

TECUMSEH

TECHNICIAN'S HANDBOOK

This manual covers VLV40 - 675.

Other illustrated Tecumseh 2-Cycle Engine, 4-Cycle Engine and Transmission manuals; booklets; and wall charts are available through Tecumseh.

For complete listing write or call

VLV (VECTOR) 4-CYCLE ENGINES



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Chapter 1

GENERAL INFORMATION

ENGINE IDENTIFICATION

Tecumseh engine model, specification and serial numbers are stamped or decaled on the blower housing. The decal also contains any emission compliance information.

The letters which precede the model numbers indicate the basic type of engine:

VLV - Vector Lightweight Vertical

The numbers which follow engine type letters indicate the basic engine horsepower:

40 - 4.0 Horsepower

50 - 5.0 Horsepower

Following the engine size numbers are the engine specifications numbers.

The specification number is used when identifying engine parts example 502012A.

The serial number is the production date code.

7040 - serial number (example)

7 - Year in decade of manufacture (1997)

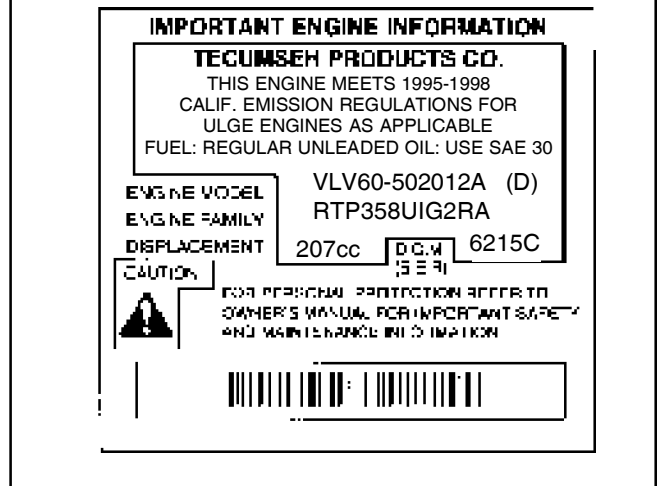
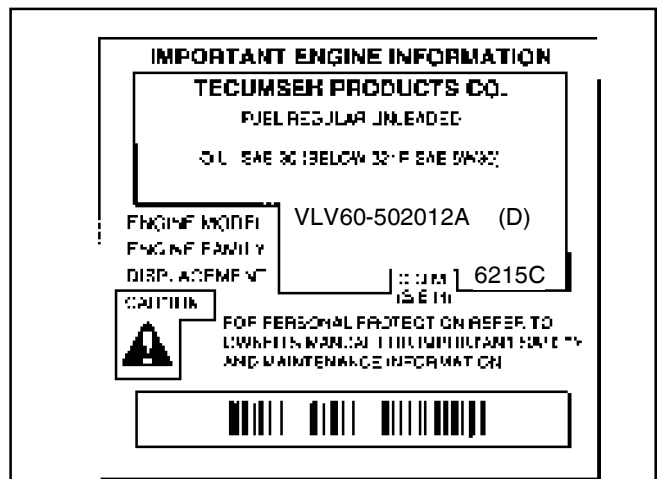
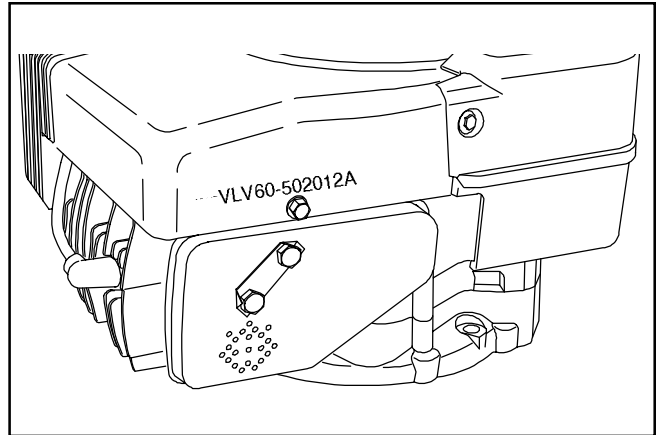
40 - The last 3 digits of date code represent the calendar (the 40th day of 1997)

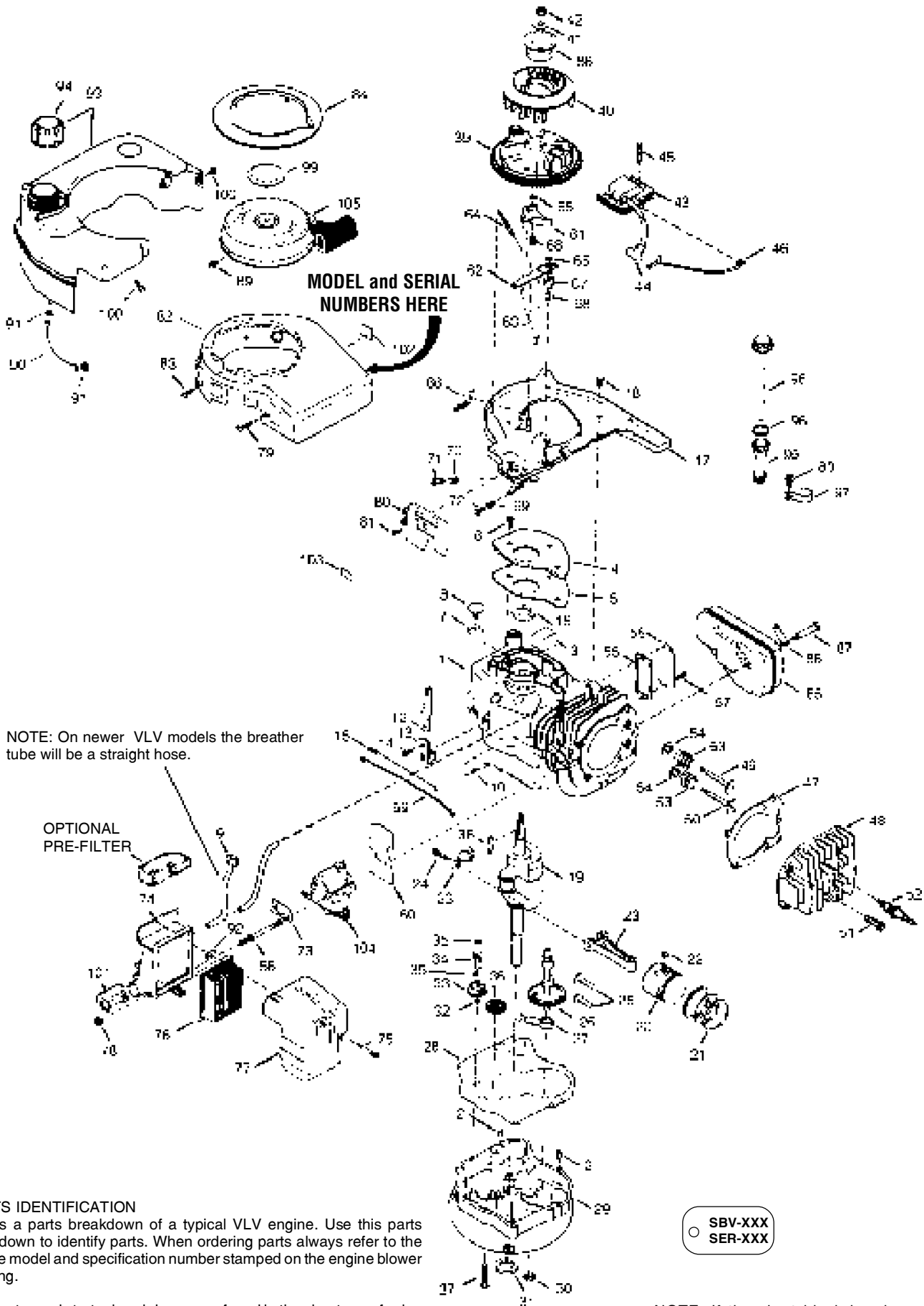
D - represents the shift and line on which the engine was built at the factory.

Emissionized engines that meet the California Air Resource Board (C.A.R.B.) or the Environmental Protection Agency (E.P.A.) standards will include additional required engine information on the engine decal.

NOTE: To maintain best possible emission performance, use only Genuine Tecumseh Parts.

SHORT BLOCKS. New short blocks are identified by a tag marked SBH (Short Block Horizontal) or SBV (Short Block Vertical). These tags are used to properly identify the correct parts if service is required. They are attached to either the sump bolts or valve box cover.





**MODEL and SERIAL
NUMBERS HERE**

NOTE: On newer VLV models the breather tube will be a straight hose.

**OPTIONAL
PRE-FILTER**

PARTS IDENTIFICATION

This is a parts breakdown of a typical VLV engine. Use this parts breakdown to identify parts. When ordering parts always refer to the engine model and specification number stamped on the engine blower housing.

Carburetor and starter breakdowns are found in the chapters referring to their repair.

SBV-XXX
SER-XXX

NOTE: If the short block has been replaced, an identification tag for service parts is located on the valve box cover.

Ref. No.	Part Name	Ref. No.	Part Name
1	Cylinder Assy.	54	Cap, Valve spring
2	Pin, Dowel	55	Gasket, Valve cover
3	Element, Breather	56	Cover, Valve spring box
4	Cover, Breather	57	Screw, 10-24 x 1/2
5	Gasket, Breather cover	58	Stud, Carburetor mounting
6	Screw, Thread forming, 10-24 x 1/2	59	Link, Governor
7	Body, Breather valve	60	Spacer, Carburetor mounting gasket
8	Valve, Breather check	61	Lever Assy., Brake
9	Breather, Tube	62	Lever, Brake control
10	Washer, Flat	63	Link, Brake control lever
11	Rod, Governor	64	Spring, Brake
12	Lever, Governor	65	Ring, Retaining
13	Clamp, Governor lever	66	Terminal
14	Screw, 8-32 x 5/16	67	Spring, Brake control lever
15	Spring, Governor extension	68	Bushing, Brake control lever & brake lever
16	Seal, Oil	69	Spring, Compression
17	Baffle, Blower housing (Incl. No. 195)	70	Spring, Compression
18	Screw, 1/4-20 x 5/8	71	Screw, 5-40 x 7/16
19	Crankshaft Assy.	72	Screw, 6-32 x 21/32
20	Piston & Pin Assy.	73	Gasket, Carburetor to air cleaner
21	Ring Set, Piston	74	Body, Air cleaner (Incl. Nos. 239, 299 & 350)
22	Ring, Piston pin retaining	75	Screw, 10-32 x 2-3/32
23	Rod Assy., Connecting	76	Filter, Air cleaner (Paper)
24	Bolt, Connecting rod	77	Cover, Air cleaner
25	Lifter, Valve	78	Nut, Lock, 1/4-20
26	Camshaft Assy.	79	Screw, 1/4-20 x 11/16
27	Pump Assy., Oil	80	Plate, Control Assy., cover
28	Gasket, Mounting flange	81	Screw, 8-32 x 1/2
29	Flange, Mounting	82	Housing, Blower
30	Plug, Oil drain	83	Screw, 1/4-20 x 1/2
31	Seal, Oil	84	Ring, Starter
32	Washer, Flat	85	Muffler
33	Gear Assy., Governor	86	Plate, Muffler locking
34	Spool, Governor	87	Screw, 5/16-18 x 2-11/32
35	Ring, Retaining	88	Cup, Starter
36	Gear, Idler	89	Screw, 8-32 x 21/64
37	Screw, 1/4-20 x 1-9/16	90	Line, Fuel
38	Key, Flywheel	91	Clamp, Fuel line
39	Flywheel	92	Clip, "U" Type Nut, 10-32
40	Fan, Flywheel	93	Tank Assy., Fuel
41	Washer, Belleville	94	Cap, Fuel
42	Nut, Flywheel	95	Tube, Oil fill
43	Solid State Assy.	96	"O" Ring
44	Cover, Spark plug	97	Clip, Fill tube
45	Screw, 10-24 x 1	98	Dipstick, Oil
46	Wire Assy., Ground	99	Plug, Starter
47	Gasket, Cylinder head	100	Screw, 10-32 x 35/64
48	Head, Cylinder	101	Primer
49	Valve, Exhaust	102	Decal, Instruction
50	Valve, Intake	103	Decal, Primer
51	Screw, 5/16-18 x 1-1/2	104	Carburetor
52	Spark Plug (Champion RJ-19LM or equivalent)	105	Starter, Rewind
53	Spring, Valve		

ENGINE CARE

FUELS. Tecumseh Products Company strongly recommends the use of fresh, clean, UNLEADED regular gasoline in all Tecumseh engines. Unleaded gasoline burns cleaner, extends engine life and promotes good starting by reducing the build-up of combustion chamber deposits. Gasoline, gasohol containing no more than 10% ethanol, 15% M.T.B.E. or ETBE, leaded fuel can be used if regular unleaded is not available.

Never use gasoline containing METHANOL, gasohol containing more than 10% ethanol, gasoline additives, or white gas because engine/fuel system damage could result. If engine is to be unused for 30 days or more see "STORAGE" instructions.

ENGINE OIL:

USE A CLEAN, HIGH QUALITY DETERGENT OIL. Be sure original container is marked: A.P.I. service "SF" or "SG".

DO NOT USE SAE 10W40 OIL.

FOR SUMMER (ABOVE 32°F) USE SAE 30 OIL.

Using multigrade oil may increase oil consumption.

FOR WINTER (BELOW 32°F) USE SAE 5W30 OIL.
(SAE 10W is an acceptable substitute.)

(BELOW 0°F ONLY): SAE 0W30 is an acceptable substitute.

OIL CHANGE INTERVALS. Change oil after first two (2) hours of operation and every 25 hours thereafter, or more often if operated under dusty or dirty conditions.

OIL CHECK. Check oil every 5 hours or each time the equipment is used. Position equipment so the engine is level when checking the oil.

STORAGE



NEVER STORE ENGINE WITH FUEL IN TANK INDOORS OR IN ENCLOSED, POORLY VENTILATED ENCLOSURES, WHERE FUEL FUMES MAY REACH AN OPEN FLAME, SPARK OR PILOT LIGHT AS ON A FURNACE, WATER HEATER, CLOTHES DRYER OR OTHER GAS APPLIANCE.

If engine is to be unused for 30 days or more, prepare as follows:



DRAIN INTO APPROVED CONTAINER OUTDOORS, AWAY FROM OPEN FLAME.

1. DRAIN FUEL SYSTEM:

Remove all gasoline from carburetor and fuel tank to prevent gum deposits from forming on these parts and causing possible malfunction of engine.

NOTE: VLV engines are equipped with a bowl drain screw. See Chapter 2 for removal procedure.

- A. Run engine until fuel tank is empty and engine stops due to lack of fuel.
- B. Disconnect fuel line at carburetor or fuel tank. Be very careful not to damage fuel line, fittings or fuel tank.

Drain any remaining fuel from system. Properly reconnect the fuel line.

NOTE: If gasohol has been used, complete preceding instructions "A" and "B" and then put a small amount of unleaded (or leaded regular) gasoline into fuel tank and repeat preceding instructions "A" and "B".

NOTE: Fuel stabilizer (such as STA-BIL) is an acceptable alternative in minimizing the formation of fuel gum deposits during storage. Add stabilizer to gasoline in fuel tank or storage container. Always follow mix ratio found on stabilizer container. Run engine at least 10 minutes after adding stabilizer to allow it to reach carburetor.

2. If oil has not been changed recently, this may be a good time to do it. See "CHANGE OIL" instructions in "MAINTENANCE" section of the Owner's Manual.
3. Remove spark plug and put 1/2 oz. (15 ml) of clean engine oil into spark plug hole. Crank engine over, slowly, several times.



AVOID SPRAY FROM SPARK PLUG HOLE WHEN CRANKING ENGINE OVER SLOWLY.

Reinstall spark plug.

4. Clean engine by removing any clippings, dirt, or chaff from exterior of engine.

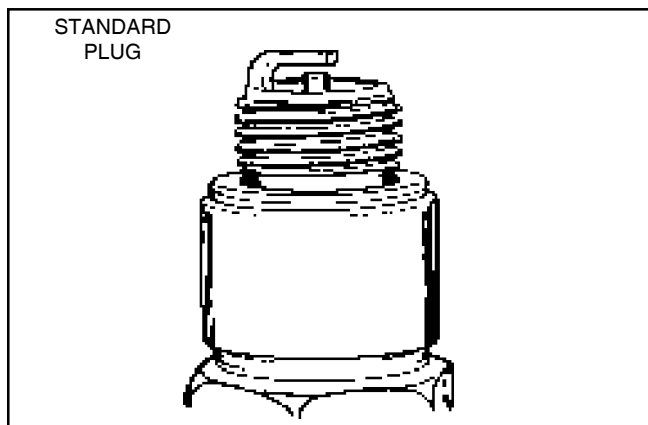
TUNE-UP PROCEDURE



CAUTION: Remove spark plug wire before doing any service work on engine.

1. Service or replace air cleaner as necessary. (See Chapter 2 Air Cleaners)
2. Inspect level and condition of oil, change or add oil as required.
3. Remove blower housing, clean all dirt, grass or debris from intake screen, head and cylinder cooling fins and carburetor governor levers and linkage.
4. Make sure fuel tank, fuel filters and fuel lines are clean. Replace any worn or damaged governor springs or linkage. Make proper governor adjustments where required. (See Chapter 3)

NOTE: If the engine is equipped with a Tecumseh fuel tank, an integral filter is molded inside.



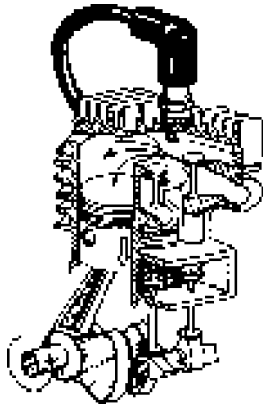
5. Replace the spark plug with the proper spark plug. Consult the parts breakdown for the spark plug to be used in the engine being serviced. The spark plug air gap is .030". Install spark plug in engine and tighten to 15 foot pounds torque. If a torque wrench isn't available, screw spark plug in as far as possible, by hand, and use a spark plug wrench to turn spark plug 1/8 to 1/4 turn further when reusing spark plug, or 1/2 turn further if using a new spark plug.
6. Make sure all ignition wires are free of abrasions, breaks and are properly routed so they will not rub on flywheel.
7. Properly reinstall the blower housing, gas tank, and fuel lines, then properly check for spark as stated in the ignition section of this manual.
8. Make sure all cables are adjusted for proper operation.

9. Run engine and allow it to warm up for 5 minutes. After the engine is warm, set the engine governed RPM to specifications. This information is located only on Micro Fiche Card 30 or the Plus One and Parts Smart computer look-up systems.

4-CYCLE ENGINE THEORY

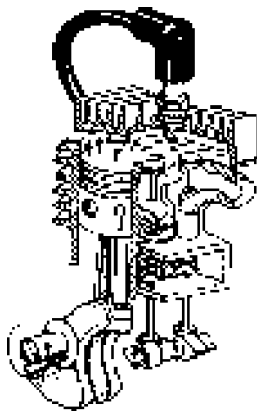
Tecumseh four-cycle engines require four strokes or cycles to complete one power cycle.

1. INTAKE. Intake valve is open, exhaust valve is closed. Piston is traveling downward creating a suction action, drawing the fuel-air mixture from the carburetor into the cylinder area above the piston.



1. INTAKE

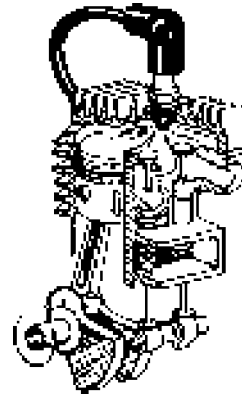
2. COMPRESSION. As the piston reaches Bottom Dead Center, the INTAKE valve closes. The piston then rises, compressing the fuel and air mixture trapped in the combustion chamber, because both valves are closed.



2. COMPRESSION

NOTE: Some emission compliance engines may use a RCR (Ramp Compression Relief) system. This system opens the intake valve during the compression stroke allowing a small amount of the intake charge back down the intake pipe. This eliminates unburned fuel going out the exhaust during normal compression relief cycle typically used on the exhaust valve.

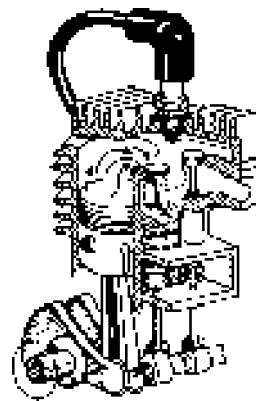
3. POWER. Both valves remain closed. As the piston reaches the Before Top Dead Center (BTDC) ignition point, the spark plug fires, igniting the fuel-air mixture. In the time it takes to ignite all the available fuel, the piston has moved to TDC (Top Dead Center), ready to take the full combusive force of the fuel for maximum power and piston downward travel. The expanding gases force the piston down.



3. POWER

4. EXHAUST. Exhaust valve opens. As the piston starts to the top of the cylinder, the exhaust gases are forced out.

After the piston reaches Top Dead Center (TDC), the four cycle process will begin again as the piston moves downward and the intake valve opens.



4. EXHAUST

Chapter 2

AIR CLEANERS

CAUTION: Before removing air cleaner, make sure ALL excess dirt is removed from around it.

NOTE: If the engine is equipped with an optional poly pre-filter always remove it first, to prevent dirt falling into the filter body.

Air cleaners must be serviced frequently, to prevent dust and dirt from entering the engine. Dust mixed with the engine oil forms an extremely abrasive compound which quickly wears out an engine.

A clogged air cleaner will affect engine performance.

Replacing a restricted (clogged) air filter should restore engine performance.

AIR CLEANER SERVICE. The engine utilizes a treated paper element with a foam rubber-like sealing edge. The seal must fit properly to prevent dirt ingestion.

Replace air filter once a year or more often in extremely dusty or dirty conditions.

DO NOT ATTEMPT TO CLEAN OR OIL THE PAPER FILTER.

Be sure to clean base and cover thoroughly before installing new paper filter.

NEVER RUN THE ENGINE WITHOUT THE COMPLETE AIR CLEANER INSTALLED ON THE ENGINE.

NOTE: Serious damage to the engine may result from using any other but the specified part number filter. Use factory recommended parts only.

Some models use a dual stage air cleaner. This air cleaner uses a polyurethane-type foam pre-filter along with the paper element.

POLYURETHANE-TYPE PRE-FILTERS. These serviceable air filters utilize a polyurethane element which will clog up with use. The element should be cleaned and serviced in the following manner.

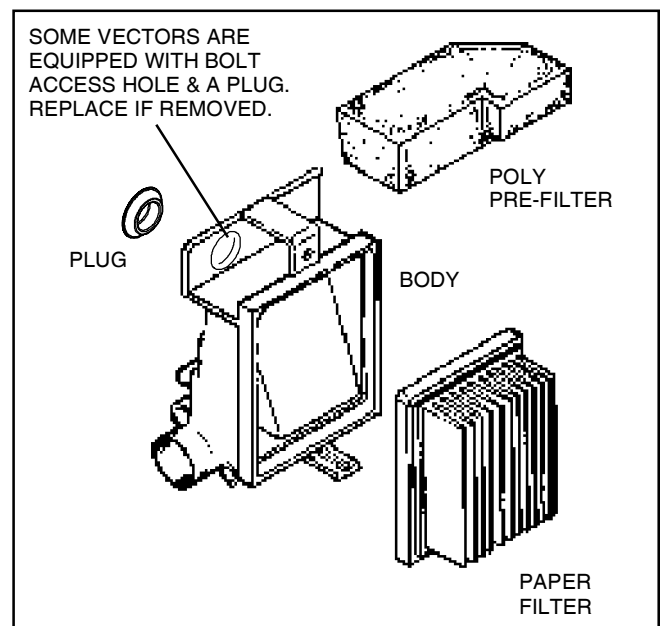
Wash element in a detergent and water solution and squeeze (don't twist) until all dirt is removed. Rinse thoroughly.

Wrap in a clean cloth and squeeze (don't twist) until completely dry.

Re-oil element by applying a generous quantity of oil to all sides. Squeeze vigorously to distribute oil and to remove excess oil.

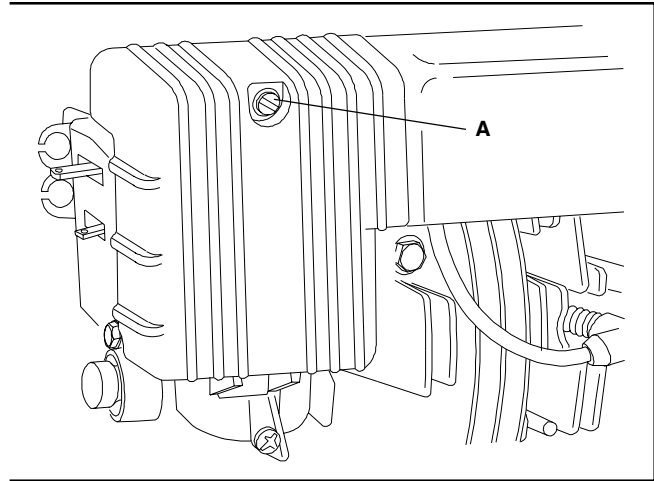
Clean air cleaner housing and cover. Dry thoroughly.

Reinstall pre-cleaner in air filter body.

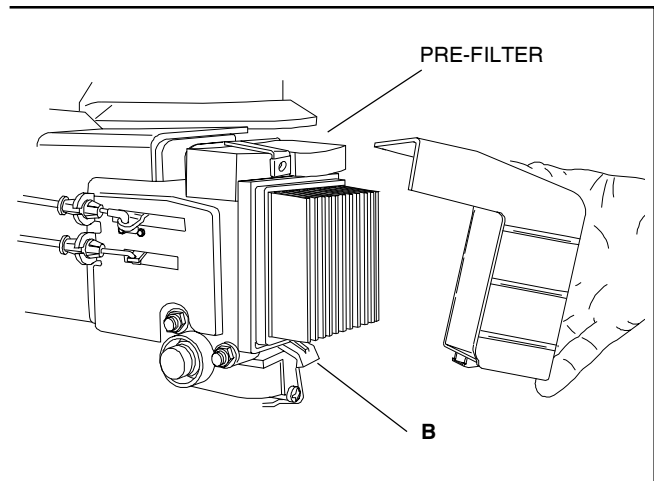


TO SERVICE AIR CLEANER

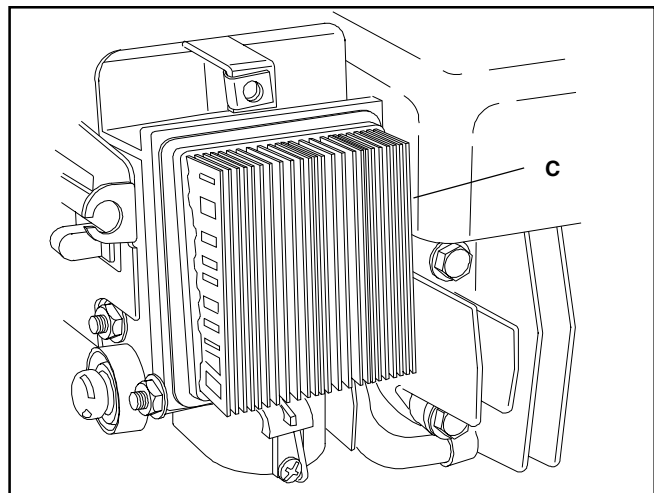
1. Loosen cover screw (A).



2. Swing cover down and remove from hinge (B).
3. Pull foam pre-filter out of air cleaner body (if equipped with pre-filter).
4. Pull air filter out of air cleaner body.
5. Clean air cleaner cover and body.



6. Install a new paper filter (part no. 36046) (C).
7. Clean and install pre-filter (if so equipped).
8. Reinstall cover to air cleaner body.
Be sure hinge is assembled properly.
9. Swing cover up and tighten cover screw. (Do not over tighten).



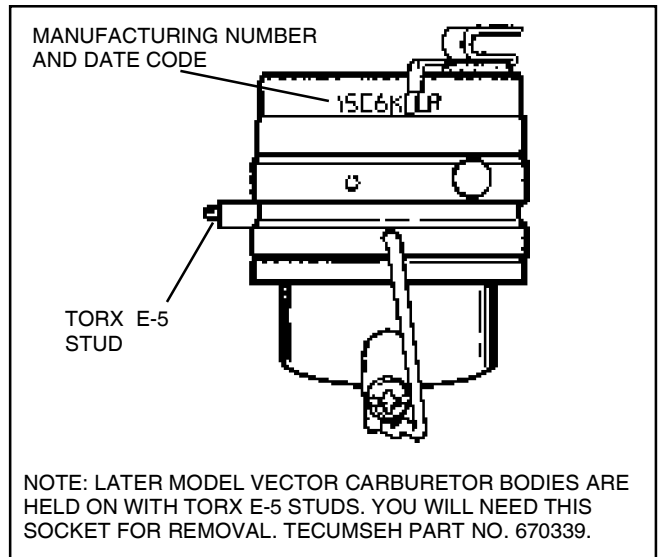
CARBURETION

Proper Carburetion Function is dependent on clean fresh fuel and a well maintained air cleaner system. Most causes of carburetion problems are directly related to stale fuel and dirt ingestion. Inspection of the carburetor for dirt wear and fuel deposits should always be done before servicing the carburetor.

Carburetor Identification:

Tecumseh carburetors are identified by a manufacturing number and date code stamped on the carburetor as shown. When servicing carburetors, use the engine model number or the manufacturing number on the carburetor to find repair parts in the Master Parts Manual.

The engine has used both a split system and married system carburetor. Below are the parts breakdowns for the two carburetor's.



SPLIT

Ref. No.	Part Name
1	Throttle Shaft & Lever Assy.
5	Dust Seal (Throttle)
6	Throttle Shutter
7	Throttle Shutter Screw
25	Float Bowl
25A	Idle Restrictor
26	Float
27	Shaft, Float
29	Gasket, Float Bowl to Body
* 30	Inlet Needle, Seat & Seat Retainer (Incl. 31)
* 31	Seat Retainer
32	Bowl Drain Assy.
36	Tube, Main Nozzle
37	O Ring, Main Nozzle Tube
38	Spring, Main Nozzle Tube
39	Float Bowl Retainer
47	Welch Plug, Idle Mixture Well

MARRIED

Ref. No.	Part Name
1	Throttle Shaft & Lever Assy.
5	Dust Seal
6	Throttle Shutter
7	Throttle Shutter Screw
25	Float Bowl
25A	Idle Restrictor
26	Float
27	Float Shaft
29	Gasket, Float Bowl to Body
* 30	Inlet Needle, Seat & Seat Retainer (Incl. 31)
* 31	Seat Retainer
32	Bowl Drain Screw
33	Bowl Drain Washer
36	Tube, Main Nozzle
37	O Ring, Main Nozzle Tube
37A	O Ring
38	Spring, Main Nozzle Tube
38A	Spring
39	Float Bowl Retainer
40	Main Fuel Jet
47	Welch Plug, Idle Mixture Well

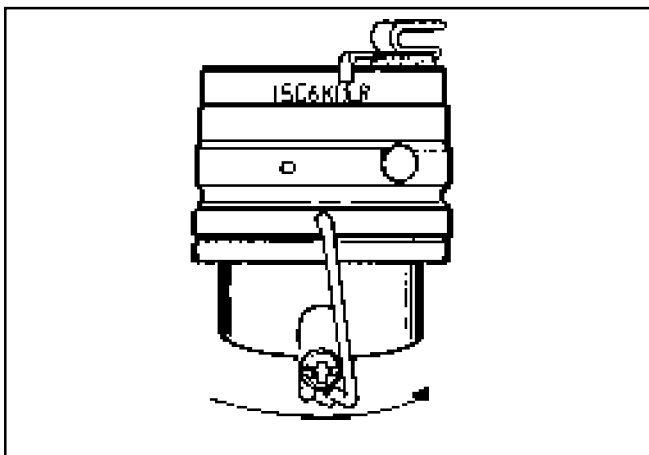
* NOTE: The seat retainer may not be present on some engines. If you receive a retainer as a service part, install it.

The carburetor is a float feed, nonadjustable type, with a 1 piece extruded aluminum body. The float bowl, float, nozzle, and venturi are nonmetallic, minimizing the corrosion and varnishing problems. Common service areas of the carburetor are contained in the fuel bowl. These areas are the float, needle, seat and main nozzle. All of these parts can be serviced without removing the carburetor body from the engine.

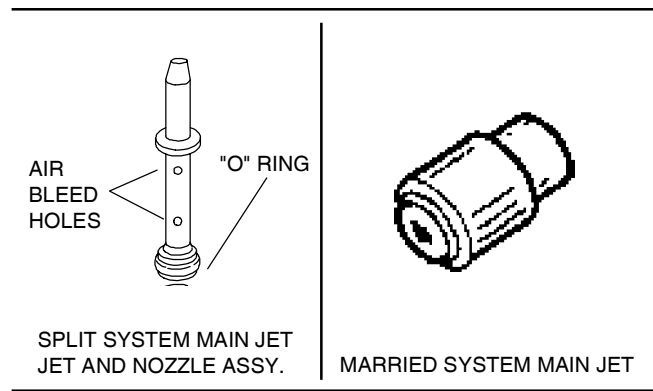
⚠️ DRAIN INTO APPROVED CONTAINER OUTDOORS, AWAY FROM OPEN FLAME.

FLOAT BOWL SERVICE. Disconnect and plug the fuel line. Remove the bowl drain screw. Remove the float bowl by snapping the bale spring towards the throttle end of the carburetor.

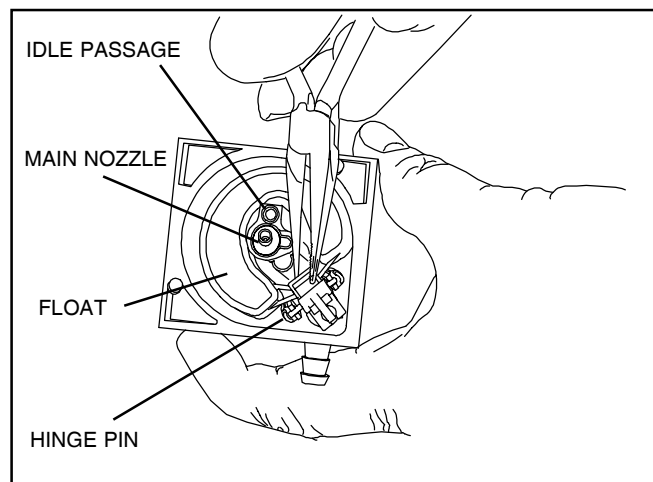
IF A SCREW DRIVER OR SIMILAR TOOL IS USED TO AID IN THE BAIL REMOVAL, CARE MUST BE TAKEN NOT TO PERMANENTLY BEND THE RETAINER.



After the bowl gasket is removed, the parts contained in the bowl can be inspected and serviced. Pull out the main nozzle and spring. Inspect the main nozzle for deposits, be sure to check the cross holes on the body of the nozzle and the main orifice in the bottom of the nozzle. Use compressed air or monofilament fishing line to remove any deposits in the main jet or cross holes. Remove the drain screw to access the spring, jet and "O" ring. The main jet should be inspected and cleaned if deposits exist.

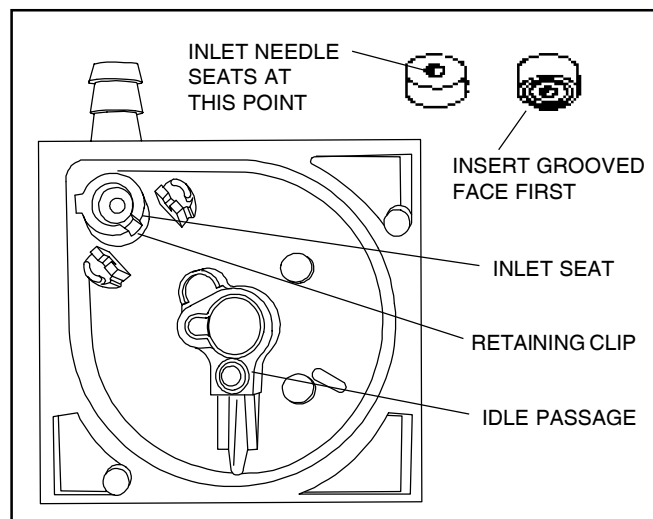


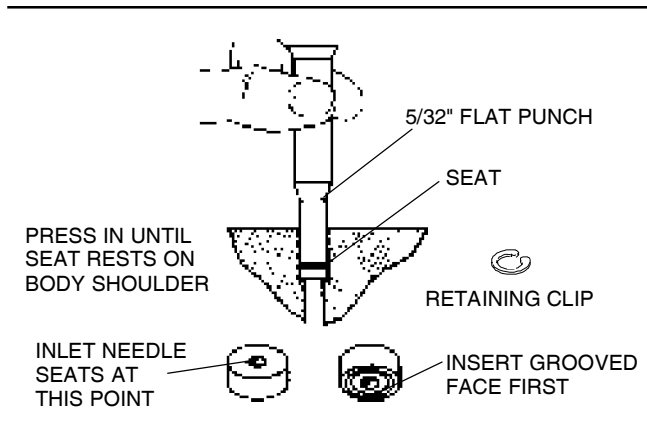
The float is held in the float bowl by the float pin which is pressed into tabs on top of the float support towers. **NOTE:** To prevent damage to the float bowl, pull straight up with a needle nose pliers in the pocket closest to the main fuel well. Carefully lift the float out of the float bowl and inspect for damage or deposits. Clean the idle passageway with compressed air, or with tag wire.



NOTE: The inlet needle is attached to the float and should also be inspected for damage or deposits.

The inlet seat can be removed with a small wire hook or a #2 crochet hook. Inspect the float bowl and main nozzle area for sediment and deposits. Use a carburetor cleaner to loosen and remove deposits and sediment.





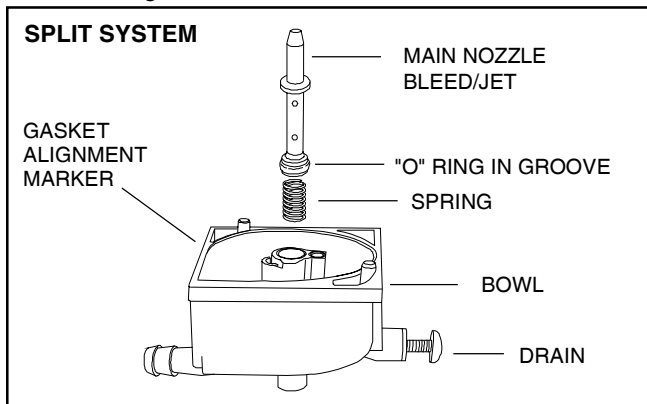
Install a new inlet seat into the float bowl. The grooved side of the inlet seat goes into the float bowl first. Place a drop of oil on the seat and press it in with a flat punch until it seats. Do not scratch the inlet bore.

NOTE: Some models are equipped with a fuel inlet seat retaining ring. If your replacement seat set comes with a retaining clip install it on top of the seat.

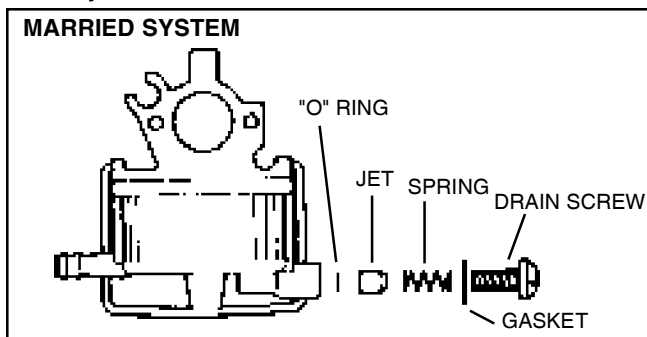
Slide the inlet needle into the tabs on the float and put the float pin into the hinge on the float. Carefully set the float into position in the float bowl.

Be sure the needle drops into the fuel inlet. Snap the float shaft into the tabs in the float bowl. It is not necessary to adjust the float height even if the float has been replaced.

Drop the main nozzle spring into the main nozzle well in the float bowl. Put a small amount of oil on the main nozzle "O" ring and push the nozzle into the main nozzle well, "O" ring end first.



In addition to this, the married system carburetor has the "O" ring, main jet, and spring located behind the drain system.



Place a new gasket on top of the float bowl with the notch on the gasket aligned with the bump on the bowl edge (the gasket will only fit onto the float bowl one way.) Hold the float bowl to the carburetor body and snap the retainer into position. Reinstall the bowl drain screw, do not over tighten, reattach the fuel line.

NOTE: Bowl service is all that is normally required for routine carburetor maintenance.

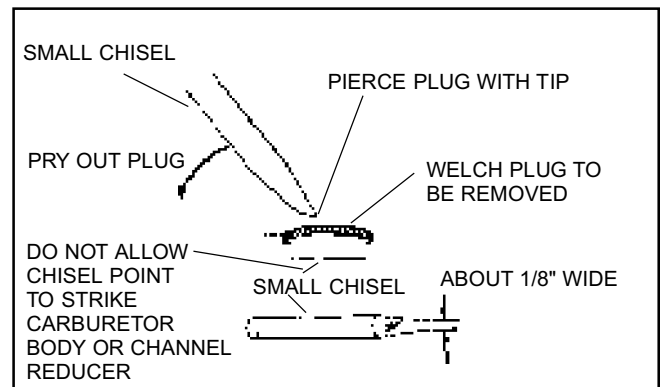
Rebuilding the carburetor body:

Before disassembling the carburetor body, check the throttle shaft and body for excessive wear. If there is excessive wear to the throttle body, it should be replaced.

To rebuild the carburetor body it is necessary to remove the carburetor from the engine.

1. Remove the speed control plate.
2. Remove the air cleaner body from the carburetor.
3. Disconnect and plug the fuel line.
4. Remove the carburetor mounting studs.
5. Remove the governor link.
6. Drain the carburetor float bowl.
7. Disassemble the float bowl (see bowl service).

To properly clean the carburetor body, the welch plugs should be removed to expose drilled passages. To remove welch plug, sharpen a small chisel to a sharp wedge point. Drive the chisel into the welch plug, push down on chisel and pry plug out of position.



After the welch plug is removed from the carburetor it can be soaked in a commercial carburetor cleaner no longer than 30 minutes. Be sure to follow the directions on the container.

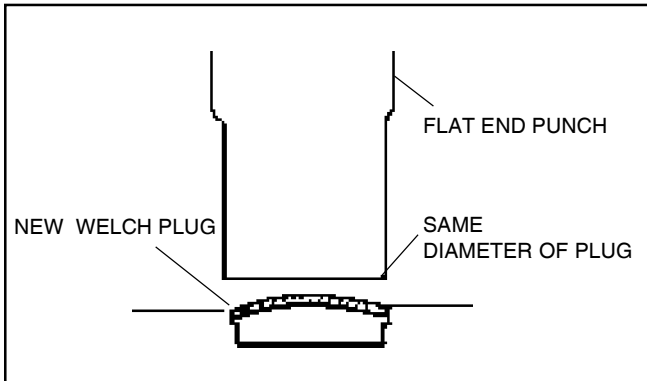
NOTE: Always pull the non metallic slip in venture out before soaking in carburetor cleaner.

Reinstall the venture using the main nozzle to align it correctly. The air bleed passages face the air filter.

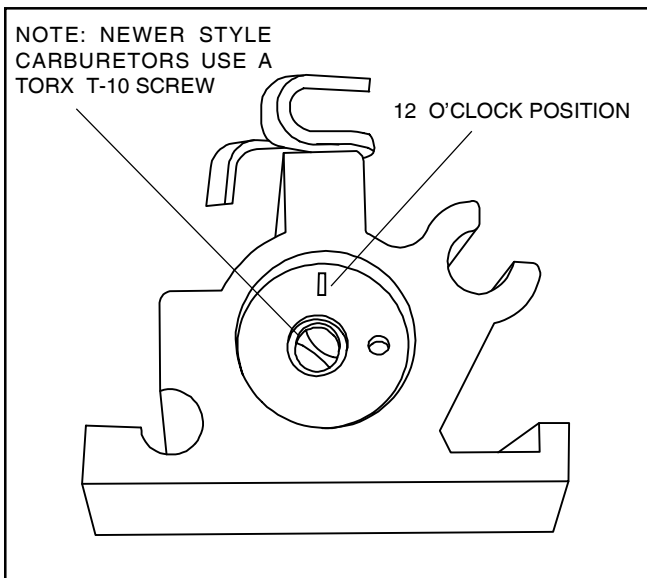
After the carburetor has been soaked, all passages may be probed with monofilament fishing line and compressed air to open plugged or restricted passages.

Install a new welch plug over the idle fuel chamber with the raised portion up. Use a punch equal to the size of the plug, to flatten the plug. Do not dent or drive the center of the plug below the top surface of the carburetor.

NOTE: To insure a good seal on this plug, we recommend coating the seam with nail polish which is gas resistant.



Install the throttle shaft and shutter (use a new shutter screw and dust seal). The scribe mark on the shutter must be in the 12 o'clock position.

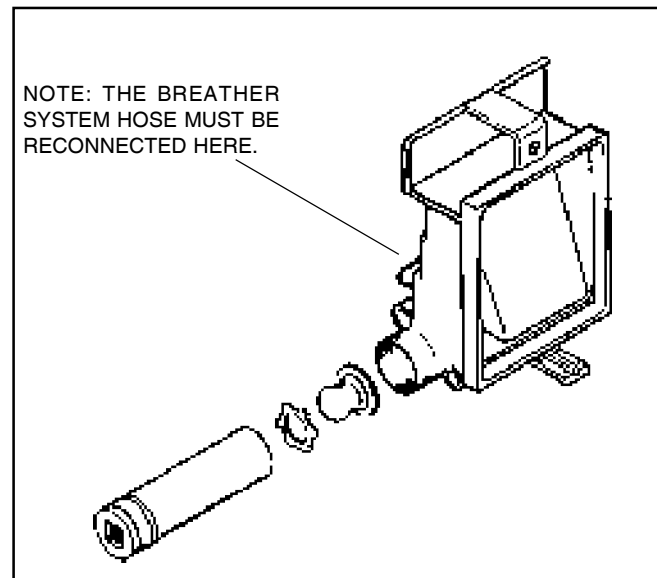
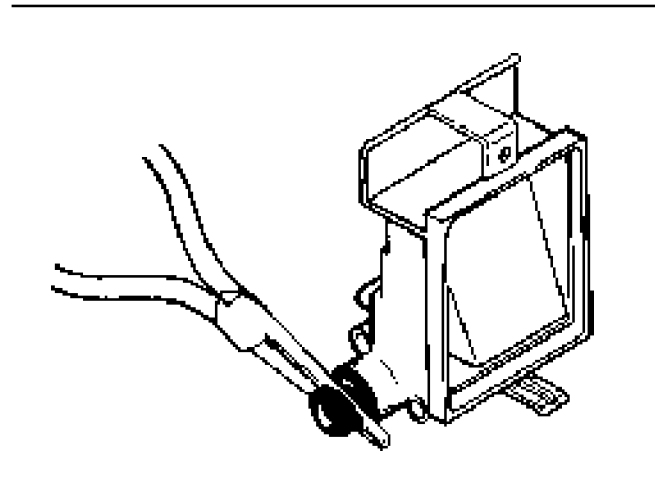


NOTE: If the scribe mark is out of position the shutter may stick.

To rebuild the Float Bowl, refer to the previous section on float bowl service.

Install the carburetor to the engine using a new gasket. The primer passage in the air cleaner body should be cleaned before it is reinstalled over the carburetor.

Primer Bulb Service: To remove the primer bulb, grasp the primer bulb with a needle nose pliers and roll the pliers along the air cleaner body. After removing the primer bulb, the retaining ring must be removed. Use a screwdriver to carefully pry the retainer out of the air cleaner body. Do not reuse old bulb or retainer.



After the primer bulb is removed, clean the primer passages thoroughly.

Press the new bulb and retainer into position using a deep reach socket as shown.

CAUTION: Wear safety glasses or goggles when removing retainer.

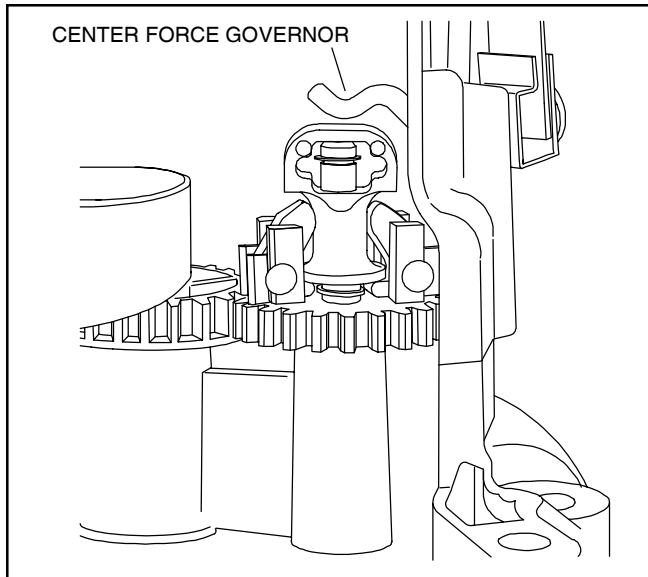
Install air cleaner body over the carburetor using a new gasket.

NOTE: The VLV models use a closed loop breather system. The crankcase breather tube must be reconnected to the air filter body

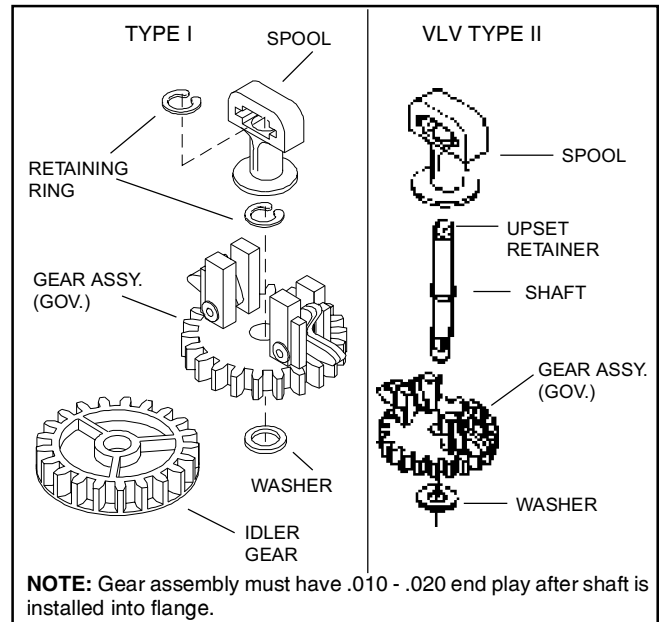
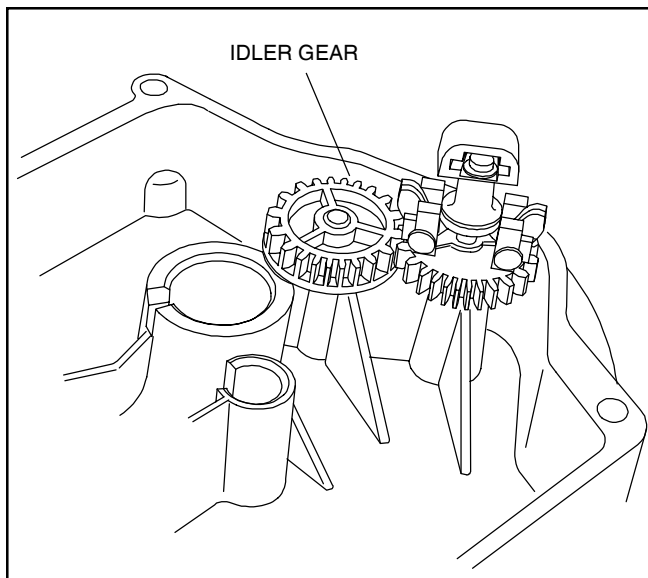
Chapter 3

GOVERNORS AND LINKAGE

All Tecumseh 4-cycle engines of recent manufacture are equipped with mechanical type governors. As the speed of an engine increases, centrifugal force moves the weights outward, lifting up the governor spool which contacts the governor shaft; this in turn closes the throttle. As engine speed decreases, the weights are pulled inward by the spring which opens the throttle. Thus, the engine speed controls the throttle opening and maintains a certain governed speed.

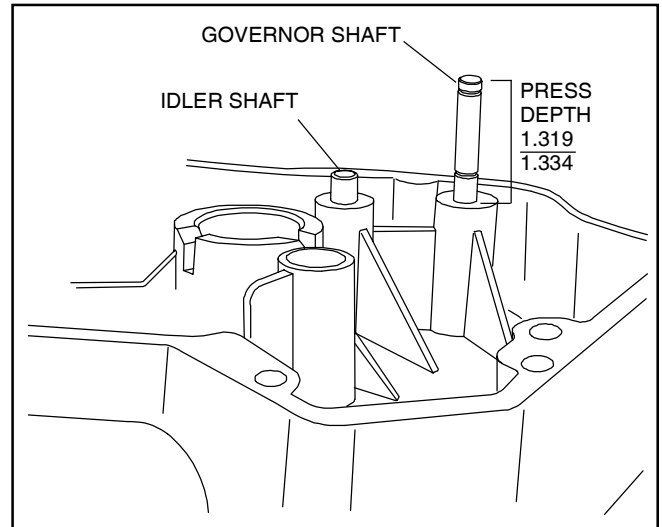


The governor gear on this engine is driven by the crankshaft through an idler gear as shown below.

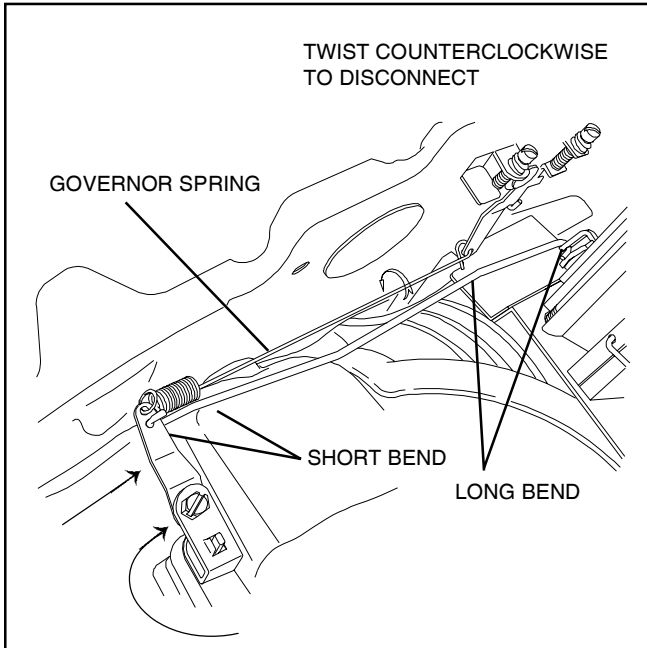


TYPE II governors do not use governor retainer clips. The spool is retained by a raised upset on the shaft.

The governor shaft is pressed into the flange or cover to a specific dimension as shown below.

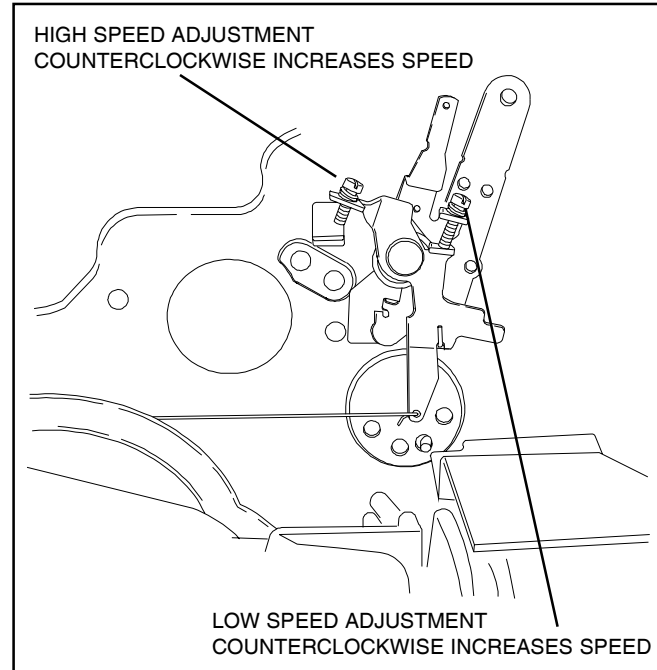


Linkage Installation: The solid link is always connected from the throttle lever on the carburetor to the lower hole on the governor lever. The shorter bend has to be toward the governor. The governor extension spring is connected with the spring end hooked into the upper hole of the governor lever and the extension end hooked through the speed control lever. To remove the governor spring, carefully twist the extension end counterclockwise to unhook the extension spring at the speed control lever. Do not bend or distort governor extension spring.



Governor Adjustment. With engine stopped, loosen the screw holding the governor clamp and lever. Turn the clamp clockwise, then push governor lever connected to the throttle to a full wide open throttle position. Hold the lever and clamp in this position and tighten the screw.

Speed Controls: This engine has an adjustable speed control. Never exceed the manufacturer's recommended speeds.



NOTE: Governor adjustment screw will be Torx head (T-10) effective August 1, 1996 for E.C. Compliance.

Chapter 4

STARTERS

REWIND STARTER

DISASSEMBLY PROCEDURE.

1. After removing the rewind assembly from the engine, remove the starter handle by first pulling a length of rope out using the handle, tie a temporary knot in the exposed rope, then untie the knot in handle or pry out the staple.
2. Untie the temporary knot and slowly allow the rope to fully retract into the starter housing and the recoil spring to fully unwind.
3. Place a 3/4" deep reach socket under the retainer pawl. Set the rewind on a bench, supported on the socket.
4. Using a 5/16" roll pin punch, drive out the center pin.
5. All components that are in need of service should be replaced.

THIS REWIND SPRING IS NOT IN A CANISTER.

Care must be used when handling the pulley because the rewind spring and cover are held together by the bosses in the pulley.

ASSEMBLY PROCEDURE.

1. Reverse the above listed procedure keeping in mind that the starter dogs with the dog springs must snap back to the center of the pulley.
2. Always replace the center pin with a new pin upon reassembly. Also place the two new plastic washers between the center leg and retainer pawl. Discard old plastic washer. The new plastic washers will be provided along with the new center pin.
3. Check retainer pawl. If it is worn, bent or damaged in any manner replace upon reassembly.

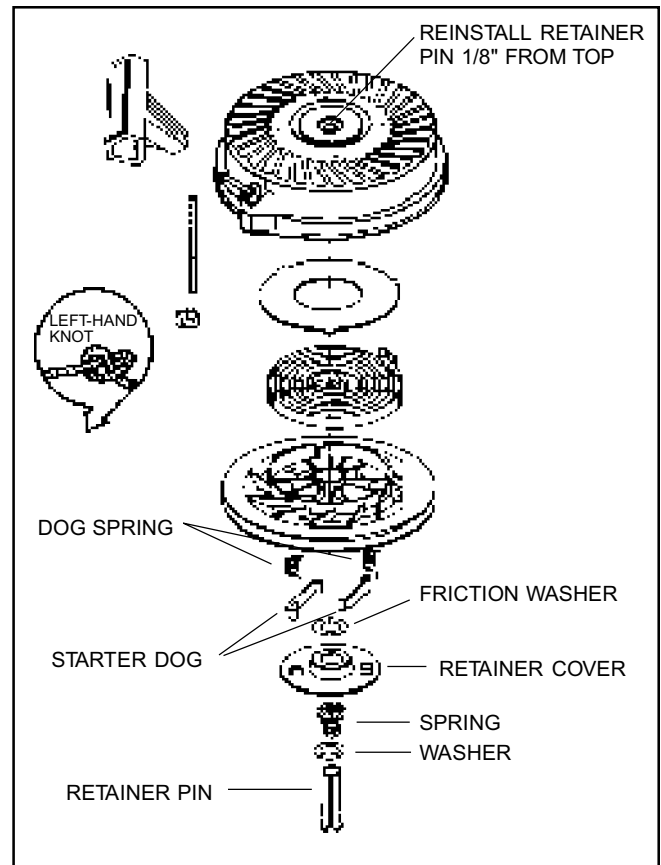
Install the new center pin in until it is within 1/8 of an inch of the top of the starter.

CAUTION: Driving the center pin in too far will cause the retainer pawl to bend and the starter dogs will not engage the starter cup.

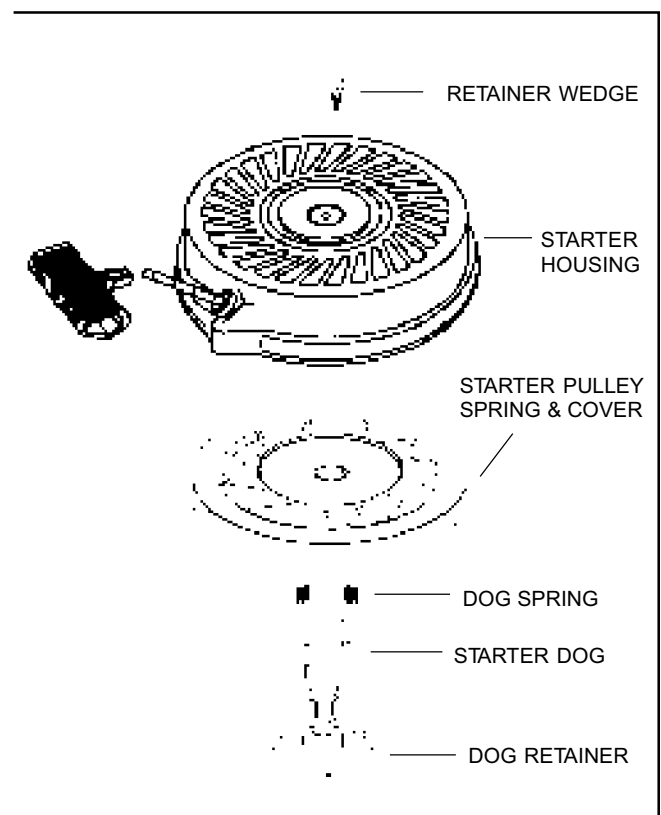
STYLIZED REWIND STARTER WITH PLASTIC RETAINER

Disassembly Procedure

1. After removing the rewind assembly from the engine, remove the starter handle by first pulling a length of rope out using the handle, tie a temporary knot in the exposed rope, then either untie the knot in handle or pry out the staple.



NOTE: Always replace the decal or plug over the roll pin or wedge to prevent moisture infiltration.



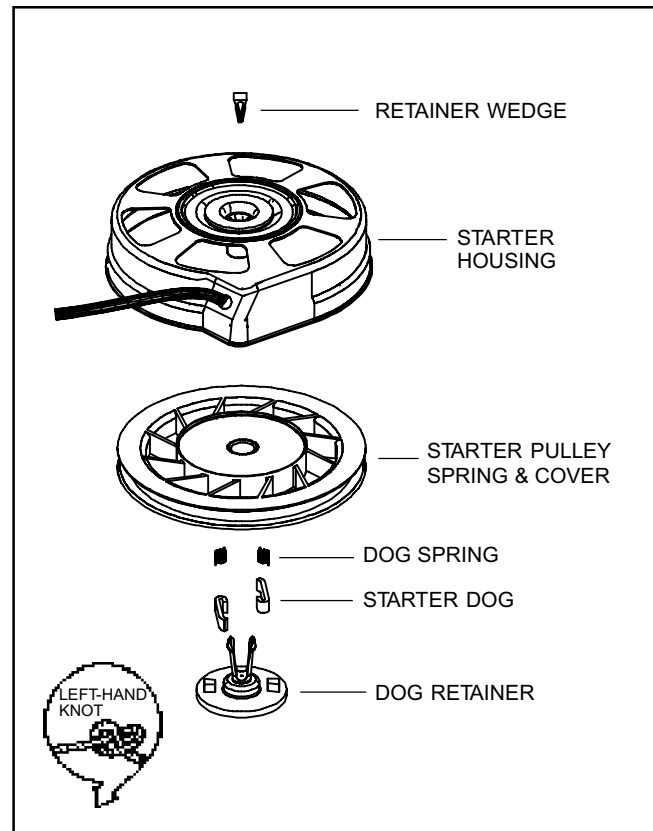
2. Untie the temporary knot and slowly allow the rope to fully retract into the starter housing and the recoil spring to fully unwind.
3. Remove the decal from the center of the starter housing.
4. Use a small Phillips screwdriver or similar tool to pry the retainer legs apart and lift out the retaining wedge.
5. Pinch the legs of the retainer together and pull on the head of the retainer to remove it from the housing.
6. Remove the pulley assembly from the recoil housing.
7. Repair or replace as necessary.

Assembly

1. If replacing the starter rope, see Step 8.

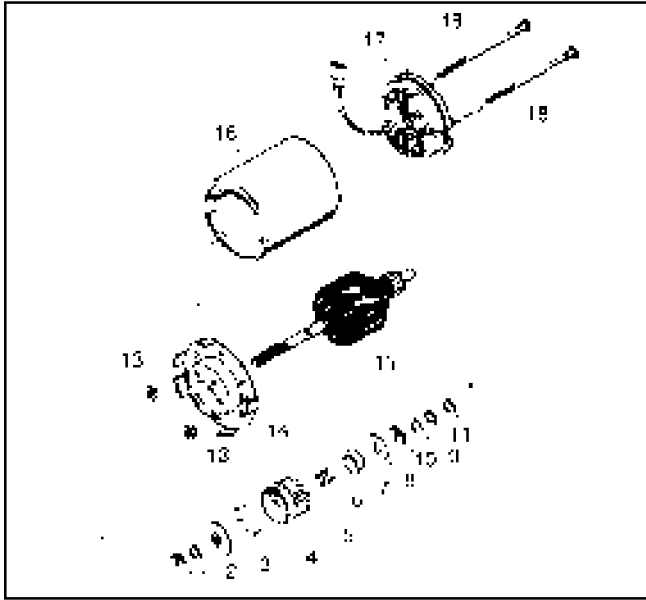
NOTE: EXTREME CAUTION AND APPROPRIATE SAFETY EQUIPMENT MUST BE USED WHEN WORKING WITH RECOIL SPRINGS.

2. Install a new recoil spring if necessary by pushing the new spring out of the holder into the pulley cavity while aligning the outside spring hook into the deep notch in the pulley. Push the spring cover in until seated.
3. Apply a small amount of lithium grease to the inner bore of the center shaft.
4. Replace or check that both starter dogs are in the pulley pockets and that the dog springs are hooked on the outer surface of the dog.
5. Pinch the two legs of the plastic retainer together and start into the center shaft hole.
6. Rotate the retainer so the two tabs on the bottom of the part fit between the dog and pulley hub (left side of the dog). Push the retainer in until the leg prongs pop out of the center shaft.
7. Turn the starter over and snap the locking tab between the retainer legs, replace the top decal.
8. Carefully turn the pulley counterclockwise until it stops. Then back the pulley up until the recoil grommet hole and the pulley hole are aligned. Next using a rope with a cauterized end, feed it into the pulley hole. Tie a left handed knot and allow the rope to be drawn into the recoil slowly.



12 Volt Electric Starters

ELECTRIC STARTER REMOVAL. Remove face plate, air cleaner assembly and gas tank. Compress plastic grommet and pull it out of the blower housing. Slide the wire through slot, being careful not to cut the wire insulation. Remove blower housing, remove flywheel (see flywheel section) and inspect ring gear for wear or damage. Replace if necessary (see flywheel section). Remove nuts on both sides of pinion. Drop starter out of back plate and remove ground wire.

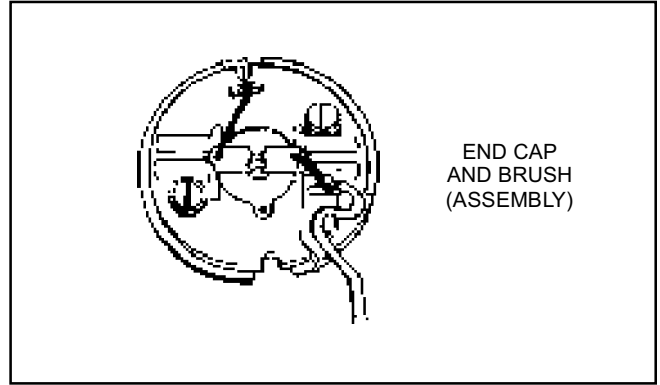


DRIVE ASSEMBLY SERVICE. Pinion gear parts should be checked for damage or wear. If the gear does not engage or slips, it should be washed in solvent (rubber parts cleaned with soap and water) to remove dirt and grease, and dried thoroughly. If damaged, replace parts.

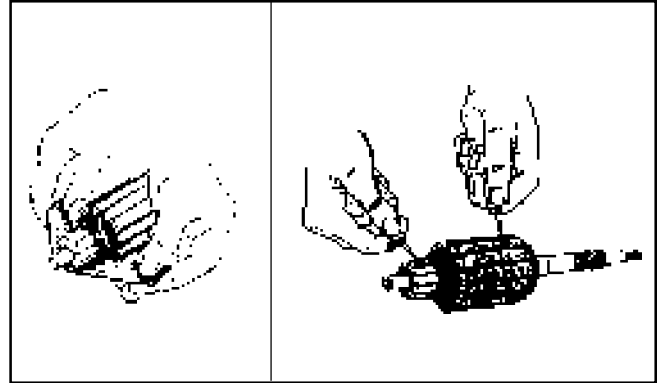
PARTS LIST:

1. Retainer ring
2. Dust washer
3. Drive nut
4. Pinion driver
5. Gear
6. Anti-drift spring
7. Spring retainer (spring collapses into retainer)
8. Cup washer (cup washer cupped over retainer spring)
9. Washer (metal)
10. Retainer ring
11. Thrust washer (metal)
12. Washer (plastic)
13. Lock nuts
14. Cap assembly drive end
15. Armature
16. Housing
17. End cap and brush card assembly
18. Bolts

Remove, inspect and replace as necessary. Use reverse procedure for assembly. (For ease of assembly assemble armature into brush end frame first.) Place a small amount of light grease such as lubriplate between the drive nut (3) and helix on armature shaft. **DO NOT** apply lubricant to pinion driver.



CHECK BRUSHES. Before removing armature, check brushes for wear. Make sure brushes are not worn to the point where brush wire bottoms out in the slot of brush holder. Brush springs must have enough strength to keep tension on the brushes and hold them against the commutator. If brushes are in need of change, replace the entire end cap assembly.



ARMATURE CHECK. If commutator bars are glazed or dirty, they can be turned down in a lathe. While rotating, hold a strip of 00 sandpaper lightly on the commutator, moving it back and forth. (Do not use emery cloth.) Recut grooves between commutator bars to depth equal to the width of the insulators.

Using a continuity tester to make certain no continuity exists between the commutator (copper) and the iron of the armature, rotate armature and check out all commutator bars.

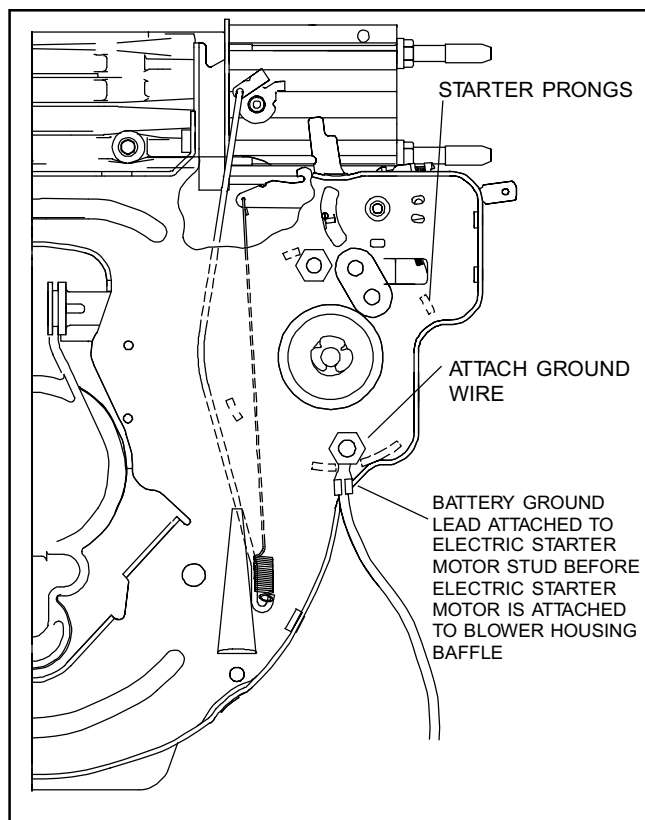
The armature can be thoroughly checked with a growler if available.

ELECTRIC STARTER ASSEMBLY

ATTACH THE GROUND WIRE prior to assembling the electric starter to the baffle, attach the black ground wire to the electric starter through bolt so the the wire extends between the two adjacent end cap prongs (illustration).

Place the starter into the back plate with the ground wire bolt away from carburetor (see picture). Note that the throttle linkage is routed around starter while the governor spring is routed through the end cap prongs (illustration).

Tighten nuts on starter bolts (see specifications). Place blower housing on engine and slide wires through slot making sure not to cut insulation. Press grommet into hole. Reassemble gas tank, air cleaner assembly and face plate.



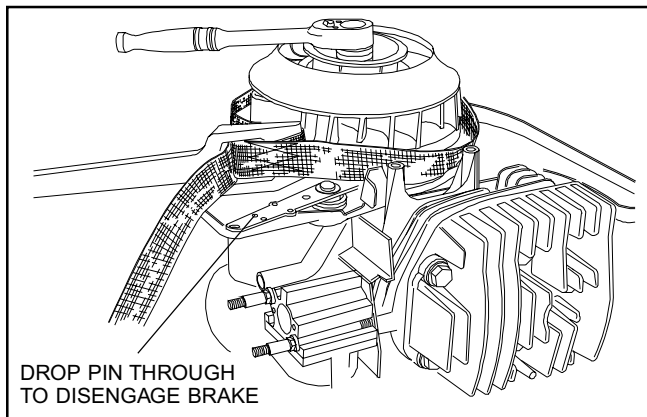
Chapter 5

FLYWHEELS

This engine uses one of two types of flywheels. The first type is a cast iron high inertia flywheel. This type of flywheel will have a pressed on steel ring gear if the engine is equipped with an electric starter. The steel ring gear is nonserviceable. The second and most popular style of flywheel is diecast aluminum. The aluminum flywheel features a replaceable plastic fan and a nonserviceable plastic ring gear when equipped with an electric stater. Disconnect battery before servicing.

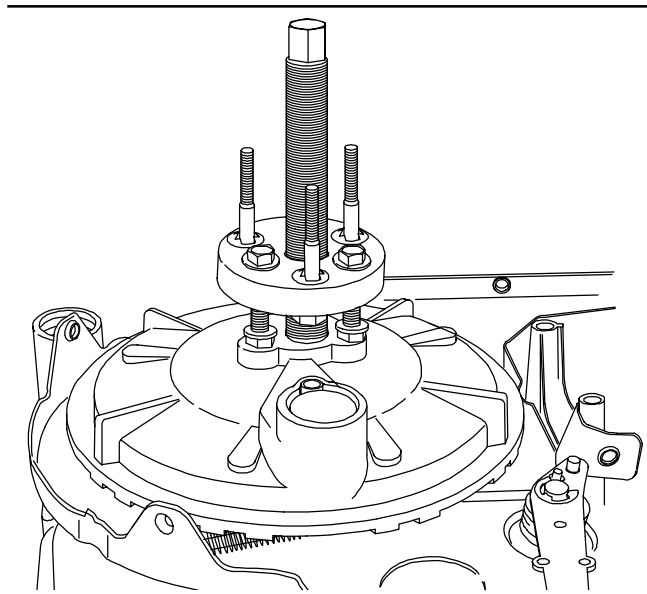
FLYWHEEL REMOVAL. Remove the ignition module. Remove the brake pressure from the flywheel. The brake can be locked in the disengaged position by placing a pin into one of the aligned holes in the backing plate lever assy.

To remove the flywheel nut, use a flywheel strap wrench (670305) to hold the flywheel, while turning the flywheel nut counterclockwise.



Lift the starter cup and fan off of the flywheel. (Aluminum flywheel only)

Remove the flywheel using a flywheel puller or knock-off tool.

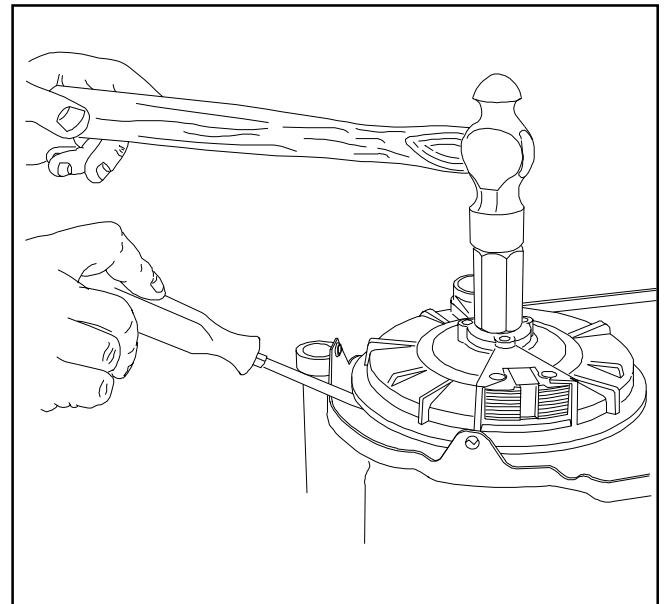


On engines with cored holes (not tapped) use flywheel puller Part No. 670306.

Screw the knock-off (no. 670169) tool down until it touches the flywheel, then back off 1 turn. Using a large screwdriver, pry upward under the flywheel (side opposite the brake) and tap sharply and squarely on the knock-off tool to break the flywheel loose. If necessary rotate flywheel a half turn and repeat until it loosens.

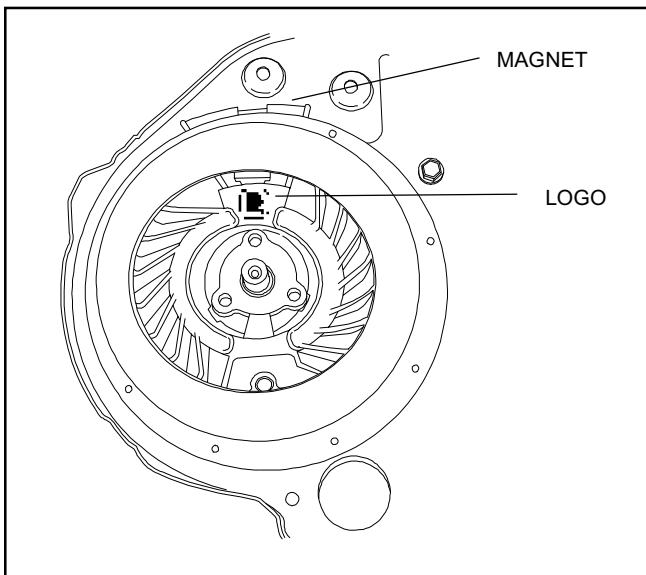
NOTE: Do not attempt to remove flywheel using a jaw type puller on the outer diameter of the flywheel or flywheel breakage will occur.

NOTE: Never use a pry bar with any type of curve on the end. Breather cover damage can result.



FOR FLYWHEEL REASSEMBLY (INSTALLATION).

1. Inspect brake pad to be free of dirt, oil or grease. If pad is contaminated, or less than .060" at the narrowest point, replace. See flywheel brake section for procedure.
2. Compress brake lever
3. Install flywheel key
4. Install flywheel
5. Install the fan onto the flywheel so the Tecumseh logo on the fan is on the magnet side of the flywheel.
6. Place starter cup into position and torque flywheel nut to specification. Use a strap wrench to hold the flywheel.



BRAKE SYSTEM

Tecumseh's brake system provides a method of meeting compliance standards which became law as of June 30, 1982. There are two additional methods used by equipment manufacturers that also meet compliance standards and they are as follows:

1. **B.B.C. Blade Brake Clutch:** This system is designed to stop the blade from rotating, in compliance with the 3 second stopping regulation, after operator lets go of the safety bail. This system allows the engine to continue running while stopping the blade. B.B.C. systems are installed by various O.E.M.'s all parts are supplied by them.

2. Use of a recoil starter (top or side mounted) with the rope handle on the engine as opposed to within 24 inches of the operator position. This method is acceptable if the mower deck passes the 360 degree foot probe test. A specified foot probe must not contact the blade when applied completely around the entire blade housing. This alternative can be used with engine mounted brake systems and typical bail controls. The blade stops within three seconds after the operator lets go of the blade control bail at the operator position and the engine is stopped.

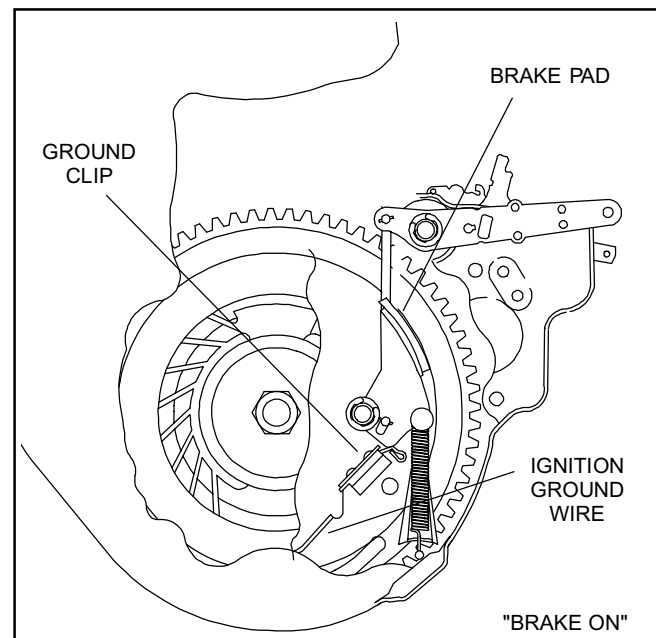
Tecumseh's Flywheel Brake System provides consumer safety by shutting down the engine and lawnmower blade within seconds after the operator releases an Engine/Blade control at the handle of the lawnmower.

The Brake Starter Mechanism may be used with either of two options for starting:

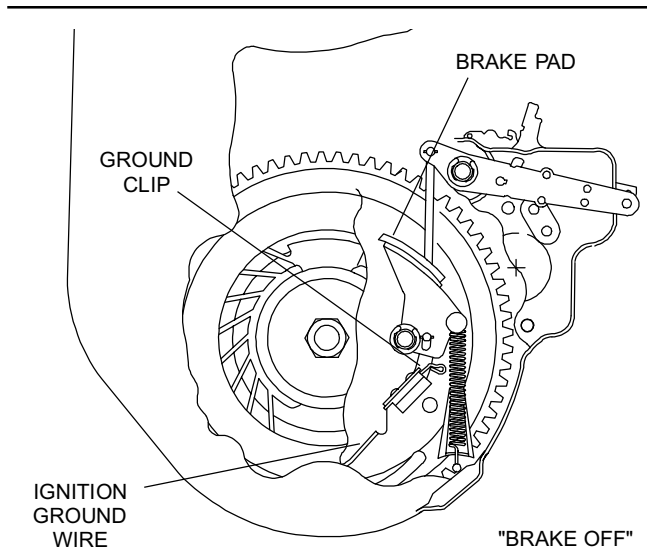
1. Manual Rope Start
2. 12 Volt Starter System

Each system requires the operator to start unit behind mower handle in operator zone area. The electric start system also provides a charging system for battery recharge when engine is running.

NOTE: Electric start systems equipped with a charging system **WILL NOT RECHARGE** a dead battery. This system is designed to maintain the charge. Before storage and again in spring the battery should be charged with the O.E.M. supplied charger.



STOPPING THE ENGINE. In the stop position the brake pad is applied to the inside edge of the flywheel; at the same time the ignition system is grounded out.

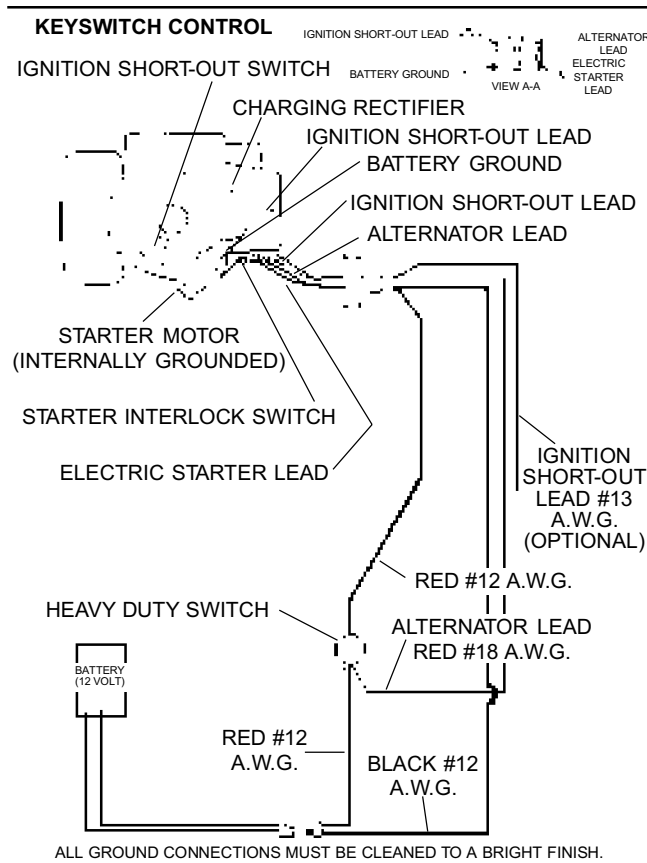


TO START THE ENGINE. In order to restart the engine, the control must be applied. This action pulls the brake pad away from the inside edge of the flywheel and opens the ignition ground switch.

On electric start systems the starter is energized to start the engine.

On non-electric start systems, recoil starter rope must be pulled to start engine.

WIRING DIAGRAMS (Electric Start Systems). All wiring beyond the connectors on the engine are supplied by the equipment manufacturer. Check all terminals and connectors for corrosion and adequate contact, and all wiring for damage and proper size.

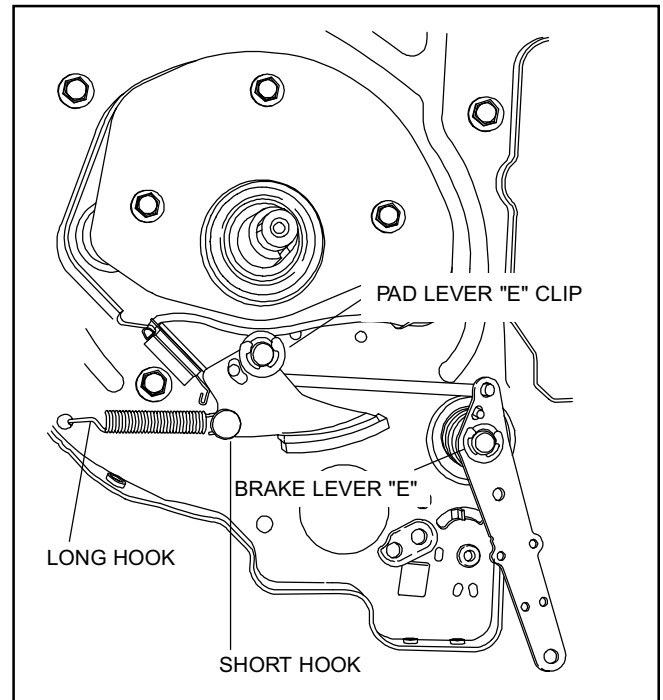


BATTERY. Check battery per manufacturer's recommendations. The charging system on the engine maintains the battery during normal use.

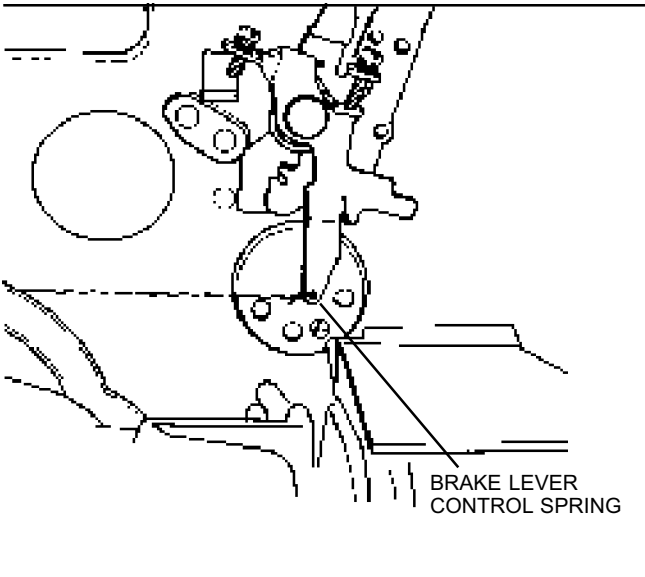
When battery is low, use the 120 volt auxiliary charger (usually supplied by the equipment manufacturer).

TO REPLACE BRAKE PAD:

1. If equipped with electric starter, locate wire routing through blower housing. Compress the grommet and pull out of the blower housing. Carefully slide wires through the slot. **DO NOT** cut the wire insulation on the blower housing.
2. Remove flywheel (see flywheel removal.)
3. Remove pad lever "E" clip. Lift pad lever, and unhook spring and link.
4. Attach the link to the new pad lever, install pad lever and "E" clip.
5. Attach spring to lever first. Use a needle nose pliers to hook the spring into the baffle.



NOTE: It is important to attach the pad lever spring with the short hook on the pad lever and the long hook to the blower housing baffle.



CONTROL SWITCH. The brake lever must close the switch before the starter can be engaged.

Disconnect battery from circuit before making check.

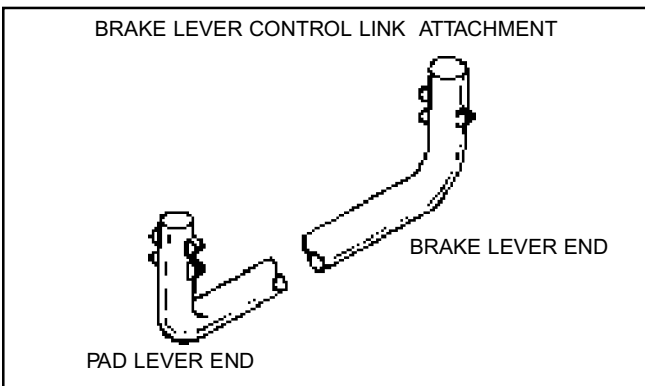
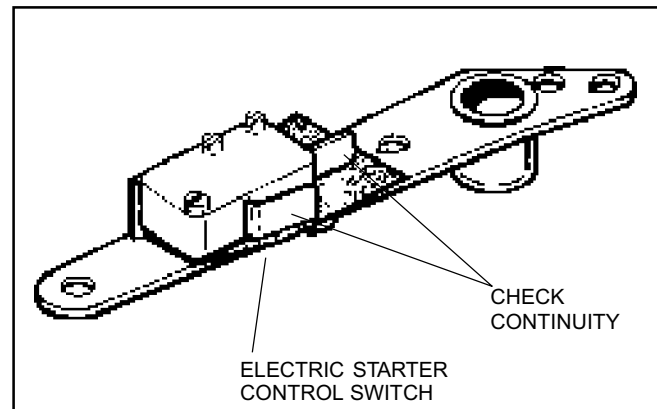
Engines equipped with an electric starter have a control switch that is attached to the brake lever. The brake lever must close the switch before the starter can be engaged.

CHECKING THE CONTROL SWITCH. Disconnect the battery from the circuit. Use a continuity light or meter to check control switch operation. Disconnect the wire harness at the engine. Attach one continuity light lead to the electric starter lead (see illustration on previous page.) Attach the other continuity light lead to the battery ground lead. With leads attached, press the control switch lever and the continuity light should go on, if not replace switch.

TO REPLACE BRAKE CONTROL LEVER:

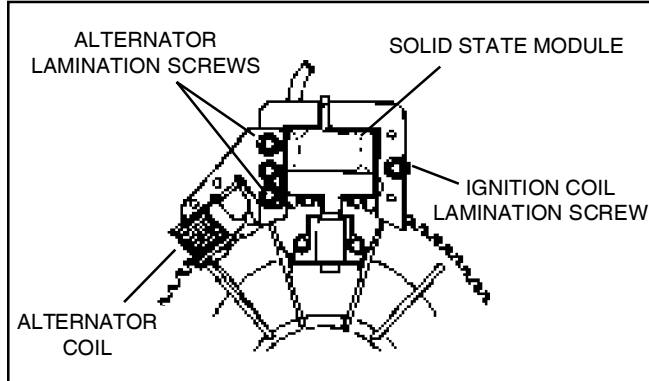
1. Mark hole that spring is installed into baffle.
2. Remove "E" clip from brake lever shaft.
3. Lift brake control lever and unhook link. Replace with new lever and reassemble in reverse order.
4. Replacement springs must be the same size and color.
5. Be sure control lever spring is in proper hole in blower housing baffle before reassembly.

When removing the brake lever with a reverse pull brake, the pad lever must be removed to unhook the brake link from the brake lever.



Chapter 6

ALTERNATOR



ALTERNATOR. The 350 Milliamp charging system consists of a single alternator coil mounted to one side of the solid state module.

NOTE: This charging system is designed to maintain a charged battery. Most O.E.M.'s supply a trickle charger, which should be used before and after off season storage. Then this system will maintain the charge level under normal use conditions.

Do not operate engine with charging system disconnected. Damage to diode may occur.

CHECKING THE SYSTEM. Connect voltmeter at the battery (should read battery voltage). The battery **MUST BE IN CIRCUIT** for test to perform properly. Next, start engine -voltage should read higher than when engine is off. If there is a change upward in voltage, the charging system is working. If there is no change in voltage, the alternator should be replaced.

NOTE: Set volt/ohm meter to 0-20 volt D.C. scale for test.

TROUBLESHOOTING ELECTRIC START ENGINES.

Following is a list of possible problems and causes.

DEAD BATTERY

- Extended storage without charging
- Excessive cranking
- Faulty starter
- Faulty wiring
- Faulty alternator
- Faulty battery

BATTERY O.K., ENGINE WON'T CRANK

- Brake cable defective
- Faulty starter switch
- Poor electrical connections
- Faulty starter. See starter section

ENGINE CRANKS SLOWLY

- Weak or discharged battery
- Faulty starter

TROUBLESHOOTING FOR BOTH MECHANICAL AND ELECTRIC START SYSTEMS

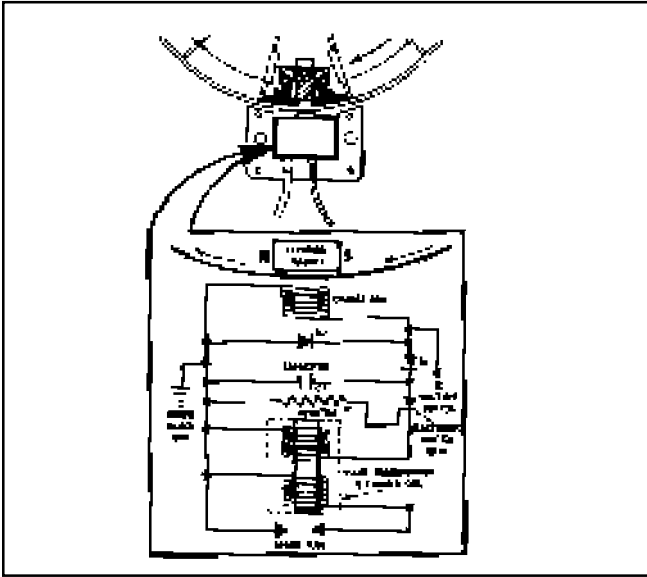
IF ENGINE PULLS OR CRANKS HARD

- Excessive engine drag due to obstructions under deck.
- Mower traction drive misadjusted
- Valve clearance too wide
- Compression release not functioning
- Compliance brake is still applied

Maximum compression should be 90 PSI. If compression is higher, de-carbon the valve seat and head area and check valve clearances. Exhaust valve clearance may be set as low as .004" if necessary to gain more compression relief. If compression is still above 90 PSI, check compression relief part of camshaft.

Chapter 7

IGNITION



SOLID STATE IGNITION. Tecumseh's solid state capacitor discharge ignition (CDI) is an all electronic ignition system and is encapsulated in epoxy for protection against dirt and moisture.

SOLID STATE IGNITION OPERATION. As the magnets in the flywheel rotate past the charge coil, electrical energy is produced in the module. This energy is transferred to a capacitor where it is stored until it is needed to fire the spark plug.

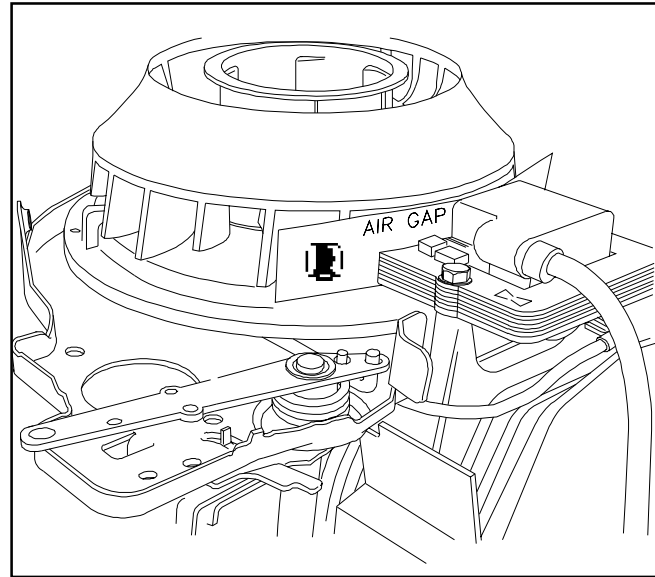
The magnet continues rotating past a trigger coil where a low voltage signal is produced and closes an electronic switch (SCR).

The energy which was stored in the capacitor is now transferred through the switch (SCR) to a transformer where the voltage is increased from 200 volts to 25,000 volts. This voltage is transferred by means of the high tension lead to the spark plug, where it arcs across the electrode of the spark plug and ignites the fuel-air mixture.

SPARK PLUG SERVICE. Spark plugs should be replaced periodically. Check electrode gap with wire feeler gauge and adjust gap to .030". Replace if electrode is pitted, burned or the porcelain is cracked. Refer to Master Parts Manual for correct replacement number. Use a spark plug tester to check for spark.

If spark plug fouls frequently, check for the following conditions:

1. Incorrect spark plug
2. Poor grade gasoline
3. Breather plugged
4. Oil level too high
5. Engine using excessive oil
6. Clogged air cleaner

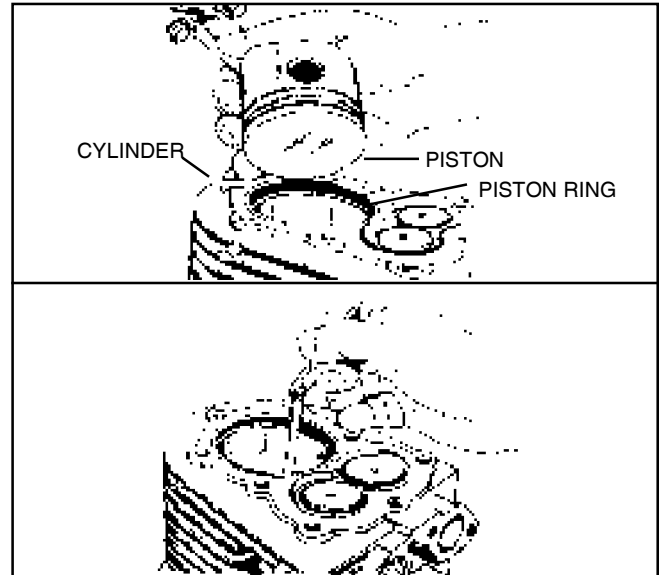
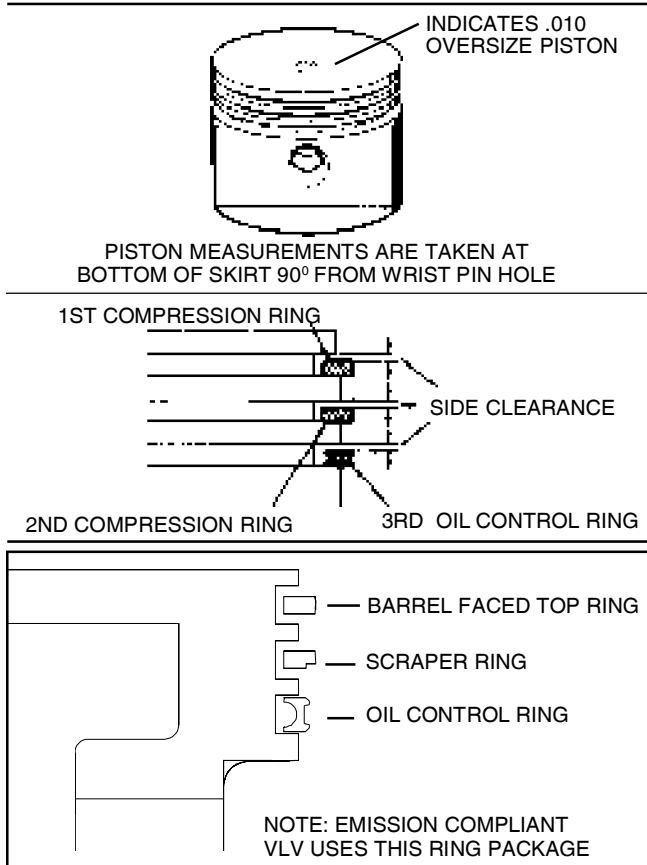


The proper air gap setting between magnets and the laminations on CDI systems is .0125". Place .0125" gauge, Part No. 670297 between the magnets and laminations and tighten mounting screws to a torque of 30-40 inch pounds. Recheck gap setting to make certain there is proper clearance between the magnets and laminations. NOTE: Due to variations between pole shoes, air gap may vary from .005/.020" when flywheel is rotated. There is no further timing adjustment on external lamination systems.

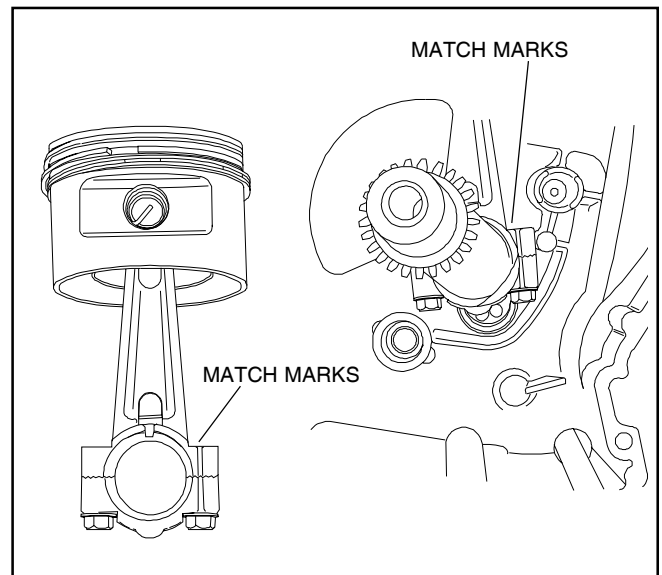
IGNITION TIMING. The flywheel key is what times the ignition for the engine. If this key is partially sheared from striking an object with the blade. The timing and engine performance could be affected. The key should be inspected if a performance problem exists.

Chapter 8

PISTON, RINGS AND CONNECTING ROD



CONNECTING RODS. Match marks on connecting rods must always align and must face outward toward the mechanic when installed in an engine.



PISTON. Before removing piston, clean any carbon from the top of the cylinder bore to prevent ring breakage when removing the piston. Push the rod and piston out through the top of the cylinder.

Oversize pistons are identified by the size imprinted on the piston as shown. Check the piston for wear by measuring at the bottom of the skirt 90° from the wrist pin hole. Clean the carbon from the piston ring grooves, install new rings and measure side clearance. Tolerances are listed in the table of specifications (page 40).

Replace rings in sets and always stagger ring gaps. When installing new rings, deglaze cylinder wall, using a commercially available deglazing tool.

Use a ring expander to remove and replace rings. Do not spread the rings too wide or breakage will result.

The top compression ring will have a chamfer on the inside edge. The ring must be installed with the chamfer up.

To check ring end gap, place ring squarely in center of ring travel area. Using the piston to push the ring down into the cylinder at least one inch.

Check ring gap on new ring to determine if cylinder should be rebored to take oversize parts. See Table of Specifications (page 40).

A new piston can be installed on to the connecting rod in either direction.

If the old piston is reused, install the piston to the connecting rod so that the piston will be in the same position when reinstalled in the engine.

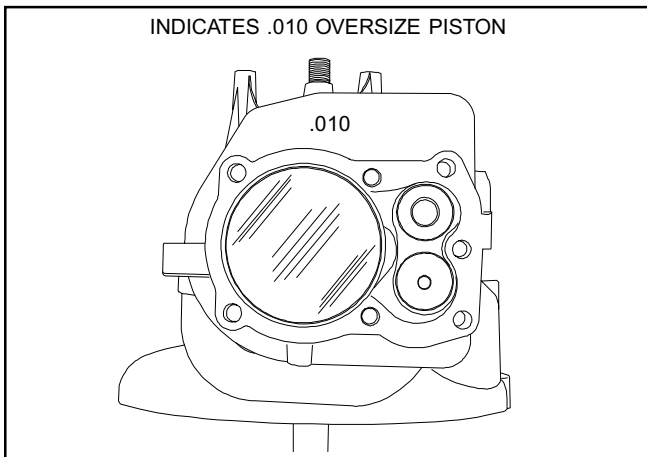
If it is necessary to replace the connecting rod be sure to mark the valve side of the piston.

Chapter 9

CYLINDERS AND CYLINDER HEADS

CYLINDER SERVICE. Check cylinder for dirty, broken or cracked fins, worn or scored bearings or scored cylinder bore surface, and warped head mounting surface.

If cylinder bore is worn more than .005" oversize, out-of-round or scored, it should be replaced or rebored to .010 or .020 oversize. In some cases engines are built with an oversize cylinder; in these instances they are identified with the oversize value imprinted on the cylinder as pictured. Service pistons have the oversized valve marked on the dome.



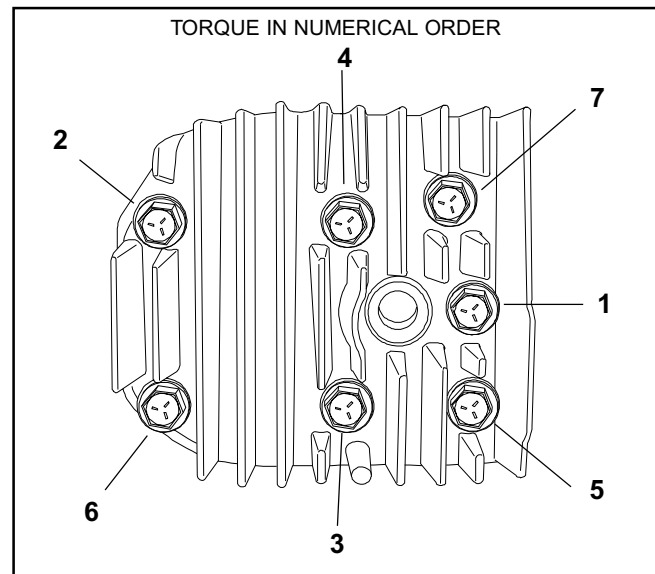
REBORING CYLINDER. To rebore cylinder we recommend using a reputable machine shop or service center.

Then hone the cylinder with 380 grit stone to obtain a good cross hatch pattern for proper ring seating.

Clean cylinder with soap and water, and dry thoroughly.

Replace piston and piston rings with correct oversize parts as indicated in parts manual.

CYLINDER HEADS. Check cylinder heads for warpage by placing on a flat surface. If the cylinder head gasket surface is warped in excess of .005 inches (.13 mm), replace head. Always replace head gasket and torque head bolts in 50 inch lb. increments in the numbered sequence to a torque of 180-220 inch lbs. (20.3 - 25 nm)



Chapter 10

CRANKSHAFTS, CAMSHAFTS AND LUBRICATION

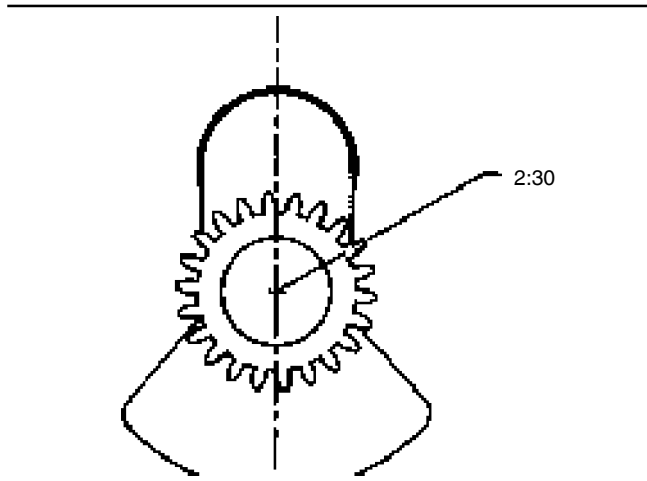
CRANKSHAFTS. Inspect crankshaft for worn, scratched or damaged bearing surfaces, out-of-round or flat spots on the journal area, or a bent P.T.O. end.

CAUTION: Never try to straighten a bent crankshaft.

When installing a crankshaft, lubricate all bearing surfaces and use oil seal protector part no. 670327.

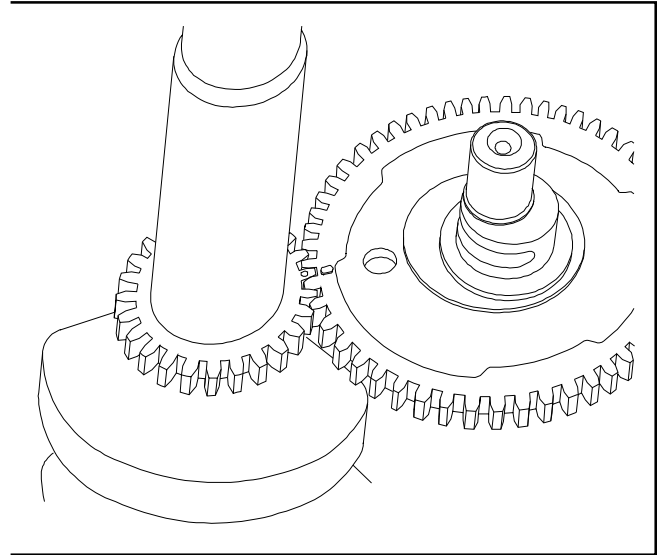
CRANKSHAFT TIMING MARK

The crankshaft has a pressed on timing gear. This gear has a small dimple punched on one of the teeth on this gear. This dimple is a timing mark. With the crankpin at top dead center, the timing mark should be in the 2:30 position.



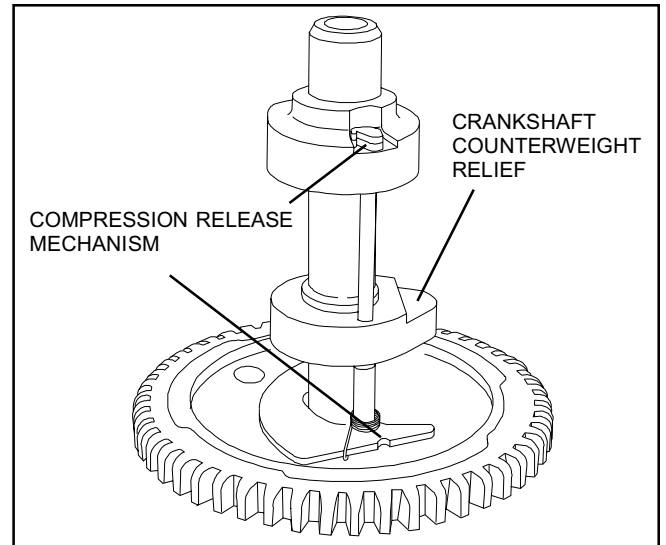
The camshaft has an aligning mark in line with the timing hole on the camshaft gear. Line this mark up with the dimple on the crankshaft gear.

Timing marks on crankshaft gear and camshaft gear must be aligned for proper valve timing.



CAMSHAFT REMOVAL:

Align timing marks to relieve valve train pressure. Lift out cam.



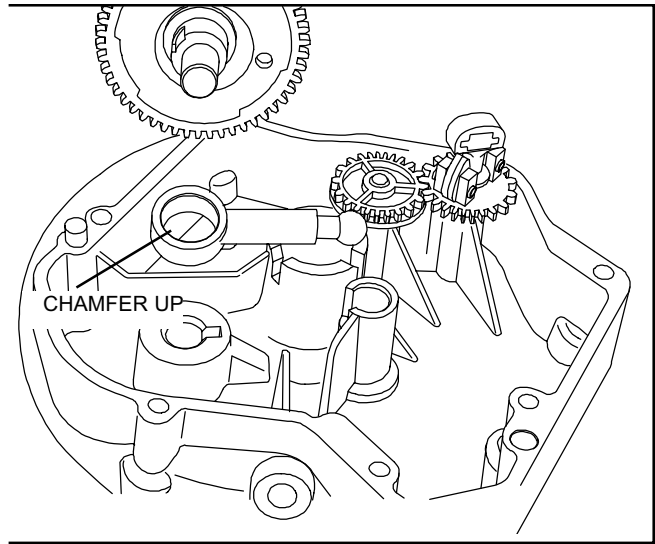
The camshaft has a mechanical compression release mechanism. A pin which runs through both cam lobes extends past the exhaust lobe and lifts the valve to relieve compression for easier starting. When the engine starts, centrifugal force moves the flyweight outward, moving the pin below the lobe, allowing full compression. The compression release mechanism is nonserviceable (replace camshaft assy. if damaged or worn.)

The camshaft has been relieved in the intake lobe area. This change was made to accommodate added crankshaft counterweight material for improved engine balance.

LUBRICATION SYSTEM:

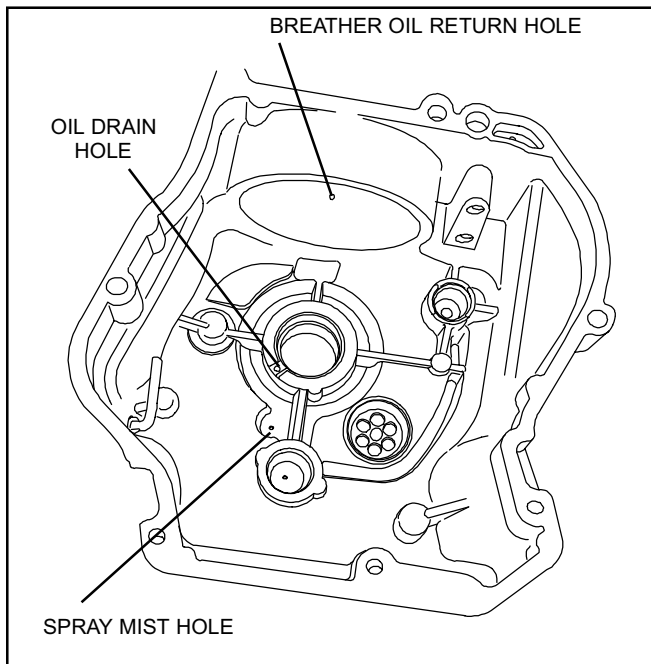
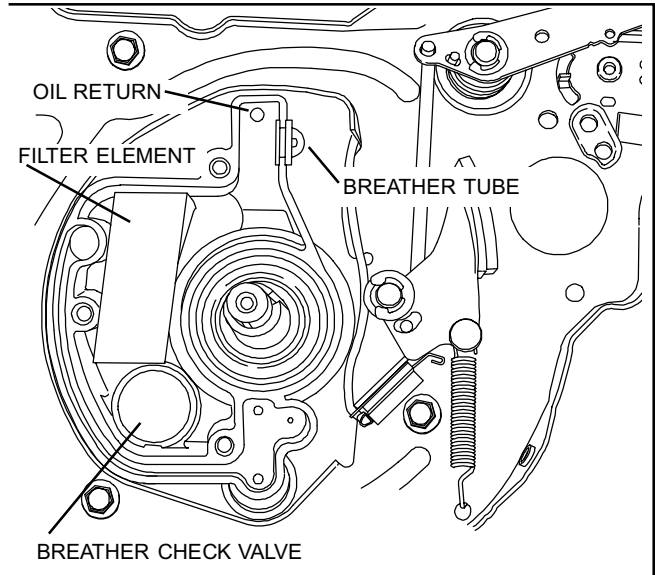
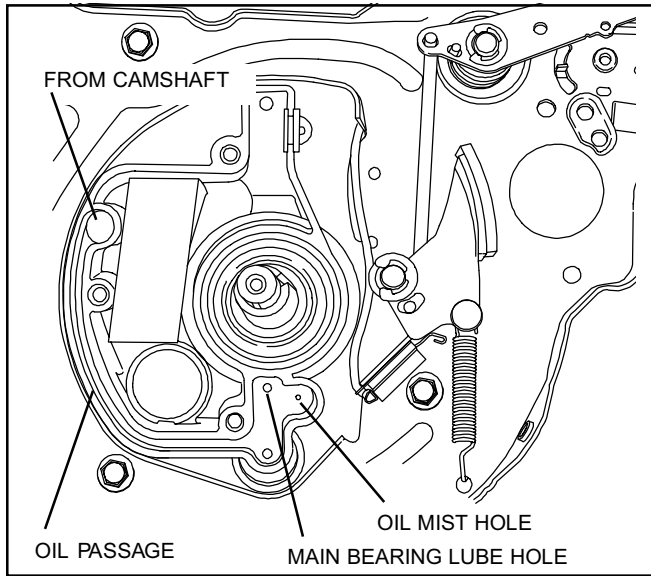
All Tecumseh Vertical shaft 4-cycle engines use a positive displacement plunger oil pump to pump oil from the crankcase, up through the camshaft to a passage in the breather box to the top crankshaft main bearing, and ultra balance bearings.

Oil is pressure sprayed out of a small hole between the crankshaft and ultra-balance bearing, to lubricate the connecting rod journal area. If a heavy leakage is noted from the breather cover check for plugged mist hole.

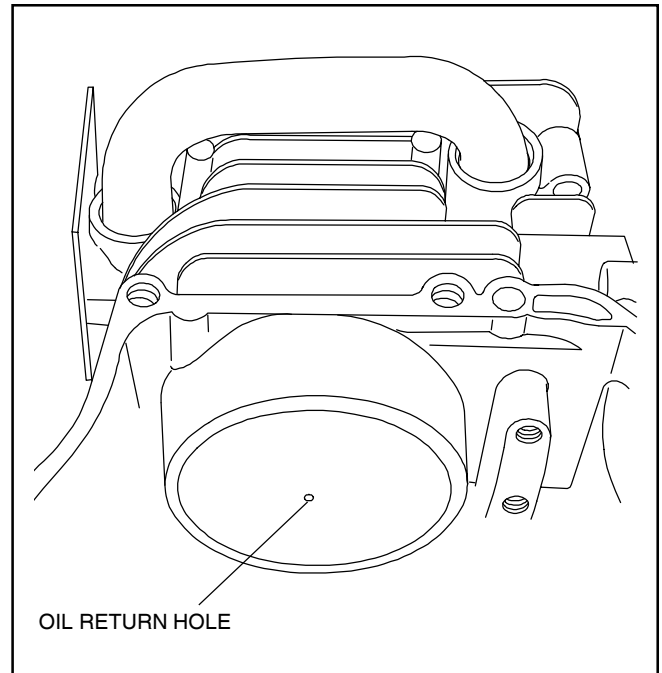
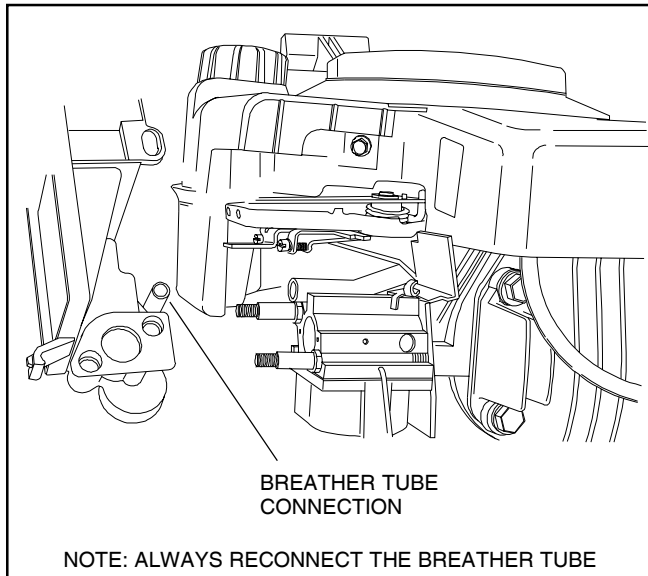


OIL PUMP. An eccentric on the camshaft works the plunger in the barrel back and forth, forcing oil up the center of the camshaft. A ball on the end of the plunger locates in a recess in the flange cover. When installing oil pump, make certain the chamfered side of the pump barrel faces the camshaft, and the plunger ball seats in the recess of the flange cover.

This engine has a top mounted integral breather.



The breather compartment is located under the flywheel. A check valve allows excess crankcase pressure to be vented through the element and out the breather tube. The breather tube is connected to the air cleaner body. When reassembling the breather, **DO NOT** pinch the filter element under the breather cover or leak may occur.



Condensed oil vapors are returned to the crankcase by means of the oil return hole. The oil return hole is opened and closed in the cylinder by the piston.

The breather filter element can be cleaned using solvent.

When reinstalling the check valve, apply oil to aid in assembly. A new breather valve body can be pressed into the block to replace a damaged breather valve body.

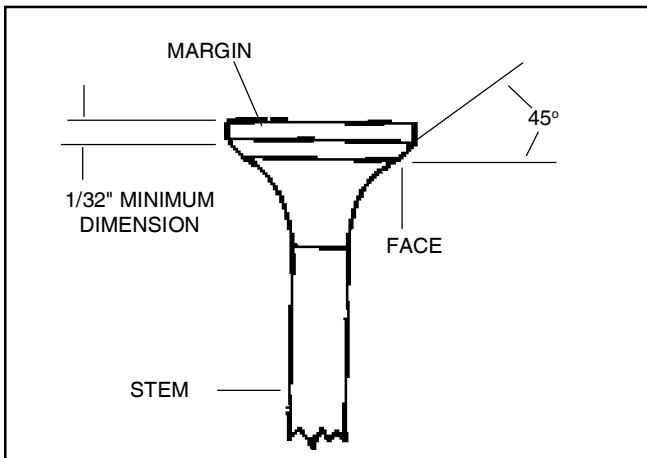
Chapter 11

VALVES, LIFTERS, SPRING & VALVE SEATS

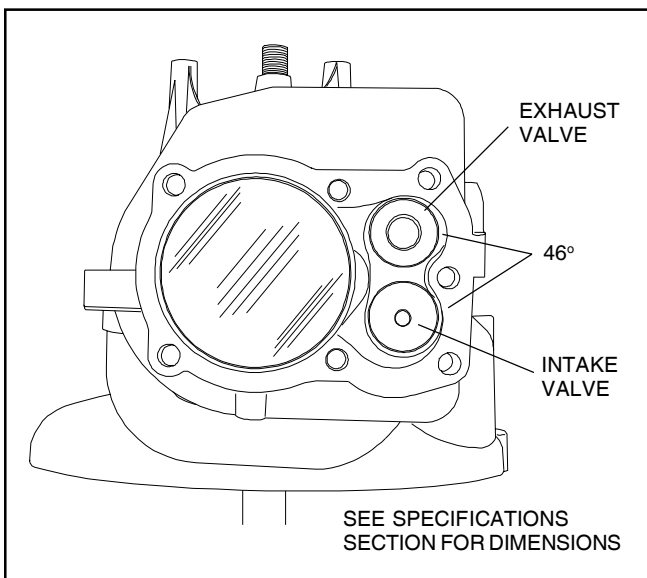
VALVES. Valves must be in good condition, proper sealing and proper gap must be maintained for full power, easy starting and efficient operation.

VALVE REMOVAL. To remove valves, use a commercially available valve spring compressor. Move the lower cap, so it will slip off the end of the valve.

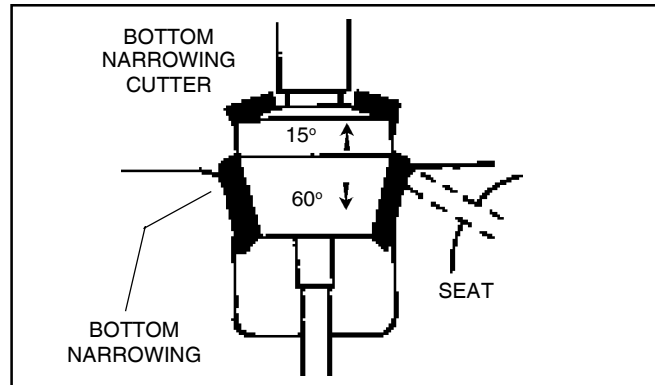
Clean all parts and remove carbon from valve heads and stems. If valves are in usable condition, grind the valve faces to a 45° angle. Replace valves if they are damaged, distorted or if the margin is ground to less than 1/32".



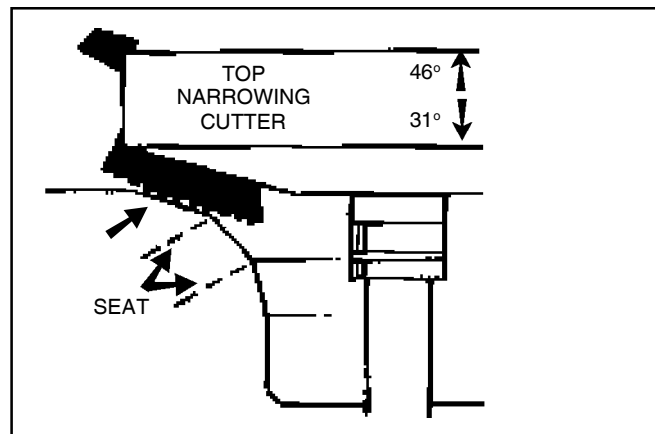
VALVE SEATS. Valve seats are not replaceable. If they are burned or pitted, they can be reground using a grinding stone or valve seat cutter.



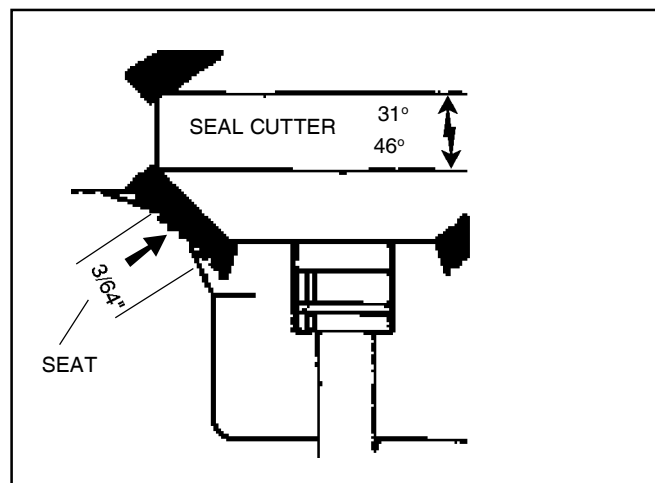
The recommended procedure to properly cut a valve seat is to use the Neway Valve Cutting System, which consists of three different degree-cutters. First, use the 60° cutter to clean and narrow the seat from the bottom toward the center.



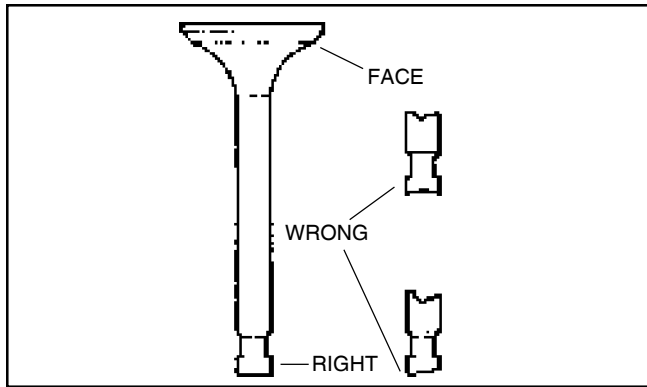
Second, use the 31° cutter to clean and narrow the seat from the top toward the center.



Seats are ground at an angle of 46°, to a width of 3/64".



Valves are not identical. Make sure the valve marked "EX" or "X" is installed in the exhaust valve location, and the valve marked "I" is installed in the intake valve location. If the valves are unmarked, the nonmagnetic valve is installed in the exhaust valve location.



VALVE ADJUSTMENT. Clearance between the valve stem and lifter must be set to the recommended specifications when the engine is cold (see page 40). Check these clearances with the piston T.D.C. on the compression stroke. Grind end of valve stem with a valve grinder, or use a "V" block to hold the valve square on grinding wheel, grinding to the proper .004" to .008" clearance.

NOTE: Some emissionized engines use intake valve stem seals to maintain proper oil control and emission compliance, they must be replaced if the valve has been removed.

VALVE INSTALLATION. To reinstall valves, position valve caps and spring in the valve compartment. Install valves in guides with valve marked "I" in the intake port. The valve stem must pass through the spring. The valve spring cap should sit around the valve lifter exposed end. Use a valve spring compressor to compress the valve spring. Position the valve spring cap onto the valve stem and release valve spring tension to lock cap in place.

VALVE LIFTERS. It is a good practice not to interchange lifters, even though they are identical, once a wear pattern has been established.

OVERSIZE VALVE GUIDES. Valve guides are permanently installed in the cylinder. If they become worn excessively, they can be reamed oversized to accommodate a 1/32" over size valve stem.

Ream guides with a straight shanked hand reamer or low speed drill press. Refer to Table of Specifications to determine correct oversize dimension. Reamers are available through your Tecumseh parts suppliers. See Tool Section for correct part numbers.

After oversizing valve guides the seats must be recut to align with the valve guides.

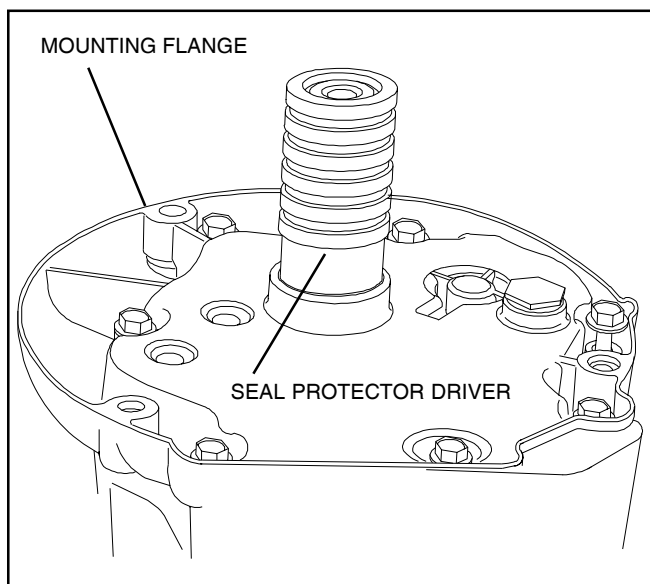
Chapter 12

OIL SEAL SERVICE AND MOUNTING FLANGE

OIL SEAL SERVICE. Drain oil from crankcase. If the crankshaft end is rusty or pitted, polish the crankshaft with emery cloth so it will not damage the bearings when the cover is removed.

Remove mounting bolts and slide seal protector-driver tool (Part No. 670327) into the oil seal. If necessary, tap edge of flange or cover lightly with a soft hammer to remove cover.

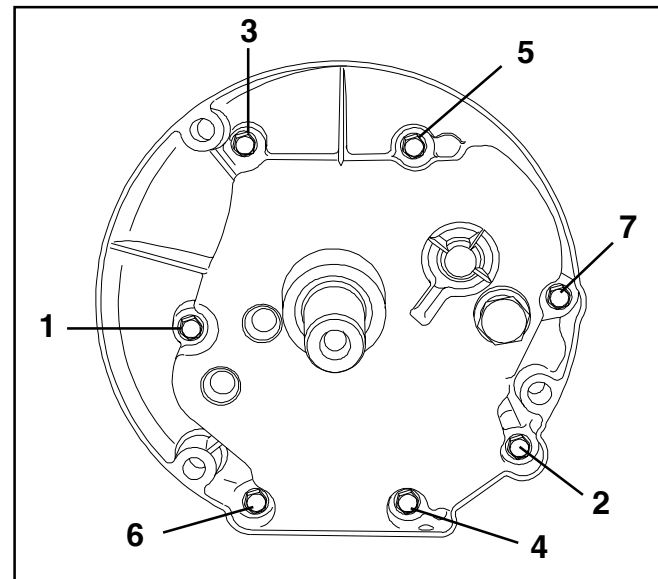
Clean and inspect the cover for wear and scoring of bearings. Inspect crankshaft bearings. Replace any worn or damaged parts.



If crankshaft is out of engine, remove old oil seals by tapping them out with a screwdriver or punch from the inside. To remove a seal with the crankshaft in the engine, insert a screwdriver between the seal and the crankshaft and pry the seal out.

TO REPLACE SEALS: Lubricate the outside of the new oil seal with oil prior to installation. Use seal driver-protector tool Part No. 670327. Place oil seal over the driver-protector and place over crankshaft, driving it into position using universal driver No. 670272. The seal will automatically be driven into the proper depth.

Torque flange bolts in numerical order as shown in illustration. See page 41 for torque specifications.



Chapter 13

TROUBLESHOOTING

A. COMMON TROUBLES AND REMEDIES.

The following charts list the most common troubles experienced with gasoline engines. Possible causes of trouble are given along with probable remedy.

B. 4-CYCLE ENGINE TROUBLESHOOTING CHART

Cause	Remedy and Reference
ENGINE FAILS TO START OR STARTS WITH DIFFICULTY	
No fuel in tank	Fill tank with clean, fresh fuel.
Shut-off valve closed	Open valve.
Obstructed fuel line	Clean fuel screen and line. If necessary, remove and clean carburetor.
Incorrect Timing	Flywheel key has sheared or partially sheared. Replace key.
Tank cap vent obstructed	Clean the vent or replace the cap.
Water in fuel	Drain tank. Clean carburetor and fuel lines. Dry spark plug points. Fill tank with clean, fresh fuel.
Engine flooded	Close fuel shut-off, if so equipped, and pull starter until engine starts. Reopen fuel shut-off for normal fuel flow.
Loose or defective ignition wiring	Check ignition wiring for shorts or grounds; repair if necessary.
Spark plug fouled	Replace spark plug.
Spark plug porcelain cracked	Replace spark plug.
Poor Compression	Overhaul engine.
No spark at plug	Check ignition air gap. If air gap is correct and there is no spark at plug replace ignition.
Electric starter does not crank engine	See 12 volt starter troubleshooting chart.
ENGINE KNOCKS	
Carbon in combustion chamber	Remove cylinder head and clean carbon from head and piston.
Loose or worn connecting rod	Replace connecting rod.
Loose flywheel	Check flywheel key and keyway; replace parts if necessary. Tighten flywheel nut to proper torque.
Worn cylinder	Replace cylinder.
Improper ignition timing	Flywheel key has sheared or partially sheared. Replace key.

4-CYCLE ENGINE TROUBLESHOOTING CHART (Cont.)

Cause	Remedy and Reference
ENGINE MISSES UNDER LOAD	
Spark plug fouled	Replace spark plug.
Spark plug porcelain cracked	Replace spark plug.
Improper spark plug gap	Regap spark plug.
Improper valve clearance	Adjust valve clearance to recommended specifications.
Weak valve spring	Replace valve spring.
ENGINE LACKS POWER	
Ignition improperly timed	Replace flywheel key.
Worn rings	Replace rings.
Lack of lubrication	Fill crankcase to the proper level.
Air cleaner fouled	Service air cleaner.
Valves leaking	Grind valves and set to recommended specifications.
ENGINE OVERHEATS	
Engine improperly timed	Replace flywheel key if sheared.
Air flow obstructed	Remove any obstructions from air passages in shrouds.
Cooling fins clogged	Clean cooling fins.
Excessive load on engine	Check operation of associated equipment. Reduce excessive load.
Carbon in combustion chamber	Remove cylinder head and clean carbon from head and piston.
Lack of lubrication	Fill crankcase to proper level.
ENGINE SURGES OR RUNS UNEVENLY	
Fuel tank cap vent hole clogged	Open vent hole.
Governor parts sticking or binding	Clean, and if necessary repair governor parts.
Carburetor throttle linkage or throttle shaft and/or butterfly binding or sticking	Clean, lubricate, or adjust linkage and deburr throttle shaft or butterfly.
Intermittent spark at spark plug	Disconnect ignition cut-off wire at the engine. Crank engine. If spark, check ignition switch, safety switch and interlock switch. If no spark, check ignition air gap. Check wires for poor connections, cuts or breaks.
Dirty carburetor	Clean carburetor.
ENGINE VIBRATES EXCESSIVELY	
Engine not securely mounted	Tighten loose mounting bolts.
Bent crankshaft	Replace crankshaft.
Associated equipment out of balance	Check associated equipment.

4-CYCLE ENGINE TROUBLESHOOTING CHART (Cont.)

Cause	Remedy and Reference
ENGINE USES EXCESSIVE AMOUNT OF OIL	
Engine speed too fast.	Using tachometer adjust engine RPM to spec.
Oil level too high.	To check level turn dipstick cap tightly into receptacle for accurate level reading.
Oil filler cap loose or gasket damaged causing spillage.	Replace ring gasket under cap and tighten tube securely.
Breather mechanism damaged or dirty causing leakage.	Replace breather assembly.
Drain hole in breather box clogged causing oil to spill out of breather.	Clean hole with wire to allow oil to return to crankcase.
Gaskets damaged or gasket surfaces nicked causing oil to leak out.	Clean and smooth gasket surfaces. Always use new gaskets.
Valve guides worn excessively thus passing oil into combustion chamber.	Ream valve guide oversize and install 1/32" oversize valve and new valve seal if equipped.
Cylinder wall worn or glazed, allowing oil to bypass rings into combustion chamber.	Bore cylinder for oversized piston & rings.
Piston rings and grooves worn excessively.	Reinstall new rings and check land clearance and correct as necessary.
Piston fit undersized.	Measure and replace as necessary.
Piston oil control ring return holes clogged.	Remove oil control ring and clean return holes.
Oil passages obstructed.	Clean out all oil passages.
Breather tube not connected to air cleaner.	Reconnect tube.
Using 10W30 oil under high load/high temperature conditions.	Replace with SAE 30 oil.
OIL SEAL LEAKS	
Crankcase breather plugged.	Clean or replace breather.
Seal/Main brg drain hole plugged.	Clean out hole.
Old seal hardened and worn.	Replace seal.
Crankshaft seal contact surface is worn undersize causing seal to leak.	Check crankshaft size and replace if worn excessively.
Crankshaft bearing under seal is worn excessively, causing crankshaft to wobble in oil seal.	Check crankshaft bearings for wear and replace if necessary.
Seal outside seat in cylinder or side cover is damaged, allowing oil to seep around outer edge of seal.	Visually check seal receptacle for nicks and damage. Replace P.T.O. cylinder cover, or small cylinder cover on the magneto end if necessary.

4-CYCLE ENGINE TROUBLESHOOTING CHART (Cont.)

Cause	Remedy and Reference
OIL SEAL LEAKS	
New seal installed without correct seal driver and not seating squarely in cavity.	Replace with new seal, using proper tools and methods.
New seal damaged upon installation.	Use proper seal protector tools and methods for installing another new seal.
Bent crankshaft causing seal to leak.	Check crankshaft for straightness and replace if necessary.
Oil seal driven too far into cavity.	Remove seal and replace with new seal, using the correct driver tool and procedures.
BREATHER PASSING OIL	
Engine speed too fast.	Use tachometer to adjust correct RPM.
Loose oil fill cap or gasket damaged or missing.	Install new ring gasket under cap and tighten securely.
Oil level too high.	Check oil level Turn dipstick cap tightly into receptacle for accurate level reading. DO NOT fill above full mark.
Breather mechanism damaged.	Replace umbrella valve/seat in Vector engine and TVS engines.
Breather mechanism dirty.	Clean thoroughly in solvent. Use new gaskets when reinstalling unit.
Drain hole in breather box clogged.	Clean hole with wire to allow oil to return to crankcase.
Breather mechanism installed upside down.	Small oil drain holes must be down to drain oil from mechanism.
Breather mechanism loose or gaskets leaking.	Install new gaskets and tighten securely.
Damaged or worn oil seals on end of crankshaft.	Replace seals.
Rings not properly seated.	Check for worn, or out of round cylinder. Replace rings. Break in new rings with engine working under a varying load. Rings must be seated under high compression, or in other words, under varied load conditions.
Breather assembly not assembled correctly.	See section on Breather Assembly.
Cylinder cover gasket leaking.	Replace cover gasket.

C. TROUBLESHOOTING CARBURETION.

POINTS TO CHECK FOR CARBURETOR MALFUNCTION

TROUBLE	CORRECTIONS
Engine will not start	1, 2, 3, 4, 5, 6, 8, 14, 15, 17
Engine will not accelerate	2, 3, 17
Engine hunts (at idle or high speed)	3, 4, 8, 9, 14
Engine will not idle	4, 8, 9, 14
Engine lacks power at high speed	2, 3, 6, 8, 17
Carburetor floods	4, 7, 16
Carburetor leaks	6, 7
Engine overspeeds	8, 9, 14, 15
Idle speed is excessive	8, 9, 14, 15
Choke does not open fully	8, 9, 15
Engine starves for fuel at high speed (leans out)	1, 3, 4, 6, 15, 16, 17
Carburetor runs rich with main adjustment needle shut off	7, 16
Performance unsatisfactory after being serviced.	1, 2, 3, 4, 5, 6, 7, 8, 9, 15, 16, 17

1. Open fuel-shut off valve at fuel tank—Fill tank with fuel.
2. Check ignition, spark plug.
3. Clean air cleaner—Service as required.
4. Dirt or restriction in fuel system—Clean tank and fuel strainers, check for kinks or sharp bends.
5. Check for stale fuel or water in fuel - - Fill with fresh fuel.
6. Examine fuel line and pick-up for sealing at fittings.
7. Check and clean atmospheric vent holes.
8. Examine throttle for binding or excessive play- - Remove all dirt or paint, replace shaft.
9. Examine throttle return spring for operation.
10. Check for bent throttle plate.
11. Adjust control cable or linkage, to assure carburetor control.
12. Clean carburetor after removing all nonmetallic parts that are serviceable. Trace all passages.
13. Check inlet needle and seat for condition and proper installation.
14. Check sealing of welch plugs, and gaskets.
15. Adjust governor linkage.
16. Check float shaft for wear and float for leaks or dents.
17. Check flywheel key for damage.

D. TROUBLESHOOTING 12 VOLT STARTERS

PROBLEM	PROBABLE CAUSE	FIX
Does not function	<p>Weak or dead battery</p> <p>Corroded battery terminals and/or electrical connections</p> <p>Brushes sticking</p> <p>Dirty or oily commutator</p> <p>Armature binding or bent</p> <p>Open or shorted armature</p> <p>Shorted, open or grounded field coil</p> <p>Loose or faulty electrical connections</p> <p>Load on engine</p> <p>Electric starter cranks, but no spark at spark plug</p> <p>Electric starter does not crank engine</p> <p>Electric starter cranks, but engine does not turn over.</p>	<p>Check charge and/or replace battery.</p> <p>Clean terminals and/or connections.</p> <p>Free brushes. Replace worn brushes and those which have come in contact with grease and oil.</p> <p>Clean and dress commutator.</p> <p>Free armature and adjust end play, replace armature, or replace starter.</p> <p>Replace armature.</p> <p>Repair or replace housing.</p> <p>Correct.</p> <p>Disengage brake.</p> <p>Disconnect ignition cut-off wire at the engine. Crank engine. If spark at spark plug, ignition switch, safety switch is in operative. If no spark, check air gap. Check wires for poor connections, cuts or breaks.</p> <p>Remove starter wire. Use a jumper battery and cables and attach directly to starter wire. If starter cranks engine the starter is okay, check solenoid, starter switches, safety switches and interlock switch. Check wires for poor connections, cuts or breaks.</p> <p>Check flywheel ring gear for broken teeth. Replace flywheel if necessary.</p>
Low RPM	<p>Unit controls engaged</p> <p>Worn bearings in cap assemblies</p> <p>Bent armature</p> <p>Binding armature</p> <p>Brushes not seated properly</p> <p>Weak or annealed brush springs</p> <p>Incorrect engine oil</p> <p>Dirty armature commutator</p> <p>Shorted or open armature</p> <p>Loose or faulty electrical connections in motor</p>	<p>Insure all unit controls are in neutral or disengaged.</p> <p>Clean bearings or replace cap assemblies.</p> <p>Replace armature.</p> <p>Free up armature. Adjust armature end play.</p> <p>Correct.</p> <p>Replace springs.</p> <p>Ensure the correct weight of oil is being used.</p> <p>Clean commutator.</p> <p>Replace armature.</p> <p>Correct.</p>

TROUBLESHOOTING 12 VOLT STARTERS (Cont.)

PROBLEM	PROBABLE CAUSE	FIX
<p>Motor stalls under load</p> <p>Intermittent operation</p> <p>Sluggish disengagement of the drive assembly pinion gear</p>	Shorted or open armature	Replace armature.
	Shorted field coil	Correct, or replace housing assembly.
	Brushes binding in holders	Free up brushes. Replace worn brushes and those which have come in contact with grease and oil.
	Dirty or oily commutator	Clean and dress commutator.
	Loose or faulty electrical connections	Correct
	<p>Open armature</p> <p>Break in electrical circuit</p>	<p>Replace armature and interlock switch.</p> <p>Disconnect ignition cut-off wire at the engine. Crank engine, if spark, check ignition switch, safety switch and interlock switch. Check wires for poor connections, cuts or breaks.</p>
Sluggish disengagement of the drive assembly pinion gear	Dirt and oil on assembly and armature shaft	Clean drive assembly and armature shaft and relubricate shaft splines.
	Bent armature	Replace armature.

Chapter 14

ENGINE SPECIFICATIONS

	VLV40		VLV50, 55, 60, 65	
	11.19	183.4 cc	12.6	207 cc
Displacement	11.19	183.4 cc	12.6	207 cc
Stroke	2.047	51.993 mm	2.047	51.993 mm
Bore	$\frac{2.6390}{2.6380}$	67.031 mm	$\frac{2.796}{2.795}$	$\frac{71.018 \text{ mm}}{70.993 \text{ mm}}$
Air Gap Dimension Ignition	.0125	.30 mm	.0125	.30 mm
Spark plug gap	.030	.70 mm	.030	.70 mm
Valve Clearance Intake and Exhaust	$\frac{.004}{.008}$	$\frac{.101 \text{ mm}}{.203 \text{ mm}}$	$\frac{.004}{.008}$	$\frac{.101 \text{ mm}}{.203 \text{ mm}}$
Valve Seat Angle	46°		46°	
Valve Seat Width	.047	1.2 mm	.047	1.2mm
Valve Guide Oversize Dia.	$\frac{.2807}{.2817}$	$\frac{71.297 \text{ mm}}{71.551 \text{ mm}}$	$\frac{.2807}{.2817}$	$\frac{71.297 \text{ mm}}{71.551 \text{ mm}}$
Crankshaft End Play	$\frac{.005}{.027}$	$\frac{.127 \text{ mm}}{.685 \text{ mm}}$	$\frac{.005}{.027}$	$\frac{.127 \text{ mm}}{.685 \text{ mm}}$
Crankpin Journal Dia.	$\frac{1.0235}{1.0230}$	$\frac{25.996 \text{ mm}}{25.984 \text{ mm}}$	$\frac{1.0235}{1.0230}$	$\frac{25.996 \text{ mm}}{25.984 \text{ mm}}$
Crankshaft Magneto Main Brg. Dia	$\frac{1.0242}{1.0237}$	$\frac{26.014 \text{ mm}}{26.001 \text{ mm}}$	$\frac{1.0242}{1.0237}$	$\frac{26.014 \text{ mm}}{26.001 \text{ mm}}$
Crankshaft P.T.O. Main Brg. Dia	$\frac{1.0242}{1.0237}$	$\frac{26.014 \text{ mm}}{26.001 \text{ mm}}$	$\frac{1.0242}{1.0237}$	$\frac{26.014 \text{ mm}}{26.001 \text{ mm}}$
Camshaft Bearing Dia.	$\frac{.4980}{.4975}$	$\frac{12.649 \text{ mm}}{12.636 \text{ mm}}$	$\frac{.4980}{.4975}$	$\frac{12.649 \text{ mm}}{12.636 \text{ mm}}$
Conn. Rod Dia. Crank Brg.	$\frac{1.0246}{1.0240}$	$\frac{26.024 \text{ mm}}{26.009 \text{ mm}}$	$\frac{1.0246}{1.0240}$	$\frac{26.024 \text{ mm}}{26.009 \text{ mm}}$
Piston Diameter	$\frac{2.6340}{2.6330}$	$\frac{66.903 \text{ mm}}{66.878 \text{ mm}}$	$\frac{2.6340}{2.6330}$	$\frac{66.903 \text{ mm}}{66.878 \text{ mm}}$
Ring Groove Side Clearance 1st & 2nd Comp.	$\frac{.002}{.005}$	$\frac{.050 \text{ mm}}{.127 \text{ mm}}$	$\frac{.002}{.005}$	$\frac{.050 \text{ mm}}{.127 \text{ mm}}$
Side Clearance (Bot.) Oil	$\frac{.0005}{.0035}$	$\frac{.012 \text{ mm}}{.088 \text{ mm}}$	$\frac{.0005}{.0035}$	$\frac{.012 \text{ mm}}{.088 \text{ mm}}$
Piston Skirt Clearance measured 90° from pin at the bottom of the skirt	$\frac{.004}{.006}$	$\frac{.101 \text{ mm}}{.152 \text{ mm}}$	$\frac{.004}{.006}$	$\frac{.101 \text{ mm}}{.152 \text{ mm}}$
Ring End Gap	$\frac{.007}{.020}$	$\frac{.177 \text{ mm}}{.508 \text{ mm}}$	$\frac{.007}{.020}$	$\frac{.177 \text{ mm}}{.508 \text{ mm}}$
Cylinder Main Brg. Dia	$\frac{1.0262}{1.0257}$	$\frac{26.065 \text{ mm}}{26.052 \text{ mm}}$	$\frac{1.0262}{1.0257}$	$\frac{26.065 \text{ mm}}{26.052 \text{ mm}}$
Cylinder Cover/Flange Main Bearing Diameter	$\frac{1.0262}{1.0257}$	$\frac{26.065 \text{ mm}}{26.052 \text{ mm}}$	$\frac{1.0262}{1.0257}$	$\frac{26.065 \text{ mm}}{26.052 \text{ mm}}$

TORQUE SPECIFICATIONS

	Inch-Lbs.	Nm
Governor Rod Clamp to Lever	7-12	1.4 - 1.4
Breather Cover	40-50	4.5 - 5.7
Valve Box Cover	25-35	3.1 - 4.0
Connecting Rod	95-110	10.7 - 12.4
Cylinder Head	180-220	20.3 - 25
Mounting Flange or Cylinder Cover	100-130	11.3 - 14.7
Housing Baffle to Cylinder	80-120	9.0 - 13.6
Solid State Ignition to Cylinder	30-50	3.4 - 5.7
Alternating Coil Assembly to Lamination	25-35	2.8 - 4.0
Flywheel Nut	400-440	45.2 - 49.7
Housing to Baffle	35-45	4.0 - 5.1
Carburetor Stud to Cylinder	50-75	5.7 - 8.5
A/C Hex Nut to Stud	35-45	4.0 - 5.1
Control Face Plate to Baffle	30-40	3.4 - 4.5
Starter Top Mounting	20-30	2.3 - 3.4
Electric Starter to Baffle	25-35	2.8 - 3.9
5/8-18 Plug (Hex Flange) Drain plug	90-150	10.2 - 17.0
Plastic Tank to Housing	12-20	1.4 - 2.3
Threaded Fill Tube (Plastic)	45-65	4.0 - 7.3
Large Diameter Oil Fill Plug	Hand Tight	
Muffler Mounting (Shoulder Screw)	100-165	11.3 - 18.7
A/C Body & Housing to Baffle	35-45	4.0 - 5.1
Conduit Clip Screw (Throttle Cable)	5-15	.6 - 1.7
Muffler Deflector	10-15	1.1 - 1.7

Chapter 15

TRAINING AIDS AND TOOLS

VIDEO PROGRAMS



695015

Carburetor Troubleshooting. Covers identification of carburetors used on Tecumseh engines and how to troubleshoot and repair them. VHS only.

695059

Understanding Tecumseh Ignition Systems. A basic program designed to give the small engine technician first hand knowledge of Tecumseh ignition systems so the technician can understand the system and perform repairs to it. VHS only.

695148

Teardown and reassembly of the 900 series transaxles. This video will show a complete step-by-step procedure for teardown and reassembly of the 900, 910 and 920 series transaxles.

695185

Electrical Troubleshooting. This video training program will assist the small engine technician in the proper procedures for troubleshooting electrical systems on outdoor power equipment.

695285

An in-depth look at the 800 series transaxles. Detailing the teardown and reassembly procedures for the 800, 801 and 820 transaxles.

SPECIAL BOOKLETS INSTRUCTIONAL GUIDE

692738

Assists in the use and understanding of the Tecumseh Master Parts Manual. Illustrates time saving features incorporated into the manual. Explains new carburetor parts breakdown format.



4-CYCLE ENGINE FAILURE ANALYSIS

695590

This booklet is designed as a tool for the average technician to correctly assess the cause of failure.



ELECTRICAL TROUBLESHOOTING BOOKLET

693505A

This booklet contains schematic drawings of Tecumseh direct current and alternating current systems and how to check them when problems occur.



CARBURETOR TROUBLESHOOTING BOOKLET

695907

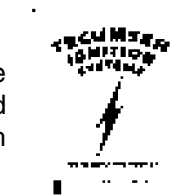
This booklet is designed as a quick reference to carburetion problems and related repair procedures.



IGNITION SYSTEMS TROUBLESHOOTING BOOKLET

694903

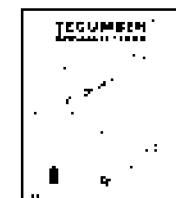
This booklet contains information on the identification, possible problems and related repair procedures of Tecumseh Ignition Systems.



SPECIAL TOOLS BOOKLET

694862

This booklet depicts all specialty tools offered by Tecumseh which can be used on 2 and 4 cycle engines and Peerless units.

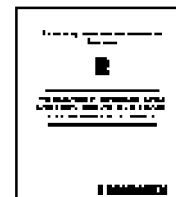


QUICK REFERENCE CHART BOOKLET

695933

This booklet contains the quick reference information found on Tecumseh wall charts.

This booklet is designed to be used as a work bench quick reference guide when servicing Tecumseh engines and motion drive systems.



TESTER BOOKLETS

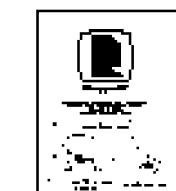
694529

Test procedures for Tecumseh electrical components using Graham-Lee Tester 31-SM or 31-SMX-H.



694530

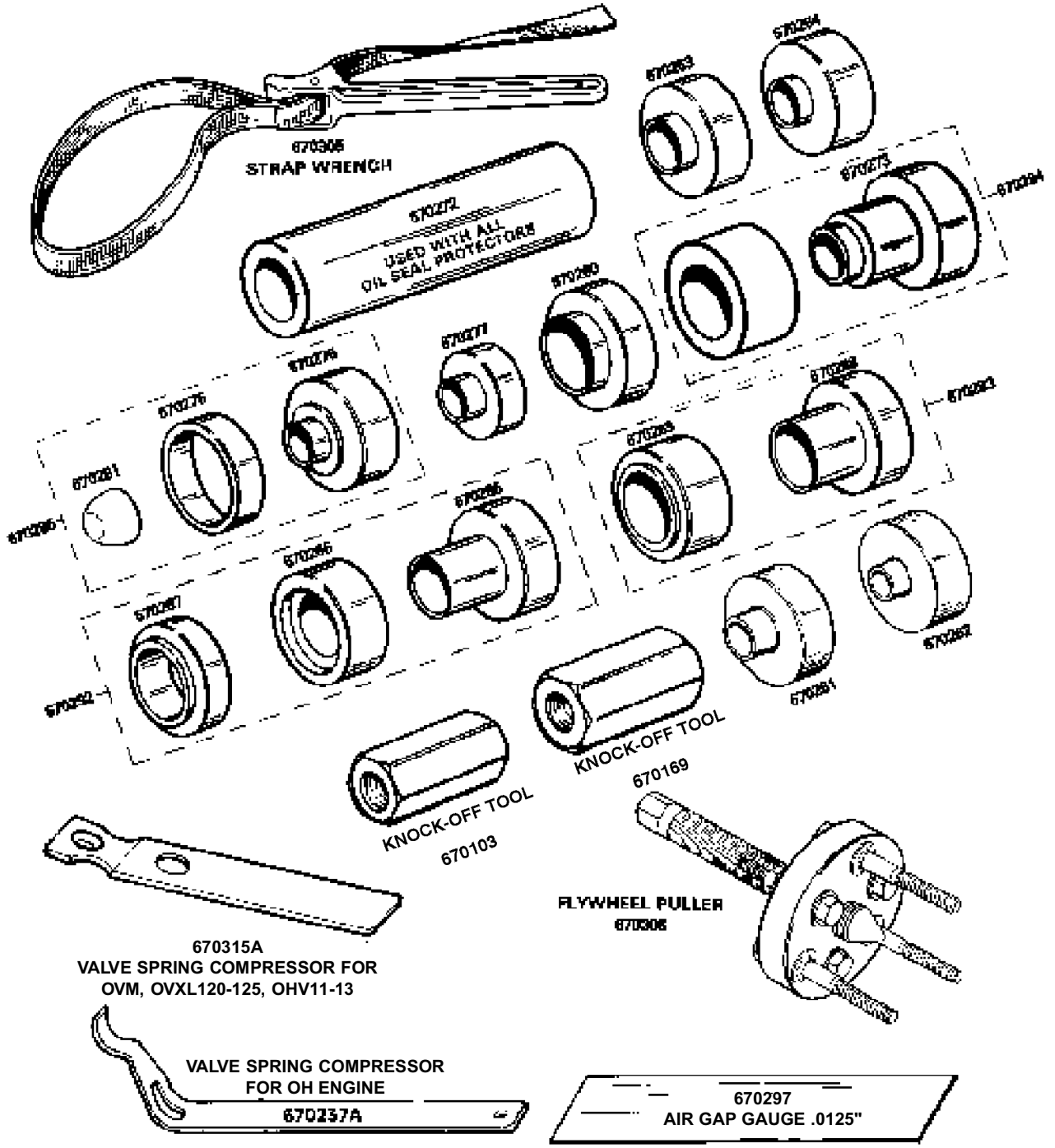
Test procedures for Tecumseh electrical components using Merco-O-Tronic Tester 9800. (Tests are similar for 98, 98A and 79.)



TOOLS

TOOL KIT 670195C

Kit contains tools for 2- and 4-cycle engines.
Includes all items on this page but items may be purchased separately.

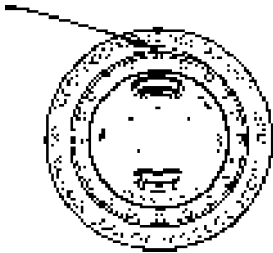


FLYWHEEL KNOCK-OFF TOOL

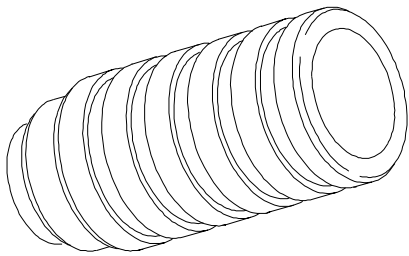


No. 670169

VIBRATION TACHOMETER



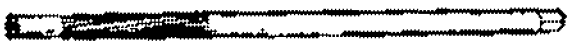
No. 670156 - Vibration tachometer.



No. 670327 - Seal Protector Driver



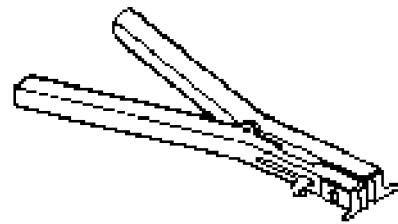
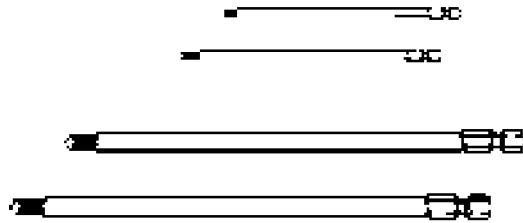
No. 670339 - E-5 Socket



No. 670283 - Valve Guide Reamer

TORX DRIVERS

- | | |
|---------|--------|
| Torx 8 | 670334 |
| Torx 10 | 670333 |
| Torx 15 | 670323 |
| Torx 20 | 670324 |
| Torx 25 | 670319 |
| Torx 30 | 670320 |



No. 670117 - Ring Expander

Chapter 16

SEARS CRAFTSMAN

CROSS REFERENCE CHART

143.434112	VLV55-501004
143.434252	VLV55-501008
143.945500	VLV55-501004A
143.956000	VLV60-502003A
143.956002	VLV60-502004A
143.956006	VLV60-502012A
143.966000	VLV60-502015B
143.966006	VLV60-502023B
143.966008	VLV60-502024B
143.966500	VLV65-502501A
143.966502	VLV65-502502A
143.966504	VLV65-502503A
143.966506	VLV65-502504A
143.966508	VLV65-502505A
143.976000	VLV60-502015C

DECIMAL/FRACTION CONVERSIONS

.016	=	1/64	.516	=	33/64
.031	=	1/32	.531	=	17/32
.047	=	3/64	.547	=	35/64
.063	=	1/16	.563	=	9/16
.078	=	5/64	.578	=	37/64
.094	=	3/32	.594	=	19/32
.109	=	7/64	.609	=	39/64
.125	=	1/8	.625	=	5/8
.141	=	9/64	.641	=	41/64
.156	=	5/32	.656	=	21/32
.172	=	11/64	.672	=	43/64
.188	=	3/16	.688	=	11/16
.203	=	13/64	.703	=	45/64
.219	=	7/32	.719	=	23/32
.234	=	15/64	.734	=	47/64
.25	=	1/4	.75	=	3/4
.266	=	17/64	.766	=	49/64
.281	=	9/32	.781	=	25/32
.297	=	19/64	.797	=	51/64
.312	=	5/16	.813	=	13/16
.328	=	21/64	.828	=	53/64
.344	=	11/32	.844	=	27/32
.359	=	23/64	.859	=	55/64
.375	=	3/8	.875	=	7/8
.391	=	25/64	.891	=	57/64
.406	=	13/32	.906	=	29/32
.422	=	27/64	.922	=	59/64
.438	=	7/16	.938	=	15/16
.453	=	29/64	.953	=	61/64
.469	=	15/32	.969	=	31/32
.484	=	31/64	.984	=	63/64
.50	=	1/2			