PIONEER

CHAIN SAWS

SHOP SERVICE MANUAL

PIONEER SAWS / Peterborough, Ontario, Canada; Lincoln, Nebraska, U.S.A.
a division of Outboard Marine Corporation, the manufacturers of Evinrude and Johnson outboard motors & snowmobiles and Lawn-Boy power mowers.

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OPERATING PRINCIPLES

The power source for the chain saw does not differ basically from that used to power automobiles, farm or garden tractors, lawn mowers, or many other items of power equipment in use today. All are technically known as "Internal Combustion, Reciprocating Engines."

The source of power is heat formed by the burning of a combustible mixture of petroleum products and air. In a reciprocating engine, this burning takes place in a closed cylinder containing a piston. Expansion resulting from the heat of combustion applies pressure on the piston to turn a shaft by means of a crank and connecting rod.

The fuel mixture may be ignited by means of an electric spark (Otto Cycle Engine) or by the heat of compression (Diesel Cycle). The complete series of events which must take place in order for the engine to run may occur in one revolution of the crankshaft (referred to as Two-Stroke Cycle), or in two revolutions of the crankshaft (Four-Stroke Cycle).

As the two-stroke cycle spark ignition engine is universally used as the power source for chain saws, this will be the only type engine discussed in this section.

OTTO CYCLE. In a spark ignited engine, a series of five events are required in order to provide power. This series of events is called the **Cycle** (or Work Cycle) and is repeated in each cylinder as long as work is done. The series of events which comprise the work cycle are as follows:

1. The mixture of fuel and air is pushed or drawn into the cylinder, by reducing cylinder pressure to less than the outside pressure, or by applying an initial, higher pressure to the fuel charge.
2. The mixture is compressed, or reduced in volume.
3. The mixture is ignited by a timed electric spark.
4. The burning fuel-air mixture expands, forcing the piston down, thus converting the generated chemical energy into mechanical power.
5. The burned gases are exhausted from the cylinder so that a new cycle can begin.

The series of events comprising the work cycle are commonly referred to as INTAKE, COMPRESSION, IGNITION, EXPANSION (POWER), and EXHAUST.

TWO-STROKE CYCLE. In a two-stroke cycle engine, the five events of intake, compression, ignition, power and exhaust must take place in two strokes of the piston; or one revolution of the crankshaft. Thus, a compressed fuel charge is fired each time the piston reaches the top of the cylinder, and each downward stroke is a power stroke. In order to accomplish this, the initial pressure of the incoming fuel-air mixture must be raised to a point somewhat higher than the lowest pressure existing in the cylinder, or a fresh charge of fuel could not be admitted and the engine would not run. This elevation of pressure requires the use of an air pump, or compressor, of approximately the same volume as the cylinder itself. Coincidentally, such an air pump is available with a minimum of additional parts, cost, or friction losses by utilizing the opposite side of the piston and cylinder as the pump. Such engines are called "Crankcase Scavenged," and are universally used in the chain saw industry.

Fig. CS1 shows a schematic view of the crankcase scavenged, reed valve type, two-stroke cycle engine commonly used. The general sequence of events required for operation is as follows: As the piston moves outward from the crankshaft as shown in view "B", the volume of the closed crankcase is enlarged and the pressure lowered, causing air to be drawn through the carburetor (C), where it is mixed with fuel. This mixture is then drawn through the reed valve (R) and into the crankcase. At the same time, a previous charge of fuel is being compressed between head of piston and closed end of cylinder as shown by the darkened area. As the piston approaches top center, a timed spark ignites the compressed fuel charge and the resultant expansion moves the piston downward on the power stroke. The reed valve (R) closes, and downward movement of piston compresses the next fuel charge in the crankcase as shown in view "A". When the piston nears the bottom of its stroke, the crown of piston uncovers the exhaust port (EX) in cylinder wall, allowing the combustion products and remaining pressure to escape as shown by the wavy arrow. Further downward movement of piston opens the transfer port (TP) leading from the crankcase to cylinder; and the then higher crankcase pressure forces the compressed fuel-air mixture through transfer port into the cylinder. The baffle which is built into crown of piston deflects the incoming charge upward, and most of the remaining exhaust gases are driven from the combustion chamber by this fresh charge. Two-stroke cycle, crankcase scavenged engines are sometimes produced with a fuel induction system other than the inlet reed valve. The two induction systems used in chain saw engines in addition to the reed valve are the three-port system illustrated in Fig. CS2 and the rotary valve system illustrated in Fig. CS3.

In the crankcase scavenged engine, most of the friction parts requiring lubrication are located in the fuel intake system. Lubrication is accomplished by mixing the required amount of oil with the fuel, so that a small amount of oil in the form of a

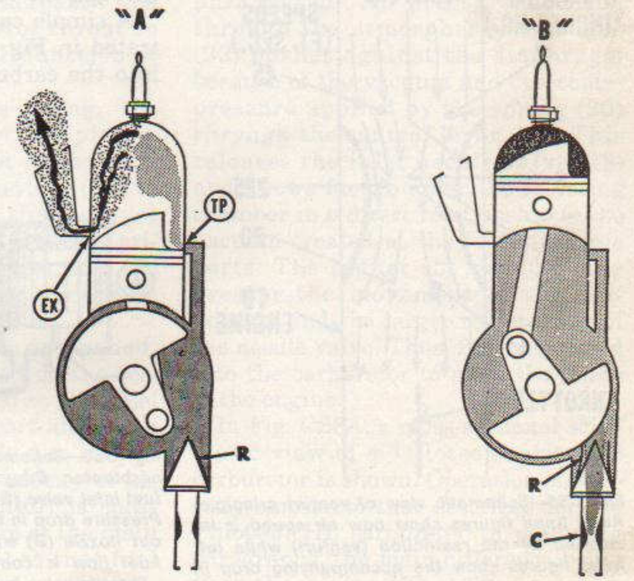


Fig. CS1—Schematic view of two-stroke cycle, crankcase scavenged engine used in most chain saws. The series of events comprising the Otto cycle takes place in one revolution of the crankshaft by using the crankcase as a scavenging pump.

C. Carburetor
R. Reed valve
TP. Transfer port
EX. Exhaust port

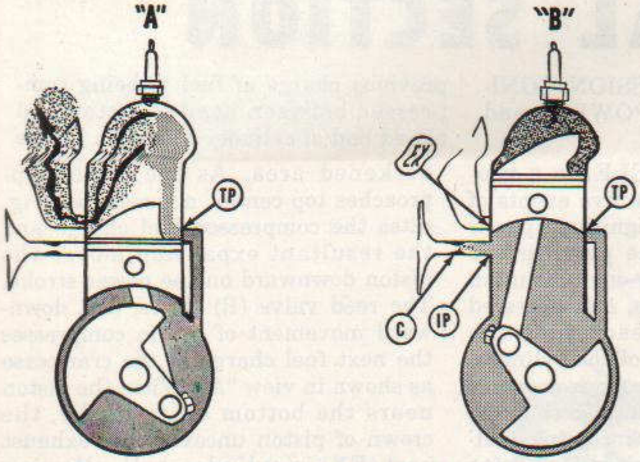


Fig. CS2—Two cycle, three port engine. Principles are similar to reed valve or rotary valve types except that a third, intake port is located in cylinder wall and opened and closed by the piston skirt.

C. Carburetor
EX. Exhaust port
IP. Intake port
TP. Transfer port

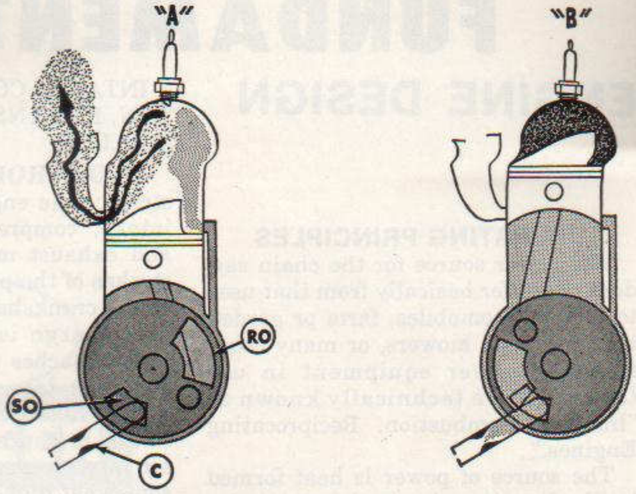


Fig. CS3—Two cycle, rotary valve engine. The incoming fuel charge is controlled by a rotary valve attached to the crankshaft. The opening in valve (RO) and crankcase (SO) align at the proper time to admit a fresh charge, then close to allow initial crankcase compression.

C. Carburetor
RO. Opening in rotating member
SO. Opening in crankcase wall

fine mist is drawn into the crankcase with each fuel charge. It should be pointed out that the new oil brought into the crankcase can do little more than supplement the losses, therefore it is necessary that the friction parts be well lubricated at the time the engine is started. The use of too much oil in the fuel mixture results in plug fouling, excessive carbon, and poor performance, as well as being wasteful.

CARBURETION

The function of the carburetor is to atomize the fuel and mix it with the air flowing through the carburetor and into the engine. The carburetor must also meter the fuel so that the proper fuel-air ratio for different engine operating conditions is provided. Normal fuel-air ratios are approximately as follows:

	Fuel	Air
For starting in cold weather	1 lb.	7 lbs.
For idling	1 lb.	11 lbs.
For full load at open throttle	1 lb.	13 lbs.

Carburetor design is based on the venturi principle which is that a gas or liquid flowing through a necked-down section (venturi) in a passage undergoes an increase in speed and a decrease in pressure as compared to its speed and pressure in the full sized sections of the passage. This principle is illustrated in Fig. CS5. Due to the low pressure at the venturi, fuel is drawn out through the fuel jet and is atomized by the stream of air flowing through the venturi.

A simple carburetor design is illustrated in Fig. CS6 where flow of fuel into the carburetor is controlled by a float valve. With the float type carburetor, the carburetor must be kept in a nearly upright position for the float valve to function. Early chain saws using this type of carburetor had a provision for tilting the bar and chain independently of the engine.

Later development of a floatless carburetor that would function in any position allowed a more simple and lighter design of chain saws. In this carburetor, the flow of fuel into the carburetor is controlled by linking the

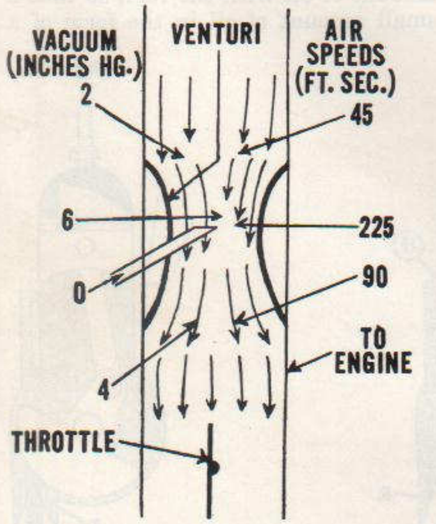


Fig. CS5—Schematic view of venturi principle. Right hand figures show how air speed is increased by the restriction (venturi) while left hand figures show the accompanying drop in air pressure.

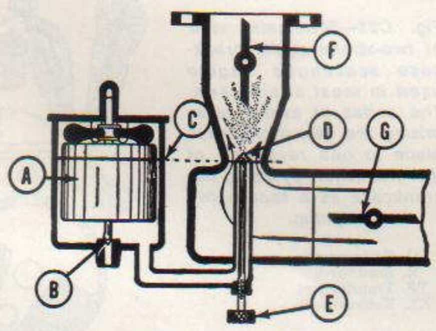


Fig. CS6—Schematic view of simple float-type carburetor. Buoyancy of float (A) closes the fuel inlet valve (B) to maintain fuel level at (C). Pressure drop in the venturi causes fuel to flow out nozzle (D) which is just above fuel level. Fuel flow is controlled by mixture valve (E). Throttle valve is at (F) and choke valve at (G)

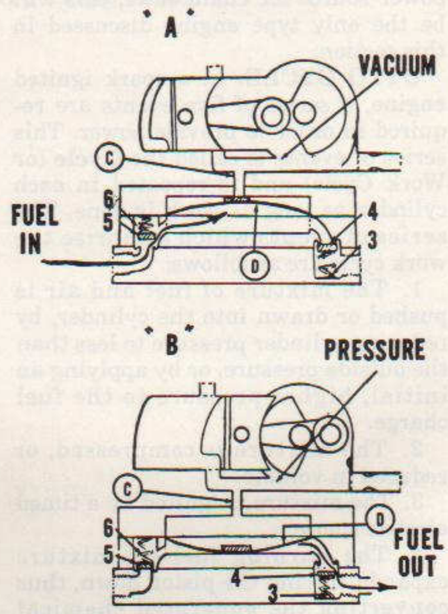


Fig. CS7—Schematic view of a typical, crankcase operated, diaphragm type fuel pump. Pressure and vacuum pulsations from crankcase pass through connection (C) to rear of diaphragm (D) which induces a pumping action on fuel line as shown.

3. Valve spring
4. Outlet check valve
5. Inlet check valve
6. Valve spring

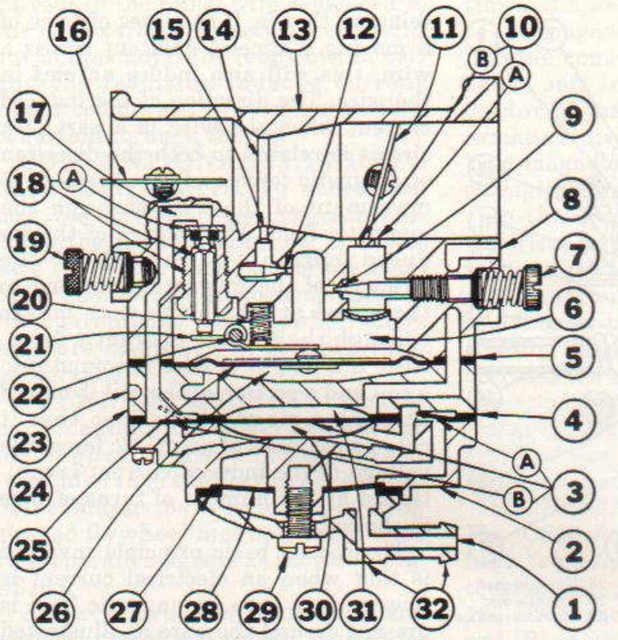


Fig. CS8—Cross-sectional schematic view of Tillotson series HL diaphragm carburetor. Some models of this type carburetor are equipped with an accelerator pump

1. Fuel inlet
2. Pump body
3. Pump diaphragm
3 A&B. Pump valves
4. Gasket
5. Gasket
6. Metering chamber
7. Idle needle
8. Impulse channel
9. Idle fuel orifice
10. Idle ports
11. Throttle shutter
12. Main fuel orifice
13. Body
14. Venturi
15. Main fuel port
16. Choke shutter
17. Inlet channel
18. Inlet valve
19. Main needle
20. Spring
21. Diaphragm lever
22. Fulcrum pin
23. Vent hole
24. Cover
25. Diaphragm
26. Atmospheric chamber
27. Gasket
28. Screen
29. Screw
30. Fuel chamber
31. Pulse chamber
32. Strainer cover

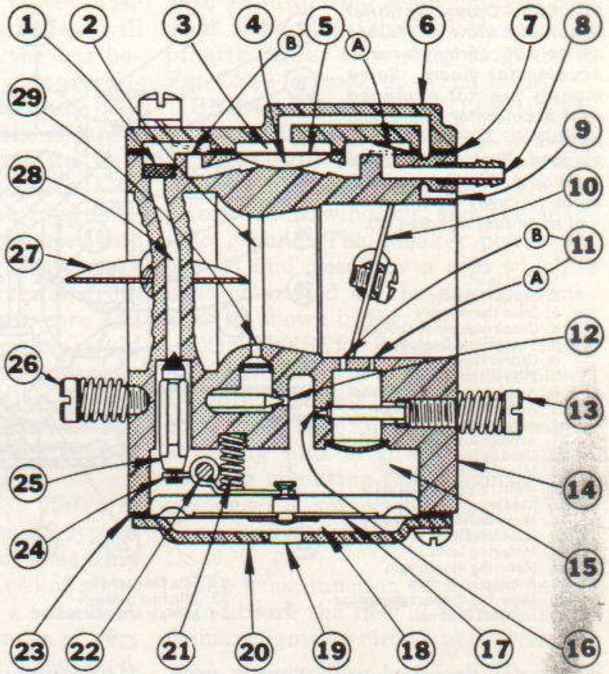


Fig. CS8A—Cross-sectional view of typical Series HS Tillotson diaphragm type carburetor

1. Filter screen
2. Venturi
3. Pulse chamber
4. Fuel chamber
5. Pump diaphragm
5A. Inlet valve
5B. Outlet valve
6. Pump body
7. Gasket
8. Inlet fitting
9. Impulse channel
10. Throttle plate
11. Primary (A) and secondary (B) idle ports
12. Main fuel orifice
13. Idle fuel needle
14. Carburetor body
15. Metering chamber
16. Idle fuel orifice
17. Metering diaphragm
18. Atmospheric chamber
19. Vent hole
20. Diaphragm cover
21. Spring
22. Fulcrum pin
23. Gasket
24. Diaphragm lever
25. Inlet valve
26. Main fuel needle
27. Choke disc
28. Inlet channel
29. Main fuel port

inlet valve to a spring-loaded diaphragm. The spring pressure is counteracted by suction through the fuel jets at the venturi of the carburetor.

To provide fuel at the carburetor with the engine in an inverted position, a fuel pump is usually incorporated within the diaphragm type carburetor. As the crankcase of 2-cycle engines is subjected to alternate surges of pressure and vacuum at each stroke of the piston, a diaphragm vented to the crankcase will pulsate at each turn of the engine crankshaft. Thus, the pulsating diaphragm can be used as a fuel pump. See Fig. CS7.

A cross-sectional schematic view of a typical Tillotson series HL diaphragm type carburetor with integral fuel pump is shown in Fig. CS8. The top of the pump diaphragm is vented to the engine crankcase through the channel (8). As the diaphragm pulsates, fuel is drawn into the carburetor through inlet (1), screen (28) and pump inlet valve (3A). The fuel is then pumped through the outlet valve (3B) into the supply channel (17). Engine suction through the main jet (15) and idle jets (10) is transmitted to the top of the carburetor diaphragm (25) and atmospheric pressure through the vent (23) pushes upward on the diaphragm (25) overcoming spring (20) pressure and unseating the inlet needle (18) allowing fuel to flow into the diaphragm chamber (6).

When starting an engine, closing the choke disc (16) increases the vacuum in the carburetor throat so that the carburetor will function at the low cranking RPM.

When the engine is idling, the throttle disc is almost completely closed and there is not enough air passing through the venturi (14) to create any vacuum on the main jet (15). A vacuum is created at the primary idle jet (10A), however, and the fuel necessary for running the engine is drawn through that jet.

As the throttle disc is opened, enough vacuum is created on the secondary idle jet port (10B) so that fuel is drawn through that port also. At a certain point, the throttle disc is open far enough so that the velocity of air passing through the venturi is sufficient to lower the pressure at the main fuel discharge port (15) so that fuel will flow through this port also. Opening the throttle disc farther results in higher air velocities and lower venturi pressures that increase the flow of fuel out of the discharge ports.

Any vacuum created at the idle discharge ports (10) or the main fuel discharge port (15) is transferred through the metering chamber (6) to the diaphragm (25). Air pressure entering through the atmospheric vent hole (23) pushes against the diaphragm because of the vacuum and overcomes pressure applied by the spring (20) through the control lever (21). This releases the inlet needle valve (18) and allows fuel to enter the metering chamber in a direct relationship to the vacuum created at the fuel discharge ports. The higher the vacuum, the greater the movement of the diaphragm and the larger the opening of the needle valve. Thus, fuel is metered into the carburetor to meet the needs of the engine.

In Fig. CS8A, a cross-sectional schematic view of a Tillotson series HS carburetor is shown. Operation is basically similar to that described for the Tillotson HL carburetor in preceding paragraphs, the main difference being that the series HS carburetor is a

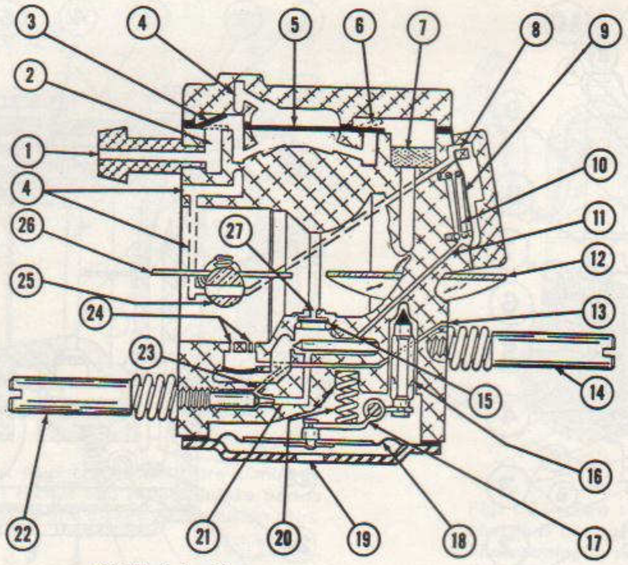


Fig. CS9—Cross-sectional schematic view of Walbro series SDC carburetor with accelerator pump. Some models are not equipped with accelerator pump and passages (8 & 11) are plugged. Fuel cavity above metering diaphragm extends to cavity shown at tip of main fuel needle (14).

1. Fuel inlet
2. Surge chamber
3. Inlet check valve
4. Crankcase pulse channel
5. Fuel pump diaphragm
6. Outlet check valve
7. Fuel filter
8. Accelerator pulse channel
9. Accelerator diaphragm
10. Accelerator spring
11. Accelerator fuel channel
12. Choke disc
13. Idle air bleed channel
14. Main (high speed) fuel needle
15. Main orifice check valve
16. Inlet needle
17. Metering lever
18. Metering diaphragm
19. Atmospheric vent
20. Metering diaphragm spring
21. Idle fuel channel
22. Idle fuel needle
23. Idle fuel passage
24. Idle air and fuel holes
25. Throttle shaft
26. Throttle disc
27. Main fuel orifice

compactly designed unit usually used on lightweight, small displacement engines.

Another compact diaphragm carburetor, the Walbro series SDC, is shown in cross-sectional schematic view in Fig. CS9. Except for some models, the Walbro SDC carburetor is equipped with an accelerator pump. When throttle is open, indexing hole in throttle shaft (25) opens pulse passage (4) to accelerator pump passage (8). Pressure against pump diaphragm (9) compresses spring (10) and pressurizes fuel passage (11), ejecting excess fuel from main nozzle (27). When throttle is closed, or partially closed, indexing hole closes pulse passage and accelerator pump spring returns diaphragm to original position, drawing fuel back up passage (11) to recharge accelerator pump.

At idle speed, air is drawn into carburetor through air bleed hole (13) and mixed with fuel from idle fuel passage in what is called the "emulsion channel". More air enters idle fuel cavity through the two idle holes (24) nearest venturi and the fuel-air mixture is ejected from the third idle hole. Air cannot enter the main fuel nozzle (27) as the check valve (15) closes against its seat when engine is idling. Note that idle fuel supply must first pass main (high speed) metering needle (14) before it reaches idle fuel needle (22).

CONVENTIONAL FLYWHEEL MAGNETO IGNITION SYSTEM

The fundamental principles of the flywheel magneto ignition system in general use on chain saw engines are presented in this section. As the study of magnetism and electricity is an entire scientific field, it is beyond the scope of this manual to fully explore these subjects. However, the information contained in this section should impart a working knowledge of the flywheel type magneto which will be useful when servicing chain saw ignition systems.

BASIC PRINCIPLES. Although the design of different flywheel magnetos varies, all flywheel magnetos operate on the same basic principles of electro-magnetic induction of electricity and formation of magnetic fields by electrical current.

The principle of electro-magnetic induction of electricity is as follows: When a wire (conductor) is moved through a magnetic field so as to cut across lines of magnetic force (flux), a potential voltage (electro-motive force or emf) is induced in the wire. If the wire is a part of a completed electrical circuit, current will flow through the circuit as illustrated in Fig. CS10. It should be noted that the movement is

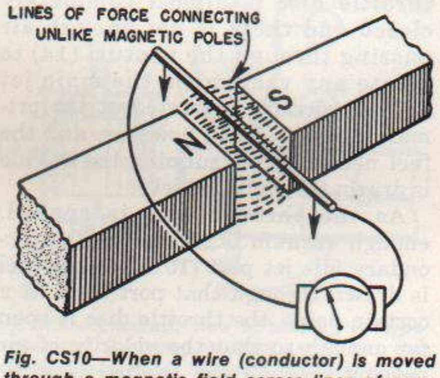


Fig. CS10—When a wire (conductor) is moved through a magnetic field across lines of magnetic force, an electro-motive force is induced into the wire. If the wire is a part of an electrical circuit, current will flow in the circuit as shown.

relative; that is, if the lines of force of a moving magnetic field cut across a wire, this will also induce an emf in the wire. The direction of the induced current when the wire is a part of a circuit is related to both the direction of magnetic force and the direction of movement of the wire through the magnetic field. The voltage of the induced current is related to the strength of the magnetic field and to the speed at which the wire moves through the lines of magnetic force. Also, if a length of wire is wound into a coil and a section of the coil is moved through a magnetic field so that it cuts across lines of magnetic force, the voltage of the induced current is multiplied by the number of turns of wire in the coil.

The second basic principle involved is that when an electrical current is flowing in a wire, a magnetic field is present around the wire as illustrated in Fig. CS11. The direction of force of the magnetic field is related to the direction of current in the wire and the strength of the magnetic field is related to the rate of flow of the electrical current. If the wire is wound in a coil, the magnetic forces around the wire converge to form a stronger single magnetic field as shown in Fig. CS12. If the wire is coiled closely, there is little tendency for the magnetic forces to surround individual loops of the coil.

When there is a change in the current flowing in a wire, there is a corresponding change in the magnetic field surrounding the wire. If the current ceases to flow, the magnetic field will "collapse." Thus, it can be seen from the illustration in Fig. CS12 that if

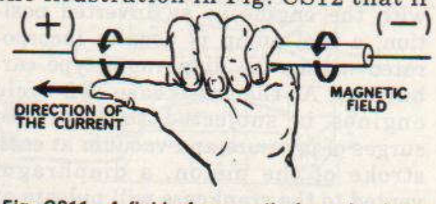


Fig. CS11—A field of magnetic force is always present around a wire through which current is flowing. The direction of magnetic force is related to the direction of electrical current as shown.

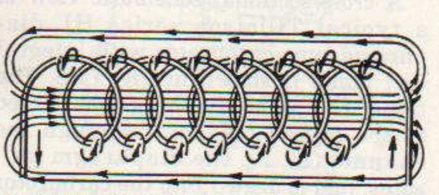


Fig. CS12—When a wire carrying an electrical current is wound in the shape of a coil or helix, the magnetic field surrounding loops of the wire tend to converge into a single electro-magnetic field as shown. If the loops of the coil are wound closely together, there is very little tendency for the electro-magnetic field to surround individual loops of the coil.

current in the coiled wire would cease, the collapsing magnetic field would cut across adjacent loops of the coil and the resulting induced current would counteract any change in flow of current through the coil.

CONVENTIONAL FLYWHEEL MAGNETO PARTS. To understand how the flywheel type magneto produces the ignition spark, it is necessary to identify each part of the magneto. The various component parts of the conventional type flywheel magneto are discussed in the following paragraphs.

FLYWHEEL MAGNETS. Permanent magnets are either attached to the flywheel as shown in Fig. CS13 or imbedded into the flywheel casting. Some magnetos use a single ring shaped flywheel magnet; others use two separate magnets as shown in Fig. CS13.

Alnico, a steel alloy containing aluminum, nickel and cobalt, is used for the flywheel magnet or magnets as Alnico retains strong magnetic properties for very long periods of time.

ARMATURE CORE (LAMINATIONS). As shown in Fig. CS14, a field of magnetic force surrounds the poles of a permanent magnet at all times. If a soft iron bar is moved close to the magnet, the magnetic field will become concentrated in the bar because soft iron is a very good conductor of magnetic flux. Thus, the armature core is used in the flywheel type magneto to concentrate the field strength of the flywheel magnets.

In the operation of the magneto, electrical currents can be induced into the armature core. To prevent these stray currents (eddy currents) from building up in the armature core and creating magnetic forces which would decrease the efficiency of the magneto, the armature core is built up of thin plates (laminations) as shown in Fig. CS15. Thus, the armature core is sometimes called laminations.

HIGH TENSION COIL. Refer to Fig. CS16 for construction of typical high tension coil. The coil assembly consists of a primary coil (A) of about 100-200 turns of wire and a secondary coil (B) of about 10,000 turns of very fine wire. The wire is insulated, usually with a fine coating of enamel, and a paper insulating strip is placed between each layer of wire. The entire coil assembly is then impregnated with an insulating compound and covered with varnished cloth tape or plastic. Refer to wiring diagram in Fig. CS19 for hook-up of coil leads.

BREAKER (CONTACT) POINTS. Refer to the magneto wiring diagram in Fig. CS19. The breaker points are installed between the lead from the primary coil windings and the magneto ground. The breaker points are opened and closed by a cam which is usually located on the engine crankshaft as shown in Fig. CS17.

CONDENSER. Refer to Fig. CS18 for construction of a typical condenser. Usually, the lead from one end of the condenser is connected to the metal covering and is thereby grounded through mounting the condenser. The condenser is connected in parallel with the breaker points as shown in Fig. CS19.

The basic function of the condenser is to absorb the flow of current in the primary ignition circuit to prevent the

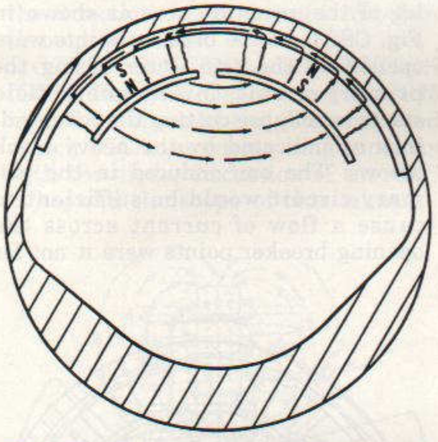


Fig. CS13—Cut-away of typical flywheel used for magneto rotor. The permanent magnets are usually cast into the flywheel. For flywheel magnetos having the ignition coil and core mounted to outside of flywheel, magnets would be flush with outer diameter of flywheel.

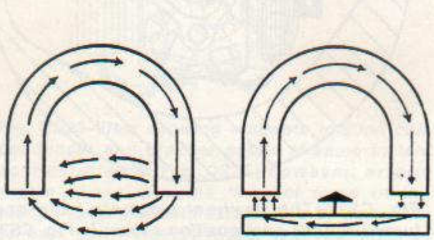


Fig. CS14—Drawing showing function of magneto armature core. At left, lines of force of permanent magnet are dispersed in the air. When a soft iron bar, which is an excellent conductor of magnetism, is moved close to the magnetic poles, the magnetic field becomes concentrated in the bar.

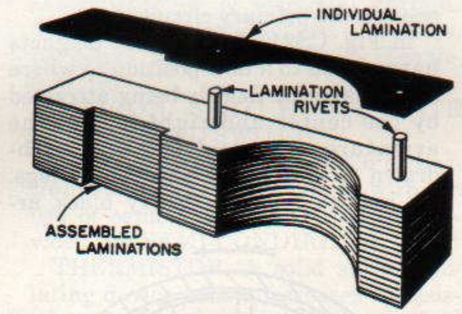


Fig. CS15–To prevent stray electrical currents (eddy currents) from building up within armature core and creating opposing magnetic fields that would decrease efficiency of magneto, armature core is constructed of thin plates (laminations) that are insulated from each other. (Oxide on surfaces of laminations usually provides sufficient insulation, although laminations in some magnetos are painted or varnished.)

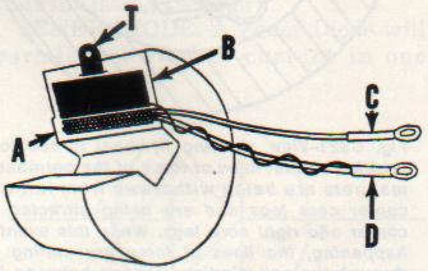


Fig. CS16–Cross-sectional view of a typical high tension coil. Primary windings (A) consist of 100-200 turns of copper wire. Secondary windings consist of about 10,000 turns of very fine wire. Lead (C) is to insulated terminal of breaker points. Lead (D) is to ground. Spark plug (high tension wire) attaches to terminal (T).

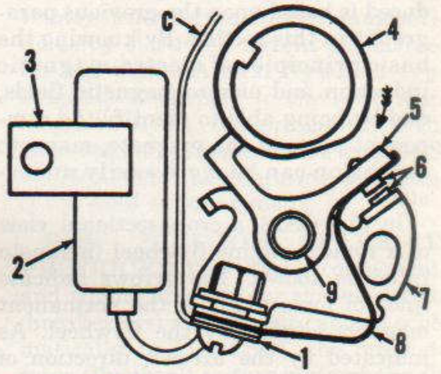


Fig. CS17–Typical flywheel magneto breaker point unit. Cam (4) is driven by engine crankshaft. Breaker arm spring (8) connects insulated contact point on breaker arm (5) to terminal (1).

C. Lead to primary coil
1. Insulated terminal
2. Condenser
3. Condenser ground (mounting) strap
4. Breaker cam
5. Breaker arm
6. Contact points
7. Breaker base
8. Spring
9. Pivot pin

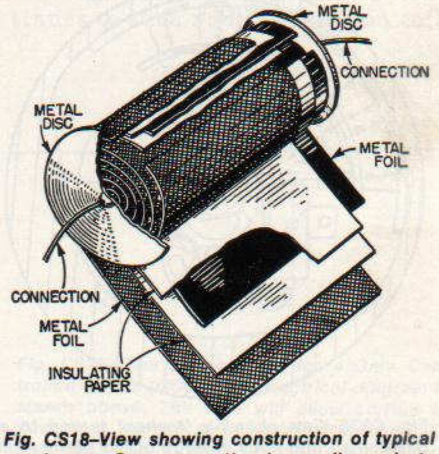


Fig. CS18–View showing construction of typical condenser. One connection is usually made to the metal housing of the condenser and is grounded to the magneto base plate through the condenser mounting strap (3–Fig. CS17).

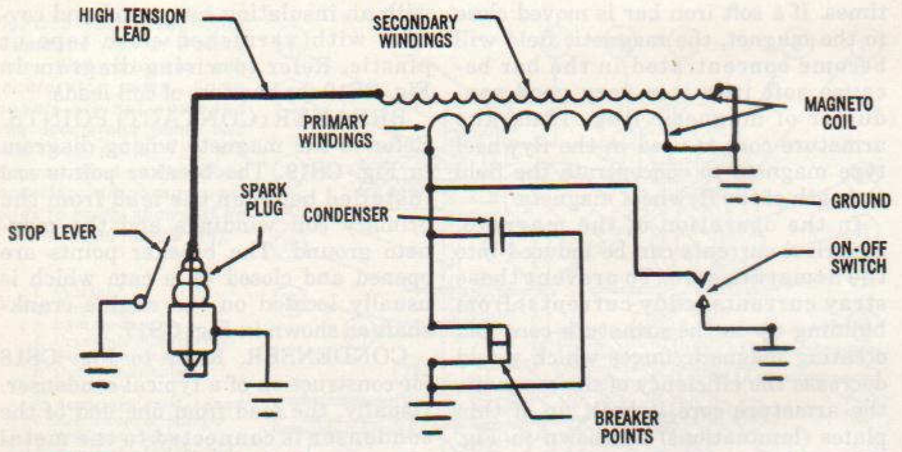


Fig. CS19–Typical wiring diagram for conventional flywheel type magneto. An on-off switch to stop the engine may be attached to the magneto primary circuit to ground out the system, or a stop lever may be used to ground out the center electrode of the spark plug.

current from arcing across the opening breaker points.

HOW IGNITION SPARK IS PRODUCED. The following explanation of how the ignition spark is produced is based upon the previous paragraphs in this section. By knowing the basic principles of electro-magnetic induction and electro-magnetic fields, and by being able to identify the component parts of the magneto, magneto operation can be more easily understood.

In Fig. CS13, a cross-sectional view of a typical engine flywheel (magneto rotor) is shown. The arrows indicate lines of force (flux) of the permanent magnets carried by the flywheel. As indicated by the arrows, direction of force of the magnetic field is from the north pole (N) of the left magnet to the south pole (S) of the right magnet.

Figs. CS20, CS21, CS22 and CS23 illustrate the operational cycle of the flywheel type magneto. In Fig. CS20, the flywheel magnets have moved to a position over the left and center legs of the armature (ignition coil) core. As the magnets moved into this position, their magnetic field was attracted by the armature core as illustrated in Fig. CS14 and a potential voltage (emf) was induced in the coil windings. However, this emf was not sufficient to cause current to flow across the spark plug electrode gap in the high tension circuit and the points were open in the primary circuit.

In Fig. CS21, the flywheel magnets have moved to a new position to where their magnetic field is being attracted by the center and right legs of the armature core, and is being withdrawn from the left and center legs. As indicated by the heavy black arrows, the lines of force are cutting up through the section of coil windings between the left and center legs of the armature and are cutting down through the coil windings section between the center and right legs. If the right hand rule, as explained in a previous paragraph, is applied to the lines of force cutting through the coil sections, it is seen that the resulting emf induced in the primary circuit will cause a current to flow through the primary coil windings and the breaker points which have now been closed by action of the cam.

At the instant the movement of the lines of force cutting through the coil winding sections is at the maximum rate, the maximum flow of current is obtained in the primary circuit. At this time, the cam opens the breaker points interrupting the primary circuit and, for an instant, the flow of current is absorbed by the condenser as illustrated in Fig. CS22. An emf is also induced in the secondary coil windings, but the voltage is not sufficient to cause current to flow across the spark plug gap.

The flow of current in the primary windings created a strong electromagnetic field surrounding the coil windings and up through the center leg of the armature core as shown in Fig. CS23. As the breaker points were opened by the cam, interrupting the primary circuit, this magnetic field starts to collapse cutting the coil windings as indicated by the heavy black arrows. The emf induced in the primary circuit would be sufficient to cause a flow of current across the opening breaker points were it not for

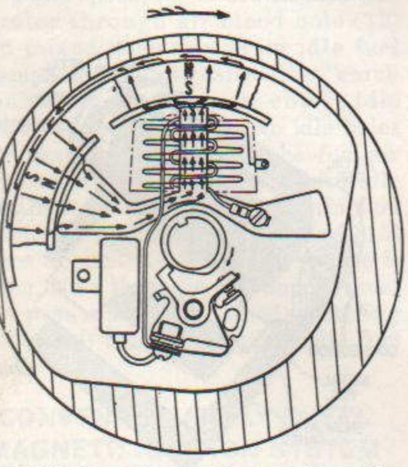


Fig. CS20–View showing flywheel turned to a position so that lines of force of the permanent magnets are concentrated in the left and center core legs and are interlocking the coil windings.

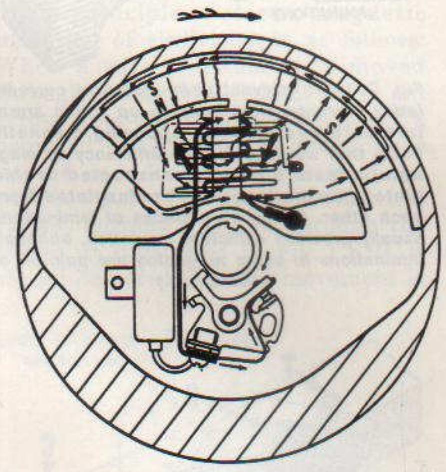


Fig. CS21–View showing flywheel turned to a position so that lines of force of the permanent magnets are being withdrawn from left and center core legs and are being attracted by center and right core legs. While this event is happening, the lines of force are cutting up through the coil windings section between left and center legs and are cutting down through section between the right and center legs as indicated by the heavy black arrows. The breaker points are now closed by the cam and a current is induced in the primary ignition circuit as lines of force cut through the coil windings.

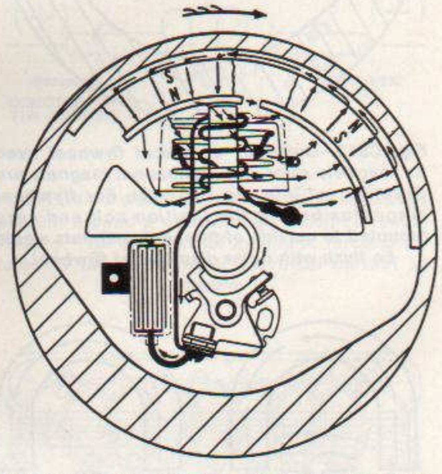


Fig. CS22–The flywheel magnets have now turned slightly past position shown in Fig. CS21 and rate of movement of lines of magnetic force cutting through coil windings is at maximum. At this instant, the breaker points are opened by the cam and flow of current in primary circuit is being absorbed by the condenser, bringing flow of current to a quick, controlled stop. Refer now to Fig. CS23.

the condenser absorbing the flow of current and bringing it to a controlled stop. This allows the electro-magnetic field to collapse at such a rapid rate to induce a very high voltage in the coil high tension or secondary windings. This voltage, in the order of 15,000 to 25,000 volts, is sufficient to break down the resistance of the air gap between the spark plug electrodes and a current will flow across the gap. This creates the ignition spark which ignites the compressed fuel-air mixture in the engine cylinder.

SOLID STATE IGNITION SYSTEMS

The introduction of the new ignition systems is bringing unfamiliar words into use which might be defined in the following non-technical terms:

CAPACITOR. The storage capacitor, or condenser.

DIODE. The diode is represented in wiring diagrams by the symbol as shown in Fig. CS24. Although the principle of diode operation is beyond the scope of this manual, it is sufficient to say that it is an electronic device that will permit passage of electrical current in one direction only. In electrical schematic diagrams, the arrow part of the symbol illustrates the direction which current can flow through the diode.

GATE CONTROLLED SWITCH (GCS). The symbol shown in Fig. CS25 is used to represent the gate controlled switch (GCS) in wiring diagrams. As with the diode, discussion of the GCS is beyond the scope of this manual. However, its action in an electrical circuit is as follows:

The GCS acts as a switch to permit passage of electrical current in the direction indicated by the arrow portion of the symbol (Fig. CS25) when in "ON" state and will not permit electric current to flow when in "OFF" state. The GCS can be turned "ON" by a positive surge of electricity at the gate (G) terminal and will remain "ON" as long as current remains positive at the gate terminal or as long as current is flowing through the GCS from anode (A) terminal to cathode (C) terminal. The GCS can be turned "OFF" with a negative surge of electricity at the gate (G) terminal or will go to "OFF" state if current stops flowing through the switch from anode (A) to cathode (C).

RECTIFIER. Any device which allows the flow of current in one direction only, or converts Alternating Current to Direct Current. Diodes are sometimes used in combination to form a BRIDGE RECTIFIER.

SCR. (Silicon Controlled Rectifier). See GATE CONTROLLED SWITCH.

SEMI-CONDUCTOR. Any of several materials which permit partial or controlled flow of electrical current. Used in the manufacture of Diodes, Rectifiers, SCR's, Thermistors, Thyristors, etc.

SILICON SWITCH. See GATE CONTROLLED SWITCH.

SOLID STATE. That branch of electronic technology which deals with the use of semi-conductors as control devices. See SEMI-CONDUCTOR.

THERMISTOR. A solid state regulating device which decreases in resistance as its temperature rises. Used for "Temperature Compensating" a control circuit.

THYRISTOR. A "Safety Valve" placed in the circuit which will not pass current in either direction but is used to provide surge protection for the other elements.

TRIGGER. The timed, small current which controls, or opens, the "Gate", thus initiating the spark.

ZENER DIODE. A Zener Diode will permit free flow of current in one direction, and will also permit current to flow in the opposite direction when the voltage reaches a pre-determined level.

Solid State (Breakerless) Magneto Ignition System

The solid state (breakerless) magneto ignition system operates somewhat on the same basic principles as the conventional type flywheel magneto previously described. The main difference is that the breaker contact points are replaced by a solid state electronic Gate Controlled Switch (GCS) which has no moving parts. Since, in a conventional system, the breaker points are closed over a longer period of crankshaft rotation than is the "GCS", a diode has been added to the circuit to provide the same characteristics as closed breaker points.

BASIC OPERATING PRINCIPLES. The same basic principles for electro-magnetic induction of electricity and formation of magnetic fields by electrical current as outlined for the conventional flywheel type magneto also apply to the solid state magneto. Thus, the principles of the different components (diode and GCS) will complete the operating principles of the solid state magneto.

HOW IGNITION SPARK IS PRODUCED. The basic components and wiring diagram for the solid state (breakerless) magneto are shown schematically in Fig. CS27, the magneto rotor (flywheel) is turning and the ignition coil magnets have just moved into position so that their lines of force are cutting the ignition coil windings and producing a negative surge of current in the primary windings. The diode (see Fig. CS26) allows current to flow as indicated by arrow and action is same as conventional magneto with breaker contact points closed.

In Fig. CS28, the magneto rotor continues to turn and the ignition coil

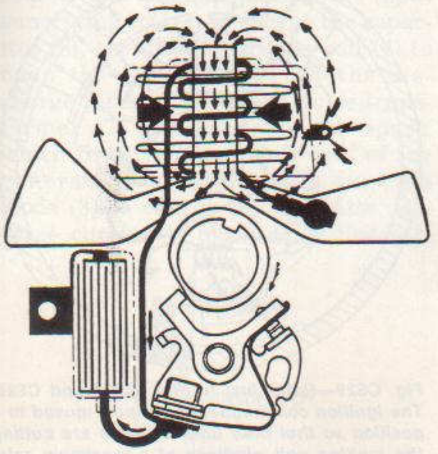


Fig. CS23–View showing magneto ignition coil, condenser and breaker points at same instant as illustrated in Fig. CS22; however, arrows shown above illustrate lines of force of the electro-magnetic field established by current in primary coil windings rather than the lines of force of the permanent magnets. As the current in the primary circuit ceases to flow, the electro-magnetic field collapses rapidly, cutting the coil windings as indicated by heavy arrows and inducing a very high voltage in the secondary coil winding resulting in the ignition spark.

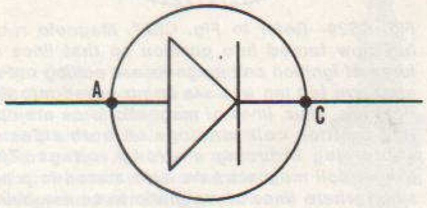


Fig.CS24—In a diagram of an electrical circuit, the diode is represented by the symbol shown above. The diode will allow current to flow in one direction only (from anode "A" to cathode "C" terminal of diode).

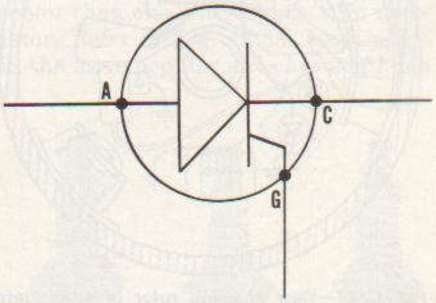


Fig. CS25—The symbol used for a Gate Controlled Switch (GCS) in an electrical diagram is shown above. The GCS will allow current to flow from anode (A) terminal to cathode (C) terminal when "turned on" by a positive electrical charge at gate (G) terminal. A negative electrical charge at gate (G) terminal will turn off the GCS.

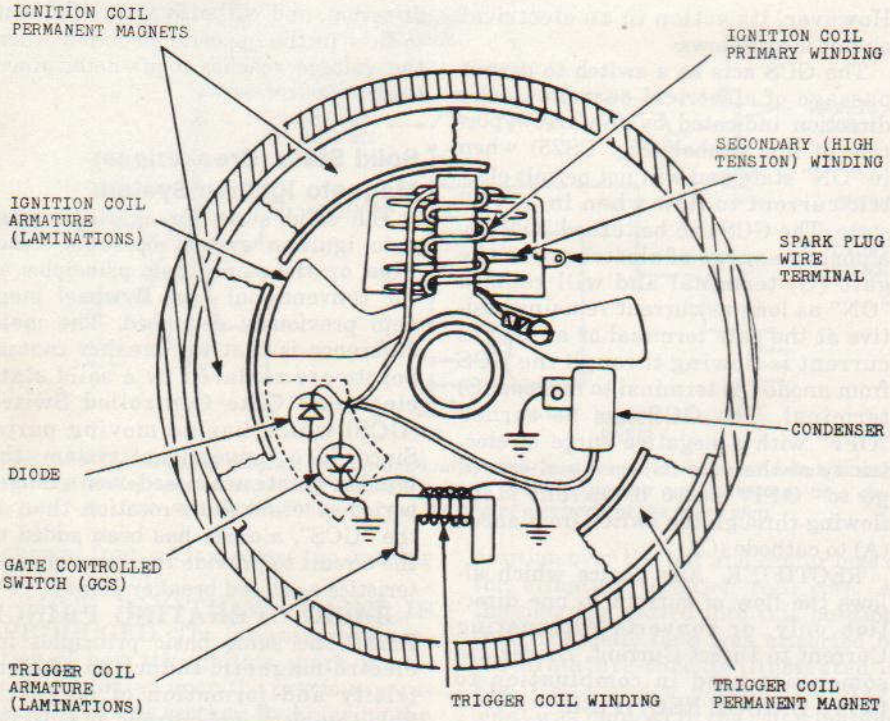


Fig. CS26—Schematic diagram of solid state (breakerless) flywheel magneto. The diagram is drawn to follow the schematic drawings of a conventional type magneto as shown in Figs. CS20, CS21, CS22 and CS23. Refer to Figs. CS24 and CS25 for diode and Gate Controlled Switch (GCS) symbols. Refer to Figs. CS27, CS28 and CS29 for schematic views of magneto operating cycle.

magnets are in the position to cause their lines of force to cut the coil windings on both sides of the center leg of armature as indicated by the arrows. At the same time, the trigger coil magnet has moved into position to allow its lines of force to cut the trigger coil windings inducing a current which is positive at the GCS gate (G) terminal (see Fig. CS25) turning the GCS to "ON" state. Thus the electrical current induced into the ignition

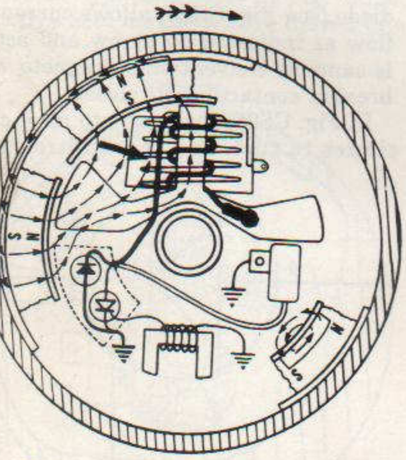


Fig. CS27—View showing rotor of solid state magneto at instant in rotation where lines of force of ignition coil magnets are being drawn into left and center legs of magneto armature. The diode (see Fig. CS24) acts as a closed set of breaker points in completing the primary ignition circuit at this time, thus preventing an unwanted (maverick) spark which could occur at this time. Refer next to Fig. CS28.

coil primary windings can flow through the "ON" GCS as though in a conventional magneto with breaker points closed.

In Fig. CS29, the magneto rotor has turned to a position so that the lines of force of the ignition coil permanent magnets are cutting the ignition coil

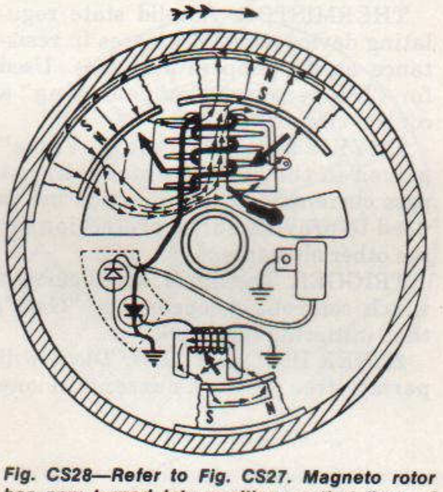


Fig. CS28—Refer to Fig. CS27. Magneto rotor has now turned into position so that lines of force of ignition coil magnets are pulling out of armature left leg and are being pulled into the right leg. Thus, lines of magnetic force are cutting ignition coil windings on both sides of center leg inducing a strong voltage. The trigger coil magnets have also moved to a position where lines of magnetic force are being pulled into the trigger coil armature creating a positive charge in the lead to the Gate Controlled Switch (GCS), thus "turning on" the switch for passage of current in the ignition primary circuit. Refer now to Fig. CS29.

windings at the maximum rate, thus the current in the primary windings is at its peak value. The trigger coil magnet is so located on the magneto rotor that at the time the ignition coil magnets are at the position to produce the highest rate of flux movement through the ignition coil, the lines of flux of the trigger coil magnet are cutting through the trigger coil windings in the direction to produce a negative charge of electricity at the GCS gate (G) terminal. This negative charge of electricity turns the GCS to "OFF" state, thus acting the same as the breaker contact points opening at peak ignition coil primary winding current. The condenser absorbs the primary current bringing it to a quick controlled stop causing the electro-magnetic field surrounding the ignition coil to quickly collapse creating an ignition spark as illustrated in Fig. CS23 for the conventional type flywheel magneto.

Solid State (Breakerless) Capacitor Discharge Ignition System

The capacitor discharge (CD) ignition system uses a permanent magnet rotor to induce a current in a coil, but unlike the conventional flywheel magneto and solid state (breakerless) magneto described previously, the current is stored in a capacitor (condenser), then the stored current is dis-

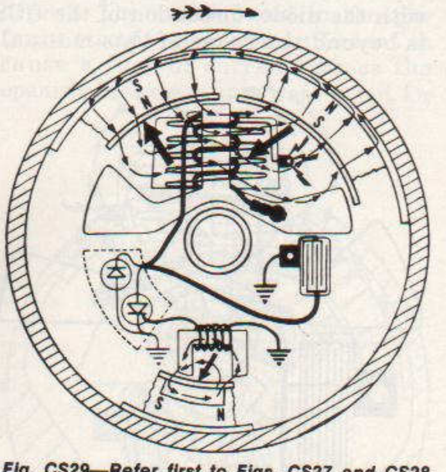


Fig. CS29—Refer first to Figs. CS27 and CS28. The ignition coil magnets have now moved to a position so that their lines of force are cutting the ignition coil windings at a maximum rate. At this same instant, movement of the trigger coil magnets is pulling lines of force away from the trigger coil armature thus creating a negative charge in the coil lead to the GCS gate terminal. This "turns off" the GCS and interrupts the primary ignition circuit just as would breaker points opening in a conventional magneto. As the primary current is interrupted at its peak, the current is brought to a quick stop by the condenser and a very high voltage is induced in the ignition coil. Refer to Fig. CS23 regarding the collapsing electro-magnetic field surrounding the ignition coil.

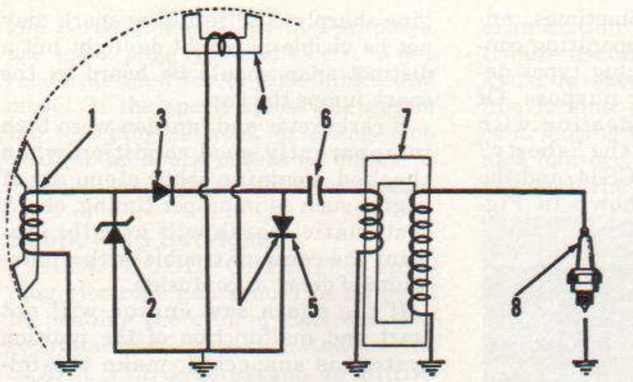


Fig. CS30—Schematic diagram of a simple Capacitor Discharge "Solid State" ignition system.

1. Generating coil
2. Zener diode
3. Diode
4. Trigger coil
5. Silicon Controlled Rectifier (SCR)
6. Capacitor
7. Pulse transformer (coil)
8. Spark plug

charged through a transformer coil to create the ignition spark, whereas the other type magnetos utilize a collapsing magnetic field passing through the ignition coil to provide current for the ignition spark. The secondary current is induced by the rapid build-up rather than by collapse of the primary current. The result is a high-energy ignition spark ideally suited to high-speed, two-stroke engine operation.

One development which made the new systems possible was the introduction of semi-conductors suitable for ignition system control. While solid state technology and the capacitor discharge system are not interdependent they are uniquely compatible and each has features which are desirable from the standpoint of reliability and performance.

Fig. CS30 shows a circuit diagram of a typical capacitor discharge, breakerless ignition system using permanent flywheel magnets as the energy source. The magnets pass by the input generating coil (1) to charge the capacitor (6), then by the trigger coil (4) to open the gate and permit the discharge pulse to enter the pulse transformer (7) and generate the spark which fires the plug. Only half of the generated current passes through diode (3) to charge the capacitor. Reverse current is blocked by diode (3) but passes through diode (2) to complete the reverse circuit. Diode (2) may be a Zener Diode to limit the maximum voltage of the forward current. When the flywheel magnet passes by the trigger coil (4) a small electrical current is generated which opens the gate of the SCR (5) allowing the capacitor to discharge through the pulse transformer (7). The rapid voltage rise in the transformer primary coil induces a high-voltage secondary current which forms the ignition spark when it jumps the spark plug gap.

SPARK PLUG

In any spark ignition engine, the spark plug (See Fig. CS31) provides the means for igniting the compressed fuel-air mixture in the cylinder. Before an electric charge can move across an air gap, the intervening air must be charged with electricity, or ionized. If the spark plug is properly gapped and the system is not shorted, not more than 7,000 volts may be required to initiate a spark. Higher voltage is required as the spark plug warms up, or if compression pressures or the distance of the air gap is increased. Compression pressures are highest at full throttle and relatively slow engine speeds, therefore, high voltage requirements or a lack of available secondary voltage most often shows up as a miss during maximum acceleration from a slow engine speed. There are many different types and sizes of spark plugs which are designed for a number of specific requirements.

THREAD SIZE. The threaded, shell portion of the spark plug and the attaching hole in the cylinder are manufactured to meet certain industry established standards. The diameter is referred to as "Thread Size." Those commonly used are: 10 mm, 14 mm, 18 mm, ⅞ inch and ½ inch pipe. The 14 mm plug is almost universal for chain saw engine use.

REACH. The length of thread, and the thread depth in cylinder head or wall are also standardized throughout the industry. This dimension is measured from gasket seat of head to cylinder end of thread. See Fig. CS32. Four different reach plugs commonly used are: ⅜-inch, 7/16-inch, ½-inch and ¾-inch. The first two mentioned are the ones commonly used in chain saw engines.

HEAT RANGE. During engine operation, part of the heat generated during combustion is transferred to the spark plug, and from the plug to the cylinder through the shell threads and gasket. The operating temperature of the spark plug plays an important part in engine operation. If too much heat is retained by the plug, the fuel-air mixture may be ignited by contact with the heated surface before the ignition spark occurs. If not enough heat is retained, partially burned combustion products (soot, carbon and oil) may build up on the plug tip resulting in "fouling" or shorting out of the plug. If this happens, the secondary current is dissipated uselessly as it is generated instead of bridging the plug gap as a useful spark, and the engine will misfire.

The operating temperature of the plug tip can be controlled, within limits, by altering the length of the path the heat must follow to reach the threads and gasket of the plug. Thus, a plug with a short, stubby insulator around the center electrode will run cooler than one with a long, slim insulator. Refer to Fig. CS33. Most plugs in the more popular sizes are available

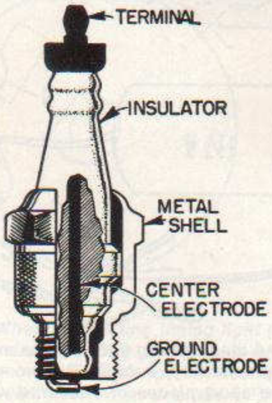


Fig. CS31—Cross sectional view of spark plug showing construction and nomenclature.

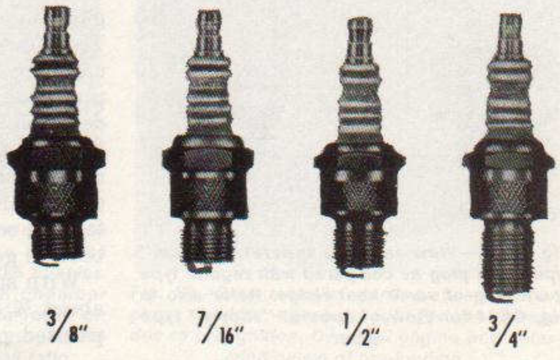


Fig. CS32—Various "reaches" of plugs available. Chain saw engines normally use a ⅜-inch reach spark plug. A ⅜-inch reach plug measures ⅜-inch from firing end of shell to gasket surface of shell.

in a number of heat ranges which are interchangeable within the group. The proper heat range is determined by engine design and the type of service. Refer to SPARK PLUG SERVICING, in SERVICE FUNDAMENTALS section, for additional information on spark plug selection.

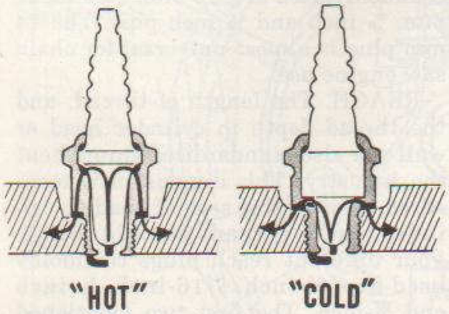


Fig. CS33—Spark plug tip temperature is controlled by the length of the path heat must travel to reach the cooling surface of the engine cylinder head.

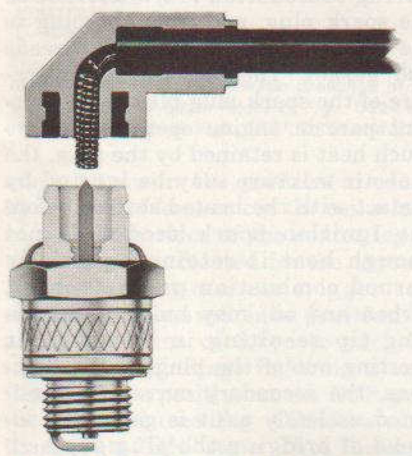


Fig. CS34—Cut-away view of special "shorty" type spark plug and terminal available for chain saw engines. Refer to Fig. CS35 for a second type special plug.

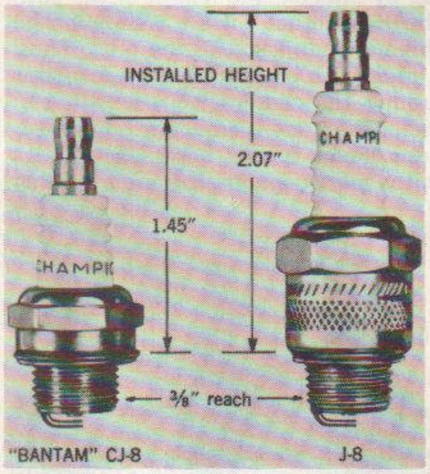


Fig. CS35—View showing special "bantam" type spark plug as compared with regular type spark plug of same heat range. Refer also to Fig. CS34 for view of special "shorty" type plug.

SPECIAL TYPES. Sometimes, engine design features or operating conditions call for special plug types designed for a particular purpose. Of special interest when dealing with chain saw engines are the "shorty" type plug shown in Fig. CS34, and the "bantam" type plug shown in Fig. CS35.

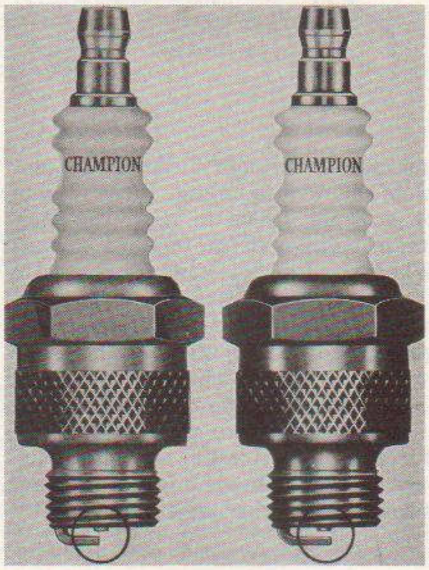


Fig. CS36—The two-cycle (left) differs from conventional plug in that the grounded electrode is shortened to minimize carbon fouling.

ENGINE SERVICE

TROUBLE SHOOTING

Most performance problems such as failure to start, failure to run properly or missing out are caused by malfunction of the ignition system or fuel system. The experienced service technician generally develops and follows a logical sequence in trouble shooting which will most likely lead him quickly to the source of trouble. One such sequence might be as follows:

Remove and examine spark plug. If fuel is reaching the cylinder in proper amount, there should be an odor of gasoline on the plugs if they are cold. Too much fuel or oil can foul the plugs causing engine not to start. Fouled plugs are wet in appearance and easily detected. The presence of fouled plugs is not a sure indication that the trouble has been located, however. The engine might have started before fouling occurred if ignition system had been in good shape.

With spark plug removed, hold wire about ⅛ to ¼ inch away from an unpainted part of engine and crank engine sharply. The resulting spark may not be visible in bright daylight but a distinct snap should be heard as the spark jumps the gap.

If carburetor and ignition were both in apparently good condition when checked, examine other elements of engine such as improper timing, etc. A systematic search will usually pinpoint the cause of trouble with a minimum of delay or confusion.

If the chain saw engine will not start and malfunction of the ignition system is suspected, make the following checks to find cause of trouble.

Check to be sure that the ignition switch is in the "On" or "Run" position and that the insulation on the wire leading to the ignition switch is in good condition. The switch can be checked with the timing and test light as shown in Fig. S1. Disconnect the lead from the switch and attach one clip of the test light to the switch terminal and the other clip to the chain saw frame or engine. The light should go on when the switch is in the "Off" or "Stop" position, and should go off when the switch is in the "On" or "Run" position.

Inspect the high tension (spark plug) wire for worn spots in the insulation or breaks in the wire. Frayed or worn insulation can be repaired temporarily with plastic electrician's tape.

If no defects are noted in the ignition switch or ignition wires, remove and inspect the spark plug as outlined in the SPARK PLUG SERVICING section. If the spark plug is fouled or is in questionable condition, connect a spark plug of known quality to the high tension wire, ground the base of the spark plug to engine and turn engine rapidly with the starter. If the spark across the electrode gap of the spark plug is a bright blue, the magneto can be considered in satisfactory condition. NOTE: Some engine manufacturers specify a certain type spark plug and a specific test gap. Refer to appropriate engine service section; if no specific spark plug type or electrode

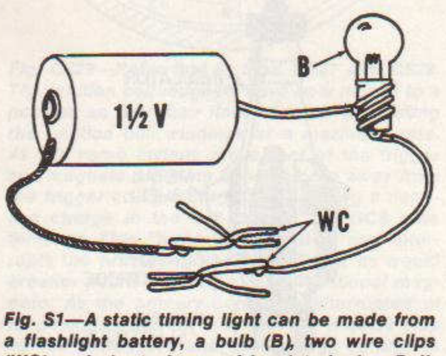


Fig. S1—A static timing light can be made from a flashlight battery, a bulb (B), two wire clips (WC) and short pieces of insulated wire. Bulb should light when clips are touched together. Refer to Fig. S2 gap is recommended for test purposes, use spark plug type and electrode gap recommended for engine make and model. If the spark across the gap of the test plug is weak or orange colored, or no spark occurs as engine is cranked, magneto should be serviced.

Spark Plug Servicing

ELECTRODE GAP. The spark plug electrode gap should be adjusted by bending the ground electrode. The recommended gap is listed in the SPARK PLUG paragraph in MAINTENANCE section for the individual motor.

CLEANING AND ELECTRODE CONDITIONING. Spark plugs are most usually cleaned by abrasive action commonly referred to as "sand blasting." Actually, ordinary sand is not used, but a special abrasive which is nonconductive to electricity even when melted, thus the abrasive cannot short out the plug current. Extreme care should be used in cleaning the plugs after sand blasting, however, as any particles of abrasive left on the plug may cause damage to piston rings, piston or cylinder walls.

After plug is cleaned by abrasive, and before gap is set, the electrode surfaces between the grounded and insulated electrodes should be cleaned and returned as nearly as possible to original shape by filing with a point file. Failure to properly dress the points can result in high secondary voltage requirements, and misfire of the plugs.

PLUG APPEARANCE DIAGNOSIS. The appearance of a spark plug will be altered by use, and an examination of the plug tip can contribute useful information which may assist in obtaining better spark plug life. It must be remembered that the contributing factors differ in two-cycle and four-cycle engine operation and, although the appearance of two spark plugs may be similar, the corrective measures may depend on whether the engine is of two-cycle or four-cycle design. Fig. S3 to Fig. S8 are provided by Champion Spark Plug Company to illustrate typical observed conditions in Two-Cycle engines. Listed also are the probable causes and suggested corrective measures.

PLUG IDENTIFICATION. Each spark plug manufacturer uses a different special code to identify spark plug characteristics. It has been found impossible to provide a plug cross reference chart which is accepted by all

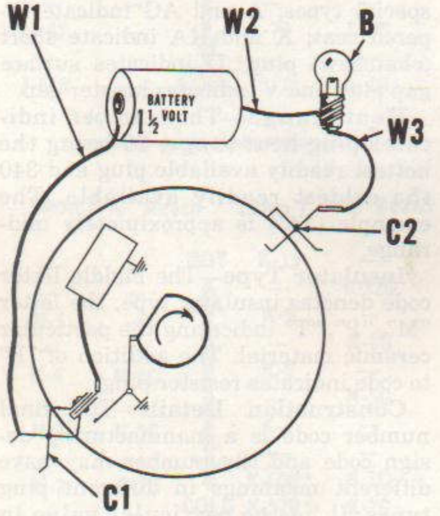


Fig. S2—When connecting timing light (see Fig. S1), first disconnect primary coil wire from breaker point terminal, then connect one wire clip (C1) to terminal and other clip (C2) to magneto back plate or engine. Bulb should be out when points are open and light when points close.

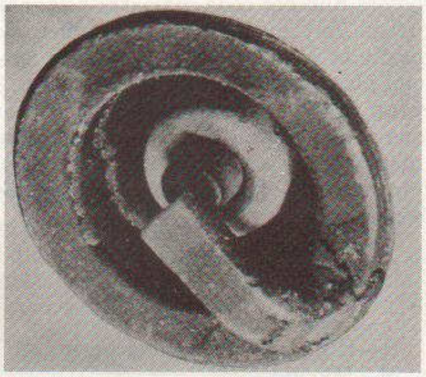


Fig. S3—Two cycle engine plug of correct heat range. Insulators light tan to gray with few deposits. Electrodes not burned.

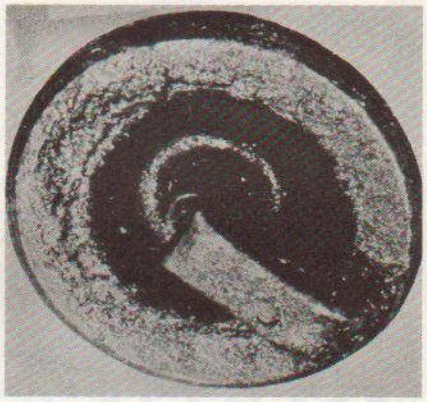


Fig. S4—Damp or wet black carbon coating over entire firing end of plug. Could be caused by rich carburetor mixture, too much oil in fuel, or low ignition voltage. Could also be caused by incorrect heat range (too cold) for operating conditions. Correct the defects or install a hotter plug.

Fig. S5—Core bridging from center electrode to shell. Fused deposits sometimes have the appearance of tiny beads or glasslike bubbles. Caused by excessive combustion chamber deposits which in turn could be the result of; excessive carbon from prolonged usage; use of improper oil or incorrect fuel-oil ratio.

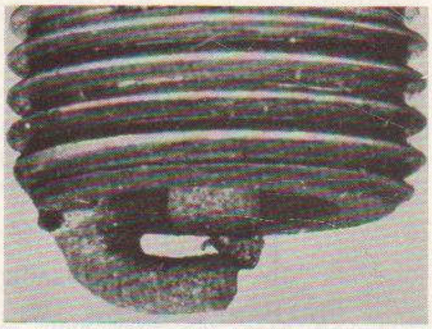


Fig. S6—Gap bridging. Usually results from the same causes outlined in Fig. S5.

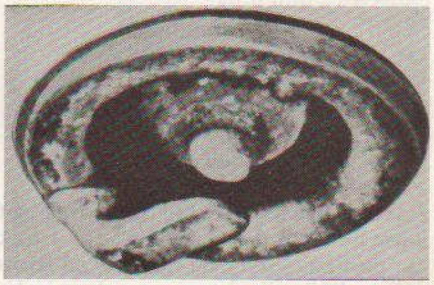


Fig. S7—Electrodes badly eroded, deposits white or light gray and gritty, insulator has "blistered" appearance. Could be caused by lean carburetor mixture, fast timing, overloading, or air intake screen and engine cooling fins blocked with sawdust or other debris. Could also be caused by incorrect heat range (too hot) for operating conditions. Check timing, carburetor adjustment, cooling system. If timing, carburetor adjustment, cooling system and engine speed are correct, install a colder plug.

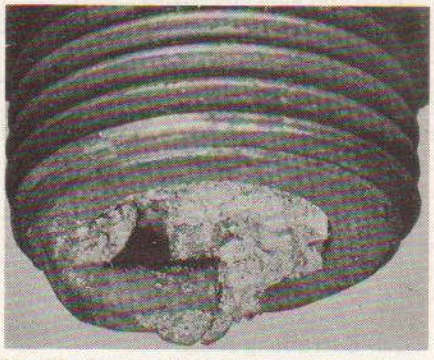
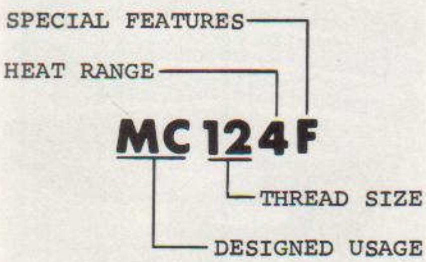


Fig. S8—Gray metallic aluminum deposits on plug. (Seldom encountered). Piston damage due to pre-ignition. Overhaul engine and determine cause of pre-ignition.

manufacturers, however the following code identification for some spark plugs may be helpful in selecting the correct plug. Although not universally true, it can be generally assumed that two plugs of different manufacture falling within similar portions of the heat range scale will interchange. In some cases it may be found necessary to move up or down the scale one or two steps for best performance.



Thread Size—the first digit or digits of the number code indicates thread size. The pictured sample indicates a 12 mm plug.

2—½ inch thread
4—14mm thread
7—⅞ inch thread
8—18mm thread
10—10mm thread
12—12mm thread

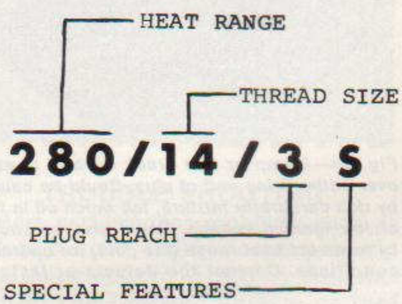
Heat Range—The last digit of number code indicates heat range. Plugs may be numbered from "0" to "9", the lower number indicating the colder plug. The pictured example "4" falls approximately in mid-range.

Suffix Letters—A letter (or letters) after the number indicates special features. The "F" in pictured example indicates that plug is "Special Reach for Foreign Applications".

B—Neon tube
D—Dual side electrodes
E—Engineer Corps shielded (Not Aircraft Type)
F—Special reach for foreign applications
FF—½-inch reach fully threaded (14mm)
G—Marine racing gap
H—Special hex size
I—Iridium center electrode
K—High performance marine
L—Long reach
XL—Extra long reach
N—Extra long reach
P—Platinum electrodes
R—Resistor plug
S—Extended tip (14mm)
S—Moderate long reach
T—Tapered seat
TS—Tapered seat, extended tip
W—Recessed termination
X—Special gap
Y—Three prong electrode

Prefix Letters—Letter (or letters) before number code indicates designed usage. In the case of snowmobiles, the prefix of SN is added only when a special plug or modification is required. A plug is not redesignated "SN" for snowmobile sale and recommendation may call for a commercial (C) or motorcycle (MC) plug as most suitable for a particular engine.

B—Series gap
C—Commercial
CS—Low profile (chainsaw)
G—Gas engine
H—High altitude or weatherproof
M—Marine
MC—Motorcycle
LM—Lawnmower
R—Resistor
S—Shielded
SN—Snow vehicle
TC—Tractor commercial
V—Surface gap
W—Waterproof



Heat Range—The first number group indicates heat range. The hottest available plug is coded "20" and the coldest available plug "400". Readily available (stocked) plugs are within the range "95" to "280", placing the example at the cold end of the commercial scale.

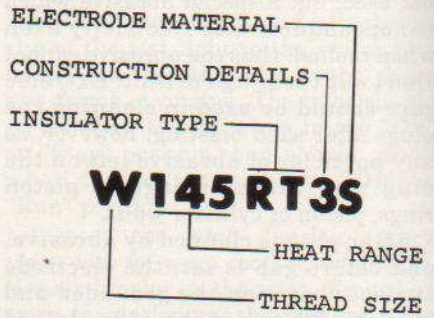
Thread Size—The second number group indicates thread size and is direct reading, millimeter sizes being given in whole number (14, 18 etc) and inch sizes in fractions (⅞, etc). The example is a 14 mm plug.

Plug Reach—The third number indicates thread or shank length, the example (3) denoting long thread. If number is not used, plug reach is ½ inch. Complete code is as follows:

2—Long shank (between gasket seat and hex)
3—¾ inch reach
4—Long thread and long shank
5—⅝ inch reach

Suffix Letters—Letter (or letters) following number code indicate special types or features. The example (S) indicates silver electrode.

A—Extended tip
AM—Short plug
HGF—Wide heat range
K—Tapered seat
P—Platinum electrode
S—Silver electrode
UK—Low profile (chainsaw type)



Thread Size—The first letter (or letters) indicates thread size and general plug type. The example "W" is 14mm plug.

U—10mm plug
X—12mm plug
W—14mm plug
M—18mm plug
Z—⅞ inch plug

Additional letters in prefix indicate special types; A and AG indicate tapered seat; K and KA indicate short (chainsaw) plug; D indicates surface gap plug and V indicates booster gap.

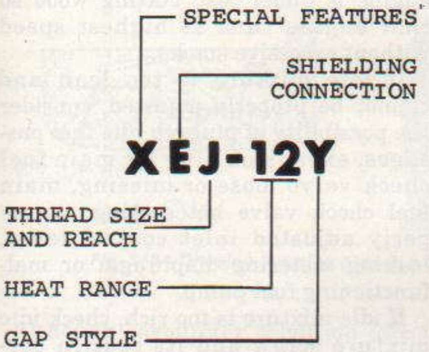
Heat Range—The number indicates plug heat range, 20 being the hottest readily available plug and 340 the coldest readily available. The example (145) is approximately mid-range.

Insulator Type—The middle letter code denotes insulator type, the letter "M", "P", "T" indicating the particular ceramic material. The addition of "R" to code indicates resistor plug.

Construction Details—The final number code is a manufacturing design code and the number may have different meanings in different plug types. It has no particular value in service identification.

Electrode Material—The letter "S" indicates silver electrode material and the letter "P" indicates platinum material.

CHAMPION SPARK PLUGS



Heat Range—Heat range number are divided into four types. Numbers 1-25 are for automotive, marine and ordnance plugs; numbers 26-50 are for aircraft; numbers 51-75 are racing plugs; numbers 76-99 indicate special features or application. On all types, the higher number (within type range) indicates hotter plug.

NOTE: Gold Palladium plug types are not completely interchangeable with standard types with respect to heat range. The following chart compares Gold Palladium plug with standard type, the first column in each type being standard plug number and the second column Gold Palladium.

14mm / ⅜" Reach			14mm / .472" Reach	
—	—	HOT	—	—
J-8J	—	↑	L-86	—
—	UJ-11G		—	—
J-7J	—		—	—
—	UJ-7G		L-81	L-6G
J-6J	—		—	—
—	—		—	—
J-4J	—		L-78	L-3G
—	—	↓	—	—
J-57R	—	COLD	L-77J	L-2G

14mm / ¾" Reach			18mm / .445" Reach	
—	—	HOT	K-13	—
—	—	↑	—	K-12G
N-5	—		K-9	—
—	—		--	K-8G
N-4	N-4G		K-8	—
—	—		—	K-5G
N-3	N-3G		K-7	—
—	—		—	—
N-2	N-2G	↓	K-60R*	K-3G
—	—	COLD	K-57R*	K-2G

* .500" Reach

Thread Size and Reach—The code letter ("J" in example) indicates thread size and reach. The example is 14mm-⅜ inch reach.

Letter	Thread Size	Thread Reach (Inch)
Y	10mm	¼
Z	10mm	.492
G	10mm	.700
P	12mm	.492
R	12mm	¾
J	14mm	⅜
J (preceded by C)	14mm	⅜
J (preceded by C)	14mm	⅜
J (preceded by D)	14mm	.325 Tapered Seat
H	14mm	7/16
L	14mm	½ or .472
L (preceded by B)	14mm	.460 Tapered Seat
N	14mm	¾
N (preceded by B)	14mm	.708 Tapered Seat
E	14mm	.680
F	18mm	.460 Tapered Seat
K	18mm	All
B	18mm	13/16
U	18mm	1⅛
W	⅞"-18	All
C	⅞"-18	All
S	1⅛"-12	.600
None	½"-14 .. Pipe Thread	All
V	Model Airplane Engine Plug	

Type of Shielding Connection—In some cases, indicates special short plugs. If this code is not used, plug is not shielded and is not a short plug. Example (E) indicates shielded plug with ⅝ inch-24 threaded connection.

B—See Thread Size Code L & N
C—(See Thread Size Code J) Short plug (bantam)
D—(See Thread Size Code J) Short plug
E—Shielded—⅝ inch-24 thread
H—Shielded—¾ inch-24 thread
M—Shielded—⅝ inch-24 thread Ordnance
P—Shielded—9/16 inch—27 thread
S—Shielded—11/16 inch—24 Whitworth
T—Low Profile Plug (Shorty)
W—Shielded 13/16 inch—20 thread

Special Internal Features—Indicates resistor or auxiliary gap. If this code is not present, plug has no resistor or auxiliary gap.

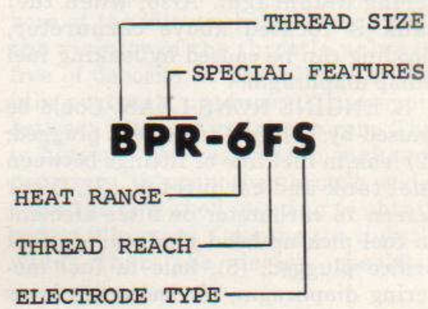
R—Resistor (Less than 6000 ohms)
X—Resistor (more than 6000 ohms)
U—Auxiliary gap

Gap or Electrode Type—Suffix letters indicate type of material of electrodes, and type of gap. Letter (Y) in example indicates projected core.

B—Two heavy duty ground electrodes
C—Protruding nose, round ground electrode, sawed gap
D—Protruding nose, round ground electrode
F—Three heavy duty ground electrodes
G—"Gold Palladium" center electrode
J—Cut back ground electrode
LM—Special Lawn Mower Plug
N—Four-prong Aircraft Type
P—Fine wire Platinum electrodes
R—Push wire ground electrode
S—Single ground electrode, side gap
T—Special Gap
V—Surface Gap
Y—Projected core

NOTE: "Gold Palladium" plugs are factory gapped at 0.015" and a gap 0.003"-0.005" narrower than standard plug is recommended.

NGK SPARK PLUGS



Thread Size—The first letter indicates thread size. Second and third letters (if used) denote variations. The letter "M" as second or third letter indicates low profile plug; "P" indicates projected nose and "R" indicates resistor plug.

A—18mm plug
AB—18mm plug
B—14mm plug
C—10mm plug
D—12mm plug

Heat Range—The number indicates heat range. Numbers are from 2 (hot) to 14 (cold). Number "6" in example is approximately mid-range.

Thread Reach—Three suffix letters (E, H & L) are used to indicate thread reach. If none of the above letters appear on 14mm plug, reach is ⅜ inch; if none appear on 18mm plug, reach is 12mm. Letter "F" suffix (example) indicates taper seat.

E—¾ inch reach
H—½ inch reach
L—7/16 inch reach

Electrode Type—Suffix letters are also used to indicate special electrode types; may be used in combination with thread suffix as in example, or alone if thread suffix is not used. If electrodes are conventional type, no suffix is used.

C—Competition type electrode
N—Racing (Nickel) electrode
P—Racing (Platinum) electrode
S—Super wide heat range
X—Surface gap electrode

CARBURETOR SERVICING

Trouble Shooting

Normally encountered difficulties resulting from carburetor malfunction, along with possible causes of difficulty, are as follows:

A. CARBURETOR FLOODS. Could be caused by: (1), dirt or foreign particles preventing inlet fuel needle from seating; (2), diaphragm lever spring not seated correctly on diaphragm lever; or (3), improperly installed metering diaphragm. Also, when fuel tank is located above carburetor, flooding can be caused by leaking fuel pump diaphragm.

B. ENGINE RUNS LEAN. Could be caused by: (1), fuel tank vent plugged; (2) leak in fuel line or fittings between fuel tank and carburetor; (3), filter screen in carburetor or filter element in fuel pick-up head plugged; (4), fuel orifice plugged; (5), hole in fuel metering diaphragm; (6), metering lever not properly set; (7), dirt in carburetor fuel channels or pulse channel to engine crankcase plugged; or (8), leaky gaskets between carburetor and crankcase intake port. Also, check for leaking crankshaft seals, porous or cracked crankcase or other cause for air leak into crankcase. When fuel tank or fuel level is below carburetor, lean operation can be caused by hole in fuel pump diaphragm or damaged valve flaps on pump diaphragm. On Walbro series SDC carburetor with diaphragm type accelerating pump, a leak in accelerating pump diaphragm will cause lean operation.

C. ENGINE WILL NOT ACCELERATE SMOOTHLY. Could be caused by: (1), inoperative accelerating pump, on carburetors so equipped, due to plugged channel, leaking diaphragm, stuck piston, etc.; (2), idle or main fuel mixture too lean on models without accelerating pump; (3), incorrect setting of metering diaphragm lever; (4), diaphragm gasket leaking; or (5), main fuel orifice plugged.

D. ENGINE WILL NOT IDLE. Could be caused by: (1), incorrect adjustment of idle fuel and/or idle speed stop screw; (2), idle discharge or air mixture ports clogged; (3), fuel channel clogged; (4), dirty or damaged main orifice check valve; (5), Welch (expansion) plug covering idle ports not sealing properly allowing engine to run with idle fuel needle closed; or (6), throttle shutter not properly aligned on throttle shaft causing fast idle.

E. ENGINE RUNS RICH. Could be caused by: (1), plug covering main nozzle orifice not sealing; or (2), when fuel level is above carburetor, leak in fuel pump diaphragm.

Adjusting

Initial setting for the mixture adjustment needles is listed in the specific engine sections of this manual. Make final carburetor adjustment with engine warm and running. Adjust idle speed screw so that engine is idling at just below clutch engagement speed; do not try to make engine idle any slower than this. Adjust idle fuel needle for best engine idle performance, keeping the mixture rich as possible (turn needle out to richen mixture). If necessary, readjust idle speed screw. Adjust main fuel needle while engine is under load cutting wood so that engine runs at highest speed without excessive smoke.

If idle mixture is too lean and cannot be properly adjusted, consider the possibility of plugged idle fuel passages, expansion plug for main fuel check valve loose or missing, main fuel check valve not seating, improperly adjusted inlet control lever, leaking metering diaphragm or malfunctioning fuel pump.

If idle mixture is too rich, check idle mixture screw and its seat in carburetor body for damage. Check causes for carburetor flooding.

If high speed mixture is too lean and cannot be properly adjusted, check for dirt or plugging in main fuel passages, improperly adjusted inlet control lever, malfunctioning diaphragm or main fuel check valve. Also check for damaged or missing packing for high speed mixture screw and for malfunctioning fuel pump.

If high speed mixture is too rich, check high speed mixture screw and its seat for damage. Check causes for carburetor flooding.

Setting or adjusting the inlet control lever (metering diaphragm lever height) necessitates disassembly of the carburetor. Refer to the following Overhauling section for adjusting the lever height.

Overhauling

General service procedures for overhauling and/or cleaning diaphragm type carburetors are outlined in the following paragraphs:

The bulk of carburetor service consists of cleaning, inspection and adjustment. After considerable service it may become necessary to overhaul the carburetor and renew worn parts to restore original operating efficiency.

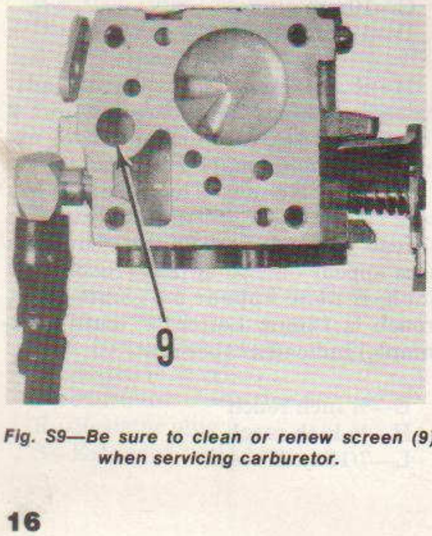


Fig. S9—Be sure to clean or renew screen (9) when servicing carburetor.

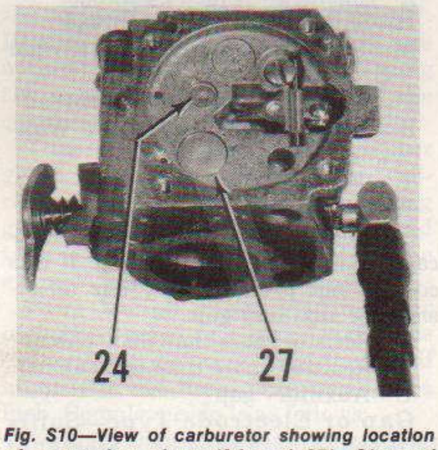


Fig. S10—View of carburetor showing location of expansion plugs (24 and 27). Channel screen (26—Fig. S13) is located under plug (24).

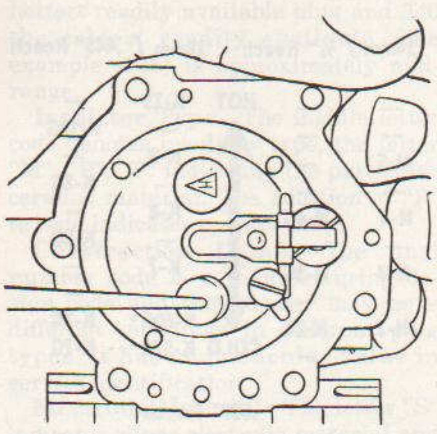


Fig. S11—A punch can be used to remove plugs from carburetor as shown, after carefully drilling a small hole in plug.

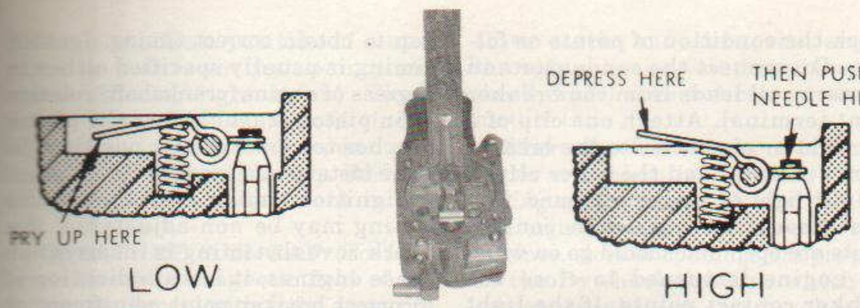


Fig. S12—Drawing showing proper adjustment of metering diaphragm lever.

Although carburetor condition affects engine operating economy and power, ignition and engine compression must also be considered to determine and correct causes of poor performance.

Before dismantling carburetor for cleaning or overhaul, clean all external surfaces and remove accumulated dirt and grease. Dismantle carburetor and note any discrepancies to assure correction during overhaul. Thoroughly clean all parts and inspect for damage or wear. Wash jets and passages and blow clear with clean, dry compressed air. NOTE: Do not blow compressed air through main nozzle orifice screen on Walbro series SDC carburetor as this will damage the rubber check valve; renew nozzle screen/seat and check valve if in doubt. A special check valve repair kit and installation tool are available. Do not use a drill or wire to clean jets as the possible enlargement of calibrated hole will disturb operating balance. The measurement of jets to determine the extent of wear is difficult and new parts are usually installed to assure satisfactory results.

An assortment of gaskets and other parts usually needed to do a correct job of cleaning and overhaul are available for most carburetors. These assortments are usually cataloged as Gasket Kits and Overhaul Kits respectively.

Check the fit of throttle and choke valve shafts. Excessive clearance will cause improper valve plate seating and will permit dust or grit to be drawn into the engine. Air leaks at throttle shaft bores due to wear will upset carburetor calibration and contribute to uneven engine operation. Rebush valve shaft holes where necessary and renew dust seals. If rebushing is not possible, renew the body part supporting the shaft. Inspect throttle and choke valve plates for proper installation and condition.

If necessary to remove plugs for cleaning passages, carefully drill through plug with small diameter drill, insert pin in drilled hole and pry plug out. Take care not to drill any deeper than thickness of plug. NOTE: Do not blow high pressure compressed air through main nozzle check valve as this may damage the valve.

Power or idle adjustment needles must not be worn or grooved. Check condition of needle seal packing or "O" ring and renew packing or "O" ring if necessary.

Adjust fuel diaphragm lever by bending lever as necessary so that lever is flush with carburetor body at each side of lever. Reinstall or renew jets, using correct size listed for specific model. Adjust power and idle settings as described for specific carburetors in engine service section of manual.

It is important that the carburetor bore at the idle discharge ports and in the vicinity of the throttle valve be free of deposits. A partially restricted idle port will produce a "flat spot" between idle and mid-range rpm. This is because the restriction makes it necessary to open the throttle wider than the designed opening to obtain proper idle speed. Opening the throttle wider than the design specified

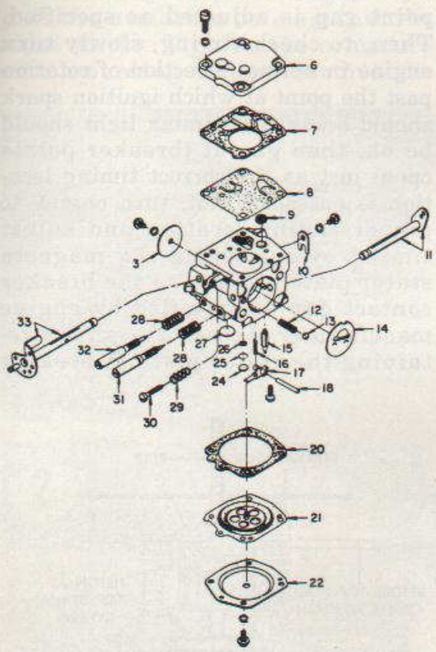


Fig. S13—Exploded view of typical Tillotson series HS carburetor.

3. Throttle disc
6. Diaphragm cover
7. Gasket
8. Pump diaphragm
9. Filter screen
10. Retainer
11. Choke shaft
12. Detent spring
13. Choke detent ball
14. Choke disc
15. Inlet valve
16. Lever spring
17. Diaphragm lever
18. Pivot pin
20. Gasket
21. Metering diaphragm
22. Diaphragm cover
24. Expansion plug
25. Retaining ring
26. Channel screen
27. Expansion plug
28. Springs
29. Spring
30. Idle speed screw
31. Main fuel needle
32. Idle mixture needle
33. Throttle shaft

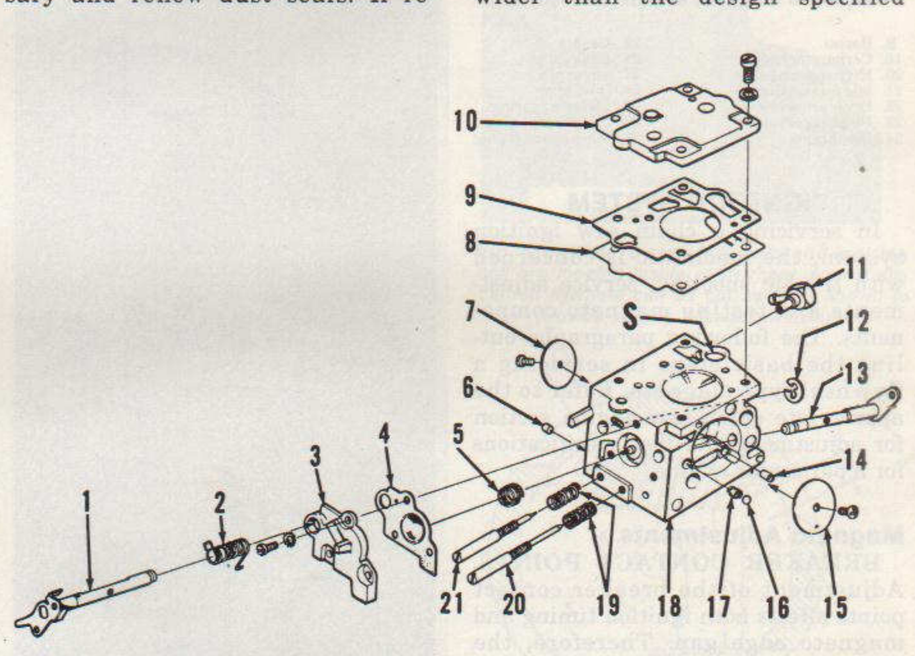


Fig. S14—Exploded view of Walbro SDC-1 carburetor assembly except for metering diaphragm, lever and inlet valve assembly; refer to Fig. S15 for exploded view of these parts. Note that throttle shaft (1) extends through accelerator diaphragm (4) and cover (3).

S. Fuel screen
1. Throttle shaft
2. Return spring
3. Pump cover
4. Accelerator diaphragm
5. Spring
6. Limiting plug
7. Throttle valve (disc)
8. Fuel pump diaphragm
9. Gasket
10. Pump cover
11. Elbow fitting
12. "E" ring
13. Choke shaft
14. Idle air jet
15. Choke valve (disc)
16. Detent ball
17. Detent spring
18. Carburetor body
19. Springs
20. High speed needle
21. Idle fuel needle

amount will uncover more of the port than was intended in the calibration of the carburetor. As a result an insufficient amount of the port will be available as a reserve to cover the transition period (idle to the mid-range rpm) when the high speed system begins to function.

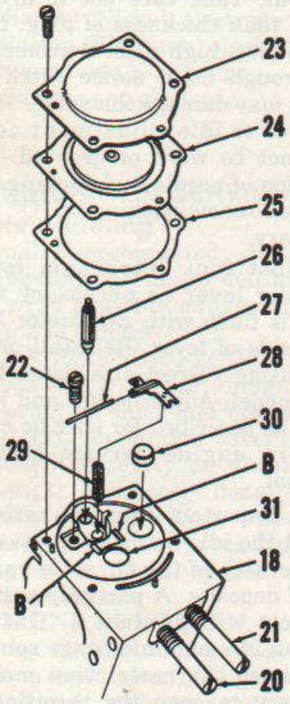


Fig. S15—Bottom view of carburetor showing exploded view of metering diaphragm, lever and inlet valve assembly. Refer to Fig. S14 for exploded view of other carburetor parts.

B. Bosses
18. Carburetor body
20. High speed needle
21. Idle fuel needle
22. Lever pin screw
23. Diaphragm cover
24. Diaphragm
25. Gasket
26. Inlet valve
27. Lever pin
28. Inlet lever
29. Metering spring
30. Idle passage plug
31. Main channel plug

IGNITION SYSTEM

In servicing a chain saw ignition system, the mechanic is concerned with trouble shooting, service adjustments and testing magneto components. The following paragraphs outline the basic steps in servicing a flywheel type magneto. Refer to the appropriate chain saw engine section for adjustment and test specifications for a particular engine.

Magneto Adjustments

BREAKER CONTACT POINTS. Adjustment of the breaker contact points affects both ignition timing and magneto edge gap. Therefore, the breaker contact point gap should be carefully adjusted according to engine manufacturer's specifications. Before adjusting the breaker contact gap, inspect contact points and renew if condition of contact surfaces is questionable. It is sometimes desirable to check the condition of points as follows: Disconnect the condenser and primary coil leads from the breaker point terminal. Attach one clip of a test light or ohmmeter to the breaker point terminal and the other clip of the test light to magneto ground. The light should be out when contact points are open and should go on when the engine is turned to close the breaker contact points. If the light stays on when points are open, insulation of breaker contact arm or condensor is defective. If light does not go on when points are closed, contact surfaces are dirty, oily or are burned.

Adjust breaker point gap as follows unless manufacturer specifies adjusting breaker gap to obtain correct ignition timing. First, turn engine so that points are closed to be sure that the contact surfaces are in alignment and seat squarely. Then, turn engine so that breaker point opening is maximum and adjust breaker gap to manufacturer's specification. Be sure to recheck gap after tightening breaker point base retaining screws.

IGNITION TIMING. On some engines, ignition timing is non-adjustable and a certain breaker point gap is specified. On other engines, timing is adjustable by changing the position of the magneto stator plate (see Fig. S16) with a specified breaker point gap or by simply varying the breaker point gap to obtain correct timing. Ignition timing is usually specified either in degrees of engine (crankshaft) rotation or in piston travel before the piston reaches top dead center position. In some instances, a specification is given for ignition timing even though the timing may be non-adjustable; if a check reveals timing is incorrect on these engines, it is an indication of incorrect breaker point adjustment or excessive wear of breaker cam. Also, on some engines, it may indicate that a wrong breaker cam has been installed or that the cam has been installed in a reversed position on engine crankshaft.

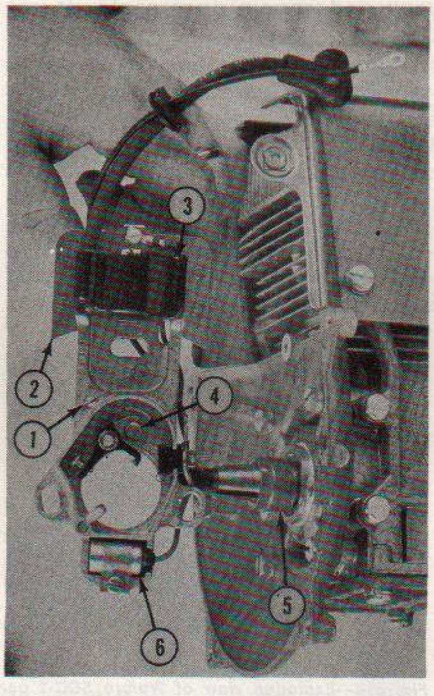


Fig. S16—On some chain saw engines, the magneto stator plate mounting holes are slotted as shown so that ignition timing can be adjusted by relocating position of stator plate.

1. Stator plate
2. Armature core
3. Ignition coil
4. Breaker point base
5. Breaker cam
6. Condenser

Some engines may have a timing mark or flywheel locating pin to locate the flywheel at proper position for the ignition spark to occur (breaker points begin to open). If not, it will be necessary to measure piston travel as illustrated in Fig. S17 or install a degree indicating device on the engine crankshaft.

A timing light or an ohmmeter is a valuable aid in checking or adjusting engine timing. After disconnecting the ignition coil lead from the breaker point terminal, connect the leads of the timing light as shown. If timing is adjustable by moving the magneto stator plate, be sure that the breaker point gap is adjusted as specified. Then, to check timing, slowly turn engine in normal direction of rotation past the point at which ignition spark should occur. The timing light should be on, then go out (breaker points open) just as the correct timing location is passed. If not, turn engine to proper timing location and adjust timing by relocating the magneto stator plate or varying the breaker contact gap as specified by engine manufacturer. Loosen the screws retaining the stator plate or breaker

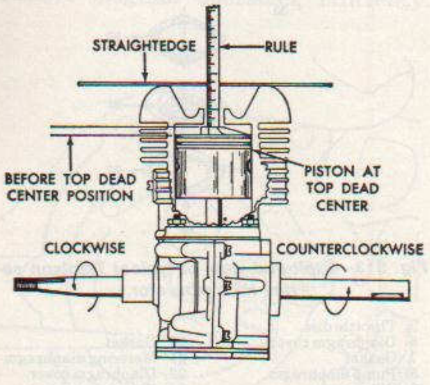


Fig. S17—Where timing is specified as measurement of piston travel, measurement can be made as illustrated. Use of a dial indicator instead of ruler will give more exact measurement. Some manufacturers provide a timing gage that can be screwed into spark plug hole or a gage that can be attached to crankshaft.

points and adjust position of stator plate or points so that points are closed (timing light is on). Then, slowly move adjustment until timing light goes out (points open) and tighten the retaining screws. Recheck timing to be sure adjustment is correct.

ARMATURE AIR GAP. To fully concentrate the magnetic field of the flywheel magnets within the armature core, it is necessary that the flywheel magnets pass as closely to the armature core as possible without danger of metal to metal contact. The clearance between the flywheel magnets and the legs of the armature core is called the armature air gap.

On magnetos where the armature and high tension coil are located outside of the flywheel rim, adjustment of the armature air gap is made as follows: Turn the engine so that the flywheel magnets are located directly under the legs of the armature core and check the clearance between the armature core and flywheel magnets. If the measured clearance is not within manufacturers specifications, loosen the armature core mounting screws and place shims of thickness equal to minimum air gap specification between the magnets and armature core (Fig. S18). The magnets will pull the armature core against the shim stocks. Tighten the armature core mounting screws, remove the shim stock and turn the engine through several revolutions to be sure the flywheel does not contact the armature core.

Where the armature core is located under or behind the flywheel, the following methods may be used to check and adjust armature air gap: On some engines, slots or openings are provided in the flywheel through which the armature air gap can be checked. Some engine manufacturers provide a cut-away flywheel that can be installed temporarily for checking the armature air gap. A test flywheel can be made out of a discarded flywheel (See Fig. S19), or out of a new flywheel if service volume on a particular engine warrants such expenditure. Another method of checking the armature air gap is to remove the flywheel and place a layer of plastic tape equal to the minimum specified air gap over the legs of the armature core. Reinstall flywheel and turn engine through several revolutions and remove flywheel; no evidence of contact between the flywheel magnets and plastic tape should be noticed. Then cover the legs of the armature core with a layer of tape of thickness equal to the maximum specified air gap; then, reinstall flywheel and turn engine through several revolutions. Indication of the flywheel magnets contacting the plastic tape should be noticed after the flywheel is again removed. If the magnets contact the first thin layer of tape applied to the armature core legs, or if they do not contact the second thicker layer of tape, armature air gap is not within specifications and should be adjusted. NOTE: Before loosening armature core mounting screws, scribe a mark on mounting plate against edge of armature core so that adjustment of air gap can be gauged.

In some instances, it may be necessary to slightly enlarge the armature core mounting holes before proper air gap adjustment can be made.

MAGNETO EDGE GAP. The point of maximum acceleration of the movement of the flywheel magnetic field through the high tension coil (and therefore, the point of maximum current induced in the primary coil windings) occurs when the trailing edge of the flywheel magnet is slightly past the left hand leg of the armature core as shown in Fig. S20. The exact point of maximum primary current is determined by using electrical measuring devices. The distance between the trailing edge of the flywheel magnet and the leg of the armature core at this point is measured and becomes a service specification. This dis-

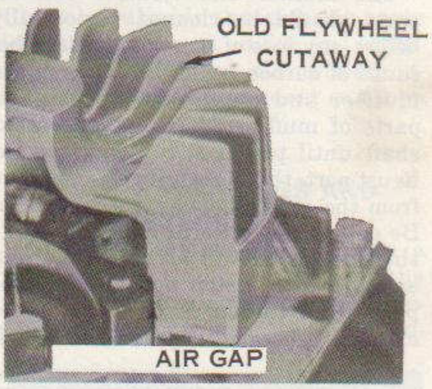


Fig. S19—Where armature core and ignition coil are located inside of flywheel, an old discarded flywheel can be cut away as shown to provide air gap adjustment fixture.

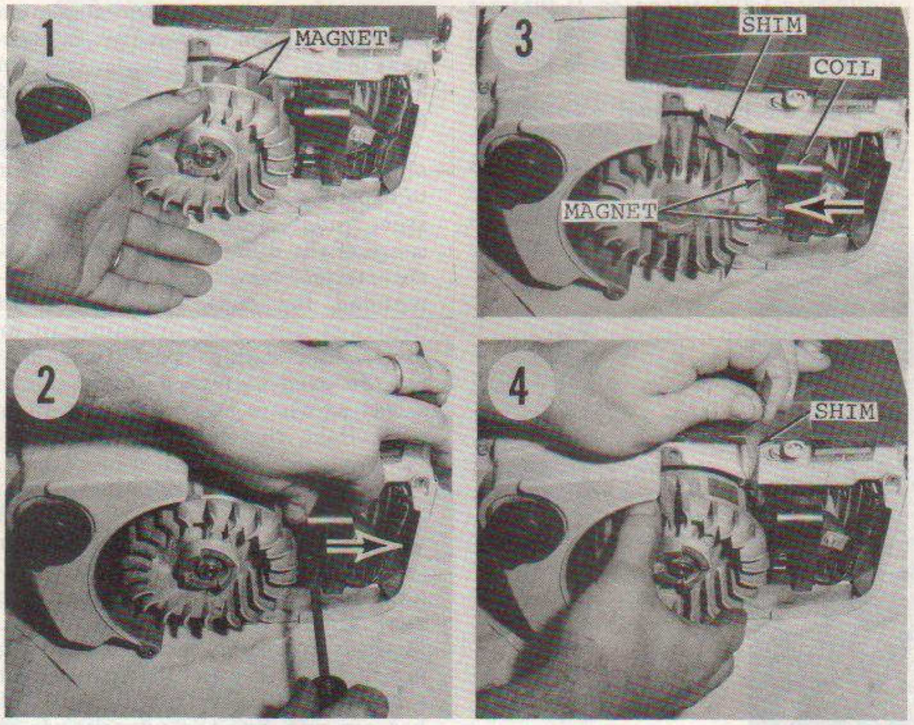


Fig. S18—Views showing adjustment of armature air gap when armature (coil) is located outside of flywheel. In view (1) the magnets are turned away from armature. In view (2) the coil is moved away from the flywheel. View (3) shows shims positioned between magnets and armature legs for setting correct clearance (gap). Tighten armature holding screws, then roll shim out as shown in view (4).

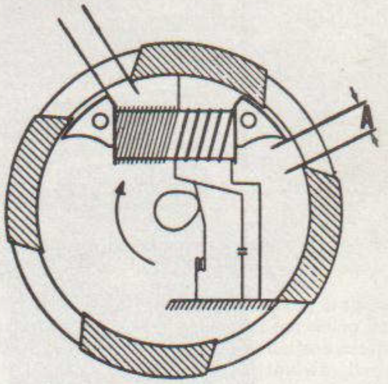


Fig. S20—The distance (A) between trailing edge of magnet and leading edge of pole shoe when primary voltage is highest is known as EDGE GAP.

tance, which is stated either in thousandths of an inch or in degrees of flywheel rotation, is called the Edge Gap or "E" Gap.

For maximum strength of the ignition spark, the breaker points should just start to open when the flywheel magnets are at the specified edge gap position. Usually, edge gap is non-adjustable and will be maintained at the proper dimension if the contact breaker points are adjusted to the recommended gap and the correct breaker cam is installed. However, magneto edge gap can change (and spark intensity thereby reduced) due to the following:

a. Flywheel drive key sheared
b. Flywheel drive key worn (loose)
c. Keyway in flywheel or crankshaft worn (oversized)
d. Loose flywheel retaining nut which can also cause any above listed difficulty
e. Excessive wear on breaker cam
f. Breaker cam loose on crankshaft
g. Excessive wear on breaker point rubbing block so that points cannot be properly adjusted.

CARBON CLEANING

The muffler and cylinder exhaust ports should be cleaned periodically before any loss of power is noticed because of carbon build up. Remove the muffler and clean carbon from all parts of muffler. Turn engine crankshaft until piston is covering the exhaust port, then carefully clean carbon from the exhaust using a soft scraper. Be especially careful not to damage the piston. Do not attempt to clean exhaust with piston not covering the port. Hard carbon deposits can cause extensive damage if permitted to fall into the engine. The engine cooling fins should be cleaned at the same time that carbon is cleaned from exhaust.

LUBRICATION

Refer to the individual section for each motor for recommended type and amount of lubricant to be used for the engine and saw chain.

OIL-FUEL RATIO. Chain saw engines are lubricated by oil that is mixed with the fuel. It is important that the manufacturer's recommended type of oil and oil to fuel ratio be closely followed. Excessive oil or improper type oil will cause low power, plug fouling and excessive carbon build-up. Insufficient amount of oil will result in inadequate lubrication and rapid internal damage. The recommended ratios and type of oil are listed in LUBRICATION paragraph for each motor. Oil should be mixed with gasoline in a separate container before it is poured into the fuel tank. The following table may be useful in mixing the correct ratio.

RATIO	Gasoline	Oil
10:1	.63 Gallon	½ Pint
12:1	.75 Gallon	½ Pint
14:1	.88 Gallon	½ Pint
15:1	.94 Gallon	½ Pint
16:1	1.00 Gallon	½ Pint
20:1	1.25 Gallons	½ Pint
22:1	1.38 Gallons	½ Pint
24:1	1.50 Gallons	½ Pint
25:1	1.56 Gallons	½ Pint
32:1	2.00 Gallons	½ Pint
50:1	3.13 Gallons	½ Pint
100:1	6.25 Gallons	½ Pint
10:1	5 U.S. Gallons	4 Pints 64 Fl. Oz.
12:1	3 U.S. Gallons	2 Pints 32 Fl. Oz.
14:1	5 U.S. Gallons	3 Pints 45¾ Fl. Oz.
15:1	5 U.S. Gallons	2¾ Pints 42½Fl. Oz.
16:1	5 U.S. Gallons	2½ Pints 40 Fl. Oz.
20:1	5 U.S. Gallons	2 Pints 32 Fl. Oz.
22:1	5 U.S. Gallons	1¾ Pints 29 Fl. Oz.
24:1	3 U.S. Gallons	1 Pint 16 Fl. Oz.
25:1	4 U.S. Gallons	1¼ Pints 20½ Fl. Oz.
32:1	4 U.S. Gallons	1 Pint 16 Fl. Oz.
50:1	3 U.S. Gallons	½ Pint 8 Fl. Oz.
100:1	3 U.S. Gallons	¼ Pint 4 Fl. Oz.

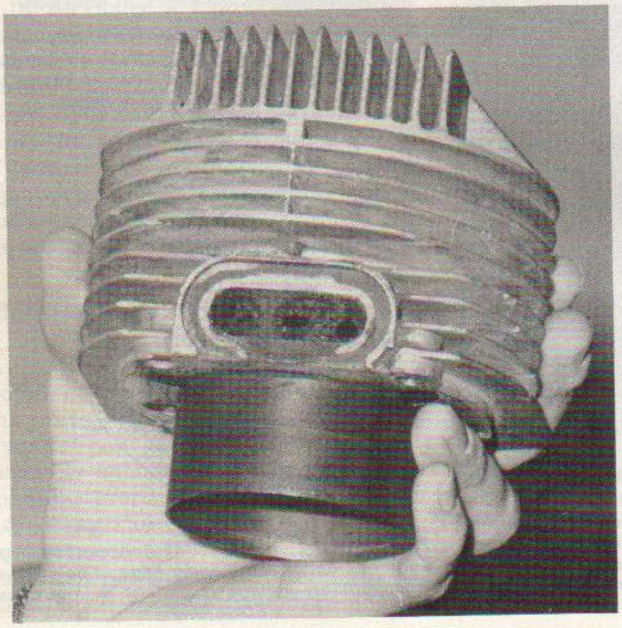


Fig. S21—Example of severe case of port carbon. Carbon must be removed to restore performance.

REPAIRS

Because of the close tolerance of the internal parts, cleanliness is of utmost importance. It is suggested that the exterior of the engine and all nearby areas be absolutely clean before any repair is started. The manufacturer's recommended torque values for tightening screw fasteners should be followed closely. The soft threads in aluminum castings are often damaged by carelessness in over-tightening fasteners or in attempting to loosen or remove seized parts.

A given amount of heat applied to aluminum or magnesium will cause it to expand a greater amount than will steel under similar conditions. Because of the different expansion characteristics, heat is usually recommended for easy installation of bearings, pins, etc., in aluminum or magnesium castings. Sometimes, heat can be used to free parts that are seized or where an interference fit is used. Heat, therefore, becomes a service tool and the application of heat, one of the required service techniques. An open flame is not usually advised because it destroys the paint and other protective coatings and because a uniform and controlled temperature with open flame is difficult to obtain. Methods commonly used for heating are: 1. In oil or water, 2. With a heat oven or kiln. 3. With hot air gun. The hot air gun has the advantages of being portable and having a directional control of heat to a small or large area depending upon the type of gun. Two types of hot air guns are shown in Figs. S22 and S23. Thermal crayons are available which can be used to determine the temperature of a heated part. These crayons melt when the part reaches specified temperature, and a number of crayons for different temperatures are available. Temperature indicating crayons are usually available at welding equipment supply houses.

On two-cycle engines the crankcase and combustion chambers must be sealed against pressure, vacuum and oil leakage. To assure a perfect seal, nicks, scratches and warpage are to be avoided, especially where no gasket is used. Slight imperfections can be removed by using a fine-grit sandpaper. Flat surfaces can be lapped by using a surface plate or a smooth piece of plate glass and a sheet of fine sandpaper or lapping compound. Use a figure-eight motion with minimum pressure, and remove only enough metal to eliminate the imperfection. Bearing clearance must not be lessened by removing metal from the joint.

Use only the specified gaskets when re-assembling, and use an approved gasket cement or sealing compound unless otherwise stated. All friction surfaces, including bearings and seals,

Fig. S22—Heat can be used efficiently as a service tool. Shown is an Electric Heat Gun available from UNGAR, 233 East Manville, Compton, California 90220.

should be coated with oil before assembling.

It is desirable to lock most of the threaded parts when assembling using "LOCTITE" or other similar product.

Retaining Threaded and Pressed Together Parts

The following products are available from "LOCTITE SERVICE PRODUCTS", Newington, Connecticut 06111 for fastening parts together. Vibration can easily loosen untreated fasteners and cause extensive damage.

"Lock N' Seal" is colored **Blue** and is formulated to lock threaded parts from shaking loose from shock and vibration. Oil, fuel and air fittings can be sealed against leakage and worn parts may sometimes be repaired using this locking sealant. Lock N' Seal flows as a liquid to completely fill the inner space between threaded parts, then hardens. Only the locking sealant which is confined hardens, excess or outside will not harden and may be wiped off.

"Stud N' Bearing Mount" is colored **Red** and is intended for parts with slip and light press fits or for extra strength for locking threaded parts such as studs. Pullers, press, heat and/or extra effort will be required when disassembling. Stud N' Bearing Mount will fill the air space and harden to form a key between the microscopic irregular surface of two close fitting parts. Worn parts can sometimes be repaired by using this hardening sealer to assist in holding a bearing in a worn bore or onto a worn shaft.

"Sleeve Retainer" is colored **Green** and is designed to improve the fit of parts that are pressed together. Seats, guides, liners, etc. can be assembled using Sleeve Retainer to help prevent loosening, leakage, wear, corrosion, seizure or hot spots. The compound is thinner than other "Loctite" resins to make it better suited for use in press fits. The compound will withstand intermittent temperatures up to 400 degrees F. The Sleeve Retainer displaces the air insulating pockets and eliminates hot spots.

"Klean N' Prime" is used to clean parts and to provide the best curing of the locking resins. Loctite resins will not work properly on dirty, oily parts. Some primers ("Locquic") are available to speed up or slow down the curing time of the resins. The "Locquic" primers are most often used for production assembly and are not often available for service.

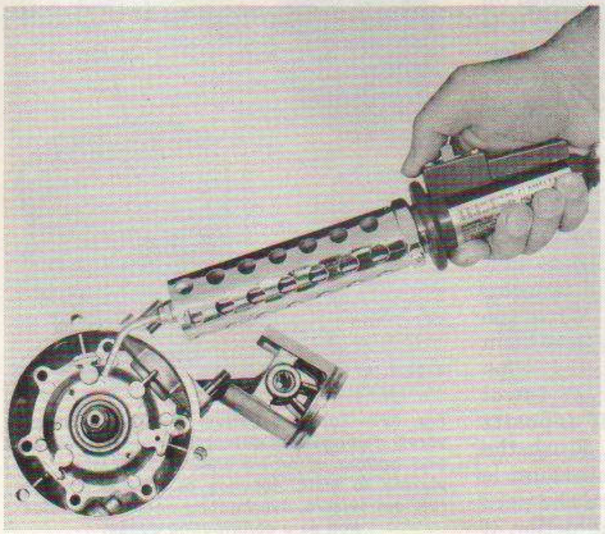


Fig. S23—Heat Torch delivers hot air to a smaller area than Heat Gun shown in Fig. S22. Dry compressed air is electrically heated and temperature (up to 1000° F.) is varied by controlling air pressure. The torch shown is available from Master Appliance Corp., 1745 Flett Ave., Racine, Wis. 53403.

REPAIRING DAMAGED THREADS

Damaged threads in castings can be renewed by use of thread repair kits which are recommended by a number of manufacturers. Use of thread repair kits is not difficult, but instructions must be carefully followed. Refer to Figs. S24 through S26 which illustrate the use of Heli-Coil thread repair kits that are manufactured by the Heli-Coil Corporation, Danbury, Connecticut.

Heli-Coil or similar thread repair kits are available through the parts departments of most engine and equipment manufacturers; the thread inserts are available in most common thread sizes and types.

PISTON, PIN, RINGS AND CYLINDER

Two cycle engines do not have a complex valve mechanism and the piston rings have no oil control function. On the other hand, carbon build-

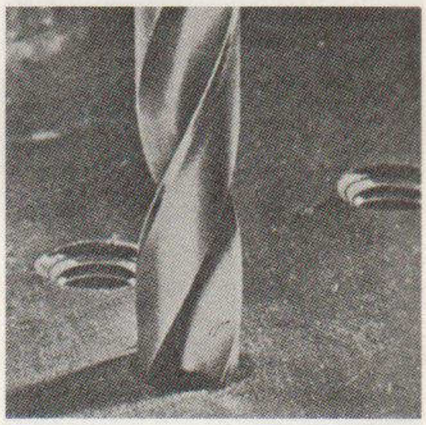


Fig. S24—First step in repairing damaged threads is to drill out old threads using exact size drill recommended in instructions provided with thread repair kit. Drill all the way through an open hole or all the way to bottom of blind hole, making sure hole is straight and that centerline of hole is not moved in drilling process. (Series of photos provided by Heli-Coil Corp., Danbury, Conn.)

up is more likely to occur, and where oil consumption is the most common service problem on four cycle engines, carbonization is the two-cycle counterpart.

The simple construction of two stroke engines and the benefits to be gained from periodic carbon removal make decarbonization a part of the recommended maintenance procedure of most two cycle experts. Because the piston rings have no oil control function, ring renewal is not required at carbon removal except to correct for wear or other damage.

Excessive carbon build-up can be harmful in two ways. First, it insulates to keep the heat from escaping normally. Second, it raises the compression ratio to create more heat. This places an additional heat load on that portion of the cylinder which is scraped clean of carbon by the piston rings.

The need for carbon removal is often first indicated by inability to properly adjust the carburetor. If performance is erratic and improper carburetion is indicated, but attempts to adjust the carburetor fail, check first for excessive carbon build up. No cleaning or adjustment of the carburetor can materially improve performance if exhaust passages are partially carbon blocked.

No problems will be encountered in removing cylinder head and/or cylinder for carbon removal provided normal standards of care and cleanliness are observed.

Examine the parts as engine is disassembled for clues to engine condition, to correct possible future trouble, or identify the cause of existing trouble. As an example, refer to Fig. S27. On this particular piston, the skirt is not scored and the first glance will show melted aluminum which has covered the ring on one side. The melted spot (D) on top and below piston crown is conclusive proof of detonation damage and the cause must be corrected during overhaul or the same failure can be expected to reoccur.

If pistons are scuffed or scored, look for metal transfer to cylinder walls. Metal transfer and score marks must be removed from cylinder walls with a hone. Install new chrome plated cylinder if the plating is worn away exposing the softer base metal. Chrome plated cylinder bores should not be honed.

Full strength muriatic acid can be used to remove aluminum deposits from a cast iron cylinder bore. Muriatic acid can be purchased in a drug store. It is also used as a soldering acid, although the supply kept in most radiator shops has usually been cut (diluted) with zinc. Use acid carefully, it can cause painful burns if spilled on the skin and the fumes are toxic. It is most easily used by carefully transferring a small amount to a plastic squeeze bottle, or to another small container and applying with a cotton swab. DO NOT allow the acid to spill or run onto aluminum portions of the cylinder, it will rapidly attack and dissolve the metal. Do not use the acid on a chrome bore. When applied to aluminum deposits, the acid will immediately start to boil and foam. When the action stops the aluminum has been dissolved or the acid is diluted; wipe the area with an old rag or towel which can be discarded. If deposits remain, repeat the process. Flush the area with water when aluminum is removed. Water will dilute the acid and can be used to stop the action if desired, or if acid runs off onto aluminum portion of cylinder, is accidentally spilled, etc. Immediately coat treated portion of cylinder with oil, as the acid makes the cast iron especially susceptible to rust.

A rule of thumb says scuffing or scoring of piston above the piston pin is due to overheating. Damage below the pin is more likely due to insufficient lubrication or improper fit. Overheating may be caused by a lean mixture, overloading, a damaged cooling fan or fins, air leaks in carburetor mounting gasket or manifold, blow-by (stuck or broken rings) as well as carbon build-up.

The greatest cylinder wear of a two-stroke engine generally occurs in port area of cylinder wall instead of at top of ring travel. Cast iron or aluminum bores should be measured using ring gap as an indicator or an inside micrometer. Check for spots on chromed bores which are different in appearance. Spots may be metal deposits from overheated pistons or may be where the thin chrome plating is worn through. Deposited metal can be scraped or carefully hand sanded from the chrome. If plating is worn through, cylinder must be renewed. Aluminum will be easily scratched by a sharp object but chrome will not.

On models with cast iron cylinder, the bore should be honed when engine is overhauled, to true the bore, remove the glaze and remove the ridge at top and bottom of ring travel area. If ridge is not removed, new unworn rings may strike the ridge and bend ring lands in piston as shown at (F—Fig. S28). The finished cylinder should have a light cross-hatch pattern. After honing, wash cylinder assembly with soap and

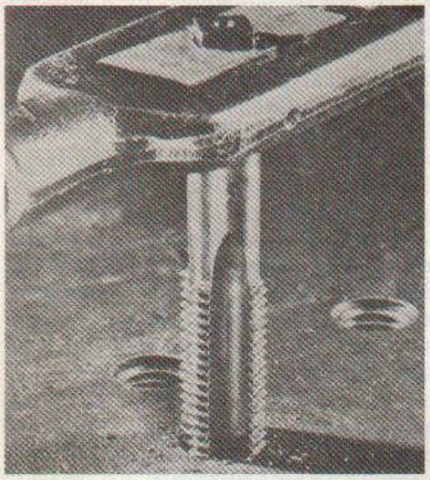


Fig. S25—Special drill taps are provided in thread repair kit for threading drilled hole to correct size for outside of thread insert. A standard tap cannot be used.

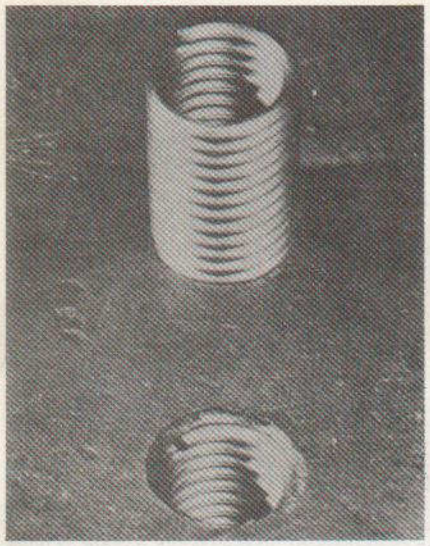


Fig. S26—A thread insert and a complete repair are shown above. Special tools are provided in thread repair kit for installation of thread insert.

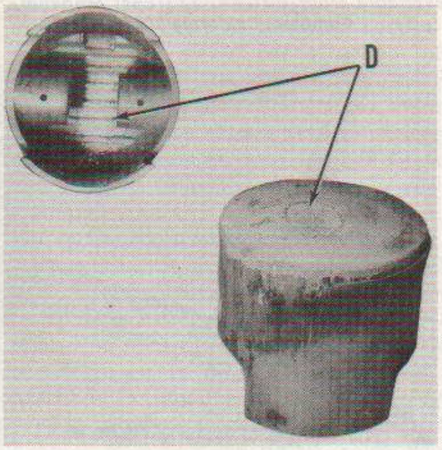


Fig. S27—Top and bottom view of piston severely damaged by detonation. Spot (D) on top and bottom of crown show where metal has started to melt. Absence of scoring on skirt rule out seizure, overheating or lack of lubrication as a contributing cause.

water, then swab with new oil on a clean rag until all tendency of rag to discolor is gone. Washing in solvent will not remove the abrasive from finished cylinder walls.

Some manufacturers have oversize piston and ring sets available. If care and approved procedures are used, installation of oversize units should result in a highly satisfactory overhaul.

The cylinder bore may be oversized by using either a boring bar or hone; however, if a boring bar is used, finish sizing should be done with a hone. Before attempting to rebore, first check to be sure that new standard units cannot be fitted within the recommended clearances and that the correct oversize is available.

Some manufacturers recommend that after boring a cylinder to an oversize, the top and bottom edges of cylinder wall ports be rounded to prevent rings from catching. Fig. S31 shows typical port cross section with area to be removed indicated in the inset.

Before installing new piston rings, check ring end gap as follows: Position the ring near the bottom of cylinder bore. The piston should be used to slide the ring in cylinder to locate ring squarely in bore. Measure the gap between end of ring using a feeler gage as shown in Fig. S29. Slide the ring down in the cylinder to the area of transfer and exhaust ports and again measure gap. Rings may break if end gap is too tight at any point; but, will not seal properly if gap is too wide. Variation in gap indicates cylinder wear (usually near the ports and at top of ring travel).

Ring grooves in the piston should be carefully cleaned and examined. Use caution when cleaning to prevent damage to piston. Grooves for Dykes (L rings), Keystone (Both sides angled) and Half Keystone rings are especially easily damaged. Carelessness can result in poor performance and possibly extensive internal engine damage. Refer to Fig. S28. When installing rings on piston, expand only far enough to slip over the piston and **do not twist rings.** After installing rings on piston, use feeler gage to measure ring side clearance in groove as shown in Fig. S30. Excessive side clearance will prevent an effective seal and may cause rings to break.

When assembling piston to connecting rod, observe special precautions outlined in the individual repair sections. The pistons in some engines may have the pin offset, rings pinned or other design features which make it necessary to install piston in only one way. Check for assembly marks or other indicators on the piston and in the individual repair sections.

Lubricate piston pin bearing (or bushing), piston, rings and cylinder as engine is assembled. Run engine with slightly rich carburetor setting during break-in period and do not overload, to prevent overheating until the parts wear in. It is sometimes advisable to install a hotter heat range spark plug in an attempt to prevent oil fouling in a newly started engine. Plug fouling during this period is not uncommon and it is advisable to have spare plugs along when running a newly overhauled engine.

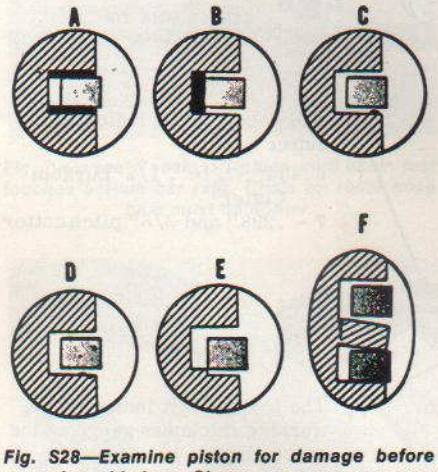


Fig. S28—Examine piston for damage before removing old rings. Shown are some common faults.

A. Carbon buildup, sides of groove
B. Carbon buildup behind ring
C. Incomplete carbon removal, loose carbon
D. Nicks in groove
E. Stepped wear
F. Broken or bent land

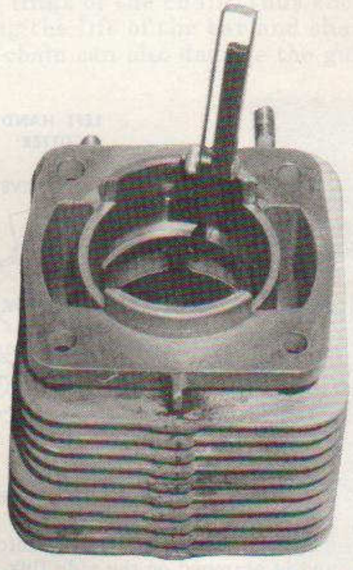


Fig. S29—Clearance between ends of ring (ring end gap) should be measured with feeler gage as shown. Make sure ring is straight in cylinder.

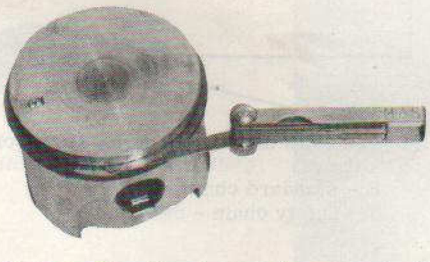


Fig. S30—Ring side clearance in groove should be measured with feeler gage as shown. Clearance should be within recommended limits and the same all the way around piston.

CONNECTING ROD, CRANKSHAFT AND BEARINGS

Before detaching connecting rods from crankshaft, mark rods and caps for correct assembly to each other. Most damage to ball and roller bearings (anti friction bearings) is evident after visual inspection and turning the assembled bearing by hand. If bearing shows evidence of overheating, renew the complete assembly. On models with plain (bushing) bearings, check the crankpin and main bearing journals for wear with a micrometer. Crankshaft journals will usually wear out-of-round with most wear on side

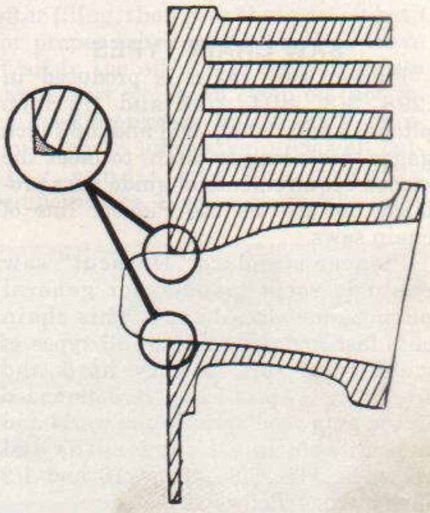


Fig. S31—Some manufacturers recommend that edges of ports be chamfered as shown in insert, after reboring.

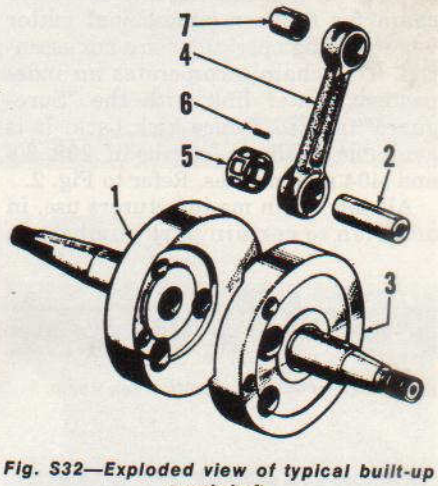


Fig. S32—Exploded view of typical built-up crankshaft.

1. Counterweight
2. Crankpin
3. Counterweight
4. Connecting rod
5. Roller bearing
6. Needle roller
7. Bushing

that takes the force of power stroke (strokes). If main bearing clearances are excessive, new crankcase seals may not be able to prevent pressure from blowing fuel and oil around crankshaft. All crankcase seals should be renewed when crankshaft, connecting rods and bearings are serviced.

Built-up crankshafts should be checked for runout when removed. A typical built-up crankshaft is shown in Fig. S32. Check for runout using either vee blocks or lathe centers. Should the shaft not meet specifications, then it should be taken to a machine shop or shop experienced in straightening built-up shafts.

PIONEER SAW CHAIN, GUIDE BARS AND SPROCKETS

SAW CHAIN

This section on saw chain maintenance has been prepared to give information that will enable mechanics to service the cutting chain as well as the engine of the chain saw. Information for trouble shooting saw chain problems is also given in this section.

SAW CHAIN TYPES

Pioneer saw chain is produced in .298, 3/8, .404, 7/16 and 1/2 inch pitches and in .050, .058 and .063 inch gages (according to pitch) to meet the varied requirements of guide bars produced for use on the Pioneer line of chain saws.

Pioneer standard "Duracut" saw chain is recommended for general purpose use on all saws. This chain cuts fast and smoothly in all types of wood from soft to very hard and frozen. It is specifically recommended in the pulpwood areas of the world and is available in all cut lengths and reels, in .298, 3/8, .404, 7/16 and 1/2 inch pitches. Refer to Fig. 1.

Pioneer "Sureguard" chain is designed to meet the requirements for an anti-kick chain for small timber such as pulp cutting, limbing and as a safer chain for the non-professional cutter where boring operations are not essential. This chain incorporates an independent center link with the "Sureguard" tang to reduce kick back. It is available in all cut lengths in .298, 3/8 and .404 inch pitches. Refer to Fig. 2.

All saw chain manufacturers use, in addition to certain part numbers, a simple code which designates their chain by pitch, configuration, type and gauge. Refer to Fig. 4.

The most important factors in identifying a loop of saw chain are—

1. Pitch of Chain—Pioneer chain has the pitch identified by A, B, C, D or F stamped on the side link and cutter.
2. Gauge of Chain—Pioneer chain has the thickness of the center link stamped on the center link.
3. Length of Loop of Chain—The length of the chain is determined by counting the number of Drive Links.

Thus C6SH-61 is a .404 pitch "Sureguard" chain with a center link gauge of .058 and containing 61 center links.

CHAIN BREAK IN, TENSION AND LUBRICATION

BREAKING IN A NEW CHAIN. As with any machine or accessory containing moving parts, the first hour or so of operation can make a great difference to the length of life. Careful

Fig. 1–View of Pioneer standard saw chain.

Fig. 2–View of Pioneer "Sureguard" saw chain.

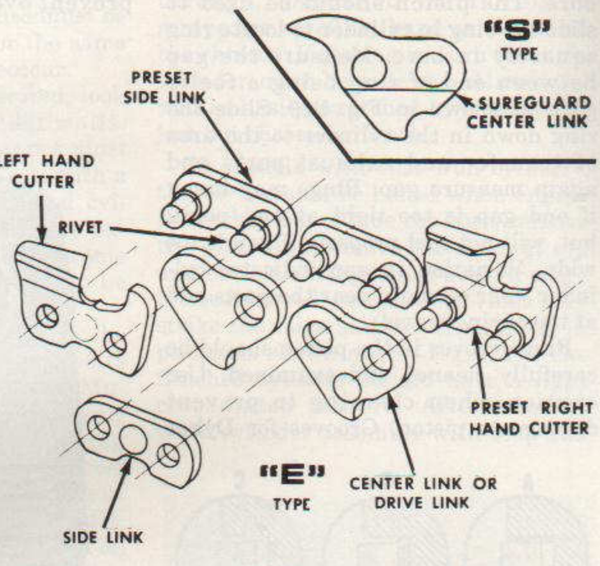


Fig. 3–Drawing showing general shape of the various parts of the saw chain.

B The first digit indicates the pitch and is stamped on the side link & on the cutter.

A - .298" pitch D - 7/16" pitch
B - 3/8" pitch F - 1/2" pitch
C .404" pitch

7 The second digit indicates the cutter design.

6 .404", 7/16", 1/2" Duracut Cutter
7 - .298" and 3/8" pitch cutter

S The third digit indicates the type of chain.

E - standard chain
S - safety chain - Sureguard

H The fourth digit indicates the working thickness gauge of the center link.

L - .050" gauge center link
H - .058" gauge center link
J - .063" gauge center link

Fig. 4–Pioneer chain is coded by a series of four digits which are explained with B, 7, S, H as an example.

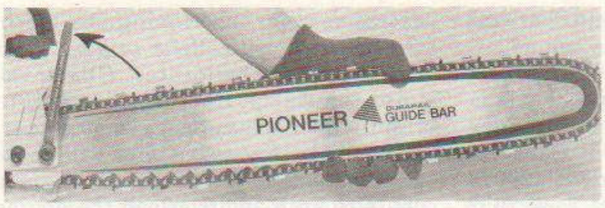


Fig. 5–Loosen the guide bar retaining nuts.

attention to the instructions for breaking in and making tension adjustments can greatly add to the life of the chain.

The following instructions are important and will add to the life of saw chain:

1. If possible, soak chain in oil bath before use and between uses.
2. Install chain properly with recommended chain tension.
3. Run chain at slow speed for about 5 minutes, giving it plenty of oil.
4. Stop engine and readjust chain tension.
5. Recheck tension until chain is fully broken in.
6. Keep chain well lubricated when in use.
7. Keep chain sharp. Always use a new file on a new chain.
8. Correct chain tension, especially on bar lengths of 32 inches and over, is important to prevent the chain jumping the bar and causing damage to the equipment and loss of time to the operator.

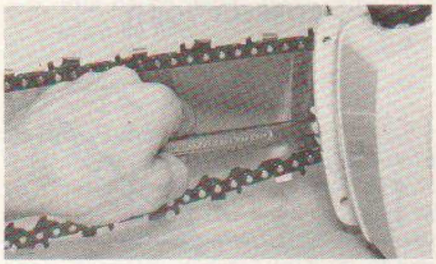


Fig. 6–Tighten the tension adjusting screw.

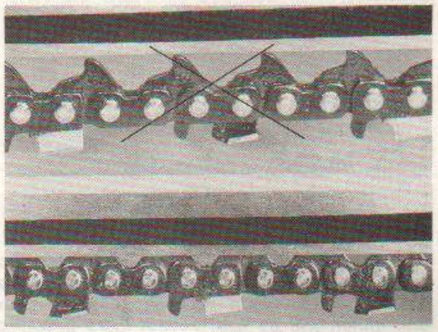


Fig. 7–Correct Tension: Tighten until chain just touches bottom bar rails. Chain on roller nose bars must be tighter.

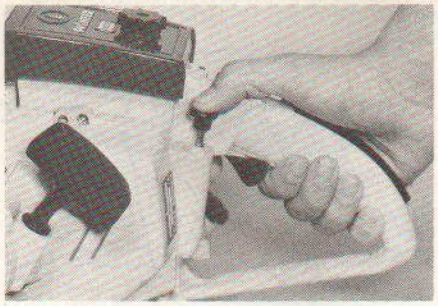


Fig. 8–Make sure that the chain is always properly lubricated.

CHAIN TENSION ADJUSTMENTS. Correct tension is very important. It will increase the life of the saw and chain. Loose tension is a major cause of saw chain problems; it ruins chain, bar and sprocket. Check chain tension often, but make adjustments only when the attachments have cooled off. To insure correct tension follow steps shown in Fig. 5, 6, 7, 8, 9 and 10.

It is well known that over-tension, or a tight chain, will lead to excessive wear on both the guide bar and the side links of the chain, thus shortening the life of the bar and chain. The chain can also damage the guide bar if it is too loose. The chain will damage the guide bar immediately in front of the stellite by a pounding operation. Further damage at the tail end of the bar can be caused by excessive pounding as the chain arcs off the sprocket. These pounding forces will cause stress in the chain components, which may eventually break, or the pounding may cause the chain to have stiff links. A loose chain may jump off of the bar, damaging the drive links, or wear the rails of the guide bar itself.

LUBRICATION. The importance of proper lubrication of the chain and guide bar cannot be over-stressed. Each rivet in the chain should be considered as a bearing and must be lubricated. This is particularly important in direct drive or high speed chains. The same applies to bearing surface between the chain and the guide bar.

Clean chain in solvent before and after filing, then give chain an oil bath for proper lubrication. DO NOT leave it all to the oil pump. Be sure to use the correct weight of clean oil (not reclaimed crankcase oil) to allow maximum chain lubrication under all cutting conditions and varying temperatures. Pioneer chain oil winter

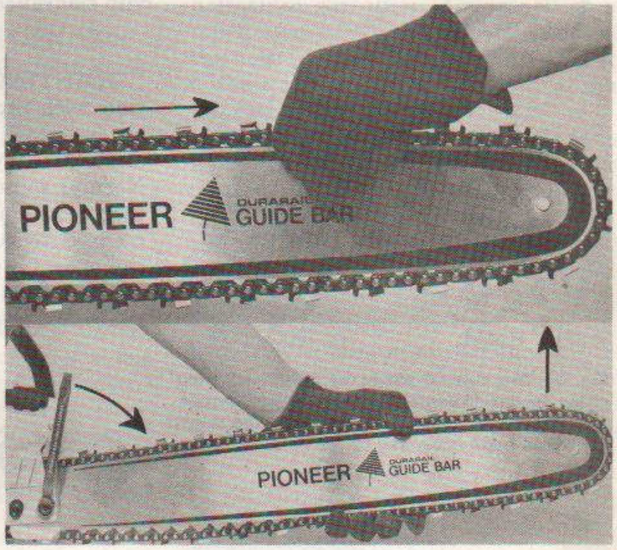


Fig. 9–Pull chain around bar to be sure it fits sprocket and bar. Hold bar tip up, then tighten nuts.

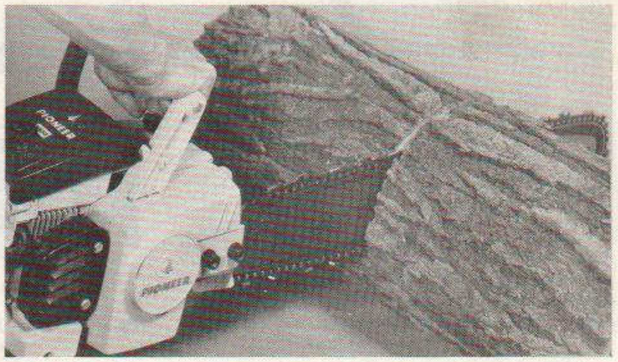


Fig. 10–Use extra oil for the first half hour of cutting with new chain.

or summer grade is recommended. A good grade SAE 10 to SAE 40 motor oil may also be used, depending upon prevailing temperature.

Adequate lubrication is essential to assure the maximum life of the chain. Be generous with the application of oil to the bar and chain. Thin the oil with kerosene or fuel oil in cold weather.

CHAIN MAINTENANCE

The chain saw engine may be perfectly maintained, but, if the chain does not function properly, it is impossible to obtain satisfactory results. The power head exists merely as a convenient method of moving a saw chain in order to cut wood. Correct maintenance and operating conditions are essential to insure the proper functioning of your chain and hence the chain saw.

CHAIN FILING INSTRUCTIONS

Correctly filed chains will allow the machine to cut faster and smoother with less operator fatigue and reduce the wear between the chain, bar and sprocket to a minimum.

SHARPENING. Use the correct size of full round chain file.

Chain Type	File Diameter	Pioneer Part No.
A	3/16 inch	429074
B & C	7/32 inch	427638
D & F	1/4 inch	425592

NOTE: Use the next smaller file when cutters are worn back.

Keep 1/5 of the file diameter above the top edge of the cutter (Fig. 11) to provide the correct undercut. A blunt, slow cutting edge will result if the file is held too high. A thin, quick dulling edge with hook will result if the file is held too low.

The top basic angle (Fig. 12) should be 35 degrees and the undercut angle (Fig. 13) should be 5 degrees. The saw may be filed either with or against the cutting tooth depending upon the filer's preference.

NOTE: File only with straight strokes and keep all cutters the same length.

To arrive at the 5 degree angle, hold the file handle 3 inches above the file tip plane when filing against the tooth or 3 inches below the file tip plane when filing with the tooth. This will help insure a proper under cut and chip clearance. See Fig. 13.

JOINTING. Proper joint in conjunction with proper filing is necessary if an operator is to obtain maximum life and efficiency from a power saw chain. Normal joint is approximately 0.025 inch on Pioneer chain and can be increased to suit the type of timber at the operator's discretion (Fig. 14). Use caution if more joint is required; because, an improper joint will result in excessive wear, shortening the life of the bar and chain. Refer to Fig. 15 for the action of the jointer. Check the joint regularly. Correct joint height results in a fast cutting, smooth operating chain. Excessive joint will cause cutters to bite too deep, causing the chain to grab and overload the engine and clutch. Insufficient joint, caused by the gage set too shallow will prevent the cutters from biting into wood and the chain will not cut efficiently or to capacity. Extra pressure will be required for sawing, resulting in excessive wear to links and guide bar rails.

There are two basic methods employed in jointing: Free hand and using a jointing gage tool (Pioneer part number 471135).

The free hand method is recommended only when no gage is available. The operator may increase the

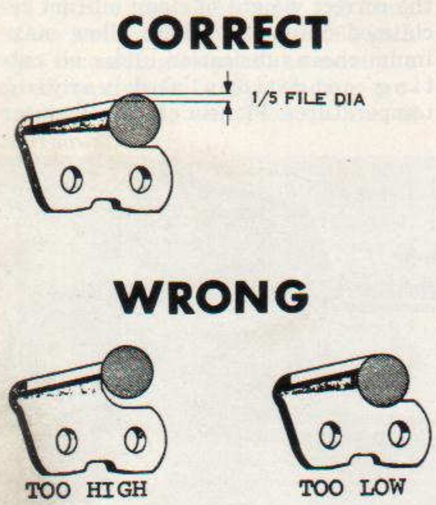


Fig. 11–The correct shape of cutter will help chain to cut faster and remain sharp longer. Back slope is caused by file held too high. Hooked edge is caused by file held too low.

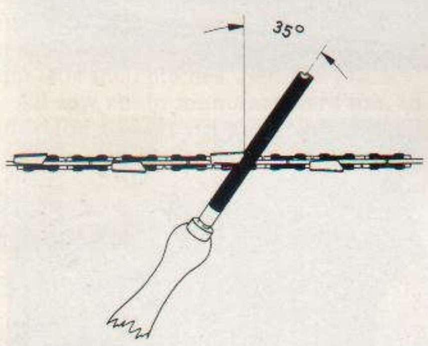


Fig. 12–Angle of cutting face should be 35 degrees as shown. Insufficient top angle causes chain to cut roughly and dull very quickly. Excessive top angle causes side thrust and wear on sides of drive lugs.

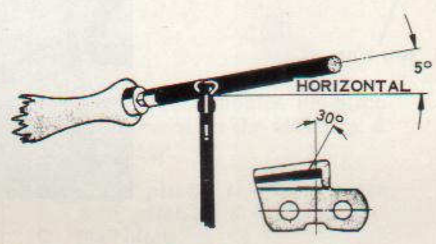


Fig. 13–The file should be held at the 5 degree angle shown to provide the correct undercut.

Fig. 14–Normal joint clearance is 0.025 inch as shown.

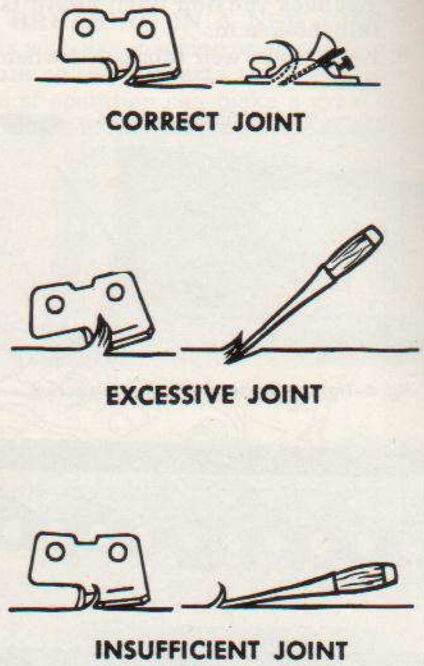


Fig. 15–Check joint clearance regularly. Too much joint clearance will cause cutters to bite too deeply. The chain will grab and the engine and clutch will be overloaded. Extra pressure will be required if the joint clearance isn't enough. The extra pressure required to cut will result in excessive wear on links and guide bar rails.

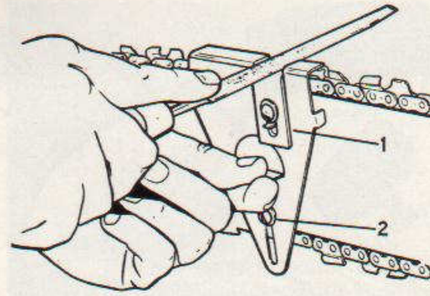


Fig. 16–View showing Pioneer jointing gage.

joint using a flat file. Remember the following, when using the free hand method:

A steady firm stroke of a flat file will remove approximately 0.002-0.003 inch of metal. File all of the depth gages with the same pressure and the same number of strokes. Two passes with a file will remove approximately 0.005 inch of metal which should be enough until the chain is retested to determine what improvements have been made.

The Pioneer Jointing Gage (part number 471135) should normally be used to set joint height. Refer to Fig. 16 and the following for using the gage.

1. Set the filing block No. 1 to desired joint with feeler gage.
2. Set screw No. 2 to rest on bar.
3. Place gage on chain so the depth gage protrudes through hole in filing block.
4. Hold gage firmly with left hand and file down depth gage to top of filing block.
5. File depth gages from same side of guide bar.

REPAIRS

In the Field

Minor repairs can be carried out in the field. If a chain breaker is not available, file off the head or heads of rivets where renewal is necessary, then remove rivets with a sharp punch. A small chisel or screwdriver may be used to spread side links if rivet is not completely cleared.

In the Shop

The use of a chain breaker is essential for ease and quickness in breaking chain where removal or replacement of a component is required.

NOTE: If a new cutter is installed in a used chain, the new cutter must be filed back to conform with the rest of the teeth. The joint on any replacement must be brought down to conform with the balance of the used chain.

RIVETTING. A special rivet spinning attachment is available from Pioneer Saws (Part number 471113) that can be used in any 1/2 inch drill (Fig. 17). Use this tool so that the rivet head will be spun down uniformly to give the same appearance and strength as original factory installation (Fig. 18.)

If a spinner is not available, then a ball peen hammer may be used but special care should be taken. DO NOT strike the rivet head too hard. This can cause a fracture to the rivet drum. The rivet can be peened over on the outside circumference with light taps of the hammer. The rivet should not have a flat appearance caused by pounding the rivet and making it spread from the center. Rivets that are pounded flat will not have enough strength around the circumference.

CHAIN TROUBLE DIAGNOSIS

If the chain is not performing satisfactorily:

1. Remove chain from bar.
2. Clean with solvent to remove pitch and resin.
3. Compare chain with the following illustrations and list. (See page 28.)
4. Repair as indicated.

PIONEER SUREGUARD CHAIN

The very fact that the chain saw is a cutting tool makes it an instrument capable of inflicting injury to the operator. The nature and requirements of lumbering are such that the chain saw must be capable of performing various types of cutting functions under conditions not considered ideal for a power tool. For this reason it is impractical and virtually impossible to protect the operator from all potential dangers.

Generally chain saw operators can allow for these dangers and predetermine their position relative to safety before executing any cut. The greatest source of danger and perhaps the most difficult to combat is the element of surprise. The Pioneer "Sureguard" chain has succeeded in reducing this problem by decreasing the violent kick back, snagging and rough cutting characteristics of the standard chain.

The cutters in a saw chain are so constructed as to produce a chip of uniform thickness within the confines of the power capacity of the engine, the strength of the saw chain and the control of the operator. The thickness of this chip is governed by a gaging element called a "jointer" which precedes the cutting edge and slides over but should never penetrate the wood. Kick back occurs when this jointer function is lost by making such a penetration and exposing a greater section of the cutting face to the cut than it is capable of severing and removing.

The operator can easily control such a situation on the flat portions of the bar because the cutting forces are in a horizontal direction. The reaction is much more severe when this occurs at the nose position because the direction of force is vertical and tends to throw the saw upward.

The Pioneer "Sureguard" chain uses a patented safety member between the cutters. As with other safety chains on the market, this element will satisfactorily reduce snagging and effect a smoother operation when using the straight portions of the bar in bucking and undercutting. However, the feature that is unique in this chain is its function at the nose of the bar. At the nose, the safety element pivots and raises to the level of the cutting edges

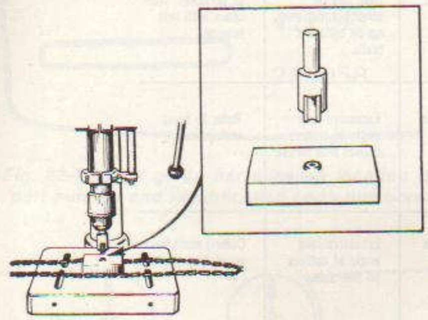


Fig. 17–Rivets should be installed using the special Pioneer rivet spinning attachment.

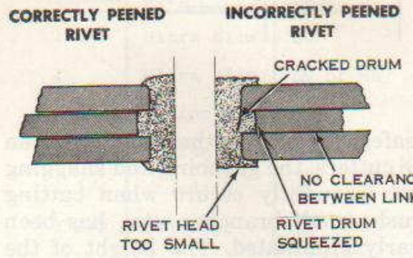


Fig. 18–Views showing correctly installed rivet and rivet damaged by incorrect installation.

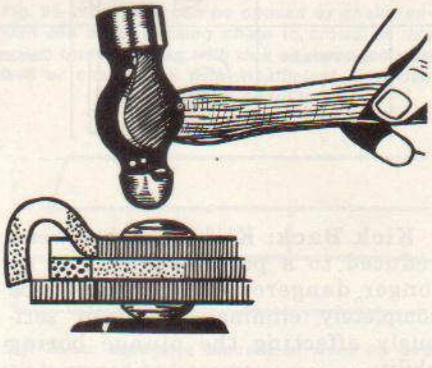


Fig. 19–Rivets can be installed using a ball peen if carefully done.

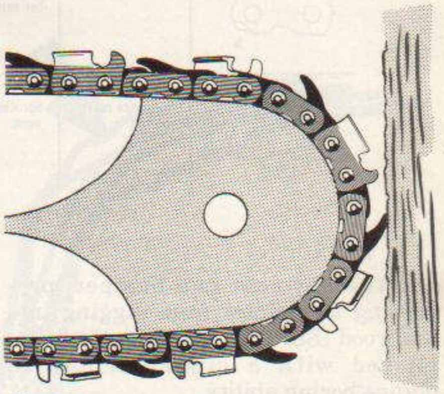


Fig. 20–View of "Sureguard" chain showing action of the safety links as chain goes around bar tip.

common problems found with CUTTERS and LINKS

	FAILURE	CAUSE	REMEDY		FAILURE	CAUSE	○ REMEDY
	Concave side link and cutter bottoms.	Chain run too tight. Insufficient lubrication. Cutters dull.	Decrease chain tension. Check oiler, file cutters.		Side wear.	Abrasive cutting condition.	Check for grit in timber being cut. Lubricate well.
	Heel wear on cutters and side links.	Chain run too loose. Too much joint. Cutters dull.	Increase chain tension. Maintain basic .025″ joint. File cutters.		Back nicked.	Chain run too loose.	Increase tension.
	Slight heel wear cutters and side links.	Back slope on cutters—chain slightly tight. Cutters dull.	Remove back slope. Decrease chain tension. File cutters.		Back rounded to bottom.	Worn sprocket. Chain run too loose.	Increase tension. Renew sprocket.
	Excessive bottom wear on cutters and side links.	Insufficient joint—chain run tight, filing blunt—no undercut, cutters dull.	Increase joint to .025″. Decrease tension—refer to filing instr. File cutters.		Back and front of link peened.	Worn or wrong pitch sprocket.	Renew sprocket. Increase tension.
	Severe side wear and abrasive damage.	Caused by striking stone or nails, etc. Cutters dull.	All visible abrasion must be removed by filing cutters back. File cutters.		Back peened.	Worn sprocket. Dull cutters.	Renew sprocket. File cutters.
	Crack under rear rivet.	Cutters dull or hooked.	Refer to filing instructions.		Bottom peened and worn.	Link riding on bottom of bar groove. Bar rails worn. Dull cutters.	Renew bar. File cutters.
	Crack under front rivet.	Insufficient joint.	Increase joint to basic .025″.		Bottom point rolled up.	Link bottoming in worn sprocket. Dull cutters.	Renew sprocket. File cutters.
	Cracks under both rivets.	Chain run dull and tight—insufficient joint.	Refer to filing instr. Increase joint to basic .025″.		Bottom rough and broken off.	Chain run too tight causes stretch and climbs up on sprocket teeth.	Renew worn chain or sprocket. Run chain with less tension.
	Bottom peened and burred.	Hooked cutters—dull—no undercut causes chain to pound on rails.	Eliminate hook. Refer to filing instructions.		Drive lugs worn on sides.	Excessive face angle of cutters causes side thrust.	Refer to filing instructions.
	Front peened.	Chain run too slack—crowds at bar entry.	Increase tension.		Drive lugs worn on one side.	Excessive face angle of cutters on one side.	Cutters must have equal face angles.
	Clearance notch peened.	Sprocket teeth worn.	Renew sprocket.		Chain jumps out of bar groove.	Uneven filing. Chain run too loose.	Increase chain tension. Refer to filing instructions.

and thereby acts as a bumper, preventing the jointer from digging into the wood (See Fig. 20). This is accomplished with a minimum loss in plunge boring ability.

The following describes some of the advantages of "Sureguard" saw chain.

Kick Back: Kick back has been reduced to a point where it is no longer dangerous. It can never be completely eliminated without seriously affecting the plunge boring ability.

Grabbing & Snagging: By placing a safety member in the valley between the cutters, the grabbing and snagging that frequently occurs when cutting brush, small branches, etc., has been nearly eliminated. The height of the safety member is sufficiently below that of the cutter to never require "jointing" during the life of the chain.

Cutting Roughness: The existence of this safety member provides a smoother bucking and undercutting operation due to its central location in the chain by acting as a rudder in stabilizing the lateral tendencies which occur while the chain is cutting. It restricts chatter and bounce of the individual cutters, thereby improving the cutting efficiency and reducing the element of operator fatigue.

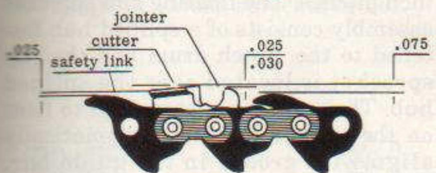


Fig. 21–Drawing of a section of "Sureguard" chain.

GUIDE BARS

All Pioneer guide bars are machined from carbon steel and heat treated to a spring temper which closely controls the hardness. The rails are electrically induction hardened to a controlled depth to withstand chain wear. The nose of standard bars is subjected to the most severe wear and is coated with stellite to prolong the life.

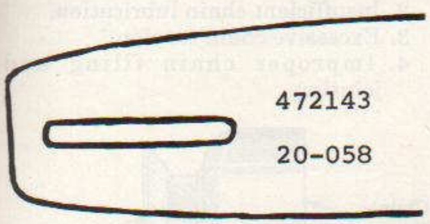
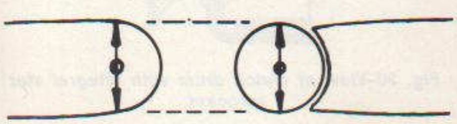


Fig. 22–View of guide bar showing location of part number and identification code numbers.



WIDTH INCHES	CONTOUR TYPE	CODE
2 1/4	Ultra Slim	LC
2	Ultra Slim	SN or SR
2 1/2	Medium Slim	NL
2 1/2	Medium Slim	NH
2 3/4	Standard	HM
3 1/8	Gear Bar	GB

Fig. 23–Guide bar contour type can be determined by measuring as shown and comparing with the accompanying table.

A source of trouble is the choking of the guide bar oil hole with sawdust. Proper lubrication is impossible if the oil hole is plugged and the chain bar and sprocket will wear out quickly if not lubricated. Pioneer guide bars feed the chain lubricating oil through a specially designed channel to reduce this problem.

Roller nose bars can contribute to fast cutting, especially with lower powered saws and small pitch chains. The bar section is made like the Pioneer stellite nose bars, but the roller nose is equipped with a precision bearing to reduce friction.

IDENTIFICATION

To identify the length of the guide bar and width of the groove, examine the tail area. (Fig. 22) The six digit number is the Pioneer part number. The second set of figures identify the guide bar length and the groove width. The example 20-058 indicates a 20 inch guide bar with a 0.058 inch groove. Pioneer guide bars are also available in a variety of guide bar contours for specialized applications. The guide bar contour can be identified by measuring the width of the nose. Refer to Fig. 23 for identification.

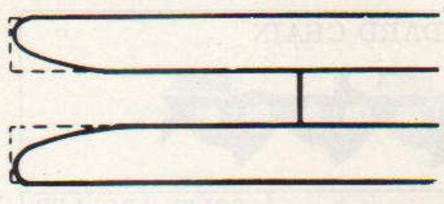


Fig. 24–Worn inside of rails can be caused by inconsistent face angles, excessive face angles or excessive joint.

Fig. 25–Worn rails can be caused by chain tension too slack causing chain to crowd at this point. Under cutting with dull or damaged cutters or chain filed with insufficient joint can also cause this condition.

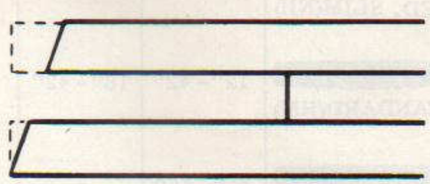


Fig. 26–An excessive amount of wear on one rail is caused by inconsistent face angles, or by greater joint setting on either left or right side of chain.

ROLLER NOSE MAINTENANCE

The precision bearings in the roller nose must be lubricated regularly in order to provide efficient operation and long life. Grease the roller bearing every time you gas the saw using Pioneer grease gun part No. 471403 or any regular hand grease gun with a needle nozzle. Use any good type gun grease available. It is particularly important to maintain correct tension when using a roller nose bar. Lack of tension causes pounding and damage to the guide bar and chain.

TROUBLE SHOOTING

Examine the condition of the guide bar carefully and refer to Figs. 24, 25, 26, 27 and 28 for explanation of faults.

MATCHING THE BAR TO THE CHAIN

Make sure that the chain and guide bar are matched. Pioneer Saws manufacture a variety of saw chain and

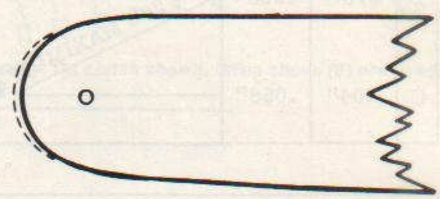


Fig. 27–Worn tip (nose) can be caused by excessive chain tension, insufficient lubrication or cutting with dull or damaged cutters.

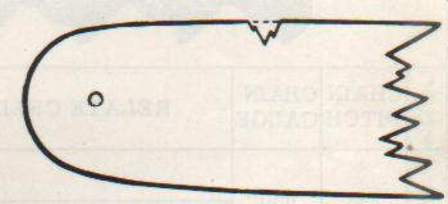


Fig. 28–Chipped rails can be caused by bar being pinched in cut or hitting bar with axe or wedge. Attempting to open the bar groove with screwdriver or similar object can also chip rail as shown.

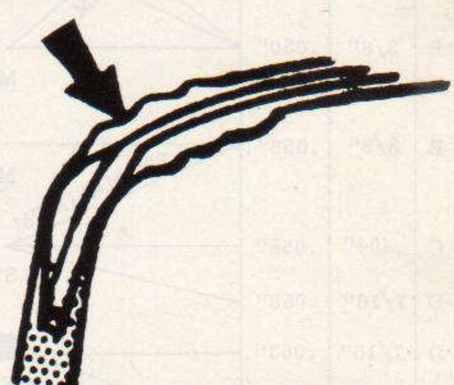


Fig. 29–Damage to the bar rails at chain entry is caused by chain that is too loose. The loose chain will crowd at the entry to guide bar.

guide bars and the chain and bar must be matched for maximum customer satisfaction and performance. The following charts illustrate the compatibility of Pioneer guide bars and the different types of Pioneer saw chain.

SUREGUARD ANTI-KICK CHAIN

CODE	CHAIN PITCH	CHAIN GAUGE	RELATE CHAIN TO BAR	SOLID NOSE BAR	ROLLER NOSE BAR
A	.298"	.050"	ULTRA SLIM(LC)	14"	-
			20" MAXIMUM — ULTRA SLIM(SN & SR)	16"-20"	16"-20"
B	3/8"	.050"	MED. SLIM(NL)	16"-24"	-
B	3/8"	.058"	MED. SLIM(NH)	16"-28"	-
C	.404"	.058"	28" MAXIMUM — STANDARD(HM)	12"-42"	-

DURACUT STANDARD CHAIN

CODE	CHAIN PITCH	CHAIN GAUGE	RELATE CHAIN TO BAR	SOLID NOSE BAR	ROLLER NOSE BAR
A	.298"	.050"	ULTRA SLIM(LC)	14"	-
			20" MAXIMUM — ULTRA SLIM(SN or SR)	16"-20"	16"-20"
B	3/8"	.050"	MED. SLIM(NL)	16"-24"	-
B	3/8"	.058"	MED. SLIM(NH)	16"-28"	-
C	.404"	.058"	28" MAXIMUM — STANDARD(HM)	12"-42"	16"-42"
D	7/16"	.058"			
D	7/16"	.063"	GEAR DRIVE(GB)	20"-50"	-
F	1/2"	.063"			

SPROCKETS AND CLUTCHES

SPROCKETS

Two types of chain drive sprockets are used: The integral star (Fig. 30) and the floating rim sprocket (Fig. 31). The integral star sprocket is permanently attached to the clutch drum and is available in .298, ⅜ and .404 inch pitches. The floating rim sprocket assembly consists of a splined hub fastened to the clutch drum and the rim sprocket is located over the splined hub. The sprocket is permitted to float on the splined hub and automatically align with groove in the guide bar. The floating rim sprockets are available in ⅜ and .404 inch pitchs for direct drive saws. The rim sprocket is also available in 7/16 and ½ inch pitches for gear drive saws. The floating rim sprockets for gear drive saws fits on the splined output shaft instead of a hub on the clutch drum.

FAILURES AND CAUSES. Drive sprockets are, like any moving part subject to extreme friction, subject to wear. A worn sprocket can quickly damage the bar and the chain. The illustrations in Fig. 32 are typical examples of worn sprockets which should be renewed to keep from damaging the bar and chain. Wear on the sprocket teeth can be caused by any of the following:

1. Wrong pitch chain.
2. Insufficient chain lubrication.
3. Excessive chain tension.
4. Improper chain filing and jointing.

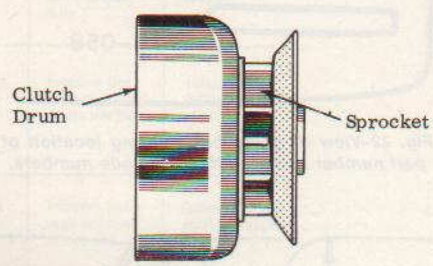


Fig. 30–View of clutch drum with integral star sprocket.

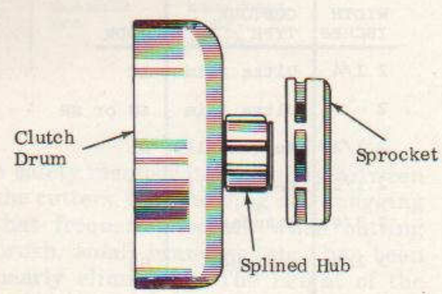


Fig. 31–View of clutch drum and floating rim sprocket.

5. A badly worn and possibly stretched chain has a slight variation in pitch which will contribute to rapid wear of sprocket teeth.
6. A badly worn bar will contribute to rapid wear of the chain which will cause the sprocket to wear. Rapid deterioration and wear on chain drive lugs, side links and cutters will result from installing a new chain. Never install a new chain on a worn sprocket or bar.

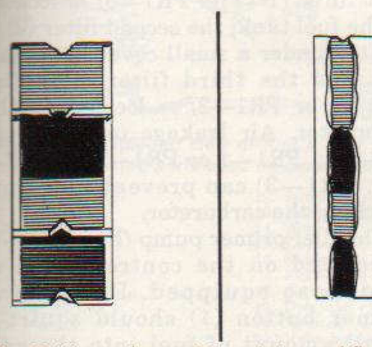


Fig. 32–Views of worn integral star and floating rim sprockets.

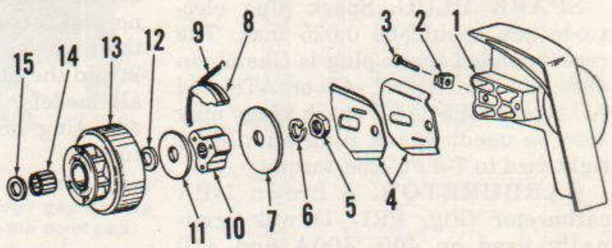
CLUTCH

CLUTCH BEARING. The clutch drum and sprocket can rotate freely (or stop) when the clutch is disengaged. A caged needle roller bearing is located between the clutch drum hub and the shaft. The bearing on most models uses the shaft as the inner race and the clutch drum hub as the outer race and can be removed by hand without any special tools.

Clutch needle bearing failure is often caused by storing the saw after operating under extremely wet conditions. The water will penetrate the needle bearing, form rust and cause the needles to become locked. It is recommended that the clutch drum be removed periodically (depending on local conditions) and the bearing repacked with a good grade of water-resistant grease (not water pump grease).

CLUTCH DRUM AND SHOES. Rapid clutch drum wear, shoe glazing or grooving may be caused by any of the following:

1. Improper filing. Hooked cutters and excessive joint will especially cause the clutch to slip.
2. Chain pinched in cut causing clutch to slip. Throttle should be released immediately when chain becomes pinched.
3. Oil soaked or worn clutch shoes. Clutch shoes should be inspected periodically. Glazing can be removed by wire brushing or other similar method.



1. Strut
2. Chain adjusting screw
3. Adjusting pin
4. Guide plates
5. Nut
6. Lock washer
7. Clutch cover
8. Clutch shoe
9. Clutch spring
10. Clutch driver
11. Clutch plate
12. Thrust washer
13. Clutch drum
14. Needle bearing
15. Washer

Fig. 33–Exploded view of typical clutch assembly. On clutch shown, three shoes (8) are used.

PIONEER

PIONEER SAWS
Peterborough, Ontario, Canada
Lincoln, Nebraska, U. S. A.

MODEL COVERAGE

Model	Bore In.	Stroke In.	Displ. Cu. In.	Drive
400, 400A, 410, NU17, 450, 550	2¼	1⅜	5.47	direct

MAINTENANCE

SPARK PLUG. Spark plug electrode gap should be 0.025 inch. The recommended spark plug is Champion J8J. Autolite AN7X, A7 or AT8 and AC type 45M or 44-S spark plugs may also be used. Spark plug should be tightened to 7-8 Ft.-Lbs. torque.

CARBURETOR. A Brown 1-PA carburetor (Fig. PR1—1) was originally used on 400, 400A and 410 models. The carburetor used on the earliest of these models was equipped with a choke as shown (28 thru 31); however, later models use a fuel primer pump (Fig. PR1—4) and the choke operating parts are removed. A Tillotson HL-108A carburetor (Fig. PR1—2) and a fuel primer pump (Fig. PR1—4) are used on all NU17, 450 and 550 models.

On Brown carburetors, normal setting for the high speed needle (22—Fig. PR1—1) is ¾ to 1 turn open and 1 to 1⅛ turns open for the idle mixture needle (23). On Tillotson carburetors, normal setting is ¾ turn open for both the high speed needle (22—Fig. PR1—2) and the idle mixture needle (23). On all models, clockwise rotation of the adjusting needles will lean the mixture.

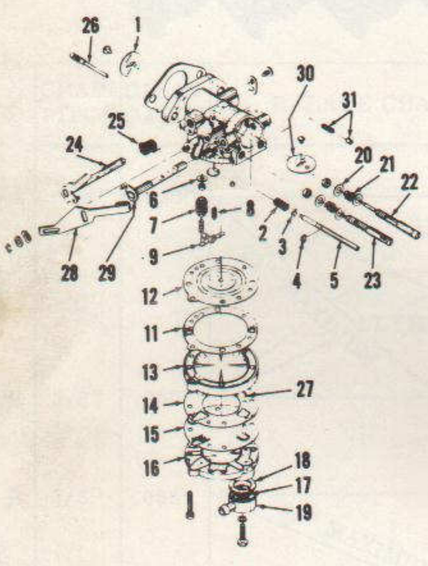


Fig. PR1-1–Exploded view of the Brown diaphragm carburetor used on early models. Springs (27) are located above both check valves. Choke parts (28-31) are sometimes removed when fuel primer pump (Fig. PR1-4) is installed. Refer to Fig. PR1-2 for legend except the following.

27. Spring
28. Choke arm
29. Choke shaft
30. Choke plate
31. Choke detent and spring

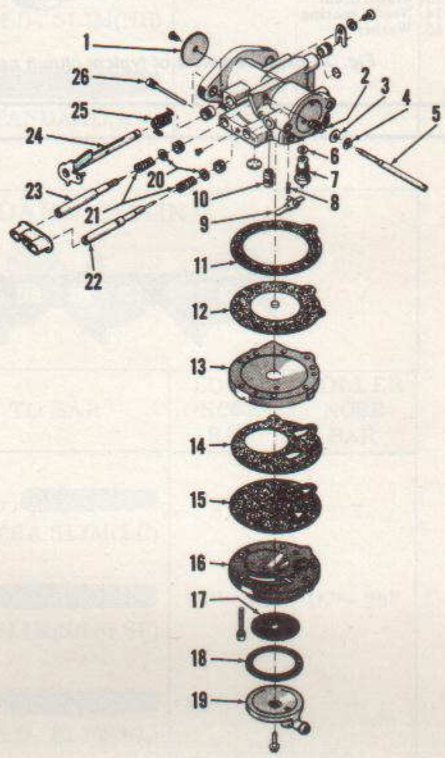


Fig. PR1-2–Exploded view of Tillotson HL model carburetor used on 450, 550 and NU17 models.

1. Throttle plate
2. Spring
3. Washer
4. Clip
5. Idle speed screw
6. Gasket
7. Inlet needle seat and valve
8. Spring
9. Inlet lever
10. Nozzle check valve
11. Gasket
12. Fuel control diaphragm
13. Cover
14. Gasket
15. Fuel pump diaphragm
16. Fuel pump body
17. Filter screen
18. Gasket
19. Cover
20. Washer
21. Spring
22. High speed adjusting screw
23. Low speed adjusting screw
24. Throttle shaft
25. Spring
26. Inlet lever pinion screw

The main fuel system on all models is equipped with three fuel filters. The first filter (1—Fig. PR1—3) is located in the fuel tank, the second filter (2) is located under a small cover in the air box and the third filter (17—Fig. PR1—1 or PR1—2) is located on the carburetor. Air leakage under covers (19—Fig. PR1—1 or PR1—2) and (C—Fig. PR1—3) can prevent fuel from reaching the carburetor.

The fuel primer pump (Fig. PR1—4) is located on the control panel of models so equipped. Depressing primer button (1) should squirt a small amount of fuel into the carburetor inlet for starting. Inspect the check valves (12 & 18), diaphragm (6) and filter (26) if fuel primer pump does not operate.

MAGNETO AND TIMING. A Pioneer magneto is used on all models. The flywheel retaining nut is left hand thread. The breaker point gap should be 0.022 inch and armature air gap (Fig. PR1—5) should be 0.008-0.012

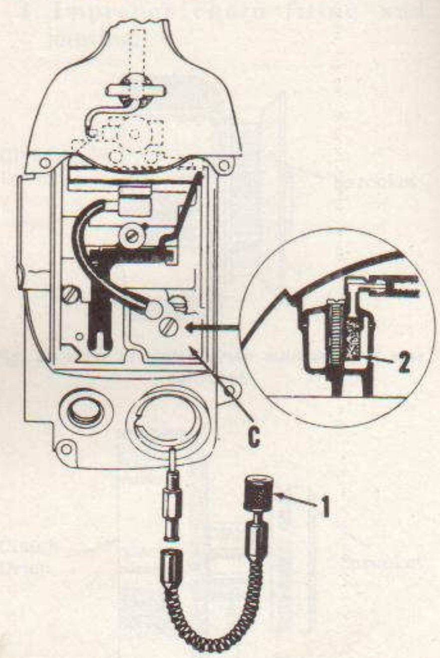


Fig. PR1-3–The first fuel filter (1) is located in the tank. Be sure that gasket located under cover (C) doesn't leak, when servicing the second filter (2).

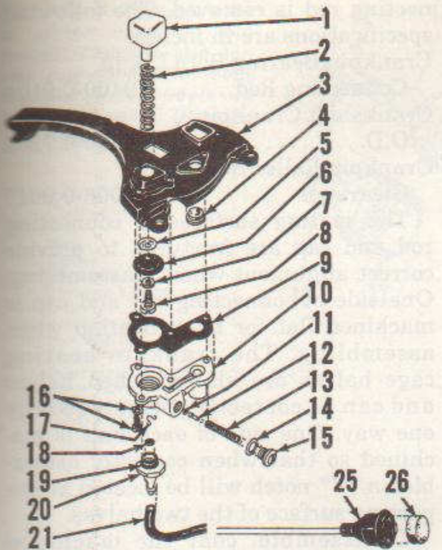


Fig. PR1-4-Exploded view of fuel primer pump and associated parts used on most models.

1. Primer pump button
2. Primer button spring
3. Control panel
4. Sight glass
5. Diaphragm cup
6. Diaphragm
7. Washer
8. Screw
9. Gasket
10. Primer pump body
11. "O" ring
12. Pump outlet valve
13. Valve spring
14. Washer
15. End cap
16. Screw & lockwasher
17. Retaining clip
18. Disc inlet valve
19. "O" ring
20. Valve housing
21. Fuel line
25. Filter body
26. Filter

inch. Condenser capacity should be 0.16-0.20 Microfarads. Ignition should occur (breaker points just open) at 30 degrees BTDC. Magneto edge gap should be 0 to 0.250 inch and can be checked using the special tool number 426847. Edge gap and timing can be adjusted only by changing the breaker point gap within the limits of 0.021-0.024 inch. The flywheel nut should be tightened to 25-30 Ft.-Lbs. torque.

LUBRICATION. The engine is lubricated by mixing oil with the fuel at a ratio of 16:1 (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines the amount of lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended and ½ pint of oil should be mixed with each gallon of gasoline. A good quality SAE 30 or SAE 40 oil with an API classification MS, SB or SD may be used if the preferred oil is not available.

Proper and complete mixing of the oil and gasoline is important. Pour about half of the gasoline to be mixed into a clean metal container, add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; then, stir or shake until it is properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

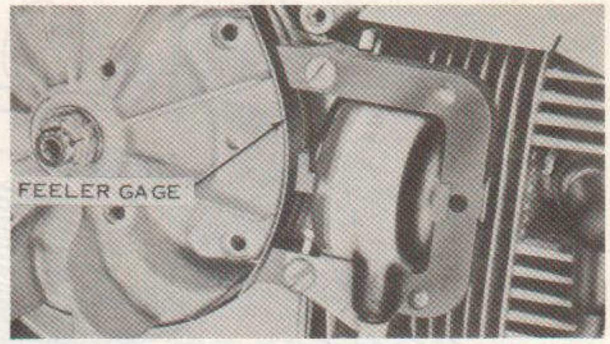


Fig. PR1-5-A feeler gage of correct thickness can be located between flywheel magneto and the three legs of coil core as shown to set the armature air gap.

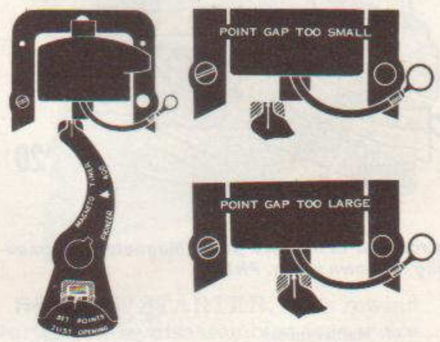


Fig. PR1-6-Edge gap can be checked using special tool number 426847. Edge gap can be changed slightly by changing the point gap.

The oil reservoir should be filled with Pioneer Chain Oil winter or summer grade, or if not available, use a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. The manual chain oiler pump is shown in Fig. PR1—8.

CARBON. The exhaust ports and muffler should be cleaned approximately every two weeks of use or if a loss of power is noticed. Excessive carbon buildup may indicate an excessive amount of oil or an improper type of oil mixed with the fuel. Cylinder

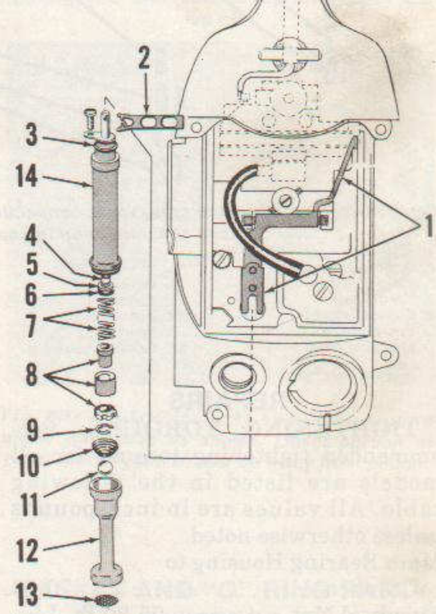


Fig. PR1-8-Exploded view of the manual chain oiler pump. Early models use spring (10) and later models have special webbing in the housing to center check ball (11).

1. Operating lever
2. Clip
3. "O" ring
4. Pump rod
5. "O" ring
6. Washer
7. Spring
8. Piston and valve
9. Snap ring
10. Centering spring
11. Check ball (9/32 inch)
12. Pick up housing
13. Screen
14. Pump body

cooling fins should also be cleaned when cleaning carbon from exhaust.

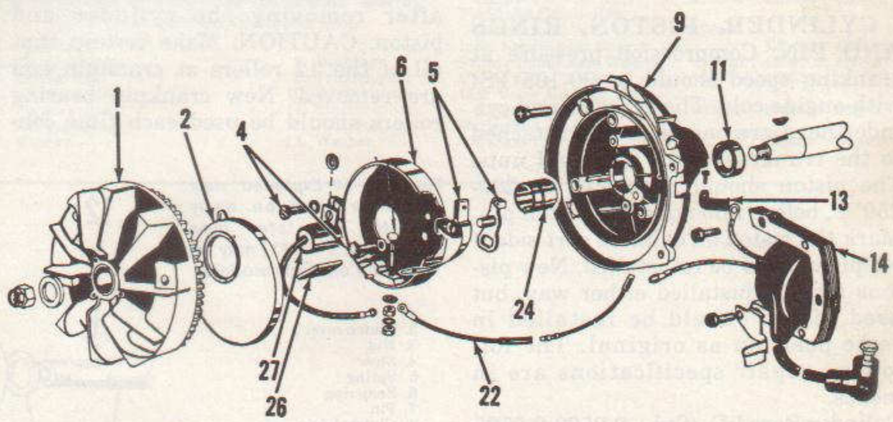


Fig. PR1-7-Exploded view of magneto used on all models.

1. Flywheel
2. Cover
5. Breaker points
6. Housing
9. Bearing housing
11. Crankcase seal
14. Coil and laminations
22. Kill wire
24. Cam
26. Felt
27. Condenser

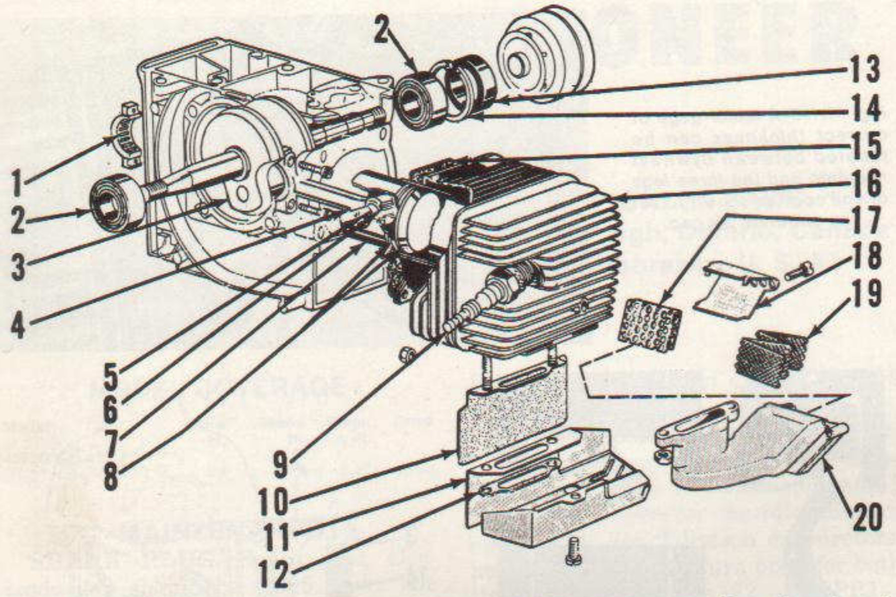


Fig. PR1-9–View of engine crankshaft, connecting rod and associated parts. Magneto end crankcase seal and bearing housing is shown in Fig. PR1-7.

1. Rod cap & bearings
2. Main bearings
3. Crankshaft
4. Connecting rod
5. Piston pin & retaining rings
6. Pin bearing
7. Piston
8. Piston rings
9. Spark plug
10. Gasket shield
11. Muffler shroud
12. Muffler gasket
13. Oil seal
14. Retaining ring
15. Cylinder gasket
16. Cylinder
17. Screen plate
18. Exhaust deflector
19. Muffler screen
20. Muffler body

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques for all models are listed in the following table. All values are in inch-pounds unless otherwise noted.

Main Bearing Housing to Crankcase	70-80
Flywheel Nut	25-30 Ft.-Lbs.
Connecting Rod Screws	60-65
Cylinder Base Nuts	60-80
Muffler to Cylinder	70-80
Clutch Nut	25-30 Ft.-Lbs.
Rear Handle to Air Box	70-80
Air Box to Crankcase—	
Size ¼-28 Screws	70-80
Size 10-24 Screws	35-40
Shroud Retaining Screws	60-80
Handle to Crankcase	60-80
Bar to Crankcase	80-110
Oil Pump to Air Box	25-35

CYLINDER, PISTON, RINGS AND PIN. Compression pressure at cranking speed should be 90-105 PSI with engine cold. The cylinder and cylinder head are one piece and attached to the crankcase with four stud nuts. The piston should be heated to 200-250° F. before removing the piston pin. Mark the piston on exhaust port side if old piston is to be reinstalled. New pistons may be installed either way, but used piston should be installed in same position as original. The following repair specifications are in inches.

Cylinder Bore I.D. (Std.)	2.2500-2.2505
Piston Skirt O.D. (Std.)	2.2435-2.2440
Piston to Cylinder Clearance— Desired	0.006-0.007
Piston Ring to Groove Side Clearance— Desired	0.002-0.004
Piston Ring End Gap— Desired	0.008-0.014
Piston Pin O.D.	0.6248-0.6250
Piston Pin Fit in Piston Bore	0-0.0005 interference
Piston Pin to Bearing Clearance	0.0005-0.0017

Oversize pistons (part number 426137) and rings (part number 426140) are available for service. The cylinder bore must be resized 0.020 inch larger than standard before installing the oversize piston and rings.

When assembling, the opening in piston pin retaining rings should be centered toward closed end of piston.

CONNECTING ROD. Connecting rod can be separated and removed after removing the cylinder and piston. CAUTION: Make certain that all of the 12 rollers at crankpin end are removed. New crankpin bearing rollers should be used each time connecting rod is removed. The following specifications are in inches.

Crankpin Bearing Bore I.D. in Connecting Rod	0.9100-0.9104
Crankshaft Crankpin O.D.	0.7199-0.7202
Crankpin Roller Bearing Clearance	0.0006-0.0017

The mating surfaces of connecting rod and cap are fractured to provide correct alignment when reassembling. One side of connecting rod and cap is machined flat for identification when assembling. The crankpin bearing cage halves are also matched halves and can be correctly assembled only one way. One side of each half is machined so that when correctly assembled a "V" notch will be located at the parting surface of the two halves.

To assemble, coat the machined bearing surface of connecting rod and cap with a light grease. CAUTION: Be sure that grease is not on fractured surfaces. Install bearing cage in cap and install five of the bearing rollers in the cage. Position the connecting rod cap with cage half and rollers under the crankpin, then install upper half of bearing cage and the remaining seven rollers. Install connecting rod and tighten the two attaching screws.

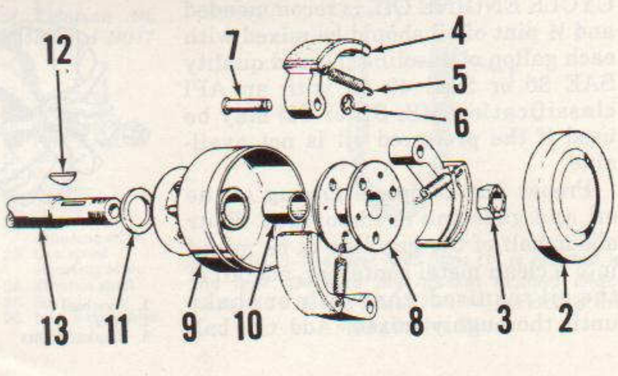
NOTE: Assembly of the connecting rod is much easier using Pioneer connecting rod spoon (Part No. 426014) and special screw installing tool (Part No. 426024).

CRANKCASE AND CRANKSHAFT. Crankshaft can be removed after removing the cylinder, connecting rod, flywheel, magneto and clutch. Remove the four attaching screws, then pull the magneto side main bearing housing away from crankcase. Crankshaft ball type main bearings should be a tight (interference) fit in crankcase and bearing housing bores. Area around bearings should be heated to 200-250° F. when installing bearings. Metal sides of crankshaft seals should be toward outside, with lip toward inside.

CLUTCH. Two different clutches have been used. Early series 400 saws

Fig. PR1-10–Exploded view of clutch used on early models. The later type clutch (Fig. PR1-11) may be installed on early models.

2. Clutch cover
3. Nut
4. Shoe
5. Spring
6. Snap ring
7. Pin
8. Clutch driver
9. Sprocket & drum
10. Bearing
11. Washer
12. Woodruff key
13. Crankshaft



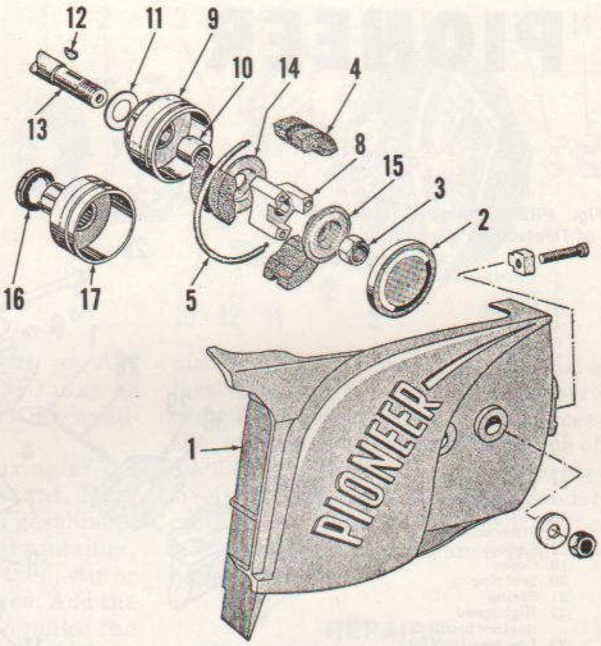


Fig. PR1-11–Exploded view of clutch used on late models. Clutch is also service replacement for early models. Some models are equipped with floating sprocket (16).

1. Cover
2. Clutch cover
3. Nut
4. Shoe
5. Spring
8. Clutch driver
9. Sprocket & drum
10. Bearing
11. Washer
12. Woodruff key
13. Crankshaft
14. Inner plate
15. Outer plate
16. Sprocket segment
17. Drum & spline

were originally equipped with the clutch shown in Fig. PR1—10. Clutch shown in Fig. PR1—11 was originally installed on NU17, 450 and 550 models and is installed as service replacement for early type. Bearing (10—Fig. PR1—10 or PR1—11) should be lubricated with a small amount of Mobil Sovarex No. 1W or Shell Alvania No. 2 lubricant before installing clutch drum. A clutch assembling tool (Part No. 429923) is available to facilitate installation of clutch shoes (4—Fig. PR1—12) and spring (5) on driver (8). Connection (C) at ends of garter spring (5) should be at the middle of a clutch shoe. Do not have connection between clutch shoes.

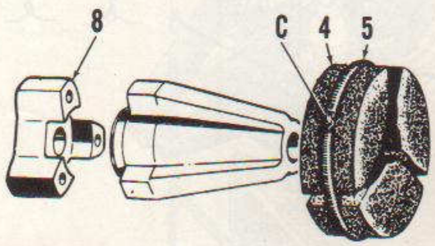


Fig. PR1-12–Special tool is available for sliding clutch shoes (4) and garter spring (5) onto driver (8). Connection of garter spring ends (C) should be at middle of clutch shoe.

REWIND STARTER. The rewind starter can be disassembled for service after removing fan housing cover and pulley cover. Remove pin (12—Fig. PR1—13) and withdraw parts from air box. Refer to Fig. PR1—14 for installation of rewind spring. Rewind spring should be liberally oiled before installing. Install friction yoke as described in Fig. PR1—15. The 5/32 inch diameter nylon starter cord (3—Fig. PR1—13) should be approximately 45 inches long. Preload the rewind spring approximately three turns before installing pulley cover.

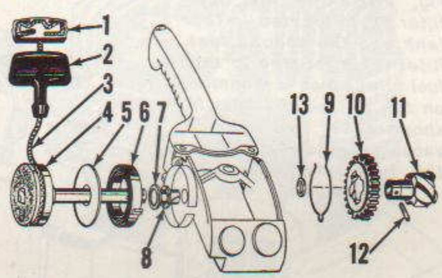


Fig. PR1-13–Exploded view of rewind starter. Cord (3) should be 45 inches long.

1. Cord anchor
2. Starter handle
3. Starter cord
4. Starter pulley
5. Backing plate
6. Rewind spring
7. Washer
8. Bushing
9. Friction yoke
10. Starter pinion
11. Starter spline
12. Roll pin
13. Washer

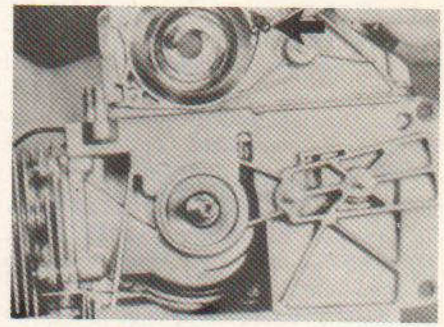


Fig. PR1-14–The outer end of rewind spring should be located between lugs on air box. Hooking end over outside lug may break the lug off.

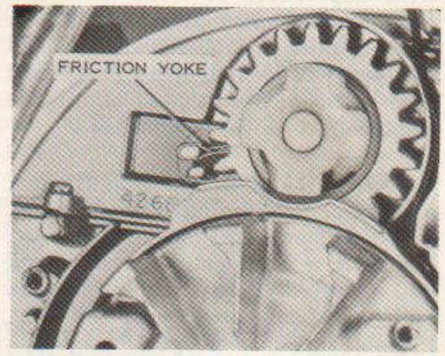


Fig. PR1-15–Friction yoke should be around upper projection as shown. Offset portion at outer end of yoke should be away from pinion.

GASKET AND "O" RING PART NUMBERS

	MODELS		
	400, 410	NU-17	450 550
Exhaust Gasket	426444	426444	426444
Cylinder Base Gasket	426453	426453	426204
Muffler Gasket Shield	426740	426740	426740
Oil Pump Rod "O" Ring	425028	425028	425028
Oil Pump Body "O" Ring	303059	303059	303059
Oil Cap Gasket	425074	425074	425074
Gas Cap Gasket	425087	425087	425087
Filter Cap Gasket	426464	426464	426464
Insulating Block Gasket	426705	426704	....
Carburetor Base Gasket	....	....	426705
Airbox Gasket	426651	426651	426651
Carburetor Mounting Gasket	425046	425046	425046
Carburetor Metering Gasket	426596	260719	260719
Carburetor Fuel Pump Gasket	426598	425506	425506
Fuel Inlet Connecting Gasket	426601	....	....
Inlet Needle Seat Gasket	....	425486	425486
Primer Pump Base Gasket	426820	426820	426820
Check Valve "O" Ring	308528	308528	308528
Disc Valve Housing "O" Ring	202893	202893	202893
Carburetor Fuel Filter Gasket	....	260663	260663

PIONEER

MODEL COVERAGE

Model	Bore In.	Stroke In.	Displ. Cu. In.	Drive
600, 600A, 610, 620, Super 6-20, 650	2¼	1 9/16	6.21	Direct

MAINTENANCE

SPARK PLUG. Spark plug electrode gap should be 0.025 inch. The recommended spark plug is Champion J8J. Autolite AN7X, A7 or AT8 and AC type 45M or 44-S spark plugs may also be used. Spark plug should be tightened to 7-8 Ft.-Lbs. torque.

CARBURETOR. Tillotson HL-22A carburetor was originally used on 600, 600A, 610 and 620 models; Tillotson HL-129A is used on Super 6-20 and 650 models. Normal setting for the high speed mixture needle (22—Fig. PR2—1) is 1¼ turns open for HL-22A carburetors; 1 turn open for HL-129A carburetors. Normal setting for idle mixture needle (23) on all carburetors is ¾ turn open. The fuel is filtered by the pick-up screen (1—Fig. PR2—2) in tank, the felt filter (2) in filter bowl and by screen (17—Fig. PR2—1) at carburetor. An air leak, especially at filter bowl (Fig. PR2—2) may prevent fuel from reaching carburetor.

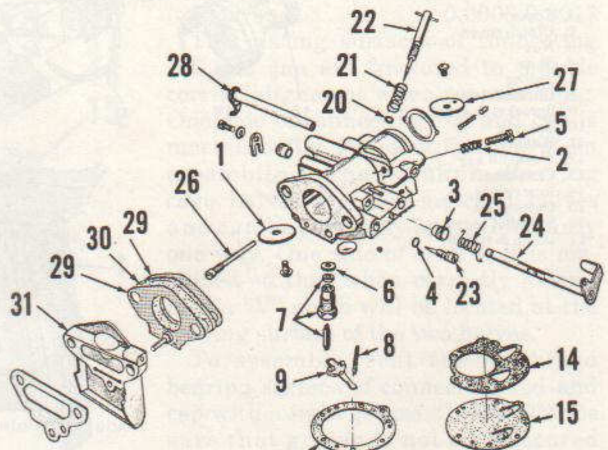
MAGNETO AND TIMING. The breaker points, cam, condenser and coil are located under the flywheel. Flywheel retaining nut is left hand thread. Breaker point gap should be 0.020 inch. Condenser capacity should be 0.16-0.20 Microfarads. Ignition should occur (breaker points just open) at 30 degrees BTDC. Ignition timing will usually be correct if marks on stator and bearing housing (Fig. PR2—3) are aligned. The flywheel retaining nut should be tightened to 25-30 Ft.-Lbs. torque.

LUBRICATION. The engine is lubricated by mixing oil with the fuel at a ratio of 16:1 (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines the amount of lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended and ½ pint of oil should be mixed with each gallon of gasoline. A good quality

Fig. PR2-1–Exploded view of Tillotson HL carburetor.

1. Throttle plate
2. Spring
3. Bushing
4. Seal ring
5. Idle speed screw
6. Gasket
7. Inlet needle valve
8. Spring
9. Inlet lever
11. Gasket
12. Diaphragm
13. Cover
14. Gasket
15. Fuel pump diaphragm
16. Fuel pump body
17. Filter screen
18. Gasket
19. Cover
20. Seal ring
21. Spring
22. High speed mixture needle
23. Low speed mixture needle
24. Throttle shaft
25. Spring
26. Inlet lever pivot
27. Choke plate
28. Choke shaft
29. Gaskets
30. Insulator
31. Adapter



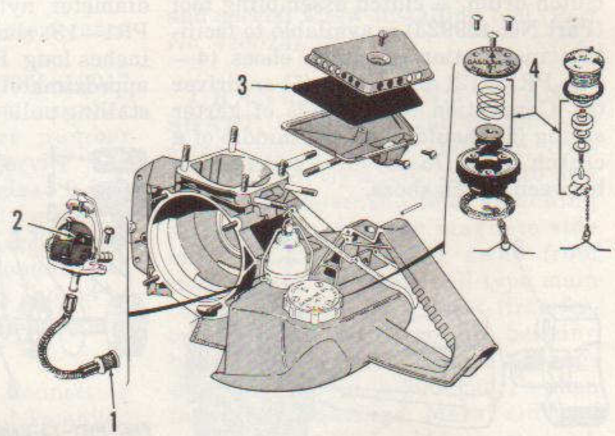
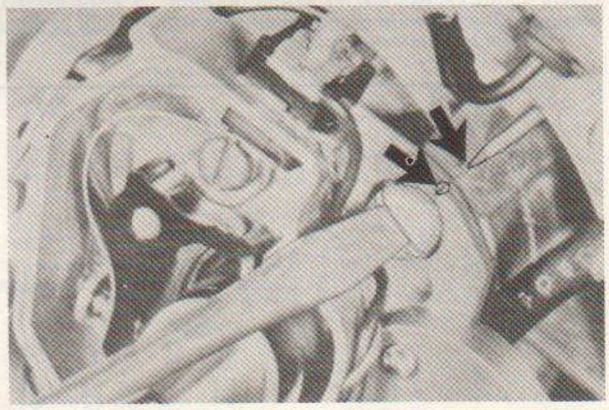


Fig. PR2-2–The first fuel filter (1) is located in the tank and the second fuel filter (2) is located in the fuel bowl which is mounted on top of tank. Air filter is shown at (3). Two types of vacuum valves (4) used in the fuel filler caps are shown.

Fig. PR2-3–Align marks on stator and main bearing housing as shown when installing magneto stator.



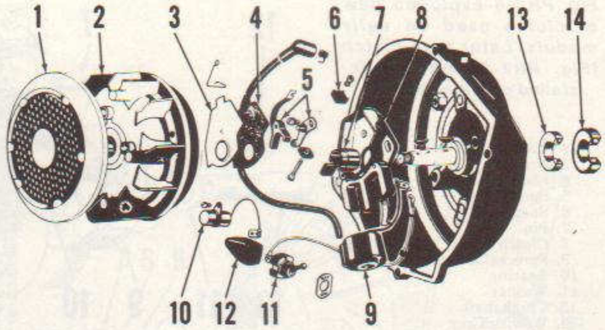


Fig. PR2-4–Exploded view of main bearing housing and magneto assembly.

1. Screen
2. Flywheel
3. Cover
4. Gasket
5. Breaker points
6. Insulator
7. Breaker cam
8. Stator
9. Coil
10. Condenser
11. Kill switch
12. Switch cover
13. Crankshaft seal
14. Main bearing

SAE 30 or SAE 40 oil with an API classification MS, SB or SD may be used if the preferred oil is not available.

Proper and complete mixing of the oil and gasoline is important. Pour about half of the amount of gasoline to be mixed into a clean metal container, add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; then, stir or shake until it is properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

The oiler reservoir should be filled with Pioneer Chain Oil winter or summer grade, or, if not available, use a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. The manual chain oiler pump is shown in Fig. PR2—5.

CARBON. The exhaust ports and muffler should be cleaned approximately every two weeks of use or if a loss of power is noticed. Excessive carbon build up may indicate an excessive amount of oil, an improper type of oil mixed with the fuel or an excessively rich fuel-air mixture. Cylinder cooling fins should be cleaned at the same time carbon is cleaned from exhaust.

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques are listed in the following table. All values are listed in inch-pounds unless otherwise noted.

Main Bearing Housing to Crankcase	60-70
Flywheel Nut	25-30 Ft.-Lbs.
Connecting Rod Screws	60-65
Cylinder Base Nuts	60-80
Cylinder Head to Cylinder—	
650 Model	60-80
Other Models	90-100
Clutch Nut	25-30 Ft.-Lbs.
Cooling Shroud Retaining Screws	60-80
Handle to Crankcase	60-80
Bar to Crankcase	80-110
Starter to Fan Housing	25-35
Chain Oiler to Crankcase	25-35
Fuel Filter to Crankcase	25-35

CYLINDER, PISTON, RINGS AND PIN. Compression pressure at cranking speed should be 125-145 PSI with engine cold. The cylinder head is attached to top of cylinder with six stud nuts. The four cylinder base retaining nuts must be loosened, then the cylinder must be raised slightly before retaining nuts can be removed. The piston should be heated before removing the piston pin. Mark the piston on exhaust port side if old piston is to be reinstalled. New pistons can be installed either way, but used piston should be installed in same position as original. The following repair specifications are in inches.

Cylinder Bore I.D. (Std.)	2.2500-2.2505
Piston Skirt O.D. (Std.)	2.2435-2.2440
Piston to Cylinder Clearance— Desired	0.006-0.007
Piston Ring to Groove Side Clearance Desired	0.002-0.004
Piston Ring End Gap— Desired	0.008-0.014
Piston Pin O. D.	0.6245-0.6248
Piston Pin Fit in Piston Bore	0-0.0005 interference
Piston Pin to Bearing Clearance	0.0005-0.0017

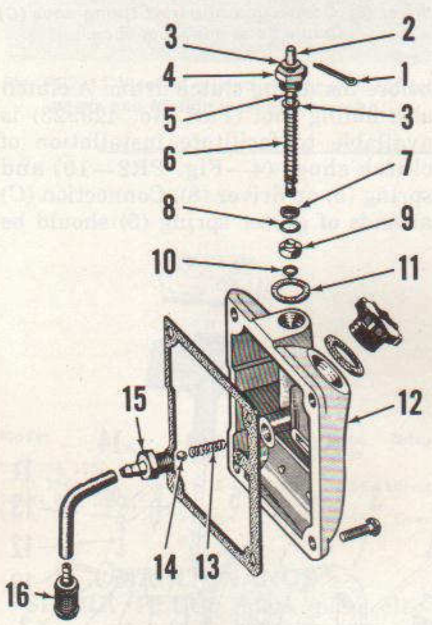


Fig. PR2-5–Exploded view of chain oiler pump.

1. Cotter pin
2. Rod
3. Washers
4. Gland nut
5. "O" ring
6. Spring
7. Washer
8. "O" ring
9. Piston
10. Snap ring
11. Gasket
12. Cover and pump body
13. Spring
14. Check valve ball
15. Valve seat and fitting
16. Pick-up filter

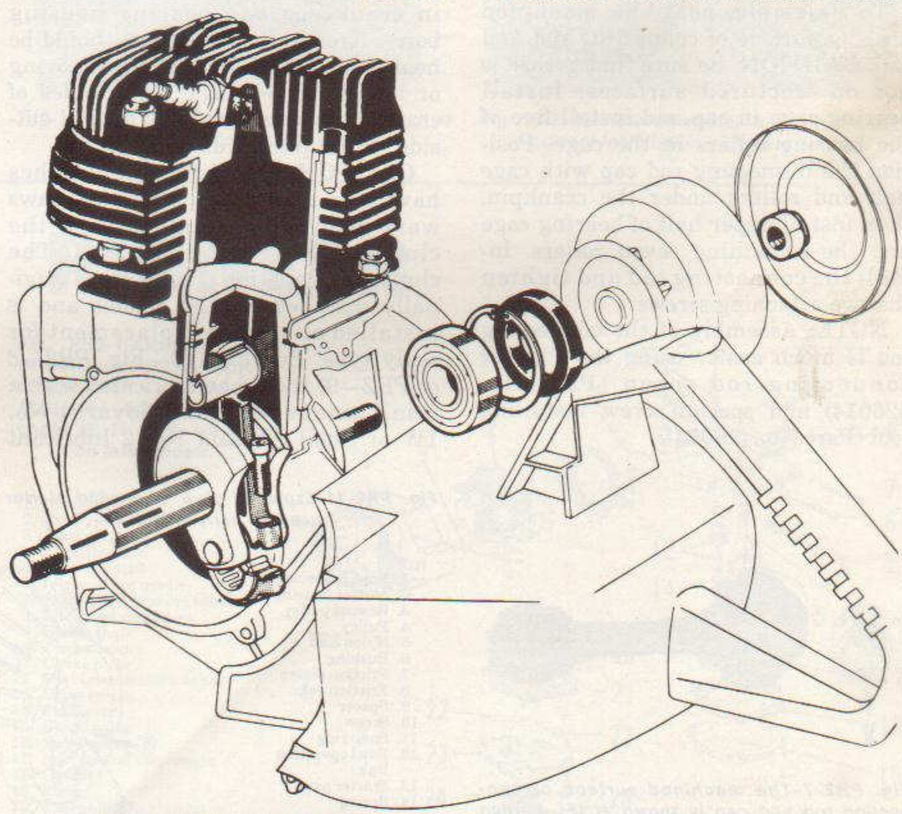


Fig. PR2-6–Cross section of engine showing crankshaft, connecting rod and piston. Main bearing and housing for magneto end are shown in Fig. PR2-4.

Oversize pistons (part number 426137) and rings (part number 426140) are available for service. The cylinder bore must be resized 0.020 inch larger than standard before installing the oversize piston and rings.

When assembling, the opening in piston pin retaining rings should be centered toward closed end of piston.

CONNECTING ROD. The connecting rod can be separated and removed after removing the cylinder and piston. CAUTION: Make certain that all 12 rollers at crankpin end are removed. New crankpin rollers should be installed each time the connecting rod is removed. The following specifications are in inches.

Crankpin Bearing Bore I. D. in
Connecting Rod 0.9100-0.9104
Crankshaft Crankpin
O. D. 0.7199-0.7202
Crankpin Roller Bearing
Clearance 0.0006-0.0017

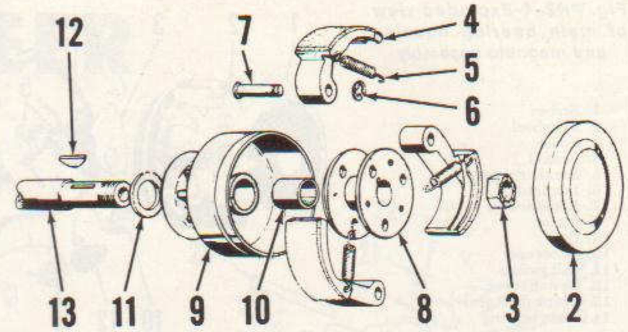
The mating surfaces of connecting rod and cap are fractured to provide correct alignment when reassembling. One side of connecting rod and cap (F—Fig. PR2—7) is machined flat for identification when assembling. The crankpin bearing cage halves are also matched halves and can be correctly assembled only one way. One side of each half is machined so that when correctly assembled a "V" notch (V) will be located at parting surface of the two halves.

To assemble, coat the machined bearing surface of connecting rod and cap. CAUTION: Be sure that grease is not on fractured surfaces. Install bearing cage in cap and install five of the bearing rollers in the cage. Position the connecting rod cap with cage half and rollers under the crankpin, then install upper half of bearing cage and the remaining seven rollers. Install the connecting rod and tighten the two attaching screws.

NOTE: Assembly of the connecting rod is much easier using the Pioneer connecting rod spoon (Part No. 426014) and special screw installing tool (Part No. 426024).

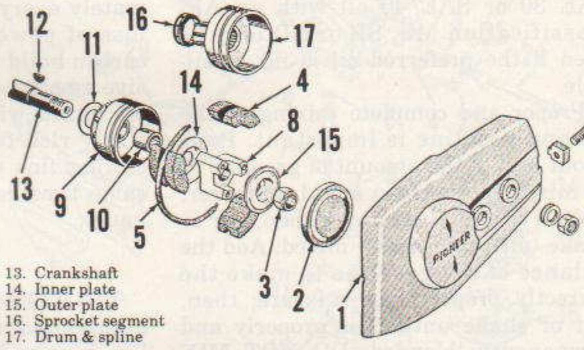
Fig. PR2-7–The machined surface of connecting rod and cap is shown at (F). Parting surface (V) on bearing cage should form a "V" at one point when correctly assembled.

Fig. PR2-8–Exploded view of clutch used on early models. Later type clutch (Fig. PR2-9) may be installed on early models.



2. Clutch cover
3. Nut
4. Shoe
5. Spring
6. Snap ring
7. Pin
8. Clutch driver
9. Sprocket & drum
10. Bearing
11. Washer
12. Crankshaft
13. Woodruff key

Fig. PR2-9–Exploded view of clutch used on late models. Clutch is also service replacement for early models. Some saws may be equipped with floating sprocket (16).



1. Cover
2. Clutch cover
3. Nut
4. Shoe
5. Spring
8. Clutch driver
9. Sprocket & drum
10. Bearing
11. Washer
12. Woodruff key
13. Crankshaft
14. Inner plate
15. Outer plate
16. Sprocket segment
17. Drum & spline

CRANKCASE AND CRANKSHAFT. The crankshaft can be removed after removing the cylinder, connecting rod, flywheel, magneto and clutch. Remove the four attaching stud nuts, then pull the magneto side main bearing housing away from the crankcase. Crankshaft ball type main bearings should be a tight (interference) fit in crankcase and bearing housing bores. Area around bearings should be heated to 200-250° F. when removing or installing bearings. Metal sides of crankshaft seals should be toward outside, with lip toward inside.

CLUTCH. Two different clutches have been used. Early series 600 saws were originally equipped with the clutch shown in Fig. PR2—8. The clutch shown in Fig. PR2—9 was originally installed on 650 models and is installed as service replacement for early type. Bearing (10—Fig. PR2—8 or PR2—9) should be lubricated with a small amount of Mobil Sovarex No. 1W or Shell Alvania No. 2 lubricant before installing clutch drum. A clutch assembling tool (Part No. 429923) is available to facilitate installation of clutch shoes (4—Fig. PR2—10) and spring (5) on driver (8). Connection (C) at ends of garter spring (5) should be

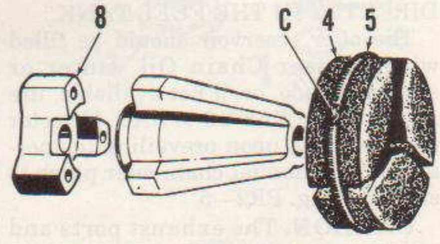
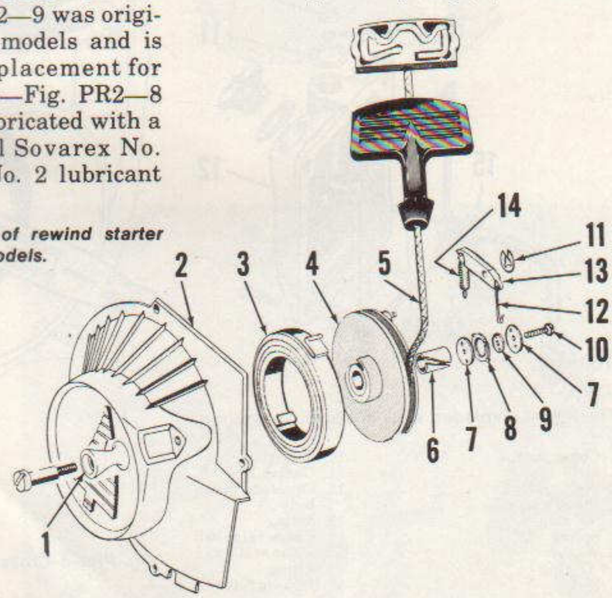


Fig. PR2-10–Special tool is available for sliding clutch shoes (4) and garter spring (5) onto driver (8). Connection of garter spring ends (C) should be at middle of shoe.

Fig. PR2-11–Exploded view of rewind starter used on early models.



1. Rope guide roller
2. Starter housing
3. Rewind pulley
4. Pulley
5. Nylon cord
6. Bushing
7. Friction plates
8. Friction yoke
9. Spacer
10. Screw
11. Snap ring
12. Pawl operating link
13. Starter pawl
14. Spring

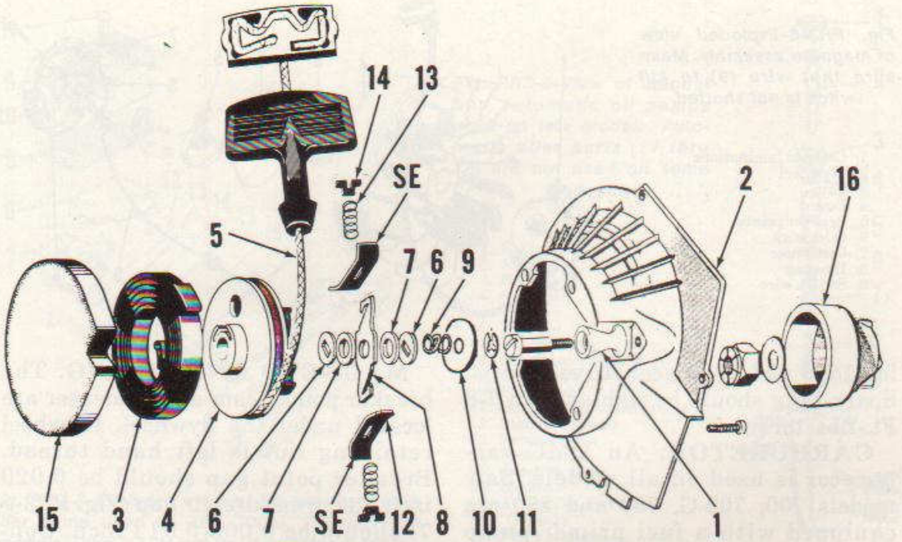


Fig. PR2-12–Exploded view of rewind starter used on later models.

1. Rope guide roller
2. Starter adapter
3. Rewind spring
4. Pulley
5. Nylon cord
6. Brake washers
7. Fiber washers
8. Brake lever
9. Spring
10. Washer
11. Snap ring
12. Starter pawls
13. Spring
14. Spring retainer
15. Starter housing
16. Starter cup

at the middle of a clutch shoe. Do not have connection between clutch shoes.

REWIND STARTER. Two types of rewind starters have been used. Early models may be equipped with the rewind starter shown in Fig. PR2—11. Later models are equipped with the starter shown in Fig. PR2—12.

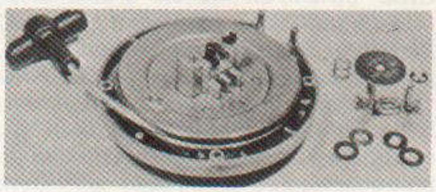


Fig. PR2-13–View of rewind starter with starter pawls and friction washers removed.

On late type, the sharp edges of pawls should be on side marked (SE).

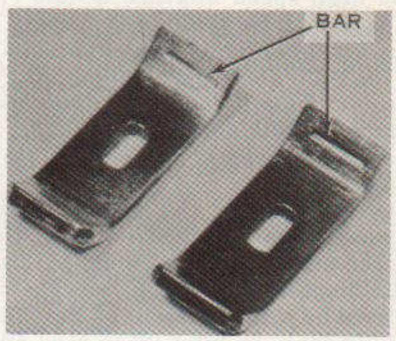


Fig. PR2-14–Bar is stamped across end of starter pawls which should be sharp.

The sharp edge should be filed to 27 degrees. The pawls may catch in the cup (13) if edge is too sharp or if cup surface is rough. Starter may slip if starter pawls are dull or if fiber washers (7) are oil soaked. Sharp edge of starter pawls are stamped with a bar (Fig. PR2—14). The 5/32-inch diameter nylon starter cord should be approximately 38 inches long.

GASKET AND "O" RING PART NUMBERS

	MODELS 600, 620	650
Exhaust Gasket	426205	426205
Cylinder Head Gasket	425643	425643
Cylinder Base Gasket	426204	426204
Oiler Gland Nut Gasket	425093	....
Oil Cap Gasket	425074	425074
Oil Pump Piston "O" Ring	425095	425095
Oiler Gland Nut "O" Ring	425028	425028
Oil Pump Base Gasket	426199	....
Fuel Pickup Head "O" Ring	304614	304614
Fuel Filter Base Gasket	425669	425669
Carburetor Air Cleaner Gasket	425669	425669
Fuel Filter Bowl Gasket	425748	425748
Gas Cap Gasket	425087	425087
Carburetor Fuel Strainer Gasket	260663	260663
Carburetor Fuel Pump Gasket	425506	425506
Carburetor Metering Gasket	260719	260719
Carburetor Inlet Seat Gasket	425486	425486
Carburetor Adapter to Crankcase Gasket	426123	426123
Carburetor Adapter and Mounting Gasket	425046	425046
Carburetor Insulating Block Gasket	425328	425328
Fan Housing Gasket	427193	427193
Breaker Box Gasket	425690	425690
Check Valve Gasket	....	427273
Check Valve "O" Ring	....	427281

Fig. PR2-15–View of starter housing showing correct installation of rewind spring.

PIONEER

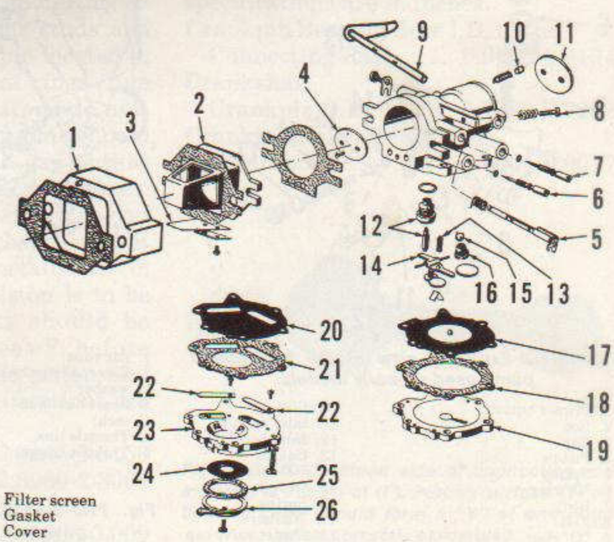
Model	Bore In.	Stroke In.	Displ. Cu. In.	Drive
700, 750, 1750, 1770, 1771	2 5/16	1 9/16	6.56	Direct
700-G, 850, 1850, 1870,	2 5/16	1 9/16	6.56	Gear

MAINTENANCE

SPARK PLUG. Spark plug electrode gap should be 0.025 inch for all models except 1771 which should be 0.030 inch. Recommended Champion spark plug is J8J for 700 and 750 models, CJ6 for 1750, 1770 and 1771 direct drive models. Recommended Champion spark plug is J4J for 700-G and 850 models, CJ4 is recommended

Fig. PR3-1–Exploded view of OMC carburetor typical of type used on all models. Insulator block (1) and choke (9, 10 & 11) are used on late models.

1. Insulator block
2. Reed valve
3. Reed petal
4. Throttle plate
5. Throttle shaft
6. Idle mixture needle
7. High speed mixture needle
8. Idle speed stop screw
9. Choke shaft
10. Choke detent
11. Choke plate
12. Fuel inlet needle and seat
13. Lever spring
14. Fuel lever
15. Check valve
16. Valve seat
17. Fuel control diaphragm
18. Gasket
19. Plate
20. Fuel pump diaphragm
21. Gasket
22. Fuel pump valves
23. Lower cover
24. Filter screen
25. Gasket
26. Cover



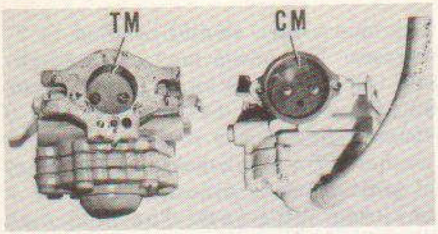


Fig. PR3-1A–Punch marks on throttle (TM) and choke (CM) plates should be toward top and outside of carburetors.

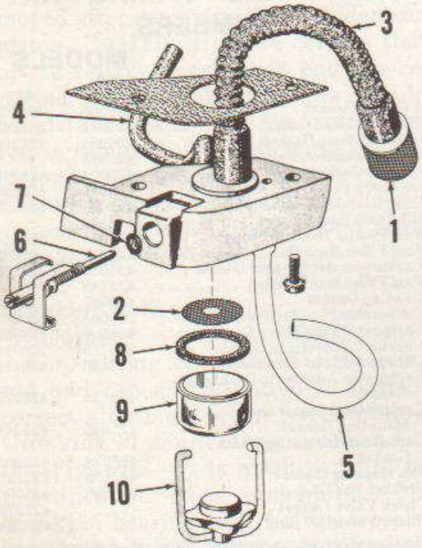


Fig. PR3-2–The fuel filter housing used on early models. Later models are not equipped with shut-off valve (6).

1. Pick-up and filter
2. Filter screen
3. Pick-up tube
4. Hose to primer
5. Hose to carburetor
6. Shut-off valve
7. "O" ring
8. Gasket
9. Bowl
10. Bail

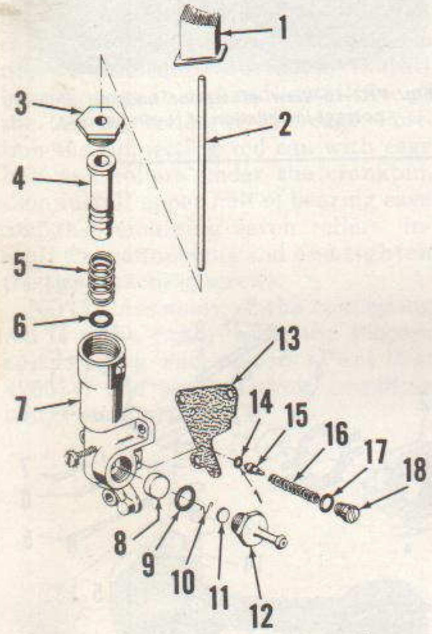
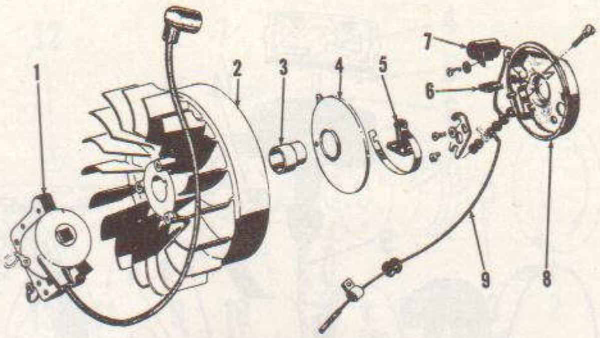


Fig. PR3-3–Exploded view of the fuel primer pump used on early models.

1. Primer button
2. Rod
3. Cap
4. Piston
5. Spring
6. "O" ring
7. Body
8. Felt
9. "O" ring
10. Clip
11. Inlet valve
12. Inlet housing
13. Gasket
14. "O" ring
15. Outlet valve
16. Spring
17. Washer
18. Outlet valve cap

Fig. PR3-6–Exploded view of magneto assembly. Make sure that wire (9) to kill switch is not shorted.

1. Coil and laminations
2. Flywheel
3. Cam
4. Cover
5. Breaker points
6. Oiler wick
7. Condenser
8. Housing
9. Switch wire

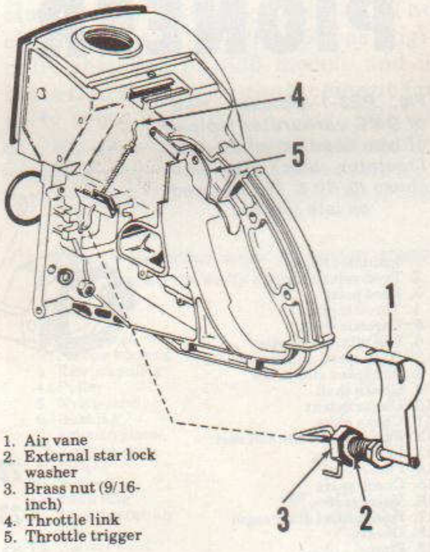


for 1850 and 1870 gear drive models. Spark plug should be tightened to 7-8 Ft.-Lbs. torque.

CARBURETOR. An OMC carburetor is used on all models. Saw models 700, 700-G, 750 and 850 are equipped with a fuel primer pump (Fig. PR3—3) and carburetor is not provided with a choke. Later saw models are equipped with a carburetor choke (9, 10 & 11—Fig. PR3—1). Saw models 750 and 850 are equipped with an air vane governor (Fig. PR3—5).

Idle mixture needle (6—Fig. PR3-1) and high speed mixture needle (7) should both be set approximately 1 turn out from lightly seated for 1750, 1770, 1771, 1850 and 1870 models; ¾ turn out for earlier models. Clockwise rotation of both needles leans the mixture. Idle speed is adjusted at stop screw (9).

On all models, the carburetor is removed toward right (drive side). The longer end of fuel lever should be flush with diaphragm chamber floor. Fuel is filtered by pick-up screen (1—Fig. PR3—2) in tank, by filter (2) in bowl and again at the carburetor screen (24—Fig. PR3—1). Air leakage at fuel bowl may prevent fuel from reaching carburetor.



1. Air vane
2. External star lock washer
3. Brass nut (9/16-inch)
4. Throttle link
5. Throttle trigger

Fig. PR3-5–View showing parts of air vane governor used on some models.

MAGNETO AND TIMING. The breaker points, cam and condenser are located under the flywheel. Flywheel retaining nut is left hand thread. Breaker point gap should be 0.020 inch and armature air gap (Fig. PR3—7) should be 0.008-0.012 inch. Condenser capacity should be 0.18-0.22 Microfarads. Ignition should occur (breaker points just open) at 30 degrees BTDC. Timing can be adjusted only by changing the breaker point gap. The flywheel nut should be tightened to 25-30 Ft.-Lbs. torque.

LUBRICATION. The engine is lubricated by mixing oil with the fuel. Mixing ratio should be 12:1 (1⅓ pints of oil with two gallons of gasoline) for 1750, 1771, 1850 and 1870 models. Other models should use a 16:1 mixture (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines the amount of lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended. A good quality SAE 30 or SAE 40 oil with an API classification MS, SB or SD may be used if the preferred oil is not available.

Proper and complete mixing of oil and gasoline is important. Pour about half of the amount of gasoline to be mixed into a clean metal container,

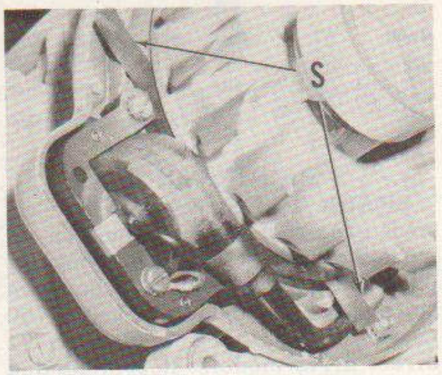


Fig. PR3-7–View showing method of checking air gap using shim stock (S).

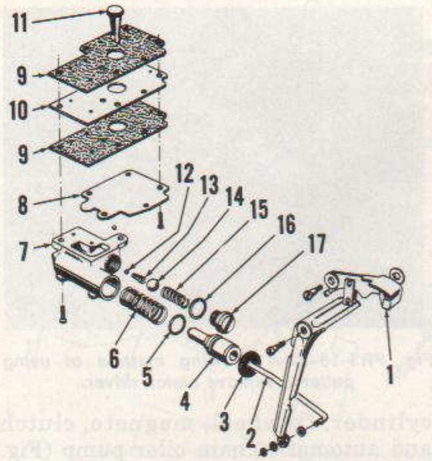


Fig. PR3-8–Exploded view of the manual chain oiler pump used on 700, 700-G, 750 and 850 models. Plug (11) is not used on later models.

1. Pump lever
2. Rod
3. Felt
4. Pump piston
5. "O" ring
6. Spring
7. Housing
8. Cover
9. Gaskets
10. Spacer
11. Plug (early models)
12. Small check valve ball
13. Tapered spring
14. Large check valve ball
15. Spring
16. Washer
17. End cap

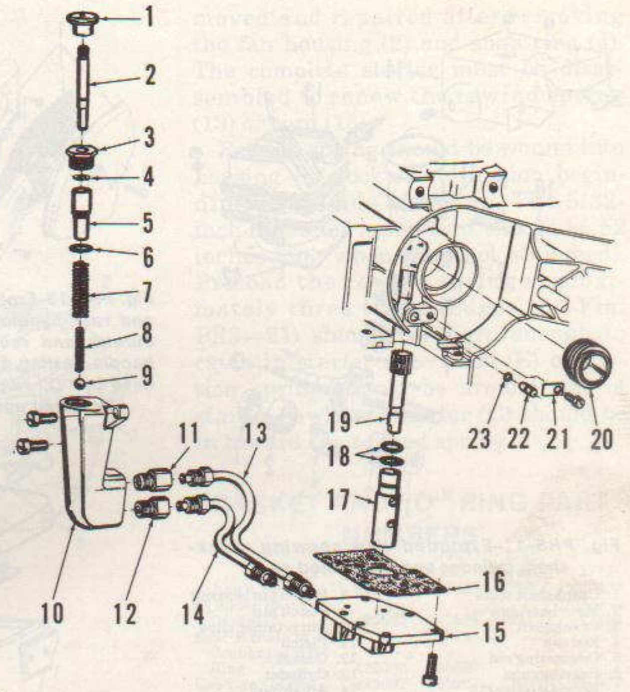


Fig. PR3-9–View of manual and automatic oil pumps used on late models. Automatic oiler parts (17 thru 23) are not used on some models.

1. Button
2. Rod
3. End cap
4. Snap ring
5. Piston
6. "O" ring
7. Piston spring
8. Check valve spring
9. Inlet check valve ball
10. Pump body
11. Outlet check valve fitting
12. Standard fitting
13. Pressure line
14. Suction line
15. Junction plate
16. Gasket
17. Automatic oiler body
18. "O" rings
19. Pump plunger
20. Worm gear
21. Lock plate
22. Locating pin
23. "O" ring

add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; Then, stir or shake until it is properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

The oil reservoir should be filled with Pioneer Chain Oil winter or summer grade, or if not available, use a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. The chain oiler pumps used are shown in Figs. PR3—8 and PR3—9.

To disassemble the automatic oiler pump on later models, it is necessary to remove the clutch and junction plate. (15—Fig. PR3—9). Remove retaining screw and lock plate (21), then pull the locating pin (22) out of housing bore. Body (17), "O" rings (18) and plunger (19) can be easily pulled from housing bore using a screw threaded into lower end of pump body.

One "O" ring (18) is located in groove of pump body (17), the other "O" ring is located against chamfered area of body below the groove.

Align the annular groove in plunger (19), hole in body (17) and hole in housing before inserting locating pin (22).

CARBON. Exhaust ports and muffler should be cleaned approximately every two weeks of use or if a loss of power is noticed. Excessive carbon buildup may indicate an excessive amount of oil, an improper type of oil mixed with the fuel or a rich fuel-air mixture. The cylinder cooling fins should also be cleaned at least once each week.

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques for all models are listed in the following table. All values are in inch-pounds unless otherwise noted.

Fan Housing to Crankcase	60-70
Flywheel Nut	25-30 Ft.-Lbs.
Connecting Rod Screws	60-65
Cylinder Base Nuts	70-80
Muffler to Cylinder	70-80
Clutch Nut	25-30 Ft.-Lbs.
Rear Handle to Crankcase	70-80
Handle Bar to Crankcase	60-70
Coil to Housing	25-35
Strut and Bar to Crankcase	80-110
Starter to Fan Housing	25-35
Oiler to Crankcase	15-25
Fuel Filter Base to Tank	25-35

CYLINDER, PISTON, RINGS AND PIN. Compression pressure at cranking speed should be 110-125 PSI with engine cold. Cylinder and cylinder head are one piece and attached to the crankcase with four studs and nuts. Some pistons use a pin located in the ring groove to prevent rings from turning, while other pistons do not. Pistons with ring locating pins should be installed with ring end gap toward rear (carburetor side of crankcase). Pistons without ring locating pins can be installed either way when new, but should be marked for installation in original position if old piston is to be reinstalled. All pistons should be heated to 200-250 degrees F. before removing or installing the piston pin. The following repair specifications are in inches.

Cylinder Bore I.D.	2.3145-2.3150
Piston Skirt Bore O.D.	2.3060-2.3065
Piston to Cylinder Clearance— Desired	0.008-0.009
Piston Ring End Gap— Models Without Pinned Rings	0.002-0.004
Piston Pin O.D.	0.6248-0.6250
Piston Pin Fit in Piston Bore	0-0.0005 interference
Piston Pin to Bearing Clearance	0.0005-0.0017

On models with pinned rings, the locating pin and ring end gap should be toward rear (carburetor side of crankcase). On all models, the opening in piston pin retaining clips should be centered toward closed end of piston.

CONNECTING ROD. Connecting rod can be separated and removed after removing the cylinder and piston. CAUTION: Make certain that all of the 12 rollers at crankpin end are removed. New crankpin bearing rollers should be used each time connecting rod is removed. The following specifications are in inches.

Crankpin Bearing Bore I.D. in the Connecting Rod	0.9100-0.9104
Crankshaft Crankpin O.D.	0.7199-0.7202
Crankpin Roller Bearing Clearance	0.0006-0.0017

Fig. PR3-10–Machined side of connecting rod and cap is shown at (F). Parting surface (V) on bearing cage should form a "V" at one point when correctly assembled.

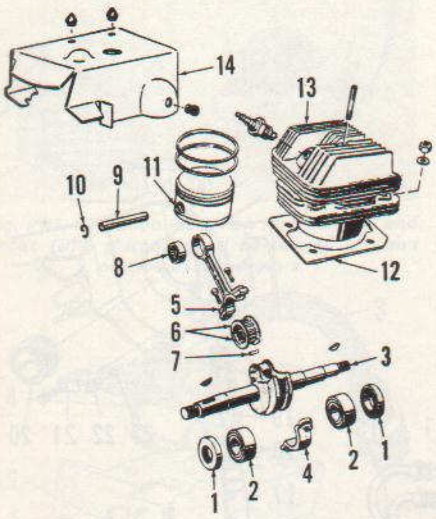


Fig. PR3-11–Exploded view showing crankshaft, cylinder and associated parts.

1. Crankshaft seals
2. Main bearings
3. Crankshaft
4. Rod cap
5. Connecting rod
6. Bearing cage
7. Bearing roller (12 used)
8. Piston pin bearing
9. Piston pin
10. Pin retainer clips
11. Piston
12. Gasket
13. Cylinder
14. Air shroud

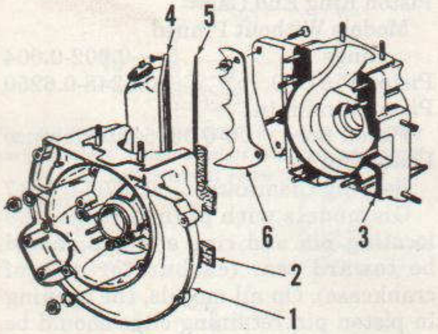


Fig. PR3-12–View of crankcase used on direct drive models.

1. Magneto side crankcase half
2. Gasket
3. PTO side crankcase half
4. Chain oil tank cover
5. Gasket
6. Pivot grip

The mating surfaces of connecting rod and cap are fractured to provide correct alignment when reassembling. One side of connecting rod and cap is machined for identification when assembling. The crankpin bearing cage halves are also matched halves and can be correctly assembled only one way. One side of each half is machined so that when correctly assembled a "V" notch will be located at the parting surface of the two halves.

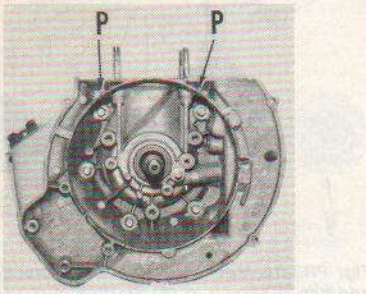


Fig. PR3-12A–Drive tapered pins (P) out before separating crankcase halves.

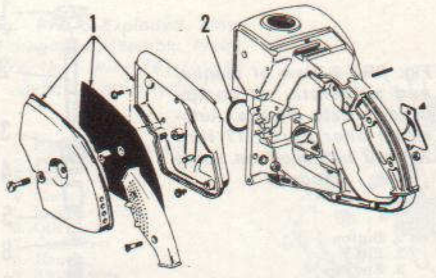
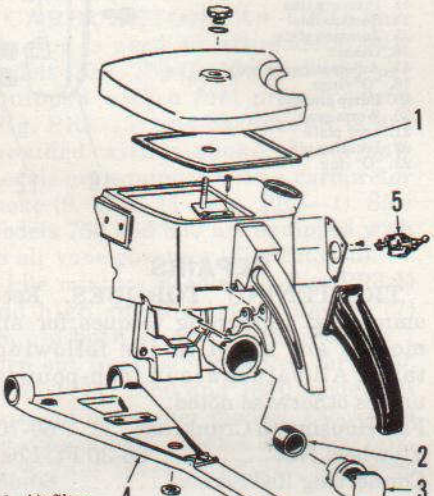


Fig. PR3-13–Exploded view of fuel tank, air box and rear handle typical of early models. Carburetor and reed valve are attached to the handle casting and casting is sealed to crankcase by "O" ring (2). Several variations of the air intake and filter (1) have been used.



1. Air filter
2. Air seal
3. Adapter
4. Base plate
5. Kill switch

Fig. PR3-14–Exploded view of fuel tank, air box and rear handle typical of later models.

To assemble, coat the machined bearing surface of connecting rod and cap. CAUTION: Be sure that grease is not on fractured surfaces. Install bearing cage in cap and install five of the bearing rollers in the cage. Position the connecting rod cap with cage half and rollers under the crankpin, then install upper half of bearing cage and the remaining seven rollers. Install the connecting rod and tighten the two attaching screws.

NOTE: Assembly of the connecting rod is much easier using the Pioneer connecting rod spoon (Part No. 426014) and special screw installing tool (Part No. 426024).

CRANKCASE AND CRANKSHAFT. Crankshaft can be removed from all models after removing the cylinder, flywheel, magneto, clutch and automatic chain oiler pump (Fig. PR3—9). Drive the two tapered aligning pins (Fig. PR3—12) out toward the chain (drive) side. Remove the five stud nuts that attach halves of crankcase together, then separate the halves. NOTE: The crankcase halves will probably be damaged if the halves are separated before removing the tapered aligning pins.

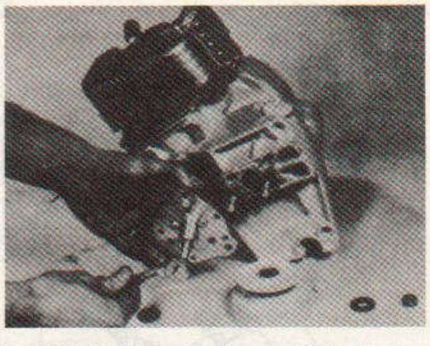


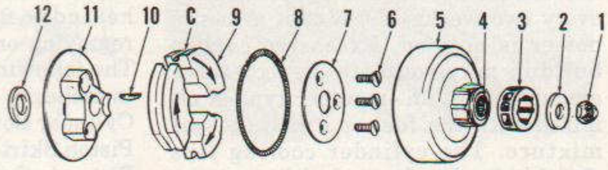
Fig. PR3-16–View showing method of using puller to remove clutch driver.

Crankshaft ball type main bearings should be a tight (interference) fit in crankcase and bearing housing bores. Area around bearings should be heated to 200-250° F. when removing or installing bearings. Metal sides of crankshaft seals should be toward outside with lip toward inside.

DIRECT DRIVE CLUTCH. Clutch drum (5—Fig. PR3—15), bearing (4) and shoes (9) can be removed after removing the cover, chain and nut (1). The chamfered end (C) of clutch shoes (9) should be on trailing end as shown. Bearing (4) should be lubricated with a small amount of Mobil Sovarex No. 1W or Shell Alvania No. 2 lubricant before installing clutch drum. Connection at ends of garter spring (8) should be at the middle of a clutch shoe. Do not have connection between clutch shoes. A puller can be used to remove the clutch driver from crankshaft as shown in Fig. PR3—16. Chamfered side of washer (12—Fig. PR3—15) should be toward engine.

CLUTCH AND GEARBOX. The clutch used on 700-G, 850, 1850 and 1870 models is contained in the gear case. It is necessary to remove the cover (2—Fig. PR3—17) in order to service the clutch, gears, bearings or shafts. Remove the handle bar, saw chain, guide bar and screws attaching

Fig. PR3-15–Exploded view of the clutch used on direct drive models.



1. Nut
2. Washer
3. Sprocket
4. Bearing
5. Clutch drum
6. Screws
7. Plate
8. Spring
9. Clutch shoes
10. Key
11. Driver
12. Washer

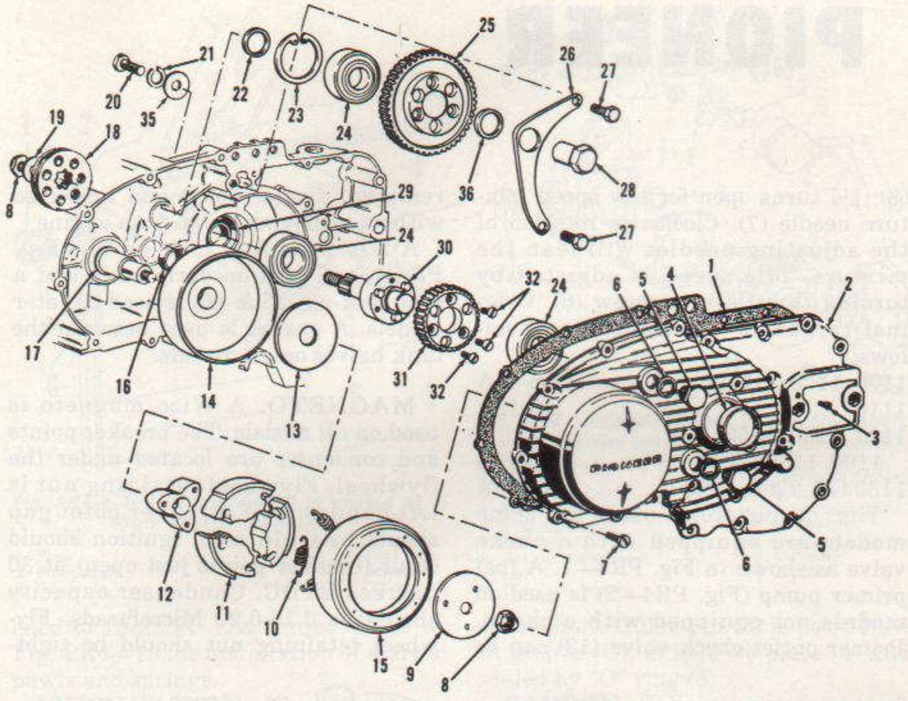


Fig. PR3–17–View of gear reduction transmission. Bearings (24) are tight fit on shaft (30) and in bores of cover and housing. Clutch cover (15) is not used on later models.

1. Gasket
2. Cover
3. Oiler plug
4. Plug
5. Oil filler and level plugs
9. Washer
10. Clutch springs
11. Clutch shoes
12. Clutch driver
13. Retainer plate
14. Clutch drum and gear
16. Plug
17. Thrust washer
18. Sprocket
20. Spindle bolt
21. Lockwasher
22. Spacer
23. Snap ring
24. Bearings
25. Idler gear
26. Brace plate
28. Spindle
29. Seal
30. Output shaft
31. Output gear
35. Washer
36. Spacer

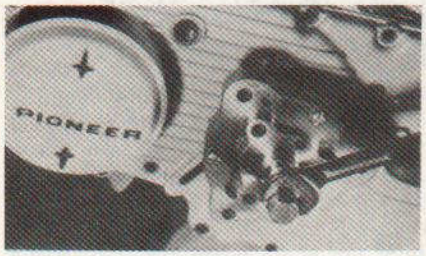


Fig. PR3–18–View showing method of using puller to remove cover from gearbox.

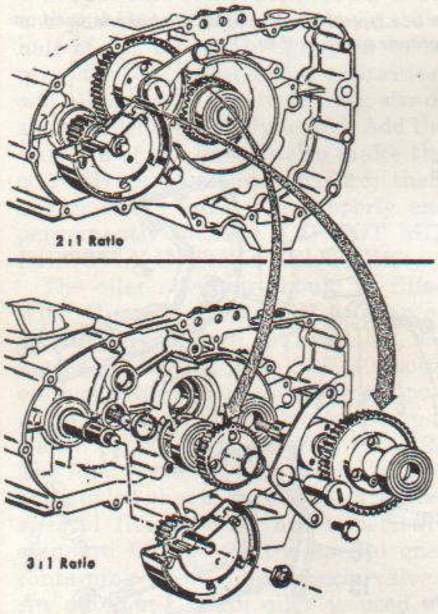


Fig. PR3–19–View showing installation of gears for 2:1 ratio and 3:1 ratio reduction.

cover to the crankcase. Heat the gearcase cover around plug (4), then remove cover, leaving outside bearing (24) on shaft (30). Special puller (No. 471108) can be used as shown in Fig. PR3—18, to push the shaft out of cover instead of heating.

REWIND STARTER. Starter pawls (7—Fig. PR3—20) can be removed and repaired after removing the fan housing (2) and snap ring (4). The complete starter must be disassembled to renew the rewind spring (13) or cord (15).

Rewind spring should be wound into housing in clockwise direction beginning at outside of spring. The 5/32-inch diameter nylon cord should be 52 inches long when free (not stretched). Preload the rewind spring approximately three turns. Edges (S—Fig. PR3—21) should be sharp enough to catch in starter cup. Ends (E) of friction spring should be around tips of starter pawls and center (C) should be in toward the rewind spring.

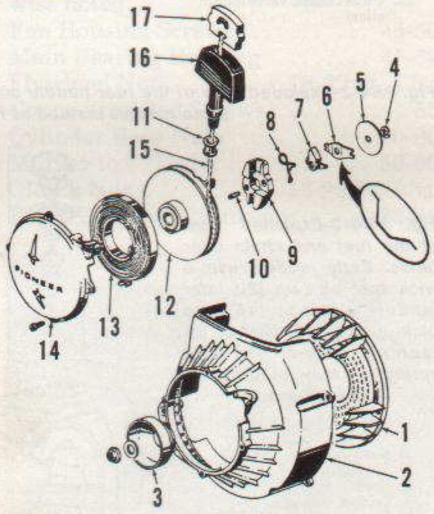


Fig. PR3–20–Exploded view of rewind starter. Friction spring (6) should be installed as shown.

1. Guard
2. Cover
3. Cup
4. Snap ring
5. Friction washer
6. Friction spring
7. Pawl (2 used)
8. Pawl spring
9. Pawl block
10. Roll pin (2 used)
11. Eyelet
12. Pulley
13. Rewind spring
14. Starter housing
15. Nylon cord
16. Handle
17. Anchor

GASKET AND "O" RING PART NUMBERS

	700, 700G	750, 850	1750, 1850	1771
Exhaust Gasket ...	427600	427600	427600	427600
Cylinder Base Gasket	427523	427523	427523	427523
Rear Handle to Crankcase "O" Ring	425030	425030	....	....
Gas Cap Gasket ...	425087	425087	425087	425087
Check Valve Gasket	427273	427273	....	....
Check Valve "O" Ring	427281	427281	....	....
Oil Pump Plunger "O" Ring	427360	427360	427360	428906
Oil Pump Base Gasket	427102	427102	427102	427102
Junction Plate Gasket	....	....	427102	427102
Exit Valve "O" Ring	308528	308528	....	308528
Oil Pump Disc Valve "O" Ring ..	202893	202893	....	202893
Primer Pump Body Gasket	427151	427151	....	....
Primer Pump Plunger "O" Ring	427444	427444	....	....
Carburetor Fuel Pump Gasket	309464	309464	309464	309464
Carburetor Metering Gasket .	309463	309463	309463	309463
Lo & Hi Speed Needle "O" Rings	304598	304598	304598	304598
Carburetor Fuel Inlet Strainer Gasket	427369	427369	....	....
Filter Bowl Gasket	....	....	427369	427369
Reed Valve to Carburetor Gasket	427137	427137	....	....
Reed to Rear Handle Gasket ..	427136	427136	....	....
Filter Clip "O" Ring	425028	425028	....	....
Filter to Rear Handle Gasket ..	427124	427124	428828	428828
Gear Cover Gasket	427183	....	427183	427183
Plug Screw Gasket .	170280	....	....	....
Crankcase Gasket .	427509	....	427509	427509
Oil Cap Gasket	425074	425074	425074	425074
Oil Tank Cover Gasket	427196	....	427196	427196
Rear Handle to Crankcase Gasket	....	428247	....	....
Insulating Block Gasket	....	428752	....	428752
Reed Valve Body Gasket	....	427136	....	427136
Carburetor Mounting Gasket	....	427137	....	427137

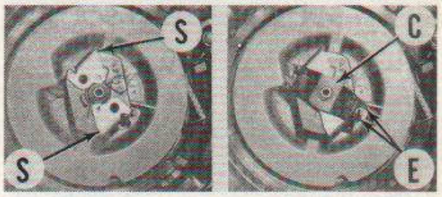


Fig. PR3–21–Views of rewind starter partially assembled. Sharp edges (S) on starter pawls should be on side shown. Ends of friction spring are shown at (E).

PIONEER

MODEL COVERAGE

Model	Bore In.	Stroke In.	Displ. Cu. In.	Drive
1110	1¾	1⅜	3.3	Direct
1100, 1120, 1130, 1150, 1160	1 13/16	1⅜	3.546	Direct
Holiday 1100 G, 1130 GT, 1160 GTA	1 13/16	1⅜	3.546	Direct
1200	1 13/16	1⅜	3.546	Direct
2200, 2270	1 13/16	1⅜	3.546	Direct

MAINTENANCE

SPARK PLUG. Spark plug electrode gap should be 0.030 inch. The recommended spark plug is Champion CJ8. AC type CS45 spark plug may also be used. Spark plug should be tightened to 7-8 Ft.-Lbs. torque.

CARBURETOR. Tillotson HS carburetors are used on all models. Normal setting for mixture needles on 1200, 2200 and 2270 models is 1 turn open for high speed needle (8—Fig. PR4—1); 1½ turns open for low speed mixture needle (7). Normal setting for mixture needles on other saw models is 1⅛ turn open for high speed needle (8); 1½ turns open for low speed mixture needle (7). Clockwise rotation of the adjusting needles will lean the mixture. Idle speed is adjusted by turning throttle stop screw (6). Original carburetor application is as follows:

1100, 1100 G, 1200 .... HS-44A
1110 .... HS-12A
1120, 1130, 1150,
1160, 1160 GTA HS-16B
1130 GT, 2200, 2270 .... HS-66A

The carburetors used on some models are equipped with a choke valve as shown in Fig. PR4—1. A fuel primer pump (Fig. PR4—2) is used on models not equipped with a choke. Primer outlet check valve (12) can be removed, disassembled and inspected without removing pump from engine.

A felt wick fuel pick-up (2—Fig. PR4—3) is used on early saws and a tube pick-up (15 & 16) is used on later models. A gasket is used between the tank halves on all models.

MAGNETO. A Wico magneto is used on all models. The breaker points and condenser are located under the flywheel. Flywheel retaining nut is left hand thread. Breaker point gap should be 0.015 inch. Ignition should occur (breaker points just open) at 30 degrees BTDC. Condenser capacity should be 0.16-0.20 Microfarads. Flywheel retaining nut should be tight-

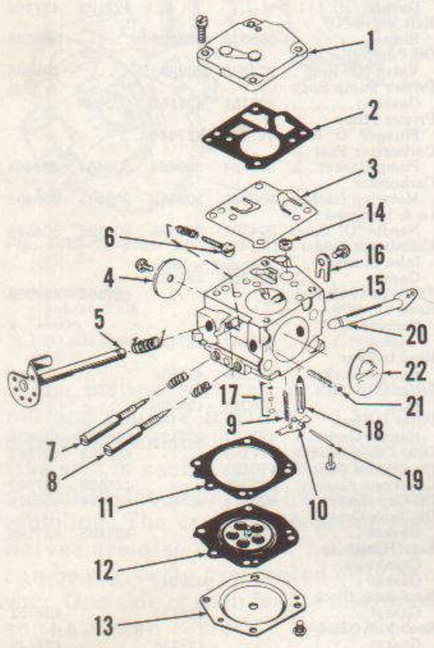


Fig. PR4–1–Exploded view of Tillotson HS carburetor. A check valve is installed at location (17) on models equipped with a fuel primer pump instead of the choke shown at (20, 21 & 22).

1. Fuel pump cover
2. Gasket
3. Fuel pump diaphragm
4. Throttle disc
5. Throttle shaft
6. Idle speed stop screw
7. Idle mixture needle
8. High speed mixture needle
9. Spring
10. Inlet control lever
11. Gasket
12. Fuel control diaphragm
13. Cover
14. Fuel inlet screen
15. Carburetor body
16. Throttle shaft retainer
17. Body channel screen, retainer ring & plug
18. Inlet needle
19. Pivot pin
20. Choke shaft
21. Choke detent
22. Choke plate

1. Primer button
2. Spring
3. Cover
4. Cup
5. Diaphragm
6. Cup washer
7. Screw
8. Gasket
9. Body
10. Inlet check valve and fitting
11. Outlet check valve
12. Throttle trigger & link rod
13. Carburetor
14. Gaskets
15. Insulator
16. Air cleaner
17. Reed valve plate
18. Reed petal
19. Reed stiffener
20. Gasket
21. "O" ring
22. Chain oiler piston
23. Spring
24. Inlet check valve (chain oiler)
25. Outlet check valve (chain oiler)

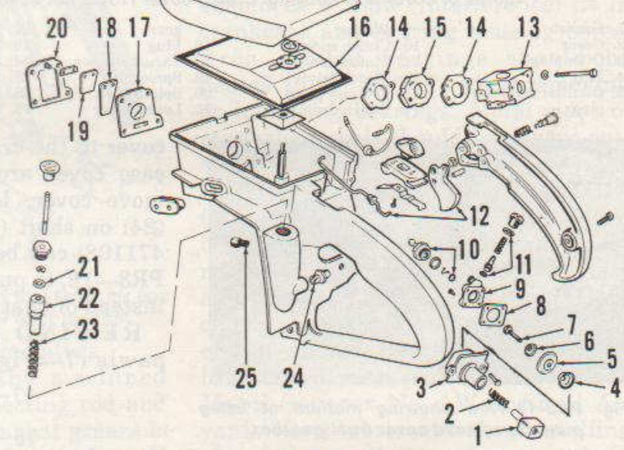
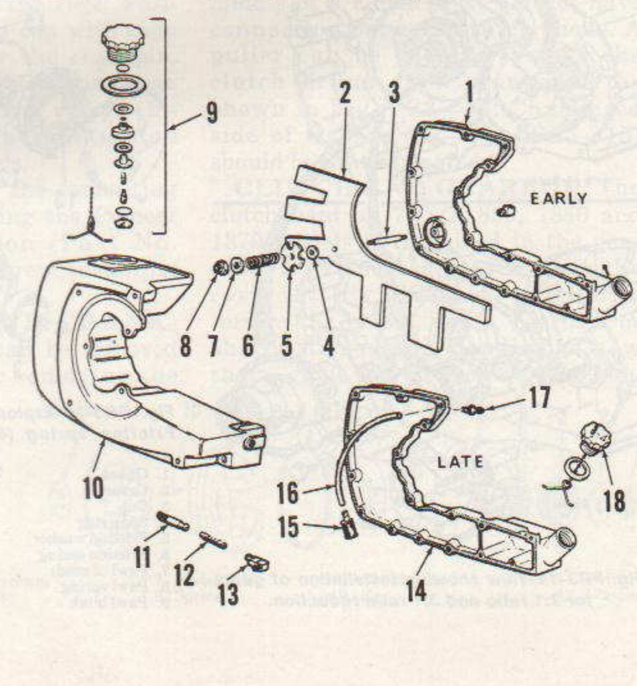


Fig. PR4–2–Exploded view of the rear handle and air box typical of all models. A choke is used on some models instead of fuel primer pump (1 thru 11).

Fig. PR4–3–Exploded view of the fuel and chain oiler tanks. Early models use a wick fuel pick-up (2); later models use tube (16) and pick-up (15). Method of attaching washer (5) and spring (6) may be different than shown.



1. Early cover
2. Wick felt
3. Stud
4. Gasket
5. Compression washer
6. Spring
7. Washer
8. Nut
9. Gas cap and vent valve
10. Fuel and chain oiler tank
11. Chain oiler pick-up
12. Hose
13. Fitting
14. Late type cover
15. Pick-up & filter
16. Hose
17. Fitting
18. Oil tank cap

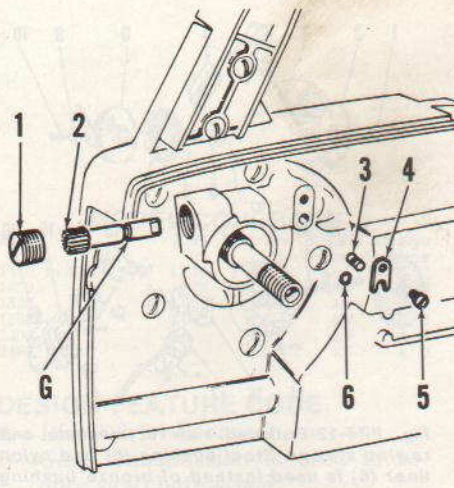


Fig. PR4-4–The oiler pump (2) is rotated by a worm gear on crankshaft.

1. Plug
2. Pump shaft
3. Guide pin
4. Lock plate
5. Screw
6. "O" ring

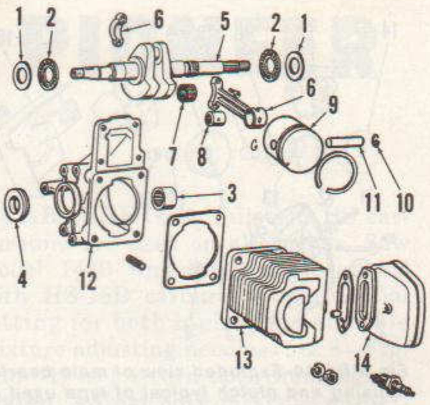


Fig. PR4-5–Exploded view of the crankshaft, crankcase and cylinder typical of all models.

1. Washers
2. Thrust bearings
3. Main bearing
4. Crankshaft seal
5. Crankshaft
6. Connecting rod and cap
7. Crankpin bearing
8. Piston pin bearing
9. Piston
10. Pin retaining clip
11. Piston pin
12. Crankcase
13. Cylinder
14. Muffler

ened to 18-22 Ft.-Lbs. torque. Refer to Fig. PR4—13 for installation of starter pawls and springs.

LUBRICATION. The engine is lubricated by mixing oil with the fuel at a ratio of 16:1 (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines the amount of lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended and ½ pint of oil should be mixed with each gallon of gasoline. A good quality SAE 30 or SAE 40 oil with an API classification MS, SB or SD may be used if the preferred oil is not available.

Proper and complete mixing of oil and gasoline is important. Pour about half of the amount of gasoline to be mixed into a clean metal container, add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; then, stir or shake until it is properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

The oiler reservoir should be filled with Pioneer Chain Oil winter or summer grade, or, if not available, use a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. The manual chain oiler pump is shown at (21 thru 25—Fig. PR4—2). The inlet check valve to pump (24) and the outlet check valve (25) are also special fittings. Do not substitute standard fittings for the special ones containing chain oiler check valves. An automatic chain oiler is used on some models. Pump shaft (2—Fig. PR4—4) is rotated by a worm gear on the crankshaft. Guide pin (3) is positioned in groove (G), is held by plate (4) and sealed by "O" ring (6).

CARBON. Exhaust ports and muffler should be cleaned approximately every two weeks of use or if a loss of power is noticed. Excessive carbon build up may indicate an excessive amount of oil, an improper type of oil mixed with the fuel or a rich fuel-air mixture. Cylinder cooling fins should be cleaned at the same time carbon is cleaned from exhaust.

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques are listed in the following table. All values are listed in inch-pounds unless otherwise noted.

Fan Housing Screws	45-50
Main Bearing Housing	45-50
Flywheel Nut	18-22 Ft.-Lbs.
Connecting Rod Screws	55
Cylinder Base Nuts	70-80
Muffler to Cylinder	50-60
Clutch Nut	18-22 Ft.-Lbs.
Rear Handle to Crankcase	35-40
Handle Bar to Crankcase	45-50
Coil to Bearing Housing	25-35
Bar to Crankcase	80-110
Pivot Grip to Crankcase	60-80

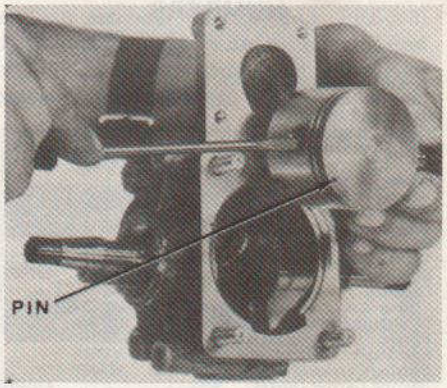


Fig. PR4-6–Ring locating pin must be away from exhaust port side of cylinder as shown, when installing the piston to the connecting rod.

CYLINDER, PISTON, RINGS AND PIN. Compression pressure at cranking speed should be approximately 130-140 PSI with engine cold. Cylinder and cylinder head is one piece and is attached to the crankcase with four stud nuts. Piston pin can be withdrawn after removing retaining clips (10—Fig. PR4—5). Cylinder bore diameter is smaller for 1110 model than others. The cylinder bore of most models is chrome plated and cylinder should be renewed if plating is worn away exposing the soft base metal. The following repair specifications are in inches.

Cylinder Bore, Nominal Diameter—	
1110 Model	1.750
Other Models	1.8125
Piston Skirt Clearance—	
1110 Model	0.007
Ring End Gap—	
1110 Model	0.070-0.076
Other Models	0.088-0.098

Piston rings on most models are pinned to prevent rotation in the grooves. Make sure that ring locating pin (Fig. PR4—6) is located on the magneto side. The opening in the piston pin retaining clips (10—Fig. PR4—5) should be toward the closed end of piston.

CONNECTING ROD. Connecting rod can be separated and removed after removing the cylinder and piston. Make certain that all of the 28 loose rollers at crankpin end are removed. New crankpin bearing rollers should be used each time connecting rod is removed. Remove the backing strip from the rollers, then carefully wrap the needles around the crankpin journal. The Pioneer special tool (No. 427899) can be used to hold the rod cap in place while installing the cap retaining screws (Fig. PR4—7).

CRANKCASE AND CRANKSHAFT. Crankshaft can be removed after removing the starter, magneto, chain, bar, clutch, muffler, carburetor,

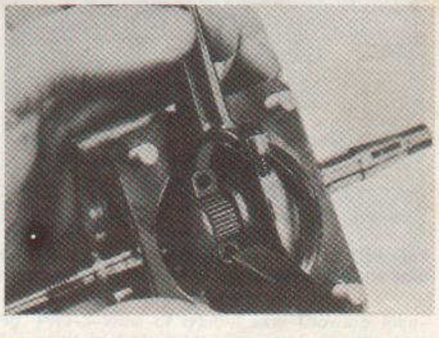


Fig. PR4-7–View showing correct method of installing connecting rod using the Pioneer special holding tool.

rear handle, cylinder, piston and connecting rod. Remove screws attaching main bearing housing to crankcase, then disconnect chain oiler line (Fig. PR4—8). On models with automatic chain oiler, remove pin (3—Fig. PR4—4), plug (1) and pump shaft (2) before removing main bearing housing.

The crankcase (12—Fig. PR4—5) should be heated before installing new main bearing (3). Main bearing housing (1—Fig. PR4—10 or Fig. PR4—11) should be heated before installing main bearing (3). Lip of seals (4) should be toward the bearings (3). Lip of magneto seal (4—Fig. PR4—5) should be toward inside. Crankshaft needle thrust bearings (2) and washers (1) should limit crankshaft end play.

CLUTCH. Different types of clutches have been used (Fig. PR4—10 and Fig. PR4—11). Bearing (7) should be lubricated with a small amount of Mobil Sovarex No. 1W or Shell Alvania No. 2 lubricant before installing clutch drum and bearing on crankshaft. Ends of garter spring (12) should be connected together and located at the middle of a clutch shoe. Do not have the spring connection between clutch shoes.

REWIND STARTER. Starter pawls (12—Fig. PR4—12) are located on the flywheel and engage a notch in pulley (8) for starting. Some (early) models are equipped with two sets of pawls (12), pivots (11) and springs (13). Later models use one pawl assembly and the weight of parts (11, 12 & 13) is counterbalanced by weight (14). Pawls and springs should be installed as shown in Fig. PR4—13. Starter must be disassembled to renew rope (3—Fig. PR4—12) or rewind spring (7). The 5/32-inch diameter nylon cord should be 45 inches long. The rewind spring should be preloaded 3 turns where assembling.

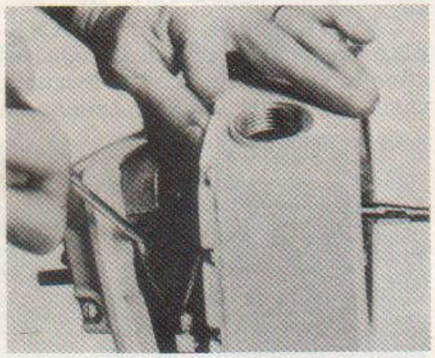


Fig. PR4-8–Chain lubricating oil line must be disconnected before removing the main bearing housing.

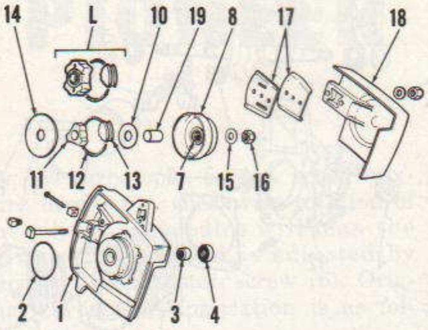


Fig. PR4-10–Exploded view of main bearing housing and clutch typical of type used on models with manual chain oiler. Metal side of seal (4) should be toward outside with lip in toward main bearing (3). Clutch shoes, driver and spring shown at (L) is used on 1200 models.

1. Main bearing housing
2. "O" ring
3. Main bearing
4. Crankshaft seal
7. Bearing
8. Clutch drum & sprocket
10. Small inner plate
11. Clutch driver
12. Clutch spring
13. Clutch shoes
14. Cover plate
15. Washer
16. Nut
17. Guide plates
18. Strut (cover)
19. Inner Race

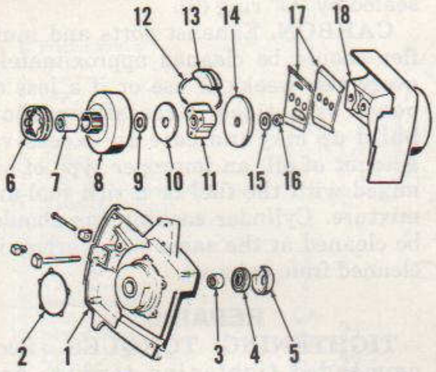


Fig. PR4-11–Exploded view of clutch used on models with automatic chain oiler. Parts shown in Fig. PR4-4 are located in main bearing housing (1) shown above.

1. Main bearing housing
2. Gasket (Used on some models)
3. Main bearing
4. Crankshaft seal
5. Seal cover
6. Sprocket
7. Bearing
8. Clutch drum
9. Thrust washer
10. Inner cover
11. Clutch driver
12. Spring
13. Clutch shoes
14. Clutch cover plate
15. Washer
16. Nut
17. Guide plates
18. Strut (cover)

GASKET AND "O" RING PART NUMBERS

	1100, 1110	1160, 1120, 1150, 1130GT	Holiday 1100G, 1100W
Carburetor Diaphragm Gasket	427950	427950	427950
Carburetor Diaphragm Fuel Pump Gasket	427940	427940	427940
Fuel Tank Cover Gasket	428016	428146	428146
Oil Cap Gasket	427689	427689	427689
Crankcase & Cylinder Base Gasket	427672	428129	427672
Exhaust Gasket	427799	428189	428189
Gas Cap Gasket	425087	425087	425087
Gas Cap Valve Gasket	427273	427273	....
Valve Body "O" Ring	427281	427281	427281
Breaker Box Gasket	427757	427757	427757
Oil Pump Plunger "O" Ring	427360	427360	....
Insulating Block Gasket	427722	427722	427722
Primer Pump Body Gasket	427715	427715	....
Exit Valve "O" Ring	308528	308528	....
Bearing Carrier "O" Ring	427667	427667	....
Bearing Carrier Gasket	....	....	428462

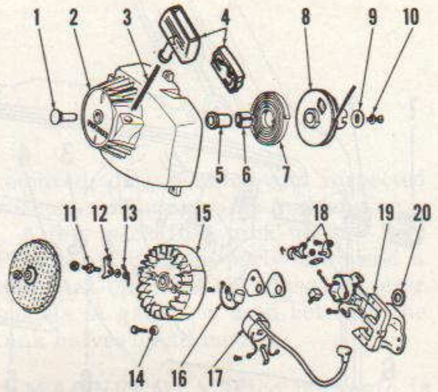


Fig. PR4-12–Exploded view of magneto and rewind starter. Steel bushing (5) and nylon liner (6) is used instead of bronze bushing used on early models. Some models use one pawl assembly (11, 12 & 13) and one balance weight (14); others are equipped with two starter pawl assemblies.

1. Center post
2. Housing
3. Rope
4. Handle & anchor
5. Bushing
6. Liner
7. Rewind spring
8. Pulley
9. Washer
10. Screw & lock washer
11. Post
12. Pawl
13. Spring
14. Balance weight
15. Flywheel
16. Condenser
17. Coil
18. Breaker points
19. Stator plate & coil core
20. Felt washer

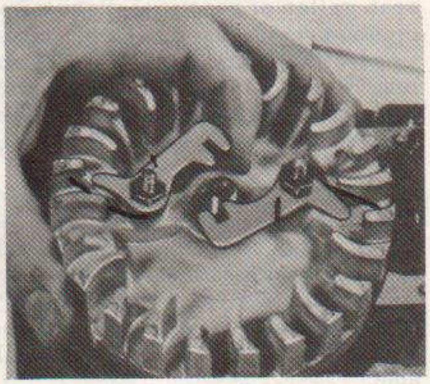


Fig. PR4-13–The starter pawls and springs should be installed as shown. A balance weight may be used with only one pawl assembly.

	2200, 2270	1200
Oil Pump Plunger "O" Ring	428906	428906
Carburetor Mounting Gasket	427722	427722
Primer Pump Cover Gasket	427715	....
Check Valve "O" Ring	308528	....
Automatic Oil Pump "O" Ring	308528	....
Reed Body Gasket	428129	....
Metering Gasket—Carburetor	427950	427950
Fuel Pump Gasket—Carburetor	427940	427940
Breaker Box Gasket	427757	427757
Tank Cover Gasket	428146	428146
Oil Cap Gasket	427689	427689
Cylinder Base Gasket	428131	....
Exhaust Gasket	428189	428189
Gas Cap Gasket	425087	425087
Reed Body Gasket	428130	....
Oil Pickup Head Gasket	307554	....
Crankcase Gasket	428462	....
Bearing Carrier Gasket	....	428462
Cylinder Base & Crankcase Gasket	....	427672

PIONEER

MODEL COVERAGE

Model	Bore In.	Stroke In.	Displ. Cu. In.	Design Features
1410, 1420	1.875	1.450	4.0	A, C
1450	1.875	1.450	4.0	A, D
1520	1.875	1.450	4.0	B, C
1560	2.0	1.5	4.7	B, D
2400, 3200	2.0	1.5	4.7	A, C
2460, 3270	2.0	1.5	4.7	A, D

DESIGN FEATURE CODE

A—Direct drive to saw chain
B—Gear transmission is used to reduce saw chain speed
Reduction ratio: 2.5:1
C—Manual chain oiler
D—Automatic and manual chain oilers

MAINTENANCE

SPARK PLUG. Spark plug electrode gap should be 0.030 inch for all models. Recommended Champion spark plug is CJ6 for 1560 models, CJ8 for all other models. Spark plug should be tightened to 7-8 Ft.-Lbs. torque.

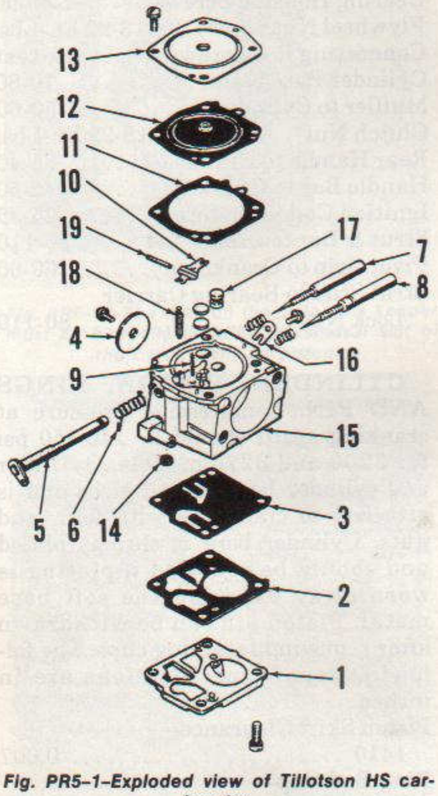


Fig. PR5-1–Exploded view of Tillotson HS carburetor.

1. Fuel pump cover
2. Gasket
3. Fuel pump diaphragm
4. Throttle disc
5. Throttle shaft
6. Throttle return spring
7. Idle mixture needle
8. High speed mixture needle
9. Spring
10. Inlet control lever
11. Gasket
12. Fuel control diaphragm
13. Cover
14. Fuel inlet screen
15. Carburetor body
16. Throttle shaft retainer
17. Check valve
18. Inlet needle
19. Pivot pin

CARBURETOR. Tillotson HS carburetors are used on all models. Saw model 1410 was originally equipped with HS-16B carburetor. The initial setting for both high speed and idle mixture adjusting needles (7 & 8—Fig. PR5—1) is 1¼ turn open from lightly seated. Adjust both mixture adjustment needles to provide smoothest running when operating under normal conditions.

Later saw models may be equipped with either Tillotson HS-39A or HS-39B carburetor. The difference between these two carburetors is the type of check valve (17). Early carburetors should be changed by installing the later type check valve. A fixed jet (calibrated orifice) is located in top of late type check valve assembly (17) and the high speed mixture needle (8) must be adjusted differently. Initial setting of idle mixture needle (7) should be 1¼ turns open for all carburetors. Initial setting of the high speed mixture needle (8) should be turned in until lightly seated on carburetors with late type check valve; ⅞ turn open on carburetors with early type check valves. Turn mixture adjustment needles to provide best running when operating under normal conditions. High speed mixture needle (8) should not be opened more than ⅛ turn for high speed cutting and limbing, if late check valve is used. High speed mixture needle should not be opened more than ⅜ turn for heavy cutting if late check valve is installed.

Idle speed on most models is adjusted by a stop screw which prevents the carburetor throttle from closing completely. Throttle stop screw is located on carburetor of 1410 models and on air box wall (S—Fig. PR5—3) of other models. Engine idle speed should be slow enough to keep drive clutch from engaging.

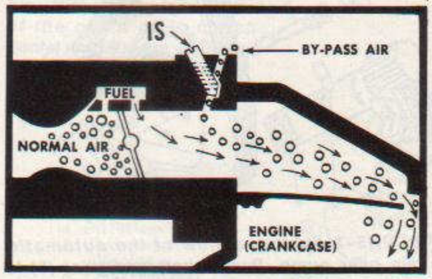


Fig. PR5-2–The idling speed of the engine is adjusted by metering the amount of by-pass air entering the engine. The throttle valve is closed at idle speed as shown.

Some saws are equipped with "Inject-Aire" and the carburetor throttle is completely closed at idle. Air is permitted to enter the engine at idle speed through a separate passage as shown in Fig. PR5—2. Position of the adjustment screw changes idle speed by varying the amount of by-pass air that is allowed to enter engine. Normal setting of idle speed adjustment needle (IS—Fig. PR5—3) is two turns out from lightly seated. Engine speed should be slow enough that clutch does not engage.

Refer to Fig. PR5—4 for exploded views of the fuel filter, primer, pump and reed valve assemblies.

MAGNETO. A Wico magneto is used on all models. Breaker points are located under the flywheel, flywheel retaining nut is left hand thread and breaker point gap should be 0.015 inch. Ignition timing should occur (breaker points just open) at 30 degrees BTDC. Armature air gap should be 0.013 inch. Condenser capacity should be 0.16-0.20 Microfarads. Flywheel retaining nut should be tightened to 18-22 Ft.-Lbs. torque. Refer to Fig. PR5—18 for installation of starter pawls and springs.

LUBRICATION. Engine is lubricated by mixing oil with the fuel at a ratio of 16:1 (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines the amount of

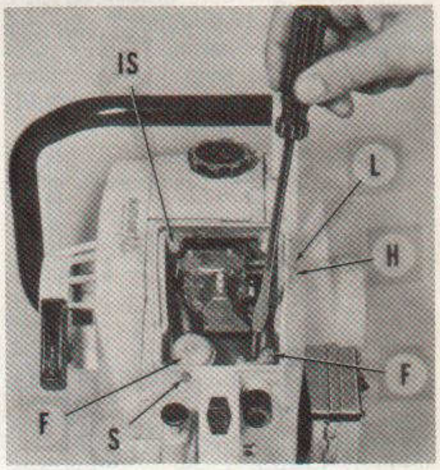
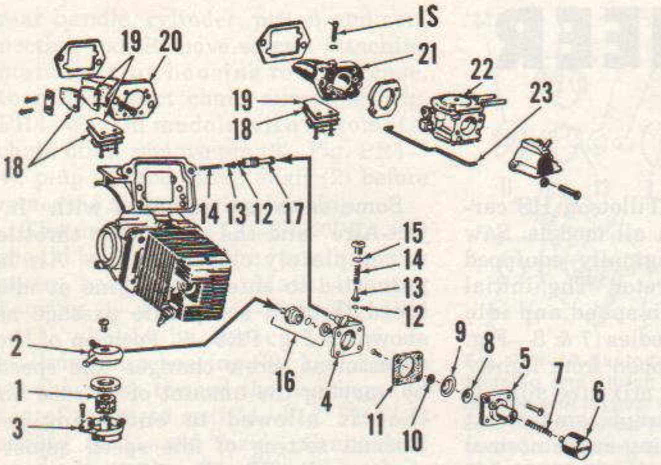


Fig. PR5-3–View of typical saw showing location of "Inject-Aire" idle speed screw (IS), fuel filter (F), fuel primer pump (P), low speed mixture adjustment needle (L) and high speed mixture needle (H).



1. Fuel filter
2. Filter cover
3. Filter body
4. Fuel primer pump body
5. Primer pump cover
6. Primer button
7. Spring
8. Cup
9. Diaphragm
10. Cup washer
11. Gasket
12. Outlet check valve "O" ring
13. Check valve stem
14. Outlet check valve spring
15. Washer
16. Inlet check valve assembly
17. Crankcase check valve housing
18. Reed stiffener
19. Reed petal
20. Three petal reed block
21. One petal reed block
22. Carburetor
23. Throttle link

Fig. PR5-4–Partially exploded view showing the early (three petal) reed valve assembly on the left and the later (one petal) reed valve assembly on the right. Other fuel system components are also shown.

lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended and ½ pint of oil should be mixed with each gallon of gasoline. A good quality SAE 30 or SAE 40 oil with an API

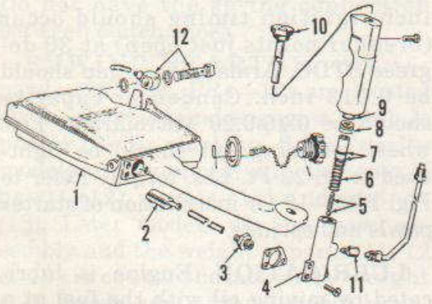


Fig. PR5-5–Exploded view of the chain oiler reservoir, manual pump and associated parts. Outlet screen and fitting (12) are for automatic chain oiler on models so equipped.

1. Oil reservoir (tank)
2. Pick-up assembly
3. Fitting (inlet check valve late models)
4. Pump body
5. Inlet check valve (early models)
6. Spring
7. Pump plunger and "O" ring
8. Washer
9. Snap ring
10. Button and push rod
11. Outlet check valve

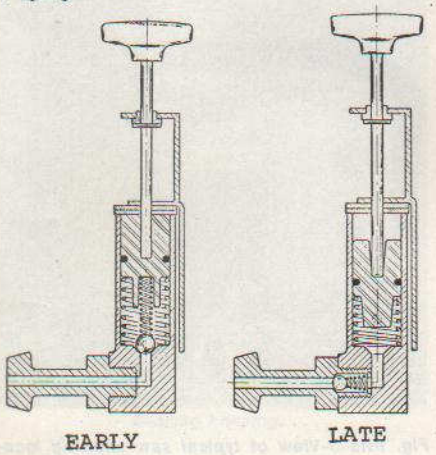


Fig. PR5-6–Cross section of early and late type manual oiler pumps. Most saws are equipped with late type.

classification MS, SB or SD may be used if the preferred oil is not available.

Proper and complete mixing of oil and gasoline is important. Pour about half of the amount of gasoline to be mixed into a clean metal container, add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; then, stir or shake until properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

Oil reservoir should be filled with Pioneer Chain Oil winter or summer grade, or if not available, a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. All models are equipped with a manual chain oiler pump (Fig. PR5—5). Some early pumps were equipped with inlet check valve as shown at (5). Most pumps use special inlet check valve fitting (3). Both early and late pumps are shown in Fig. PR5—6. The automatic chain oiler pump used on some models is shown in Fig. PR5—7. Remove automatic oiler parts in sequence shown.

Worm gear (W) on crankshaft turns pump shaft and gear (6). Guide pin (3)

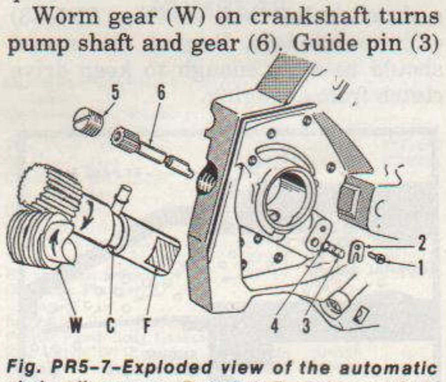


Fig. PR5-7–Exploded view of the automatic chain oiler pump. Pump shaft and gear (6) is turned by a worm gear on crankshaft.

1. Screw
2. Locating plate
3. Guide pin
4. "O" ring
5. Plug
6. Pump shaft and gear

rides in a cam slot (C) of pump shaft and causes pump shaft to move back and forth as it rotates. The back and forth movement pumps oil to the chain. Flat (F) on shaft acts as a valve to open intake port on outward stroke and outlet port on the inward stroke.

CARBON. Muffler and cylinder exhaust ports should be cleaned periodically before any loss of power is noticed because of carbon build up. Remove muffler and clean carbon from all parts of muffler. Turn engine crankshaft until piston is covering the exhaust port, then carefully clean carbon from exhaust using a soft scraper. Be especially careful not to damage piston. Do not attempt to clean exhaust with piston not covering the port. Hard carbon deposits can cause extensive damage if permitted to fall into the engine. Engine cooling fins should be cleaned at the same time that carbon is cleaned from exhaust.

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques listed in the following table are inch-pounds unless otherwise noted.

Bearing Housing Screws	45-50
Flywheel Nut	18-22 Ft.-Lbs.
Connecting Rod Screws	See text
Cylinder Base Nuts	70-80
Muffler to Cylinder	50-60
Clutch Nut	18-22 Ft.-Lbs.
Rear Handle to Crankcase	35-40
Handle Bar to Crankcase	45-50
Ignition Coil to Engine	25-35
Strut & Bar to Crankcase	80-110
Pivot Grip to Crankcase	60-80
Strut Stud to Bearing Carrier Lock Nut	80-110

CYLINDER, PISTON, RINGS AND PIN. Compression pressure at cranking speed should be 140-150 psi for 3200 and 3270 models. Cylinder and cylinder head is one piece and is attached to crankcase with four stud nuts. Cylinder bore is chrome plated and should be renewed if plating is worn away exposing the soft base metal. Piston pin can be withdrawn after removing retaining clips. The following repair specifications are in inches.

Piston Skirt Clearance—
1410 .... 0.007

Ring End Gap—
1410 .... 0.008-0.014
All Other Models .... 0.092—0.098

A special assembly tool (part number 472213) should be used when assembling the piston to connecting rod on 1560, 2400, 2460, 3200 and 3270 models. Piston pin (1—Fig. PR4—11) is installed on loader and

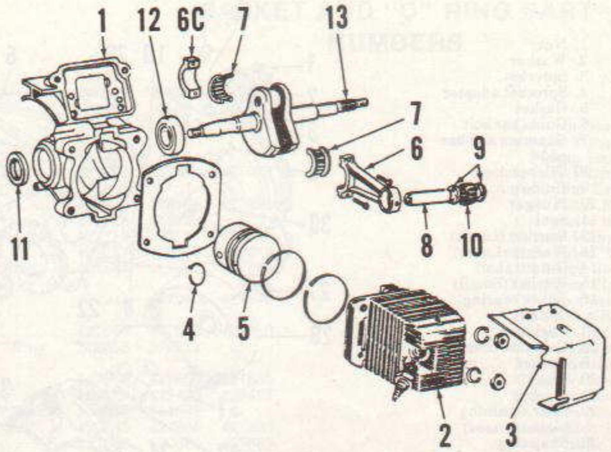


Fig. PR5-10–Exploded view of crankcase, crankshaft and associated parts. Several differences may exist between parts for early engines and late type shown.

1. Crankcase
2. Cylinder
3. Shroud
4. Pin retaining clip
5. Piston
6. Connecting rod
6C. Rod cap
7. Crankpin bearing
8. Piston pin
9. Thrust washer
10. Piston pin bearings
11. Crankshaft seal
12. Main bearing
13. Crankshaft

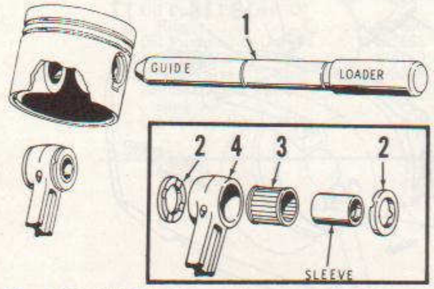


Fig. PR5-11–The three piece special Pioneer tool will facilitate installation of the piston pin. Refer to text.

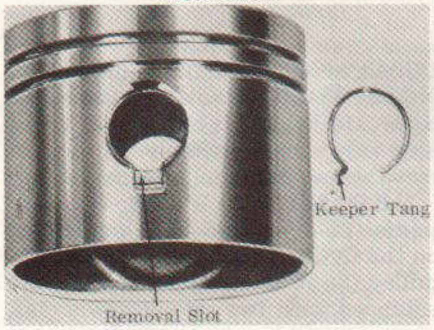


Fig. PR5-12–The tang on the piston pin keeper must be correctly installed in removal slot of the 2 inch diameter pistons.

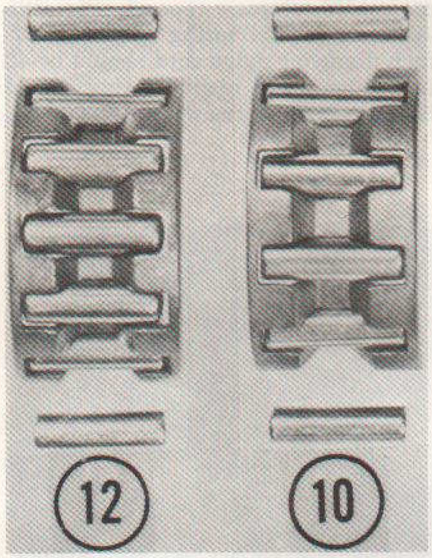


Fig. PR5-13–View of the 12 and 10 roller crankpin bearings used on 4. 7 cubic inch engines. The bearing with eight captive rollers and two loose rollers should be installed.

the guide is located over end of loader. Assemble thrust washers (2) and bearing (3) into rod (4), then use the sleeve to hold these parts in position. Heat piston, then press guide and piston pin (1) through one piston boss, bearing (3) and other piston boss. Make sure that the piston ring locating pin is positioned on magneto side of piston, away from the exhaust port.

On all models, piston rings are pinned to prevent rotation in grooves. Make sure that ring locating pin is on magneto side of engine, away from exhaust port.

CONNECTING ROD. Connecting rod can be separated and removed after removing cylinder and piston. Be sure that all of the bearing rollers are removed. New bearing rollers should be used each time that the connecting rod is removed. The Pioneer special tool (No. 427975) can be used to hold the rod cap in place while installing the retaining screws.

The crankpin bearing on 1410, 1420, 1450 and 1520 models uses a separating cage and 12 loose rollers. Piston pin bearing is the cartridge type and is pressed into bore in connecting rod. Press only on lettered end of piston pin bearing.

Several types of connecting rods and crankpin bearings have been used in the larger (4.7 cubic inch) engines. The latest connecting rods are preferred and can be identified by the solid rod cap (not slotted). The early crankpin bearing contained 12 rollers (Fig. PR5—13) and the latest bearing has 10 rollers. The late bearing has eight rollers retained in the bearing cage halves and two loose rollers between the ends of the cage halves. The late type bearing should be used when servicing all 1560, 2400, 2460, 3200, 3270 and 3270S models. Tighten the retaining screws to 75 inch-pounds torque

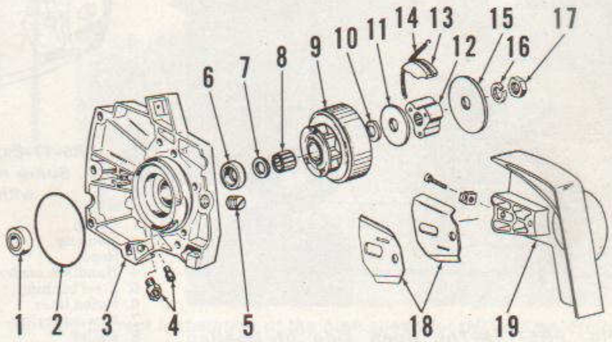
Mating surfaces of connecting rod and cap are fractured to provide correct alignment when assembling all models. One side of rod and cap are machined flat for identification.

On 1410, 1420, 1450 and 1520 models, the crankpin bearing cage halves are machined halves and can be correctly assembled only one way. One side of each half is machined so that when correctly assembled a "V" notch will be located at the parting surface of the two halves. Coat the machined bearing surface of connecting rod and cap with suitable grease to hold bearing rollers when assembling. CAUTION: Be sure that grease is not on fractured surfaces. Install bearing cage in cap and install five of the bearing rollers in the cage. Position the connecting rod cap with cage half and rollers under the crankpin, then install upper half of bearing cage and the remaining seven rollers. Install connecting rod and tighten the two attaching screws to 80 inch-pounds torque.

CRANKCASE AND CRANKSHAFT. The crankshaft can be removed from all models after removing the cylinder, piston, rod, flywheel, magneto, fuel tank, chain drive clutch and the main bearing carrier assembly. Automatic chain oiler pump (Fig. PR5—7) must be removed from models so equipped before removing the main bearing carrier.

Crankshaft ball type main bearings should be a tight (interference) fit in bores of crankcase and bearing carrier.

Fig. PR5-15–Exploded view of the chain drive clutch. Some models are equipped with a floating sprocket.



1. Main bearing
2. Seal ring
3. Bearing carrier
4. Oil fittings
5. Chain automatic oiler plug
6. Crankshaft seal
7. Washer
8. Bearing
9. Clutch drum
10. Thrust washer
11. Plate
12. Clutch driver
13. Clutch shoe (3 used)
14. Garter spring
15. Cover
16. Lock washer
17. Nut
18. Guide plate
19. Strut

Area around bearings should be heated when installing the bearings. Closed side of crankshaft seals should be toward outside with lip toward inside (connecting rod journal).

DIRECT DRIVE CLUTCH. The direct drive clutch typical of all models is shown in Fig. PR5—15. Bearing (8) should be lubricated with a small amount of Mobil Sovarex No. 1W or Shell Alavania No. 2 lubricant before installing the clutch drum. A clutch assembling tool (Part No. 429923) is available to facilitate installation of clutch shoes (13), spring (14) and driver (12). Connection at ends of garter spring should be at the middle of a clutch shoe, not between two of the shoes.

On models with floating sprocket, open side of sprocket should be away from the clutch drum as shown in Fig. PR5—15A.

CLUTCH AND GEARBOX. The clutch used on gear drive models is contained in the gearcase. It is necessary to remove the gearcase cover (18—Fig. PR5—16) in order to service the clutch, gears, shafts or bearings. Remove the handlebar, saw chain, guide bar, fuel tank (17), then remove screws and cover (18). A puller should be used to remove clutch driver (32) from the crankshaft. Idler spindle (26) should be tight fit in gearcase bore. The gearcase should be heated before removing or installing idler spindle.

The automatic chain oiler pump shaft (10) should be removed from models so equipped before attempting to pull the gearcase from the engine crankcase. Guide pin (9) operates in groove of pump shaft and must be removed before pump shaft can be pulled from pump bore.

Lip of crankshaft seal should be toward inside of engine and lip of output shaft seal (11) should be toward inside of gearcase. Inside diameter of washer (13) is larger than inside diameter of washer (15). Outside diameter of retaining plate (31) is smaller than outside diameter of retaining plate (35). Oil in gearcase should be maintained at level of filler plug (28). NOTE: The fuel tank and fuel tank cover are bonded together and available only as an assembly. Do not remove screws from fuel tank cover.

REWIND STARTER. Starter pawls (12—Fig. PR5—17) are located on the flywheel and engage a notch in pulley (8) for starting. All models are equipped with two sets of pawls (12), pivots (11) and springs (13). Pawls and springs should be installed as shown in Fig. PR5—18. Starter must be disassembled to renew rope (3—Fig. PR5—17), or rewind spring (7). The 5/32-inch diameter nylon cord should be 45 inches long. The rewind spring should be preloaded 3 turns when assembling.

1. Nut
2. Washer
3. Sprocket
4. Sprocket adapter
5. Gasket
6. Guide bar bolt
7. Gearcase and bar pad
8. Oiler pick-up
9. Guide pin
10. Plunger
11. Seal
12. Bearing (Large)
13. Washer (Large)
14. Output shaft
15. Washer (Small)
16. Roller bearing (Small)
17. Fuel tank
18. Gearcase cover
19. Gasket
20. Nut
21. Washer
22. Gear retaining plates (2 used)
23. Snap ring
24. Bearing
25. Gear
26. Idler spindle
27. Fitting
28. Oil plug
29. Clutch drum and bearing
30. Thrust washer
31. Inner retaining plate
32. Clutch driver
33. Clutch shoes
34. Garter springs
35. Outer retaining plate
36. Nut

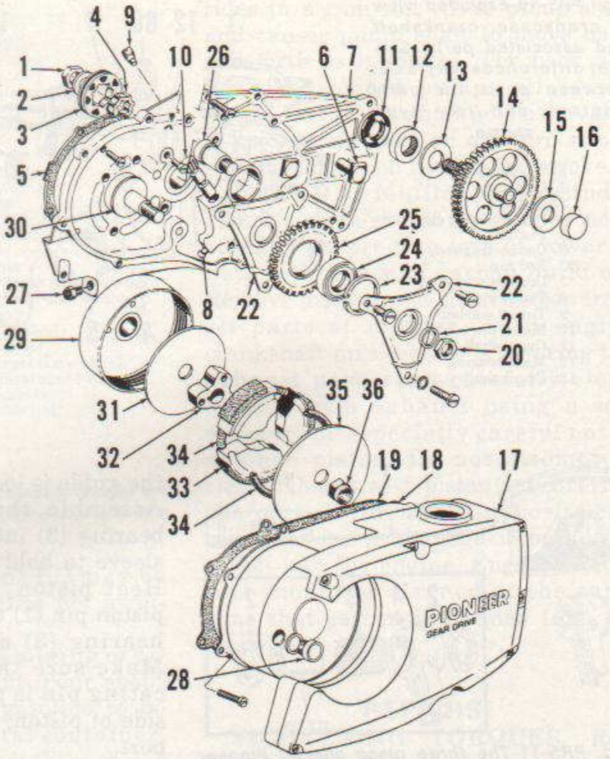


Fig. PR5-16–Exploded view of gearcase and clutch assembly typical of 1520 and 1560 models. Automatic chain oiler (parts 8, 9 & 10) is not used on all models.

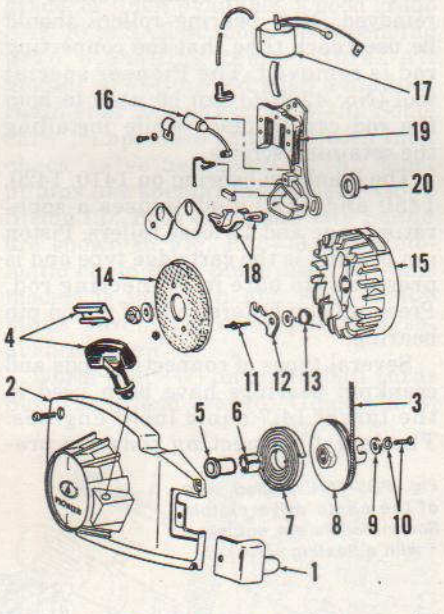


Fig. PR5-17–Exploded view of the rewind starter. Some models may not be equipped with steel bushing (5).

1. Cover
2. Housing
3. Rope
4. Handle & anchor
5. Steel bushing
6. Nylon liner
7. Rewind spring
8. Pulley
9. Washer
10. Screw & lock washer
11. Post (2 used)
12. Pawl (2 used)
13. Spring (2 used)
14. Screen
15. Flywheel
16. Condenser
17. Coil
18. Breaker points
19. Stator plate & coil core
20. Felt washer

Fig. PR5-15A–The open side of floating sprocket should be away from clutch drum as shown.

Fig. PR5-18–The starter pawls and springs should be installed as shown.

GASKET AND "O" RING PART NUMBERS

	1410A, 1450, 1420	2400, 2460	3200, 3270
Gas Cap Gasket	425087	425087	425087
Filter Disc Gasket	427273	....	....
Filter Disc "O" Ring	427281	....	....
Fuel Filter Base Gasket	427369	427369	427369
Carburetor Mounting Gasket	427888	427888	427888
Exit Valve "O" Ring	308528	308528	....
Primer Pump Cover Gasket	427715	427715	427715
Breaker Box Gasket	427757	429076	429849
Bearing Carrier "O" Ring	427889	427889	427889
Carburetor Fuel Pump Gasket	427940	427940	427940
Carburetor Metering Gasket	427950	427950	427950
Fuel Pickup Line "O" Ring	202612	202612	....
Connector "O" Ring (Washer)	427855	427855	427855
Cylinder Base Gasket	429429	429429	429429
Reed—Idle Speed "O" Ring	304598	304598	....
Reed Valve Body Gasket	427885	427885	427885
Oil Cap Gasket	427689	427689	427689
Oil Pump Plunger "O" Ring	427360	427360	428906
Oil Pump Body Gasket	427861	427861	427861
Exhaust Gasket	428189	428189	428189
Check Valve "O" Ring	308528	308528	308528
Automatic Oil Pump "O" Ring	....	....	308528
Oil Pickup Head Gasket	....	....	307554

	1520	1560
Gas Cap Gasket	425087	425087
Primer Pump "O" Ring (Fuel Pickup Head "O" Ring)	202612	202612
Primer Fitting Gasket (Washer)	....	427855
Air Filter Knob "O" Ring	....	304614
Fuel Filter Bowl Gasket	427369	427369
Carburetor to Crankcase Gasket	427888	427888
Primer Pump Cover Gasket	427715	427715
Exit Valve "O" Ring	308528	308528
Oil Pump Body Gasket	427861	427861
Oil Pump Plunger "O" Ring	427360	428906
Oil Cap Gasket	427689	427689
Oil Pickup Head Gasket	....	307554
Breaker Box Gasket	427757	429076
Reed Valve to Crankcase Gasket	427885	427885
Idle Speed Needle "O" Ring	304598	304598
Check Valve "O" Ring	308528	308528
Exhaust Gasket	428189	428189
Cylinder Base Gasket	428371	429429
Valve Body Gasket	427273	....
Valve Body "O" Ring	427281	....
Carburetor Fuel Pump Gasket	427940	....
Carburetor Metering Gasket	427950	....
Crankcase Gasket	428319	....
Gearcase Cover Gasket	428913	....
Oil Plug Gasket	428314	....

PIONEER

MODEL COVERAGE

Model	Bore In.	Stroke In.	Displ. Cu. In.	Design Features
Holiday II—970	1.625	1½	3.14	A, C
Holiday II—1072	1.625	1½	3.14	B, C
1073	1.625	1½	3.14	B, D
2071	1.625	1½	3.14	B, C
2073	1.625	1½	3.14	B, D

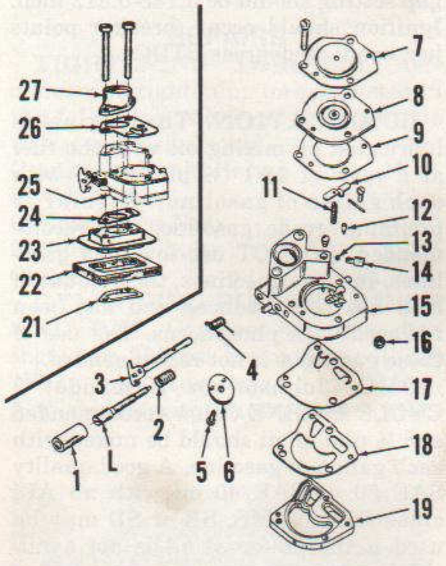


Fig. PR6-1–Exploded view of the Pioneer carburetor used on some models.

- L. Mixture adjusting needle
- 1. Seal tube
- 2. Spring
- 3. Throttle shaft
- 4. Return spring
- 5. Screw
- 6. Throttle plate
- 7. Cover
- 8. Control diaphragm
- 9. Gasket
- 10. Fuel control lever
- 11. Spring
- 12. Fuel inlet needle
- 13. Metering valve ball
- 14. Fitting
- 15. Body
- 16. Screen
- 17. Fuel pump diaphragm
- 18. Gasket
- 19. Cover
- 21. Gasket
- 22. Gasket
- 23. Insulator block
- 24. Gasket
- 25. Carburetor
- 26. Plate
- 27. Blow back tube

DESIGN FEATURE CODE

A—Standard rewind starter
B—"Easy-Arc" starting (Automatic compression release)
C—OMC carburetor
D—Tillotson carburetor

MAINTENANCE

SPARK PLUG. The electrode gap should be 0.030 inch. Champion CJ6 spark plug is recommended for all models. Tighten spark plug to 7-8 Ft.-Lbs. torque.

CARBURETOR. A Pioneer diaphragm carburetor with an integral fuel pump is used on 970, 1072 and 2071 models. Initial setting for the mixture adjustment needle (L—Fig. PR6—8) is 1¼ turns out from lightly seated. Lean mixture results from turning needle in (clockwise). Idle speed is adjusted by turning the adjusting screw (I). End of fuel control lever (10—Fig. PR6—1) that contacts diaphragm (8) should be 0.020 inch below flush with top surface for gasket (9). A special gage (Pioneer No. 429775) is available for measuring the lever position. The high speed jet (H—Fig. PR6—2) and the metering valve ball (13) can be cleaned after pulling the fitting (14) out of carburetor body. Be sure that ball is correctly located before installing the fitting (14). Punch mark (M—Fig. PR 6—3) should

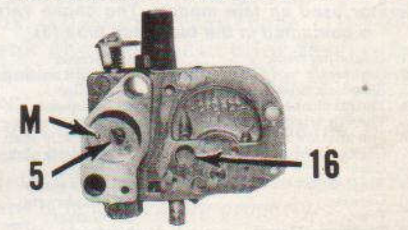


Fig. PR6-3–Punch mark (M) on throttle plate should be down as shown. Fuel screen is shown at (16).

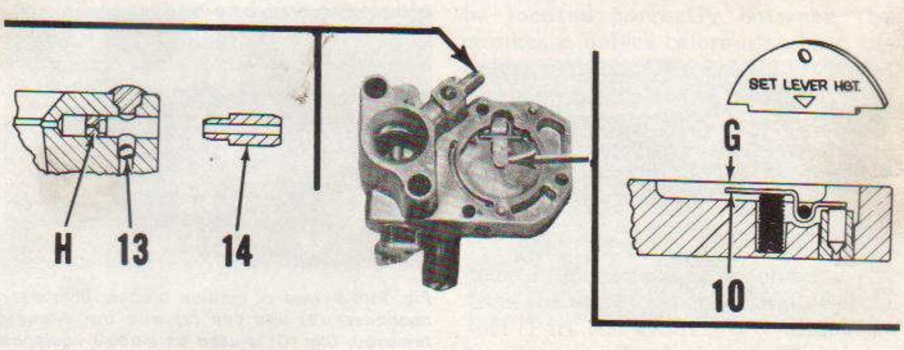


Fig. PR6-2–Views of carburetor showing correct installation of the high speed jet (H) and metering valve ball (13). The top of control lever (10) should be 0.020 inch below gasket surface (G) of carburetor body.

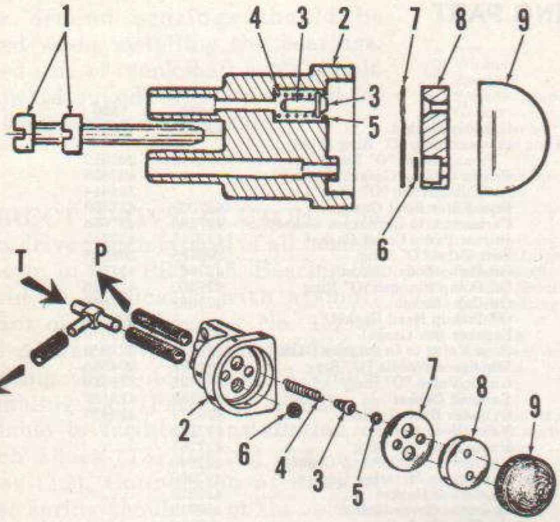


Fig. PR6-4–Exploded and cross sectional views of the fuel primer pump. Fuel from tank enters at (T). Short hose connects to normal fuel fitting of carburetor (C). Primer hose (P) connects to the primer fitting (14–Fig. PR6-1) of carburetor.

1. Self tapping screws
2. Body
3. Outlet valve
4. Spring
5. "O" ring
6. Inlet (disc) valve
7. Gasket
8. Valve plate
9. Bulb

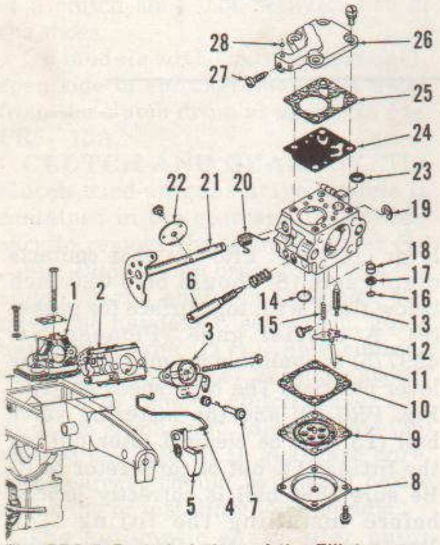


Fig. PR6-5–Exploded view of the Tillotson carburetor used on late models. The choke valve is contained in the blowback tube (3).

1. Insulating block
2. Carburetor
3. Blowback tube
4. Throttle link
5. Throttle trigger
6. Idle mixture needle
7. Choke knob
8. Cover
9. Diaphragm
10. Gasket
11. Pivot
12. Fuel control lever
13. Needle
14. Plug
15. Spring
16. Retainer ring
17. Screen
18. Main nozzle and orifice
19. Snap ring
20. Return spring
21. Throttle shaft
22. Throttle plate
23. Screen
24. Fuel pump diaphragm
25. Gasket
26. Cover
27. Idle speed stop screw
28. Nylon ball

be down as shown. Use "Loctite" on threads of screw (5) to prevent screw from loosening. Screen (16) can be removed and cleaned or renewed. A felt filter is located in the fuel pick-up in tank. Gaskets (21, 22 & 24—Fig. PR6—1) should be stuck onto insulator block (23) with sealer before installing carburetor. Sealing tube (1) prevents dirt from entering engine around mixture needle. Refer to Fig. PR6—4. Fuel lines should be connected as shown. Primer bulb (9) should be full of fuel before attempting to start engine. The fuel tank is integral with oil tank and the engine crankcase.

A Tillotson diaphragm carburetor with integral fuel pump is used on 1073 and 2073 models. Initial setting for the low speed mixture needle (6—Fig. PR6—5) is ⅞-1 turn open from the lightly seated position. The high speed mixture is determined by the size of the orifice (18). Idle speed is adjusted by turning the adjusting screw (27). End of fuel control lever (12) that contacts diaphragm (9) should be flush with casting. The choke valve is located in the blowback tube (3).

MAGNETO. The breaker points and condenser are located under the flywheel. Flywheel retaining nut is left hand thread and should be tightened to 25 Ft.-Lbs. torque. The breaker point gap should be 0.015 inch. The breaker point cam is ground into the engine crankshaft. The clearance between the coil core and the flywheel magnets (armature air gap) should be 0.005-0.012 inch. Check air gap using correct thickness of shim stock as shown in Fig. PR6—7. Edge gap setting should be 0.188-0.312 inch. Ignition should occur (breaker points just open) 30 degrees BTDC.

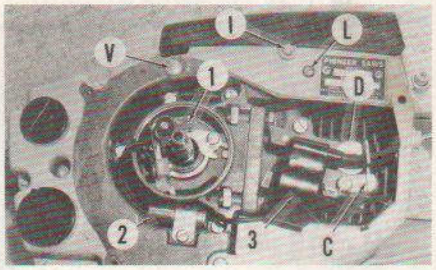


Fig. PR6-8–View of ignition breaker points (1), condenser (2) and coil (3) with the flywheel removed. Clip (C) is used on models equipped with "Easy-Arc" starting to prevent the spark plug wire from holding decompression valve (D) open. The fuel tank vent valve is located at (V).

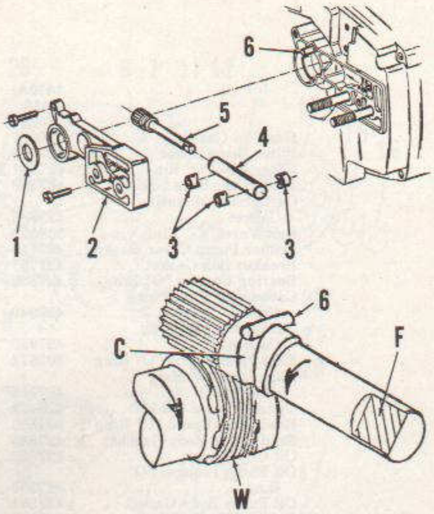


Fig. PR6-9–View of the chain oiler pump. The worm (W) is part of the engine crankshaft. Refer to text.

1. Felt washer
2. Bar pad
3. Sealing pads
4. Pump sleeve
5. Pump shaft and gear
6. Pin

LUBRICATION. The engine is lubricated by mixing oil with the fuel at a ratio of 16:1 (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines, the amount of lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended and ½ pint of oil should be mixed with each gallon of gasoline. A good quality SAE 30 or SAE 40 oil with an API classification MS, SB or SD may be used if the preferred oil is not available.

Proper and complete mixing of the oil and gasoline is important. Pour about half of the amount of gasoline to be mixed into a clean metal container, add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; then, stir or shake until it is properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

Fig. PR6-7–Armature air gap should be checked and adjusted using correct thickness of shim stock (S).

The oiler reservoir should be filled with Pioneer Chain Oil winter or summer grade, or, if not available, use a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. All models are equipped with an automatic chain oiler pump (Fig. PR6—9). The worm gear (W) on the crankshaft turns the pump shaft and gear (5). The guide pin (6) rides in a cam slot (C) of pump shaft and causes the pump shaft to move back and forth as it rotates. The back and forth movement pumps oil to the chain. The flat (F) on shaft acts as a valve to open the intake port on the outward stroke and the outlet port on the inward stroke. The felt washer (1) should be stuck to the bar pad (2).

CARBON. The muffler and cylinder exhaust ports should be cleaned periodically before any loss of power is noticed because of carbon build up. Remove the muffler and clean carbon from all parts of muffler. Turn engine crankshaft until piston is covering the exhaust port, then carefully clean carbon from the exhaust using a soft scraper. Be especially careful not to damage the piston. Do not attempt to clean exhaust with piston not covering the port. Hard carbon deposits can cause extensive damage if permitted to fall into the engine. The engine cooling fins should be cleaned at the same time that carbon is cleaned from exhaust.

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques listed in the following table are inch-pounds unless otherwise noted.

Crankcase (Tank) Halves	25-35
Flywheel Nut	25 Ft.-Lbs.
Cylinder Base Nuts	70-80
Muffler to Cylinder	25-35
Clutch Driver	25 Ft.-Lbs.

CYLINDER, PISTON, RINGS AND PIN. Compression pressure should be 150 psi for models without "Easy-Arc" starting and all "Easy-Arc" models with decompression valve

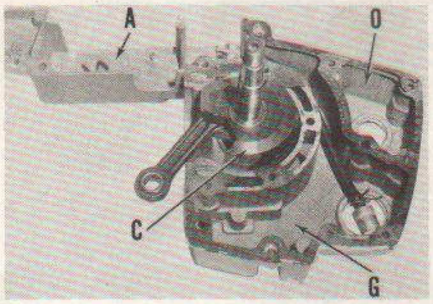


Fig. PR6-10–View of crankcase half showing location of the four compartments; Air box (A), Crankcase (C), Fuel tank (G) and Oil tank (O).

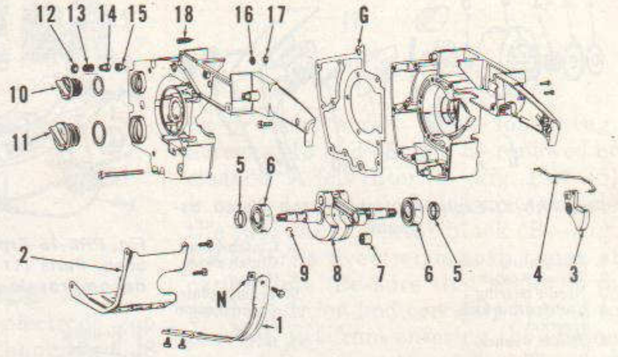


Fig. PR6-11–Exploded view of the crankcase and crankshaft.

1. Rear handle brace
2. Lower shroud
3. Throttle trigger
4. Throttle link
5. Crankshaft seals
6. Main bearings
7. Piston pin bearing
8. Crankshaft assembly
9. Woodruff key
10. Oil cap
11. Fuel cap
12. Plug
13. Spring
14. Valve cap
15. Fuel vent check valve
16. Screen
17. Retaining ring
18. Idle speed screw

closed. The cylinder and head is one piece and is attached to the crankcase with four screws. The cylinder bore is chrome plated and should be renewed if plating is worn away exposing the soft base metal. The piston should be heated to 300 degrees F. before removing the piston pin. Use caution to prevent bending the connecting rod even after piston is heated. Mark the piston on exhaust port side if old piston is to be reinstalled. New pistons may be installed either way, but a used piston should be installed in the same position that it was first installed. NOTE: The needle rollers may fall out of the piston pin bearing when the piston pin is removed. The needle rollers are not held in the cartridge of bearings used for original production. The bearing rollers of service piston pin bearings are held in the cartridge, but these rollers may fall out if extensively damaged. Press only on lettered end, when installing new piston pin bearing. Make sure that none of the bearing rollers fall into the crankcase. Refer to the following specification data:

Cylinder Bore
Nominal Diameter .... 1.625 inches
Piston Ring End Gap 0.088-0.098 inch

The open end of piston pin retaining clips should be toward top (closed) end of piston.

CRANKSHAFT AND CONNECTING ROD. The crankshaft, crankpin and connecting rod are pressed together and are available only as a complete assembly. The crankshaft can be easily damaged by incorrect service procedures. Dropping

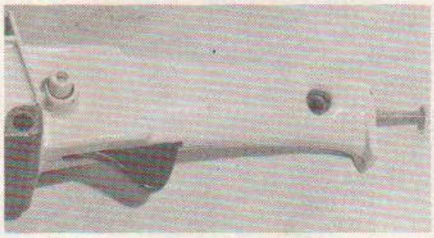


Fig. PR6-12–The nut (N–Fig. PR6-11) can be held in position with a screw while assembling.

the crankshaft or pounding on the ends can easily knock the crankshaft out of alignment. The crankshaft seals can be removed and installed without separating the crankcase (fuel tank) halves. Use Pioneer tool number 471437 to remove seals and tool number 429445 to install seals.

To separate the crankcase halves, remove the handle bar, rewind starter, lower handle, carburetor, ignition coil, flywheel, ignition breaker points, condenser, exhaust manifold, cylinder, piston, guide bar, saw chain, clutch and the automatic chain oiler pump (Fig. PR6—7). Remove the 14 screws attaching the crankcase halves together and carefully separate the halves. Heat the crankcase halves before installing the crankshaft main bearings.

The gasket surface between the two crankcase halves must be completely clean and free from nicks and burrs. The crankcase forms four different compartments when the halves are joined together: (A—Fig. PR6—10) Air box, (C) Engine crankcase, (G) Fuel tank and (O) Chain oiler reservoir. Check the condition of the fuel tank vent (12, 13, 14, 15, 16 & 17—Fig. PR6—11). Individual parts of the fuel tank vent are not available and the complete unit should be renewed if the vent is not operating properly.

The throttle trigger (3—Fig. PR6—11), throttle link (4), fuel pick-up hose, the handle brace nut (N), crankshaft assembly (8) and gasket (G) should all be located correctly between the crankcase halves before attaching the halves together. The handle brace nut can be held in place with the screw as shown in Fig. PR6—12 until the crankcase halves are together. The nut is captive between the halves after they are together.

CLUTCH. The clutch can be removed by unscrewing the clutch driver from the end of the crankshaft. Special tool (Part No. 473372) is available for turning the clutch driver. The clutch driver has left hand thread. The felt dust seal washer (1—Fig. PR6—7)

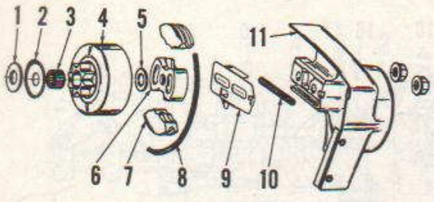


Fig. PR6-13–Exploded view of the clutch assembly.

1. Felt sealing washer
2. Thrust washer
3. Needle bearing
4. Clutch drum and sprocket
5. Thrust washer
6. Clutch driver
7. Clutch shoes
8. Spring
9. Tension plate
10. Chain tension spring
11. Strut

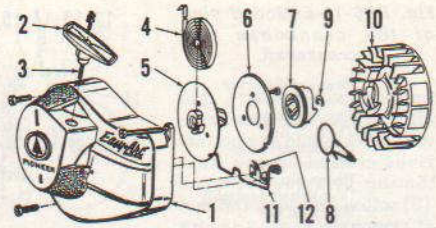


Fig. PR6-15–Exploded view of starter assembly used. Parts (11 and 12) are used to operate decompression valve on models with "Easy-Arc" starting.

1. Housing
2. Handle
3. Cord
4. Rewind spring
5. Pulley
6. Plate
7. Pinion
8. Friction yoke
9. Snap ring
10. Flywheel
11. Decompression link
12. Spring

should be glued onto the pump cover (2).

Clutch slippage for as little as 30 seconds can generate enough heat to melt the clutch shoes and stick them to the drum.

When assembling the clutch, lubricate bearing (3—Fig. PR6—13) and tighten the clutch driver to approximately 25 Ft.-Lbs. torque.

REWIND STARTER. The starters used on models with and without "Easy-Arc" starting are similar. Starter pinion (7—Fig. PR6—14 and Fig. PR6—15) moves in to engage the lugs on the flywheel. On models with "Easy-Arc" starting, the lever (11) is twisted by movement of the pinion and the lever pushes the decompression valve (D—Fig. PR6—6) opening the valve.

New starter cord can be installed without removing the rewind spring. Remove the housing and starter assembly (Fig. PR6—15). Remove the two screws attaching the decompression lever (11) and spring (12), on models so equipped. Remove the brake spring (8) and starter pinion (7) by turning the pinion. NOTE: Do not remove snap ring (9). Remove handle (2) and allow cord to unwind if not broken. Remove the three screws and plate (6), then install new 0.130 diameter cord that is 43 inches long. The rewind spring should be preloaded approximately 2½-turns.

The starter pulley (5) and rewind spring (4) can be removed after snap ring (9) is withdrawn. The rewind spring will probably come out of housing when pulley is lifted out. CAUTION: Use care to prevent injury. To assemble, wind all but the last 5 or 6 inches of the starter cord onto the pulley, then locate the end out of the notch (N—Fig. PR6—14) in plate. Stick the inner end of the rewind spring through the housing and attach spring to the pulley as shown in Fig. PR6—16. Position the pulley over the center post and wind the spring into the starter housing as shown in PR6—17. Allow the spring (and pulley) to unwind after the spring is wound into the housing. Preload the rewind spring 2½ turns and push end of starter cord out through the hole in housing. Install the brake spring, starter pinion and decompression lever as shown in Fig. PR6—14. Washer (W) should be on screw closest to starter pinion.

GASKET AND "O" RING PART NUMBERS

	970, 1072, 2071	1073 2073
Crankcase Gasket	429228	429228
Cylinder Base Gasket	429262	429262
Oil Cap "O" Ring	429324	429324
Gas Cap "O" Ring	429322	429322
Carburetor & Insulating Block Gasket	429303	....
Insulating Block & Air Box Gasket	429305	473865
Cylinder & Insulating Block Gasket	429301	....

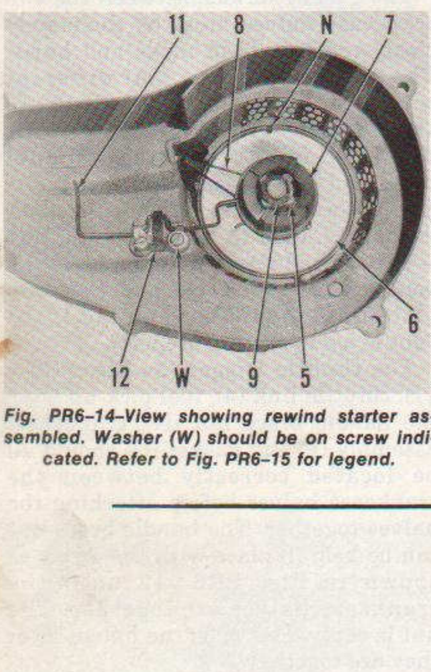


Fig. PR6-14–View showing rewind starter assembled. Washer (W) should be on screw indicated. Refer to Fig. PR6-15 for legend.

Fig. PR6-16–Rewind starter spring should be installed as shown through housing and attached to pulley.

Fig. PR6-17–The rewind spring is wound into housing as shown.

PIONEER

MODEL COVERAGE

Model	Bore In.	Stroke In.	Displ. Cu. In.	Design Features
3071 (Before Serial Number 696730)	1⅞	1 7/16	4.0	A, C
3071 (Serial Number 696730 and Up)	1⅞	1 7/16	4.0	B, D

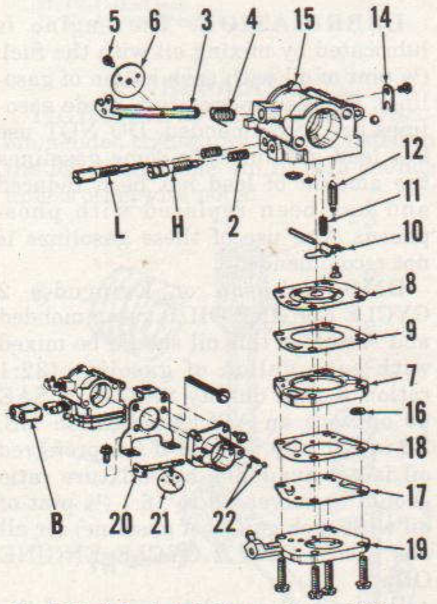


Fig. PR7-1–Exploded view of the OMC carburetor used on some models. The low speed mixture needle is shown at (L) and high speed mixture needle at (H).

2. Springs
3. Throttle shaft
4. Return spring
5. Screw
6. Throttle valve
7. Cover
8. Fuel control diaphragm
9. Gasket
10. Fuel control lever
11. Spring
12. Fuel needle
14. Shaft retainer
15. Carburetor body
16. Fuel screen
17. Fuel pump diaphragm
18. Gasket
19. Fuel pump cover
20. Choke shaft
21. Choke valve
22. Choke detent

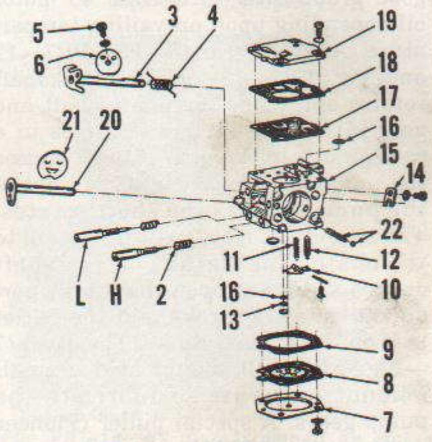


Fig. PR7-2–Exploded view of Tillotson HS carburetor used on late models. Refer to Fig. PR7-1 for legend except for retaining ring (13).

DESIGN FEATURE CODE

A—OMC carburetor
B—Tillotson carburetor
C—Six reed valve
D—One reed valve

MAINTENANCE

SPARK PLUG. The electrode gap should be 0.030 inch. Champion CJ8 spark plug is recommended for all models. Tighten spark plug to 7-8 Ft.-Lbs. torque.

CARBURETOR. An OMC diaphragm carburetor (Fig. PR7—1) was originally used on 3071 models before serial number 696730. These early models were also equipped with a six reed valve assembly (Fig. PR7—3). A Tillotson HS-116A carburetor (Fig. PR7—2) is used on late models (series number 696730 and up).

Initial setting for the mixture needles on OMC carburetors should be ¼ to ½ turns open for the high speed needle (H—Fig. PR7—4) and 1¼ to 1½ turns open for the low speed needle (L). Initial setting for the mixture needles on Tillotson carburetors should be ⅞ turns open for the high speed needle (H) and 1¼ turns open for the low speed needle (L). The idle speed stop screw (S) should be adjusted so that the clutch will disengage and chain will not move with the engine idling. Use "Loctite" on threads of screw (5—Fig. PR7—1 or Fig. PR7—2) to prevent screw from loosening. Screens (13 and 16) can be renewed or cleaned. A felt filter (5—Fig. PR7—5) is located on the fuel pick up (4) inside the fuel tank. Sealer block (B—Fig. PR7—1) is used with both types of carburetors. Be sure that sealer is in good condition and correctly located to prevent dirt from entering the engine around the mixture needles. The fuel tank (3—Fig. PR7—5) is located between the two halves of the crankcase (2 & 10).

MAGNETO. A capacitor discharge magneto ignition system is used. The ignition charging coil, trigger coil and control circuit is located on the flywheel side of the engine. The ignition output (high tension) coil and the capacitor (condenser) are located on the output (right) side of the engine.

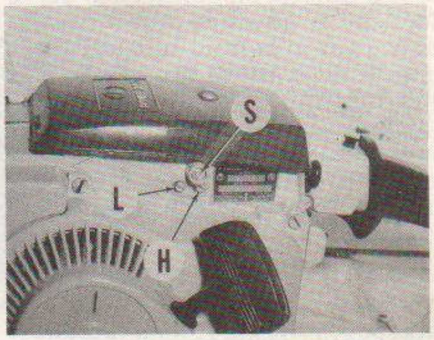
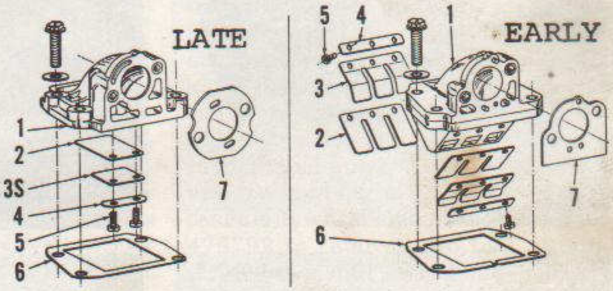


Fig. PR7-4–View showing location of the idle speed stop screw (S), low speed mixture needle (L) and high speed mixture needle (H).

Fig. PR7-3–Exploded views of early and late reed valves. A reed stiffener (3S) is used on late models instead of a stop (3).

1. Reed block
2. Reed
3. Reed stop
3S. Reed stiffener
4. Plate
5. Screws
6. Gasket
7. Gasket



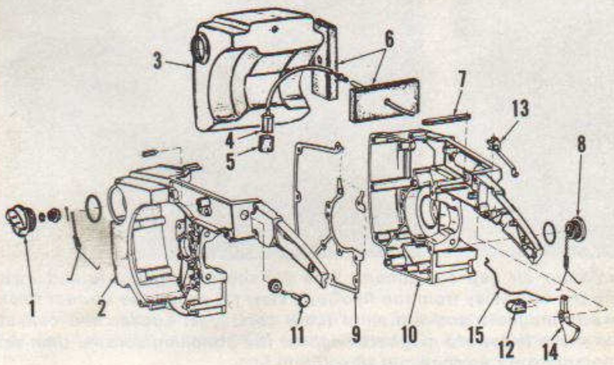


Fig. PR7-5–The fuel tank (3) is located between the halves of the crankcase (2 & 10). Pads (6) must be correctly located to keep tank tight between halves.

1. Fuel cap
2. Crankcase left half
3. Fuel tank
4. Fuel pick-up
5. Felt filter
6. Pads
7. Insulator-sealing strip
8. Oil tank cap
9. Crankcase gasket
10. Crankcase right half
11. Choke knob
12. Throttle link seal
13. Throttle lock
14. Throttle trigger
15. Throttle link

A Wico Magneto Test Plug (Pioneer Part No. 426814) or equivalent can be used as shown in Fig. PR7—6 to check the overall condition of the ignition. If the test plug does not fire, check the stop switch connection (1—Fig. PR7—7). The lead can be easily shorted against the cylinder and can prevent engine from starting. The stop switch can be checked by disconnecting and insulating the lead as shown at (2).

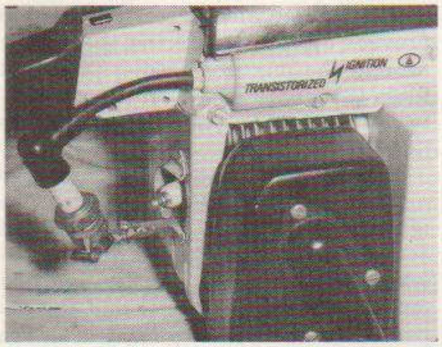


Fig. PR7–6–View of a test plug connected for testing the ignition system.

To diagnose ignition troubles, first check for loose connections, shorted connections or wires and for shorted stop switch. If the test plug still will not fire, install a new condenser (5—Fig. PR7—8) and recheck. If the test plug still will not fire, install a new high tension coil (6) and recheck. If the test plug still will not fire, the problem has been isolated to the charging coil and trigger assembly (3—Fig. PR7—7).

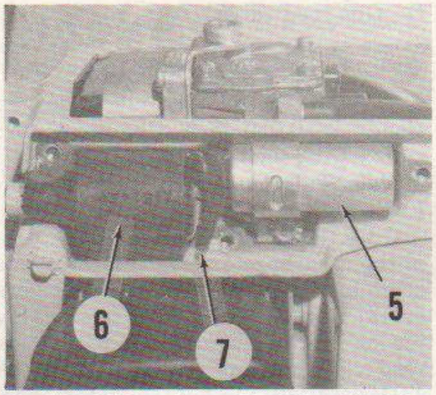


Fig. PR7–8–View of capacitor (5) and high tension coil (6), with cover removed. Insulator (7) should be located between terminals on coil and the capacitor.

The only adjustment on the unit is the air gap between the coil core and the flywheel magnets (Fig. PR7—10). Clearance (air gap) should be 0.012 inch. Ignition should occur at 30 degrees BTDC with engine running. Ignition automatically retards for engine starting.

LUBRICATION. The engine is lubricated by mixing oil with the fuel. (½ pint of oil with each gallon of gasoline). Regular or premium grade gasolines are recommended. DO NOT use low lead gasolines. In some gasolines the amount of lead has been reduced and has been replaced with phosphorus. The use of these gasolines is not recommended.

OMC (Johnson or Evinrude) 2 CYCLE ENGINE OIL is recommended and ¼ pint of this oil should be mixed with each gallon of gasoline (32:1 ratio). A good quality SAE 30 or SAE 40 oil with an API classification MS, SB or SD may be used if the preferred oil is not available, but mixture ratio should be increased to 16:1 (½ pint of oil with each gallon of gasoline) for all oils except OMC 2 CYCLE ENGINE OIL.

Proper and complete mixing of the oil and gasoline is important. Pour about half of the amount of gasoline to be mixed into a clean metal container, add all of the oil required; then, stir or shake until thoroughly mixed. Add the balance of the gasoline to make the correctly proportioned mixture; then, stir or shake until it is properly and permanently blended. DO NOT MIX DIRECTLY IN THE FUEL TANK.

The oiler reservoir should be filled with Pioneer Chain Oil winter or summer grade, or, if not available, a good grade SAE 10 to SAE 40 motor oil depending upon prevailing temperature. A worm gear (6—Fig. PR7—12 and Fig. PR7—13) on the crankshaft rotates and turns the pump shaft and gear (5). The guide pin (P) rides in a cam groove in the gear (5) and causes the pump shaft to move in and out of the pump body as the shaft rotates. The in and out movement pumps oil to the chain. The flat (F) on the shaft acts as a valve to open the intake port on the outward stroke and the outlet port on the inward stroke. The cover (7—Fig. PR7—12) should hold a small amount of grease to lubricate the pump gears. A special puller (Pioneer part number 473643) is available for pulling the worm gear from the crankshaft.

Fig. PR7–7–It is possible for the stop switch connection (1) to short out against the cylinder. View (2) shows wire disconnected and insulated for testing. Wire from capacitor (condenser) is attached to wire from charging coil (3) at connector (4).

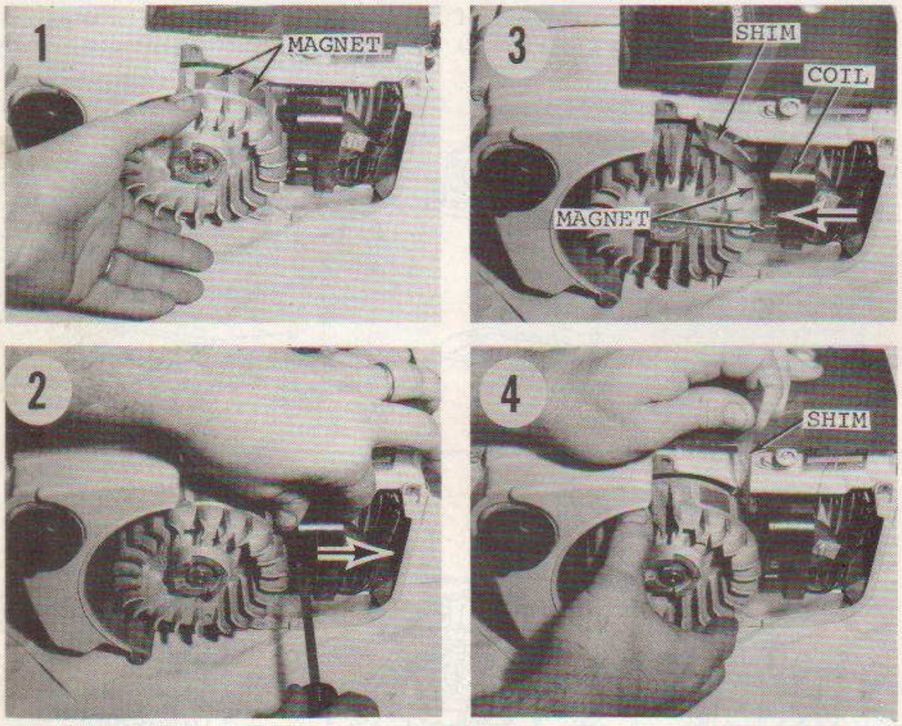
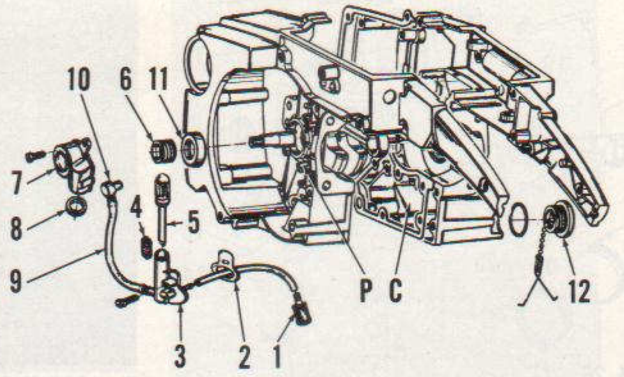


Fig. PR7–10–Views showing armature air gap adjustment. View (1) shows magnets turned away from coil. View (2) shows moving the coil away from the flywheel. View (3) shows the correct thickness of shims positioned between magnets and armature (coil) core legs. Loosen the coil attaching screws and allow coil to move in toward magnets. Tighten the attaching screws, then roll shims out as shown in view (4).

Fig. PR7-12–Exploded view of the chain oiler pump and associated parts. Oil reservoir is located at (C). Guide pin is located at (P).

1. Oil pick-up
2. Gasket
3. Pump body
4. Spring
5. Pump gear and shaft
6. Worm gear
7. Cover
8. Sealer ring
9. Output hose
10. Fitting
11. Crankshaft seal
12. Chain oil filler cap



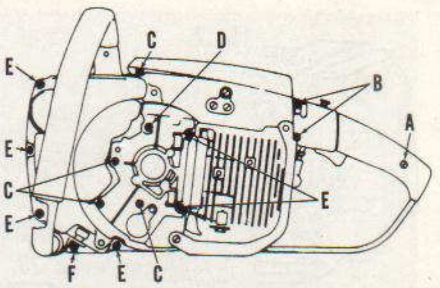


Fig. PR7-19–The proper length of screws should be installed to prevent damage and to be sure that the crankcase does not leak.

A. ½ inch
B. ⅞ inch
C. 1¼ inches
D. 1¾ inches
E. 2⅛ inches
F. 2½ inches

REPAIRS

TIGHTENING TORQUES. Recommended tightening torques listed in the following table are in inch-pounds unless otherwise noted.

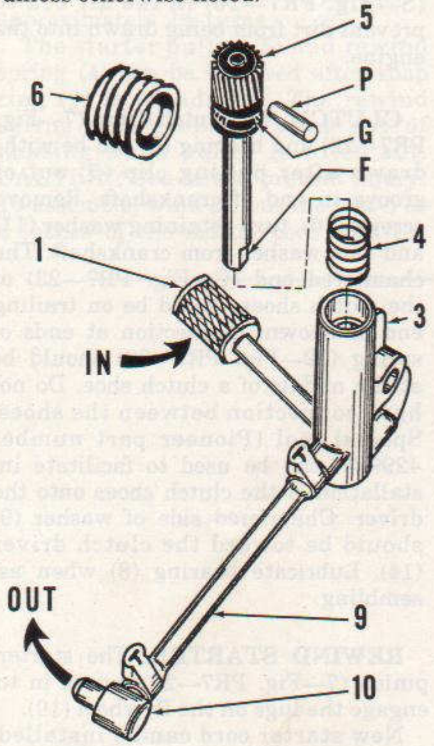


Fig. PR7-13–View of chain oiler pump. Refer to Fig. PR7-12 for legend.

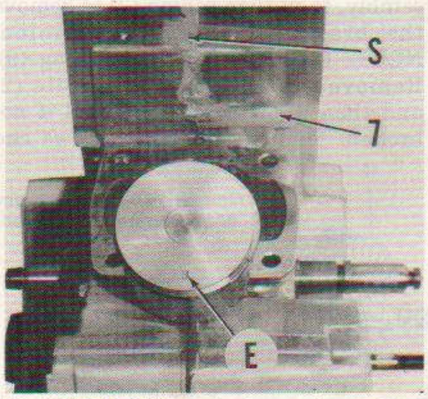


Fig. PR7-16–"E" mark stamped on piston should be toward exhaust port. One piston ring retaining pin will be located on each side of the exhaust port.

Ignition Coil Cover	18-22
Air Filter Cover	15-20
Cylinder Base Screws	90-100
Flywheel	20-25 Ft.-Lbs.
Spark Plug	7-8 Ft.-Lbs.
Carburetor Mounting	30-35
Muffler Mounting	80-90
Reed Valve to Crankcase	25-30
Oil Pump Cover	10-15
Ignition Switch	25-35
Isolator Mount	70-80
Isolator to Handle Bar	15-20
Valve Insert in Fuel Tank Cap	15-20
Carburetor Bracket to Crankcase	25-30

CYLINDER, PISTON AND PIN. The cylinder and head is one piece and is attached to the crankcase with four screws. The cylinder bore is chrome plated and should be renewed if the plating is worn away exposing the soft base metal. The piston should be heated to 300 degrees F. before removing the piston pin. Use care to prevent bending the connecting rod even after the piston is heated. The piston pin is equipped with a caged bearing (23—Fig. PR7—20) and specially shaped thrust washers (22). Notches on thrust washers must be toward the sides of connecting rod. The "E" mark, stamped on head of piston must be toward exhaust side of cylinder (down) as shown in Fig. PR7—16. The pins located in the piston ring grooves will be located at sides of exhaust port. NOTE: Incorrect installation of the piston will cause extensive damage to the piston and cylinder. The ends of the piston pin retaining clips must engage notch in piston.

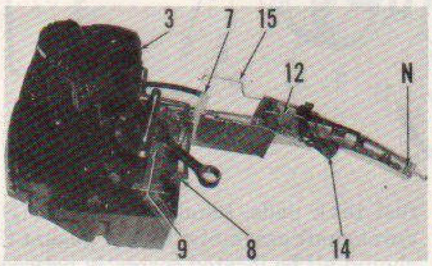


Fig. PR7-18–The right side of crankcase should be assembled as shown before positioning the left half on top.

2. Fuel tank
7. Insulator strip
9. Crankshaft
9. Gasket
12. Sealer
14. Trigger
15. Throttle link
N. Nut

CRANKSHAFT AND CONNECTING ROD. The crankshaft, crankpin and connecting rod are pressed together and are available only as a complete assembly. The crankshaft can be easily damaged by incorrect service procedures. Dropping the crankshaft or pounding on the ends can easily knock the crankshaft out of alignment. The crankshaft seals can be removed and installed without separating the crankcase halves. Use Pioneer tool number 471437 to remove and tool number 429445 to install the seal on flywheel side. Use Pioneer tool 470792 to remove and tool number 427407 to install seal on clutch side.

To separate the crankcase halves, remove the handle bar, rewind starter,

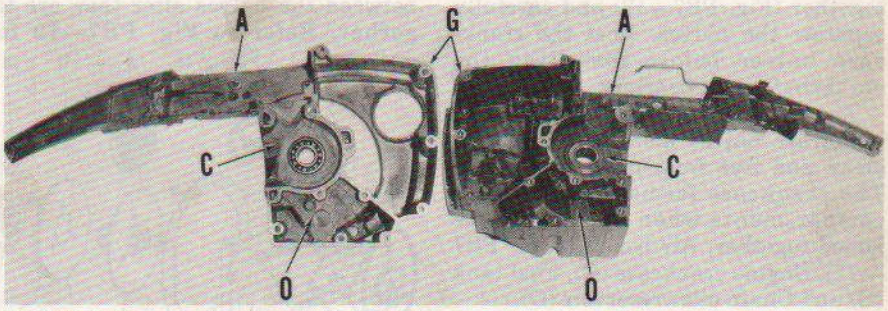


Fig. PR7-17–View showing the crankcase halves separated. The carburetor is located in air box (A), the fuel tank is located in compartment (G), chain lubricating oil is stored in compartment (O) and the engine crankcase is compartment (C).

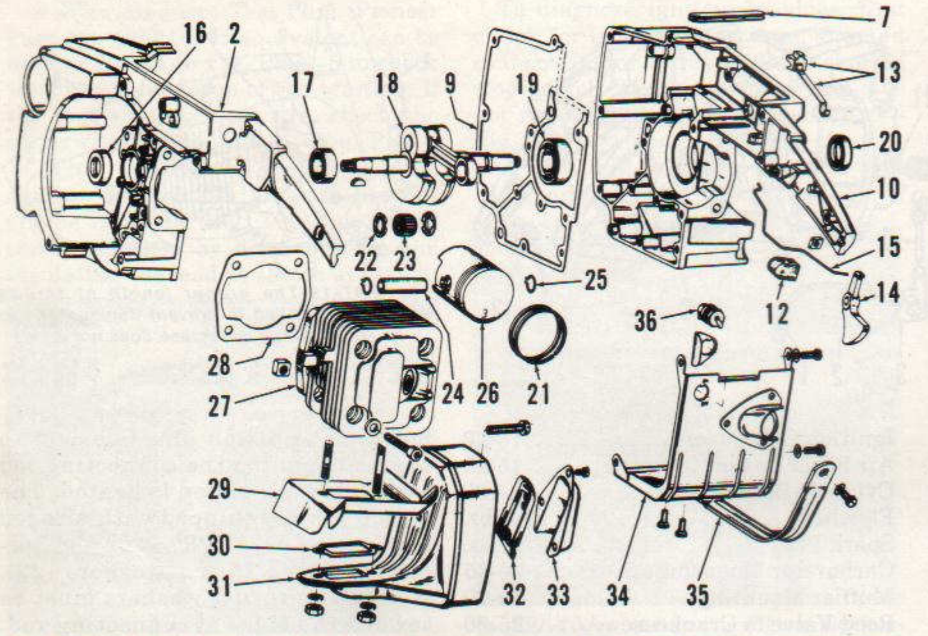
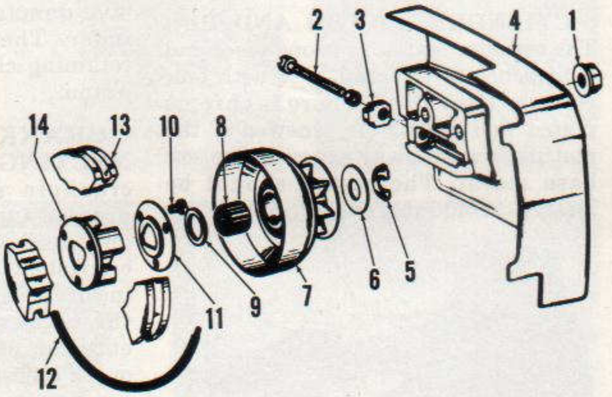


Fig. PR7-20–Exploded view showing the crankshaft and associated parts. Refer also to Fig. PR7-5.

2. Left crankcase half
7. Insulator-sealing strip
9. Gasket
10. Right crankcase half
12. Throttle link seal
13. Throttle lock
14. Throttle trigger
15. Throttle link
16. Crankshaft seal
17. Main bearing
18. Crankshaft
19. Main bearing
20. Crankshaft seal
21. Piston rings
22. Thrust washers
23. Needle bearing
24. Piston pin
25. Retaining ring
26. Piston
27. Cylinder
28. Cylinder base gasket
29. Shroud
30. Gasket
31. Muffler
32. Screen
33. Cover
34. Cylinder shroud
35. Rear handle brace
36. Stop switch

Fig. PR7-22–Exploded view of the clutch assembly.



1. Nuts
2. Tension adjuster screw
3. Chain tensioner
4. Strut
5. Prong lock (retainer)
6. Washer
7. Drum and sprocket
8. Bearing
9. Washer
10. Screw
11. Retaining washer (plate)
12. Spring
13. Shoe
14. Driver

rear handle brace, carburetor, reed valve, ignition high tension coil, capacitor (condenser), flywheel, ignition charging and trigger assembly, exhaust manifold, cylinder, piston, saw chain, guide bar, clutch and the automatic chain oiler pump. Remove the screws attaching the crankcase halves together (Fig. PR7—19) and carefully separate the halves. Heat the crankcase halves before installing the crankshaft main bearings.

The gasket surface between the two crankcase halves must be completely clean and free from nicks and burrs. The crankcase forms four different compartments when the halves are joined together; Air box (A—Fig. PR7—17), Engine crankcase (C), Fuel tank (G) and Chain oiler reservoir (O).

The throttle trigger (14—Fig. PR7—18), throttle lock, throttle link (15), insulator (7), seal (12), fuel tank (3), fuel tank pads, handle brace nut (N), crankshaft assembly (8) and gasket (9) should all be located correctly between the crankcase halves before attaching the halves together. The handle brace nut (N) can be held in place with the screw as shown until the crankcase halves are together. The nut is captive between the halves after they are together. Refer to Fig. PR7—19 for length of the crankcase screws. Apply an appropriate sealer along the seam (S—Fig. PR7—16) in the air box to prevent dirt from being drawn into the engine.

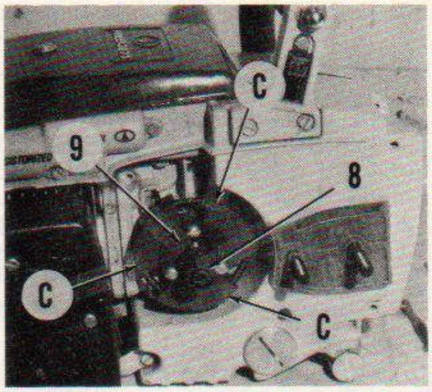


Fig. PR7-23–Chamfered ends of shoes (C) should be on trailing end as shown. Thrust washer is shown at (9) and bearing at (8).

CLUTCH. The clutch drum (7—Fig. PR7—22) and bearing (8) can be withdrawn after pulling clip (5) out of groove in end of crankshaft. Remove screws (10), turn retaining washer (11) and side washer from crankshaft. The chamfered end (C—Fig. PR7—23) of the clutch shoes should be on trailing end as shown. Connection at ends of spring (12—Fig. PR7—22) should be at the middle of a clutch shoe. Do not have connection between the shoes. Special tool (Pioneer part number 429923) can be used to facilitate installation of the clutch shoes onto the driver. Chamfered side of washer (9) should be toward the clutch driver (14). Lubricate bearing (8) when assembling.

REWIND STARTER. The starter pinion (7—Fig. PR7—24) moves in to engage the lugs on the flywheel (10).

New starter cord can be installed without removing the rewind spring. Remove the housing and starter assembly, then turn pinion (7) to remove the brake spring (8) and pinion. NOTE: Do not remove snap ring (9). Remove anchor (13) and handle (2) and then allow cord to unwind if not broken. Remove the three screws and

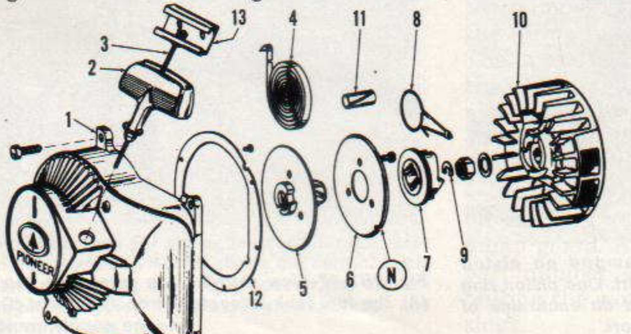


Fig. PR7-24–Exploded view of the rewind starter used.

1. Housing
2. Handle
3. Cord
4. Rewind spring
5. Pulley
6. Plate
7. Pinion
8. Friction yoke
9. Snap ring
10. Flywheel
11. Bushing
12. Stop plate
13. Anchor

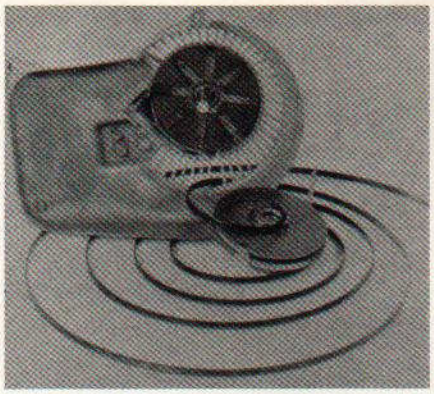


Fig. PR7-25–Rewind starter spring should be installed as shown through housing and attached to pulley.

plate (6), then install new 0.130 inch diameter cord that is 43 inches long. The rewind spring should be preloaded approximately 2½-turns.

The starter pulley (5) and rewind spring (4) can be removed after snap ring (9) is withdrawn. The rewind spring will probably come out of housing when pulley is lifted out. CAUTION: Use care to prevent injury. To assemble, wind all but the last 5 or 6 inches of the starter cord onto the

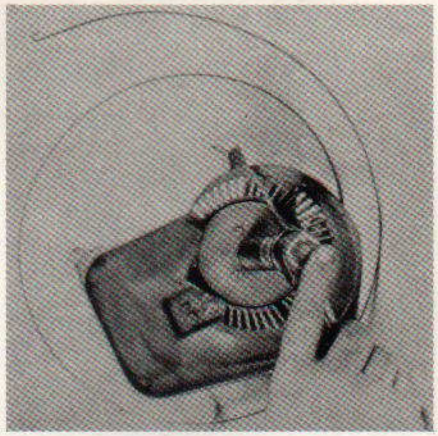


Fig. PR7-26–The rewind spring is wound into housing as shown.

pulley, then locate the end out of the notch in plate (16). Stick the inner end of the rewind spring through the housing and attach spring to the pulley. Position the pulley over the center post and wind the spring into the starter housing. Allow the spring (and pulley) to unwind after the spring is wound into the housing. Preload the rewind spring 2½-turns and push end of starter cord out through the hole in

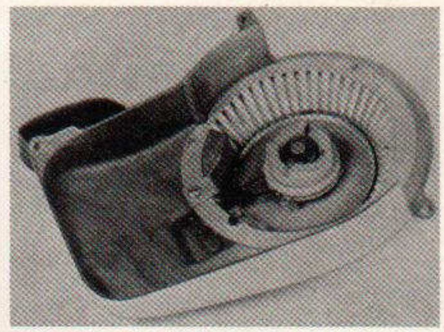


Fig. PR7-27–View of starter assembled into housing.

housing. Install the brake spring and starter pinion.

GASKET AND "O" RING PART NUMBERS

	3071
Crankcase Gasket	429609
Oil Cap "O" Ring	429322
Cylinder Base Gasket	429608
Exhaust Gasket	429642
Oil Pump Base Gasket	429774
Fuel Connector "O" Ring	305857
Gas Cap "O" Ring	429946
Reed Body Gasket	429897
Carburetor Mounting Gasket	427888
Indicator "O" Ring	304598
Air Filter Cover Gasket	307566
Carburetor Fuel Pump Gasket	427940
Carburetor Metering Gasket	429950

PIONEER

CHAIN SAWS

Part No. 430095

Litho in USA 8/72