BF, B43M, B48M AND CCKA ONAN ENGINES

Service Manual No. 9-51391

J I Case
A Tenneco Company

This Safety Alert Symbol Indicates Important Safety Messages In This Manual When You See This Symbol Carefully Read The Message That Follows and Be Alert To The Possibility Of Personal Injury Or Death

IF THIS MACHINE IS USED BY AN EMPLOYEE OR IS LOANED OR RENTED, MAKE ABSOLUTELY CERTAIN THAT THE OPERATOR(S), PRIOR TO OPERATING:

1. IS INSTRUCTED IN SAFE AND PROPER USE.

2. REVIEWS AND UNDERSTANDS THE MANUAL(S) PERTAINING TO THE MACHINE.

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WARNING

BEFORE STARTING ENGINE

STUDY OPERATOR'S MANUAL SAFETY MESSAGES
READ ALL SAFETY SIGNS ON MACHINE
CLEAR THE AREA OF OTHER PERSONS

LEARN & PRACTICE SAFE USE OF CONTROLS BEFORE OPERATING

IT IS YOUR RESPONSIBILITY TO UNDERSTAND AND FOLLOW MANUFACTURER'S INSTRUCTIONS ON MACHINE OPERATION, SERVICE, AND TO OBSERVE PERTINENT LAWS AND REGULATIONS. OPERATOR AND SERVICE MANUALS MAY BE OBTAINED FROM YOUR EQUIPMENT DEALER.

ENGINE SAFETY PRECAUTIONS

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

IMPORTANT **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.

Safety Codes

- All local, state and federal codes should be consulted and complied with.

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- DO NOT SMOKE while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- DO NOT fill fuel tank while engine is running.
- DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine installations, especially those within a confine, should be equipped with an exhaust system to discharge gases to the atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Engine Exhaust Gas (Carbon Monoxide) is Deadly!

Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- Dizziness
- Intense Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- 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.

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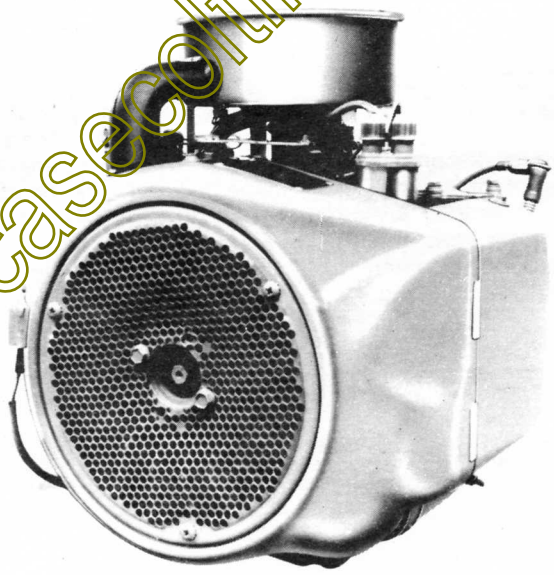


GENERAL INFORMATION

INTRODUCTION

This manual deals with specific mechanical and electrical information needed by engine mechanics for troubleshooting, servicing, repairing, or overhauling the engine.

Use the table of contents for a quick reference to the separate engine system sections.

The troubleshooting guide is provided as a quick reference for locating and correcting engine trouble.

The illustrations and procedures presented in each section apply to the engine on the cover. The flywheel-blower end of the engine is the front end so right and left sides are determined by viewing the engine from the front.

The disassembly section contains major overhaul procedures for step by step removal, disassembly, inspection, repair and assembly of the engine components.

If a major repair or an overhaul are necessary, a competent mechanic should either do the job or supervise and check the work of the mechanic assigned to do the job to ensure that all dimensions, clearances and torque values are within the specified tolerances.

A parts catalog (available at the dealer level) contains detailed exploded views of each assembly and the individual piece part numbers and their proper names for ordering replacement parts.

Use only Genuine Onan replacement parts to ensure quality and the best possible repair and overhaul results. When ordering parts, always use the complete Model and Spec number as well as the Serial number shown on the nameplate.

ENGINE MODEL REFERENCE

Identify your model by referring to the MODEL and SPEC (specification) NO. as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine or when ordering replacement parts.

WARNING

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

SPECIFICATIONS

This manual contains SI metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

	BF	B43M	B48M	CCKA
Engine Design		Four Cycle, Air-Cooled, Two Cylinder		
Horsepower (3600 rpm)	16	16	18	16.5
Displacement (cubic inches)	40.3 ^{3}" (660.4cm^3)	43.7" (775cm^3)	47.7 ^{3}" (782cm^3)	49.8 ^{3}" (816cm^3)
Bore	3.13" (79.5mm)	3.25" (82.5mm)	3.25" (82.5mm)	3.25" (82.5mm)
Stroke	2.62" (66.6mm)	2.62" (66.6mm)	2.875" (73mm)	3" (76.2mm)
Compression Ratio	7 to 1	6.6 to 1	6.6 to 1	7 to 1
Crankshaft		Horizontal, Ductile Iron		
Valves		Mechanical, Poppet		
Oil Capactiy with Filter Change			4 pts. (1.9 l)	4 qt. (3.8 l)
Oil Capacity without Filter Change	4 pts.	3.5 pts. (1.7 l)	3.5 pts. (1.7 l)	3.4 qt. (3.2 l)
Battery Charging System	12 Volt, 15 Amp Flywheel Alternator (20 amp CCKA)			

TUNE-UP SPECIFICATIONS

Tappets (Cold)				
Intake	.008" (0.20mm)	.008" (0.20mm)	.008" (0.20mm)	.007" (0.18mm)
Exhaust	.013" (0.33mm)	.013" (0.33mm)	.013" (0.33mm)	.016" (0.41mm)
Breaker Point Gap	.020" (0.51mm)	.021" (0.53mm)	.021" (0.53mm)	.020" (0.51mm)
Spark Plug Gap	.025" (0.64mm)	.025" (0.64mm)	.025" (0.64mm)	.025" (0.64mm)
Ignition Timing (Cold, Static Setting)	21^{o}BTC	21^{o}BTC	21^{o}BTC	20^{o}BTC

DIMENSIONS AND CLEARANCES

FOR BF ENGINE

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

	Minimum		Maximum	
	Inches	(mm)	Inches	(mm)
CAMSHAFT AND CRANKSHAFT				
Crankshaft Main Bearing Journal to Bearing Clearance	0.0025	0.06	0.0038	0.10
*Crankshaft End Play	0.006	0.15	0.012	0.3
Camshaft Bearing to Camshaft	0.0015	0.38	0.0030	0.084
Camshaft End Play	0.003	0.08		
*Crankshaft Rod Journal to Rod Bearing	0.0020	0.51	0.0033	0.08
Connecting Rod End Play	0.002	0.05	0.016	0.41
Timing Gear Backlash	0.002	0.05	0.003	0.08
Oil Pump Gear Backlash	0.002	0.05	0.005	0.13
PISTON AND CYLINDER				
Piston Pin in Piston	0.0002	0.005	0.0004	0.010
Piston Pin in Rod	0.0002	0.005	0.0007	0.018
*Piston Ring Gap in Cylinder	0.010	0.25	0.020	0.51
Piston Clearance in Cylinder - Measured .10 Below Oil Control Ring, 90° from Pin.	0.001	0.03	0.003	0.084
Cylinder Bore — Standard Size	3.1245	79.362	3.1255	79.388
Crankshaft Main Bearing Journal — Standard Size	1.9992	50.8	2.0000	50.8
Crankshaft Rod Bearing Journal — Standard Size	1.6252	41.28	1.6260	41.30
TAPPETS AND VALVES				
*Valve Seat Width	1/32	0.8	1/8	3.2
*Valve Face Angle	44°		44°	
*Valve Seat Angle	45°		45°	
Valve Stem to Guide — Intake	0.0010	0.03	0.0025	0.06
Valve Stem to Guide — Exhaust	0.0025	0.06	0.0040	0.10
Tappet to Cylinder Block Clearance	0.0015	0.04	0.0030	0.08
Tappet Adjustment (Clod)				
Tappet Adjustment (Cold				
*Intake	0.007	0.18	0.009	0.23
*Exhaust	0.012	0.30	0.014	0.35

* - Frequently used overhaul values.

ASSEMBLY TORQUES

ASSEMBLY 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. Tighten as needed to prevent them from working loose.

BOLT TORQUE	FT.-LB.	Nm
Gearcase Cover	8 - 10	11 - 14
Cylinder Head Stud Nuts (Cold)	14 - 16	19 - 22
Rear Bearing Plate Screws	25 - 27	34 - 37
Starter Mounting Bolts	18 - 20	24 - 27
Connecting Rod Bolt	14 - 16	19 - 22
Flywheel Cap Screw	35 - 40	48 - 54
Other 5/16" Cylinder Block Stud and Nuts	8 - 10	11 - 14
Oil Base	18 - 23	24 - 31
Manifold Mounting Stud Nuts	8 - 10	11 - 14
Oil Pump	7 - 9	10 - 12

DIMENSIONS AND CLEARANCES

FOR B43M AND B48M ENGINES

All dimensions and clearances given at room temperature at 70° F (21° C).
All values in inches (mm) unless otherwise specified.

	Minimum		Maximum	
	inches	(mm)	inches	(mm)
CAMSHAFT AND CRANKSHAFT				
Crankshaft Main Bearing Journal to Bearing Clearance	0.0025	0.06	0.0038	0.10
*Crankshaft End Play	0.006	0.15	0.012	0.3
Camshaft Bearing to Camshaft	0.0015	0.38	0.0030	0.084
Camshaft End Play	0.003	0.08		
*Crankshaft Rod Journal to Rod Bearing	0.0020	0.51	0.0033	0.08
Connecting Rod End Play	0.002	0.05	0.016	0.41
Timing Gear Backlash	0.002	0.05	0.003	0.08
Oil Pump Gear Backlash	0.002	0.05	0.005	0.13
PISTON AND CYLINDER				
Piston Pin in Piston	0.0002	0.005	0.0004	0.010
Piston Pin in Rod	0.0002	0.005	0.0007	0.018
*Piston Ring Gap in Cylinder	0.010	0.25	0.020	0.51
Piston Clearance in Cylinder—Measured 0.10 Below Oil Control Ring, 90° from Pin	0.004	0.10	.006	0.15
Cylinder Bore—Standard Size	3.249	82.53	3.250	82.55
Crankshaft Main Bearing Journal—Standard Size	1.9992	50.8	2.0000	50.8
Crankshaft Rod Bearing Journal—Standard Size	1.6252	41.28	1.6260	41.30
TAPPETS AND VALVES				
*Valve Seat Width	1/32	0.8	1/8	3.2
*Valve Face Angle	44°		44°	
Valve Seat Angle	45°		45°	
Valve Stem to Guide—Intake	0.0010	0.03	0.0025	0.06
Valve Stem to Guide—Exhaust	0.0035	0.09	0.0040	0.10
Tappet to Cylinder Block Clearance	0.0015	0.04	0.0030	0.08

* - Frequently used overhaul values.

ASSEMBLY TORQUES AND SPECIAL TOOLS

BOLT TORQUE	FT.-LB.	N•m
Gearcase Cover	8-10	11-14
Cylinder Head Cap Screws (Cold)	16-18	22-24
Rear Bearing Plate Screws	25-27	34-37
Starter Mounting Bolts	18-20	24-27
Connecting Rod Bolt	14-16	19-22
Flywheel Cap Screw	35-40	48-54
Other 5/16" Cylinder Block Stud and Nuts	8-10	11-14
Oil Base	18-23	24-31
Intake Manifold Mounting Screws	6-10	8-14
Oil Pump	7- 9	10-12
Valve Cover	8- 8	6- 8
Exhaust Manifold Mounting Screws	9-11	12-15

The following special tools are available from Onan. For further information see *TOOL CATALOG 900-0019.*

Valve Seat Driver
Valve Guide Driver
Oil Guide and Driver
Combination Bearing Remover (Main and Cam)
Combination Bearing Driver (Main and Cam)
Flywheel Puller

DIMENSIONS AND CLEARANCES

FOR CCKA ENGINE

(All clearances given at room temperature of 70°F.)

	Minimum		Maximum	
	Inches	(mm)	Inches	(mm)
Valve Stem in Guide — Intake	0.001	0.03	0.0025	0.06
Valve Stem in Guide — Exhaust	0.0025	0.06	0.004	0.10
Valve Seat Interference Width	1/32	0.8	3/64	1.2
Valve Face Angle	44°		44°	
Valve Seat Angle	45°		45°	
Crankshaft Main Bearing	0.0025	0.06	0.0038	0.10
Crankshaft End Play	0.006	0.15	0.012	0.3
Camshaft Bearing	0.0015	0.38	0.003	0.08
Camshaft End Play	0.003	0.08		
Rod Bearing	0.0005	0.013	0.0023	0.058
Connecting Rod End Play	0.002	0.05	0.016	0.41
Timing Gear Backlash	0.002	0.05	0.003	0.08
Oil Pump Gear Backlash	0.002	0.05	0.005	0.13
Piston to Cylinder, Conformatic Type (Measured below oil-controlling ring — 90° from pin) Clearance	0.0016	0.04	0.0035	0.09
Piston Pin in Piston	Thumb Push Fit			
Piston Pin in Rod	0.0001	0.003	0.0006	0.015
Piston Ring Gap in Cylinder	0.010	0.25	0.023	0.58
Crankshaft Main Bearing Journal — Standard Size	1.9992	50.8	2.000	50.8
Crankshaft Rod Bearing Journal — Standard Size	1.6252	41.28	1.6260	41.30
Cylinder Bore — Standard Size	3.248	82.50	3.249	82.52
Valve Tappet Adjustment				
Intake	0.006	0.15	0.008	0.20
Exhaust	0.015	0.38	0.017	0.43
Breaker Point Gap (Full Separation)	0.20" (51 mm)			
Spark Pu				
Spark Plug Gap	0.25" (0.64)			
Ignition Timing Advance (Engine Running)	20°BTC			

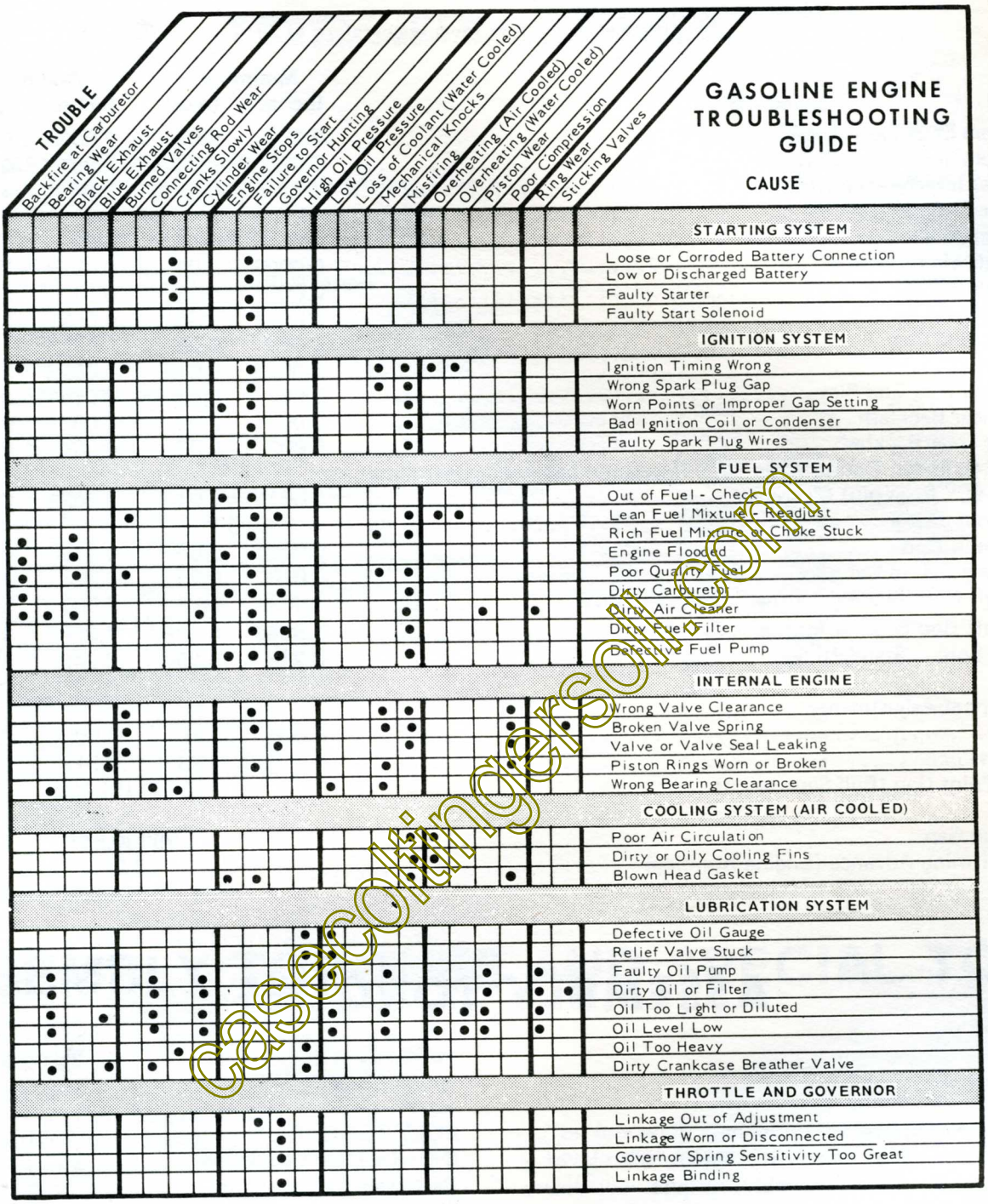
ASSEMBLY TORQUES

ASSEMBLY 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. Tighten as needed to prevent them from working loose.

BOLT TORQUE	FT.-LB	Nm
Cylinder Head Cap Screws	29 - 31	39 - 42
Rear Bearing Plate Nuts	20 - 25	27 - 34
Starter Mounting Bolts	25 - 30	34 - 41
Connecting Rod Bolt	27 - 29	37 - 39
Flywheel Cap Screw	30 - 35	41 - 48
Other 5/16" Cylinder Block Studs and Nuts	10 - 12	14 - 16
Oil Base	38 - 43	52 - 58
Manifold Mounting Bolts	15 - 20	20 - 27

ENGINE TROUBLESHOOTING



OIL SYSTEM

CRANKCASE OIL

Change crankcase oil according to the oil chart and only when engine is warm.

IMPORTANT **Do not overfill crankcase. Do not use service DS oil. Do not mix brands nor grades of motor oil. Engine damage could result from mixing non-compatible oils.**

To drain, remove the oil drain plug. After oil drains, replace the oil drain plug and refill crankcase with a good quality detergent oil. Oil must meet or exceed the API (American Petroleum Institute) designation SE or SE/CC. For temperatures above 32°F (0°C), use SAE 30 oil; for temperatures below 32°F (-0°C), use 5W30.

ENGINE OIL CHART

MODEL	PINTS (LITRE)	PINTS (LITRE) W/FILTER	OIL CHANGE	FILTER CHANGE
BF	4 (1.9)	N/A	25 hrs.	N/A
B43M	3-1/2 (1.7)	N/A	25 hrs.	N/A
B48M	3-1/2 (1.7)	4 (1.9)	25 hrs.	50 hrs.
CCKA	7 (3.3)	8 (3.8)	50* hrs.	100 hrs.

* 25 hours initial fill.

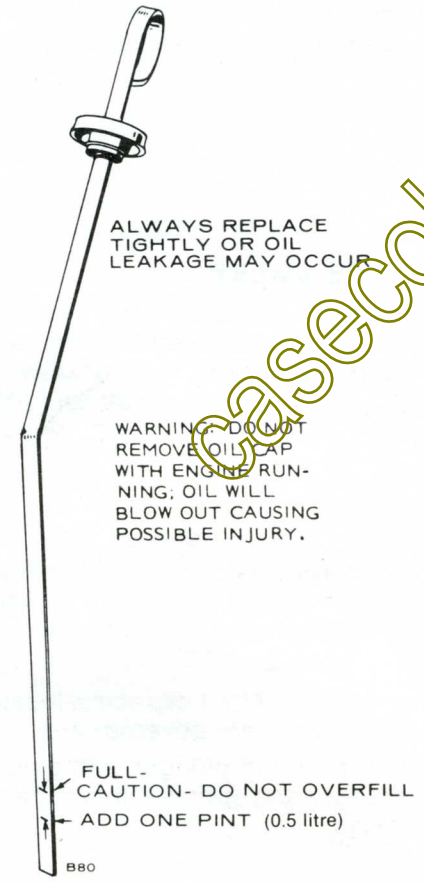


FIGURE 1. CRANKCASE OIL FILL

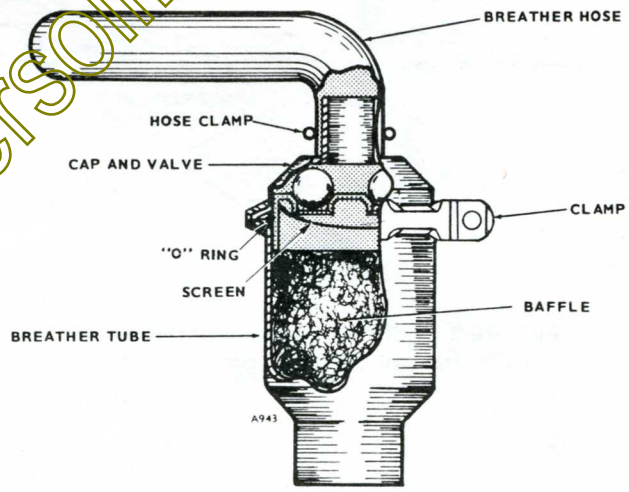


FIGURE 2. CRANKCASE BREATHER FOR CCKA

OIL FILTER (if equipped)

Change the crankcase oil filter according to the oil chart; change more frequently in extremely dusty condition. Remove the filter by turning counterclockwise with a filter wrench. Before installing a new filter, coat the gasket on the filter base with a light film of new oil. Install by turning clockwise until a light friction is noted, then turn an additional 1/2 turn.

Crankcase Breather

This engine uses a crankcase breather valve for maintaining crankcase vacuum. If the crankcase becomes pressurized as evidenced by oil leaks at the seals, clean baffle pack and valve in a suitable solvent.

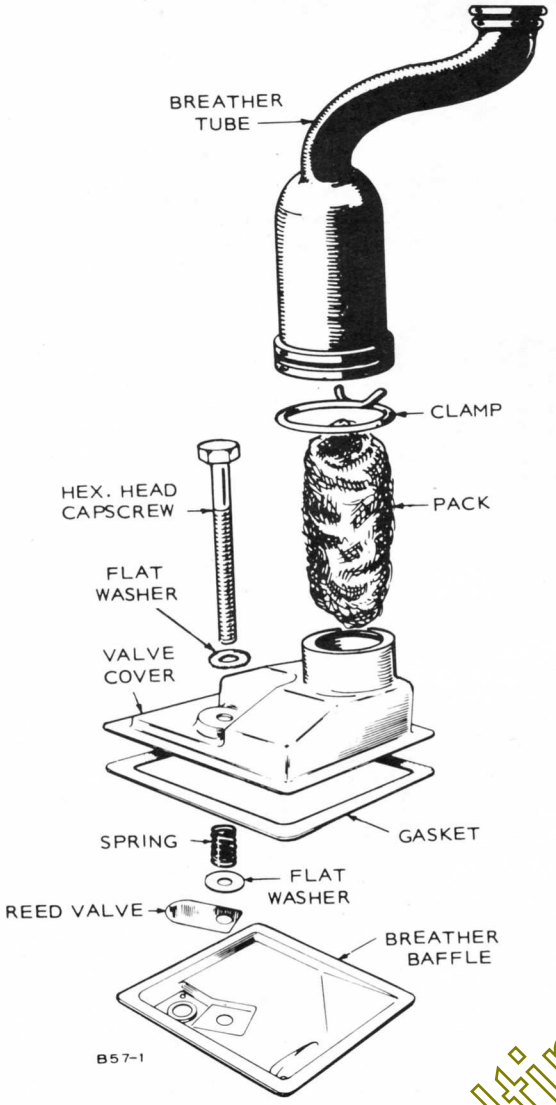


FIGURE 3. CRANKCASE BREATHER FOR BF, B43 AND B48

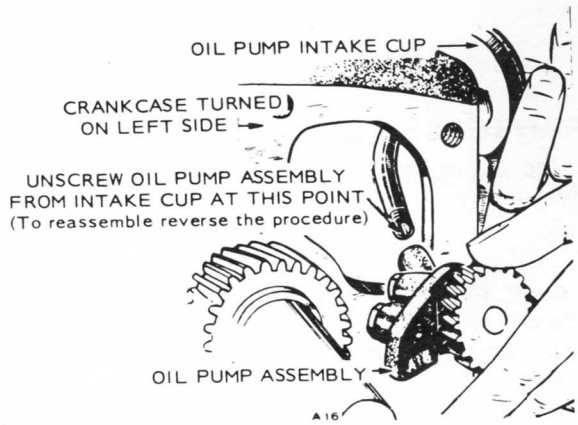


FIGURE 4. OIL PUMP ASSEMBLY

PRESSURE LUBRICATION

Pressure lubricated engines use an oil pump to lubricate engine parts. If oil pressure is low, the pump should be checked.

To remove the oil pump, it is necessary to detach the intake cup assembly, as illustrated in Figure 4.

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

If new oil pump gaskets are installed, they should be the same thickness as those removed. A gasket kit with various thickness gaskets is available.

OIL BY-PASS VALVE

The by-pass valve (located to the right and behind gear cover), controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open about 30 psi (200 kPa).

The valve is non-adjustable and normally does not need maintenance. To determine if valve is not working correctly, caused by a sticky plunger, inspect as follows:

1. Remove the 3/8 x 24 x 1 cap screw located behind gear cover and under governor arm.
2. Remove spring and plunger with a magnet tool. Clean plunger and spring with a suitable solvent and reinstall.

FUEL SYSTEM

FOR BF, B43M AND B48M

CARBURETOR CLEANING AND INSPECTION

To clean the carburetor, soak all components thoroughly in a good carburetor cleaner, following the manufacturer's instructions. Be sure to remove all carbon from carburetor bore, especially in the area of the throttle valve. After soaking, clean out all passages with filtered, compressed air.

Check the adjusting needles and nozzle for damage. If float is loaded with fuel or damaged, replace it. The float should fit freely on its pin without binding.

Check the choke and throttle shafts for excessive side play and replace if necessary.

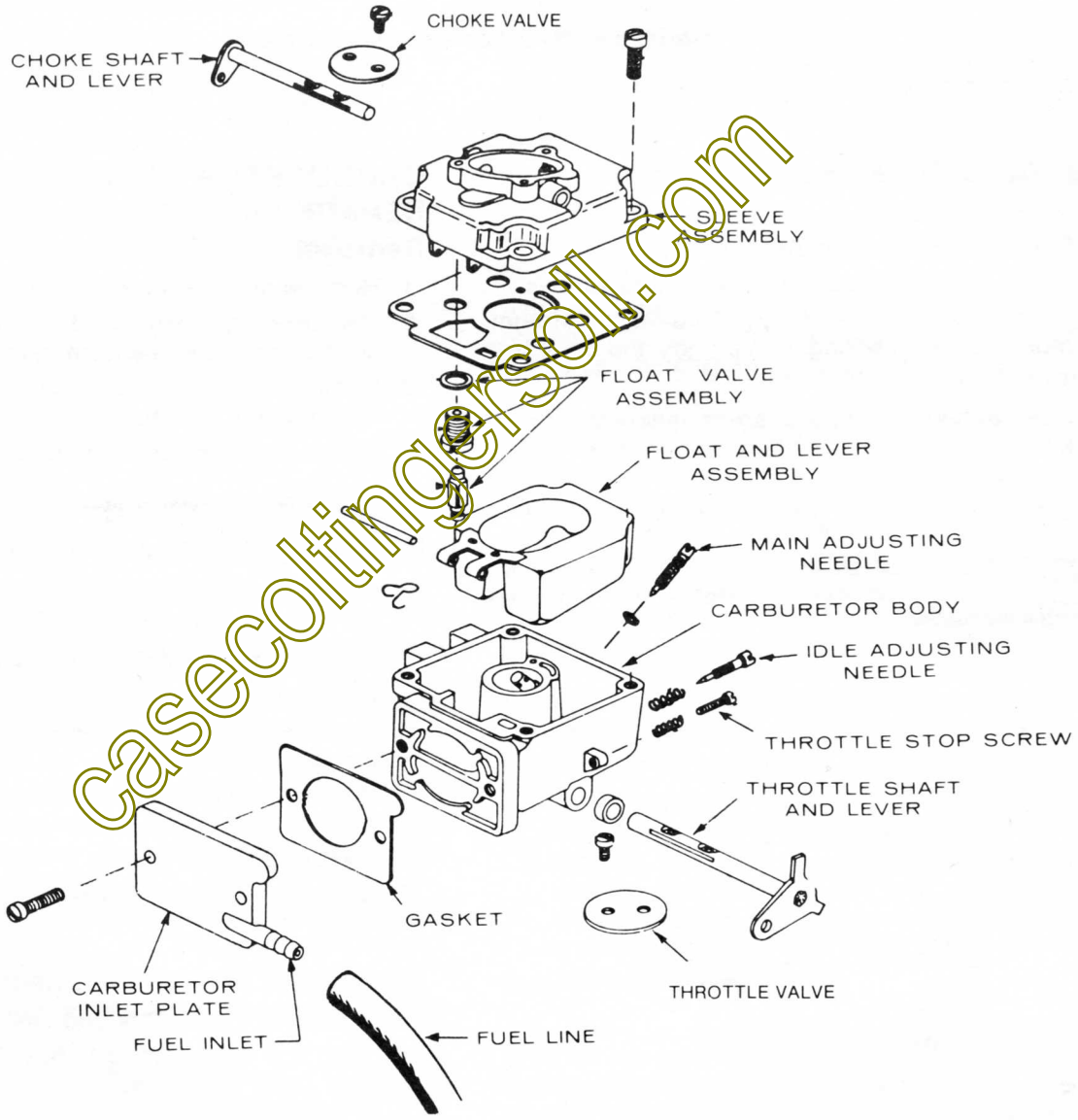


FIGURE 5. EXPLODED VIEW OF CARBURETOR

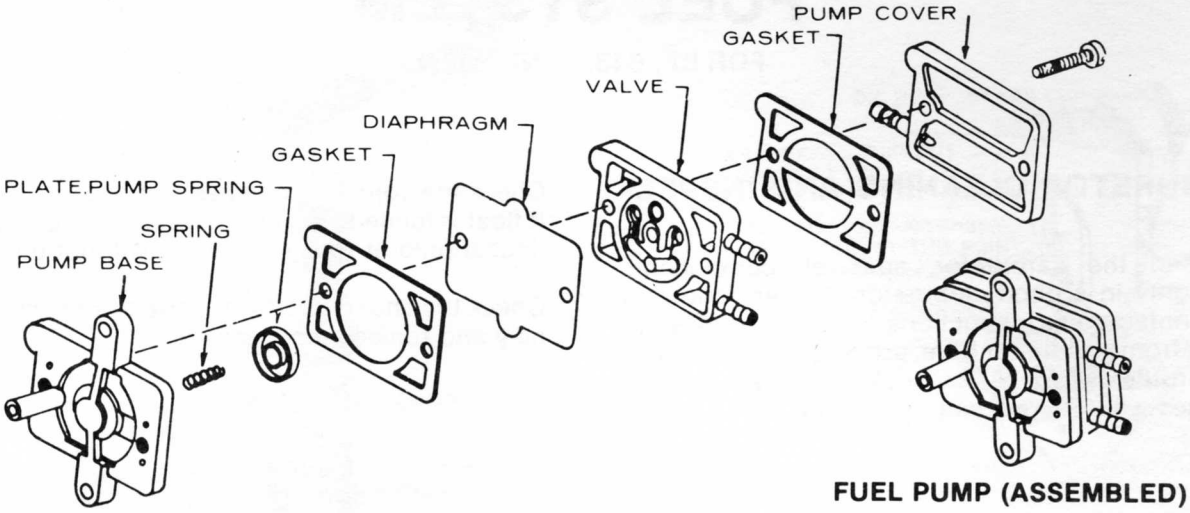


FIGURE 5A. EXPLODED VIEW OF FUEL PUMP

Fuel Pump Disassembly (Figure 5A)

1. Remove vacuum line and fuel line.
2. Remove the two fuel pump attaching screws.
3. Grasp pump and carefully pull apart. Diaphragm, plunger, return spring, pump body and mounting gaskets will now be loose.
4. Internal fuel pump parts are available in a repair kit.
5. Ensure that clamps are replaced on fuel line.

IMPORTANT **Use care when reassembling pump, all parts must be perfectly aligned, or pump will leak, creating a fire hazard.**

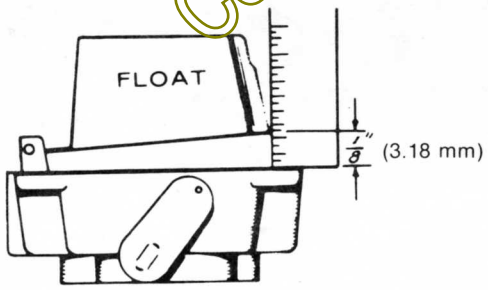


FIGURE 6. FLOAT ADJUSTMENT

CARBURETOR DISASSEMBLY AND REPAIR (Figure 5)

Removal

1. Remove air cleaner and hose.
2. Disconnect governor and throttle linkage, choke control and fuel line from carburetor.
3. Remove the four intake manifold cap screws and lift complete manifold assembly from engine.
4. Remove carburetor from intake manifold.

Always work on carburetor in clean conditions.

Replacing Needle and Valve Seat

1. Remove four screws from top of carburetor and lift off float assembly.
2. Invert float assembly as shown in Figure 6.
3. Push out pin that holds float to cover.
4. Remove float and set aside in a clean place. Pull out needle and spring.
5. Remove valve seat and replace with a new one, making sure to use a new gasket.
6. Install new bowl gasket.
7. Clip new needle to float assembly with spring clip. Install float.

Carburetor Float Adjustment

1. Invert float assembly and casting.
2. With the float resting lightly against the needle and seat, there should be 1/8-inch (3.18 mm) clearance between the bowl cover gasket and the free end of float.
3. If it is necessary to reset the float level, bend float tangs near pin to obtain a 1/8-inch (3.18 mm) clearance (Figure 6).

CARBURETOR ADJUSTMENTS

The carburetor has a main fuel valve adjusting screw and an idle valve adjusting screw (Figure 7). A low speed adjustment screw is shown in Figure 8.

Initial Adjustment

1. Turn main fuel valve clockwise until it just closes.

IMPORTANT **Do not open main fuel jet more than 1/2 turn beyond the maximum power point as this could cause spark plug fouling, etc.**

2. Now open main fuel valve 1-1/4 turn counterclockwise from seat.
3. Close idle valve in same manner and open it one turn (counterclockwise).
4. This initial adjustment will permit engine to start and warm up prior to final adjustment.

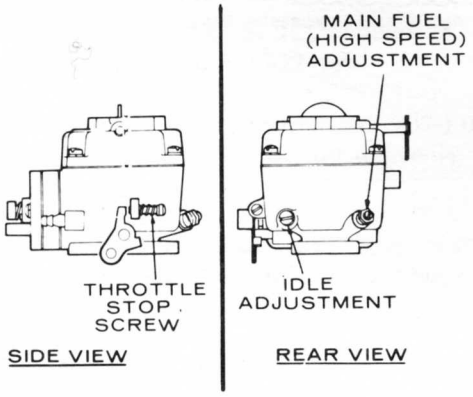


FIGURE 7. MAIN FUEL AND IDLE VALVE ADJUSTMENT

Final Adjustment

1. Turn main fuel valve in until engine misses (lean mixture), then turn it out past the point where engine runs smoothly until engine runs unevenly (rich mixture). Turn valve to mid-point between lean and rich so engine runs smoothly. (This should be 1-1/4 to 1-1/2 from seat.)
2. Hold engine at idle position and set low speed adjustment screw (Figure 8) until a fast idle is obtained (1200 rpm).
3. *Hold throttle in idle position* and turn idle adjustment valve in (lean) and out (rich) until engine idles smoothly.
4. Reset low speed adjustment screw so engine idles at 1200 rpm.
5. Release throttle—engine should accelerate without hesitation. If engine does not accelerate properly, readjust main fuel valve by turning out slightly.

Do not open more than 1/2 turn beyond maximum power point.

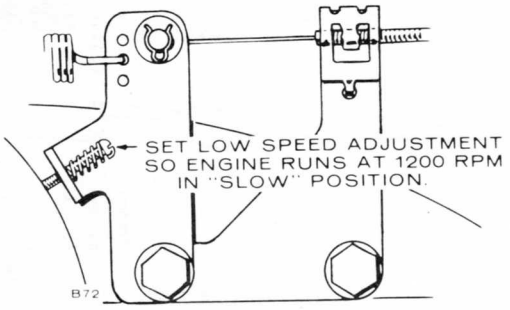


FIGURE 8. LOW SPEED ADJUSTMENT ON VARIABLE SPEED GOVERNOR

GOVERNOR

These engines are adapted for use where a wide range of speed settings is desired (see Figure 9). Engine speed is controlled at any given point between minimum and maximum by simply shifting the throttle lever on the dash panel until the desired speed is reached.

The fixed speed (standard) and the variable speed (optional) governor gives an automatic decrease in sensitivity when the speed is increased. The result is good stability at all speeds.

A reliable instrument for checking engine speed is required for accurate governor adjustment. Engine speed can be checked with a tachometer.

Check the governor arm, linkage, throttle shaft, and lever for binding condition or excessive slack and wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness may cause a hunting condition and regulation could be erratic. Work the arm back and forth several times by hand while the engine is idling to check for above conditions.

If the governor is hunting or not operating properly, adjust as follows and as shown in Figure 9.

1. Disconnect linkage (A) from one of holes (C).
2. Push linkage (A) and governor arm (B) as far back (toward carburetor) as they will go.
3. Holding linkage and governor arm toward direction of carburetor, insert end of linkage into whichever hole (C) in governor arm lines up the closest. If between two holes, insert in next hole out.

The governor control spring is factory set in the third hole of the governor arm (farthest from pivot). To increase sensitivity, move spring loop into hole nearest the pivot point or shaft. To decrease sensitivity, move spring outward. After the sensitivity has been set, adjust the low speed with adjustment screw on the control wire bracket. The spring will normally be in third hole from pivot.

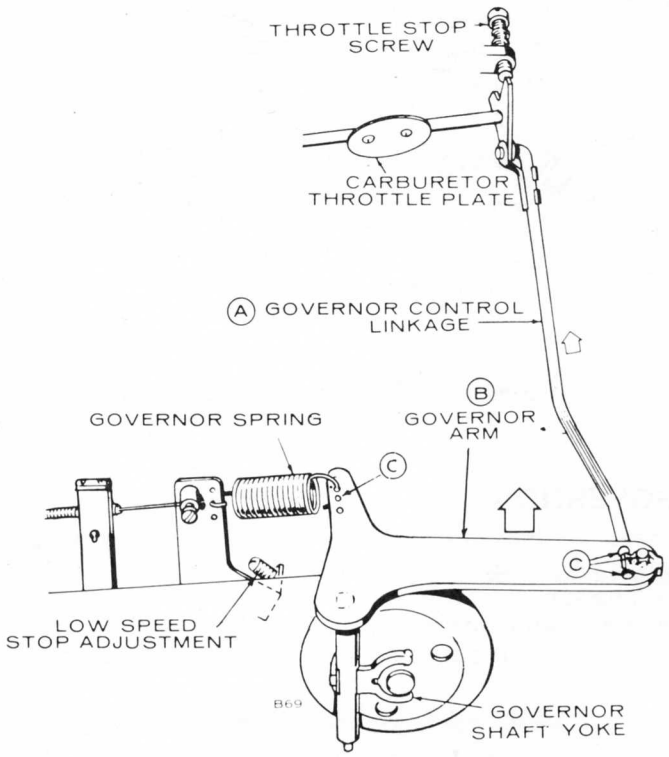


FIGURE 9. VARIABLE SPEED GOVERNOR ADJUSTMENTS

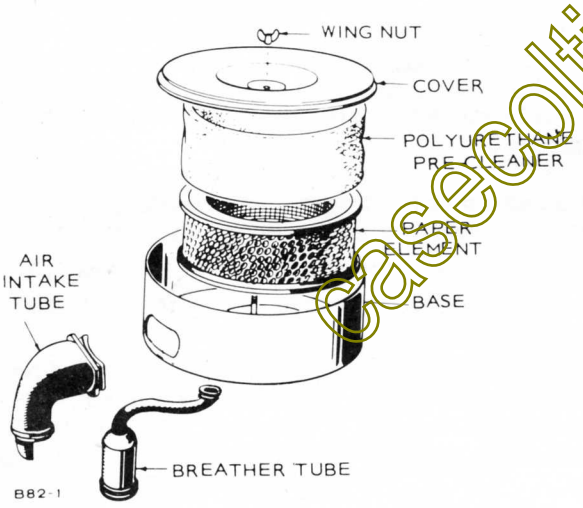
AIR CLEANER

IMPORTANT **If air cleaner becomes too dirty, engine will not receive sufficient air to run properly. Symptoms: Loss of power, flooding, hard to start and overheating.**

Engine is equipped with a paper element. If the engine is equipped with polyurethane precleaner, it must be removed, cleaned and oiled every 25 hours of operation, or more under extremely dusty conditions.

1. To clean precleaner, wash in water and detergent referring to Figure 10. Remove excess water by squeezing like a sponge and allow to dry thoroughly. Distribute three tablespoons of SAE 30 engine oil evenly around the precleaner. Knead into and wring excess oil from precleaner.
2. Depending on conditions in which the tractor is operating, the inner paper element should be replaced whenever it becomes excessively dirty or oily.

IMPORTANT **Never run engine with air cleaner removed. Dirt will enter engine and wear out rings causing excessive blow-by.**



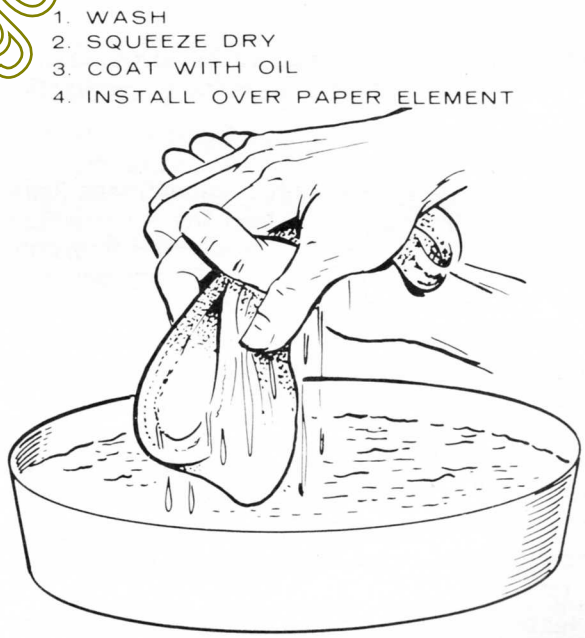


FIGURE 10. AIR CLEANER ASSEMBLY

FUEL SYSTEM

FOR CCKA

CARBURETOR

The carburetor has an idle jet and a main jet. The idle jet which is adjustable, affects engine operation at low speed. The main jet usually affects operation under load (high speed). Under normal circumstances, factory carburetor adjustments should not be disturbed. If the idle adjustment has been disturbed, turn the needle (counterclockwise) off its seat 1 to 1-1/2 turns to permit starting the engine, then readjust as follows:

Carburetor Idle Adjustment

1. Allow the engine to run at least 10 minutes to warm it up.
2. Move engine speed control to SLOW position. The engine should run at about 1300 rpm.
3. Turn the idle needle out (counterclockwise) until engine begins to slow down or run unevenly. Remember this position.
4. Turn needle in (clockwise) past the position where the engine runs smoothly until it begins to slow down or run unevenly.
5. Back the needle out to a position approximately halfway between the two positions. This should provide a smooth running idle.

IMPORTANT **Do not force the needle against its seat; doing so will damage it.**

Carburetor Main (Load) Adjustment

If engine runs unevenly at half or full load due to faulty carburetion, the main adjusting needle needs readjustment.

1. Start engine and allow it to warm up.
2. Push in on the governor mechanism to slow the unit down to about 400-500 rpm.
3. Set idle adjustment so engine runs smoothly.
4. Release governor mechanism to allow engine to accelerate. If engine accelerates evenly and without hesitation, main adjustment is correct. If not, turn needle outward about 1/2 turn and again slow the engine down and release the mechanism. Continue until the engine accelerates evenly and without a hesitation after releasing the governor.

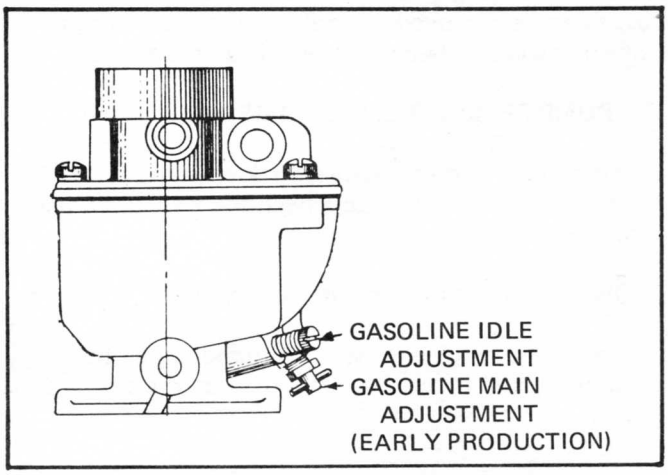


FIGURE 11. GASOLINE IDLE ADJUSTMENT

5. If engine tends to hunt (alternate increase and decrease of speed), open the main adjusting needle a little more. Do not open more than 1/2 turn beyond the maximum power point.

NOTE: Some carburetors do not have a main adjustment jet.

Carburetor Float Adjustment

1. Disconnect throttle control, choke cable, and fuel line from carburetor.
2. With a screwdriver, remove the three screws on the top of the carburetor and lift off.
3. With the carburetor casting inverted and the float resting lightly against the needle and seat, there should be 1/4 inch clearance between the bowl cover gasket and the free end of the float (side opposite needle and seat). See Figure 12.
4. If it is necessary to reset the float level, bend the float near the shaft to obtain the correct level.

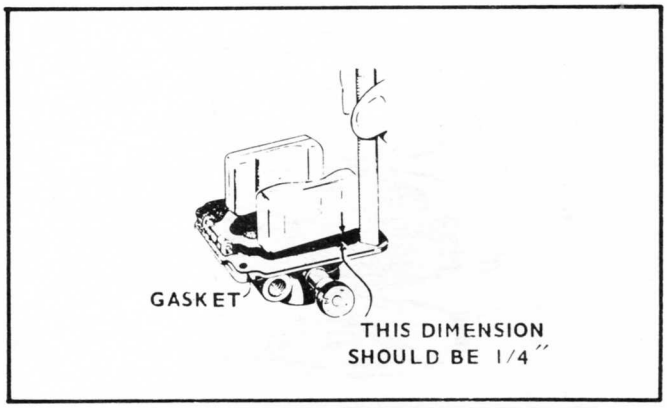


FIGURE 12. FLOAT LEVEL ADJUSTMENT

Carburetor Cleaning

Carburetor maintenance should consist of regular cleaning. Some gasolines have a tendency toward formation of gum deposits inside the carburetor. These deposits can be removed by soaking in a good carburetor cleaning solvent. Use compressed air to clean jets.

FUEL PUMP PROBLEM DIAGNOSIS

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 slowly by hand and observe whether fuel comes from the line at the carburetor.

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

3. If there is enough fuel in the tank, and the line between the tank and the pump is open but the pump fails, repair or replace it.

Failure of the pump is usually due to a leaking diaphragm, valve or valve gasket, a weak or broken spring, or wear in the drive linkage. If the operator chooses to repair the pump rather than install a new one, use a complete repair kit. Refer to Parts Catalog.

Gasoline diluted oil may indicate a faulty fuel pump.

AIR CLEANER

Most engines used for tractor applications utilize a dry element air cleaner.

IMPORTANT **Never run the engine with the air cleaner element removed. Dirt will enter the carburetor and score the cylinders.**

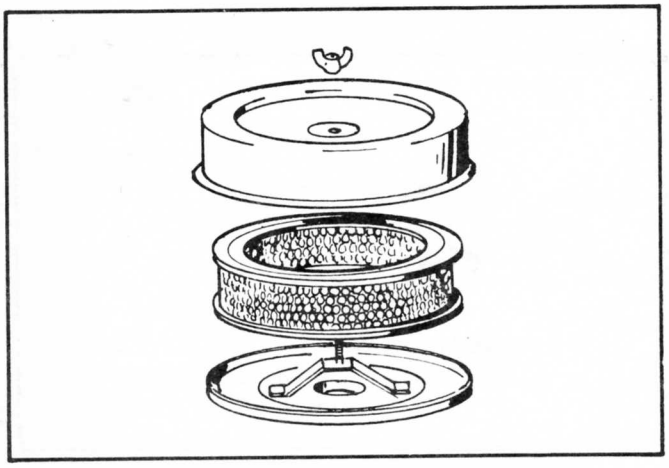


FIGURE 13. TYPICAL AIR CLEANER ELEMENT

In normal operating conditions, clean the air filter every 50 hours. To clean, remove the filter element and tap it gently on a clean, flat surface to dislodge the dirt particles. Do not use high pressure compressed air as damage may occur to the paper pleats.

Replace element every 200 operating hours; replace more often in dusty conditions.

GOVERNOR ADJUSTMENT

If governor requires readjustment, observe the following:

Low Speed Adjustment

A tachometer (electric or mechanical) is required to accurately set the governor speed.

1. Use a screwdriver to accurately adjust the throttle stop screw (A) to 1000 rpm when carburetor throttle is held closed.
2. Readjust the carburetor idle mixture (B) so engine runs smoothly.
3. Check the adjustment made in step 1 and readjust the minimum idle speed if necessary.
4. Adjust the nuts at (C) so the engine will run at 1200 rpm in the "slow" position. To increase speed, turn the nuts clockwise; to decrease speed, turn counterclockwise.
5. Turn the two nuts securely against each other so they will stay in position.

High Speed Adjustment

1. Move the engine speed control all the way ahead to the "fast" position.
2. Turn the adjustment nuts (D) clockwise or counterclockwise as required so engine runs at 3600 rpm.
3. Tighten the two nuts against each other so they will stay in position.

IMPORTANT **Do not exceed 3600 rpm.**

CLEANING

Inspect the governor linkage, springs, etc., for binding or wear. Clean often in dusty conditions. Blow dust and dirt from linkage with compressed air. Use an approved solvent and apply with a soft brush to remove excessive grease or oil.

NOTE: Later style governor adjustment is the same as for BF, B43M and B48M on page 13.

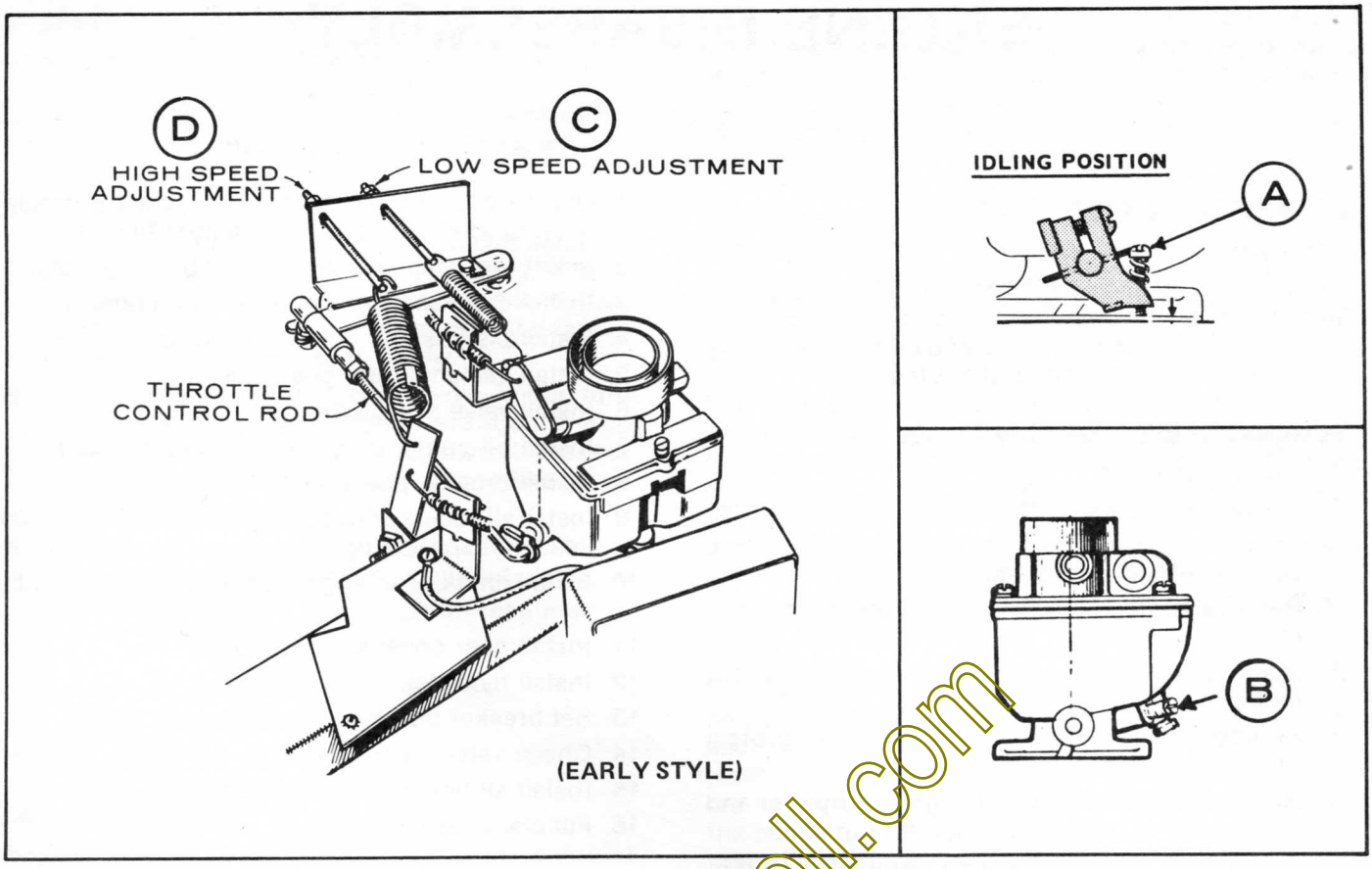


FIGURE 14. GOVERNOR ADJUSTMENT

ENGINE DISASSEMBLY

DISASSEMBLY/ASSEMBLY

General

When complete engine disassembly is necessary, first remove all complete assemblies. Individual assemblies such as fuel pump and carburetor can be disassembled and repaired at another time.

Suggested Disassembly Order

1. Drain crankcase.
2. Disconnect all exhaust lines and electrical lines.
3. Remove engine from its mountings and place on a suitable bench or work stand.
4. Remove all housings, shrouds, blower housings, etc.
5. Remove flywheel, using a puller or pry bar method.
6. Remove the gear cover, being careful to protect the oil seal from keyway damage.
7. Remove the crank gear, using a gear puller and ring.
8. Remove all accessories such as oil filter, starter, intake manifold, fuel lines, spark plugs, etc.
9. Remove breaker point box.
10. Remove oil base, oil pump and cylinder heads.
11. Remove valves, springs, lifters, etc.
12. Remove camshaft and gear assembly.
13. Remove connecting rods and pistons.
14. Remove rear bearing plate.
15. Remove crankshaft.
16. Remove front bearing.

Keep all parts in their respective orders. Keep valve assemblies together. Return rod cans to their respective pistons. Analyze the reasons for parts failure.

Suggested Assembly Procedure

Engine assembly is normally the reverse of the disassembly procedure, observing proper clearances and torques. Use a torque wrench to assure proper tightness. Coat the internal engine parts with oil as they are assembled. After the internal engine parts are assembled, the engine should turn over by hand freely. Use only genuine Onan parts and special tools when reassembling your engine.

1. Use the proper bearing driver to install front main bearing after coating it with a light film of oil.
2. Insert rear main bearing in rear bearing plate.
3. Install crankshaft and rear bearing plate.
4. Install pistons and connecting rods.
5. Install camshaft and gear assembly.
6. Install valve assemblies.
7. Install oil pump, oil base and cylinder heads.
8. Install breaker point box.
9. Install all accessories such as oil filter, starter, fuel lines and spark plugs.
10. Install crank gear, aligning crank gear mark with cam gear mark.
11. Install gear cover and oil seal.
12. Install flywheel.
13. Set breaker points to obtain proper timing.
14. Check valve clearance.
15. Install all housings and air cleaner.
16. Fill crankcase with oil.

Operation

Start engine and check oil pressure. Run for approximately 15 minutes to bring engine to operating temperature. Check for oil leaks, fuel leaks and exhaust leaks. Adjust carburetor and governor for speed and sensitivity.

Tappet Adjustment

The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 150 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 ignition key to prevent accidental starting.
2. Remove all parts necessary to gain access to valve tappets.
3. Remove spark plugs to ease the task of turning the engine over by hand.
4. 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.

5. Check the tappet clearance on the intake valve. See the specifications section of this manual.

6. Check the tappet clearance on the exhaust valve. See the specifications section of this manual.

7. To correct the valve clearance, use a 7/16-inch open end wrench to turn the adjusting screw to obtain the correct clearance. The screw is self-locking and will stay where it is set. A 9/16-inch open end wrench is required to hold the tappet while turning the adjusting screw.

8. 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.

9. Replace all parts removed in Step 2. Tighten all screws securely. Torque manifold bolts to specified torque.

VALVE SYSTEM

Properly seated valves are essential to good engine performance. The aluminum cylinder heads are 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 heads, piston tops, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new one.

Worn valve stem guides may be replaced from inside the valve chamber. Valve locks are split, tapered type, of which the smaller diameter must face toward the valve head. Tappets are also replaceable from the valve chamber, after first removing the valve asssemblies.

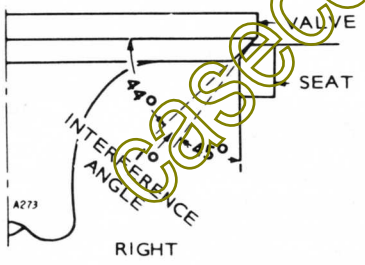
The valve *face* angle is 44 degrees. The valve *seat* angle is 45 degrees. This 1-degree interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grind valves minimizes face deposits and lengthens valve life.

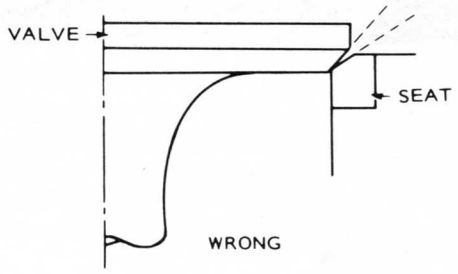
The valves should not be hand lapped, if at all avoidable, because the sharp contact may be destroyed. This is especially important where chrome cobalt faced valves and seats are used. Valve faces should be finished in a machine to 44 degrees. Valve seats should be ground with a 45-degree stone and the width of the seat band should be 1/32-inch to 3/64-inch (0.79 to 1.2 mm) 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 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 assemble all parts removed.

The positive type valve rotators prolong valve life and decrease valve repairs. When functioning properly, the valve is rotated a fraction of a turn each time it opens. While at open position, the valve must rotate freely, but in only one direction. If rotators are faulty, install new rotators.





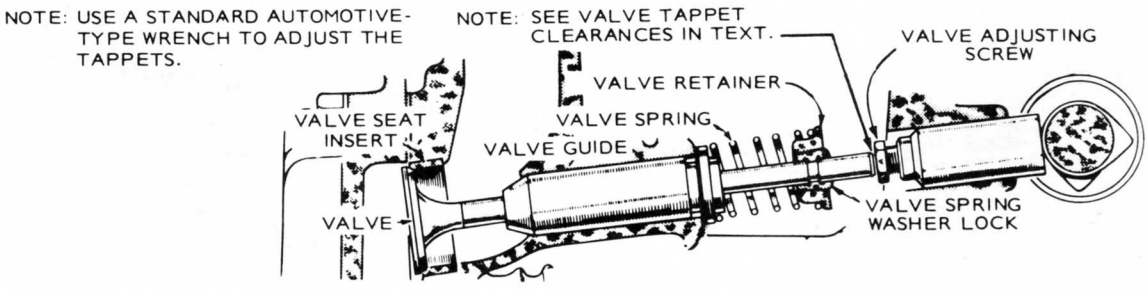


FIGURE 15. VALVE SYSTEM

BF, B43M, B48M
INTAKE 0.008 IN. (0.20 mm)
EXHAUST 0.013 IN. (0.33 mm)

CCKA
INTAKE .007 IN. (0.18 mm)
EXHAUST .016 IN. (0.41 mm)

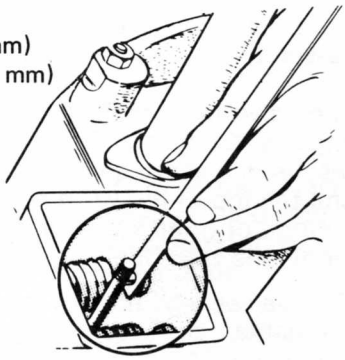


FIGURE 16. VALVE CLEARANCE

FLYWHEEL

Removing the flywheel is a relatively simple process, but the following procedure must be followed to avoid damage to the gear case and possible injury to the operator.

1. Turn the flywheel mounting screw outward about two turns.

WARNING: Do not remove the screw completely since it acts as a restrainer when the flywheel snaps loose. If the flywheel is not held by the screw, the spring action in the wheel will cause it to fly off with great force which can cause injury to the operator.

2. Install a puller bar on the flywheel as shown in Figure 17.

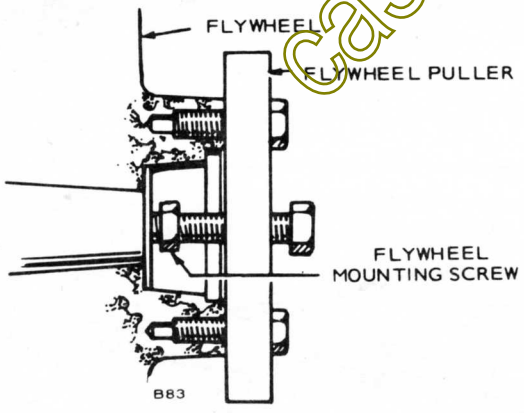


FIGURE 17. BLOWER WHEEL PULLEY

3. Turn the puller bar bolts in, alternately, until the wheel snaps loose on the shaft.

IMPORTANT **Do not use a screwdriver or similar tool or pry behind the flywheel against the gear case. The gear case cover is die-cast material and will break if undue pressure is applied in this manner.**

4. Unscrew the puller from the flywheel, remove the flywheel mounting screw and washer and pull the flywheel off the shaft. Take care not to drop the wheel. A bent or broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

GEAR COVER

After removing the mounting screws, tap the gear cover gently with a soft faced hammer to loosen it (see Figure 18).

When installing the gear cover, make sure that the pin in the gear cover engages the lined (smooth) hole in the governor cup. Turn the governor cup so that the lined hole is at the three o'clock position. Use a small amount of grease to assist in holding governor cup in 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. Catch the flyballs while sliding the cup off (Figure 19).

Replace with a new part any flyball which is grooved or has a flat spot; the ball spacer if its arms are worn or otherwise damaged; and the governor cup if the race surface is grooved or rough. The governor cup must be a free-spinning fit on the camshaft center pin, but without any excessive play.

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

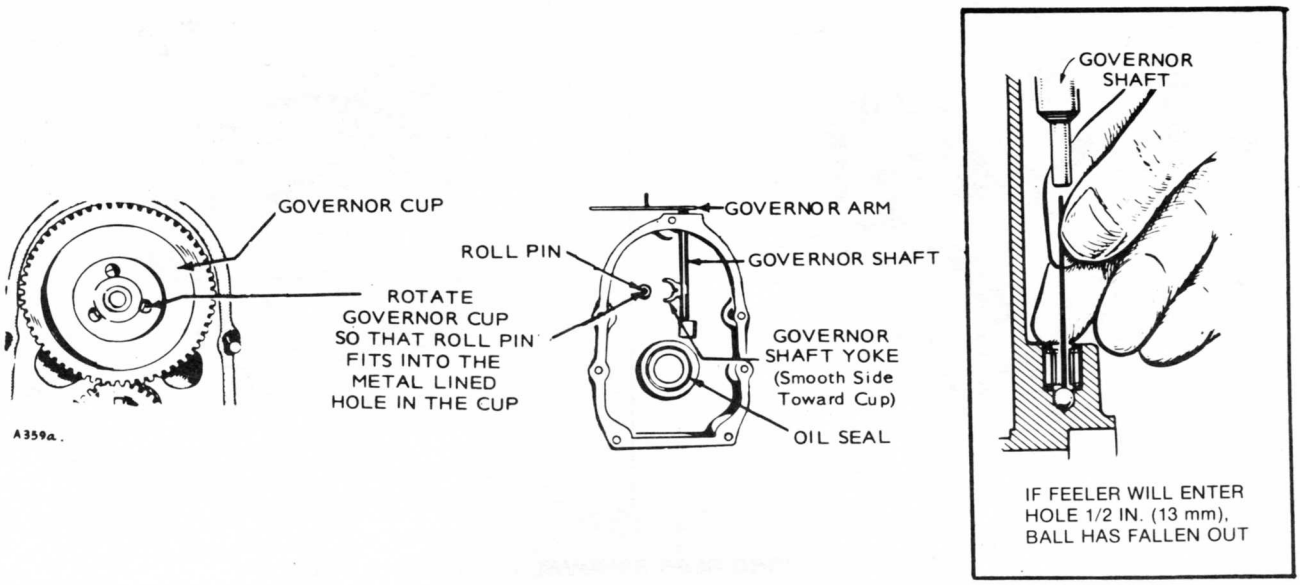


FIGURE 18. GEAR COVER ASSEMBLY

The camshaft center pin extends out 3/4 inch (19 mm) from the end of the camshaft. This distance provides an in-and-out travel distance of 7/32 inch (5.6 mm) for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine will race, especially at no load) remove the center pin and press in a new pin or grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

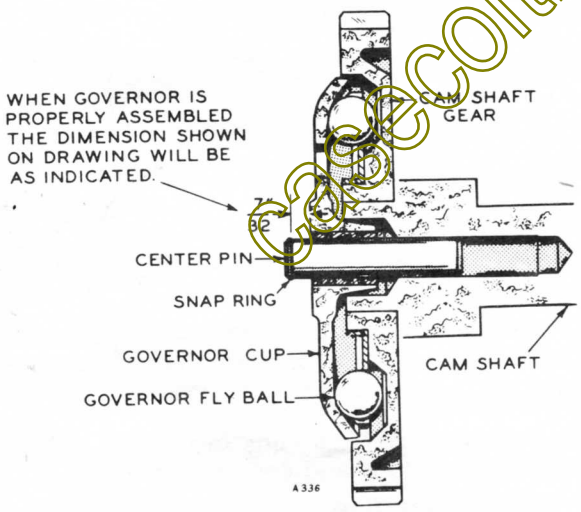


FIGURE 19. GOVERNOR CUP DETAIL

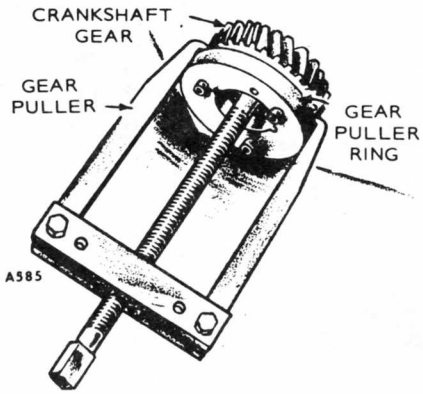
TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, always install both gears new.

To remove the crankshaft gear, first remove the snap ring and retainer washer, then attach the gear pulling ring using two No. 10-32 screws (Figure 20). Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and proceed to remove the gear.

The camshaft and gear must be replaced as an assembly. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Then remove the operating plunger for the breaker points and tappets.

Each timing gear is stamped with "O" near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. When installing the camshaft gear and shaft assembly, be sure that the thrust washer is properly in place behind the camshaft gear. Then install the crankshaft retaining washer and lock ring.



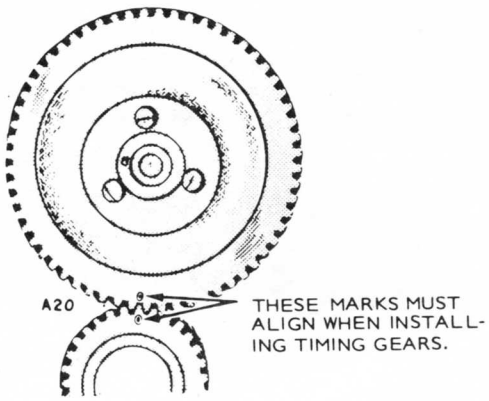


FIGURE 20. TIMING GEAR REMOVAL AND INSTALLATION

PISTONS AND CONNECTING RODS

Observe the following procedure when removing pistons and connecting rods from the engine.

1. Drain oil.
2. Remove the cylinder head and oil base pan from the engine.
3. Remove the ridge from the top of each cylinder with a ridge reamer before attempting piston removal (Figure 21).

IMPORTANT **Forcing the piston from the cylinder before reaming may cause damage to the piston lands and break rings.**

4. Turn the crankshaft until the piston is at the bottom of its stroke and remove the connecting rod nuts. Lift the rod bearing cap from the rod and push the rod and piston assembly out through the top of the cylinder using a hammer handle. Avoid scratching the crankpin and cylinder wall when removing the piston and rod.

Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps with their respective rods.

5. Remove the piston rings from the piston with a piston ring spreader as shown in Figure 22. Remove the piston pin retainer and push the piston pin out.

Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (Figure 23). Care must be taken not to remove metal from the groove sides.

IMPORTANT **Do not use a caustic cleaning solvent or wire brush for cleaning pistons. These materials will cause piston damage.**

When cleaning the connecting rods in solvent, include the rod bore. Blow out all passages with compressed air.

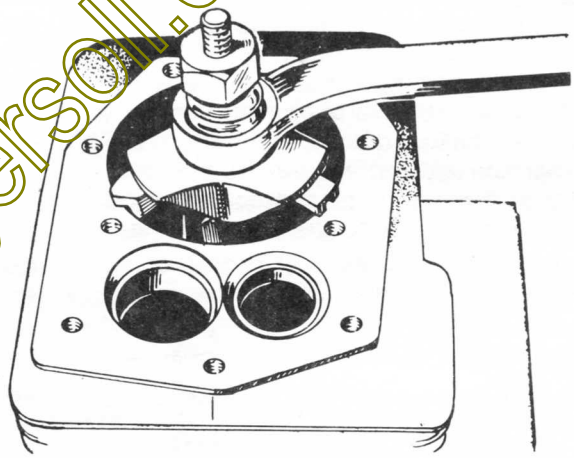


FIGURE 21. REMOVING RIDGE FROM CYLINDER

Inspection

The following text contains inspection procedures concerning pistons and connecting rods.

1. **Piston Inspection**
   a. Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 24. Replace the piston when the side clearance of the top compression ring reaches 0.004" (0.10 mm) on B43M and B48M; 0.008" (0.20 mm) on BF and CCKA.

FIGURE 22. REMOVING PISTON RINGS

b. Replace pistons showing signs of scuffing, scoring, worn ring lands, fractures or damage from preignition. Excessive piston wear near the edge of the top ring land indicates preignition.

2. **Connecting Rod Inspection**
   a. Replace connecting rod bolts and nuts with damaged threads. Replace connecting rods with deep nicks, signs of fractures, scored bores or bores out of round more than 0.002 inch.
   b. Use a new piston pin to check connecting rod for wear. A push fit clearance is required and varies from engine to engine. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod.

3. **Connecting Rod Bearings Inspection (CCKA)**
   a. Inspect the bearings for burrs, breaks, pitting and wear. Replace bearing inserts that are scored, have the overlay wiped out, show fatigue failure or are badly scratched.

   b. If the bearings appear to be serviceable, check them for proper clearance. If they exceed the specified clearances, replace them.

Connecting Rod Bushing Replacement

a. Press out the old bearing with a press and proper driver.

b. After checking to be sure the right bushing is used, carefully press the new bushing in with the same driver used to remove the old one.

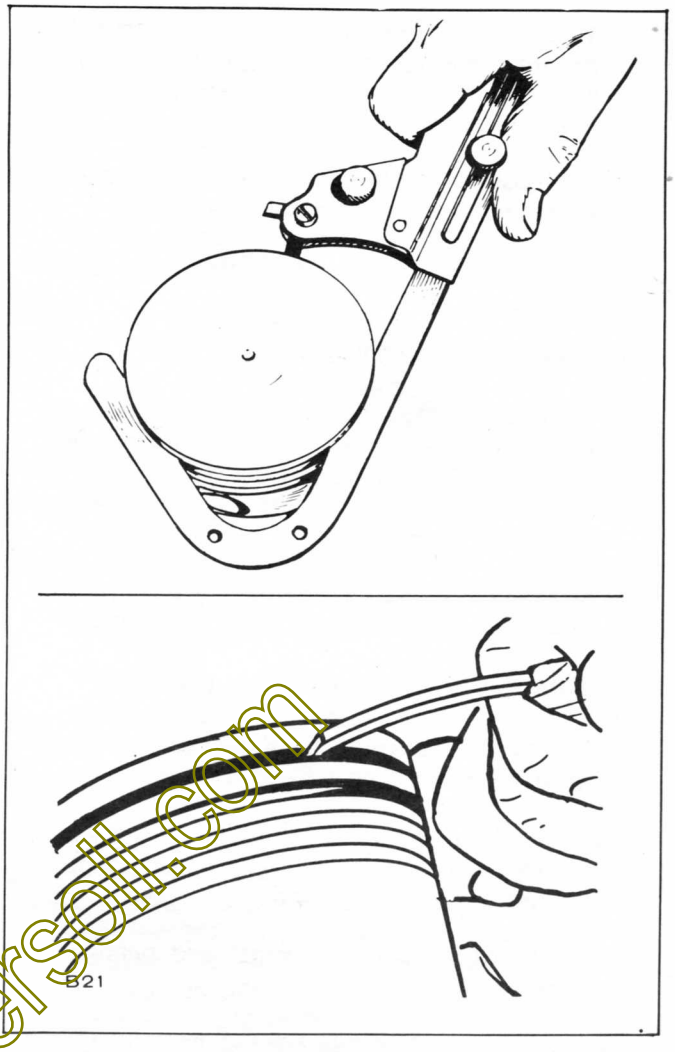


FIGURE 23. PISTON GROOVE CLEANING

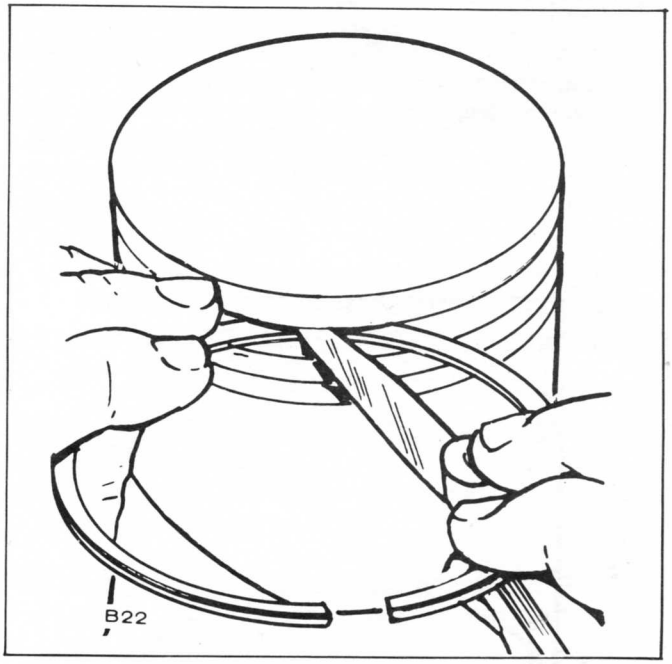


FIGURE 24. CHECKING RING SIDE CLEARANCE

Most Onan engines use precision bearings that do not require reaming. Be sure that the oiler holes are at least half open to permit sufficient oiling of the pin.

The bushing can then be finish reamed making sure the oil spray hole remains open.

c. Check all bushings for push fit of the piston pin.

Connecting Rod Alignment

a. Place the connecting rod in an alignment fixture such as "Connecting Rod Aligning Set" Onan No. 420P173. This set can be used on all models which require the "Small Rod Adapter" Onan No. 420P195.

b. Straighten or replace connecting rods twisted more than 0.012" or bent more than 0.005".

Rod Bearing Replacement (Piston in engine)

a. Rotate the crankshaft until the connecting rod to which the bearing is fitted is down.

b. Remove the connecting rod cap. Push the connecting rod up into the cylinder and remove the bearing insert from the rod and cap.

c. Clean the crankshaft journal and bearing inserts.

d. Install new bearings in the connecting rod and cap and pull the connecting rod assembly down firmly on the crankshaft journal.

e. Insert a piece of Plastigauge on the lower bearing surface according to the directions in this section and install and torque the rod cap. Remove the rod cap and measure the clearance of the new bearing according to the Plastigauge width.

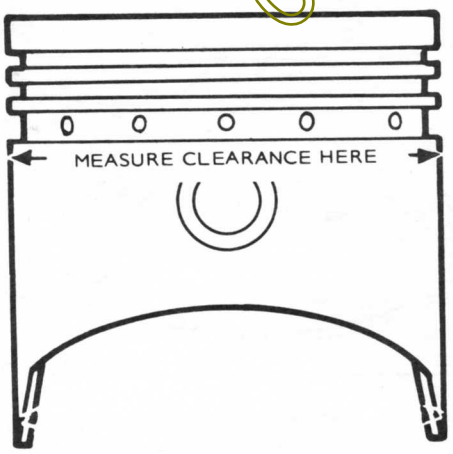


FIGURE 25. MEASURING PISTON CLEARANCE

f. When the new bearing clearance has been checked and is found to be satisfactory, apply a light coat of engine oil to the journal and bearings. Install and torque the rod cap.

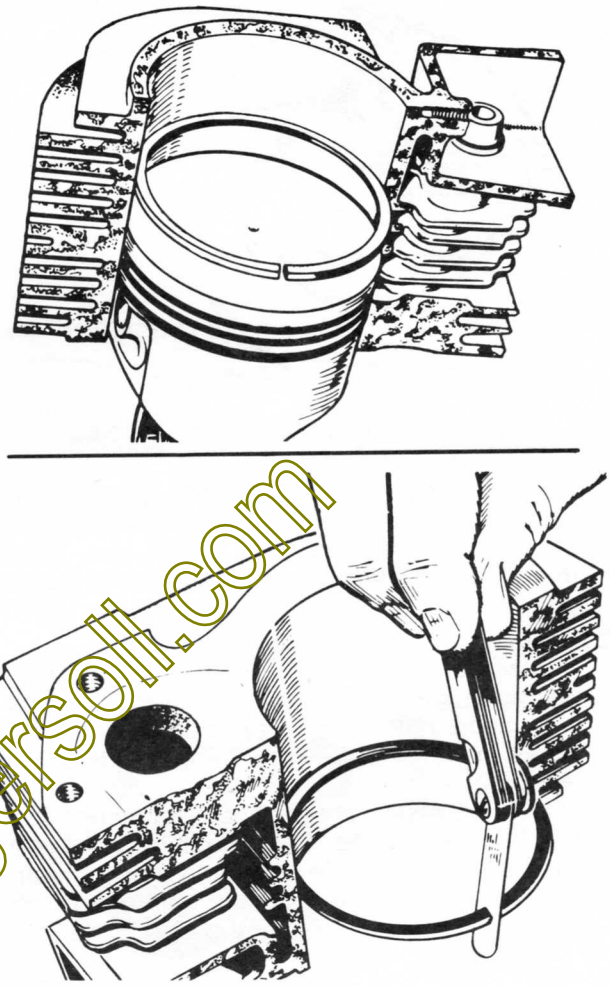
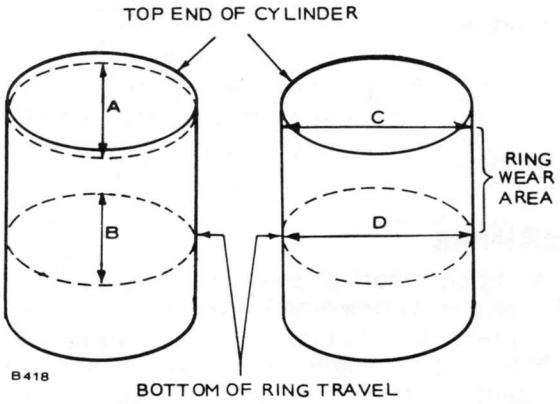


FIGURE 26. POSITIONING OF PISTON RING AND MEASURING OF END GAP

4. **Fitting Pistons**
   a. Proper piston tolerances must be maintained for satisfactory operation.
   b. Measure the piston to cylinder clearance as shown in Figure 25 to be sure the total clearance follows specifications.
5. **Fitting Piston Rings**
   a. Install the piston ring in the cylinder bore. Invert the piston and push the ring to the end of ring travel, about halfway into the bore, which trues the ring end gap. Check the gap with a feeler gauge as shown in Figure 26.
   b. The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correct set of rings and the correct bore size. A cylinder bore that is 0.001 inch under size will reduce the end gap 0.003 inch.



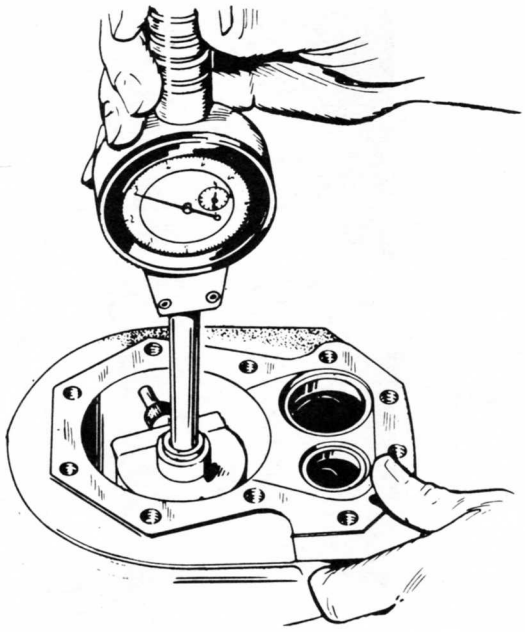


FIGURE 27.· METHODS OF MEASURING THE DIAMETER OF A CYLINDER

CYLINDER BLOCK

1. Make a thorough check for cracks. Minute cracks may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area.
2. Inspect the cylinder bore for scoring. Check the Welsh plugs for a tight, even fit and the fins for breakage.
3. Check the cylinder bore for taper, out of round and wear, with a cylinder bore gauge, telescope gauge or inside micrometer (Figure 27). These measurements should be taken at four places—the top and bottom of piston ring travel.
4. Record measurements taken lengthwise at the top and bottom of the piston travel as follows:
   a. Lengthwise of the block, measure and record as "A" the diameter of the cylinder at the top of the cylinder where greatest ring wear occurs.
   b. Also, lengthwise of the block, measure and record as "B" the cylinder diameter at the piston skirt travel.
   c. Crosswise of the block, measure and record as "C" the diameter of the top of the cylinder at the greatest point of wear.
   d. Measure and record as "D" the diameter at the bottom of the cylinder bore and crosswise of the block.
   e. Reading "A" compared to reading "B" and reading "C" compared to reading "D" indicates cylinder taper.
   f. If cylinder taper exceeds 0.005 inch (0.13 mm), rebore and hone to accommodate the next oversize piston. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicates whether or not the cylinder is out of round. If the out of round exceeds 0.002 inch (0.05 mm), the cylinders must be rebored and honed for the next oversize piston. A reboring machine is used when going to oversize pistons. The following repair data covers honing to oversize by use of a hone.

Repair

1. A hone can be used to rebore a cylinder. Remove stock to 0.002" undersize of finish bore with a coarse hone (100 grit) then complete honing with finish hones (300 grit).
2. Anchor the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.
3. Lower the hone into the cylinder until it protrudes 1/2 to 3/4 inch past the end of the cylinder. Rotate the adjusting nut until the stones come in contact with the cylinder wall at the narrowest point.
4. Turn the hone by hand. Loosen the adjusting nut until the hone can be turned.

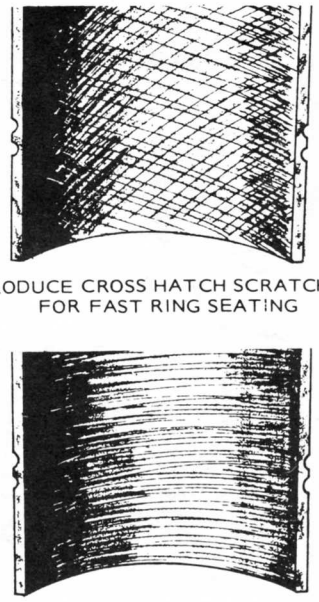


FIGURE 28. CROSSHATCHING

5. Connect drill to hone and start drill. Move the hone up and down in the cylinder approximately 40 cycles per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. Then when the cylinder takes a uniform diameter, move the hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.

6. Check the diameter of the cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore; measure twice at the top, middle and bottom at 90° angles.

7. When the cylinder is approximately 0.002" (0.05 mm) within the desired bore, change to fine stones and finish the bore. The finish should not be smooth but as shown in Figure 28. The crosshatch formed by the scratching of the stones should form an angle of 23°. This can be achieved by moving the hone up and down in the cylinder about 40 cycles per minute.

8. Clean the cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete. Do not use a solvent or gasoline since they wash the oil from the walls but leave the metal particles.

9. Dry the crankcase and coat it with oil.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, replace the crankshaft.

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

Removing camshaft or crankshaft bearings (Figures 29-31) 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.

New camshaft bearings are precision type which *do not* require line reaming or line boring after installation. Coat the bearing with SAE 20 oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the elongated hole in proper position and narrow section facing out (except bores without oil holes install with bearing groove at the top). Be sure to start the bearing straight. Press the front bearing in flush with the bottom of counterbore which received the expansion plug (see Figure 29).

Crankshaft main bearings are precision type which do not require line reaming or line boring after installation. They are available in standard size and under size. Expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F (93°C).

IMPORTANT **If a torch is used, apply only a little heat. Distortion will result from too much local heat.**

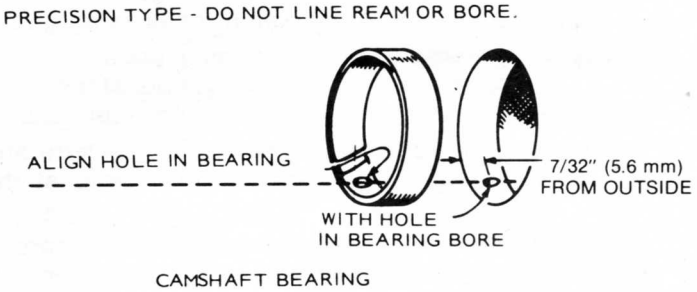


FIGURE 29. CAMSHAFT BEARING

To ease assembly, cool the precision bearing to shrink it. 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. Lubricate bearings with SAE 20 oil before installing. The cold oiled precision bearing should require only light taps to position it with a driving tool. If head of lock pin is damaged, use side cutters or Easy Out tool to remove and install new pin. Apply oil to thrust washer (one used with each bearing) to hold it in place while installing the crankshaft. Oil grooves in thrust washers must face the crankshaft and washers must be flat (not bent). The two notches on each washer must fit over the two lock pins to prevent riding on the crankshaft.

Original front bearing uses a separate thrust washer. Replacement front bearing is a one piece assembly with thrust washer part of the bearing. Do not use a separate thrust washer when installing this replacement part.

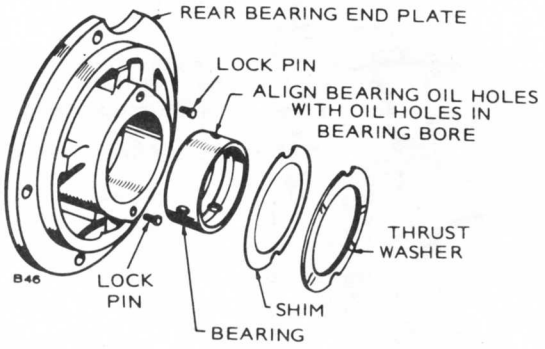


FIGURE 30. BEARINGS FOR REAR BEARING PLATE

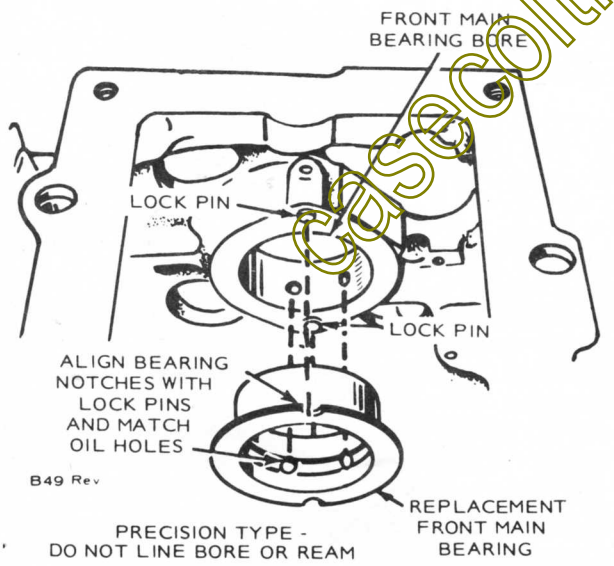


FIGURE 31. FRONT MAIN BEARING INSTALLATION

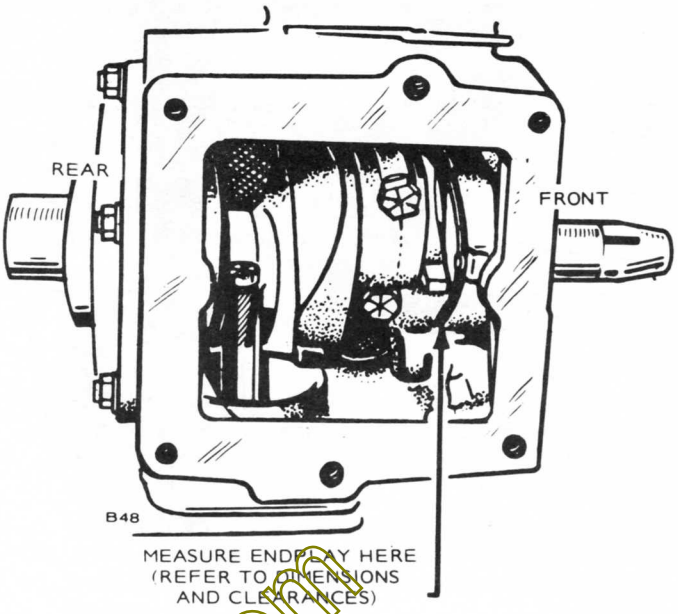


FIGURE 32. CRANKSHAFT ENDPLAY

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in *ASSEMBLY TORQUES*, check the crankshaft endplay as shown in Figure 32. 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 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.

Checking Bearing Clearance with Plastigauge

1. Make certain that all parts are marked or identified so that they are reinstalled in their original positions.
2. Place a piece of correct size Plastigauge in the bearing cap the full width of the crankshaft rod surface about 1/4 inch (6.35 mm) off center (Figure 33).
3. Rotate the crank about 30 degrees from bottom dead center and reinstall the bearing cap; tighten the bolts to the torque specified in *ASSEMBLY TORQUES AND SPECIAL TOOLS*. Do not turn the crankshaft.
4. Remove the bearing cap. Leave the flattened Plastigauge on the part to which it has adhered and compare the widest point with the graduations of the Plastigauge envelope to determine bearing clearance.

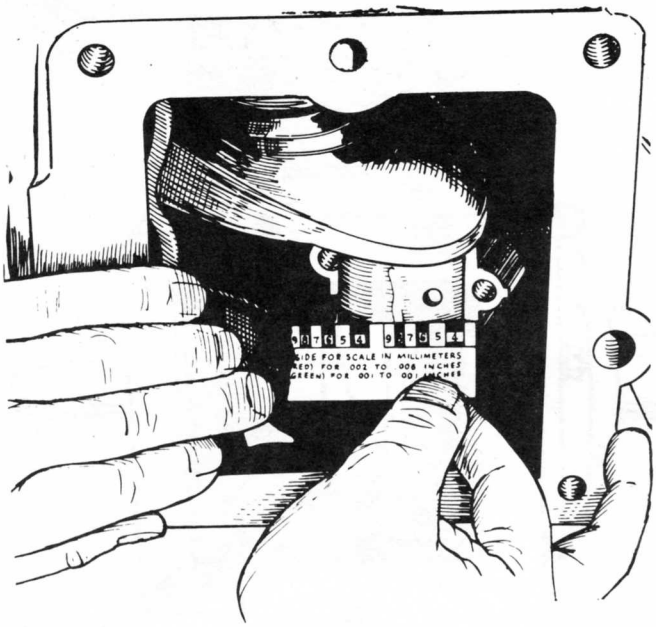


FIGURE 33. MEASURING BEARING CLEARANCE

ASSEMBLY

1. Lubricate all parts with engine oil.
2. Position piston on its respective rod and install the pin.
3. Install the rings on the pistons starting with the oil control ring (Figure 35). Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings have a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. The oil control ring has an expander; install the expander first and then close until the expander ends butt. The joint should be 180 degrees from the gap of that ring. The second compression ring has an expander also.

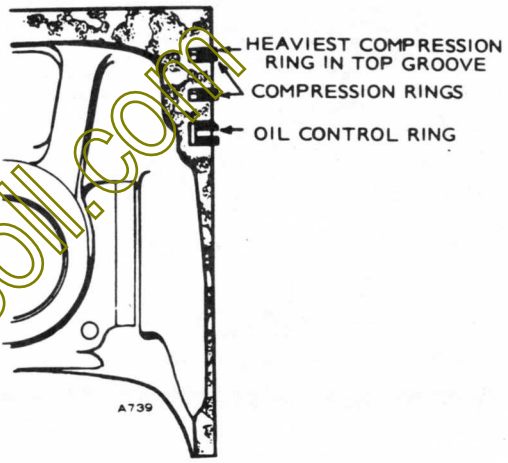


FIGURE 35. PISTON RINGS

OIL SEALS

The bearing plate must be removed to replace the oil seal (see Figure 34). Drive the oil seal out from the inside.

Before installing the seals, fill the space between lips with a multi-purpose grease. This will improve sealing.

When installing the gear cover oil seal, tap the seal inward until it is 1-1/32" (26 mm) on B43M and B48M, 31/32" (24.6 mm) on BF and CCKA from the mounting face of the 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.

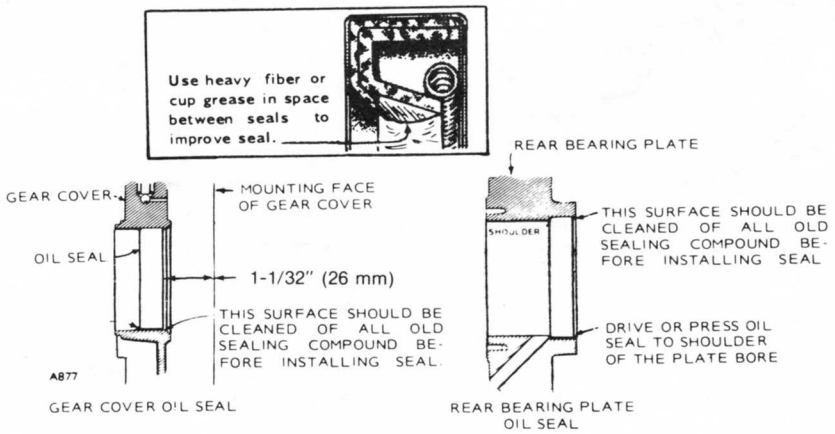


FIGURE 34. GEAR COVER AND REAR BEARING PLATE OIL SEALS

INSTALLATION OF PISTON IN CYLINDER

1. Turn the crankshaft to position the number one rod bearing journal at the bottom of its stroke.
2. Lubricate the number one piston assembly and inside of the cylinder. Compress the rings with a ring compressor
3. Position the piston and rod assembly in the cylinder block.

Rod bolts are off-set toward outside of block.

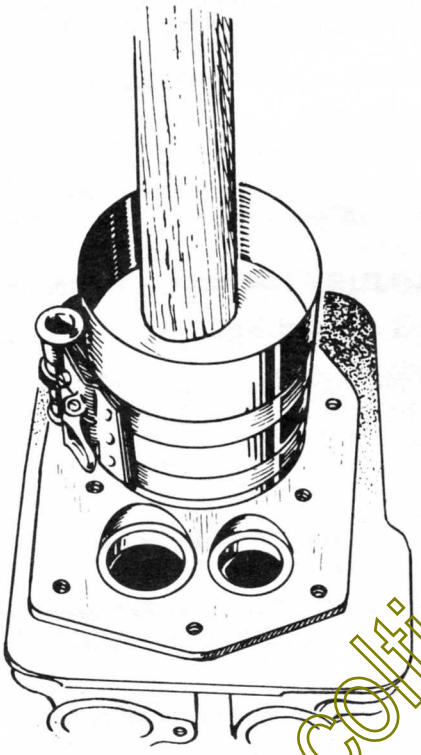


FIGURE 36. INSTALLING PISTON

4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal (Figure 36). Install the bearing cap on the rod with the stamped reference numbers matching the marks on the rod. Install and tighten the bolts evenly in steps to the specified torques.

   The bearing cap must be tapped to properly align it with the rest of the connecting rod. Clearance varies on the journal if this is not done.

   Install the remaining piston and rod in the same manner. Crank the engine over by hand to see that all bearings are free.
5. Install the oil base with a new gasket.
6. Install the cylinder heads
7. Replace oil and break in engine.

CYLINDER HEADS

Remove the cylinder heads for cleaning each 200 hours or when poor engine performance is noticed.

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

IMPORTANT **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 45. Start out tightening all bolts to 5 ft. lb (7 N•m), then 10 ft. lb (14 N•m), etc., until all bolts are torqued. See the Assembly Torque Section of this manual.
5. Recheck torque before engine has run a total of 25 hours. (50 hours for CCKA).

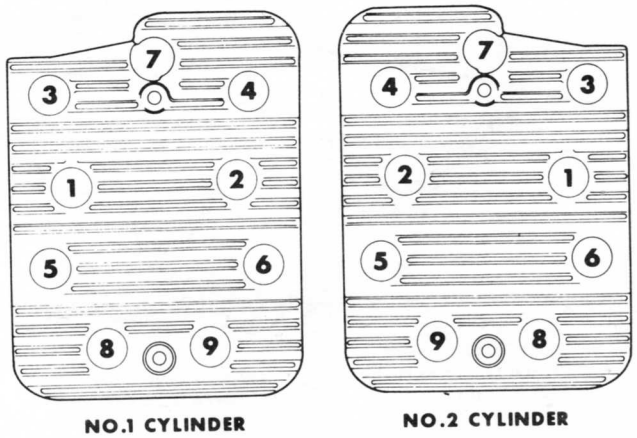


FIGURE 37. CYLINDER HEAD TORQUE SEQUENCE

IGNITION AND BATTERY CHARGING

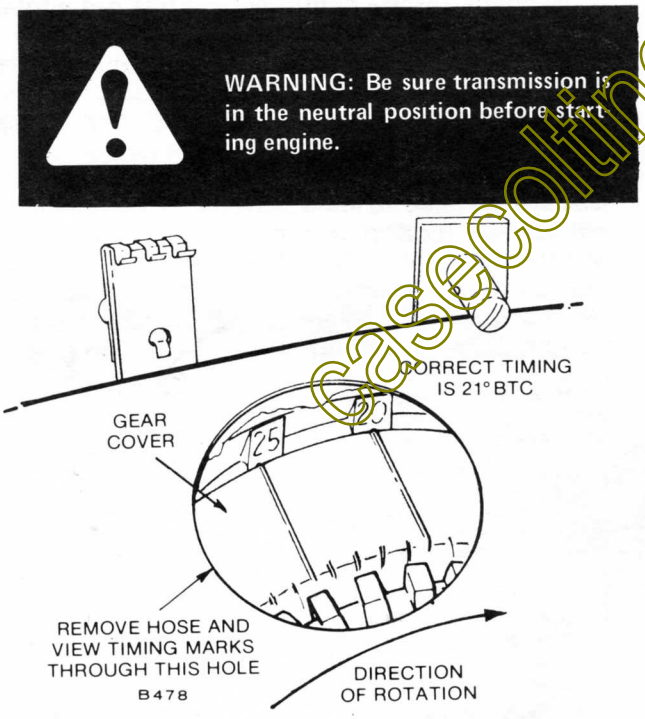
IGNITION TIMING

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 21° (20° for CCKA) 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 and Hot

1. To accurately check ignition timing, use a timing light when engine is running. Connect timing light according to its manufacturer's instructions. Either spark plug can be used as they fire simultaneously.
2. Remove the air intake hose that connects to blower housing to provide an access to view timing marks.



CORRECT TIMING IS 21° BTC (20° for CCKA)

FIGURE 38. TIMING ADJUSTMENT

3. Start the engine. When engine warms up check the ignition timing. The mark on the flywheel should line up with the 21 (20° for CCKA) -degree mark on the cover.
4. Replace hose, breaker box cover and any other hardware removed from engine

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.

TOP ADJUST BREAKER POINTS— TIMING (Cold Setting)

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

1. Remove the air intake hose that connects to blower housing. This provides an access to view timing mark.
2. Remove spark plugs and rotate flywheel TC mark clockwise to 21° (20° for CCKA) BTC (points open).
3. Remove breaker box cover and unplug coil wire at coil (+) terminal.
4. Remove condenser (screw A) and detach condenser lead and coil lead (screw B).
5. Remove two Allen screws (C) and lift breaker assembly from engine.
6. Replace condenser and point assembly with new parts and reinstall using above procedure in reverse order of removal.
7. Connect an ohmmeter or 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.
8. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
9. The lamp should go out just as the points break which is the time at which ignition occurs (21° (20° for CCKA) BTC).

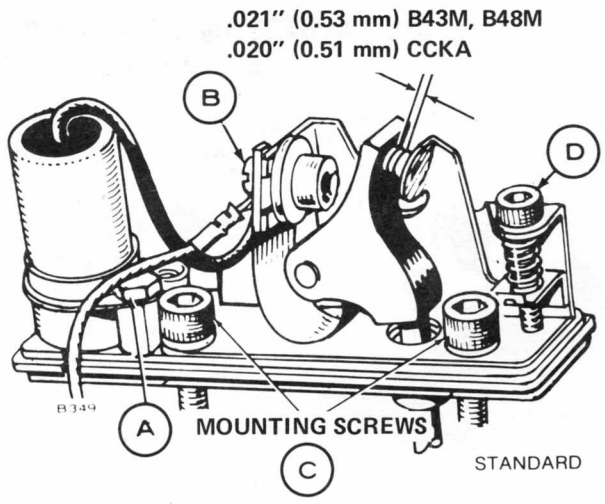


FIGURE 39. BREAKER POINT ADJUSTMENT

10. If timing is early (large point gap) or late (small point gap), adjust point gap using Allen screw (D) so that lamp goes out at 21° (20° for CCKA) BTC with crankshaft rotation clockwise.

    If a continuity lamp or an ohmmeter is not available, use a clean flat feeler gauge as follows: Rotate crankshaft clockwise (facing flywheel) by hand until TC mark on flywheel aligns with 21° (20° CCKA) BTC mark on gear cover. Then rotate flywheel another 1/4 turn clockwise (90°) to ensure points open fully. Using Allen screw (D), set point gap.

11. Replace breaker box cover, coil wire and spark plug cables and air intake hose.

BREAKER POINTS-TIMING

(Side Adjust Points Early BF and CCKA)

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

1. Remove the two screws and cover on breaker box.
2. Remove the two spark plugs so engine can be easily rotated by hand. Check condition of spark plugs at this time.
3. Refer to Figure 40. Remove mounting nut (A) and pull points from 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 nut (A).
6. Remove the air intake hose that connects to blower housing. This provides an access to view timing mark.
7. Rotate the engine clockwise (facing flywheel) by hand until the 21° (20° for CCKA) BTC mark on gear cover aligns with mark on flywheel. Turn another 1/4 turn (90 degrees) to ensure points are fully open.
8. Using a screwdriver inserted in notch (D) on the right side of points, turn points until gap measures .020 to .023 inch (0.51 to 0.58 mm) with a flat thickness gauge. (Be sure feeler is clean.) Tighten mounting nut and recheck gap.
9. Connect a continuity test lamp set across ignition breaker points. Touch one test prod to the breaker box terminal to which the coil lead is connected and touch other test prod to a good ground on the engine.

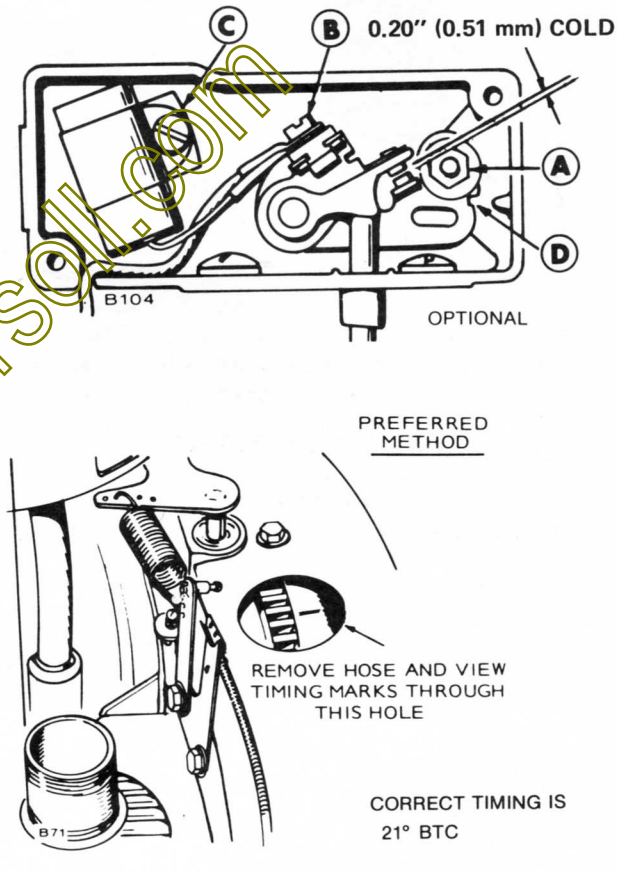


FIGURE 40. IGNITION AND TIMING ADJUSTMENT

10. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
11. The lamp should go out just as the points break which is the time at which ignition occurs.

IGNITION COIL

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

1. Use a Simpson 260 VOM or equivalent.
2. Place black lead on ground (-) terminal of coil and red lead to positive (+) terminal. Primary resistance should read 3.87 - 4.73 ohms.
3. Change resistance setting on ohmmeter. Place ohmmeter leads inside of spark plug cable holes (Figure 41). Secondary resistance should read 12,600 - 15,400 ohms.
4. If any of the above conditions are not met, replace coil.

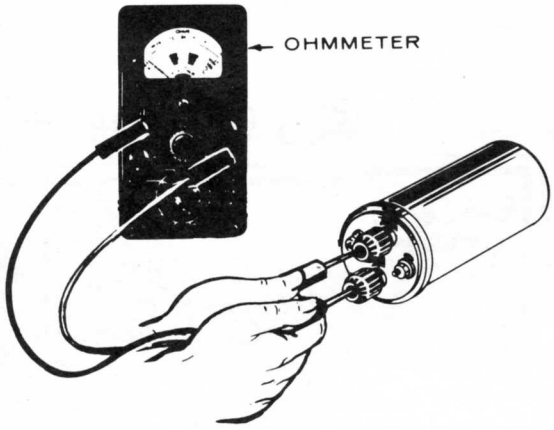


FIGURE 41. COIL TEST

IMPORTANT: **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. Damage to regulator or ignition coil could result if cables are reversed.**

SPARK PLUGS

Remove both spark plugs (see Figure 42) and install new ones every 100 hours. Use Prestolite 14L7 (Prestolite 14RL7 in Canada) or equivalent.

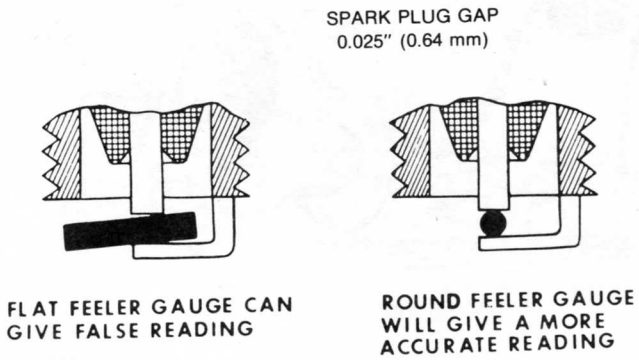


FIGURE 42. SPARK PLUG GAP

Battery Inspection

Check battery cells with a hydrometer. The specific gravity reading should be approximately 1.265 at 80° F (27° C). See Figure 43. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks. 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 non-conductive grease to retard corrosion.

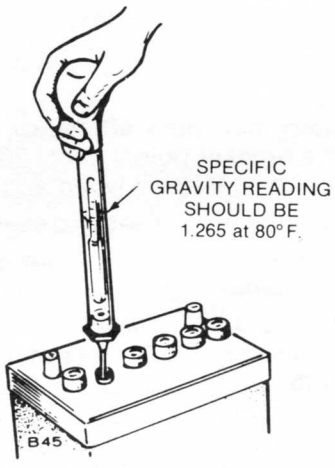


FIGURE 43. SPECIFIC GRAVITY TEST

FLYWHEEL ALTERNATOR
(BF, B43M AND B48M)

This unit is equipped with a permanent magnet flywheel alternator and solid-state voltage regulator-rectifier (output control). See Figure 44. As with all solid-state electrical units, precautions are necessary when servicing. Observe the following.

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.

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 full charged battery.

With the engine running between 1800 to 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

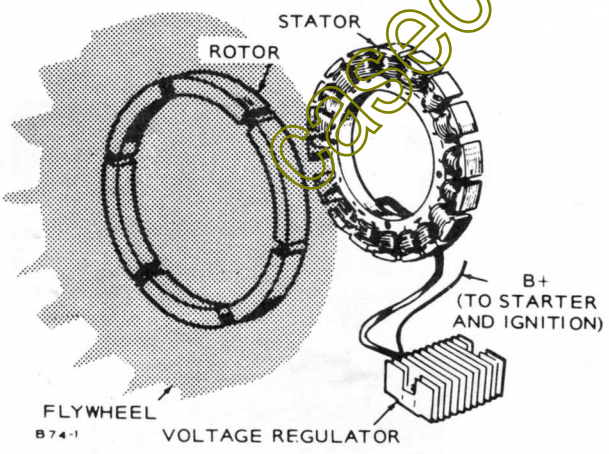
1. Check the B+ to ground voltage using a DC voltmeter. See Figure 44 for wiring diagram.
2. If voltmeter reads 13.8 volts or higher, add a load to system (e.g. headlights) to reduce battery voltage to below 13.6 volts.
3. Observe ammeter. If charge rate increases, consider the system as satisfactory. 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.

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.

Various alternator problems are listed in Table 1.



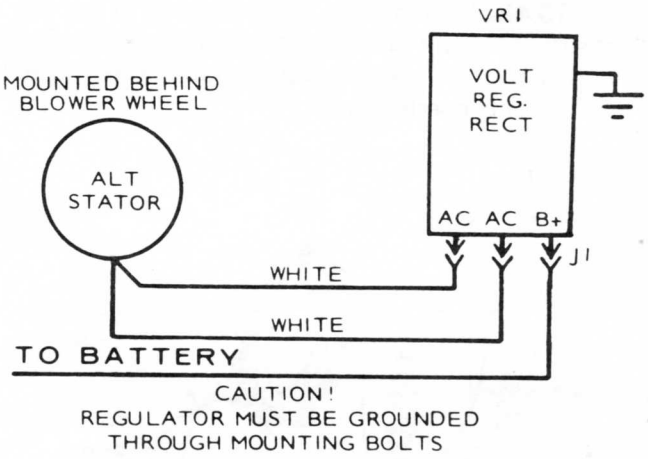


FIGURE 44. FLYWHEEL ALTERNATOR SYSTEM (BF, B43M, B48M)

FLYWHEEL ALTERNATOR (CCKA)

This unit is equipped with a Wico permanent magnet flywheel alternator and solid-state voltage regulator-rectifier (output control). As with all solid-state electrical units, precautions are necessary when servicing. Observe the following:

1. Be sure output control plug (connector) is properly inserted into the stator receptacle. This means the plug must push into and solidly bottom in the receptacle so as to eliminate any resistance due to a poor connection. Keep it clean and tight.

2. Be sure the regulator-rectifier output control has a good clean ground connection to operate properly. This means the mating surface where the control unit mounts on the housing must be clean and fasteners tightened properly.

3. Do not reverse battery leads.

Regulator-Rectifier Test

A weak spark or discharged battery indicate trouble in the charging system.

IMPORTANT: Charging system tests require fully charged battery.

1. Charge battery and check its condition to be sure it is serviceable.

2. Connect a voltmeter across battery. Start engine and operate at 1800 to 3600 rpm. If voltmeter registers 13.4 to 14.05 volts, no further testing is required.

3. If voltage is below 13.4 volts, install a new regulator-rectifier and retest. If meter does not register 13.4 volts minimum, then proceed to test the stator group. Be sure regulator-rectifier has a good clean ground connection and that the wire connector is properly seated.

Flywheel Stator Test

For testing stator use a Simpson Model 260 V.O.M. or equivalent. Set voltage switch to DC+. Be sure test meter is in good condition and if battery powered, that the battery is good. Be sure the meter is zeroed before each reading and each time you change scales. Check with engine NOT running.

1. Unplug connector at regulator. Zero meter on Rx1 scale.

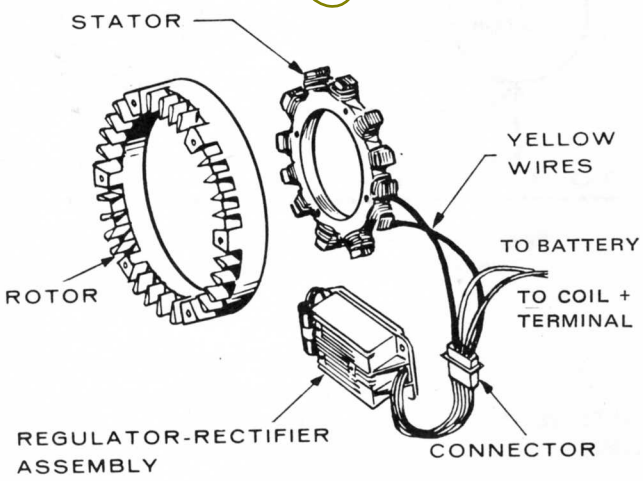
2. Connect meter leads to the two outside terminals of the female plug (both yellow wires). Meter should read less than .8 ohms. This checks stator winding for continuity. If no reading shows on meter, winding is open – replace stator.

3. To check for grounded stator winding, touch red meter lead to yellow wire plug and other meter lead to metal core. Meter should read infinity. If meter shows a reading then winding is grounded – replace stator.

Flywheel Magnet Group

This should be treated in the same manner as the standard magneto flywheel. There is very little testing that can be done in the field other than to lay a piece of ferrous (iron) material up against the magnets to be sure they are charged or to replace the magnet group.

IMPORTANT: Be sure to check torque of bolts fastening magnet ring group to flywheel. The torque should be 60-80 in.-lb. (6.8-9 Nm).



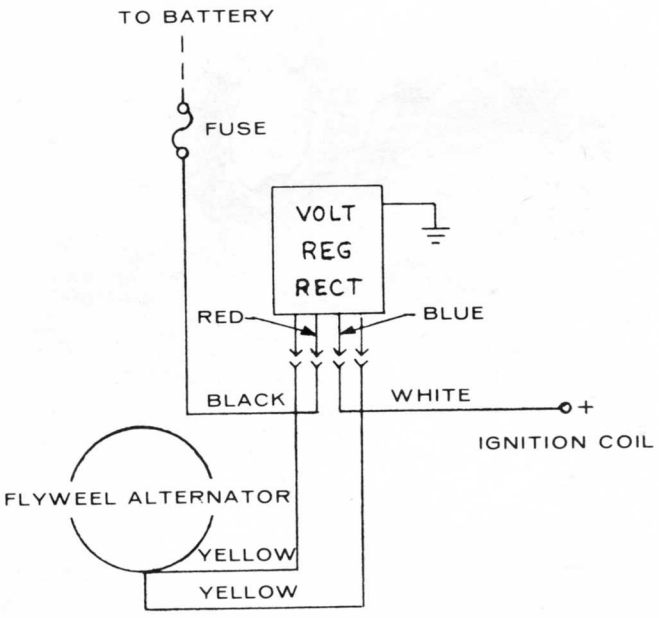


FIGURE 45. FLYWHEEL ALTERNATOR SYSTEM (CCKA)

TESTING FLYWHEEL ALTERNATOR SYSTEM

BASIC TEST	PROCEDURE	TEST VALUES	
		BF, B43M, B48M	CCKA
1. Battery	Battery Voltage — unit not running	12 VDC	12 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes	13.6 to 14.7 VDC	13.4 to 14 VDC
3. Alternator Stator and Wiring with Fully Charged Battery.	Ohmmeter reading from stator output — unit not running. Check at plug.	0.11 to 0.19 ohms	Less than .8 ohms
4. Alternator and Wiring	Measure AC open circuit stator voltage with unit running. Measure between two stator leads with plug disconnected.	28 VAC at 3600 rpm	17 VAC at 1800 rpm

INSPECTION OF PARTS

1. *Testing Armature for Grounds:* Touch armature with a pair of ohmmeter leads. If the ohmmeter reading is low, the armature is grounded. Replace grounded armature. See Figure 48.
2. **Testing Armature for a Short Circuit:** Use a growler for locating shorts in the armature. Place armature in growler and hold a thin steel blade (e.g. hacksaw blade) parallel to the core and just above it while slowly rotating armature in growler. A shorted armature will cause the blade to vibrate and be attracted to the core. If armature is shorted, replace with a new one (Figure 49).
3. **Inspecting for an Open Circuit in Armature:** The most likely place to check for an open circuit is at the commutator riser bars. Inspect for loose connections on the points where the conductors are joined to the commutator bars.

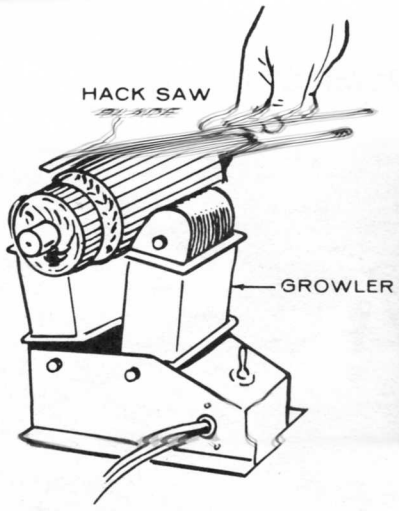


FIGURE 49. TESTING ARMATURE FOR SHORT CIRCUITS

TESTING FLYWHEEL ALTERNATOR SYSTEM

BASIC TEST	PROCEDURE	TEST VALUES	
		BF, B43M, B48M	CCKA
1. Battery	Battery Voltage — unit not running	12 VDC	12 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes	13.6 to 14.7 VDC	13.4 to 14 VDC
3. Alternator Stator and Wiring with Fully Charged Battery.	Ohmmeter reading from stator output — unit not running. Check at plug.	0.11 to 0.19 ohms	Less than .8 ohms
4. Alternator and Wiring	Measure AC open circuit stator voltage with unit running. Measure between two stator leads with plug disconnected.	28 VAC at 3600 rpm	17 VAC at 1800 rpm

Fuse

A 30 amp fuse is included in the battery charging system to protect the alternator in case battery cables are reversed. Replace a blown fuse with a Buss AGC30 or equivalent.

IMPORTANT: 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 JUMP STARTING

WARNING: To jump start this machine, connect positive jumper cable to battery terminal on starter solenoid and connect negative jumper cable to good engine ground. Start engine only when seated in operator's seat. Stop engine before leaving machine. Disconnect jumper cables. Any other method could result in uncontrolled machine movement.

Always wear protective goggles and clothing when you work near batteries. Prevent acid from coming in contact with your skin or clothing.

Connect the jumper cables as shown below. Follow the numbers for the correct sequence of installation.

To remove the jumper cables, reverse the sequence.

To prevent any possible sparks near the battery:

1. Make the last connection as far as possible from the battery.
2. Do not let the ends of the cables make contact with each other.
3. If the booster battery is on another machine, make sure machines do not make contact.

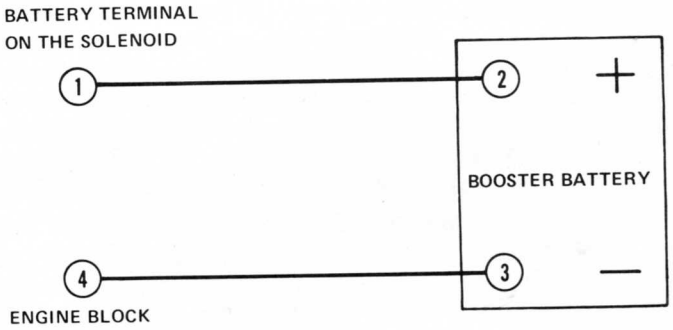


FIGURE 46.

STARTING SYSTEM

BF, B43M AND B48M

ELECTRIC STARTER

Normally the starter will require little or no service other than possible brush replacement. However, if through accident or misuse, the starter requires service or overhaul, the following information will provide the information necessary to perform this service.

STARTER DISASSEMBLY

1. Remove the through-bolts and separate the end cap, the housing and the armature.

2. Disassemble the drive assembly and the drive end cap by loosening the self-locking nut.

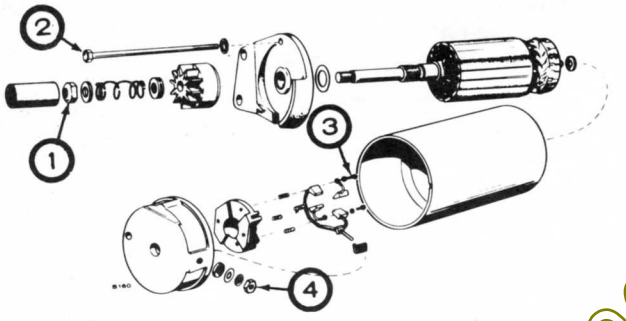


FIGURE 47. STARTER DISASSEMBLY

INSPECTION OF PARTS

1. **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 48.
2. **Testing Armature for a Short Circuit:** Use a growler for locating shorts in the armature. Place armature in growler and hold a thin steel blade (e.g. hacksaw blade) parallel to the core and just above it while slowly rotating armature in growler. A shorted armature will cause the blade to vibrate and be attracted to the core. If armature is shorted, replace with a new one (Figure 49).
3. **Inspecting for an Open Circuit in Armature:** The most likely place to check for an open circuit is at the commutator riser bars. Inspect for loose connections on the points where the conductors are joined to the commutator bars.

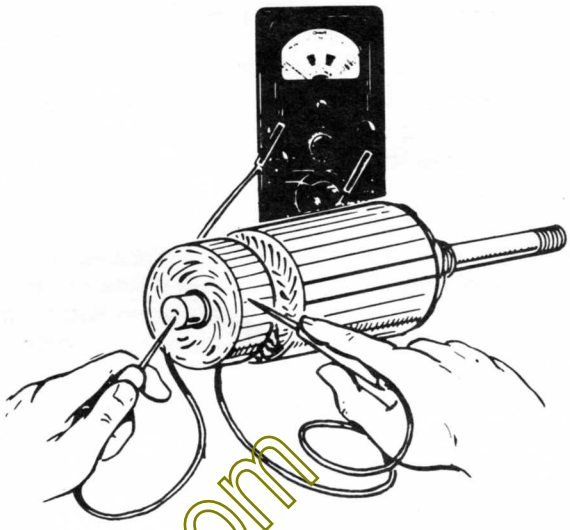


FIGURE 48. TESTING ARMATURE FOR GROUNDS

4. **Brush Inspection:** If brushes are worn shorter than 1/4 inch (6.35 mm), replace them. Check to see that brushes move smoothly in the brush holders. See Figure 50.

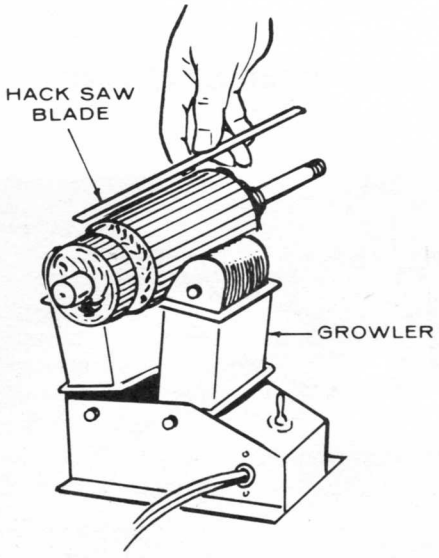


FIGURE 49. TESTING ARMATURE FOR SHORT CIRCUITS

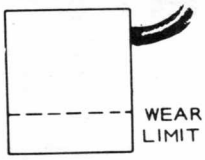


FIGURE 50. BRUSH WEAR LIMIT

STARTER ASSEMBLY

Reassembly is the reverse of disassembly. When reassembling, observe the following:

1. Wipe off any dirty parts with a clean cloth or blow clean using filtered, compressed air.

   Bearings must not be immersed in cleaning fluid. These parts should be cleaned with a brush dipped in clean engine oil.

2. Apply SAE 10W-30 oil on the armature shaft, spline and bearings.

REASSEMBLY

1. Assemble brushes so that chamfered side is away from the brush springs and position the brush shunts so that they will not contact the commutator or commutator end cap.
2. Torque bolts (Figure 47, item 3) to a value of 3 to 3-1/2 ft-lbs (4 to 5 N•m).
3. Torque nut (Figure 47, item 4) to a value of 4 to 5 ft-lbs (5 to 7 N•m).
4. Apply a thin film of grease to the commutator end of the armature shaft and to the portion of the shaft that contacts the bearings. Apply a generous film of Lubriplate "Aero" grease to the shaft thread.
5. Torque stop nut (Figure 47, item 1) to a value of 20 to 25 ft-lbs (27 to 34 N•m). Hold armature in a vise.
6. Torque thru-bolts (Figure 47, item 2) to a value of 4.5 to 6 ft-lbs (6 to 8 N•m).

IMPORTANT **Do not exceed the rated voltage of the motor (12-VDC). Excessive voltage could demagnetize the motor permanent magnet field.**

INSPECTING REASSEMBLED STARTER

1. To ensure good electrical contact, make sure starter to engine mounting surfaces are free of dirt or oil.
2. When tightening attaching bolts and nut, starter gear should be held into ring gear to assure proper backlash.
3. Battery to starting motor wire must be tightened securely.

IMPORTANT **Starter motors are not designed for continuous operation. Do not operate more than 30 seconds per "ON" cycle. Do not operate starter more than 10 seconds in a stall condition if engine will not rotate. Serious damage could result if these time limits are exceeded.**

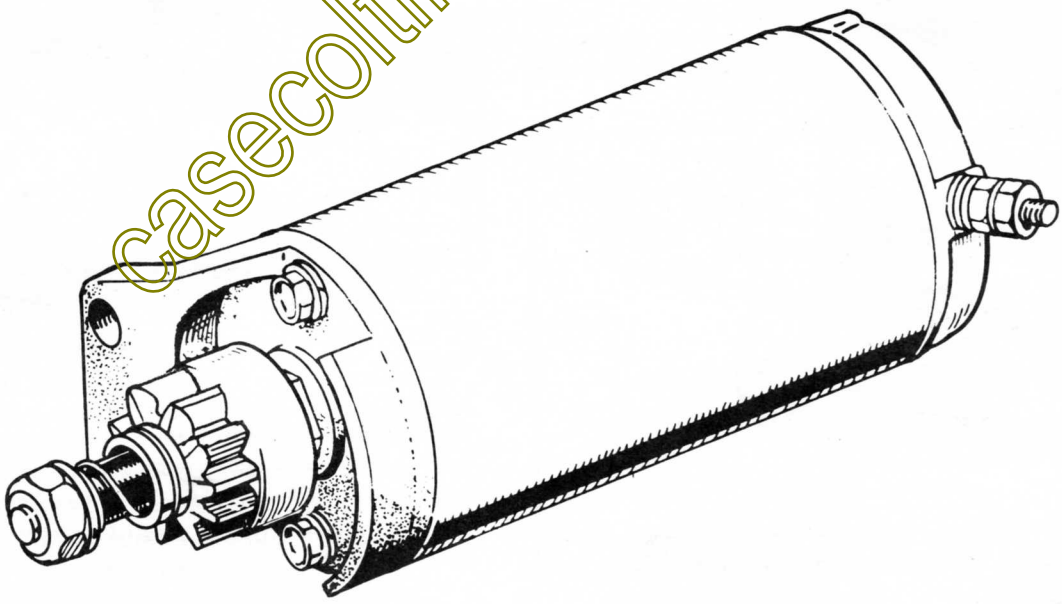


FIGURE 51. REASSEMBLED STARTER

STARTING SYSTEM

CCKA

ELECTRIC STARTER

Normally the starter will require little or no service other than possible brush replacement. However, if through accident or misuse, the starter requires service or overhaul, the following procedures will provide the information necessary to perform this service.

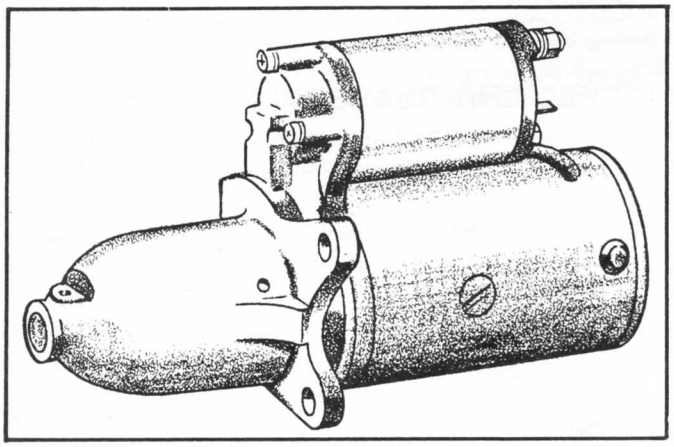


FIGURE 52. STARTER ASSEMBLY

STARTER 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.**

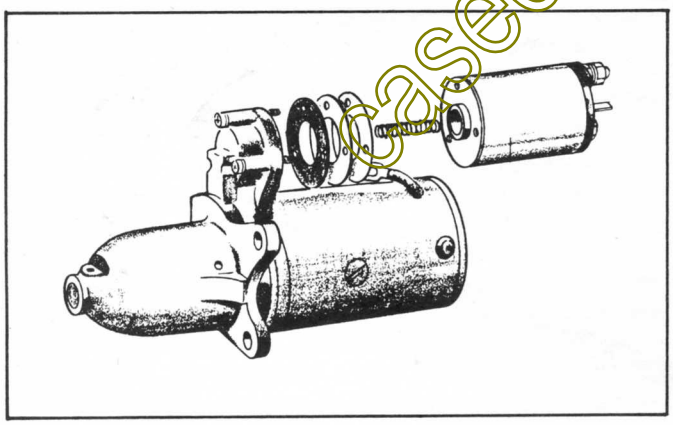


FIGURE 53. MAGNETIC SWITCH REMOVAL

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 54 are used for adjustment of the thrust gap of the armature shaft and are placed between the rear bracket and the commutator.

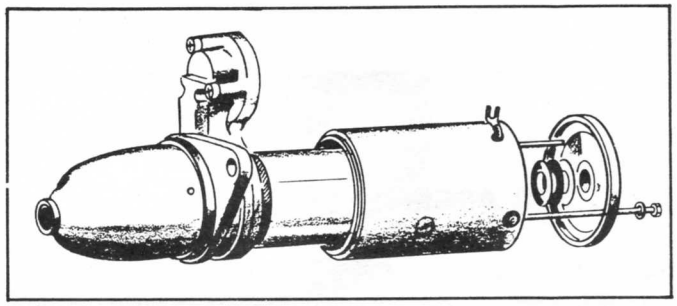


FIGURE 54. REMOVING THROUGH-BOLTS

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

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.

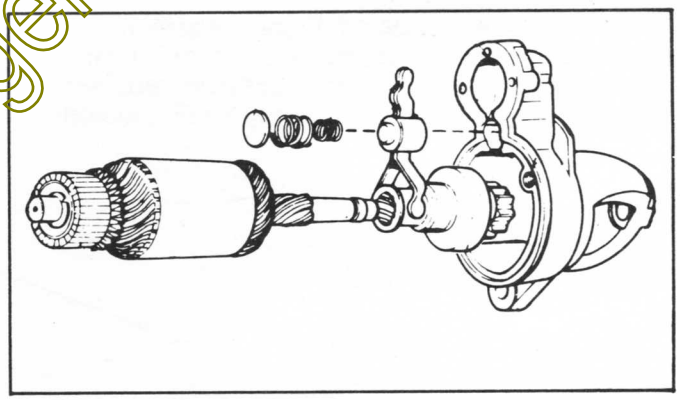


FIGURE 55. REMOVING ARMATURE

4. Remove the ring after driving the pinion stopper toward the pinion gear using a cylindrical tool as shown in Figure 56. 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.

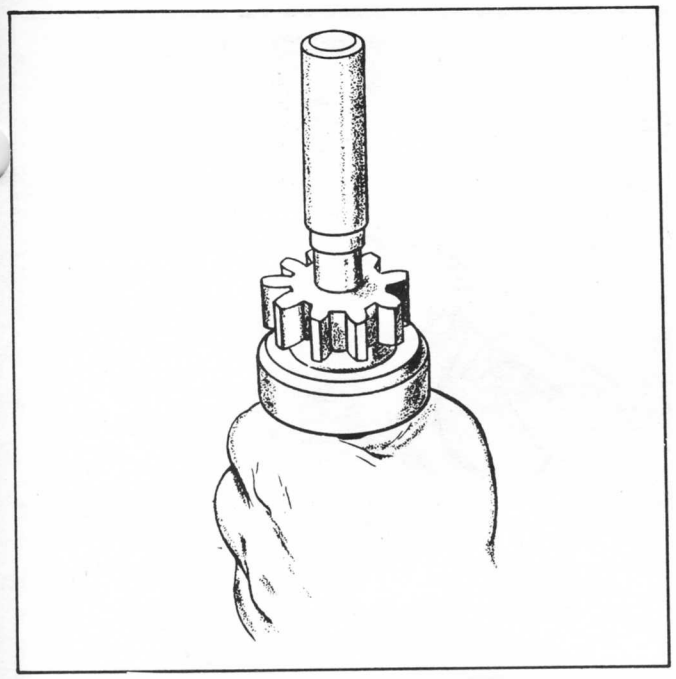


FIGURE 56. REMOVING RING

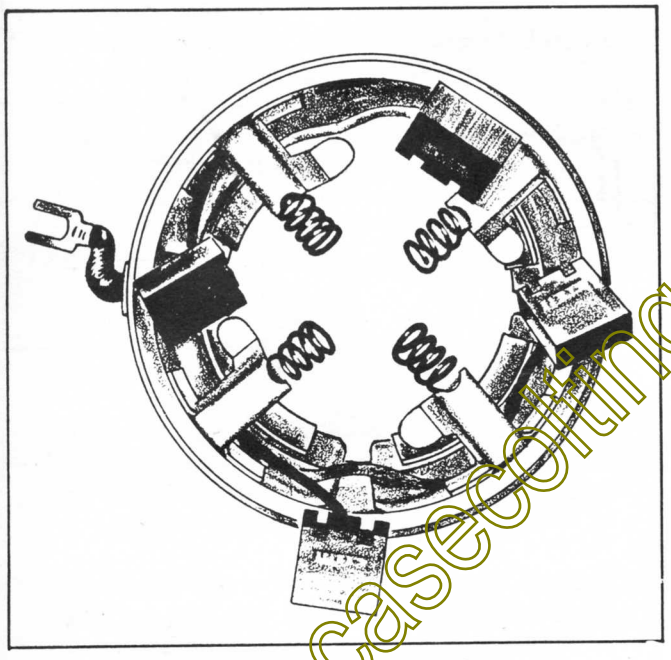


FIGURE 57. BRUSHES

STARTER 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:

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

IMPORTANT: Do not use steam or high pressure water to clean the starter.

NOTE: (A) 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. (B) Do not immerse overrunning clutch in cleaning solvent. (C) Thoroughly dry any parts that have come into contact with the cleaning fluid.

2. Apply SAE 20 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 58 and pull the pinion stopper up.

4. Use spacing washers to adjust the armature to give end play of .004" to .020" (0.10 to 0.5 mm).

5. Tighten the thru bolts to a torque of 35 to 44 in.-lbs. (4 to 5 Nm).

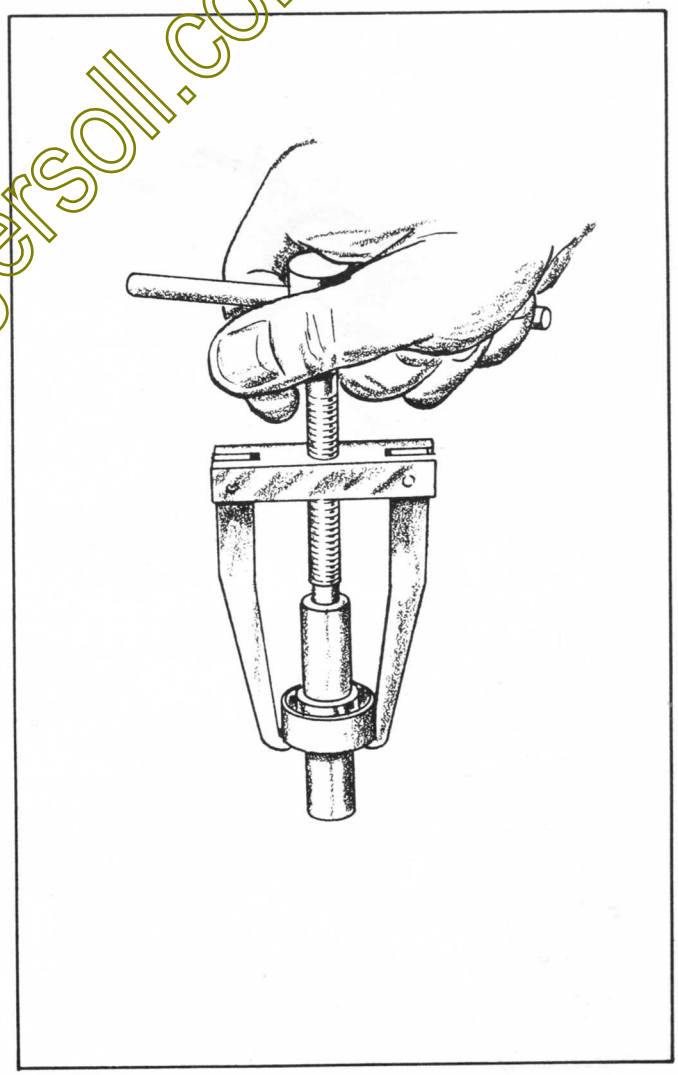


FIGURE 58. MOUNTING OVERRUNING CLUTCH

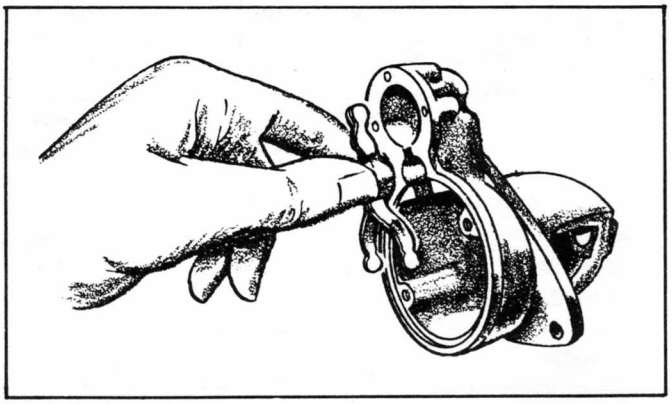


FIGURE 59. INSTALLING SHIFT LEVER

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.

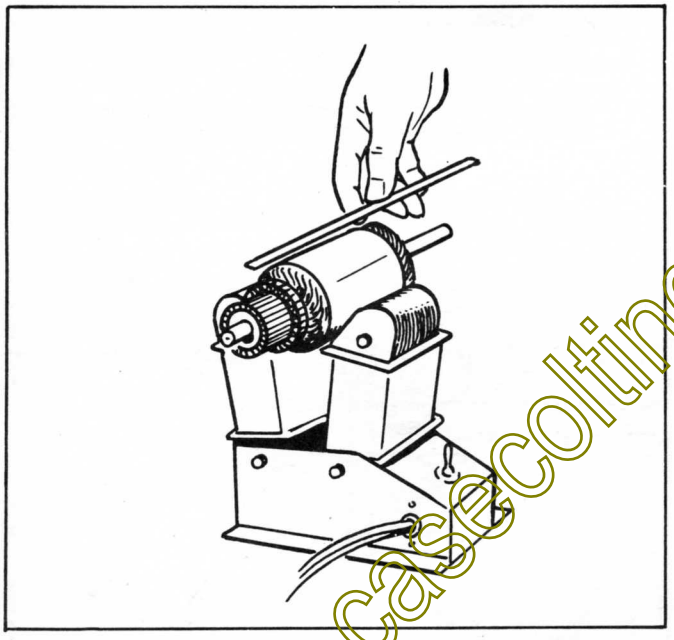


FIGURE 60. TESTING ARMATURE FOR SHORT CIRCUITS

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.

3. **Testing Armature for Open Circuits:** The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections.

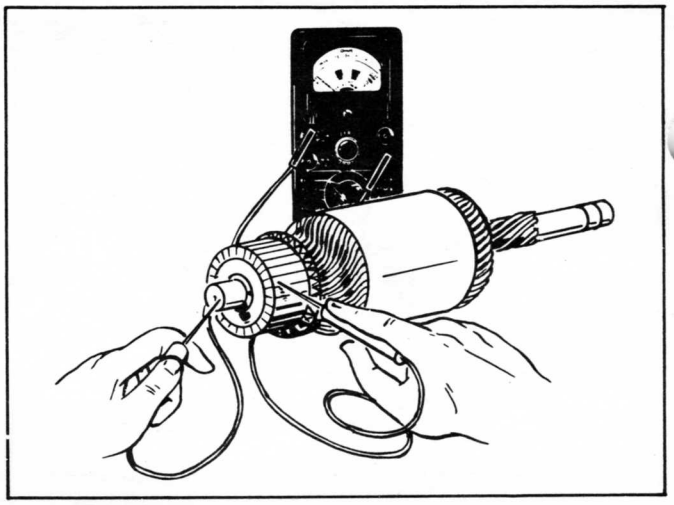


FIGURE 61. TESTING ARMATURE FOR GROUNDS

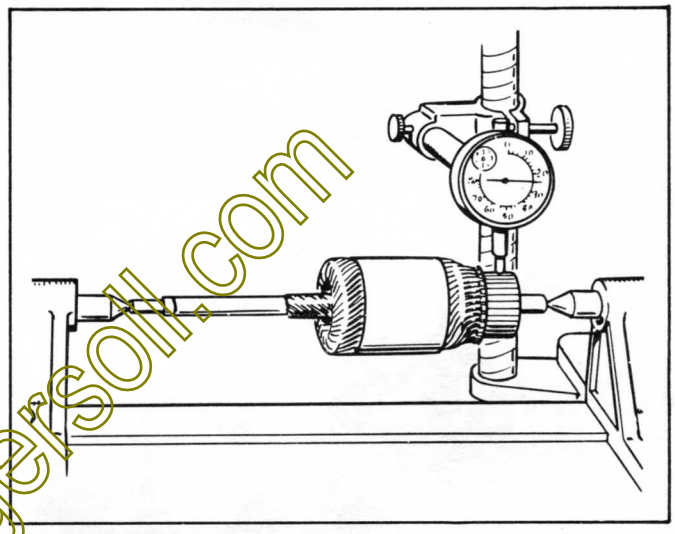


FIGURE 62. TESTING COMMUTATOR RUNOUT

4. **Testing Commutator Runout:** Place armature in a test bench and check runout with a dial indicator. When commutator runout exceeds .004", (0.10 mm) commutator should be refaced.

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.

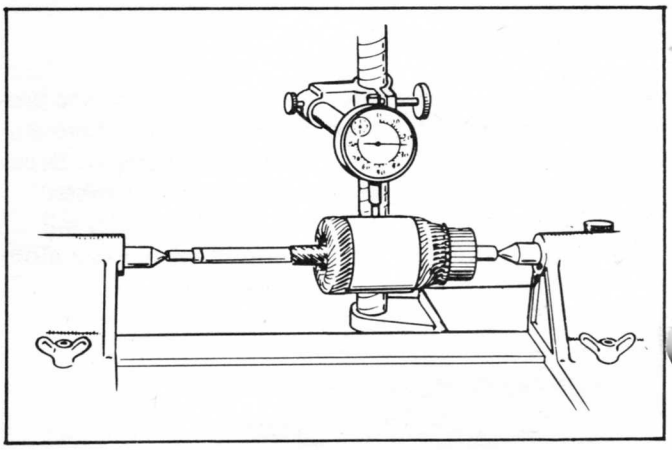


FIGURE 63. TESTING ARMATURE RUNOUT

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.

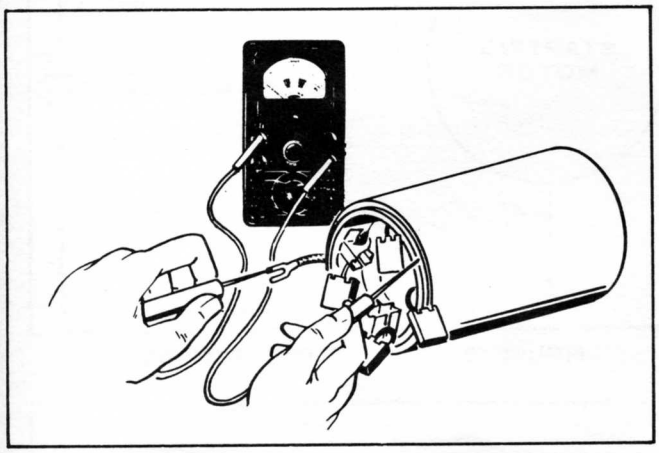


FIGURE 64. TESTING FIELD COILS FOR GROUNDS

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.

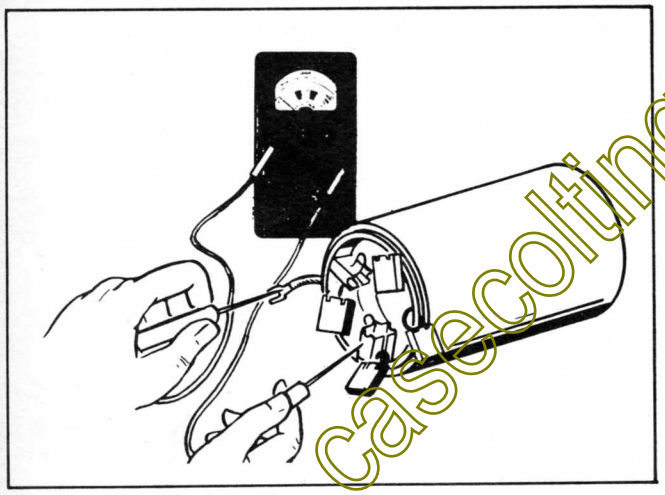


FIGURE 65. TESTING FIELD COILS FOR OPENS

8. **Inspection of Brushes:** When brushes are worn more than .3" (7.6 mm) they are to be replaced. Figure 66 shows the wear limit. See that the brushes move smoothly in the brushholders.

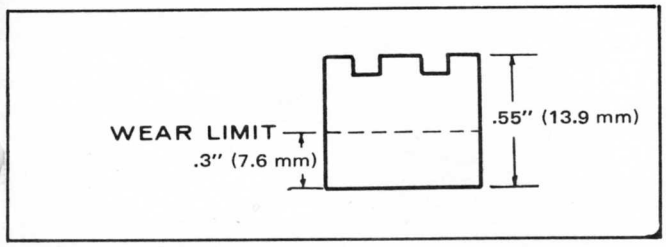


FIGURE 66. BRUSH WEAR LIMIT

9. **Inspection for Brush Spring Tension:** Measure brush spring tension with a tension meter as shown in Figure 67. 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.(8 to 10 N).

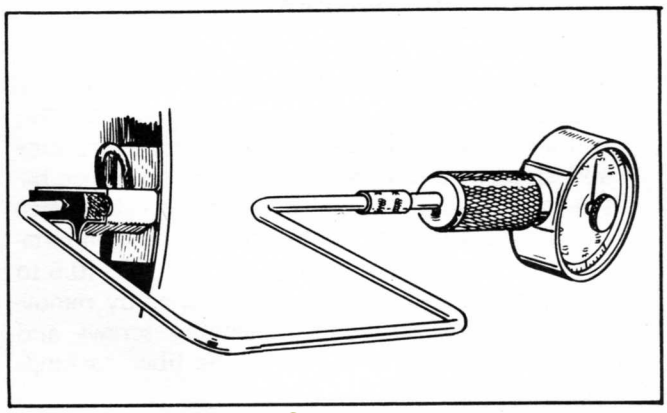


FIGURE 67. TESTING BRUSH SPRING TENSION

INSPECTION AFTER OVERHAUL

1. For no load test, the starting motor is wired as shown in Figure 68 and run. The value of the meter reading at this condition should be as follows:

Voltage	11.5 Volt
RPM	3700
Current Draw	60 A Max.

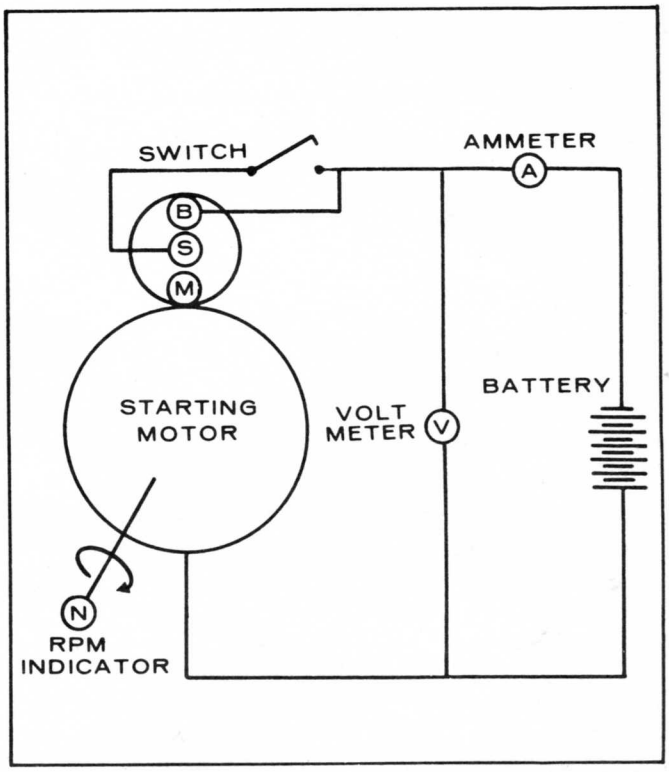


FIGURE 68. STARTER MOTOR WIRING

NOTE: The conductor for this test should be large enough and as short as possible. If anything is wrong in the previous 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**

2. To adjust pinion clearance, connect the battery to the starting motor as shown in Figure 69. 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 stop when the pinion is pushed lightly toward the commutator end. Clearance should be .02" to .06" (0.5 to 1.5 mm). Adjust for proper clearance by removing the magnetic switch attaching screws and select the proper thickness of the fiber packings shown in Figure 70.

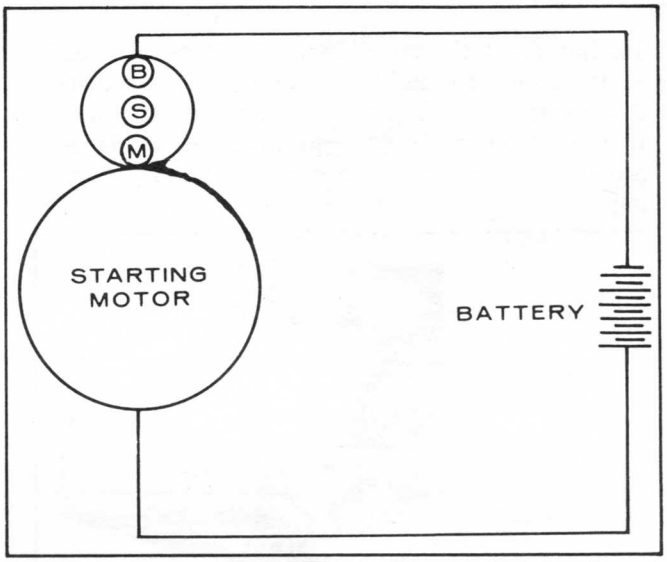


FIGURE 69. BATTERY CONNECTIONS

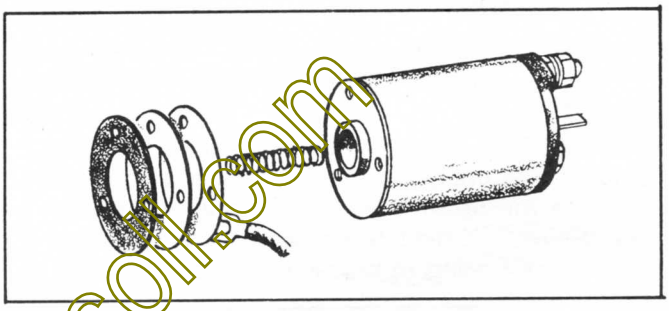


FIGURE 70. ADJUSTING PINION CLEARANCE

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