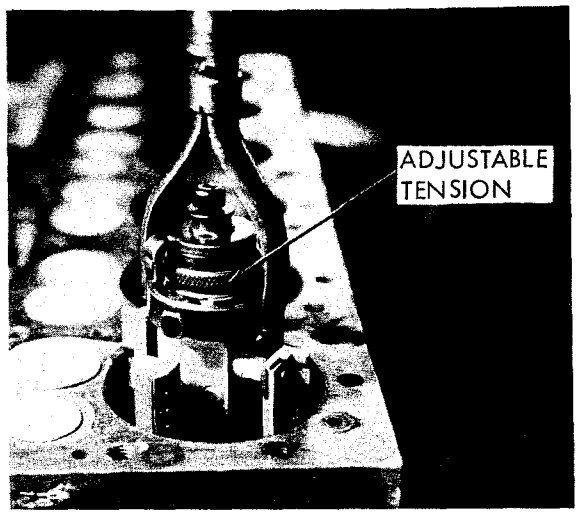


Figure 128 — Honing cylinders

b. Remove the excess carbon deposits from the top of the cylinder wall before beginning the glaze breaking operation. (This is to prevent loading the stones.)

c. Insert hone in cylinder and expand to cylinder wall with slight tension. Using a clean brush, wet cylinder wall and stones with kerosene. Use a hand drill and surface hone cylinder with a rapid up and down motion to produce a good cross hatch pattern. Apply kerosene occasionally as needed and increase tension on hone adjustment until a good pattern and finish is obtained. A smooth finish of 10 to 15 micro inches is desired.

d. Clean the loose abrasives from the stones by using kerosene and a wire brush.

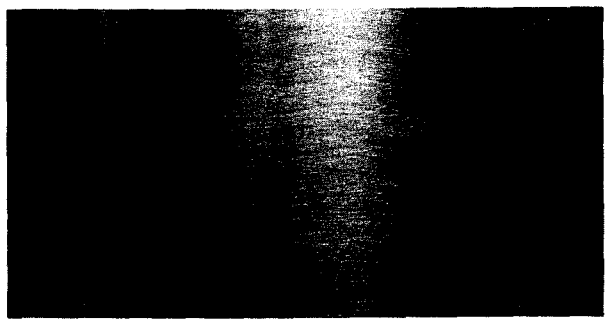


Figure 129 — Desirable cross hatch pattern obtained with a cylinder hone

IMPORTANT

Stones must be used wet. Keep applying kerosene during honing to prevent stones from drying out and causing an incorrect honing pattern.

e. The most desirable cylinder finish is 10-15 micro inches; with this finish the depressions in the surface tend to keep the supply of lubrication between the mating parts. This finish can be obtained by using 280 grit stones on the hone.

f. Clean all bores thoroughly with a clean oiled rag to pick up all the small particles of dust that may be embedded in the walls. Follow this with a clean cloth to make certain the walls are **CLEAN.**

PISTONS

Check the pistons for excessive ring groove wear, and replace any that exceed the allowable limits in our limits and clearance data.

The cylinder walls and pistons must be perfectly clean and dry when fitting pistons in the cylinder bores. Pistons should be fitted with the block and piston at room temperature (68° - 70° F).

PISTON FIT ON STANDARD PISTONS*
(with 5 to 10# Pull)

N-Y Series	.002
F4, F6 Series	.003
M271	.004
M330	.005
M363	.003
B Series	.005

*This fit may vary on some special applications.

Check the piston fit in the bore using a half-inch wide strip of feeler stock, of the thickness specified in the Limits and Clearance Chart, the feeler being attached to a small scale of approximately 15 lbs. capacity.

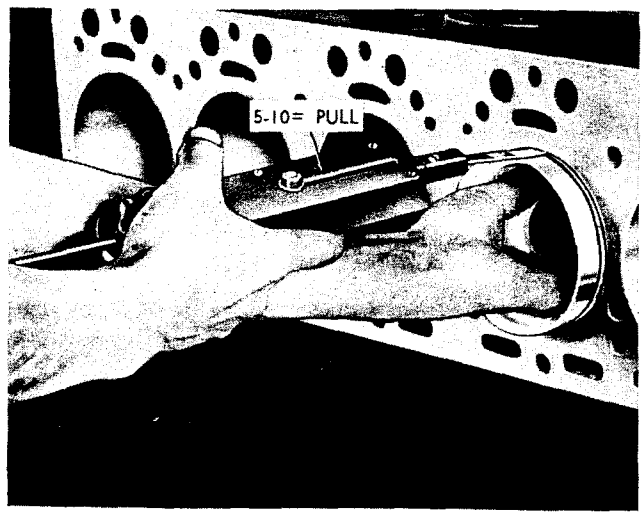


Figure 130 — Checking Piston fit in bore

When the correct fit is obtained you must be able to withdraw the feeler with a pull of 5-10 pounds on the scale, with the feeler inserted between the piston and the cylinder midway between the piston pin bosses where the diameter of the piston is the greatest. Check the fit of the piston when it is approximately 2" down in the cylinder bore in an inverted position.

PISTON PINS

Check the bushing in the upper end of the connecting rod for wear. If worn and you are using the original pistons with a service set of rings, an oversize piston pin may be obtained in .003 or .005" oversize.

The piston pin hole in the piston and the bushing in the connecting rod may be honed to increase

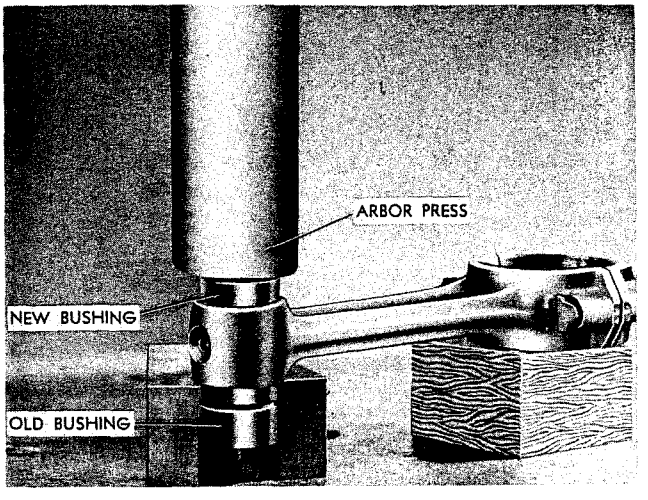


Figure 131 — Pressing in Piston Pin Bushing

their diameter to obtain the desired fit as shown in your Limits and Clearance Chart.

> Note that while the chart specifies a light push fit of the pin in the piston, there is a definite clearance of the piston pin in the connecting rod.

CONNECTING ROD

Replace the bushing in the connecting rod if new pistons and sleeves are used. Using an arbor press, press out the old bushing and press in the new one — after which the bushing must be honed to obtain the correct fit of the pin in the bushing as shown on Limits and Clearance Chart.

If there is an excess of stock in the piston pin bushing, it may be reamed first, then honed. In any event, the final operation should be done with a hone to obtain the desired fit with better than 75% bearing area on the pin.

PISTON AND CONNECTING ROD ASSEMBLY

1. Assemble the pistons on the connecting rod by first heating them in some form of oven or in hot water to a minimum temperature of 160°F. When heated, the piston pin will enter the piston very easily and can be tapped through the connecting rod and into place without distorting the piston.

The snap rings must be assembled in the grooves, making sure they are fully seated in place.

2. The piston pin hole in the connecting rod must be parallel to and in plane with, the large bore in the bearing end of the connecting rod.

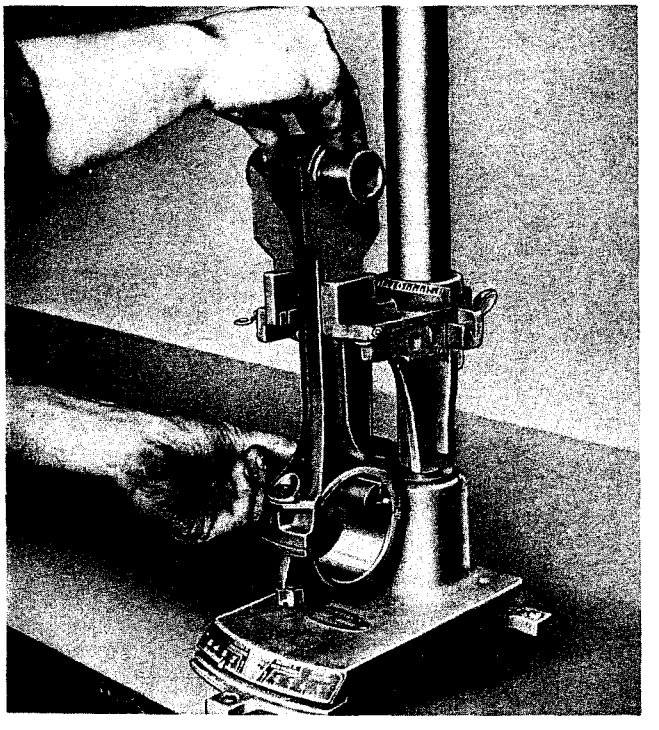


Figure 132 — Checking connecting rod for twist and alignment

This may be checked on a fixture with the piston pin assembled in the rod before assembling the piston; but regardless of this preliminary check, the completed piston and rod assembly must be rechecked and there must not be more than .002" twist or out of squareness checked over a spread of approximately 4 inches. The connecting rod can be bent or twisted to meet this specification.

Pistons are cam and taper ground, and this must be taken into consideration when checking alignment of the assembly, since the diameter in line with the piston pin would be less at the top of the skirt than at the bottom.

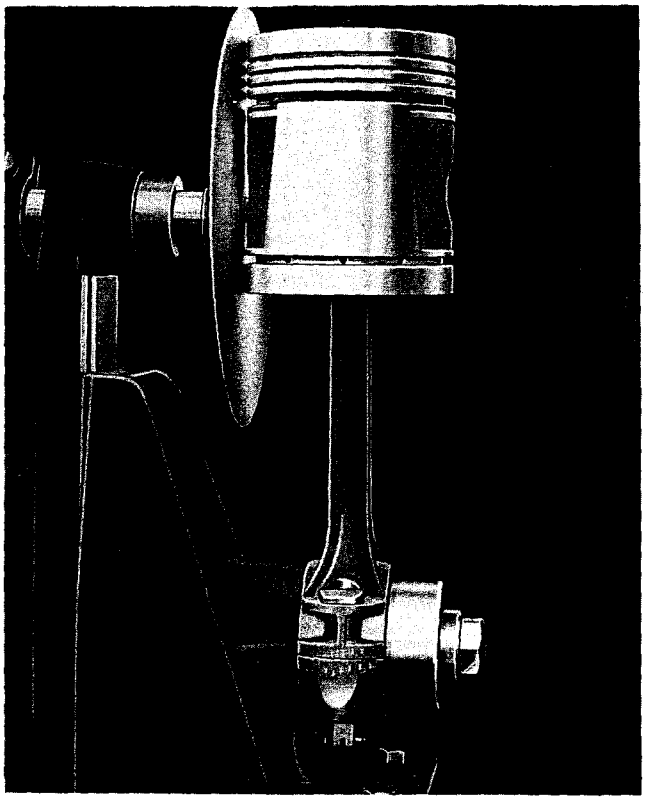


Figure 134 — Checking connecting rod assembly for alignment

PISTON RINGS

Check the piston rings in the cylinders for g

To do this, insert a piston in the cylinder bo in an inverted position and then insert each ri one at a time about 2" down in the bore and bri the bottom edge of the piston up against the ri to square it up in the cylinder bore.

Check the gap between the ends of the ring wi a feeler gauge in accordance with specificatio shown in the Limits and Clearance chart.

RECOMMENDED METHOD OF INSTALLIN PISTON RINGS

1. Grip the connecting rod in a vise with lea lined jaws to hold the piston firmly and roll eac of the straight side rings in its groove to be sur there are no burrs or other interference with th free action of the ring in the groove.

Figure 135 — Installing rings with ring expander tool

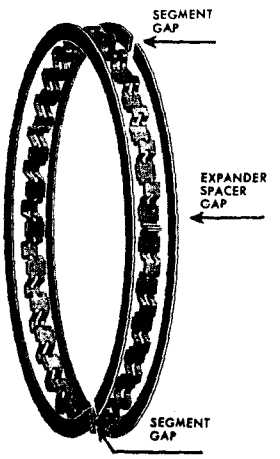


Figure 136 — Three piece oil ring

a. Place stainless steel expander spacer in groove with ends butted.

b. Install steel segment on top side of expander spacer with gap of segment approximately 90° beyond gap of stainless steel expander spacer, making certain that the expander spacer is still in a butted position.

c. Install second segment on bottom side of the expander spacer with segment gap approximately 90° from the expander gap in opposite direction from which the top segment has been installed.

d. Recheck assembly — rings should be free to move in the groove, however, a slight drag will be evident because of the side scaling action of the ring assembly. BE SURE EXPANDER SPACER REMAINS IN BUTTED POSITION.

e. When pistons are ready for installation in the cylinders, compress rings carefully using a good ring compressor and a light tap on the head of the piston will allow the assembly to go into the cylinder very easily. If any difficulty in tapping piston and ring assembly into the cylinder is encountered, the compressor should be removed and rings checked for correct installation in the groove.

PIN MILLED APPLICATION

Install gap of expander spacer 90° from pin, with hump of expander over pin and ends butted. Install top segment, then bottom segment with gaps of segments over pin.

2. The 3 piece oil ring should be installed first on the piston, from the top side so skirt will not be scratched.

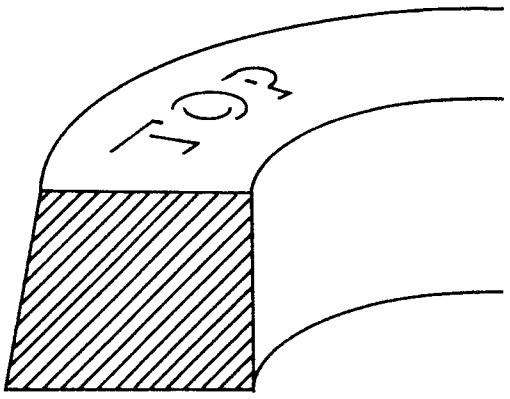


Figure 137 — Install Tapered Rings with "Top" Side Up

3. To install the balance of the rings, use a ring tool with **recess** side up and place the ring in with the bottom side up. **Start with the lowest ring first.**

Some piston rings are taper faced. These are clearly marked "TOP" on the side to be **up** when assembled on piston.

4. Position ring in the tool so the expanding fingers will fully engage both ends.

5. Apply pressure on handles so ring is completely expanded. Pass the expanded ring and tool **recessed side down** over the piston to the proper groove.

CAUTION

If piston is equipped with a steel groove insert, this must be installed on top of the number one ring. (The steel groove insert is not part of the re-ring kit — this can be re-used when replacing rings.)

6. Check the ring side clearance at various positions with a feeler in accordance with the tolerances shown on the Limits and Clearance Chart.

Figure 138 — Checking Ring Clearance in Groove

CRANKSHAFT AND MAIN BEARINGS

1. Using a puller, remove pulley from crankshaft.

2. Take out screws and remove gear cover.

3. Drop the oil pump, by removing nut or cap screws holding pump to center main bearing cap.

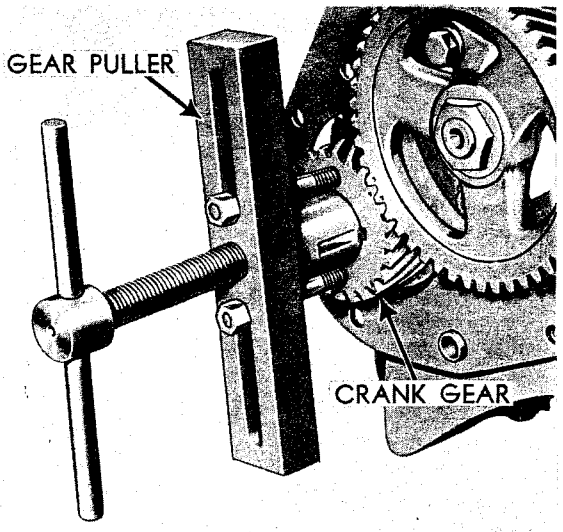


Figure 138A — Removing Crank Gear

4. Remove each main bearing cap, one at a time, and inspect the bearing and crankshaft journals.

If there is any indication of flaking out, scoring or actual wear, — **they must be replaced.**

BEARINGS

Some models use tri-metal bearings which when new are smooth and highly polished. However, a *very few hours of operation will change their appearance completely.* The bearing surface becomes a leaden gray in color and develops minute craters, almost cellular in appearance as indicated in the photograph, which follow the pattern of the matrix. *This appearance is a natural characteristic of this type bearing and in no way indicates failure.*

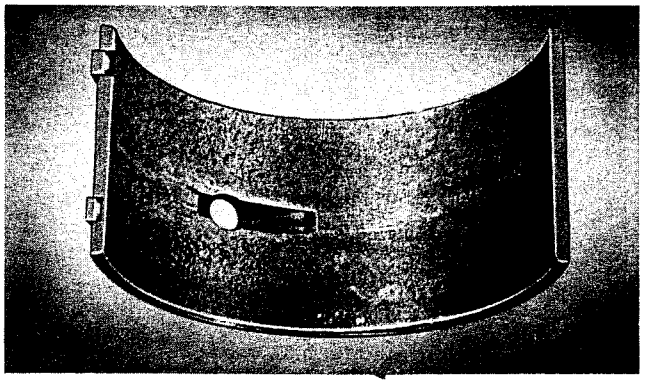


Figure 139 — Appearance of a Good Bearing

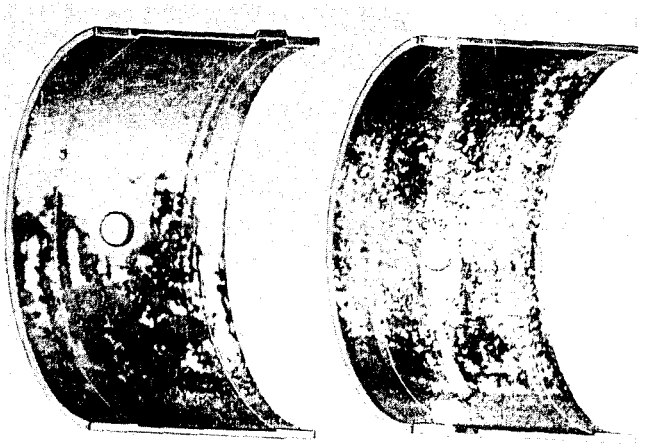


Figure 140 — Bearing Damage Due to Corrosion

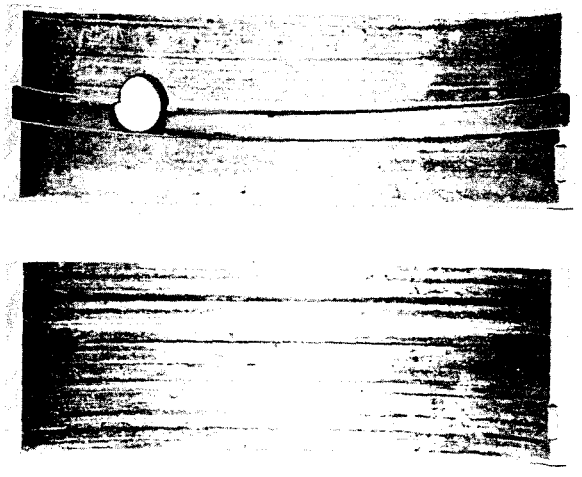


Figure 141 — Scored Bearing Due to Dirt or Lack of Oil

5. If the visual inspection appears satisfactory, they should be removed and checked for thickness using a ball micrometer.

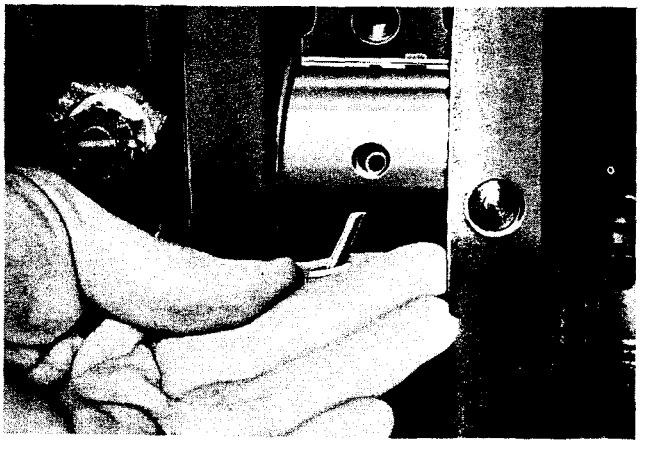


Figure 142 — Removing Main Bearing

To remove the upper half of the bearing shell use a special tool obtainable at most parts houses, which is a pin with an angular head. It may be inserted in the oil hole of the crankshaft and as the crankshaft is turned in a clockwise direction, the head of this pin picks up the bearing shell and forces it out of the bore in the block.

Figure 143 — Measuring Bearing Thickness

The thickness of the bearing shells is given in the Limits and Clearance Chart, and if this thickness has been reduced more than .0005 beyond the maximum allowable tolerance the bearing shell must be replaced.

6. If visual inspection of the crankshaft shows no indication of excessive wear or scoring, the clearance of the feeler should be checked.

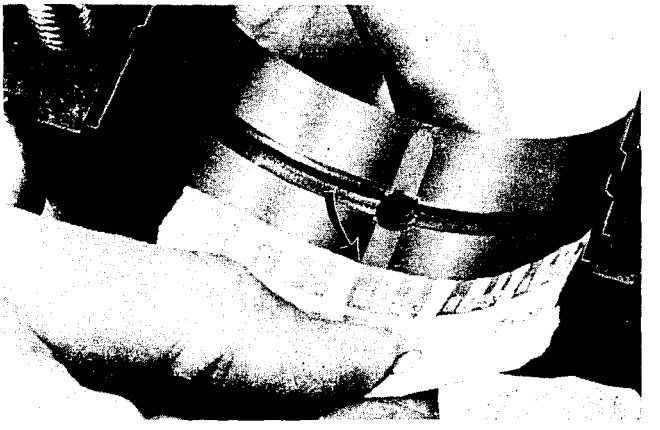


Figure 144 — Checking Bearing Clearance with Plastigauge

7. Check each bearing, one at a time, by using a piece of Plastigage of a diameter specified to check certain clearances.

By placing this Plastigage in the bearing and tightening it in place, the width of the Plastigage after crushing determines the bearing clearance as shown above.

CAUTION

When using this method DO NOT TURN the crankshaft as that would destroy the Plastigage.

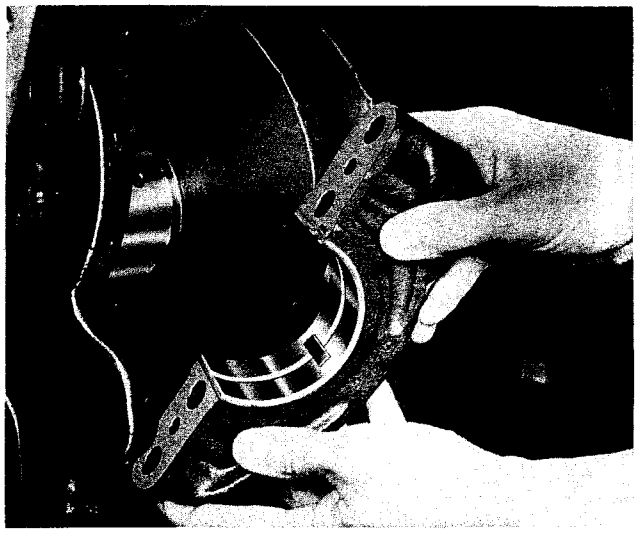


Figure 145 — Checking Bearing Clearance with Feeler Stock

An alternative method is to use a piece of ½" feeler stock (the thickness of which should be equivalent to the maximum clearance permissible in the bearing) lengthwise, in the bearing shell, on a film of oil. Assemble the bearing cap and tighten the screws, torquing them to the specifications, — then try to turn the crankshaft by hand to determine whether or not you can feel a drag.

If a definite drag is felt and the piece of feeler stock is equivalent to, but no more in thickness than the maximum clearance specified, you may be sure that neither the crankshaft nor bearing are worn excessively as far as clearance is concerned.

When using new bearings and the crankshaft is not worn, checking with a piece of feeler stock as outlined above should lock up the crankshaft, making it possible to turn only by use of a bar or wrench.

If crankshaft is scored, or worn enough so that new bearings will not fit with the required clearance, it should be removed and reground.

Standard crankshafts may be reground to decrease the diameter a maximum of .040.

Before shaft is reground, it must be checked for straightness and straightened if necessary to be within .002 indicator reading. When reground, the fillet radii must be within dimensional limits and must be perfectly blended into thrust and bearing surfaces.

8. Connecting rod bearings and crank pins may be checked in the same manner with one exception; instead of trying to turn the crankshaft when the connecting rod bearing is tightened on it with a piece of feeler gauge assembled, try to move the connecting rod from side to side.

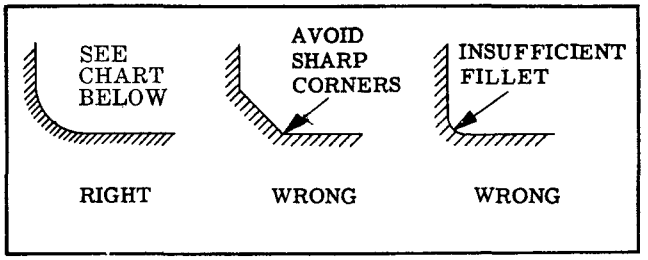


Figure 146 — Crankshaft Fillet Radii

N	3/32" R on all crankpins and mains
Y	5/64" R on all crankpins and front & center mains 3/32" R on rear main
F M	3/32" ± 1/64" R on all crankpins and mains except rear 1/8" ± 1/64" R on rear main
B	3/32" ± 1/64" R on all crankpins and mains

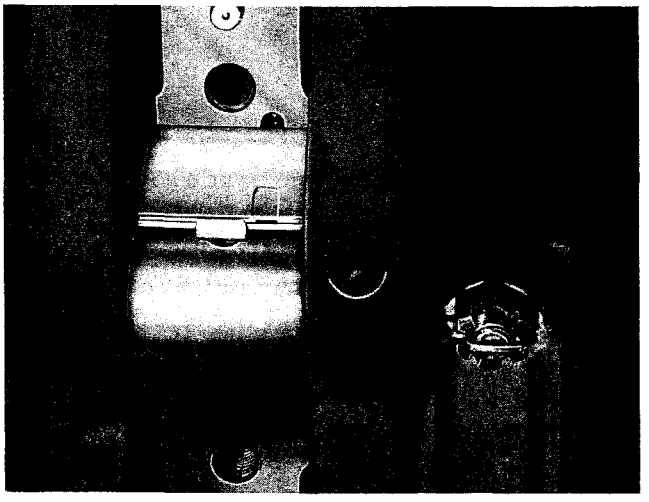


Figure 147 — Replacing Bearing

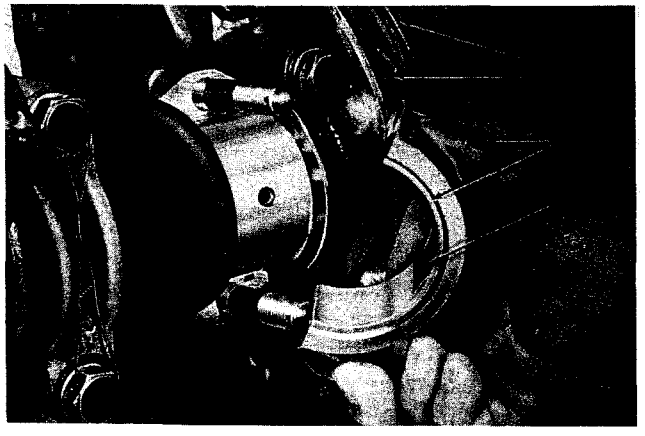


Figure 148 — Checking Rod Bearing with Feeler Stock

With new bearing shells and feeler stock equivalent to the specified clearance in thickness, if the crank pin is not worn you will quite probably have to use a hammer tap to move the rod from side to side, indicating that the clearance is well within the specification range.

CAMSHAFT

1. Using a puller, remove the cam and crank gears.

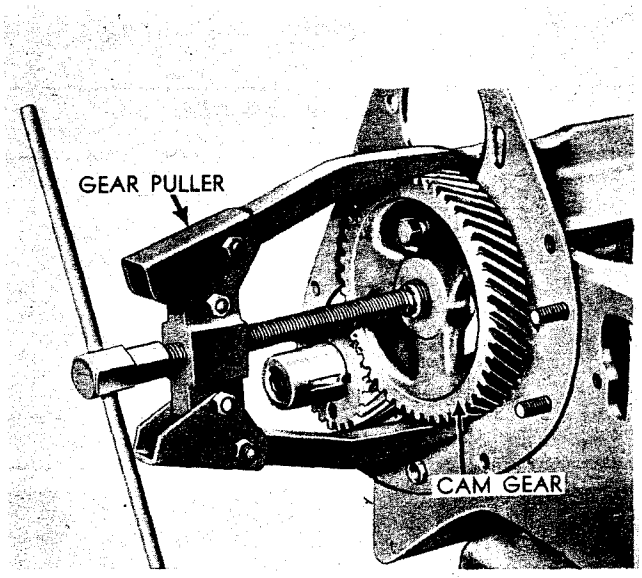


Figure 149 — Removing Cam Gear with Puller

2. Remove the screws holding the camshaft thrust plate to the front of the cylinder block, which makes it possible to pull the camshaft forward out of the bearings.

3. Unless engine is lying on its side, tappets must be removed or lifted before camshaft can be pulled.

4. Remove tappet chamber covers.

5. Tappets can then be lifted out and lined up in sequence, for installation in the same location unless inspection shows that they require replacement.

6. Before pulling the camshaft completely, check the clearance of the bearing journals in the bushing (or block in some models). To do this use strips of feeler stock ¼" wide with edges dressed with a stone to eliminate any burrs or feathered edges.

7. If clearance is equal to or greater than the amount indicated under wear limits, check the diameter of the camshaft journals to determine the next step. Excess wear at these positions require replacement of the shaft.

If wear is found to be in the bushings instead, these must be replaced using precision service bushings, available for that purpose, which require no reaming, only care in assembly, to line up oil holes, and not to damage the bushings as they are being pressed in.

TAPPETS

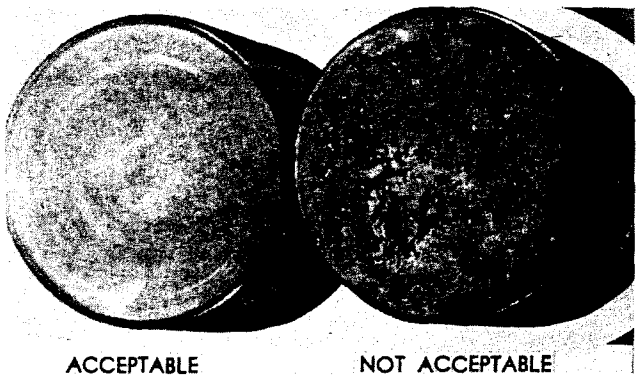


Figure 150 — Valve Tappet Wear Comparison

1. Inspect each tappet carefully. Two or more small pits on the contact face is acceptable; more than that calls for replacement of the tappet on the N, Y, F4, F6 Series.

Oversize tappets are available as required.

2. Check the outside diameter with micrometers to determine if replacement is necessary because of wear.

3. On the M and B series, tappet guides or guide bushings may be checked for wear with a plug gauge or preferably with a telescopic gauge and micrometer.

If guide bushings are used, they may be replaced and std. tappets used. If bushings are not used, the tappet bore may be reamed oversize, and oversize tappets installed.

TAPPETS

ENGINE	O. D. TAPPET	BORE IN BLOCK	TOTAL MAX. WEAR LIMITS	
N, Y, F4, F6 Series	.9995 .9990	1.0008 1.0000	.005	Oversize tappets available

ENGINE	O.D. TAPPET	SLEEVE DIA.	TOTAL MAX. WEAR LIMITS	
M-B Series	1.1242 1.1237	1.1260 1.1250	.005	Std. sleeves and Std. Tappets available

Note: On the N, Y, F4, F6 engines, the tappets ride in a tappet bore in the block. On the M and B, guide bushings are used: the dimension shown is the I.D. after bushing is installed in block.

CAUTION — WHEN INSTALLING CAMSHAFT USE SPECIAL CARE TO PREVENT CAMSHAFT BUMPING AND LOOSENING EXPANSION PLUG TO CAUSE AN OIL LEAK

TIMING GEARS

1. Timing gears and timing gear fits must be checked carefully while the engine is being overhauled. To check the fit, use a screw driver to force the mating teeth as far apart as possible and check this clearance with a feeler gauge. If this clearance is .002" or greater, or if the gear teeth are badly scuffed and worn, the gear must be replaced. Timing gears must be replaced in pairs.

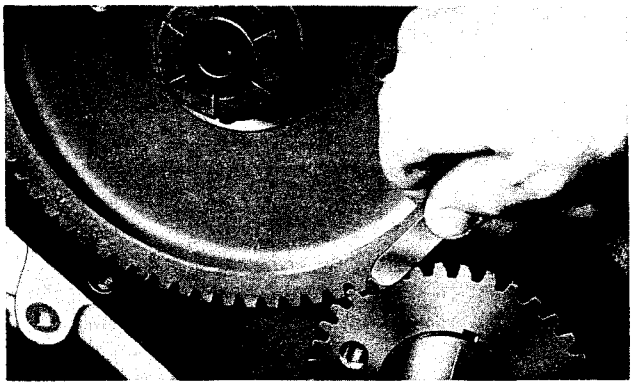


Figure 152 — Checking Timing Gear Backlash

Gears marked same as the original as far as sizes are concerned should be used as replacements.

2. Examine the camshaft thrust plate carefully for scoring and wear and if any indication of either shows, a new thrust plate should be assembled without question.

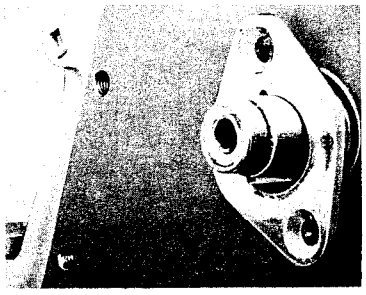


Figure 153 — Camshaft Thrust Plate

3. Assemble the cam gear to the camshaft by driving or pressing it on, at the same time **holding the camshaft forward with a suitable bar through the fuel pump opening in the block so there is no possibility of the camshaft bumping the expansion plug at the rear end and forcing it out of position, thus causing an oil leak.**

Check camshaft end play as shown in illustration. Refer to limits and clearance section for the correct dimension.

> CAUTION: NEVER USE THE CAMSHAFT NUT TO PULL THE GEAR ONTO THE CAMSHAFT. This will break the threaded end off cast iron camshafts and damage threads on steel camshafts.

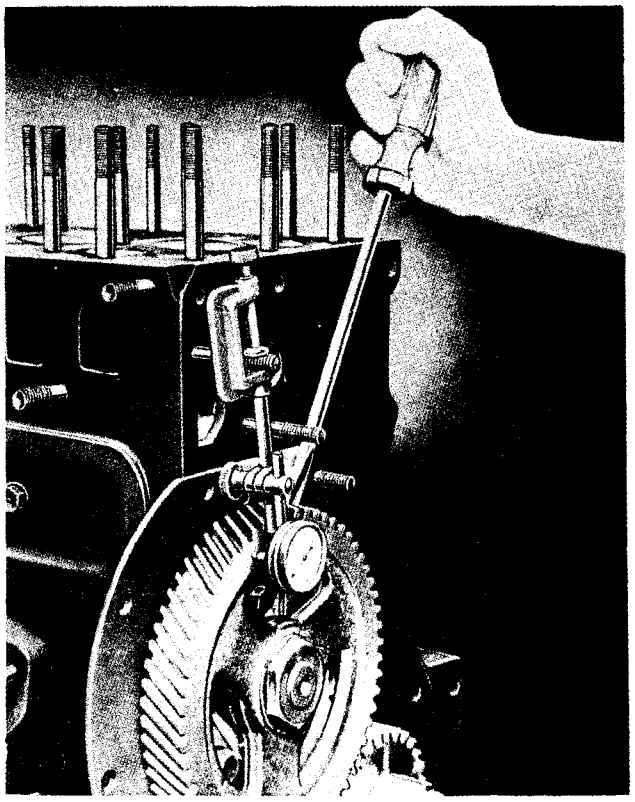


Figure 154 — Checking Camshaft End Play

4. Inspect crankshaft thrust washers for wear and scoring. Replace if necessary before reassembling gear.

5. Drive the crank gear on the shaft making sure that the marked teeth on the cam gear straddle the marked tooth on the crank gear, which assures you of the crankshaft and camshaft being in time.

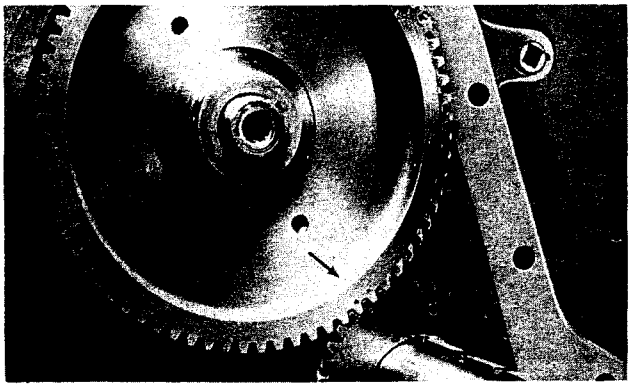


Figure 155 — Timing Gears Assembled According to Timing Marks

6. Check for clearance with the above gears assembled in place, since it may be possible that it is not within specifications. Repeat the operation previously outlined. Using a screwdriver pry the teeth as far apart as possible and check the clearance with a feeler gauge. If a .0015" feeler will not enter the gap the clearance is not excessive.

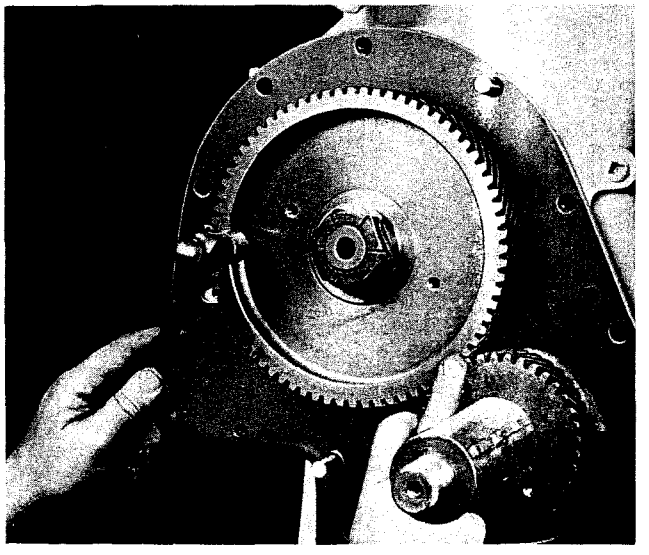


Figure 156 — Checking Gear Fit

To be certain that there is enough clearance, hold your finger at the junction of the two gears and with a light hammer tap the rim of the cam gear and note if there is vibration felt at this point.

If there is vibration and a .0015" feeler gauge will not enter the gap between the two gear teeth, the gear fit is within specifications.

7. Crankshaft gears and camshaft gears are furnished in standard and under and over sizes. Gears marked "S" are standard; if they are marked with figures "1" or "2" in a letter "U" this signifies undersize. If they are marked with figures in the letter "O" this signifies oversize.

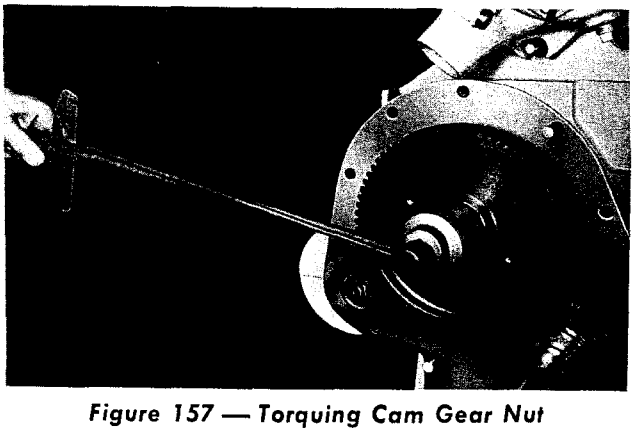
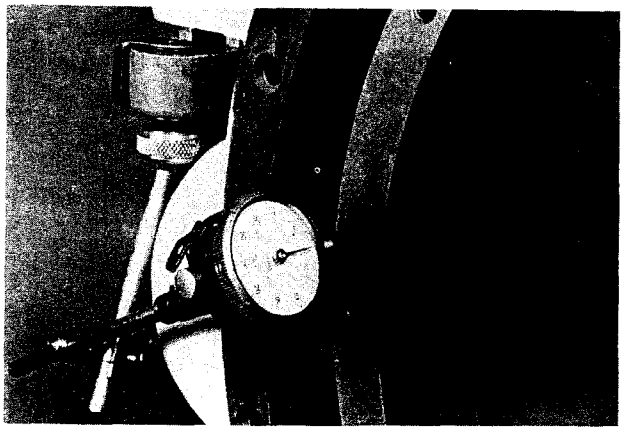


Figure 157 — Torquing Cam Gear Nut

CRANKSHAFT END PLAY

1. Check the crankshaft end play before replacing the gear cover. A shim pack containing shims of .002" and .008" thickness is incorporated in the assembly between the front end of the main bearing journal and the crank gear and by removing or adding shims, this end play can be corrected to fall within the specifications.



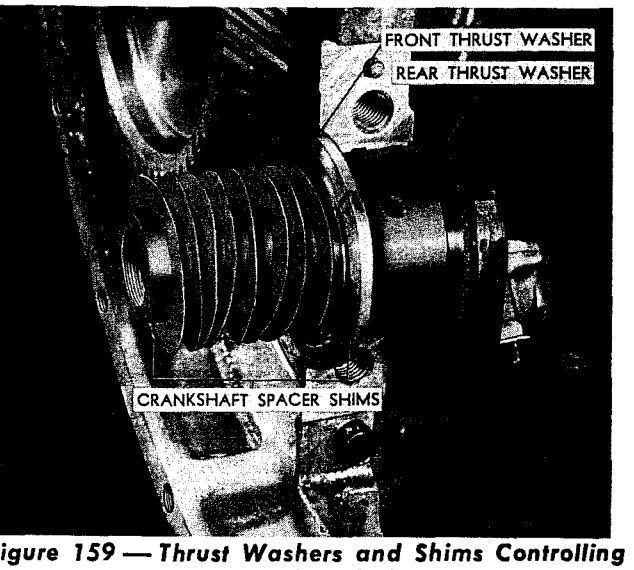


Figure 159 — Thrust Washers and Shims Controlling Crankshaft End Play

At all times when checking end play, the crank gear must be tightened firmly against the shim pack, which can be done by using a sleeve or the regular pulley, slipping it over the crankshaft and using the standard assembly parts to tighten the pulley and gear in place.

On F135 & F163 thrust is controlled by flanged center bearings, which require no shims. On the F227 and F245 models, thrust is controlled by flanged brgs. located at the rear main. If end play exceeds .006 (using a feeler gauge) replace the flanged bearings. End play should be between the .002 and .006 limits.

Figure 159A — Flanged Bearing Controls Crankshaft End Play.

ASSEMBLING OIL SEALS IN FILLER BLOCK AND OIL GUARD

Continental L-head engines have 3 types of crankshaft and oil pan seals.

The first type is jute packing which is used in sealing the filler block and oil guard in block to crankshaft.

The second type is a neoprene seal which is used in sealing the oil pan to the filler block.

The third type is a neoprene circular spring type which is currently used on the N-series engines.

JUTE TYPE OIL SEALS

First, remove the filler block and oil guard, the latter being the semi-circular die casting which fits in the cylinder block just to the rear of the rear bearing bore. Clean out the grooves thoroughly and clean the outer surface of this oil guard so as to remove all dried cement and grease.

Jute packing for crankshaft seal as it is received is approximately one-third larger in diameter than the width of the groove. To fit the grooves in the filler block, this must be crushed in a vise or flattened with a hammer on a flat surface so the jute packing is narrow enough to fit into the grooves.

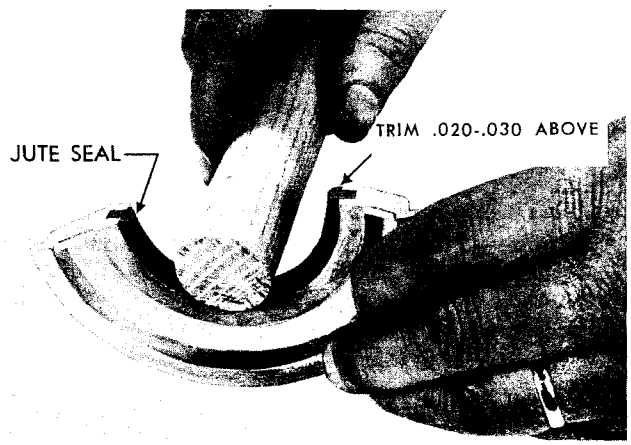


Figure 160 — Top Half of Rear Seal

Next, press it into the grooves of both the filler block and the oil guard. Then, using a piston pin, a smooth hammer handle or some other instrument with a rounded surface, iron this packing into the groove so that it is seated firmly and expanded so that it seizes the sides.

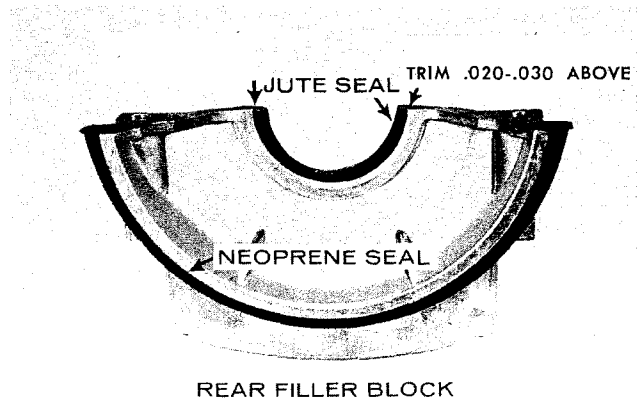


Figure 161 — Lower Half of Rear Seal

In its present condition the packing will protrude from the grooves at either end in varying amounts. With a sharp knife, or razor blade, cut this off to project .020-.030 above, making the cut parallel to the surface of the casting. Then slip it into place, either around the crankshaft, if the engine is still assembled, or directly into the groove if the crankshaft is out.

NEOPRENE OIL SEAL

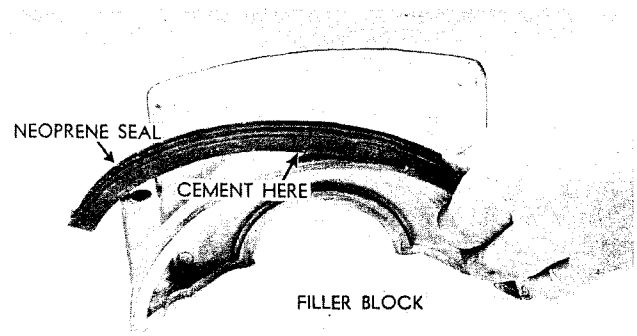


Figure 162 — Installing Neoprene Seal in Rear Filler Block

1. To replace neoprene seal, thoroughly clean all cement, dirt, and oil from the contacting surface of the filler block. To hold seal in place for assembly, use **only a small spot** of non-hardening cement in the center of the contacting surface, before inserting seal in groove. **No other cement is required.**

Lubricate outside of neoprene seals before installing pan to prevent possible distortion of seals.

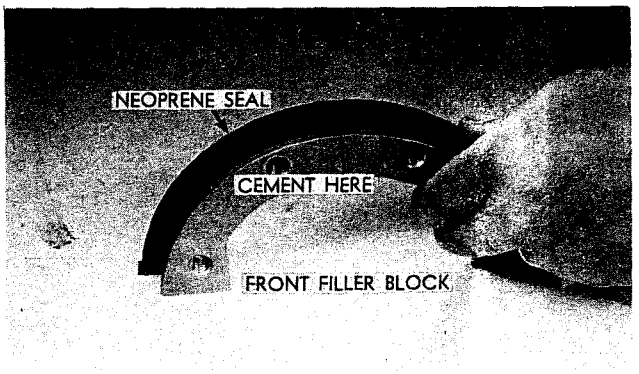


Figure 163 — Installing Neoprene Seal in Front Filler Block

2. Neoprene seal on front filler block is installed in the same manner.

When replacing gear cover, cement gasket to gear cover with a quick drying gasket cement and reassemble to engine block.

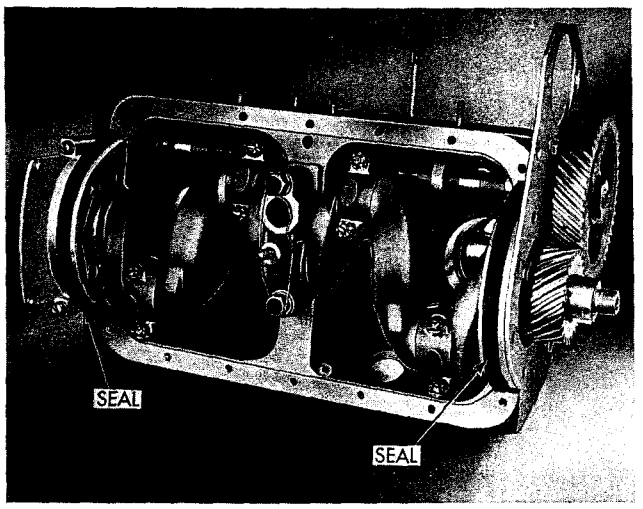


Figure 164 — Neoprene Seals in Place

In order to prevent possible oil leaks, it is imperative to use **only** genuine Continental replacement gaskets and seals — since these have been engineered and designed to do a superlative job.

NEOPRENE CIRCULAR SPRING TYPE SEAL

The "N" series of engines uses a circular spring type seal which is replaced as follows:

1. Remove flywheel assembly.
2. Remove cap screws from oil seal retainer assembly.
3. Remove retainer from 2 dowel pins and slide off seal surface of crankshaft.
4. Press oil seal from retainer with a driver slightly smaller than seal diameter. Thoroughly clean back of cylinder block and retainer in a solvent.
5. On an arbor press, press in new seal with driver which fits oil seal to prevent damage to seal. If a driver of the correct diameter is not available, use a piece of ¼" sheet steel, 8" x 8" or larger, and press seal into retainer on an arbor press. **Be sure the seal wiping edge and spring face is toward engine.**

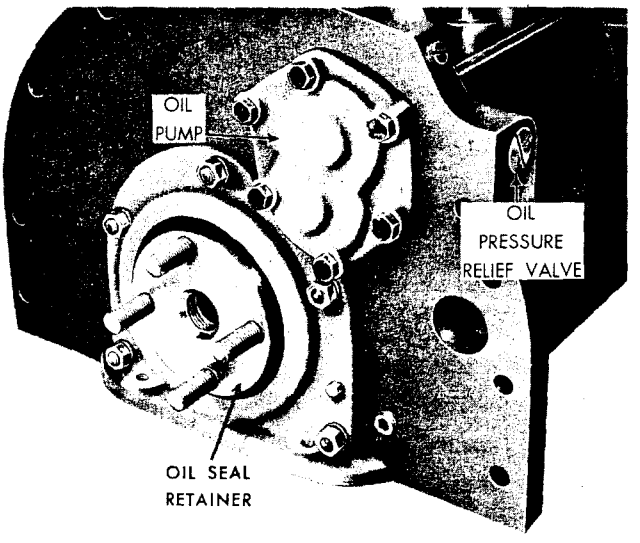


Figure 165 — "N" Series Circular Spring Type Seal

6. Examine crank flange seal surface carefully. Any roughness or scratches should be polished off, otherwise they will damage new seal.
7. Apply coat of fibre lubricant to seal as well as seal surface of crankshaft (A good wheel bearing type of lubricant should be used).
8. Install a new gasket between retainer and cylinder block.
9. Carefully slide seal assembly over crankshaft seal surface using a piece of shim stock to guide it in place. Align dowel holes of retainer with dowel pins in block and tap retainer gently in place.
10. Replace retainer cap screws and torque evenly to 15 - 20 ft. pounds so as not to distort the retainer.
11. Replace flywheel.

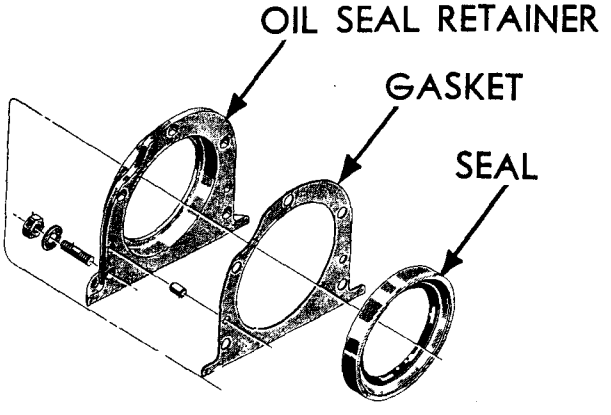


Figure 166 — Exploded View of Oil Seal Retainer and Seal

OIL PUMPS

The oil pump is assembled to the center main bearing, held in position vertically against a machined pad by studs, (except the "N" series engines, which have the oil pump on the rear end plate, and driven off end of camshaft.)

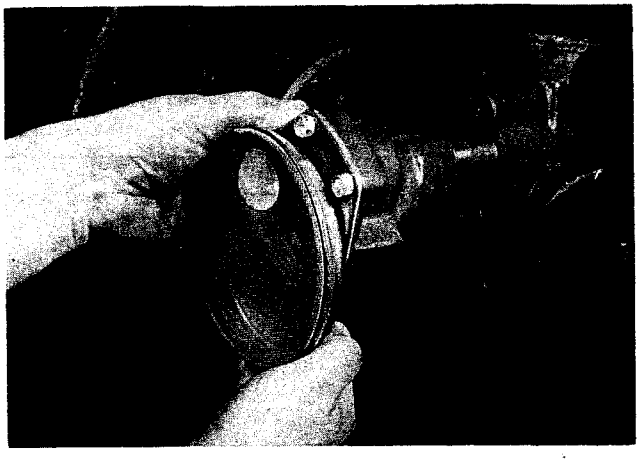


Figure 167 — Oil Pump Removal

The extended portion of the body acts as a pilot, fitting closely in a reamed hole in the main bearing web, maintaining definite relationship between the camshaft and the oil pump drive shaft.

A gear assembled to the upper end of this shaft is driven by a mating gear cut on the camshaft and drives the oil pump gear which is assembled to the lower end of the pump shaft.

The pump shaft is carried in two bronze bushings assembled in the cast iron housing, which is also a part of the oil distributing system, transmitting oil to the drilled passages.

The gear type pump has a capacity well in excess of that required by the engine.

When the pump is removed, examine the drive gear carefully for wear, inspecting the gear on the camshaft at the same time. If scored or worn badly, both the camshaft and the gear on the pump must be replaced.

Examine the pick-up screen (which may be either the Floato type or the stationary screen type) for clogging or damage.

Remove the cover, being careful not to damage the lead gasket which acts as a spacer as well as a gasket to seal the joint.

Examine the gears and pump body for any sign of wear indicating lack of clearance. The gears should have from .001 to .003 clearance in the chamber and should make no contact with the walls.

Inspect the cover and face of the gears for excessive wear or scoring. With the gasket assembled to the body there should be .0015 - .006 clearance between the gears and the cover.

Worn or scored gears can be replaced, as can a worn cover. If the body shows wear in the chamber, it can be replaced, but in a case like this a new pump would be the most economical.

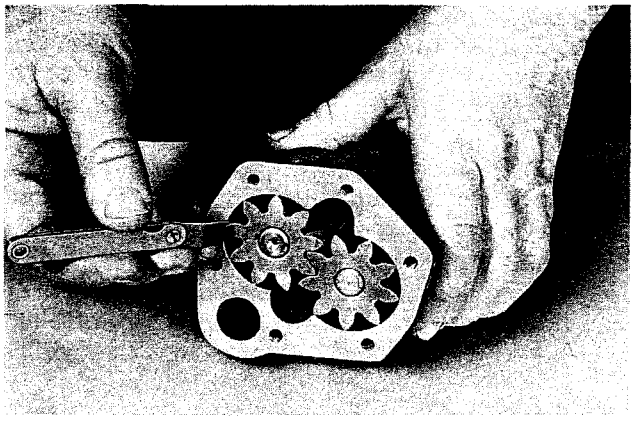


Figure 168 — Checking Oil Pump Gear Clearance in Body

Engine oil pressure must be maintained to specification for satisfactory engine life.

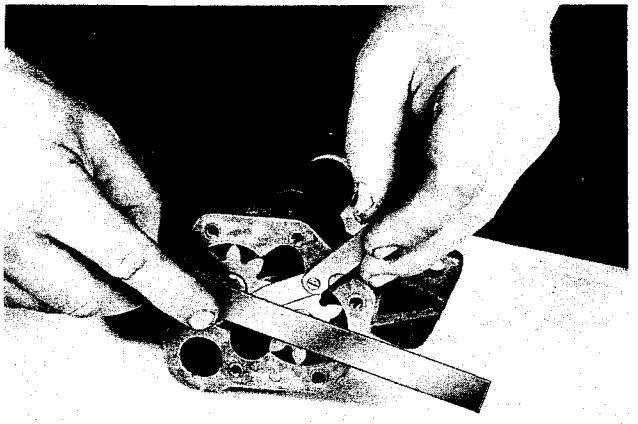


Figure 169 — Checking Oil Pump End Clearance

Pressure relief is located externally on the right-hand side, near the oil pan flange at the center. (on the N series, it is located in the rear end plate). Pressure is controlled by a plunger and spring, the latter specifically for a certain range. The only adjustment variation is either to change springs or assemble or remove washers from behind the present spring. Up to four washers are permissible.

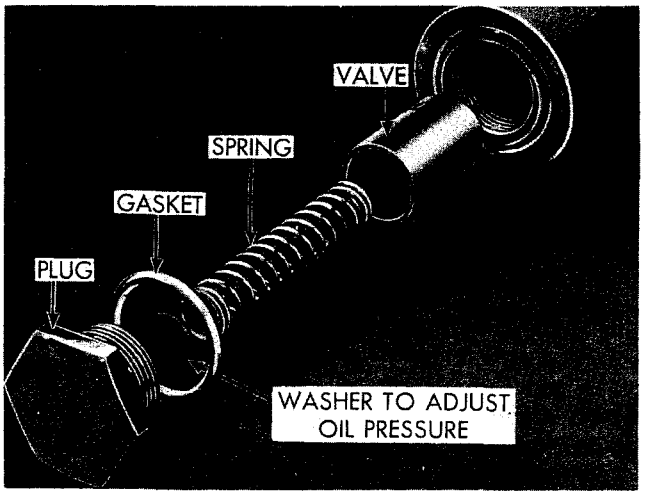


Figure 170 — Oil Pressure Relief Valve

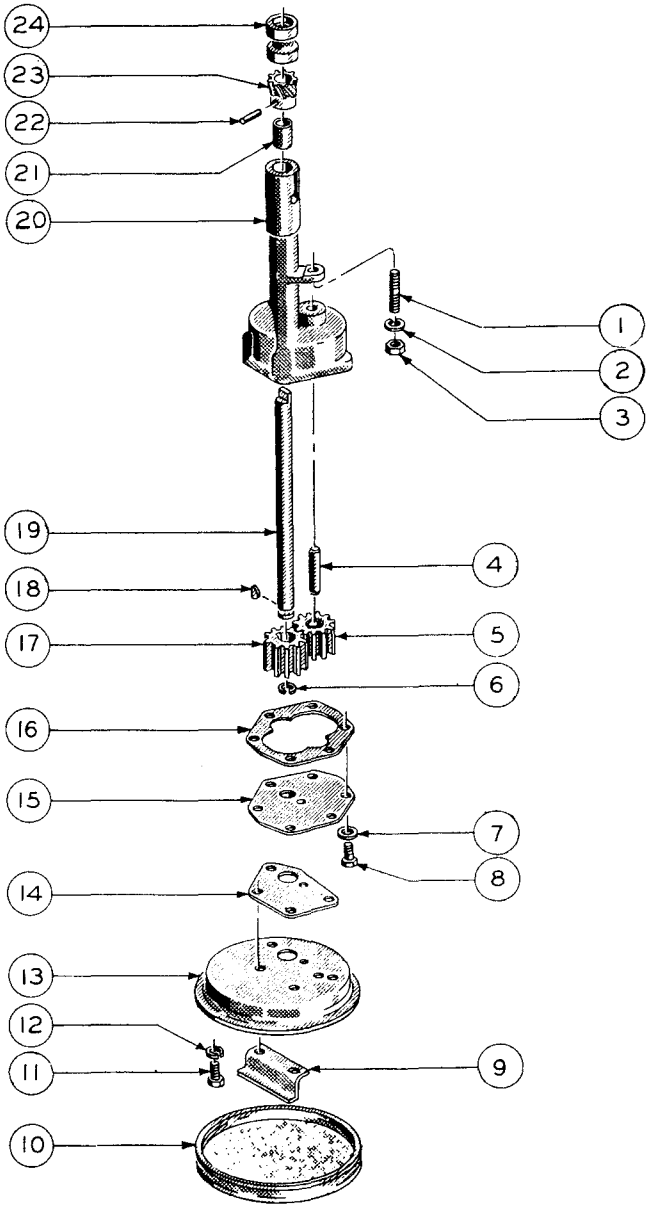


Figure 171 — Typical Oil Pump

1. Stud
2. Washer
3. Nut
4. Stud
5. Gear — idler
6. Snap ring
7. Washer
8. Screw
9. Spacer
10. Screen
11. Screw
12. Washer
13. Frame — oil pump screen
14. Gasket
15. Cover — oil pump
16. Gasket
17. Gear — driver
18. Key
19. Drive shaft
20. Body assembly
21. Bushing
22. Pin
23. Gear
24. Bushing

CAUTION

On several models of our L-Head engines, a 1/8" flat spacer washer is used **between** the oil pump mounting lug and the center main bearing cap. When reassembling, be **SURE** that this washer is placed on the oil pump mounting stud before the oil pump is installed in place. Failure to do this will cause interference between oil pump and camshaft and will not allow the distributor drive to mesh correctly.

NOTE

When replacing oil pump drive gear (Item 23, Fig. 171) it is necessary to line up the hole in the gear with the hole in shaft and drill through the other half of the gear before pinning in place.

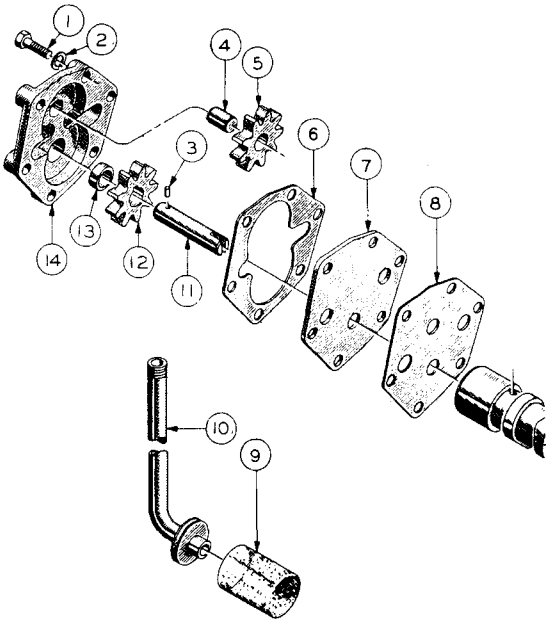


Figure 172 — "N" Series Oil Pump

1. Screw
2. Lockwasher
3. Pin
4. Stud
5. Idler gear
6. Gasket
7. Cover
8. Gasket
9. Screen
10. Tube assembly
11. Shaft
12. Gear
13. Bushing
14. Body

FLYWHEEL AND FLYWHEEL HOUSING

The flywheel is machined and balanced so that the clutch face and locating counterbore will run true with its axis.

To be sure that the crankshaft flange has not been sprung or otherwise damaged or that the counterbore in the flywheel, which locates it on the crankshaft, is not damaged, mount an indicator on the flywheel housing and check the flywheel for runout. Caution: When checking runout remove spark plugs to allow engine to be turned over freely.

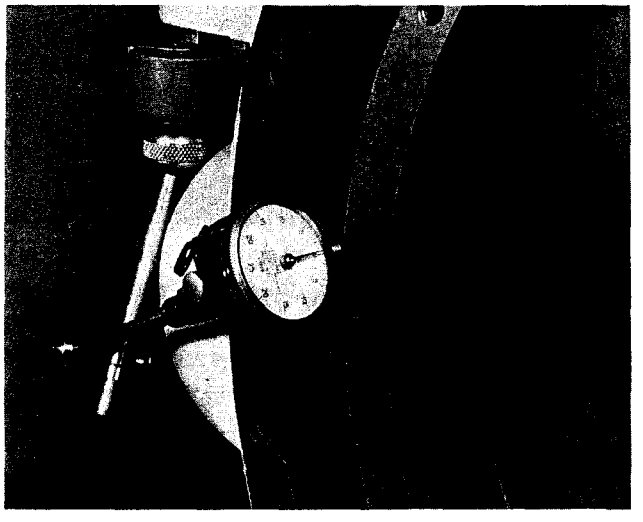


Figure 173 — Checking Flywheel Run-Out

The indicator should be set up so that it contacts the clutch face or the vertical surface of the clutch counterbore, then turn the flywheel at least one full revolution at the same time holding against the crankshaft to offset the possibility of end play.

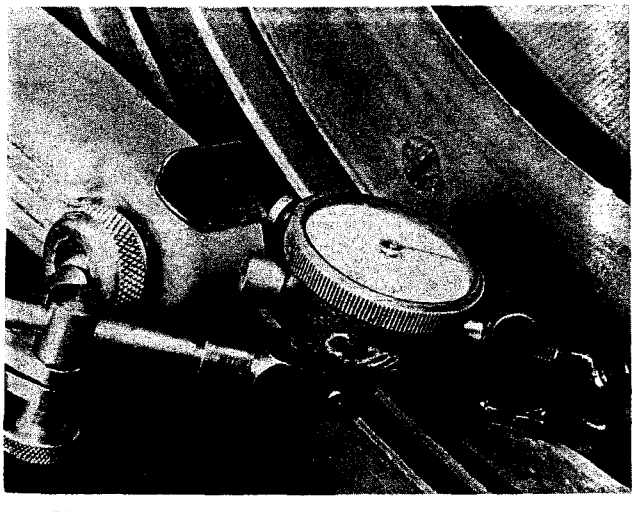


Figure 174 — Checking Flywheel Counterbore

Excessive runout of the flywheel, in either position, is probably caused by dirt in or damage to counterbore locating the flywheel on the crankshaft flange.

Re-locate the indicator to check the inside diameter of the counterbore. In both cases the maximum indicator reading must not be more than .008.

When assembled, mount the indicator on the flywheel so that it contacts the housing face and turn the crankshaft, at the same time holding against it to counteract end play. The maximum indicator reading must not exceed .008.

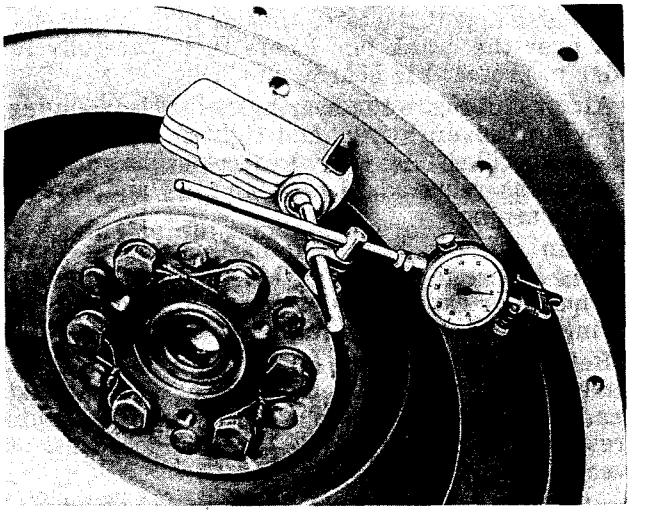


Figure 175 — Checking Flywheel Housing Face

Re-locate the indicator to contact the housing bore and check this in the same manner. The same runout limits prevail.

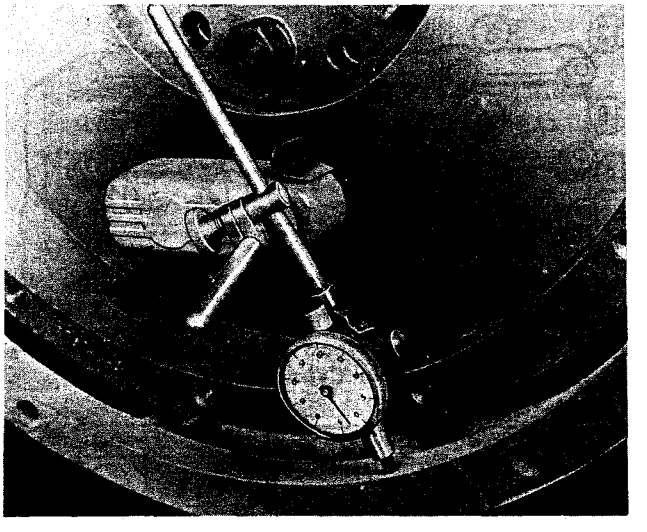


Figure 176 — Checking Housing Bore

If more than one engine is being rebuilt at a time, the housing should be identified with its original cylinder block and should be reassembled to that block in the rebuilding process.

REASSEMBLING ENGINE

In the foregoing, we have outlined procedures for checking, repairing or replacing the many wearing parts in the engine.

In most cases, the instructions have covered the reassembly of parts or subassemblies made up of several parts.

When reassembling pistons and connecting rods, use a good ring compressor and oil the bores thoroughly. A hammer handle may be used to bump the pistons out of the ring compressor into the cylinder bore.

Once more, we call attention to care demanded to prevent connecting rods damaging the cylinder bore finish and at the same time as they are assembled over the crank pin, locate them carefully in order to protect the bearing surfaces.

Always lubricate the bearings with clean engine oil when assembling, and tighten them to the torque specified. Use lockwires, cotter pins or lockwashers as required to prevent nuts and screws from loosening.

Clean cylinder head and block surfaces thoroughly before installing gasket. Tighten all cylinder heads or cap screws evenly and torque in following sequence to the recommended torque.

Before assembling the oil pan with new gaskets make certain that gasket surfaces are flat and clean. Tighten screws in accordance with limits prescribed in torque chart — to avoid looseness or overstressing.

Torque Specifications for Cylinder Head Tightening Sequence in Foot Pounds

Size - Diameter				
3/8"	7/16"	1/2"	9/16"	5/8"
Cylinder Heads				
35-40	70-75	100-110	130-140	145-155

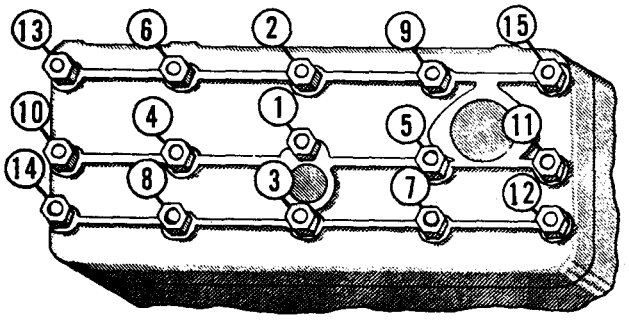


Figure 177 — Cylinder Head Tightening Sequence — Four Cylinder

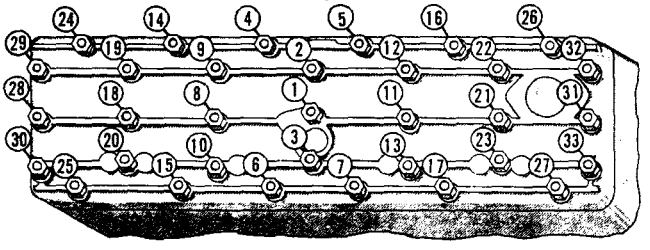


Figure 178 — Cylinder Head Tightening Sequence — Six Cylinder

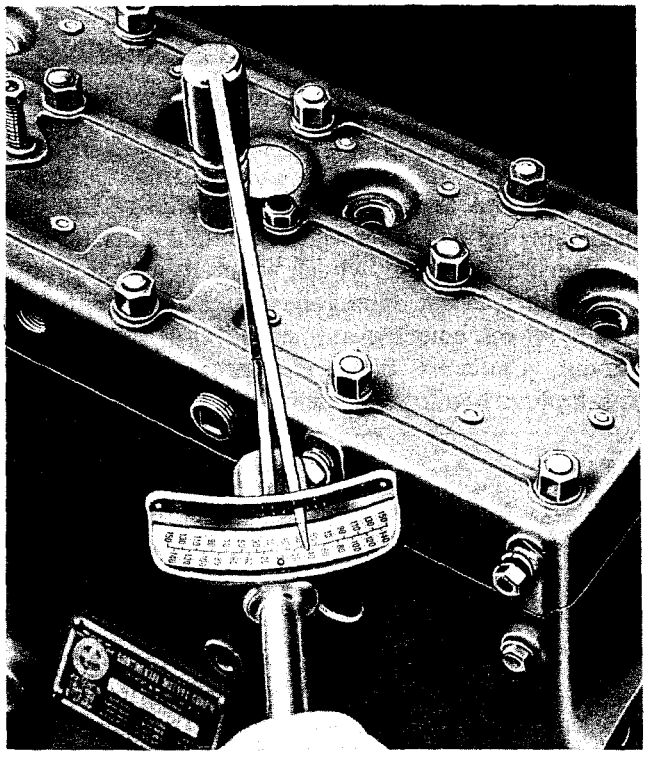


Figure 179

When engine is completely assembled and filled with proper oil, (See Lubrication Sec.) set tappets according to the following chart:

MODEL	INTAKE	EXHAUST
Y112, F135, F163	.012	.020
F227, F245	.012	.020
M330, M363	.017	.020
B427	.017	.022

Please check your engine nameplate for the correct setting.

NOTE: Tappet settings for previous models are listed on pages 5 & 6.

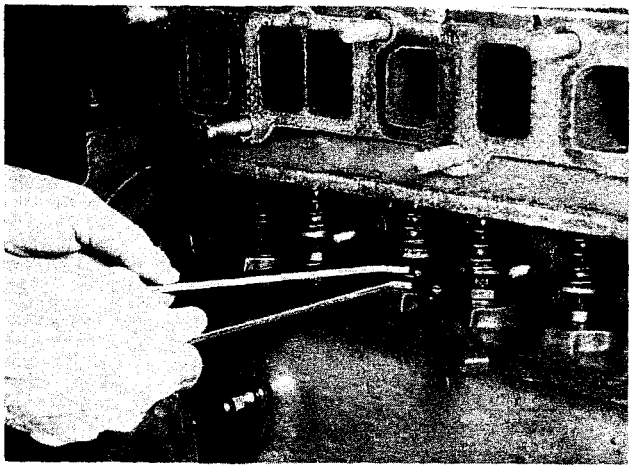


Figure 180 — Setting Tappets

SECTION IX
TROUBLE SHOOTING

A preventive maintenance system including inspection, lubrication and adjustment as recommended in our Maintenance Section will prevent the greater portion of gasoline engine troubles.

Failure of a gasoline engine to start is mainly due to two things: ignition trouble or failure in the fuel system.

Operators handling the same engine every day, soon develop a sense of impending trouble when abnormal operation occurs. Immediate attention to these danger signals can prevent major failures, insure dependable operation and increase the life of the engine.

Operators should depend on their well-developed senses of **feeling, hearing, seeing** and **smelling** and replace their sense of taste in this type of work — with a generous amount of "Common-Sense".

A good rule to follow in locating trouble is to never make more than **one** adjustment at a time — then locate the trouble by a process of elimination. Remember the cause is usually **Simple** — rather than mysterious and complicated.

Following are listed some of the normal complaints encountered in routine operation of all gasoline engines and the probable causes.

A — STARTING MOTOR — WILL NOT CRANK ENGINE:

1 — Weak or dead battery.
2 — Poor ground connection.
3 — Faulty starting switch or relay.
4 — Defective starting motor.
5 — Internal engine seizure — turn engine manually to determine cause.

B — ENGINE CRANKS — BUT DOES NOT START:

Disconnect one spark plug wire, turn ignition on with starter cranking engine and free end of wire 1/8" from cylinder head — note spark.

1 — **NO SPARK:**

(A) — **If Ammeter Shows No Discharge** — it indicates an open primary circuit due to:

1 — Points not closing.
2 — Open primary wires.
3 — Defective ignition switch.
4 — Faulty coil.

(B) — **Normal Ammeter Reading (2-5 Amps)** — this indicates that primary circuit is OK — trouble may be in secondary circuit due to:

1 — Broken or grounded high tension wire from coil to distributor.
2 — Wet high tension wires.
3 — Faulty distributor cap or rotor.
4 — Broken secondary winding of coil.

(C) — **Excessive Ammeter Reading (over 5 Amps)** — indicates a "short" in the primary winding which may be due to:

1 — Shorted or grounded primary winding.
2 — Distributor or magneto points not opening.
3 — Grounded breaker point arm.
4 — Defective condenser.

2 — **WEAK SPARK** — may be caused by:

(A) Loose ignition wiring connections.
(B) Burned or pitted distributor points.
(C) Wet spark plug wires.
(D) Defective condenser.
(E) Cracked distributor cap.
(F) Weak ignition coil.

3 — **GOOD SPARK AT EACH PLUG** — indicates that ignition system is OK and trouble is in fuel system — which may be due to:

(A) **No Gas in Carburetor** — which may be due to:

1 — No gas in tank.
2 — Clogged filter or lines.
3 — Faulty fuel pump.
4 — Leaky fuel line from tank.
5 — Plugged vent in fuel tank cap.

(B) **Gas in Carburetor** — which may be flooded due to:

1 — Too much choking — plugs are wet.
2 — Wrong float level.
3 — Choke not operating correctly.
4 — Water in Gas.

C — ENGINE RUNS WITH CONTINUOUS MIS-FIRING: Due to:

1 — Uneven compression.

2 — Wet or deteriorated high tension wires.

3 — Cracked distributor cap.

4 — Faulty spark plugs—if spark plug porcelain is white when removed, use **Colder** plug — if light brown OK — if Black or oily use **Hotter** plug.

D — ENGINE RUNS UNEVENLY

1 — **At Idling Speed**—which may be due to:

(A) Too wide spark plug gaps.

(B) Poor Carburetor idle adjustment.

(C) Wrong float level.

(D) Carburetor or intake manifold air leaks.

(E) Leaky cylinder head gasket.

2 — **At High Speed** — which may be due to:

(A) Wide breaker points.

(B) Weak distributor breaker arm spring

(C) Weak valve springs.

(D) Spark plug of wrong type or incorrect gap.

E — ENGINE RUNS IMPROPERLY

1 — **Back-Firing into Manifold** — indicates **Too Rich** a fuel mixture; into carburetor indicates **Too Lean** a mixture—may be due to:

(A) Late Ignition Timing.

(B) Clogged Air Cleaner.

(C) Fuel line restrictions.

(D) Clogged carburetor jets.

(E) Sticking Valves.

(F) Weak or broken valve springs.

2 — **Excessive Ping (Detonation)**—Results in damaged pistons and bearings and is caused by pre-ignition or using inferior grade of gas.

3 — **Engine Idles Too Fast** — indicates improper throttle adjustment or weak throttle return springs.

4 — **Engine Dies When Idling** — which indicates incorrect speed or mixture adjustment; clogged idling circuit in carburetor or wrong choke adjustment, or air leaks in intake manifold.

5 — **Engine "Stumbles" on Acceleration** — which may be due to defective accelerator pump or air in fuel lines.

6 — **Defective Spark Plugs.**

F — LACK OF POWER — which may be due to:

1 — Poor Compression.

2 — Wrong Timing.

3 — Throttle control not opening fully.

4 — Air leak in fuel system.

5 — Restriction in air cleaner — should have vacuum less than 10″ water.

6 — Exhaust line obstructed — should have back pressure of not more than 20″ water.

7 — Poor fuel.

8 — Piston rings sticking or worn.

G — POOR COMPRESSION—check with compression gauge — if irregular, seal the piston with a teaspoonful of engine oil poured through the spark plug hole, and take a second reading; if pressure does not increase this will indicate that poor seating of valves are at fault.
Poor compression may be due to:

1 — Valves holding open — no tappet clearance.

2 — Leaky cylinder head gasket.

3 — Broken or weak valve springs.

4 — Burned or sticking valves.

5 — Badly worn, broken or stuck piston rings.

6 — Wrong valve timing.

H — OVERHEATING

1 — Lack of water in radiator.

2 — Fan belts slipping.

3 — Thermostat sticking or inoperative.

4 — Radiator clogged or leaky.

5 — Late ignition timing.

6 — Back pressure in exhaust line.

7 — Defective water pump.

8 — Overloading of engine.

I — LOW OIL PRESSURE

1 — Low Oil level.

2 — Oil pressure gauge or line faulty.

3 — Oil too light — diluted.

4 — Suction screen plugged.

5 — Dirt in relief valve or broken spring.

6 — Worn bearings.

7 — Worn or damaged oil pump gears.

8 — Worn Cam Bushings.

J — HIGH OIL PRESSURE—should not exceed recommended pressures except when engine is starting up cold. Abnormally high oil pressure is not desirable because it increases oil consumption — possible causes of high oil pressures are:

1 — Engine oil too heavy.

2 — Stuck relief valve.

3 — Obstruction in distributing line.

4 — Faulty oil pressure gauge.

K — HIGH OIL CONSUMPTION

1 — Oil leaks.

2 — Too high oil level.

3 — Incorrect grade of oil used.

4 — Clogged crankcase breather.

5 — Oil pressure too high — stuck relief valve.

6 — Piston rings not run-in, due to too smooth cylinder bore finish or glazed condition.

7 — Worn, broken or stuck piston rings and clogged oil control rings.

8 — Worn pistons and sleeves.

9 — Worn bearings.

10 — Worn valve guides.

(Manifold may be removed for visual inspection.)

L — ENGINE KNOCKS AND OTHER NOISES

1 — Operating Knocks — which may be due to:

(A) **Pre-Ignition** — Most common cause is due to wrong type plugs which are too hot.

(B) **Carbon** — noticeable when engine is accelerated while hot — clean head and pistons.

(C) **Timing**—early timing causes knocks similar to carbon — but may tend to kick back when starting.

(D) **Fuel** — detonation knock caused by poor gas.

(E) **Overloads** — particularly at lower operating speeds.

2 — **Mechanical Knocks**—result from wear, abuse or improper adjustments — which may be due to:

(A) **Crankshaft and Main Bearings:**

(1) **Worn or burned-out Main Bearings** — A heavy, dull knock when accelerating under load. Locate by shorting out plugs on both sides of the bad bearing.

(2) **Crankshaft End-Play** — excessive end-play is indicated by an intermittent knock which will come and go when the load is released and engaged.

(B) **Connecting Rod Bearings**

(1) **Worn or Burned-out Bearings** — The worst condition, a light pound or metallic knock, is noted at idling and to about ⅔ maximum speed. Bad bearings can be determined by shorting out plugs.

(C) **Pistons and Wrist-Pins**

(1) **Loose Wrist Pins** — noise doubles when the correct plug is shorted out — most noticeable at idling speed.

(2) **Piston Loose in Cylinder** — "Piston-Slap" is noted by metallic knocking at low speed under load; but disappears at high speed — also most noticeable when starting cold —test by shorting out plugs.

(D) **Broken Piston Ring or Pin**
sharp clicking noise that won't short out.

(E) **Valves**

(1) **Burned Valves and Seats** — engine misses, especially at low speeds, or acceleration under load.

(2) **Weak or Broken Valve Springs** — missing at low or high speeds when under load.

(3) **Sticking Valves** — loss of power and popping sound when bad.

(4) **Tappet noise** — excessive clearances cause noise when cold — which diminishes at normal operating temperature.

(F) **Camshaft** — Noise due to loose bearings or end play — usually occurs at half engine speed.

(G) **Timing Gear Noise** — Loose or worn gears rattle or knock — tight gears hum.

3 — **Vibration Originating at Engine** — The most common sources of vibration originating in or on the engine, as distinguished from causes created outside the engine are as follows:

(A) Misfiring

(B) Misalignment of engine

(C) Bent or off-center coupling

(D) Engine loose on bed and type of mountings.

(E) Out of balance condition of flywheel and clutch assembly.

SECTION X
TORQUE SPECIFICATIONS

Continental L-IIead engines have many studs, bolts, and cap screws of special material and sizes and it is very important that special care be exercised to replace all studs and bolts in their respective locations during assembly of engine.

The torque specifications, foot pounds, listed below, MUST be followed in order to have the assembled engine conform to the original specifications:

Size-Diameter	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"
Cylinder Heads	.....	35-40	70-75	100-110	130-140	145-155
Main Bearing Caps	.....	35-40	70-75	85-95	110-120	140-150
Connecting Rods	20-25	40-45	55-60	90-100	110-120	.....
Flywheels	20-25	35-40	70-75	85-95	100-110	145-155
Manifolds	15-20	25-30	40-50	50-60	50-60	60-70
Gear Covers, Water Pumps, Front and Rear End Plates	15-20	25-30	50-55	80-90	.....	.....
Oil Pans	12-16	12-16	.....	.....	.....	.....
Flywheel Housings	15-20	25-30	50-55	80-90	115-125	.....

Camshaft Nut

Thread Size	¾"	⅞"	1"	1⅛"	1¼"	
C.I. Shafts	65-70#	70-80#	95-100#	125-130#	145-150#	
Forged Steel Shafts		*120-125#	*175-180#			
Elastic Stop Nut w/C.I. or Forged Steel Shaft		65-70#				

*When Cam Gear Governor is used with a steel camshaft, torque cam nut to 85-90#

SECTION XI
LIMITS AND CLEARANCE DATA

NOTE: DIMENSIONS SHOWN ARE FOR STANDARD ENGINES

Engine Model	N-56 N-62	Y-69 Y-91 Y-112	F-124 F-140 F-162 F-244	F-186 F-209 F-226	F-135 F-163 F-227 F-245	M-271 M-290 M-330 M-363		B-371 B-427	
VALVE GUIDE	INTAKE AND EXHAUST	INTAKE AND EXHAUST	INTAKE AND EXHAUST	INTAKE AND EXHAUST	INTAKE AND EXHAUST	INT.	EXH.	INT.	EXH.
Length	1 21/32	2 9/32	2 5/16	2 5/16	2 5/16	3 5/16	3.0	2 7/8	3 7/16
Outside Dia.	.5645/.5635	.5645/.5635	.6575/.6565	.6575/.6565	.6575/.6565	.752/.751		.814/.813	
Stem Hole Dia.	.3169/.3159	.3167/.3157	.3432/.3422	.3432/.3422	.3432/.3422	.4067/.4057		.4370/.4360	
*Wear Limits—Max. Dia.	.3184	.3182	.3447	.3447	.3447	.4082		.4385	
Distance, Cyl. Block Contact Face to Guide	25/32	7/8	1 15/32	1 15/32	1 15/32	1 1/4	1 9/16	1 7/8	1 5/16
VALVES, INTAKE									
Stem Dia.	.3149/.3141	.3149/.3141	.3414/.3406	.3414/.3406	.3414/.3406	.4037/.4026		.4340/.4329	
*Wear Limits, Min. Dia.	.3121	.3121	.3386	.3386	.3386	.4006		.4309	
Seat Angle	30°	30°	30°	30°	30°	30°		30°	
Stem Clearance Limits	.001/.0006	.001/.0006	.0026/.0008	.0026/.0008	.0026/.0008	.0036/.002		.0036/.002	
*Wear Limits—Max. Cl.	.003	.003	.0046	.0046	.0046	.0056		.0056	
Desired Stem Clear.	.0008	.0008	.0015	.0015	.0015	.002		.002	
VALVES, EXHAUST									
Stem Dia.	.3132/.3124	.3132/.3124	.3385/.3377	.3385/.3357	.3385/.3377	.4014/.4007		.4315/.4305	
*Wear Limits—Min. Dia.	.3104	.3104	.3357	.3357	.3357	.3987		.4285	
Seat Angle	45°	45°	45°	45°	45°	45°		45°	
Stem Clearance—Limits	.0047/.0043	.0047/.0043	.0055/.0037	.0055/.0037	.0055/.0037	.0055/.0043		.006/.0045	
*Wear Limits, Max. Cl.	.0063	.0063	.0075	.00.75	.0075	.0075		.008	
Desired Stem Cl.	.0035	.0035	.0045	.0045	.0045	.0045		.0045	
VALVE SPRINGS									
Outside Dia.	7/8	31/32	31/32	1.150/1.130	31/32	1.302/1.282		1 5/16	
Length—Valve closed	1 3/8	1 45/64	1 45/64	1 21/32	1 45/64	1 7/8		1.617	
Load—Valve closed	18-22#	47-53#	47-53#	47-53#	47-53#	58-64#		65 1/2-72 1/2	
*Wear Limits—Min. Wgt.	16#	42#	42#	42#	42#	52#		59#	
Length—Valve open	1 1/8	1 27/64	1 27/64	1 3/8	1 27/64	1.521		1.316	
Load—Valve open	32-38#	96-104#	96-104#	103-110#	96-104#	115-123#		137-151#	
*Wear Limits—Min. Wgt.	29#	86#	86#	93#	86#	103#		123#	

LIMITS AND CLEARANCE DATA

Engine Model	N-56 N-62	Y-69 Y-91 Y-112	F-124 F-140 F-162	F-135**** F-163****	F-186 F-209	F-226 F-244	F-227*** F-245**	M-271 M-290 M-330 M-363	B-371 B-427
CAMSHAFT									
Brg. Journal Dia. #1	1.7465/1.7455	1.8095/1.8085	1.8725/1.8715	1.8725/1.8715	1.8725/1.8715	1.8725/1.8715	1.8725/1.8715	2.1850/2.1840	2.2430/2.2420
#2	1.7465/1.7455	1.7465/1.7457	1.7465/1.7457	1.7465/1.7455	1.8095/1.8085	1.8095/1.8085	1.8095/1.8085	2.1225/2.1215	2.2430/2.2420
#3	1.2465/1.2455	1.2475/1.2465	1.2475/1.2465	1.2475/1.2465	1.7465/1.7457	1.7465/1.7457	1.7465/1.7457	2.0600/2.0590	2.2430/2.2420
#4	None	None	None	None	1.2475/1.2465	1.2475/1.2465	1.2475/1.2465	1.7475/1.7465	2.2430/2.2420
*Wear Limits—Min. Dia.				(.001 UNDER MINIMUM NEW SHAFT DIAMETER)					
Bushing—Inside Dia. #1	1.750/1.749	1.8125/1.8115	1.8755/1.8745	1.8755/1.8745	1.8755/1.8745	1.8755/1.8745	1.8755/1.8745	2.1870/2.1865	2.2450/2.2445
#2	1.750/1.749	1.7502/1.7495	1.7502/1.7495	1.7502/1.7495	1.8125/1.8115	1.8125/1.8115	1.8125/1.8115	2.1245/2.1240	2.2450/2.2445
#3	1.250/1.249	1.2505/1.2495	1.2505/1.2495	1.2505/1.2495	1.7502/1.7495	1.7502/1.7495	1.7502/1.7495	2.0620/2.0615	2.2450/2.2445
#4	(No Bushings)	None	None	None	1.2505/1.2495	1.2505/1.2495	1.2505/1.2495	1.7495/1.7490	2.2450/2.2445
Bushing—Clearance Limits	.0045/.0025	.004/.002	.004/.002	.004/.002	.004/.002	.004/.002	.004/.002	.003/.0015	.003/.0015
End Play	.007/.003	.007/.003	.009/.005	.009/.005	.009/.005	.009/.005	.009/.005	.008/.005	.009/.005
CONNECTING RODS									
Bush. Hole Dia.	.6067/.6057	.7632/.7622	.914/.913	.914/.913	.914/.913	.914/.913	.914/.913	1.313/1.312	1.500/1.499
Brg. Hole Dia.	1.6240/1.6245	1.6245/1.6240	2.0620/2.0615	2.1870/2.1865	2.0620/2.0615	2.1870/2.1865	2.1870/2.1865	2.3745/2.3740	2.6870/2.6865
Brg. Thickness	.06175/.06150	.0617/.0614	.0617/.0614	.0616/.0613	.0617/.0614	.0616/.0613	.0616/.0613	.0621/.0618	.0933/.0930
*Wear Limits—Min. Thk.	.0610	.0609	.0609	.0608	.0609	.0608	.0608	.0613	.0925
Dia.—Crank Pin	1.500-1.499	1.500-1.499	1.9375/1.9365	2.0627/2.0619	1.9375/1.9365	2.0627/2.0619	2.0627/2.0619	2.248/2.249	2.498/2.499
*Wear Limits—Min. Dia.	1.498	1.498	1.9355	2.0609	1.9355	2.0609	2.0609	2.247	2.497
Clearance Limits	.0005/.0025	.0006/.0027	.0006/.0027	.0006/.0022	.0006/.0027	.0006/.0022	.0006/.0022	.0008/.0029	.0009/.0030
Desired Clearance	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015
*Wear Limits—Max. Cl.	.0035	.0037	.0037	.0032	.0037	.0032	.0032	.0039	.004
Side Play	.010/.006	.0105/.006	.010/.006	.010/.006	.010/.006	.010/.006	.010/.006	.010/.006	.010/.006
Desired Side Play	.006	.0065	.006	.006	.006	.006	.006	.006	.006
MAIN BEARINGS									
Dia. of Brg. Bore in Block	2.1710/2.1703	1.8747/1.8740	2.4372/2.4365	2.5622/2.5615	2.4372/2.4365	2.5622/2.5615	2.5622/2.5615	2.8122/2.8115	3.0622/3.0615
Brg. Thickness	.08475/.08450	.0625/.0622	.0926/.0929	.0925/.0928	.0926/.0929	.0925/.0928	.0925/.0928	.0930/.0933	.0930/.0933
*Wear Limits—Min. Thk.	.0840	.0617	.0921	.0920	.0921	.0920	.0920	.0925	.0925
Dia. of Main Brg. Jr.	2.000/1.999	1.7485/1.7475	2.250/2.249	2.3752/2.3744	2.250/2.249	2.3752/2.3744	2.3752/2.3744	2.624/2.623	2.874/2.873
*Wear Limits—Min. Dia.	1.998	1.7465	2.248	2.3734	2.248	2.3734	2.3734	2.622	2.872
Clearance Limits	.003/.0008	.0005/.0028	.0007/.0030	.0007/.0028	.0007/.0033	.0007/.0028	.0007/.0028	.0009/.0032	.0009/.0032
Desired Clearance	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0020	.0020
C/S End Play.	.003/.008	.003/.008	.003/.008	.002/.006	.003/.008	.003/.008	.002/.006	.003/.008	.003/.008
PISTON PIN		See Note 1	See Note 2	See Note 7	See Note 3	See Note 4	See Note 4	See Note 5	See Note 6
Length	1.925/1.920	2.066/2.056	2.504/2.489	2.878/2.868	2.504/2.489	2.815/2.805	2.868/2.878	3.190/3.175	3.365/3.355
Diameter	.5435/.5433	.7085/.7083	.8593/.8591	.8593/.8591	.8593/.8591	.8593/.8591	.8593/.8591	1.1093/1.1091	1.2500/1.2498
*Wear Limits—Min. Dia.	.5430	.7080	.8588	.8588	.8588	.8588	.8588	.8588	1.2495
Desired Fit	Light Push	Light Push	Light Push	Light Push	Light Push	Light Push	Light Push	Light Push	Light Push
Bush. Hole Dia.—Fin.	.5438/.5436	.7089/.7087	.8597/.8595	.8597/.8595	.8597/.8595	.8597/.8595	.8597/.8595	1.1097/1.1095	1.2504/1.2502
*Wear Limits—Max. Dia.	.5448	.7099	.8607	.8607	.8607	.8607	.8607	1.1107	1.2514
Pin Cl. in Bushing	.0005/.0001	.0006/.0002	.0006/.0002	.0006/.0002	.0006/.0002	.0006/.0002	.0006/.0002	.0006/.0002	.0006/.0002
Desired Pin Fit	.0003	.0004	.0004	.0004	.0004	.0004	.0004	.0004	.0004

NOTE 1 — Y-91 PISTON PIN LENGTH 2.441 /2.431
Y-112 PISTON PIN LENGTH 2.7553/2.7543

NOTE 2 — F-140 PISTON PIN LENGTH 2.691 /2.676
F-162 PISTON PIN LENGTH 2.878 /2.868

NOTE 3 — F-209 PISTON PIN LENGTH 2.691 /2.676

NOTE 4 — F-244 PISTON PIN LENGTH 2.878 /2.868

NOTE 5 — M-271 PISTON PIN LENGTH 3.065/3.050
M-330 PISTON PIN LENGTH 3.440/3.425
M-363 PISTON PIN LENGTH 3.440/3.425

NOTE 6 — B-427 PISTON PIN LENGTH 3.630/3.620

NOTE 7 — F135 Piston Pin Length 2.691/2.676

** F245
Rear Flange Bearing
Thickness ..... .0926 - .09290
*Wear Limits Min Thickness .0921

*** F227
Camshaft Bearing Journal Dia. #3..... 1.7465 -1.7455
Rear Flange Bearing
Thickness ..... .0926 - .09290

**** F135 and F163
Center Flange Bearing
Thickness ..... .0926 - .09290
*Wear Limits, Min. Thickness..... .0921

LIMITS AND CLEARANCE DATA

Engine Model	N-56	N-62	Y-69	Y-91	Y-112	F-124	F-135	F-140	F-162	F-163
PISTONS							PISTON NO. F135A00402			PISTON NO. F163A00403
Cylinder Dia.	2.252 /2.250	2.377 /2.375	2.502 /2.500	2.877 /2.875	3.1875/3.1895	3.002 /3.000	3.1270/3.1250	3.1895/3.1875	3.4395/3.4375	3.4395/3.4375
*Wear Limits—Cyl. Bore	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
Piston Pin Hole Dia.	.5436/.5434	.5436/.5434	.7086/.7084	.7086/.7084	.7086/.7084	.8594/.8592	.8597/.8595	.8594/.8592	.8597/.8595	.8597/.8595
Ring Groove Width—#1	.096 /.095	.096 /.095	.0955/.0945	.0955/.0945	.0955/.0945	.127 /.126	.081 /.080	.1265/.1255	.1285/.1275	.081 /.080
*Max. Wear Limit Width	.098	.098	.0975	.0975	.0975	.129	.083	.1285	.1305	.083
Ring Groove Width #2—	.096 /.095	.096 /.095	.0955/.094	.0955/.094	.0955/.094	.127 /.126	.0965/.0955	.126 /.125	.1285/.1275	.0965/.0955
*Max. Wear #3—	.1885/.1875	.1885/.1875	.251 /.250	.251 /.250	.251 /.250					
Limit Width #2—	.098	.098	.0975	.0975	.0975	.1290	.0985	.1280	.1305	.0985
#3—	.1905	.1905	.253	.253	.253					
Ring Groove Width #4	None	None	None	None	None	.251 /.250	.189 /.188	.251 /.250	.253 /.252	.2515/.2505
*Max. Wear Limit Width	—	—	—	—	—	.253	.191	.253	.255	.2535
Piston Fit-Feeler Gauge	.002	.002	.002	.002	.002	.003	.003	.003	.003	.003
Lbs. Pull	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#
PISTON RINGS										
Ring Width—#1	.0935/.0925	.0935/.0925	.0935/.0925	.0935/.0925	.0935/.0925	.124 /.123	.078 /.077	.124 /.123	.124 /.123	.078 /.077
*Wear Limits—Min. Width	.0905	.0905	.0905	.0905	.0905	.121	.075	.121	.121	.075
Ring Width—#2	.0935/.0925	.0935/.0925	.0935/.0925	.0935/.0925	.0935/.0925	.124 /.123	.094 /.093	.124 /.123	.124 /.123	.0930/.0925
#3	.1865/.1860	.1865/.1860	.249 /.2485	.249 /.2485	.249 /.2485					
*Wear Limits—										
Min. Width #2	.0905	.0905	.0905	.0905	.0905	.121	.091	.121	.121	.0905
#3	.1840	.1840	.2465	.2465	.2465					
Ring Width—#4	None	None	None	None	None	.249 /.2485	.188 /.184	.249 /.2485	.249 /.2485	.248 /.244
Wear Limits—Min. Width	—	—	—	—	—	.2465	.182	.2465	.2465	.242
Ring Width—#5	None	None	None	None	None	None	None	None	None	None
Wear Limits—Min. Width	—	—	—	—	—	—	—	—	—	—
Ring Gap Clear.—#1	.013 /.005	.017 /.007	.015 /.007	.015 /.007	.013 /.008	.013 /.008	.008 /.018	.017 /.007	.017 /.007	.008 /.018
Ring Gap Clear.—#2 & 3	.013 /.005	.017 /.007	#2-.015/.007 #3-.013/.005	#2-.015/.007 #3-.013/.005	#2-.013/.008 #3-.016/.008	.013 /.008	.008 /.018	.017 /.007	.017 /.007	.008 /.018
Ring Gap Clear.—#4	None	None	None	None	None	.017 /.007	.015 /.055	.016 /.008	.017 /.007	.010 /.030
Ring Gap Clear.—#5	None	None	None	None	None	None	None	None	None	None
Ring Side Clear.—#1	.0035/.0015	.0035/.0015	.003 /.001	.0025/.001	.003 /.001	.004 /.002	.002 /.004	.0035/.0015	.0055/.0035	.002 /.004
Ring Side Clear.—#2	.0035/.0015	.0035/.0015	.003 /.001	.0025/.001	.003 /.001	.004 /.002	.0015/.0035	.0035/.0015	.0055/.0035	.0025/.004
#3	.0025/.001	.0025/.001	.0025/.001	.0025/.001	.0025/.001					
Ring Side Clear.—#4	None	None	None	None	None	.0025/.001	.000 /.005	.0025/.001	.0045/.003	.0025/.0075

CAMSHAFT BORE IN BLOCK — FINISH REAMED

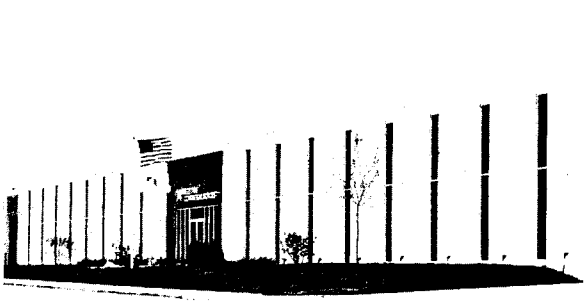
Model	Front	Front Interm.	Center	Rear Interm.	Rear
N56	1.749	None	None	None	1.249
	1.748				1.248
N62	1.750	None	None	None	1.250
	1.749				1.249
Y400	1.9375	None	1.8750	None	1.3750
	1.9370		1.8745		1.3745
F400	2.0000	None	1.8750	None	1.3750
	1.9995		1.8740		1.3745
F600	2.0000	1.9375	None	1.8750	1.3750
	1.9995	1.9370		1.8745	1.3745
M600	2.3750	2.3125	None	2.2500	1.9375
	2.3740	2.3115		2.2490	1.9365
B600	2.3750	2.3750	None	2.3750	2.3750
	2.3740	2.3740		2.3740	2.3740

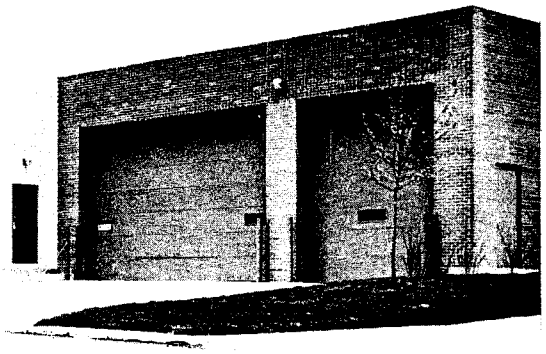
LIMITS AND CLEARANCE DATA

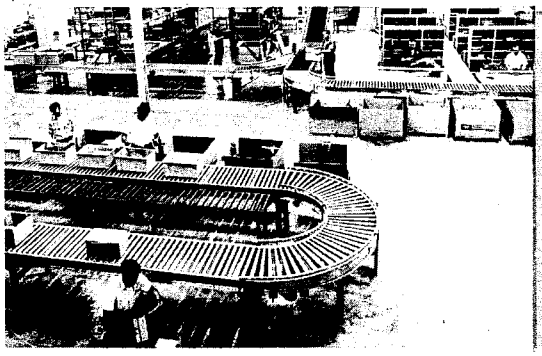
Engine Model	F-186	F-209	F-226	F-227	F-244	F-245	M-271
PISTONS				PISTON NO. F227A00406		PISTON NO. F163A00403	
Cylinder Dia.	3.002 /3.000	3.1895/3.1875	3.3145/3.3125	3.3145/3.3125	3.4395/3.4375	3.4395/3.4375	3.627/3.625
*Wear Limits—Cyl. Bore	.008	.008	.008	.008	.008	.008	.008
Piston Pin Hole Dia.	.8594/.8592	.8597/.8595	.8594/.8592	.8597/8595	.8597-.8595	.8597/.8595	1.1096/1.109
Ring Groove Width—#1	.127 /.126	.1285/.1275	.1265/.1255	.081 /.080	.1285/.1275	.081 /.080	.1275/ .126
*Max. Wear Limit Width	.129	.1305	.1285	.083	.1305	.083	.1295
Ring Groove Width—#2-3	.127 /.126	.1285/.1275	.126 /.125	.0965/.0955	.1285/.1275	.0965/.0955	.1265/ .125
*Max. Wear Limit Width	.1290	.1305	.1280	.0985	.1305	.0985	.1285
Ring Groove Width—#4	.251 /.250	.253 /.252	.251 /.250	.2515/2505	.253 /.252	.2515/2505	.1895/ .188
*Max. Wear Limit Width	.2530	.2550	.2530	.2535	.2550	.2535	.1915
Ring Groove Width—#5	None	None	None	None	None	None	.1895/ .188
*Max. Wear Limit	—	—	—	—	—	—	.1915
Piston Fit-Feeler Gauge	.003	.003	.003	.003	.003	.003	.004
Lbs. Pull	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#	5-10#
PISTON RINGS							
Ring Width—#1	.124 /.123	.124 /.123	.124 /.123	.078 /.077	.124 /.123	.078 /.077	.124 /.123
*Wear Limits—Min. Width	.121	.121	.121	.075	.121	.075	.121
Ring Width—#2 & 3	.124 /.123	.124 /.123	.124 /.123	.0930/.0925	.124 /.123	.0930/.0925	.124 /.123
*Wear Limits—Min. Width	.121	.121	.121	.0905	.121	.0905	.121
Ring Width—#4	.249 /.2485	.249 /.2485	.249 /.2485	.248 /.244	.249 /.2485	.248 /.244	.1865/.186(
*Wear Limits—Min. Width	.2465	.2465	.2465	.242	.2465	.242	.184
Ring Width—#5	None	None	None	None	None	None	.1865/.1855
*Wear Limits—Min. Width	—	—	—	—	—		.1835
Ring Gap Clearance—#1	.013 /.008	.017 /.007	.020 /.010	.008 /.018	.017 /.007	.008 /.018	.015 /.008
Ring Gap Clearance—#2 & 3	.013 /.008	.017 /.007	.020 /.010	.008 /.018	.017 /.007	.008 /.018	.015 /.008
Ring Gap Clearance—#4	.017 /.007	.017 /.007	.016 /.008	.010 /.030	.017 /.007	.010 /.030	.015 /.008
Ring Gap Clearance—#5	None	None	None	None	None	None	.018 /.008
Ring Side Clearance—#1	.004 /.002	.0055/.0035	.0035/.0015	.002 /.004	.005 /.0035	.002 /.004	.0045/.002
Ring Side Clearance—#2 & 3	.004 /.002	.0055/.0035	.003 /.001	.0025/.004	.0055/.0035	.0025/.004	.0035/.0015
Ring Side Clearance—#4	.0025/.001	.0045/.003	.0025/.001	.0025/.0075	.0045/.003	.0025/.0075	.0035/.0015
Ring Side Clearance—#5	None	None	None	None	None	None	.004 /.0015

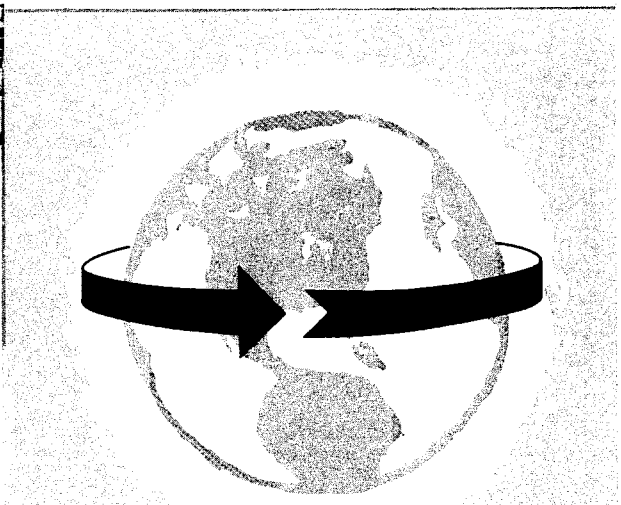
LIMITS AND CLEARANCE DATA

Engine Model	M-290	M-330	M-363	B-371	B-427
PISTONS					
Cylinder Dia.	3.752 /3.750	4.002 /4.000	4.000 /3.9995	4.127 /4.125	4.3145/4.3125
*Wear Limits—Cyl. Bore	.008	.008	.008	.008	.008
Piston Pin Hole Dia.	1.1096/1.1094	1.1096/1.1094	1.1097/1.1095	1.2503/1.2501	1.2503/1.2501
Ring Groove Width—#1	.1275/ .1265	.1275/ .1265	.0975/ .0965	.1275/ .1265	.0975/ .0965
*Max. Wear Limits	.1295	.1295	.0995	.1295	.0995
Ring Groove Width—#2-3	.1265/ .1255	.1265/ .1255	.0975/ .0965	.1265/ .1255	.0975/ .0965
*Max. Wear Limit	.1285	.1285	.0995	.1285	.0995
Ring Groove Width—#4	.1895/ .1880	.1895/ .1880	.1885/ .1875	.251 / .250	.251 / .250
*Max. Wear Limit	.1915	.1915	.1915	.2530	.2530
Ring Groove Width—#5	.1895/ .1880	.1895/ .1880	.1895/ .1880	.1885/ .1875	.1885/ .1875
*Max. Wear Limit	.1915	.1915	.1915	.1905	.1905
Piston Fit-Feeler Gauge	.005	.005	.003	.005	.005
Lbs. Pull	5-10#	5-10#	5-10#	5-10#	5-10#
PISTON RINGS					
Ring Width—#1	.124 /.123	.124 /.123	.0935/.0930	.124 /.123	.0935/.0930
*Wear Limits—Min. Width	.121	.121	.0910	.121	.0910
Ring Width—#2 & 3	.124 /.123	.124 /.123	.0935/.0930	.124 /.123	.0935/.0930
*Wear Limits—Min. Width	.121	.121	.0910	.121	.0910
Ring Width—#4	.1865/.1860	.1865/.1860	.1865/.1860	.249 /.2485	.249 /.2485
*Wear Limits—Min. Width	.184	.184	.1840	.2465	.2465
Ring Width—#5	.1865/.1855	.1865/.1855	.1865/.1860	.1865/.1855	.1865/.1855
*Wear Limits—Min. Width	.1835	.1835	.1840	.1835	.1835
Ring Gap Clearance—#1	.013 /.008	.013 /.008	.025 /.013	.016 /.011	.023 /.013
Ring Gap Clearance—#2 & 3	.018 /.008	.016 /.011	.023 /.013	.016 /.011	.023 /.013
Ring Gap Clearance—#4	.018 /.008	.020 /.010	.023 /.013	.017 /.007	.023 /.013
Ring Gap Clearance—#5	.018 /.008	.016 /.011	.023 /.013	.017 /.007	.023 /.013
Ring Side Clearance—#1	.0045/.0025	.0045/.0025	.0045/.003	.0045/.0025	.0045/.003
Ring Side Clearance—#2 & 3	.0035/.0015	.0035/.0015	.0045/.003	#2—.0045/.0025 #3—.0035/.0015	.0045/.003
Ring Side Clearance—#4	.0035/.0015	.0035/.0015	.0025/.001	.0025/.001	.0025/.001
Ring Side Clearance—#5	.004 /.0015	.004 /.0015	.0035/.0015	.003 /.001	.0025/.001









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