

# SPIRIT

(Prior to 1985)

## CONDENSED SERVICE DATA

ENGINE MODEL	AB25F1	AA28F	AA34F	AF34A	AC44A
Bore—mm	70	54	60	60	65
Inch	2.756	2.126	2.362	2.362	2.559
Stroke—mm	65	60	60	60	65
Inches	2.559	2.362	2.362	2.362	2.559
No. of Cylinders	1	2	2	2	2
Displacement—cc	250	274.8	339.3	339.3	431.4
Cubic Inches	15.25	16.76	20.70	20.70	26.31
Cooling Type	F/A	F/A	F/A	Fan	Fan
Carburetor Model	VM-30*	VM-30*	VM-30*	B-34	VM-34
Number Used	1	1	1	1	1
Ignition Type	Mag	CDI	CDI	CDI	CDI
Point Gap—mm	0.3-0.4	.....	.....	.....	.....
Inch	0.012-0.016	.....	.....	.....	.....
Timing BTDC—mm	3	1.86	1.44	1.86	2.02
Inch	0.118	0.073	0.056	0.073	0.080
Degrees	22	18	16	18	18
Spark Plug:					
NGK	BR9ES	BR8ES	BR8ES	BR8ES	BR8ES
Gap—mm	0.5	0.5	0.5	0.5	0.5
Inch	0.020	0.020	0.020	0.020	0.020
Fuel:Oil Ratio—					
W/Spirit Oil	50:1	50:1	50:1	Oil Injection	50:1
Other Oil	20:1	20:1	20:1	.....	20:1

\*Some models are equipped with a Mikuni B-34 carburetor.

ENGINE MODEL	AF44LI	AG44A	AD50F	AE50A	AH50L	AL50A
Bore—mm	68	65	70	70	70	70
Inch	2.677	2.559	2.756	2.756	2.756	2.756
Stroke—mm	60	65	65	65	65	65
Inches	2.362	2.559	2.559	2.559	2.559	2.559
No. of Cylinders	2	2	2	2	2	2
Displacement—cc	435.8	431.4	500.3	500.3	500.3	500.3
Cubic Inches	26.58	26.31	30.52	30.52	30.52	30.52
Cooling Type	Liquid	Fan	F/A	F/C	Liquid	Liquid
Carburetor Model	VM-34	VM34*	VM-32	VM-34	VM-38	VM-34*
Number Used	2	1	2	1	2	2
Ignition Type	CDI	CDI	CDI	CDI	CDI	CDI
Point Gap—mm	.....	.....	.....	.....	.....	.....
Inch	.....	.....	.....	.....	.....	.....
Timing BTDC—mm	3	2.02	2.02	2.49	3.85	2.02
Inch	0.118	0.080	0.080	0.098	0.151	0.080
Degrees	22	18	18	20	25	18
Spark Plug:						
NGK	BR9ES	BR9ES	BR9ES	BR9ES	BR10EV	BR9ES
Gap—mm	0.5	0.5*	0.5	0.5	0.5	0.5
Inch	0.020	0.020*	0.020	0.020	0.020	0.020
Fuel:Oil Ratio—						
W/Spirit Oil	20:1	Oil Injection	50:1	50:1	Oil Injection	Oil Injection
Other Oil	20:1	.....	20:1	20:1	.....	.....

\*Some models are equipped with a Mikuni B-40 carburetor.

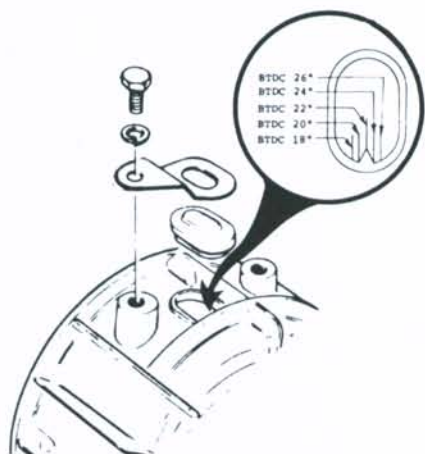


Fig. 1—View of magneto case on single cylinder engine showing timing marks aligned.

## MAINTENANCE

**SPARK PLUG.** The recommended NGK spark plug for normal service is listed in CONDENSED SERVICE DATA tables. Spark plugs should be tightened to 18-20 ft.-lbs. (24.4-27.1 N·m).

**CARBURETOR.** All models use a Mikuni Model VM carburetor with a separate impulse type fuel pump located in engine compartment.

Normal initial setting of the pilot air screw from a lightly seated position is  $\frac{3}{4}$  to  $1\frac{1}{2}$  turns on 1981 and earlier models and  $1\frac{1}{4}$  to  $1\frac{3}{4}$  turns on 1984 and later models. Refer to MIKUNI service section in CARBURETOR SERVICE FUNDAMENTALS section for complete procedure on carburetor fine tuning and carburetor overhaul.

**IGNITION SYSTEM.** An energy transfer magneto ignition system with breaker points is used on the single cylinder AB25F1 engine. All other

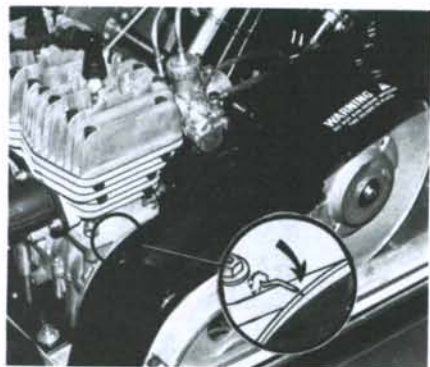


Fig. 2—To check the timing on twin cylinder models, install a temporary timing pointer as shown in inset and check at high idle (6000 rpm) using a timing light. Timing pointer must be as close to drive pulley rim as possible without touching. Refer to text for procedure.

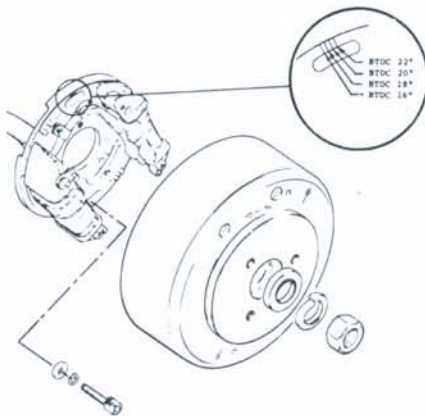


Fig. 3—View of stator timing marks on most twin cylinder models. Refer to text for timing procedure.

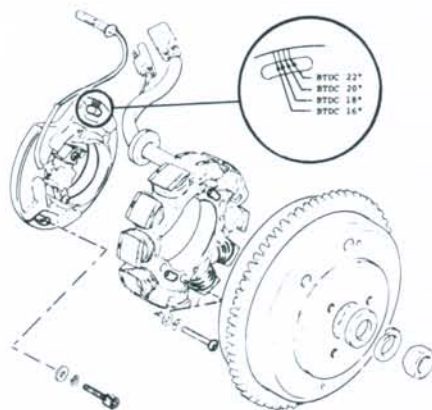


Fig. 4—View of ignition stator timing marks on twin cylinder models with 150W lighting system. Flywheel and lighting stator will need to be removed to check or adjust stator timing.

models use a Nippon Denso or Kokusan breakerless capacitor discharge ignition system. The ignition manufacturer may be identified by examining the CD unit mounted on top of the magneto case on free air and liquid cooled models or rear side of fan housing on fan cooled models.

**Breaker Point Ignition.** On single cylinder AB25F1 engine, breaker point gap should be 0.012-0.016 inch (0.3-0.4 mm) and timing should be 22° BTDC. Timing can be checked by removing the timing cap on top side of magneto case and viewing the scribed timing marks on magneto rotor (flywheel) as shown in Fig. 1. The long single mark indicates TDC position when aligned with timing pointer, and correct (22° BTDC) timing mark is the center mark of the group of five, counterclockwise from the single TDC mark. Timing is correct when points open at the moment indicated (22° BTDC). Point opening can be best determined using a buzzer equipped ignition tester, a change in sound indicating the moment the points break. Flywheel must be removed to renew breaker points or adjust timing by moving breaker plate.

**Breakerless Ignition.** On twin cylinder models a CDI Tester and Trigger Pulse Simulator (such as the Model IL, available from Electro-Specialties, Inc., 11225 W. Bluebound Road, Wauwatosa, WI 53225) is recommended for complete system testing. If suitable testing equipment is not available, parts may be removed and taken to a tester equipped shop for component testing, or trial and error parts replacement process must be followed. Timing seldom changes on a CDI system unless parts loosen. The only practical way to check the timing on a Spirit CD system is with a timing light at 6000 engine rpm.

On early models, affix a short piece of malleable wire to cylinder block base as shown in Inset, Fig. 2. Use a flexible, heat-proof adhesive such as RTV silicone seal to hold the wire. Bend free end of wire as close as possible to outer rim of drive sheave inner half as shown, making sure clearance exists at all speeds. Remove number 2 (pto end) spark plug, install a dial indicator and note correct BTDC timing position as listed in CONDENSED SERVICE DATA tables. With crankshaft positioned, mark the pulley half in direct line with timing pointer as shown. Reinstall spark plug and attach timing light, then check timing at 6000 rpm using the temporary timing pointer and mark.

On later models, a timing pointer is affixed to the magneto case and timing marks are present on the flywheel. Timing marks on fan cooled models are visible after removing the fan cover or fan belt cover. Timing marks on liquid-cooled models are visible after removing the cover plate adjacent to the CDI module. A typical set of timing marks is shown in Fig. 1. Each mark indicates an increment of 2°. The center mark indicates 22° BTDC on Models AA28F, AB25F and AD50F, 27° BTDC on Model AH50L and 18° BTDC on all other models. If accuracy of timing marks is doubted, verify timing marks using static timing procedure. Refer to CONDENSED SERVICE DATA for ignition timing specifications. Dynamic timing is performed with engine running at 6000 rpm.

On all models, adjust ignition timing by rotating the stator plate. The stator plate is accessible after removing manual starter and flywheel. On models equipped with 150 watt alternator, remove alternator stator. The stator plate on most models has timing marks located as shown in Figs. 3 and 4 to

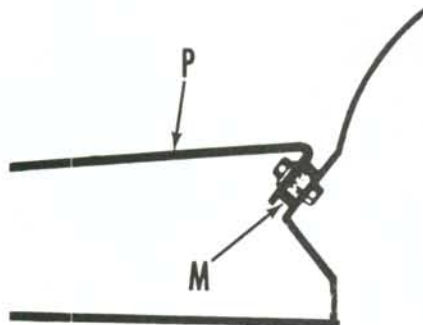


Fig. 5—On some models, rear engine mounts (M) are only accessible from below. Mounting plate (P) must be removed with the engine.

serve as a reference when assembling engine. The stator plate should be marked before disassembly so original timing can be obtained when engine is reassembled.

**LUBRICATION.** Arctic Cat snowmobile engines are lubricated by either an oil injection pump or a fuel mixture of oil and gasoline. Recommended oils are Arctic Injection Oil on oil injected models and Spirit Synthetic Oil on fuel:oil mix models. Recommended fuel grade is regular leaded with a minimum octane rating of 88.

Most new or overhauled engines require additional lubrication during break-in. On oil injected models, the first tank of fuel must contain a 50:1 fuel:oil mixture in conjunction with oil injection to ensure adequate lubrication. On fuel:oil mix models having a 50:1 fuel:oil ratio for normal operation, increase fuel:oil ratio to 25:1 for the first tank of fuel. On models having a 20:1 fuel:oil ratio for normal operation, additional lubrication during break-in is not required. A ratio of 20:1 should be used for all fuel:oil mix models if other two-stroke oil is substituted for Spirit Synthetic Oil.

Mix fuel and oil thoroughly in a separate container before pouring mixture into fuel tank. For cold weather blending, premix the oil with a small amount of gasoline and shake thoroughly until mixture is liquid, then blend with remainder of fuel. Do not use kerosene or fuel oil for premixing.

On models equipped with oil injection system, a separate oil tank and metering system is used. The system delivers varying amounts of oil depending upon engine rpm and throttle setting (load).

Oil delivery is controlled by a cable attached to pump control lever at one end and throttle control lever at other end. Oil injection pump should be adjusted after all carburetor adjustments are completed. With the throttle lever held in wide open position, mark on oil pump control lever should align with sta-

tionary mark on pump housing. To adjust oil pump, loosen cable adjuster locknut at the oil pump and reposition the adjuster as required.

Any operation that required draining or repair of oil injection components will make it necessary to fill and bleed system. During bleeding procedure, the fuel tank must contain a 50:1 fuel:oil mixture to prevent severe engine damage due to loss of engine lubrication. Check oil reservoir fluid level and fill with Arctic Injection Oil or a manufacturer approved equivalent. Bleed air from injection pump before running engine. To bleed injection pump, remove bleeder screw on pump until air-free oil flows from screw opening then reinstall screw. Start engine and run at idle speed only. Rotate oil pump control lever to maximum output position until air-free oil is observed passing through the clear oil delivery hoses to engine. If an oil injection malfunction occurs, carefully inspect check valves in banjo fittings, hoses and oil tank filter and oil tank filter and renew defective or questionable components. Renew the complete oil injection pump assembly if required.

**REPAIRS**

**TIGHTENING TORQUES.** Recommended tightening torques are as follows:

- Cylinder head nuts:
  - Six-stud heads\* . . . . . 14-18 ft.-lbs. (19.0-24.4 N·m)
  - Four-stud heads . . . . . 13-16 ft.-lbs. (17.6-21.7 N·m)
- Cylinder base nuts:
  - 8 mm . . . . . 13-16 ft.-lbs. (17.6-21.7 N·m)
  - 10 mm . . . . . 22-29 ft.-lbs. (29.8-39.3 N·m)
- Crankcase bolts
  - 6 mm . . . . . 6-7 ft.-lbs. (8.1-9.5 N·m)
  - 8 mm . . . . . 13-16 ft.-lbs. (17.6-21.7 N·m)
  - 10 mm . . . . . 15-22 ft.-lbs. (20.3-29.8 N·m)
- Flywheel nut . . . . . 49-63 ft.-lbs. (66.4-85.4 N·m)
- Manifolds . . . . . 11-14 ft.-lbs. (15-19 N·m)
- Engine mounting bolts . . . . . 50-55 ft.-lbs. (67.8-74.5 N·m)
- Spark plugs . . . . . 18-22 ft.-lbs. (24.4-29.8 N·m)

\*Six-stud head on liquid-cooled engine should be tightened to 22-29 ft.-lbs. (29.8-39.3 N·m) torque.

**ENGINE REMOVAL.** On all models open or remove hood then remove drive belt shield, drive belt and muffler. Unbolt recoil starter and lay it out of the

way. Remove air intake silencers, loosen spigot clamps and slide carburetor(s) out of mounting flange without disconnecting fuel lines or linkage.

On oil injection engines, detach oil pump control cable and oil supply hose at injection pump. Plug openings in hose and pump to prevent oil loss and the entrance of dirt.

On liquid-cooled engines, disconnect the hose from water manifold and use a suitable container to catch the coolant. Disconnect coolant hose from thermostat housing and heat exchanger end cap. Carefully remove temperature gage sending unit from thermostat housing. Make certain sending unit does not rotate with retaining nut during removal as permanent damage to temperature gage will result.

On all models, disconnect wiring and fuel pump impulse hose. Engine is removed along with mounting plate. On some units rear mounts are only accessible from below as shown in Fig. 5. On these units tip snowmobile on right side and remove rear nuts, then tip machine upright and remove engine and mounting plate. On other models all mounting nuts are accessible from above and engine and plate assembly can be lifted off after nuts are removed. Check for and save any shims used on left rear engine mount. These shims help align drive sheaves and may be needed when engine is reinstalled.

Install engine by reversing removal procedure. Refer to vehicle section for pulley alignment procedure. Tighten engine mounts to a torque of 23 ft.-lbs. (31.3 N·m). When reinstalling starter, install mounting cap screws loosely and pull starter rope until pawls engage to properly align the units, then tighten screws to 7 ft.-lbs. (9.5 N·m).

**DISASSEMBLY AND REASSEMBLY.** On all models, remove engine

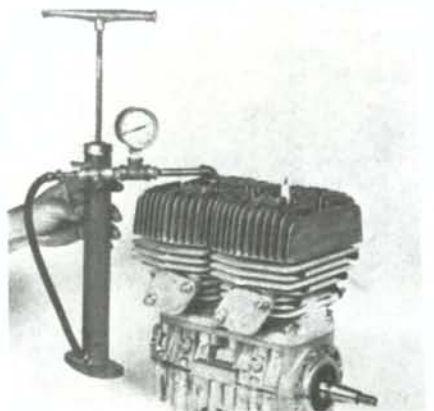


Fig. 6—Method of constructing a manual pressure tester for checking crankshaft seals. Never exceed 15 psi when checking the seals.



Fig. 7—Lifting off the cylinder block on single cylinder engine.

mounting plate and torque converter drive. Suggested procedures include pressure testing crankcase for leaks which requires removal of flywheel (plus magneto if engine is to be submerged) for observation of magneto end seal.

Construct a manual pressure tester consisting of a hand pump, piping, a shut-off valve, pressure gage and connections as shown in Fig. 6. Also prepare suitable sealing plates and gaskets for intake and exhaust port flanges in cylinders. Pressurize the crankcase to 12 psi (NEVER EXCEED 15 psi or seals may be damaged). Close shut-off valve and record pressure drop which should not exceed 1 pound per minute, or 2 pounds for a two cylinder engine. If pressure drop exceeds the ac-

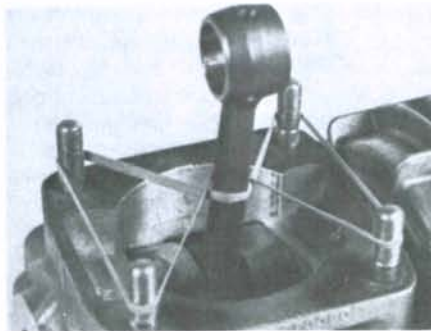


Fig. 8—Use a rubber band as shown to protect engine parts from damage when cylinder and piston are off. Refer to text.

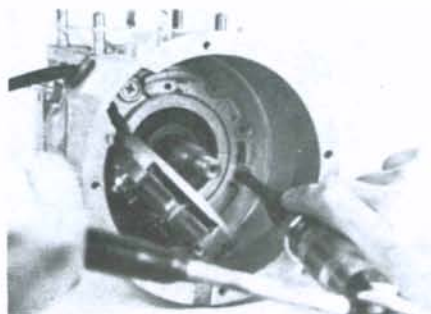


Fig. 9—An impact screwdriver is required to loosen or tighten magneto housing screws.

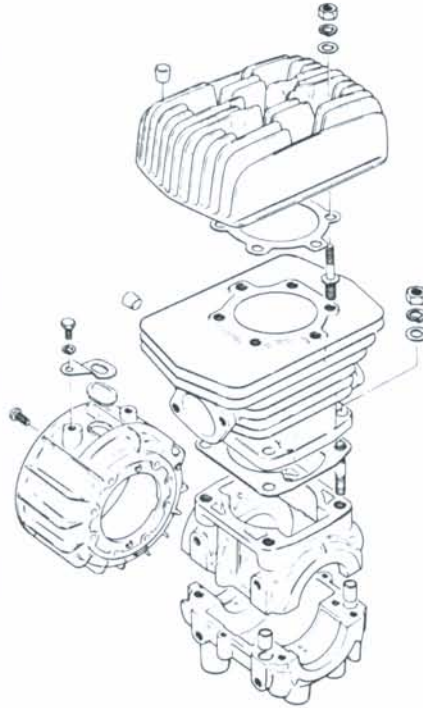


Fig. 10—Exploded view of housing components and associated parts used in single cylinder engine.

cepted rate, check for leaks with soapy water and a brush. Engine may be submerged if preferred, but all electrical components must be stripped off before submersion.

Disassembly sequence for the different engine types is outlined in the appropriate following paragraphs.

**SINGLE CYLINDER ENGINE.** With engine removed as previously outlined, remove cylinder head nuts, cylinder head and gasket. Unbolt and remove cylinder by lifting it straight up, catching piston as cylinder is lifted off. Remove piston pin retainers and push out the pin using a suitable removing tool. Use a rubber band to center rod as shown in Fig. 8, thus avoiding damage to parts if crankshaft should be accidentally turned.

Remove flywheel using a suitable puller if not previously removed. DO NOT hammer on end of crankshaft in an effort to loosen flywheel. Scribe mark on magneto baseplate to aid in reassembly, remove the two retaining screws and lay baseplate aside as shown in Fig. 9. Do not attempt to remove at this time. Use an impact driver to loosen magneto case retaining cap screws as shown, and lift off case and magneto baseplate as an assembly. Use a soft mallet to loosen magneto case if it sticks.

Remove the eight cap screws securing crankcase halves and separate the halves by tapping sides with a soft mallet. Do not use a pry in separating



Fig. 11—Tighten crankcase retaining cap screws in the sequence shown. Refer to text for tightening torques of the various sized screws.

crankcase. Lift out crankshaft assembly and slide off end seals.

Refer to the appropriate service sections which follow to service engine components.

Assemble by reversing the disassembly procedure. Apply a liberal amount of grease between double lips of crankshaft seals and slip on shaft with spring side of seal toward bearing. Also make sure alignment hole in outer race of each crankshaft bearing fits over dowel in bearing bore.

Apply a thin coat of sealer such as RTV silicone seal to cleaned mating surfaces of each crankcase half and install top half. Install the various sized crankcase cap screws finger tight. Make sure correct size and length is installed in each hole, that heads seat and that crankcase parting line closes along its entire length; then tighten cap screws in small increments using the sequence shown in Fig. 12. Tightening torques are as follows:

Screws	Ft.-Lbs.	N·m
6mm	6-7	8.2-9.5
8 mm	13-16	17.7-21.7
10 mm	15-22	20.4-29.9

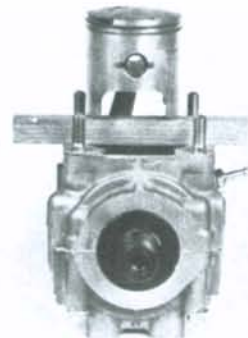


Fig. 12—Use a block of wood or plastic to support piston while installing cylinder assembly.

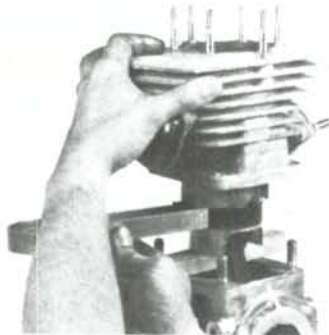


Fig. 13—Installing the cylinder using an approved ring compressor.

Install piston with arrow on piston crown pointing toward exhaust side of engine, insert piston pin and secure with retaining rings, making sure rings fully seat in their grooves. Coat cylinder base gasket on both sides with a light coating of RTV silicone sealer and install the gasket. Insert a small piece of wood underneath piston skirt as shown in Fig. 12, then using a ring compressor as shown in Fig. 13, slide cylinder down over piston making sure inlet port flange is on same side as pulse passage fitting. Tighten cylinder base nuts to 22-29 ft.-lbs. (30-39 N·m) using a crisscross pattern.

Install cylinder head gasket and cylinder head, tightening stud nuts to 13-16 ft.-lbs. (17.7-21.7 N·m) using a crisscross pattern, then pressure test crankcase for air leaks as previously outlined.

Install magneto case to crankcase using Loctite on attaching screws and installing with an impact driver. Align scribe marks and reinstall magneto base plate, install flywheel and tighten retaining nut to 50-63 ft.-lbs. (66.4-85.4 N·m).

**FREE AIR TWIN ENGINES.** With engine removed as previously outlined, remove cylinder heat nuts, cylinder heads and gaskets. Identify pistons and

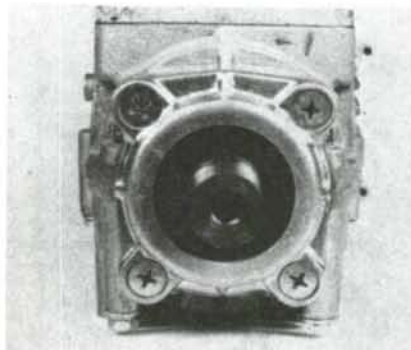
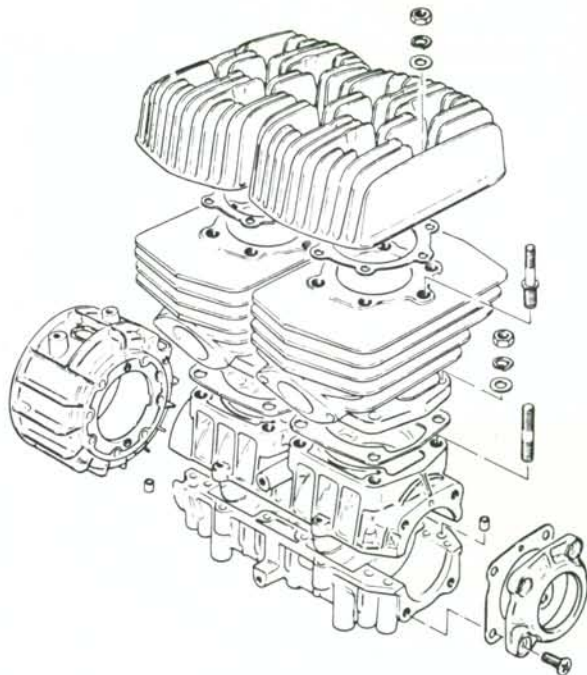


Fig. 14—Some twin cylinder models have a seal retainer on top end of housing as shown.

Fig. 15—Exploded view of housing components and associated parts used on 500cc free air engines. Major components of other twins are similar.



cylinders for reassembly. Remove exhaust manifold and if so equipped, the intake manifold. Unbolt and remove cylinders by lifting them straight up, holding pistons as cylinders are removed, to prevent damage. Remove piston pin retainers and push out the pins using a suitable removing tool. Use rubber bands to center rods and prevent damage if crankshaft is accidentally turned. (Fig. 8).

Remove flywheel using a suitable screw type puller if not previously removed. Scribe a mark on magneto baseplate so it can be reinstalled in the same position. Remove the two retaining screws and lay baseplate aside. Use an impact driver to loosen magneto case if necessary, using a soft mallet, and lift off the case and magneto baseplate as an assembly.

Some models have a seal retainer on top end of crankcase as shown in Fig. 14. Use an impact driver to loosen the screws, then unbolt and remove the plate. On all models remove the cap screws securing the crankcase halves and separate the crankcase by tapping sides with a soft mallet. Do not pry when separating the crankcase. Check dowels in bearing bores and "C" ring in center bearing bore of lower crankcase half when crankshaft is lifted out, to prevent loss. Refer to the appropriate following service sections to service engine components.

Assemble by reversing the disassembly procedure. Apply a liberal

amount of grease between double lips of crankshaft seals and slip on shaft with spring side of seal toward bearing. Also make sure alignment holes of bearing races fit on dowels in bearing bores and that alignment "C" ring in center bore is properly positioned.

Apply a thin coat of RTV silicone seal to cleaned mating surfaces of each crankcase half, then lay a piece of #50 cotton thread just to the inside of bolt holes on lower crankcase half as shown at T—Fig. 16. Carefully insert rods up through cylinder mounting holes and install crankcase top half. Tip crankcase on its side and install the various sized crankcase cap screws finger tight. Make sure correct size and length is installed in each hole, that heads seat and that crankcase parting line closes along its entire length; then tighten cap screws in small increments using the sequence

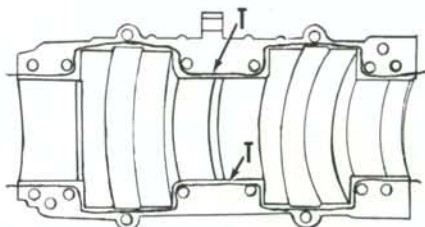


Fig. 16—After applying sealant to crankcase lower half, lay a cotton thread at inside of bolt holes as shown at (T).

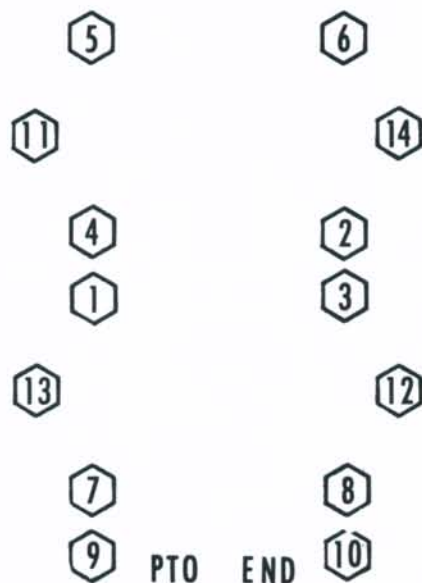


Fig. 17—Crankcase bolt tightening sequence to be used on small twin cylinder units. Refer to text for tightening torques of the various bolt sizes.

shown in Fig. 17 or Fig. 18. Tightening torques are as follows:

Screws	Ft.-Lbs.	N·m
6 mm	6-7	8.2-9.5
8 mm	13-16	17.7-21.7
10 mm	15-22	20.4-29.9

On models so equipped, install crankshaft seal end plate (Fig. 14). Use RTV silicone seal on gasket surface, Loctite on screw threads and tighten screws using an impact driver.

Thoroughly lubricate crankshaft and rod bearings then install pistons with arrow on piston crowns pointing toward exhaust side of engine. Insert piston pins and secure with retaining rings, making sure rings fully seat in their grooves. Coat cylinder base gaskets on both sides with a light coating of RTV sealer and install gaskets. Insert a small piece of wood underneath skirt of piston (Fig. 12) then using a ring compressor, slide cylinder down over piston making sure inlet port flange of cylinder is on same side as pulse passage fitting in crankcase. Install the other cylinder using the same procedure. Install but DO NOT TIGHTEN cylinder base nuts at this time. On single carburetor models, temporarily install intake manifold as shown in Fig. 19 to align manifold flanges of cylinders. On dual carburetor models, temporarily install exhaust manifold. Tighten accessible cylinder base nuts firmly, then remove installed manifold and tighten all cylinder base nuts to 22-29 ft.-lbs. (30-39 N·m) using a crisscross pattern.

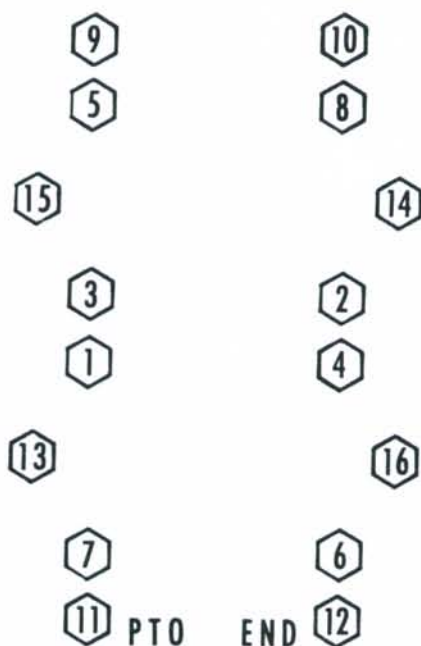


Fig. 18—Crankcase bolt tightening sequence for big twin cylinder motors except 1984-1985 Panther and 1985-1986 Jag models. Refer to text for tightening torques.

Coat both sides of cylinder head gaskets with RTV sealer and install cylinder heads, noting that heads reverse for opposite cylinders as shown in Fig. 20. Tighten nuts on four-stud cylinder heads to a torque of 22-29 ft.-lbs. (30-39 N·m) and nuts on six-stud heads to 13-16 ft.-lbs. (17.7-21.7 N·m). Use a crisscross tightening pattern. With crankcase and cylinders assembled, pressure test for air leaks as previously outlined.

Install magneto case on crankcase using Loctite on attaching screws and installing with an impact driver. Align scribe marks and reinstall magneto base plate. Install flywheel and tighten retaining nut to 50-63 ft.-lbs. (66.4-85.4 N·m).

FAN COOLED TWINS. With engine removed as previously outlined, remove the three cap screws and lockwashers securing the starter pulley then remove starter pulley and fan drive pulley. Unbolt and remove upper cowling, exhaust gaskets, front cowling, intake manifold and rear cowling. Unbolt and remove fan housing as an assembly.

Remove flywheel using a suitable puller. It may be necessary to reinstall starter/fan pulley in order to use the flywheel holding tool. Unbolt and lay aside the alternator stator without withdrawing wiring from housing. Scribe re-assembly lines on ignition stator and magneto case or note and record positioning of timing marks. Unbolt ignition

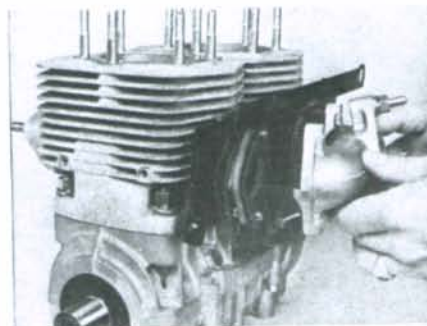


Fig. 19—Install intake or exhaust manifold to align cylinders before tightening cylinder mounting stud nuts.

stator and move it aside, then remove screws securing magneto case to crankcase using an impact driver. Loosen magneto case if necessary using a soft mallet, then lift off case and stators as an assembly.

Unbolt and remove cylinder heads noting that long, stand-off nuts go on outer studs at magneto and pto end. Identify pistons and cylinders for proper reassembly, then unbolt and remove cylinders by lifting them straight up, holding pistons to prevent damage. Remove piston pin retainers and push out the pins using a suitable removing tool. Use rubber bands to center rods and prevent damage if crankshaft is accidentally turned.

Some models have a seal retainer on pto end of crankcase as shown in Fig. 14. Use an impact driver to loosen the screws, then unbolt and remove the plate. On all models, remove the cap screws securing the crankcase halves and separate the crankcase by tapping sides with a soft mallet. Do not pry when separating the crankcase. Check dowels in bearing bores and "C" ring in center bearing bore of lower crankcase half when crankshaft is lifted out. Refer to the appropriate service sections which follow, to service engine components.

Assemble by reversing the disassembly procedure. Apply a liberal amount of grease between double lips of crankcase seals and slip on shaft with spring side of

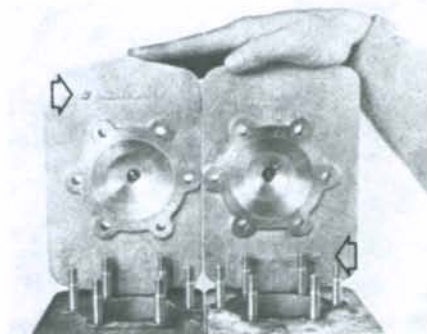


Fig. 20—Cylinder heads are identical but reversed on twin cylinder free engines.

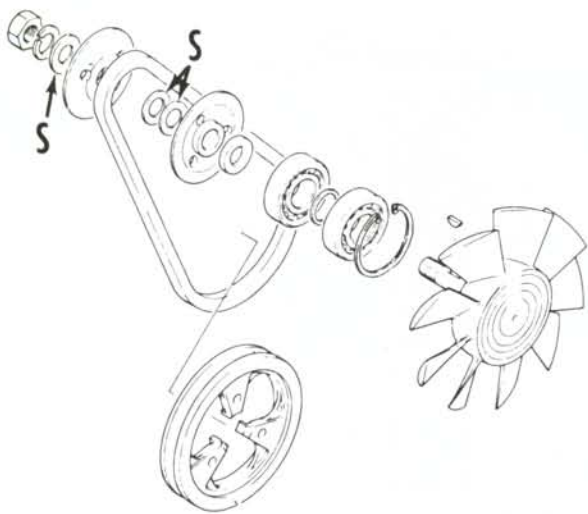


Fig. 21—Cooling fan drive belt is adjusted by moving shims (S) on fanshaft sheave. Refer to text for details.

seal toward bearing. Also make sure alignment holes of bearing races fit on dowels in bearing bores and that alignment "C" ring in center bore is properly positioned.

Apply a thin coat of RTV sealer to cleaned mating surfaces of each crankcase half, then lay a piece of #50 cotton thread just to the inside of bolt holes on lower crankcase half as shown at T—Fig. 16. Carefully insert rods through cylinder mounting holes and install crankcase top half. Tip crankcase on its side and install the various sized crankcase cap screws finger tight. Make sure correct size is installed in each hole, that heads seat and that crankcase parting line closes along its entire length; then tighten cap screws in small increments using the sequence shown in Fig. 17. Tightening torques are as follows:

Screws	Ft.-Lbs.	N·m
6 mm	6-7	8.2-9.5
8 mm	13-16	17.7-21.7
10 mm	15-22	20.4-29.9

On models so equipped, install crankshaft seal end plate (Fig. 14). Use RTV silicone seal on gasket surface and Loctite on screw threads, and tighten screws using an impact driver.

Thoroughly lubricate crankshaft and rod bearings then install pistons with arrow on piston crowns pointing toward exhaust side of engine. Insert piston pins and secure with retaining rings, making sure rings fully seat in their grooves. Coat cylinder base gaskets on both sides with a light coating of RTV sealer and install gaskets. Insert a small piece of wood underneath skirt of piston (Fig. 12) then using a ring compressor, slide cylinder down over piston making sure inlet port flange of cylinder is on

same side as pulse passage fitting in crankcase. Install the other cylinder using the same procedure.

On models equipped with six-stud cylinder heads, install but DO NOT TIGHTEN cylinder base nuts. Temporarily install intake manifold to align manifold flanges of cylinders. Tighten front cylinder base nuts firmly to maintain alignment of cylinders, then remove intake manifold. Install the remaining cylinder base nuts and tighten all nuts to 22-29 ft.-lbs. (30-39 N·m) using a crisscross pattern.

On models equipped with four-stud cylinder heads, install intake manifold and tighten to 6-7 ft.-lbs. (8.2-9.5 N·m) to align cylinders.

On all models, install cylinder head gaskets and cylinder heads. Note that standoff (long) stud nuts go on end studs to support shroud. Using a crisscross tightening pattern, tighten six-stud cylinder head nuts to 14-18 ft.-lbs. (19.0-24.4 N·m) and four-stud cylinder head nuts to 13-16 ft.-lbs. (17.7-21.7 N·m). With crankcase and cylinders assembled, pressure test for air leaks as previously outlined.

Install magneto case on crankcase

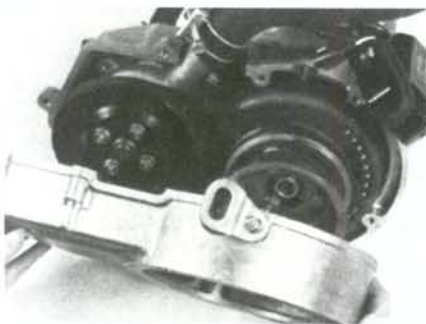


Fig. 22—Removing magneto housing cover on liquid-cooled engines.

using Loctite on attaching screws and install with an impact driver. Align scribe marks and reinstall ignition base plate. Reinstall alternator stator and flywheel. Refer to TIGHTENING TORQUES section and tighten flywheel retaining nut to specified torque.

Complete assembly by reversing disassembly procedure. Cooling fan belt tension should be adjusted to allow ¼ inch belt deflection midway between pulleys when depressed with finger. Belt tension is adjusted by adding or removing spacer shims (S—Fig. 21) between pulley halves on fan shift. (IF shims are removed, store spare shims on outside of sheave half behind shaft nut). Turn pulleys slowly while assembling, to keep from pinching belt.

**LIQUID-COOLED ENGINE.** With engine removed as previously outlined, remove the screws retaining the outside magneto cover and lift off cover as shown in Fig. 22. Using a holding spanner as shown in Fig. 3, loosen flywheel nut, then remove the three cap screws securing starter pulley and water pump drive pulley to flywheel. Remove pulleys and belt, then remove flywheel using a suitable screw puller as in Fig. 24.

Loosen the screw securing magneto wiring harness clamp. Scribe mark on magneto backing plate timing position to help in reassembly, then unbolt and lay magneto aside. Disconnect coolant bypass hose from cylinder head. Use an impact driver to loosen the magneto housing retaining screws and remove the screws. Use a rubber mallet to loosen magneto housing from crankcase, then remove magneto housing, water pump and magneto plate as an assembly as shown in Fig. 25.

Remove the cap screws, lockwashers and flat washers securing cylinder head, loosen cylinder head using a soft mallet as shown in Fig. 26, then lift off the head. Remove head gaskets. Unbolt and remove the water intake manifold. (Fig. 27).

Remove cylinder base nuts, lockwashers and flat washers. Use a soft

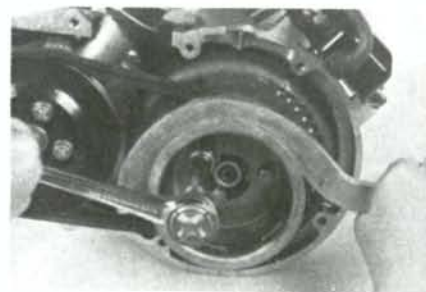


Fig. 23—A spanner wrench is available for use in loosening flywheel nut and starter pulley retaining cap screws.



Fig. 24—Use a suitable screw puller to remove the flywheel.

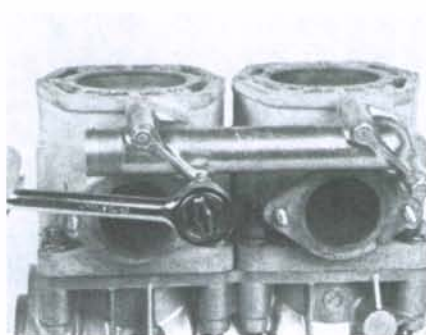


Fig. 27—Removing water manifold.

mallet to tap cylinders free of crankcase, then lift cylinders straight up over piston assemblies. Mark the cylinders and pistons so they can be reinstalled in same location.

**NOTE: Use care when handling cylinder units to prevent head surface from becoming scratched or reed stops from becoming bent.**

Remove piston pin retainers and push out the pins using a suitable removing tool. Use rubber bands to center rods and prevent damage if crankshaft is accidentally turned.

Lay crankcase on its side and remove the 16 bolts and washers securing the crankcase halves. Separate the crankcase by tapping sides with a soft mallet. Do not use a pry in separating the crankcase. Check dowel in bearing bore and "C" ring at center bearing of lower

crankcase half when crankshaft is lifted out. Refer to the appropriate service sections which follow to service engine components.

Assemble by reversing the disassembly procedure. Apply a liberal amount of grease between double lips of crankcase seals and slip on shaft with spring side of seal toward bearing. Also make sure alignment holes of bearing races fit on dowels in bearing bores and that alignment "C" ring in center bore is properly positioned.

Apply a thin coat of RTV sealer to cleaned mating surfaces of each crankshaft half, then lay a piece of #50 cotton thread just to the inside of bolt holes on lower crankcase half as shown at T—Fig. 28. Carefully insert rods through cylinder mounting holes and install crankcase top half. Tip crankcase on its side and install the various sized crankcase cap screws finger tight. Make sure correct size and length is installed in each hole, that head seat and crankcase parting line closes along its entire length; then tighten cap screws in small increments using the sequence shown in Fig. 29. Tightening torques are as follows:

Screws	Ft.-Lbs.	N·m
6 mm	6-7	8.2-9.5
8 mm	13-16	17.7-21.7
10 mm	15-22	20.4-29.9

Thoroughly lubricate crankshaft and rod bearings then install pistons with ar-

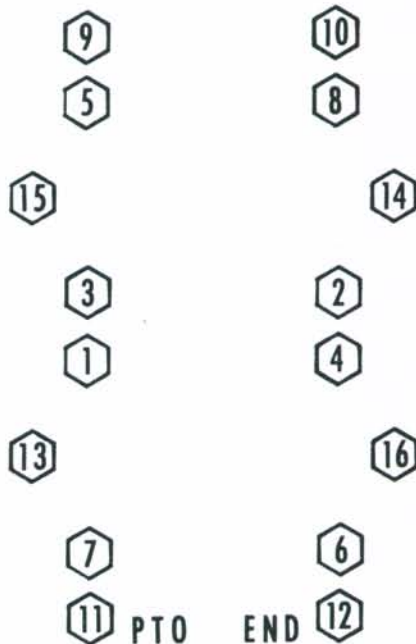


Fig. 29—Crankcase bolt tightening sequence to be used for liquid-cooled engines. Refer to text for tightening torques.

row on piston crowns pointing toward exhaust side of engine. Insert piston pins and secure with retaining rings, making sure rings fully seat in their grooves. Coat cylinder base gaskets on both sides with a light coating of RTV sealer and install gaskets. Insert a small piece of wood underneath skirt of piston as shown in Fig. 30, then using a ring compressor, slide cylinder down over piston. Install the other cylinder using the same procedure. Install but do not tighten cylinder base nuts at this time. Coat water manifold gaskets lightly with RTV sealer and install water manifold, tightening retaining cap screws to 5-7 ft.-lbs. (6.8-9.5 N·m). Installation of water manifold aligns cylinder flanges. Tighten all six stud nuts on each cylinder firmly, then torque the four 8 mm nuts to 13-16 ft.-lbs. (17.7-21.7 N·m) using a crisscross pattern. With large stud nuts torqued, tighten the 6 mm nuts to a torque of 6-7

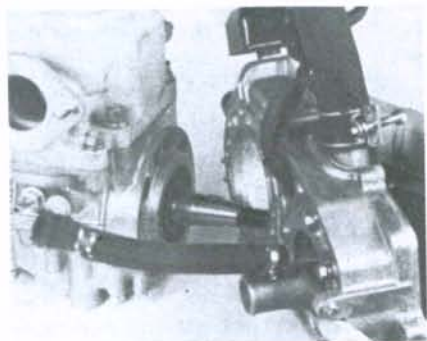


Fig. 25—Removing magneto housing on liquid-cooled engine.



Fig. 26—Removing cylinder head on liquid-cooled engine.

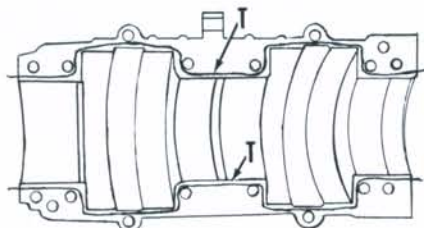


Fig. 28—After applying sealant to crankcase lower half, lay a cotton thread (T) inside bolt holes as shown.



Fig. 30—Use a suitable ring compressor to install cylinders.



ft.-lbs. (8.2-9.5). Use a very thin coat of RTV Sealer on head gaskets then position over cylinders, making sure large water passage holes are toward INTAKE side of cylinders. Position cylinder head and install the twelve cap screws, lockwashers and flat washers which secure the head. Snug up the cylinder head cap screws then torque to 22-29 ft.-lbs. (30-39 N·m) using the tightening sequence shown in Fig. 33. With crankcase and cylinder assembled, pressure test for air leaks as previously outlined.

Install thermostat as shown in Fig. 34, gasket and outlet elbow as in Fig. 35. Install thermostat housing retaining screws using Loctite and tighten using an impact driver.

Install magneto case on crankcase using Loctite on attaching screws and tightening with an impact driver. Align scribe marks and reinstall magneto base plate. Reinstall flywheel, tightening retainer nut to a torque of 50-63 ft.-lbs. (66.4-85.4 N·m). Reinstall coolant pump belt and pulley, starter pulley and pulley retaining screws. Check coolant pump belt tension, which should allow 1/4-inch deflection midway between pulley sheaves. Adjust belt tension if necessary by slackening the three water pump

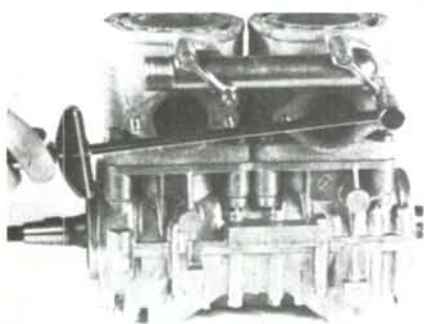


Fig. 31—Water manifold can be used to align cylinders before tightening stud nuts.

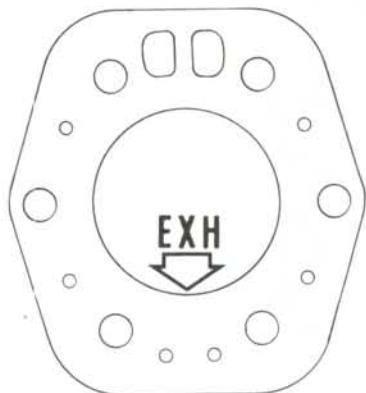
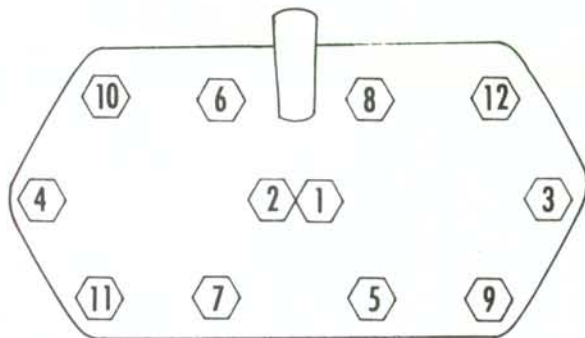


Fig. 32—Large water passage holes in cylinder head gasket must be installed toward intake port side of engine.

Fig. 33—Cylinder head tightening torque for liquid-cooled six studs per cylinder engine. Recommended tightening torque is 22-29 ft.-lbs. (3.0-4.0 kg-m).



mounting cap screws and turning belt adjusting screw (S—Fig. 36) either way as required.

**PISTONS, RINGS AND CYLINDERS.** Piston pins are fully floating. Piston rings are pinned in place and should be installed with identifying letter up. Piston ring end gap should not exceed 0.033 inch (0.84 mm) for 70 mm

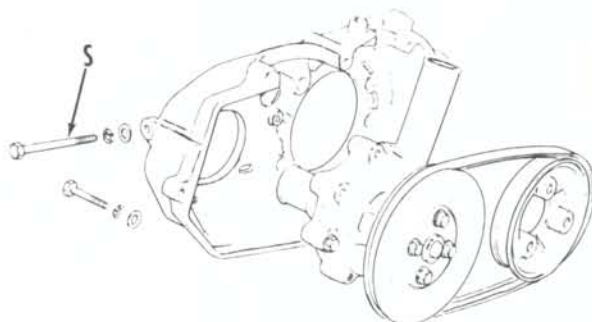


Fig. 34—Installing thermostat in liquid cooled engine.



Fig. 35—Installing outlet elbow.

Fig. 36—Screw (S) on rear side of magneto housing is used to adjust water pump tension after slackening the pump mounting cap screws.



piston or 0.031 inch (0.79 mm) for other sizes. Disassembly notches (N—Fig. 37) in pin bosses may be located at top or sides. Gap of pin retaining circlip should be located at bottom of pin boss when disassembly notch is at the top, and at top or bottom when disassembly notch is at sides.

Most pistons are marked with an arrow (A) on top of piston crown. Arrow should point toward exhaust side of engine when reassembling. If piston is not marked, ring locating pins (P) should be on intake side of the assembly. Piston to cylinder wall clearance should be 0.002-0.0025 inch (0.05-0.06 mm) with a

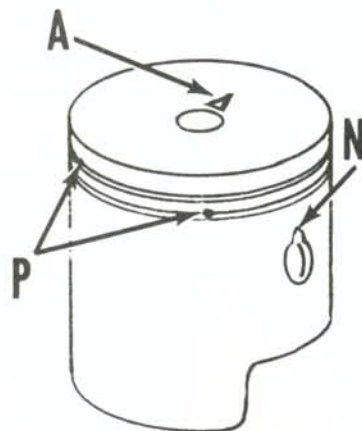


Fig. 37—View of typical Spirit piston. Arrow (A) on piston crown points to exhaust side of engine. Ring locating pins (P) are on intake side. Disassembly notches for piston pin retainers may be on top or sides of pin bore.

wear limit of 0.006 inch (0.15 mm) for all models.

Maximum allowable out-of-round, taper or barreling is 0.002 inch (0.05 mm). Minor imperfections in the cylinder can be removed with a 500 grit cylinder hone. Inspect threaded areas for damaged or stripped threads and gasket surfaces for warped areas or scratches. Check pistons for cracks in skirt areas or piston pin bosses. Use a piece of broken ring and carefully remove carbon from piston ring grooves. Because all engines use key-stone rings, a conventional ring groove tool cannot be used. Pistons and rings are available in standard size only.

**CRANKSHAFT AND CONNECTING ROD ASSEMBLIES.** Thoroughly wash crankshaft assembly in a mineral base solvent and inspect for external wear, scoring or scuffing. Rotate the bearings by hand to be sure they turn freely without binding or roughness.

Mount crankshaft assembly on "V" blocks and check runout at seal area as shown in Fig. 38. Runout should not exceed 0.002 inch (0.05 mm). Check radial clearance of connecting rod bearing using a dial indicator as shown in Fig. 39. Radial clearance should be within the limits of 0.0008-0.0012 inch (0.02-0.03 mm). If end play is excessive, if bearing is rough, or if other defects exist, affected parts should be renewed.

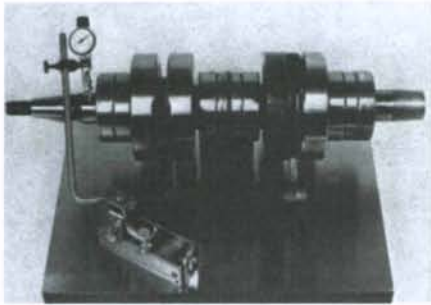


Fig. 38—Crankshaft runout should not exceed 0.002 inch (0.05 mm) when measured as shown.

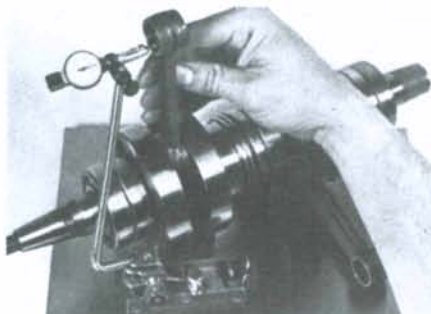


Fig. 39—Radial clearance of assembled connecting rod bearing should not exceed 0.0008-0.0012 inch (0.02-0.03 mm). Method of measurement is shown.

All crankshaft parts are available individually but shaft overhaul should not be attempted without proper equipment and a certain amount of experience.

**REED INLET VALVE.** Liquid-cooled engines are equipped with a two-reed induction plate instead of piston porting. Reed block assembly fastens to

Fig. 40—Exploded view of crankshaft, connecting rod and associated parts used on single cylinder engine.

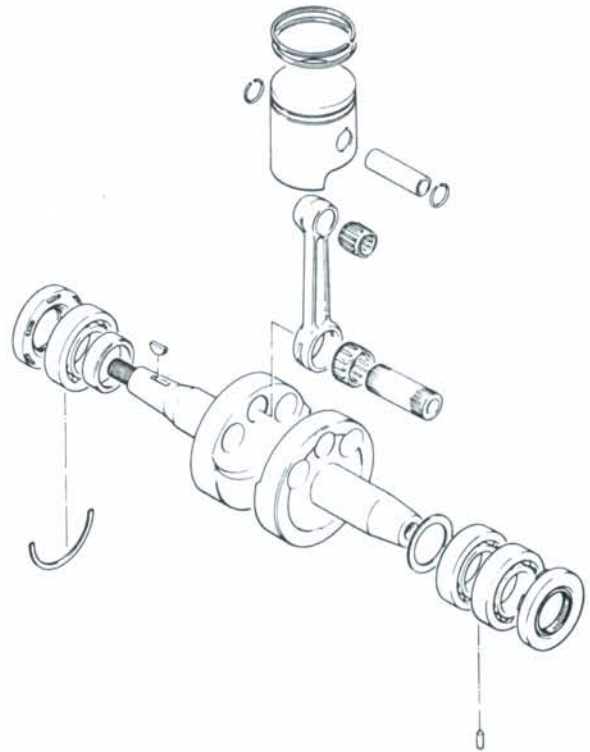
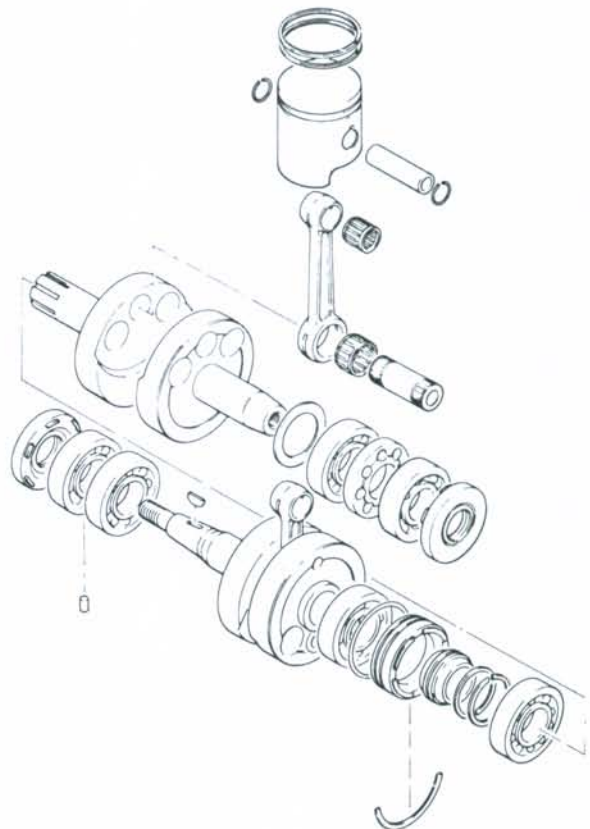
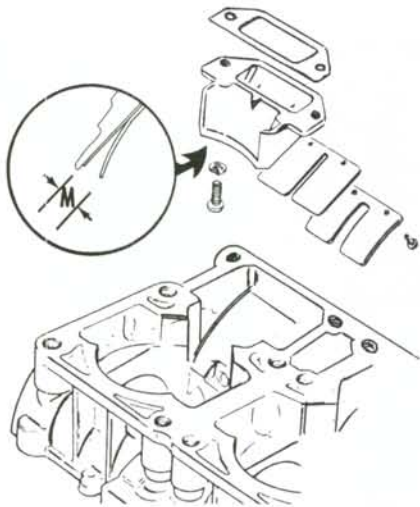


Fig. 41—Exploded view of crankshaft, connecting rod and associated parts used on twin cylinder engine.





**Fig. 42—Exploded view of intake reed valve and associated parts used on liquid-cooled engines. Measured height (M) of reed stop should be 0.362 inch (9.2 mm).**

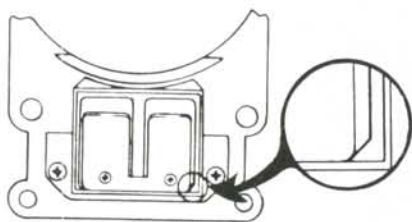
bottom of each cylinder block and can be removed after cylinder is off.

Reed leaves should lie flat against rubber seating surface of reed block throughout their entire length. Do not attempt to straighten a bent reed or bend a reed to modify performance. Rubber seating surface of reed block must not be excessively worn, cracked, flaked or chipped.

Reed stop must be uniform and properly arched. A bent or malformed stop can cause reed damage and improper engine operation. Measure the distance between outside edge of stop and seating surface of reed block as shown at (M—Fig. 42). Distance should measure 0.362 inch (9.2 mm). If measurement is incorrect, renew the reed stop.

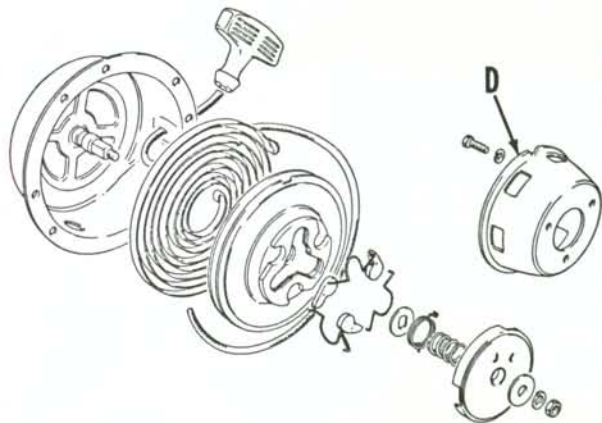
When assembling reed valve unit, put beveled corner of reed to lower right as shown in Fig. 43. Install reed retaining screws and block retaining screws with Loctite and tighten securely.

**RECOIL STARTER. 1981 Tiger Cat And All Other Models Prior to 1981.** If stator is being removed for service, first



**Fig. 43—Beveled locating corner of reed valve components should be installed at lower right as shown.**

**Fig. 44—Exploded view of recoil starter showing component parts. Drive (D) is bolted to engine flywheel and is not a part of removed assembly.**



raise the hood. Pull a small amount of slack into recoil rope and untie the knot securing pull handle; then allow rope to slowly retract into starter housing. Remove the four mounting cap screws and lift off starter unit.

To disassemble the removed starter, apply slight pressure to the drive plate and remove nut, lockwasher and flat washer from center stud. Lift off the drive plate, compression spring, return spring and compression spring seat. Remove the three pawl springs and pawls.

Carefully lift the rope pulley from housing, turning pulley clockwise as it is lifted, to unhook inner end of recoil spring from lug on pulley. Recoil spring should remain in starter housing well, when pulley is removed.

Recoil spring and rope can be renewed at this time. To install a new spring, refer to Fig. 44. Hook outer end of spring on lug in starter housing and wrap spring in a counterclockwise direction in spring well. Lubricate the spring and spring well with Lithium base grease.

Thread a new rope through hole in bottom of rope slot in pulley. Tie a knot in end of rope and pull tight; then while facing pawl side of pulley, wind the rope into pulley in a counterclockwise direction. Lubricate pulley hub with Lithium

base grease and install pulley, aligning inner hook of recoil spring with spring notch in pulley hub.

Install pawls and pawl springs as shown in Fig. 45. Install spring seat and compression spring. Install return spring with straight end down, then install drive plate making sure hooked upper end of return spring engages chevron slot in drive plate. Secure with flat washer, lockwasher and nut, tightening nut to 15 ft.-lbs. (20.4 N·m).

Thread outer end of rope through rope guide in housing and pull out approximately 50 cm (20 inch) of rope to reach through cowl then tie a temporary slip knot in rope. Turn rope pulley until notch in pulley rim aligns with rope guide in housing and, using a hooked wire, pull a loop of rope outside pulley rim. Continue to turn pulley in same direction for three more turns to preload the recoil spring. Pull on rope to check recoil tension and if insufficient, preload one more turn.

When installing starter, install the four mounting cap screws loosely, then pull on starter rope until starter pawls engage, then tighten mounting cap screws. Pull starter rope end through rope guide in cowl and install handle, then untie the temporary slip knot in rope.

**Fig. 45—Partially assembled starter with pawls and pawl springs installed.**

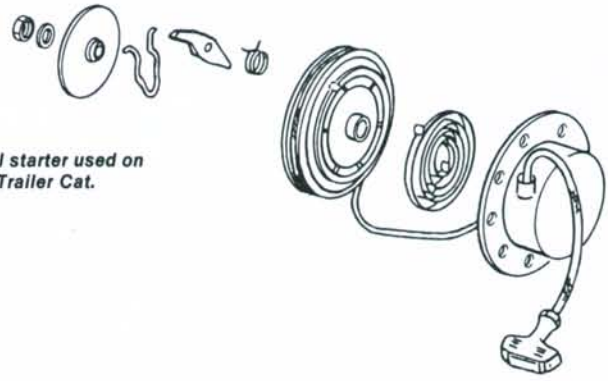


**1981-1984 Models Except Trail Cat.**

To disassemble the starter (Fig. 46), detach the starter handle and allow the rope to wind into the starter. Remove starter. Remove the starter shaft nut, drive plate, wire clip, pawl and pawl spring. Carefully remove the rope pulley. If necessary, remove rewind spring cover and spring while being careful not to allow spring to uncoil uncontrolled.

When assembling the starter note that the rewind spring must be installed so spring coils are wound in a counterclockwise direction from outer end. If so equipped, install decompression mechanism with springs in proper location. Wrap the starter rope around the rope pulley in a counterclockwise direction as viewed from pawl side of pulley. Leave approximately 50 cm (20 inch) of rope unwrapped. Install rope pulley, pass rope end through rope outlet and

**Fig. 46—Exploded view of recoil starter used on 1981-1984 models except Trailer Cat.**



install rope handle. Install the pawl spring and pawl with the long end of the spring inserted into the rope pulley and the short end against the backside of the pawl. Install pawl so narrow end points in a clockwise direction. Install wire clip,

drive plate and nut; closed end of wire clip must be adjacent to wide end of pawl. Pull rope into notch in pulley and rotate pulley four turns clockwise to preload rewind spring. Check starter operation then install starter on engine.

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