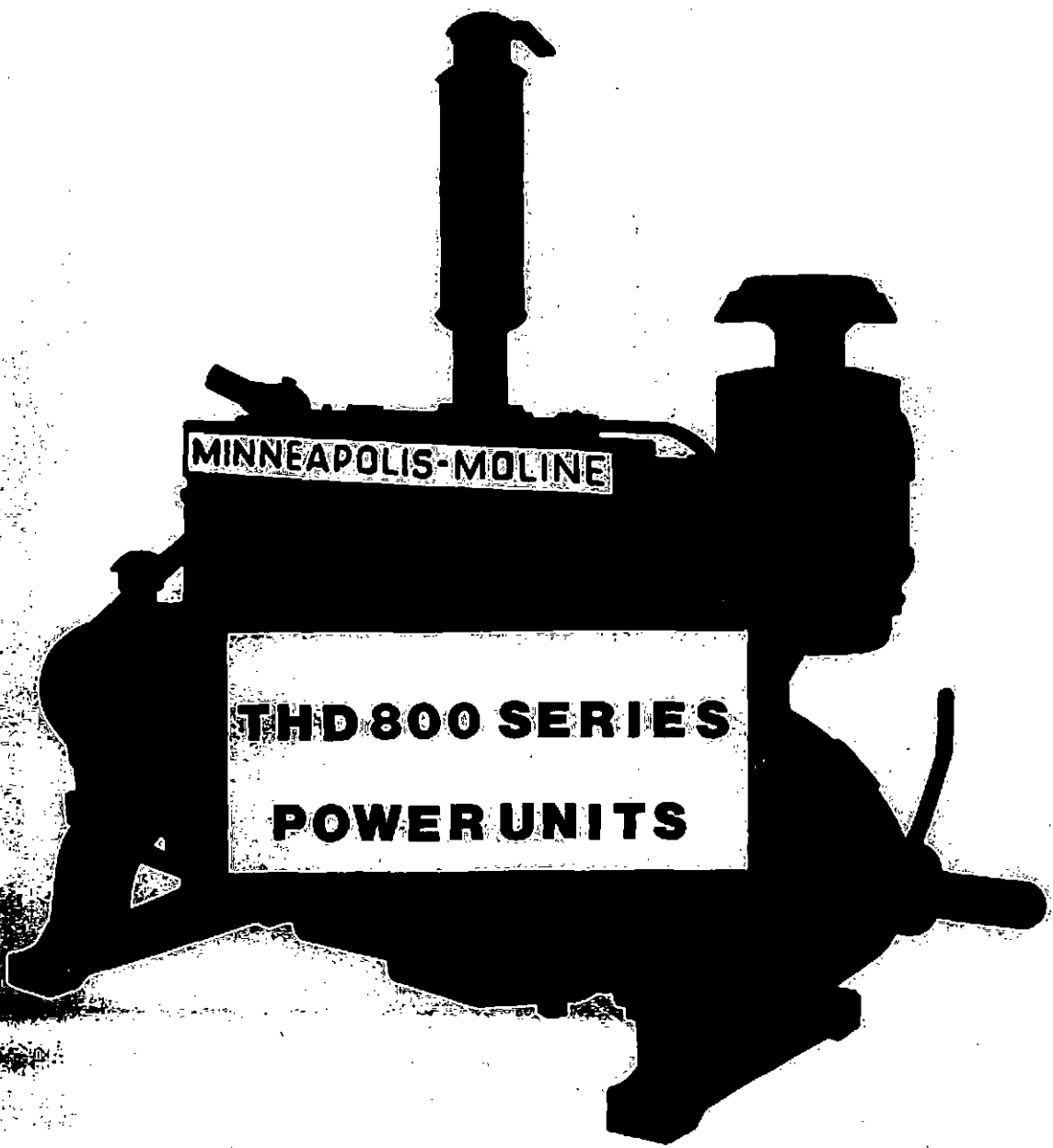


**MM MINNEAPOLIS-MOLINE.**  
AN ENSERVE COMPANY

# OPERATION & MAINTENANCE MANUAL



Issued March 1982  
REVISED JANUARY 1983

Form #04-05-010

# DEALER PRE-DELIVERY AND POST-DELIVERY CHECK LIST

**OWNER NOTE:** The engine should have a post-delivery service inspection after 100 hours of operation. Present this service check sheet to the dealer performing the post-delivery service.

**DEALER NOTE:** Use the following check list to serve as a guide for pre-delivery and post-delivery service. Circle each "X" as service is accomplished. For detailed information not contained in this check list, refer to the manual.

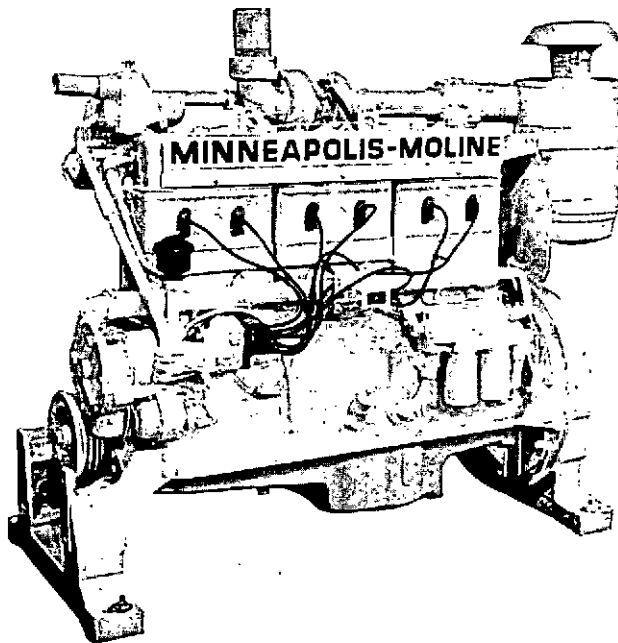
<u>PRE</u>	<u>POST</u>	
X	X	<b>COOLING SYSTEM</b> Fill system with clean, soft water. If the unit is exposed to freezing temperature, use a permanent type antifreeze. Follow manufacturer's recommendations for desired protection. To prevent loss of solution, make certain head gaskets and hoses are tight before adding antifreeze.
X	X	<b>CRANKCASE OIL</b> Crankcase capacity w/filter: Regular base pan - 14 quarts; heat exchanger base pan - 24 quarts. The crankcase is filled with a special non-corrosive run-in oil at the factory. Change oil and filter as specified in Lubrication section after the first 150 hours of use.
X	X	<b>FUEL SYSTEM</b> Check fuel system for leaks, and check all fuel valves for proper operation. Make certain LP-Gas and natural gas fuel equipment is properly installed. If LP-Gas is used as a fuel, make certain an adequate flow of hot water reaches the LP-Gas vaporizer. According to fuel being used, make correct starting, idling, and high speed adjustments as explained in manual.
X	X	<b>AIR CLEANER</b> Fill air cleaner cup to level mark, or check condition of dry filter element. Check all hose connections to make certain they are tight. Use soap solution or other appropriate means to determine if connections are leaking when engine is operating.
X	X	<b>CRANKCASE BREATHER</b> Make certain breather is clean and oil is at level mark.
X	X	<b>SPARK PLUGS</b> Remove spark plugs and inspect for cracks, pitting or damage. Set point gap to .015". Pour 1 or 2 ounces of engine oil through each spark plug port; then, reinstall plugs. Torque spark plugs to 40-45 ft-lbs.
X	X	<b>DISTRIBUTOR</b> Adjust points to gap of .018" to .024"; dwell angle 31-37°. Place two drops of engine oil on felt pad in center of cam. Place a small amount of ball bearing lubricant on breaker cam.
X	X	<b>MAGNETO</b> Service magneto as explained in manual.
X	X	<b>GOVERNOR</b> Adjust governor to obtain proper engine rpm as explained in manual. Check governor to carburetor linkages. The linkages must be free of binds and a full range of movement of carburetor throttle shaft must be obtained.

# DEALER PRE-DELIVERY AND POST-DELIVERY CHECK LIST

<u>PRE</u>	<u>POST</u>	
X	X	<b>ENGINE TIMING</b> Check and adjust timing according to fuel being used as explained in manual.
X	X	<b>HEAD NUT TORQUE</b> Torque in correct sequence to values given in manual.
X	X	<b>VALVES</b> Adjust valves AFTER torquing heads. Engine running at idle speed and normal operating temperature; intake .010", exhaust .025". See Maintenance section of manual.
X	X	<b>OIL PRESSURE</b> With engine running at full governed speed and at normal operating temperature, oil pressure should read 40 to 50 pounds.
X	X	<b>FAN AND ALTERNATOR BELTS</b> Adjust belts as explained in manual.
X	X	<b>FAN HUB</b> Lubricate as outlined in manual.
X	X	<b>CLUTCH</b> Adjust clutch as explained in manual.
X	X	<b>THROWOUT COLLAR</b> Lubricate the throwout bearing collar with a high quality chassis lubricant.
X	X	<b>PILOT BEARING</b> Lubricate pilot bearing sparingly with a high quality lubricant.
X	X	<b>POWER SHAFT BEARINGS</b> Lubricate as explained in manual.
X	X	<b>CONTROLS</b> Make certain all instruments and controls function properly.
X	X	<b>EXTRA EQUIPMENT</b> Check any adjustments relating to extra equipment as explained in manual.
X	X	<b>ENGINE RUN-IN</b> Engine should be allowed to warm up slowly and then operated at half throttle a sufficient length of time to detect any faulty adjustments. We do not recommend operating the engine under full load until it has been operated a length of time sufficient for all component parts to become "broken-in".
X		<b>FINAL INSPECTION</b> Check general appearance of unit; paint, cleanliness, etc. The unit is now ready for delivery and installation. Make certain to obtain a signed Delivery Report.
X		

**MM**®**MINNEAPOLIS-MOLINE®**

AN ENSERVE COMPANY

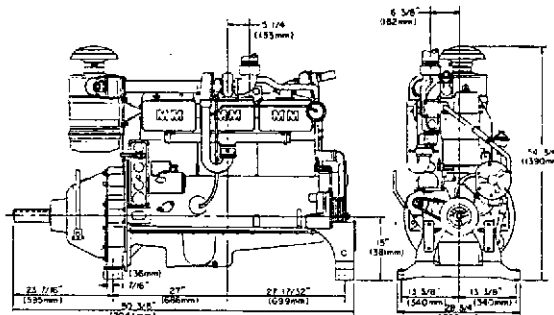


# THD800-6A

## INDUSTRIAL GAS ENGINE

The naturally aspirated HD800's reputation for dependability speaks for itself. That same dependability has been engineered into the turbocharged THD800-6A. Low compression ratio heads assure trouble-free operation on a wide variety of gaseous fuels. Features such as improved lubrication and cooling systems, heavy-duty bearing caps, high strength crankshaft, and heavy-duty piston pins give you the extra power you need and the reliability you expect at a highly competitive cost.

### SPECIFICATIONS



#### Fuel

Maximum Intermittent Output, BHP\*  
 Maximum Intermittent Output, Kw\*  
 Maximum Continuous Output, BHP\*  
 Maximum Continuous Output, Kw\*  
 Maximum Torque, lb-ft\*  
 Maximum Torque, N-m\*  
 Bore and Stroke, in.  
 Bore and Stroke, mm  
 Displacement, cu. in.  
 Displacement, liters  
 Dry Weight, lbs.  
 Dry Weight, Kg

#### Natural Gas

265 @ 2000 RPM  
 198 @ 2000 RPM  
 225 @ 1800 RPM  
 168 @ 1800 RPM  
 678 @ 1200 RPM  
 922 @ 1200 RPM  
 5.312 x 6.0  
 135 x 152  
 800  
 13.1  
 2720  
 1234

\*without accessories

### STANDARD EQUIPMENT

Air Cleaner, Oil Bath  
 Base Pan, Regular Cast Iron  
 Carburetor, Impco  
 Cooler, Lube Oil  
 Fan Drive Pulley with Vibration Damper  
 Filter, Oil, Dual Full Flow  
 Flywheel with Ring Gear  
 Flywheel Housing, SAE No. 1  
 Governor, Constant Speed  
 Ignition—Semi-Low Tension Magneto  
 Instrument Panel, Safety Cutout Gauges  
 —Oil Pressure  
 —Coolant Temperature  
 Lifting Eyes  
 Manifolds, Water Cooled  
 Muffler, Standard  
 Positive Crankcase Ventilation Pump, Oil

Pump, Water  
 SAE Standard Rotation  
 (CCW viewed from flywheel end)  
 Spark Plugs, One Per Cylinder  
 Support Legs, Front and Rear, Cast  
 Turbocharger  
 Dual Thermostats with Full Flow Bypass

### OPTIONAL EQUIPMENT

Hi-Tension Magneto Ignition  
 Solid State Magneto Ignition  
 Shielded Solid State Magneto Ignition  
 Governor, 3-5% Regulation  
 Governor, Variable Speed  
 Tachometer, Mechanical  
 Overspeed Shut-Down—Mechanical  
 Tach Drive Adapter

Intake Manifold Pressure Gauge  
 Starting Motor, 12 Volt  
 Electric Starting Receptacle  
 Starting Motor—Air/Gas  
 Alternator—12 Volt  
 Power Take-Off, Double Disc Clutch  
 Stub Shaft with Guard  
 Auxiliary Front Drive Pulley  
 Special Front Support  
 Weather Enclosure  
 Natural Gas Pressure Reducing Valve  
 Battery Cables  
 Heat Exchanger Expansion Tank  
 Oil Sight Gauge  
 Low Coolant Level Shut-Off  
 High Attenuation Muffler

**RATING DATA**

CONTINUOUS RATINGS	800 RPM	1000 RPM	1200 RPM	1400 RPM	1600 RPM	1800 RPM
<b>NATURAL GAS WITHOUT ACCESSORIES &amp; HD-5 PROPANE*</b>						
Brake Horsepower	101	128	155	179	203	225
Shaft KW	75	95	116	133	151	168
*Fuel Consumption cu. ft./hr.	929	1153	1382	1601	1815	2047
Brake Specific Fuel Consumption BTU/HP Hr.	8280	8110	8030	8050	8075	8190
Accessory HP Power	2	3	5	7	10	14
KW	1.5	2.2	3.7	5.2	7.5	10.4

GENERATOR DRIVER APPLICATIONS	1500 RPM	
	I	C
Shaft KW	158	142
*Fuel Consumption (Cu. ft./hr.)	1860	1710
Brake Specific Fuel Consumption (BTU/KWH)	10600	10810
Accessory Power KW	6	

\* 1500 RPM MAXIMUM SPEED WHEN USING PROPANE  
OR LP GAS FUEL.

**RATING DEFINITIONS**

- Intermittent Rating (I) is the load which may be applied to an engine being used on an intermittent duty cycle, such as standby electric power generation or peakshaving applications. Intermittent duty can be defined as a probable annual operation of 500 hours or less and with operation generally not exceeding 5 hours during any one period. The load demand is typically a cycle of low and high periods, with the high period demand usually followed by a similar low period demand. Maintenance costs of the engine may be higher than would be experienced if the engine is operated at the continuous rating.
- Continuous Rating (C) is the load which may be applied to an engine when it is being used on a continuous duty cycle. Continuous duty can be defined as an anticipated, 24 hours a day, 7 days a week, annual operation. The applied load will generally be steady, without significant load cycling.

- The continuous power output will require derating for certain temperature and altitude conditions. The intermittent power output will require derating for all conditions, other than standard SAE J816 conditions (500 feet above sea level and 85°F ambient temperature).  
At operating speeds of 1300 RPM and greater, the continuous power does not require derating if the engine is operated at altitudes of less than 3000 feet above sea level and ambient temperatures of less than 100°F.  
Combinations of lower temperatures at higher altitudes or higher temperatures at lower altitudes may allow continuous power output without derating.
- Accessory Horsepower includes alternator, standard fan, radiator, and weather enclosure. Deduct this amount from the no accessories rating to determine the net power rating.

- Maximum torque ratings are corrected to sea level barometer of 29.92 in Hg and a standard temperature of 60°F, (SAE J606). For SAE J816 maximum torque, (29.83 in. Hg, 85°F) multiply maximum specification table torque by 0.947.
- Fuel consumption data is furnished for reference only to aid the sizing of fuel supply systems, and is not guaranteed. Natural Gas fuel consumption is based on 900 BTU/cu. ft. lower heat value.

**CAPACITIES**

Jacket Water Capacity — 9.5 gallons (36.0 liters)  
Radiator add 14.0 gallons (53.0 liters)  
Jacket Water Pump Flow 1200 RPM/65 GPM  
1800 RPM/85 GPM  
Specific Heat Rejection 52 BTU/HP/MIN.  
Crankcase Oil Capacity with Filters 14 qt. (13.2 liters)

Materials, specifications and ratings are subject to change without notice. Minneapolis-Moline Engine Company assumes no liability for any change with respect to engines previously sold or in the process of manufacture. For specific information, contact your Minneapolis-Moline dealer or the Minneapolis-Moline Marketing Department.

## STANDARD EQUIPMENT

Air Cleaner, Oil Bath  
 Base Pan, Regular Cast Iron  
 Carburetor, Impco  
 Cooler, Lube Oil  
 Fan Drive Pulley with Vibration Damper  
 Filter, Oil, Dual Full Flow  
 Flywheel with Ring Gear  
 Flywheel Housing, SAE No. 1  
 Governor, Constant Speed  
 Ignition—Semi-Low Tension Magneto  
 Instrument Panel, Safety Cutout Gauges  
 —Oil Pressure  
 —Coolant Temperature  
 Lifting Eyes  
 Manifolds, Water Cooled  
 Muffler, Standard  
 Positive Crankcase Ventilation Pump, Oil

Pump, Water  
 SAE Standard Rotation (CCW viewed from flywheel end)  
 Spark Plugs, One Per Cylinder  
 Support Legs, Front and Rear, Cast Turbocharger  
 Dual Thermostats with Full Flow Bypass

## OPTIONAL EQUIPMENT

Solid State Magneto Ignition  
 Shielded Solid State Magneto Ignition  
 Governor, 3-5% Regulation  
 Governor, Variable Speed  
 Tachometer, Mechanical  
 Overspeed Shutdown—Mechanical  
 Tach Drive Adapter

Intake Manifold Pressure Gauge  
 Starting Motor, 12 Volt  
 Electric Starting Receptacle  
 Starting Motor—Air/Gas  
 Alternator—12 Volt  
 Power Take-Off, Double Disc Clutch  
 Stub Shaft with Guard  
 Auxiliary Front Drive Pulley  
 Special Front Support  
 Weather Enclosure  
 Natural Gas Pressure Reducing Valve  
 Battery Cables  
 Heat Exchanger Expansion Tank  
 Oil Sight Gauge  
 Low Coolant Level Shut-Off  
 High Attenuation Muffler

## RATING DATA

	1500 RPM		1550 RPM		1600 RPM		1800 RPM		2000 RPM	
	I	C	I	C	I	C	I	C	I	C
<b>NATURAL GAS WITHOUT ACCESSORIES</b>										
Brake HP	*	*	235	197	241	203	265	225	280	-
Shaft KW	*	*	175	147	180	151	198	168	209	-
<b>HD-5 PROPANE WITHOUT ACCESSORIES</b>										
Brake HP	*	*	224	197	229	203	250	225	265	-
Shaft KW	*	*	167	147	171	151	186	168	198	-
Fan Power HP	*	*		8		10		14		19
Requirement KW	*	*		6.0		7.5		10.4		14.2

## RATING DEFINITIONS

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# NOTES

SECTION I  
SAFETY INFORMATION

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This Safety Alert Symbol Means:

ATTENTION!

BECOME ALERT!

DANGER!

YOUR SAFETY IS INVOLVED!

This symbol is used throughout the Operation & Maintenance Manual and the Application Manual. It is put there to call attention to a warning.

Minneapolis-Moline Engine Company (MMEC) is constantly striving to design and manufacture a product that has a minimum of hazards and we urge that anyone involved in designing or manufacturing an engine power equipment package also strive to eliminate or minimize hazards.

If the hazard cannot be eliminated, then the designer of the package should place a WARNING LABEL on the unit which clearly identifies all hazards, specify the correct procedure, and indicate the consequences if the warning is not heeded. The manufacturer is obligated to warn of all recognized hazards. These hazards should be discussed in the equipment operation manual.

Some hazards may be classed as an inherent hazard or "patent" hazard. These hazards are one's which are obviously hazardous, but which cannot be totally enclosed if the product is to perform its function.

All such patent hazards should be warned against, using appropriate warning labels.

These warnings should be made to stand out by the use of a different type in a different color ink. Usually red in the Operation manual. An appropriate warning label should be located in a readily visible location on the equipment, usually printed on yellow with black lettering and sufficiently durable to last the lifetime of the equipment.

MMEC cannot be responsible for hazards which are associated with the design, manufacture, or operation of an engine powered equipment package which MMEC did not design or manufacture.



## SAFETY PRECAUTIONS

The following list of safety precautions are areas that deserve special consideration when designing, manufacturing and operating engine powered equipment packages to minimize hazards. The publication of these safety precautions is done for your information. The Minneapolis-Moline Engine Company (MMEC) does not, by the publication of these precautions, imply or in any way represent that these published precautions are the total of all the danger present near industrial engines. It is the obligation of everyone involved in the design, manufacture, installation and operation of the engine powered equipment packages to ensure that the operation is in full accordance with all applicable safety requirements and codes. The obligation includes providing operators with the proper operation manuals and training them in correct and safe procedures.

All requirements of the United States Federal Occupational Safety and Health Administration Act must be met when Minneapolis-Moline Engines are operated in areas that are under the jurisdiction of the OSHA act.

Minneapolis-Moline Engines operated in countries other than the United States of America must be installed, operated and serviced in accordance and compliance with any and all safety requirements of that country which may be applicable.

### COMPRESSED AIR

Compressed air or gases should never be used to clean clothing or body of foreign materials. A highly compressed stream of air flowing through a very small opening can pierce the skin and cause severe and very painful injury. Never use your hand to check air, gas, or liquid flow rates. Do not engage in "horseplay" with air, gas, or liquid hoses. Observe all applicable regulations as related to compressed gases.

### CLEANING SOLVENTS

Use approved cleaning solvents in a well ventilated area. Avoid breathing fumes. Keep away from open flames or sparks. Do not use gasoline or paint thinners or other highly volatile fluids for cleaning. Breathing carbon tetrachloride or carbon disulfide fumes can be fatal. Always read and observe the "CAUTION" labels on containers. Do not destroy the labels on the containers. Cleaning solvents can cause various types of skin irritations.

### ELECTRIC POWER TOOLS

Be certain the electric tool is properly grounded. Wear proper eye protection. Do not work in wet or damp conditions. Be sure the tool is in good condition and safety guards are in position. An electric trouble light must also be grounded. Do not carry electric power tools by the cord. Do not yank the cord when removing from outlet; instead grasp the plug to remove it from outlet. Use an automatic ground fault interrupter on any circuits that are providing current for electric power tools.

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## ENGINE AND EQUIPMENT, REPAIR AND SERVICE

Always stop the engine before cleaning, servicing, or repairing the engine or driven equipment. Place all controls in off position to prevent accidental restarting. Before restarting, make sure that all tools and other materials are removed from the engine and equipment.

Proper service and repair is important to the safe reliable operation of engines and equipment. The procedures recommended by MMEC in this manual are effective methods for performing service and repair operations. Some of these procedures require the use of specially designed tools. The special tools should be used when and as recommended. Anyone who uses a service, repair, or installation procedure not recommended by MMEC must first satisfy themselves thoroughly that their safety will not be jeopardized by the service methods they select.

### ENGINE FUELS

All internal combustion engine fuels are highly combustible and may ignite or explode. Fuels must be conducted to the engine with proper piping, free from leaks, and designed to resist breakage from vibration. When filling fuel tanks, never smoke or use open flame in the immediate area. Fuel tanks should be grounded to prevent buildup of static electricity.

### ENGINE FAN BLADES

If a fan blade or fan drive shaft is bent or damaged in any way, it should be replaced. No attempt should be made to repair the damaged parts. Fan assemblies must remain in proper balance. When damaged, an unbalanced fan can fly apart during use and create an extremely dangerous condition.

### ENGINE SURGE TANK AND RADIATOR PRESSURE CAPS AND CONNECTIONS

Do not remove the pressure caps while the engine is operating or while coolant is hot. The cooling system is under pressure and severe burns could result from the hot coolant spewing out when cap is removed. Wait until engine and coolant have cooled down before removing radiator or surge tank caps. Always replace weak hoses, lines, and fittings.

### EXHAUST GASES

The exhaust products of an internal combustion engine are toxic and may cause injury or death if inhaled. All engine installations, especially those within a closed shelter or building, should be equipped and maintained with an exhaust discharge pipe so that exhaust gases are delivered into the outside air. A closed building or shelter must be adequately vented. A means of providing fresh air into a closed building or shelter is necessary.

### FIRE PROTECTION

Locate fire extinguishers so that they are easily accessible if a fire starts. Carefully maintain records of extinguisher inspection and recharging to ensure the fire extinguishing capabilities when required. Consult your fire extinguisher supplier or insurance engineer for recommendations on the type, size, and quantity of fire extinguishers required for the engine installation. Select alternate routes of escape from any engine installation and post such routes in accordance with local and government requirements.

---

## GENERATOR SETS

The voltage produced by generator sets is dangerous to personnel coming in contact with any part of the electrical system during operation. Severe, possibly fatal shock may result. Make sure the generator set is grounded before operation. Be extremely careful when the unit or surrounding area is damp or wet.

When servicing any part of the electrical system or making any connections, make sure the main power switch is OFF. Clean or service generator set only when engine is shut down.

In case of an accident from electrical shock, shut down the generator set or main power switch at once. Avoid direct contact with the victim until all electrical power is turned off. If the victim is unconscious, apply artificial respiration and get medical help.

Do not operate the generator set with the ammeter circuit open. Voltage, dangerous to both equipment and personnel, can be generated in an open secondary circuit of a current transformer.

If the generator set is stopped by operation of safety devices, do not attempt to operate it until the cause has been eliminated.

When the generator set is shut down after operation, disconnect all line switches to all external power load and parallel circuits.

## GAS USED TO ENERGIZE STARTERS

Gas used to energize starters must be discharged away from the engine into a harmless area. Ignition connections and electrical equipment on engines exposed to potentially explosive ambient atmospheres should be specially equipped to eliminate spark hazard and it is the responsibility of the engine owner to specify or provide such connections and equipment.

## HOUSEKEEPING

Good housekeeping results in a clean, safe work area. An orderly work area with clean walkways and neatly arranged tools and equipment is conducive to better work performance and morale, and is a major factor in accident prevention. Accidents resulting from poor housekeeping include tripping over loose objects on the floor, stairs, or platforms, slipping on greasy, oily, wet, or dirty floors, falling of poorly piled materials, and cuts from sharp edges.

## IGNITION SYSTEMS

Breakerless magneto and battery ignition systems can cause electrical shocks. Avoid contacting these units or their wiring. The reaction from the shock could cause persons to fall or jerk their hands, thus striking other objects and injuries could occur.

---

## LEAD ACID BATTERIES

Always disconnect the battery ground connection from batteries before performing any work on the engine or equipment. This will prevent sparks or burns when accidentally shorting an electrical connection.

Never expose batteries to open flame or electric spark. Battery action generates hydrogen gas which is flammable and explosive. Don't allow battery fluid to contact skin, eyes, fabrics, or painted surfaces. Battery fluid is a sulfuric acid solution which could cause serious personal injury or property damage. Wear eye protection when working with batteries.

## PRECAUTIONS WHEN USING BOOSTER BATTERIES AND CABLES

Do not attempt to jump start an engine having a frozen battery because the battery may rupture or explode. If a frozen battery is suspected, examine all fill vents on the battery. If ice can be seen, or if the electrolyte fluid cannot be seen, do not attempt to start with jumper cables.

Both charged and discharged batteries should be treated carefully when using jumper cables. The following procedures assist in reducing sparks and explosion hazards always present in both batteries when connecting charged batteries to discharged batteries.

Turn off all electrical loads. Remove vent caps and lay a damp cloth over open vent wells of each battery. The charged booster battery or batteries must have the same voltage rating as the discharged battery or batteries.

The positive post is identified by a +, pos. and red color and is larger in diameter than the negative post.

The negative post is identified by a -, neg. and green color.

### Negative Grounded Battery or Batteries

First, connect one jumper cable from the positive post on charged battery or batteries to positive post on discharged battery or batteries. If more than one battery is connected in "series" or "series parallel" connect jumper cable to positive post that has cable leading to starting motor.

Second, connect other jumper cable from negative post on charged battery or batteries to a good ground on engine.

When removing jumper cables, always disconnect the ground jumper cable from the engine before disconnecting the other jumper cable.

---

## POSITIVE FUEL SHUT-OFF

All engine installations should be equipped with a means of positive fuel shut-off for emergency use when fuel is conducted to the engine from a remote source. Fuels under pressure such as natural gas or liquified petroleum gas, should be controlled by a positive shut-off valve, preferably automatic, other than those integral with the carburetor or gas pressure regulation equipment. It shall be the final responsibility of the engine owner to ensure that the installation is free from fuel or exhaust leakage, and that such installation meets all applicable codes.

## SAFETY GUARDS

Internal combustion engines must be properly provided with guards against hazards to persons or structures in close proximity to rotating or heated parts and it is the responsibility of the engine owner to specify or provide such protection.

## WELDING EQUIPMENT

If a welding gas cylinder is damaged by falling or being struck, it could burst with destructive force. Cylinders must be stored in accordance with manufacturer's specifications and applicable safety requirements.

When welding, brazing or cutting with acetylene, check valves should be installed between the regulators and hoses to prevent flashback into the regulators and supply tanks. Without these check valves, the flashback could cause the regulators and supply tanks to explode.

Oily and greasy materials must be kept away from oxygen valves, hoses, etc. Oxygen may combine with such materials and an explosive reaction could result.

Always wear protective eye shields when welding, cutting or watching a welding operation. Protective clothing and face shields must be worn. Do not weld or cut near combustible materials.

## INTOXICANTS AND NARCOTICS

Workers under the influence of intoxicants and/or narcotics are unsafe workers and are a hazard to themselves and other employees.

## SAFE DRESS

When around machinery, loose clothing, neckties, rings, wrist watches, bracelets, etc., should not be worn. Severe injuries have resulted from this all too common practice.

## HAIR LENGTH

Long hair worn around rotating equipment is dangerous. Hair is charged with static electricity and can be drawn to a piece of rotating machinery like a magnet. Persons with long hair must wear complete head covering when around rotating machinery.

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## NOISE PROTECTION

Wear O.S.H.A. approved hearing protection devices when around excessive noise.

## FOOT PROTECTION

Wear O.S.H.A. approved steel tip safety shoes.

## HEAD PROTECTION

Wear O.S.H.A approved safety helmets.

## EYE PROTECTION

Wear O.S.H.A. approved eye shields, safety glasses, and sweat bands.

## RESPIRATORY SYSTEM PROTECTION

Wear O.S.H.A approved equipment when near dust and toxic fumes to protect the eyes and respiratory system. This type of equipment must be checked and maintained on a regular basis.

## REFERENCES

For details on safety rules and regulations in the United States, contact your local Occupational Safety and Health Administration (O.S.H.A.).

For details regarding natural gas or propane fuel installations contact your local gas company

## DISTRIBUTORS AND SERVICE

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The Minneapolis-Moline Engine Company has established a system of authorized distributors and dealers, with trained service personnel and full facilities for maintenance and rebuilding of the engines. These distributors and dealers also stock a supply of the service parts used to maintain the engines discussed in this manual. These outlets are located in all areas of major engine population. If you cannot locate a MMEC distributor or dealer in your area, contact the Minneapolis-Moline Engine Company Technical Service Department, P. O. Box 788, Russellville, Ark. 72801, phone (501) 968-2700, Telex 783006, and you will be provided with the name of the outlet in your area.

Authorized distributors and dealers can more accurately respond to your service needs if the following procedures are observed:

1. Give the engine model and serial number which are stamped on the name plate attached to the crankcase.
2. When ordering service parts, always furnish the complete description and part number, if known, of the parts wanted. State the quantity of each item required.
3. Tell the distributor how and where to ship the parts. i.e. truck freight, parcel post, UPS, or best way. Without specific shipping instructions the distributor will use his own discretion and will not be responsible for any charges by doing so. Be sure to mark your name, address, and where you can be reached on any order for parts as well as any other correspondence.
4. Terms - To avoid delay, all repairs will be C.O.D. unless prior arrangements are made with the distributor or dealer.

In situations which may fall within the area of the Minneapolis-Moline Engine Company standard warranty conditions, proceed as follows:

1. When placing a request for service, specifically state that the repair is believed to be within the terms of the warranty. Refer to the purchaser copy of the delivery report for these terms. Be prepared to provide the distributor or dealer with a copy of this report which shows the date of delivery of the engine, engine model and serial number, and other important information.
2. Once the service or repair is completed, pay for the service and/or parts in accordance with whatever terms were previously arranged, but indicate with the payment that a request is pending under the provisions of the warranty.
3. Confirmation of the submission of a warranty request can be requested from the Minneapolis-Moline distributor or dealer handling the repair. This is usually done by a notation on the distributor's invoice to the customer.
4. The Minneapolis-Moline Distributor or dealer will notify you via letter or credit memo on an invoice of the decision of the Minneapolis-Moline Engine Company Warranty Department as to the request for warranty credit on a particular repair.
5. Any parts replaced in the repair which may be subject to warranty should be left with the distributor for proper handling.

---

# INTRODUCTION

This manual has been prepared as a guide for the owner and operator of the power unit. In order to attain maximum life and efficiency from the unit, read this manual thoroughly, and follow all instructions carefully.

If any major repair or overhaul becomes necessary, we recommend that you consult your dealer. He is properly equipped and has service personnel that are thoroughly trained and familiar with service procedures. In addition, only he can supply you with genuine replacement parts.

Be sure that serial number of your unit is recorded on your copy of Delivery Service Report. For your convenience, space has been made available below to insert the serial numbers of the engine. When ordering parts, always give your dealer this information as it will aid him in supplying you with correct parts.

<u>MODEL</u>	<u>SERIAL NO.</u>
<u>THD800-6A</u>	<u>3500</u>
<u>THD800-6B</u>	<u>3510</u>

Terms "Right-Left-Front-Rear" are determined by standing at flywheel end of power unit and facing the flywheel. Flywheel end of engine is rear end; and, as viewed from flywheel end, engine rotates in a counterclockwise direction.



This Safety Alert symbol means:

**ATTENTION!  
BECOME ALERT!  
YOUR SAFETY IS INVOLVED!**

## SPECIFICATIONS

# SPECIFICATIONS

### GENERAL:

Bore and stroke	5-5/16" x 6"	
Number of cylinders	6	
Piston displacement - cu. in.	800	
RPM	Continuous	Intermittent
Full Load	1800	2000
No Load	1975	2200
Idle Speed	600	

### COOLING SYSTEM CAPACITY:

Standard engine	9.5 gallons
Standard radiator add	14.0 gallons
Heat exchange base pan add	1.5 gallons

### CYLINDER BLOCK AND HEAD:

Block bore diameter	5.320-5.321
Compression ratio	
Head No. 10A4227	7.5:1
Compression pressure	
Head No. 10A4227	160-180 PSI

### CRANKSHAFT: MATERIAL - Tufftrided, Forged Steel

#### Bearings

Number	4
Diameter	3.499-3.498"
Clearance	.0033-.0053"
End Play	.008-.012"
Main bearing bolt torque	
5/8"	140 ft-lbs
3/4"	240 ft-lbs

### CONNECTING RODS:

Material	Drop-forged steel, heat-treated
Style	Forged I-section
Journal Diameter	3.248-3.249"
Bearing Clearance	.0026-.0046"
End Play	.008-.013"
Bolt Torque (lubricated bolts)	35-40 ft-lbs

### PISTONS AND RINGS:

Piston diameter (90° from pin at bottom)	5.312-5.313"
Ring gap	.017-.032"
Ring clearance in groove (Top, 2nd, and 3rd)	.0025-.0045"

## SPECIFICATIONS

### PISTON PINS:

Size and type . . . . . 1-3/4" D x 4-1/2", full floating, .0015" clearance, lubricated  
 Pin fit . . . . . @70° F.

### VALVES:

Clearance  
 Intake cold . . . . . .012"  
 Intake warm . . . . . .010"  
 Exhaust cold . . . . . .028"  
 Exhaust warm . . . . . .025"  
 Face-to-seat angle  
 Intake . . . . . 29°  
 Exhaust . . . . . 29°  
 Seat Angle  
 Intake . . . . . 30°  
 Exhaust . . . . . 30°  
 Stem diameter . . . . . .497-.496"  
 Stem-to-guide clearance . . . . . .0015-.0035"  
 Guide bore diameter  
 Finished - (precision reamed) . . . . . .499-.500  
 Semi-finished - Ream to . . . . . .499-.500

### SPARK PLUGS:

Gap . . . . . .015"  
 Torque . . . . . 35 ft-lbs

### ENGINE LUBRICATING SYSTEM:

Oil pump capacity . . . . . 17.5 GPM, 50 PSI @ 1800 RPM  
 Crankcase capacity  
 Standard base pan w/out spin-on filters . . . . . 12 quarts  
 Standard base pan w/spin-on filters . . . . . 14 quarts  
 Heat exchanger base pan w/out by-pass filters . . . . . 18 quarts  
 Heat exchanger base pan w/by-pass filters . . . . . 24 quarts

### POWER TAKE-OFF:

Clutch . . . . . Standard - 14" Double disc  
 Shaft . . . . . 3" diameter with 3/8" x 3/4" keyway  
 Flywheel housing . . . . . SAE No. 1 flange

### MISCELLANEOUS:

Air cleaner . . . . . Oil bath-standard  
 . . . . . Dry type-optional  
 Electric starting equipment . . . . . 12 volt, Delco-Remy  
 Recommended battery equipment . . . . . Three 12 volt, 72 amp hour  
 Distributor  
 Dwell angle . . . . . 31-37°  
 Breaker point opening . . . . . .018-.024"  
 Breaker point spring tension . . . . . 19-23 oz.

### Timing

Natural Gas 10A4227 heads . . . . . 20° BTDC  
 LPGAS 10A4227 Heads . . . . . 13° BTDC

# LUBRICATION

## ENGINE OIL

### 1. INITIAL BREAK-IN AND OIL DRAIN

Drain break-in oil after first 150 hours of operation.

Continuous heavy loads during break-in period should be avoided to prevent overheating and possible piston scuffing. Conversely, operation at very light loads should also be avoided as cylinder walls may "glaze" preventing ring seating. If glazing occurs, break-in oil may be left in for an additional 50 hours to complete the break-in process.

### 2. REPLACEMENT OIL SPECIFICATIONS

Oil recommendations must be followed. Oils are compounded after a long series of tests, both in the laboratory and in the field. They meet and exceed all applicable military and commercial specifications. Oil designed for a specific type of engine is better than oil that attempts to meet the requirements of all engines. Oils for THDB00-6A power units are available from your dealer. Use "low ash" oils specifically recommended for LP and natural gas service. Maximum ash level is 0.4%, with 0.1% preferred.

If engine is shut down for extended periods, use oil identified as API class SD or CC.

### 3. Drain Periods

Drain oil when it is at operating temperature.

#### a. Normal Operation:

Effective life of lubricating oils depends on engine type, operating conditions, and oil characteristics. For normal conditions using recommended oils, following drain periods apply:

#### NATURAL GAS:

- 500 hours with regular base pan
- 500 hours with heat exchanger base pan

b. Abnormal Conditions: Oil should be changed at shorter intervals if engine is subjected to abnormal conditions such as extreme dust, short running periods in cold weather, heavy duty operation in hot weather, or operation on "sour gas" fuel.

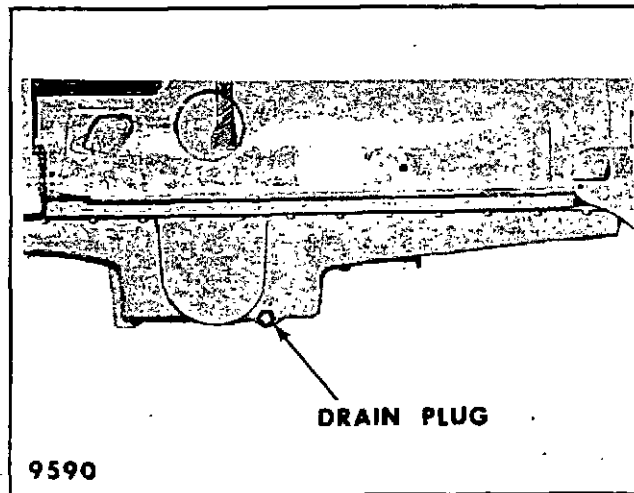


Fig. 1. Crankcase Drain Plug (Standard Pan).

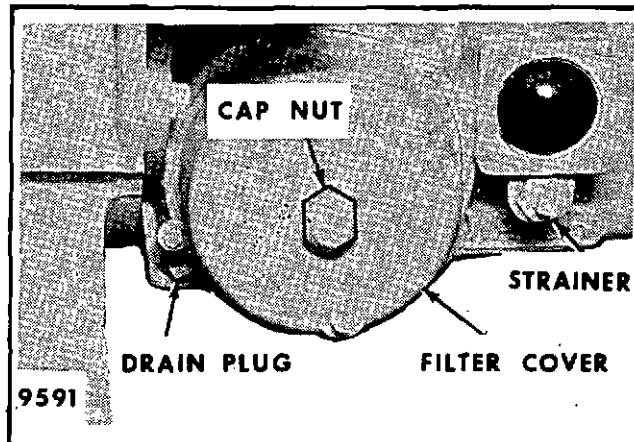


Fig. 2. Crankcase Drain Plug (Heat Exchanger Base Pan)

# LUBRICATION

## 4. Viscosity

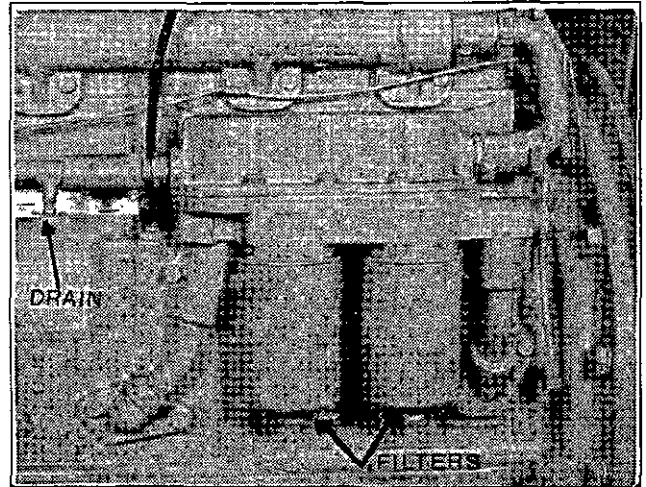
Recommended viscosity values are based on the lowest anticipated atmospheric temperature for winter operation and the highest expected temperature for summer operation. Recommended SAE viscosities are:

<u>Lowest Temperature</u>	<u>Highest Temperature</u>	<u>SAE Viscosity</u>
Below 10°		10 or 10W30
10° to 32°		20
	Above 32°	30

## SPIN ON OIL FILTERS

Change oil filters when break-in oil is drained and thereafter each time crankcase oil is changed. If engine is operating in adverse conditions and oil is changed more often, change filters at same time.

When installing new filters, spread a film of engine oil on seal ring, turn filter onto stud until seal contacts filter base, then turn filter one-half turn further. Fig. 3 shows oil filters installed. Check for oil leaks after engine is re-started.



*Fig. 3. Cooler Drain & Spin-on Filters*

## LUBRICATION CHART

PAGE	ITEM	LUBE POINTS	150 HOURS	250 HOURS	500 HOURS	500 HOURS	1000 HOURS
4	Engine Crankcase - Regular Base Pan	1			✓		
4	Engine Crankcase - Heat Exchanger Base Pan	1				✓	
5	Spin-on Filters	2			R		
6	Bypass Filter Elements	2				R	
8	Starting Motor	1		✓			
9	Fan Hub	1					✓
9	Clutch & Power Shaft	3	✓				
9	Distributor	2	- Per Discussion -				
6, 7	Oil Bath Air Cleaner	1	- Per Discussion -				
8	Crankcase Breather	1	- Per Discussion -				

✓ Check, service or add oil if necessary

✓ Drain and refill with recommended lubricant

R Replace with a GENUINE MINNEAPOLIS - MOLINE ENGINE COMPANY PART

✓ Lubricate with pressure gun using multi-purpose grease

Lubrication chart items are numbered to correspond to page on which a discussion appears concerning lubrication procedure for each item. Refer to discussion for further information.

## LUBRICATION

### BY-PASS OIL FILTERS

(Used with heat exchanger base pan)

Change by-pass oil filter cartridges in heat exchanger base pan when break-in oil is drained and thereafter every 1500 hours of operation (every 3rd oil change).

Change filter cartridges sooner if engine oil appears unusually dirty before recommended filter change interval is reached.

Remove cap nut (Fig. 2) and cover. Remove centering nut from stud and withdraw cartridges. Wipe filter shell and cover.

Install new cartridges, being sure inner element slides in place on centering spacer. Secure cartridges with centering nut. Install cover, using a new gasket and tighten cap nut securely.

If unit is equipped with an automatic oil level control, disconnect oil line and remove strainer. Wash strainer in solvent each time filters are changed.

### AIR CLEANER

Regular air cleaner service is one of the most important preventative maintenance procedures that can be performed, yet is one that is often neglected.

**A NEW AIR CLEANER, PROPERLY SERVICED, IS ALMOST 100% EFFICIENT. TO MAINTAIN THIS HIGH RATE OF EFFICIENCY, SERVICE AIR CLEANER REGULARLY.**

Since engine uses about 25,000 cubic feet of air every hour of operation, a neglected air cleaner may cause severe engine damage by permitting dust and dirt to enter cylinders.

Dust and dirt mix with oil on cylinder walls, forming a grinding compound. As oil circulates through engine, a grinding action takes place where oil lubricating qualities are most needed.

**UNDER DIRTY OPERATING CONDITIONS WITH NO AIR CLEANER, AN ENGINE COULD REQUIRE A COMPLETE OVERHAUL IN LESS THAN 15 HOURS OF OPERATION.**

Oil bath air cleaner (Fig. 4) is standard equipment. Dry-type air cleaner (Fig. 5) is available as optional equipment.

Specific intervals for servicing air cleaner are determined by conditions under which unit is being operated.

To determine proper interval for servicing air cleaner, inspect oil in oil cup or dust accumulation in dry air cleaner dust cup at least once daily until a satisfactory service interval has been determined.

Clean oil cups and renew oil in oil bath air cleaner any time 1/2-inch of dirt has collected in bottom of either cup. Operating engine with 1/2-inch or more of residue in oil cups may cause excessive engine wear.

Remove and empty dust collector cup in dry air cleaner BEFORE dust and dirt has accumulated to within 1/2-inch of slot at top of cup. When reinstalling cup, be sure arrows on bottom are pointing up.

**IMPORTANT: DO NOT USE OIL IN DRY AIR CLEANER DUST CUP.**

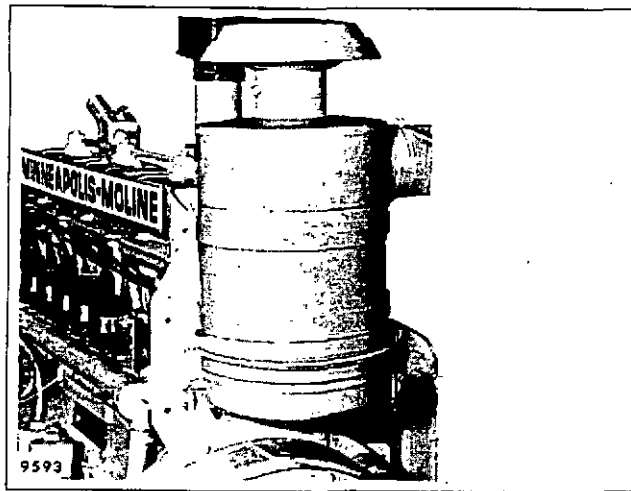


Fig. 4. Oil Bath Air Cleaner

After proper air cleaner service interval has been determined, follow a regular schedule of service to maintain air cleaner at maximum efficiency.

**IMPORTANT: MAINTAIN AIR-TIGHT CONNECTIONS BETWEEN AIR CLEANER AND CARBURETOR. REPLACE RUPTURED OR DAMAGED CONNECTOR HOSES IMMEDIATELY.**

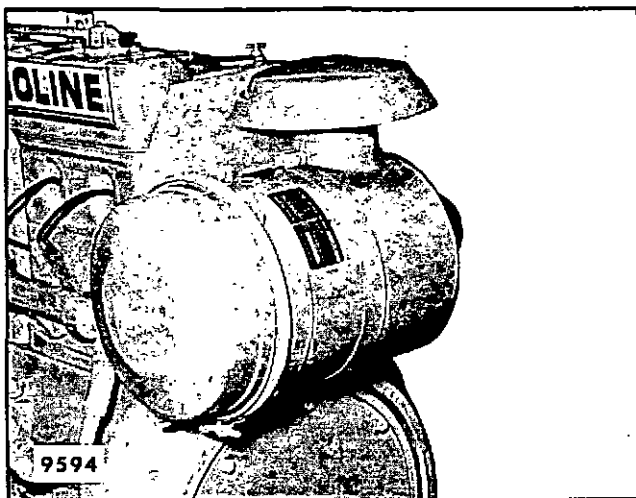


Fig. 5. Dry Element Air Cleaner

### OIL BATH AIR CLEANER

To service oil bath air cleaner, remove oil cup assembly from air cleaner and remove screen and inner cup from outer cup (Fig. 6). Wash all parts in solvent (clean kerosene or diesel fuel) and apply compressed air to screen to blow out sediment.

Remove cap from intake tube and remove accumulated dirt and foreign material from screen. Inspect center tube and clean with a suitable swab dipped in solvent if tube is dirty. Once annually, remove entire air cleaner and soak in solvent to clean inner screen. Do not attempt to remove inner screen to clean.

Reassemble inner cup to outer cup and refill both cups with clean engine oil to indicated level. Use SAE 10 oil for temperatures below freezing and SAE 30 oil for temperatures above freezing. Be sure end clamps are securely tightened.

**IMPORTANT: DO NOT OVER-FILL OIL CUPS. TO OBTAIN MAXIMUM PERFORMANCE FROM AIR CLEANER, MAINTAIN OIL AT LEVEL MARK. OVER-FILLING MAY ALLOW EXCESS OIL AND DIRT TO BE PULLED INTO ENGINE.**

### DRY ELEMENT AIR CLEANER

In addition to regular servicing of dust cup, filter element must be removed and cleaned occasionally, depending on operating conditions.

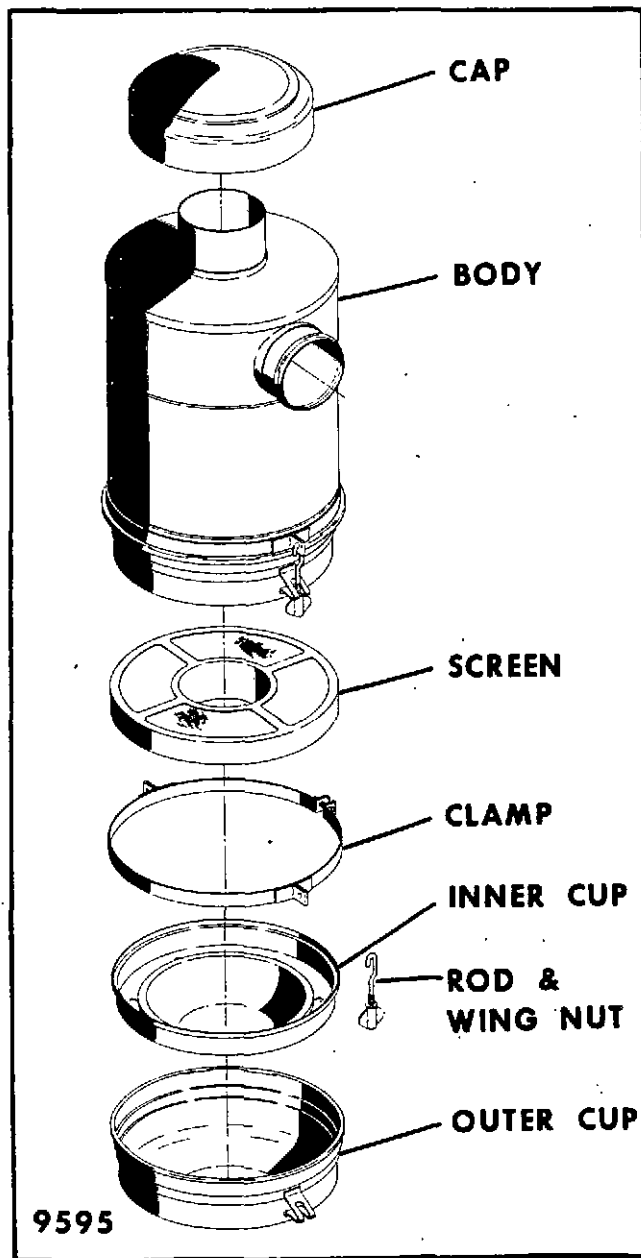


Fig. 6. Oil Bath Air Cleaner - Exploded View

To remove element, remove dust cup (Fig. 7). Remove wing screw securing element in cleaner body.

Direct clean, dry compressed air up and down pleats on the clean air side (inside) of element. **DO NOT** tap element against a solid surface as element is not designed to withstand this type of abuse.

**CAUTION: AIR PRESSURE AT NOZZLE MUST NOT EXCEED 100 PSI. DO NOT HOLD NOZZLE TOO CLOSE. APPLY AIR AT AN ANGLE TO ELEMENT.**

## LUBRICATION

If filter element is laden with dirt or soot that does not come off with compressed air, wash element in cleaning compound (10P2704). Follow instructions on package when mixing solution. Soak element for 15 minutes, then, rinse thoroughly with clean, running water.

Allow element to air dry. Before installation, **DO NOT ATTEMPT TO DRY ELEMENT WITH COMPRESSED AIR, AS ELEMENT WILL RUPTURE. DO NOT USE A LIGHT TO DRY ELEMENT – HEAT MAY BURN THE PAPER.**

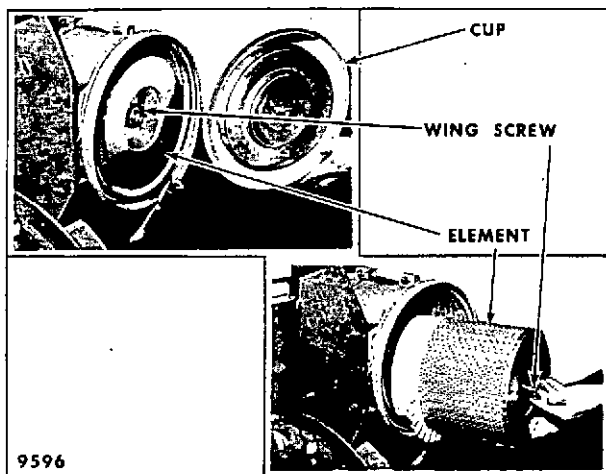


Fig. 7. Dry Element Air Cleaner Servicing

After cleaning, inspect element for damage by placing a bright light inside. The slightest rupture necessitates replacing element. Element should be replaced after 6 cleanings, or annually, whichever comes first.

Wipe out air cleaner body before reinstalling element. Tighten element retaining screw securely. Finger tightening is adequate – do not use a wrench or pliers.

Renew seal ring for dust cup, if damaged, and reinstall cup. Cup must be positioned as indicated by arrows and word "TOP".

### CRANKCASE BREATHER

Service crankcase breather (Fig. 8) each time air cleaner is serviced. Remove element and cup and dump out old oil. Clean cup and refill to level mark with clean engine oil. Clean element in solvent and shake out solvent before reinstalling. Replace gasket if hard or cracked.

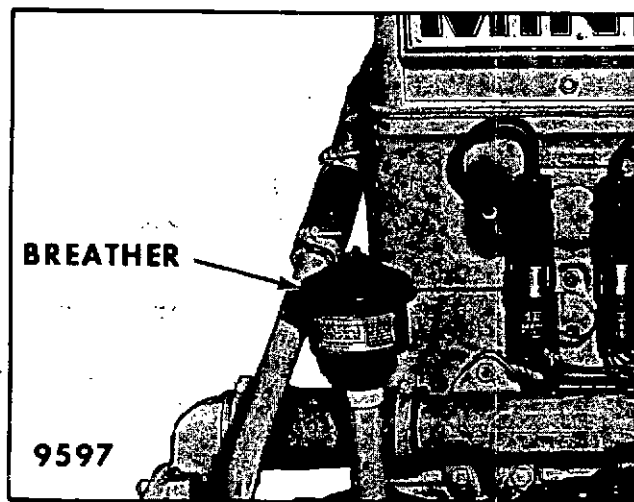


Fig. 8. Crankcase Breather

### STARTING MOTOR

Remove slotted plug from starting motor and apply 8 to 10 drops of light engine oil every 250 hours of operation.

### AIR STARTING MOTOR

Use filter (Fig. 9) in starter air supply line to keep abrasives and moisture out of starter. **DO NOT OPERATE STARTER ON AIR PRESSURE GREATER THAN 150 PSI!**

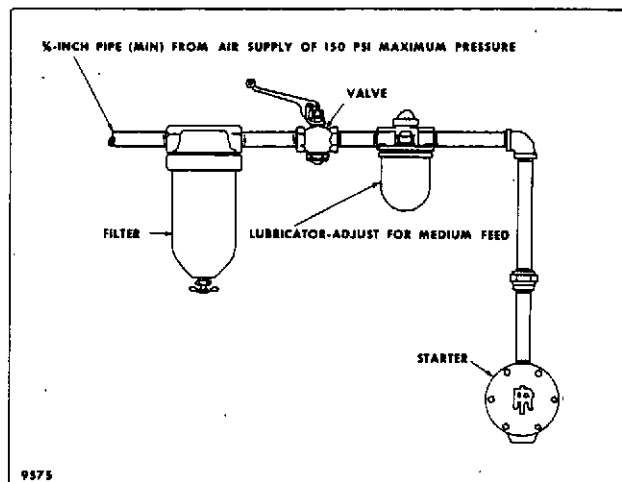


Fig. 9. Air Starting Motor Filter & Lubricator

## LUBRICATION

If an in-line lubricator is not used in air supply line, check lubricant in end cover periodically and maintain oil level at hex plug (Fig. 10). Use SAE 20, high quality motor oil for refilling oil chamber.

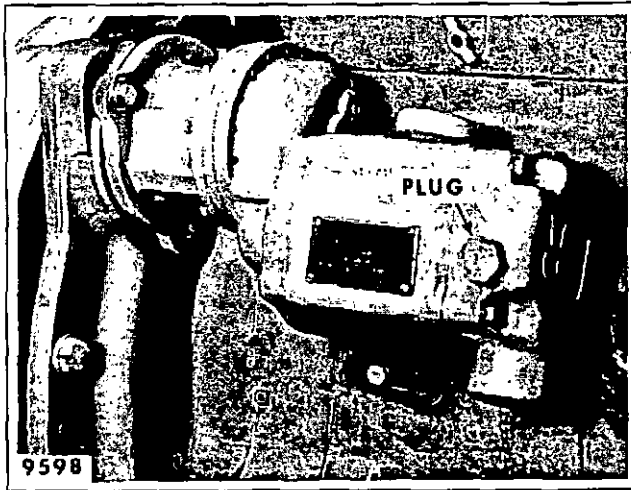


Fig. 10. Air Starting Motor

### DISTRIBUTOR

Apply a trace of high-quality ball bearing lubricant to breaker cam every 250 hours of operation. Also, place two drops of light engine oil on felt wick under rotor.

Bendix breakerless distributor requires no lubrication.

### FAN HUB

At initial engine servicing and after each 1000 hours of operation, turn fan hub so that vent plug and grease fitting are straight to either side (Fig. 11). Remove slotted vent plug and inject lithium base grease through grease fitting until grease is visible at vent plug opening. **DO NOT OVERFILL** – some air space must remain. Reinstall vent plug, tightening it securely.

Once annually, remove, disassemble, clean, and repack spindle bearings, using lithium base grease. Refer to Maintenance Section for disassembly and reassembly procedure.

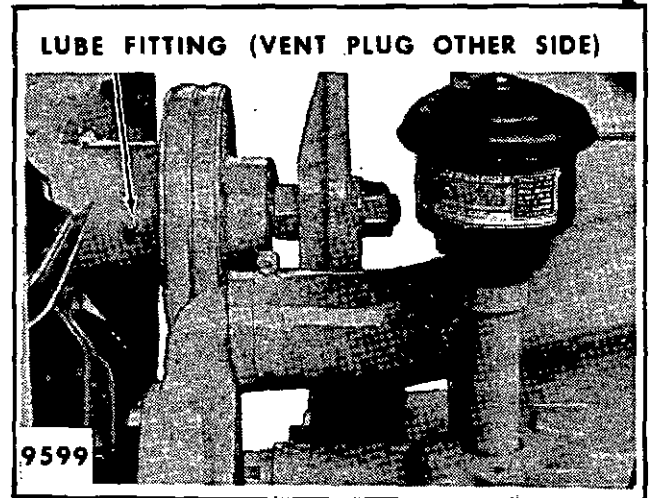


Fig. 11. Fan Hub Lube Fitting

### CLUTCH AND POWER SHAFT

Lubricate clutch throwout collar, power shaft bearing and pilot bearing every 150 hours of operation, using an automotive lithium base grease. **DO NOT** apply excess grease to throwout collar.

Bump crankshaft rearward after lubricating pilot bearing. Do not over-lubricate and avoid using heavy viscosity grease. These procedures will relieve forward thrust on crankshaft which could result in premature rear main or thrust bearing failure.

If fitting for pilot bearing in end of shaft is inaccessible, move fitting to alternate location as shown in Fig. 12. Install plug in end of shaft.

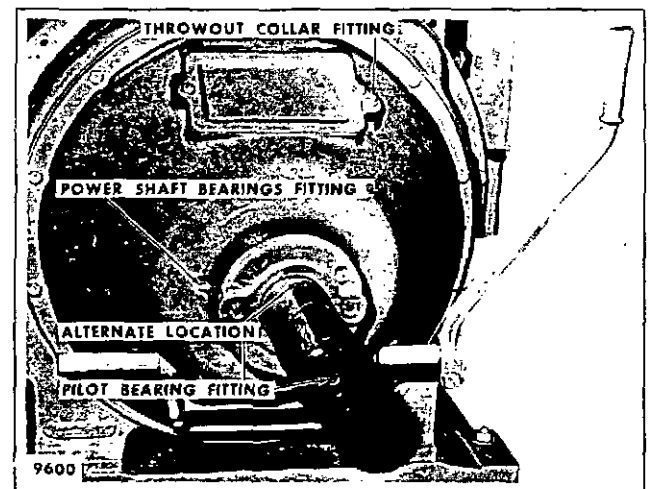


Fig. 12. Clutch & Power Shaft

# CONTROLS



USE CAUTION WHEN ENGAGING POWER SHAFT! KEEP BODY AND LOOSE CLOTHING CLEAR OF ALL MOVING PARTS. OBTAIN AND INSTALL SHIELDS ON ALL MOVING PARTS.

## INSTRUMENT PANEL --

Is enclosed and can be mounted on either side of power unit.

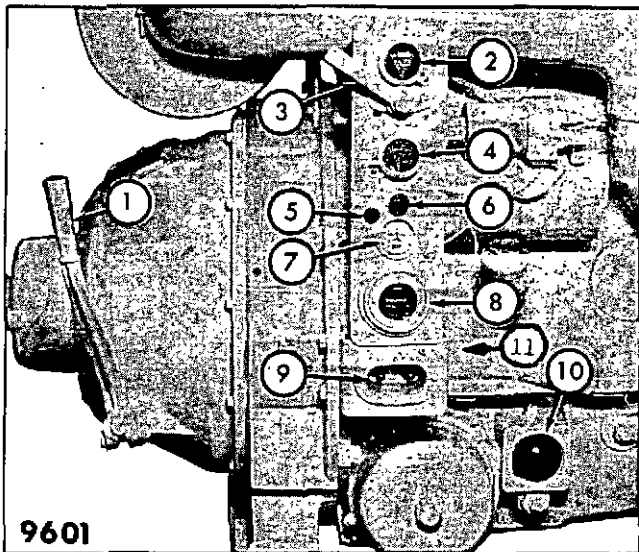


Fig. 13. Instrument Panel

- |                       |                                 |
|-----------------------|---------------------------------|
| 1. Clutch lever       | 6. Ignition switch              |
| 2. Temperature gauge  | 7. Ammeter                      |
| 3. Throttle lever     | 8. Tachometer                   |
| 4. Oil pressure gauge | 9. Electric starting receptacle |
| 5. Starter button     | 10. Automatic oil level control |
|                       | 11. Ignition cut-out relay      |

## TEMPERATURE GAUGE --

Indicates temperature of cooling fluid. Thermostats should maintain coolant temperature at approximately 185° F. If gauge indicates wide variations from this figure (after a warm-up period), stop engine and locate and correct trouble before placing engine under load or running it for long periods of time.

## TEMPERATURE GAUGE AND SAFETY CUT-OUT --

Indicates temperature of cooling fluid and also shuts off engine any time fluid heats beyond a safe limit.

Contact screw in gauge should be set so that engine will shut off if fluid temperature exceeds 210 degrees F.

As engine cools, needle will move away from contact screw and engine can be restarted (after trouble has been corrected).

Since cut-out may not shut off engine if sudden coolant loss occurs, use of a low-level shut down in addition to cut-out is recommended.

## CONTROLS

### OIL PRESSURE GAUGE --

Indicates oil pressure in engine lubrication system. In case of pressure failure, stop engine immediately and locate *cause of failure before restarting*. An oil pressure of 40 to 50 pounds should be maintained when engine is at operating temperature and running at 1800 rpm.

If there is a sudden drop or loss of pressure, stop engine immediately. Do not restart until trouble has been located and corrected.

### OIL PRESSURE GAUGE AND SAFETY CUT-OUT --

Indicates engine oil pressure, and also will shut off engine if the oil pressure drops below a safe limit.

If the cut-out stops engine, be sure to locate and correct trouble before restarting.

Contact screw in gauge should be set to shut off engine if pressure drops below 18 pounds.

Before starting a unit equipped with magneto ignition, depress button on gauge so lockout holds needle away from contact screw. Needle should clear contact screw by about 1/32-inch. When engine starts and oil pressure builds up, be sure lockout drops down so needle can touch contact screw if pressure drops.

Gauge reset button for units with distributor ignition is on magnetic switch. Button must be held in until engine oil pressure builds up sufficiently to separate gauge needle and contact point.

### START BUTTON --

Starting motor is activated by pushing start button. Release button as soon as engine starts. Never re-engage starter until engine has come to a complete stop. Engaging starter while engine is turning will cause undue strain on starting motor housing. Never operate starting motor continuously for more than 10 or 15 seconds.

### THROTTLE LEVER --

Will allow engine to operate at idle speed, or at speed determined by governor setting. It should not be used to adjust engine speed. If speed adjustments are desired, governor setting must be changed.

### CLUTCH LEVER --



USE CAUTION

Is used to engage power shaft. When lever is forward, clutch is engaged and power shaft will turn. When lever is pulled rearward, clutch is disengaged and motion will stop.

Lever may be mounted on either end of cross shaft, whichever position is more accessible.

### ELECTRIC STARTING RECEPTACLE --

Is available as extra equipment and can be installed in knockout plate just below instrument panel.

On multiple unit installations, this feature eliminates need for individual batteries and generators. (Unit must be equipped with magneto ignition to use starting receptacle.)

### IGNITION SWITCH --

Is a "push-pull" switch. On units equipped with distributor ignition, switch is on when it is pulled out. On units equipped with magneto ignition, switch is on when button is pushed in.

### AMMETER --

Indicates activity of electrical system. If needle indicates a continuous discharge when engine is operating at normal speed, locate and correct cause of trouble. Normally, needle will be slightly to positive side of "O" when engine is running at normal speed.

### IGNITION CUT-OUT RELAY ---

Reset button pops out when water temperature or oil pressure gauge signals a shutdown. Used only on units with Altronic ignition. Reset button must be pressed in before restarting.

### TURBOCHARGER ---

Turbocharger operation and boost pressure control are automatic. Before operating engine please review information on pages 46-A through 46-E.

## CONTROLS

---

### MECHANICAL TACHOMETER (OPTIONAL) --

Registers engine revolutions per minute and hours of engine operation. Full hours of operation register at 1800 rpm, partial hours register at reduced rpm.

### (1) AUTOMATIC OIL LEVEL CONTROL (OPTIONAL) --

Can be used only on units equipped with a heat exchanger base pan. Oil level control regulates oil level in crankcase when a constant supply of oil, such as a large drum, is used. Oil is fed into crankcase by gravity from drum, and when it reaches a predetermined level, control shuts off flow.

Float should be adjusted by means of adjusting nuts so that oil level will be maintained at full mark on dipstick.

Each time drum is changed or refilled, clean filter screen located in base of control.

### (1) SIGHT OIL GAUGE --

Level and condition of crankcase oil can be checked through sight gauge.

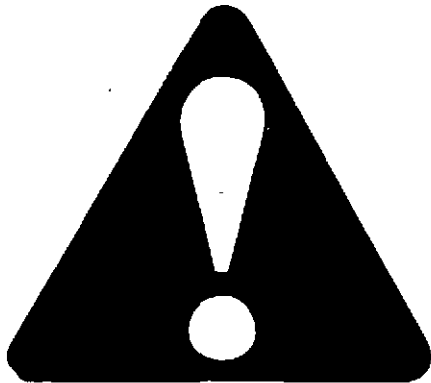
### VACUUM-PRESSURE GAUGE---(OPTIONAL)

Provides a means of checking intake manifold vacuum or pressure. To protect gauge, close valve after reading has been checked.

### OVERSPEED SHUT-OFF --

Will shut down engine if engine speed exceeds RPM setting to which shut-off is adjusted.

(1) Must be vented to crankcase - position vent tube to avoid trapping oil which will result in erroneous readings and operation.



**THINK SAFE**

**WORK SAFE**

**BE SAFE**

# OPERATION

## PRE-STARTING CHECKS

If unit has been idle for an extended period of time, recommended practice is to remove spark plugs and pour a liberal amount of clean engine oil into cylinders to provide initial lubrication. Turn engine over several revolutions to distribute oil on cylinder walls.

Before installing spark plugs, clean and check gap. Correct gap is .015". Tighten plugs to 40-45 ft-lbs.

Check oil level in crankcase to see that oil is up to specified mark on dipstick. If engine has break-in oil in crankcase and level is low, use SAE 30 Mil-L-2104B oil to bring oil up to specified level.

If engine has an oil bath air cleaner, check to see that oil in cups is at specified level. Check to see that oil in crankcase breather is at specified level.

Be sure coolant in cooling system is up to proper level. Use only permanent type anti-freeze in system if temperatures are expected to be below freezing.

Refer to appropriate heading, depending on fuel being used, for information on carburetor adjustments and fuel pressures before attempting to start engine. Additionally, see returning unit to service after storage. Page 48.

**NOTE: TORQUE CYLINDER HEAD STUD NUTS AFTER FIRST 10 HOURS OF OPERATION. SEE FIG. 47 FOR CORRECT TORQUE SEQUENCE.**

## ENGINE OIL PRESSURE

Normal oil pressure is 40 to 50 pounds with engine at operating temperature and running at 1800 rpm. Lower oil pressures at lower speeds are normal.

Unit does not have an external adjustment for changing oil pressure. Oil pressure is set at factory.

If after unit has been in operation for some time it becomes necessary to change oil pressure, base pan must be removed to gain access to pressure regulator parts.

With base pan removed, remove snap ring from bore in pump and remove spring retainer and spring. Add or remove shims between spring and regulator piston. Each shim will alter oil pressure approximately 3 pounds.

## COOLING SYSTEM

Depending on cooling equipment installed, unit may have following system drains in addition to 3 block drains:

Radiator .....	2
Oil Cooler .....	1
Heat Exchanger Base Pan .....	1
Water Cooled Manifolds .....	3
LP Gas Converter .....	1

When filling cooling system of an engine equipped with water cooled manifolds, open taps on top of manifolds to permit air to escape. A tap is also provided on top of thermostat housing to release air from system when filling.

Use clean soft water together with a suitable rust inhibitor in cooling system if there is no possibility of freezing. Avoid use of hard or dirty water, as it can cause formation of scale and rust in the system, resulting in possible engine overheating.

If possibility of freezing exists, use a solution of permanent type anti-freeze in the cooling system. **DO NOT USE ALCOHOL SOLUTIONS.**

**DO NOT**, under any circumstances, start engine with an empty cooling system and then fill system while engine is running. This is dangerous practice and may result in serious damage to engine from overheating.

Pressure type cooling system relieves at 7 pounds pressure. Be sure radiator cap is on tight when engine is in operation.



**When removing radiator cap, turn it to the first notch to allow pressure to relieve.**

## OPERATION

### VENTILATION

Power unit equipped with a radiator type system has ample capacity for normal operating conditions. When a power unit is installed in a building or cab, adequate ventilation must be provided so that radiator can be supplied with fresh air in a sufficient quantity to enable cooling system to operate efficiently.

It is necessary to thoroughly ventilate engine room and to install unit so there will be no restriction in flow of air to radiator. An opening to outside in front of radiator is desirable. Openings in building wall or cab, and ceiling ventilation should be provided in order to carry off engine heat and fumes.

Exhaust must be piped to outside of building as directly as possible, and pipe inside building insulated with air cell asbestos or an equivalent product, unless heat is desired in building. Arrange outside end of exhaust pipe or muffler so rain cannot enter.

Side covers should always be removed when engine is being operated inside a building.

### NATURAL GAS FUEL

Since natural gas fuel may contain impurities such as rust, scale, and dirt, it is extremely important that fuel be properly filtered before it enters engine.

Size and type of filter or scrubber is contingent on local fuel conditions and horsepower output of engine. Natural gas filtering or scrubbing equipment must be installed in fuel supply line ahead of all pressure regulating equipment.

A scrubber made from a 55 gallon drum, using SAE 10 or 20 non-detergent engine lubricating oil, may be adequate for removing impurities from fuel.

**IMPORTANT: CHECK LOCAL REGULATIONS CONCERNING INSTALLATION OF NATURAL GAS FUEL EQUIPMENT.**

If a fine filter is being used to remove impurities from fuel, be sure to use one of adequate size to allow minimum amount of fuel to flow freely to engine. Minimum fuel requirement for the THD800 power unit, based on 1000 BTU fuel and maximum horsepower output, is 3.7 cubic feet per minute.

Some natural gas fuels contain high amounts of sulphur, although basic constituent is methane. Sulphur content limit for power units is 5 grains per 100 cubic feet of fuel.

If sulphur content in fuel is in excess of 5 grains per 100 cubic feet, a commercial neutralizing type scrubber must be installed.

If an Impco carburetor is being used, a pressure reducing valve must be installed in fuel supply line ahead of carburetor to reduce fuel pressure to 3 ounces per square inch. When using a pressure reducing valve, line pressure regulator may be set as high as 14 inches of water column to overcome line loss of pressure to engine. Fuel pressure to carburetor can be checked at test plug location shown in Fig. 39.

Fuel outlet pressure from Impco pressure reducing valve must be checked with engine operating at idle speed. Fuel outlet pressure may drop as low as atmospheric pressure with engine at full load; however, this is immaterial as long as carburetor power adjustment is still effective.

If fuel pressure to Impco carburetor is not as specified, remove slotted plug from top of regulator and turn adjusting screw as necessary to obtain specified pressure.

Since these gas pressures are quite low, they are often referred to as inches of water or water column.

Water column method is generally simplest way to check gas pressures in field.

To check fuel pressure by water column method, connect a rubber tube to test port in regulator or pressure reducing valve, and place other end of tube in a container of water.

With engine operating as specified previously, and gas flowing through tube, immerse end of tube straight down into water until gas stops bubbling from tube. Distance from end of tube to surface of water is inches of water or water column.

To convert inches of water to ounces, multiply the number of inches by .578. The result will be gas pressure in ounces.

EXAMPLE: 8" x .578 = 4.624 ounces

## OPERATION

### STARTING NATURAL GAS ENGINE (IMPCO FUEL EQUIPMENT)

Adjust position of load mixture valve in fuel intake so it is between the L and R positions for initial starting (Fig. 14). Final adjustment of load mixture valve must be made while engine is operating under full load. Adjustment of load mixture valve has no effect at fast idle or light load.

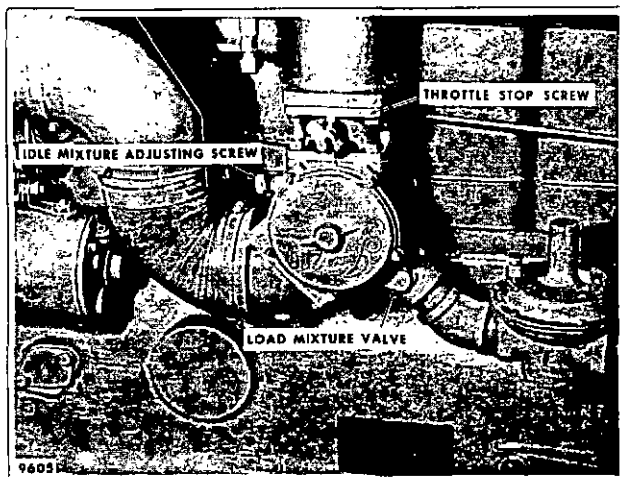


Fig. 14. Natural Gas Equipment Adjustments

NOTE: Fig.14 is the HD800A-6A installation. Adjustments are similar on the THD800-6A which has the mixing chamber mounted on the turbocharger inlet.

Turn idle mixture adjusting screw all the way in, then open it 4 to 5 turns.

Disengage clutch, open throttle about half way, and start engine. Close throttle so engine runs at idle speed and adjust idle mixture screw to obtain smoothest idle.

If engine idle speed is too high or too low, adjust throttle stop screw on inner end of throttle shaft to obtain idle speed of 600 rpm.

Operate engine until it is thoroughly warmed up; then, engage clutch to place engine under load. Re-adjust load mixture valve to obtain maximum engine power.

**WARNING!** Use of HD-5 LPG in a THD800-6A may cause serious engine damage. Power rating of the engine may have to be reduced and ignition timing retarded to prevent possible piston damage caused by detonation. Consult your distributor or dealer before operating engine on this fuel.

### LP GAS FUEL

LP Gas is a liquefied petroleum gas, composed of a mixture of propane and butane and other gases of similar nature in smaller amounts. LP Gas is transported and stored as a liquid under pressure but burned in engine as a true gas.

Fuel companies supplying LP Gas mix or blend fuel with varying percentages of propane and butane to meet fuel specification designated as HD-5. Fuel mixture will also depend on existing climatic conditions; however, it must have a minimum of 90 per cent propane to meet HD-5 specification.

LP Gas boils at a very low temperature; therefore, any container used for transporting or storing this fuel must have space to accumulate vapor pressure created by fuel. LP Gas fuel storage tanks must not be filled above 80 per cent level to allow room for vapor pressure.

Consult LP Gas distributor in your community for information on local and state regulations with regard to handling this type of fuel. All plumbing between fuel storage tank and engine must be installed in accordance with approved standards.

A converter (Fig. 15) is used to reduce fuel pressure and vaporize liquid fuel before it enters engine. Since a refrigerant action takes place when fuel is released from fuel tank to converter, heat is applied to converter to prevent fuel temperature from dropping below its vaporization point. Hot water from engine cooling system is circulated through converter to provide necessary heat.

LP Gas liquid fuel enters converter at tank pressure and passes through high pressure valve where fuel pressure is reduced. Liquid fuel is converted to vapor fuel in converter vaporizing chamber and enters low pressure chamber.

Formation of frost or moisture on converter when it is cold indicates that either high or low pressure valves are leaking or that low pressure valve lever is not properly set.

## OPERATION

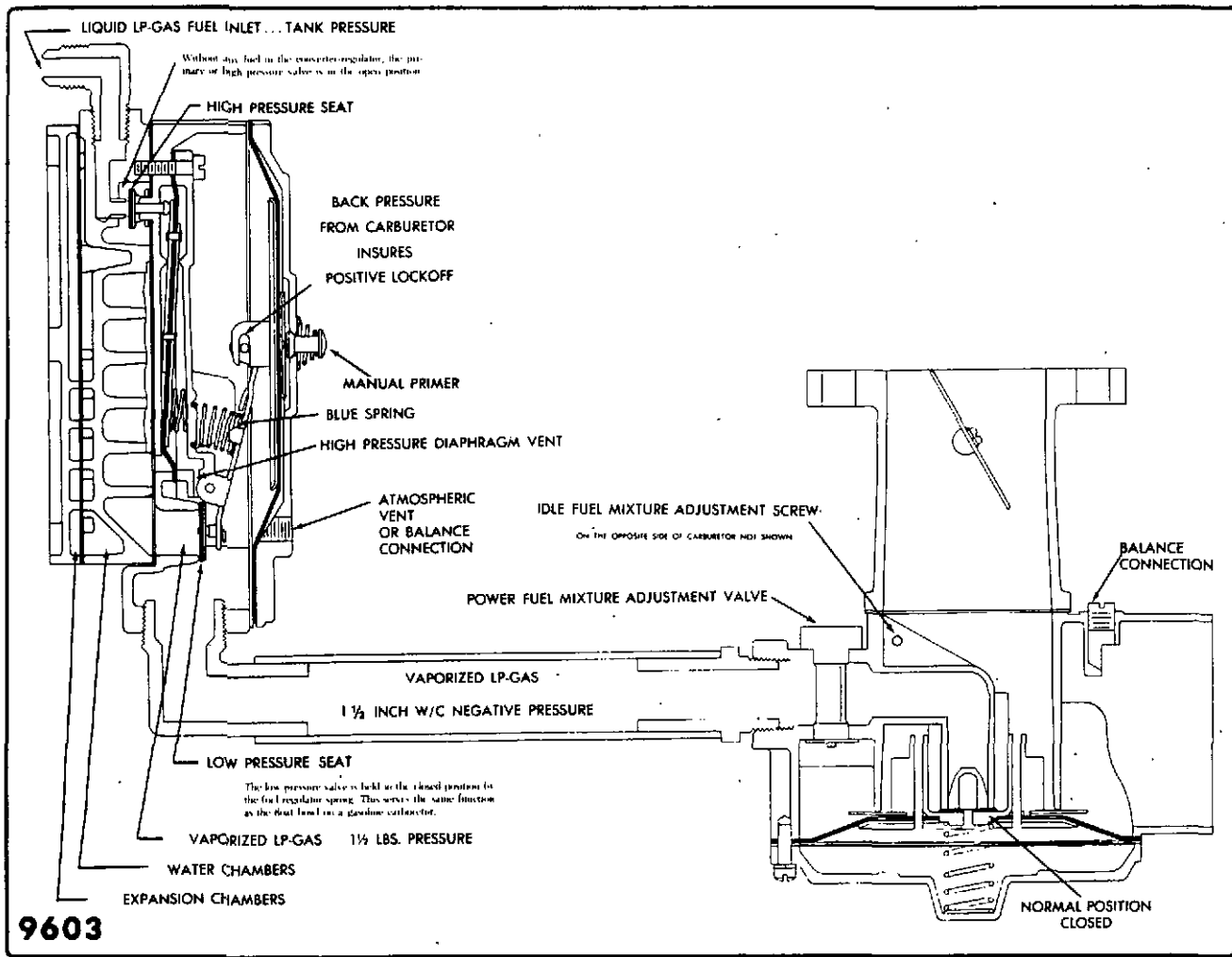


Fig. 15. Converter

### DUAL FUEL CARBURETION – NATURAL AND LP GAS

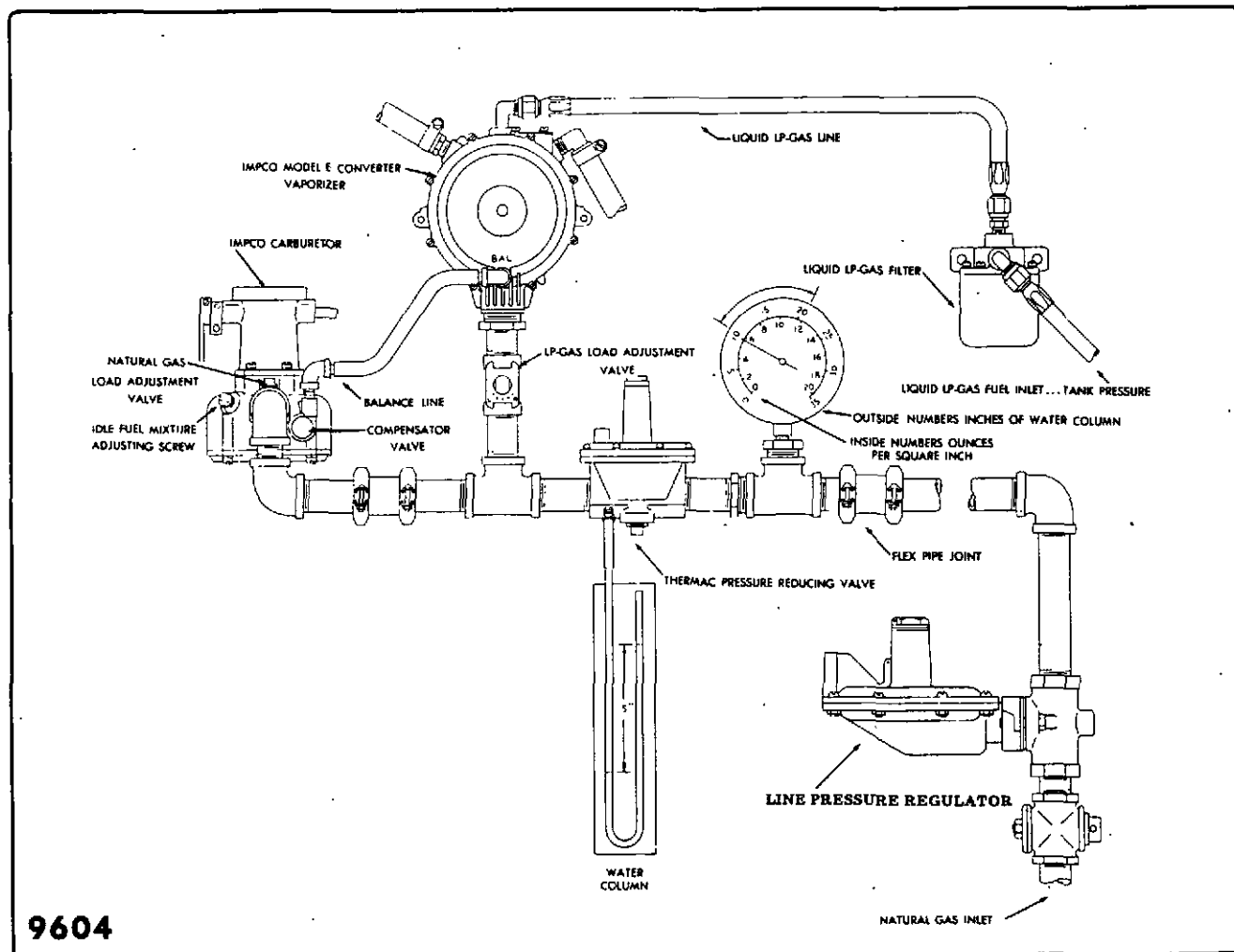
Fig. 16 is a schematic diagram showing use of LP Gas as emergency standby fuel to secure favorable interrupted service rates on natural gas.

Automatic changeover is accomplished by use of a line pressure regulator for natural gas and a converter/vaporizer (vacuum operated) for propane. Difference in pressures compensates for greater BTU value of propane.

During operation on natural gas, a 5" water column pressure exists in common line to carburetor which closes propane vaporizer. Cut-off of natural gas pressure creates a partial vacuum in line and vaporizer opens to admit propane to system.

A separate load adjustment valve in propane line assures correct amount of propane flow for accurate air/fuel ratio. Changeover is entirely automatic with engine in operation:

## OPERATION



9604

*Fig. 16. Dual Fuel Carburetion - Natural & LP-Gas*

### STARTING LP GAS ENGINE (IMPCO FUEL EQUIPMENT)

Adjust position of load mixture valve in fuel intake (Fig. 17) so that it is between L and R positions for initial starting. Final adjustment must be made while engine is operating under full load. Adjustment of load mixture valve has no effect at fast idle or light load.

Turn idle mixture adjusting screw all the way in; then, open it 4 to 5 turns.

Disengage clutch, open throttle half way, and start engine. Use manual priming button on converter to prime fuel system, if necessary, when starting.

Close throttle so that engine runs at idle speed and adjust idle mixture screw to obtain smoothest idle.

If engine idle speed is too high or too low, adjust throttle stop screw on inner end of throttle shaft to obtain an idle speed of 600 rpm.

Operate engine until it is thoroughly warmed up; then, engage clutch to place engine under load. With engine running at full throttle, readjust load mixture valve to obtain maximum engine power.

## OPERATION

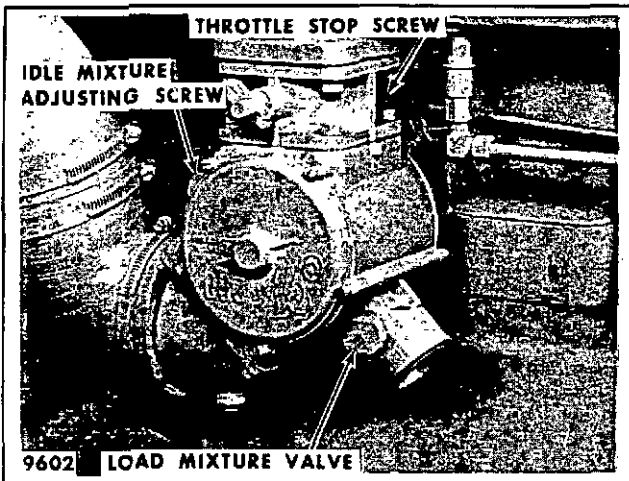


Fig. 17. LP-Gas Equipment Adjustments

### STOPPING ENGINE

Do not stop engine immediately after it has been operating under load. Disengage power shaft and allow engine to idle for a few minutes. This will dissipate excess heat and allow valves to cool gradually.

If engine is operating on LP Gas, shut off liquid valve and open vapor valve several minutes before stopping engine. This will clear fuel line of liquid fuel and provide for easier starting. Close storage tank vapor valve or gas supply shutoff valve. Push in ignition switch.

### GOVERNOR ADJUSTMENTS

Governor limits speed at which engine will operate with throttle fully open. No-load engine speed for 1800 rpm full load operation is (1975 rpm w/standard governor) (1870 rpm w/3-5% regulation governor).

**IMPORTANT: BEFORE ATTEMPTING TO MAKE ANY GOVERNOR ADJUSTMENTS, CHECK TO BE SURE ALL LINKAGES MOVE FREELY WITHOUT BINDING.**



**Be Careful When Making Adjustments.**

If engine speed is not as specified, operate engine at high idle and turn speed adjusting screw (Fig. 18) as necessary to obtain proper no-load speed. Turning screw in will increase engine speed.

With engine running at high idle with no-load, turn in bumper screw until speed increases approximately 10 rpm; then, back screw out 1/8 turn. This will provide a positive stop to limit governor weight travel.

If unit is being operated at low rpm, use same bumper screw adjusting procedure as above, but first obtain lower high idle, no-load rpm.

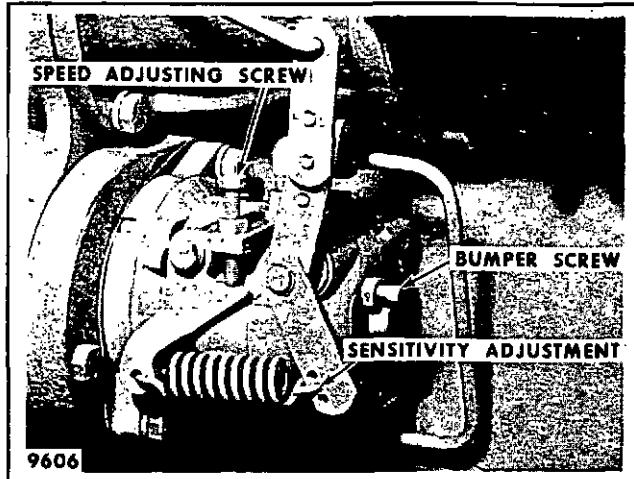


Fig. 18. Governor Adjustments

Governor sensitivity is regulated by holes in sensitivity arm and spring. Governor is most sensitive when spring is connected to upper hole in arm (Fig. 18). For less sensitivity, move spring to center or lower hole.

If governor cannot be adjusted to obtain satisfactory engine performance, refer to page 30 for information on checking lever position and linkages.

### PTO CLUTCH ADJUSTMENT

Clutch, when properly adjusted, will engage with a definite snap when lever is moved over center. As normal wear of clutch plates occurs, effort required to engage clutch will be reduced, necessitating adjustment of clutch.

Remove cover from top of clutch housing, disengage clutch and turn it over until lock ring is exposed (Fig. 19).

Depress lock pin and turn adjusting ring to right until lock pin engages next notch in ring.

## OPERATION

Engage clutch to check adjustment. If clutch engages with a distinct snap, adjustment is satisfactory. If further adjustment is required, turn adjusting ring one more notch. Usually one notch is sufficient adjustment.

If adjustments cannot be made that will result in satisfactory clutch performance, it indicates that clutch parts are worn, necessitating replacement. Procedure to follow for servicing clutch can be found on page 45.

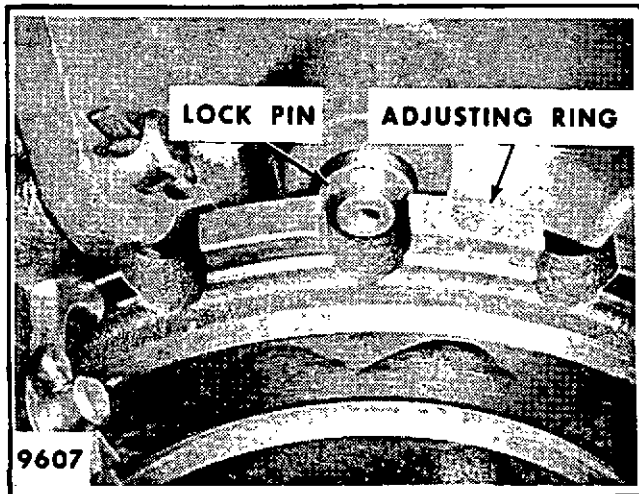


Fig. 19. PTO Clutch Adjustment

### ADJUSTING VALVE CLEARANCES

Check valve clearances at pre-delivery service, at 100 hours and at 300 hour intervals until clearances remain unchanged in two successive checks. Be sure to check valve clearances any time cylinder head stud nuts are torqued.

For greatest accuracy, check and adjust valve clearances. If necessary, while engine is cold. With engine cold, intake valves should have a clearance of .012" and exhaust valves should have a clearance of .028". When engine is at operating temperature, intake valve clearance should be .010" and exhaust valve clearance should be .025".

To check valve clearances, turn engine over until intake valve for No. 1 cylinder closes. This is second valve from front. Then turn engine over one-half turn further until piston in No. 1 cylinder is at top of its compression stroke and both valves are closed. Adjust clearances on valves as specified.

Turn engine over one-third turn further. In this position, No. 5 piston will be at top of its compression stroke and

ready to fire. Turn engine over one-third turn to bring each succeeding piston to top in order of firing (1-5-3-6-2-4) and adjust valve clearances.

### IRRIGATION UNIT COOLING COILS

There are two basic factors to be considered when selecting plumbing size, and selecting or fabricating a heat exchanger for power unit irrigation applications:

1. Heat transfer area of tubing or coil must be sufficient to dissipate heat generated by engine.
2. Flow area (tubing size and length) for engine coolant must be sufficient so as not to cause an excessive pressure drop from engine outlet to pump inlet. (A 2 PSI pressure drop is considered excessive.) Cooling coils must be adequate so that vacuum at inlet is zero inches.

Following conditions are considered to be standard, and information in tables is based on these conditions:

1. Discharge water is assumed to be 50° F., or less.
2. Discharge water velocity is assumed to be 5 ft/sec., or greater.
3. Copper tubing is used for cooling coil or in heat exchanger.
4. Cooling tubing is assumed to run parallel to discharge pipe.
5. Heat rejection, and consequently cooling system design, is based on intermittent horsepower and speed.
6. Pressure differential between engine outlet and pump inlet should not exceed 2 PSI with a minimum of ZERO inches of vacuum at pump inlet.

Use copper tubing cooling coils in discharge because of its excellent heat transfer characteristics and resistance to corrosion. It is also generally good economics to use copper tubing to and from engine to minimize corrosion and avoid periodic replacement.

Use of an expansion tank with 7 pound pressure cap is also recommended to prevent pump cavitation and eliminate resulting hot spots and steam pockets in coolant.

## OPERATION

Table 1 shows required information to construct an efficient cooling system when above standard conditions prevail.

Tubing diameter shown in table is **MINIMUM** recommended diameter of tubing to and from engine. It is also minimum size to be used when tubing in cooling coil is in series.

Maximum equivalent length is maximum permissible length of **ENTIRE** cooling system. It includes cooling tubing and tubing **TO AND FROM** cooling tubing. Each bend causes a resistance to flow which equals a certain length of tubing (see Table 6) and must be deducted from total permissible length to determine maximum equivalent length.

**TABLE 1**

Heat Rejection at Int. HP (BTU/Hr.) .....	675,000
Required Heat Transfer Area (sq. in.) (In cooling coil or exchanger) .....	3,400
Recommended Tubing Diameter and Length in Cooling Water .....	2" - 45' 2-1/2" - 36'
Maximum Equivalent Length in Ft. ....	2" - 70' 2-1/2" - 190'

**CORRECTION FACTORS (FOR APPLICATIONS WHERE ABOVE STANDARD CONDITIONS DO NOT APPLY)**

1. If discharge water temperature is above 50° F., a greater length of cooling tubing is required. Table 2 shows correction factor to use for various water temperatures over 50°. Correction factor must be multiplied by recommended length of cooling tubing in cooling water.

**EXAMPLE:**

THD800-6A unit requires 45 feet of 2 inch tubing when water temperature is 50° or less (from Table 1).

If water temperature is 70°, multiply 45 feet by 1.20 (correction factor from Table 2). System would require 54 feet of 2 inch tubing, rather than 45 feet.

**TABLE 2**

**CORRECTION FACTOR FOR WATER TEMPERATURE**

<u>TEMPERATURE</u>	<u>CORRECTION FACTOR</u>
50° or cooler	NONE
55°	1.04
60°	1.08
65°	1.14
70°	1.20
75°	1.28
80°	1.37
85°	1.45
90°	1.55

2. If discharge water velocity is less than 5 feet per second, additional cooling tubing is required to compensate for reduced flow. Table 3 shows correction factor to be applied to length of cooling tubing shown in Table 1.

**EXAMPLE:**

If discharge pipe diameter is 10", and flow is 1000 GPM, correction factor is 1.10 (from Table 3).

Multiply 1.10 by standard length of cooling tubing shown in Table 1. Result is amount of tubing required when flow is less than 5 ft/sec.

**NOTE: IF WATER TEMPERATURE IS ABOVE 50° F., AND FLOW IS LESS THAN 5 FT/SEC., BOTH CORRECTION FACTORS MUST BE APPLIED.**

## OPERATION

**TABLE 3**

**DISCHARGE WATER VELOCITY**

G.P.M.	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19"	20"	
500				1.25	1.42	1.69	1.85										
1000					1.05	1.10	1.17	1.25	1.42	1.69	1.85						
1500								1.09	1.17	1.25	1.34	1.47	1.63	1.85			
2000									1.05	1.13	1.17	1.25	1.28	1.42	1.57	1.63	
2500											1.05	1.13	1.18	1.25	1.38	1.42	
3000														1.08	1.13	1.17	1.18

**ALL VALUES IN SHADED AREA FALL WITHIN STANDARD SPECIFICATIONS (MORE THAN 5 FT/SEC FLOW) AND DO NOT NEED A CORRECTION FACTOR.**

### FABRICATING HEAT EXCHANGERS

In addition to general conditions specified previously, following specific conditions apply:

1. Use smooth bends with an inside radius of at least twice pipe diameter.
2. When using heat exchangers with tubing in series, tubing diameter and length of tubing exposed to cooling water in discharge should be as determined from Table 1 and any applicable correction factors.
3. When fabricating parallel flow heat exchangers, tubing size will be determined by number of passes. Use Table 4 to determine tubing size. To determine required length of each pass exposed to cooling water, proceed as follows:
  - a. Obtain required heat transfer area from Table 1.
  - b. Recommended tubing diameter to and from parallel heat exchanger is same as "Recommended Tubing Diameter..." in Table 1.
  - c. Select desired tubing size and number of passes required (inside the parallel heat exchanger) from Table 4.

- d. From Table 5, determine heat transfer area per foot of tubing length.
- e. Divide total required heat transfer area (from Table 1) by heat transfer area per foot of tubing (from Table 5). Result is total length of tubing required in exchanger.
- f. Apply any applicable correction factors to this result.
- g. Divide this corrected length by total number of passes (from Table 4). Result is total length per pass.

### SELECTING COMMERCIAL HEAT EXCHANGERS

In general, manufacturer's recommendations should be followed when sizing commercial heat exchangers, and adequacy of recommended exchanger can be evaluated by considering factors outlined in preceding sections.

## OPERATION

**TABLE 4**

Recommended Minimum Pipe Size for Parallel Flow Heat Exchangers

Minimum Pipe Size From TABLE 1	Number of Parallel Tubes					
	2	4	6	8	10	12
2	1-1/2	1-1/4	1	1	1	1
2-1/2	2	1-1/2	1-1/4	1-1/4	1-1/4	1-1/4

Number of Passes

### RESISTANCE OF BENDS TO FLOW

Each bend in system causes a resistance in flow, which is equivalent to a certain length of tubing. This length must be deducted from maximum equivalent length. Table 6 shows equivalent length of tubing or pipe for each bend. Count number of bends in system, multiply by figure obtained from Table 6, and subtract from maximum equivalent length (from Table 1).

#### EXAMPLE:

Tubing diameter is 2". There are four 90° bends in system. Each bend is equivalent to 2 ft. of tubing. Therefore, 4 bends are equivalent to 8 ft. of tubing. This 8 ft. must be subtracted from maximum equivalent length shown in Table 1.

**TABLE 5**

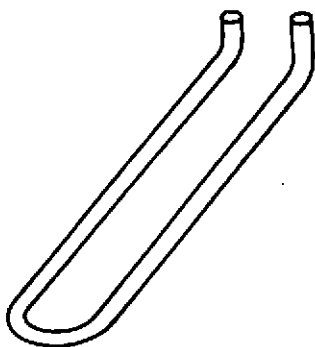
Heat Transfer Area Per Foot of Length

	Pipe Dia. (inches)	
	2	2-1/2
Heat Transfer Area Per Linear Foot of Pipe (In Square Inches)	75.3	94.0

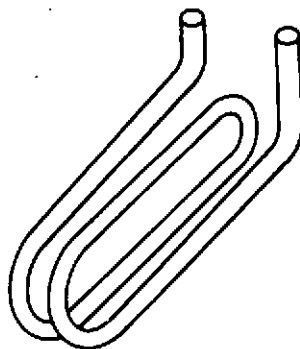
**TABLE 6**

Resistance of Bends to Flow-Equivalent Length in Feet of Pipe. (Centerline Bend Radius = 2 Times Pipe Dia.)

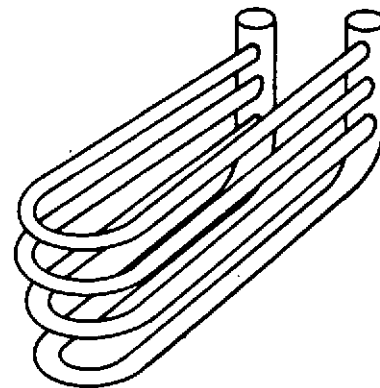
Pipe Dia. (In.)	Copper Pipe			Galvanized Pipe	
	45°	90°	180°	45°	90°
2	1'	2'	4'	2-1/2'	4-1/2'
2-1/2	1-1/4'	2-1/2'	5'	3'	5-1/2'



2-Pass Series



4 Pass Series



4 Pass Parallel

# MAINTENANCE



USE SAFE WORK PRACTICES

## SPARK PLUGS

Remove, clean, and re-gap spark plugs twice annually or any other time it appears that service is necessary.

Use a fine point file to dress electrodes to obtain flat, parallel surfaces on center and side electrodes.

Adjust gap by bending outside electrode. Correct gap is .015". Measure gap with a wire-type feeler gauge.

Use a new gasket when reinstalling plugs. Apply anti-seize compound on threads and tighten plugs to 40-45 ft-lbs.

Recommended spark plugs for use in TH0800 unit are:

- Single electrode, 10A26344 - Pkg. of 10.
- Triple electrode, 20-700 0658 - Pkg. of 10.

## CRANKCASE VENTILATOR

Remove and clean ventilator line orifice every 500 hours of operation. Orifice is located in fitting where the valve cover vent lines connect into the turbocharger air inlet tube.

## ENGINE TIMING

Engine timing can be checked either on crankshaft pulley (Fig. 21) or on flywheel (Fig. 22). Correct engine timing is extremely important to efficient engine operation.

NOTE: WHEN USING POINTER ON CRANKSHAFT PULLEY, IT IS A GOOD IDEA TO CHECK ACCURACY OF POINTER AGAINST POINTER AND MARK ON FLYWHEEL TO BE ABSOLUTELY SURE POINTER HAS NOT BEEN ACCIDENTALLY BENT OUT OF POSITION.

Depending on fuel being used to operate engine, locate timing mark on flywheel or crankshaft pulley as indicated below. A dab of white paint added to applicable timing mark will make it easier to see as timing light flashes.

- LP GAS 10A4227 . . . . . 13° BTDC
- Natural Gas 10A4227 . . . . . 20° BTDC

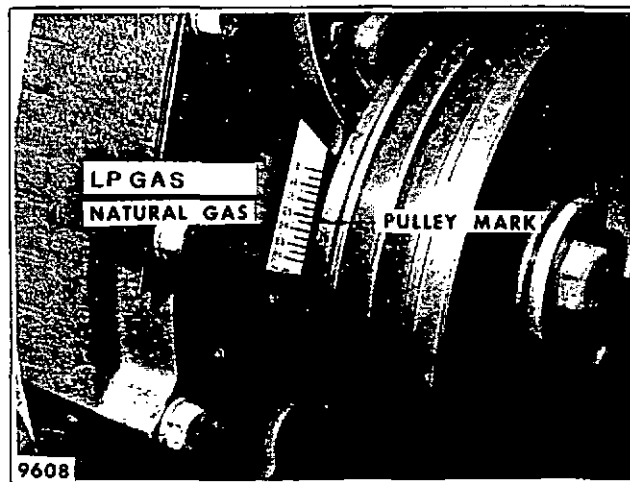


Fig. 21. Pulley Timing Marks

Connect timing light to No. 1 spark plug, start engine and operate it at 1500 rpm or higher. As light flashes, mark on flywheel or pulley should line up with center of window or pointer. If timing is not correct, advance or retard magneto or distributor to correctly align mark and pointer.

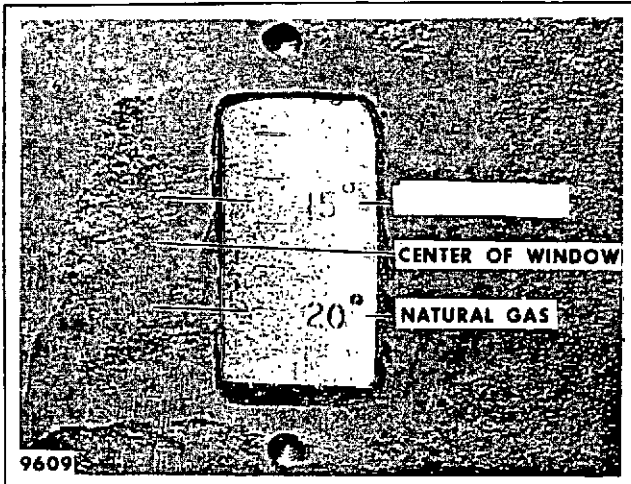


Fig. 22. Flywheel Timing Marks

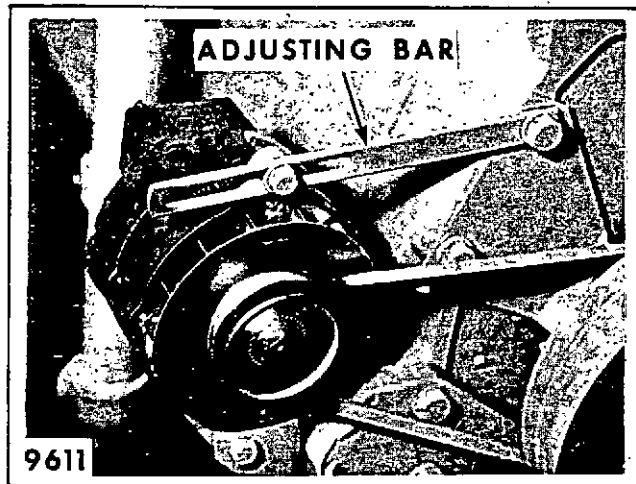


Fig. 24. Adjusting Bar

### FAN BELT.

If unit is equipped with a fan and radiator, maintain proper tension on fan belts to assure that fan will be driven at proper speed.

Tension of fan belts is correct when belts can be depressed 1 to 1-1/4 inch midway on span. If fan belt has more than 1-1/4" of slack, loosen nut on end of fan spindle (Fig. 23) and raise fan assembly to obtain proper belt tension. Tighten nut securely to maintain adjustment.

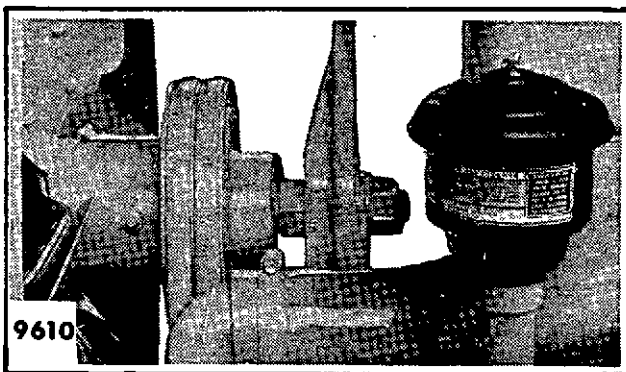


Fig. 23. Fan Spindle Nut

Replace fan belts if they are grease or oil soaked or worn to extent that they will not drive fan at proper speed. Replace fan belts in pairs.

If unit is equipped with an alternator or generator, maintain belt tension by means of adjusting bar (Fig. 24). Drive belt should deflect 3/4 to 1 inch when 10 pounds of pressure is applied midway on span.

### DISTRIBUTOR (REGULAR)

Efficient distributor operation depends on periodic inspections and proper adjustments.

Remove two screws holding cap to body and lift off cap. Remove rotor and dust shield. Wipe cap, rotor and shield clean with a cloth. Inspect cap and rotor for chips, cracks or carbonized paths. Such defects allow high tension leaks to ground. Clean contact tip on rotor.

Check centrifugal advance mechanism for free operation by turning distributor shaft in direction of rotation; then, release it. Advance springs should return shaft to its original position without sticking.

Keep distributor points clean and properly gapped at all times. Use a fine-cut contact file to clean breaker points. Do not attempt to remove all roughness, merely remove any scale and dirt on contacting surfaces. Never use emery cloth or sandpaper to clean points, since abrasive particles will imbed in contacting surfaces and cause points to burn. Make certain to clean points thoroughly after filing them.

It is advisable to adjust USED contact points using a dwell meter, as normal roughness of points makes it nearly impossible to obtain an accurate point gap setting with a feeler gauge. Correct dwell angle for used points is 31 to 37 degrees, 34 degrees preferred. If new points are installed, set dwell angle to lowest setting (31 degrees).

If new points are installed, point gap may be adjusted with a feeler gauge. Turn engine over until cam follower

block is on high point of the cam lobe. Set point gap to .018 to .024 inch (Fig. 25). Gap should be set to wider opening to compensate for wear on rubbing block.

Check alignment of points to be sure they are centered. Apply a dab of ball bearing lubricant to breaker cam and reinstall dust shield, rotor, and cap. After completing service work on points, check ignition timing as explained on page 23.

If distributor is to be removed from engine for service, turn engine over until No. 1 piston is at top of its compression stroke. Remove distributor cap and mark position of rotor in relation to distributor body. Also mark position of distributor housing in relation to adapter housing. Use these marks to install distributor in its proper position at reassembly.

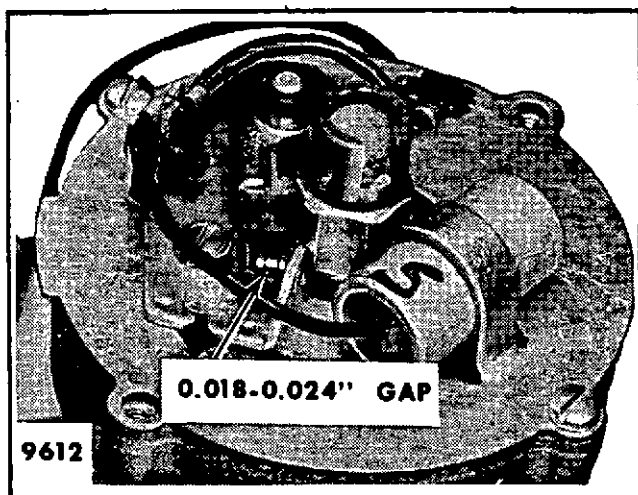


Fig. 25. Point Gap

### DISTRIBUTOR (BREAKERLESS)

Breakerless distributor requires no maintenance or service except an occasional cleaning of rotor contact point and contacts inside distributor cap. Keep wire connections and terminals between transmitter and distributor clean and free of corrosion or oil.

If distributor is removed from engine for any reason, turn engine over in direction of rotation, until No. 1 piston is at top of its compression stroke.

Remove distributor cap and note position of rotor in relation to vertical timing marks inside body. There are two vertical marks for determining rotor position, depending on direction of distributor rotation. Distributor rotor turns in a clockwise direction when looking down

into body, so with No. 1 piston at top of its compression stroke, trigger vane nearest rotor should be pointing to vertical mark indicated in Fig. 26.

NOTE: FIG. 26 SHOWS ROTOR OUT OF POSITION TO FIRE NO. 1 CYLINDER TO ILLUSTRATE TIMING MARK IN HOUSING.

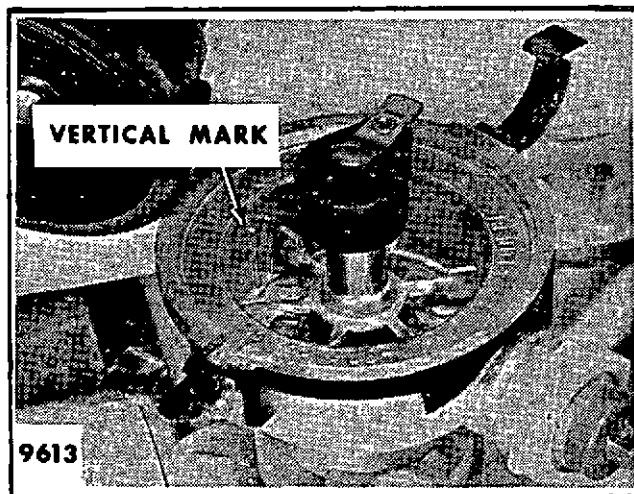


Fig. 26. Timing Distributor

### MAGNETO

Field service of magnetos used on THD800-6A power units is limited to cleaning or replacing breaker points and replacing condenser. Whenever major service becomes necessary, take magneto to an authorized magneto service station that has proper facilities and specialized equipment for overhauling and testing magneto.

**IMPORTANT: IF DIFFICULTY IS EXPERIENCED WITH A MAG-TRONIC BREAKERLESS MAGNETO, TAKE IT TO AN AUTHORIZED AMERICAN-BOSCH MAGNETO SERVICE STATION FOR INSPECTION AND TESTING.**

To clean or replace contact points, remove distributor cover. Figs. 27, 28, and 29 show contact points and condensers of three magnetos available for THD800 power unit. The Mag-tronic magneto does not have contact points.

Check condition of points and clean them with a fine cut point file if they are severely burned, pitted or corroded. Replace points if they cannot be cleaned up satisfactorily. Replace condenser when new points are installed.

Adjust contact points to obtain a .015" gap with points wide open (cam follower on high part of cam lobe).

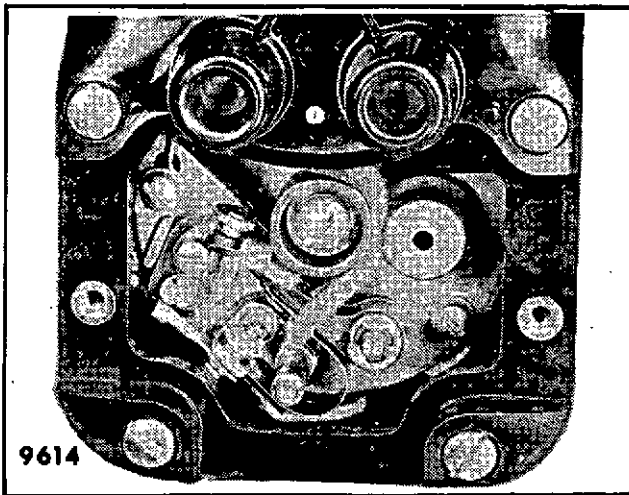


Fig. 27. American-Bosch High Tension Magneto

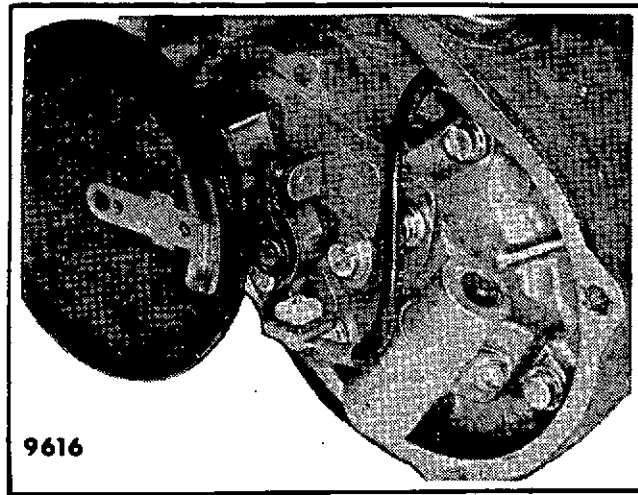


Fig. 29. Fairbanks-Morse Low Tension Magneto

If magneto was removed from engine for service, refer to **TIMING MAGNETO TO ENGINE** for instructions on properly installing magneto.

If wires were disconnected from high tension magneto, reconnect wire for No. 1 cylinder to No. 1 wire terminal and reconnect remaining wires in a clockwise rotation, following firing order of engine (1-5-3-6-2-4).

If wires were disconnected from low tension magneto or transformers, refer to heading **MAGNETO-TO-TRANSFORMER WIRING** on page 28 for instructions on properly reconnecting wiring harness.

Note: See pages 48 & 50 for more magneto information.

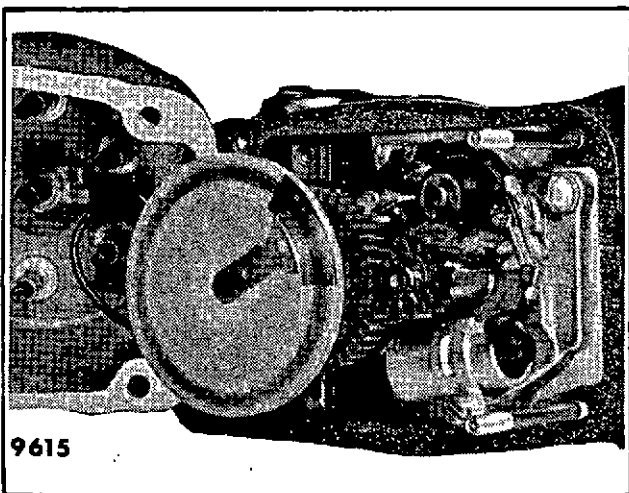


Fig. 28. American-Bosch Low Tension Magneto

### TIMING MAGNETO TO ENGINE

If magneto has been removed from engine, it must be properly re-timed to engine when it is reinstalled. Engine must be timed to fire No. 1 cylinder. Timing marks are provided on crankshaft pulley (Fig. 21) and on flywheel (Fig. 22). Use most easily accessible location for determining correct timing.

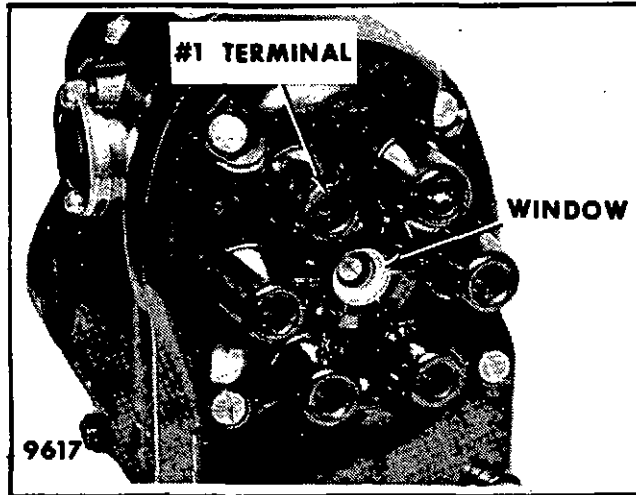
Unscrew spark plug for No. 1 cylinder a few turns and slowly turn engine over in direction of rotation until air is heard escaping around plug, indicating that No. 1 piston is coming up on compression stroke. Continue turning engine over until DC-1 mark on flywheel or pulley is lined up with pointer. No. 1 piston is now at top of its compression stroke. Retighten spark plug.

Depending on fuel being used to operate engine, locate timing mark on flywheel or crankshaft pulley as indicated below. Turn engine back until specified timing mark is lined up with pointer. No. 1 cylinder is now in firing position.

To determine that magneto distributor rotor is in position to fire No. 1 cylinder, check according to type of magneto being used. All magnetos fire in a clockwise direction when looking at terminal wire end.

**AMERICAN BOSCH HIGH TENSION  
(10A12822)**

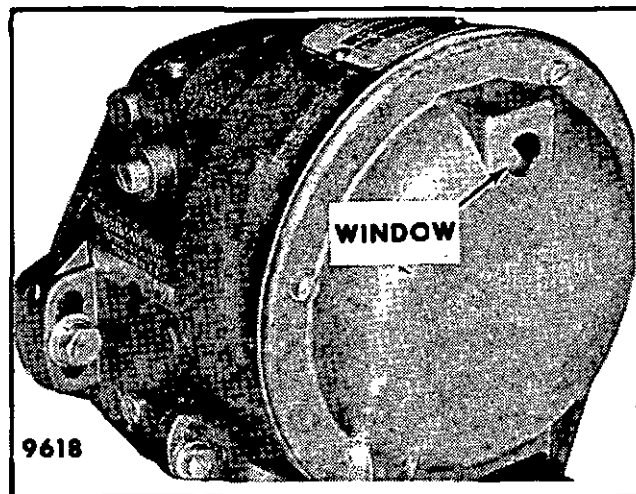
Turn impulse coupling in a counterclockwise direction to avoid engaging impulse coupling lugs until arrow in window points to wire terminal for No. 1 cylinder.



*Fig. 30. Timing American-Bosch High Tension Magneto To Engine*

**AMERICAN BOSCH BREAKERLESS  
(10A26720)**

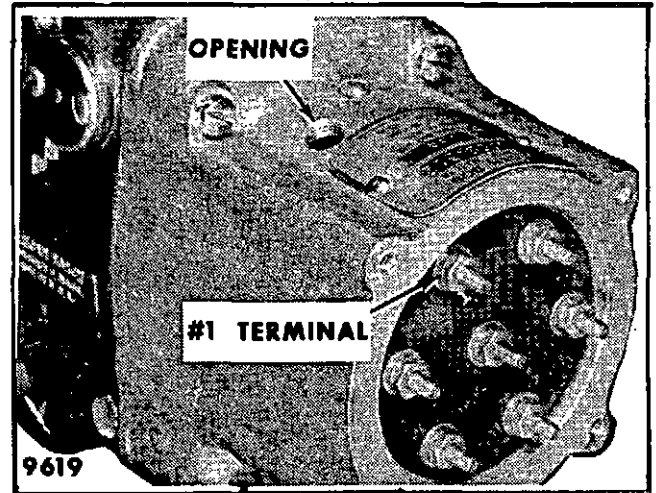
Turn drive coupling until RED indicator appears in window.



*Fig. 31. Timing American-Bosch Breakerless Magneto To Engine*

**AMERICAN BOSCH LOW TENSION  
(10A27184)**

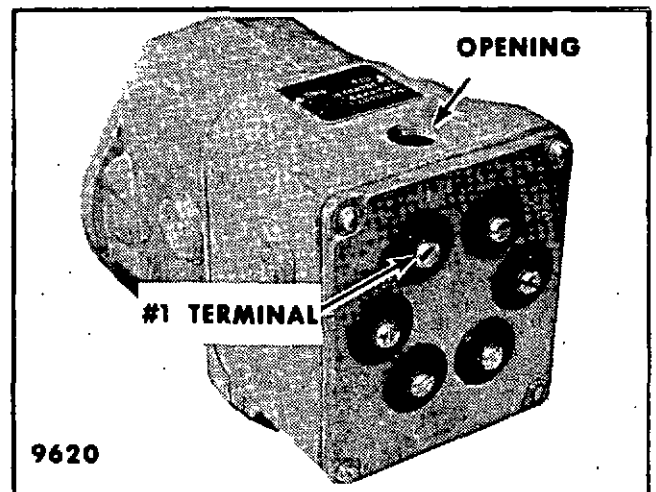
Remove slotted plug from top of magneto and rotate coupling until mark on rotor appears in opening.



*Fig. 32. Timing American-Bosch Low Tension Magneto To Engine*

**FAIRBANKS MORSE LOW TENSION  
(10A27199)**

Remove 3/4-inch hex plug from top of magneto and rotate coupling until mark on rotor is visible in plug opening.



*Fig. 33. Timing Fairbanks-Morse Low Tension Magneto To Engine*

Install magneto on engine. With rotor in position to fire No. 1 cylinder, breaker points should be JUST STARTING TO OPEN. (This does not apply to Mag-tronic Breakerless Magneto.)

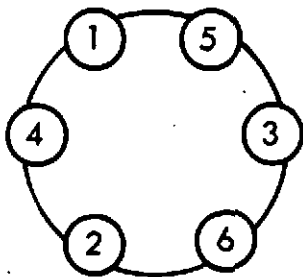
## MAINTENANCE

Distributor cover must be removed to determine if breaker points are just starting to open. Refer to Figs. 27, 28, and 29. If points are not just starting to open, loosen magneto mounting bolts and rotate magneto in proper direction to place breaker points in position to just start opening.

If correct position for breaker points cannot be obtained by rotating magneto, it will be necessary to loosen lock screws in breaker plate and reposition it so that points are just starting to open when distributor rotor is in position to fire No. 1 cylinder.

### MAGNETO-TO-TRANSFORMER WIRING

Wiring in harness between American Bosch or Fairbanks Morse low tension magnetos and transformers is color coded to assist in obtaining correct wire connections. Illustration below shows magneto terminals and wire color that must be attached to each:



- 1. Blue
- 5. Green
- 3. Orange
- 6. Red
- 2. White
- 4. Yellow

If wires are disconnected from transformers for any reason, they must be reconnected as indicated. Notice that colored wires are attached to negative terminals on transformers for No. 1, 2 and 3 cylinders and to positive terminals for No. 4, 5 and 6 cylinders. Black wires are transformer grounds.

NO. 1  
+     -  
Black   Blue

NO. 4  
+     -  
Yellow   Black

NO. 2  
+     -  
Black   White

NO. 5  
+     -  
Green   Black

NO. 3  
+     -  
Black   Orange

NO. 6  
+     -  
Red   Black

### WATER PUMP

To service water pump, proceed as follows:

Drain cooling system, disconnect hoses, and remove pump cover (Fig. 34). Remove and discard 3/8" x 5" lock bolt through impeller and shaft. Remove pump from gear case.

**NOTE: IF UNIT IS EQUIPPED WITH A RADIATOR, IT MAY NOT BE POSSIBLE TO WITHDRAW 5-INCH LOCK BOLT. IN THIS CASE, MERELY BACK OUT BOLT ENOUGH TO DISENGAGE THREADS; THEN, REMOVE ENTIRE PUMP FROM GEAR CASE.**

Remove three 1/4 x 1/2" lock bolts. Remove O-Ring from shaft. Press shaft out of impeller from impeller end. This will also remove bearing from pump housing.

Remove water seal and oil seal from housing. Remove ceramic washer (includes rubber cup) from impeller.

Examine all parts carefully and discard any that are worn or damaged.

Before reinstalling rubber and ceramic washer, dip assembly in water. Water acts as a lubricant to facilitate installation. Press water seal into housing by hand.

**IMPORTANT: BE SURE THAT MATING SURFACES OF WASHER AND SEAL ARE FREE OF OIL OR DIRT.**

Press oil seal into housing with lip edge out. **PRESS ONLY UNTIL SEAL EDGE IS FLUSH WITH HOUSING.**

Press bearing onto shaft and install O-Ring in groove in shaft. Place a light coating of grease on O-Ring. Secure bearing with 1/4 x 1/2" cap screws. Torque to 9 ft-lbs.

Insert shaft and bearing assembly into housing through seals. Install impeller and lock bolt and washer. **NOTE: USE NEW 3/8 x 5" LOCK BOLT.** Use new gaskets and coat both sides with a sealing compound.

**IMPORTANT: A clearance of 0.025 to 0.065" must be maintained between impeller and housing.**

Install pump assembly, rotating shaft to be sure dowel pin is engaged in accessory shaft gear. Tighten new lock bolt to 26 ft-lbs.

**NOTE:** If lock bolt is not installed properly and comes loose, water may leak into crankcase.

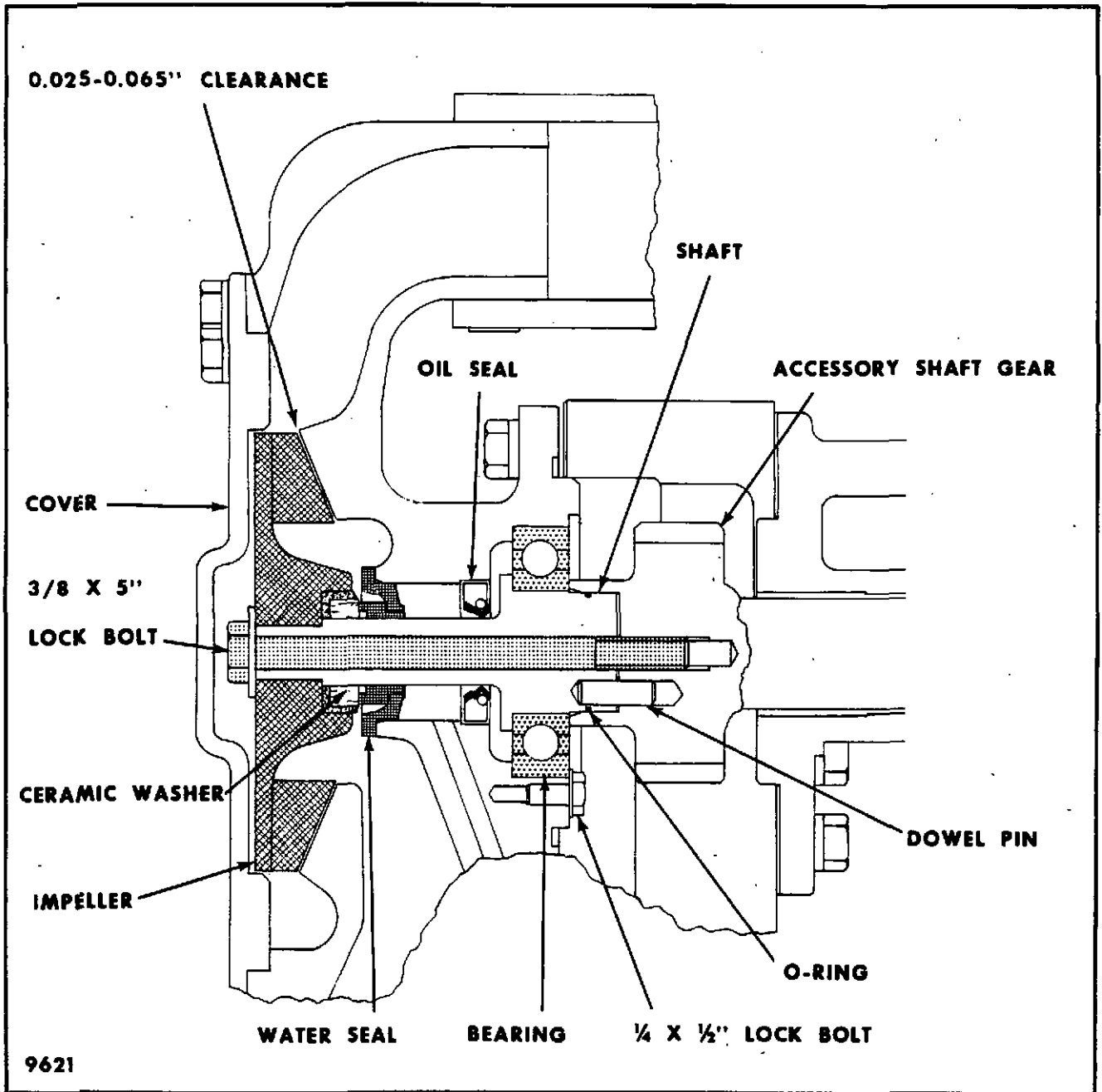


Fig. 34. Water Pump

### ACCESSORY SHAFT BUSHINGS

Accessory shaft that drives water pump and magneto (or distributor) turns in a bushing in adapter housing. If bushing becomes worn excessively, it must be replaced to prevent damage to adjoining components.

Remove water pump to expose gear on accessory shaft. Mark accessory shaft gear and camshaft gear if timing marks are not present. If a number "3" is stamped in tooth on accessory shaft gear, turn engine over so marked tooth is engaged in tooth space in camshaft gear that is marked with a "3".

## MAINTENANCE

Remove magneto, noting position of drive lug on impulse coupling. Remove breather and coil support on units equipped with a distributor. Remove adapter housing.

Pull magneto drive coupling from shaft and remove key. Remove shaft and thrust washer.

If the unit has a distributor, mark position of rotor and distributor in relation to adapter housing. Remove distributor, withdraw shaft and thrust washer.

Press out old bushing. Carefully press in new bushing and line ream to 1.2527/1.2520" inside diameter.

Install shaft in housing. Reinstall key and magneto drive coupling, if used. Coupling must be pressed onto shaft to obtain a dimension of  $53/64 \pm 1/64$ " from bottom of slot in coupling to rear face on adapter.

Reinstall adapter housing, turning shaft as necessary to properly align marks made at disassembly. If gear teeth are marked, tooth marked with a "3" must be engaged with tooth space on camshaft that is marked with a "3".

Reinstall magneto in its original position. If magneto was turned over while it was removed, see page 26 for instructions on properly re-timing magneto to engine.

If unit has a distributor, reinstall distributor in its original position, using marks made at disassembly.

### FAN HUB

To replace bearings or seal, remove blade assembly and cover, lock nut and washer, and tap spindle out rear of hub (Fig. 35). Remove seal and bearings from hub.

Inspect all parts and replace those showing signs of wear or damage. Repack bearings with lithium base grease. Install rear bearing. Install seal in hub until it protrudes .070" outside hub.

Install spindle and front bearing, washer, lock washer, and bearing adjusting nut. Adjust bearings to obtain from .003 to .005" end play.

After assembly is complete, refill housing with vent plug removed through grease fitting with 3-1/2 ounces of lithium base grease. **DO NOT OVERFILL** — some air space must remain. Reinstall vent plug.

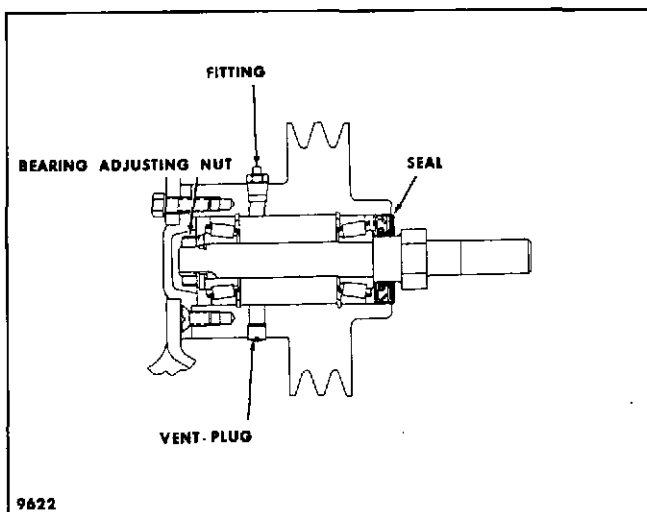


Fig. 35. Fan Hub

### GOVERNOR

To obtain desirable governor action, it is necessary that governor linkage be free from binding. Whenever erratic governor action is noticed, linkage should be checked first. Several other conditions could cause erratic governor action and they should be checked before disassembling governor. If carburetor is adjusted for too lean a mixture of fuel, this will invariably cause erratic governor action.

To determine correct adjustments on governor linkages, it will first be necessary to check to see that throttle butterfly in carburetor is correctly positioned to maintain proper engine idling speed.

Position of throttle butterfly in carburetor can be determined by looking at butterfly shaft. Throttle butterfly in carburetor is **FULLY OPEN** when line on end of shaft is in vertical position.

Position throttle butterfly wide open, then move it 15° toward the closed position. Loosen throttle stop arm clamp and pivot arm until it contacts roll pin, while holding butterfly in 15° position, re-tighten clamp. Butterfly adjusted in this manner will assure proper idle speed and will not effect maximum power output of engine.

Check position of linkage lever on carburetor throttle shaft. Lever must be pointing down and positioned 45 to 50 degrees from vertical toward front of engine. Be sure butterfly is held in previously adjusted wide open position if lever position must be changed.

# MAINTENANCE

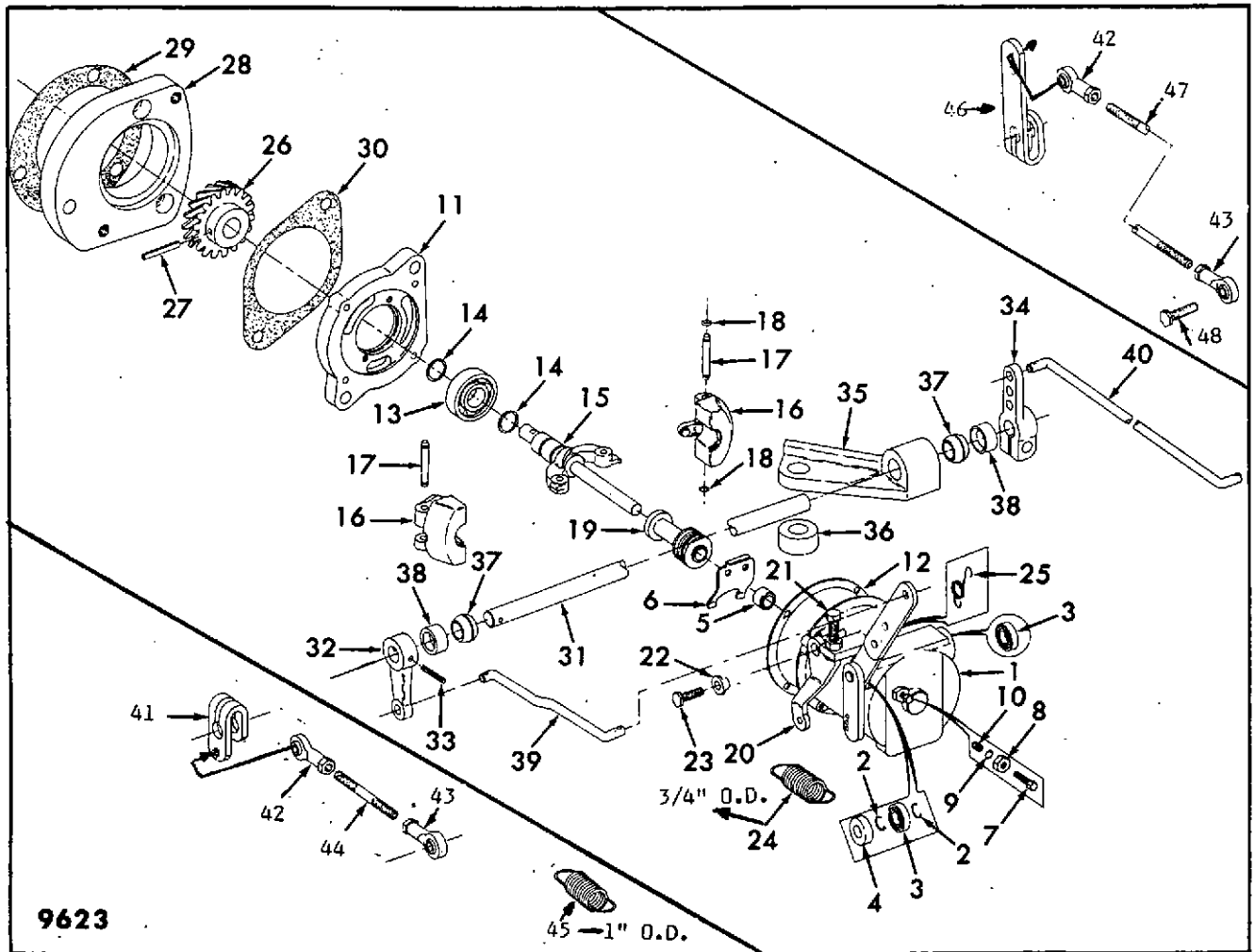


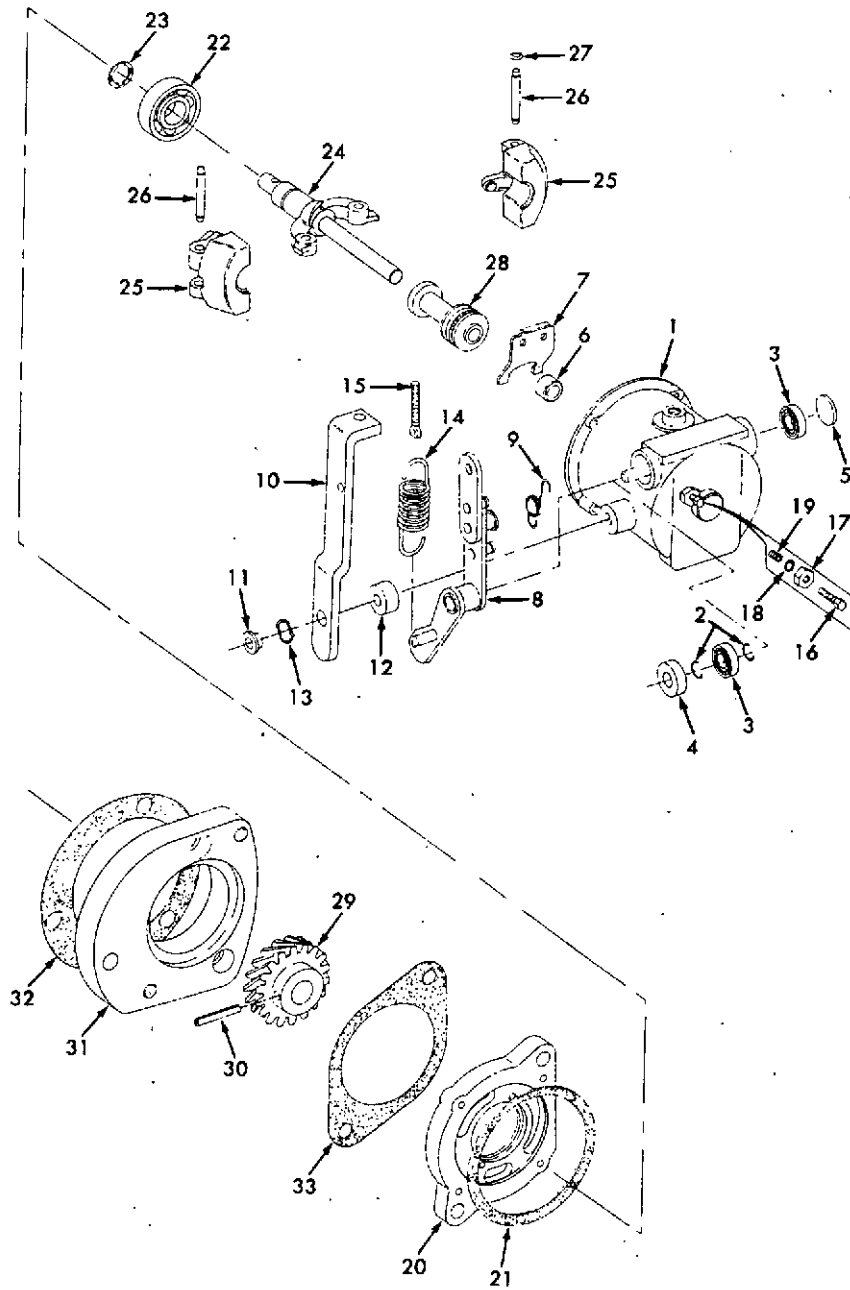
Fig. 36. Constant Speed Governor, \* Used with 3-5% regulation governor

- |              |               |                  |
|--------------|---------------|------------------|
| 1. Body      | 15. Shaft     | 29. Gasket       |
| 2. Retainer  | 16. Weight    | 30. Gasket       |
| 3. Bearing   | 17. Pin       | 31. Rod          |
| 4. Seal      | 18. Retainer  | 32. Lever        |
| 5. Bearing   | 19. Bearing   | 33. Pin          |
| 6. Lever     | 20. Lever     | 34. Lever        |
| 7. Screw     | 21. Screw     | 35. Support      |
| 8. Nut       | 22. Bushing   | 36. Spacer       |
| 9. Seal      | 23. Cap Screw | 37. Bearing      |
| 10. Spring   | 24. Spring    | 38. Ferrule      |
| 11. Base     | 25. Spring    | 39. Rod          |
| 12. Gasket   | 26. Pinion    | 40. Rod          |
| 13. Bearing  | 27. Pin       | 41. Lever *      |
| 14. Retainer | 28. Adapter   | 42. Ball joint * |
|              |               | 43. Ball joint * |
|              |               | 44. Rod *        |
|              |               | 45. Spring *     |
|              |               | 46. Lever **     |
|              |               | 47. Rod *        |
|              |               | 48. Bolt *       |

NOTE: Adjust rod #47 approx. 20. 5/8" long, center to center.

Adjust rod #44 approx. 4 5/16" long, center to center

# MAINTENANCE



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Fig. 37. Variable Speed Governor

## MAINTENANCE

Callouts for Fig. 37		
1. Body	12. Spacer	23. Retainer
2. Retainer	13. Washer	24. Shaft
3. Bearing	14. Spring	25. Weight
4. Seal	15. Eye Bolt	26. Pin
5. Plug	16. Screw	27. Retainer
6. Bearing	17. Nut	28. Bearing
7. Lever	18. Seal	29. Pinion
8. Lever	19. Spring	30. Pin
9. Spring	20. Base	31. Adaptor
10. Lever	21. Gasket	32. Gasket
11. Bushing	22. Bearing	33. Gasket

If position of lever on carburetor throttle shaft was changed, it may be necessary to change position of lever on cross shaft. With governor spring holding governor arm in maximum rearward position, change lever position on cross shaft so linkage rod holds throttle butterfly in wide open position. Breakaway arm on governor must not be broken at joint while making this adjustment.

If, after making previous check, governor action is not improved, it will be necessary to remove governor from engine for disassembly.

Disconnect oil line and linkage rod from governor and remove governor from engine.

Refer to Figures 36 and 37 and disassemble governor as far as necessary to service worn parts. Clean all parts thoroughly and check carefully for wear or damage.

Reassemble components of governor in reverse order of disassembly. Use new gaskets when reinstalling governor on engine. Check all linkages to be absolutely sure that there are no binds. Make governor adjustments as described on page 18.

### IMPCO CARBURETOR

This carburetor (Fig. 38) may be used with either natural gas or vaporized LP Gas fuel. Carburetor utilizes diaphragm operated air-gas valves to regulate amount of fuel dispensed to engine. Air-gas valves measure air flow and meters fuel in proper proportions at all throttle settings and load conditions.

Only moving parts in carburetor, other than throttle shaft, are diaphragm operated air-gas valves. Diaphragm and valve are sold as an assembly, complete with gasket, which is easily replaced. Assembly is available under part number 20-700 0568.

To replace air-gas valve assemblies, close fuel supply valve and disconnect fuel line and air cleaner hose from carburetor. Remove carburetor.

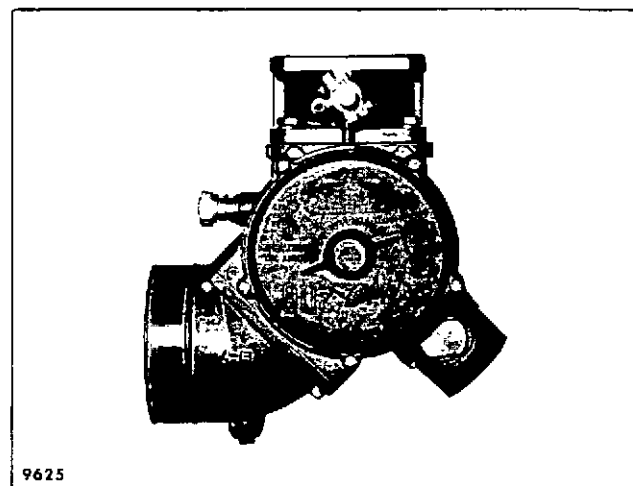


Fig. 38. IMPCO Carburetor

Remove screws securing side covers to carburetor (covers are under spring tension), and remove diaphragm and air-gas valve assembly. Tighten cover screws securely when new valve assemblies are installed.

### IMPCO PRESSURE REDUCING VALVE (NATURAL GAS)

Function of pressure reducing valve is to maintain proper fuel inlet pressure to carburetor. Pressure of natural gas entering carburetor should not exceed 3 ounces per square inch.

Fuel pressure may be regulated by removing plug from top of valve (Fig. 39) and turning slotted screw inside plug opening. Fuel pressure can be checked at either test plug indicated.

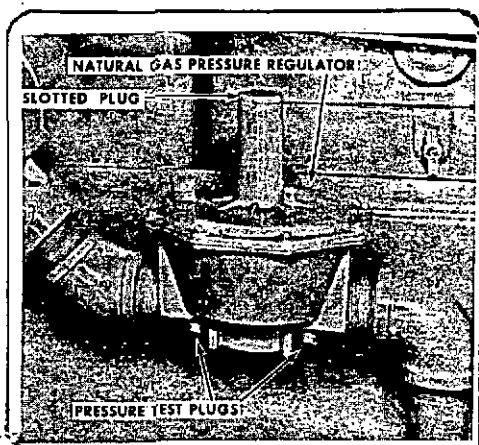


Fig. 39. Pressure Reducing Valve

### LP-GAS FILTER

Filter element should be removed every 500 hours of operation. Close liquid and vapor valves on supply tank. Unscrew filter stud nut slowly to relieve any built-up pressure. Remove bowl and element.

Wash element in a cleaning solution and thoroughly dry it before reinstalling it in filter bowl. Examine gaskets and replace them if they are damaged.

### IMPCO LP GAS CONVERTER

Converter (Fig. 40) is a two-stage pressure regulator and liquid fuel vaporizer. Liquid fuel enters converter at tank pressure and is reduced to 1-1/2 pounds by high pressure regulating valve.

Liquid fuel enters vaporizing chamber and is changed to vapor fuel. Low pressure valve maintains vapor fuel at 3 ounces per square inch. Diaphragms unseat pressure regulating valves, depending on engine demand for fuel.

If it is determined that converter is malfunctioning, it must be removed for service. Close fuel supply valves and disconnect water and fuel lines from converter. Remove converter from engine.

Remove screws securing front cover and lift off cover. Disengage low pressure diaphragm from lever and remove diaphragm.

Remove lever pin and remove low pressure lever and seat assembly and spring.

Remove screws securing high pressure diaphragm cover (cover is under spring tension) and remove springs and diaphragm.

Remove screws from back side of body and separate cover, gasket, and water jacket from body. Remove sponge pad and high pressure seat.

Carefully examine all parts, paying special attention to high and low pressure valve seats and diaphragms.

Use components found in repair kit 10R1181 when reassembling converter. Parts included in repair kit are listed below and illustrated in Fig. 40:

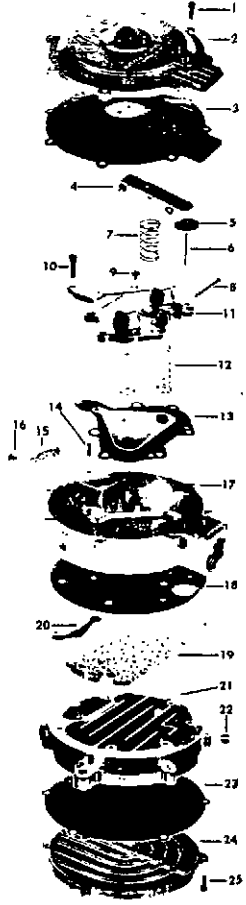
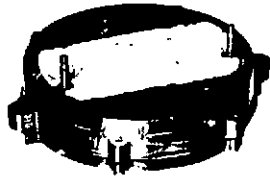
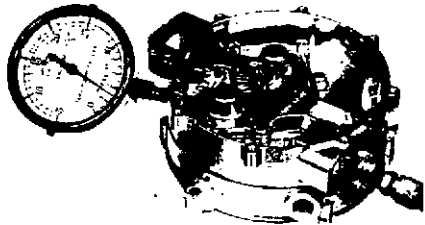
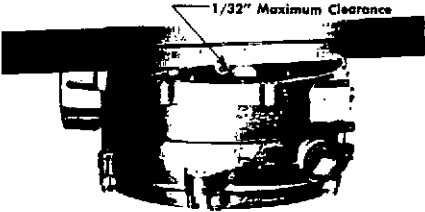
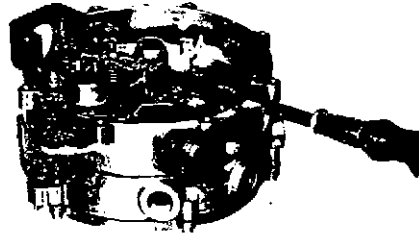
#### PARTS IN 10R1181 REPAIR KIT:

1. Cover screw (8)
  3. Low pressure diaphragm
  5. Low pressure seat
  6. Pin for low pressure seat
  9. Screw for high pressure cover (2)
  10. Screw for high pressure cover (7)
  13. High pressure diaphragm
  14. Pin for high pressure valve
  18. Gasket
  19. Sponge pad
  20. High pressure valve
  23. Gasket
  25. Cover Screw (6)
- Washer for primer button (not illustrated)

Reinstall back cover or water jacket, using a new gasket. Be sure cover and gasket are properly aligned with mounting lugs. Secure cover with six 5/8" screws.

Turn unit over and set high pressure seat in position. Before attempting to reassemble main body to water jacket, make two aligning pins by grinding heads off two original screws removed from high pressure diaphragm cover (item 10 in Fig. 40).

# MAINTENANCE

	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">1 SCREW</td> <td style="width: 50%;">14 PIN</td> </tr> <tr> <td>2 COVER</td> <td>15 PLATE</td> </tr> <tr> <td>3 DIAPHRAGM</td> <td>16 SCREW</td> </tr> <tr> <td>4 LEVER</td> <td>17 BODY</td> </tr> <tr> <td>5 SEAL</td> <td>18 GASKET</td> </tr> <tr> <td>6 PIN</td> <td>19 SPONGE</td> </tr> <tr> <td>7 SPRING</td> <td>20 SEAT</td> </tr> <tr> <td>8 PIN</td> <td>21 BODY</td> </tr> <tr> <td>9 SCREW</td> <td>22 PLUG</td> </tr> <tr> <td>10 SCREW</td> <td>23 GASKET</td> </tr> <tr> <td>11 COVER</td> <td>24 COVER</td> </tr> <tr> <td>12 SPRING</td> <td>25 SCREW</td> </tr> <tr> <td>13 DIAPHRAGM</td> <td></td> </tr> </table>	1 SCREW	14 PIN	2 COVER	15 PLATE	3 DIAPHRAGM	16 SCREW	4 LEVER	17 BODY	5 SEAL	18 GASKET	6 PIN	19 SPONGE	7 SPRING	20 SEAT	8 PIN	21 BODY	9 SCREW	22 PLUG	10 SCREW	23 GASKET	11 COVER	24 COVER	12 SPRING	25 SCREW	13 DIAPHRAGM	
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 <p style="text-align: center;">C</p>	 <p style="text-align: center;">D</p>																										

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Fig. 40. IMPCO LP-Gas Converter

## MAINTENANCE

Lay sponge pad in place as shown in Fig. 40A and install aligning pins in two bosses located at notches in pad.

Install new gasket on flat side of converter body and work protruding boss through snug hole. Holding gasket with fingertips, carefully set body in place over aligning pins. Insert two body retaining screws (item 10, Fig. 40) in holes that are **OUTSIDE** of bolt pattern for high pressure diaphragm cover. Engage threads on screws and check to **BE SURE PAD HAS NOT SHIFTED POSITION**. Tighten screws securely.

Slip new high pressure seat contact pin in place, checking to be sure that it slides freely without any indication of binding. Carefully lay new high pressure diaphragm in place with large metal plate up. Work diaphragm down over aligning pins and bosses.

Set springs in place on flanges on back-up plate and carefully install high pressure diaphragm cover, being careful not to disturb position of springs or diaphragm. With springs and diaphragm in position, hold cover firmly against body and install two short screws (item 9, Fig. 40) in holes marked **COVER SCREWS**. Make a visual inspection of diaphragm, especially at large rounded corners. Edge of diaphragm will be visible around all edges if cover is properly installed.

Remove low pressure seat from lever by cutting pin and install new seat using new pin provided. Pin must be inserted through seat from rubber side. Install pin through brass spacer on lever, pulling pin through until head is flush with rubber seat. Hold seat against lever and bend pin 90 degrees to secure seat. **DO NOT HAMMER ON PIN TO BEND IT**. Cut off pin about 3/16" from bend. Allow a little play in seat and lever assembly to permit seat to align itself with orifice in body.

Install low pressure lever and spring, securing lever with pin. Open and close valve a few times to align seat to orifice and to see that spring is seated squarely.

Remove aligning pins and install and tighten remaining screws in high pressure diaphragm cover. Be careful not to distort diaphragm when installing screws.

Converter is now ready for testing. An accurate gasoline fuel pump test gauge may be used for checking high pressure valve. Remove 1/8" plug from body and install gauge as shown in Fig. 40B. Connect an air hose, that will apply 50 to 150 psi, to fuel inlet port.

With air pressure applied, gauge should indicate a steady pressure of 1 to 2 PSI and should not drop more than 1/4 pound when low pressure valve is opened slightly. Pressure drop in excess of 1/4 pound indicates that high pressure seat is leaking or high pressure contact pin is binding and not sliding freely.

Check for leaks by plugging vapor outlet and filling body with water with air pressure applied. Dump water out of body before releasing air pressure or water will be drawn into chamber above high pressure diaphragm. A leaky low pressure seat can be corrected by bending pin slightly. Remove gauge and reinstall plug.

Check height of low pressure lever by placing a straight edge across face of body as shown in Fig. 40C. Pin for diaphragm link must just clear straight edge by no more than 1/32".

If pin position is not correct, insert a screwdriver between tail of lever and pin as shown in Fig. 40D and bend lever to obtain correct pin position.

Install new low pressure diaphragm, being sure both sides of link are engaged on pin in low pressure lever. Before installing cover, remove rubber washer from primer pin and install new washer. New washer can be slipped over flared end of pin without removing pin.

Carefully reinstall front cover, being careful not to distort or wrinkle diaphragm when tightening cover retaining screws.

Reinstall converter on engine and reconnect water and fuel lines. Use a suitable sealer on fuel line connections (threaded fittings) to avoid possibility of leaks. All fuel line connections that were disturbed should be checked for leaks, using a soapy water solution.

### OIL PUMP

If it is determined that oil pump must be repaired, drain crankcase. Drain cooling system if unit has a heat exchanger base pan.

Remove base pan attaching bolts and drop pan. Remove oil pump attaching bolts and pull pump down and out of engine.

Remove oil strainer and place it in a container of solvent to soak. Remove cover from bottom of pump and remove idler gear.

Pump gear on lower end of shaft and drive pinion on upper end are press-fit on shaft. If gears require replacement, press shaft out of gears.

Be careful not to damage adapter bushing that is pressed into end of shaft. Adapter bushing is used to drive a mechanical tachometer on unit so equipped.

Remove oil pressure regulator components and thoroughly clean all parts in solvent. Examine parts very carefully and replace any that are unsuitable for further use. If either pump gear requires replacement, it is recommended that both gears be replaced.

Check pump shaft for excessive wear in bearing areas. If there is any indication that drive pinion or pump gear were loose on shaft, shaft should be replaced.

Press pump gear on drive shaft so that it is flush to .010" below end of shaft. Gear must not be pressed on so far that shaft protrudes beyond end. Pump gear must withstand 30 ft-lbs. torque without turning on shaft.

Install drive shaft in housing. Install idler gear and cover. Press drive pinion on shaft until a clearance of .010 to .030" (Fig. 41) is obtained between housing and pinion. Pinion must withstand 30 ft-lbs torque without turning on shaft.

Reinstall oil pump and install base pan using a new gasket. Tighten base pan retaining bolts to 20-25 ft-lbs.

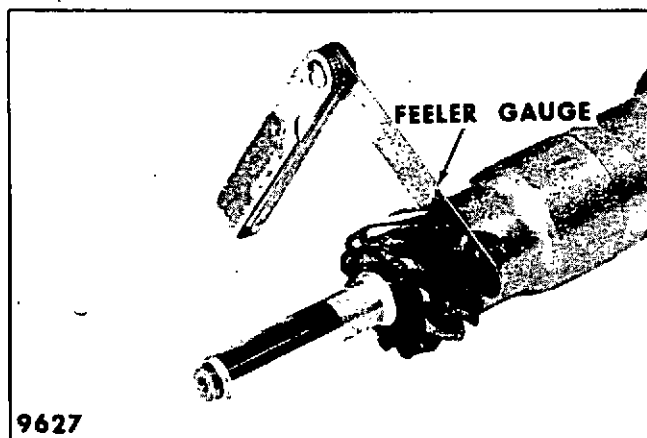


Fig. 41. Oil Pump Drive Gear Clearance

## VALVES

Valves should be kept in good condition at all times for efficient engine operation. Sticky or leaky valves will cause a noticeable reduction in power output of an engine and could also cause pitted or burned valves or valve seats. If engine "rolls" over easily on any compression stroke, it could indicate possibility of leaky valves in that particular cylinder and need of valve reconditioning.

If valve sticks, remove valve chamber covers and squirt solvent on valve stems. Allow engine to run a few minutes, and repeat operation. If this improves valve operation, it might indicate faulty valve stem lubrication. Check flow of oil to rocker arms and valve stems. With engine running, there should be a small stream of oil from oil hole in each rocker arm.

An excessively worn rocker arm or shaft could cause erratic valve action. Valve contact end of rocker arm and push rod surface of adjusting screw should be smooth and round. Check these parts, and replace as necessary, following instructions given under respective headings.

When engine is cold, intake valves should have a clearance of .012" and exhaust valves .028".

Turn engine over slowly until intake valve on No. 1 cylinder closes. This is second valve from front. Then turn engine over one-half turn further until No. 1 piston is at top of its compression stroke and both valves will be closed. Adjust clearance on intake valve to .012" and clearance on exhaust valve to .028".

Turn engine over one-third turn further. In this position, No. 5 piston will be at top of its compression stroke and ready to fire. Turn engine over one-third turn to bring each succeeding piston to top in order of firing (1-5-3-6-2-4) and adjust clearance.

After all valves have been adjusted, start engine and allow it to warm up to operating temperature. Then check clearance again. When engine is at operating temperature, intake valve clearance should be .010" and exhaust valve clearance should be .025". Make any adjustments necessary.

Before disassembling engine for valve reconditioning, check compression, using a reliable compression tester (Fig. 42). To obtain an accurate compression reading, be sure valves have proper clearances and engine is at normal operating temperature. Make certain battery and starting

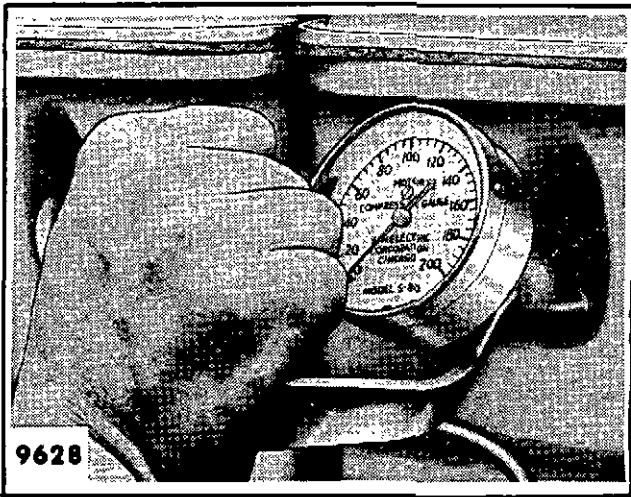


Fig. 42. Checking Compression

motor are in good condition. Before removing spark plugs, be sure ports are clean. Remove distributor-to-coil high tension lead. Move throttle lever to wide-open position. Turn engine over at cranking speed, and note compression reading obtained from each cylinder of engine.

Compression pressure at cranking speed, with valves and rings in good condition, should be as follows:

Head No. 10A4227 . . . . . 160-180 psi

If it is determined after making previous checks that a valve reconditioning job is necessary, disassemble engine.

Drain cooling system. Remove ventilator assembly and valve covers. Remove air cleaner intake, exhaust and water manifolds. Check condition of O-Ring seals on water outlet manifold and replace them if damaged.

Remove rocker arm assemblies, marking them so that they can be reinstalled in their original position. Lift out push rods, keeping them in order so they can be reinstalled in their original position.

Remove nuts from cylinder head studs and lift heads from blocks. Compress valve springs and remove keepers, spring seats, and springs. Remove stem seals from intake valves and discard. Remove valves and place them in a rack so that they can be reinstalled in same order.

## VALVE RECONDITIONING

If valves are not worn or pitted too badly, they may be refaced. Methods using grinding compounds are not recommended. Valve angles are as follows:

Intake .....	29° ± 15'
Exhaust .....	29° ± 15'

Margin of refaced valve must not be less than 1/32". If margin is less than 1/32" at any point after being refaced, valve must be discarded.

After valve is refaced, face runout should be checked. Maximum runout in reference to stem must be less than .002". Any warped or bent valves should be discarded.

Check stem runout. Stem runout must be less than .001".

If tips of valves are not too badly damaged, smooth tips on side of refacing wheel. If tips are badly damaged, or keeper grooves are badly worn, valves should be discarded.

It is good practice to replace valves after a long period of use even though there is no evident damage. Old valves sometimes develop fatigue cracks or become brittle, and without special inspection equipment, this may not be noticed. Old valves should be replaced in order to avoid possible future valve breakage or failure.

## VALVE SEAT INSERTS

Valve seat angles are listed under Fig. 43.

Before regrinding seats, true cutting stone to above angle, and select correct pilot for valve guide. If necessary to grind valve seat to a considerable depth before it cleans up all around, this may cause valve to seat too deep, and it will be necessary in such cases to install new valve seat inserts.

Inserts have a .005 to .007" interference fit in head at normal temperatures and must be chilled with dry ice or in a freezer before they can be installed.

Portion of seat that contacts face of valve should be 3/32" wide. Fig. 43 shows correct valve seat.

Place a light coat of bearing blue on face of valve and rotate valve around in seat. This check will show where contact is, if there are any high spots and width of contact. By making this check occasionally, seat can be properly ground so that seat width and its location on valve face are correct.

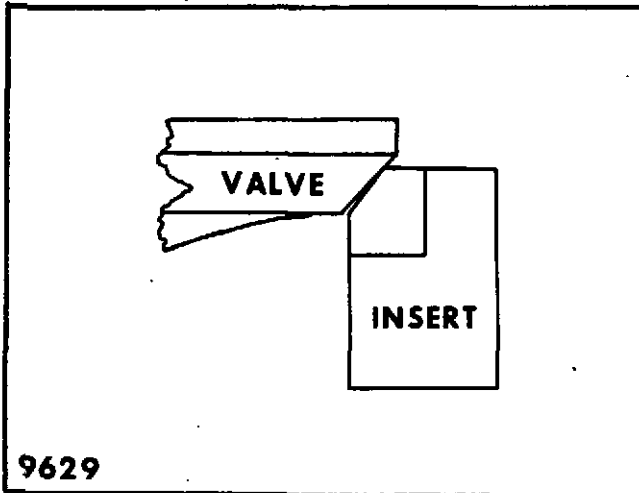


Fig. 43. Valve & Insert Seat Angles

	INTAKE	EXHAUST
Valve Angle	$29^{\circ} \pm 15'$	$29^{\circ} \pm 15'$
Valve Seat Angle	$30^{\circ} \pm 30'$	$30^{\circ} \pm 30'$

### VALVE GUIDES

Check valve guides for wear. Nominal diameter of guide bore is .4985 to .4995". If guides are worn or out of round more than .002", or bell mouthed, they should be replaced.

Guides are pressed into head and can be removed with a regular valve guide driver. New guides should be pressed or driven in place with a soft driver.

Press guides into head so that shoulder is in firm contact with head (Fig. 44). (Precision reamed, finished guides or semi-finished guides are available). Valve stem clearance should be .0015-.0035". Use correct pilot and regrind valve seat so it is correctly centered in relation to new guide.

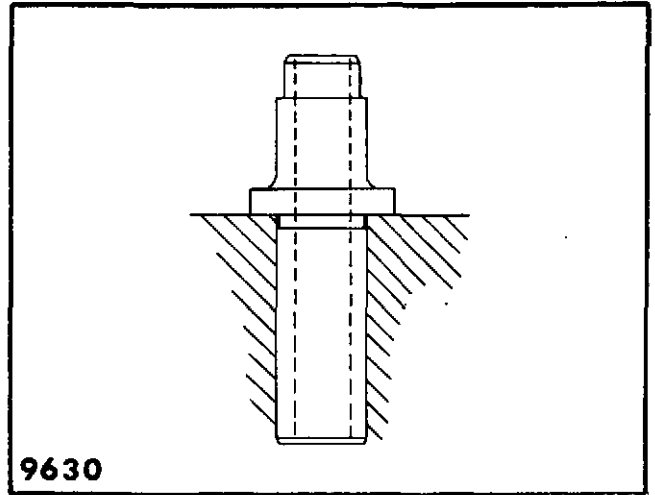


Fig. 44. Valve Guide

### VALVE SPRINGS

Check valve springs on a spring testing fixture (Fig. 45). Scale reading for both intake and exhaust valve springs should be 130 to 135 lbs. at 2-5/64 inches. If spring is too weak, valve will bounce and cause seat pounding and eventual burning or breakage of valve. Correct free length of springs is 3.11 inches. Springs must be square at ends to prevent binding or side pressure on valve. Install springs with inactive coils down.

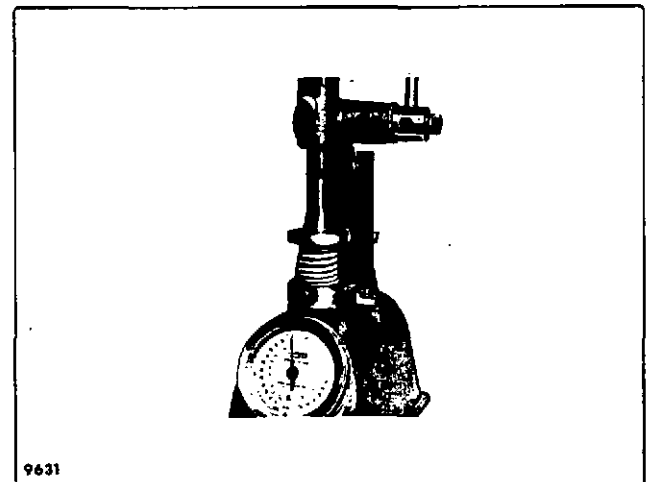


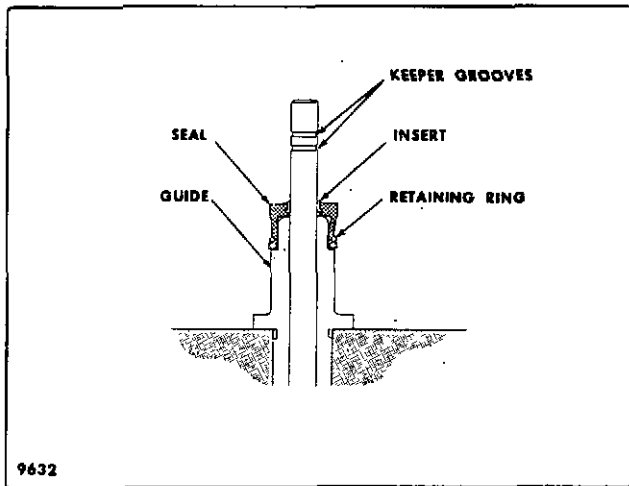
Fig. 45. Valve Spring Tester

**STEM SEALS (INTAKE VALVES ONLY)**

Intake valves are equipped with stem seals. Any time valves are removed, replace seals.

Apply heavy oil (STP) to valve stem and slip valve into place in head and install lower retainer for spring. An installation cap or cellophane tape must be placed over keeper grooves (Fig. 46) to protect seal during installation.

**NOTE:** If installation cap extends more than 1/16-inch below lower groove on valve stem, remove cap and cut off excess length.



*Fig. 46. Valve Stem Seal Installation*

Place tape or a light film of oil over cap and valve guide to facilitate installation. Start seal carefully on valve stem. Hold thumbs against white seal insert to avoid dislodging insert. Push seal down slowly until jacket of valve seal contacts top of valve guide. Remove installation cap or tape.

Pull seal down on guide as far as it will go without stretching, by pulling down on retaining ring with two small screwdrivers, each spaced approximately 90° from gap in retaining ring.

Install valve spring (inactive coils against lower retainer), upper retainer, and keepers to prevent valve from slipping out of head.

**ROCKER ARM ASSEMBLY**

Rocker arms must have a free running fit on shaft. If bushings are worn excessively, it will cause erratic valve action and make correct valve adjustment difficult. Excessive wear will permit too much oil to be forced out from around rocker arm bushings and shaft, leaving insufficient oil to escape through drilled holes in the rocker arms where it flows to valves and push rods. Bushing replacement is not recommended. Entire rocker arm should be replaced.

Check valve contact end of rocker arms. They should be smooth and rounded so they cannot tip or bind valve stems in guides.

**PUSH RODS**

Examine push rods carefully to see that cups are not broken or cracked. Make certain that push rods are not bent. **DO NOT ATTEMPT TO STRAIGHTEN A BENT PUSH ROD! INSTALL A NEW ONE.**

**REINSTALLING CYLINDER HEADS**

Thoroughly clean gasket surfaces on engine blocks, being careful not to allow gasket material to fall into water holes or on top of pistons. Clean threads on cylinder head studs.

Install a new head gasket and carefully set head in place on blocks. Install push rods, rocker arm assemblies and stud nuts. Follow sequence shown in Fig. 47 when torquing stud nuts, and tighten to 170-175 ft-lbs. **DO NOT APPLY FULL TORQUE IN ONE APPLICATION.** Instead, tighten stud nuts a little at a time, in indicated sequence, until recommended torque is obtained.

Use special offset wrench (10T19263) when tightening nuts that are inaccessible due to rocker arms.

Adjust valve clearances as described on page 37. Drain and refill crankcase, following recommendations in Lubrication section.

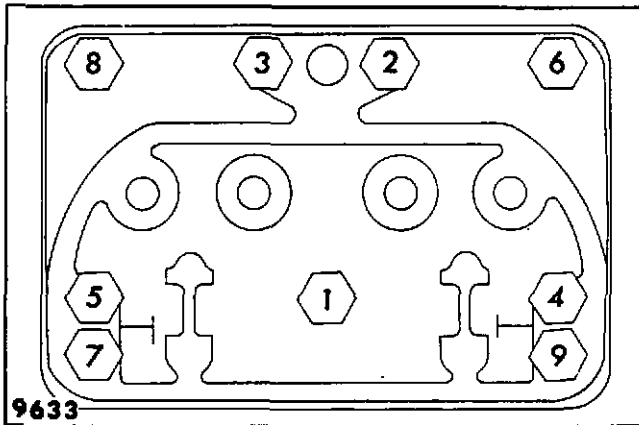


Fig. 47. Cylinder Head Nut Tightening Sequence

### REPLACING REAR ENGINE SEAL

Remove flywheel, seal adapter with seal and gasket. Remove wear sleeve if replacement is required. Separate seal from adapter.

Use RTV sealant 10P3901 sparingly in seal adapter cavity. Press new seal into adapter so that lip will be toward front of engine. If wear sleeve is not being replaced, press seal into adapter so that lip will be 1/8-inch from groove worn in sleeve by old seal when adapter and seal are secured to crankcase. If wear sleeve is being replaced, press seal into adapter until it bottoms. With new gasket between adapter and crankcase, secure adapter and seal to crankcase with cap screws tightened to 22-24 ft-lbs.

Install flywheel and tighten cap screws to 70-75 ft-lbs.

### CONNECTING ROD BEARINGS

To replace rod bearings, base pan must be removed. Turn crankshaft until rod bearing being replaced is at its lowest point. Remove lock nuts and bearing cap. Lower half of bearing will usually come off with cap. Connecting rod and piston can then be pushed up into cylinder far enough to allow upper half of bearing to be removed.

Whenever a bearing is to be replaced, drilled oil hole in crankshaft must be swabbed or blown out so that no gum, dirt or burned out bearing material remains in oil line.

**IMPORTANT:** See information on page 46 regarding crankshaft regrinding.

Connecting rod bearing journals are finished to a factory standard of 3.248" to 3.429".

Check diameter of crankshaft journals with a micrometer. If micrometer readings average .002-.004" undersize, .002" undersize bearing shells should be used. In cases where journals are in excess of .004" undersize, badly scored, tapered or out-of-round, crankshaft must be replaced or reground to correspond with next available undersize bearing insert.

Undersize bearings are available in .010", .020", .030" and .040" for replacement of connecting rod and main bearings.

If journals measure up to dimensions given for an undersize bearing but journal is rough, it should be dressed with crocus cloth.

When installing new bearing shells, make certain that guide lip (Fig. 48) is entered in recess of rod and cap.

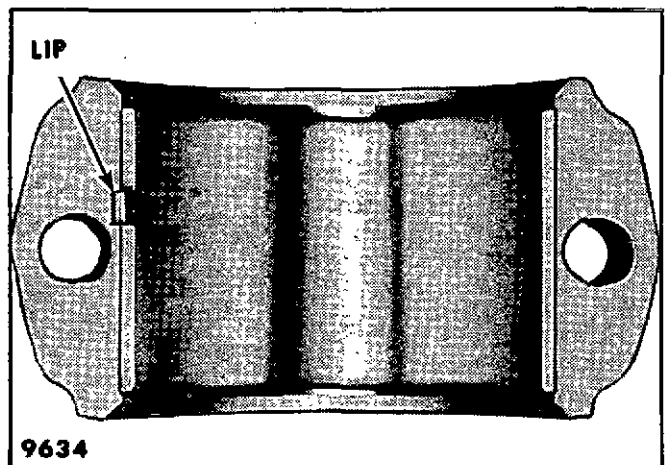


Fig. 48. Bearing Installation

Rods and caps are numbered corresponding to cylinder number. Caps must be installed on correct rods and numbers on rods and caps must be on camshaft side of engine.

**IMPORTANT:** USE NEW NUTS WHEN INSTALLING BEARING CAPS.

Tighten rod bearing nuts to 35-40 ft-lbs torque. This reading is for oiled threads and faces.

**MAIN BEARINGS**

Main bearing journals are finished at factory to a 3.498" to 3.499" standard.

If only one main bearing is to be replaced, it will not be necessary to remove crankshaft. Remove base pan. Remove nuts from bearing studs and loosen bearing cap adjacent to bearing to be replaced. This will release crankshaft enough to allow upper bearing shell to be rolled out around crankshaft.

If shell is pinched, a strip of soft metal may be used as a driver to roll shell around crankshaft and out of recess.

Always roll shells out so that guide lip (Fig. 49) comes out first. When shell has been removed, clean out drilled oil hole in crankshaft.

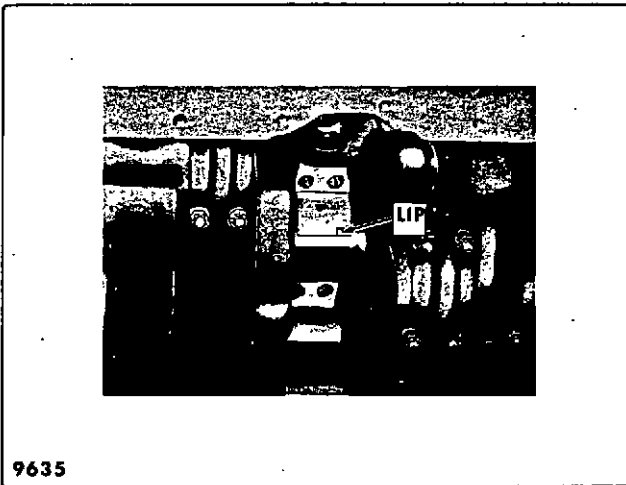


Fig. 49. Main Bearing Removal

When reinstalling new bearing shell, always enter smooth end first, pushing shell around the crankshaft until guide lip seats in recess. Never drive bearing shell into place with a hard metal driver as this can damage shell. After replacing cap, see that nuts are drawn up to correct torque readings and that lock plates are replaced and ear of plate bent against nuts.

Bearing clearance of .0033 to .0053" must be maintained. Check this with Plastigage or a narrow feeler gauge.

Intermediate and rear main bearing caps are marked "Front". They must be installed with mark toward radiator end of engine.

Intermediate bearing caps are interchangeable and are punch marked with one and two dots. When they are installed, they must be installed with punch marks matching punch marks on crankcase.

Torque reading for front main bearing nuts (Fig. 50) is 240 ft-lbs, and for intermediate and rear main bearing nuts 140 ft-lbs. These readings are for oiled threads and faces.

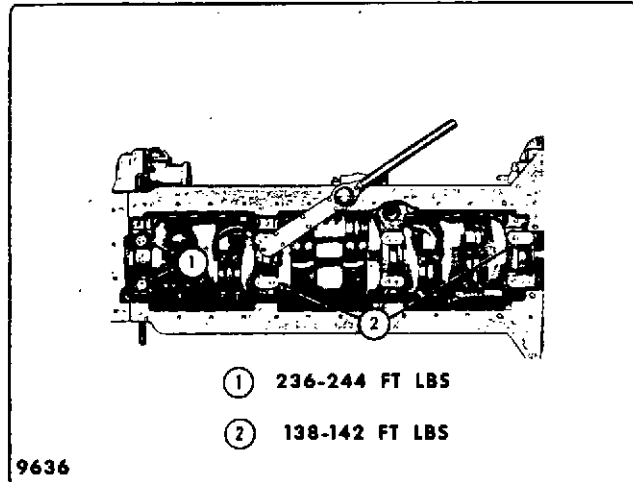


Fig. 50. Torquing Main Bearing Nuts

**CRANKSHAFT AND MAIN BEARINGS**

If it is necessary to install a complete set of main bearings or to regrind crankshaft, remove crankshaft from engine.

Drain cooling and lubricating systems. Remove radiator, fan and generator belts, fan and sheave, spacer and oil seal, starter and generator. If possible, remove engine from its mounts and place it on its right side. Remove base pan and oil pump. Remove water pump, magneto and timing gear cover.

Pull camshaft timing gear from camshaft, remove cap screws from timing gear body and remove body from engine. Remove flywheel, oil seal and adapter, main and rod bearing caps and crankshaft from engine.

If crankshaft journals are badly worn, undersize in excess of .004, or out-of-round, crankshaft must be replaced or reground to correspond to next available undersize bearing. Undersize bearings are available in .010", .020", .030" and .040".

**IMPORTANT:** See information on page 46 regarding crankshaft regrinding.

## MAINTENANCE

If timing gear on front end of crankshaft is worn, it should be replaced. Press new timing gear on shaft with numbered side out.

Install bearing inserts in crankcase bores so that oil holes are toward camshaft side of engine. Be sure inserts are completely seated in bores.

Reinstall crankshaft. Install main bearing caps, checking bearing clearance if it has not been done previously. Bearing clearance must be .0033 to .0053". Tighten main bearing bolts as specified in Fig. 50 and secure by bending ears on locking plates up against nuts.

Check end clearance on crankshaft as shown in Fig. 51. Desired end clearance is from .008 to .012".

Install seal and adapter.

Turn crankshaft until No. 1 and 6 journals are at top of their throw. Install flywheel with DC1-6 mark pointing straight up. Tighten flywheel mounting bolts to 70-75 ft-lbs.

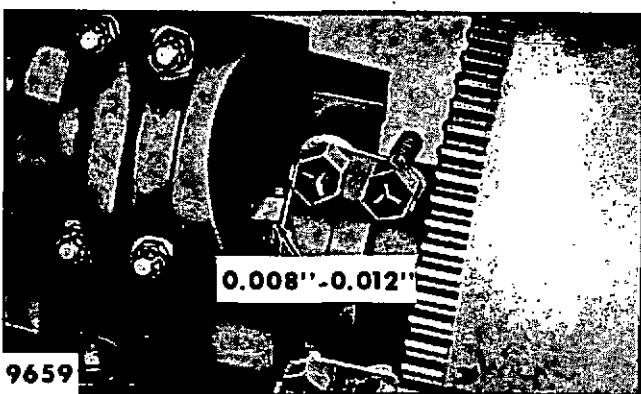


Fig. 51. Checking End Play

Use a new gasket and bolt timing gear body to front of engine. Install locking plate under inside cap screws. Check condition of camshaft gear. If teeth are badly worn, gear should be replaced. Press gear onto camshaft with numbered side out. Tooth marked "1" on crankshaft gear (Fig. 52) must fit into tooth space marked "1" on camshaft gear. Secure camshaft gear with large washer and cap screw. Install a new oil seal on crankshaft.

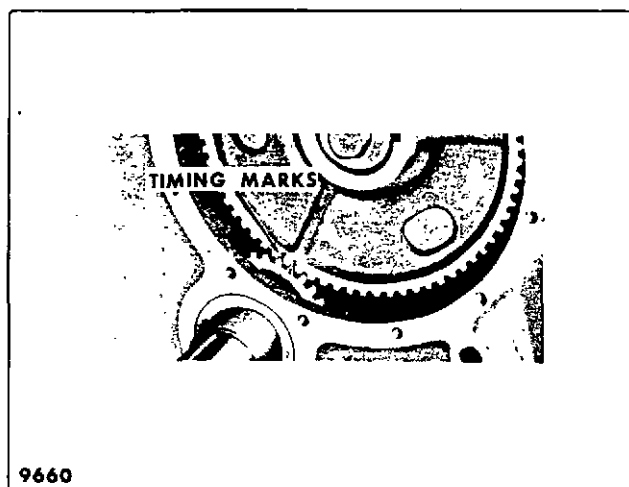


Fig. 52. Timing Marks

### PISTONS AND RINGS

Measure pistons for wear. Major diameter of pistons is 5.3130-5.3120". If piston is worn more than .008", it should be resized or replaced. These pistons are cam ground, so all measurements must be made of major diameter, or 90° from pin bore.

Recommended clearance between cylinder wall and piston skirt is .007 to .009". To check clearance, install piston in its original bore, in inverted position, together with a 1/2-inch wide, .008" thick feeler gauge that is long enough to extend into bore full length of piston. Be sure to locate the feeler gauge 90° from pin bore. Pull feeler strip out with a spring scale. A pull of 4 to 6 pounds (maximum 6 pounds) should be required to withdraw feeler gauge.

Maximum allowable clearance for worn parts is .012". If clearances are found to be excessive, blocks must be replaced or cylinders rebored to accept next available oversize piston.

Clean all carbon from ring grooves with a groove cleaner or a broken section of ring and check grooves for wear. Listed below are allowable clearances between ring and ring grooves. If clearances exceed these dimensions pistons should be replaced. Worn grooves will allow oil to pass between piston and rings resulting in excessive oil consumption.

Groove No. 1 (Top) .....	.0025-.0045"
No. 2 .....	.0025-.0045"
No. 3 .....	.0025-.0045"
No. 4 (cast iron oil ring) .....	.002 -.004"

**PISTON RINGS**

Piston ring sets are available in standard .020", .040" and .060" oversize to correspond with piston sizes. Ring gaps must be staggered 180° on adjacent rings.

Ring gap must be .017" to .032" when ring is inserted in cylinder bore. Insert ring and push it down with piston. This prevents canting ring in cylinder.

If cylinder has a ridge around the top, it should be removed with a ridge reamer. Cylinder walls should be de-glazed and cleaned thoroughly so that new rings will seal properly.

**PISTON PINS**

Check piston and rod assembly. If piston pin play is evident, remove snap ring retainer and slip pin out of piston and rod.

Any time piston is removed from rod, it should be marked or identified in some manner so that it can be replaced on same rod and in same cylinder.

Connecting rods are offset at pin end. When reinstalling rod and piston assemblies, be sure wide offset on each rod is toward end of block (Fig. 53).

If pin fits rod bushing correctly, but is loose in piston, hone piston and bushing to correct size for an oversize pin.

If pin fits piston correctly but is loose in rod bushing, remove old bushing and press in a new one. Make certain oil hole in bushing lines up with oil hole in rod. After pressing new bushing in place, hone it to correct size.

Bore of rod bushing for a standard pins in 1.7506" to 1.7509". Pin bore in piston for standard pins is 1.7498" to 1.7500" at normal room temperature of 70° F. For oversize pins, add .005" or .010", as applicable.

Pin fit in piston should be loose with piston and pin at normal room temperature of 70° F. Piston should rock on rod without binding. Secure pins with snap ring retainers, making certain snap rings fit into grooves.

Standard pin O.D. -----1.7495/1.7494

**CONNECTING RODS**

Whenever any work is done on pistons, pins, or rod bushings, rod must be carefully checked for twist or misalignment. Place rod in a rod aligning fixture, check for any distortion, and make any necessary adjustments with aligning tool.

**CYLINDER BLOCKS**

To remove blocks, base pan must be removed. Remove place bolts. If crankshaft is not removed, use a long extension and a universal joint and socket.

If rods have been removed, place a shield of some sort (such as a split section of rubber hose) around crankshaft journals to prevent damage.

Engine cylinders in this unit are finished at factory to a 5.320 - 5.321" standard. If bore is found to be worn, tapered or out-of-round in excess of .008", block should be replaced or cylinders rebored.

When reboring cylinders, it is necessary that reboring be done from bottom of block. All factory machining operations are lined up from bottom, and to duplicate factory alignment, it will be necessary to place boring bar on two 1-1/2" x 4" parallel bars.

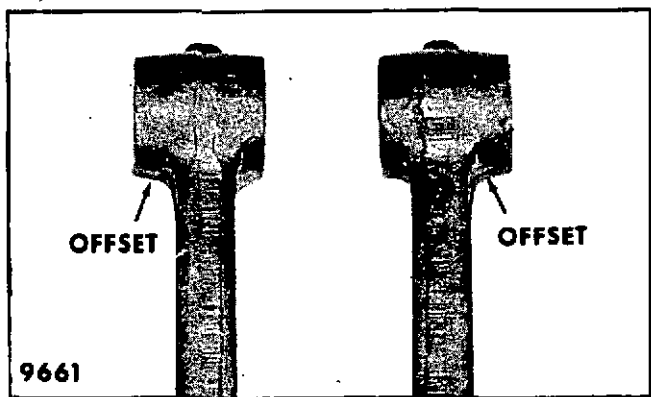


Fig. 53. Connecting Rod Installation

If pin fits loosely in both bushing and piston, pin may be worn. Check piston and rod with a new pin. If new pin is also loose, an oversize pin must be used and piston and bushing honed to correct size for new pin. Piston pins are available in standard, .005" and .010" oversize.

Pistons are available for unit in standard, .020", .040", and .060" oversize. To obtain correct fit for oversize pistons, cylinders must be bored to 5.340-5.341", 5.360-5.361" or 5.380-5.381" as applicable.

When reinstalling blocks, use new gaskets. Tighten place bolts inside crankcase evenly to 170-175 ft-lbs.

### CAMSHAFT

To remove camshaft, remove rocker arm assemblies and push rods, keeping push rods in their original order. Use a piece of wire inserted down through each push rod hole to hold tappets up so that they will clear camshaft lobes and bearing journals when camshaft is removed.

Two front bearing surfaces of camshaft turn in bushings in crankcase. Nominal inside diameter of front bushing is 3.344-3.342", and second 3.3135-3.3115". Bearing clearance for No. 1 and 2 is .002 to .007"; for No. 3 and 4, .003 to .005". If wear on bushings exceeds .005-.008", there will be excessive play on camshaft and possible damage to timing gears. To replace bushings, press out old ones and press in new (Fig. 54).

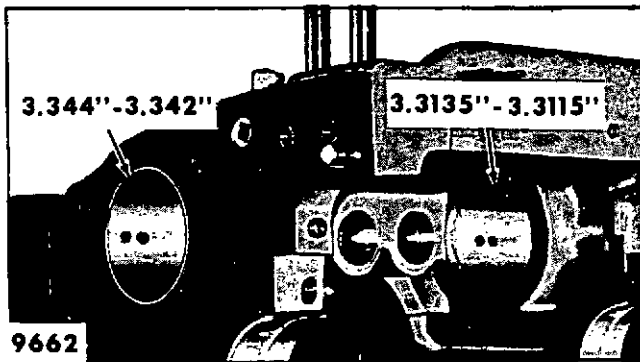


Fig. 54. Camshaft Bushings

Replacement bushings are precision reamed during manufacture and require no further machining after assembly, provided they are not damaged during installation.

When reinstalling camshaft, remember to time camshaft gear with crankshaft gear (No. 1 tooth in No. 1 tooth space).

After the camshaft is installed, apply a coat of Molybdenum disulfide grease to the cam lobes to provide initial lubrication between the lobes and lifters when the engine is first started.

### CAMSHAFT END PLAY

Camshaft should have .010-.025" end play. To adjust, loosen lock nut shown in Fig. 55, turn adjusting screw all the way in, then back screw out approximately 1/4 turn to obtain proper end play. Tighten lock nut.

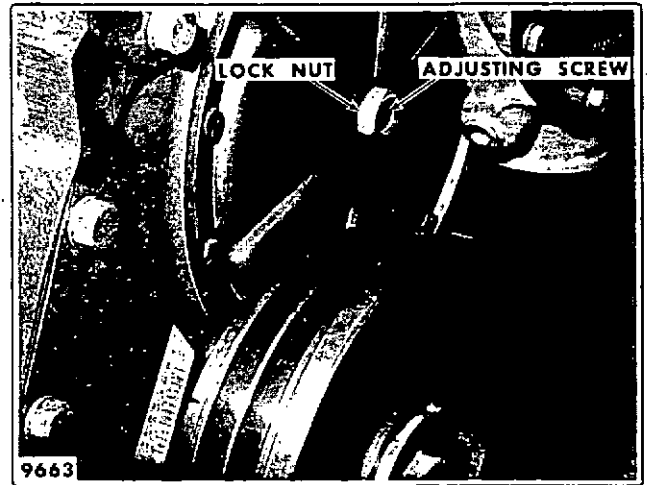


Fig. 55. Camshaft End Play Adjustment

### PTO CLUTCH

If satisfactory clutch adjustments can no longer be obtained, it indicates that driving plates are badly worn and must be replaced.

To gain access to clutch plates, it will be necessary to remove complete clutch assembly from engine. Remove bolts securing clutch housing to flywheel housing. Install a fairly long 1/2"-13 bolt in tapped hole in each side of bell housing. Turn bolts in evenly to force clutch housing away from flywheel housing.

Pull pilot bearing from shaft. Straighten bent over portion of lock washer and remove nut and washer.

Disconnect grease tube from shifter collar. Install a 5/8"-11 bolt in each tapped hole in clutch backing plate and attach a suitable puller. Remove clutch assembly from shaft.

Before removing floating plate and sliding sleeve assembly, check fit of shifting collar on sleeve. Collar should fit snug on sleeve with no evidence of drag.

If collar is loose on sleeve and shims are installed between collar halves, remove shims to obtain proper fit. If collar is worn so that it is loose with shims removed, replace collar.

## MAINTENANCE

Depress lock pin for clutch adjusting ring, unscrew ring and remove floating plate, shifter collar and linkage. Remove driving plates and center plate.

To remove power shaft bearings, remove lock clip and unscrew bearing adjusting nut. Drive shaft and inner bearing cup out of housing. Use a long punch to drive out other cup.

Install new bearings and cups if worn or damaged. With new bearings installed, tighten adjusting nut (Fig. 56) to obtain from .010 to .016" end play on shaft.

Install new driving plates on backing plate. In order to properly align teeth on driving plates to those on driving ring, remove driving ring from flywheel and use it as aligning tool. Be sure to mark driving ring in relation to flywheel so that it can be reinstalled in its original position.

With clutch parts reassembled and clutch disengaged, position driving plates so that teeth mesh properly inside driving ring and are centered with shaft. Engage clutch to hold plates.

Install clutch assembly on shaft engaging shifting forks with shifting collar as clutch enters housing. Tighten clutch retaining nut securely and lock in place by bending washer over one of flats on nut.

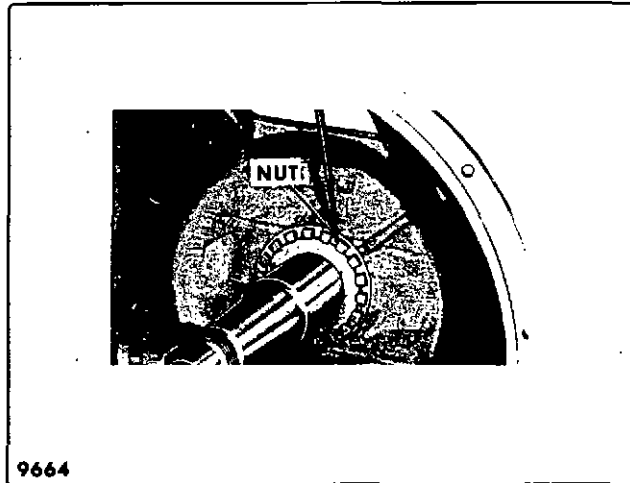


Fig. 56. Bearing Adjusting Nut

Install a new pilot bearing on shaft if original one was unsuitable for further use. Install bearing so that open side will enter flywheel (sealed side toward nut).

Reinstall driving ring on flywheel, aligning marks made when ring was removed. Reinstall clutch housing assembly. Adjust clutch as explained on page 18.

## MAINTENANCE

### CRANKSHAFT

Crankshaft has a tufftrided or melonized bearing surface and cannot be ground for undersize bearings unless facilities are available for re-tufftriding. Crankshafts can be identified by their overall black color. Crankshafts ground 0.010 undersize and tufftrided can be purchased from MMEC on an exchange basis.

**CAUTION:** Re-grinding beyond 0.010 undersize and subsequent tufftriding is a specialized operation requiring special care and preparation. Do not undertake regrinding without first consulting facility which will re-tufftride the crankshaft.

# WORK SAFELY

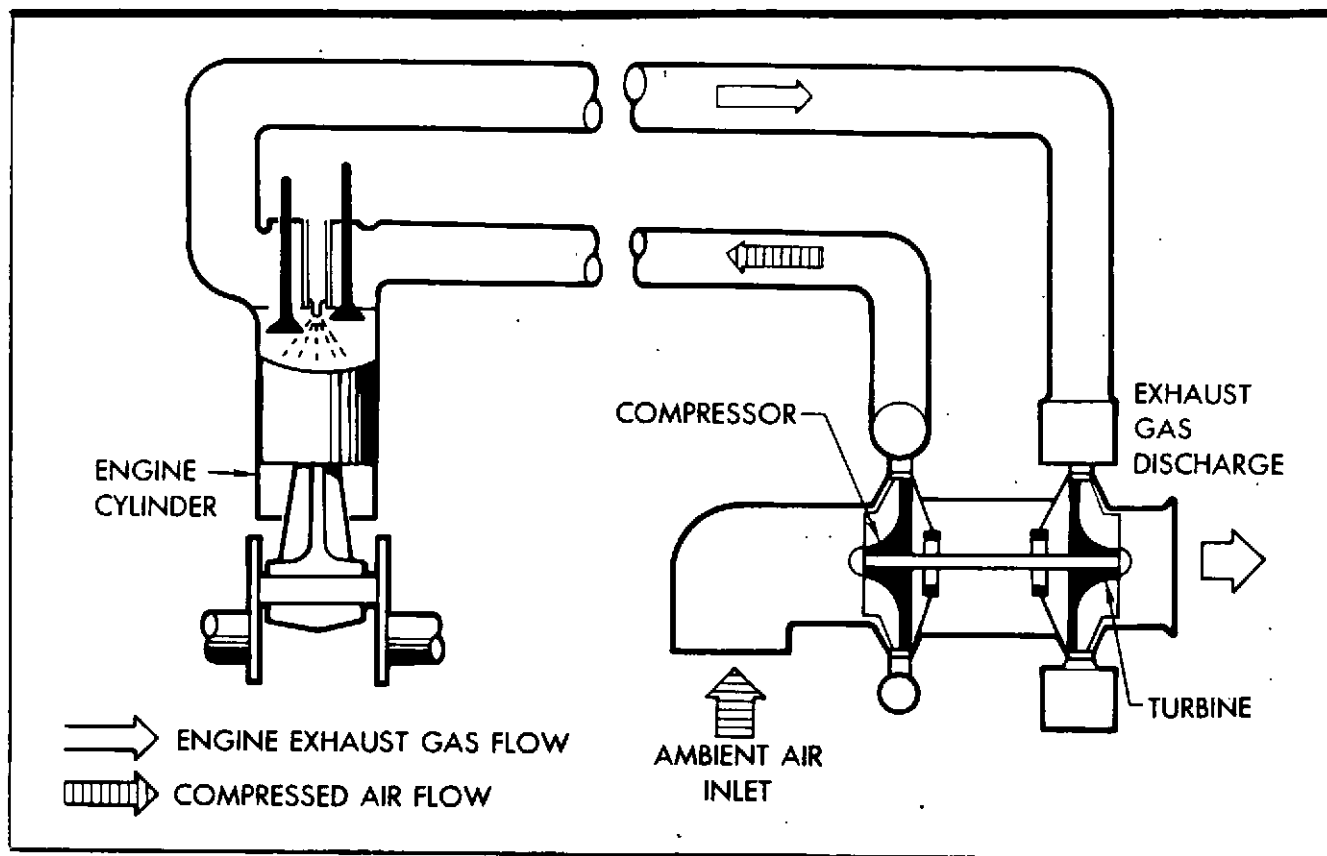


Fig. 57 Turbocharger Operation

### TURBOCHARGER

The turbocharger, mounted on the exhaust manifold is designed to increase power output and efficiency of an engine by supplying a compressed air-fuel mixture into the engine cylinders. (Fig. 57)

Principal components of a turbocharger are a rotating assembly with turbine and compressor wheels at opposite ends of a common shaft; a center housing, a turbine housing, and a compressor housing. Turbine wheel and shaft are integral. Shaft is supported by two floating sleeve type bearings. (Fig. 59)

Exhaust gases emitted from the engine are routed through the turbine housing, causing

the turbine wheel to rotate. The compressor wheel, which is mounted on a common shaft with the exhaust turbine wheel, rotates drawing in ambient air-fuel mixture from the mixing chamber. This air-fuel mixture is compressed and supplied to the combustion chamber via the intake manifold. The amount of the air-fuel mixture drawn into the intake manifold is controlled by a throttle butterfly valve located where the compressor outlet tube joins the intake manifold.

Air pressure created by the turbocharger is greater than atmospheric pressure, thus, the quantity of air placed in the combustion chamber is greater as opposed to a naturally aspirated engine. With a greater supply of the air-fuel mixture in a turbocharger engine, the combustion

process will result in an increased power output. (Fig. 57) As engine output increases, the flow of exhaust gas is increased, speed of rotating assembly, quantity of air-fuel mixture and charging (boost) pressure increase proportionately. The maximum charging (boost) pressure (5 psi) is controlled by a regulating valve mounted on the front end of the exhaust manifold. This regulating valve controls maximum boost pressure by sensing compressor outlet pressure. When the compressor outlet pressure exceeds the preset rate of the spring in the diaphragm on the regulating valve, the valve opens and diverts exhaust gases around the turbine wheel, directly out the exhaust pipe.

### LUBRICATION

Bearing and thrust plate are pressure lubricated by oil from engine oil gallery through passages in center housing and thrust plate (Fig. 59) A piston ring and series of lands prevent lube oil from entering compressor housing. Oil is directed back into center ring of thrust collar. Center ring acts as a centrifugal pump, forces oil back into housing through radial drilled holes in outer edge of ring. Backplate, bolted to housing, absorbs thrust and channels lubricant to thrust bearing surfaces and turbo reservoir. Oil pressure is dissipated upon reaching radial bearings and is gravity discharged to crankcase through an external oil line (Fig. 58)

Unit has floating sleeve type bearings in which oil clearance is provided between bearing and housing as well as oil clearance between bearing and shaft. When turbocharger is operating, this allows bearings to turn as shaft rotates (Fig. 59) CAUTION: Clean engine oil is imperative to life of turbocharger.

Check engine specifications section for oil gallery pressure. Oil pressure at turbocharger must be a minimum of 10 psig at idle.

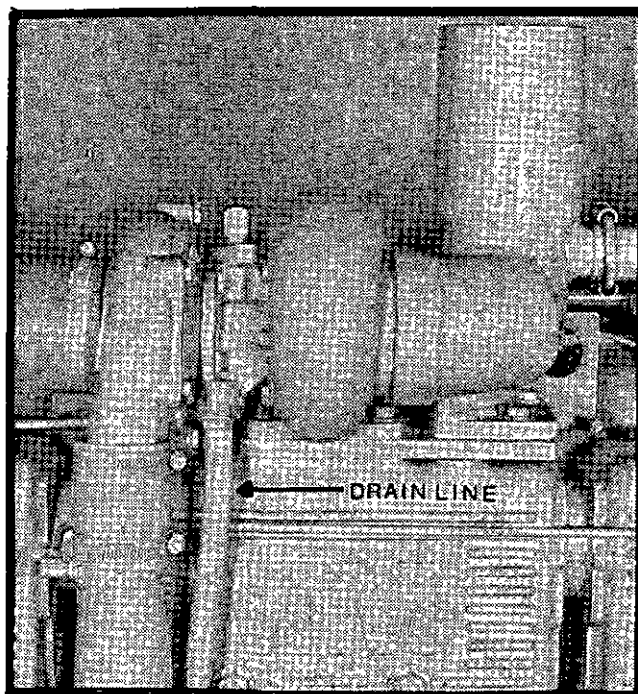


Figure 58. Turbocharger Drain Line

### SPECIAL INSTRUCTIONS FOR TURBOCHARGED ENGINES

Follow these special operating instructions when operating a turbocharged engine.

1. After starting engine do not accelerate or apply load until there is positive indication of oil pressure.
2. After starting during cold weather, allow engine to run five minutes at half throttle to insure oil pressure at turbocharger before putting engine under load.
3. Before stopping engine, allow it to run at near slow idle speed for a few minutes to allow internal engine temperature to normalize. Failure to do this can damage turbocharger, oil in center section may "coke" causing oil passages to clog. Should engine stall when operating at normal operating temperature, restart it immediately.

CAUTION: When transporting a turbocharged engine in an open conveyance, cover exhaust outlet to prevent entrance of foreign matter and possible rotation of turbocharger. Rotation of turbocharger could damage rotor bearings due to lack of lubrication. When engine is not operating, cover exhaust outlet to prevent entrance of water or other foreign matter.

### TURBOCHARGER MAINTENANCE

Field service of turbochargers used on the THD800 power units is limited to cleaning the assembly or replacing complete units. Whenever major service becomes necessary, take the turbocharger to an authorized turbocharger service station that has proper facilities and specialized equipment for overhauling and testing turbochargers.

NOTE: Life of a turbocharger depends greatly upon conditions under which it operates. On compressor side, there are definite limits on permissible dirt-oil-accumulation, acceptable air-cleanliness and air-supply restriction; let any one or a combination of these conditions exceed specified limits, and in all probability failure will be the result.

When turbocharger malfunction is suspected it is important to remember that turbochargers can not compensate for other engine problems and cannot tolerate certain types of abuse. If turbocharger is replaced without determining cause of failure and taking corrective action, failure will no doubt reoccur. Turbocharger failures can be grouped into five categories!

1. Excessively high exhaust temperatures .
2. Lack of lubricating oil.
3. Contaminated oil.
4. Foreign material in intake or exhaust system.

5. Defects in material or workmanship.

When removing turbochargers care should be exercised to avoid losing evidence such as loose intake clamps or oil line restrictions.

In order to prevent reoccurrence of failure turbochargers should never be removed without being examined to determine cause of failure. Careful examination along with some logical reasoning devoted to determine sequence of failure can reveal primary cause of failure. Often times, part that is most severely damaged was not part that failed first. Careful analysis can not only explain cause of turbocharger failure but can also prove that other engine problems exist.

The following steps are provided to assist when determining if turbocharger has failed and if so, why.

1. Inspect mounting and connections of turbocharger to be certain they are secure and there is no leakage of oil or air.
2. Check engine crankcase breather and vent lines to be sure there is no restrictions to air flow.
3. Operate engine at approximately rated output and listen for unusual turbocharger noise. If a shrill whine (other than normal) is heard, stop engine immediately, bearing failure is imminent. Remove turbocharger for overhaul.

NOTE: Do not confuse whine heard during "rundown", as engine stops, with a bearing failure during operation.

Other unusual turbocharger noises could mean improper clearance between turbine wheel and housing. If such noises are heard turbocharger must be removed, disassembled and inspected.

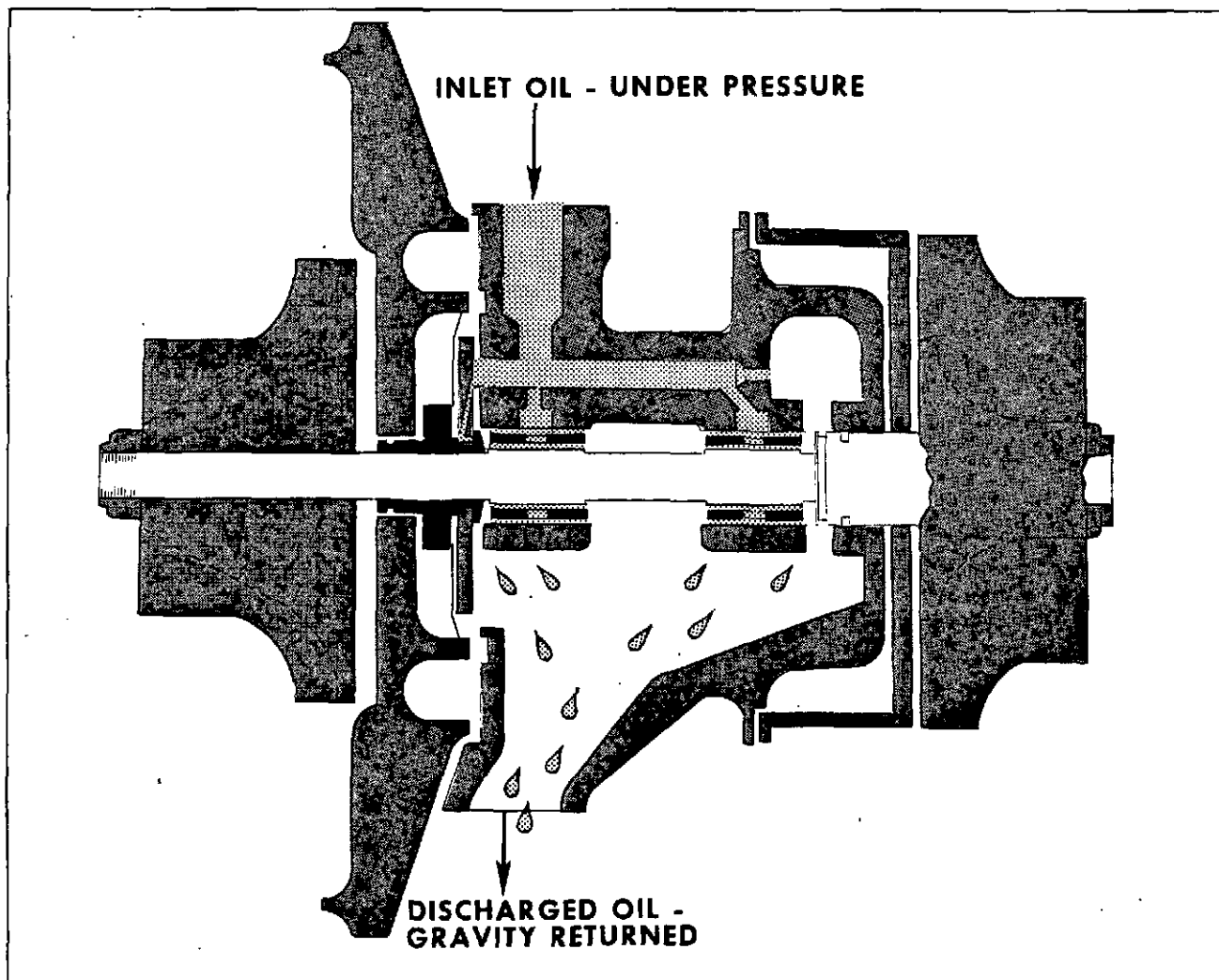


Fig. 59 Turbocharger Cross Section

4. Check turbocharger for unusual vibrations while engine is operating at rated output. If excessive vibration is evident, remove, disassemble and inspect.
  5. Check engine under loaded conditions. Low boost pressure may indicate not enough fuel-air mixture. This could be due to engine overload, turbocharger, or boost pressure regulator malfunction.
  6. Inspect and service engine air cleaner according to instructions in operator's manual.
  7. Check manifold connections to turbine inlet and exhaust gaskets for air leaks. Make inspection with engine shut off and with engine running.
- CAUTION:** Do not operate turbocharger if leak exists in ducting or if air cleaner is not filtering efficiently. Dust leaking into air ducting will damage engine.
8. Remove air inlet duct and compressor housing and check for dirt or dust build-up. Remove all such foreign matter, determine and correct cause of build-up. Uneven deposits left on impeller can affect rotor balance and

cause bearing failure.

9. With compressor housing removed, push impeller toward turbine wheel end and turn rotating assembly by hand; check for binding or rubbing. If binding or rubbing is evident, remove turbocharger for disassembly and inspection.



**WARNING** - The air-fuel mixture being compressed by the turbocharger will burn. If an air-fuel mixture leak should develop in the turbocharger system immediately STOP the engine, find source of air-fuel leak and repair it. Consult your dealer or distributor for more information.

**CAUTION:** Always make sure there is oil in the turbocharger before allowing the rotor assembly to turn. When installing a new or rebuilt turbocharger, prefill the inlet oil cavity with fresh clean motor oil. Disconnect the supply line at the turbocharger and crank the engine until oil appears, connect line and start the engine. Allow the turbocharger to operate at rated load and speed for awhile to dry up any residue oil that might have leaked in housings during the prefilling.



***WORK SAFELY***

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NOTES

## STORAGE

### PREPARING UNIT FOR STORAGE

To help prevent unnecessary deterioration of power unit due to cold weather, blowing snow, dust or rain during extended storage periods, following procedure is recommended:

Drain crankcase oil when warm and change oil filter. Refill crankcase with recommended lubricant. Use medium detergent oil in crankcase during periods of extended storage. If low ash oil is used, add two cans of 20-700 0967 Engine Preservative. Operate engine for a short time to circulate new oil through engine. NOTE: Use ashless or low ash engine oil during operating season.

Remove rocker arm covers and flush rocker arms, valve springs etc., with same oil as used in engine. Apply engine oil or preservative to all exposed linkages, clevises, etc., to afford protection against rusting and corrosion.

Use of permanent antifreeze is recommended in all engines equipped with radiator or cooling coils rather than draining. If cooling system is drained, reinstall all hoses and close all drains to prevent entry of foreign material. Drain fuel vaporizer and lines if unit is so equipped.

Service air cleaner by cleaning element and wiping out body with clean dry cloth. If unit has oil bath air cleaner, clean thoroughly and refill cup with clean oil.

Remove spark plugs and pour or squirt two tablespoons of engine preservative or clean engine oil into each cylinder. Turn engine over several times to distribute preservative on cylinder walls and piston tops. Dip spark plug

electrodes and threads in clean engine oil and reinstall in cylinder head.

Remove battery, if unit is so equipped, and store in a cool, dry place, preferably on a wood platform. Clean battery and cable ends and apply clean grease to prevent corrosion. Battery should be fully charged when placed in storage and maintained in this condition by periodical recharging.

Relieve tension on fan belts and slip a piece of paper between pulley and belt to retard belt deterioration.

Remove distributor cap and apply light film of petroleum jelly to breaker cam lobes. Reinstall cap and seal breather hole with waterproof tape to prevent entry of moisture.

Thoroughly inspect unit and make note of items such as hoses, belts, wires, etc., that should be replaced prior to returning unit to service. Carefully examine intake and exhaust manifolds for cracks and replace, if necessary, prior to placing unit in storage.

Seal exhaust pipe, exhaust manifold joints, air cleaner opening, crankcase breather and all other openings that could admit blowing snow, dust or rain, using a heavy plastic tape such as heating duct tape. Avoid using rags to seal openings as rags will draw moisture.

If unit has clutch, place clutch lever in disengaged position to prevent possibility of clutch lining sticking to driving plates.

If possible, cover unit with a suitable tarpaulin, tying it down securely to prevent it from being blown off.

## STORAGE

### RETURNING UNIT TO SERVICE AFTER STORAGE

Remove all sealing material from openings, including distributor breather hole.

Remove distributor cap and carefully wipe preservative from breaker cam lobes. Apply light film of distributor cam lubricant to cam lobes. Check condition of breaker points and replace if necessary. Adjust gap.

Remove spark plugs, pour two tablespoons of engine oil into each cylinder and turn engine over several times to assure free engine rotation. Clean and re-gap spark plugs; replace if defective.

Drain storage oil from crankcase and refill with recommended low ash oil of proper seasonal grade. Oil filter change is not necessary at this time if new filter was installed when unit was prepared for storage.

Refill cooling system with proper seasonal coolant if system was drained. Check for leaks. Adjust fan belt tension.

Service air cleaner, replacing dry element if used. Refill oil cup of oil bath air cleaner with clean oil.

Reinstall battery being sure all terminals are clean.

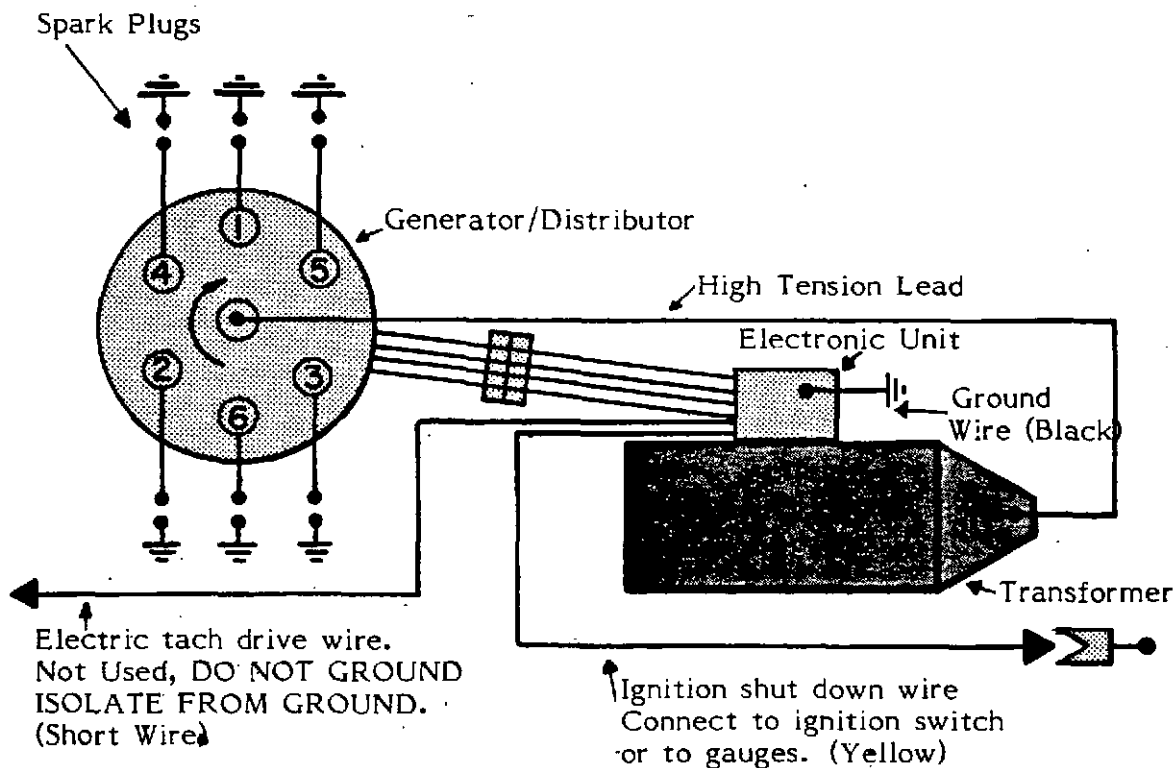
Start engine and operate at low idle. Check oil pressure gauge. Operate engine at 1000 RPM until operating temperature is reached, keeping close watch on oil and coolant temperature gauges. Check unit for oil or coolant leaks.

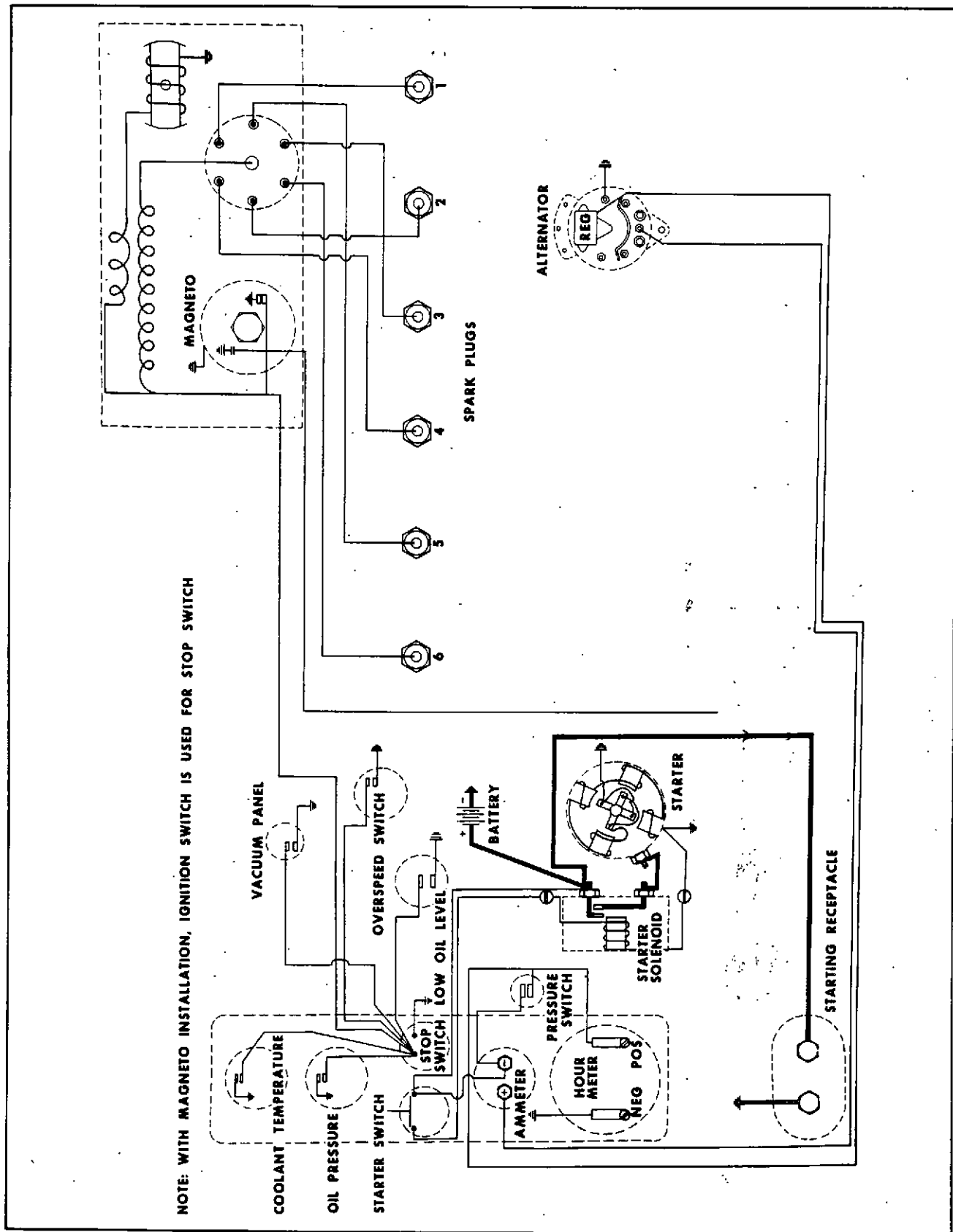
Check engine timing, governor function and fuel adjustments.

Apply load and increase engine to operating speed.

### WIRING DIAGRAM

#### AMERICAN BOSCH MCD-SEMI LOW TENSION BREAKERLESS MAGNETO

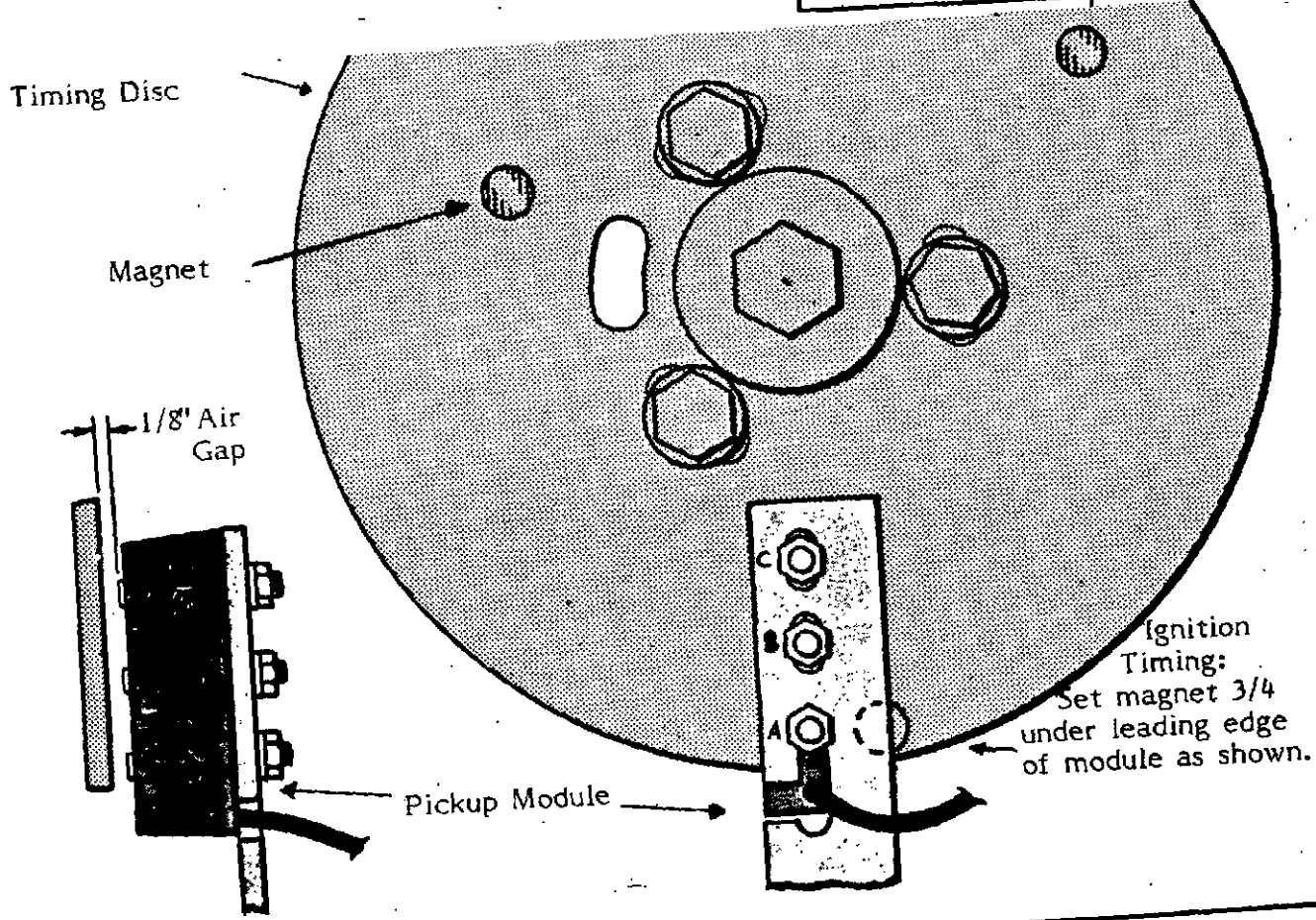
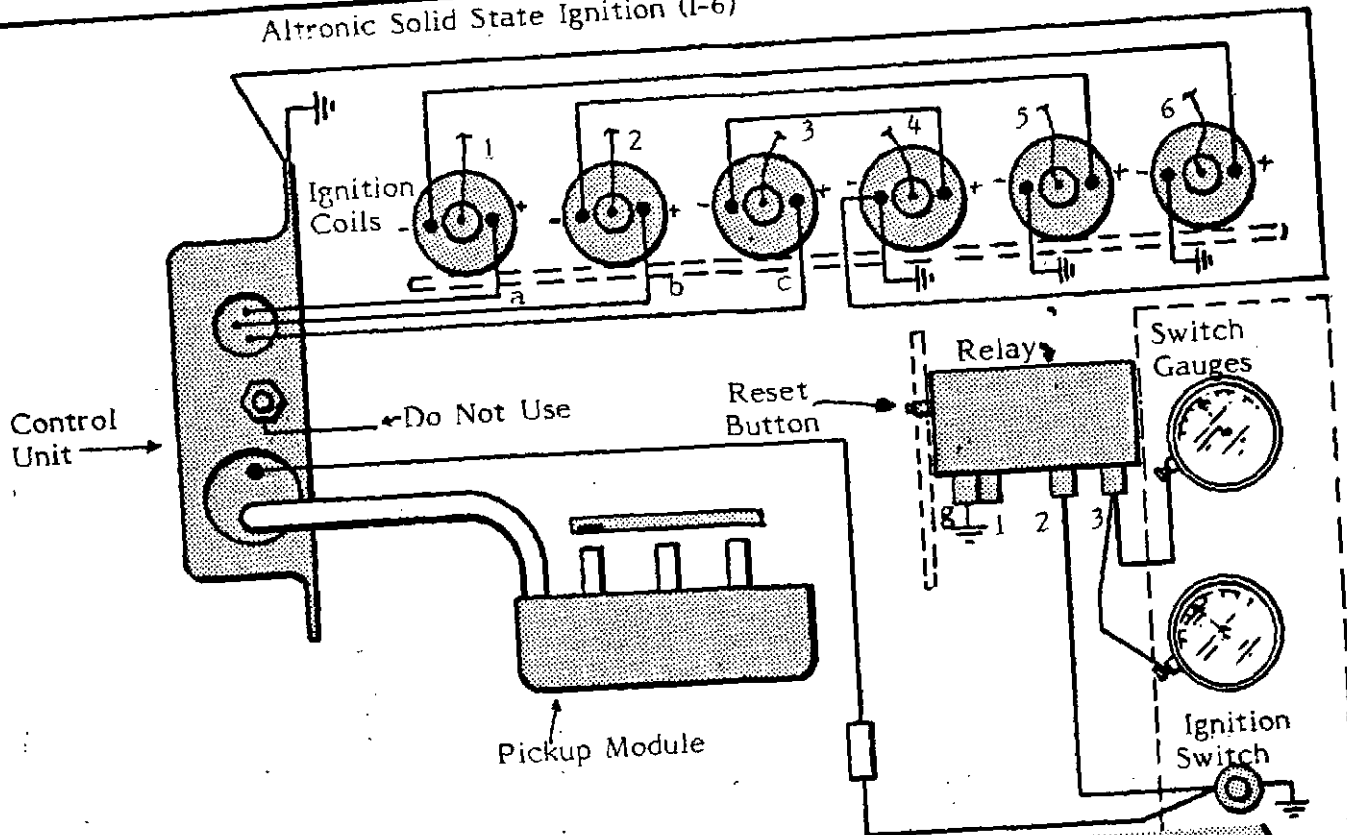




Wiring Diagram - Magneto Ignition

# WIRING DIAGRAM

## Altronic Solid State Ignition (I-6)







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# NOTES

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Post-Office Box 788

Russellville, Arkansas 72801



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