Onan®

OPERATOR'S/SERVICE MANUAL AND PARTS CATALOG

FOR
SERIES

NHC-NHCV
INDUSTRIAL ENGINES

Literature File Copy

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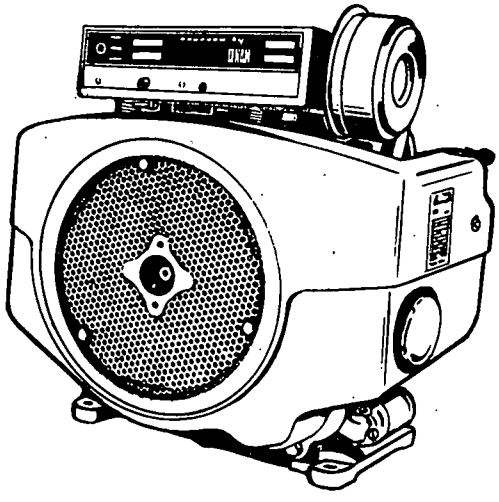
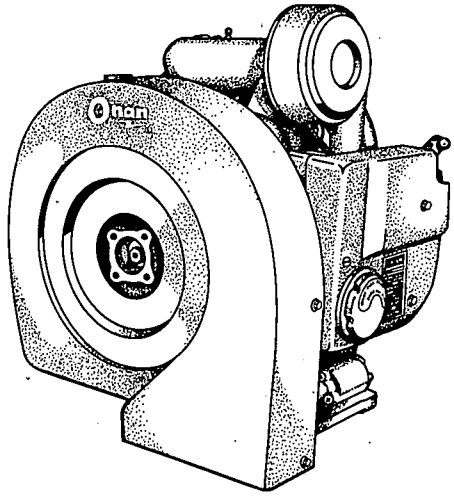
add OIL SYSTEM





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By Will

INTRODUCTION

THIS OPERATOR'S MANUAL CONTAINS INFORMATION PERTAINING TO THE OPERATION AND MAINTENANCE OF YOUR UNIT.

WE SUGGEST YOU KEEP THE MANUAL AND THE WIRING DIAGRAM WHICH ACCOMPANIES EVERY UNIT AND REFER TO IT WHEN MAKING EQUIPMENT ADJUSTMENTS OR ORDERING PARTS. ADDITIONAL COPIES ARE AVAILABLE FOR A NOMINAL CHARGE FROM YOUR DISTRIBUTOR.

WHEN ORDERING PARTS, REMEMBER TO INCLUDE THE MODEL, SPECIFICATION LETTER, AND SERIAL NUMBER LOCATED ON THE UNIT NAMEPLATE. THIS IS ESSENTIAL TO ENSURE THE CORRECT PART IS SHIPPED TO YOU.

FOR REPAIR SERVICE, CONTACT YOUR AUTHORIZED SERVICE REPRESENTATIVE.

WARNING

TO AVOID POSSIBLE PERSONAL INJURY OR EQUIPMENT DAMAGE, AN AUTHORIZED SERVICE REPRESENTATIVE MUST PERFORM ALL SERVICE.

GENERAL INFORMATION

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This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of the engine. Since the first and most important part of repair work is the correct diagnosis of the trouble, a troubleshooting chart is included.

Study and follow the instructions carefully. Proper service and maintenance will result in longer engine life and better performance.

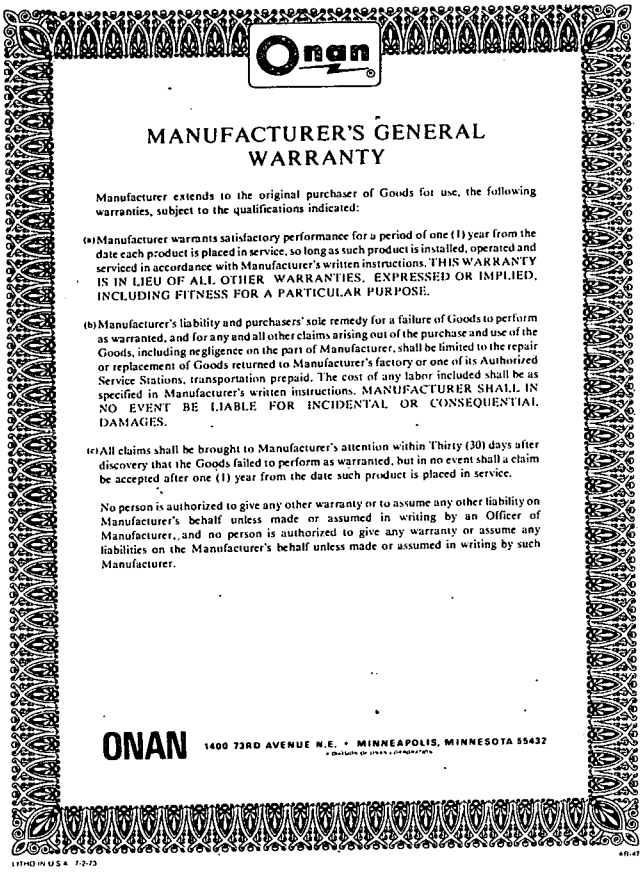
How to interpret *MODEL* and *SPEC NO.*

NHC - MS / 123 A

1 2 3 4

1. Factory code for general identification purposes.
2. Specific Type:
   S—MANUAL starting

   MS—ELECTRIC starting
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.



Onan

MANUFACTURER'S GENERAL WARRANTY

Manufacturer extends to the original purchaser of Goods for use, the following warranties, subject to the qualifications indicated:

(a) Manufacturer warrants satisfactory performance for a period of one (1) year from the date each product is placed in service, so long as such product is installed, operated and serviced in accordance with Manufacturer's written instructions. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING FITNESS FOR A PARTICULAR PURPOSE.

(b) Manufacturer's liability and purchasers' sole remedy for a failure of Goods to perform as warranted, and for any and all other claims arising out of the purchase and use of the Goods, including negligence on the part of Manufacturer, shall be limited to the repair or replacement of Goods returned to Manufacturer's factory or one of its Authorized Service Stations, transportation prepaid. The cost of any labor included shall be as specified in Manufacturer's written instructions. MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

(c) All claims shall be brought to Manufacturer's attention within Thirty (30) days after discovery that the Goods failed to perform as warranted, but in no event shall a claim be accepted after one (1) year from the date such product is placed in service.

No person is authorized to give any other warranty or to assume any other liability on Manufacturer's behalf unless made or assumed in writing by an Officer of Manufacturer, and no person is authorized to give any warranty or assume any liabilities on the Manufacturer's behalf unless made or assumed in writing by such Manufacturer.

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IMPORTANT! RETURN WARRANTY CARD ATTACHED TO UNIT.

SAFETY PRECAUTIONS

The following symbols in this manual signal potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

WARNING **Onan uses this symbol throughout this manual to warn of possible serious personal injury.**

CAUTION **This symbol refers to possible equipment damage.**

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

- **Use Extreme Caution Near Gasoline, Gaseous Fuel And Diesel Fuel. A constant potential explosive or fire hazard exists.**

  Do not fill fuel tank near unit with engine running. Do not smoke or use open flame near the unit or the fuel tank.

  Be sure all fuel supplies have a positive shutoff valve.

  Fuel lines must be of steel piping, adequately secured and free from leaks. Do not use copper piping on flexible lines as copper becomes hardened and brittle. Use black pipe on natural gas or gaseous fuels, not on gasoline or diesel fuels. Piping at the engine should be approved flexible line.

  Have a fire extinguisher nearby. Be sure extinguisher is properly maintained and be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications. Consult the local fire department for the correct type of extinguisher for various applications.

- **Guard Against Electric Shock**

  Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.

  Jewelry is a good conductor of electricity and should be removed when working on electrical equipment.

  Use extreme caution when working on electrical components. High voltages cause injury or death.

  Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician.

- **Do Not Smoke While Servicing Batteries**

  Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

- **Exhaust Gases Are Toxic**

  Provide an adequate exhaust system to properly expel discharged gases. Check exhaust system regularly for leaks. Ensure that exhaust manifolds are secure and not warped.

  Be sure the unit is well ventilated.

- **Keep The Unit And Surrounding Area Clean.**

  Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

  Dispose of oily rags. Keep the floor clean and dry.

- **Protect Against Moving Parts.**

  Avoid moving parts of the unit. Loose jackets, shirts or sleeves should not be permitted because of the danger of becoming caught in moving parts.

  Make sure all nuts and bolts are secure. Keep power shields and guards in position.

  If adjustments *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

  Do not work on this equipment when mentally or physically fatigued.

SPECIFICATIONS

Number of Cylinders	2
Displacement (cubic inch)	60
Cylinder Bore	3-9/16 in.
Piston Stroke	3 inch
Horsepower—NHC (Pressure Cooled)	25 BHP @ 3600 rpm
Horsepower—NHCV (Vacu-Flo Cooled)	22.5 BHP @ 3300 rpm
Compression Ratio	7.0 to 1
Ventilation Required (cfm @ 3600 rpm) NHC	1080
(cfm @ 3600 rpm) NHCV	1200
Oil Capacity	3-1/2 quart
Oil Capacity with Filter Change	4 quart
Starting	Electric
Ignition	Battery
Combustion Air (cfm @ 3600 rpm)	80
Fuel	Gasoline (regular grade)
Fuel Pump	Diaphragm, 4 ft. lift
Battery	12 Volt

TUNE-UP SPECIFICATIONS

Spark Plug Gap	.025-inch
Breaker Point Gap	.016-inch
Ignition Timing (Fixed), Electric Start Units	20° BTC
Tappets (Cold) Intake	.003-inch
Exhaust	.012-inch

DIMENSIONS AND CLEARANCES

All clearances given at room temperature of 70° F.
All dimensions in inches unless otherwise specified.

	Minimum	Maximum
Valve Stem in Guide—Intake	0.0010	0.0025
Valve Stem in Guide—Exhaust	0.0025	0.0040
Valve Spring Length		
Free Length	1.662	
Compressed Length	1.375	
Valve Spring Tension (lb.)		
Open	71	79
Closed	38	42
Valve Seat Bore Diameter		
Intake	1.5645	1.5655
Exhaust	1.2510	1.2520
Valve Seat Diameter		
Intake	1.569	1.570
Exhaust	1.255	1.256
Valve Stem Diameter		
Intake	0.3425	0.3430
Exhaust	0.3410	0.3415
Valve Guide Diameter (I.D.)	0.344	0.346
Valve Lifter Diameter	0.7575	0.7480
Valve Lifter Bore	0.7505	0.7515
Valve Seat Interference Width	1/32	3/64
Valve Face Angle	44°	
Valve Seat Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing	0.0025	0.0038
Crankshaft End Play	0.005	0.009
Camshaft Bearing	0.0015	0.0030
Camshaft End Play	0.003	—
Camshaft Lift	0.300	
Camshaft Bearing Diameter	1.3760	1.3770
Camshaft Journal Diameter	1.3740	1.3745
Rod Bearing (Forged Rod)	0.0005	0.0023
Connecting Rod End Play (Ductile Iron)	0.002	0.016
Timing Gear Backlash	0.002	0.003
Oil Pump Gear Backlash	0.002	0.005
Piston to Cylinder, Strut Type (Measured below oil-controlling ring—90° from pin) Clearance	0.0015	0.0035
Piston Pin Diameter	0.7500	0.7502
Piston Pin in Piston	Thumb Push Fit	
Piston Pin in Rod	0.0001	0.0005
Piston Ring Groove Width		
Top 1	0.0955	0.0965
Top 2	0.0955	0.0965
Top 3	0.1880	0.1890
Piston Ring Gap in Cylinder	0.010	0.020
Piston Ring Side Clearance (Top compression ring only)	0.006	
Crankshaft Main Bearing Journal—Standard Size	1.9992	2.0000
Main Bearing Diameter	2.0015	2.0040
Main Bearing Clearance	0.0015	0.0043
Crankshaft Rod Bearing Journal—Standard Size	1.6252	1.6260
Cylinder Bore—Standard Size	3.5625	3.5635

ASSEMBLY TORQUES

TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often with the engine cold. Tighten as needed to prevent them from working loose.

TORQUE SPECIFICATIONS	Ft.-Lb.
Cylinder Head Nuts	17-19
Rear Bearing Plate	25-28
Connecting Rod Bolt	27-29
Flywheel Capscrew	35-40
Starter Mounting Bracket to Oil Base Screws	43-48
Gear Case Cover	8-10
Oil Pump	7-9
Other 3/8 Cylinder Block Nuts	18-23
Intake Manifold	18-20
Exhaust Manifold	10-12

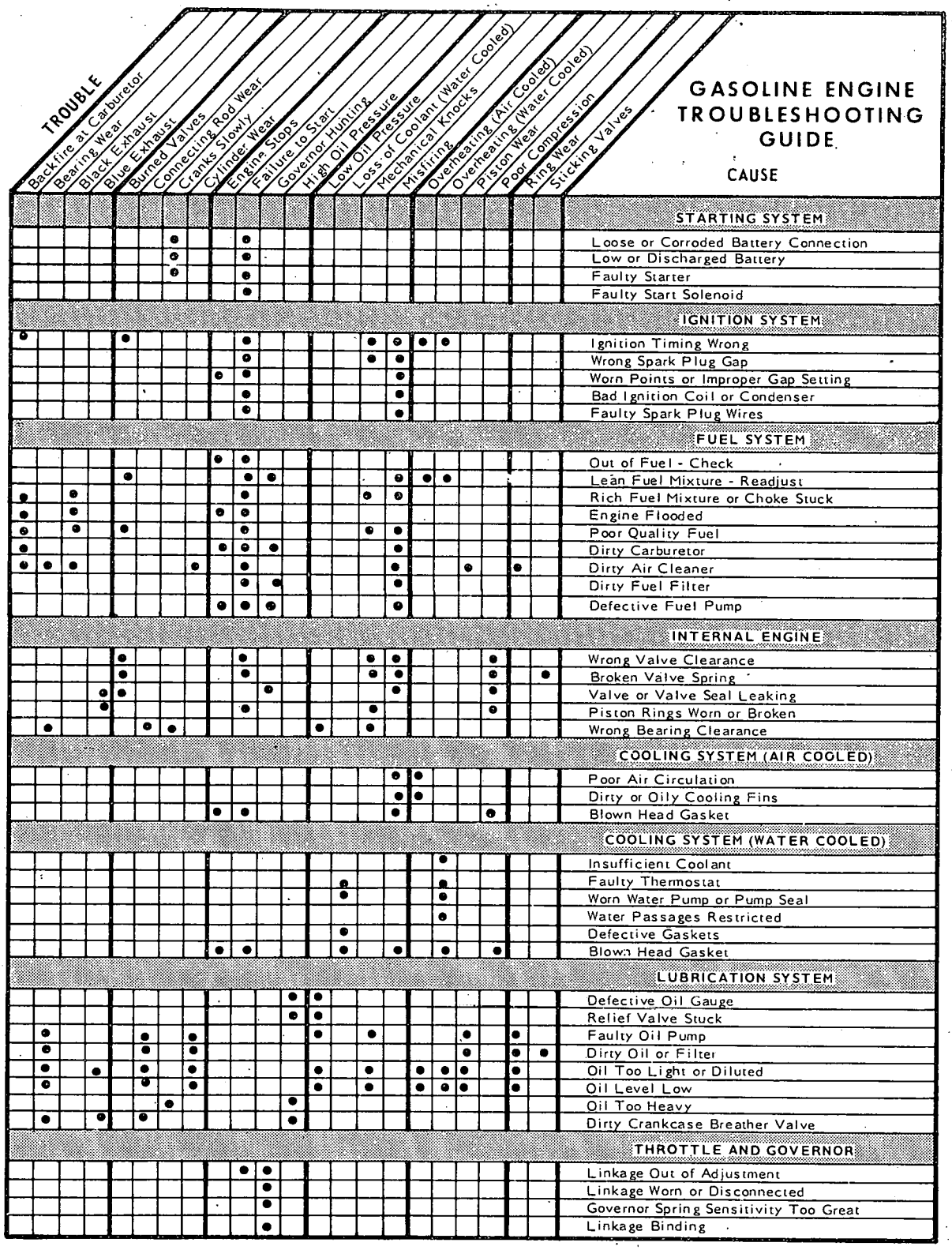
SPECIAL TOOLS

SPECIAL TOOLS

These tools are available from Onan to aid service and repair work.

Crankshaft Gear Pulling Ring	420-0248
Flywheel Puller	420-0100
Combination Bearing Remover, Main and Cam	420-0325
Combination Bearing Driver, Main and Cam	420-0324
Valve Guide Driver	420-0300
Valve Seat Driver	420-0308
Valve Seat Staker	
Intake	420-0309
Exhaust	420-0310
Valve Seat Cutter	420-0311
Oil Seal Guide and Driver	
Bearing Plate	420-0181
Gear Cover	420-0313
Timing Advance Mechanism Cover Driver	420-0296
Piston Ring Spreader	420-0146
Piston Groove Cleaner	420-0332

ENGINE TROUBLESHOOTING



INSTALLATION

The type of installation can affect the life of the engine, the cost of operation and the frequency of necessary service. Plan the installation carefully to ensure the best performance.

Because of the great variety of uses, and the many variations of the engine, these installation instructions are typical or general in nature. Use the installation recommendations given as a general guide.

MOUNTING

There are several acceptable methods of mounting the engine. Among factors to be considered are: location, method of coupling the engine to the load, type of foundation or support, etc. The engine should be mounted on a level surface if possible. Maximum operation angle is 15 degrees sideways, 30 degrees front to rear tilt. If the engine is to operate at an angle, be sure to re-mark the oil level indicator to compensate for the tilt.

VENTILATION

The engine must be provided with a supply of fresh air for cooling and for combustion.

Pressure Cooled Engine: Position the air inlet opening directly in front of the engine and as close to the engine blower wheel as possible. The area of the inlet should be not less than 80 square inches. If louvers or grill work are used, increase the area to compensate for the reduced air flow. Provide extra ventilation if the driven load generates heat during operation.

The heated air outlet must allow the heated air to escape freely and prevent recirculation with the cooling air. A duct between the compartment air inlet and the engine blower housing may be necessary. Locate the air outlet opposite the intake or at least at a 90 degree angle. The area of the outlet should be at least 15 percent larger than that of the inlet. Allow sufficient room on all sides to permit access for servicing.

Open Air Installation: For installations where the engine is operated outside, ventilation will be no problem. However, in protecting the engine from the elements, see that nothing obstructs the flow of air around the engine.

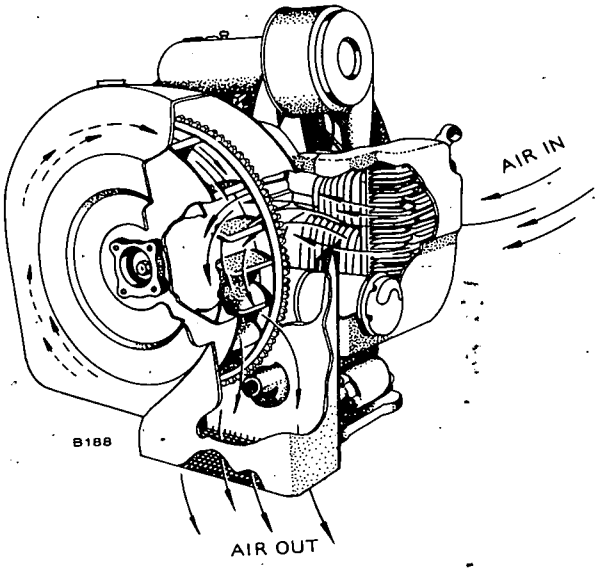


FIGURE 1. AIRFLOW THROUGH VACU-FLO SYSTEM

Vacu-Flo Cooled Engine: The vacu-flo equipped engine uses an integral flywheel-centrifugal fan to pull cool air into the engine shroud and over the cooling fins and surfaces of the engine, Figure 1. The heated air is directed through an air tight scroll which encases the flywheel fan. The scroll may be positioned to discharge heated air in the downward, upward, left or right direction. This is possible because the back section of the scroll (Figure 2) has four identical holes shaped to fit over the end of the starter motor. The scroll outlet has a mesh-type screen for safety.

CAUTION **The outlet of the vacu-flo scroll must not be restricted or overheating will result. Engine overheating can cause troubles ranging from vapor lock to scored pistons and cylinders.**

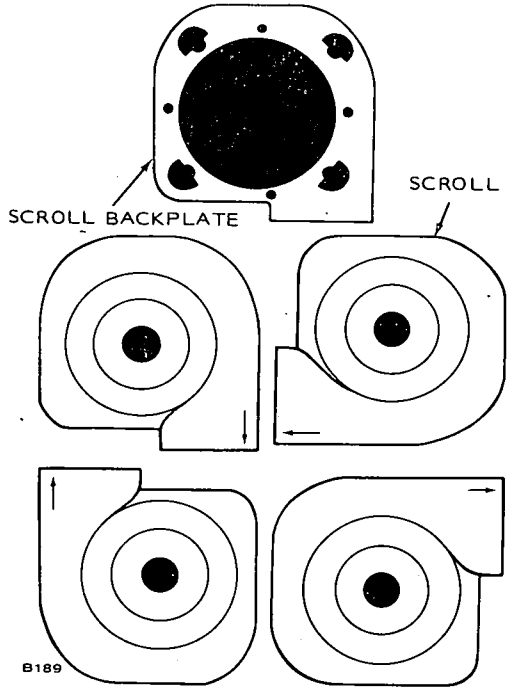


FIGURE 2. VACU-FLO SCROLL POSITIONS

Should a vacu-flo engine chronically overheat, the most likely sources of the problem are:

1. Air inlet is obstructed or too small to allow proper ventilation.
2. Air discharge opening is partially blocked by external ducts or exhaust systems.
3. Recirculation of heated air into fresh air inlet.

The vacu-flo installation permits greater freedom in choice of locating the air inlet and outlet openings, and permits the use of a compartment only slightly larger than the engine itself.

The area of the air inlet must be at least 140 square inches. If a filter, grille, or louvers are used, the inlet opening must be increased accordingly. The air outlet opening should be located as close to the engine as possible.

If the duct length exceeds 5 feet, increase duct size 30 percent. Use no more than two 90 degree radius-type (not square-type) elbows if it is necessary to change air flow direction. When a duct is used between the scroll discharge and the outlet vent, its unobstructed airflow area must be at least as large as the scroll discharge. The cross-sectional area of the duct must be increased if air flow is restricted by bends, long runs, screens or the exhaust pipe. Exhaust pipes running inside Vacu-Flo ducts should be covered with asbestos tape.

WARNING **The safety screen used to cover vents must be 1/4-inch mesh or larger to permit sufficient air flow, and must be commensurate with safety standards for hazardous moving parts to avoid personal contact. Provide a short canvas section between the engine air outlet and the external duct or opening, to absorb vibration. If operation in cold weather is likely, installing a shutter in the air outlet is advisable. Cold weather can cause overcooling if air flow is not regulated.**

EXHAUST

WARNING **Exhaust gases are toxic. Provide an adequate exhaust system to properly expel exhaust gases. Check exhaust system regularly for leaks. Ensure that exhaust manifolds are secure and not warped. Be sure the unit is well ventilated.**

Use a length of flexible tubing between the engine exhaust outlet and any rigid piping to absorb engine vibration. Shield the line if it passes through a combustible wall or partition. If turns are necessary, use sweeping type (long radius) elbows. Increase one pipe size (from manifold outlet size) for each additional ten feet in length. Locate the outlet away from the air intake.

CARBURETOR AIR INTAKE

Proper engine efficiency depends upon a supply of fresh air to the carburetor. Under special conditions, it may be necessary to move the air cleaner off the engine, using a longer connection hose as necessary. For extremely dusty or dirty conditions, install a special heavy duty air cleaner.

FUEL SYSTEM

The engine uses either a diaphragm or pulsating diaphragm type fuel pump. The fuel pump has a 1/8-inch pipe threaded inlet, fitted with a 1/4-inch inverted flare tube fitting. If a solid wall line is used, form a loop in the line, or install a section of flexible fuel hose, to absorb vibration. If a line with a pipe thread end is used, remove the flare type fitting from the fuel pump inlet.

The fuel supply tank may be installed in any safe, convenient location. If the tank is installed within the engine enclosure, provide a vent line to the outside of the enclosure.

The installation of a fuel filter between the fuel tank and the fuel pump is recommended. The fuel filter should be fitted with a shutoff valve and should be easily accessible for cleaning.

CONNECTING TO THE LOAD

The dimensions of various power takeoff shafts are as follows:

SHAFT	DIAMETER	LENGTH	KEY SIZE
STD	1-7/16	3-1/16	3/8
Rockford Clutch	1-7/16	3-1/16	3/8
Gear Reduction	1-1/4	2-3/4	1/4

Belt Drive: V-belts are preferable to flat belts. Consult a reliable belting supplier for recommendations regarding size of pulleys, number of belts, etc. required. A typical belt drive installation is shown in Figure 3.

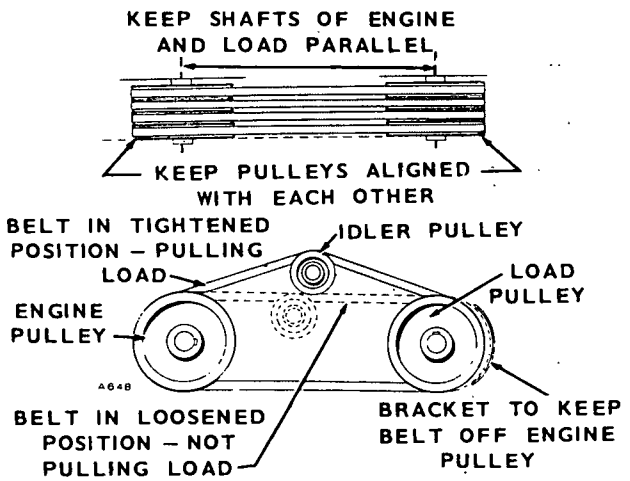


FIGURE 3. DRIVE BELT INSTALLATION

Comply with the following installation requirements:

1. The shafts of the engine and the load must be parallel with each other.
2. The pulleys of the engine and the load must be in alignment.
3. Mount the engine pulleys as close to the engine as possible.
4. If the installation permits, belts should run horizontally.
5. Some method of disconnecting the load for starting is recommended. If a clutch is not used, a belt-tightener idler arrangement can be used.

Flexible Coupling: If a flexible coupling engine-to-load drive is used, the load shaft must be in line and centered with the engine shaft (Figure 4).

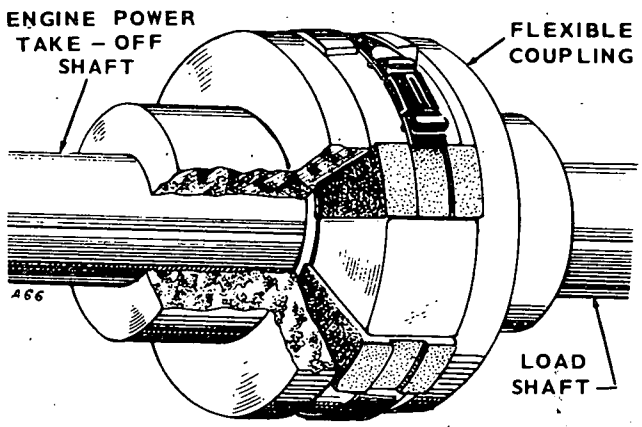


FIGURE 4. FLEXIBLE COUPLING

Reduction Gear Drive: Reduction gear drives are mounted at the factory (when ordered). The method of connecting the load is the same as when connecting directly to the engine shaft.

Clutch Installation: A Rockford Clutch can be installed at the factory or in the field. Install the clutch according to the following instructions and Figure 5.

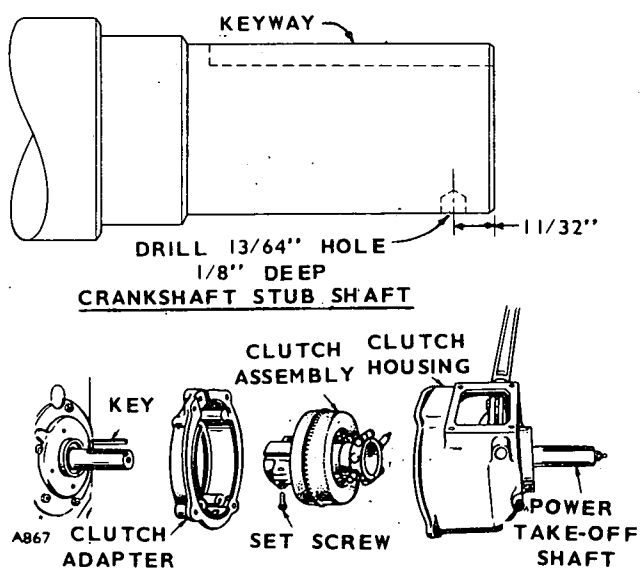


FIGURE 5. CLUTCH INSTALLATION

Provide room for the clutch adapter casting by plugging the wet holes with a 3/8-16 x 1/2-inch slotted headless set screw. Apply sealing compound to the threads and install screw flush with the cylinder block.

Drill a 13/64-inch hole (or filed slot) in the crankshaft for the clutch set screw. Locate center of hole 11/32-inch from the end and directly opposite the keyway in the crankshaft.

Install the clutch adapter, with drain slot downward, using two cap screws 3/8-16 x 2-inches on the lower and one cap screw 3/8-16 x 1-3/4-inch on the upper #2 cylinder side (cylinder nearer clutch). Install the 3/8 x 3-7/8-inch stud through the adapter into the engine block upper remaining hole. Use a lock washer on each assembly screw. Use a flat washer and a lock washer under the stud nut.

Install the crankshaft key. Remove the clutch set screw. Install the clutch assembly (less housing) to the crankshaft, driving it on carefully with a soft-faced hammer until set screw hole is aligned. Install set screw to bottom in crankshaft hole, then back it out one full turn. Tighten clutch retaining screws until clutch is clamped securely to crankshaft. Lock the screws and tighten the set screw.

Apply grease to splined power takeoff shaft. Position the clutch throw-out to align the grease fitting with the hole in the housing (#1 cylinder side, horizontal). Pull the throw-out collar outward to remove tension.

Install the clutch housing so that the clutch throw-out fork engages the throw-out collar. Be sure the serrated shaft is properly meshed with the clutch plate. Use two cap screws 7/16-14 x 2-inches on the lower and one cap screw 7/16-14 x 1-3/3-inch on the upper #2 cylinder side. Install the stud washer and nut. Lubricate the two grease fittings just until grease appears.

BATTERY CONNECTIONS (Engines with Automotive Type Separate Starter)

Connect the 12 volt battery positive cable to the engine start switch terminal. Connect the battery negative cable to the ground point on the engine oil base (Figure 6).

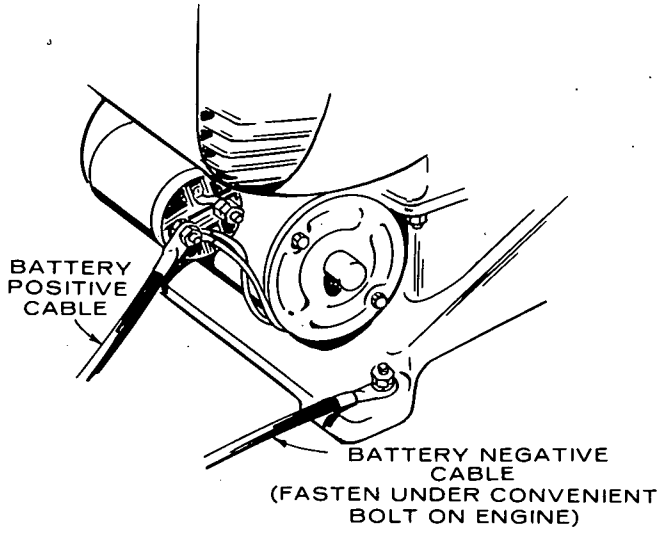


FIGURE 6. BATTERY CONNECTIONS

OPERATION

BEFORE STARTING

Crankcase Oil: Be sure the crankcase has been filled with oil to the "FULL" mark on the oil level indicator. Use oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines.

Recommended Fuel: Use clean, regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

CAUTION **If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, preignition could occur causing severe damage to the engine.**

WARNING **Never fill the tank when the engine is running. Leave some space in the tank for fuel expansion.**

Open the fuel line valve (when used) and operate primer to assure fuel supply after filling an empty tank.

STARTING (Electric Start)

1. Move ignition switch to its ON position.
2. Push START button to crank engine.

If the engine fails to start at first attempt, inhibitor oil used at the factory may have fouled the spark plugs. Remove the plugs, clean in suitable solvent, dry thoroughly and install. Heavy exhaust smoke when the engine is first started is normal and is caused by inhibitor oil.

STARTING (Manual Start)

1. Hold choke about three quarter way closed or as necessary according to temperature conditions.
2. Pull start rope with a fast steady pull to crank engine. Do not jerk.
3. Open choke as engine warms up.

APPLYING LOAD

When applying the load to a new or reconditioned engine, it should be applied gradually in about four steps; each step of not less than 30 minutes running time. Start with 1/4 load, then 1/2, 3/4 and full load.

BATTERY CHARGING

The battery charge rate is controlled by a charge regulator. The regulator is set to allow the proper rate of charge at operating speed.

STOPPING THE ENGINE

Disconnect all load before stopping the engine. Engines equipped with battery ignition are stopped by positioning the ignition switch to the OFF position.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the engine.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow, but use care to avoid overheating.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often than recommended under normal conditions.
4. Keep oil and gasoline in dust tight containers.
5. Keep governor linkage clean.

HIGH ALTITUDE

For operation at altitudes of 2500 feet or more, close the carburetor main jet adjustment slightly to maintain proper air-to-fuel ratio. Refer to the *Fuel System* section. Maximum power will be reduced about 4 percent for each 1000 feet increase in altitude.

PROTECTION FOR EXTENDED OUT-OF-SERVICE PERIOD

Protect an engine that is to be out-of-service for more than 30 days as follows:

1. Run engine until thoroughly warmed up.
2. Turn off fuel supply and run until engine stops from lack of fuel.
3. Drain oil from oil base while still warm. Attach a warning tag to refill before operation.
4. Remove each spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50) oil into cylinder. Crank engine over a few times to distribute oil film on cylinder walls and rings. Reinstall each spark plug.
5. Service air cleaner per maintenance schedule.
6. Lubricate governor linkage. Protect against dust, etc. by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of bugs, moisture, or dirt.
8. Wipe entire unit clean. Coat parts likely to rust with a light film of grease or oil.
9. Provide a suitable cover for entire unit.
10. Disconnect battery and follow standard battery storage procedure.

CAUTION **Discharged batteries are subject to severe damage if exposed to freezing temperatures. Store all batteries in a fully charged condition and maintain charge during storage.**

RETURNING THE SET TO OPERATION

1. CHECK SERVICE IDENTIFICATION TAGS to properly service the engine.
2. Uncover and remove all storage seals from engine. Remove any dust, dirt, or foreign matter.
3. CHECK fuel supply tanks for moisture accumulations (drain tanks if necessary). CHECK lubricating oil for moisture or contamination (drain if necessary). CHECK fuel line connections, all wiring connections, and exhaust line connections.
4. Service air cleaner. Bleed fuel system (if moisture or contamination are found in fuel, replace filters and clean fuel pump sediment bowl).
5. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
6. Clean and check battery. Measure specific gravity (1.260 at 25° C [77° F]) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct.DO NOT OVERCHARGE.

   WARNING **Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.**
7. Check engine for fuel or oil leaks. Correct leakage as required.
8. Install fully charged batteries.
9. Start engine and check while running for leaks, correct voltage output, and proper cooling.

After engine has started, excessive blue smoke will be exhausted and the engine will run rough until the rust inhibitor or oil has burned away.

PERIODIC MAINTENANCE

TABLE 1. PERIODIC MAINTENANCE SCHEDULE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS						
	8	50	100	200	500	1000	5000
* Inspect Engine Generally	x						
Check Fuel Supply	x						
Check Oil Level	x						
Clean Governor Linkage		x*					
Change Crankcase Oil		x1	x*				
Check Breaker Points			x				
Check Battery Electrolyte Level			x				
Clean Fuel Filter			x				
Check Spark Plugs			x				
Replace Oil Filter				x*			
Replace Air Cleaner				x*			
Remove Deposits in Combustion Chamber					x		
Check Valve Clearance				x1	x		
Inspect Valves, Grind if Necessary						x	
Complete Reconditioning							x

* - Check for exhaust leaks, fuel leaks, proper mounting, etc.
x* - Perform more often under dusty or extreme cold weather conditions.
x1 - Recommended interval in hot weather or heavily loaded conditions.

PERIODIC MAINTENANCE SCHEDULE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The schedule (Table 1) can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, etc. frequently until the proper service time periods can be established. When any abnormalities occur in operation—unusual noises from engine or accessories, loss of power, overheating, etc.—contact your Onan dealer.

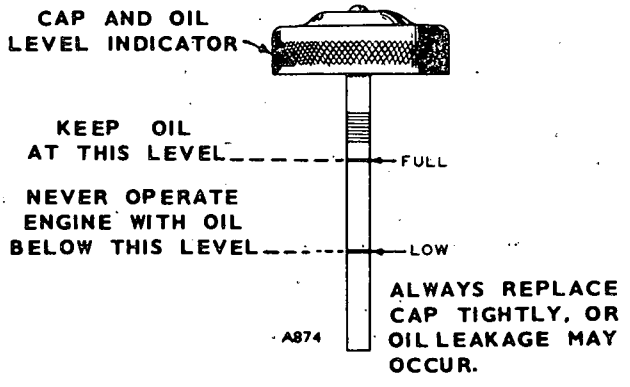


FIGURE 7. OIL LEVEL INDICATOR

CRANKCASE OIL

The oil capacity is 3-1/2 U.S. quarts (4 with filter). Fill to the "FULL" mark on the oil level indicator, Figure 7.

When adding oil between changes, always use the same brand and weight that is in the crankcase. Various brands of oil may not be compatible when mixed together.

Oil consumption may be higher with a multigrade oil than with a single grade oil if both oils have comparable viscosities at 210° F. Therefore, single grade oils are generally more desirable, unless anticipating a wide range of temperatures. Use the proper grade oil for the expected conditions.

TEMPERATURE	GRADE
Below 0°	5W
0° to 30°	10W
30° to 90°	30
Above 90°	50

Check oil level daily. Change oil every 100 hours under normal operating conditions. When operating in extremely dusty or dirty conditions, change oil more often.

OIL FILTER

Change the crankcase oil filter every 200 hours. Remove the filter (Figure 8) by turning counterclockwise, using a filter wrench. Add the strip provided with the filter to prevent air loss in the area indicated. It is advisable to wipe dry the drip pan located below the filter. Coat rubber gasket on filter with a film of oil before installing. Install the filter finger-tight plus 1/4 to 1/2 turn. If oil becomes so dirty that the markings on the oil level indicator cannot be seen, change the filter and shorten the filter service period.

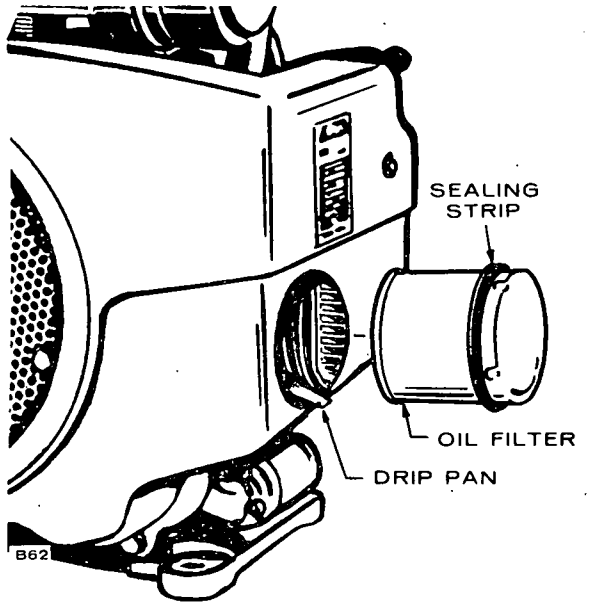


FIGURE 8. OIL FILTER LOCATION

CRANKCASE BREATHER

The engine is equipped with a ball check valve (Figure 9) for maintaining crankcase vacuum. No maintenance is generally required. Should the crankcase become pressurized, as evidenced by oil leaks at the seals or around the cap of the oil level indicator, clean baffle in suitable solvent.

Clean or replace crankcase breather baffle periodically. Be sure baffle material doesn't come apart and work into the manifold.

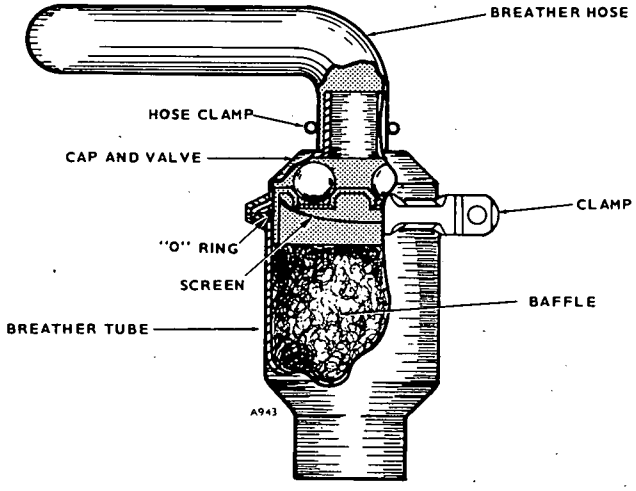


FIGURE 9. CRANKCASE BREATHER

AIR CLEANER

The NHC engine uses a replaceable, spin-on air cleaner, Figure 10. Remove and replace every 200 hours.

CAUTION **Do not run engine with air cleaner removed. Intake of dirty air or solid materials could cause severe damage to engine parts.**

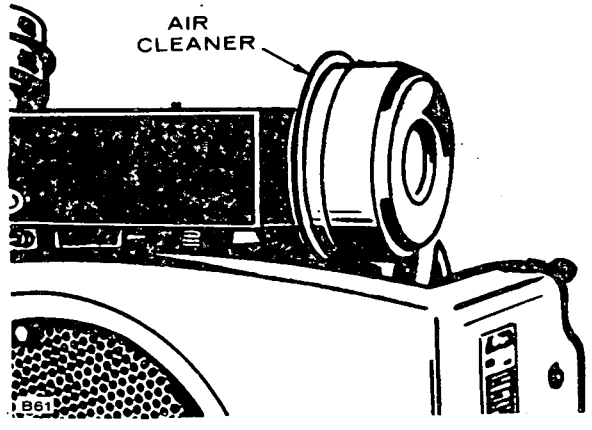


FIGURE 10. AIR CLEANER

GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Every 50 hours of operation clean the metal joints as shown in Figure 11. Also inspect the linkage for binding, excessive slack and wear.

Clean and lubricate metal ball joints. Don't lubricate plastic joints.

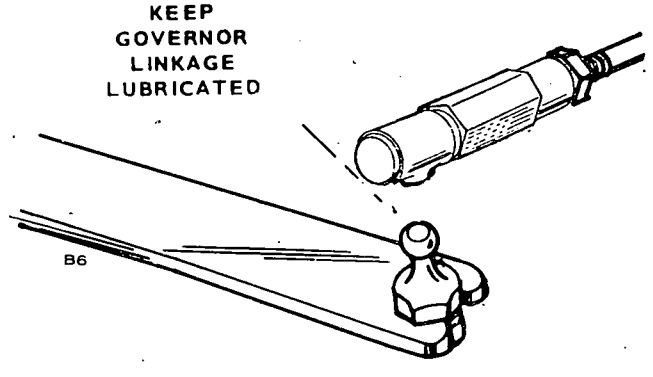


FIGURE 11. GOVERNOR LINKAGE

REDUCTION GEAR DRIVE

Drain the gear box after the first 100 hours of operation and refill with fresh lubricant of the recommended grade. Repeat this procedure every six months thereafter, or every 100 hours.

Use only SAE 50 motor oil or SAE 90 mineral gear oil. Do not use lubricants commonly known as extreme pressure lubricants, hypoid lubricants, etc.

Maintain the proper oil level between changes. Overfilling will cause foaming, which can lead to an oil leak due to overheating. Remove the filler plug on top of the case and the oil level plug from the face of the gear case. Fill the case until the oil just begins to flow from the oil level plug hole. Gear box holds 1/2 pint U.S. measure. Replace both plugs. See Figure 12.

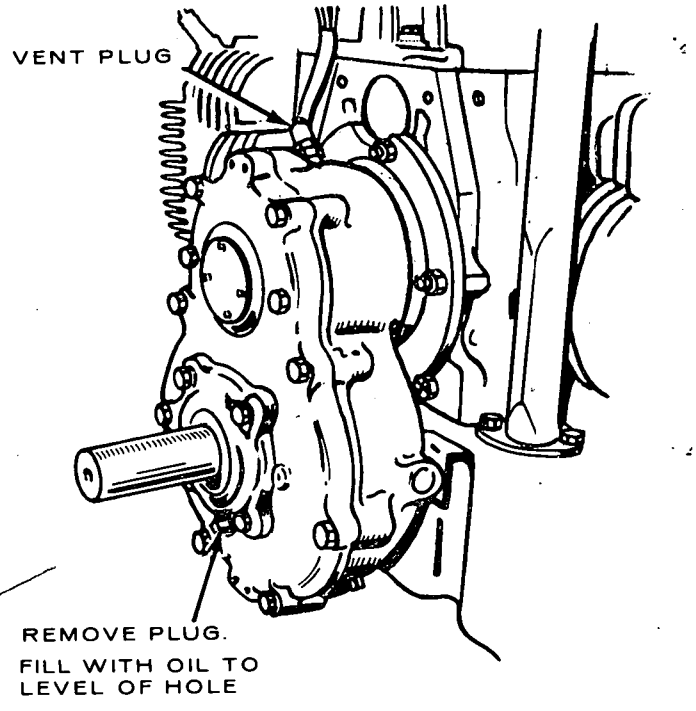


FIGURE 12. REDUCTION GEAR DRIVE

EXHAUST SYSTEM

Make regular inspections of the exhaust system throughout the entire life of the engine. Locate leaks in muffler and piping while the engine is operating. Repair all leaks immediately after they are detected for personnel safety.

WARNING **Leaky exhaust systems emit noxious carbon monoxide fumes which are a potential safety hazard in enclosed areas.**

BATTERY

Check charge condition. Check electrolyte level. Add distilled water to keep electrolyte at its proper level. In freezing weather, run engine immediately after adding water. Keep battery connections tight and clean.

FUEL SYSTEM

GASOLINE CARBURETOR

For correction of problems traced to the gasoline carburetor, use the appropriate procedures selected from the following sequence, referring to Figures 13 and 14.

Adjustment Under Load: Adjust the carburetor as follows when a full load can be applied.

1. Make sure the ignition system is working properly and that the governor is adjusted.
2. Start the engine and allow it to warm up. If the carburetor is so far out of adjustment that the engine will not start, close both needle valves gently to their seats. Then open each 1 to 1-1/2 turns, first the idle and then the main adjustment.
3. With no load applied to engine, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until the engine speed returns to normal.
4. Apply a full load to the engine and then carefully turn the main adjustment in until the speed drops slightly below normal. Turn the needle out until the engine speed returns to normal.

Adjustment Under "No Load" Conditions: When a load cannot be applied, adjust the carburetor as follows:

1. Perform steps 1 and 2 as given under *Adjustment Under Load.*
2. Pull out on the governor mechanism to slow the unit down to about 800 to 900 rpm.

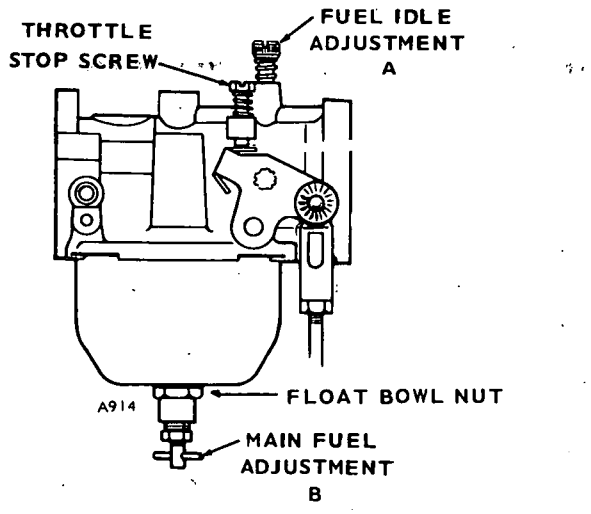


FIGURE 14. CARBURETOR ADJUSTMENTS

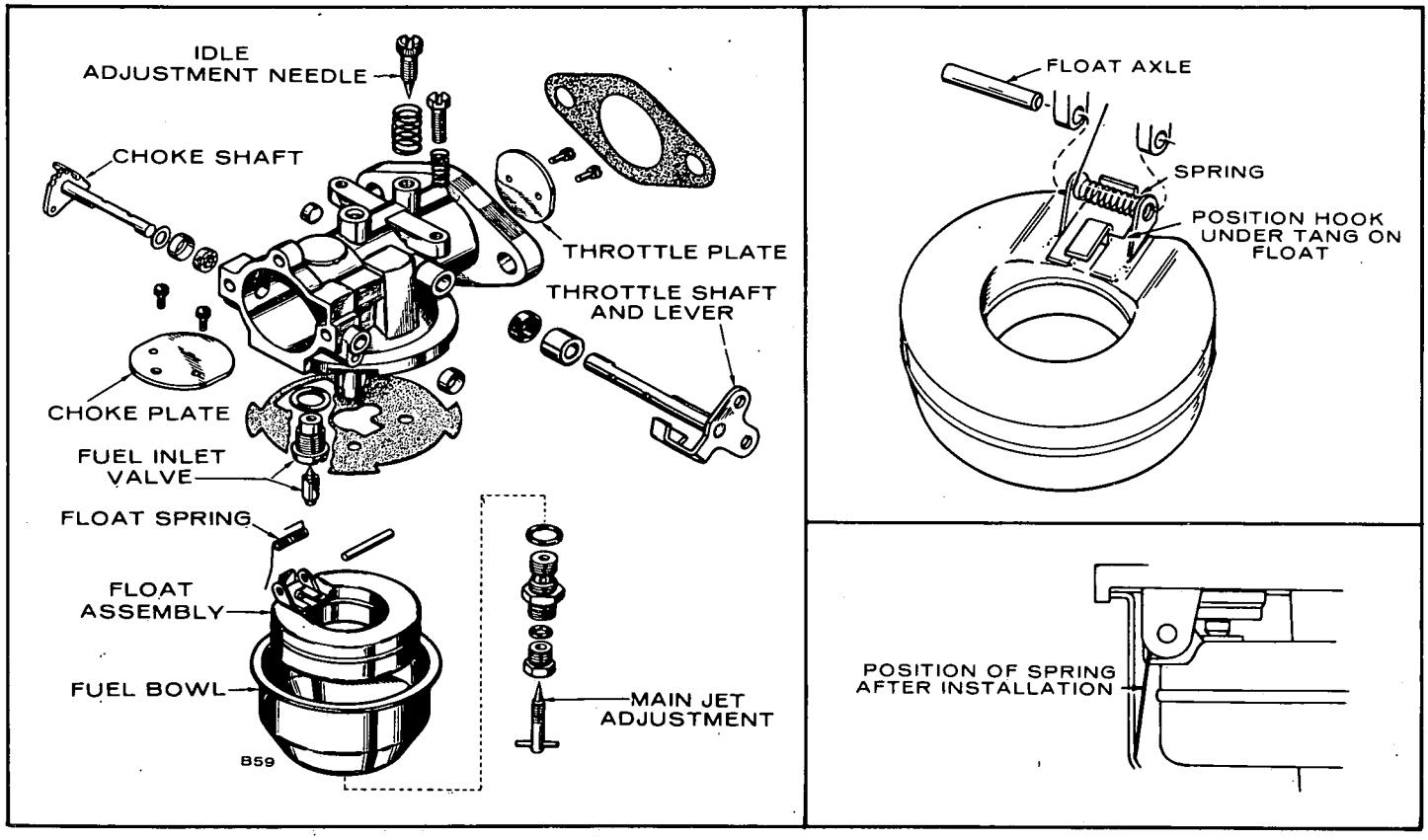


FIGURE 13. CARBURETOR ASSEMBLY

3. Set the idle adjustment screw for even operation (so the engine is firing on both cylinders and is running smoothly).
4. Release the governor mechanism to allow the engine to accelerate. If the engine accelerates evenly and without a lag, the main adjustment is correct. If not, adjust the needle outward about 1/4 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.
5. With the carburetor and governor adjusted, set the throttle stop screw at the desired idle speed.

Float-Level Check: If the carburetor adjustment fails to provide satisfactory operation, remove the carburetor and check the float level as follows:

1. Remove the fuel line, air cleaner hose, governor linkage and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Unscrew the float bowl nut and remove the entire main fuel adjustment assembly from the float bowl.
4. Invert the carburetor and check that the float surface nearest the gasket is 1/8 ± 1/16-inch from the gasket. Bend the float tab as required to produce this spacing.

   If the carburetor utilizes an internally spring loaded fuel inlet valve, the float surface should be 1/8 ± 1/16-inch from the gasket with the full weight of the float compressing the spring in the needle.
5. Reassemble, install and test.
6. See Figure 15.

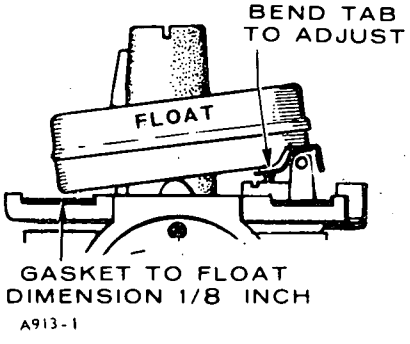


FIGURE 15. FLOAT LEVEL ADJUSTMENT

Carburetor Removal and Disassembly: Remove and disassemble the carburetor assembly as follows, referring to Figure 15:

1. Remove the fuel line, air cleaner hose, governor linkage, and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Remove the main jet assembly and bowl.
4. Remove the float pin and float.
5. Lift out the fuel inlet valve and unscrew the valve seat.
6. Remove the idle adjustment needle.
7. Remove the throttle plate screws and the plate, then pull out the throttle shaft.
8. Remove the choke plate screws and plate, then pull out the choke shaft.

Carburetor Assembly and Installation: Clean the components and repair or replace defective or worn parts. Use acetone or alcohol to dissolve gum deposits if carburetor cleaner is not effective. Soak the parts in carburetor cleaner, using it as directed by the manufacturer. Clean all carbon from the carburetor bowl, especially in the area of the throttle plate. Blow out clogged passages with compressed air. Check the needles, nozzle, and float for damage or fuel loading. Check the choke and throttle shafts. Reassemble and install as follows:

1. Install the throttle shaft and plate, using new screws and lock washers. Install with bevel mated to the carburetor body. If the plate is marked with the letter C, install it with the mark on the side toward the idle port when viewed from the flange end of the carburetor. To center the plate, back off the top screw, close the throttle lever and then set the plate by tapping it with a small screwdriver.
2. Install the choke shaft and plate. Center the plate in the same manner as the throttle plate (see step 1). Use new screws and lock washers.
3. Install the fuel inlet valve seat and valve.
4. Install the float and float pin, adjusting the float as previously described.
5. Install the bowl ring gasket, bowl and bowl nut. Make sure that the bowl is centered in the gasket and tighten the main jet assembly securely. Turn in until it seats and back out to 1-1/2 turns.
6. Install the idle adjusting screw finger-tight. Then back it out 1 to 1-1/2 turns.
7. Install the choke and adjust as previously described.
8. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism, air cleaner hose, and choke wires.
9. Adjust the carburetor needle settings as described under *Adjustments* and check out the performance.

Complete Replacement: Complete replacement of the carburetor should be performed as follows:

1. Follow the previously given disassembly instructions as required for removal of the defective carburetor.
2. Replace the carburetor with a new unit, using attaching parts in good condition and making all the connections previously disengaged.
3. Adjust the needle settings as described under *Adjustments*.

DIAPHRAGM FUEL PUMP

Some engines use a diaphragm-type fuel pump, Figure 16. If fuel does not reach the carburetor, check the fuel pump before dismantling it.

1. Disconnect the fuel line at the carburetor.
2. Crank the engine and observe whether fuel comes from the line at the carburetor.

WARNING **Be sure to direct the fuel flow into a container so gasoline does not spill on ignition wires.**

3. If there is enough fuel in the tank, and line does not have fuel flowing, the pump needs replacing.

Pump failure is usually caused by a leaking diaphragm, valve or valve gasket, a weak or broken spring or wear in the drive linkage. Gasoline diluted oil may also indicate a faulty pump.

Always return the hand priming lever all the way inward so that lever does not prevent normal operation of fuel pump.

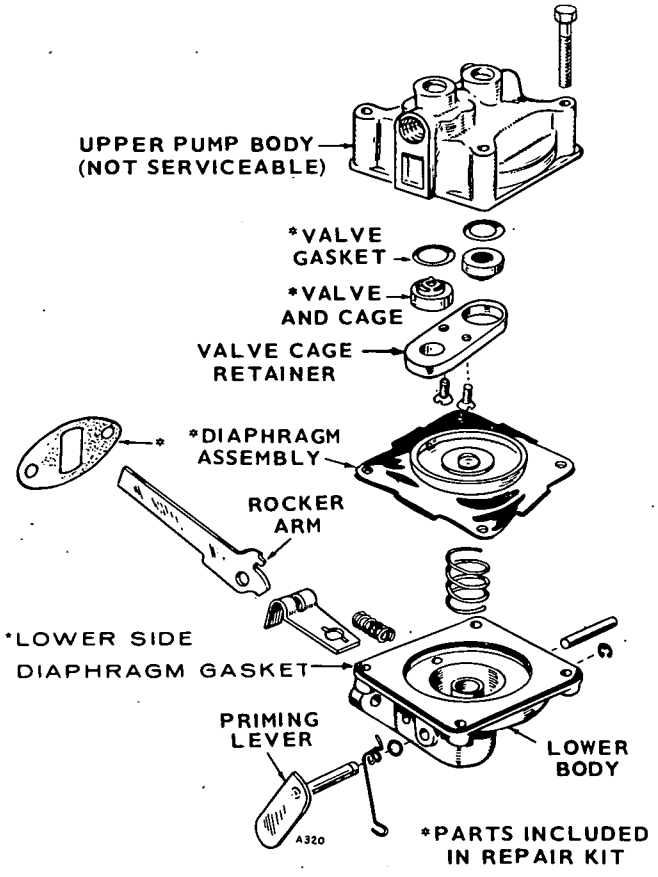


FIGURE 16. DIAPHRAGM FUEL PUMP

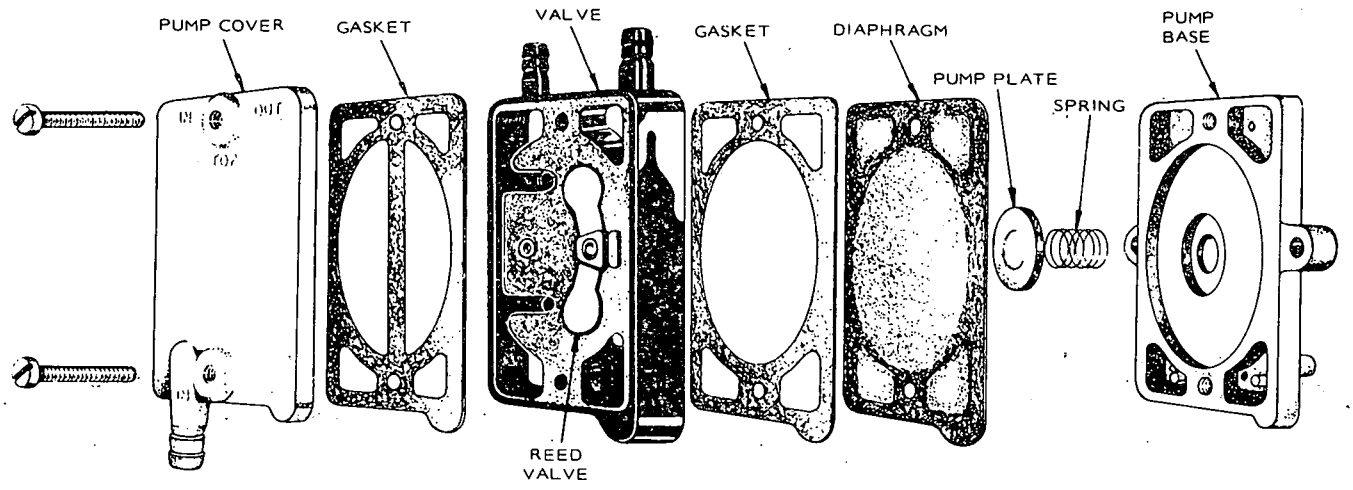
Fuel Pump Reconditioning: Reconditioning of the fuel pump should be as follows, referring to Figure 16.

1. Remove the fuel lines and mounting screws holding the pump to the engine.
2. Make an indicating mark with a file across a point at the union of the fuel pump bolt and cover. Remove the assembly screws and the upper pump body.
3. Turn the pump body over and remove the valve plate screw and washer. Remove the valve retainer, valves, valve springs, and valve gasket, noting their position. Discard the valve springs, valves and valve retainer gasket.
4. Clean the pump body thoroughly with a solvent and a fine wire brush.
5. Holding the pump cover with the diaphragm surface up, place the new valve gasket in the cavity. Assemble the valves in the cavity. Reassemble valve retainer. Lock in position by inserting and tightening the fuel pump retainer screw.
6. Place the pump body assembly in a clean work area and rebuild the lower diaphragm section.
7. Holding the mounting bracket, press down on the diaphragm to compress the spring under it, then turn the bracket 90 degrees to unhook the diaphragm so it can be removed.
8. Clean the mounting bracket with a solvent and a fine wire brush.
9. Replace the diaphragm operating spring, stand the new spring in the casting, and position the diaphragm. Press down on the diaphragm to compress the spring and turn it 90 degrees. This will reconnect the diaphragm.
10. Hold the bracket, place the pump cover on it (making sure the indicating file marks are in line) and insert the four attaching screws but do not tighten. With the hand on the mounting bracket only, push the pump lever to the limit of its travel and hold in this position while then tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount the fuel pump on the engine, using new mounting gaskets. Connect the fuel lines.

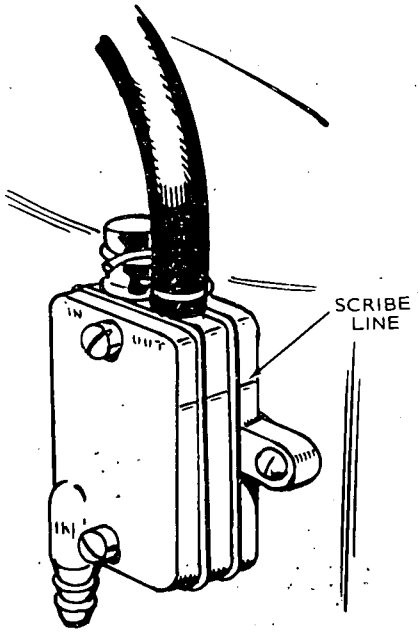
PULSATING DIAPHRAGM FUEL PUMP

Pulsating diaphragm fuel pumps (Figure 17) use a combination of crankcase and spring pressure to work a diaphragm thus pumping fuel. This pump may be mounted on the engine rear housing on NHCV models and on the upper right hand corner of the blower housing on NHC models. See Figure 17.

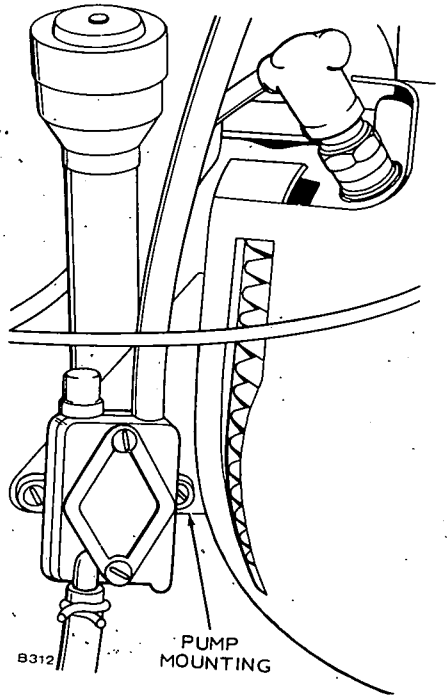
On the downstroke of the engine piston, when the crankcase pressure is greatest, the pump diaphragm is forced back against the diaphragm spring compressing it and drawing fuel into the pump intake chamber. The fuel then passes through the intake reed valve into the output chamber side of the pump. On the compression stroke, when crankcase pressure is the lowest, the diaphragm spring forces the



PULSATING DIAPHRAGM FUEL PUMP (EXPLODED VIEW)



PUMP MOUNTS ON NHC BLOWER HOUSING



PUMP MOUNTS ON NHCV ENGINE REAR HOUSING

FIGURE 17. PULSATING DIAPHRAGM FUEL PUMP

diaphragm out pushing fuel through the pump output reed valve into the output chamber and into the fuel line.

Servicing the Pulsating Diaphragm Fuel Pump

1. Remove vacuum and fuel lines. Inspect lines for wear, cracking, etc.
2. Scribe two lines (one each on opposite ends of pump) across pump parts. This will insure correct alignment of pump parts with each other and carburetor when pump is reassembled.
3. Remove fuel pump attaching screws.
4. Holding pump carefully, pull sections of the pump apart. The diaphragm, plunger, return spring and plate, pump body and gaskets will now be loose.
5. Check parts for wear and damage. Replace with new parts where necessary.
6. The pump air bleed hole in pump base must be unclogged to allow unrestricted movement of pump diaphragm.

CAUTION **A clogged diaphragm air bleed hole can cause diaphragm wear and seal damage while inhibiting pump operation.**

7. Replace gaskets and reassemble pump as shown in Figure 17.
8. Install pump and replace lines. Make sure fuel line clamps are replaced on fuel line.

WARNING **Use care when reassembling the pump. All parts must be perfectly aligned or the pump will leak creating a fire hazard.**

THERMO-MAGNETIC CHOKE (Optional)

This choke uses a strip heating element and a heat sensitive bimetal spring to control the choke plate position. In addition to this, a solenoid is actuated during engine cranking, closing the choke all or part way, depending on ambient temperature. The bimetal is factory set to position the choke to the proper opening under any ambient condition.

Choke Adjustment: If adjustment of the bimetal is needed, it must be made at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Loosen the screw which secures the choke body assembly. Refer to Figure 18.

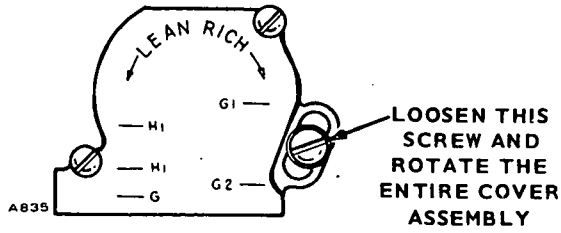


FIGURE 18. THERMO-MAGNETIC CHOKE

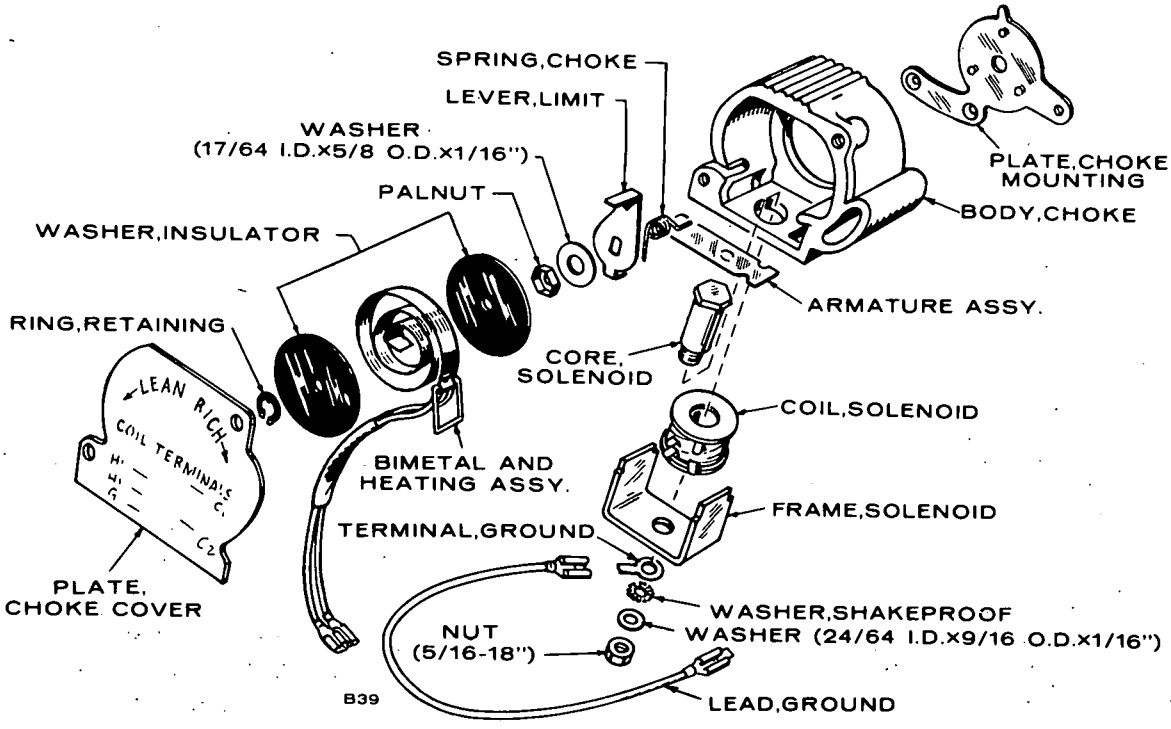


FIGURE 19. CHOKE ASSEMBLY

Rotating the choke body clockwise richens and counterclockwise leans the choking effect. For ambient temperatures above 85° F, the choke should be fully opened. For ambient temperatures below 25° F, the choke should be opened 1/4 inch with the solenoid not engaged. Tighten the screw that secures the choke body.

If the choke will not close, check for binding, incorrect adjustment, or incorrect assembly of the bimetal and heater assembly. If the choke will not open after the engine starts, check for heating. The choke bimetal should be warm to the touch within a minute or two after starting.

To disassemble the choke, refer to Figure 19.

If the heater assembly will not heat properly, check for broken heater wire, high resistance connections or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 37.8 to 46.2 ohms for a 12 volt system. If the heater is defective, replace. There must be slack in the lead wires between the choke body and the bimetal and heater assembly. When the start button is engaged, the solenoid should cause the spring loaded lever to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid core.

The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 12 volt system.

Assembly: Refer to Figure 19. When assembling the thermomagnetic choke, connect the bimetal and heater assembly as follows:

1. Lead tagged G to ground terminal in coil solenoid.
2. Lead tagged H to either of the H1 terminals on the solenoid core.

GOVERNOR SYSTEM

GOVERNOR ADJUSTMENT

Where engine speed is governor controlled, the governor is set at the factory to allow a nominal engine speed of 2400 rpm at no load operation (unless another speed is specified when the engine is ordered). Proper governor adjustment is one of the most important factors in maintaining the power and speed desired from the engine.

Before making governor adjustment, run the engine about 15 minutes to reach normal operating temperature.

It is difficult to determine if, after long usage, the governor spring has become fatigued. If, after properly making all other adjustments, the regulation is still erratic, install a new spring (Figure 20 and 21).

A tachometer for checking engine speed is required for accurate governor adjustment.

Check the governor arm, linkage, throttle shaft and lever for binding or excessive wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor.

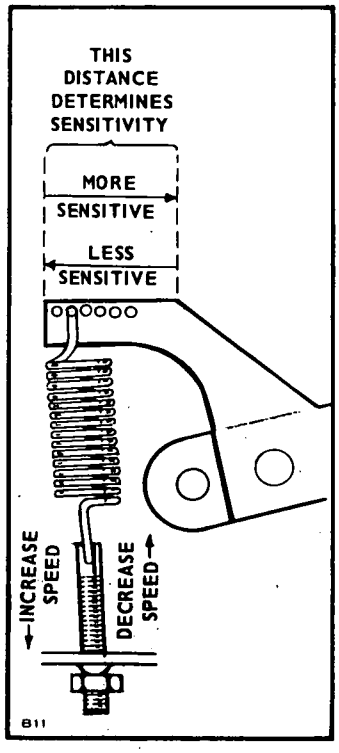
Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the engine idles. If either of these conditions exist, determine the cause and adjust or replace parts as needed.

Procedure:

1. Adjust the carburetor main jet for the best fuel mixture at full load operation.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage.
4. Check the governor linkage and throttle shaft for binding or excessive looseness.
5. Adjust the governor spring tension for nominal engine speed at no load operation.
6. Check the rpm drop between no load and full load operation and adjust the governor sensitivity as needed.
7. Recheck the speed adjustment.
8. Set the carburetor throttle stop screw.

Linkage: The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle arm is adjusted by rotating the ball joint housing. Adjust the length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever is 1/32-inch from the carburetor stop boss. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and the throttle shaft.

Speed Adjustment: The speed at which the engine operates is determined by the tension applied to the governor spring. Increasing spring tension increases



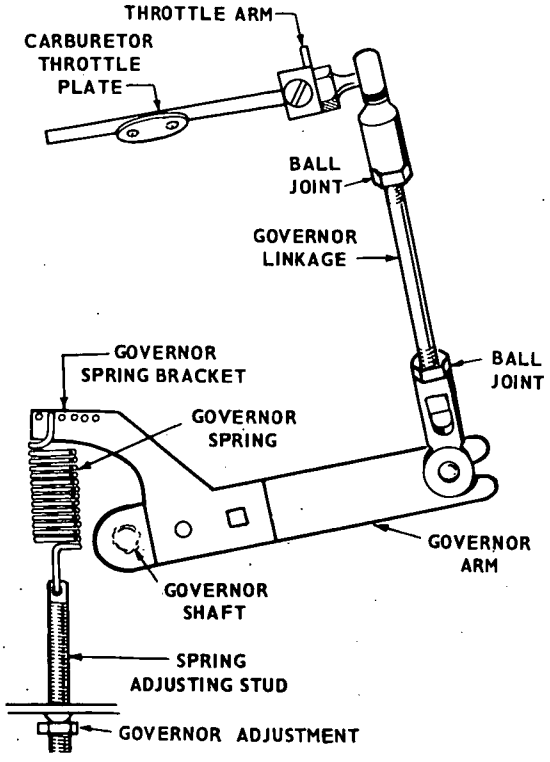


FIGURE 20. GOVERNOR ADJUSTMENTS

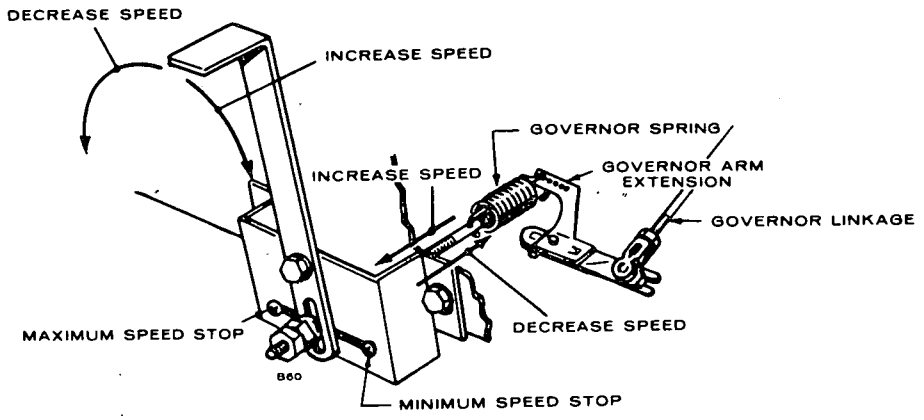


FIGURE 21. VARIABLE SPEED GOVERNORS

engine speed. Decreasing spring tension decreases engine speed. The no load speed of the engine should be slightly higher than the speed requirements of the connected load. For example: If the connected load is to turn at 3510 rpm, set the no load speed of the engine at about 3600 rpm. Check speed with a tachometer.

If a speed adjustment is needed, turn the speed adjusting nut in to increase the speed or out to decrease the speed (Figure 21).

Sensitivity Adjustment: The engine speed drop from no load to full load should be not less than 100 rpm. Check the engine speed with no load connected and again after connecting full load. Do not exceed 4000 rpm at no load.

The sensitivity of the governor depends upon the position of the arm end of the governor spring. A series of holes in the governor arm provides for adjustment. To increase sensitivity, move the spring toward the governor shaft. To decrease sensitivity, move the spring toward the linkage end of the governor arm.

If the setting is too sensitive, a hunting condition (alternate increase and decrease in engine speed) will result. If the setting is not sensitive enough, the speed variation between no load and full load conditions will be too great. Therefore, the correct sensitivity will result in the most stable speed regulation without causing a surge condition.

Always recheck the speed adjustment after a sensitivity adjustment. Increasing sensitivity will cause a slight decrease in speed and will require a slight increase in the governor spring tension.

Variable Speed Governor Adjustments: These engines are adapted for use where a wide range of speed settings is desired. The design of the variable speed governors give an automatic increase in sensitivity when the speed is increased and the result is good stability at all speeds.

To adjust the variable speed governors, refer to Figure 21 and the following:

1. Run the engine and make necessary carburetor adjustments.
2. Adjust the throttle stop screw on the carburetor to allow a recommended minimum idling speed of 900 rpm. A lower minimum does not assure smooth operation under load.
3. Adjust the tension of the governor spring for minimum speed.

   For governors having a manual control arm, set lever to minimum speed with no load and adjust the spring tension for about 1500 rpm.

   For governors having a Bowdin wire remote control knob (NHC engines with mounted engine controls), pull back the knob and slide to the first notch (low speed). Adjust speed to about 1500 rpm (or the desired low speed) at no load by turning the knob as required.

4. Adjust the sensitivity while operating at minimum speed to attain the smoothest no load to full load operation as follows:

   To decrease sensitivity (allow more speed drop from no load to full load operation) move the governor spring outward into a different groove or hole in the extension arm.

   To increase sensitivity (closer regulation by the governor which permits less speed drop from no load to full load operation), move the governor spring inward into a different groove or hole in the extension arm.
5. Apply a full load and shift the variable control to maximum speed—moving the control arm to the right or shifting the control knob and slide to the second notch. For the governor control with the control arm, set the screw in the bracket slot to stop lever travel at the desired maximum full load speed position. For the control with the control knob and slide, increase or decrease speed by turning the knob as required.

Approximately 3000 rpm is the recommended maximum full load speed for continuous operation. The speed must agree with the load requirements.

IGNITION SYSTEM

BREAKER POINTS

To maintain maximum efficiency from the engine, change the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove the two spark plugs so engine can be easily rotated by hand. If plugs have not been changed within the last 100 hours, replace them with new ones after setting the breaker points.
3. Refer to Figure 22. Remove mounting screw (A) and pull the points out of the box just far enough so screw (B) can be removed and leads disconnected.
4. Remove screw (C) and replace condenser with a new one.
5. Replace points with a new set but do not completely tighten mounting screw (A).
6. Rotate the engine by hand until the 20° BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90°) to ensure points are fully open.
7. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .016-inch with a flat thickness gauge. Tighten mounting screw and recheck gap.
8. Check ignition timing.

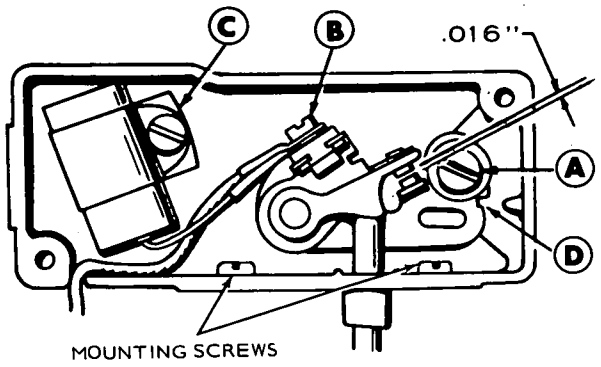


FIGURE 22. BREAKER POINT ADJUSTMENT

TIMING PRESSURE COOLED ENGINE

The timing on the engine is preset at the factory. A non-movable breaker point box is used, however a slight timing change could be made by adjusting points.

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. Spark advance is set at 20° BTC (before top center), and should be maintained for best engine performance. Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

Timing Procedure—Engine Running:

1. To accurately check the ignition timing, use a timing light with engine running at idle speed. Connect the timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.
2. Start the engine and check the timing. The pointer on the flywheel should line up with the 20° mark on the cover. The timing hole through the flywheel and the timing marks on the timing gear cover can be seen by looking through the flywheel blower screen. See Figure 23.

If timing marks do not line up, readjust point gap. To advance timing, slightly open gap on breaker points. To retard timing, slightly close gap on breaker points. Recheck timing and breaker point gap after making this adjustment.

Timing Procedure—Engine Not Running: If a timing light is not available, check the timing as follows:

1. Connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch the other test prod to a good ground on the engine.
2. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
3. The lamp should go out just as the points break which is the time at which ignition occurs (20° BTC).

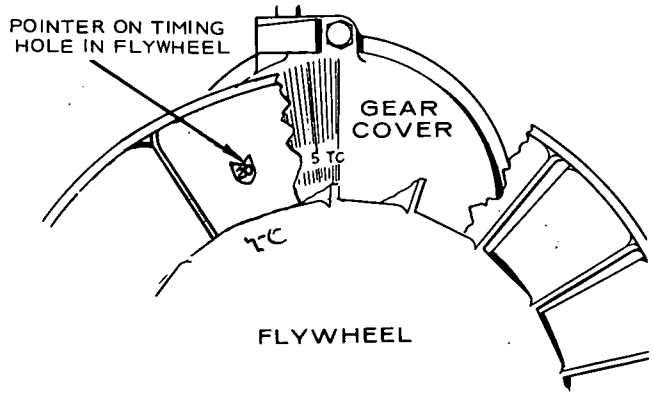


FIGURE 23. FLYWHEEL TIMING HOLE

TIMING VACU-FLO ENGINE

Engine timing is advanced or retarded by opening or closing the breaker point gap. Setting the point gap at 0.016 inch is the most accurate method of timing the engine.

Dynamic timing (engine running) may be less accurate because the sight angle from the viewer to the flywheel scribe mark and timing pointer may vary ± 2° from 20° BTC, Figure 24.

The timing pointer is mounted on the cylinder block above the oil filter; it is made accessible by removing the right hand shroud.

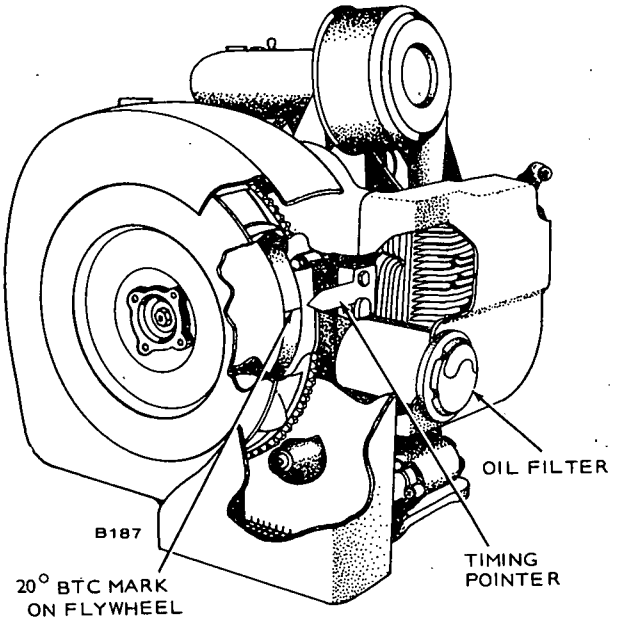


FIGURE 24. VACU-FLO ENGINE—TIMING MARK AND POINTER

SPARK PLUGS

Remove both spark plugs and install new ones every 100 hours. Use Onan spark plugs 167-0240 or equivalent. Check to be sure spark plug gap is set at .025 inch, Figure 25.

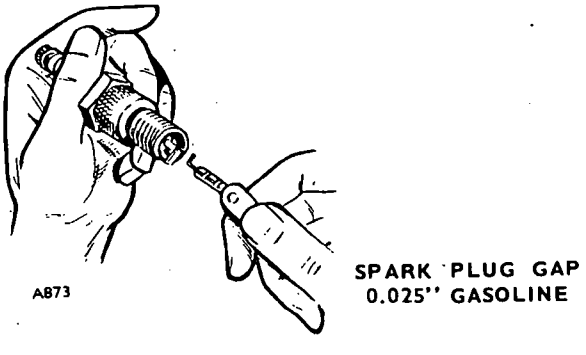


FIGURE 25. SPARK PLUG GAP

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use Simpson 260 VOM or equivalent.
2. Place black lead on ground (-) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 4.30 (± 10%) ohms @ 70° F.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 26). Secondary resistance should read 14,000 (±10%) ohms @ 70° F.
4. If any of the above conditions are not met, replace coil. Refer to *Parts Catalog* for correct part number.

CAUTION **This engine uses a 12 volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.**

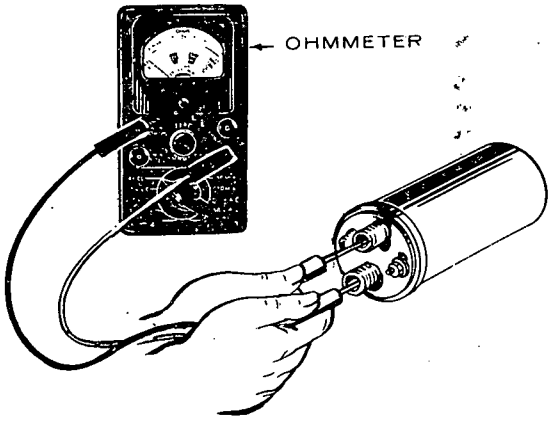


FIGURE 26. COIL TEST

BATTERY INSPECTION

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.280 at 80° F, Figure 27.

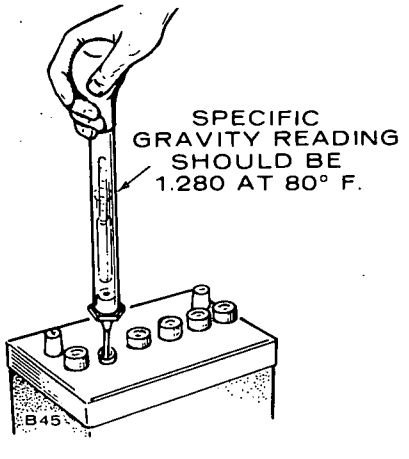


FIGURE 27. SPECIFIC GRAVITY TEST

If one or more cells are low on water, add distilled water and recharge.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.

BATTERY CHARGING SYSTEM

BATTERY CHARGING, FLYWHEEL ALTERNATORS

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output.

Two different alternator systems are used with NHC and NHCV engines. One is a 20 amp Synchro system; the other is a 15 amp Phelon system.

A 30-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. Replace the fuse with Onan Fuse 321-0162, Buss AGC30 or equivalent.

Weak ignition spark or a discharged battery indicate trouble in the charging system. But before testing the engine's charging system, always check the battery for serviceability.

TESTING OR SERVICING

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure output control plug (connector) is inserted properly. Plug must bottom in receptacle—eliminates any resistance due to a poor connection. Keep clean and tight.
2. Make sure alternator stator leads are not shorted together.
3. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
4. Never reverse the battery leads.

Charging system tests require a fully charged battery.

20 AMP SYNCHRO SYSTEM

The 20 amp flywheel alternator systems use a separate regulator and a separate rectifier, Figure 28.

Testing: For testing this system, use a voltmeter-ohmmeter such as a Simpson 270. Various alternator problems with individual test procedures are listed in Table 2.

No Output—Stator Assembly: Examine leadwires for loose or broken connections at the regulator and rectifier. Use the Rx1 scale on the ohmmeter for detecting opens in the stator. Disconnect the three wires that come from alternator stator (two black, one red). Connect ohmmeter test leads to red leadwire and ground to check continuity. The ohmmeter reading should be about 2.0 ohms. See Figure 29 for wiring diagram.

Next, connect meter to black leadwires and ground. Approximately 0.1 ohm should be read from either black lead to ground. If no connection exists between ground and black leads, stator assembly should be replaced.

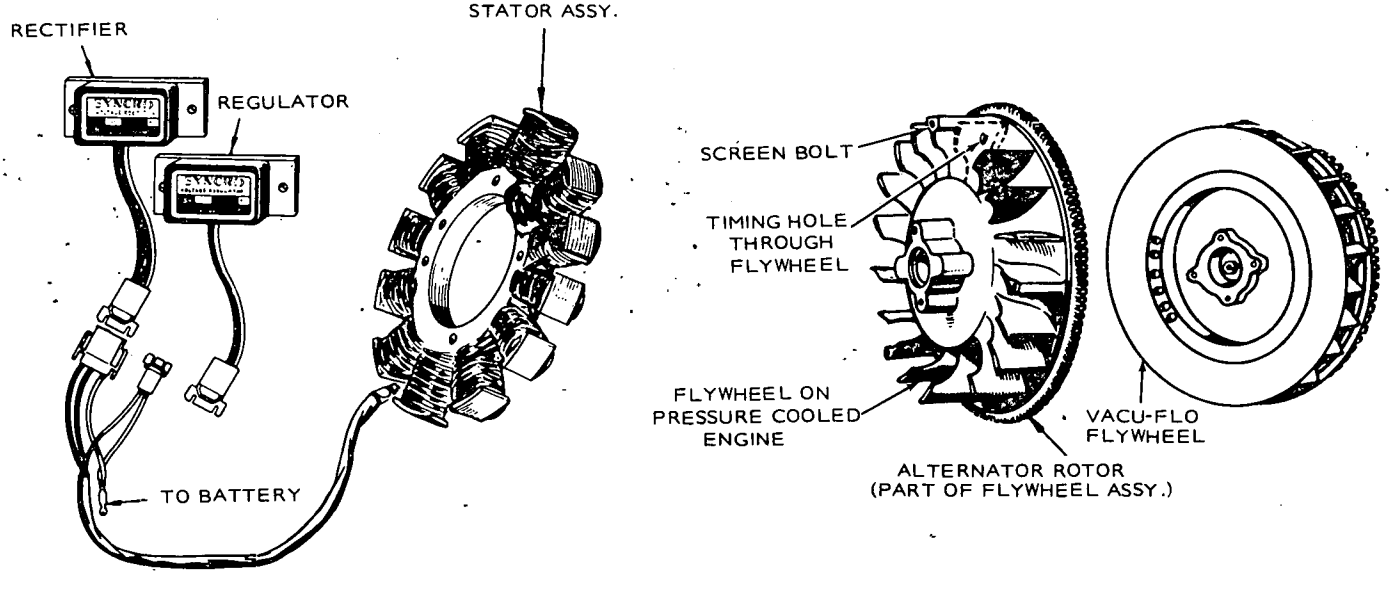
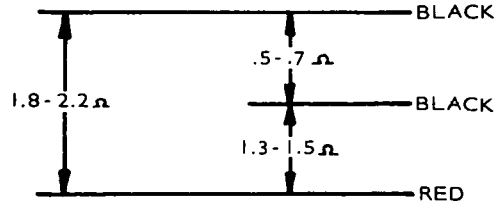


FIGURE 28. 20 AMP SYSTEM

TABLE 2. TESTING SYNCHRO 20 AMP SYSTEM

TEST	VALUE
Battery voltage - unit not running	12 Volts DC
Battery voltage with unit running at 1800 rpm or more	14.2 — 14.8* Volt DC
AC voltage from stator with plug disconnected and unit running at approximately 1800 rpm	17 volts AC Black to Black
Ohmmeter reading at plug when checking two AC stator leads - unit not running	
Resistance values (Ohms) are as follows between wire pairs. 	

* - 60 Volt minimum at greater than 2000 rpm, Red to Ground.

Checking Rectifier Assembly: Examine each of the two diodes for breakdown by connecting ohmmeter (Rx1 scale) from one black lead to white lead. Meter should read 10 ohms in proper polarity. A shorted diode would read zero resistance and would cause a short circuit through the lead winding when in operation. An open diode would read infinite in both directions indicating that replacement is necessary.

Testing Regulator Assembly: To check for proper voltage regulation, attach a DC voltmeter to battery and operate engine at about 1800 rpm. Battery voltage will climb to the preset factory setting (14.2 to 14.8 volts).

Some installations may vary due to voltage drop in the length of ammeter harnesses. Other variations may stem from a loose connector in the harness or loose or corroded battery leads. Low voltage readings at the battery mean poor battery connections.

To test regulator, remove connector. Using the Rx10,000 scale of your ohmmeter, connect one meter lead to red leadwire and other meter lead to regulator base. No deflection should be noted on the ohmmeter in either polarity. Next connect meter to black leadwire and base of regulator. Meter will deflect fully in one polarity with no deflection in the other.

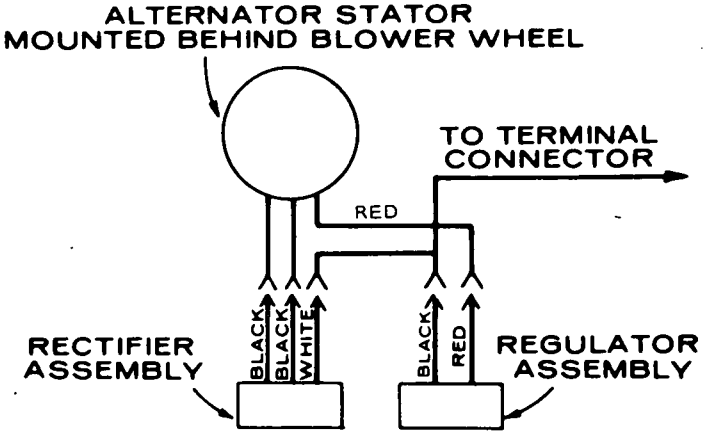


FIGURE 29. 20 AMP SYNCHRO SYSTEM

Full Charge—Will Not Regulate: Check for broken leads at connection to regulator plates. To be sure regulator winding operates properly, connect red lead to ground and start engine. A maximum of 4 amperes should be noted. This would indicate stator winding is satisfactory. If so, replace regulator.

No Charge: If alternator does not charge when load is applied to battery, shut off engine and disconnect one red leadwire from regulator terminal. Be sure lead is taped or isolated from conducting engine parts. Once again, start engine. Alternator should charge to full output; if it doesn't, replace stator assembly.

15 AMP PHELON SYSTEM

The 15 amp flywheel alternator systems (Figure 30) have a one piece regulator-rectifier assembly. Various alternator problems are listed in Table 3.

Testing

With the engine running between 1800-2600 rpm, observe the panel ammeter (if not already equipped, connect a test ammeter). If no charging is evident, proceed with the NO CHARGE TEST. If ammeter shows a constant higher charge rate, follow the HIGH CHARGE RATE TEST procedure.

No Charge Test: Perform as follows:

1. Check the B+ to ground voltage using a DC voltmeter. See Figure 31 for wiring diagram.
2. If voltmeter reads 13.8 volts or higher, add a load to system (e.g. headlights) to reduce battery voltage to below 13.6 volts.
3. Observe ammeter. If charge rate increases, consider the system as satisfactory. If charge rate does not increase, proceed with testing.
4. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running near 3600 rpm. If AC voltage reads less than 28 volts, replace the stator. If AC voltage is more than 28 volts, replace the regulator-rectifier assembly.

TABLE 3. TESTING PHELON 15 AMP SYSTEM

BASIC TEST	PROCEDURE	TEST VALUES
1. Battery	Battery Voltage - unit not running	12 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes	13.6 to 14.7 VDC
3. Alternator Stator and Wiring with Fully Charged battery.	Ohmmeter reading from stator output - unit not running. Check at plug.	.11 to .19 Ohms
4. Alternator and Wiring	Measure AC open circuit stator voltage with unit running. Measure between two stator leads with plug disconnected and unit running at approximately 3600 rpm.	28 VAC

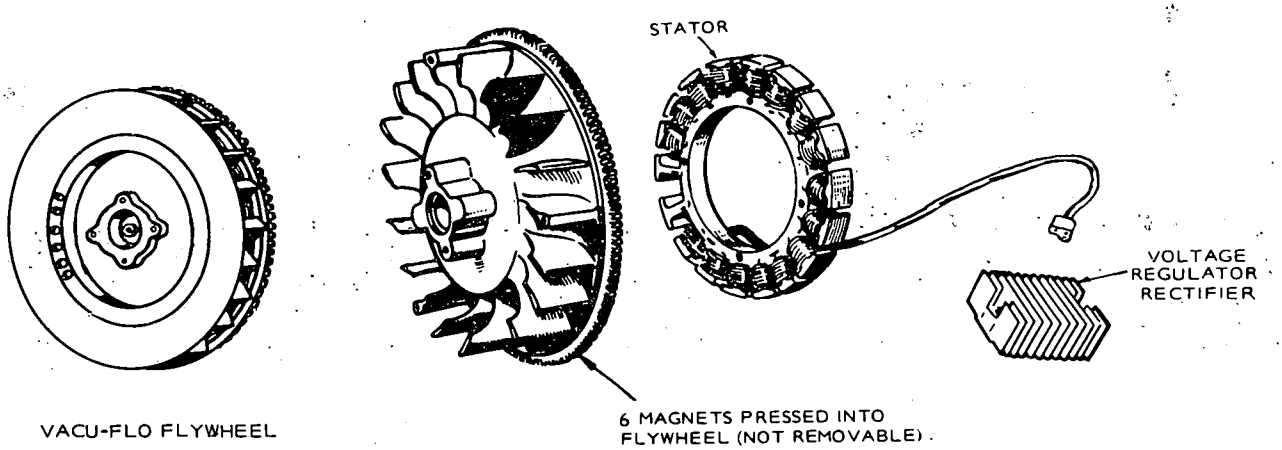


FIGURE 30. 15 AMP SYSTEM (PHELON)

High Charging Rate Test: Perform this test as follows:

1. Check B+ to ground voltage with a DC voltmeter.
2. If voltmeter reads over 14.7 volts, replace regulator-rectifier assembly.
3. If reading is under 14.7 volts the system is probably okay. Recheck the battery and connections. If the battery does have a low charge, but accepts recharging, system is okay.

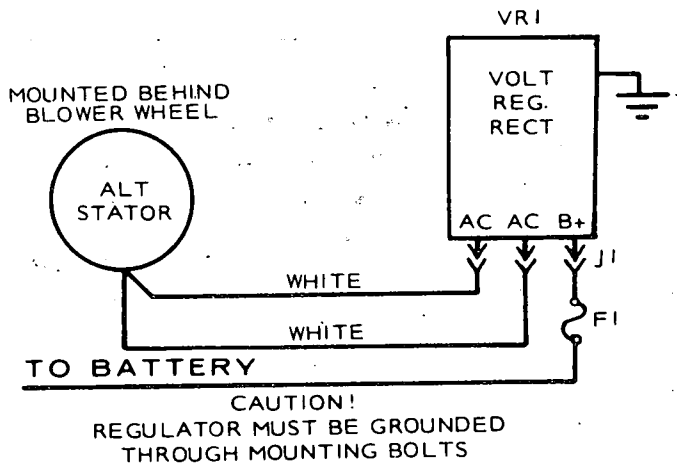


FIGURE 31. 15 AMP PHELON SYSTEM

STARTING SYSTEM

ELECTRIC STARTER REPAIR

CAUTION **To prevent insulation damage, do not use steam or high pressure water to clean the starter assembly (Figure 32).**

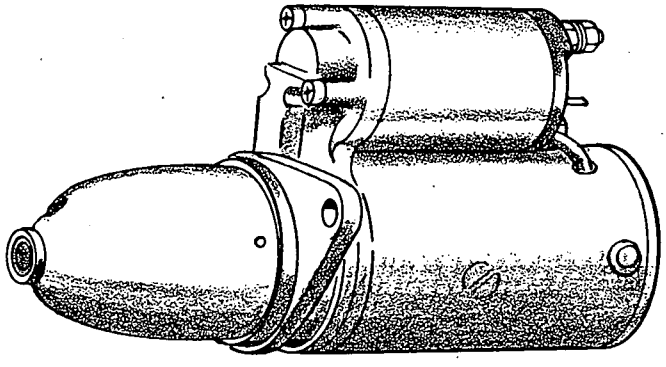


FIGURE 32. STARTER ASSEMBLY

DISASSEMBLY

1. Loosen the M terminal nut on the magnetic switch and remove the connector. Then unscrew attaching screws and remove the magnetic switch, Figure 33.

The packings for the magnetic switch are mounted so that the steel packing is located in the front bracket side.

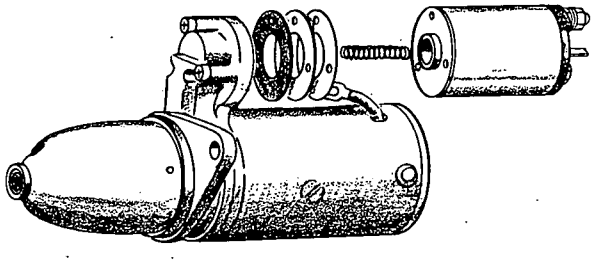


FIGURE 33. MAGNETIC SWITCH REMOVAL

2. After removing the thru bolts, the starting motor can be divided into three parts—the front bracket, housing and rear bracket. The spacers shown in Figure 34 are used for adjustment of the thrust gap of the armature shaft and are placed between the rear bracket and the commutator.

These washers are inserted so the steel washer is located in the commutator side.

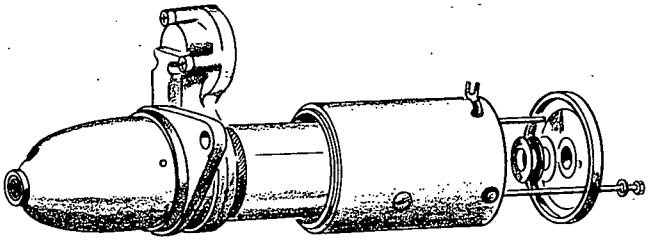


FIGURE 34. REMOVING THROUGH BOLTS

3. The armature can easily be removed from the front bracket. Be careful not to miss a small steel washer used in the end of the armature shaft. The shift lever can be removed along with the armature when it is removed: In this case, the spring holder, lever springs and retainer can be taken out before the lever. See Figure 35.

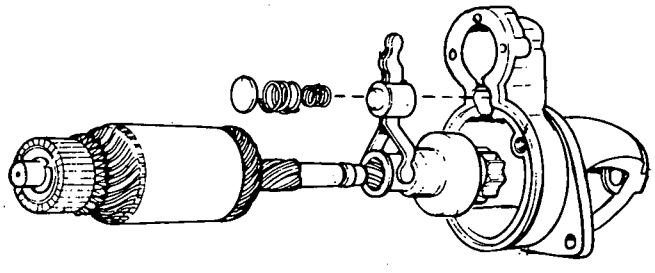


FIGURE 35. REMOVING ARMATURE

4. Remove the ring after driving the pinion stopper toward the pinion gear using a cylindrical tool as shown in Figure 36. The overrunning clutch and the pinion stopper should be removed simultaneously.
5. All four brushes have been soldered to the brushholder in the same way. The brush springs can be removed from the brushholder.
6. The pole shoes may be removed if necessary, by removing the flat head machine screws from the frame.

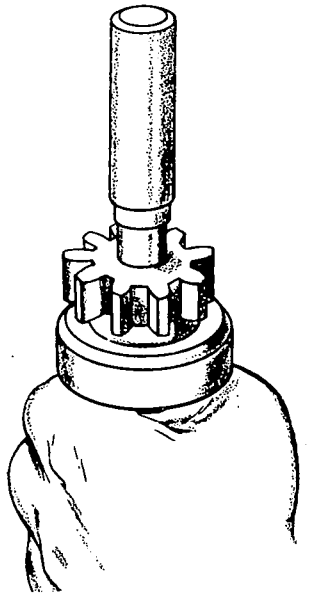


FIGURE 36. REMOVING RING

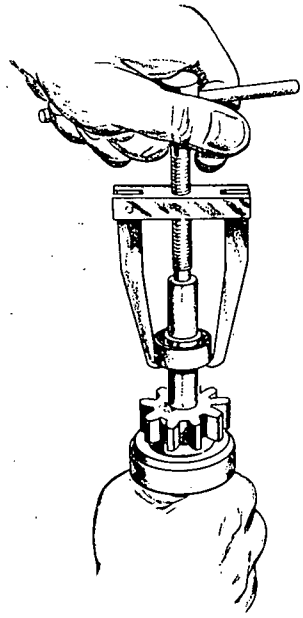


FIGURE 38. MOUNTING OVERRUNNING CLUTCH

REASSEMBLY

Inspect the parts carefully in accordance with the procedure described in *Inspection of Parts*. Make any repairs necessary. Reassembly is the reverse of disassembly. The following precautions should be taken:

CAUTION **Parts containing lubricated bearings must not be immersed in cleaning fluid to prevent breakdown of lubricant. These parts should be cleaned with a brush dipped in "Varsol" or any other comparable mineral spirits. Do not immerse overrunning clutch in cleaning solvent. Thoroughly dry any parts that have come into contact with the cleaning fluid.**

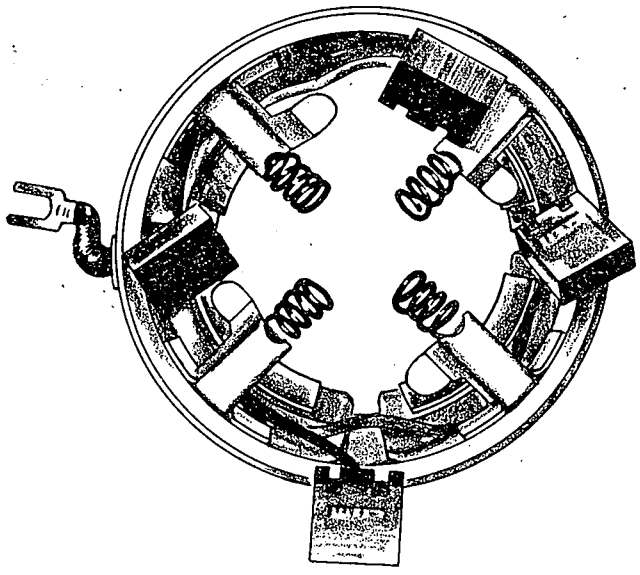


FIGURE 37. BRUSHES

1. Inspect brushes (Figure 37) and clean all parts carefully with a dry cloth and compressed air if it is available.
2. Apply 20 weight non-detergent oil to the armature shaft and splines. Apply grease (Shell Albania No. 2 or equivalent) sparingly on the shift lever pin, the joint of the shift lever and plunger, the plunger and spacing washers at the end of the shaft.
3. To mount overrunning clutch, first insert pinion stopper in armature shaft; then install ring in groove of the shaft. For insertion of the ring, use tool shown in Figure 38 and pull the pinion stopper up.
4. Use spacing washers to adjust the armature to give end play of .004" to .020".
5. Tighten the thru bolts to a torque of 35 to 44 in-lbs.
6. Insert the shift lever as shown in Figure 39 into the front bracket.

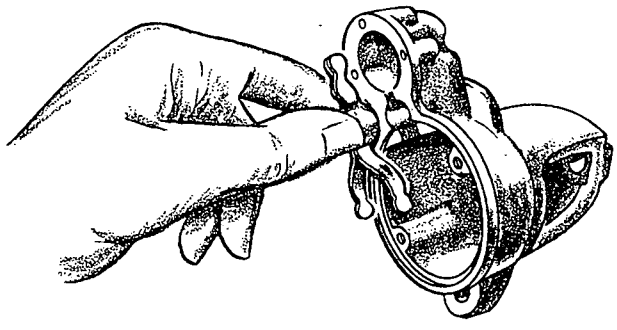


FIGURE 39. INSTALLING SHIFT LEVER

INSPECTION OF PARTS

1. **Testing Armature for Short Circuits.** Place the armature in a growler and hold a thin steel blade parallel to the core and just above it while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace shorted armature. See Figure 40.

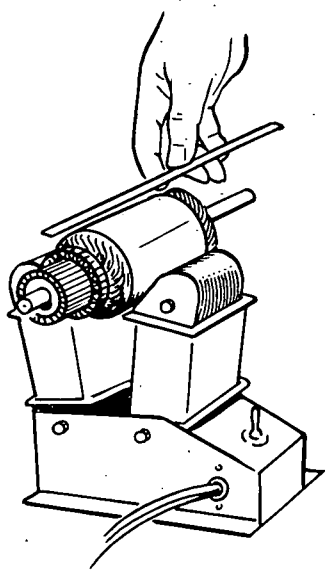


FIGURE 40. ARMATURE SHORT CIRCUIT TEST

2. **Testing Armature for Grounds.** Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads. If the ohmmeter reading is low, it indicates a grounded armature. Replace grounded armature. See Figure 41.

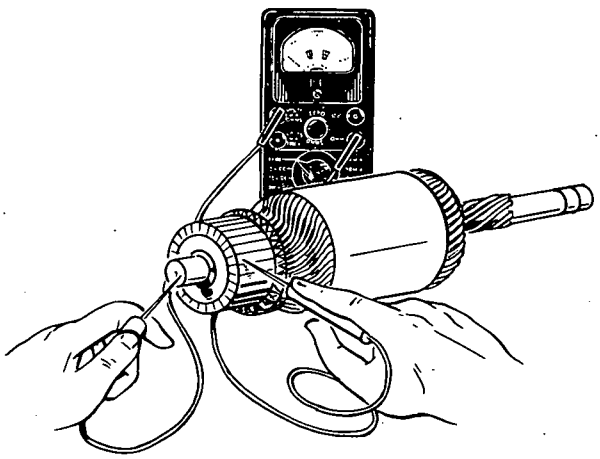


FIGURE 41. ARMATURE GROUND TEST

3. **Testing Armature for Open Circuit.** The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections.
4. **Testing Commutator Runout.** Place armature in a test bench and check runout with a dial indicator. When commutator runout exceeds .004", commutator should be refaced (Figure 42).

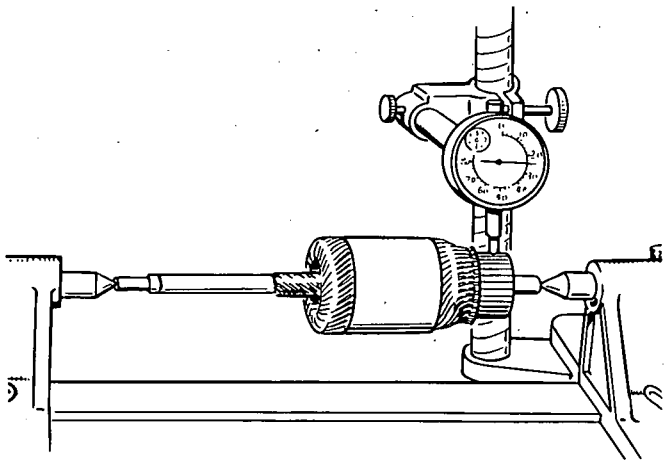


FIGURE 42. CHECKING COMMUTATOR RUNOUT

5. **Testing Armature Shaft Runout.** The armature shaft as well as the commutator may be checked. A bent armature often may be straightened, but if the shaft is worn, a new armature is required (Figure 43).

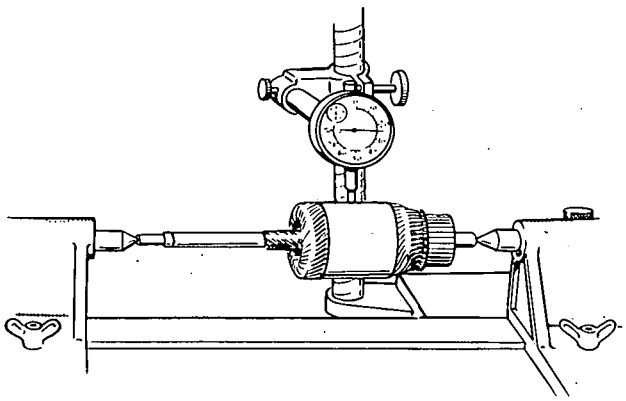


FIGURE 43. CHECKING ARMATURE SHAFT RUNOUT

6. **Testing Field Coils for Grounds.** Place one lead on the connector and the other on a clean spot on the frame after unsoldering shunt field coil wire. If the ohmmeter reading is low, the fields are grounded, either at the connector or in the windings (Figure 44).

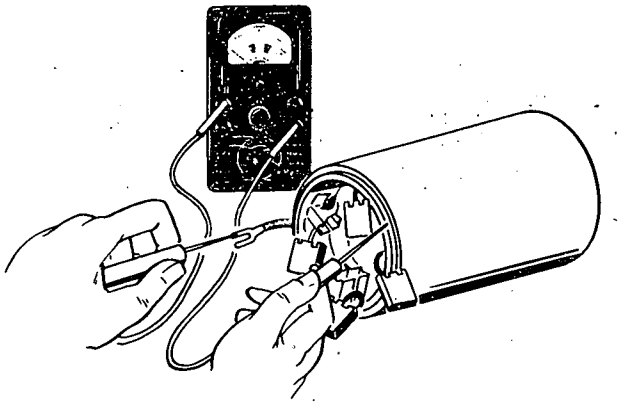


FIGURE 44. FIELD COIL GROUND TEST

7. **Testing Field Coils for Open Circuit.** Place one lead on the connector and the other on a clean spot on the brushholder. If the ohmmeter reading is high, the field coil is open. Check the other three brushholders in the same manner (Figure 45).

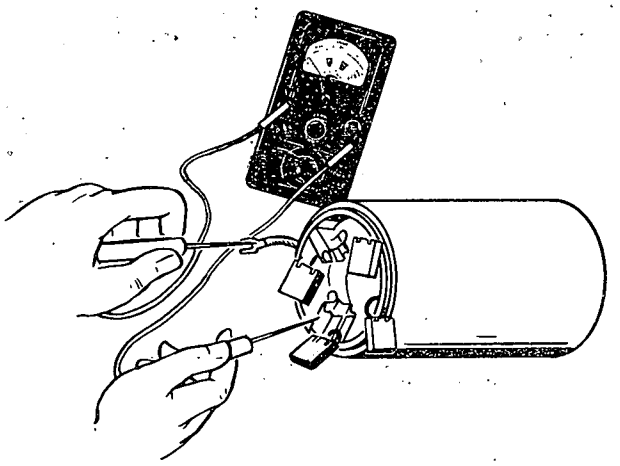


FIGURE 45. FIELD COIL OPEN CIRCUIT TEST

8. **Inspection of Brushes.** Replace brushes when they are worn less than .3" as shown in Figure 46. See that all brushes move freely in their holders.

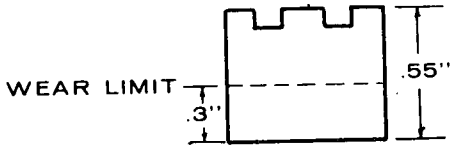


FIGURE 46. BRUSH WEAR LIMIT

9. **Inspection for Brush Spring Tension.** Measure brush spring tension with a tension meter as shown in Figure 47. Push the brush and take a reading just as the brush projects a little from the brushholder. On a new brush the spring tension should be 29 to 38 ounces.

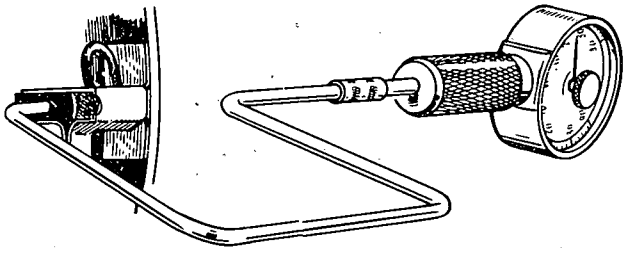


FIGURE 47. BRUSH SPRING TENSION TEST

INSPECTION AFTER OVERHAUL

1. For no load test, the starting motor is wired as shown in Figure 48 and revolved. The meter readings for this test should be:

Voltage	11.5 volt
Speed	3700 rpm minimum
Current Draw	60 amp maximum

The conductor for this test should be large enough to carry 60 amps and as short as possible. If anything is wrong in the above test, inspect the following items:

Annealed brush springs
Improperly seated brushes
Insufficient armature endplay
Shorted, open or grounded armature
Grounded or open field coil
Poor electrical connection
Dirty commutator

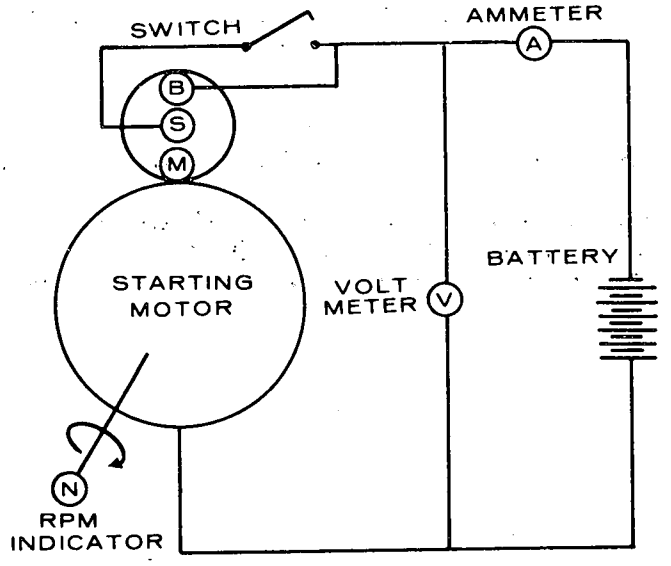


FIGURE 48. STARTING MOTOR WIRING

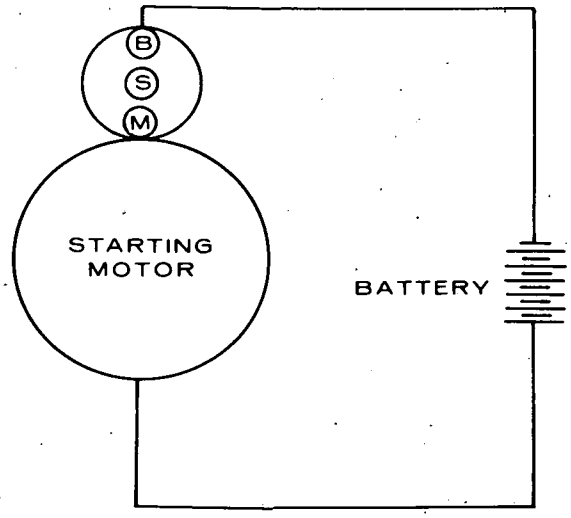


FIGURE 49. BATTERY CONNECTIONS

2. **Adjusting Pinion Clearance.** Connect the battery to the starting motor as shown in Figure 49. This will allow the pinion of the starting motor to slide and stop. In this state, measure the clearance between the end of the pinion and pinion stopper when the pinion is pushed lightly toward the commutator end. Clearance should be .02" to .06". Adjust for proper clearance by removing the magnetic switch attaching screws and select proper thickness of the fiber packings shown in Figure 50.

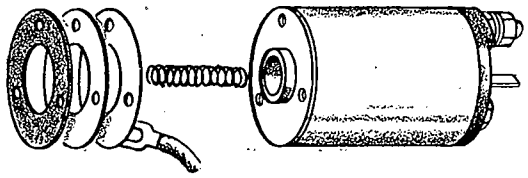


FIGURE 50. ADJUSTING PINION CLEARANCE

ENGINE DISASSEMBLY

VALVES

Proper seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44 degrees. The valve *seat* angle is 45 degrees. This 1-degree interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life (Figure 51).

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44 degrees. Valve seats should be ground with a 45-degree stone and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

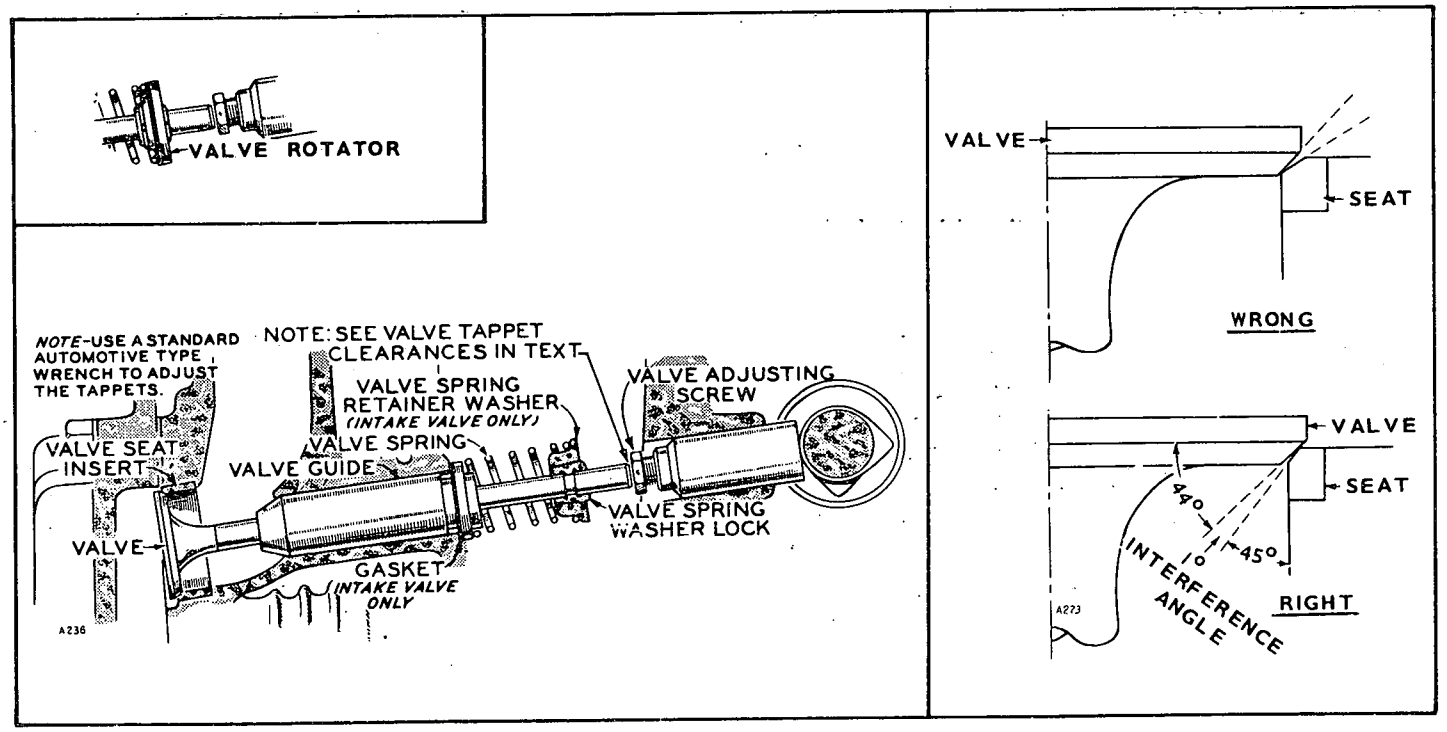


FIGURE 51. VALVE SYSTEM

Tappet Adjustment: The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 400 operating hours or when poor engine performance is noticed. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to valve tappets.
2. Remove spark plugs to make turning the engine easier.
3. Use the engine flywheel to turn the engine over slowly by hand until the left hand intake valve opens and closes. Continue turning the flywheel until the TC mark is on the top and lined up with the TC mark on the gear cover. Both valves should be closed. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder.
4. Clearances are shown in Figure 52 and *Tune-up Specifications.* For each valve, the gauge should just pass between the valve stem and valve tappet.
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self locking.
6. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

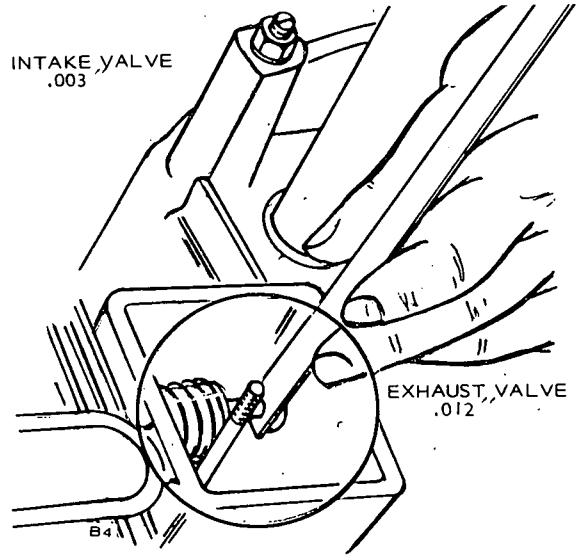


FIGURE 52. VALVE ADJUSTMENT

FLYWHEEL

Use a suitable puller (with claws or with bolts to agree with flywheel) to pull the flywheel.

CAUTION **Do not drop the flywheel. A broken fin will destroy the balance. Always use a steel key for mounting the flywheel.**

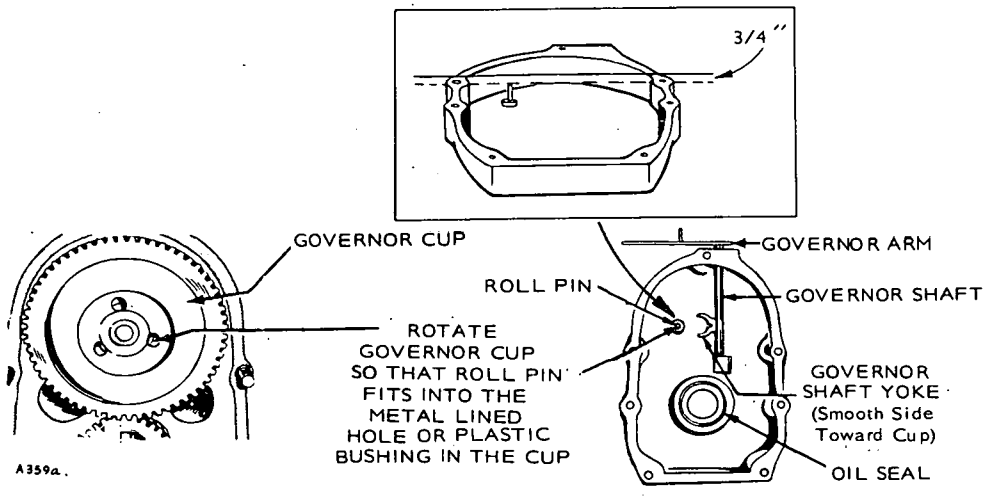
If a puller is not available turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp endwise blow on the head of the cap screw with a heavy soft-faced hammer to loosen.

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.

CAUTION **When installing the gear cover, make sure that the roll pin in the gear cover engages the metal lined (smooth) hole or plastic bushing in the governor cup, Figure 53.**

The roll pin protrudes upward from the cover and its outer end is 3/4 inch from a straight edge placed across the cover mounting surface.



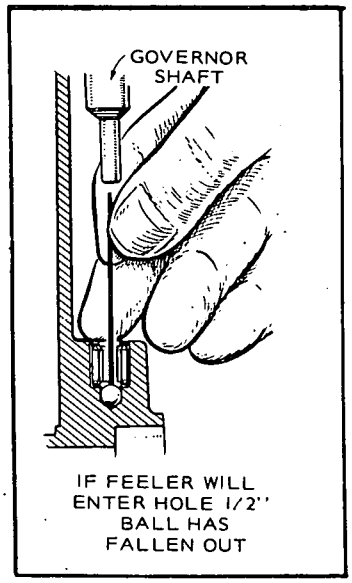


FIGURE 53. GEAR COVER ASSEMBLY

Turn the governor cup so that the metal lined hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin, Figure 54. Catch the flyballs while sliding the cup off.

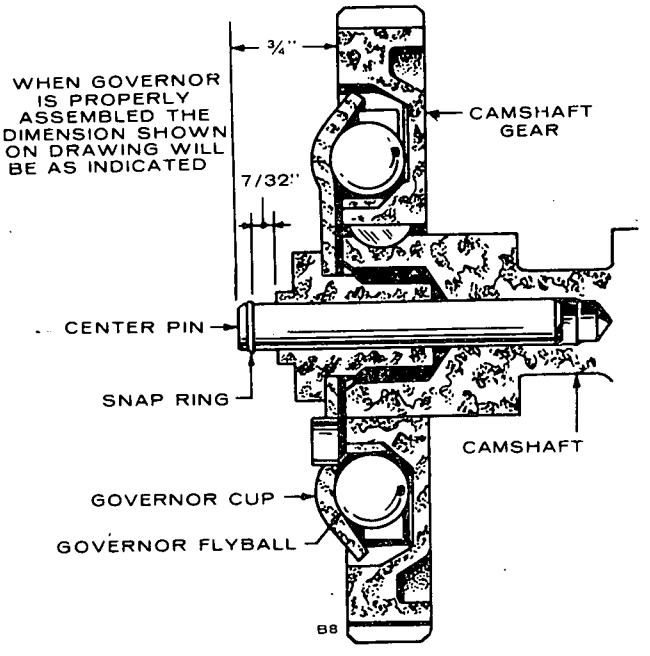


FIGURE 54. GOVERNOR CUP DETAILS

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting with a chisel. Replace the spacer with a new one. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the cup and snap ring on the center pin.

The camshaft center pin extends out 3/4-inch from the end of the camshaft. This distance provides an in and out travel distance of 7/32-inch for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture. See Figure 55.

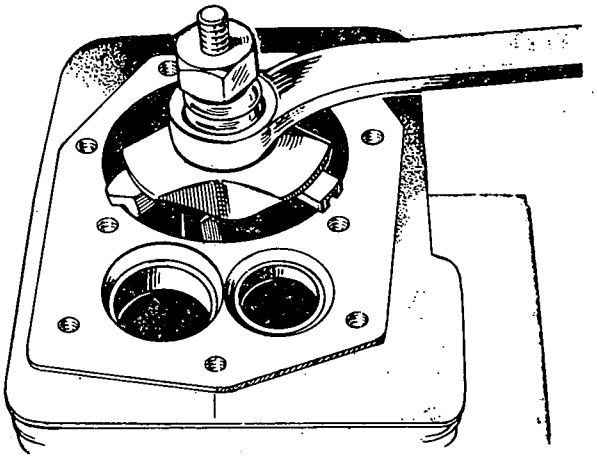


FIGURE 55. REMOVING WEAR RIDGE

To remove the piston and connecting rod assemblies; turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

Keep the connecting rod bearing caps and bearings with their respective rods.

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader.

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point. All passages should be cleaned with a non-caustic solvent. Clean the rod bore and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land

using new rings and a feeler gauge as shown in Figure 56. See *Dimensions and Clearances* for proper side clearance measurement and ring groove widths.

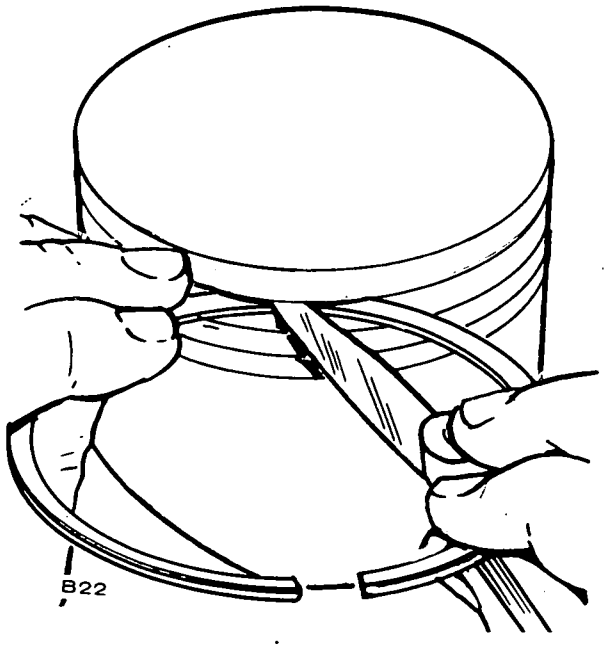


FIGURE 56. RING LAND INSPECTION

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves don't have good cylinder wall contact (Figure 57).

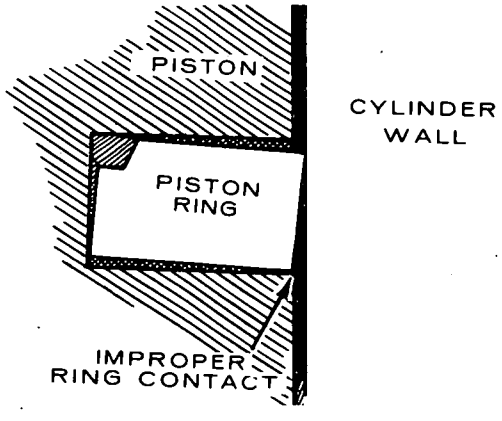


FIGURE 57. NEW RING IN WORN RING GROOVE

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002-inch.

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in *Dimensions and Clearances.*

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder, at a position corresponding to the bottom of its travel (Figure 58). The gap between the ends of the ring is given in *Dimensions and Clearances.* Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on .005" oversize pistons. Rings that are .010", .020", .030" and .040" oversize are to be used on corresponding oversize pistons. Rings of the tapered type are usually marked *top* on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

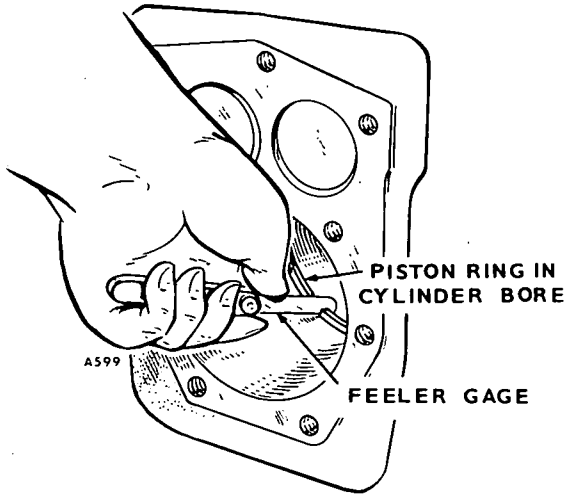


FIGURE 58. FITTING PISTON RINGS TO THE CYLINDER

Engines that have been fitted with .005" oversize pistons at the factory are identified by the letter E after the serial number which is stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in *Dimensions and Clearances.*

Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Refer to *Dimensions and Clearances* for the correct piston-to-cylinder clearance.

CONNECTING RODS

Connecting rods should be serviced at the same time as the pistons and rings. Replaceable bushings and bearings are used. Bearings are available in standard or .002", .010", .020" or .030" undersize.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts (forged rod), then refinish it to take the corresponding undersize bearing insert available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

Crankshaft Regrinding: Crankshaft grinding requires a trained, experienced operator, with precision equipment. Onan emphasizes that if facilities or trained personnel are not available, the crankshaft may be sent to the factory.

Special procedures must be observed when reworking crankshafts. In addition to machining, the crankshaft must be super finished.

Shot Peening: On older model engines, shot peening is required to prevent failures. When the shaft is machined follow the data to shot peen each crank pin fillet.

1. Almen gauge reading, .012-A.
2. Mask off connecting rod bearing areas.
3. Peen with .019" diameter cast steel shot.
4. Peen for 30 seconds on each crankpin fillet.

Undersize bearings and connecting rods are available to rework the shaft to .010", .020", and .030" undersize.

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing, Figure 59. Use combination bearing driver 420-0324 to install the camshaft bearings.

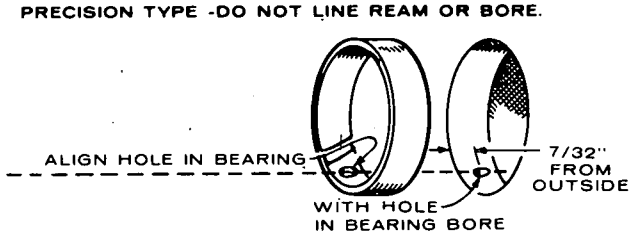


FIGURE 59. CAMSHAFT BEARING

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

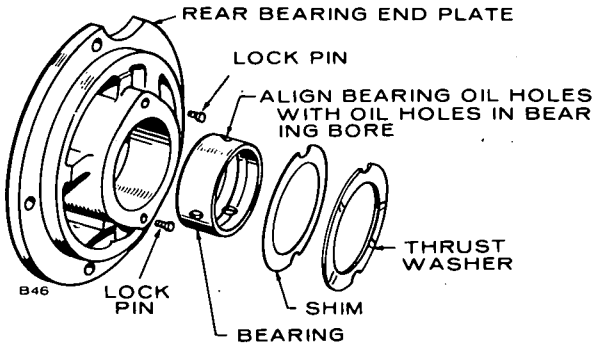
New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard size, .002", .010", .020" or .030" undersize.

Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heater to 200° F. If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

The cold oiled precision bearing should require only light taps to position it. In the rear bearing plate, install the bearing flush to 1/64 inch below the end of the bore using combination driver (same one used for camshaft bearing). See Figure 60.

If the special combination tool isn't available, it's necessary to remove the lock pins with side cutters or Easy Out tool. After the new bearings are installed, insert new lock pins.

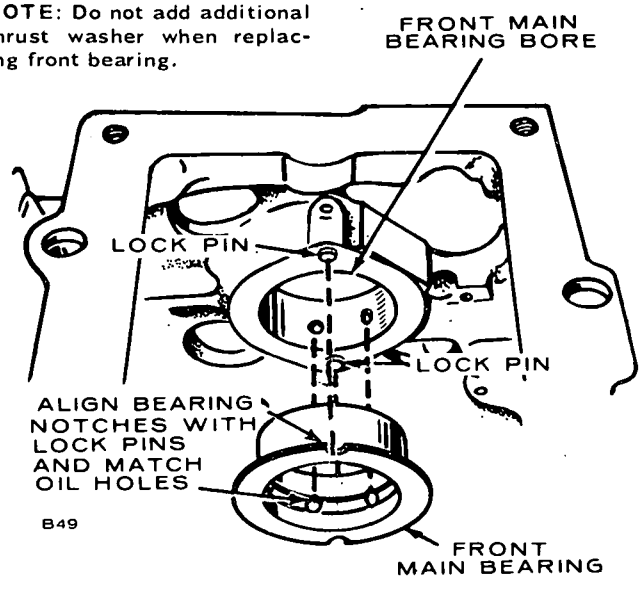


PRECISION TYPE- DO NOT LINE REAM OR BORE

FIGURE 60. BEARINGS FOR REAR BEARING PLATE

Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 61. Do not add an additional thrust washer to this front bearing.

NOTE: Do not add additional thrust washer when replacing front bearing.



PRECISION TYPE-
DO NOT LINE BORE OR REAM OR BORE

FIGURE 61. FRONT BEARING INSTALLATION

Before installing the front bearing, use the Locktite Bearing Mount furnished in the bearing kit. Use the towelette in the package to clean the outside of the bearing and the bearing bore in the block.

WARNING **Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well ventilated.**

After allowing three to four minutes for drying, apply the Locktite Bearing Mount from the small tube to the mating surfaces of the bearing and bearing bore. Install the bearing flush with the block using the combination driver just used for the rear bearing. Wipe off any excess Locktite around the bearing. Allow at least one hour for hardening at room temperature.

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. Line up the notches of the thrust washer with the lock pins before tightening the end plate or the lock pins will be damaged.

A light film of oil on the thrust washer may hold it in place while installing the crankshaft.

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in *Assembly Torques and Special Tools,* check the crankshaft endplay as shown in Figure 62. If there is too much endplay (see *Dimensions and Clearances* for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 60) between the thrust washer and plate. Reinstall the end plate making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

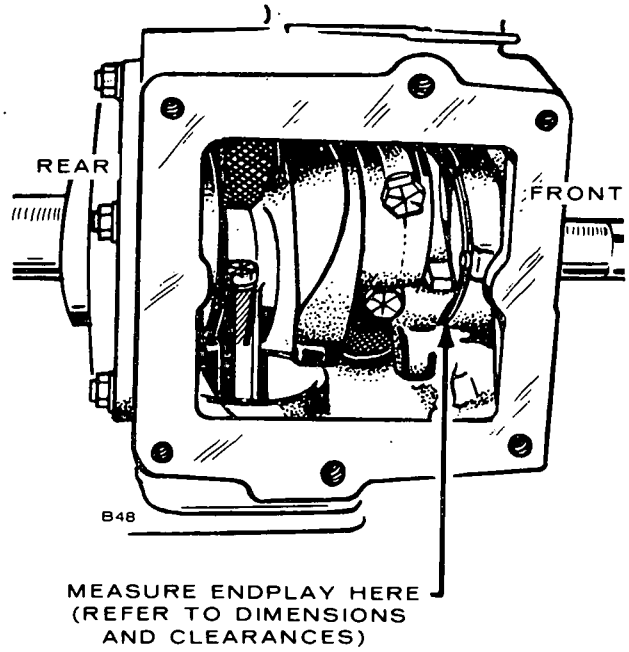


FIGURE 62. CRANKSHAFT ENDPLAY

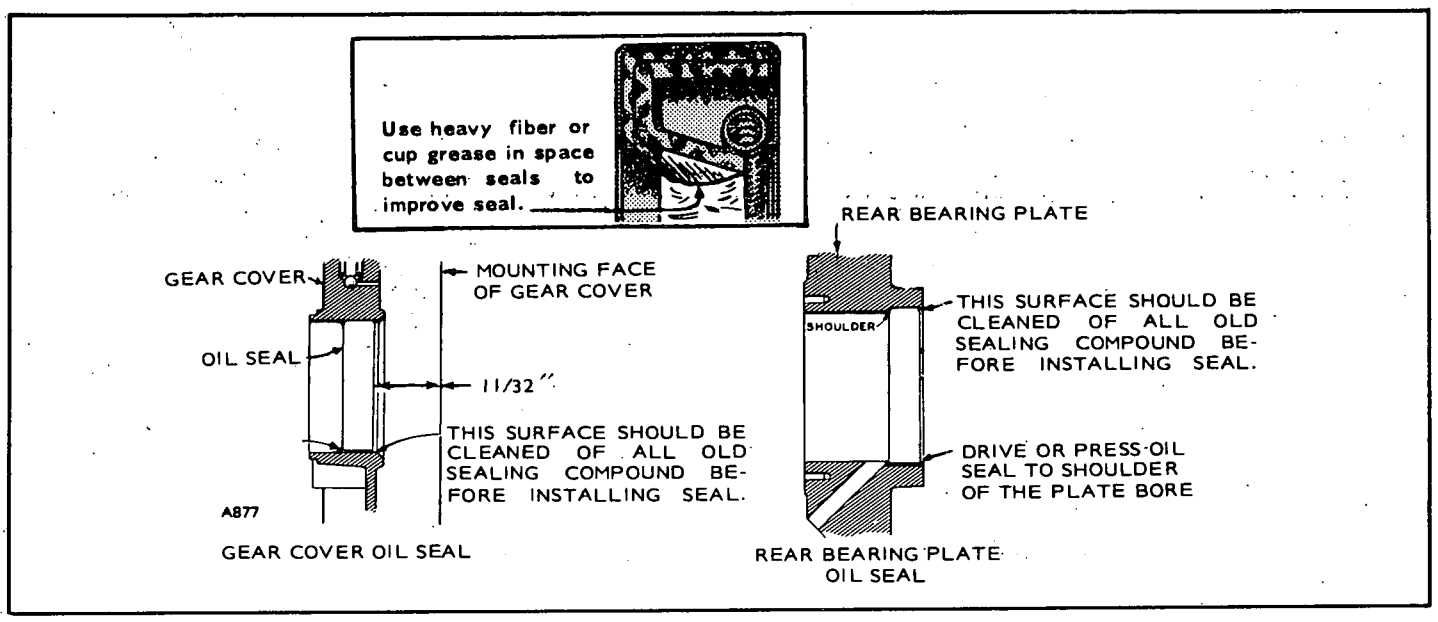


FIGURE 63. GEAR COVER AND REAR BEARING PLATE OIL SEALS

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using bearing plate driver and gear cover driver.

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing. See Figure 63.

When installing the gear cover oil seal, tap the seal inward until it is 11/32 of an inch from the mounting face of the cover. Install new style, thin open face seal, 1-7/64 inches from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

Engines equipped with some types of reduction gear assemblies do not use the rear oil seal. The reduction gear assembly is oiled directly from the engine crankcase. Refer to the instructions screened on the case of the reduction gear assembly.

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and ring set of the available oversizes. Pistons are available in .005", .010", .020", .030" and .040" oversize. Piston rings are available in .010", .020", .030" and .040" oversize. Use standard size rings on a .005" oversize piston. If the cylinder is not being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore. Engine might be fitted at the factory with a .005" oversize piston and are so indicated by a letter E following the engine serial number stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in *Dimensions and Clearances.*

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly as shown in Figure 64.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

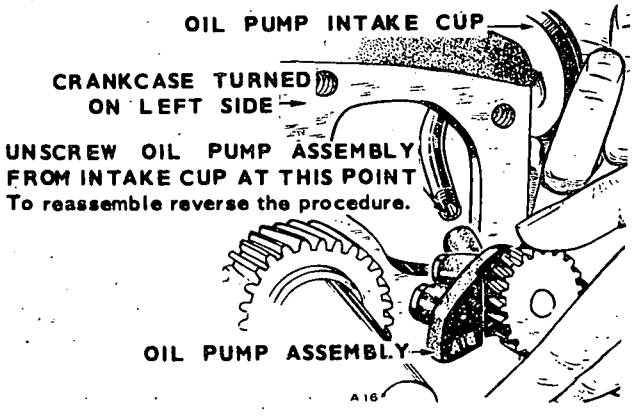


FIGURE 64. OIL PUMP ASSEMBLY

CYLINDER HEADS

Remove the cylinder heads for cleaning at least every 400 hours or when poor engine performance is noticed.

1. Use a 1/2 inch socket wrench to remove cylinder head bolts. Lift heads off.

CAUTION **Do not remove heads when they are hot. Warpage may occur.**

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place heads in position and follow head torque tightening sequence shown in Figure 65. Start out tightening all bolts to 5 ft-lb, then 10 ft-lb, etc., until all bolts are torqued to 17-19 ft-lb.
5. Recheck torque before engine has run a total of 50 hours.

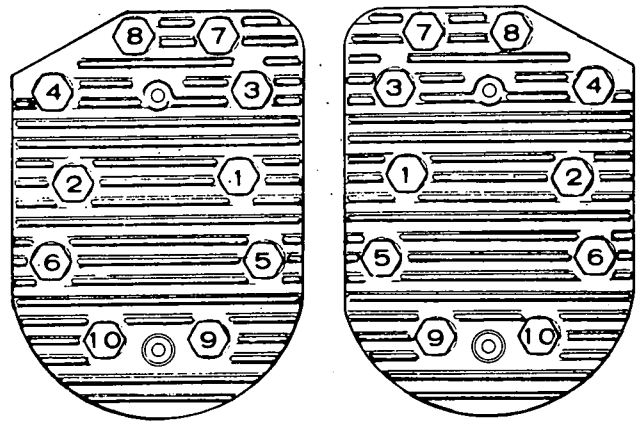


FIGURE 65. HEAD BOLT TIGHTENING SEQUENCE

PARTS CATALOG

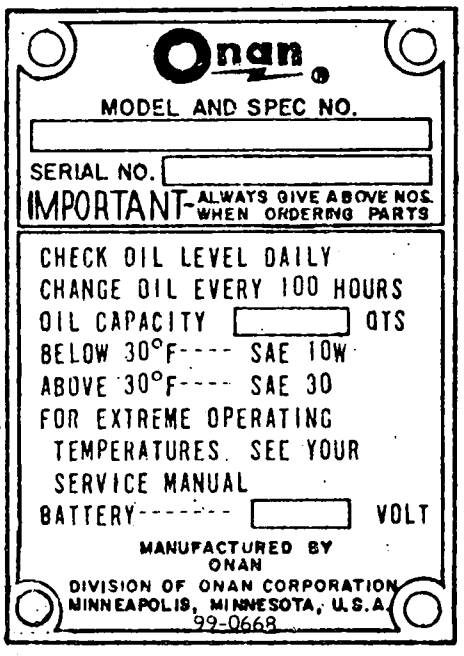
INSTRUCTIONS FOR ORDERING REPAIR PARTS

For parts or service, contact the dealer from whom you purchased this equipment or refer to your Nearest Authorized Onan Parts and Service Center.

To avoid errors or delay in filling your parts order, please furnish all information requested.

Always refer to the nameplate on your unit:

1. Always give the MODEL and SPEC NO. and SERIAL NO.



For handy reference, insert "YOUR" nameplate information in the spaces above.

2. Do not order by reference number or group number; always use part number and description.
3. Give the part number, description and quantity needed of each item. If an older part cannot be identified, return the part prepaid to your dealer or nearest AUTHORIZED SERVICE STATION. Print your name and address plainly on the package. Write a letter to the same address stating the reason for returning the part.
4. State definite shipping instructions. Any claim for loss or damage to your unit in transit should be filed promptly against the transportation company making the delivery. Shipments are complete unless the packing list indicates items are back ordered.

Prices are purposely omitted from this Parts Catalog due to the confusion resulting from fluctuating costs, import duties, sales taxes, exchange rates, etc.

For current parts prices, consult your Onan Dealer, Distributor or Parts and Service Center.

"En esta lista de partes los precios se omiten de proposito, ya que bastante confusion resulto de fluctuaciones de los precios, derechos aduanales, impuestos de venta, cambios extranjeros, etc."

Consiga los precios vigentes de su distribuidor de productos "ONAN".

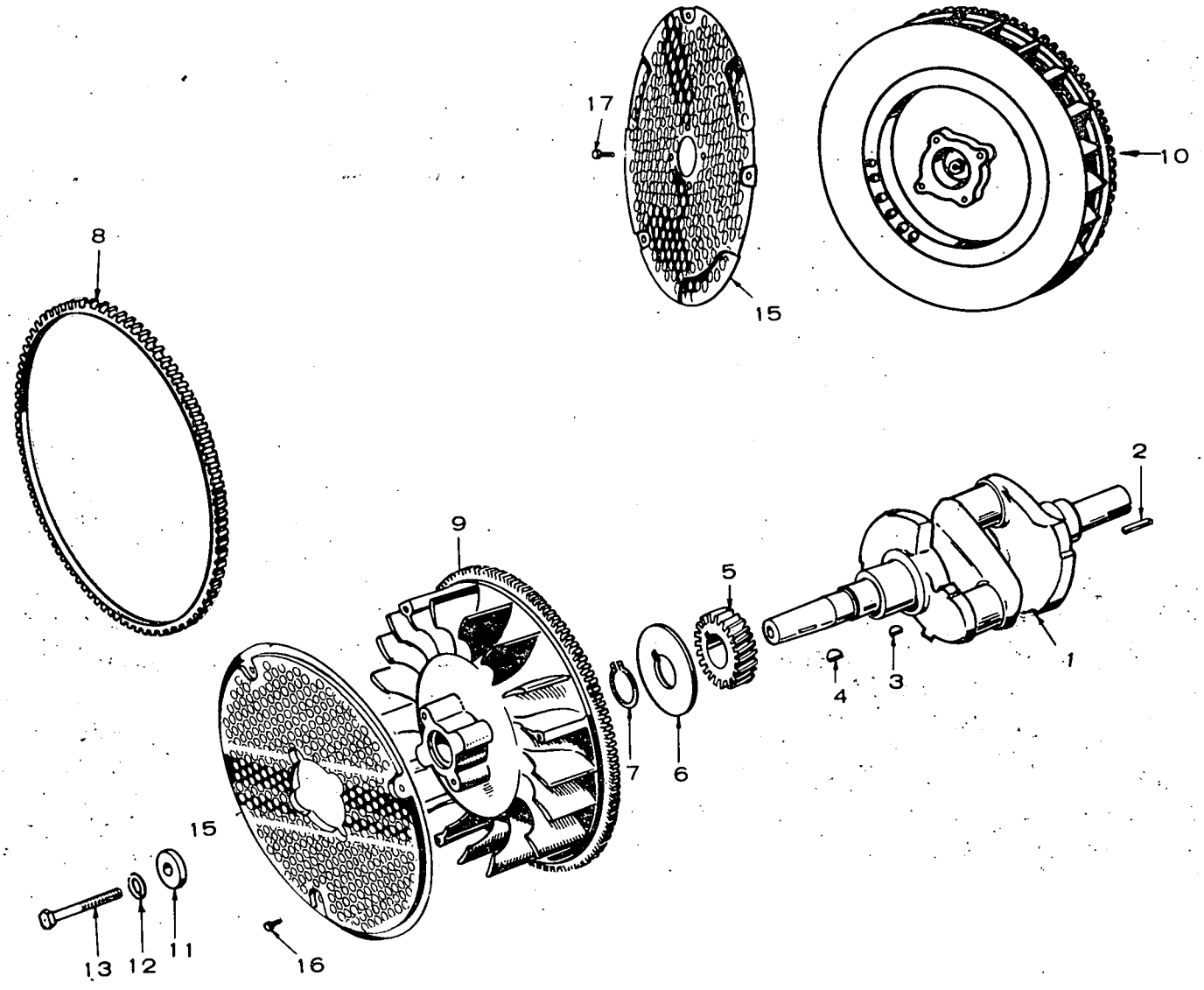
This catalog applies to the standard NHC and NHCV Engines as listed below. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number in the parts list for that group. Parts illustrations are typical. Using the *Model* and *Spec No.* from the nameplate, select the *Parts Key No.* (1, 2, etc., in the last column) that applies to your *Engine Model* and *Spec No.* This *Parts Key No.* represents parts that differ between models. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left sides are determined by facing the blower end (front) of the engine.

ENGINE DATA TABLE

MODEL AND SPEC NO. £	PARTS KEY NO.	MODEL AND SPEC NO. £	PARTS KEY NO.
NHC-MS/*A	1	NHCV-MS/*A	3
NHC-MS/*B	2	NHCV-MS/*B	4

£ - The Specification Letter Advances (A to B, B to C, etc.) with manufacturing changes.

* - The factory code number portion of the specification number indicates standard equipped engines and/or customer selected optional equipment.

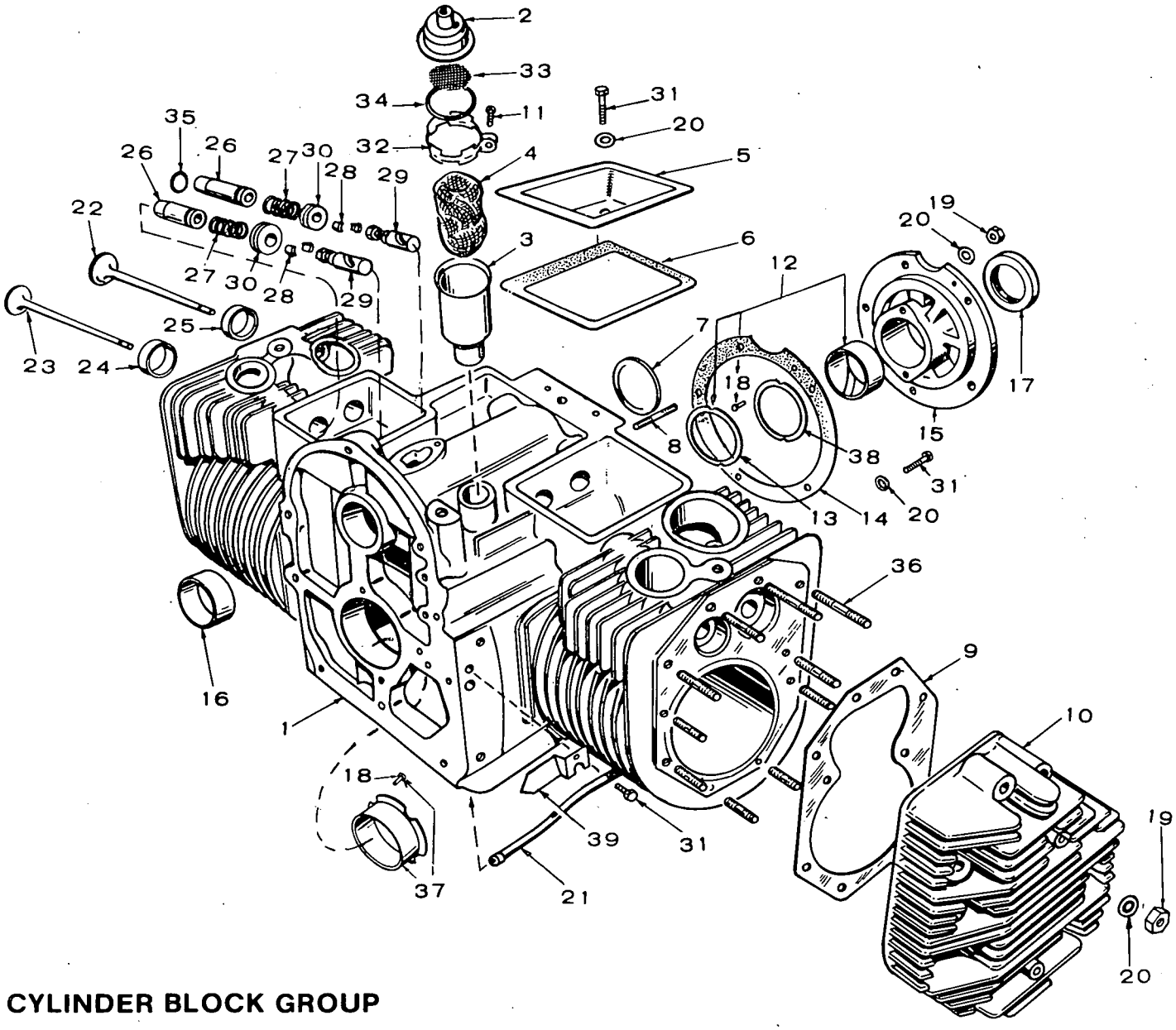


CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	£	1	Crankshaft
	KEY, SHAFT		
2	515-0198	1	Crankshaft Stub
3	515-0001	1	Crankshaft Gear
4	515-0002	1	Flywheel - Key 1, 3
	515-0098	1	Flywheel - Key 2, 4
5	104-0032	1	Gear, Crankshaft
6	104-0043	1	Washer, Gear Retaining
7	518-0014	1	Ring, Retaining - Gear
8	134-0673	1	Ring Gear (Part of all Fly Wheels)
9	FLYWHEEL ASSEMBLY - Key 1 & 2 (Includes Ring Gear)		
	134-2464	1	Standard
	134-2462	1	With Magnet Ring (Phelon 12 Amp Alternator)
	134-2467	1	With Magnet Ring (Synchro 20 Amp Alternator)
10	FLYWHEEL ASSEMBLY - KEY 3 & 4 (Includes Ring Gear)		
	134-2768	1	Standard
	134-2770	1	With Magnet Ring (Phelon 12 Amp Alternator)
	134-2769	1	With Magnet Ring (Synchro 20 Amp Alternator)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
11	526-0262	1	Washer, Flat, Steel (7/16")
12	850-0055	1	Washer, Lock, Steel (7/16")
13	104-0170	1	Screw, Special (Flywheel Mounting)
15	134-2433	1	Guard, Flywheel - Key 1, 2
	134-2384	1	Guard, Flywheel - Key 1, 2 - Optional
16	821-0010	3	Screw, Locking Hex Head, Flanged, Steel (1/4-20 x 1/2") - Key 1, 2
17	821-0014	2	Screw, Locking Hex Head, Flanged, Steel (5/16-18 x 1/2") - Key 1, 2

£ - Order by Description, giving Model, Spec and Engine Serial Number.



CYLINDER BLOCK GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	£	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	123-0954	1	Cap & Valve, Breather
3	123-0952	1	*Tube, Breather
4	123-0865	1	Baffle, Breather Tube
5	110-1624	2	Cover, Valve Compartment
6	110-1720	2	Gasket, Valve Cover
7	517-0048	1	*Plug, Expansion
8	520-0736	5	*Stud, Bearing Plate Mounting
9	110-1731	2	Gasket, Cylinder Head
10	HEAD, CYLINDER		
	110-1912	1	Right Side
	110-1913	1	Left Side
11	809-0035	1	Screw, Round Head Sheet Metal (#8 x 3/4")
12	BEARING, SLEEVE - CRANKSHAFT REAR		
	101-0420	1	*Standard
	101-0420-02	1	.002" Undersize
	101-0420-10	1	.010" Undersize
	101-0420-20	1	.020" Undersize
	101-0420-30	1	.030" Undersize
13	104-0575	AR	*Washer, Thrust - Crankshaft Bearing
14	101-0415	1	*Gasket, Bearing Plate
15	*PLATE, BEARING - REAR		
	101-0439	1	Standard
	101-0417	1	Special (Use with Reduction Gear Assembly)
16	101-0405	2	*Bearing, Sleeve - Camshaft
17	509-0041	1	*Seal, Oil - Crankshaft
18	516-0072	4	*Pin - Bearing Stop
19	NUT, HEX		
	104-0091	5	*Bearing Plate Mounting
	104-0091	20	Cylinder Head Mounting
20	WASHER, FLAT		
	526-0063	2	Copper (1/4") - Valve Cover Mounting
	526-0250	20	Steel (3/8") - Cylinder Head Mounting
	526-0251	5	Steel (3/8") - Bearing Plate Mounting
	526-0066	2	Copper (3/8") - Cylinder Block

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
21	120-0680	1	*Tube, Oil - Crankcase
22	110-1974	2	Valve, Intake
23	110-1719	2	Valve, Exhaust
24	INSERT, VALVE SEAT - EXHAUST		
	110-1716	2	*Standard
	110-1716-02	2	.002" Oversize
	110-1716-05	2	.005" Oversize
	110-1716-10	2	.010" Oversize
	110-1716-25	2	.025" Oversize
25	INSERT, VALVE SEAT - INTAKE		
	110-1933	2	*Standard
	110-1933-02	2	.002" Oversize
	110-1933-05	2	.005" Oversize
	110-1933-10	2	.010" Oversize
	110-1933-25	2	.025" Oversize
26	110-1939	4	*Guide, Valve
27	110-0539	4	Spring, Valve
28	110-0639	8	Lock, Valve Spring
29	TAPPET, VALVE		
	115-0006	4	Standard
	115-0006-05	4	.005" Oversize
30	110-0904	4	Roto Cap
31	SCREW, HEX HEAD, CAP, STEEL		
	800-0011	2	1/4-20 x 2" - Valve Cover Mounting
	806-0027	2	3/8-16 x 3/4" - Cylinder Block
	821-0010	1	1/4-20 x 1/2" - Key 3 & 4 - Timing Pointer

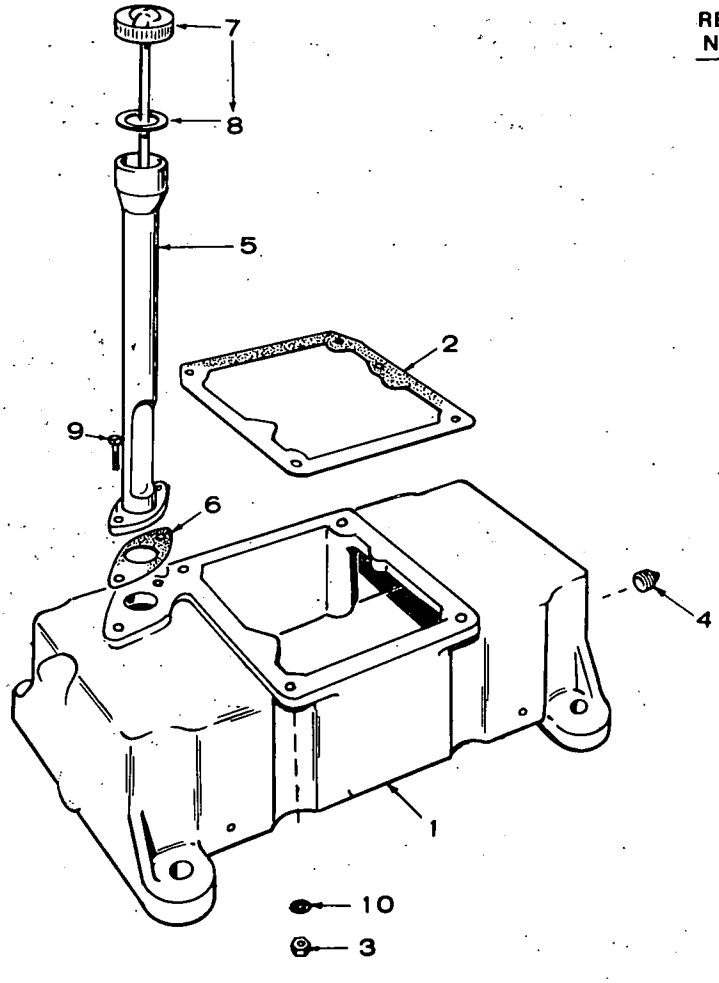
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
32	123-0951	1	Clamp, Loop - Breather Tube Cap
33	123-0958	1	Screen - Breather Tube
34	509-0117	1	Seal "O" Ring - Breather Tube
35	110-0068	2	*Gasket - Valve Guide (Intake)
36	STUD - CYLINDER HEAD MOUNTING		
	520-0717	8	3/8 x 1-7/8"
	520-0773	12	3/8 x 2-5/16"
37	BEARING, SLEEVE - FLANGED, CRANKSHAFT		
	101-0432	1	*Standard
	101-0432-02	1	.002" Undersize
	101-0432-10	1	.010" Undersize
	101-0432-20	1	.020" Undersize
	101-0432-30	1	.030" Undersize
38	104-0776	AR	Shim (.005") - Crankshaft Thrust
39	160-1190	1	Pointer, Timing - Key 3 & 4

£ - Order by description, giving complete Model; Spec and Engine Serial Number.

AR - Quantity as Required.

* - Parts Included in Block Assembly.

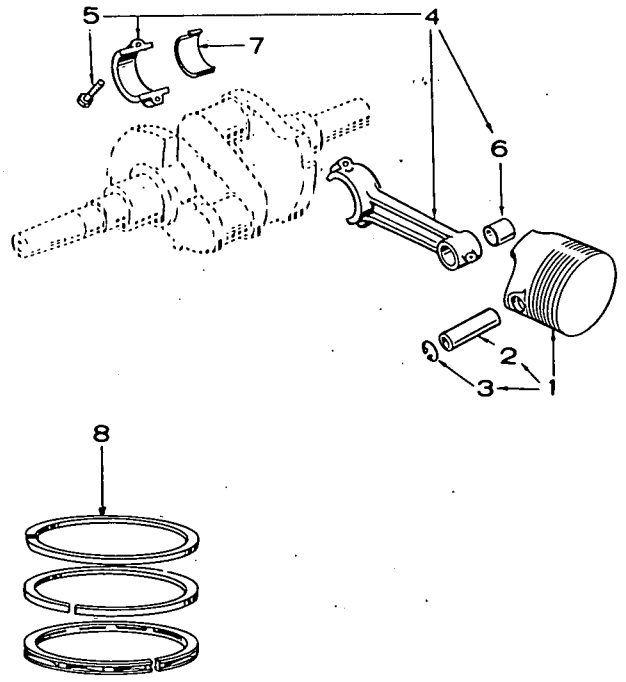
OIL BASE GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	£	1	Base, Oil
2	102-0646	1	Gasket, Base
3	800-0051	4	Screw, Hex Head, Cap, Steel (3/8-16 x 1-1/4")
4	505-0056	1	Plug, Drain
5	TUBE, OIL FILL		
	123-1117	1	Standard - Key 1 & 2
	123-1272	1	Standard - Key 3 & 4
	123-1276	1	Special - Key 3 & 4 - (Used with Pulse Type Fuel Pumps)
6	141-0078	1	Gasket, Fill Tube
7	CAP & INDICATOR, OIL FILL		
	123-0527	1	Standard - Key 1 & 2
	123-1290	1	Special - Key 3 & 4
8	123-0191	1	Gasket, Oil Fill Cap
9	821-0010	2	Screw, Hex Head, Cap, Steel (1/4-20 x 5/8")
10	850-0050	4	Washer, Lock, Steel (3/8)

£ - Order by description, giving complete Model, Spec and Engine Serial Number.

PISTON AND ROD GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	PISTON AND PIN SET (Includes Parts Marked *)		
	112-0141	2	Standard
	122-0141-05	2	.005" Oversize
	112-0141-10	2	.010" Oversize
	112-0141-20	2	.020" Oversize
	112-0141-30	2	.030" Oversize
	112-0141-40	2	.040" Oversize
2	*PIN, WRIST - PISTON		
	112-0112	2	Standard
	112-0112-02	2	.002" Oversize
3	518-0294	4	*Ring, Retaining - Wrist Pin
4	114-0203	2	Rod Assembly, Connecting (Includes Parts Marked †)
5	805-0010	4	†Bolt, Rod Cap
6	114-0036	2	†Bushing, Sleeve - Wrist Pin
7	BEARING, HALF SLEEVE - CONNECTING ROD		
	114-0188	4	Standard
	114-0188-02	4	.002" Undersize
	114-0188-10	4	.010" Undersize
	114-0188-20	4	.020" Undersize
	114-0188-30	4	.030" Undersize
8	RING SET, PISTON		
	113-0165	2	Standard
	113-0165-05	2	.005" Oversize
	113-0165-10	2	.010" Oversize
	113-0165-20	2	.020" Oversize
	113-0165-30	2	.030" Oversize
	113-0165-40	2	.040" Oversize

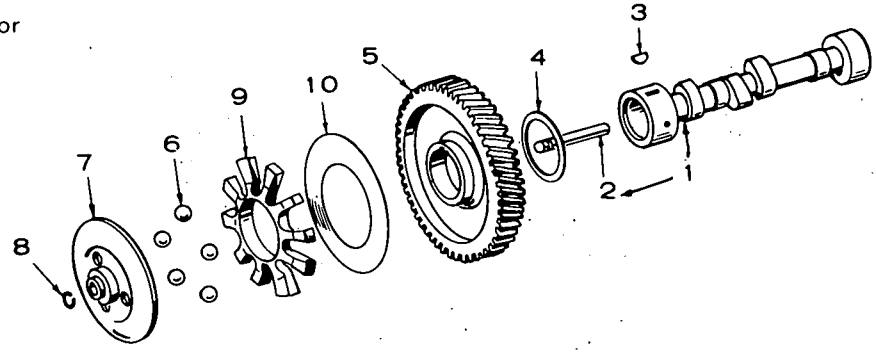
* - Parts Included in Piston and Pin Set.
† - Parts Included in Connecting Rod Assembly.

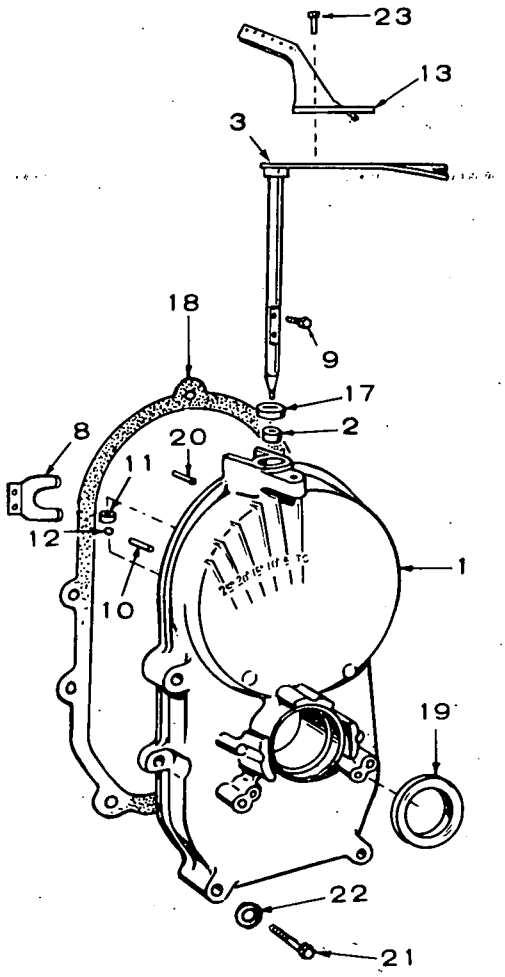
CAMSHAFT GROUP

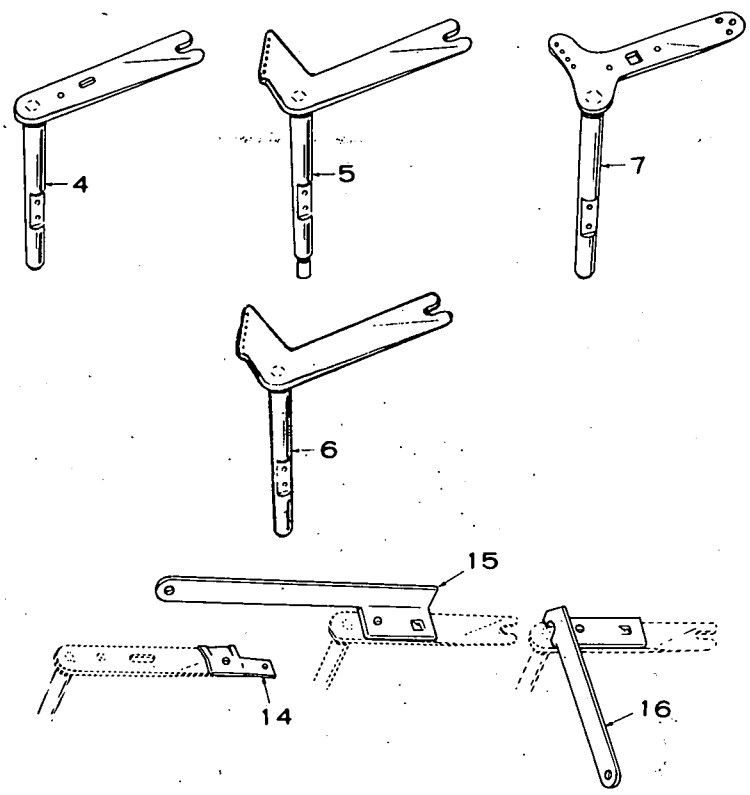
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	105-0382	1	Camshaft (Includes Parts Marked *)
2	105-0075	1	*Pin, Camshaft
3	515-0001	1	Key - Camshaft Gear
4	105-0004	1	Washer, Thrust
5	105-0332	1	Gear, Camshaft (Includes Parts Marked †)
6	510-0015	5	Ball, Fly - Governor
7	150-0612	1	Cup, Governor
8	150-0078	1	Ring, Retaining
9	150-1257	1	†Spacer, Fly Ball
10	150-0077	1	†Plate, Fly Ball

* - Parts Included in Camshaft Assembly.

† - Parts included in Camshaft Gear.





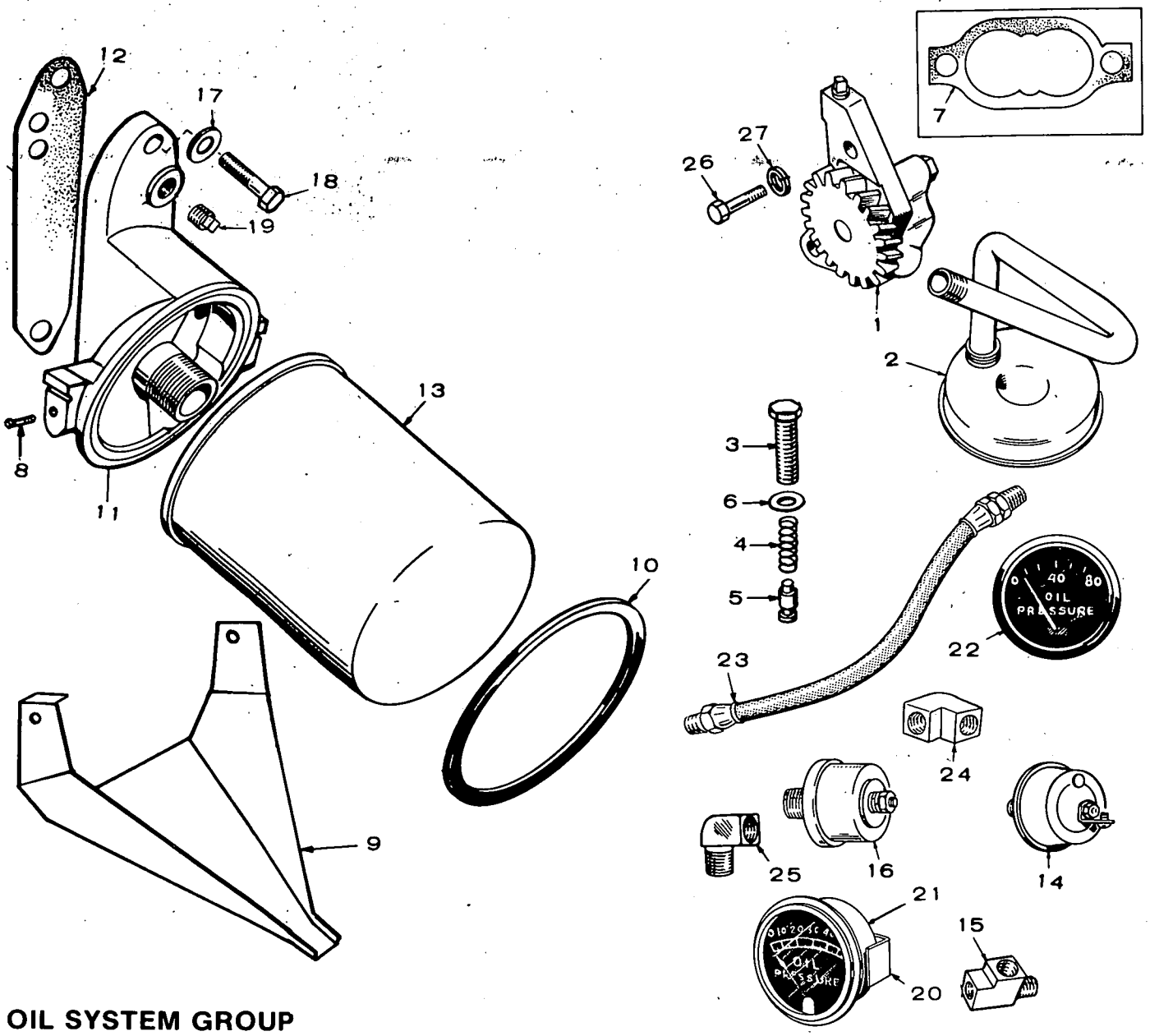


GEARCASE GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	GEAR CASE ASSEMBLY (All Include Parts Marked †)		
	103-0386	1	Standard - Key 1 (Includes Parts Marked *)
	103-0472	1	Standard - Key 2 (Includes Parts Marked *)
	103-0447	1	Standard - Key 3 (Includes Parts Marked *)
	103-0474	1	Standard - Key 4 (Includes Parts Marked *)
	103-0387	1	Special - Key 1, 2 - Without Governor Parts - Manual Throttle
	103-0446	1	Special - Key 3, 4 - Without Governor Parts - Manual Throttle
	103-0475	1	Special - Key 2 - Side Pull Governor (Includes Standard Parts Marked *)
	103-0473	1	Special - Key 2 - Includes Dust Seals & Standard Parts Marked *)
2	*BEARING, (Upper Governor Shaft)		
	510-0013	1	Needle - Key 1, 3
	510-0105	1	Sleeve - Key 2, 4
	*SHAFT & ARM, GOVERNOR		
3	150-1260	1	Standard - Key 1
4	150-1450	1	Standard - Key 2
5	150-1436	1	Standard - Key 3
6	150-1451	1	Standard - Key 4
7	150-1453	1	Special - Key 2 (Side Pull)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
8	150-1187	1	*Yoke, Governor Shaft
9	815-0046	2	*Screw, Pan Head, Steel (8-32 x 3/8")
10	516-0130	1	*Pin, Roll
11	510-0008	1	*Bearing, Needle - Key 1, 3
12	510-0014	1	*Bearing, Ball
	EXTENSION, GOVERNOR ARM		
13	150-1073	1	Standard - Key 1, 2 - Left Pull
14	150-1268	1	Optional - Key 1, 2 - Rear Pull
15	150-0755	1	Optional - Key 1, 2 - Front Pull
16	150-0752	1	Optional - Key 1, 2 - Right Pull
17	509-0008	1	*†Seal, Oil
18	103-0408	1	Gasket, Gearcase
19	509-0040	1	*Seal, Oil - Crankshaft
20	516-0011	2	Pin, Roll
21	SCREW, HEX HEAD, CAP, STEEL		
	800-0032	4	5/16-18 x 1-3/4"
	800-0034	1	5/16-18 x 2-1/4"
22	526-0065	5	Washer, Flat, Copper (5/16")
23	815-0181	1	Screw, Hex Head, Cap, Thread Cutting with Lock Washer (10-32 x 1/2")

* - Parts Included in Specific Gearcase Assemblies.
† - Parts Included in all Gearcase Assemblies.

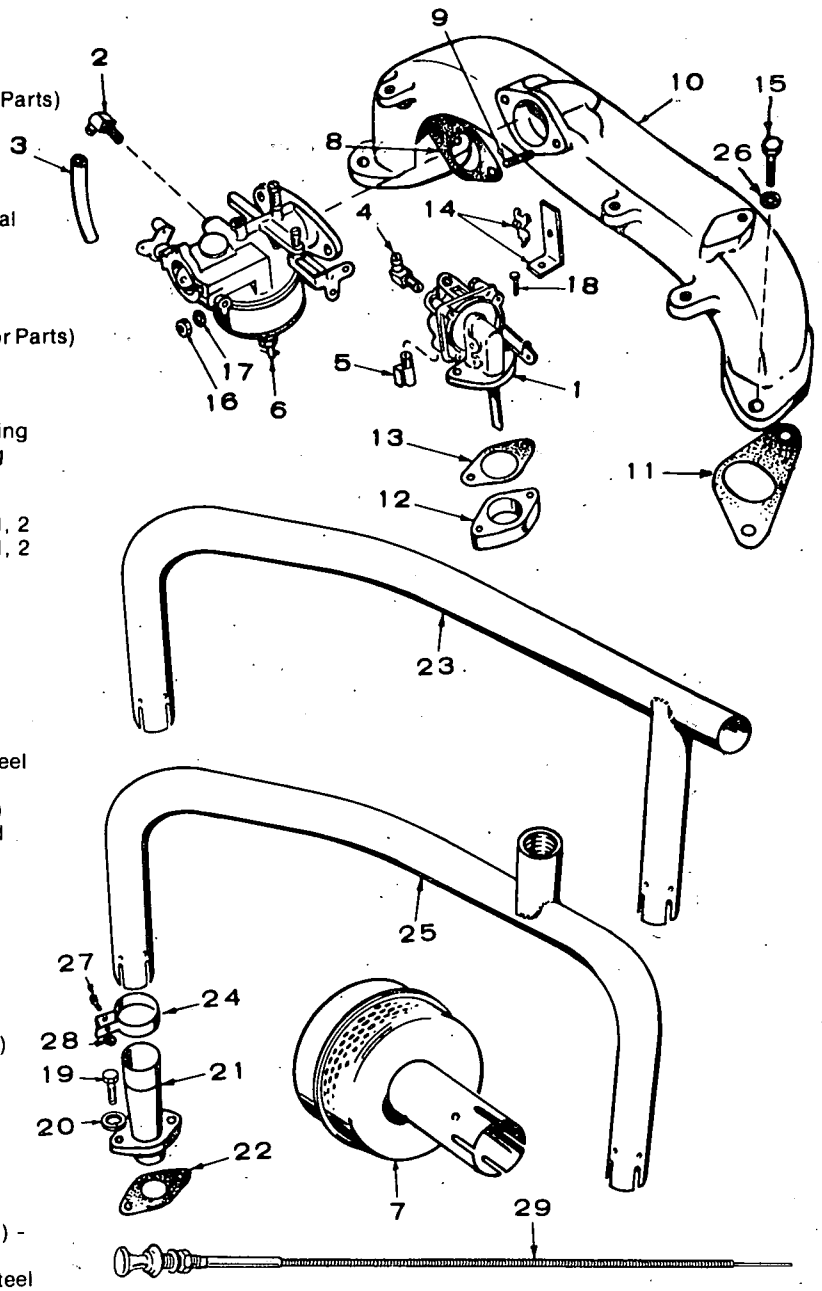


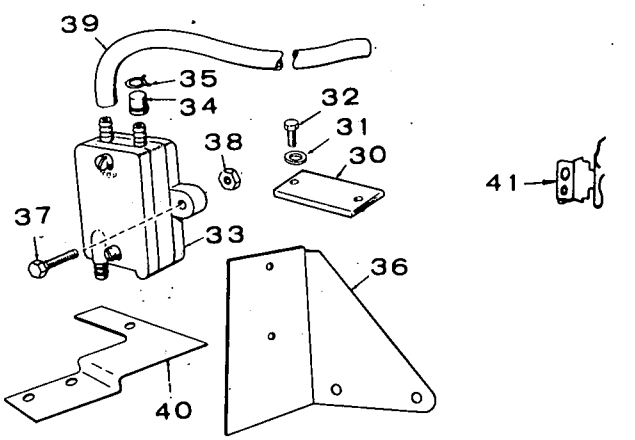
OIL SYSTEM GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120-0491	1	Pump, Oil (Parts Not Sold Separately)
2	120-0648	1	Intake, Oil Pump
3	801-0050	1	Screw, Hex Head, Cap, Steel (3/8-24 x 1")
4	120-0140	1	Spring, By-Pass Valve
5	120-0398	1	Valve, By-Pass
6	526-0066	1	Washer, By-Pass Valve
7	120-0161	1	Gasket Kit - Oil Pump
8	815-0194	2	Screw, Hex Head, Cap, Thread Cutting with Lock Washer (10-32 x 3/8")
9	DRAIN, OIL		
	122-0352	1	Key 1, 2
	122-0360	1	Key 3, 4
10	122-0347	1	Seal, Air - Oil Filter
11	122-0320	1	Adapter, Oil Filter
12	122-0321	1	Gasket - Adapter Mounting
13	122-0323	1	Filter, Oil
14	309-0010	1	Switch, Low Oil Pressure - Optional
15	502-0058	1	Tee - Low Oil Pressure Switch - Optional
16	193-0198	1	Sender, Oil Pressure - Optional
17	526-0065	2	Washer, Flat, Copper (5/16")
18	800-0028	2	Screw, Hex Head, Cap, Steel (5/16-18 x 1")
19	505-0057	1	Plug, Pipe (1/8")
20	193-0031	1	Clamp, Meter
21	193-0068	1	Gauge, Oil Pressure - Optional
22	193-0107	1	Gauge, Oil Pressure (Electrical) - Optional
23	501-0004	1	Line, Flexible - Oil - Optional
24	502-0005	1	Elbow, Pipe - Oil Line - Optional
25	502-0020	1	Elbow, Pipe - Oil Line - Optional
26	800-0007	2	Screw, Hex Head, Cap, Steel (1/4-20 x 1")
27	850-0040	2	Washer, Lock, Steel (1/4")

FUEL & EXHAUST SYSTEMS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	149-1223	1	Pump, Fuel - Key 1 & 2 - (See Separate Group for Parts)
2	505-0313	1	Elbow, Pipe - Carburetor Inlet
3	LINE, FUEL - PUMP TO CARBURETOR		
	149-1228	1	Standard - Key 1, 2
	503-0708	1	Special - Key 3, 4 - Optional
4	502-0313	1	Elbow, Pipe - Key 1, 2 - Fuel Pump Outlet
5	502-0002	1	Elbow, Pipe - Key 1, 2 - Fuel Pump Inlet
6	CARBURETOR, GASOLINE (See Separate Group for Parts)		
	141-0802	1	Standard - Manual Choke
	141-0803	1	Special - Electric Choke
7	155-1217	1	Muffler, Exhaust
8	141-0281	1	Gasket, Carburetor Mounting
9	520-0526	2	Stud, Carburetor Mounting
10	154-1466	1	Manifold, Intake
11	154-1483	2	Gasket, Intake Manifold
12	149-0045	1	Spacer, Fuel Pump - Key 1, 2
13	149-0003	2	Gasket, Fuel Pump - Key 1, 2
14	153-0263	1	Bracket & Clamp - Manual Choke - Optional
15	800-0538	4	Screw, Hex Head, Cap (3/8-16 x 1-1/2")
16	868-0002	2	Nut, Hex, Jam (5/16-24)
17	854-0017	2	Washer, Lock, Steel (5/16)
18	806-0009	2	Screw, Counterbore, Cap, Steel (1/4-20 x 1-1/4")
19	800-0512	4	Screw, Hex Head, Cap, Steel (5/16-18 x 1")
20	850-0045	4	Washer, Lock, Steel (5/16)
21	154-1484	2	Adapter, Exhaust Manifold
22	154-1482	2	Gasket, Exhaust Manifold
23	154-1492	1	Manifold, Exhaust - High Profile (Side Outlet) - Optional
24	155-1219	2	Clamp, Exhaust Pipe
25	154-1493	1	Manifold, Exhaust - High Profile (Top Outlet) - Optional
26	850-0050	4	Washer, Lock, Steel (3/8")
27	805-0018	2	Bolt, Place, Steel (3/8-16 x 1")
28	862-0003	2	Nut, Hex (3/8-16)
29	153-0097	1	Choke, Control, Manual - Optional
30	149-0136	1	Cover - Fuel Pump Block Opening - Key 3, 4
31	526-0043	2	Washer, Flat, Copper (1/4) - Key 3, 4
32	800-0004	2	Screw, Hex Head, Cap, Steel (1/4-20 x 5/8") - Key 3, 4
33	149-1322	1	Pump, Fuel - Optional - Key 3, 4 (See Separate Group for Parts)
34	149-1321	1	Cap, Inlet - Fuel Pump - Key 3, 4
35	503-0301	1	Clamp, Loop - Key 3, 4
36	149-1364	1	Bracket, Angle - Fuel Pump - Key 3, 4
37	813-0102	2	Screw, Round Head, Steel (10-32 x 5/8") - Key 3, 4
38	870-0131	2	Nut, Hex (10-32) - Key 3, 4
39	503-0706	1	Line, Flexible - Key 3, 4
40	153-0464	1	Bracket, Angle - Manual Choke - Key 3, 4
41	518-0176	1	Clip, Cable - Manual Choke - Key 3, 4

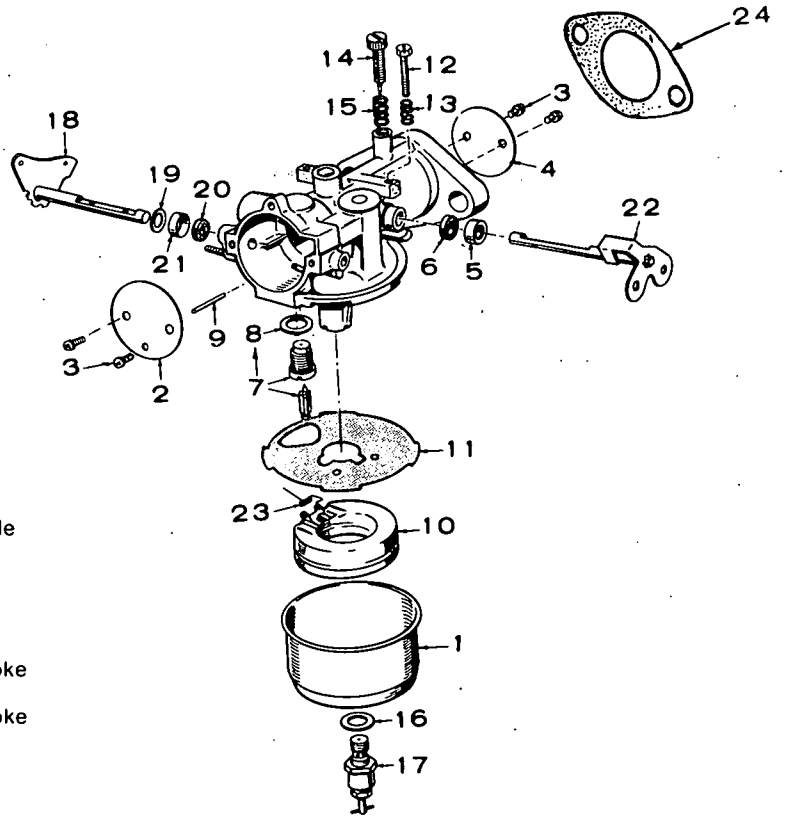




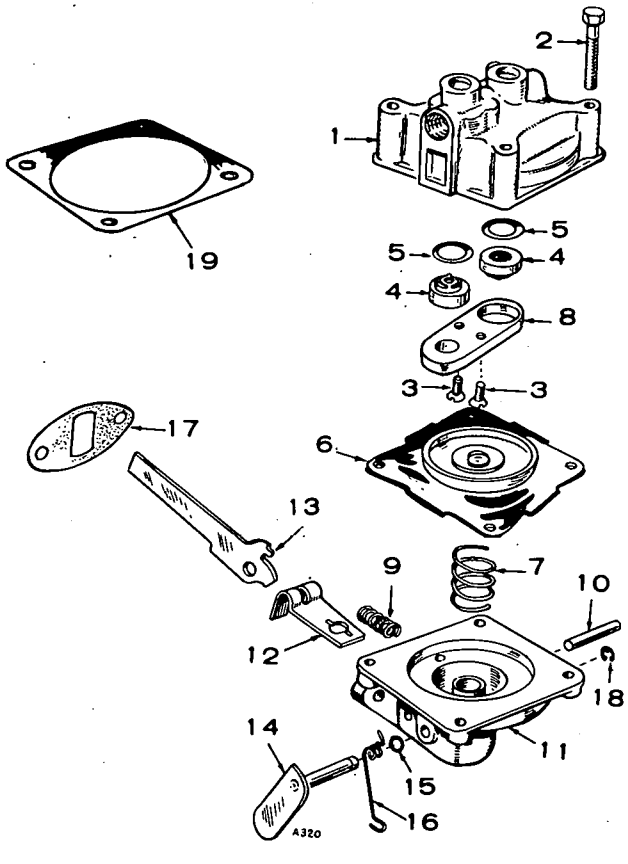
CARBURETOR PARTS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	CARBURETOR, GASOLINE		
	141-0802	1	Standard - Manual Choke
	141-0803	1	Special - Electric Choke
1	141-0708	1	Bowl, Fuel
2	141-0741	1	Plate, Choke
3	141-0698	4	Screw, Round Head with Washer
4	141-0813	1	Plate, Throttle
5	141-0705	1	*Retainer, Seal
6	141-0661	1	*†Seal, Rubber
7	141-0798	1	*Seat, Valve
8	141-0811	1	†Washer, Valve Seat
9	141-0703	1	*Shaft, Float Pivot
10	141-0702	1	Float, Carburetor
11	141-0701	1	*†Gasket, Bowl
12	141-0700	1	Screw, Throttle Stop
13	141-0711	1	Spring, Throttle Stop
14	141-0713	1	*Needle, Idle Adjusting
15	141-0710	1	Spring, Idle Adjusting Needle
16	141-0077	1	*†Washer, Main Jet
17	141-0810	1	Jet, Main (Adjustable)
18	SHAFT, CHOKE		
	141-0742	1	Manual Choke
	141-0679	1	Electric Choke
19	141-0699	1	*Washer, Shaft - Manual Choke
20	141-0697	1	*†Seal, Felt - Manual Choke
21	141-0203	1	*Retainer, Seal - Manual Choke
22	141-0809	1	Shaft, Throttle
23	141-0799	1	*Spring, Fuel Float
24	141-0281	1	*†Gasket, Carburetor Flange

* - Included in Repair Kit #141-0814.
† - Included in Gasket Kit #141-0748.

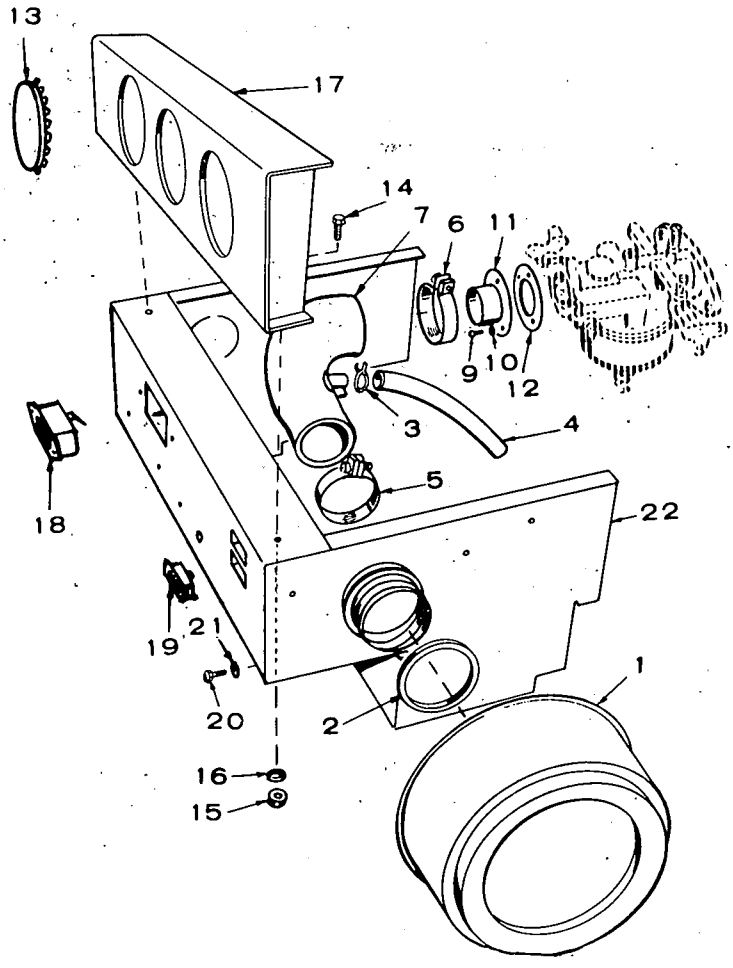


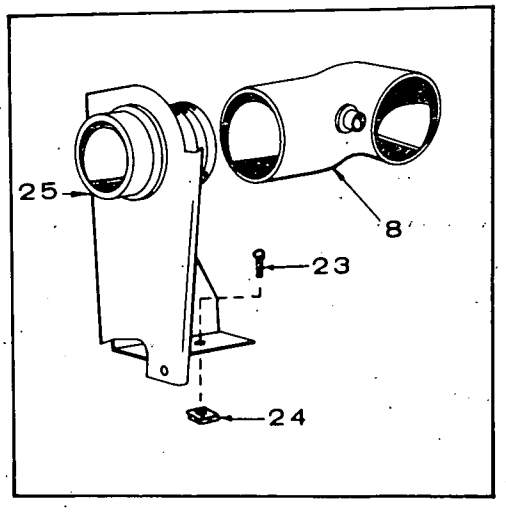
FUEL PUMP PARTS GROUP (MECHANICAL TYPE)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149-1223	1	Pump, Fuel - Key 1, 2
1	—	1	Body, Top - Fuel Pump (Not Sold Separately)
2	815-0148	4	Screw, Hex Head, Slotted, Steel, Zinc Plated, Cromate Dip (8-32 x 7/8")
3	815-0147	2	Screw, Oval Head, Cross Recess, Steel, Thread Cutting (6-32 x 7/8")
4	149-0096	2	*Valve, Check
5	149-0095	2	*Gasket, Valve
6	149-0582	1	*Diaphragm, Fuel Pump
7	149-0672	1	*Spring, Diaphragm
8	149-0539	1	Retainer, Check Valve
9	149-0675	1	Spring, Pump Arm
10	516-0113	1	Pin, Rocker Arm
11	—	1	Body, Lower - Fuel Pump (Not Sold Separately)
12	149-0670	1	Link, Rocker Arm
13	149-1148	1	Arm, Rocker
14	149-1042	1	Lever, Prime
15	509-0065	2	Seal, O-Ring
16	149-1044	1	Spring, Prime Lever
17	149-0003	1	*Gasket, Pump Mount
18	518-0129	1	Ring, Retaining - Prime Lever
19	149-0858	1	*Gasket, Diaphragm - Optional - (Prevents Air Lock)

* - Included in Repair Kit #149-0526.

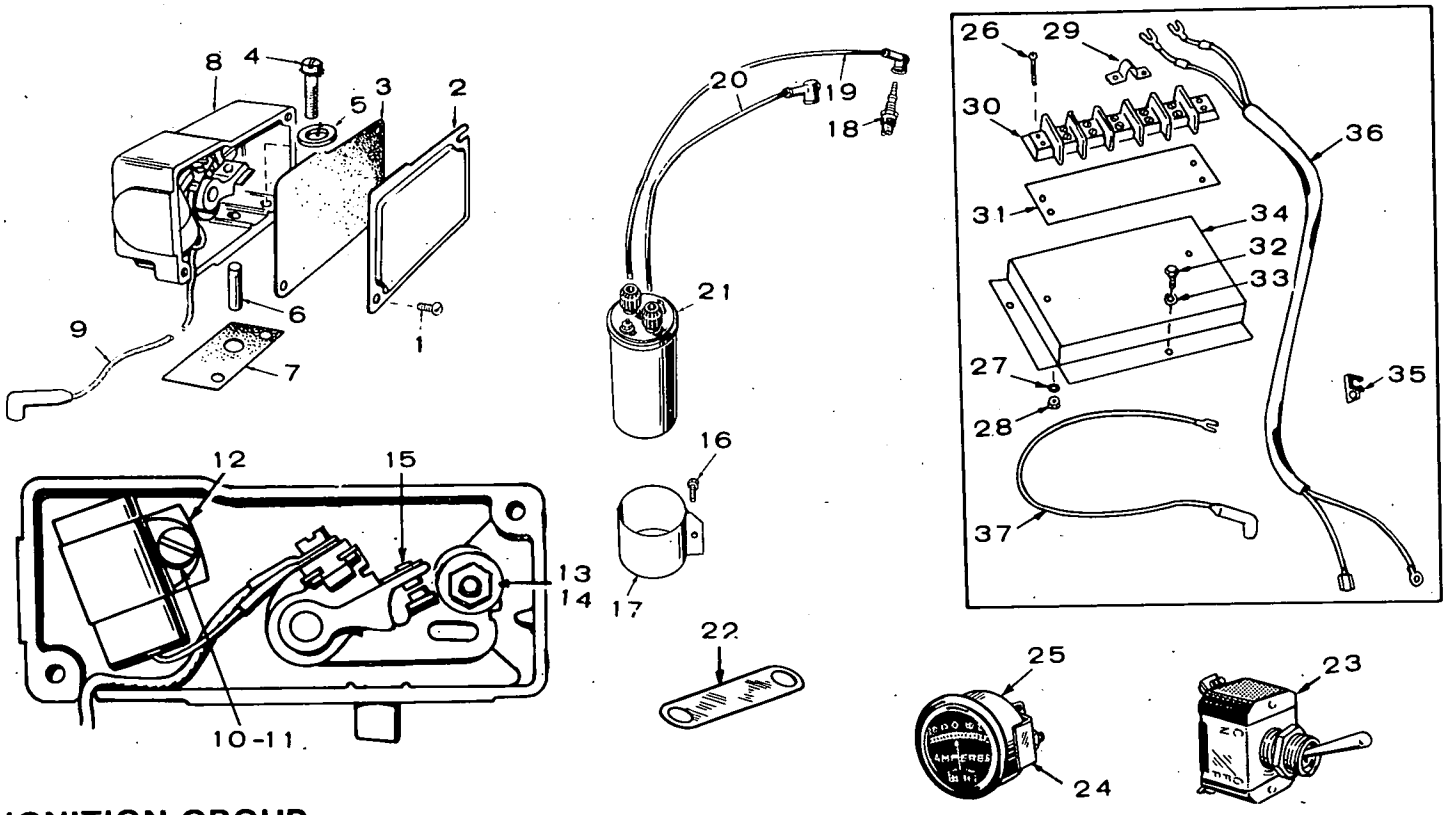




AIR CLEANER GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	140-1175	1	Filter, Air Cleaner - Disposable
2	140-1185	1	Gasket, Air Cleaner
3	503-0170	2	Clamp, Hose
4	HOSE, FLEXIBLE - BREATHER		
	503-0582	1	Key 1, 2
	123-1241	1	Key 3, 4
5	CLAMP, LOOP		
	503-0365	1	Key 1, 2
	503-0274	1	Key 3, 4
6	CLAMP, LOOP		
	503-0004	1	Key 1, 2, 3
	503-0368	1	Key 4
7	140-1186	1	Elbow, Carburetor Inlet - Key 1, 2
8	140-1282	1	Elbow, Carburetor Inlet - Key 3, 4
9	815-0199	3	Screw, Fillister Head, Steel (10-32 x 5/16")
10	850-0030	3	Washer, Lock, Steel (#10)
11	ADAPTER, CARBURETOR INLET		
	145-0398	1	Key 1, 2
	145-0453	1	Key 3, 4
12	140-0921	1	Gasket, Carburetor Inlet
13	517-0009	1	Plug, Button - Key 1, 2
14	800-0003	2	Screw, Hex Head, Cap, Steel (1/4-20 x 1/2")

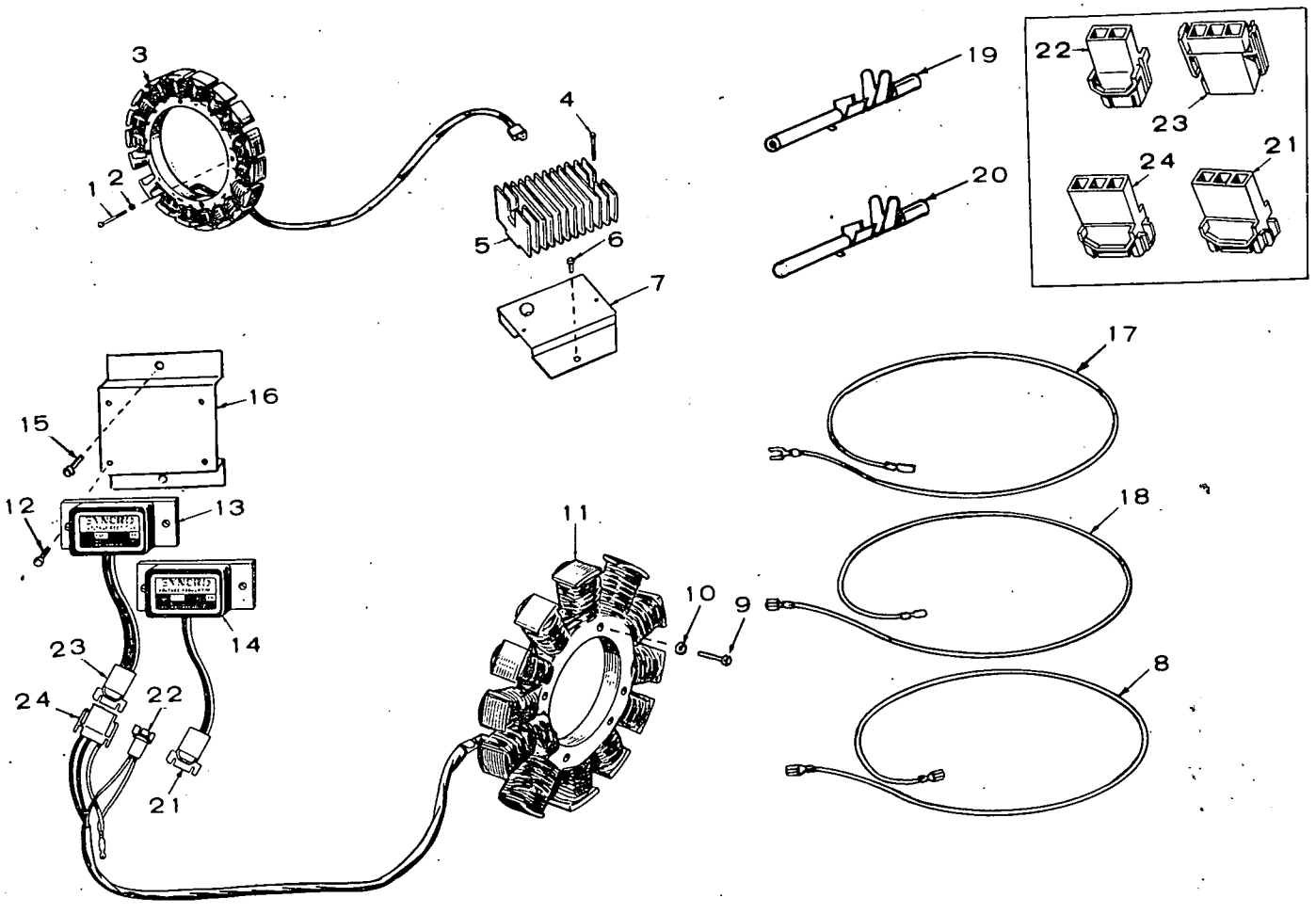
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
15	862-0001	2	Nut, Hex (1/4)
16	853-0013	2	Washer, Lock, External Tooth, Steel (1/4)
17	193-0218	1	Panel, Instrument - Key 1, 2 - Optional
18	302-0885	1	Meter, Time Totalizing - Key 1, 2 - Optional
19	322-0108	2	Light, Indicator - Key 1, 2 - Optional
20	821-0010	4	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2) - Key 1, 2
21	526-0015	4	Washer, Flat, Steel (1/4) - Key 1, 2
22	PANEL, AIR CLEANER		
	140-1179	1	Standard - Key 1, 2
	140-1184	1	Optional - Key 1, 2 (Used with Variable Speed Governor)
23	SCREW		
	809-0059	2	Round Head, Steel, Sheet Metal (1/4-20 x 1/2") - Key 3
	821-0010	2	Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 4
24	870-0160	2	Nut, Speed (1/4) - Key 3, 4
25	140-1280	1	Bracket, Air Cleaner - Key 3, 4



IGNITION GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	815-0358	2	Screw, Hex Head, Slotted, Steel, Thread Forming (8-32 x 5/16")
2	160-1149	1	*Cover, Breaker Box
3	160-1148	1	*Gasket, Cover
4	SCREW		
	815-0373	2	Fillister Head, Cross-Recessed, Steel, with External Tooth Lockwasher (1/4-20 x 5/8") - Key 1, 3
	802-0034	2	Socket Head, Steel (1/4-20 x 3/4") - Key 2, 4
5	850-0038	2	Washer, Lock, Steel (1/4) - Key 2, 4
6	160-1151	1	Plunger
7	160-1150	1	Gasket
8	160-1158	1	Breaker Assembly (Includes Parts Marked *)
9	336-2132	1	*Lead, Electrical - Points to Coil
10	815-0403	1	*Screw, Pan Head, Steel, Thread Forming (8-32 x 5/16")
11	850-0025	1	*Washer, Lock, Steel (#8)
12	312-0069	1	*Condenser
13	870-0221	1	*Nut, Hex, Steel, with External Lockwasher (8-32)
14	815-0405	1	*Screw, Pan Head, Cross-Recessed, Steel (8-32 x 1/2")
15	160-1154	1	*Point Set, Breaker
16	821-0010	1	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2")
17	166-0617	1	Clamp, Coil Mounting
18	167-0240	2	Spark Plug
19	167-1463	1	Cable, Electrical - Spark Plug
20	167-1462	1	Cable, Electrical - Spark Plug
21	166-0535	1	Coil, Ignition
22	LEAD, ELECTRICAL		
	332-0592	1	Jumper - Optional
	336-2271	1	Switch to Starter Solenoid - Optional
	336-2272	1	Switch to Ignition Coil - Optional
	336-2273	1	Switch to Terminal Board - Optional
	336-0794	1	Ammeter to Terminal Board - Optional
23	300-0140	1	Switch, Toggle - Ignition - Optional
24	302-0270	1	Clamp, Meter - Optional
25	302-0060	1	Ammeter - Optional
26	812-0082	2	Screw, Round Head, Cross-Recessed, Steel (8-32 x 3/4")
27	850-0025	2	Washer, Lock, Steel (#8)
28	860-0008	2	Nut, Hex, Steel (8-32)
29	332-1043	1	Jumper, Terminal
30	332-0604	1	Block, Terminal
31	332-1273	1	Strip, Marker
32	SCREW		
	813-0100	2	Round Head, Cross-Recessed, Steel (10-32 x 1/2") - Key 1, 3
	821-0004	2	Hex Locking Head, Flanged, Steel (10-32 x 5/16") - Key 2, 4
33	856-0003	2	Washer, Lock, Steel (#10) - Key 1, 3
34	301-3530	1	Bracket, Terminal Block
35	167-0188	1	Clip, Cable
36	338-0619	1	Harness, Wiring - Starter Solenoid to Terminal Block
37	336-2132	1	Lead, Electrical - Terminal Block to Ignition Coil

* - Parts Included in Breaker Assembly.



CHARGING ALTERNATOR GROUP - OPTIONAL EQUIPMENT

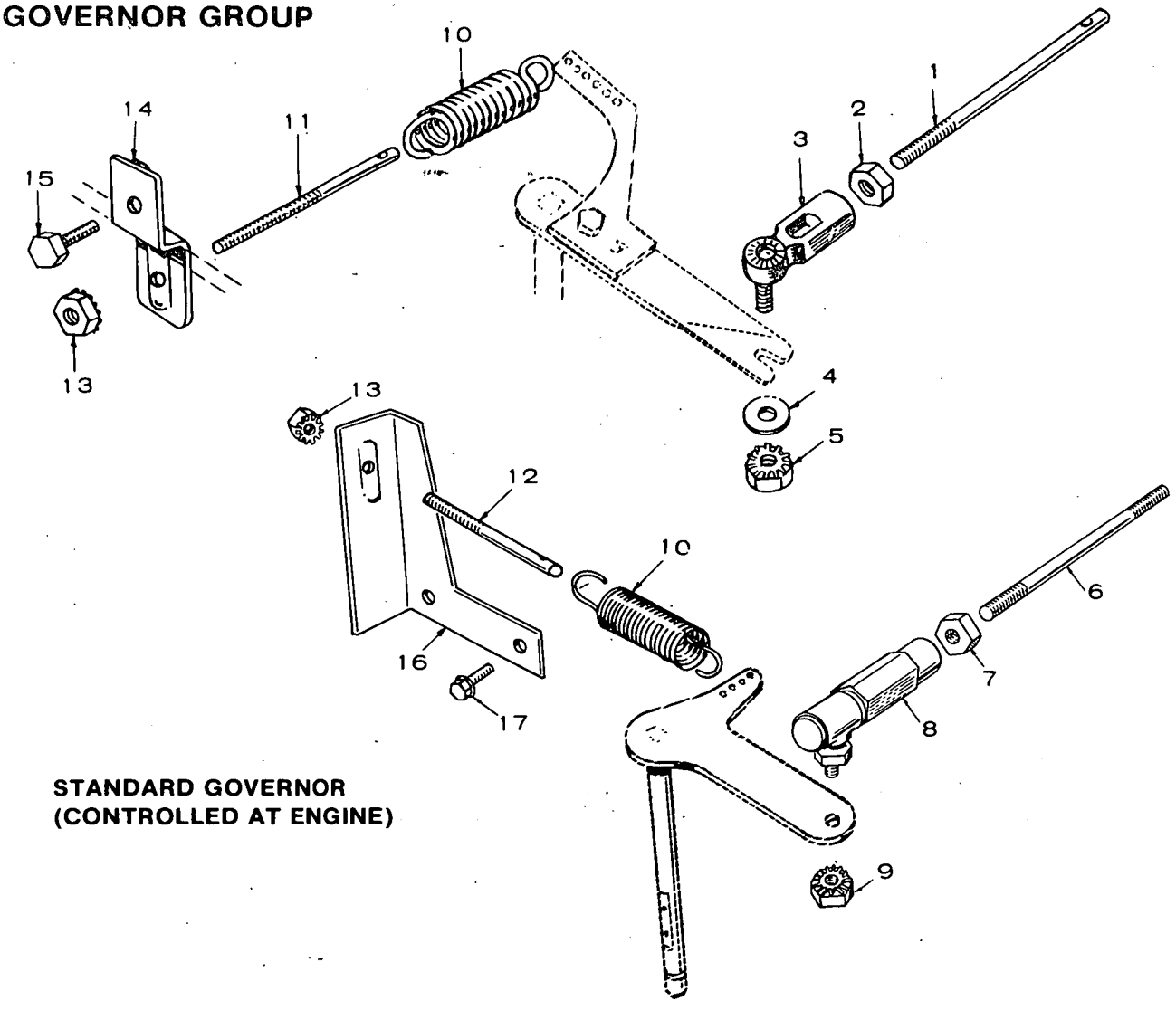
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	£	1	Alternator Group - Phelon - 12 Volt 15 Amp (Includes Flywheel with Magnet Ring, Illustrated in the Crankshaft and Flywheel Group; and Parts Marked *
1	813-0108	3	*Screw, Round Head, Cross-Recessed, Steel (10-32 x 1-1/4")
2	850-0030	3	*Washer, Lock, Steel (#10)
3	191-0885	1	*Stator, Alternator - 12 Volt, 15 Amp
4	821-0018	2	*Screw, Hex Locking Head, Flanged, Steel (1/4-20 x 5/8")
5	191-0886	1	*Regulator, Voltage
6	821-0010	1	*Screw, Hex Locking Head; Flanged, Steel (1/4-20 x 1/2")
7	191-1059	1	*Bracket, Mounting, Regulator
8	336-2192	1	*Lead, Electrical - Regulator to Terminal Board
	£	1	Alternator Group - Synchro - 12 Volt 20 Amp (Includes Flywheel with Magnet Rings Illustrated in Crankshaft & Flywheel Group; and Parts Marked †)
9	813-0108	3	†Screw, Round Head, Cross-Recessed, Steel (10-32 x 1-1/4")
10	850-0030	3	†Washer, Lock, Steel (#10)
11	191-0937	1	†Stator, Alternator - 12 Volt 20 Amp
12	821-0004	4	†Screw, Hex Locking Head, Flanged, Steel (10-32 x 5/16")
13	191-0938	1	†Rectifier, Current
14	191-0939	1	†Regulator, Voltage
15	821-0010	2	†Screw, Hex Locking Head, Flanged, Steel (1/4-20 x 1/2")
16	191-1060	1	†Bracket, Mounting, Rectifier - Regulator
17	336-2222	1	†Lead, Electrical - Optional
18	336-2236	1	†Lead, Electrical - Optional
19	323-0488	5	†Contact, Electrical - Female, Connecting
20	323-0496	5	†Contact, Electrical - Male, Connector
21	323-0880	1	†Shell, Connector (2 Sockets)
22	323-0879	1	†Shell, Connector (2 Pins)
23	323-0882	1	†Shell, Connector (3 Sockets)
24	323-0881	1	†Shell, Connector (3 Pins)

£ - Factory Installed Optional Equipment. When Ordering Parts give Complete Engine Model, Spec and Serial Numbers.

* - Parts Included in 12 Volt 15 Amp Alternator Group.

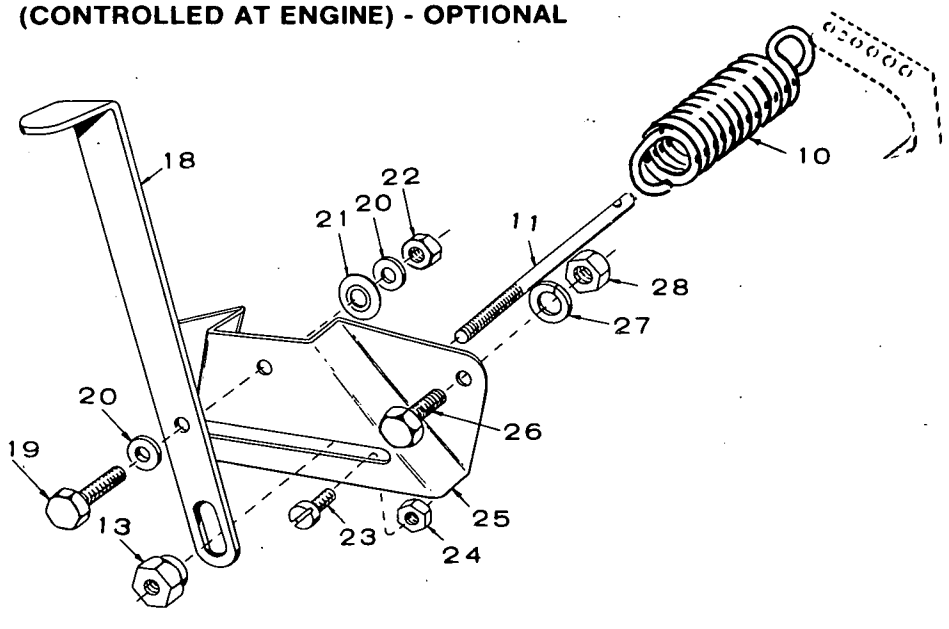
† - Parts Included in 12 Volt 20 Amp Alternator Group.

GOVERNOR GROUP

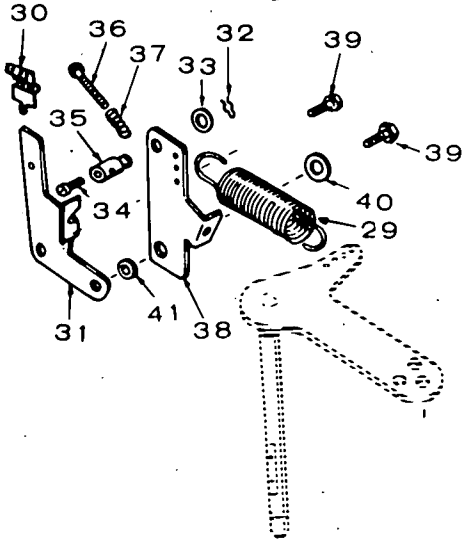


STANDARD GOVERNOR
(CONTROLLED AT ENGINE)

VARIABLE SPEED GOVERNOR
(CONTROLLED AT ENGINE) - OPTIONAL



VARIABLE SPEED GOVERNOR
(REMOTE CONTROLLED)
- OPTIONAL



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	£	1	Linkage Assembly, Governor - Used on Engines up thru Serial Number 832097 (Includes Parts Marked *) - Key. 1 thru 4
1	520-0623	1	*Stud, Link Assembly
2	870-0053	2	*Nut, Hex (3/8)
3	150-0939	2	*Joint, Ball, Nylon
4	526-0196	2	*Washer, Flat (#10)
5	870-0131	2	*Nut, Hex with External Lockwasher (10-32)
	£	1	Linkage Assembly, Governor - Used on Engines Starting with Serial 832098 and up (Includes Parts Marked †) - Key 2, 4
6	†STUD, LINK ASSEMBLY		
	520-0187	1	Key 2
	520-0690	1	Key 4
7	870-0053	2	†Nut, Hex (3/8) - Key 2, 4
8	150-0639	2	†Joint, Ball, Steel - Key 2, 4
9	870-0131	2	†Nut, Hex with External Lockwasher - (10-32) Key 2, 4
10	150-0098	1	Spring, Governor
11	150-0147	1	Stud, Speed Adjustment - Key 1, 2
12	STUD, SPEED ADJUSTMENT		
	150-0096	1	Key 3
	150-1418	1	Key 4
13	870-0131	1	Nut, Hex with External Lockwasher
14	150-1359	1	Bracket, Speed Stud - Key 1, 2
15	821-0010	1	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 1, 2
16	150-1433	1	Bracket, Speed Stud - Key 3, 4
17	821-0010	2	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4
	£	1	Control, Variable Speed Governor - (Includes Parts Marked #) - Optional - Key 1, 2
18	152-0095	1	#Arm, Control
19	800-0005	1	#Screw, Hex Head, Cap, Steel (1/4-20 x 3/4")
20	526-0015	2	#Washer, Flat, Steel (1/4)
21	152-0041	1	#Washer, Spring Tension
22	870-0065	2	#Nut, Hex, Steel (1/4-20)
23	815-0199	2	#Screw, Fillister Head, Steel (10-32 x 5/16".)
24	870-0131	2	#Nut, Hex with External Lockwasher (10-32)
25	152-0190	1	#Bracket, Control
26	800-0003	2	Screw, Hex Head, Cap, Steel (1/4-20 x 1/2") - Key 1, 2
27	856-0006	2	Washer, Lock, External Tooth, Steel (1/4) - Key 1, 2
28	862-0001	2	Nut, Hex, Steel, Zinc Plate (1/4-20) - Key 1, 2
	£	1	Remote Control, Variable Speed Governor (Includes Parts Marked +) - Optional - Key 3, 4
29	150-1214	1	+Spring, Governor
30	518-0176	1	+Clip, Cable
31	150-1343	1	+Bracket, Cable
32	516-0059	1	+Pin, Cotter
33	526-0006	1	+Washer, Flat, Steel (#6)
34	815-0104	1	+Screw, Fillister Head, Steel (8-32 x 5/16")
35	152-0155	1	+Swivel, Cable Holding
36	812-0066	1	+Screw, Round Head, Steel (6-32 x 3/4")
37	150-1398	1	+Spring, Idle Setting
38	150-1435	1	+Arm, Governor Control
39	821-0010	2	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4
40	526-0214	1	Washer, Flat, Steel (1/4) - Key 3, 4
41	150-1269	1	Bushing, Control Arm - Key 3, 4

£ - Not Stocked as an Assembly; When Ordering give Complete Engine Nameplate Model, Spec and Serial Number and/or Order Individual Parts.

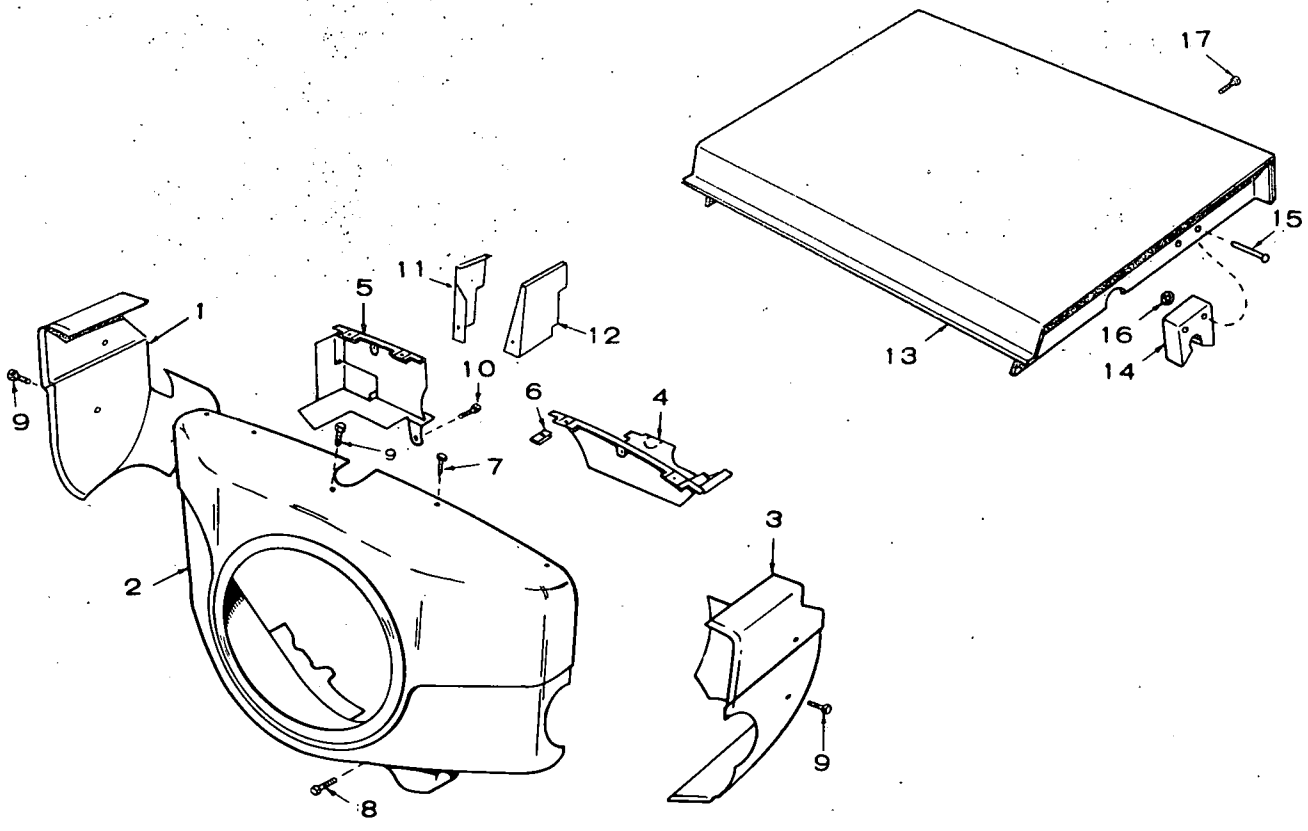
* - Parts Included in old type Nylon Ball Joint Throttle Linkage.

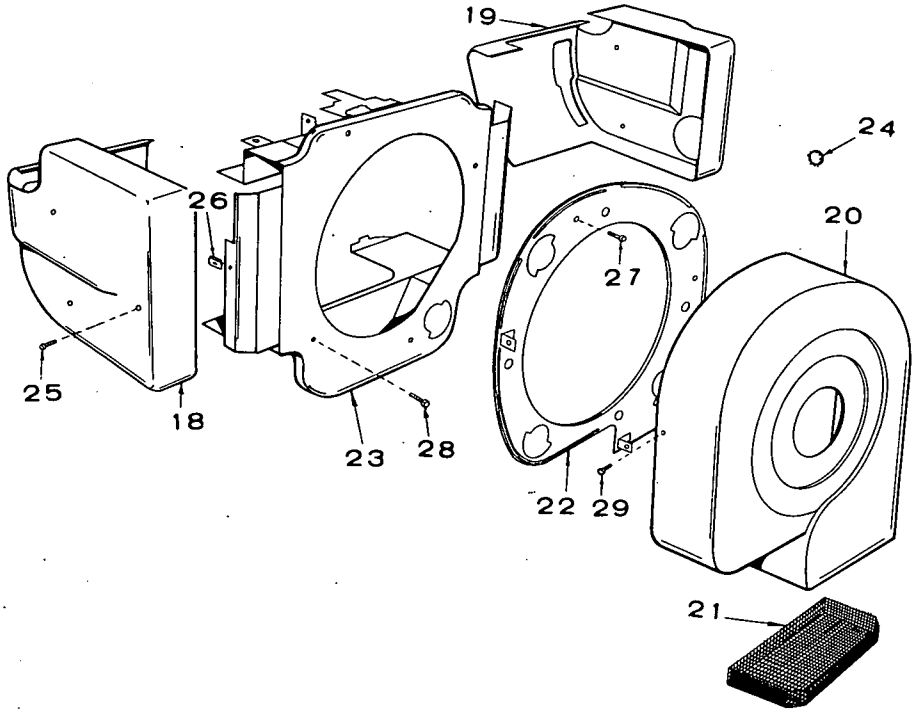
† - Parts Included in new type Metal Ball Joint Throttle Linkage.

- Parts Included in Engine Mounted Variable Speed Governor.

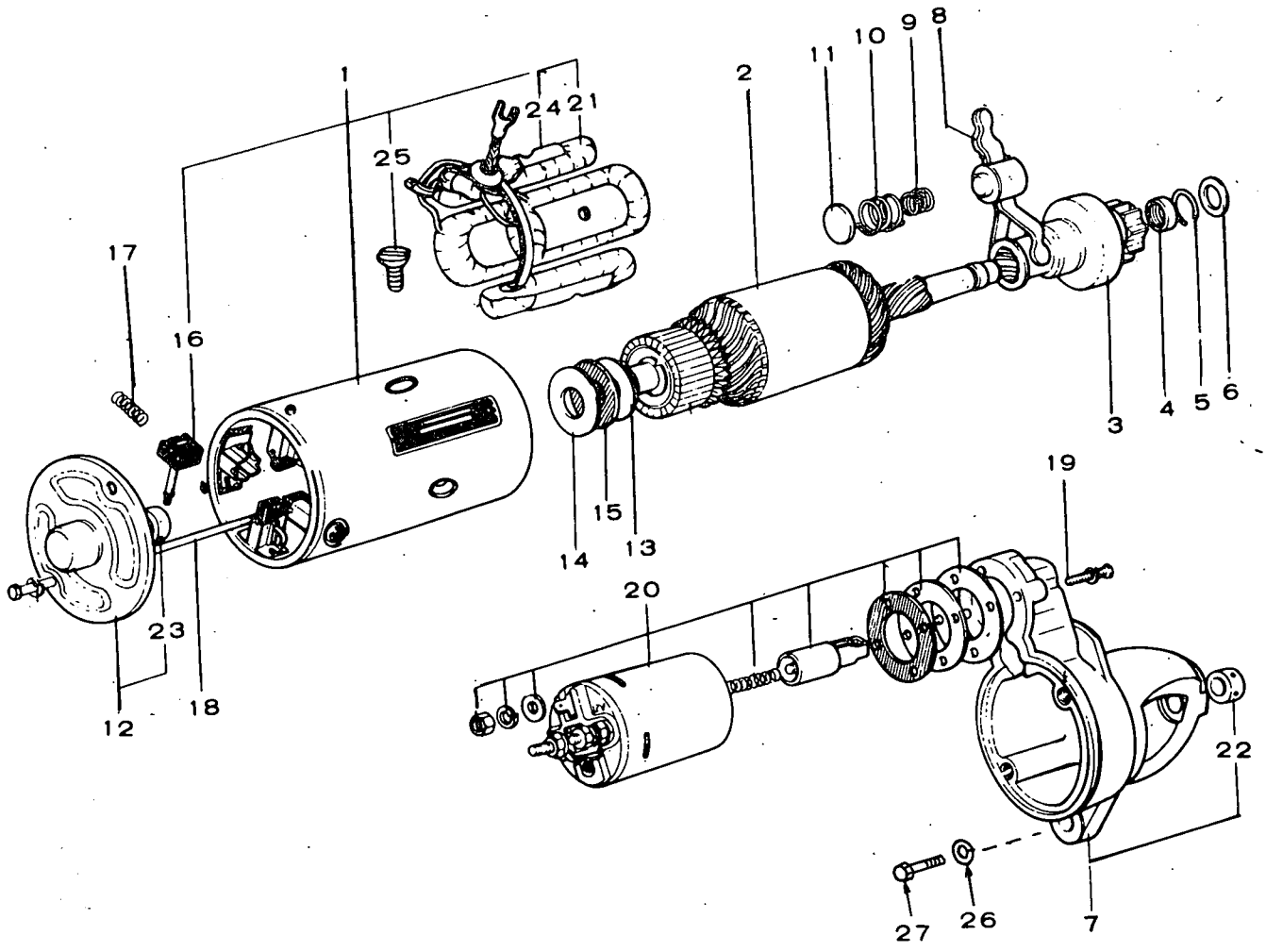
+ - Parts Included in Remote Controlled Variable Speed Governor.

HOUSING GROUP





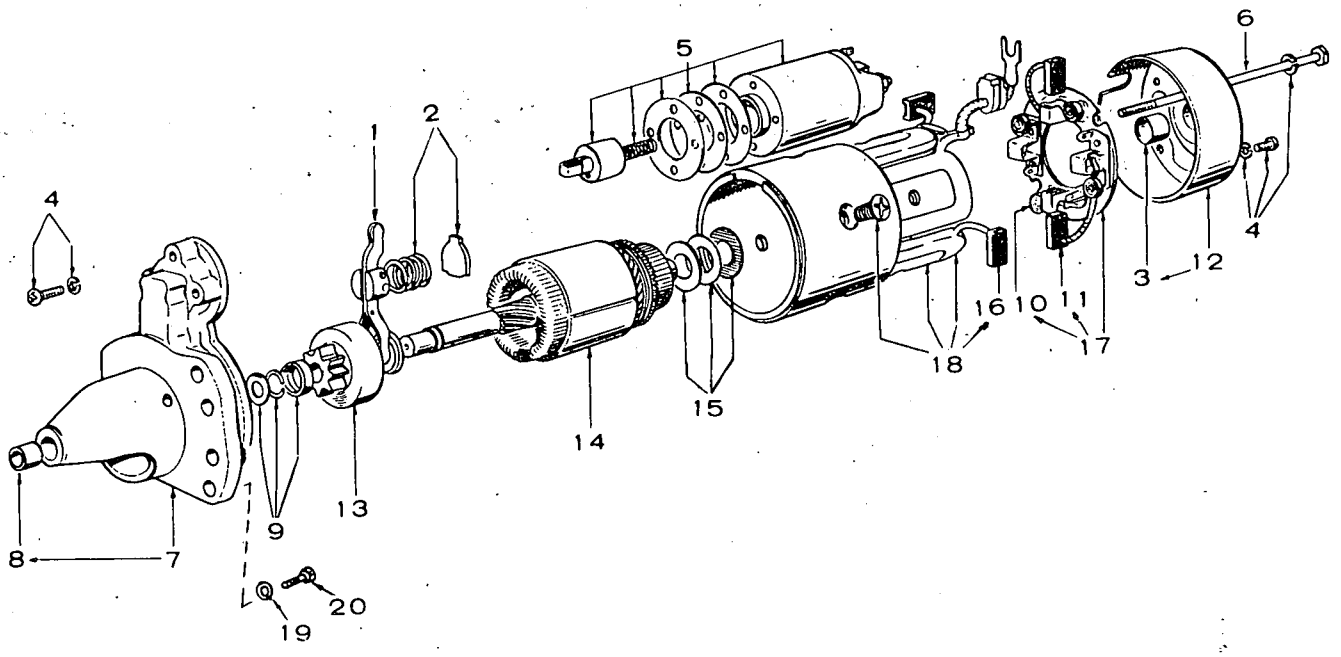
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134-2489	1	Housing, Air - Left Side - Key 1, 2
2	HOUSING, BLOWER		
	134-2494	1	Standard - Key 1
	134-2811	1	Standard - Key 2
	134-2531	1	Optional - With Flywheel Guard - Key 1
	134-2810	1	Optional - With Flywheel Guard - Key 2
3	HOUSING, AIR - RIGHT SIDE		
	134-2488	1	Key 1
	134-2799	1	Key 2
4	134-2483	1	Support, Housing - Right Side - Key 1, 2
5	134-2487	1	Support, Housing - Left Side - Key 1, 2
6	870-0107	4	Nut, Speed (#14A) - Key 1, 2
7	809-0059	4	Screw, Round Head, Sheet Metal (1/4 x 1/2") - Key 1, 2
8	821-0010	2	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4
9	815-0261	5	Screw, Hex Washer Head, Steel, Thread Forming (1/4-20 x 7/16") - Key 1, 2
10	815-0370	4	Screw, Hex Head, Steel, Thread Forming (1/4-20 x 1/2") - Key 1, 2
11	140-1193	1	Shield, Heat, Left Side - Carburetor - Optional - Key 1, 2
12	140-1192	1	Shield, Heat, Right Side - Carburetor - Optional - Key 1, 2
13	405-1935	1	Hood, Engine - Optional - Key 1, 2
14	405-1872	2	*Clip, Hood - Optional - Key 1, 2
15	818-0150	4	*Rivet, Drive - Optional - Key 1, 2
16	526-0003	4	*Washer, Flat - Optional - Key 1, 2
17	821-0010	2	Screw, Locking Head, Steel, Thread Forming (1/4-20 x 1/2") - Key 1, 2
18	134-2755	1	Housing, Air - Left Side - Key 3, 4
19	134-2752	1	Housing, Air - Right Side - Key 3, 4
20	134-2761	1	Scroll, Air (Includes Guard) - Key 3, 4
21	134-2763	1	Guard, Scroll - Key 3, 4
22	134-2747	1	Backplate, Scroll - Key 3, 4
23	134-2737	1	Housing, Blower - Key 3, 4
24	517-0021	1	Plug, Button - Key 3, 4
25	SCREW		
	809-0059	2	Round Head, Sheet Metal, Steel (1/4 x 1/2") - Key 3
	820-0010	2	Locking Head, Flanged, Steel, Thread Forming (1/4-20 x 1/2") - Key 4
26	870-0106	2	Nut, Speed (#14Z) - Key 3
27	821-0010	4	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2) - Key 3, 4
28	815-0261	4	Screw, Hex Washer Head, Steel, Thread Forming (1/4-20 x 7/16") - Key 3, 4
29	821-0010	5	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4



STARTING MOTOR PARTS GROUP - KEY 1, 3

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191-0734	1	Motor, Starting - Key 1, 3
1	191-0742	1	Yoke Assembly (Includes Parts Marked *)
2	191-0743	1	Armature, Starter
3	191-0744	1	Clutch - Pinion Gear, Starter
4	191-0745	1	Stop, Pinion Gear
5	191-0746	1	Ring, Retaining
6	191-0747	1	Washer, Thrust
7	191-0748	1	Bracket, Starter - Front (Includes Bearing)
8	191-0749	1	Lever, Clutch
9	191-0750	1	Spring, Helical, Compression (A)
10	191-0751	1	Spring, Helical, Compression (B)
11	191-0752	1	Holder, Spring
12	191-0753	1	Bracket, Starter - Rear (Includes Bearing)
13	191-0754	1	Washer, Flat
14	191-0755	1	Washer, Flat
15	191-0756	1	Insulator, Disc
16	191-0757	4	*Brush, Starter
17	191-0758	4	Spring, Helical, Compression (Brush)
18	191-0759	2	Bolt, Machine (Through)
19	191-0760	3	Screw, Machine, Pan Head
20	191-0761	1	Solenoid, Starter
21	191-0762	1	*Coil, Field, Starter
22	191-0763	1	Bearing, Sleeve (Front)
23	191-0764	1	Bearing, Sleeve (Rear)
24	191-0765	4	*Shoe, Pole, Field Coil
25	191-0766	4	*Screw, Machine, Pan Head
26	850-0050	2	Washer, Lock, Steel (3/8)
27	800-0051	2	Screw, Machine, Hex Head, Steel (3/8-16 x 1-1/4")

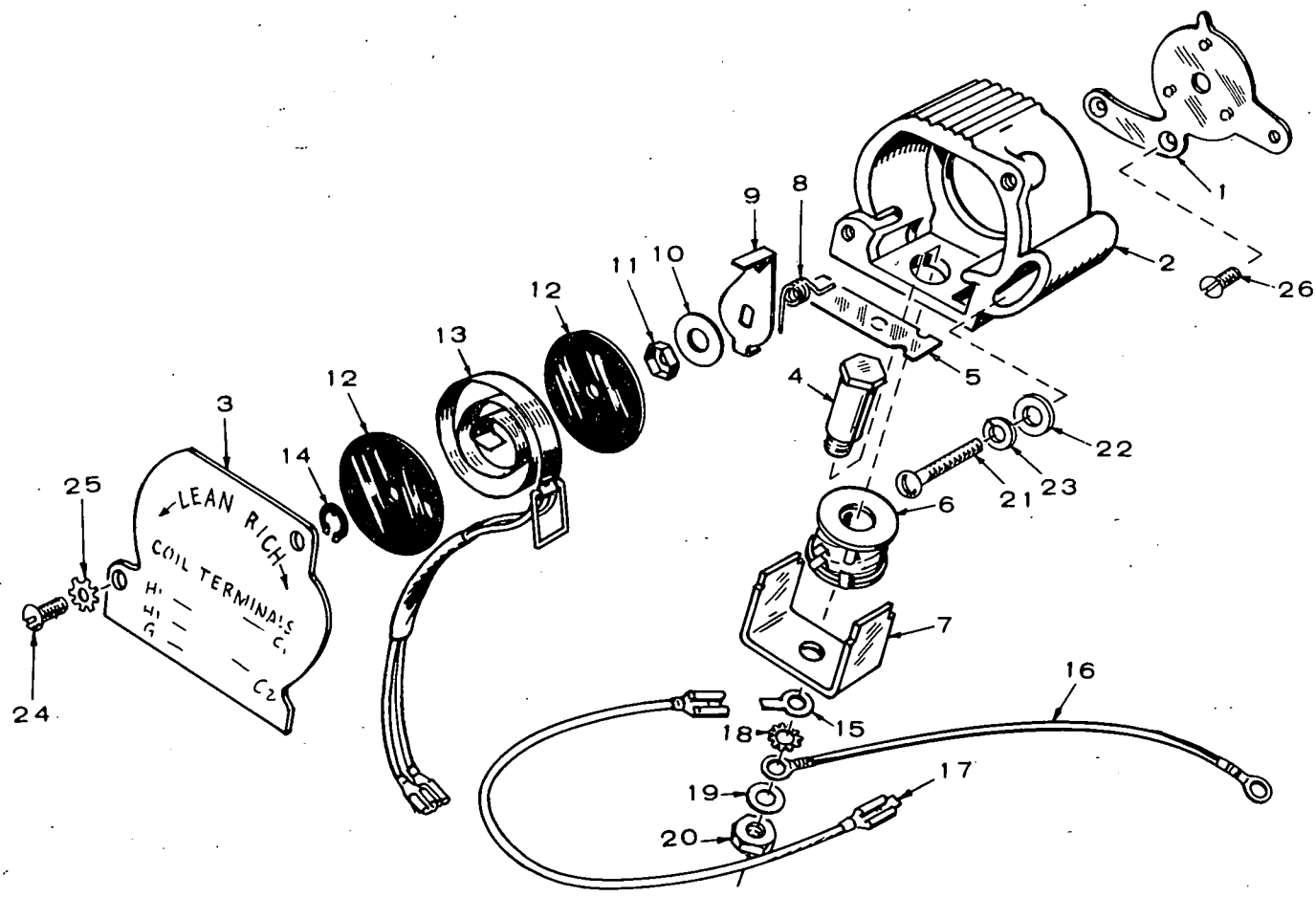
* - Included in Yoke Assembly.



STARTING MOTOR PARTS GROUP - KEY 2, 4

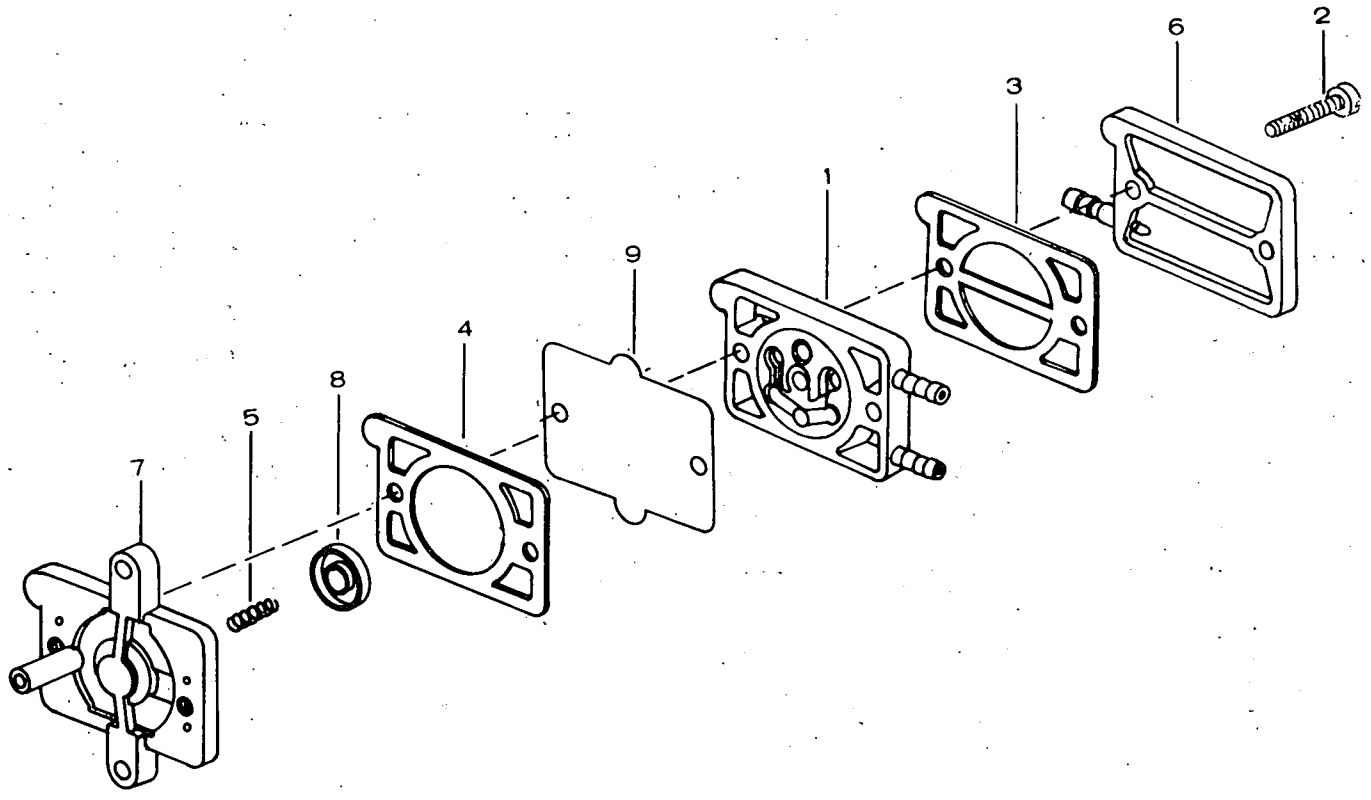
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191-1052	1	Motor, Starting - Key 2, 4
1	191-0983	1	Lever, Clutch
2	191-0984	1	Spring - Plate Set
3	191-1010	1	Bearing, Sleeve (Rear)
4	191-1011	1	Screw Set
5	191-0987	1	Solenoid, Clutch
6	191-0988	2	Bolt, Machine (Through)
7	191-1086	1	Bracket, Starter - Front (Includes Bearing)
8	191-0971	1	Bearing, Sleeve (Front)
9	191-0991	1	Stop - Retaining Set, Pinion Gear
10	191-1007	4	*Spring, Helical, Compression (Brush)
11	191-1008	2	*Brush, Starter (Negative)
12	191-1009	1	Bracket, Starter - Rear (Includes Bearing)
13	191-1087	1	Clutch - Pinion Gear, Starter
14	191-1088	1	Armature, Starter
15	191-0997	1	Washer - Insulator Set
16	191-1005	2	Brush, Starter (Positive)
17	191-1006	1	Holder, Brush (Includes Parts Marked *)
18	191-1089	1	Coil, Field, Starter (Includes Positive Brushes)
19	850-0050	2	Washer, Lock, Steel (3/8)
20	800-0051	2	*Screw, Machine, Hex Head, Steel (3/8-16 x 1-1/4")

* - Included in Brush Holder.



THERMO-MAGNETIC CHOKE GROUP - OPTIONAL EQUIPMENT

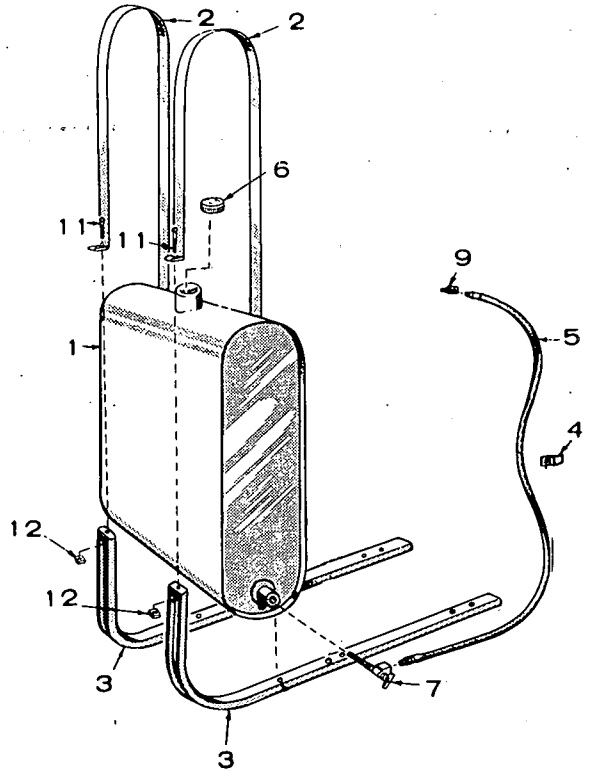
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	153-0385	1	Plate, Mounting
2	153-0386	1	Housing, Choke
3	153-0389	1	Cover, Choke
4	153-0391	1	Core, Solenoid
5	153-0395	1	Armature, Solenoid
6	307-0801	1	Coil, Solenoid
7	153-0392	1	Frame, Solenoid
8	153-0387	1	Spring, Armature
9	153-0390	1	Lever, Limit
10	526-0018	1	Washer, Flat, Steel (5/8")
11	870-0134	1	Palnut (1/4-20)
12	153-0399	2	Insulator, Disc
13	153-0400	1	Bimetal - Heater Assembly
14	518-0129	1	Ring, Retaining
15	332-0876	1	Terminal, Lug - Ground
16	336-1550	1	Lead, Electrical - Ground
17	336-1549	1	Lead, Electrical - Solenoid
18	854-0017	1	Washer, Lock, Internal Tooth (5/16)
19	526-0022	1	Washer, Flat, Steel (5/16")
20	864-0002	1	Nut, Hex (5/16-18)
21	813-0107	1	Screw, Round Head, Steel (10-32 x 1-1/4")
22	526-0008	1	Washer, Flat, Steel (#10)
23	850-0030	1	Washer, Lock, Steel (#10)
24	812-0076	2	Screw, Round Head, Steel (8-32 x 5/16")
25	854-0007	2	Washer, Lock, Internal Tooth (#8)
26	815-0161	2	Screw, Flat Head, Steel (10-32 x 3/8")
	153-0429	1	Kit, Replacement (Includes Complete Choke, Less Electrical Leads, and Carburetor Air Horn Gaskets)



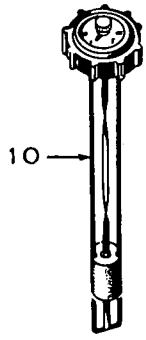
FUEL PUMP PARTS GROUP (PULSE TYPE) - OPTIONAL

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149-1322	1	Pump, Fuel
1	142-0537	1	Valve Plate Assembly
2	142-0540	2	Screw, Cover
3	149-1323	1	Gasket, Base
4	142-0541	1	Gasket, Valve Plate
5	142-0545	1	Spring, Pump
6	149-1326	1	Cover, Pump
7	149-1324	1	Base, Pump
8	142-0552	1	Disc, Pump
9	142-0555	1	Diaphragm, Pump

SIDE MOUNTED FUEL TANK GROUP (OPTIONAL EQUIPMENT)

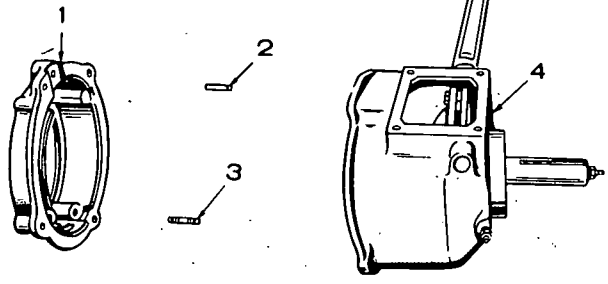


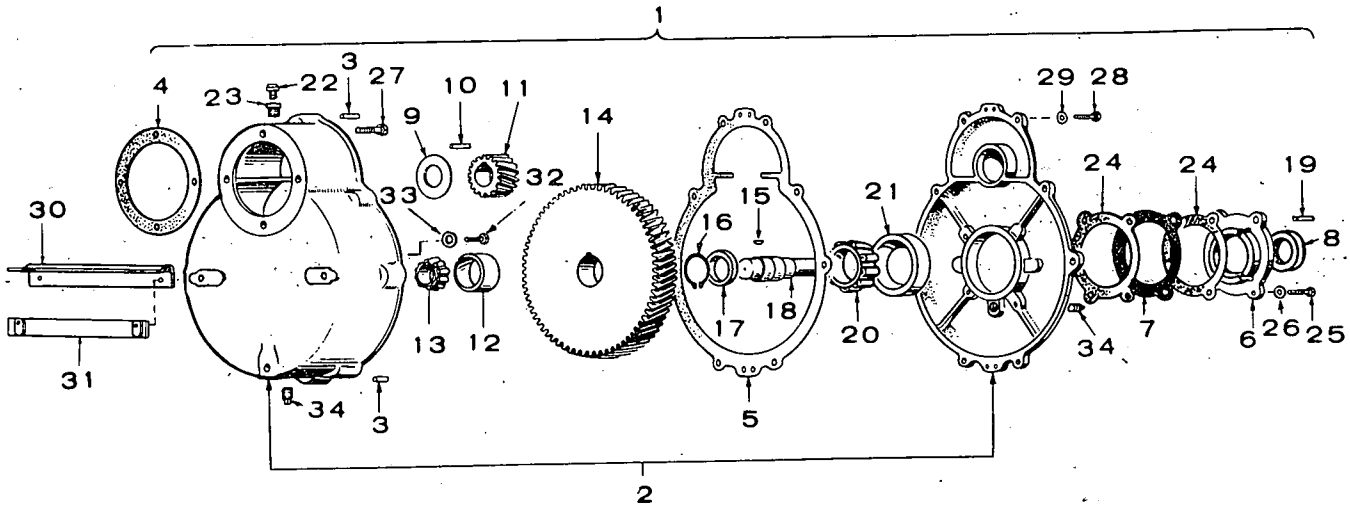
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	159-0981	1	Tank, Fuel
2	159-0596	2	Strap, Fuel Tank
3	159-0595	2	Bracket, Fuel Tank
4	134-0599	1	Clip, Fuel Line
5	501-0008	1	Line, Fuel
6	159-0007	1	Cap, Fuel Tank
7	504-0013	1	Valve, Shutoff
8	505-0057	1	Plug, Pipe (1/8)
9	502-0020	1	Elbow, Fuel Pump to Fuel Line
10	193-0207	1	Cap and Gauge Assembly, Fuel Tank
11	813-0108	2	Screw, Machine, Round Head, Cross Recessed, Steel (10-32 x 1-1/2") - Hold-down Strap to Bracket
12	870-0053	2	Nut, Hex (10-32)



CLUTCH GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190-0171	1	Adapter, Clutch to Engine
2	515-0196	1	Key, Clutch
3	STUD, CLUTCH HOUSING TO ENGINE		
	520-0738	1	3/8-16 x 4"
	520-0739	2	3/8-16 x 3"
4	190-0288	1	Clutch Assembly
	190-0289	1	Clutch Kit - Includes Complete Clutch, Adapter, Mounting Hardware and Instructions





REDUCTION GEAR GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190-0290	1	Reduction Gear Assembly
2	190-0300	1	Housing, Gear Assembly
3	516-0012	2	Pin, Dowel
4	190-0020	1	Gasket - Housing to Engine
5	191-0021	1	Gasket - Cover to Housing
6	190-0016	1	Plate, Retaining - Bearing
7	190-0115	1	Shim Set (Includes 1 Each of Following Sizes: .005", .009", .012", .016", .020", .025")
8	509-0016	1	Seal, Oil
9	190-0195	1	Washer, Pinion Gear
10	515-0142	1	Key, Pinion Gear
11	190-0191	1	Gear, Pinion
12	510-0022	1	Race, Outer, Roller Bearing - (Cup)
13	510-0021	1	Race, Inner with Roller Bearings - (Cone)
14	190-0190	1	Gear, Helical, Drive
15	515-0159	1	Key, Woodruff
16	518-0013	1	Ring, Retaining
17	190-0202	1	Spacer, Bearing
18	190-0192	1	Shaft, Take Off, Power
19	515-0103	1	Key, Woodruff
20	510-0023	1	Race, Inner with Roller Bearings - (Cone)
21	510-0024	1	Race, Outer, Roller Bearing - (Cup)
22	518-0172	1	Vent
23	505-0007	1	Reducer, Pipe (1/4 x 1/8")
24	190-0306	2	Gasket - Bearing Plate to Housing Cover
25	800-0007	4	Screw, Hex Head, Cap, Steel (1/4-20 x 1")
26	526-0063	4	Washer, Flat, Copper (1/4)
27	805-0009	4	Bolt, Hex Head, Steel (5/16-18 x 1")
28	800-0028	8	Screw, Hex Head, Cap, Steel (5/16-18 x 1")
29	526-0045	8	Washer, Flat, Copper (5/16)
30	190-0297	1	Bracket, Support, Housing
31	190-0298	1	Nut Bar, Support Bracket
32	800-0026	2	Screw, Hex Head, Cap, Steel (5/16-18 x 3/4")
33	526-0065	2	Washer, Flat, Copper (5/16)
34	505-0054	2	Plug, Pipe (1/4)

SERVICE KITS AND MISCELLANEOUS

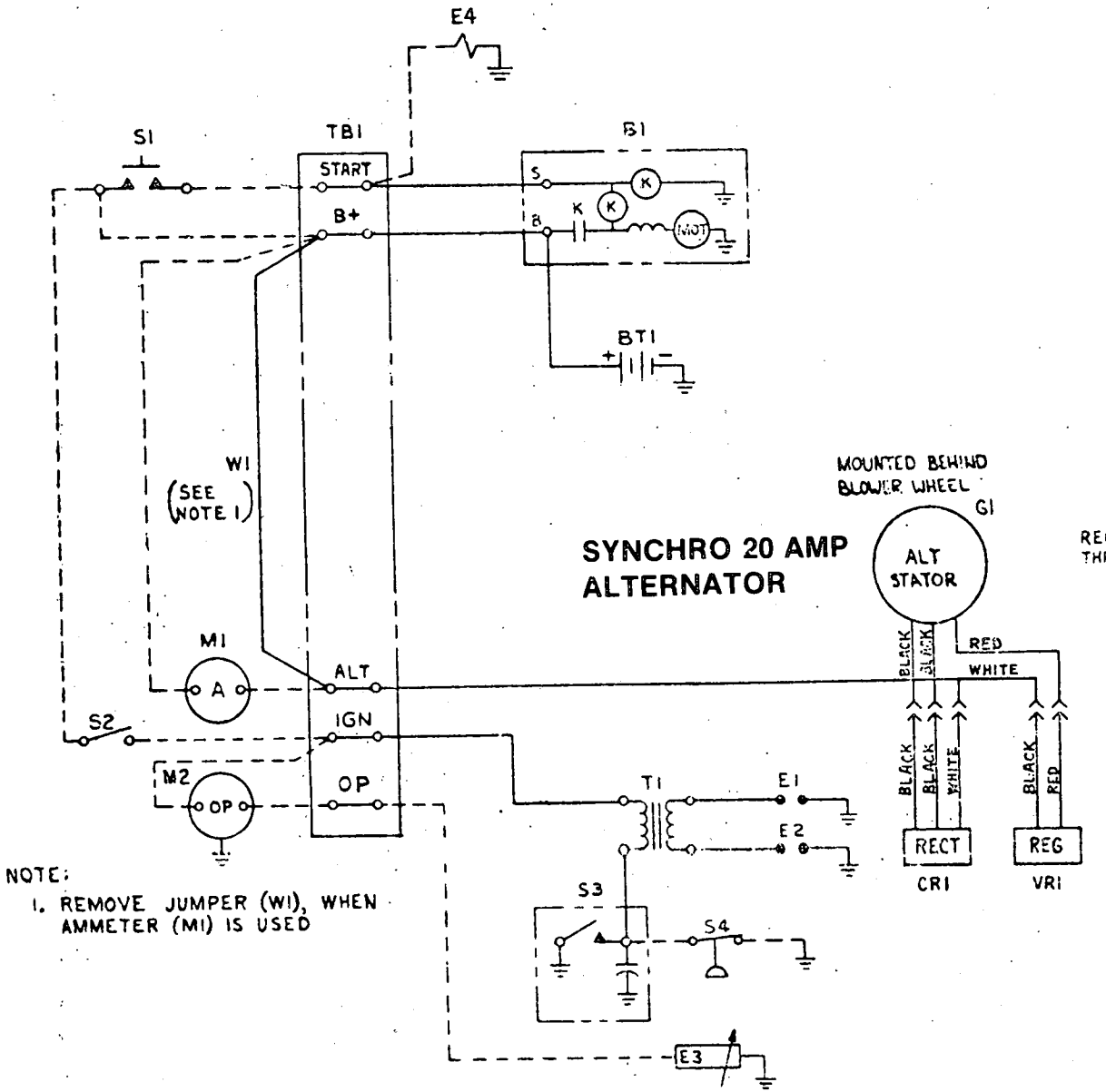
NOTE: For Additional Kits, refer to the Applicable Parts Group in Question.

PART NO.	QTY. USED	PART DESCRIPTION
98-1807	1	Kit, Decal
168-0122	1	Kit, Gasket, Complete Engine
168-0121	1	Kit, Gasket, Carbon Removal
160-1161	1	Kit, Ignition Tune-Up
522-0265	1	Kit, Engine Overhaul
525-0137	1	Paint, Touch-Up, Metallic Green (16 oz. pressurized can)
525-0305	1	Paint, Touch-Up, Non-Metallic Green (13 oz. Pressurized Can)

WIRING DIAGRAMS

The wiring diagrams in this section are typical for NHC and NHCV engines with 15- or 20-amp flywheel alternators and other options. The separate engine control wiring diagrams shipped with each unit should be used for troubleshooting. The following drawings are included herein:

Engine Control Wiring Diagram with options 67
Engine Control Wiring Diagram with Thermo-Magnetic Choke (622-0270) 68
Wiring Diagram for Flywheel Alternator (Phelon 15 Amp) 69
Wiring Diagram for Flywheel Alternator (Synchro 20 Amp) 69

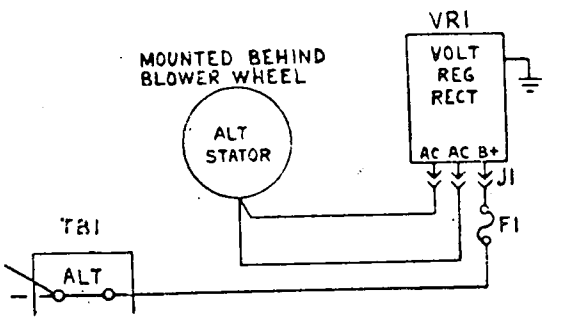


NOTE:
1. REMOVE JUMPER (W1), WHEN AMMETER (M1) IS USED

	PARTS LIST (REF)	
	REF DES.	DESCRIPTION
*	E4	CHOKE - ELECTRIC
	B1	STARTER & SOLENOID - ENGINE
	BT1	BATTERY - 12 V.
	CR1	RECTIFIER ASSY
	E1, 2	SPARK PLUG
*	E3	SENDER - OIL PRESSURE
	G1	ALTERNATOR
*	M1	AMMETER
*	M2	METER - OIL PRESSURE
	S1	SWITCH - START
	S2	SWITCH - IGNITION
	S3	BREAKER & CAP. ASSEMBLY
*	S4	SWITCH - LOPKO
	T1	COIL - IGNITION
	TB1	BLOCK - TERMINAL
		STRIP - MARKER
	VR1	REGULATOR - VOLTAGE
	W1	JUMPER (SEE NOTE 1)

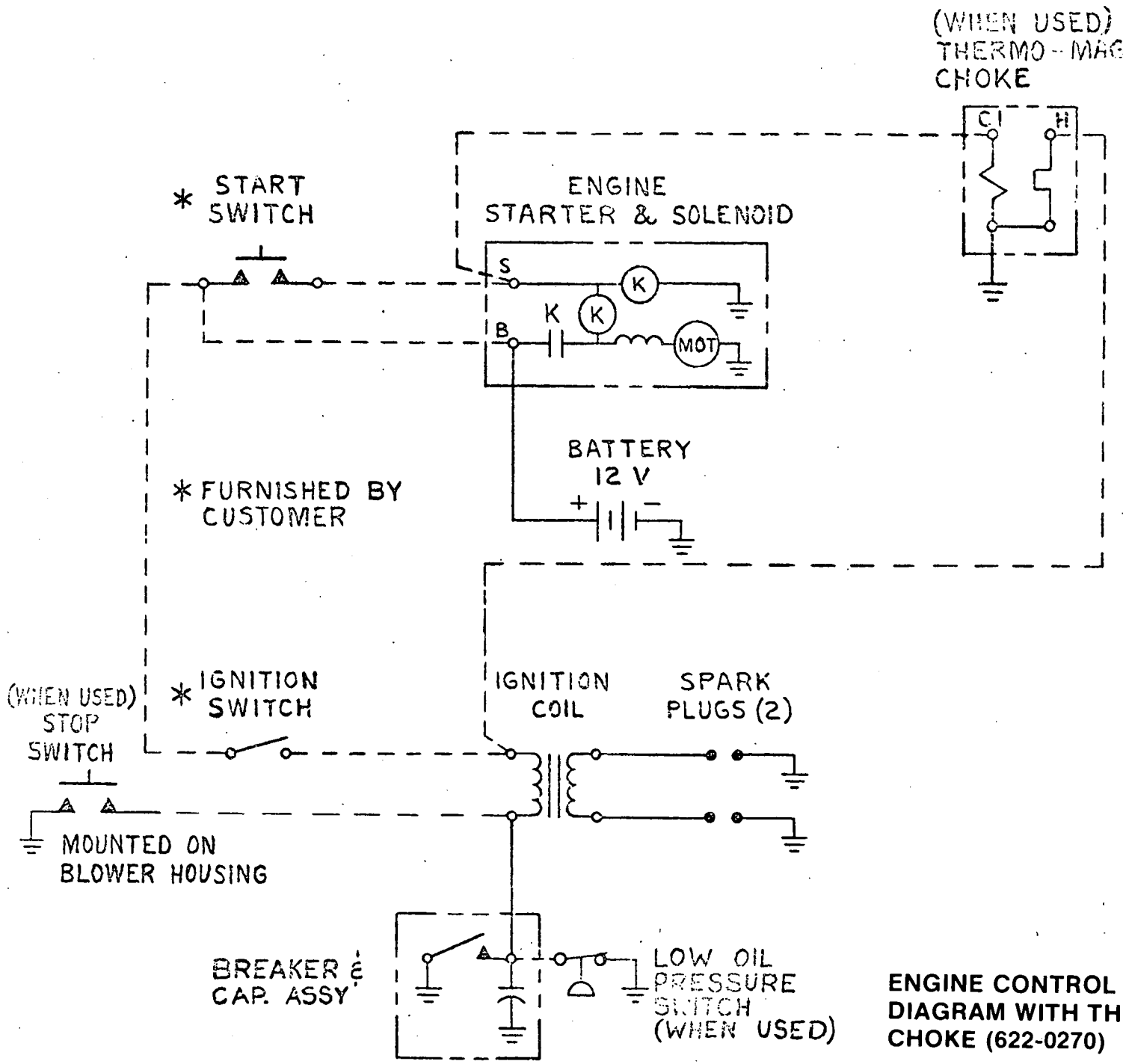
* WHEN USED

CAUTION!
REGULATOR MUST BE GROUNDED THROUGH MOUNTING BOLTS

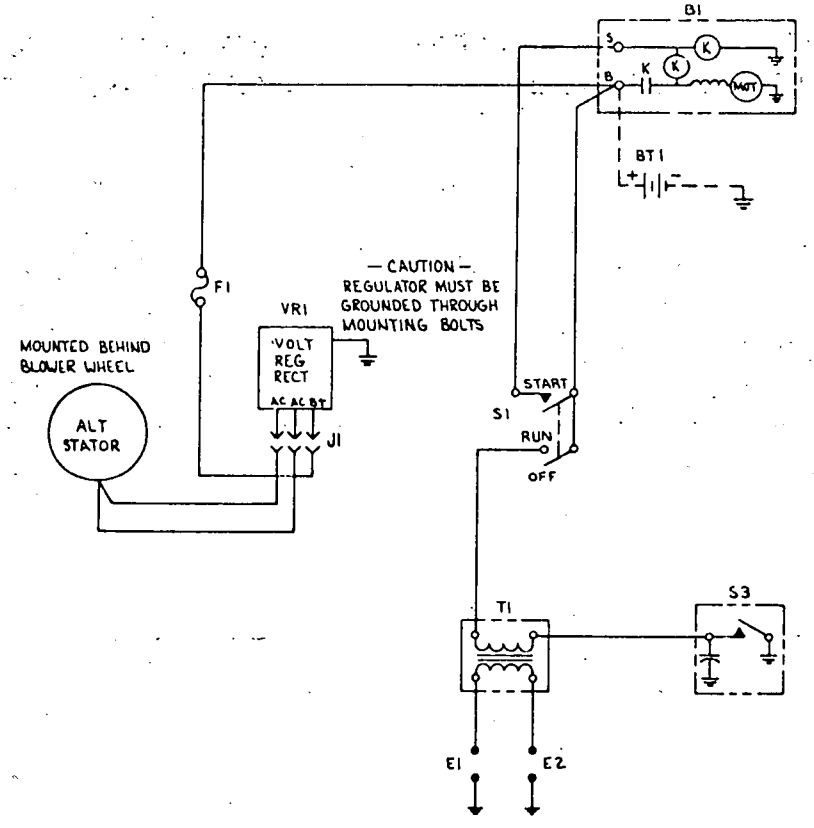


PHELON 15 AMP ALTERNATOR

ENGINE CONTROL WIRING DIAGRAM WITH OPTIONS



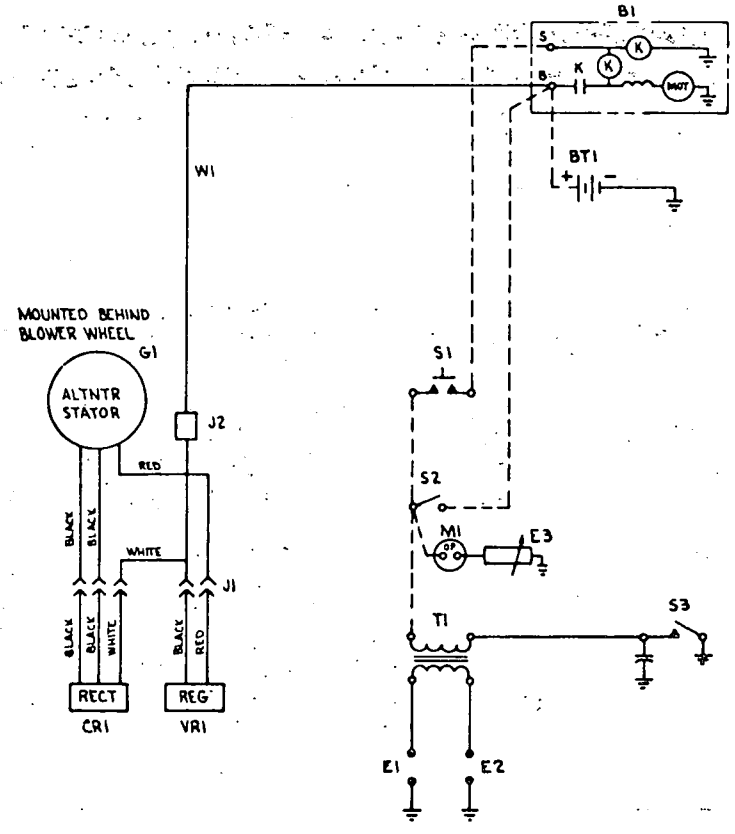
ENGINE CONTROL WIRING DIAGRAM WITH THERMO-MAGNETIC CHOKE (622-0270)



WIRING DIAGRAM FOR FLYWHEEL ALTERNATOR (PHELON 15 AMP)

(622-0386)

REF DES.	PART NO.	QTY	DESCRIPTION
B1		1	STARTER & SOLENOID-ENGINE
BT1		1	BATTERY, 12 V
E1 & 2		2	SPARK PLUG
F1		1	FUSE, 35 AMP
		1	HOLDER-FUSE
G1		1	ALTERNATOR-FLYWHEEL 15 AMP
J1		1	CONNECTOR
S1		1	SWITCH-START, RUN, OFF
S2		1	BREAKER & CAP ASSEMBLY
T1		1	IGNITION COIL-(ONAN)
VR1		1	REGULATOR-RECTIFIER-VOLTAGE



WIRING DIAGRAM FOR FLYWHEEL ALTERNATOR (SYNCRO 20 AMP)

(622-0382)

REF DES	PART NO.	DWG SIZE	QTY	DESCRIPTION
B1			1	STARTER & SOLENOID - ENG
BT1			1	BATTERY, 12V
CR1			1	RECTIFIER ASSY
E1, E2			2	SPARK PLUG
E3	193-0108	A	1	SENDER - OIL PRESSURE
J1			1	CONNECTOR
J2			1	CONNECTOR - FASTON
M1	193-0107	B	1	METER - OIL PRESSURE
S1			1	SWITCH - START
S2			1	SWITCH - IGN
S3			1	BREAKER & CAP ASSY
T1			1	IGNITION COIL
VR1			1	REGULATOR - VOLTAGE
W1	336-1590	A	1	LEAD ASSY
G1			1	ALTERNATOR - FLYWHEEL 20 AMP

CUSTOMER SERVICES

OWNER'S WARRANTY SERVICE - ENGINE DRIVEN ELECTRIC GENERATOR SETS, SEPARATE GENERATORS, INDUSTRIAL ENGINES

QUALITY OF PRODUCT

Onan products are engineered and designed to perform as stated on product nameplate and published specification. With proper installation and operation, regular maintenance and periodic repair service, the equipment will provide reliable service.

GENERAL WARRANTY PRACTICES

All Onan-manufactured engine-driven electric generator sets, separate generators, and industrial engines are sold with a full one-year warranty. This warranty is issued only to the original user and promises satisfactory performance of the product when properly installed, serviced, and operated under normal conditions, according to the manufacturer's instructions. The text of the Onan published warranty appears in the Onan Operator's Manual sent with the product.

Warranty Registration: A Warranty Registration card accompanies each Onan Product. This card must be properly filled out and returned to the Onan Factory in order to qualify for warranty consideration as covered in this bulletin. When requesting warranty repair work you must provide the purchase date, Onan model, and serial number of the equipment.

Warranty Authorization: Warranty service must be performed by Onan Factory or Onan Authorized Distributors or their Approved and Registered Service Dealers. A complete listing of these Onan Authorized Parts and Service Centers is provided in our brochure F-115, a copy of which is supplied with each Onan Product. These Onan Authorized Service Centers have trained service personnel, parts stock, and the necessary facilities and tools for the service and repair of Onan equipment.

Material Allowances: Onan will allow credit or furnish free of charge to the Onan Authorized Service Station or his Approved Service Dealer, all genuine Onan parts used in a warranty repair of these products which fail to perform as warranted.

Labor Allowance: Onan will allow warranty repair credit to the Onan Authorized Parts and Service Center and his Approved Dealer at straight time labor when the cause of failure is determined to be defective material or factory workmanship. This labor allowance will be based on the factory's standard time schedule of published flat rate labor allowances, or, otherwise a time judged reasonable by the factory. Repair work not covered by warranty will be charged to the owner. The Onan's Warranty practice does not provide for allowance of expenses such as start-up charges, communication charges, transportation charges, travel time and/or mileage, unit removal or installation expense, cost of fuel, oil, normal maintenance adjustments, tune-up adjustments or parts maintenance items, and does not cover incidental or consequential damages.

Administration: Warranty of Onan Products is administered through Onan Authorized Distributors in whose territory the equipment is located. These Distributors and their Approved or Registered Onan Service Dealers are authorized to make settlement of all customer warranty claims within the limits of the manufacturer's warranty policy as described herein.

Onan reserves the right to change warranty practices without prior notice.

MAINTENANCE

A Planned Preventive Maintenance Program is extremely important if you are to receive efficient operation and long service life from your Onan unit. Neglecting routine maintenance can result in premature failure or permanent damage to your equipment. The Onan Operator's Manual sent with the product contains recommended maintenance schedules and procedures.

Maintenance is divided into two categories:

1. Operator Maintenance . . . . . performed by the operator.
2. Critical Maintenance . . . . . performed only by qualified service personnel.

Regular maintenance will help you avoid sudden and costly repairs in the future. Adequate evidence of this scheduled maintenance must be offered when applying for a warranty claim.

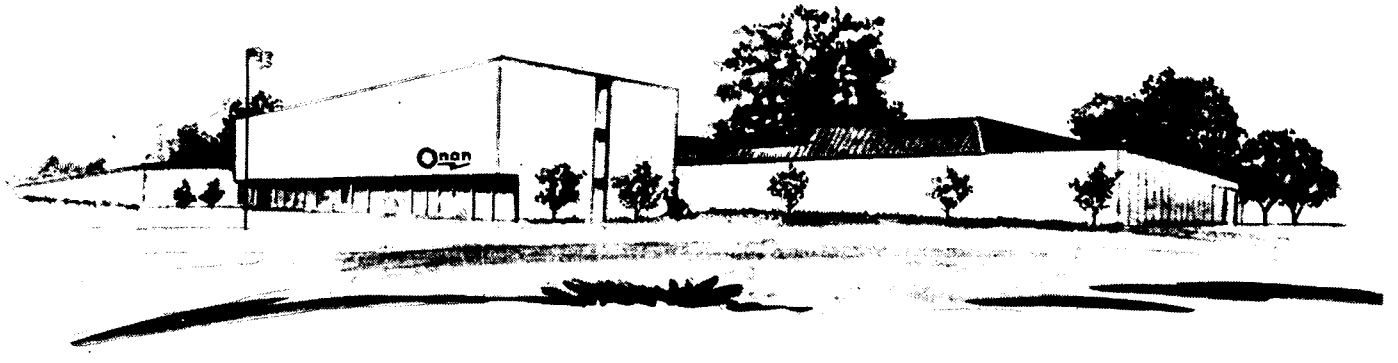
INSTALLATION

Installation is extremely important and all Onan Products should be installed in accordance with the manufacturer's recommendations. If the owner experiences any difficulty with such items as mounting, ventilation, exhaust location, fuel lines, wiring, etc., he should immediately contact the company from whom he purchased the equipment so that corrective action can be taken. Although the Onan Authorized Distributor and his Approved or Registered Service Dealers may be able to remedy certain installation difficulties, such repair work is not considered Onan warranty and there will be a charge for this service.

Onan

Minneapolis, Minnesota 55432

MSS-22B
Replaces 23B054 and MSS-22A
Rev. 7-2-73



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Onan®

OPERATOR'S/SERVICE MANUAL AND PARTS CATALOG

FOR

SERIES

NHC

INDUSTRIAL ENGINES

Pg 6
37

940-404

Printed in U.S.A.
2A73

ONAN 940-1011 (8-10-73)

SUPPLEMENTARY INSTRUCTION AND PARTS CATALOG

Use these instructions with Operator's Manual and Parts Catalog 940-404, NHC Industrial Engines with pressure cooling system. The NHCV engine is basically the same as the NHC, but has a vacu-flo cooling system.

GENERAL

The NHCV industrial engine (Figure 1) is designed to run cool and efficiently in numerous enclosed applications. However, any inlet and outlet openings or ducts required by the engine application must provide for adequate ventilation through the vacu-flo cooling system.

VACU-FLO COOLING

The vacu-flo equipped engine uses an integral flywheel-centrifugal fan to pull cool air into the engine shroud and over the cooling fins and surfaces of the engine, Figure 2. The heated air is directed through an air tight scroll which encases the flywheel fan. The scroll may be positioned to discharge heated air in the downward, upward, left or right direction. This is possible because the back section of the scroll (Figure 3) has four identical holes shaped to fit over the end of the starter motor. The scroll outlet has a mesh type screen for safety.

CAUTION *The outlet of the vacu-flo scroll must not be restricted or overheating will result. Engine overheating can cause troubles ranging from vapor lock to scored pistons and cylinders.*

Should a vacu-flo engine chronically overheat, the most likely sources of the problem are:

1. Air inlet is obstructed or too small to allow proper ventilation.
2. Air discharge opening is partially blocked by external ducts or exhaust systems.
3. Recirculation of heated air into fresh air inlet.

INSTALLATION

The vacu-flo installation permits greater freedom in choice of locating the air inlet and outlet openings, and permits the use of a compartment only slightly larger than the engine itself.

The area of the air inlet must be at least 140 sq. inch. If a filter, grille, or louvers are used, the inlet opening must be increased accordingly. The air outlet opening should be located as close to the engine as possible.

If the duct length exceeds 5 feet, increase duct size 30%. Use no more than two 90^{o} radius-type (not square-type) elbows if it is necessary to change air flow direction.

When a duct is used between the scroll discharge and the outlet vent, its free airflow area must be at least as large as the scroll discharge. The cross sectional area of the duct must be increased if air flow is restricted by bends, long runs, screens or the exhaust pipe. Exhaust pipes running inside Vacu-Flo ducts should be covered with asbestos tape.

The safety screen used to cover vents must be 1/4 inch mesh or larger, and commensurate with safety standards.

Provide a short canvas section between the engine air outlet and the external duct or opening, to absorb vibration.

If operation in cold weather is likely, installing a shutter in the air out is advisable. Cold weather can cause overcooling if air flow is not regulated.

TIMING VACU-FLO ENGINE

Engine timing is advanced or retarded by opening or closing the breaker point gap. Setting the point gap at 0.020 inch is the most accurate method of timing the engine.

Dynamic timing (engine running) may be less accurate because the sight angle from the viewer to the flywheel scribe mark and timing pointer may vary $\pm 2^{o}$ from 25^{o} BTC.

The timing pointer is mounted on the cylinder block above the oil filter; it is made accessible by removing the right hand shroud.

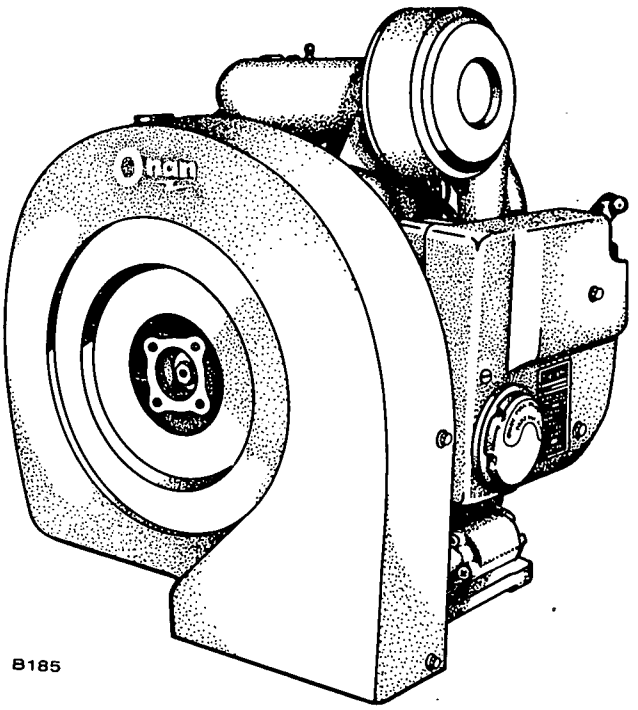


FIGURE 1. NHCV INDUSTRIAL ENGINE

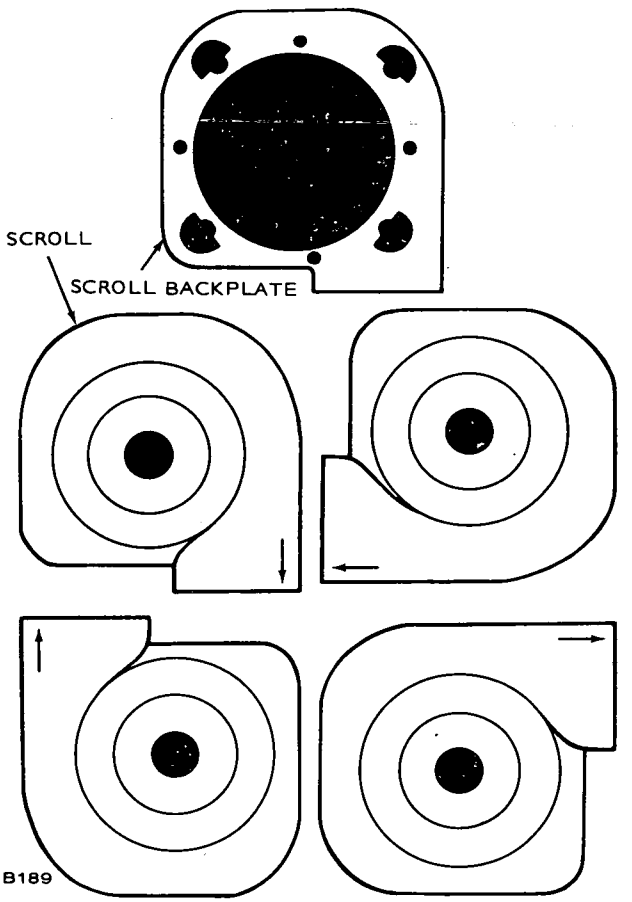


FIGURE 3. VACU-FLO SCROLL POSITIONS

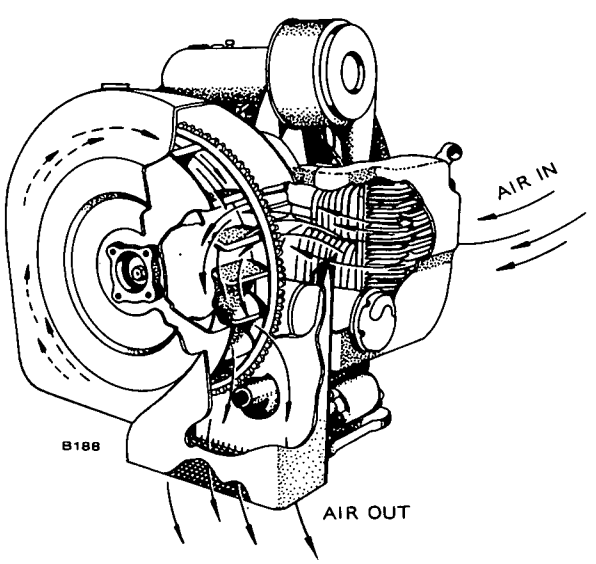


FIGURE 2. AIRFLOW THROUGH VACU-FLO SYSTEM

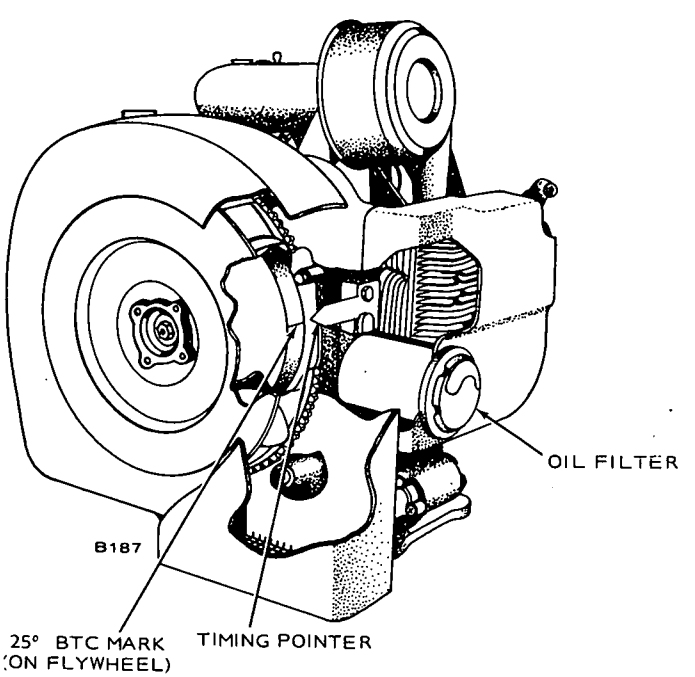


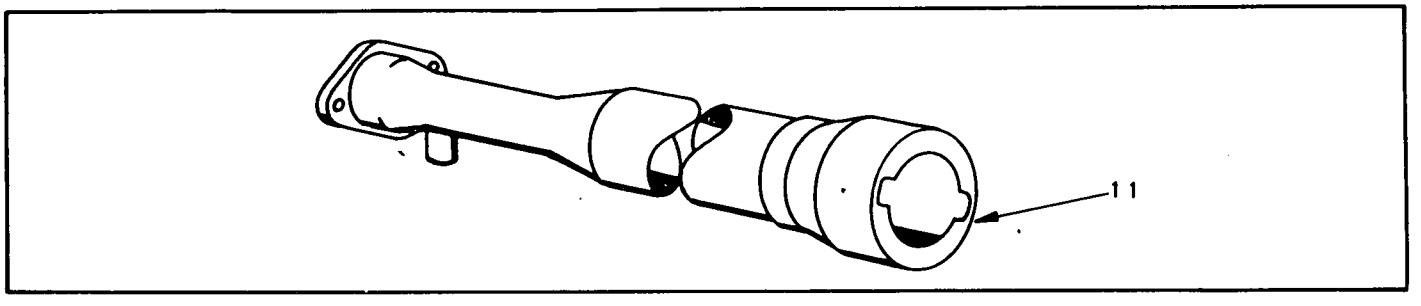
FIGURE 4. VACU-FLO ENGINE DYNAMIC TIMING

940-1011 (9/73)

SUPPLEMENTARY PARTS LIST

Parts in this list apply to the NHCV Industrial Engines. Use these parts in place of/or in addition to those listed in the Operator's/Service Manual and Parts Catalog 940-404.

NOTE: Parts that are similar in appearance to those in the main parts catalog are not illustrated.

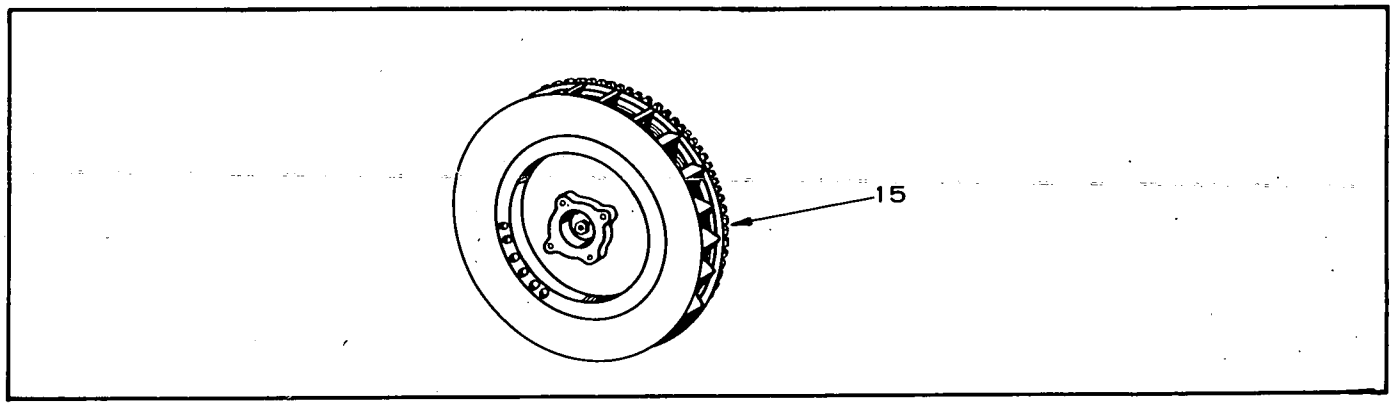


OIL BASE GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
5	123B1117	1	Tube, Oil Fill - Standard
11	123B1234	1	Tube, Oil Fill - Units with Pulse Type Fuel Pump - Optional

GEAR COVER GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	103B446	1	Standard Governor (Drilled and tapped for Flywheel Alternator Stator) - Includes parts marked *
	103B447	1	Manual Throttle Controlled Engines - Includes Oil Seal (Drilled and tapped for Flywheel Alternator Stator)
2	510P105	1	*Bearing, Governor Shaft (Upper)
3	150B1436	1	*Shaft & Arm, Governor
7	Delete		

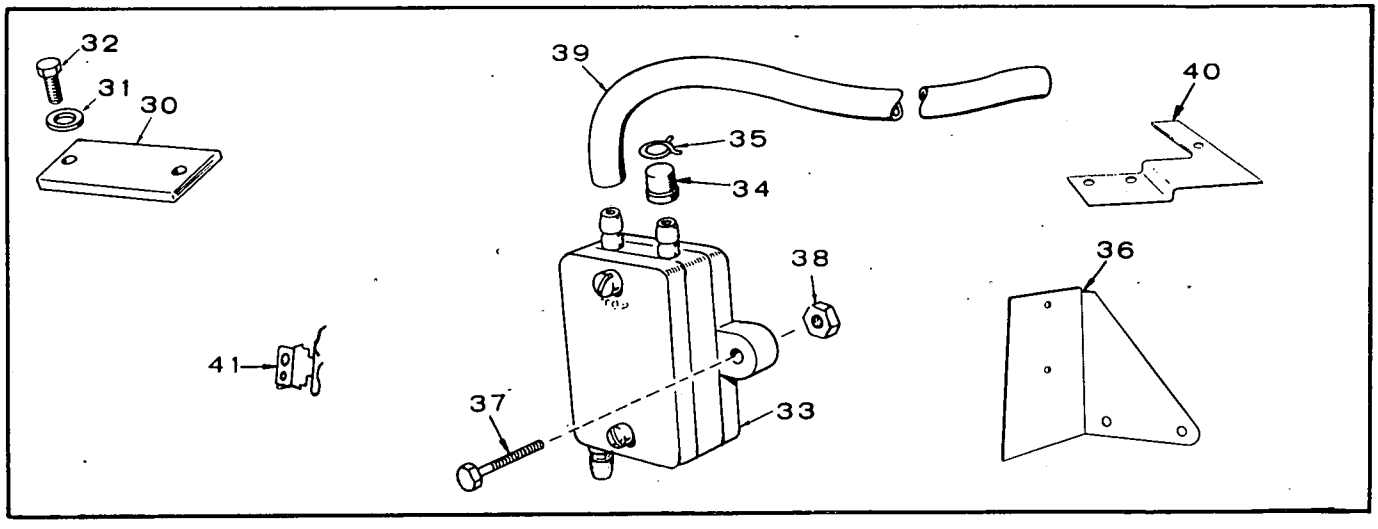


CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
7	Delete		
8	Delete		
13	Delete		
14	Delete		
15	FLYWHEEL		
	134B2768	1	Standard Units (Includes Ring Gear)
	134B2770	1	Units with Flywheel Alternator System (Includes Ring Gear and Magnet Ring) - Optional

OIL SYSTEM GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
2	120B648	1	Intake, Oil Pump - Includes Cup Screen and Pipe
9	122C360	1	Drain, Oil Filter

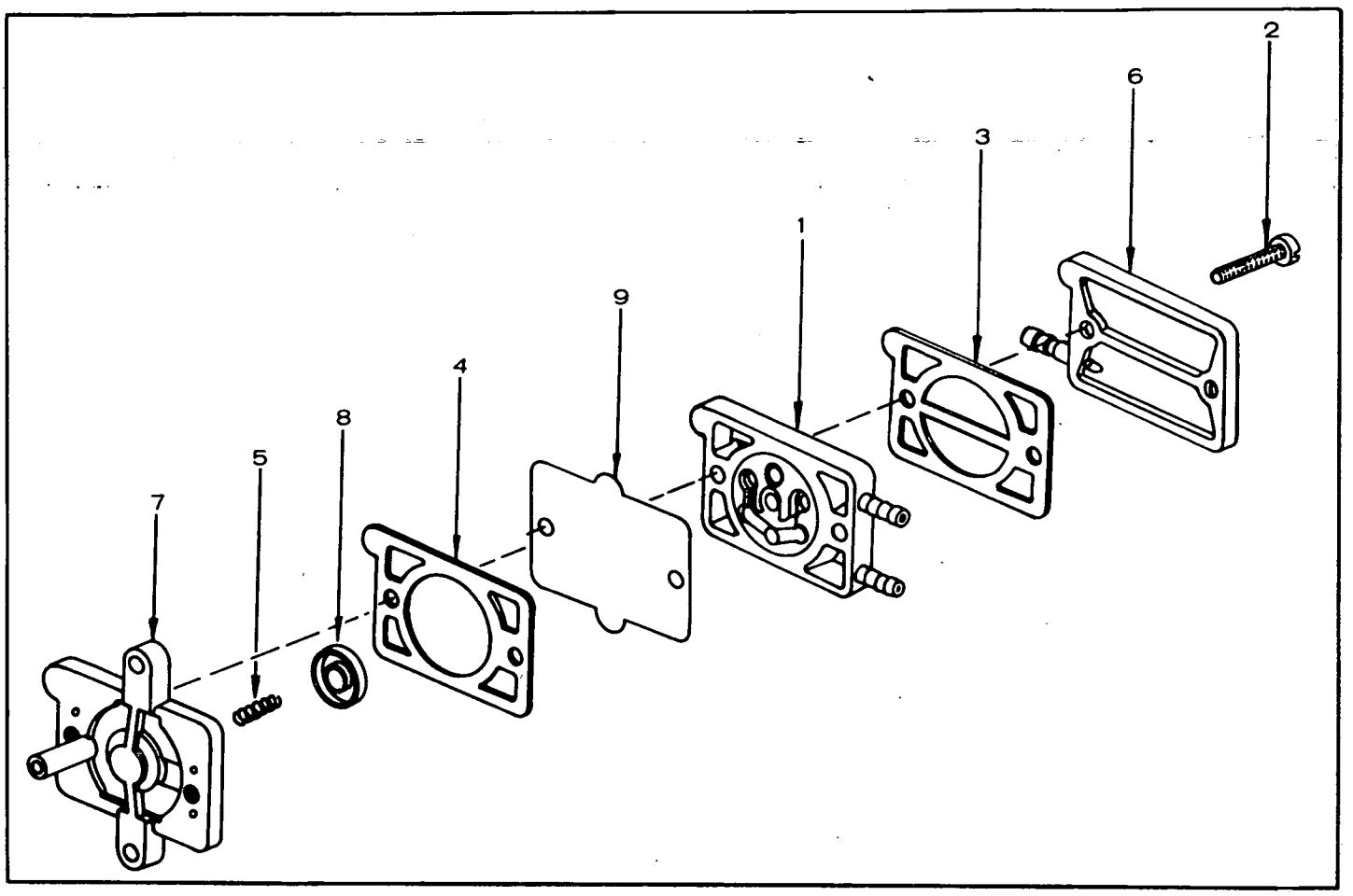


FUEL SYSTEM GROUP (Gasoline)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	Delete		
3	LINE, FUEL PUMP TO CARBURETOR		
	149A1228	1	Standard Units
	503-708	1	Units with Pulse Type Fuel Pump - Optional
4	Delete		

FUEL SYSTEM GROUP (Gasoline) (Continued)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
5	Delete		
12	Delete		
14	Delete		
18	Delete		
30	149A136	1	Cover, Fuel Pump Opening In Block
31	526-63	2	Washer, Flat - Copper - Fuel Pump Hole Cover Mounting
32	800-4	2	Screw, Hex Cap - Fuel Pump Hole Cover Mounting (1/4-20 x 5/8")
33	149C1322	1	Pump Fuel (Pulse Type) - Optional (See Separate Group for Components)
34	149A1321	1	Cap, Pulse Type Fuel Pump Top Inlet - Optional
35	503-301	1	Clamp, Pulse Type Fuel Pump Cap - Optional
36	149B1364	1	Bracket, Pulse Type Fuel Pump Mounting - Optional
37	813-102	2	Screw, Round Head - Pulse Type Fuel Pump Mounting (#10-32 x 5/8") - Optional
38	870-131	2	Nut, Hex - Pulse Type Fuel Pump Mounting (#10-32) - Optional
39	503-706	1	Line, Pulse - Fuel Pump to Oil Fill Tube - Optional
40	153A464	1	Bracket, Manual Choke - Optional
41	518-176	1	Clip, Manual Choke - Optional

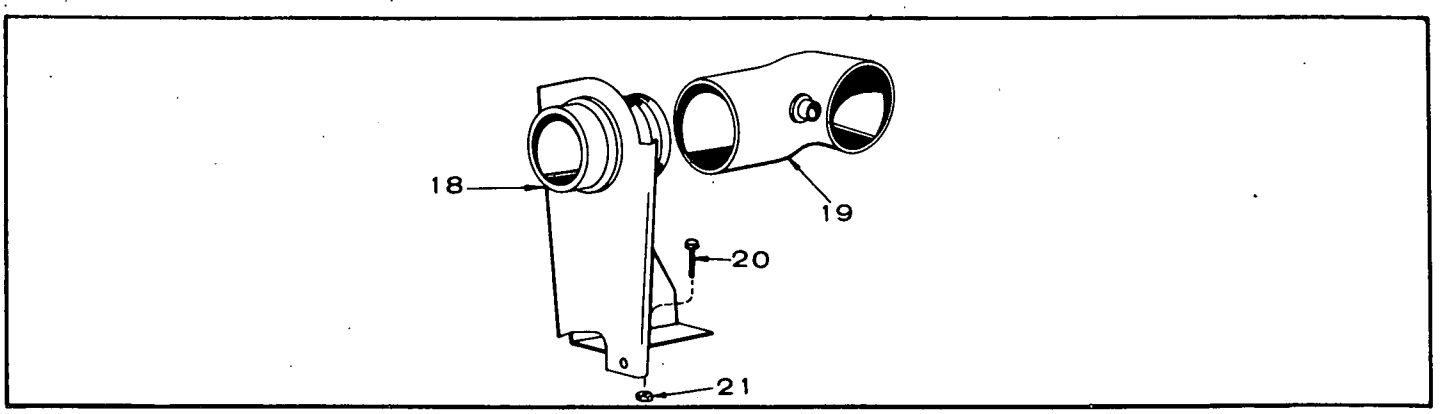


FUEL PUMP PARTS GROUP (Pulse Type) - OPTIONAL EQUIPMENT

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149B1322	1	Pump Assembly, Complete
1	142-537	1	Valve Plate Assembly
2	142-540	2	Screw, Pump Cover
3	149-1323	1	Gasket, Base to Diaphragm
4	142-541	1	Gasket, Cover to Valve Plate
5	142-545	1	Spring, Pump Diaphragm
6	149-1326	1	Cover, Pump
7	149-1324	1	Base, Pump
8	142-552	1	Plate, Pump Spring
9	142-555	1	Diaphragm, Pump

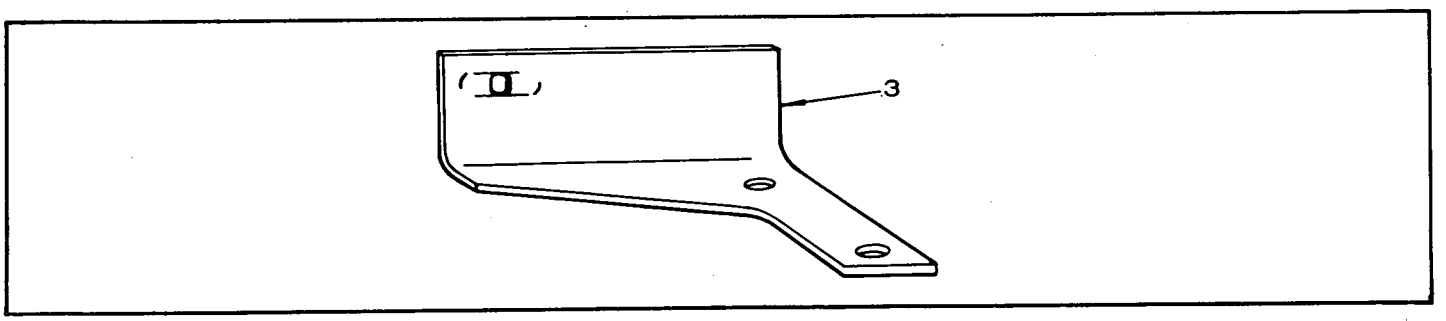
FUEL PUMP PARTS GROUP (Mechanical Type)

DELETE ENTIRE GROUP



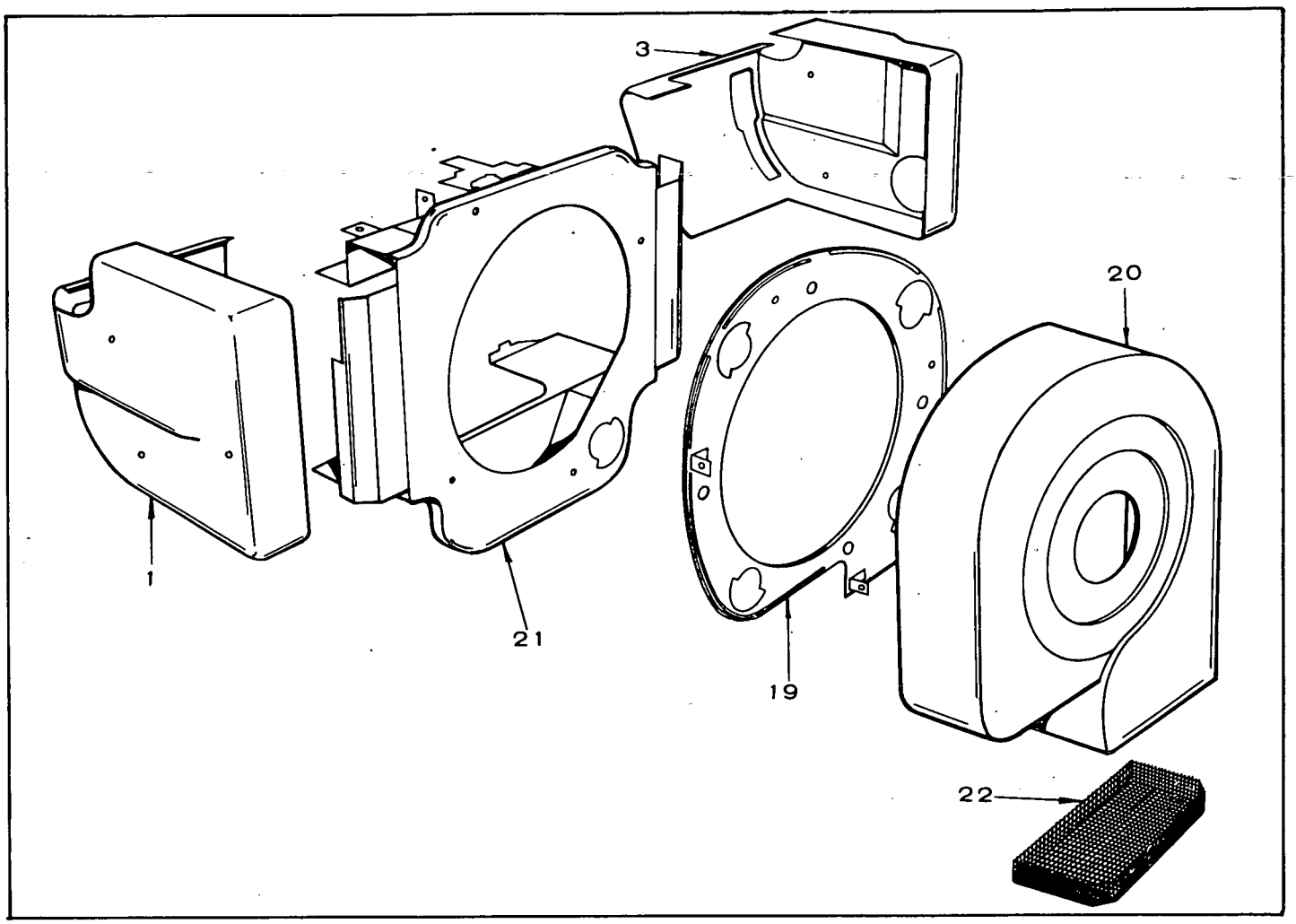
AIR CLEANER GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
2	Delete		
3	Delete		
6	145A453	1	Adapter, Carburetor Air Inlet
7	123A1241	1	Hose, Breather
13	821-10	1	Screw, Self Locking - Air Cleaner Bracket Mounting (1/4-20 x 1/2")
18	140B1280	1	Adapter and Bracket, Air Cleaner Mounting
19	140A1282	1	Elbow, Carburetor - Air Inlet
20	809-59	1	Screw, Sheet Metal - Air Cleaner Bracket Mounting
21	870-106	1	Nut, Tinnerman - Air Cleaner Bracket Mounting



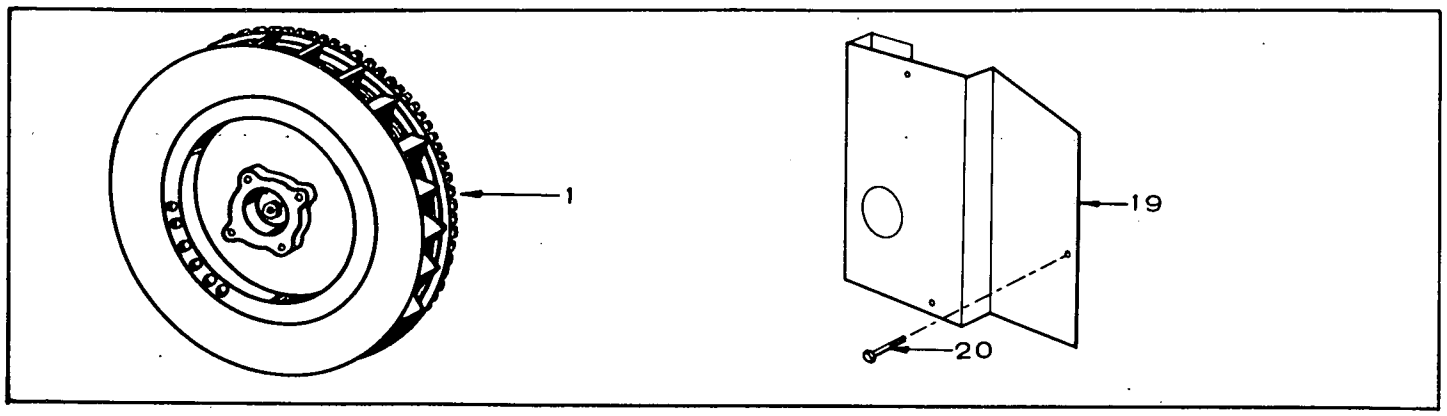
GOVERNOR GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
2	150A96	1	Stud, Speed Adjustment (Standard Governor Controlled Engines)
3	150A1433	1	Bracket, Speed Stud (Standard Governor Controlled Engines)
5	150A939	1	Joint, Ball
6	520A623	1	Link, Throttle



BLOWER HOUSING GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134D2755	1	Housing, Cylinder Air - Left Side
2	Delete		
3	134B2752	1	Housing, Cylinder Air - Right Side
4	Delete		
5	Delete		
6	Delete		
7	Delete		
8	Delete		
9	Delete		
11	Delete		
12	Delete		
13	Delete		
14	Delete		
15	Delete		
16	Delete		
17	SCREW, SELF LOCKING		
	821-10	4	Backplate Mounting (1/4-20 x 1/2")
	821-10	5	Scroll Mounting (1/4-20 x 1/2")
	821-10	2	Housing Cover (1/4-20 x 1 1/2")
18	Delete		
19	134A2747	1	Backplate, Scroll
20	134A2761	1	Scroll, Air (Includes Guard)
21	134D2737	1	Housing Assembly - Air
22	134B2763	1	Guard, Scroll



CHARGING ALTERNATOR GROUP - 12 VOLT (OPTIONAL)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134C2770	1	Flywheel Assembly (Includes Ring Gear and Magnet Ring) Also listed in the crankshaft and Flywheel Group
19	191B59	1	Bracket, Regulator Mounting
20	821-10	4	Screw, Lock Head - Regulator Bracket Mounting

ONAN INDUSTRIAL ENGINES

NHC

SERIES

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GENERAL INFORMATION

This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of the engine. Since the first and most important part of repair work is the correct diagnosis of the trouble, a trouble-shooting chart is included.

Study and follow the instructions carefully. Proper service and maintenance will result in longer engine life and better performance.

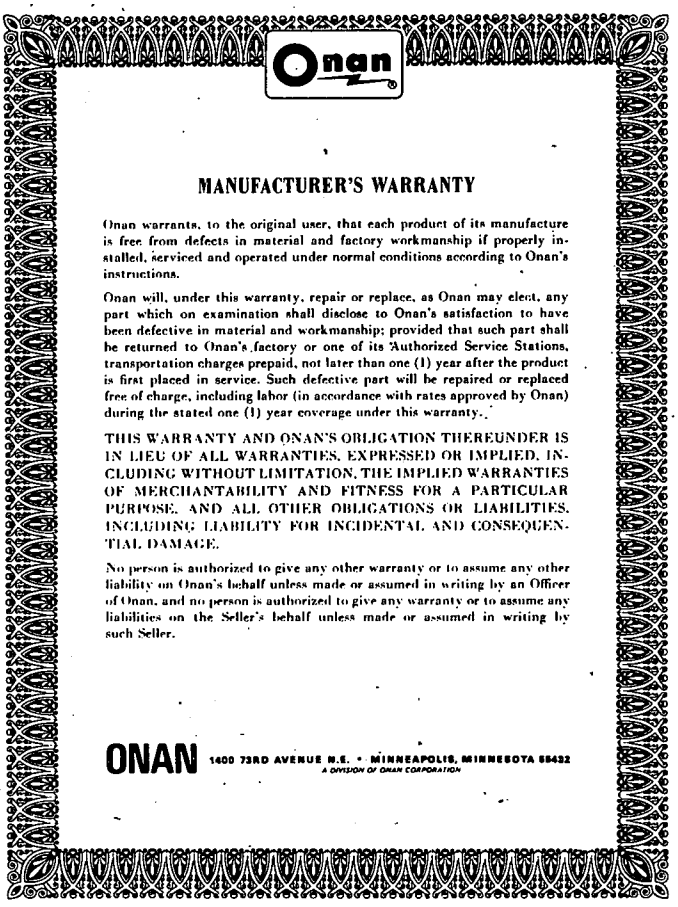
How To Interpret MODEL and SPEC NO.

NHC - MS / 123 A

1 2 3 4

1. Factory code for general identification purposes.
2. Specific Type:
   S - MANUAL starting

   MS - ELECTRIC starting
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.



Onan

MANUFACTURER'S WARRANTY

Onan warrants, to the original user, that each product of its manufacture is free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to Onan's instructions.

Onan will, under this warranty, repair or replace, as Onan may elect, any part which on examination shall disclose to Onan's satisfaction to have been defective in material and workmanship; provided that such part shall be returned to Onan's factory or one of its Authorized Service Stations, transportation charges prepaid, not later than one (1) year after the product is first placed in service. Such defective part will be repaired or replaced free of charge, including labor (in accordance with rates approved by Onan) during the stated one (1) year coverage under this warranty.

THIS WARRANTY AND ONAN'S OBLIGATION THEREUNDER IS IN LIEU OF ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER OBLIGATIONS OR LIABILITIES, INCLUDING LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGE.

No person is authorized to give any other warranty or to assume any other liability on Onan's behalf unless made or assumed in writing by an Officer of Onan, and no person is authorized to give any warranty or to assume any liabilities on the Seller's behalf unless made or assumed in writing by such Seller.

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

SPECIFICATIONS

	NHC-MS/1
Number of Cylinders	2
Displacement (cubic inch)	60
Cylinder Bore	3-9/16 in.
Piston Stroke	3 inch
Horsepower	25 BHP @ 3600 rpm
Compression Ratio	7.0 to 1
Ventilation Required (cfm @ 3600 rpm)	1080
Oil Capacity	3-1/2 qt.
Oil Capacity With Filter Change	4 qt.
Starting	Electric
Ignition	Battery
Combustion Air (cfm @ 3600 rpm)	80
Fuel	Gasoline (regular grade)
Fuel Pump	Diaphragm, 4 ft. lift

TUNE-UP SPECIFICATIONS

Spark Plug Gap	.025″
Breaker Point Gap	.020″
Ignition Timing (Fixed), Electric Start Units	25°BTC
Tappets (Cold) Intake	.003″
Exhaust	.012″

NOTE: For gaseous fuel operation set spark plugs at .018″ and ignition timing at 26°BTC and exhaust valve lash at .014″.

DIMENSIONS AND CLEARANCES

All clearances given at room temperature of 70°F.
All dimensions in inches unless otherwise specified.

	Minimum	Maximum
Valve Tappet Clearance		
Intake	0.003	
Exhaust	0.012*	
Valve Stem in Guide – Intake	0.001	0.0025
Valve Stem in Guide – Exhaust	0.0025	0.004
Valve Spring Length		
Free Length	1.662	
Compressed Length	1.375	
Valve Spring Tension (lb.)		
Open	71	79
Closed	38	42
Valve Seat Bore Diameter		
Intake	1.5645	1.5655
Exhaust	1.2510	1.2520
Valve Seat Diameter		
Intake	1.569	1.570
Exhaust	1.255	1.256
Valve Stem Diameter		
Intake	0.3425	0.3430
Exhaust	0.3410	0.3415
Valve Guide Diameter (I.D.)	0.344	0.346
Valve Lifter Diameter	0.7575	0.7480
Valve Lifter Bore	0.7505	0.7515
Valve Seat Interference Width	1/32	3/64
Valve Face Angle	44°	
Valve Seat Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing	0.0025	0.0038
Crankshaft End Play	0.005	0.009
Camshaft Bearing	0.0015	0.003
Camshaft End Play	0.003	–
Camshaft Lift	0.300	
Camshaft Bearing Diameter	1.3760	1.3770
Camshaft Journal Diameter	1.3740	1.3745
Rod Bearing (Forged Rod)	0.0005	0.0023
Connecting Rod End Play (Ductile Iron)	0.002	0.016
Timing Gear Backlash	0.002	0.003
Oil Pump Gear Backlash	0.002	0.005
Piston to Cylinder, Strut Type (Measured below oil-controlling ring – 90° from pin) Clearance	0.0015	0.0035
Piston Pin Diameter	0.7500	0.7502
Piston Pin in Piston	Thumb Push Fit	
Piston Pin in Rod	0.0001	0.0005
Piston Ring Groove Width		
Top 1	0.0955	0.0965
Top 2	0.0955	0.0965
Top 3	0.1880	0.1890

Piston Ring Gap in Cylinder	0.010	0.020
Piston Ring Side Clearance (Top compression ring only)		0.006
Breaker Point Gap (Full Separation)		0.020
Spark Plug Gap – For Gasoline Fuel		0.025
Crankshaft Main Bearing Journal – Standard Size	1.9992	2.0000
Main Bearing Diameter	2.0015	2.0040
Main Bearing Clearance	0.0015	0.0043
Crankshaft Rod Bearing Journal – Standard Size	1.6252	1.6260
Cylinder Bore – Standard Size	3.5625	3.5635

* Set exhaust valve at .014 for gaseous fuel operation.

ASSEMBLY TORQUES AND SPECIAL TOOLS

TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often with the engine cold. Tighten as needed to prevent them from working loose.

TORQUE SPECIFICATIONS	Ft.-Lb.
Cylinder Head Nuts	17-19
Rear Bearing Plate	20-23
Connecting Rod Bolt	27-29
Flywheel Capscrew	35-40
Starter Mounting Bracket to Oil Base Screws	43-48
Gear Case Cover	8-10
Oil Pump	7-9
Other 3/8 Cylinder Block Nuts	18-23
Intake Manifold	18-20
Exhaust Manifold	10-12

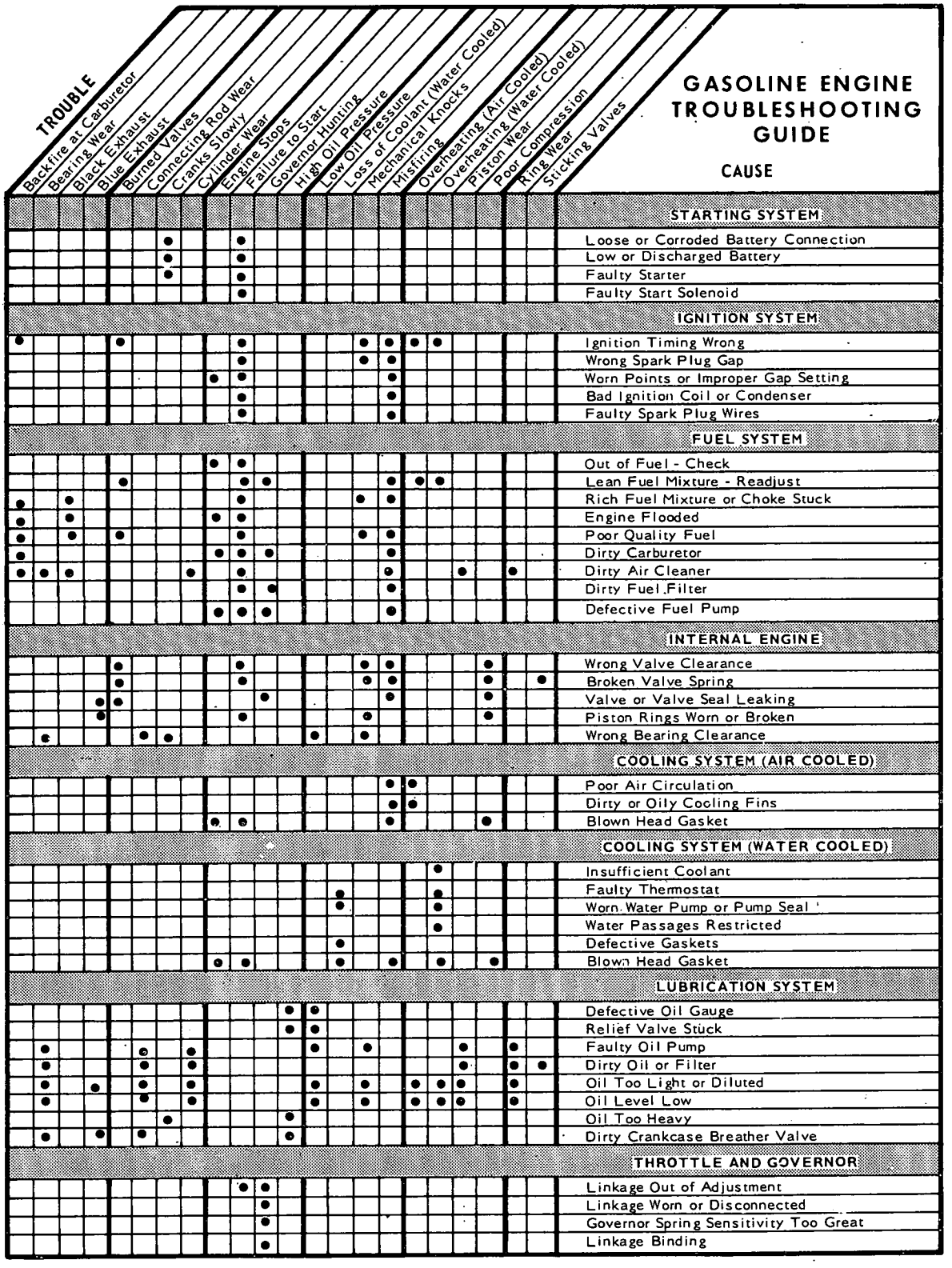
25 to 28

SPECIAL TOOLS

These tools are available from Onan to aid service and repair work.

Crankshaft Gear Pulling Ring	420A248
Flywheel Puller	420A100
Combination Bearing Remover, Main and Cam	420A325
Combination Bearing Driver, Main and Cam	420B324
Valve Guide Driver	420A300
Valve Seat Driver	420A308
Valve Seat Staker Intake	420A309
Exhaust	420A310
Valve Seat Cutter	420A311
Oil Seal Guide and Driver Bearing Plate	420B181
Gear Cover	420B313
Timing Advance Mech. Cover Driver	420A296

ENGINE TROUBLESHOOTING



INSTALLATION

The type of installation can affect the life of the engine, the cost of operation and the frequency of necessary service. Plan the installation carefully to ensure the best performance.

Because of the great variety of uses, and the many variations of the engine, these installation instructions are typical or general in nature. Use the installation recommendations given as a general guide, improvising or altering as necessary.

MOUNTING

There are several acceptable methods of mounting the engine. Among factors to be considered are: location, method of coupling the engine to the load, type of foundation or support, etc. The engine should be mounted on a level surface if possible. Maximum operation angle is 15° sideways, 30° front to rear tilt. If the engine is to operate at an angle, be sure to remark the oil level indicator to compensate for the tilt.

VENTILATION

The engine must be provided with a supply of fresh air for cooling and for combustion.

Pressure Cooled Engine: Position the air inlet opening directly in front of the engine and as close to the engine blower wheel as possible. The area of the inlet should be not less than 80 square inches. If louvers or grill work are used, increase the area to compensate for the reduced air flow. Provide extra ventilation if the driven load generates heat during operation.

The heated air outlet must allow the heated air to escape freely and prevent recirculation with the cooling air. A duct between the compartment air inlet and the engine blower housing may be necessary. Locate the air outlet opposite the intake or at least at a 90° angle. The area of the outlet should be at least 15% larger than that of the inlet. Allow sufficient room on all sides to permit access for servicing.

Open Air Installation: For installations where the engine is operated outside, ventilation will be no problem. However, in protecting the engine from the elements, see that nothing obstructs the flow of air around the engine.

EXHAUST

Pipe *POISONOUS* exhaust gas outside enclosure. Use a length of flexible tubing between the engine exhaust outlet and any rigid piping to absorb engine vibration. Shield the line if it passes through a combustible wall or partition. If turns are necessary, use sweeping type (long radius) elbows. Increase one pipe size (from manifold outlet size) for each additional ten feet in length. Locate the outlet away from the air intake.

CARBURETOR AIR INTAKE

Proper engine efficiency depends upon a supply of fresh air to the carburetor. Under special conditions, it may be necessary to move the air cleaner off the engine, using a longer connection hose as necessary. For extremely dusty or dirty conditions, install a special heavy duty air cleaner.

FUEL SYSTEM

The engine uses a diaphragm type fuel pump. The fuel pump has a 1/8″ pipe thread inlet, fitted with a 1/4″ inverted flare tube fitting. If a solid wall line is used, form a loop in the line, or install a section of flexible fuel hose, to absorb vibration. If a line with a pipe thread end is used, remove the flare type fitting from the fuel pump inlet.

The fuel supply tank may be installed in any safe, convenient location. If the tank is installed within the engine enclosure, provide a vent line to the outside of the enclosure.

The installation of a fuel filter between the fuel tank and the fuel pump is recommended. The fuel filter should be fitted with a shutoff valve and should be easily accessible for cleaning.

CONNECTING TO THE LOAD

The dimensions of various power takeoff shafts are as follows:

SHAFT	DIAMETER	LENGTH	KEY SIZE
STD	1-7/16	3-1/16	3/8
Rockford Clutch	1-7/16	3-1/16	3/8
Gear Reduction	1-1/4	2-3/4	1/4

Belt Drive: V-belts are preferable to flat belts. Consult a reliable belting supplier for recommendations regarding size of pulleys, number of belts, etc. required. A typical belt drive installation is shown in Figure 1.

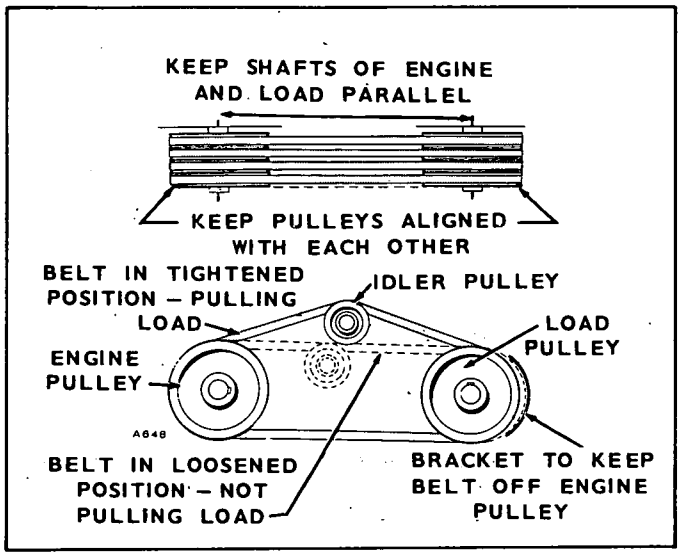


FIGURE 1. DRIVE BELT INSTALLATION

Comply with the following installation requirements:

1. The shafts of the engine and the load must be parallel with each other.
2. The pulleys of the engine and the load must be in alignment.
3. Mount the engine pulleys as close to the engine as possible.
4. If the installation permits, belts should run horizontally.
5. Some method of disconnecting the load for starting is recommended. If a clutch is not used, a belt-tightener idler arrangement can be used.

Flexible Coupling: If a flexible coupling engine-to-load drive is used, the load shaft must be in line and centered with the engine shaft (Figure 2).

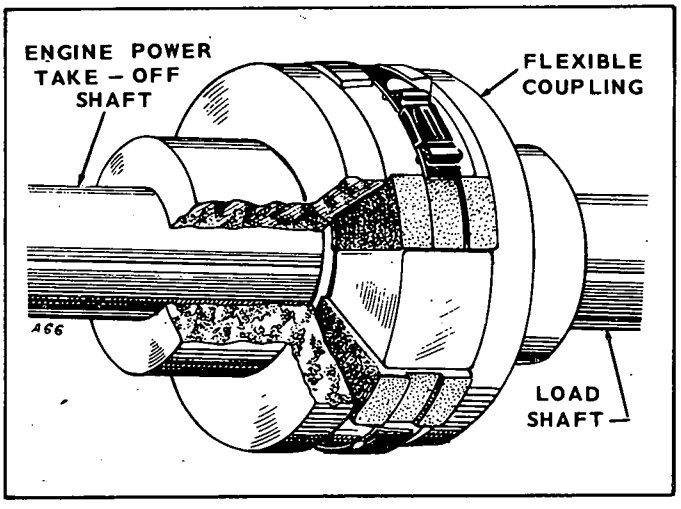


FIGURE 2. FLEXIBLE COUPLING

Reduction Gear Drive: Reduction gear drives are mounted at the factory (when ordered). The method of connecting the load is the same as when connecting directly to the engine shaft.

Clutch Installation: A Rockford Clutch can be installed at the factory or in the field. Install the clutch according to the following instructions and Figure 3.

Provide room for the clutch adapter casting by plugging the wet holes with a 3/8-16 x 1/2″ slotted headless set screw. Apply sealing compound to the threads and install screw flush with the cylinder block.

Drill a 13/64″ hole (or filed slot) in the crankshaft for the clutch set screw. Locate center of hole 11/32″ from the end and directly opposite the keyway in the crankshaft.

Install the clutch adapter, with drain slot downward, using two cap screws 3/8-16 x 2″ on the lower and one cap screw 3/8-16 x 1-3/4″ on the upper #2 cylinder side (cylinder nearer clutch). Install the 3/8 x 3-7/8″ stud through the adapter into the engine block upper remaining hole. Use a lock washer on each assembly screw. Use a flat washer and a lock washer under the stud nut.

Install the crankshaft key. Remove the clutch set screw. Install the clutch assembly (less housing) to the crankshaft, driving it on carefully with a soft-faced hammer until set screw hole is aligned. Install set screw to bottom in crankshaft hole, then back it out one full turn. Tighten clutch retaining screws until clutch is clamped securely to crankshaft. Lock the screws and tighten the set screw.

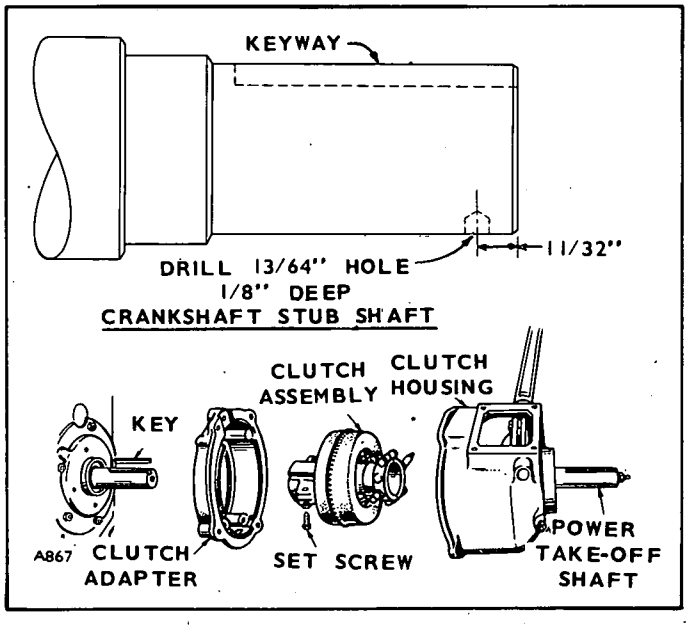


FIGURE 3. CLUTCH INSTALLATION

Apply grease to splined power takeoff shaft. Position the clutch throw-out to align the grease fitting with the hole in the housing (#1 cylinder side, horizontal). Pull the throw-out collar outward to remove tension.

Install the clutch housing so that the clutch throw-out fork engages the throw-out collar. Be sure the serrated shaft is properly meshed with the clutch plate. Use two cap screws 7/16-14 x 2″ on the lower and one cap screw 7/16-14 x 1-3/4″ on the upper #2 cylinder side. Install the stud washer and nut. Lubricate the two grease fittings just until grease appears.

BATTERY CONNECTIONS (Engines with Automotive Type Separate Starter)

Connect the 12 volt battery positive cable to the engine start switch terminal. Connect the battery negative cable to the ground point on the engine oil base (Figure 4).

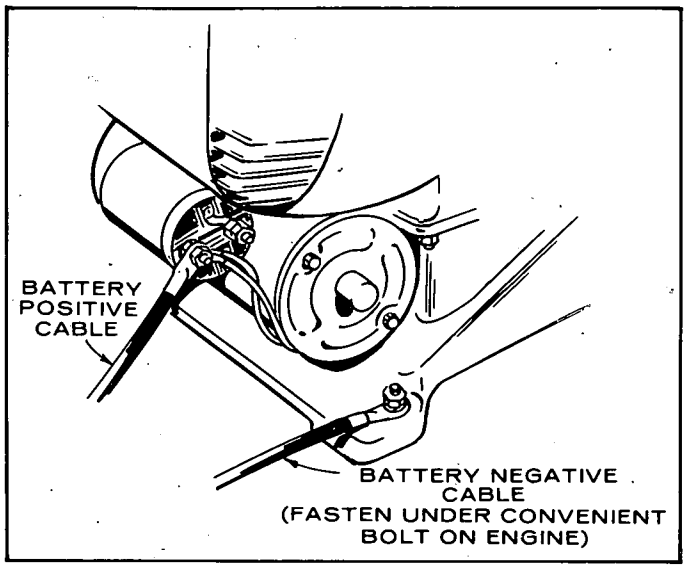


FIGURE 4. BATTERY CONNECTIONS

OPERATION

BEFORE STARTING

Crankcase Oil: Be sure the crankcase has been filled with oil to the "FULL" mark on the oil level indicator. Use a good quality oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines.

Recommended Fuel: Use clean, fresh, regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

CAUTION *If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, preignition could occur causing severe damage to the engine.*

Never fill the tank when the engine is running. Leave some space in the tank for fuel expansion. Open the fuel line valve (when used) and operate primer to assure fuel supply.

STARTING (Electric Start)

1. Move the ignition switch to its ON position.
2. Push the START button to crank the engine.

If the engine fails to start at first attempt, inhibitor oil used at the factory may have fouled the spark plugs. Remove the plugs, clean in suitable solvent, dry thoroughly and install. Heavy exhaust smoke when the engine is first started is normal and is caused by inhibitor oil.

STARTING (Manual Start)

1. Close the choke about three quarters of the way or as necessary according to temperature conditions.
2. Pull the start rope with a fast steady pull to crank the engine. Do not jerk.

APPLYING LOAD

When applying the load to a new or reconditioned engine, it should be applied gradually in about four steps; each step of not less than 30 minutes running time. Start with 1/4 load, then 1/2, 3/4 and full load.

BATTERY CHARGING

The battery charge rate is controlled by a charge regulator. The regulator is set to allow the proper rate of charge at operating speed.

STOPPING THE ENGINE

Disconnect all load before stopping the engine. Engines equipped with battery ignition are stopped by the ignition switch to the OFF position.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the engine.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow, but use care to avoid overheating.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often than recommended under normal conditions.
4. Keep oil and gasoline in dust tight containers.
5. Keep governor linkage clean.

OUT-OF-SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows:

1. Run unit until thoroughly warm.
2. Turn off fuel supply and run until unit stops.
3. Drain oil from oil base while still warm. Refill and attach a warning tag stating oil viscosity used.
4. Remove each spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50 oil) into each cylinder. Crank engine slowly (by hand) several times. Install spark plug.
5. Service air cleaner.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery is used, disconnect and follow standard battery storage procedure.

SERVICE AND MAINTENANCE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS						
	8	50	100	200	500	1000	5000
Inspect Engine Generally	x						
Check Fuel Supply	x						
Check Oil Level	x						
Clean Governor Linkage		x*					
Change Crankcase Oil		x1	x*				
Check Breaker Points			x				
Check Battery Electrolyte Level			x				
Clean Fuel Filter			x				
Check Spark Plugs			x				
Replace Oil Filter				x*			
Replace Air Cleaner				x*			
Remove Deposits in Combustion Chamber					x		
Check Valve Clearance					x		
Inspect Valves, Grind if Necessary						x	
Complete Reconditioning							x

x* - Perform more often under dusty or extreme cold weather conditions.
x1 - Recommended interval in hot weather or heavily loaded natural gas and propane operation.

PERIODIC MAINTENANCE SCHEDULE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The above schedule can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, etc. frequently until the proper service time periods can be established. When any abnormalities occur in operation – unusual noises from engine or accessories, loss of power, overheating, etc. – contact your Onan dealer.

CRANKCASE OIL

The oil capacity is 3-1/2 U.S. quarts (4 with filter). Fill to the "FULL" mark on the oil level indicator. Use a good quality, detergent oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines. Ambient temperatures must be the factor for determining the proper SAE oil weight.

IMPORTANT: *Use low ash content oils .03-.85 percent by weight with natural gas or propane fueled engines.*

NOTE: *If oils with these designations are not yet available, use oil with the API designation MS, MS/DG or MS/DM which has passed all the Automotive Manufacturer's Sequence Tests and the MIL-L-2104B Tests. Don't use an oil with the API designation DS.*

When adding oil between changes, always use the same brand and weight that is in the crankcase. Various brands of oil may not be compatible when mixed together.

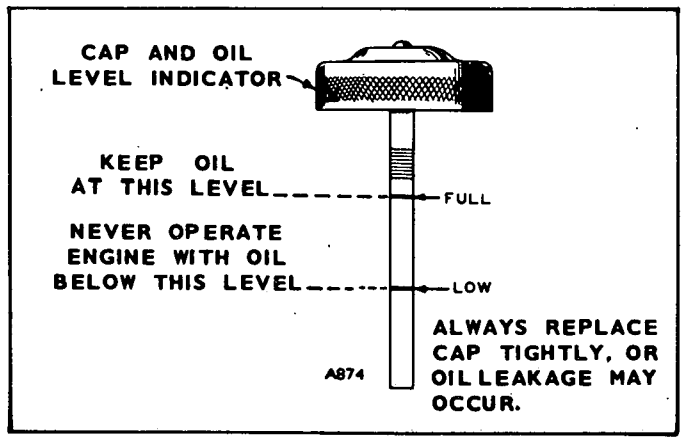


FIGURE 5. OIL LEVEL INDICATOR

Oil consumption may be higher with a multigrade oil than with a single grade oil if both oils have comparable viscosities at 210°F. Therefore, single grade oils are generally more desirable, unless anticipating a wide range of temperatures. Use the proper grade oil for the expected conditions.

TEMPERATURE	GRADE
Below 0°	5W
0° to 30°	10W
30° to 90°	30
Above 90°	50

Check oil level daily. Change oil every 100 hours under normal operating conditions. When operating in extremely dusty or dirty conditions, change oil more often.

Change the crankcase oil filter every 200 hours. Remove the filter by turning counterclockwise, using a filter wrench. Add the strip provided with the filter to prevent air loss in the area indicated. It is advisable to wipe dry the drip pan located below the filter. Coat rubber gasket on filter with a film of oil before installing. Install the filter finger-tight plus 1/4 to 1/2 turn. If oil becomes so dirty that the markings on the oil level indicator cannot be seen, change the filter and shorten the filter service period.

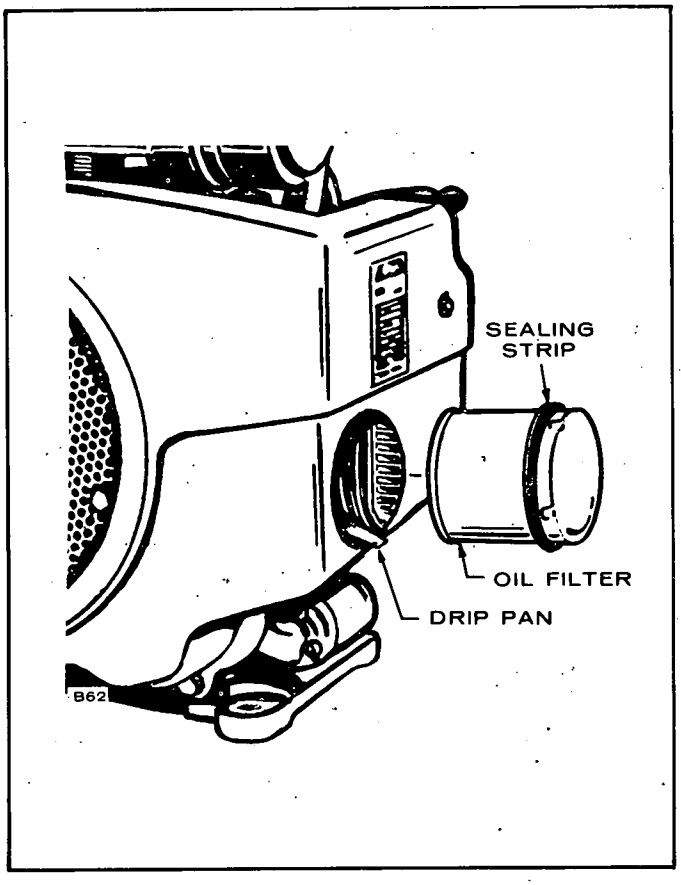


FIGURE 6. OIL FILTER LOCATION

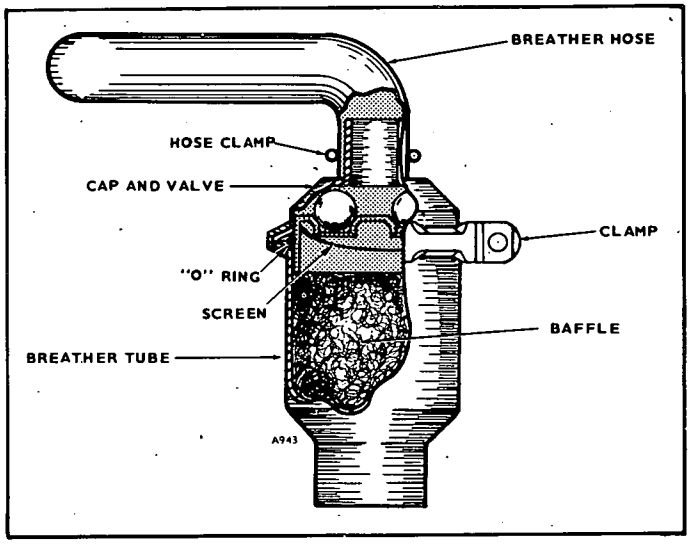


FIGURE 7. CRANKCASE BREATHER

AIR CLEANER

The NHC engine uses a replaceable, spin-on air cleaner. Remove and replace every 200 hours.

CAUTION *Do not run engine with air cleaner removed.*

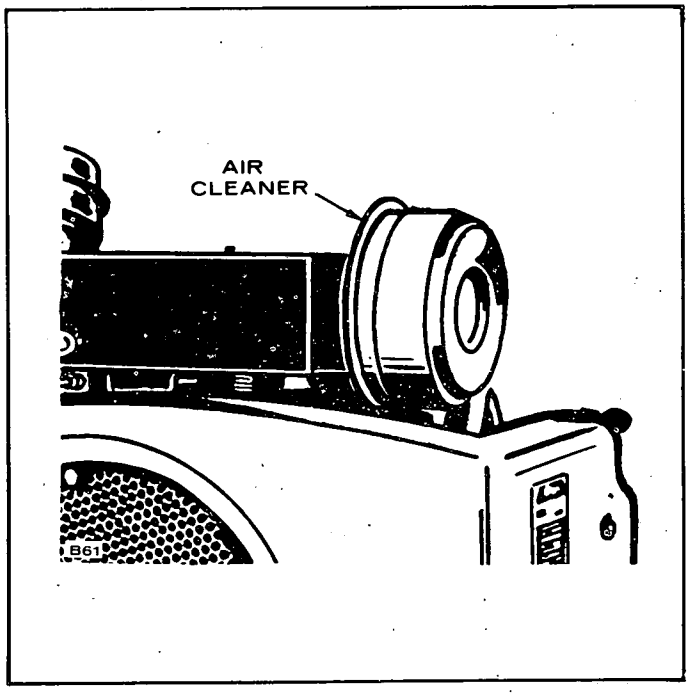


FIGURE 8. AIR CLEANER

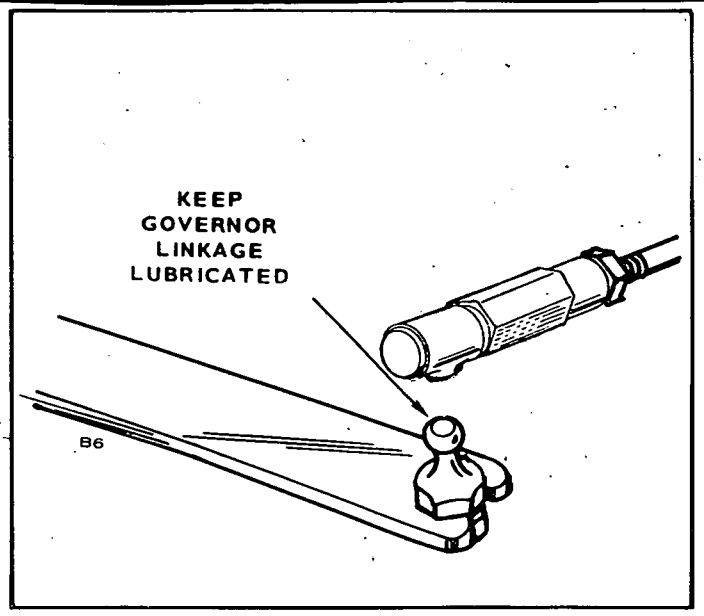


FIGURE 9. GOVERNOR LINKAGE

REDUCTION GEAR DRIVE

Drain the gear box after the first 100 hours of operation and refill with fresh lubricant of the recommended grade. Repeat this procedure every six months thereafter, or every 100 hours.

Use only SAE50 motor oil or SAE90 mineral gear oil. Do not use lubricants commonly known as extreme pressure lubricants, hypoide lubricants, etc.

Maintain the proper oil level between changes. Overfilling will cause foaming, which can lead to an oil leak due to overheating. Remove the filler plug on top of the case and the oil level plug from the face of the gear case. Fill the case until the oil just begins to flow from the oil level plug hole. Gear box holds 1/2 pint U.S. measure. Replace both plugs. See Figure 10.

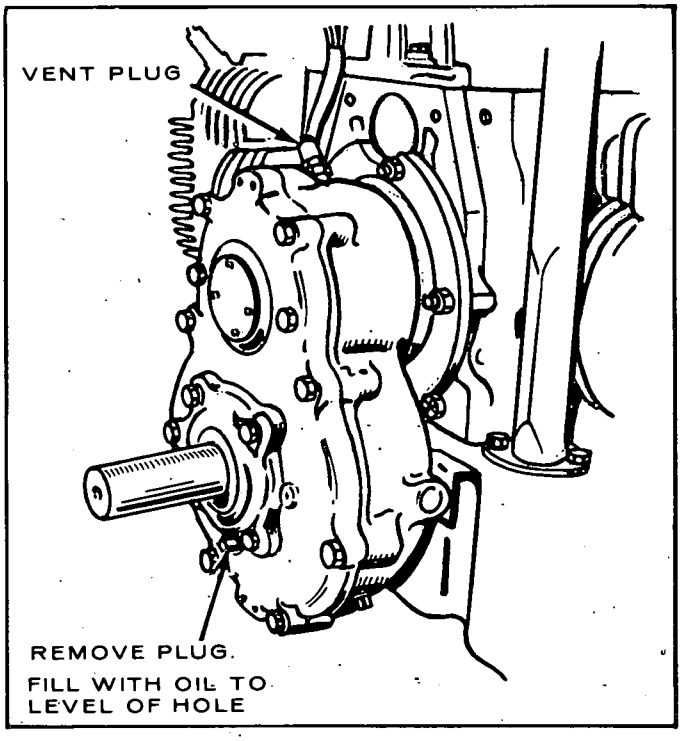


FIGURE 10. REDUCTION GEAR DRIVE

FUEL SYSTEM

GASOLINE CARBURETOR

For correction of problems traced to the gasoline carburetor, use the appropriate procedures selected from the following sequence, referring to Figures 11 and 13.

Adjustment Under Load: Adjust the carburetor as follows when a full load can be applied.

1. Make sure the ignition system is working properly and that the governor is adjusted.
2. Start the engine and allow it to warm up. If the carburetor is so far out of adjustment that the engine will not start, close both needle valves gently to their seats. Then open each 1 to 1-1/2 turns, first the idle and then the main adjustment.
3. With no load applied to engine, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until the engine speed returns to normal.
4. Apply a full load to the engine and then carefully turn the main adjustment in until the speed drops slightly below normal. Turn the needle out until the engine speed returns to normal.

Adjustment Under "No Load" Conditions: When a load cannot be applied, adjust the carburetor as follows:

1. Perform steps 1 and 2 as given under Adjustment Under Load.
2. Pull out on the governor mechanism to slow the unit down to about 400-500 rpm.
3. Set the idle adjustment screw for even operation (so the engine is firing on both cylinders and is running smoothly).
4. Release the governor mechanism to allow the engine to accelerate. If the engine accelerates evenly and without a lag, the main adjustment is correct. If not, adjust the needle outward about 1/4 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.
5. With the carburetor and governor adjusted, set the throttle stop screw at the desired idle speed.

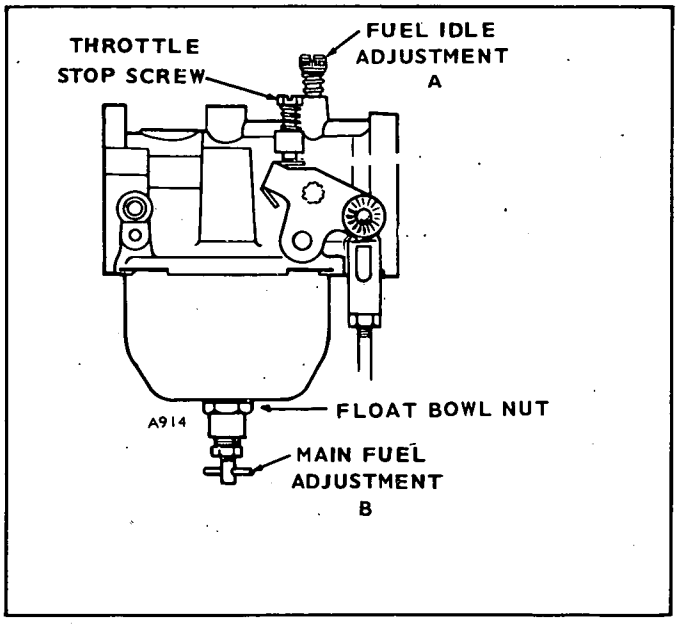


FIGURE 11. CARBURETOR ADJUSTMENTS

Float-Level Check: If the carburetor adjustment fails to provide satisfactory operation, remove the carburetor and check the float level as follows:

1. Remove the fuel line, air cleaner hose, governor linkage and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Unscrew the float bowl nut and remove the entire main fuel adjustment assembly from the float bowl.
4. Invert the carburetor and check that the float surface nearest the gasket is 1/8 ± 1/16 inch from the gasket. Bend the float tab as required to produce this spacing.

   NOTE: *If the carburetor utilizes an internally spring loaded fuel inlet valve, the float surface should be 1/8 ± 1/16 inch from the gasket with the full weight of the float compressing the spring in the needle.*
5. Reassemble, install and test.
6. See Figure 12.

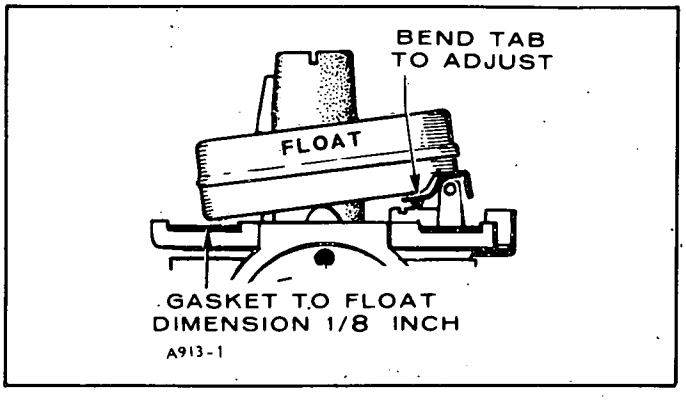


FIGURE 12. FLOAT LEVEL ADJUSTMENT

Carburetor Removal and Disassembly: Remove and disassemble the carburetor assembly as follows, referring to Figure 13.

1. Remove the fuel line, air cleaner hose, governor linkage, and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Remove the main jet assembly and bowl.
4. Remove the float pin and float.
5. Lift out the fuel inlet valve and unscrew the valve seat.
6. Remove the idle adjustment needle.
7. Remove the throttle plate screws and the plate, then pull out the throttle shaft.
8. Remove the choke plate screws and plate, then pull out the choke shaft.

Carburetor Assembly and Installation: Clean the components and repair or replace defective or worn parts. Use acetone or alcohol to dissolve gum deposits if carburetor cleaner is not effective. Soak the parts in carburetor cleaner, using it as directed by the manufacturer. Clean all carbon from the carburetor bowl, especially in the area of the throttle plate. Blow out clogged passages with compressed air. Check the needles, nozzle, and float for damage or fuel loading. Check the choke and throttle shafts. Reassemble and install as follows:

1. Install the throttle shaft and plate, using new screws and lock washers. Install with bevel mated to the carburetor body. If the plate is marked with the letter C, install it with the mark on the side toward the idle port when viewed from the flange end of the carburetor. To center the plate, back off the top screw, close the throttle lever and then set the plate by tapping it with a small screwdriver.
2. Install the choke shaft and plate. Center the plate in the same manner as the throttle plate (see step above). Use new screws and lock washers.
3. Install the fuel inlet valve seat and valve.
4. Install the float and float pin, adjusting the float as previously described.
5. Install the bowl ring gasket, bowl and bowl nut. Make sure that the bowl is centered in the gasket and tighten the main jet assembly securely. Turn in until it seats and back out to 1-1/2 turns.
6. Install the idle adjusting screw finger tight. Then back it out 1 to 1-1/2 turns.
7. Install the choke and adjust as previously described.
8. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism, air cleaner hose, and choke wires.
9. Adjust the carburetor needle settings as described under Adjustments and check out the performance.

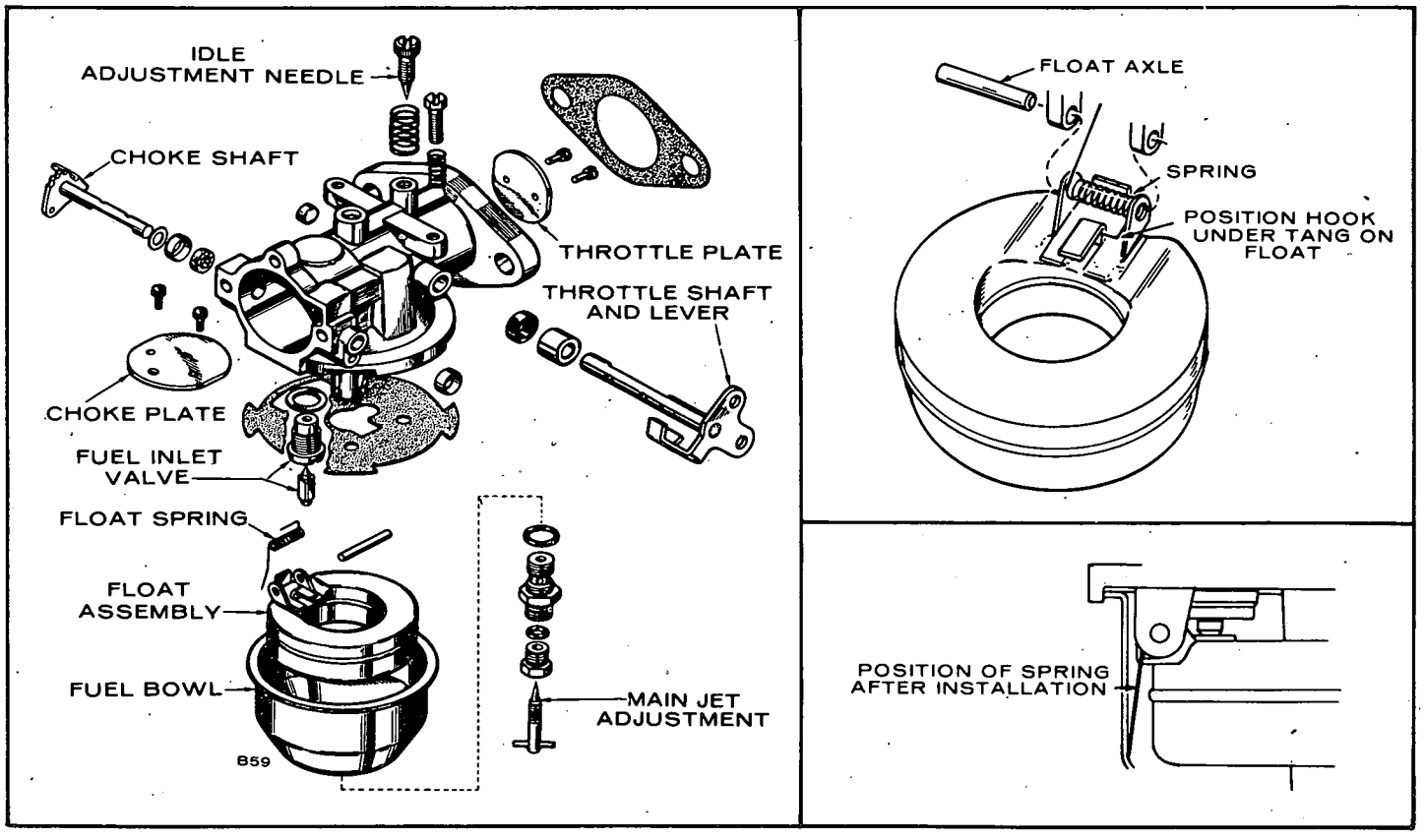


FIGURE 13. CARBURETOR ASSEMBLY

Complete Replacement: Complete replacement of the carburetor should be performed as follows:

1. Follow the previously given disassembly instructions as required for removal of the defective carburetor.
2. Replace the carburetor with a new unit, using attaching parts in good condition and making all the connections previously disengaged.
3. Adjust the needle settings as described under Adjustments.

FUEL PUMP

The engine uses a diaphragm-type fuel pump. If fuel does not reach the carburetor, check the fuel pump before dismantling it.

1. Disconnect the fuel line at the carburetor.
2. Crank the engine and observe whether fuel comes from the line at the carburetor.

   WARNING *Be sure to direct the fuel flow into a container so gasoline does not spill on ignition wires.*

3. If there is enough fuel in the tank, and line does not have fuel flowing, the pump needs replacing.

Pump failure is usually caused by a leaking diaphragm, valve or valve gasket, a weak or broken spring or wear in the drive linkage. Gasoline diluted oil may also indicate a faulty pump.

NOTE: *Always return the hand priming lever all the way inward so that lever does not prevent normal operation of fuel pump.*

Fuel Pump Reconditioning: Reconditioning of the fuel pump should be as follows, referring to Figure 14.

1. Remove the fuel lines and mounting screws holding the pump to the engine.
2. Make an indicating mark with a file across a point at the union of the fuel pump bolt and cover. Remove the assembly screws and the upper pump body.
3. Turn the pump body over and remove the valve plate screw and washer. Remove the valve retainer, valves, valve springs, and valve gasket, noting their position. Discard the valve springs, valves and valve retainer gasket.
4. Clean the pump body thoroughly with a solvent and a fine wire brush.
5. Holding the pump cover with the diaphragm surface up, place the new valve gasket in the cavity. Assemble the valves in the cavity. Reassemble valve retainer. Lock in position by inserting and tightening the fuel pump retainer screw.
6. Place the pump body assembly in a clean work area and rebuild the lower diaphragm section.
7. Holding the mounting bracket, press down on the diaphragm to compress the spring under it, then turn the bracket 90 degrees to unhook the diaphragm so it can be removed.
8. Clean the mounting bracket with a solvent and a fine wire brush.
9. Replace the diaphragm operating spring, stand the new spring in the casting, and position the diaphragm. Press down on the diaphragm to compress the spring and turn it 90 degrees. This will reconnect the diaphragm.
10. Hold the bracket, place the pump cover on it (making sure the indicating file marks are in line) and insert the four attaching screws but do not tighten. With the hand on the mounting bracket only, push the pump lever to the limit of its travel and hold in this position while then tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount the fuel pump on the engine, using new mounting gaskets. Connect the fuel lines.

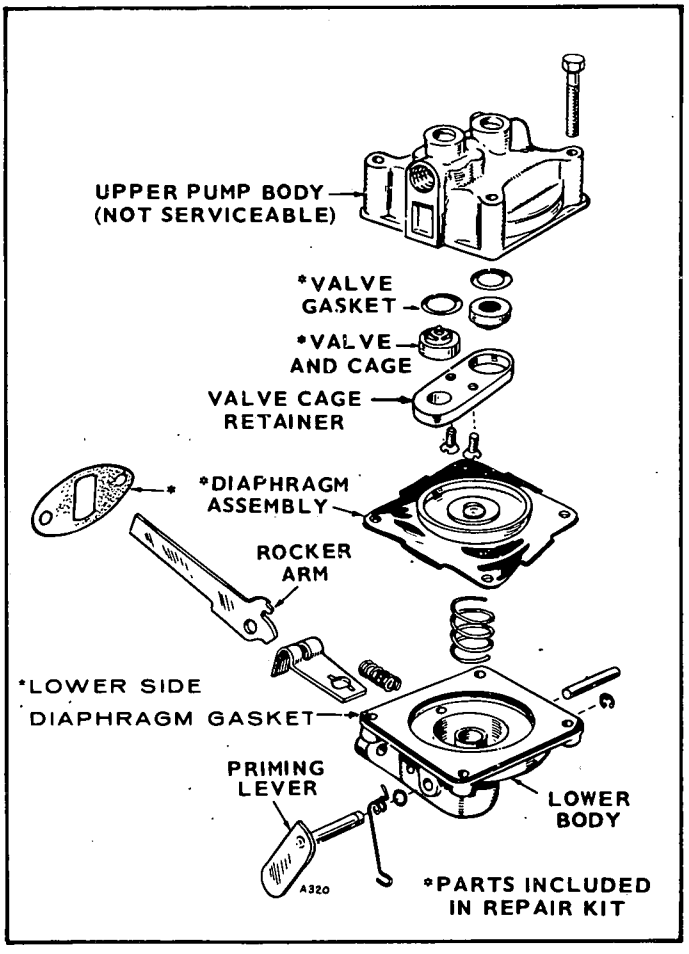


FIGURE 14. FUEL PUMP

THERMO-MAGNETIC CHOKE (Optional)

This choke uses a strip heating element and a heat sensitive bimetal spring to control the choke plate position. In addition to this, a solenoid is actuated during engine cranking, closing the choke all or part way, depending on ambient temperature. The bimetal is factory set to position the choke to the proper opening under any ambient condition.

Choke Adjustment: If adjustment of the bimetal is needed, it must be made at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Loosen the screw which secures the choke body assembly. Refer to Figure 15. Rotating the choke body clockwise richens and counter-clockwise leans the choking effect. For ambient temperatures above 85°F, the choke should be fully opened. For ambient temperatures below 25°F, the choke should be opened 1/4 inch with the solenoid not engaged. Tighten the screw that secures the choke body.

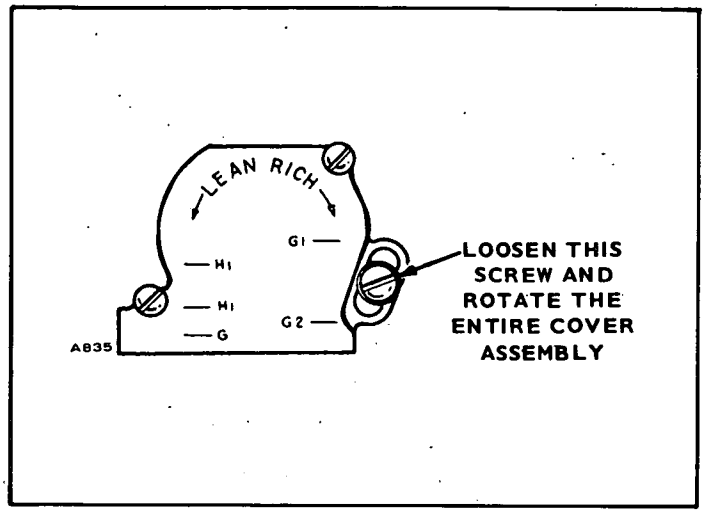


FIGURE 15. THERMO-MAGNETIC CHOKE

If the choke will not close, check for binding, incorrect adjustment, or incorrect assembly of the bimetal and heater assembly. If the choke will not open after the engine starts, check for heating. The choke bimetal should be warm to the touch within a minute or two after starting.

To disassemble the choke, refer to Figure 16.

If the heater assembly will not heat properly, check for broken heater wire, high resistance connections or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 37.8 to 46.2 ohms for a 12 volt system. If the heater is defective, replace. There must be slack in the lead wires between the choke body and the bimetal and heater assembly. When the start button is engaged, the solenoid should cause the spring loaded lever to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid core.

The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 12 volt system.

Assembly: Refer to Figure 16. When assembling the thermomagnetic choke, connect the bimetal and heater assembly as follows:

1. Lead tagged G to ground terminal in coil solenoid.
2. Lead tagged H to either of the H1 terminals on the solenoid core.

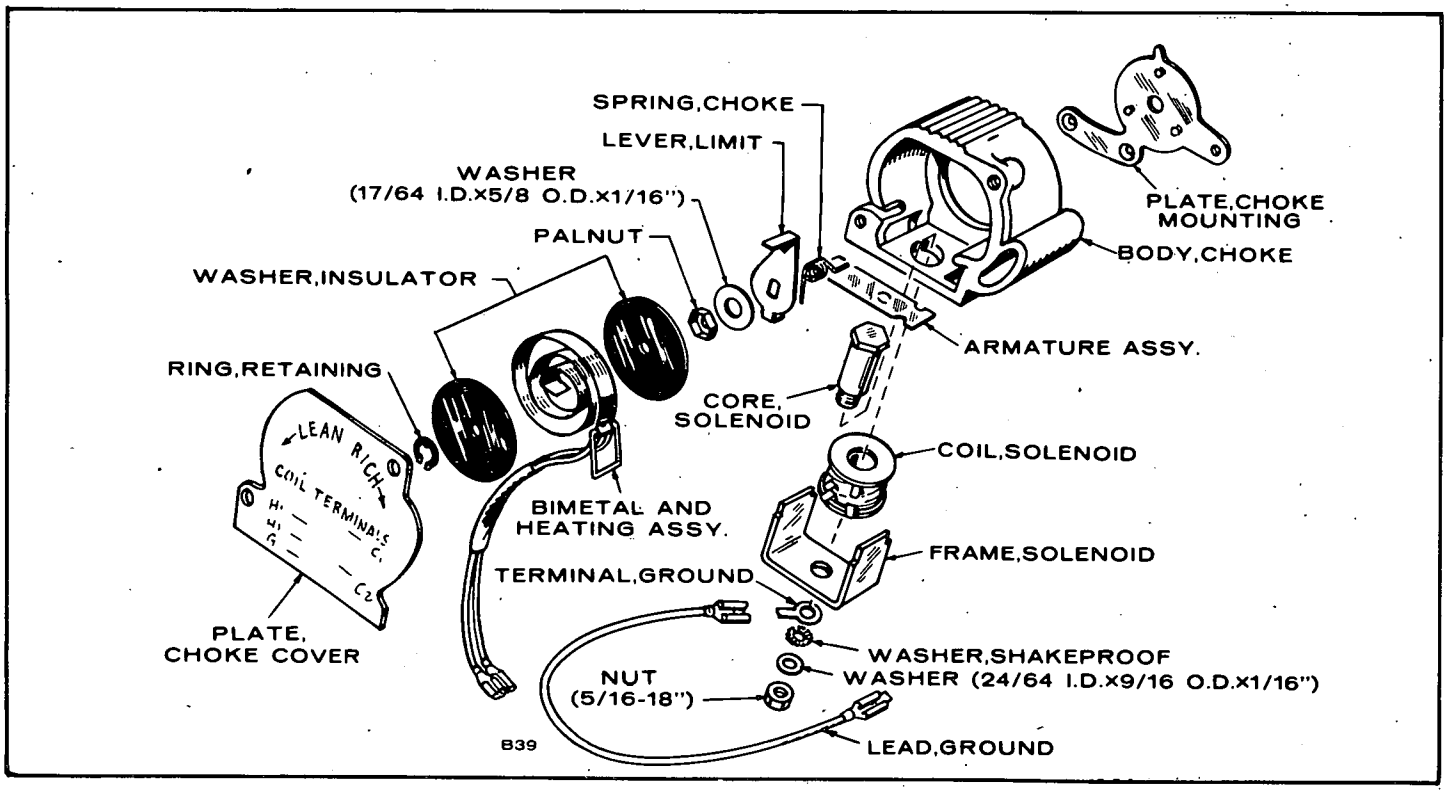


FIGURE 16. CHOKE ASSEMBLY

GASEOUS FUEL CARBURETOR

For correction of problems traced to a gaseous fuel carburetor perform the following:

1. Clean or replace the air cleaner.
2. Inspect hoses, replacing defective units, and securing all connections.
3. Clean the dry fuel filter (if present).
4. Check the regulator and carburetor for proper adjustment as described later in this section.

Gas Regulator Adjustment: This regulator was factory adjusted to lock-off at a pressure of 4 oz. (7″ water column). The regulator will operate satisfactorily at incoming pressures of from 2 to 4 oz. If your gas supply pressure is within these limits, no regulator adjustment is required. If your gas supply pressure is under 2 oz., the regulator will not operate. If your gas supply pressure is between 4 and 8 oz., install an appliance regulator set for 2 oz. ahead of the regulator, or adjust the regulator as follows and reference to Figure 17.

WARNING *A soap bubble placed over the regulator outlet will not accurately test for regulator closing. The soap bubble's resistance when multiplied by the greater area of the regulator diaphragm, is enough to shut off this very sensitive demand type regulator.*

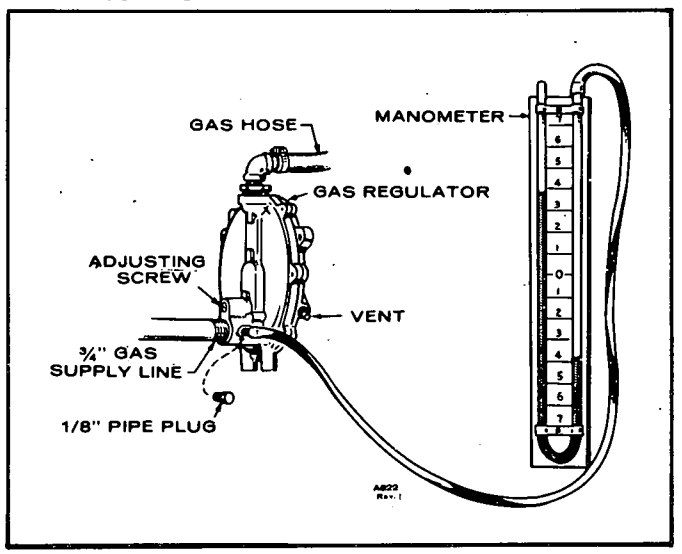


FIGURE 17. TESTING WITH MANOMETER

1. Refer to Figure 17.
2. Connect a manometer which reads up to 14″ water column to the regulator's plugged test hole near inlet. Turn gas on and energize the solenoid valve.
3. Turn regulator lock-off adjusting screw inward just far enough so that the manometer reading remains constant when you repeatedly cover and uncover the regulator outlet with your hand. Failure to lock off indicates too high incoming pressure or dirty regulator valve and seat.
4. Close the gas supply line valve. Remove manometer. Bleed air from gas supply line. Install test-hole plug in regulator. Open gas supply line valve. See that vent fitting is installed.
5. With a clamp on each end, secure the hose between the regulator outlet nipple and the carburetor inlet.
6. Operate the engine to assure quick starting results.

Gas Carburetor Adjustment

1. Adjust the main gas adjusting screw on the carburetor, depending upon the type of gas used. For 800 BTU gas turn to approximately six turns open. For 1,100 BTU gas turn to 3-1/2 turns open. For propane gas, turn to approximately three turns open. Turn the idle screw to two turns open. These settings are preliminary ones, to permit starting the engine.

   For starting an engine manually, the gas should have a BTU rating above 800 BTU per cubic foot. The temperature should be above 40°F (–1°C) to permit sufficient cranking speed to be developed. Too low a cranking speed would prevent proper intake vacuum for starting. Load should be disconnected, or reduced to the minimum.
2. Allow the engine to thoroughly warm up. When operating temperature is reached, make final carburetor adjustments. Apply a full load and turn the carburetor main gas adjusting screw in (clockwise) until the engine begins to lose speed from lack of fuel. Slowly back out the main adjusting screw (counterclockwise) until the engine will carry the full load smoothly. Remove all load and adjust the small slotted idle adjusting screw in the same manner. Check the operation at various loads. Make any necessary governor adjustments as given in following section.

When operating on gas fuel of approximately 800 BTU rating, some loss in power output may be evident. However, full power should be developed if using a gas rated at 1,100 BTU or higher. Gas fuel usually is clean burning, which means that carbon removal and valve grinding services may not have to be performed as frequently as with gasoline fuel.

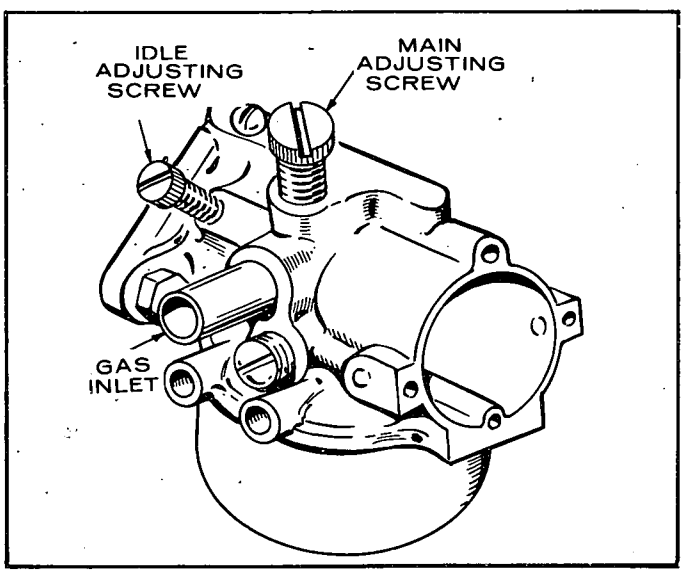


FIGURE 18. GAS CARBURETOR ADJUSTMENT

GOVERNOR SYSTEM

GOVERNOR ADJUSTMENT

Where engine speed is governor controlled, the governor is set at the factory to allow a nominal engine speed of 2400 rpm at no load operation (unless another speed is specified when the engine is ordered). Proper governor adjustment is one of the most important factors in maintaining the power and speed desired from the engine.

Before making governor adjustment, run the engine about 15 minutes to reach normal operating temperature.

It is difficult to determine if, after long usage, the governor spring has become fatigued. If, after properly making all other adjustments, the regulation is still erratic, install a new spring (Figure 19).

A tachometer for checking engine speed is required for accurate governor adjustment.

Check the governor arm, linkage, throttle shaft and lever for binding or excessive wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the engine is idle. If either of these conditions exist, determine the cause and adjust or replace parts as needed.

Procedure:

1. Adjust the carburetor main jet for the best fuel mixture at full load operation.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage.
4. Check the governor linkage and throttle shaft for binding or excessive looseness.
5. Adjust the governor spring tension for nominal engine speed at no load operation.
6. Check the rpm drop between no load and full load operation and adjust the governor sensitivity as needed.
7. Recheck the speed adjustment.
8. Set the carburetor throttle stop screw.

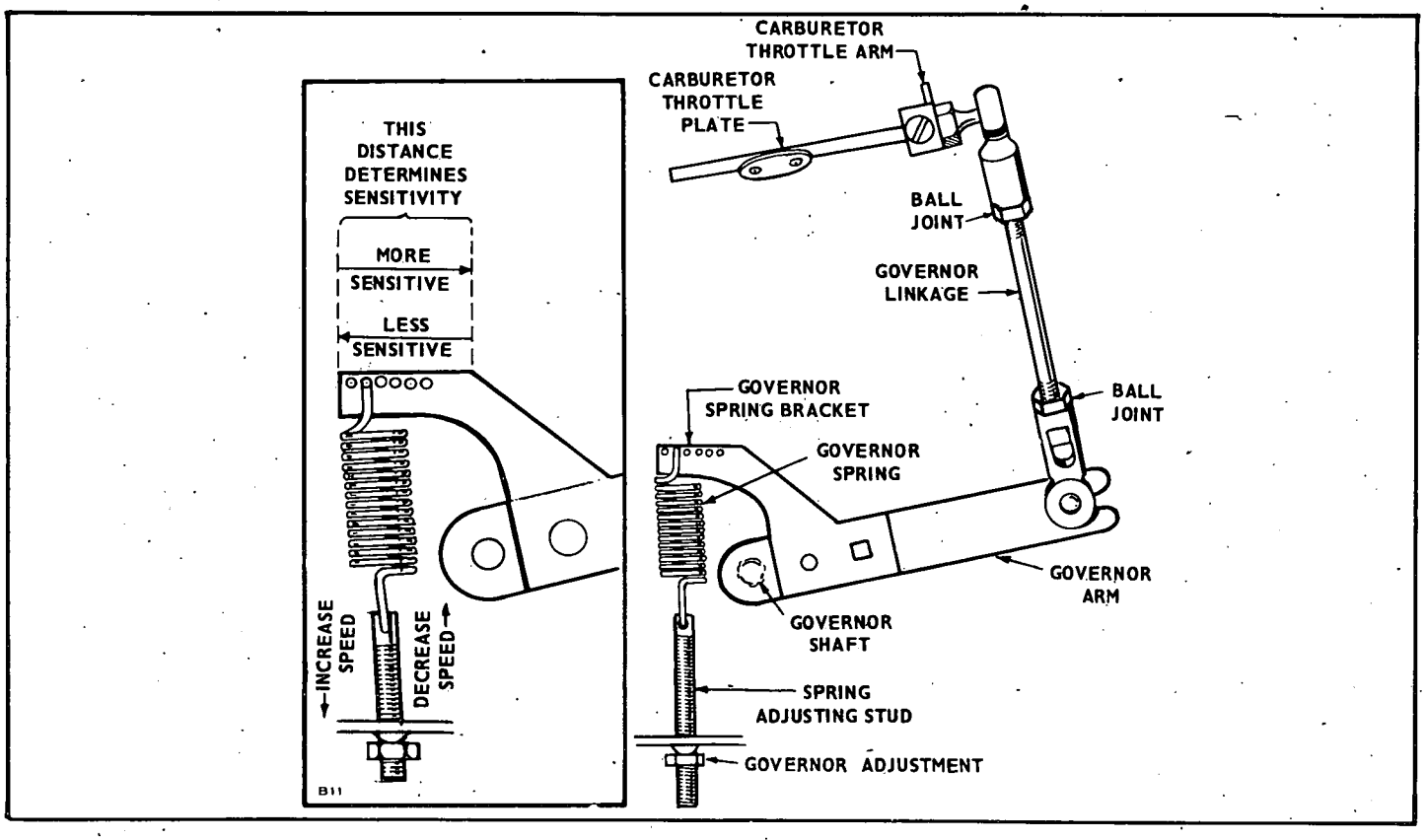


FIGURE 19. GOVERNOR ADJUSTMENTS

Linkage: The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle arm is adjusted by rotating the ball joint housing. Adjust the length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever is 1/32 inch from the carburetor stop boss. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and the throttle shaft.

Speed Adjustment: The speed at which the engine operates is determined by the tension applied to the governor spring. Increasing spring tension increases engine speed. Decreasing spring tension decreases engine speed. The no load speed of the engine should be slightly higher than the speed requirements of the connected load. For example: If the connected load is to turn at 3510 rpm, set the no load speed of the engine at about 3600 rpm. Check speed with a tachometer.

If a speed adjustment is needed, turn the speed adjusting nut in to increase the speed or out to decrease the speed (Figure 19).

Sensitivity Adjustment: The engine speed drop from no load to full load should be not less than 100 rpm. Check the engine speed with no load connected and again after connecting full load. Do not exceed 4000 rpm at no load.

The sensitivity of the governor depends upon the position of the arm end of the governor spring. A series of holes in the governor arm provides for adjustment. To increase sensitivity, move the spring toward the governor shaft. To decrease sensitivity, move the spring toward the linkage end of the governor arm.

If the setting is too sensitive, a hunting condition (alternate increase and decrease in engine speed) will result. If the setting is not sensitive enough, the speed variation between no load and full load conditions will be too great. Therefore, the correct sensitivity will result in the most stable speed regulation without causing a surge condition.

Always recheck the speed adjustment after a sensitivity adjustment. Increasing sensitivity will cause a slight decrease in speed and will require a slight increase in the governor spring tension.

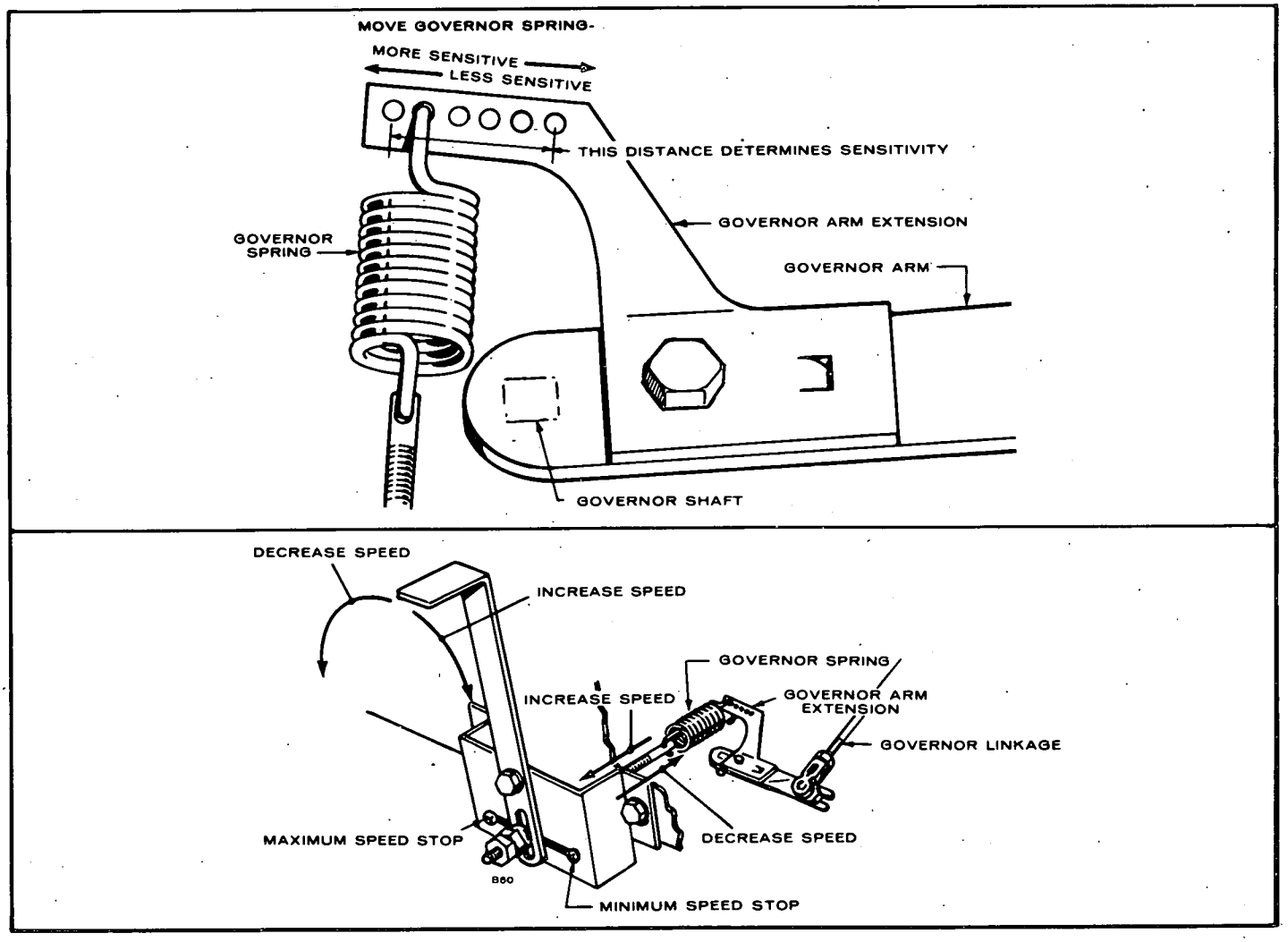


FIGURE 20. VARIABLE SPEED GOVERNORS

Variable Speed Governor Adjustments: These engines are adapted for use where a wide range of speed settings is desired. The design of the variable speed governors gives an automatic increase in sensitivity when the speed is increased and the result is good stability at all speeds.

To adjust the variable speed governors, refer to Figure 20 and the following:

1. Run the engine and make necessary carburetor adjustments.
2. Adjust the throttle stop screw on the carburetor to allow a recommended minimum idling speed of 900 rpm. A lower minimum does not assure smooth operation under load.
3. Adjust the tension of the governor spring for minimum speed. For the control with the control arm, shift the lever to minimum speed with no load and adjust the spring tension for approximately 1500 rpm.

   For the control with the control knob and slide (NHC engines with mounted engine controls), pull back the knob and slide and set at the first notch (low speed). Adjust speed to approximately 1500 rpm (or the desired low speed) at no load by turning the knob as required.
4. Adjust the sensitivity while operating at minimum speed to attain the smoothest no load to full load operation as follows:

   To decrease sensitivity (allow more speed drop from no load to full load operation) move the governor spring outward into a different groove or hole in the extension arm.

   To increase sensitivity (closer regulation by the governor which permits less speed drop from no load to full load operation) move the governor spring inward into a different groove or hole in the extension arm.
5. Apply a full load and shift the variable control to maximum speed – moving the control arm to the right or shifting the control knob and slide to the second notch. For the governor control with the control arm, set the screw in the bracket slot to stop lever travel at the desired maximum full load speed position. For the control with the control knob and slide, increase or decrease speed by turning the knob as required.

Approximately 3000 rpm is the recommended maximum full load speed for continuous operation. The speed must agree with the load requirements.

IGNITION AND BATTERY CHARGING

BREAKER POINTS

To maintain maximum efficiency from the engine, change the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove the two spark plugs so engine can be easily rotated by hand. If plugs have not been changed within the last 100 hours, replace them with new ones after setting the breaker points.
3. Refer to Figure 21. Remove mounting screw (A) and pull the points out of the box just far enough so screw (B) can be removed and leads disconnected.
4. Remove screw (C) and replace condenser with a new one.
5. Replace points with a new set but do not completely tighten mounting screw (A).
6. Rotate the engine by hand until the 25°BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90°) to ensure points are fully open.
7. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .020" with a flat thickness gauge. Tighten mounting screw and recheck gap.
8. Check ignition timing.

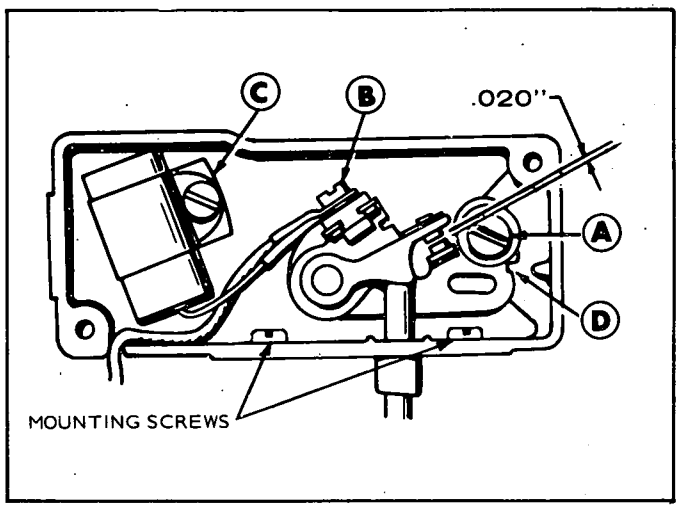


FIGURE 21. BREAKER POINT ADJUSTMENT

IGNITION TIMING

The timing on the engine is preset at the factory. A non-movable breaker point box is used, however a slight timing change could be made by adjusting points.

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. Spark advance is set at 25°BTC (before top center), and should be maintained for best engine performance. Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

Timing Procedure - Engine Running:

1. To accurately check the ignition timing, use a timing light with engine running at idle speed. Connect the timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.
2. Start the engine and check the timing. The pointer on the flywheel should line up with the 25° mark on the cover. The timing hole through the flywheel and the timing marks on the timing gear cover can be seen by looking through the flywheel blower screen. See Figure 25.

   NOTE: *If timing marks do not line up, readjust point gap. To advance timing, slightly open gap on breaker points. To retard timing, slightly close gap on breaker points. Recheck timing and breaker point gap after making this adjustment.*

Timing Procedure - Engine Not Running: If a timing light is not available, check the timing as follows:

1. Connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch the other test prod to a good ground on the engine.
2. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
3. The lamp should go out just as the points break which is the time at which ignition occurs (25° BTC).

SPARK PLUGS

Remove both spark plugs and install new ones every 100 hours. Use Champion N-6 or equivalent. Check to be sure spark plug gap is set at .025".

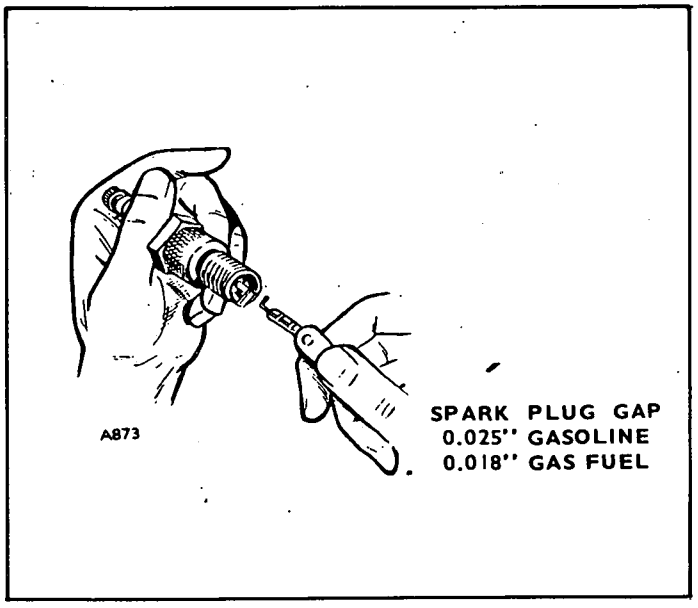


FIGURE 22. SPARK PLUG GAP

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use Simpson 260 VOM or equivalent.
2. Place black lead on ground (–) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 4.30 (±10%) ohms @ 70°F.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 23). Secondary resistance should read 14,000 (±10%) ohms @ 70°F.
4. If any of the above conditions are not met, replace coil. Refer to parts catalog for correct part number.

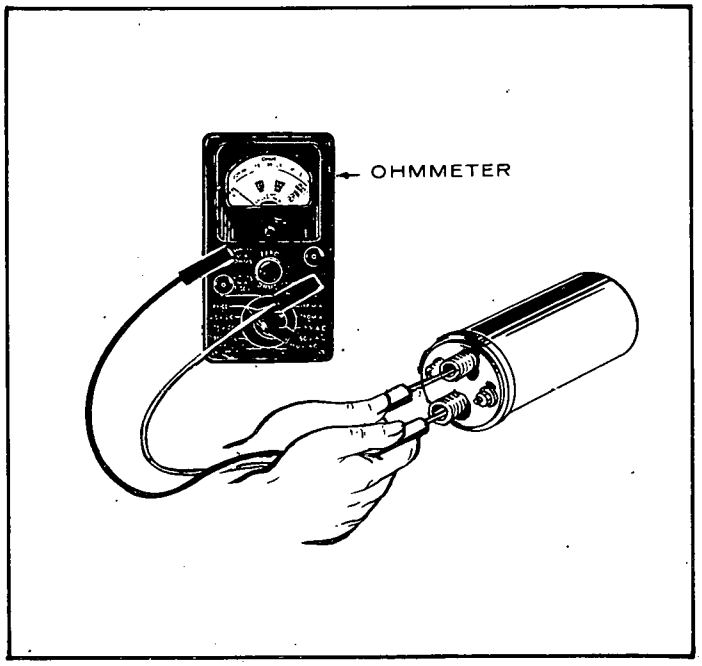


FIGURE 23. COIL TEST

CAUTION *This engine uses a 12 volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.*

BATTERY INSPECTION

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.280 at 80°F.

If one or more cells are low on water, add distilled water and recharge.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

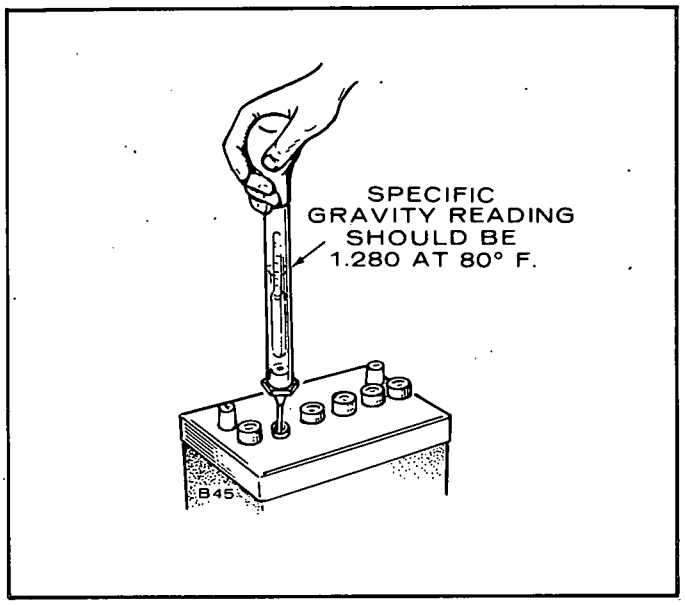


FIGURE 24. SPECIFIC GRAVITY TEST

FLYWHEEL ALTERNATOR

The alternator is a permanent magnet flywheel alternator with a solid-state voltage regulator-rectifier for controlling output. If ignition spark is weak or if the battery discharges inspect the following:

Inspection:

1. Check battery cells to make sure they are filled to appropriate level adding distilled water as required. Check specific gravity in each cell. Specific gravity should be 1.280 at 80°F; if not, recharge battery to bring it up to this level.

NOTE: *Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.*

2. Make sure the two alternator stator leads are not shorted together.
3. Check mounting of regulator-rectifier case to unit. It should provide a good electrical ground with clean, bright surfaces.
4. Output control plug (connector) must be pushed in so it bottoms solidly in the receptacle. Keep it clean and tight.

IMPORTANT: *Charging system tests require a fully charged battery.*

Testing: With the engine running between 1800-2600 rpm, observe the panel ammeter. (if not already equipped, connect a test ammeter.) If no charging is evident, proceed with the NO CHARGE TEST given as follows. If ammeter shows a constant higher charge rate, follow the HIGH CHARGE RATE TEST procedure.

No Charge Test: Perform as follows:

1. Check the B+ to ground voltage using a DC voltmeter.
2. If voltmeter reads 13.8 volts or higher, add a load to system (e.g. headlights) to reduce battery voltage to below 13.6 volts.
3. Observe ammeter. If charge rate increases, consider the system as satisfactory. If charge rate does not increase, proceed with testing.
4. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running near 3600 rpm. If AC voltage reads less than 28 volts, replace the stator. If AC voltage is more than 28 volts, replace the regulator-rectifier assembly.

High Charging Rate Test: Perform this test as follows:

1. Check B+ to ground voltage with a DC voltmeter.
2. If voltmeter reads over 14.7 volts, replace regulator-rectifier assembly.
3. If reading is under 14.7 volts the system is probably okay. Recheck the battery and connections. If the battery does have a low charge, but accepts recharging, system is okay.

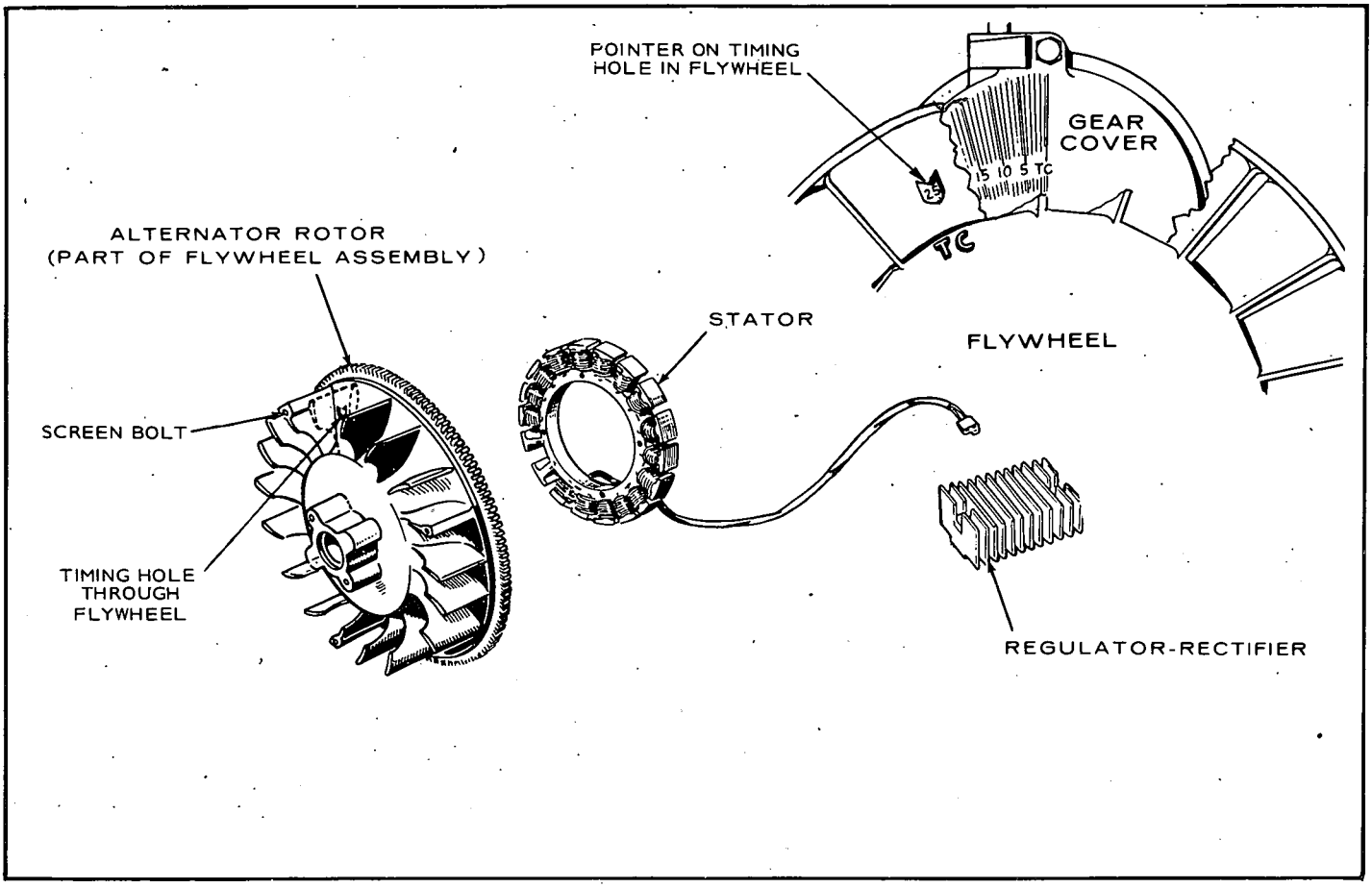


FIGURE 25. FLYWHEEL ALTERNATOR

STARTING SYSTEM

ELECTRIC STARTER REPAIR

CAUTION *Do not use steam or high pressure water to clean the starter.*

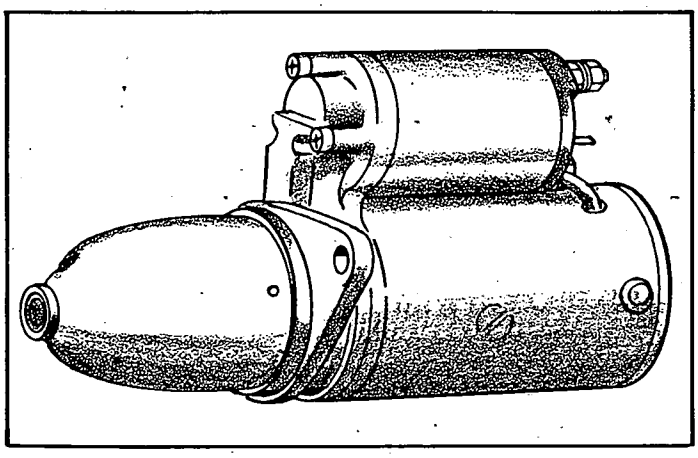


FIGURE 26. STARTER ASSEMBLY

DISASSEMBLY

1. Loosen the M terminal nut on the magnetic switch and remove the connector. Then unscrew attaching screws and remove the magnetic switch.

   NOTE: *The packings for the magnetic switch are mounted so that the steel packing is located in the front bracket side.*

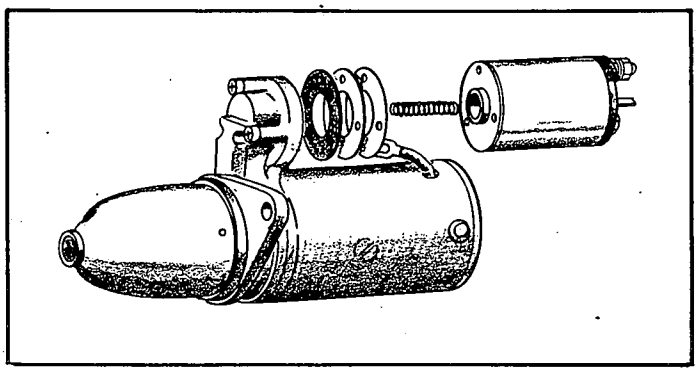


FIGURE 27. MAGNETIC SWITCH REMOVAL

2. After removing the thru bolts, the starting motor can be divided into three parts – the front bracket, housing and rear bracket. The spacing washers shown in Figure 28 are used for adjustment of the thrust gap of the armature shaft and are placed between the rear bracket and the commutator.

   NOTE: *These washers are inserted so the steel washer is located in the commutator side.*

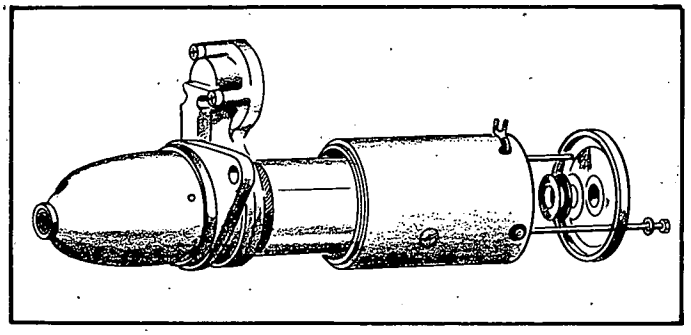


FIGURE 28. REMOVING THROUGH BOLTS

3. The armature can easily be removed from the front bracket. Be careful not to miss a small steel washer used in the end of the armature shaft. The shift lever can be removed along with the armature when it is removed. In this case, the spring holder, lever springs and retainer can be taken out before the lever. See Figure 29.

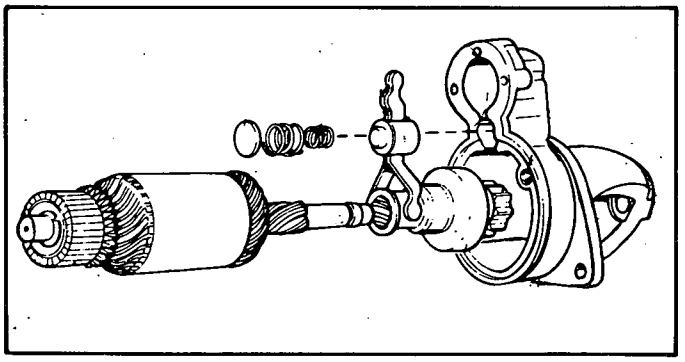


FIGURE 29. REMOVING ARMATURE

4. Remove the ring after driving the pinion stopper toward the pinion gear using a cylindrical tool as shown in Figure 30. The overrunning clutch and the pinion stopper should be removed simultaneously.
5. All four brushes have been soldered to the brushholder in the same way. The brush springs can be removed from the brushholder.
6. The pole shoes may be removed if necessary, by removing the flat head machine screws from the frame.

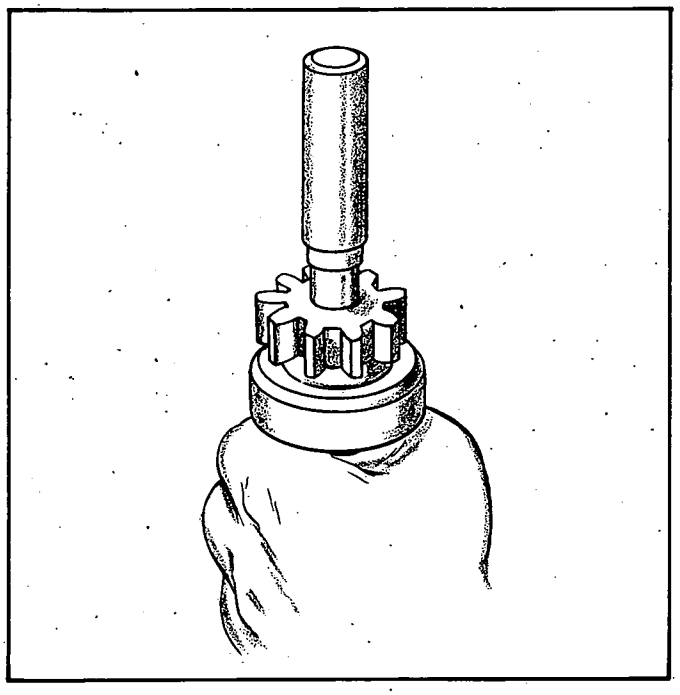


FIGURE 30. REMOVING RING

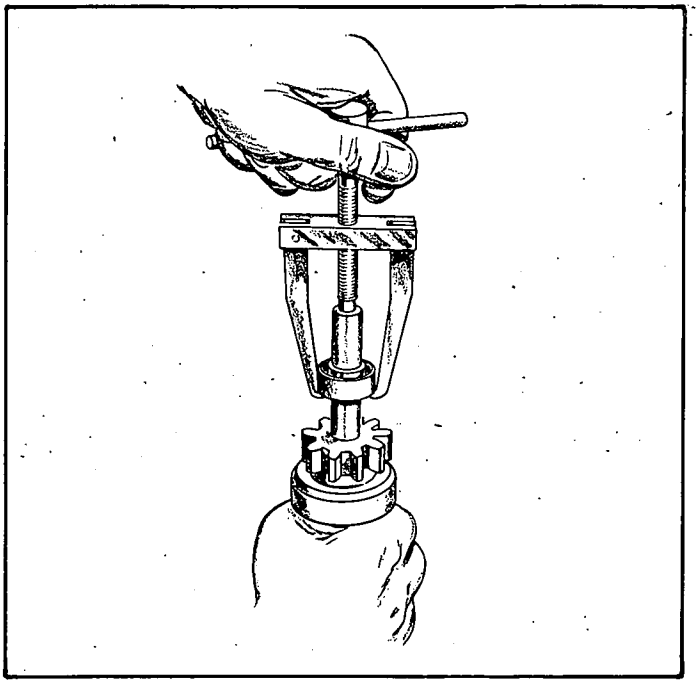


FIGURE 32. MOUNTING OVERRUNNING CLUTCH

REASSEMBLY

Inspect the parts carefully in accordance with the procedure described in "Inspection of Parts". Make any repairs necessary. Reassembly is the reverse of assembly. The following precautions should be taken:

1. Clean all of the parts carefully with a dry cloth and compressed air if it is available.

   NOTE: *Bearing equipped parts must not be immersed in cleaning fluid. These parts should be cleaned with a brush dipped in "Varsol" or any other comparable mineral spirits. Do not immerse overrunning clutch in cleaning solvent. Thoroughly dry any parts that have come into contact with the cleaning fluid.*

2. Apply 20 weight non-detergent oil to the armature shaft and splines. Apply grease (Shell Albania No. 2 or equivalent) sparingly on the shift lever pin, the joint of the shift lever and plunger, the plunger and spacing washers at the end of the shaft.
3. To mount the overrunning clutch; first insert the pinion stopper into the armature shaft, then apply the ring to the groove of the shaft rigidly. For the insertion of the ring, use a tool as shown in Figure 32 and pull the pinion stopper up.
4. Use spacing washers to adjust the armature to give end play of .004" to .020".
5. Tighten the thru bolts to a torque of 35 to 44 in-lbs.
6. Insert the shift lever as shown in Figure 33 into the front bracket.

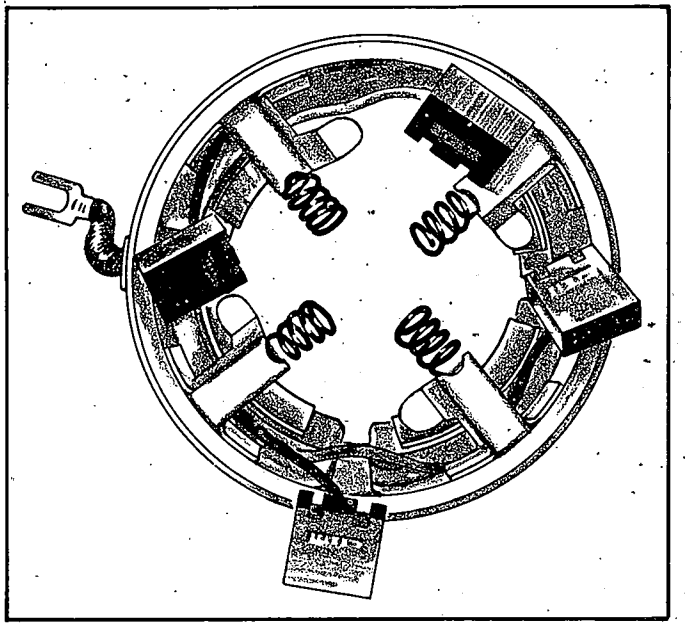


FIGURE 31. BRUSHES

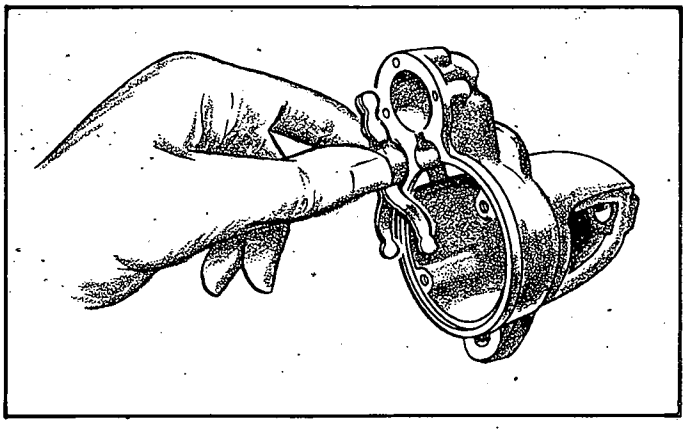


FIGURE 33. INSTALLING SHIFT LEVER

INSPECTION OF PARTS

1. **Testing Armature for Short Circuits.** Place the armature in a growler and hold a thin steel blade parallel to the core and just above it while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace shorted armature. See Figure 34.

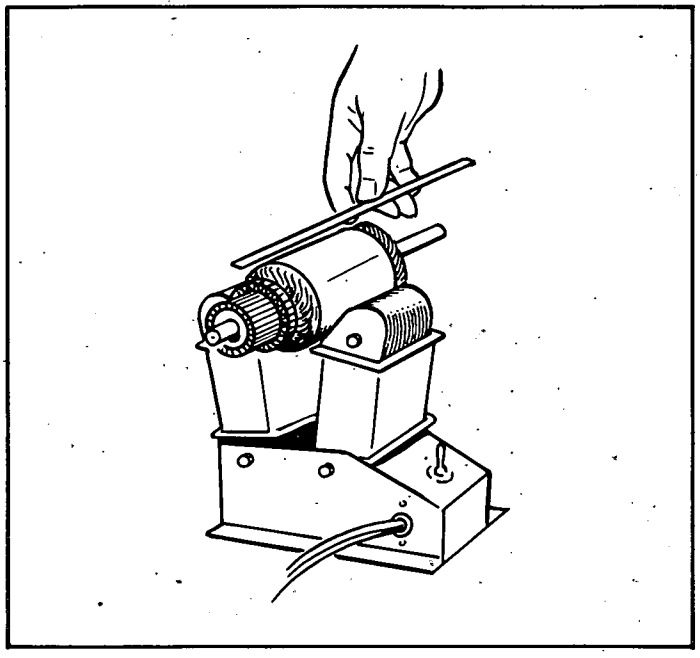


FIGURE 34. ARMATURE SHORT CIRCUIT TEST

2. **Testing Armature for Grounds.** Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads. If the ohmmeter reading is low, it indicates a grounded armature. Replace grounded armature. See Figure 35.

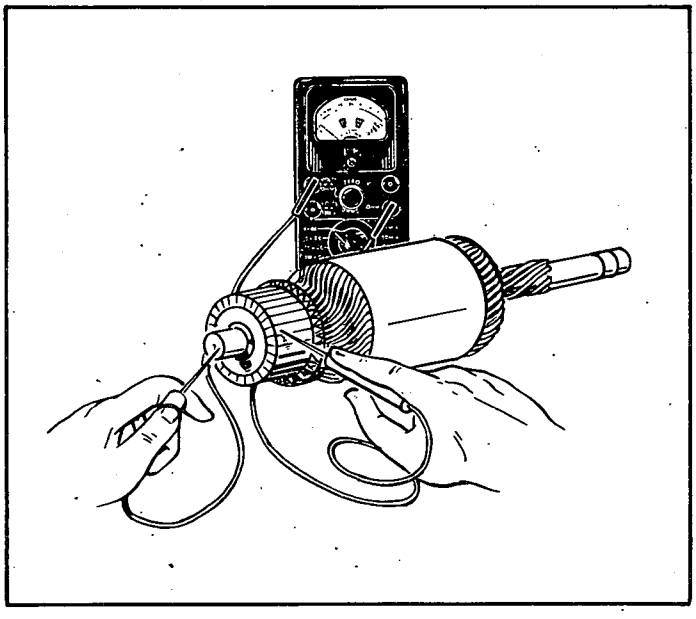


FIGURE 35. ARMATURE GROUND TEST

3. **Testing Armature for Open Circuit.** The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections.
4. **Testing Commutator Runout.** Place armature in a test bench and check runout with a dial indicator. When commutator runout exceeds .004″, commutator should be refaced (Figure 36).

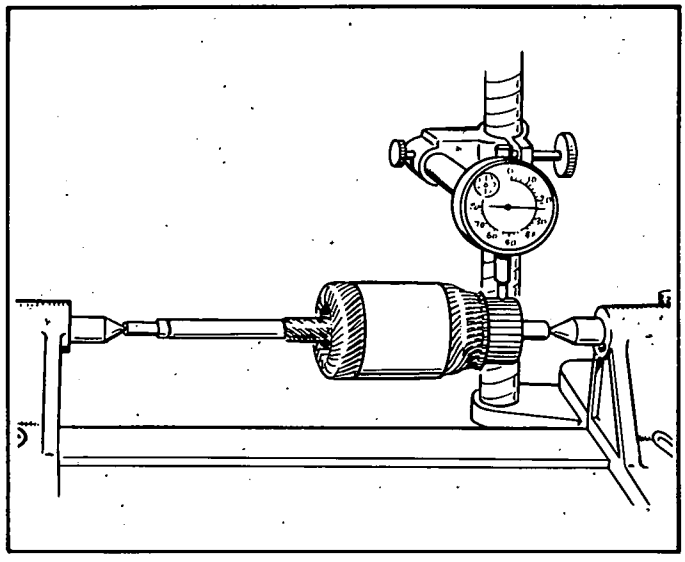


FIGURE 36. CHECKING COMMUTATOR RUNOUT

5. **Testing Armature Shaft Runout.** The armature shaft as well as the commutator may be checked. A bent armature often may be straightened, but if the shaft is worn, a new armature is required (Figure 37).

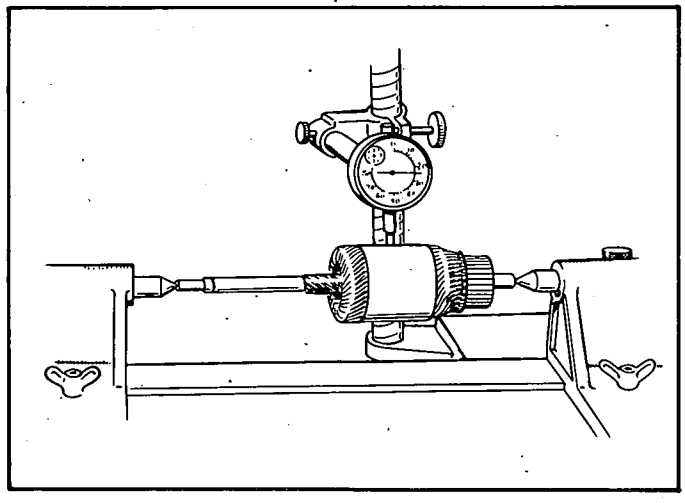


FIGURE 37. CHECKING ARMATURE SHAFT RUNOUT

6. **Testing Field Coils for Grounds.** Place one lead on the connector and the other on a clean spot on the frame after unsoldering shunt field coil wire. If the ohmmeter reading is low, the fields are grounded, either at the connector or in the windings (Figure 38).

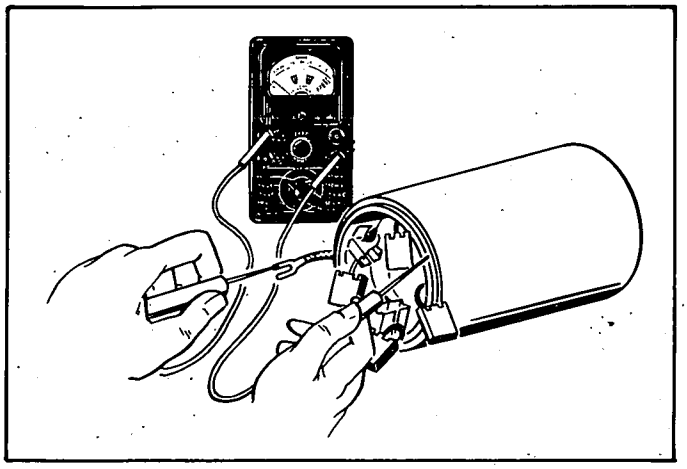


FIGURE 38. FIELD COIL GROUND TEST

7. **Testing Field Coils for Open Circuit.** Place one lead on the connector and the other on a clean spot on the brushholder. If the ohmmeter reading is high, the field coil is open. Check the other three brushholders in the same manner (Figure 39).

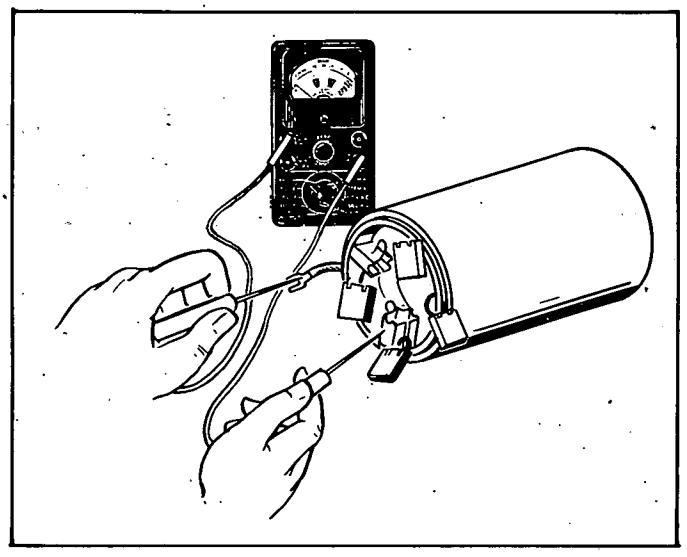


FIGURE 39. FIELD COIL OPEN CIRCUIT TEST

8. **Inspection of Brushes.** Replace brushes when they are worn less than .3" as shown in Figure 40. See that all brushes move freely in their holders.

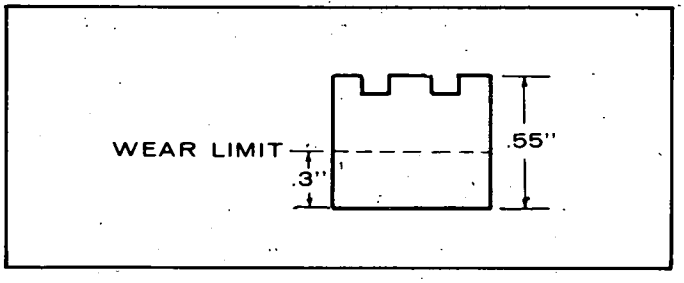


FIGURE 40. BRUSH WEAR LIMIT

9. **Inspection for Brush Spring Tension.** Measure brush spring tension with a tension meter as shown in Figure 41. Push the brush and take a reading just as the brush projects a little from the brushholder. On a new brush the spring tension should be 29 to 38 ounces.

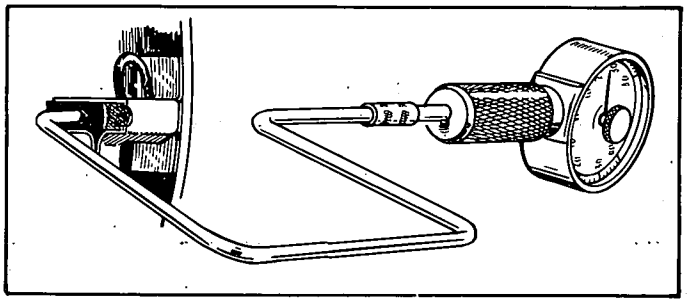


FIGURE 41. BRUSH SPRING TENSION TEST

INSPECTION AFTER OVERHAUL

1. For no load test, the starting motor is wired as shown in Figure 42 and revolved. The value of the meter reading at this condition should be as follows:

Voltage	11.5 volt
Speed	3700 rpm minimum
Current Draw	60 amp maximum

NOTE: *The conductor for this test should be large enough and as short as possible. If anything is wrong in the above test, inspect the following items:*

Annealed brush springs
Improperly seated brushes
Insufficient armature endplay
Shorted, open or grounded armature
Grounded or open field coil
Poor electrical connection
Dirty commutator

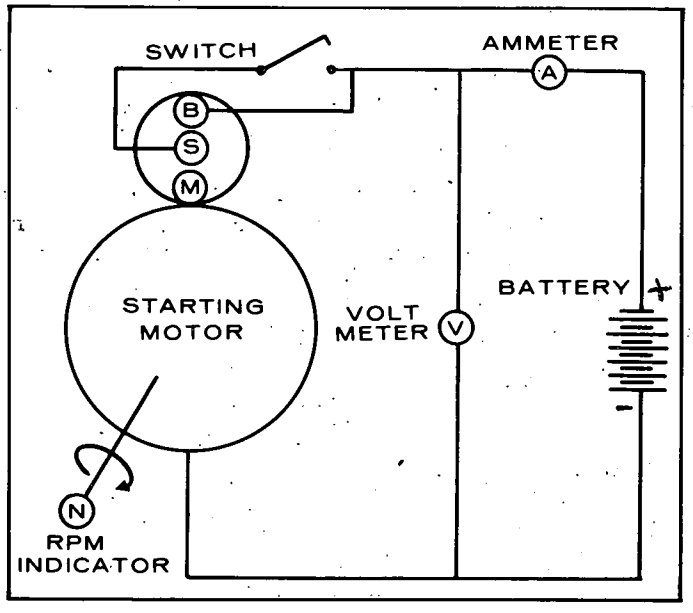


FIGURE 42. STARTING MOTOR WIRING

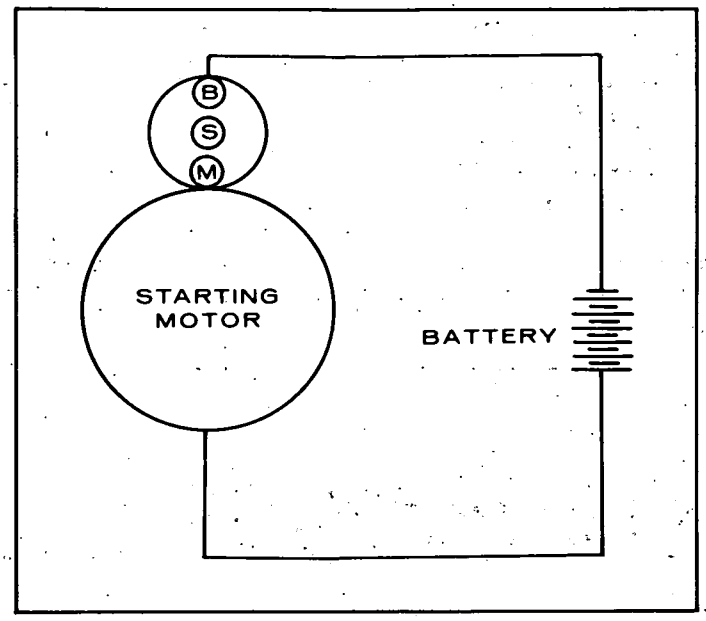


FIGURE 43. BATTERY CONNECTIONS

2. **Adjusting Pinion Clearance.** Connect the battery to the starting motor as shown in Figure 43. This will allow the pinion of the starting motor to slide and stop. In this state, measure the clearance between the end of the pinion and pinion stopper when the pinion is pushed lightly toward the commutator end. Clearance should be .02″ to .06″. Adjust for proper clearance by removing the magnetic switch attaching screws and select proper thickness of the fiber packings shown in Figure 44.

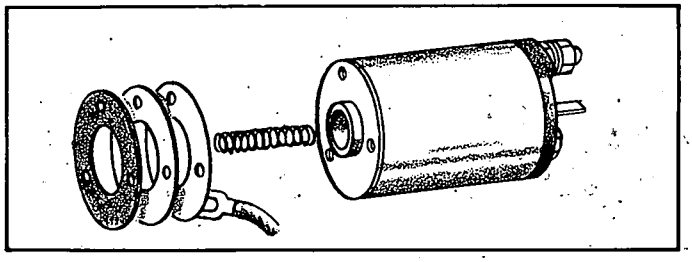


FIGURE 44. ADJUSTING PINION CLEARANCE

ENGINE DISASSEMBLY

VALVES

Proper seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44°. The valve *seat* angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life (Figure 45).

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

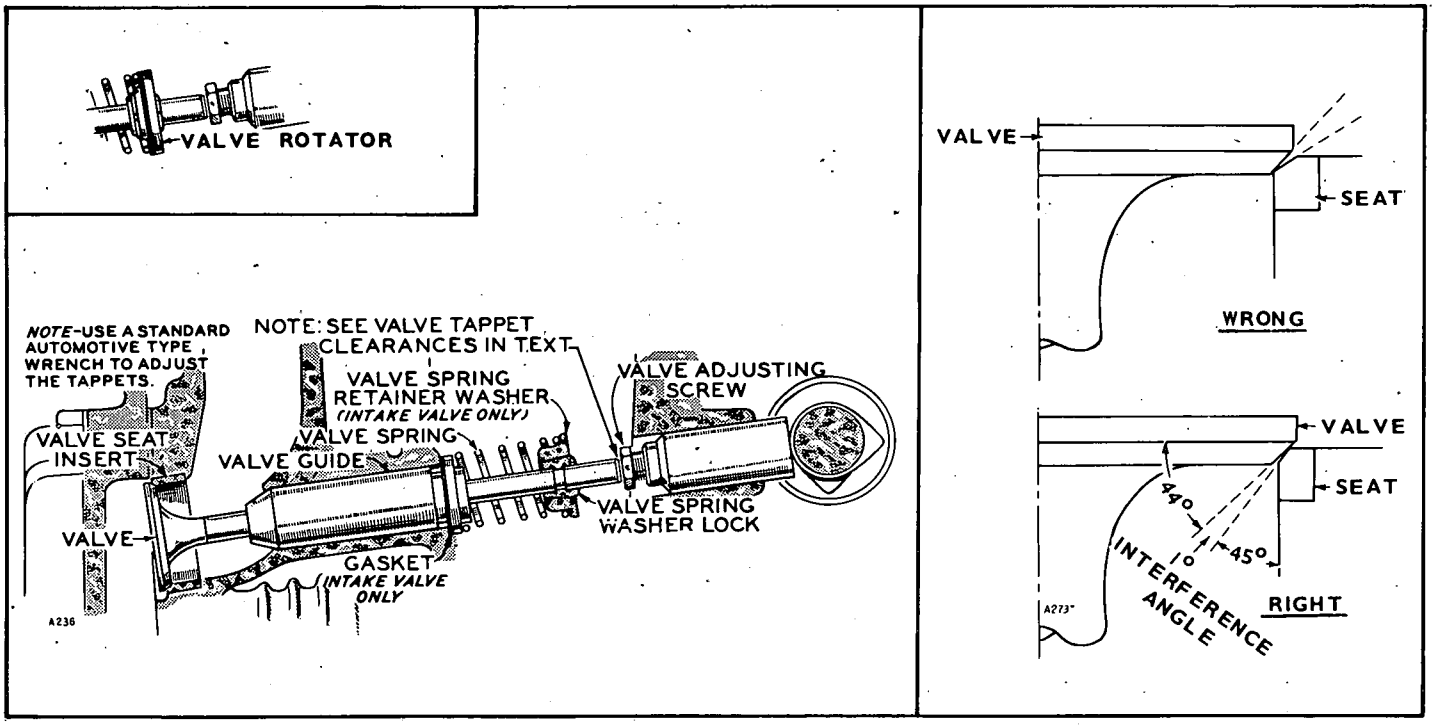


FIGURE 45. VALVE SYSTEM

Tappet Adjustment: The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 400 operating hours or when poor engine performance is noticed. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to valve tappets.
2. Remove spark plugs to make turning the engine easier.
3. Use the engine flywheel to turn the engine over slowly by hand until the left hand intake valve opens and closes. Continue turning the flywheel until the TC mark is on the top and lined up with the TC mark on the gear cover. Both valves should be closed. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder.
4. Clearances are shown in Dimensions and Clearances. For each valve, the gauge should just pass between the valve stem and valve tappet.
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.
6. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

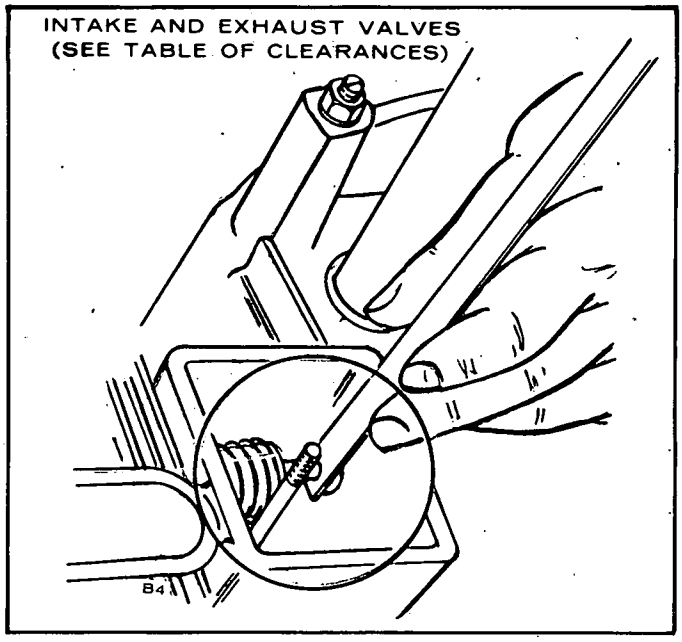


FIGURE 46. VALVE ADJUSTMENT

FLYWHEEL

Use a suitable puller (with claws or with bolts to agree with flywheel) to pull the flywheel.

Do not drop the flywheel. A broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

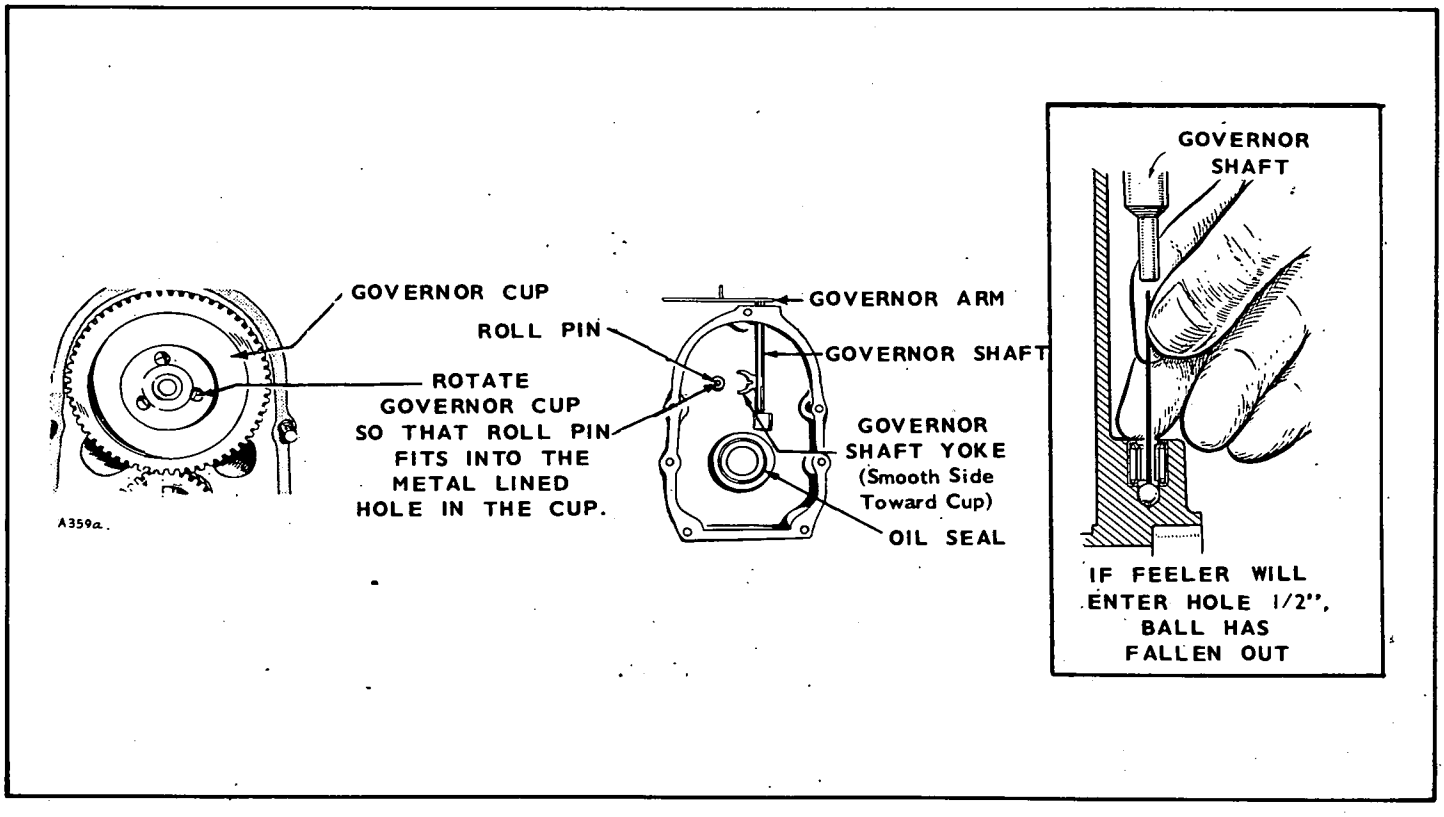


FIGURE 47. GEAR COVER ASSEMBLY

If a puller is not available turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp endwise blow on the head of the cap screw with a heavy soft-faced hammer to loosen.

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.

CAUTION *When installing the gear cover, make sure that the pin in the gear cover engages the metal lined (smooth) hole in the governor cup.*

Turn the governor cup so that the metal lined hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a point 3/4" from the cover mounting surface. See Figure 48.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off.

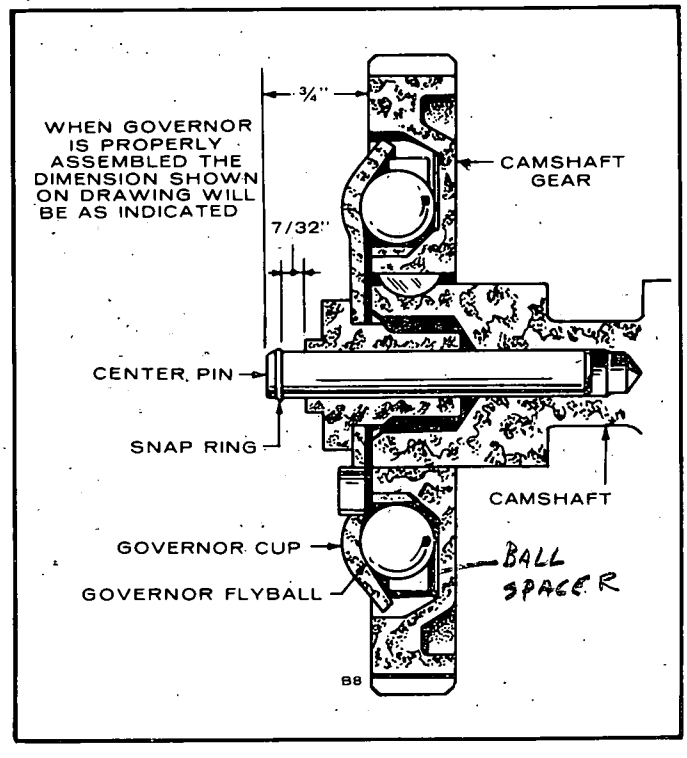


FIGURE 48. GOVERNOR CUP DETAILS

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting with a chisel. Replace the spacer with a new one. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the cup and snap ring on the center pin (Figure 48).

The camshaft center pin extends out 3/4" from the end of the camshaft. This distance provides an in and out travel distance of 7/32" for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no-load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture. See Figure 49.

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

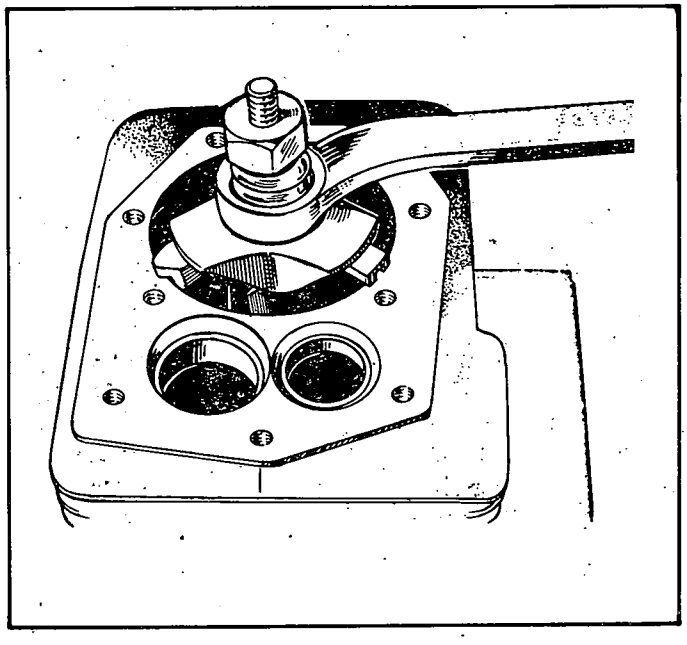


FIGURE 49. REMOVING WEAR RIDGE

NOTE: *Keep the connecting rod bearing caps and bearings with their respective rods.*

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader (Onan 420P146).

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point. All passages should be cleaned with a non-caustic solvent. Clean the rod bore and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land using new rings and a feeler gauge as shown in Figure 50. See Dimensions and Clearances for proper side clearance measurement and ring groove widths.

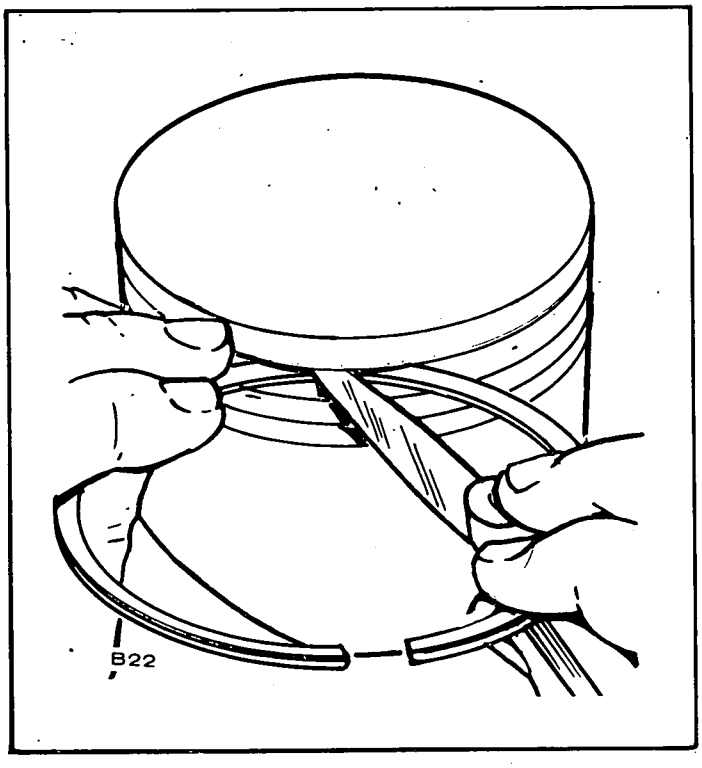


FIGURE 50. RING LAND INSPECTION

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves don't have good cylinder wall contact (Figure 51).

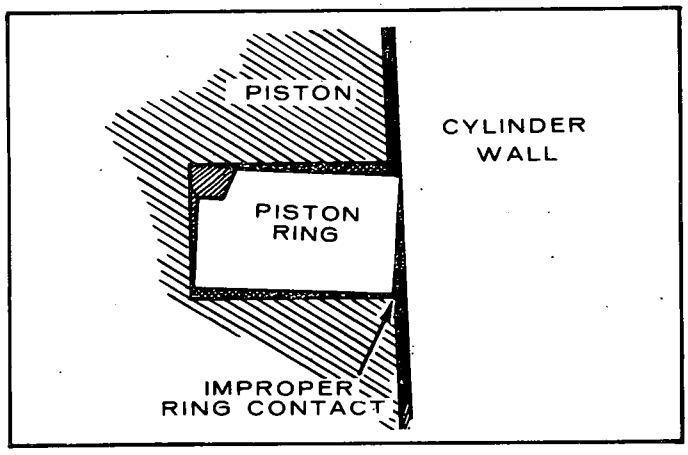


FIGURE 51. NEW RING IN WORN RING GROOVE

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002″.

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in Dimensions and Clearances.

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel (Figure 52). The gap between the ends of the ring is given in Dimensions and Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on .005″ oversize pistons. Rings that are .010″, .020″, .030″ and .040″ oversize are to be used on corresponding oversize pistons. Rings of the tapered type are usually marked *top* on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

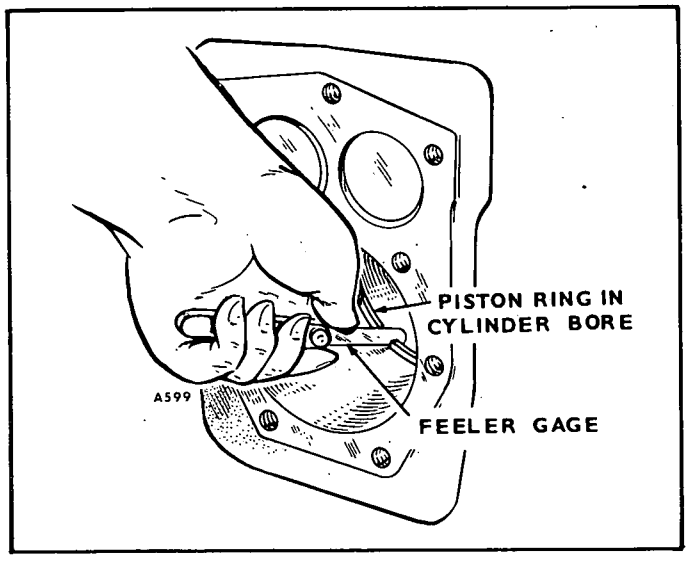


FIGURE 52. FITTING PISTON RINGS TO THE CYLINDER

Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Refer to Dimensions and Clearances for the correct piston-to-cylinder clearance.

CONNECTING RODS

The connecting rods should be serviced at the same time the pistons or rods are serviced. Rods must be removed with the piston. Replaceable bushings and bearings are used. Bearings are available in standard or .002″, .010″, .020″ or .030″ undersize.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts (forged rod), then refinish it to take the corresponding undersize bearing insert available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

Crankshaft Regrinding. Crankshaft grinding requires a trained, experienced operator, with precision equipment. Onan emphasizes that if facilities or trained personnel are not available, the crankshaft may be sent to the factory.

Special procedures must be observed when reworking crankshafts. In addition to machining the crankshaft must be shot-peened and super finished. Failure to shot-peen the crankpin fillets is likely to cause early failure. When the shaft is machined follow the data to shot-peen each crank pin fillet.

1. Almen gauge reading, .012-A.
2. Peen with .019″ diameter cast steel shot.
3. Peen for 30 seconds on each crankpin fillet.
4. Mask off connecting rod bearing areas.

Undersize bearings and connecting rods are available to rework the shaft to .010″, .020″ and .030″ undersize.

Remove any ridge which may have formed at the top of piston ring travel in the cylinder bore. Engine might be fitted at the factory with .005″ oversize piston and are so indicated by a letter E following the engine serial number stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in *Dimensions and Clearances*.

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing (Figure 53). Use combination bearing driver 420B324 to install the camshaft bearings.

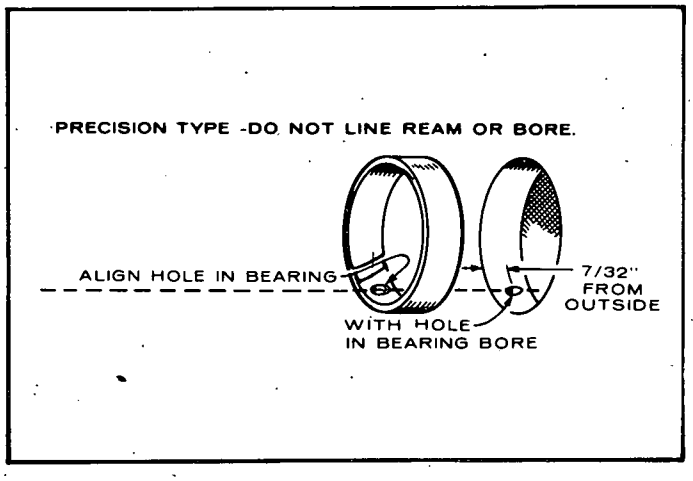


FIGURE 53. CAMSHAFT BEARING

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the

outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard size, .002″, .010″, .020″ or .030″ undersize.

Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heater to 200°F. If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

The cold oiled precision bearing should require only light taps to position it.

NOTE: *Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 55. Do not add an additional thrust washer to this front bearing.*

In the rear bearing plate, install the bearing flush to 1/64″ below the end of the bore using combination driver 420B324 (same one used for camshaft bearing). See Figure 54.

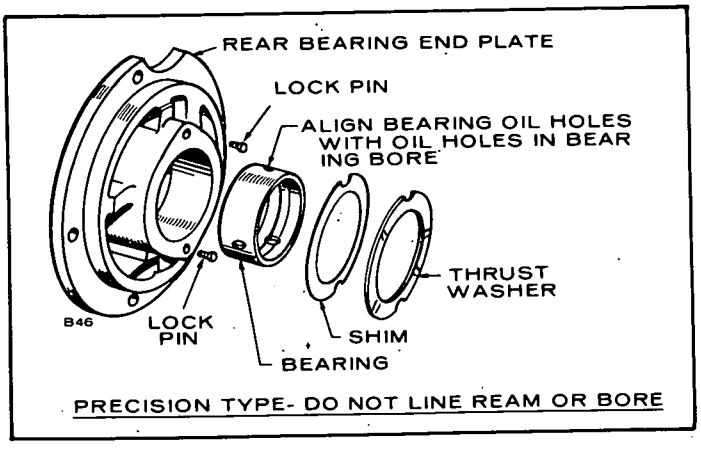


FIGURE 54. BEARINGS FOR REAR BEARING PLATE

NOTE: *If the special combination tool isn't available, it's necessary to remove the lock pins with side cutters or Easy Out tool. After the new bearings are installed, insert new lock pins.*

Before installing the front bearing (Figure 55), use the Locktite Bearing Mount furnished in the bearing kit. Use the towelette in the package to clean the outside of the bearing and the bearing bore in the block.

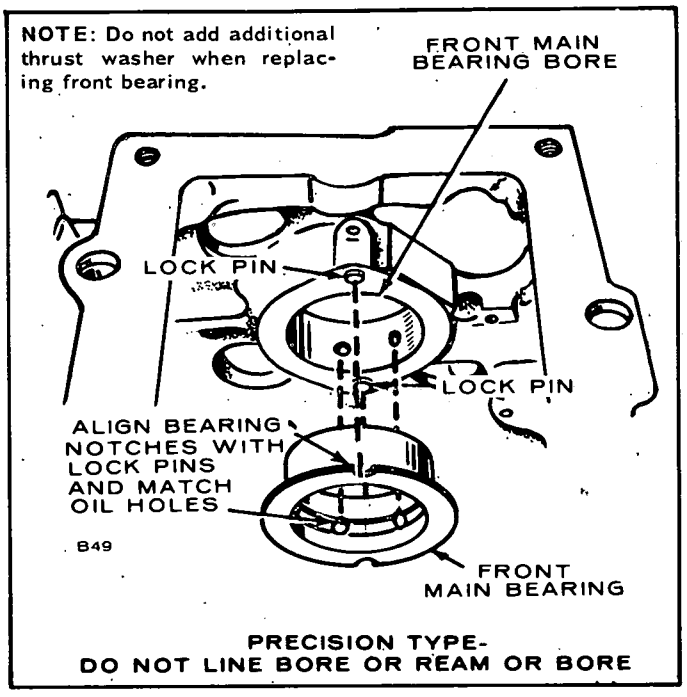


FIGURE 55. FRONT BEARING INSTALLATION

WARNING *Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well ventilated.*

After allowing three to four minutes for drying, apply the Locktite Bearing Mount from the small tube to the mating surfaces of the bearing and bearing bore. Install the bearing flush with the block using the combination driver just used for the rear bearing. Wipe off any excess Locktite around the bearing. Allow at least one hour for hardening at room temperature.

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. Line up the notches of the thrust washer with the lock pins before tightening the end plate or the lock pins will be damaged.

NOTE: *A light film of oil on the thrust washer may hold it in place while installing the crankshaft.*

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in Assembly Torques and Special Tools, check the crankshaft endplay as shown in Figure 56. If there is too much endplay (see Dimensions and Clearances for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 54) between the thrust washer and plate. Reinstall the end plate making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

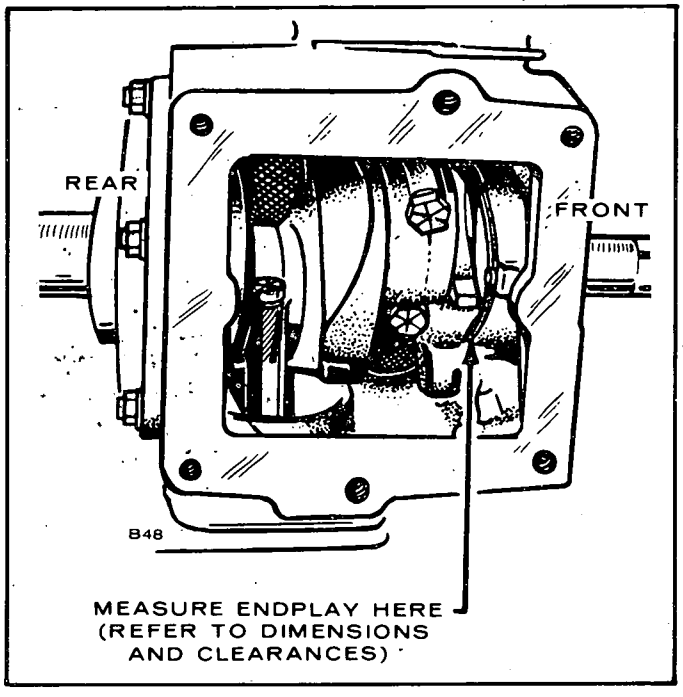


FIGURE 56. CRANKSHAFT ENDPLAY

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using bearing plate driver 420B181 and gear cover driver 420B313.

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing (see Figure 57).

When installing the gear cover oil seal, tap the seal inward until it is 31/32 of an inch from the mounting face of the cover. Install new style, thin open face seal, 1-7/64 inches from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

Engines equipped with some types of reduction gear assemblies do not use the rear oil seal. The reduction gear assembly is oiled directly from the engine crankcase. Refer to the instructions screened on the case of the reduction gear assembly.

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and ring set of the available oversizes. Pistons are available in .005″, .010″, .020″, .030″ and .040″ oversize. Piston rings are available in .010″, .020″, .030″ and .040″ oversize. Use standard size rings on a .005″ oversize piston. If the cylinder is not being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore. Engine might be fitted at the factory with a .005″ oversize piston and are so indicated by a letter E following the engine serial number stamped on the cylinder block and on the unit nameplate.

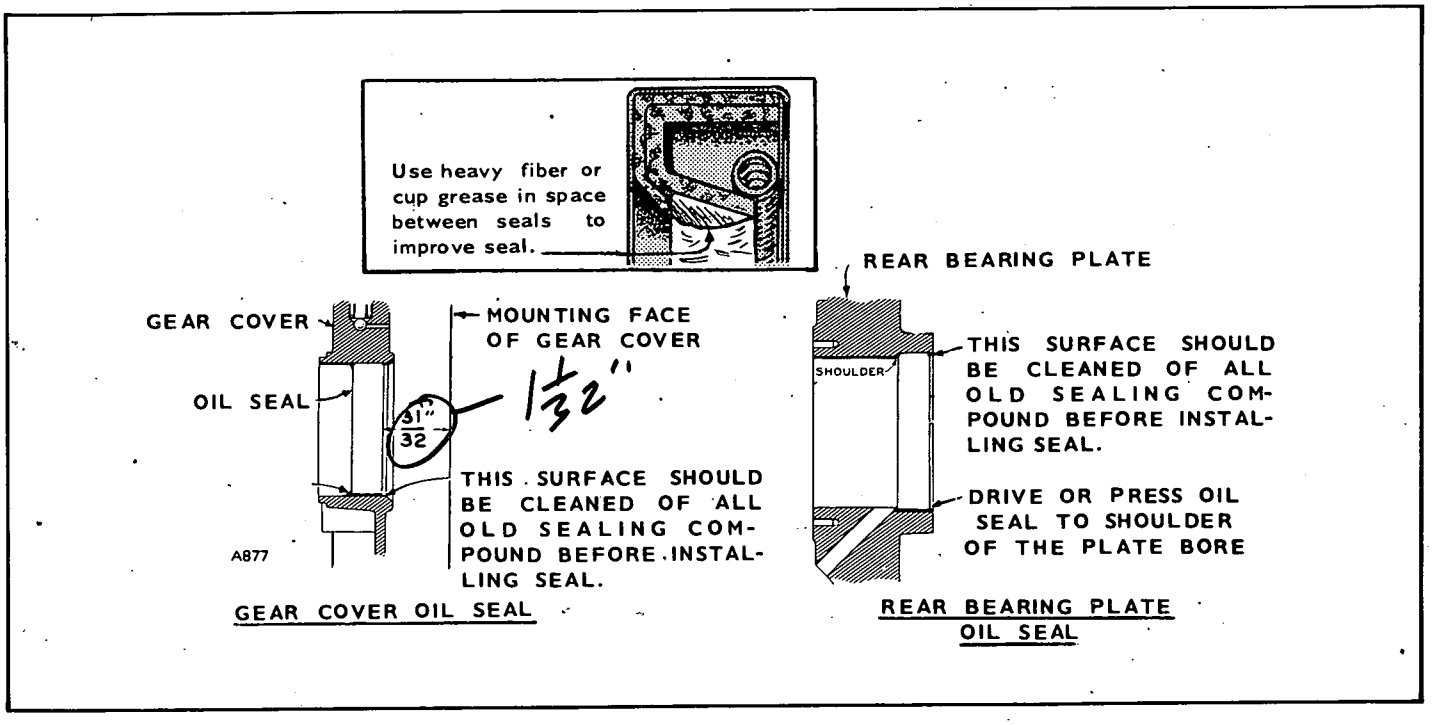


FIGURE 57. GEAR COVER AND REAR BEARING PLATE OIL SEALS

The standard cylinder bore size appears in Dimensions and Clearances.

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly as shown in Figure 58.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

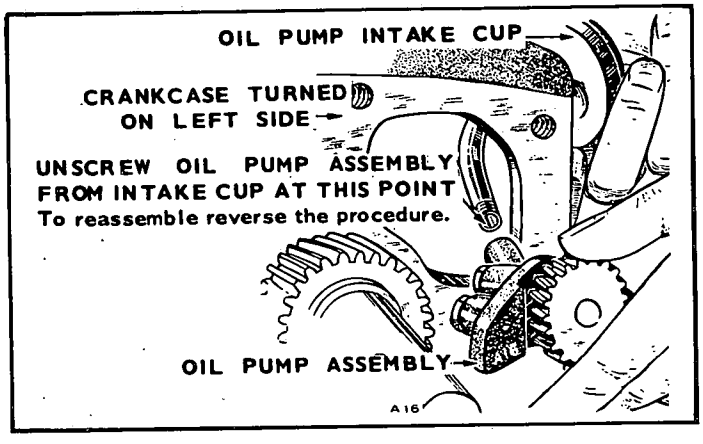


FIGURE 58. OIL PUMP ASSEMBLY

CYLINDER HEADS

Remove the cylinder heads for cleaning at least every 400 hours or when poor engine performance is noticed.

1. Use a 1/2 inch socket wrench to remove cylinder head bolts. Lift heads off.

   CAUTION *Do not remove heads when they are hot. Warpage may occur.*

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place heads in position and follow head torque tightening sequence shown in Figure 59. Start out tightening all bolts to 5 ft-lb, then 10 ft-lb, etc., until all bolts are torqued to 17-19 ft-lb.
5. Recheck torque before engine has run a total of 50 hours.

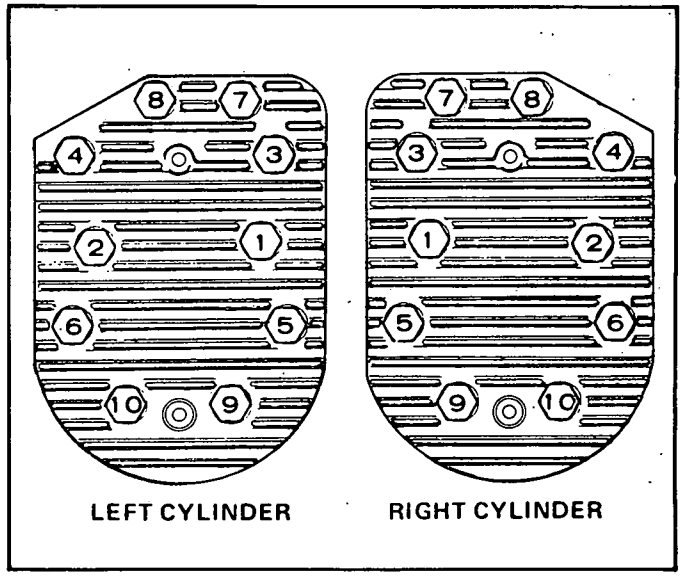


FIGURE 59. HEAD BOLT TIGHTENING SEQUENCE

PARTS CATALOG

This catalog applies to the standard NHC Engines. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number following the illustration. Parts illustrations are typical. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left engine sides are determined by *facing* the blower end (front) of the engine.

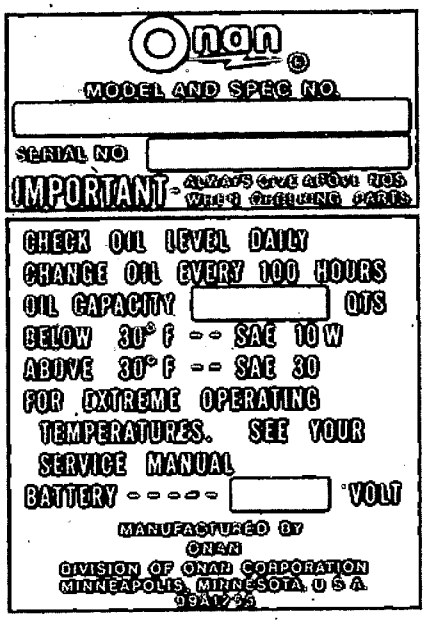
INSTRUCTIONS FOR ORDERING REPAIR PARTS

For parts or service, contact the dealer from whom you purchased this equipment or refer to your Nearest Authorized Onan Parts and Service Center.

To avoid errors or delay in filling your parts order, please furnish all information requested.

Always refer to the nameplate on your unit:

1. Always give the MODEL and SPEC NO. and SERIAL NO.

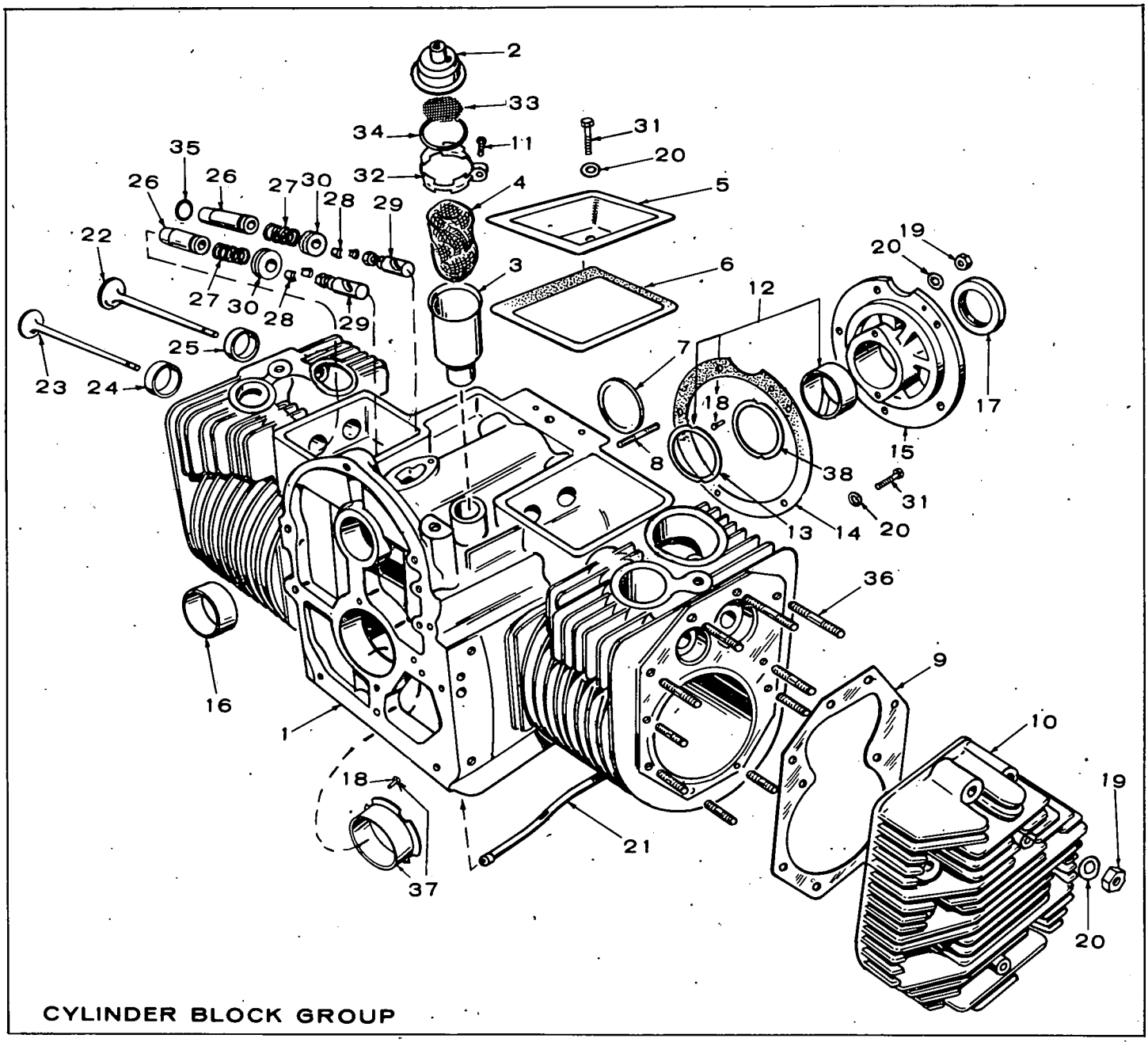


For handy reference, insert YOUR engine nameplate information in the spaces above.

2. Do not order by reference number or group number, always use part number and description.
3. Give the part number, description and quantity needed of each item. If an older part cannot be identified, return the part prepaid to your dealer or nearest AUTHORIZED SERVICE STATION. Print your name and address plainly on the package. Write a letter to the same address stating the reason for returning the part.
4. State definite shipping instructions. Any claim for loss or damage to your unit in transit should be filed promptly against the transportation company making the delivery. Shipments are complete unless the packing list indicates items are back ordered.

Prices are purposely omitted from this Parts Catalog due to the confusion resulting from fluctuating costs, import duties, sales taxes, exchange rates, etc.

For current parts prices, consult your Onan Dealer, Distributor or Parts and Service Center.



CYLINDER BLOCK GROUP

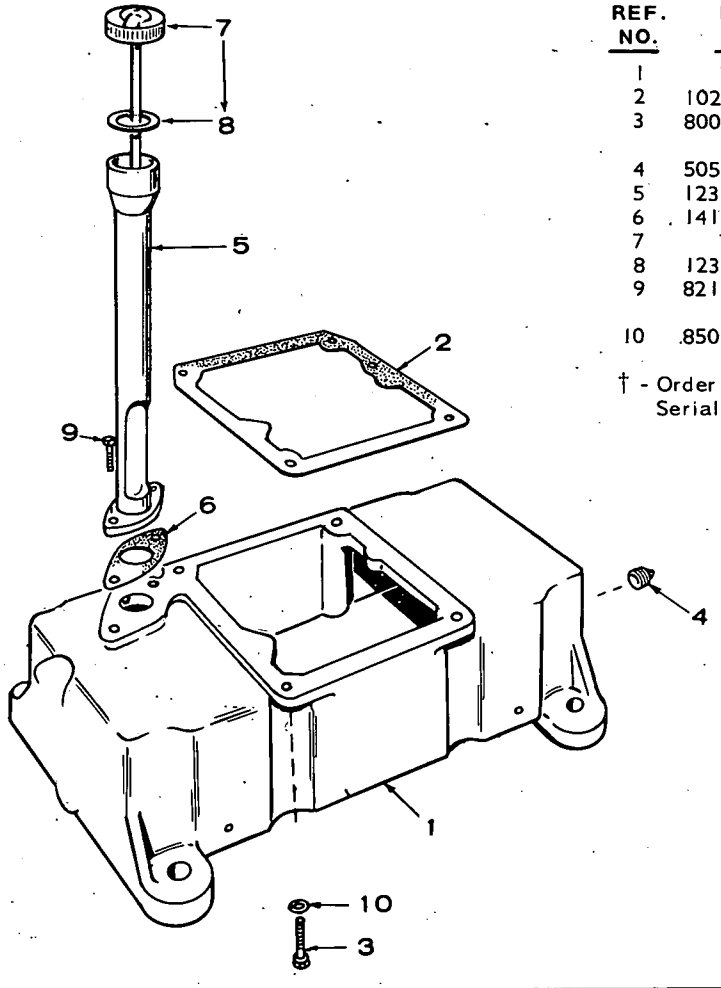
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	★	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	123A954	1	Cap & Valve, Breather
3	123A952	1	Tube, Breather
4	123P865	1	Baffle, Breather Tube
5	110A1624	2	Cover, Valve Compartment
6	110B1720	2	Gasket, Valve Cover
7	517-48	1	Plug, Camshaft Expansion
8	520A736	5	Stud, Rear Bearing Plate Mounting
9	110C1731	2	Gasket, Cylinder Head
10	HEAD, CYLINDER		
	110B1912	1	Right Side (#2)
	110B1913	1	Left Side (#1)
11	809-35	1	Screw, Breather Cap Clamp
12	BEARING, CRANKSHAFT – REAR		
	101K420	1	*Standard
	101K420-02	1	.002″ Undersize
	101K420-10	1	.010″ Undersize
	101K420-20	1	.020″ Undersize
	101K420-30	1	.030″ Undersize
13	104A575	2	£Washer, Crankshaft Bearing Thrust
14	101B415	1	Gasket, Bearing Plate
15	* PLATE, REAR BEARING (EXCLUDES BEARING)		
	101C407	1	Engines Without Reduction Gear Assembly
	101B417	1	Engines With Reduction Gear Assembly
16	101B405	2	*Bearing, Camshaft (Precision)
17	509A41	1	Seal, Bearing Plate
18	516A72	4	*Pin, Main Bearing Stop
19	NUT, HEX		
	104A91	5	Bearing Plate Mounting
	104A91	20	Cylinder Head Mounting
20	WASHER, FLAT		
	526-63	2	Valve Compartment Mounting (1/4″ Copper)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	526A250	20	Cylinder Head Mounting (3/8)
	526-251	5	Bearing Plate Mounting (3/8)
	526-66	2	Cylinder Block (3/8 ″ Copper)
21	120B680	1	*Tube, Crankcase Oil
22	110B1974	2	Valve, Intake (Aluminized)
23	110B1719	2	Valve, Exhaust (Stellite)
24	INSERT, EXHAUST VALVE SEAT (STELLITE)		
	110A1716	2	*Standard
	110A1716-02	2	.002 ″ Oversize
	110A1716-05	2	.005 ″ Oversize
	110A1716-10	2	.010 ″ Oversize
	110A1716-25	2	.025 ″ Oversize
25	INSERT, INTAKE VALVE SEAT		
	110A1933	2	*Standard
	110A1933-02	2	.002 ″ Oversize
	110A1933-05	2	.005 ″ Oversize
	110A1933-10	2	.010 ″ Oversize
	110A1933-25	2	.025 ″ Oversize
26	110A1939	4	*Guide, Valve (Standard Only)
27	110A539	4	Spring, Valve
28	110A639	8	Lock, Valve and Spring
29	TAPPET, VALVE		
	115A6	4	Standard
	115A6-05	4	.005 ″ Oversize

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
30	110A904	4	Rotocap
31	SCREW, HEX CAP		
	800-11	2	Valve Box Cover Mounting (1/4-20 x 2″)
	806-27	2	Cylinder Block (3/8-16 x 3/4″)
32	123A951	1	Clamp, Breather Tube Cap
33	123A958	1	Screen, Breather Tube
34	509-117	1	Seal, "O" Ring - Breather Tube
35	110A68	2	*Gasket, Valve Guide (Intake)
36	STUD, CYLINDER HEAD MOUNTING		
	520A717	8	3/8 x 1-7/8″
	520A773	12	3/8 x 2-5/16″
37	BEARING, CRANKSHAFT – FRONT		
	101K432	1	*Standard
	101K432-02	1	.002″ Undersize
	101K432-10	1	.010″ Undersize
	101K432-20	1	.020″ Undersize
	101K432-30	1	.030″ Undersize
38	104A776	As Req.	Shim (.005″) - Crankshaft Thrust

★ - Order by description, giving complete Model, Spec and Serial Number.
* - Included in Cylinder Block Assembly.
£ - Use one only with rear bearing on units with flange type front bearing.

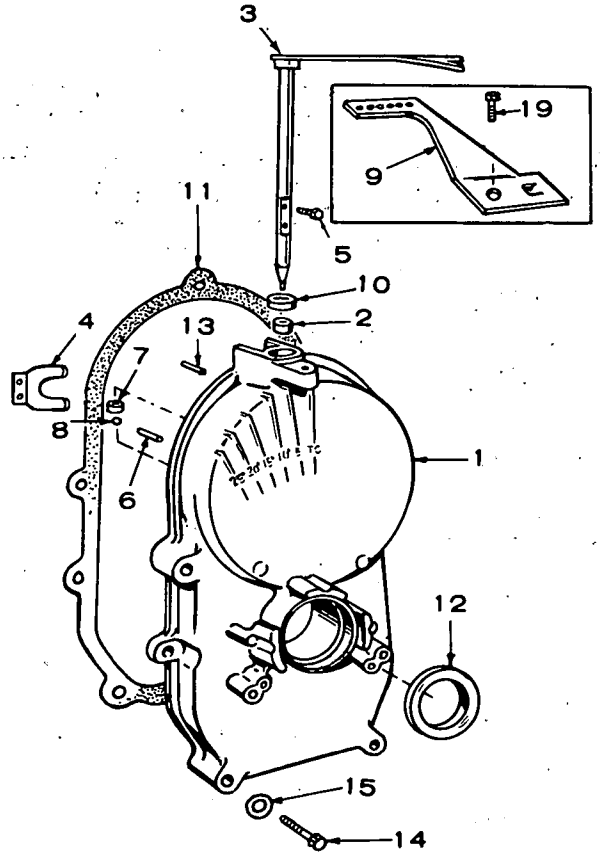
OIL BASE GROUP

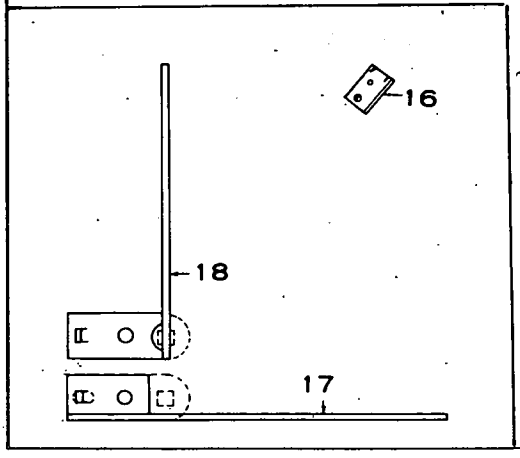


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	†	1	Base, Oil
2	102B646	1	Gasket, Oil Base
3	800-51	4	Screw (3/8-16 x 1-1/4″), Oil Base to Block
4	505-56	1	Plug, Oil Drain (1/2)
5	123B1117	1	Tube, Oil Fill
6	141B78	1	Gasket, Oil Fill Tube Mounting
7	†	1	Cap & Indicator, Oil Fill
8	123A191	1	Gasket, Oil Fill Cap
9	821-18	2	Screw, Hex Cap - Oil Fill Tube Mounting
10	850-50	4	Washer, Lock - Oil Base Mounting

† - Order by description, giving complete Model, Spec and Serial Number.

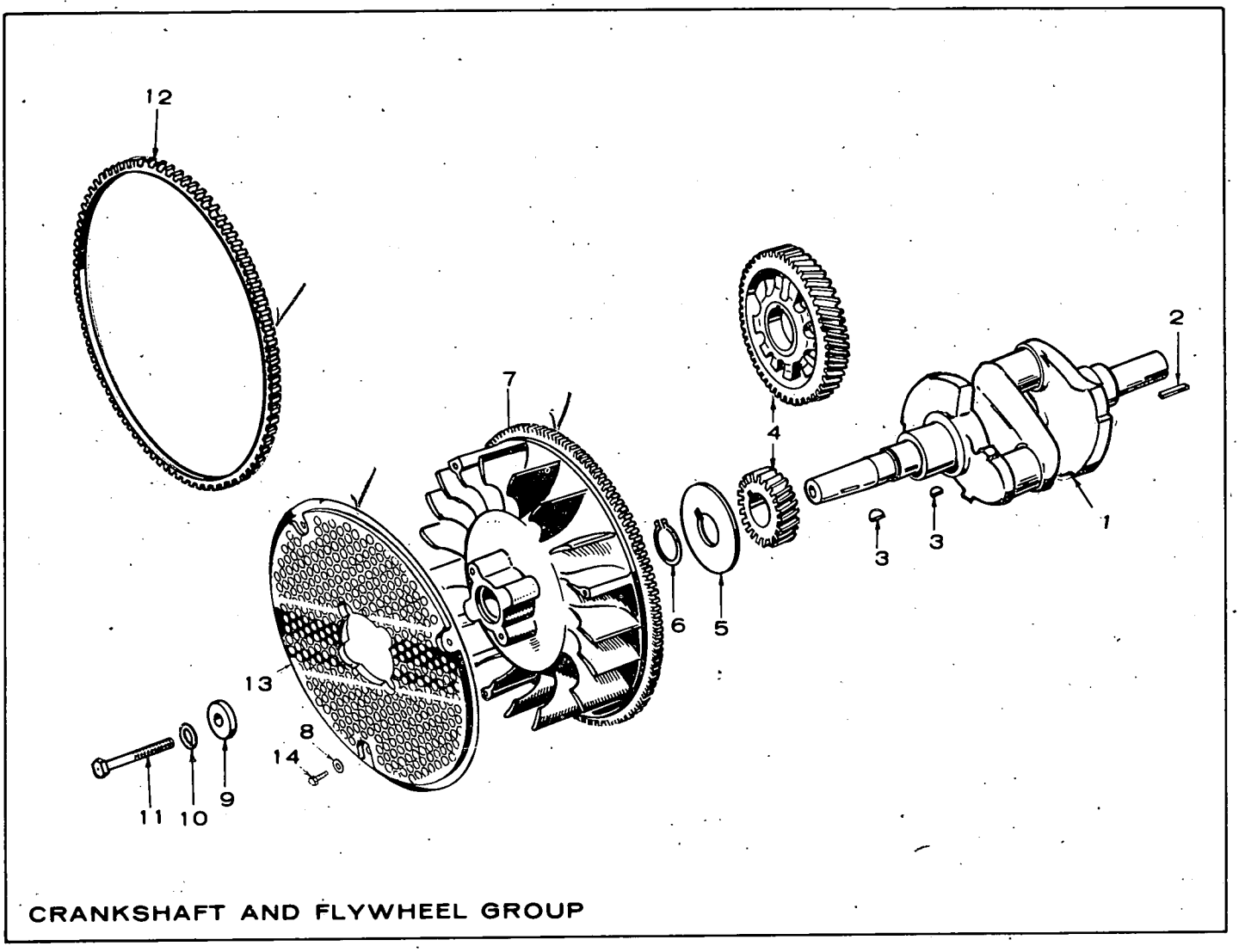
GEAR COVER GROUP





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	COVER ASSEMBLY, GEAR		
	103A386	1	Standard Governor (Drilled and Tapped for Flywheel Alternator Models) - Includes Parts Marked *
	103A387	1	Manual Throttle Controlled Engines - Includes Oil Seal (Drilled and Tapped for Flywheel Alternator Models)
2	510P13	1	*Bearing, Governor Shaft (Upper)
3	150B1260	1	*Shaft & Arm, Governor
4	150B1187	1	*Yoke, Governor Shaft
5	815-46	2	*Screw, Yoke Mounting
6	516-130	1	*Pin, Governor Cup Stop (In Gear Cover)
7	510A8	1	*Bearing, Governor Shaft (Lower)
8	510P14	1	*Ball, Bearing - Governor Shaft
9	150B1073	1	Extension, Governor Arm
10	509P8	1	*Seal, Oil
11	103B408	1	Gasket, Gear Cover
12	509A40	1	*Seal, Gear Cover
13	516A11	2	Pin, Gear Cover (5/16 x 1-1/8")
14	SCREW, HEX CAP		
	800-32	4	Gear Cover Mounting (5/16-18 x 1-3/4")
	800-34	1	Gear Cover Mounting (5/16-18 x 2-1/4")
15	526-65	5	Washer (Copper), Flat - Gear Cover Mounting
	ARM, GOVERNOR PULL – CONSTANT SPEED GOVERNOR – OPTIONAL.		
16	150A1268	1	Rear Pull
17	150A755	1	Front Pull
18	150A752	1	Right Pull
19	815-181	1	Screw, Governor Arm Extension Mounting

* - Included in Gear Cover Assembly.



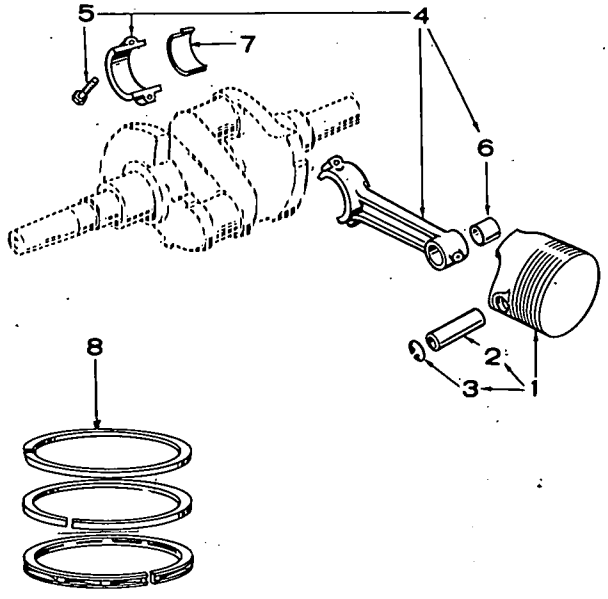
CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	*	1	Crankshaft
2	515A198	1	Key, Crankshaft Stub
3	KEY		
	515-1	1	Crankshaft Gear Mounting
	515-2	1	Flywheel Mounting
4	105A353	1	Gear Set, Timing (1 Each Crankshaft & Camshaft Gears With Flyball Spacer & Plate)
5	104A43	1	Washer, Crankshaft Gear Retaining
6	518P14	1	Lock, Crankshaft Gear Washer
7	FLYWHEEL ASSEMBLY		
	134B2530	1	Standard Units (Includes Ring Gear)
	134C2462	1	Units with Flywheel Alternator System (Includes Ring Gear and Magnet Ring) - Optional
8	526-18	3	Washer, Flat - Guard Mounting
9	526A262	1	Washer, Flywheel Mounting
10	850-55	1	Washer, Lock - Flywheel Mtg.
11	104A170	1	Screw, Flywheel Mounting
12	134C673	1	Gear, Ring - Flywheel
13	134B2433	1	Guard, Blower Wheel
14	821-10	3	Screw, Guard Mounting

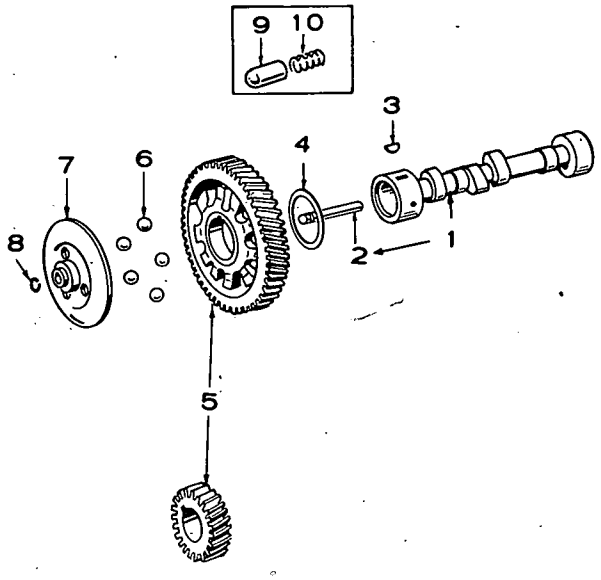
* - Order by description, giving complete Model, Spec and Serial Number.

PISTON AND CONNECTING ROD GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	PISTON AND PIN (INCLUDES RETAINING RINGS)		
	112-111	2	Standard
	112-111-05	2	.005" Oversize
	112-111-10	2	.010" Oversize
	112-111-20	2	.020" Oversize
	112-111-30	2	.030" Oversize
	112-111-40	2	.040" Oversize
2	PIN, PISTON		
	112-112	2	Standard
	112-112-02	2	.002" Oversize
3	518P294	4	Ring, Piston Pin Retaining
4	114C203	2	Rod, Connecting (Includes Bushing & Bolts)
5	805A10	4	Bolt, Place-Connecting Rod Cap
6	114A36	2	Bushing, Piston Pin-Connecting Rod
7	BEARING HALF, CONNECTING ROD		
	114B188	4	Standard
	114B188-02	4	.002" Undersize
	114B188-10	4	.010" Undersize
	114B188-20	4	.020" Undersize
	114B188-30	4	.030" Undersize
8	RING SET, PISTON		
	113A165	2	Standard
	113A165-05	2	.005" Oversize
	113A165-10	2	.010" Oversize
	113A165-20	2	.020" Oversize
	113A165-30	2	.030" Oversize
	113A165-40	2	.040" Oversize

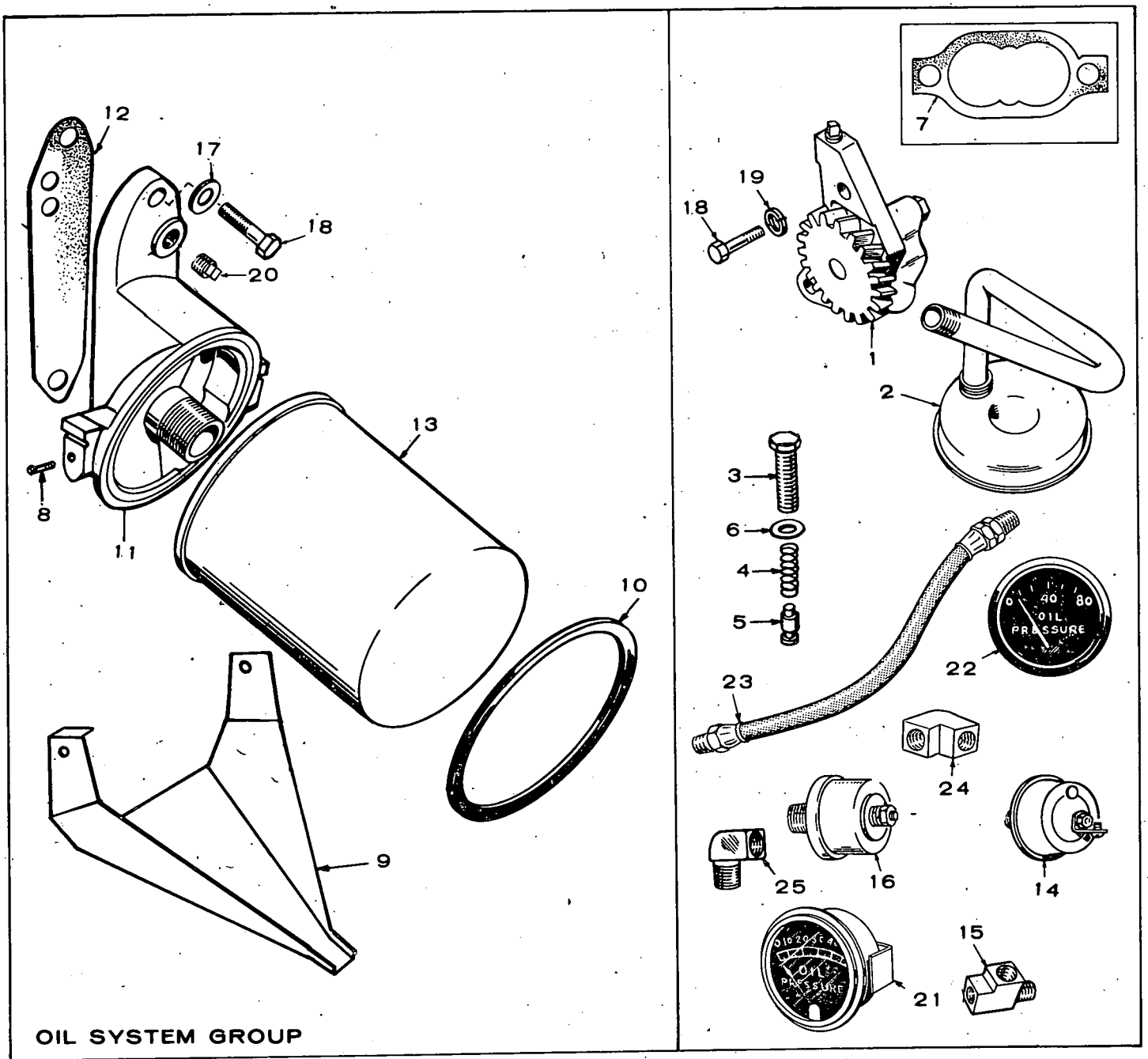


CAMSHAFT GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	CAMSHAFT		
	105B382	1	Governor Controlled Engine (Includes Center Pin)
	*	1	Manually Controlled Engine
2	150A75	1	Pin, Center-Camshaft
3	515-1	1	Key, Camshaft Gear Mounting
4	105A4	1	Washer, Camshaft Gear Thrust
5	105A353	1	Gear Set, Timing-1 Each Crankshaft & Camshaft Gears (Includes Flyball Spacer & Plate)
6	510-15	5	Ball, Fly-Governor
7	150A612	1	Cup, Governor Flyball
8	150A78	1	Ring, Camshaft Center Pin
9	105A58	1	Plunger, Camshaft Thrust (Manually Controlled Engine)
10	105A59	1	Spring, Camshaft Plunger (Manually Controlled Engine)

* - Order by description, giving complete Model, Spec and Serial Number.

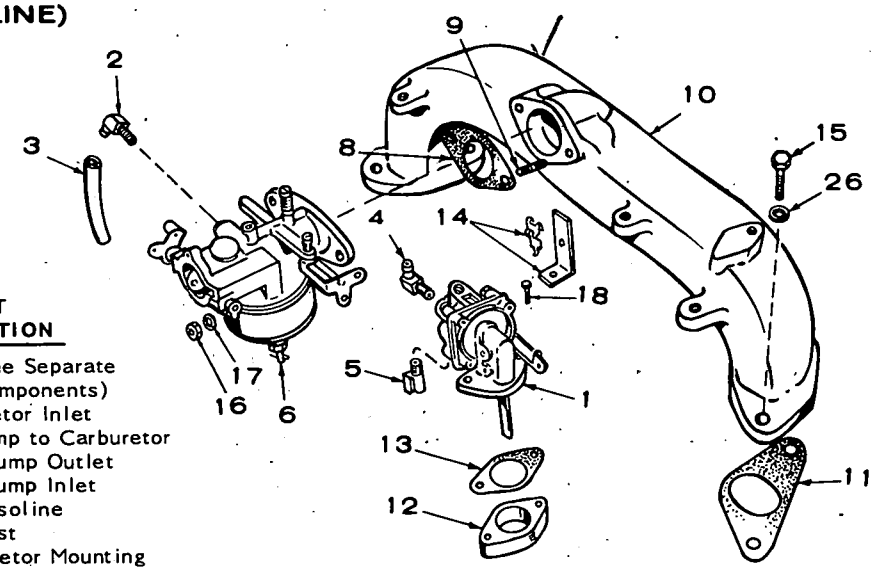


OIL SYSTEM GROUP

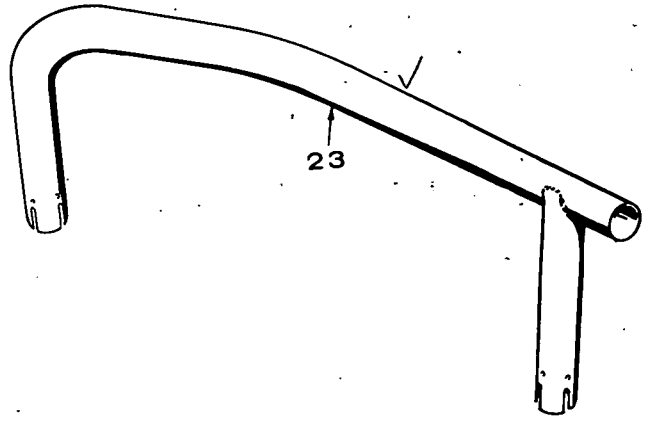
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120A491	1	Pump, Oil (Components Not Sold Separately)
2	120B691	1	Intake, Oil Pump - Includes Cup, Screen & Pipe
3	801-50	1	Screw, Hex Head - By-Pass
4	120A140	1	Spring, By-Pass Valve
5	120A398	1	Valve, By-Pass
6	526-66	1	Washer, Oil Pressure Relief Valve Screw
7	120K161	1	Gasket Kit, Oil Pump
8	815A194	2	Screw (10-32 x 3/8″) - Oil Drain Mounting
9	122C352	1	Drain, Oil Filter
10	122A347	1	Seal, Oil Filter (Air)
11	122D320	1	Adapter, Oil Filter
12	122A321	1	Gasket, Adapter
13	122B323	1	Filter, Oil

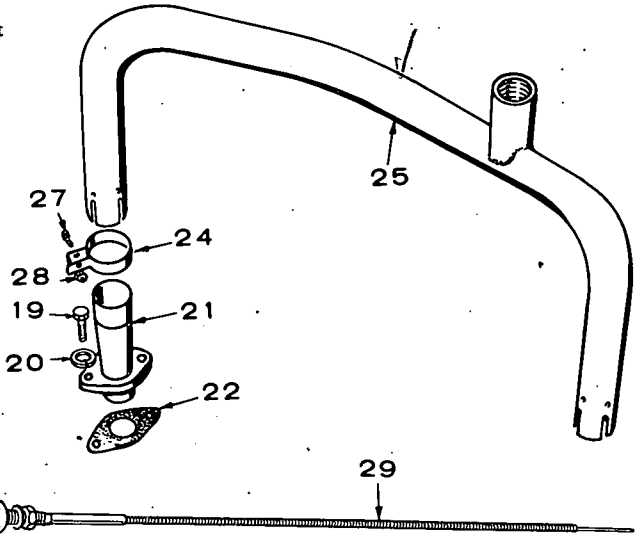
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
14	309A10	1	Switch, Low Oil Pressure - Optional
15	502-58	1	Tee, Low Oil Pressure Switch - Optional
16	193-108	1	Sender, Oil Pressure - Optional
17	526-65	2	Washer, Flat (Copper) - Adapter Mounting
18	SCREW, HEX CAP		
	800-28	2	Adapter Mounting (5/16-18 x 1″)
	800-7	2	Oil Pump Mounting (1/4-20 x 1″)
19	850-40	2	Washer, Lock - Oil Pump Mounting
20	505-57	1	Plug (1/8″)
21	193A68	1	Gauge, Oil Pressure - Optional
22	193-107	1	Gauge, Oil Pressure (Electric) - Optional
23	501A4	1	Line, Oil - Optional
24	502-5	1	Elbow, Oil Line to Gauge - Opt.
25	502-20	1	Elbow, Oil Line to Cylinder Block - Optional

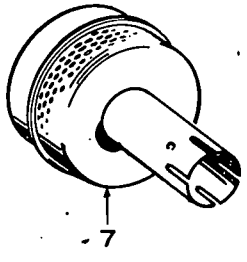
FUEL SYSTEM GROUP (GASOLINE)



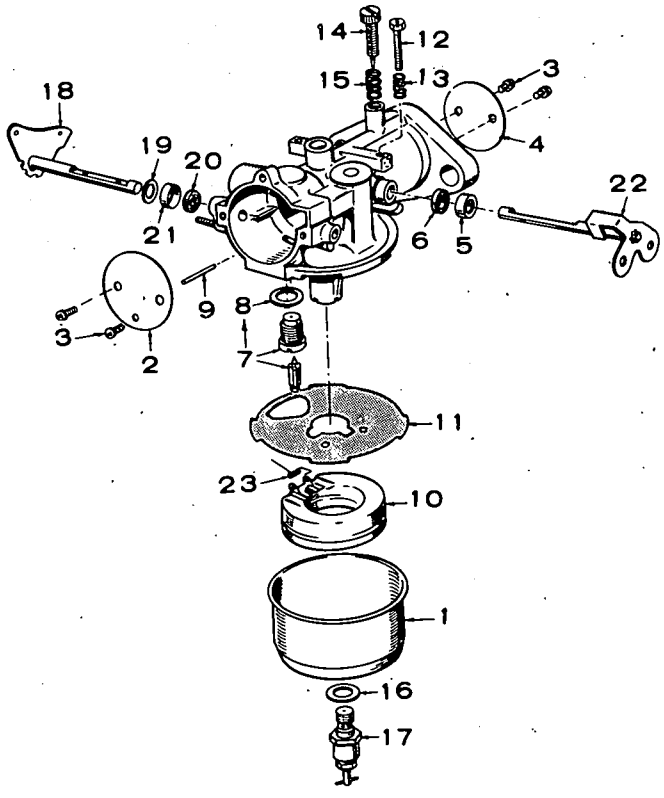
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	149D1223	1	Pump, Fuel (See Separate Group for Components)
2	502-313	1	Elbow, Carburetor Inlet
3	149A1228	1	Line, Fuel Pump to Carburetor
4	502-313	1	Elbow, Fuel Pump Outlet
5	502-2	1	Elbow, Fuel Pump Inlet
6	141D802	1	Carburetor, Gasoline
7	155B1217	2	Muffler, Exhaust
8	141A281	1	Gasket, Carburetor Mounting
9	520A526	2	Stud, Carburetor Mounting
10	154C1466	1	Manifold, Intake
11	154A1483	2	Gasket, Intake Manifold to Cylinder Block
12	149A45	1	Spacer, Fuel Pump Mounting
13	149A3	2	Gasket, Fuel Pump Mounting
14	153-263	1	Bracket & Clamp, Manual Choke - Optional
15	800A538	4	Screw 3/8-16 x 1-1/2", Intake Manifold Mounting
16	868-2	2	Nut, Hex (Jam) - Carburetor Mounting
17	854-17	2	Washer, Shakeproof - Carburetor Mounting
18	806-9	2	Screw, Fuel Pump Mounting
19	800P512	4	Screw (5/16-18 x 1") - Exhaust Adapter Mounting
20	850-45	4	Washer, Lock (5/16")
21	154B1484	2	Adapter, Exhaust Manifold
22	154A1482	2	Gasket, Exhaust Manifold Adapter
23	154D1492	1	Manifold, Exhaust - High Profile (Right or Left Outlet) - Opt.
24	155P1219	2	Clamp, Exhaust Manifold
25	154C1493	1	Manifold, Exhaust - High Profile (Top Outlet) - Optional
26	850-50	4	Washer, Lock - Intake Manifold Mounting
27	805A18	2	Screw (3/8-16 x 1") - Exhaust Clamp
28	862-3	2	Nut (3/8-16) - Exhaust Clamp
29	153B97	1	Choke, Manual - Optional







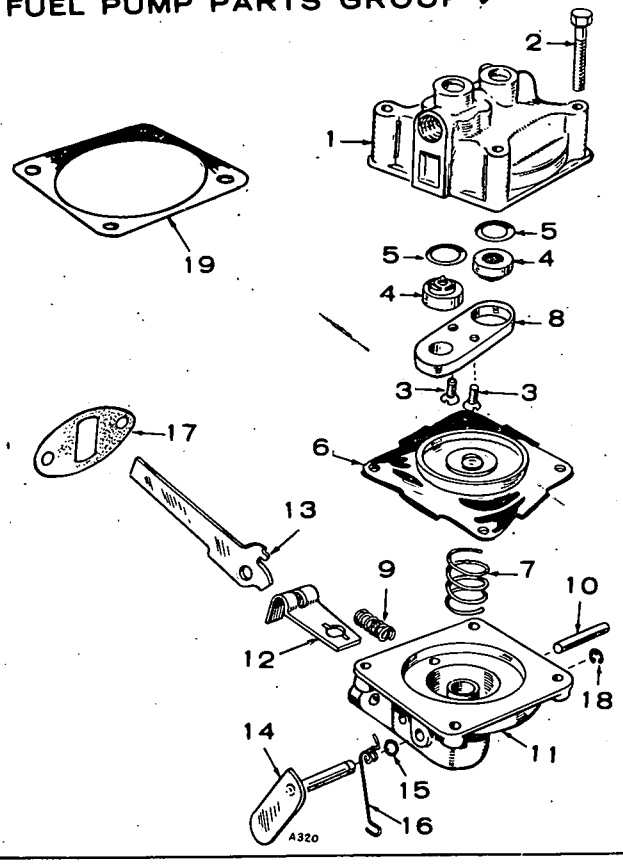
CARBURETOR PARTS GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	CARBURETOR, GASOLINE		
	141D802	1	Manual Choke
	141D803	1	Electric Choke
	141P814	1	Repair Kit (Includes Parts Marked *)
	141K748	1	Gasket Kit (Includes Parts Marked ▲)
	141A281	1	*▲Gasket, Carburetor Flange
1	141P708	1	Bowl, Fuel
2	141P741	1	Plate, Choke
3	141P698	4	Screw & Washer, Choke & Throttle Plate Mounting
4	141-813	1	Plate, Throttle
5	141P705	1	*Retainer, Seal
6	141-661	1	*▲Seal, Rubber
7	141P798	1	*Valve, Seat Assembly, Fuel
8	141-811	1	▲Washer, Fuel Valve Seat
9	141P703	1	*Shaft, Float
10	141P702	1	Float Assembly
11	141P701	1	*▲Gasket, Bowl to Body
12	141P700	1	Screw, Throttle Stop
13	141P711	1	Spring, Throttle Stop
14	141P713	1	*Needle, Idle Adjusting
15	141P710	1	Spring, Idle Needle
16	141A77	1	*▲Washer, Main Jet Assembly
17	141-810	1	Jet Assembly, Main (Adjustable)
18	SHAFT, CHOKE		
	141-742	1	Manual Choke Units
	141B679	1	Electric Choke Units
19	141P699	1	*Washer, Choke Shaft - Manual Choke Units
20	141P697	1	*▲Seal, Felt - Manual Choke Units
21	141P203	1	*Retainer, Felt Seal - Manual Choke Units
22	141-809	1	Shaft & Lever, Throttle
23	141-799	1	*Spring, Float

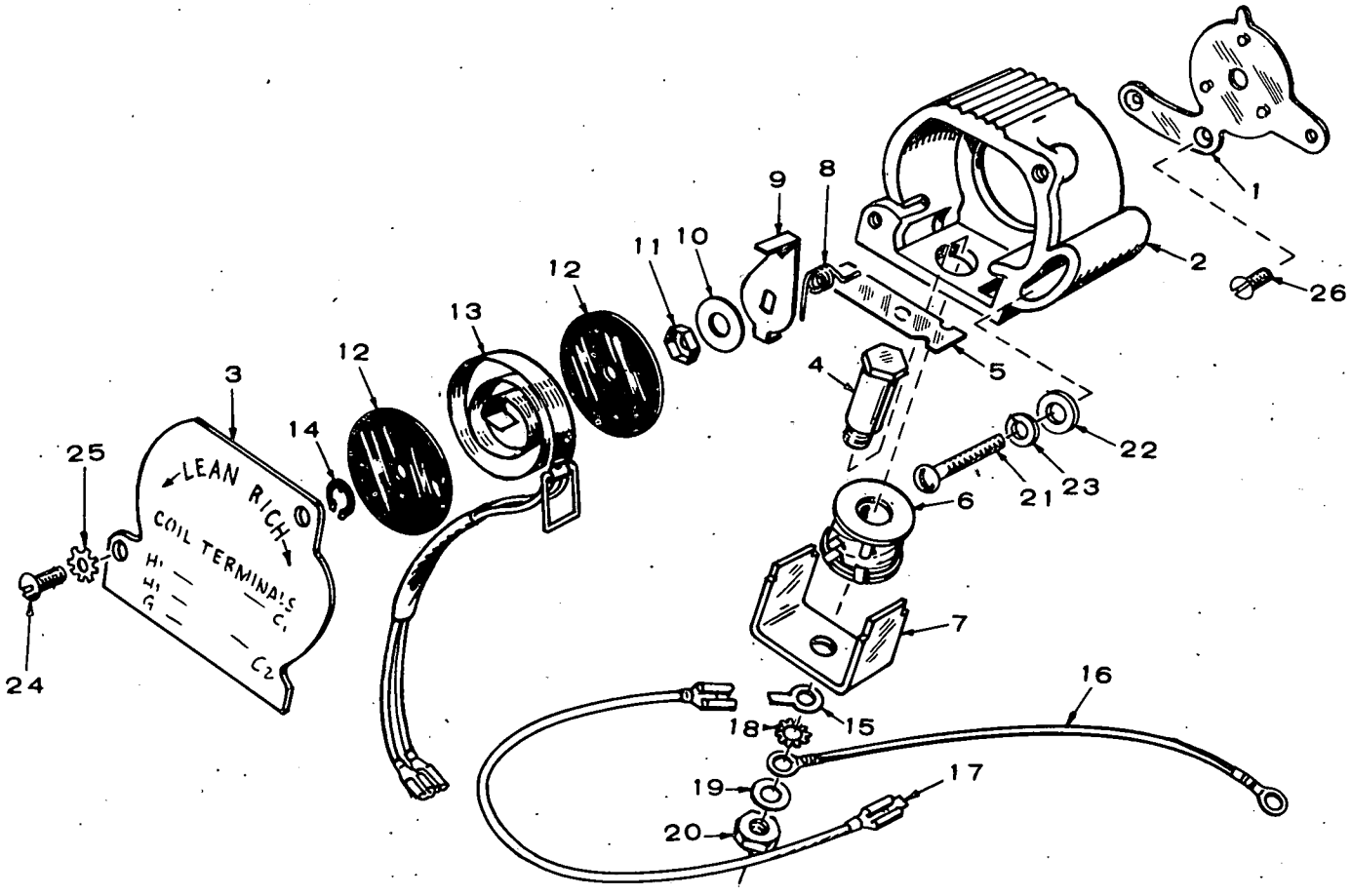
* - Parts Contained in Repair Kit.
▲ - Parts Contained in Gasket Kit.

FUEL PUMP PARTS GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149D1223	1	Pump, Fuel (Illustrated in Fuel System Group)
	149K526	1	Repair Parts Kit - Includes Parts Marked *
1		1	Body, Not Sold Separately
2	815-148	4	Screw, Machine, #8-32 x 7/8″
3	815-147	2	Screw, Phillips Self Tapping, #6-32 x 5/8″, Valve Retainer
4	149-96	2	*Valve & Cage
5	149A95	2	*Gasket, Valve
6	149A582	1	*Diaphragm Assembly
7	149A672	1	*Spring
8	149A539	1	Retainer, Valve Cage
9	149A675	1	*Spring
10	516A113	1	Pin, Rocker Arm
11		1	Body, Not Sold Separately
12	149A670	1	Link, Rocker Arm
13	149B1148	1	Arm, Rocker
14	149A1042	1	Lever, Primer
15	509-65	2	Seal, "O" Ring
16	149A1044	1	Spring, Primer Lever
17	149A3	1	*Gasket, Pump Mounting
18	518P129	1	Ring, Retainer, Primer Lever
19	149A858	1	*Gasket, Diaphragm - Lower Side

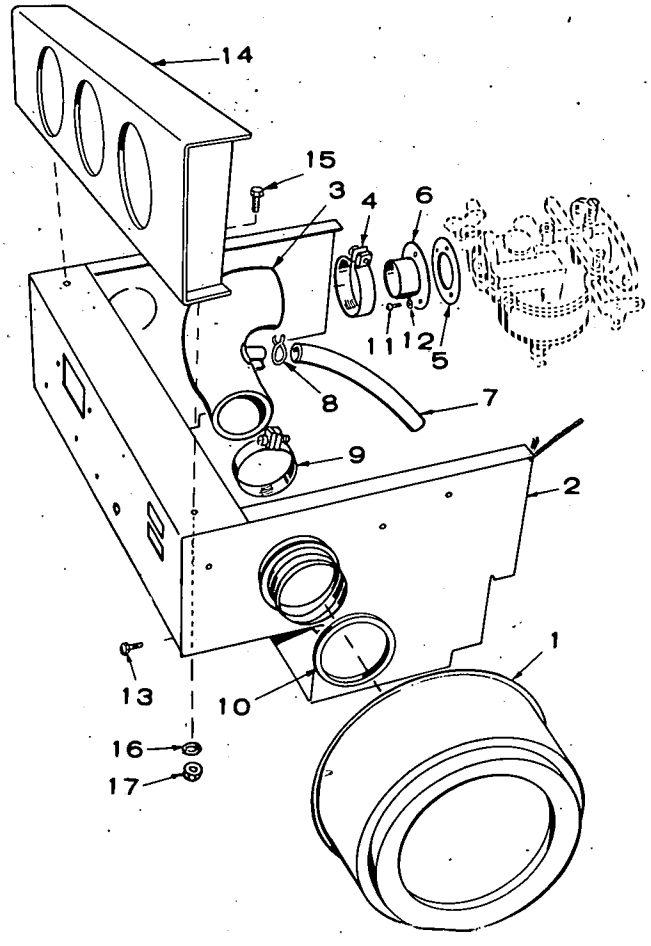
* Parts in Repair Kit



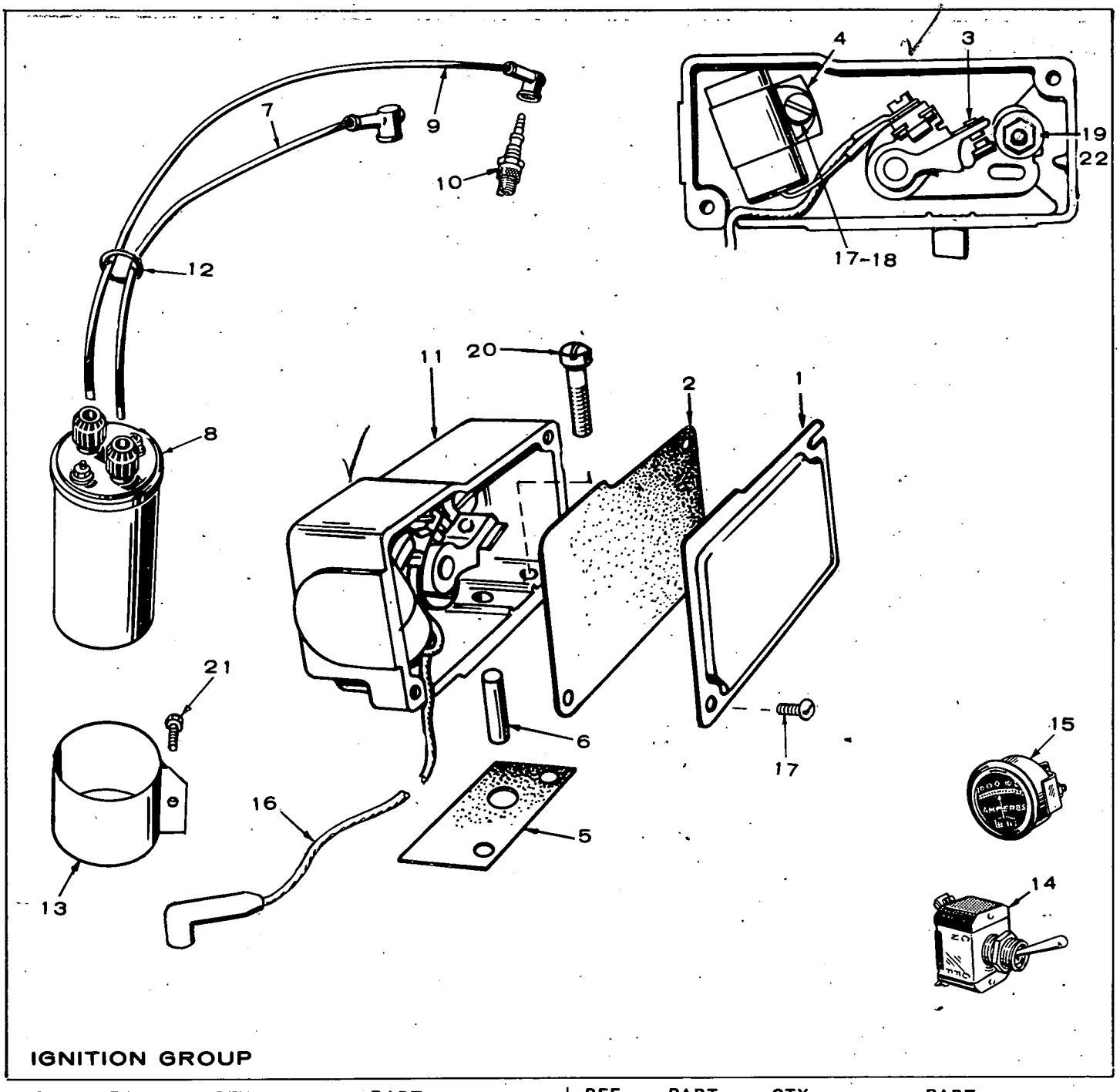
THERMO-MAGNETIC CHOKE GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	153K429	1	Replacement Kit (Includes Complete Choke Less Leads)
1	153C385	1	Plate, Mounting
2	153D386	1	Body
3	153C389	1	Cover
4	153B391	1	Core, Solenoid
5	153A395	1	Armature
6	307B801	1	Coil, Solenoid Assembly
7	153B392	1	Frame, Solenoid
8	153B387	1	Spring
9	153B390	1	Lever, Thermostat
10	526-18	1	Washer (17/64″ I.D. x 5/8″ O.D. x 1/16″)
11	870-134	1	Palnut (1/4-20)
12	153A399	2	Insulator
13	153B400	1	Heater Assembly
14	518-129	1	Ring, Retaining
15	332A876	1	Terminal, Ground
	LEAD, CHOKE		
16	336A1550	1	Choke to Ground
17	336A1549	1	Choke Solenoid Ground
18	857-17	1	Washer, Shakeproof (5/16″)
19	526-22	1	Washer, Flat
20	864-2	1	Nut, Hex (5/16-18)
21	813-107	1	Screw (#10-32 x 1-1/4″) - Choke Body to Mounting Plate
22	526A8	1	Washer, Flat
23	850-30	1	Washer, Lock (#10)
24	812-76	2	Screw (#8-32 x 5/16″) - Cover Mounting
25	854-7	2	Washer, Shakeproof (#8)
26	815-161	2	Screw (#10-32 x 3/8″) - Plate Mounting

AIR CLEANER GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	140B1175	1	Cleaner, Air
2	140B1179	1	Adapter & Panel, Air Cleaner Mounting
3	140A1186	1	Elbow, Carburetor Air Inlet
4	503-4	1	Clamp, Hose - Air Inlet Elbow to Adapter
5	140A921	1	Gasket, Adapter to Carburetor
6	145A398	1	Adapter, Carburetor Air Inlet
7	503A582	1	Hose, Breather
8	503-170	2	Clamp, Breather Hose
9	503P365	1	Clamp, Hose - Air Cleaner
10	140A1185	1	Gasket, Air Cleaner
11	815-199	3	Screw (10-32 x 5/16″) - Adapter Mounting
12	850-30	3	Washer, Lock (#10)
13	821-10	4	Screw (1/4-20 x 1/2″) - Air Cleaner Panel Mounting
14	193B218	1	Panel, Instrument - Optional
15	800-3	2	Screw (1/4-20 x 1/2″) - Instrument Panel Mounting
16	853-13	2	Washer, Lock (1/4″)
17	862-1	2	Nut, Hex (1/4″)

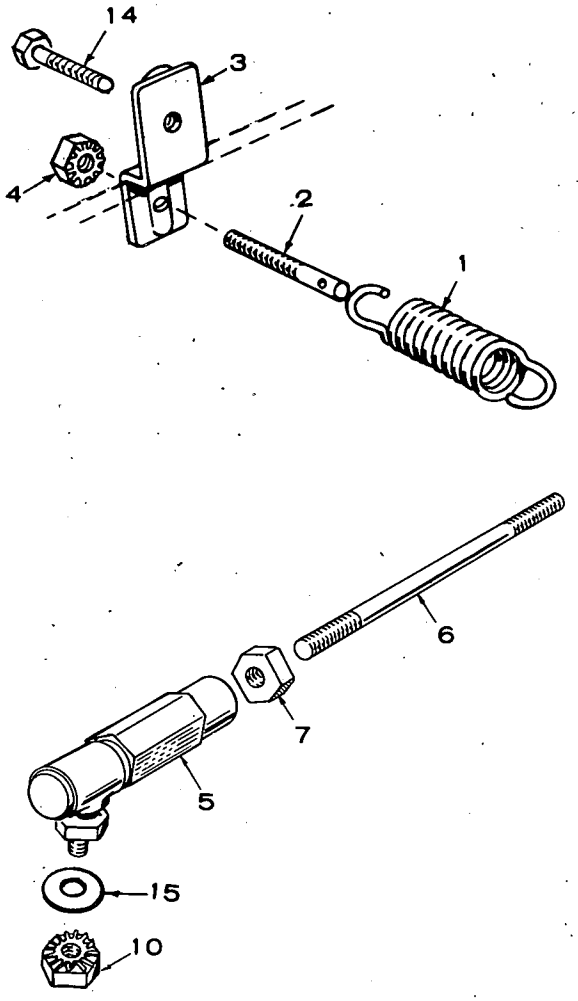


IGNITION GROUP

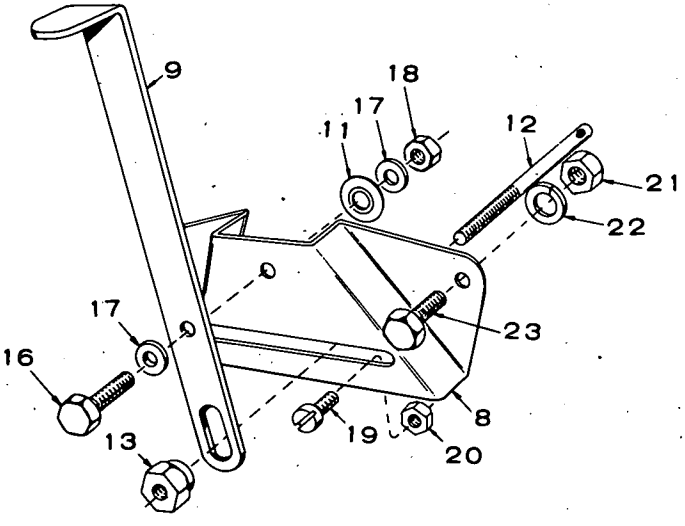
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	160A1149	1	*Cover, Breaker Box
2	160A1148	1	*Gasket, Breaker Box Cover
3	160B1154	1	*Point Set, Breaker
4	312A69	1	*Condenser, Breaker Points
5	160A1150	1	Gasket, Breaker Box Mounting
6	160A1151	1	Plunger, Breaker Box
7	167A1462	1	Cable, Spark Plug - Right Side
8	166B535	1	Coil, Ignition
9	167A1463	1	Cable, Spark Plug - Left Side
10	167-240	2	Plug, Spark
11	160A1158	1	Box, Breaker (Includes Parts Marked *)
12	509-35	1	"O" Ring, Spark Plug Cables
13	166B617	1	Clamp, Coil Mounting
14	308A140	1	Switch, Toggle - Ignition (Start-On-Off) - Optional
15	302A60	1	Ammeter, DC (20-0-20) - Optional
16	336A2132	1	*Lead Assembly, Points to Coil
17	815-358	3	*Screw, Pan Head (1) Condenser Mounting (2) Cover Mounting
18	850-25	1	*Washer, Lock - Condenser Mtg.
19	870-221	1	*Nut (8-32) - Breaker Points Mounting
20	815-373	2	Screw, Fillister Head - Breaker Box Mounting
21	821-10	1	Screw (1/4-20 x 1/2 ") - Coil Mounting Clamp
22	815-46	1	Screw (8-32 x 3/8 ") - Breaker Point Mounting

* - Included in Breaker Box Assembly.

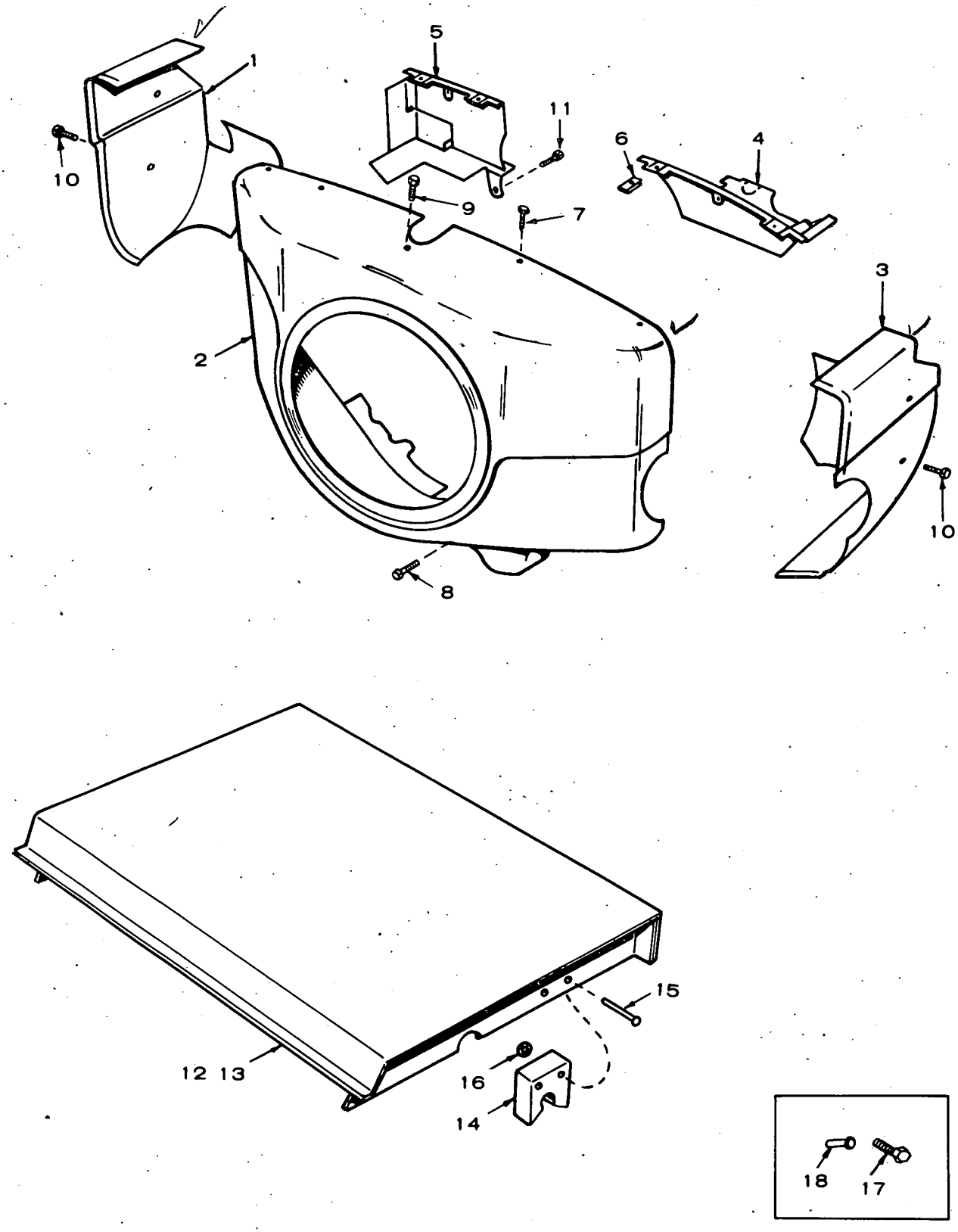
GOVERNOR GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	150A98	1	Spring, Governor (All Governor Controlled Engines)
2	150A147	1	Stud, Speed Adjustment (Standard Governor Controlled Engines)
3	150A1359	1	Bracket, Speed Stud (Standard Governor Controlled Engines)
4	870-131	1	Nut, Speed Adjustment (Standard Governor Controlled Engines)
5	150A639	2	Joint, Ball (All Governor Controlled Engines)
6	520A187	1	Link, Throttle (All Governor Controlled Engines)
7	870P188	2	Palnut, Locking (All Governor Controlled Engines)
8	152B190	1	Bracket, Variable Speed Control - Optional
9	152A95	1	Lever, Variable Speed Control - Optional
10	870-131	2	Nut, Keps (All Governor Controlled Engines)
11	152A41	1	Washer, Variable Speed Lever Tension - Optional
12	152A90	1	Stud, Variable Speed Adjustment - Optional
13	150A621	1	Nut, Variable Speed Adjustment Stud - Optional
14	821-10	1	Screw (1/4-20 x 1/2″) - Bracket Mounting (Standard Governor Controlled Engines)
15	526A196	1	Washer, Flat (All Governor Controlled Engines)
16	800-5	1	Screw (1/4-20 x 3/4″)
17	526-15	2	Washer, Flat (1/4)
18	870-65	1	Nut, Hex (1/4-20)
19	815-199	2	Screw (10-32 x 5/16″)
20	870-131	2	Nut & Washer (10-32)
21	862-1	2	Nut, Hex (1/4-20) - Bracket Mounting
22	856-6	2	Washer, Lock (1/4)
23	800-3	2	Screw (1/4-20 x 1/2″) - Bracket Mounting



BLOWER HOUSING GROUP

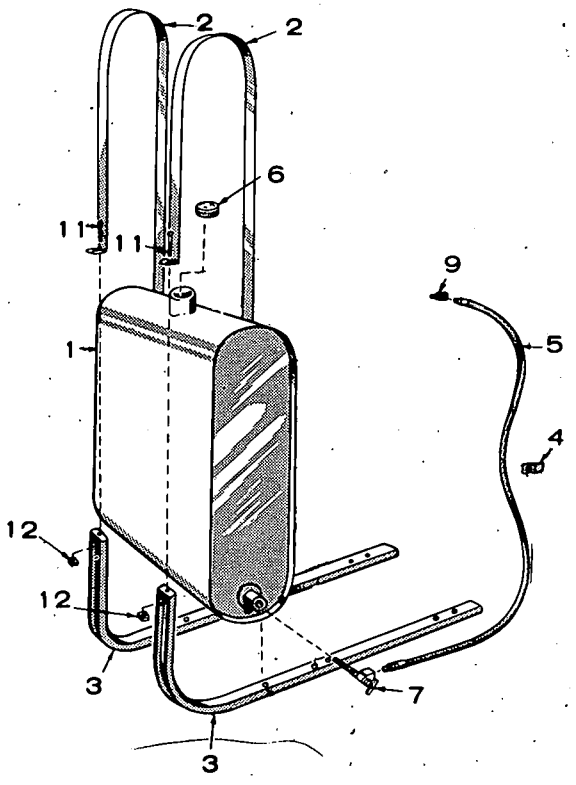


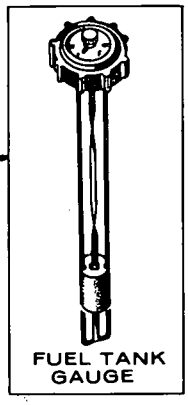
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134D2489	1	Housing, Cylinder Air - Left Side
2	HOUSING, BLOWER		
	134C2494	1	Standard
	134C2531	1	With Flywheel Guard - Optional
3	134B2488	1	Housing, Cylinder Air - Right Side
4	134B2483	1	Support, Blower Housing Baffle - Right Side
5	134B2487	1	Support, Blower Housing Baffle - Left Side
6	870-107	4	Nut, Tinnerman - Support to Blower Housing
7	809-59	4	Screw (1/4 x 1/2), Sheet Metal - Support to Blower Housing
8	821-10	2	Screw (1/4-20 x 1/2") - Blower Housing Mounting

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
9	815-261	1	Screw (1/4-20 x 7/16") - Blower Housing Mounting (Top Hole)
10	815-261	4	Screw (1/4-20 x 7/16") - Cylinder Air Housing Mtg.
11	815-370	4	Screw (1/4 x 1/2") - Support Mounting
12	405A1935	1	Hood Assembly, Engine (Include Parts Marked *) - Optional
13	405B1934	1	*Hood, Engine
14	405A1872	2	*Clip, Hood
15	818-150	4	*Rivet, Drive
16	526-3	4	*Washer, Flat
17	821-10	2	Screw (1/4-20 x 1/2") - Hood Mounting
18	870P258	2	Stud (1/4-20) - Hood Mounting

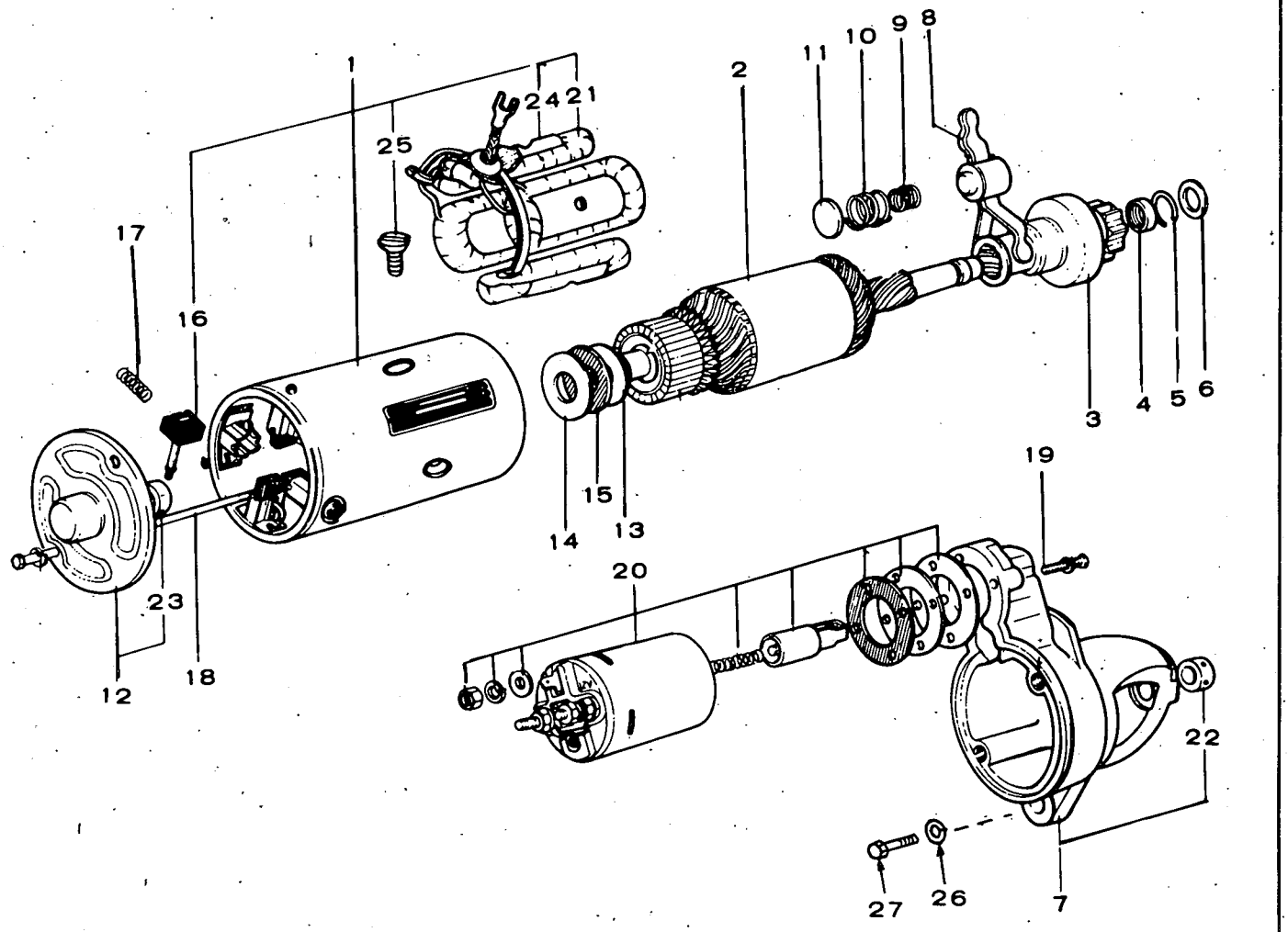
* - Included in Engine Hood Assembly.

SIDE MOUNTED FUEL TANK GROUP (OPTIONAL EQUIPMENT)





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	159B981	1	Tank, Fuel
2	159A596	2	Strap, Fuel Tank
3	159B595	2	Bracket, Fuel Tank
4	134A599	1	Clip, Fuel Line
5	501A8	1	Line, Fuel
6	159A7	1	Cap, Fuel Tank
7	504A13	1	Valve, Shutoff
8	505-57	1	Plug, Pipe (1/8)
9	502-20	1	Elbow, Fuel Pump to Fuel Line
10	193P207	1	Cap and Gauge Assembly, Fuel Tank
11	813-108	2	Screw (10-32 x 1-1/2") - Hold-down Strap to Bracket
12	870-53	2	Nut, Hex (10-32)

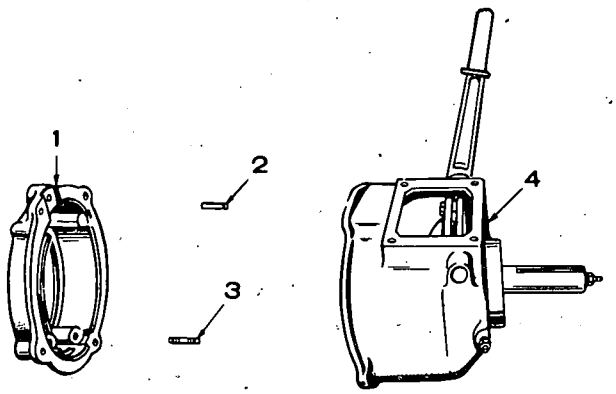


STARTING MOTOR PARTS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191D734	1	Motor Assembly, Starting
1	191-742	1	Yoke Assembly (Frame)--Includes Parts Marked *
2	191-743	1	Armature
3	191-744	1	Clutch, Starter
4	191-745	1	Stop, Pinion
5	191-746	1	Ring
6	191-747	1	Washer, Plain
7	191-748	1	Bracket Assembly, Front
8	191-749	1	Lever Assembly
9	191-750	1	Spring, Lever (A)
10	191-751	1	Spring, Lever (B)
11	191-752	1	Holder, Spring
12	191-753	1	Bracket Assembly, Rear
13	191-754	1	Washer, Plain
14	191-755	1	Washer, Plain
15	191-756	1	Washer, Insulator
16	191-757	4	*Brush
17	191-758	4	Spring, Brush
18	191-759	2	Bolt, Through
19	191-760	3	Screw, Machine P.H.
20	191-761	1	Switch Assembly, Solenoid
21	191-762	1	*Coil Assembly, Field
22	191-763	1	Bearing, Front
23	191-764	1	Bearing, Rear
24	191-765	4	*Pole Shoe
25	191-766	4	*Screw, Pan Head
26	850-50	2	Washer, Lock-Starter Motor Mounting
27	800-51	2	Screw, Hex Cap-Starter Motor Mounting

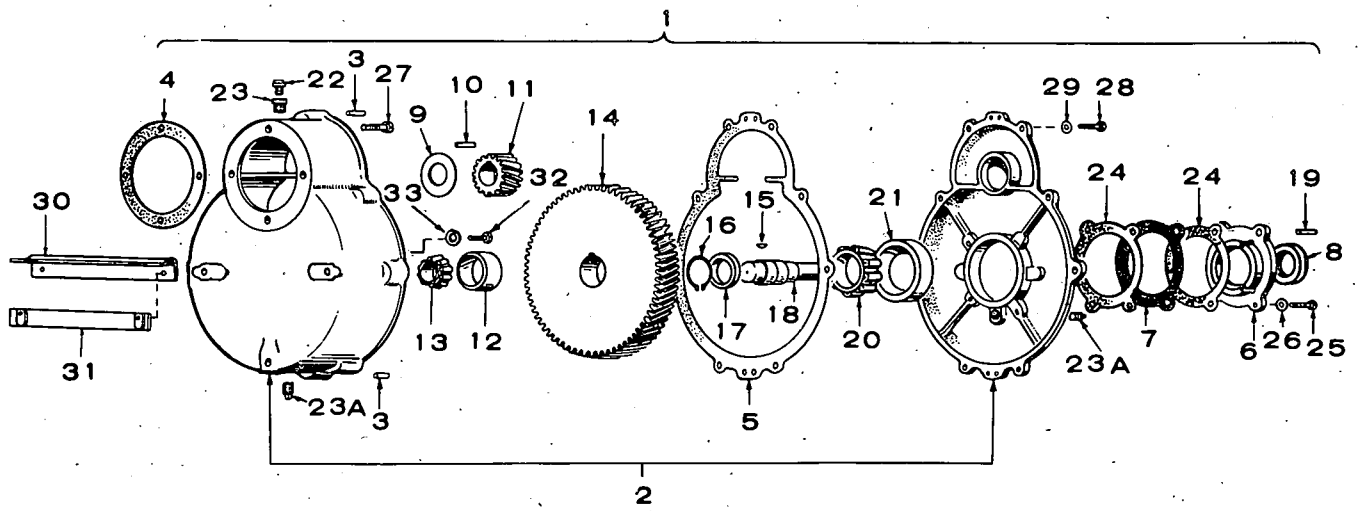
* Included in Yoke Assembly.

CLUTCH GROUP (OPTIONAL EQUIPMENT)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190D171	1	Adapter, Clutch to Engine
2	515A196	1	Key, Clutch
3	STUD, CLUTCH HOUSING TO ENGINE		
	520A738	1	3/8-16 x 4″
	520A739	2	3/8-16 x 3″
4	190D288	1	*Clutch Assembly
	190K289	1	Clutch Kit - Includes Complete Clutch, Adapter, Mounting Hardware & Instructions

* For component parts, check clutch nameplate and order by description from your nearest Rockford Dealer.

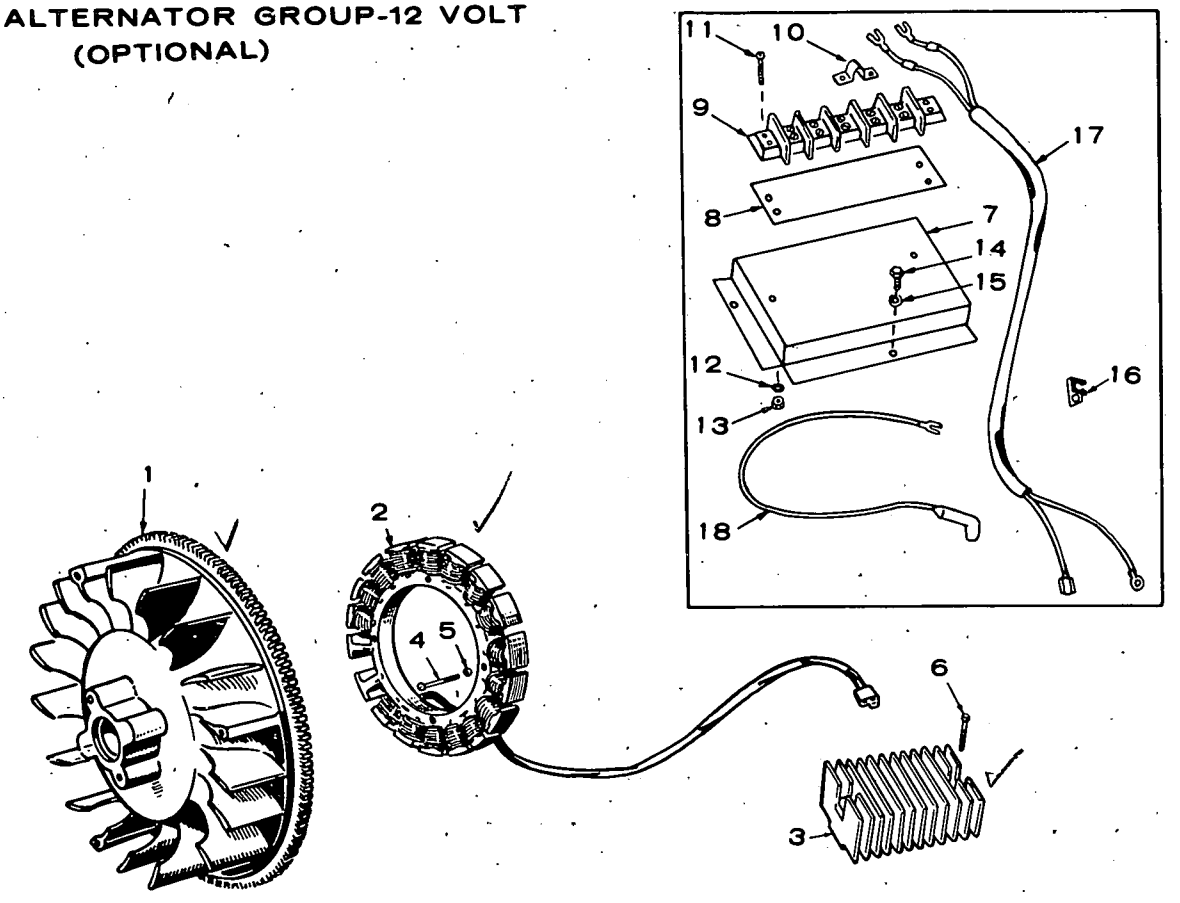


REDUCTION GEAR GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190C290	1	Reduction Gear Assembly (4-1) Complete
2	190A300	1	Housing - Includes Cover (Also Order 2 #516A12 Pins)
3	516A12	2	Pin, Dowel, Cover to Housing
4	190A20	1	Gasket, Housing to Engine
5	190B21	1	Gasket, Cover to Housing
6	190B16	1	Plate, Bearing Retainer
7	190A115	1	Shim Set, End Play Adjustment (1 Each .005″, .009″, .012″, .016″, .020″, .025″)
8	509-16	1	Seal, Oil, Retainer Plate
9	190A195	1	Washer, Pinion Gear
10	515A142	1	Key, Pinion Gear
11	190A191	1	Gear, Pinion
12	510-22	1	Cup, Roller Bearing, Engine End
13	510-21	1	Cone, Roller Bearing, Engine End
14	190B190	1	Gear, Driven
15	515A159	1	Key, Driven Gear
16	518-13	1	Ring, Snap, Retainer
17	190A202	1	Spacer, Bearing
18	190A192	1	Shaft, Take-Off
19	515A103	1	Key, Take-Off Shaft

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
20	510-23	1	Cone, Roller Bearing Take-Off End
21	510-24	1	Cup, Roller Bearing, Take-Off End
22	518P172	1	Vent
23	505-7	1	Bushing, Reducer (1/4 x 1/8)
23A	505-54	2	Plug, Pipe (1/4)
24	190A306	2	Gasket, Bearing Plate to Housing
25	800-7	4	Screw (1/4-20 x 1″) - Bearing Plate to Housing
26	526-63	4	Washer, Flat (Copper)
27	805-9	4	Bolt, Place (5/16-18 x 1″) - Housing to Engine
28	800-28	8	Screw (5/16-18 x 1″) - Cover to Housing
29	526-65	8	Washer, Flat (Copper)
30	190B297	1	Support, Housing Assembly
31	190A298	1	Fastener, Support - Housing Assembly
32	800-26	2	Screw (5/16-18 x 3/4″) - Housing to Support
33	526-65	2	Washer, Flat (Copper) - Housing to Support

CHARGING ALTERNATOR GROUP-12 VOLT (OPTIONAL)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134C2462	1	Flywheel Assembly (Includes Ring Gear and Magnet Ring) - (Also Listed in the Crankshaft and Flywheel Group)
2	191B885	1	Stator
3	191A886	1	Regulator
4	813-108	3	Screw (10-32 x 1-1/2″) - Stator to Gear Cover
5	850-30	3	Washer, Lock - Stator Mounting
6	821-18	2	Screw (1/4-20 x 3/4″) - Regulator Mounting
7	301B3530	1	Bracket, Terminal Block
8	332A1273	1	Strip, Marker
9	332A604	1	Block, Terminal (5 Place)
10	332C1043	1	Jumper, Terminal Block
11	812-82	2	Screw (8-32 x 3/4″) - Terminal Block to Bracket
12	850-25	2	Washer, Lock (#8) - Terminal Block to Bracket
13	860-8	2	Nut (8-32) - Terminal Block to Bracket
14	813-100	2	Screw (10-32 x 1/2″) - Bracket to Cylinder Block
15	856-3	2	Washer, Lock (#10)
16	167A188	1	Clip, Regulator Harness
17	338A619	1	Harness, Wiring - Start Solenoid to Terminal Block
18	336A2132	1	Lead Assembly - Terminal Block to Coil

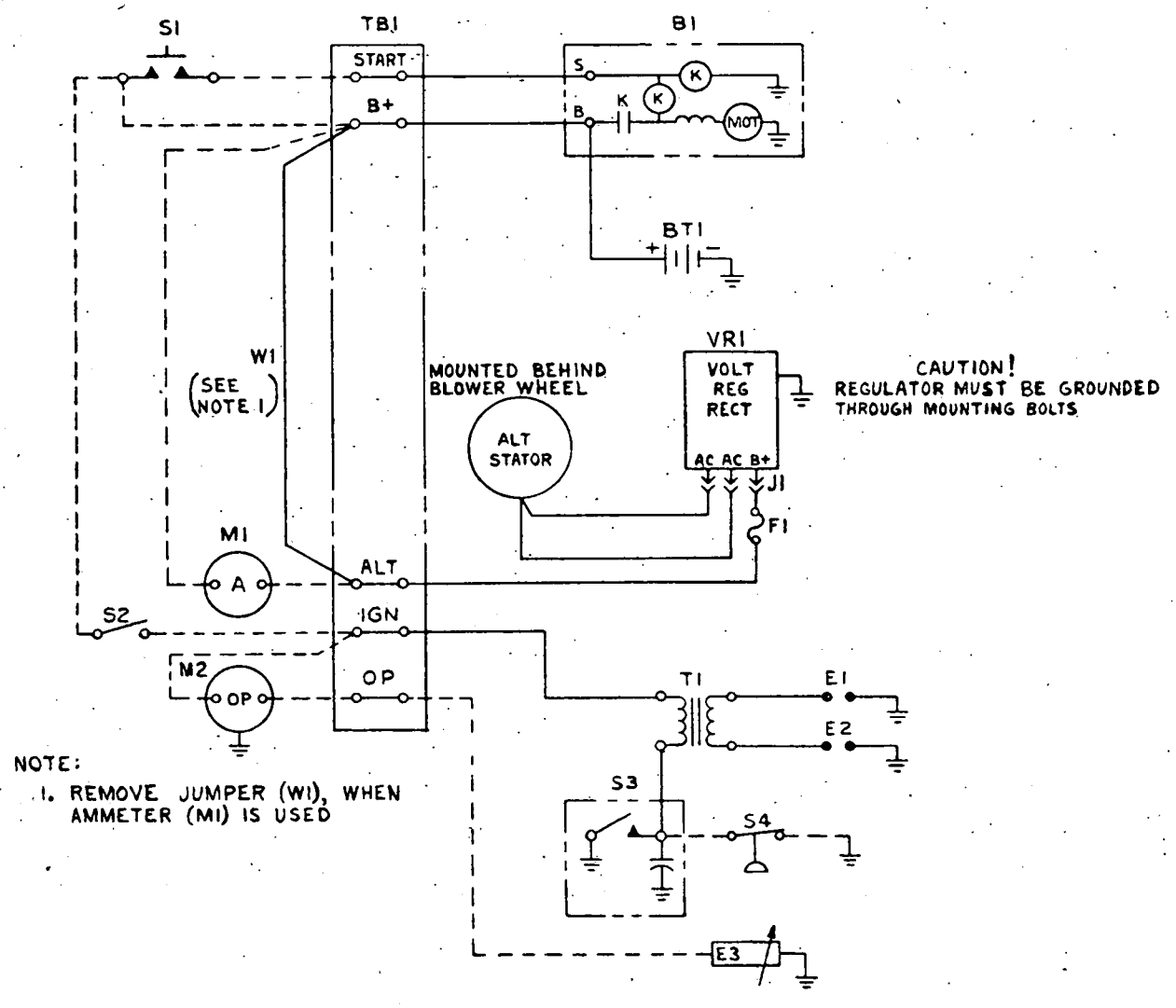
SERVICE KITS AND MISCELLANEOUS

NOTE: For other kits, refer to the group for the part in question.

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	98C1807	1	Decal Kit
	168K122	1	Gasket Kit, Complete Engine
	168K121	1	Gasket Kit, Carbon Removal
	160K1161	1	Ignition Tune-up Kit
	522K265	1	Overhaul Kit, Engine
	TOUCH-UP PAINT (Pressurized Can)		
	525-137	As Req.	Metallic Green (16 Oz.)
	525-305	As Req.	Non-Metallic Green (13 Oz.)

	PARTS LIST (REF)			
	REF DES.	PART NO.	QTY	DESCRIPTION
	B1		1	STARTER & SOLENOID - ENGINE
	BT1		1	BATTERY - 12 V.
	E1, 2		2	SPARK PLUG
*	E3		1	SENDER - OIL PRESSURE
	F1		1	FUSE, 35 AMP
	G1		1	ALTERNATOR
	J1		1	CONNECTOR
*	M1		1	AMMETER
*	M2		1	METER - OIL PRESSURE
	S1		1	SWITCH - START
	S2		1	SWITCH - IGNITION
	S3		1	BREAKER & CAP. ASSEMBLY
*	S4		1	SWITCH - LOPKO
	T1		1	COIL - IGNITION
	TB1		1	BLOCK - TERMINAL
			1	STRIP - MARKER
	VR1		1	REGULATOR - VOLTAGE
	W1		1	JUMPER (SEE NOTE 1)

* WHEN USED



ENGINE WIRING DIAGRAM (INCLUDES FLYWHEEL ALTERNATOR)

CUSTOMER SERVICES

OWNER'S WARRANTY SERVICE - ENGINE DRIVEN ELECTRIC GENERATOR SETS, SEPARATE GENERATORS, INDUSTRIAL ENGINES

QUALITY OF PRODUCT

Onan products are engineered and designed to perform as stated on product nameplate and published specification. Only quality material and workmanship are used in the manufacture of this product. With proper installation, regular maintenance and periodic repair service, the equipment will provide many enjoyable hours of service.

GENERAL WARRANTY PRACTICES

All Onan-manufactured engine-driven electric generator sets, separate generators, and industrial engines are sold with a full one-year warranty. This warranty is issued only to the original user and promises that these products are free from defects in material or factory workmanship when properly installed, serviced, and operated under normal conditions, according to the manufacturer's instructions. The text of the Onan published warranty appears in the Onan Operator's Manual sent with the product.

Warranty Registration: A Warranty Registration card accompanies each Onan Product. This card must be properly filled out and returned to the Onan Factory in order to qualify for warranty consideration as covered in this bulletin. When requesting warranty repair work you must provide the purchase date, Onan model and serial number of the equipment.

Warranty Authorization: Warranty service must be performed by Onan Factory or Onan Authorized Distributors or their Approved and Registered Service Dealers. A complete listing of these Onan Authorized Parts and Service Centers is provided in our brochure F-115, a copy of which is supplied with each Onan Product. These Onan Authorized Service Centers have trained service personnel, parts stock, and the necessary facilities and tools for the service and repair of Onan equipment.

Material Allowances: Onan will allow credit or furnish free of charge to the Onan Authorized Service Station or his Approved Service Dealer, all genuine Onan parts used in a warranty repair of these products which fail because of defective material or workmanship.

Labor Allowance: Onan will allow warranty repair credit to the Onan Authorized Parts and Service Center and his Approved Dealer at straight time labor when the cause of failure is determined to be defective material or factory workmanship. This labor allowance will be based on the factory's standard time schedule of published flat rate labor allowances, or, otherwise a time judged reasonable by the factory. Repair work other than warranty will be charged to the owner. The Onan Division's Warranty practice does not provide for allowance of expenses such as start-up charges, communication charges, transportation charges, travel time and/or mileage, unit removal or installation expense, cost of fuel, oil, normal maintenance adjustments, tune-up adjustments or parts maintenance items.

Administration: Warranty of Onan Products is administered through Onan Authorized Distributors in whose territory the equipment is located. These Distributors and their Approved or Registered Onan Service Dealers are authorized to make settlement of all customer warranty claims within the limits of the manufacturer's warranty policy as described herein.

Onan reserves the right to change warranty practices without prior notice.

MAINTENANCE

A Planned Preventive Maintenance Program is extremely important if you are to receive efficient operation and long service life from your Onan unit. Neglecting routine maintenance can result in premature failure or permanent damage to your equipment. The Onan Operator's Manual sent with the product contains recommended maintenance schedules and procedures.

Maintenance is divided into two categories:

1. Operator Maintenance . . . . . performed by the operator.
2. Critical Maintenance . . . . . performed only by qualified service personnel.

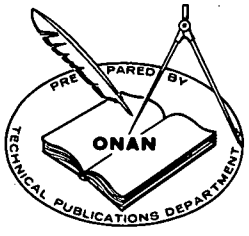
Regular maintenance will help you avoid sudden and costly repairs in the future. Adequate evidence of this scheduled maintenance must be offered when applying for a warranty claim.

INSTALLATION

Installation is extremely important and all Onan Products should be installed in accordance with the manufacturer's recommendations. If the owner experiences any difficulty with such items as mounting, ventilation, exhaust location, fuel lines, wiring, etc., he should immediately contact the company from whom he purchased the equipment so that corrective action can be taken. Although the Onan Authorized Distributor and his Approved or Registered Service Dealers may be able to remedy certain installation difficulties, such repair work is not considered Onan warranty and there will be a charge for this service.

Onan

Minneapolis, Minnesota 55432



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Onan®

OPERATOR'S/SERVICE MANUAL AND PARTS CATALOG

FOR

SERIES

NHC

INDUSTRIAL ENGINES

add
Timing
Gear Marks.
add
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info

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ONAN INDUSTRIAL ENGINES

NHC

SERIES

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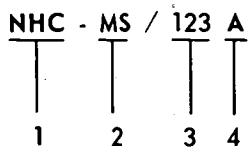
GENERAL INFORMATION

This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of the engine. Since the first and most important part of repair work is the correct diagnosis of the trouble, a trouble-shooting chart is included.

Study and follow the instructions carefully. Proper service and maintenance will result in longer engine life and better performance.

How To Interpret MODEL and SPEC NO.



1. Factory code for general identification purposes.
2. Specific Type:
   S - MANUAL starting with stub shaft power take off.
   MS - ELECTRIC starting with stub shaft, starter and generator.
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.

Onan

MANUFACTURER'S WARRANTY

Onan warrants, to the original user, that each product of its manufacture is free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to Onan's instructions.

Onan will, under this warranty, repair or replace, as Onan may elect, any part which on examination shall disclose to Onan's satisfaction to have been defective in material and workmanship; provided that such part shall be returned to Onan's factory or one of its Authorized Service Stations, transportation charges prepaid, not later than one (1) year after the product is first placed in service. Such defective part will be repaired or replaced free of charge, including labor (in accordance with rates approved by Onan) during the stated one (1)-year coverage under this warranty.

THIS WARRANTY AND ONAN'S OBLIGATION THEREUNDER IS IN LIEU OF ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER OBLIGATIONS OR LIABILITIES, INCLUDING LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGE.

No person is authorized to give any other warranty or to assume any other liability on Onan's behalf unless made or assumed in writing by an Officer of Onan, and no person is authorized to give any warranty or to assume any liabilities on the Seller's behalf unless made or assumed in writing by such Seller.

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SPECIFICATIONS

	NHC-MS/1
Number of Cylinders	2
Displacement (cubic inch)	60
Cylinder Bore	3-9/16 in.
Piston Stroke	3 inch
Horsepower	25 BHP @ 3600 rpm
Compression Ratio	7.0 to 1
Ventilation Required (cfm @ 3600 rpm)	1080
Oil Capacity	3-1/2 qt.
Oil Capacity With Filter Change	4 qt.
Starting	Electric
Ignition	Battery
Combustion Air (cfm @ 3600 rpm)	80
Fuel	Gasoline (regular grade)
Fuel Pump	Diaphragm, 4 ft. lift

TUNE-UP SPECIFICATIONS

Spark Plug Gap	.025″
Breaker Point Gap	.020″
Ignition Timing (Fixed), Electric Start Units	25°BTC
Tappets (Cold) Intake	.003″
Exhaust	.012″

NOTE: For gaseous fuel operation set spark plugs at .018″ and ignition timing at 26°BTC and exhaust valve lash at .014″.

DIMENSIONS AND CLEARANCES

All clearances given at room temperature of 70°F.
All dimensions in inches unless otherwise specified.

	Minimum	Maximum
Valve Tappet Clearance		
Intake	0.003	
Exhaust	0.012*	
Valve Stem in Guide – Intake	0.001	0.0025
Valve Stem in Guide – Exhaust	0.0025	0.004
Valve Spring Length		
Free Length	1.662	
Compressed Length	1.375	
Valve Spring Tension (lb.)		
Open	71	79
Closed	38	42
Valve Seat Bore Diameter		
Intake	1.5645	1.5655
Exhaust	1.2510	1.2520
Valve Seat Diameter		
Intake	1.569	1.570
Exhaust	1.255	1.256
Valve Stem Diameter		
Intake	0.3425	0.3430
Exhaust	0.3410	0.3415
Valve Guide Diameter (I.D.)	0.344	0.346
Valve Lifter Diameter	0.7575	0.7480
Valve Lifter Bore	0.7505	0.7515
Valve Seat Interference Width	1/32	3/64
Valve Face Angle	44°	
Valve Seat Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing	0.0025	0.0038
Crankshaft End Play	0.005	0.009
Camshaft Bearing	0.0015	0.003
Camshaft End Play	0.003	–
Camshaft Lift	0.300	
Camshaft Bearing Diameter	1.3760	1.3770
Camshaft Journal Diameter	1.3740	1.3745
Rod Bearing (Forged Rod)	0.0005	0.0023
Connecting Rod End Play (Ductile Iron)	0.002	0.016
Timing Gear Backlash	0.002	0.003
Oil Pump Gear Backlash	0.002	0.005
Piston to Cylinder, Strut Type (Measured below oil-controlling ring – 90° from pin) Clearance	0.0015	0.0035
Piston Pin Diameter	0.7500	0.7502
Piston Pin in Piston	Thumb Push Fit	
Piston Pin in Rod	0.0001	0.0005
Piston Ring Groove Width		
Top 1	0.0955	0.0965
Top 2	0.0955	0.0965
Top 3	0.1880	0.1890

Piston Ring Gap in Cylinder	0.010	0.020
Piston Ring Side Clearance (Top compression ring only)		0.006
Breaker Point Gap (Full Separation)		0.020
Spark Plug Gap – For Gasoline Fuel		0.025
Crankshaft Main Bearing Journal – Standard Size	1.9992	2.0000
Main Bearing Diameter	2.0015	2.0040
Main Bearing Clearance	0.0015	0.0043
Crankshaft Rod Bearing Journal – Standard Size	1.6252	1.6260
Cylinder Bore – Standard Size	3.5625	3.5635

* Set exhaust valve at .014 for gaseous fuel operation.

ASSEMBLY TORQUES AND SPECIAL TOOLS

TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often with the engine cold. Tighten as needed to prevent them from working loose.

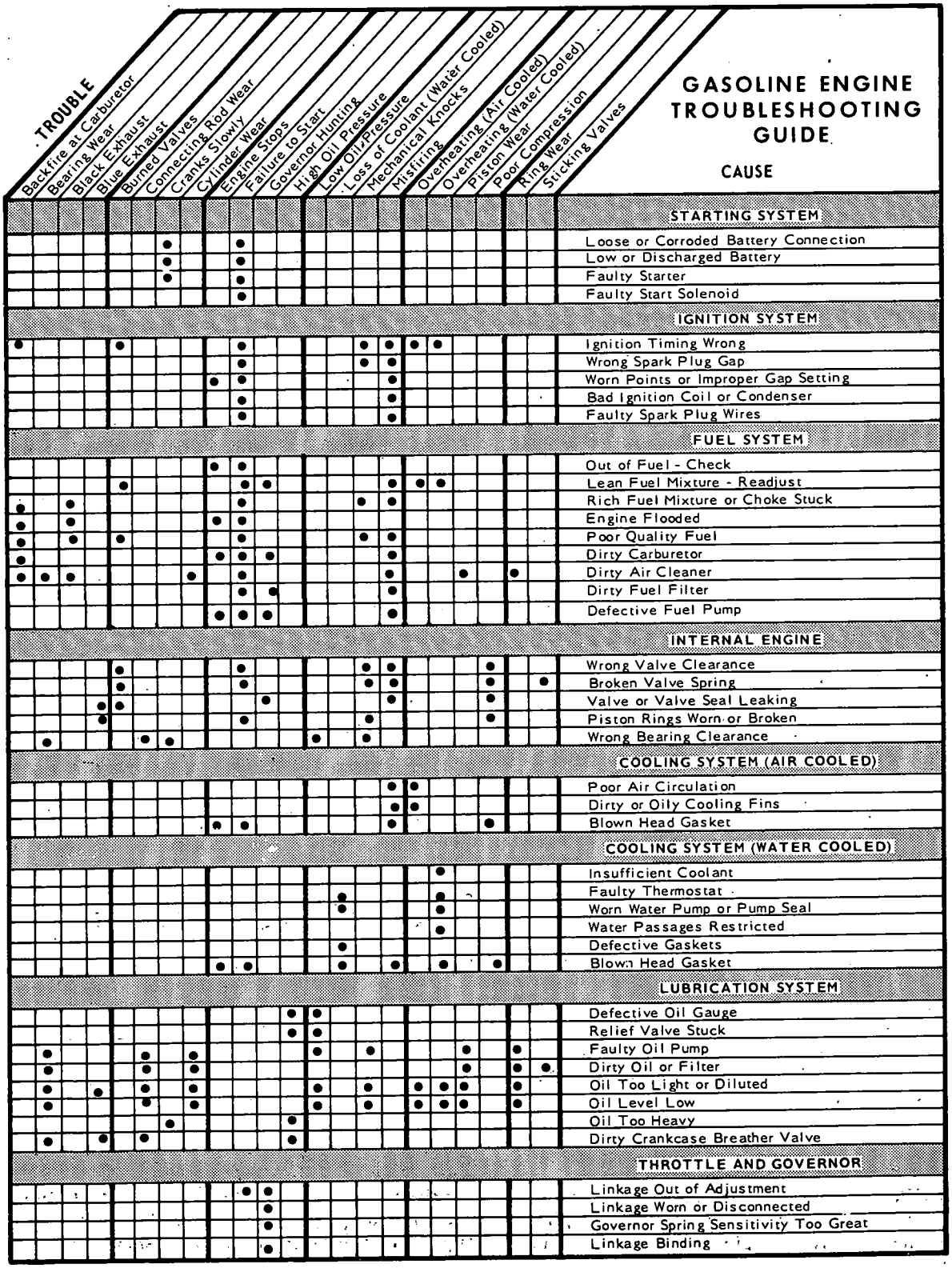
TORQUE SPECIFICATIONS	Ft.-Lb.
Cylinder Head Nuts	17-19
Rear Bearing Plate	20
Connecting Rod Bolt	27-29
Flywheel Capscrew	30-35
Starter Mounting Bracket to Oil Base Screws	43-48
Gear Case Cover	8-10
Oil Pump	7-9
Other 3/8 Cylinder Block Nuts	18-23
Intake Manifold	18-20
Exhaust Manifold	10-12

SPECIAL TOOLS

These tools are available from Onan to aid service and repair work.

Crankshaft Gear Pulling Ring	420A248
Flywheel Puller	420A100
Combination Bearing Remover, Main and Cam	420A325
Combination Bearing Driver, Main and Cam	420B324
Valve Guide Driver	420A300
Valve Seat Driver	420A308
Valve Seat Staker Intake	420A309
Exhaust	420A310
Valve Seat Cutter	420A311
Oil Seal Guide and Driver Bearing Plate	420B181
Gear Cover	420B313
Timing Advance Mech. Cover Driver	420A296

ENGINE TROUBLESHOOTING



INSTALLATION

The type of installation can affect the life of the engine, the cost of operation and the frequency of necessary service. Plan the installation carefully to ensure the best performance.

Because of the great variety of uses, and the many variations of the engine, these installation instructions are typical or general in nature. Use the installation recommendations given as a general guide, improvising or altering as necessary.

MOUNTING

There are several acceptable methods of mounting the engine. Among factors to be considered are: location, method of coupling the engine to the load, type of foundation or support, etc. The engine should be mounted on a level surface if possible. Maximum operation angle is 15° sideways, 30° front to rear tilt. If the engine is to operate at an angle, be sure to remark the oil level indicator to compensate for the tilt.

VENTILATION

The engine must be provided with a supply of fresh air for cooling and for combustion.

Pressure Cooled Engine: Position the air inlet opening directly in front of the engine and as close to the engine blower wheel as possible. The area of the inlet should be not less than 80 square inches. If louvers or grill work are used, increase the area to compensate for the reduced air flow. Provide extra ventilation if the driven load generates heat during operation.

The heated air outlet must allow the heated air to escape freely and prevent recirculation with the cooling air. A duct between the compartment air inlet and the engine blower housing may be necessary. Locate the air outlet opposite the intake or at least at a 90° angle. The area of the outlet should be at least 15% larger than that of the inlet. Allow sufficient room on all sides to permit access for servicing.

Open Air Installation: For installations where the engine is operated outside, ventilation will be no problem. However, in protecting the engine from the elements, see that nothing obstructs the flow of air around the engine.

EXHAUST

Pipe *POISONOUS* exhaust gas outside enclosure. Use a length of flexible tubing between the engine exhaust outlet and any rigid piping to absorb engine vibration. Shield the line if it passes through a combustible wall or partition. If turns are necessary, use sweeping type (long radius) elbows. Increase one pipe size (from manifold outlet size) for each additional ten feet in length. Locate the outlet away from the air intake.

CARBURETOR AIR INTAKE

Proper engine efficiency depends upon a supply of fresh air to the carburetor. Under special conditions, it may be necessary to move the air cleaner off the engine, using a longer connection hose as necessary. For extremely dusty or dirty conditions, install a special heavy duty air cleaner.

FUEL SYSTEM

The engine uses a diaphragm type fuel pump. The fuel pump has a 1/8″ pipe thread inlet, fitted with a 1/4″ inverted flare tube fitting. If a solid wall line is used, form a loop in the line, or install a section of flexible fuel hose, to absorb vibration. If a line with a pipe thread end is used, remove the flare type fitting from the fuel pump inlet.

The fuel supply tank may be installed in any safe, convenient location. If the tank is installed within the engine enclosure, provide a vent line to the outside of the enclosure.

The installation of a fuel filter between the fuel tank and the fuel pump is recommended. The fuel filter should be fitted with a shutoff valve and should be easily accessible for cleaning.

CONNECTING TO THE LOAD

The dimensions of various power takeoff shafts are as follows:

SHAFT	DIAMETER	LENGTH	KEY SIZE
STD	1-7/16	3-1/16	3/8
Rockford Clutch	1-7/16	3-1/16	3/8
Gear Reduction	1-1/4	2-3/4	1/4

Belt Drive: V-belts are preferable to flat belts. Consult a reliable belting supplier for recommendations regarding size of pulleys, number of belts, etc. required. A typical belt drive installation is shown in Figure 1.

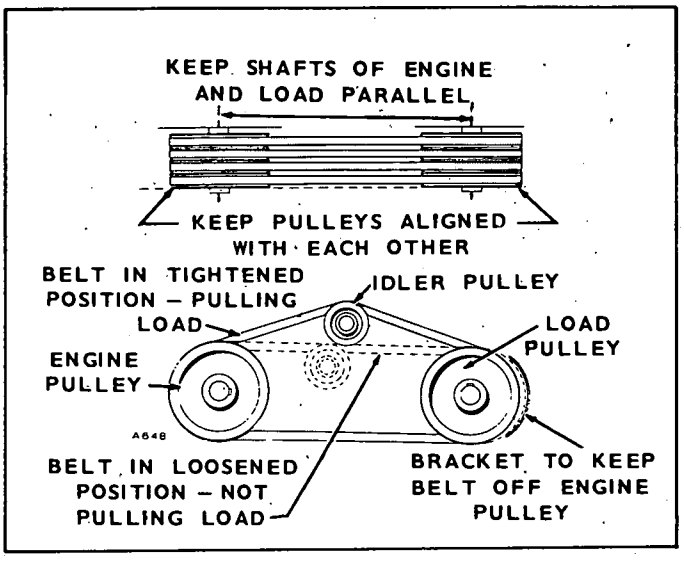


FIGURE 1. DRIVE BELT INSTALLATION

Comply with the following installation requirements:

1. The shafts of the engine and the load must be parallel with each other.
2. The pulleys of the engine and the load must be in alignment.
3. Mount the engine pulleys as close to the engine as possible.
4. If the installation permits, belts should run horizontally.
5. Some method of disconnecting the load for starting is recommended. If a clutch is not used, a belt-tightener idler arrangement can be used.

Flexible Coupling: If a flexible coupling engine-to-load drive is used, the load shaft must be in line and centered with the engine shaft (Figure 2).

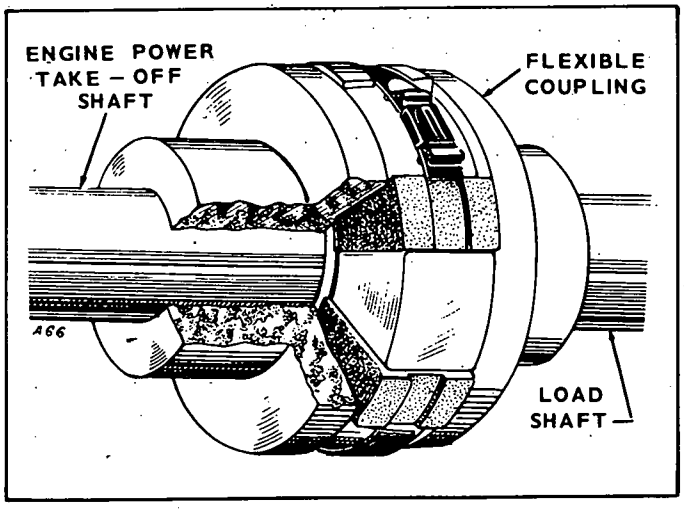


FIGURE 2. FLEXIBLE COUPLING

Reduction Gear Drive: Reduction gear drives are mounted at the factory (when ordered). The method of connecting the load is the same as when connecting directly to the engine shaft.

Clutch Installation: A Rockford Clutch can be installed at the factory or in the field. Install the clutch according to the following instructions and Figure 3.

Provide room for the clutch adapter casting by plugging the wet holes with a 3/8-16 x 1/2" slotted headless set screw. Apply sealing compound to the threads and install screw flush with the cylinder block.

Drill a 13/64" hole (or filed slot) in the crankshaft for the clutch set screw. Locate center of hole 11/32" from the end and directly opposite the keyway in the crankshaft.

Install the clutch adapter, with drain slot downward, using two cap screws 3/8-16 x 2" on the lower and one cap screw 3/8-16 x 1-3/4" on the upper #2 cylinder side (cylinder nearer clutch). Install the 3/8 x 3-7/8" stud through the adapter into the engine block upper remaining hole. Use a lock washer on each assembly screw. Use a flat washer and a lock washer under the stud nut.

Install the crankshaft key. Remove the clutch set screw. Install the clutch assembly (less housing) to the crankshaft, driving it on carefully with a soft-faced hammer until set screw hole is aligned. Install set screw to bottom in crankshaft hole, then back it out one full turn. Tighten clutch retaining screws until clutch is clamped securely to crankshaft. Lock the screws and tighten the set screw.

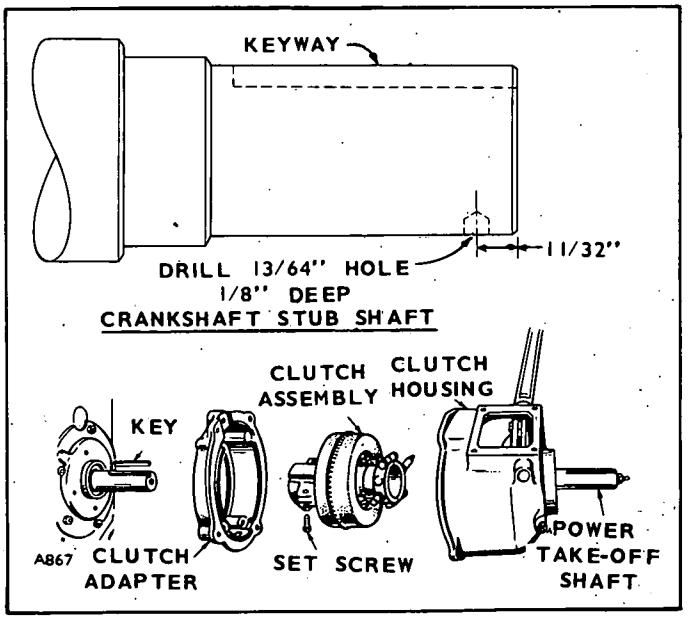


FIGURE 3. CLUTCH INSTALLATION

Apply grease to splined power takeoff shaft. Position the clutch throw-out to align the grease fitting with the hole in the housing (#1 cylinder side, horizontal). Pull the throw-out collar outward to remove tension.

Install the clutch housing so that the clutch throw-out fork engages the throw-out collar. Be sure the serrated shaft is properly meshed with the clutch plate. Use two cap screws 7/16-14 x 2″ on the lower and one cap screw 7/16-14 x 1-3/4″ on the upper #2 cylinder side. Install the stud washer and nut. Lubricate the two grease fittings just until grease appears.

BATTERY CABLE CONNECTIONS (Engines with Automotive Type ~~Separate~~ Starter)

Connect the 12 volt battery positive cable to the engine starter switch terminal. Connect the battery negative cable to the ground point on the engine oil base (Figure 4).

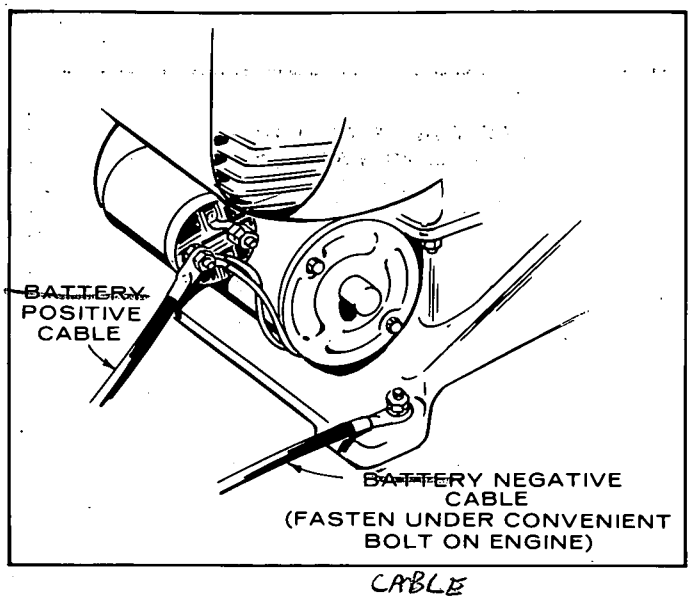


FIGURE 4. BATTERY CABLE CONNECTIONS

OPERATION

BEFORE STARTING

Crankcase Oil: Be sure the crankcase has been filled with oil to the "FULL" mark on the oil level indicator. Use a good quality oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines.

Recommended Fuel: Use clean, fresh, regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

CAUTION *If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, preignition could occur causing severe damage to the engine.*

Never fill the tank when the engine is running. Leave some space in the tank for fuel expansion. Open the fuel line valve (when used) and operate primer to assure fuel supply.

STARTING (Electric Start)

1. Move the ignition switch to its ON position.
2. Push the START button to crank the engine.

If the engine fails to start at first attempt, inhibitor oil used at the factory may have fouled the spark plugs. Remove the plugs, clean in suitable solvent, dry thoroughly and install. Heavy exhaust smoke when the engine is first started is normal and is caused by inhibitor oil.

STARTING (Manual Start)

1. Close the choke about three quarters of the way or as necessary according to temperature conditions.
2. Pull the start rope with a fast steady pull to crank the engine. Do not jerk.

APPLYING LOAD

When applying the load to a new or reconditioned engine; it should be applied gradually in about four steps; each step of not less than 30 minutes running time. Start with 1/4 load, then 1/2, 3/4 and full load.

BATTERY CHARGING

The battery charge rate is controlled by a charge regulator. The regulator is set to allow the proper rate of charge at operating speed.

STOPPING THE ENGINE

Disconnect all load before stopping the engine. Engines equipped with battery ignition are stopped by the ignition switch to the OFF position.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the engine.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow, but use care to avoid overheating.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often than recommended under normal conditions.
4. Keep oil and gasoline in dust tight containers.
5. Keep governor linkage clean.

OUT-OF-SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows:

1. Run unit until thoroughly warm.
2. Turn off fuel supply and run until unit stops.
3. Drain oil from oil base while still warm. Refill and attach a warning tag stating oil viscosity used.
4. Remove each spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50 oil) into each cylinder. Crank engine slowly (by hand) several times. Install spark plug.
5. Service air cleaner.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery is used, disconnect and follow standard battery storage procedure.

SERVICE AND MAINTENANCE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS						
	8	50	100	200	500	1000	5000
Inspect Engine Generally	x						
Check Fuel Supply	x						
Check Oil Level	x						
Clean Governor Linkage		x*					
Change Crankcase Oil		x1	x*				
Check Breaker Points			x				
Check Battery Electrolyte Level			x				
Clean Fuel Filter			x				
Check Spark Plugs			x				
Replace Oil Filter				x*			
Replace Air Cleaner				x*			
Remove Deposits in Combustion Chamber					x		
Check Valve Clearance					x		
Inspect Valves, Grind if Necessary						x	
Complete Reconditioning							x

x* - Perform more often under dusty or extreme cold weather conditions.
x1 - Recommended interval in hot weather or heavily loaded natural gas and propane operation.

PERIODIC MAINTENANCE SCHEDULE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The above schedule can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, etc. frequently until the proper service time periods can be established. When any abnormalities occur in operation – unusual noises from engine or accessories, loss of power, overheating, etc. – contact your Onan dealer.

CRANKCASE OIL

The oil capacity is 3-1/2 U.S. quarts (4 with filter). Fill to the "FULL" mark on the oil level indicator. Use a good quality, detergent oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines. Ambient temperatures must be the factor for determining the proper SAE oil weight.

IMPORTANT: *Use low ash content oils .03-.85 percent by weight with natural gas or propane fueled engines.*

NOTE: *If oils with these designations are not yet available, use oil with the API designation MS, MS/DG or MS/DM which has passed all the Automotive Manufacturer's Sequence Tests and the MIL-L-2104B Tests. Don't use an oil with the API designation DS.*

When adding oil between changes, always use the same brand and weight that is in the crankcase. Various brands of oil may not be compatible when mixed together.

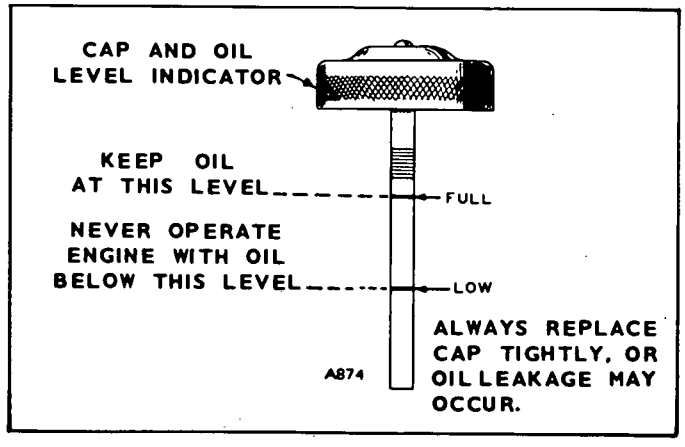


FIGURE 5. OIL LEVEL INDICATOR

Oil consumption may be higher with a multigrade oil than with a single grade oil if both oils have comparable viscosities at 210°F. Therefore, single grade oils are generally more desirable, unless anticipating a wide range of temperatures. Use the proper grade oil for the expected conditions.

TEMPERATURE	GRADE
Below 0°	5W
0° to 30°	10W
30° to 90°	30
Above 90°	50

Check oil level daily. Change oil every 100 hours under normal operating conditions. When operating in extremely dusty or dirty conditions, change oil more often.

Change the crankcase oil filter every 200 hours. Remove the filter by turning counterclockwise, using a filter wrench. Add the strip provided with the filter to prevent air loss in the area indicated. It is advisable to wipe dry the drip pan located below the filter. Coat rubber gasket on filter with a film of oil before installing. Install the filter finger-tight plus 1/4 to 1/2 turn. If oil becomes so dirty that the markings on the oil level indicator cannot be seen, change the filter and shorten the filter service period.

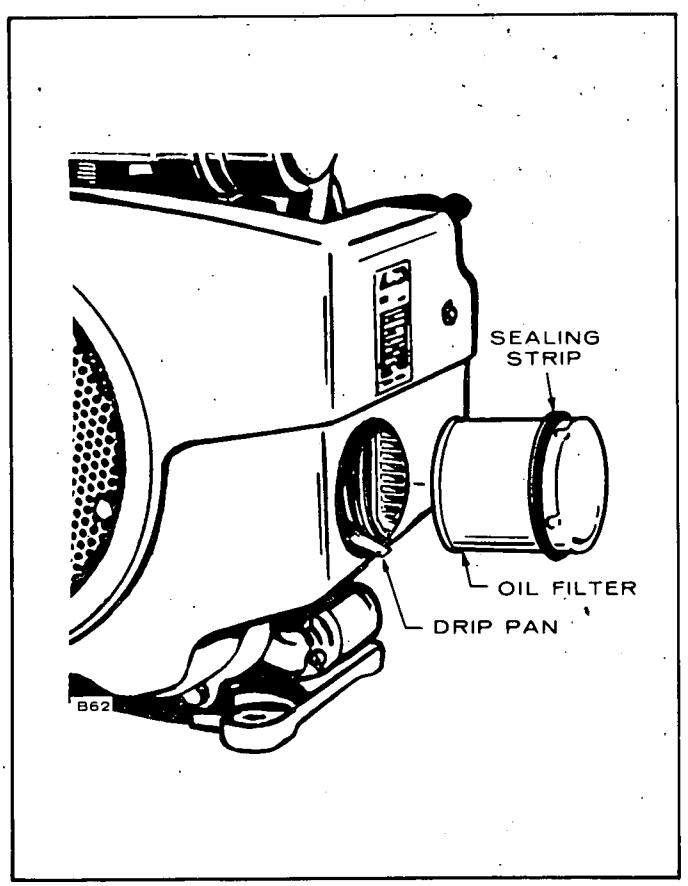


FIGURE 6. OIL FILTER LOCATION

CRANKCASE BREATHER

The engine is equipped with a ball check valve for maintaining crankcase vacuum. No maintenance is generally required. Should the crankcase become pressurized, as evidenced by oil leaks at the seals or around the cap of the oil level indicator, clean baffle in suitable solvent.

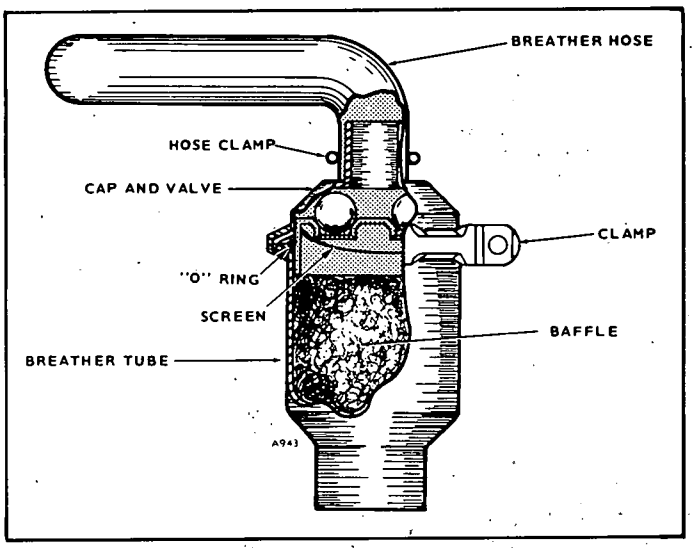


FIGURE 7. CRANKCASE BREATHER

AIR CLEANER

The NHC engine uses a replaceable, spin-on air cleaner. Remove and replace every 200 hours.

CAUTION *Do not run engine with air cleaner removed.*

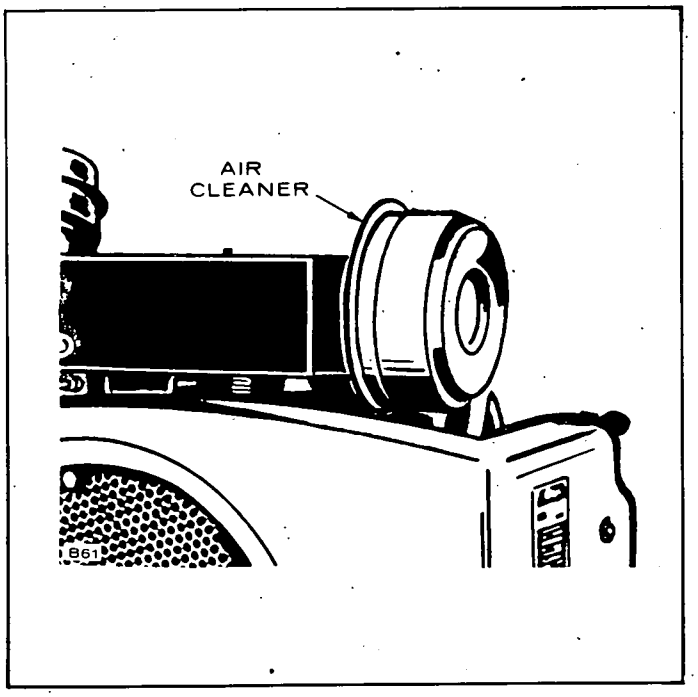


FIGURE 8. AIR CLEANER

GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Every 50 hours of operation clean the metal joints as shown in Figure 9. Also inspect the linkage for binding, excessive slack and wear.

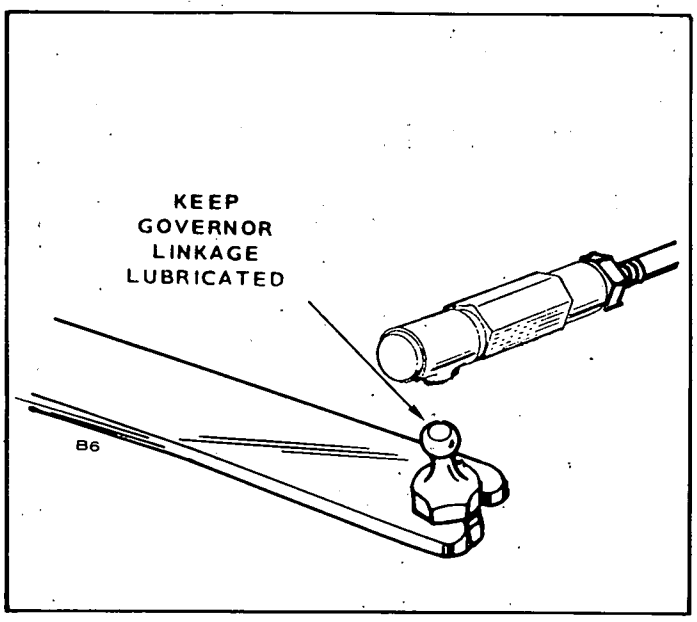


FIGURE 9. GOVERNOR LINKAGE

REDUCTION GEAR DRIVE

Drain the gear box after the first 100 hours of operation and refill with fresh lubricant of the recommended grade. Repeat this procedure every six months thereafter, or every 100 hours.

Use only SAE50 motor oil or SAE90 mineral gear oil. Do not use lubricants commonly known as extreme pressure lubricants, hypoide lubricants, etc.

Maintain the proper oil level between changes. Overfilling will cause foaming, which can lead to an oil leak due to overheating. Remove the filler plug on top of the case and the oil level plug from the face of the gear case. Fill the case until the oil just begins to flow from the oil level plug hole. Gear box holds 1/2 pint U.S. measure. Replace both plugs. See Figure 10.

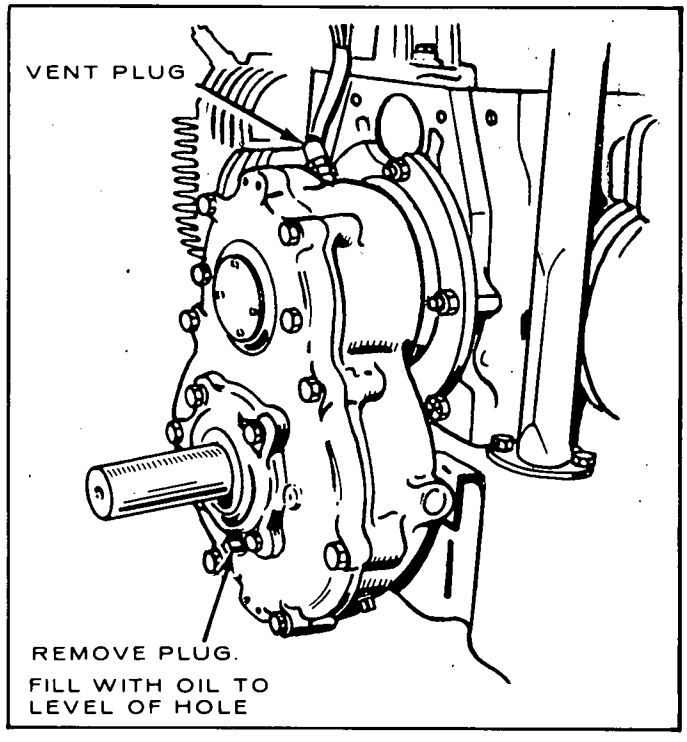


FIGURE 10. REDUCTION GEAR DRIVE

FUEL SYSTEM

GASOLINE CARBURETOR

For correction of problems traced to the gasoline carburetor, use the appropriate procedures selected from the following sequence, referring to Figures 11 and 13.

Adjustment Under Load: Adjust the carburetor as follows when a full load can be applied.

1. Make sure the ignition system is working properly and that the governor is adjusted.
2. Start the engine and allow it to warm up. If the carburetor is so far out of adjustment that the engine will not start, close both needle valves gently to their seats. Then open each 1 to 1-1/2 turns, first the idle and then the main adjustment.
3. With no load applied to engine, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until the engine speed returns to normal.
4. Apply a full load to the engine and then carefully turn the main adjustment in until the speed drops slightly below normal. Turn the needle out until the engine speed returns to normal.

Adjustment Under "No Load" Conditions: When a load cannot be applied, adjust the carburetor as follows:

1. Perform steps 1 and 2 as given under Adjustment Under Load.
2. Pull out on the governor mechanism to slow the unit down to about 400-500 rpm.
3. Set the idle adjustment screw for even operation (so the engine is firing on both cylinders and is running smoothly).
4. Release the governor mechanism to allow the engine to accelerate. If the engine accelerates evenly and without a lag, the main adjustment is correct. If not, adjust the needle outward about 1/4 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.
5. With the carburetor and governor adjusted, set the throttle stop screw at the desired idle speed.

Float-Level Check: If the carburetor adjustment fails to provide satisfactory operation, remove the carburetor and check the float level as follows:

1. Remove the fuel line, air cleaner hose, governor linkage and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Unscrew the float bowl nut and remove the entire main fuel adjustment assembly from the float bowl.
4. Invert the carburetor and check that the float surface nearest the gasket is 1/8 ± 1/16 inch from the gasket. Bend the float tab as required to produce this spacing.

   NOTE: *If the carburetor utilizes an internally spring loaded fuel inlet valve, the float surface should be 1/8 ± 1/16 inch from the gasket with the full weight of the float compressing the spring in the needle.*
5. Reassemble, install and test.
6. See Figure 12.

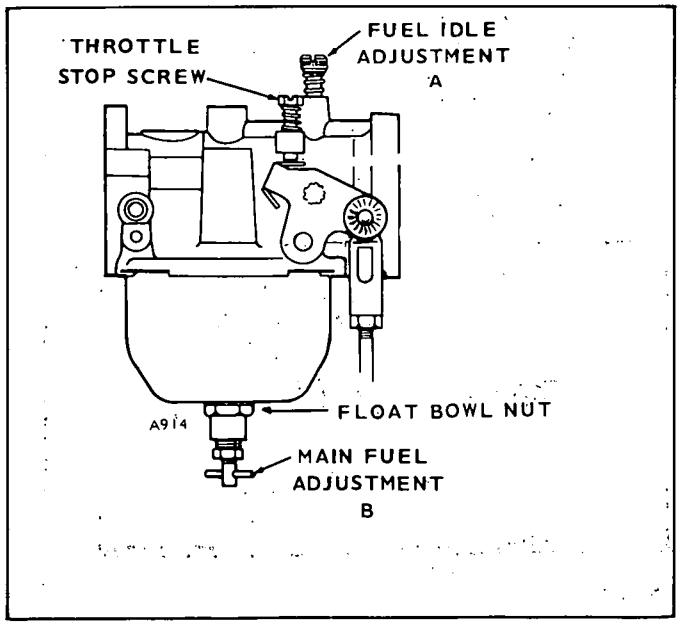


FIGURE 11. CARBURETOR ADJUSTMENTS

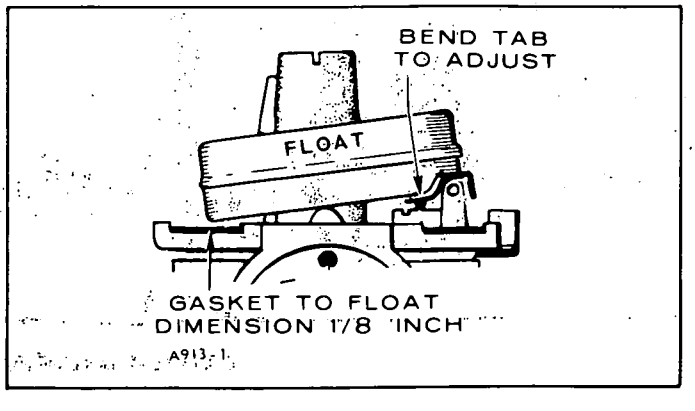


FIGURE 12. FLOAT LEVEL ADJUSTMENT

Carburetor Removal and Disassembly: Remove and disassemble the carburetor assembly as follows, referring to Figure 13.

1. Remove the fuel line, air cleaner hose, governor linkage, and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Remove the main jet assembly and bowl.
4. Remove the float pin and float.
5. Lift out the fuel inlet valve and unscrew the valve seat.
6. Remove the idle adjustment needle.
7. Remove the throttle plate screws and the plate, then pull out the throttle shaft.
8. Remove the choke plate screws and plate, then pull out the choke shaft.

Carburetor Assembly and Installation: Clean the components and repair or replace defective or worn parts. Use acetone or alcohol to dissolve gum deposits if carburetor cleaner is not effective. Soak the parts in carburetor cleaner, using it as directed by the manufacturer. Clean all carbon from the carburetor bowl, especially in the area of the throttle plate. Blow out clogged passages with compressed air. Check the needles, nozzle, and float for damage or fuel loading. Check the choke and throttle shafts. Reassemble and install as follows:

1. Install the throttle shaft and plate, using new screws and lock washers. Install with bevel mated to the carburetor body. If the plate is marked with the letter C, install it with the mark on the side toward the idle port when viewed from the flange end of the carburetor. To center the plate, back off the top screw, close the throttle lever and then set the plate by tapping it with a small screwdriver.
2. Install the choke shaft and plate. Center the plate in the same manner as the throttle plate (see step above). Use new screws and lock washers.
3. Install the fuel inlet valve seat and valve.
4. Install the float and float pin, adjusting the float as previously described.
5. Install the bowl ring gasket, bowl and bowl nut. Make sure that the bowl is centered in the gasket and tighten the main jet assembly securely. Turn in until it seats and back out to 1-1/2 turns.
6. Install the idle adjusting screw finger tight. Then back it out 1 to 1-1/2 turns.
7. Install the choke and adjust as previously described.
8. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism, air cleaner hose, and choke wires.
9. Adjust the carburetor needle settings as described under Adjustments and check out the performance.

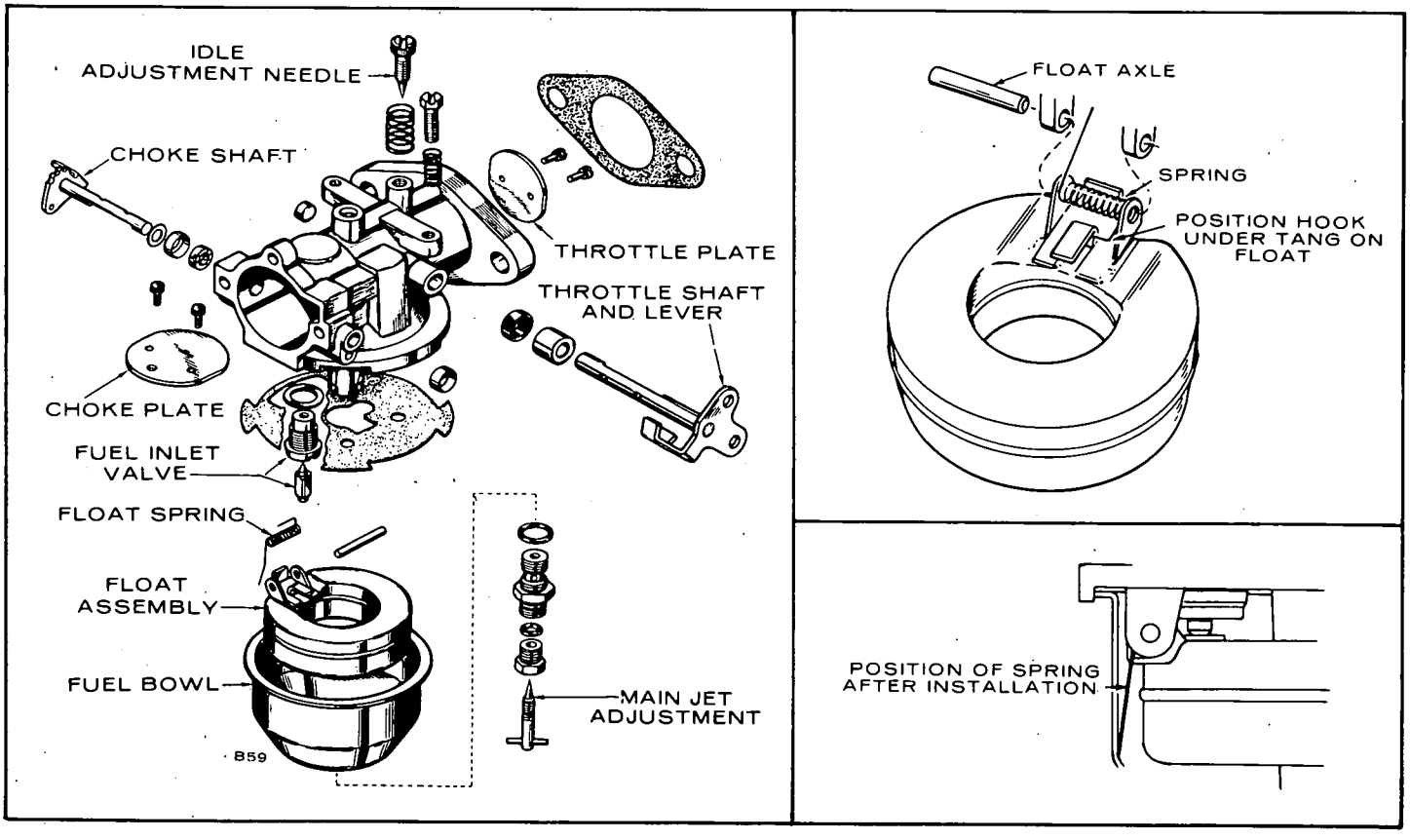


FIGURE 13. CARBURETOR ASSEMBLY

Complete Replacement: Complete replacement of the carburetor should be performed as follows:

1. Follow the previously given disassembly instructions as required for removal of the defective carburetor.
2. Replace the carburetor with a new unit, using attaching parts in good condition and making all the connections previously disengaged.
3. Adjust the needle settings as described under Adjustments.

FUEL PUMP

The engine uses a diaphragm-type fuel pump. If fuel does not reach the carburetor, check the fuel pump before dismantling it.

1. Disconnect the fuel line at the carburetor.
2. Crank the engine and observe whether fuel comes from the line at the carburetor.

   WARNING *Be sure to direct the fuel flow into a container so gasoline does not spill on ignition wires.*
3. If there is enough fuel in the tank, and line does not have fuel flowing, the pump needs replacing.

Pump failure is usually caused by a leaking diaphragm, valve or valve gasket, a weak or broken spring or wear in the drive linkage. Gasoline diluted oil may also indicate a faulty pump.

NOTE: *Always return the hand priming lever all the way inward so that lever does not prevent normal operation of fuel pump.*

Fuel Pump Reconditioning: Reconditioning of the fuel pump should be as follows, referring to Figure 14.

1. Remove the fuel lines and mounting screws holding the pump to the engine.
2. Make an indicating mark with a file across a point at the union of the fuel pump bolt and cover. Remove the assembly screws and the upper pump body.
3. Turn the pump body over and remove the valve plate screw and washer. Remove the valve retainer, valves, valve springs, and valve gasket, noting their position. Discard the valve springs, valves and valve retainer gasket.
4. Clean the pump body thoroughly with a solvent and a fine wire brush.
5. Holding the pump cover with the diaphragm surface up, place the new valve gasket in the cavity. Assemble the valves in the cavity. Reassemble valve retainer. Lock in position by inserting and tightening the fuel pump retainer screw.
6. Place the pump body assembly in a clean work area and rebuild the lower diaphragm section.
7. Holding the mounting bracket, press down on the diaphragm to compress the spring under it, then turn the bracket 90 degrees to unhook the diaphragm so it can be removed.
8. Clean the mounting bracket with a solvent and a fine wire brush.
9. Replace the diaphragm operating spring, stand the new spring in the casting, and position the diaphragm. Press down on the diaphragm to compress the spring and turn it 90 degrees. This will reconnect the diaphragm.
10. Hold the bracket, place the pump cover on it (making sure the indicating file marks are in line) and insert the four attaching screws but do not tighten. With the hand on the mounting bracket only, push the pump lever to the limit of its travel and hold in this position while then tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount the fuel pump on the engine, using new mounting gaskets. Connect the fuel lines.

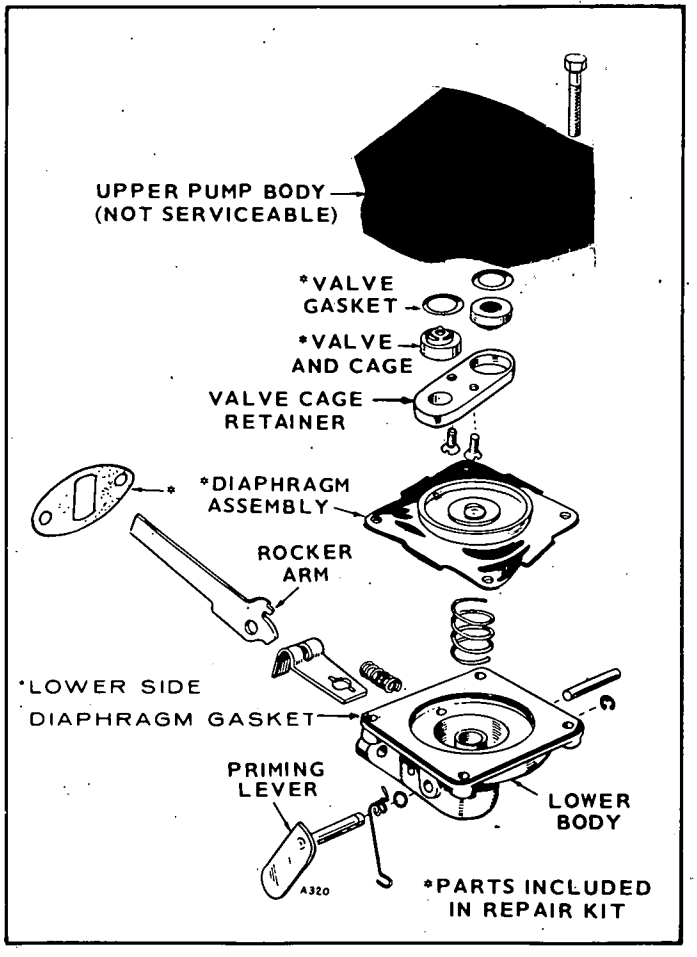


FIGURE 14. FUEL PUMP

THERMO-MAGNETIC CHOKE (Optional)

This choke uses a strip heating element and a heat sensitive bimetal spring to control the choke plate position. In addition to this, a solenoid is actuated during engine cranking, closing the choke all or part way, depending on ambient temperature. The bimetal is factory set to position the choke to the proper opening under any ambient condition.

Choke Adjustment: If adjustment of the bimetal is needed, it must be made at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Loosen the screw which secures the choke body assembly. Refer to Figure 15. Rotating the choke body clockwise richens and counter-clockwise leans the choking effect. For ambient temperatures above 85°F, the choke should be fully opened. For ambient temperatures below 25°F, the choke should be opened 1/4 inch with the solenoid not engaged. Tighten the screw that secures the choke body.

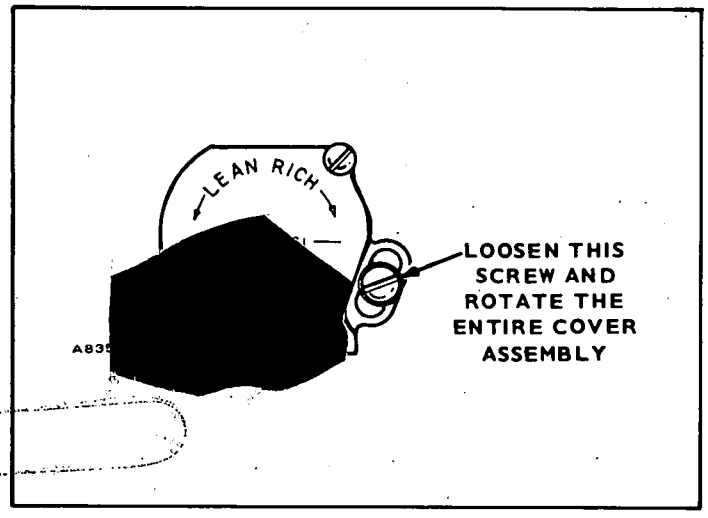


FIGURE 15. THERMO-MAGNETIC CHOKE

If the choke will not close, check for binding, incorrect adjustment, or incorrect assembly of the bimetal and heater assembly. If the choke will not open after the engine starts, check for heating. The choke bimetal should be warm to the touch within a minute or two after starting.

To disassemble the choke, refer to Figure 16.

If the heater assembly will not heat properly, check for broken heater wire, high resistance connections or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 37.8 to 46.2 ohms for a 12 volt system. If the heater is defective, replace. There must be slack in the lead wires between the choke body and the bimetal and heater assembly. When the start button is engaged, the solenoid should cause the spring loaded lever to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid core.

The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 12 volt system.

Assembly: Refer to Figure 16. When assembling the thermomagnetic choke, connect the bimetal and heater assembly as follows:

1. Lead tagged G to ground terminal in coil solenoid.
2. Lead tagged H to either of the H1 terminals on the solenoid core.

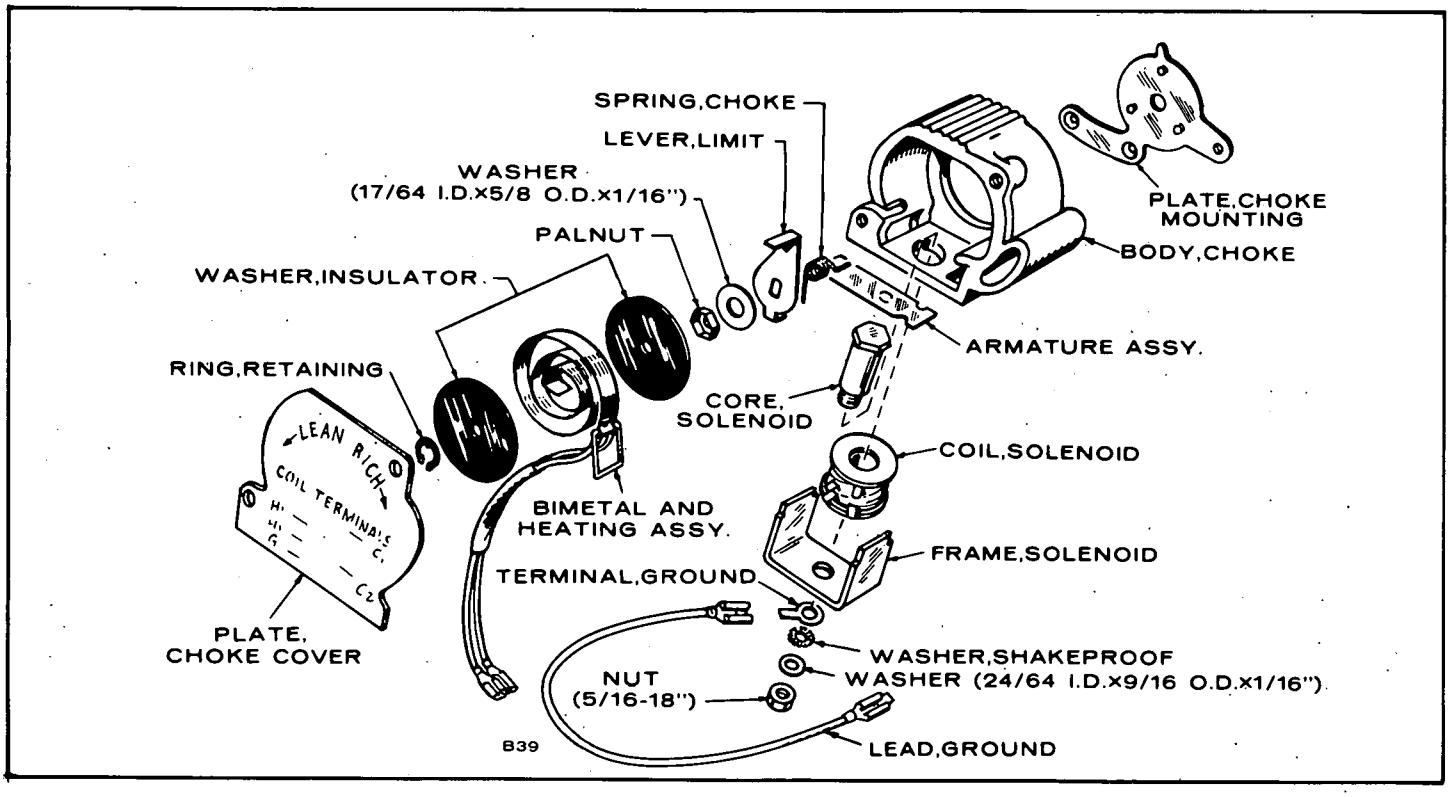


FIGURE 16. CHOKE ASSEMBLY

GASEOUS FUEL CARBURETOR

For correction of problems traced to a gaseous fuel carburetor perform the following:

1. Clean or replace the air cleaner.
2. Inspect hoses, replacing defective units, and securing all connections.
3. Clean the dry fuel filter (if present).
4. Check the regulator and carburetor for proper adjustment as described later in this section.

Gas Regulator Adjustment: This regulator was factory adjusted to lock-off at a pressure of 4 oz. (7″ water column). The regulator will operate satisfactorily at incoming pressures of from 2 to 4 oz. If your gas supply pressure is within these limits, no regulator adjustment is required. If your gas supply pressure is under 2 oz., the regulator will not operate. If your gas supply pressure is between 4 and 8 oz., install an appliance regulator set for 2 oz. ahead of the regulator, or adjust the regulator as follows and reference to Figure 17.

WARNING *A soap bubble placed over the regulator outlet will not accurately test for regulator closing. The soap bubble's resistance when multiplied by the greater area of the regulator diaphragm, is enough to shut off this very sensitive demand type regulator.*

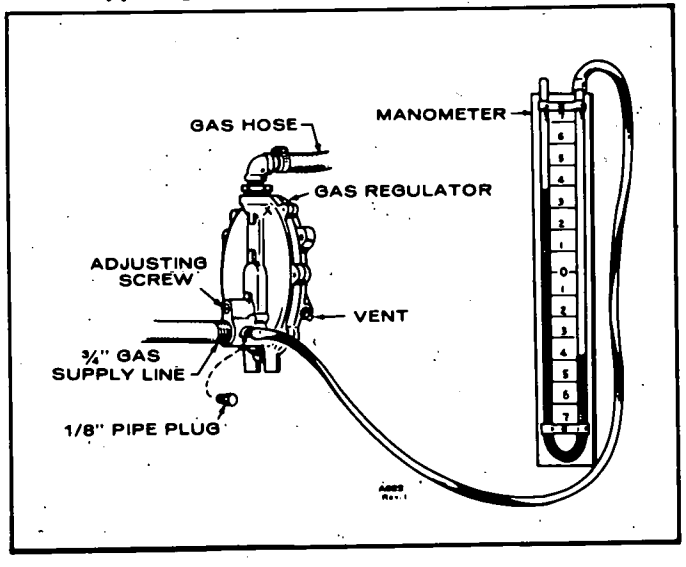


FIGURE 17. TESTING WITH MANOMETER

1. Refer to Figure 17.
2. Connect a manometer which reads up to 14″ water column to the regulator's plugged test hole near inlet. Turn gas on and energize the solenoid valve.
3. Turn regulator lock-off adjusting screw inward just far enough so that the manometer reading remains constant when you repeatedly cover and uncover the regulator outlet with your hand. Failure to lock off indicates too high incoming pressure or dirty regulator valve and seat.
4. Close the gas supply line valve. Remove manometer. Bleed air from gas supply line. Install test-hole plug in regulator. Open gas supply line valve. See that vent fitting is installed.
5. With a clamp on each end, secure the hose between the regulator outlet nipple and the carburetor inlet.
6. Operate the engine to assure quick starting results.

Gas Carburetor Adjustment:

1. Adjust the main gas adjusting screw (M) on the carburetor, depending upon the type of gas used. For 800 BTU gas turn to approximately six turns open. For 1,100 BTU gas turn to 3-1/2 turns open. For propane gas, turn to approximately three turns open. Turn the idle screw (N) to two turns open. These settings are preliminary ones, to premit starting the engine.

   For starting an engine manually, the gas should have a BTU rating above 800 BTU per cubic foot. The temperature should be above 30°F (–1°C) to permit sufficient cranking speed to be developed. Too low a cranking speed would prevent proper intake vacuum for starting. Load should be disconnected, or reduced to the minimum.
2. Allow the engine to thoroughly warm up. When operating temperature is reached, make final carburetor adjustments. Apply a full load and turn the carburetor main gas adjusting screw (M) in (clockwise) until the engine begins to lose speed from lack of fuel. Slowly back out the main adjusting screw (counterclockwise) until the engine will carry the full load smoothly. Remove all load and adjust the small slotted idle adjusting screw (N) in the same manner. Check the operation at various loads. Make any necessary governor adjustments as given in following section.

When operating on gas fuel of approximately 800 BTU rating, some loss in power output may be evident. However, full power should be developed if using a gas rated at 1,100 BTU or higher. Gas fuel usually is clean burning, which means that carbon removal and valve grinding services may not have to be performed as frequently as with gasoline fuel.

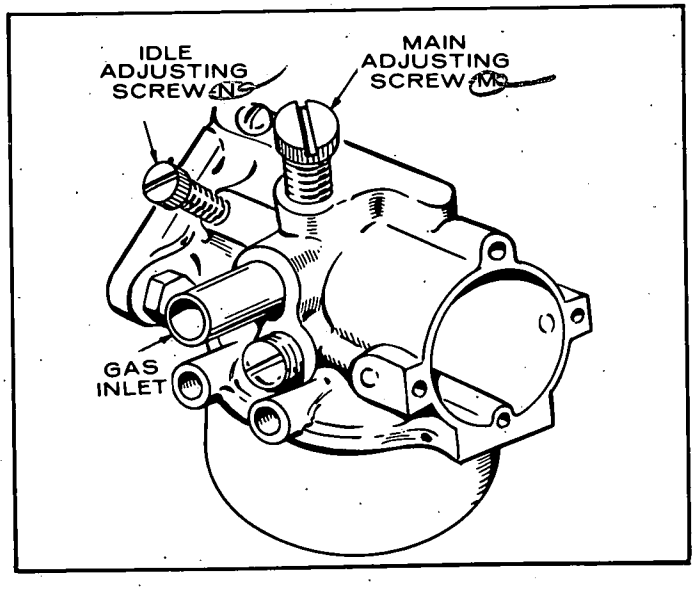


FIGURE 18. GAS CARBURETOR ADJUSTMENT

GOVERNOR SYSTEM

GOVERNOR ADJUSTMENT

Where engine speed is governor controlled, the governor is set at the factory to allow a nominal engine speed of 2400 rpm at no load operation (unless another speed is specified when the engine is ordered). Proper governor adjustment is one of the most important factors in maintaining the power and speed desired from the engine.

Before making governor adjustment, run the engine about 15 minutes to reach normal operating temperature.

It is difficult to determine if, after long usage, the governor spring has become fatigued. If, after properly making all other adjustments, the regulation is still erratic, install a new spring (Figure 19).

A tachometer for checking engine speed is required for accurate governor adjustment.

Check the governor arm, linkage, throttle shaft and lever for binding or excessive wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the engine is idle. If either of these conditions exist, determine the cause and adjust or replace parts as needed.

Procedure:

1. Adjust the carburetor main jet for the best fuel mixture at full load operation.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage.
4. Check the governor linkage and throttle shaft for binding or excessive looseness.
5. Adjust the governor spring tension for nominal engine speed at no load operation.
6. Check the rpm drop between no load and full load operation and adjust the governor sensitivity as needed.
7. Recheck the speed adjustment.
8. Set the carburetor throttle stop screw.

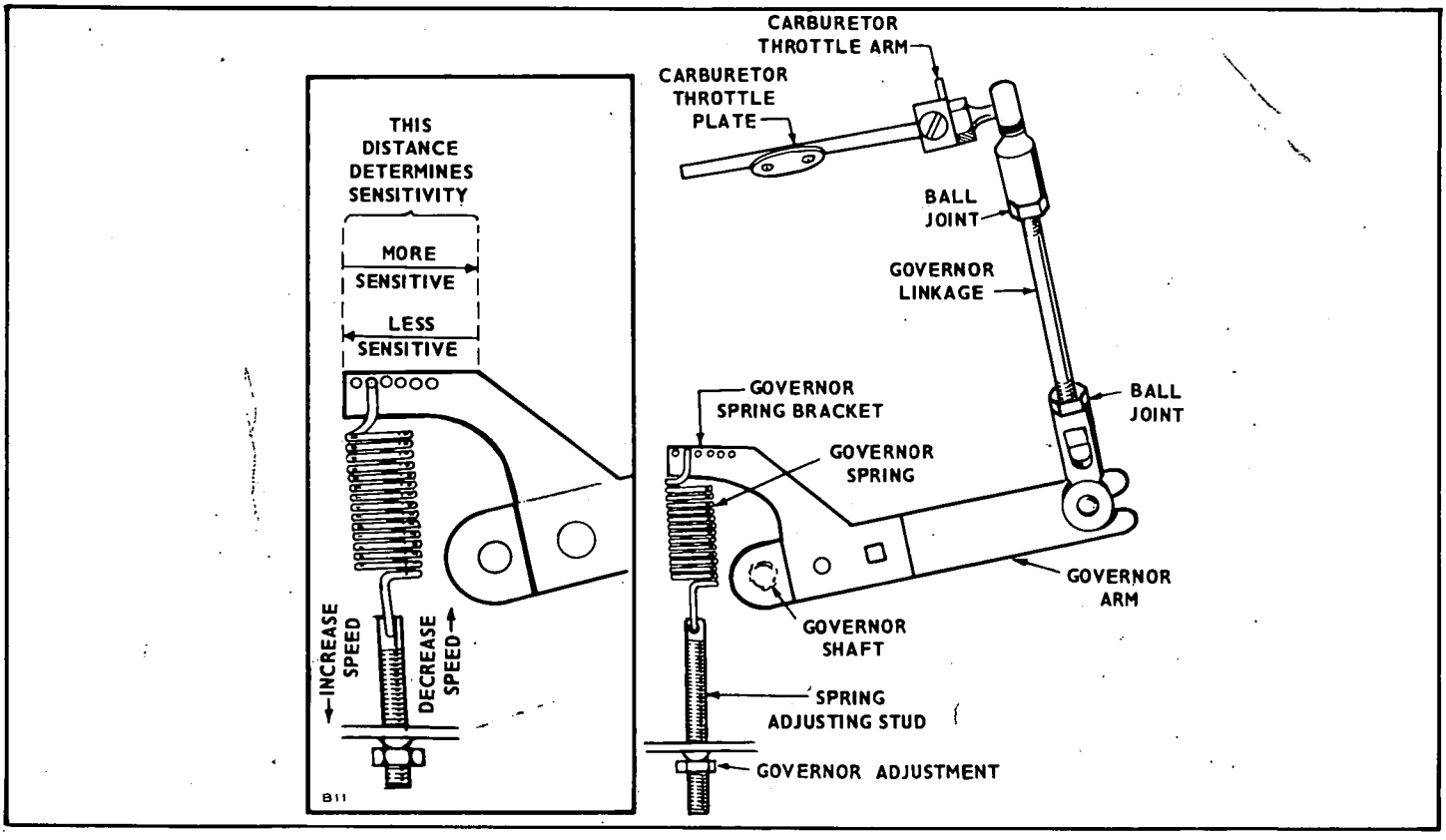


FIGURE 19. GOVERNOR ADJUSTMENTS

Linkage: The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle arm is adjusted by rotating the ball joint housing. Adjust the length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever is 1/32 inch from the carburetor stop boss. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and the throttle shaft.

Speed Adjustment: The speed at which the engine operates is determined by the tension applied to the governor spring. Increasing spring tension increases engine speed. Decreasing spring tension decreases engine speed. The no load speed of the engine should be slightly higher than the speed requirements of the connected load. For example: If the connected load is to turn at 3510 rpm, set the no load speed of the engine at about 3600 rpm. Check speed with a tachometer.

If a speed adjustment is needed, turn the speed adjusting nut in to increase the speed or out to decrease the speed (Figure 19).

Sensitivity Adjustment: The engine speed drop from no load to full load should be not less than 100 rpm. Check the engine speed with no load connected and again after connecting full load. Do not exceed 4000 rpm at no load.

The sensitivity of the governor depends upon the position of the arm end of the governor spring. A series of holes in the governor arm provides for adjustment. To increase sensitivity, move the spring toward the governor shaft. To decrease sensitivity, move the spring toward the linkage end of the governor arm.

If the setting is too sensitive, a hunting condition (alternate increase and decrease in engine speed) will result. If the setting is not sensitive enough, the speed variation between no load and full load conditions will be too great. Therefore, the correct sensitivity will result in the most stable speed regulation without causing a surge condition.

Always recheck the speed adjustment after a sensitivity adjustment. Increasing sensitivity will cause a slight decrease in speed and will require a slight increase in the governor spring tension.

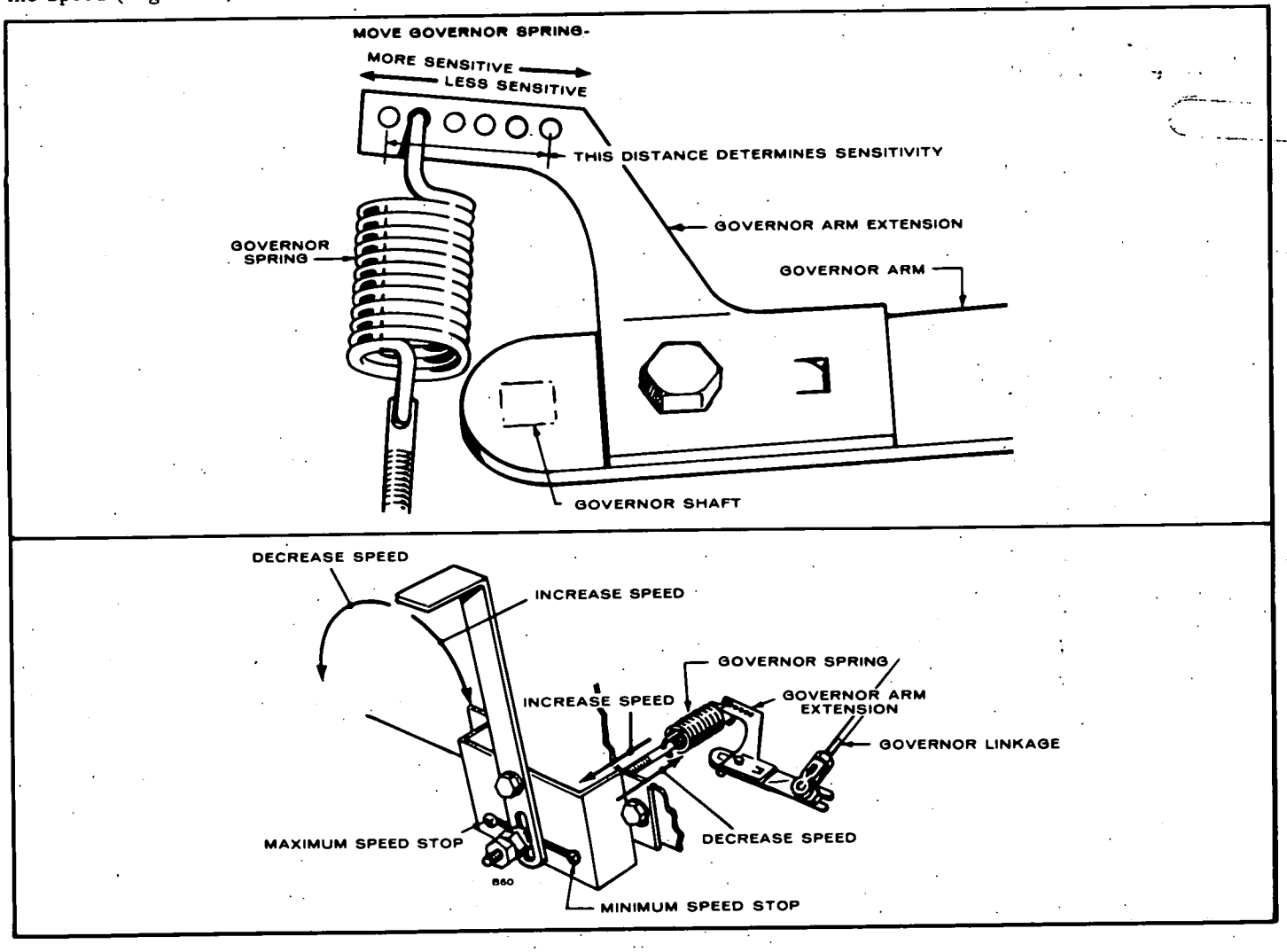


FIGURE 20. VARIABLE SPEED GOVERNORS

Variable-Speed Governor Adjustments: These engines are adapted for use where a wide range of speed settings is desired. The design of the variable speed governors gives an automatic increase in sensitivity when the speed is increased and the result is good stability at all speeds.

To adjust the variable speed governors, refer to Figure 20 and the following:

1. Run the engine and make necessary carburetor adjustments.
2. Adjust the throttle stop screw on the carburetor to allow a recommended minimum idling speed of 900 rpm. A lower minimum does not assure smooth operation under load.
3. Adjust the tension of the governor spring for minimum speed. For the control with the control arm, shift the lever to minimum speed with no load and adjust the spring tension for approximately 1500 rpm.

   For the control with the control knob and slide (NHC engines with mounted engine controls), pull back the knob and slide and set at the first notch (low speed). Adjust speed to approximately 1500 rpm (or the desired low speed) at no load by turning the knob as required.
4. Adjust the sensitivity while operating at minimum speed to attain the smoothest no load to full load operation as follows:

   To decrease sensitivity (allow more speed drop from no load to full load operation) move the governor spring outward into a different groove or hole in the extension arm.

   To increase sensitivity (closer regulation by the governor which permits less speed drop from no load to full load operation) move the governor spring inward into a different groove or hole in the extension arm.
5. Apply a full load and shift the variable control to maximum speed – moving the control arm to the right or shifting the control knob and slide to the second notch. For the governor control with the control arm, set the screw in the bracket slot to stop lever travel at the desired maximum full load speed position. For the control with the control knob and slide, increase or decrease speed by turning the knob as required.

Approximately 3000 rpm is the recommended maximum full load speed for continuous operation. The speed must agree with the load requirements.

IGNITION AND BATTERY CHARGING

BREAKER POINTS

To maintain maximum efficiency from the engine, change the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove the two spark plugs so engine can be easily rotated by hand. If plugs have not been changed within the last 100 hours, replace them with new ones after setting the breaker points.
3. Refer to Figure 21. Remove mounting screw (A) and pull the points out of the box just far enough so screw (B) can be removed and leads disconnected.
4. Remove screw (C) and replace condenser with a new one.
5. Replace points with a new set but do not completely tighten mounting screw (A).
6. Rotate the engine by hand until the 25°BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90°) to ensure points are fully open.
7. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .020" with a flat thickness gauge. Tighten mounting screw and recheck gap.
8. Check ignition timing.

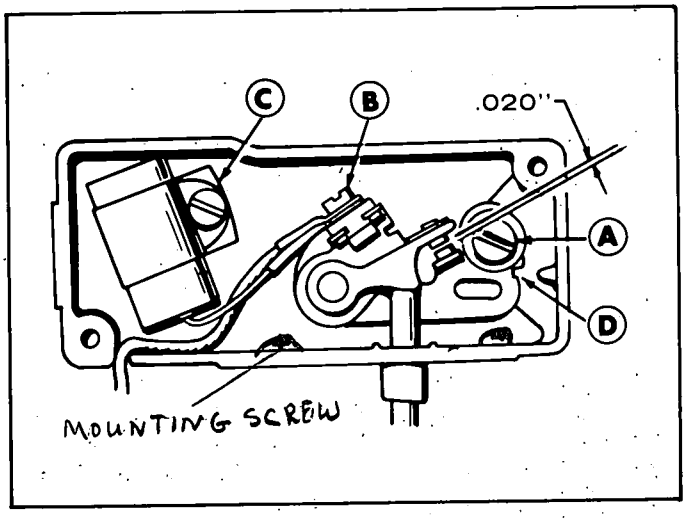


FIGURE 21. BREAKER POINT ADJUSTMENT

IGNITION TIMING

The timing on the engine is preset at the factory. A non-movable breaker point box is used, however a slight timing change could be made by adjusting points.

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. Spark advance is set at 25°BTC (before top center), and should be maintained for best engine performance. Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

Timing Procedure - Engine Running:

1. To accurately check the ignition timing, use a timing light with engine running at idle speed. Connect the timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.
2. Start the engine and check the timing. The mark on the flywheel should line up with the 25° mark on the cover.

NOTE: *If timing marks do not line up, readjust point gap. To advance timing, slightly close gap on breaker points. To retard timing, slightly open gap on breaker points. Recheck timing and breaker point gap after making this adjustment.*

The timing hole through the flywheel and the timing marks on the timing gear cover can be seen by looking through the flywheel blower screen - see Figure 25.

Timing Procedure - Engine Not Running: If a timing light is not available, check the timing as follows:

1. Connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch the other test prod to a good ground on the engine.
2. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
3. The lamp should go out just as the points break which is the time at which ignition occurs (25° BTC).

SPARK PLUGS

Remove both spark plugs and install new ones every 100 hours. Use Champion N-6 or equivalent. Check to be sure spark plug gap is set at .025".

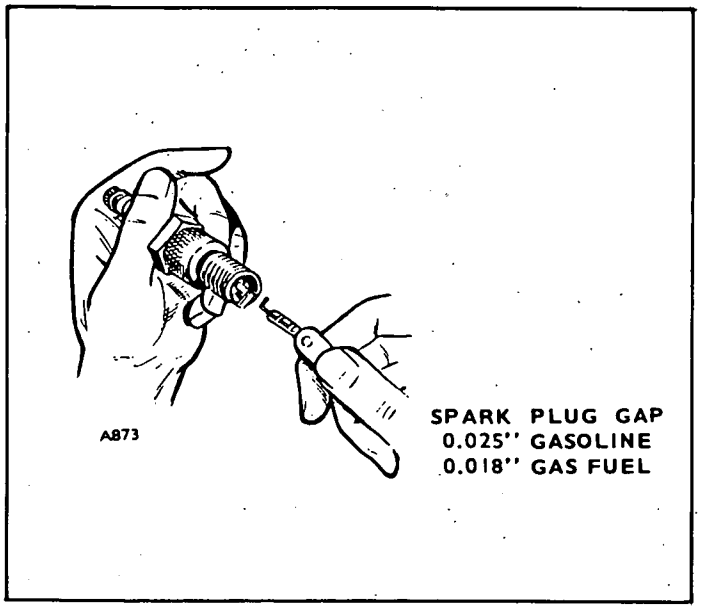


FIGURE 22. SPARK PLUG GAP

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use Simpson 260 VOM or equivalent.
2. Place black lead on ground (–) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 4.30 (±10%) ohms @ 70°F.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 23). Secondary resistance should read 14,000 (±10%) ohms @ 70°F.
4. If any of the above conditions are not met, replace coil. Refer to parts catalog for correct part number.

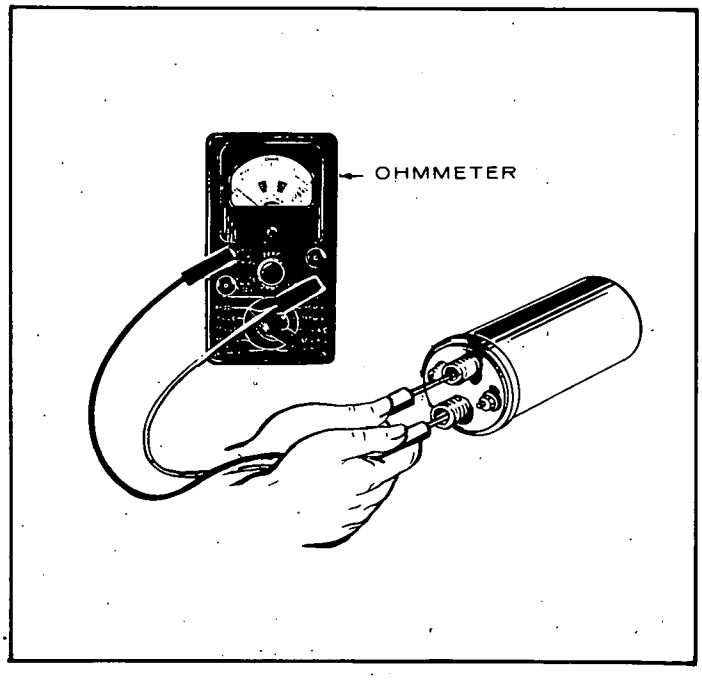


FIGURE 23. COIL TEST

CAUTION *This engine uses a 12 volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.*

BATTERY INSPECTION

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.280 at 80°F.

If one or more cells are low on water, add distilled water and recharge.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

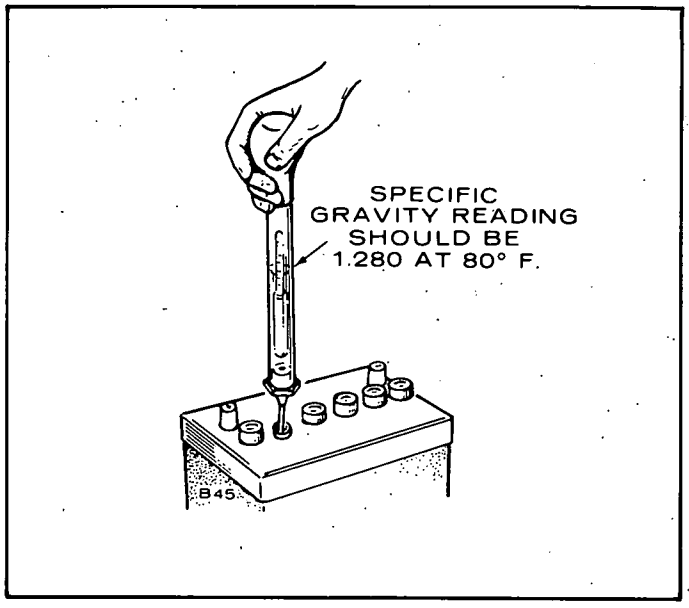


FIGURE 24. SPECIFIC GRAVITY TEST

FLYWHEEL ALTERNATOR

The alternator is a permanent magnet flywheel alternator with a solid-state voltage regulator-rectifier for controlling output. If ignition spark is weak or if the battery discharges inspect the following:

Inspection:

1. Check battery cells to make sure they are filled to appropriate level adding distilled water as required. Check specific gravity in each cell. Specific gravity should be 1.280 at 80°F; if not, recharge battery to bring it up to this level.

NOTE: *Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.*

2. Make sure the two alternator stator leads are not shorted together.
3. Check mounting of regulator-rectifier case to unit. It should provide a good electrical ground with clean, bright surfaces.
4. Output control plug (connector) must be pushed in so it bottoms solidly in the receptacle. Keep it clean and tight.

IMPORTANT: *Charging system tests require a fully charged battery.*

Testing: With the engine running between 1800-2600 rpm, observe the panel ammeter. (if not already equipped, connect a test ammeter.) If no charging is evident, proceed with the NO CHARGE TEST given as follows. If ammeter shows a constant higher charge rate, follow the HIGH CHARGE RATE TEST procedure.

No Charge Test: Perform as follows:

1. Check the B+ to ground voltage using a DC voltmeter.
2. If voltmeter reads 13.8 volts or higher, add a load to system (e.g. headlights) to reduce battery voltage to below 13.6 volts.
3. Observe ammeter. If charge rate increases, consider the system as satisfactory. If charge rate does not increase, proceed with testing.
4. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running near 3600 rpm. If AC voltage reads less than 28 volts, replace the stator. If AC voltage is more than 28 volts, replace the regulator-rectifier assembly.

High Charging Rate Test: Perform this test as follows:

1. Check B+ to ground voltage with a DC voltmeter.
2. If voltmeter reads over 14.7 volts, replace regulator-rectifier assembly.
3. If reading is under 14.7 volts the system is probably okay. Recheck the battery and connections. If the battery does have a low charge, but accepts recharging, system is okay.

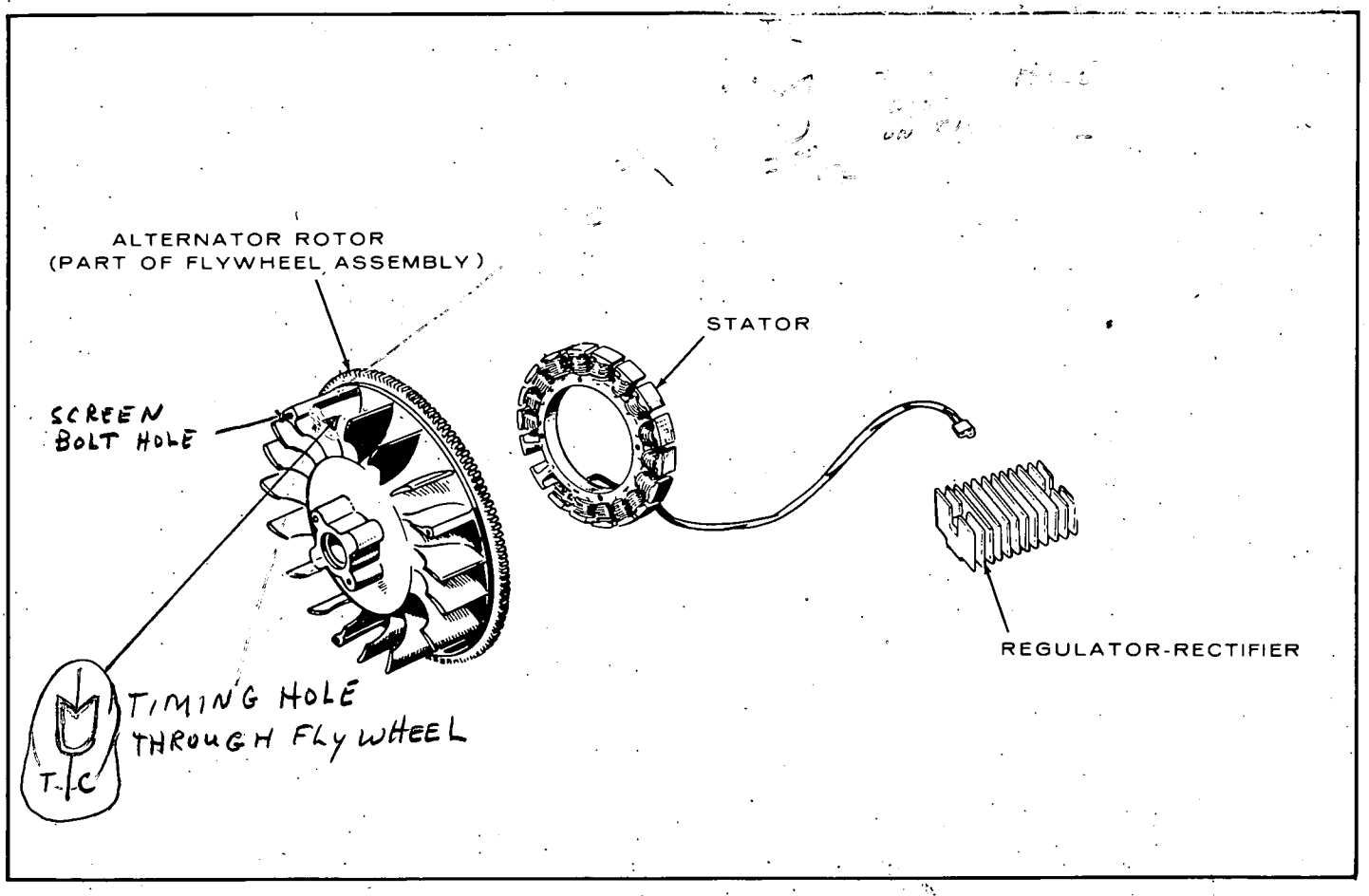


FIGURE 25. FLYWHEEL ALTERNATOR AND ENGINE TIMING VIEW

STARTING SYSTEM

ELECTRIC STARTER REPAIR

CAUTION *Do not use steam or high pressure water to clean the starter.*

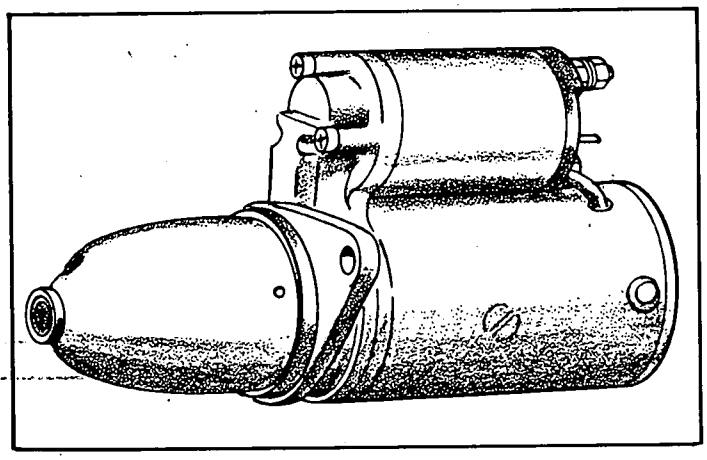


FIGURE 26. STARTER ASSEMBLY

DISASSEMBLY

1. Loosen the M terminal nut on the magnetic switch and remove the connector. Then unscrew attaching screws and remove the magnetic switch.

   NOTE: *The packings for the magnetic switch are mounted so that the steel packing is located in the front bracket side.*

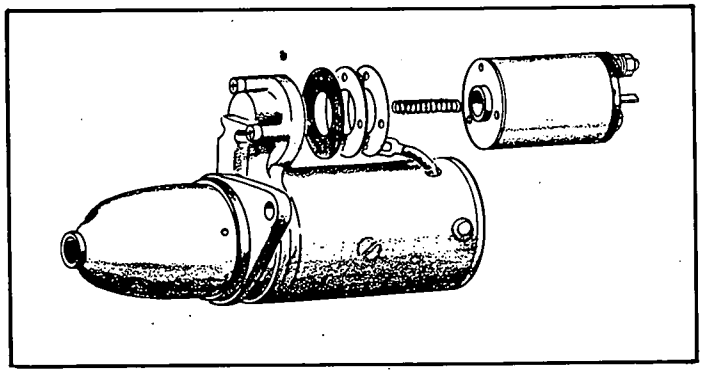


FIGURE 27. MAGNETIC SWITCH REMOVAL

2. After removing the thru bolts, the starting motor can be divided into three parts – the front bracket, housing and rear bracket. The spacing washers shown in Figure 28 are used for adjustment of the thrust gap of the armature shaft and are placed between the rear bracket and the commutator.

   NOTE: *These washers are inserted so the steel washer is located in the commutator side.*

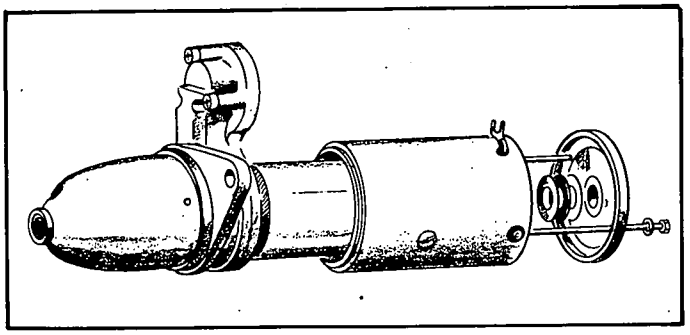


FIGURE 28. REMOVING THROUGH BOLTS

3. The armature can easily be removed from the front bracket. Be careful not to miss a small steel washer used in the end of the armature shaft. The shift lever can be removed along with the armature when it is removed. In this case, the spring holder, lever springs and retainer can be taken out before the lever. See Figure 29.

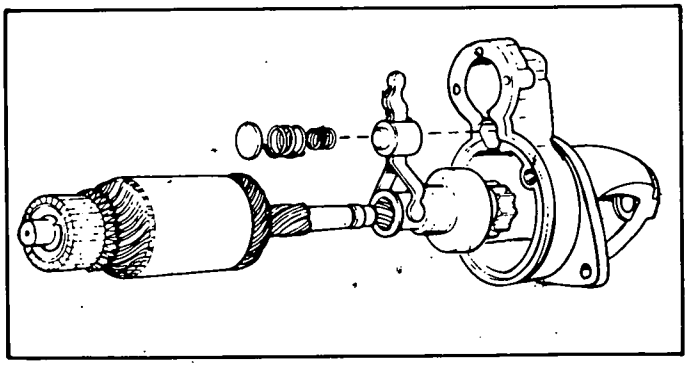


FIGURE 29. REMOVING ARMATURE

4. Remove the ring after driving the pinion stopper toward the pinion gear using a cylindrical tool as shown in Figure 30. The overrunning clutch and the pinion stopper should be removed simultaneously.
5. All four brushes have been soldered to the brushholder in the same way. The brush springs can be removed from the brushholder.
6. The pole shoes may be removed if necessary, by removing the flat head machine screws from the frame.

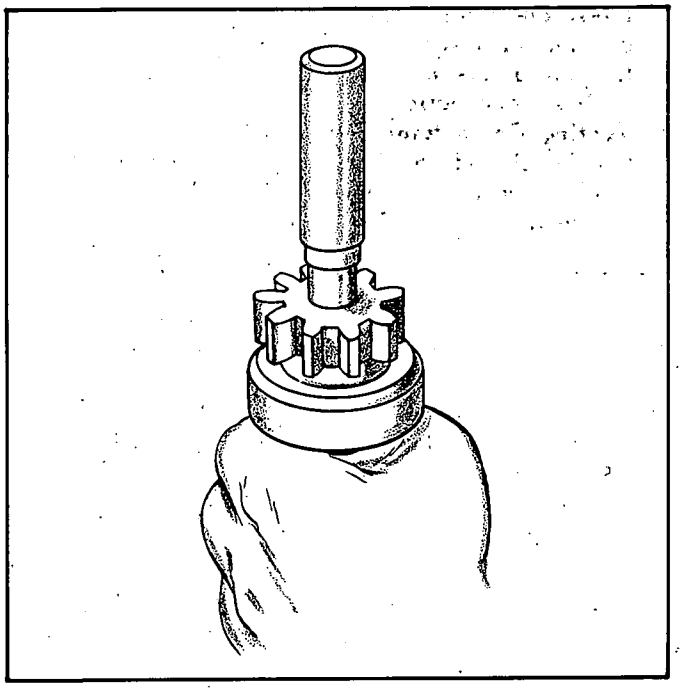


FIGURE 30. REMOVING RING

REASSEMBLY

Inspect the parts carefully in accordance with the procedure described in "Inspection of Parts". Make any repairs necessary. Reassembly is the reverse of assembly. The following precautions should be taken:

1. Clean all of the parts carefully with a dry cloth and compressed air if it is available.

   NOTE: *Bearing equipped parts must not be immersed in cleaning fluid. These parts should be cleaned with a brush dipped in "Varsol" or any other comparable mineral spirits. Do not immerse overrunning clutch in cleaning solvent. Thoroughly dry any parts that have come into contact with the cleaning fluid.*

2. Apply 20 weight non-detergent oil to the armature shaft and splines. Apply grease (Shell Albania No. 2 or equivalent) sparingly on the shift lever pin, the joint of the shift lever and plunger, the plunger and spacing washers at the end of the shaft.
3. To mount the overrunning clutch; first insert the pinion stopper into the armature shaft, then apply the ring to the groove of the shaft rigidly. For the insertion of the ring, use a tool as shown in Figure 32 and pull the pinion stopper up.
4. Use spacing washers to adjust the armature to give end play of .004" to .020".
5. Tighten the thru bolts to a torque of 35 to 44 in-lbs.
6. Insert the shift lever as shown in Figure 33 into the front bracket.

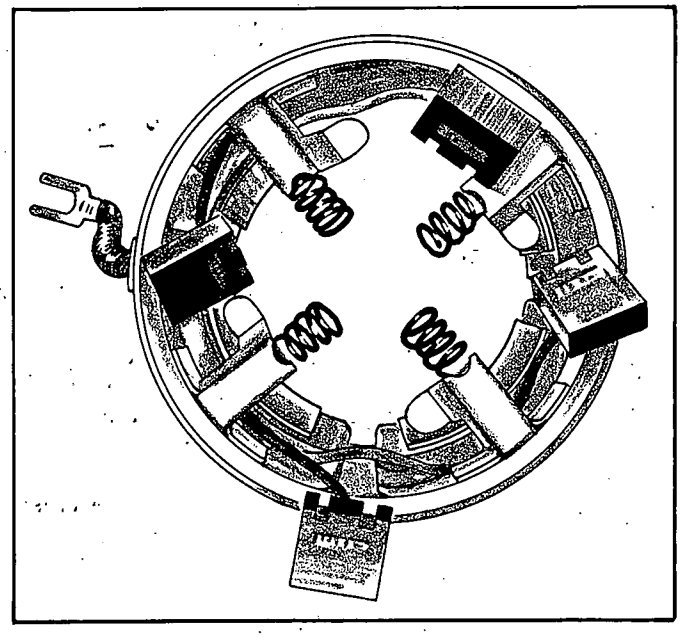


FIGURE 31. BRUSHES

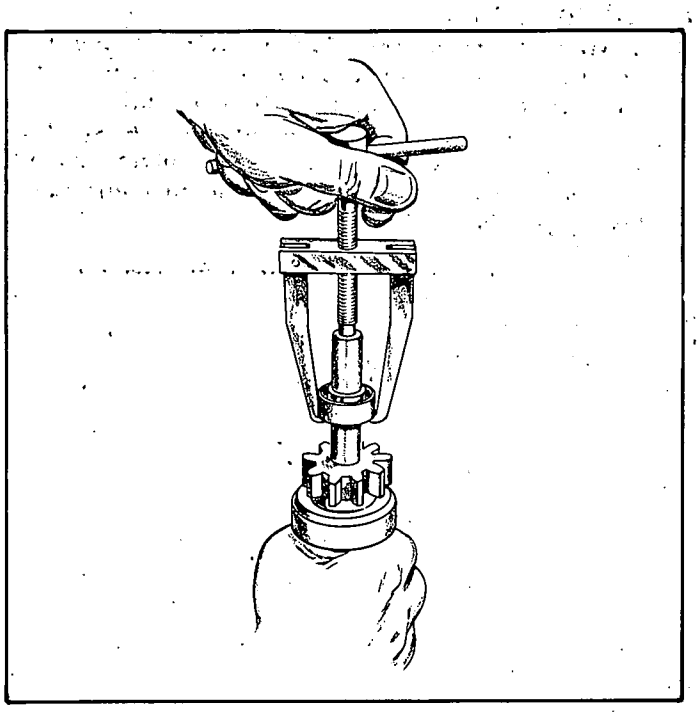


FIGURE 32. MOUNTING OVERRUNNING CLUTCH

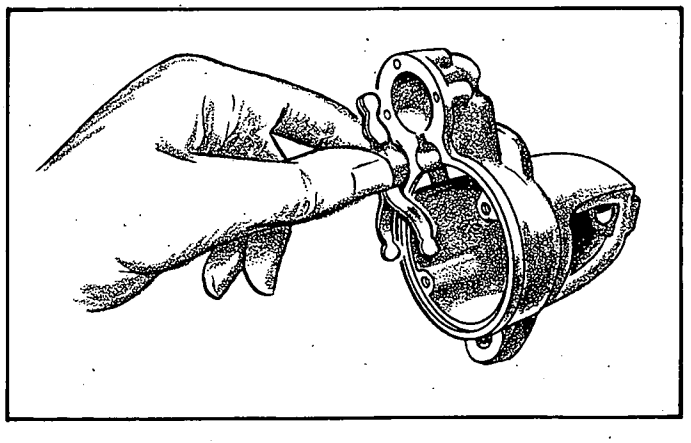


FIGURE 33. INSTALLING SHIFT LEVER

INSPECTION OF PARTS

1. **Testing Armature for Short Circuits.** Place the armature in a growler and hold a thin steel blade parallel to the core and just above it while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace shorted armature. See Figure 34.

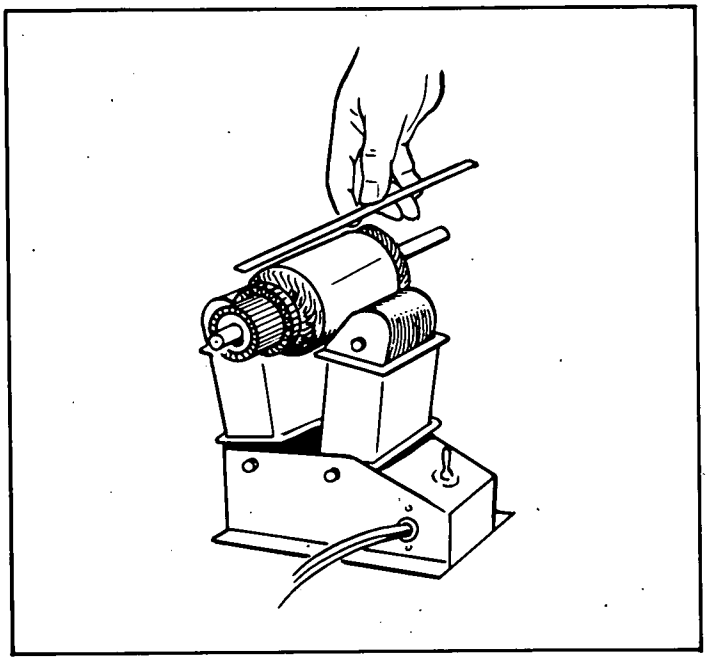


FIGURE 34. ARMATURE SHORT CIRCUIT TEST

2. **Testing Armature for Grounds.** Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads. If the ohmmeter reading is low, it indicates a grounded armature. Replace grounded armature. See Figure 35.

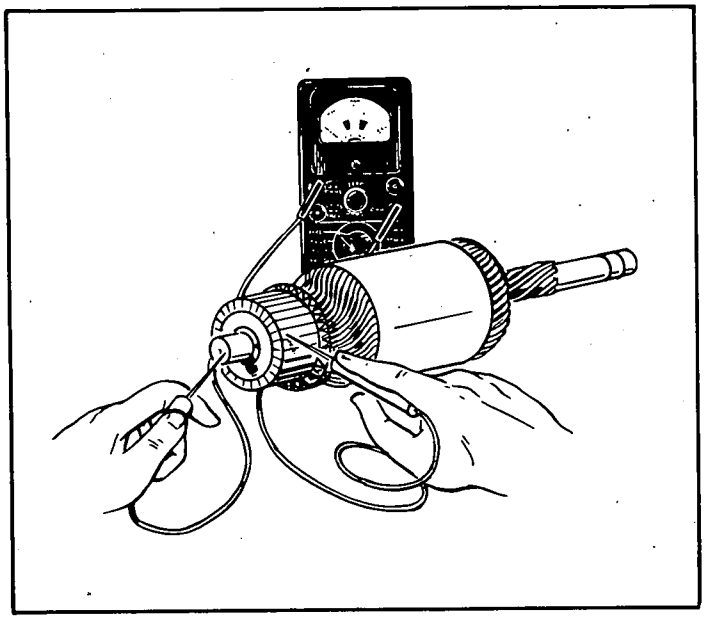


FIGURE 35. ARMATURE GROUND TEST

3. **Testing Armature for Open Circuit.** The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections.
4. **Testing Commutator Runout.** Place armature in a test bench and check runout with a dial indicator. When commutator runout exceeds .004", commutator should be refaced (Figure 36).

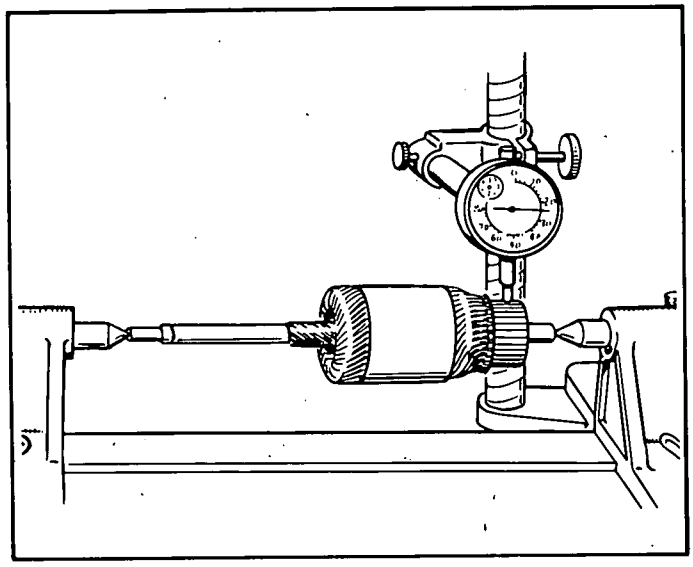


FIGURE 36. CHECKING COMMUTATOR RUNOUT

5. **Testing Armature Shaft Runout.** The armature shaft as well as the commutator may be checked. A bent armature often may be straightened, but if the shaft is worn, a new armature is required (Figure 37).

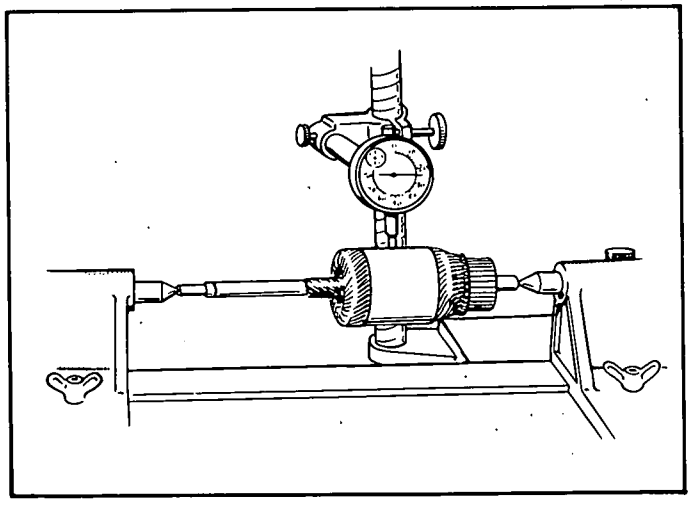


FIGURE 37. CHECKING ARMATURE SHAFT RUNOUT

6. **Testing Field Coils for Grounds.** Place one lead on the connector and the other on a clean spot on the frame after unsoldering shunt field coil wire. If the ohmmeter reading is low, the fields are grounded, either at the connector or in the windings (Figure 38).

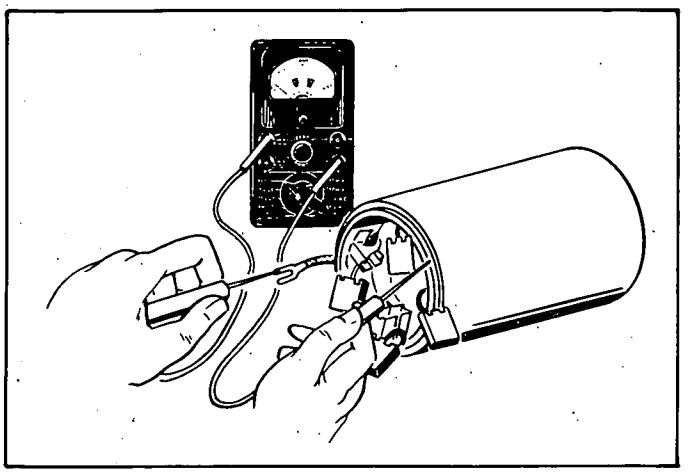


FIGURE 38. FIELD COIL GROUND TEST

7. **Testing Field Coils for Open Circuit.** Place one lead on the connector and the other on a clean spot on the brushholder. If the ohmmeter reading is high, the field coil is open. Check the other three brushholders in the same manner (Figure 39).

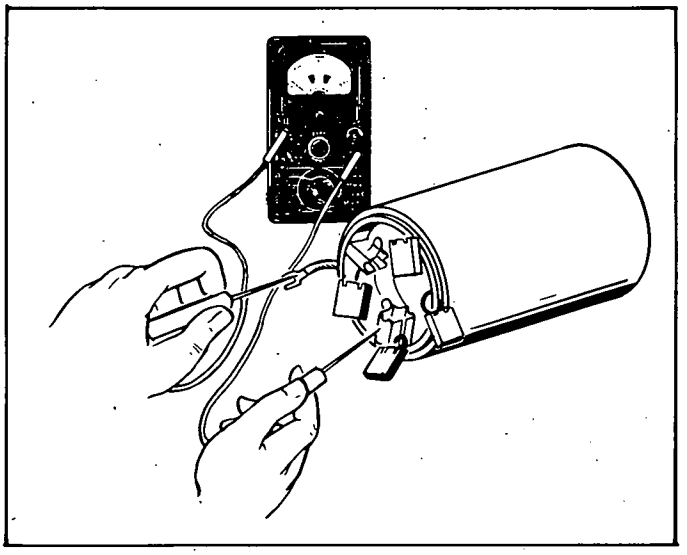


FIGURE 39. FIELD COIL OPEN CIRCUIT TEST

8. **Inspection of Brushes.** Replace brushes when they are worn less than .3" as shown in Figure 40. See that all brushes move freely in their holders.

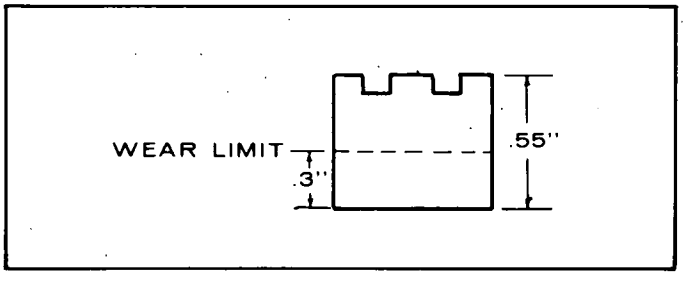


FIGURE 40. BRUSH WEAR LIMIT

9. **Inspection for Brush Spring Tension.** Measure brush spring tension with a tension meter as shown in Figure 41. Push the brush and take a reading just as the brush projects a little from the brushholder. On a new brush the spring tension should be 29 to 38 ounces.

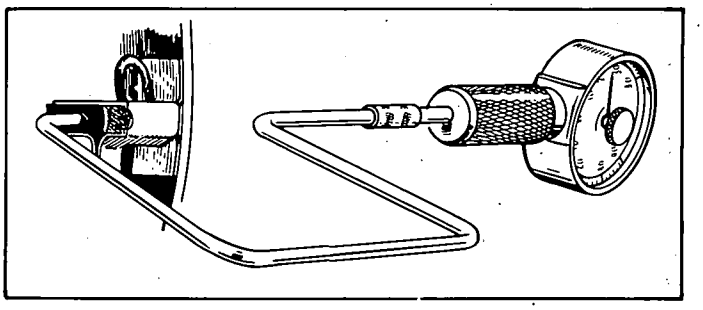


FIGURE 41. BRUSH SPRING TENSION TEST

INSPECTION AFTER OVERHAUL

1. For no load test, the starting motor is wired as shown in Figure 42 and revolved. The value of the meter reading at this condition should be as follows:

Voltage	11.5 volt
Speed	3700 rpm minimum
Current Draw	60 amp maximum

NOTE: *The conductor for this test should be large enough and as short as possible. If anything is wrong in the above test, inspect the following items:*

Annealed brush springs
Improperly seated brushes
Insufficient armature endplay
Shorted, open or grounded armature
Grounded or open field coil
Poor electrical connection
Dirty commutator

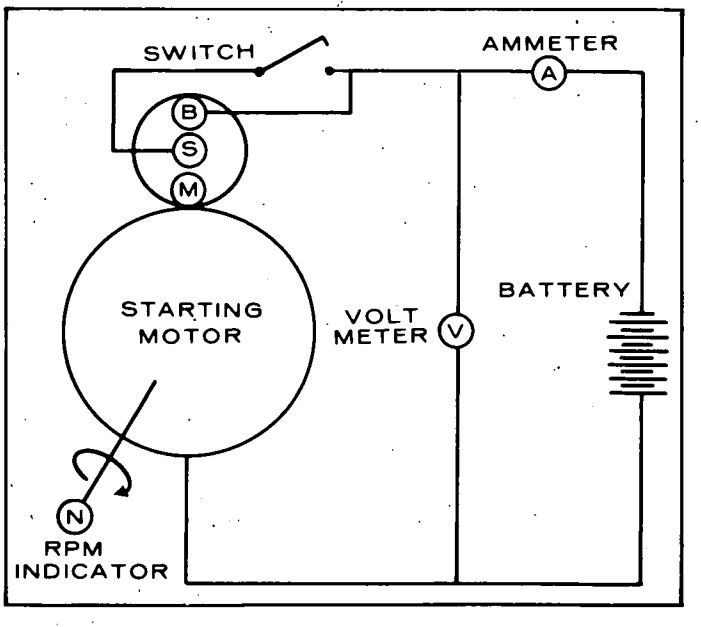


FIGURE 42. STARTING MOTOR WIRING

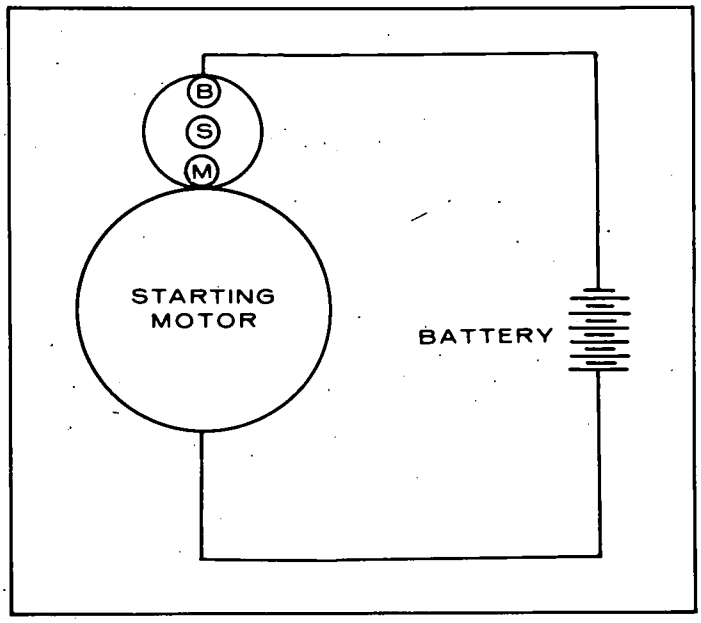


FIGURE 43. BATTERY CONNECTIONS

2. **Adjusting Pinion Clearance.** Connect the battery to the starting motor as shown in Figure 43. This will allow the pinion of the starting motor to slide and stop. In this state, measure the clearance between the end of the pinion and pinion stopper when the pinion is pushed lightly toward the commutator end. Clearance should be .02″ to .06″. Adjust for proper clearance by removing the magnetic switch attaching screws and select proper thickness of the fiber packings shown in Figure 44.

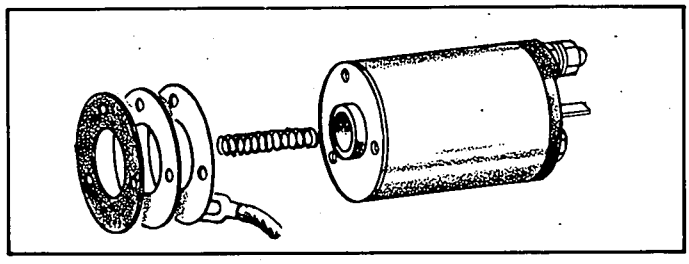


FIGURE 44. ADJUSTING PINION CLEARANCE

ENGINE DISASSEMBLY

VALVES

Proper seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44°. The valve *seat* angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life (Figure 45).

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

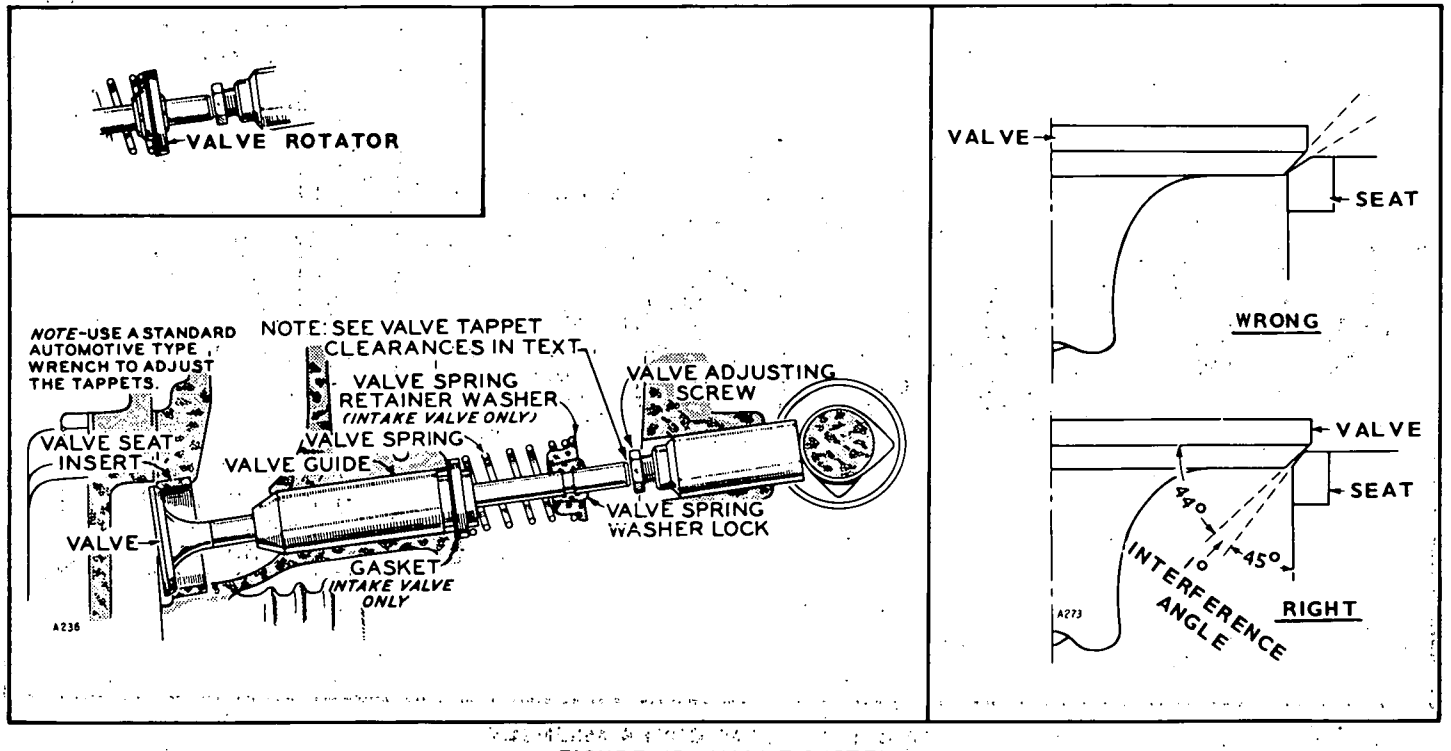


FIGURE 45. VALVE SYSTEM

Tappet Adjustment: The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 400 operating hours or when poor engine performance is noticed. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to valve tappets.
2. Remove spark plugs to make turning the engine easier.
3. Use the engine flywheel to turn the engine over slowly by hand until the left hand intake valve opens and closes. Continue turning the flywheel until the TC mark is on the top and lined up with the TC mark on the gear cover. Both valves should be closed. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder.
4. Clearances are shown in Dimensions and Clearances. For each valve, the gauge should just pass between the valve stem and valve tappet.
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.
6. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

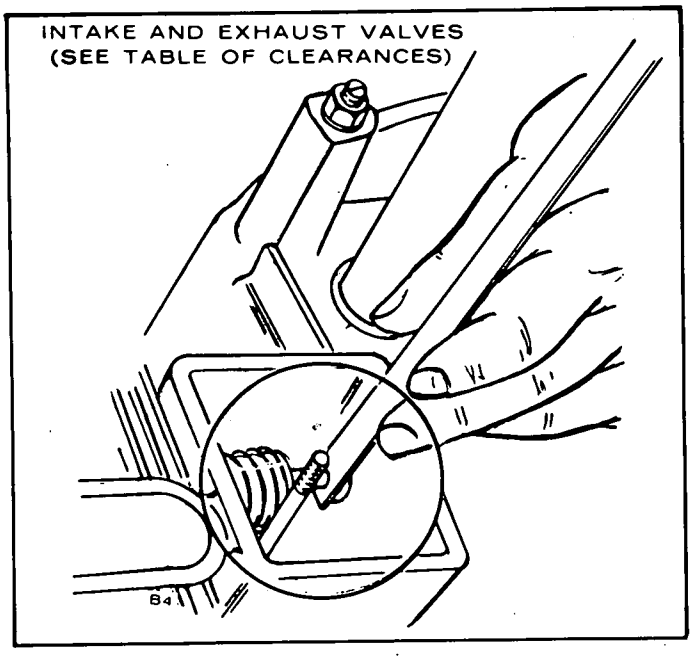


FIGURE 46. VALVE ADJUSTMENT

FLYWHEEL

Use a suitable puller (with claws or with bolts to agree with flywheel) to pull the flywheel.

Do not drop the flywheel. A broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

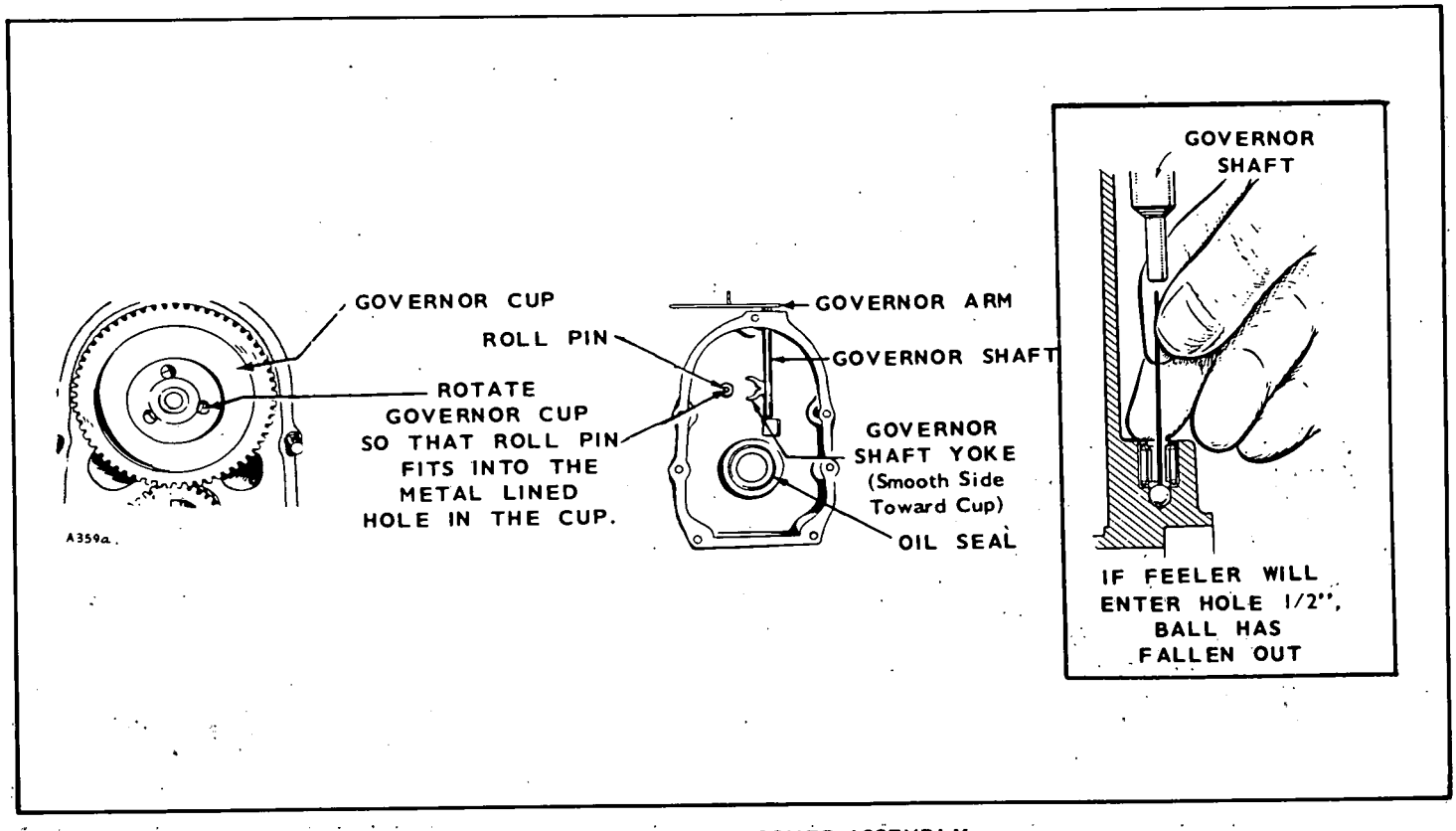


FIGURE 47. GEAR COVER ASSEMBLY

ENGINE DISASSEMBLY

VALVES

Proper seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44°. The valve *seat* angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life (Figure 45).

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

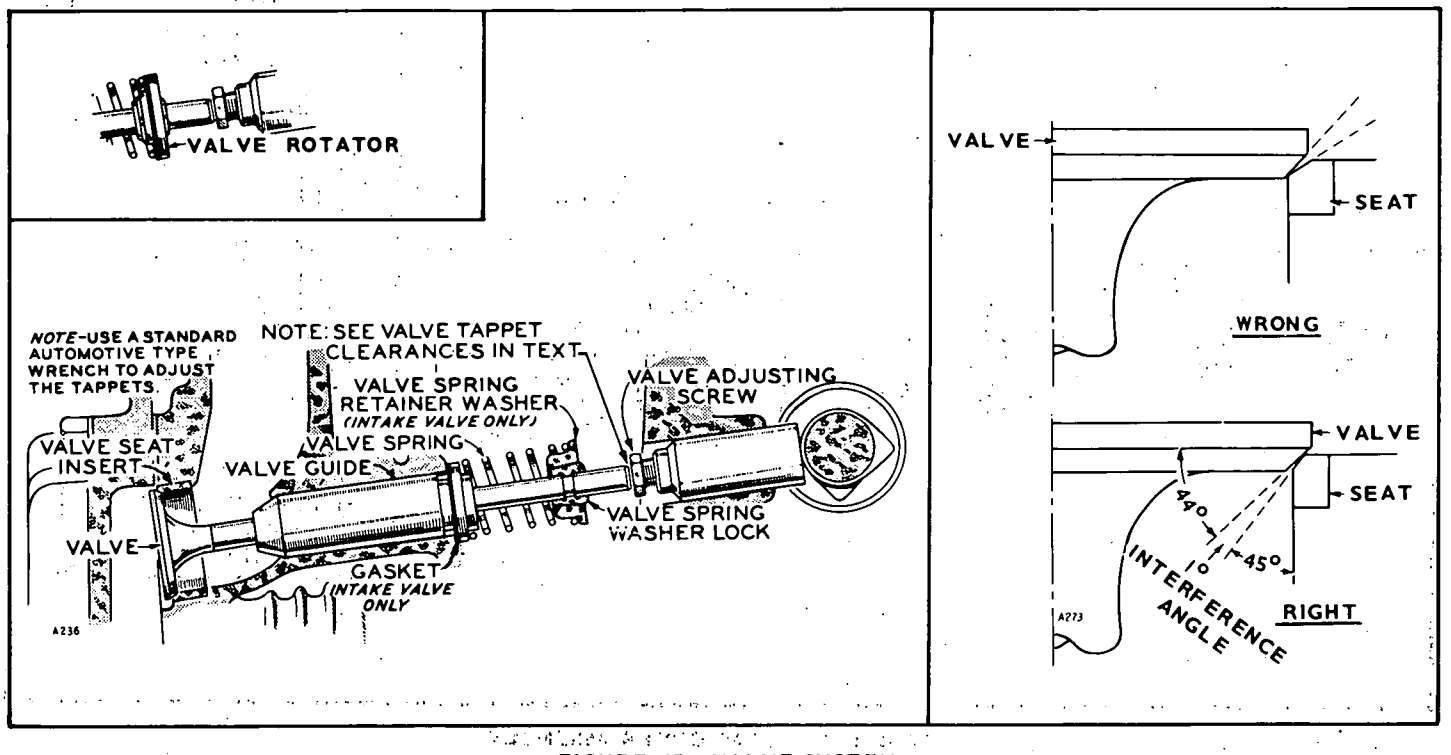


FIGURE 45. VALVE SYSTEM

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7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

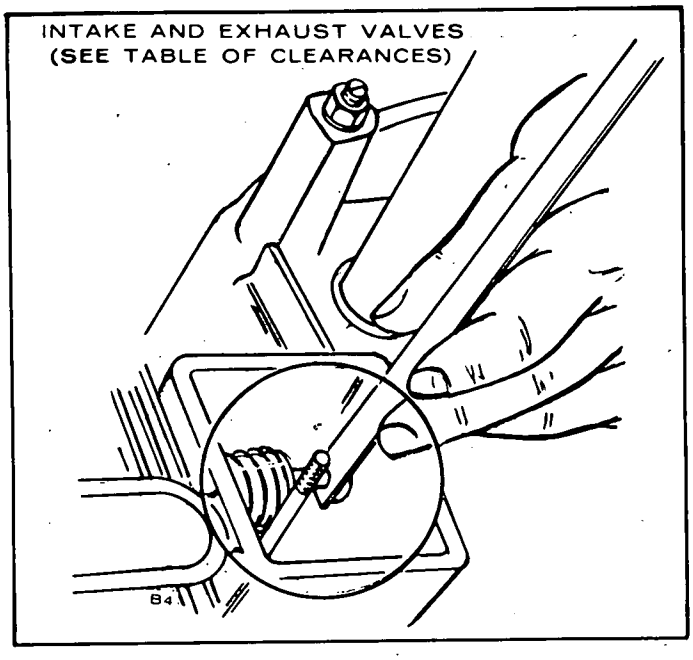


FIGURE 46. VALVE ADJUSTMENT

FLYWHEEL

Use a suitable puller (with claws or with bolts to agree with flywheel) to pull the flywheel.

Do not drop the flywheel. A broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

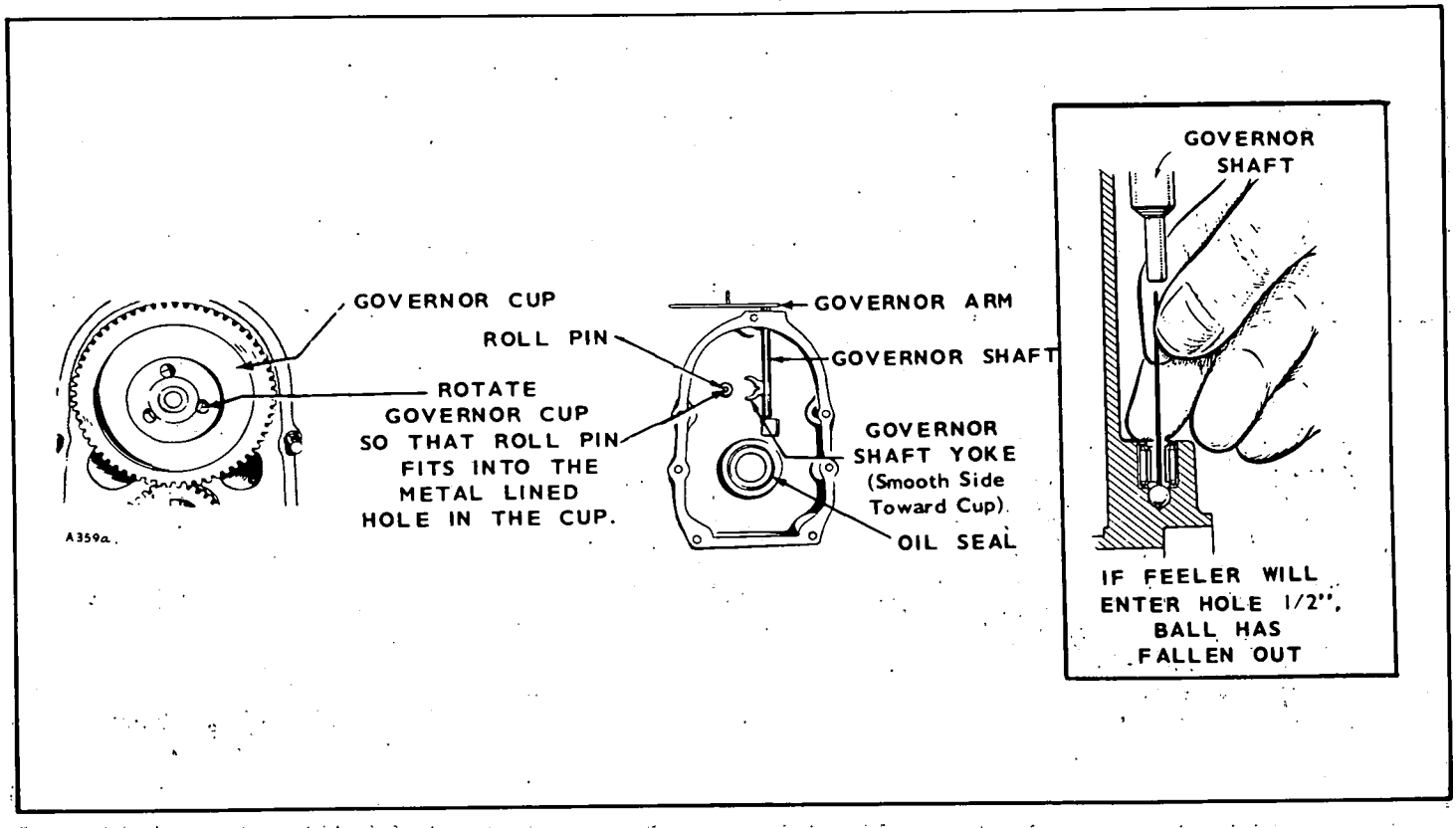


FIGURE 47. GEAR COVER ASSEMBLY

If a puller is not available turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp endwise blow on the head of the cap screw with a heavy soft-faced hammer to loosen.

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.

CAUTION *When installing the gear cover, make sure that the pin in the gear cover engages the metal lined (smooth) hole in the governor cup.*

Turn the governor cup so that the metal lined hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Adjust the center (stop) pin to protrude to a point 3/4" from the cover mounting surface. See Figure 48.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off.

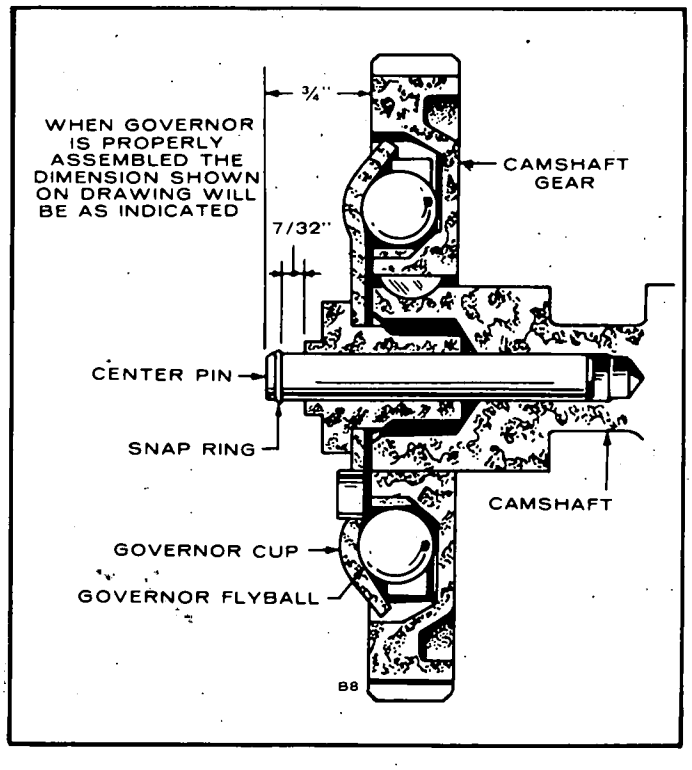


FIGURE 48. GOVERNOR CUP DETAILS

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting with a chisel. Replace the spacer with a new one. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the cup and snap ring on the center pin (Figure 48).

The camshaft center pin extends out 3/4" from the end of the camshaft. This distance provides an in and out travel distance of 7/32" for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture. See Figure 49.

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

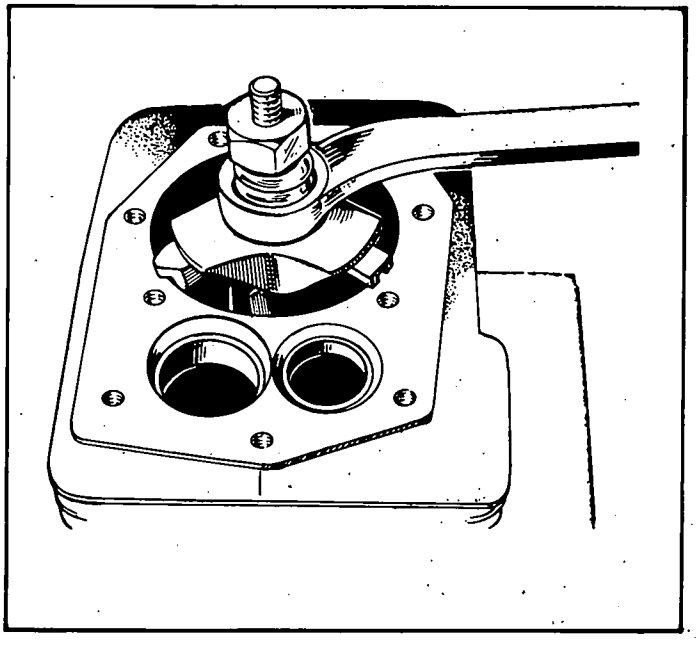


FIGURE 49. REMOVING WEAR RIDGE

NOTE: *Keep the connecting rod bearing caps and bearings with their respective rods.*

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader (Onan 420P146).

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point. All passages should be cleaned with a non-caustic solvent. Clean the rod bore and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land using new rings and a feeler gauge as shown in Figure 50. See Dimensions and Clearances for proper side clearance measurement and ring groove widths.

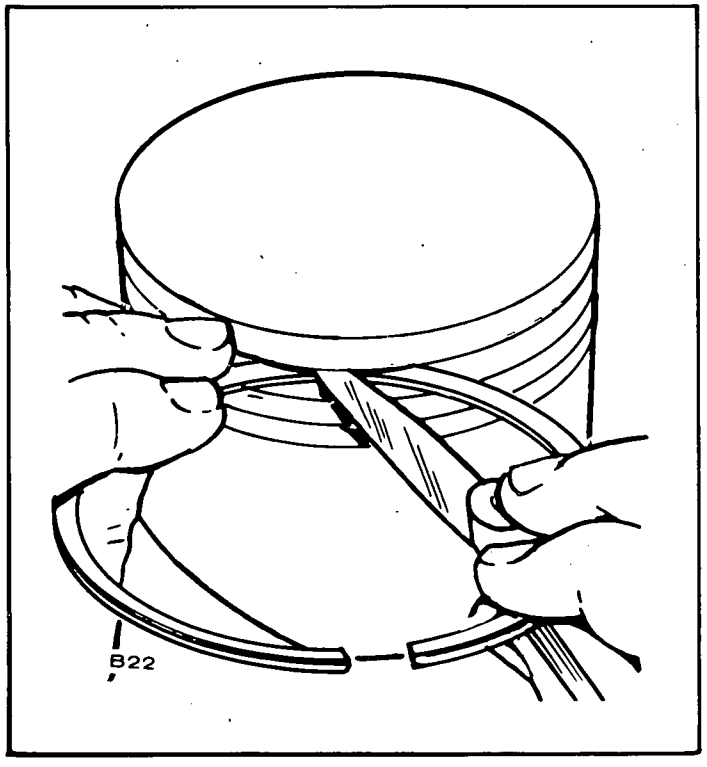


FIGURE 50. RING LAND INSPECTION

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves don't have good cylinder wall contact (Figure 51).

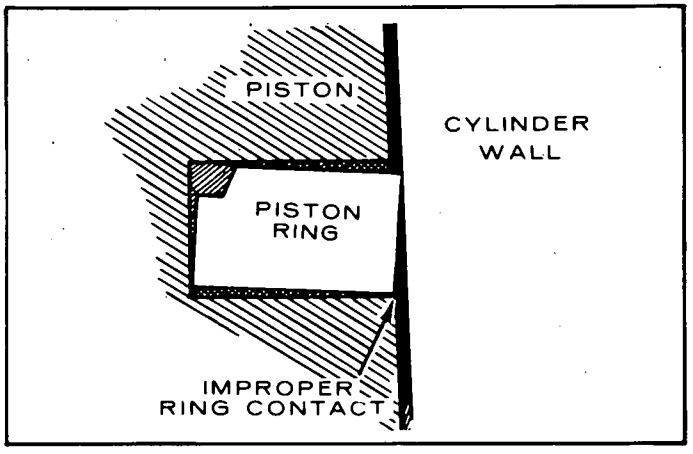


FIGURE 51. NEW RING IN WORN RING GROOVE

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002″.

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in Dimensions and Clearances.

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel (Figure 52). The gap between the ends of the ring is given in Dimensions and Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on .005″ oversize pistons. Rings that are .010″, .020″, .030″ and .040″ oversize are to be used on corresponding oversize pistons. Rings of the tapered type are usually marked *top* on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

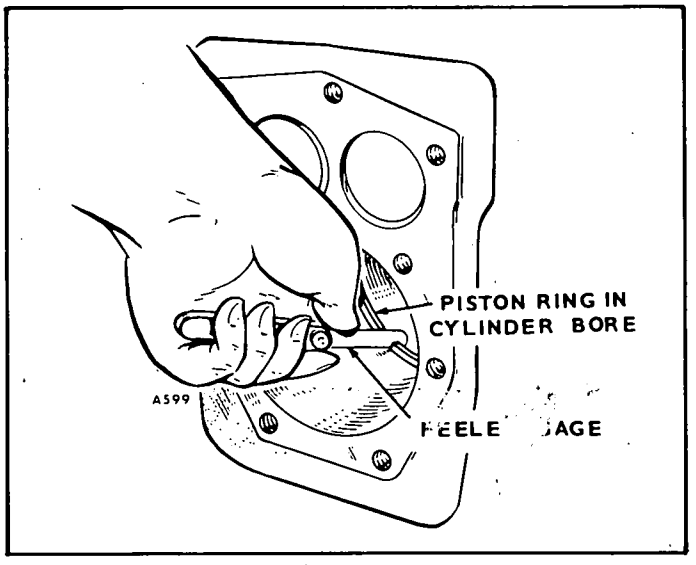


FIGURE 52. FITTING PISTON RINGS TO THE CYLINDER

Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Refer to Dimensions and Clearances for the correct piston-to-cylinder clearance.

CONNECTING RODS

The connecting rods should be serviced at the same time the pistons or rods are serviced. Rods must be removed with the piston. Replaceable bushings and bearings are used. Bearings are available in standard or .002″, .010″, .020″ or .030″ undersize.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts (forged rod), then refinish it to take the corresponding undersize bearing insert available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

SHOT PEENING

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing (Figure 53). Use combination bearing driver 420B324 to install the camshaft bearings.

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

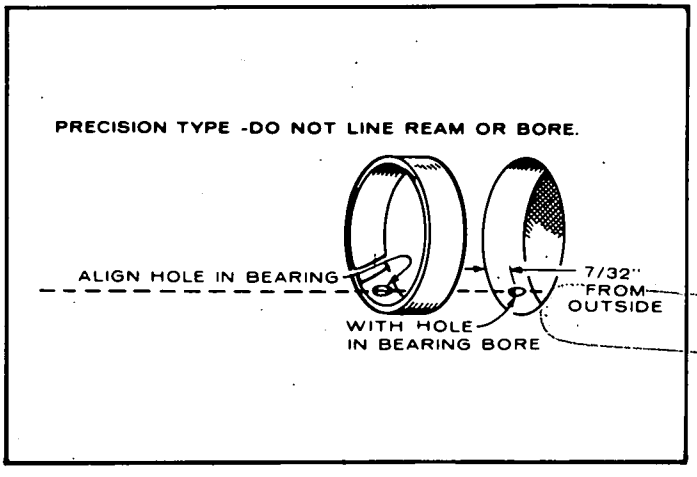


FIGURE 53. CAMSHAFT BEARING

New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard size, .002″, .010″, .020″ or .030″ undersize.

Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heater to 200°F. If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

The cold oiled precision bearing should require only light taps to position it.

NOTE: *Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 55. Do not add an additional thrust washer to this front bearing.*

In the rear bearing plate, install the bearing flush to 1/64″ below the end of the bore using combination driver 420B324 (same one used for camshaft bearing). See Figure 54.

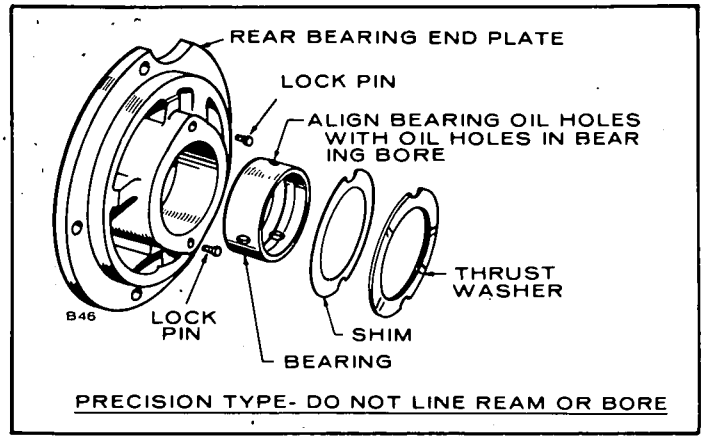


FIGURE 54. BEARINGS FOR REAR BEARING PLATE

NOTE: *If the special combination tool isn't available, it's necessary to remove the lock pins with side cutters or Easy Out tool. After the new bearings are installed, insert new lock pins.*

Before installing the front bearing (Figure 55), use the Locktite Bearing Mount furnished in the bearing kit. Use the towelette in the package to clean the outside of the bearing and the bearing bore in the block.

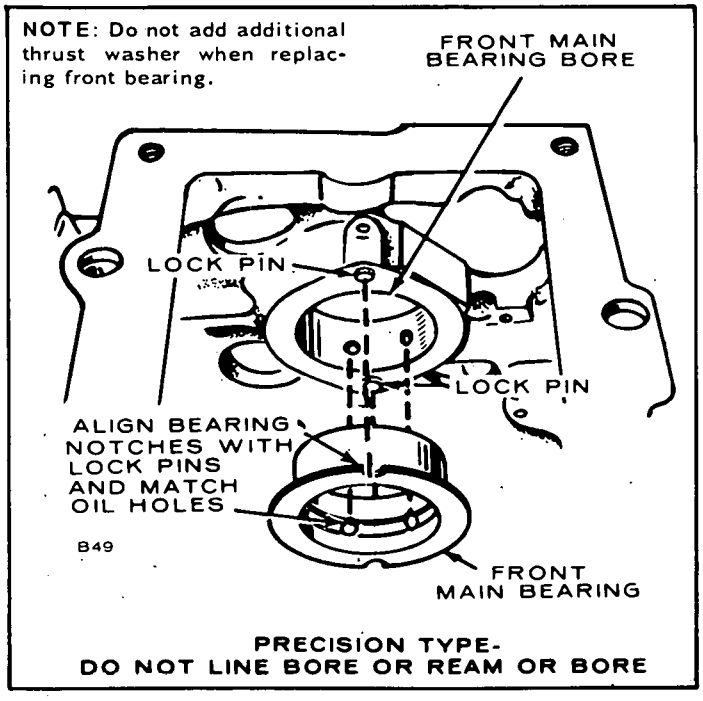


FIGURE 55. FRONT BEARING INSTALLATION

WARNING *Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well ventilated.*

After allowing three to four minutes for drying, apply the Locktite Bearing Mount from the small tube to the mating surfaces of the bearing and bearing bore. Install the bearing flush with the block using the combination driver just used for the rear bearing. Wipe off any excess Locktite around the bearing. Allow at least one hour for hardening at room temperature.

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. Line up the notches of the thrust washer with the lock pins before tightening the end plate or the lock pins will be damaged.

NOTE: *A light film of oil on the thrust washer may hold it in place while installing the crankshaft.*

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in Assembly Torques and Special Tools, check the crankshaft endplay as shown in Figure 56. If there is too much endplay (see Dimensions and Clearances for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 54) between the thrust washer and plate. Reinstall the end plate making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

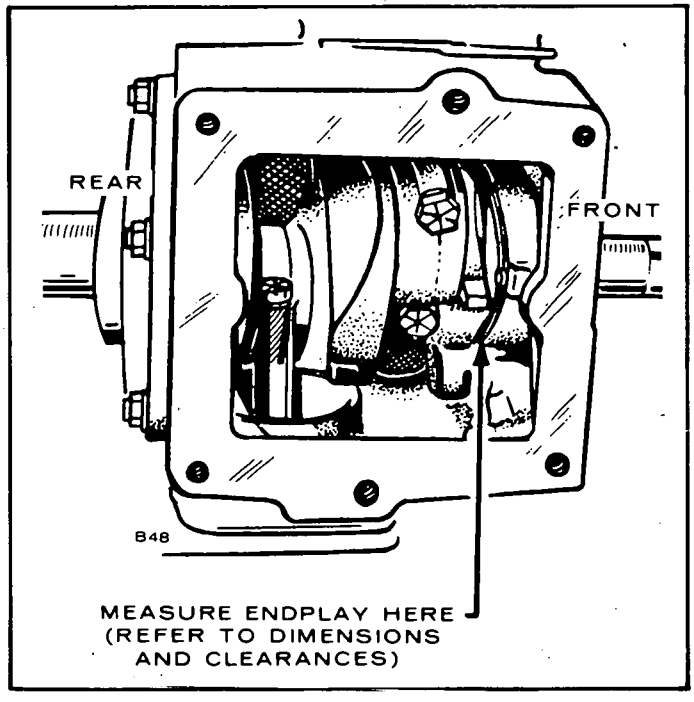


FIGURE 56. CRANKSHAFT ENDPLAY

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using bearing plate driver 420B181 and gear cover driver 420B313.

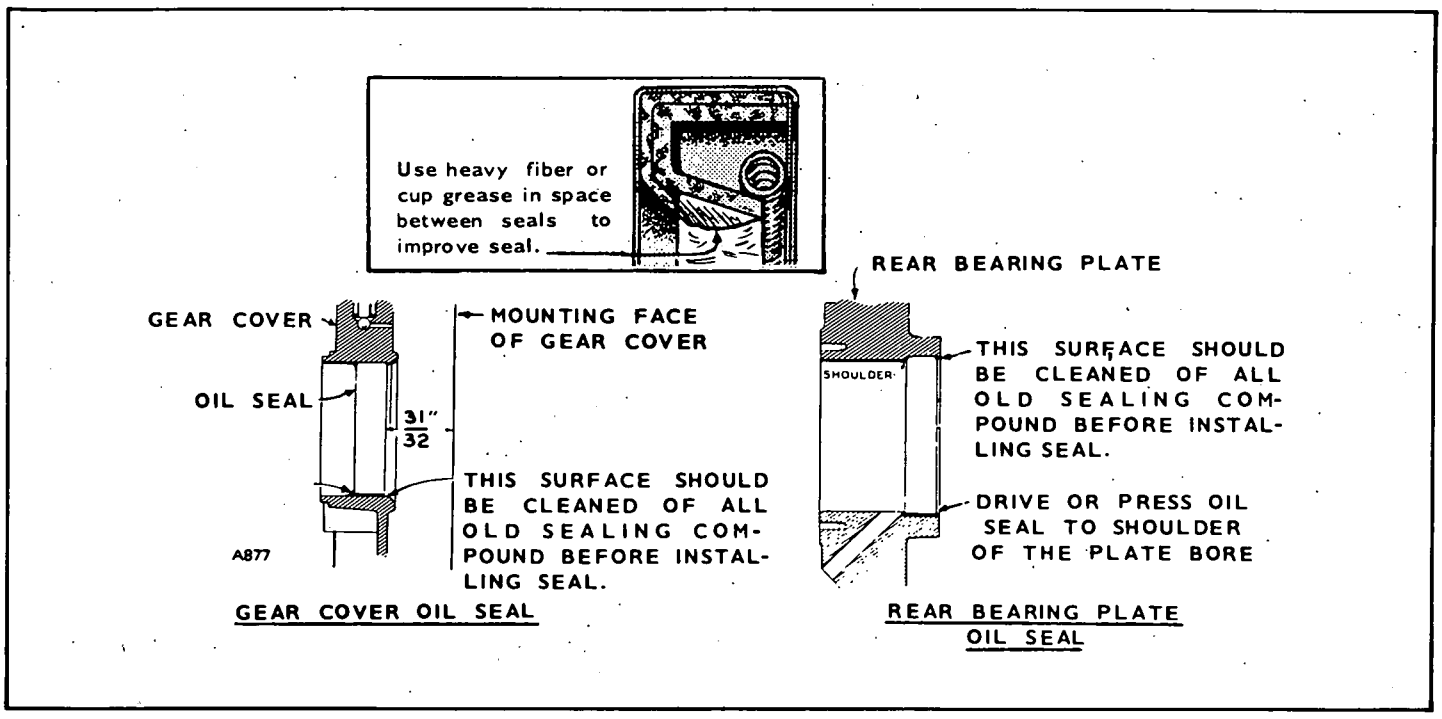


FIGURE 57. GEAR COVER AND REAR BEARING PLATE OIL SEALS

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing (see Figure 57).

When installing the gear cover oil seal, tap the seal inward until it is 31/32 of an inch from the mounting face of the cover. Install new style, thin open face seal, 1-7/64 inches from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

Engines equipped with some types of reduction gear assemblies do not use the rear oil seal. The reduction gear assembly is oiled directly from the engine crankcase. Refer to the instructions screened on the case of the reduction gear assembly.

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly as shown in Figure 58.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

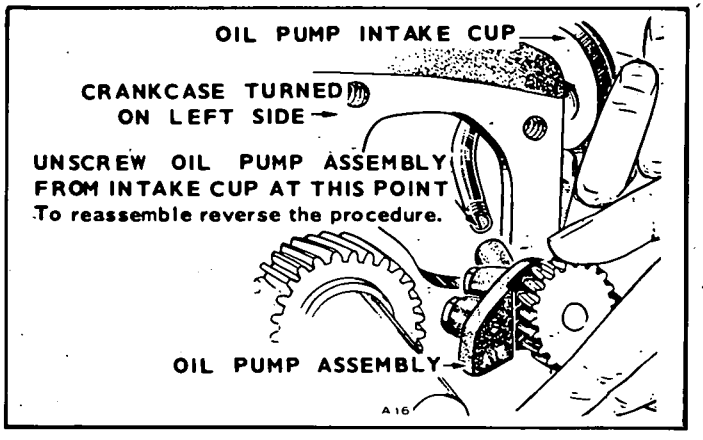


FIGURE 58. OIL PUMP ASSEMBLY

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and ring set of the available oversizes. Pistons are available in .005″, .010″, .020″, .030″ and .040″ oversize. Piston rings are available in .010″, .020″, .030″ and .040″ oversize. Use standard size rings on a .005″ oversize piston. If the cylinder is not being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore. Engine might be fitted at the factory with a .005″ oversize piston and are so indicated by a letter E following the engine serial number stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in Dimensions and Clearances.

CYLINDER HEADS

Remove the cylinder heads for cleaning at least every 400 hours or when poor engine performance is noticed.

1. Use a 1/2 inch socket wrench to remove cylinder head bolts. Lift heads off.

   CAUTION *Do not remove heads when they are hot. Warpage may occur.*
2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place heads in position and follow head torque tightening sequence shown in Figure 59. Start out tightening all bolts to 5 ft-lb, then 10 ft-lb, etc., until all bolts are torqued to 17-19 ft-lb.
5. Recheck torque before engine has run a total of 50 hours.

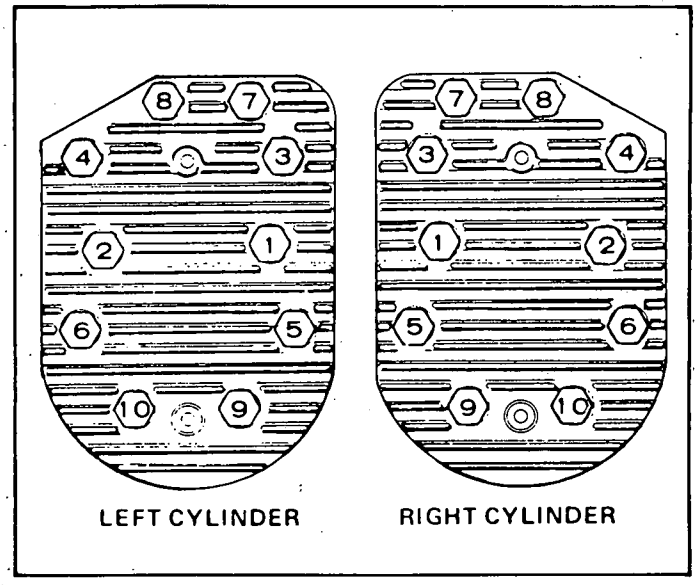


FIGURE 59. HEAD BOLT TIGHTENING SEQUENCE

PARTS CATALOG

This catalog applies to the standard NHC Engines. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number following the illustration. Parts illustrations are typical. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left engine sides are determined by *facing* the blower end (front) of the engine.

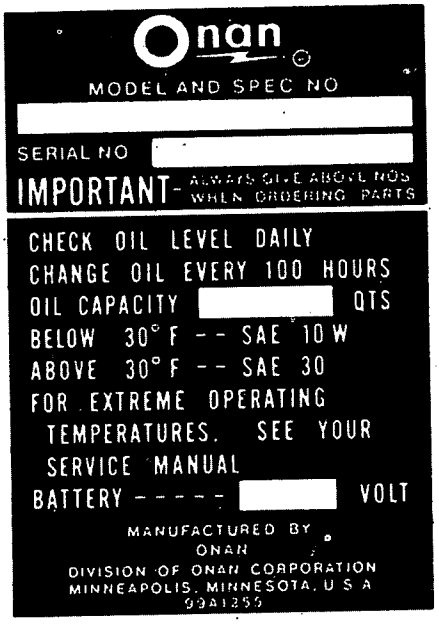
INSTRUCTIONS FOR ORDERING REPAIR PARTS

For parts or service, contact the dealer from whom you purchased this equipment or refer to your Nearest Authorized Onan Parts and Service Center.

To avoid errors or delay in filling your parts order, please furnish all information requested.

Always refer to the nameplate on your unit:

1. Always give the MODEL and SPEC NO. and SERIAL NO.

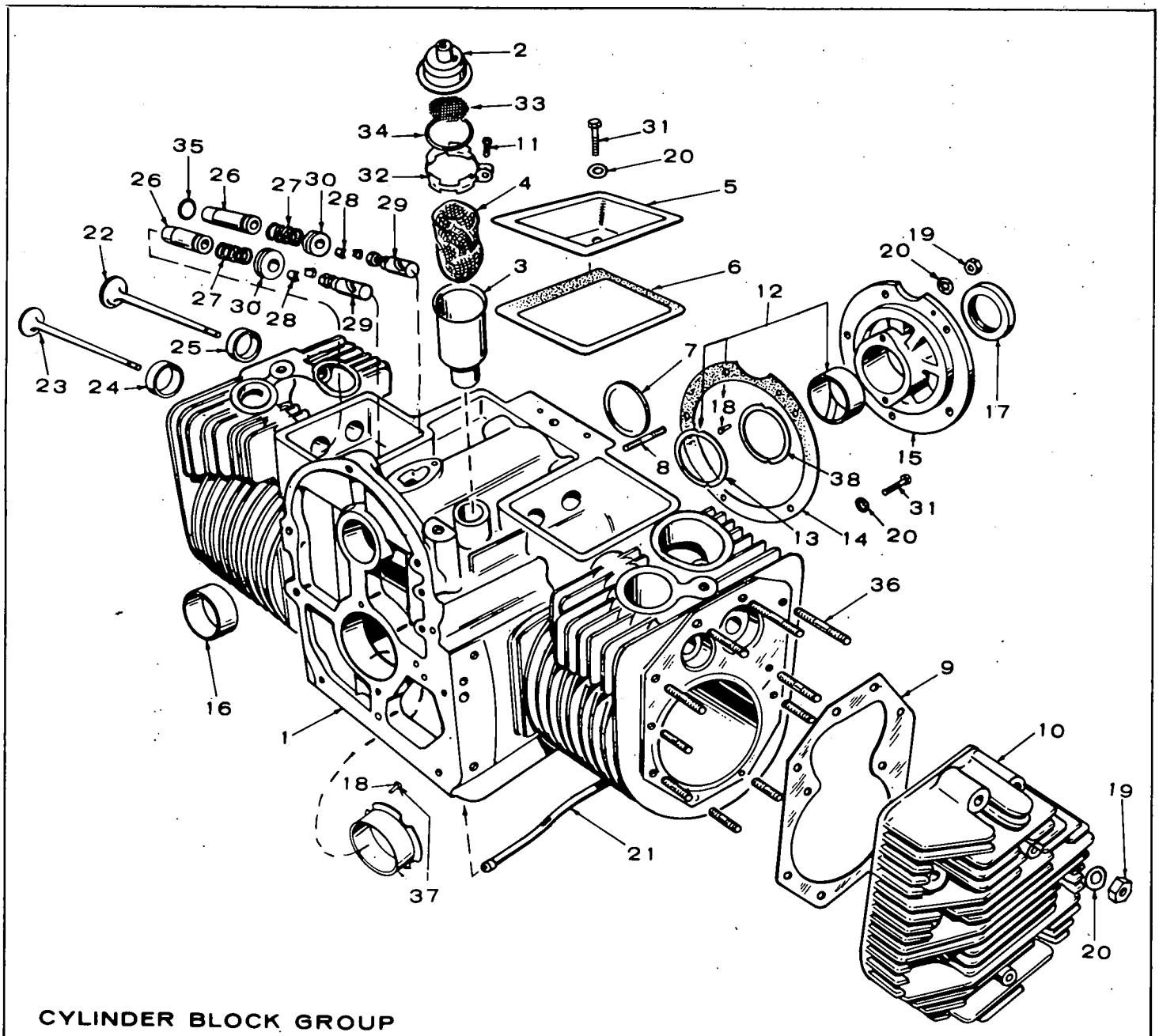


For handy reference, insert YOUR engine nameplate information in the spaces above.

2. Do not order by reference number or group number, always use part number and description.
3. Give the part number, description and quantity needed of each item. If an older part cannot be identified, return the part prepaid to your dealer or nearest AUTHORIZED SERVICE STATION. Print your name and address plainly on the package. Write a letter to the same address stating the reason for returning the part.
4. State definite shipping instructions. Any claim for loss or damage to your unit in transit should be filed promptly against the transportation company making the delivery. Shipments are complete unless the packing list indicates items are back ordered.

Prices are purposely omitted from this Parts Catalog due to the confusion resulting from fluctuating costs, import duties, sales taxes, exchange rates, etc.

For current parts prices, consult your Onan Dealer, Distributor or Parts and Service Center.



CYLINDER BLOCK GROUP

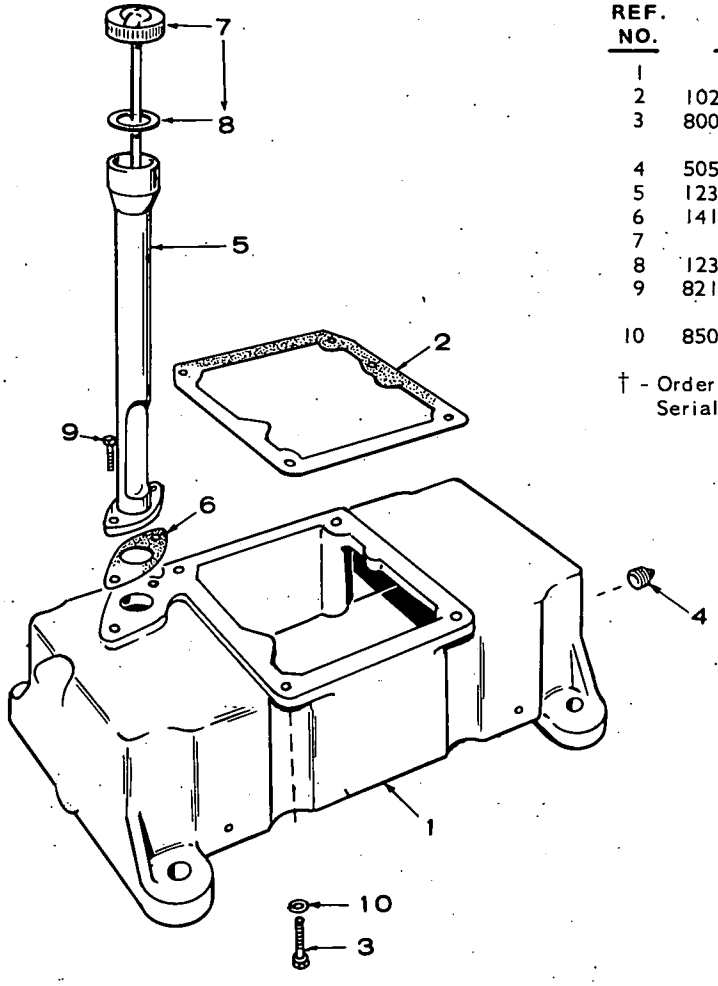
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	★	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	123A954	1	Cap & Valve, Breather
3	123A952	1	Tube, Breather
4	123P865	1	Baffle, Breather Tube
5	110A1624	2	Cover, Valve Compartment
6	110B1720	2	Gasket, Valve Cover
7	517-48	1	Plug, Camshaft Expansion
8	520A736	5	Stud, Rear Bearing Plate Mounting
9	110C1731	2	Gasket, Cylinder Head
10	HEAD, CYLINDER		
	110B1912	1	Right Side (#2)
	110B1913	1	Left Side (#1)
11	809-35	1	Screw, Breather Cap Clamp
12	BEARING, CRANKSHAFT – REAR		
	101K420	1	*Standard
	101K420-02	1	.002″ Undersize
	101K420-10	1	.010″ Undersize
	101K420-20	1	.020″ Undersize
	101K420-30	1	.030″ Undersize
13	104A575	2	£Washer, Crankshaft Bearing Thrust
14	101B415	1	Gasket, Bearing Plate
15	* PLATE, REAR BEARING (EXCLUDES BEARING)		
	101C406	1	Engines Without Reduction Gear Assembly
	101B417	1	Engines With Reduction Gear Assembly
16	101B405	2	*Bearing, Camshaft (Precision)
17	509A41	1	Seal, Bearing Plate
18	516A72	4	*Pin, Main Bearing Stop
19	NUT, HEX		
	104A91	5	Bearing Plate Mounting
	104A91	20	Cylinder Head Mounting
20	WASHER, FLAT		
	526-63	2	Valve Compartment Mounting (1/4″ Copper)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	526A250	20	Cylinder Head Mounting (3/8)
	526-251	5	Bearing Plate Mounting (3/8)
	526-66	2	Cylinder Block (3/8″ Copper)
21	120B680	1	*Tube, Crankcase Oil
22	110B1756	2	Valve, Intake (Stellite)
23	110B1719	2	Valve, Exhaust (Stellite)
24	INSERT, EXHAUST VALVE SEAT (STELLITE)		
	110A1716	2	*Standard
	110A1716-02	2	.002″ Oversize
	110A1716-05	2	.005″ Oversize
	110A1716-10	2	.010″ Oversize
	110A1716-25	2	.025″ Oversize
25	INSERT, INTAKE VALVE SEAT		
	110A1932	2	*Standard
	110A1932-02	2	.002″ Oversize
	110A1932-05	2	.005″ Oversize
	110A1932-10	2	.010″ Oversize
	110A1932-25	2	.025″ Oversize
26	GUIDE, VALVE		
	110A1939	4	*Standard
	110A1939-01	4	.001″ Oversize
27	110A539	4	Spring, Valve
28	110A639	8	Lock, Valve & Spring
29	TAPPET, VALVE		
	115A6	4	Standard
	115A6-05	4	.005″ Oversize

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
30	110A904	4	Rotocap
31	SCREW, HEX CAP		
	800-11	2	Valve Box Cover Mounting (1/4-20 x 2″)
	806-27	2	Cylinder Block (3/8-16 x 3/4″)
32	123A951	1	Clamp, Breather Tube Cap
33	123A958	1	Screen, Breather Tube
34	509-117	1	Seal, "O" Ring - Breather Tube
35	110A68	2	*Gasket, Valve Guide (Intake)
36	STUD, CYLINDER HEAD MOUNTING		
	520A717	8	3/8 x 1-7/8″
	520A773	12	3/8 x 2-5/16″
37	BEARING, CRANKSHAFT – FRONT		
	101K432	1	*Standard
	101K432-02	1	.002″ Undersize
	101K432-10	1	.010″ Undersize
	101K432-20	1	.020″ Undersize
	101K432-30	1	.030″ Undersize
38	104A776	As Req.	Shim (.005″) - Crankshaft Thrust

★ - Order by description, giving complete Model, Spec and Serial Number.
*. - Included in Cylinder Block Assembly.
£ - Use one only with rear bearing on units with flange type front bearing.

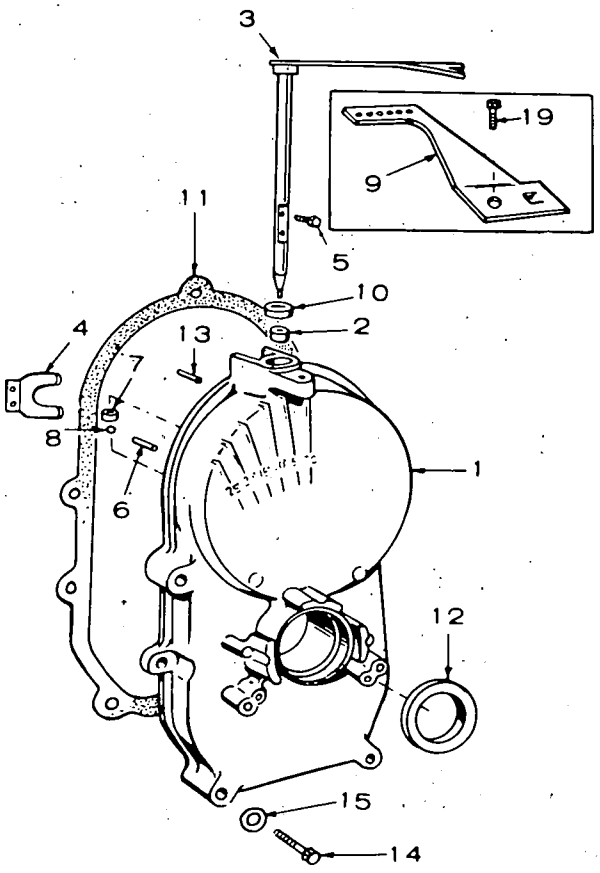
OIL BASE GROUP

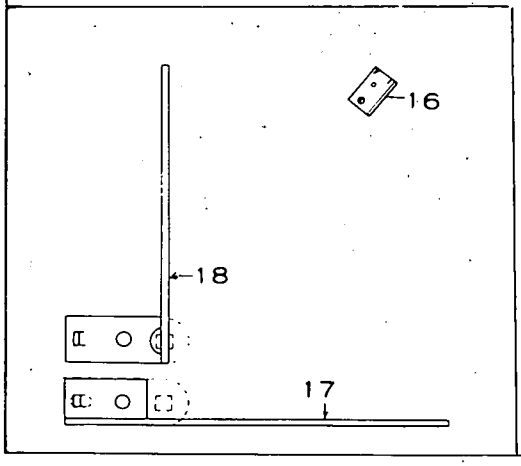


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	†	1	Base, Oil
2	102B646	1	Gasket, Oil Base
3	800-51	4	Screw (3/8-16 x 1-1/4″), Oil Base to Block
4	505-56	1	Plug, Oil Drain (1/2)
5	123B1117	1	Tube, Oil Fill
6	141B78	1	Gasket, Oil Fill Tube Mounting
7	†	1	Cap & Indicator, Oil Fill
8	123A191	1	Gasket, Oil Fill Cap
9	821-18	2	Screw, Hex Cap - Oil Fill Tube Mounting
10	850-50	4	Washer, Lock - Oil Base Mounting

† - Order by description, giving complete Model, Spec and Serial Number.

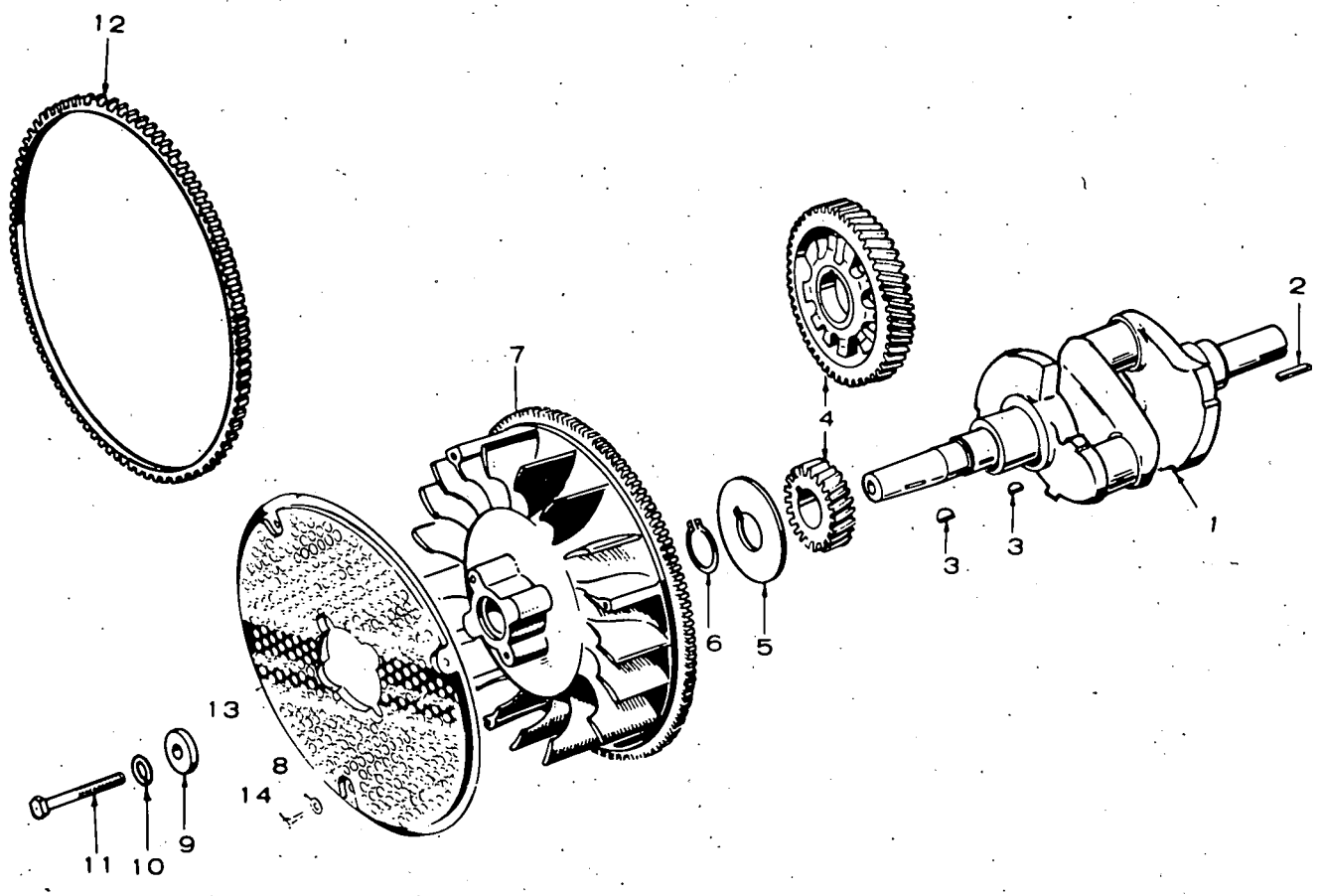
GEAR COVER GROUP





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	COVER ASSEMBLY, GEAR		
	103A386	1	Standard Governor (Drilled and Tapped for Flywheel Alternator Models) - Includes Parts Marked *
	103A387	1	Manual Throttle Controlled Engines - Includes Oil Seal (Drilled and Tapped for Flywheel Alternator Models)
2	510P13	1	*Bearing, Governor Shaft (Upper)
3	150B1260	1	*Shaft & Arm, Governor
4	150B1187	1	*Yoke, Governor Shaft
5	815-46	2	*Screw, Yoke Mounting
6	516-130	1	*Pin, Governor Cup Stop (In Gear Cover)
7	510A8	1	*Bearing, Governor Shaft (Lower)
8	510P14	1	*Ball, Bearing - Governor Shaft
9	150B1073	1	Extension, Governor Arm
10	509P8	1	*Seal, Oil
11	103B11	1	Gasket, Gear Cover
12	509A40	1	*Seal, Gear Cover
13	516A11	2	Pin, Gear Cover (5/16 x 1-1/8")
14	SCREW, HEX CAP		
	800-32	4	Gear Cover Mounting (5 16-18 x 1-3 4")
	800-34	1	Gear Cover Mounting (5/16-18 x 2-1/4")
15	526-65	5	Washer (Copper), Flat - Gear Cover Mounting
	ARM, GOVERNOR PULL – CONSTANT SPEED GOVERNOR – OPTIONAL		
16	150A1268	1	Rear Pull
17	150A755	1	Front Pull
18	150A752	1	Right Pull
19	815-181	1	Screw, Governor Arm Extension Mounting

* - Included in Gear Cover Assembly.



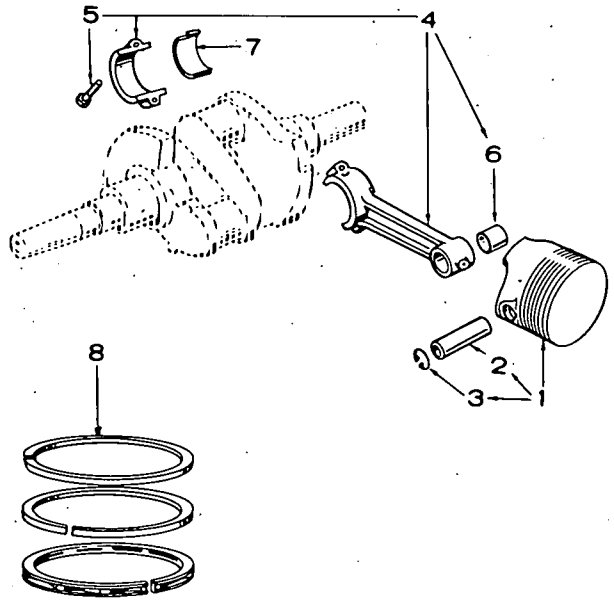
CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	*	1	Crankshaft
2	515A198	1	Key, Crankshaft Stub
3	KEY		
	515-1	1	Crankshaft Gear Mounting
	515-2	1	Flywheel Mounting
4	105A353	1	Gear Set, Timing (1 Each Crankshaft & Camshaft Gears With Flyball Spacer & Plate)
5	104A43	1	Washer, Crankshaft Gear Retaining
6	518P14	1	Lock, Crankshaft Gear Washer
7	FLYWHEEL ASSEMBLY		
	134B2530	1	Standard Units (Includes Ring Gear)
	134C2462	1	Units with Flywheel Alternator System (Includes Ring Gear and Magnet Ring) - Optional
8	526-18	3	Washer, Flat - Guard Mounting
9	526A128	1	Washer, Flywheel Mounting
10	850-55	1	Washer, Lock - Flywheel Mtg.
11	104A170	1	Screw, Flywheel Mounting
12	134C673	1	Gear, Ring - Flywheel
13	134B2433	1	Guard, Blower Wheel
14	821-10	3	Screw, Guard Mounting

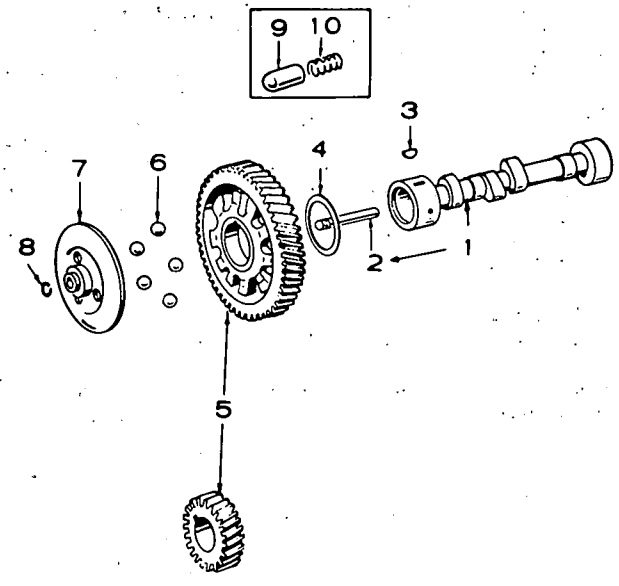
* - Order by description, giving complete Model, Spec and Serial Number.

PISTON AND CONNECTING ROD GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	PISTON AND PIN (INCLUDES RETAINING RINGS)		
	112-111	2	Standard
	112-111-05	2	.005" Oversize
	112-111-10	2	.010" Oversize
	112-111-20	2	.020" Oversize
	112-111-30	2	.030" Oversize
	112-111-40	2	.040" Oversize
2	PIN, PISTON		
	112-112	2	Standard
	112-112-02	2	.002" Oversize
3	518P294	4	Ring, Piston Pin Retaining
4	114C203	2	Rod, Connecting (Includes Bushing & Bolts)
5	805A10	4	Bolt, Place-Connecting Rod Cap
6	114A36	2	Bushing, Piston Pin-Connecting Rod
7	BEARING HALF, CONNECTING ROD		
	114B188	4	Standard
	114B188-02	4	.002" Undersize
	114B188-10	4	.010" Undersize
	114B188-20	4	.020" Undersize
	114B188-30	4	.030" Undersize
8	RING SET, PISTON		
	113A165	2	Standard
	113A165-05	2	.005" Oversize
	113A165-10	2	.010" Oversize
	113A165-20	2	.020" Oversize
	113A165-30	2	.030" Oversize
	113A165-40	2	.040" Oversize

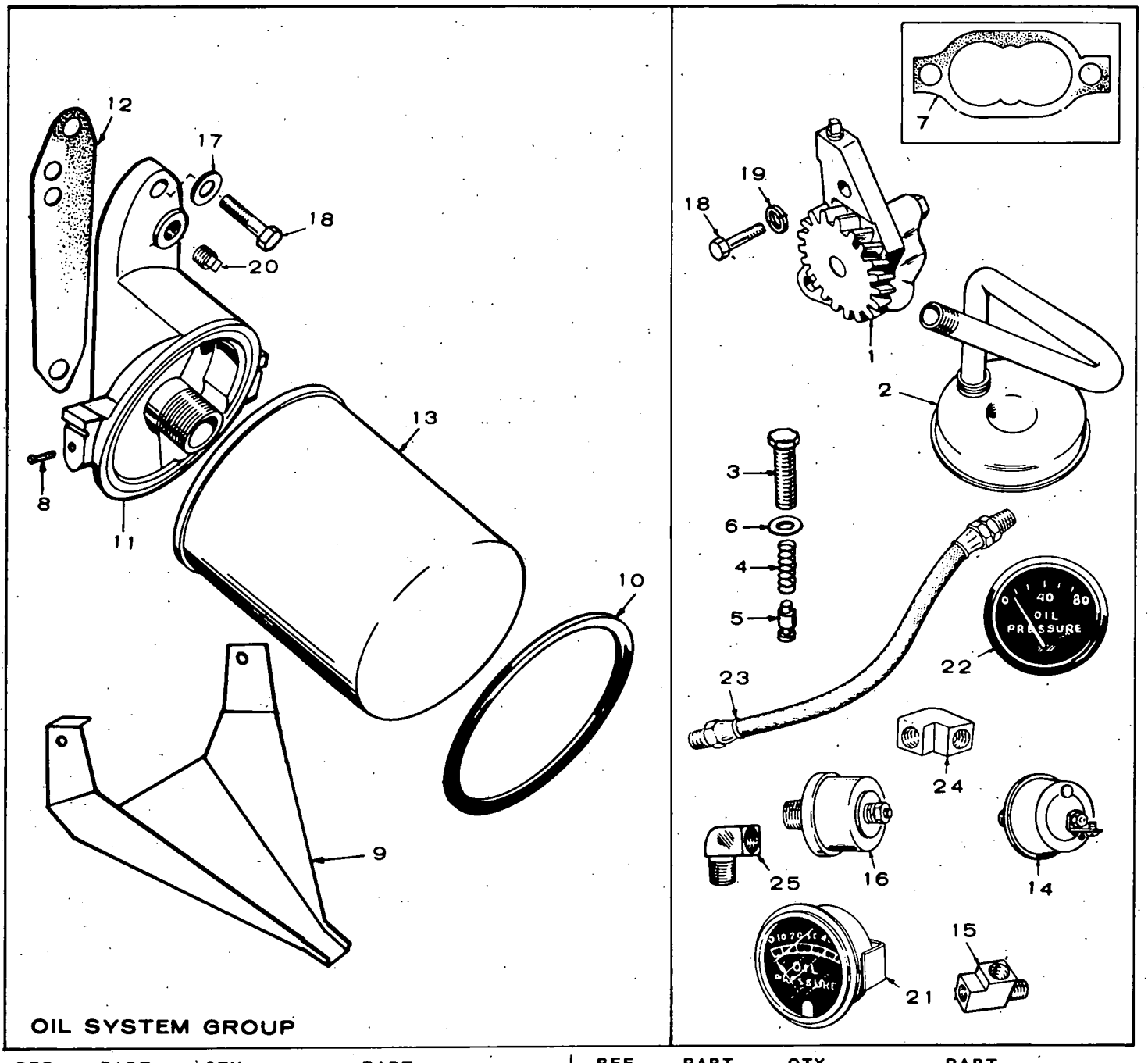


CAMSHAFT GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	CAMSHAFT		
	105B382	1	Governor Controlled Engine (Includes Center Pin)
	*	1	Manually Controlled Engine
2	150A75	1	Pin, Center-Camshaft
3	515-1	1	Key, Camshaft Gear Mounting
4	105A4	1	Washer, Camshaft Gear Thrust
5	105A353	1	Gear Set, Timing-1 Each Crankshaft & Camshaft Gears (Includes Flyball Spacer & Plate)
6	510-15	5	Ball, Fly-Governor
7	150A612	1	Cup, Governor Flyballs
8	150A78	1	Ring, Camshaft Center Pin
9	105A58	1	Plunger, Camshaft Thrust (Manually Controlled Engine)
10	105A59	1	Spring, Camshaft Plunger (Manually Controlled Engine)

* - Order by description, giving complete Model, Spec and Serial Number.

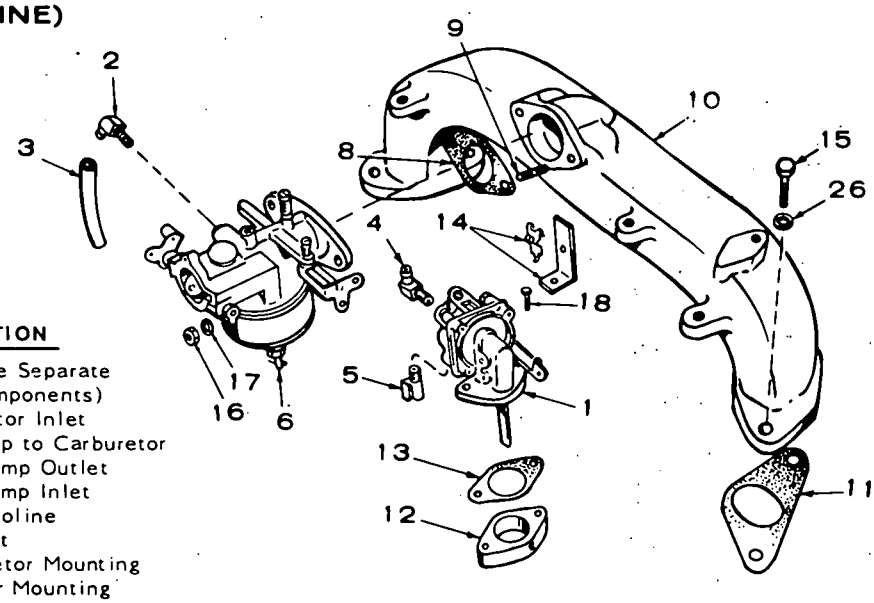


OIL SYSTEM GROUP

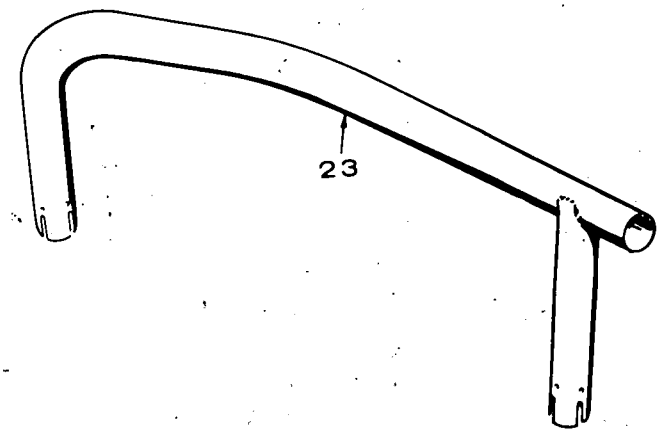
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120A491	1	Pump, Oil (Components Not Sold Separately)
2	120B691	1	Intake, Oil Pump - Includes Cup, Screen & Pipe
3	801-50	1	Screw, Hex Head - By-Pass
4	120A140	1	Spring, By-Pass Valve
5	120A398	1	Valve, By-Pass
6	526-66	1	Washer, Oil Pressure Relief Valve Screw
7	120K161	1	Gasket Kit, Oil Pump
8	815A194	2	Screw (10-32 x 3/8″) - Oil Drain Mounting
9	122C352	1	Drain, Oil Filter
10	122A347	1	Seal, Oil Filter (Air)
11	122A363	1	Adapter, Oil Filter
12	122A321	1	Gasket, Adapter
13	122B323	1	Filter, Oil

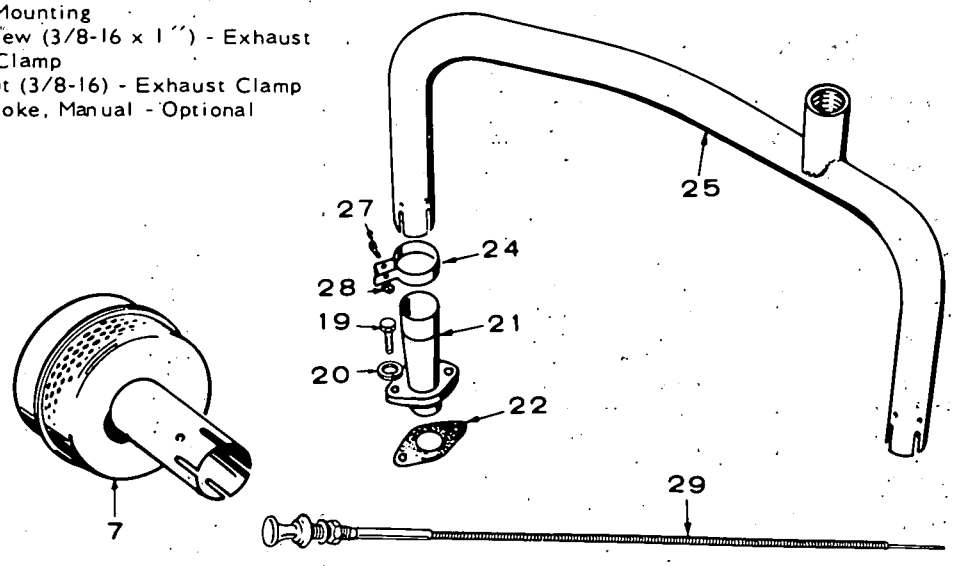
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
14	309A10	1	Switch, Low Oil Pressure - Optional
15	502-58	1	Tee, Low Oil Pressure Switch - Optional
16	193-108	1	Sender, Oil Pressure - Optional
17	526-65	2	Washer, Flat (Copper) - Adapter Mounting
18	SCREW, HEX CAP		
	800-28	2	Adapter Mounting (5/16-18 x 1″)
	800-7	2	Oil Pump Mounting (1/4-20 x 1″)
19	850-40	2	Washer, Lock - Oil Pump Mounting
20	505-57	1	Plug (1/8″)
21	193A68	1	Gauge, Oil Pressure - Optional
22	193-107	1	Gauge, Oil Pressure (Electric) - Optional
23	501A4	1	Line, Oil - Optional
24	502-5	1	Elbow, Oil Line to Gauge - Opt.
25	502-20	1	Elbow, Oil Line to Cylinder Block - Optional

FUEL SYSTEM GROUP (GASOLINE)

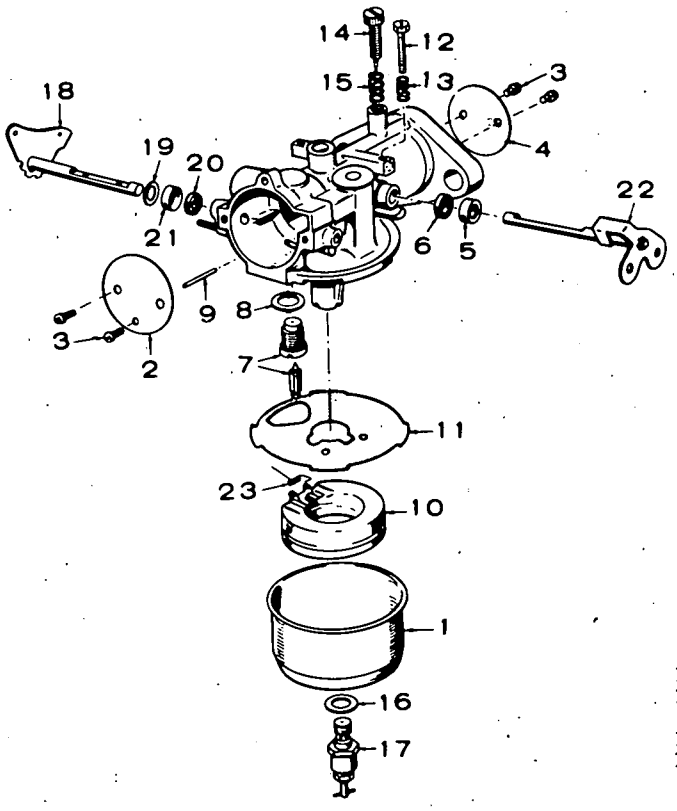


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	149D1223	1	Pump, Fuel (See Separate Group for Components)
2	502-313	1	Elbow, Carburetor Inlet
3	149A1228	1	Line, Fuel Pump to Carburetor
4	502-313	1	Elbow, Fuel Pump Outlet
5	502-2	1	Elbow, Fuel Pump Inlet
6	141D802	1	Carburetor, Gasoline
7	155B1217	2	Muffler, Exhaust
8	141A281	1	Gasket, Carburetor Mounting
9	520A526	2	Stud, Carburetor Mounting
10	154C1466	1	Manifold, Intake
11	154A1483	2	Gasket, Intake Manifold to Cylinder Block
12	149A45	1	Spacer, Fuel Pump Mounting
13	149A3	2	Gasket, Fuel Pump Mounting
14	153-263	1	Bracket & Clamp, Manual Choke - Optional
15	800A538	4	Screw 3/8-16 x 1-1/2", Intake Manifold Mounting
16	868-2	2	Nut, Hex (Jam) - Carburetor Mounting
17	854-17	2	Washer, Shakeproof - Carburetor Mounting
18	806-9	2	Screw, Fuel Pump Mounting
19	800P512	4	Screw (5/16-18 x 1") - Exhaust Adapter Mounting
20	850-45	4	Washer, Lock (5/16")
21	154B1484	2	Adapter, Exhaust Manifold
22	154A1482	2	Gasket, Exhaust Manifold Adapter
23	154D1492	1	Manifold, Exhaust - High Profile (Right or Left Outlet) - Opt.
24	155P1219	2	Clamp, Exhaust Manifold
25	154C1493	1	Manifold, Exhaust - High Profile (Top Outlet) - Optional
26	850-50	4	Washer, Lock - Intake Manifold Mounting
27	805A18	2	Screw (3/8-16 x 1") - Exhaust Clamp
28	862-3	2	Nut (3/8-16) - Exhaust Clamp
29	153B97	1	Choke, Manual - Optional





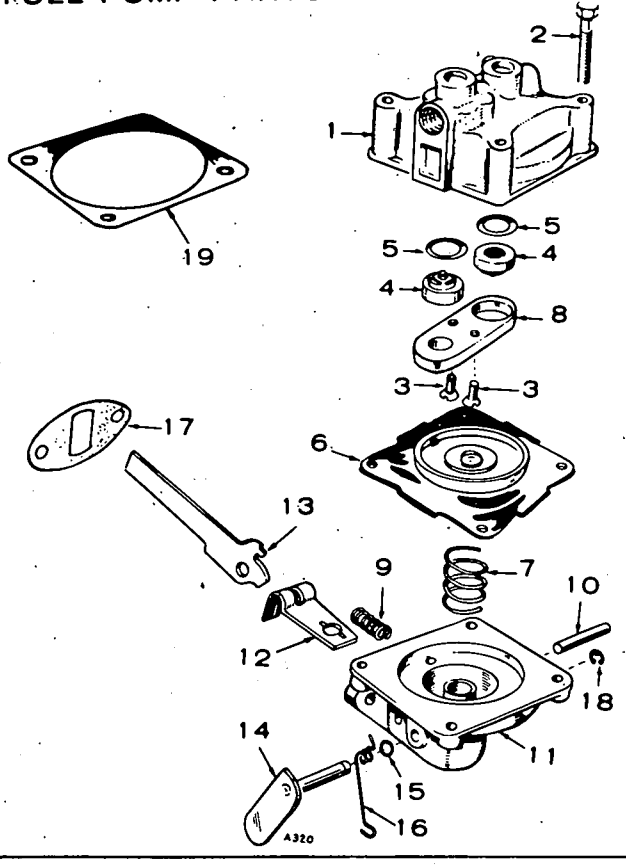
CARBURETOR PARTS GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	CARBURETOR, GASOLINE		
	141D802	1	Manual Choke
	141D803	1	Electric Choke
	141P814	1	Repair Kit (Includes Parts Marked *)
	141K748	1	Gasket Kit (Includes Parts Marked ▲)
	141A281	1	*▲Gasket, Carburetor Flange
1	141P708	1	Bowl, Fuel
2	141P741	1	Plate, Choke
3	141P698	4	Screw & Washer, Choke & Throttle Plate Mounting
4	141-813	1	Plate, Throttle
5	141P705	1	*Retainer, Seal
6	141-661	1	*▲Seal, Rubber
7	141P798	1	*Valve, Seat Assembly, Fuel
8	141-811	1	Washer, Fuel Valve Seat
9	141P703	1	*Shaft, Float
10	141P702	1	Float Assembly
11	141P701	1	*▲Gasket, Bowl to Body
12	141P700	1	Screw, Throttle Stop
13	141P711	1	Spring, Throttle Stop
14	141P713	1	*Needle, Idle Adjusting
15	141P710	1	Spring, Idle Needle
16	141A77	1	*▲Washer, Main Jet Assembly
17	141-810	1	Jet Assembly, Main (Adjustable)
18	SHAFT, CHOKE		
	141-742	1	Manual Choke Units
	141B679	1	Electric Choke Units
19	141P699	1	*Washer, Choke Shaft - Manual Choke Units
20	141P697	1	*▲Seal, Felt - Manual Choke Units
21	141P203	1	*Retainer, Felt Seal - Manual Choke Units
22	141-809	1	Shaft & Lever, Throttle
23	141-799	1	*Spring, Float

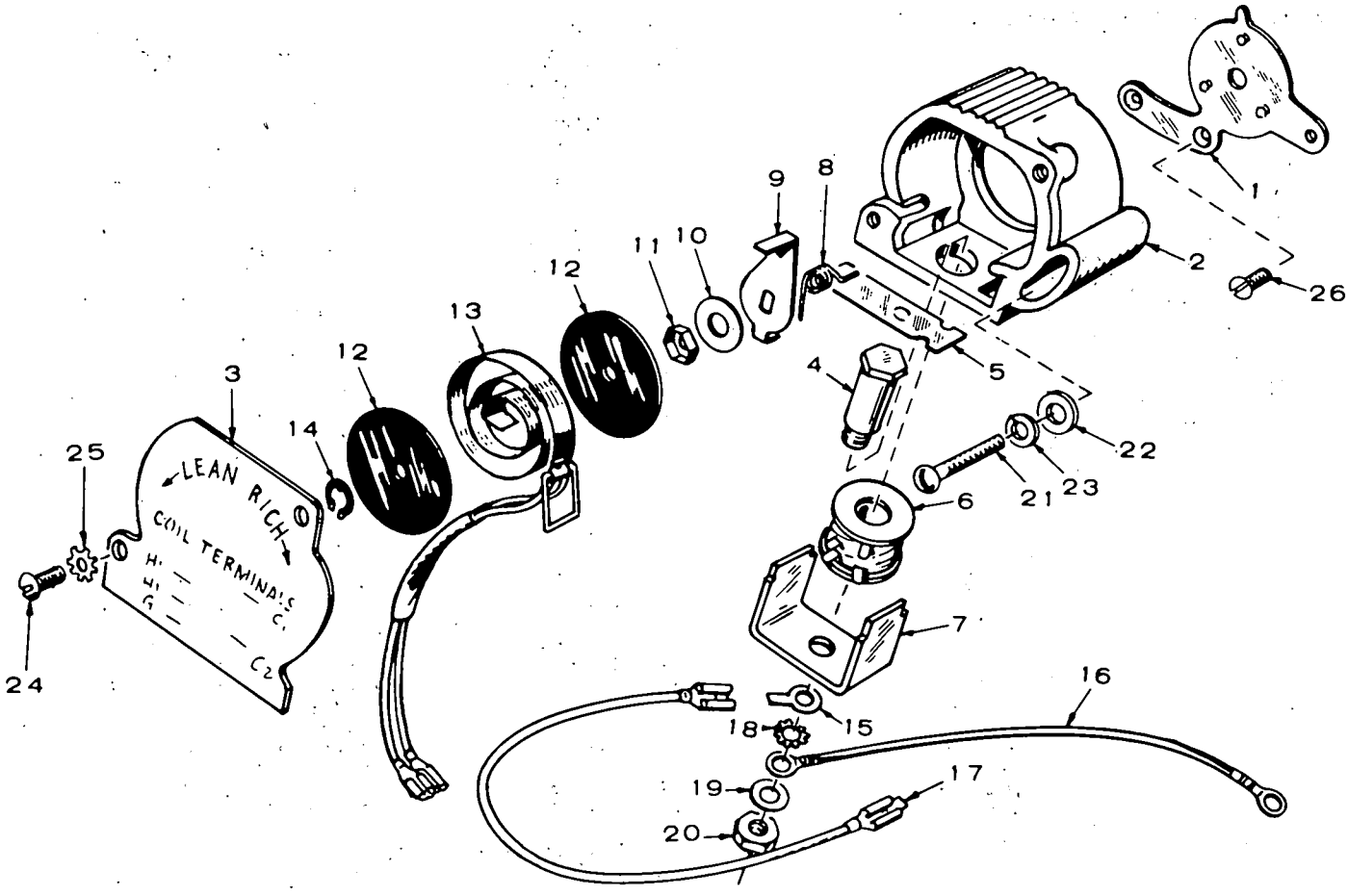
* - Parts Contained in Repair Kit.
▲ - Parts Contained in Gasket Kit.

FUEL PUMP PARTS GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149D1223	1	Pump, Fuel (Illustrated in Fuel System Group)
	149K526	1	Repair Parts Kit - Includes Parts Marked *
1		1	Body, Not Sold Separately
2	815-148	4	Screw, Machine, #8-32 x 7/8"
3	815-147	2	Screw, Phillips Self Tapping, #6-32 x 5/8", Valve Retainer
4	149-96	2	*Valve & Cage
5	149A95	2	*Gasket, Valve
6	149A582	1	*Diaphragm Assembly
7	149A672	1	*Spring
8	149A539	1	Retainer, Valve Cage
9	149A675	1	*Spring
10	516A113	1	Pin, Rocker Arm
11		1	Body, Not Sold Separately
12	149A670	1	Link, Rocker Arm
13	149B1148	1	Arm, Rocker
14	149A1042	1	Lever, Primer
15	509-65	2	Seal, "O" Ring
16	149A1044	1	Spring, Primer Lever
17	149A3	1	*Gasket, Pump Mounting
18	518P129	1	Ring, Retainer, Primer Lever
19	149A858	1	*Gasket, Diaphragm - Lower Side

* Parts in Repair Kit

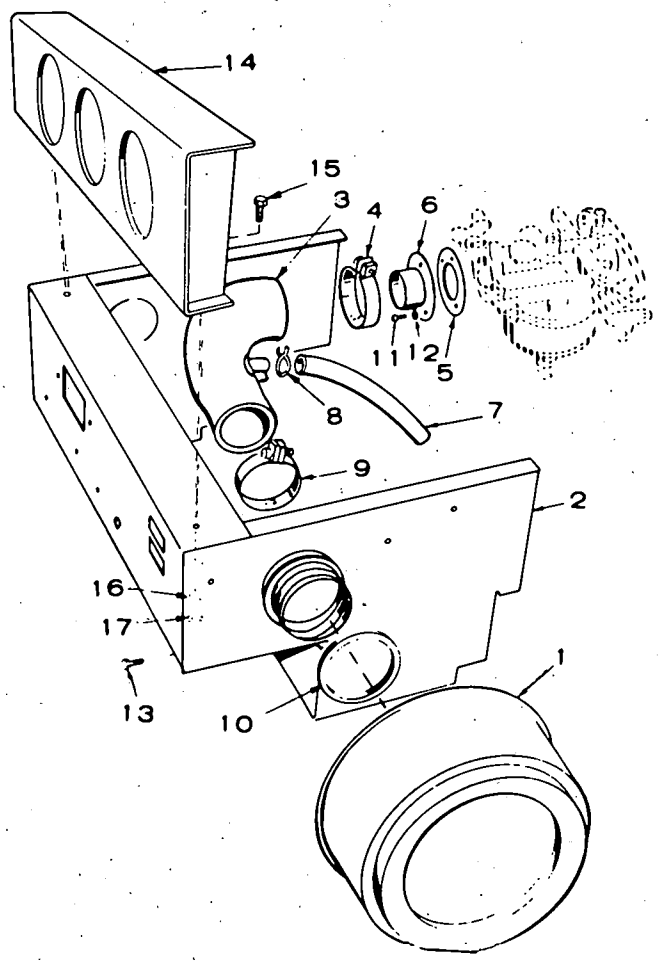


THERMO-MAGNETIC CHOKE GROUP (OPTIONAL EQUIPMENT)

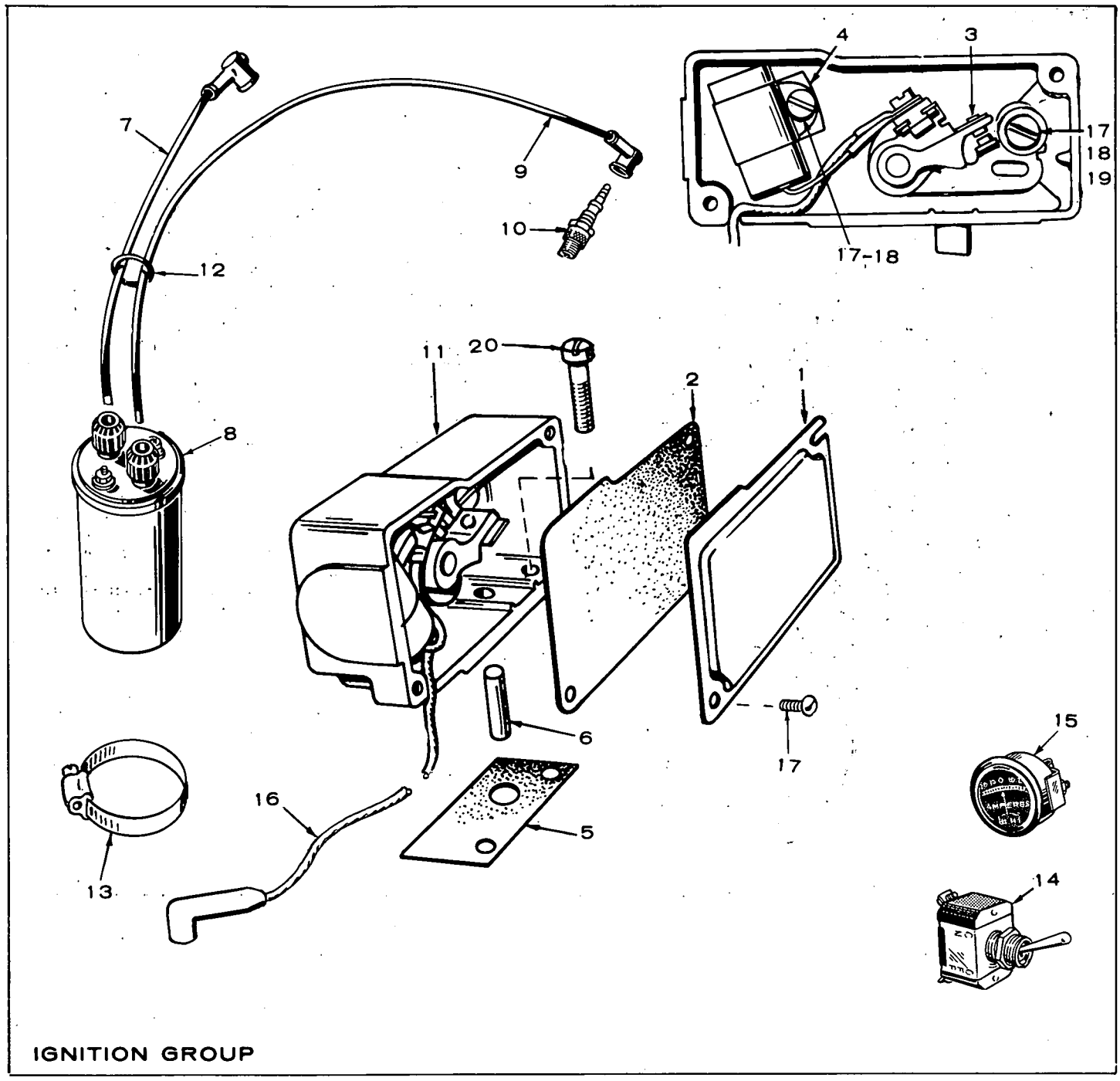
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	153K429	1	Replacement Kit (Includes Complete Choke Less Leads)
1	153C385	1	Plate, Mounting
2	153D386	1	Body
3	153C389	1	Cover
4	153B391	1	Core, Solenoid
5	153A395	1	Armature
6	307B801	1	Coil, Solenoid Assembly
7	153B392	1	Frame, Solenoid
8	153B387	1	Spring
9	153B390	1	Lever, Thermostat
10	526-18	1	Washer (17/64″ I.D. x 5/8″ O.D. x 1/16″)
11	870-134	1	Palnut (1/4-20)
12	153A399	2	Insulator
13	153B400	1	Heater Assembly
14	518-129	1	Ring, Retaining

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
15	332A876 LEAD, CHOKE	1	Terminal, Ground
16	336A1550	1	Choke to Ground
17	336A1549	1	Choke Solenoid Ground
18	857-17	1	Washer, Shakeproof (5/16″)
19	526-22	1	Washer, Flat
20	864-2	1	Nut, Hex (5/16-18)
21	813-107	1	Screw (#10-32 x 1-1/4″) - Choke Body to Mounting Plate
22	526A8	1	Washer, Flat
23	850-30	1	Washer, Lock (#10)
24	812-76	2	Screw (#8-32 x 5/16″) - Cover Mounting
25	854-7	2	Washer, Shakeproof (#8)
26	815-161	2	Screw (#10-32 x 3/8″) - Plate Mounting

AIR CLEANER GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	140B1175	1	Cleaner, Air
2	140B1179	1	Adapter & Panel, Air Cleaner Mounting
3	140A1186	1	Elbow, Carburetor Air Inlet
4	503-4	1	Clamp, Hose - Air Inlet Elbow to Adapter
5	140A921	1	Gasket, Adapter to Carburetor
6	145A398	1	Adapter, Carburetor Air Inlet
7	503A582	1	Hose, Breather
8	503-170	2	Clamp, Breather Hose
9	503P365	1	Clamp, Hose - Air Cleaner
10	140A1185	1	Gasket, Air Cleaner
11	815-199	3	Screw (10-32 x 5/16″) - Adapter Mounting
12	850-30	3	Washer, Lock (#10)
13	821-10	4	Screw (1/4-20 x 1/2″) - Air Cleaner Panel Mounting
14	193B218	1	Panel, Instrument - Optional
15	800-3	2	Screw (1/4-20 x 1/2″) - Instrument Panel Mounting
16	853-13	2	Washer, Lock (1/4″)
17	862-1	2	Nut, Hex (1/4″)

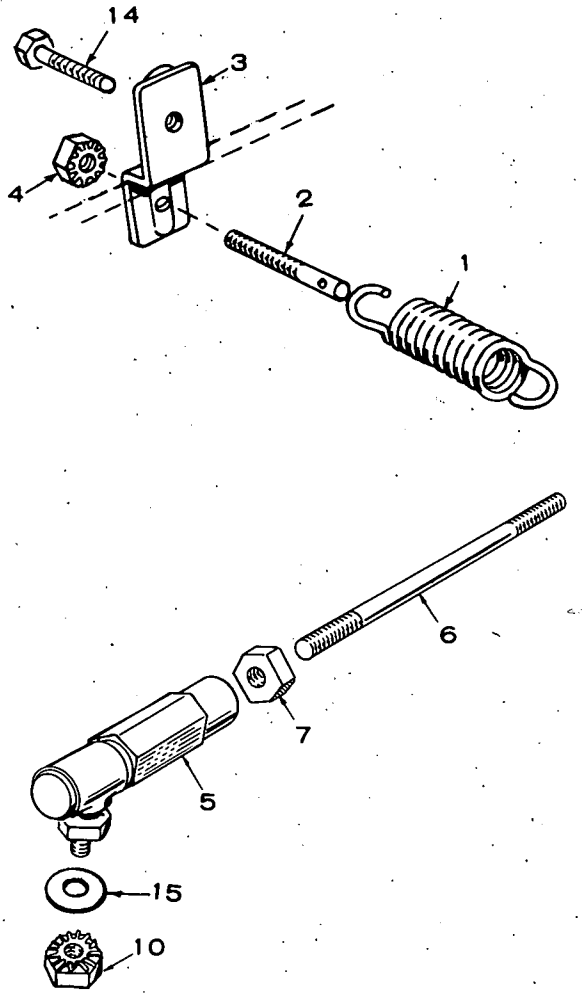


IGNITION GROUP

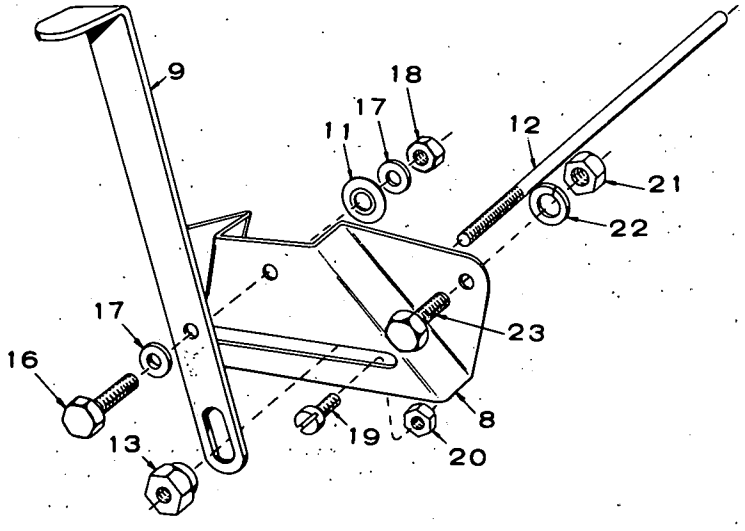
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	160A1149	1	*Cover, Breaker Box
2	160A1148	1	*Gasket, Breaker Box Cover
3	160B1154	1	*Point Set, Breaker
4	312A69	1	*Condenser, Breaker Points
5	160A1150	1	Gasket, Breaker Box Mounting
6	160A1151	1	Plunger, Breaker Box
7	167A1548	1	Cable, Spark Plug - Right Side
8	166B535	1	Coil, Ignition
9	167A1463	1	Cable, Spark Plug - Left Side
10	167-240	2	Plug, Spark
11	160A1158	1	Box, Breaker (Includes Parts Marked *)
12	509-35	1	"O" Ring, Spark Plug Cables
13	503P365	1	Clamp, Coil Mounting
14	308A140	1	Switch, Toggle - Ignition (Start-On-Off) - Optional
15	302A60	1	Ammeter, DC (20-0-20) - Optional
16	336A2132	1	*Lead Assembly, Points to Coil
17	815-358	4	*Screw, Pan Head (1) Condenser Mounting (1) Breaker Points Mounting (2) Cover Mounting
18	*WASHER, LOCK		
	850-25	1	Condenser Mounting
	850-25	1	Breaker Point Mounting
19	526-3	1	*Washer, Flat - Breaker Points Mounting
20	815-373	2	Screw, Fillister Head - Breaker Box Mounting

* - Included in Breaker Box Assembly.

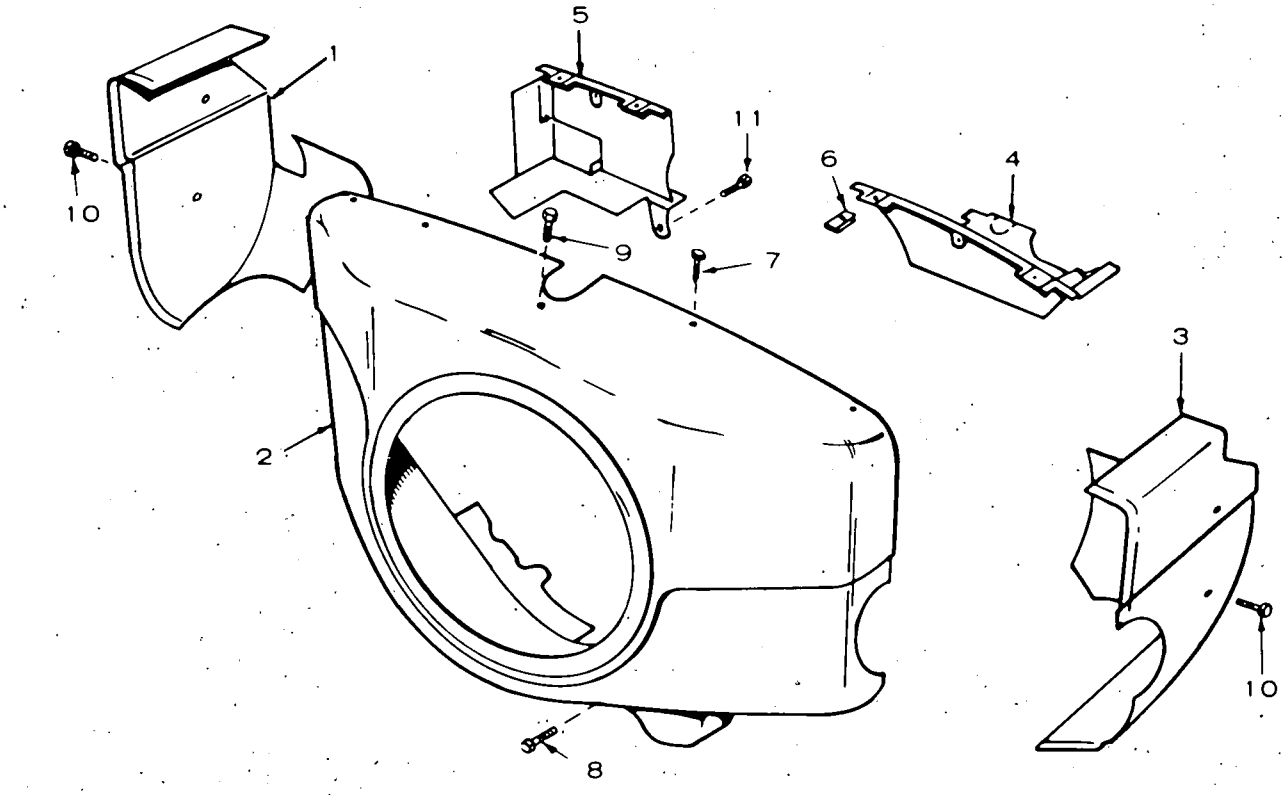
GOVERNOR GROUP

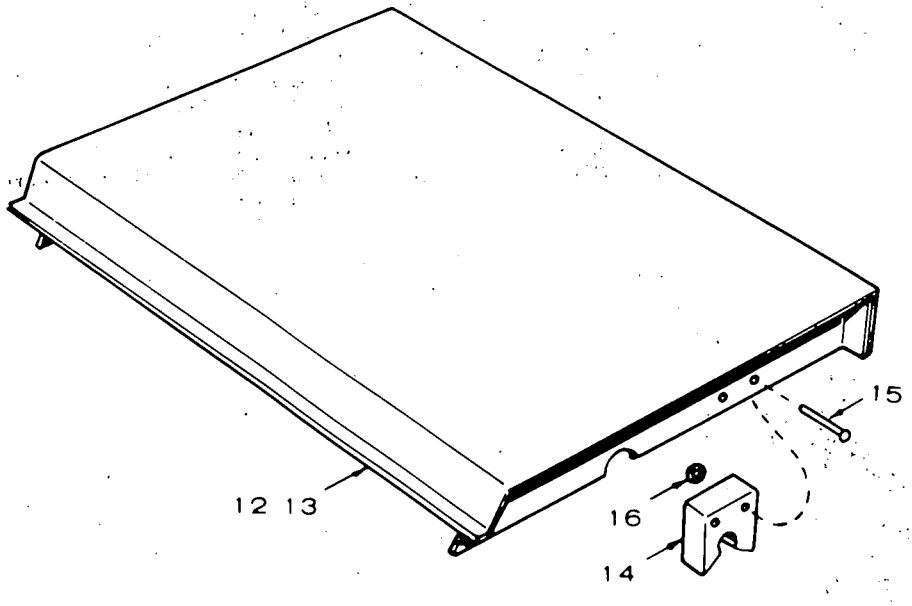


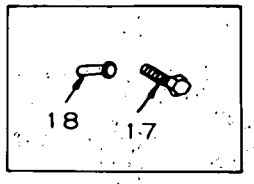
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	150A98	1	Spring, Governor (All Governor Controlled Engines)
2	150A147	1	Stud, Speed Adjustment (Standard Governor Controlled Engines)
3	150A1359	1	Bracket, Speed Stud (Standard Governor Controlled Engines)
4	870-131	1	Nut, Speed Adjustment (Standard Governor Controlled Engines)
5	150A639	2	Joint, Ball (All Governor Controlled Engines)
6	520A187	1	Link, Throttle (All Governor Controlled Engines)
7	870P188	2	Palnut, Locking (All Governor Controlled Engines)
8	152B190	1	Bracket, Variable Speed Control - Optional
9	152A95	1	Lever, Variable Speed Control - Optional
10	870-131	2	Nut, Keps (All Governor Controlled Engines)
11	152A41	1	Washer, Variable Speed Lever Tension - Optional
12	152A90	1	Stud, Variable Speed Adjustment - Optional
13	150A621	1	Nut, Variable Speed Adjustment Stud - Optional
14	821-10	1	Screw (1/4-20 x 1/2″) - Bracket Mounting (Standard Governor Controlled Engines)
15	526A196	2	Washer, Flat (All Governor Controlled Engines)
16	800-5	1	Screw (1/4-20 x 3/4″)
17	526-15	2	Washer, Flat (1/4)
18	870-65	1	Nut, Hex (1/4-20)
19	815-199	2	Screw (10-32 x 5/16″)
20	870-131	2	Nut & Washer (10-32)
21	862-1	2	Nut, Hex (1/4-20) - Bracket Mounting
22	856-6	2	Washer, Lock (1/4)
23	800-3	2	Screw (1/4-20 x 1/2″) - Bracket Mounting



BLOWER HOUSING GROUP



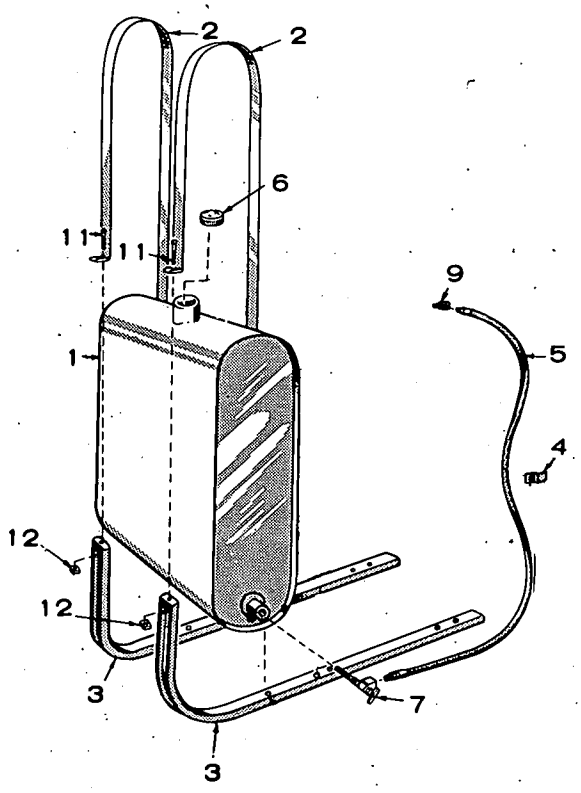


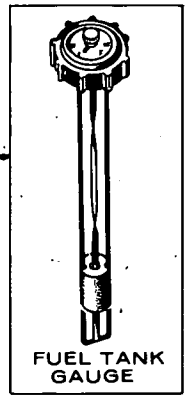


REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134D2489	1	Housing, Cylinder Air - Left Side
2	HOUSING, BLOWER		
	134C2494	1	Standard
	134C2531	1	With Flywheel Guard - Optional
3	134B2488	1	Housing, Cylinder Air - Right Side
4	134B2483	1	Support, Blower Housing Baffle - Right Side
5	134B2487	1	Support, Blower Housing Baffle - Left Side
6	870-107	4	Nut, Tinnerman - Support to Blower Housing
7	809-59	4	Screw (1/4 x 1/2), Sheet Metal - Support to Blower Housing
8	815-265	2	Screw (1/4-20 x 1/2") - Blower Housing Mounting
9	815-261	1	Screw (1/4-20 x 7/16") - Blower Housing Mounting (Top Hole)
10	815-261	4	Screw (1/4-20 x 7/16") - Cylinder Air Housing Mtg.
11	815-370	4	Screw (1/4 x 1/2") - Support Mounting
12	405A1935	1	Hood Assembly, Engine (Includes Parts Marked *) - Optional
13	405B1934	1	*Hood, Engine
14	405A1872	2	*Clip, Hood
15	818-150	4	*Rivet, Drive
16	526-3	4	*Washer, Flat
17	821-10	2	Screw (1/4-20 x 1/2") - Hood Mounting
18	870P258	2	Stud (1/4-20) - Hood Mounting

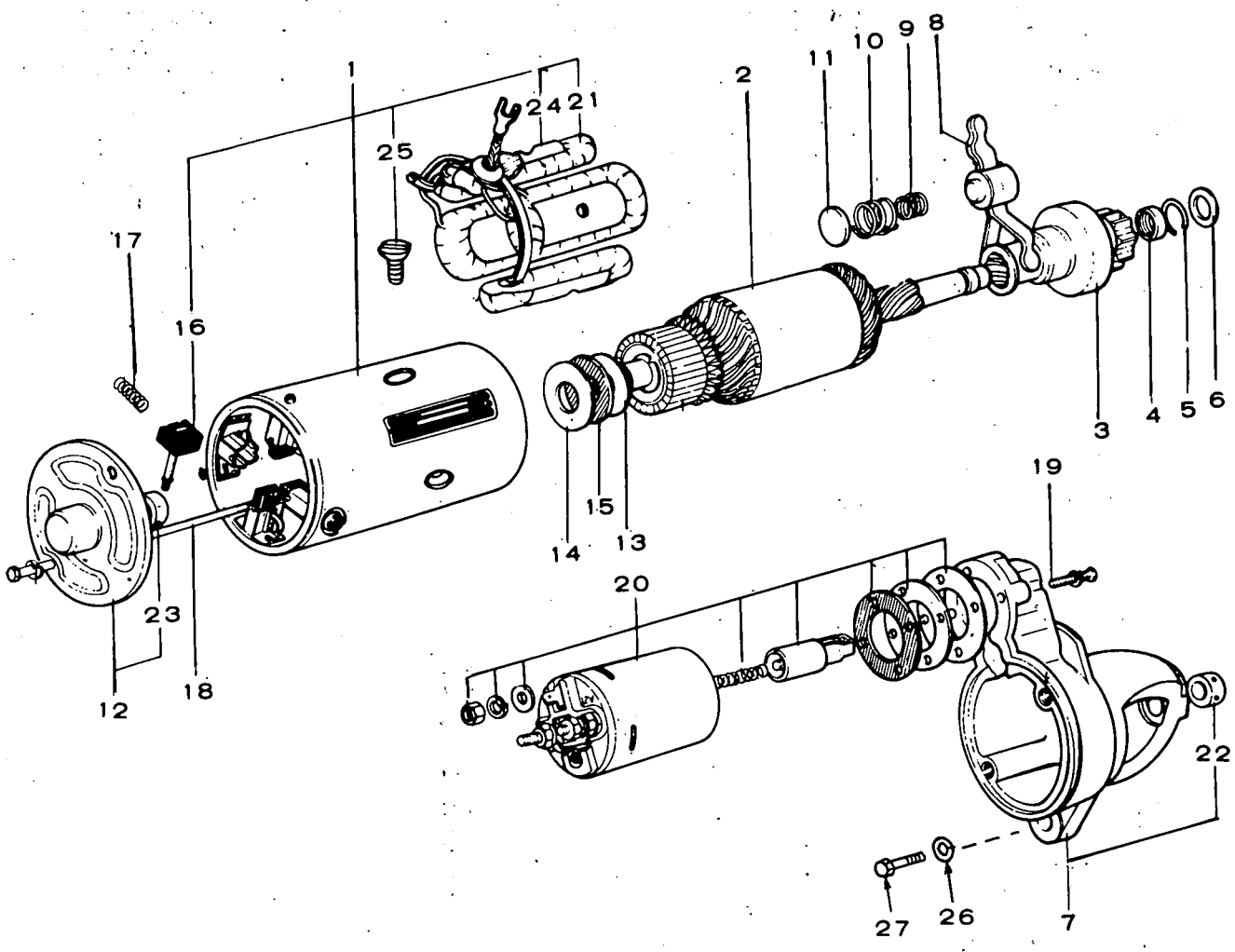
* - Included in Engine Hood Assembly.

SIDE MOUNTED FUEL TANK GROUP (OPTIONAL EQUIPMENT)





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	159B981	1	Tank, Fuel
2	159A596	2	Strap, Fuel Tank
3	159B595	2	Bracket, Fuel Tank
4	134A599	1	Clip, Fuel Line
5	501A8	1	Line, Fuel
6	159A7	1	Cap, Fuel Tank
7	504A13	1	Valve, Shutoff
8	505-57	1	Plug, Pipe (1/8)
9	502-20	1	Elbow, Fuel Pump to Fuel Line
10	193P207	1	Cap and Gauge Assembly, Fuel Tank
11	813-108	2	Screw (10-32 x 1-1/2") - Hold-down Strap to Bracket
12	870-53	2	Nut, Hex (10-32)

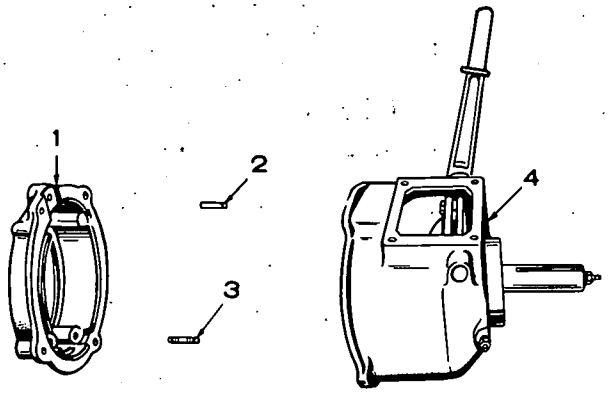


STARTING MOTOR PARTS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191D734	1	Motor Assembly, Starting
1	191-742	1	Yoke Assembly (Frame) - Includes Parts Marked *
2	191-743	1	Armature
3	191-744	1	Clutch, Starter
4	191-745	1	Stop, Pinion
5	191-746	1	Ring
6	191-747	1	Washer, Plain
7	191-748	1	Bracket Assembly, Front
8	191-749	1	Lever Assembly
9	191-750	1	Spring, Lever (A)
10	191-751	1	Spring, Lever (B)
11	191-752	1	Holder, Spring
12	191-753	1	Bracket Assembly, Rear
13	191-754	1	Washer, Plain
14	191-755	1	Washer, Plain
15	191-756	1	Washer, Insulator
16	191-757	4	*Brush
17	191-758	4	Spring, Brush
18	191-759	2	Bolt, Through
19	191-760	3	Screw, Machine P.H.
20	191-761	1	Switch Assembly, Solenoid
21	191-762	1	*Coil Assembly, Field
22	191-763	1	Bearing, Front
23	191-764	1	Bearing, Rear
24	191-765	4	*Pole Shoe
25	191-766	4	*Screw, Pan Head
26	850-50	2	Washer, Lock - Starter Motor Mounting
27	800-51	2	Screw, Hex Cap - Starter Motor Mounting

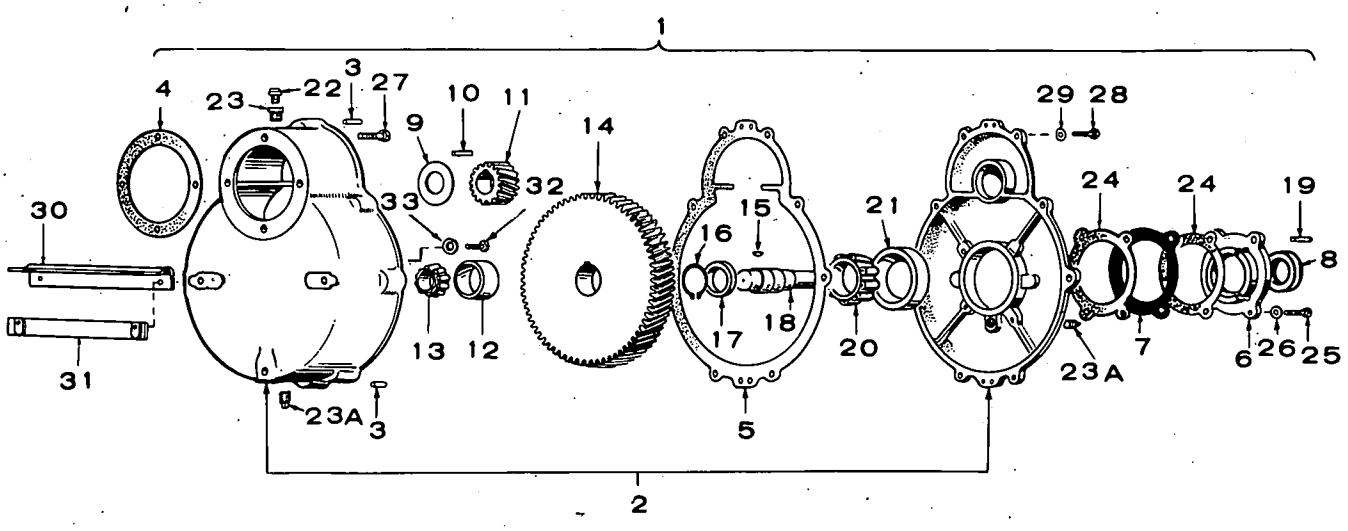
* Included in Yoke Assembly.

CLUTCH GROUP (OPTIONAL EQUIPMENT)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190D171	1	Adapter, Clutch to Engine
2	515A196	1	Key, Clutch
3	STUD, CLUTCH HOUSING TO ENGINE		
	520A738	1	3/8-16 x 4″
	520A739	2	3/8-16 x 3″
4	190D288	1	*Clutch Assembly
	190K289	1	Clutch Kit - Includes Complete Clutch, Adapter, Mounting Hardware & Instructions

* For component parts, check clutch nameplate and order by description from your nearest Rockford Dealer.

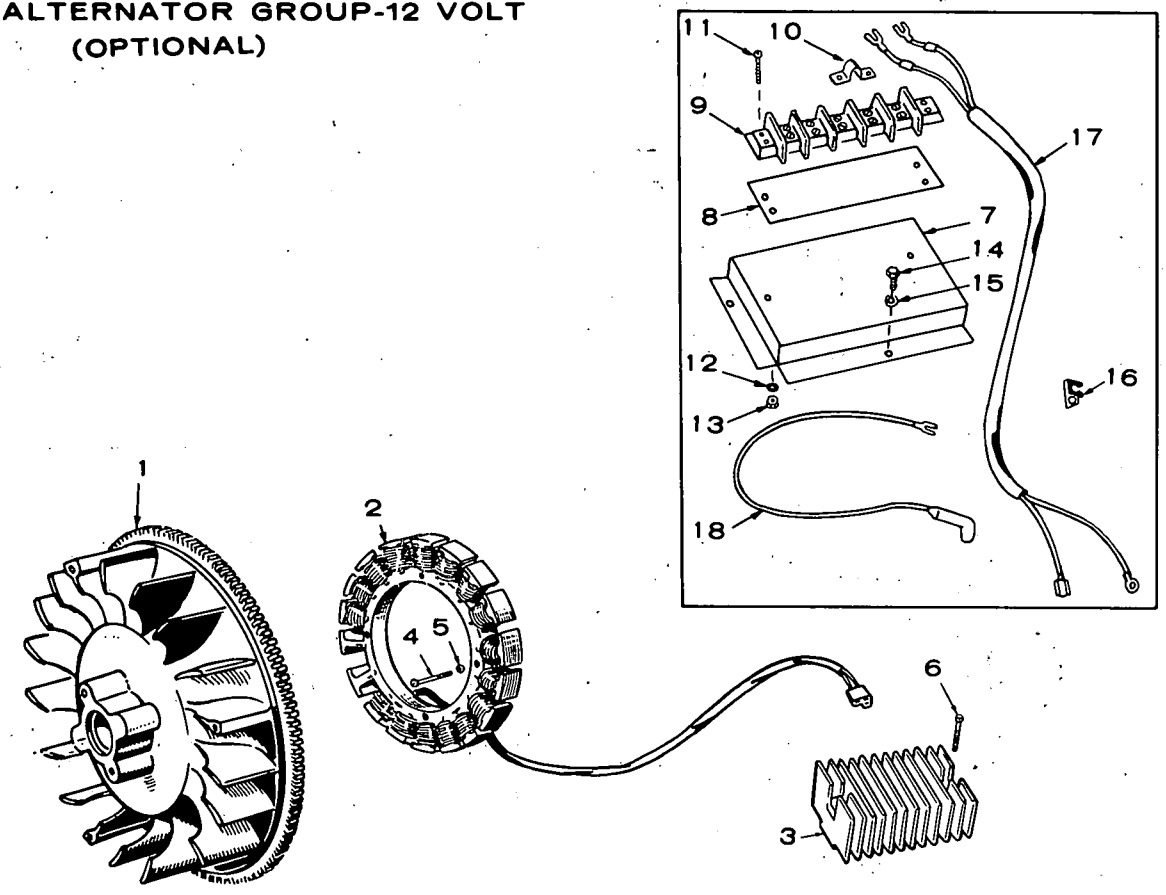


REDUCTION GEAR GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190C290	1	Reduction Gear Assembly (4-1) Complete
2	190A300	1	Housing - Includes Cover (Also Order 2 #516A12 Pins)
3	516A12	2	Pin, Dowel, Cover to Housing
4	190A20	1	Gasket, Housing to Engine
5	190B21	1	Gasket, Cover to Housing
6	190B16	1	Plate, Bearing Retainer
7	190A115	1	Shim Set, End Play Adjustment (1 Each .005″, .009″, .012″, .016″, .020″, .025″)
8	509-16	1	Seal, Oil, Retainer Plate
9	190A195	1	Washer, Pinion Gear
10	515A142	1	Key, Pinion Gear
11	190A191	1	Gear, Pinion
12	510-22	1	Cup, Roller Bearing, Engine End
13	510-21	1	Cone, Roller Bearing, Engine End
14	190B190	1	Gear, Driven
15	515A159	1	Key, Driven Gear
16	518-13	1	Ring, Snap, Retainer
17	190A202	1	Spacer, Bearing
18	190A192	1	Shaft, Take-Off
19	515A103	1	Key, Take-Off Shaft

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
20	510-23	1	Cone, Roller Bearing Take-Off End
21	510-24	1	Cup, Roller Bearing, Take-Off End
22	518P172	1	Vent
23	505-7	1	Bushing, Reducer (1/4 x 1/8)
23A	505-54	2	Plug, Pipe (1/4)
24	190A306	2	Gasket, Bearing Plate to Housing
25	800-7	4	Screw (1/4-20 x 1″) - Bearing Plate to Housing
26	526-63	4	Washer, Flat (Copper)
27	805-9	4	Bolt, Place (5/16-18 x 1″) - Housing to Engine
28	800-28	8	Screw (5/16-18 x 1″) - Cover to Housing
29	526-65	8	Washer, Flat (Copper)
30	190B297	1	Support, Housing Assembly
31	190A298	1	Fastener, Support - Housing Assembly
32	800-26	2	Screw (5/16-18 x 3/4″) - Housing to Support
33	526-65	2	Washer, Flat (Copper) - Housing to Support

CHARGING ALTERNATOR GROUP-12 VOLT (OPTIONAL)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134C2462	1	Flywheel Assembly (Includes Ring Gear and Magnet Ring) - (Also Listed in the Crankshaft and Flywheel Group)
2	191B885	1	Stator
3	191A886	1	Regulator
4	813-108	3	Screw (10-32 x 1-1/2″) - Stator to Gear Cover
5	850-30	3	Washer, Lock - Stator Mounting
6	821-18	2	Screw (1/4-20 x 3/4″) - Regulator Mounting
7	301B3530	1	Bracket, Terminal Block
8	332A1273	1	Strip, Marker
9	332A604	1	Block, Terminal (5-Place)
10	332C1043	1	Jumper, Terminal Block
11	812-82	2	Screw (8-32 x 3/4″) - Terminal Block to Bracket
12	850-25	2	Washer, Lock (#8) - Terminal Block to Bracket
13	860-8	2	Nut (8-32) - Terminal Block to Bracket
14	813-100	2	Screw (10-32 x 1/2″) - Bracket to Cylinder Block
15	856-3	2	Washer, Lock (#10)
16	167A188	1	Clip, Regulator Harness
17	338A619	1	Harness, Wiring - Start Solenoid to Terminal Block
18	336A2132	1	Lead Assembly - Terminal Block to Coil

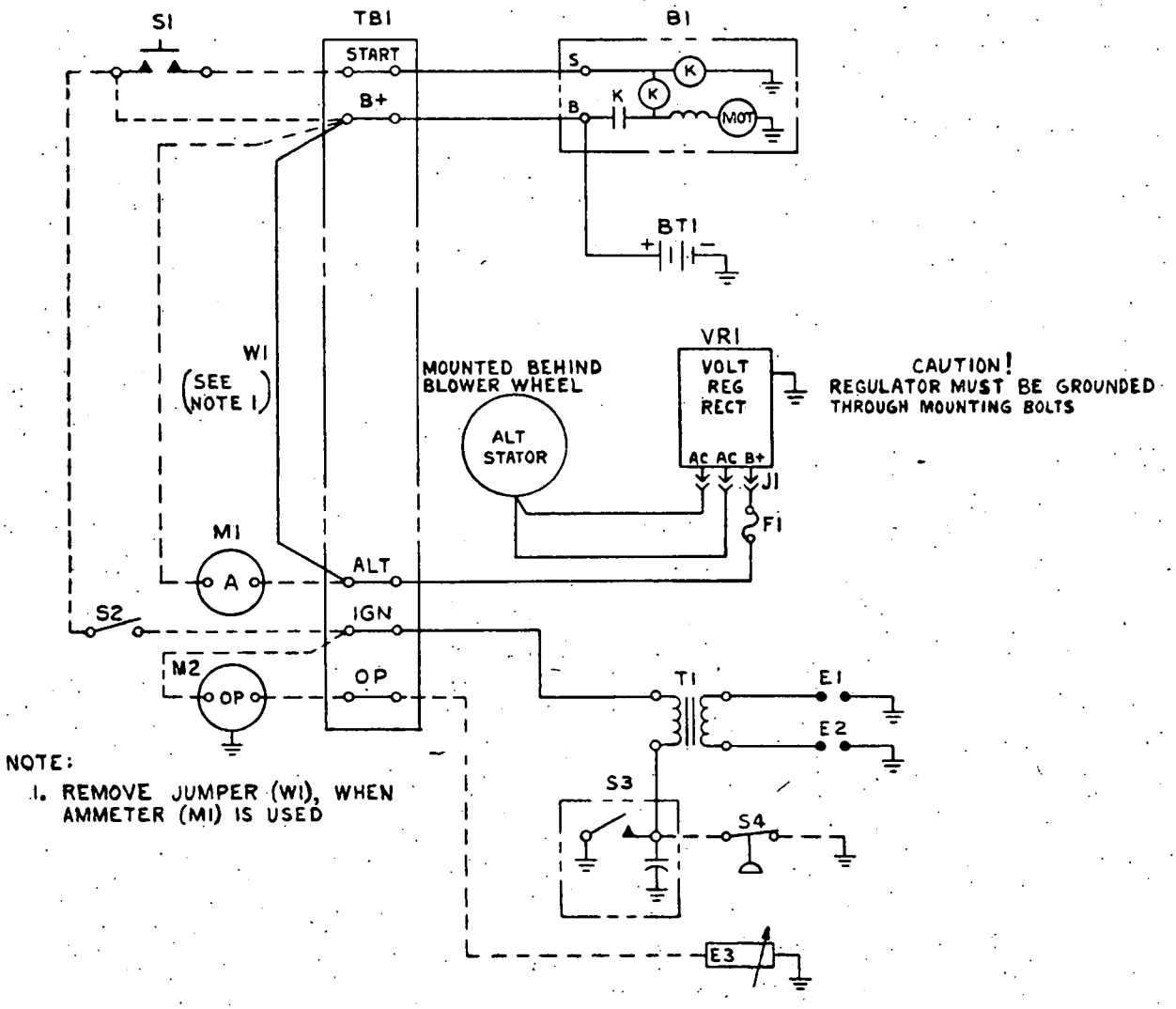
SERVICE KITS AND MISCELLANEOUS

NOTE: For other kits, refer to the group for the part in question.

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	98C1807	1	Decal Kit
	168K122	1	Gasket Kit, Complete Engine
	168K121	1	Gasket Kit, Carbon Removal
	160K1161	1	Ignition Tune-up Kit
	522K123	1	Overhaul Kit, Engine
	525P137	1	Paint, Green Touch-up Enamel - 16 Oz. Pressurized Can

	PARTS LIST (REF)			
	REF DES.	PART NO.	QTY	DESCRIPTION
	B1		1	STARTER & SOLENOID - ENGINE
	BT1		1	BATTERY - 12 V.
	E1, 2		2	SPARK PLUG
*	E3		1	SENDER - OIL PRESSURE
	F1		1	FUSE, 35 AMP
	G1		1	ALTERNATOR
	J1		1	CONNECTOR
*	M1		1	AMMETER
*	M2		1	METER - OIL PRESSURE
	S1		1	SWITCH - START
	S2		1	SWITCH - IGNITION
	S3		1	BREAKER & CAP, ASSEMBLY
*	S4		1	SWITCH - LOPKO
	T1		1	COIL - IGNITION
	TB1		1	BLOCK - TERMINAL
			1	STRIP - MARKER
	VR1		1	REGULATOR - VOLTAGE
	W1		1	JUMPER (SEE NOTE 1)

* WHEN USED



ENGINE WIRING DIAGRAM (INCLUDES FLYWHEEL ALTERNATOR)

CUSTOMER SERVICES

OWNER'S WARRANTY SERVICE - ENGINE DRIVEN ELECTRIC GENERATOR SETS, SEPARATE GENERATORS, INDUSTRIAL ENGINES

QUALITY OF PRODUCT

Onan products are engineered and designed to perform as stated on product nameplate and published specification. Only quality material and workmanship are used in the manufacture of this product. With proper installation, regular maintenance and periodic repair service, the equipment will provide many enjoyable hours of service.

GENERAL WARRANTY PRACTICES

All Onan-manufactured engine-driven electric generator sets, separate generators, and industrial engines are sold with a full one-year warranty. This warranty is issued only to the original user and promises that these products are free from defects in material or factory workmanship when properly installed, serviced, and operated under normal conditions, according to the manufacturer's instructions. The text of the Onan published warranty appears in the Onan Operator's Manual sent with the product.

Warranty Registration: A Warranty Registration card accompanies each Onan Product. This card must be properly filled out and returned to the Onan Factory in order to qualify for warranty consideration as covered in this bulletin. When requesting warranty repair work you must provide the purchase date, Onan model and serial number of the equipment.

Warranty Authorization: Warranty service must be performed by Onan Factory or Onan Authorized Distributors or their Approved and Registered Service Dealers. A complete listing of these Onan Authorized Parts and Service Centers is provided in our brochure F-115, a copy of which is supplied with each Onan Product. These Onan Authorized Service Centers have trained service personnel, parts stock, and the necessary facilities and tools for the service and repair of Onan equipment.

Material Allowances: Onan will allow credit or furnish free of charge to the Onan Authorized Service Station or his Approved Service Dealer, all genuine Onan parts used in a warranty repair of these products which fail because of defective material or workmanship.

Labor Allowance: Onan will allow warranty repair credit to the Onan Authorized Parts and Service Center and his Approved Dealer at straight time labor when the cause of failure is determined to be defective material or factory workmanship. This labor allowance will be based on the factory's standard time schedule of published flat rate labor allowances, or, otherwise a time judged reasonable by the factory. Repair work other than warranty will be charged to the owner. The Onan Division's Warranty practice does not provide for allowance of expenses such as start-up charges, communication charges, transportation charges, travel time and/or mileage, unit removal or installation expense, cost of fuel, oil, normal maintenance adjustments, tune-up adjustments or parts maintenance items.

Administration: Warranty of Onan Products is administered through Onan Authorized Distributors in whose territory the equipment is located. These Distributors and their Approved or Registered Onan Service Dealers are authorized to make settlement of all customer warranty claims within the limits of the manufacturer's warranty policy as described herein.

Onan reserves the right to change warranty practices without prior notice.

MAINTENANCE

A Planned Preventive Maintenance Program is extremely important if you are to receive efficient operation and long service life from your Onan unit. Neglecting routine maintenance can result in premature failure or permanent damage to your equipment. The Onan Operator's Manual sent with the product contains recommended maintenance schedules and procedures.

Maintenance is divided into two categories:

1. Operator Maintenance . . . . . performed by the operator.
2. Critical Maintenance . . . . . performed only by qualified service personnel.

Regular maintenance will help you avoid sudden and costly repairs in the future. Adequate evidence of this scheduled maintenance must be offered when applying for a warranty claim.

INSTALLATION

Installation is extremely important and all Onan Products should be installed in accordance with the manufacturer's recommendations. If the owner experiences any difficulty with such items as mounting, ventilation, exhaust location, fuel lines, wiring, etc., he should immediately contact the company from whom he purchased the equipment so that corrective action can be taken. Although the Onan Authorized Distributor and his Approved or Registered Service Dealers may be able to remedy certain installation difficulties, such repair work is not considered Onan warranty and there will be a charge for this service.

Onan

Minneapolis, Minnesota 55432

MSS-22A
Replaces 23B054
Rev. 11-1-71

Onan®

OPERATOR'S/SERVICE MANUAL AND PARTS CATALOG

FOR

SERIES

NHC

INDUSTRIAL ENGINES

902486

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

940-404

9A72 Printed in U.S.A.

ONAN INDUSTRIAL ENGINES

NHC

SERIES

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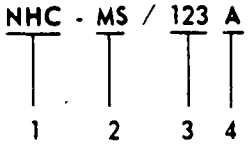
902487

GENERAL INFORMATION

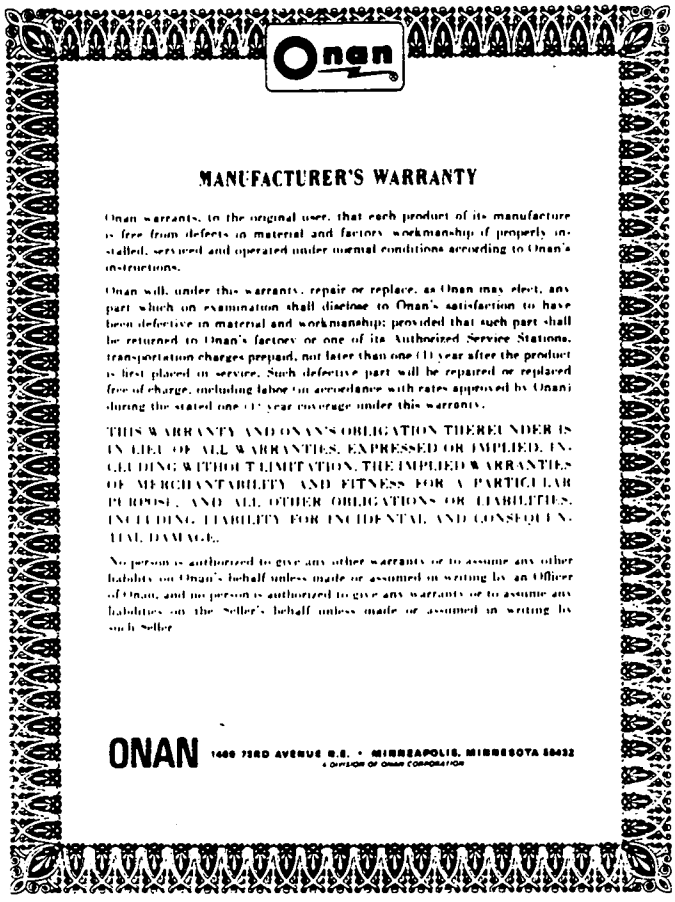
This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of the engine. Since the first and most important part of repair work is the correct diagnosis of the trouble, a trouble-shooting chart is included.

Study and follow the instructions carefully. Proper service and maintenance will result in longer engine life and better performance.

How To Interpret MODEL and SPEC NO.



1. Factory code for general identification purposes.
2. Specific Type:
   S - MANUAL starting with stub shaft power take off.
   MS - ELECTRIC starting with stub shaft, starter and generator.
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.



Onan

MANUFACTURER'S WARRANTY

Onan warrants, to the original user, that each product of its manufacture is free from defects in material and factory workmanship if properly installed, serviced and operated under normal conditions according to Onan's instructions.

Onan will, under this warranty, repair or replace, as Onan may elect, any part which on examination shall disclose to Onan's satisfaction to have been defective in material and workmanship; provided that such part shall be returned to Onan's factory or one of its Authorized Service Stations, transportation charges prepaid, not later than one (1) year after the product is first placed in service. Such defective part will be repaired or replaced free of charge, including labor in accordance with rates approved by Onan, during the stated one (1) year coverage under this warranty.

THIS WARRANTY AND ONAN'S OBLIGATION THEREUNDER IS IN LIEU OF ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER OBLIGATIONS OR LIABILITIES, INCLUDING LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES.

No person is authorized to give any other warranty or to assume any other liability on Onan's behalf unless made or assumed in writing by an Officer of Onan, and no person is authorized to give any warranty or to assume any liabilities on the Seller's behalf unless made or assumed in writing by such Seller.

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432
A DIVISION OF ONAN CORPORATION

902487A

SPECIFICATIONS

	NHC-MS/1
Number of Cylinders	2
Displacement (cubic inch)	60
Cylinder Bore	3-9/16 in.
Piston Stroke	3 inch
Horsepower	25 BHP @ 3600 rpm
Compression Ratio	7.0 to 1
Ventilation Required (cfm @ 3600 rpm)	1080
Oil Capacity	3-1/2 qt.
Oil Capacity With Filter Change	4 qt.
Starting	Electric
Ignition	Battery
Combustion Air (cfm @ 3600 rpm)	80
Fuel	Gasoline (regular grade)
Fuel Pump	Diaphragm, 4 ft. lift

TUNE-UP SPECIFICATIONS

Spark Plug Gap	.025″
Breaker Point Gap	.020″
Ignition Timing (Fixed), Electric Start Units	25°BTC
Tappets (Cold) Intake	.003″
Exhaust	.012″

NOTE: For gaseous fuel operation set spark plugs at .018″ and ignition timing at 26°BTC and exhaust valve lash at .014″.

902488

DIMENSIONS AND CLEARANCES

All clearances given at room temperature of 70°F.
All dimensions in inches unless otherwise specified.

	Minimum	Maximum
Valve Tappet Clearance		
Intake	0.003	
Exhaust	0.012*	
Valve Stem in Guide – Intake	0.001	0.0025
Valve Stem in Guide – Exhaust	0.0025	0.004
Valve Spring Length		
Free Length	1.662	
Compressed Length	1.375	
Valve Spring Tension (lb.)		
Open	71	79
Closed	38	42
Valve Seat Bore Diameter		
Intake	1.5645	1.5655
Exhaust	1.2510	1.2520
Valve Seat Diameter		
Intake	1.569	1.570
Exhaust	1.255	1.256
Valve Stem Diameter		
Intake	0.3425	0.3430
Exhaust	0.3410	0.3415
Valve Guide Diameter (I.D.)	0.344	0.346
Valve Lifter Diameter	0.7575	0.7480
Valve Lifter Bore	0.7505	0.7515
Valve Seat Interference Width	1/32	3/64
Valve Face Angle	44°	
Valve Seat Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing	0.0025	0.0038
Crankshaft End Play	0.005	0.009
Camshaft Bearing	0.0015	0.003
Camshaft End Play	0.003	–
Camshaft Lift	0.300	
Camshaft Bearing Diameter	1.3760	1.3770
Camshaft Journal Diameter	1.3740	1.3745
Rod Bearing (Forged Rod)	0.0005	0.0023
Connecting Rod End Play (Ductile Iron)	0.002	0.016
Timing Gear Backlash	0.002	0.003
Oil Pump Gear Backlash	0.002	0.005
Piston to Cylinder, Strut Type (Measured below oil-controlling ring – 90° from pin) Clearance	0.0015	0.0035
Piston Pin Diameter	0.7500	0.7502
Piston Pin in Piston	Thumb Push Fit	
Piston Pin in Rod	0.0001	0.0005
Piston Ring Groove Width		
Top 1	0.0955	0.0965
Top 2	0.0955	0.0965
Top 3	0.1880	0.1890

Piston Ring Gap in Cylinder	0.010	0.020
Piston Ring Side Clearance (Top compression ring only)		0.006
Breaker Point Gap (Full Separation)		0.020
Spark Plug Gap – For Gasoline Fuel		0.025
Crankshaft Main Bearing Journal – Standard Size	1.9992	2.0000
Main Bearing Diameter	2.0015	2.0040
Main Bearing Clearance	0.0015	0.0043
Crankshaft Rod Bearing Journal – Standard Size	1.6252	1.6260
Cylinder Bore – Standard Size	3.5625	3.5635

* Set exhaust valve at .014 for gaseous fuel operation.

ASSEMBLY TORQUES AND SPECIAL TOOLS

TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often with the engine cold. Tighten as needed to prevent them from working loose.

TORQUE SPECIFICATIONS	Ft.-Lb.
Cylinder Head Nuts	17-19
Rear Bearing Plate	20
Connecting Rod Bolt	27-29
Flywheel Capscrew	30-35
Starter Mounting Bracket to Oil Base Screws	43-48
Gear Case Cover	8-10
Oil Pump	7-9
Other 3/8 Cylinder Block Nuts	18-23
Intake Manifold	18-20
Exhaust Manifold	10-12

SPECIAL TOOLS

These tools are available from Onan to aid service and repair work.

Crankshaft Gear Pulling Ring	420A248
Flywheel Puller	420A100
Combination Bearing Remover, Main and Cam	420A325
Combination Bearing Driver, Main and Cam	420B324
Valve Guide Driver	420A300
Valve Seat Driver	420A308
Valve Seat Staker Intake	420A309
Exhaust	420A310
Valve Seat Cutter	420A311
Oil Seal Guide and Driver, Bearing Plate	420B181
Gear Cover	420B313
Timing Advance Mech. Cover Driver	420A296

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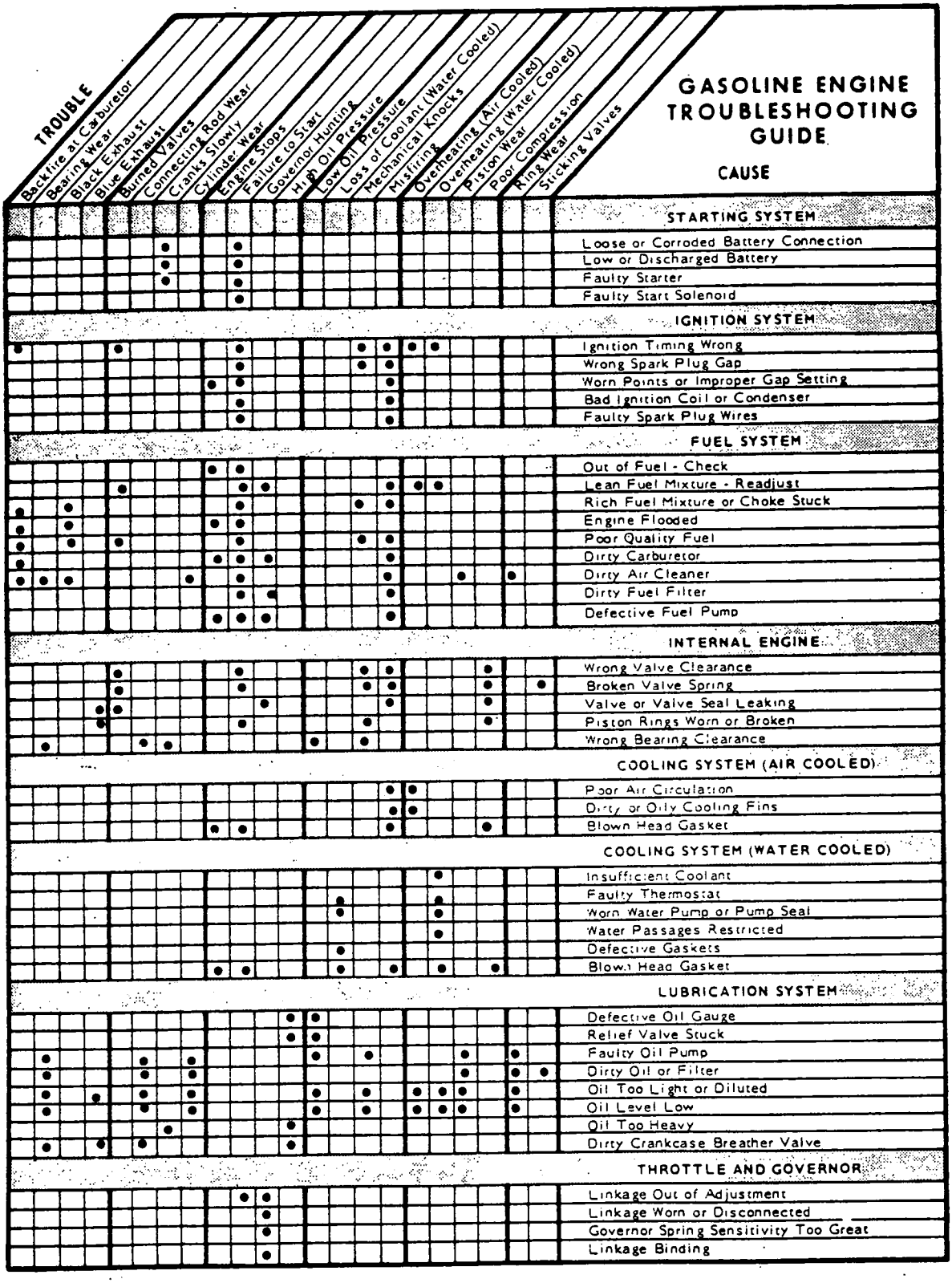
ENGINE TROUBLESHOOTING



INSTALLATION

The type of installation can affect the life of the engine, the cost of operation and the frequency of necessary service. Plan the installation carefully to ensure the best performance.

Because of the great variety of uses, and the many variations of the engine, these installation instructions are typical or general in nature. Use the installation recommendations given as a general guide, improvising or altering as necessary.

MOUNTING

There are several acceptable methods of mounting the engine. Among factors to be considered are: location, method of coupling the engine to the load, type of foundation or support, etc. The engine should be mounted on a level surface if possible. Maximum operation angle is 15° sideways, 30° front to rear tilt. If the engine is to operate at an angle, be sure to remark the oil level indicator to compensate for the tilt.

VENTILATION

The engine must be provided with a supply of fresh air for cooling and for combustion.

Pressure Cooled Engine: Position the air inlet opening directly in front of the engine and as close to the engine blower wheel as possible. The area of the inlet should be not less than 80 square inches. If louvers or grill work are used, increase the area to compensate for the reduced air flow. Provide extra ventilation if the driven load generates heat during operation.

The heated air outlet must allow the heated air to escape freely and prevent recirculation with the cooling air. A duct between the compartment air inlet and the engine blower housing may be necessary. Locate the air outlet opposite the intake or at least at a 90° angle. The area of the outlet should be at least 15% larger than that of the inlet. Allow sufficient room on all sides to permit access for servicing.

Open Air Installation: For installations where the engine is operated outside, ventilation will be no problem. However, in protecting the engine from the elements, see that nothing obstructs the flow of air around the engine.

EXHAUST

Pipe *POISONOUS* exhaust gas outside enclosure. Use a length of flexible tubing between the engine exhaust outlet and any rigid piping to absorb engine vibration. Shield the line if it passes through a combustible wall or partition. If turns are necessary, use sweeping type (long radius) elbows. Increase one pipe size (from manifold outlet size) for each additional ten feet in length. Locate the outlet away from the air intake.

CARBURETOR AIR INTAKE

Proper engine efficiency depends upon a supply of fresh air to the carburetor. Under special conditions, it may be necessary to move the air cleaner off the engine, using a longer connection hose as necessary. For extremely dusty or dirty conditions, install a special heavy duty air cleaner.

FUEL SYSTEM

The engine uses a diaphragm type fuel pump. The fuel pump has a 1/8" pipe thread inlet, fitted with a 1/4" inverted flare tube fitting. If a solid wall line is used, form a loop in the line, or install a section of flexible fuel hose, to absorb vibration. If a line with a pipe thread end is used, remove the flare type fitting from the fuel pump inlet.

The fuel supply tank may be installed in any safe, convenient location. If the tank is installed within the engine enclosure, provide a vent line to the outside of the enclosure.

The installation of a fuel filter between the fuel tank and the fuel pump is recommended. The fuel filter should be fitted with a shutoff valve and should be easily accessible for cleaning.

CONNECTING TO THE LOAD

The dimensions of various power takeoff shafts are as follows:

SHAFT	DIAMETER	LENGTH	KEY SIZE
STD	1-7/16	3-1/16	3/8
Rockford Clutch	1-7/16	3-1/16	3/8
Gear Reduction	1-1/4	2-3/4	1/4

Belt Drive: V-belts are preferable to flat belts. Consult a reliable belting supplier for recommendations regarding size of pulleys, number of belts, etc. required. A typical belt drive installation is shown in Figure 1.

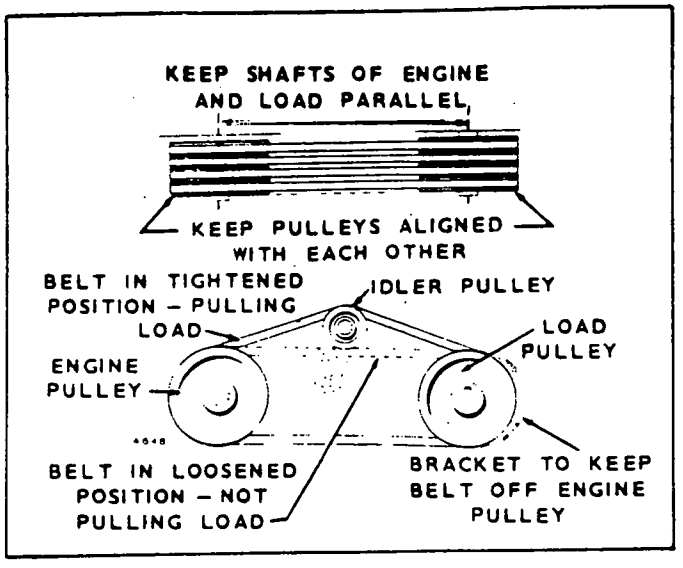


FIGURE 1. DRIVE BELT INSTALLATION

Comply with the following installation requirements:

1. The shafts of the engine and the load must be parallel with each other.
2. The pulleys of the engine and the load must be in alignment.
3. Mount the engine pulleys as close to the engine as possible.
4. If the installation permits, belts should run horizontally.
5. Some method of disconnecting the load for starting is recommended. If a clutch is not used, a belt-tightener idler arrangement can be used.

Flexible Coupling: If a flexible coupling engine-to-load drive is used, the load shaft must be in line and centered with the engine shaft (Figure 2).

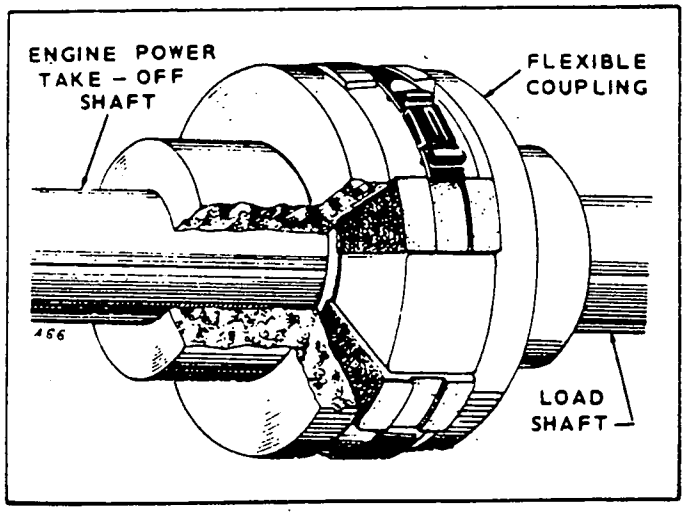


FIGURE 2. FLEXIBLE COUPLING

Reduction Gear Drive: Reduction gear drives are mounted at the factory (when ordered). The method of connecting the load is the same as when connecting directly to the engine shaft.

Clutch Installation: A Rockford Clutch can be installed at the factory or in the field. Install the clutch according to the following instructions and Figure 3.

Provide room for the clutch adapter casting by plugging the wet holes with a 3/8-16 x 1/2″ slotted headless set screw. Apply sealing compound to the threads and install screw flush with the cylinder block.

Drill a 13/64″ hole (or filed slot) in the crankshaft for the clutch set screw. Locate center of hole 11/32″ from the end and directly opposite the keyway in the crankshaft.

Install the clutch adapter, with drain slot downward, using two cap screws 3/8-16 x 2″ on the lower and one cap screw 3/8-16 x 1-3/4″ on the upper #2 cylinder side (cylinder nearer clutch). Install the 3/8 x 3-7/8″ stud through the adapter into the engine block upper remaining hole. Use a lock washer on each assembly screw. Use a flat washer and a lock washer under the stud nut.

Install the crankshaft key. Remove the clutch set screw. Install the clutch assembly (less housing) to the crankshaft, driving it on carefully with a soft-faced hammer until set screw hole is aligned. Install set screw to bottom in crankshaft hole, then back it out one full turn. Tighten clutch retaining screws until clutch is clamped securely to crankshaft. Lock the screws and tighten the set screw.

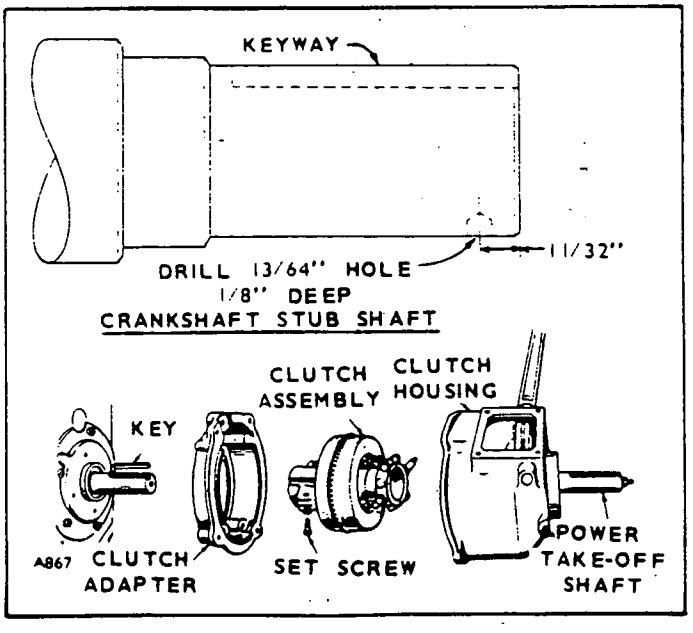


FIGURE 3. CLUTCH INSTALLATION

Apply grease to splined power takeoff shaft. Position the clutch throw-out to align the grease fitting with the hole in the housing (#1 cylinder side, horizontal). Pull the throw-out collar outward to remove tension.

Install the clutch housing so that the clutch throw-out fork engages the throw-out collar. Be sure the serrated shaft is properly meshed with the clutch plate. Use two cap screws 7/16-14 x 2'' on the lower and one cap screw 7/16-14 x 1-3/4'' on the upper #2 cylinder side. Install the stud washer and nut. Lubricate the two grease fittings just until grease appears.

BATTERY CONNECTIONS (Engines with Automotive Type Separate Starter)

Connect the 12 volt battery positive cable to the engine start switch terminal. Connect the battery negative cable to the ground point on the engine oil base (Figure 4).

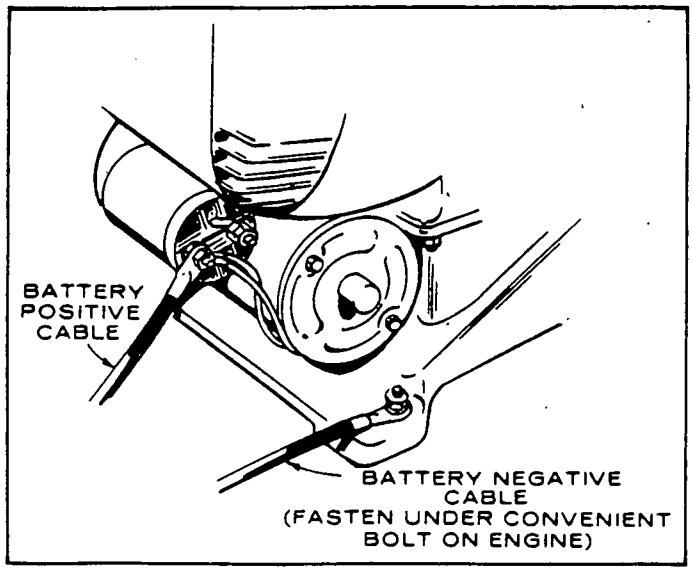


FIGURE 4. BATTERY CONNECTIONS

OPERATION

BEFORE STARTING

Crankcase Oil: Be sure the crankcase has been filled with oil to the "FULL" mark on the oil level indicator. Use a good quality oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines.

Recommended Fuel: Use clean, fresh, regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

CAUTION *If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, preignition could occur causing severe damage to the engine.*

Never fill the tank when the engine is running. Leave some space in the tank for fuel expansion. Open the fuel line valve (when used) and operate primer to assure fuel supply.

STARTING (Electric Start)

1. Move the ignition switch to its ON position.
2. Push the START button to crank the engine.

If the engine fails to start at first attempt, inhibitor oil used at the factory may have fouled the spark plugs. Remove the plugs, clean in suitable solvent, dry thoroughly and install. Heavy exhaust smoke when the engine is first started is normal and is caused by inhibitor oil.

STARTING (Manual Start)

1. Close the choke about three quarters of the way or as necessary according to temperature conditions.
2. Pull the start rope with a fast steady pull to crank the engine. Do not jerk.

APPLYING LOAD

When applying the load to a new or reconditioned engine, it should be applied gradually in about four steps; each step of not less than 30 minutes running time. Start with 1/4 load, then 1/2, 3/4 and full load.

BATTERY CHARGING

The battery charge rate is controlled by a charge regulator. The regulator is set to allow the proper rate of charge at operating speed.

STOPPING THE ENGINE

Disconnect all load before stopping the engine. Engines equipped with battery ignition are stopped by the ignition switch to the OFF position.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the engine.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow, but use care to avoid overheating.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often than recommended under normal conditions.
4. Keep oil and gasoline in dust tight containers.
5. Keep governor linkage clean.

OUT-OF-SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows:

1. Run unit until thoroughly warm.
2. Turn off fuel supply and run until unit stops.
3. Drain oil from oil base while still warm. Refill and attach a warning tag stating oil viscosity used.
4. Remove each spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50 oil) into each cylinder. Crank engine slowly (by hand) several times. Install spark plug.
5. Service air cleaner.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery is used, disconnect and follow standard battery storage procedure.

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SERVICE AND MAINTENANCE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS						
	8	50	100	200	500	1000	5000
Inspect Engine Generally	x						
Check Fuel Supply	x						
Check Oil Level	x						
Clean Governor Linkage		x*					
Change Crankcase Oil		x1	x*				
Check Breaker Points			x				
Check Battery Electrolyte Level			x				
Clean Fuel Filter			x				
Check Spark Plugs			x				
Replace Oil Filter				x*			-
Replace Air Cleaner				x*			
Remove Deposits in Combustion Chamber					x		
Check Valve Clearance					x		
Inspect Valves, Grind if Necessary						x	
Complete Reconditioning							x

x* - Perform more often under dusty or extreme cold weather conditions.
x1 - Recommended interval in hot weather or heavily loaded natural gas and propane operation.

PERIODIC MAINTENANCE SCHEDULE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The above schedule can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, etc. frequently until the proper service time periods can be established. When any abnormalities occur in operation – unusual noises from engine or accessories, loss of power, overheating, etc. – contact your Onan dealer.

CRANKCASE OIL

The oil capacity is 3-1/2 U.S. quarts (4 with filter). Fill to the "FULL" mark on the oil level indicator. Use a good quality, detergent oil with the API (American Petroleum Institute) designation SE or SE CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines. Ambient temperatures must be the factor for determining the proper SAE oil weight.

IMPORTANT: *Use low ash content oils .03-.35 percent by weight with natural gas or propane fueled engines.*

NOTE: *If oils with these designations are not yet available, use oil with the API designation MS, MS/DG or MS/DM which has passed all the Automotive Manufacturer's Sequence Tests and the MIL-L-2104B Tests. Don't use an oil with the API designation DS.*

When adding oil between changes, always use the same brand and weight that is in the crankcase. Various brands of oil may not be compatible when mixed together.

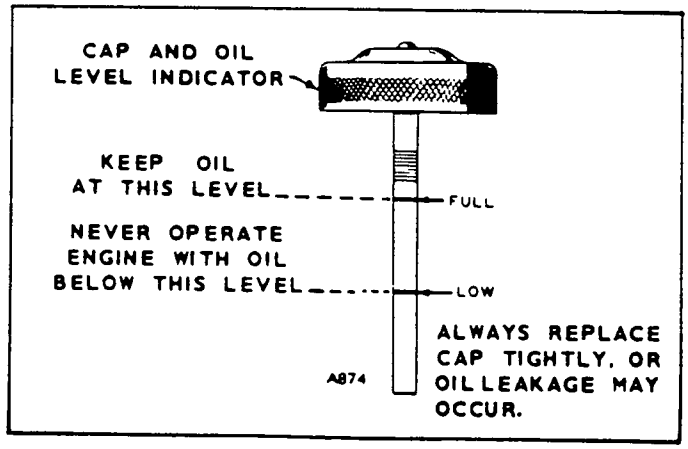

FIGURE 5. OIL LEVEL INDICATOR

Oil consumption may be higher with a multigrade oil than with a single grade oil if both oils have comparable viscosities at 210 F. Therefore, single grade oils are generally more desirable, unless anticipating a wide range of temperatures. Use the proper grade oil for the expected conditions.

TEMPERATURE	GRADE
Below 0	5W
0 to 30	10W
30 to 90	30
Above 90	50

Check oil level daily. Change oil every 100 hours under normal operating conditions. When operating in extremely dusty or dirty conditions, change oil more often.

Change the crankcase oil filter every 200 hours. Remove the filter by turning counterclockwise, using a filter wrench. Add the strip provided with the filter to prevent air loss in the area indicated. It is advisable to wipe dry the drip pan located below the filter. Coat rubber gasket on filter with a film of oil before installing. Install the filter finger-tight plus 1/4 to 1/2 turn. If oil becomes so dirty that the markings on the oil level indicator cannot be seen, change the filter and shorten the filter service period.

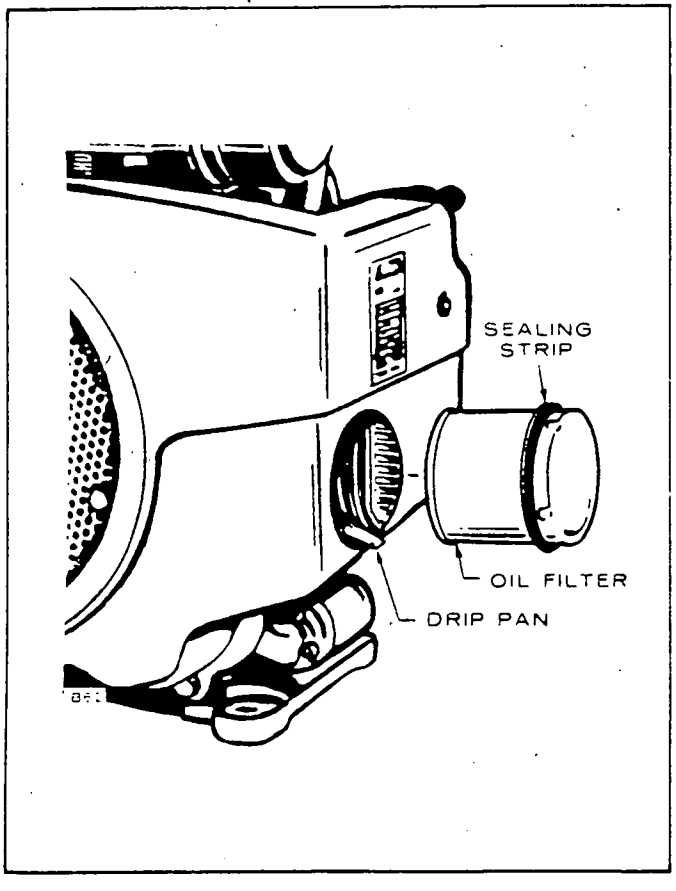

FIGURE 6. OIL FILTER LOCATION

CRANKCASE BREATHER

The engine is equipped with a ball check valve for maintaining crankcase vacuum. No maintenance is generally required. Should the crankcase become pressurized, as evidenced by oil leaks at the seals or around the cap of the oil level indicator, clean baffle in suitable solvent.

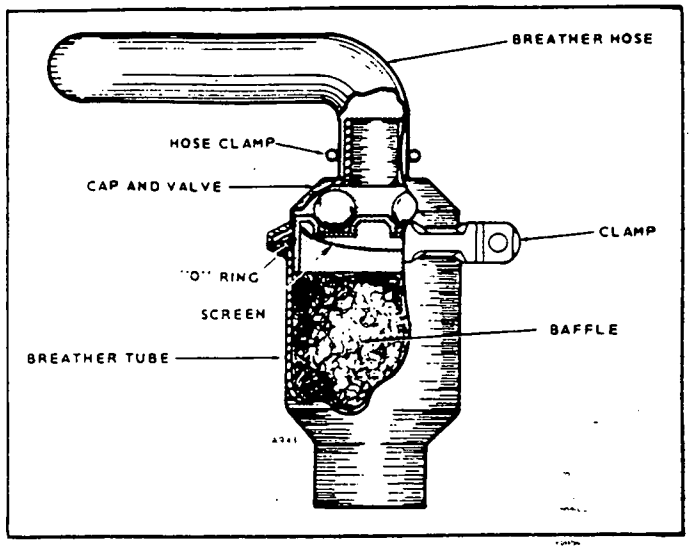

FIGURE 7. CRANKCASE BREATHER

AIR CLEANER

The NHC engine uses a replaceable, spin-on air cleaner. Remove and replace every 200 hours.

CAUTION *Do not run engine with air cleaner removed.*

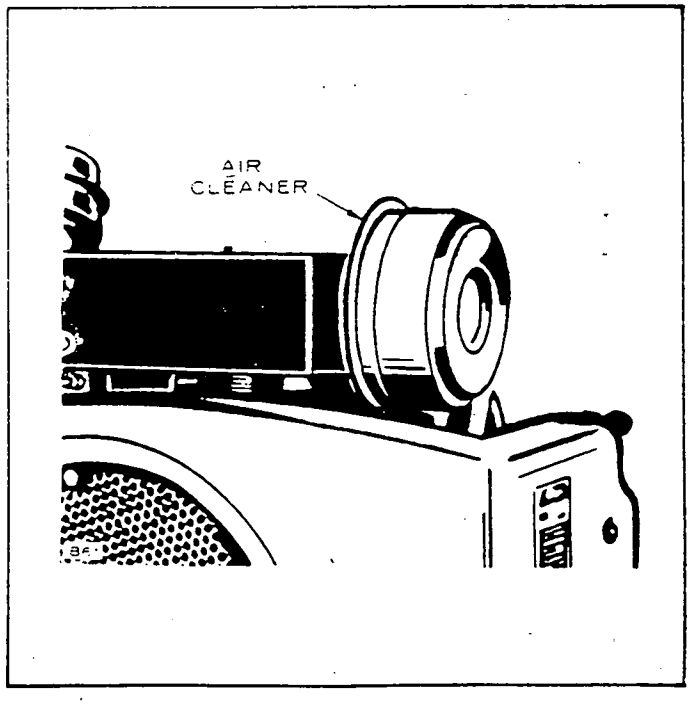

FIGURE 8. AIR CLEANER

GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Every 50 hours of operation clean the metal joints as shown in Figure 9. Also inspect the linkage for binding, excessive slack and wear.

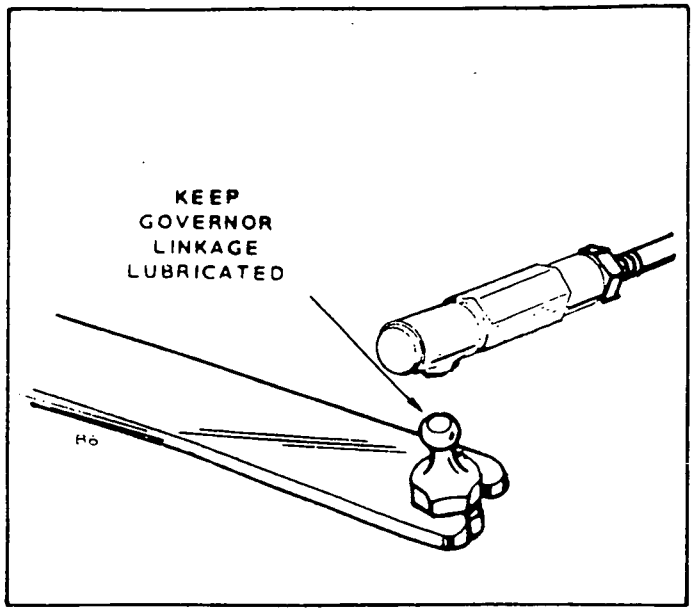

FIGURE 9. GOVERNOR LINKAGE

REDUCTION GEAR DRIVE

Drain the gear box after the first 100 hours of operation and refill with fresh lubricant of the recommended grade. Repeat this procedure every six months thereafter, or every 100 hours.

Use only SAE50 motor oil or SAE90 mineral gear oil. Do not use lubricants commonly known as extreme pressure lubricants, hypoide lubricants, etc.

Maintain the proper oil level between changes. Overfilling will cause foaming, which can lead to an oil leak due to overheating. Remove the filler plug on top of the case and the oil level plug from the face of the gear case. Fill the case until the oil just begins to flow from the oil level plug hole. Gear box holds 1/2 pint U.S. measure. Replace both plugs. See Figure 10.

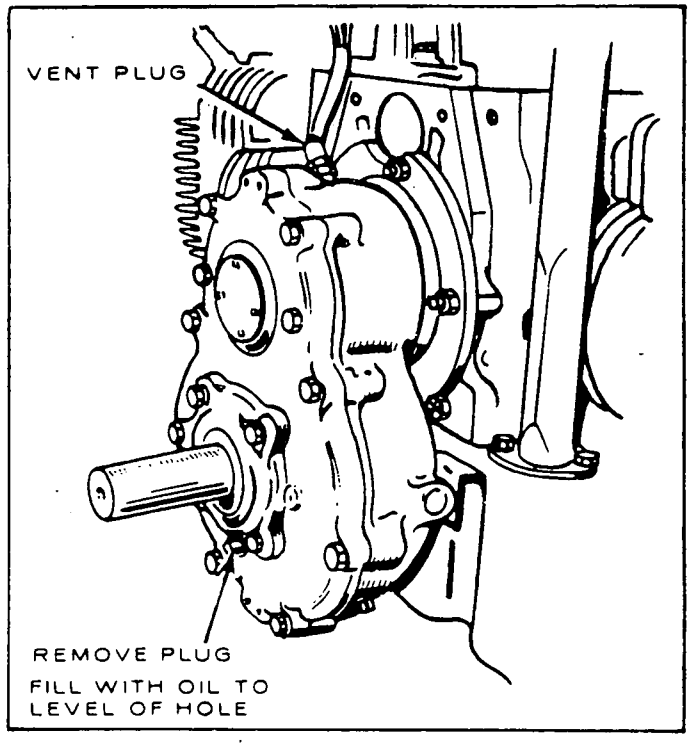

FIGURE 10. REDUCTION GEAR DRIVE

FUEL SYSTEM

GASOLINE CARBURETOR

For correction of problems traced to the gasoline carburetor, use the appropriate procedures selected from the following sequence, referring to Figures 11 and 13.

Adjustment Under Load: Adjust the carburetor as follows when a full load can be applied.

1. Make sure the ignition system is working properly and that the governor is adjusted.
2. Start the engine and allow it to warm up. If the carburetor is so far out of adjustment that the engine will not start, close both needle valves gently to their seats. Then open each 1 to 1-1/2 turns, first the idle and then the main adjustment.
3. With no load applied to engine, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until the engine speed returns to normal.
4. Apply a full load to the engine and then carefully turn the main adjustment in until the speed drops slightly below normal. Turn the needle out until the engine speed returns to normal.

Adjustment Under "No Load" Conditions: When a load cannot be applied, adjust the carburetor as follows:

1. Perform steps 1 and 2 as given under Adjustment Under Load.
2. Pull out on the governor mechanism to slow the unit down to about 400-500 rpm.
3. Set the idle adjustment screw for even operation (so the engine is firing on both cylinders and is running smoothly).
4. Release the governor mechanism to allow the engine to accelerate. If the engine accelerates evenly and without a lag, the main adjustment is correct. If not, adjust the needle outward about 1/4 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.
5. With the carburetor and governor adjusted, set the throttle stop screw at the desired idle speed.

Float-Level Check: If the carburetor adjustment fails to provide satisfactory operation, remove the carburetor and check the float level as follows:

1. Remove the fuel line, air cleaner hose, governor linkage and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Unscrew the float bowl nut and remove the entire main fuel adjustment assembly from the float bowl.
4. Invert the carburetor and check that the float surface nearest the gasket is 1 3/8 ± 1/16 inch from the gasket. Bend the float tab as required to produce this spacing.

   NOTE: *If the carburetor utilizes an internally spring loaded fuel inlet valve, the float surface should be 1 3/8 ± 1/16 inch from the gasket with the full weight of the float compressing the spring in the needle.*
5. Reassemble, install and test.
6. See Figure 12.

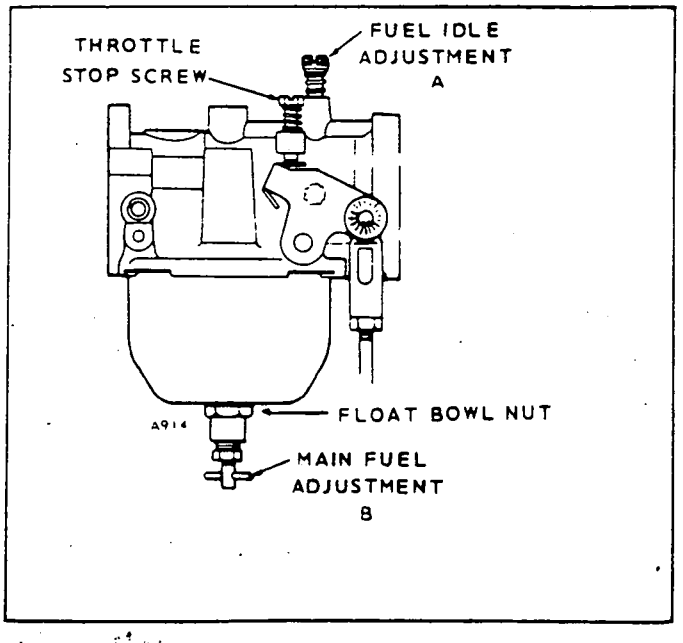

FIGURE 11. CARBURETOR ADJUSTMENTS

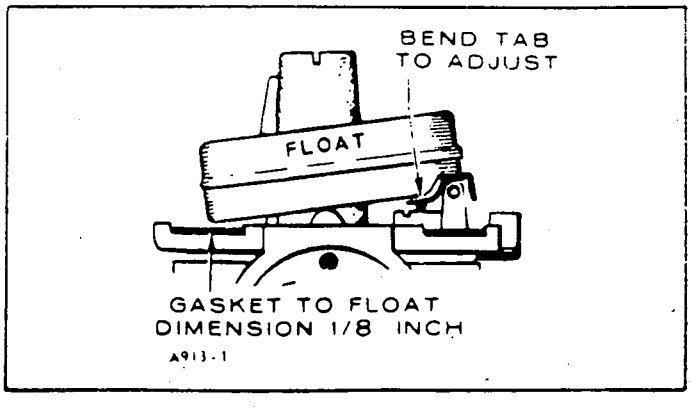

FIGURE 12. FLOAT LEVEL ADJUSTMENT

Carburetor Removal and Disassembly: Remove and disassemble the carburetor assembly as follows, referring to Figure 13.

1. Remove the fuel line, air cleaner hose, governor linkage, and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Remove the main jet assembly and bowl.
4. Remove the float pin and float.
5. Lift out the fuel inlet valve and unscrew the valve seat.
6. Remove the idle adjustment needle.
7. Remove the throttle plate screws and the plate, then pull out the throttle shaft.
8. Remove the choke plate screws and plate, then pull out the choke shaft.

Carburetor Assembly and Installation: Clean the components and repair or replace defective or worn parts. Use acetone or alcohol to dissolve gum deposits if carburetor cleaner is not effective. Soak the parts in carburetor cleaner, using it as directed by the manufacturer. Clean all carbon from the carburetor bowl, especially in the area of the throttle plate. Blow out clogged passages with compressed air. Check the needles, nozzle, and float for damage or fuel loading. Check the choke and throttle shafts. Reassemble and install as follows:

1. Install the throttle shaft and plate, using new screws and lock washers. Install with bevel mated to the carburetor body. If the plate is marked with the letter C, install it with the mark on the side toward the idle port when viewed from the flange end of the carburetor. To center the plate, back off the top screw, close the throttle lever and then set the plate by tapping it with a small screwdriver.
2. Install the choke shaft and plate. Center the plate in the same manner as the throttle plate (see step above). Use new screws and lock washers.
3. Install the fuel inlet valve seat and valve.
4. Install the float and float pin, adjusting the float as previously described.
5. Install the bowl ring gasket, bowl and bowl nut. Make sure that the bowl is centered in the gasket and tighten the main jet assembly securely. Turn in until it seats and back out to 1-1/2 turns.
6. Install the idle adjusting screw finger tight. Then back it out 1 to 1-1/2 turns.
7. Install the choke and adjust as previously described.
8. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism, air cleaner hose, and choke wires.
9. Adjust the carburetor needle settings as described under Adjustments and check out the performance.

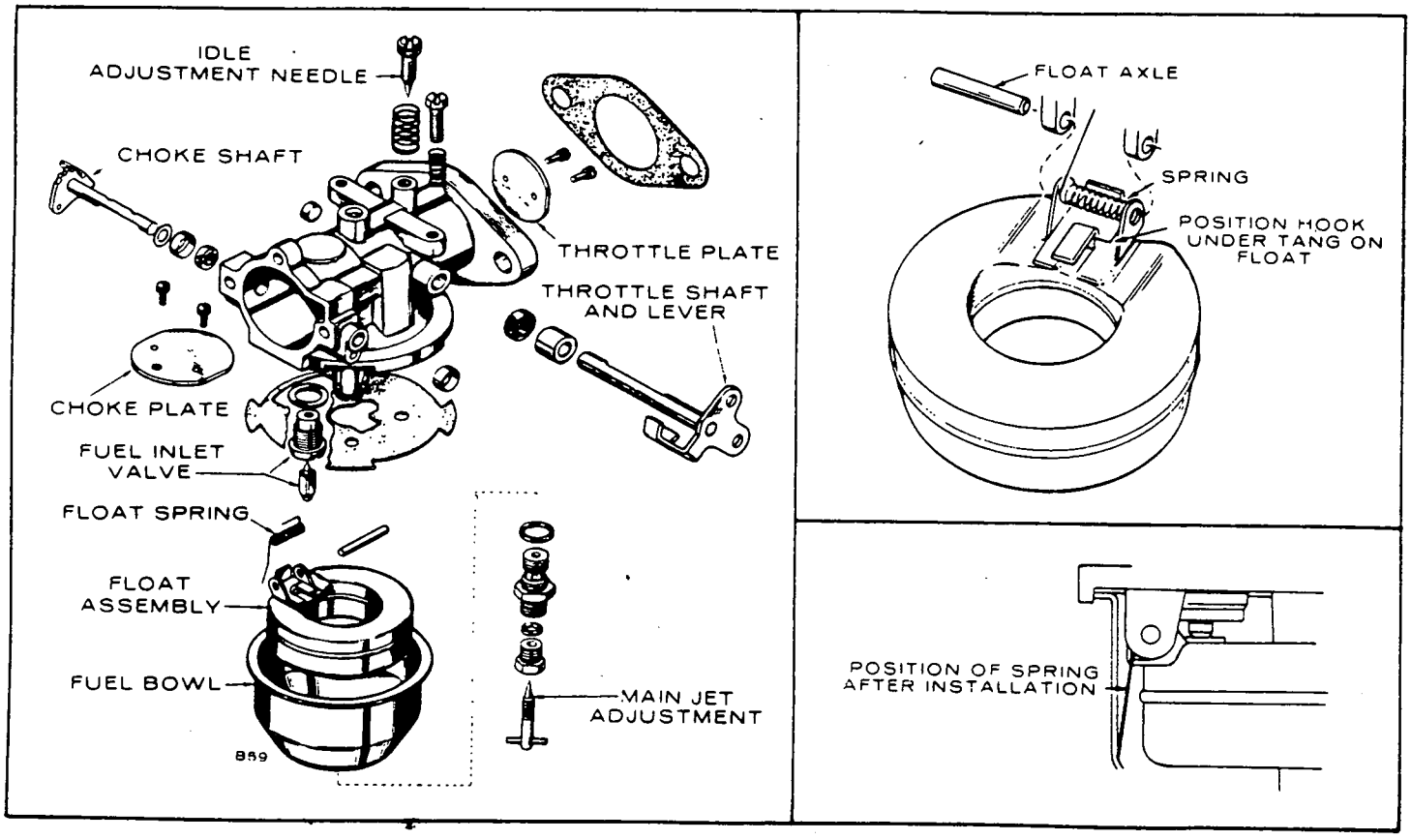

FIGURE 13. CARBURETOR ASSEMBLY

Complete Replacement: Complete replacement of the carburetor should be performed as follows:

1. Follow the previously given disassembly instructions as required for removal of the defective carburetor.
2. Replace the carburetor with a new unit, using attaching parts in good condition and making all the connections previously disengaged.
3. Adjust the needle settings as described under Adjustments.

FUEL PUMP

The engine uses a diaphragm-type fuel pump. If fuel does not reach the carburetor, check the fuel pump before dismantling it.

1. Disconnect the fuel line at the carburetor.
2. Crank the engine and observe whether fuel comes from the line at the carburetor.

   WARNING *Be sure to direct the fuel flow into a container so gasoline does not spill on ignition wires.*

3. If there is enough fuel in the tank, and line does not have fuel flowing, the pump needs replacing.

Pump failure is usually caused by a leaking diaphragm, valve or valve gasket, a weak or broken spring or wear in the drive linkage. Gasoline diluted oil may also indicate a faulty pump.

NOTE: *Always return the hand priming lever all the way inward so that lever does not prevent normal operation of fuel pump.*

Fuel Pump Reconditioning: Reconditioning of the fuel pump should be as follows, referring to Figure 14.

1. Remove the fuel lines and mounting screws holding the pump to the engine.
2. Make an indicating mark with a file across a point at the union of the fuel pump bolt and cover. Remove the assembly screws and the upper pump body.
3. Turn the pump body over and remove the valve plate screw and washer. Remove the valve retainer, valves, valve springs, and valve gasket, noting their position. Discard the valve springs, valves and valve retainer gasket.
4. Clean the pump body thoroughly with a solvent and a fine wire brush.
5. Holding the pump cover with the diaphragm surface up, place the new valve gasket in the cavity. Assemble the valves in the cavity. Reassemble valve retainer. Lock in position by inserting and tightening the fuel pump retainer screw.
6. Place the pump body assembly in a clean work area and rebuild the lower diaphragm section.
7. Holding the mounting bracket, press down on the diaphragm to compress the spring under it, then turn the bracket 90 degrees to unhook the diaphragm so it can be removed.
8. Clean the mounting bracket with a solvent and a fine wire brush.
9. Replace the diaphragm operating spring, stand the new spring in the casting, and position the diaphragm. Press down on the diaphragm to compress the spring and turn it 90 degrees. This will reconnect the diaphragm.
10. Hold the bracket, place the pump cover on it (making sure the indicating file marks are in line) and insert the four attaching screws but do not tighten. With the hand on the mounting bracket only, push the pump lever to the limit of its travel and hold in this position while then tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount the fuel pump on the engine, using new mounting gaskets. Connect the fuel lines.

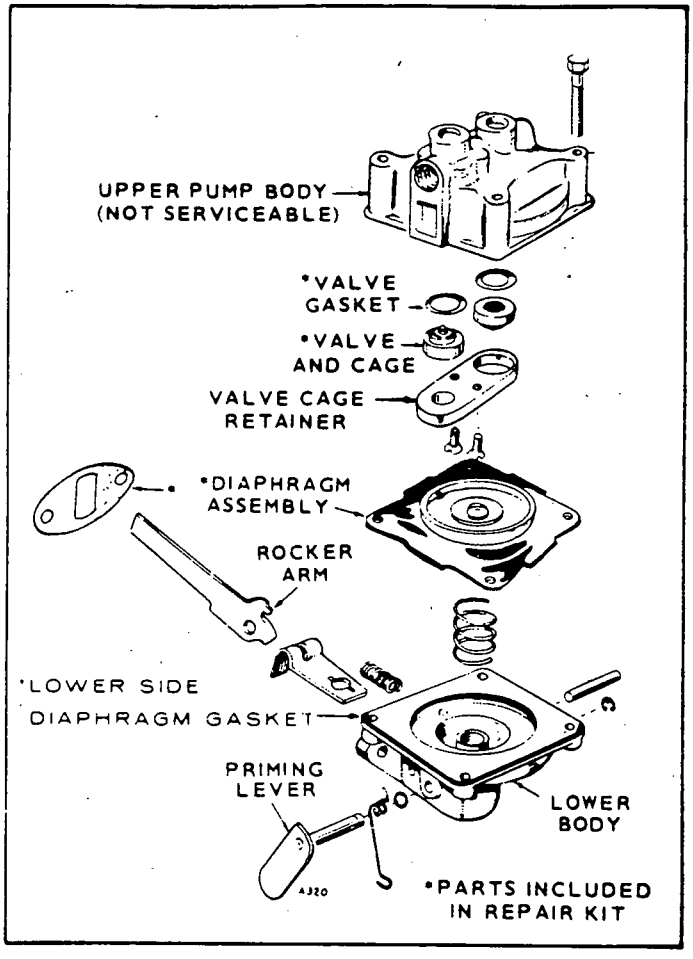

FIGURE 14. FUEL PUMP

THERMO-MAGNETIC CHOKE (Optional)

This choke uses a strip heating element and a heat sensitive bimetal spring to control the choke plate position. In addition to this, a solenoid is actuated during engine cranking, closing the choke all or part way, depending on ambient temperature. The bimetal is factory set to position the choke to the proper opening under any ambient condition.

Choke Adjustment: If adjustment of the bimetal is needed, it must be made at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Loosen the screw which secures the choke body assembly. Refer to Figure 15. Rotating the choke body clockwise richens and counter-clockwise leans the choking effect. For ambient temperatures above 85°F, the choke should be fully opened. For ambient temperatures below 25°F, the choke should be opened 1/4 inch with the solenoid not engaged. Tighten the screw that secures the choke body.

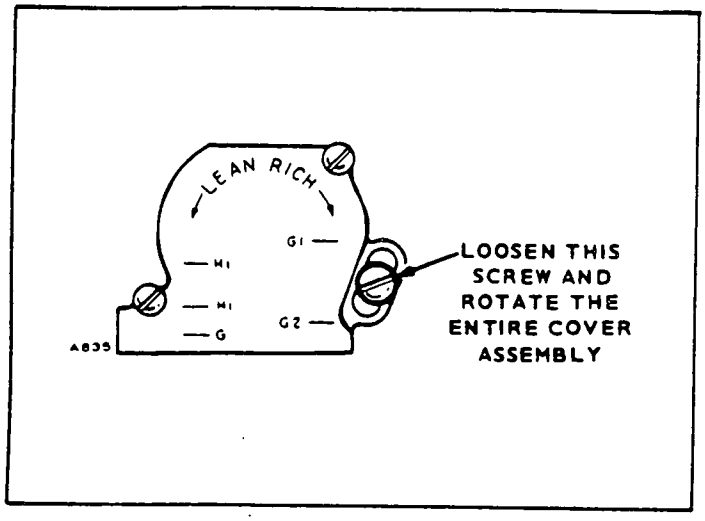

FIGURE 15. THERMO-MAGNETIC CHOKE

If the choke will not close, check for binding, incorrect adjustment, or incorrect assembly of the bimetal and heater assembly. If the choke will not open after the engine starts, check for heating. The choke bimetal should be warm to the touch within a minute or two after starting.

To disassemble the choke, refer to Figure 16.

If the heater assembly will not heat properly, check for broken heater wire, high resistance connections or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 37.8 to 46.2 ohms for a 12 volt system. If the heater is defective, replace. There must be slack in the lead wires between the choke body and the bimetal and heater assembly. When the start button is engaged, the solenoid should cause the spring loaded lever to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid core.

The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 12 volt system.

Assembly: Refer to Figure 16. When assembling the thermomagnetic choke, connect the bimetal and heater assembly as follows:

1. Lead tagged G to ground terminal in coil solenoid.
2. Lead tagged H to either of the H1 terminals on the solenoid core.

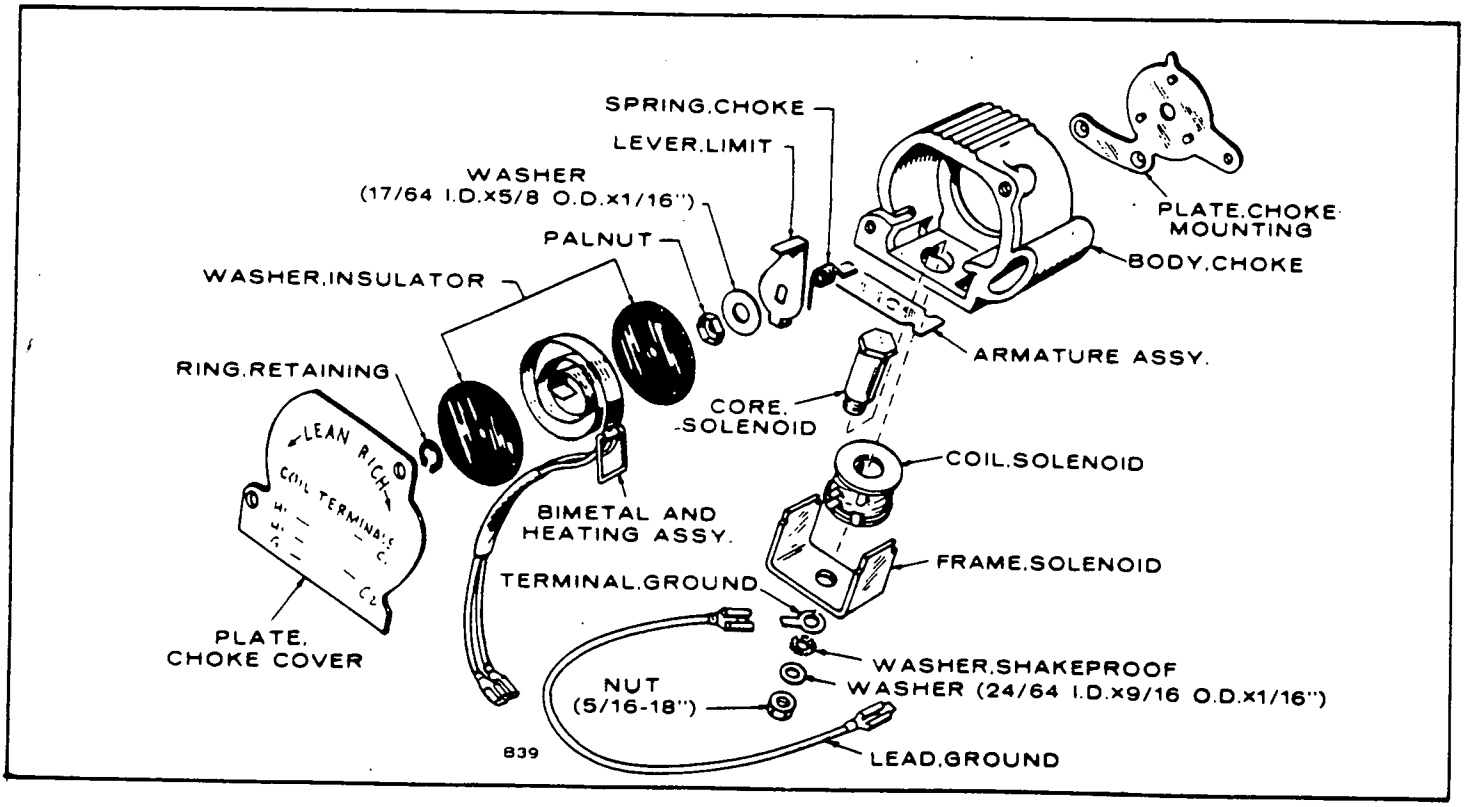

FIGURE 16. CHOKE ASSEMBLY

GASEOUS FUEL CARBURETOR

For correction of problems traced to a gaseous fuel carburetor perform the following:

1. Clean or replace the air cleaner.
2. Inspect hoses, replacing defective units, and securing all connections.
3. Clean the dry fuel filter (if present).
4. Check the regulator and carburetor for proper adjustment as described later in this section.

Gas Regulator Adjustment: This regulator was factory adjusted to lock-off at a pressure of 4 oz. (7″ water column). The regulator will operate satisfactorily at incoming pressures of from 2 to 4 oz. If your gas supply pressure is within these limits, no regulator adjustment is required. If your gas supply pressure is under 2 oz., the regulator will not operate. If your gas supply pressure is between 4 and 8 oz., install an appliance regulator set for 2 oz. ahead of the regulator, or adjust the regulator as follows and reference to Figure 17.

WARNING *A soap bubble placed over the regulator outlet will not accurately test for regulator closing. The soap bubble's resistance when multiplied by the greater area of the regulator diaphragm, is enough to shut off this very sensitive demand type regulator.*

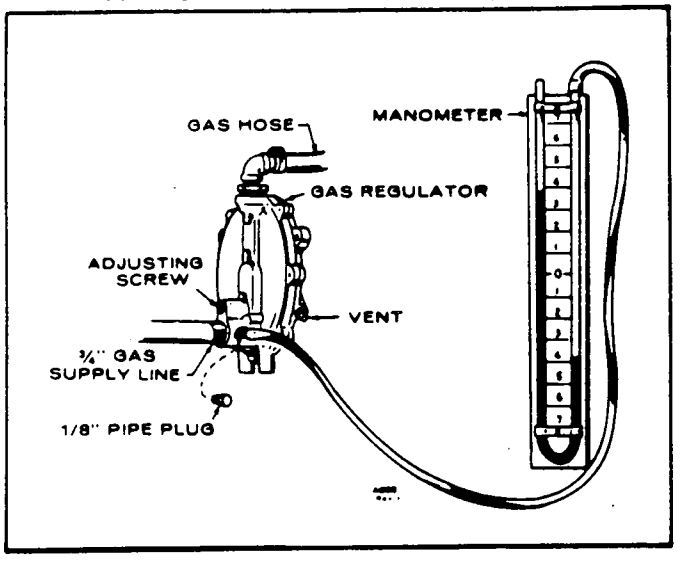

FIGURE 17. TESTING WITH MANOMETER

1. Refer to Figure 17.
2. Connect a manometer which reads up to 14″ water column to the regulator's plugged test hole near inlet. Turn gas on and energize the solenoid valve.
3. Turn regulator lock-off adjusting screw inward just far enough so that the manometer reading remains constant when you repeatedly cover and uncover the regulator outlet with your hand. Failure to lock off indicates too high incoming pressure or dirty regulator valve and seat.
4. Close the gas supply line valve. Remove manometer. Bleed air from gas supply line. Install test-hole plug in regulator. Open gas supply line valve. See that vent fitting is installed.
5. With a clamp on each end, secure the hose between the regulator outlet nipple and the carburetor inlet.
6. Operate the engine to assure quick starting results.

Gas Carburetor Adjustment:

1. Adjust the main gas adjusting screw (M) on the carburetor, depending upon the type of gas used. For 800 BTU gas turn to approximately six turns open. For 1,100 BTU gas turn to 3-1/2 turns open. For propane gas, turn to approximately three turns open. Turn the idle screw (N) to two turns open. These settings are preliminary ones, to premit starting the engine.

   For starting an engine manually, the gas should have a BTU rating above 800 BTU per cubic foot. The temperature should be above 30°F (-1°C) to permit sufficient cranking speed to be developed. Too low a cranking speed would prevent proper intake vacuum for starting. Load should be disconnected, or reduced to the minimum.
2. Allow the engine to thoroughly warm up. When operating temperature is reached, make final carburetor adjustments. Apply a full load and turn the carburetor main gas adjusting screw (M) in (clockwise) until the engine begins to lose speed from lack of fuel. Slowly back out the main adjusting screw (counterclockwise) until the engine will carry the full load smoothly. Remove all load and adjust the small slotted idle adjusting screw (N) in the same manner. Check the operation at various loads. Make any necessary governor adjustments as given in following section.

When operating on gas fuel of approximately 800 BTU rating, some loss in power output may be evident. However, full power should be developed if using a gas rated at 1,100 BTU or higher. Gas fuel usually is clean burning, which means that carbon removal and valve grinding services may not have to be performed as frequently as with gasoline fuel.

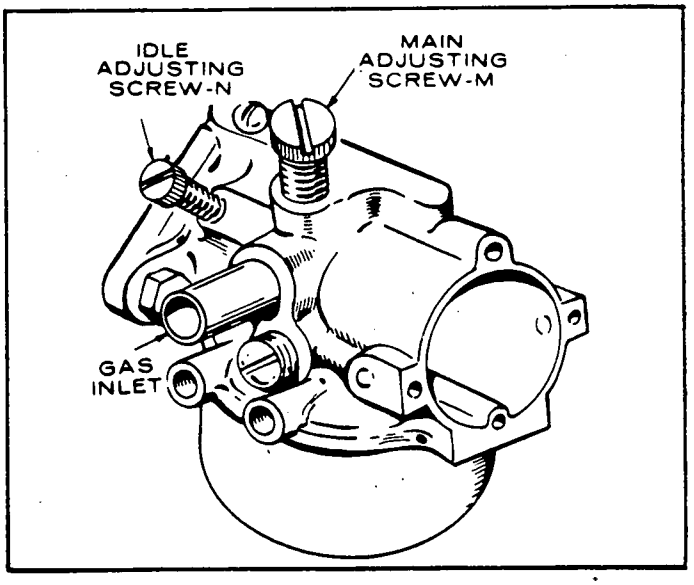

FIGURE 18. GAS CARBURETOR ADJUSTMENT

GOVERNOR SYSTEM

GOVERNOR ADJUSTMENT

Where engine speed is governor controlled, the governor is set at the factory to allow a nominal engine speed of 2400 rpm at no load operation (unless another speed is specified when the engine is ordered). Proper governor adjustment is one of the most important factors in maintaining the power and speed desired from the engine.

Before making governor adjustment, run the engine about 15 minutes to reach normal operating temperature.

It is difficult to determine if, after long usage, the governor spring has become fatigued. If, after properly making all other adjustments, the regulation is still erratic, install a new spring (Figure 19).

A tachometer for checking engine speed is required for accurate governor adjustment.

Check the governor arm, linkage, throttle shaft and lever for binding or excessive wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the engine is idle. If either of these conditions exist, determine the cause and adjust or replace parts as needed.

Procedure:

1. Adjust the carburetor main jet for the best fuel mixture at full load operation.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage.
4. Check the governor linkage and throttle shaft for binding or excessive looseness.
5. Adjust the governor spring tension for nominal engine speed at no load operation.
6. Check the rpm drop between no load and full load operation and adjust the governor sensitivity as needed.
7. Recheck the speed adjustment.
8. Set the carburetor throttle stop screw.

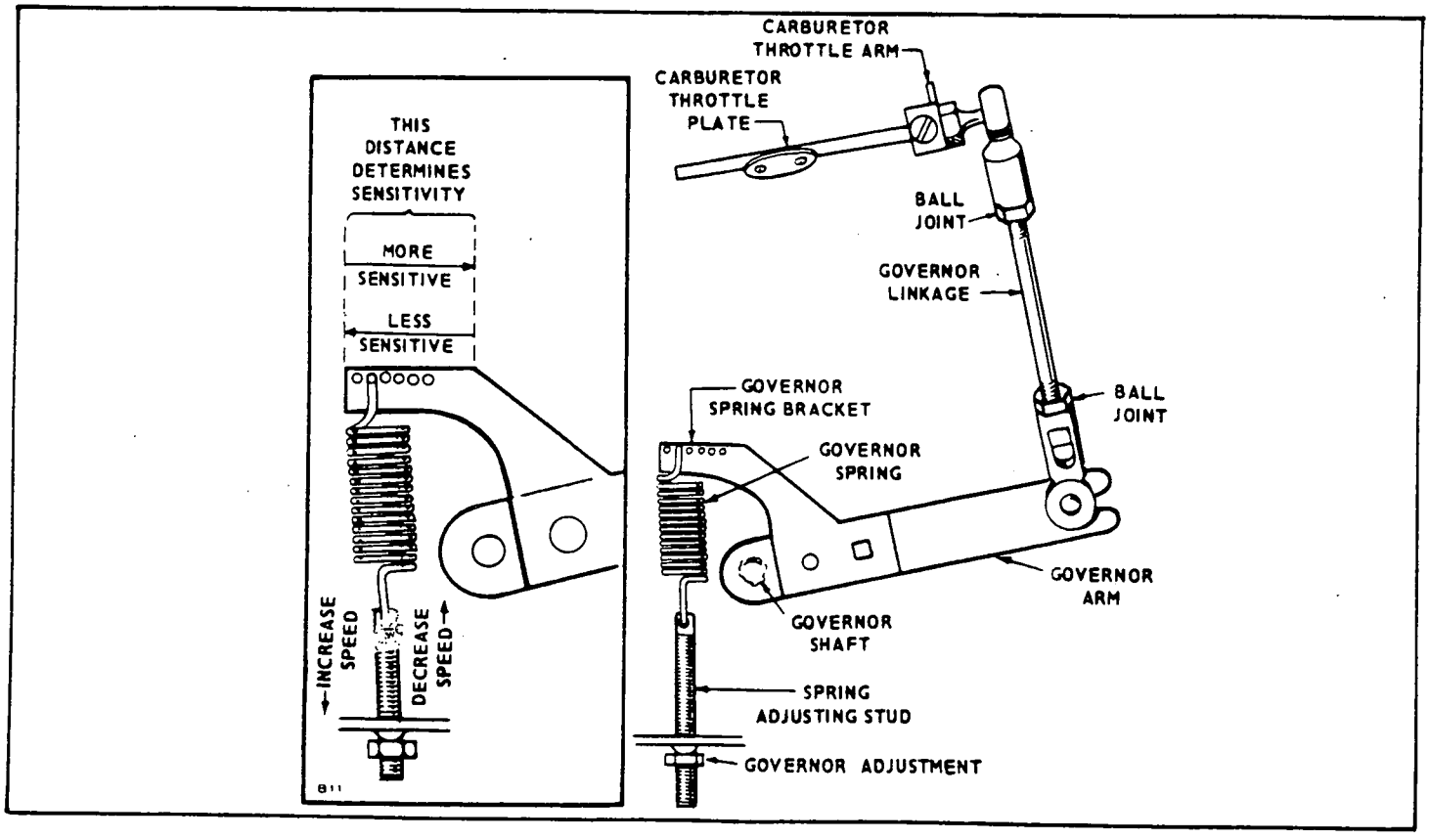

FIGURE 19. GOVERNOR ADJUSTMENTS

Linkage: The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle arm is adjusted by rotating the ball joint housing. Adjust the length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever is 1/32 inch from the carburetor stop boss. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and the throttle shaft.

Speed Adjustment: The speed at which the engine operates is determined by the tension applied to the governor spring. Increasing spring tension increases engine speed. Decreasing spring tension decreases engine speed. The no load speed of the engine should be slightly higher than the speed requirements of the connected load. For example: If the connected load is to turn at 3510 rpm, set the no load speed of the engine at about 3600 rpm. Check speed with a tachometer.

If a speed adjustment is needed, turn the speed adjusting nut in to increase the speed or out to decrease the speed (Figure 19).

Sensitivity Adjustment: The engine speed drop from no load to full load should be not less than 100 rpm. Check the engine speed with no load connected and again after connecting full load. Do not exceed 4000 rpm at no load.

The sensitivity of the governor depends upon the position of the arm end of the governor spring. A series of holes in the governor arm provides for adjustment. To increase sensitivity, move the spring toward the governor shaft. To decrease sensitivity, move the spring toward the linkage end of the governor arm.

If the setting is too sensitive, a hunting condition (alternate increase and decrease in engine speed) will result. If the setting is not sensitive enough, the speed variation between no load and full load conditions will be too great. Therefore, the correct sensitivity will result in the most stable speed regulation without causing a surge condition.

Always recheck the speed adjustment after a sensitivity adjustment. Increasing sensitivity will cause a slight decrease in speed and will require a slight increase in the governor spring tension.

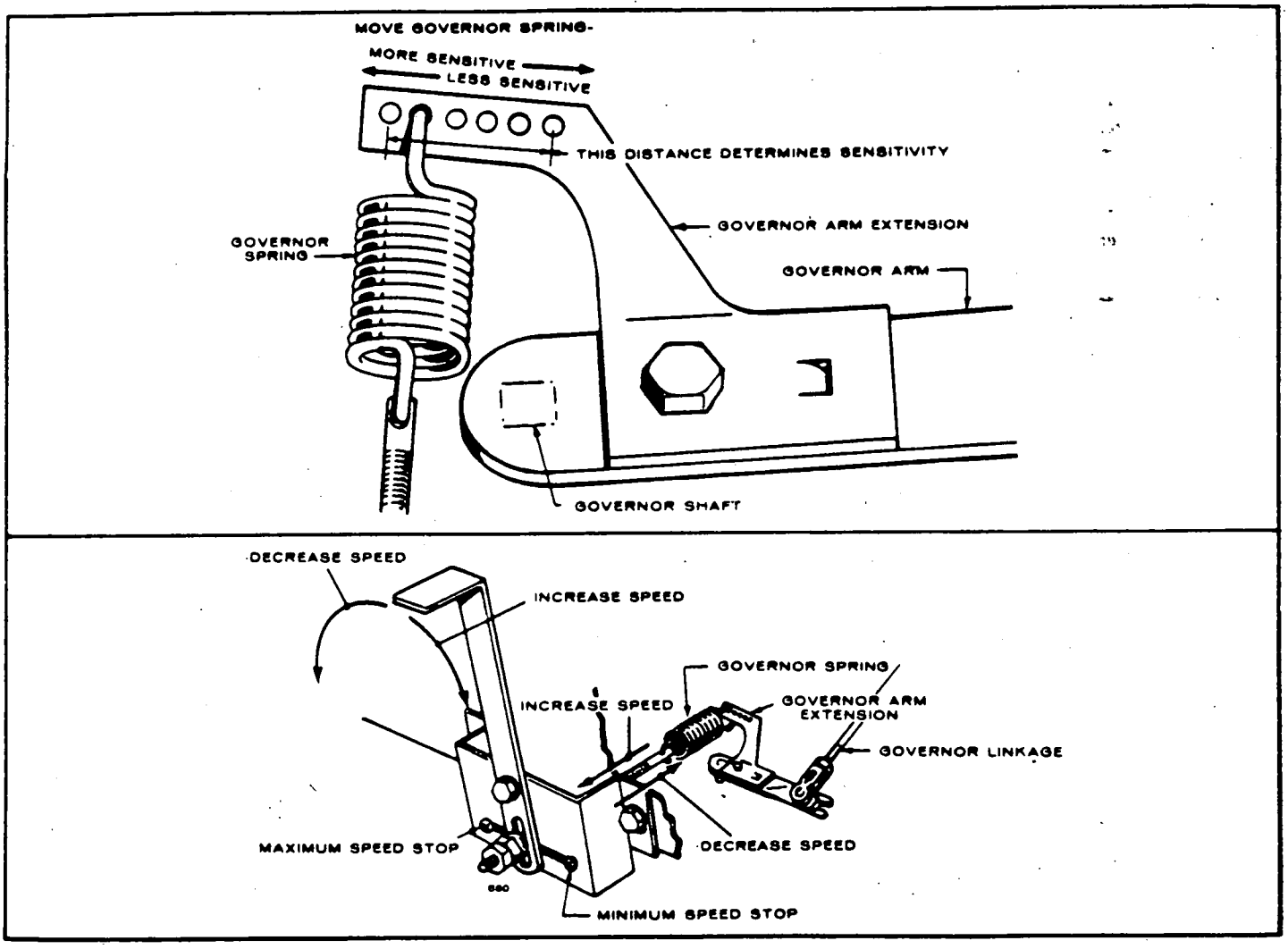

FIGURE 20. VARIABLE SPEED GOVERNORS

Variable Speed Governor Adjustments: These engines are adapted for use where a wide range of speed settings is desired. The design of the variable speed governors gives an automatic increase in sensitivity when the speed is increased and the result is good stability at all speeds.

To adjust the variable speed governors, refer to Figure 20 and the following:

1. Run the engine and make necessary carburetor adjustments.
2. Adjust the throttle stop screw on the carburetor to allow a recommended minimum idling speed of 900 rpm. A lower minimum does not assure smooth operation under load.
3. Adjust the tension of the governor spring for minimum speed. For the control with the control arm, shift the lever to minimum speed with no load and adjust the spring tension for approximately 1500 rpm.

   For the control with the control knob and slide (NHC engines with mounted engine controls), pull back the knob and slide and set at the first notch (low speed). Adjust speed to approximately 1500 rpm (or the desired low speed) at no load by turning the knob as required.
4. Adjust the sensitivity while operating at minimum speed to attain the smoothest no load to full load operation as follows:

   To decrease sensitivity (allow more speed drop from no load to full load operation) move the governor spring outward into a different groove or hole in the extension arm.

   To increase sensitivity (closer regulation by the governor which permits less speed drop from no load to full load operation) move the governor spring inward into a different groove or hole in the extension arm.
5. Apply a full load and shift the variable control to maximum speed – moving the control arm to the right or shifting the control knob and slide to the second notch. For the governor control with the control arm, set the screw in the bracket slot to stop lever travel at the desired maximum full load speed position. For the control with the control knob and slide, increase or decrease speed by turning the knob as required.

Approximately 3000 rpm is the recommended maximum full load speed for continuous operation. The speed must agree with the load requirements.

IGNITION AND BATTERY CHARGING

BREAKER POINTS

To maintain maximum efficiency from the engine, change the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove the two spark plugs so engine can be easily rotated by hand. If plugs have not been changed within the last 100 hours, replace them with new ones after setting the breaker points.
3. Refer to Figure 21. Remove mounting screw (A) and pull the points out of the box just far enough so screw (B) can be removed and leads disconnected.
4. Remove screw (C) and replace condenser with a new one.
5. Replace points with a new set but do not completely tighten mounting screw (A).
6. Rotate the engine by hand until the 25°BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90°) to ensure points are fully open.
7. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .020" with a flat thickness gauge. Tighten mounting screw and recheck gap.
8. Check ignition timing.

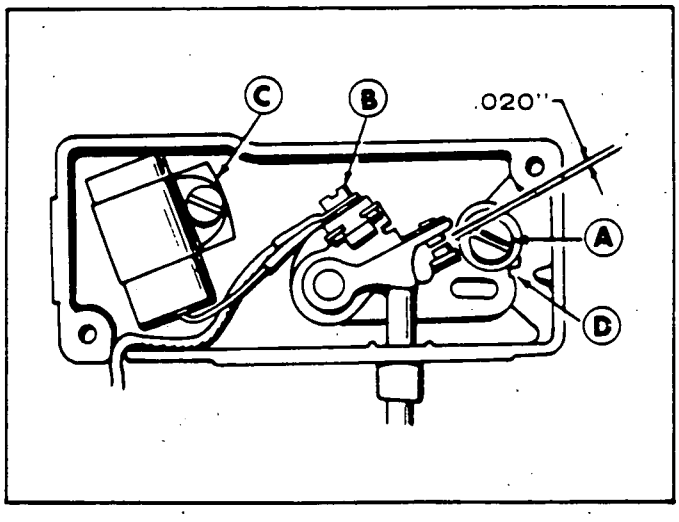

FIGURE 21. BREAKER POINT ADJUSTMENT

IGNITION TIMING

The timing on the engine is preset at the factory. A non-movable breaker point box is used, however a slight timing change could be made by adjusting points.

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. Spark advance is set at 25°BTC (before top center), and should be maintained for best engine performance. Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

Timing Procedure - Engine Running:

1. To accurately check the ignition timing, use a timing light with engine running at idle speed. Connect the timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.
2. Start the engine and check the timing. The mark on the flywheel should line up with the 25° mark on the cover.

NOTE: *If timing marks do not line up, readjust point gap. To advance timing, slightly close gap on breaker points. To retard timing, slightly open gap on breaker points. Recheck timing and breaker point gap after making this adjustment.*

Timing Procedure - Engine Not Running: If a timing light is not available, check the timing as follows:

1. Connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch the other test prod to a good ground on the engine.
2. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
3. The lamp should go out just as the points break which is the time at which ignition occurs (25° BTC).

SPARK PLUGS

Remove both spark plugs and install new ones every 100 hours. Use Champion N-6 or equivalent. Check to be sure spark plug gap is set at .025".

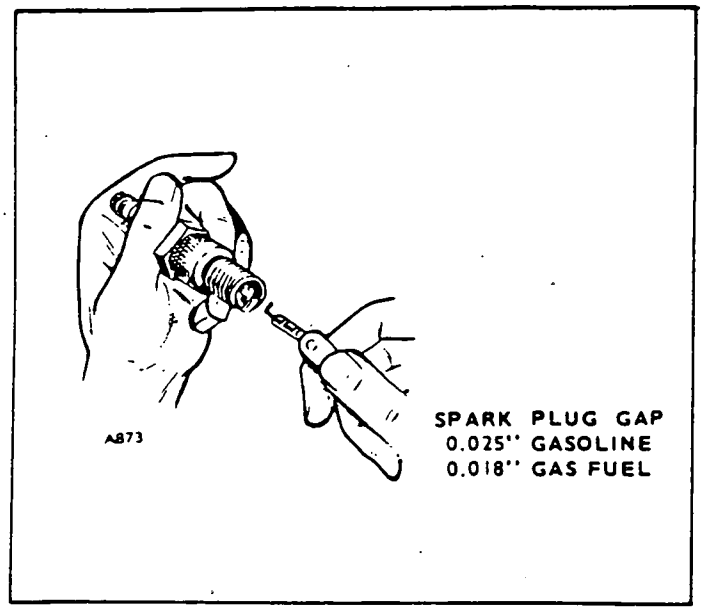

FIGURE 22. SPARK PLUG GAP

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use Simpson 260 VOM or equivalent.
2. Place black lead on ground (–) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 4.30 (±10%) ohms @ 70°F.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 23). Secondary resistance should read 14,000 (± 10%) ohms @ 70°F.
4. If any of the above conditions are not met, replace coil. Refer to parts catalog for correct part number.

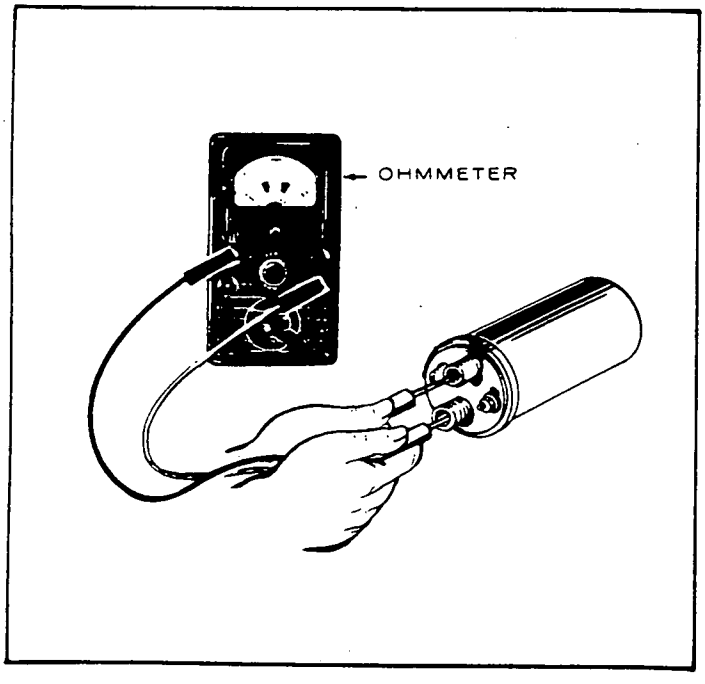

FIGURE 23. COIL TEST

CAUTION *This engine uses a 12 volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.*

BATTERY INSPECTION

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.280 at 80°F.

If one or more cells are low on water, add distilled water and recharge.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

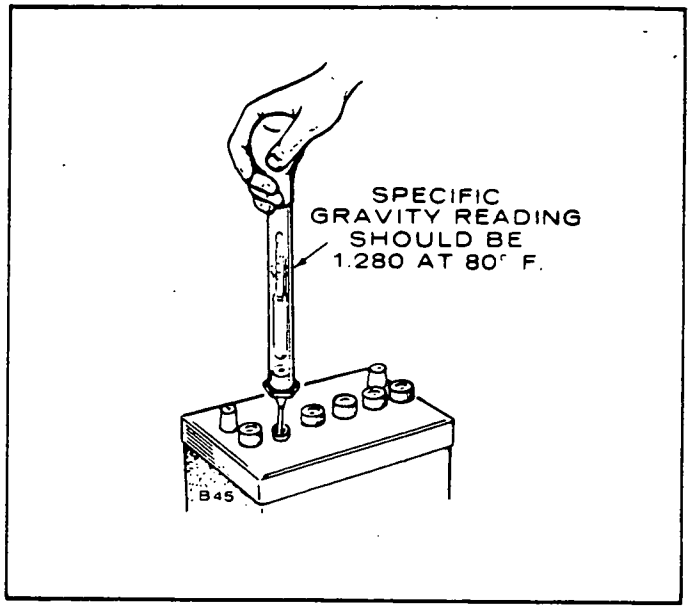

FIGURE 24. SPECIFIC GRAVITY TEST

FLYWHEEL ALTERNATOR

The alternator is a permanent magnet flywheel alternator with a solid-state voltage regulator-rectifier for controlling output. If ignition spark is weak or if the battery discharges inspect the following:

Inspection:

1. Check battery cells to make sure they are filled to appropriate level adding distilled water as required. Check specific gravity in each cell. Specific gravity should be 1.280 at 80°F; if not, recharge battery to bring it up to this level.

NOTE: *Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.*

2. Make sure the two alternator stator leads are not shorted together.
3. Check mounting of regulator-rectifier case to unit. It should provide a good electrical ground with clean, bright surfaces.
4. Output control plug (connector) must be pushed in so it bottoms solidly in the receptacle. Keep it clean and tight.

IMPORTANT: *Charging system tests require a fully charged battery.*

Testing: With the engine running between 1800-2600 rpm, observe the panel ammeter. (if not already equipped, connect a test ammeter.) If no charging is evident, proceed with the NO CHARGE TEST given as follows. If ammeter shows a constant higher charge rate, follow the HIGH CHARGE RATE TEST procedure.

No Charge Test: Perform as follows:

1. Check the B+ to ground voltage using a DC voltmeter.
2. If voltmeter reads 13.8 volts or higher, add a load to system (e.g. headlights) to reduce battery voltage to below 13.6 volts.
3. Observe ammeter. If charge rate increases, consider the system as satisfactory. If charge rate does not increase, proceed with testing.
4. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running near 3600 rpm. If AC voltage reads less than 28 volts, replace the stator. If AC voltage is more than 28 volts, replace the regulator-rectifier assembly.

High Charging Rate Test: Perform this test as follows:

1. Check B+ to ground voltage with a DC voltmeter.
2. If voltmeter reads over 14.7 volts, replace regulator-rectifier assembly.
3. If reading is under 14.7 volts the system is probably okay. Recheck the battery and connections. If the battery does have a low charge, but accepts recharging, system is okay.

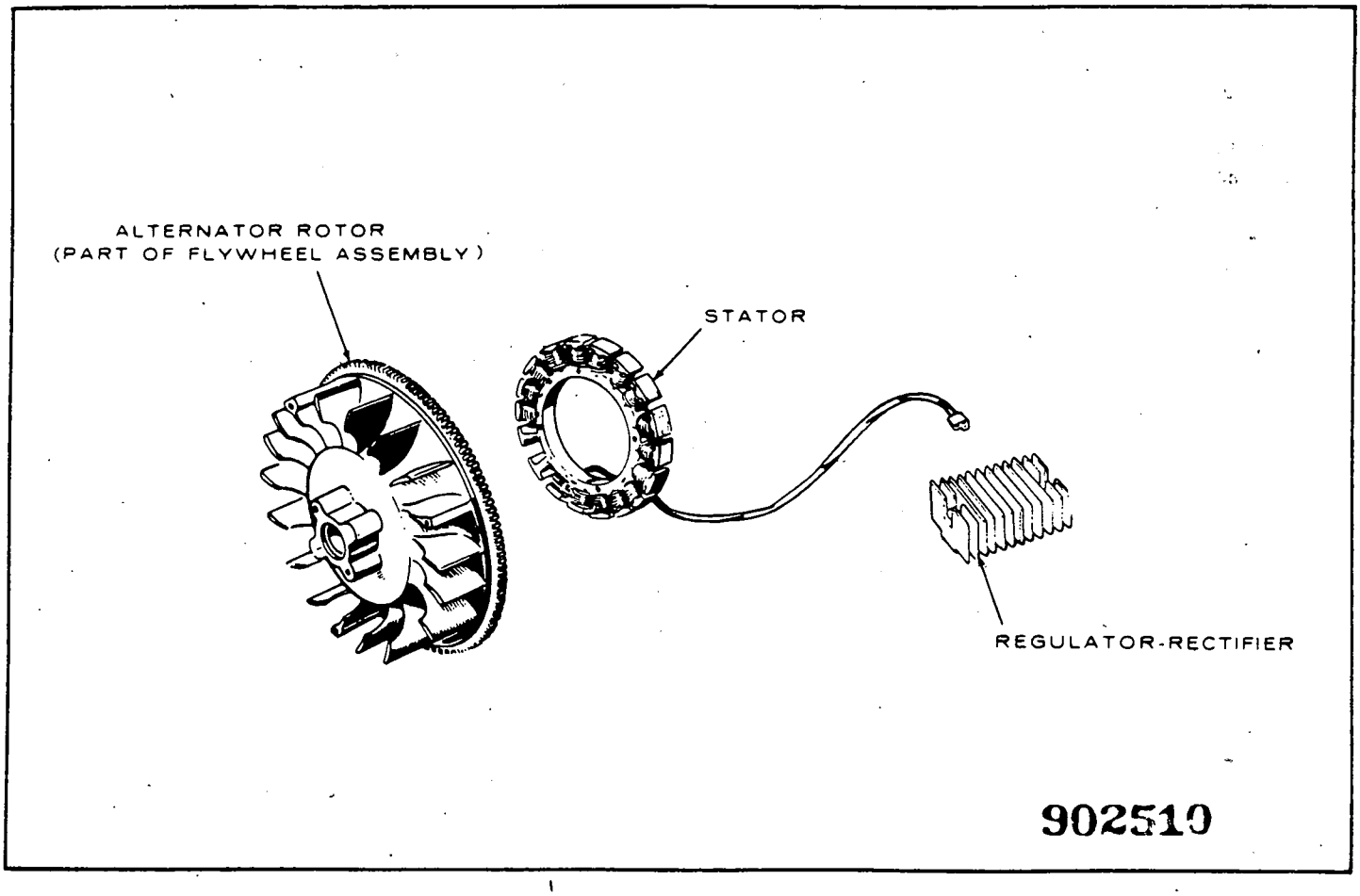

FIGURE 25. FLYWHEEL ALTERNATOR

ELECTRIC STARTER REPAIR

CAUTION *Do not use steam or high pressure water to clean the starter.*

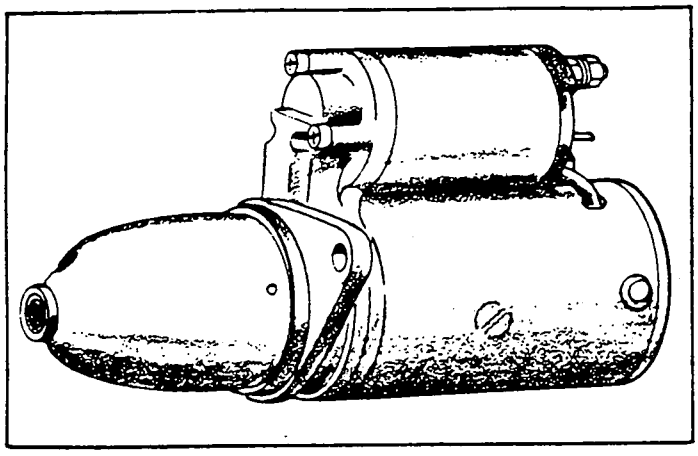

FIGURE 26. STARTER ASSEMBLY

DISASSEMBLY

1. Loosen the M terminal nut on the magnetic switch and remove the connector. Then unscrew attaching screws and remove the magnetic switch.

   NOTE: *The packings for the magnetic switch are mounted so that the steel packing is located in the front bracket side.*

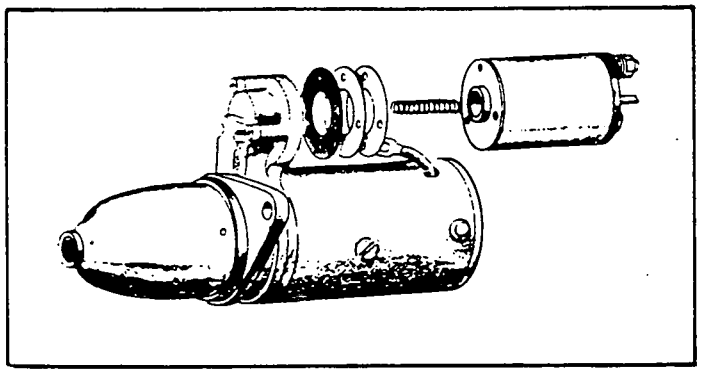

FIGURE 27. MAGNETIC SWITCH REMOVAL

2. After removing the thru bolts, the starting motor can be divided into three parts – the front bracket, housing and rear bracket. The spacing washers shown in Figure 28 are used for adjustment of the thrust gap of the armature shaft and are placed between the rear bracket and the commutator.

   NOTE: *These washers are inserted so the steel washer is located in the commutator side.*

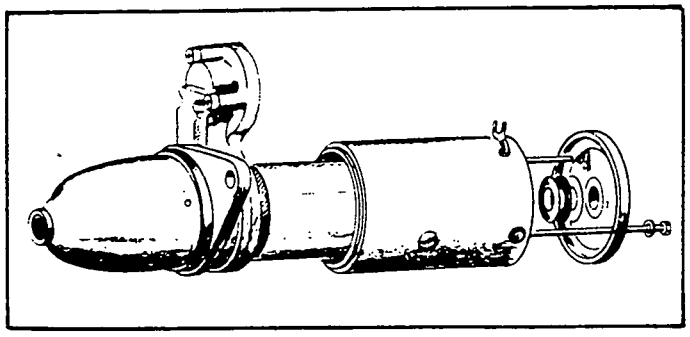

FIGURE 28. REMOVING THROUGH BOLTS

3. The armature can easily be removed from the front bracket. Be careful not to miss a small steel washer used in the end of the armature shaft. The shift lever can be removed along with the armature when it is removed. In this case, the spring holder, lever springs and retainer can be taken out before the lever. See Figure 29.

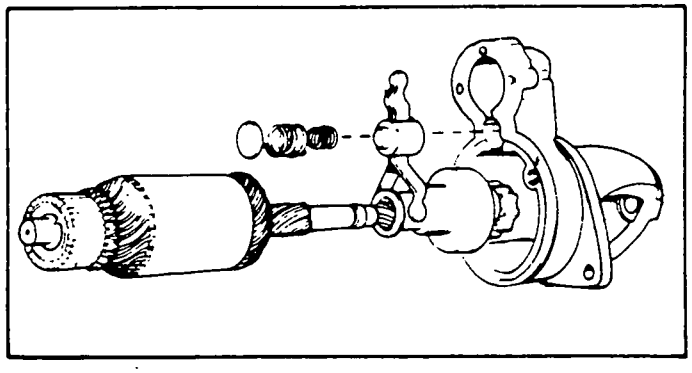

FIGURE 29. REMOVING ARMATURE

4. Remove the ring after driving the pinion stopper toward the pinion gear using a cylindrical tool as shown in Figure 30. The overrunning clutch and the pinion stopper should be removed simultaneously.
5. All four brushes have been soldered to the brushholder in the same way. The brush springs can be removed from the brushholder.
6. The pole shoes may be removed if necessary, by removing the flat head machine screws from the frame.

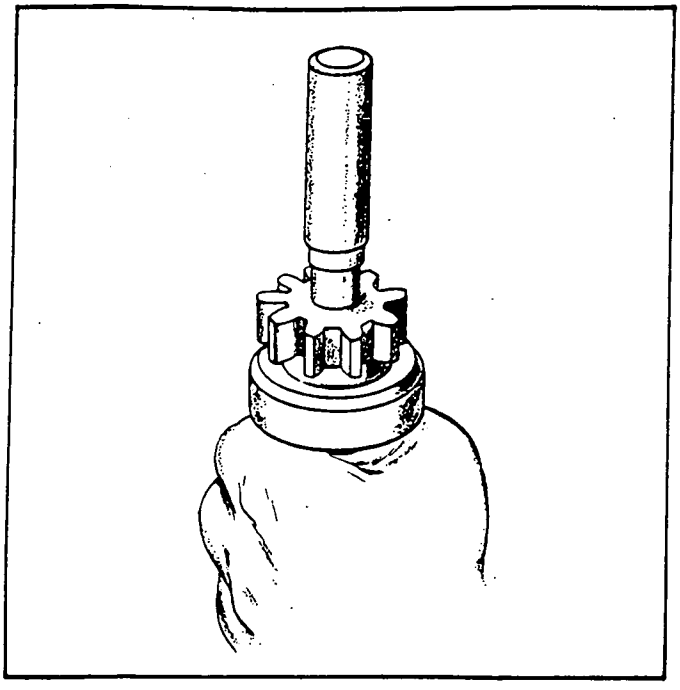

FIGURE 30. REMOVING RING

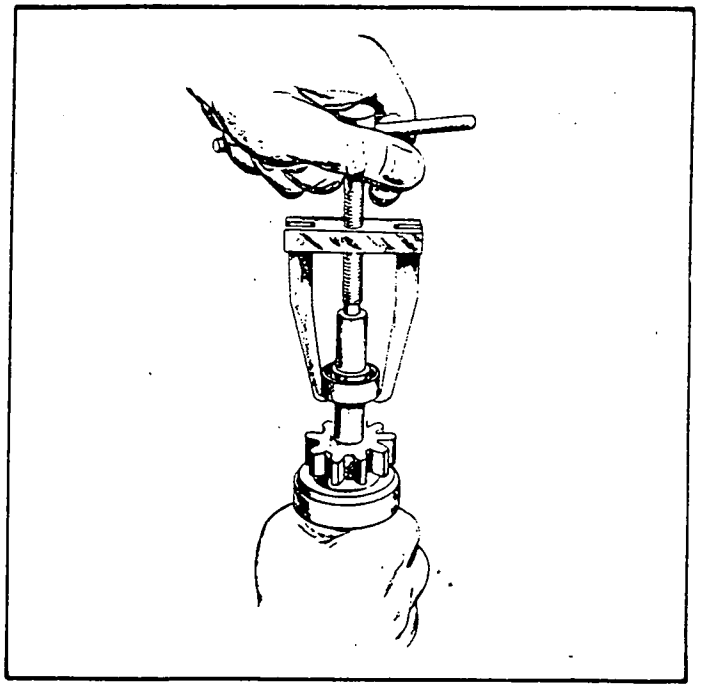

FIGURE 32. MOUNTING OVERRUNNING CLUTCH

REASSEMBLY

Inspect the parts carefully in accordance with the procedure described in "Inspection of Parts". Make any repairs necessary. Reassembly is the reverse of assembly. The following precautions should be taken:

1. Clean all of the parts carefully with a dry cloth and compressed air if it is available.

   NOTE: *Bearing equipped parts must not be immersed in cleaning fluid. These parts should be cleaned with a brush dipped in "Varsol" or any other comparable mineral spirits. Do not immerse overrunning clutch in cleaning solvent. Thoroughly dry any parts that have come into contact with the cleaning fluid.*

2. Apply 20 weight non-detergent oil to the armature shaft and splines. Apply grease (Shell Albania No. 2 or equivalent) sparingly on the shift lever pin, the joint of the shift lever and plunger, the plunger and spacing washers at the end of the shaft.
3. To mount the overrunning clutch; first insert the pinion stopper into the armature shaft, then apply the ring to the groove of the shaft rigidly. For the insertion of the ring, use a tool as shown in Figure 32 and pull the pinion stopper up.
4. Use spacing washers to adjust the armature to give end play of .004" to .020".
5. Tighten the thru bolts to a torque of 35 to 44 in-lbs.
6. Insert the shift lever as shown in Figure 33 into the front bracket.

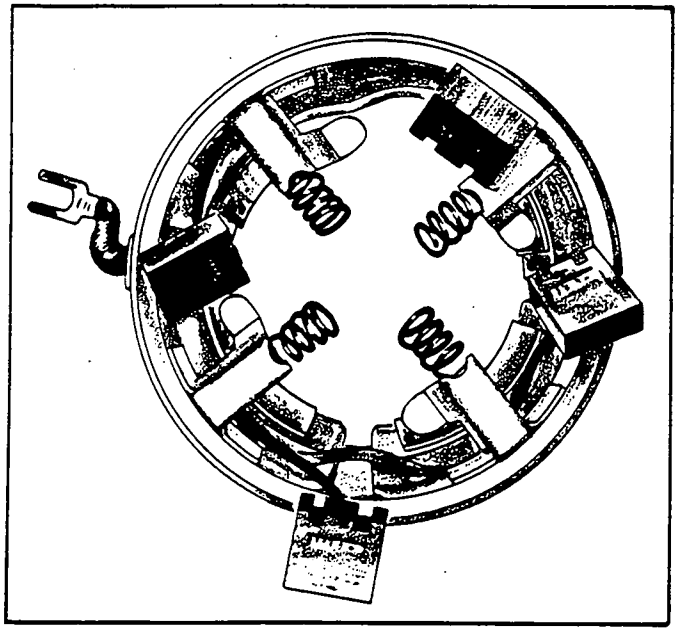

FIGURE 31. BRUSHES

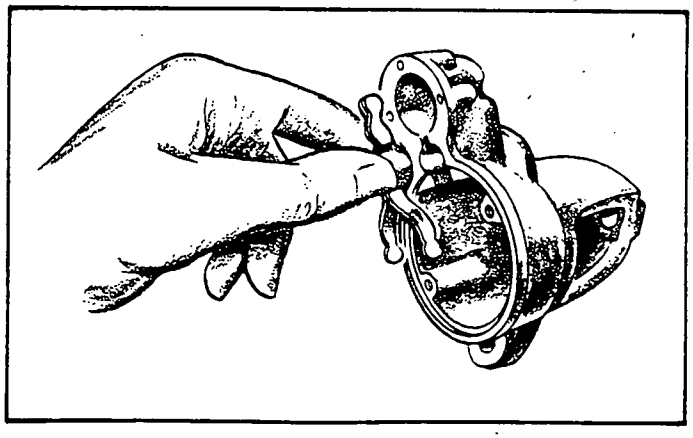

FIGURE 33. INSTALLING SHIFT LEVER

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INSPECTION OF PARTS

1. **Testing Armature for Short Circuits.** Place the armature in a growler and hold a thin steel blade parallel to the core and just above it while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace shorted armature. See Figure 34.

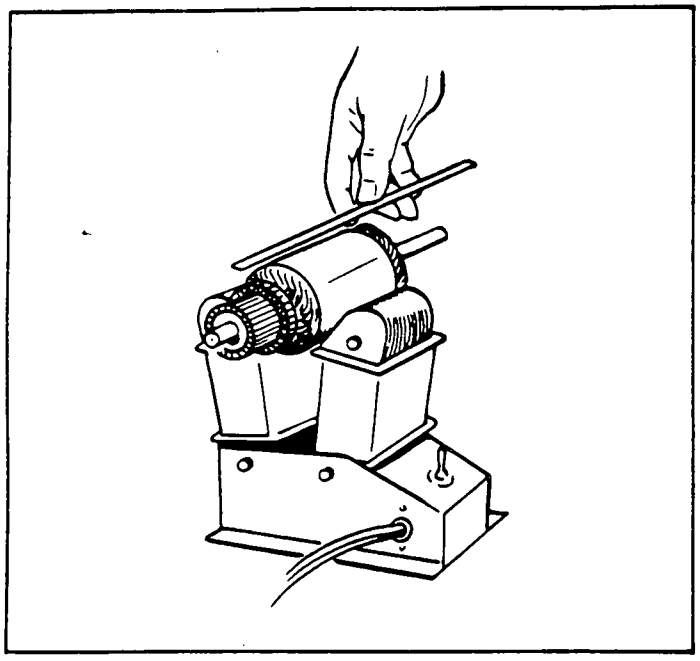

FIGURE 34. ARMATURE SHORT CIRCUIT TEST

2. **Testing Armature for Grounds.** Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads. If the ohmmeter reading is low, it indicates a grounded armature. Replace grounded armature. See Figure 35.

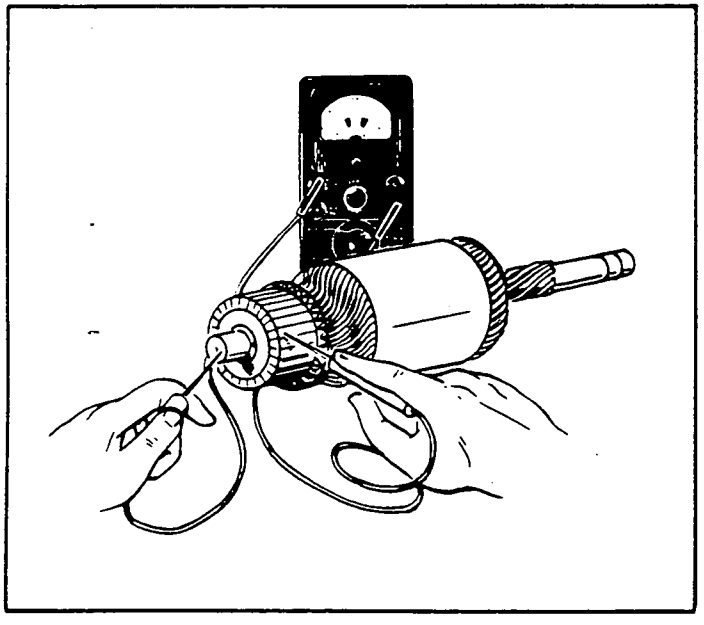

FIGURE 35. ARMATURE GROUND TEST

3. **Testing Armature for Open Circuit.** The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections.
4. **Testing Commutator Runout.** Place armature in a test bench and check runout with a dial indicator. When commutator runout exceeds .004", commutator should be refaced (Figure 36).

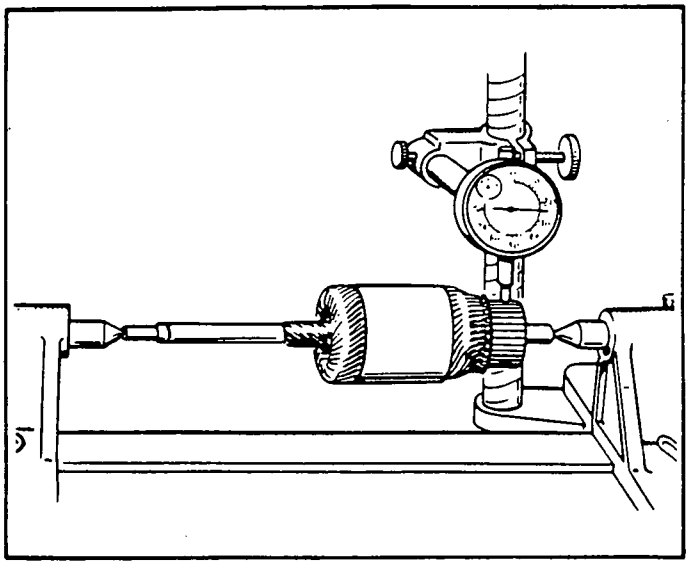

FIGURE 36. CHECKING COMMUTATOR RUNOUT

5. **Testing Armature Shaft Runout.** The armature shaft as well as the commutator may be checked. A bent armature often may be straightened, but if the shaft is worn, a new armature is required (Figure 37).

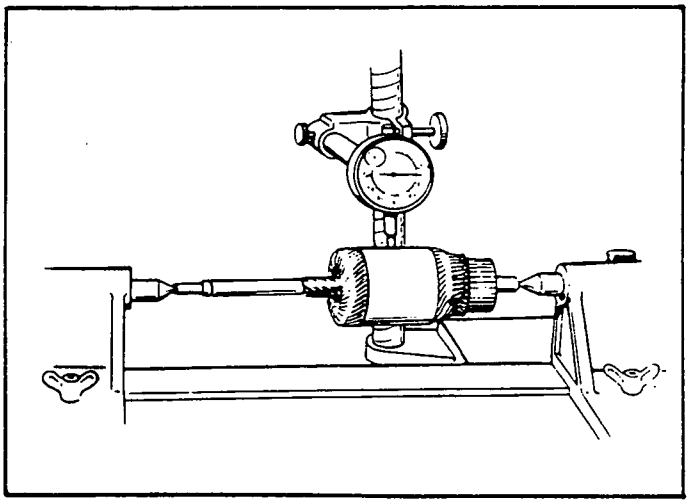

FIGURE 37. CHECKING ARMATURE SHAFT RUNOUT

6. **Testing Field Coils for Grounds.** Place one lead on the connector and the other on a clean spot on the frame after unsoldering shunt field coil wire. If the ohmmeter reading is low, the fields are grounded, either at the connector or in the windings (Figure 38).

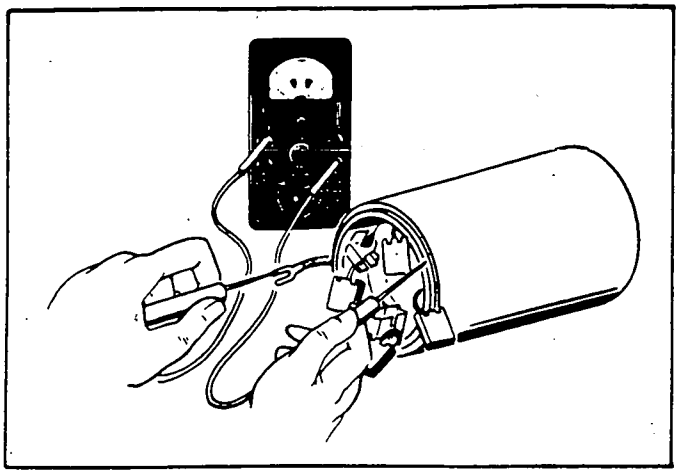

FIGURE 38. FIELD COIL GROUND TEST

7. **Testing Field Coils for Open Circuit.** Place one lead on the connector and the other on a clean spot on the brushholder. If the ohmmeter reading is high, the field coil is open. Check the other three brushholders in the same manner (Figure 39).

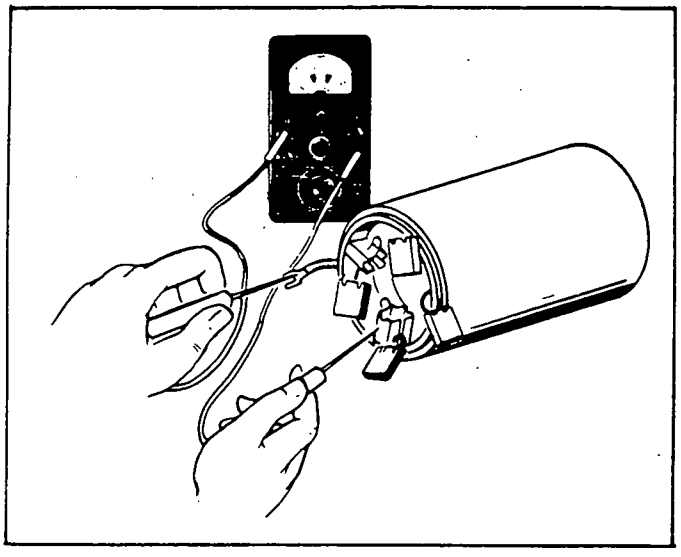

FIGURE 39. FIELD COIL OPEN CIRCUIT TEST

8. **Inspection of Brushes.** Replace brushes when they are worn less than .3" as shown in Figure 40. See that all brushes move freely in their holders.

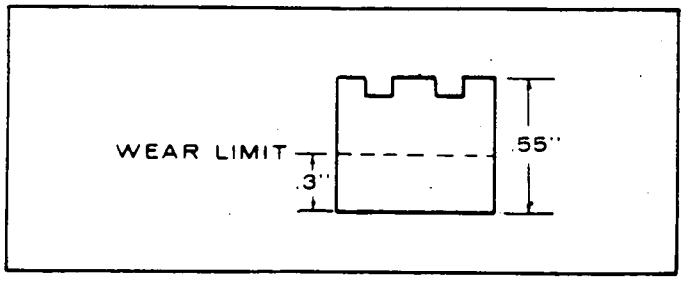

FIGURE 40. BRUSH WEAR LIMIT

9. **Inspection for Brush Spring Tension.** Measure brush spring tension with a tension meter as shown in Figure 41. Push the brush and take a reading just as the brush projects a little from the brushholder. On a new brush the spring tension should be 29 to 38 ounces.

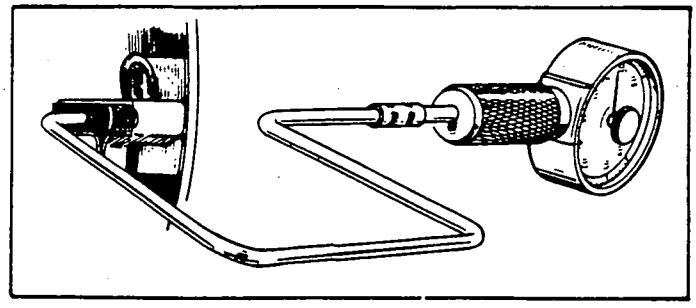

FIGURE 41. BRUSH SPRING TENSION TEST

INSPECTION AFTER OVERHAUL

1. For no load test, the starting motor is wired as shown in Figure 42 and revolved. The value of the meter reading at this condition should be as follows:

Voltage	11.5 volt
Speed	3700 rpm minimum
Current Draw	60 amp maximum

NOTE: *The conductor for this test should be large enough and as short as possible. If anything is wrong in the above test, inspect the following items:*

Annealed brush springs
Improperly seated brushes
Insufficient armature endplay
Shorted, open or grounded armature
Grounded or open field coil
Poor electrical connection
Dirty commutator

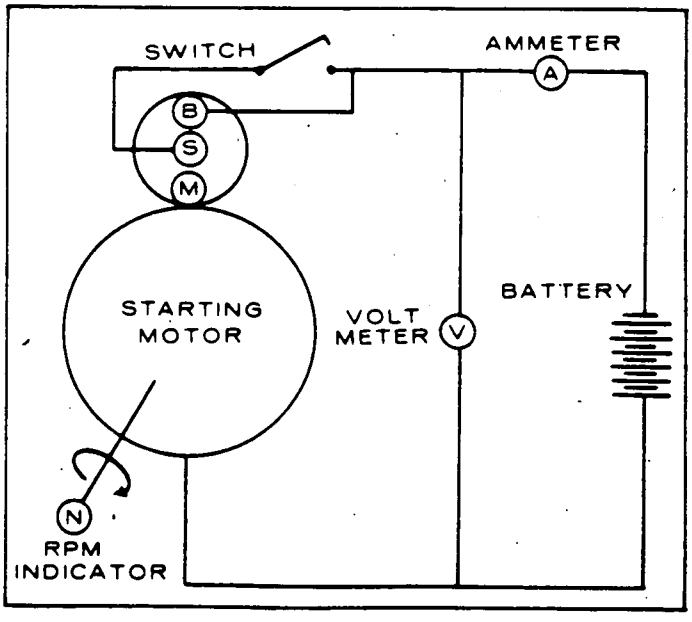

FIGURE 42. STARTING MOTOR WIRING

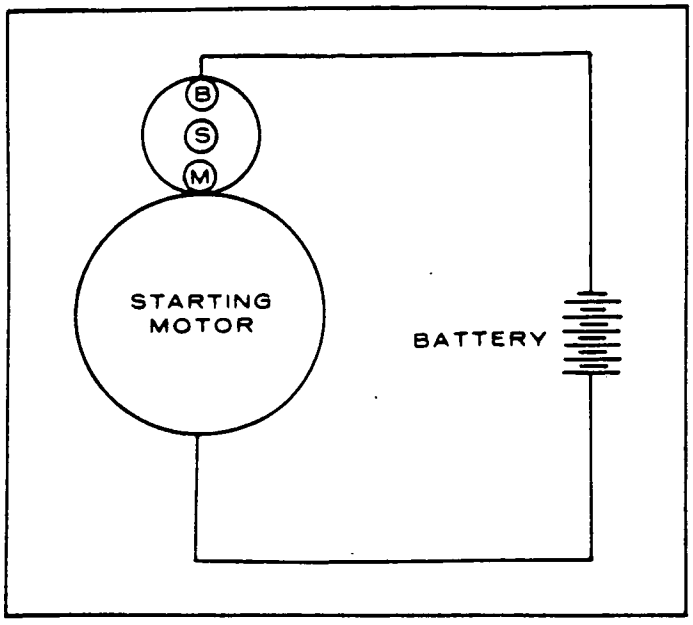

FIGURE 43. BATTERY CONNECTIONS

2. **Adjusting Pinion Clearance.** Connect the battery to the starting motor as shown in Figure 43. This will allow the pinion of the starting motor to slide and stop. In this state, measure the clearance between the end of the pinion and pinion stopper when the pinion is pushed lightly toward the commutator end. Clearance should be .02″ to .06″. Adjust for proper clearance by removing the magnetic switch attaching screws and select proper thickness of the fiber packings shown in Figure 44.

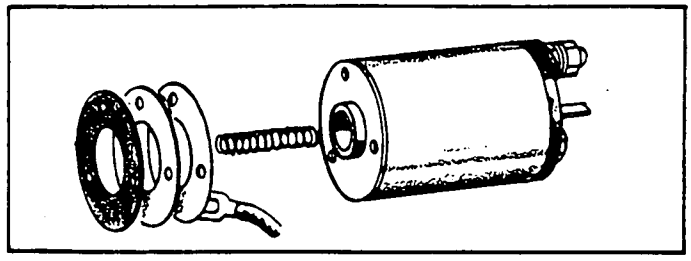

FIGURE 44. ADJUSTING PINION CLEARANCE

ENGINE DISASSEMBLY

VALVES

Proper seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44°. The valve *seat* angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life (Figure 45).

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

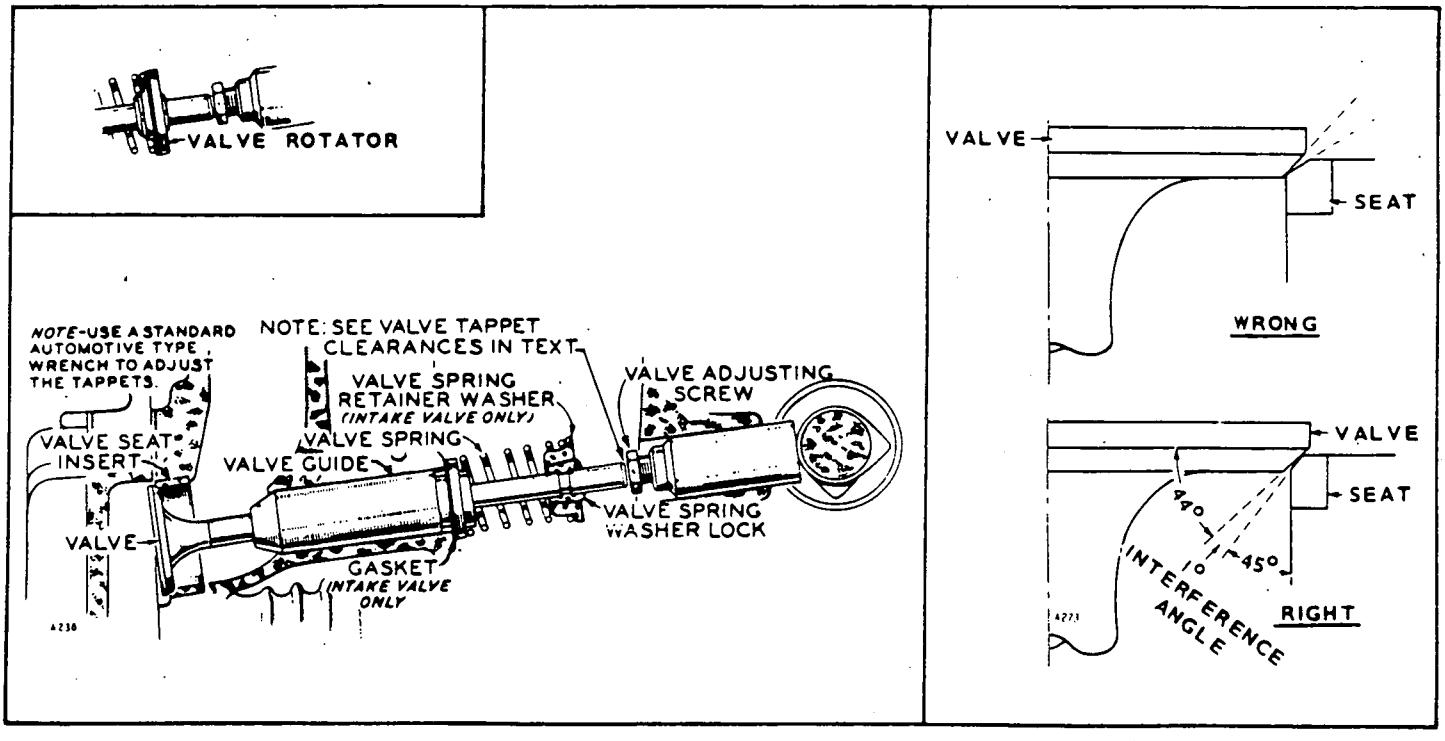

FIGURE 45. VALVE SYSTEM

Tappet Adjustment: The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 400 operating hours or when poor engine performance is noticed. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to valve tappets.
2. Remove spark plugs to make turning the engine easier.
3. Use the engine flywheel to turn the engine over slowly by hand until the left hand intake valve opens and closes. Continue turning the flywheel until the TC mark is on the top and lined up with the TC mark on the gear cover. Both valves should be closed. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder.
4. Clearances are shown in Dimensions and Clearances. For each valve, the gauge should just pass between the valve stem and valve tappet.
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.
6. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

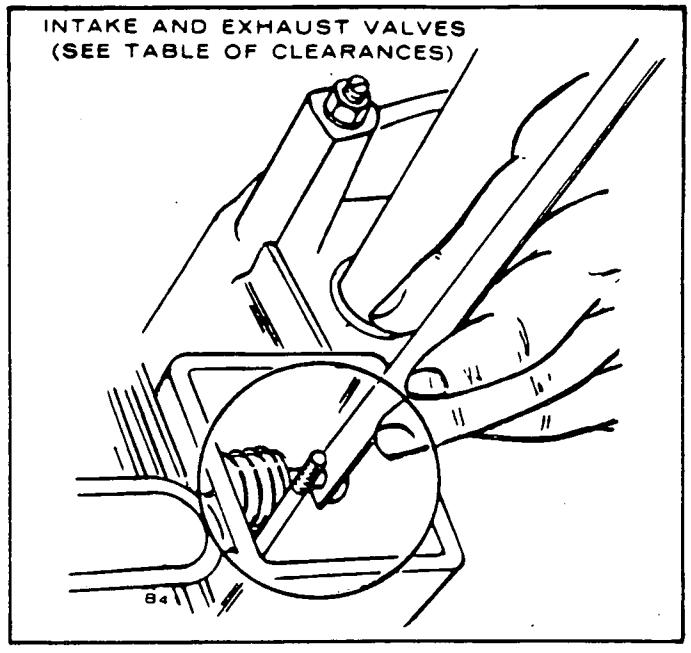

FIGURE 46. VALVE ADJUSTMENT

FLYWHEEL

Use a suitable puller (with claws or with bolts to agree with flywheel) to pull the flywheel.

Do not drop the flywheel. A broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

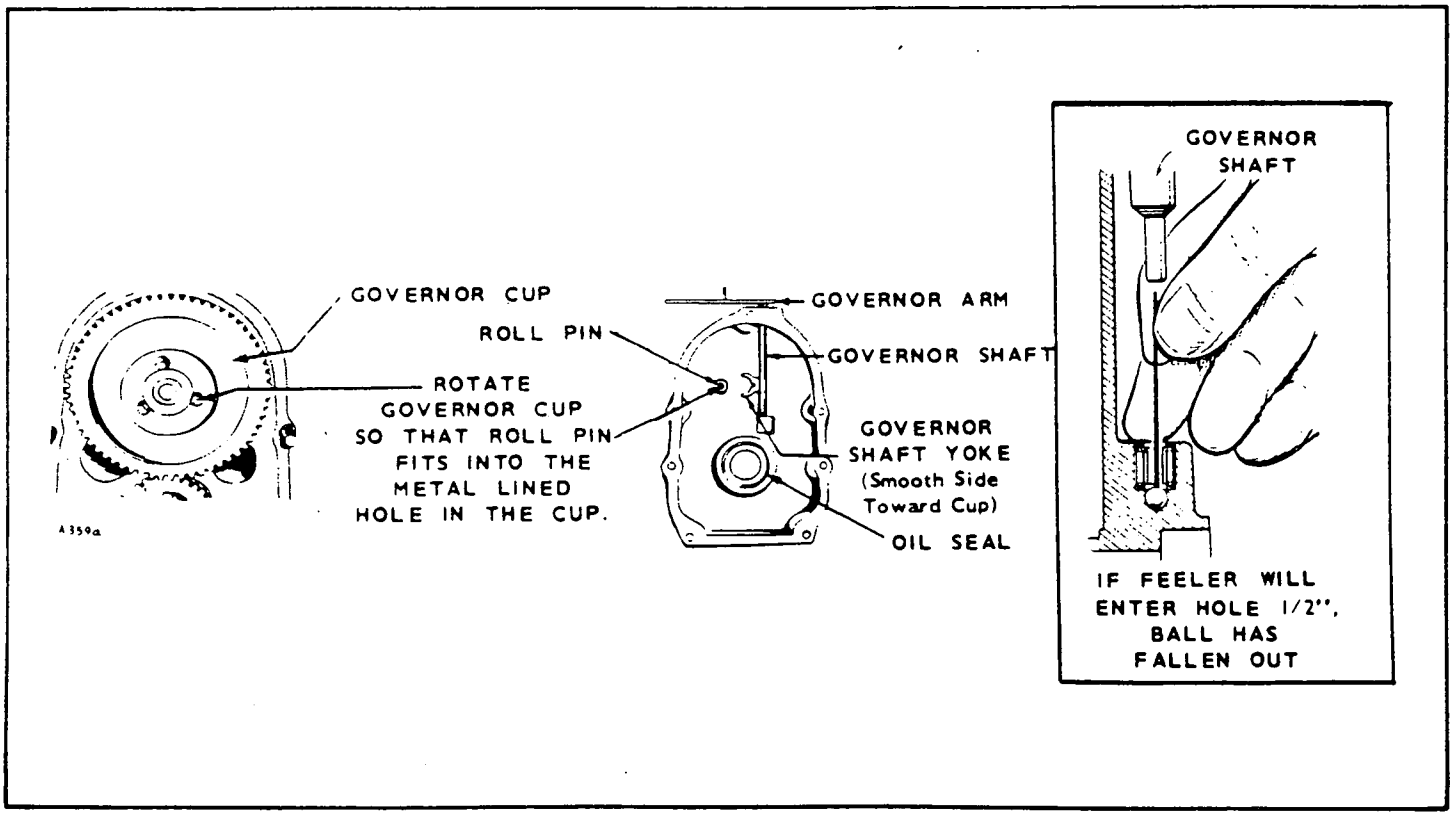

FIGURE 47. GEAR COVER ASSEMBLY

If a puller is not available turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp endwise blow on the head of the cap screw with a heavy soft-faced hammer to loosen.

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.

CAUTION *When installing the gear cover, make sure that the pin in the gear cover engages the metal lined (smooth) hole in the governor cup.*

Turn the governor cup so that the metal lined hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a point 3/4" from the cover mounting surface. See Figure 48.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off.

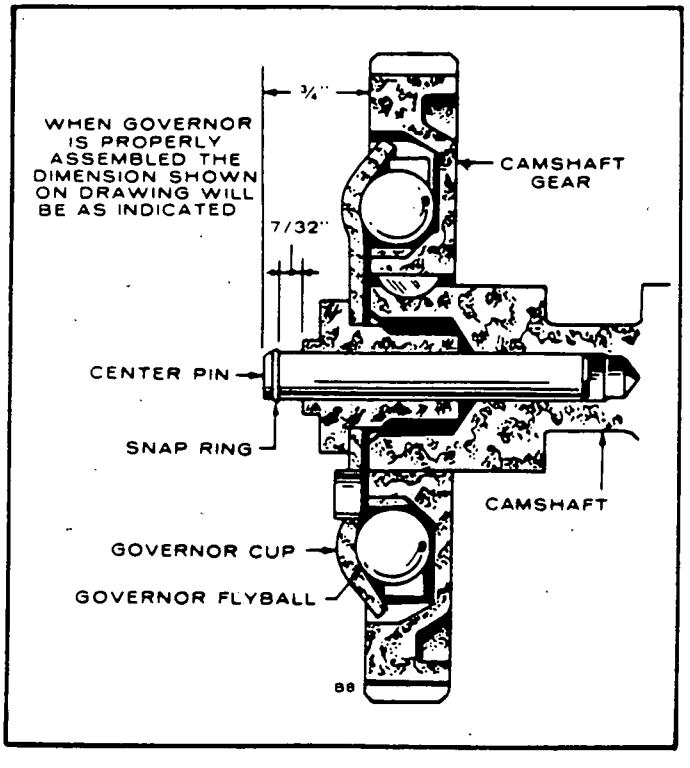

FIGURE 48. GOVERNOR CUP DETAILS

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting with a chisel. Replace the spacer with a new one. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the cup and snap ring on the center pin (Figure 48).

The camshaft center pin extends out 3/4" from the end of the camshaft. This distance provides an in and out travel distance of 7/32" for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture. See Figure 49.

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

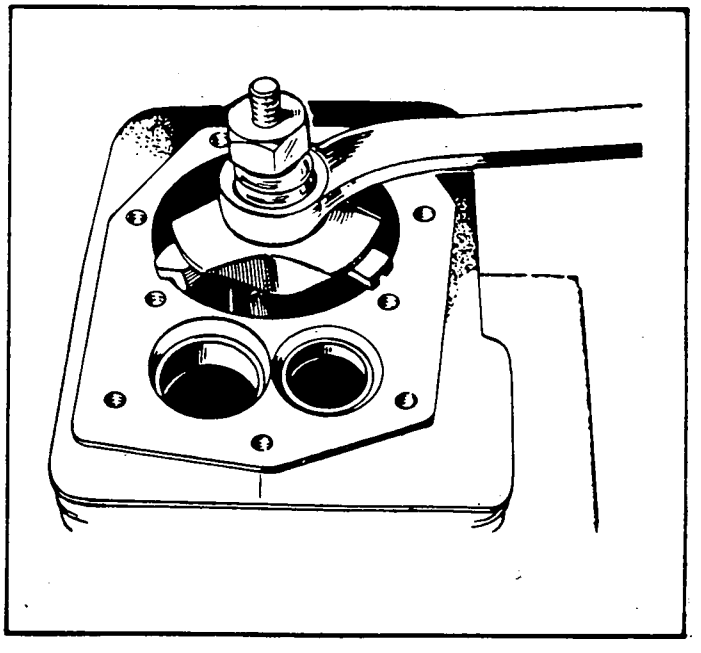

FIGURE 49. REMOVING WEAR RIDGE

NOTE: *Keep the connecting rod bearing caps and bearings with their respective rods.*

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader (Onan 420P146).

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point. All passages should be cleaned with a non-caustic solvent. Clean the rod bore and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land using new rings and a feeler gauge as shown in Figure 50. See Dimensions and Clearances for proper side clearance measurement and ring groove widths.

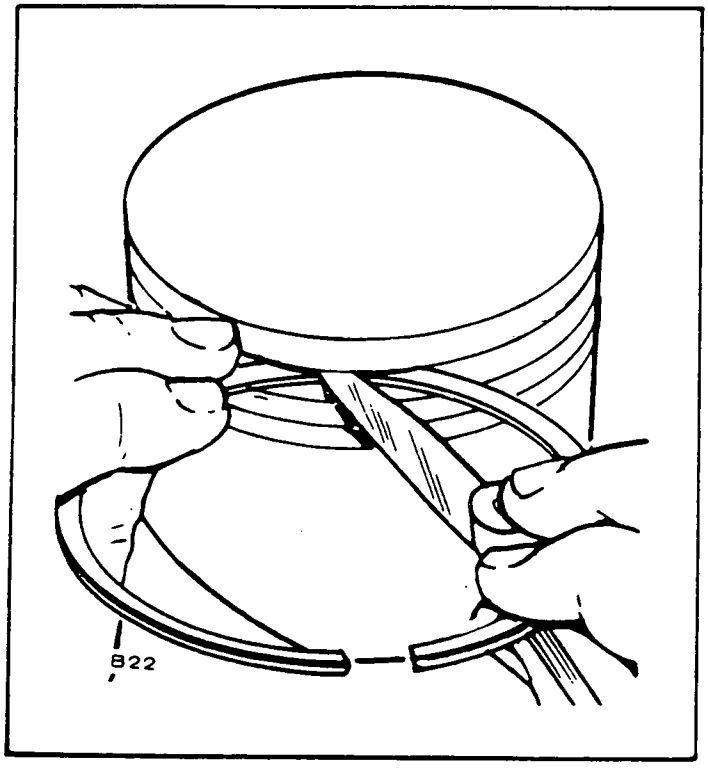

FIGURE 50. RING LAND INSPECTION

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves don't have good cylinder wall contact (Figure 51).

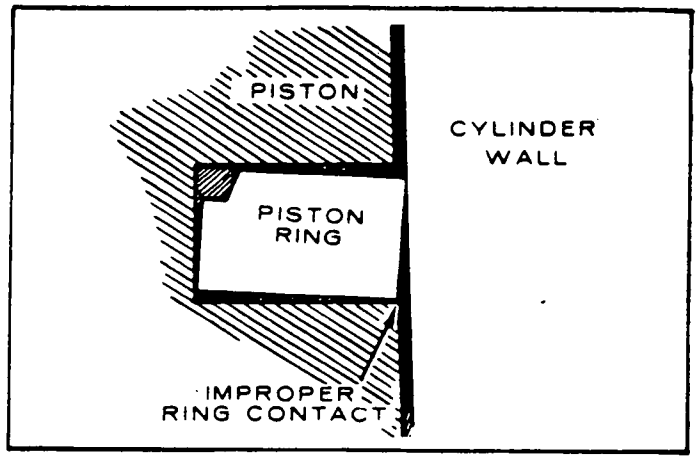

FIGURE 51. NEW RING IN WORN RING GROOVE

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002".

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in Dimensions and Clearances.

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel (Figure 52). The gap between the ends of the ring is given in Dimensions and Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on .005" oversize pistons. Rings that are .010", .020", .030" and .040" oversize are to be used on corresponding oversize pistons. Rings of the tapered type are usually marked *top* on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

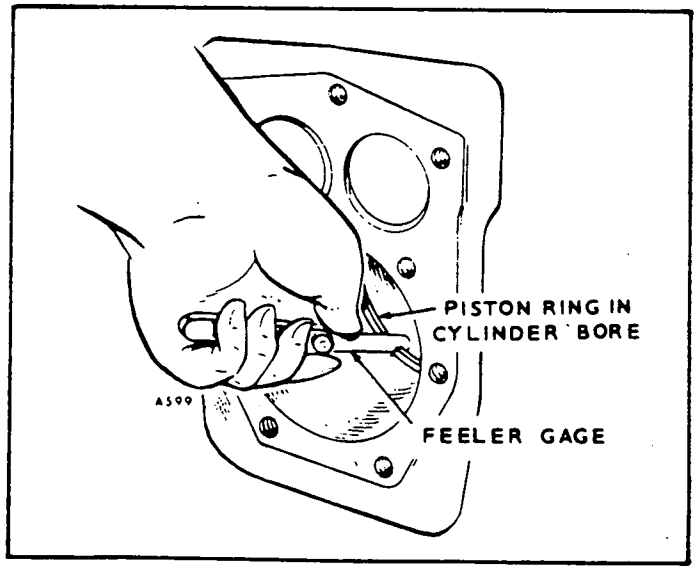

FIGURE 52. FITTING PISTON RINGS TO THE CYLINDER

Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Refer to Dimensions and Clearances for the correct piston-to-cylinder clearance.

CONNECTING RODS

The connecting rods should be serviced at the same time the pistons or rods are serviced. Rods must be removed with the piston. Replaceable bushings and bearings are used. Bearings are available in standard or .002", .010", .020" or .030" undersize.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts (forged rod), then refinish it to take the corresponding undersize bearing insert available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing (Figure 53). Use combination bearing driver 420B324 to install the camshaft bearings.

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

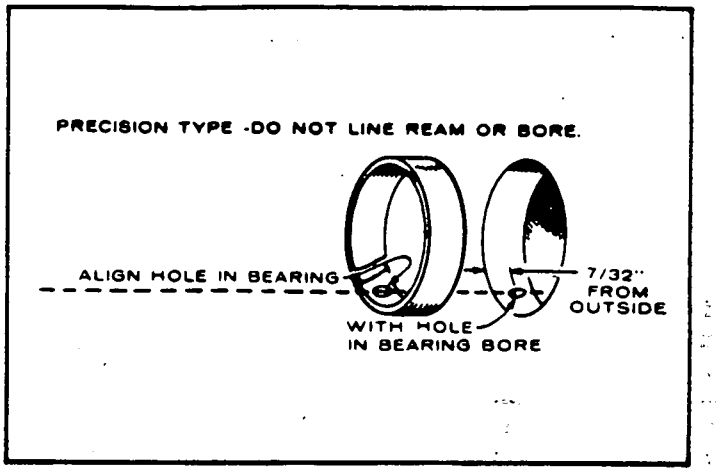

FIGURE 53. CAMSHAFT BEARING

New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard size, .002", .010", .020" or .030" undersize.

Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heater to 200°F. If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

The cold oiled precision bearing should require only light taps to position it.

NOTE: *Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 55. Do not add an additional thrust washer to this front bearing.*

In the rear bearing plate, install the bearing flush to 1/64" below the end of the bore using combination driver 420B324 (same one used for camshaft bearing). See Figure 54.

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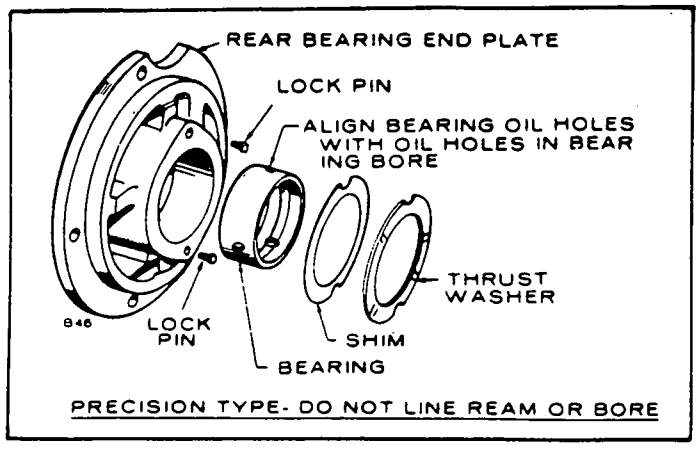

FIGURE 54. BEARINGS FOR REAR BEARING PLATE

NOTE: *If the special combination tool isn't available, it's necessary to remove the lock pins with side cutters or Easy Out tool. After the new bearings are installed, insert new lock pins.*

Before installing the front bearing (Figure 55), use the Locktite Bearing Mount furnished in the bearing kit. Use the towelette in the package to clean the outside of the bearing and the bearing bore in the block.

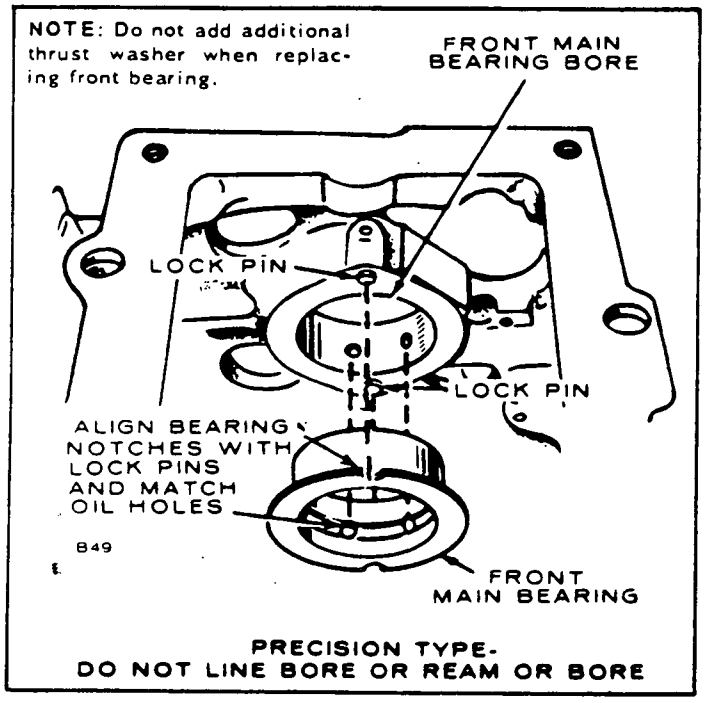

FIGURE 55. FRONT BEARING INSTALLATION

WARNING *Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well ventilated.*

After allowing three to four minutes for drying, apply the Locktite Bearing Mount from the small tube to the mating surfaces of the bearing and bearing bore. Install the bearing flush with the block using the combination driver just used for the rear bearing. Wipe off any excess Locktite around the bearing. Allow at least one hour for hardening at room temperature.

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. Line up the notches of the thrust washer with the lock pins before tightening the end plate or the lock pins will be damaged.

NOTE: *A light film of oil on the thrust washer may hold it in place while installing the crankshaft.*

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in Assembly Torques and Special Tools, check the crankshaft endplay as shown in Figure 56. If there is too much endplay (see Dimensions and Clearances for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 54) between the thrust washer and plate. Reinstall the end plate making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

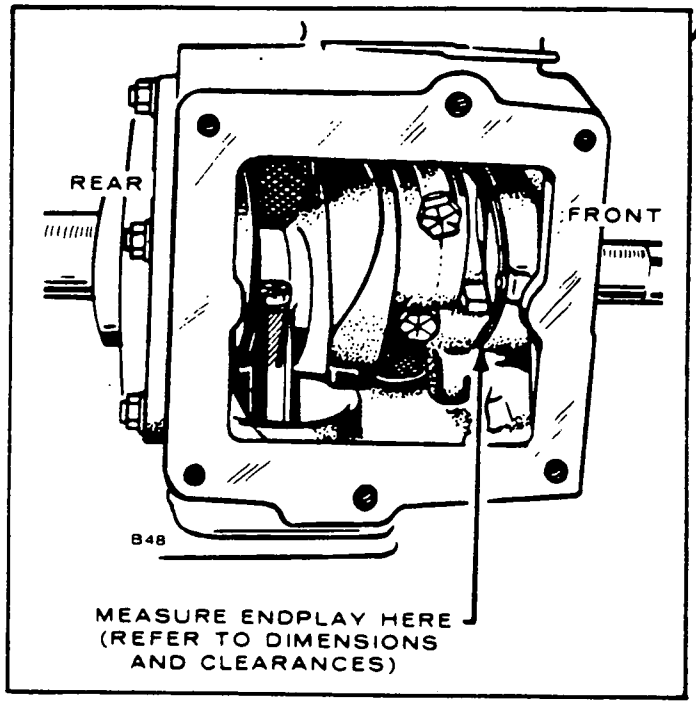

FIGURE 56. CRANKSHAFT ENDPLAY

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using bearing plate driver 420B181 and gear cover driver 420B313.

902521

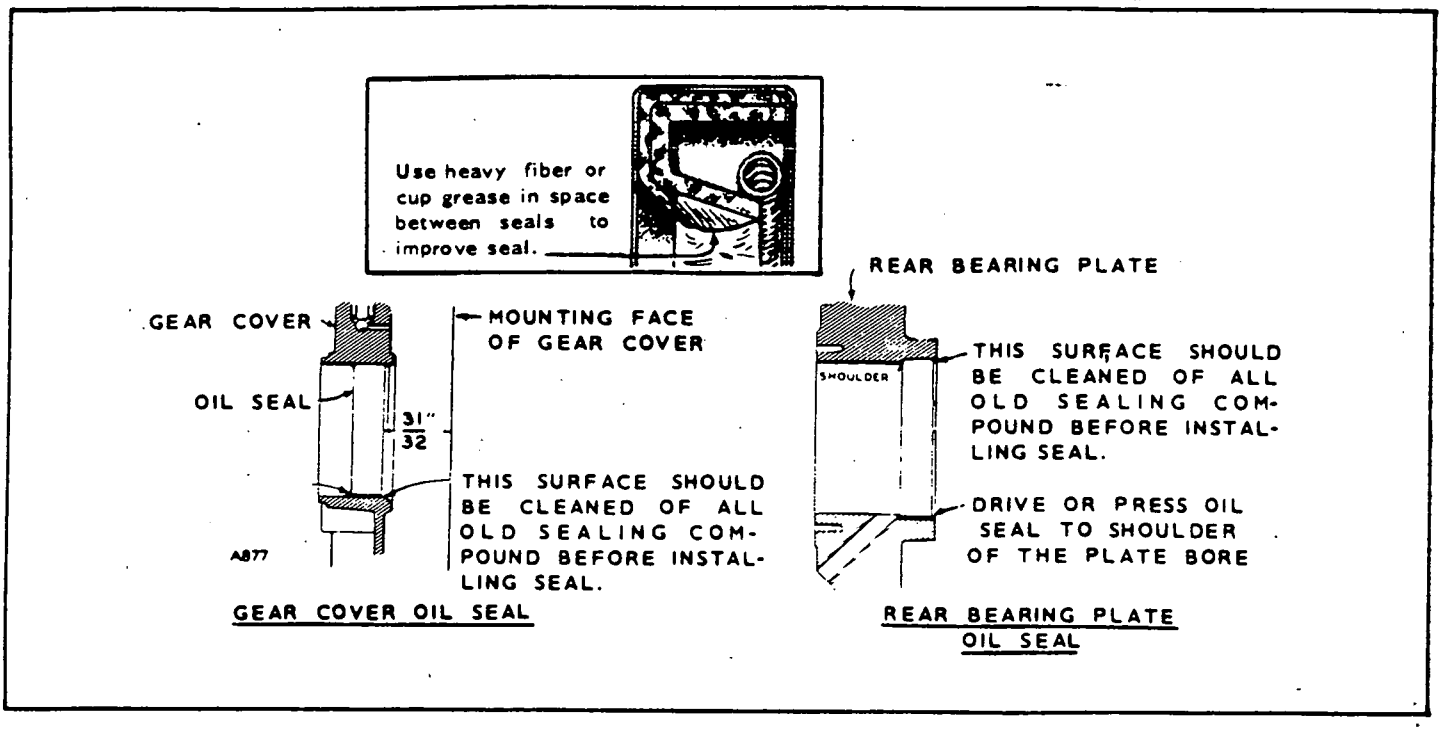

FIGURE 57. GEAR COVER AND REAR BEARING PLATE OIL SEALS

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing (see Figure 57).

When installing the gear cover oil seal, tap the seal inward until it is 31/32 of an inch from the mounting face of the cover. Install new style, thin open face seal, 1-7/64 inches from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

Engines equipped with some types of reduction gear assemblies do not use the rear oil seal. The reduction gear assembly is oiled directly from the engine crankcase. Refer to the instructions screened on the case of the reduction gear assembly.

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly as shown in Figure 58.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

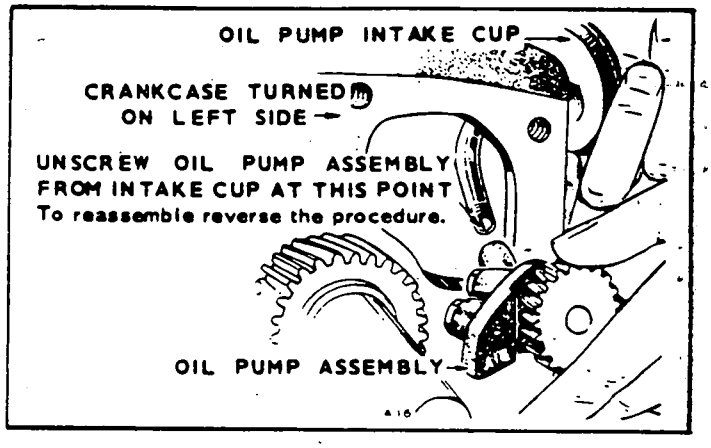

FIGURE 58. OIL PUMP ASSEMBLY

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and ring set of the available oversizes. Pistons are available in .005", .010", .020", .030" and .040" oversize. Piston rings are available in .010", .020", .030" and .040" oversize. Use standard size rings on a .005" oversize piston. If the cylinder is not being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore. Engine might be fitted at the factory with a .005" oversize piston and are so indicated by a letter E following the engine serial number stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in Dimensions and Clearances.

CYLINDER HEADS

Remove the cylinder heads for cleaning at least every 400 hours or when poor engine performance is noticed.

1. Use a 1/2 inch socket wrench to remove cylinder head bolts. Lift heads off.

   CAUTION *Do not remove heads when they are hot. Warpage may occur.*

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place heads in position and follow head torque tightening sequence shown in Figure 59. Start out tightening all bolts to 5 ft-lb, then 10 ft-lb, etc., until all bolts are torqued to 17-19 ft-lb.
5. Recheck torque before engine has run a total of 50 hours.

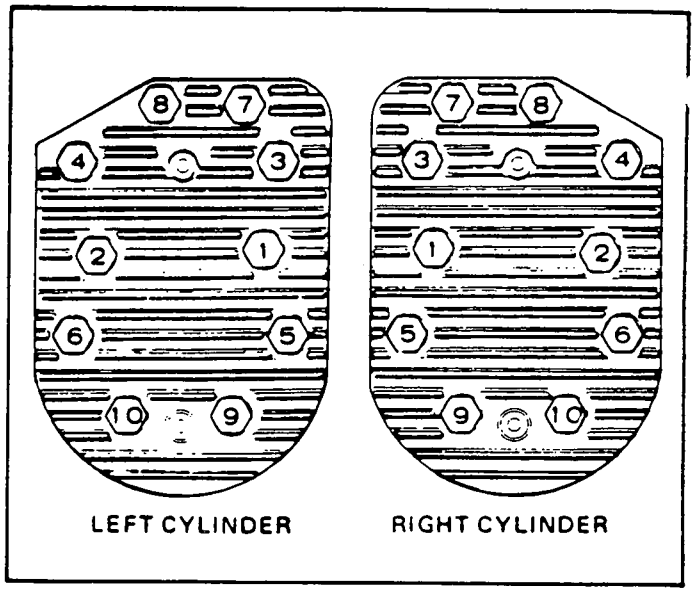

FIGURE 59. HEAD BOLT TIGHTENING SEQUENCE

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PARTS CATALOG

This catalog applies to the standard NHC Engines. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number following the illustration. Parts illustrations are typical. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left engine sides are determined by *facing* the blower end (front) of the engine.

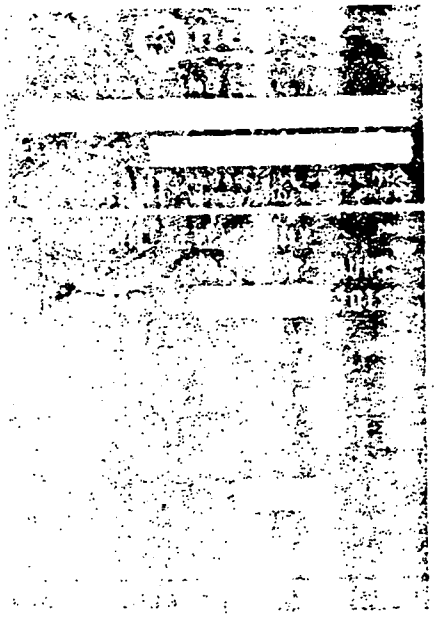
INSTRUCTIONS FOR ORDERING REPAIR PARTS

For parts or service, contact the dealer from whom you purchased this equipment or refer to your Nearest Authorized Onan Parts and Service Center.

To avoid errors or delay in filling your parts order, please furnish all information requested.

Always refer to the nameplate on your unit:

1. Always give the MODEL and SPEC NO. and SERIAL NO.

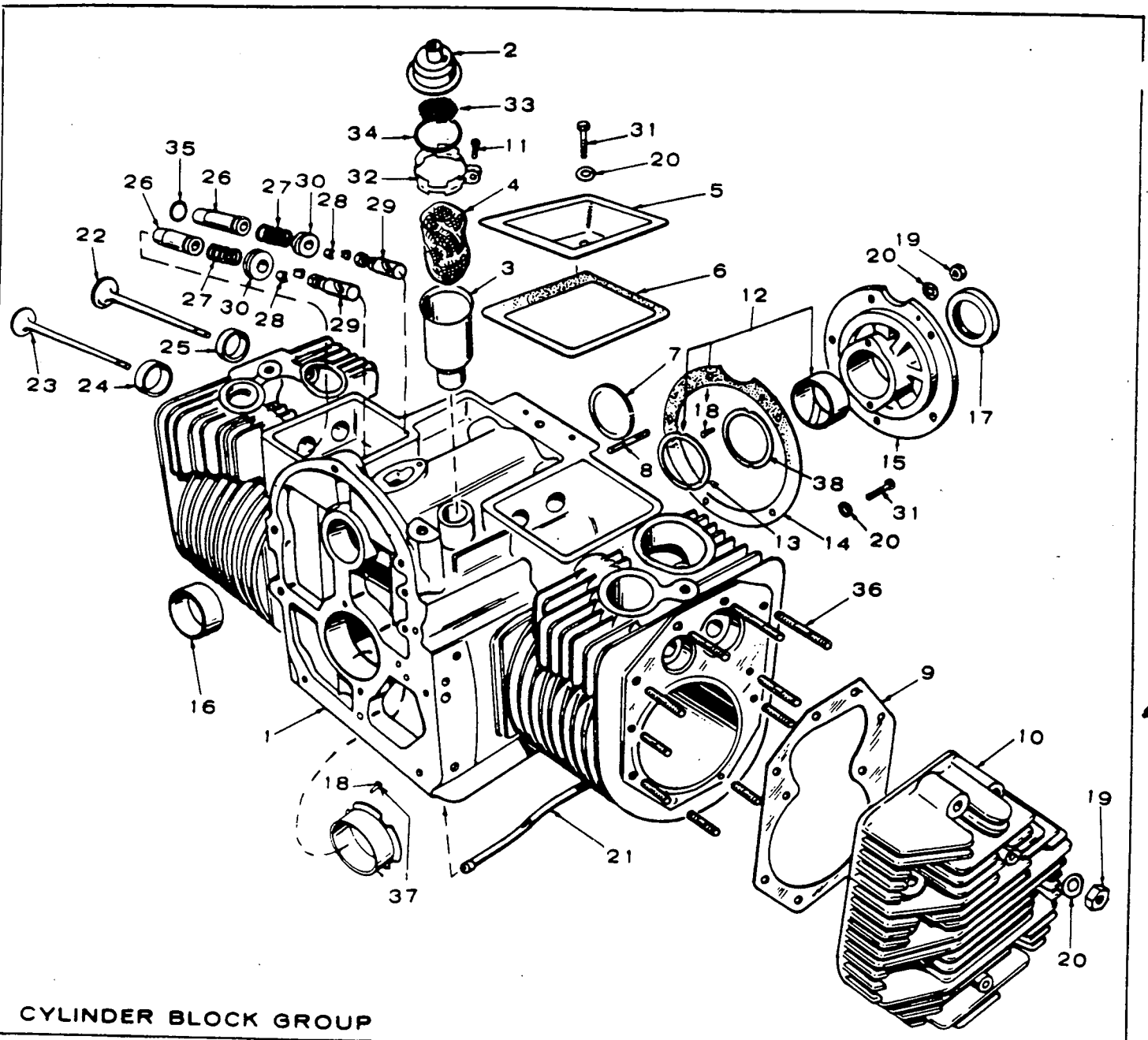


For handy reference, insert YOUR engine nameplate information in the spaces above.

2. Do not order by reference number or group number, always use part number and description.
3. Give the part number, description and quantity needed of each item. If an older part cannot be identified, return the part prepaid to your dealer or nearest AUTHORIZED SERVICE STATION. Print your name and address plainly on the package. Write a letter to the same address stating the reason for returning the part.
4. State definite shipping instructions. Any claim for loss or damage to your unit in transit should be filed promptly against the transportation company making the delivery. Shipments are complete unless the packing list indicates items are back ordered.

Prices are purposely omitted from this Parts Catalog due to the confusion resulting from fluctuating costs, import duties, sales taxes, exchange rates, etc.

For current parts prices, consult your Onan Dealer, Distributor or Parts and Service Center.



CYLINDER BLOCK GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	★	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	123A954	1	Cap & Valve, Breather
3	123A952	1	Tube, Breather
4	123P865	1	Baffle, Breather Tube
5	110A1624	2	Cover, Valve Compartment
6	110B1720	2	Gasket, Valve Cover
7	517-48	1	Plug, Camshaft Expansion
8	520A736	5	Stud, Rear Bearing Plate Mounting
9	110C1731	2	Gasket, Cylinder Head
10	HEAD, CYLINDER		
	110B1912	1	Right Side (#2)
	110B1913	1	Left Side (#1)
11	809-35	1	Screw, Breather Cap Clamp
12	BEARING, CRANKSHAFT – REAR		
	101K420	1	*Standard
	101K420-02	1	.002″ Undersize
	101K420-10	1	.010″ Undersize
	101K420-20	1	.020″ Undersize
	101K420-30	1	.030″ Undersize
13	104A575	2	£Washer, Crankshaft Bearing Thrust
14	101B415	1	Gasket, Bearing Plate
15	*PLATE, REAR BEARING (EXCLUDES BEARING)		
	101C406	1	Engines Without Reduction Gear Assembly
	101B417	1	Engines With Reduction Gear Assembly
16	101B405	2	*Bearing, Camshaft (Precision)
17	509A41	1	Seal, Bearing Plate
18	516A72	4	*Pin, Main Bearing Stop
19	NUT, HEX		
	104A91	5	Bearing Plate Mounting
	104A91	20	Cylinder Head Mounting
20	WASHER, FLAT		
	526-63	2	Valve Compartment Mounting (1/4″ Copper)

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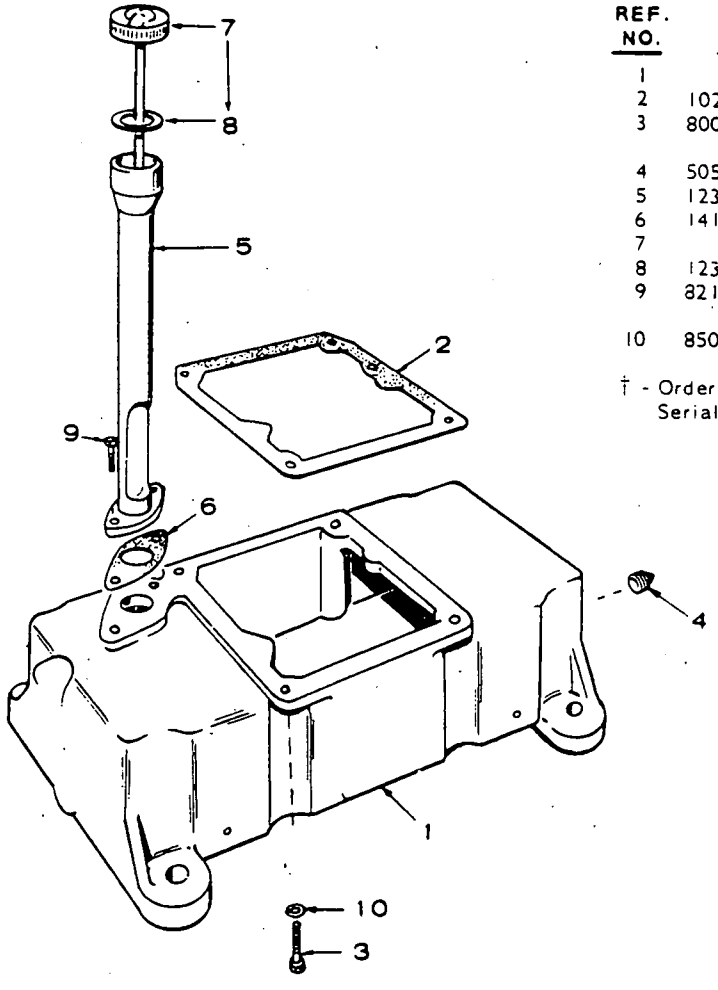
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	526A250	20	Cylinder Head Mounting (3/8)
	526-251	5	Bearing Plate Mounting (3/8)
	526-66	2	Cylinder Block (3/8" Copper)
21	120B680	1	*Tube, Crankcase Oil
22	110B1756	2	Valve, Intake (Stellite)
23	110B1719	2	Valve, Exhaust (Stellite)
24	INSERT, EXHAUST VALVE SEAT (STELLITE)		
	110A1716	2	*Standard
	110A1716-02	2	.002" Oversize
	110A1716-05	2	.005" Oversize
	110A1716-10	2	.010" Oversize
	110A1716-25	2	.025" Oversize
25	INSERT, INTAKE VALVE SEAT		
	110A1932	2	*Standard
	110A1932-02	2	.002" Oversize
	110A1932-05	2	.005" Oversize
	110A1932-10	2	.010" Oversize
	110A1932-25	2	.025" Oversize
26	GUIDE, VALVE		
	110A1939	4	*Standard
	110A1939-01	4	.001" Oversize
27	110A539	4	Spring, Valve
28	110A639	8	Lock, Valve & Spring
29	TAPPET, VALVE		
	115A6	4	Standard
	115A6-05	4	.005" Oversize

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
30	110A904	4	Rotocap
31	SCREW, HEX CAP		
	800-11	2	Valve Box Cover Mounting (1/4-20 x 2")
	806-27	2	Cylinder Block (3/8-16 x 3/4")
32	123A951	1	Clamp, Breather Tube Cap
33	123A958	1	Screen, Breather Tube
34	509-117	1	Seal, "O" Ring - Breather Tube
35	110A68	2	*Gasket, Valve Guide (Intake)
36	STUD, CYLINDER HEAD MOUNTING		
	520A717	8	3/8 x 1-7/8"
	520A773	12	3/8 x 2-5/16"
37	BEARING, CRANKSHAFT – FRONT		
	101K432	1	*Standard
	101K432-02	1	.002" Undersize
	101K432-10	1	.010" Undersize
	101K432-20	1	.020" Undersize
	101K432-30	1	.030" Undersize
38	104A776	As Req.	Shim (.005") - Crankshaft Thrust

★ - Order by description, giving complete Model, Spec and Serial Number.
* - Included in Cylinder Block Assembly.
£ - Use one only with rear bearing on units with flange type front bearing.

OIL BASE GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	†	1	Base, Oil
2	102B646	1	Gasket, Oil Base
3	800-51	4	Screw (3/8-16 x 1-1/4"), Oil Base to Block
4	505-56	1	Plug, Oil Drain (1/2)
5	123B1117	1	Tube, Oil Fill
6	141B78	1	Gasket, Oil Fill Tube Mounting
7	†	1	Cap & Indicator, Oil Fill
8	123A191	1	Gasket, Oil Fill Cap
9	821-18	2	Screw, Hex Cap - Oil Fill Tube Mounting
10	850-50	4	Washer, Lock - Oil Base Mounting

† - Order by description, giving complete Model, Spec and Serial Number.

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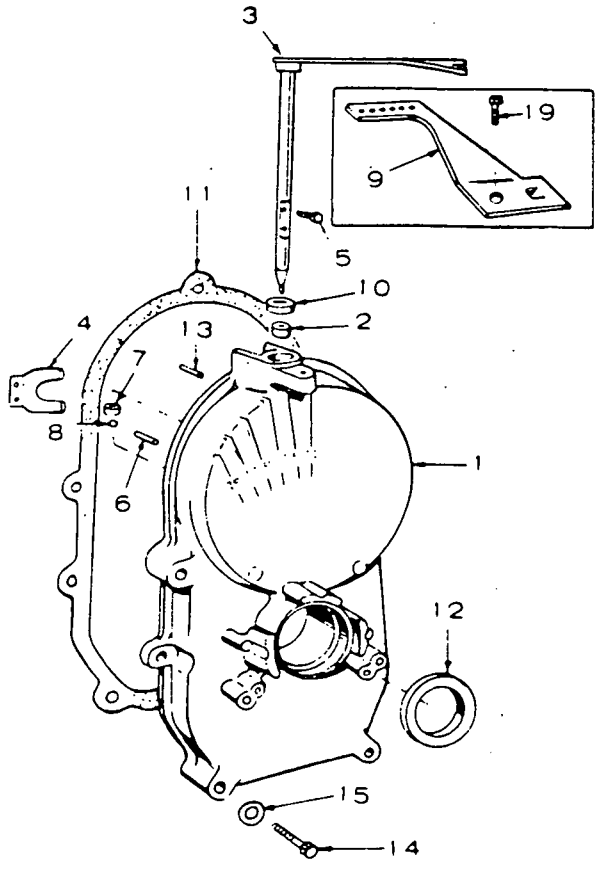
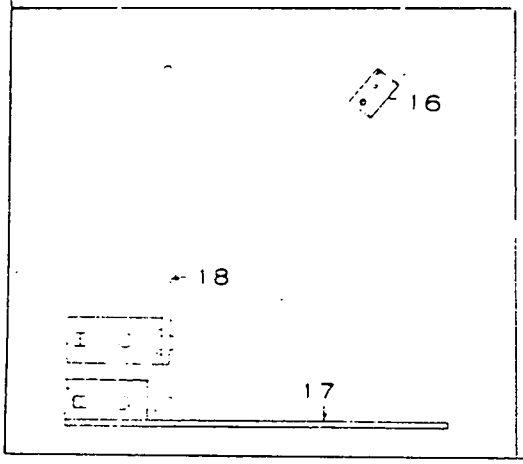
GEAR COVER GROUP





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	COVER ASSEMBLY, GEAR		
	103A386	1	Standard Governor (Drilled and Tapped for Flywheel Alternator Models) - Includes Parts Marked *
	103A387	1	Manual Throttle Controlled Engines - Includes Oil Seal (Drilled and Tapped for Flywheel Alternator Models)
2	510P13	1	*Bearing, Governor Shaft (Upper)
3	150B1260	1	*Shaft & Arm, Governor
4	150B1187	1	*Yoke, Governor Shaft
5	815-46	2	*Screw, Yoke Mounting
6	516-130	1	*Pin, Governor Cup Stop (In Gear Cover)
7	510A8	1	*Bearing, Governor Shaft (Lower)
8	510P 4	1	*Ball, Bearing - Governor Shaft
9	150B1073	1	Extension, Governor Arm
10	509P9	1	*Seal, Oil
11	103B11	1	Gasket, Gear Cover
12	509A40	1	*Seal, Gear Cover
13	516-[illegible]	2	Pin, Gear Cover (5/16 x 1-1/8")
14	SCREW, HEX CAP		
	800-32	4	Gear Cover Mounting (5/16-18 x 1-3/4")
	800-34	[illegible]	Gear Cover Mounting (5/16-18 x 2-1/4")
15	526-65	5	Washer (Copper), Flat - Gear Cover Mounting
	ARM, GOVERNOR PULL – CONSTANT SPEED GOVERNOR – OPTIONAL		
16	150A1268	1	Rear Pull
17	150A1255	[illegible]	Front Pull
18	150A1252	[illegible]	Rear Pull
19	815-[illegible]	[illegible]	Screw, Governor Arm Extension Mounting

* - Included in Gear Cover Assembly.

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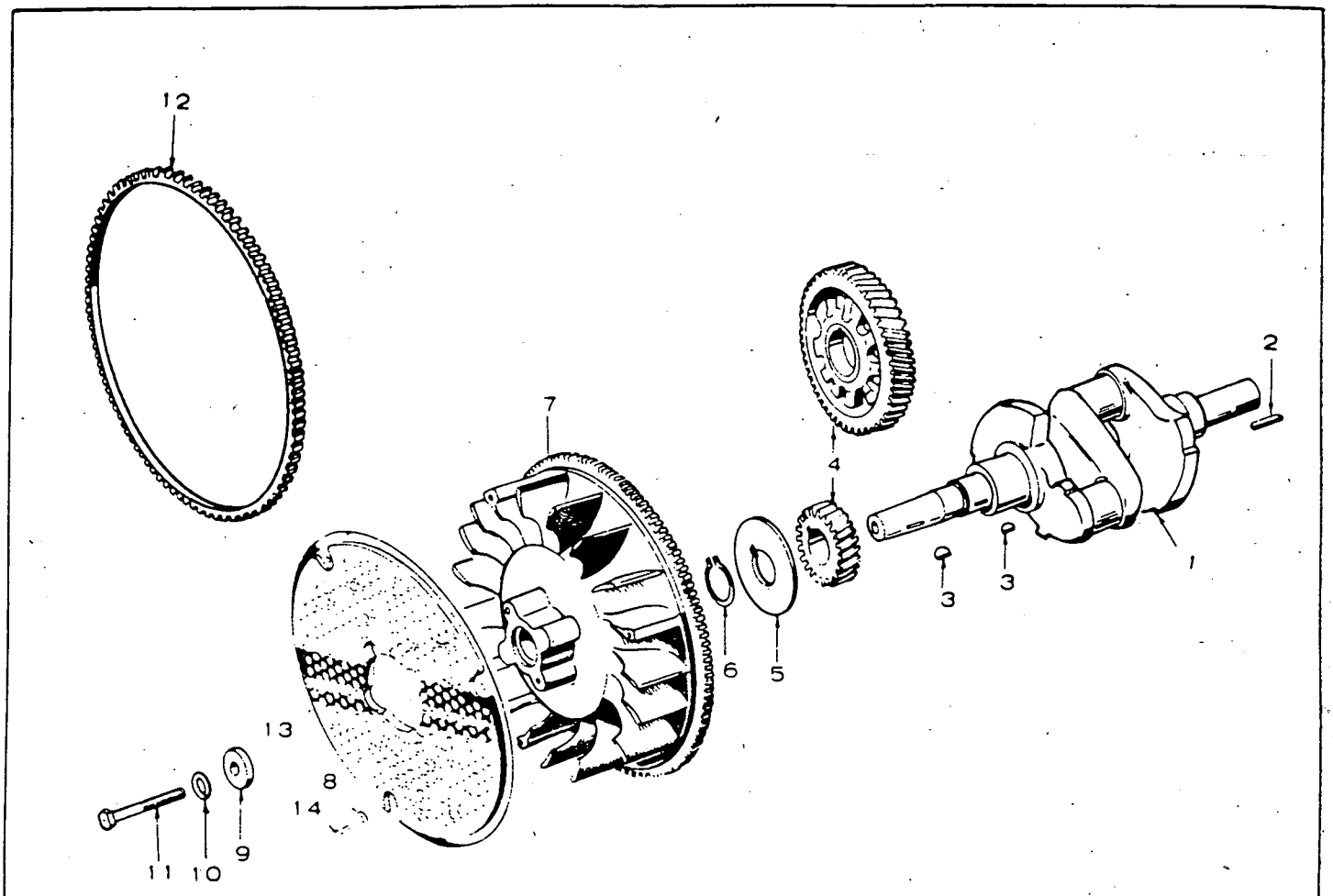

CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	*	1	Crankshaft
2	515A198	1	Key, Crankshaft Stub
3	KEY		
	515-1	1	Crankshaft Gear Mounting
	515-2	1	Flywheel Mounting
4	105A353	1	Gear Set, Timing (1 Each Crankshaft & Camshaft Gears With Flyball Spacer & Plate)
5	104A43	1	Washer, Crankshaft Gear Retaining
6	518P14	1	Lock, Crankshaft Gear Washer
7	FLYWHEEL ASSEMBLY		
	134B2530	1	Standard Units (Includes Ring Gear)
	134C2462	1	Units with Flywheel Alternator System (Includes Ring Gear and Magnet Ring) - Optional
8	526-18	3	Washer, Flat - Guard Mounting
9	526A122	1	Washer, Flywheel Mounting
10	850-55	1	Washer, Lock - Flywheel Mtg.
11	104A170	1	Screw, Flywheel Mounting
12	134C673	1	Gear, Ring - Flywheel
13	134B2433	1	Guard, Blower Wheel
14	821-10	3	Screw, Guard Mounting

* - Order by description, giving complete Model, Spec and Serial Number.

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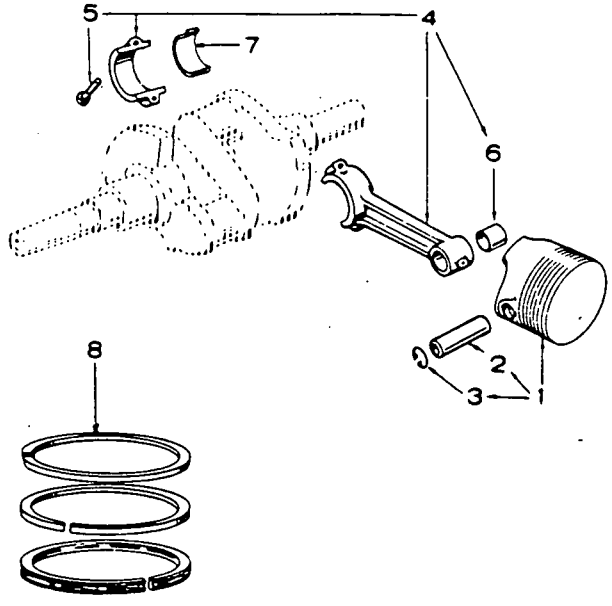
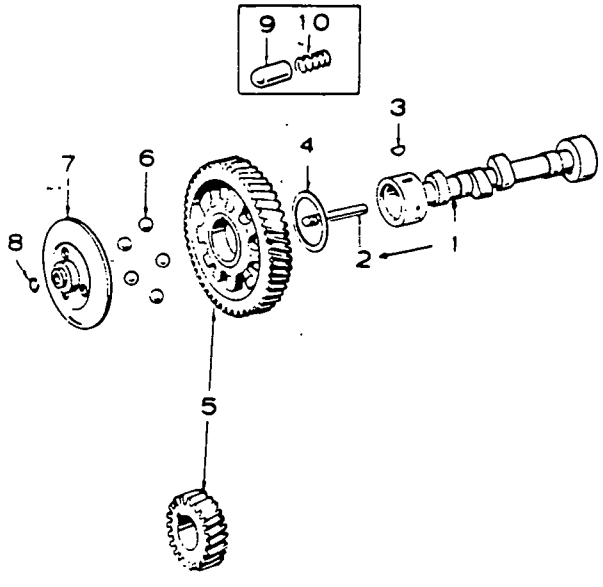
PISTON AND CONNECTING ROD GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	PISTON AND PIN (INCLUDES RETAINING RINGS)		
	112-111	2	Standard
	112-111-05	2	.005" Oversize
	112-111-10	2	.010" Oversize
	112-111-20	2	.020" Oversize
	112-111-30	2	.030" Oversize
	112-111-40	2	.040" Oversize
2	PIN, PISTON		
	112-112	2	Standard
	112-112-02	2	.002" Oversize
3	518P294	4	Ring, Piston Pin Retaining
4	114C203	2	Rod, Connecting (Includes Bushing & Bolts)
5	805A10	4	Bolt, Place-Connecting Rod Cap
6	114A36	2	Bushing, Piston Pin-Connecting Rod
7	BEARING HALF, CONNECTING ROD		
	114B188	4	Standard
	114B188-02	4	.002" Undersize
	114B188-10	4	.010" Undersize
	114B188-20	4	.020" Undersize
	114B188-30	4	.030" Undersize
8	RING SET, PISTON		
	113A165	2	Standard
	113A165-05	2	.005" Oversize
	113A165-10	2	.010" Oversize
	113A165-20	2	.020" Oversize
	113A165-30	2	.030" Oversize
	113A165-40	2	.040" Oversize

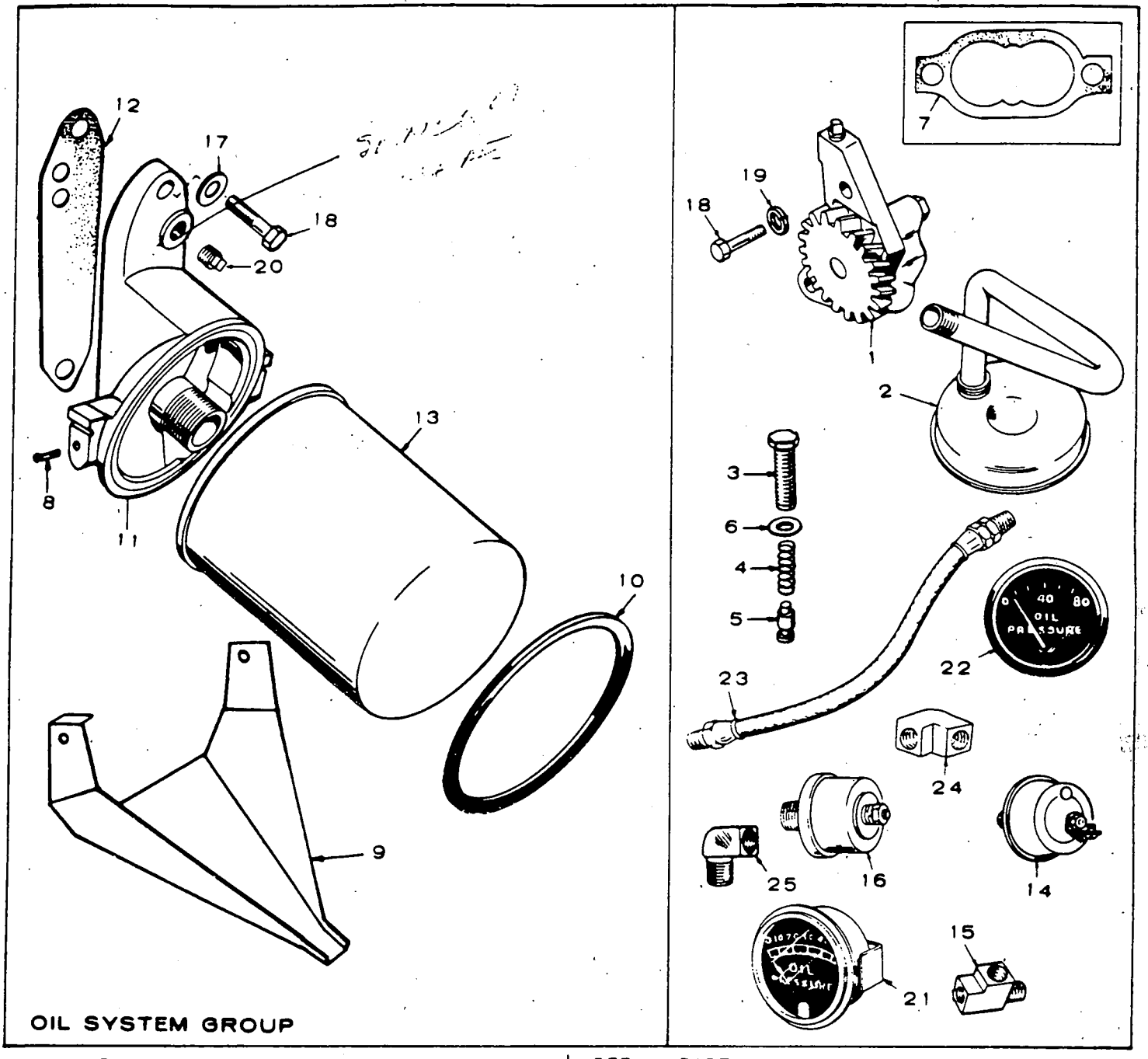


CAMSHAFT GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	CAMSHAFT		
	105B382	1	Governor Controlled Engine (Includes Center Pin)
	*	1	Manually Controlled Engine
2	150A75	1	Pin, Center-Camshaft
3	515-1	1	Key, Camshaft Gear Mounting
4	105A4	1	Washer, Camshaft Gear Thrust
5	105A353	1	Gear Set, Timing-1 Each Crankshaft & Camshaft Gears (Includes Flyball Spacer & Plate)
6	510-15	5	Ball, Fly-Governor
7	150A612	1	Cup, Governor Flyballs
8	150A78	1	Ring, Camshaft Center Pin
9	105A58	1	Plunger, Camshaft Thrust (Manually Controlled Engine)
10	105A59	1	Spring, Camshaft Plunger (Manually Controlled Engine)

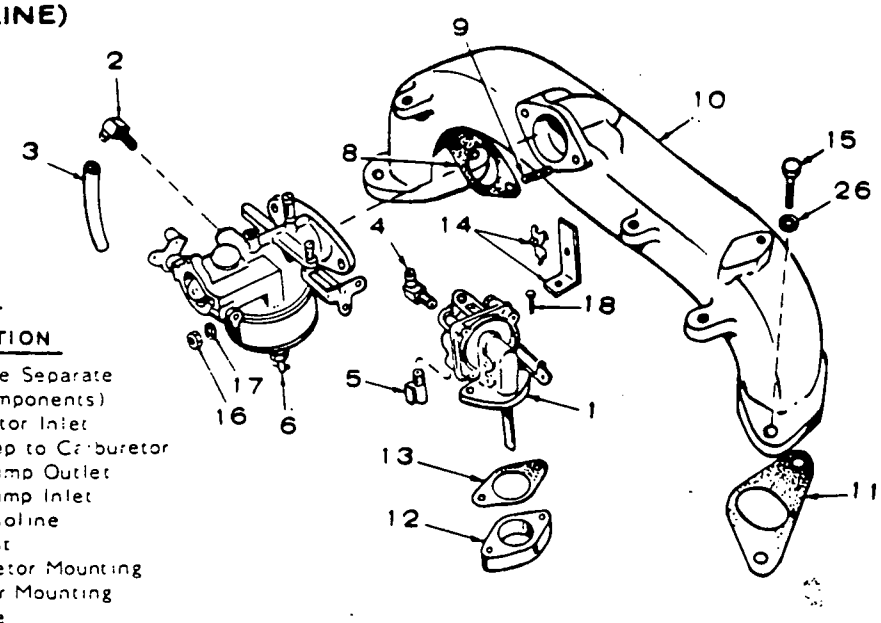
* - Order by description, giving complete Model, Spec and Serial Number.



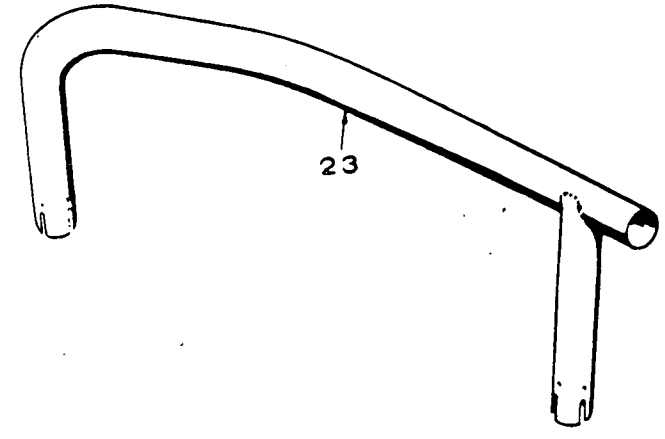
OIL SYSTEM GROUP

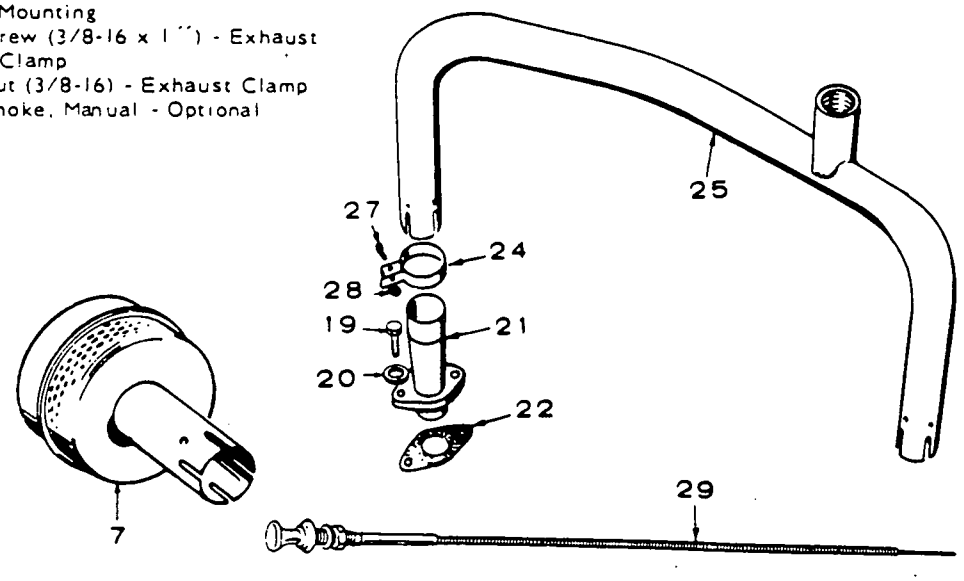
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120A491	1	Pump, Oil (Components Not Sold Separately)
2	120B691	1	Intake, Oil Pump - Includes Cup, Screen & Pipe
3	801-50	1	Screw, Hex Head - By-Pass
4	120A140	1	Spring, By-Pass Valve
5	120A398	1	Valve, By-Pass
6	526-66	1	Washer, Oil Pressure Relief Valve Screw
7	120K161	1	Gasket Kit, Oil Pump
8	815A194	2	Screw (10-32 x 3/8") - Oil Drain Mounting
9	122C352	1	Drain, Oil Filter
10	122A347	1	Seal, Oil Filter (Air)
11	122A363	1	Adapter, Oil Filter
12	122A321	1	Gasket, Adapter
13	122B323	1	Filter, Oil
14	309A10	1	Switch, Low Oil Pressure - Optional
15	502-58	1	Tee, Low Oil Pressure Switch - Optional
16	193-108	1	Sender, Oil Pressure - Optional
17	526-65	2	Washer, Flat (Copper) - Adapter Mounting
18	SCREW, HEX CAP		
	800-28	2	Adapter Mounting (5/16-18 x 1")
	800-7	2	Oil Pump Mounting (1/4-20 x 1")
19	850-40	2	Washer, Lock - Oil Pump Mounting
20	505-57	1	Plug (1/8")
21	193A68	1	Gauge, Oil Pressure - Optional
22	193-107	1	Gauge, Oil Pressure (Electric) - Optional
23	501A4	1	Line, Oil - Optional
24	502-5	1	Elbow, Oil Line to Gauge - Opt.
25	502-20	1	Elbow, Oil Line to Cylinder Block - Optional

FUEL SYSTEM GROUP (GASOLINE)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	149D1223	1	Pump, Fuel (See Separate Group for Components)
2	502-313	1	Elbow, Carburetor Inlet
3	149A1228	1	Line, Fuel Pump to Carburetor
4	502-313	1	Elbow, Fuel Pump Outlet
5	502-2	1	Elbow, Fuel Pump Inlet
6	141D802	1	Carburetor, Gasoline
7	155B1217	2	Muffler, Exhaust
8	141A281	1	Gasket, Carburetor Mounting
9	520A526	2	Stud, Carburetor Mounting
10	154C1466	1	Manifold, Intake
11	154A1483	2	Gasket, Intake Manifold to Cylinder Block
12	149A45	1	Spacer, Fuel Pump Mounting
13	149A3	2	Gasket, Fuel Pump Mounting
14	153-263	1	Bracket & Clamp, Manual Choke - Optional
15	800A538	4	Screw 3/8-16 x 1-1/2", Intake Manifold Mounting
16	868-2	2	Nut, Hex (Jam) - Carburetor Mounting
17	854-17	2	Washer, Shakeproof - Carburetor Mounting
18	806-9	2	Screw, Fuel Pump Mounting
19	800P512	4	Screw (5/16-18 x 1") - Exhaust Adapter Mounting
20	850-45	4	Washer, Lock (5/16")
21	154B1484	2	Adapter, Exhaust Manifold
22	154A1482	2	Gasket, Exhaust Manifold Adapter
23	154D1492	1	Manifold, Exhaust - High Profile (Right or Left Outlet) - Opt.
24	155P1219	2	Clamp, Exhaust Manifold
25	154C1493	1	Manifold, Exhaust - High Profile (Top Outlet) - Optional
26	850-50	4	Washer, Lock - Intake Manifold Mounting
27	805A18	2	Screw (3/8-16 x 1") - Exhaust Clamp
28	862-3	2	Nut (3/8-16) - Exhaust Clamp
29	153B97	1	Choke, Manual - Optional





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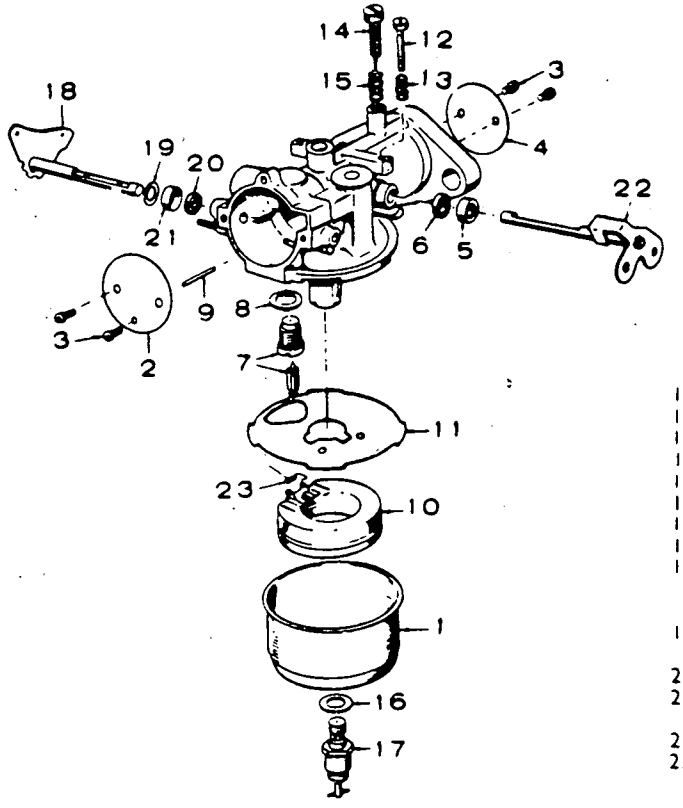
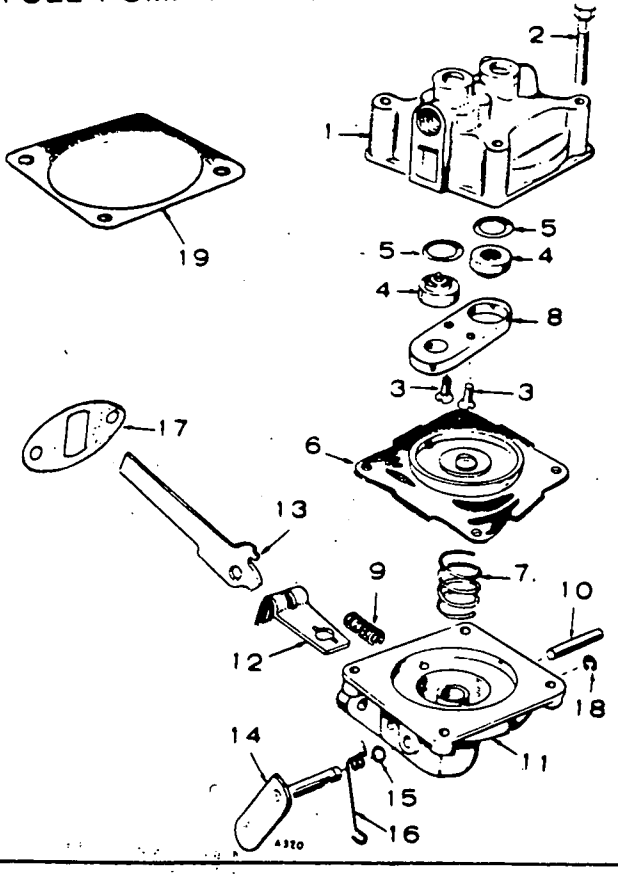
CARBURETOR PARTS GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	CARBURETOR, GASOLINE		
	141D802	1	Manual Choke
	141D803	1	Electric Choke
	141P814	1	Repair Kit (Includes Parts Marked •)
	141K748	1	Gasket Kit (Includes Parts Marked ▲)
	141A281	1	•▲Gasket, Carburetor Flange
1	141P708	1	Bowl, Fuel
2	141P741	1	Plate, Choke
3	141P698	4	Screw & Washer, Choke & Throttle Plate Mounting
4	141-813	1	Plate, Throttle
5	141P705	1	•Retainer, Seal
6	141-661	1	•▲Seal, Rubber
7	141P798	1	•Valve, Seat Assembly, Fuel
8	141-811	1	Washer, Fuel Valve Seat
9	141P703	1	•Shaft, Float
10	141P702	1	Float Assembly
11	141P701	1	•▲Gasket, Bowl to Body
12	141P700	1	Screw, Throttle Stop
13	141P711	1	Spring, Throttle Stop
14	141P713	1	•Needle, Idle Adjusting
15	141P710	1	Spring, Idle Needle
16	141A77	1	•▲Washer, Main Jet Assembly
17	141-810	1	Jet Assembly, Main (Adjustable)
18	SHAFT, CHOKE		
	141-742	1	Manual Choke Units
	1418679	1	Electric Choke Units
19	141P699	1	•Washer, Choke Shaft - Manual Choke Units
20	141P697	1	•▲Seal, Felt - Manual Choke Units
21	141P203	1	•Retainer, Felt Seal - Manual Choke Units
22	141-809	1	Shaft & Lever, Throttle
23	141-799	1	•Spring, Float

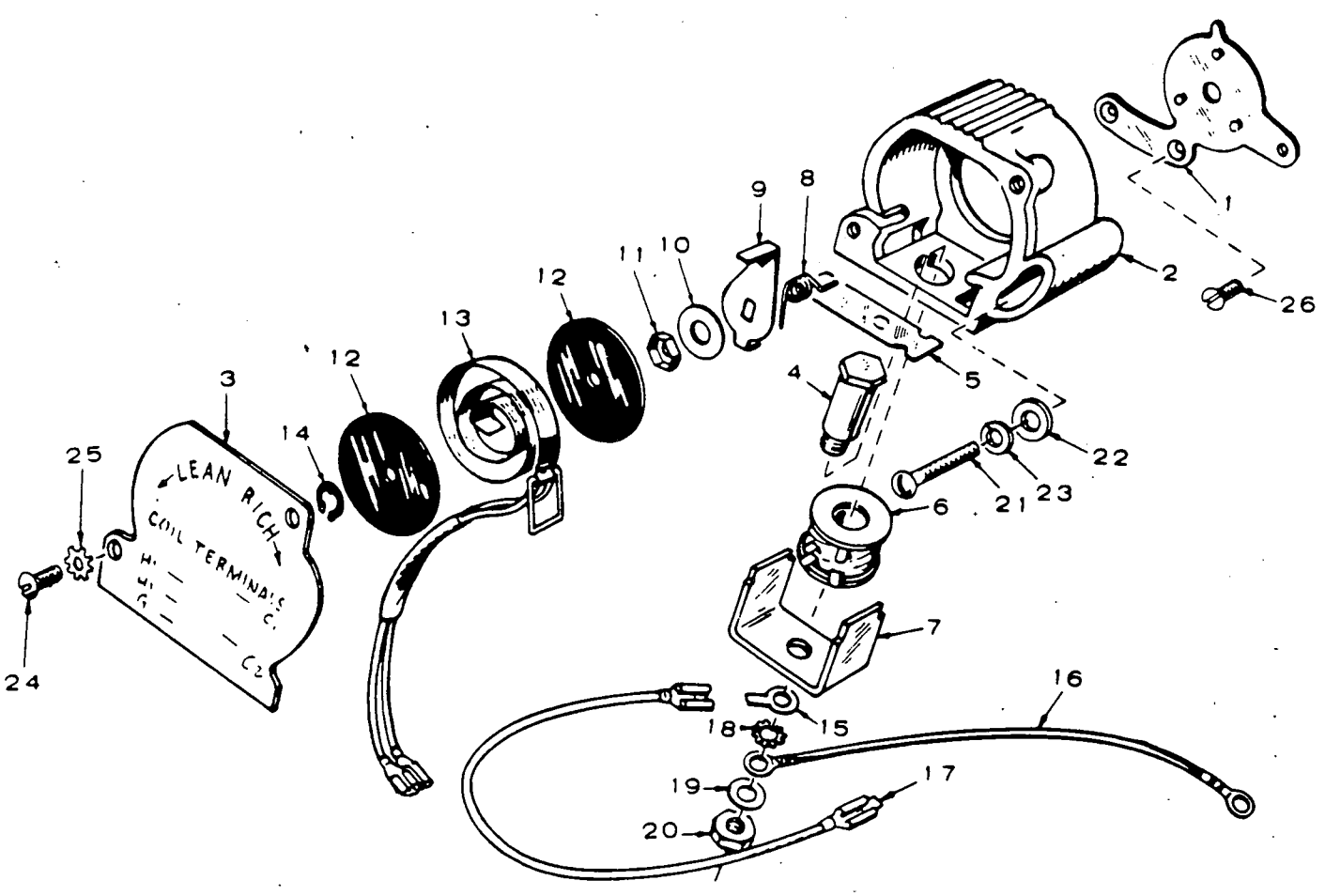
• - Parts Contained in Repair Kit.
▲ - Parts Contained in Gasket Kit.

FUEL PUMP PARTS GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149D1223	1	Pump, Fuel (Illustrated in Fuel System Group)
	149K526	1	Repair Parts Kit - Includes Parts Marked •
1		1	Body, Not Sold Separately
2	815-148	4	Screw, Machine, #8-32 x 7/8"
3	815-147	2	Screw, Phillips Self Tapping, #6-32 x 5/8", Valve Retainer
4	149-96	2	•Valve & Cage
5	149A95	2	•Gasket, Valve
6	149A582	1	•Diaphragm Assembly
7	149A672	1	•Spring
8	149A539	1	Retainer, Valve Cage
9	149A675	1	•Spring
10	516A113	1	Pin, Rocker Arm
11		1	Body, Not Sold Separately
12	149A670	1	Link, Rocker Arm
13	149B1148	1	Arm, Rocker
14	149A1042	1	Lever, Primer
15	509-65	2	Seal, "O" Ring
16	149A1044	1	Spring, Primer Lever
17	149A3	1	•Gasket, Pump Mounting
18	518P129	1	Ring, Retainer, Primer Lever
19	149A858	1	•Gasket, Diaphragm - Lower Side

• Parts in Repair Kit



THERMO-MAGNETIC CHOKE GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	153K429	1	Replacement Kit (Includes Complete Choke Less Leads)
1	153C385	1	Plate, Mounting
2	153D386	1	Body
3	153C389	1	Cover
4	153B391	1	Core, Solenoid
5	153A395	1	Armature
6	307B801	1	Coil, Solenoid Assembly
7	153B392	1	Frame, Solenoid
8	153B387	1	Spring
9	153B390	1	Lever, Thermostat
10	526-18	1	Washer (17/64" I.D. x 5/8" O.D. x 1/16")
11	870-134	1	Palnut (1/4-20)
12	153A399	2	Insulator
13	153B400	1	Heater Assembly
14	518-129	1	Ring, Retaining

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
15	332A876	1	Terminal, Ground
	LEAD, CHOKE		
16	336A1550	1	Choke to Ground
17	336A1549	1	Choke Solenoid Ground
18	857-17	1	Washer, Shakeproof (5/16")
19	526-22	1	Washer, Flat
20	864-2	1	Nut, Hex (5/16-18)
21	813-107	1	Screw (#10-32 x 1-1/4") - Choke Body to Mounting Plate
22	526A8	1	Washer, Flat
23	850-30	1	Washer, Lock (#10)
24	812-76	2	Screw (#8-32 x 5/16") - Cover Mounting
25	854-7	2	Washer, Shakeproof (#8)
26	815-161	2	Screw (#10-32 x 3/8") - Plate Mounting

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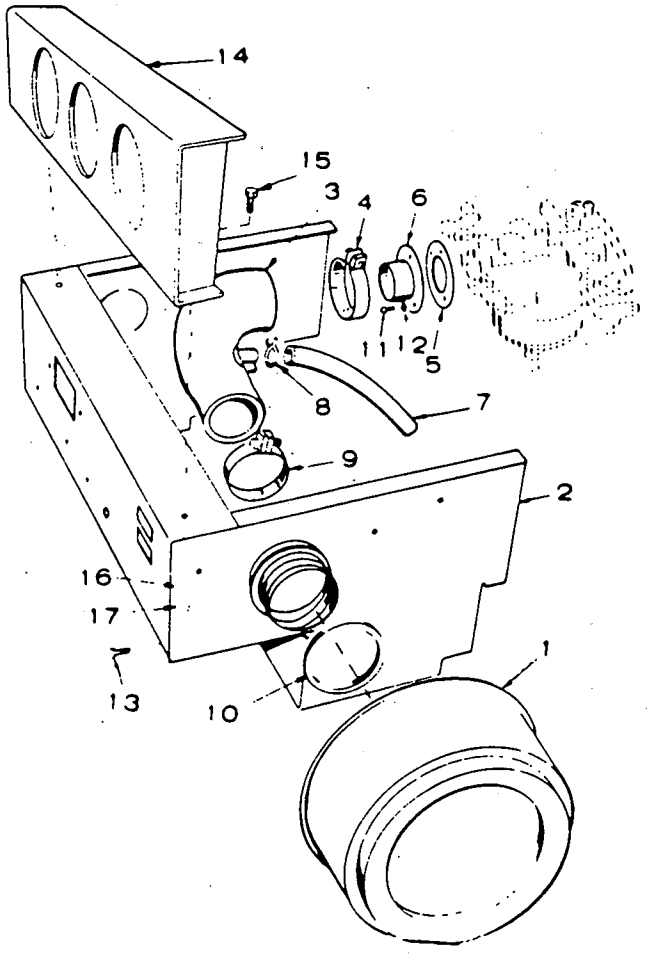
AIR CLEANER GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	140B1175	1	Cleaner, Air
2	140B1179	1	Adapter & Panel, Air Cleaner Mounting
3	140A1186	1	Elbow, Carburetor Air Inlet
4	503-4	1	Clamp, Hose - Air Inlet Elbow to Adapter
5	140A921	1	Gasket, Adapter to Carburetor
6	145A398	1	Adapter, Carburetor Air Inlet
7	503A582	1	Hose, Breather
8	503-170	2	Clamp, Breather Hose
9	503P365	1	Clamp, Hose - Air Cleaner
10	140A1185	1	Gasket, Air Cleaner
11	815-199	3	Screw (10-32 x 5/16") - Adapter Mounting
12	850-30	3	Washer, Lock (#10)
13	821-10	4	Screw (1/4-20 x 1/2") - Air Cleaner Panel Mounting
14	193B218	1	Panel, Instrument - Optional
15	800-3	2	Screw (1/4-20 x 1/2") - Instrument Panel Mounting
16	853-13	2	Washer, Lock (1/4")
17	862-1	2	Nut, Hex (1/4")

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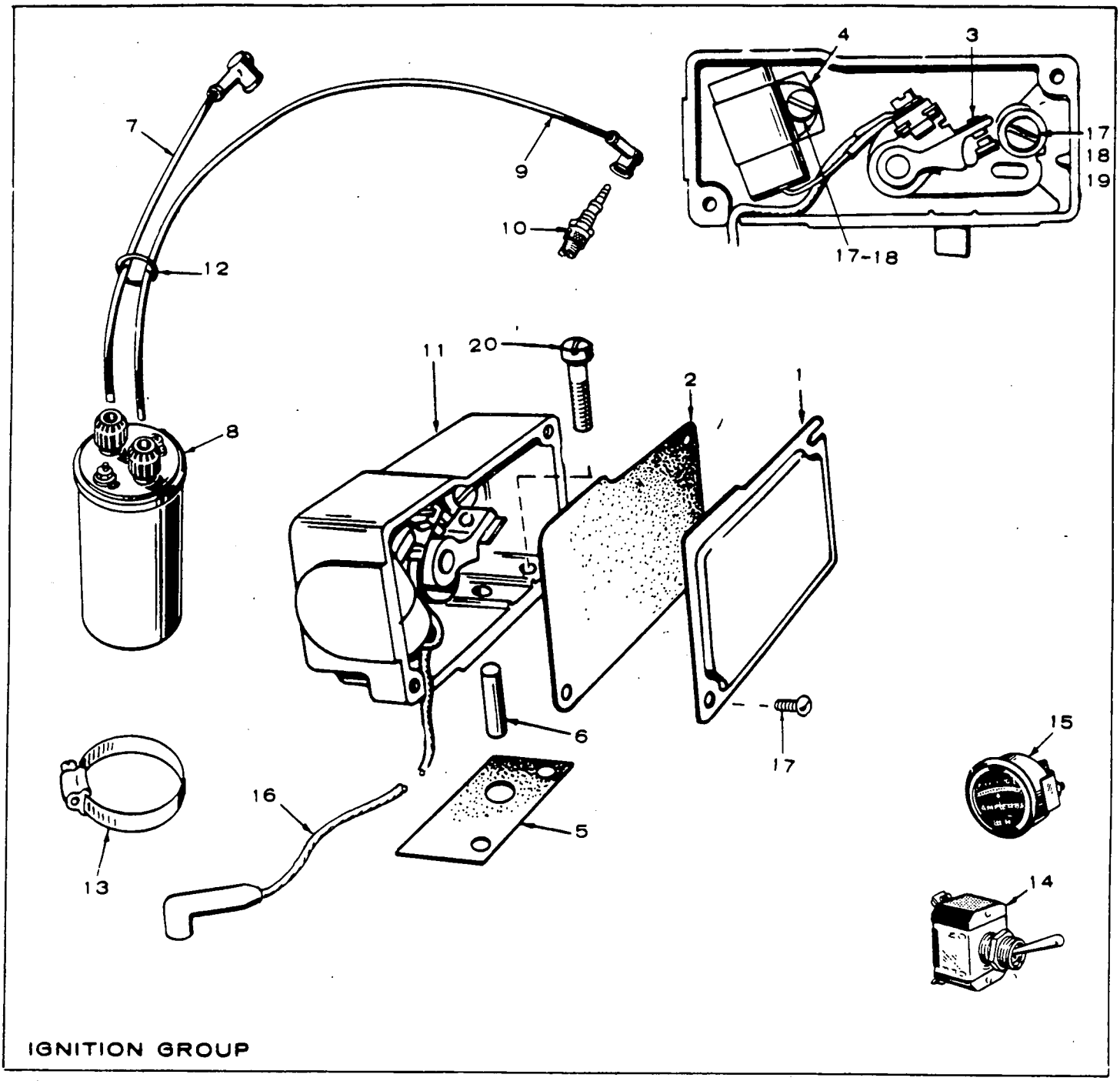
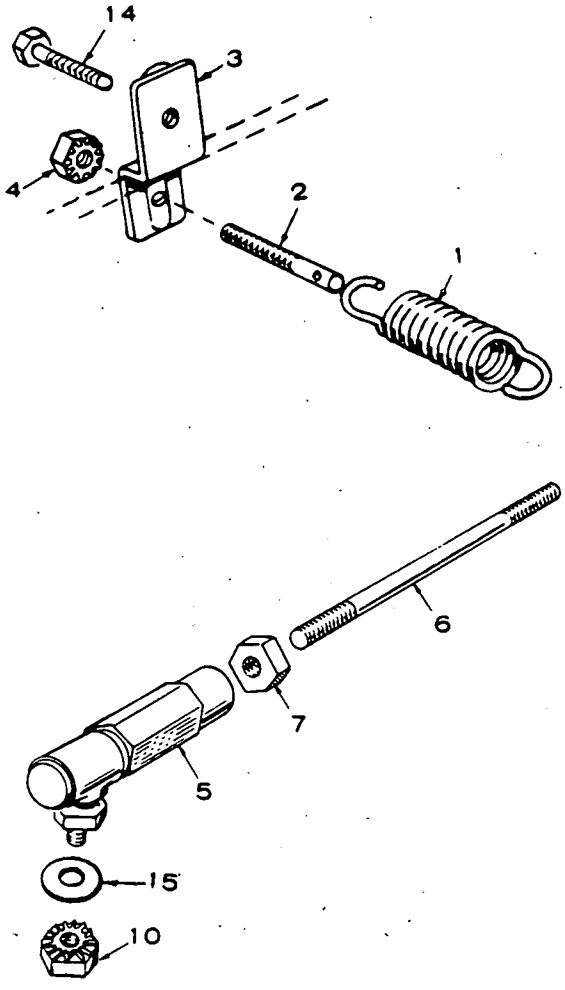


IGNITION GROUP

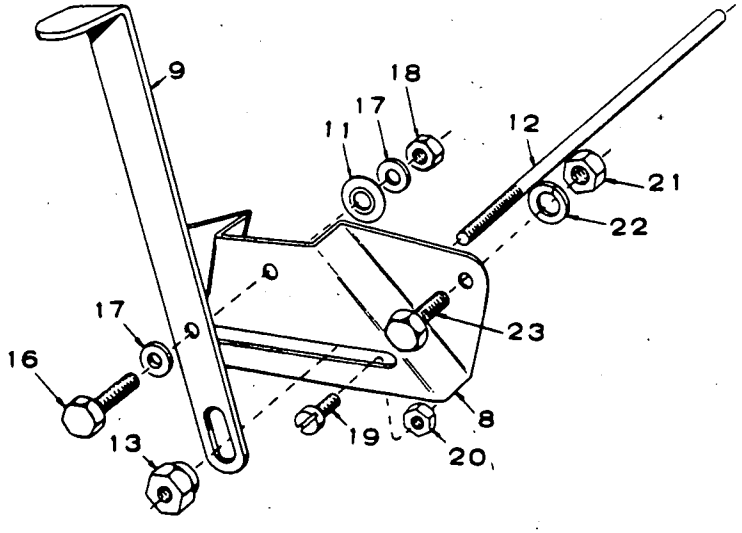
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	160A1149	1	*Cover, Breaker Box
2	160A1148	1	*Gasket, Breaker Box Cover
3	160B1154	1	*Point Set, Breaker
4	312A69	1	*Condenser, Breaker Points
5	160A1150	1	Gasket, Breaker Box Mounting
6	160A1151	1	Plunger, Breaker Box
7	167A1548	1	Cable, Spark Plug - Right Side
8	166B535	1	Coil, Ignition
9	167A1463	1	Cable, Spark Plug - Left Side
10	167-240	2	Plug, Spark
11	160A1158	1	Box, Breaker (Includes Parts Marked *)
12	509-35	1	"O" Ring, Spark Plug Cables
13	503P365	1	Clamp, Coil Mounting
14	308A140	1	Switch, Toggle - Ignition (Start-On-Off) - Optional
15	302A60	1	Ammeter, DC (20-0-20) - Optional
16	336A2132	1	*Lead Assembly, Points to Coil
17	815-358	4	*Screw, Pan Head (1) Condenser Mounting (1) Breaker Points Mounting (2) Cover Mounting
18	*WASHER, LOCK		
	850-25	1	Condenser Mounting
	850-25	1	Breaker Point Mounting
19	526-3	1	*Washer, Flat - Breaker Points Mounting
20	815-373	2	Screw, Fillister Head - Breaker Box Mounting

* - Included in Breaker Box Assembly.

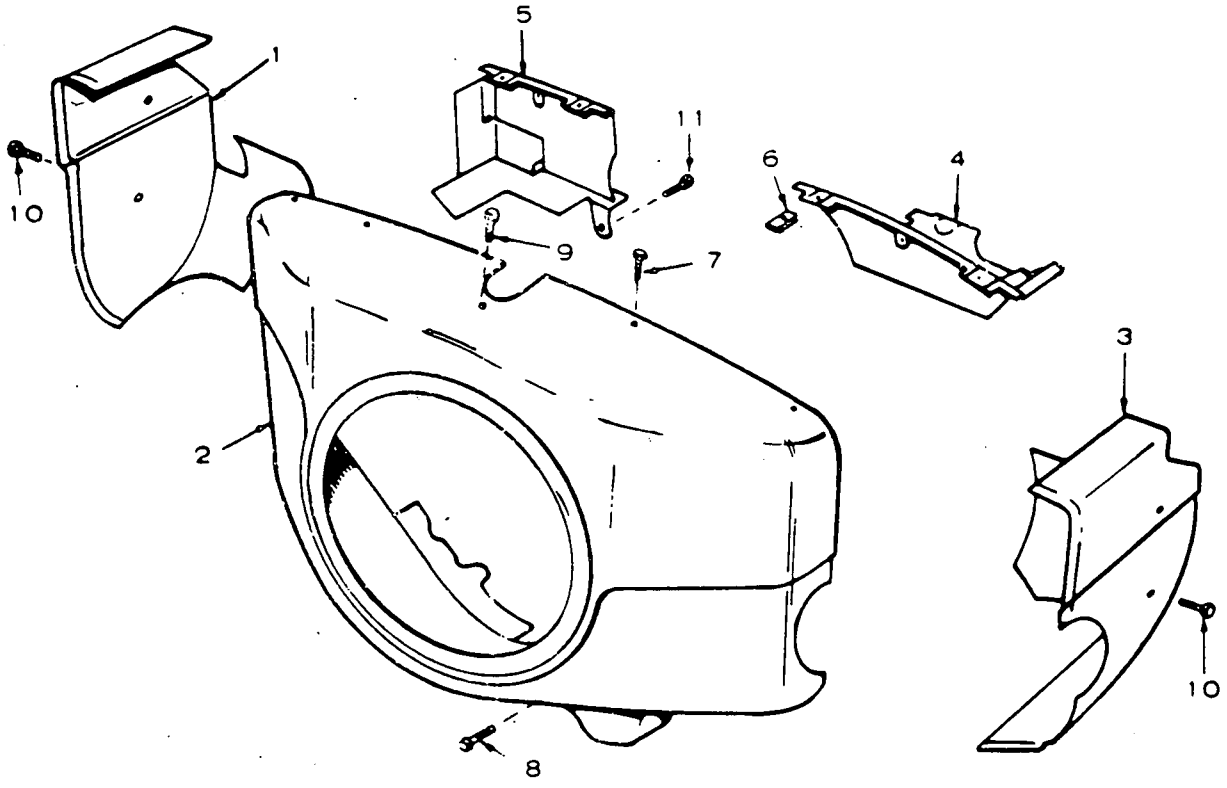
GOVERNOR GROUP

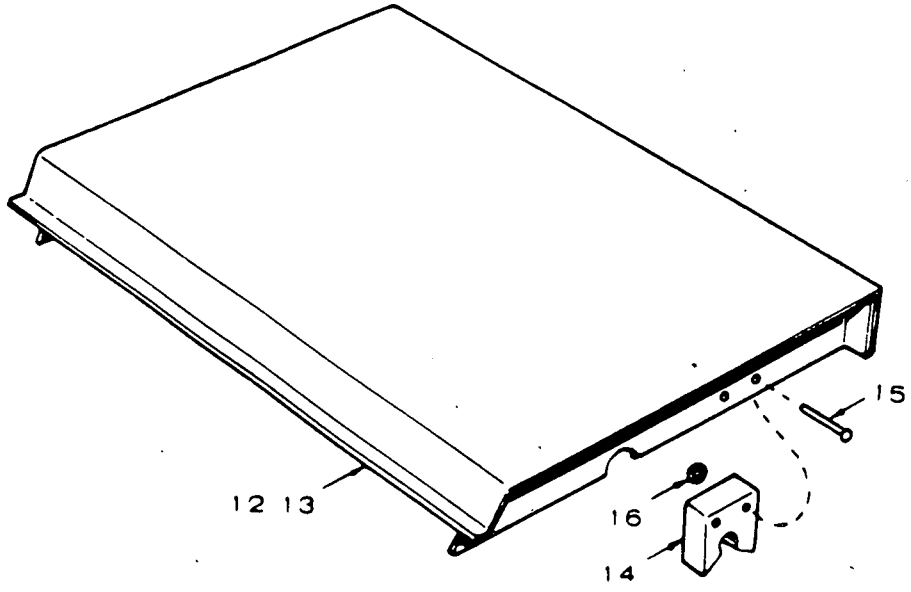


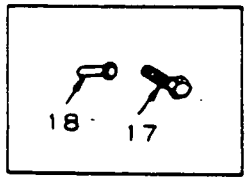
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	150A98	1	Spring, Governor (All Governor Controlled Engines)
2	150A147	1	Stud, Speed Adjustment (Standard Governor Controlled Engines)
3	150A1359	1	Bracket, Speed Stud (Standard Governor Controlled Engines)
4	870-131	1	Nut, Speed Adjustment (Standard Governor Controlled Engines)
5	150A639	2	Joint, Ball (All Governor Controlled Engines)
6	520A187	1	Link, Throttle (All Governor Controlled Engines)
7	870P188	2	Palnut, Locking (All Governor Controlled Engines)
8	152B190	1	Bracket, Variable Speed Control - Optional
9	152A95	1	Lever, Variable Speed Control - Optional
10	870-131	2	Nut, Keps (All Governor Controlled Engines)
11	152A41	1	Washer, Variable Speed Lever Tension - Optional
12	152A90	1	Stud, Variable Speed Adjustment - Optional
13	150A621	1	Nut, Variable Speed Adjustment Stud - Optional
14	821-10	1	Screw (1/4-20 x 1/2") - Bracket Mounting (Standard Governor Controlled Engines)
15	526A196	2	Washer, Flat (All Governor Controlled Engines)
16	800-5	1	Screw (1/4-20 x 3/4")
17	526-15	2	Washer, Flat (1/4)
18	870-65	1	Nut, Hex (1/4-20)
19	815-199	2	Screw (10-32 x 5/16")
20	870-131	2	Nut & Washer (10-32)
21	862-1	2	Nut, Hex (1/4-20) - Bracket Mounting
22	856-6	2	Washer, Lock (1/4)
23	900-3	2	Screw (1/4-20 x 1/2") - Bracket Mounting



BLOWER HOUSING GROUP







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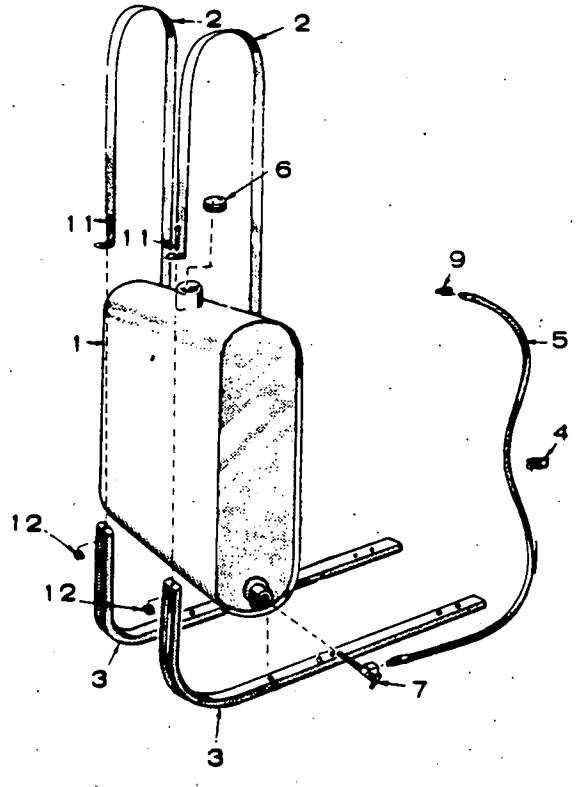
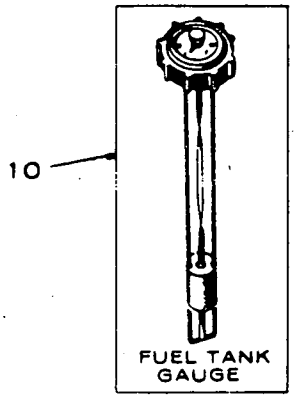
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134D2489	1	Housing, Cylinder Air - Left Side
2	HOUSING, BLOWER		
	134C2494	1	Standard
	134C2531	1	With Flywheel Guard - Optional
3	134B2488	1	Housing, Cylinder Air - Right Side
4	134B2483	1	Support, Blower Housing Baffle - Right Side
5	134B2487	1	Support, Blower Housing Baffle - Left Side
6	870-107	4	Nut, Tinnerman - Support to Blower Housing
7	809-59	4	Screw (1/4 x 1/2), Sheet Metal - Support to Blower Housing
8	815-265	2	Screw (1/4-20 x 1/2") - Blower Housing Mounting
9	815-261	1	Screw (1/4-20 x 7/16") - Blower Housing Mounting (Top Hole)
10	815-261	4	Screw (1/4-20 x 7/16") - Cylinder Air Housing Mtg.
11	815-370	4	Screw (1/4 x 1/2") - Support Mounting
12	405A1935	1	Hood Assembly, Engine (Includes Parts Marked *) - Optional
13	405B1934	1	*Hood, Engine
14	405A1872	2	*Clip, Hood
15	818-150	4	*Rivet, Drive
16	526-3	4	*Washer, Flat
17	821-10	2	Screw (1/4-20 x 1/2") - Hood Mounting
18	870P258	2	Stud (1/4-20) - Hood Mounting

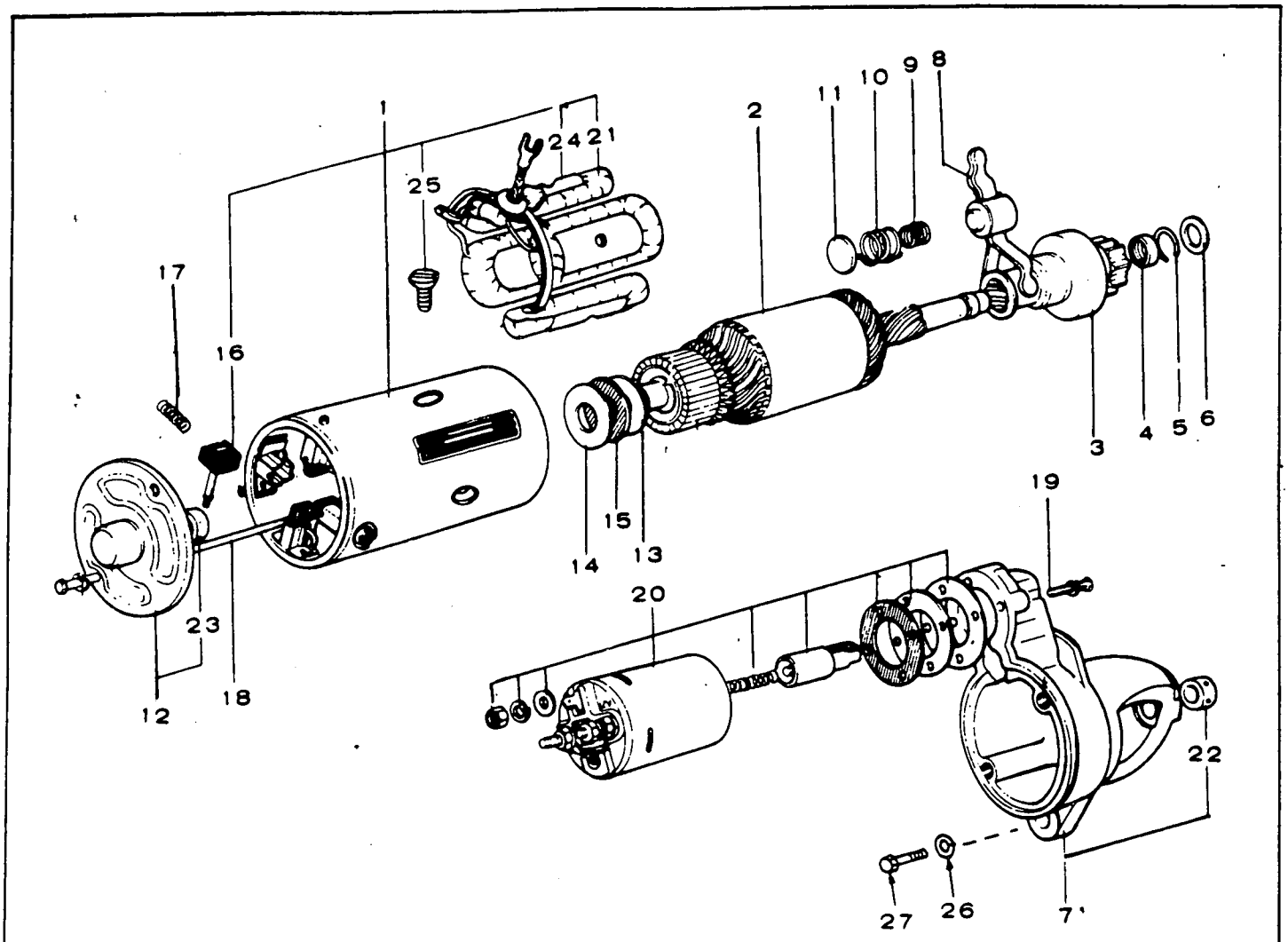
* - Included in Engine Hood Assembly.

SIDE MOUNTED FUEL TANK GROUP (OPTIONAL EQUIPMENT)





REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	159B981	1	Tank, Fuel
2	159A596	2	Strap, Fuel Tank
3	159B595	2	Bracket, Fuel Tank
4	134A599	1	Clip, Fuel Line
5	501A8	1	Line, Fuel
6	159A7	1	Cap, Fuel Tank
7	504A13	1	Valve, Shutoff
8	505-57	1	Plug, Pipe (1/8)
9	502-20	1	Elbow, Fuel Pump to Fuel Line
10	193P207	1	Cap and Gauge Assembly, Fuel Tank
11	813-108	2	Screw (10-32 x 1-1/2") - Hold-down Strap to Bracket
12	870-53	2	Nut, Hex (10-32)



STARTING MOTOR PARTS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191D734	1	Motor Assembly, Starting
1	191-742.	1	Yoke Assembly (Frame) - Includes Parts Marked *
2	191-743	1	Armature
3	191-744	1	Clutch, Starter
4	191-745	1	Stop, Pinion
5	191-746	1	Ring
6	191-747	1	Washer, Plain
7	191-748	1	Bracket Assembly, Front
8	191-749	1	Lever Assembly
9	191-750	1	Spring, Lever (A)
10	191-751	1	Spring, Lever (B)
11	191-752	1	Holder, Spring
12	191-753	1	Bracket Assembly, Rear
13	191-754	1	Washer, Plain
14	191-755	1	Washer, Plain
15	191-756	1	Washer, Insulator
16	191-757	4	*Brush
17	191-758	4	Spring, Brush
18	191-759	2	Bolt, Through
19	191-760	3	Screw, Machine P.H.
20	191-761	1	Switch Assembly, Solenoid
21	191-762	1	*Coil Assembly, Field
22	191-763	1	Bearing, Front
23	191-764	1	Bearing, Rear
24	191-765	4	*Pole Shoe
25	191-766	4	*Screw, Pan Head
26	850-50	2	Washer, Lock - Starter Motor Mounting
27	800-51	2	Screw, Hex Cap - Starter Motor Mounting

* Included in Yoke Assembly.

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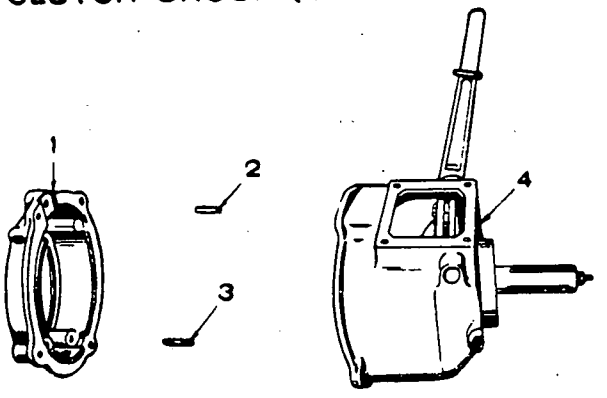
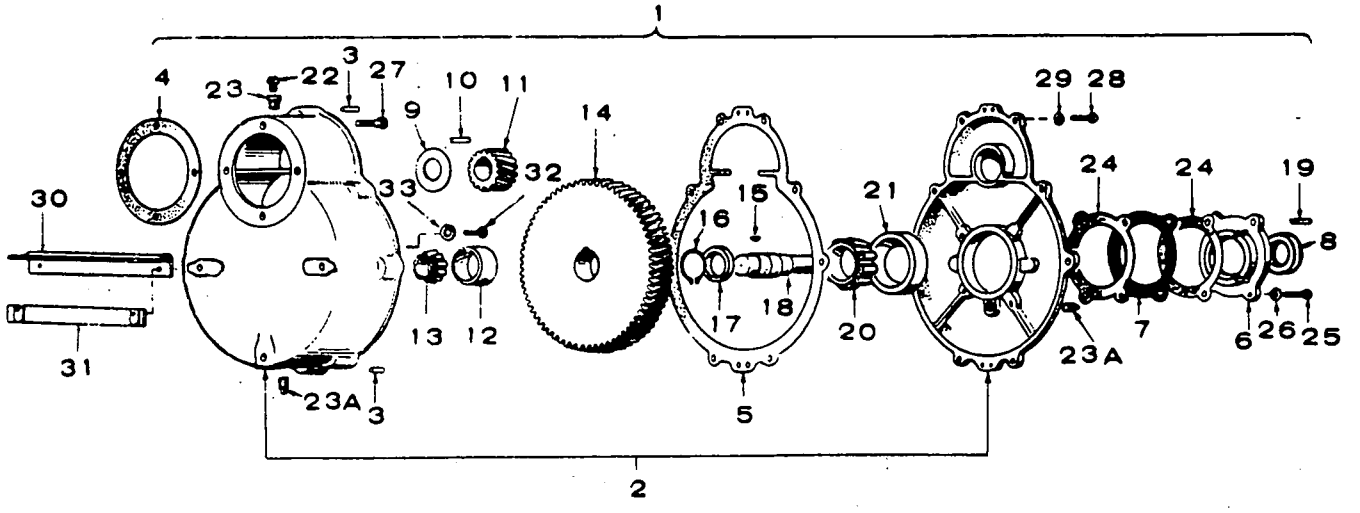
CLUTCH GROUP (OPTIONAL EQUIPMENT)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190D171	1	Adapter, Clutch to Engine
2	515A196	1	Key, Clutch
3	STUD, CLUTCH HOUSING TO ENGINE		
	520A738	1	3/8-16 x 4″
	520A739	2	3/8-16 x 3″
4	190D288	1	*Clutch Assembly
	190K289	1	Clutch Kit - Includes Complete Clutch, Adapter, Mounting Hardware & Instructions

* For component parts, check clutch nameplate and order by description from your nearest Rockford Dealer.

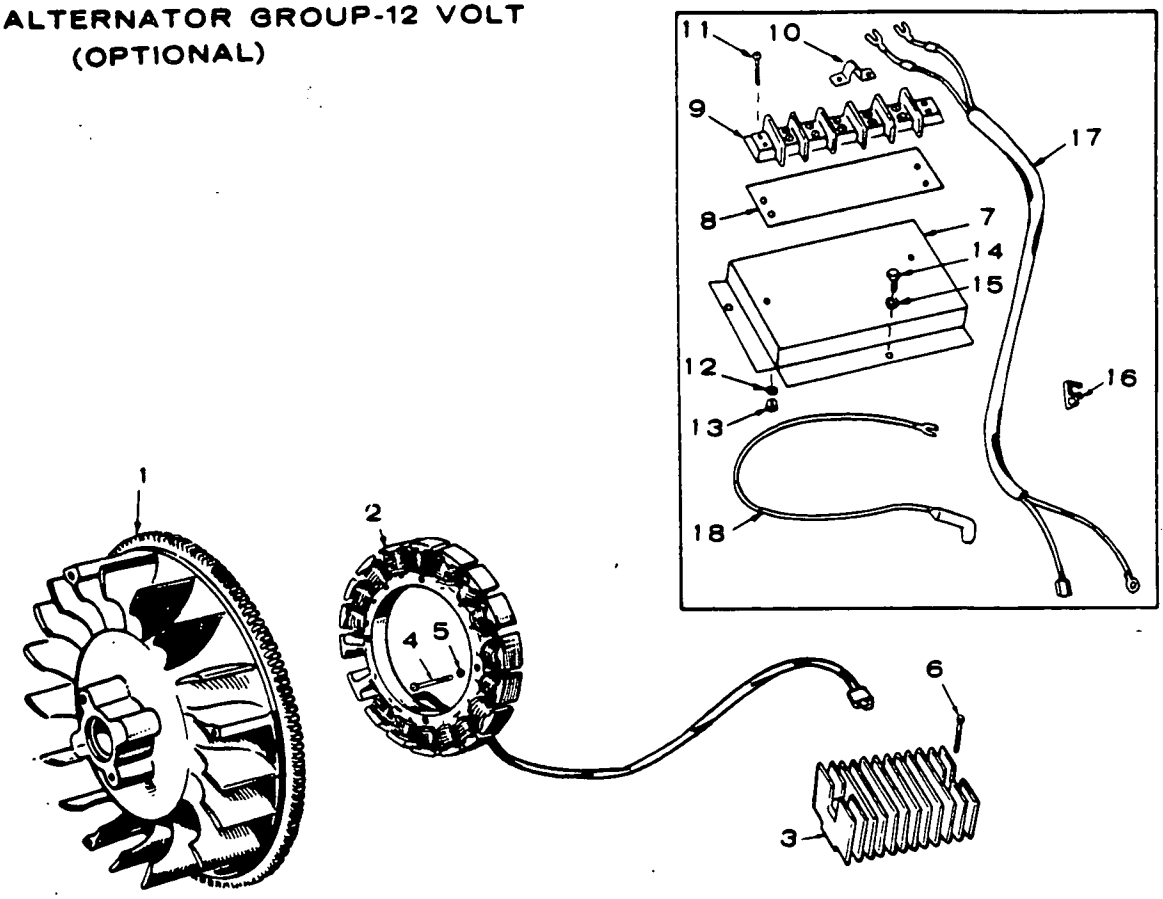


REDUCTION GEAR GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190C290	1	Reduction Gear Assembly (4-1) Complete
2	190A300	1	Housing - Includes Cover (Also Order 2 #516A12 Pins)
3	516A12	2	Pin, Dowel, Cover to Housing
4	190A20	1	Gasket, Housing to Engine
5	190B21	1	Gasket, Cover to Housing
6	190B16	1	Plate, Bearing Retainer
7	190A115	1	Shim Set, End Play Adjustment (1 Each .005″, .009″, .012″, .016″, .020″, .025″)
8	509-16	1	Seal, Oil, Retainer Plate
9	190A195	1	Washer, Pinion Gear
10	515A142	1	Key, Pinion Gear
11	190A191	1	Gear, Pinion
12	510-22	1	Cup, Roller Bearing, Engine End
13	510-21	1	Cone, Roller Bearing, Engine End
14	190B190	1	Gear, Driven
15	515A159	1	Key, Driven Gear
16	518-13	1	Ring, Snap, Retainer
17	190A202	1	Spacer, Bearing
18	190A192	1	Shaft, Take-Off
19	515A103	1	Key, Take-Off Shaft

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
20	510-23	1	Cone, Roller Bearing Take-Off End
21	510-24	1	Cup, Roller Bearing, Take-Off End
22	518P172	1	Vent
23	505-7	1	Bushing, Reducer (1/4 x 1/8)
23A	505-54	2	Plug, Pipe (1/4)
24	190A306	2	Gasket, Bearing Plate to Housing
25	800-7	4	Screw (1/4-20 x 1″) - Bearing Plate to Housing
26	526-63	4	Washer, Flat (Copper)
27	805-9	4	Bolt, Place (5/16-18 x 1″) - Housing to Engine
28	800-28	8	Screw (5/16-18 x 1″) - Cover to Housing
29	526-65	8	Washer, Flat (Copper)
30	190B297	1	Support, Housing Assembly
31	190A298	1	Fastener, Support - Housing Assembly
32	800-26	2	Screw (5/16-18 x 3/4″) - Housing to Support
33	526-65	2	Washer, Flat (Copper) - Housing to Support

CHARGING ALTERNATOR GROUP-12 VOLT (OPTIONAL)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134C2462	1	Flywheel Assembly (Includes Ring Gear and Magnet Ring) - (Also Listed in the Crankshaft and Flywheel Group)
2	191B885	1	Stator
3	191A886	1	Regulator
4	813-108	3	Screw (10-32 x 1-1/2″) - Stator to Gear Cover
5	850-30	3	Washer, Lock - Stator Mounting
6	821-18	2	Screw (1/4-20 x 3/4″) - Regulator Mounting
7	301B3530	1	Bracket, Terminal Block
8	332A1273	1	Strip, Marker
9	332A604	1	Block, Terminal (5-Place)
10	332C1043	1	Jumper, Terminal Block
11	812-82	2	Screw (8-32 x 3/4″) - Terminal Block to Bracket
12	850-25	2	Washer, Lock (#8) - Terminal Block to Bracket
13	860-8	2	Nut (8-32) - Terminal Block to Bracket
14	813-100	2	Screw (10-32 x 1/2″) - Bracket to Cylinder Block
15	856-3	2	Washer, Lock (#10)
16	167A188	1	Clip, Regulator Harness
17	338A619	1	Harness, Wiring - Start Solenoid to Terminal Block
18	336A2132	1	Lead Assembly - Terminal Block to Coil

SERVICE KITS AND MISCELLANEOUS

NOTE: For other kits, refer to the group for the part in question.

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	98C1807	1	Decal Kit
	168K122	1	Gasket Kit, Complete Engine
	168K121	1	Gasket Kit, Carbon Removal
	160K1161	1	Ignition Tune-up Kit
	522K123	1	Overhaul Kit, Engine
	525P137	1	Paint, Green Touch-up Enamel - 16 Oz. Pressurized Can

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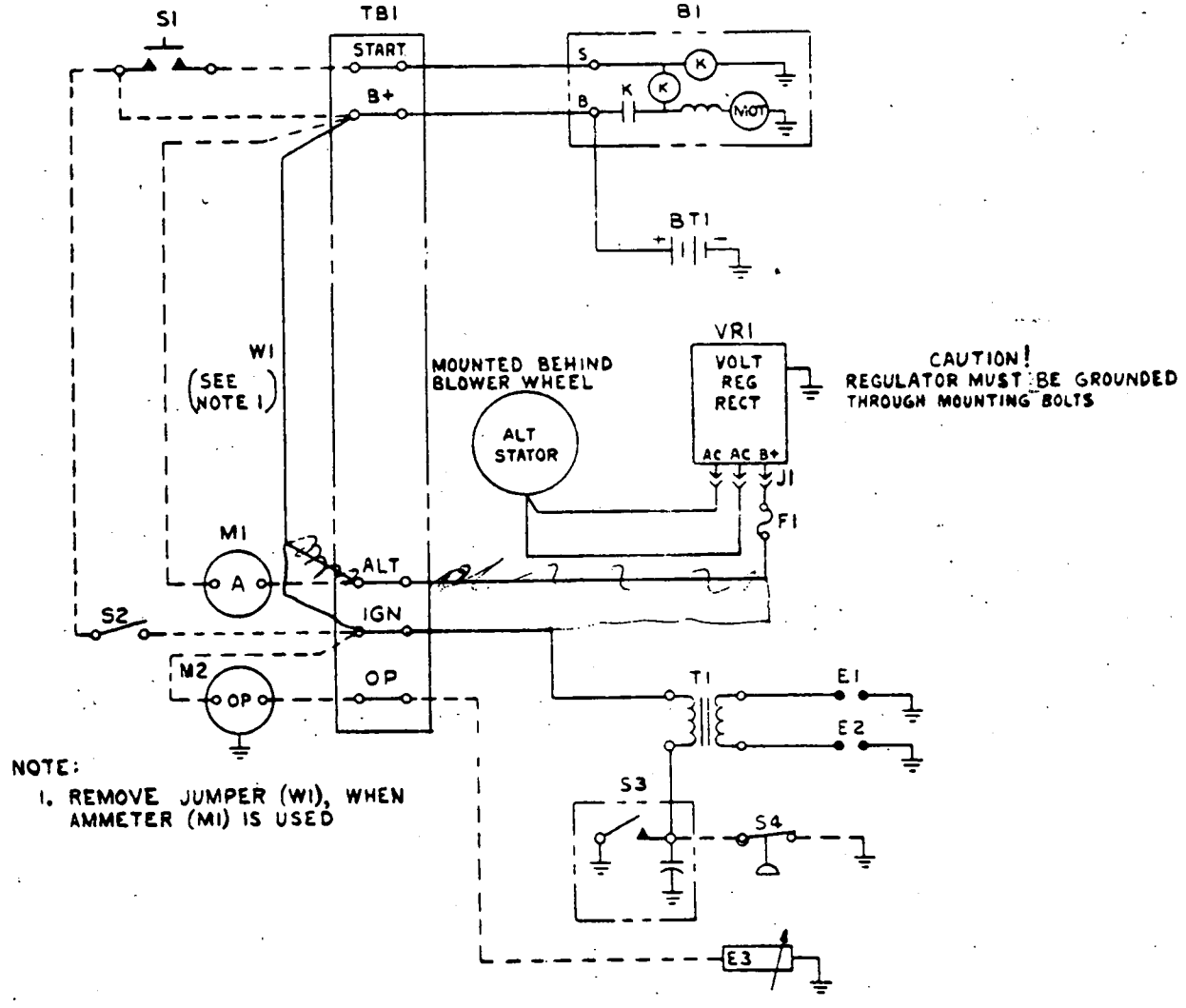
PARTS LIST (REF)

	REF DES.	PART NO.	QTY	DESCRIPTION
	B1		1	STARTER & SOLENOID - ENGINE
	BT1		1	BATTERY - 12 V.
	E1, 2		2	SPARK PLUG
*	E3		1	SENDER - OIL PRESSURE
	F1		1	FUSE, 35 AMP
	G1		1	ALTERNATOR
	J1		1	CONNECTOR
*	M1		1	AMMETER
*	M2		1	METER - OIL PRESSURE
	S1		1	SWITCH - START
	S2		1	SWITCH - IGNITION
	S3		1	BREAKER & CAP ASSEMBLY
*	S4		1	SWITCH - LOPKS
	T1		1	COIL - IGNITION
	TB1		1	BLOCK - TERMINAL
			1	STRIP - MARKER
	VR1		1	REGULATOR - VOLTAGE
	W1		1	JUMPER (SEE NOTE 1)

* WHEN USED



ENGINE WIRING DIAGRAM (INCLUDES FLYWHEEL ALTERNATOR)

[illegible] SERVICES

[illegible] WARRANTY
ENGINE DRIVEN EL[illegible] GENERATOR
SEPARATE GENERATOR, INDUSTRIAL E[illegible]

QUALITY OF PRODUCT

Onan products are engineered and designed to perform as stated on product nameplate and published specification. Only quality material and workmanship are used in the manufacture of this product. With proper installation, regular maintenance and periodic repair service, the equipment will provide many enjoyable hours of service.

GENERAL WARRANTY PRACTICES

All Onan-manufactured engine-driven electric generator sets, separate generators and industrial engines are sold with a full one-year warranty. This warranty is issued only to the original [illegible] that these products are free from defects in material or factory workmanship when properly installed, serviced, and operated under normal conditions; according to the manufacturer's instructions. The terms of the Onan published warranty appears in the Onan Operator's Manual sent with [illegible]

Warranty Registration: A Warranty Registration card accompanies each Onan Product. This card must be properly filled out and returned to the Onan Factory in order to qualify for warranty consideration covered in this bulletin. When requesting warranty repair work you must provide the purchase date, model and serial number of the equipment.

Warranty Authorization: Warranty service must be performed by Onan Factory or Onan Authorized Distributors or their Approved and Registered Service Dealers. A complete listing of these Onan Authorized Parts and Service Centers is provided in our brochure F-115, a copy of which is supplied with each Onan Product. These Onan Authorized Service Centers have trained service personnel, parts stock, and the necessary facilities and tools for the service and repair of Onan equipment.

Material Allowances: Onan will allow credit or furnish free of charge to the Onan Authorized Service Station or his Approved Service Dealer, all genuine Onan parts used in a warranty repair of these products which fail because of defective material or workmanship.

Labor Allowance: Onan will allow warranty repair credit to the Onan Authorized Parts and Service Center and his Approved Dealer at straight time labor when the cause of failure is determined to be defective material or factory workmanship. This labor allowance will be based on the factory's standard time schedule of published flat rate labor allowances, or, otherwise a time judged reasonable by the factory. Repair work other than warranty will be charged to the owner. The Onan Division's Warranty practice does not provide for allowance of expenses such as start-up charges, communication charges, transportation charges, travel time and/or mileage, unit removal or installation expense, cost of fuel, oil, normal maintenance adjustments, tune-up adjustments or parts maintenance items.

Administration: Warranty of Onan Products is administered through Onan Authorized Distributors in whose territory the equipment is located. These Distributors and their Approved or Registered Onan Service Dealers are authorized to make settlement of all customer warranty claims within the limits of the manufacturer's warranty policy as described herein.

Onan reserves the right to change warranty practices without prior notice.

MAINTENANCE

A Planned Preventive Maintenance Program is extremely important if you are to receive efficient operation and long service life from your Onan unit. Neglecting routine maintenance can result in premature failure or permanent damage to your equipment. The Onan Operator's Manual sent with the product contains recommended maintenance schedules and procedures.

Maintenance is divided into two categories:

1. Operator Maintenance ... performed by the operator.
2. Critical Maintenance ... performed only by qualified service personnel.

Regular maintenance will help you avoid sudden and costly repairs in the future. Adequate evidence of this scheduled maintenance must be offered when applying for a warranty claim.

INSTALLATION

Installation is extremely important and all Onan Products should be installed in accordance with the manufacturer's recommendations. If the owner experiences any difficulty with such items as mounting, ventilation, exhaust location, fuel lines, wiring, etc., he should immediately contact the company from whom he purchased the equipment so that corrective action can be taken. Although the Onan Authorized Distributor and his Approved or Registered Service Dealers may be able to remedy certain installation difficulties, such repair work is not considered Onan warranty and there will be a charge for this service.

Onan

Minneapolis, Minnesota 55432

MSS-22A
Replaces 23B054
Rev. 11-1-71

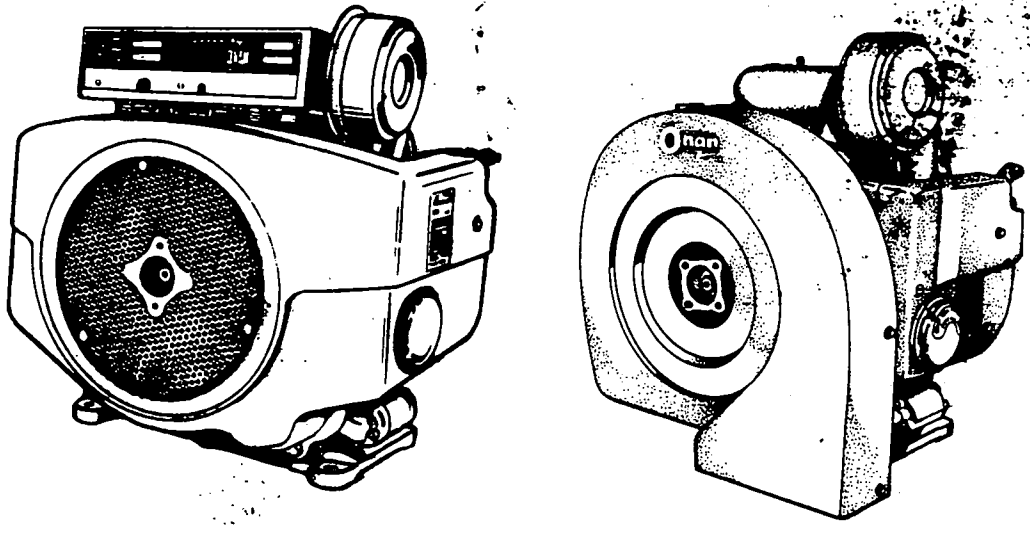
902544

Onan®

OPERATOR'S/SERVICE MANUAL AND PARTS CATALOG

FOR
SERIES

NHC-NHCV
INDUSTRIAL ENGINES



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INTRODUCTION

THIS OPERATOR'S MANUAL CONTAINS INFORMATION PERTAINING TO THE OPERATION AND MAINTENANCE OF YOUR UNIT.

WE SUGGEST YOU KEEP THE MANUAL AND THE WIRING DIAGRAM WHICH ACCOMPANIES EVERY UNIT AND REFER TO IT WHEN MAKING EQUIPMENT ADJUSTMENTS OR ORDERING PARTS. ADDITIONAL COPIES ARE AVAILABLE FOR A NOMINAL CHARGE FROM YOUR DISTRIBUTOR.

WHEN ORDERING PARTS, REMEMBER TO INCLUDE THE MODEL, SPECIFICATION LETTER, AND SERIAL NUMBER LOCATED ON THE UNIT NAMEPLATE. THIS IS ESSENTIAL TO ENSURE THE CORRECT PART IS SHIPPED TO YOU.

FOR REPAIR SERVICE, CONTACT YOUR AUTHORIZED SERVICE REPRESENTATIVE.

WARNING

TO AVOID POSSIBLE PERSONAL INJURY OR EQUIPMENT DAMAGE, AN AUTHORIZED SERVICE REPRESENTATIVE MUST PERFORM ALL SERVICE.

GENERAL INFORMATION

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This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of the engine. Since the first and most important part of repair work is the correct diagnosis of the trouble, a troubleshooting chart is included.

Study and follow the instructions carefully. Proper service and maintenance will result in longer engine life and better performance.

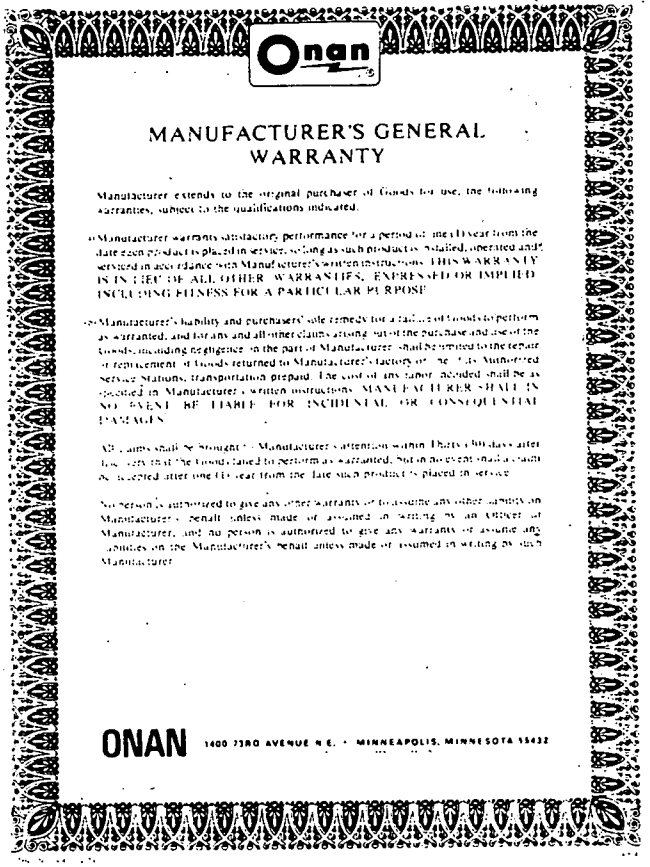
How to interpret *MODEL* and *SPEC NO.*

NHC - MS / 123 A

1 2 3 4

1. Factory code for general identification purposes.
2. Specific Type:
   S—MANUAL starting

   MS—ELECTRIC starting
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.



Onan

MANUFACTURER'S GENERAL WARRANTY

Manufacturer extends to the original purchaser of Goods for use, the following warranties, subject to the qualifications indicated.

(a) Manufacturer warrants satisfactory performance for a period of one (1) year from the date such products is placed in service, so long as such products is installed, operated and serviced in accordance with Manufacturer's written instructions. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED INCLUDING FITNESS FOR A PARTICULAR PURPOSE

(b) Manufacturer's liability and purchasers' sole remedy for a failure of Goods to perform as warranted, and for any and all other claims arising out of the purchase and use of the Goods, including negligence on the part of Manufacturer, shall be limited to the repair or replacement of Goods returned to Manufacturer's factory or the Duly Authorized Service Stations, transportation prepaid. The cost of any labor provided shall be as specified in Manufacturer's written instructions. MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES

All claims shall be brought to Manufacturer's attention within Thirty (30) days after the discovery that the Goods failed to perform as warranted, but in no event shall a claim be accepted after one (1) year from the date such products is placed in service.

No person is authorized to give any other warranties or to assume any other liability on Manufacturer's behalf unless made or assumed in writing by an Officer of Manufacturer, and no person is authorized to give any warranty or assume any liability on the Manufacturer's behalf unless made or assumed in writing by such Manufacturer.

ONAN 1400 73RD AVENUE N.E. • MINNEAPOLIS, MINNESOTA 55432

IMPORTANT! RETURN WARRANTY CARD ATTACHED TO UNIT.

SAFETY PRECAUTIONS

The following symbols in this manual signal potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

WARNING **Onan uses this symbol throughout this manual to warn of possible serious personal injury.**

CAUTION **This symbol refers to possible equipment damage.**

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

- **Use Extreme Caution Near Gasoline, Gaseous Fuel And Diesel Fuel. A constant potential explosive or fire hazard exists.**

  Do not fill fuel tank near unit with engine running. Do not smoke or use open flame near the unit or the fuel tank.

  Be sure all fuel supplies have a positive shutoff valve.

  Fuel lines must be of steel piping, adequately secured and free from leaks. Do not use copper piping on flexible lines as copper becomes hardened and brittle. Use black pipe on natural gas or gaseous fuels, not on gasoline or diesel fuels. Piping at the engine should be approved flexible line.

  Have a fire extinguisher nearby. Be sure extinguisher is properly maintained and be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications. Consult the local fire department for the correct type of extinguisher for various applications.

- **Guard Against Electric Shock**

  Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.

  Jewelry is a good conductor of electricity and should be removed when working on electrical equipment.

  Use extreme caution when working on electrical components. High voltages cause injury or death.

  Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician.

- **Do Not Smoke While Servicing Batteries**

  Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

- **Exhaust Gases Are Toxic**

  Provide an adequate exhaust system to properly expel discharged gases. Check exhaust system regularly for leaks. Ensure that exhaust manifolds are secure and not warped.

  Be sure the unit is well ventilated.

- **Keep The Unit And Surrounding Area Clean.**

  Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

  Dispose of oily rags. Keep the floor clean and dry.

- **Protect Against Moving Parts.**

  Avoid moving parts of the unit. Loose jackets, shirts or sleeves should not be permitted because of the danger of becoming caught in moving parts.

  Make sure all nuts and bolts are secure. Keep power shields and guards in position.

  If adjustments *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

  Do not work on this equipment when mentally or physically fatigued.

SPECIFICATIONS

Number of Cylinders	2
Displacement (cubic inch)	60
Cylinder Bore	3-9/16 in.
Piston Stroke	3 inch
Horsepower—NHC (Pressure Cooled)	25 BHP @ 3600 rpm
Horsepower—NHCV (Vacu-Flo Cooled)	22.5 BHP @ 3300 rpm
Compression Ratio	7.0 to 1
Ventilation Required (cfm @ 3600 rpm) NHC	1080
(cfm @ 3600 rpm) NHCV	1200
Oil Capacity	3-1/2 quart
Oil Capacity with Filter Change	4 quart
Starting	Electric
Ignition	Battery
Combustion Air (cfm @ 3600 rpm)	80
Fuel	Gasoline (regular grade)
Fuel Pump	Diaphragm, 4 ft. lift
Battery	12 Volt

TUNE-UP SPECIFICATIONS

Spark Plug Gap	.025-inch
Breaker Point Gap	.016-inch
Ignition Timing (Fixed), Electric Start Units	20° BTC
Tappets (Cold) Intake	.003-inch
Exhaust	.012-inch

DIMENSIONS AND CLEARANCES

All clearances given at room temperature of 70° F.
All dimensions in inches unless otherwise specified.

	Minimum	Maximum
Valve Stem in Guide—Intake	0.0010	0.0025
Valve Stem in Guide—Exhaust	0.0025	0.0040
Valve Spring Length		
Free Length	1.662	
Compressed Length	1.375	
Valve Spring Tension (lb.)		
Open	71	79
Closed	38	42
Valve Seat Bore Diameter		
Intake	1.5645	1.5655
Exhaust	1.2510	1.2520
Valve Seat Diameter		
Intake	1.569	1.570
Exhaust	1.255	1.256
Valve Stem Diameter		
Intake	0.3425	0.3430
Exhaust	0.3410	0.3415
Valve Guide Diameter (I.D.)	0.344	0.346
Valve Lifter Diameter	0.7575	0.7480
Valve Lifter Bore	0.7505	0.7515
Valve Seat Interference Width	1/32	3/64
Valve Face Angle	44°	
Valve Seat Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearing	0.0025	0.0038
Crankshaft End Play	0.005	0.009
Camshaft Bearing	0.0015	0.0030
Camshaft End Play	0.003	
Camshaft Lift	0.300	
Camshaft Bearing Diameter	1.3760	[illegible]
Camshaft Journal Diameter	1.3740	1.3748
Rod Bearing (Forged Rod)	0.0005	0.0023
Connecting Rod End Play (Ductile Iron)	0.002	0.016
Timing Gear Backlash	0.002	0.004
Oil Pump Gear Backlash	0.002	[illegible]
Piston to Cylinder, Strut Type (Measured below oil-controlling ring 90° from pin) Clearance	0.0015	[illegible]
Piston Pin Diameter	0.7500	[illegible]
Piston Pin in Piston	Thumb Push Fit	
Piston Pin in Rod	0.0001	[illegible]
Piston Ring Groove Width		
Top 1	0.0955	[illegible]
Top 2	0.0955	[illegible]
Top 3	0.1880	[illegible]
Piston Ring Gap in Cylinder	0.010	[illegible]
Piston Ring Side Clearance (Top compression ring only)	0.006	
Crankshaft Main Bearing Journal—Standard Size	1.9985	[illegible]
Main Bearing Diameter	2.0017	[illegible]
Main Bearing Clearance	0.0009	[illegible]
Crankshaft Rod Bearing Journal—Standard Size	1.625	1.6260
Cylinder Bore—Standard Size	3.56[illegible]	[illegible]

ASSEMBLY TORQUES

TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often with the engine cold. Tighten as needed to prevent them from working loose.

TORQUE SPECIFICATIONS	Ft.-Lb.
Cylinder Head Nuts	17-19
Rear Bearing Plate	25-28
Connecting Rod Bolt	27-29
Flywheel Capscrew	35-40
Starter Mounting Bracket to Oil Base Screws	43-48
Gear Case Cover	8-10
Oil Pump	7-9
Other 3/8 Cylinder Block Nuts	18-23
Intake Manifold	18-20
Exhaust Manifold	10-12

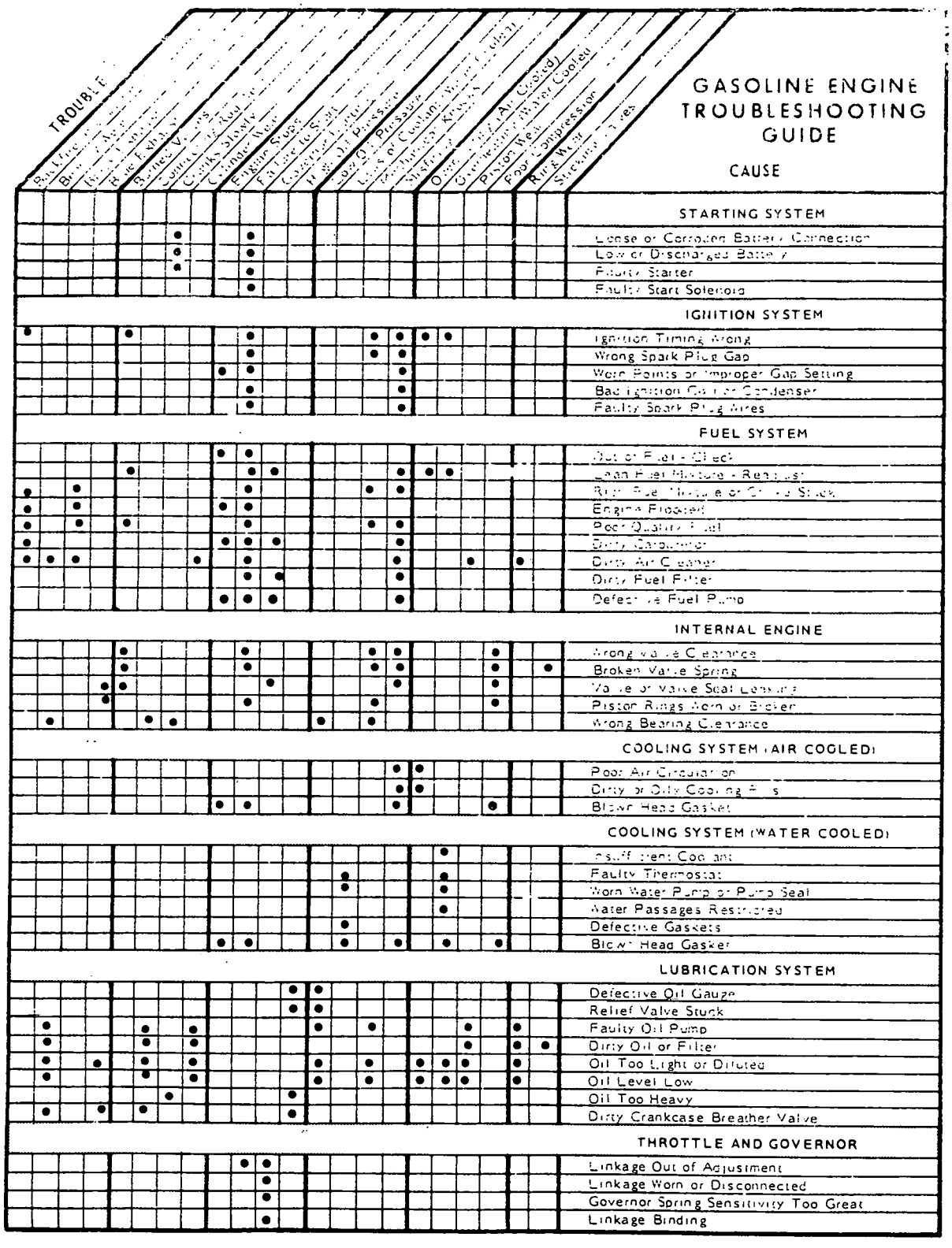
SPECIAL TOOLS

SPECIAL TOOLS

These tools are available from Onan to aid service and repair work.

Crankshaft Gear Pulling Ring	420-0248
Flywheel Puller	420-0100
Combination Bearing Remover, Main and Cam	420-0325
Combination Bearing Driver, Main and Cam	420-0324
Valve Guide Driver	420-0300
Valve Seat Driver	420-0308
Valve Seat Staker, Intake	420-0309
Valve Seat Staker, Exhaust	420-0310
Valve Seat Cutter	420-0311
Oil Seal Guide and Driver, Bearing Plate	420-0181
Oil Seal Guide and Driver, Gear Cover	420-0313
Timing Advance Mechanism Cover Driver	420-0296
Piston Ring Spreader	420-0146
Piston Groove Cleaner	420-0332

ENGINE TROUBLESHOOTING



INSTALLATION

The type of installation can affect the life of the engine, the cost of operation and the frequency of necessary service. Plan the installation carefully to ensure the best performance.

Because of the great variety of uses, and the many variations of the engine, these installation instructions are typical or general in nature. Use the installation recommendations given as a general guide.

MOUNTING

There are several acceptable methods of mounting the engine. Among factors to be considered are: location, method of coupling the engine to the load, type of foundation or support, etc. The engine should be mounted on a level surface if possible. Maximum operation angle is 15 degrees sideways, 30 degrees front to rear tilt. If the engine is to operate at an angle, be sure to re-mark the oil level indicator to compensate for the tilt.

VENTILATION

The engine must be provided with a supply of fresh air for cooling and for combustion.

Pressure Cooled Engine: Position the air inlet opening directly in front of the engine and as close to the engine blower wheel as possible. The area of the inlet should be not less than 80 square inches. If louvers or grill work are used, increase the area to compensate for the reduced air flow. Provide extra ventilation if the driven load generates heat during operation.

The heated air outlet must allow the heated air to escape freely and prevent recirculation with the cooling air. A duct between the compartment air inlet and the engine blower housing may be necessary. Locate the air outlet opposite the intake or at least at a 90 degree angle. The area of the outlet should be at least 15 percent larger than that of the inlet. Allow sufficient room on all sides to permit access for servicing.

Open Air Installation: For installations where the engine is operated outside, ventilation will be no problem. However, in protecting the engine from the elements, see that nothing obstructs the flow of air around the engine.

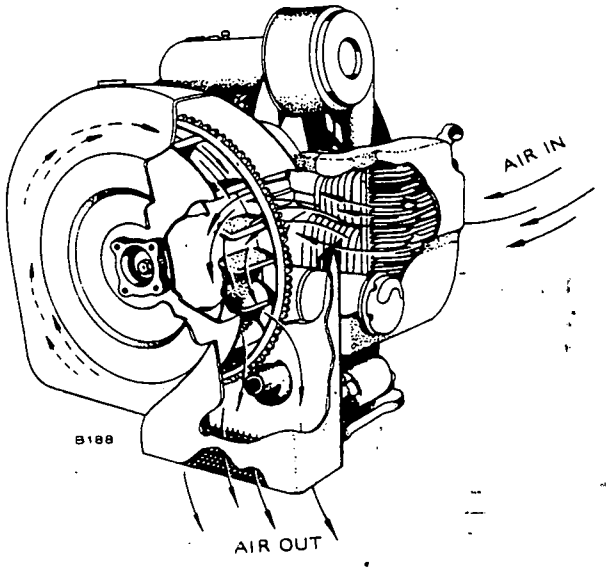


FIGURE 1. AIRFLOW THROUGH VACU-FLO SYSTEM

Vacu-Flo Cooled Engine: The vacu-flo, equipped engine uses an integral flywheel-centrifugal fan to pull cool air into the engine shroud and over the cooling fins and surfaces of the engine. Figure 1. The heated air is directed through an air tight scroll which encases the flywheel fan. The scroll may be positioned to discharge heated air in the downward, upward, left or right direction. This is possible because the back section of the scroll (Figure 2) has four identical holes shaped to fit over the end of the starter motor. The scroll outlet has a mesh-type screen for safety.

CAUTION **The outlet of the vacu-flo scroll must not be restricted or overheating will result. Engine overheating can cause troubles ranging from vapor lock to scored pistons and cylinders.**

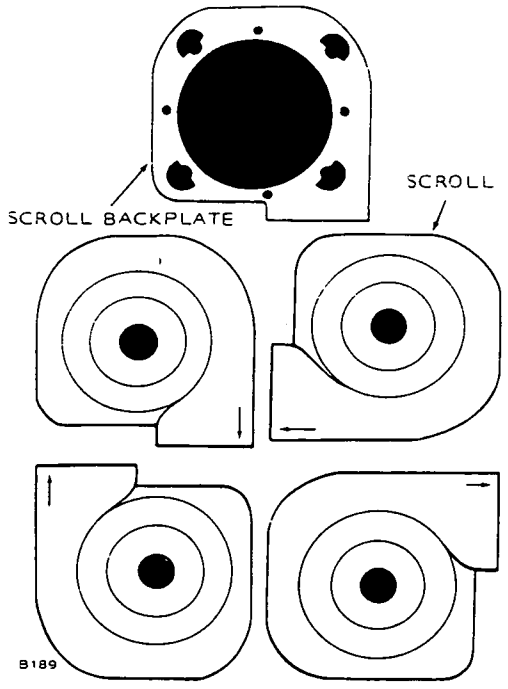


FIGURE 2. VACU-FLO SCROLL POSITIONS

Should a vacu-flo engine chronically overheat, the most likely sources of the problem are:

1. Air inlet is obstructed or too small to allow proper ventilation.
2. Air discharge opening is partially blocked by external ducts or exhaust systems.
3. Recirculation of heated air into fresh air inlet.

The vacu-flo installation permits greater freedom in choice of locating the air inlet and outlet openings, and permits the use of a compartment only slightly larger than the engine itself.

The area of the air inlet must be at least 140 square inches. If a filter, grille, or louvers are used, the inlet opening must be increased accordingly. The air outlet opening should be located as close to the engine as possible.

If the duct length exceeds 5 feet, increase duct size 30 percent. Use no more than two 90 degree radius-type (not square-type) elbows if it is necessary to change air flow direction. When a duct is used between the scroll discharge and the outlet vent, its unobstructed airflow area must be at least as large as the scroll discharge. The cross-sectional area of the duct must be increased if air flow is restricted by bends, long runs, screens or the exhaust pipe. Exhaust pipes running inside Vacu-Flo ducts should be covered with asbestos tape.

WARNING **The safety screen used to cover vents must be 1/4-inch mesh or larger to permit sufficient air flow, and must be commensurate with safety standards for hazardous moving parts to avoid personal contact. Provide a short canvas section between the engine air outlet and the external duct or opening, to absorb vibration. If operation in cold weather is likely, installing a shutter in the air outlet is advisable. Cold weather can cause overcooling if air flow is not regulated.**

EXHAUST

WARNING **Exhaust gases are toxic. Provide an adequate exhaust system to properly expel exhaust gases. Check exhaust system regularly for leaks. Ensure that exhaust manifolds are secure and not warped. Be sure the unit is well ventilated.**

Use a length of flexible tubing between the engine exhaust outlet and any rigid piping to absorb engine vibration. Shield the line if it passes through a combustible wall or partition. If turns are necessary, use sweeping type (long radius) elbows. Increase one pipe size (from manifold outlet size) for each additional ten feet in length. Locate the outlet away from the air intake.

CARBURETOR AIR INTAKE

Proper engine efficiency depends upon a supply of fresh air to the carburetor. Under special conditions, it may be necessary to move the air cleaner off the engine, using a longer connection hose as necessary. For extremely dusty or dirty conditions, install a special heavy duty air cleaner.

FUEL SYSTEM

The engine uses either a diaphragm or pulsating diaphragm type fuel pump. The fuel pump has a 1/8-inch pipe threaded inlet, fitted with a 1/4-inch inverted flare tube fitting. If a solid wall line is used, form a loop in the line, or install a section of flexible fuel hose, to absorb vibration. If a line with a pipe thread end is used, remove the flare type fitting from the fuel pump inlet.

The fuel supply tank may be installed in any safe, convenient location. If the tank is installed within the engine enclosure, provide a vent line to the outside of the enclosure.

The installation of a fuel filter between the fuel tank and the fuel pump is recommended. The fuel filter should be fitted with a shutoff valve and should be easily accessible for cleaning.

CONNECTING TO THE LOAD

The dimensions of various power takeoff shafts are as follows:

SHAFT	DIAMETER	LENGTH	KEY SIZE
STD	1-7/16	3-1/16	3/8
Rockford Clutch	1-7/16	3-1/16	3/8
Gear Reduction	1-1/4	2-3/4	1/4

Belt Drive: V-belts are preferable to flat belts. Consult a reliable belting supplier for recommendations regarding size of pulleys, number of belts, etc. required. A typical belt drive installation is shown in Figure 3.

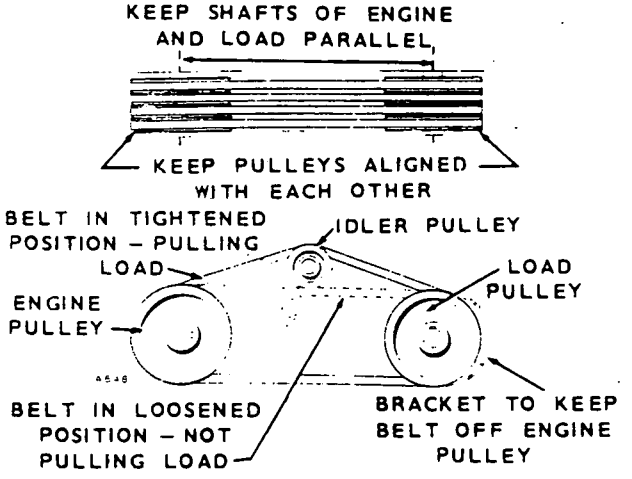


FIGURE 3. DRIVE BELT INSTALLATION

Comply with the following installation requirements:

1. The shafts of the engine and the load must be parallel with each other.
2. The pulleys of the engine and the load must be in alignment.
3. Mount the engine pulleys as close to the engine as possible.
4. If the installation permits, belts should run horizontally.
5. Some method of disconnecting the load for starting is recommended. If a clutch is not used, a belt-tightener idler arrangement can be used.

Flexible Coupling: If a flexible coupling engine-to-load drive is used, the load shaft must be in line and centered with the engine shaft (Figure 4).

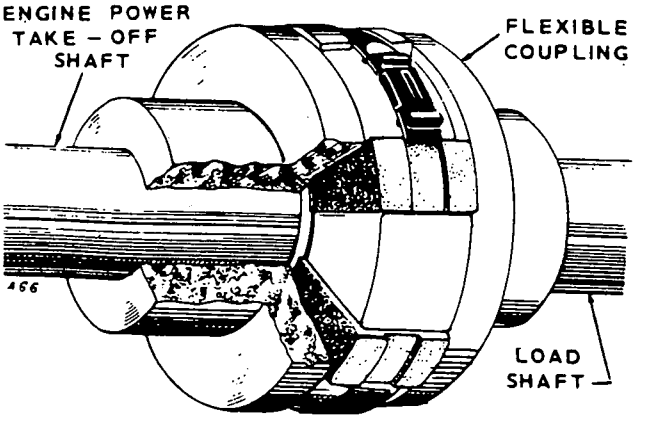


FIGURE 4. FLEXIBLE COUPLING

Reduction Gear Drive: Reduction gear drives are mounted at the factory (when ordered). The method of connecting the load is the same as when connecting directly to the engine shaft.

Clutch Installation: A Rockford Clutch can be installed at the factory or in the field. Install the clutch according to the following instructions and Figure 5.

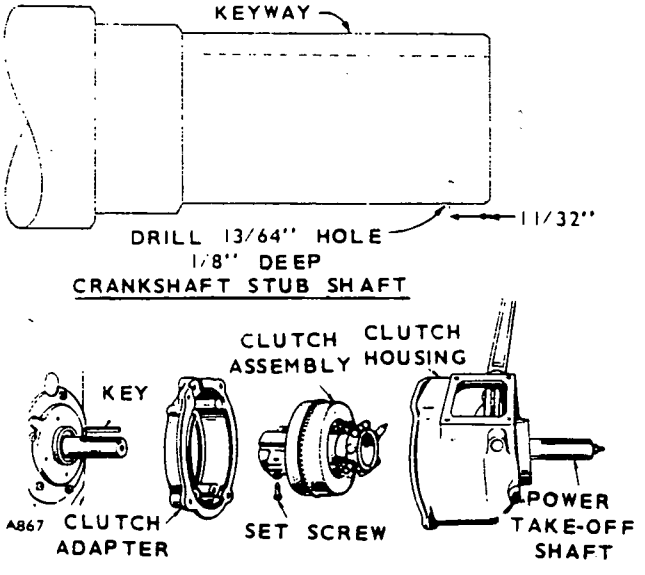


FIGURE 5. CLUTCH INSTALLATION

Provide room for the clutch adapter casting by plugging the wet holes with a 3/8-16 x 1/2-inch slotted headless set screw. Apply sealing compound to the threads and install screw flush with the cylinder block.

Drill a 13/64-inch hole (or filed slot) in the crankshaft for the clutch set screw. Locate center of hole 11/32-inch from the end and directly opposite the keyway in the crankshaft.

Install the clutch adapter, with drain slot downward, using two cap screws 3/8-16 x 2-inches on the lower and one cap screw 3/8-16 x 1-3/4-inch on the upper #2 cylinder side (cylinder nearer clutch). Install the 3/8 x 3-7/8-inch stud through the adapter into the engine block upper remaining hole. Use a lock washer on each assembly screw. Use a flat washer and a lock washer under the stud nut.

Install the crankshaft key. Remove the clutch set screw. Install the clutch assembly (less housing) to the crankshaft, driving it on carefully with a soft-faced hammer until set screw hole is aligned. Install set screw to bottom in crankshaft hole, then back it out one full turn. Tighten clutch retaining screws until clutch is clamped securely to crankshaft. Lock the screws and tighten the set screw.

Apply grease to splined power takeoff shaft. Position the clutch throw-out to align the grease fitting with the hole in the housing (#1 cylinder side, horizontal). Pull the throw-out collar outward to remove tension.

Install the clutch housing so that the clutch throw-out fork engages the throw-out collar. Be sure the serrated shaft is properly meshed with the clutch plate. Use two cap screws 7/16-14 x 2-inches on the lower and one cap screw 7/16-14 x 1-3/3-inch on the upper #2 cylinder side. Install the stud washer and nut. Lubricate the two grease fittings just until grease appears.

BATTERY CONNECTIONS (Engines with Automotive Type Separate Starter)

Connect the 12 volt battery positive cable to the engine start switch terminal. Connect the battery negative cable to the ground point on the engine oil base (Figure 6).

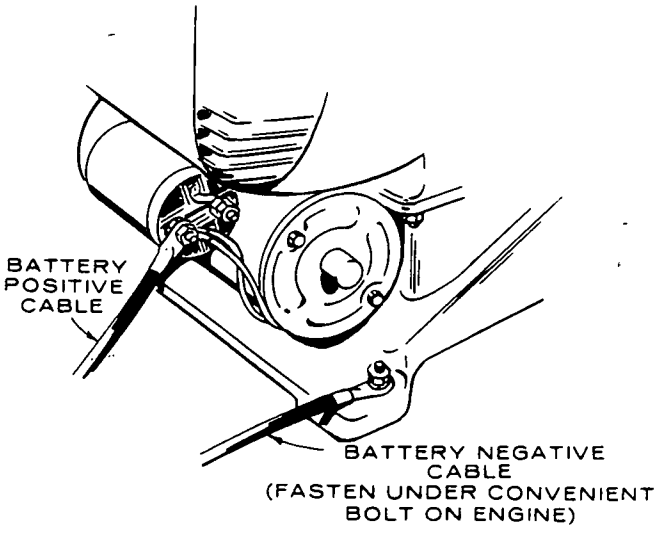


FIGURE 6. BATTERY CONNECTIONS

OPERATION

BEFORE STARTING

Crankcase Oil: Be sure the crankcase has been filled with oil to the "FULL" mark on the oil level indicator. Use oil with the API (American Petroleum Institute) designation SE or SE/CC. Do not use an oil with the designation CD unless it is also designated SE and the oil manufacturer certifies it will perform satisfactorily in gasoline engines.

Recommended Fuel: Use clean, regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using nonleaded gasoline. For older engines that have previously used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to nonleaded gasoline.

CAUTION **If lead deposits are not removed from engine before switching from leaded to nonleaded gasoline, preignition could occur causing severe damage to the engine.**

WARNING **Never fill the tank when the engine is running. Leave some space in the tank for fuel expansion.**

Open the fuel line valve (when used) and operate primer to assure fuel supply after filling an empty tank.

STARTING (Electric Start)

1. Move ignition switch to its ON position.
2. Push START button to crank engine.

If the engine fails to start at first attempt, inhibitor oil used at the factory may have fouled the spark plugs. Remove the plugs, clean in suitable solvent, dry thoroughly and install. Heavy exhaust smoke when the engine is first started is normal and is caused by inhibitor oil.

STARTING (Manual Start)

1. Hold choke about three quarter way closed or as necessary according to temperature conditions.
2. Pull start rope with a fast steady pull to crank engine. Do not jerk.
3. Open choke as engine warms up.

APPLYING LOAD

When applying the load to a new or reconditioned engine, it should be applied gradually in about four steps; each step of not less than 30 minutes running time. Start with 1/4 load, then 1/2, 3/4 and full load.

BATTERY CHARGING

The battery charge rate is controlled by a charge regulator. The regulator is set to allow the proper rate of charge at operating speed.

STOPPING THE ENGINE

Disconnect all load before stopping the engine. Engines equipped with battery ignition are stopped by positioning the ignition switch to the OFF position.

HIGH TEMPERATURES

1. See that nothing obstructs air flow to and from the engine.
2. Keep cooling fins clean. Air housing should be properly installed and undamaged.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow, but use care to avoid overheating.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often than recommended under normal conditions.
4. Keep oil and gasoline in dust tight containers.
5. Keep governor linkage clean.

HIGH ALTITUDE

For operation at altitudes of 2500 feet or more, close the carburetor main jet adjustment slightly to maintain proper air-to-fuel ratio. Refer to the *Fuel System* section. Maximum power will be reduced about 4 percent for each 1000 feet increase in altitude.

PROTECTION FOR EXTENDED OUT-OF-SERVICE PERIOD

Protect an engine that is to be out-of-service for more than 30 days as follows:

1. Run engine until thoroughly warmed up.
2. Turn off fuel supply and run until engine stops from lack of fuel.
3. Drain oil from oil base while still warm. Attach a warning tag to refill before operation.
4. Remove each spark plug. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50) oil into cylinder. Crank engine over a few times to distribute oil film on cylinder walls and rings. Reinstall each spark plug.
5. Service air cleaner per maintenance schedule.
6. Lubricate governor linkage. Protect against dust, etc. by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of bugs, moisture, or dirt.
8. Wipe entire unit clean. Coat parts likely to rust with a light film of grease or oil.
9. Provide a suitable cover for entire unit.
10. Disconnect battery and follow standard battery storage procedure.

CAUTION **Discharged batteries are subject to severe damage if exposed to freezing temperatures. Store all batteries in a fully charged condition and maintain charge during storage.**

RETURNING THE SET TO OPERATION

1. CHECK SERVICE IDENTIFICATION TAGS to properly service the engine.
2. Uncover and remove all storage seals from engine. Remove any dust, dirt, or foreign matter.
3. CHECK fuel supply tanks for moisture accumulations (drain tanks if necessary). CHECK lubricating oil for moisture or contamination (drain if necessary). CHECK fuel line connections, all wiring connections, and exhaust line connections.
4. Service air cleaner. Bleed fuel system (if moisture or contamination are found in fuel, replace filters and clean fuel pump sediment bowl).
5. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
6. Clean and check battery. Measure specific gravity (1.260 at 25° C [77° F]) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct.DO NOT OVERCHARGE.

   WARNING **Do not smoke while servicing batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.**
7. Check engine for fuel or oil leaks. Correct leakage as required.
8. Install fully charged batteries.
9. Start engine and check while running for leaks, correct voltage output, and proper cooling.

After engine has started, excessive blue smoke will be exhausted and the engine will run rough until the rust inhibitor or oil has burned away.

PERIODIC MAINTENANCE

TABLE 1. PERIODIC MAINTENANCE SCHEDULE

SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS						
	8	50	100	200	500	1000	5000
* Inspect Engine Generally	x						
Check Fuel Supply	x						
Check Oil Level	x						
Clean Governor Linkage		x*					
Change Crankcase Oil		x1	x*				
Check Breaker Points			x				
Check Battery Electrolyte Level			x				
Clean Fuel Filter			x				
Check Spark Plugs			x				
Replace Oil Filter				x*			
Replace Air Cleaner				x*			
Remove Deposits in Combustion Chamber					x		
Check Valve Clearance				x1	x		
Inspect Valves, Grind if Necessary						x	
Complete Reconditioning							x

* - Check for exhaust leaks, fuel leaks, proper mounting, etc.
x* - Perform more often under dusty or extreme cold weather conditions.
x1 - Recommended interval in hot weather or heavily loaded conditions.

PERIODIC MAINTENANCE SCHEDULE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The schedule (Table 1) can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, etc. frequently until the proper service time periods can be established. When any abnormalities occur in operation—unusual noises from engine or accessories, loss of power, overheating, etc.—contact your Onan dealer.

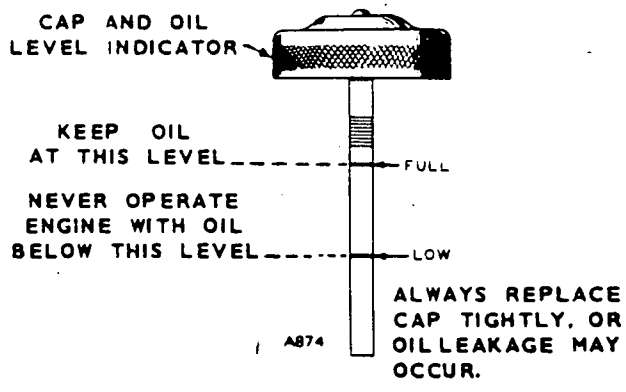


FIGURE 7. OIL LEVEL INDICATOR

CRANKCASE OIL

The oil capacity is 3-1/2 U.S. quarts (4 with filter). Fill to the "FULL" mark on the oil level indicator, Figure 7.

When adding oil between changes, always use the same brand and weight that is in the crankcase. Various brands of oil may not be compatible when mixed together.

Oil consumption may be higher with a multigrade oil than with a single grade oil if both oils have comparable viscosities at 210° F. Therefore, single grade oils are generally more desirable, unless anticipating a wide range of temperatures. Use the proper grade oil for the expected conditions.

TEMPERATURE	GRADE
Below 0°	5W
0° to 30°	10W
30° to 90°	30
Above 90°	50

Check oil level daily. Change oil every 100 hours under normal operating conditions. When operating in extremely dusty or dirty conditions, change oil more often.

OIL FILTER

Change the crankcase oil filter every 200 hours. Remove the filter (Figure 8) by turning counterclockwise, using a filter wrench. Add the strip provided with the filter to prevent air loss in the area indicated. It is advisable to wipe dry the drip pan located below the filter. Coat rubber gasket on filter with a film of oil before installing. Install the filter finger-tight plus 1/4 to 1/2 turn. If oil becomes so dirty that the markings on the oil level indicator cannot be seen, change the filter and shorten the filter service period.

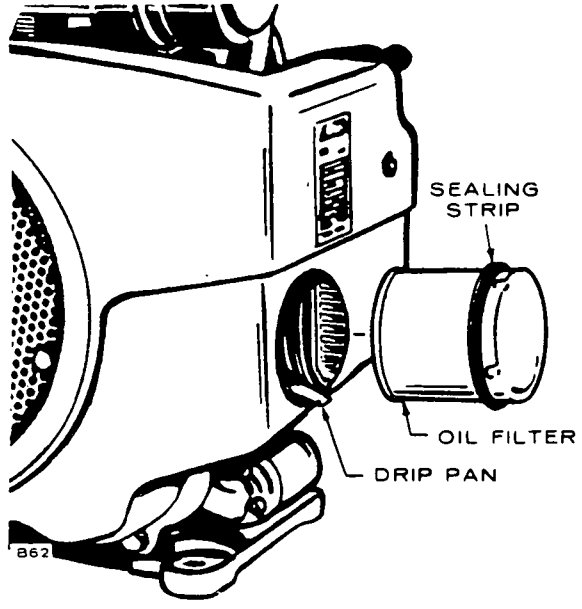


FIGURE 8. OIL FILTER LOCATION

CRANKCASE BREATHER

The engine is equipped with a ball check valve (Figure 9) for maintaining crankcase vacuum. No maintenance is generally required. Should the crankcase become pressurized, as evidenced by oil leaks at the seals or around the cap of the oil level indicator, clean baffle in suitable solvent.

Clean or replace crankcase breather baffle periodically. Be sure baffle material doesn't come apart and work into the manifold.

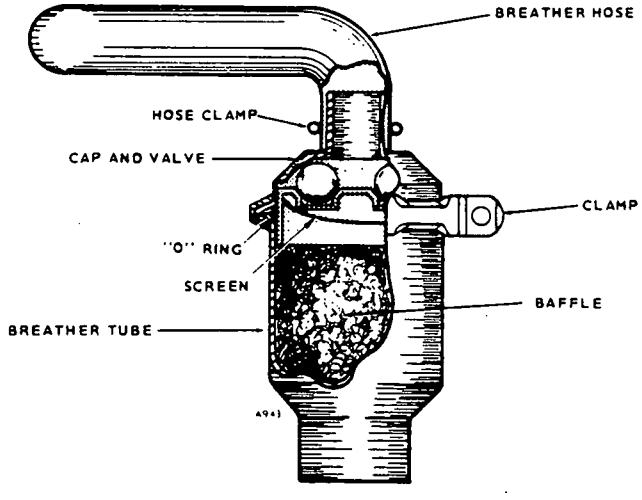


FIGURE 9. CRANKCASE BREATHER

AIR CLEANER

The NHC engine uses a replaceable, spin-on air cleaner, Figure 10. Remove and replace every 200 hours.

CAUTION **Do not run engine with air cleaner removed. Intake of dirty air or solid materials could cause severe damage to engine parts.**

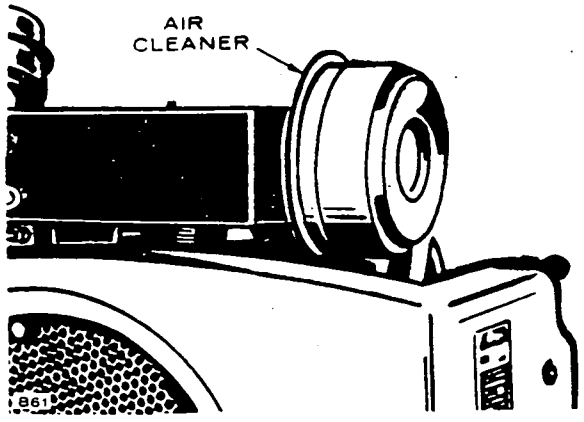


FIGURE 10. AIR CLEANER

GOVERNOR LINKAGE

The linkage must be able to move freely through its entire travel. Every 50 hours of operation clean the metal joints as shown in Figure 11. Also inspect the linkage for binding, excessive slack and wear.

Clean and lubricate metal ball joints. Don't lubricate plastic joints.

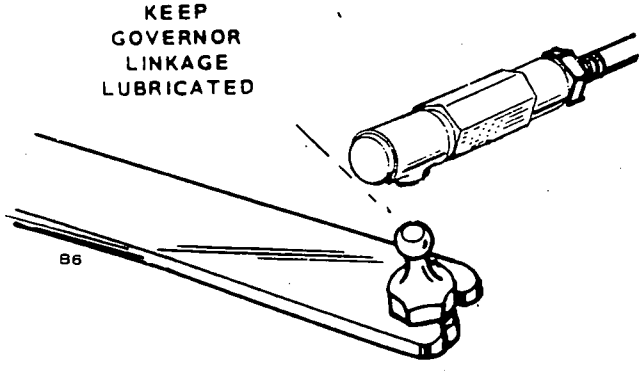


FIGURE 11. GOVERNOR LINKAGE

REDUCTION GEAR DRIVE

Drain the gear box after the first 100 hours of operation and refill with fresh lubricant of the recommended grade. Repeat this procedure every six months thereafter, or every 100 hours.

Use only SAE 50 motor oil or SAE 90 mineral gear oil. Do not use lubricants commonly known as extreme pressure lubricants, hypoid lubricants, etc.

Maintain the proper oil level between changes. Overfilling will cause foaming, which can lead to an oil leak due to overheating. Remove the filler plug on top of the case and the oil level plug from the face of the gear case. Fill the case until the oil just begins to flow from the oil level plug hole. Gear box holds 1/2 pint U.S. measure. Replace both plugs. See Figure 12.

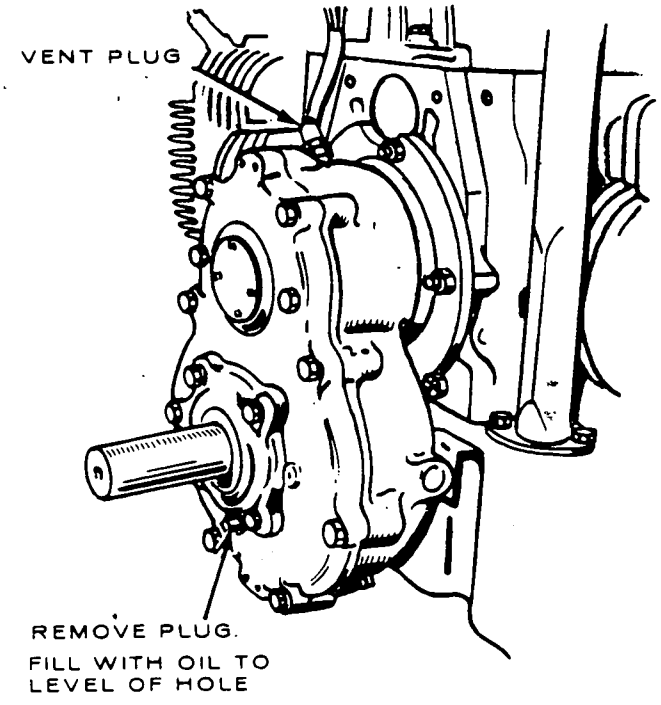


FIGURE 12. REDUCTION GEAR DRIVE

EXHAUST SYSTEM

Make regular inspections of the exhaust system throughout the entire life of the engine. Locate leaks in muffler and piping while the engine is operating. Repair all leaks immediately after they are detected for personnel safety.

WARNING **Leaky exhaust systems emit noxious carbon monoxide fumes which are a potential safety hazard in enclosed areas.**

BATTERY

Check charge condition. Check electrolyte level. Add distilled water to keep electrolyte at its proper level. In freezing weather, run engine immediately after adding water. Keep battery connections tight and clean.

FUEL SYSTEM

GASOLINE CARBURETOR

For correction of problems traced to the gasoline carburetor, use the appropriate procedures selected from the following sequence, referring to Figures 13 and 14.

Adjustment Under Load: Adjust the carburetor as follows when a full load can be applied.

1. Make sure the ignition system is working properly and that the governor is adjusted.
2. Start the engine and allow it to warm up. If the carburetor is so far out of adjustment that the engine will not start, close both needle valves gently to their seats. Then open each 1 to 1-1/2 turns, first the idle and then the main adjustment.
3. With no load applied to engine, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until the engine speed returns to normal.
4. Apply a full load to the engine and then carefully turn the main adjustment in until the speed drops slightly below normal. Turn the needle out until the engine speed returns to normal.

Adjustment Under "No Load" Conditions: When a load cannot be applied, adjust the carburetor as follows:

1. Perform steps 1 and 2 as given under *Adjustment Under Load.*
2. Pull out on the governor mechanism to slow the unit down to about 800 to 900 rpm.

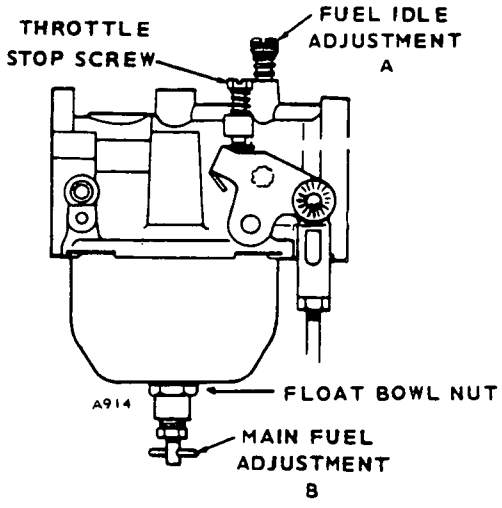


FIGURE 14. CARBURETOR ADJUSTMENTS

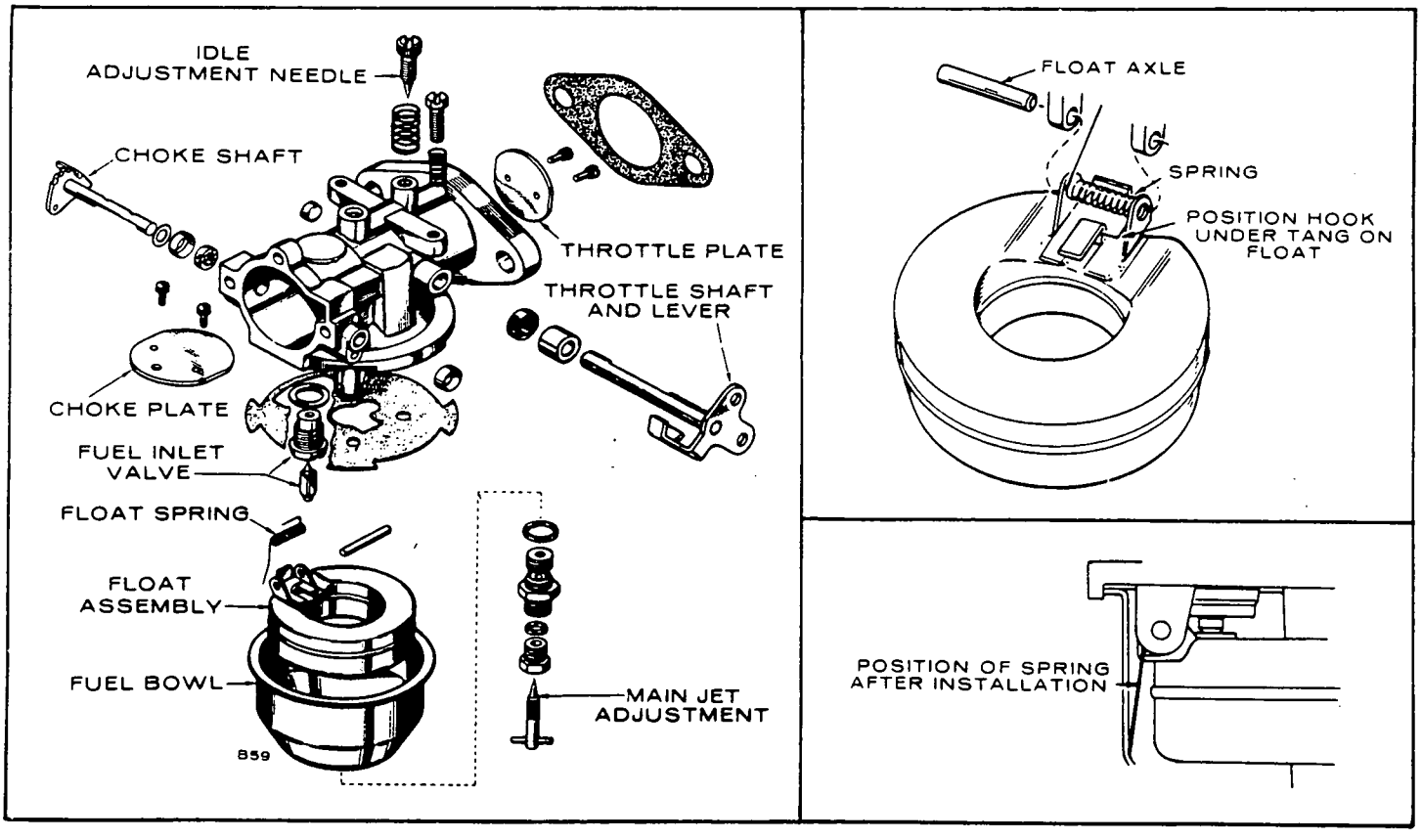


FIGURE 13. CARBURETOR ASSEMBLY

3. Set the idle adjustment screw for even operation (so the engine is firing on both cylinders and is running smoothly).
4. Release the governor mechanism to allow the engine to accelerate. If the engine accelerates evenly and without a lag, the main adjustment is correct. If not, adjust the needle outward about 1/4 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.
5. With the carburetor and governor adjusted, set the throttle stop screw at the desired idle speed.

Float-Level Check: If the carburetor adjustment fails to provide satisfactory operation, remove the carburetor and check the float level as follows:

1. Remove the fuel line, air cleaner hose, governor linkage and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Unscrew the float bowl nut and remove the entire main fuel adjustment assembly from the float bowl.
4. Invert the carburetor and check that the float surface nearest the gasket is 1/8 ± 1/16-inch from the gasket. Bend the float tab as required to produce this spacing.

   If the carburetor utilizes an internally spring loaded fuel inlet valve, the float surface should be 1/8 ± 1/16-inch from the gasket with the full weight of the float compressing the spring in the needle.
5. Reassemble, install and test.
6. See Figure 15.

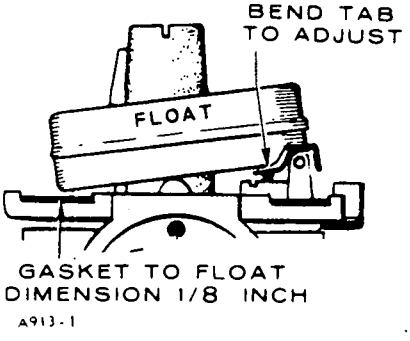


FIGURE 15. FLOAT LEVEL ADJUSTMENT

Carburetor Removal and Disassembly: Remove and disassemble the carburetor assembly as follows, referring to Figure 15:

1. Remove the fuel line, air cleaner hose, governor linkage, and choke wires.
2. Remove the two carburetor mounting nuts and remove the carburetor.
3. Remove the main jet assembly and bowl.
4. Remove the float pin and float.
5. Lift out the fuel inlet valve and unscrew the valve seat.
6. Remove the idle adjustment needle.
7. Remove the throttle plate screws and the plate, then pull out the throttle shaft.
8. Remove the choke plate screws and plate, then pull out the choke shaft.

Carburetor Assembly and Installation: Clean the components and repair or replace defective or worn parts. Use acetone or alcohol to dissolve gum deposits if carburetor cleaner is not effective. Soak the parts in carburetor cleaner, using it as directed by the manufacturer. Clean all carbon from the carburetor bowl, especially in the area of the throttle plate. Blow out clogged passages with compressed air. Check the needles, nozzle, and float for damage or fuel loading. Check the choke and throttle shafts. Reassemble and install as follows:

1. Install the throttle shaft and plate, using new screws and lock washers. Install with bevel mated to the carburetor body. If the plate is marked with the letter C, install it with the mark on the side toward the idle port when viewed from the flange end of the carburetor. To center the plate, back off the top screw, close the throttle lever and then set the plate by tapping it with a small screwdriver.
2. Install the choke shaft and plate. Center the plate in the same manner as the throttle plate (see step 1). Use new screws and lock washers.
3. Install the fuel inlet valve seat and valve.
4. Install the float and float pin, adjusting the float as previously described.
5. Install the bowl ring gasket, bowl and bowl nut. Make sure that the bowl is centered in the gasket and tighten the main jet assembly securely. Turn in until it seats and back out to 1-1/2 turns.
6. Install the idle adjusting screw finger-tight. Then back it out 1 to 1-1/2 turns.
7. Install the choke and adjust as previously described.
8. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism, air cleaner hose, and choke wires.
9. Adjust the carburetor needle settings as described under *Adjustments* and check out the performance.

Complete Replacement: Complete replacement of the carburetor should be performed as follows:

1. Follow the previously given disassembly instructions as required for removal of the defective carburetor.
2. Replace the carburetor with a new unit, using attaching parts in good condition and making all the connections previously disengaged.
3. Adjust the needle settings as described under *Adjustments.*

DIAPHRAGM FUEL PUMP

Some engines use a diaphragm-type fuel pump, Figure 16. If fuel does not reach the carburetor, check the fuel pump before dismantling it.

1. Disconnect the fuel line at the carburetor.
2. Crank the engine and observe whether fuel comes from the line at the carburetor.

WARNING **Be sure to direct the fuel flow into a container so gasoline does not spill on ignition wires.**

3. If there is enough fuel in the tank, and line does not have fuel flowing, the pump needs replacing.

Pump failure is usually caused by a leaking diaphragm, valve or valve gasket, a weak or broken spring or wear in the drive linkage. Gasoline diluted oil may also indicate a faulty pump.

Always return the hand priming lever all the way inward so that lever does not prevent normal operation of fuel pump.

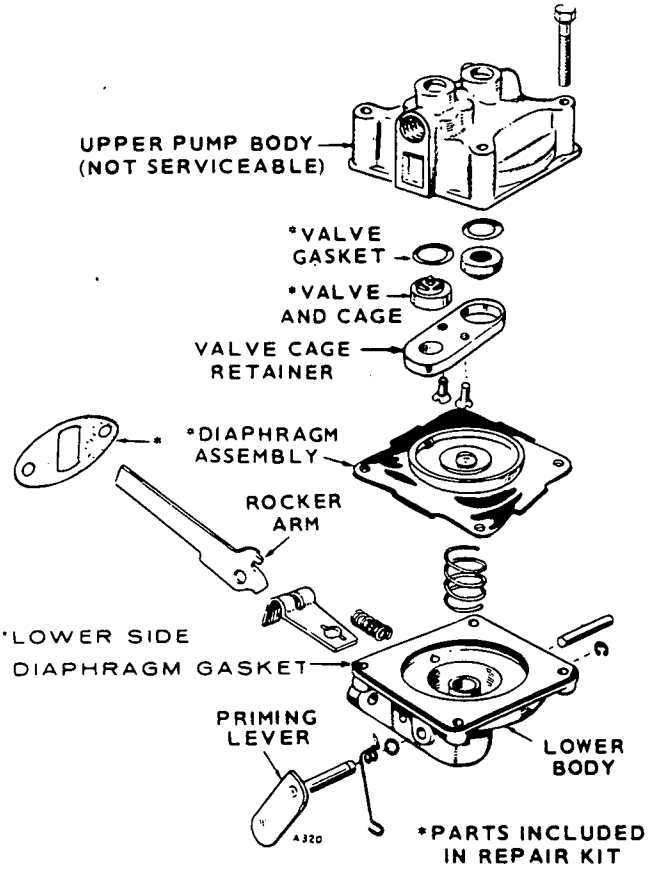


FIGURE 16. DIAPHRAGM FUEL PUMP

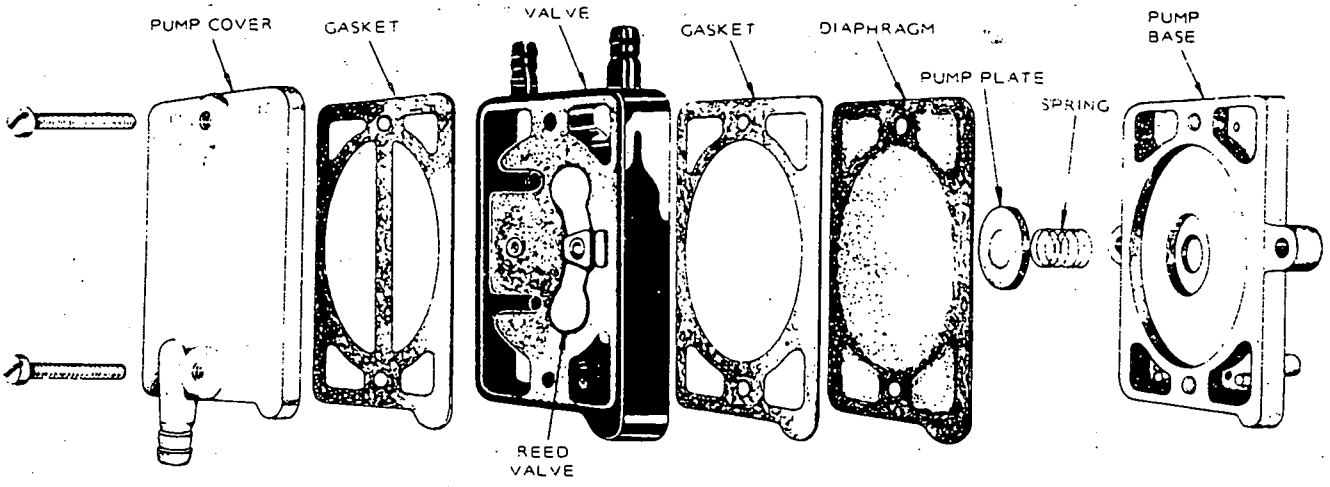
Fuel Pump Reconditioning: Reconditioning of the fuel pump should be as follows, referring to Figure 16.

1. Remove the fuel lines and mounting screws holding the pump to the engine.
2. Make an indicating mark with a file across a point at the union of the fuel pump bolt and cover. Remove the assembly screws and the upper pump body.
3. Turn the pump body over and remove the valve plate screw and washer. Remove the valve retainer, valves, valve springs, and valve gasket, noting their position. Discard the valve springs, valves and valve retainer gasket.
4. Clean the pump body thoroughly with a solvent and a fine wire brush.
5. Holding the pump cover with the diaphragm surface up, place the new valve gasket in the cavity. Assemble the valves in the cavity. Reassemble valve retainer. Lock in position by inserting and tightening the fuel pump retainer screw.
6. Place the pump body assembly in a clean work area and rebuild the lower diaphragm section.
7. Holding the mounting bracket, press down on the diaphragm to compress the spring under it, then turn the bracket 90 degrees to unhook the diaphragm so it can be removed.
8. Clean the mounting bracket with a solvent and a fine wire brush.
9. Replace the diaphragm operating spring, stand the new spring in the casting, and position the diaphragm. Press down on the diaphragm to compress the spring and turn it 90 degrees. This will reconnect the diaphragm.
10. Hold the bracket, place the pump cover on it (making sure the indicating file marks are in line) and insert the four attaching screws but do not tighten. With the hand on the mounting bracket only, push the pump lever to the limit of its travel and hold in this position while then tightening the four screws. This is important to prevent stretching the diaphragm.
11. Mount the fuel pump on the engine, using new mounting gaskets. Connect the fuel lines.

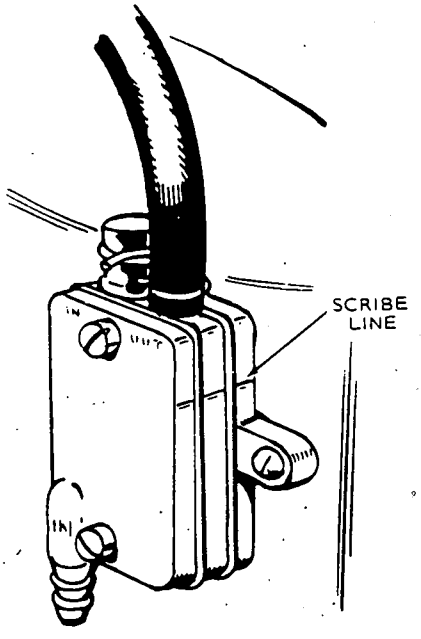
PULSATING DIAPHRAGM FUEL PUMP

Pulsating diaphragm fuel pumps (Figure 17) use a combination of crankcase and spring pressure to work a diaphragm thus pumping fuel. This pump may be mounted on the engine rear housing on NHCV models and on the upper right hand corner of the blower housing on NHC models. See Figure 17.

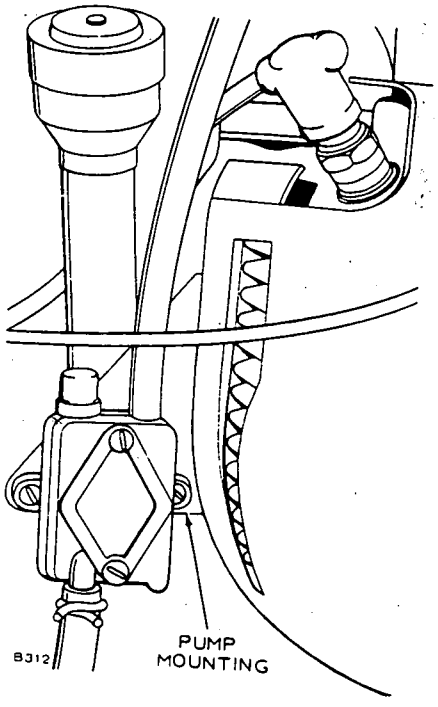
On the downstroke of the engine piston, when the crankcase pressure is greatest, the pump diaphragm is forced back against the diaphragm spring compressing it and drawing fuel into the pump intake chamber. The fuel then passes through the intake reed valve into the output chamber side of the pump. On the compression stroke, when crankcase pressure is the lowest, the diaphragm spring forces the



PULSATING DIAPHRAGM FUEL PUMP (EXPLODED VIEW)



PUMP MOUNTS ON NHC BLOWER HOUSING



PUMP MOUNTS ON NHCV ENGINE REAR HOUSING

FIGURE 17. PULSATING DIAPHRAGM FUEL PUMP

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diaphragm out pushing fuel through the pump output reed valve into the output chamber and into the fuel line.

Servicing the Pulsating Diaphragm Fuel Pump

1. Remove vacuum and fuel lines. Inspect lines for wear, cracking, etc.
2. Scribe two lines (one each on opposite ends of pump) across pump parts. This will insure correct alignment of pump parts with each other and carburetor when pump is reassembled.
3. Remove fuel pump attaching screws.
4. Holding pump carefully, pull sections of the pump apart. The diaphragm, plunger, return spring and plate, pump body and gaskets will now be loose.
5. Check parts for wear and damage. Replace with new parts where necessary.
6. The pump air bleed hole in pump base must be unclogged to allow unrestricted movement of pump diaphragm.

CAUTION **A clogged diaphragm air bleed hole can cause diaphragm wear and seal damage while inhibiting pump operation.**

7. Replace gaskets and reassemble pump as shown in Figure 17.
8. Install pump and replace lines. Make sure fuel line clamps are replaced on fuel line.

WARNING **Use care when reassembling the pump. All parts must be perfectly aligned or the pump will leak creating a fire hazard.**

THERMO-MAGNETIC CHOKE (Optional)

This choke uses a strip heating element and a heat sensitive bimetal spring to control the choke plate position. In addition to this, a solenoid is actuated during engine cranking, closing the choke all or part way, depending on ambient temperature. The bimetal is factory set to position the choke to the proper opening under any ambient condition.

Choke Adjustment: If adjustment of the bimetal is needed, it must be made at ambient temperature. Do not attempt adjustments until engine has been shut down for at least one hour. Loosen the screw which secures the choke body assembly. Refer to Figure 18.

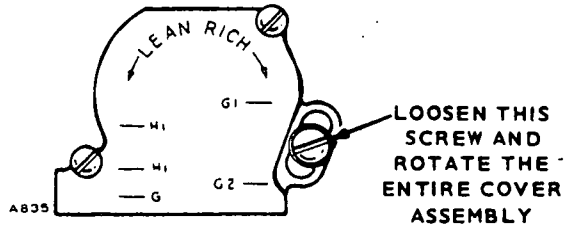


FIGURE 18. THERMO-MAGNETIC CHOKE

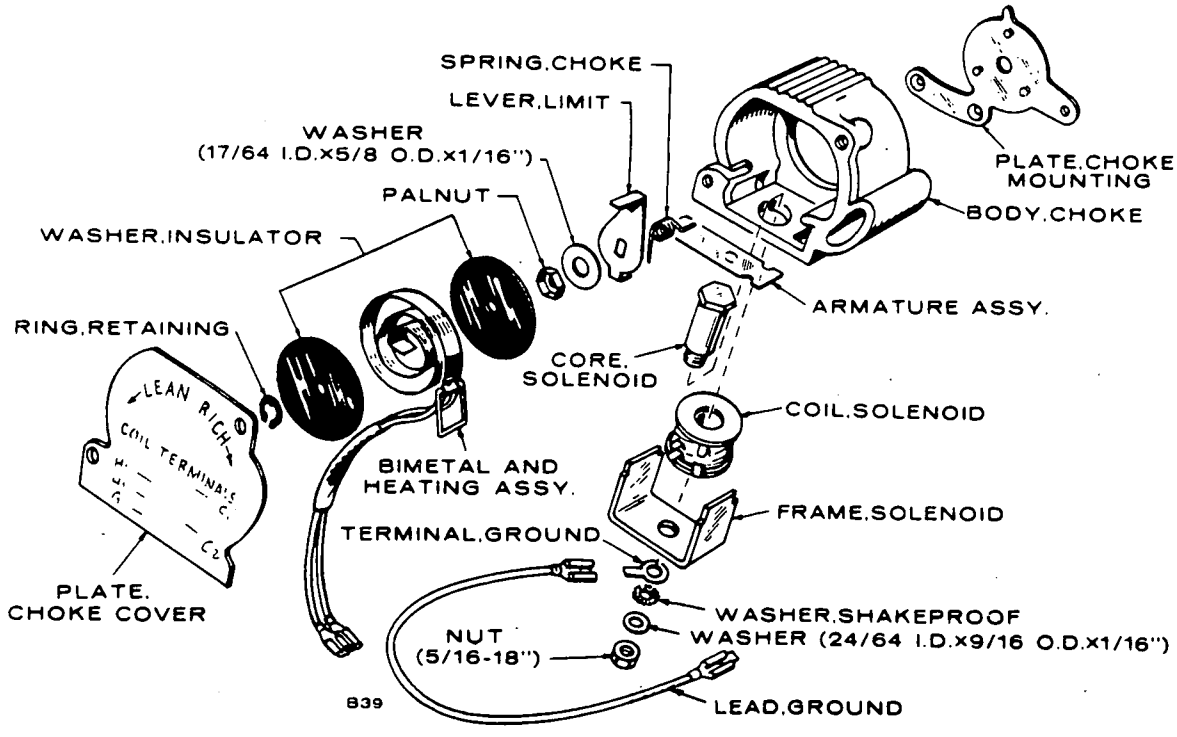


FIGURE 19. CHOKE ASSEMBLY

Rotating the choke body clockwise richens and counterclockwise leans the choking effect. For ambient temperatures above 85° F, the choke should be fully opened. For ambient temperatures below 25° F, the choke should be opened 1/4 inch with the solenoid not engaged. Tighten the screw that secures the choke body.

If the choke will not close, check for binding, incorrect adjustment, or incorrect assembly of the bimetal and heater assembly. If the choke will not open after the engine starts, check for heating. The choke bimetal should be warm to the touch within a minute or two after starting.

To disassemble the choke, refer to Figure 19.

If the heater assembly will not heat properly, check for broken heater wire, high resistance connections or broken lead wires to the bimetal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 37.8 to 46.2 ohms for a 12 volt system. If the heater is defective, replace. There must be slack in the lead wires between the choke body and the bimetal and heater assembly. When the start button is engaged, the solenoid should cause the spring loaded lever to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid core.

The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 12 volt system.

Assembly: Refer to Figure 19. When assembling the thermomagnetic choke, connect the bimetal and heater assembly as follows:

1. Lead tagged G to ground terminal in coil solenoid.
2. Lead tagged H to either of the H1 terminals on the solenoid core.

GOVERNOR SYSTEM

GOVERNOR ADJUSTMENT

Where engine speed is governor controlled, the governor is set at the factory to allow a nominal engine speed of 2400 rpm at no load operation (unless another speed is specified when the engine is ordered). Proper governor adjustment is one of the most important factors in maintaining the power and speed desired from the engine.

Before making governor adjustment, run the engine about 15 minutes to reach normal operating temperature.

It is difficult to determine if, after long usage, the governor spring has become fatigued. If, after properly making all other adjustments, the regulation is still erratic, install a new spring (Figure 20 and 21).

A tachometer for checking engine speed is required for accurate governor adjustment.

Check the governor arm, linkage, throttle shaft and lever for binding or excessive wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor.

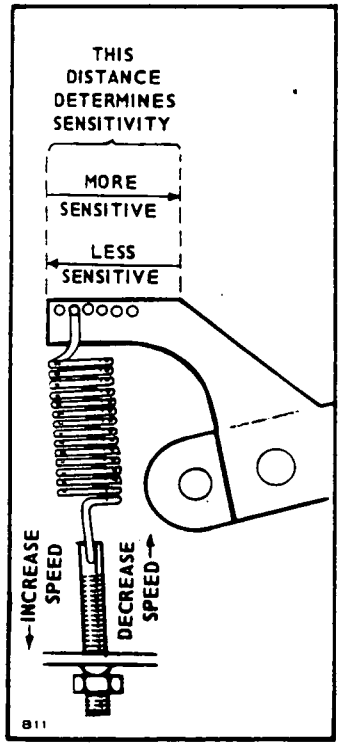
Excessive looseness will cause a hunting condition and regulation will be erratic. Work the arm back and forth several times by hand while the engine idles. If either of these conditions exist, determine the cause and adjust or replace parts as needed.

Procedure:

1. Adjust the carburetor main jet for the best fuel mixture at full load operation.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage.
4. Check the governor linkage and throttle shaft for binding or excessive looseness.
5. Adjust the governor spring tension for nominal engine speed at no load operation.
6. Check the rpm drop between no load and full load operation and adjust the governor sensitivity as needed.
7. Recheck the speed adjustment.
8. Set the carburetor throttle stop screw.

Linkage: The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle arm is adjusted by rotating the ball joint housing. Adjust the length so that with the engine stopped and tension on the governor spring, the stop on the carburetor throttle lever is 1/32-inch from the carburetor stop boss. This setting allows immediate control by the governor after starting and synchronizes travel of the governor arm and the throttle shaft.

Speed Adjustment: The speed at which the engine operates is determined by the tension applied to the governor spring. Increasing spring tension increases



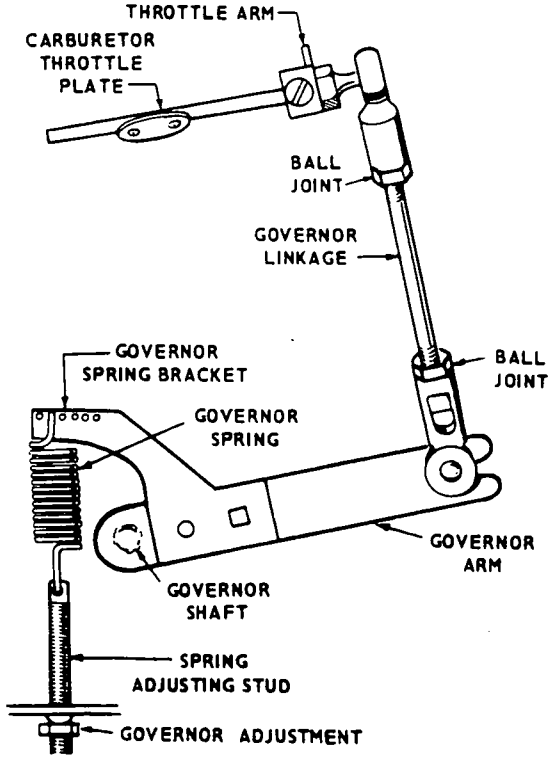


FIGURE 20. GOVERNOR ADJUSTMENTS

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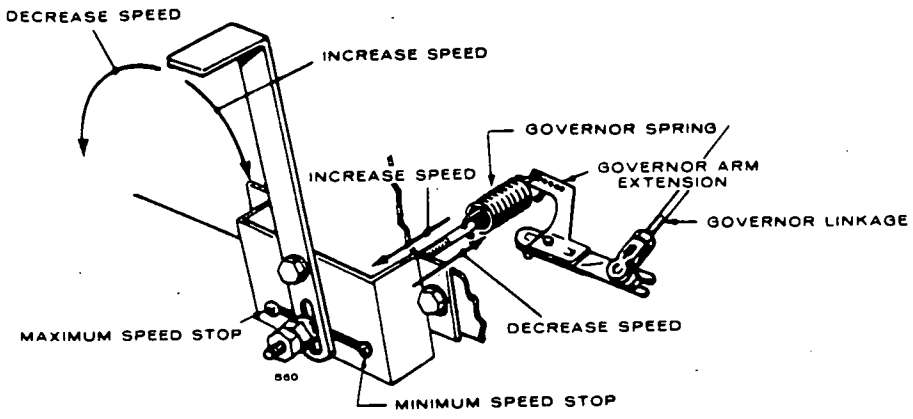

FIGURE 21. VARIABLE SPEED GOVERNORS

engine speed. Decreasing spring tension decreases engine speed. The no load speed of the engine should be slightly higher than the speed requirements of the connected load. For example: If the connected load is to turn at 3510 rpm, set the no load speed of the engine at about 3600 rpm. Check speed with a tachometer.

If a speed adjustment is needed, turn the speed adjusting nut in to increase the speed or out to decrease the speed (Figure 21).

Sensitivity Adjustment: The engine speed drop from no load to full load should be not less than 100 rpm. Check the engine speed with no load connected and again after connecting full load. Do not exceed 4000 rpm at no load.

The sensitivity of the governor depends upon the position of the arm end of the governor spring. A series of holes in the governor arm provides for adjustment. To increase sensitivity, move the spring toward the governor shaft. To decrease sensitivity, move the spring toward the linkage end of the governor arm.

If the setting is too sensitive, a hunting condition (alternate increase and decrease in engine speed) will result. If the setting is not sensitive enough, the speed variation between no load and full load conditions will be too great. Therefore, the correct sensitivity will result in the most stable speed regulation without causing a surge condition.

Always recheck the speed adjustment after a sensitivity adjustment. Increasing sensitivity will cause a slight decrease in speed and will require a slight increase in the governor spring tension.

Variable Speed Governor Adjustments: These engines are adapted for use where a wide range of speed settings is desired. The design of the variable speed governors give an automatic increase in sensitivity when the speed is increased and the result is good stability at all speeds.

To adjust the variable speed governors, refer to Figure 21 and the following:

1. Run the engine and make necessary carburetor adjustments.
2. Adjust the throttle stop screw on the carburetor to allow a recommended minimum idling speed of 900 rpm. A lower minimum does not assure smooth operation under load.
3. Adjust the tension of the governor spring for minimum speed.

   For governors having a manual control arm, set lever to minimum speed with no load and adjust the spring tension for about 1500 rpm.

   For governors having a Bowdin wire remote control knob (NHC engines with mounted engine controls), pull back the knob and slide to the first notch (low speed). Adjust speed to about 1500 rpm (or the desired low speed) at no load by turning the knob as required.

4. Adjust the sensitivity while operating at minimum speed to attain the smoothest no load to full load operation as follows:

   To decrease sensitivity (allow more speed drop from no load to full load operation) move the governor spring outward into a different groove or hole in the extension arm.

   To increase sensitivity (closer regulation by the governor which permits less speed drop from no load to full load operation), move the governor spring inward into a different groove or hole in the extension arm.
5. Apply a full load and shift the variable control to maximum speed—moving the control arm to the right or shifting the control knob and slide to the second notch. For the governor control with the control arm, set the screw in the bracket slot to stop lever travel at the desired maximum full load speed position. For the control with the control knob and slide, increase or decrease speed by turning the knob as required.

Approximately 3000 rpm is the recommended maximum full load speed for continuous operation. The speed must agree with the load requirements.

IGNITION SYSTEM

BREAKER POINTS

To maintain maximum efficiency from the engine, change the breaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove the two spark plugs so engine can be easily rotated by hand. If plugs have not been changed within the last 100 hours, replace them with new ones after setting the breaker points.
3. Refer to Figure 22. Remove mounting screw (A) and pull the points out of the box just far enough so screw (B) can be removed and leads disconnected.
4. Remove screw (C) and replace condenser with a new one.
5. Replace points with a new set but do not completely tighten mounting screw (A).
6. Rotate the engine by hand until the 20° BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90°) to ensure points are fully open.
7. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .016-inch with a flat thickness gauge. Tighten mounting screw and recheck gap.
8. Check ignition timing.

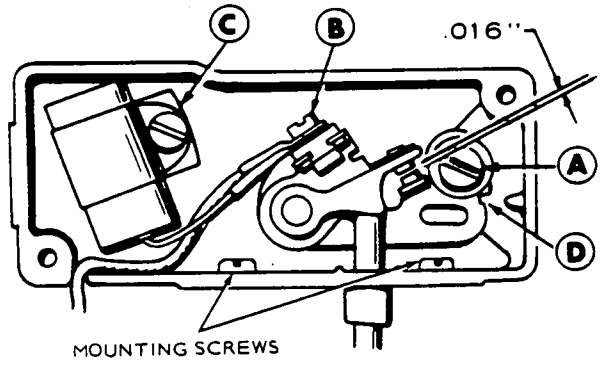

FIGURE 22. BREAKER POINT ADJUSTMENT

TIMING PRESSURE COOLED ENGINE

The timing on the engine is preset at the factory. A non-movable breaker point box is used, however a slight timing change could be made by adjusting points.

The engine is equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. Spark advance is set at 20° BTC (before top center), and should be maintained for best engine performance. Always check timing after replacing ignition points or if noticing poor engine performance. Proceed as follows:

Timing Procedure—Engine Running:

1. To accurately check the ignition timing, use a timing light with engine running at idle speed. Connect the timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.
2. Start the engine and check the timing. The pointer on the flywheel should line up with the 20° mark on the cover. The timing hole through the flywheel and the timing marks on the timing gear cover can be seen by looking through the flywheel blower screen. See Figure 23.

If timing marks do not line up, readjust point gap. To advance timing, slightly open gap on breaker points. To retard timing, slightly close gap on breaker points. Recheck timing and breaker point gap after making this adjustment.

Timing Procedure—Engine Not Running: If a timing light is not available, check the timing as follows:

1. Connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch the other test prod to a good ground on the engine.
2. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
3. The lamp should go out just as the points break which is the time at which ignition occurs (20° BTC).

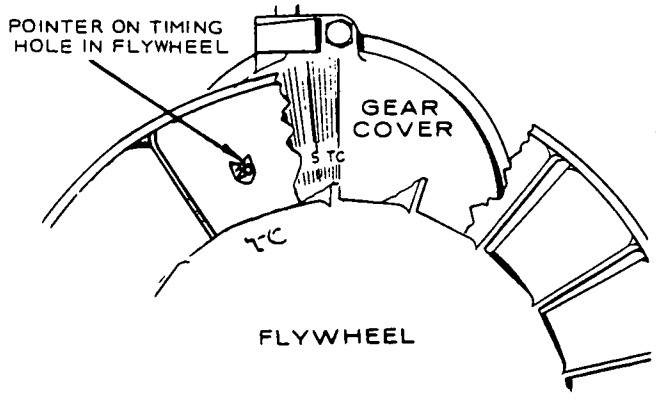

FIGURE 23. FLYWHEEL TIMING HOLE

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TIMING VACU-FLO ENGINE

Engine timing is advanced or retarded by opening or closing the breaker point gap. Setting the point gap at 0.016 inch is the most accurate method of timing the engine.

Dynamic timing (engine running) may be less accurate because the sight angle from the viewer to the flywheel scribe mark and timing pointer may vary ± 2° from 20° BTC, Figure 24.

The timing pointer is mounted on the cylinder block above the oil filter; it is made accessible by removing the right hand shroud.

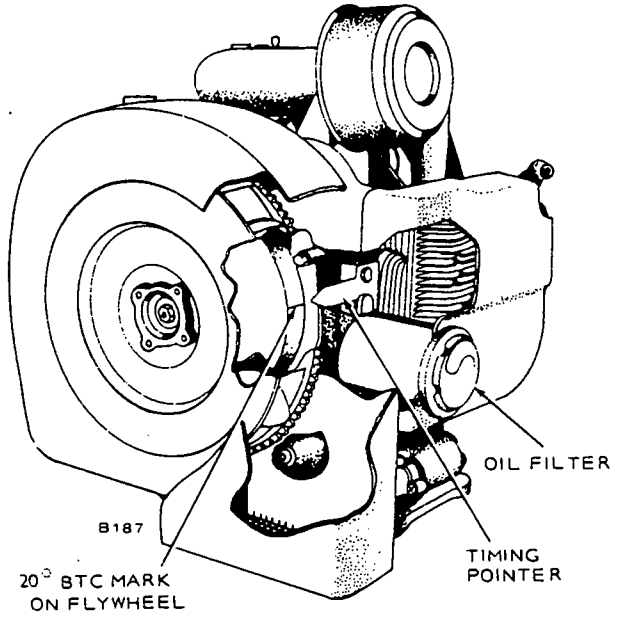

FIGURE 24. VACU-FLO ENGINE—TIMING MARK AND POINTER

SPARK PLUGS

Remove both spark plugs and install new ones every 100 hours. Use Onan spark plugs 167-0240 or equivalent. Check to be sure spark plug gap is set at .025 inch, Figure 25.

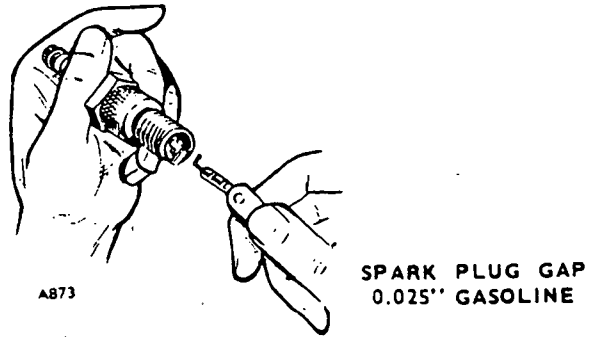

FIGURE 25. SPARK PLUG GAP

IGNITION COIL

To test primary and secondary windings within the ignition coil proceed as follows:

1. Use Simpson 260 VOM or equivalent.
2. Place black lead on ground (-) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 4.30 (± 10%) ohms @ 70° F.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 26). Secondary resistance should read 14,000 (±10%) ohms @ 70° F.
4. If any of the above conditions are not met, replace coil. Refer to *Parts Catalog* for correct part number.

CAUTION **This engine uses a 12 volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.**

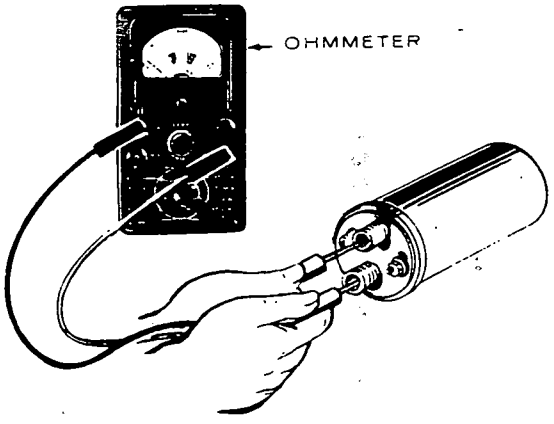

FIGURE 26. COIL TEST

BATTERY INSPECTION

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.280 at 80° F, Figure 27.

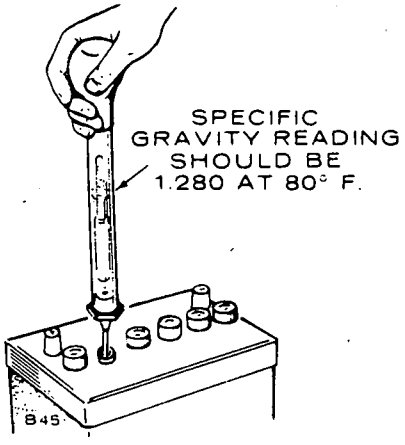

FIGURE 27. SPECIFIC GRAVITY TEST

If one or more cells are low on water, add distilled water and recharge.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.

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BATTERY CHARGING SYSTEM

BATTERY CHARGING, FLYWHEEL ALTERNATORS

The flywheel alternator is a permanent magnet alternator and uses a solid-state voltage regulator-rectifier for controlling output.

Two different alternator systems are used with NHC and NHCV engines. One is a 20 amp Synchro system; the other is a 15 amp Phelon system.

A 30-ampere fuse is included in the battery charging system to protect the alternator in case the battery cables are accidently reversed. Replace the fuse with Onan Fuse 321-0162. Buss AGC30 or equivalent.

Weak ignition spark or a discharged battery indicate trouble in the charging system. But before testing the engine's charging system, always check the battery for serviceability.

TESTING OR SERVICING

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure output control plug (connector) is inserted properly. Plug must bottom in receptacle—eliminates any resistance due to a poor connection. Keep clean and tight.
2. Make sure alternator stator leads are not shorted together.
3. Be sure regulator-rectifier output control has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
4. Never reverse the battery leads.

Charging system tests require a fully charged battery.

20 AMP SYNCHRO SYSTEM

The 20 amp flywheel alternator systems use a separate regulator and a separate rectifier, Figure 28.

Testing: For testing this system, use a voltmeter-ohmmeter such as a Simpson 270. Various alternator problems with individual test procedures are listed in Table 2.

No Output—Stator Assembly: Examine leadwires for loose or broken connections at the regulator and rectifier. Use the Rx1 scale on the ohmmeter for detecting opens in the stator. Disconnect the three wires that come from alternator stator (two black, one red). Connect ohmmeter test leads to red leadwire and ground to check continuity. The ohmmeter reading should be about 2.0 ohms. See Figure 29 for wiring diagram.

Next, connect meter to black leadwires and ground. Approximately 0.1 ohm should be read from either black lead to ground. If no connection exists between ground and black leads, stator assembly should be replaced.

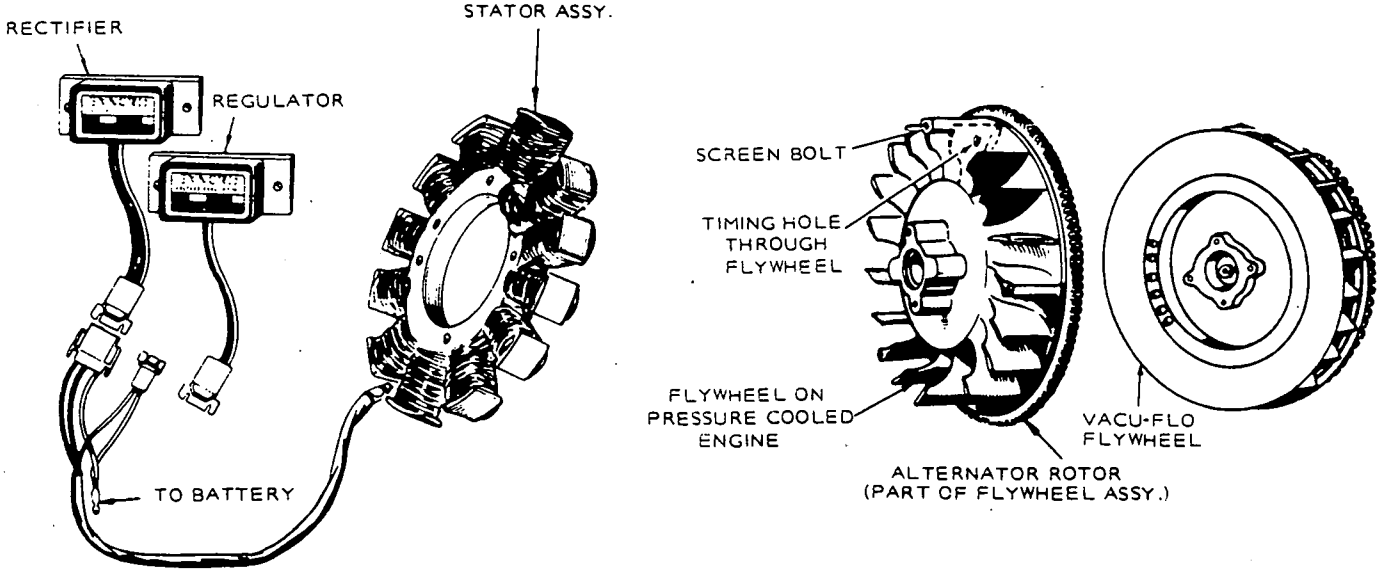
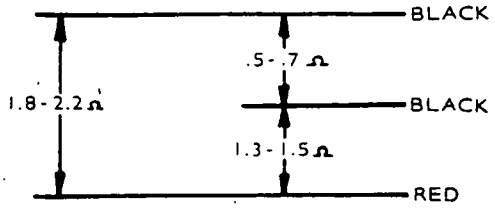


FIGURE 28. 20 AMP SYSTEM

TABLE 2. TESTING SYNCHRO 20 AMP SYSTEM

TEST	VALUE
Battery voltage - unit not running	12 Volts DC.
Battery voltage with unit running at 1800 rpm or more	14.2 — 14.8* Volt DC
AC voltage from stator with plug disconnected and unit running at approximately 1800 rpm	17 volts AC Black to Black
Ohmmeter reading at plug when checking two AC stator leads - unit not running	
Resistance values (Ohms) are as follows between wire pairs. 	

* - 60 Volt minimum at greater than 2000 rpm, Red to Ground.

Checking Rectifier Assembly: Examine each of the two diodes for breakdown by connecting ohmmeter (Rx1 scale) from one black lead to white lead. Meter should read 10 ohms in proper polarity. A shorted diode would read zero resistance and would cause a short circuit through the lead winding when in operation. An open diode would read infinite in both directions indicating that replacement is necessary.

Testing Regulator Assembly: To check for proper voltage regulation, attach a DC voltmeter to battery and operate engine at about 1800 rpm. Battery voltage will climb to the preset factory setting (14.2 to 14.8 volts).

Some installations may vary due to voltage drop in the length of ammeter harnesses. Other variations may stem from a loose connector in the harness or loose or corroded battery leads. Low voltage readings at the battery mean poor battery connections.

To test regulator, remove connector. Using the Rx10,000 scale of your ohmmeter, connect one meter lead to red leadwire and other meter lead to regulator base. No deflection should be noted on the ohmmeter in either polarity. Next connect meter to black leadwire and base of regulator. Meter will deflect fully in one polarity with no deflection in the other.

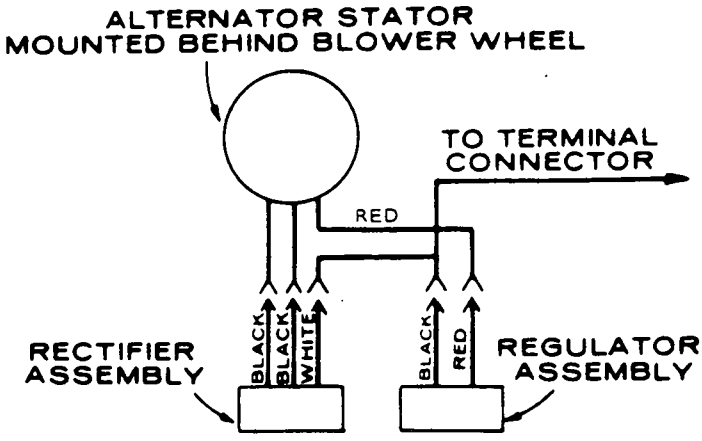


FIGURE 29. 20 AMP SYNCHRO SYSTEM

Full Charge—Will Not Regulate: Check for broken leads at connection to regulator plates. To be sure regulator winding operates properly, connect red lead to ground and start engine. A maximum of 4 amperes should be noted. This would indicate stator winding is satisfactory. If so, replace regulator.

No Charge: If alternator does not charge when load is applied to battery, shut off engine and disconnect one red leadwire from regulator terminal. Be sure lead is taped or isolated from conducting engine parts. Once again, start engine. Alternator should charge to full output; if it doesn't, replace stator assembly.

15 AMP PHELON SYSTEM

The 15 amp flywheel alternator systems (Figure 30) have a one piece regulator-rectifier assembly. Various alternator problems are listed in Table 3.

Testing

With the engine running between 1800-2600 rpm, observe the panel ammeter (if not already equipped, connect a test ammeter). If no charging is evident, proceed with the NO CHARGE TEST. If ammeter shows a constant higher charge rate, follow the HIGH CHARGE RATE TEST procedure.

No Charge Test: Perform as follows:

1. Check the B+ to ground voltage using a DC voltmeter. See Figure 31 for wiring diagram.
2. If voltmeter reads 13.8 volts or higher, add a load to system (e.g. headlights) to reduce battery voltage to below 13.6 volts.
3. Observe ammeter. If charge rate increases, consider the system as satisfactory. If charge rate does not increase, proceed with testing.
4. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running near 3600 rpm. If AC voltage reads less than 28 volts, replace the stator. If AC voltage is more than 28 volts, replace the regulator-rectifier assembly.

TABLE 3. TESTING PHELON 15 AMP SYSTEM

BASIC TEST	PROCEDURE	TEST VALUES
1. Battery	Battery Voltage - unit not running	12 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes	13.6 to 14.7 VDC
3. Alternator Stator and Wiring with Fully Charged battery.	Ohmmeter reading from stator output - unit not running. Check at plug.	.11 to .19 Ohms
4. Alternator and Wiring	Measure AC open circuit stator voltage with unit running. Measure between two stator leads with plug disconnected and unit running at approximately 3600 rpm.	28 VAC

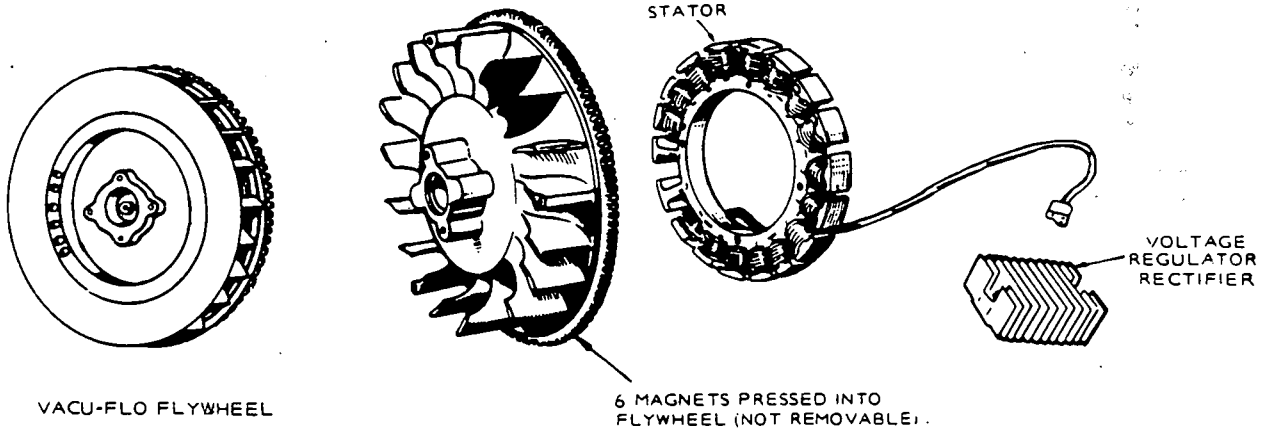


FIGURE 30. 15 AMP SYSTEM (PHELON)

High Charging Rate Test: Perform this test as follows:

1. Check B+ to ground voltage with a DC voltmeter.
2. If voltmeter reads over 14.7 volts, replace regulator-rectifier assembly.
3. If reading is under 14.7 volts the system is probably okay. Recheck the battery and connections. If the battery does have a low charge, but accepts recharging, system is okay.

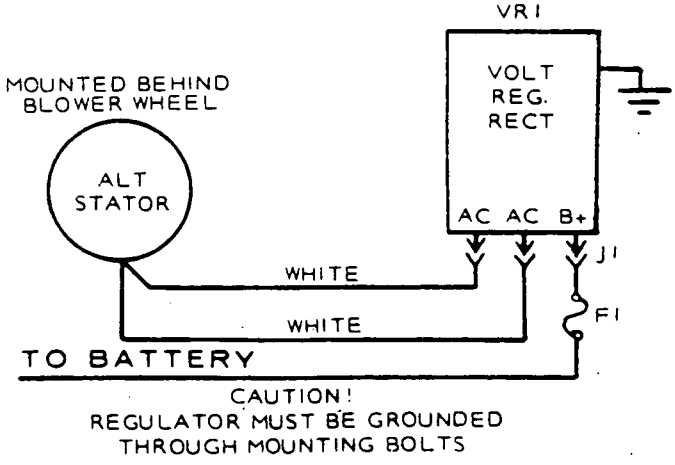


FIGURE 31. 15 AMP PHELON SYSTEM

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STARTING SYSTEM

ELECTRIC STARTER REPAIR

CAUTION To prevent insulation damage, do not use steam or high pressure water to clean the starter assembly (Figure 32).

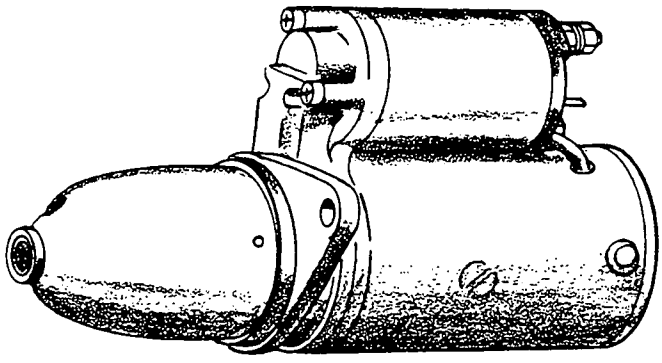

FIGURE 32. STARTER ASSEMBLY

DISASSEMBLY

1. Loosen the M terminal nut on the magnetic switch and remove the connector. Then unscrew attaching screws and remove the magnetic switch, Figure 33.

The packings for the magnetic switch are mounted so that the steel packing is located in the front bracket side.

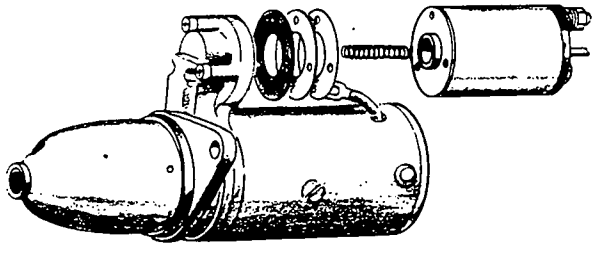

FIGURE 33. MAGNETIC SWITCH REMOVAL

2. After removing the thru bolts, the starting motor can be divided into three parts—the front bracket, housing and rear bracket. The spacers shown in Figure 34 are used for adjustment of the thrust gap of the armature shaft and are placed between the rear bracket and the commutator.

These washers are inserted so the steel washer is located in the commutator side.

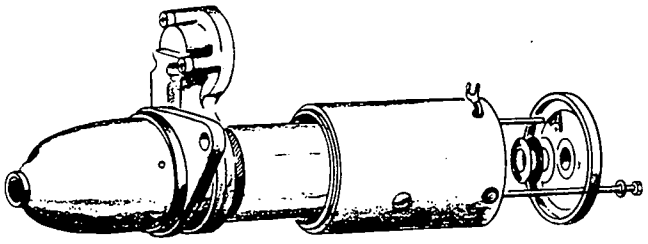

FIGURE 34. REMOVING THROUGH BOLTS

3. The armature can easily be removed from the front bracket. Be careful not to miss a small steel washer used in the end of the armature shaft. The shift lever can be removed along with the armature when it is removed. In this case, the spring holder, lever springs and retainer can be taken out before the lever. See Figure 35.

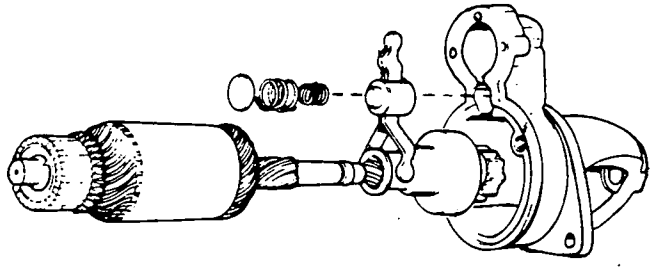

FIGURE 35. REMOVING ARMATURE

4. Remove the ring after driving the pinion stopper toward the pinion gear using a cylindrical tool as shown in Figure 36. The overrunning clutch and the pinion stopper should be removed simultaneously.
5. All four brushes have been soldered to the brushholder in the same way. The brush springs can be removed from the brushholder.
6. The pole shoes may be removed if necessary, by removing the flat head machine screws from the frame.

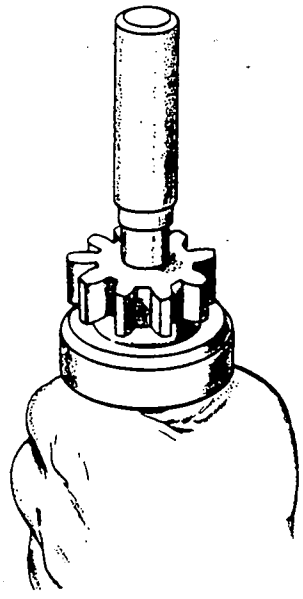

FIGURE 36. REMOVING RING

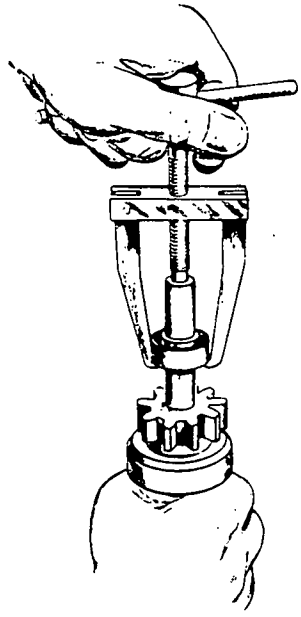

FIGURE 38. MOUNTING OVERRUNNING CLUTCH

REASSEMBLY

Inspect the parts carefully in accordance with the procedure described in *Inspection of Parts*. Make any repairs necessary. Reassembly is the reverse of disassembly. The following precautions should be taken:

CAUTION **Parts containing lubricated bearings must not be immersed in cleaning fluid to prevent breakdown of lubricant. These parts should be cleaned with a brush dipped in "Varsol" or any other comparable mineral spirits. Do not immerse overrunning clutch in cleaning solvent. Thoroughly dry any parts that have come into contact with the cleaning fluid.**

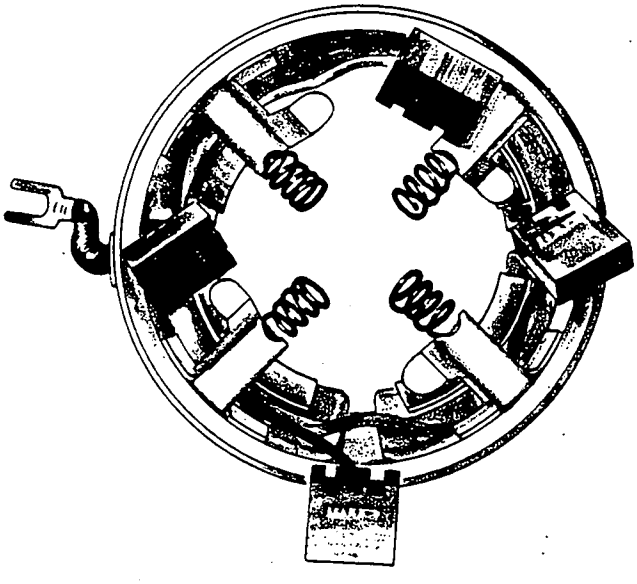

FIGURE 37. BRUSHES

1. Inspect brushes (Figure 37) and clean all parts carefully with a dry cloth and compressed air if it is available.
2. Apply 20 weight non-detergent oil to the armature shaft and splines. Apply grease (Shell Albania No. 2 or equivalent) sparingly on the shift lever pin, the joint of the shift lever and plunger, the plunger and spacing washers at the end of the shaft.
3. To mount overrunning clutch, first insert pinion stopper in armature shaft; then install ring in groove of the shaft. For insertion of the ring, use tool shown in Figure 38 and pull the pinion stopper up.
4. Use spacing washers to adjust the armature to give end play of .004" to .020".
5. Tighten the thru bolts to a torque of 35 to 44 in-lbs.
6. Insert the shift lever as shown in Figure 39 into the front bracket.

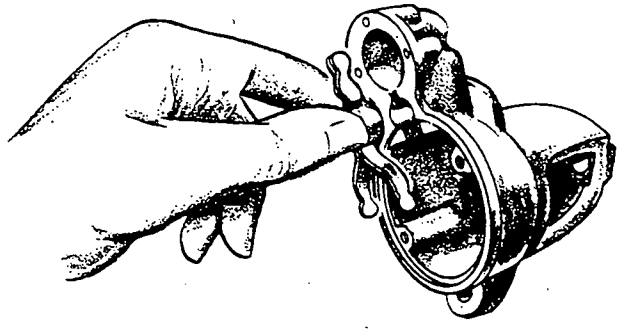

FIGURE 39. INSTALLING SHIFT LEVER

INSPECTION OF PARTS

1. **Testing Armature for Short Circuits.** Place the armature in a growler and hold a thin steel blade parallel to the core and just above it while slowly rotating the armature in the growler. A shorted armature will cause the blade to vibrate and be attracted to the core. Replace shorted armature. See Figure 40.

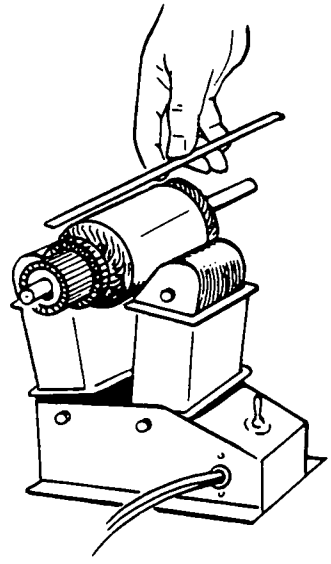

FIGURE 40. ARMATURE SHORT CIRCUIT TEST

2. **Testing Armature for Grounds.** Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads. If the ohmmeter reading is low, it indicates a grounded armature. Replace grounded armature. See Figure 41.

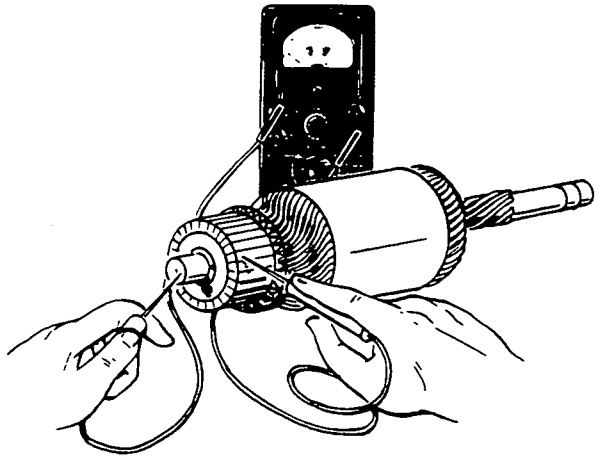

FIGURE 41. ARMATURE GROUND TEST

3. **Testing Armature for Open Circuit.** The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections.
4. **Testing Commutator Runout.** Place armature in a test bench and check runout with a dial indicator. When commutator runout exceeds .004", commutator should be refaced (Figure 42).

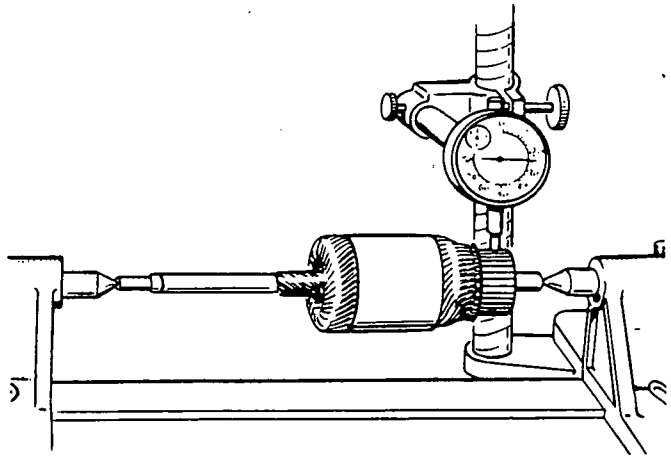

FIGURE 42. CHECKING COMMUTATOR RUNOUT

5. **Testing Armature Shaft Runout.** The armature shaft as well as the commutator may be checked. A bent armature often may be straightened, but if the shaft is worn, a new armature is required (Figure 43).

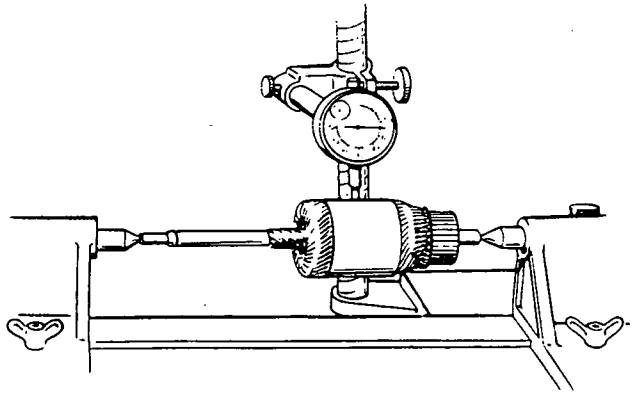

FIGURE 43. CHECKING ARMATURE SHAFT RUNOUT

6. **Testing Field Coils for Grounds.** Place one lead on the connector and the other on a clean spot on the frame after unsoldering shunt field coil wire. If the ohmmeter reading is low, the fields are grounded, either at the connector or in the windings (Figure 44).

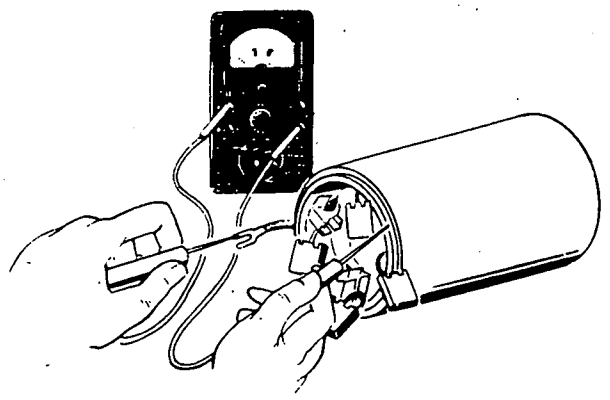

FIGURE 44. FIELD COIL GROUND TEST

7. **Testing Field Coils for Open Circuit.** Place one lead on the connector and the other on a clean spot on the brushholder. If the ohmmeter reading is high, the field coil is open. Check the other three brushholders in the same manner (Figure 45).

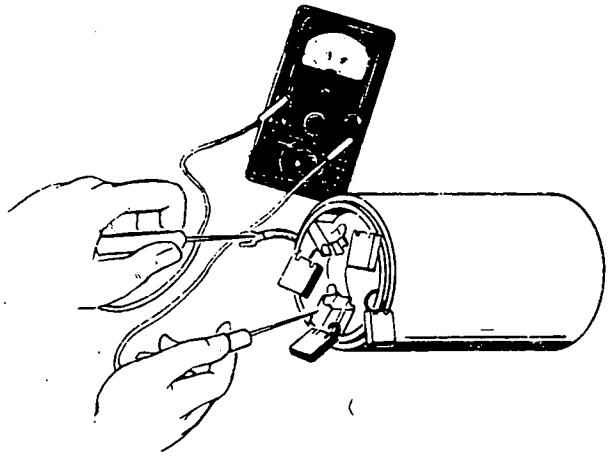

FIGURE 45. FIELD COIL OPEN CIRCUIT TEST

8. **Inspection of Brushes.** Replace brushes when they are worn less than .3" as shown in Figure 46. See that all brushes move freely in their holders.

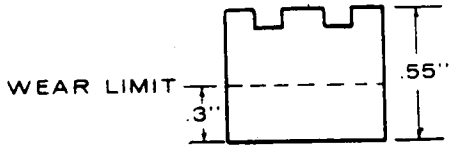

FIGURE 46. BRUSH WEAR LIMIT

9. **Inspection for Brush Spring Tension.** Measure brush spring tension with a tension meter as shown in Figure 47. Push the brush and take a reading just as the brush projects a little from the brushholder. On a new brush the spring tension should be 29 to 38 ounces.

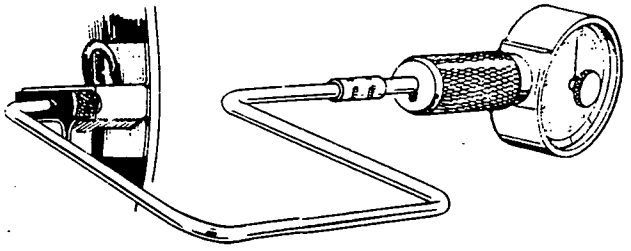

FIGURE 47. BRUSH SPRING TENSION TEST

INSPECTION AFTER OVERHAUL

1. For no load test, the starting motor is wired as shown in Figure 48 and revolved. The meter readings for this test should be:

Voltage	11.5 volt
Speed	3700 rpm minimum
Current Draw	60 amp maximum

The conductor for this test should be large enough to carry 60 amps and as short as possible. If anything is wrong in the above test, inspect the following items:

Annealed brush springs
Improperly seated brushes
Insufficient armature endplay
Shorted, open or grounded armature
Grounded or open field coil
Poor electrical connection
Dirty commutator

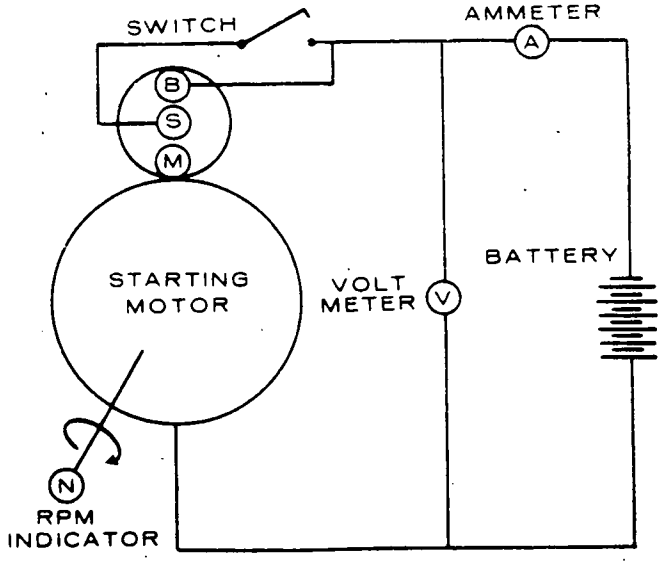

FIGURE 48. STARTING MOTOR WIRING

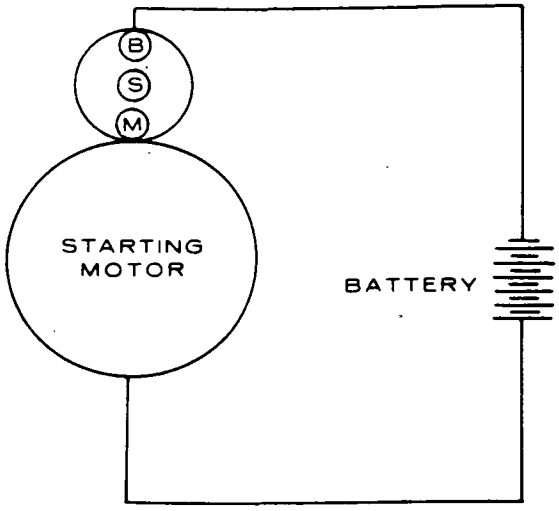

FIGURE 49. BATTERY CONNECTIONS

2. **Adjusting Pinion Clearance.** Connect the battery to the starting motor as shown in Figure 49. This will allow the pinion of the starting motor to slide and stop. In this state, measure the clearance between the end of the pinion and pinion stopper when the pinion is pushed lightly toward the commutator end. Clearance should be .02" to .06". Adjust for proper clearance by removing the magnetic switch attaching screws and select proper thickness of the fiber packings shown in Figure 50.

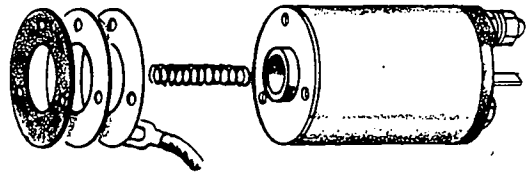

FIGURE 50. ADJUSTING PINION CLEARANCE

ENGINE DISASSEMBLY

VALVES

Proper seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44 degrees. The valve *seat* angle is 45 degrees. This 1-degree interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life (Figure 51).

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where stellite faced valves and seats are used. Valve faces should be finished in a machine to 44 degrees. Valve seats should be ground with a 45-degree stone and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance.

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

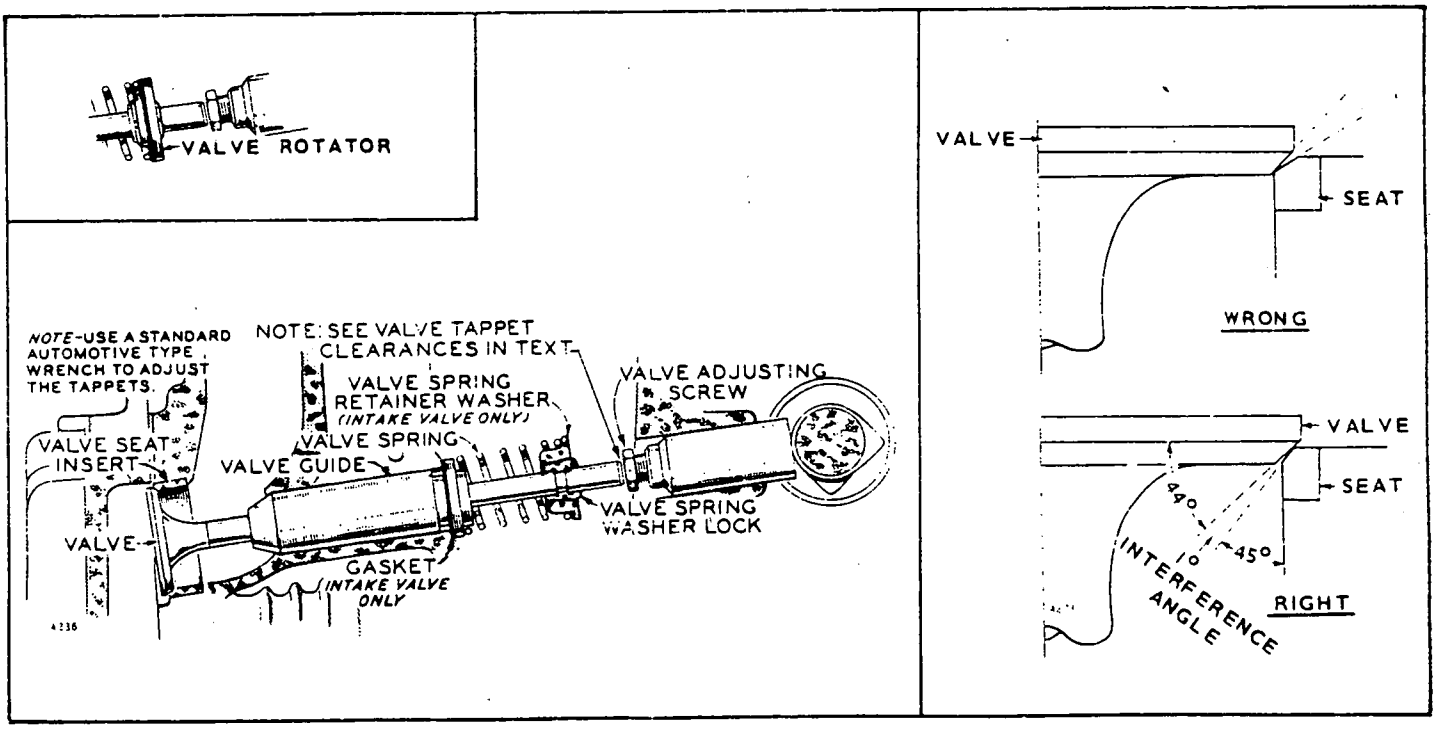

FIGURE 51. VALVE SYSTEM

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Tappet Adjustment: The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 400 operating hours or when poor engine performance is noticed. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to valve tappets.
2. Remove spark plugs to make turning the engine easier.
3. Use the engine flywheel to turn the engine over slowly by hand until the left hand intake valve opens and closes. Continue turning the flywheel until the TC mark is on the top and lined up with the TC mark on the gear cover. Both valves should be closed. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left cylinder.
4. Clearances are shown in Figure 52 and *Tune-up Specifications*. For each valve, the gauge should just pass between the valve stem and valve tappet.
5. To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self locking.
6. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
7. Replace all parts removed. Tighten all screws securely. Torque manifold bolts.

FLYWHEEL

Use a suitable puller (with claws or with bolts to agree with flywheel) to pull the flywheel.

CAUTION **Do not drop the flywheel. A broken fin will destroy the balance. Always use a steel key for mounting the flywheel.**

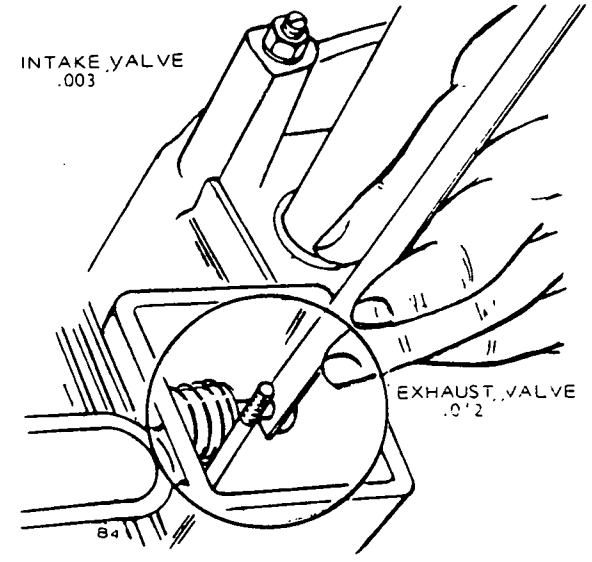


FIGURE 52. VALVE ADJUSTMENT

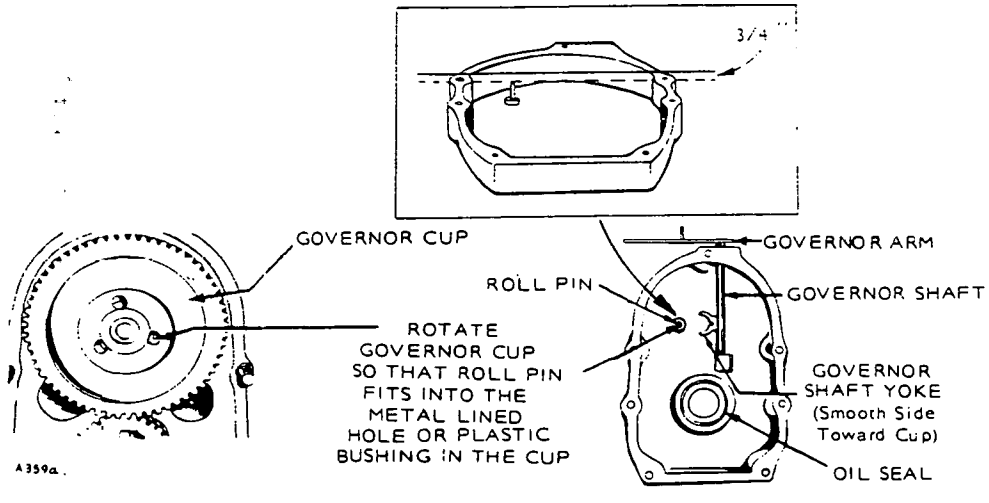
If a puller is not available turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp endwise blow on the head of the cap screw with a heavy soft-faced hammer to loosen.

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.

CAUTION **When installing the gear cover, make sure that the roll pin in the gear cover engages the metal lined (smooth) hole or plastic bushing in the governor cup, Figure 53.**

The roll pin protrudes upward from the cover and its outer end is 3/4 inch from a straight edge placed across the cover mounting surface.



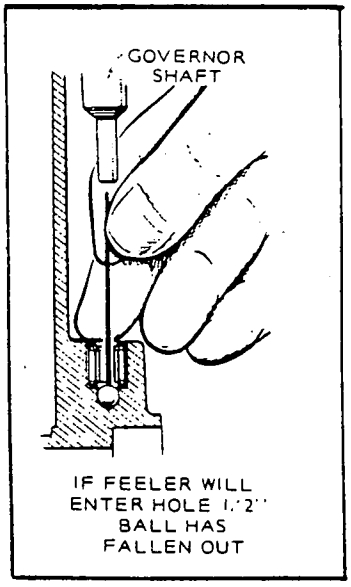


FIGURE 53. GEAR COVER ASSEMBLY

Turn the governor cup so that the metal lined hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin, Figure 54. Catch the flyballs while sliding the cup off.

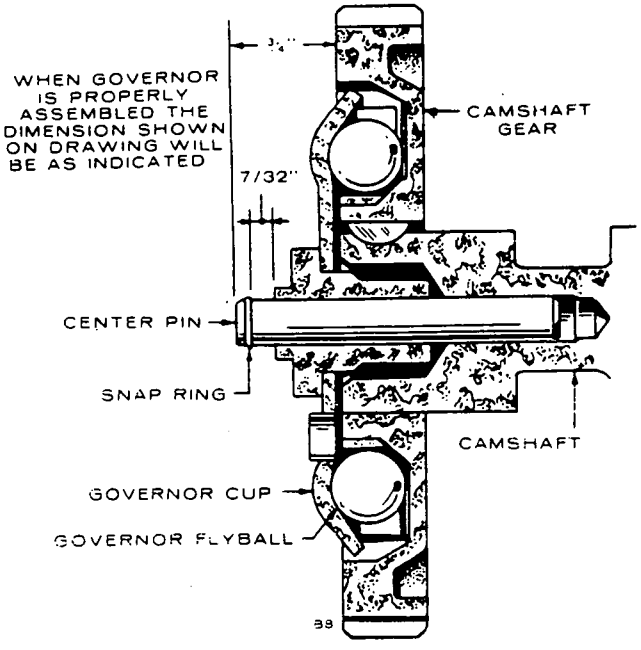


FIGURE 54. GOVERNOR CUP DETAILS

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, remove the spacer by splitting with a chisel. Replace the spacer with a new one. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the cup and snap ring on the center pin.

The camshaft center pin extends out 3/4-inch from the end of the camshaft. This distance provides an in and out travel distance of 7/32-inch for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture. See Figure 55.

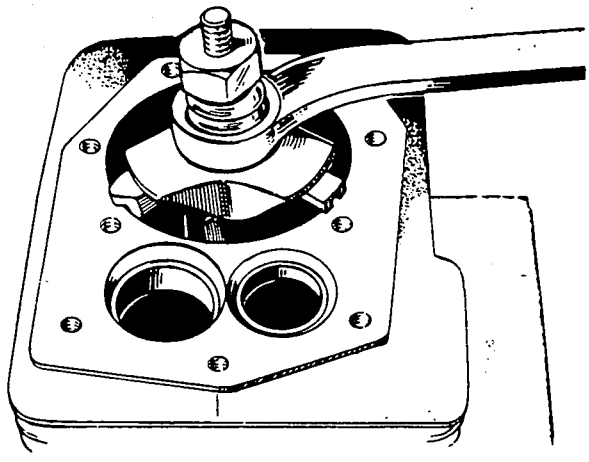


FIGURE 55. REMOVING WEAR RIDGE

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

Keep the connecting rod bearing caps and bearings with their respective rods.

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader.

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point. All passages should be cleaned with a non-caustic solvent. Clean the rod bore and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land

using new rings and a feeler gauge as shown in Figure 56. See *Dimensions and Clearances* for proper side clearance measurement and ring groove widths.

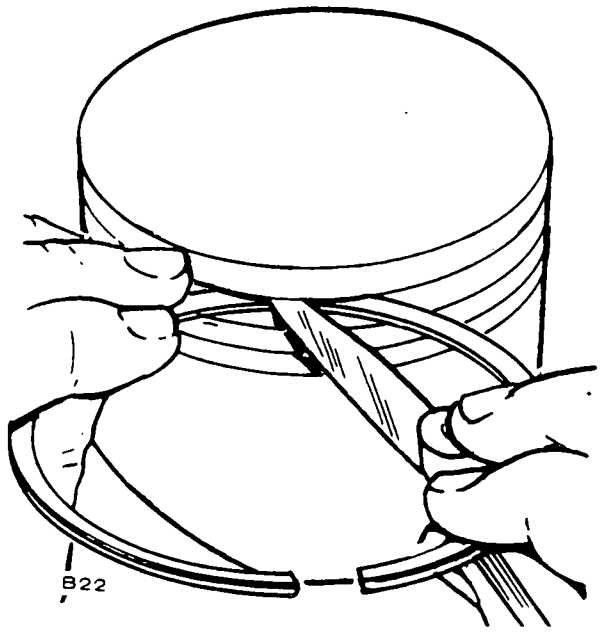


FIGURE 56. RING LAND INSPECTION

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves don't have good cylinder wall contact (Figure 57).

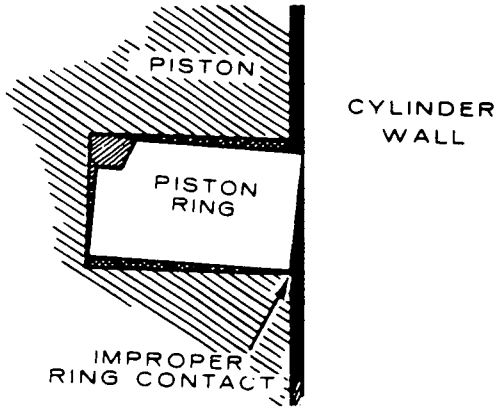


FIGURE 57. NEW RING IN WORN RING GROOVE

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002-inch.

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in *Dimensions and Clearances.*

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder, at a position corresponding to the bottom of its travel (Figure 58). The gap between the ends of the ring is given in *Dimensions and Clearances.* Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on .005" oversize pistons. Rings that are .010", .020", .030" and .040" oversize are to be used on corresponding oversize pistons. Rings of the tapered type are usually marked *top* on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

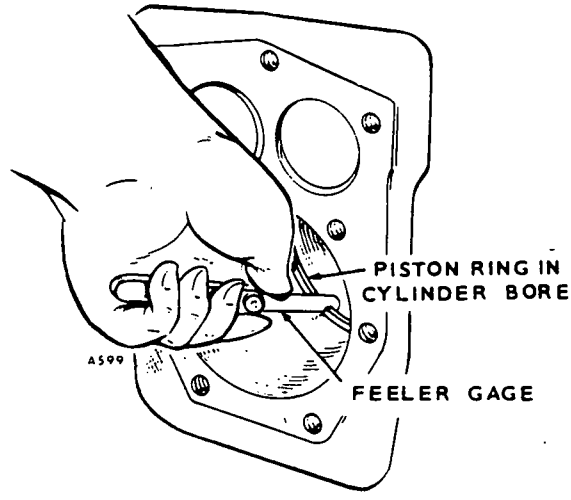


FIGURE 58. FITTING PISTON RINGS TO THE CYLINDER

Engines that have been fitted with .005" oversize pistons at the factory are identified by the letter E after the serial number which is stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in *Dimensions and Clearances.*

Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine. Refer to *Dimensions and Clearances* for the correct piston-to-cylinder clearance.

CONNECTING RODS

Connecting rods should be serviced at the same time as the pistons and rings. Replaceable bushings and bearings are used. Bearings are available in standard or .002", .010", .020" or .030" undersize.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts (forged rod), then refinish it to take the corresponding undersize bearing insert available.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

Crankshaft Regrinding: Crankshaft grinding requires a trained, experienced operator, with precision equipment. Onan emphasizes that if facilities or trained personnel are not available, the crankshaft may be sent to the factory.

Special procedures must be observed when reworking crankshafts. In addition to machining, the crankshaft must be super finished.

Shot Peening: On older model engines, shot peening is required to prevent failures. When the shaft is machined follow the data to shot peen each crank pin fillet.

1. Almen gauge reading, .012-A.
2. Mask off connecting rod bearing areas.
3. Peen with .019" diameter cast steel shot.
4. Peen for 30 seconds on each crankpin fillet.

Undersize bearings and connecting rods are available to rework the shaft to .010", .020", and .030" undersize.

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing, Figure 59. Use combination bearing driver 420-0324 to install the camshaft bearings.

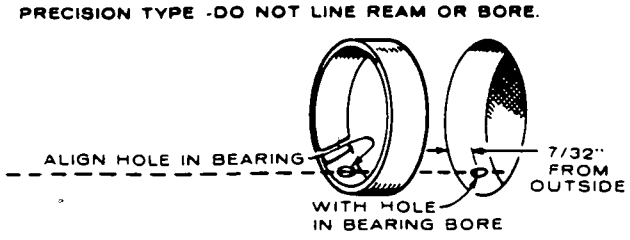


FIGURE 59. CAMSHAFT BEARING

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

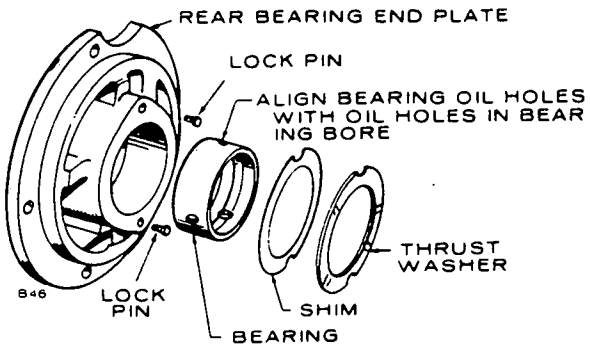
New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard size, .002", .010", .020" or .030" undersize.

Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heater to 200° F. If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

The cold oiled precision bearing should require only light taps to position it. In the rear bearing plate, install the bearing flush to 1/64 inch below the end of the bore using combination driver (same one used for camshaft bearing). See Figure 60.

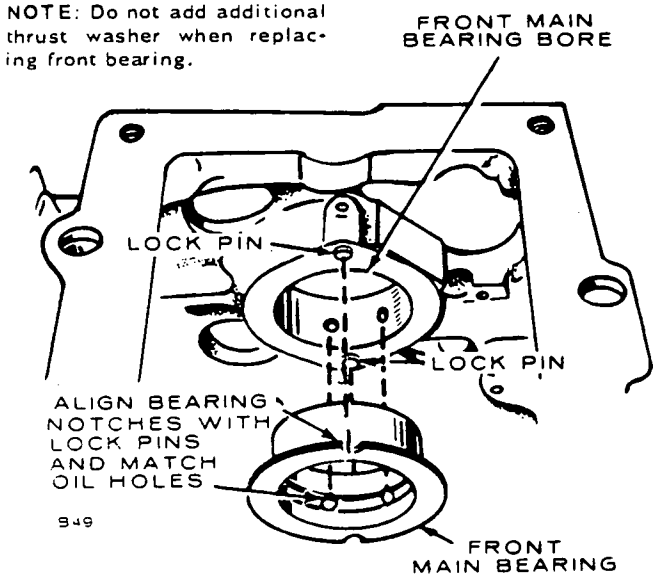
If the special combination tool isn't available, it's necessary to remove the lock pins with side cutters or Easy Out tool. After the new bearings are installed, insert new lock pins.



PRECISION TYPE- DO NOT LINE REAM OR BORE

FIGURE 60. BEARINGS FOR REAR BEARING PLATE

Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 61. Do not add an additional thrust washer to this front bearing.



PRECISION TYPE-
DO NOT LINE BORE OR REAM OR BORE

FIGURE 61. FRONT BEARING INSTALLATION

Before installing the front bearing, use the Locktite Bearing Mount furnished in the bearing kit. Use the towelette in the package to clean the outside of the bearing and the bearing bore in the block.

WARNING **Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well ventilated.**

After allowing three to four minutes for drying, apply the Locktite Bearing Mount from the small tube to the mating surfaces of the bearing and bearing bore. Install the bearing flush with the block using the combination driver just used for the rear bearing. Wipe off any excess Locktite around the bearing. Allow at least one hour for hardening at room temperature.

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. Line up the notches of the thrust washer with the lock pins before tightening the end plate or the lock pins will be damaged.

A light film of oil on the thrust washer may hold it in place while installing the crankshaft.

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in *Assembly Torques and Special Tools*, check the crankshaft endplay as shown in Figure 62. If there is too much endplay (see *Dimensions and Clearances* for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 60) between the thrust washer and plate. Reinstall the end plate making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

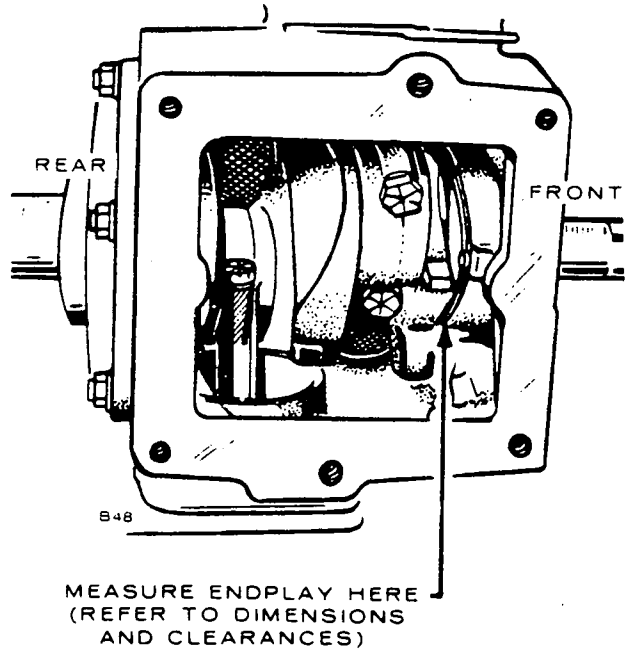


FIGURE 62. CRANKSHAFT ENDPLAY

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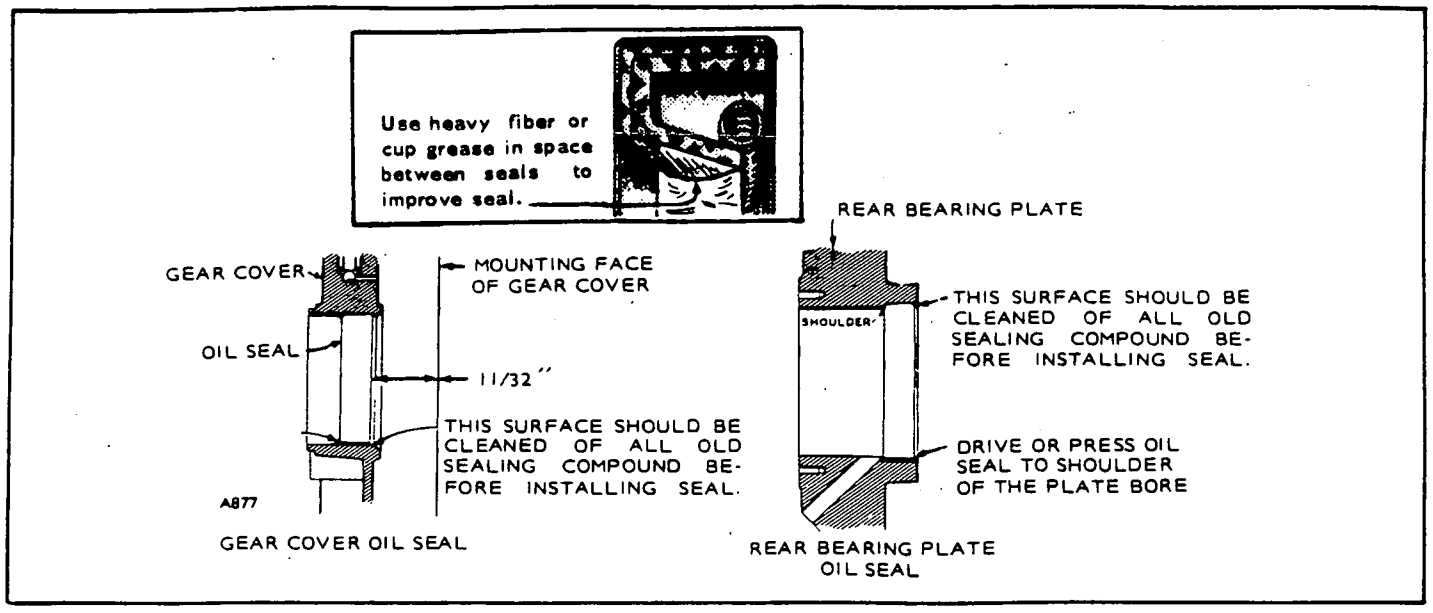

FIGURE 63. GEAR COVER AND REAR BEARING PLATE OIL SEALS

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using bearing plate driver and gear cover driver.

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing. See Figure 63.

When installing the gear cover oil seal, tap the seal inward until it is 11/32 of an inch from the mounting face of the cover. Install new style, thin open face seal, 1-7/64 inches from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

Engines equipped with some types of reduction gear assemblies do not use the rear oil seal. The reduction gear assembly is oiled directly from the engine crankcase. Refer to the instructions screened on the case of the reduction gear assembly.

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and ring set of the available oversizes. Pistons are available in .005", .010", .020", .030" and .040" oversize. Piston rings are available in .010", .020", .030" and .040" oversize. Use standard size rings on a .005" oversize piston. If the cylinder is not being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore. Engine might be fitted at the factory with a .005" oversize piston and are so indicated by a letter E following the engine serial number stamped on the cylinder block and on the unit nameplate.

The standard cylinder bore size appears in *Dimensions and Clearances.*

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly as shown in Figure 64.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

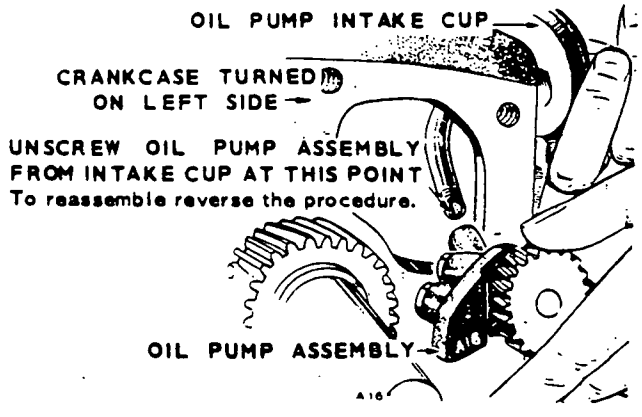

FIGURE 64. OIL PUMP ASSEMBLY

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CYLINDER HEADS

Remove the cylinder heads for cleaning at least every 400 hours or when poor engine performance is noticed.

1. Use a 1/2 inch socket wrench to remove cylinder head bolts. Lift heads off.

   CAUTION **Do not remove heads when they are hot. Warpage may occur.**

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place heads in position and follow head torque tightening sequence shown in Figure 65. Start out tightening all bolts to 5 ft-lb, then 10 ft-lb, etc., until all bolts are torqued to 17-19 ft-lb.
5. Recheck torque before engine has run a total of 50 hours.

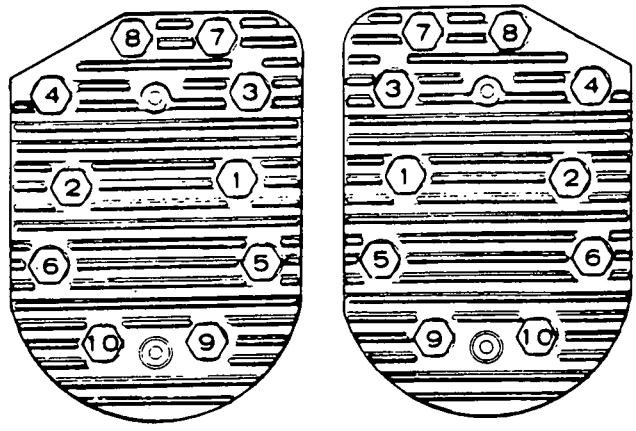


FIGURE 65. HEAD BOLT TIGHTENING SEQUENCE

PARTS CATALOG

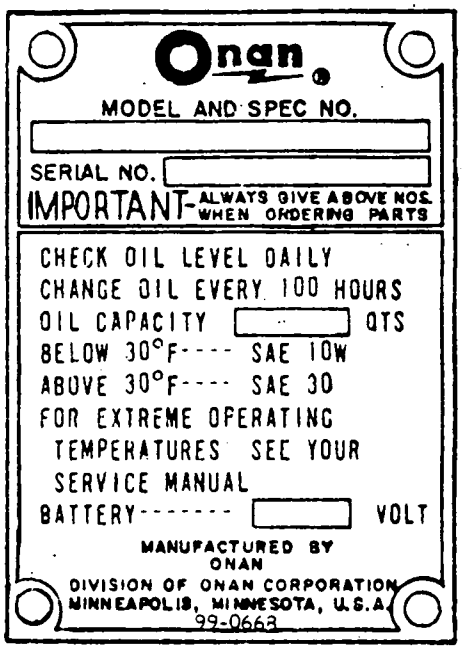
INSTRUCTIONS FOR ORDERING REPAIR PARTS

For parts or service, contact the dealer from whom you purchased this equipment or refer to your Nearest Authorized Onan Parts and Service Center.

To avoid errors or delay in filling your parts order, please furnish all information requested.

Always refer to the nameplate on your unit:

1. Always give the MODEL and SPEC NO. and SERIAL NO.



For handy reference, insert "YOUR" nameplate information in the spaces above.

2. Do not order by reference number or group number; always use part number and description.
3. Give the part number, description and quantity needed of each item. If an older part cannot be identified, return the part prepaid to your dealer or nearest AUTHORIZED SERVICE STATION. Print your name and address plainly on the package. Write a letter to the same address stating the reason for returning the part.
4. State definite shipping instructions. Any claim for loss or damage to your unit in transit should be filed promptly against the transportation company making the delivery. Shipments are complete unless the packing list indicates items are back ordered.

Prices are purposely omitted from this Parts Catalog due to the confusion resulting from fluctuating costs, import duties, sales taxes, exchange rates, etc.

For current parts prices, consult your Onan Dealer, Distributor or Parts and Service Center.

"En esta lista de partes los precios se omiten de proposito, ya que bastante confusion resulto de fluctuaciones de los precios, derechos aduanales, impuestos de venta, cambios extranjeros, etc."

Consiga los precios vigentes de su distribuidor de productos "ONAN".

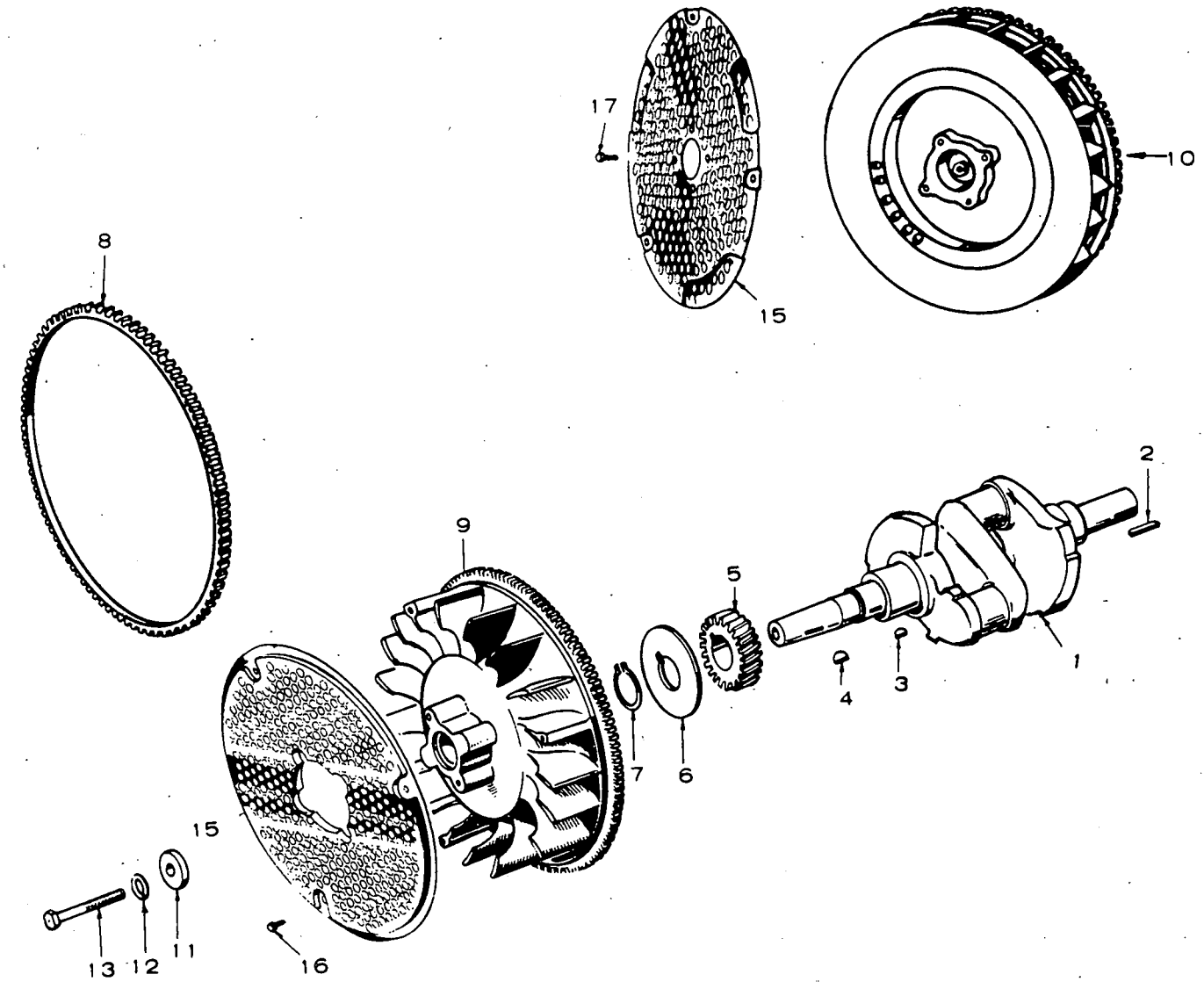
This catalog applies to the standard NHC and NHCV Engines as listed below. Parts are arranged in groups of related items. Each illustrated part is identified by a reference number corresponding to the same reference number in the parts list for that group. Parts illustrations are typical. Using the *Model* and *Spec No.* from the nameplate, select the *Parts Key No.* (1, 2, etc., in the last column) that applies to your *Engine Model* and *Spec No.* This *Parts Key No.* represents parts that differ between models. Unless otherwise mentioned in the description, parts are interchangeable between models. Right and left sides are determined by facing the blower end (front) of the engine.

ENGINE DATA TABLE

MODEL AND SPEC NO. £	PARTS KEY NO.	MODEL AND SPEC NO. £	PARTS KEY NO.
NHC-MS/*A	1	NHCV-MS/*A	3
NHC-MS/*B	2	NHCV-MS/*B	4

£ - The Specification Letter Advances (A to B, B to C, etc.) with manufacturing changes.

* - The factory code number portion of the specification number indicates standard equipped engines and/or customer selected optional equipment.

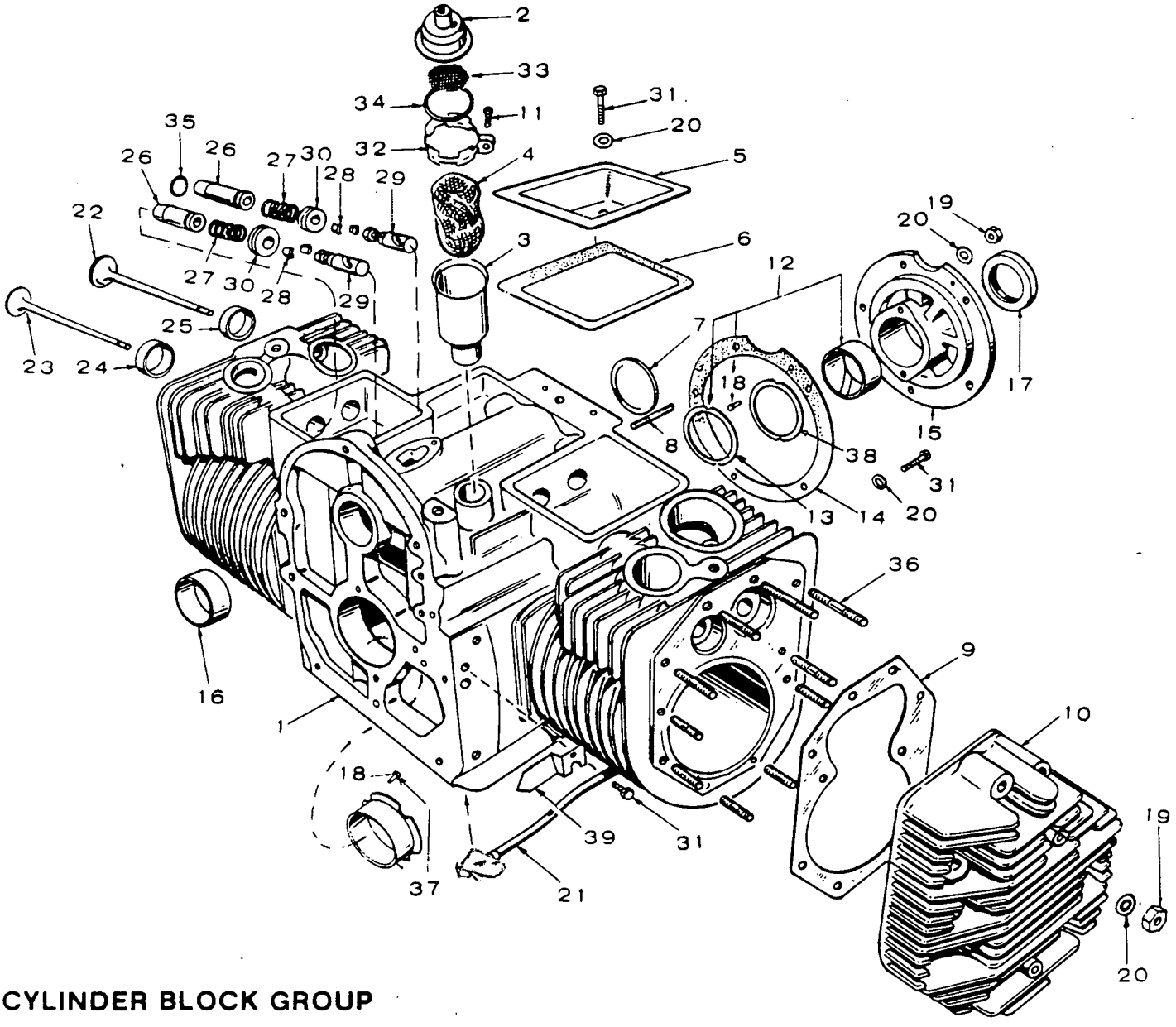


CRANKSHAFT AND FLYWHEEL GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	£	1	Crankshaft
	KEY, SHAFT		
2	515-0198	1	Crankshaft Stub
3	515-0001	1	Crankshaft Gear
4	515-0002	1	Flywheel - Key 1, 3
	515-0098	1	Flywheel - Key 2, 4
5	104-0032	1	Gear, Crankshaft
6	104-0043	1	Washer, Gear Retaining
7	518-0014	1	Ring, Retaining - Gear
8	134-0673	1	Ring Gear (Part of all Fly Wheels)
9	FLYWHEEL ASSEMBLY - Key 1 & 2 (Includes Ring Gear)		
	134-2464	1	Standard
	134-2462	1	With Magnet Ring (Phelon 12 Amp Alternator)
	134-2467	1	With Magnet Ring (Synchro 20 Amp Alternator)
10	FLYWHEEL ASSEMBLY - KEY 3 & 4 (Includes Ring Gear)		
	134-2768	1	Standard
	134-2770	1	With Magnet Ring (Phelon 12 Amp Alternator)
	134-2769	1	With Magnet Ring (Synchro 20 Amp Alternator)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
11	526-0262	1	Washer, Flat, Steel (7/16")
12	850-0055	1	Washer, Lock, Steel (7/16")
13	104-0170	1	Screw, Special (Flywheel Mounting)
15	134-2433	1	Guard, Flywheel - Key 1, 2
	134-2384	1	Guard, Flywheel - Key 1, 2 - Optional
16	821-0010	3	Screw, Locking Hex Head, Flanged, Steel (1/4-20 x 1/2") - Key 1, 2
17	821-0014	2	Screw, Locking Hex Head, Flanged, Steel (5/16-18 x 1/2") - Key 1, 2

£ - Order by Description, giving Model, Spec and Engine Serial Number.



CYLINDER BLOCK GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	£	1	Block Assembly, Cylinder (Includes Parts Marked *)
2	123-0954	1	Cap & Valve, Breather
3	123-0952	1	*Tube, Breather
4	123-0865	1	Baffle, Breather Tube
5	110-1624	2	Cover, Valve Compartment
6	110-1720	2	Gasket, Valve Cover
7	517-0048	1	*Plug, Expansion
8	520-0736	5	*Stud, Bearing Plate Mounting
9	110-1731	2	Gasket, Cylinder Head
10	HEAD, CYLINDER		
	110-1912	1	Right Side
	110-1913	1	Left Side
11	809-0035	1	Screw, Round Head Sheet Metal (#8 x 3/4")
12	BEARING, SLEEVE - CRANKSHAFT REAR		
	101-0420	1	*Standard
	101-0420-02	1	.002" Undersize
	101-0420-10	1	.010" Undersize
	101-0420-20	1	.020" Undersize
	101-0420-30	1	.030" Undersize
13	104-0575	AR	*Washer, Thrust - Crankshaft Bearing
14	101-0415	1	*Gasket, Bearing Plate
15	*PLATE, BEARING - REAR		
	101-0439	1	Standard
	101-0417	1	Special (Use with Reduction Gear Assembly)
16	101-0405	2	*Bearing, Sleeve - Camshaft
17	509-0041	1	*Seal, Oil - Crankshaft
18	516-0072	4	*Pin - Bearing Stop
19	NUT, HEX		
	104-0091	5	*Bearing Plate Mounting
	104-0091	20	Cylinder Head Mounting
20	WASHER, FLAT		
	526-0063	2	Copper (1/4") - Valve Cover Mounting
	526-0250	20	Steel (3/8") - Cylinder Head Mounting
	526-0251	5	Steel (3/8") - Bearing Plate Mounting
	526-0066	2	Copper (3/8") - Cylinder Block

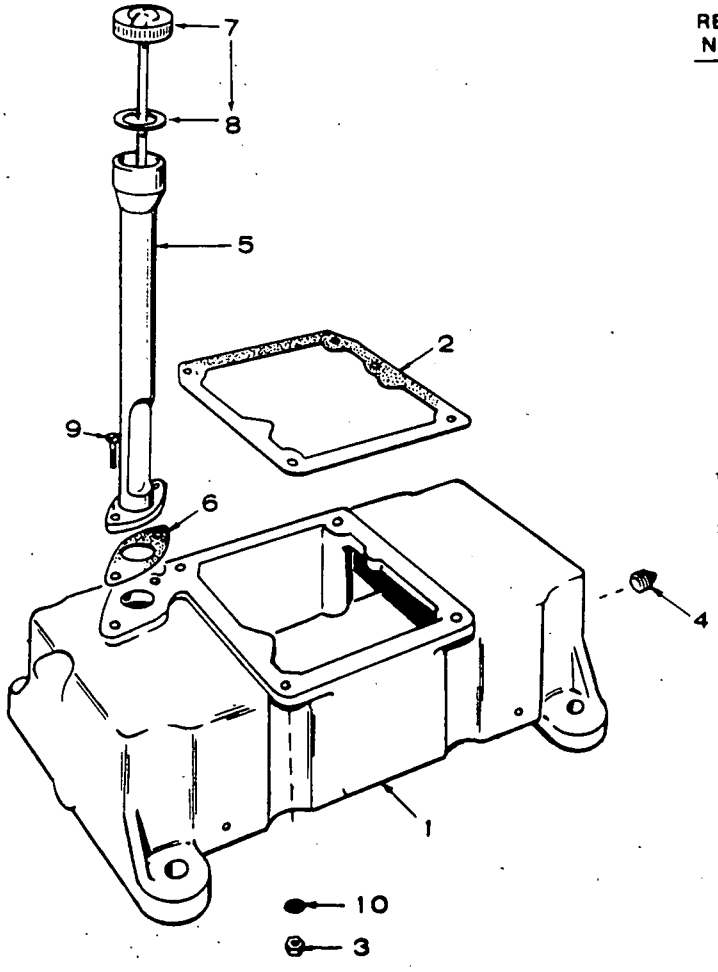
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
21	120-0680	1	*Tube, Oil - Crankcase
22	110-1974	2	Valve, Intake
23	110-1719	2	Valve, Exhaust
24	INSERT, VALVE SEAT - EXHAUST		
	110-1716	2	*Standard
	110-1716-02	2	.002" Oversize
	110-1716-05	2	.005" Oversize
	110-1716-10	2	.010" Oversize
	110-1716-25	2	.025" Oversize
25	INSERT, VALVE SEAT - INTAKE		
	110-1933	2	*Standard
	110-1933-02	2	.002" Oversize
	110-1933-05	2	.005" Oversize
	110-1933-10	2	.010" Oversize
	110-1933-25	2	.025" Oversize
26	110-1939	4	*Guide, Valve
27	110-0539	4	Spring, Valve
28	110-0639	8	Lock, Valve Spring
29	TAPPET, VALVE		
	115-0006	4	Standard
	115-0006-05	4	.005" Oversize
30	110-0904	4	Roto Cap
31	SCREW, HEX HEAD, CAP, STEEL		
	800-0011	2	1/4-20 x 2" - Valve Cover Mounting
	806-0027	2	3/8-16 x 3/4" - Cylinder Block
	821-0010	1	1/4-20 x 1/2" - Key 3 & 4 - Timing Pointer
32	123-0951	1	Clamp, Loop - Breather Tube Cap
33	123-0958	1	Screen - Breather Tube
34	509-0117	1	Seal "O" Ring - Breather Tube
35	110-0068	2	*Gasket - Valve Guide (Intake)
36	STUD - CYLINDER HEAD MOUNTING		
	520-0717	8	3/8 x 1-7/8"
	520-0773	12	3/8 x 2-5/16"
37	BEARING, SLEEVE - FLANGED, CRANKSHAFT		
	101-0432	1	*Standard
	101-0432-02	1	.002" Undersize
	101-0432-10	1	.010" Undersize
	101-0432-20	1	.020" Undersize
	101-0432-30	1	.030" Undersize
38	104-0776	AR	Shim (.005") - Crankshaft Thrust
39	160-1190	1	Pointer, Timing - Key 3 & 4

£ - Order by description, giving complete Model, Spec and Engine Serial Number.

AR - Quantity as Required.

* - Parts Included in Block Assembly.

OIL BASE GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	£	1	Base, Oil
2	102-0646	1	Gasket, Base
3	800-0051	4	Screw, Hex Head, Cap, Steel (3/8-16 x 1-1/4")
4	505-0056	1	Plug, Drain
5	TUBE, OIL FILL		
	123-1117	1	Standard - Key 1 & 2
	123-1272	1	Standard - Key 3 & 4
	123-1276	1	Special - Key 3 & 4 - (Used with Pulse Type Fuel Pumps)
6	141-0078	1	Gasket, Fill Tube
7	CAP & INDICATOR, OIL FILL		
	123-0527	1	Standard - Key 1 & 2
	123-1290	1	Special - Key 3 & 4
8	123-0191	1	Gasket, Oil Fill Cap
9	821-0010	2	Screw, Hex Head, Cap, Steel (1/4-20 x 5/8")
10	850-0050	4	Washer, Lock, Steel (3/8)

£ - Order by description, giving complete Model, Spec and Engine Serial Number.

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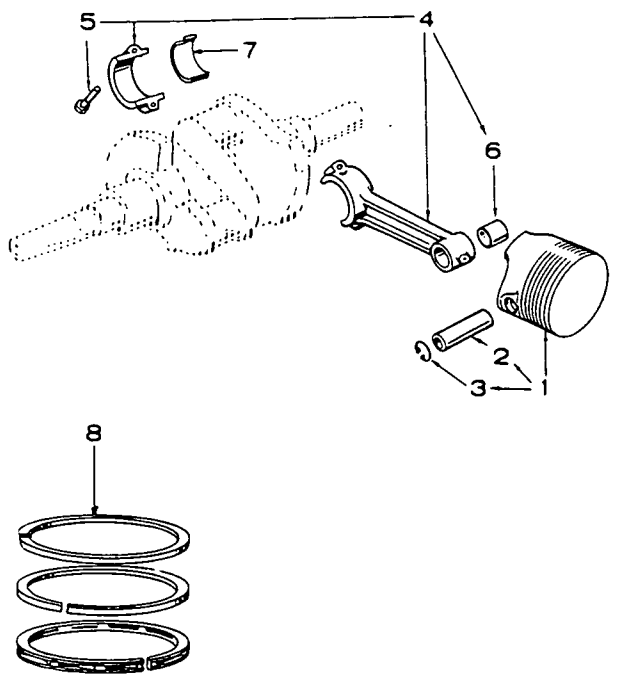
PISTON AND ROD GROUP



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	PISTON AND PIN SET (Includes Parts Marked *)		
	112-0141	2	Standard
	122-0141-05	2	.005" Oversize
	112-0141-10	2	.010" Oversize
	112-0141-20	2	.020" Oversize
	112-0141-30	2	.030" Oversize
	112-0141-40	2	.040" Oversize
2	*PIN, WRIST - PISTON		
	112-0112	2	Standard
	112-0112-02	2	.002" Oversize
3	518-0294	4	*Ring, Retaining - Wrist Pin
4	114-0203	2	Rod Assembly, Connecting (Includes Parts Marked †)
5	805-0010	4	†Bolt, Rod Cap
6	114-0036	2	†Bushing, Sleeve - Wrist Pin
7	BEARING, HALF SLEEVE - CONNECTING ROD		
	114-0188	4	Standard
	114-0188-02	4	.002" Undersize
	114-0188-10	4	.010" Undersize
	114-0188-20	4	.020" Undersize
	114-0188-30	4	.030" Undersize
8	RING SET, PISTON		
	113-0165	2	Standard
	113-0165-05	2	.005" Oversize
	113-0165-10	2	.010" Oversize
	113-0165-20	2	.020" Oversize
	113-0165-30	2	.030" Oversize
	113-0165-40	2	.040" Oversize

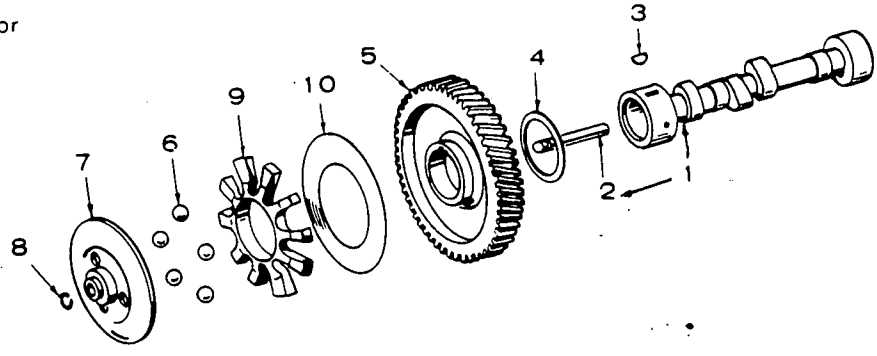
* - Parts Included in Piston and Pin Set.
† - Parts Included in Connecting Rod Assembly.

CAMSHAFT GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	105-0382	1	Camshaft (Includes Parts Marked *)
2	105-0075	1	*Pin, Camshaft
3	515-0001	1	Key - Camshaft Gear
4	105-0004	1	Washer, Thrust
5	105-0332	1	Gear, Camshaft (Includes Parts Marked †)
6	510-0015	5	Ball, Fly - Governor
7	150-0612	1	Cup, Governor
8	150-0078	1	Ring, Retaining
9	150-1257	1	†Spacer, Fly Ball
10	150-0077	1	†Plate, Fly Ball

* - Parts Included in Camshaft Assembly.

† - Parts included in Camshaft Gear.



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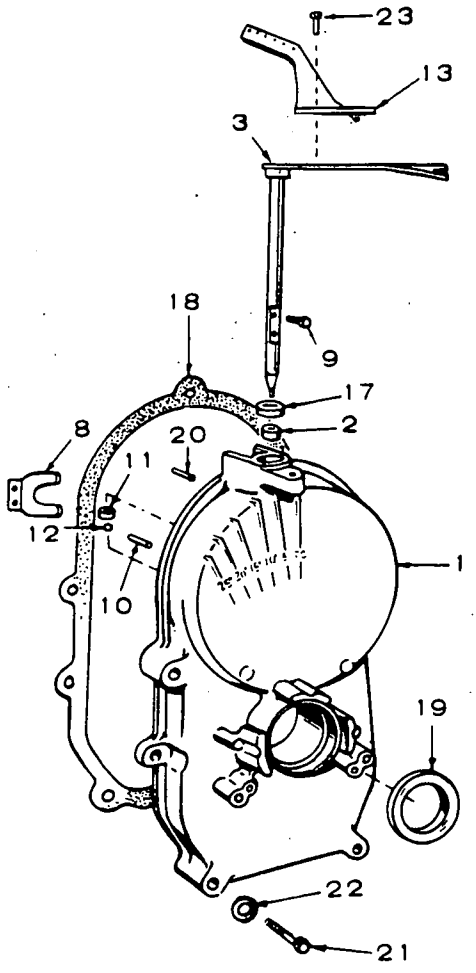
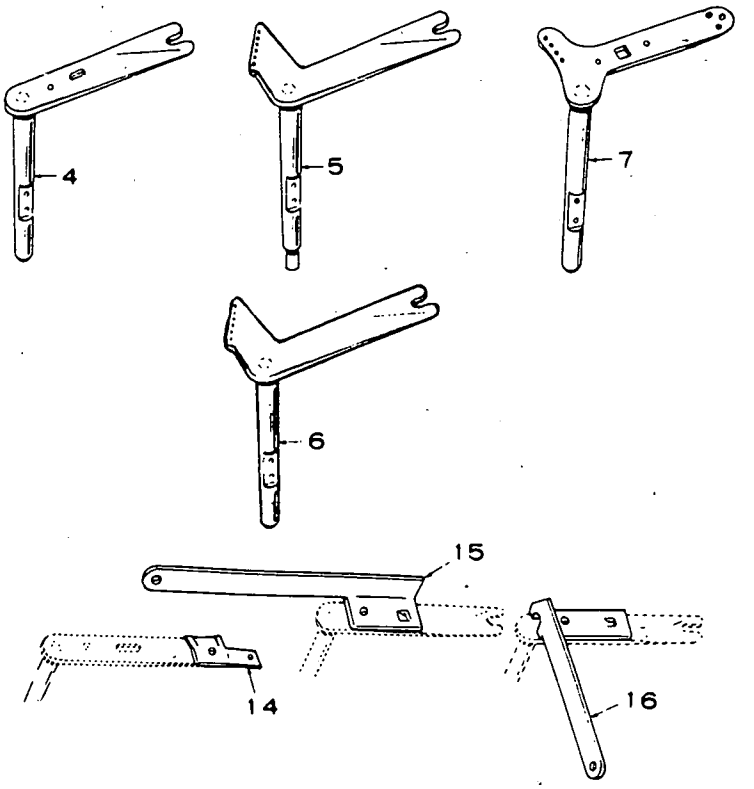


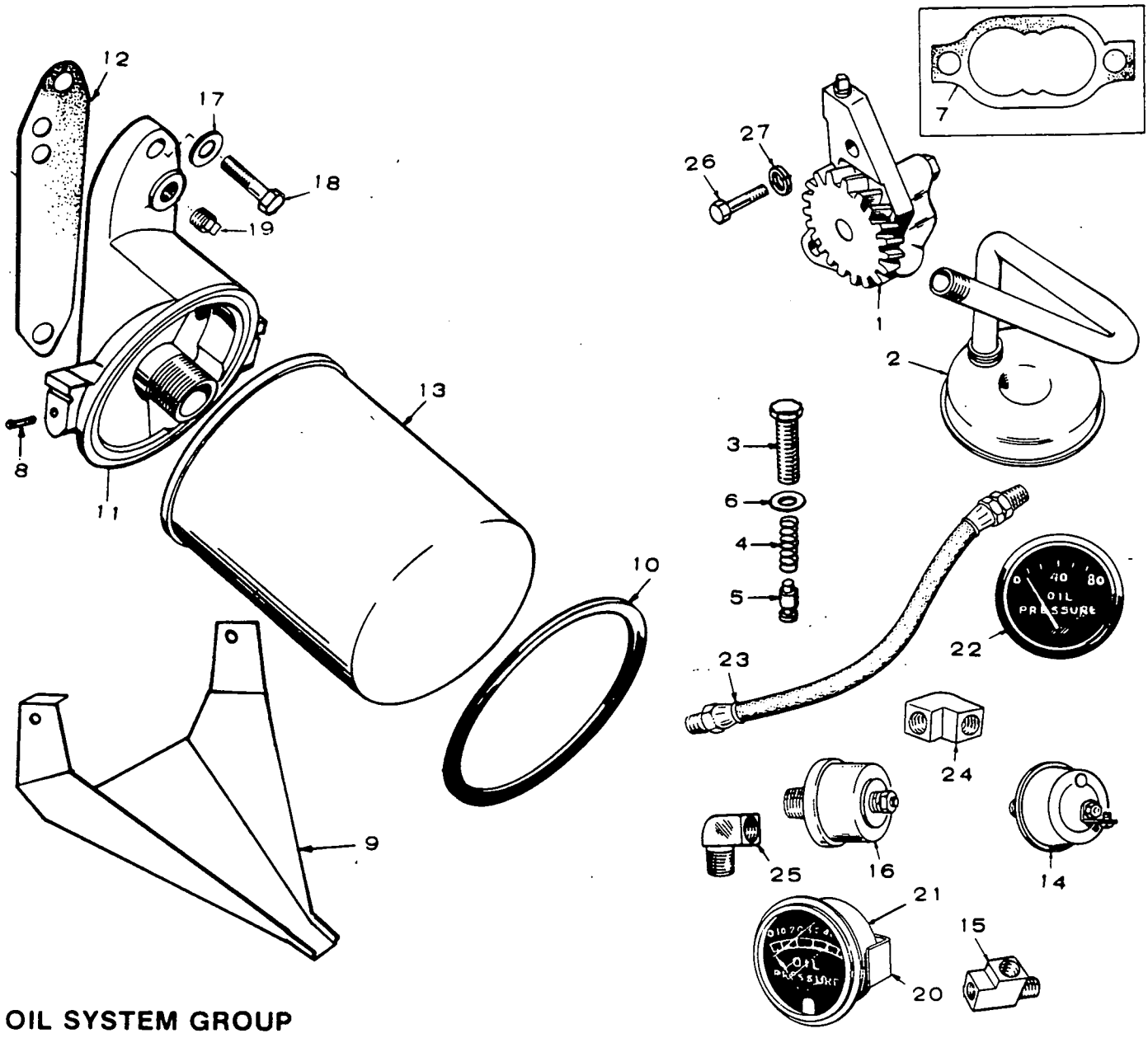


GEARCASE GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	GEAR CASE ASSEMBLY (All Include Parts Marked †)		
	103-0386	1	Standard - Key 1 (Includes Parts Marked *)
	103-0472	1	Standard - Key 2 (Includes Parts Marked *)
	103-0447	1	Standard - Key 3 (Includes Parts Marked *)
	103-0474	1	Standard - Key 4 (Includes Parts Marked *)
	103-0387	1	Special - Key 1, 2 - Without Governor Parts - Manual Throttle
	103-0446	1	Special - Key 3, 4 - Without Governor Parts - Manual Throttle
	103-0475	1	Special - Key 2 - Side Pull Governor (Includes Standard Parts Marked *)
	103-0473	1	Special - Key 2 - Includes Dust Seals & Standard Parts Marked *)
2	*BEARING, (Upper Governor Shaft)		
	510-0013	1	Needle - Key 1, 3
	510-0105	1	Sleeve - Key 2, 4
	*SHAFT & ARM, GOVERNOR		
3	150-1260	1	Standard - Key 1
4	150-1450	1	Standard - Key 2
5	150-1436	1	Standard - Key 3
6	150-1451	1	Standard - Key 4
7	150-1453	1	Special - Key 2 (Side Pull)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
8	150-1187	1	*Yoke, Governor Shaft
9	815-0046	2	*Screw, Pan Head, Steel (8-32 x 3/8")
10	516-0130	1	*Pin, Roll
11	510-0008	1	*Bearing, Needle - Key 1, 3
12	510-0014	1	*Bearing, Ball
	EXTENSION, GOVERNOR ARM		
13	150-1073	1	Standard - Key 1, 2 - Left Pull
14	150-1268	1	Optional - Key 1, 2 - Rear Pull
15	150-0755	1	Optional - Key 1, 2 - Front Pull
16	150-0752	1	Optional - Key 1, 2 - Right Pull
17	509-0008	1	*†Seal, Oil
18	103-0408	1	Gasket, Gearcase
19	509-0040	1	*Seal, Oil - Crankshaft
20	516-0011	2	Pin, Roll
21	SCREW, HEX HEAD, CAP, STEEL		
	800-0032	4	5/16-18 x 1-3/4"
	800-0034	1	5/16-18 x 2-1/4"
22	526-0065	5	Washer, Flat, Copper (5/16")
23	815-0181	1	Screw, Hex Head, Cap, Thread Cutting with Lock Washer (10-32 x 1/2")

* - Parts Included in Specific Gearcase Assemblies.
† - Parts Included in all Gearcase Assemblies.



OIL SYSTEM GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	120-0491	1	Pump, Oil (Parts Not Sold Separately)
2	120-0648	1	Intake, Oil Pump
3	801-0050	1	Screw, Hex Head, Cap, Steel (3/8-24 x 1")
4	120-0140	1	Spring, By-Pass Valve
5	120-0398	1	Valve, By-Pass
6	526-0066	1	Washer, By-Pass Valve
7	120-0161	1	Gasket Kit - Oil Pump
8	815-0194	2	Screw, Hex Head, Cap, Thread Cutting with Lock Washer (10-32 x 3/8")
9	DRAIN, OIL		
	122-0352	1	Key 1, 2
	122-0360	1	Key 3, 4
10	122-0347	1	Seal, Air - Oil Filter
11	122-0320	1	Adapter, Oil Filter
12	122-0321	1	Gasket - Adapter Mounting
13	122-0323	1	Filter, Oil
14	309-0010	1	Switch, Low Oil Pressure - Optional

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
15	502-0058	1	Tee - Low Oil Pressure Switch - Optional
16	193-0198	1	Sender, Oil Pressure - Optional
17	526-0065	2	Washer, Flat, Copper (5/16")
18	800-0028	2	Screw, Hex Head, Cap, Steel (5/16-18 x 1")
19	505-0057	1	Plug, Pipe (1/8")
20	193-0031	1	Clamp, Meter
21	193-0068	1	Gauge, Oil Pressure - Optional
22	193-0107	1	Gauge, Oil Pressure (Electrical) - Optional
23	501-0004	1	Line, Flexible - Oil - Optional
24	502-0005	1	Elbow, Pipe - Oil Line - Optional
25	502-0020	1	Elbow, Pipe - Oil Line - Optional
26	800-0007	2	Screw, Hex Head, Cap, Steel (1/4-20 x 1")
27	850-0040	2	Washer, Lock, Steel (1/4")

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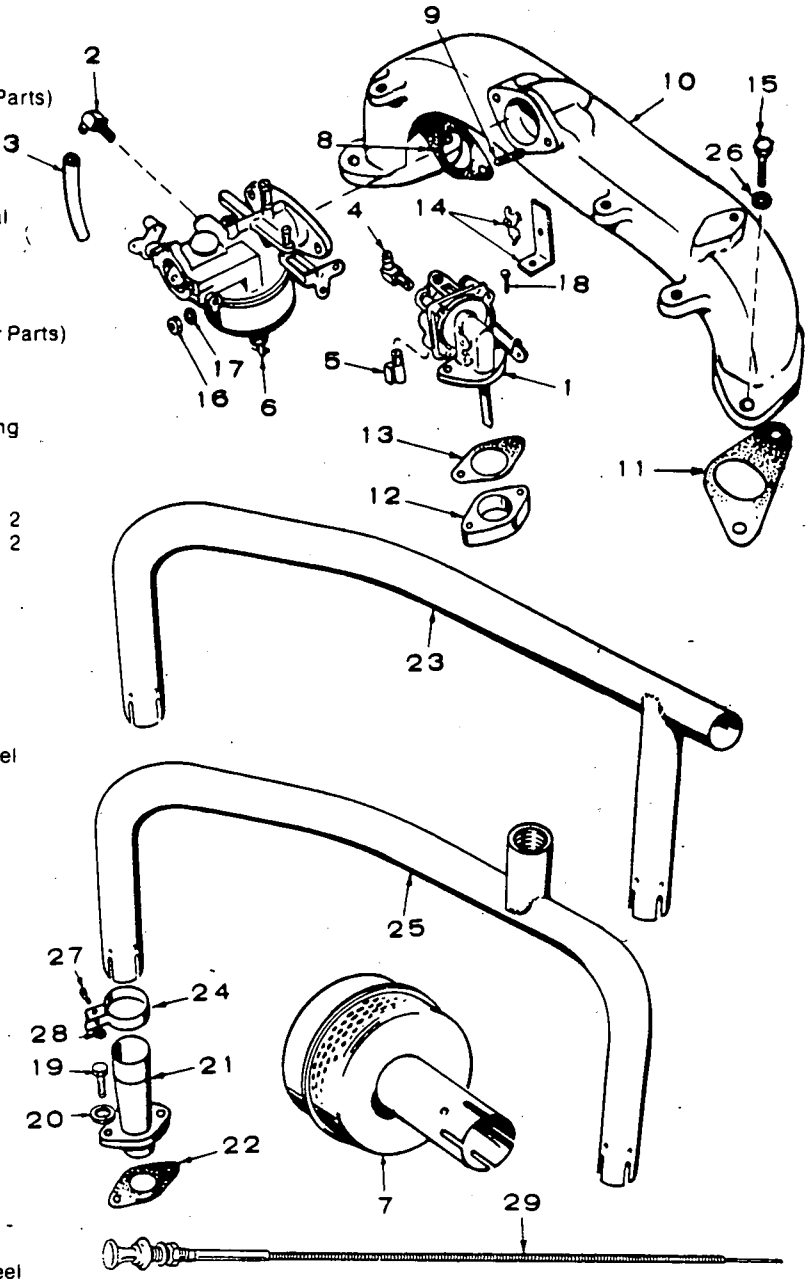
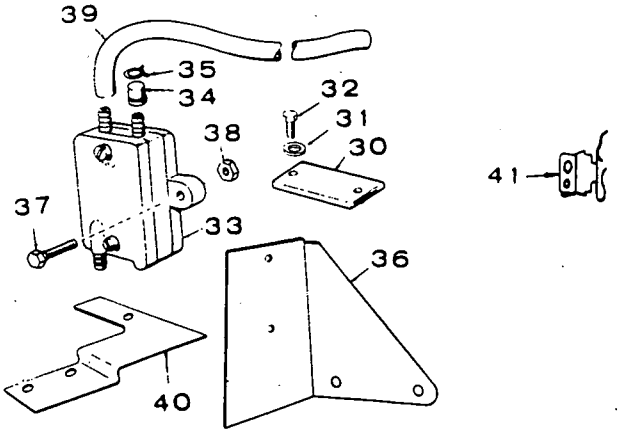
FUEL & EXHAUST SYSTEMS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	149-1223	1	Pump, Fuel - Key 1 & 2 - (See Separate Group for Parts)
2	505-0313	1	Elbow, Pipe - Carburetor Inlet
3	LINE, FUEL - PUMP TO CARBURETOR		
	149-1228	1	Standard - Key 1, 2
	503-0708	1	Special - Key 3, 4 - Optional
4	502-0313	1	Elbow, Pipe - Key 1, 2 - Fuel Pump Outlet
5	502-0002	1	Elbow, Pipe - Key 1, 2 - Fuel Pump Inlet
6	CARBURETOR, GASOLINE (See Separate Group for Parts)		
	141-0802	1	Standard - Manual Choke
	141-0803	1	Special - Electric Choke
7	155-1217	1	Muffler, Exhaust
8	141-0281	1	Gasket, Carburetor Mounting
9	520-0526	2	Stud, Carburetor Mounting
10	154-1466	1	Manifold, Intake
11	154-1483	2	Gasket, Intake Manifold
12	149-0045	1	Spacer, Fuel Pump - Key 1, 2
13	149-0003	2	Gasket, Fuel Pump - Key 1, 2
14	153-0263	1	Bracket & Clamp - Manual Choke - Optional
15	800-0538	4	Screw, Hex Head, Cap (3/8-16 x 1-1/2")
16	868-0002	2	Nut, Hex, Jam (5/16-24)
17	854-0017	2	Washer, Lock, Steel (5/16)
18	806-0009	2	Screw, Counterbore, Cap, Steel (1/4-20 x 1-1/4")
19	800-0512	4	Screw, Hex Head, Cap, Steel (5/16-18 x 1")
20	850-0045	4	Washer, Lock, Steel (5/16)
21	154-1484	2	Adapter, Exhaust Manifold
22	154-1482	2	Gasket, Exhaust Manifold
23	154-1492	1	Manifold, Exhaust - High Profile (Side Outlet) - Optional
24	155-1219	2	Clamp, Exhaust Pipe
25	154-1493	1	Manifold, Exhaust - High Profile (Top Outlet) - Optional
26	850-0050	4	Washer, Lock, Steel (3/8")
27	805-0018	2	Bolt, Place, Steel (3/8-16 x 1")
28	862-0003	2	Nut, Hex (3/8-16)
29	153-0097	1	Choke, Control, Manual - Optional
30	149-0136	1	Cover - Fuel Pump Block Opening - Key 3, 4
31	526-0043	2	Washer, Flat, Copper (1/4) - Key 3, 4
32	800-0004	2	Screw, Hex Head, Cap, Steel (1/4-20 x 5/8") - Key 3, 4
33	149-1322	1	Pump, Fuel - Optional - Key 3, 4 (See Separate Group for Parts)
34	149-1321	1	Cap, Inlet - Fuel Pump - Key 3, 4
35	503-0301	1	Clamp, Loop - Key 3, 4
36	149-1364	1	Bracket, Angle - Fuel Pump - Key 3, 4
37	813-0102	2	Screw, Round Head, Steel (10-32 x 5/8") - Key 3, 4
38	870-0131	2	Nut, Hex (10-32) - Key 3, 4
39	503-0706	1	Line, Flexible - Key 3, 4
40	153-0464	1	Bracket, Angle - Manual Choke - Key 3, 4
41	518-0176	1	Clip, Cable - Manual Choke - Key 3, 4





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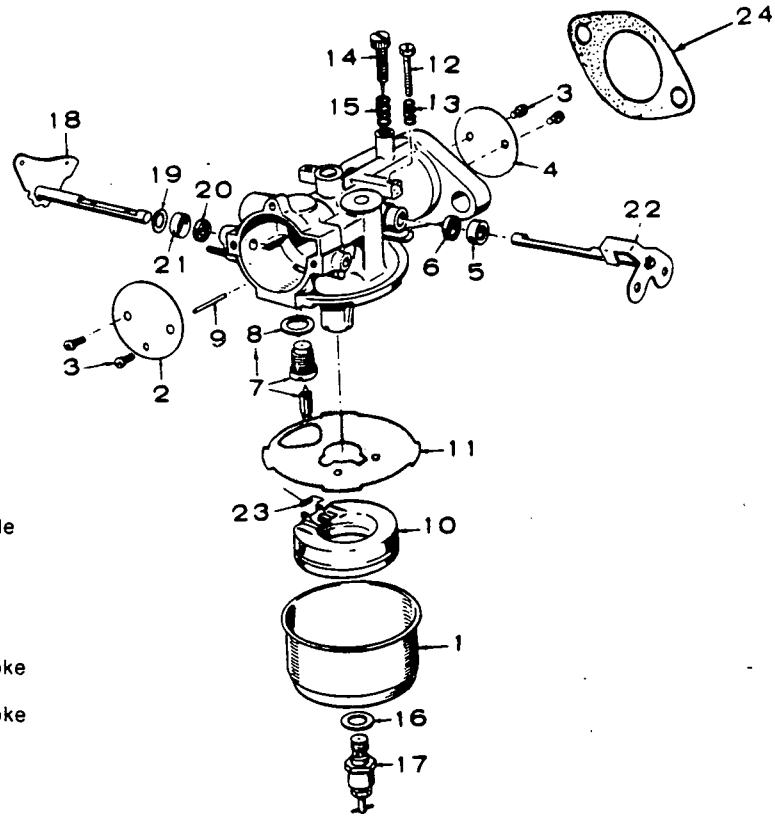
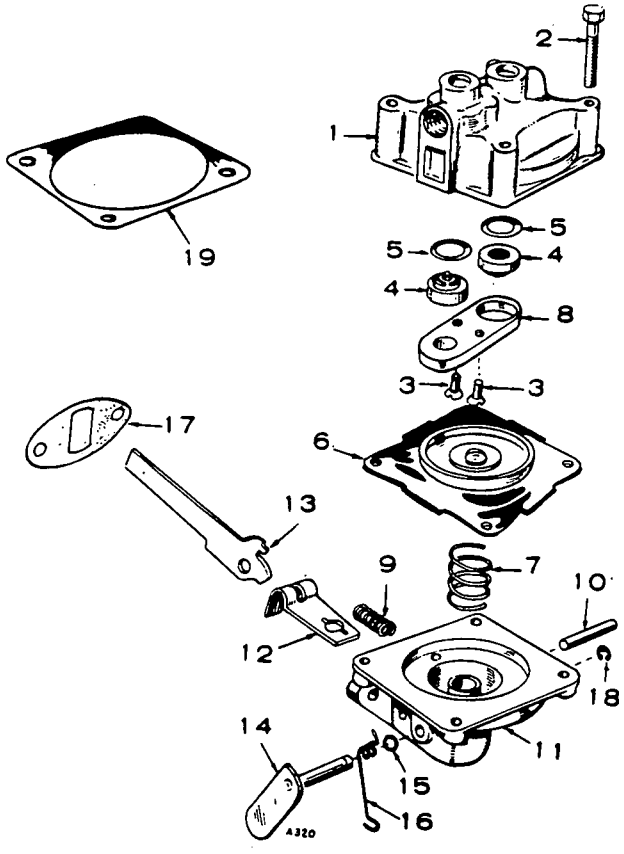
CARBURETOR PARTS GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	CARBURETOR, GASOLINE		
	141-0802	1	Standard - Manual Choke
	141-0803	1	Special - Electric Choke
1	141-0708	1	Bowl, Fuel
2	141-0741	1	Plate, Choke
3	141-0698	4	Screw, Round Head with Washer
4	141-0813	1	Plate, Throttle
5	141-0705	1	*Retainer, Seal
6	141-0661	1	*†Seal, Rubber
7	141-0798	1	*Seat, Valve
8	141-0811	1	†Washer, Valve Seat
9	141-0703	1	*Shaft, Float Pivot
10	141-0702	1	Float, Carburetor
11	141-0701	1	*†Gasket, Bowl
12	141-0700	1	Screw, Throttle Stop
13	141-0711	1	Spring, Throttle Stop
14	141-0713	1	*Needle, Idle Adjusting
15	141-0710	1	Spring, Idle Adjusting Needle
16	141-0077	1	*†Washer, Main Jet
17	141-0810	1	Jet, Main (Adjustable)
18	SHAFT, CHOKE		
	141-0742	1	Manual Choke
	141-0679	1	Electric Choke
19	141-0699	1	*Washer, Shaft - Manual Choke
20	141-0697	1	*†Seal, Felt - Manual Choke
21	141-0203	1	*Retainer, Seal - Manual Choke
22	141-0809	1	Shaft, Throttle
23	141-0799	1	*Spring, Fuel Float
24	141-0281	1	*†Gasket, Carburetor Flange

* - Included in Repair Kit #141-0814.
† - Included in Gasket Kit #141-0748.



FUEL PUMP PARTS GROUP (MECHANICAL TYPE)



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149-1223	1	Pump, Fuel - Key 1, 2
1	—	1	Body, Top - Fuel Pump (Not Sold Separately)
2	815-0148	4	Screw, Hex Head, Slotted, Steel, Zinc Plated, Cromate Dip (8-32 x 7/8")
3	815-0147	2	Screw, Oval Head, Cross Recess, Steel, Thread Cutting (6-32 x 7/8")
4	149-0096	2	*Valve, Check
5	149-0095	2	*Gasket, Valve
6	149-0582	1	*Diaphragm, Fuel Pump
7	149-0672	1	*Spring, Diaphragm
8	149-0539	1	Retainer, Check Valve
9	149-0675	1	Spring, Pump Arm
10	516-0113	1	Pin, Rocker Arm
11	—	1	Body, Lower - Fuel Pump (Not Sold Separately)
12	149-0670	1	Link, Rocker Arm
13	149-1148	1	Arm, Rocker
14	149-1042	1	Lever, Prime
15	509-0065	2	Seal, O-Ring
16	149-1044	1	Spring, Prime Lever
17	149-0003	1	*Gasket, Pump Mount
18	518-0129	1	Ring, Retaining - Prime Lever
19	149-0858	1	*Gasket, Diaphragm - Optional - (Prevents Air Lock)

* - Included in Repair Kit #149-0526.

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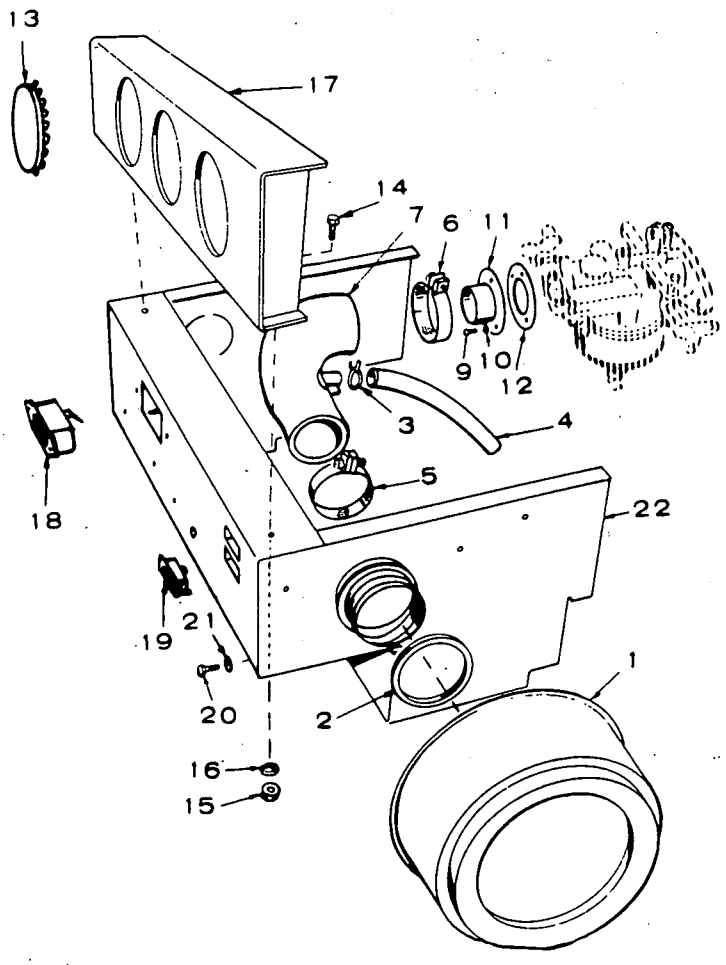
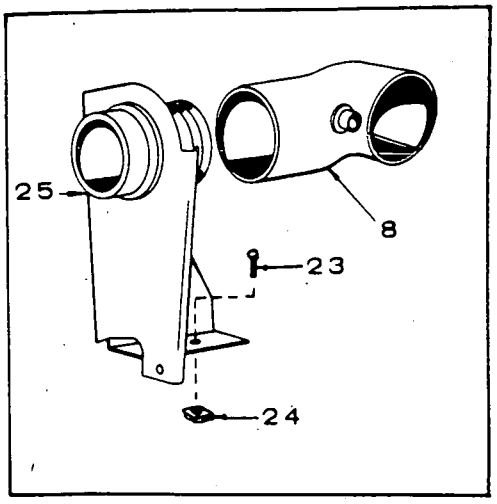
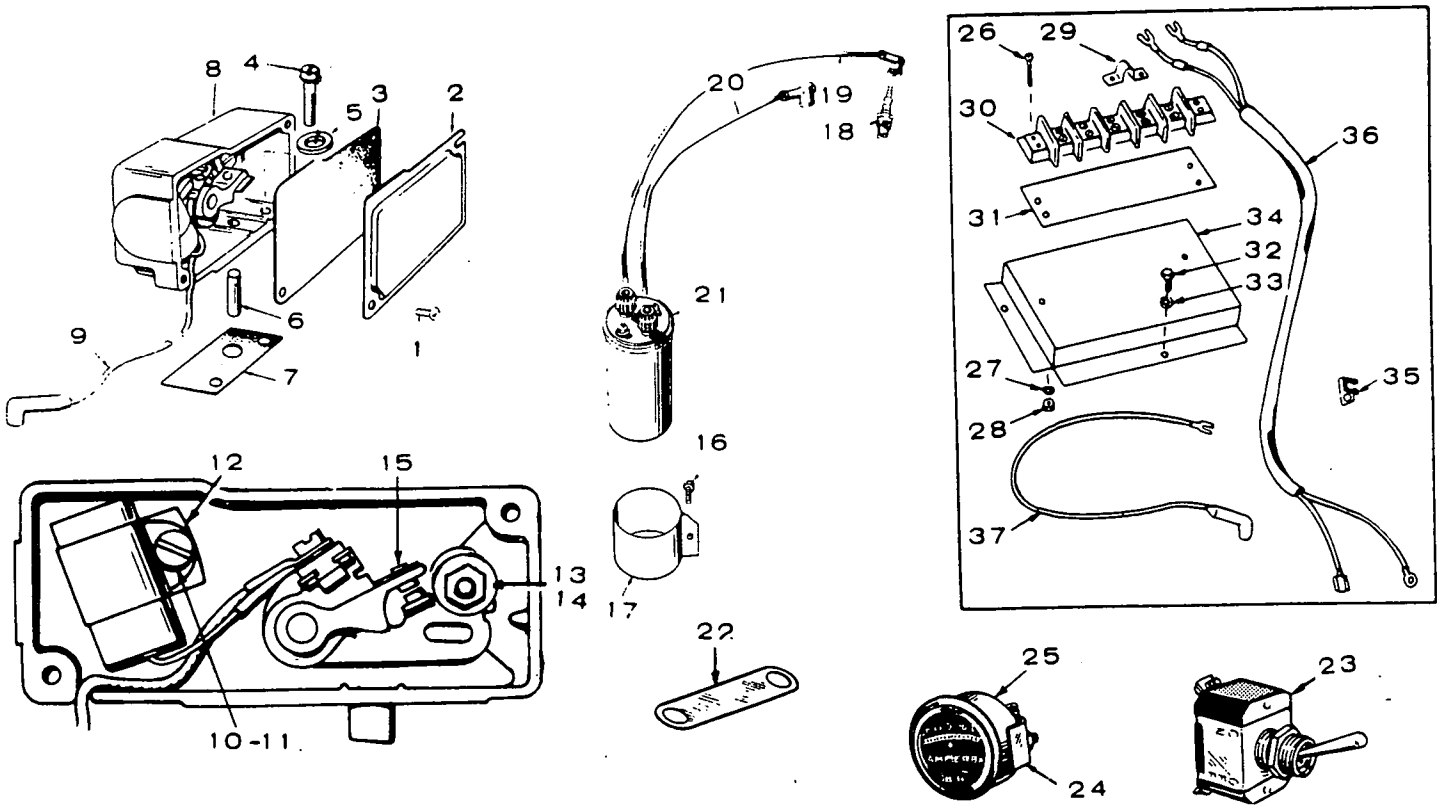




AIR CLEANER GROUP

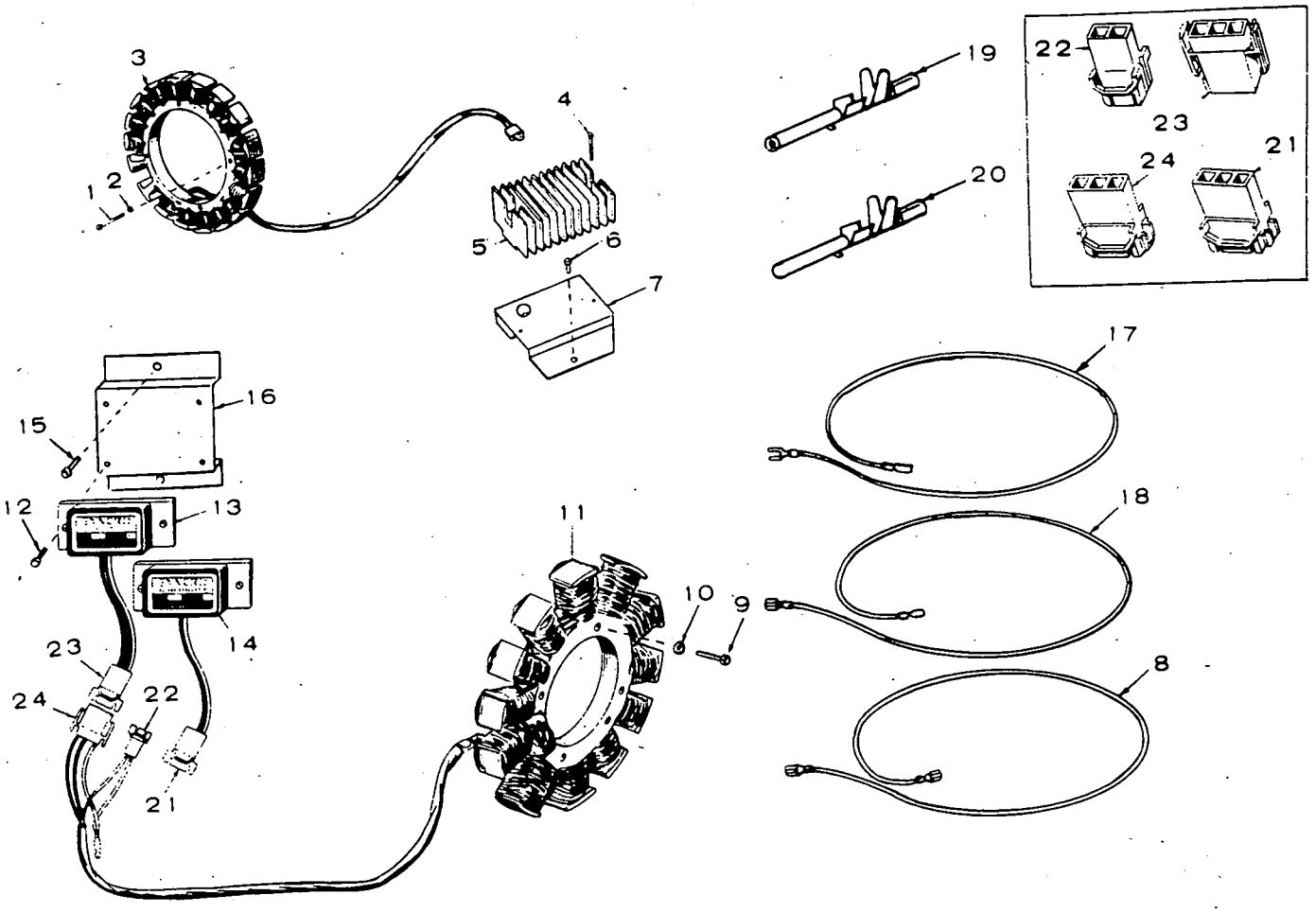
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	140-1175	1	Filter, Air Cleaner - Disposable
2	140-1185	1	Gasket, Air Cleaner
3	503-0170	2	Clamp, Hose
4	HOSE, FLEXIBLE - BREATHER		
	503-0582	1	Key 1, 2
	123-1241	1	Key 3, 4
5	CLAMP, LOOP		
	503-0365	1	Key 1, 2
	503-0274	1	Key 3, 4
6	CLAMP, LOOP		
	503-0004	1	Key 1, 2, 3
	503-0368	1	Key 4
7	140-1186	1	Elbow, Carburetor Inlet - Key 1, 2
8	140-1282	1	Elbow, Carburetor Inlet - Key 3, 4
9	815-0199	3	Screw, Fillister Head, Steel (10-32 x 5/16")
10	850-0030	3	Washer, Lock, Steel (#10)
11	ADAPTER, CARBURETOR INLET		
	145-0398	1	Key 1, 2
	145-0453	1	Key 3, 4
12	140-0921	1	Gasket, Carburetor Inlet
13	517-0009	1	Plug, Button - Key 1, 2
14	800-0003	2	Screw, Hex Head, Cap, Steel (1/4-20 x 1/2")
15	862-0001	2	Nut, Hex (1/4)
16	853-0013	2	Washer, Lock, External Tooth, Steel (1/4)
17	193-0218	1	Panel, Instrument - Key 1, 2 - Optional
18	302-0885	1	Meter, Time Totalizing - Key 1, 2 - Optional
19	322-0108	2	Light, Indicator - Key 1, 2 - Optional
20	821-0010	4	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2) - Key 1, 2
21	526-0015	4	Washer, Flat, Steel (1/4) - Key 1, 2
22	PANEL, AIR CLEANER		
	140-1179	1	Standard - Key 1, 2
	140-1184	1	Optional - Key 1, 2 (Used with Variable Speed Governor)
23	SCREW		
	809-0059	2	Round Head, Steel, Sheet Metal (1/4-20 x 1/2") - Key 3
	821-0010	2	Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 4
24	870-0160	2	Nut, Speed (1/4) - Key 3, 4
25	140-1280	1	Bracket, Air Cleaner - Key 3, 4



IGNITION GROUP

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	815-0358	2	Screw, Hex Head, Slotted, Steel, Thread Forming (8-32 x 5/16")
2	160-1149	1	*Cover, Breaker Box
3	160-1148	1	*Gasket, Cover
4	SCREW		
	815-0373	2	Fillister Head, Cross-Recessed, Steel, with External Tooth Lockwasher (1/4-20 x 5/8") - Key 1, 3
	802-0034	2	Socket Head, Steel (1/4-20 x 3/4") - Key 2, 4
5	850-0038	2	Washer, Lock, Steel (1/4) - Key 2, 4
6	160-1151	1	Plunger
7	160-1150	1	Gasket
8	160-1158	1	Breaker Assembly (Includes Parts Marked *)
9	336-2132	1	*Lead, Electrical - Points to Coil
10	815-0403	1	*Screw, Pan Head, Steel, Thread Forming (8-32 x 5/16")
11	850-0025	1	*Washer, Lock, Steel (#8)
12	312-0069	1	*Condenser
13	870-0221	1	*Nut, Hex, Steel, with External Lockwasher (8-32)
14	815-0405	1	*Screw, Pan Head, Cross-Recessed, Steel (8-32 x 1/2")
15	160-1154	1	*Point Set, Breaker
16	821-0010	1	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2")
17	166-0617	1	Clamp, Coil Mounting
18	167-0240	2	Spark Plug
19	167-1463	1	Cable, Electrical - Spark Plug
20	167-1462	1	Cable, Electrical - Spark Plug
21	166-0535	1	Coil, Ignition
22	LEAD, ELECTRICAL		
	332-0592	1	Jumper - Optional
	336-2271	1	Switch to Starter Solenoid - Optional
	336-2272	1	Switch to Ignition Coil - Optional
	336-2273	1	Switch to Terminal Board - Optional
	336-0794	1	Ammeter to Terminal Board - Optional
23	300-0140	1	Switch, Toggle - Ignition - Optional
24	302-0270	1	Clamp, Meter - Optional
25	302-0060	1	Ammeter - Optional
26	812-0082	2	Screw, Round Head, Cross-Recessed, Steel (8-32 x 3/4")
27	850-0025	2	Washer, Lock, Steel (#8)
28	860-0008	2	Nut, Hex, Steel (8-32)
29	332-1043	1	Jumper, Terminal
30	332-0604	1	Block, Terminal
31	332-1273	1	Strip, Marker
32	SCREW		
	813-0100	2	Round Head, Cross-Recessed, Steel (10-32 x 1/2") - Key 1, 3
	821-0004	2	Hex Locking Head, Flanged, Steel (10-32 x 5/16") - Key 2, 4
33	856-0003	2	Washer, Lock, Steel (#10) - Key 1, 3
34	301-3530	1	Bracket, Terminal Block
35	167-0188	1	Clip, Cable
36	338-0619	1	Harness, Wiring - Starter Solenoid to Terminal Block
37	336-2132	1	Lead, Electrical - Terminal Block to Ignition Coil

* - Parts Included in Breaker Assembly.



CHARGING ALTERNATOR GROUP - OPTIONAL EQUIPMENT

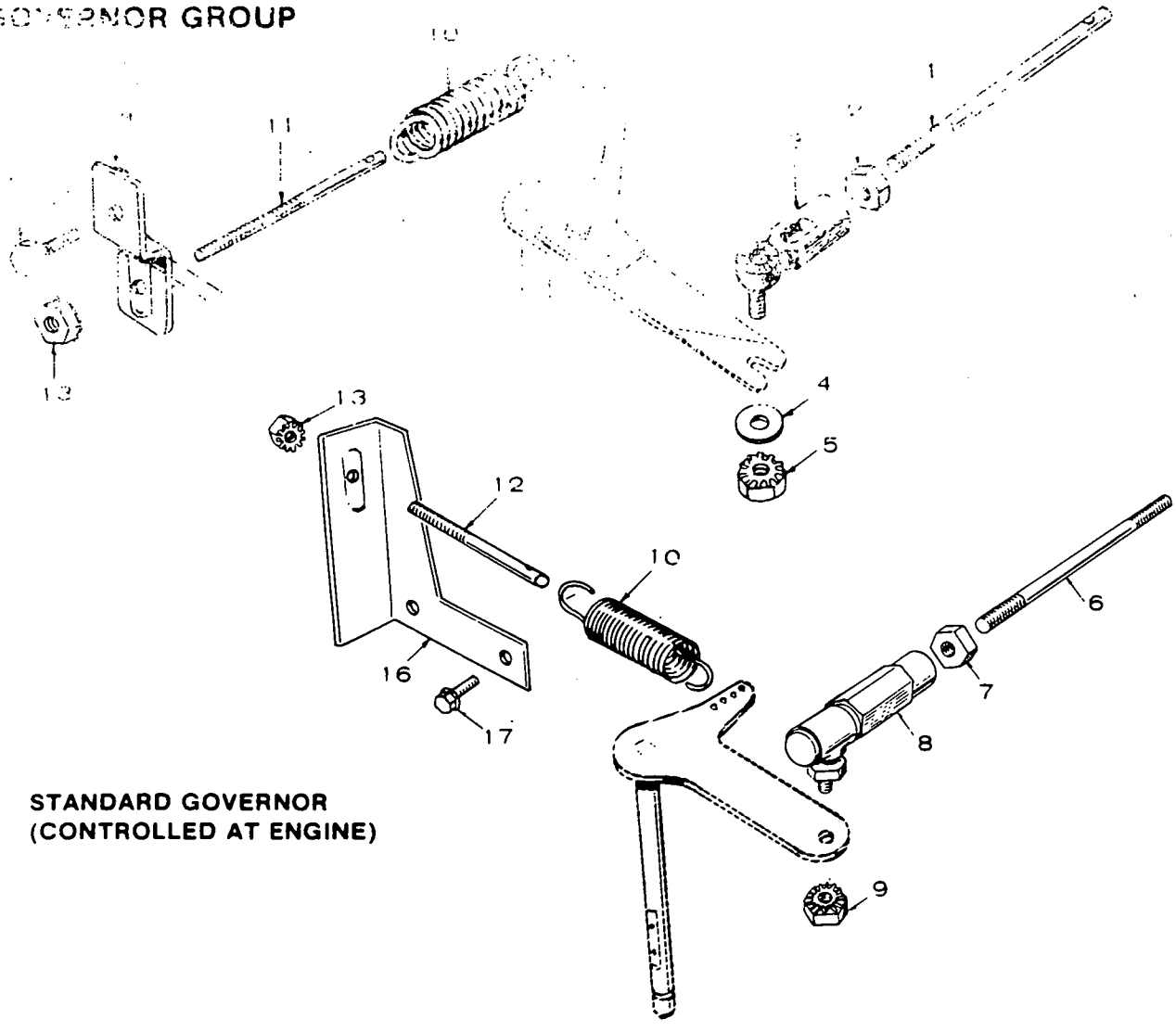
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	£	1	Alternator Group - Phelon - 12 Volt 15 Amp (Includes Flywheel with Magnet Ring, Illustrated in the Crankshaft and Flywheel Group; and Parts Marked *
1	813-0108	3	*Screw, Round Head, Cross-Recessed, Steel (10-32 x 1-1/4")
2	850-0030	3	*Washer, Lock, Steel (#10)
3	191-0885	1	*Stator, Alternator - 12 Volt, 15 Amp
4	821-0018	2	*Screw, Hex Locking Head, Flanged, Steel (1/4-20 x 5/8")
5	191-0886	1	*Regulator, Voltage
6	821-0010	1	*Screw, Hex Locking Head, Flanged, Steel (1/4-20 x 1/2")
7	191-1059	1	*Bracket, Mounting, Regulator
8	336-2192	1	*Lead, Electrical - Regulator to Terminal Board
	£	1	Alternator Group - Synchro - 12 Volt 20 Amp (Includes Flywheel with Magnet Rings Illustrated in Crankshaft & Flywheel Group; and Parts Marked †)
9	813-0108	3	†Screw, Round Head, Cross-Recessed, Steel (10-32 x 1-1/4")
10	850-0030	3	†Washer, Lock, Steel (#10)
11	191-0937	1	†Stator, Alternator - 12 Volt 20 Amp
12	821-0004	4	†Screw, Hex Locking Head, Flanged, Steel (10-32 x 5/16")
13	191-0938	1	†Rectifier, Current
14	191-0939	1	†Regulator, Voltage
15	821-0010	2	†Screw, Hex Locking Head, Flanged, Steel (1/4-20 x 1/2")
16	191-1060	1	†Bracket, Mounting, Rectifier - Regulator
17	336-2222	1	†Lead, Electrical - Optional
18	336-2236	1	†Lead, Electrical - Optional
19	323-0488	5	†Contact, Electrical - Female, Connecting
20	323-0496	5	†Contact, Electrical - Male, Connector
21	323-0880	1	†Shell, Connector (2 Sockets)
22	323-0879	1	†Shell, Connector (2 Pins)
23	323-0882	1	†Shell, Connector (3 Sockets)
24	323-0881	1	†Shell, Connector (3 Pins)

£ - Factory Installed Optional Equipment. When Ordering Parts give Complete Engine Model, Spec and Serial Numbers.

* - Parts Included in 12 Volt 15 Amp Alternator Group.

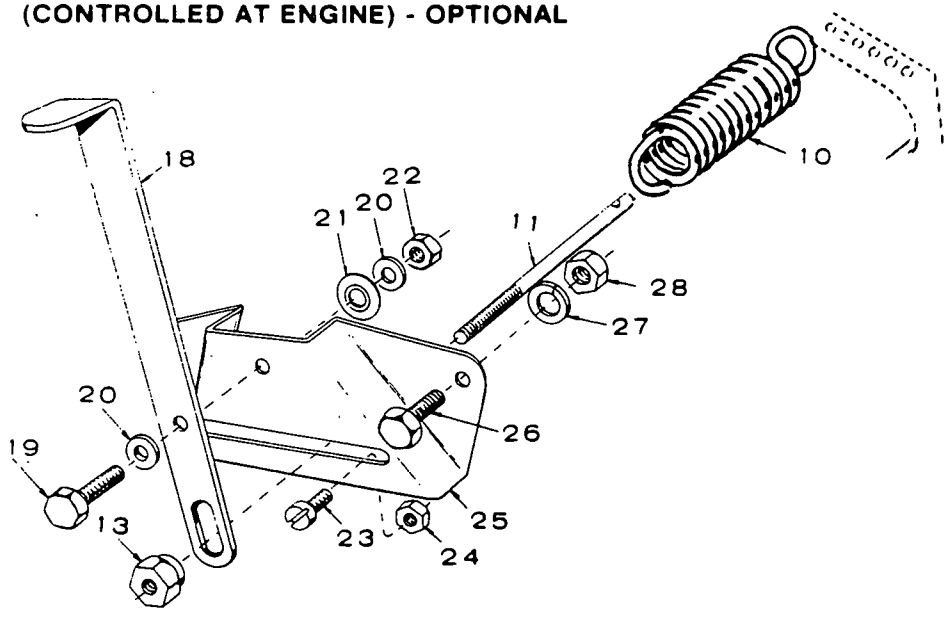
† - Parts Included in 12 Volt 20 Amp Alternator Group.

GOVERNOR GROUP

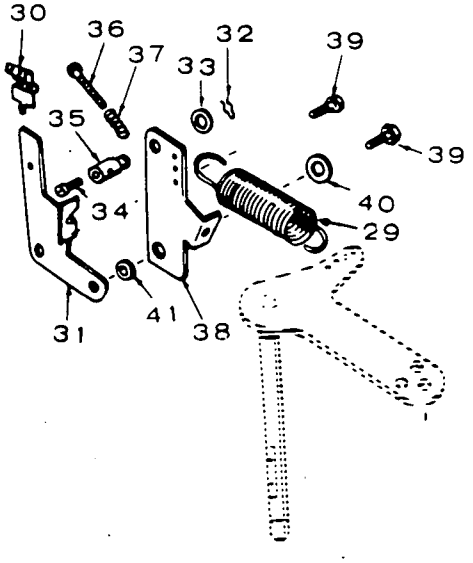


STANDARD GOVERNOR
(CONTROLLED AT ENGINE)

VARIABLE SPEED GOVERNOR
(CONTROLLED AT ENGINE) - OPTIONAL



VARIABLE SPEED GOVERNOR
(REMOTE CONTROLLED)
- OPTIONAL



REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	£	1	Linkage Assembly, Governor - Used on Engines up thru Serial Number 832097 (Includes Parts Marked *) - Key 1 thru 4
1	520-0623	1	*Stud, Link Assembly
2	870-0053	2	*Nut, Hex (3/8)
3	150-0939	2	*Joint, Ball, Nylon
4	526-0196	2	*Washer, Flat (#10)
5	870-0131	2	*Nut, Hex with External Lockwasher (10-32)
	£	1	Linkage Assembly, Governor - Used on Engines Starting with Serial 832098 and up (Includes Parts Marked †) - Key 2, 4
6	†STUD, LINK ASSEMBLY		
	520-0187	1	Key 2
	520-0690	1	Key 4
7	870-0053	2	†Nut, Hex (3/8) - Key 2, 4
8	150-0639	2	†Joint, Ball, Steel - Key 2, 4
9	870-0131	2	†Nut, Hex with External Lockwasher - (10-32) Key 2, 4
10	150-0098	1	Spring, Governor
11	150-0147	1	Stud, Speed Adjustment - Key 1, 2
12	STUD, SPEED ADJUSTMENT		
	150-0096	1	Key 3
	150-1418	1	Key 4
13	870-0131	1	Nut, Hex with External Lockwasher
14	150-1359	1	Bracket, Speed Stud - Key 1, 2
15	821-0010	1	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 1, 2
16	150-1433	1	Bracket, Speed Stud - Key 3, 4
17	821-0010	2	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4
	£	1	Control, Variable Speed Governor - (Includes Parts Marked #) - Optional - Key 1, 2
18	152-0095	1	#Arm, Control
19	800-0005	1	#Screw, Hex Head, Cap, Steel (1/4-20 x 3/4")
20	526-0015	2	#Washer, Flat, Steel (1/4)
21	152-0041	1	#Washer, Spring Tension
22	870-0065	2	#Nut, Hex, Steel (1/4-20)
23	815-0199	2	#Screw, Fillister Head, Steel (10-32 x 5/16")
24	870-0131	2	#Nut, Hex with External Lockwasher (10-32)
25	152-0190	1	#Bracket, Control
26	800-0003	2	Screw, Hex Head, Cap, Steel (1/4-20 x 1/2") - Key 1, 2
27	856-0006	2	Washer, Lock, External Tooth, Steel (1/4) - Key 1, 2
28	862-0001	2	Nut, Hex, Steel, Zinc Plate (1/4-20) - Key 1, 2
	£	1	Remote Control, Variable Speed Governor (Includes Parts Marked +) - Optional - Key 3, 4
29	150-1214	1	+Spring, Governor
30	518-0176	1	+Clip, Cable
31	150-1343	1	+Bracket, Cable
32	516-0059	1	+Pin, Cotter
33	526-0006	1	+Washer, Flat, Steel (#6)
34	815-0104	1	-Screw, Fillister Head, Steel (8-32 x 5/16")
35	152-0155	1	+Swivel, Cable Holding
36	812-0066	1	+Screw, Round Head, Steel (6-32 x 3/4")
37	150-1398	1	+Spring, Idle Setting
38	150-1435	1	+Arm, Governor Control
39	821-0010	2	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4
40	526-0214	1	Washer, Flat, Steel (1/4) - Key 3, 4
41	150-1269	1	Bushing, Control Arm - Key 3, 4

£ - Not Stocked as an Assembly; When Ordering give Complete Engine Nameplate Model, Spec and Serial Number and/or Order Individual Parts.

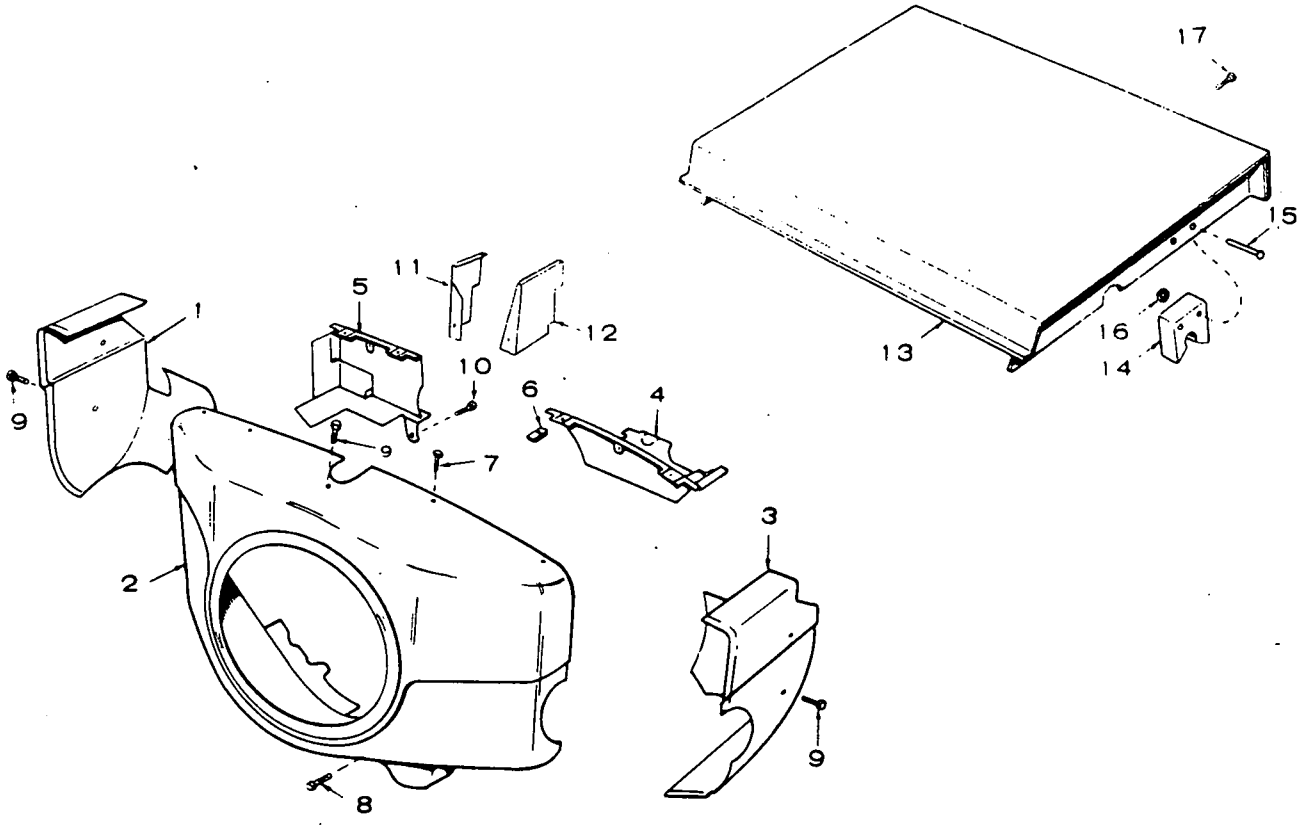
* - Parts Included in old type Nylon Ball Joint Throttle Linkage.

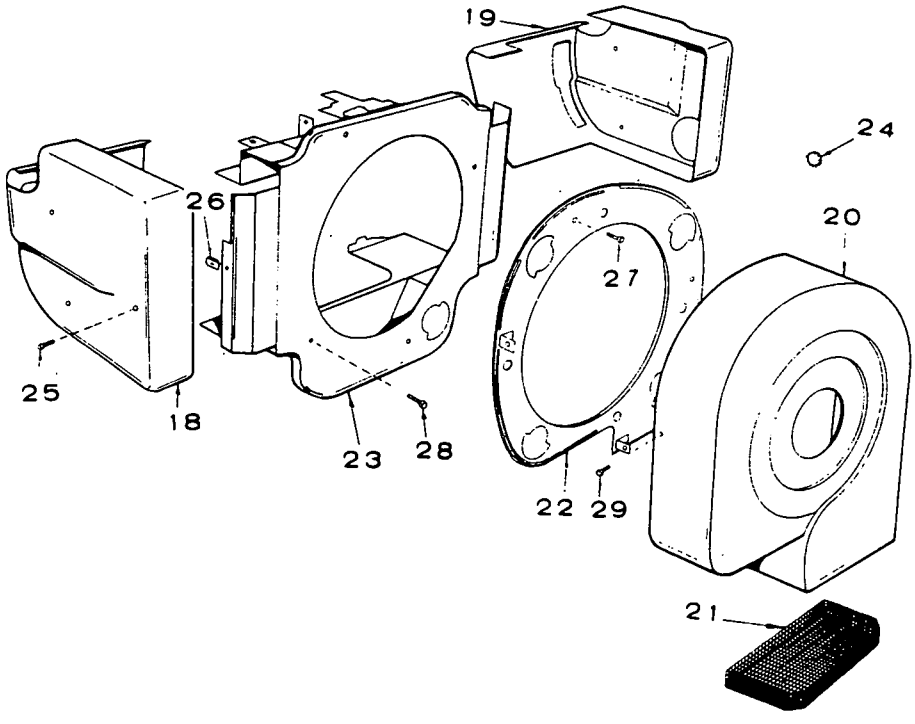
† - Parts Included in new type Metal Ball Joint Throttle Linkage.

- Parts Included in Engine Mounted Variable Speed Governor.

+ - Parts Included in Remote Controlled Variable Speed Governor.

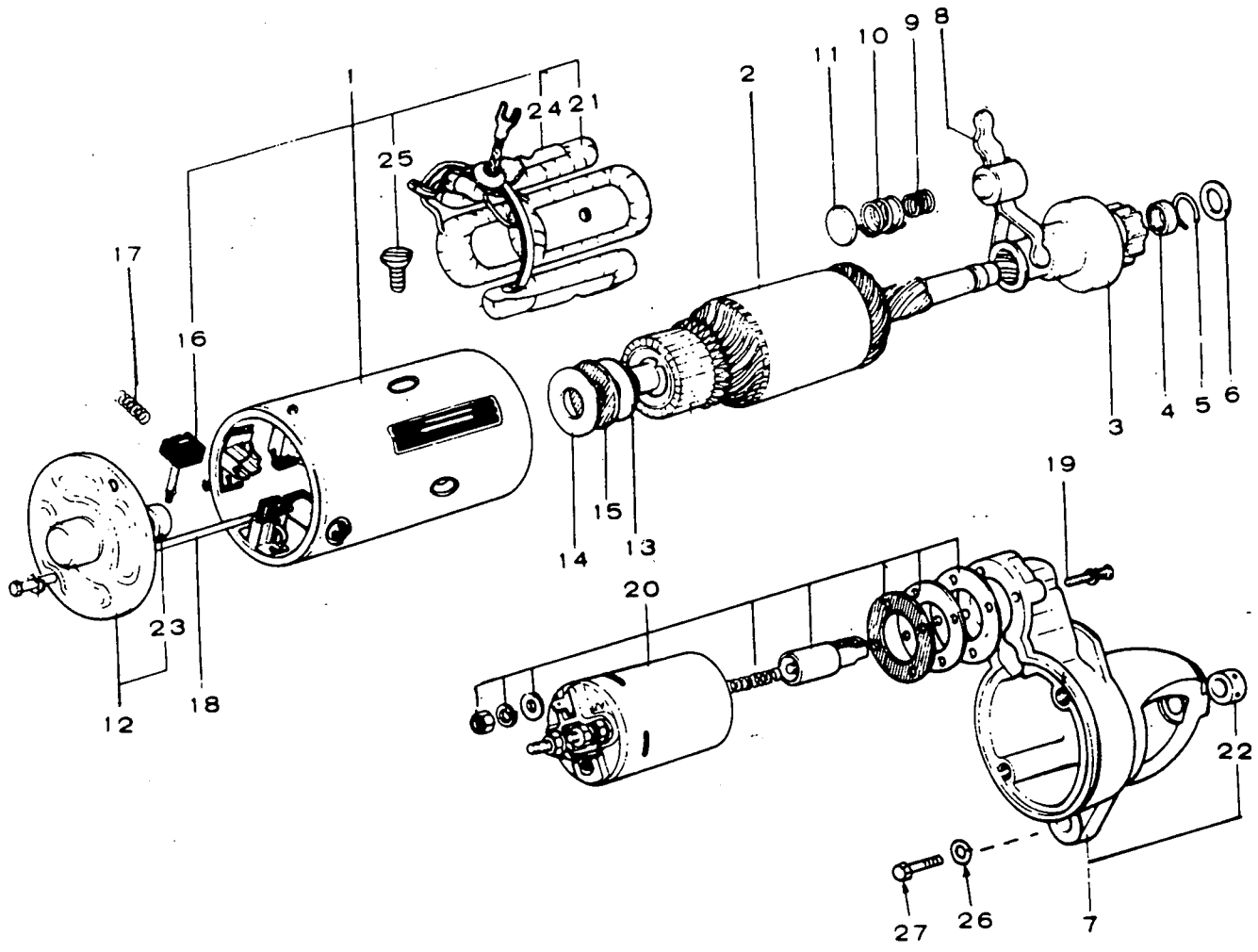
HOUSING GROUP





902424

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	134-2489	1	Housing, Air - Left Side - Key 1, 2
2	HOUSING, BLOWER		
	134-2494	1	Standard - Key 1
	134-2811	1	Standard - Key 2
	134-2531	1	Optional - With Flywheel Guard - Key 1
	134-2810	1	Optional - With Flywheel Guard - Key 2
3	HOUSING, AIR - RIGHT SIDE		
	134-2488	1	Key 1
	134-2799	1	Key 2
4	134-2483	1	Support, Housing - Right Side - Key 1, 2
5	134-2487	1	Support, Housing - Left Side - Key 1, 2
6	870-0107	4	Nut, Speed (#14A) - Key 1, 2
7	809-0059	4	Screw, Round Head, Sheet Metal (1/4 x 1/2") - Key 1, 2
8	821-0010	2	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4
9	815-0261	5	Screw, Hex Washer Head, Steel, Thread Forming (1/4-20 x 7/16") - Key 1, 2
10	815-0370	4	Screw, Hex Head, Steel, Thread Forming (1/4-20 x 1/2") - Key 1, 2
11	140-1193	1	Shield, Heat, Left Side - Carburetor - Optional - Key 1, 2
12	140-1192	1	Shield, Heat, Right Side - Carburetor - Optional - Key 1, 2
13	405-1935	1	Hood, Engine - Optional - Key 1, 2
14	405-1872	2	*Clip, Hood - Optional - Key 1, 2
15	818-0150	4	*Rivet, Drive - Optional - Key 1, 2
16	526-0003	4	*Washer, Flat - Optional - Key 1, 2
17	821-0010	2	Screw, Locking Head, Steel, Thread Forming (1/4-20 x 1/2") - Key 1, 2
18	134-2755	1	Housing, Air - Left Side - Key 3, 4
19	134-2752	1	Housing, Air - Right Side - Key 3, 4
20	134-2761	1	Scroll, Air (Includes Guard) - Key 3, 4
21	134-2763	1	Guard, Scroll - Key 3, 4
22	134-2747	1	Backplate, Scroll - Key 3, 4
23	134-2737	1	Housing, Blower - Key 3, 4
24	517-0021	1	Plug, Button - Key 3, 4
25	SCREW		
	809-0059	2	Round Head, Sheet Metal, Steel (1/4 x 1/2") - Key 3
	820-0010	2	Locking Head, Flanged, Steel, Thread Forming (1/4-20 x 1/2") - Key 4
26	870-0106	2	Nut, Speed (#14Z) - Key 3
27	821-0010	4	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2) - Key 3, 4
28	815-0261	4	Screw, Hex Washer Head, Steel, Thread Forming (1/4-20 x 7/16") - Key 3, 4
29	821-0010	5	Screw, Locking Head, Flanged, Steel (1/4-20 x 1/2") - Key 3, 4



STARTING MOTOR PARTS GROUP - KEY 1, 3

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191-0734	1	Motor, Starting - Key 1, 3
1	191-0742	1	Yoke Assembly (Includes Parts Marked *)
2	191-0743	1	Armature, Starter
3	191-0744	1	Clutch - Pinion Gear, Starter
4	191-0745	1	Stop, Pinion Gear
5	191-0746	1	Ring, Retaining
6	191-0747	1	Washer, Thrust
7	191-0748	1	Bracket, Starter - Front (Includes Bearing)
8	191-0749	1	Lever, Clutch
9	191-0750	1	Spring, Helical, Compression (A)
10	191-0751	1	Spring, Helical, Compression (B)
11	191-0752	1	Holder, Spring
12	191-0753	1	Bracket, Starter - Rear (Includes Bearing)
13	191-0754	1	Washer, Flat
14	191-0755	1	Washer, Flat
15	191-0756	1	Insulator, Disc
16	191-0757	4	*Brush, Starter
17	191-0758	4	Spring, Helical, Compression (Brush)
18	191-0759	2	Bolt, Machine (Through)
19	191-0760	3	Screw, Machine, Pan Head
20	191-0761	1	Solenoid, Starter
21	191-0762	1	*Coil, Field, Starter
22	191-0763	1	Bearing, Sleeve (Front)
23	191-0764	1	Bearing, Sleeve (Rear)
24	191-0765	4	*Shoe, Pole, Field Coil
25	191-0766	4	*Screw, Machine, Pan Head
26	850-0050	2	Washer, Lock, Steel (3/8)
27	800-0051	2	Screw, Machine, Hex Head, Steel (3/8-16 x 1-1/4")

* - Included in Yoke Assembly.

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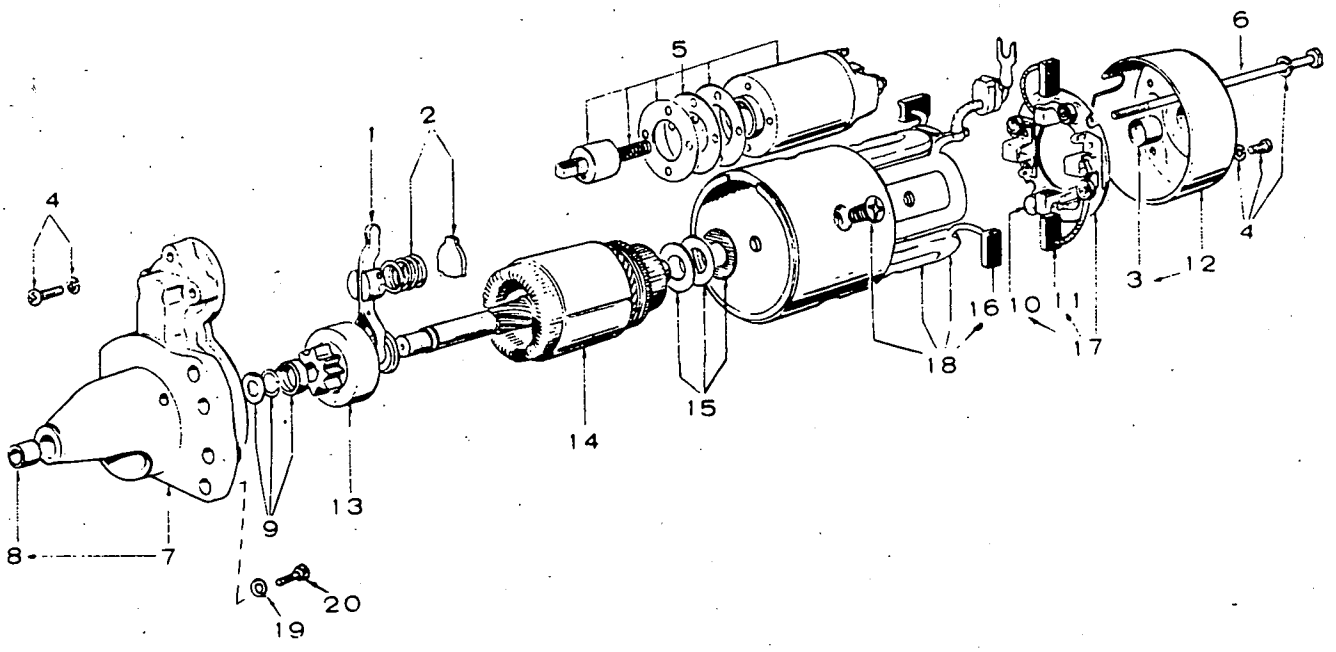
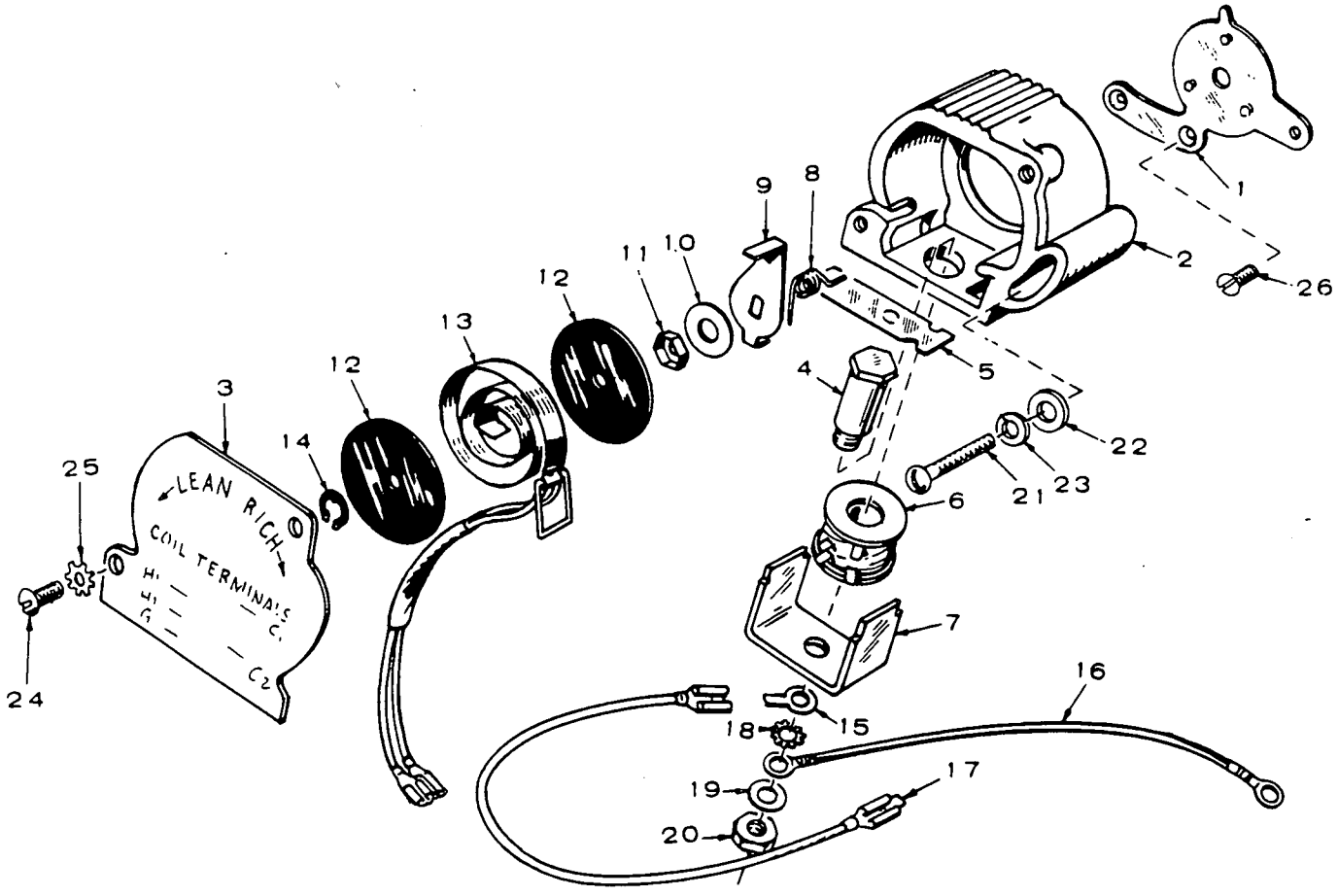


STARTING MOTOR PARTS GROUP - KEY 2, 4

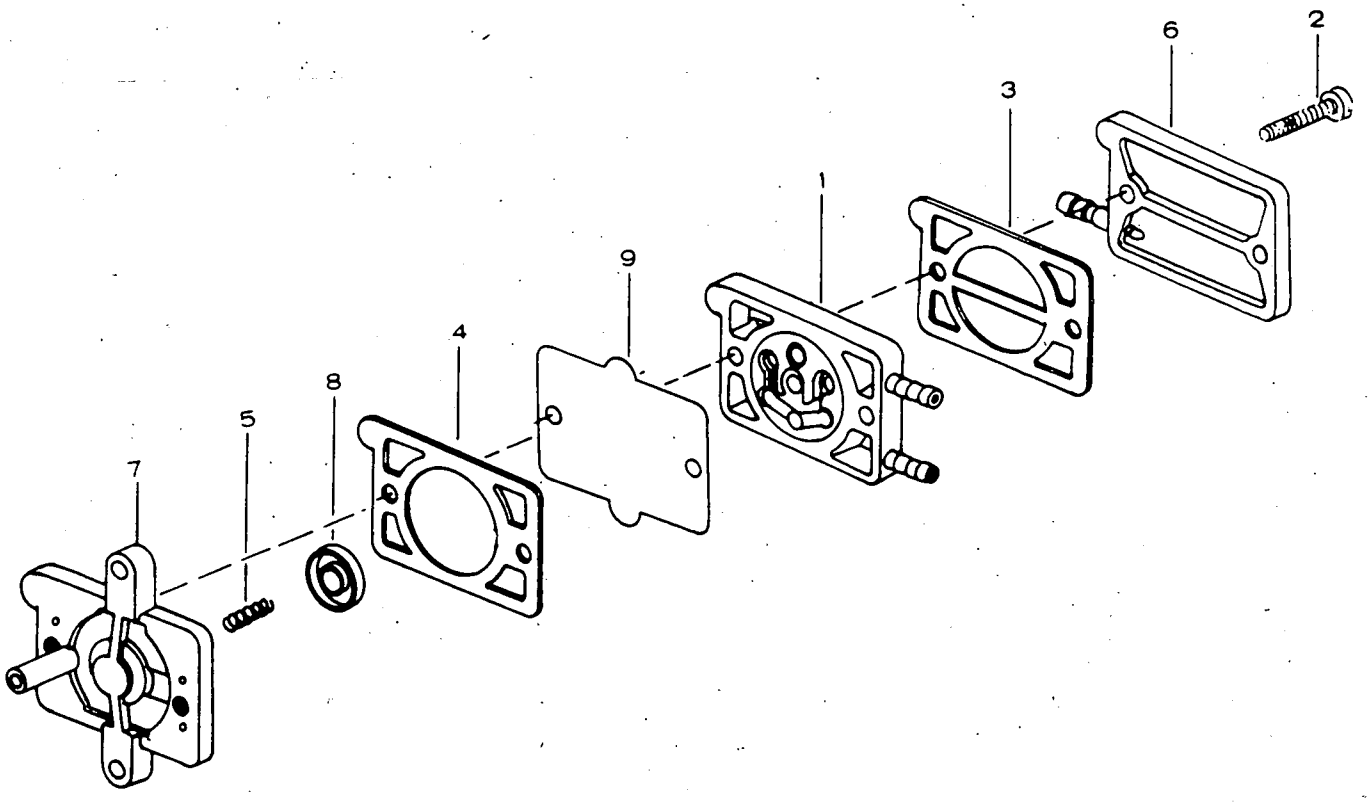
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	191-1052	1	Motor, Starting - Key 2, 4
1	191-0983	1	Lever, Clutch
2	191-0984	1	Spring - Plate Set
3	191-1010	1	Bearing, Sleeve (Rear)
4	191-1011	1	Screw Set
5	191-0987	1	Solenoid, Clutch
6	191-0988	2	Bolt, Machine (Through)
7	191-1086	1	Bracket, Starter - Front (Includes Bearing)
8	191-0971	1	Bearing, Sleeve (Front)
9	191-0991	1	Stop - Retaining Set, Pinion Gear
10	191-1007	4	*Spring, Helical, Compression (Brush)
11	191-1008	2	*Brush, Starter (Negative)
12	191-1009	1	Bracket, Starter - Rear (Includes Bearing)
13	191-1087	1	Clutch - Pinion Gear, Starter
14	191-1088	1	Armature, Starter
15	191-0997	1	Washer - Insulator Set
16	191-1005	2	Brush, Starter (Positive)
17	191-1006	1	Holder, Brush (Includes Parts Marked *)
18	191-1089	1	Coil, Field, Starter (Includes Positive Brushes)
19	850-0050	2	Washer, Lock, Steel (3/8)
20	800-0051	2	Screw, Machine, Hex Head, Steel (3/8-16 x 1-1/4")

* - Included in Brush Holder.



THERMO-MAGNETIC CHOKE GROUP - OPTIONAL EQUIPMENT

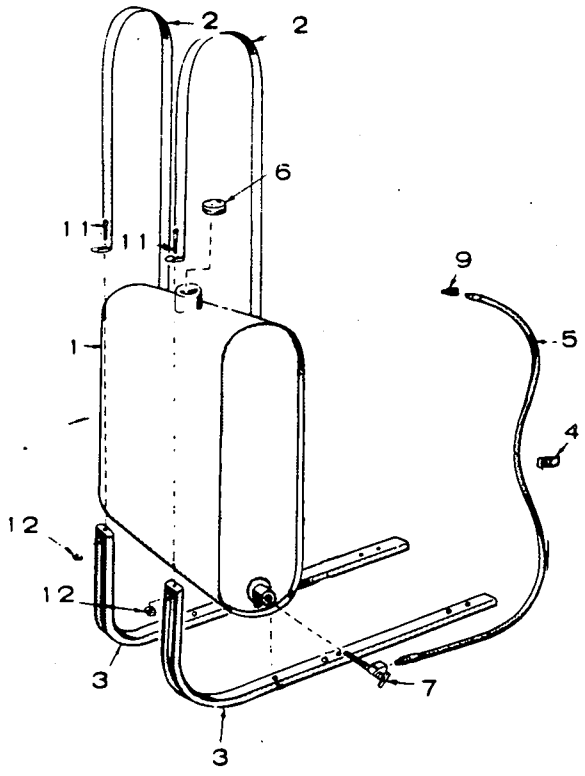
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	153-0385	1	Plate, Mounting
2	153-0386	1	Housing, Choke
3	153-0389	1	Cover, Choke
4	153-0391	1	Core, Solenoid
5	153-0395	1	Armature, Solenoid
6	307-0801	1	Coil, Solenoid
7	153-0392	1	Frame, Solenoid
8	153-0387	1	Spring, Armature
9	153-0390	1	Lever, Limit
10	526-0018	1	Washer, Flat, Steel (5/8")
11	870-0134	1	Palnut (1/4-20)
12	153-0399	2	Insulator, Disc
13	153-0400	1	Bimetal - Heater Assembly
14	518-0129	1	Ring, Retaining
15	332-0876	1	Terminal, Lug - Ground
16	336-1550	1	Lead, Electrical - Ground
17	336-1549	1	Lead, Electrical - Solenoid
18	854-0017	1	Washer, Lock, Internal Tooth (5/16)
19	526-0022	1	Washer, Flat, Steel (5/16")
20	864-0002	1	Nut, Hex (5/16-18)
21	813-0107	1	Screw, Round Head, Steel (10-32 x 1-1/4")
22	526-0008	1	Washer, Flat, Steel (#10)
23	850-0030	1	Washer, Lock, Steel (#10)
24	812-0076	2	Screw, Round Head, Steel (8-32 x 5/16")
25	854-0007	2	Washer, Lock, Internal Tooth (#8)
26	815-0161	2	Screw, Flat Head, Steel (10-32 x 3/8")
	153-0429	1	Kit, Replacement (Includes Complete Choke, Less Electrical Leads, and Carburetor Air Horn Gaskets)



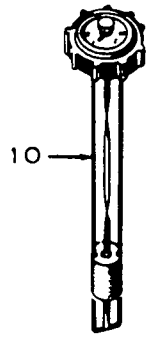
FUEL PUMP PARTS GROUP (PULSE TYPE) - OPTIONAL

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
	149-1322	1	Pump, Fuel
1	142-0537	1	Valve Plate Assembly
2	142-0540	2	Screw, Cover
3	149-1323	1	Gasket, Base
4	142-0541	1	Gasket, Valve Plate
5	142-0545	1	Spring, Pump
6	149-1326	1	Cover, Pump
7	149-1324	1	Base, Pump
8	142-0552	1	Disc, Pump
9	142-0555	1	Diaphragm, Pump

SIDE MOUNTED FUEL TANK GROUP (OPTIONAL EQUIPMENT)

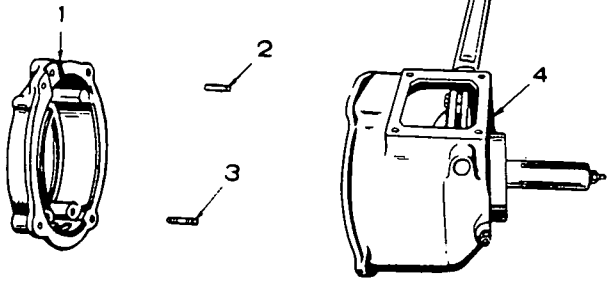


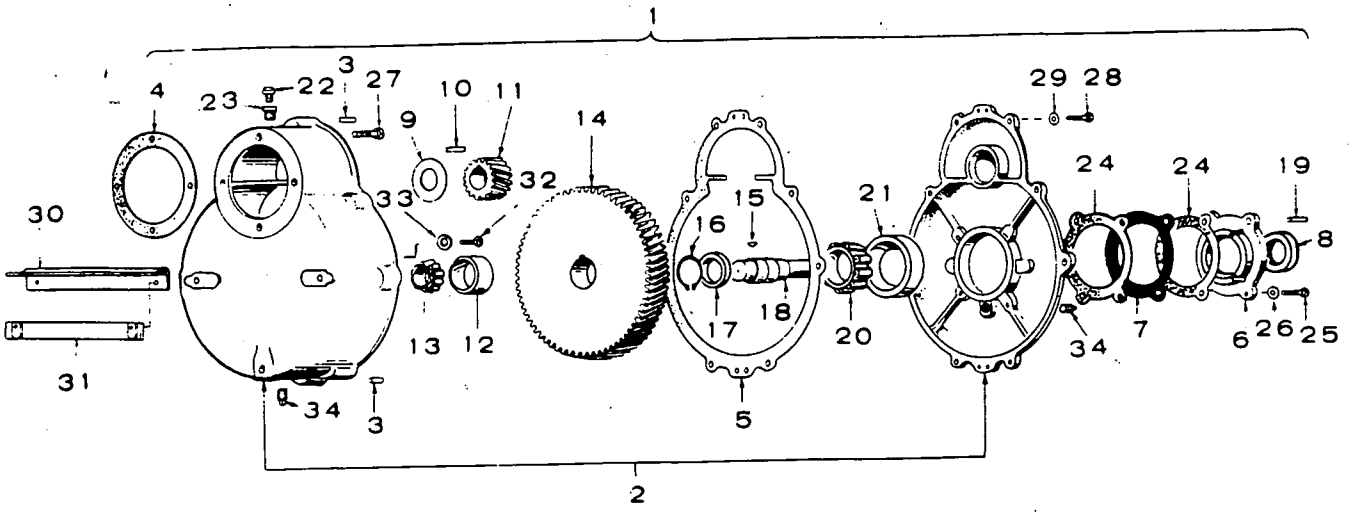
REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	159-0981	1	Tank, Fuel
2	159-0596	2	Strap, Fuel Tank
3	159-0595	2	Bracket, Fuel Tank
4	134-0599	1	Clip, Fuel Line
5	501-0008	1	Line, Fuel
6	159-0007	1	Cap, Fuel Tank
7	504-0013	1	Valve, Shutoff
8	505-0057	1	Plug, Pipe (1/8)
9	502-0020	1	Elbow, Fuel Pump to Fuel Line
10	193-0207	1	Cap and Gauge Assembly, Fuel Tank
11	813-0108	2	Screw, Machine, Round Head, Cross Recessed, Steel (10-32 x 1-1/2") - Hold-down Strap to Bracket
12	870-0053	2	Nut, Hex (10-32)



CLUTCH GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190-0171	1	Adapter, Clutch to Engine
2	515-0196	1	Key, Clutch
3	STUD, CLUTCH HOUSING TO ENGINE		
	520-0738	1	3/8-16 x 4"
	520-0739	2	3/8-16 x 3"
4	190-0288	1	Clutch Assembly
	190-0289	1	Clutch Kit - Includes Complete Clutch, Adapter, Mounting Hardware and Instructions





REDUCTION GEAR GROUP (OPTIONAL EQUIPMENT)

REF. NO.	PART NO.	QTY. USED	PART DESCRIPTION
1	190-0290	1	Reduction Gear Assembly
2	190-0300	1	Housing, Gear Assembly
3	516-0012	2	Pin, Dowel
4	190-0020	1	Gasket - Housing to Engine
5	191-0021	1	Gasket - Cover to Housing
6	190-0016	1	Plate, Retaining - Bearing
7	190-0115	1	Shim Set (Includes 1 Each of Following Sizes: .005", .009", .012", .016", .020", .025")
8	509-0016	1	Seal, Oil
9	190-0195	1	Washer, Pinion Gear
10	515-0142	1	Key, Pinion Gear
11	190-0191	1	Gear, Pinion
12	510-0022	1	Race, Outer, Roller Bearing - (Cup)
13	510-0021	1	Race, Inner with Roller Bearings - (Cone)
14	190-0190	1	Gear, Helical, Drive
15	515-0159	1	Key, Woodruff
16	518-0013	1	Ring, Retaining
17	190-0202	1	Spacer, Bearing
18	190-0192	1	Shaft, Take Off, Power
19	515-0103	1	Key, Woodruff
20	510-0023	1	Race, Inner with Roller Bearings - (Cone)
21	510-0024	1	Race, Outer, Roller Bearing - (Cup)
22	518-0172	1	Vent
23	505-0007	1	Reducer, Pipe (1/4 x 1/8")
24	190-0306	2	Gasket - Bearing Plate to Housing Cover
25	800-0007	4	Screw, Hex Head, Cap, Steel (1/4-20 x 1")
26	526-0063	4	Washer, Flat, Copper (1/4)
27	805-0009	4	Bolt, Hex Head, Steel (5/16-18 x 1")
28	800-0028	8	Screw, Hex Head, Cap, Steel (5/16-18 x 1")
29	526-0045	8	Washer, Flat, Copper (5/16)
30	190-0297	1	Bracket, Support, Housing
31	190-0298	1	Nut Bar, Support Bracket
32	800-0026	2	Screw, Hex Head, Cap, Steel (5/16-18 x 3/4")
33	526-0065	2	Washer, Flat, Copper (5/16)
34	505-0054	2	Plug, Pipe (1/4)

SERVICE KITS AND MISCELLANEOUS

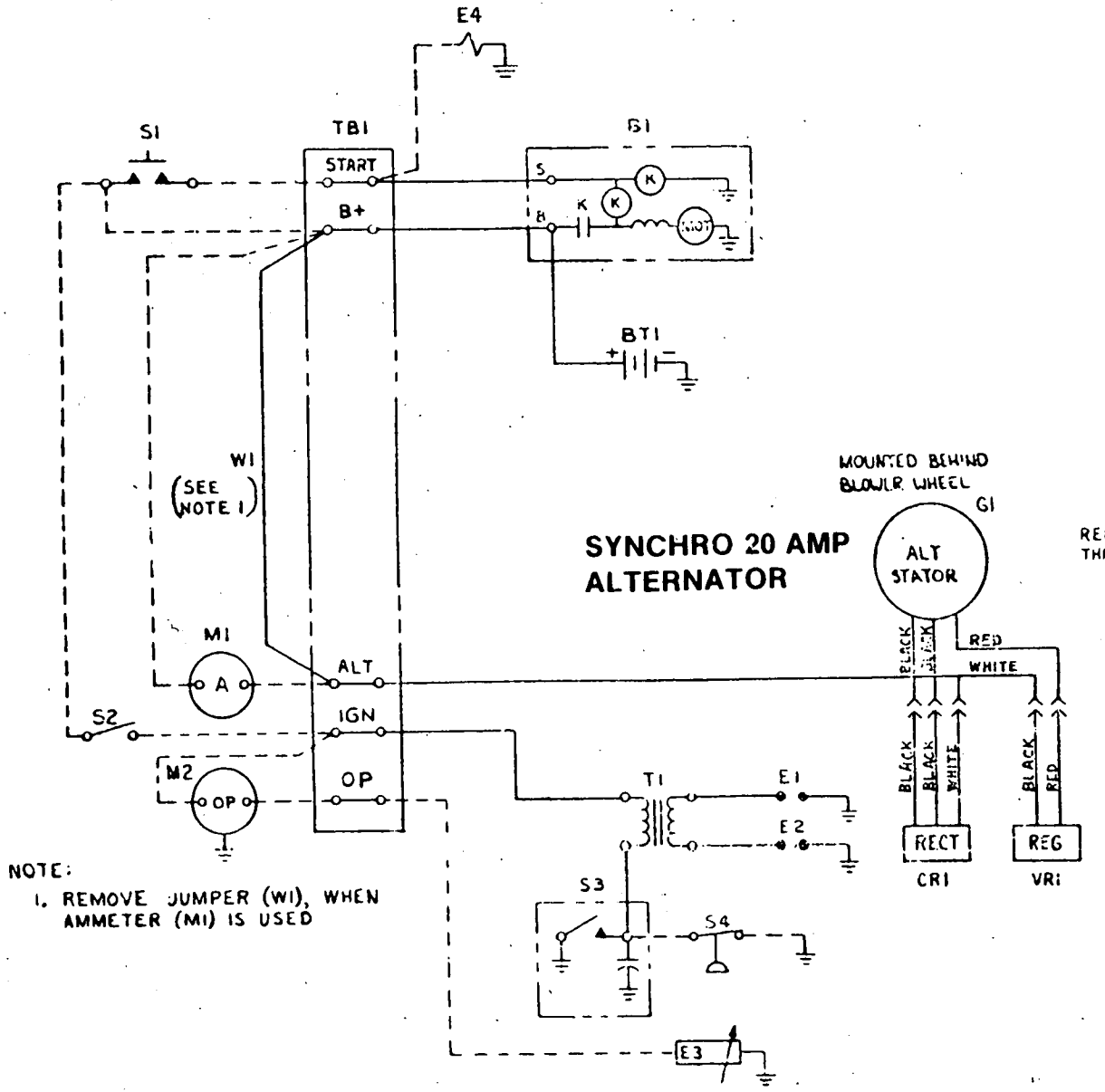
NOTE: For Additional Kits, refer to the Applicable Parts Group in Question.

PART NO.	QTY. USED	PART DESCRIPTION
98-1807	1	Kit, Decal
168-0122	1	Kit, Gasket, Complete Engine
168-0121	1	Kit, Gasket, Carbon Removal
160-1161	1	Kit, Ignition Tune-Up
522-0265	1	Kit, Engine Overhaul
525-0137	1	Paint, Touch-Up, Metallic Green (16 oz. pressurized can)
525-0305	1	Paint, Touch-Up, Non-Metallic Green (13 oz. Pressurized Can)

WIRING DIAGRAMS

The wiring diagrams in this section are typical for NHC and NHCV engines with 15- or 20-amp flywheel alternators and other options. The separate engine control wiring diagrams shipped with each unit should be used for troubleshooting. The following drawings are included herein:

Engine Control Wiring Diagram with options 67
Engine Control Wiring Diagram with Thermo-Magnetic Choke (622-0270) 68
Wiring Diagram for Flywheel Alternator (Phelon 15 Amp) 69
Wiring Diagram for Flywheel Alternator (Synchro 20 Amp) 69



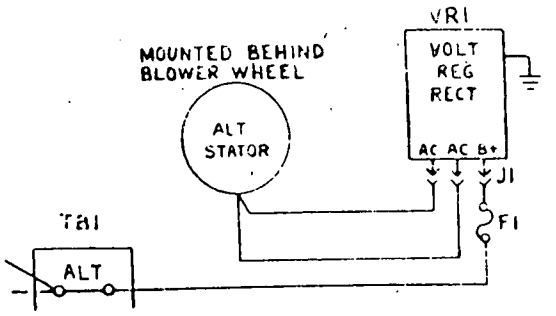
NOTE:

1. REMOVE JUMPER (W1), WHEN AMMETER (M1) IS USED

REF DES	DESCRIPTION
* E4	CHOKE - ELECTRIC
B1	STARTER & SOLENOID - ENGINE
BT1	BATTERY - 12 V.
CR1	RECTIFIER ASSY
E1, 2	SPARK PLUG
* E3	SENDER - OIL PRESSURE
G1	ALTERNATOR
* M1	AMMETER
* M2	METER - OIL PRESSURE
S1	SWITCH - START
S2	SWITCH - IGNITION
S3	BREAKER & CAP ASSEMBLY
* S4	SWITCH - LOPKO
T1	COIL - IGNITION
TB1	BLOCK - TERMINAL STRIP - MARKER
VR1	REGULATOR - VOLTAGE
W1	JUMPER (SEE NOTE 1)

* WHEN USED

CAUTION!
REGULATOR MUST BE GROUNDED THROUGH MOUNTING BOLTS

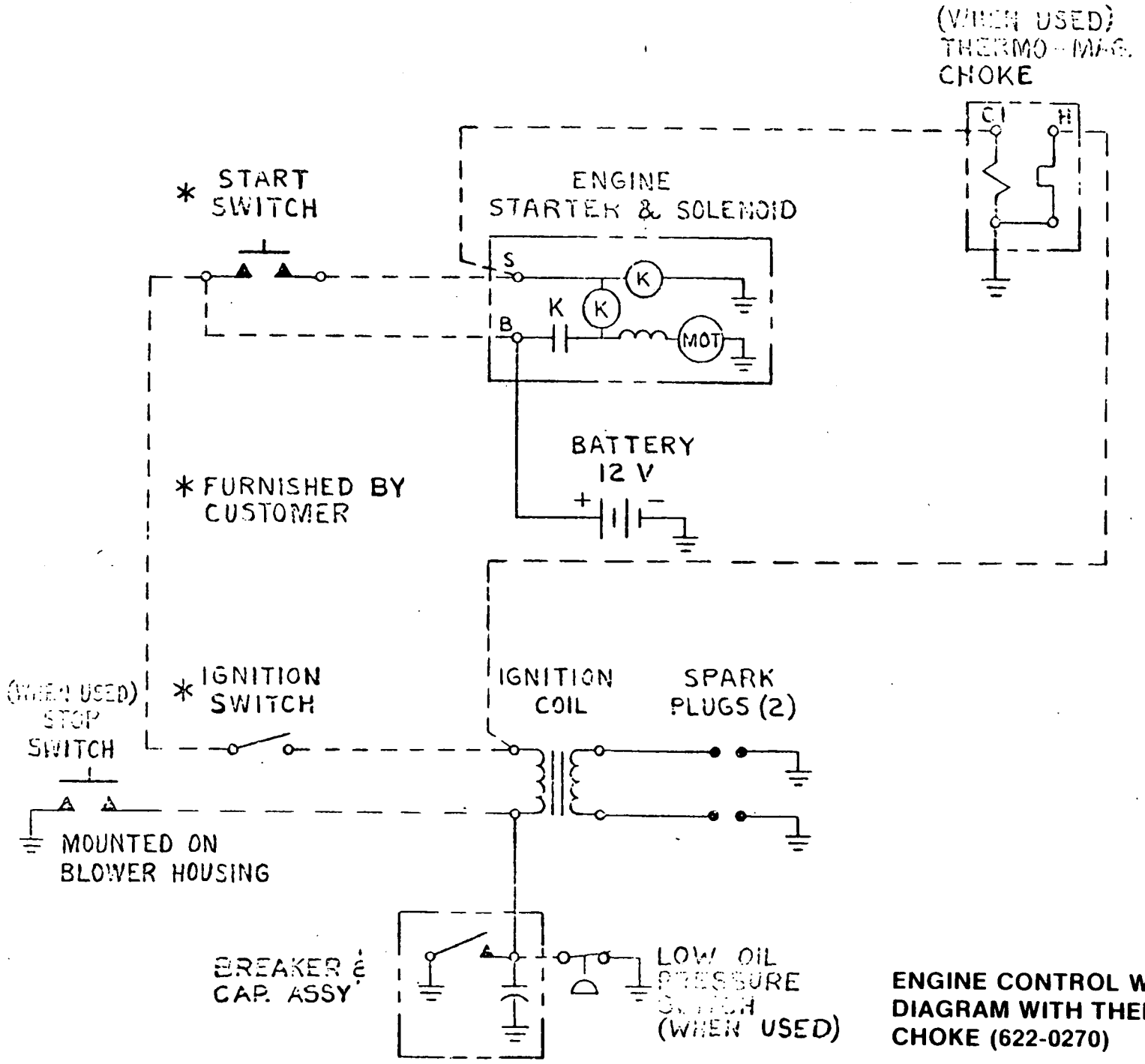


PHELON 15 AMP ALTERNATOR

ENGINE CONTROL WIRING DIAGRAM WITH OPTIONS

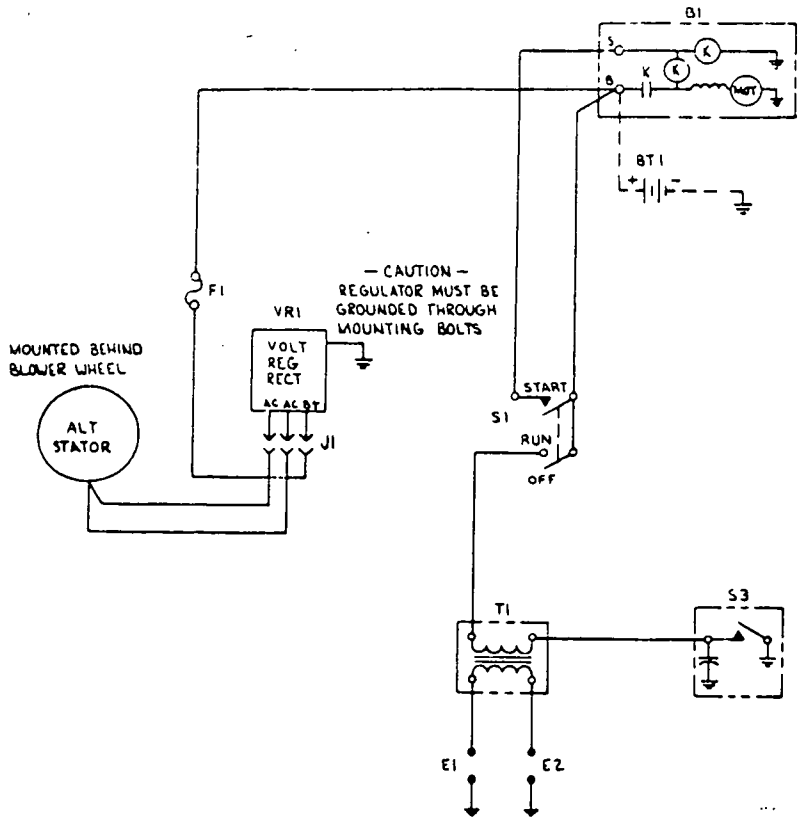
902433

67



ENGINE CONTROL WIRING DIAGRAM WITH THERMO-MAGNETIC CHOKE (622-0270)

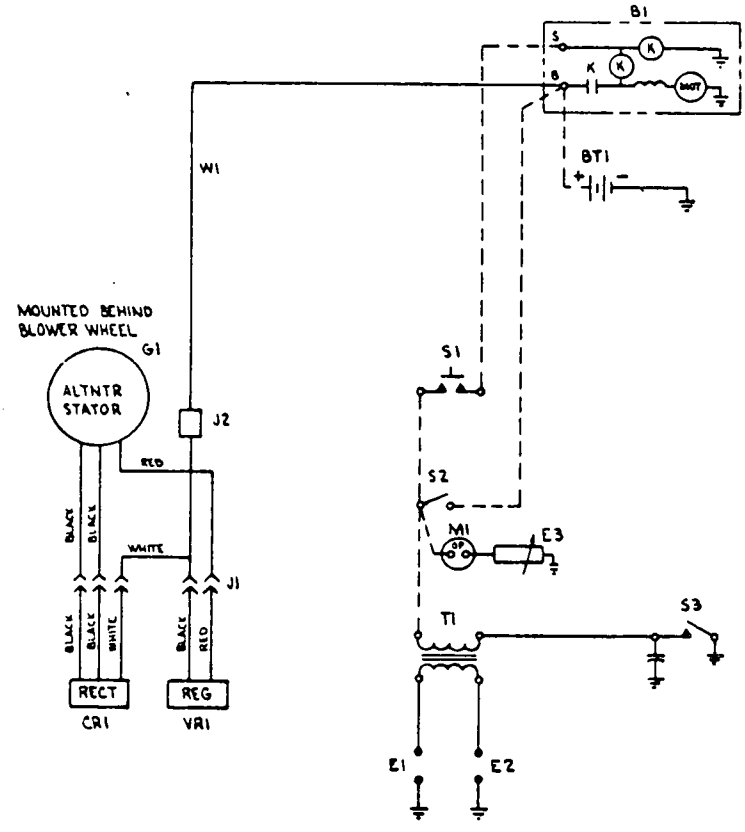
902434



WIRING DIAGRAM FOR FLYWHEEL ALTERNATOR (PHELON 15 AMP)

(622-0386)

REF DES	PART NO.	QTY	DESCRIPTION
B1		1	STARTER & SOLENOID-ENGINE
BT1		1	BATTERY 12 V
E1 & 2		2	SPARK PLUG
F1		1	FUSE 15 AMP
		1	HOLDER-FUSE
G1		1	ALTERNATOR-FLYWHEEL 15 AMP
J1		1	CONNECTOR
S1		1	SWITCH-START, RUN, OFF
S2		1	BREAKER & CAP ASSEMBLY
T1		1	IGNITION COIL-(ONAN)
VR1		1	REGULATOR-RECTIFIER-VOLTAGE



WIRING DIAGRAM FOR FLYWHEEL ALTERNATOR (SYNCRO 20 AMP)

(622-0382)

REF DES	PART NO.	DWG SIZE	QTY	DESCRIPTION
B1			1	STARTER & SOLENOID-ENG
BT1			1	BATTERY, 12V
CR1			1	RECTIFIER ASSY
E1, E2			2	SPARK PLUG
E3	193-0108	A	1	SENDER-OIL PRESSURE
J1			1	CONNECTOR
J2			1	CONNECTOR-FASTON
M1	193-0107	B	1	METER-OIL PRESSURE
S1			1	SWITCH-START
S2			1	SWITCH-IGN
S3			1	BREAKER & CAP ASSY
T1			1	IGNITION COIL
VR1			1	REGULATOR-VOLTAGE
W1	336-1590	A	1	LEAD ASSY
G1			1	ALTERNATOR-FLYWHEEL 20 AMP

CUSTOMER SERVICES

OWNER'S WARRANTY SERVICE - ENGINE DRIVEN ELECTRIC GENERATOR SETS, SEPARATE GENERATORS, INDUSTRIAL ENGINES

QUALITY OF PRODUCT

Onan products are engineered and designed to perform as stated on product nameplate and published specification. With proper installation and operation, regular maintenance and periodic repair service, the equipment will provide reliable service.

GENERAL WARRANTY PRACTICES

All Onan-manufactured engine-driven electric generator sets, separate generators, and industrial engines are sold with a full one-year warranty. This warranty is issued only to the original user and promises satisfactory performance of the product when properly installed, serviced, and operated under normal conditions, according to the manufacturer's instructions. The text of the Onan published warranty appears in the Onan Operator's Manual sent with the product.

Warranty Registration: A Warranty Registration card accompanies each Onan Product. This card must be properly filled out and returned to the Onan Factory in order to qualify for warranty consideration as covered in this bulletin. When requesting warranty repair work you must provide the purchase date, Onan model, and serial number of the equipment.

Warranty Authorization: Warranty service must be performed by Onan Factory or Onan Authorized Distributors or their Approved and Registered Service Dealers. A complete listing of these Onan Authorized Parts and Service Centers is provided in our brochure F-115, a copy of which is supplied with each Onan Product. These Onan Authorized Service Centers have trained service personnel, parts stock, and the necessary facilities and tools for the service and repair of Onan equipment.

Material Allowances: Onan will allow credit or furnish free of charge to the Onan Authorized Service Station or his Approved Service Dealer, all genuine Onan parts used in a warranty repair of these products which fail to perform as warranted.

Labor Allowance: Onan will allow warranty repair credit to the Onan Authorized Parts and Service Center and his Approved Dealer at straight time labor when the cause of failure is determined to be defective material or factory workmanship. This labor allowance will be based on the factory's standard time schedule of published flat rate labor allowances, or, otherwise a time judged reasonable by the factory. Repair work not covered by warranty will be charged to the owner. The Onan's Warranty practice does not provide for allowance of expenses such as start-up charges, communication charges, transportation charges, travel time and/or mileage, unit removal or installation expense, cost of fuel, oil, normal maintenance adjustments, tune-up adjustments or parts maintenance items, and does not cover incidental or consequential damages.

Administration: Warranty of Onan Products is administered through Onan Authorized Distributors in whose territory the equipment is located. These Distributors and their Approved or Registered Onan Service Dealers are authorized to make settlement of all customer warranty claims within the limits of the manufacturer's warranty policy as described herein.

Onan reserves the right to change warranty practices without prior notice.

MAINTENANCE

A Planned Preventive Maintenance Program is extremely important if you are to receive efficient operation and long service life from your Onan unit. Neglecting routine maintenance can result in premature failure or permanent damage to your equipment. The Onan Operator's Manual sent with the product contains recommended maintenance schedules and procedures.

Maintenance is divided into two categories:

1. Operator Maintenance . . . . . performed by the operator.
2. Critical Maintenance . . . . . performed only by qualified service personnel.

Regular maintenance will help you avoid sudden and costly repairs in the future. Adequate evidence of this scheduled maintenance must be offered when applying for a warranty claim.

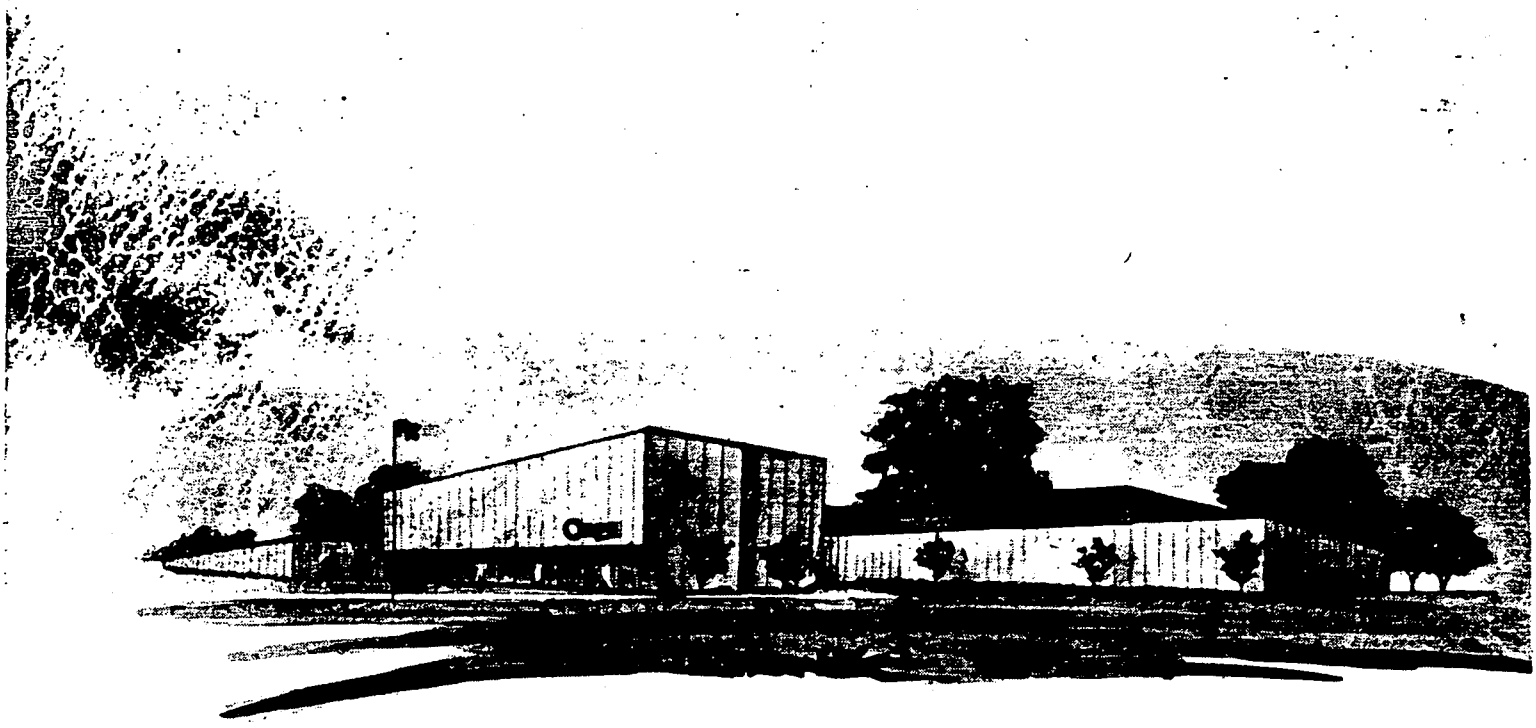
INSTALLATION

Installation is extremely important and all Onan Products should be installed in accordance with the manufacturer's recommendations. If the owner experiences any difficulty with such items as mounting, ventilation, exhaust location, fuel lines, wiring, etc., he should immediately contact the company from whom he purchased the equipment so that corrective action can be taken. Although the Onan Authorized Distributor and his Approved or Registered Service Dealers may be able to remedy certain installation difficulties, such repair work is not considered Onan warranty and there will be a charge for this service.

Onan

Minneapolis, Minnesota 55432

MSS-22B
Replaces 23B054 and MSS-22A
Rev. 7-2-73



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