

***STIHL***®

**Engine Failure  
Analysis Manual**

# **STIHL ENGINE FAILURE ANALYSIS MANUAL**

This manual has been designed as an aid to the servicing dealer in diagnosing why an engine has failed. We have attempted to include as many examples as possible, but there are probably some we have missed. Perhaps as these come to our attention we can include them in future editions.

We have grouped the engine failures in four parts types, the piston, the cylinder, the crankshaft and the bearings. The photographs are in that order. To use this manual simply match the failed components to the picture in the manual. The description which accompanies the photograph describes the cause of the failure. In some cases you will be referred to another photograph that relates to the failure.

We hope this manual will help you diagnose problems and enable you to offer a solution for the customer to prevent a re-occurrence.

# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 1

Subject: **NEW PISTON**

Observation: Intake side – note machine marks, use for reference.



Photo No. 2

Subject: **NEW PISTON**

Observation: Exhaust side – note machine marks, use for reference.



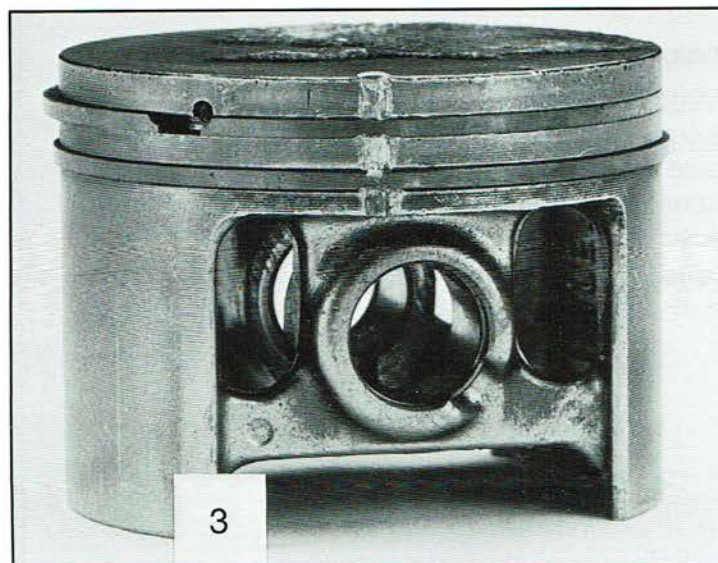
Photo No. 3

Subject: **TRANSFER PORT OF PISTON**

Observation: Piston ported engine, deep score from top edge to piston pin boss.

Cause: Lower con rod bearing and/or cage damaged. RPM's above recommended top end. Leads to excessive load on the components, causing lubrication breakdown.

Note: See photos 62, 63, 64.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 4

Subject: **EXHAUST SIDE OF PISTON**

Observation: Material between ring grooves is broken.

Cause: Over-revving of the engine for extended periods of time can cause ring flutter and extreme heat, which will weaken the piston along with extreme shock from detonation.



Photo No. 5

Subject: **PISTON**

Observation: Piston has a lean seizure. Piston top has a hole as if burned by a torch.

Cause: Severe lean seizure.

Note: See photos 8, 9, 45, 68.

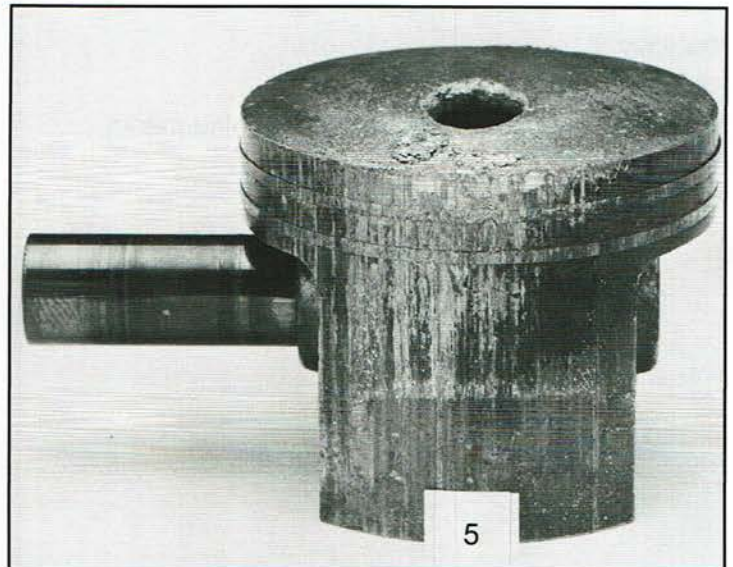


Photo No. 6

Subject: **PISTON**

Observation: Indentations on the piston dome could be perceived as detonation marks. Examination of the cylinder photo No. 39 shows debris was caught in combustion chamber.

Cause: Foreign object has gone through engine. Sharp edges have lead to pre-ignition and seizure.





Photo No. 7

Subject: **EXHAUST PISTON SKIRT AND DOME**

Observation: Very fine vertical scratches, may also be on intake, evidence of blow-by on piston sides. Possible detonation marks on piston dome.

Cause: Main bearings may be breaking up and particles getting caught between piston and cylinder.

Note: See photos 6, 14, 15, 39.



Photo No. 8

Subject: **EXHAUST SIDE OF PISTON**

Observation: PTO half of exhaust side is scored, with possible seized condition. Score marks run from top edge to bottom edge of piston. Note dark dis-coloration around score.

Cause: This is a lean seizure and may have seized more than once. See photo 9, 10, 11.



Photo No. 9

Subject: **PISTON**

Observation: Lean seizure.

Cause: Severe detonation.

Note: See photos 10, 11.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 10

Subject: **PISTON**

Observation: Lean seizure.

Cause: Among the possibilities are wrong carburetor settings, stiff carburetor diaphragms, clogged fuel filters, stale gas, alcohol in fuel, air leaks, incorrect ignition timing, part throttle operation, modified mufflers. Note photo 11.



Photo No. 11

Subject: **PISTON**

Observation: Lean seizure.

Cause: This seizure is opposite of the heavy exhaust score and was crowded or pushed by the expanding exhaust side of the piston.

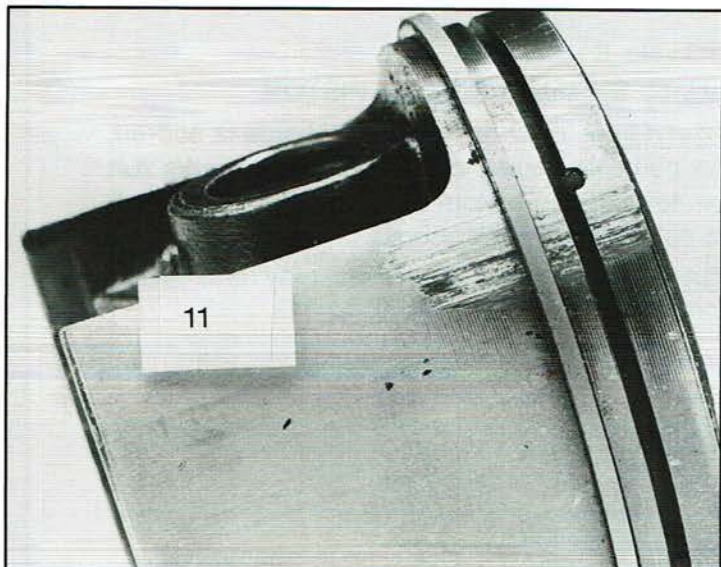


Photo No. 12

Subject: **PISTON INTAKE**

Observation: Piston is scored from the rings down.

Cause: This type of score has two different causes. One is called a snow or water score. The lubricant has been washed off the piston skirt. Occurs in snow or very humid conditions. The second type is alcohol or either score. Effect is the same.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 13

Subject: **PISTON INTAKE SKIRT**

Observation: Deposits on the piston dome, burnished piston skirt, build up of carbon-like deposits in the ring landings. Rings show beginning of clipping condition. Intake skirt is highly polished.

Cause: Combination of ingested fine dirt, fuel and oil mix build up in the ring grooves inhibiting the ring movement.

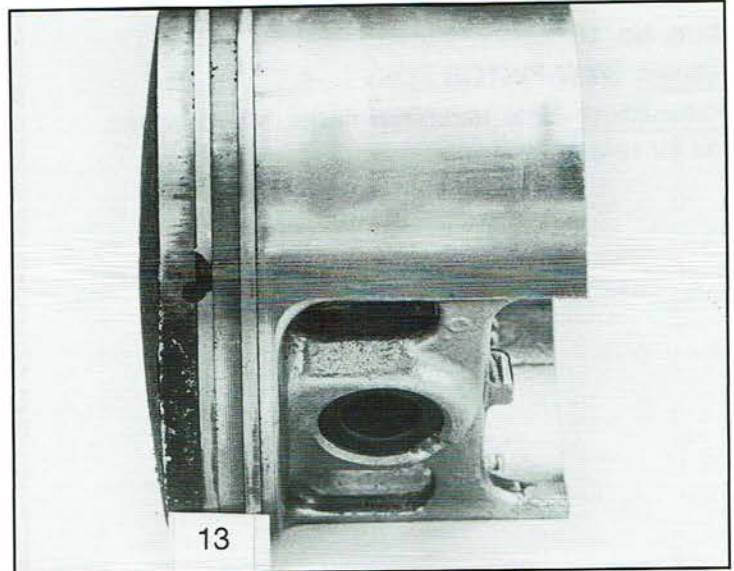


Photo No. 14

Subject: **INTAKE SKIRT OF PISTON**

Observation: Skirt has been ground and scored.

Cause: Dirt and grit ingested into the engine. Note photo 41 for the cylinder damage.

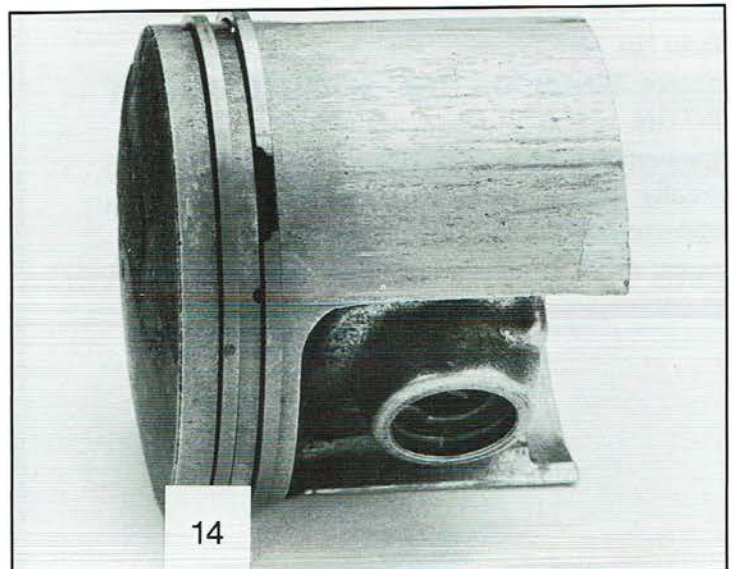


Photo No. 15

Subject: **INTAKE SIDE OF PISTON**

Observation: Deep scores, broken skirt, marks in the dome of piston.

Cause: Foreign debris caught between intake port and the piston skirt.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 16

Subject: **NEW PISTON RING**

Observation: Note machine marks, sharp edges.  
Use for reference.

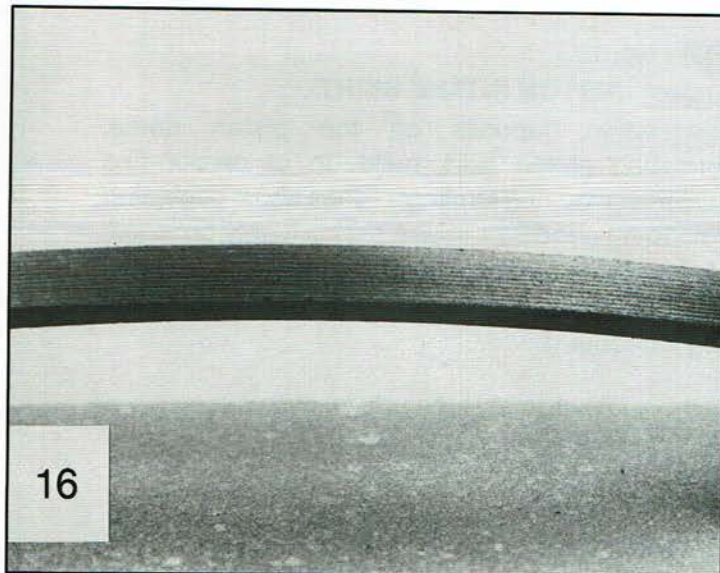


Photo No. 17

Subject: **RINGS ON THE EXHAUST SIDE OF PISTON**

Observation: Top ring almost broken in, bottom ring partially broken in, area above top ring has a peppered look.

Cause: Ring wear is normal, top ring seats first, dirt particles can cause a peppered effect.

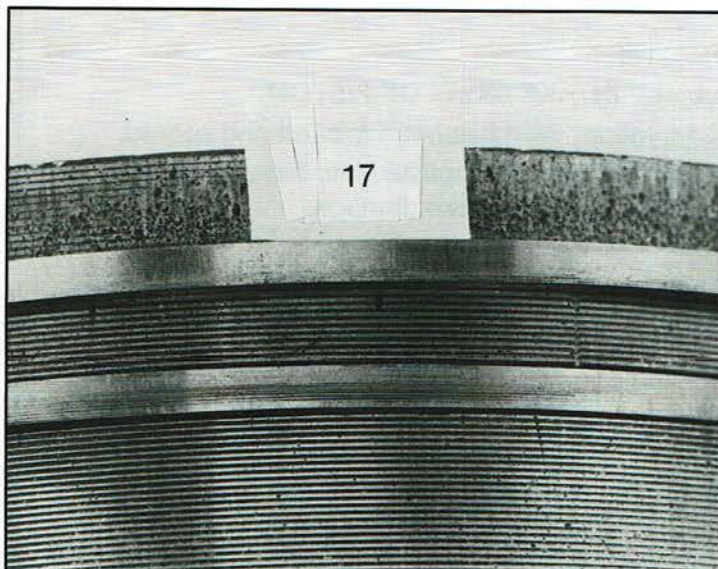
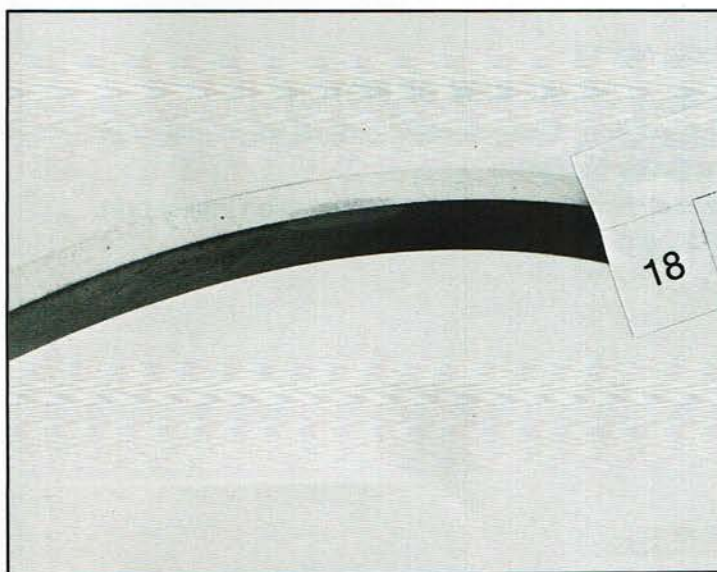


Photo No. 18

Subject: **PISTON RING**

Observation: Sharp edge on the ring is burnished.

Cause: This is the first sign of ring clipping. This is caused by over revving the engine. Because of the excessive piston speed the rings do not have time to retract into their grooves.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 19

Subject: **PISTON**

Observation: Heavy build up on top and sides of piston, partial ring sticking.

Cause: Improper fuel/oil mix or ratio. These symptoms are also related to improper RPM operations. Example half throttle running.

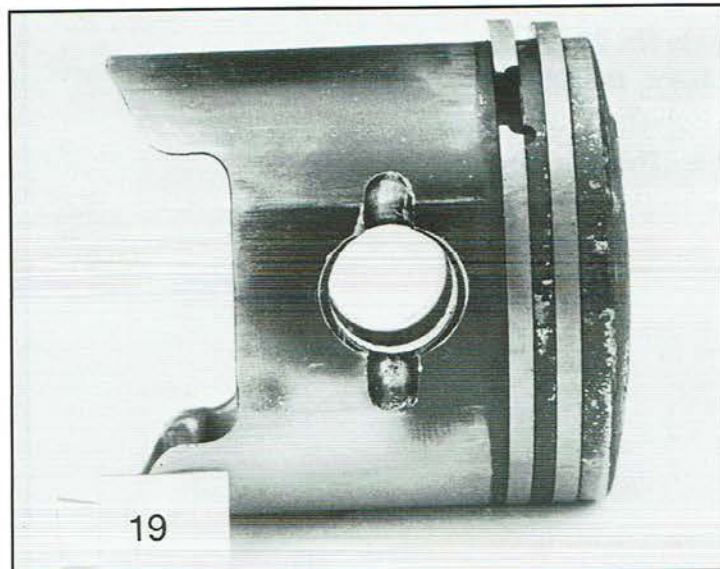


Photo No. 20

Subject: **PISTON**

Observation: Piston scored over most of surface from the top to the bottom, dark discoloration in and around the score.

Note: This piston is from a long stroke, reed plate, induction type engine.

Cause: This is lean seizure.

Note: See photo 8.

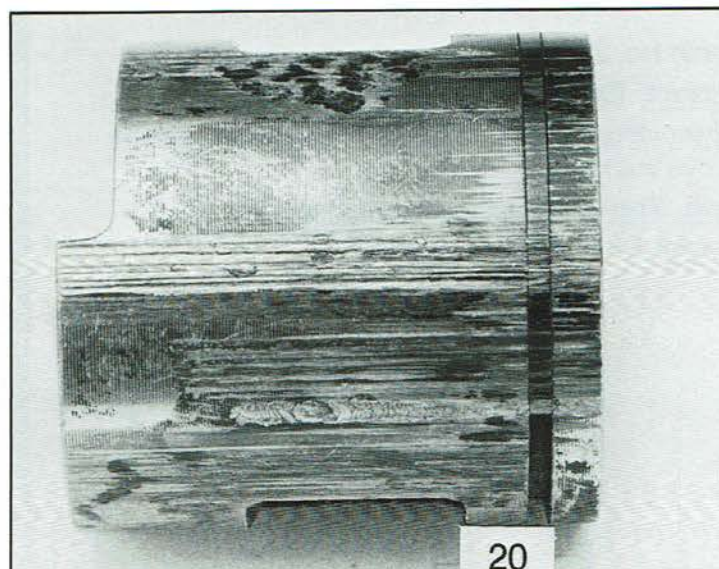


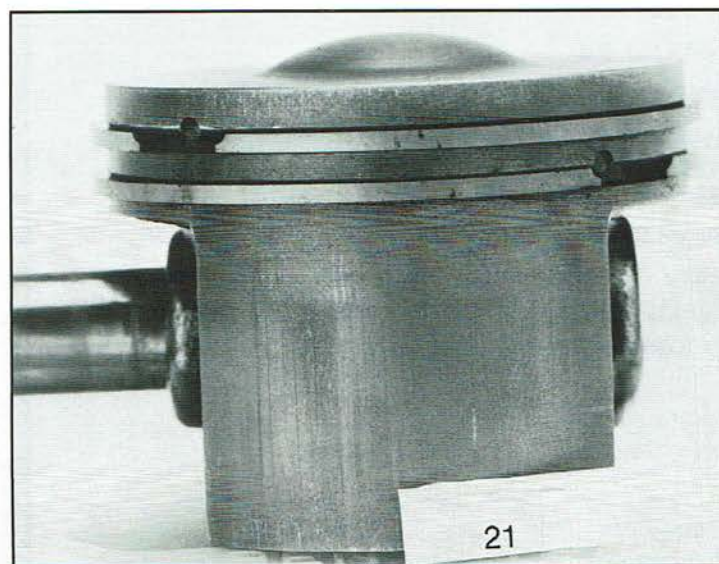
Photo No. 21

Subject: **INTAKE SKIRT OF THE PISTON**

Observation: Intake skirt has tiny scratches and a sandblasted look. Some of the machine marks are still visible. Piston in service only a short period of time.

Cause: Dirt ingested into the engine. Piston is from an actual test engine.

Note: See also photo 22.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 22

Subject: **INTAKE SIDE OF THE PISTON**

Observation: See photo No. 21.

Note: This is a close up of photo 21.

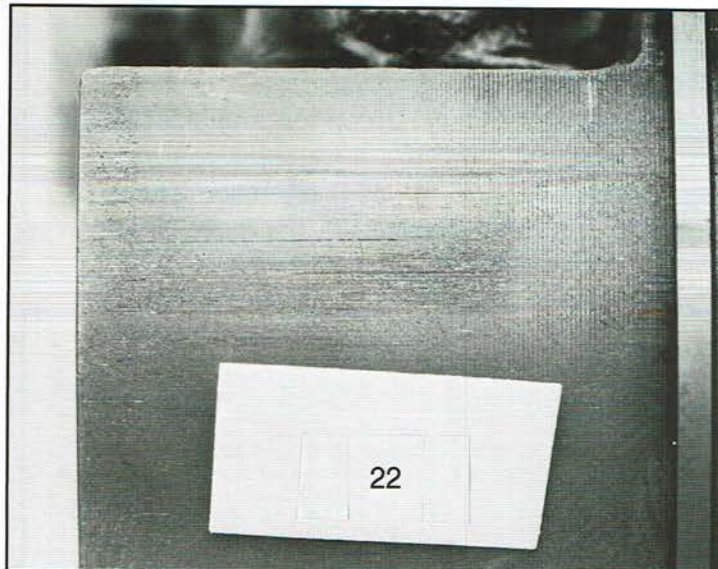


Photo No. 23

Subject: **EXHAUST SIDE OF THE PISTON**

Observation: Pitted and scratched piston surface above the rings.

Note: The wear on the piston rings.

Cause: Dirt in the exhaust flow.

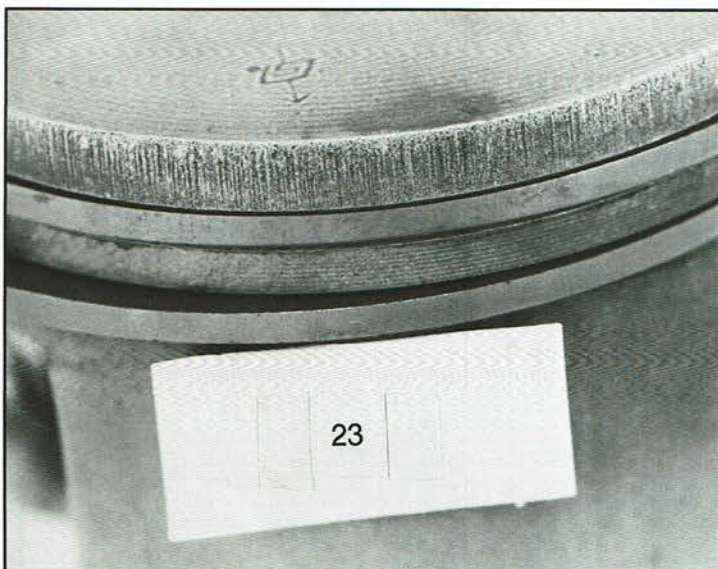
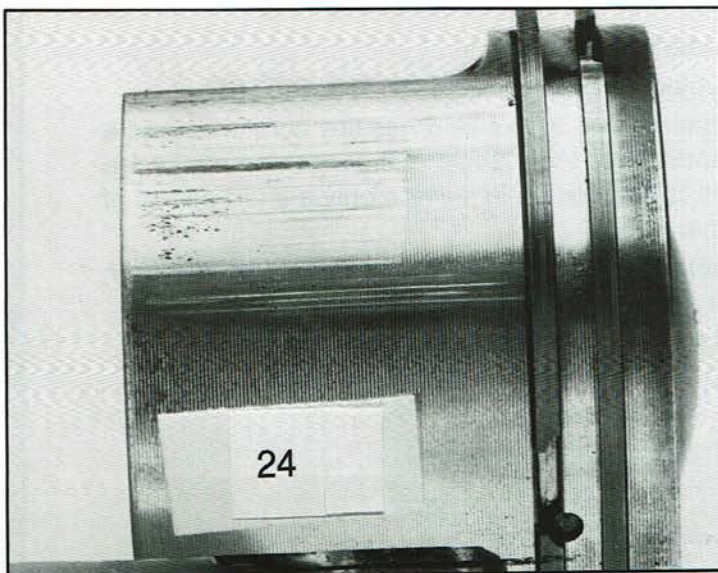


Photo No. 24

Subject: **INTAKE SIDE OF THE PISTON**

Observation: Score marks are primarily below the rings to the bottom of the skirt. On the flywheel side of the skirt they are found across the entire face of the piston.

Cause: Snow/water score. A pre-heater kit would prevent icing conditions. Wet (water score) air filter. Dry filter before use. Alcohol or ether in gas.





# STIHL® ENGINE FAILURE ANALYSIS MANUAL

Photo No. 25

**Subject:** EXHAUST SIDE OF PISTON

**Observation:** Piston is broken from the upper edge down to bottom ring. This is different from photo 4.

**Cause:** Saw was run lean, rings got too tight in grooves and clipped the port. Rings have been caught on bottom edge of exhaust port, broken on the down stroke. Check engine for over revving.

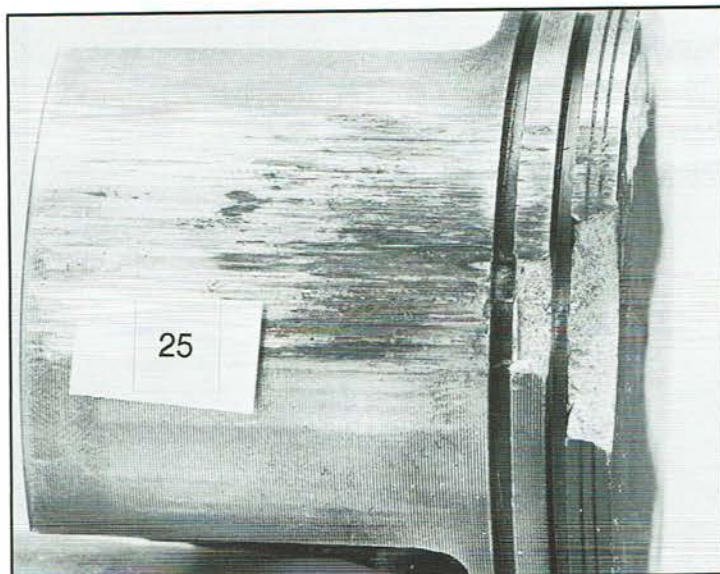


Photo No. 26

**Subject:** INTAKE SKIRT OF THE PISTON

**Observation:** Piston surface worn, various patterns and shades.

**Cause:** Dirt ingested into the engine. Different types of dirt will cause different score patterns. Dirty, worn or wrong application air filter will change scoring patterns on piston.

**Note:** See photos 27, 28.

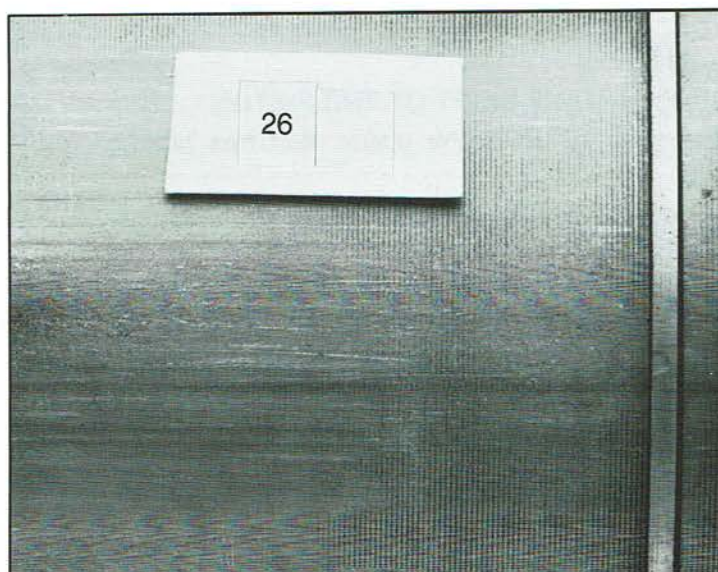
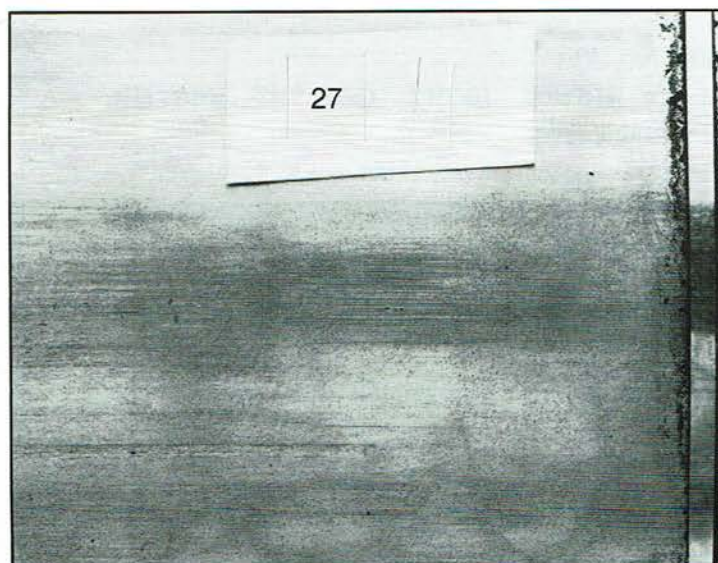


Photo No. 27

**Subject:** INTAKE SKIRT OF THE PISTON

**Observation:** Same as photo No. 26.

**Cause:** Same as photo No. 26.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 28

Subject: **INTAKE SKIRT OF THE PISTON**

Observation: Same as photo No. 26.

Cause: Same as No. 26.

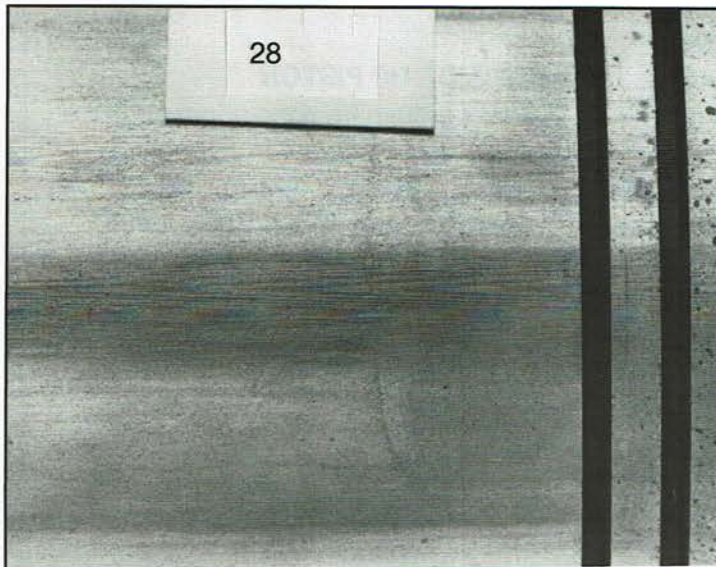


Photo No. 29

Subject: **INTAKE SKIRT OF THE PISTON**

Observation: Part of the piston skirt has broken away.

Cause: The intake skirt has been worn thin by abrasive dirt ingested into the engine. When the tolerances got too big the piston began to slap itself against the cylinder wall until it broke up.



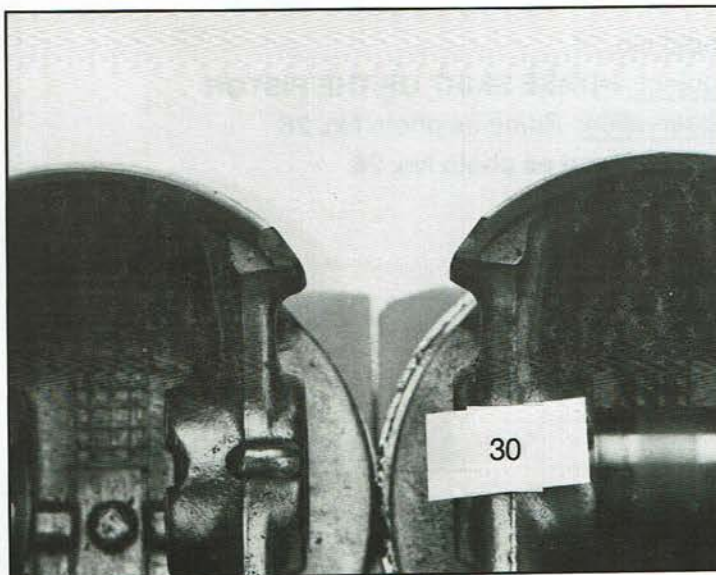
Photo No. 30

Subject: **INTAKE SKIRT OF THE PISTON. BOTTOM VIEW.**

Observation: The intake skirts are at the top of the picture. The piston skirt on the right is much thinner than the skirt on the left.

Cause: Dirt ingested into the engine. Dirt is an abrasive and wears down the surfaces it comes in contact with.

Note: Left piston close up photo 26. Right piston photo 28.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 31

Subject: **EXHAUST SIDE OF THE PISTON**

Observation: Skirt is broken and scored.

Cause: Carbon build up in exhaust port breaking off and lodging in between the piston and cylinder walls.

Note: See photo No. 42.

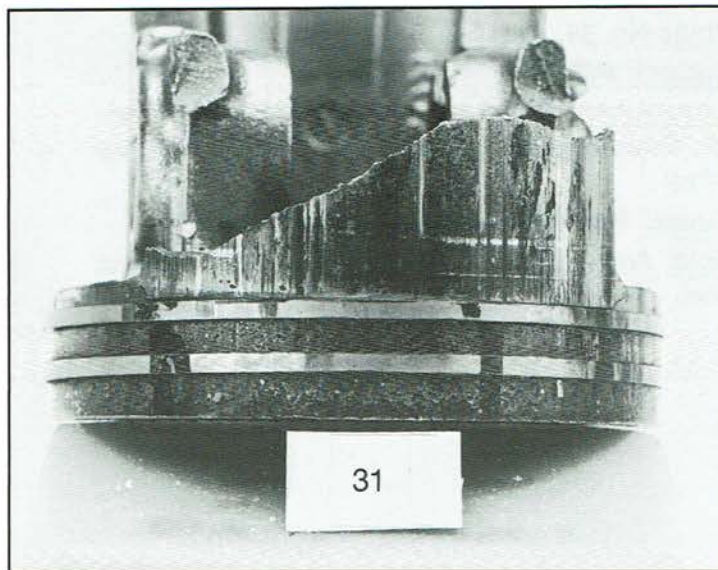


Photo No. 32

Subject: **PISTON LOCATING PIN FOR RINGS**

Observation: Top locating pin has been hammered through the top of the piston.

Cause: Over revving the engine. Ring was jammed into the ring groove when the ring passes the port. The ring end hammers on the locating pin.



Photo No. 33

Subject: **PISTON RINGS**

Observation: Edges of the rings are worn excessively. See photos 16, 18.

Cause: Over revving of the engine.  
See photos 16, 18.





Photo No. 34

Subject: **PISTON**

Observation: Rings and ring landings are broken up. Similar to photo No. 25 but locating pins are intact.

Cause: Piston was installed backwards.

Note: Arrow on piston top always points to exhaust port.



Photo No. 35

Subject: **TRANSFER PORT SIDE OF THE PISTON**

Observation: Twin scores aligned to the wrist pin.

Cause: Wrist pin keeper has come out of piston pin or was not installed. Related damage may be at the bridge of the transfer port.

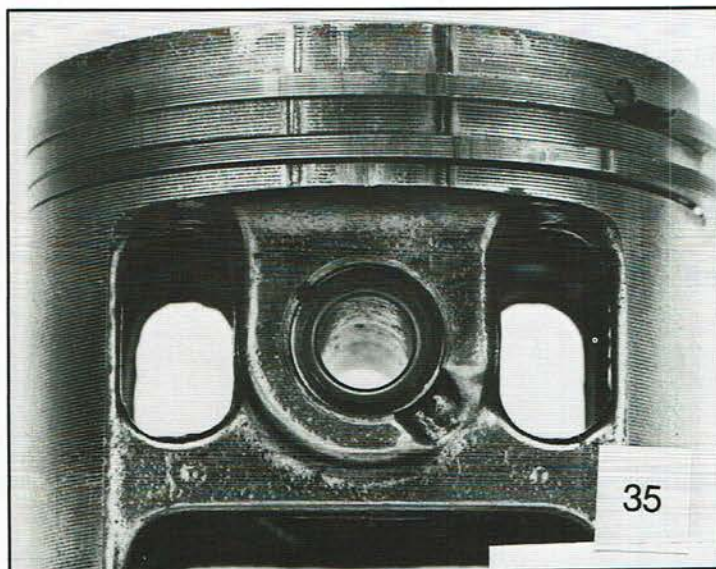
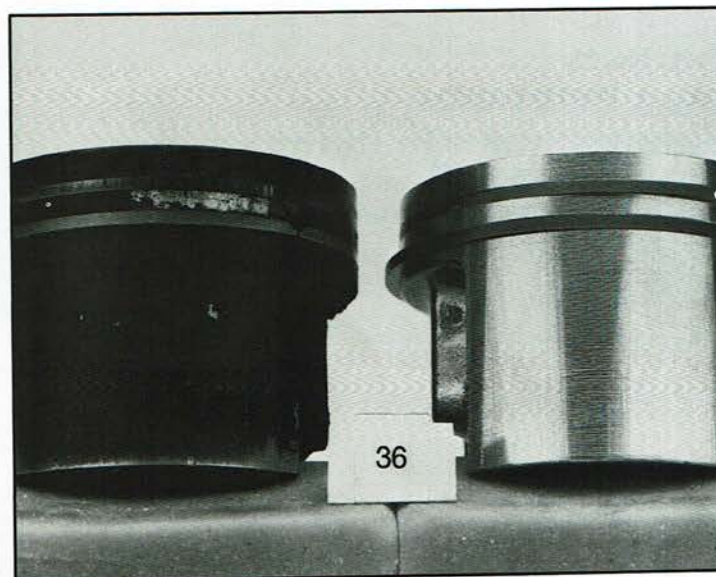


Photo No. 36

Subject: **PISTON**

Observation: Piston on the right is new, piston on the left is coated with a sticky, wax-like varnish.

Cause: Something has been added to the fuel. Possibly bar oil was used as engine oil, or some other unburnable substance.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 37

Subject: **PISTON RING AND PISTON SKIRT**

Observation: Varnish and gum build up in and around the ring area.

Cause: Improper fuel/mixture or incorrect mixing ratio.



Photo No. 38

Subject: **PISTON PINS**

Observation: Pin on the right is discolored by extreme heat. Pin in the middle is new. The pin on the left is worn.

Cause: Pin on the right, the engine has been over revving and this has caused the lubricating oil to breakdown. Pin on the left is worn from abrasive dirt ingested into the engine.

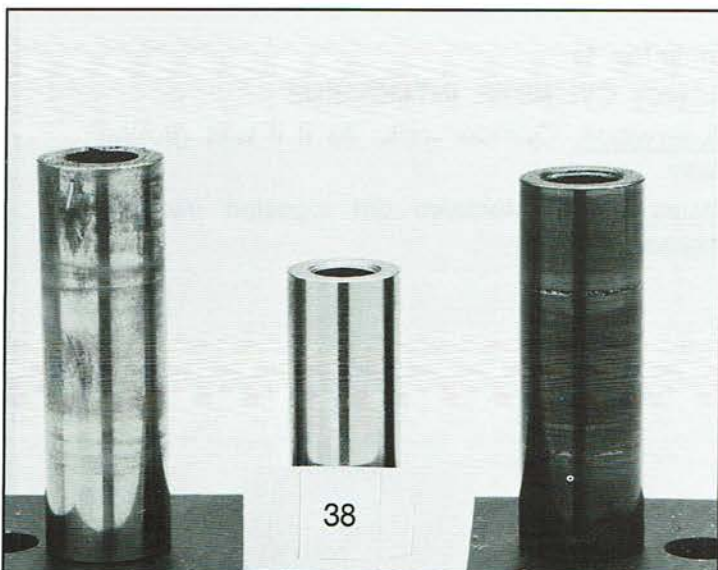
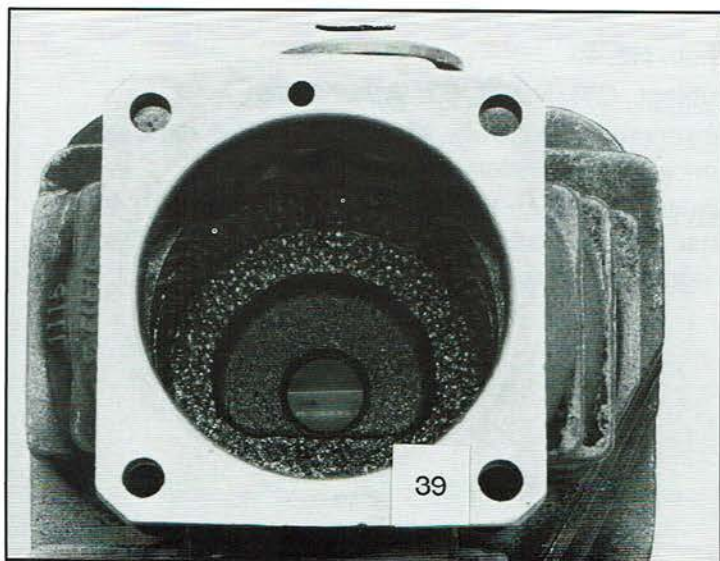


Photo No. 39

Subject: **CYLINDER**

Observation: Indentations on the top of the combustion area.

Cause: Foreign debris has gone through the engine. See photo No. 6.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 40

Subject: **CYLINDER DOME AND EXHAUST PORT**

Observation: Heavy build-up of carbon in combustion chamber and in exhaust ports.

Cause: Any one or a combination of incomplete burn of fuel/oil mix, incorrect engine mix oil, choke malfunction, clogged air filter, incorrect fuel/oil ratio improper carburetor settings, see photos 31, 42.

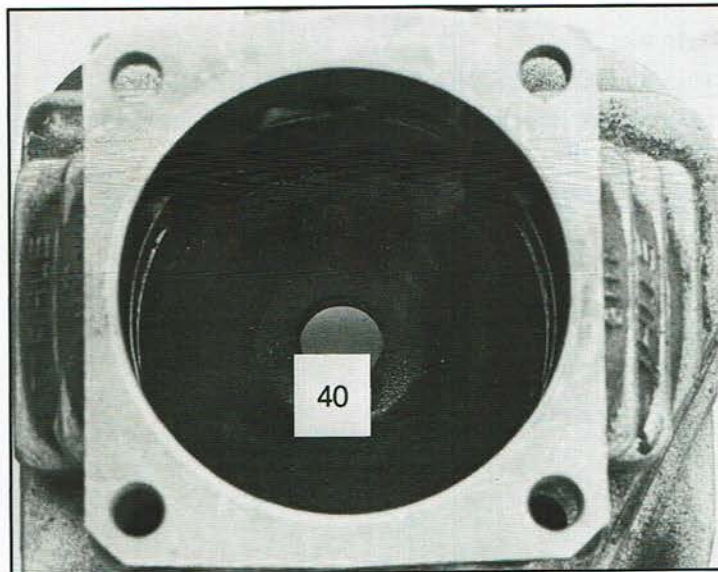


Photo No. 41

Subject: **CYLINDER, INTAKE SIDE**

Observation: Cylinder looks as if it was ground away.

Cause: Severe abrasive dirt ingested into the engine.

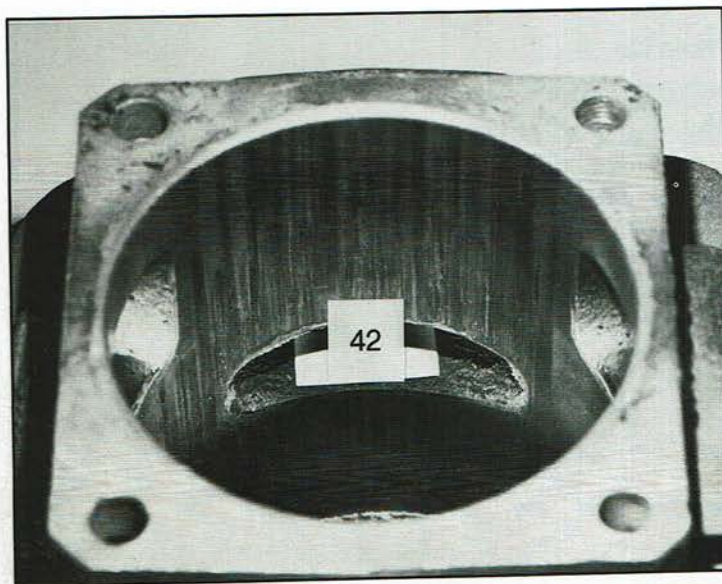


Photo No. 42

Subject: **CYLINDER, EXHAUST SIDE**

Observation: Build-up of carbon in the exhaust port and combustion chamber.

Cause: Incorrect fuel/oil mix, incorrect fuel/oil ratio, incorrect carburetor settings, clogged air filter, clogged fire screen.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 43

Subject: **CYLINDER**

Observation: Chrome in cylinder is flaking off and under layer of whitish colored powder.

Cause: Moisture in the form of water has caused this damage. See also photo No. 67.

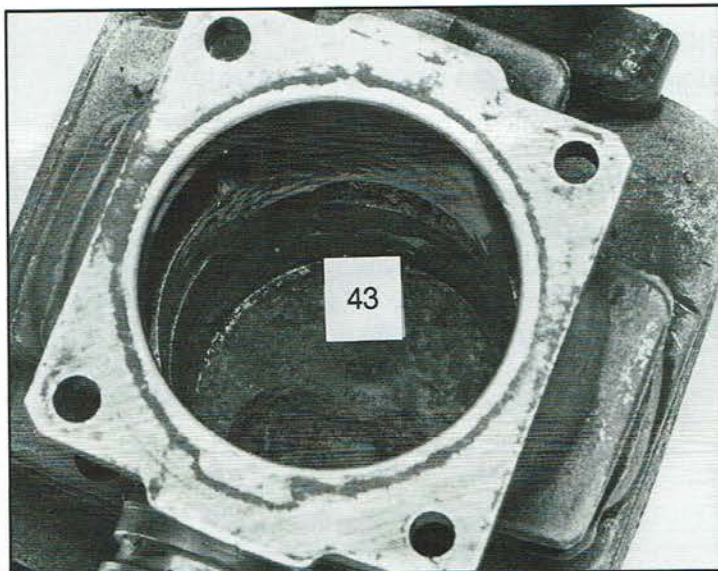


Photo No. 44

Subject: **NEW CYLINDER - SPARK PLUG THREADS**

Observation: Threads are stripped the length of the plug.

Cause: Plug was installed incorrectly with an air wrench.

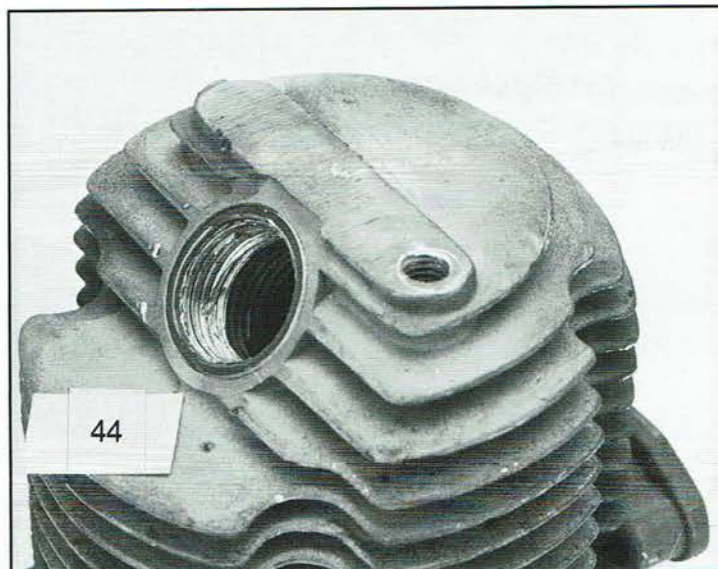


Photo No. 45

Subject: **CYLINDER COOLING FINS**

Observation: Cooling fins are clogged with a build-up of tree sap and sawdust. Saw is developing heat related problems.

Cause: Poor operator maintenance, saw should be checked and cleaned if necessary once a week.

Note: See photo No. 68





Photo No. 46

Subject: **CYLINDERS INTAKE PORT VIEW**

Observation: Cylinder on the left has a larger intake port.

Cause: Cylinders are the same, the one on the left has been modified by enlarging the intake port. This has caused an overloading of the engine and shortened the life of this engine. This type of modification voids the engine warranty.



Photo No. 47

Subject: **CYLINDER INTAKE PORT**

Observation: Close-up of modified cylinder in photo No. 46.

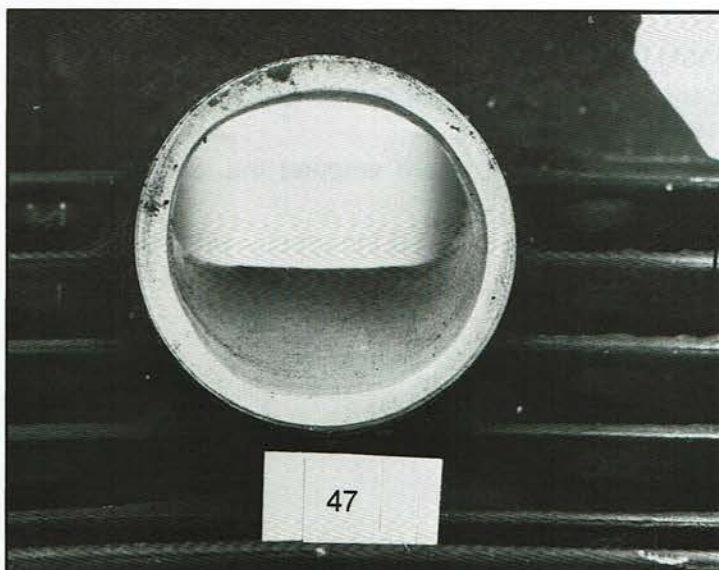


Photo No. 48

Subject: **CYLINDER INTAKE PORT**

Observation: Close up of stock cylinder intake port. Compare to photo No. 47.

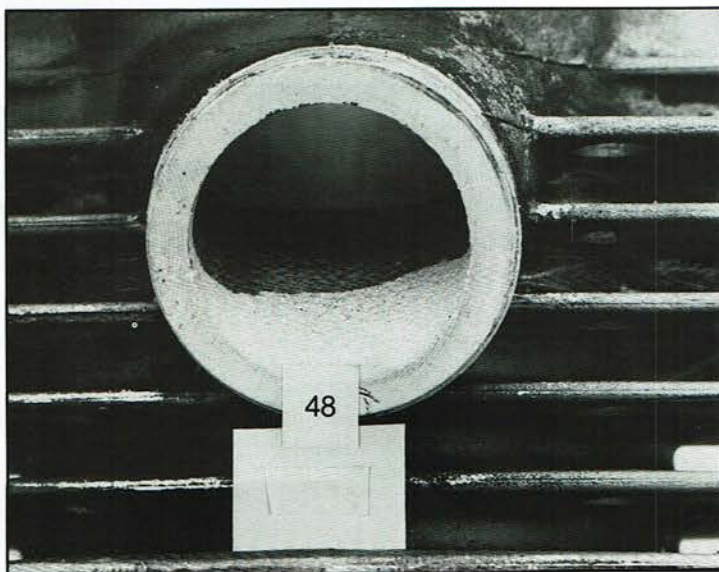




Photo No. 49

**Subject:** BISECTED CYLINDER FOR A PISTON PORTED ENGINE

**Observation:** Note the dirt build-up in the transfer ports and the dirt and carbon crusting in the combustion chamber.

**Cause:** Poor maintenance of the air filter and/or fuel/oil mix and fuel/oil ratio.

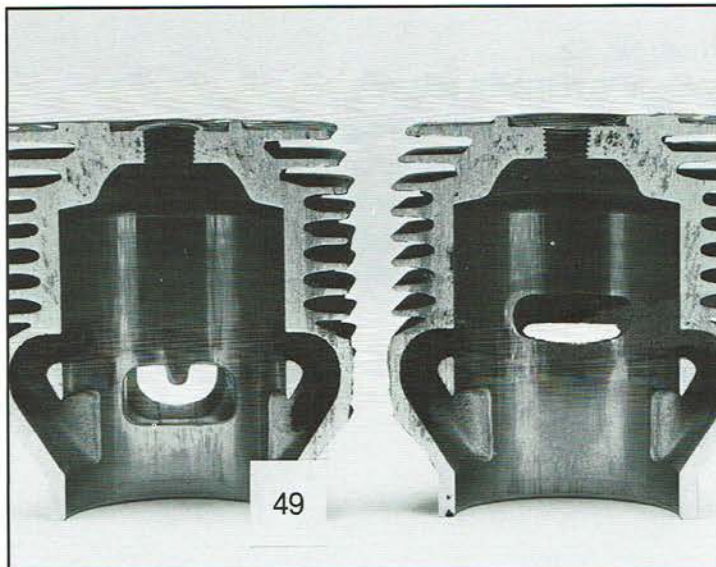


Photo No. 50

**Subject:** CYLINDER HALF

**Observation:** Close-up of the intake port half of cylinder in photo No. 49. Inverted view.

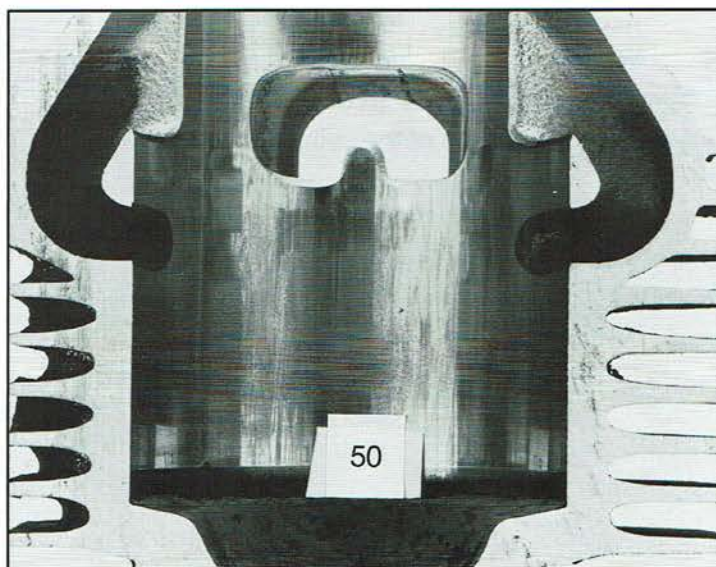
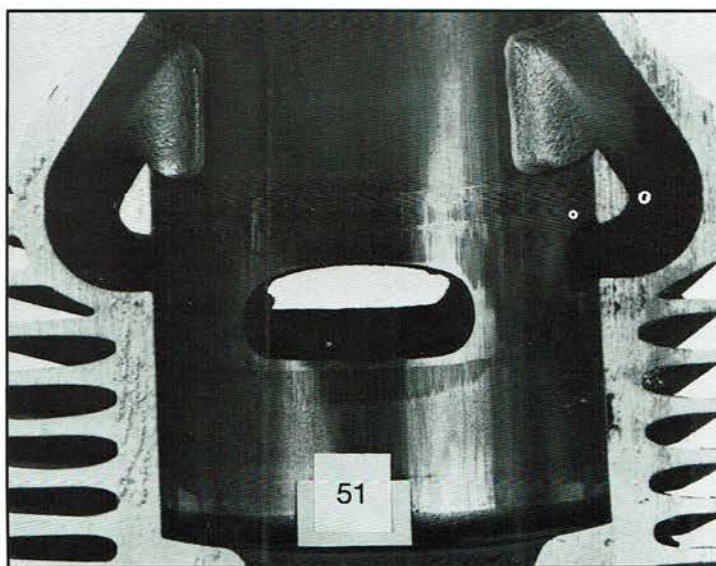


Photo No. 51

**Subject:** CYLINDER HALF

**Observation:** Close up of the exhaust half of the cylinder in photo No. 49. Inverted view.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 52

Subject: **CYLINDER HALVES**

Observation: Cylinder has damage to the cylinder wall in the area of the exhaust port, as well as scratches above and below intake port.

Cause: Engine has ingested a lot of abrasive dirt. The piston wore to the point of breaking up in the cylinder.

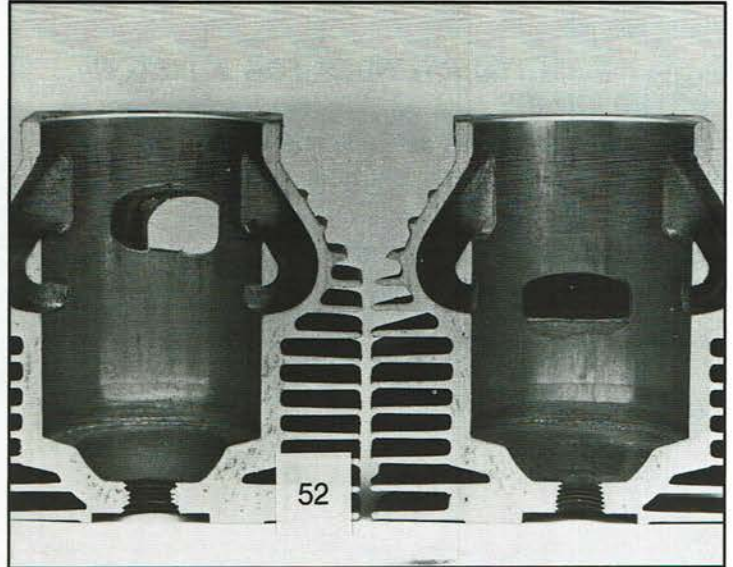


Photo No. 53

Subject: **CYLINDER HALF INTAKE PORT**

Observation: Close-up of the cylinder half in photo No. 52.

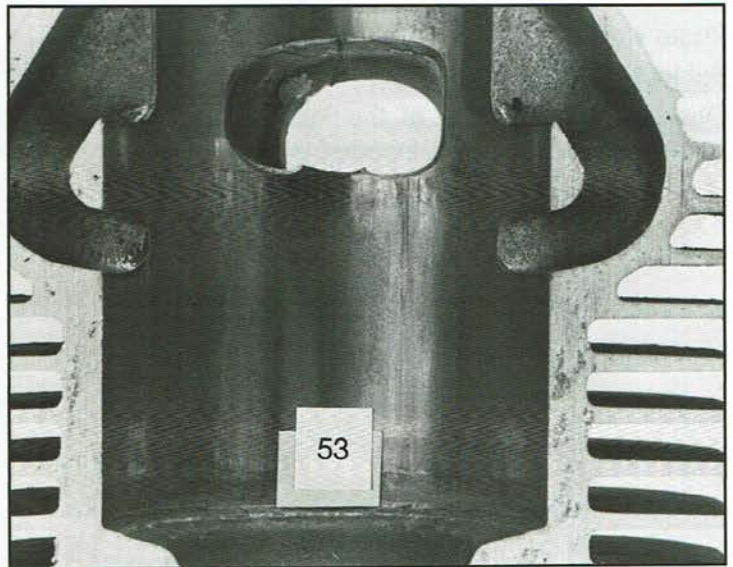


Photo No. 54

Subject: **CYLINDER HALF EXHAUST PORT**

Observation: Close up of the cylinder half in photo No. 52.

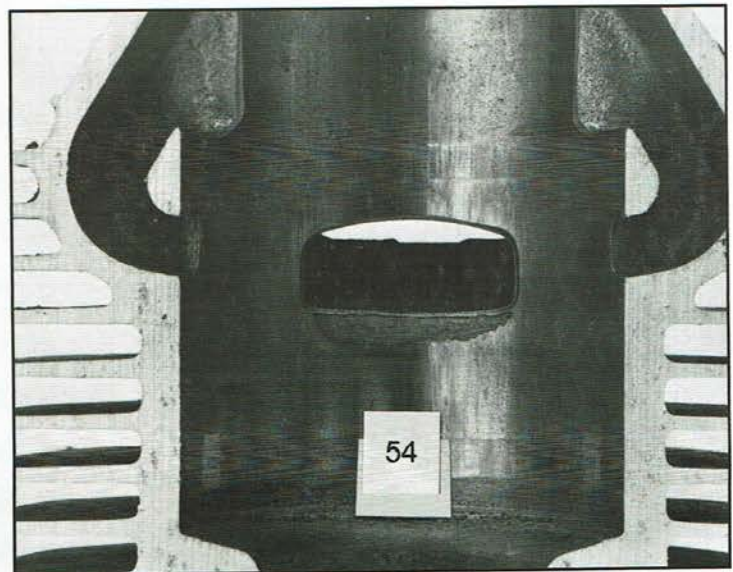




Photo No. 55

Subject: **CYLINDER HALVES**

Observation: Heavy burnishing on the cylinder walls, dirt build-up in the transfer ports and in the combustion chamber.

Cause: Engine has ingested abrasive dirt.

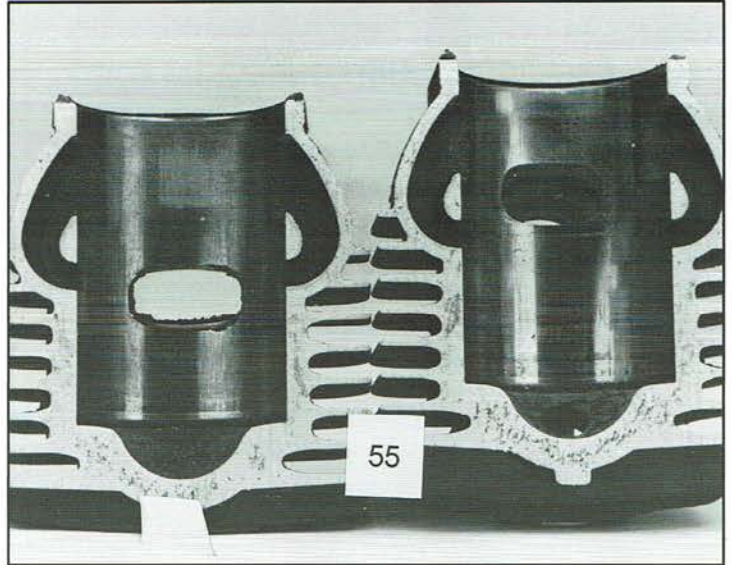


Photo No. 56

Subject: **CYLINDER HALF INTAKE SIDE**

Observation: Heavy burnishing and grinding on the cylinder walls. Build-up of dirt in the transfer ports and combustion chamber. Close-up of photo No. 55.

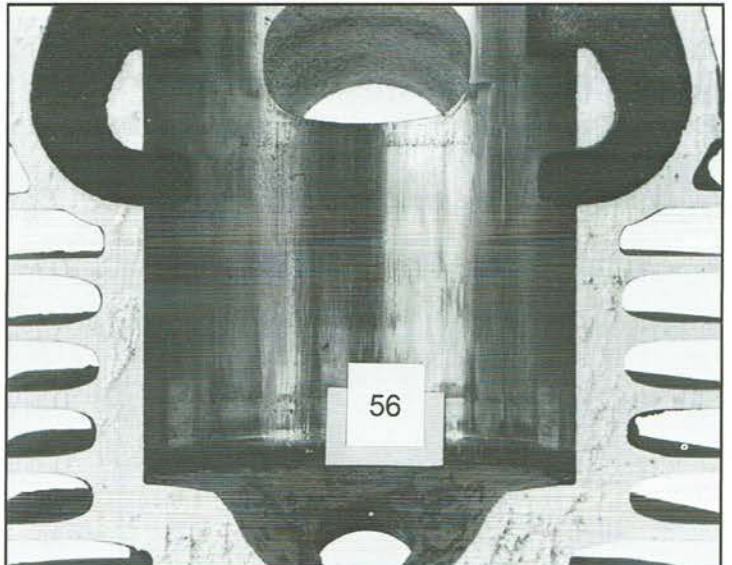


Photo No. 57

Subject: **CYLINDER HALF EXHAUST SIDE**

Observation: Dirt in the transfer ports, pitting and grinding around exhaust port areas and a build-up of dirt in the combustion chamber. Close-up of cylinder in photo No. 55.

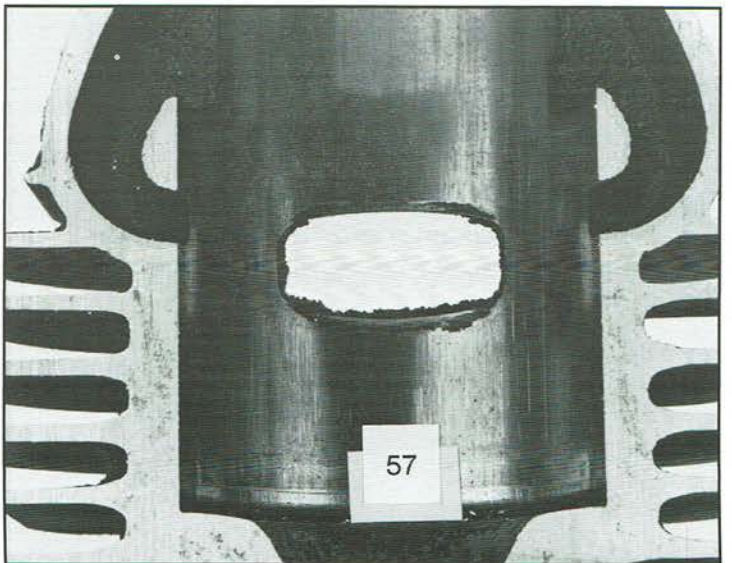




Photo No. 58

Subject: **CRANKSHAFT AND CONNECTING ROD**

Observation: Connecting rod and crankshaft stroke pin both show over heating.

Cause: Over revving of the engine has caused the lubrication to breakdown and the bearings to overheat. Note also that dirt wear on the upper connecting rod bearing will put excessive side load on the connecting rod, leading to overheating and lubrication breakdown.

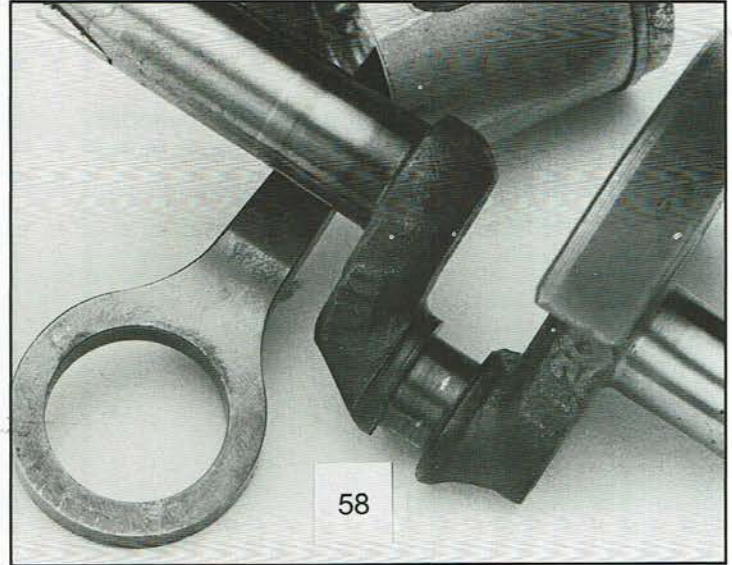


Photo No. 59

Subject: **CRANKSHAFT THREE PIECE TYPE**

Observation: Heat build up on the crank pin and lower connecting rod.

Cause: Center line of the crankshaft is twisted.



Photo No. 60

Subject: **CRANKSHAFT TWO PIECE TYPE**

Observation: Crankshaft has snapped at the crank pin.

Cause: The engine has been revved beyond its maximum recommended speed the additional force has caused high speed flexing of the crankshaft until it broke.

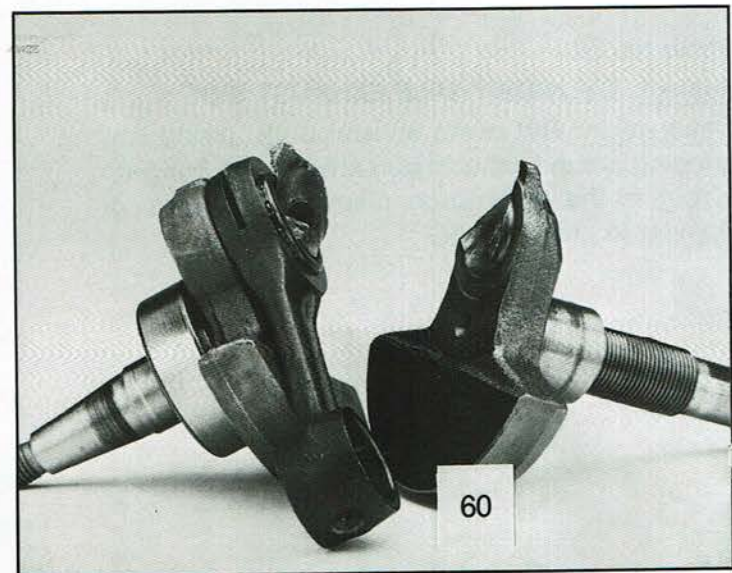




Photo No. 61

Subject: **MAIN BEARING, CONNECTING ROD AND BEARING RACE**

Observation: Bearing is coated with baked on dirt and carbon, bearing surfaces are rough, bearing race surface are pitted.

Cause: Engine has ingested dirt.

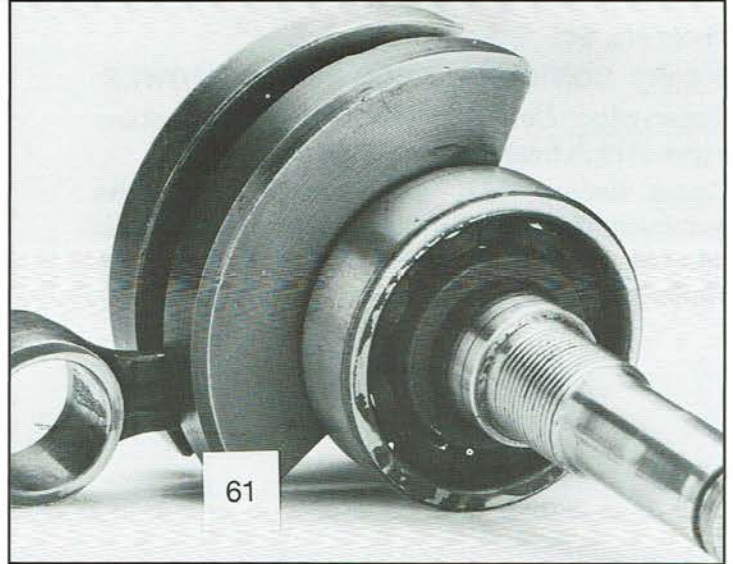


Photo No. 62

Subject: **BEARING LOWER CONNECTING ROD**

Observation: The rod bearing cage is being worn away.

Cause: Dirt ingested into the engine will eventually cause cracking or skidding (flat spots) of the bearings. This causes a build up of heat leads to the failure of the bearing.

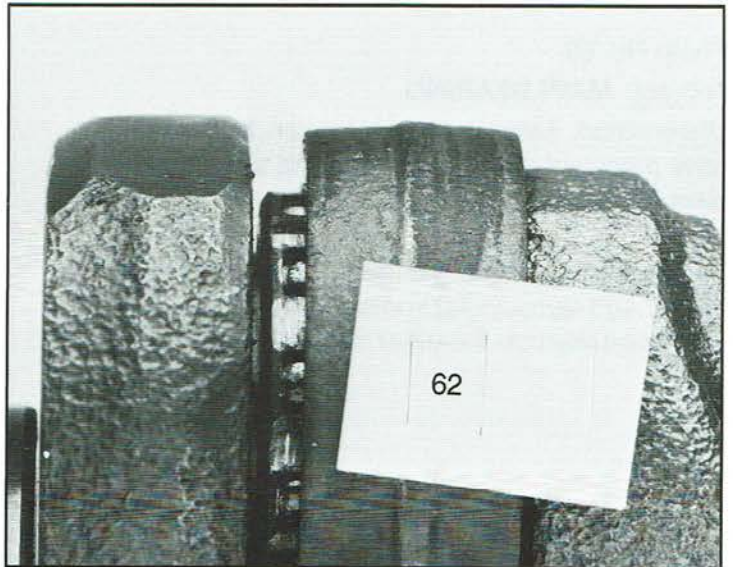


Photo No. 63

Subject: **MAIN BEARING CRANKSHAFT**

Observation: Bearing is darkened from severe heat, cage is distorted.

Cause: Engine has been revved above its maximum recommended speed resulting in overheating and a lubrication breakdown.





Photo No. 64

Subject: **CONNECTING ROD BEARING, LOWER**

Observation: Connecting rod and stroke pin show signs of high heat. Bearing cage is cracked.

Cause: Engine has been run above the recommended maximum speed. The resulting heat has caused the lubrication to breakdown, cage fracture from load.

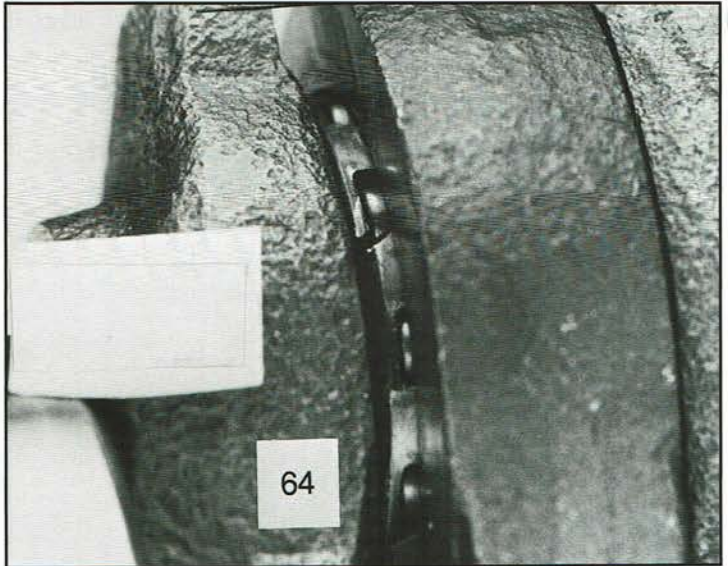


Photo No. 65

Subject: **MAIN BEARING**

Observation: Bearing cage is broken, ball bearings have pieces of material missing and are pitted and have flat spots.

Cause: Engine has been ingesting dirt, the dirt has collected in the bearing races and causes the balls to skid and develop flat spots resulting in heat and increased load on the other balls.

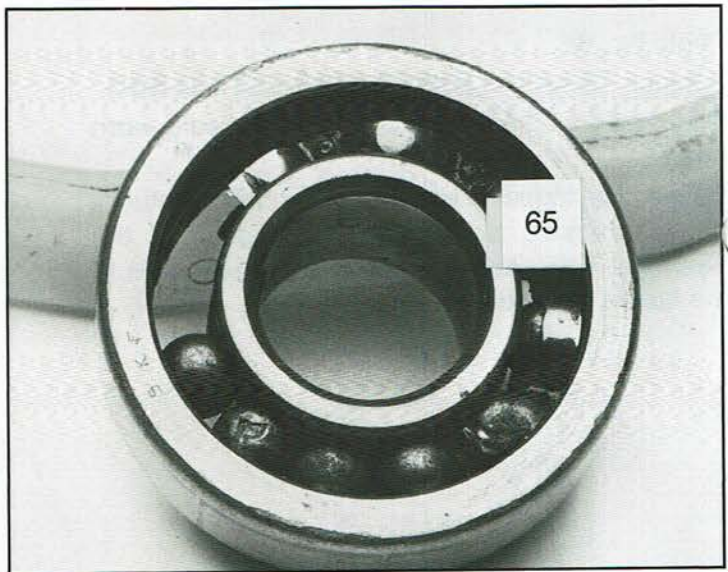
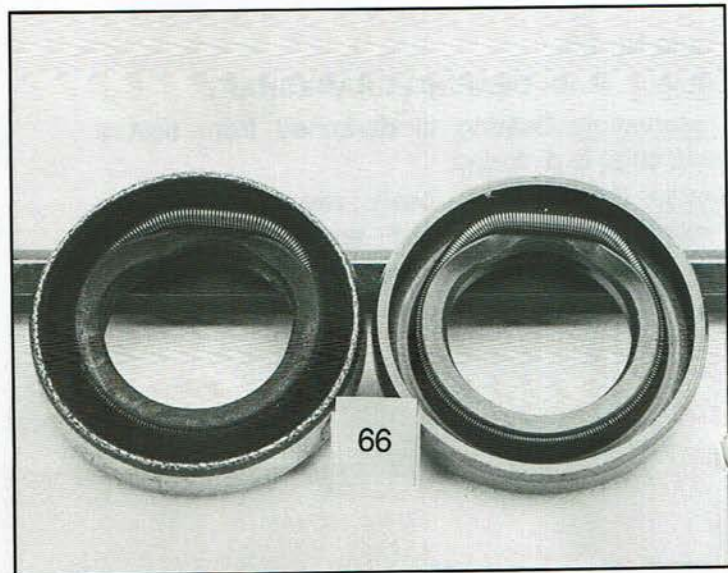


Photo No. 66

Subject: **SEALS**

Observation: Seal on the right is new, seal on the left has been leaking.

Cause: Dirt ingested into the engine will wear the seals away, seal spring damaged or missing.





# **STIHL®** ENGINE FAILURE ANALYSIS MANUAL

Photo No. 67

Subject: **MAGNESIUM TANK**

Observation: Material crumbling.

Cause: Corrosive substance in contact with magnesium. Corrosive substances include palm tree sap, alcohol, water, acids used in re-refining used oils for some types of bar/chain oils, some agricultural products including lime.

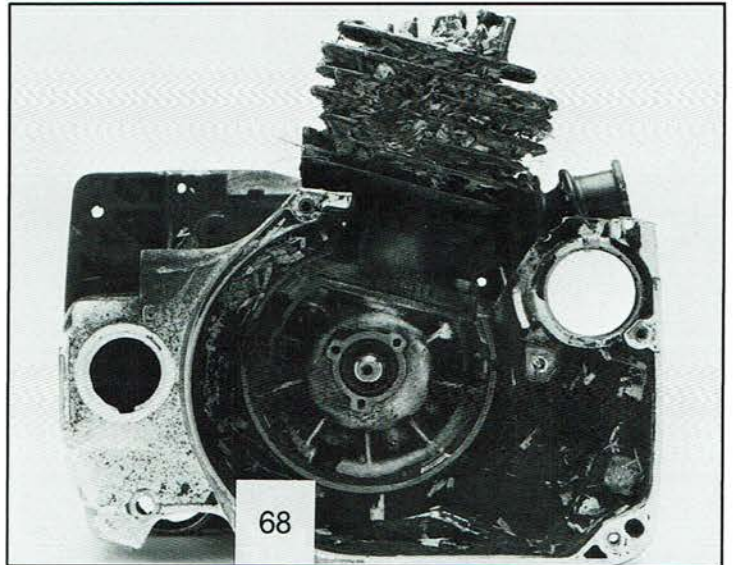


Photo No. 68

Subject: **CRANKCASE WITH CYLINDER**

Observation: Cylinder fins are packed with sawdust and chips.

Cause: Operator has not cleaned saw. This resulted in extreme heat buildup in engine. This causes seized pistons, broken bearings, detonation and lubrication breakdown.





## NOTES