

Instruction Book
of
The RED SEAL
CONTINENTAL ENGINES
and POWER UNITS

MODELS

R513 Industrial	R6513 Transportation
Bore	4½"
Stroke	5¾"
Displacement	513 cu. in.
R572 Industrial	R6572 Transportation
Bore	4¾"
Stroke	5¾"
Displacement	522 cu. in.
R602 Industrial	R6602 Transportation
Bore	4¾"
Stroke	5¾"
Displacement	602 cu. in.

WHEN ORDERING SPARE PARTS BE SURE TO SPECIFY THE FOLLOWING INFORMATION WHICH CAN BE FOUND ON THE ENGINE NAMEPLATE ON THE SIDE OPPOSITE THE MANIFOLD:

ENGINE MODEL
ENGINE SERIAL NUMBER
SPECIFICATION NUMBER.—When indicated

Your cooperation in giving the above data will be of material assistance in filling your orders promptly and correctly.

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ENGINE DESCRIPTION

General

The Continental R600 Engine is a six-cylinder over-head valve engine. The engine is designed to operate on regular gasoline of 70-80 Octane. Satisfactory results may also be obtained on gasoline of lower Octane rating.

Continental engines are "run-in" and thoroughly tested for power. These tests are made on a test stand, under approximate operating conditions. When the engine is placed in service, it is ready for operation. Extended break-in runs are not necessary.

Cylinder

The cylinders and crankcase are cast together. Generous water passages are provided and each cylinder is entirely surrounded by water for its full length. Uniform cooling is therefore assured.

Crankshaft

The heavy duty crankshaft (3 1/4 inches diameter) is counter balanced and supported by seven main bearings. Bearing caps are very heavy, and are held in place by four to six 1/2 inch heat treated cap screws and located positively by dowel pins. All main and connecting rod bearings are the replaceable shell type and are not adjustable.

Lubrication

Full pressure lubrication is provided for all main bearings, connecting rod bearings, camshaft bearings and the rocker arms. There are no separate oil pipes in the engine. Drilled passages in the cylinder block and in the crankshaft carry the oil directly to all working parts.

The lubrication system also includes dual base mounted "Military Type" oil filters to insure clean oil. In addition a large oil cooler is "built in" as a part of the lubrication and filter system. The oil cooler prevents high oil temperatures. See illustrations of the lubrication diagram as well as the oil filter and oil cooler equipment. Note particularly the method of attaching the oil filters and cooler assembly to the engine. A single casting serves as a base for the oil filters, the housing for the oil cooler and the cover for the rear valve tappet assemblies.

Cylinder Heads

The engine is equipped with two heads. This design makes servicing of the engine much easier to handle. Individual intake and exhaust ports are provided for each cylinder. This is a Continental feature, and with the manifolds used insures equal fuel distribution to each cylinder.

Valves

Intake valves are conventional, large size, and have a 30 degree seat angle. The spring retainers, locks and caps on the ends of the intake valve stems are different from those used on the exhaust valves. The intake valve seat is machined in the cylinder head since intake valves run cooler than exhaust valves and are washed continually by the fresh charge of gas entering the cylinder.

Exhaust valves are different in material and shape as well as size and therefore are not interchangeable with the intake valves. The exhaust valves are the "Roto type" having a 45 degree seat angle and seat against hardened inserts in the cylinder head. See illustration on page 23.

"ROTO VALVES" means that the valve is free to turn when the valve is in the open position or raised off of its seat. By referring to the illustration it will be seen that the rocker arm pushes against a cap over the end of the valve. This cap rides against the spring retainer so that actually the movement of the rocker arm pushes the spring down and since the cap does not touch the valve it is free to turn when the spring tension is relieved.

Refer to the illustration on page 23 which shows the intake valve. In this case the rocker arm applies pressure against the end of the valve stem.

The "Roto" type exhaust valve prevents rapid accumulation of carbon or lead deposits on the exhaust valve seat which might cause the valve to burn. The

"Roto" feature means longer valve life and eliminates frequent "valve grind jobs" when engines are used in severe service.

INSPECTION OF A NEW ENGINE

The engine is shipped from the factory mounted on heavy skids and properly crated. All accessories are mounted; however, some small parts are usually packed in a separate container. When the engine is received, it should be thoroughly inspected for possible accidental damage in transit, also for possible shortage of parts or equipment.

LIFTING THE ENGINE

While every effort has been made at the factory to see that every part of this engine was assembled exactly according to the blueprints and the engine had numerous inspections during the time it was being built and tested, it must be remembered that it has been crated and then shipped and probably handled quite roughly since it left the factory. For that reason it is advisable to check everything about the engine to make sure that no parts or units have been damaged and that all bolts and nuts which hold accessories in place are tight. Be very sure to check the lubrication of this new engine thoroughly before making any attempt to start the engine. Refer to the lubrication diagram of the engine and also to the lubrication instructions.

The engine is provided with two lifting eyes attached to the cylinder heads. When the engine assembly is to be lifted for any reason, these lifting eyes must be used. Never use a sling or light ropes.

INSTRUCTIONS FOR STARTING ENGINE FIRST TIME

Before Starting the Engine

1. Check Fuel Supply: Be sure the tank is clean, then fill with a good grade of standard gasoline (70-80 octane).
2. Fill Carburetor: Fill sediment bowl and carburetor.
3. Check Lubricating Oil in Crankcase: Do not fail to check oil level. Fill to the high level notch on oil depth gauge.
4. Inspect the Engine: For loose nuts or screws. Transportation frequently loosens things on a new motor.
5. Check Storage Battery: Make sure that storage battery is filled with water at least 3/4" above the plates, and fully charged. Proper fluid gravity is 1.275. Low battery will result in slow cranking speed and weak spark.
6. Check All Electrical Connections, including battery cables. Make sure they are tight.
7. Check All Controls, to make sure they are working freely, with sufficient travel so that they do not interfere with other parts.
8. Final Check on Engine: Crank the engine over a couple of turns with ignition "off." This is to make sure that everything is "free."

HOW TO START THE ENGINE

1. Set the Throttle above idling position, about 1/4 open.
2. Pull Out the Choke. Keep your hand on it for quick adjustment as soon as engine starts. Use the choke and throttle same as when starting an automobile.
3. Turn on Ignition Switch.
4. Press Starter Button.

CAUTION: Do not engage starter longer than 30 seconds. A longer period than 30 seconds may damage the starting motor. If engine does not start, refer to detailed instruction on page 6.

"FLOODING": If you flood the engine by too much choking, the correct way to dry it out is to open the throttle wide. Put the choke in the "Running" or non-choking position. Then with ignition off, crank the engine a half dozen times. This draws nothing but air through the carburetor, as the idling jet is out of action at full throttle, and the engine does not revolve fast enough for the main jet to go into action.

AFTER THE ENGINE STARTS

1. Check Oil Pressure Gauge: Normal oil pressure at operating speeds is 55 to 65 pounds. Oil Pressure of less than 30 pounds calls for investigation. (5 to 15 pounds is satisfactory at idle). NOTE: The gauge may show no pressure for a minute or two while the filter is filling with oil.
2. The first time the engine is started, run it at idle for 5 minutes, no longer, then stop engine and recheck oil level. Oil level may be found low due to the fact that considerable oil is required to fill the oil passages. Or it may be found high if depth stick was not removed for venting air during the initial filling. Bring oil level to high mark on depth stick.

TROUBLE SHOOTING GUIDE

A good rule to follow in locating engine trouble is to never make more than one adjustment at a time. Stop and think how the motor operators, and figure out the probable cause of any irregular operation. Then locate the trouble by a process of elimination. Remember that the cause usually is a simple one, rather than a mysterious and complicated one. The following outline will be helpful in locating ordinary engine troubles:

STARTER WILL NOT OPERATE

1. Discharged or low battery: A quick check for battery condition is to "couch" a pair of pliers across the terminals. A good spark will indicate a live battery.
2. Loose or corroded battery terminals: Check cable connections at the terminal posts. Don't just look: break the connection, clean and reclamp.
3. Defective starter switch: First inspect the connections. Try the starting button—then short across the relay switch on starting motor. Test push button by "shorting" across it with a pair of pliers or test wire.
4. Bendix pinion of starting motor jammed: Loosen the starter and see if the starting pinion is "free."
5. Defective starting motor: Inspect commutator and brushes.

STARTING MOTOR TURNS BUT ENGINE DOES NOT

1. Weak Battery: Not sufficient power to turn motor at normal speed.
2. Acid-eaten cable: Insufficient current getting through. Give particular attention to ground connection on battery.
3. Broken Bendix Drive, or gum on Bendix Spiral: Starter gear will not engage when this condition exists, the starting motor will have a characteristic hum.
4. Remove the starting motor and look for broken parts. If Bendix pinion does not move freely on spiral, wash pinion and spiral in gasoline and lubricate sparingly with light engine oil, S.A.E. 10.
5. Engine itself may be "frozen."
Crank engine by hand, to make sure it is "free."
Stripped gear on flywheel:
This is extremely rare.

**STARTER TURNS ENGINE AT NORMAL SPEED—
ENGINE WILL NOT START**

(This also covers hard starting and slow starting. Possible causes will be covered under (A) Improper Carburetion, (B) Electrical Difficulties, (C) Poor Compression, (D) Wrong Timing.)

A. IMPROPER CARBURETION

1. Out of fuel: Tank empty?
2. Is gasoline reaching fuel pump?
See if sediment bowl on fuel pump is filled with gasoline. If it is not, and if there is fuel in tank, shut off cock may be closed, or the line may be clogged. Disconnect line at fuel pump and blow through line. Look for dents in tubing, and air leaks in fuel pump gaskets or in fuel line connections. Make sure that vent to gasoline tank is open.

3. Is fuel reaching the carburetor?
First remove sediment bowl from fuel pump and see if screen is clean. Then disconnect line from fuel pump to carburetor, and see if gasoline flows out freely. This line may be clogged with dirt.
4. Is fuel reaching the cylinders?
The choke may not be closing tightly. The carburetor may be out of adjustment, float level too low, or the jets may be clogged with dirt or gum.
5. Engine flooded?
If the spark plugs are wet, this indicates flooding, caused by using the choke too long. Refer to page 5 for instruction in cleaning the engine after flooding.
6. Air leaks at intake manifold or governor gaskets.
7. Poor grade, old or stale fuel in combination with cold weather. In very cold weather, heating the oil will help.

B. ELECTRICAL DIFFICULTIES

Follow the trouble-locating procedure outlined under "Electrical System." Possible troubles may be summarized as follows:

1. Primary Circuit
Corroded, dirty or loose connections.
Weak, leaky or grounded condenser.
Distributor points pitted or fused.
Distributor points set to wrong gap.
Breaker arm sticking.
Hinge bushing tight on pin.
2. Secondary Circuit
Corroded, dirty or loose connections.
Pay particular attention to high tension wire from coil to distributor, and all wires in distributor cap.
Wet wires.
Moisture or carbon on spark plug.
Cracked insulation, leaks and shorts.
Cracked distributor cap.
Carbon contact inside distributor cap broken or missing.
Rotor contact spring broken.
Ignition coil weak.

- Improper gap on spark plugs.
Fouled or cracked spark plugs.
Distributor wired to wrong plugs.

C. POOR COMPRESSION

A rough-and-ready check for compression is to remove a spark plug and place your thumb over the spark plug hole, then crank the engine. Accurate method is to use a compression gauge. Do not expect all cylinders to show the same compression pressure, but a decided difference will indicate improperly seating valves, worn rings, worn cylinder, or leaky gasket. After taking an initial reading, seal the piston with a teaspoonful of engine oil poured through spark plug hole, and take a second reading; if pressure does not increase this will indicate that improperly seating valves are at fault. Poor compression may be caused by any of the following:

1. Loose head.
2. Damaged cylinder head gasket.
3. Poorly seating valves.
4. Broken valve springs.
5. Valves holding open due to insufficient tappet clearance.
6. Valves sticking open due to carbon and gum on stems or in guides.
7. Badly worn, broken or stuck piston rings.
8. Cylinder scored.

D. WRONG TIMING

Remove No. 1 spark plug, put your thumb over the spark plug hole and test for compression stroke, cranking the engine over by hand. Then set piston on top dead center of the compression stroke. When T.D.C. mark on flywheel lines up

with pointer in bell housing, the breaker points in distributor should be just starting to open. To retune distributor and to check wires to spark plugs, follow the procedure under ignition timing, page 19.

Lack of Power

1. Faulty compression.
2. Incorrect timing.
3. Poor carburetion.
4. Restriction in air supply to carburetor caused by choke valve not completely opening.
5. Throttle control linked up so that throttle valve is not fully opening.
6. Dirt in sediment bowl of fuel pump.
7. Dirt in fuel lines or carburetor jets.
8. Air leak in fuel pump or fuel line.
9. Air leak in manifold gaskets or at governor gaskets.
10. High engine temperature, caused by worn water pump or clogged water jackets.
11. Vent of gasoline tank not open.
12. Pre-ignition, caused by carbon deposits.
13. Engine misalignment.

Rough, Uneven Idling

1. Improper adjustment of carburetor.
Idling jet air passage clogged.
2. Air leaks in intake manifold or carburetor.
Loose manifold nuts.
Damaged gasket at manifold or governor.
3. Faulty ignition.
Weak ignition coil.
4. Spark plug difficulties.
5. Uneven compression.
6. Water leak at cylinder head gasket or manifold.
Missing at High Speed

MISSING AT ALL SPEEDS

1. Spark plug troubles.
2. Broken insulation on high-tension wires.
3. Faulty breaker-points.
4. Fuel obstruction, indicated by back-firing.
5. Incorrect tappet clearance.

Crankshaft Knocks

These are usually detected as dull, heavy, metallic knocks which increase in frequency as the speed and load on the engine is increased. The most common crankshaft knock is that caused by excessive clearance at one or more main bearings. This is most audible when engine is pulling hard, on acceleration, or when engine is cold. By alternately shorting out each spark plug, the approximate location of the loose bearing can usually be determined. Excessive crankshaft end play caused a sharper noise or rap which occurs at irregular intervals. In bad cases this can generally be detected by releasing and engaging the clutch. Causes of crankshaft knocks include the following:

1. Excessive bearing clearance.
2. Excessive end play.
3. Eccentric or out-of-round journals.
4. Sprung crankshaft.
5. Insufficient oil supply.
6. Low oil pressure.

7. Badly diluted oil.
8. Loose flywheel.

Connecting Rod Noises

Connecting rod noises are usually a light pound or knock of much less intensity than main bearing knocks. The noise is usually evident with the engine idling and becomes louder when engine speed is slightly increased. Connecting rod noise can best be located by shorting out one spark plug at a time. These noises should not be confused with piston or piston pin noises. Possible causes are as follows:

1. Excessive bearing clearance on crank pin.
2. Insufficient oil supply.
3. Low oil pressure.
4. Badly diluted oil.
5. Misaligned connecting rods.
6. Out-of-round or tapered crank pin journal.

Piston Noises

The most common piston noise is "slap," due to the piston rocking from side to side in the cylinder. Piston-slap usually causes a hollow, rattled, bell-like sound, or a click. Slight piston noises that occur with a cold engine and disappear after engine is warm, do not warrant replacement. Piston-slap is most audible when driving the engine at low speed under load. Piston and ring noises can be located by putting a spoonful of heavy engine oil (S.A.E. 50) into the suspected cylinder through the spark plug hole. Crank the engine over by hand for several revolutions with the ignition off, until the oil has worked down past the piston rings. Replace the spark plug, start the engine, and determine if the noise still exists.

Piston Pin Noises

The most common piston pin noise is the result of excessive piston pin clearance. This is characterized by a sharp, metallic double knock, generally audible with the engine idling. Possible causes:

1. Excessive piston pin clearance in piston boss.
2. Excessive piston pin clearance in bushing.
3. Bushing loose in connecting rod.

Valve and Tappet Noises

Noisy valve action has a characteristic clicking noise occurring usually at regular intervals. The frequency of valve action noise is generally less than other engine noises, because the valves are operated by the camshaft running at one-half of crankshaft speed. If one or two of the valves or tappets are causing the noise, the clicking sound will be intermittent, but if the condition exists with a majority of the valves, the noise may be continuous.

The common cause of valve action noise is that of excessive clearance between tappet and valve stem. Correct setting for this engine is .022. Instructions for valve tappet adjustment are covered in detail on page 26. Do not set for less than .022 because this is liable to cause burned valves. Possible causes of valve and tappet noises:

1. Excessive tappet clearance.
2. Threads stripped on adjusting screw.
3. Broken valve springs.
4. Excessive valve stem to guide clearance.

Spark Knock and Fuel Knock

Included under this heading are Pre-ignition and Detonation. Pre-ignition is caused by an incandescent particle of carbon or metal in the combustion chamber, which fires the mixture prematurely, while the piston is still rising. Detonation is caused by fuel of wrong octane rating, which burns too rapidly, throwing a sudden and abnormally high pressure against the down-moving piston. The two have a similar sound, a metallic ringing knock which is often described as a "ping." This is usually heard when the engine is laboring, accelerating rapidly, or overheated. Causes:

1. Carbon deposits in combustion chamber.
2. Ignition timed too early.
3. Faulty spark plugs.

4. Carbon on spark plugs or burned porcelains.
5. Hot valves resulting from:
 - Insufficient tappet clearance.
 - Improper seating.
6. Excessive engine temperature, caused by faulty water circulation.
7. Low octane fuel.
8. Old or stale fuel.
9. Extremely lean carburetor mixture.

Vibration Originating at Engine

The most common sources of vibration originating in or on the engine, are distinguished from causes originating outside the engine (covered below) are as follows:

1. Misfiring.
2. Misalignment of engine and drive shaft.
3. Bent or off-center coupling.
4. Engine loose on bed.

Uncommon Engine Noises

The following possible causes of engine noise are more rare, but should be considered and checked in locating foreign sounds:

1. Flywheel loose on crankshaft.
2. Crankshaft pulley loose on crank.
3. Loose exhaust pipe at manifold connection.
4. Loose engine accessories, such as generator, water pump, etc.

Backfiring at Carburetor

Engine back-firing through the carburetor when starting cold is many times unavoidable as it is the result of imperfect air-gasoline mixture, which will automatically correct itself after the engine reaches normal operating temperatures. The "reason why" of back-firing in this case is late burning of the mixture in the cylinder, due to improper ratio of fuel to air, igniting the incoming charge and causing an explosion in the intake manifold and carburetor. Thin lean mixtures and retarded spark are the commonest cause of back-firing. Continued back-firing after the engine is warm should be corrected by checking the following possible causes:

1. Excessively lean fuel-mixture.
2. Late ignition timing.
3. Improperly seating valves, especially intake.
4. Obstruction in fuel line.
5. Dirt or water in sediment bowl.
6. Intake manifold air leaks.
7. Poor grade of fuel.
8. Secondary wires crossed in distributor cap.
9. Faulty spark plugs.

Abnormal Oil Consumption

Before deciding that worn piston rings or worn cylinders are the cause of high oil consumption, don't overlook the possibility of oil leaks. Give attention particularly to the oil seals. Slow leaks can be located by spreading a paper under the engine.

If plugs foul up persistently, and if the exhaust is smoking, this indicates that the engine may be pumping oil, either past the pistons or along the valve stems. Another cause of fouled plugs is too high an oil level, causing crankshaft to dip and splash excessive oil.

Remember that it is normal for an engine to consume and burn a certain amount of oil, the quantity depending on the speed of operation. Normal oil consumption in a new engine operating under load at 2750 r.p.m. is about one quart every 2 to 3 hours of running. When engine requires more than 4 quarts added per day, the cause requires investigation.

Low Oil Pressure

Complete absence of oil pressure is sure sign of a broken oil pump or lack of oil. Normal oil pressure in a new engine is 55 to 65 pounds. A pressure of less than 30 lbs. calls for investigation. (5 to 15 lbs. is satisfactory at idle). Possible causes of low oil pressure:

1. Incorrect grade of oil.

2. Badly diluted engine oil.
3. Oil relief valve not properly seating.
 - Look for dirt on seat of valve.
4. Clogged oil cooler.
5. Air leak in oil pump suction line.
6. Sludge on oil pick-up screen.
7. Worn or damaged pump gears.
8. Inaccurate oil pressure gauge.

High Oil Pressure

Oil pressure should not exceed 65 lbs. except momentarily when the engine is started up cold. Abnormally high oil pressure is not desirable because it increases oil consumption. Possible causes of high oil pressure:

1. Engine oil too heavy.
2. Relief valve not opening (It may be stuck).
3. Obstruction in distributing line.
4. Inaccurate oil pressure gauge.

Fouled Spark Plugs

1. Worn piston rings.
2. Worn cylinders.
3. Excess piston clearance.
4. Rich mixture.
5. Gap too narrow, causes missing at idle.

Burned Spark Plugs

1. Lean mixture.
2. Late ignition timing.
3. Engine overheated, due to worn water pump, obstructions, etc.
4. Low octane fuel.
5. Badly leaking valves.

POSSIBLE ELECTRICAL TROUBLES

Slow Starter Speed

1. Discharged battery.
2. Loose or dirty terminals.
3. Worn brushes in starting motor.
4. Sticking brushes.
5. Dirty commutator.
6. Burned starter switch contacts.

Low Charging Rate

1. Dirty commutator in generator.
2. Drive belt to generator loose.
3. Voltage regulation improperly adjusted.
4. High resistance in charging circuit.

Hard Starting

1. Distributor points burned or corroded.
2. Points improperly adjusted.
3. Wrong gap in spark plugs.
4. Spark plug wires loose and corroded in distributor cap.
5. Loose connections in primary circuit.
6. Corroded battery terminals.
7. Defective condenser.
8. Choke not fully closing.

Back Firing

1. Crossed plug wires.
2. See "Trouble-Shooting" for other causes.
1. Incorrect gap in spark plugs.
2. Defective spark plugs.
3. Defective coil.

Pre-Ignition

1. Carbon deposits.
2. Overheating.
3. Ignition timing set too early.

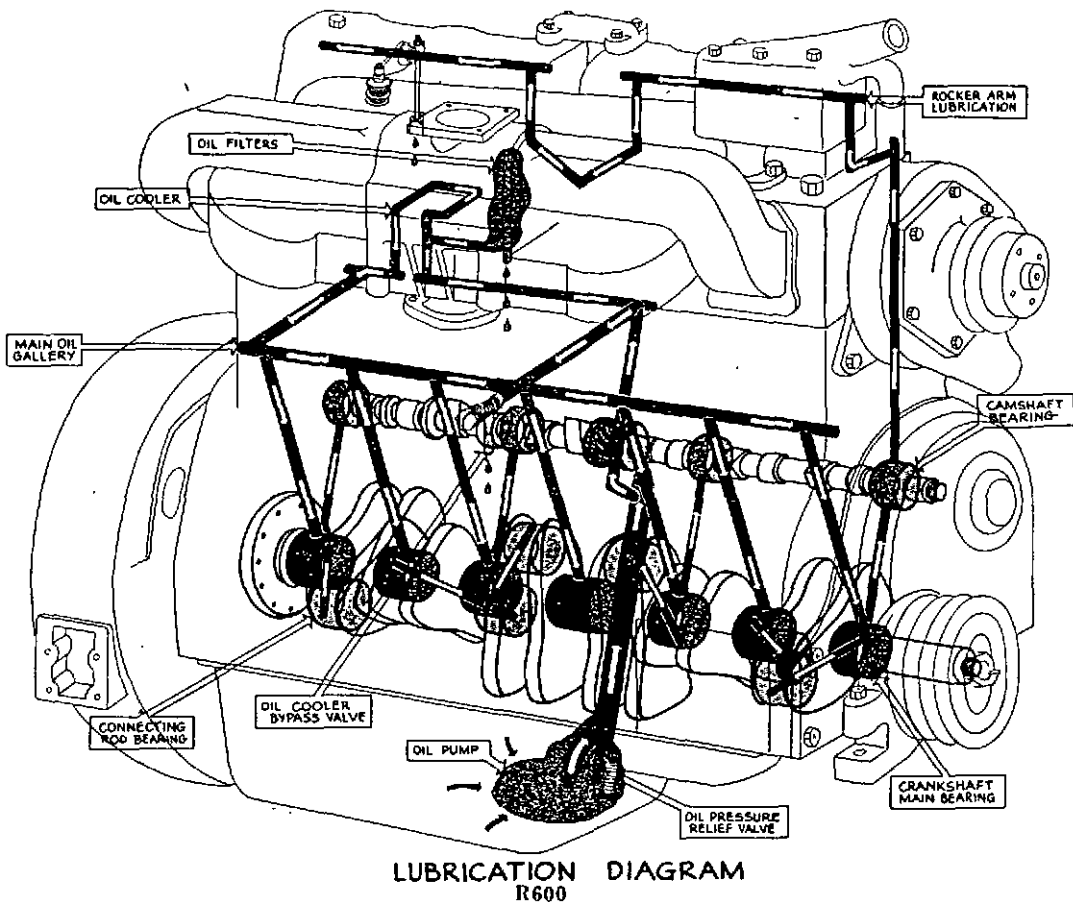


Figure No. 1

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LUBRICATING OIL RECOMMENDATIONS

Engine design, the service it performs and the prevailing atmospheric temperatures in which it operates, are factors which determine the body and character of the lubricating oil required to assure maximum performance with minimum costs for supplies, adjustments, repairs and replacements.

Engines of this series are particularly adapted to, and used in motor vehicle and for industrial purposes. Encompassing as they do, a wide field of operating conditions, the lubricating oil recommendations are established to meet the requirements of the several classifications of service.

SUMMER

Heavy Duty Service

In summer, when atmospheric temperatures above freezing (32°F) prevail and in such installations where the engine is called upon to produce average; more than half its rated power, it is interpreted as heavy duty service. For this service use a high quality of S.A.E. Number 30.

Normal Service

For summer atmospheric temperatures and where the operation demands an average less than half the rated power of the engine, it shall be regarded as normal service. Where these conditions prevail use a high quality oil of S.A.E. Number 20.

SPRING AND FALL

The atmospheric temperatures of these seasons are moderate. Where good grade, high viscosity index oils are employed, one grade lighter than those specified above may be used, if desired by the operator.

WINTER

Protected Operation

Where the vehicle or unit is housed in a warm building when not in operation the Spring and Fall recommendations are to apply.

Unprotected Operation

For atmospheric temperatures from 32°F to zero ° F, and where the vehicle or unit is exposed to a thorough chilling when not in operation, then a big grade, good viscosity index oil of S.A.E. number 20 oil should be used. (Similar) for temperatures consistently below zero ° F use a high grade S.A.E. number 10 oil.

NEW ENGINES

The crankshaft clearances and those between the pistons, piston rings and cylinders are very small in new engines before they have been thoroughly run-in. To assure adequate distribution of oil to these closely fit surfaces during the first week or 20 hours of operation, a lighter bottled oil should be used. For this run-in period we recommend the use of high grade oil of S.A.E. Number 20.

RECONDITIONED ENGINES

The expression of Reconditioned Engines is to be interpreted as those engines which have been renewed in the sense of remachining the cylinder bores, installation of new pistons and piston rings, also new crankshaft bearings. As such reconditioning re-establishes the small mechanical clearances similar to that of new engines, a high grade oil of S.A.E. Number 20 should be used for the first 20 hours of operation.

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OIL PRESSURE

Normal oil gauge pressures are between 55 and 65 pounds. If due to extremely cold operating temperatures the oil pressure tends to remain above 65 pounds, oil should be changed to one having lighter body. If due to extremely hot operating temperatures the oil pressure tends to drop below 15 pounds, oil should be changed to one having heavier body.

DRAINING THE CRANKCASE OIL

Frequency of Drains

A very important factor in reducing wear and maintaining engine efficiency is the frequent and regular draining of the Crankcase oil. Drain the used oil after the first 20 hours of operation, if used for industrial service, and after 500 miles if used in automotive service. Thereafter drain oil each 50 hours for industrial engines and each 1,500 to 2,000 miles for automotive service.

Flushing

Do not use Kerosene. Kerosene possesses cutting properties; it promotes engine wear. If it were used, some would be trapped in the oil distribution system and in engine pockets which would adversely dilute the fresh engine oil refill. If engine flushing is practiced, use a good grade of flushing oil.

Refilling

CAUTION: Do not overfill the Crankcase. An excess of oil does not improve lubrication. It causes high oil consumption, smoking and carbon deposit. Fill to the proper level, never letting it come below the low mark on Bayonet Gauge.

WATER PUMP

Engines of this series are equipped with water pumps having either a low pressure gun fitting or hand operated grease cup. Lubricate the bearings of the water pump at the end of each 50-hour operating period with a suitable high temperature sodium soap grease.

GOVERNOR

Governor is Mechanical Type, automatically lubricated from engine oil reservoir.

DISTRIBUTOR

Fill oiler or grease cup on side of Distributor when necessary and lubricate distributor drive shaft at Zerk Fitting every 50-hour operating period.

CONTROL ROD JOINTS

Make daily application of a few drops of engine lubricating oil to the throttle and choke control rod joints, carburetor levers, and all points where friction will occur.

CARBURETION

Carburetor adjustment is predetermined and made at factory. No readjustment is necessary except for extreme deviations from normal operating conditions.

COOLING

If the water is permitted to drain or evaporate down to an insufficient amount, serious over-heating will take place. Moderately soft water is most desirable; if not obtainable we recommend that the system be drained every two weeks and flushed with clear running water. Under extreme conditions it is well to add a pound of soda ash, the addition of this tending to soften the water and delay, if not prevent entirely, the formation of lime and other coatings on the inside of the Water Jacket and Radiator Core.

Never use kerosene for cooling purposes in place of water, as its vapor is highly inflammable, increasing the fire risk to a prohibitive extent.

In cold weather Radiator should be kept partially covered and the following amount of alcohol used at the corresponding temperatures:

Freezing Temperature	Denatured Alcohol Percentage by Volume	Water Percentage by Volume
30° above zero	5%	95%
20° above zero	15%	85%
10° above zero	25%	75%
Zero	30%	70%
10° below zero	35%	65%
20° below zero	40%	60%
35° below zero	50%	50%

MAGNETO

See separate instruction booklet on Magneto.

POWER TAKE-OFF

When Power Take-Off is used it should be lubricated through the Zerk Fitting provided for that purpose following the instructions on the plate attached to the unit.

Where clutch is used follow the direction on manufacturer's plate attached to unit. Where, in isolated cases, this plate is omitted, the following should be observed:

IMPORTANT: If clutch does not pull, heats, or operating lever jumps on the clutch must be adjusted.

ADJUSTMENT: Remove hand hole plate, turn clutch until adjusting loc pin can be reached. Pull adjusting pin out and turn adjusting yoke to right (clockwise, until operating lever requires a distinct pressure to engage. A new clutch requires several adjustments until friction discs are worn in.

LUBRICATION: Lubricate clutch throw-out collar and ball bearings on a day before starting.

THE LUBRICATION SYSTEM

GENERAL DESCRIPTION: The lubrication system is a full-pressure type, consisting of a gear type pump, equipped with a large oil screen submerged in the oil in the oil pan. The pump is driven by a gear on the camshaft.

Oil is drawn through the screen by the pump, then forced through drilled passages to all main bearings, connecting rod bearings, camshaft bearings and rocker arms. All other parts in the engine are lubricated by "splash" or oil thrown "off" from the connecting rod bearings.

The lubrication diagram on page 12 shows how the oil flows through the engine to all points fed under pressure. This diagram should be studied carefully so that you will be thoroughly familiar with the lubrication system.

An oil pressure relief valve or safety valve is provided to prevent excessive pressure particularly when the engine is first started and the oil is cold. This relief valve also insures correct lubrication over a wide range of engine speeds which would be hard to accomplish without such a valve in the system.

Oil and Oil Changes

The oil should be changed each 50 to 60 hours of operation. The capacity of the oil reservoir together with the cooler and filter system is 18 quarts. After the oil has been changed run the engine for about five minutes and recheck the oil level by inspecting the gauge dip stick.

Oil Screen Service

The oil screen can be inspected by removing the oil pan. This screen should be inspected occasionally to be sure that it is clean and free of sludge.

Oil Cooler

A built-in oil cooler is provided and is encased in a housing attached to the engine on the left hand side, at the rear. This housing also acts as the base for the dual oil filters and the rear tappet cover plate.

Drilled oil passages permit the oil to flow directly from the oil pump thru this cooler, and there are no outside lines for either oil or water connections. With the water circulating thru the cooler, oil temperature is reduced from 35° to 50° as it flows thru the cooler.

Oil Cooler Service

Dirt or corrosion in the cooler will seriously affect its efficiency. (The cooler should be cleaned at least twice each year. To clean the cooler remove the oil filter housing assembly by removing the screws holding it to the cylinder block).

Oil Filters

Dual base-mounted military oil filters are provided and are attached to the oil cooler body. These filters are the shunt type, oil reaching the filters directly from the gallery line and flowing back to the case freely after it has passed thru the filter cartridges.

These filters are equipped with the "standard military" element, which should be replaced when the oil begins to darken noticeably. Before new filter cartridges are installed be sure to remove the drain plug in the bottom of the filter case and drain all of the sludge that has collected in the filter body.

Before the filter cover is replaced be sure to examine the gasket, and if necessary install a new one.

IMPORTANT: It will be necessary to add between four quarts of oil when new filter cartridges are installed. Run the engine for several minutes and check the filters for possible leaks after the new cartridge has been installed.

How the Filter Works

The illustration Figure 2 shows a section thru one of the base mounted filters. Arrows show the oil flow thru the filter. Oil enters the base under pressure and is forced to the top of the filter thru the small tube on the outside of the filter body. The oil then circulates completely around the filter element and flows thru the filtering medium to the center tube thru which the clean oil is returned to the engine oil pan.

Oil Filter Service

Each time the oil is changed the filter elements should be changed and the sludge chamber inside each filter housing cleaned thoroughly.

IMPORTANT: Always use a new filter element. Do not try to wash or otherwise clean the dirty element.

Lubrication Diagram

The lubrication diagram for this engine is illustrated on page 12. This diagram shows the oil flow through the screen and pump to all bearings to which oil is fed under pressure. The arrows indicate the direction of oil flow to each of the bearings, also how the oil flows through the oil cooler and oil filter. Oil is forced under pressure to all main bearings, connecting rod bearings, camshaft bearings and rocker arms. The timing gears at the front end of the engine are lubricated by a spray of oil in the gear case. The pistons, rings and cylinders are lubricated through drilled holes in the connecting rod and by oil thrown off by the connecting rod bearings.

This lubrication diagram is only intended to show the various parts lubricated under pressure and to show how the oil flows through the engine to reach the bearings and other parts. Accessories such as the ignition distributor, starter and generator all have their separate lubricating instructions which should be read carefully and followed exactly.

Oil Pump and Pressure Control

The oil pump is driven from the camshaft at the approximate center of the engine. The pump body is submerged in the oil. Inspection covers on the oil pump make inspection easy.

The oil pressure is regulated by a recirculating type of pressure regulator built into the pump body. The spring that controls the oil pressure is set to provide approximately 60 lbs. oil pressure. Excess oil beyond engine requirements is by-passed from the pressure side of the pump thru this regulator directly back to the intake side of the pump.

The oil pressure regulator consists of a plunger and a coil spring. The spring is calibrated to give the correct oil pressure, and under normal condition will require no attention. Should the oil pressure drop after several hundred hours service, the pressure may be increased by adding one or two plain washers between the spring and plunger.

An auxiliary oil pressure regulator is built into the side of the engine and into the gallery line feeding oil to the oil cooler.

The difference between the pressure of the main regulator and that of the auxiliary regulator permits the oil to flow thru the oil cooler in the correct quantities.

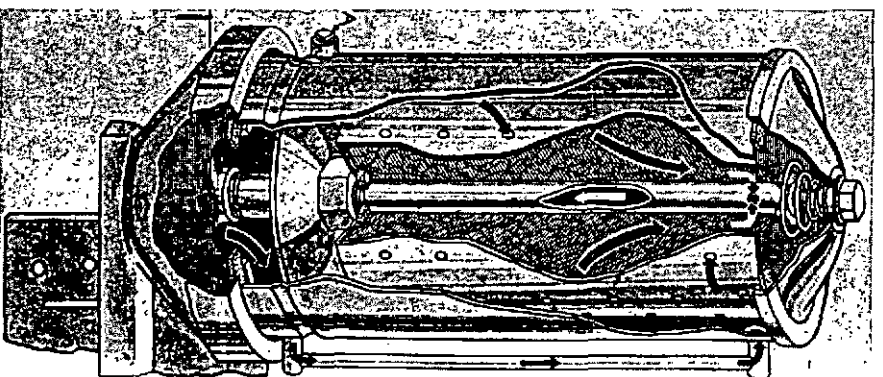


Figure No. 2

Camshaft Timing

If the timing gears are removed for any reason the camshaft must be timed when the gears are replaced. See illustration below.

Both the crankshaft and camshaft gears are marked. The camshaft gear has center punch marks on two teeth. The crankshaft gear has only one tooth marked. Assemble the gear so that the marked tooth on the crankshaft gear goes between the two marked teeth on the camshaft gear. See Figure 4.

When the timing gears are assembled with marks matching as shown, the camshaft is timed correctly.

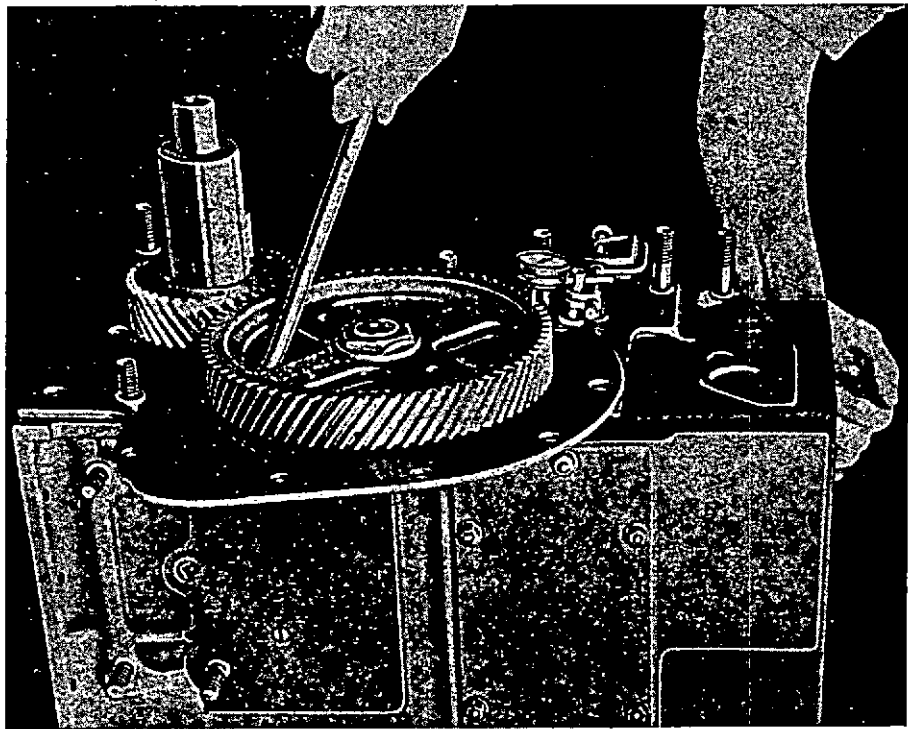


Figure No. 3

Checking Camshaft End Play

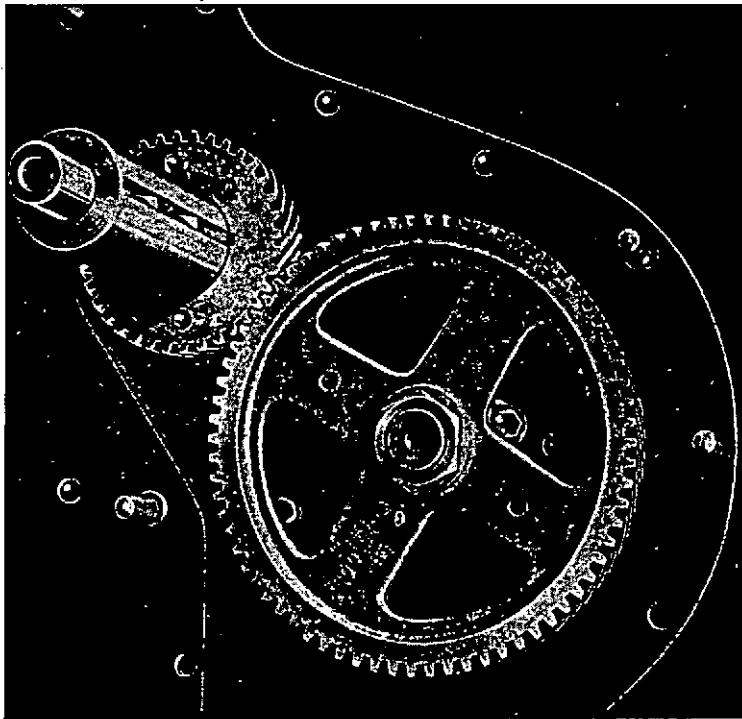


Figure No. 4

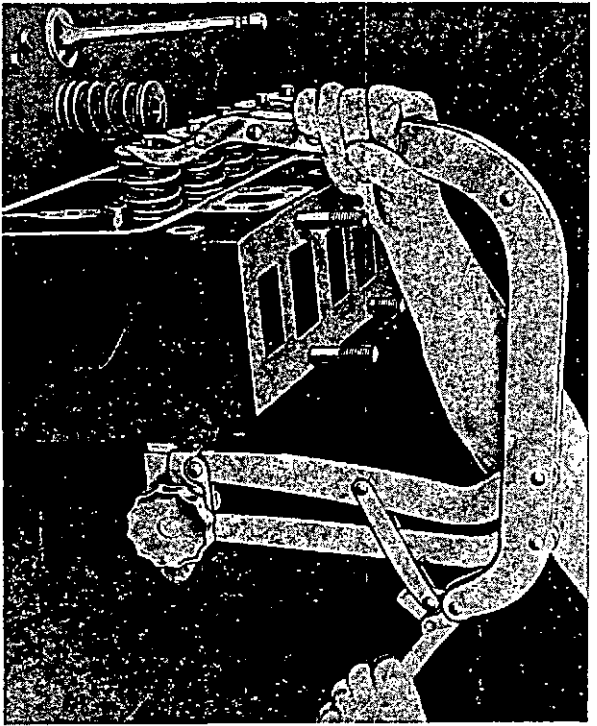


Figure No. 5

VALVE REMOVAL

After the cylinder head has been removed it is a very simple matter to remove the valves by using a conventional type valve lifter, as illustrated.

The retaining locks are made in two pieces.

When the valves are replaced be very careful to see that the locks are properly engaged with the rings in the valve stem.

VALVE AND VALVE SEATS ANGLES

Intake valves have a 30° seat angle, and run against a seat machined in the cylinder head. Dual springs are used with a conventional type spring retainer. See Figure 6. A small cap is used over the end of the valve stem, which in turn rides against a cap over the end of the rocker arm. Due to a difference in size and shape, the cap on the intake valve is not interchangeable with that used on the exhaust valve.

The exhaust valve has a 45° seat angle and runs against a hardened insert in the cylinder head. Dual springs are used the same as for the intake valve, but the retainer mechanism at the top is entirely different. This mechanism is constructed so that when the pressure is exerted against the valve spring retainer instead of the end of the valve. This permits the valve to rotate or move freely when it is lifted away from the seat. This feature is important in keeping the seat free of lead deposits and to prevent valve sticking in the guide.

VALVE STEM GUIDES

Caution: Ferrox guides now used are pre-reamed and do not require reaming in place.

Valve stem guides should be installed from the combustion chamber side of the cylinder head. Both the intake and exhaust guides are exactly the same, but the intake valve guide extends into the port more than the exhaust guide.

The exhaust and intake guide should be pressed in place by measuring 1% from the flat machined surface at the valve seat to the end of the guide.

IMPORTANT: The dimensions for installing valve guides must be maintained — otherwise interference between the valve spring retainers and the ends of the guides may result.

Both intake and exhaust guides are the same diameter.

The desired valve stem clearance is .002 for the intake valve and .004 for the exhaust valve.

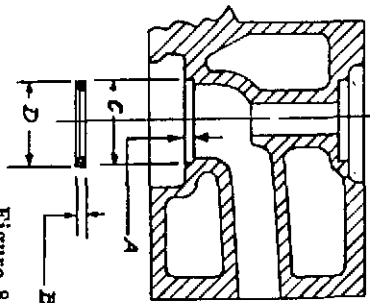
The exhaust valve stem is smaller than the intake valve stem to provide correct clearance. Stem diameter of the exhaust valve is .494-.495. The stem diameter of the intake valve is .4969-.4977.

**INSTRUCTIONS FOR INSTALLING
VALVE SEAT INSERT**

To obtain satisfactory results the new insert must be oversized and the recess must be reamed so the insert can be driven in to fit tight at all points in the recess. This is very important to insure proper cooling of the valve.

The recess must be .005 smaller than the diameter of the insert to provide for a drive or press fit. The recess must also be .005 to .010 deeper than the thickness of the insert so it can be locked in place as shown in Figure 10.

Figure 8



- Tools or equipment necessary:
- 1—Puller—to remove insert
 - 1—Recess reamer
 - 1—Driver for insert (see Fig. 9)
 - 1—Rolling or crimping tool
 - 1—Valve seat grinder

Installation Procedure

(1) Remove the old insert—use a good puller—if no puller is available it is possible to break the insert with a hammer and chisel, but this is dangerous practice and extreme care must be exercised.

(2) Ream the recess to receive the insert—do this operation carefully—the reamer must cut .005 smaller ("C" Fig. 8) than the diameter of the insert—"D" Fig. 8—the depth of the recess—"A" Fig. 8) must be .005 to .010 greater than the thickness of the insert ("B" Fig. 8).

(3) Place the insert on dry ice for several minutes. This chilling of the insert will reduce the diameter and permit it being driven into the recess easier. This procedure also insures a tight fit. Place the insert in the recess and drive firmly into place. Use the special driver for this purpose. (See "E" Fig. 9)

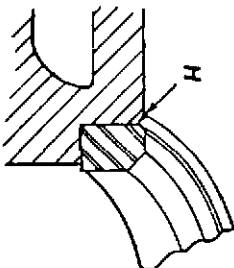
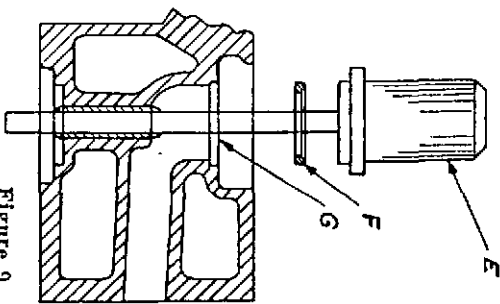
(Read paragraph 2.)

(4) Roll or crimp the edge of the recess over the top edge of the insert. (See Fig. 10.)

(5) Grind the valve seat to the correct angle (45°) with a good seat grinder. The insert is extremely hard and a valve seat reamer cannot be used successfully.

(6) Use a new valve or reface the old valve and lap to the seat with fine compound.

Figure 9



ROCKER ARMS AND SHAFT

The rocker arms are fitted to the rocker shaft with a clearance of .0005 to .0015. The desired clearance with new parts is .001. The finished diameter of the rocker arm bushing is .968 - .969. The mean limit is desired.

The rocker shaft is made from steel tubing and oil is forced into the shaft from a drilled passage leading from the front camshaft bearing. See Lubrication Diagram. Holes are drilled in the rocker shaft so that oil is fed directly to each rocker arm. The rocker shaft should be assembled so that these holes point down when viewed from the top.

INSTALLATION OF CYLINDER HEAD

The installation of the cylinder head may appear to be a very simple matter, but care should be exercised to insure a perfect seal of the cylinder head gasket at all points.

Remember that the compression pressures are very high when the explosion takes place in the cylinder. Before installing a new gasket be sure that the top surface of the cylinder block is perfectly clean. Also that the gasket and the surface of the cylinder head is perfectly clean.

In tightening the cylinder head nuts start in the center by pulling the nuts down firmly and then work towards each end of the cylinder head, tightening alternate nuts. Do not attempt to pull the nut absolutely tight the first time. Be sure to go over all cylinder head nuts at least three times. If a torque wrench is available by all means use it.

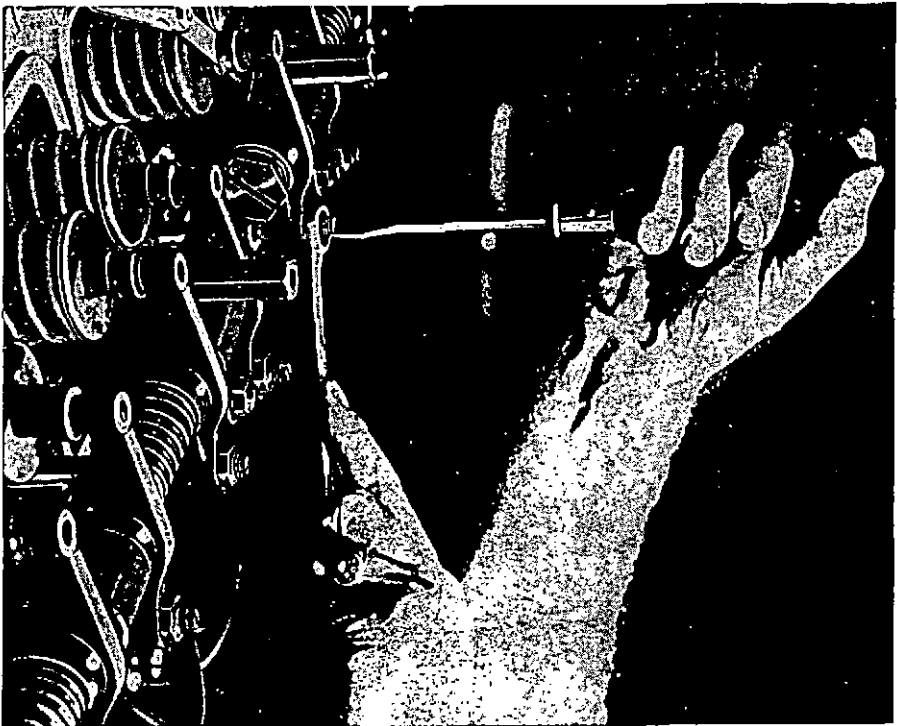


Figure 12

VALVE CLEARANCE ADJUSTMENT

Correct clearance between the rocker arm and valve stems is essential for satisfactory operation and long valve life.

The correct clearance is .024 for exhaust and .018 for intake.

When the adjustment has been correctly made a .024 feeler will pass between the tappet and valve freely. A .025 feeler should be snug or fairly tight. Use .018 and .019 for intake.

IT IS RECOMMENDED THAT THE VALVES BE ADJUSTED WITH THE ENGINE RUNNING AT IDLE SPEED WHENEVER POSSIBLE. If it is not possible to make the adjustment with the engine running, it will be necessary to crank the engine until both valves are closed and the piston is on Top Dead Center on the compression stroke. As a final check start the engine and be sure the correct feeler will pass between the rocker arm and valves.

CONNECTING ROD AND PISTON ASSEMBLY

The piston used in this engine is made of aluminum alloy but differs from other such pistons because it does not have a split skirt. Instead the piston is both oval and taper ground and is fitted with five piston rings.

The piston pin is a so-called full floating type, because it is not locked in either the piston or connecting rod. The two retaining rings shown in the illustration fit into the grooves in the piston at each end of the piston pin. The fitting of the piston pin to the piston is described under "Piston Pins."

The connecting rod bearings are replaceable shells, and are held in position by lock tabs on the bearing shells which fit into the slots in the connecting rods. Refer to the section under "Connecting Rod Bearings."

CONNECTING RODS AND BEARINGS

The connecting rod and piston assembly is removed thru the top of the cylinder block. Cylinder numbers are stamped on the rod and cap, and the rods must be installed with these numbers assembled toward the camshaft side of the crankcase.

IMPORTANT: Before installing new bearings be sure that all oil passages are thoroughly cleaned. When replacing connecting rod bearings be sure that the rods and caps, as well as the bearing shells are clean and free from oil. This is extremely important. Oil on the back of the bearing shell will prevent it seating properly in the rod and cap.

Bearings are of the replaceable shell type, and the clearance limits are from .002 to .0046. The desired clearance is .003.

A check of the clearance may be made by placing a short piece of .003 feeler stock between the bearing and crankshaft, and tightening the cap. A slight stiffness should be noticed for any movement of the connecting rod. After this check has been made the crankshaft journal should be oiled thoroughly before the rod bearing is tightened.

CRANKSHAFT

The crankshaft is fully counter-weighted for balance and is supported by seven (7) large main bearings. All bearing journals for both main and connecting rod bearings are hardened. The process is known as "Tocco Hardening." The flywheel flange and the method of attaching the flywheel to the flange differs from conventional engines. Instead of using bolts and nuts, the holes in the flange are threaded and special screws hold the flywheel in place. In addition to the screws dowel pins are driven into reamed holes through both the wheels and flange.

This method of attaching the flywheel permits the use of a much better oil seal at the rear end of the shaft.

CRANKSHAFT JOURNALS

Main bearing journals and crank pins should be checked for out-of-round and taper before installing new bearings. If this exceeds .002 the crankshaft should be reground and polished.

The main bearing journals are $3\frac{1}{4}$ " diameter (3.249-3.250). The crank pins are 3" in diameter (2.999-3.000).

MAIN BEARINGS

Main bearings are of the replaceable shell type, and are held in place by lock tabs which fit into slots machined in the crankcase and bearing cap. Bearing shells may be removed simply by removing the cap and rotating the upper half around the shaft until it drops out of the case.

IMPORTANT: Before new bearing shells are installed be sure to clean the oil passages thoroughly, and to wash both the crankshaft and the crankcase bearing hole so that they are perfectly clean, and dry. Oil between the bearing shell and crankcase will prevent the bearing shells seating perfectly.

All bearing caps are numbered and these numbers are on the camshaft side of the engine.

All main bearing caps are also doweled in place so that there can be no misalignment and they cannot be interchanged from one bearing to another.

Main bearing clearance limits are from .002 to .0046. The desired clearance is .003.

For a check of bearing clearance a short piece of feeler stock can be placed between the bearing and the crankshaft, as described under the heading "Connecting Rods."

CRANKSHAFT END PLAY

The end play should be between .004 and .006. More than .010 end play indicates it should be readjusted by removing shims between the crankshaft gear and the shoulder on the crankshaft. To check the end play, install a sleeve over the end of the shaft and install the crankshaft nut so the gear will be held firmly and in its correct position. Then pry the crankshaft ahead with a screw driver or pinch bar as illustrated and insert a feeler gauge between the crankshaft gear and the thrust plate.

FLYWHEEL MOUNTING

The flywheel is held to the crankshaft by six special cap screws and dowel pins. When assembling the flywheel to the crankshaft check the flange to be sure that it is perfectly smooth and undamaged.

Maximum run-out of the flange should not exceed .002 indicator reading. Be sure that the cap screws are firmly tightened and secured with a lock wire thru the drilled holes in the heads of the screws.

INSTALLING SERVICE RINGS IN BADLY WORN CYLINDERS

After an engine has been operated for a considerable period of time, the cylinders may wear so that they are both out of round and tapered. The greatest wear will naturally take place in the ring travel portion of the cylinder, particularly at the top and usually about one inch down. Cylinders that are not more than .010 tapered or more than .005 out of round in the ring travel can be made to operate satisfactorily and give good oil economy by installing the correct type of piston ring. You will, of course, have to install rings that are more severe in their wiping action in order to control oil in a cylinder that is badly worn. Under such conditions it is a common practice to install taper faced rings in the two top grooves because this type of ring will run in and form itself to a worn cylinder much more rapidly than a plain compression ring. In the third groove a wiper or corner cut ring is usually installed. The standard oil ring in the fourth groove is usually replaced by an oil ring controlled by an expander. The fifth ring installed in the groove at the bottom of the piston is usually the corner cut type, the same as is used in the third groove from the top. This piston ring combination should not be used except where cylinders are worn quite badly, but are not sufficiently worn to warrant re-boring or honing. Under no circumstances should a ring combination of this kind be used in a new or reconditioned cylinder.

PREPARING AN OLD CYLINDER TO RECEIVE NEW RINGS

If the cylinder shows enough wear so there is a decided ridge near the top of the cylinder, this ridge should be removed by using a standard ridge reamer or by breaking the corner of the ridge with emery cloth. The entire ring surface in the cylinder should be roughened by using fine emery cloth. This will permit the new rings to shape themselves to the cylinder quickly and will result in a far more satisfactory job.

CYLINDER RECONDITIONING

Cylinders can be re honed to take normal oversize pistons, or they may be rebored and honed to take pistons up to .060 oversize.

For pistons up to .010 oversize honing is recommended rather than the use of a boring bar. Care should be exercised in the honing operation so that the maximum out-of-round or taper will not exceed .001.

After the honing or boring operation the cylinder block must be thoroughly washed and cleaned to remove all dirt and abrasives.

PISTONS

Since the pistons in this engine do not have a split skirt no particular directions will be needed, for installing them on the connecting rod except to be sure that the piston pin lock rings are in their correct position at each end of the piston pin.

These pistons are both oval and taper ground below the oil ring. The piston is .002 smaller just below the oil ring than it is at the bottom of the skirt and its largest diameter is a point across the piston between the piston pin bosses. It is very important to remember these things when new pistons are being installed in an engine. Pistons must be ordered in the correct size and the cylinder honed to obtain the correct piston fit.

The piston and connecting rod assembly is removed thru the top of the cylinder block.

Ring land clearances are important and are much greater than the piston skirt clearance. Clearance for the top land is .031 to .037. Clearance for the other three lands should be .022 to .028.

FITTING NEW PISTONS

When new pistons are to be installed, it is essential that the cylinder be honed or bored oversize and finished by honing until the cylinder is perfectly straight and round. If this operation is done correctly, the cylinder should not be more than .001 out of round or tapered. Do not use inside micrometer to measure cylinder bores, use a good cylinder gauge made for the purpose.

The pistons used in this engine are both tapered and oval ground and for this reason it is necessary to fit the pistons to the exact clearance by honing the cylinder. The correct clearance for the pistons in this engine is .0055. The clearance should be checked by attaching a strip of feeler stock to an ordinary pull type scale. Insert the piston in the cylinder with the feeler on the high side of the piston. This is important because the piston is oval ground. This means

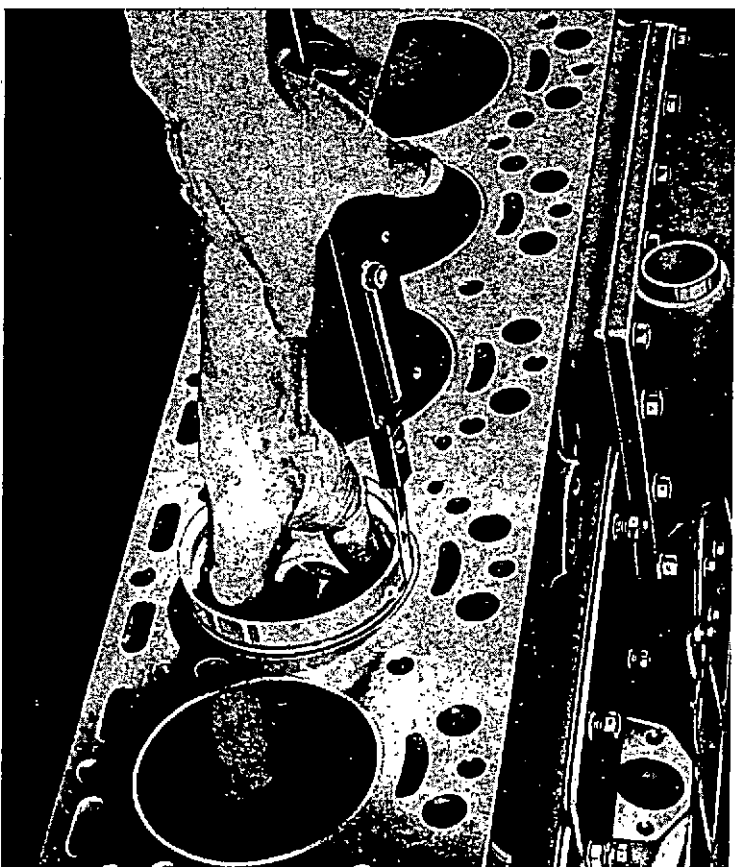


Figure 13

that the feeler must be placed so that it rides on the piston at the high point, which is half way between the two piston pin holes on either side.

This procedure is illustrated in Figure 13. It should require 5 to 10 pounds pull on the scale to pull the feeler past the piston.

PISTON RINGS

It is essential that the specified side clearance in the groove, as well as the gap clearance be maintained.

Be sure that the ring grooves are free from dirt and carbon when checking the clearance between the ring and piston.

The ring combination as used in this engine is as follows:

Three—Top— $\frac{5}{8}$ " Taper faced compression (These rings must be installed in the groove with the word "Top" up).

No. 4— $\frac{1}{4}$ " Slotted oil ring.

No. 5— $\frac{1}{8}$ " Corner Cut Compression.

All rings should have .002 side clearance.

Gap clearance should be .013 to .018.

FITTING PISTON RINGS

The first step in fitting new rings to an engine is to fit them to the cylinder bore. This is illustrated in Figure 14. The rings should be pushed into the cylinder about an inch down from the top and must be square with the cylinder bore.



Figure 14

It is a good plan to use one of the pistons to push the rings in place, which will insure their being in the correct position. To check the gap clearance use feeler gauge. The gap clearance should be between .013 and .018. Refer to "Engine Specifications" where all fits and clearances are shown.

If the ring gap is too close to permit a .012 feeler to be inserted the ring must be filed until the proper gap is obtained.

After the rings have been fitted to the cylinder, they must then be fitted into the grooves of the piston. The correct side clearance for piston rings is very important. All rings should have a .002 side clearance. This means that you should be able to force a feeler between the ring and the side of the groove at points around the piston.

If the rings are too tight, place a piece of fine emery cloth on a piece of plate glass or face plate and rub the rings on this emery cloth to reduce the thickness of the ring.

When the rings are installed on the pistons the gaps should be staggered.

PISTON PINS

When piston pins are fitted originally to the engine the holes in the piston as well as the piston pin bushing are diamond bored. Since these holes are very accurate the piston pin is fitted to the bushing to provide a clearance of between .0003 to .0005.

The hole in the piston is sized so that when the piston is heated in hot water the piston pin can be pushed in easily by hand.

Piston pins are full floating and are held in place by a retainer that fits into grooves in each of the piston bosses.

Should oversize piston pins be fitted these clearances must be maintained.

CONNECTING ROD ALIGNMENT

When the connecting rod and piston assembly is removed for any reason or if new piston pins or bushings are installed, it is essential that the connecting rod be checked for alignment before it is replaced. The connecting rod is clamped to the mandrel in the fixture, and the alignment is checked by moving the piston up against the face plate in every possible position and inserting a feeler gauge between the piston and the face plate. Remember that the pistons are tapered so when the piston touches the face plate at the bottom of the skirt there will be approximately .002 clearance between the piston and the plate at a point just below the oil ring, or the 4th ring from the top.

DISTRIBUTOR DRIVE ADAPTER ASSEMBLY

The distributor drive adapter assembly is the connecting unit between the engine and the distributor itself.

This unit consists of a shaft with a gear at its lower end, which when placed on the engine, meshes with the gear on the camshaft. This is the drive gear not only for this unit but also for the engine oil pump. Near the top of the shaft another gear is pinned in place and meshes with a smaller gear that drives the tachometer. A coupling is attached on the upper end of the shaft which drives the distributor.

When this unit is installed on the engine, the two screws which hold the lower end of the unit to the cylinder assembly must be tightened first. The flange at the upper end which acts as a brace and is connected to the side of the cylinder must be checked carefully to see whether or not there is space between the bracket and the cylinder. Under no circumstances should the bolts on this flange be tightened before this check is made. If the bracket does not touch the cylinder, metal shims must be installed to fill up this space. Failure to follow these instructions may cause this assembly to fall or may be the cause of broken bracket when the attaching bolts are tightened.

WATER PUMP

The water pump used on this engine is a front-mounted centrifugal ball-bearing, self-sealing type. It incorporated the Schwitzer Cummins type carbon seal against a stainless steel thrust and should ordinarily give little trouble. The impeller is pressed on the shaft and locked in place with a grooved taper pin obviating any chance of a loose impeller. The bearings are of the sealed type, packed at the factory with Mobilgrease No. 5. This grease, or some equivalent quality, should always be used. A pressure gun type of fitting with a low-pressure pop-valve is assembled for greasing. This will require greasing only at very long intervals. The fan hub is locked to the bearing assembly by a nut on the front end of the shaft.

In case one desires to dismantle the water pump, the following procedure should be followed:

1. Remove the six screws holding the cover or support to the body. The entire shaft and hub assembly can then be removed from the pump.
2. Remove impeller by loosening set screw.
3. The seal can be removed from the impeller by first removing the lock wire in the bore of the hub.
4. If you wish to remove ball bearings, first remove fan hub and then the lock screw on top of the body.
5. To reassemble, reverse the procedure.

GASKETS

When replacing water pump gaskets, coat them with graphite grease, such as Greder.

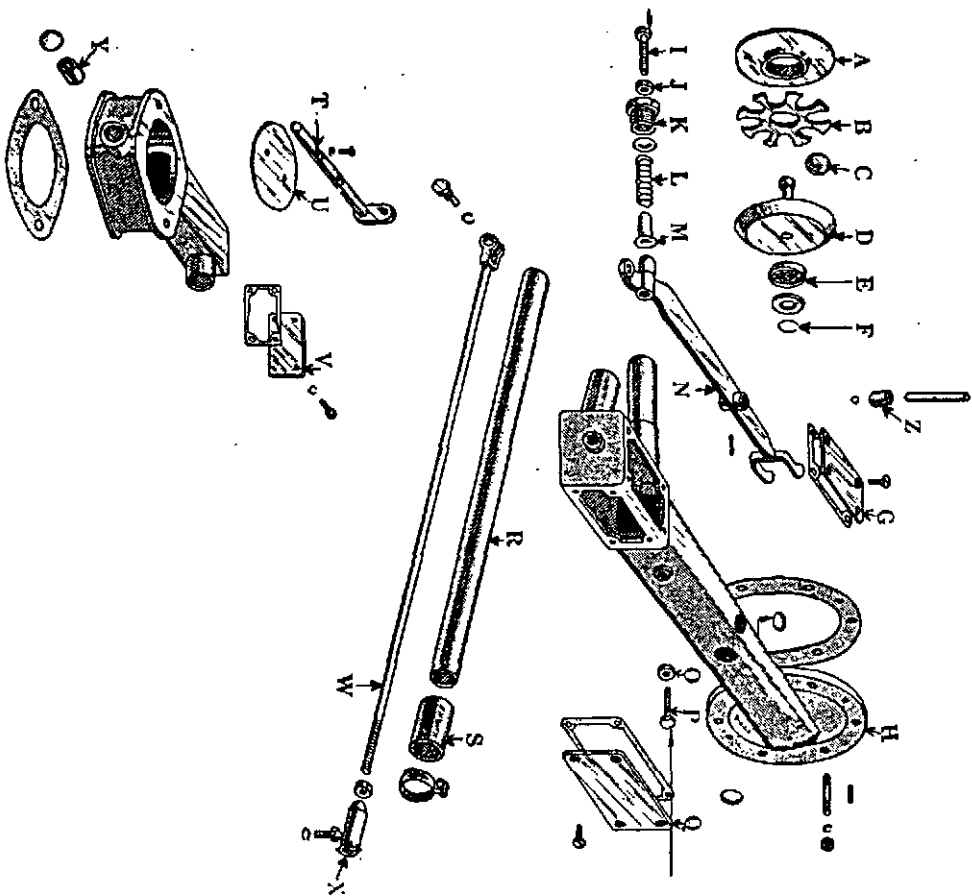
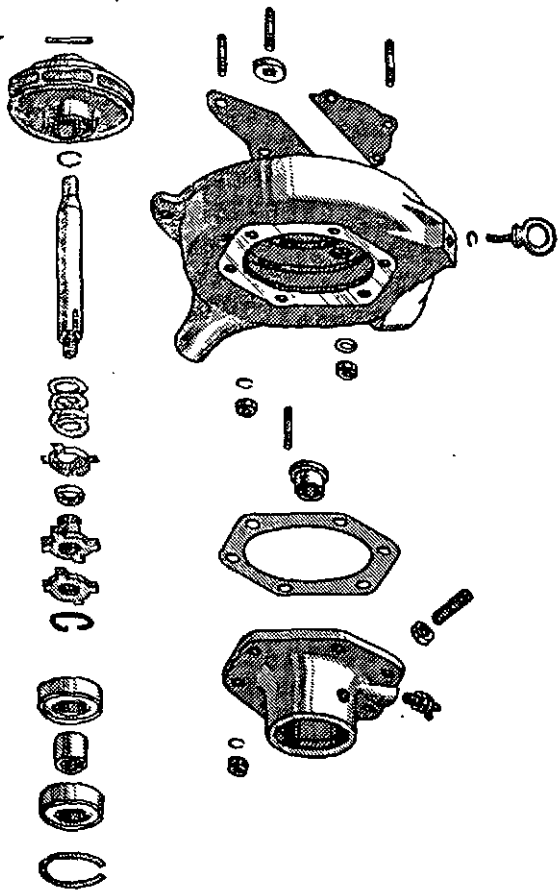


Figure 15

Governor Parts

GOVERNOR

DESCRIPTION

A centrifugal type governor controls the operating speed of the R600 engine. It consists of a series of steel ball weights "C" (usually six in automotive engines and eight in industrial engines) located in a driver "R" attached to the Camshaft Timing Gear. A flat (inner) ball race, "A", and a saucer-shaped (Outer) ball race "D" provide the bearing surfaces on which the balls move.

The outer ball race "D" is part of a Race and Shaft Assembly, the shaft of which is designed to rotate and slide in a hole drilled in the end of the Camshaft. A Thrust bearing "E" completes the assembly which is locked together as a unit by means of a snap ring "F".

Centrifugal action forces the ball weights outward which in turn force the Race and Shaft Assembly forward against the Governor Lever, "N".

The Governor Lever, or Rocker Arm as it is sometimes called, because of the central location of its supporting shaft, operates the Throttle Valve Shaft "T" by means of a Control Rod "W" which is enclosed in a tubular housing "R".

The Governor Lever and "Thrust" parts of the Governor are enclosed in a cast-iron Governor Lever Housing "H" bolted to the Gear Cover. Attached to the upper end of the housing is a short tube containing the Governor Spring "L" which due to its tension exerts a pressure against the upper end of the Governor Lever.

An adjusting screw "J" and lock nut "I" are provided to adjust the Governor Spring tension which tends to overcome (to a greater or lesser degree depending upon the adjustment) the movement of the Governor Lever brought about by the centrifugal action of the ball weights, thus controlling the speed of the engine.

This type of governor requires no special attention since it is lubricated through its entirety by the engine oil reservoir and the oil vapors drawn through the governor housings by the vacuum created in the intake manifold. The Governor is set at the factory so that under ordinary conditions when 70-80 Octane Gasoline is used the engine speed will conform to the proper or required R.P.M.'s under full load in the equipment in which it is to be installed.

If for any reason a different Octane Gasoline is used, or there is a change in equipment or maximum load, further adjustment of the governor may be necessary. To adjust the Governor follow the procedure listed below.

ADJUSTMENT

To decrease the speed of the engine, turn the cap screw "J" to the left or counter-clockwise.

To increase the speed of the engine loosen lock nut "I" and turn cap screw to right or clock-wise.

When proper speed of engine is obtained, be certain to tighten lock nut, thus locking the cap screw securely in place.

If when desiring to increase the engine speed the above procedure does not produce the proper results, turn the cap screw "J" slightly to the left or counter-clockwise.

When proper engine speed is obtained tighten lock nut "O".

TESTING

When engine surges or "hunts" at any speed it will be necessary to test the Governor parts for freedom of movement.

To test the action of governor parts for possible binding or excessive looseness, remove Governor lever housing covers "G" and "Q", and Throttle body cover "Y". Remove spring tube cap "K" and withdraw spring "L" together with seat and guide assembly "M".

Freedom of movement of the internal governor parts may now be ascertained by grasping the Governor lever "N" at the ball joint connection and applying a backward and forward motion. Lever should operate freely with the exception of a very slight "drag" during forward movement. This "drag" is created by the front ball race "D" returning the governor weights "C" to their proper positions after they have dropped slightly out of place during the backward movement of the Governor lever.

By preventing the Throttle Valve Shaft "T" from moving, and at the same time applying forward and backward pressure to the Governor Lever "N" the presence of excessive looseness in the control rod "W" connections may be determined.

Should an appreciable amount of effort be required to move the governor lever, or should an excessive amount of looseness be noted, it is probable that some part of the governor assembly is not working freely or is badly worn. To determine the location of the part causing the trouble, proceed with the following instructions.

DISASSEMBLY OF THROTTLE BODY

Detach the ball joint "X" from the governor lever "N" so that the throttle body and connections may be operated independently of Governor lever. If friction is found to be present in the Throttle Body, remove the carburetor and throttle body from the engine by unscrewing carburetor stud nuts, loosening hose connection at governor lever housing, "S" and removing ball joint "X" from end of control rod "W".

Remove throttle body valve "U" and shaft "T" and inspect needle bearings "Y" for possible lubricant "Gum" deposits. If they are completely "frozen", replacement is recommended. If only slightly obstructed, clean by flushing with gasoline and apply a few drops of light machine oil to each bearing.

REASSEMBLY OF THROTTLE BODY

To reassemble the throttle body, reverse disassembly procedure, being certain to attach throttle body valve "U" to shaft "T" so that the shaft lever points in the opposite direction from flat spot on circumference of valve.

Before attaching control rod ball joint "X" to governor lever, check linkage for proper length. With throttle valve "U" in full throttle position (Vertical), and with governor lever "N" in extreme forward position, adjust ball joint screw so that it is in alignment with hole in governor lever.

DISASSEMBLY OF GOVERNOR

If friction is noticeable in governor lever "N" when operated independently of the throttle body control rod "W", remove governor lever housing "H" from engine and inspect governor lever shaft bearings "Z" for lubricant "Gum" deposit.

Remove governor shaft and race assembly "D" from camshaft by grasping thrust bearing "E" and pulling. Governor ball weights "C" will now drop out of place and may be inspected for damage, or wear.

Inspect thrust bearing "E" and clean or replace as required. By removing the small snap ring "F", the thrust bearing can readily be disassembled from the shaft and race assembly.

REASSEMBLY OF GOVERNOR

To reassemble reverse disassembly procedure.

When replacing governor weights "C" a small amount of cup grease may be used to hold them in place while inserting shaft and race assembly "D" into camshaft.

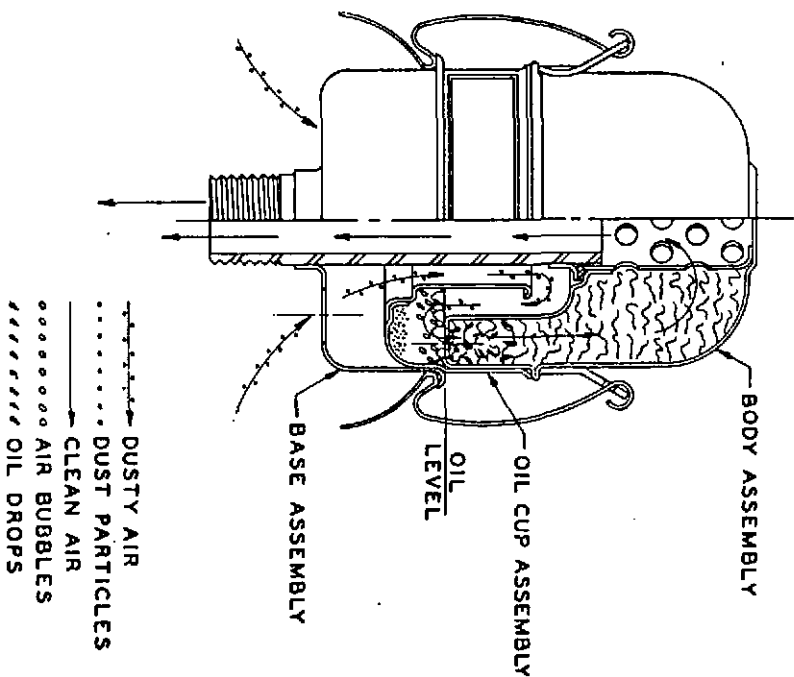
Before connecting the ball joint "X" to the governor lever "N" and before governor speed control spring "L" is inserted, move the lever back and forth several times to determine if the parts are assembled correctly and are in proper working order.

After making this test pull governor lever "N" as far forward as it will go. It should now rest against the cap screw "P" and should not be closer than 1/16" from the governor lever housing "H" at a point approximately 1" above the screw.

With the lever in this position, check to see if the throttle body valve "U" is in a vertical or full throttle position. If not, adjust ball joint "X" on Governor to Throttle Body Control Rod "W" so that the vertical position is obtained, before connecting ball joint to governor lever. Be sure to tighten ball joint lock nut after adjustment is made.

Replace seat and guide assembly "M", governor control spring and governor spring tube cap "L" and "K", respectively. Replace covers "G", "Q", and "V".

CRANKCASE BREATHER



The crankcase breather pictured above is a very simple device which has the function of filtering the air entering the crankcase. The oil which washes the air must be changed at least once every 8 hours. If the engine is operating under severe dust conditions, the oil in the breather cup should be inspected at least every four hours and replaced with clean oil if necessary.

TORQUE WRENCH DATA

Size	Limit in Foot Pounds Torque	Size	Limit in Foot Pounds Tor
Cylinder Heads			
3/8"	35-40	1 1/8"	15-
1/2"	70-75	3/4"	25-
5/8"	100-110	1 1/4"	50-
3/4"	130-140	1 3/8"	80-
7/8"	145-155	1 1/2"	100-
		1 3/4"	130-
Manifolds			
1/2"		1 1/8"	
5/8"		1 1/4"	
3/4"		1 3/8"	
7/8"		1 1/2"	
1"		1 3/4"	
Main Bearing Caps & Connecting Rods			
1/2"	20-25	1 1/8"	15-
5/8"	35-40	3/4"	25-
3/4"	70-75	1 1/4"	50-
7/8"	85-95	1 3/8"	80-
1"	100-110	1 1/2"	
		1 3/4"	
Flywheels			
1 1/8"	20-25	Flywheel Housings	
3/4"	35-40	1 1/8"	15-
1 1/4"	70-75	3/4"	25-
1 1/2"	85-95	1 1/4"	50-
1 3/4"	100-110	1 3/8"	80-
2"	145-155	1 1/2"	115-
		1 3/4"	
Gear Covers, Water Pumps, Front & Rear End Plates, Oil Pans			
1/2"		1 1/8"	
3/8"		1 1/4"	
1/4"		1 3/8"	
1/2"		1 1/2"	
		1 3/4"	

WHEN ORDERING SPARE PARTS BE SURE TO SPECIFY THE FOLLOWING INFORMATION WHICH CAN BE FOUND ON THE ENGINE NAMEPLATE ON THE SIDE OPPOSITE THE MANIFOLD:

ENGINE MODEL
ENGINE SERIAL NUMBER
SPECIFICATION NUMBER—When indicated
Your cooperation in giving the above data will be of material assistance in filling your orders promptly and correctly.

WARRANTY

for



TRANSPORTATION AND INDUSTRIAL ENGINES

The Continental Motors Corporation warrants each new engine manufactured by same to be free from defects in material and workmanship on the basis of installations and applications as herein defined.

1. BUS and TRUCK EQUIPMENT - Six months from date of shipment but not to exceed ninety days or 15,000 miles of service.
2. RAIL CARS and LOCOMOTIVES - Six months from date of shipment but not to exceed ninety days or 15,000 miles of service.
3. AGRICULTURAL EQUIPMENT - Six months from date of shipment but not to exceed ninety days of service.
4. INDUSTRIAL and OIL FIELD EQUIPMENT - Six months from date of shipment but not to exceed ninety days of service.
5. MARINE EQUIPMENT - One year from date of shipment.
6. FIRE EQUIPMENT - One year from date of shipment.

The obligation under this Warranty, statutory or otherwise, is limited to the replacement or repair at the Manufacturer's factory, or at a point designated by the Manufacturer, of such part as shall be found by the Manufacturer, upon inspection at such point, to have been defective in material or workmanship.

This Warranty does not obligate the Manufacturer to bear the cost of labor or transportation charges in connection with the replacement or repair of defective parts, nor shall it apply to an engine upon which repairs or alterations have been made unless authorized by the Manufacturer.

The Manufacturer makes no Warranty in respect to trade accessories, such being subject to the Warranties of their respective manufacturers.

The Manufacturer shall in no event be liable for consequential damages or contingent liabilities arising out of the failure of any engine or parts to operate properly.

No express, implied or statutory Warranty other than herein set forth is made or authorized to be made by the Manufacturer.

Before consideration can be given to requests for adjustments covering field service and alleged defective material, the Buyer shall furnish CONTINENTAL MOTORS CORPORATION with the following data:

Owner's name and address	Information as to the nature of the trouble
Engine Model	Date actually placed in service
Serial Number	Accumulated days or miles of service

Continental Motors Corporation

MUSKEGON, MICHIGAN