1976
Scorpion
Lil Whip

Service Manual

Engine Section

ENGINE SYSTEM

Functional Description:

2-CYCLE ENGINE FUNDAMENTALS

The Cuyuna 2-cycle air-cooled gasoline engine, particularly the axial fan-cooled twin cylinder engine, has become very popular today for snowmobiles. It is uniquely qualified for this application because of its high power output, light weight and ease of lubrication, with fewer moving parts than other conventional 2-cycle and 4-cycle engines.

However, in order to get the best possible use and ensure that it retains its high degree of dependability and endurance, it must receive proper care and maintenance. Therefore, it is necessary for us to know something about the basic fundamentals of this engine and how it functions.

OPERATION

The Cuyuna 2-cycle Twin Cylinder engine is of the loop-scavenged third port type, the most widely used design today. It uses a mixture of gasoline, oil and air for combustion, lubrication and cooling. It fires on every stroke of each piston. There are two power strokes for every revolution of the crankshaft.

As the piston moves upward in the cylinder it draws the fuel/air mixture into the crankcase through the intake manifold while at the same time compressing fuel that has been forced into the combustion chamber. See Fig. 1-1A.

As the piston nears top dead center the spark plug is fired and the compressed fuel/air mixture burns and expands thereby forcing the piston downward on a power stroke.

As the downward stroke of the piston turns the crankshaft, it also starts to compress the fuel/air mixture in the crankcase and, simultaneously, opens the exhaust port and closes the intake port. See Figs. 1-1 B & C.

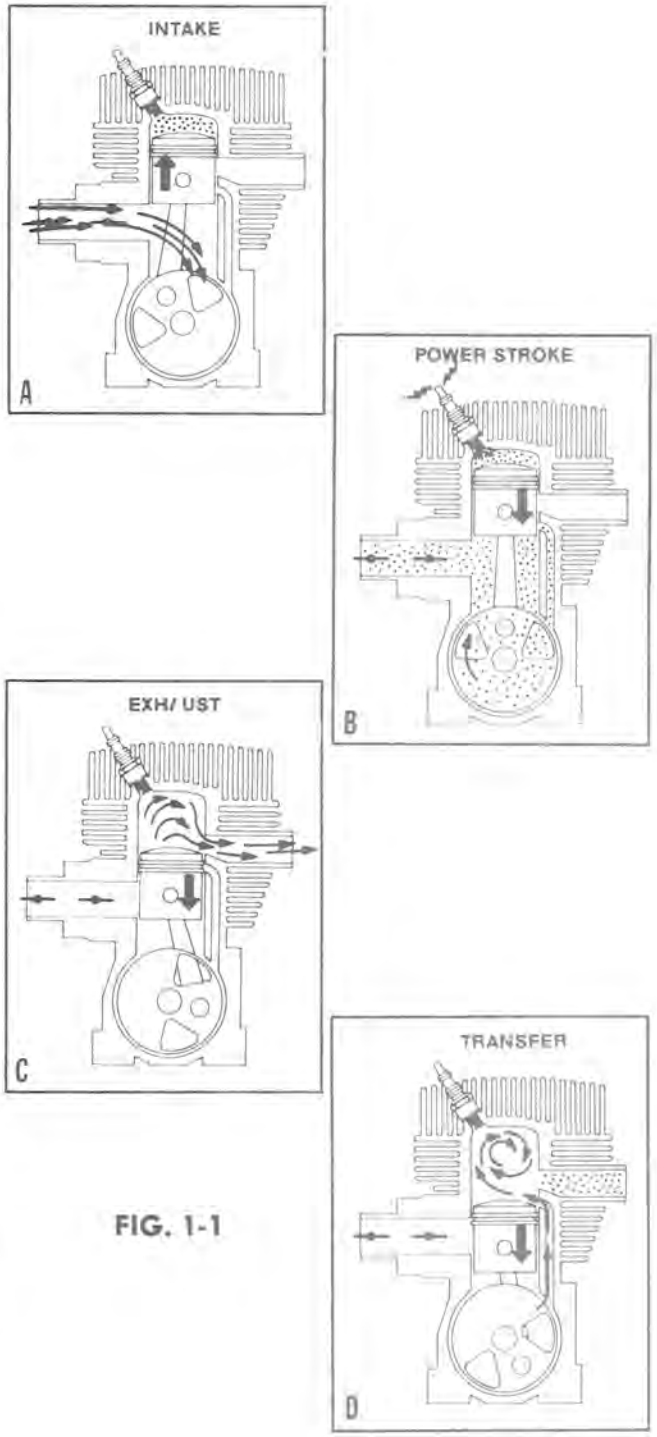


FIG. 1-1

After the exhaust port is fully open and the intake port is fully closed, further piston travel starts to open the transfer ports. The compressed fuel/air mixture from the crankcase then travels up the transfer ports and into the combustion area.

After most of the burned exhaust gases have left the cylinder, an incoming charge of fuel/air mixture scavenges the combustion area giving it a fresh charge and the cycle is then repeated. See Fig. 1-1 D.

Because lubrication is dependent on the mixing of oil and fuel, it is extremely important that good quality oil and gasoline are properly mixed. The proper ratio of oil to gasoline will prevent possible engine overheating, piston or cylinder scoring, or eventual engine seizure. Too much oil and not enough gasoline can lead to incomplete combustion, fouled plugs, carbon build-up and muffler clogging.

EXHAUST SYSTEMS

SELECTION

Selection of an exhaust system (including exhaust manifold, intermediate pipes, elbows and muffler), is a result of thorough test procedures involving measurement of fuel consumption, horsepower and noise level. Contrary to popular belief, the exhaust system is not only for quieting the engine, but also serves to increase horsepower output. Changes made to the original equipment exhaust system by changing any component in the system can result in loss of power and/or severe engine damage. For these reasons, intermediate lengths of pipe between the cylinder and the muffler are particularly critical.

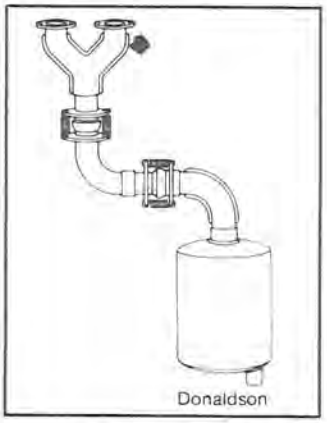


FIG. 1-2

TUNED MUFFLERS

Tuned mufflers allow the engine to exhaust its spent charge into an adequate volume and properly matched muffling system. More important, the mufflers that are tuned incorporate designs that suck the exhaust gas from the cylinder allowing fuel and air to rapidly replace it and also "cram" over-scavenged fuel and air mixture from the exhaust pipe back into the cylinder using sound waves and sound energy. This is accomplished at the speed of sound which allows the engine to produce higher torque at higher RPMs.

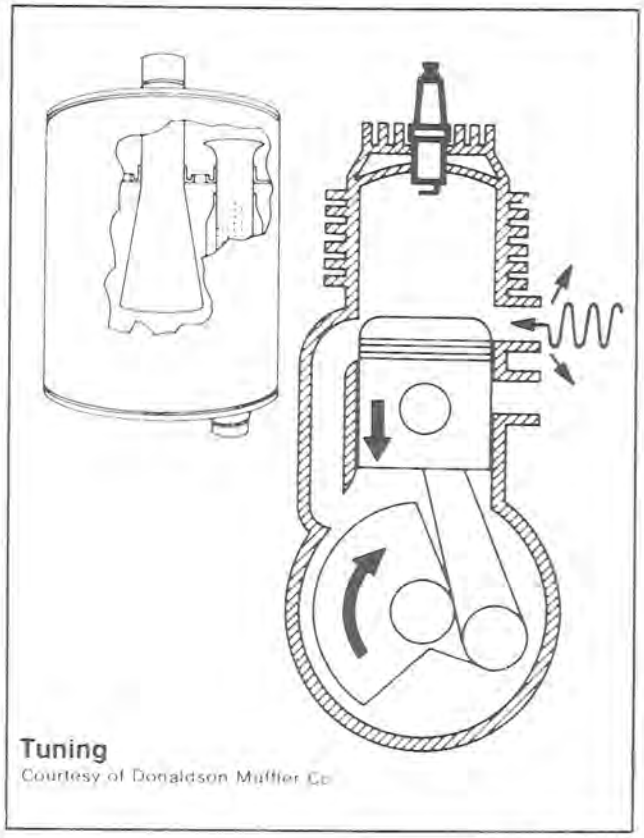


FIG. 1-3

HOW TUNING WORKS

The megaphone effect of the expanded intake tube scavenges exhaust gas from the cylinder allowing rapid replacement of the fuel/air mixture from the crankcase. Reflected sound waves and sound energy stop over-scavenging and return fuel/air mixture to the cylinder. It gives a supercharging effect even though it operates from the exhaust rather than the intake side. Over-scavenging is also retarded by moderate muffler back pressure. Silencing is accomplished after power is maximized by acoustical packing in the resonator outlet tube plus chambering and baffling which gives an effective 2-pass muffler design.

TABLE OF SPECIFICATIONS

DESCRIPTION	ENGINE MODEL		
		2F 295-2	
BORE		2.190 (55.6mm)	
STROKE	2.362" (60mm)		
DISPLACEMENT IN cc		294	
COMPRESSION RATIO (actual)		12:1	
IGNITION SYSTEM	Bosch Flywheel Magneto		
LIGHTING COIL VOLTAGE AND OUTPUT		12V 150W	
*TIMING BEFORE TDC (CENTRIFUGAL WEIGHT ADVANCED)		.102 - .112	
TIMING BEFORE TDC (CENTRIFUGAL WEIGHT RETARDED)		.018" to .020"	
BREAKER POINT GAP	.014" to .016"		
SPARK PLUG THREAD	14mm. x 1.25 - 3/4" reach		
SPARK PLUG GAP		.020" (0.5mm.)	
SPARK PLUG-BOSCH (ORIGINAL EQUIPMENT)		W260T2	
TYPE OF ENGINE COOLING	Axial Flow Fan		
ROTATION OF CRANKSHAFT	Counterclockwise (PTO side)		
CARBURETOR	Walbro		
FUEL/OIL RATIO	As Specified on Scorpion Cuyuna Oil Container		
GASOLINE	95 octane, minimum (lead free not acceptable)		
TYPE OF OIL	Special 2-Cycle Snowmobile Oil		

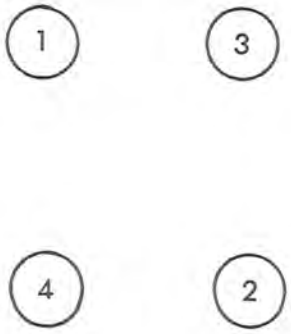
* Do not exceed indicated advance, as this will result in severe engine damage.

TABLE OF SPECIFICATIONS

TORQUE SPECIFICATIONS	2F 295-2
CYLINDER HEAD NUTS	28-32 Ft.-Lb.
CYLINDER BASE NUTS	16-18 Ft. - Lbs.
FLYWHEEL NUT	56-72 Ft. - Lbs.
INTAKE MANIFOLD NUTS	16-18 Ft. - Lbs.
FAN HOUSING SCREWS	16-18 Ft. - Lbs.
FAN WHEEL NUT	22-24 Ft. - Lbs.

Tightening Sequence for Cylinder Base Nuts
All Models

Tightening Sequence for:
Cylinder Head Nuts, Fan Housing, Intake Manifold
and Recoil Starter Clamps



'75
290

CUYUNA TWIN CYLINDER ENGINES

MODEL 2F-295-2

DISASSEMBLY

A. Recoil Starter

Remove four (4) screws holding the recoil assembly to the fan housing.

See Fig. 1-4.

See pages 1-28 A, B, C for recoil starter disassembly.

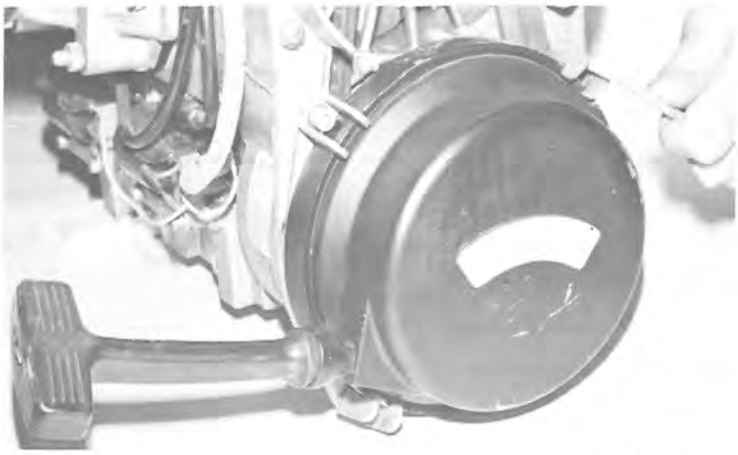


FIG. 1-4

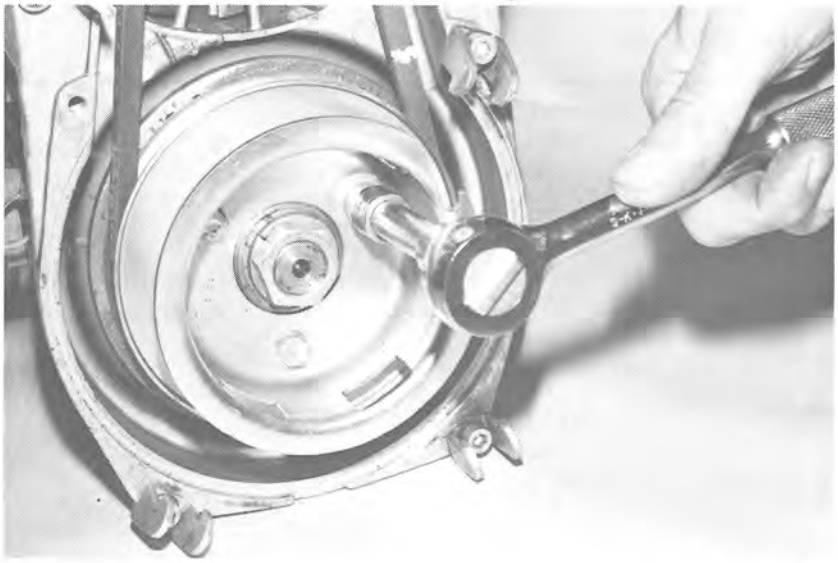


FIG. 1-5

B. Lower Fan Pulley and Carrier Assembly

Remove the three (3) hex head bolts on the carrier. Remove carrier, lower pulley assembly and V-belt. See Figs. 1-5, 1-6.

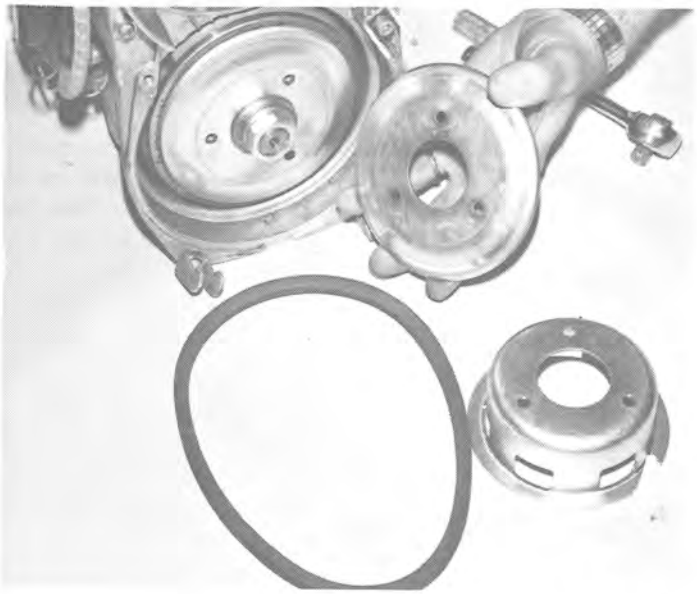


FIG. 1-6

C. Upper Fan Belt Pulley Assembly.

Insert a 3/16" drill or a suitable punch through the indexing hole into the impeller body. With a 17 mm socket wrench, remove the fan nut, lock washer, pulley halves and spacers. See Figs. 1-7, 1-8, 1-9.

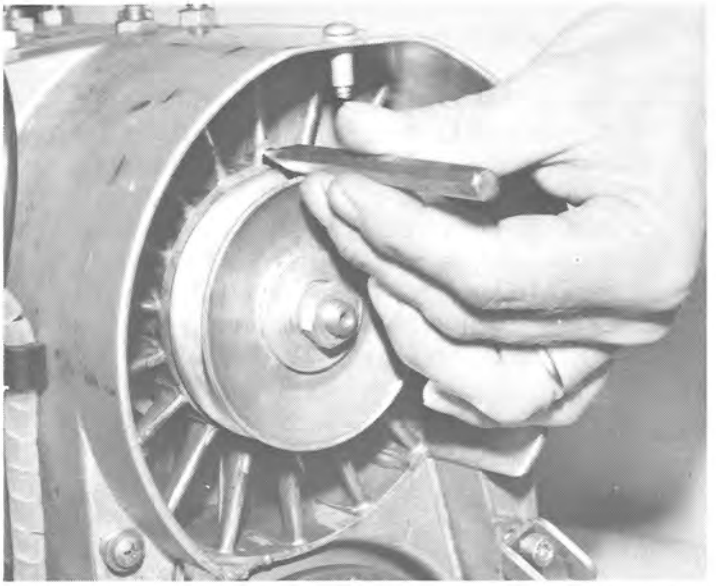


FIG. 1-7

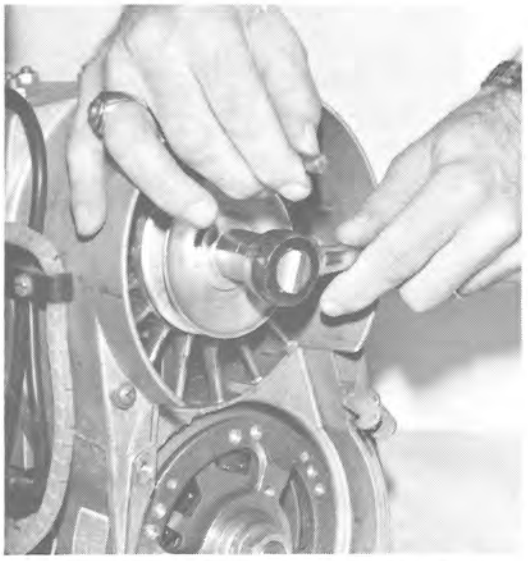


FIG. 1-8

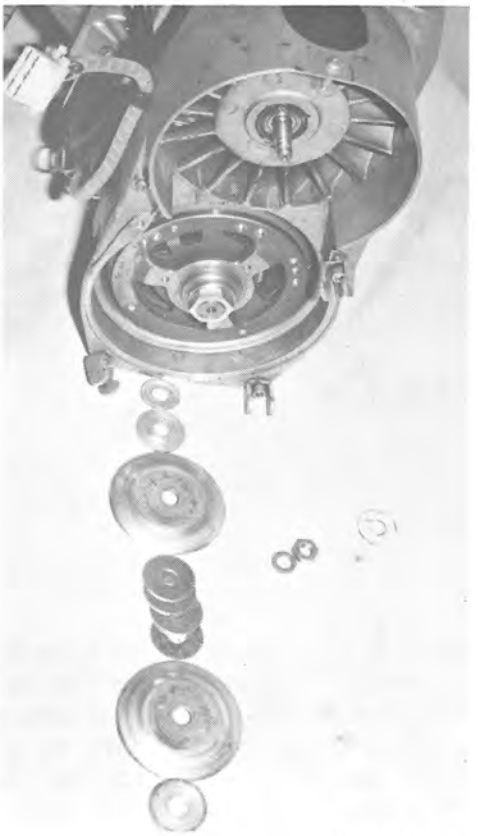


FIG. 1-9

D. Flywheel Magneto

Remove the crankshaft nut using a 27 mm socket wrench. Pull the flywheel by attaching flywheel puller 444-31-843-2 to the flywheel flange using bolts provided. Screw the three bolts through the puller into the flange and tighten evenly. With a socket wrench, tighten the puller bolt until the flywheel loosens on the crankshaft. See Figs. 1-10, 1-11, 1-12, 1-13.

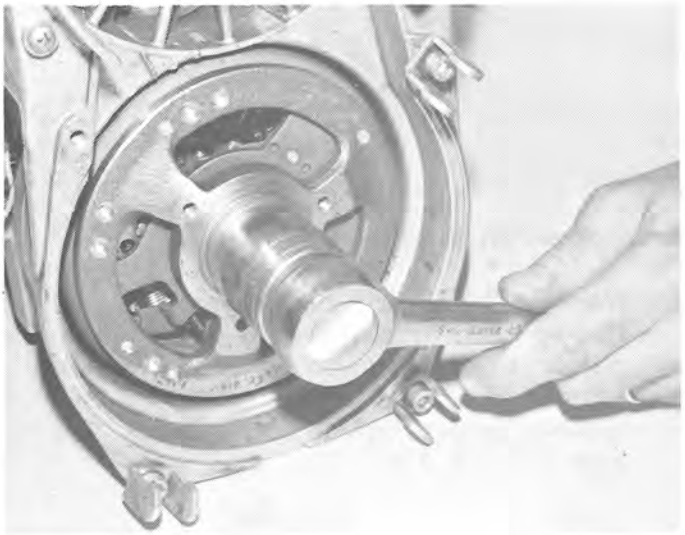


FIG. 1-10

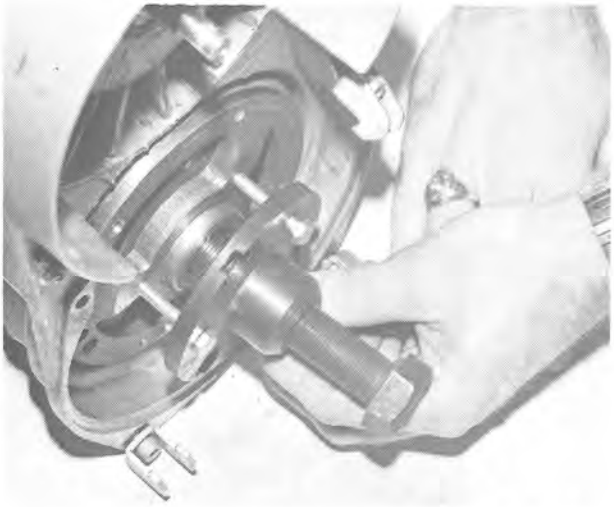


FIG. 1-11

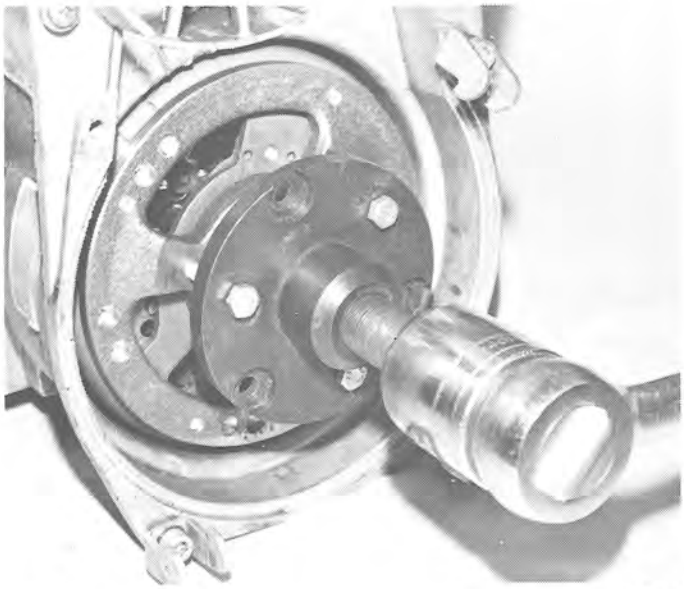


FIG. 1-12

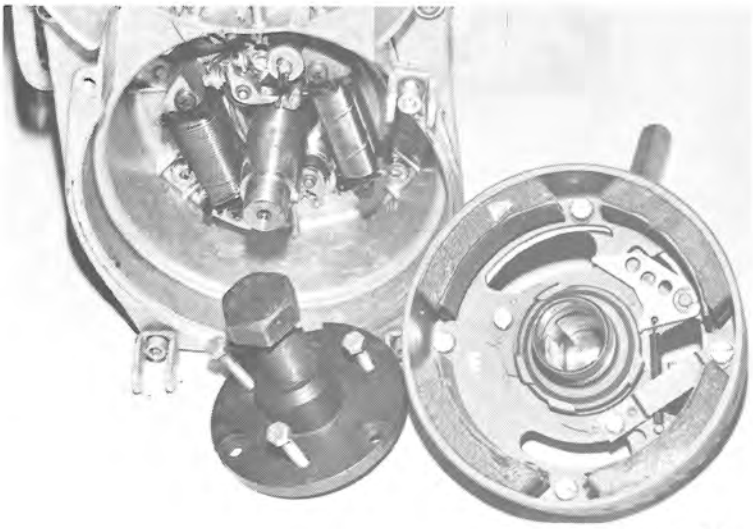


FIG. 1-13

NOTE: It is important that care is taken to remove the positioning key in crankshaft before attempting to remove the flywheel assembly. Failure to do this could result in damage to advance mechanism.

E. Intake Manifold Assembly

Remove the four (4) intake manifold nuts and washers. Remove manifold assembly and insulators. See Fig. 1-14.

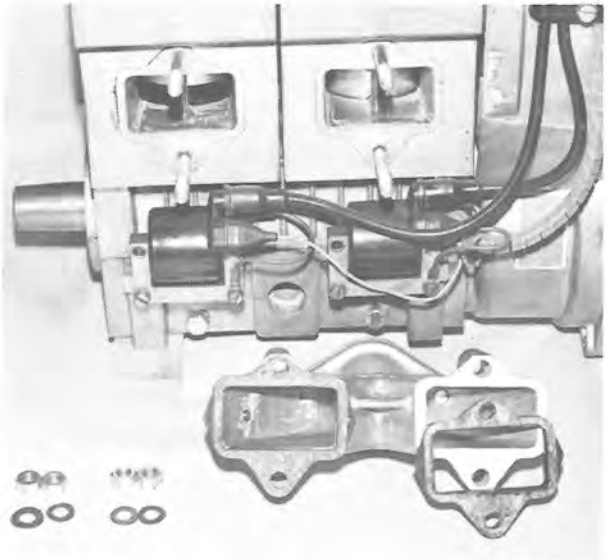


FIG. 1-14

F. Fan Housing and Armature Plate Assembly

Remove screw holding spark plug wire bracket to fan housing. With a socket type 5 mm Allen wrench and impact driver, remove the four (4) mounting bolts holding fan housing to crankcase. (See Fig. 1-15). Remove fan housing from crankcase (See Fig. 1-16).

FIG. 1-15

Unplug connector housing coil wires. (Note color coding of wires.) Remove armature plate assembly and wires, as a unit, from fan housing.

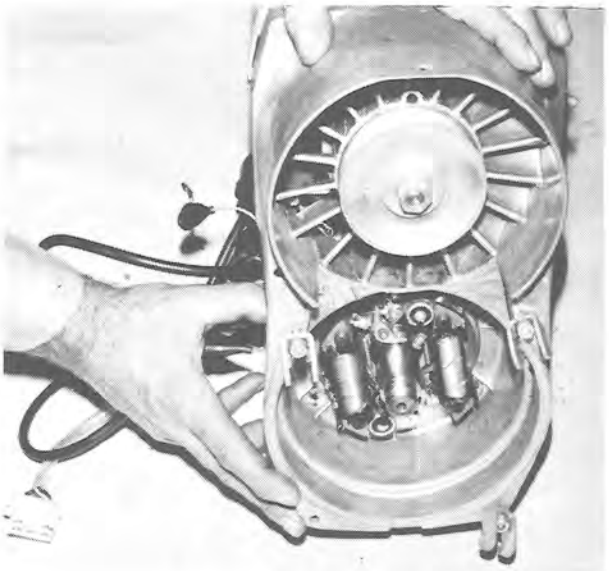


FIG. 1-16

Remove the fan by tapping the end of fan shaft with a soft hammer. With a flat punch and hammer, tap the inner race of the furthest bearing in the housing. See Figs. 1-17, 1-18, 1-19.

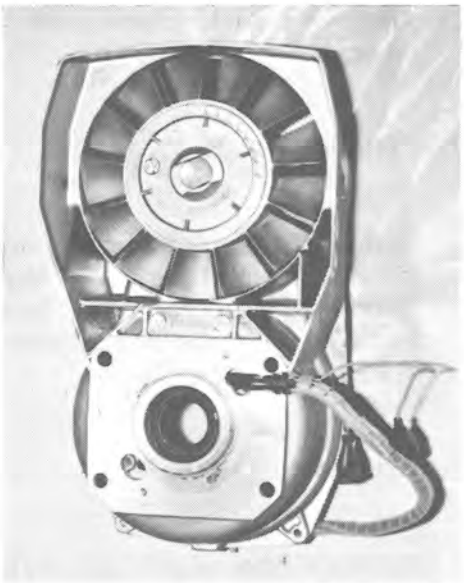


FIG. 1-17

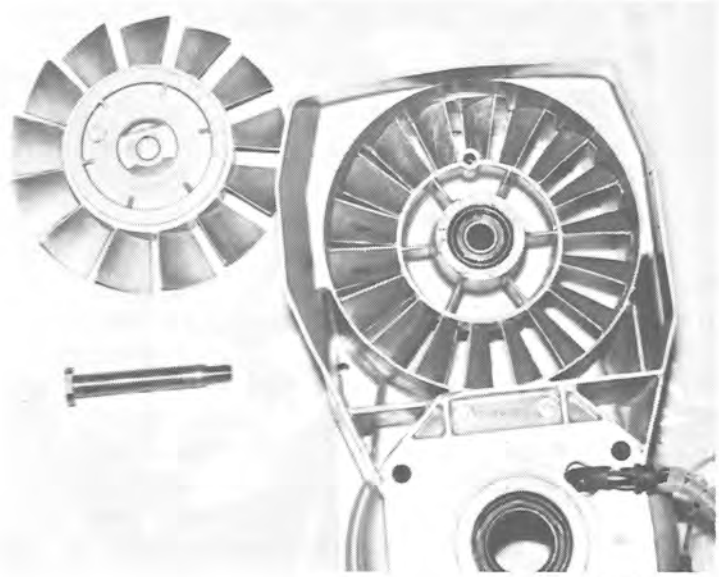


FIG. 1-18

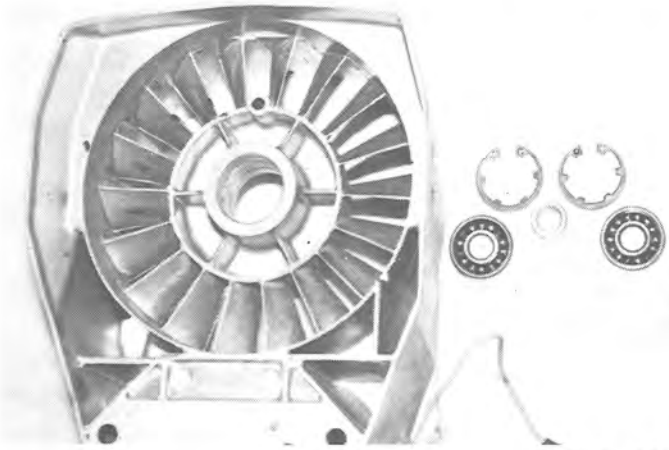


FIG. 1-19

G. Remove spark plugs with spark plug wrench.

H. Cylinder Heads

Remove cylinder head nuts with a 17 mm socket wrench. Mark cylinder heads before removal from cylinder. Remove and discard gaskets. See Fig. 1-20.

I. Cylinders

Remove the eight (8) cylinder base nuts using a 13 mm socket wrench and remove the eight (8) spring washers. The cylinders may be removed. See Fig. 1-21.

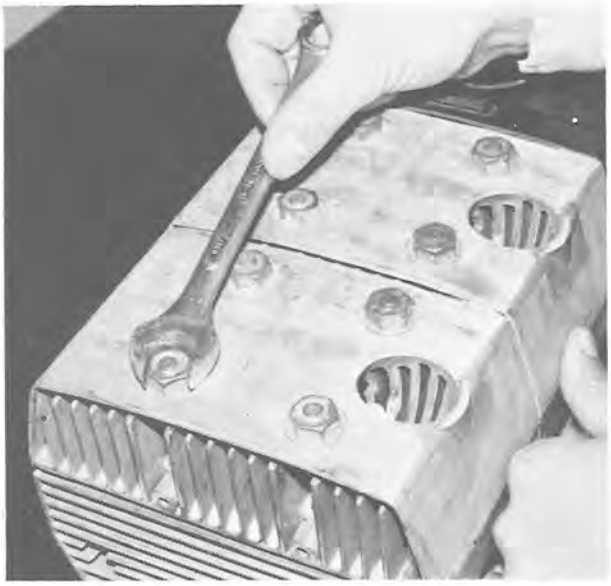


FIG. 1-20

NOTE: IMPORTANT

If removal of cylinders only is required, care must be taken that the crankcase seal is not disturbed. The removal of the PTO cylinder will allow the placement of two bolts and nuts with flat washers to apply constant pressure to crankcase assembly. Bolts should be placed in the center two holes (adjacent to the fan side cylinder). See Fig. 1-29. The second cylinder may now be removed.

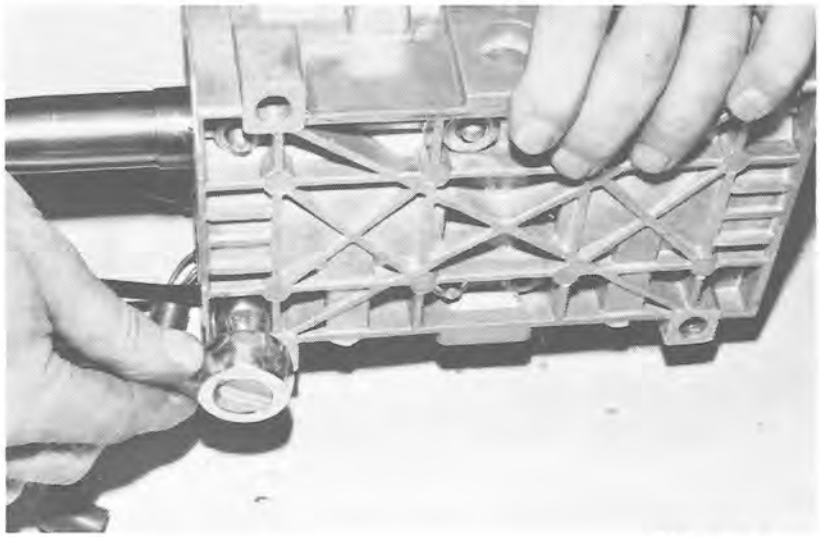


FIG. 1-21

J. Piston and Wrist Pin

With needle nose pliers, remove circlips from pistons. Heat the piston with a heat gun or propane torch. Heat only to the point where piston may still be held in hand. Push the pin out.

K. To separate the crankcase halves, hold upper portion of crankcase assembly in one hand, lifting slightly and tap the end of the crankcase with a soft hammer. The crankcase will separate and the crankcase may be removed. See Fig. 1-22.

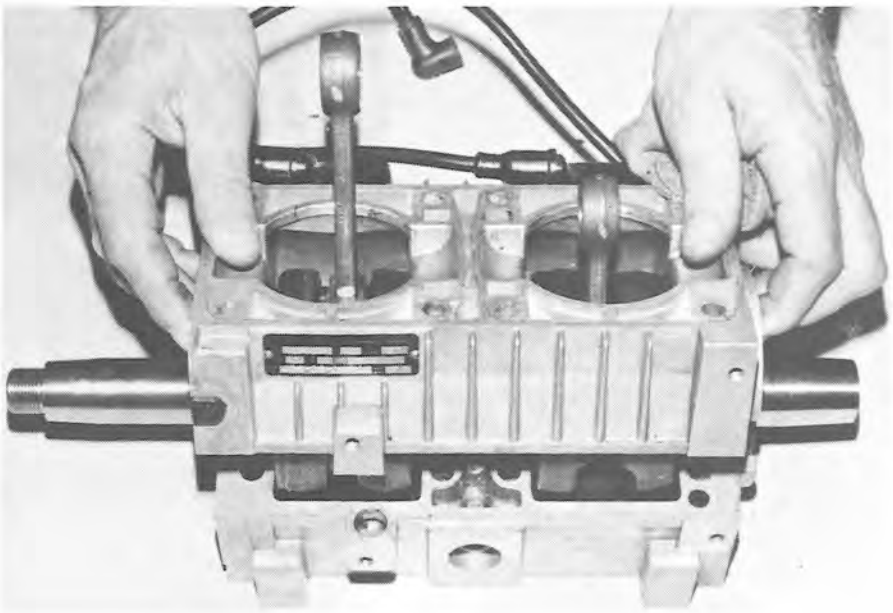


FIG. 1-22

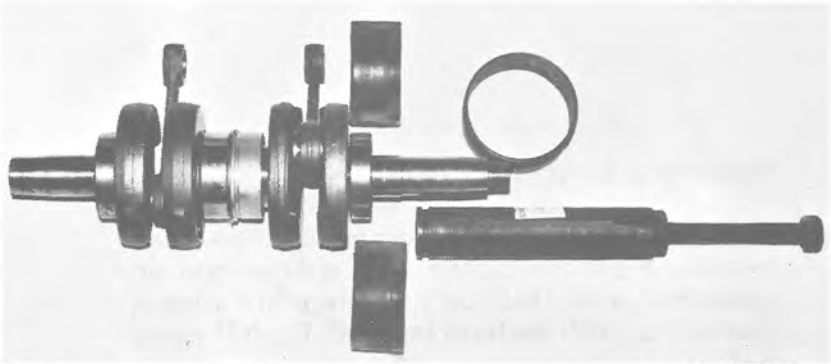


FIG. 1-23

L. Crankshaft Bearings

To remove crankshaft end bearings, use bearing puller 444-31-807-0. See Figs. 1-23, 1-24, 1-25. Slip the puller half shells around the outer bearing race and around puller assembly. Slide the retaining ring over the half shells. Using two (2) 27 mm wrenches, turn the center bolt clockwise with one wrench and use the second wrench to hold the puller body. Before removing the PTO side crankshaft bearing, insert a 1/2" 20 UNF bolt, 1/2" long, to protect the internal thread of the crankshaft.

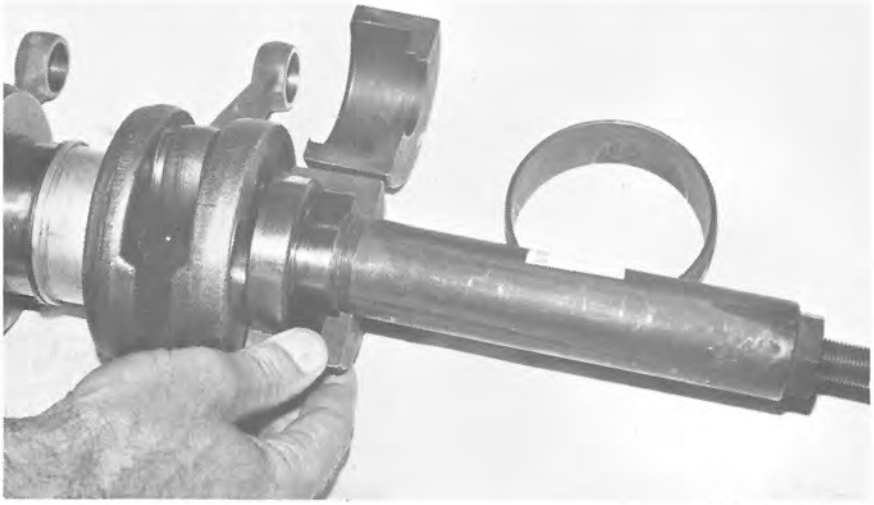


FIG. 1-24

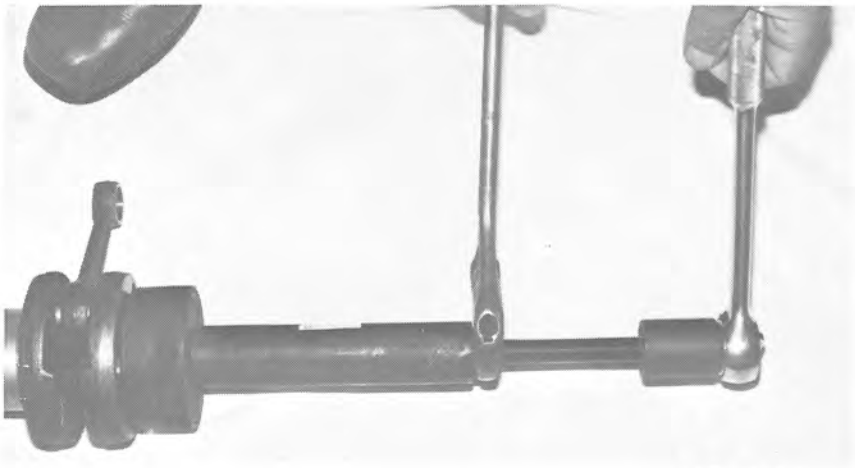


FIG. 1-25

ASSEMBLY

A. Crankshaft Bearings.

Heat crankshaft bearings in oil (or oven) to approximately 180 degrees.

Slide bearing on crankshaft.

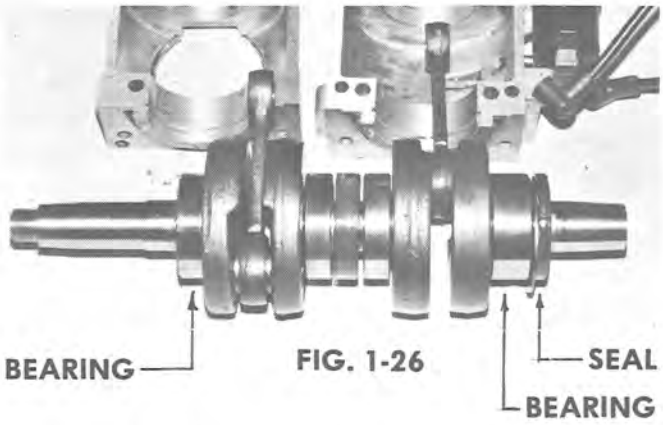


FIG. 1-26

B. Crankcase.

Inspect and clean both halves of crankcase. The proper sealant material such as Permatex Hy-Tack Spray should be now sprayed on crankcase sealing surfaces. See Fig. 1-27. Before installing crankshaft into crankcase lower half of it will be necessary that all bearing outer surfaces be wiped clean of foreign material so that proper sealing will occur. After installing PTO thrust washer and oil seal (inside groove of oil seal coated with light grease) place the crankshaft carefully into the lower crankcase half and properly position all componenets. See Figs. 1-28. Placement of the upper crankcase half may now be made. Be certain that the center seal is lined up with the crankcase split line.

Tap upper crankcase half to seat with lower half.

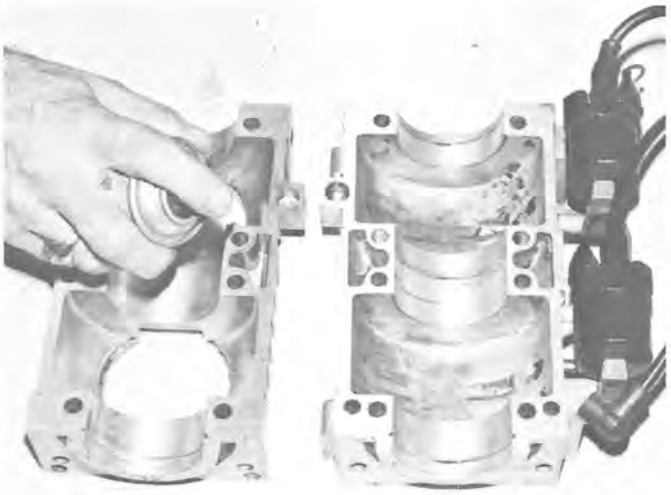


FIG. 1-27

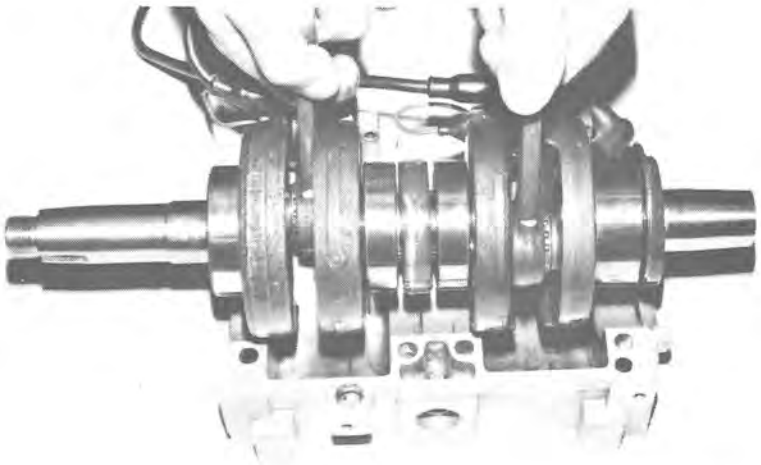


FIG. 1-28

Install two crankcase holding bolts in the center holes of the PTO side of crankcase. (Fig. 1-29) Tighten finger tight.

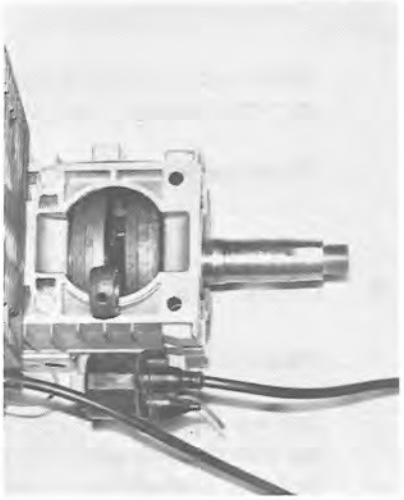


FIG. 1-29

C. Piston, Cylinder and Cylinder Heads

The pistons must be clean and free from carbon deposits and the piston rings must fit freely in their grooves. Rings are marked for proper side up. The arrow on the crown of pistons must point toward **exhaust side** of engine. Piston pins, needle bearings, check plates and circlips may now be installed, according to the procedure below. (Always use new circlips.) See Figs. 1-30, 1-31, 1-32, 1-33).

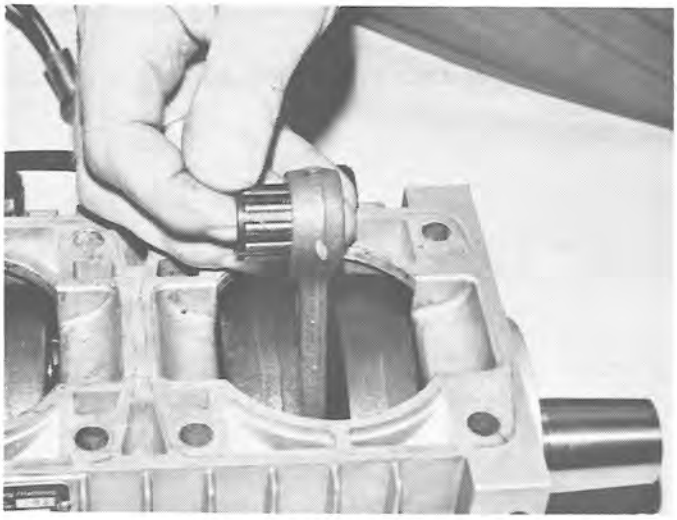


FIG. 1-30

CIRCLIP OPENING HERE

FIG. 1-31

1. Oil the piston pin end bearings.

2. Install one circlip in piston.

3. Heat the piston sufficiently to allow pin to push into piston and install pin.

4. Install second circlip. (See Fig. 1-31 for correct orientation of circlips.)

FIG. 1-32

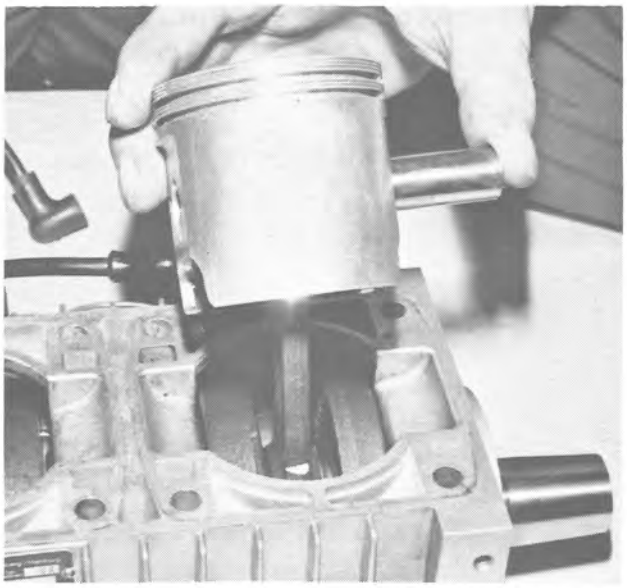


FIG. 1-33

Install base gaskets on the cylinder studs and position against the cylinder flanges (see Fig. 1-34). With the use of a ring compressor, lower cylinders one at a time over the pistons. Install base washers and nuts finger tight. See Fig. 1-35, 1-36.

Temporarily install the intake manifold without gaskets and tighten manifold nuts to sixteen (16) to eighteen (18) foot pounds. See Fig. 1-37. Cylinder base nuts may now be torqued to sixteen (16) to eighteen (18) foot pounds as outlined on specification page. The proper piston height can be measured at the top of the cylinder. The edge of the crown of the piston must not protrude above the top of the cylinder with the piston in the top dead center position. If the piston does protrude above the cylinder, a thicker base gasket must be used. See specification page for dimensions and color coding. It is important that only one cylinder at a time be adjusted or the crankcase will separate and lose it's seal.

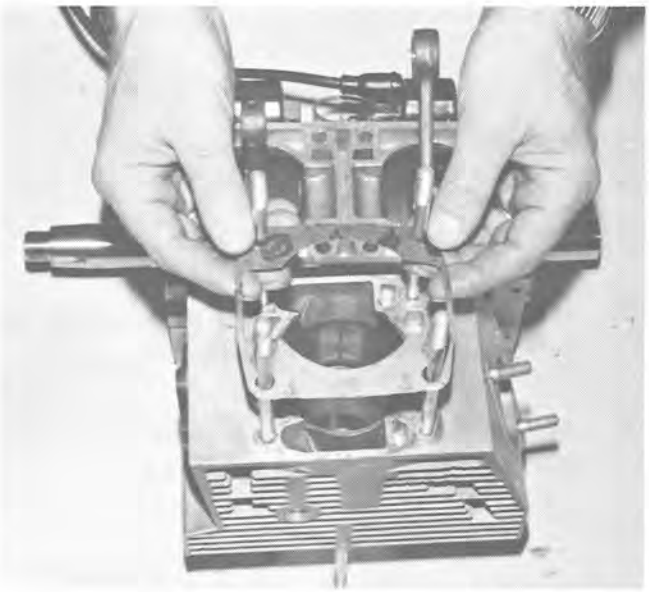


FIG. 1-34

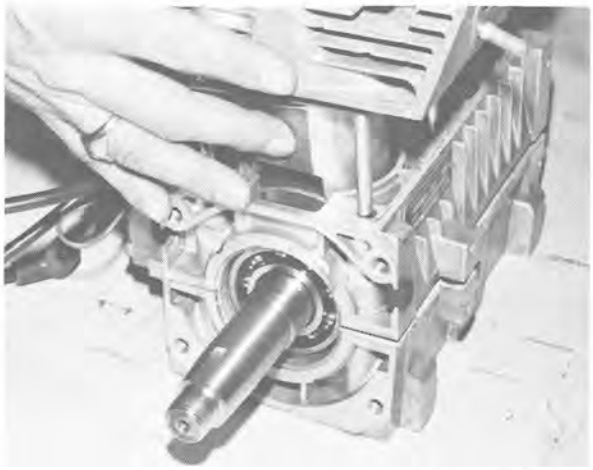


FIG. 1-35

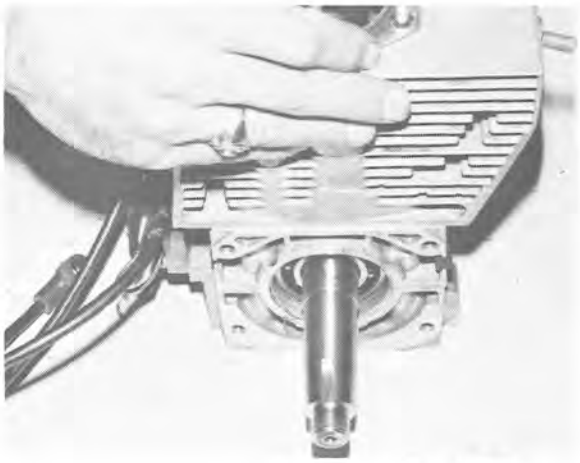


FIG. 1-36

Oil cylinders and pistons before installing cylinder heads. Install head gaskets with the wide side of inner metal flange of the gaskets **up** toward the cylinder heads. Torque cylinder head nuts to twenty-eight (28) to thirty-two (32) foot pounds.

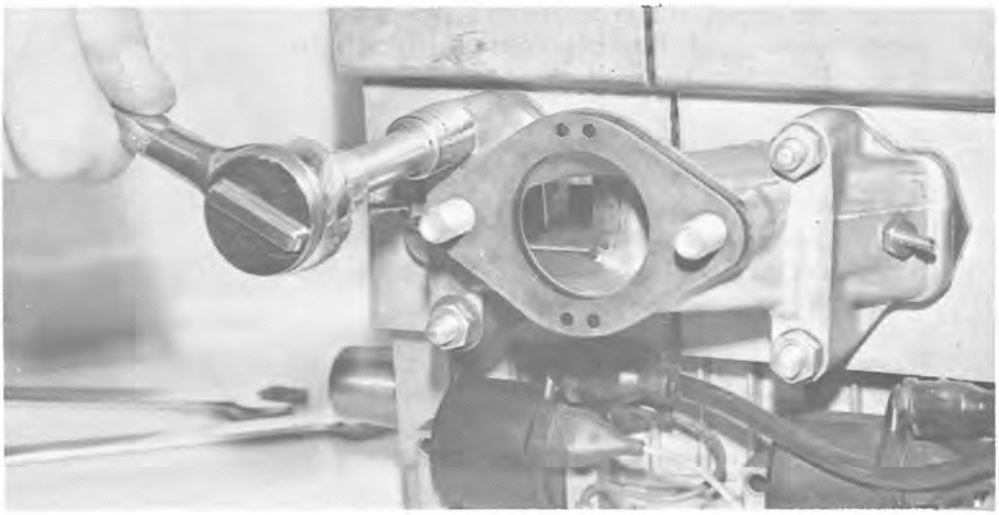


FIG. 1-37

D. Fan Housing and Impeller Bearings

Clean fan shaft hub. Install circlips and spacer. Use grease to hold spacer in place. Pack bearings in medium grease into housing with sealed surface outward. See Figs. 1-18, 1-19. Install fan and shaft.

E. Fan Housing and Armature Plate.

Install new seal in fan housing. Lubricate the inner groove of the oil seal with a light grease. See Fig. 1-38.

Install new o-ring and apply sealant material around o-ring surface (see Fig. 1-41). Install the armature plate wires through hole in fan housing and install armature plate with hold down screws, washers, and lockwashers. See Fig. 1-39.

Place fan housing assembly over crankshaft and position to crankcase assembly. Install the four Allen head screws and lockwashers and tighten evenly until fan housing is against crankcase assembly. See Fig. 1-40.

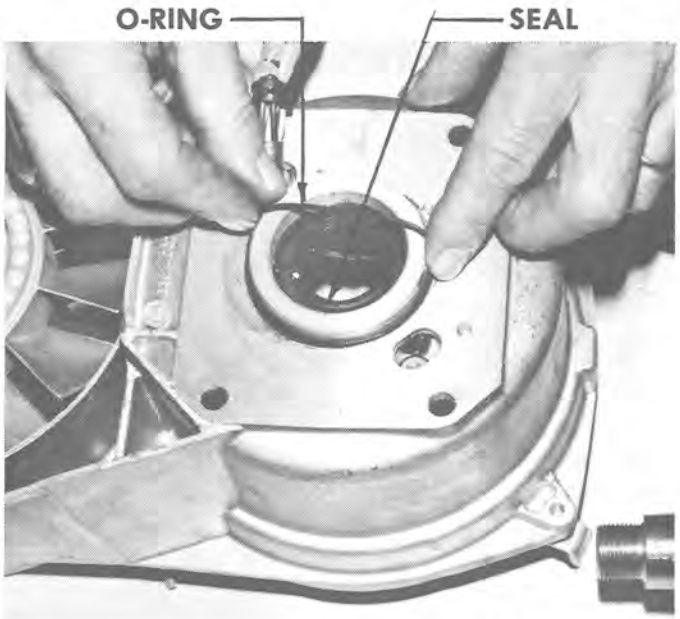


FIG. 1-38

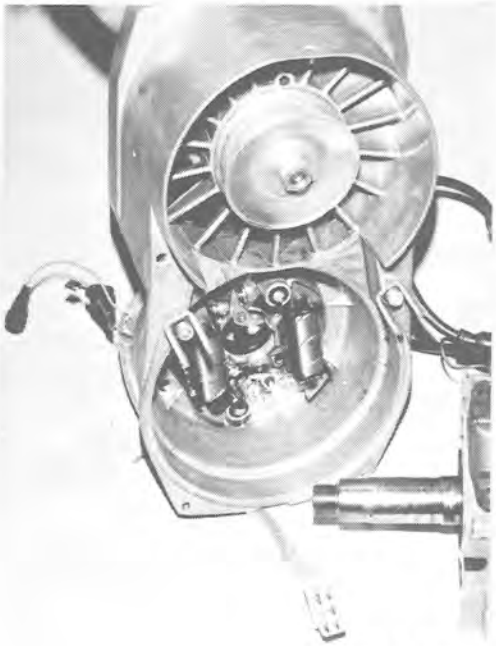


FIG. 1-39

FIG. 1-40

Torque to sixteen (16) to eighteen (18) foot pounds. Connect ignition wires to external ignition coil and to connector housing. Check ground wires for proper position. Install ignition cable bracket to fan housing.

F. Intake Manifold

Install spacers, gaskets and intake manifold (Fig. 1-41). Torque nuts evenly to sixteen (16) to (18) foot pounds.

G. Upper Fan Pulley Assembly

Install the tapered washer. Install pulley half, shims, second pulley half, tapered washer, lock washer and nut. Use 3/16" drill bit or punch to hold fan assembly and tighten nut. See Fig. 1-42.

H. Flywheel Assembly

Check advance mechanism for free operation, lubricate inside cam surface (Grooved area). Slide assembly over crankshaft and align key ways.

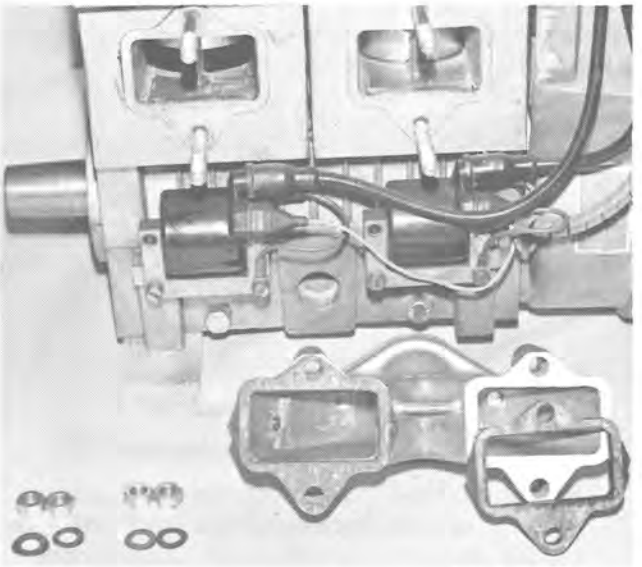


FIG. 1-41

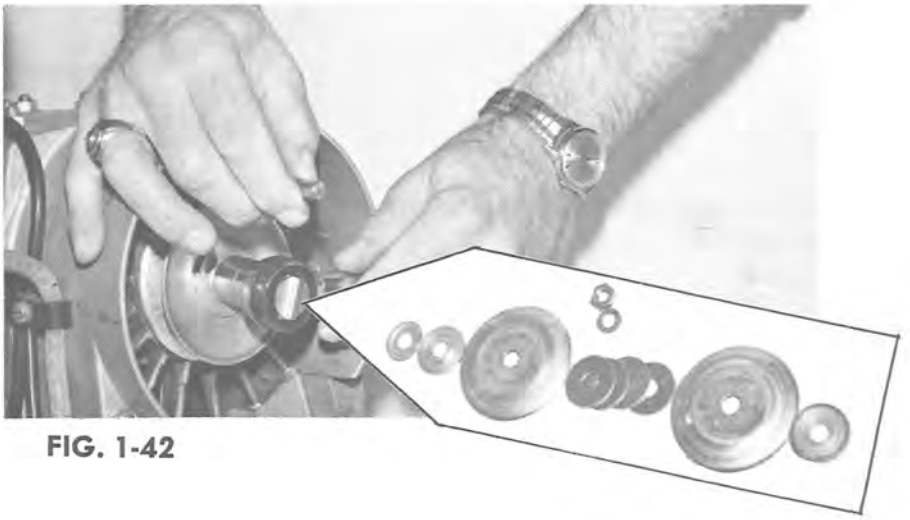


FIG. 1-42

Install key, lockwasher and nut in that order. Tighten securely. See Fig. 1-43. Follow Timing Procedure Section as next step.

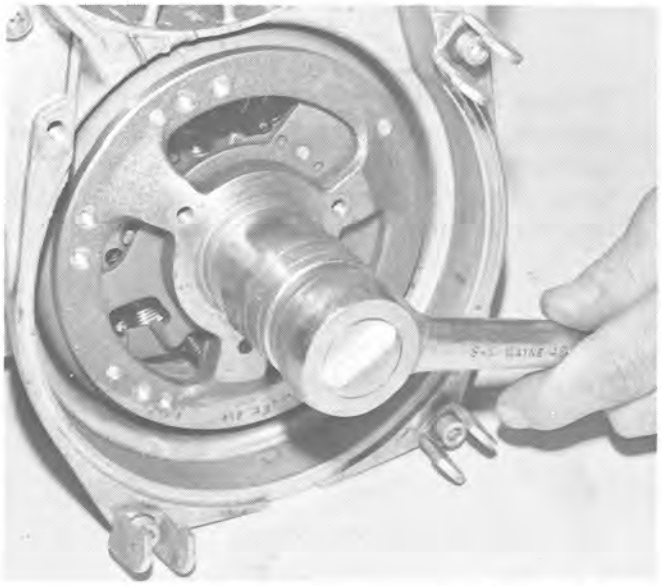


FIG. 1-43

I. Lower Fan Pulley Assembly

Install pulley half, belt, second pulley half, recoil carrier, lockwashers and bolts evenly while rotating crankshaft. The proper belt deflection should be 1/8" on each side. Proper adjustment can be made by adding or removing shims between upper pulley halves. See Fig. 1-44.

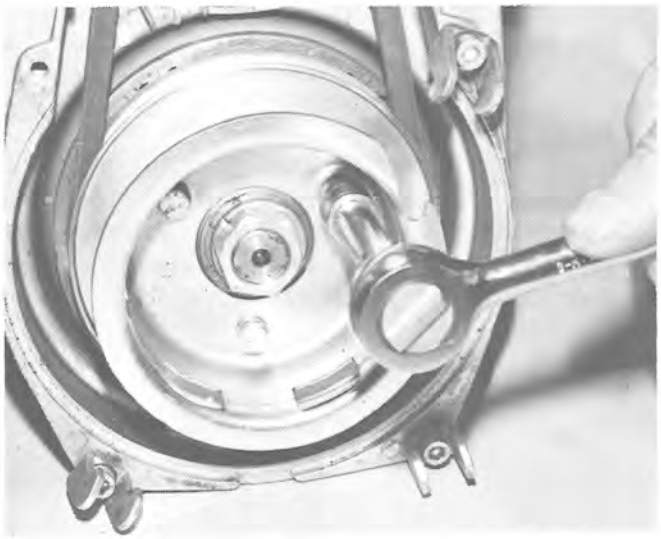


FIG. 1-44

J. Recoil Starter

Install the recoil starter assembly and tighten securely. See Fig. 1-45.

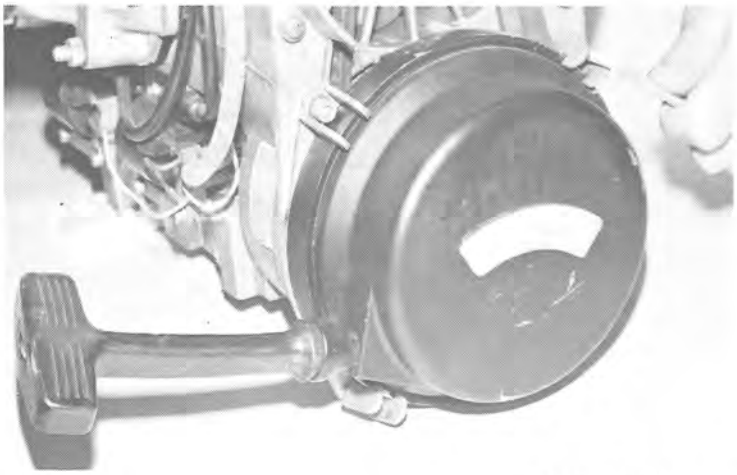


FIG. 1-45

Torque to sixteen (16) to eighteen (18) foot pounds. Connect ignition wires to external ignition coil and to connector housing. Check ground wires for proper position. Install ignition cable bracket to fan housing.

F. Intake Manifold

Install spacers, gaskets and intake manifold (Fig. 1-41). Torque nuts evenly to sixteen (16) to (18) foot pounds.

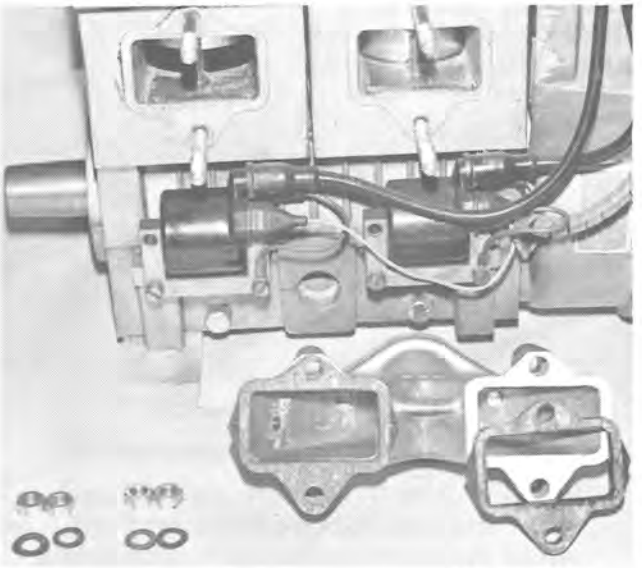


FIG. 1-41

G. Upper Fan Pulley Assembly

Install the tapered washer. Install pulley half, shims, second pulley half, tapered washer, lock washer and nut. Use 3/16" drill bit or punch to hold fan assembly and tighten nut. See Fig. 1-42.

H. Flywheel Assembly

Check advance mechanism for free operation, lubricate inside cam surface (Grooved area). Slide assembly over crankshaft and align key ways.

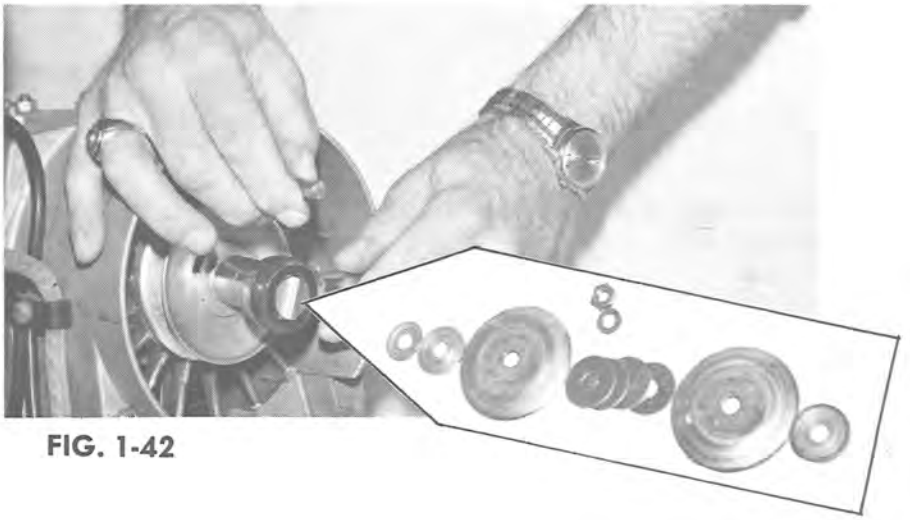


FIG. 1-42

Install key, lockwasher and nut in that order. Tighten securely. See Fig. 1-43. Follow Timing Procedure Section as next step.

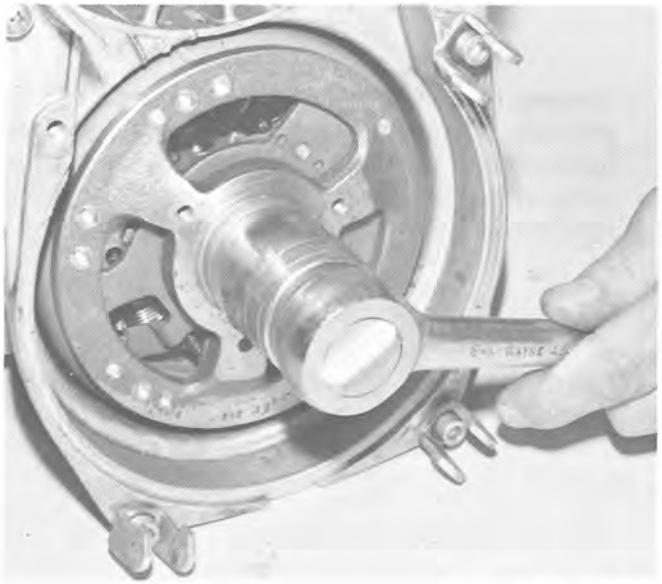


FIG. 1-43

I. Lower Fan Pulley Assembly

Install pulley half, belt, second pulley half, recoil carrier, lockwashers and bolts evenly while rotating crankshaft. The proper belt deflection should be 1/8" on each side. Proper adjustment can be made by adding or removing shims between upper pulley halves. See Fig. 1-44.

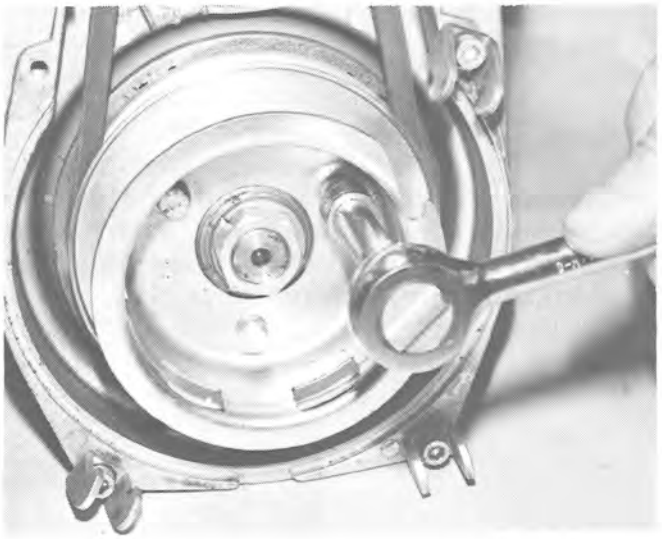


FIG. 1-44

J. Recoil Starter

Install the recoil starter assembly and tighten securely. See Fig. 1-45.

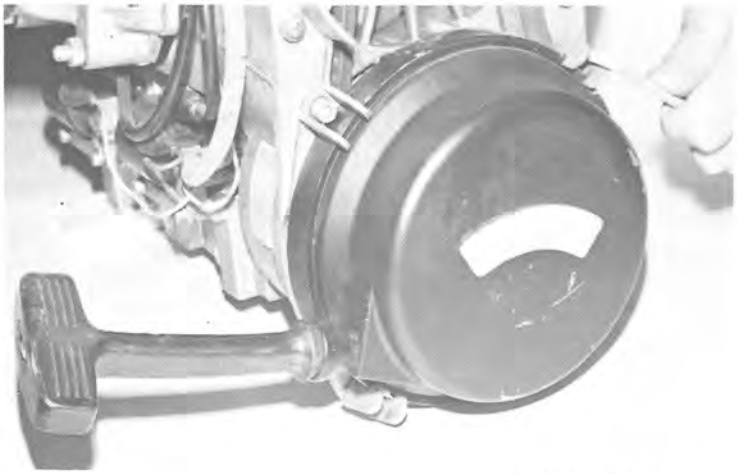


FIG. 1-45

RECOIL STARTER

Disassembly
(See Fig. 1-46 for recoil start breakdown, and Fig 1-47 for Recoil Starter Assembly.)

1. Remove retaining nut (11), spring washer (12) and Thrust washer (8) from threaded shaft of reel hub. (Fig. 1-48).

2. Manipulate friction plate (4) on reel hub until eye end of return spring (9) aligns with retaining slot. Remove friction plate. (Fig. 1-49, 1-50).

3. Remove the three pawls (3), (Fig. 1-51).

4. Remove return spring (9), spring (6) and cup washer (7). Fig. 1-50. Note position of plain end of return spring in the spring retaining hole in reel hub.

5. Unwind the rope; lift and untie the knotted end from center hub of reel, remove reel (2). (Fig. 1-52).

6. Lift long rolled end of main spring (5) from the fixed spring retaining pin in the case and carefully remove the spring (Fig. 1-53).

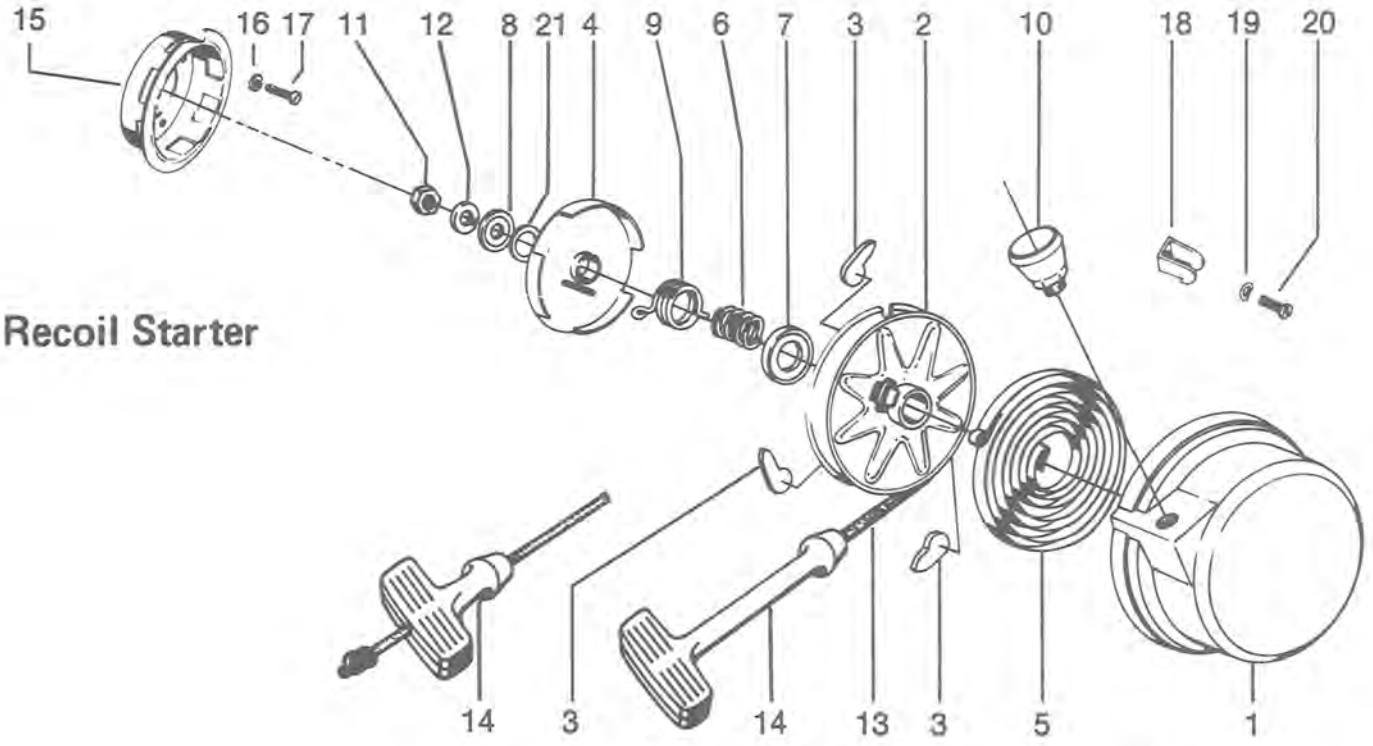


FIG. 1-46

7. Clean all parts, except rope, using a suitable cleaning solvent. If rope requires cleaning, wash it in a solution of soap and water. Thoroughly dry all parts after cleaning.

8. Inspect all parts for obvious damage and wear.

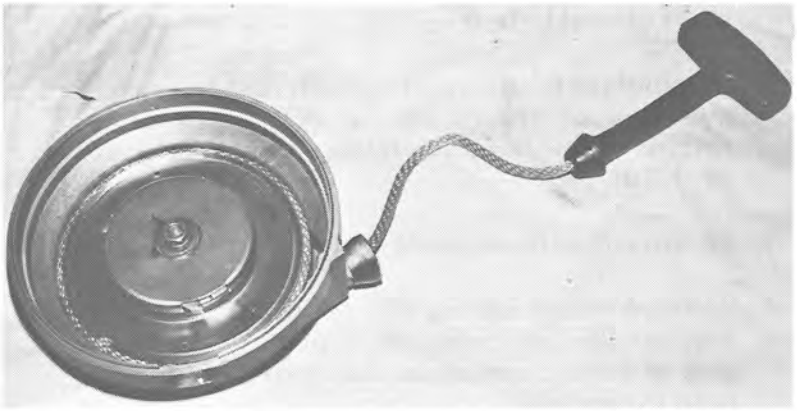


FIG. 1-47

FIG. 1-48

FIG. 1-49

FIG. 1-50

FIG. 1-51

FIG. 1-52

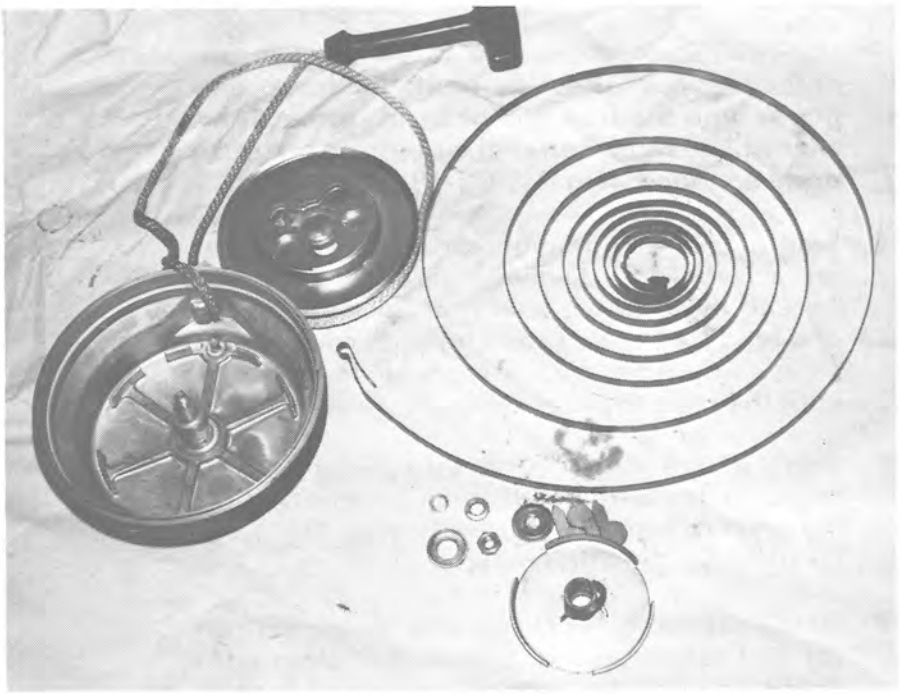


FIG. 1-53

Assembly

1. Replace defective parts.

2. Install main spring as follows:

   a. Secure main spring winding tool, part number 43-0797-60, or equivalent tool, circular end up, in a suitable bench vise.

   b. Start with the long rolled end of main spring (5) and wind spring into circular end of tool in a clockwise direction. (Fig. 1-54).

   c. Remove tool from vise. Grasp the tool by its handle and lower the tool, with spring installed, into case (1) (Fig. 1-55).

   d. Secure the long rolled end of spring over the fixed spring retaining pin. (Fig. 1-56). Remove winding tool (Fig. 1-57). Apply a light film of Lubriplate, or equivalent, to spring.

3. Secure case, open side up, in bench vise.

4. Tie a knot at one end of the rope. Secure knotted end in the center of reel (2). Pull rope taut and wind entire rope around reel in an anti-clockwise direction until the free end protrudes through the notched section of the reel.

5. Apply a light film of Lubriplate, or equivalent, to center hub of case and install the reel. Push down and rotate reel in an anti-clockwise direction until the hook engages with the free end of main spring. Tension will be felt when reel and spring are properly engaged. (Fig. 1-58, 1-59).

6. Rotate reel a maximum of three complete turns in an anti-clockwise direction. Do not exceed three turns; hold reel in this position and feed free end of rope through case at the rope guide hole. Install rope guide. Loosely knot the rope to prevent recoil.

7. Apply a light film of Lubriplate or equivalent to pawls (6) and install them on the reel in the pawl retainers. (Fig. 1-60). (See Fig. 1-46 for part identification numbers.)

8. Install cup washer (7) flat side down, spring (6) and return spring. Ensure that plain end of return spring is properly engaged in the retaining hole in reel hub.

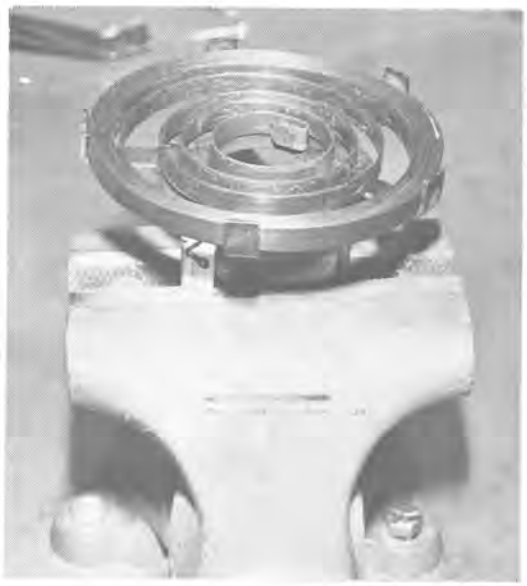


FIG. 1-54

FIG. 1-55

FIG. 1-56

9. Install friction plate (5) over reel hub. Manipulate plate until eye end of return spring engages and locks crosswise in retaining slot.

10. Rotate friction plate until the three notches are aligned with pawls when pawls are at the recoil position.

11. Install flatwasher (8), lockwasher (12) and nut (11). Tighten nut securely.

12. Untie the temporary knot in free end of rope and install the rope handle. Tie a permanent knot and fit handle securely.

13. Check starter for proper operation. When handle is pulled outward, pawls should move outward.

NOTE:
If main spring is to be installed without the use of a spring winding tool, wind main spring into case in an anti-clockwise direction. Clockwise installation on the winding tool is necessary to ensure correct anti-clockwise installation of the spring when tool is placed upside down in the case.

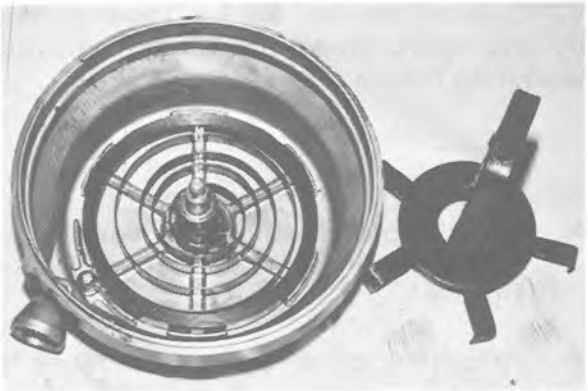


FIG. 1-57

FIG. 1-58

FIG. 1-59

FIG. 1-60

TIMING PROCEDURE

NOTE: Recoil starter, carrier, lower pulley assembly and spark plugs should be removed before beginning timing procedure.

A. Install the dial indicator assembly into spark plug hole of No. 1 cylinder (P.T.O. side). See Fig. 1-61.

B. Attach negative lead of ohmmeter to engine ground. Attach positive lead of ohmmeter to No. 1 cylinder terminal in connector housing. See Fig. 1-62.

C. Rotate flywheel counterclockwise until points are on the high side of cam on No. 1 cylinder. Points are at maximum open position observed through opening in flywheel. Check gap with wire gauge and adjust to .015 if necessary. See Fig. 1-63.

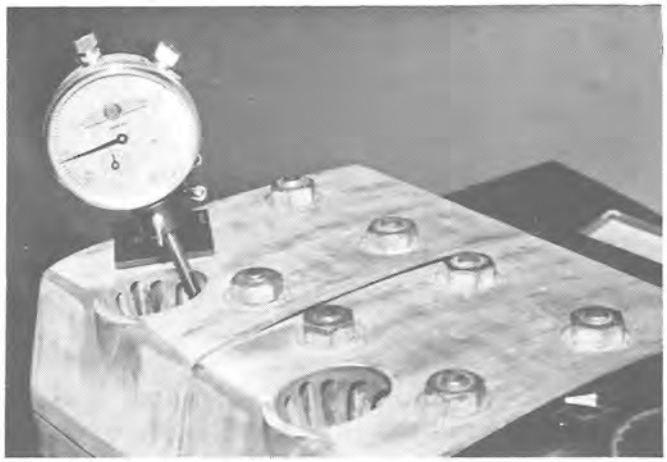


FIG. 1-61

FIG. 1-62

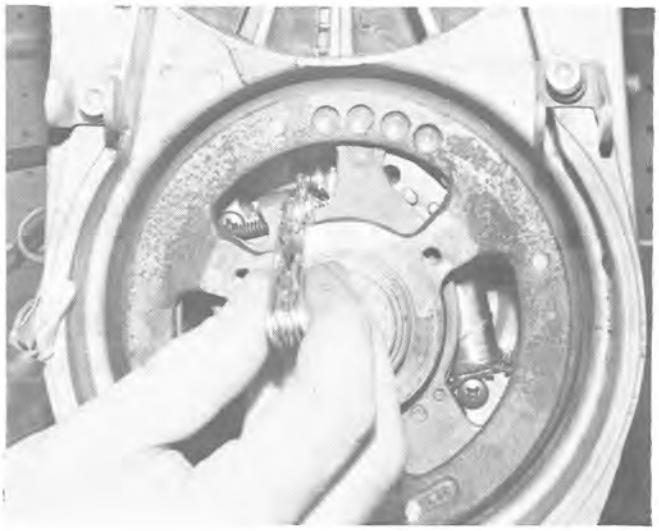


FIG. 1-63

D. Rotate flywheel counterclockwise to top dead center and adjust dial to zero. Place selector knob on ohmmeter to R x 1. Ohmmeter needle will indicate a closed circuit. See Fig. 1-64.

FIG. 1-64

Move the centrifugal weights in flywheel to the **full** advanced position. See Fig. 1-65.

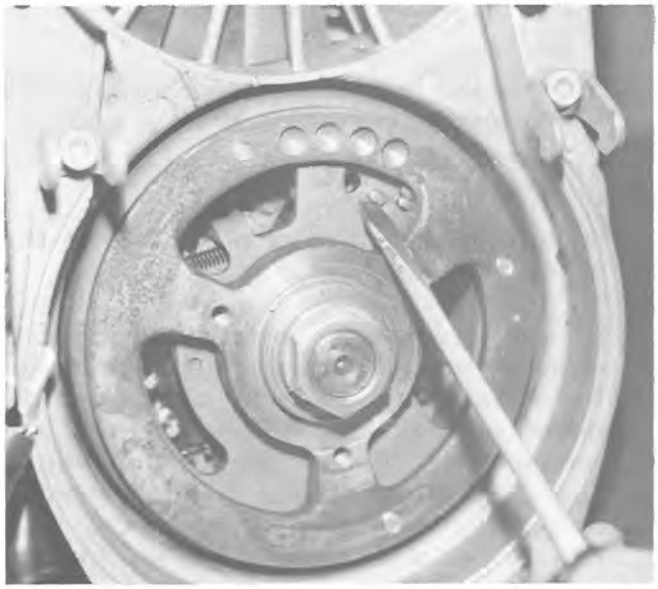


FIG. 1-65

Rotate flywheel counterclockwise one complete revolution to between .102 and .112. See Fig. 1-66.

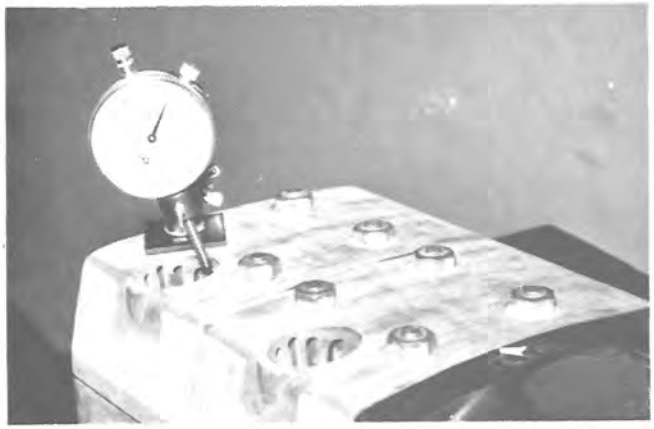


FIG. 1-66

At this point the breaker points for No. 1 cylinder should open. (Break contact) This will show on the ohmmeter. Needle will move to the left. If this does not occur, the armature plate needs adjusting. This is accomplished by loosening the hold-down screws and turning plate either left or right while observing needle action. With proper positioning, needle should move to left with slight movement of armature plate and flicker back with opposite plate movement. Tighten hold-down screws **securely.** Re-check procedure. See Fig. 1-67.

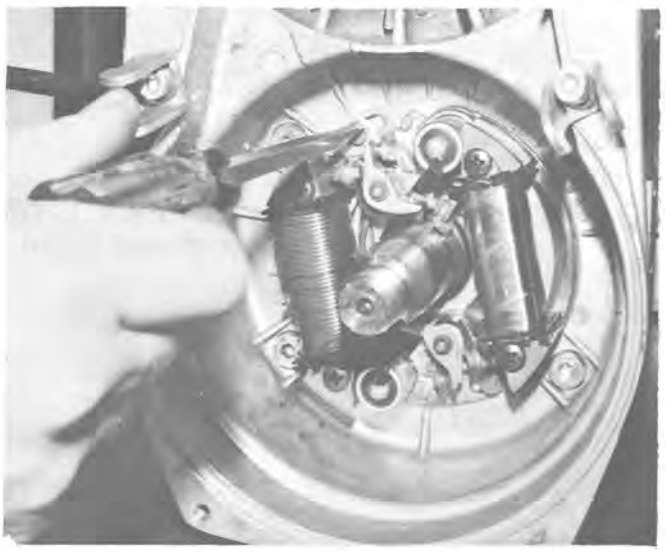


FIG. 1-67

NOTE:
In Fig. 1-67 flywheel has been removed for clarity of illustration.

E. Remove dial indicator assembly and install in No. 2 cylinder (fan side). See Fig. 1-68.

Attach positive lead of ohmmeter to No. 2 cylinder terminal in connector housing.

Rotate flywheel counterclockwise to top dead center. Set dial indicator to zero. Again move centrifugal weights in flywheel to full advanced position. Rotate flywheel counterclockwise while watching dial indicator. The needle must make one full revolution and stop at between .102 and .112. At this point, needle should move to left indicating point contact open. If this does not occur, points need slight adjustment. Re-check procedure.

FIG. 1-68

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Manual starter rope comes out but pawls don't engage.	1. Lack of friction plate return spring action. 2. Defective pawls.	1. Check friction plate return-spring. Replace as required. 2. Check for broken or bent pawls. Replace pawls as required.
Manual starter rope doesn't return.	1. Recoil spring broken or bent. 2. Pulley housing warped or bent. 3. Starting pulley worn.	1. Replace spring. 2. Replace housing. 3. Replace pulley.
Hard to start or won't start.	1. Carburetor adjustments too lean (not allowing enough gas to engine). 2. Inoperative diaphragm or flapper valve. 3. Engine not being choked to start. 4. Spark plugs improperly gapped, dirty or broken. 5. Magneto breaker points improperly gapped or dirty. 6. Head gasket blown or leaking. 7. Empty gas tank or improper fuel mixture. 8. Water in fuel system. 9. Weak coil or condenser. 10. Obstructed fuel system.	1. Adjust carburetor. Refer to Carburetor Section 2. Refer to Carburetor Section. 3. Ensure choke is fully closed. 4. Remove plugs. Clean, adjust or install new plugs. 5. Clean, adjust or replace points. 6. Replace gasket. 7. Refill tank with specified fuel/oil mixture. 8. Drain fuel from carburetor. Add carburetor de-icer as required to fuel. 9. Replace faulty coil or condenser. 10. Disconnect fuel lines - clear obstruction. Flush system. Connect fuel lines.

TROUBLE SHOOTING CHART (CONT.)

TROUBLE	PROBABLE CAUSE	REMEDY
	10. Air leak in crankcase or inlet system.	10. Check crankcase pressure (3-6 PSIG)
	11. Primary wire broken.	11. Repair or replace primary wire.
	12. Engine not timed properly.	12. Re-time engine.
	13. Secondary wire not connected or spark plug protector not installed properly.	13. Secure secondary wire or spark plug protector.
Impossible to adjust idle.	1. Spark retarding mechanism not working properly.	1. Repair retard mechanism.
	2. Pistons or rings worn.	2. Replace as necessary.
	3. Faulty carburetor.	3. Check carburetor, check valve. Refer to Carburetor Section.
Missing at low speed or won't idle smoothly or slowly.	1. Incorrect carburetor idle adjustment.	1. Adjust idle-Refer to Carburetor Section.
	2. Spark plugs improperly gapped or dirty.	2. Clean, adjust or install new plugs.
	3. Head gasket blown or leaking.	3. Replace gasket.
	4. Loose or broken magneto wires.	4. Repair or replace wires.
	5. Magneto breaker points improperly gapped or dirty.	5. Adjust, clean or install new points.
	6. Weak coil or condenser.	6. Replace coil or condenser.
	7. Improper fuel mixture. (1) Too much oil (2) Too little oil	7. Refuel, using specified fuel/oil mixture.
	8. Leaking crankshaft seal.	8. Replace seal.
Missing at high speed or intermittent spark.	1. Spark plugs improperly gapped or dirty.	1. Clean, adjust or install new plugs.
	2. Loose or broken magneto wires.	2. Repair or replace wires.
	3. Magneto breaker points improperly gapped or dirty.	3. Clean, adjust or install new points.
	4. Weak coil or condenser.	4. Replace coil or condenser.
	5. Heat range of spark plug incorrect.	5. Install specified spark plugs.
	6. Leaking head gasket.	6. Replace head gasket.
	7. Engine improperly timed.	7. Re-time engine.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Coughs, spits, slows down, surges	1. Idle or high speed jets too lean. 2. Leaking gasket flange. 3. Inlet control level set too low. 4. Pulsation line obstructed. 5. Fuel pump not supplying enough fuel due to: (1) Punctured diaphragm. (2) Inoperative flapper valve.	1. to 5. Adjust carburetor or fuel pump. Refer to Carburetor Section.
	6. Crankcase not properly sealed.	6. Reseal crankcase.
	7. Idle or main carburetor nozzle obstructed.	7. Refer to Carburetor Section.
	8. Fuel line obstructed.	8. Remove fuel line. Clear obstruction. Replace line.
	9. Carburetor inlet needle and seat obstructed.	9. Refer to Carburetor Section.
	10. Welch plug leaking.	10. Refer to Carburetor Section.
Overheating	1. Carburetor too lean. 2. Carburetor too rich.	1. and 2. Adjust carburetor. Refer to Carburetor Section.
	3. Incorrect timing.	3. Retime engine to Specifications.
	4. Too much carbon.	4. Remove cylinder heads. Clean top of pistons and inside compression chamber. Clean out exhaust port.
	5. Spark plug too hot.	5. Install specified spark plugs.
	6. Engine fan belt loose or broken.	6. Replace or adjust.
	7. Air leak in manifold.	7. Tighten nuts or change gaskets.
	8. Crankcase seal leaking.	8. Fit new seal.
Vibrates excessively or runs rough and smokes.	1. Idle or high speed carburetor adjustment too rich. 2. Choke not opening properly (bent linkage). 3. Inlet control lever too high. (carburetor floods) 4. Idle air bleed plugged. 5. Welch plug loose.	1 to 5. Adjust carburetor. Refer to Carburetor Section.
	6. Muffler obstructed.	6. Check and clear muffler.
	7. Engine not secured tightly to engine support.	7. Tighten engine mounting bolts.
	8. Water in gas.	8. Add carburetor de-ice fluid as required.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Won't start, kicks back and backfires.	1. Spark plug wires reversed. 2. Flywheel key missing or sheared. 3. Faulty condenser. 4. Improper timing. 5. Faulty breaker points. 6. Unhooked spark retarding mechanism - or spring broken.	1. Install wire correctly. 2. Replace key. 3. Replace condenser. 4. Re-time engine. 5. Adjust or replace points. 6. Reconnect mechanism or replace spring.
No acceleration, low top R.P.M., hard to start.	1. Spark plugs improperly gapped or dirty. 2. Magneto breaker points improperly gapped or dirty. 3. Faulty coil or condenser. 4. Loose or broken magneto wires. 5. Blown head gasket. 6. Inlet lever adjustment too low. 7. Crankcase leaking.	1. Clean, adjust or install new plugs. 2. Clean, adjust or install new points. 3. Replace coil or condenser. 4. Repair or replace magneto wires. 5. Replace head gasket. 6. Refer to Carburetor Section. 7. Install new seal.
Good spark but engine runs on one cylinder.	1. Leaking cylinder head. 2. Magneto wires broken inside (coil ground broken). 3. Cracked cylinder wall. 4. Defective spark plug. 5. Breaker points improperly gapped. 6. Crankcase seal leaking.	1. Check head for warps, cracks. Install new gasket and cylinder head. 2. Repair or replace wires. 3. Replace faulty cylinder. 4. Clean, adjust or install new plug. 5. Re-adjust points. 6. Install new seal.
No acceleration. Idles well but dies down when put to full throttle.	1. Low speed needle set too lean. 2. Dirt behind needle and seat. 3. High speed jet obstructed. 4. Inlet lever set too low. 5. Choke partly closed. 6. Silencer obstructed. 7. Fuel pump not supplying enough fuel due to: (1) Punctured diaphragm (2)Flapper valves distorted. 8. Fuel line obstructed. 9. Not enough oil in gas. 10. Breaker points improperly gapped or dirty. 11. Engine improperly timed.	1. to 7. Adjust carburetor. Refer to Carburetor Section. 8. Remove fuel line. Clear obstruction. Replace line. 9. Refuel, using specified fuel/oil mixture. 10. Adjust, clean or install new points. 11. Re-time engine to specifications.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Engine runs by using choke at high speed.	1. High speed needle set too lean. 2. Dirt behind needle and seat. 3. Fuel line obstructed. 4. Inoperative fuel pump.	1. & 2. Adjust carburetor. Refer to Carburetor Section. 3. Remove line, clear obstruction, replace line. 4. Refer to Carburetor Section.
No power under heavy load.	1. Magneto breaker points improperly gapped or dirty. 2. Ignition timing too far advanced. 3. Magneto coil plate loose. 4. Faulty carburetion.	1. Clean, adjust or install new points. 2. Adjust timing. 3. Check magneto and secure coil plate. 4. Refer to Carburetor Section.
Cranks over extremely easy on one or both cylinders. Loss of compression.	1. Scored piston. 2. Blown head gasket. 3. Loose spark plug. 4. Head bolts not tight.	1. Replace faulty piston. 2. Replace head gasket. 3. Check plug for security. 4. Torque head bolts to proper specifications.
Engine won't crank over. Unable to rotate flywheel.	1. Piston rusted to cylinder wall. 2. Crankshaft seized to bearing. (main or rod) 3. Broken connecting rod. 4. Flywheel seized to coil plate. 5. Engine improperly assembled after repair.	1. Remove piston and cylinder. Replace defective parts. 2. & 3. Disassemble engine. Replace defective parts. 4. Remove flywheel. Replace defective parts. 5. Recheck re-assembly procedure.

1976
Scorpion
Lil Whip

Service Manual

Carburetor
Section

Functional Description:

General -

The purposes of the carburetor are (1) to provide the amount of fuel that the engine needs in operation and (2) to properly mix the fuel with air so that it will vaporize.

Pulsations from the crankcase through the impulse tube, actuates the carburetor fuel pump diaphragm to move the fuel into the carburetor from the fuel lines. An increased engine fuel demand causes a reduced pressure at the metering diaphragm which opens the needle valve. More fuel enters through the needle valve into the carburetor bore where it is mixed with incoming air.

The four operational phases of the Walbro Carburetor used on the 1976 Lil' Whip are:

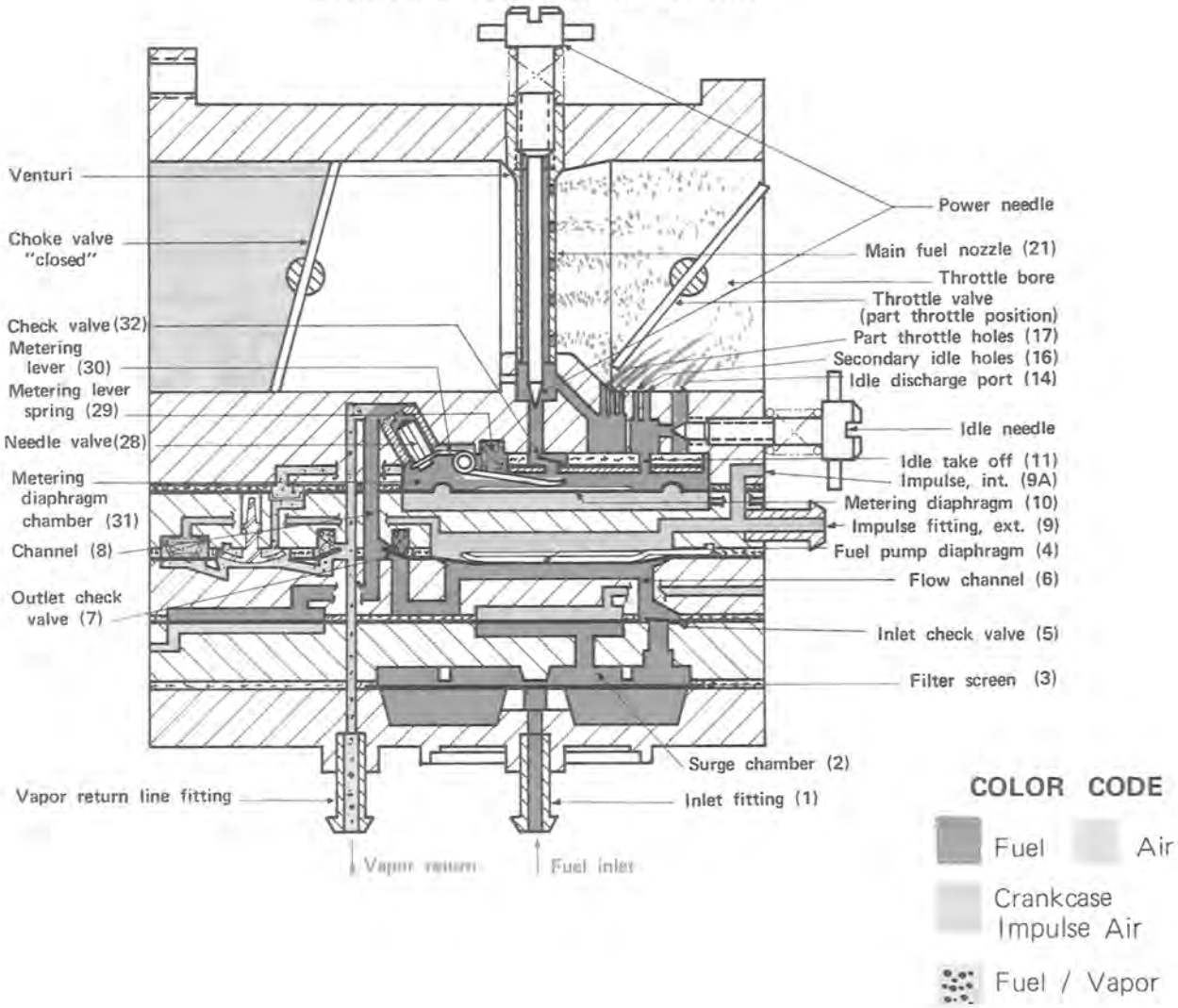
(1) Starting (choke) operation
(2) Idle operation
(3) Part-throttle operation
(4) Full-throttle operation

Detailed performance of the carburetor in each of the four phases is described below. Figures 2-1 through 2-4 are schematic diagrams and as such are accurate, functional representations of the carburetor, but in some features deviate from actual physical appearance.

STARTING (CHOKE) OPERATION (See Fig. 2-1)

Fuel from the supply tank is drawn in the fuel inlet (1) into the surge chamber (2) through the filter screen (3) by pulsations of the fuel pump diaphragm (4). The engine crankcase pulsation transmitted through the external impulse fitting (9) or internal impulse hole (9A) actuates the fuel pump diaphragm (4) which supplies pumping action for the fuel pump. The fuel is drawn from the surge chamber through the check valve (5) and the channel (6). The fuel continues past the fuel pump outlet check valve (7) and into channel (8). Fuel continues through fuel channel (8) and to the needle valve (28). The metering lever spring (29) transmits a force through the metering lever (30) and seats the inlet needle valve (28) against pressure. The metering diaphragm (10) is pulled upward by engine suction which is transmitted through the idle discharge port idle hole (14) secondary idle holes (16) and part throttle feed holes (17). The diaphragm action depresses the metering lever (30) and unseats the needle valve (28) and allows the fuel to enter the metering diaphragm chamber (31) and pass through the idle take off (11). Check valve (32) is forced open passing fuel into the main nozzle (21) which also feeds the part throttle holes (17). Fuel only is fed through all discharge holes.

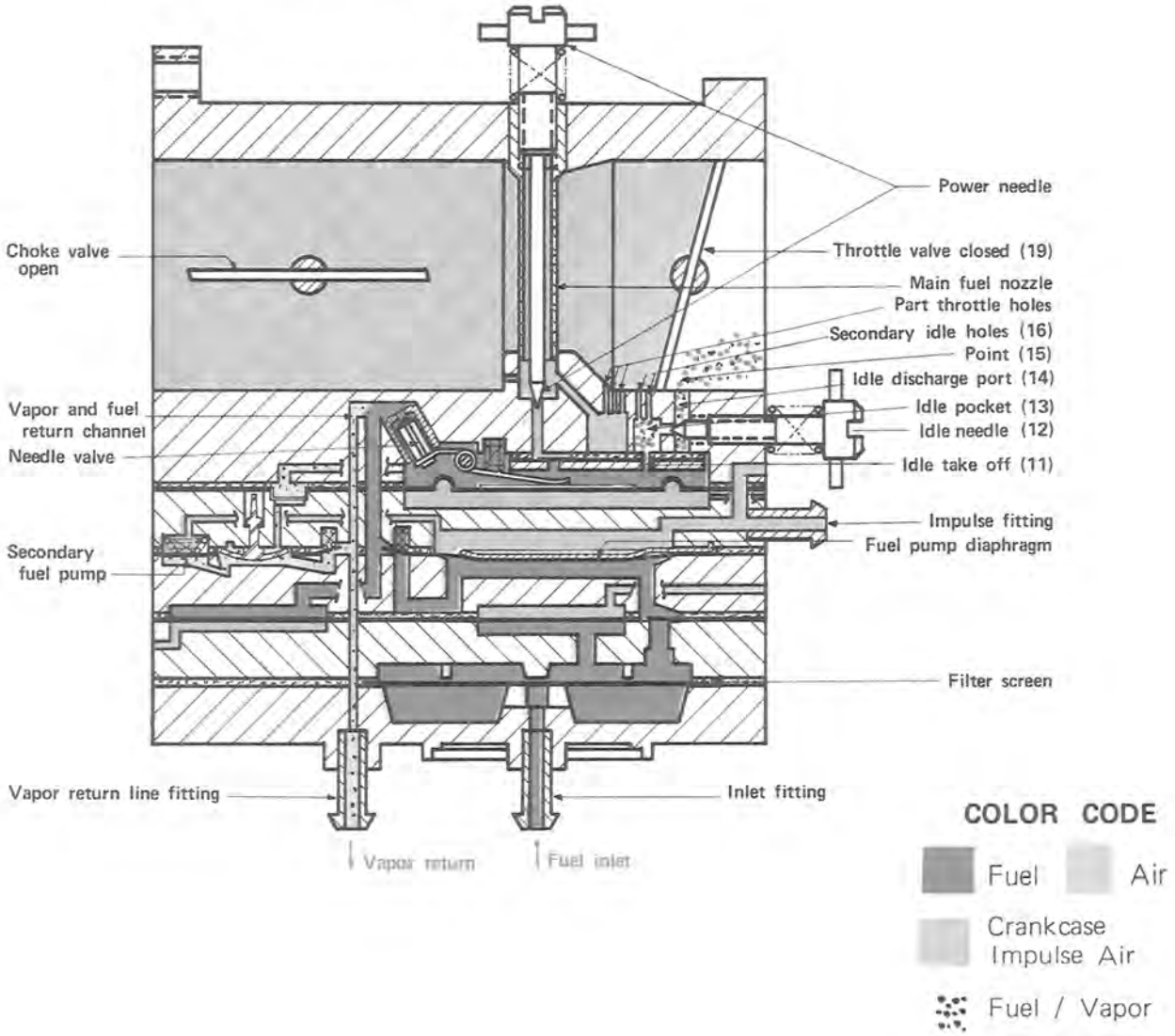
STARTING (CHOKE) OPERATION



IDLE OPERATION (See Fig. 2-2)

At idle speed the fuel passes from the idle take off (11) to the idle pocket (13) where it mixes with air from the secondary idle holes (16). This rich mixture passes around idle needle (12) through the idle discharge port (14) where it mixes with additional air passing the throttle valve (19) at point (15).

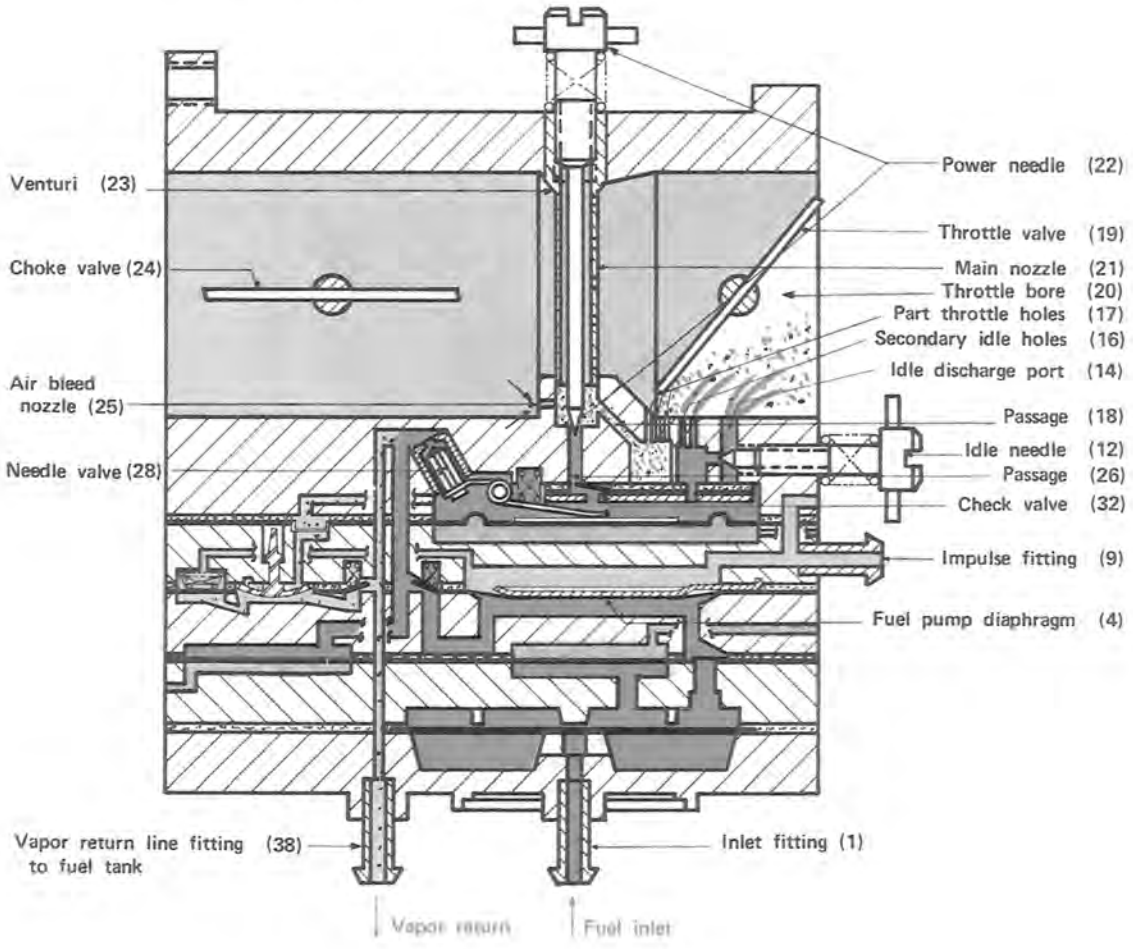
FIG. 2-2 IDLE OPERATION



PART THROTTLE OPERATION (See Fig. 2-3)

At part throttle, in addition to the fuel fed into the throttle bore by the idle system, more fuel enters past the check valve (32) through passage (26) around the power needle (22) and through the passage (18) and discharges into the throttle bore (20) through the part throttle holes (17). All ports except the main nozzle feed progressively as throttle valve opens for smooth acceleration. Air is intermixed through air bleed nozzle (25).

FIG. 2-3 PART THROTTLE OPERATION

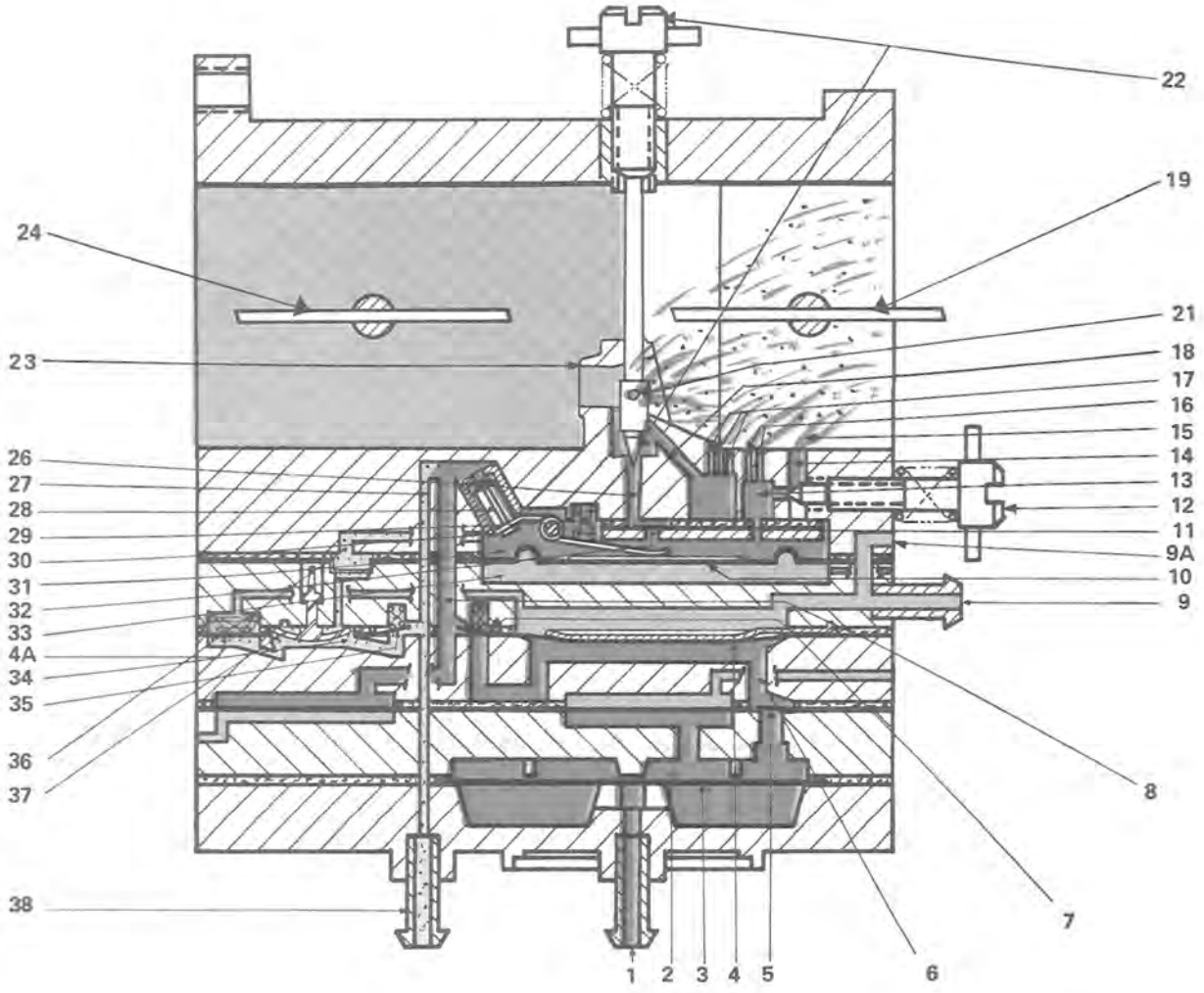


FULL THROTTLE OPERATION (See Fig. 2-4)

Note: Starting, idle, and part throttle operations of the WDA carburetor are identical to that of the WD and WR models. You will notice the main difference is the discharge of fuel at full throttle operation. The WR discharges fuel through #(21) main nozzle, at only the base of the power needle, where as the WD and WDA discharge at five discharge ports parallel to power needle (22). This is noted by comparing Fig. 1 and Fig. 4.

At full throttle operation fuel passes around the power needle (22) and is discharged through the main nozzle (21). During full throttle air is mixed with fuel in the main nozzle (21) through the nozzle air bleed (25). Suction (or vacuum) created by the engine's piston action draws fuel and air as the ports are exposed by position of the throttle valve.

FIG. 2-4 FULL (WIDE OPEN) THROTTLE OPERATION



DISASSEMBLY OF PLATES, GASKETS AND DIAPHRAGMS FOR CLEANING

To remove the plates, gaskets and diaphragms from the lower part of the carburetor body, remove the four mounting screws. Lay each part on a clean surface in the sequence removed. (See FIG. 2-5)

1. Cover Assembly
2. Fuel Inlet Gasket
3. Filter Screen
4. Filter Plate
5. Check Valve Diaphragm
6. Fuel Pump Check Valve Gasket
7. Fuel Pump Plate
8. Fuel Pump Diaphragm
9. Fuel Pump Gasket
10. Fuel Pump Leaf Gasket
11. Valve Springs (3)
12. Pressure Spring
13. Metering Diaphragm Assembly
14. Metering Diaphragm

Check diaphragms and gaskets thoroughly for cracks or leaks, by holding them against light. Clean as required.

Reassemble in reverse sequence of disassembly.

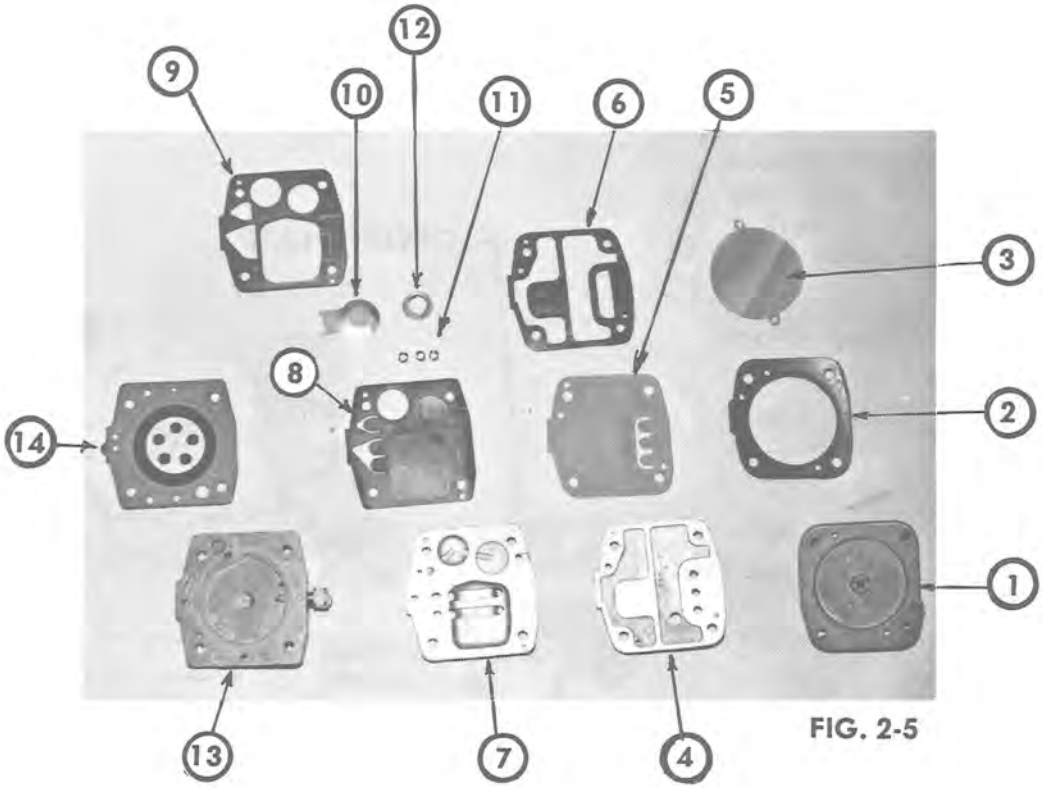


FIG. 2-5

MAIN CARBURETOR BODY DISASSEMBLY IN CONJUNCTION WITH INLET NEEDLE VALVE

1. Remove the four screws holding the plates to the main body and disassemble in one mass.
2. Remove metering lever pin screw. (FIG. 2-6)
3. Remove metering lever. Watch that spring does not fly out. (FIG. 2-6)
4. Remove spring and Inlet Needle Valve.
5. Clean or replace as required.

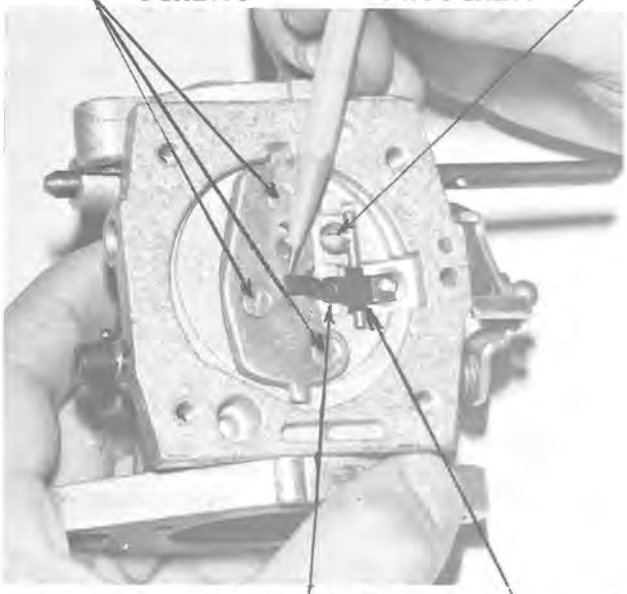


FIG. 2-6

MAIN CARBURETOR BODY DISASSEMBLY IN CONJUNCTION WITH FINAL CHECK VALVES AND DIAPHRAGMS.

1. It is not necessary to remove Inlet Needle Valve assembly, but it may be easier to work in this area without them. (See Procedure Above).
2. Remove three circuit plate screws. (FIG. 2-6)
3. Remove circuit plate, check valve diaphragm and gasket. (FIG. 2-7)
4. Inspect check valve diaphragm.
5. Remove Low and High speed needles, if necessary, for cleaning, grooves, channels, etc.

NOTE - DO NOT REMOVE SCREEN UNDER HIGH SPEED NEEDLE. CARBURETOR WILL NOT FUNCTION WITH SCREEN REMOVED. (See FIG. 2-7)

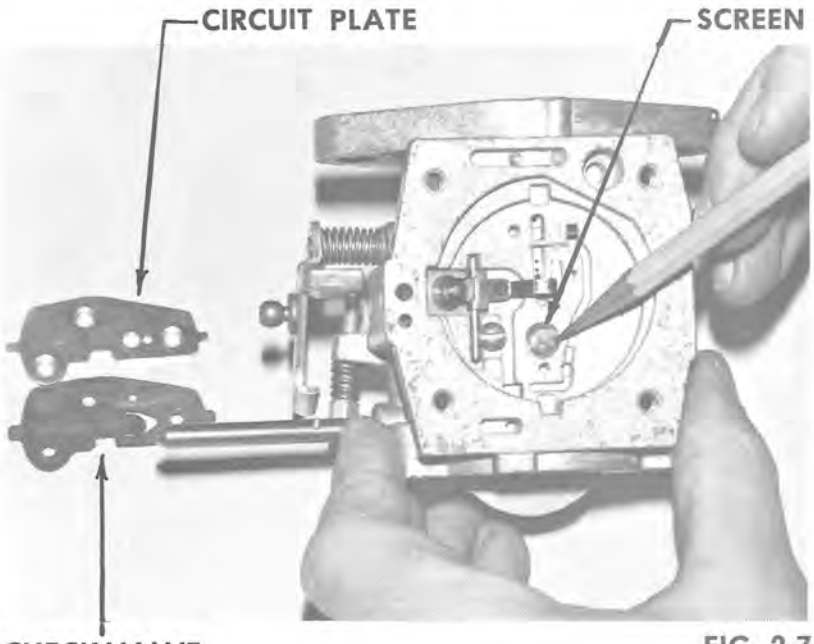


FIG. 2-7

SPECIAL ADJUSTMENTS/TESTS

High Speed Adjustment:

The Factory setting of the High Speed Needle on the carburetor is approximately 1¼ turns open. However, each machine requires individual adjustment for optimum performance. A typical curve showing the relationship between ENGINE RPM (maximum operating) and HIGH SPEED CARBURETOR SETTING is shown in FIG. 2-8.

To determine the optimum high speed setting, operate the machine with decreasing high speed jet settings starting at 1½ turns open, decreasing in 1/8 turn increments. When the maximum normal operating engine speed reaches 6750 RPM, that is the optimum setting.

At settings richer (more turns open) than optimum, speed of the machine will drop off and cylinders, pistons and plugs will have carbon buildup. Engine may not start due to flooding.

At settings leaner (less turns open) than optimum, speed of the machine tends to level off or increase slightly. Such increase is insignificant in normal operation, and there is an attendant increased likelihood of burned plugs or pistons.

Variables which will affect the optimum high speed carburetor setting are:

a. Temperature - As temperature drops, the air becomes more dense and the pumping diaphragm less flexible. Both conditions require a richer setting (more turns open) on the high speed needle.

b. Air Density (altitude) - At higher altitudes, it is necessary to set the carburetor leaner (less turns open).

So when marked changes in temperature or altitude are experienced, it is advisable to adjust the carburetor high speed needle.

NOTE: The 290cc. Lil' Whip is equipped with a WRA-37 carburetor. It is essential for optimum performance, not to replace the high speed needle from this carburetor with that of another vintage Walbro carburetor, as the metering portion may be different.

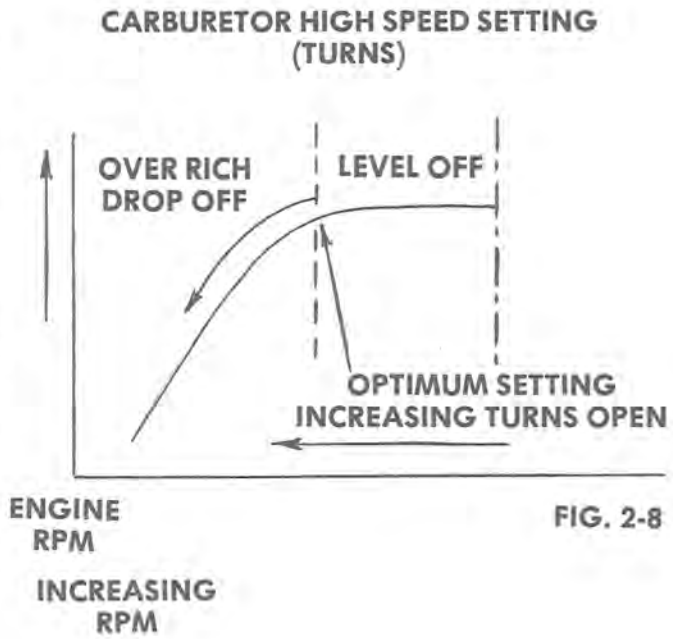


FIG. 2-8

LOW SPEED CARBURETOR ADJUSTMENT

Low speed carburetor adjustment on the 290 Lil' Whip is simplified greatly using the following steps:

1. Back off idle speed screw so it does not contact throttle arm.
2. Turn idle speed screw in until contact is made with throttle arm.
3. Turn idle speed screw in one full turn.
4. Turn low speed mixture screw in until needle seats lightly.
5. Back off one complete turn.
6. Close choke, priming if necessary, to start engine.
7. After engine starts, open choke and let engine warm up.
8. Turn idle mixture screw in to reach maximum R.P.M. on tachometer. Continue until R.P.M. drop is indicated.
9. Turn idle mixture screw out to reach maximum R.P.M. Continue out until R.P.M. drop is indicated.
10. Set idle mixture screw half way between drop points. This is correct idle mixture adjustment.
11. Adjust idle speed screw to obtain 2,200 R.P.M.

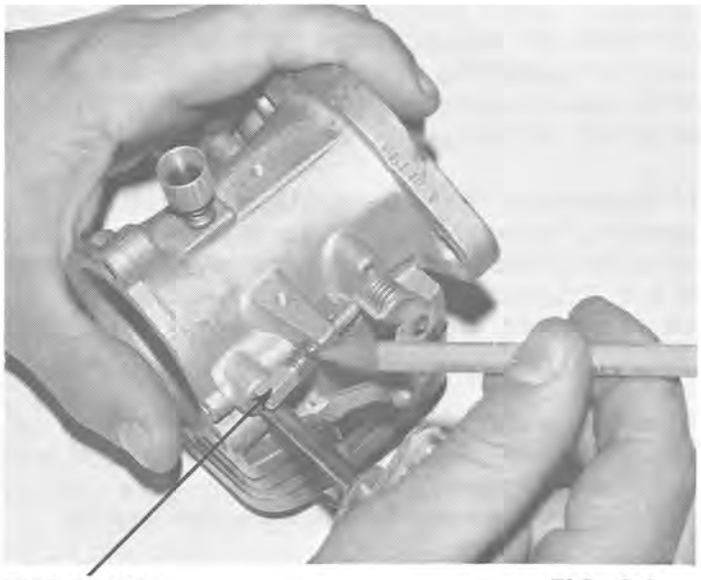


FIG. 2-9

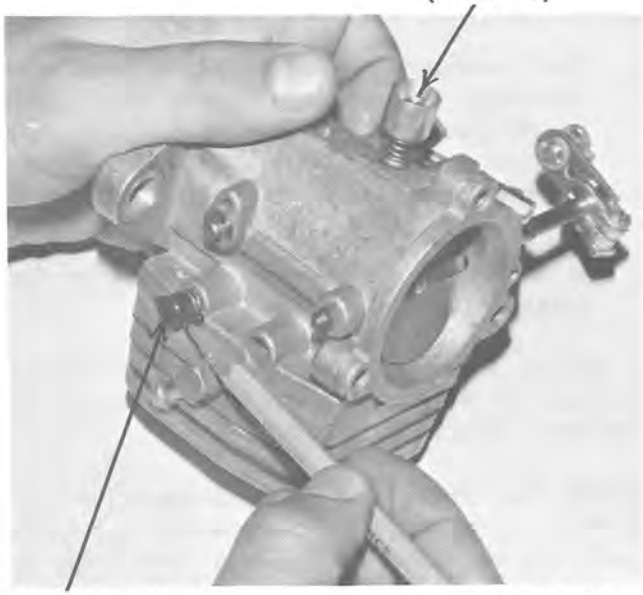


FIG. 2-10

CARBURETOR PRESSURE TEST

The pressure test is used to determine if the needle valve leaks.

The test procedure is as follows:

1. Disconnect the fuel line from the fuel inlet connector on the carburetor.
2. Connect the leak detector (Scorpion P/N 907000) pressure line to the carburetor fuel inlet connector.
3. Remove the carburetor vapor return line and hold your finger over the carburetor fitting.
4. Pressurize the carburetor with the leak detector plunger pump. Do not exceed 12 PSI.

The needle valve, properly seated, should hold a constant 8 psi.

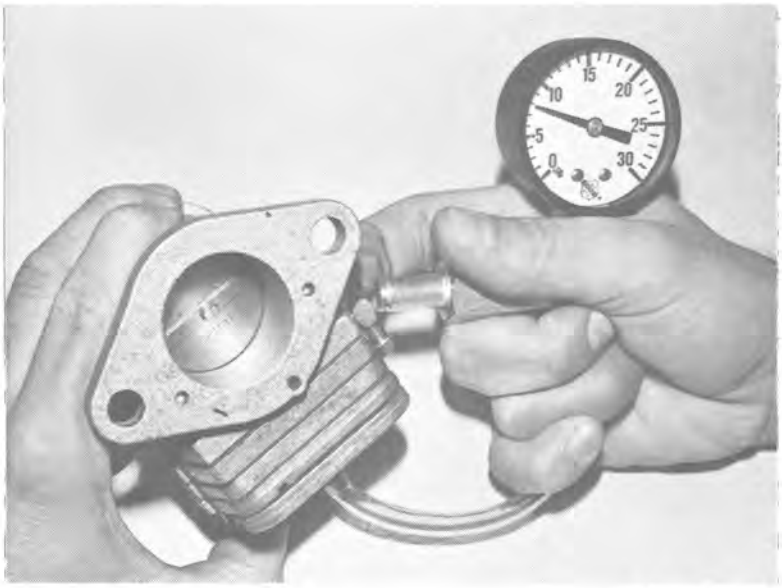


FIG. 2-11

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Excessive carbon build-up in engine & on spark plugs or engine flooding. (Fuel Rich Condition)	1. Foreign obstacle under inlet needle.	1. Remove needle valve. Inspect and clean. (See Procedure P 2-8)
	2. Diaphragm lever adjustment OFF.	2. (See Fig. 2-13) Should be .020" above surface of valve body.
	3. Metering lever spring not seated in dimple on metering lever.	3. Remove plates and inspect spring. Locate spring correctly (See FIG. 2-6)
	4. Leaking fuel pump diaphragm.	4. Install new diaphragm.
	5. Foreign matter under umbrella check valve.	5. Blow through screen on opposite side of Plate #13. (See FIG. 2-5) Umbrella check valve is orange colored rubber plug.
	6. Wrong angle, or abused metering portion of high speed needle.	6. (See FIG. 2-9) Install correct needle.
	7. Leaking check valve in primer.	7. Inspect and replace as necessary.
	8. Choke cable is not activating choke.	8. Be certain retainer nut on choke cable housing is controlling cable movement caused by engine vibration.

FIG. 2-12

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Engine runs hot, spark plugs burn. (Fuel lean condition)	1. Dirt in fuel channels.	1. Disassemble, wash and blow clean.
	2. Metering lever adjustment incorrect.	2. (See FIG. 2-13) Should be .020" above surface of valve body as shown.
	3. Leaky nozzle check valve diaphragm.	3. Replace diaphragm.
	4. Hole in metering diaphragm.	4. Replace diaphragm.
	5. Impulse line leaking or pinched.	5. Replace as necessary.
	6. Intake manifold gasket leaking.	6. Replace as necessary.
	7. Leaking insulation plate between carburetor and manifold.	7. Replace as necessary.
	8. Leaking diaphragm check valve.	8. Replace diaphragm check valve assembly. (See procedure P 2-8)
	9. Fuel pump diaphragm check valve worn.	9. Replace fuel pump diaphragm.
	10. Fuel inlet screen dirty.	10. Remove bottom plate and clean screen.
	11. Restrictions of fuel from main supply.	11. Check complete system from fuel pick-up in tank to carburetor making sure fuel pick-up is staying in fuel and tank is vented sufficiently.
	12. Air intake silencer leaks.	12. Repair or replace as required.
	13. Damaged diaphragms (From incorrect de-icing).	13. Replace as necessary. Use de-icers developed specifically for use with diaphragm carburetors. Do not use regular automobile de-icers.

1976 Scorpion Lil Whip

Service Manual

Electrical Section

ELECTRICAL SYSTEM

The Scorpion Lil' Whip Electrical System is divided into four (4) subdivisions:

A. Power Generation
B. Ignition
C. Voltage Regulation
D. Electrical Control and Distribution

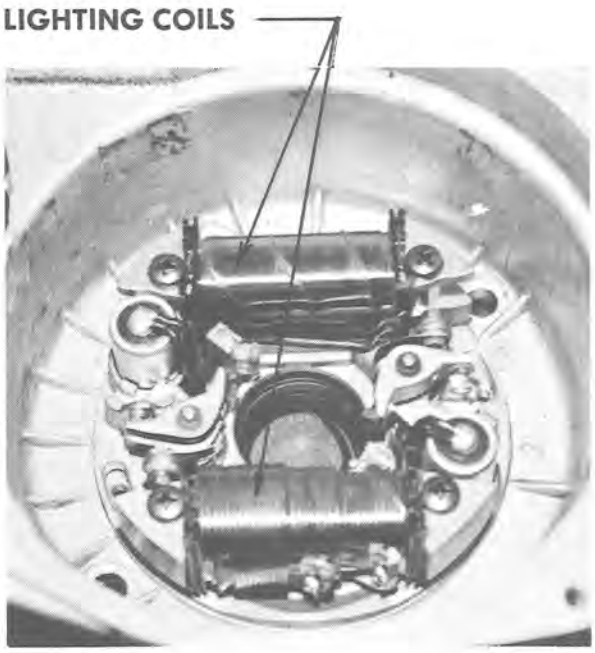


FIG. 3-2

POWER GENERATION

Functional Description:

Electrical AC power, used for lighting and tachometer operation is generated by rotating a permanently magnetized flywheel around two stationary coils (1-120 watt and 1-23 watt). The no-load voltage increases with engine RPM and could reach 32 volts RMS. To maintain the voltage at the required system level (13-14 volts), an external voltage regulator is utilized. (See VOLTAGE REGULATION)

MAIN ELEMENTS:

1. Magnetic Flywheel
2. 120 watt coil (mounted on stator plate)
3. 23 watt coil (mounted on stator plate)

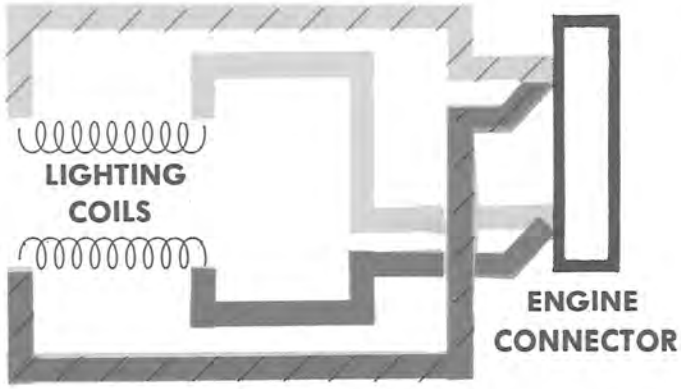


FIG. 3-1 POWER GENERATION SCHEMATIC

IGNITION

Functional Description:
(See SCHEMATIC FIG. 3-7).

Rockwell engines are equipped with a flywheel magneto type ignition. An electrical current is generated by rotating a permanently magnetized flywheel about the ignition coil. The current initiated in this coil in turn energizes the primary coils of the external ignition coils. The secondary coils of the external ignition coils are situated in the force field generated by the primary coils.

When the points close, causing an interruption of the current flow through the primary winding, its force field immediately collapses and generates a very high voltage in the second coil. This voltage in the region of several thousand volts will jump the spark plug gap causing ignition to begin.

The collapsing lines of force cut through the primary windings, raising the voltage in that circuit also. As this occurs, the condenser absorbs the generated current to reduce the tendency to overload the points. As soon as the voltage level in the primary winding drops below that of the condenser, current again flows in the original direction, energizing the system. This occurrence and the reversal happens several times each cycle creating a powerful, long duration spark for more reliable ignition.

FIG. 3-3

FIG. 3-4

MAIN ELEMENTS:

1. Ignition Coil (Stator)
2. Condensers (2)
3. Breaker Points (2)
4. Ignition Coils (External) (2)
5. Spark Plugs (2)

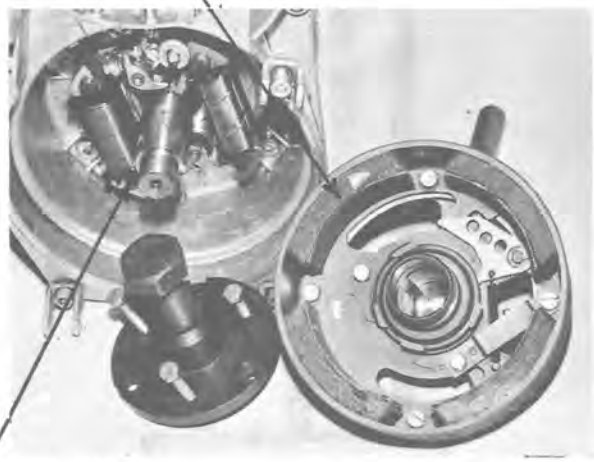


FIG. 3-5

SEE ENGINE DISASSEMBLY
(SECTION 1) FOR FLYWHEEL
AND STATOR REMOVAL

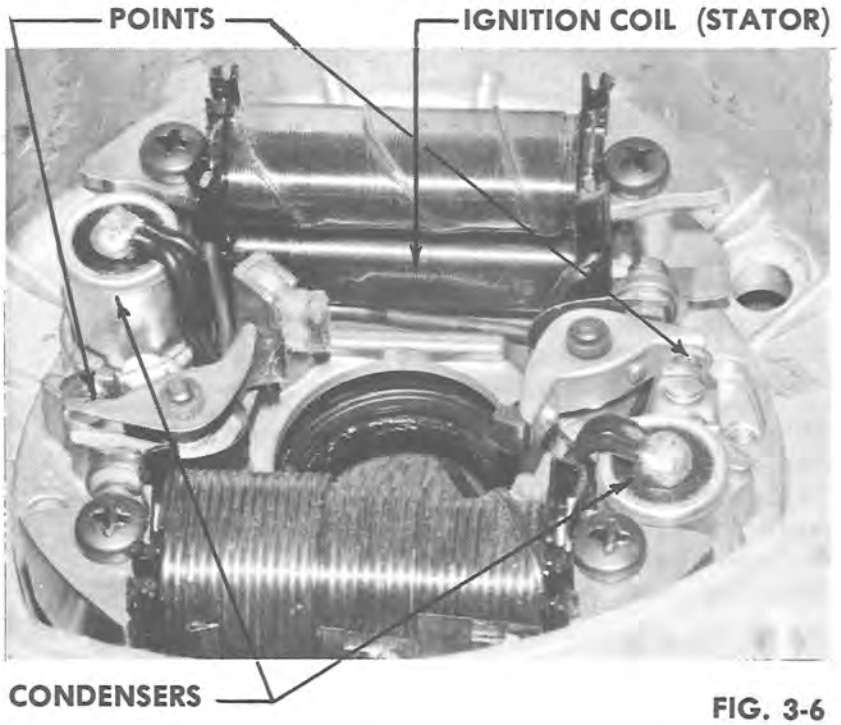


FIG. 3-6

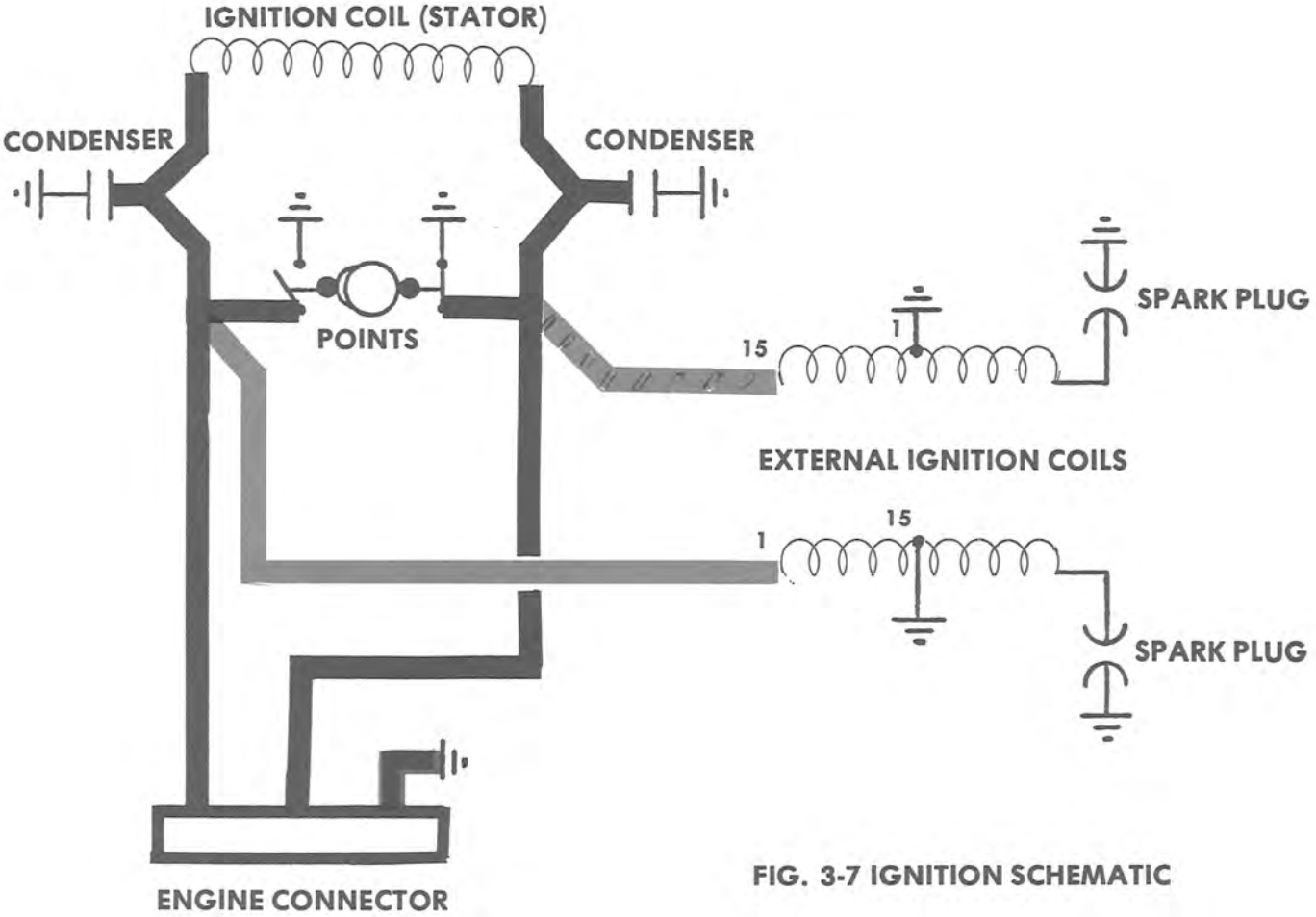


FIG. 3-7 IGNITION SCHEMATIC

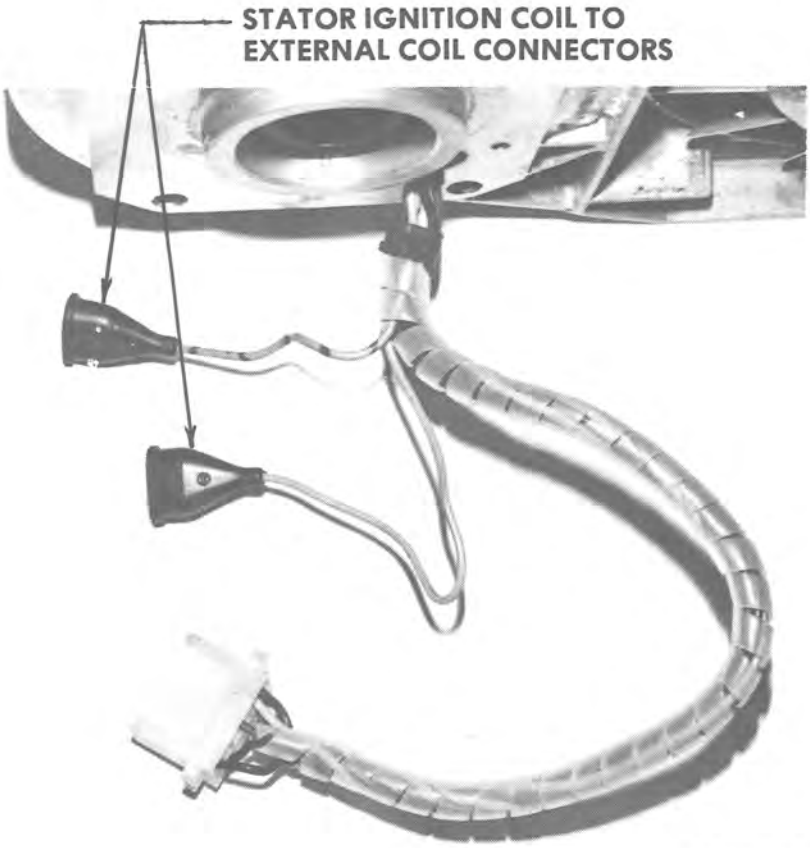

STATOR IGNITION COIL TO
EXTERNAL COIL CONNECTORS

FIG. 3-8

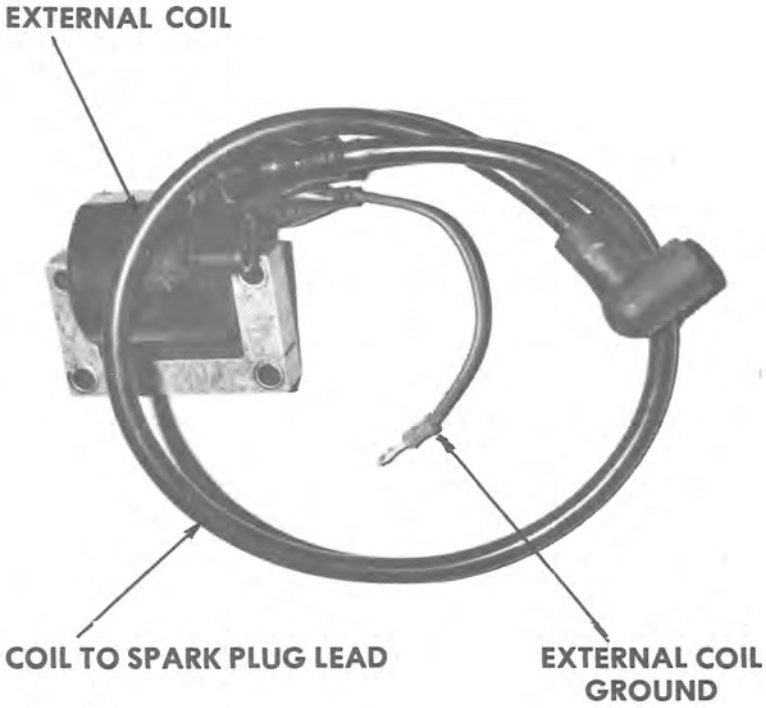

EXTERNAL COIL
COIL TO SPARK PLUG LEAD
EXTERNAL COIL
GROUND

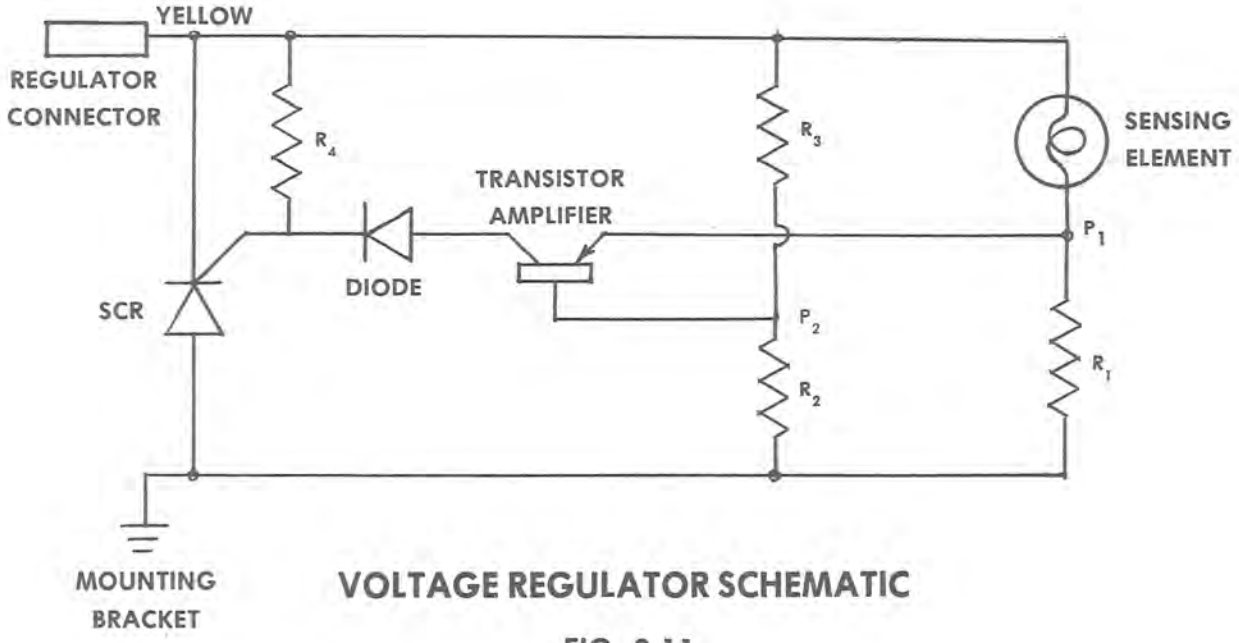
FIG. 3-9

VOLTAGE REGULATION

Functional Description:

The voltage regulator is connected across the lighting coils in parallel with the electrical load of the sled. Under operating conditions, the voltage drop across the regulator is such that 13.8 volts RMS is supplied to the snowmobile lighting circuit.

FIG. 3-10



VOLTAGE REGULATOR SCHEMATIC

FIG. 3-11

VOLTAGE REGULATOR CHECKS

1. Resistance across regulator

   Two most common catastrophic failure modes of the regulator may be identified by simply checking the resistance of the regulator.

   a. Burned out sensing element.

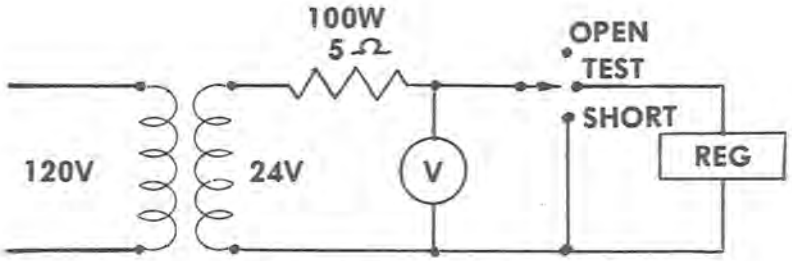
      Normal resistance across the regulator is approximately 155 - 160 . The symptom of a burned out sensing element is a significantly increased resistance reading.

   b. Shorted SCR.

      Shorted SCR is characterized by a significantly reduced resistance reading.

2. Set point check

   Use test circuit as shown below. Read voltage across regulator. Value should be 13.8 ± .5V.



REGULATOR SET POINT TEST CIRCUIT

FIG. 3-12

ELECTRICAL CONTROL AND DISTRIBUTION

Functional Description

Power is supplied continuously to the brake light switch, so that any time power is being generated, the brake light will go on if the brake is applied.

Power to all the other items is supplied through the ignition switch in the "LIGHTS" mode.

Grounding of the System is accomplished at three locations:

1. To the chassis at the rear end
2. To the chassis from wire harness at eng. connector.
3. To the stator plate on the engine

MAIN ELEMENTS:

1. Main Wiring Harness
2. Seat Wiring Harness
3. Taillight Wiring Harness
4. Safety Stop Switch
5. Break Light Switch
6. Hi-Lo Switch
7. Ignition Switch
8. Headlight Harness

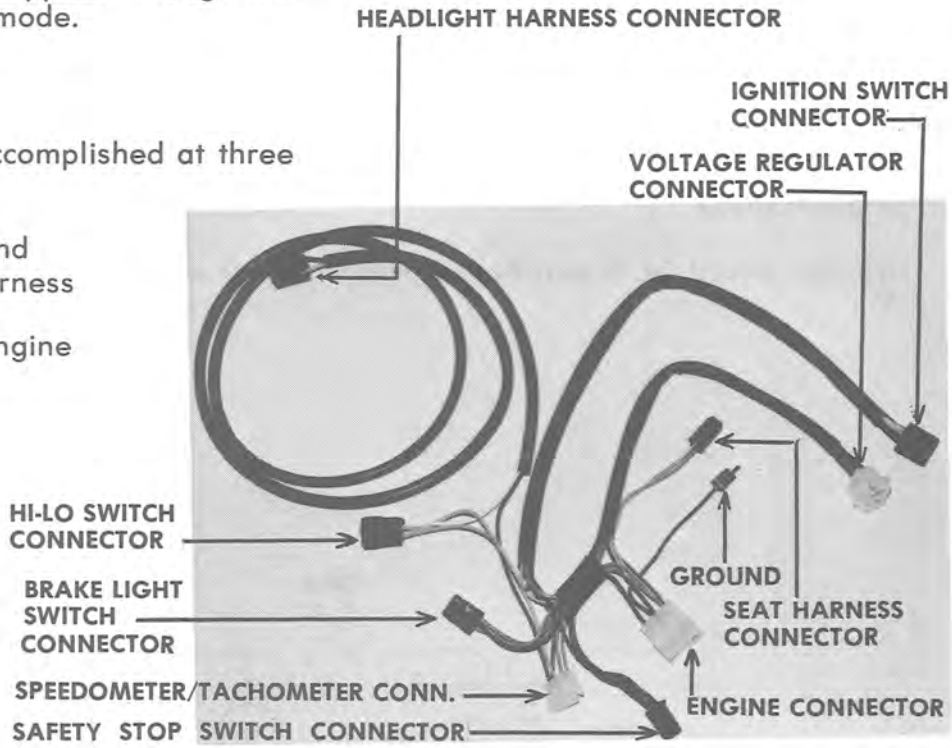


FIG. 3-13

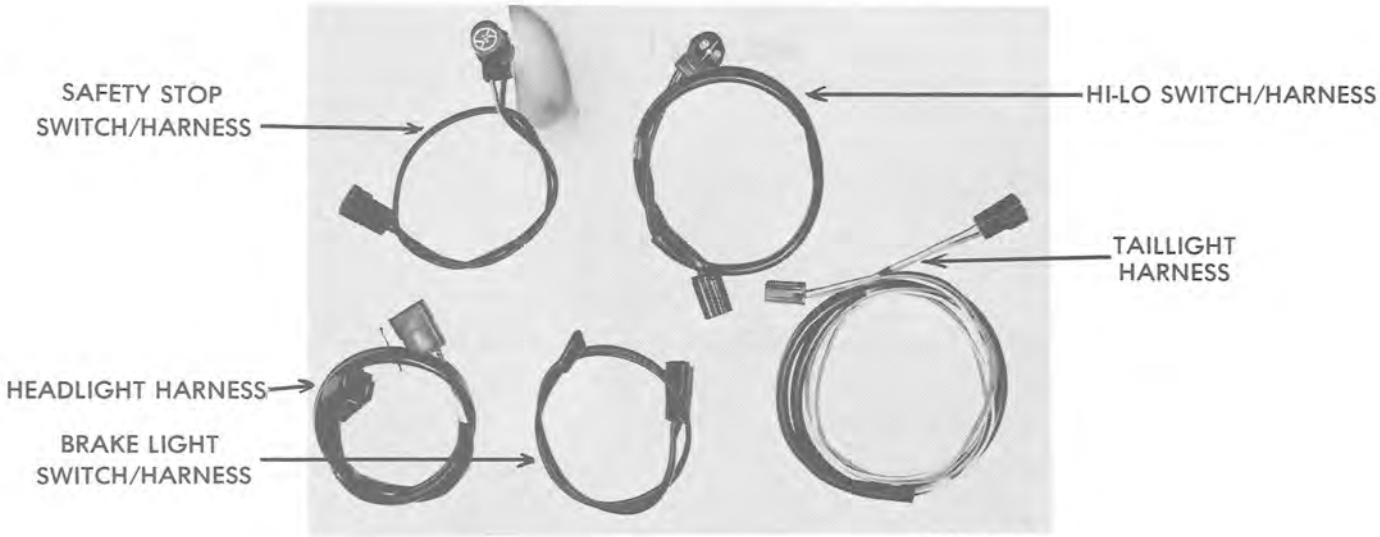
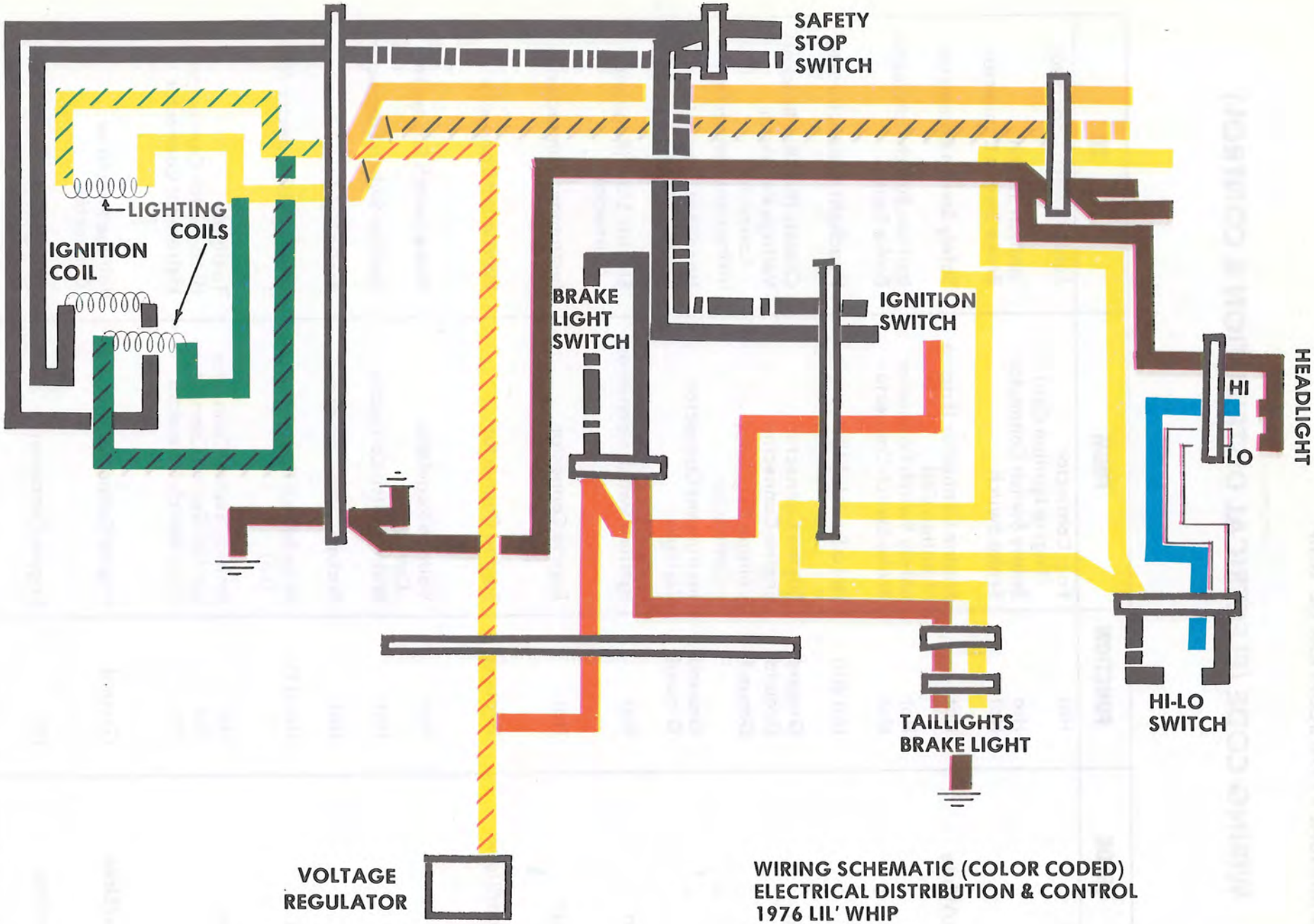


FIG. 3-14



WIRING SCHEMATIC (COLOR CODED)
ELECTRICAL DISTRIBUTION & CONTROL
1976 LIL' WHIP

FIG. 3-15

WIRING CODE (ELECTRICAL DISTRIBUTION & CONTROL)

COLOR	FUNCTION	FROM	TO
Black	Hot	Eng. Connector (Engine Ignition Coil)	Safety Switch Connector
	Hot	Safety Switch Connector	Ignition Switch
	Hot	Brake Switch	Brake Switch Connector
Black/White	Hot	Engine Connector (Engine Ignition Coil	Safety Switch Connector
	Hot	Safety Switch Connector	Ignition Switch Connector
	Hot	Brake Switch Connector	Brake Switch
Blue	Hot (Hi)	Hi-Lo Switch (Hi)	Headlight Connector (Hi)
Brown	Ground	Engine Connector	Chassis (Roll Bar Bracket)
	Ground	Engine Connector	Voltage Regulator Connector
	Ground	Voltage Regulator Connector	Instrument Connector
	Ground	Instrument Connector	Headlight Connector
	Ground	Taillight	Chassis (Tunnel)
Green	Hot	Ignition Switch Connector	Electric Start (Regulator Connector)
Orange	Hot	Engine Connector	Instrument Connector
Orange/Black	Ground	Engine Connector	Instrument Connector
Red	Hot	Voltage Regulator Connector	Brake Switch Connector
	Hot	Brake Switch Connector	Ignition Switch Connector
Tan	Hot	Brake Switch Connector	Brake Lights
White	Hot (LO)	Hi-Lo Switch Connector (Lo)	Headlight Connector (Lo)
Yellow	Hot	Ignition Switch Connector	Taillights
	Hot	Ignition Switch Connector	Hi-Lo Switch Connector
	Hot	Hi-Lo Switch Connector	Instrument Connector
Yellow/Black	Ground	Engine Connector	Voltage Regulator Connector
Yellow/Red	Hot	Engine Connector	Voltage Regulator Connector

TROUBLE SHOOTING (ELECTRICAL)

TROUBLE	PROBABLE CAUSE	REMEDY
No lights	Open Circuit: Faulty Switch(s) Separated Connector(s) Cut Wiring	Repair or replace faulty or damaged element.
	Wiring shorted to ground: Damaged Insulation	Repair or replace damaged or faulty element.
	Faulty Regulator (Shorted SCR)	Replace regulator.
Dim lights	Shorted or open lighting coil.	Replace armature plate.
	Faulty regulator - Incorrect regulator set point (too low).	Replace regulator.
Burned out lights (all)	Faulty regulator -Incorrect Set Point (too high).	Replace regulator and failed bulbs.
Burned out lights (individual)	Failed bulb.	Replace bulb.
Burned out lights	Intermittent short in wire harness.	Repair or replace wire harness.
Engine won't run Weak or no spark	1. Open or shorted windings in ignition coils (stator).	1. Replace armature plate.
	2. Open or shorted windings. in external ignition coil.	2. Replace external coil.
	3. Shorted condenser - dirty or worn.	3. Replace condenser.
	4. Damaged (burned) points.	4. Replace points.
Engine won't run - Adequate spark.	1. Burned or fouled plugs.	1. Replace plugs. Determine that correct plugs are being used. CHECK ENGINE TROUBLE SHOOTING.
	2. See Engine Trouble Shooting Section	
Unacceptable Engine Performance	See Engine Trouble Shooting Section	

1976 Scorpion Lil' Whip

Service Manual

Clutch/Drive Section

DRIVE SYSTEM

Functional Description:

The main elements included in this system are:

1. Drive Clutch
2. Drive Belt
3. Driven Clutch
4. Chain Case with sprockets, chain and chain tensioners.
5. Drive shaft with track drive sprockets.

The power from the engine is transmitted through this system to the track in sequence of elements listed above to propel the machine.

The drive clutch, belt and driven clutch serve as a torque converter. The torque converter on the snowmobile "down shifts" to a lower ratio as the track load increases as readily as it "up shifts" when the track load decreases.

To accomplish the automatic shifting, the movable sheave of the driven clutch is fitted with a helical ramp which is guided by a follower. This sheave is controlled by a spring pre-stressed in torsion and compression to hold the sheaves together at the maximum pitch diameter.

Under acceleration, the torque from the engine is greater than the demand from the track. The drive clutch then closes, forcing the belt outward between the sheaves. Belt tension and wedging action is unbalanced at the driven clutch and the sheave faces are wedged open against the helical cam. This action winds up and compresses the spring.

Under steady running, all forces are balanced and the belt chooses a ratio at which this balance exists.

Under deceleration, the driven sheave is stalled slightly, which unbalances the forces so that the sheave is forced to a new larger pitch diameter. Belt tension is thus increased, the wedging action opens drive sheave and a new lower pitch diameter is chosen to again bring all forces to balance.

DRIVE CLUTCH DISASSEMBLY

1. Open hood and clutch guard.

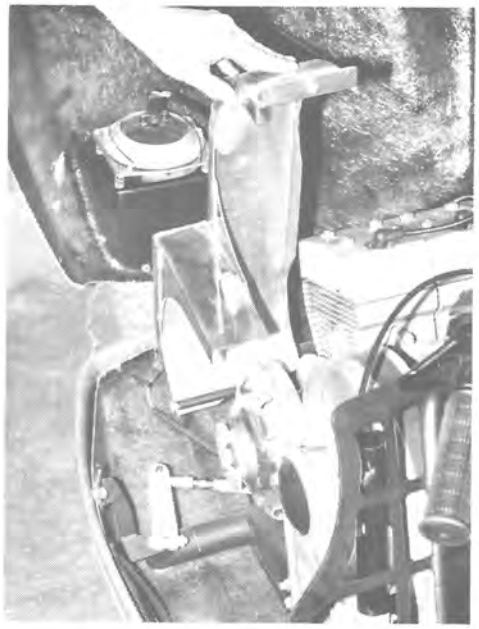


FIG 4-1

2. Remove clutch attaching bolt and bell retaining bolt. Use impact wrench capable of 75 or more ft. lbs. torque (In the field alternate method may be used.) Making sure ignition is off, run engine up on compression using ¾" socket and ratchet. Strike ratchet with plastic or rubber mallet. (See Figure 4-2).

FIG 4-2

3. Remove bell housing (See Figure 4-3.)

FIG. 4-3

4 Movable sheave should slide off spline easily. Next remove spring and retainer. (See Figure 4-4.)

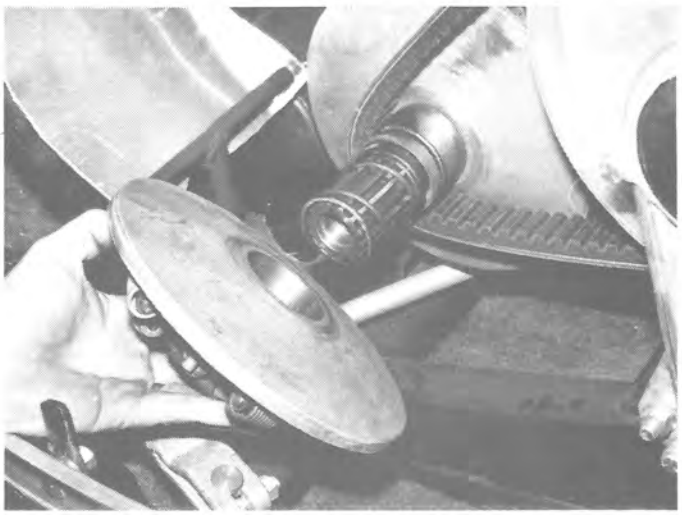


FIG 4-4

5. Remove snap ring retainer and idler bearing if necessary. (See Figures 4-5 and 4-6.)

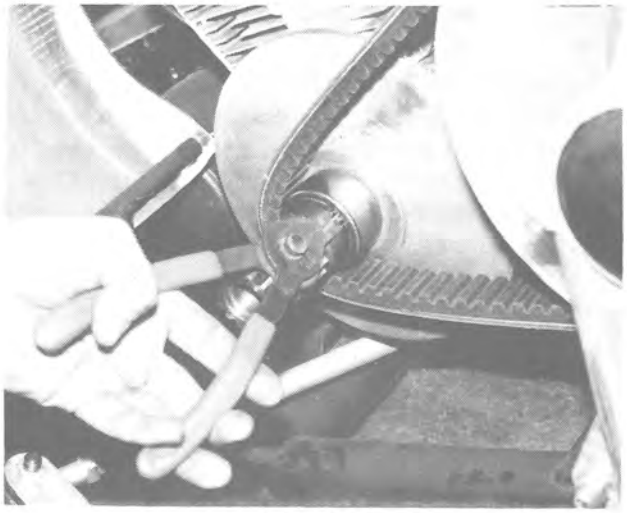


FIG. 4-5

FIG. 4-6

6. If necessary to remove stationary sheave, insert plug (2 13/16" long x 3/4" diameter) in stationary center hole and re-insert bell retainer bolt. Tightening bell bolt will force stationary off crankshaft. (See Figure 4-7.)

FIG. 4-7

7. Removing torque plug retainer will allow torque plug to be removed and inspected. (See Figure 4-8.)

FIG. 4-8

8. Detaching springs and weight arm retainers will allow weight arms to be removed. (See Figures 4-9, 4-10, 4-11.)

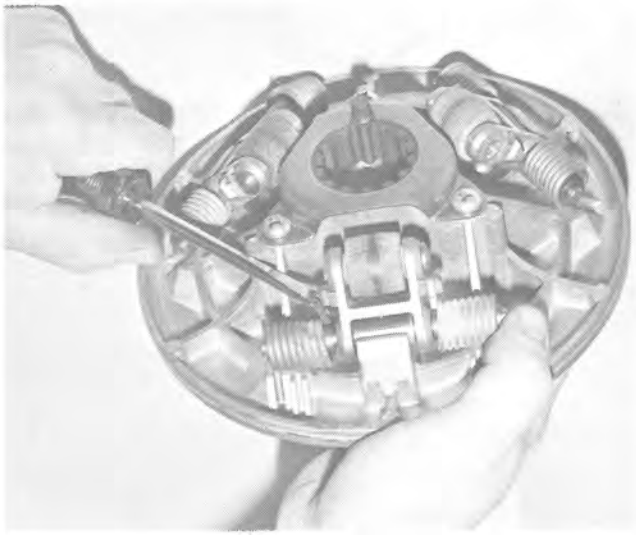


FIG. 4-9

DRIVE CLUTCH INSPECTION

Inspect weight arm bushings and rollers for cracks and flat spots. Also check snap rings on weight arm shaft ends.

Inspect torque plug for fit and wear. (Should have no more than .020" space between torque plug and casting.)

Inspect idler bearing for freedom of rollers and retention of lubricant.

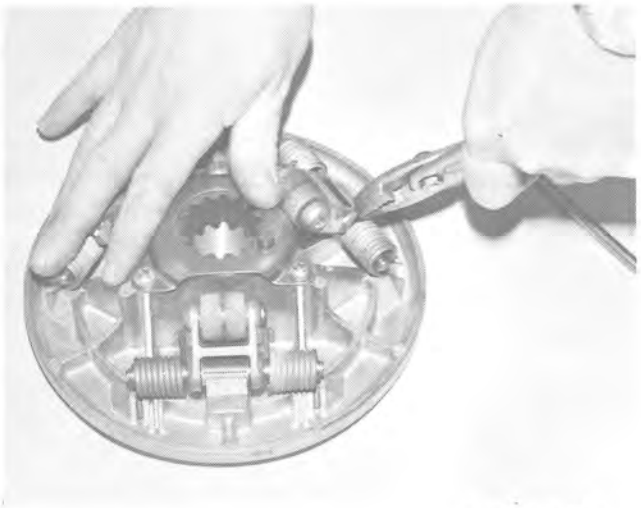


FIG. 4-10

Inspect snap ring groove on stationary and spring retainer for wear.

Inspect bell housing for cracks, particularly in center area near spline.

FIG. 4-11

RE-ASSEMBLY OF DRIVE CLUTCH

CAUTION: If stationary has been removed, assure that there is no grease on either the shaft or sheave before re-assembly.

Re-install idler bearing, snap ring, retainer and spring. Place weight arms on movable sheave (after checking them for lubrication). Attach retainers, checking to see that the small locating hole in the bearing aligns with the detent on inner face of retainer. Install torque plug and torque plug retainer. Install bell housing, checking alignment with stub on torque plug provided for this purpose. Place spring washer and bell retainer bolt on next, assuring that the bolt has bottomed out securely in proper alignment. Install clutch attaching bolt. Torque on both bolts to 50 ft. lbs.

FIG. 4-12

FIG. 4-13

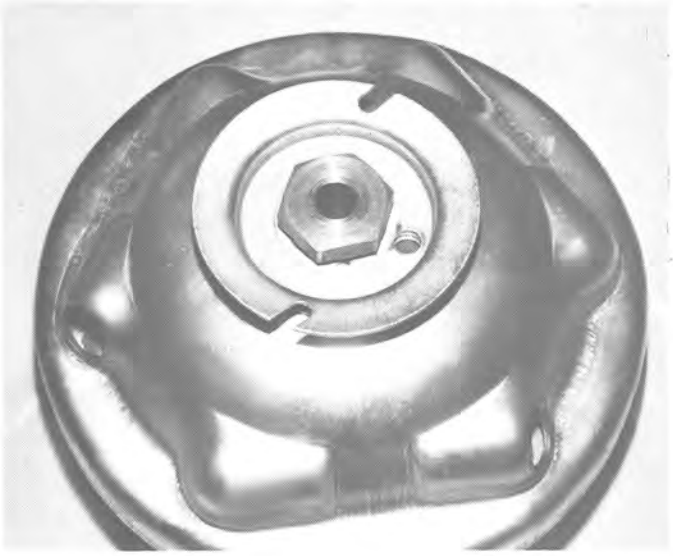


FIG. 4-14

DRIVEN CLUTCH DISASSEMBLY

1. Remove chain case cover.

2. Remove chain tensioners, unbolt and remove top sprocket and chain .

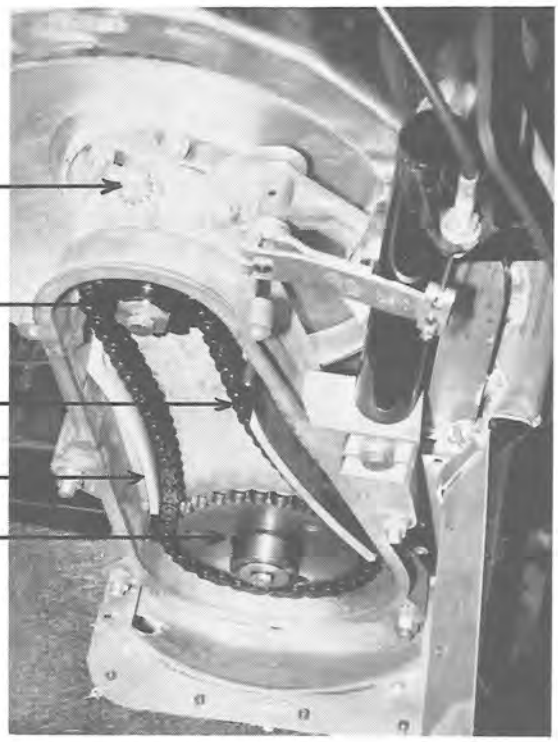


FIG. 4-15

3. Remove driven unit from chaincase (tapping shaft lightly with plastic mallet). Remove snap ring and washer from cam top and slide off shaft. (See Figures 4-16, 4-17, 4-18).

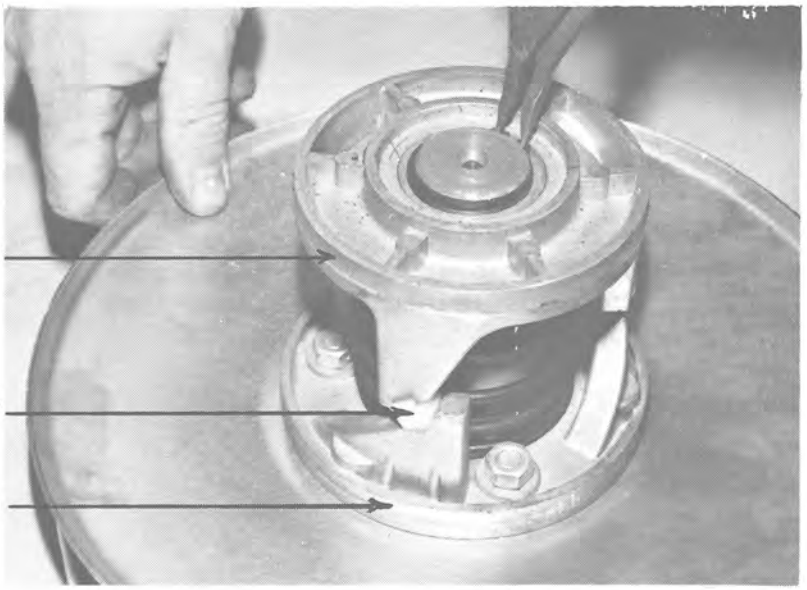


FIG. 4-16

FIG. 4-17

FIG. 4-18

4. Remove key and main spring. (See Figure 4-19).

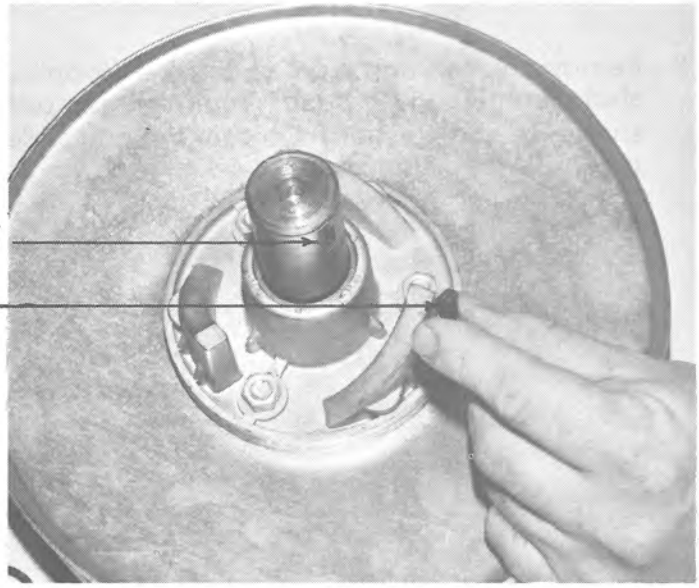


FIG. 4-19

5. This should allow cam bottom and movable sheave to be removed as a unit (See Figure 4-20), and disassembled if necessary. (See Figure 4-21.)

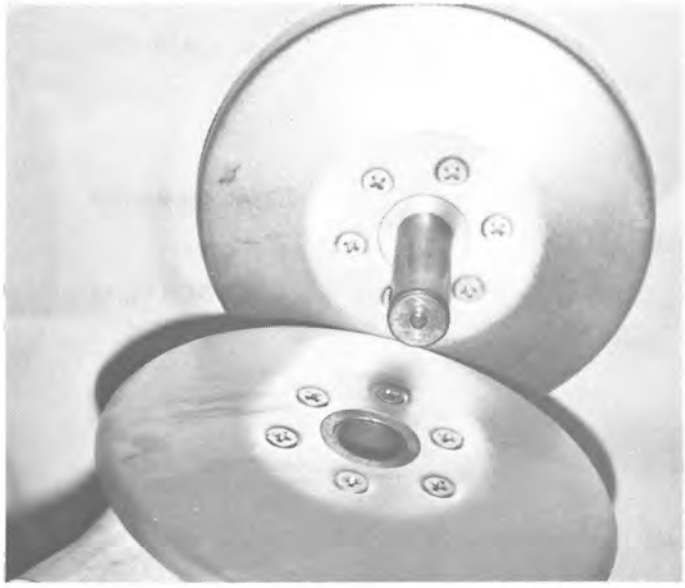


FIG. 4-20

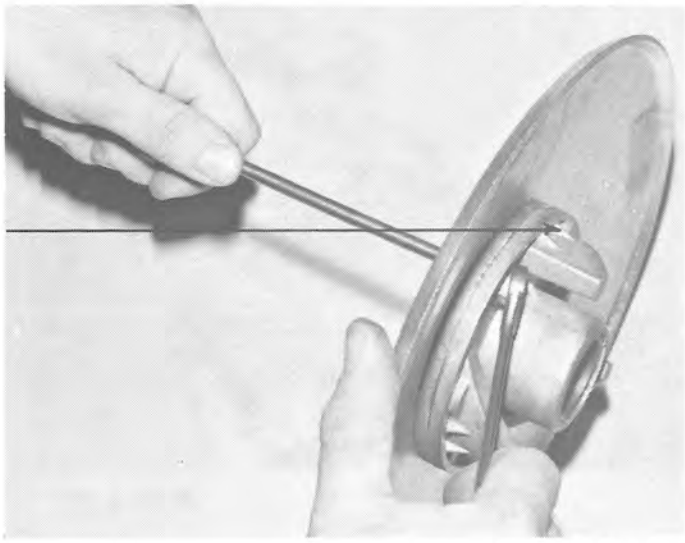


FIG. 4-21

6. Stationary sheave may then be unbolted from clutch shaft (See Figures 4-22 and 4-23) and bearings can be pressed off if necessary.

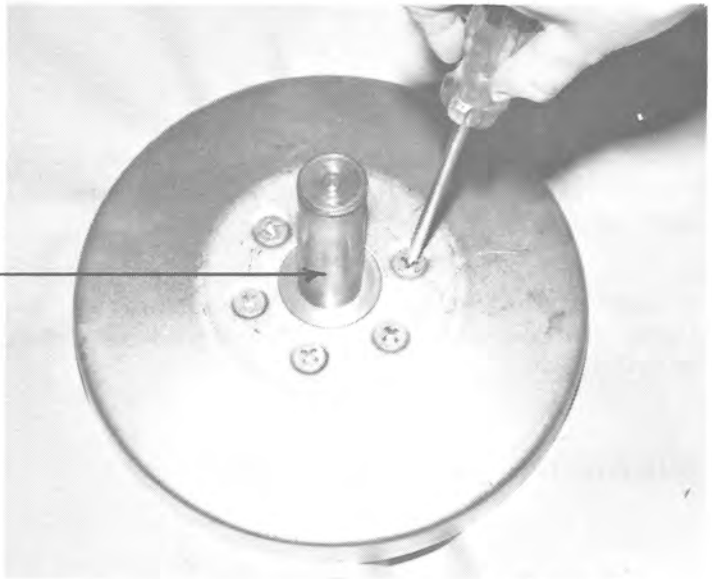


FIG. 4-22

FIG. 4-23

DRIVEN CLUTCH INSPECTION

Inspect snap ring groove for wear.

Inspect Helical ramps for wear and breakage. (See Fig. 4-16).

Inspect bronze bushing in cam bottom for any signs of looseness or slippage (should be staked in solidly).

Rotate and check bearings visually.

Inspect sheaves for cracks particularly around bolt holes.

Check splines and threads on sprocket side of main shaft for wear, crossthreading, etc.

RE-ASSEMBLY OF DRIVEN CLUTCH

Attach stationary sheave to clutch shaft. Assemble cam bottom and movable, then place on shaft followed by the woodruff key and main spring. Place cam top on shaft, preloading spring ⅓ turn and install washer and snap ring.

Upon replacing the driven clutch in chaincase, check to assure that the O-ring in chaincase bore is intact and in good condition. Also check O-ring in chaincase cover before installation.

DRIVE BELT SPECIFICATIONS

Drive belt width	1 1/8 - 1 3/16 inches
Drive belt outside diameter inches.	43 1/8 - 43 1/4

Clutch offset (Drive to Driven) - 3/8 inch

Center to center distance - 10½ inches
(Drive clutch to Driven clutch)

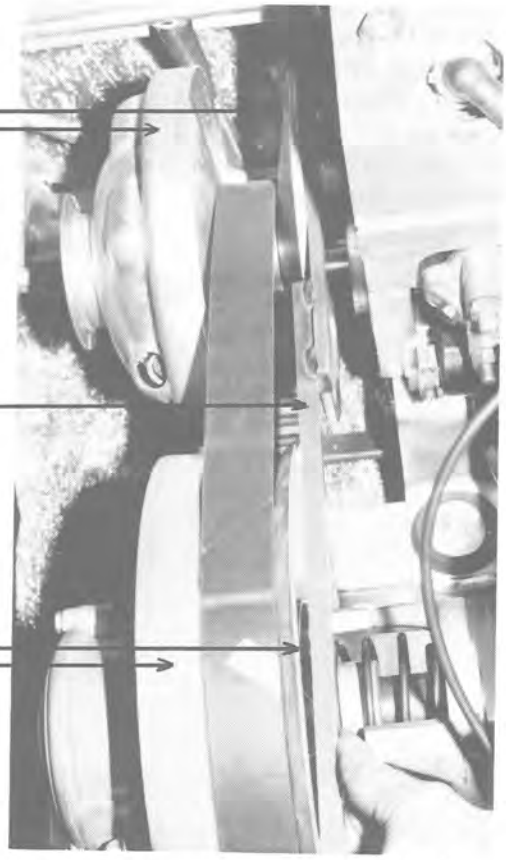


FIG. 4-24

CHAINCASE DISASSEMBLY

Remove brake cable at chain case end. Remove cover, tensioners, upper and lower bolts. Remove sprockets with chain. Remove bearing flange bolts and brake cable. Taking care to check number of shims between the chaincase and the tunnel and their specific locations, remove the chaincase from the tunnel. When the chaincase is reassembled to tunnel, assure that the spacers go back where they were. Before tightening case to tunnel be sure to adjust case to achieve correct center distance of 10½" between center of driven and drive clutches. Reverse procedure to install.

REMOVAL OF FRONT DRIVE SHAFT

Remove brake cable at chain case end. Remove chaincase cover, tensioners, lower sprocket and chain. Loosen locking collars on front drive bearings (see Fig. 4-25). Remove speedometer, drive adaptor and flanges. Slide drive shaft through chaincase mounting hole until right side clears main frame and remove. (It is necessary to detach forward end of pararail to gain clearance for entire removal of front drive shaft - See Suspension Section.)

REMOVAL OF FRONT DRIVE SPROCKET

Punch out spirol pins (see Fig. 4-25, 4-26). Then taking care to see that the shaft is clean, slide sprockets off. To reassemble, reverse procedure.

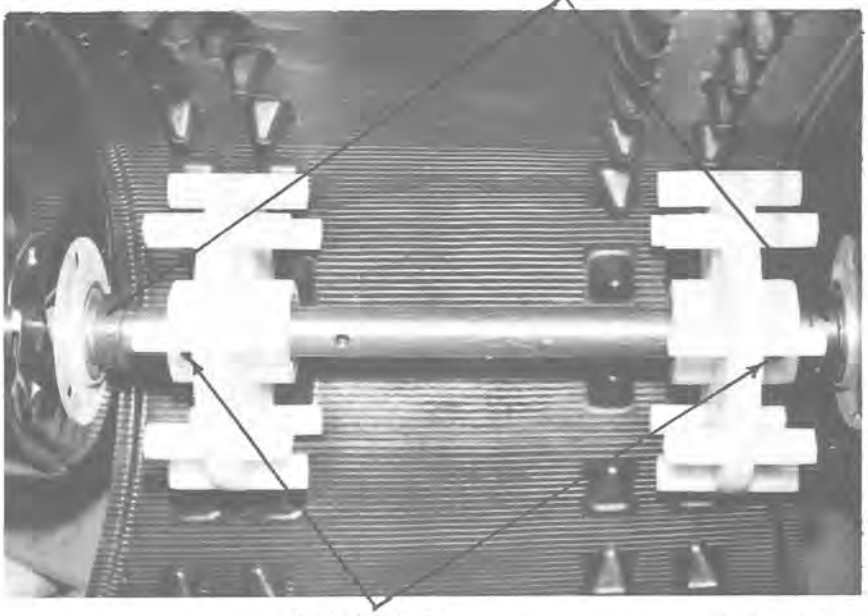
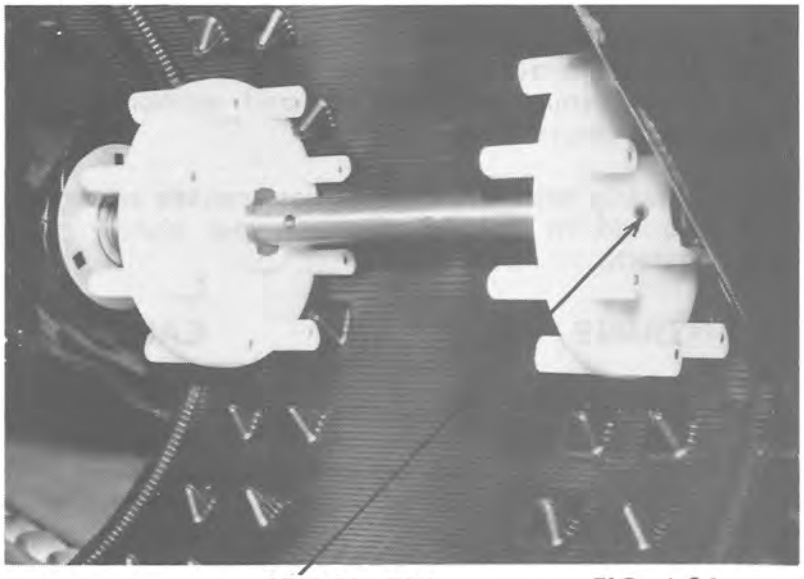


FIG. 4-25



SPIROL PIN

FIG. 4-26

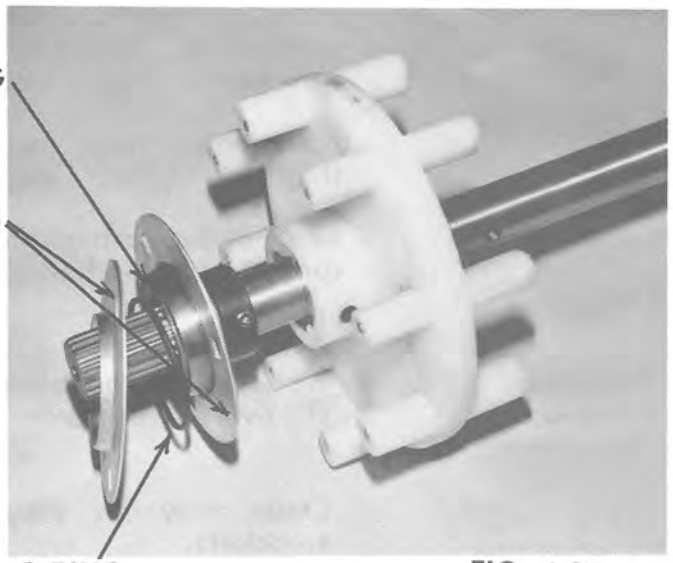


FIG. 4-27

Inspection of Drive Shaft

Observe shaft for signs of stress, cracks and bending, check bearings and collars for breakage. Check sprockets for loosening of pin holes.

NOTE: Small cracks in the white material of the drive sprocket are not signs of failure, but a result of shrinkage during manufacture.

TROUBLE SHOOTING

The operating diameter of the drive and driven clutch governs the ratio of reduction or advantage in the snowmobile drive train. Therefore, to gain maximum performance and economy, these areas cannot be overlooked.

The following are some symptoms, causes and cures to aid in trouble shooting the clutch/ drive system.

TROUBLE	CAUSE	REMEDY
Engine Overspeed:	Drive clutch may not be closing fully. This can be checked by drawing a line on the face of the sheave (drive or driven) with a crayon from the center outward. Then running the machine at top speed will tell you how far the clutch closed by erasure of the line by the belt.	Disassemble clutches examine and replace malfunctioning parts.
	If the clutch is closing fully, the belt may be wrong length or the center to center distance of the clutches may be off. Finally, check the number of teeth on upper and lower sprockets.	Replace belt. Correct center to center distance (see belt specs.) Replace incorrect sprocket.
	Tachometer may be reading incorrectly (high)	Replace tach.
	Belt may be worn and too narrow to achieve correct ratio (see belt specs).	Replace belt.
Excessive vibration of drive train:	Track may be too loose allowing sprockets to slip over drive lugs or "ratchet".	Correct track tension.
	Chain may be slipping over teeth on sprockets.	Check and replace broken or weak chain tensioners.
Excessive noise from front drive system:	Malfunction of front drive bearings.	Replace bearings.
	Chain case may be dry of oil.	Disassemble and check - chain, sprockets and chain case cover seal (O ring) replace worn parts and reassemble. Refill with oil check level and check for leaks.

1976
Scorpion
Lil' Whip

Service Manual

Suspension
Section

FUNCTIONAL DESCRIPTION:

The four main elements of a snowmobile suspension are:

1. Skis
2. Track Suspension
3. Seat
4. Operator

All elements work together to perform the suspension functions to the optimum degree.
The suspensions are basically designed to:

1. Protect the operator from physical abuse or injury.
2. Keep the operator from being ejected from his operating position and controls.
3. Prevent damage to the machine.
4. Increase ground contact and improve traction.

On the 1976 Lil' Whip, the track suspension (truck bogey) is a multiple type suspension unit which means that it has a number of separate components. It possesses the advantage of being able to traverse marginal snow conditions without damaging effects to the suspension system.

SUSPENSION SYSTEM - REMOVAL, DISASSEMBLY, ASSEMBLY

(A) REMOVAL.

1. Raise and block vehicle off the ground.

   Loosen the two (2) sliding nuts.

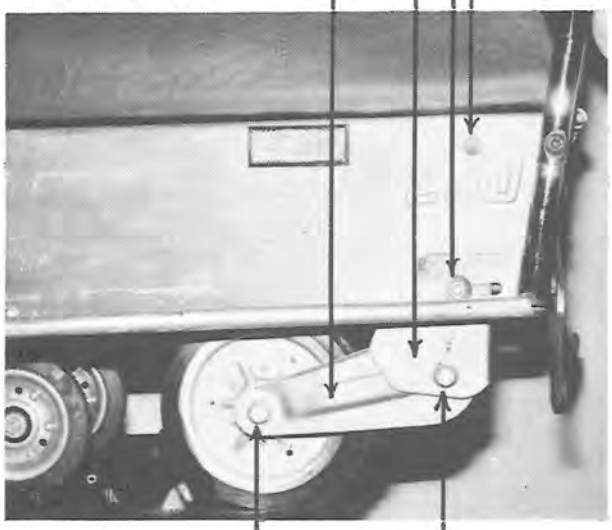


FIG. 5-1

2. Remove the two (2) adjusting bolts from the draw blocks. This will relieve the track tension and permit easy removal of the bogey units.

FIG. 5-2

3. Remove the two (2) bolts that anchor the rear bogey assembly to the tunnel. Pull the assembly down to disengage the assembly axle from between the mounting brackets. The assembly will come out as a unit. Remove the front bogey assembly in the same manner.

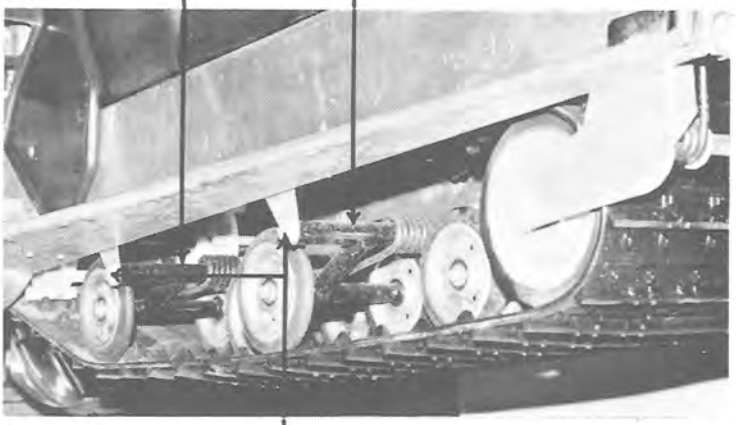


FIG. 5-3

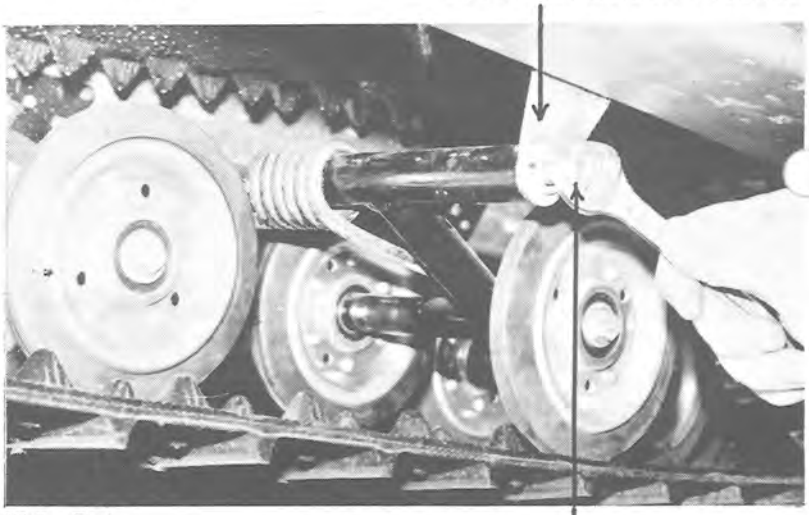


FIG. 5-4

4. Release the two rear idler spring tangs from the adjustment notches. Note in which notch the springs are inserted. Remove the sliding nuts, draw blocks and tension pivot bolts. (See Fig. 5-1, 5-2). Remove the rear idler assembly as a unit.

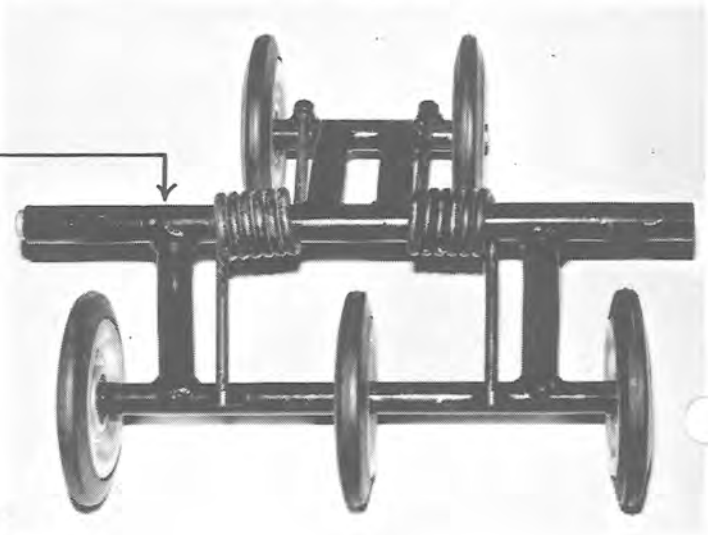


FIG. 5-5

(B) DISASSEMBLY

1. Bogey Assembly.

Remove four (4) hex screws which secure the wheels to the cross shafts.

Remove the four outside bogey wheels.

Remove the suspension shaft and the long cross shaft.

Slide the keeper of the left-hand tubing weldment off the spring tang.

Remove the spring from the center tubing weldment.

Repeat process for right-hand side of assembly.

NOTE: Cross shafts are left in position in photographs for clarity of illustration.

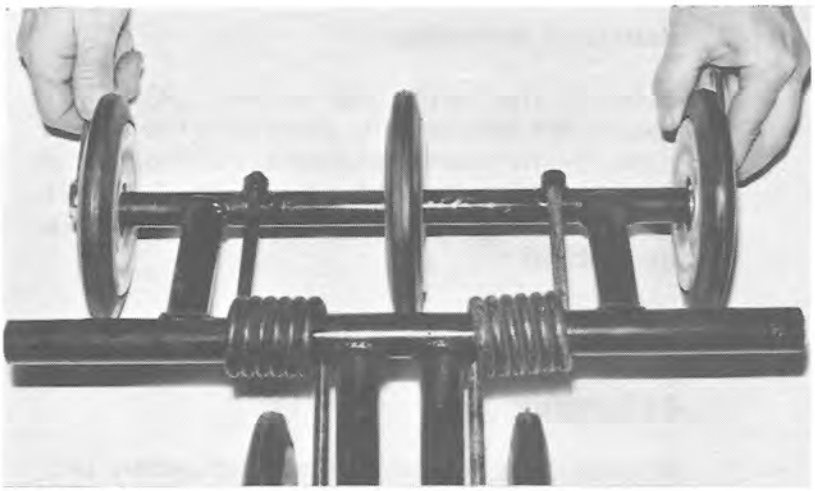


FIG. 5-6

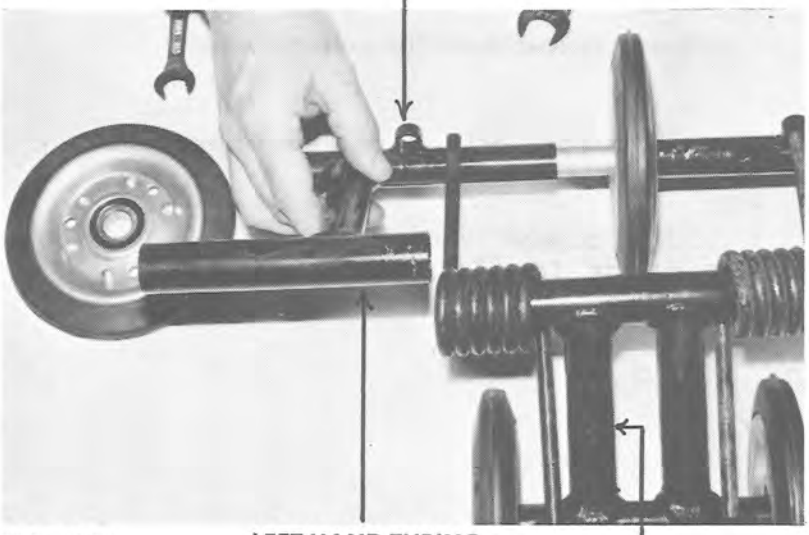


FIG. 5-7

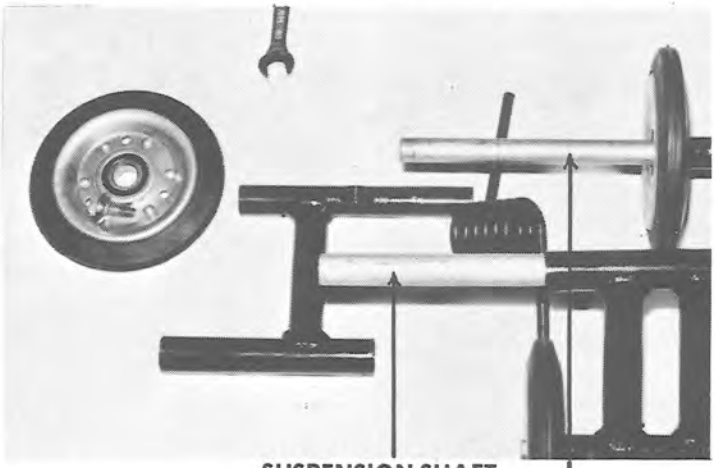


FIG. 5-8

2. Rear Idler Assembly.

   Remove the whiz lock screws (4) which secure the tension adj. plate and the flipper plate to the shaft weldment and the flipper plate to the axle shaft. (See Figs. 5-1, 5-2). The assembly may then be completely disassembled.

(C) ASSEMBLY

To assemble the units, the disassembly procedure is reversed.

Torque requiremenns for assembly are:

Whiz Lock Screws on rear idler assembly - 45 Ft/Lbs.

Hex Screws which secure wheels to cross shafts - 15 - 14 Ft./Lbs.

SPECIAL ADJUSTMENTS

REAR IDLER SUSPENSION ADJUSTMENT

The rear idler spring adjustment governs preload and should be correlated with the weight of the rider normally using the machine.

Too much spring tension will result in a harsh ride and increases the weight carried on the skis, thus increasing steering effort.

Too little spring tension will result in the bottoming out of the suspension. A harsh ride and shortened life to the suspension components will occur.

1. Proper spring tension is a function of operator weight and preference. Therefore, the correct setting can only be determined by a trial ride.

2. To adjust, move spring tang to desired slot, making certain that each spring is tightened or loosened the same amount. Check track alignment after changing spring setting.

3. Evaluation by the rider may require further adjustment to obtain the desired riding qualities.

FIG. 5-9

TRAILING ARM BOGEY SUSPENSION: TRACK TENSION

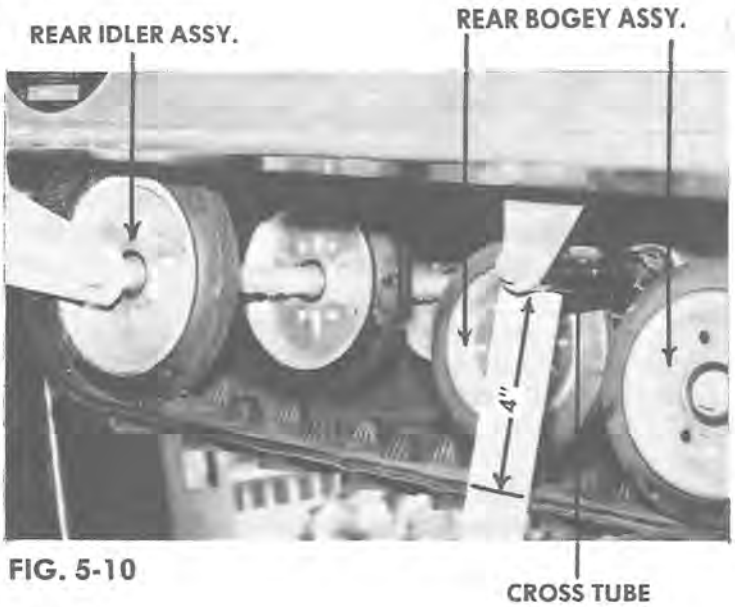


FIG. 5-10

Proper track tension is extremely important to assure long life of all associated components and efficiency of the track drive system.

The track tension should be checked at the following intervals:

1. When the machine is new (dealer preparation).
2. After the first hour and 10 hours.
3. Every 30 days, or 200 miles of operation.
4. At the start of each snow season.
5. Upon hearing track sprocket ratcheting. Ratcheting is most noticeable under hard acceleration or a braking condition. (Ratcheting is best explained as a harsh grinding or thumping noise.)

The following procedure is recommended for adjusting track tension:

1. The track should be at room temperature or should have been recently run to remove any stiffness, caused by cold weather.
2. Raise the rear of the sled so that the track is clear of the floor.
3. Measure distance between bottom of Bogey Cross Tube at rear Bogey Set and inside of track. Measurement should be 4.0" and should be made on both sides of machine. (See Fig. 5-10).
4. Loosen the two (2) tension pivot bolts and the two (2) sliding nuts to allow the tension plates to move. (See FIG. 5-1) if adjustment is necessary.
5. Tighten or loosen the draw bolts located at the rear of the sled (See FIG. 5-2) to properly tension the track.
   NOTE: Make certain that the fasteners are retightened after adjustments are complete.
6. If ratchetting is noted after making suspension adjustments, track tension will have to be increased slightly as follows: Loosen tension pivot bolts and sliding nuts, and tighten the draw bolts one-half turn. If ratchetting continues, repeat the process.