

ONAN

- Electric Plants
- Two-Bearing Generators
- Air Cooled Engines

THESE OUTSTANDING PRODUCTS, designed and built by D. W. Onan & Sons Inc., are known the world over for their ruggedness and dependability!

WHENEVER YOU NEED an independent source of electric power for any purpose, be sure to see the complete line of Onan Gasoline or Diesel Engine - Driven Electric Plants and Onan Generators. You'll find a type and size to fit every job... portable or mobile... heavy-duty primary or emergency standby. (A. C. - 500 to 50,000 Watts. D. C. to 5,000 Watts. Battery Chargers 500 to 3,500 Watts.

IF YOU DESIGN AND BUILD commercial or military equipment requiring stamina-tested air-cooled engines, consult the Onan factory for complete information about Onan deluxe engines.



INSTRUCTION MANUAL

ONAN INDUSTRIAL ENGINES

Series
COM-1B

**Governor Controlled
Hand Throttle**

D. W. ONAN & SONS INC.

MINNEAPOLIS 14, MINN.

901-19 *****

Printed in

Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

Fire, explosion, and personal injury can result from improper practices.

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC-rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work-harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a genset or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.

- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [-] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (-) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocution can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [-] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. Do not tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [-] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

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Form 27B104

GENERAL INFORMATION

THE PURPOSE OF THIS BOOK. This instruction book is furnished so that the operator may learn of the characteristics of the plant. A thorough study of the book will help the operator to keep the plant in good operating condition so that it will give efficient service. An understanding of the plant will also assist the operator in determining the cause of trouble if it occurs.

KEEP THIS BOOK HANDY. Such simple mistakes as the use of improper oil, improper fuel, or the neglect of routine servicing may result in failure of the plant at a time when it is urgently needed. It is suggested that this book be kept near the plant so that it may be referred to when necessary.

SERVICE. If trouble occurs and the operator is unable to determine the cause after a thorough study of this book, or if he is unable to determine what repair parts are required, needed information will be furnished upon request. WHEN ASKING FOR INFORMATION, BE SURE TO STATE THE MODEL, SPEC., AND SERIAL NUMBERS OF THE PLANT. THIS INFORMATION IS ABSOLUTELY NECESSARY AND MAY BE OBTAINED FROM THE NAMEPLATE ON THE PLANT.

MANUFACTURER'S WARRANTY

The manufacturer warrants each new engine or electric plant to be free from defects in material and workmanship. Under normal use and service our obligation under this warranty is limited to the furnishing of any part without charge which, within ninety (90) days after delivery to the original user shall be returned to us or our authorized service station with transportation charges prepaid and which our examination shall disclose to have been defective

Our liability in case of defective workmanship, material or any costs incurred in remedying any claimed defective condition in any unit or such unit having been repaired, altered or which installation and service recommendations have not been complied with, is limited strictly to the proper adjustment authorized by the factory.

This warranty does not include or cover standard accessories used, such as carburetors, magnetos, fuel pumps, etc., made by other manufacturers. Such accessories have separate warranties made by the respective manufacturers. Repair or exchange of such accessories will be made by us on the basis of such warranties.

This warranty is in lieu of all other warranties expressed or implied.

This manual serves to assist the operator in installing and operating the engine and in maintaining it so that it will provide maximum service at minimum cost.

The engine model, which appears on the nameplate, serves to designate one or several characteristics of that engine. Typical examples are COM. 1B-9 and COM. 1B-12 are hand throttle instead of governor controlled; COM. 1B-10 uses gas or gasoline fuel instead of gasoline only; COM. 1B-7, COM. 1B-10 and COM. 1B-12 have oil bath instead of dry type air cleaner; COM. 1B-6 and COM. 1B-8 have a special fuel tank.

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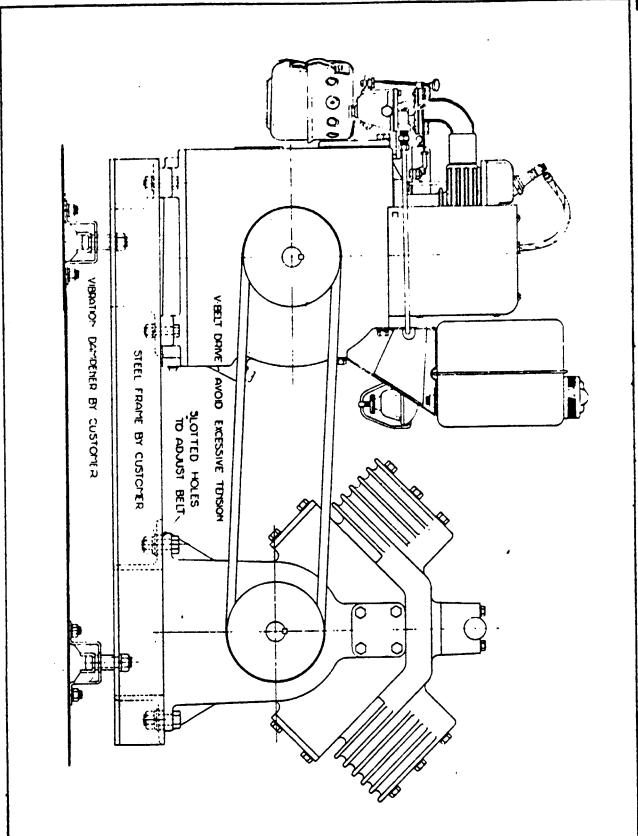


FIG. A-TYPICAL MOUNTING-ENGINE AND LOAD ON SINGLE BASE

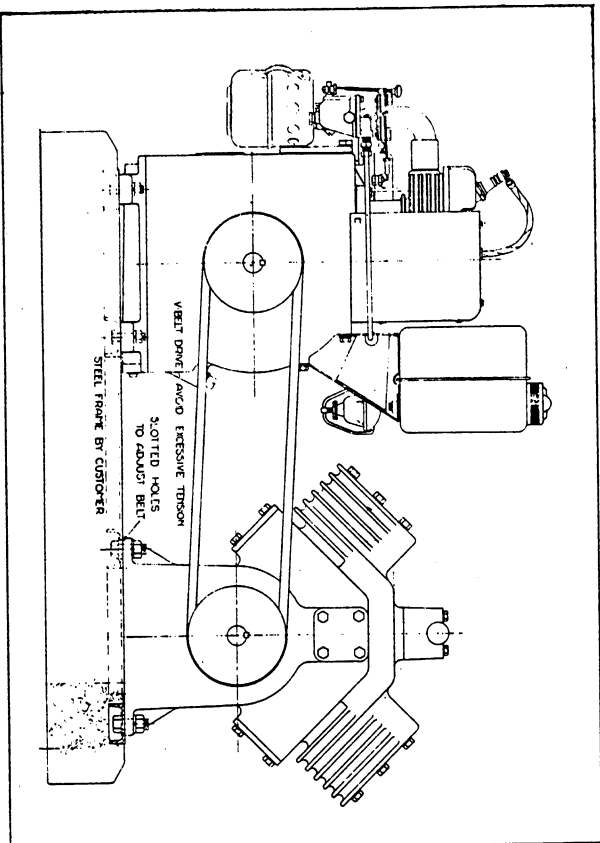


FIG. B-TYPICAL MOUNTING-ENGINE AND LOAD ON PERMANENT BASE

INSTALLATION

3

IMPORTANCE OF PROPER INSTALLATION. - It is important that the engine be properly installed to give good service. It may be operated out of doors, but rain, snow, dust, dirt, and grit are unfavorable to satisfactory operation. If practicable, install the engine in a building or inside a mobile vehicle.

CAUTION

Proper ventilation must be provided. Exhaust gases are poisonous. Excessive inhalation will cause severe sickness or even death. Do not operate the plant in a building or other confined space without piping exhaust gases outdoors.

INDOOR STATIONARY INSTALLATION. - The location selected should be clean, dry, well ventilated, and if necessary, heated in very cold weather. Suggestions for mounting the engine are given elsewhere in this section. Be sure to mount the engine to a base so it will set level when operating. Locate it so as to provide proper ventilation and space for servicing. There must be an air inlet and outlet, each at least 1-1/2 square feet in area, for proper ventilation. Pipe the exhaust gases outside the building with pipe as large as the exhaust outlet of the engine. Attach the short length of pipe to the exhaust outlet, a short length of flexible tubing to this pipe, another length of pipe if necessary, and then the muffler to the pipe outside the building. Keep the exhaust pipe at least several inches from inflammable material. Avoid using elbows, if possible. If the exhaust line must be pitched upward, construct a condensation trap of pipe fittings, and install at the point where the upward pitch begins.

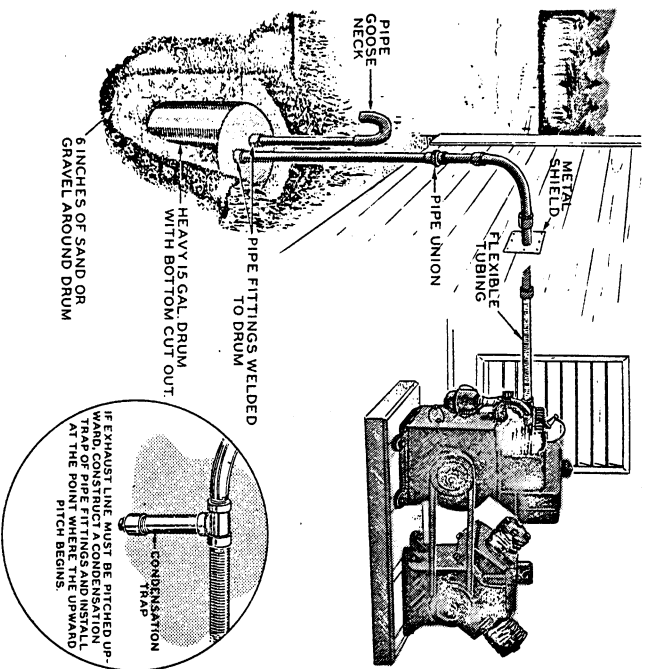
MOBILE INSTALLATION. - Follow generally the instructions for indoor installation, taking care to provide ample ventilation if the vehicle is a closed one.

NOTE

If the engine is to be operated out of doors, connect the short length of pipe to the exhaust outlet, the elbow to this pipe, and the muffler to the elbow with the open end toward the ground.

UNDERGROUND EXHAUST INSTALLATION. - If the installation is to be a permanent one, an underground exhaust muffler may be installed instead of the automotive type if so desired. However, if there is danger of the underground muffler filling with water at any time it cannot be used. A heavy 15 gallon drum is suitable for this purpose. If necessary to use a larger drum, either cut this drum down to the approximate dimensions of a 15 gallon drum or fill the larger drum with large rocks to take up the excess air space. Remove the bottom from the drum selected. Weld a one inch, or larger, fitting on the drum for the inlet and another for the outlet

and connect the inlet and outlet pipes. Dig a pit which is at least six inches larger on all sides than the drum. Fill the bottom of the pit with loose sand or gravel, lower the drum into the pit, and fill in around the drum with loose sand or gravel. The outlet pipe should be at least 24 inches above ground with a gooseneck fitting on the end. The inlet pipe must be shielded where it passes through the wall, the opening for the shields being at least 2 inches larger on all sides than the pipe.



UNDERGROUND EXHAUST INSTALLATION

MOUNTING. - The most desirable way of mounting an industrial type engine will depend largely on the type of load and the provisions available for mounting. Recommendations for mounting are as follows:

A. If the load and engine are to be mounted on a floor or light foundation, it is desirable to construct a bedplate out of structural steel or timber and to mount the engine and load, properly aligned, to the bedplate. This bedplate should be supported on a suitable foundation, but isolated from the foundation by means of flexible mountings. These mountings can be in the form of springs or bonded rubber supports. The design of the mountings should be such that the total weight of the engine con-

nected load, and bedplate, will deflect the mountings at least 1/8 inch. This will result in reducing the forces of vibration transmitted to the foundation. The heavier the foundation, the more satisfactory will be the installation. See Figure A.

B. If a heavy, rigid foundation is available, it is desirable to attach the the load and engine rigidly to the foundation as shown in Figure B.

C. If the engine and load must be mounted on separate foundations, each should be fastened rigidly to its respective foundation and the foundation made large enough so that vibration is not objectionable.

POWER TRANSMISSION. - Power can be transmitted from the engine to the connected load by means of a flexible coupling, a flat or V-belt, a chain, or a train of gears.

NOTE

A clutch is recommended when the connected load cannot be reduced sufficiently to permit easy starting of the engine or when the service is intermittent.

The following suggestions are recommended for best performance.

1. If the load is connected to the engine through a coupling, the shafts must be properly aligned. Small misalignments can be taken care of in a flexible coupling but to avoid failure of the coupling and damage to bearings, the alignment must be as close as possible.
2. The pulleys or sheaves must be in line with one another if belts are used. When using crown faced pulleys, the high point of the crowns must be in line. If V-belts are used, the V-belt sheaves must be in line.
3. V-belts are recommended in preference to flat belts as they permit higher belt loads with lower belt tension. Consult a reliable belt dealer as to the proper sheave and belt for the drive.
4. The engine pulley should be mounted on the take-off shaft as close to the engine as practicable.

REMOTE STOP SWITCH. - To connect a remote stop switch, remove the blower housing, connect one end of a No. 18 wire to the clip inside the housing and the other end to the remote stop switch. Then run another wire of the same size from the switch to the engine and ground to any clean surface on the engine. Remote stop switches may be located at any point within 250 feet of the engine.

PRELIMINARY. - Before the engine is operated it is necessary to supply it with proper oil and fuel. Comply with the following instructions.

LUBRICATION. - The use of a good detergent type oil in the engine crankcase greatly increases the life of the piston and piston rings, and is strongly recommended. Fill the crankcase to the top of the threads in the oil filler hole with 2-1/2 quarts of the proper SAE number oil according to the lowest temperature to which the engine will be exposed, as indicated in the following table. Do not overfill the crankcase as the connecting rod may strike the oil causing it to foam and interfering with proper lubrication. Too high an oil level may also cause leakage.

LOWEST TEMPERATURE	SAE NUMBER
Above 90° F. Above 32° C.	No. 40
Between 40° F. and 90° F. Between 5° C. and 32° C.	No. 30
Between 0° F. and 40° F. Between -17° C. and 5° C.	No. 10W
Below 0° F. Below -17° C.	No. 5 or as alternate, 10W diluted with 10% kerosene

CAUTION!

Do not put diluted oil in the engine crankcase until ready to start the engine. Mix the diluted oil thoroughly just before pouring it into the engine.

If a change is made to detergent oil after using non-detergent oil in this engine, allow only 1/3 the normal operating hours before changing the oil for each of the next two change periods. Change at the same intervals as for non-detergent oil thereafter.

For engine equipped with a governor, lubricate the governor arm to throttle control link using powdered graphite or a light non-gumming oil on the ball joint. Lubricate the choke shaft bearings on all engines.

For engines equipped with an oil bath type air cleaner, fill the cup to the indicated level with oil of the same SAE number as used in the engine crankcase.

FUEL. - Fill the fuel tank nearly full with clean, fresh, unleaded gasoline of at least 68 octane. For natural, Butane or Propane gas operation refer to OPERATION section. Do not use Premium or Ethyl Gasoline.

After all the foregoing instructions have been carefully complied with, the engine is ready to be started. However, before starting the engine study the paragraphs under the headings OPERATION and ABNORMAL OPERATING CONDITIONS.

PRELIMINARY. - Do not start the engine until it has been properly prepared for operation and the following instructions have been studied.

CAUTION

If the preparation has been made for cold weather, the initial filling of the crankcase with diluted oil may have been left to be done immediately before starting the engine. Make sure the crankcase is filled with proper oil to the top of the threads in the oil fill hole. Do not operate the engine if the oil level is one inch or more below this high level.

STARTING THE ENGINE. - Before starting the engine be sure the shut-off valve on the filter bowl is fully open. See that the load is disconnected, if practicable. Then pull the choke control knob out all the way. Insert the knot of the starting rope in the notch of the rope sheave and wind the rope in a clockwise direction around the sheave, leaving about six inches free. Grasp the handle of the starting rope firmly in the right hand and give a strong, steady, pull the full length of the rope. If the engine does not start at the first attempt, push the choke control knob half way in and repeat the cranking procedure. If the engine does not start, check the ignition and fuel systems and repeat the starting procedure after correcting the trouble. After the engine starts, push the choke control knob in gradually until it is at its innermost position with the engine running smoothly. If the engine is warm, it may not be necessary to choke it when starting; excessive choking causes hard starting.

NOTE

Oil was placed in the cylinder before shipping and it may be necessary to remove and clean the spark plug in gasoline before the engine will start the first time.

ADJUSTING THE SPEED (GOVERNOR). - The speed may be adjusted by turning the governor adjusting nut to the right (clockwise) to increase the speed or to the left (counterclockwise) to decrease it.

ADJUSTING THE SPEED (HAND THROTTLE). - The quadrant has eight numbered positions on it. Moving the arm from the number "8" position toward the number "1" position increases the speed. Moving the arm toward the number "8" position decreases the speed. The number "5" position will give an approximate speed of 1800 rpm with no load connected. With a full load and the throttle at No. 1 position, rpm is approximately 2000.

HORSEPOWER. - Recommended peak horsepower and maximum horsepower for continuous duty. Best performance at 1800 rpm.

R. P. M.	PEAK H.P.	CONTINUOUS H. P.
1600	2.3	1.9
1800	2.6	2.2
2000	2.9	2.4
2200	3.1	2.6

STOPPING THE ENGINE. - Press the STOP button firmly until the engine has completely stopped running.

EMERGENCY STOPPING. - If the engine fails to stop when pressing the STOP button, close the fuel shut-off valve. The engine will continue to operate until the fuel in the line and carburetor is used up. If the engine is to be moved or stored, use this method of stopping.

In extreme cases, if the engine must be stopped in a hurry, and the STOP button is defective, pull the choke control knob all the way out. This method is not recommended unless absolutely necessary.

INSTRUCTIONS FOR OPERATING THE ENGINE ON NATURAL, BUTANE OR PROPANE GAS

Unless the gas to be used carries the same B. T. U. rating as the gas for which the regulator was set at the factory, it will be necessary to change the main adjustment slightly for smooth and economical operation.

Follow the national and local codes on installing fuel pipes and fuel containers according to the type fuel being used. Make the necessary connections and proceed as follows:

CAUTION

Make sure that the line pressure does not exceed 8 inches water column or about 4.6 ounces per square inch. If it exceeds this value, a primary regulator will be needed to reduce the pressure before it enters the atmospheric regulator on the engine.

1. Turn on the supply of natural gas or fuel vapor and start the engine. The priming button, which is provided on the regulator may have to be pushed to get the engine started. It should not be necessary to use it after proper regulator adjustments have been made. **DO NOT USE CHOKE.** The choke plate must be in the fully open position at all times

when using natural, Butane or Propane gas.

2. Adjust the gas adjustment valve for best operation at the maximum load that will be placed on the engine. This procedure should be repeated after the engine reaches operating temperature to insure proper adjustment.

RETURN TO GASOLINE OPERATION. - If for any reason it is desired to again operate the engine on gasoline, the following steps should be followed:

1. Shut off natural gas or Propane-Butane vapor supply.
2. Open gasoline shut-off cock.
3. Release the carburetor float lock.
4. Reset spark plug gap as given in Table of Clearances.

NOTE

It is important that the float lock screw be turned clockwise or down as far as it will go to fully release the carburetor float and to prevent gasoline from leaking from the carburetor bowl.

PREPARING THE PLANT FOR STORAGE. - If the engine service is seasonal or if the engine is to stand idle or to be stored for a considerable length of time, certain operations should be performed to prevent deterioration during the period while the engine is not being used and to assure starting and proper performance when it is desired to again put the engine in service. After stopping the engine and while it is still warm, remove the drain plug from the oil base and permit the oil to thoroughly drain from the oil base. Replace drain plug and fill to the proper level with the correct grade of new oil. Run engine for about ten minutes to thoroughly circulate new oil over all internal parts of the engine.

Drain the fuel tank and all fuel lines and clean the fuel filter. Drain and clean the carburetor. Thoroughly clean the exterior surface of the engine. Remove the spark plug and place about two tablespoonsful of oil in the cylinder. Crank the engine over slowly a few times to permit the oil to form a film on the cylinder wall, piston and piston rings. Continue to crank engine until the piston is on top dead center of the compression stroke. Leave in this position, both valves will be closed. Replace spark plug.

RETURNING THE STORED PLANT TO SERVICE. - To again place the engine in operation, fill the fuel tank with clean fresh fuel, if the engine does not start after cranking a few times, it may be necessary to remove the spark plug and wash in gasoline. The spark plug may have become fouled by the oil which was placed in the cylinder, this excess oil however, will all pass out through the exhaust system when the engine has run a few minutes.

COLD TEMPERATURES. - Lubrication and fuel require special consideration at temperatures below 0°F. or -170°C.

LUBRICATION. - For temperatures below 0°F. (-170°C.) thoroughly mix 1/2 pint of kerosene with each 2-1/4 quarts of SAE number 10W oil and fill the crankcase to the top threads in the oil filler hole. Then run the engine ten minutes to circulate the mixture. If the crankcase is filled with undiluted oil or if the engine is cold, run the engine until warm before draining. **NEVER ADD KEROSENE ALONE TO THE CRANKCASE.** When using diluted oil, change oil every 50 operating hours and check the oil level at least every 8 operating hours.

Do not thin any oil heavier than SAE No. 10W as the mixture may separate when the engine is stopped. When adding oil between drain periods, use a mixture of 1/4 pint of kerosene to one quart of oil.

AIR CLEANER. - If congealed oil or frost formation within the air cleaner restricts the flow of air, remove and clean the air cleaner. Use without oil until temperature conditions permit use of oil in the normal manner.

FUEL. - Give special attention to fuel. Fresh fuel and high test fuel aid starting. Never fill the fuel tank entirely full with gasoline. It may expand, overflow, and cause a fire.

HOT TEMPERATURES. - Under extremely hot operating conditions, provide ample ventilation, keep all cooling surfaces clean and free of dirt or grease, and keep the oil level at or near the high level at all times. Change oil every 100 operating hours.

DUST AND DIRT. - Keep the engine as clean as practicable. Check the operation often and service as needed. Clean the air cleaner often. Keep supplies of fuel and oil in airtight containers.

PRELIMINARY. - Follow a definite schedule of inspection and service. Service periods indicated are for normal service. For extreme conditions of load, temperature, frequent starts, dust, and dirt, service more often.

DAILY SERVICE

If the engine is to be operated more than 8 hours a day, perform the following services every 8 hours.

FUEL. - Check the fuel supply often enough to assure a continuous supply of fuel.

CRANKCASE OIL LEVEL. - Check the oil level and add oil if needed. Never operate the engine if the oil level is one inch or more below the top threads in the oil filler hole. Do not overfill.

AIR CLEANER (OIL BATH TYPE). - Check the oil level in the cup and refill to the level indicated thereon.

CLEANING. - Keep the engine clean and free of dirt. Remove excess grease from external surfaces.

WEEKLY SERVICE

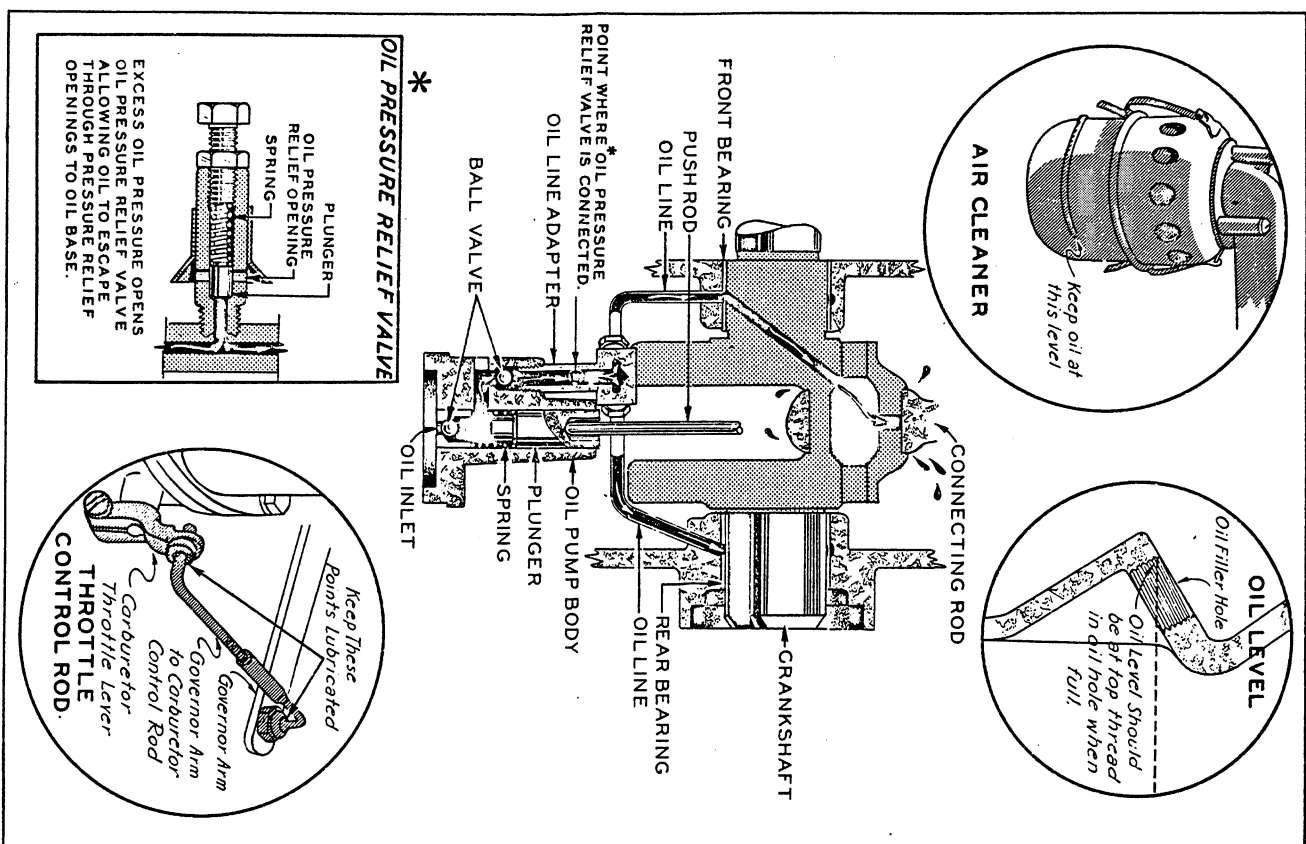
If the engine is to be operated more than 50 hours a week, perform the following services every 50 hours.

LUBRICATION. - Check the oil level. Add oil if necessary. Change oil every 100 operating hours unless the engine is operated with diluted oil or leaded fuel, then change every 50 operating hours. Lubricate the governor arm to throttle ball joint using powdered graphite or a light non-gummy oil.

AIR CLEANER (OIL BATH TYPE). - Clean the element thoroughly in gasoline or other suitable solvent. Allow to dry or dry by using an air hose. Refill the cup to the indicated level with oil of the same SAE number as used in the engine crankcase except as noted under **ABNORMAL OPERATING CONDITIONS.**

AIR CLEANER (DRY TYPE). - Clean the air cleaner thoroughly in gasoline or other suitable solvent. Allow it to dry or dry by using an air hose. Dip in light oil and allow to thoroughly drain before replacing.

SPARK PLUG. - Clean and reset the gap between electrodes to 0.024 to 0.026 inch. More frequent servicing may be necessary if leaded fuels are used. With gaseous fuel, set the plug gap at 0.018".



LUBRICATION

PERIODIC SERVICE

15

MONTHLY SERVICE

If the engine is to be operated more than 200 hours a month, perform the following services every 200 hours.

CARBURETOR. - Drain and clean the carburetor bowl.

EXHAUST SYSTEM. - Inspect all exhaust connections. Tighten or replace all parts requiring it.

ENGINE COMPRESSION. - Check the compression of the cylinder by rocking (cranking) the flywheel with the hands. If the compression is good, a considerable amount of effort will be required to rock the flywheel over the compression stroke. Little effort will be required to rock the flywheel over the compression stroke if the compression is poor. Loss of compression may be due to a leaking spark plug, spark plug gasket, valves, cylinder head gasket, or piston rings. Repair or replace, as needed.

MAGNETO BREAKER POINTS. - Contact points can be resurfaced by using a fine stone. If necessary, they may be replaced. After either resurfacing or replacing, adjust the point gap to 0.018 to 0.022 inch. If excessive arcing occurs at the breaker points, a defective condenser is indicated and it should be replaced.

CARBON. - Clean carbon every 250 operating hours. More frequent cleaning may be necessary if leaded fuels are used.

FUEL SYSTEM. - Close the fuel shut-off valve and remove and clean the filter bowl and screen. Be sure the gasket is in good shape and in its proper place when reassembling. Check for leaks after opening the shut-off valve.

GENERAL. - Inspect the engine thoroughly for leaks, loose connections, or other external items that may require attention.

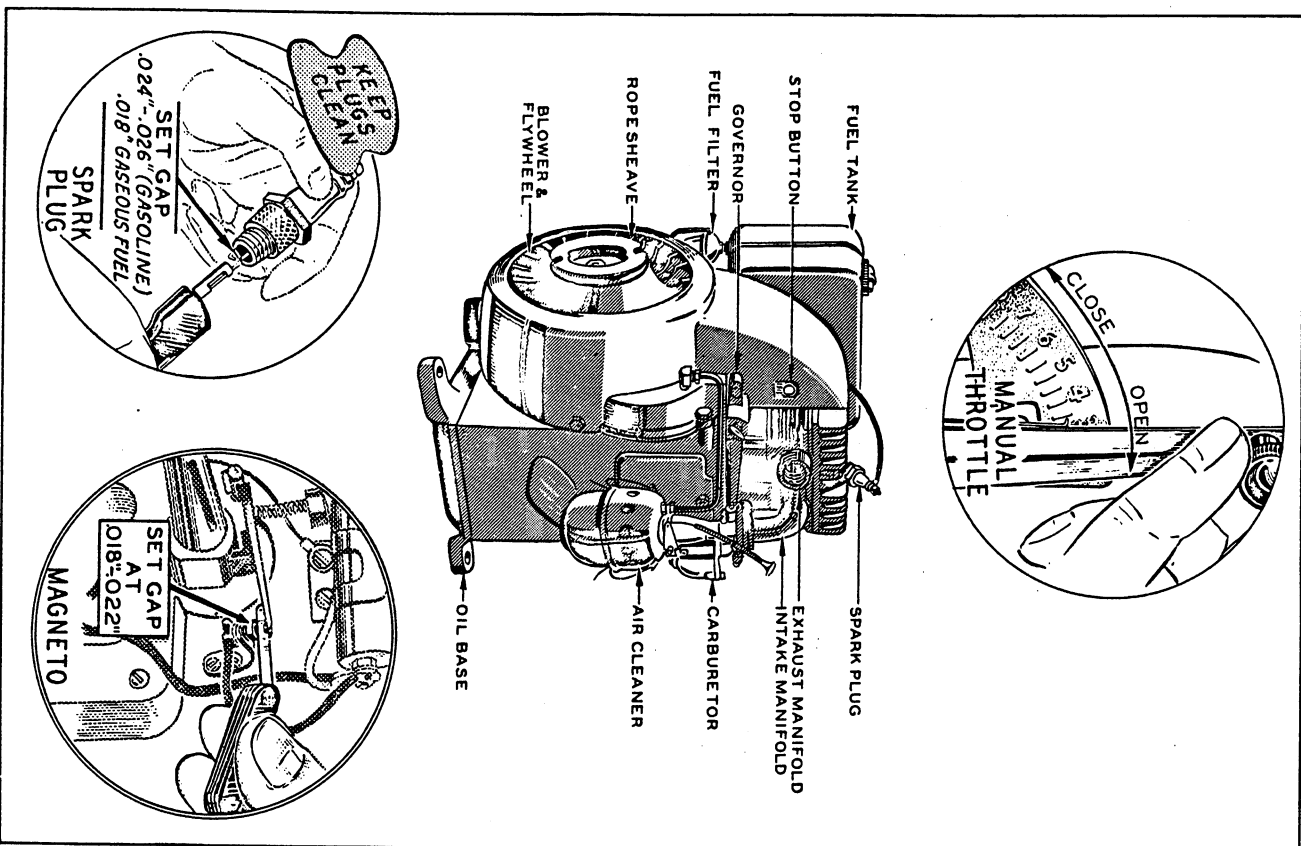
SIX-MONTHLY SERVICE

If the engine is to be operated more than 1200 hours semi-yearly, perform the following services every 1200 hours.

OIL PUMP. - The oil pump should be removed twice a year and thoroughly cleaned with gasoline. Be sure the screen is clean. Dry with compressed air if possible. Hold the pump half submerged in a pan of clean oil and prime the pump by working the plunger by hand until oil flows freely from the outlet. Thoroughly clean the oil base before replacing. Install a new oil base gasket.

CAUTION

Do not disturb adjustment of the oil pressure relief valve.



ACCESSORY SERVICE

GENERAL. - This section includes instructions for certain adjustments which are not of an accessory nature but which the operator should be able to make when needed. If trouble develops, the operator should follow an orderly procedure in determining the cause before attempting adjustments. For assistance, reference should be made to the **SERVICE DIAGNOSIS** section.

CARBURETOR ADJUSTMENT. - All jets are of a fixed size with the exception of the idling jet for the Com 1B-12 which is adjustable. When adjusting the idle jet needle, the engine should be running at normal operating temperature and carrying no load. Turn the needle in (clockwise) until the engine loses considerable speed, then turn it out (counterclockwise) until the engine runs smoothly. The correct setting is approximately $1/2$ to 1 turn open. If the jet is entirely out of adjustment, turn the needle in until it contacts the seat, then turn the needle out approximately one full turn to permit starting. Make final adjustment after the engine reaches normal operating temperature. Refer to **OPERATION** section for adjustment when using natural, Butane or Propane gas.

When cleaning jets and passages use compressed air or fine soft copper wire. Use proper size screwdriver to remove jets to avoid burring or distorting them. Be sure a small fiber gasket is in place below the head of each jet when reassembling.

GOVERNOR ADJUSTMENT. - The adjusting screw serves to regulate the speed of the engine. Turning the screw in (clockwise) increases the speed. Turning it out (counterclockwise) decreases the speed.

NOTE

Unless otherwise specified, the governor is adjusted at the factory to provide a no-load speed of 1800 rpm. This may be adjusted to any desired speed between 1500 and 2200 rpm.

Check the freedom of action of the governor linkage periodically to assure smooth operation. If it does not respond to the slightest variation of load, correct the trouble and adjust after the engine reaches normal operating temperature. To obtain the correct governor arm setting, loosen the governor arm clamp screw and close the carburetor throttle butterfly by pushing the governor arm toward the cylinder. While holding the arm in that position, insert a screw driver in the slot at the top of the governor shaft and turn the shaft clockwise as far as possible. Tighten the governor arm clamp screw slightly, but not enough to prevent moving the arm on the shaft. At this point the throttle stop screw should be against the carburetor stop. Now pull the governor arm outward carefully until the quadrant stop is about $1/16$ " from the carburetor stop for the wide open position of the throttle plate. Tighten the

governor arm clamp screw. This is the correct position of the governor arm and the carburetor stop quadrant when the engine is not running.

SPARK PLUG. - Clean the carbon from the spark plug with a stiff wire brush or a regular plug cleaning machine if one is available. Reset the electrode gap to 0.024 to 0.026 inch if gasoline fuel is being used. Reset the electrode gap to 0.018 inch if gaseous fuel is being used on the engine equipped with the combination carburetor. Use a Champion No. 6M spark plug, or a comparable type made by another manufacturer, when necessary to replace the spark plug.

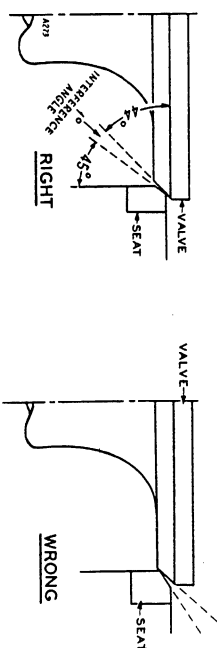
GENERAL. - If a major overhaul becomes necessary, the engine should be checked carefully and all necessary repairs made by a competent mechanic who is thoroughly familiar with the operation of a modern, internal combustion type engine. Reference may be made to the **SERVICE DIAGNOSIS** section for assistance in locating and correcting troubles which may occur. Maintain factory limits and clearances as listed in the **TABLE OF CLEARANCES** in this section.

CRANKCASE INSPECTION. - A competent mechanic can determine the need for major repairs by removing the oil base from the crankcase, inserting a trouble lamp inside the crankcase, and checking the clearances of the working parts of the engine.

VALVE SERVICE. - Compression reading should not be lower than 68 pounds at sea level. Compressed gases leaking past the exhaust valve can be heard at the exhaust outlet. If leaking past the intake valve, a hissing noise may be heard through the carburetor. If either valve is leaking, both should be serviced. A compression leak past the piston rings may be heard at the oil filler opening.

Clean the valves and the combustion chamber of all carbon. Note the condition of the valves and seats. Replace with a new valve any valve that is burned or warped.

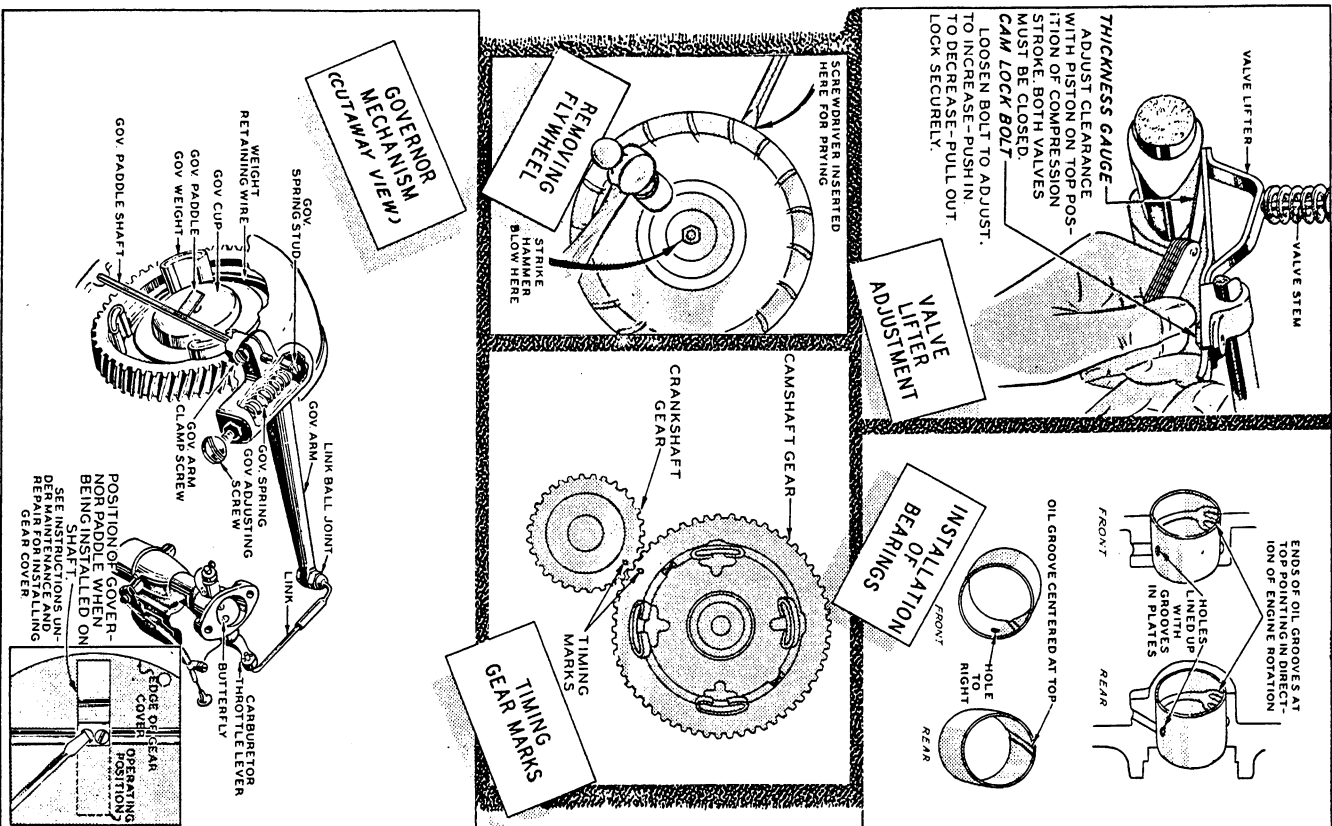
The correct valve **FACE** angle is 44° . The correct valve **SEAT** angle is 45° . This 10° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.



VALVE GRINDING

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where Stellite faced valves and seats are used. Valve faces should be finished in a machine to 44° . Valve seats should be ground with a 45° stone, and the width of the seat band should be $3/64$ to $5/64$ of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air



MAINTENANCE AND REPAIR - ENGINE

pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Be sure the valves drop of their own weight in their respective places before assembling. Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

VALVE LIFTER ADJUSTMENT. - Remove the valve inspection plate behind the carburetor. Remove the

spark plug and crank the engine slowly until the intake valve opens and closes and the piston is at the extreme top of the cylinder. Loosen the valve lifter lock screw to make the adjustment. Pushing in on the valve lifter increases the clearance between the valve lifter and the cam and pulling out on the valve lifter decreases the clearance between the valve lifter and the cam. The correct clearance for the intake valve is 0.008 to 0.010 inch and the correct clearance for the exhaust valve is 0.010 to 0.012 inch when the engine is cold. In each case the thinner feeler gauge should pass freely between the cam surface and the valve lifter, but the thicker feeler gauge should not. Tighten the valve lifter lock screw securely, after completing the valve adjustment.

CYLINDER. - The cylinder bore is 2-3/4 inches; stroke, 2-3/4 inches; piston displacement, 16.3 cubic inches; compression ratio, 4.3 to 1. If the cylinder is worn more than 0.005 inch out of true, it is advisable to install a new cylinder block with a new standard size piston, or to refinish the cylinder to accommodate a new piston of one of the available oversizes. Pistons are available in 0.010, 0.020, and 0.030 inch oversize.

PISTON RING SERVICE. - The aluminum piston has three compression rings and one oil control ring. Inspect the piston rings carefully for fit in grooves, for tension, and for seating on cylinder walls. If there is any doubt about the serviceability of old piston rings, install new ones. Fit each ring individually to the cylinder from the crankcase end. The correct ring gap, while in the cylinder, is between 0.010 and 0.015 of an inch. If necessary to increase the ring gap slightly, a small amount of metal may be filed from the ends of the piston ring. Rings so large as to require too much filing should not be used. Each ring gap should be 1/4 of the way around the piston from the preceding one. Rings of the tapered type will be marked "TOP", or identified in some other manner, and this mark must be placed nearer the top of the piston. Install all rings on the piston. Piston rings are available in 0.010", 0.020", and 0.030" oversizes. Use standard rings for 0.005" oversize piston.

CONNECTING ROD. - The aluminum connecting rod and its bearing cap are marked. If replacement of the connecting rod, piston pin, or piston rings becomes necessary, these numbers must

face the camshaft when reassembling. The clearance between the connecting rod bearing surface and the crankshaft bearing surface may be adjusted by carefully surfacing the connecting rod cap, use medium emery cloth placed on a true surface to remove sufficient material to reduce the clearance to between 0.0025 and 0.0035 inch. Wash with gasoline to remove all grit and metal particles. Tighten the connecting rod screws to 18 to 20 pounds feet when using a torque wrench.

CRANKSHAFT. - The crankshaft is drilled for pressure lubrication of the connecting rod. When making major repairs, these drilled passages should be inspected and thoroughly cleaned to assure proper lubrication of the connecting rod.

BEARINGS. - The sleeve type, steel-backed, babbit-lined, crankshaft bearings must be installed with the oil holes in the bearing and the bearing boss properly aligned and the outer oil grooves pointing in the direction of rotation. Press both bearings in from the inside until the ends are flush with the inner ends of the bearing bosses.

The camshaft is supported by sleeve type, steel-backed, babbit-lined bearings. Press the front bearing in flush with the bearing boss. Press the rear bearing in flush with recess in the bearing boss.

The crankshaft and camshaft bearings must be line reamed after being installed in the crankcase. The correct crankshaft bearing clearance is 0.002 to 0.003 of an inch, the correct camshaft bearing clearance, 0.0015 to 0.0025 of an inch.

OIL SEALS. - When replacing the rear main bearing oil seal, if expanding and driving tools are not available, place a piece of shimstock over the crankshaft, tap the seal into the crankcase evenly, and shellac the surface after the seal is installed. The oil seal in the gear cover is a synthetic cork member and must be cemented into the cover. Use a good, hard setting cement. When installing the gear cover, place a piece of shimstock over the keyway to avoid damaging the seal.

LUBRICATING SYSTEM. - A plunger type oil pump provides for pressure lubrication of the main bearings and the connecting rod and spray lubrication of the other internal parts of the engine. Check the oil pump thoroughly for worn parts. Make sure all oil passages are unobstructed.

OIL PRESSURE RELIEF VALVE. - A by-pass valve in the oil pressure line controls the amount of oil delivered to the main bearings and connecting rod. This valve is properly set at the factory to maintain the correct oil pressure within the plant. This adjustment should not be disturbed. If for any reason the adjustment of the valve has been changed, a new by-pass valve assembly

should be installed. Any change in the adjustment other than a factory setting might cause serious trouble.

FLYWHEEL. - Remove the blower housing, loosen the hexagon nut at the center of the flywheel hub until it is flush with the end of the threads. Insert a heavy screw driver between the flywheel and the crankcase. Pull outward on the screw driver and at the same time strike the end of the stud a sharp endwise blow with a hammer to loosen the flywheel. When reassembling tighten the flywheel stud nut to 40 pounds feet when using a torque wrench.

CRANKSHAFT GEAR. - The steel crankshaft gear may be pulled from the crankshaft after first removing the nut and special washer. If the gear is to be used again, apply the puller carefully to avoid damage to the teeth.

CAMSHAFT GEAR. - Remove the cast iron camshaft gear and the camshaft as an assembly, sliding it out while raising the valve lifters and the oil pump operating lever, so they will clear the cams and rear journal. The gear should be removed and replaced, from the shaft by means of an arbor press.

TIMING GEAR MARKS. - The timing mark on the crankshaft gear must coincide with the timing mark on camshaft gear when the gears are installed. It is advisable to install both gears if a replacement of either is required.

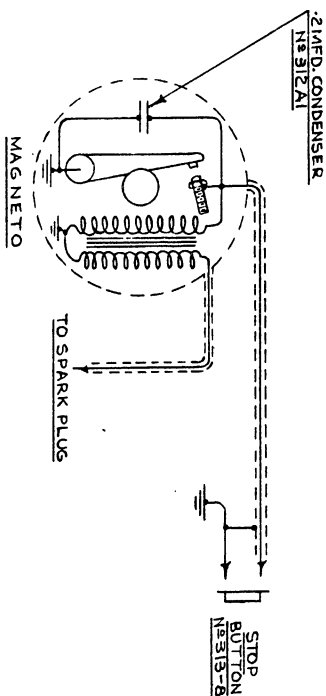
REPLACING GOVERNOR WEIGHTS. - Before removing the retaining wire, examine the ends of the wire and note exactly how they are inserted in small holes in the gear and how the wire has been bent outward. Hold the retaining wire with pliers while removing. Then install new weights and install the new retaining wire in position in the groove. Be sure the ends of the wire enter the small holes in the gear. Then, using a small punch and a light hammer, strike a blow near each end of the wire at the center of the recess so that each end of the wire will bow slightly outward (toward the teeth) instead of inward. It is important that the ends of the wire seat securely in the holes and expand the wire outward tightly in the groove. If not so expanded, it may become loosened, release the weights, and cause extensive damage. When ordering a new gear, always order a complete assembly with weights attached.

GEAR COVER (GOVERNOR EQUIPPED ENGINES). - When installing the gear cover, turn the shaft counterclockwise (looking at the top of the shaft) as far as it will go and hold in this position until the cover is located on the dowel pins. Refer to subject **OIL SEALS** before installing.

IGNITION SYSTEM. - A high tension magneto provides high voltage current to the spark plug at low cranking speed. Refer to the sections on PERIODIC and ACCESSORY SERVICE for instructions on servicing.

TIMING THE IGNITION. - The marks on the timing gears must coincide. Revolve the crankshaft clockwise until the in-

take valve opens and closes and the piston is at the extreme top of the cylinder. Remove the flywheel and check the magneto breaker point gap. To obtain the proper setting of the breaker points, slightly loosen the two screws that hold the stationary point bracket to the magneto backplate, and slide the bracket up or down for the proper clearance of 0.018 to 0.022 inch. A low voltage, series timing light is used to obtain the correct ignition timing. Disconnect the coil lead from the condenser terminal.



IGNITION CIRCUIT

Connect one lead from the timing light to the stop wire and the other lead to a good ground on the engine. Place the flywheel loosely in position on the crankshaft and rotate clockwise. The light will go out when the points separate, this is also the point at which the spark occurs at the spark plug when the engine is running. The two screws holding the magneto backplate assembly, to the gear cover are loosened to permit shifting of the backplate to correct the ignition timing. With the piston on the compression stroke, if the light goes out before the 25° timing mark on the flywheel aligns with the mark on the gear cover, shift the backplate clockwise to retard the timing. If the light goes out after the 25° flywheel timing mark aligns with the timing mark on the gear cover, shift the backplate counterclockwise to advance the timing.

GASKET. - Check all gasket surfaces to see that they are clean before installing new gaskets. Be sure to replace with new gaskets those gaskets that have been disturbed.

Tighten cylinder head cap screw to 18 to 20 pounds feet torque.

Tighten flywheel stud and nut to 35 to 40 pounds feet torque.

Tighten connecting rod screws to 18 to 20 pounds feet torque.

TABLE OF CLEARANCES

	MINIMUM	MAXIMUM
Valve Lifter Clearance (Intake)	0.008 in.	0.010 in.
Valve Lifter Clearance (Exhaust)	0.010 in.	0.012 in.
Valve FACE, Angle	44°	
Valve SEAT, Angle	45°	
Valve Interference Angle	1°	
Valve Seat Width	0.046 in.	0.078 in.
Valve Stem Clearance in Guide (ALL) ...	0.002 in.	0.0035 in.
Crankshaft Main Bearing	0.002 in.	0.003 in.
Crankshaft End Play	0.006 in.	
Connecting Rod Bearing	0.0025 in.	0.0035 in.
Connecting Rod End Play	0.004 in.	0.006 in.
Camshaft Bearing	0.0015 in.	0.0025 in.
Timing Gear Backlash	0.003 in.	0.005 in.
Piston Clearance in Cylinder	0.006 in.	0.0075 in.
Piston Pin in Piston		Hand Push Fit
Piston Pin in Connecting Rod		Thumb Push Fit
Piston Ring Gap in Cylinder	0.010 in.	0.015 in.
Piston Ring to Groove	0.0025 in.	0.003 in.
Cylinder Bore Actual Diameter	2.7495 in.	2.7505 in.
Breaker Point Gap	0.018 in.	0.022 in.
Spark Plug Gap - With Gasoline Fuel ...	0.024 in.	0.026 in.
Spark Plug Gap - With Gaseous Fuel	0.018 in.	

POSSIBLE CAUSE	REMEDY
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain, refill with lighter oil.
Engine stuck.	Disassemble and repair.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, spark plug, condenser, etc. or retune magneto.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust or replace parts necessary.
Clogged fuel screen.	Clean.
Cylinder flooded.	Ground spark plug cable. Crank few times with spark plug removed.
Poor fuel.	Drain, refill with good fuel.
Poor compression.	Tighten cylinder head and spark plug. If still not corrected, grind the valves. Replace piston rings, if necessary.
Wrong timing.	Reset breaker points or retune magneto.
POWER DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies for engine missing under heavy load.
Poor compression.	Tighten cylinder head and spark plug. If still not corrected, grind the valves. Replace piston rings, if necessary.
Faulty carburetion.	Check the fuel system. Clean, adjust or replace parts necessary.
Restricted air cleaner.	Clean.
Faulty choke.	See that it opens wide enough.

POSSIBLE CAUSE	REMEDY
POWER DROPS UNDER HEAVY LOAD (CONT.)	
Carbon in cylinder.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.
ENGINE MISFIRES AT LIGHT LOAD	
Carburetor idle jet clogged.	Clean.
Spark plug gap too narrow.	Adjust to correct gap.
Intake air leak.	Tighten or replace gaskets.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plug, condenser, etc.
Poor compression.	Tighten cylinder head and spark plug. If still not corrected, grind valves. Replace piston rings, if necessary.
ENGINE MISFIRES AT HEAVY LOAD	
Defective spark plug.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plug, condenser, etc.
Clogged carburetor.	Clean jets.
Clogged fuel screen.	Clean.
Defective spark plug cable.	Replace.
ENGINE MISFIRES AT ALL SPEEDS	
Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Sticking valves.	Grind, or replace.
Broken valve spring.	Replace.
Defective ignition wires.	Replace.
Defective or improperly adjusted points.	Adjust or replace breaker points.

POSSIBLE CAUSE	REMEDY
ENGINE LOW ON POWER	
Oil too light.	Drain, refill with proper oil.
Oil badly diluted.	Drain, refill with proper oil.
Oil too low.	Add oil.
Badly worn engine.	Overhaul.
Sludge on oil screen.	Remove and clean.
Badly worn oil pump.	Replace.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean or adjust carburetor.
Clogged fuel screen.	Clean screen.
Air leaks at intake manifold.	Replace gaskets, tighten.
Poor fuel.	Refill with good, fresh fuel.
Spark too late.	Readjust magneto backplate.
Intake valve leaking.	Grind or replace.
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST	
Poor compression, usually due to worn piston, rings, or cylinder.	Refinish or replace cylinder. Replace piston and rings.
Oil leaks from oil base. This does not cause smoky exhaust.	Replace gaskets. Tighten screws.
Oil too light or diluted.	Drain, refill with correct oil.
Too large bearing clearance.	Replace bearings.
Engine misfires.	Refer to section "Engine Misfires At All Speeds."
Faulty ignition.	Clean, adjust, or replace breaker points, spark plug, condenser, etc.

POSSIBLE CAUSE	REMEDY
EXCESSIVE OIL CONSUMPTION, LIGHT BLUE SMOKY EXHAUST (CONT.)	
Unit operated at light or no load for long periods.	No remedy needed.
Too much oil.	Drain excess oil.
BLACK SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUG WITH SOOT, POSSIBLE LACK OF POWER UNDER HEAVY LOAD	
Fuel mixture too rich.	Adjust carburetor or choke. Install needed carburetor parts, adjust float level.
Choke not open.	See that choke opens properly.
Dirty air cleaner.	Clean, service according to type.
LIGHT POUNDING KNOCK	
Loose connecting rod bearing.	Adjust or replace.
Low oil supply.	Add oil.
Oil badly diluted.	Change oil.
ENGINE STOPS UNEXPECTEDLY	
Fuel tank empty.	Refill.
Defective ignition.	Check the ignition system. Repair or replace parts necessary.
DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD	
Loose crankshaft bearing.	Replace, unless one of the next two remedies permanently correct the trouble.
SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED	
Low oil supply.	Add oil.

POSSIBLE CAUSE REMEDY

SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE
FIRST STARTED (CONT.)

Oil badly diluted. Change oil.

PINGING SOUND WHEN ENGINE IS RAPIDLY ACCELERATED OR
HEAVILY LOADED

Carbon in cylinder. Remove carbon.

Spark too early. Reset breaker points or retune magneto.

Wrong spark plug. Install correct spark plug.

Spark plug burned or carboned. Install new plug.

Valves hot. Adjust valve clearance.

Fuel stale or low octane. Use good fresh fuel.

Lean fuel mixture. Clean carburetor.

TAPPING SOUND

Valve clearance too great. Adjust

Broken valve spring. Install new spring.

HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD

Loose piston. If noise only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace worn parts.