

# S E R V I C E   H A N D B O O K

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T O A L L S K I - D O O D E A L E R S

The various texts contained in this Handbook were originally put together to serve as a reference manual for the Distributors who were to conduct Service Schools.

The different sections of this handbook cover the Ski-Doo engines, carburetion and electrical system, plus a brief look on fiber glass body repair. More texts are liable to be added to these later on.

The 1969 Ski-Doo Service Handbook was made available to dealers following requests by Distributors. We trust you will be entirely satisfied with it.

BOMBARDIER LIMITED

Publication Dept.

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## INTERNAL COMBUSTION ENGINE BASIC

The two-cycle gasoline engine was first developed in the latter part of the 19th. Century. Before World War II, it was used as an outboard engine for sporting, fishing and small boat racing. Later on, it was employed on farms and ranches to power electric generators and water pumps. After World War II, the small two-cycle gasoline engine really came through as a power plant.

Nowadays, there are many more uses for two-cycle gasoline engines. They equip chain saws and lawn-mowers, hole-digging machines to install telephone poles or to plant trees, handling carts, racing carts and septic tanks drainers. The small two-cycle gasoline engine has become the ideal and most reliable source of power in use in the world today.

The easiest way to understand how our two-cycle engine operates is to compare it with a four-cycle engine. Originally, both engines were known as two-stroke and four-stroke-cycle engines. The word stroke was later dropped, which left the terms two-cycle and four-cycle engines. However, the word stroke is still the key to the main difference of operation of these two engines.

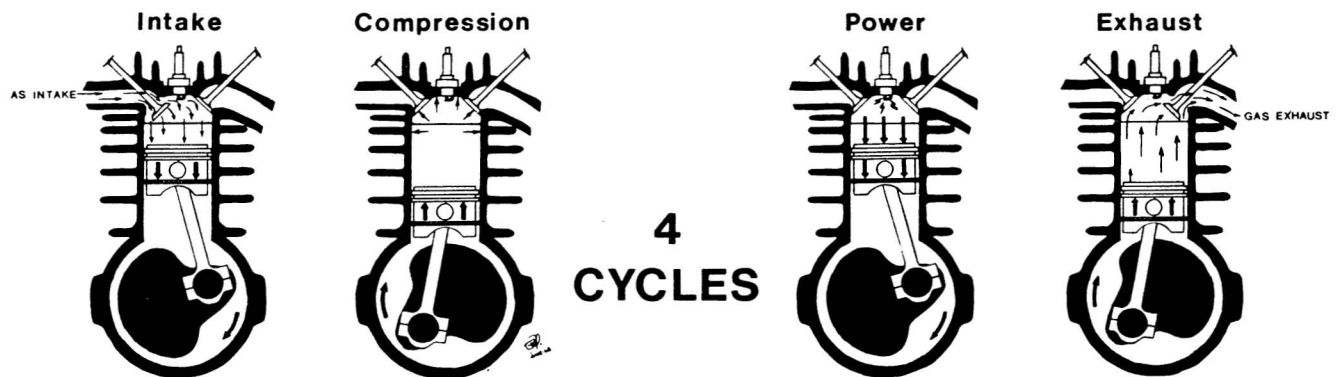
On the four-cycle engine, four strokes are required for the piston to achieve its full cycle. The piston of the two-cycle engine goes through the same cycle in two strokes only. The four-cycle engine has valves, valve lifters, valve springs, a camshaft and camshaft drive gears in addition to the fly-wheel, piston, crankshaft and connecting rods. The two-cycle engine has no camshaft, valve springs or valve lifters; moreover, its piston acts as a slide-valve in most cases. The four-cycle engine crankcase is used as a lubricating oil storage pump while the lubrication of the two-cycle engine is achieved by mixing oil with the gasoline. Therefore, the crankcase of this last engine serves as a fuel mixture transfer pump.

### FOUR-CYCLE OPERATION

At the beginning of the intake stroke of the four-cycle engine, the intake valve is opened and the piston is at the top of the combustion chamber. As the piston moves downward toward the crankshaft, the fuel is sucked into the combustion chamber.

At the bottom of the first stroke, the intake valve closes and traps the fuel into the combustion chamber. This fuel

charge is then compressed when the piston goes upward with the second stroke. The fuel charge is ignited by the spark plug just before the piston arrives at the top of this stroke. The fuel charge does not explode, it burns and spreads across the combustion chamber so to give an increasing pressure which drives the piston downward as it comes past top dead center. This produces the third stroke of the piston which is the power stroke, caused by the expansion of the heated gas which shoves the piston down. When the piston reaches the bottom of this third stroke, the exhaust valve opens and the burned gas is pushed out of the combustion chamber by the piston coming up for the fourth stroke. At the top of this stroke, the exhaust valve closes, the inlet valve opens and the piston is ready to begin a new cycle.



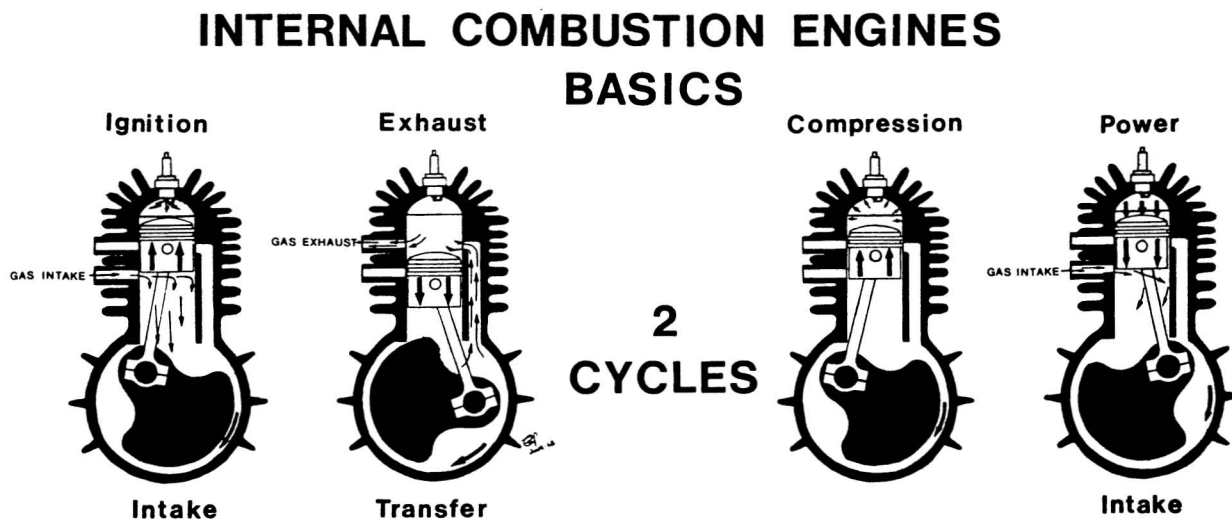
## INTERNAL COMBUSTION ENGINES BASICS

### TWO-CYCLE OPERATION

The two-cycle engine has to do in two strokes what is done by the four-cycle engine in four strokes. In addition, the crankcase must be charged with the air-fuel mixture that will be pumped into the combustion chamber. On the upward stroke of the piston, the crankcase must be charged and the fuel compressed and ignited while the downward stroke must permit the exhaust of the burned gas and the intake of a fresh fuel charge.

Figure "00" shows how this is possible through the use of three openings or ports; two ports open into the combustion chamber\* and the other one into the crankcase from the carburetor.

\*Rotax use 2 transfer ports located on each side of the cylinder. Therefore, 3 ports at the time open into the combustion chamber (2 transfer and one (1) exhaust).



When the piston starts its upward stroke, a vacuum is created in the crankcase and the air-fuel mixture is sucked in from the carburetor. At the same time, the piston blocks the inlet and exhaust ports and compresses the fuel charge in the combustion chamber. When the piston arrives at the top of the cylinder, the fuel charge is ignited by the spark plug. The burning gas expands in the same way as in the four-cycle engine and pushes the piston downward; this causes the power stroke. When the piston descends, the entrance to the crankcase from the carburetor is blocked and pressure begins to build inside the crankcase. The exhaust port is uncovered as the piston continues its course downward, and the burned gas is allowed to escape. Near the bottom of this downward stroke, the inlet port is uncovered and the compressed air-fuel mixture in the crankcase rushes into the combustion chamber. To prevent some of the fuel charge to escape through the exhaust port, most small engine manufacturers shape the top of the piston to act as a barrier. This turbulence assists in clearing the combustion chamber of all the burned gas and limits the escape of the fresh fuel charge to a minimum.

## REFERENCE NOTES TO ENGINE BASICS

# ROTAX (ENGINE) SPECIFICATIONS

TYPE		300	320	370	371	640
ENGINE	DISPLACEMENT	299 C.C.	318 C.C.	368 C.C.	368 C.C.	638 C.C.
	MAX. H.P.	12.5 H.P.	18 H.P.	19 H.P.	22 H.P.	40 H.P.
	NUMBER OF CYLINDERS	ONE	ONE	TWO	TWO	TWO
	BORE	76 MM	76 MM	62 MM	62 MM	76 MM
	STROKE	66 MM	70 MM	61 MM	61 MM	70 MM
	COMPRESSION RATIO	6.5:1	8.8:1	9.15:1	9.1:1	9.1:1
	PISTON CLEARANCE	.004 to .006	.004 to .006	.004 to .006	.004 to .006	.004 to .006
ELECTRICAL SYSTEM	SPARK PLUG (Bosch) (Gap. 020)	M-240-T-1	M-240-T-1	W-225-T-1	W-240-T-1	280-T-1
	FLYWHEEL MAGNETO	12V. 50W.	M - 12V.50W. EL- 12V.75W.	12V. 75W.	12V. 75W.	12V. 75W.
	IGNITION TIMING (B.T.D.C.)	.150 to .170	.170 MAX.	.140 to .160	.150 MAX.	.170 MAX.
	BREAKER SPRING TENSION	.22 to .28oz.	.22 to .28oz.	.22 to .28oz.	.22 to .28oz.	.22 to .28oz.
	POINT GAP	.014 to .018	.014 to .018	.014 to .018	.014 to .018	.014 to .018
	EDGE GAP	.315 to .472	.315 to .472	.315 to .472	.315 to .472	.315 to .472
MISC.	FUEL (Min. octane)	75 oct.	75 oct.	75 oct.	75 oct.	75 oct.
	LUBRICATION RATIO (Ski-Doo oil)	20:1	20:1	20:1	20:1	20:1
	CARBURETOR (Tillotson model no.)	HR-7-A HR-7-B	HR-17-A HR-17-B	HD-8-B	HR-16-B	N.A.



REFERENCE NOTES TO SPECIFICATIONS

ENGINE REACTION	PROBLEM	CAUSE	CHECK POINTS
Rope comes out but pawls don't engage	Inoperative manual starter	Lack of friction spring action	<ol style="list-style-type: none"> <li>1. Pawls bent or broken</li> <li>2. Friction spring bent or burred</li> </ol>
Manual starter rope doesn't return	Inoperative manual starter		<ol style="list-style-type: none"> <li>1. Recoil spring broken or bent</li> <li>2. Pulley housing warped or bent</li> <li>3. Starting pulley worn</li> </ol>
Electric starter inoperative	Electric starter or dead battery	Faulty battery or shorted electrical circuits	<ol style="list-style-type: none"> <li>1. Loose connections</li> <li>2. Weak battery</li> <li>3. Faulty starter solenoid</li> <li>4. Moisture in electric starter motor</li> <li>5. Broken or worn brushes in starter motor</li> <li>6. Faulty starter switch</li> <li>7. Broken wire in harness or connector</li> <li>8. Bad ground</li> </ol>
Hard to start or won't start	Faulty carburetor or ignition	Improper air-fuel mixture; weak or no spark at spark plugs	<ol style="list-style-type: none"> <li>1. Carburetor adjustments too lean (Not allowing enough gas to engine)</li> <li>2. Inoperative diaphragm or flapper valve</li> <li>3. Motor not being choked to start</li> <li>4. Spark plugs improperly gapped, dirty or broken</li> <li>5. Magneto points improperly gapped or dirty</li> <li>6. Head gasket blown or leaking</li> <li>7. Empty gas tank</li> <li>8. Water in fuel system</li> <li>9. Weak coil or condenser</li> <li>10. Obstructed fuel system</li> <li>11. Primary wire broken</li> <li>12. Engine not timed properly</li> <li>13. Secondary wire not connected or spark plug protector not installed properly</li> </ol>

ENGINE REACTION	PROBLEM	CAUSE	CHECK POINTS
Impossible to adjust idle			<ol style="list-style-type: none"> <li>1. Spark retarding mechanism too late</li> <li>2. Too much clearance on ring gap</li> </ol>
Missing at low speed or won't idle smoothly or slowly	Faulty carburetor or ignition	Improper air-fuel mixture; weak or no spark to spark plug	<ol style="list-style-type: none"> <li>1. Carburetor idle adjustment</li> <li>2. Spark plugs improperly gapped or dirty</li> <li>3. Head gasket blown or leaking</li> <li>4. Loose or broken magneto wires</li> <li>5. Magneto points improperly gapped or dirty</li> <li>6. Weak coil or condenser</li> <li>7. Improper fuel mixture               <ol style="list-style-type: none"> <li>(1) Too much oil</li> <li>(2) Too little oil</li> </ol> </li> <li>8. Leaking crankshaft seal</li> </ol>
High speed missing or intermittent spark	Ignition	Not enough voltage to fire spark plug at high speeds	<ol style="list-style-type: none"> <li>1. Spark plugs improperly gapped or dirty</li> <li>2. Loose or broken magneto wires</li> <li>3. Magneto points improperly gapped or dirty</li> <li>4. Weak coil or condenser</li> <li>5. Heat range of spark plug incorrect</li> <li>6. Leaking head gasket</li> <li>7. Engine improperly timed</li> </ol>
Coughs, spits, slows down, surges	Carburetor too lean	Improper air-fuel mixture	<ol style="list-style-type: none"> <li>1. Idle or high speed jets too lean</li> <li>2. Leaking gasket flange</li> <li>3. Inlet control lever set too low</li> <li>4. Pulsation line obstructed</li> <li>5. Fuel pump not supplying enough fuel because:               <ol style="list-style-type: none"> <li>(1) Punctured diaphragm</li> <li>(2) Inoperative flapper valve</li> </ol> </li> <li>6. Crankcase not properly sealed</li> <li>7. Idle or main carburetor nozzle obstructed</li> <li>8. Fuel line obstructed</li> <li>9. Carburetor inlet needle and seat obstructed</li> <li>10. Welch plug leaking</li> </ol>

ENGINE REACTION	PROBLEM	CAUSE	CHECK POINTS
Motor runs too hot			<ol style="list-style-type: none"> <li>1. Carburetor too lean</li> <li>2. Carburetor too rich</li> <li>3. Incorrect timing</li> <li>4. Too much carbon</li> <li>5. Spark plug too hot</li> <li>6. Air deflector not installed</li> </ol>
Vibrates excessively or runs rough and smokes	Carburetor too rich	Improper air-fuel mixture	<ol style="list-style-type: none"> <li>1. Idle or high speed adjustment too rich</li> <li>2. Choke not opening properly (bent linkage)</li> <li>3. Inlet control lever too high (carburetor floods)</li> <li>4. Idle air bleed plugged</li> <li>5. Welch plug loose</li> <li>6. Silencer obstructed</li> <li>7. Motor not secured tightly to motor support</li> <li>8. Water in gas</li> <li>9. Water in the ignition switch</li> </ol>
Won't start, kicks back and backfires	Ignition system	Timing or edge gap adjustment	<ol style="list-style-type: none"> <li>1. Spark plug wires reversed (on two set points)</li> <li>2. Flywheel key (missing) sheared</li> <li>3. Bad condenser</li> <li>4. Improper timing</li> <li>5. Faulty breaker points</li> <li>6. Unhooked spark retarding mechanism (or spring broken)</li> </ol>
No acceleration, low top R.P.M., hard to start	Runs on one (1) cylinder	Fouled spark plug, faulty ignition system	<ol style="list-style-type: none"> <li>1. Spark plugs improperly gapped or dirty</li> <li>2. Magneto points improperly gapped or dirty</li> <li>3. Faulty coil or condenser</li> <li>4. Loose or broken magneto wires</li> <li>5. Blown head gasket</li> <li>6. Inlet lever adjustment too low</li> </ol>

ENGINE REACTION	PROBLEM	CAUSE	CHECK POINTS
Good spark but engine runs on (1) cylinder			<ol style="list-style-type: none"> <li>1. Leaking head</li> <li>2. Magneto wires broken inside (coil ground broken)</li> <li>3. Cracked cylinder wall</li> <li>4. Defective spark plug</li> <li>5. Seized piston</li> </ol>
High speed back-fires	Carburetor adjustment		<ol style="list-style-type: none"> <li>1. Lean carburetor adjustment</li> <li>2. Spark plug carbon</li> <li>3. Crankshaft oil seal leaking</li> <li>4. Condenser</li> <li>5. Breaker points improperly gapped</li> </ol>
No acceleration. Idles well but dies down when put to full throttle	Fuel system	Lack of fuel or air to engine	<ol style="list-style-type: none"> <li>1. High speed needle set too lean</li> <li>2. Dirt behind needle and seat</li> <li>3. High speed jet obstructed</li> <li>4. Inlet lever set too low</li> <li>5. Choke partly closed</li> <li>6. Silencer obstructed</li> <li>7. Fuel line obstructed</li> <li>8. Fuel pump not supplying enough fuel because: <ol style="list-style-type: none"> <li>(1) Punctured diaphragm</li> <li>(2) Flapper valves bent</li> </ol> </li> <li>9. Not enough oil in gas</li> <li>10. Breaker points improperly gapped or dirty</li> <li>11. Engine improperly timed</li> </ol>
Engine runs by using choke at high speed	Fuel system	Lack of fuel to carburetor	<ol style="list-style-type: none"> <li>1. High speed needle set too lean</li> <li>2. Dirt behind needle and seat</li> <li>3. Fuel line obstructed</li> <li>4. Inoperative fuel pump</li> </ol>

ENGINE REACTION	PROBLEM	CAUSE	CHECK POINTS
No power under heavy load			<ol style="list-style-type: none"> <li>1. Magneto points improperly gapped or dirty</li> <li>2. Ignition timing too far advanced</li> <li>3. Magneto plate loose</li> <li>4. Faulty carburetion</li> </ol>
Cranks over extremely easy on one or both cylinders	Loss of compression	Improper torque on head nuts	<ol style="list-style-type: none"> <li>1. Scored piston caused by:               <ol style="list-style-type: none"> <li>(1) Not enough oil in gas</li> <li>(2) Lack of cooling</li> </ol> </li> <li>2. Blown head gasket</li> <li>3. Loose spark plug</li> <li>4. Head bolts not tight enough</li> </ol>
Engine won't crank over	Unable to rotate flywheel		<ol style="list-style-type: none"> <li>1. Piston rusted to cylinder wall</li> <li>2. Crankshaft seized to bearing (main or rod)</li> <li>3. Broken connecting rod</li> <li>4. Flywheel seized to stator plate</li> <li>5. Engine improperly assembled after repair</li> </ol>

## REFERENCE NOTES TO TROUBLE SHOOTING

## DISASSEMBLY OF THE 320 C.C. ENGINE

NOTE: The following disassembly procedure of the 320 c.c. engine is the original text sent to us by Rotax along with the slides which you have received for your Service School. Slide numbers correspond to your own slide kit.

### PUBLICATION DEPARTMENT

The basic design of the 320 c.c. follows the same principle as on the 300 regular engine, out of which it was developed. Yet crankcase and crankshaft are different from the 300 regular engine. Cylinder bore is 76 mm, same as on the 300 regular engine, the stroke is 70 mm, compared to 66 mm of the 300 regular. The engine has an aluminum cylinder with cast iron sleeve. Piston, piston rings and cylinder head also differ from the 300 regular engine. Compression ratio is 9 to 1. The engine performance is 18 H.P.

Another major improvement over the 300 regular engine is that this engine is equipped with two roller bearings, instead of the two ball bearings of the 300 regular. The roller bearings make engine disassembly essentially easier, they can take higher radial load, and it is possible to have the outer race in the crankcase in a narrower bearing seat, giving a narrower fit.

You have this engine in 3 versions. There is the engine with manual start only equipped with a 40 watts unit, same as in

250 and 300 c.c. engines. There is the Sea-Doo version, which has the electric starter and a 12 V 50 watts unit, same as it was mounted last year in the electrically started 300 regular engine.

Talking about the Sea-Doo version of this engine, a first lot of these engines have been assembled with one roller bearing (on power-take-off side) and one ball bearing. While obviously this is not any cause for troubles, we would recommend, if for one reason or another the ball bearing would have to be removed, to assemble a roller bearing on magneto side also.

Slide 1: In this picture you see the third version. It is the electrically started engine for the Ski-Doo. It has a 12 V 75 watts ignition unit. With a lighting output of 75 watts, it is no more possible to locate an ignition coil both with primary and secondary winding in the flywheel magneto. Therefore you have only the generator coil, producing the primary current, on the armature plate, while the high tension ignition coil is mounted outside on the crankcase, opposite the electric starter.

Slide 2: Here is a view of the carburetor side of this engine. The carburetor used is a Tillotson HR with the diameter increased to 1 - 9/32". It will have a fuel back-flow connection to the fuel tank. On this engine you have also a thick isolating flange of about 3/4".

Slide 3: Here is engine exhaust side; you can see the high tension ignition coil assembled to the crankcase.

Slide 4: This is a schematic illustration of the 75 watts unit. The blue generator cable has to be connected to terminal 1 of the high tension ignition coil. Also connected to this terminal is the black shorting cable. Connected to terminal 15 is the yellow mass cable. The other two cables are the lighting cables.

Since we can see it quite well in this picture, please note that the armature plate always has to be mounted in such a way that the lubricating wick is at the bottom.

Slide 5: There is nothing much new about the tools. Please note illustration #16. This 11 mm socket wrench is supplied standard for 300 regular and 320 engines to remove the lock nuts of the intake silencer.

Illustration #15 shows two ring halves, to be used with the standard puller (#11) that you are familiar with, to pull the roller bearing inner race.

Slide 6: Except for the roller bearing, there is no difference in servicing the 320 c.c. or the 300 regular engine.

To remove or install the roller bearing outer race in the crankcase, heat crankcase to approx. 210 degrees. When crank-

case has cooled off, take dimension of crankcase down to bearing inner race. Take this dimension on both crankcase halves with crankcase gasket removed, summing up these two dimensions.

Slide 7: Take crankshaft dimension over blades, adding to this dimension the axial dimension of the roller bearings.

Compare this amount with the dimension resulting from the two crankcase halves. To compensate for the difference, put the necessary amount of shims, divided about equally between the two crankshaft sides. The crankcase gasket will account for the necessary axial crankshaft play. Axial crankshaft play has to be between .004 and .012".

Heat bearing inner races in oil to 180 - 200 degrees before assembling them to the crankshaft journals. Assembling bearing inner races to the crankshaft journals, be careful not to hurt the crankshaft by pressing the crankshaft blades together.

Slide 8: For removal of the bearing inner races, use the ring halves already mentioned before.

Here the puller ring is slid over the ring halves.

Slide 9: The puller plate is being fixed to the ring halves.

Slide 10: Remove inner race, using a suitable puller. Be careful not to damage the crankshaft journal. Depending on the

kind of puller you use, it may be necessary to use a protection cap over the crankshaft thread.

Slide 11-12-13: Inserting the crankshaft into the crankcase, use the proper protection sleeves in order not to damage the oil seals. Check for the proper axial clearance of the crankshaft, which has to be between .004 to .012".

REFERENCE NOTES TO 320 C.C.

## ROTAX 370 C.C. ENGINE

### DISASSEMBLY AND ASSEMBLY PROCEDURE

Figures 1 and 2 show the Rotax 370 c.c. (front and rear view), simultaneous firing opposed-twin-piston engine.

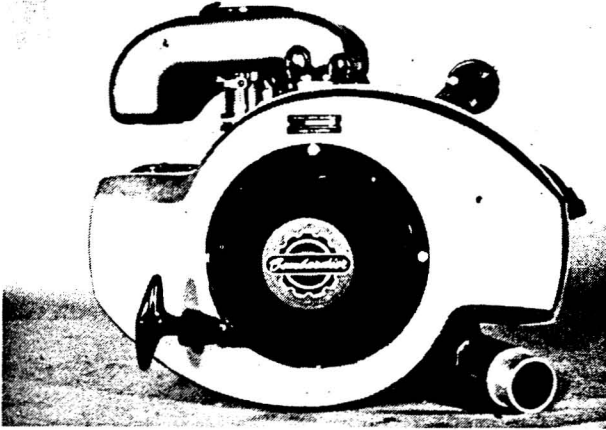


FIGURE #1

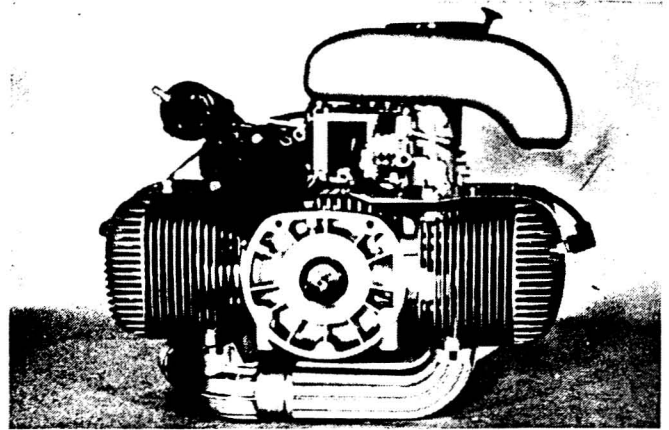


FIGURE #2

#### ENGINE DISASSEMBLY

To disassemble the 370 c.c. engine, it is highly recommended to follow this step-by-step procedure:

Step 1: As illustrated in Figure #3, remove the starter rewind assembly.

Step 2: Remove the air intake silencer and the whole carburetor assembly.

NOTE: In order to prevent the following materials from getting into the engine, close the cylinder intake flange with masking tape.

Step 3: Remove the ignition coils from the engine (See Figure #4). For ignition coil assembly removal, unscrew the ignition cable clamps from the cylinder cowls.

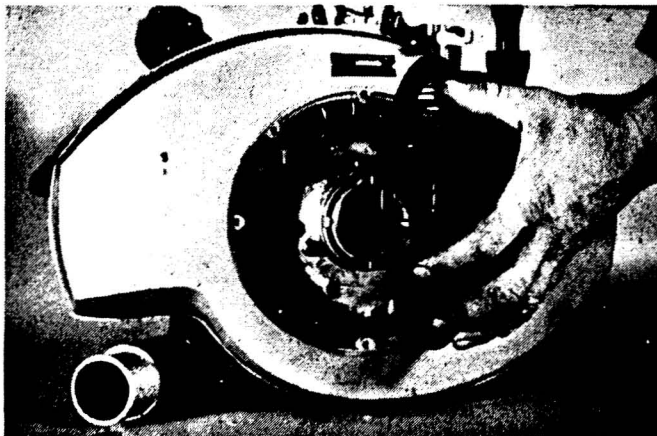


FIGURE #3

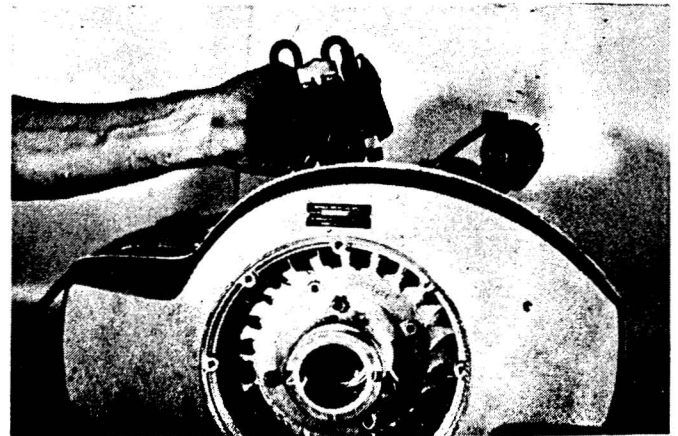


FIGURE #4

Step 4: As illustrated in Figure # 5, remove the electric starter assembly (starter & brackets). FOR ELECTRIC MODELS ONLY.

Step 5: Turn the engine around and unscrew the 4 nuts which hold the exhaust pipe assembly (muffler elbows). Remove the whole assembly from the engine.

Step 6: When the muffler elbows are removed, it is possible to make a primary check of the piston and cylinder condition. Check for sticking piston rings, trace of seizure or other damages.

Step 7: Remove the fan coil cover (See Figure 6).

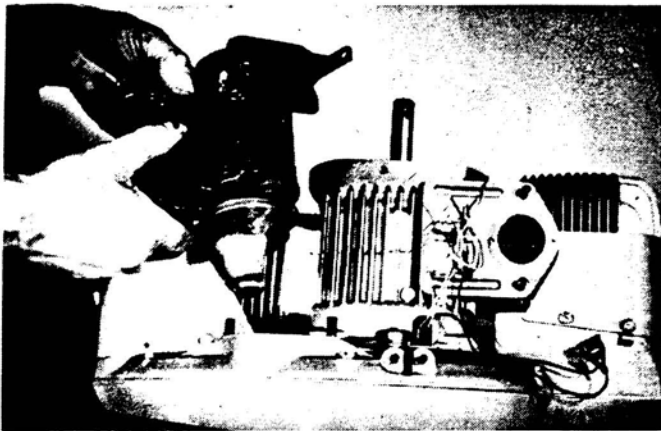


FIGURE #5



FIGURE #6

Step 8: The removal of the fan cowl cover gives access to the fan and the starting pulley. Remove the manual starting pulley.

Step 9: As illustrated in Figure #7, bend back the crankshaft lock washer.

Step 10: As shown in Figure #8, install the special fan assembly holding tools, and then remove the crankshaft nut from the crankshaft.

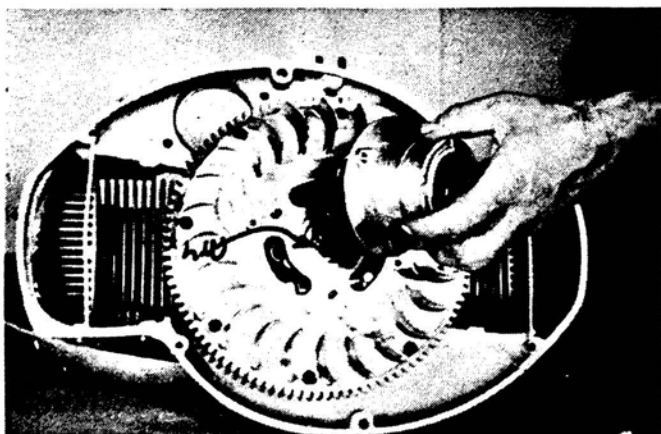


FIGURE #7

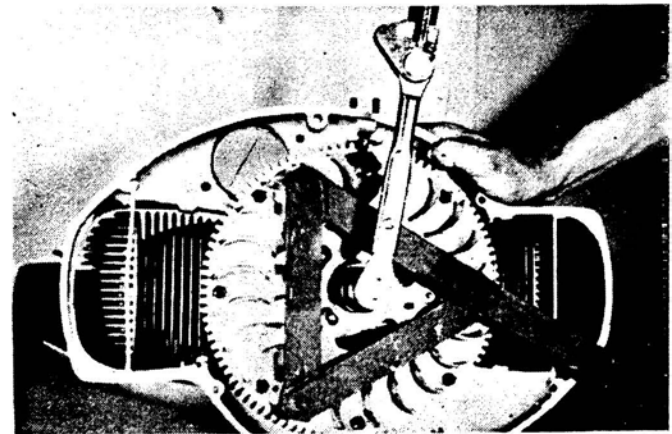


FIGURE #8

Step 11: To prevent the flywheel puller from damaging the crankshaft extension, put a protection sleeve over the crankshaft thread. Screw the puller on the flywheel thread; fasten the puller screw firmly (See Figure #9).

NOTE: If the flywheel does not come off, it may be necessary to tap gently on the puller screw with a plastic mallet.

Step 12: Disassemble the labyrinth ring from the engine by removing the 6 cap screws which retain it to the fan cowl (See Figure #10).

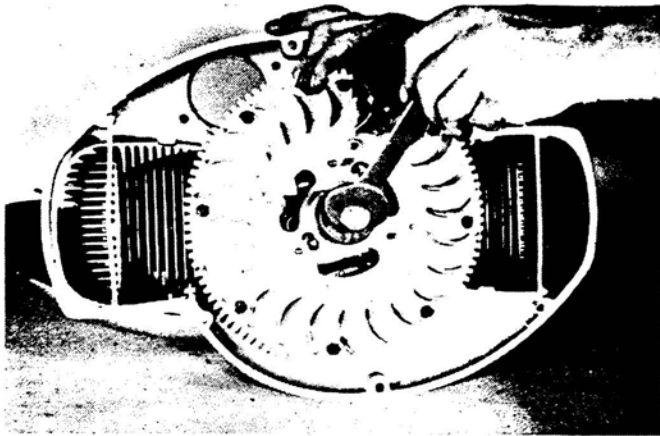


FIGURE #9

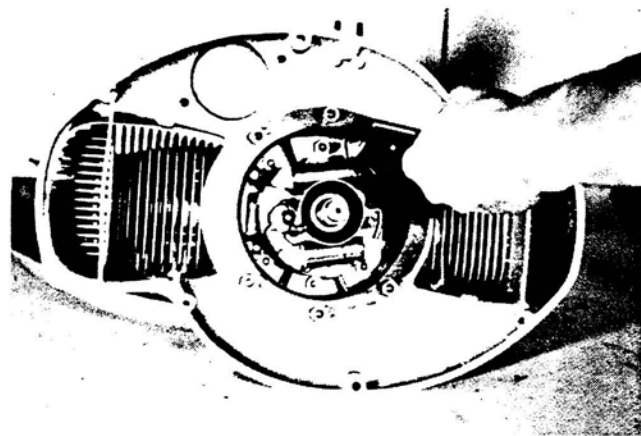


FIGURE #10

Step 13: From the magneto side of the crankshaft, remove:

- a) Woodruff key.
- b) Breaker cam, cam spring and cam spring washer.
- c) Remove the armature plate with cable and cable grommet from the engine (by unscrewing the armature plate assembly cap screw).

Step 14: CYLINDER REMOVAL

- a) Unscrew the (4) nuts holding the cylinder head on the engine studs.
- b) As shown in Figure 11, remove the cylinder head.
- c) Remove the cylinder.

NOTE: Repeat the same operation for the other cylinder.

- d) Disassemble the piston from the connecting rod.

- e) As illustrated in Figure #12, remove the piston pin circlip. BE CAREFUL NOT TO DAMAGE THE PISTON OR THE CONNECTING ROD.

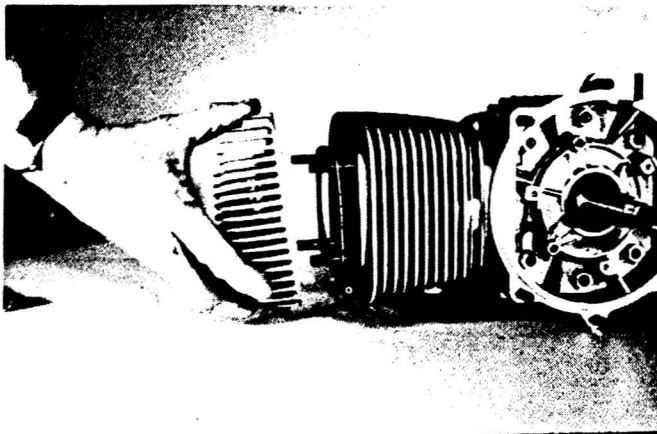


FIGURE #11



FIGURE #12

- Step 15: Push out the piston pin from the connecting rod. An auxiliary bolt may be used for the purpose.

CAUTION: Take care not to damage the needle cage or the needle bearings on the small end of the connecting rod during the process. Always support the piston to prevent connecting rod damage

- Step 16: Remove the cap screw which holds the bearing cover to the engine.

- Step 17: Lift off the bearing cover as illustrated in Figure #13. Be careful not to scratch the oil seal.

- Step 18: As shown in Figure #14, remove the 6 crankcase nuts.

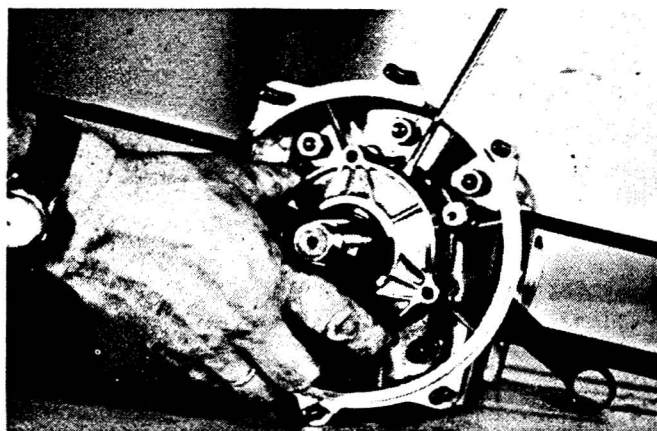


FIGURE #13

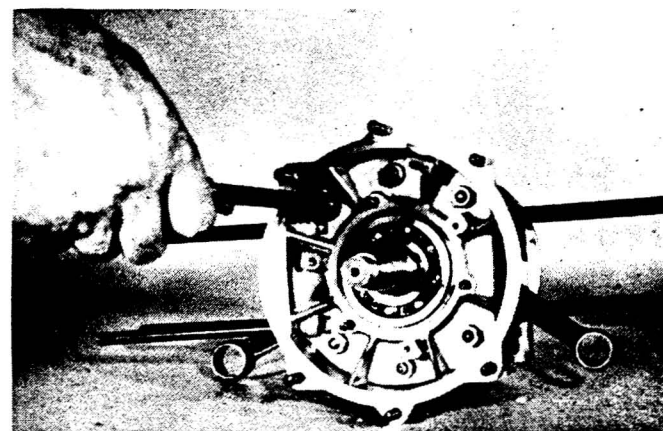


FIGURE #14

- Step 19: To separate the crankcase, use a plastic mallet and tap gently on the crankshaft magneto side extension (See Figure #15).

Step 20: REMOVAL OF THE CRANKSHAFT FROM THE CRANKCASE HALF  
(MAGNETO SIDE)

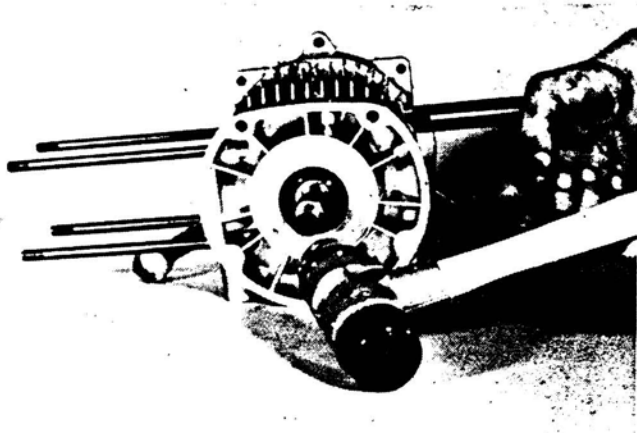


FIGURE #15

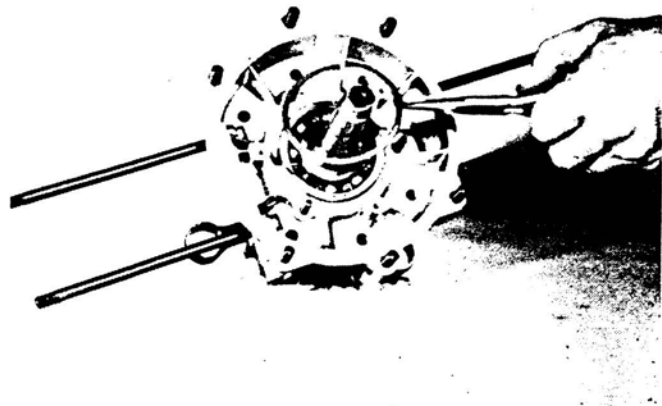


FIGURE #16

- a) As illustrated in Figure #16, remove the bearing snap ring (on magneto side).
- b) To remove the crankshaft from the crankcase half, heat the crankcase to 170° to 180°.

THE TORCH SHOULD BE CONTINUALLY MOVING AND MUST BE DIRECTED AGAINST THE MIDDLE PARTS OF THE CRANKCASE ONLY. As soon as the proper temperature is reached, the crankshaft can be easily pulled out (See Figure #17).

NOTE: There is a roller bearing on the power-take-off side of the crankcase and a ball bearing on the magneto side. A circlip fixes the ball bearing on the axis. It should be removed before this bearing can be pulled out.

Step 21: To remove the crankshaft bearings, you have to use the proper puller assembly.

As illustrated in Figure #18, use a special crankshaft bearing puller to remove the crankshaft roller bearing.

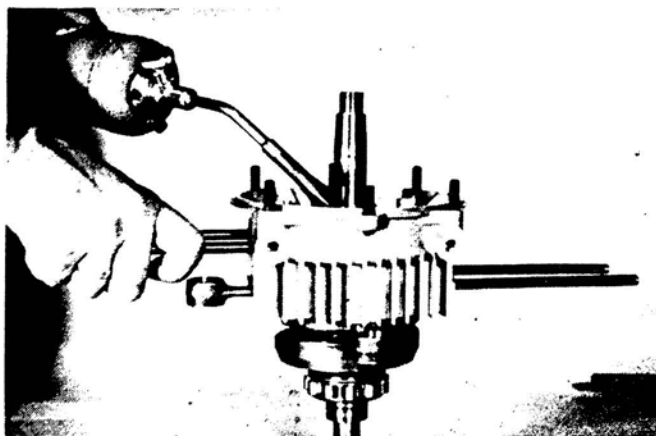


FIGURE # 17

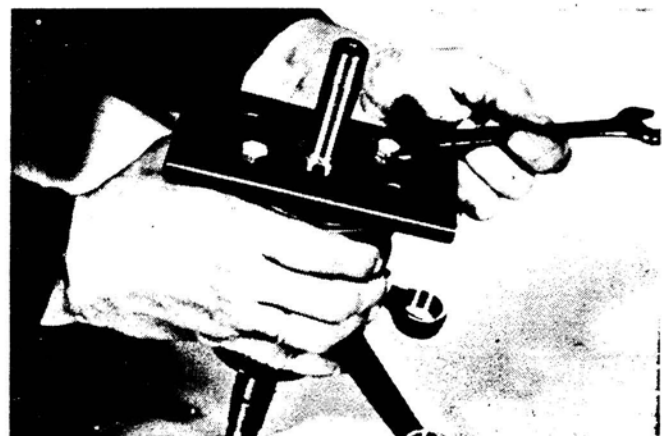


FIGURE #18

CAUTION: Be careful to use the proper puller rings.

Remove the circlips retaining the ball bearing on the shaft and install a protection cap on the crankshaft thread. Pull out the ball bearing with the appropriate puller.

Step 22: ROLLER BEARING OUTER RACE REMOVAL:

- a) Remove the locking ring from the crankcase (See Figure #19).
- b) Heat the outer race bed (about  $170^{\circ}$  to  $180^{\circ}$ ) with a torch, as shown in Figure #20. As soon as the heated surface of the crankcase reaches the specified temperature, tap the crankcase gently on a wooden block; the bearing outer race will then fall out.

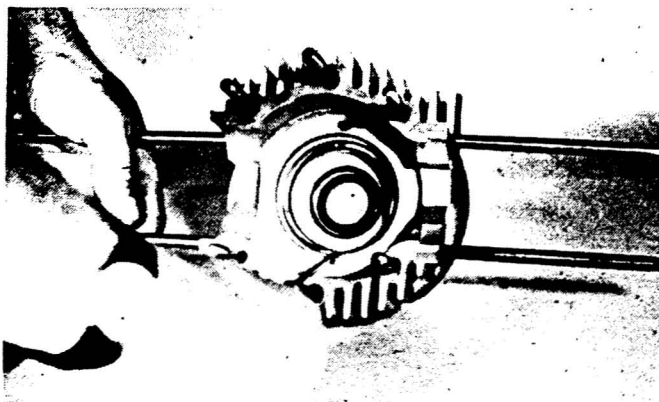


FIGURE #19

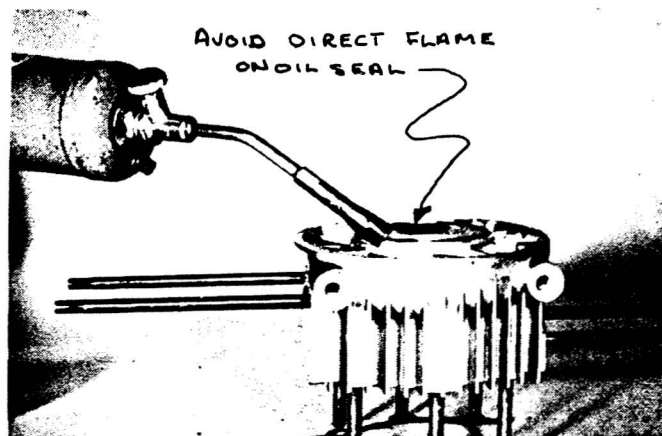


FIGURE #20

Step 23: CYLINDER AND RING WEAR: Check the cylinder bore (taper and out of round) with a dial indicator (See Figure #21). Compare your reading with the specifications in your Shop Manual.

As shown in Figure #22, you can check the ring end gap by putting the ring into the cylinder and measuring the distance between the ring ends with a feeler gauge.



FIGURE #21

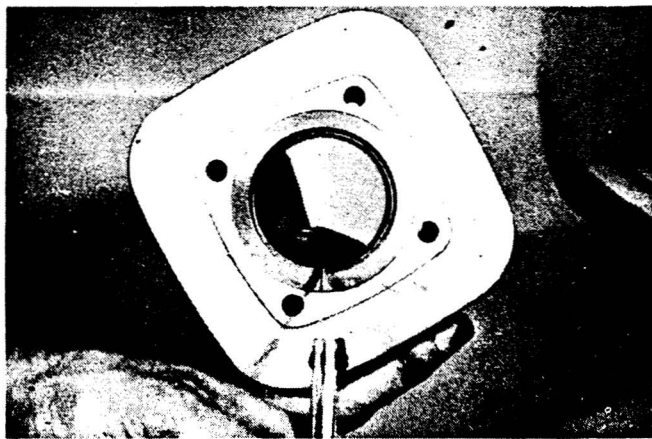


FIGURE #22

## REASSEMBLY PROCEDURE (370 C.C.)

Step 1: To reassemble the crankshaft roller bearing outer race on the crankcase, heat the P.T.O. side crankcase half to  $160^{\circ}$  to  $180^{\circ}$ . As soon as the crankcase has reached this temperature, fix the outer race into it (See Figure #23).

Step 2: REASSEMBLY OF THE OIL SEAL: To reassemble the oil seal and the P.T.O. half, select the recommended size of stamp and fix the oil seal to it.

Place the oil seal into its position, as shown in Figure #24.

NOTE: Before replacing the oil seal, make sure the crankcase is back to normal room temperature.

Step 3: Reinsert the locking ring in its groove behind the roller bearing outer race.

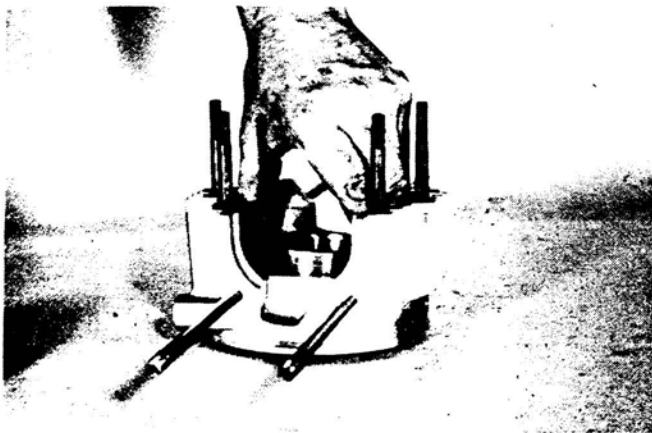


FIGURE #23

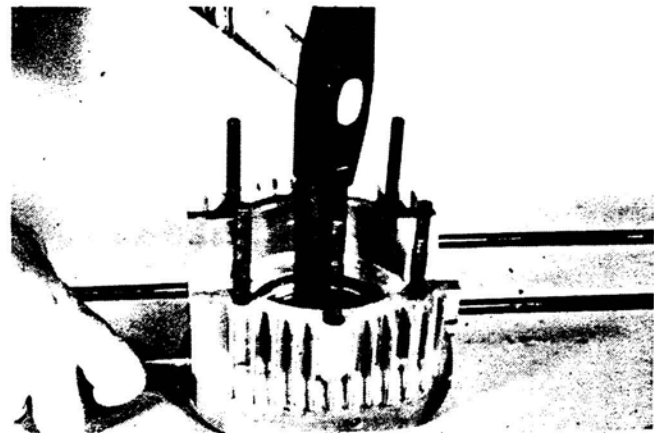


FIGURE #24

Step 4: REINSTALLATION OF THE CRANKSHAFT BEARING:

- a) Heat both bearings (roller and ball) in oil to a temperature of  $170^{\circ}$  to  $180^{\circ}$ . As soon as they have reached this temperature, insert them on their respective crankshaft extension.
- b) Lock the magneto side ball bearing with the circlips.
- c) Let both bearings cool off.

Step 5: Heat the magneto side crankcase half to  $160^{\circ}$  to  $180^{\circ}$  and slide the crankshaft into it.

Step 6: Assemble the groove ring to the ball bearing.

Step 7: REASSEMBLY OF CRANKCASE UNIT: (SEE FIGURE #25)

- a) In order to protect oil seals, put the recommended size of sleeves on the crankshaft.
- b) Before reassembling, make sure the dowel tubes are properly assembled into their respective seats.
- c) Fix the crankcase gaskets in their position and assemble the 2 crankcase halves. When this has been completed, make sure the crankshaft lies free and can be turned easily.

Step 8: Screw the crankcase nuts slightly and evenly. Then, torque the nuts at 16 foot-pound (make sure to balance the tightening evenly).

Step 9: REASSEMBLY OF THE BEARING COVER:

- a) As illustrated in Figure #26, fix the bearing cover gasket to the crankcase.
- b) Check the bearing cover oil seals for proper seating. Make sure that the oil seal spring is well in place.
- c) Mount the bearing cover on the crankcase and tighten the cover nuts evenly.

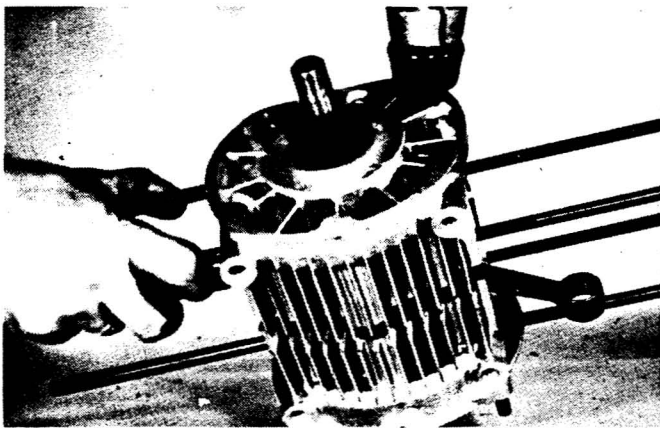


FIGURE #25

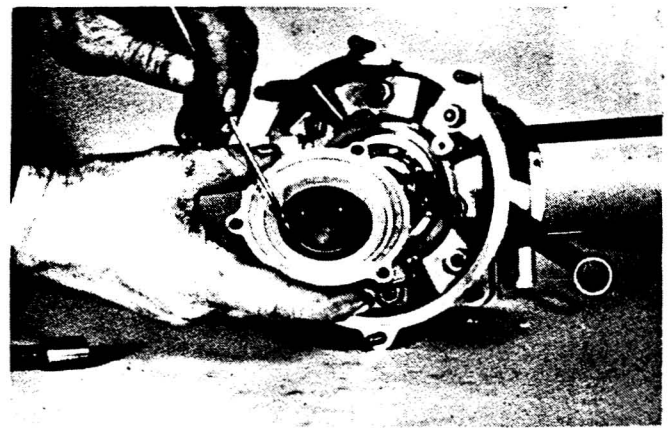


FIGURE #26

Step 10: REASSEMBLY OF THE PISTON: (SEE FIGURE #27)

NOTE: On the top of the piston assembly, there is a mark (AUS and an arrow). This mark should always face the exhaust side. Damage may occur to rings and cylinder if the piston is mounted in the opposite way.

- a) Heat the piston assembly to  $120^{\circ}$  -  $140^{\circ}$ .
- b) Pass a mounting bolt through the piston and connecting rod. Then, slide in the piston pin. THE PISTON SHOULD BE AT THE TEMPERATURE SPECIFIED BEFORE.
- c) Lock the piston pin with the circlips (2).

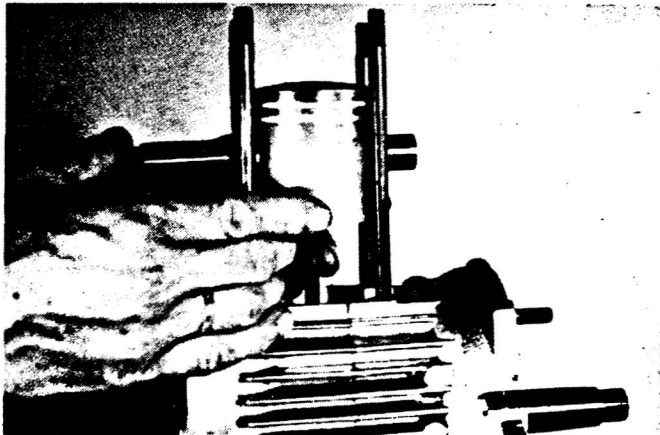


FIGURE #27

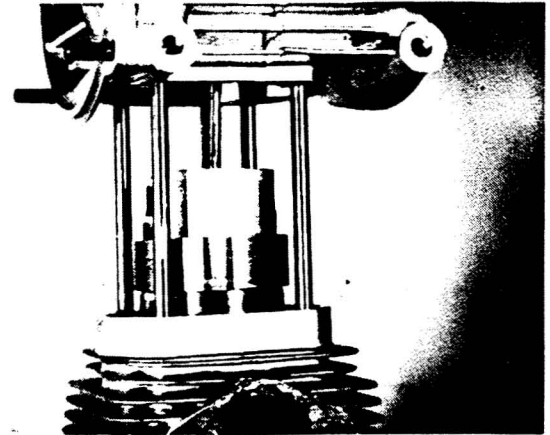


FIGURE #28

Step 11: REASSEMBLING THE PISTON AND CYLINDER:

- a) As illustrated in Figure #28, slide a ring assembler sleeve (with slot) over the piston, MAKE SURE THE PISTON RINGS ARE IN THEIR RESPECTIVE GROOVE.
- b) Use the 4 cylinder studs as guides and press the cylinder down into position. LET THE CYLINDER ASSEMBLY PRESS DOWN THE RING SLEEVE.

NOTE: During removal of the cylinder and the piston, the connecting rod may be slightly bent. The same problem may happen when installing a new crankshaft. Damage may also occur to the connecting rod during transportation.

To make sure the pistons run parallel to the cylinder bore:

- a) The cylinder must be well in place on the crankcase.
- b) As illustrated in Figure #29, place the piston at top dead center and try to move it from side to side (magneto to power-take-off side). This operation should be possible without using much strength.
- c) Repeat with the piston at the bottom dead center.

If the piston cannot be moved into the cylinder, it will be necessary to straighten the connecting rod. In this event, remove the cylinder and insert a rod through the bore of the piston pin; bend the connecting rod slightly in the required direction. Proceeding directly as above, repeat the check with the piston ring removed.



FIGURE #29

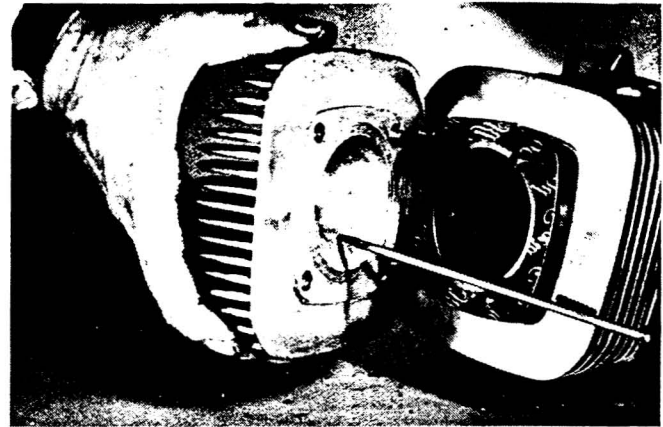


FIGURE #30

Step 12: REASSEMBLING THE CYLINDER HEAD:

- a) Fix the cylinder head gasket on the cylinder studs.
- b) Place the cylinder head over the cylinder. AS SHOWN ON FIGURE #30, THIS LOWER SECTION OF THE COMBUSTION CHAMBER SHOULD FACE THE EXHAUST SIDE.
- c) Fix the cylinder head with the nuts. Tighten equally until a slight resistance is felt then, torque the nuts at 20 foot-pound.

REFERENCE NOTES TO 370 C.C.

## ROTAX 371 C.C. - PARALLEL TWIN ENGINE

### DISASSEMBLY AND ASSEMBLY PROCEDURE

Figures 1 and 2 show a front and rear view of the 371 c.c. alternate firing, parallel twin cylinder engine. On Figure #1 (front view), you can see the carburetor, ignition coils, spark plugs, flywheel and manual starter assembly. The rear view (Fig. #2) shows the exhaust and power-take-off sides of the engine.

NOTE: On electric starting engines, a ring gear is mounted on the P.T.O. side.

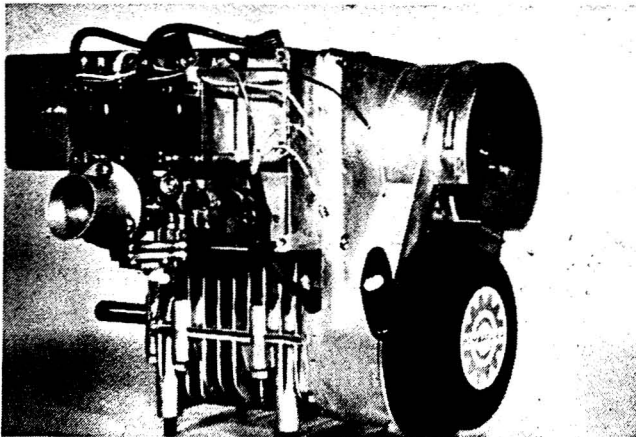


FIGURE #1

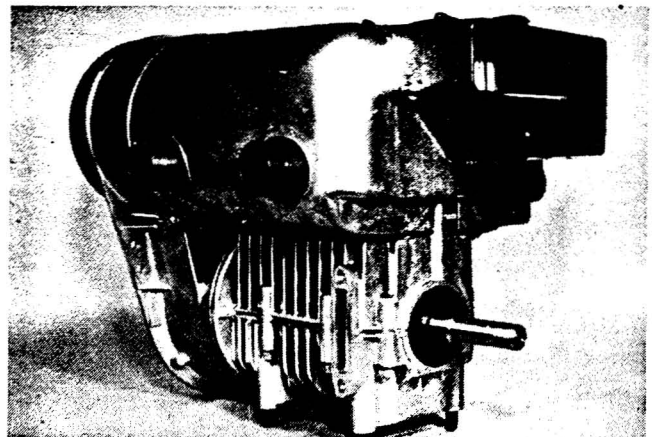


FIGURE #2

### ENGINE DISASSEMBLY

To disassemble the 371 c.c. engine, follow this step-by-step procedure.

Step 1: Remove the rewind starter assembly.

Step 2: Holding the bottom pulley, remove the 3 pulley nuts.

Remove pulley and V-belt.

Step 3: Using a chisel, bend back the crankshaft lock washer.

Step 4: Put the holding tool in place over the 3 flywheel studs (Fig. #3). Remove the crankshaft nut.

Step 5: Place a protection sleeve on the crankshaft extension. Thread the flywheel puller into the holding tool (Fig. #3) and pull the flywheel by tightening the puller bolt.

NOTE: If the flywheel does not come off, tap on the puller bolt with a hammer. If a sleeve is not available, replace the flywheel nut on the crankshaft, flush with the end, to protect it from flaring.

Step 6: Remove the woodruff key, breaker cam, spring and washer.

Step 7: a) Remove the 4 nuts and washers in the flywheel recess of the housing.

b) Remove the housing screws and pull off the flywheel housing.

c) Disconnect both leads to the exterior ignition coils and free them from the plastic strap.

d) Loosen the 2 lock nuts on the armature plate and remove from flywheel housing. See Figure #4.

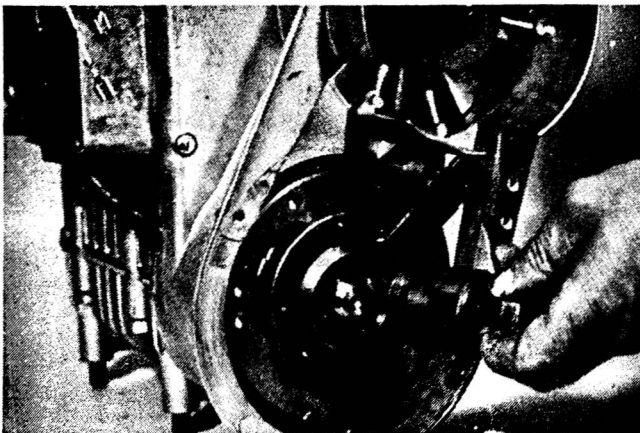


FIGURE #3

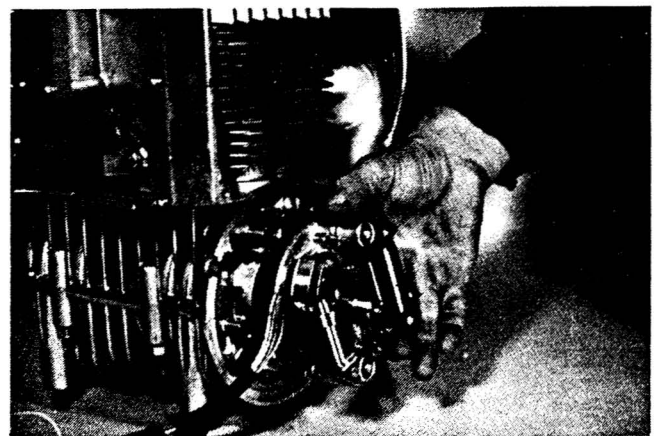


FIGURE #4

NOTE: The black and blue wired lead goes to the first exterior coil (closest to magneto side). The blue and yellow wired lead goes to the second exterior coil. Always bear in mind that the set of points with a lubricating wick goes towards the bottom of the engine.

Step 8: Remove carburetor and spark plugs. By unscrewing the 2 screws over the magneto side cylinder head and by removing one of the lock nuts on the long stud on the cylinder cowls, (P.T.O. side) the cowls may both be removed. See Figure #5.

Step 9: Unscrew both M8 nuts on the intake cover, and remove both the cover and manifold.

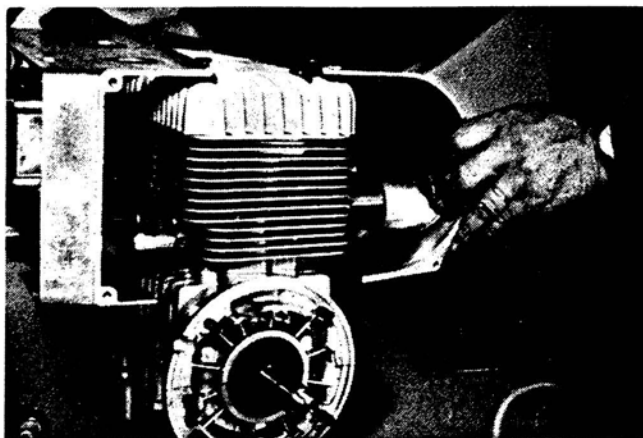


FIGURE #5

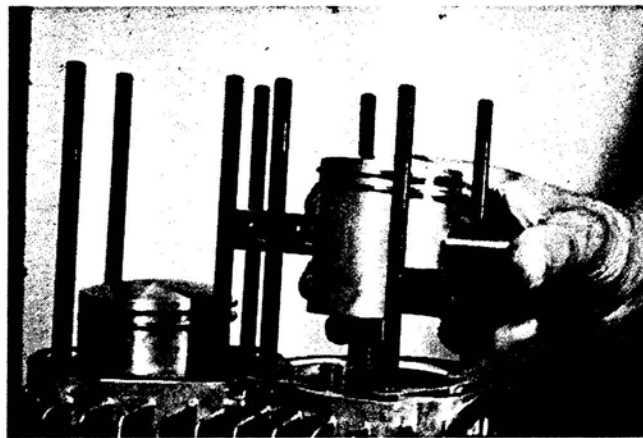


FIGURE #6

Step 10: Cylinder removal:

a) Remove the head nuts\* and pull out the cylinder heads.

\*Before removal, take note of the type and location of each nut.

b) Pull the cylinders from the engine studs.

Step 11: Piston removal (Fig. #6):

a) Using a narrow pick or screw driver, remove the circlip.

b) Hold the piston to prevent the connecting rod from bending; press out the piston pin. Repeat same operation for other piston.

NOTE: Take care not to damage the needle bearing when pressing out the piston pin.

Step 12: Crankshaft removal:

- a) Turn crankcase upside down and crosswise; remove the nuts following the sequence shown in Figure #7.
- b) Gently tap with a plastic mallet and remove the upper half of the crankcase. See Figure #8.
- c) Lift out the crankshaft.

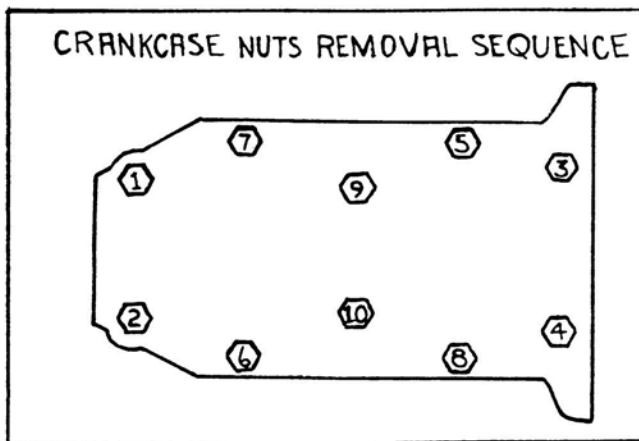


FIGURE #7

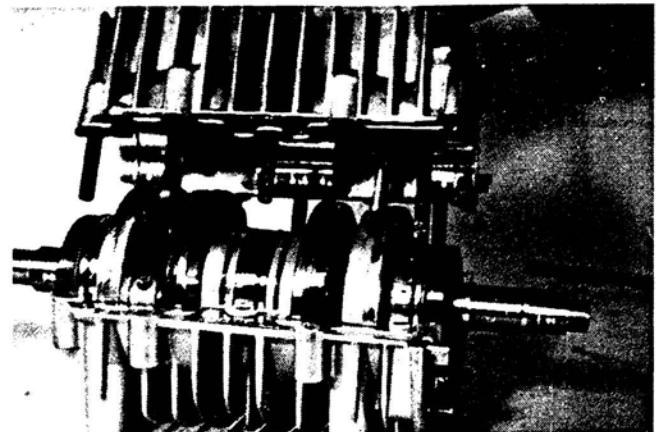


FIGURE #8

Step 13: Ball bearing removal (P.T.O. or magneto side):

- a) Remove both oil seals (and sleeve on P.T.O. side) and bearing retainer clips (Fig. #9).

- b) Using the proper bearing puller assembly, place both ring halves with lips, behind the ball bearing and between the crankshaft outer blade.
- c) Slide the ring evenly over the ring halves.
- d) Screw the puller plate to the ring halves. See Figure #10.

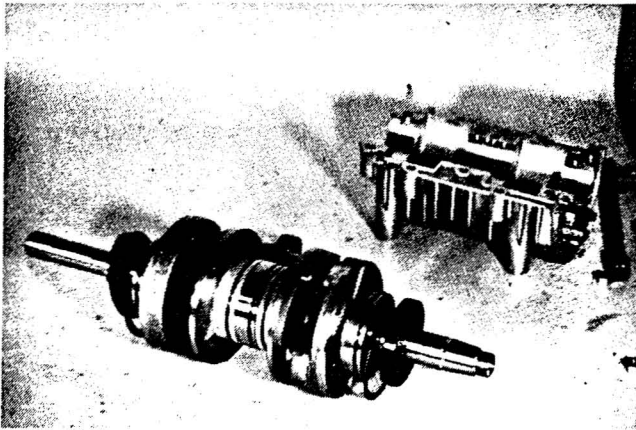


FIGURE #9



FIGURE #10

- e) Place a protection cap over the crankshaft extension.

Screw the puller on the crankshaft extension, and tighten until the bearing is free. See Figure #11.

Step 14: Cylinder and ring wear: To check the cylinder bore and ring end gap, refer to the procedure contained in the 370 c.c. section of this manual.

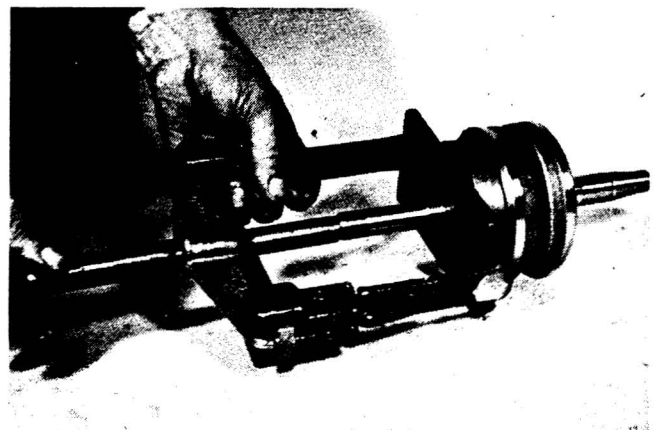


FIGURE #11

## REASSEMBLY PROCEDURE (371 C.C.)

NOTE: Before installing a new crankshaft, always take the dimension of the crankshaft that you have removed, over the 2 bearings P.T.O. side and magneto side. On the new crankshaft, put shims on the magneto side, between bearing and crankshaft blade, to obtain the same overall dimension.

Step 1: Heat ball bearings in oil to  $180 - 200^{\circ}$  and press them onto the crankshaft extension, on either end.

Step 2: Clean the sealing surfaces of both crankcase halves. Heat the crankcase halves to  $200 - 210^{\circ}$  and install the crankshaft.

NOTE: With a plastic mallet, tap gently on both crankshaft extensions to insure perfect seating of the bearings.

With a feeler gauge, check the clearance between the retainer clips and ball bearings (.004 - .020"). See Figure #12.

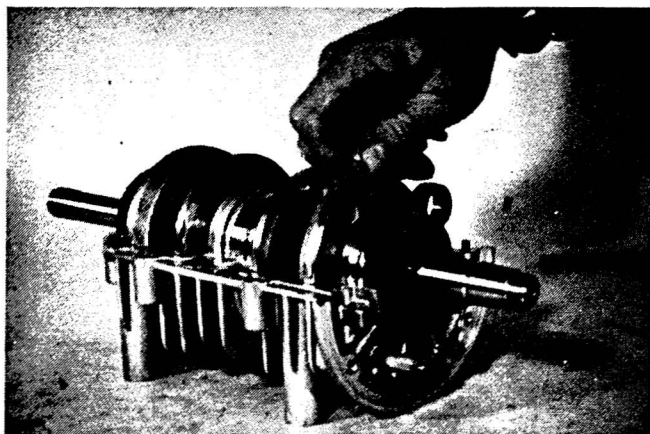


FIGURE #12

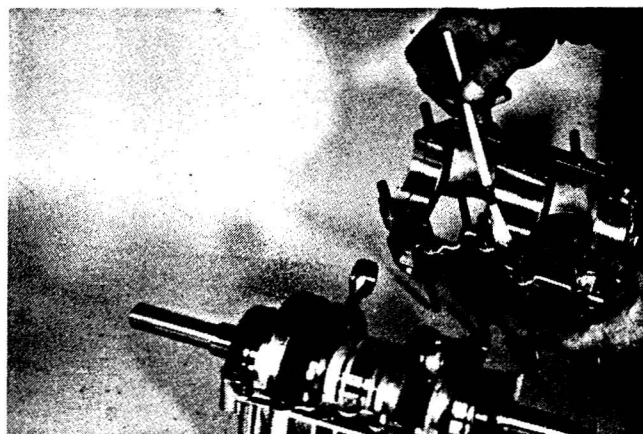


FIGURE #13

Step 3: With a pencil brush, apply a thin layer of "Volkswagen Sealer" (glue), on the sealing surfaces of both crankcase halves. See Figure #13.

Step 4: Seat the upper crankcase half over the lower half. Install the (10) crankcase nuts and washers.

Step 5: Following reverse sequence to disassembly (Fig. #7), cross-torque the nuts to 10 ft. lbs; then according to disassembly sequence, torque them to 16 ft. lbs. maximum.

Step 6: Re-assembly of the piston:

NOTE: On the piston top you will find a mark (AUS over an arrow). This mark must face the exhaust side, with the arrow pointing in the direction of the exhaust. Damage to the rings and cylinder will occur if the piston is mounted wrongly.

- a) Insert the wrist pin needle cage into the small end of the connecting rod.
- b) Heat piston assembly to  $120 - 140^{\circ}$ . Slide the pin into the piston through the connecting rod. Use a mounting bolt to push it even.
- c) Press the circlips into their grooves to lock the piston pin.

Step 7: Re-assembly of the cylinder:

- a) Slide a ring assembler sleeve (with slot) over the piston. Make sure that the rings are in position to the locating pins.

b) Using the 4 cylinder studs as guides, press the cylinder into position (Fig. #14). Let the cylinder assembly press down the assembler sleeve.

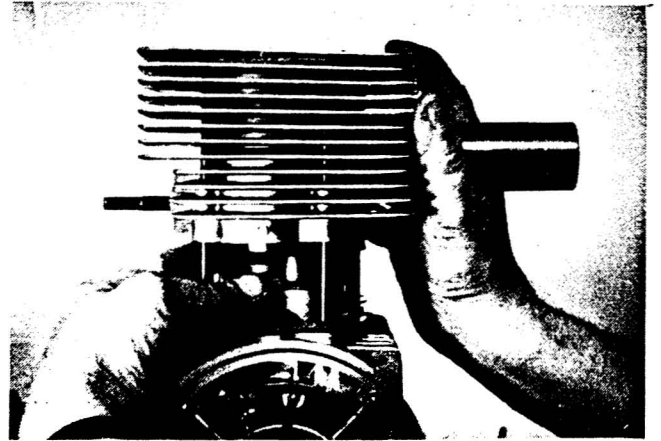


FIGURE #14

NOTE: The connecting rod may be bent slightly during removal of the cylinder and the piston, or when installing a new crankshaft. Damage may also occur to the connecting rod during transportation.

To make sure the pistons run parallel to the cylinder bore:

- a) The cylinder must be well in place on the crankcase.
- b) Place the piston at T.D.C. and try to move it from side to side (magneto to P.T.O. side). There should not be much resistance felt on either side. If necessary, refer to Figure #29 of 370 c.c. section of the Service Handbook.
- c) Repeat this operation with piston at B.D.C.

NOTE: If the piston cannot be moved in the cylinder, either towards magneto or P.T.O. side, it will be necessary to straighten the connecting rod. In this event, remove the cylinder and insert a rod through the bore of the piston pin; bend the connecting rod slightly in the required direction. Proceeding as above, repeat this check with the piston rings removed.

Step 8: Cylinder head re-assembly:

- a) Fix the head gasket over the cylinder studs.
- b) Install each cylinder head over the corresponding cylinder.  
As shown in Figure #15, the lower or filled-in portion faces the exhaust side (i.e. spark plug hole on intake side).
- c) Place the nuts and washers as illustrated in Figure #16 and torque crosswise to 20 ft. lbs. maximum.



FIGURE #15

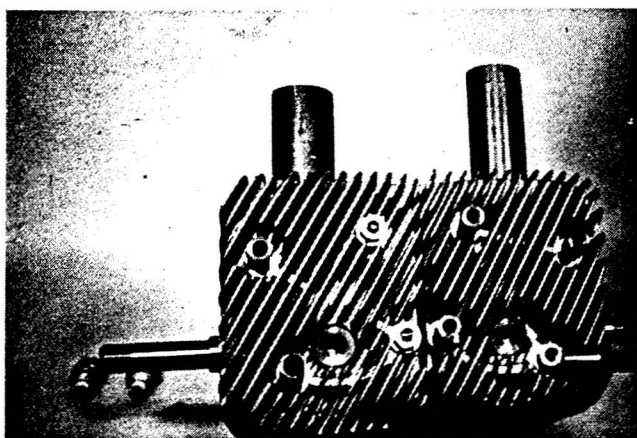


FIGURE #16

NOTE: Always make sure that the inner flange gaskets are not interchanged. Note that the magneto side intake port gasket has an impulse bore at the bottom left corner of the gasket. You must also have the rubber "O" ring gasket in its groove of the intake manifold.

Step 9: Assemble by reversing order of disassembly.

REMARK: *Flywheel nut must be torqued to 50 ft. lbs. maximum.*

Step 10: V-belt adjustment: If the free-play of the V-belt is different from  $\frac{1}{2}$ ", proceed as follows:

a) Using the special holder, remove nut and outer pulley half. See Figure #17.

b) To loosen the belt, take shims from the outside of the pulley and add them to the inside. Reverse this procedure to tighten the belt.

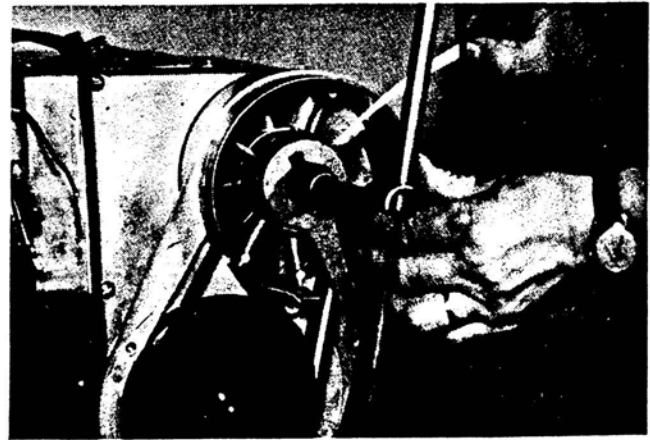


FIGURE #17

Step 11: All final adjustments must be carried out.

PUBLICATION DEPARTMENT

REFERENCE NOTES TO 371 C.C.

INDEX TO SECTION B

B-1     Disassembly and repair

B-2     Trouble shooting

## CARBURETION

### SKI-DOO ENGINE FUEL

The fuel used in most internal combustion engines is gasoline, although fuels such as methanol, benzine, alcohol and so on could be used. The two important characteristics of gasoline, as used for fuel in automotive engines, are volatility and anti-knocking properties. The volatility of a liquid is its vaporizing ability. Gasoline as used for motor fuel boils in a range of approximately 110°F. to 400°F.

The fuel mixture should remain liquid until it enters the air stream in the carburetor bore. Then, it must vaporize and mix uniformly with the incoming air.

### EFFECTS OF VOLATILITY

The volatility of gasoline affects the starting facility, the length of the warm-up period and the engine performance during normal operation. In other words, fuel must vaporize easily for cold weather starting. If the percentage of volatile element is too high, it will produce vapor lock. Vapor lock is caused by fuel which vaporizes in the system before entering the carburetor throat. Vapor lock, in the case of a 2-cycle engine, could result in a lack of fuel (improper lubrication), overheating, and possibly piston seizure.

In addition to the highly volatile fuel needed for easy starting, less volatile fuel is needed during the warm-up period. A portion of the fuel must be sufficiently volatile to insure proper vaporisation during periods of acceleration. If, during



acceleration, the fuel does not vaporize immediately as the throttle shutter opens, a lean mixture will result and create a situation known as flat-spot.

REMARK: *For maximum performances, fuel with low volatility and high lead content should be used.*

*Overchoking or too rich a mixture will cause carbon build-up and varnish deposit on the piston and rings.*

### TILLOTSON CARBURETORS

The Tillotson carburetors are dependable and trouble-free, providing correct maintenance, care and service. The following pages show the proper steps to inspect and repair the various models of carburetors used on the Bombardier Ski-Doo.

The Tillotson carburetor is a very simple multi-purposes unit which performs 3 basic operations:

FUEL FILTERING: A fuel filter removes dirt particles and residues from the fuel system.

FUEL PUMPING: A fuel pump supplies gasoline to the carburetor.

FUEL METERING: A carburetor or metering device injects the proper quantity of fuel into the engine.

#### FUEL FILTER

The fuel filter, as shown in Figure #1, consists mainly of a fine meshed screen, a gasket and a cover with a built-in

inlet fitting. On some other models, the cover and the filter are incorporated in one unit\*.

\*Such was last year's filter installed on HR-7-A carburetors (used on the 1968 - 300 c.c. Rotax engine).

#### FUEL PUMP

The pump consists of a pump cover and gasket, a pumping diaphragm and a valving diaphragm (See Fig. #2). In the case of the duplex pump, these above mentioned elements have been doubled.



FIGURE #1



FIGURE #2

#### CARBURETOR:

The carburetor includes the main body, adjusting screws, shutters, needle and seat, metering diaphragm and related parts.

#### FILTER CARE

The filter can either be a fine meshed screen or a paper element enclosed in a plastic casing which can be located

underneath the pump or anywhere in the fuel line. The only purpose of the filter is to stop any dirt coming from the fuel tank to jeopardize the operation of the carburetor.

PAPER ELEMENT FILTER: The paper element is the most efficient type of filter that can be installed. However, if it becomes clogged or if the flow slows down below the minimum required, it should be discarded and replaced by a new unit.

SCREEN TYPE FILTER: The screen type filter is serviceable and therefore reusable. To clean it, flush with fuel or solvent and blow with compressed air; then, replace it in its original position. This will prevent small particles that might not have been removed during cleaning from being carried to the carburetor by the fuel flow.

NOTE: When servicing the filter, it is advisable to replace the gasket and the components as shown in Figures #3 and #4. Varnish coated or extremely clogged screens should be replaced when servicing.

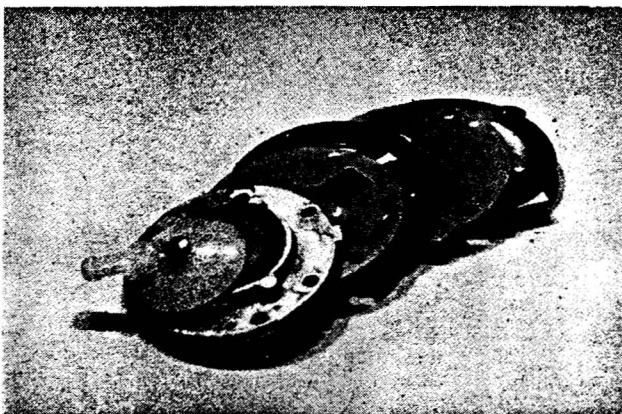


FIGURE #3

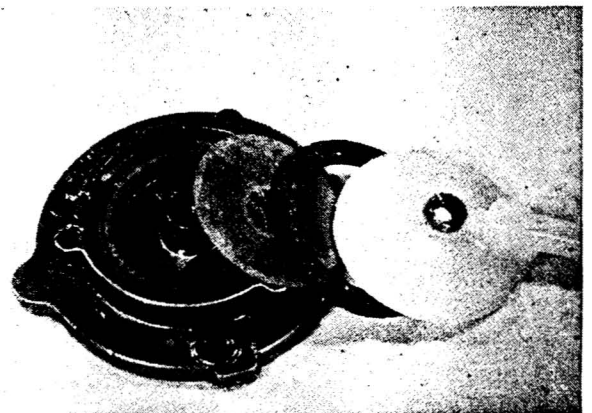


FIGURE #4

## FUEL PUMP OPERATION

The fuel pump's main function is to supply a constant and steady flow of liquid gas to the metering chamber. There are 2 types of pump used on Tillotson carburetors as installed on Bombardier Ski-Doos.

**SINGLE STAGE PUMP:** The single stage pump is used on small carburetors or on medium size carburetors for engines having a fairly low fuel consumption.

**DUPLEX PUMP:** The large duplex pump was used on last year's HD-8-A carburetors and will be used this year on HR-16-B carburetors to be installed on the new 371 c.c. engines.

**OPERATION:** The fuel pump is a pulse operated diaphragm pump. The pressure-vacuum pulse is supplied from the engine crankcase where the pulse cycles are created by the reciprocating action of the engine piston. Crankcase pulse is transmitted to the pump pulse chamber through the fuel pump pulse port in the mounting flange of the carburetor body.

**VACUUM ACTION:** The vacuum part of the pulse cycle causes the fuel pump diaphragm to move into the pump pulse chamber. The vacuum allows fuel to flow from the fuel inlet through the fuel strainer screen, pass the inlet check-valve and into the fuel pump chamber. The outlet check valve closes during this part of the pumping cycle.

PRESSURE ACTION: The pressure part of the pulse cycle forces the fuel pump diaphragm into the fuel pump chamber, creating a pressure that forces the fuel out through the outlet check valve and the fuel inlet supply channel to the inlet needle valve. The fuel pressure closes the inlet check valve during this part of the pumping cycle.

NOTE: On all carburetors equipped with a duplex pump the inlet and outlet surge chambers diminish the pressure surges of the fuel and provide steady fuel flow through the pump system (Refer to Fig. #5).

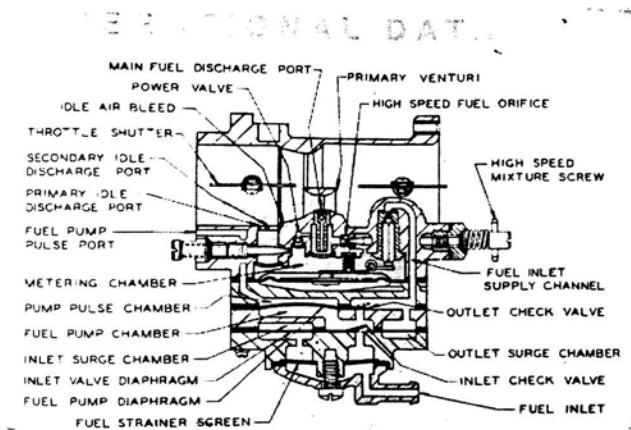


FIGURE #5

REMARK: *The fuel pump does not build pressure in the metering chamber. If there was some pressure in the metering chamber at idle speed, the intermediate and high speed jets would leak constantly and thus cause flooding. To bring it down to bare facts, the metering diaphragm is only meant to operate the needle valve, whenever the QUANTITY of fuel becomes insufficient, not the pressure. Pressure building is a side effect, since the jets are opened to a low pressure area in the venturi throat and the metering diaphragm is opened to a high pressure area or to the atmospheric pressure.*

#### CARBURETOR OPERATION

Before looking through the carburetor operating principles,

bear in mind that the pump and the filter could be removed and the carburetor would still operate properly, providing the gasoline is gravity feed. Therefore, the pump is just there to keep the metering chamber full of liquid gasoline.

#### STARTING (CHOKE) OPERATION:

Starting an engine with a Tillotson diaphragm carburetor involves the same methods as used in a conventional float type carburetor. Operating principle is shown in Figure #6.

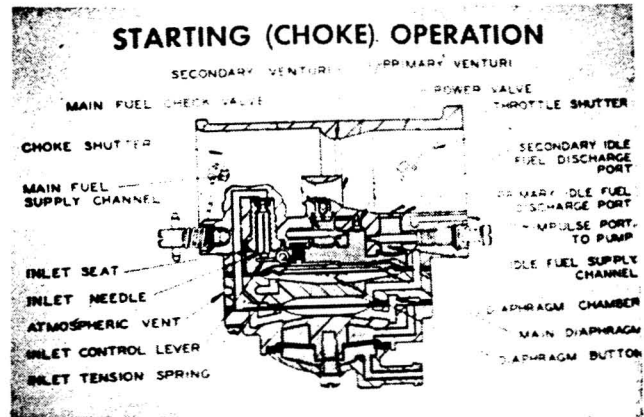


FIGURE #6

When the engine is cranked with the choke in the closed position, the suction is transmitted to the diaphragm fuel chamber through both primary and secondary idle discharge ports as well as main fuel discharge port, creating a low pressure area on the fuel side of the metering diaphragm. Atmospheric air pressure on the opposite side will force the metering diaphragm upward causing the diaphragm button to contact the inlet control lever and overcome the inlet tension spring pressure, permitting fuel under pressure to force the needle off its seat and enter the metering chamber. The fuel then travels from the metering chamber up through the idle and main fuel supply orifices and channels and out the discharge ports to the engine.

Fuel is delivered from all of the discharge ports when the choke is closed to provide a full, rich mixture for starting. A small amount of air is added to this rich mixture through a hole or port in the choke shutter.

**IDLING OPERATION:** The throttle shutter is in a partially open position when the engine is idling. Engine suction is transmitted through the primary idle fuel discharge port to the fuel chamber side of metering diaphragm via the idle fuel supply channel. Again, the metering diaphragm is forced upward

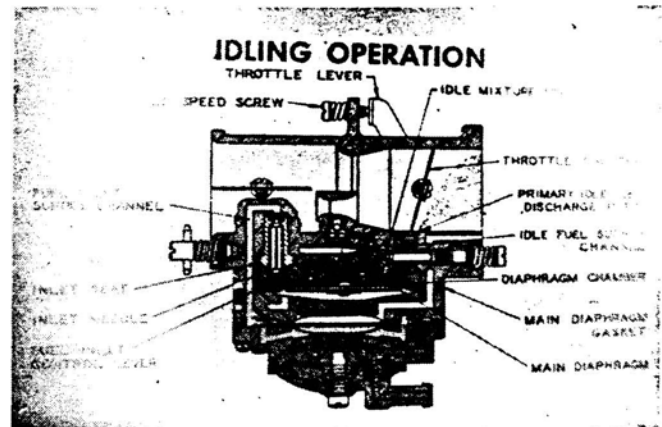


FIGURE #7

by atmospheric pressure, depressing the inlet control lever and permitting fuel under pressure to force the inlet needle off its seat and enter the metering chamber. The fuel is then drawn up through the idle fuel adjustment orifice and delivered to the engine through the primary idle discharge port. Operation is shown in Figure #7.

The engine carburetor bore from the air inlet to the back of the throttle shutter is at atmospheric pressure during idle operation. The ball check valve in the main fuel port is closed to prevent air from entering the metering chamber. In all phases of operation, the amount of fuel entering the metering chamber is equal to the amount of fuel being used by the engine.

## INTERMEDIATE OPERATION

Fuel is delivered into and through the carburetor in the same manner as when the engine is idling. Figure #8 shows the principle of intermediate operation. As the throttle opens and engine speed increases, more fuel is demanded from the carburetor and supplied to the engine by the secondary idle discharge port located immediately behind the throttle shutter.

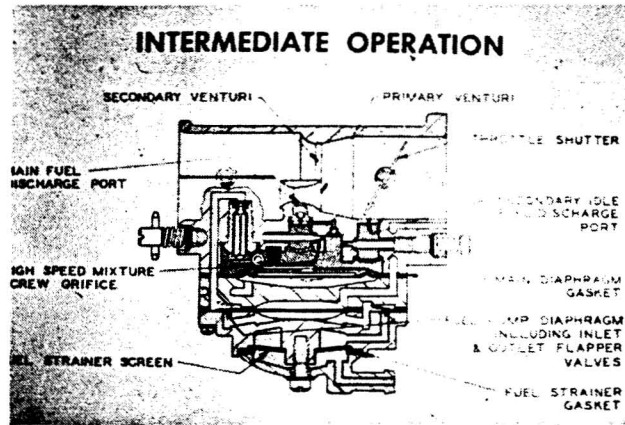


FIGURE #8

As the throttle shutter continues to open and the engine speed increases, the velocity of the air through the venturi creates a low pressure on the engine side of the throttle shutter. When the pressure at the venturi throat is lower than the pressure existing within the metering diaphragm fuel chamber, the fuel is drawn up through the high speed mixture screw orifice and out through the main fuel discharge port.

## HIGH SPEED OPERATION

As the throttle shutter progressively opens from intermediate position to full open position, the air velocity through the venturi increases and fuel is metered up through the high

speed mixture screw orifice and main fuel discharge port in accordance with the power requirements of the engine. The action of the metering diaphragm is the same as previously described with suction required to operate the diaphragm being transmitted through the main fuel discharge port.

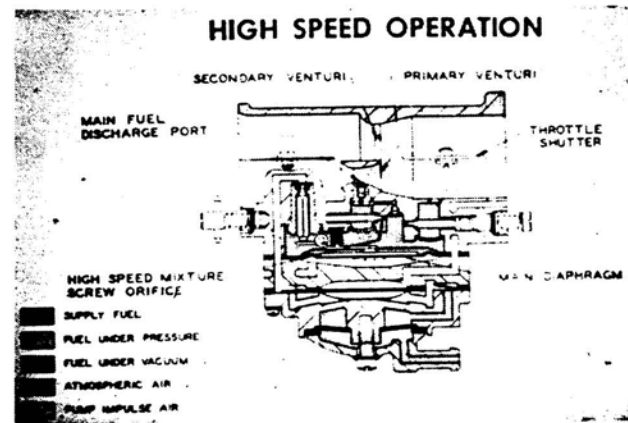


FIGURE #9

Figure #9 illustrates the principles of high speed operation.

#### CARBURETOR CONSTRUCTION DETAILS

- 1 - HIGH SPEED MIXTURE SCREW GLAND ON H.D. CARBURETORS: An air leak in the thread of the high speed mixture adjustment could possibly be responsible for a loss of engine performance.

In order to avoid this possibility, the carburetor high speed screws have been mounted with gland (See Fig. #10), a device which provides greater wearing resistance. Should it become worn, it can easily be replaced by screwing it off the carburetor body.

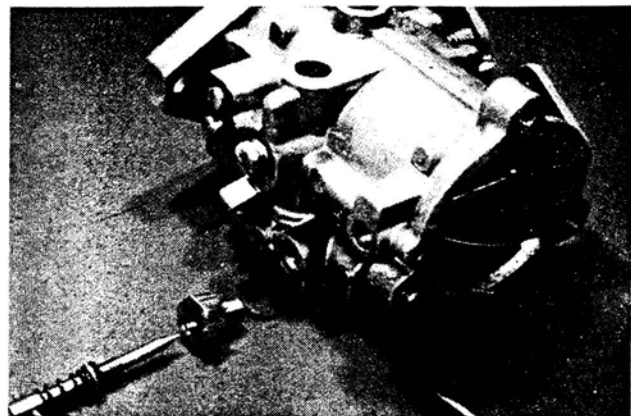


FIGURE #10

- 2 - ADJUSTING SCREWS: The Tillotson carburetors have two different types of adjusting screw, with different size of thread

and different points. Both high speed and low speed mixture adjustment screws have cross bars for easier and more precise adjustments when the machine is moving at high speed or on rough terrain.

3 - VENTURI: All carburetors used this year will have two venturi, as shown in Figure #11.

A venturi is a device which has the property of increasing the differential of pressure between the inside of the carburetor throat and the outside air.

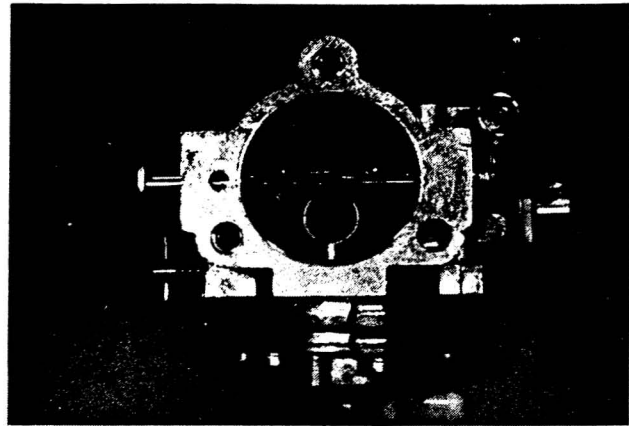


FIGURE #11

This to allow better atomization of the fuel in the carburetor and therefore a better engine operation at all speeds.

The venturi is a specially designed section of the carburetor throat where the area is reduced. Since the same volume of air flows through all sections of the carburetor throat, this reduction in area increases the velocity of the air passing through this section.

Besides increasing the air velocity, the venturi produces a vacuum at its point of maximum restriction. Usually a fuel jet is installed at that point with the result that the fuel drawn from the jet mixes with the incoming air. This mixing of fuel and air is known as vaporization.

4 - CARBURETOR SIZES: Depending on their size, engines have different fuel requirements. The Tillotson carburetors used by Bombardier are sufficient to supply engines from 10 cu. in. to 40 cu. in., i.e. 164 c.c. to 655 c.c.

5 - NEEDLE VALVE RUBBER TIP:

The rubber tip on the needle valve (See Fig. #12) is designed to hold the higher pressure built by the new duplex fuel pump. It also reduces wear in this area of the carburetor.

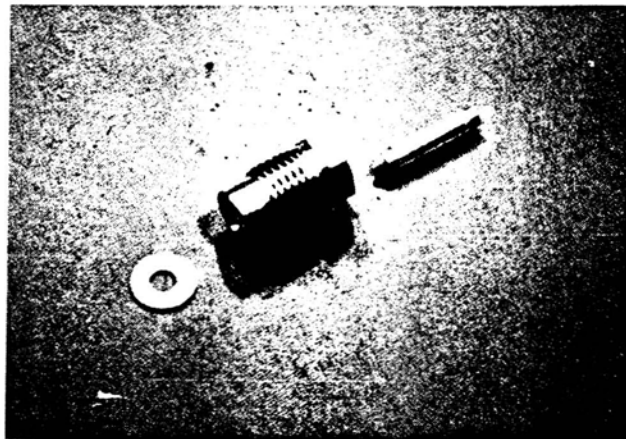


FIGURE #12

CARBURETOR REPAIR PROCEDURE

If for some reason you must repair a carburetor, ALWAYS FLUSH IT IN FUEL AND BLOW IT CLEAN before disassembling.

CAUTION: *Do not use any of these so-called carburetor cleaners as they could damage the rubber parts or the aluminum casting.*

Step 1: Inspect the carburetor body for cracks in the casting, bent or broken shafts, loose levers or swivels, and stripped threads.

Step 2: Remove the idle speed adjusting screw and finder cup assembly. Reassemble according to sequence shown in Fig. 13.

Step 3: Remove the idle and high speed mixture adjustment screws with compression springs and o-rings. See Fig. #14.

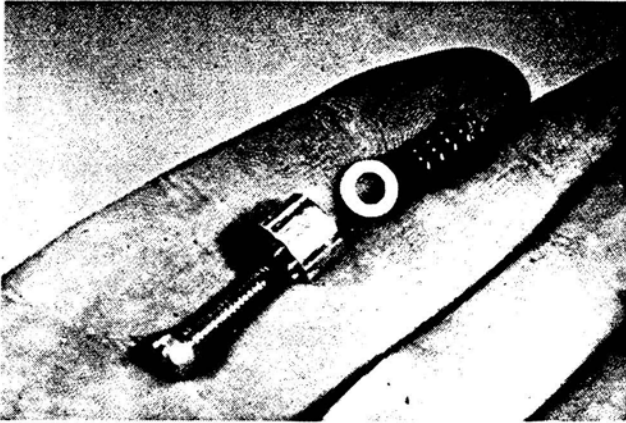


FIGURE #13

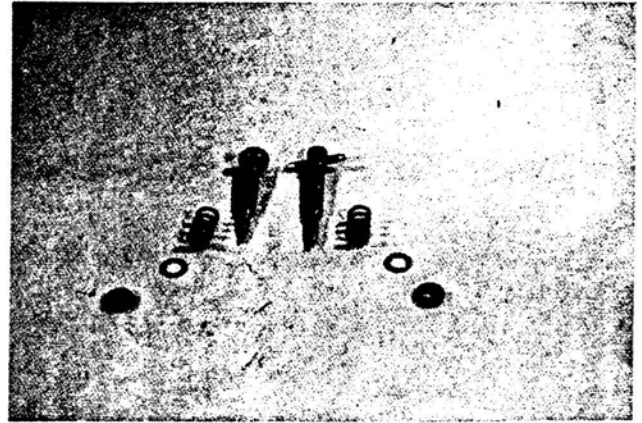


FIGURE #14

NOTE: The spring serves as a vibration damper for the mixture adjustment needle. The washer is used to keep an even pressure around the rubber seal, in order to prevent air leaks through the thread.

- a) Check for apparent damage on the adjusting screws; if they show any signs of failure, they should be replaced.
- b) Inspect the needle seats in the carburetor body; if damaged, replace the carburetor body.

Step 4: Inspect and service the pump and filter section. The fuel inlet and filter cover are removed by taking out the center screw, as shown in Fig. #15.

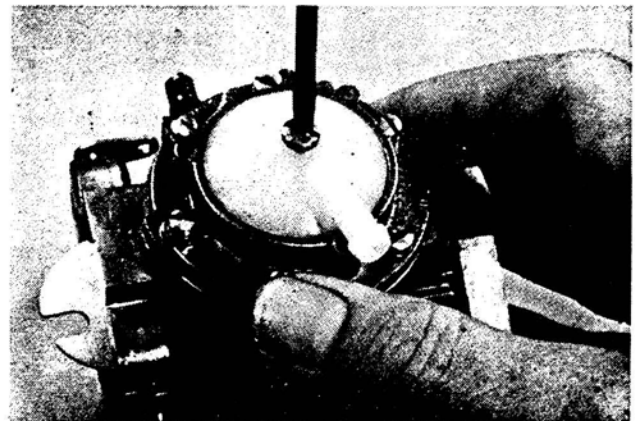


FIGURE #15

REMARK: *The cap must seal airtight.*

Step 5: Reassemble according to the following sequence:

filter screw, gasket, then plastic filter cover.

NOTE: The fuel inlet fitting can be positioned in any direction to accept the fuel line.

Step 6: Remove the six body screws and the fuel pump as shown in Figure #16.

You will then have access to the valving and pulsing diaphragm.

a) The pulsing diaphragm is made out of rubber for flexibility. It should be free of holes or the engine will draw unmetered fuel through it.

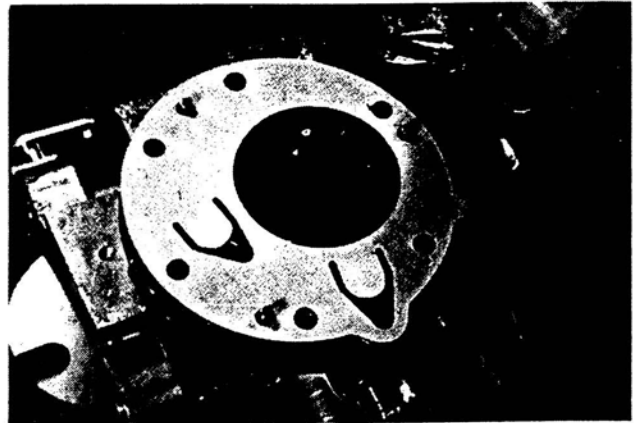


FIGURE #16

b) The valving diaphragm is made of plastic for long wear and capacity to stand pressure without deformation.

NOTE: When reassembling the pump, always make sure the diaphragm is installed in proper position, otherwise the valves will not seal and the pump will not function.

Step 7: Remove the metering diaphragm cover, as shown in Figure #17, and inspect the metering diaphragm. Look for pin holes, tears, loose rivets or any other imperfections. If in doubt, replace the diaphragm.



FIGURE #17

Step 8: Remove the needle valve lever as illustrated in Figure #18.

a) Place your finger over the inlet control lever when removing the retainer screw in order to prevent the lever, fulcrum pin, and spring from shooting out of the body and getting damaged or lost.

b) Check if the control lever moves freely on the fulcrum pin, by rotating the pin in the lever, as illustrated in Figure #19.

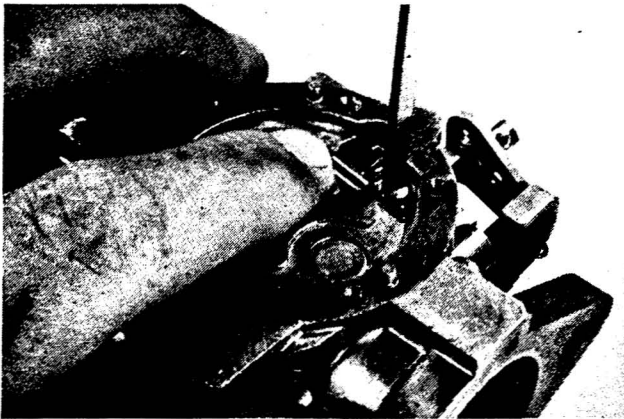


FIGURE #18

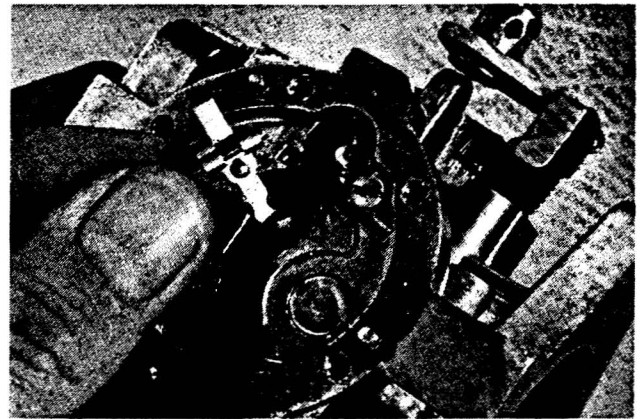


FIGURE #19

The lever should slide on the pin from its own offset weight. If it should catch or bind, replace the defective part.

c) Handle the inlet control spring carefully, as shown in Figure #20.

CAUTION: *Do not stretch the spring nor change its compression characteristics.*

If in doubt about its condition, replace with the correct

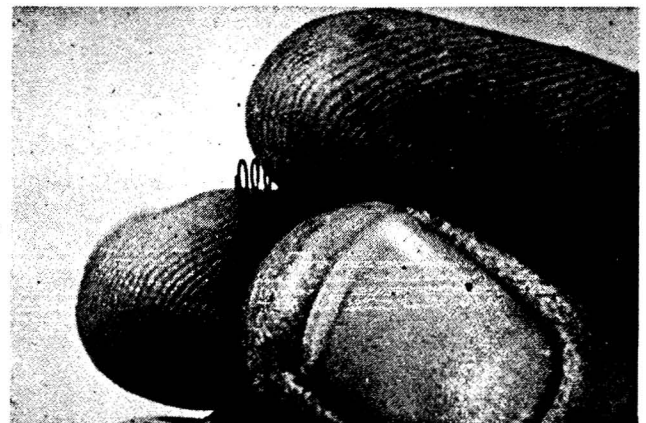


FIGURE #20

spring specified for this model number carburetor.

NOTE: Bombardier uses two types of spring, both of the same length (15/32"). One is of silver metallic color and is used on the H.L. carburetor installed on the 250 c.c. and 165 c.c. engines. The other one is green and is used on H.R. and H.D. carburetors.

- Step 9: Inspect the inlet needle valve and seat assembly.
  - a) Check needle point for wear. The needle and its seat are matched and tested at the factory; should one piece become defective, the whole unit should be replaced.

REMARK: *If you are installing the old type seat, you should make sure that the smooth side of the neoprene insert is the one contacting the needle valve (Fig. #21).*

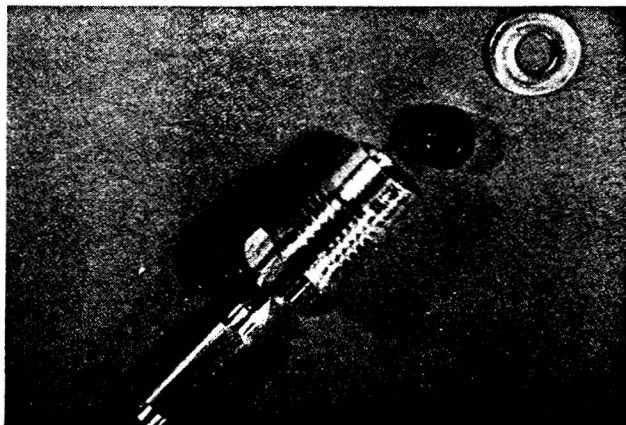


FIGURE #21

- b) On some models, a rubber tipped needle and a brass case are used in order to provide better control of the higher

fuel pressure produced by the new duplex fuel pump.

- c) When installing a new needle valve seat, use a new copper gasket and torque it to the required specifications:

25 to 30 inch-pounds for H.L. and H.R. carburetors,

40 to 50 inch-pounds for H.D. carburetor.

Step 10: When installing the control lever, adjust it flush with the carburetor floor.

- a) Gauge the lever with a suitable straight edge, as illustrated in Figure #22.
- b) In order to attain the proper lever setting, insert the tip of a screw driver under the tip of the lever (See Figure #23). Bend the tab up or down to correct the setting.

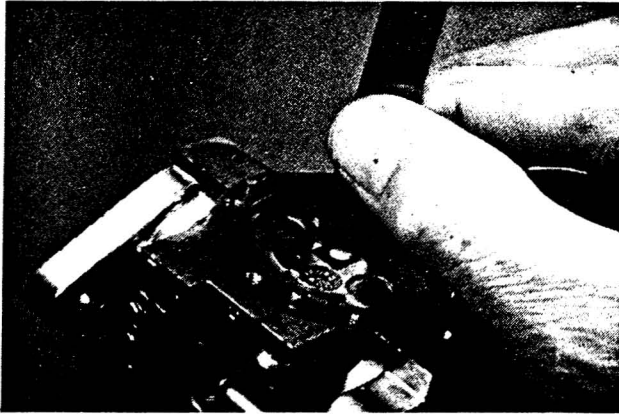


FIGURE #22

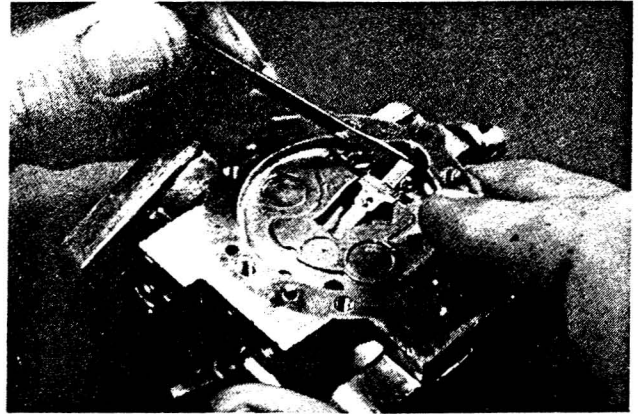


FIGURE #23

CAUTION: *Do not force the lever into the inlet needle. This will cause the needle to stick and may damage the insert or the needle point.*

Step 11: To reassemble all parts, proceed following sequence of Figure #24.

- a) Test the carburetor once the reassembly is completed.

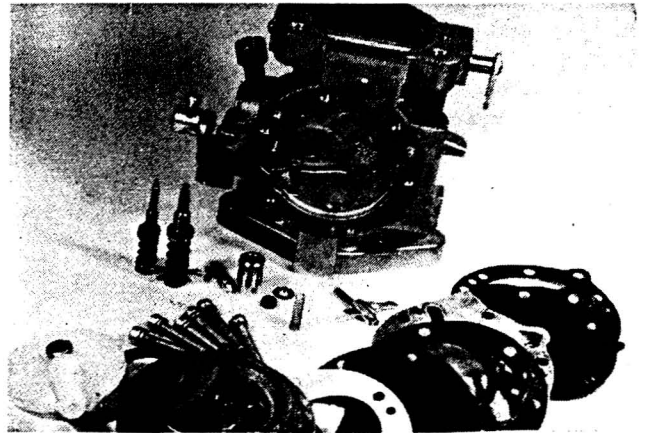


FIGURE #24

CAUTION: *Do not force any of the adjustments.*

Using the recommended gauge, make sure the carburetor holds a 3-pound pressure at least one minute (See Figure #25).

b) If carburetor fails to hold pressure, submerge it entirely in fluid, locate the leak by tracing the bubbles, and correct the flow (See Figure #26).

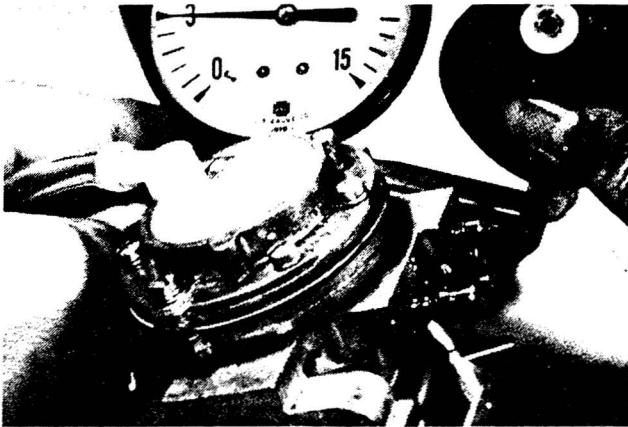


FIGURE #25



FIGURE #26

Step 12: To remove a worn throttle shaft, remove the 2 screws and throttle shutter as shown in Figure #27.

a) Remove the throttle shaft clip (Figure #28) and pull the shaft out of the casting.

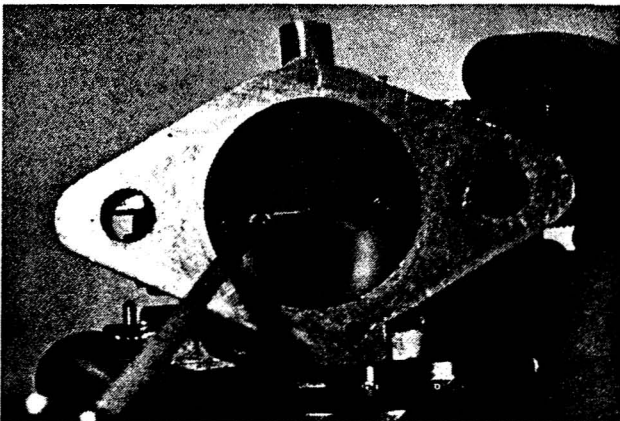


FIGURE #27

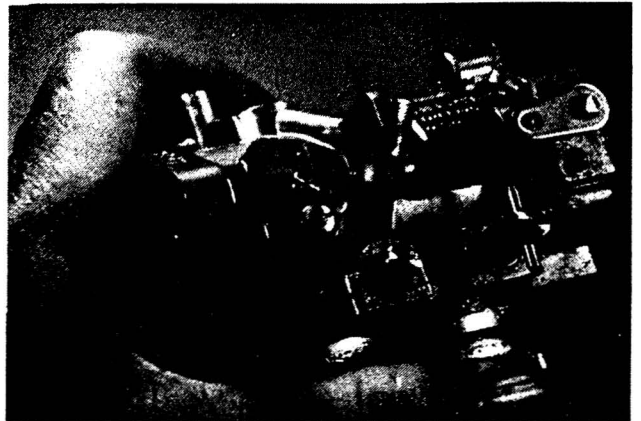


FIGURE #28

NOTE: A shutter will not wear out of normal service. However, if the throttle shaft clip is missing, the shutter will wear where it contacts the throttle bore (See Figure #29). Wear in

this area will lead to a high and non-adjustable idle speed setting.

b) Install new shaft, making sure the screw and the washer attached (See Figure #30) are in good condition.

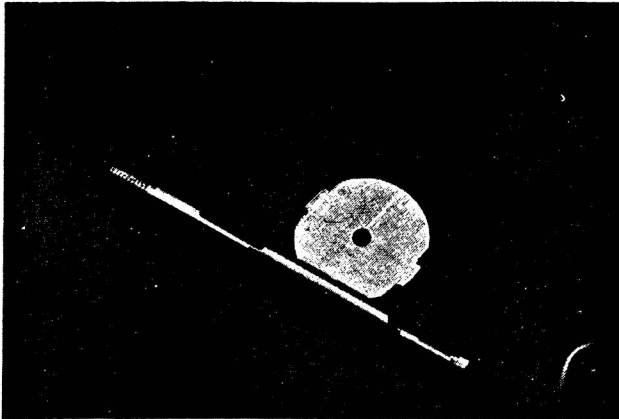


FIGURE #29

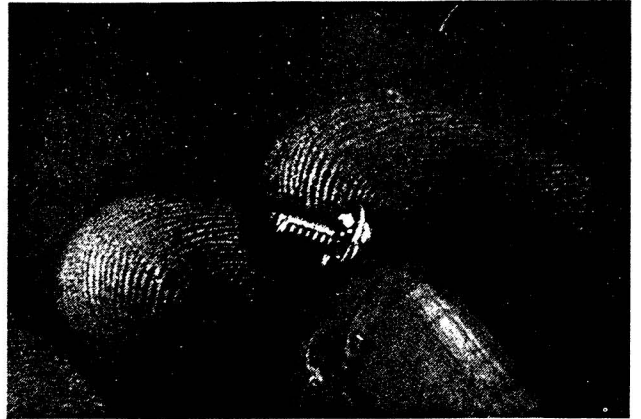


FIGURE #30

c) Check the lever condition and make sure it is tight on the shaft (See Figure #31).

d) Check the swivel condition (it should rotate freely in the lever).

e) Install the shutter. Make sure the return spring is well hooked up (See Figure #32).

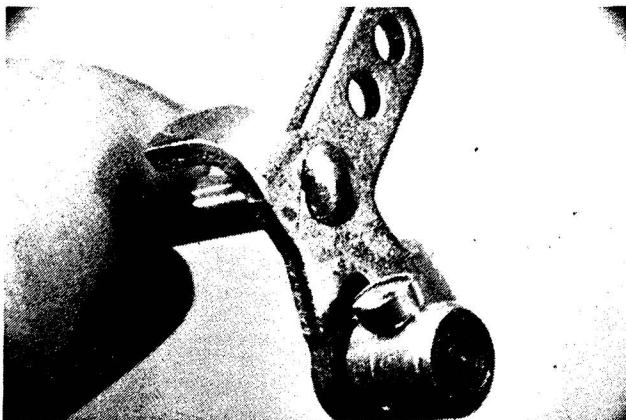


FIGURE #31

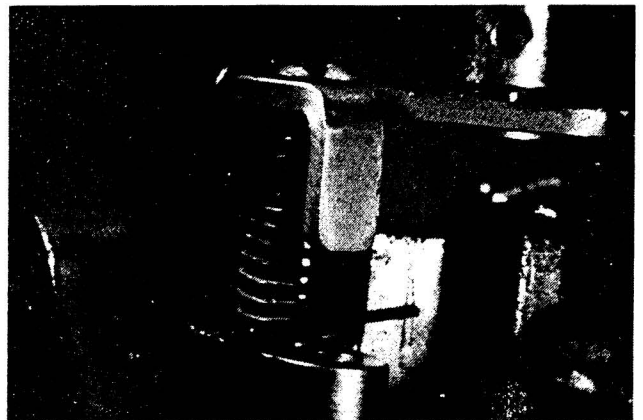


FIGURE #32

NOTE: The edges of the shutter are not cut square with the faces (Figure #33), but on die cut at an angle so that the shutter will close lightly in the throttle bore when the idle speed screw is backed out entirely.

This angle cut lessens the possibility of assembling the shutter into the carburetor backwards. Poor fit and uncontrollable idle speed would result.

f) After the shutter is installed correctly with the idle speed screw backed away from the throttle lever, bring the carburetor choke bore to light and align the shutter (See Figure #34).



FIGURE #33

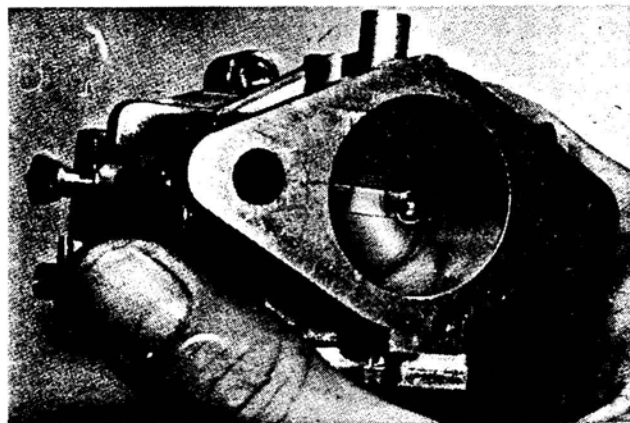


FIGURE #34

NOTE: The shutter may be rotated slightly in the throttle bore in order to correct any slight gaps before tightening.

Step 13: To replace the choke shaft, first remove the choke shutter following the same procedure as for the throttle shutter.

NOTE: The wear points are the same as for the throttle shutter, but not as severe.

a) Pull the choke shaft slowly so the friction ball and spring will not pop out of the casting through the air hole.

b) To install the new choke shaft, insert the tension spring then the ball in the cavity, as shown in Figure #35.

Then use a body screw to press down on the ball while you slip in the choke shaft (See Figure #36). Continue pushing the choke shaft until the stop dent and groove in the shaft and the spring loaded ball are aligned. Then proceed to install the choke shutter with the cut-out portion down.

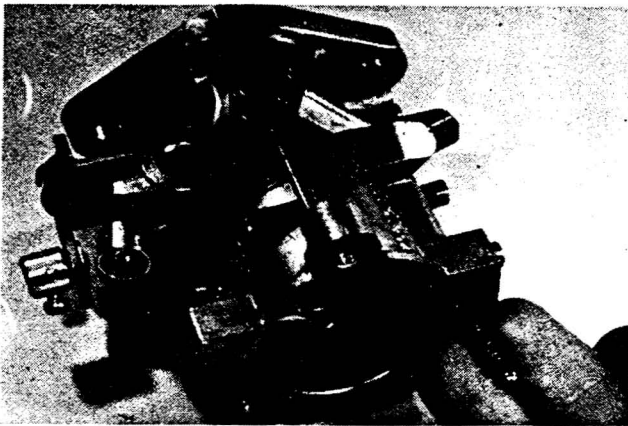


FIGURE #35



FIGURE #36

NOTE: The idle bypass parts and main nozzle are sealed from the metering chamber by welch plugs. It is seldom necessary to remove either of these plugs because there is no wear in either section. Any dirt that may accumulate can be blown with compressed air through the adjustment holes into the carburetor bore.

Step 14: To acced to the area located behind the welch plugs, remove the plugs as follows:

- a) Using a 1/8" drill, just break through the welch plug, as shown in Figure #37. Otherwise you might ruin the casting.
- b) Pry the plug with the tip of a small punch (See Figure #38).

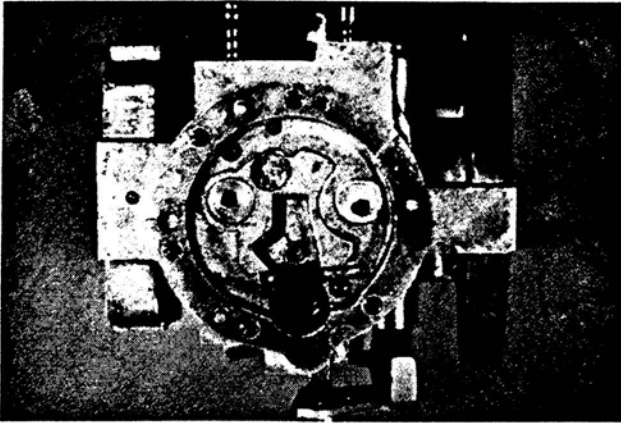


FIGURE #37

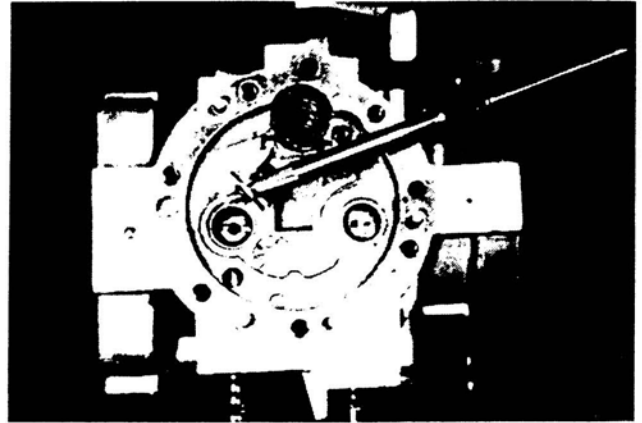


FIGURE #38

- c) You then have access to the different jets.

NOTE: On the H.R. series, you have access to the check-ball assembly after removing the plug. The cage is threaded into the carburetor body (See Figure #39).

- d) Use a screw driver of proper blade width to remove.



FIGURE #39



FIGURE #40

The ball type nozzle valve (See Figure #40) allows fuel to flow in one direction into the venturi. If the check-ball

is defective, the engine will not idle unless the high speed mixture needle is shut off.

If the ball is stuck closed there will be no high speed performance.

NOTE: On the H.L. serie carburetor used in the past year, the check-valve is pressed into the body and can be replaced by pressing it into the carburetor base with a 3/16" flat end punch.

Step 15: Replacement of welch plug.

- a) Insert the welch plug into the counterbars (high center section of the plug up).
- b) Center a 5/16" flat end punch on it and strike with a hammer.

NOTE: A leak around the welch plug would allow an overrich idle mixture with adjustment closed.

Step 16: TO REASSEMBLE THE CARBURETOR, REVERSE THE DISMANTLING PROCEDURE.

PD/fs  
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SERVICE DEPARTMENT

REFERENCE NOTES TO CARBURETOR REPAIR

## CARBURETOR TROUBLE SHOOTING

### SECTION 1: IDLE SYSTEM

TROUBLE	CAUSE	REMEDY
1. Idle operation too lean	Adjustment set too lean	Readjust
	Dirt in idle fuel channels	Blow out with compressed air
	Channel plugs missing or not tightly sealed	Re-seat or replace channel plugs
	Main fuel check valve not sealing	Blow out with compressed air or replace
	Inlet control lever set too far away from diaphragm	Re-set control lever flush with metering chamber wall
2. Idle operation too rich	Carburetor flooding	Refer to trouble #2 of section 4
	Idle adjustment screw point damaged	Replace the adjustment screw
	Idle air bleed plugged	Blow out with compressed air
	Idle adjustment hole damaged, forced, oversize or casting cracked near the adjustment point	Replace carburetor

## SECTION 2: INTERMEDIATE SYSTEM

TROUBLE	CAUSE	REMEDY
1. Lean operation at intermediate speeds	Adjustment set too lean	Readjust
	Dirt in intermediate fuel ports or supply channels	Blow out with compressed air
	Channel plugs missing or not tightly sealed	Re-seat or replace channel plugs
	Main fuel check valve not sealing	Blow out with compressed air or replace
	Power valve ball stuck closed	Remove welch plug and steel ball and blow out channel with compressed air
	Inlet control lever incorrectly set	Readjust inlet control lever
2. Rich operation at intermediate speeds	Adjustment set too rich	Readjust
	Carburetor flooding	Refer to trouble #2 of section 4
	Main fuel check valve welch plug not tightly sealed	Re-seat or replace the welch plug
	Choke valve partially closed	See that choke friction spring and ball are correctly assembled
	Inlet control lever incorrectly set	Readjust inlet control lever flush with metering chamber wall

### SECTION 3: MAIN NOZZLE SYSTEM

TROUBLE	CAUSE	REMEDY
1. Lean operation at high speeds	Adjustment set too lean	Readjust
	Dirt in nozzle system	Blow out channels with compressed air
	Adjustment packing damaged	Replace packing
	Main fuel check valve damaged	Replace the valve
	Main fuel check valve not seated correctly in body casting	Re-seat the assembly flush with nozzle well surface
	Inlet control lever incorrectly set	Readjust inlet control lever flush with metering chamber wall
2. Rich operation at high speeds	Adjustment set too rich	Readjust
	Carburetor flooding	Refer to trouble #2 of section 4
	Power valve ball check not seating	Remove welch plug and steel ball and blow out channel with compressed air
	Inlet control lever incorrectly set	Readjust inlet control lever flush with metering chamber wall

# SECTION 4: ACCELERATING PUMP SYSTEM

TROUBLE	CAUSE	REMEDY
1. Lean acceleration	Incorrect adjustment	Readjust
	Dirt in acceleration fuel channels	Blow out all channels in the metering diaphragm cover and the accelerating pump outlet in the carburetor body
	Accelerating pump assembly damaged or worn	Replace this assembly
	Diaphragm cover plug screw loose or missing	Tighten or replace
	Power valve ball check stuck closed	Remove welch plug and steel ball and blow channel clean with compressed air
2. Carburetor flooding	Dirt in inlet needle and seat assembly	Remove and clean or replace
	Inlet seat gasket missing or damaged	Replace gasket
	Inlet control lever incorrectly adjusted	Readjust lever flush with metering chamber wall
	Diaphragm incorrectly installed	Replace or correct installation
	Inlet control lever pin loose or not correctly installed	Tighten retaining screw and correct installation
	Inlet control lever tight on fulcrum pin	Replace damaged part or clean dirt from these parts

#### SECTION 4: ACCELERATING PUMP SYSTEM

TROUBLE	CAUSE	REMEDY
2. Carburetor flooding (Cont'd)	Inlet needle or seat damaged or worn	Replace the assembly
	Persistent flooding	Clean the fuel tank and fuel lines.

# SECTION 5: GENERAL OPERATION

TROUBLE	CAUSE	REMEDY
1. Lean operation in all speed ranges	Filter screens plugged or dirty	Clean or replace
	Inlet control lever incorrectly adjusted	Readjust lever flush with metering chamber wall
	Diaphragm cover plates loose	Tighten screws
	Air leak into the metering system	All channel plugs, plug screws and lead plugs to be tightly sealed
	Inlet tension spring stretched or damaged	Replace spring
	Fuel pump not operating	Clean fuel pump and replace worn parts or check assembly to be certain that gaskets and diaphragms are correctly installed
	Carburetor loose on manifold	Tighten in place
	Air leak in fuel lines	Replace fuel line
	Fuel line plugged	Clean fuel line
	Low fuel supply	Fill fuel tank
	Pump pulse channel plugged or not aligned to engine	Clean or correct alignment
	Fuel tank vent not operating	Repair vent

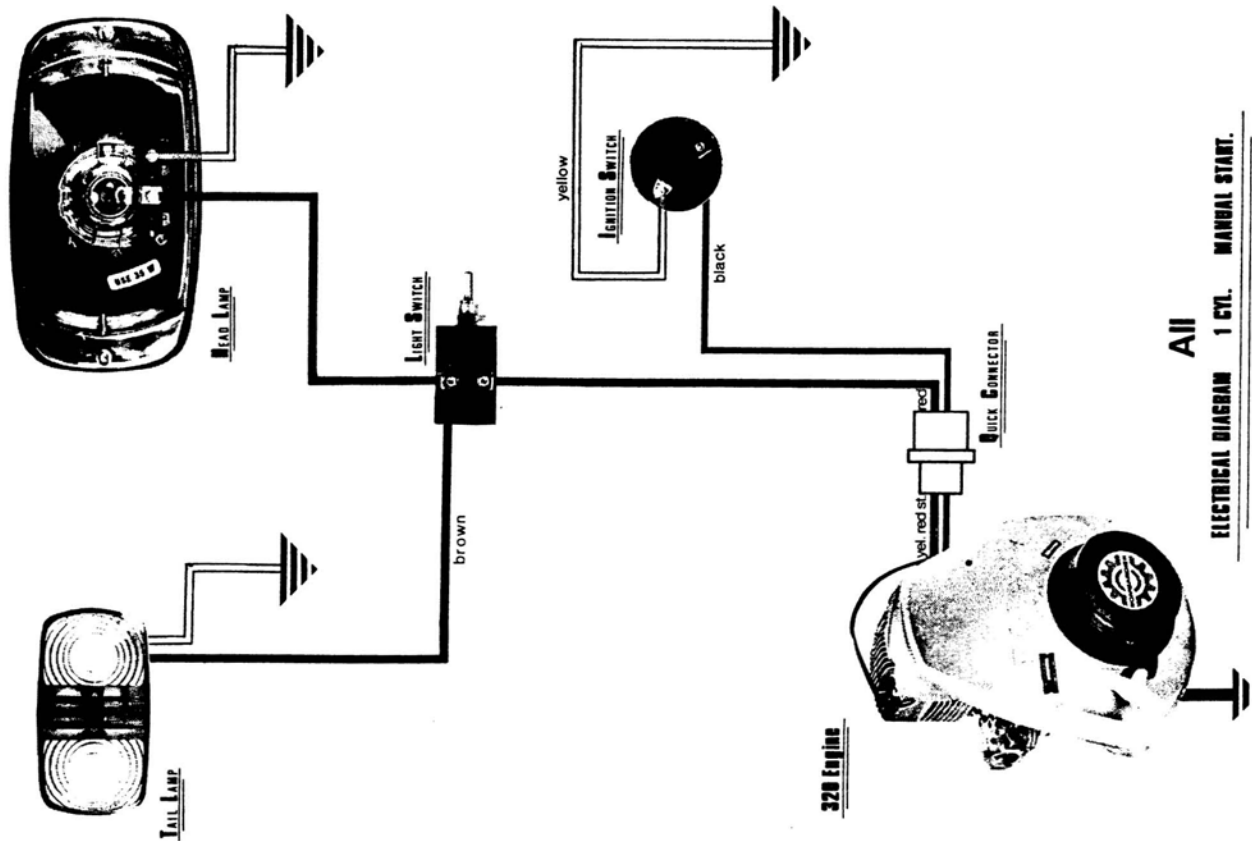
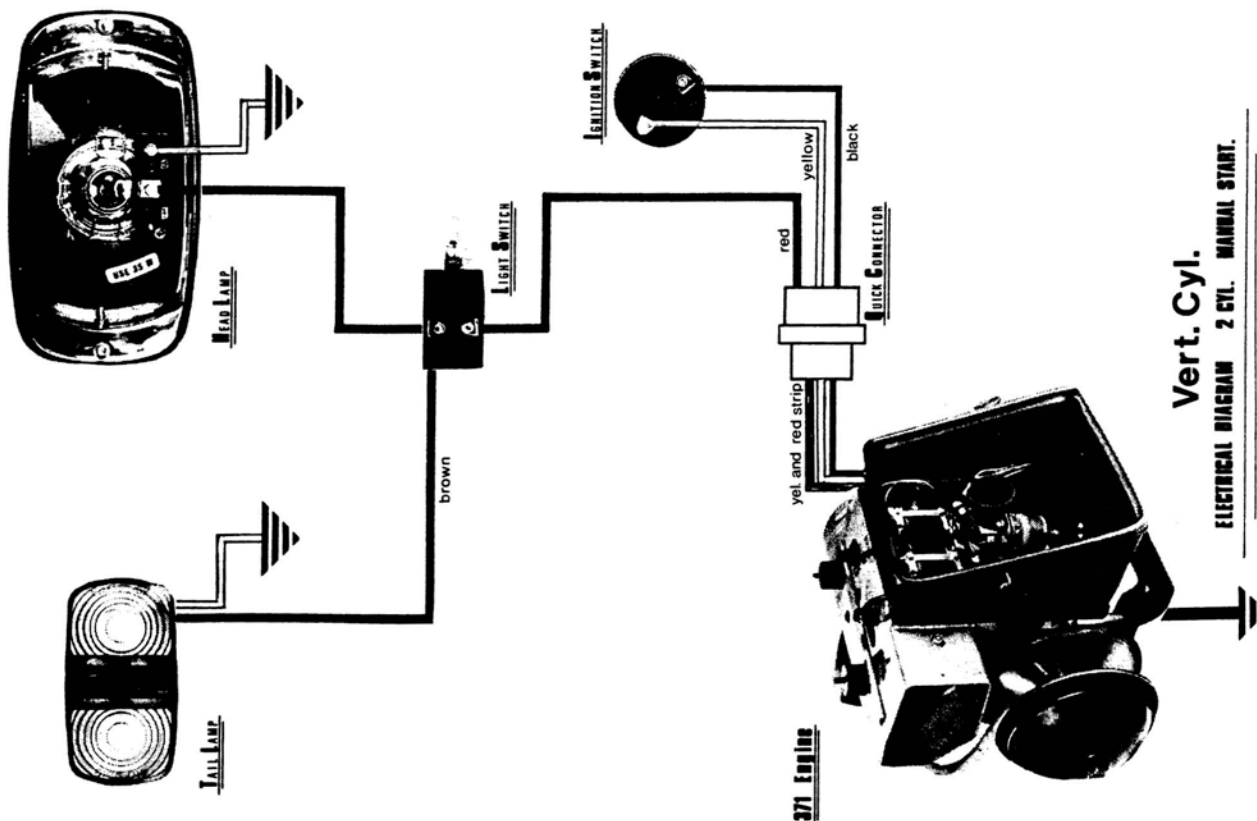
# SECTION 5: GENERAL OPERATION

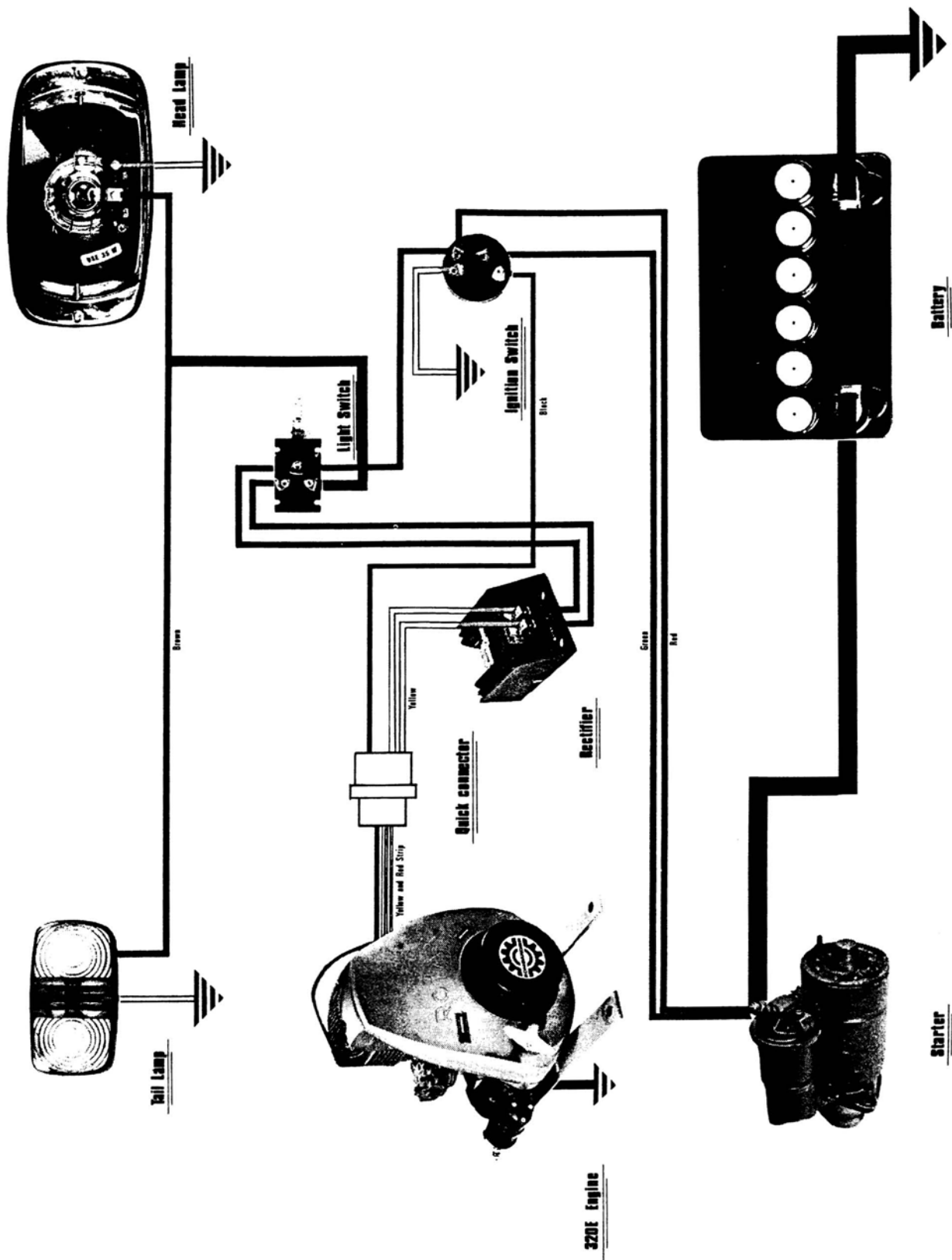
TROUBLE	CAUSE	REMEDY
2. Rich operations in all speed ranges	Ruptured pump diaphragm	Replace diaphragm
	Carburetor flooding	Refer to trouble #2 of section 4
	Welch plugs not sealing	Re-seat or replace
	Inlet control lever incorrectly set	Readjust lever flush with metering chamber wall
	Plugged air filter	Clean or replace

## REFERENCE NOTES TO TROUBLE SHOOTING

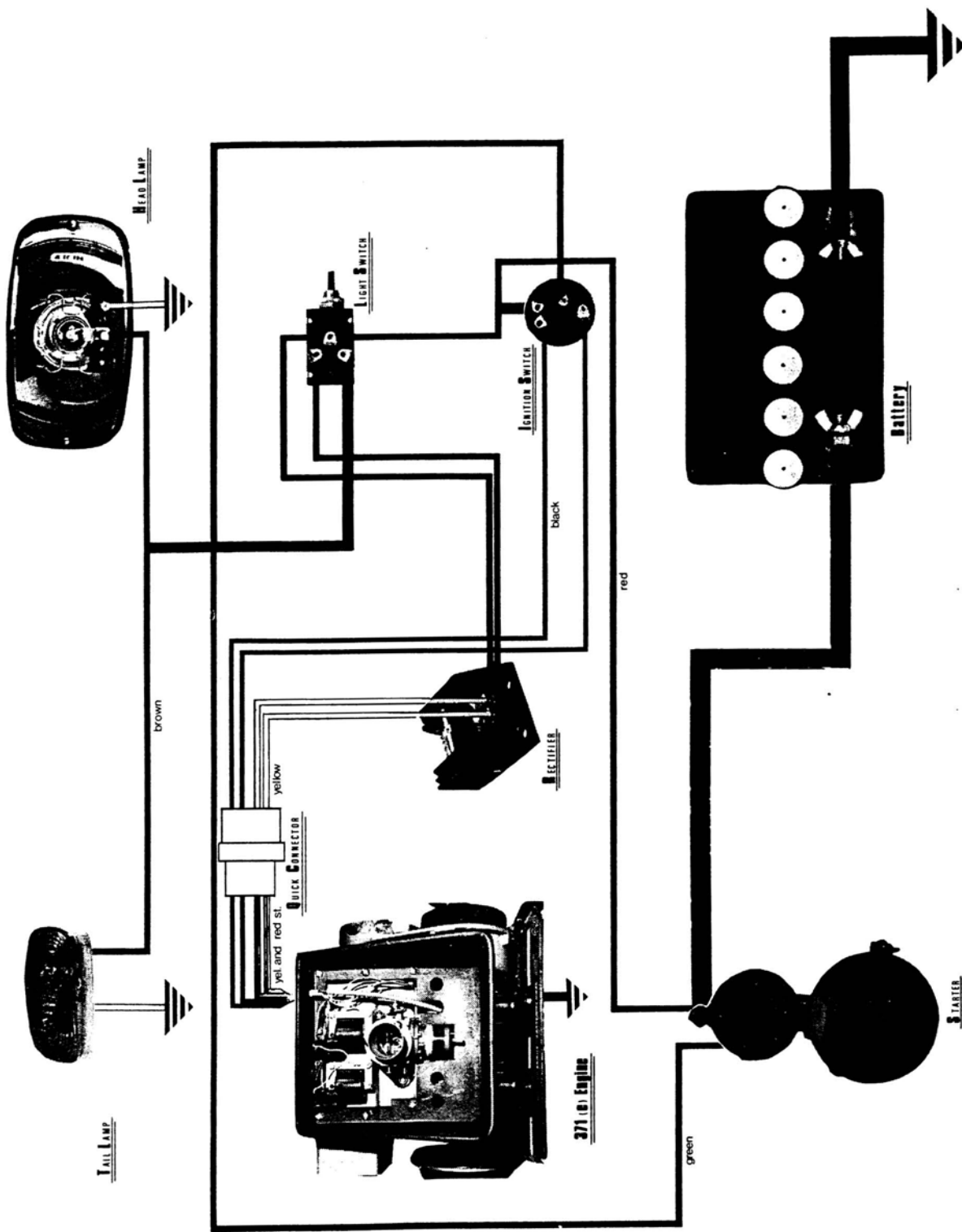
## INDEX TO SECTION C

- C-1     Wiring diagrams
- C-2     What makes the spark
- C-3     Spark plugs for motor vehicles
- C-4     Assembly and Service
- C-5     Ignition timing
- C-6     Merc-o-tronic tester



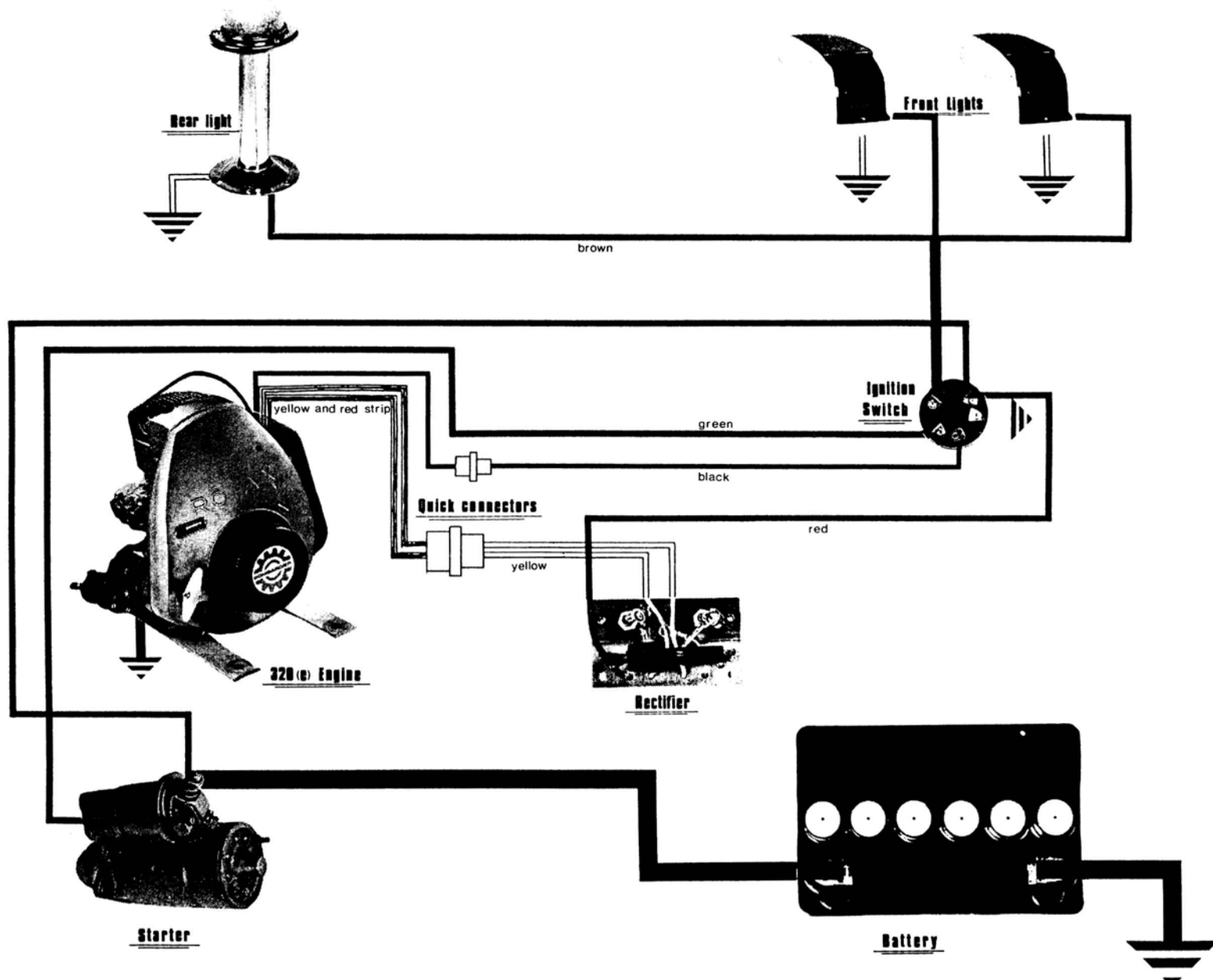


Applicable to all 1 cylinder electric and 370 (4)



81-00 371 (C) Electrical System

Also applicable to all 2 cylinders electric except 370 (C)



Sea Doo Electrical System

REFERENCE NOTES TO DIAGRAMS

## WHAT MAKES THE SPARK?

### MAGNETISM AND ELECTRICITY - BASIS OF A MAGNETO

One of the basic and most useful fact relative to electricity and magnetism is the close existing relationship between them. Every time an electric current flows, it sets up a magnetic field. Conversely, if a magnetic field is increased, decreased or changed in direction, an electric voltage is set up in any nearby conductor.

This principle is the basis for the operation of an electric generator, and a magneto is simply a specialized type of generator. In a magneto, permanent magnets are used to produce a magnetic field directed through the iron core of a coil, and then reverse the field direction, thereby creating a voltage in the windings of the coil.

### WHAT IS A MAGNET?

Any time a current passes through a coil of wire around a piece of iron, it turns the iron into an electromagnet. If the iron is hardened, it will retain a certain amount of magnetism after the current is shut off. In fact, hard alloys retain a very large portion of the magnetism and are nearly as strong as permanent magnets. Magnetizing an iron core lines up the axes of the electrons in one direction so that their separate forces act together. In a hardened piece of iron, the axes of the electrons remain lined up after the electric current stops flowing, and the piece of iron becomes a permanent magnet with established North and South poles.

### THE MAGNETIC FIELD

The field of a magnet is its area of magnetic influence, concentrated between its respective North and South poles, and particularly strong within the iron core. This principle forms the basis on which a magneto operates. The core leads the magnetic field through the path chosen by the magneto designer and concentrates itself inside the coil.

### WHAT IS A MAGNETO COIL?

A magneto coil generates and transports electricity. It consists in a primary and a secondary winding of wire. The primary, made

of heavy wire next to the core, is connected to the frame of the magneto as ground, and at the other end to the live insulated breaker points.

The secondary, about 10,000 turns of fine wire outside the primary, is grounded on one end with the primary and the other end is connected to the spark plug wire. This creates a circuit which captures the electricity produced by the magneto and delivers it to the spark plug.

#### WHAT IS A CONDENSER?

A condenser is a reserve for electricity, made up of two strips of foil with paper insulation between them. One strip is grounded - the other is connected to the live breaker point. When the points are open, the condenser paper acts as a reservoir or "surge tank" for electricity.

#### WHY IS THE CORE LAMINATED?

The iron core in which magnetism is concentrated - and rapidly reversed from one direction to the other - is split up into many thin laminations. This prevents the build-up of any one large electrical path for an eddy current. The slight amount of oxide between laminations provides enough insulation to prevent the eddy currents from travelling from one lamination to the other.

#### THE MAGNETIC CIRCUIT

If an ordinary generating coil was used in place of the ignition coil, and the flywheel rotated, the magneto would act as a generator. First, the North pole would be over the center leg of the core and the magnetic direction would be DOWN that leg to the left leg and the South pole magnet. As the flywheel rotates to the right, the North pole would move over the right-hand core leg, and the direction of magnetism would change so that the flow would be down the right-hand leg, and UP through the center leg to the South pole. This reversal of magnetism generates electricity in the generator winding around the center leg core, and operates a light as indicated in the illustration. The intensity of the voltage generated in each turn depends on the amount of magnetism and the speed with which it is reversed in direction.

#### A MAGNETO WITH MAGNETISM ESTABLISHED THROUGH A COIL

A magneto concentrates the electricity generated into one very high voltage discharge of short duration. The addition of primary,

breaker points, and condenser accomplishes this.

Looking at the magneto with ignition coil, condenser and points in operation, the magnetism (as in the case of the generator) first establishes itself from the North right-hand pole downward through the center leg to the left-hand South pole.

#### POINTS ABOUT TO OPEN

As the flywheel rotates and the center leg is disengaged by the North pole and engaged by the South pole, the magnetic circuit attempts to reduce and reverse the direction of magnetism in the center leg. The slightest reduction in the amount of magnetism causes a current to pass through the primary coil, making it an electromagnet. The direction of magnetism in this electromagnet opposes an attempted change in the direction of magnetism in the core, thus acting as a choke when the breaker points are closed. The opposing forces virtually hold the magnetism through the center leg in a state of momentary suspense.

#### POINTS OPEN

The primary coil must continue this choking effect only for a fraction of a second. As soon as the South pole magnet has sufficiently covered the end of the center leg, the breaker points are opened by the cam. This instantly interrupts the flow of current in the primary circuit and releases its choking effect. The built-up magnetic forces surge through the center leg, reversing the direction of the magnetic field within it. This sudden complete reversal of the magnetic field in the core generates an enormous voltage in the secondary coil, allowing it to break down the spark plug gap and produce an ignition spark.

At the same instant that the breaker points open, the condenser "surge tank" momentarily absorbs the surge of current in the primary, which, if it had nowhere else to go, would continue to arc across the breaker points. The current then surges from the condenser and magnifies the reversal of the magnetic field in the coil core, thereby increasing the voltage of the secondary output.

REFERENCE NOTES TO MAGNETO

## SPARK PLUGS FOR MOTOR VEHICLES

The air-fuel mixture in the combustion chamber of a gasoline engine is ignited by an electric spark. The ignition voltage is generated by magnetos.

It is the function of the spark plug to introduce the high-tension ignition current (well insulated) into the combustion chamber of the engine cylinder, and to initiate the combustion of the compressed air-fuel mixture by a spark jumping across its electrodes.

### OPERATING PRINCIPLE:

The high-tension ignition current flows from the terminal through the insulated center electrode, and sparks across the gap between the center and ground electrodes, igniting the air-fuel mixture at an exactly determined position of the piston.

### SELECTION OF THE PLUG AND ITS BEHAVIOUR IN SERVICE:

The design of a universal spark plug suitable for all engines is impossible because of the considerable differences prevailing in motor vehicle engines in regard to operating conditions, type of engine ( 2 or 4 cycle), compression ratio, rotational speed, cooling arrangements, carburetor setting and fuel. That is why motor vehicle manufacturers, as a result of exhaustive tests, specify a spark plug which shows the most favorable reaction to heat under the prevailing operating conditions.

In normal operation of an engine, a correctly selected BOSCH spark plug will adjust itself to a certain operating temperature WHICH MUST BE WITHIN A DEFINITE RANGE. Where this temperature is exceeded, pre-ignition occurs, i.e. the air-fuel mixture is ignited not by the spark but by some overheated spot before the correct firing point. THE SPARK PLUG SHOULD TEMPORARILY HEAT UP SUFFICIENTLY to burn off particles of oil or soot deposited on its tip, and thereby clean itself. The limit of the upper temperature range is specifically determined by the pre-ignition temperature of approx. 1560o F.

The following can be said in reference to the limit downwards (self-cleaning temperature of the spark plug):

Soot, oil, and oil carbon, which may cause electrical leakage on the insulator below 930 o F, burn off entirely at 930o to 980o F.

Therefore, they constitute a danger under certain conditions only below 930o F, but not above it.

This is entirely different with the inevitable deposits such as lead oxide, sulphate of lead, lead chloride, lead bromide and the lead phosphate compounds from leaded fuels. These may become electrically conductive and therefore weaken the ignition spark by providing a leakage path, when their temperature exceeds 930o F. For this reason no definite temperature, e.g. 930o F, can be given at which misfiring due to leakage paths can be avoided. The fouling limit (soot or oil) is by no means absolute, for when the engine is overrun, temperatures under 500o C. occur frequently.

Nevertheless, fouling troubles need not occur on engines in good condition. During the combustion of the air-fuel mixture in the combustion chamber a HEAT SHOCK, WELL ABOVE 930o F. will exist in the scavenging area of the spark plug and thus around the insulator surface. This will burn the soot which is being formed in small quantities.

The situation is somewhat different if, after a long period of service, an engine has worn cylinders, worn or broken piston rings or when carburetor-and air-adjustment or spark timing are faulty:

Then more oil may get into the combustion chamber and form more soot and hard carbon THAN CAN BURN OFF DURING THE SHORT PERIOD IN WHICH THE HIGH GAS TEMPERATURES OCCUR. This may lead to plug fouling and cause ignition trouble. The higher gas temperature would have to be present for a longer period of time to burn the oil and soot deposits, or the insulator tip would have to reach a temperature above 930o F, even at light engine load as our experiments have shown, this is hardly ever the case, even if plugs with a particularly low heat value are fitted.

Here, temporary remedy is possible by installing a plug of lower heat value than normally provided by the motor vehicle manufacturer: a hotter plug must be installed e.g. one with a heat value of 145 or less, instead of 175. However, this serves only as a short-term makeshift arrangement and only a complete overhaul of the engine carburetor, or ignition system can be considered as a final and effective remedy.

In yet another case, a plug of lower heat value (hotter plug) may prove advantageous: provided a vehicle in good order is only driven slowly with frequent stops. This especially applies to high-powered vehicles with high top speed, whose power reserve is only rarely used, as for instance, when accelerating. In continuous driving at a low engine speed, and at light loads, with frequent idling etc., the air-fuel mixture is always rather rich, and oil entering the combustion chamber does not always burn away entirely. It may be an advantage to fit a hotter plug, i.e. one with a lower heat value than that specified by the makers. This applies in particular to two-cycle engines running on a gasoline-oil mixture.

#### THE HEAT VALUE OF THE SPARK PLUG

The heat value indicates the heat conductivity, expressed in the form of a comparative index figure. The higher this figure, the higher the thermal loading capacity of the spark plug. This basis of grading spark plugs according to their heat conductivity was evolved in the early days of spark plug development and used to indicate the time it took a plug to pre-ignite in a special test engine running under certain conditions.

The heat value of a spark plug is determined by:

- 1- The thermal conductivity of the insulator and the electrodes, especially the center electrode.
- 2- The surface area of the insulator exposed to the combustion gases.

- 3- Size and shape of the space between insulator and plug shell (largely dependent on the diameter of the plug shell bore); type and shape of the material for the sealing washer between insulator and plug shell.
- 4- The surface area of the spark plug exposed to the cooling air.
- 5- The method of fixing the center electrode in the insulator.

The higher the heat value of a spark plug, the higher the thermal load it can take without risk of pre-ignition; but on the other hand, it also has a bigger tendency to fouling since the surface of the heated insulator tip is the smaller, the higher the heat value is. The lower the heat value of a spark plug, the more susceptible it is to overheating and the less is its tendency to fouling.

The proper selection is therefore (assuming perfect condition of the engine):

WHEN PRE-IGNITION OCCURS:

BOSCH Spark Plugs with the  
next higher heat value.

WHEN FOULING OCCURS

BOSCH Spark Plugs with the  
next lower heat value.

#### THE PLUG FACE

The condition of the engine, operating conditions,

method of driving, and above all the fuel may give defects which the spark plug reveals though it cannot be held responsible for them. For these reasons, it is advisable to inspect your spark plug at regular intervals, examining in particular the "plug face" i.e. the part of the plug projecting into the combustion chamber. The plug face reveals the root of the trouble.

PRE-IGNITION: Pre-ignition results in poor engine performance because the prematurely ignited air-fuel mixture brakes the piston during the compression stroke. When pre-ignition becomes really bad, the ignited air-fuel mixture may even pop through the open inlet valve, thus producing no power but overheating the parts. The ignited gases give rise to popping and spluttering in the carburetor and may even cause carburetor fire. Pre-ignition, apart from being due to overheated spark plugs, may also be caused by other parts inside the combustion chamber projecting into the combustion chamber, and residues from combustion. PRE-IGNITION MUST NOT BE MISTAKEN FOR KNOCKING OR PINGING which occurs only after the spark has ignited the charge in the combustion chamber. The cause of knocking is the spontaneous self-ignition of the last portion of the fuel-air mixture.

The running-on of engines, after switching off the ignition may be due to pre-ignition caused by overheated spark plugs, but only if this occurs immediately after prolonged full-load driving. Running-on sometimes occurs after part-load operation or even

after idling; in these cases the spark plug can not be the cause of the trouble.

Excessive plug temperatures need not solely be caused by too low a heat value. Where, for instance, the gasket on the plug seat has been omitted, the spark plugs are overheated by the blow-by of hot combustion gases, or the plug thread, projecting too far into the combustion chamber, becomes red hot together with the ground electrode and thereby causes pre-ignition. Leaner mixture or a higher compression ratio, or excessively advanced ignition may also give rise to pre-ignition.

**FOULING:** Fouling of the spark plug is indicated by irregular running of the engine, decreasing engine speed due to misfiring, reduced performance, and increased fuel consumption.

This may be due - apart from too high a heat value of the spark plug - to excess lubricating oil in the combustion chamber, possibly as a result of an excessively high oil level in the crankcase, broken piston rings or worn cylinder walls. Other possible causes are protracted idling or running the engine with the choke pulled out, or running it on too rich a mixture due to faulty carburetor adjustment or on an unsuitable fuel. The "plug face" of a fouled spark plug has either a dry coating of soot, or an oily, glossy coating owing to an excess of oil

or oil with soot. Such coating forms a conductive connection between the center electrode via the insulator tip to the plug shell and there to ground. The high-tension current uses this coating as a leakage path because of its lower resistance.

In some engines, particularly two-cycle engines, "gap-bridging" may occur between the center and ground electrodes, or sometimes also between insulator tip and plug shell so that the spark gap or the scavenging area becomes encrusted, i.e. bridged, and the high-tension current leaks along these paths of low resistance instead of flashing across the gap between the electrodes as a spark.

In both cases, the trouble starts with occasional misfiring, which owing to increased cooling and fouling, eventually leads to a complete breakdown of the ignition. Such fouling is not caused by the slight layer of soot which forms during the short period of idling prior to stopping the engine and which results in a plug face with a slight soot deposit.

This slight layer of soot burns off immediately once the engine is restarted. Plug firing also fails when the glazed surface of the upper part of the insulator, the "insulator head" is fouled or wet, forming a leakage path for the ignition current between terminal and plug shell.

## REFERENCE NOTES TO SPARK PLUGS

## ASSEMBLY AND SERVICE OF THE ELECTRICAL SYSTEM

### IGNITION UNIT

ARMATURE PLATE ASSEMBLY: The armature plate having slots should be assembled in such a way that screws are about in the center of the slots.

Insert cable grommet into crankcase.

Assemble washer, cam spring and breaker cam to crankshaft extension.

Mount woodruff key.

Assemble fan cowl and labyrinth ring.

Armature plate with high tension ignition coil mounted outside on engine. The current for the ignition is produced in the generator coil and conducted outside to ignition coil where the current is transformed to the required voltage for the ignition. The second coil is the lighting coil, generating alternating current, 12 volts, 50 watts in rewind starter engines, 75 watts in electrically started engines.

CONNECTIONS: Correct wiring is important. Connect blue generator cable to terminal (15) of first ignition coil; the shorting cable is also connected to this terminal. Connect terminal (1) of first coil to terminal (15) of second coil. Connect terminal (1) of second coil to ground. Incorrect wiring causes the spark to weaken considerably on 370 c.c.

Connections are plugged, protected by caps against dirt and moisture.

Ignition cable to be screwed to its terminal, also protected by a protection cap.

DISASSEMBLY OF CONTACT POINTS: If contacts are heavily burned or soiled, disassemble them for cleaning.

Loosen cable connection nut.

Remove spring clip and shim.

Remove contact breaker with suitable long-nose pliers.

Disassemble screw fastening breaker contact to armature plate.

Remove breaker contact.

Clean contacts with non film solvent.



ASSEMBLY OF CLEANED CONTACTS: Apply high quality bearing grease to the pivot pin and install on contact breaker, engaging its spring from the bottom and fastening it. Do not touch contacts with fingers or grease or dirt.

After assembling shim and spring clip, make sure that contacts are aligned. Use shims to align them. If the contact breaker is heavily burned due to heavy sparking at the contacts, the condenser should be checked and replaced if necessary.

NOTE: The following items must be greased with high quality bearing grease: lubricating wick, slip block and pivot pin of contact breaker.

In the breaker cam there is a groove to take a high quality grease, in order to prevent the cam from rusting on the crankshaft. Before assembling the flywheel make sure that cables lie properly, and rotate cam to check proper opening of contacts.

De-grease taper of crankshaft extension carefully.

De-grease bore of flywheel.

Turn breaker cam so the flyweight will engage in its slot and assemble flywheel watching for the key.

Assemble lock washer.

Torque flywheel nut to 54 ft. lb., holding fan with recommended wrench on 370 c.c.

Bend lock washer.

Assemble fan cowl cover.

IGNITION TIMING: Marks on fan cowl cover and fan indicate when piston is in the sparking position, without centrifugal weight of spark retarding mechanism being lifted, i.e. .02" BTDC. on 370 c.c.

To check and adjust the ignition timing, only rewind starter and starting pulley need be removed. With marks on fan cowl cover and fan aligned, the piston is in the sparking position, and contacts must start opening. To adjust, loosen breaker contact fastening screw, adjust contact with screwdriver in such a way that contacts start opening with marks aligned. Now fasten screw again. Contact points gap: .014 - .018.

#### REWIND STARTER

Rewind starter has plastic sleeve as a protection against intrusion

of foreign parts. This must be removed for rewind starter disassembly.

DISASSEMBLY: Disassemble starter stop and countersunk screws.

Remove circlip.

Remove pawls with pivot arm.

Remove D-washer.

NOTE: It is advisable to lay the parts in the sequence of their disassembly, so nothing will be mixed up on reassembly.

Side starter grip through starter housing, put rope into its respective groove of the rope sheave and allow rope sheave to rotate slowly for rewind spring to relax.

Lift out rope sheave, taking care that spring cartridge with rewind spring remains in starter housing, and that spring end is not bent.

Check for proper condition of rewind spring.

Rewind starter and its parts.

To disassemble starter rope, lift knot out of rope sheave.

ROPE REPLACEMENT: Assembling a new rope, do not forget starter grip, rubber buffer and starter stop.

Lead rope through rope sheave and make a knot.

Push rope end into respective opening of rope sheave below knot.

Push knot into opening by pulling.

Wind rope on rope sheave.

NOTE: Assembling the rope sheave, watch for the inner end of the spring to engage in the proper slot of the rope sheave. Put rope into respective groove of rope sheave and rotate rope sheave 4 full turns to give a pre-tension. Slide starter grip, rubber buffer and starter stop through starter housing and assemble starter stop.

REASSEMBLY: Assemble D-washer, which is hardened and ground on both sides, to starter bolt.

Assemble pawls with pivot arm.

NOTE: Open hook of pivot arm must face in the direction of engine rotation, that is in a counterclockwise direction. Sharp edge of pawl must be opposite the hook of the pivot arm.

Assembly of pawl spring stop.

Insert sideways, then rotate and engage it in pivot arm.

Assemble serrated friction washer, serrations of pivot arm and friction washer to lock towards each other. Put a drop of lubricant on serrations.

Assemble friction spring.

Assemble top washer.

Assemble circlip.

Check starter for proper operation.

REFERENCE NOTES TO ELECTRICAL ASSEMBLY

## IGNITION TIMING (300,320,370 ENGINES)

### BREAKER POINT

Remove engine.

Remove fan cowl cover.

Unscrew nut and washer and remove flywheel.

Check breaker point condition. Install new set if necessary.

ADJUSTMENT: Use gauge (Breaker point gap .014 to .018).

Connect the tester (Timing flashlight or Merc-O-Tronic).

Attach one wire to black wire in connector, ground the other.

Reinstall flywheel and turn until marks on labyrinth ring and on flywheel coincide.

At this point, the breaker should open and the light on the tester should go out.

### EDGE GAP (STRAIGHT GAP)

ADJUSTMENT: Leave the tester on the same connections.

Hold the spark retarding mechanism.

Rotate the flywheel about an inch counterclockwise until the light goes on and out.

At this very moment, calculate the gap between the bottom of the coil lamination and the top of the magnet.

Correct setting is .315 to .472 (8 MM to 12 MM).

Change stator plate position if necessary.

Re-check the breaker point setting.

## TIMING AND SYNCHRONIZATION (371, 640 ENGINES)

### BREAKER POINTS

Remove engine.

Remove starter housing.

Remove pulley and "V" belt.

Unscrew nut and washer and take out flywheel.

Check breaker point condition. Replace by new set if necessary.

BREAKER POINTS ADJUSTMENT: Correct gap (.014 to .018).

Reinstall flywheel.

Connect the tester (timing flashlight or Merc-0-Tronic).

Place one wire to the connector (on black wire from breaker) and ground the other on the engine.

For first set of points, turn flywheel until the marks on the casting and on the flywheel are in line. The light should go out.

To adjust the second set of points, connect your tester on the other black wire from the second breaker. Rotate the flywheel 180° from the previous mark. The light should go out again. Readjust if necessary.

### EDGE GAP (STRAIGHT GAP)

Check the edge gap by using the first set of points.

ADJUSTMENT: Connect the tester on first set of points.

Advance spark retarding mechanism.

Turn flywheel about one inch counterclockwise, until light goes on and out.

At this point, check the gap between the bottom of the coil lamination and the top of the magnet.

Correct adjustment is .315 to .472 (8 MM to 12 MM).

Change stator plate position if necessary.

Re-check points setting and synchronization.

REFERENCE NOTES TO IGNITION TIMING

## MERC-O-TRONIC ANALYZER (MODEL 98)

Your Merc-O-Tronic analyzer is actually one of the most precise tester available to check all the Bosch coils and condensers used on the Ski-Doo. It can also be used very successfully to accelerate the Rotax engine ignition timing process.

The following step by step procedure illustrates and explains the required operations to test Bosch ignition coils and condensers. A Specifications Chart, given on page C.6-7, will help you determine whether replacements are necessary in your ignition system.

### Step 1: MERC-O-TRONIC INSTALLATION

a) Place the analyzer (Merc-O-Tronic), a 12-volt Ski-Doo battery and the parts to be checked on an isolated or wooden table.

b) Connect the small red test lead of the analyzer to the battery positive terminal and the small black test lead to the battery negative terminal. Turn the volt switch to "ON". See Fig. #1.

c) Check if the pointer indicates 12 volts. Turn the switch back to "OFF".



FIGURE #1

NOTE: If the pointer does not reach 12 volts, charge the battery.

It must be fully charged to permit an exact reading when you perform the coil power test.

## Step 2: IGNITION COIL POWER TEST

### TESTER SET-UP

- a) Remove the (2) metal screws holding the analyzer cover and open it.
- b) Disconnect the wires from the 7½-volt battery inside the analyzer. Use extension leads to connect the analyzer positive wire (red) to the 12-volt Ski-Doo battery positive terminal and the negative wire (black) to the battery negative terminal.
- c) Connect the large red test lead to the coil secondary, the small red test lead to the coil primary and ground the small black test lead to the coil laminations (Fig. #2).

### COIL TEST

- a) Turn the selector switch knob to position 1 (coil power test). Let the current flow gradually through the ignition coil by turning the current control knob from "LO" to "HI". See Fig. #2.
- b) Check if the reading indicated by the pointer on scale 2 corresponds to specifications. See the Chart under Operating Amperage.

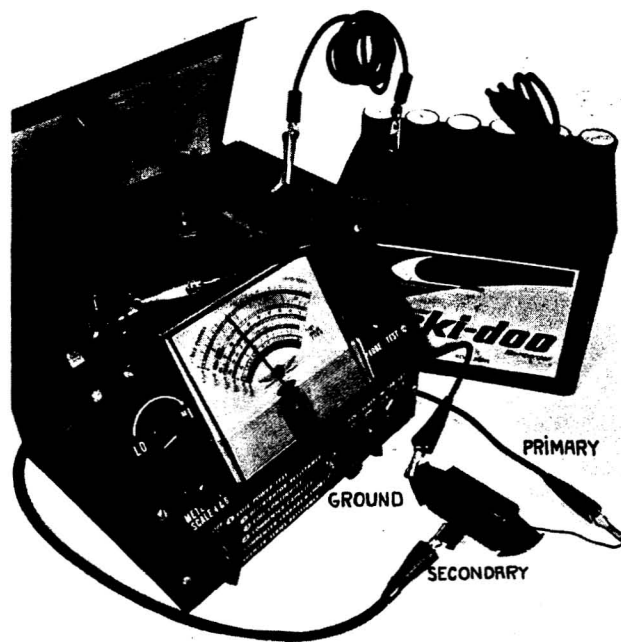


FIGURE #2

- c) Replace current control and selector switch knobs to "OFF".
- d) Disconnect the 12-volt Ski-Doo battery and re-install the 7½-volt battery. Close the analyzer cover.
- e) Disconnect the large red test lead.

REMARK: *The use of a 12-volt Ski-Doo battery is only applicable to the coil power test.*

### Step 3: COIL AND IGNITION CABLE LEAKAGE TEST

#### TESTER CONNECTIONS

- a) Remove the protection cap from the ignition cable.
- b) Insert the ignition cable in the coil secondary orifice and connect the large red test lead to the cable in the spark plug protector (Fig. #3).
- c) Connect the probe test lead in the analyzer probe outlet (Fig. #3).

#### LEAKAGE TEST

- a) Turn the current control knob to "HI" and the selector switch knob to 1 (coil power test).
- b) Pass the probe tester along the ignition cable and around the ignition coil; BE CAREFUL NOT TO TOUCH THE IGNITION CABLE OR THE COIL WITH YOUR HANDS.

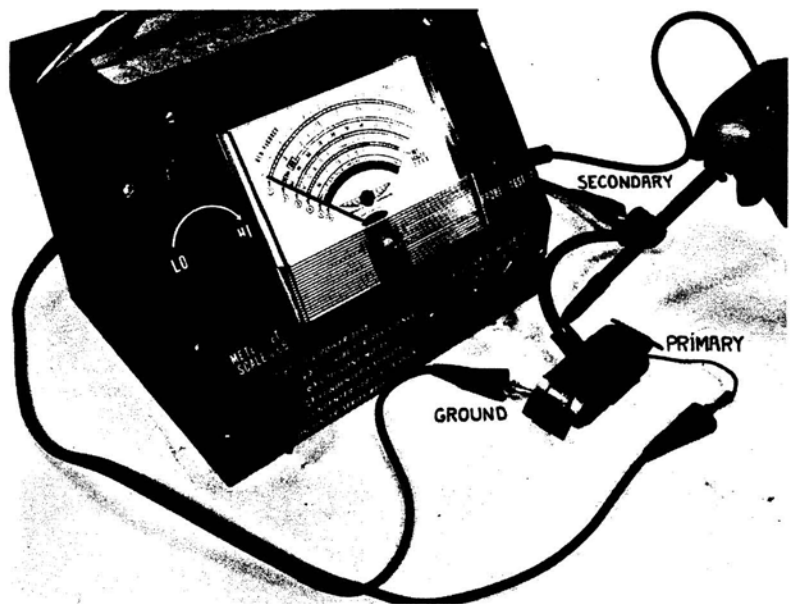


FIGURE #3

NOTE: If you notice a leak of any kind, replace the defective part.

- c) Replace the current control and selector switch knobs to "OFF".
- d) Disconnect the test leads from the ignition coil.

#### Step 4: PRIMARY RESISTANCE TEST

##### CONTROLS DISPOSITION •

- a) Turn the selector switch knob to position 2 (distributor resistance).
- b) Turn (either to the left or to the right) the meter set for scales 2 and 3, in order to adjust the pointer on the reference line of the scales.

##### TEST AND READING

- a) Connect the small red test lead to the coil primary and ground the black test lead to the coil laminations. See Fig. #4.

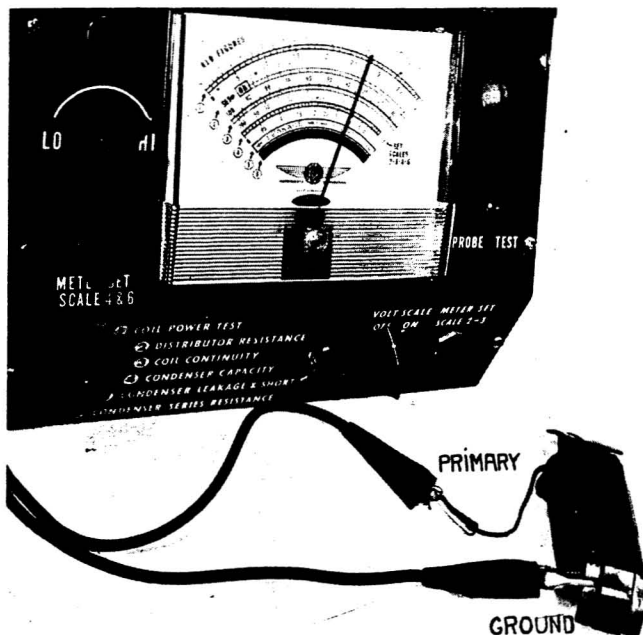


FIGURE #4

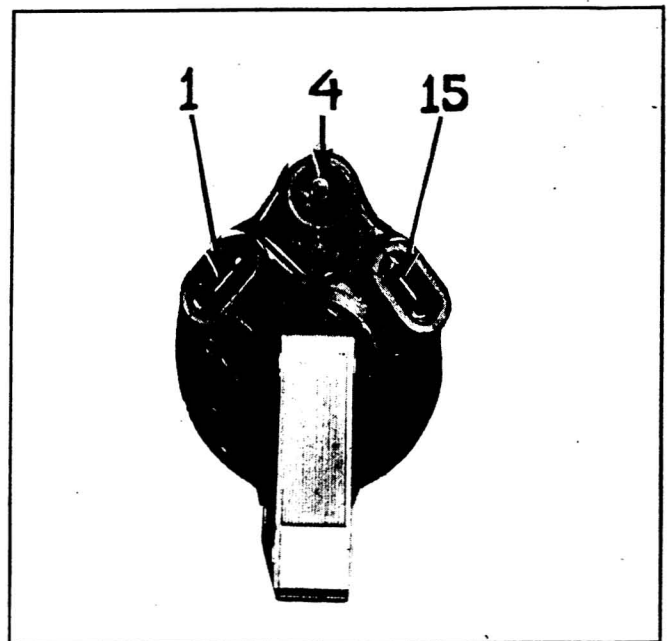


FIGURE #5

REMARK: For coils used on the 320E, 370, 371 and 640 engines, connect the small red test lead to terminal #1 (primary) and the small black test lead to terminal #15 (ground). See Fig. #5.

- b) Take the reading on scale 2.
- c) Disconnect the test leads.

#### Step 5: SECONDARY CONTINUITY TEST

##### CONTROLS ADJUSTMENT

- a) Turn the selector switch knob to 3 (coil continuity) and join the small red and black test leads together.
- b) Turn meter set knob for scales 2 and 3 (left or right) to adjust the meter.
- c) Disjoin the test leads

##### CONTINUITY TEST

- a) Connect the small red test lead to the coil secondary and the small black test lead to the coil primary. See Fig. #6.

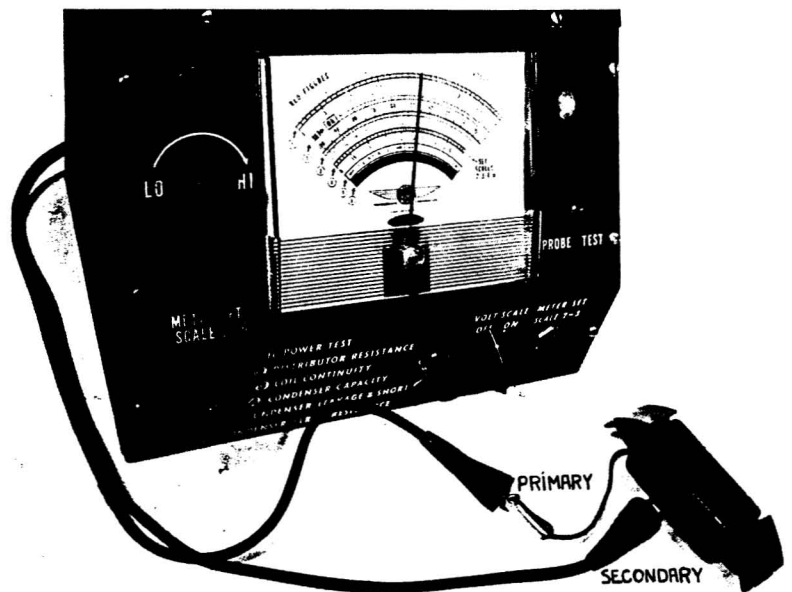


FIGURE #6

- b) Check the pointer indication. It should stand between the minimum and maximum indicated on the Specifications Chart.
- c) Disconnect both small black and red test leads.

#### Step 6: CONDENSER MICROFARAD CAPACITY TEST

##### CONTROLS AND CONNECTIONS

- a) Turn the selector switch knob to 4 (condenser capacity).
- b) Connect the cable from the analyzer in a 115-volt 60 cycle A. C. outlet.

- c) Join the small red and black test leads together.
- d) Press on the red button; adjust the scale by turning (left or right) the meter set knob for scales 4 and 6, then release the red button.

#### CAPACITY TEST

- a) Connect the small red test lead to the condenser central terminal and the small black test lead to the condenser housing. See Fig. #7.

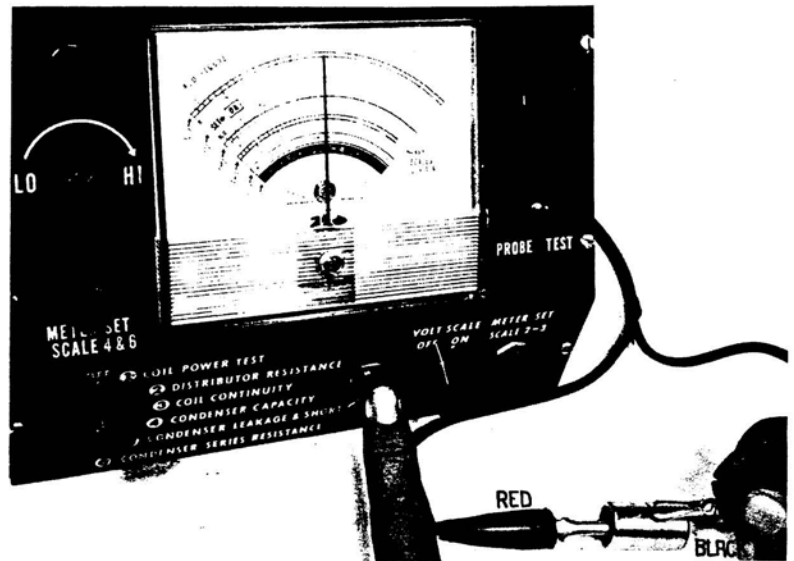


FIGURE #7

- b) Press on the red button, take the reading on scale 4, then release the button.
- c) Compare your reading with the specifications.

#### Step 7: CONDENSER LEAKAGE AND SHORT TEST

##### PRIMARY CHECK-UP

- a) Turn the selector switch knob to 5 (condenser leakage and short).
- b) Make sure the test leads are connected as for the precedent test (Fig. #7).

##### CONDENSER SHORT TEST

- a) Press on the red button. Check if the pointer indicates a reading and returns (immediately) to its starting point.

REMARK: *If the pointer does not return to starting point, the condenser must be replaced.*

b) Disconnect the test leads.

CAUTION: *Disconnect the analyzer cable from the 115-volt outlet BEFORE replacing the selector switch knob to "OFF". Otherwise, the analyzer may suffer serious damages.*

SPECIFICATIONS CHART						
COIL NUMBERS		OPERATING AMPERAGE	PRIMARY RESISTANCE		SECONDARY CONTINUITY	
BOMBARDIER	BOSCH		MIN.	MAX.	MIN.	MAX.
402 4038	2-204-210-013	1.0	1.8	2.1	35	45
402 4040	2-204-211-008	0.9	1.5	1.9	40	50
402 7008	0-221-500-800	0.6	1.6	2.0	50	60
CONDENSER NUMBERS		MICROFARAD CAPACITY				
BOMBARDIER	BOSCH	MINIMUM		MAXIMUM		
402 4067	1-237-330-035	.13		.17		
402 4068	1-237-330-037	.26		.30		

REMARK: *Replace all coils and condensers which do not agree with the above specifications.*

TECHNICAL PUBLICATION DEPARTMENT

REFERENCE NOTES TO MERC-O-TRONIC ANALYZER

INDEX TO SECTION D

D-1     Fiber glass repair

## FIBERGLASS REPAIR

Fiberglass repairs are very easy to perform when done according to the right procedure. Before attempting to make any repair, it is important to determine the damage occurred and to select the appropriate procedure:

1. A minor damage when only the outer surface has been damaged and the inner structure is still in good shape.
2. A crack when the outside surface is damaged and the inner structure is perforated, but no major pieces are missing.
3. Finally a major damage when the inner structure is punctured and parts are missing.

All repairs are easy to perform providing they are done according to the suggested step-by-step procedure. The same procedure applies to repair a crack or a punctured inner structure. In both cases, the structure has lost its strenght because it has been perforated after its construction. In order to be successful when performing that type of repair, you have to rebuild strenght in the fiberglass structure.

### REPAIR PROCEDURE

1. Remove all loose chips from the area to be repaired.
2. For better adhesion, grind the back of the area to be repaired in order to remove the gloss.
3. Then cut 2 or 3 layers of fiberglass mat about twice as large as the area to be repaired.

4. Before using the fiberglass resin, add hardener or catalyst in a ratio of 2 drops of catalyst for each ounce of resin. Then mix thoroughly.
5. Set these layers of fiberglass one on top of the other and coat them with fiberglass resin, using a paint brush as shown on Figure 1.
6. Apply this resin coated mat on the back of the area to be repaired. See Figure 2.



Figure 1



Figure 2

7. Then use a small roller or paint brush to press the newly applied mat to the existing part. Make sure that you smoothen out all the air bubbles trapped between the repaired area and the newly applied mat: otherwise weak spots may result. See Figure 3.
- Allow 15 to 30 minutes to dry.



Figure 3

From this step on, the same procedure applies for major damages, cracks or minor alterations.

1. With the help of an air-powered or electric grinder, cut the edges of the area to be repaired at a 45° angle.

See Figure 4.

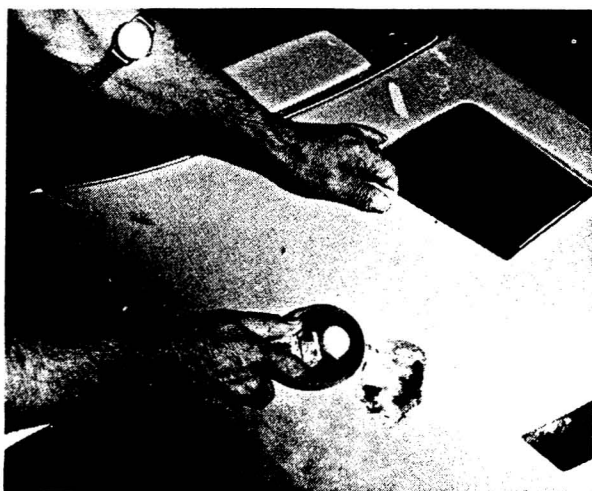


Figure 4



Figure 5

2. Prepare some plastic putty to fill the damaged area.
  - a) Make sure you have a sufficient amount of plastic.
  - b) Mix 2 drops of catalyst (or hardener) with each ounce of plastic to be used.

NOTE: A larger or a smaller amount of hardener will not affect the consistence of the plastic, it will only change the duration of the hardening reaction.

3. Using a putty knife or any suitable tool, fill the damaged area with plastic, as shown on Figure 5.
4. Allow 15 minutes to dry.
5. Once it's dry, use a body file to level out the repaired surface. See Figure 6.

6. After this operation has been completed, polish the new surface as illustrated in Figure 7.

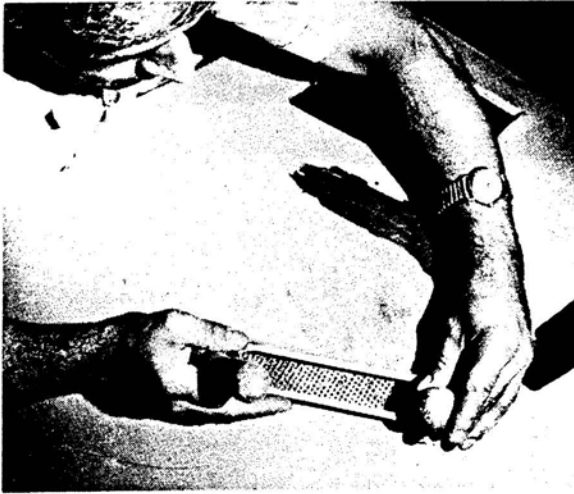


Figure 6



Figure 7

- a) At first, use some 100 gauge sandpaper and polish until the surface is smooth and level.
- b) Then using some wet sandpaper, polish the repaired area, making sure the paper is kept wet at all times.
- c) The final polishing should be done with wet 600 gauge sandpaper.

7. Dry out the wet surface.

8. The plastic is now ready to be painted. Apply 3 or 4 thin coats of acrylic paint, at intervals of 15 to 20 minutes.

See Figure 8.



Figure 8

9. When the paint is dry, use some rubbing compound to polish the painted area until it matches the rest of the surface.

See Figure 9.

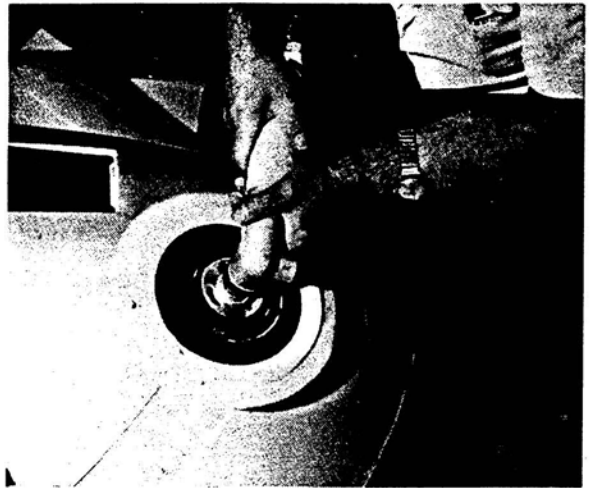


Figure 9

In most cases, a repair job done according to this

procedure will be unnoticeable

and the unit will keep the same strenght as when new. It is of the outmost importance that you and your dealers become familiar with this fiberglass repair procedure.

As the quantity of Ski-Doos and Sea-Doos increases, the rate of repairs needed will also increase in proportion, specially with the Sea-Doo as people have a tendency to beach it a little roughly. Almost any type of damage can be repaired if you proceed as illustrated before, even scratches around corners and edges.

REFERENCE NOTES TO FIBER GLASS REPAIR