

DIESEL ENGINE REPAIR AND MAINTENANCE MANUAL

Raymond Nazare, Priscilla Gasa, Mildret Mudarikwa, Oliver Remeredzai Mushangure,
Dorcas Matangi, Frédéric Baudron



Foreword

Increasing the productivity and profitability of smallholder agriculture in East and Southern Africa requires, among other interventions, increased access to mechanization. Mechanization options, however, need to be adapted to the financial capacity and the farm size of smallholders. Recognizing this, the Australian Center for International Agricultural Research (ACIAR) and the International Maize and Wheat Improvement Center (CIMMYT) joined forces with the Ethiopian Institute of Agricultural Research (EIAR), the Kenya Network for Dissemination of Agricultural Technologies (KENDAT), the Tanzania Agricultural Research Institute (TARI) and the University of Zimbabwe (UZ) to test, promote and develop markets around appropriate mechanization options targeting smallholders in the region through the project 'Farm Power and Conservation Agriculture for Sustainable Intensification' (FACASI).

The capacity to maintain and repair machinery is key to the success of mechanization interventions. Thus, this 'Diesel Engine Repair and Maintenance Manual' provides a step-by-step visual aid to disassemble and assemble a diesel engine, and targets machinery owners, users and mechanics. It is my hope that this manual will be widely used and will contribute to the expansion of mechanization in the region, for the benefit of smallholders and market actors in the value chain of mechanization.

Dr Frédéric Baudron

Systems Agronomist, FACASI Project Leader

CIMMYT Zimbabwe

With support from



ENGINE DISASSEMBLY

FULL ENGINE



ENGINE DISASSEMBLY

REMOVAL OF THE FLYWHEEL

before



Flywheel

Flywheel
securing nut

Activity

1. Locate the flywheel securing nut.
2. Loosen the nut.
3. Pull the flywheel out. Tool: Wrench

after



Position of crankshaft

ENGINE DISASSEMBLY

REMOVAL OF FUEL TANK AND FUEL SUPPLY PIPE

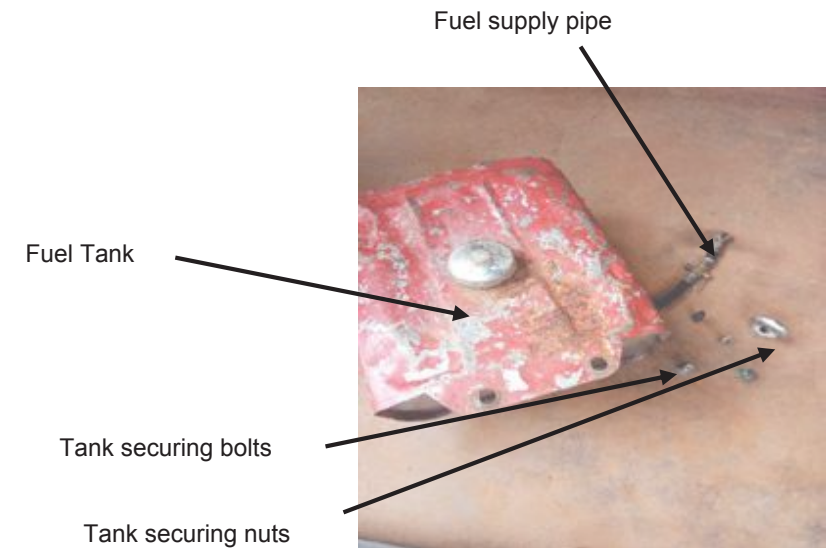
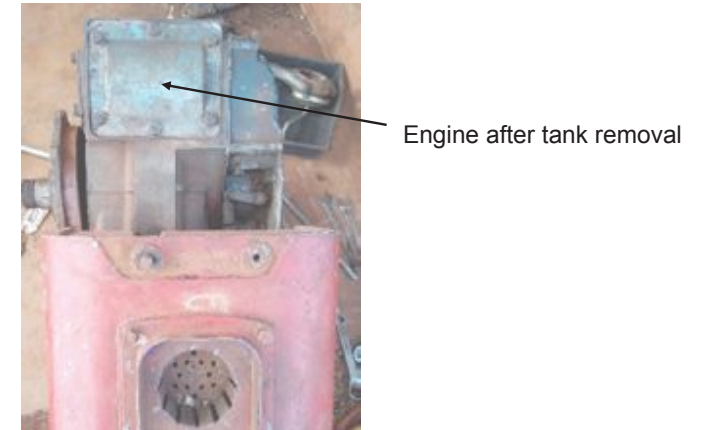
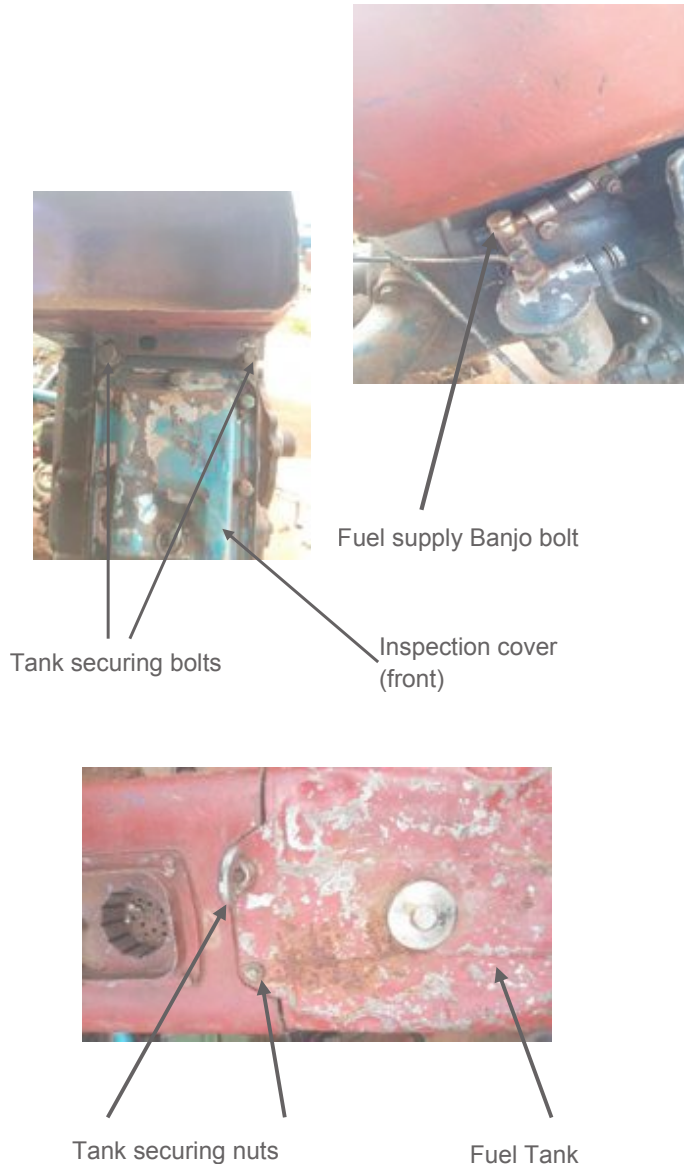
before

after

Activity

1. Locate the flywheel securing nut.
2. Loosen the nut.
3. Pull the flywheel out.

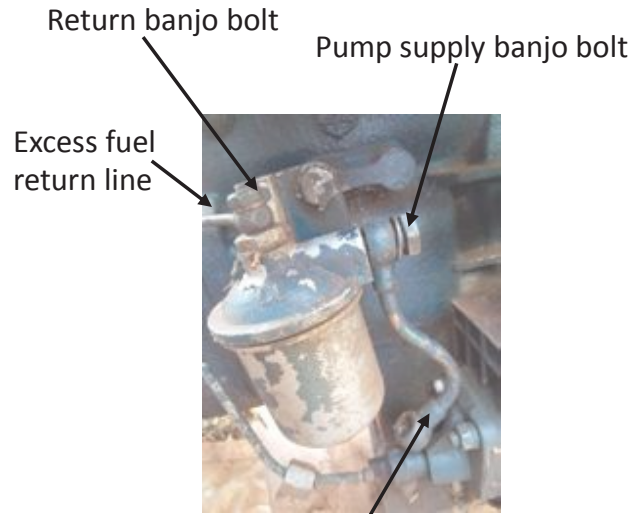
Tool: Wrenc



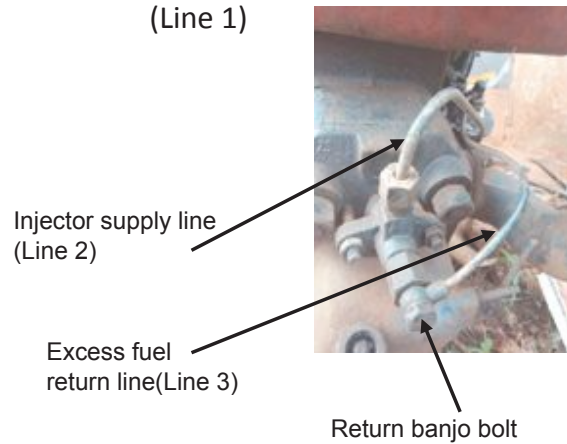
ENGINE DISASSEMBLY

REMOVAL OF FUEL LINES

before



Pump supply line
(Line 1)



Activity

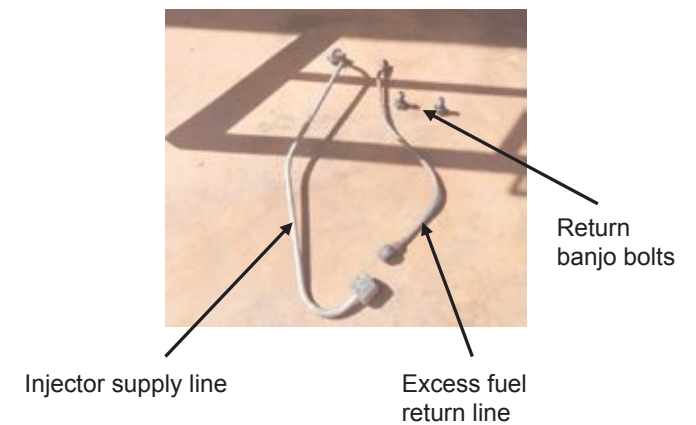
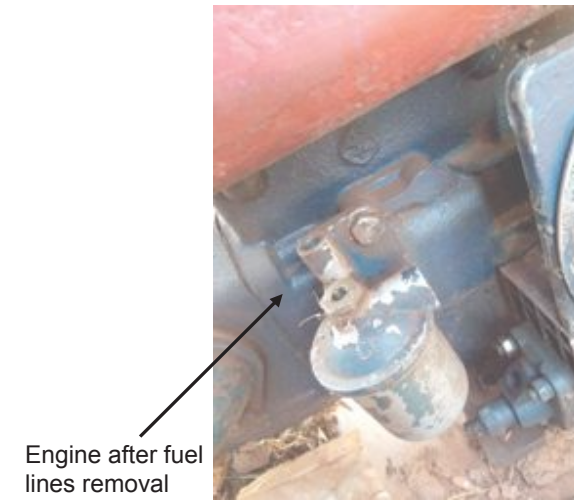
1. Locate the fuel lines 1, 2 and 3.

2. Loosen the banjo bolts securing lines 1 and 3 and remove the lines from the engine.

3. Loosen the nuts securing line to the engine and remove line 2.

Tools: 13 and 18 mm spanners

after



ENGINE DISASSEMBLY

REMOVAL OF FUEL FILTER HOUSING

before



Fuel filter

Bolt securing fuel filter

Activity

1. Locate the bolt securing fuel filter housing and loosen it.
2. Take the fuel filter housing off the engine block.

Tool: 17 mm spanner

after



Engine block after removal of fuel filter



Fuel filter after removal from block

Bolt securing fuel filter

ENGINE DISASSEMBLY

INSPECTION OF FUEL FILTER

before



Fuel filter housing

Bolt

Activity

1. Locate the bolt and loosen it.

2. Lift the filter housing cap.

3. Remove the fuel filter and spring. (If the filter material is worn out or is clogged by dirt, replace with a new one)

Tool: 17 mm spanner

after



Fuel filter housing components

Fuel filter components

ENGINE DISASSEMBLY

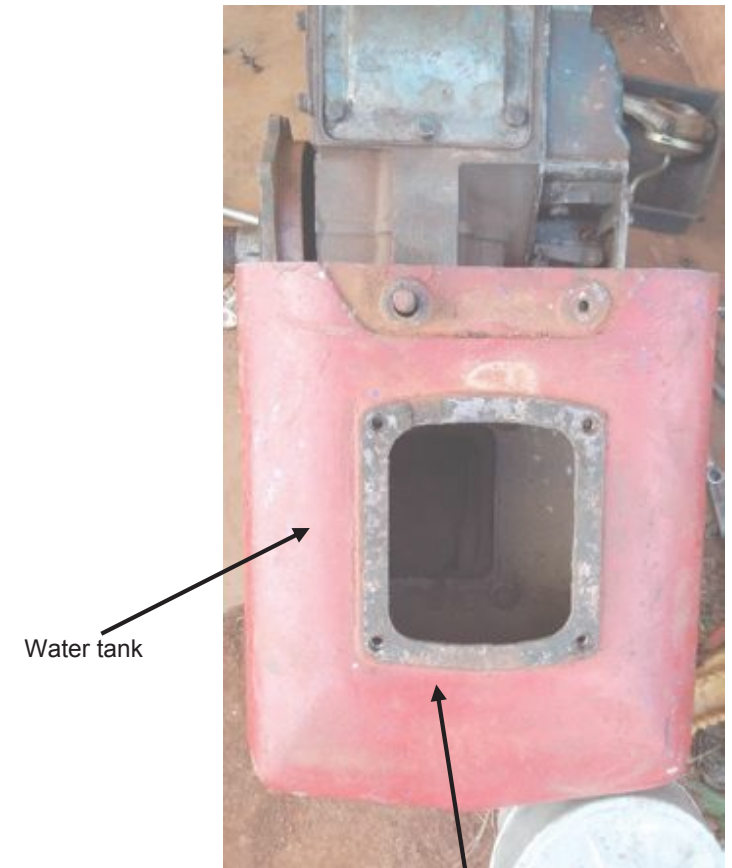
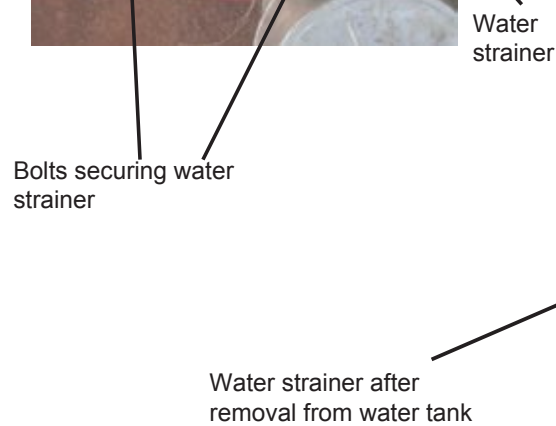
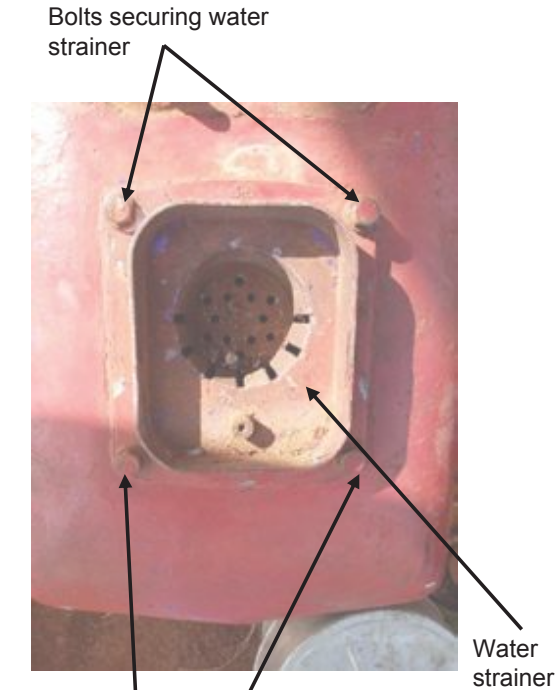
REMOVAL OF WATER STRAINER AND GASKET

before

after

Activity

1. Locate the four bolts securing water strainer to water tank.
2. Loosen the bolts and lift the water strainer and strainer gasket off the water tank.



ENGINE DISASSEMBLY

REMOVAL OF WATER TANK AND GASKET

before



Bolts securing water tank to engine block

Activity

1. Locate the four bolts securing the water tank to engine block.
2. Loosen the bolts and lift the tank off the block.

Tool: 15 mm spanner

after



Position of water tank and gasket



Bolts securing water tank to engine block

Water tank

ENGINE DISASSEMBLY

REMOVAL OF AIR FILTER

before



Nut securing air filter.

Air filter

Activity

1. Locate the nut securing air filter.

2. Loosen the nut and pull the air filter of the engine.

Tool: 10 mm spanner

after



Engine block after removal of air filter



Components of the air filter

ENGINE DISASSEMBLY

REMOVAL OF AIR INLET MANIFOLD AND GASKET

before



Bolts securing air inlet manifold to engine

Air inlet manifold

Activity

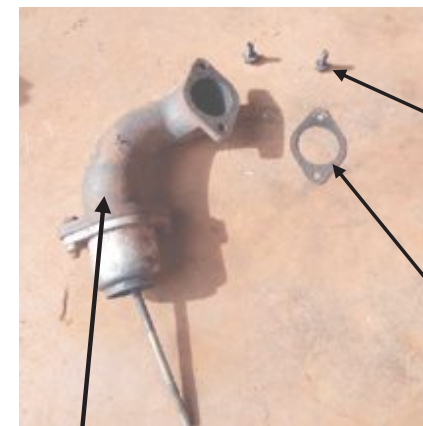
1. Locate the two bolts securing the air inlet manifold to the engine block.
2. Loosen the bolts and remove the manifold and gasket.

Tool: 13 mm spanner

after



Engine block after removal of air inlet manifold



Air inlet manifold

Bolts securing air inlet manifold to engine block

Inlet manifold gasket

ENGINE DISASSEMBLY

REMOVAL OF TOP INSPECTION COVER AND GASKET

before

after

Activity

1. Locate the 6 bolts securing top inspection cover to engine block.
2. Loosen the bolts and take off the top inspection cover and gasket.

Tool: 13 mm spanner.

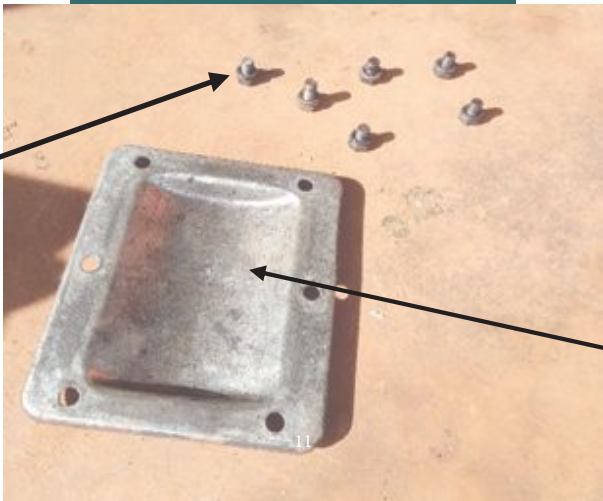


Bolts securing inspection cover to block

Top inspection cover



Engine block after removal of top inspection cover and gasket



Bolts securing inspection cover to block

Top inspection cover

ENGINE DISASSEMBLY

REMOVAL OF SUMP DIPSTICK

before



Sump dipstick

Activity

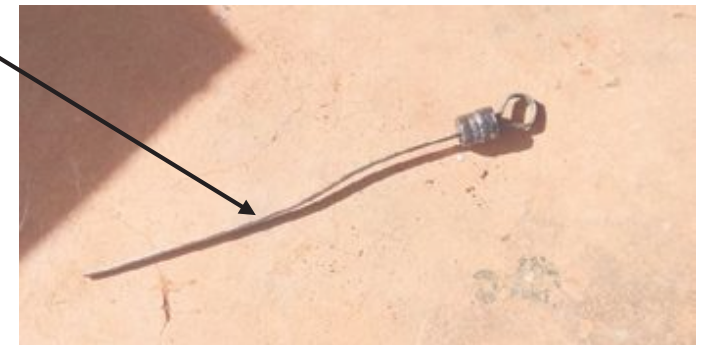
1. Locate the dipstick and pull it from the engine.

after



Engine after removal of dipstick

Sump dipstick



ENGINE DISASSEMBLY

REMOVAL OF FRONT INSPECTION COVER AND GASKET

before



Front inspection cover

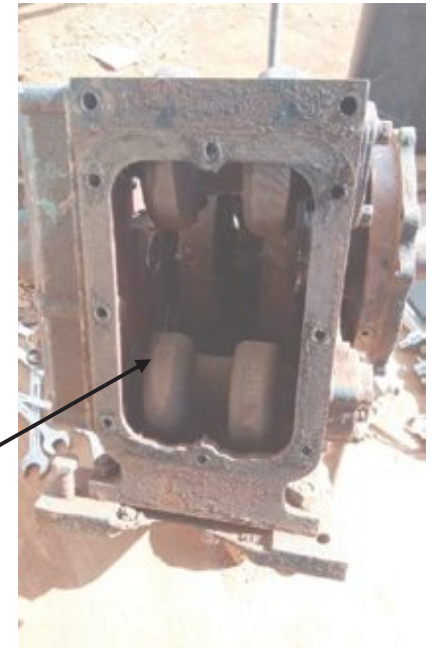
Bolts securing front inspection cover to engine block

Activity

1. Locate the 8 bolts securing front inspection cover to engine block.
2. Loosen the bolts.
3. Remove front inspection cover.
4. Remove front inspection cover gasket.

Tool: 13 mm spanner

after



Engine block after removal of front inspection cover and gasket



Front inspection cover

Bolts securing front inspection cover to engine block

ENGINE DISASSEMBLY

REMOVAL OF OIL LINE

before



Oil line banjo bolt

Oil line

Activity

1. Locate the 2 oil line banjo bolts.

2. Loosen the banjo bolts and remove the oil line. The two extreme pictures shows the position of banjo bolts to engine.

Tool: 13 mm spanner

after



Oil line banjo bolt



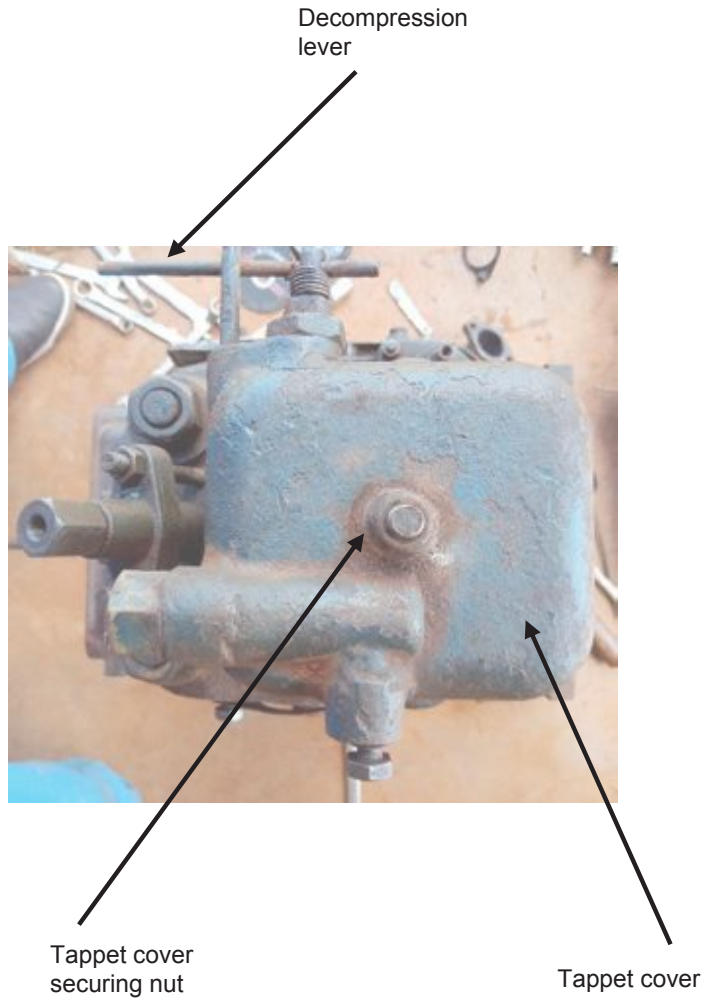
Oil line

Oil line banjo bolt

ENGINE DISASSEMBLY

REMOVAL OF TAPPET COVER AND GASKET

before



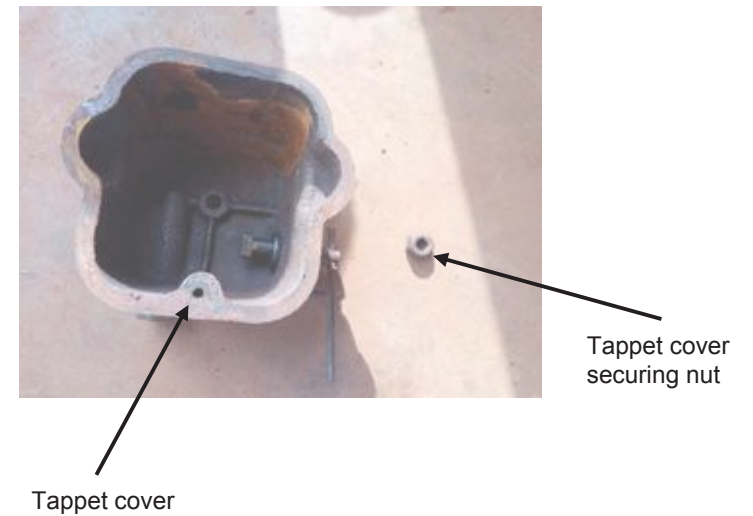
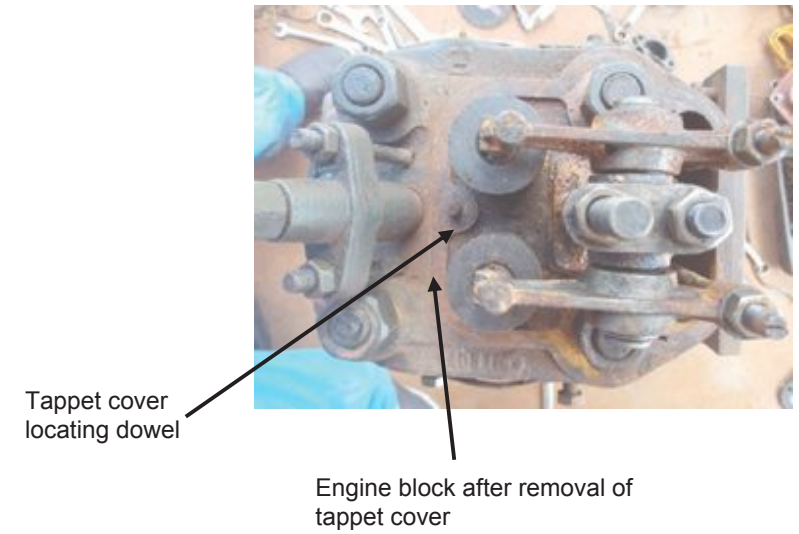
Activity

1. Locate the tappet cover securing nut.

2. Loosen the nut and pull off the tappet cover and gasket.

Tool: 17 mm spanner

after



ENGINE DISASSEMBLY

REMOVAL OF PUSH RODS AND ROCKER ARMS

before



Clearance
adjustment nuts

Rocker arms
securing nuts

Rocker arms

Activity

1. Locate the 2 rocker arm securing nuts and loosen them.

2. Locate the 2 clearance adjustment nuts and loosen them.

3. Pull the rocker arms off the engine.

4. Pull the push rods out of the engine.

Tools: 13 mm and 15 mm spanners

after

Engine block after
removal of push
rods and rocker arms



Push rods

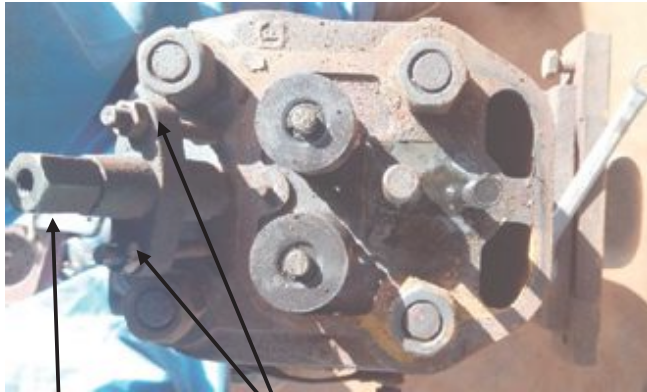
Rocker
arms

Clearance
adjustment
nuts

ENGINE DISASSEMBLY

REMOVAL OF FUEL INJECTOR

before



Injector securing nuts

Fuel injector



Flat screw driver

Head securing stud

Activity

1. Locate the 2 injector securing nuts and loosen them.
2. Support the flat screw driver with the head securing stud to lift the fuel injector off the engine.
3. Remove the fuel injector.

Tools: Flat screw driver, 13 mm spanner

after



Engine block after removal of fuel injector



Injector securing nuts

Fuel injector

ENGINE DISASSEMBLY

REMOVAL OF HEAD CYLINDER AND GASKET

before



Head securing nuts

Head cylinder

Activity

1. Locate the 4 nuts securing head cylinder to engine block.

2. Loosen the nuts and pull the head off the engine.

3. Remove the head cylinder gasket. (It is good practice to avoid refitting the removed head cylinder gasket onto the engine)

Tool: 30 mm spanner

after



Head cylinder and cylinder gasket position



Head securing nuts

Head cylinder gasket

Head cylinder

ENGINE DISASSEMBLY

REMOVAL OF OIL SUMP AND GASKET

before



Oil sump
securing bolts

Oil sump

Activity

1. Locate the 16 bolts securing oil sump to engine block.

2. Loosen the bolts and remove the oil sump.

3. Remove the oil sump gasket.

Tool: 13 mm
socket/spanner/T13

after



Engine after the
removal of oil
sump and gasket



Oil sump

Oil sump

ENGINE DISASSEMBLY REMOVAL OF OIL STRAINER

before



Activity

1. Locate the oil strainer banjo bolt.
2. Loosen the banjo bolt and remove the oil strainer.

Tool: 22 mm spanner

after



ENGINE DISASSEMBLY

REMOVAL OF GEARBOX DIPSTICK

before



Gearbox dipstick

Activity

1. Locate the gearbox dipstick and pull it off the engine.

after



Engine after removal of gearbox dipstick



Gearbox dipstick

ENGINE DISASSEMBLY

REMOVAL OF TIMING COVER AND GASKET

before



Bolts securing timing cover to engine block

Timing cover

Activity

1. Locate and loosen the bolts securing timing cover to engine block.

2. Lift the timing cover and gasket off the engine block. Note: Do not remove fuel filter from the timing cover

Tool: 13 mm socket, spanner/ T10



Timing cover gasket

after



Engine block after removal of timing cover and gasket

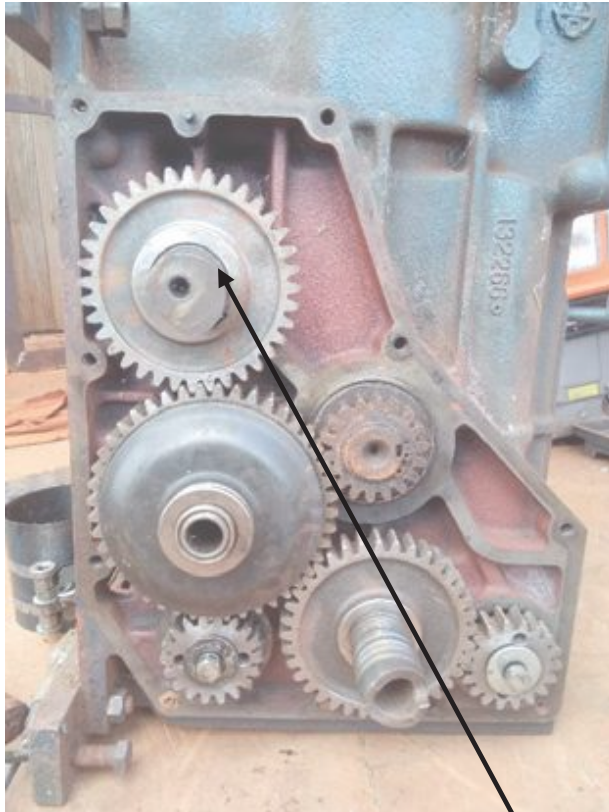


Timing cover

ENGINE DISASSEMBLY

REMOVAL OF CAM SHAFT AND GEAR UNIT

before

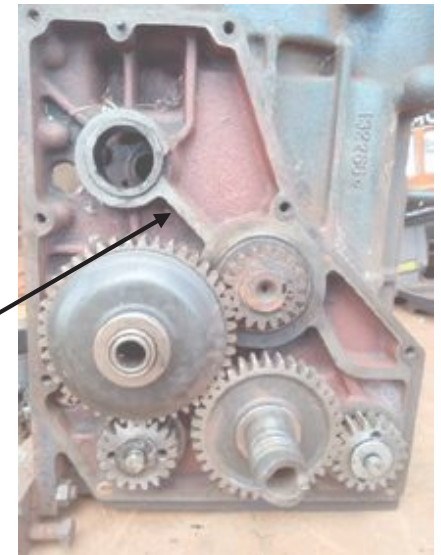


Cam shaft and gear unit

Activity

1. Locate the cam shaft and gear unit.
2. Pull the cam shaft and gear unit off the engine block.

after



Engine after removal of cam shaft and gear unit



Cam shaft and gear unit

ENGINE DISASSEMBLY

REMOVAL OF CAM FOLLOWERS

before



Cam followers in position

Activity

1. Locate cam followers on engine block and pull them out of the engine block.

after



Engine block after removal of cam followers



Cam followers

ENGINE DISASSEMBLY

REMOVAL OF STARTING GEAR

before

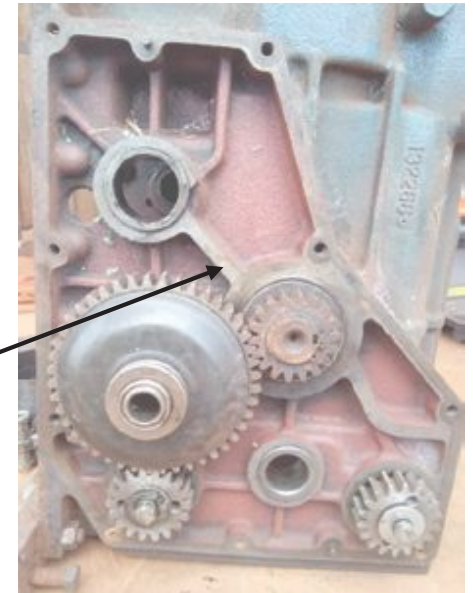


Starting gear

Activity

1. Locate the starting gear and pull it off the engine block.s

after



Position of the starting gear



Starting gear

ENGINE DISASSEMBLY

REMOVAL OF FUEL LINES

before

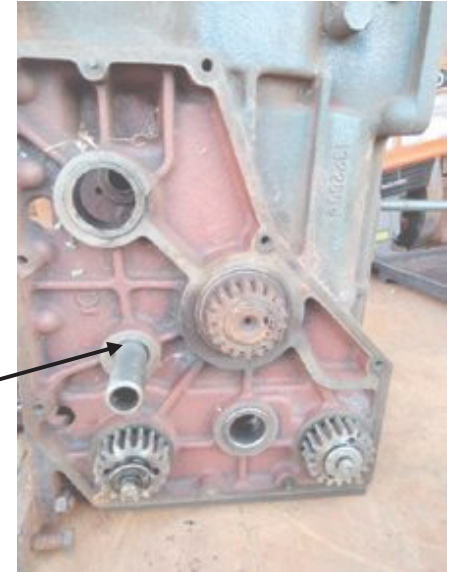


Timing gear

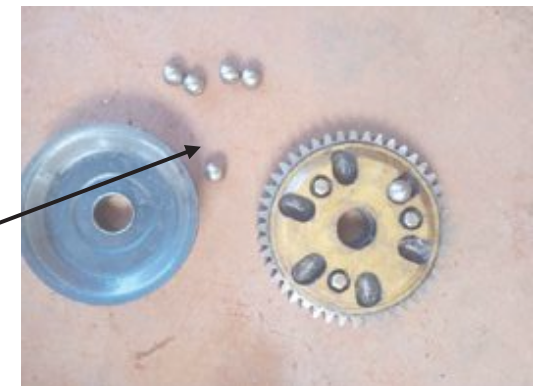
Activity

1. Locate the timing gear and pull it off the engine block. (There are no bolts or nuts securing timing gear to engine block)

after



Position of timing gear



Timing gear components

ENGINE DISASSEMBLY

REMOVAL OF CON ROD END CAP

before



Bolts securing end cap to con rod

End cap

Activity

1. Locate the 2 bolts securing the end cap to con rod
2. Loosen the bolts and pull off the end cap.

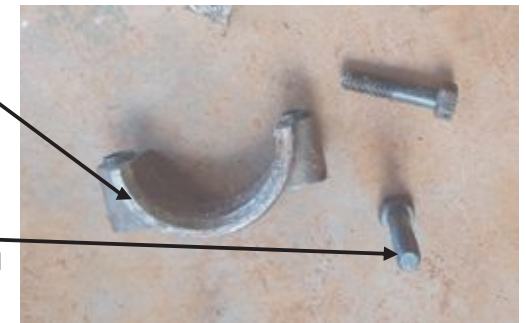
Tool: 17 mm spanner

after



Engine after removal of end cap

End cap



Bolts securing end cap to con rod

ENGINE DISASSEMBLY

REMOVAL AND INSPECTION OF END BEARING

before



Activity

1. Locate the position of the end bearing.

2. Place your thumb at the thumb position and slide the bearing out.

Note: If the bearing inner surface scratched (kumarika) replace the bearing.

after



ENGINE DISASSEMBLY

REMOVAL OF CRANKSHAFT COVER AND GASKET

before



Bolts securing crankshaft cover



Hammering screw driver between the gap

Crankshaft cover

Activity

1. Locate 6 bolts securing the crankshaft cover and loosen them.
2. Hammer a flat screw driver in the gap between cover and engine block.
3. Enlarge the gap using spanners.
4. Pull cover off the block and remove the gasket

Tools: 13, 17 and 22 mm spanners, flat screw driver, rubber hammer.

after



Engine block after removal of crankshaft cover



Enlarging gap using spanners

ENGINE DISASSEMBLY

REMOVAL OF AND INSPECTION OF CRANKSHAFT

before

after

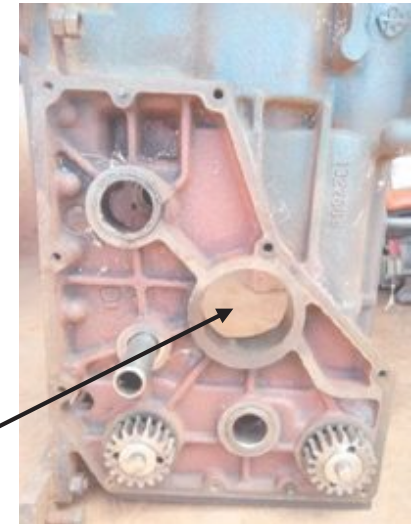
Activity

1. Locate the crankshaft and pull it out of the engine.

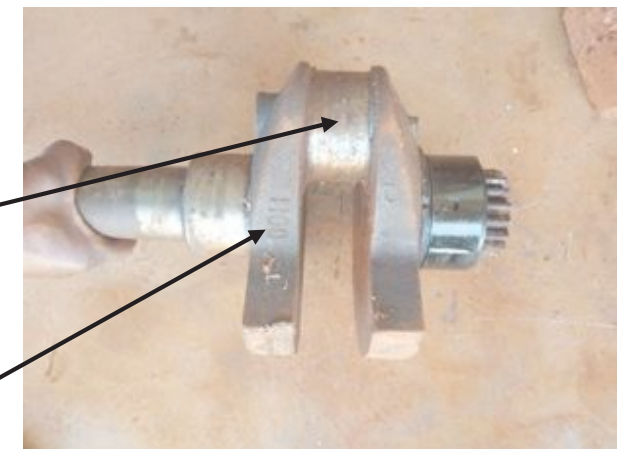
(There are no bolts or nuts securing crankshaft to engine block)(If the position of the con rod is scratched (kumarika), send the crankshaft to specialists for repair).



Crankshaft



Engine after removal of the crankshaft



Position of con rod

Crankshaft

ENGINE DISASSEMBLY

REMOVAL OF PISTON AND CON ROD UNIT

before



Piston in cylinder



Con rod

Activity

1. Locate the con rod.
2. Push the con rod up from below towards head cylinder position.
3. Hold the piston and pull the unit out of the cylinder. (If the piston is stuck into the cylinder, use a wooden block to knock the piston out)

after



Position of piston



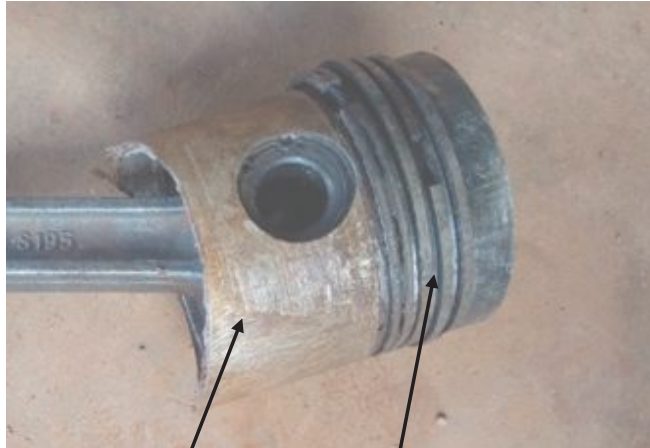
Con rod

Piston

ENGINE DISASSEMBLY

REMOVAL OF RINGS OFF THE PISTON

before



piston

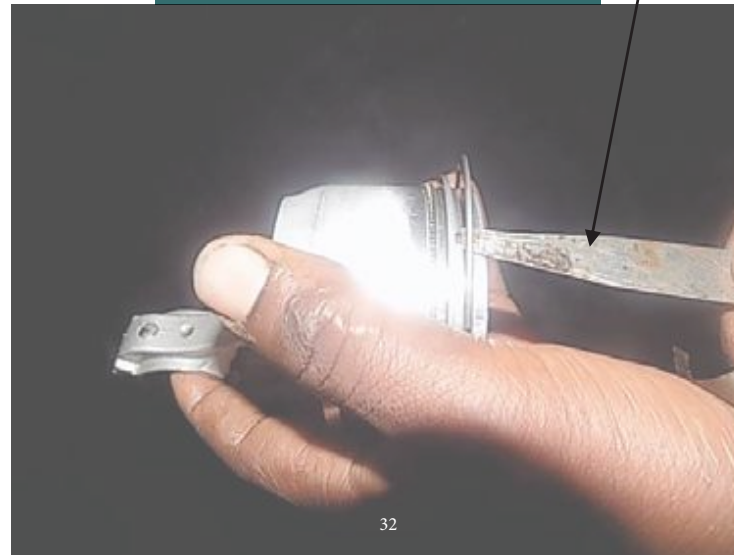
rings

Activity

Activity:1. Locate piston rings on piston

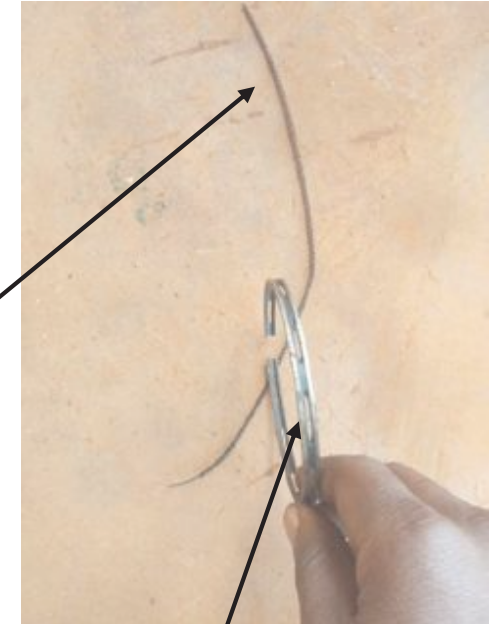
2. Use a filler gauge to remove piston rings from piston starting with the top ring

Tool: Filler gauge



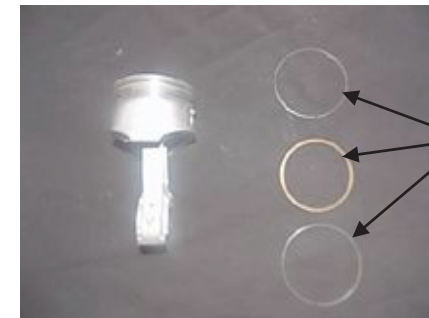
Filler gauge

after



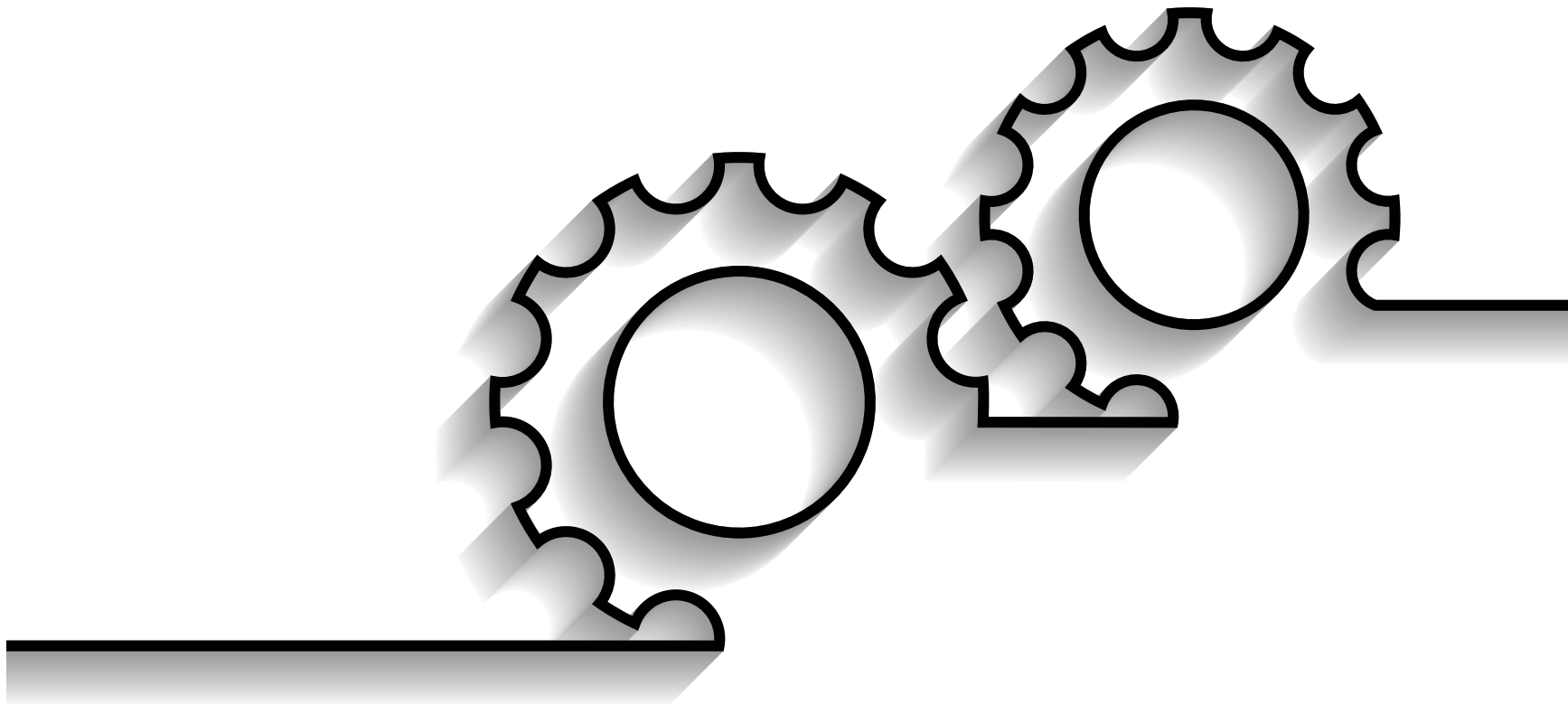
Oil ring spring

Oil ring



3 compression rings

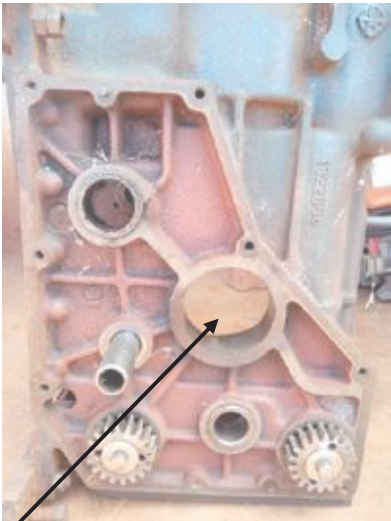
ENGINE ASSEMBLY



ENGINE ASSEMBLY

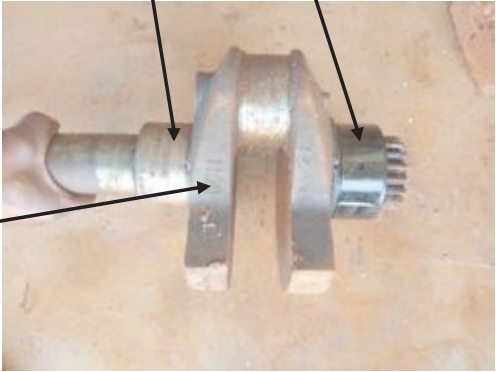
INSTALLATION OF CRANKSHAFT

before



Position of the crankshaft

Crankshaft support positions



Crankshaft

Activity

1. Smear oil on the crankshaft support positions.
2. Locate the crankshaft position and push the crankshaft into position.

after

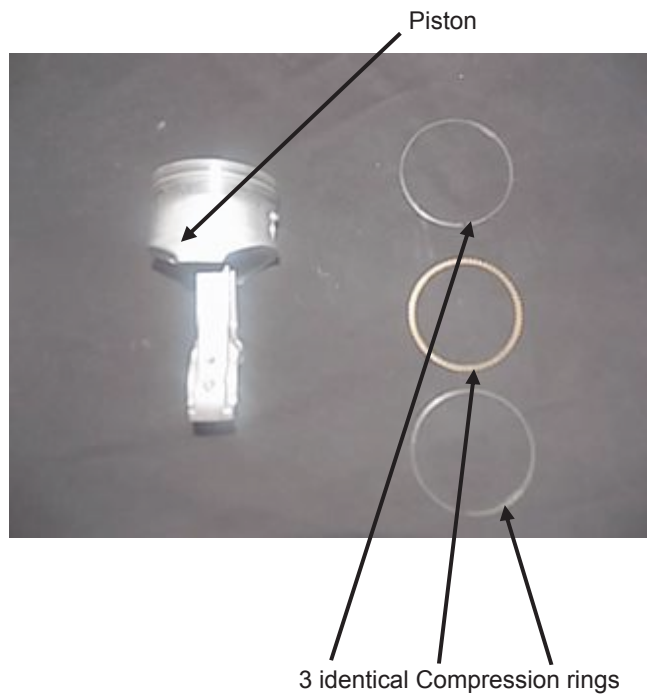


Crankshaft in position after installation

ENGINE ASSEMBLY

INSTALLATION OF RINGS OVER PISTON

before

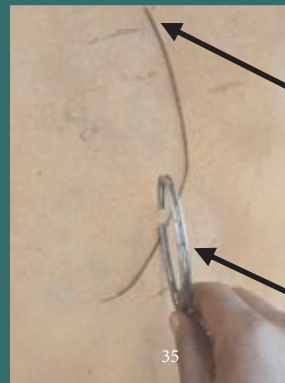


Activity

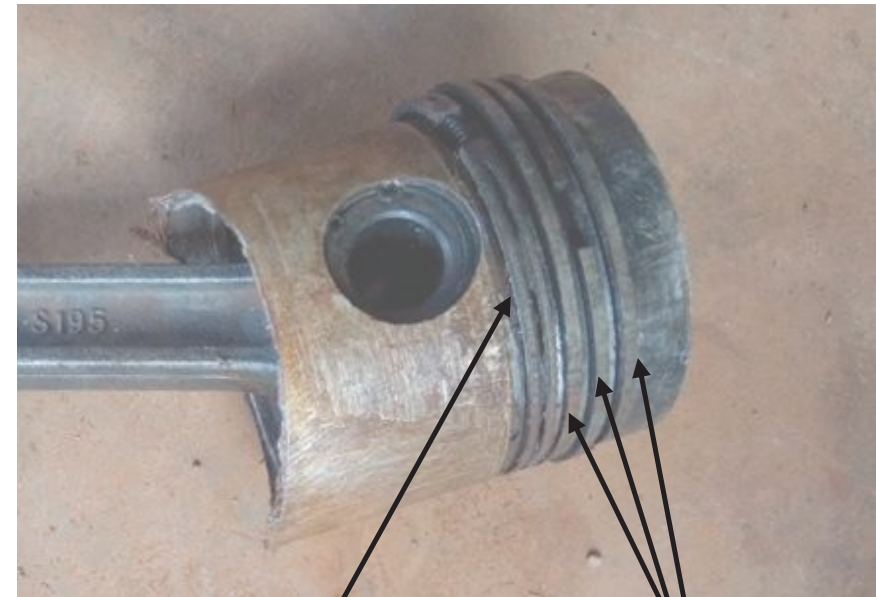
1. Slide the oil ring over piston from the bottom of the piston into the most bottom groove and insert spring.

2. Slide the 3 compression rings into their respective grooves fitting the most bottom groove first.

3. Ensure that the ring ends are not in line.



after



Oil ring in position

3 compression rings in position after installation

Oil ring spring

Oil ring

ENGINE ASSEMBLY

INSTALLATION OF PISTON AND CON ROD UNIT

before



Position of piston

Cylinder wall



Con rod

Piston

Activity

1. Smear oil on the walls of the piston and cylinder.

2. Insert the piston in a ring squeezer and squeeze the rings.

3. Locate the position of the piston and push the piston in position.

4. Use a wooden rod to knock the piston into the cylinder.

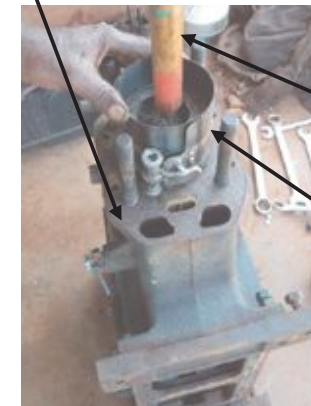
Tools/materials: Ring squeezer, wooden rod

after



Piston in cylinder after installation

Installation of piston in cylinder



Wooden rod

Ring squeezer

ENGINE ASSEMBLY

INSTALLATION OF END BEARING

before



Position of end bearing

End bearing

Activity

1. Locate the position of the end bearing.

2. Align the groove on end cap and dowel on end bearing.

3. Push the bearing into position.

Note: If the bearing inner surface scratched (kumarika), replace the bearing.

after



Position after installation

ENGINE ASSEMBLY

INSTALLATION OF CON ROD END CAP

before



Position of end cap

End bearing



Bolts securing end cap to con rod

Activity

1. Smear oil on end bearing inner wall and end cap position.
2. Place the end cap in position.
3. Place the 2 securing bolts in position and tighten.

after



Bolts securing end cap to con rod

End cap in position after installation

ENGINE ASSEMBLY

INSTALLATION OF CRANKSHAFT COVER AND GASKET

before



Crankshaft cover position

Crankshaft cover gasket position

Activity

1. Locate the position of crankshaft cover gasket.
2. Place the new gasket in position.
3. Smear oil on the walls of the bearing and slide the cover in position.
4. Place the securing bolts in position and tighten.

Tools: 13mm spanner.

after



Crankshaft cover in position after installation

Bolts securing crankshaft cover

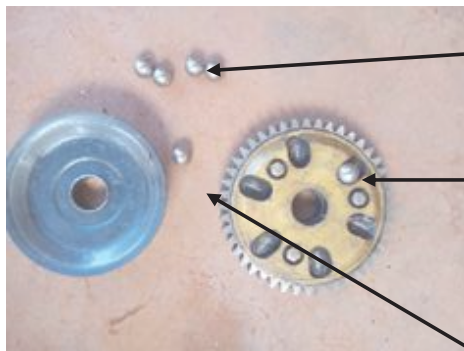
ENGINE ASSEMBLY

INSTALLATION OF TIMING GEAR

before



Position of timing gear



Lubrication balls

Lubrication ball in position

Timing gear components

Activity

1. Locate the timing gear position and smear oil onto it.

2. Align the timing marks and push the timing gear into position.

3. Apply grease to lubrication balls and stick them into position.

Note: An illustration showing engine timing is shown in the next slide.

after

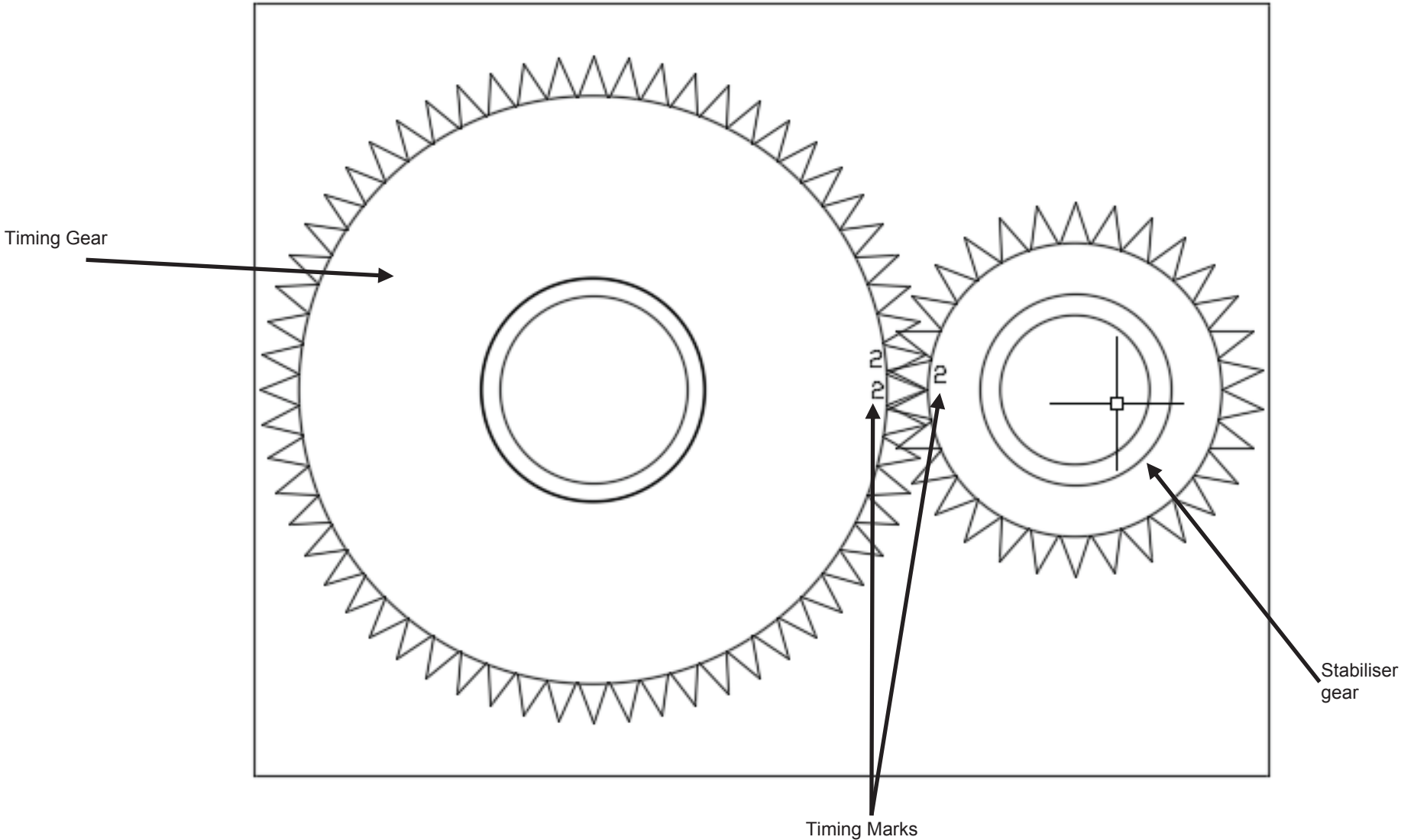


Timing gear in position after installation



Timing marks

ENGINE ASSEMBLY TIMING ILLUSTRATION



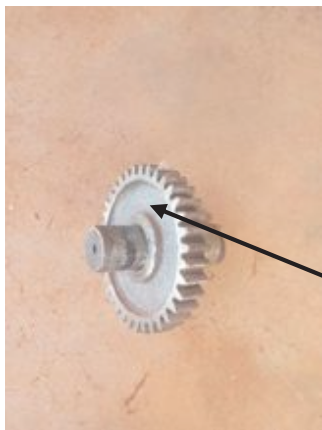
ENGINE ASSEMBLY

INSTALLATION OF STARTING GEAR

before



Position of the starting gear



Starting gear

Activity

1. Locate the starting gear position and smear oil on its inner walls.

2. Align the timing marks and push the starting gear in position. (There are no bolts or nuts securing starting gear to engine block)

after

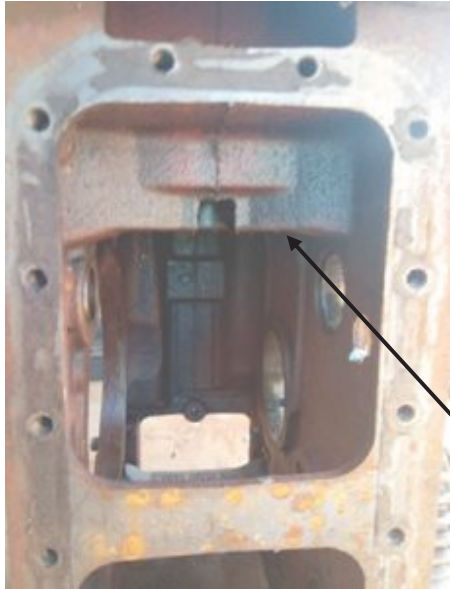


Starting gear in position after installation

ENGINE ASSEMBLY

INSTALLATION OF CAM FOLLOWERS

before



Position of
cam followers



Cam
followers

Activity

1. Locate cam followers and smear oil onto them.

2. Locate cam follower position on engine block and push the cam followers into the engine block.

(There are no bolts or nuts securing cam followers to engine block)

after

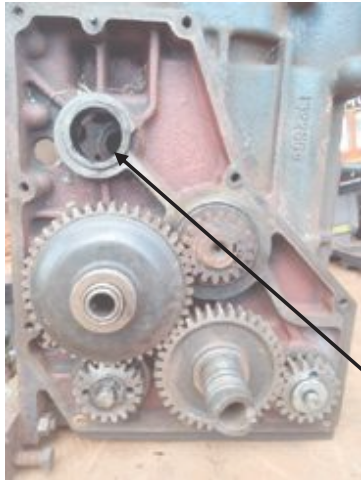


Cam followers in
position after
installation

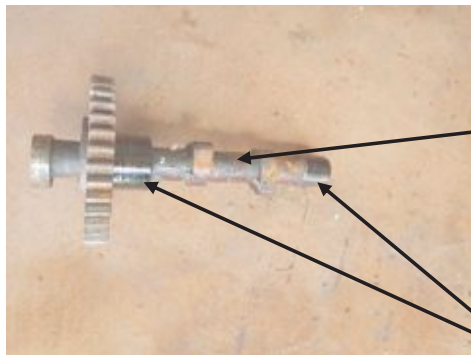
ENGINE ASSEMBLY

INSTALLATION OF CAM SHAFT AND GEAR UNIT

before



Position of cam shaft and gear unit



Cam shaft and gear unit

Cam shaft and gear unit support positions

Activity

1. Locate the cam shaft and gear unit position and smear oil on the inner walls.
2. Smear oil onto the cam shaft and gear unit support positions
3. Push the cam shaft and gear unit in position. (There are no bolts or nuts securing cam shaft and gear unit to engine block)

after



Cam shaft and gear unit in position after installation

ENGINE ASSEMBLY

INSTALLATION OF GEARBOX COVER AND GASKET

before



Position of gearbox cover and gasket



Gearbox cover

Activity

1. Locate the gearbox cover gasket position.
2. Place new gasket and cover in position.
3. Position 10 bolts securing gear box to engine block and tighten them.

Tool: 13 mm spanner

after



Bolts securing gearbox cover to engine block

Gearbox cover in position after installation

ENGINE ASSEMBLY

INSTALLATION OF OIL SUMP AND GASKET

before



Oil sump and gasket position



Oil sump

Oil sump securing bolts

Activity

1. Locate oil sump gasket position and place new gasket in position.
2. Place oil sump in position.
3. Place the 16 sump securing bolts in position and tighten them.

Tool: 13 mm socket/spanner/T13

after



Oil sump securing bolts

Oil sump in position after installation

ENGINE ASSEMBLY

INSTALLATION OF HEAD CYLINDER AND GASKET

before



Head cylinder and cylinder gasket position



Head securing nuts

Head cylinder gasket

Head cylinder

Activity

1. Locate the head cylinder position and place a new gasket on that position.
2. Place the head cylinder in position.
3. Place the head securing nuts in position and tighten them.

Tool: 30 mm spanner

after



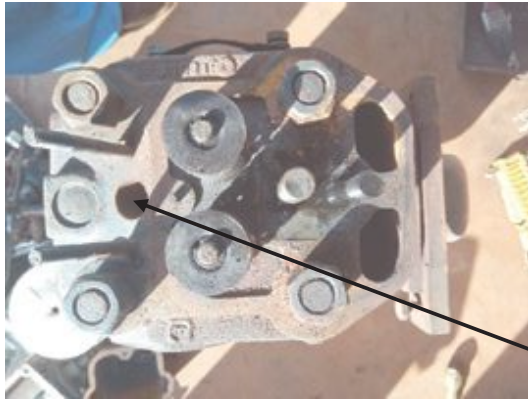
Head securing nuts

Head cylinder in position after installation

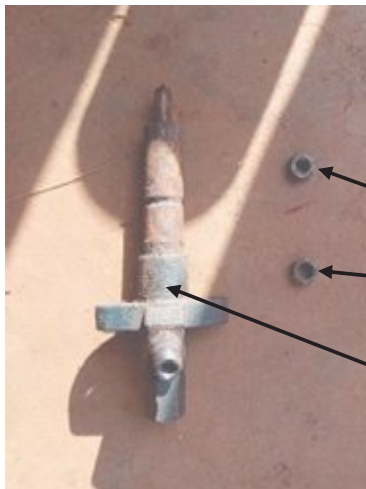
ENGINE ASSEMBLY

INSTALLATION OF FUEL INJECTOR

before



Fuel injector position



Injector securing nuts

Fuel injector

Activity

1. Locate the fuel injector position and push the injector in position.
2. Place the 2 injector securing nuts in position and tighten them.

Tool: 13 mm spanner

after



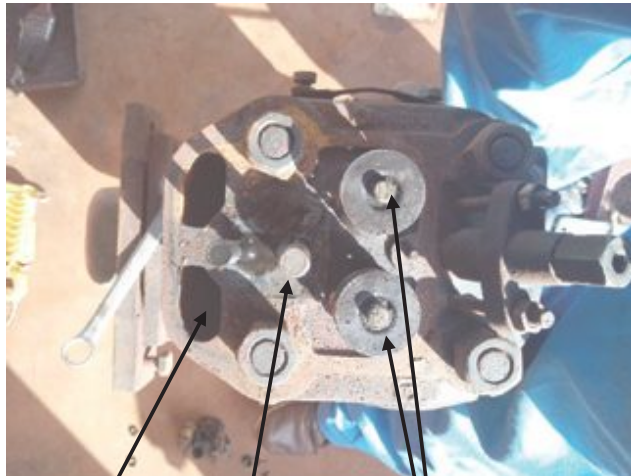
Fuel injector in position after installation

Injector securing nuts

ENGINE ASSEMBLY

INSTALLATION OF PUSH RODS AND ROCKER ARMS

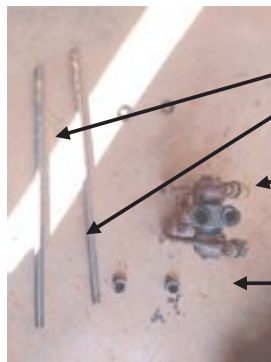
before



Position of push rods

Position of rocker arms

Valve stems



Push rods

Rocker arms

Clearance adjustment nuts

Activity

1. Locate the position of push rods and drop the push rods in position. (Make sure rods drop on cam followers)

2. Locate the position of rocker arms and place the rocker arms in position.

3. Place rocker arm securing nuts in position and tighten them.

4. Turn engine crankshaft until all rocker arms are loose and place a 3 mm filler gauge between exhaust valve and rocker arms and 2.5 mm filler gauge for the inlet side.

5. Tighten clearance adjustment nuts without disturbing the set clearances.

Tools: 13 mm and 15 mm spanners, filler gauge.

after



Clearance adjustment nuts

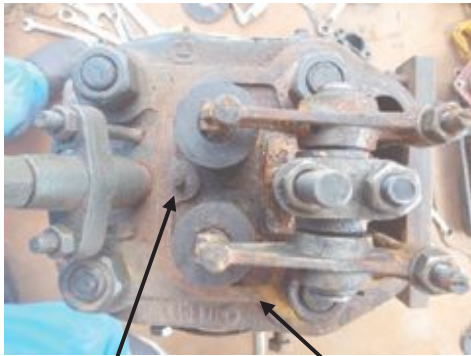
Rocker arms securing nuts

Rocker arms in position after installation

ENGINE ASSEMBLY

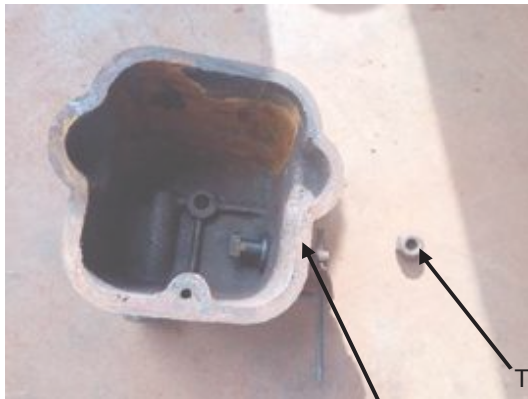
INSTALLATION OF TAPPET COVER AND TAPPET COVER GASKET

before



Tappet cover locating dowel

Position of tappet cover and gasket



Tappet cover securing nut

Tappet cover

Activity

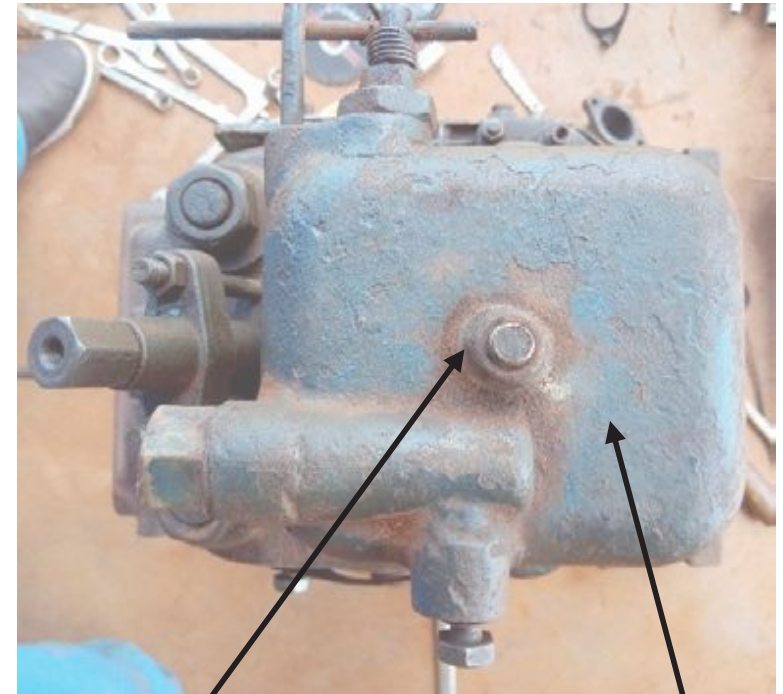
1. Locate the position of the tappet cover gasket and place new gasket in position.

2. Locate position of tappet cover and place tappet cover in position.

3. Position the cover securing nut and tighten it.

Tool: 17 mm spanner

after



Tappet cover securing nut

Tappet cover in position after installation

ENGINE ASSEMBLY INSTALLATION OF OIL LINE

before



Oil line banjo bolt

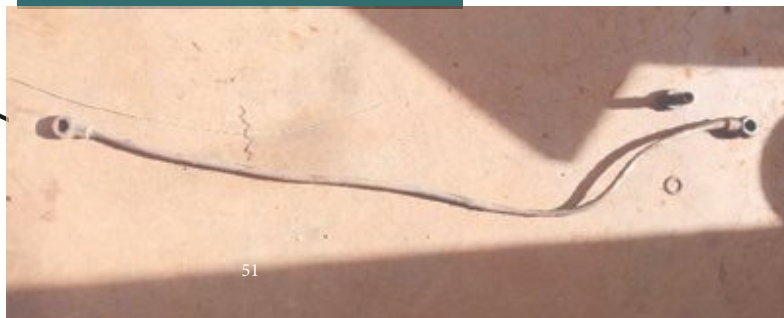
Oil line

Activity

1. Locate position of oil line and place oil line in position.

2. Place oil line banjo bolts in position and tighten them.

Tool: 13 mm spanner



after



Oil line banjo bolt

ENGINE ASSEMBLY

ASSEMBLY OF FUEL FILTER COMPONENTS

before



Fuel filter components

Activity

1. Locate the filter spring and slide it into the filter bottom cover through the shaft.
2. Place fuel filter on top of the spring.
3. Place the filter top of the bottom cover.
4. Tighten the bolt to secure the fuel filter.

Tool: 17 mm spanner

after



Fuel filter after assembly of components

Bolt

ENGINE ASSEMBLY

INSTALLATION OF FUEL FILTER

before



Fuel filter position



Fuel filter

Bolt securing
fuel filter

Activity

1. Locate the position of filter and place the filter in position.

2. Position fuel filter securing bolt in position and tighten it.

Tool: 17 mm spanner

after



Bolt securing
fuel filter

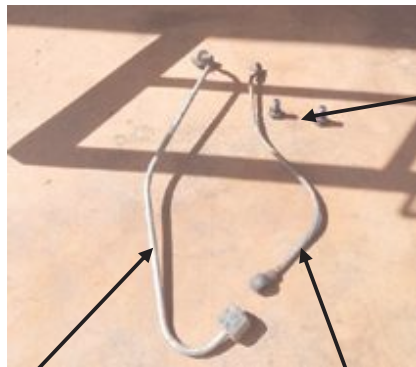
Fuel filter

ENGINE ASSEMBLY INSTALLATION OF FUEL LINES

before



Position of fuel lines on fuel filter



Return banjo bolts

Injector supply line (Line 2)

Excess fuel return line (Line 3)

Activity

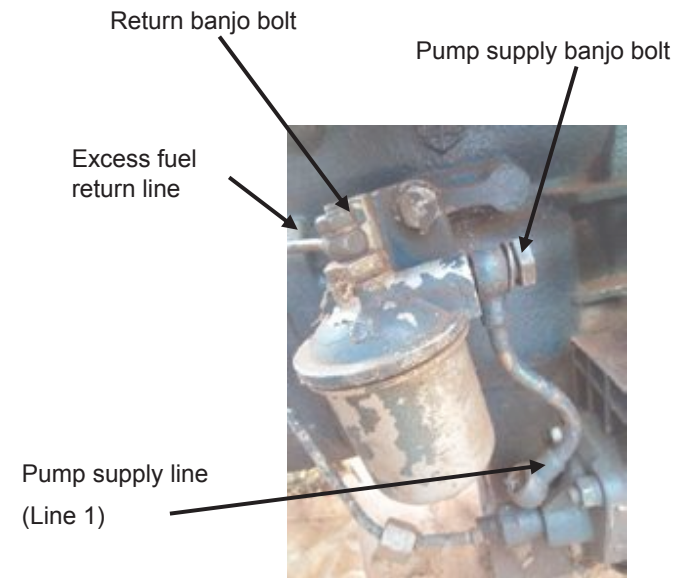
1. Locate the fuel lines 1, 2 and 3.

2. Position fuel lines 1 and 3 in their positions and tighten banjo bolts to secure them.

3. Position line 2 in position and tighten the nuts at the ends to secure it.

Tools: 13 and 18 mm spanners

after



Pump supply line (Line 1)

Injector supply line (Line 2)

Excess fuel return line (Line 3)



Return banjo bolt

ENGINE ASSEMBLY

INSTALLATION OF FRONT INSPECTION COVER AND GASKET

before



Front inspection cover and gasket position



Front inspection cover

Bolts securing front inspection cover to engine block

Activity

1. Place new cover gasket and front inspection cover in position.
2. Place 8 securing bolts in position and tighten them.

Tool: 13 mm socket/spanner/T13

after



Front inspection cover in position after installation

Bolts securing front inspection cover to engine block

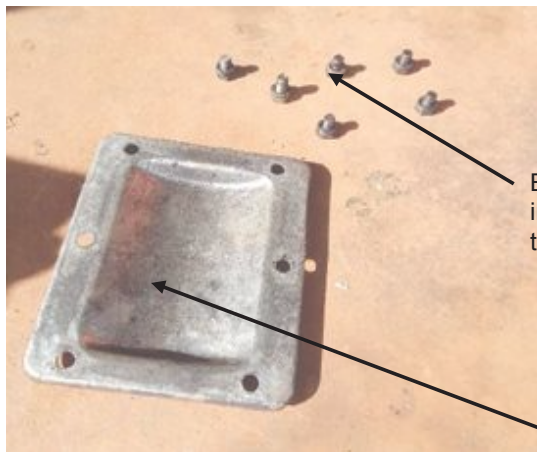
ENGINE DISASSEMBLY

REMOVAL OF TOP INSPECTION COVER AND GASKET

before



Position of top inspection cover and gasket



Bolts securing inspection cover to block

Inspection cover

Activity

1. Locate the position of the top inspection cover and gasket.
2. Place new gasket and cover in position.
3. Place 6 securing bolts in position and tighten them.

Tool: 13 mm socket/spanner/T13.

after



Bolts securing inspection cover to block

Inspection cover

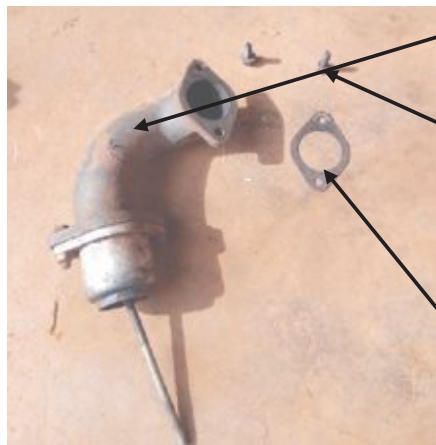
ENGINE ASSEMBLY

INSTALLATION OF AIR INLET MANIFOLD AND GASKET

before



Air inlet manifold and gasket position



Air inlet manifold

Bolts securing air inlet manifold to engine block

Inlet manifold gasket

Activity

1. Locate and place air inlet manifold and new gasket in position.

2. Place 2 securing bolts in position and tighten them.

Tool: 13 mm spanner

after



Bolts securing air inlet manifold to engine block

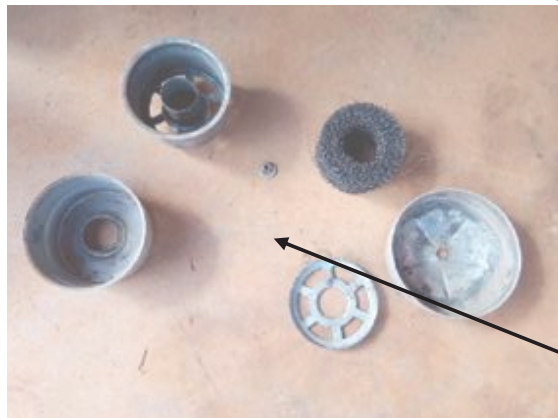
Air inlet manifold in position after installation

ENGINE ASSEMBLY INSTALLATION OF AIR FILTER

before



Position of air filter



Air filter components

Activity

1. Locate air filter position.
2. Place air filter and filter securing nut in position.
3. Tighten nut to secure the air filter.

Tool: 10 mm spanner

after



Nut securing air filter.

Air filter in position after installation

ENGINE ASSEMBLY

INSTALLATION OF WATER TANK AND GASKET

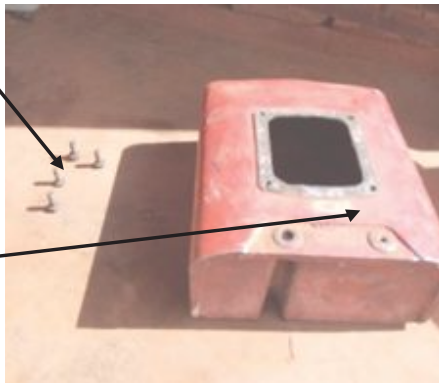
before



Bolts securing water tank to engine block

Position of water tank and gasket

Water tank



Activity

1. Locate the water tank and water tank gasket position.

2. Place water tank and new gasket in position

3. Place and tighten 4 tank securing bolts.

Tool: 15 mm spanner

after



Bolts securing water tank to engine block after tank installation

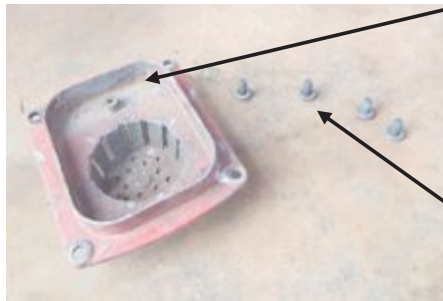
ENGINE ASSEMBLY

INSTALLATION OF WATER STRAINER AND GASKET

before



Position of water strainer and strainer gasket



Water strainer

Bolts securing water strainer

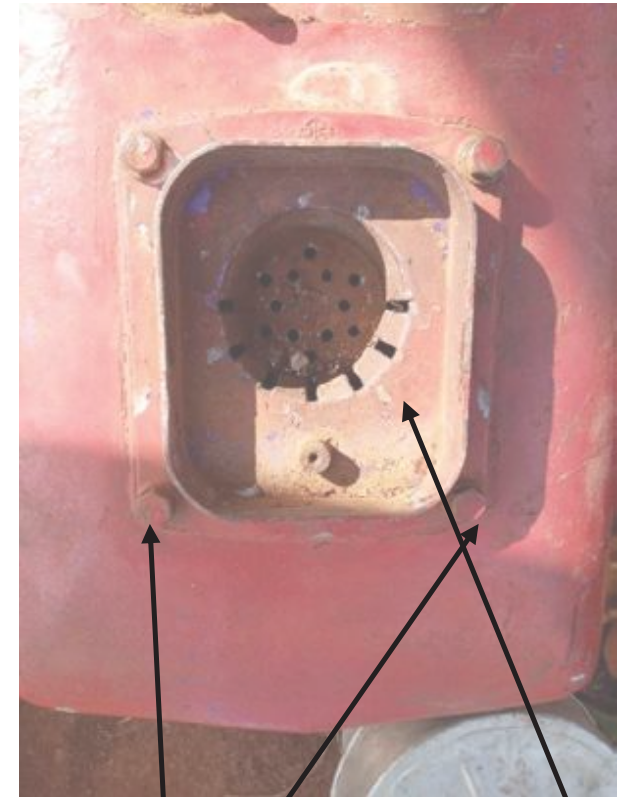
Activity

1. Place water strainer and new strainer gasket in position.

2. Place 4 strainer securing bolts in position and tighten them.

Tool: 13 mm spanner

after



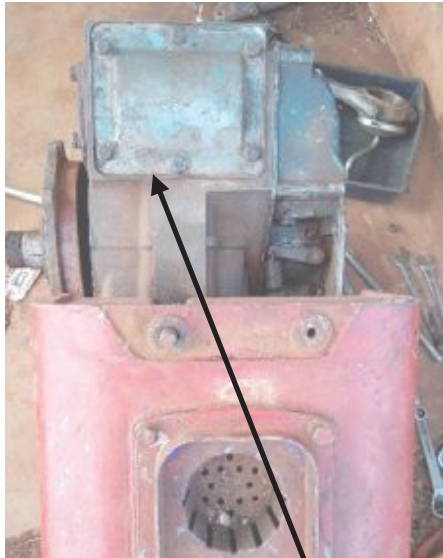
Bolts securing water strainer

Water strainer in position after installation

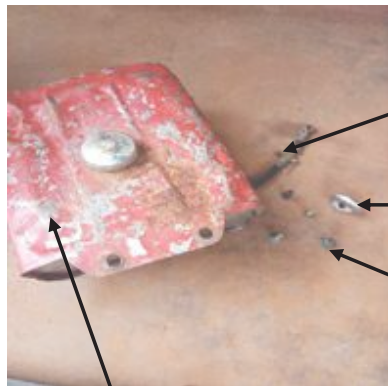
ENGINE DISASSEMBLY

REMOVAL OF FUEL LINES

before



Position of fuel



Fuel Tank

Fuel supply pipe

Tank securing nuts

Tank securing bolts

Activity

1. Locate tank position and place the tank in position.
2. Place 2 tank securing bolts and 2 tank securing nuts in position and tighten them.
3. Locate fuel supply pipe and fuel supply banjo bolt position on fuel filter.
4. Place fuel supply line and banjo bolt in position and tighten banjo bolt.

Tools: 13 mm, 16 mm and 17 mm spanners

after



Tank securing bolts

Inspection cover (front)



Fuel filter

Position of fuel supply pipe

Fuel supply Banjo bolt



Tank securing nuts

Fuel Tank

ENGINE ASSEMBLY

INSTALLATION OF THE FLYWHEEL

before



Position of crankshaft

Activity

1. Locate the position of the flywheel.
2. Place the flywheel in position
3. Place flywheel securing nut in position and tighten it. Tool: Wrench

after



Flywheel in position after installation

Flywheel securing nut

ENGINE ASSEMBLY

INSTALLATION OF GEARBOX DIPSTICK

before



Position of gearbox dipstick



Gearbox dipstick

Activity

1. Locate the gearbox dipstick position and push the gearbox dipstick in position.

after



Gearbox dipstick in position after installation

ENGINE ASSEMBLY

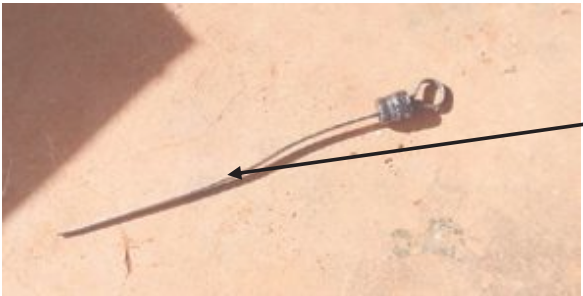
INSTALLATION OF SUMP DIPSTICK

before



Front inspection cover

Position of dipstick



Sump dipstick

Activity

1. Locate the sump dipstick position and push the sump dipstick in position.

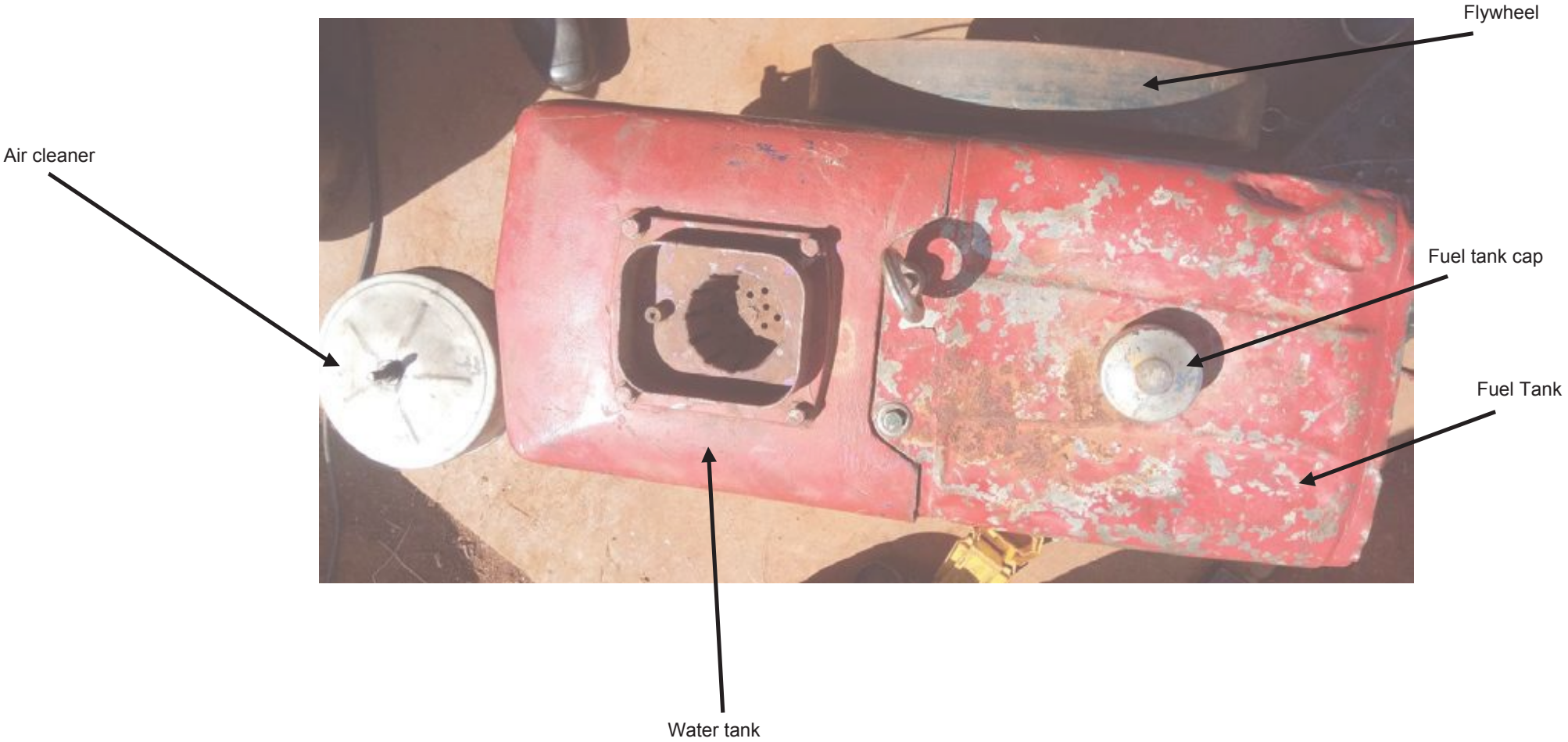
after



Sump dipstick in position after installation

ENGINE ASSEMBLY

FULL ENGINE



GLOSSARY

Air filter	Cleans air from the atmosphere.
Air filter adaptor	Connects air filter to engine.
Breather	Allows air trapped in tappet cover from the cylinder to escape into the atmosphere.
Capacitor/condenser	Prevents arching
Carburetor	Creates air fuel mixture for combustion.
Carburetor gasket	Creates a seal to prevent fuel-air mixture from leaking.
Carburetor seat	This is where the carburetor is mounted.
Compression rings	Help to prevent air leaks from the cylinder and also help with air suction and air compression
Con rod	Connects the piston to the crankshaft.
Crankshaft	Converts piston harmonic motion into circular motion.
Cylinder head	Contains valves and covers the top of the cylinder.
Cylinder head gasket	Creates a seal between the cylinder head and engine block to prevent air leaks
End bearing	Secures the crankshaft to the con-rod.
Engine block	Houses the crankshaft and contains the engine cylinder
Engine cylinder	This is a chamber where combustion takes place
Exhaust	Smoke produced after combustion during the power stroke.
Exhaust gasket	Creates a seat between the engine block and exhaust manifold to prevent leakage of exhaust gases.
Exhausts/manifold	This is the passage for exhaust gases from the cylinder into the atmosphere
Exhaust valve	Opens to allow air to exit the cylinder during the exhaust cycle.
Flywheel	This is responsible for smooth running of engine (provides momentum)

GLOSSARY

Fuel cap	Prevents fuel from leaking and prevents dirt from entering the fuel tank.
Fuel pipe	Conveys fuel from the fuel tank to the carburetor.
Fuel tank	Stores fuel.
Gearbox cover	Covers the gearbox
Gearbox cover gasket	Creates a seal between the gearbox cover and engine block to prevent oil in the gearbox from leaking.
Inlet valve	Opens to allow air entry into cylinder during the induction cycle.
Locating dowels	Allows for easy matching of two components
Magneto	Generates air to cool the engine
Oil rings	These scrap oil in cylinder walls
Piston	Contains rings and prevents air from escaping the cylinder.
Push rods	Connects rocker arms to cam followers.
Rocker arms	These are responsible for the opening and closing of the valves.
Spark Plug	Provides heat to initiate combustion during the power cycle.
Spark plug spanner	A tool used for removal and installation of spark plugs.
Tappet cover	Creates a seal between the cylinder head and tappet cover to prevent oil leaks.
Timing gear	Synchronizes cam shaft and crankshaft movement.
Timing points	Referral marks on timing gears for proper timing.

ENGINE TROUBLESHOOTING

<p>Engine turns but will not start</p>	<ol style="list-style-type: none"> 1. There is no fuel in engine 2. Turning speed is too low 3. Fuel tap is closed 4. Pipe feeding fuel to fuel filter from fuel tank is not connected 5. Blocked fuel supply banjo bolts 6. Pipe feeding fuel to fuel filter from fuel tank is blocked 7. Fuel filter is dirty 8. Defective fuel pump 9. Defective fuel injector/ injector is blocked 10. Timing is off 	<ol style="list-style-type: none"> 1. Open fuel supply valve/ refill tank 2. Increase turning speed 3. Turn on the fuel tap 4. Connect the pipe 5. Unblock the banjo bolts 6. Unblock the pipe 7. Clean the fuel filter 8. Replace fuel pump 9. Repair/replace fuel injector 10. Retime the engine
<p>Engine runs but does not produce power</p>	<ol style="list-style-type: none"> 1. Timing is off 2. Valves are not closing properly 3. Low fuel level in tank (Engine sucking air bubbles) 4. Poor quality fuel (diesel mixed with paraffin) 5. Low fuel supply in cylinder 	<ol style="list-style-type: none"> 1. Align timing marks when retiming. 2. Check rocker arm clearance. 3. Refill fuel tank 4. Buy genuine diesel 5. Fully open fuel tap, send injector and fuel pump for repair by specialists

ENGINE TROUBLESHOOTING

Engine is smoking
(White smoke)

Insufficient fuel in cylinder

- i. fuel tap is not properly opened
- ii. fuel leak along the line
- iii. defective copper washers causing fuel leaks at banjo bolts
- iv. blocked fuel filter
- v. defective fuel pump
- vi. Defective injector

- i. Fully open fuel tap
- ii. Repair leaks
- iii. replace copper washers.
- iv. change fuel filter,
- v. send fuel pump or injector for repair by specialists
- vi. send fuel pump or injector for repair by specialists

Engine is smoking
(White smoke + popping sound)

- i. Air lock

- i. Open fuel supply banjo bolts and allow fuel to flow freely until a constant flow is observed.

ENGINE TROUBLESHOOTING

Engine is smoking (Black smoke)	Excessive fuel in cylinder resulting in incomplete combustion i. defective injector ii. or fuel pump iii. blocked air cleaner	i. Service fuel filter ii. Service fuel pump iii. Clean/replace air filter.
Engine is smoking (Blue smoke + burning oil smell)	i. Defective oil scrapper rings.	i. Replace oil rings

ENGINE TROUBLESHOOTING

Tractor is vibrating excessively	<ul style="list-style-type: none"> i. loose flywheel bolts. ii. Loose engine mounting securing nuts, iii. defective pulley bearings, iv. poor timing(especially stabilisers mis-timing v. defective stabiliser bearings, 	<ul style="list-style-type: none"> i. tighten flywheel bolts. ii. Tighten mounting nuts, iii. replace bearings, iv. Retime the engine, v. Replace bearings
Engine is mixing oil and water	<ul style="list-style-type: none"> i. Defective head gasket ii. Defective washer plugs iii. Warped head cylinder 	<ul style="list-style-type: none"> i. Replace head gasket ii. Replace cylinder head iii. Send head to specialists for repair.
Oil level is declining abnormally	<ul style="list-style-type: none"> i. Oil leaks around the engine ii. Broken oil sump iii. Defective sump gasket iv. Defective oil scrapper rings 	<ul style="list-style-type: none"> i. Fix the leakages ii. Fix the sump iii. Replace sump gasket iv. Replace oil rings

International Maize and Wheat Improvement Center (CIMMYT)
Southern Africa Regional Office
P.O. Box MP 163, Mt Pleasant, 12.5km Peg Mazowe Road
Harare, Zimbabwe
Tel: +263 772 469 211/2
www.cimmyt.org

