Internship at Swaraj Engines LTD.

December 2020

Vedant Chavan (Common App ID - 28611071)

Summary of Internship

This internship was an opportunity to understand work life in an automotive engine manufacturing company. I understood the practical application of physics in real life e.g. reciprocating motion conversion in rotating motion. I looked closely at all the parts involved in the system like piston, connecting rod, crankshaft. Also understood how they are assembled; what precautions are taken to increase efficiency of any engine. I studied the different systems involved in working of an engine like Water cooling, oil pumping system etc.

I was fortunate to work with the shop floor team to understand how the engines are tested, what kind of quality problems are encountered and how they are resolved. I also participated and assisted the team in the diagnostic process. Overall this experience truly built my conviction to pursue mechanical engineering as my major.

Summary

Day wise Schedule	Key Learning
Day1 – Overview : Company & Diesel Engines Day 2 – Overview : Different parts of engine Day 3 – Overview : Different types of circuits	•Understanding of engines and application of physics •Different parts and their role in engine functioning •Different processes ,machines & facilities in engine manufacturing
Day 4 – Orientation of Engine Assembly line Day 5 – Orientation of Engine Assembly line Day 6 - Orientation of Engine Testing	•Different stages and precautions in assembling engines •How different tools used help in improving efficiency of assembling •Standard operating procedures used on shop floor •Facilities and processes used for testing the engines
Day 7 – Detailed Understanding of Piston Assembly Day 8 – Hands on experience - Assembling a piston	•Understanding in detail about parts of piston standard operating process for Piston assembly •Learning to assemble a piston and quality requirements in assembly process
Day 9 – Team working – Engine Quality issue Diagnostic Day 10 – Reflections and summary	•Working in teams to solve a quality problem detected on assembly line •Actual working experience to use different testing equipment and participate in solving the puffing problem detected in engine

Hands on experience and team working

Company Overview - Swaraj Engine LTD.

- Incorporated in 1985
- Located in Punjab, India
- Rolled out 1st engine in 1989 for tractor
- Listed on Bombay Stock Exchange
- Employees 1250 people
- State of the art manufacturing facilities for engines
- Cumulatively sold 1.2 million engines

Total Area – 50586 Sq. Meters
Covered area- 16470 Sq. Meters

Product Range

HP Range	Engine Model	
20-30 HP	Model	No. Of Cylinders
	S15 XM	1
	RV2	2
31-40 HP	RV3	3
	RV30	3
41-50 HP	RB30	3
	RB33	3
54 HP	RB33XPDC	3
60 HP	SK360NH	3

RV3 AVL

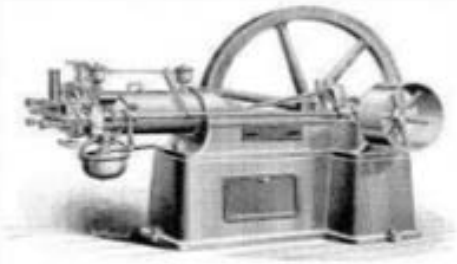
RV2 AVL

RB 33

RB 30

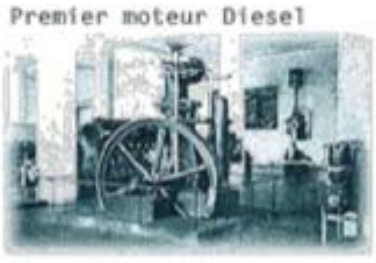
History of Engines

The first person to build a working four-stroke engine, a stationary engine using a coal gas-air mixture for fuel (a gas engine), was German engineer Dr. Nicolaus Otto. This is why the four-stroke principle today is commonly known as the Otto cycle and four-stroke engines using spark plugs often are called Otto engines.



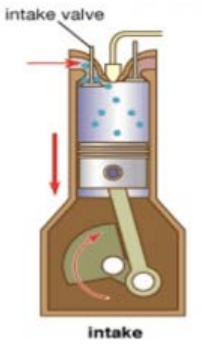
Otto Cycle: Dr. Nicolaus Otto -1876

4-Stroke Diesel Engine Rudolf Christian Karl Diesel (March 18, 1858 — September 29, 1913) was a German inventor and mechanical engineer, famous for the invention of the 4-stroke diesel engine.

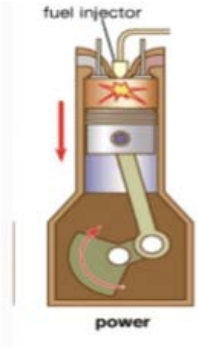


Diesel Engine - Dr.Rudolph Diesel -1895

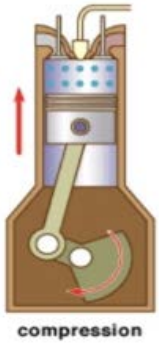
Diesel Engine 4 Stroke Cycle



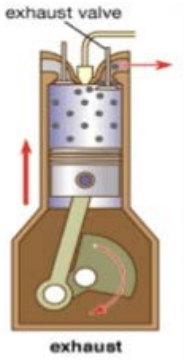
1. Suction Stroke
In suction stroke piston starts at Top Dead Center (TDC) of the cylinder and moves to the Bottom Dead Center (BDC).Outlet valve will be Closed and the inlet valve will be open to allow the fresh charge of mixed fuel & air into the cylinder.



3. Power Stroke
In Power stroke, Both the valves are closed. When piston reaches top of its stroke. the fuel is sprinkled by the Fuel Injector and the fuel mixture is ignited due to high temperature & pressure generated inside the cylinder & push down the piston to BDC. Hence it is known as Power stroke. The Power generated in this stroke is stored in the flywheel for its further utilization in the other strokes.

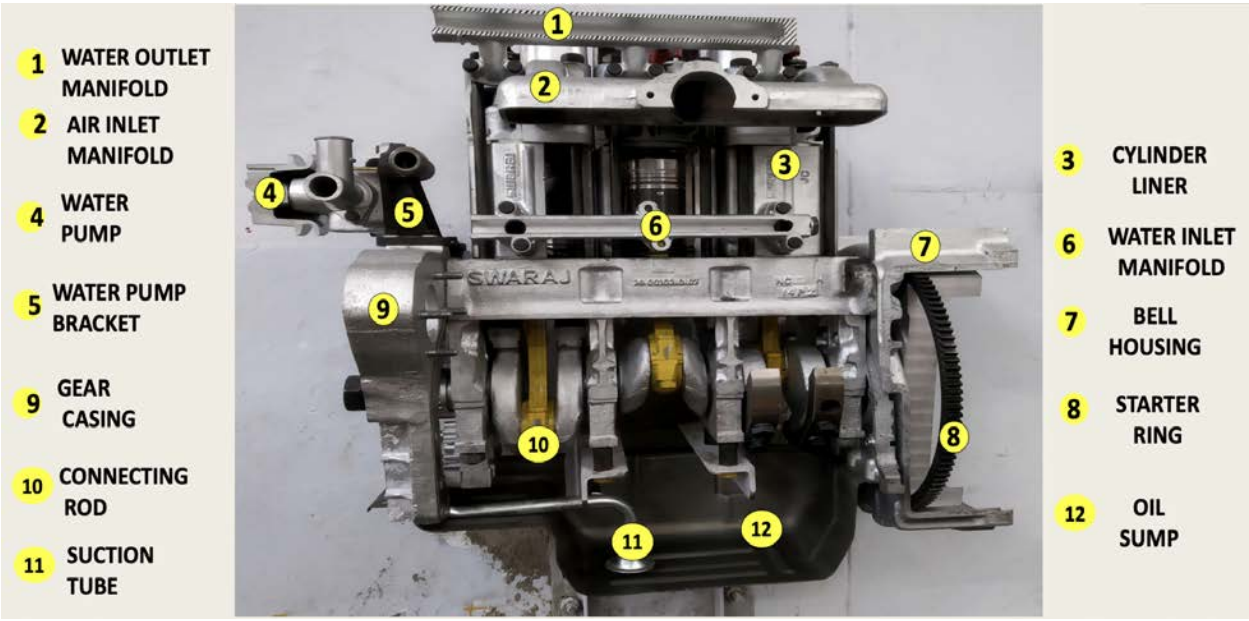


2. Compression Stroke
In compression stroke, Once piston reaches BDC & moves back TDC, inlet valve will be closed. As the piston moves towards TDC. It compress air inside the cylinder & compression takes place. Hence it is called compression stroke.



4. Exhaust Stroke
In this stroke exhaust valve is opened when piston reaches to BDC & moves to upward. Piston pushes out the burnt gases to the atmosphere through the exhaust valve.Hence called exhaust stroke & the engine is ready to begin the cycle again.

Engine Components



The function of an engine is to convert chemical energy into heat energy.
The heat energy is then converted into mechanical energy.
Mechanical energy thus formed is used for moving vehicle.

Crankcase

The crankcase supports the individual main journals & bearings of crank shaft & also maintains the alignment of journal axis of rotation as they are subjected to rotary and reciprocating inertia forces. The crankcase walls are flanged at the bottom to strengthen the casting & to attach the sump at bottom.

Crank Shaft

The Crank Shaft converts the reciprocating motion of piston in cylinder into rotary motion of the flywheel or vice versa. Power from the burnt gases in the combustion chamber is delivered to the crank shaft through piston and connecting rod assembly. The conversion of the motion is executed by the use of offset in the crankshaft. The stroke of piston is controlled by throws of crank shaft . All Engine power is delivered by crankshaft. And the material used for crank shaft is alloy steel.

Engine Components(contd.)

Cam Shaft

The cam shaft acts as a means of controlling the opening & closing of both inlet and outlet valves. It also provides a drive to the ignition and performs the function of distributing and mechanizing fuel pump. The Cam Shaft installed on one side of crankcase is the second rotating shaft in the crankcase after crank shaft. The gear mounted on the Cam shaft is bigger in size and having more teeth on its periphery in comparison to crank shaft. The speed of the cam shaft is half the speed of crank shaft.

Gear Casing

Gear Casing covers various gear assembly in the diesel engine. It is made of cast iron and its main function is to provide housing for the gear assembly to prevent any damage to the gears of cam shaft, crank shaft, intermediate gear and lubrication pump gear assembly etc.

Cylinder Block

Cylinder block is the portion of the engine between the cylinder head and crankcase and is supporting structure of the entire engine. Large diameter holes in the casting form the cylinder bore required to guide the piston assembly.

Cylinder Liner

The Cylinder liner acts as a medium between piston assembly and casting. It encloses the piston assembly and protects it against any damage. It also increases the cylinder bore life, due to its high wearing against cast iron.

Piston Assembly

The piston converts the combustion pressure to force on crank shaft. The piston is made of aluminum alloy. Piston rings comprises of compression rings located towards the top of the piston and Oil control rings located below the compression rings.The function of the compression ring is to seal the space between cylinder walls and the piston preventing the escape of the burning gases from the combustion chamber. These rings help to obtain maximum power by maintaining a seal with the cylinder wall while keeping friction minimum as possible.

Engine Components(contd.)

Connecting Rod Assembly
The connecting rod joins the piston to the crankshaft and transfers reciprocating force to crankshaft rotation. The small end of the connecting rod reciprocates and the big end of the connecting rod follows the rotational pattern. For this dynamic moment, the connecting rod should be as light as possible.

Piston Head & Connecting Rod Assembly
The piston head & connecting rod assembly comprises piston head attached with the connecting rod small end side. The piston head is connected to the connecting rod by a pin called a piston pin or sometimes called a gudgeon pin. On the bigger end of the connecting rod it is attached to the crankshaft.

Cylinder Head Assembly
Cylinder head is the casing bolted to the top of the cylinder block. It houses the inlet and exhaust valves and the injection location holes. It forms the upper face of the combustion chamber, coolant passage, and lubricating passage. The cylinder head is detachable for easy access to the valve's piston tops. The valve arrangement of the engine controls in and out movement of the charge and exhaust gases. The valves are located in the cylinder head. The valves disk heads open or close the passage leading to the cylinder during the movement of system.

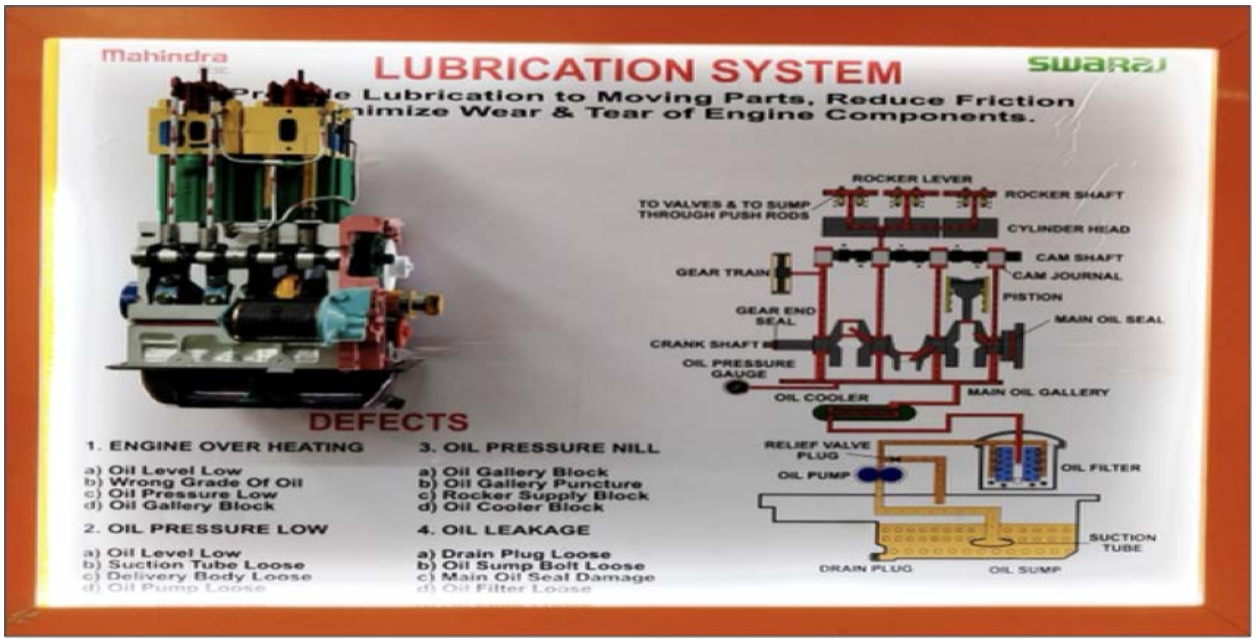
Intake & exhaust Manifold
The primary function of intake manifold is to carry the air to the intake port in the engine. The exhaust manifold collects the high temperature spent gases from the cylinder exhaust port with the least possible back pressure while keeping the noise at a minimum level.

Push Rod
It is a strut which transmits the to and fro cam follower movement to the pivoting rocker arm. Both ends of the push rod consist of semi spherical ball and socket joint permitting the rod to tilt slightly and revolve when the rocker arm oscillates about pivot.

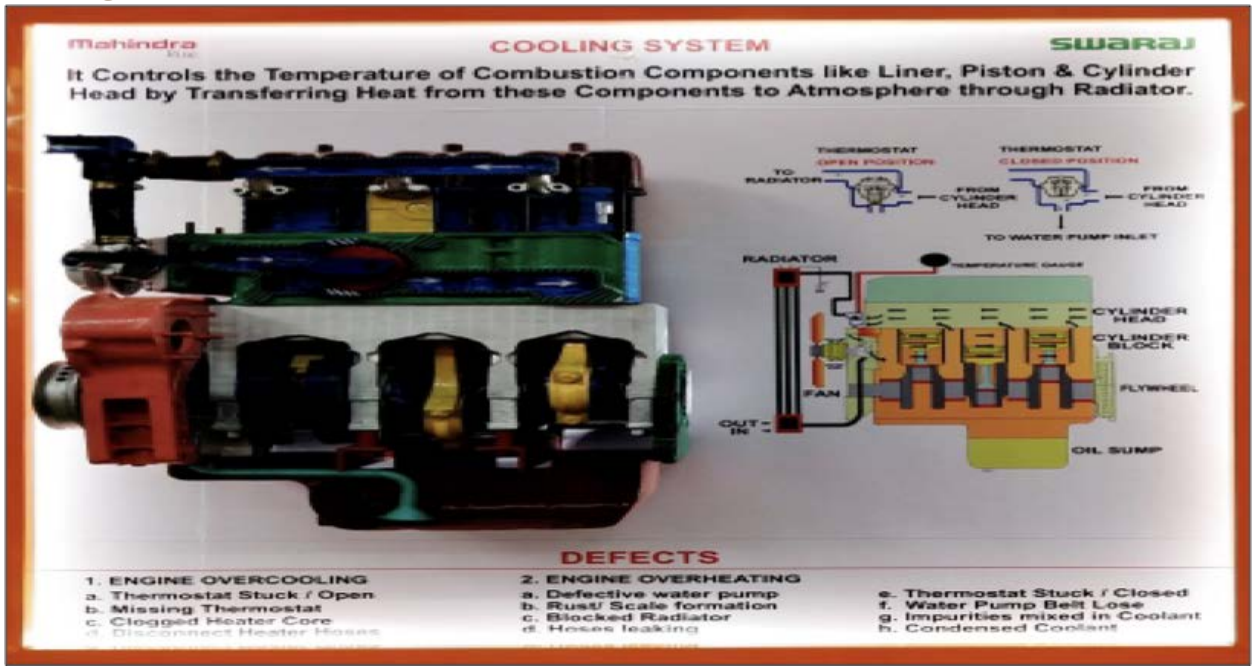
Rocker Arms
Rocker Arms oscillate about its pivot and relay the push rod up and down to the stem of the valve. Therefore its arm acts as rocking beam. Rocker arms are manufactured with malleable cast iron.

Type of Circuits in Engine

Lubricant Circuit

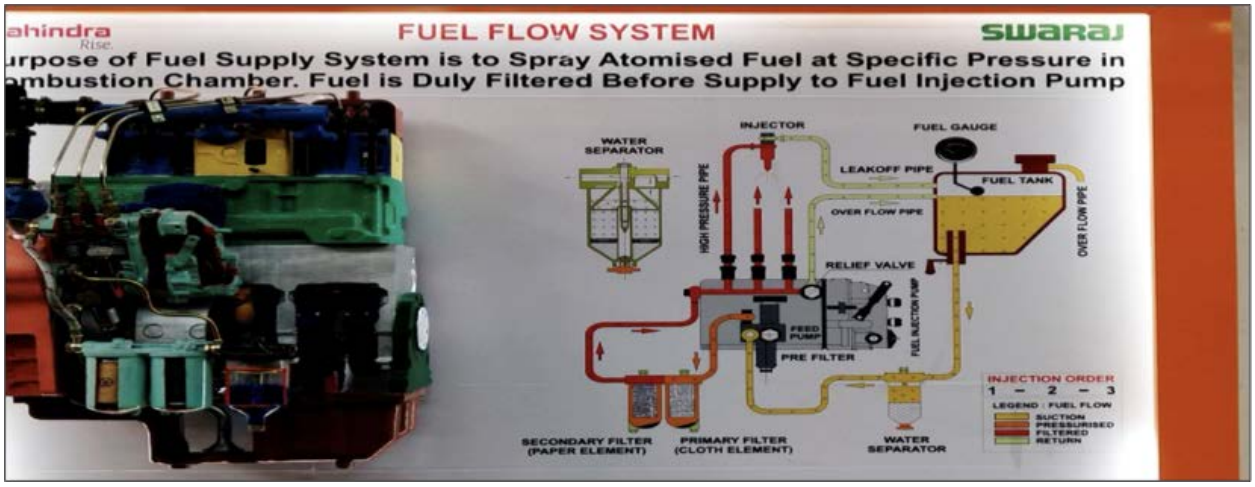


Cooling Circuit



Type of Circuits in Engine(Contd.)

Fuel Flow Circuit



Engine Assembly Line

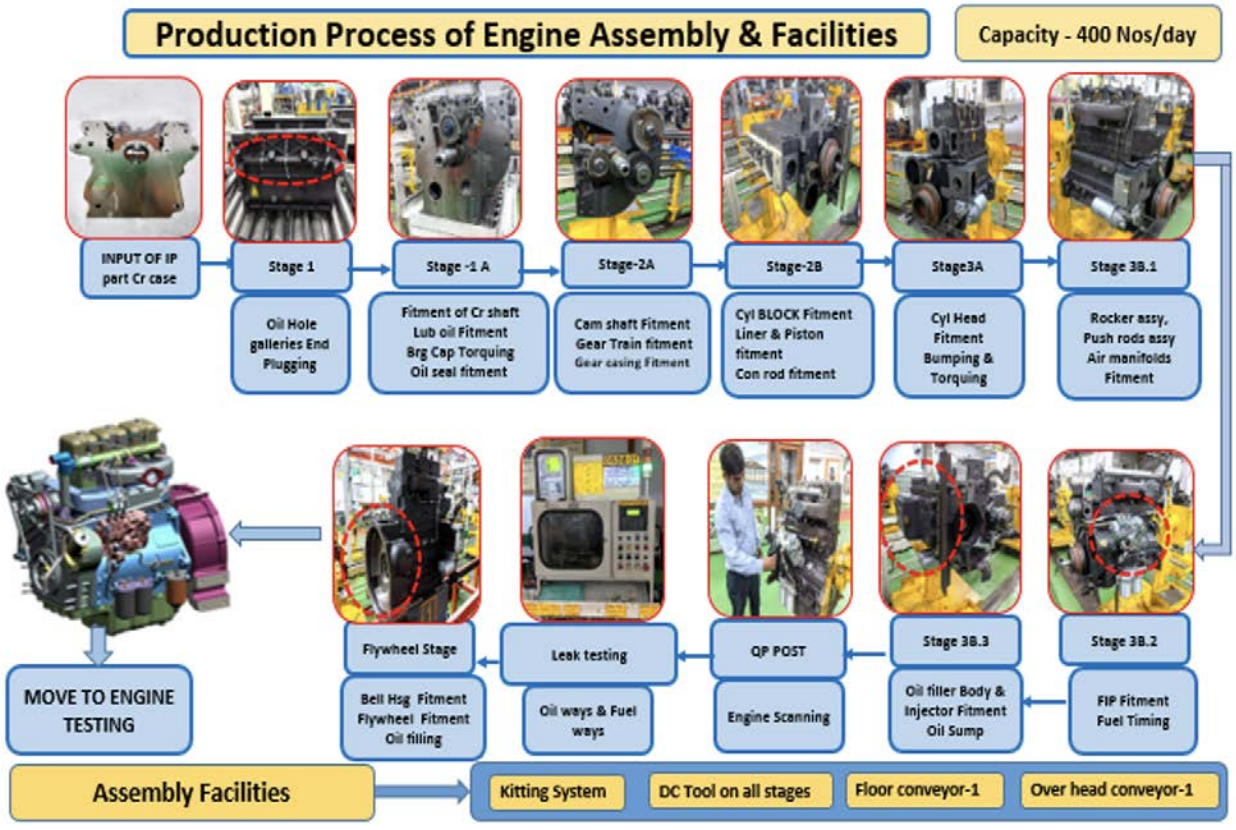
Most of the products are formed from a large number of single parts produced at different times by various production processes. All these may not be made at a single place but are procured from different sources. The objective of assembly shop is to combine individual components into a useful product of higher value.

The assembly shop assembles RV-2, RV-3, RV-30, RB-30 & RB-33 engines.

Assembly is done manually in which workers perform various assembly operations by using dexterity, sense organs and intelligence along with various tools and fixtures.

Different components are brought from the stores and the machine shop to be assembled into engines on a common assembly line for all models.

Engine Assembly Stages



Engine Assembly & Testing Facilities

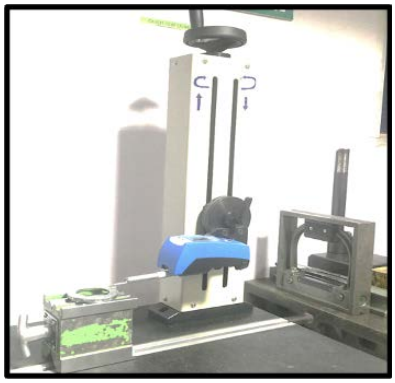
Kitting system on Assembly line

Modern & Dust Free Engine Assembly

Engine testing Facility

CMM Machine

ADCOLE -Facility



Portable Roughness Tester

Engine Testing

A completely assembled engine is bought from the assembly shop for testing in the Engine testing lab. The engine here is tested, inspected at various rpm's and loads. Engine is checked at full load, no load and over load, and is inspected for any kind of unusual noise. The engine finally marked as OK or Not Ok.

Procedure :

Engine brought from the assembly shop is first of all placed over the Engine Testing Bed and then hydraulically and power clamped to the bed. After clamping has been done.

Then various inlet and outlet connections are joined, which include :

- Inlet Air Supply
- Exhaust for smoke & various dust particles
- Inlet of cold air
- Outlet for hot water
- Fuel Oil Supply
- Pressure checking gauge connection of lubricating oil
- Lubricating oil supply
- Fuel oil overflow pipe

A butterfly valve is provided at the air inlet supply which regulates the air supply. Eddy current Dynamometer is provided to deliver torque. A thermostat valve is provided for water exhaust. Breather pipe is also one of the exhausts for other gases produced in the engine.

Engine Testing (contd.)

After joining various connections, engine is started to evaluate the performance of the engine by taking the following basic measurements :

1. 1.B.H.P. (Brake Horse Power)
2. 2.S.F.C. (Specific Fuel Consumption)
3. 3.Air Consumption
4. 4.Lubricating Oil Consumption
5. 5.Smoke Density

Engine Rejections :
Main reasons for rejections of engines include

- Less B.H.P.
- More S.F.C.

The main reasons for less B.H.P. :

- Crankshaft rotation is not free
- Fuel Timing is not OK
- Injectors is not working properly
- F.I.P. is not giving proper delivery
- Piston is wrongly fitted

The reasons for more S.F.C. :

- F.I.P. is not working properly
- Injector is not working properly
- Leakage in fuel system

Piston Features and Assembly

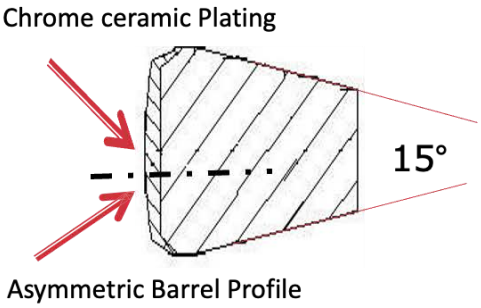
A piston is a cylindrical engine component that slides back and forth in the cylinder bore by forces produced during the combustion process. The piston acts as a movable end of the combustion chamber. The stationary end of the combustion chamber is the cylinder head

- Piston head is the top surface (closest to the cylinder head) of the piston which is subjected to tremendous forces and heat during normal engine operation.
- Piston pin bore is a through hole in the side of the piston perpendicular to piston travel that receives the piston pin.
- Piston pin is a hollow shaft that connects the small end of the connecting rod to the piston.
- Piston skirt of a piston is the portion of the piston closest to the crankshaft that helps align the piston as it moves in the cylinder bore.
- Piston ring is an expandable split ring used to provide a seal between the piston and the cylinder wall.

Piston Ring

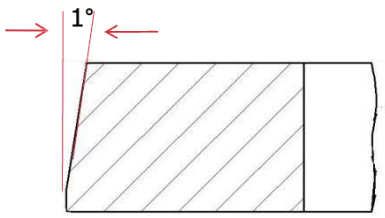
Compression Ring

It traps combustion gases and increase combustion pressure and efficiency. Also plays major role in heat transfer between piston and cylinder wall.



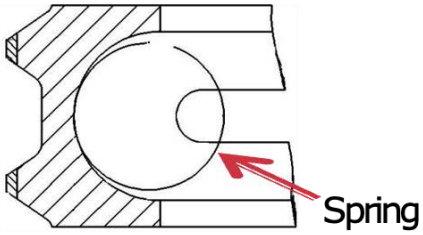
Oil Scraper Ring

It scraps oil and prevent it from reaching the combustion chamber. Also provides second seal for trapping combustion gases and aid in heat transfer



Oil Control Ring

It distribute and regulate oil within the cylinder block and help scrap it back to crankcase. This is necessary to keep the cylinder wall lubricated with the cooler replacement oil, thereby aiding the heat transfer and lowering the friction between the piston and the cylinder. Coiled spring expander is used to force the ring into cylinder wall



Piston Assembly Standard Operating Procedure

SWARAJ ENGINES LTD	STANDARD OPERATING PROCEDURE -ENGINE ASSEMBLY ASSEMBLY PROCEDURE: SUB ASSEMBLY.OPN : 255 (SHEET 2/5)	SOP/ASSY/255(2/5)/REV-5

CHECK POINTS	FREQ.	ACTION	PHOTO-GRAPH	WHAT TO DO	HOW TO DO	WHY TO DO	In case of abnormality reaction plan
1) Ensure for no air leakage in pneumatic connections.	Start of shift	Assy		Oil Ring Inserting on Piston	1) Insert Oil control Ring (RV - P310528 / RB - P713033 / P313281-RV XM+ 3A),P10004439A-RB3-Refresh, Second Comp. Ring (RV - P310527 / RB - P713032 / P313280 RV XM+ 3A,P10001328A-RB Refresh) and Top Comp. Ring (RV - P310526 / RB - P713031/ P313279 RV XM+ 3A,P10001014A-RB3-Refresh), on Piston (P213013A-RV2/RV3, P313266 RV2/RV3 XM+ 3A, 3301101000-RV30, P313267-RV30 XM+ 3A, P713012-RB30 , P713013-RB33,P10004406-RB3-Refresh) respectively through Piston Ring inserting fixture (J-788051 / RB, J-783051 / RV, J788105-RV XM+ 3A) after unpacking the Piston from boxes.	1)Check the component for machining burr/Rusty/dents/unclean/blow hole/porosity/chamfer miss tapping holes/opeartion miss and component is properly dried if found any concern report to supervisor 2)Place the component on LR table along with tag and marking with RED paint.
2) Ensure pneumatic units are functioning properly	Start of shift	Assy					
3) Check visually oil level in lubricator (FRL) which should be up to "max" top mark.	Start of shift	Assy	Oil Control Ring Second Ring Top Comp. Ring 	Inserting the Piston Pin	2) Insert Piston Pin (RV-P213025, RB-P110301, P313268- RVXM+ 3A & P110301-60HP) from the 'Identification mark' side of Piston after fitting circlip (M14203-RV XM, M73113-RB & P110312-60HP) in the other side of bore for Piston Pin, as shown in picture. Apply 2-3 drops of Lub. oil (Grade 20W/40) at O.D of Piston Pin while fittment.		
4) Ensure that torque wrenches are Calliberated by QE	Start of shift	Assy		Connecting Rod Fitment	3) Push the Piston Pin further through Con. Rod's (P110380 - RB,P10001480A-RB3-Refresh, P110380-60HP & P313200A RV XM+ 3A SML Type Long Rod) Small end bore (Keep the Con. Rod & Piston position as shown in picture) till it touches the ciclip previously fitted. Then fit second circlip to fully lock the Piston Pin.		
5) Check air pr. Of FRL visually. (Which should be within 4 to 5 bar)	Start of shift	Assy			Note:- Each set of this assembly (For one engine) must be fitted with Con. Rods of same Weight group. Ensure identification number of each Con. Rod to be matching with its Cap.		

TOOL USED	FREQ.	ACTION
J-788051	On 1st and 16th of every	Replace
J-783051	On 1st and 16th of every	Replace
J-788105	On 1st and 16th of every	Replace

REVISION HISTORY :-

DATE	C.L.	PROP. BY	CHANGE
4-May-09	A	JSB	What, How & Why to do added
22-Apr-10	B	Paramjit	Hanging of assy on trolley eliminated.
3-Jan-11	C	KLD	Stock no XM+ 3A Components and tools introduced
24-Jan-18	D	Amrit	Format changed
24-Jan-18	E	Gurjinder	RB33 refresh New stock no introduced

DATE	C.L.	PROP. BY	CHANGE

DATE(ORIGIN): 22-Oct-08
REVISION NO.: 05
DATE(REVISION): 24-Jan-18

Safety instructions

1) Use safety shoes& safety googles
2) Do not keep any unwanted material on Machine
3)Keep the Area dry near machine to avoid the accident due to slippage.
4)Ensure the normal sound and noise level of machine
5) Ensure the sufficient lux level on & around the machine .

General instructions

1) Keep the machine neat and clean.
2) Check the leakage of air near machine.
3)Turn off fan,heater,lights, motors during lunch break or when the m/c is idle due to some reasons.

PREPARED BY (Amritpal Sharma) :- | CHECKED BY (ASSEMBLY HOD) :- | QUALITY :- | APPROVED BY (M.E) :-

<SC> Special Characteristic ▽ Critical to Quality C.L. Changed Letter

Hands on experience : Piston Sub-Assembly

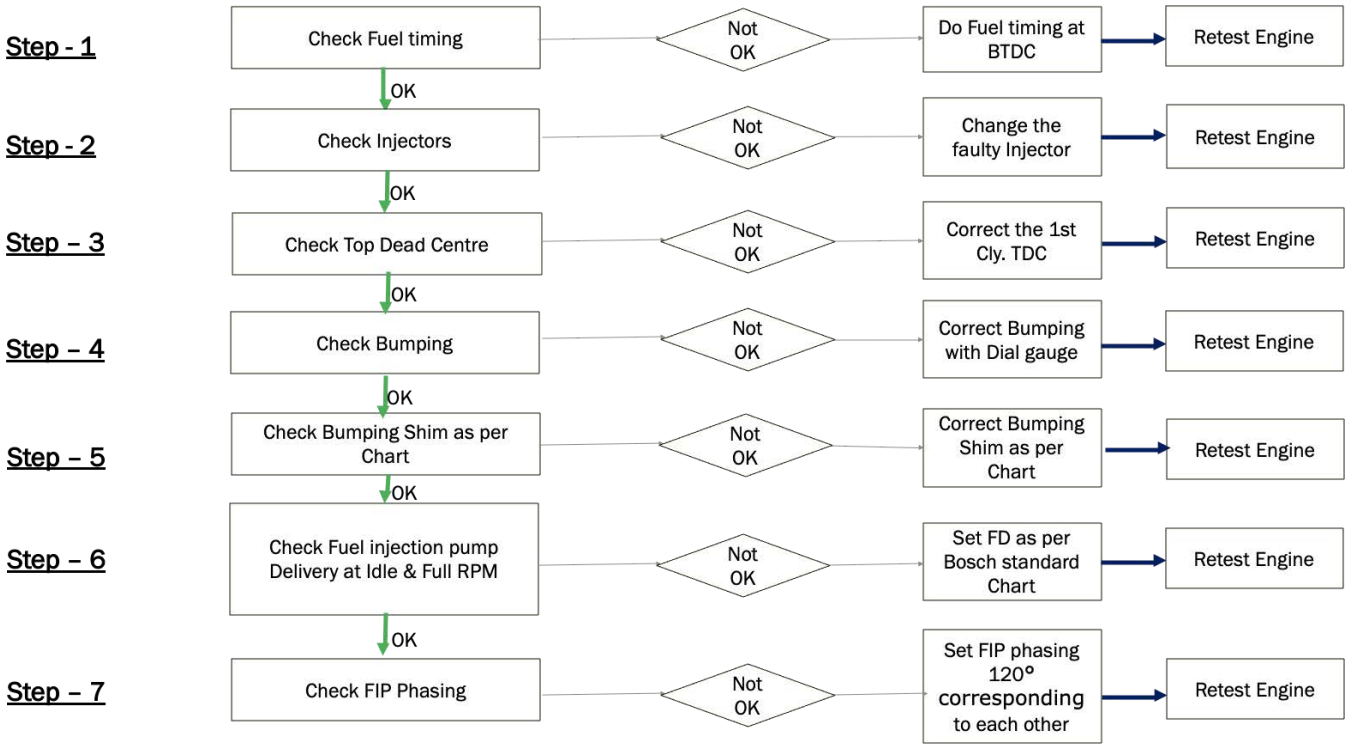
Engine Diagnostic

Problem- Tractor Engine Puffing (White Smoke) during Engine testing

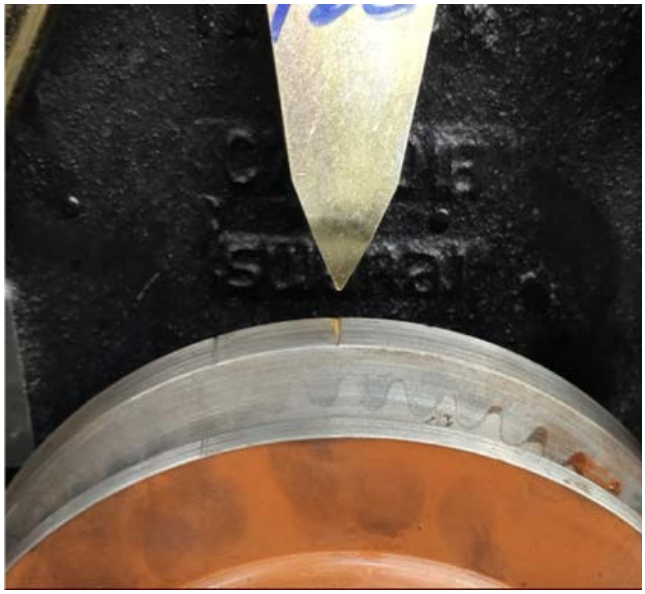
Mentor : Amritpal Sharma
Members : Vedant Chavan
Heera Lal
Arun Kumar
Anil Kumar

Engine No-DC.3009/SBP27914
FIP Number-469/07969959
Test Bed No.01

Steps for Engine Puffing Diagnostic



Fuel timing verification

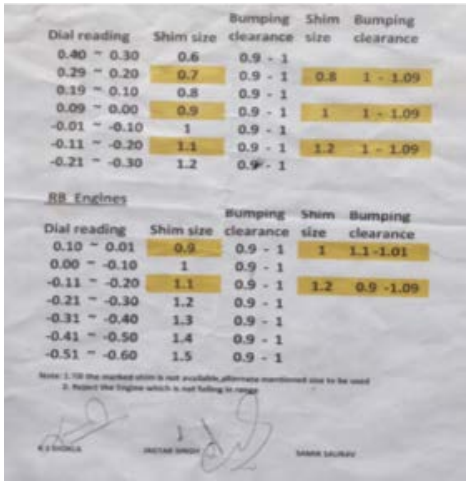


Fuel timing checked and found fuel cut at BTDC point-Functionally ok

Engine Injector Testing

Injector disconnected one bye one and observed that engine RPM dropped and all injector functionally working

Bumping clearance verification



Dial reading	Shim size	Bumping clearance	Shim size	Bumping clearance
0.40 ~ 0.30	0.6	0.9 - 1		
0.29 ~ 0.20	0.7	0.9 - 1	0.8	1 - 1.09
0.19 ~ 0.10	0.8	0.9 - 1		
0.09 ~ 0.00	0.9	0.9 - 1	1	1 - 1.09
-0.01 ~ -0.10	1	0.9 - 1		
-0.11 ~ -0.20	1.1	0.9 - 1	1.2	1 - 1.09
-0.21 ~ -0.30	1.2	0.9 - 1		

RR Engines

Dial reading	Shim size	Bumping clearance	Shim size	Bumping clearance
0.10 ~ 0.01	0.9	0.9 - 1	1	1.1 -1.01
0.00 ~ -0.10	1	0.9 - 1		
-0.11 ~ -0.20	1.1	0.9 - 1	1.2	0.9 -1.09
-0.21 ~ -0.30	1.2	0.9 - 1		
-0.31 ~ -0.40	1.3	0.9 - 1		
-0.41 ~ -0.50	1.4	0.9 - 1		
-0.51 ~ -0.60	1.5	0.9 - 1		

Cylinder No.	Observed Reading	Observed Bumping and CV Shim Size	Conclusion
Cyl-1	-0.16	1.2 & 0.6	As per chart ok
Cyl-2	-0.21	1.2 & 0.6	As per chart ok
Cyl-3	-0.18	1.2 & 0.6	As per chart ok

Cylinder head was disengaged from the engine , to check the bumping shim. To do so we use the dial gauge to check the bumping reading. We verified this reading with the help of shim selection chart . After doing this we found the shim selection was correct.

Fuel Injection Pump

FIP removed from the engine & brought into the FIP calibration room

Preparation for test bench

FIP front inspection window was opened & coupling was attached with FIP .
This was done in-order to mount it on test bench

FIP setting at test bench for testing

After mounting the FIP on the test bench , we connected the following things:-

1.FIP Coupling with test bench spindle

2.Main fuel line

3.High pressure pipe tight on plunger holder

FIP fuel delivery testing @325 RPM (IDLE RPM)

Cylinder No.	Observed Fuel Delivery	Required Fuel Delivery	Conclusion
Cyl-1	2.8 ml/100 Stroke	2.7-2.9 ml/100 Stroke	OK
Cyl-2	2.9 ml/100 Stroke	2.7-2.9 ml/100 Stroke	OK
Cyl-3	2.9 ml/100 Stroke	2.7-2.9 ml/100 Stroke	Ok

End of the Report