# INDUSTRIAL TRAINING REPORT I

**TRAINING ORGANIZATION : SRI LANKA RAILWAYS**

**PERIOD OF TRAINING : FROM 30/10/2017 TO 07/01/2018**

**FIELD OF SPECIALIZATION : MECHANICAL ENGINEERING**

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**E/14/369**

## ACKNOWLEDGMENTS

Initially, I would like to thank, Mr W.R.M.U.Wickramasinghe, the Director of Industrial Training
& Career Guidance Unit of Faculty of Engineering, University of Peradeniya for arranging the training opportunity for a successful training session.

I would like to give my sincere gratitude to Mrs. S.H.M.P.Y. Samarasinghe, Training Operational Manager of Sri Lanka German Railway Technical Training Center for accepting me as an apprentice and providing all the facilities for the training period of 10 weeks. I would like to thank Eng. W.G.D.L. Wickramathunge, Chief Mechanical Engineer and Eng. K.G.S. Bandara, Deputy Mechanical Engineer of Chief Mechanical Engineering Office Rathmalana.

Also I am grateful to all foremen, Supervisors, Technicians and Labors of workshops 10, 32,14,16,28, of Chief Mechanical Engineering workshops, Rathmalana.

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**Table 1.1** Training schedule 2

# LIST OF ABBREVIATIONS

| | |
|---|---|
| BDC | Bottom Dead Center |
| CEE | Chief Electrical Engineer |
| CME | Chief Mechanical Engineer |
| DME | Deputy Mechanical Engineer |
| EEC | Electrical Engineer of Carriage |
| EEP | Electrical Engineer of power |
| EET | Electrical Engineer of Traction |
| MEC | Mechanical Engineer of Carriage |
| MED | Mechanical Engineer of Drawing |
| MEF | Mechanical Engineer of Foundry |
| MEL (E) | Mechanical Engineer of Locomotive |
| MEL (H) | Mechanical Engineer of Locomotive |
| MEL (P) | Mechanical Engineer of Locomotive -Power |
| MEP | Mechanical Engineer of Production |
| MES | Mechanical Engineer of special project |
| MEW | Mechanical Engineer of Wagon |
| TKC | Time keeper clerk |
| TDC | Top Dead Center |

# Chapter 1

# INTRODUCTION

## 1.1 TRAINING SESSION

I was assigned as a trainee mechanical engineer at Chief Mechanical Engineering Workshops, Ratmalana, which is a government sub department of Sri Lanka Railways. The time period was 10 weeks, starting from 30.10.2017 to 07.01.2018.

Table 1.1 Training schedule

| Section | Shop | Period | Start on |
|---|---|---|---|
| Diesel Electric Loco Repair (2 stroke) | 14 | 02 weeks | 30.10.2017 |
| Diesel Electric Loco Repair (4 stroke) | 16 | 02 weeks | 09.11.2017 |
| Diesel Hydraulic Loco Repair | 28 | 02 weeks | 24.11.2017 |
| Automobile Repair | 17 | 01 weeks | 09.12.2017 |
| Millwright Shop | 32 | 01 weeks | 16.12.2017 |
| Diesel Engine Auxiliaries | 10 | 02 weeks | 24.12.2017 |

## 1.2 INTRODUCTION TO TRAINING ORGANIZATION

Sri Lanka Railways (SLR) is a government department functioning under the Ministry of Transport and Civil Aviation. It is a major transport service provider and is the only rail transport organization in the country. SLR transports both passenger and freight. At its inception, railway was carrying more freight than passenger. But today, it is passenger oriented. In Sri Lanka, the service provided by SLR in carrying the daily commuters to their workplaces, is inevitable. Sri Lanka Railway operates approximately 396 trains which include 67 Long-Distance and 16 intercity trains and carries about 3.72 million passengers daily. SLR owns and maintains 1561km of rail tracks, 72 locomotives, power sets 78565 carriages and the signalling network. At present, it has a workforce of 17634. As shown in the figure 1.1, Sri Lanka Railways has its own logo.

Figure 1.1 Sri Lanka Railways Logo

Sri Lanka Railways functions under the General Manager of Railways (GMR). The General Manager reports to the Secretary of the Ministry of Transport. SLR has been divided into ten Sub Departments and three Units. Sub departments are managed by the Heads of the Sub Departments who reports directly to the General Manager of Railways. Chief Mechanical Engineering Sub Department is organized as follows. See figure 1.2.

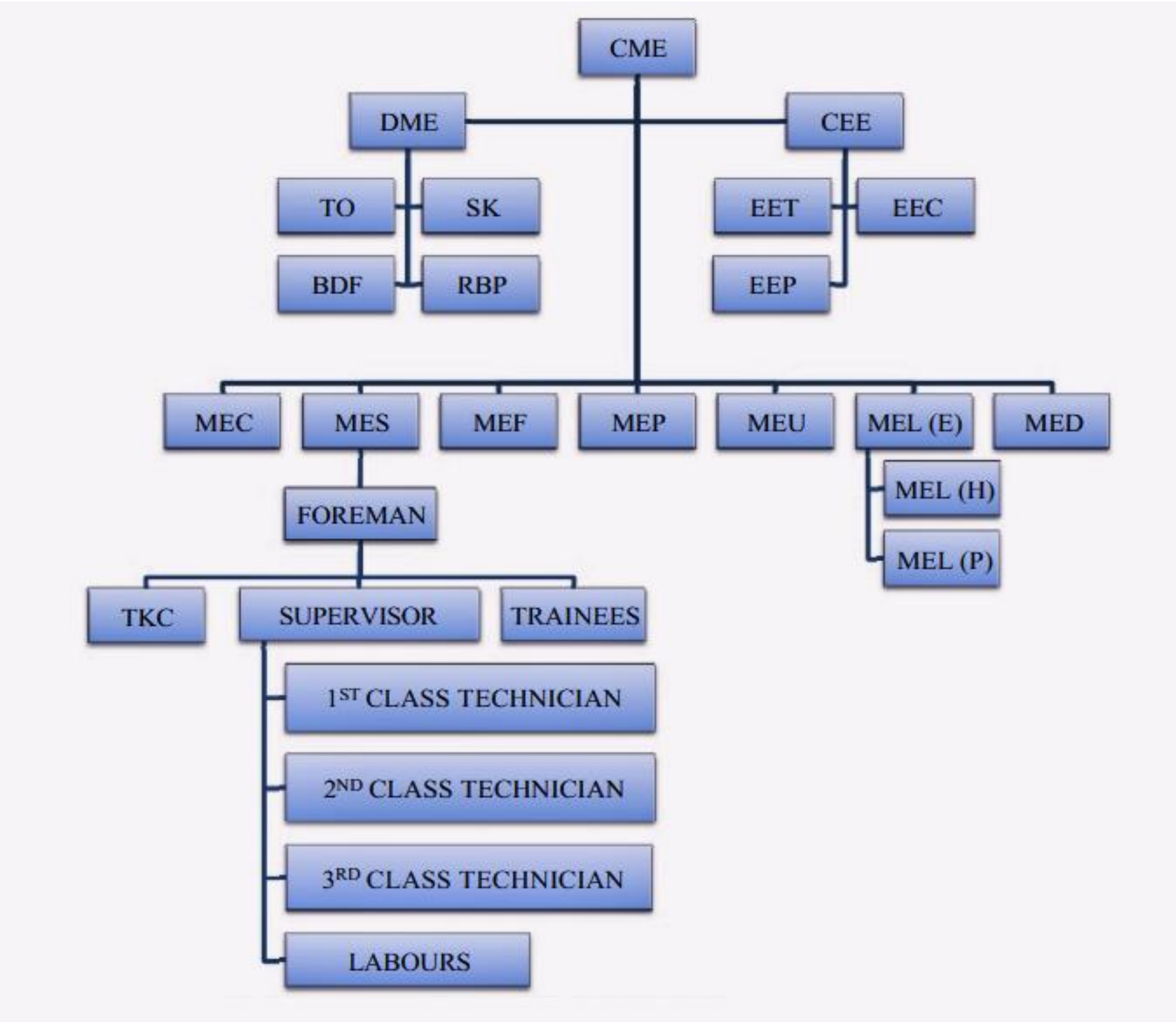


Figure 1.2 Organizational structure of CME's sub department

Vision: To be the most sought-after land transport provider in Sri Lanka, providing unsurpassed value to our stakeholders.

Mission: Provision of safe, reliable and punctual rail transport service for both passenger and freight traffic, economically and efficiently.

### 1.3 SUMMARY OF THE WORK ENGAGED IN TRAINING

The table 1.1 shows how the training period was divided in to several locations at the workshop. It was created to enhance the training exposure of the trainees considering their field of specialization. First four weeks were allocated to the diesel electric locomotive repair workshops and another two weeks were allocated for the diesel hydraulic locomotive repair workshop. Therefore, in six weeks of the training period, we were fully engaged with studying of locomotive working principles, repairing processes and the working principle of other engine auxiliaries.

Table 1.1 Training schedule

| Section | Shop | Period | Start on |
|---|---|---|---|
| Diesel Electric Loco Repair (2 stroke) | 14 | 02 weeks | 30.10.2017 |
| Diesel Electric Loco Repair (4 stroke) | 16 | 02 weeks | 09.11.2017 |
| Diesel Hydraulic Loco Repair | 28 | 02 weeks | 24.11.2017 |
| Automobile Repair | 17 | 01 weeks | 09.12.2017 |
| Millwright Shop | 32 | 01 weeks | 16.12.2017 |
| Diesel Engine Auxiliaries | 10 | 02 weeks | 24.12.2017 |

# Chapter 2

# TRAINING EXPOSURE

## 2.1 INTRODUCTION

The training exposure can be categorized under six major topics. Each topic represents the experience gained in one particular training location at the Chief Mechanical Engineering sub department. Other than that, the last part of the chapter is allocated to discuss the safety and health care of the organization.

## 2.2 DIESEL ELECTRIC LOCO REPAIR (2 STROKE AND 4 STROKE-WORKSHOP 14 & 16)

### 2.2.1 Locomotive Maintenance

It was scheduled two weeks for each workshop in the time table. Workshop 14 mainly carries out repairs of two stroke diesel electric locomotives, while the workshop 16 undertake repairs of four stroke diesel electric engines. There are two main scheduled services for a locomotive engine. The first one is at 360 000 miles of run time and the other one is at 720 000 miles of run time.

In service done at 360 000 miles of run time, which is called the Light Repair, engine was kept in the engine casing and inspections and necessary repairs were carried out. In the General Repair, which is undertaken after a mileage of 720 000, engine is removed from the engine body and overhauled completely. The engine parts are sent to relevant workshops in order for the repairs to be done if they cannot be done in the workshop itself.

Mostly two stroke engines are used in hilly tracks because they are able to give more power. The size of bogie should be considered when there are steep bends in the track. A two-stroke engine basically occupies with two bogies with two traction motors in each. Some of them have two pairs of wheels with one motor per each and some have three pairs of wheels. In that case the middle pair does not have a traction motor.M1, M2, M3, M7 are the locomotive engine types, which belong to the two-stroke engine category. Following steps were taken out under the general repair.

1. Disassembling the whole engine
2. Repairing necessary engine parts
3. Reassembling
4. Checking the engine for any leakages
5. Re-torqueing the engine
6. Speed running
7. Load testing

What happens in the re-torqueing process is heating up the engine to a temperature of $150^0$C by running it under stand still idle conditions and tightening the nuts of the engine, which has already tightened before at the reassembling step. The temperature was measured using sophisticated infrared thermometers for accurate and precise readings.

In the process of speed running, the engine was run for 30 minutes at each notch and the functioning of the engine was checked by the following details, taken out while testing.

- Engine RPM
- Inlet and outlet circulating water temperatures
- Inlet and outlet circulating oil temperatures
- Engine oil pressure
- Piston pipe oil pressure
- Compressor oil pressure

Checking the engine for any leakages are done by using glass indicators, which are connected with fuel lines. They had to be filled with fuel without any air bubbles, if functioning perfectly. See figure 2.1.

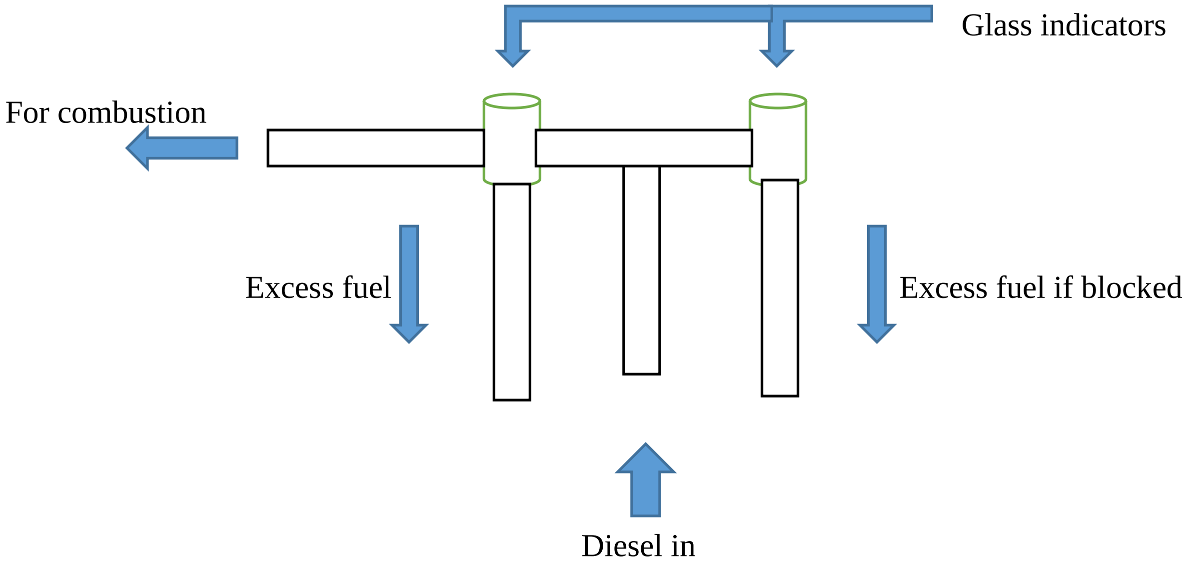


Figure 2.1 Diagram of Fuel Lines and Glass Indicators

### 2.2.2 Locomotive Governors

The governor room is an important part of the workshop 14. There, the governors of the locomotives, that has come for the general repair are disassembled, tested and repaired if needed.

Basically, what happens through the governor is controlling the fuel supply that is going for the combustion process.

The Accumulator Piston is an additional part in the governor, which regulates the fuel that goes to the engine for the combustion process. This is done by simply restricting the fuel from flowing further if the pressure is not 7 psi or more. In two stroke engines, which we observed in the workshop 14, fuel is pumped by separate pumps for each cylinder.

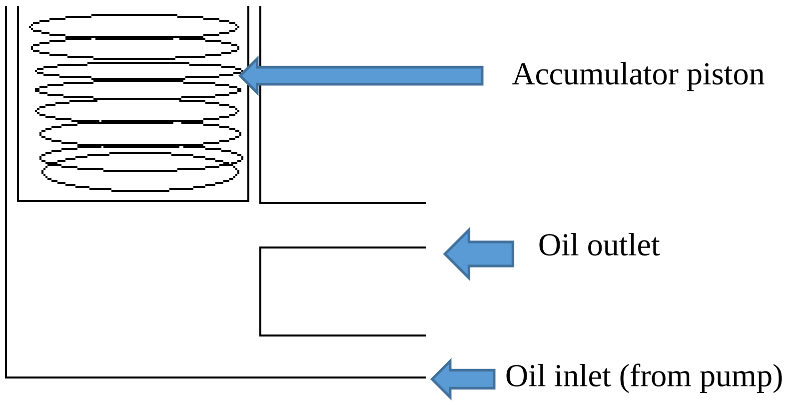


Figure 2.2 Accumulator Piston Setting

The governor of the two stroke and four stroke engines are connected to a setting piston, a power piston and a load controlling valve. Unlike the gear system of an automobile, trains have a notch system. The greater the number of the notch, greater the speed that a locomotive can achieve. When the notch of the train is increased by the train driver to go for a higher speed, the setting piston compresses the spring of the governor leading a slight closure of the oil supply to the power piston. The governor’s rotating speed should be increased in order to regulate the fuel supply, which means the engine speed should also have to be increased. See figure 2.2, 2.3, 2.4.

Figure 2.3 Governor

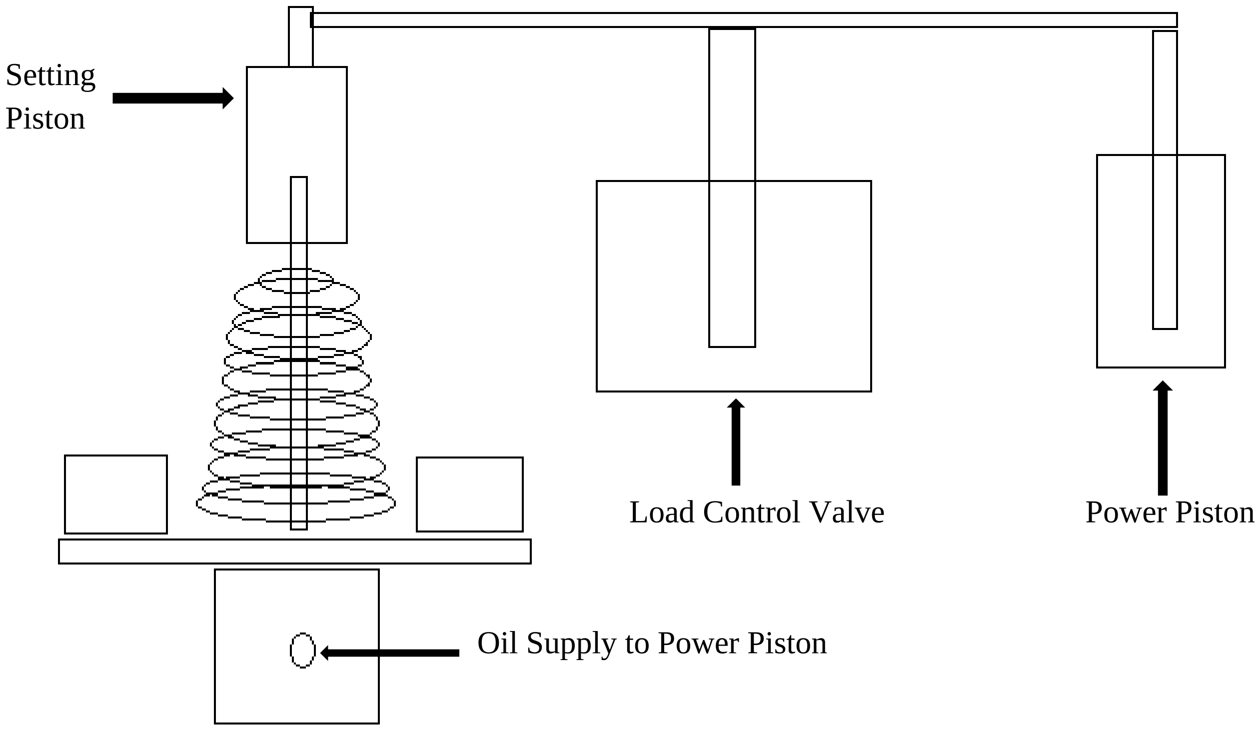


Figure 2.4 Diagram of the Governor Setting

When the speed of the engine reduces, speed of the rotation of the governor reduces causing the power piston to move upwards and to load control valve move and send a signal to the generator to increase the power, which is given to the traction motors.

The task of the power piston is adjusting the fuel amount that goes to the cylinders for the combustion. There are four solenoids in the governor called as A, B, C and D, which are used to change the position of the setting piston when driver changes the notch. In this workshop, the adjusting of the solenoids was observed in order to move the setting piston at the required amount. Figure 2.5 shows the combination for notches.


Figure 2.5 Solenoid Combination for Each Notch

There is a maximum load that can be carried in a certain notch. When the load increases, the current sent to the generator is decreased. Because of that the notch number should be lowered by the train driver before the load comes to a maximum point at the particular notch.

**2.2.3 Locomotive Fuel Pump**

The only difference of the workshop 16 when comparing to workshop 14 is the engines that are repaired in workshop 14 are two stroke and the all the engines in the workshop 16 are 4 stroke engines.


Figure 2.6 Fuel Pump Tester

There were two other rooms which are connected to the workshop 16 called Injectors Room and Cylinder Block Room. Injector Room is completely allocated for the testing and repairs of the fuel injectors and the Cylinder Block Room undertakes the repairs of engine cylinders, pistons and valves.

It was observed how the fuel pump of a locomotive engine works and how the calibration of fuel pumps is done at the Injector Room using the fuel pump tester, which occupies a separate indicating cylinder for each pump in a four-stroke engine. The necessary adjustments are done to change the fuel amount that is pumped. See figure 2.6.

The other testing type is phasing. In four stroke engines when the engine crack rotates an angle of $720^0$, cam shaft rotates an angle of $360^0$. When travelling through this $360^0$, all pistons should have fired one time, which means fuel is injected only one time. The timing of these pumps is set with the help of the fuel pump tester. First the inlet pressure of a pump should set to 1 bar and the cam is rotated until the first drop of fuel is released under 15 seconds. The point at which that happens is set to 00 in the dial gauge and the other pumps are adjusted pump fuel at standard angles.

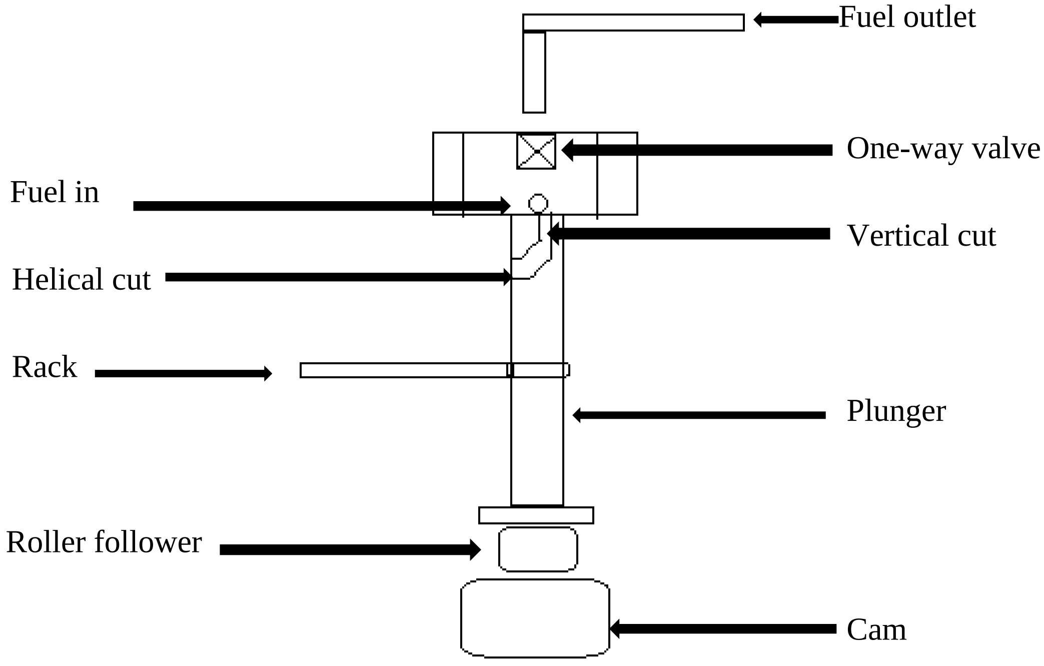


Figure 2.7 Fuel Pump of a Locomotive Engine

One plunger is occupied for each cylinder in the engine and they act as valves. The rack is used to rotate the plunger. When the vertical cut is in line with the fuel inlet hole, there is no pressure built up in fuel line. But when the plunger rotates there is a time that the fuel is pressurized and ready to be pumped under that pressure. The amount of fuel pumped is changed by rotating the plunger to change its position.

### 2.2.3 Locomotive Fuel Injector

There were two types of fuel injecting methods in the locomotive engines, which was observed in the workshop 16. One type occupies separate fuel pumps and an injectors for each cylinder, making the engine to have up to 16 unit type fuel injectors. The other method was having only one fuel pump and separate injectors for each cylinder.

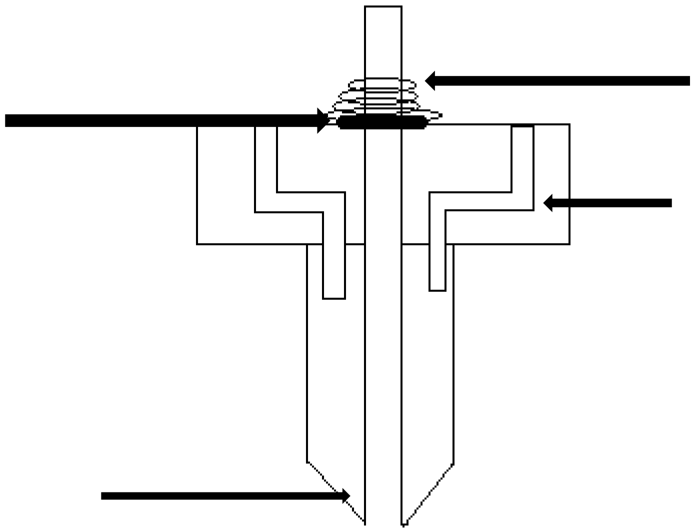

Figure 2.8 Unit Type Fuel Injector

Unit type injectors can be found in M8 and M9 engines. In M8 type engines the standard injecting pressure is 270 psi and in M9 engines it is 4300 psi. These standard pressures are fixed at the injector room for each injector individually, using methods, which are very old and time consuming. O-rings are used to change the tension in the spring in order to fix the standard pressure and the constant pressure valve keeps the pressure in the fuel line at a certain pressure. As an example the fuel line pressure in M9 engines are maintained as 3.5 bars. The injecting pressure values are changed by removing or adding O-rings of the spring.

### 2.2.3 Locomotive Suspension System

The locomotive suspension system, shown in figure 2.9 is also an important section as well as the engine section. It is somewhat different from other vehicles, because the load that the suspension system had to bear is large in amount. For the repairs to be done for the suspension system, engine compartment had to be separated from the bogie. Suspension system is mainly used to place the traction motors to the bogie (See figure 2.10).

A bolt is used to change the height of the suspension’s alternating layers of rubber and steel.it was observed how the placing of suspensions after reducing the height and removing the bolts and again fixing it with nuts and bolts again.

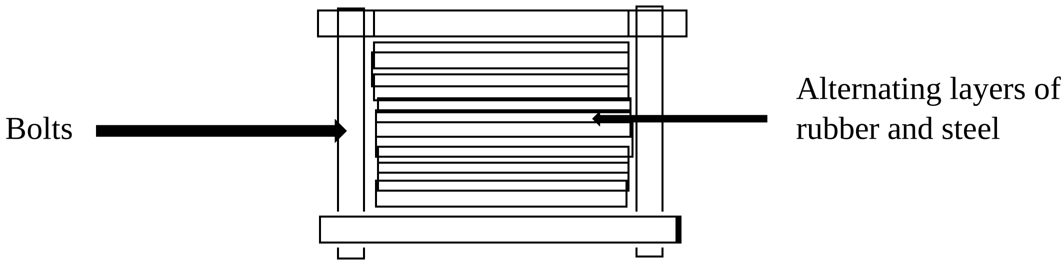


Figure 2.9 Locomotive Suspension System

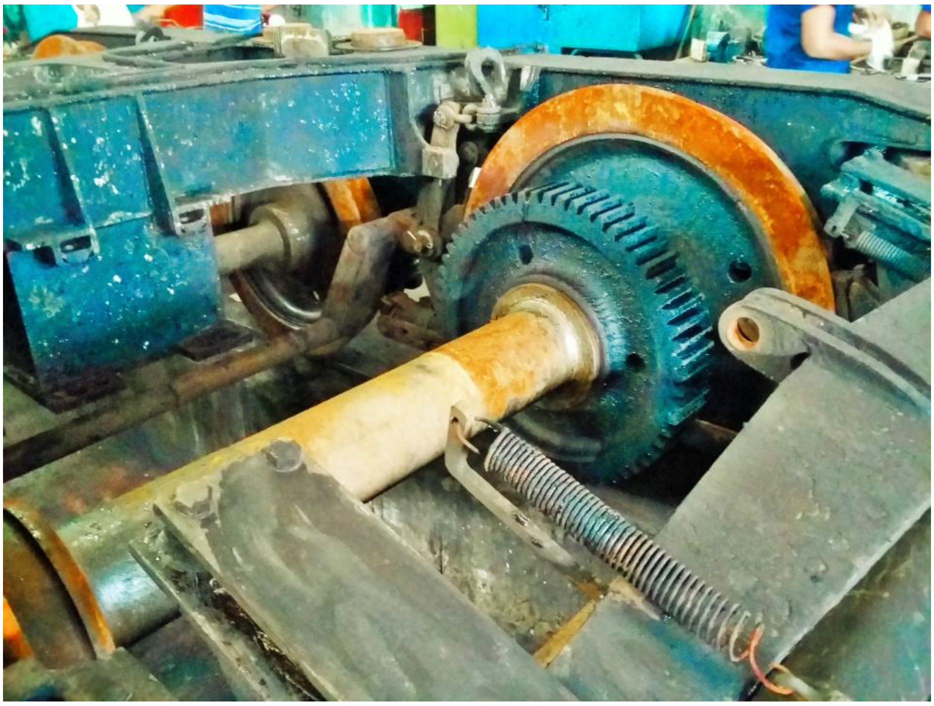

Figure 2.10 Locomotive Bogie

### 2.2.4 Oil Filters

Oil filters of the engine are contained in a cylindrical shape container. That container is filled with 7 oil filters, which are also cylindrical in shape. These oil filters were changed in every general and light repair, as shown in figure 2.11.

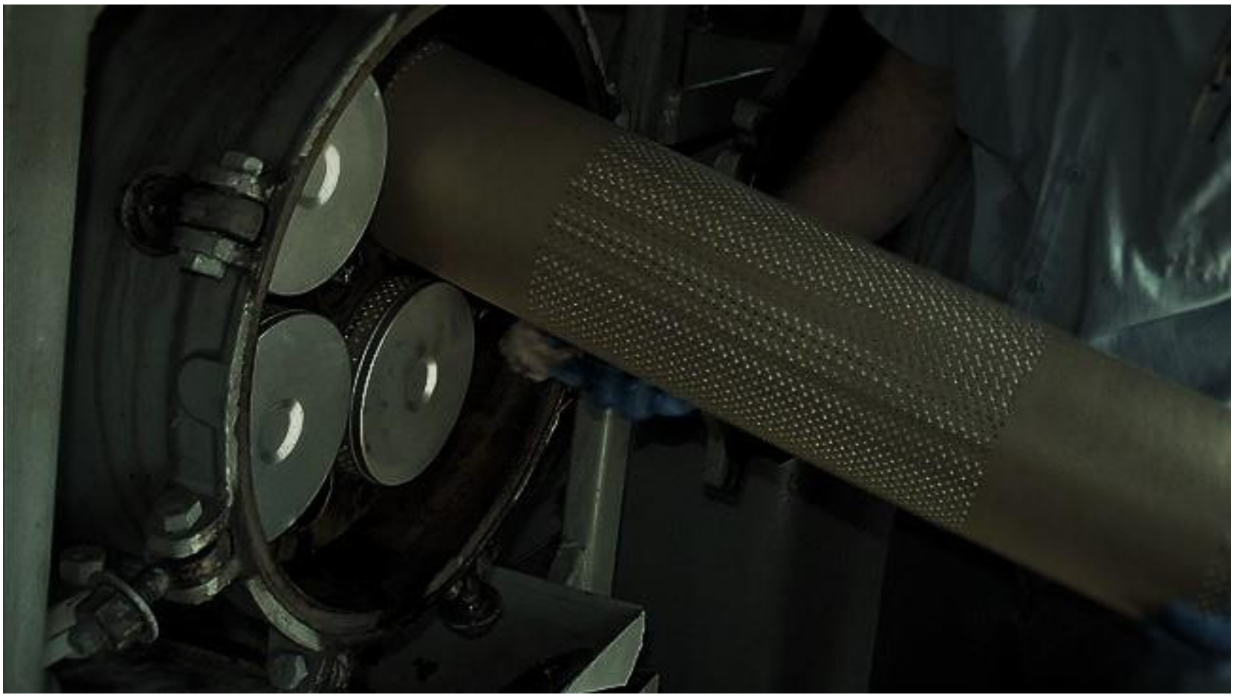

Figure 2.11 Oil Filter Replacement

### 2.2.5 Engine Cylinders

Damages caused to the engine cylinder cross heads, shown in figure 2.12 are inspected in a special room in workshop 16. Even if there are no damages in brand new engines they are delivered to this special room before let them in to the track. The whole piston cylinder arrangement is inspected for any defects and they are prepared for optimum functioning.

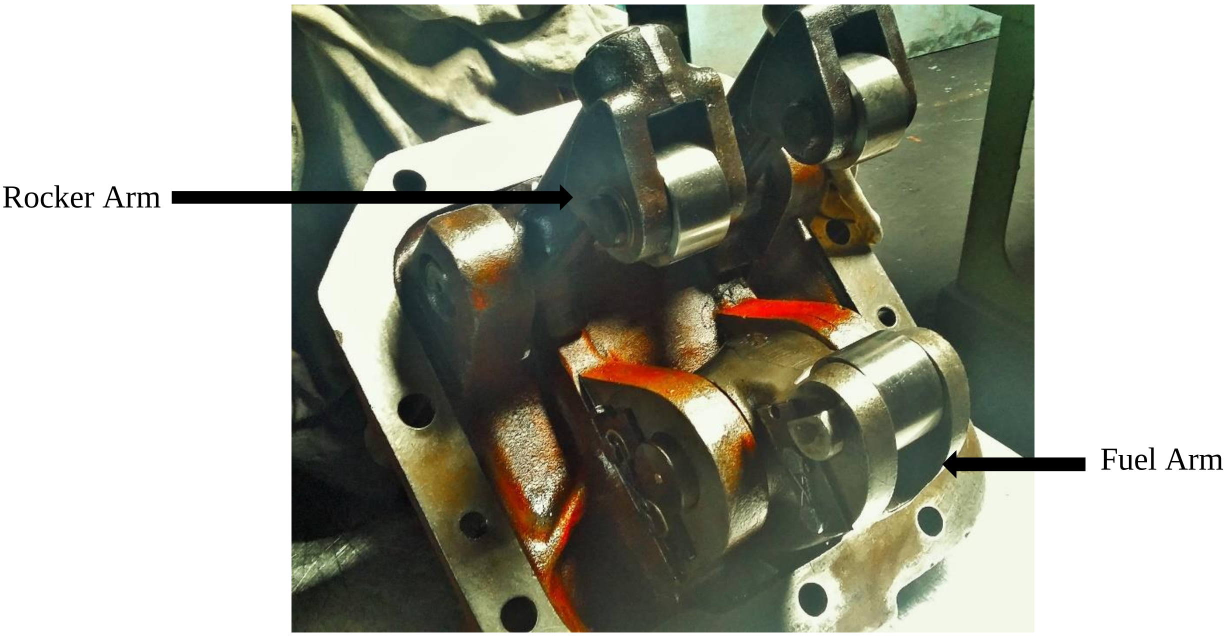


Figure 2.12 Cylinder Cross Head

The arms in the above figure are connected with cam shafts. Inlet and exhaust valves of the cylinder is controlled by the motion of the rocker arms and they can be moved separately when disassembled from the engine. Fuel arm controls the pumping of fuel for the combustion process. The defects of these arms may cause damages to the cam shafts, which can cost a considerable amount of money.

As the employees at the workshop complained, the valves of the cylinders of the locomotives that were imported recently from India are not in better conditions. So they had to be checked even before their first run. It was a significant problematic situation faced and in order to overcome it, the valves of the cylinders were cut to the standard angle by grinding.th inserts were also grinded to the standard form. Inserts are the parts that are used between the valves and their relevant ports for heat transfer purposes. There is a coolant water flow inside every insert. Usually repairs are done by replacing O-rings of the inserts. O-rings are used to seal the coolant water flow, as per figure 2.13.

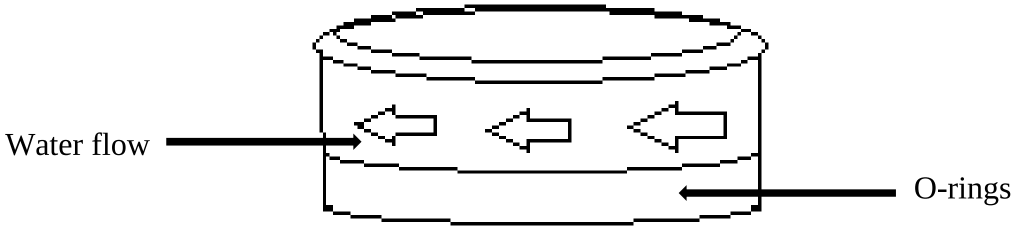


Figure 2.13 Insert

Tulip, flat head, sodium and mushroom are the most common type valve used in locomotive engines. Most of the valves, which were in the workshop were flat head and tulip type ones.

### 2.2.6 Firing Order

The power transmission and correct timing of each firing is fixed in the workshop itself without sending the transmission parts to another workshop, when trains come for the general repair or when engines face with problematic situations with the transmission system. (See figure 2.14)

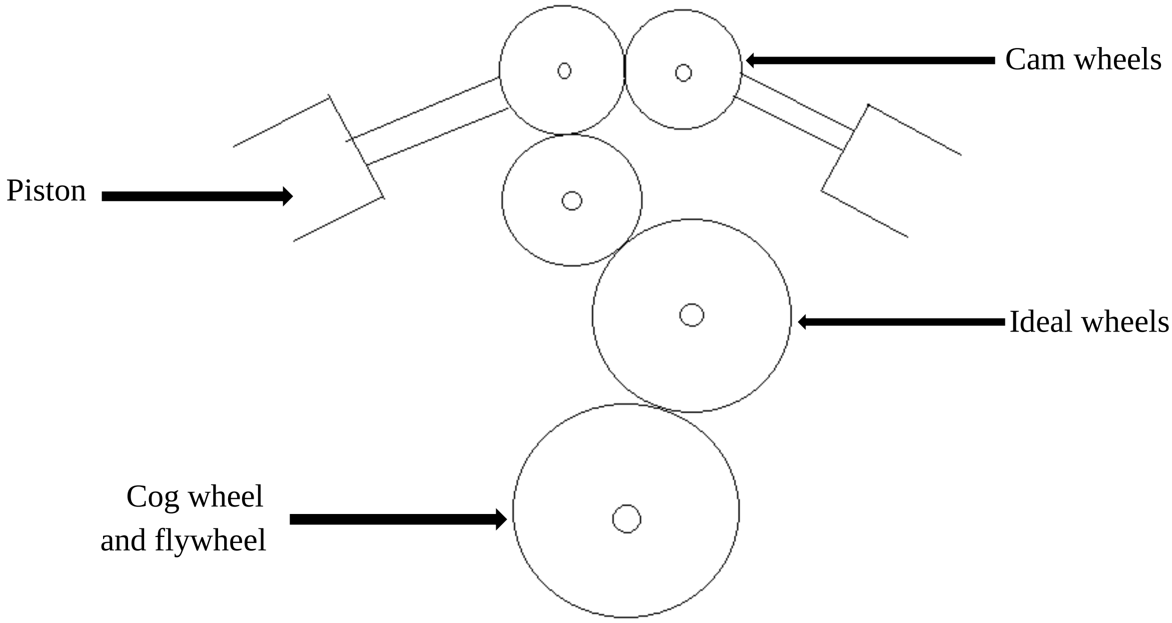


Figure 2.14 Cross Section of the Transmission System

In all above wheels there are marks to indicate the correct orientation for the perfect timing of the engine. Injector timing is adjusted as the fuel is injected for the combustion process, $4^0$ before TDC (top death centre). Top death centre is marked in the fly wheel by fixing a dial gauge to the piston and moving the flywheel until the direction of the dial gauge is changed. The pointer is marked as the TDC, as per figure 2.15 and when TDC of the flywheel is identified the pointer is moved to the $0^0$ position in the scale of the flywheel.

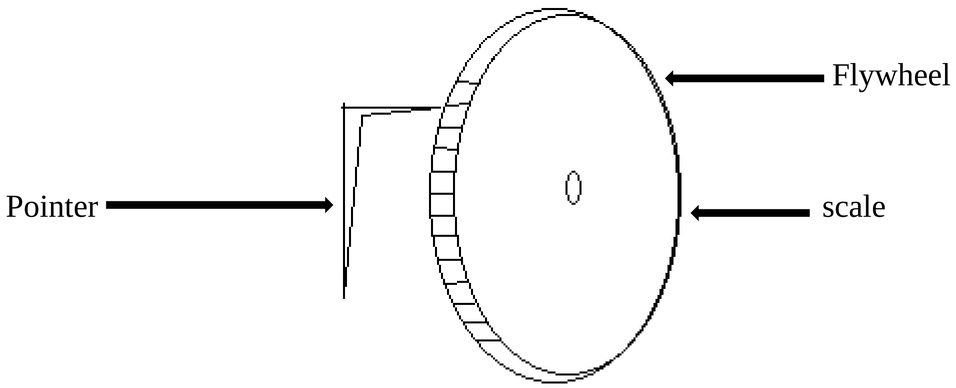


Figure 2.15 Flywheel and Pointer

At the same time the crankshaft (see figure 2.16) and the bearings should be aligned perfectly. If not the lifetime of them will be reduced drastically. For this task the bearings are separated from the engine body and fixed temporally at another engine body in the workshop. After that 'Engineering Blue' is applied on a shaft which has a diameter, similar to the crankshaft and it is turned inside the bearings. This process leads to show the points, at which the shaft is not in a good contact with bearings.

Figure 2.16 Crankshaft and Pistons

**2.3 DIESEL HYDRAULIC LOCO REPAIR (WORKSHOP 28)**

The difference between diesel electric engine and diesel hydraulic engine. (See figure 2.17 & 2.18)

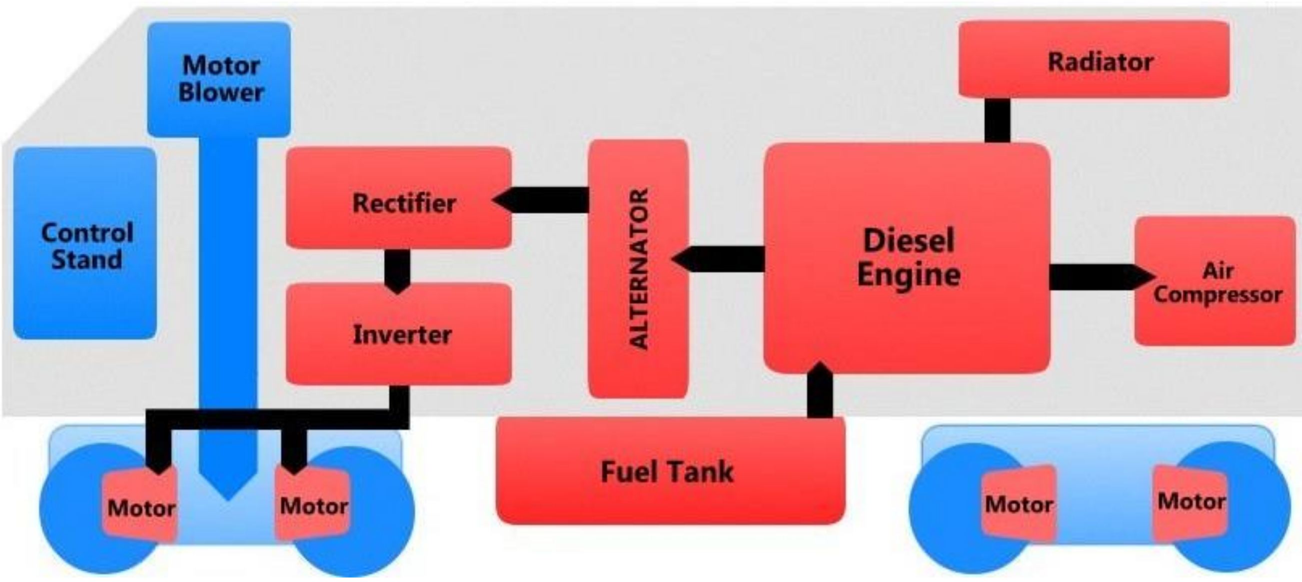


Figure 2.17 Schematic Diagram of Diesel Electric Locomotive

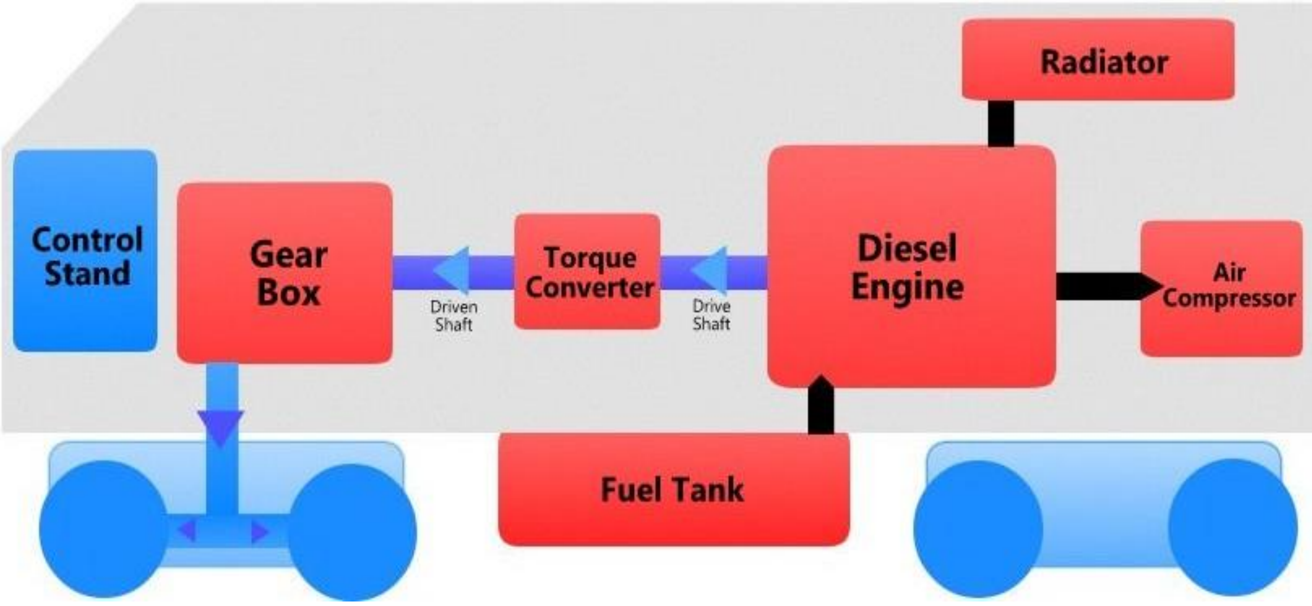


Figure 2.18 Schematic Diagram of Diesel hydraulic Locomotive

The workshop 28 or the Diesel hydraulic locomotive Repair workshop is solely allocated for the repairs of hydraulic locomotives. Unlike in other type of locomotives this type has a torque converter (see figure 2.19) and a gear box. To transmit the motion few shafts are used and the number of shafts depends on the type of the engine. Some diesel hydraulic locomotives are older than diesel electric locomotives but there are some S class engines running in Sri Lanka, which were imported recently. W class engines are the other type, which comes with a hydraulic transmission system and they are specially used in upcountry, since they could produce a large amount of power. Another significant feature of the diesel hydraulic locomotives is their high acceleration. Because of that they were widely used in commuter trains to accelerate and decelerate between small distances efficiently. Torque is a major factor for diesel hydraulic transmission and when the torque increases the speed get decreased. The solution for this is using an engine with a higher RPM value. The RPM of the Sri Lankan diesel hydraulic locomotives are around 1500.

### 2.3.1 Hydraulic Locomotive Power Transmission

Diesel from the fuel tank travels to the combustion chambers of the diesel engine & the drive shaft starts its rotation. There's a connection between this shaft & the driven shaft through a special component called Torque Convertor. It's a modified fluid coupling. When the driver changes the notch, gearbox acts accordingly & rotates the wheels of the locomotive by a shaft. The dynamic brakes of these locomotives are known as Hydro Dynamic Brakes. Here a special chamber gets filled with oil which creates a resistive force for the rotation of the wheels.

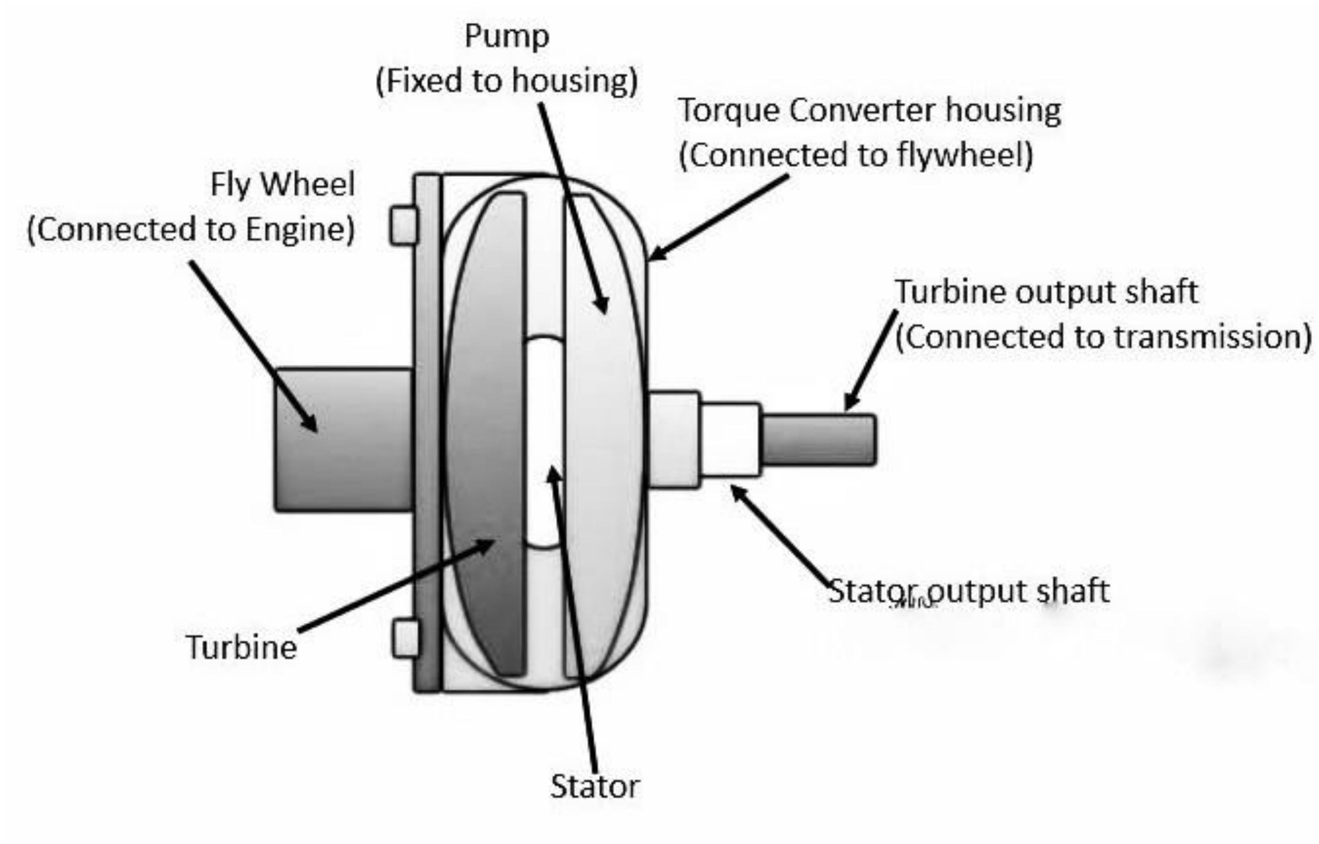


Figure 2.19 Torque Converter

As stated above torque converter is a modified fluid coupling. Therefore, we should identify the features of fluid coupling. A fluid coupler consists of 2 main parts.

1. An Impeller or a Pump connected to the engine which rotates with the engine
2. A turbine connected to the gear box

These two parts consist of 2 rotors fixed very close to each other & the space between these fans are filled with a high dense oil. Therefore, when the engine rotates impeller also get rotated. But there is a limit for power transmission by this method. Torque doesn't increase above a certain value and you cannot transmit more power than that level. Therefore, power output gets decreased and the highest torque is equal to the input power. The fluid used in the converter is cooled down by a heat exchanger. Unlike in S8 engines, in Y class engines, it is possible to couple the engine to the transmission system directly, when they reach the same speed. It is done by using four clutch plates and three gear wheels, as per figure 2.20.

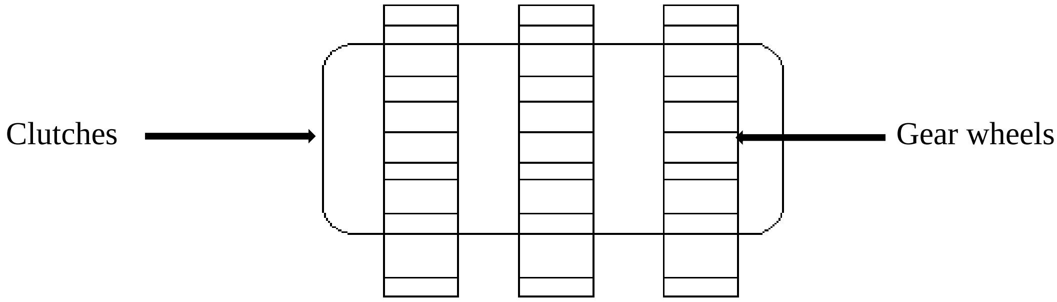


Figure 2.20 Gear System

Connecting shafts (see figure 2.22, 2.23, 2.24) on the other hand play an important role in the hydraulic transmission system. The power delivered from the torque converter is delivered to the gear system and then to the connecting shafts, which are connected with the locomotive wheels. As the vibrations, other internal and external stresses are occurred while the train is moving and because of the fact that the connecting shafts are not co-linear, there are universal joints between shafts. The length of the shafts is also slightly adjustable when in running mode. The cross link (see figure 2.21) allows the shaft to be bend and rotate at the same time.

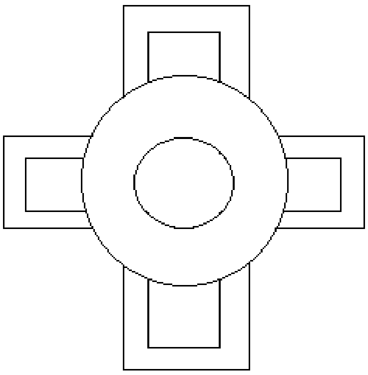

Figure 2.21 Front View of the Cross link

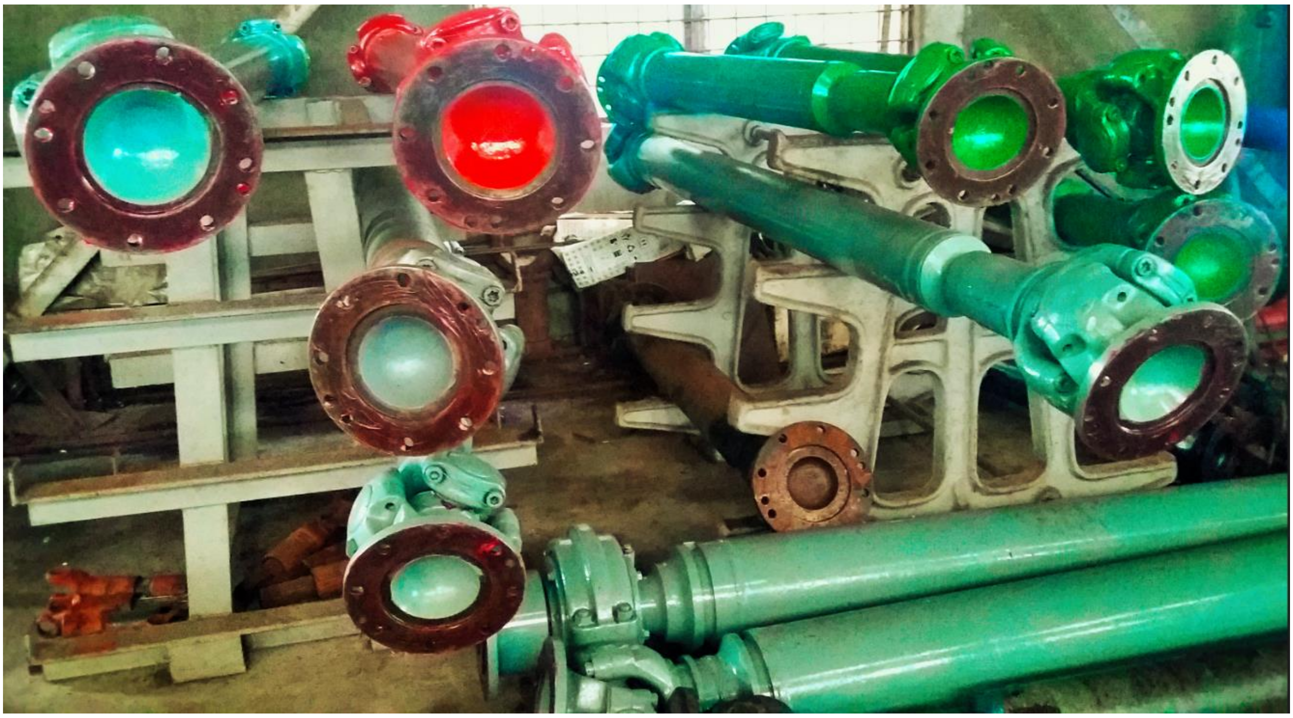

Figure 2.22 Connecting Shafts

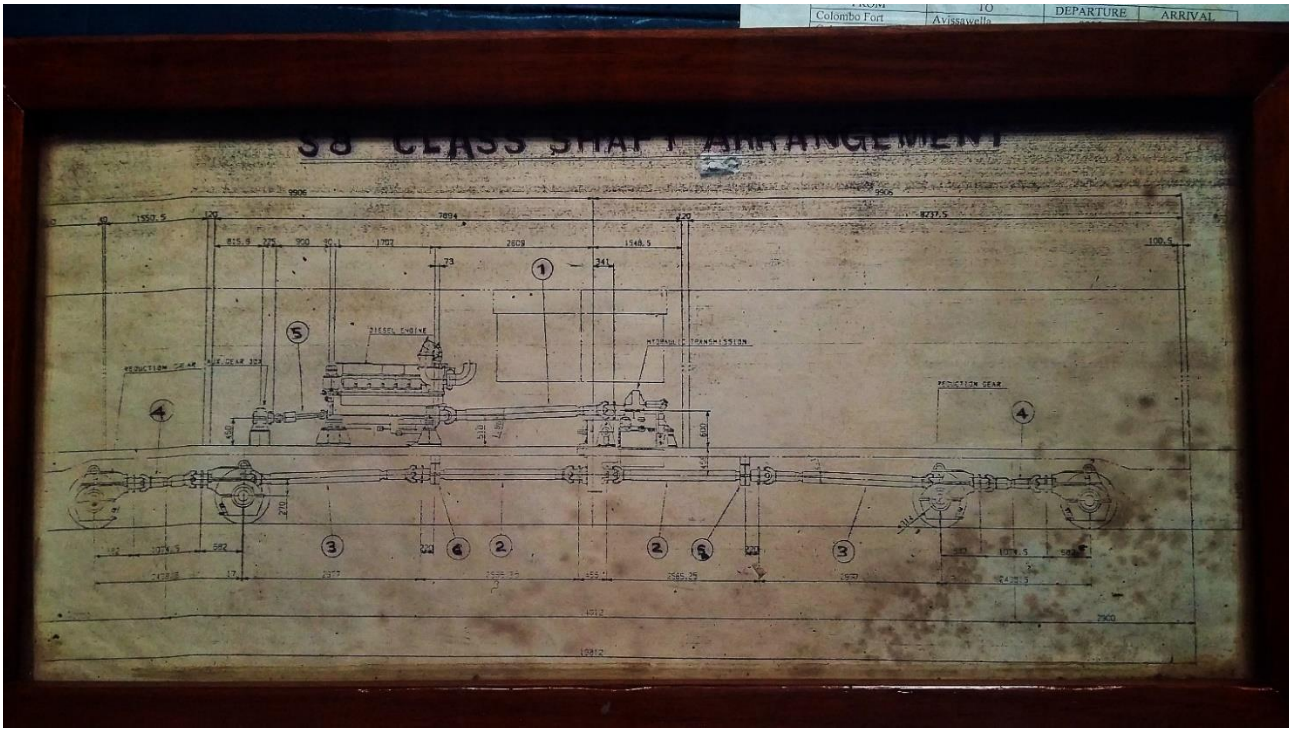

Figure 2.23 Shaft Arrangement of a S8 Engine

In the workshop 28, new shafts or repaired shafts are cleaned and lubricated before connecting to a train for smooth operation and for the durability of the components. Since there are two universal joints, the non-uniformity of the rotation through the shaft is corrected at the other end of the shaft, where the output is taken. The spline joint is usually biased to an edge of the shaft to lower the impact of centre of mass to the rotation and to eliminate vibration.


Figure 2.24 Universal Joint and Spline Joint

There are several lathe machines (see figure 2.25) in the workshop 28 and they are used only to make parts, which are needed in the workshop 28. There is also a shaping machine used to carve through metal easily. The tip of that is made out of high-speed steel (20% tungsten).

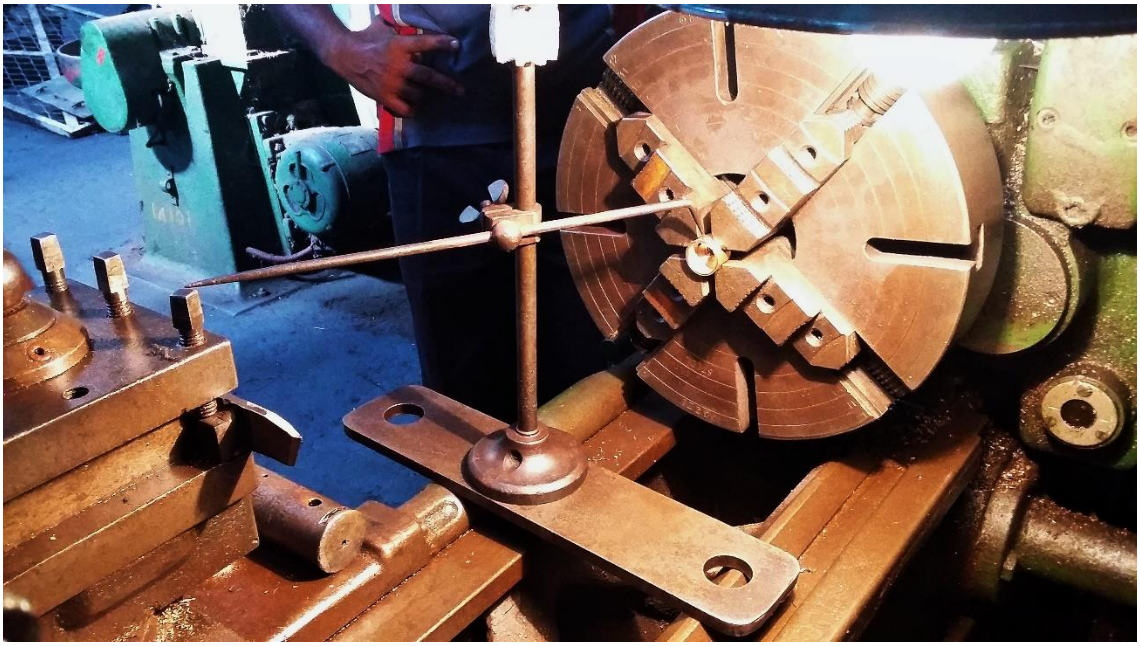

Figure 2.25 Lathe Machine

In the workshop 28, there is a special section allocated for repairs done for cylinder heads. Cylinder heads are usually exposed to high amount of wear due to the continuous combustion process. This happens due to the cyclic contact with the piston. These non-uniform surfaces are grinded or filled with metals, as the repair is undertaken. (see figure 2.26)

### 2.3.2 Cylinder Head Repair

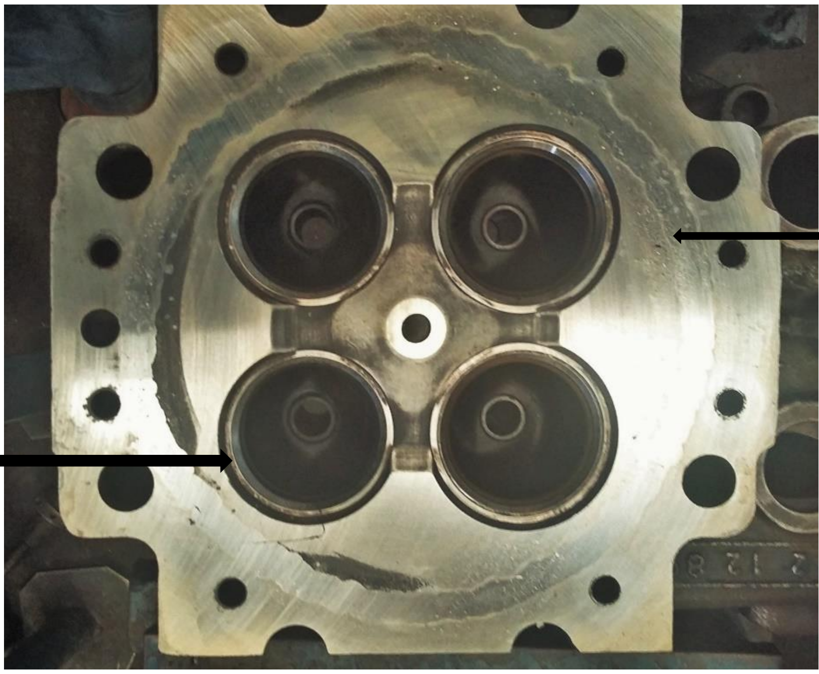


Figure 2.26 Surface of the Cylinder Head

Inserts are the ring like components, which are used fixed between the valves and the valve ports in the cylinder head. It was observed and studied how the inserts (see figure 2.27) are inserted to the cylinder heads.

Procedure of inserting inserts is as follows.

1. Submerging inserts in liquid Nitrogen.
2. Submerging cylinder heads in the water, at a temperature of $160^0$ F.
3. Connecting those two without any delays.

Submerging inserts in liquid Nitrogen will shrink them while submerging cylinder heads in hot water will expand their valve ports. After connected, these two attempts to go back into their original size, due to heat transfer process. But it will only create a strong bond between them.

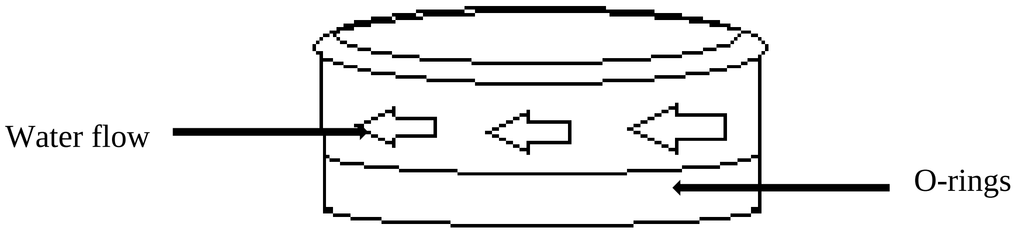


Figure 2.27 Insert

**2.3.3 Engine Cooling Problem**

There was a locomotive engine with a problematic situation of its cooling system in the workshop 28. It was found that there is some sort of a leakage in cooling water lines. To figure out the exact location or locations of leakages, pressurized water was used. Water was pressurized inside the cooling line and it led to visible locations where there are leakages.

**2.3.4 Tamping Machine**

Apart from passenger carrying locomotives, there were tamping machines shown in figure 2.28 that are used to repair railway tracks, to get repaired. Those machines can lift, straighten and level railroads.

Figure 2.28 Tamping Machine

## 2.4 AUTOMOBILE WORKSHOP (WORKSHOP 17)

### 2.4.1 Introduction to Automobile Workshop

Figure 2.29 Automobile Workshop

Only one week was allocated for the automobile workshop to observe and study the work done there. The main task of workshop 17 (see figure 2.29) is carrying out all types of repairs in automobiles, which belongs to Sri Lanka Railways Chief Mechanical Engineering Department.

Having an automobile workshop inside the engineering workshops is very helpful because the vehicles like forklifts, tractors, fire department vehicles do not have to leave the workshop premises for the repairs. On the other hand, it's a huge save of money since every vehicle which belongs to Sri Lanka Railways can be repaired in this workshop without any charging and do not have to worry about scams. This workshop undertook every kind of vehicle repairs of many kind of automobile.

1. Light vehicles

- Cars
- Vans
- Three wheelers
- Cabs
- Jeeps

2. Heavy vehicles

- Buses
- Trucks
- Firefighting trucks

- Dozers
- Excavators

3. Industrial vehicles

- Fork lifts
  - Tractors

Repairs undertaken

- Battery works
- Tyre works
- Paint jobs
- Body works
- Mechanical repairs

**2.4.2 Automobile Clutch Issue**

A car, which belongs to Sri Lanka Railways had found with some trouble of a noise that is coming out from the engine part. The suspicion of the mechanics at the workshop was, a problematic situation with the clutches. When disassembled the parts they found that their suspicion was correct. The clutch plate’s (see figure 2.31) fibres had worn to the point they make a weird noise.

Clutch plates have to be replaced if they were found with exposed reverts, worn fibres, or untighten damping cushions. The different of those can be identified by going on a test run. The clutch plate is pressured by a pressure plate, shown in figure 2.32.

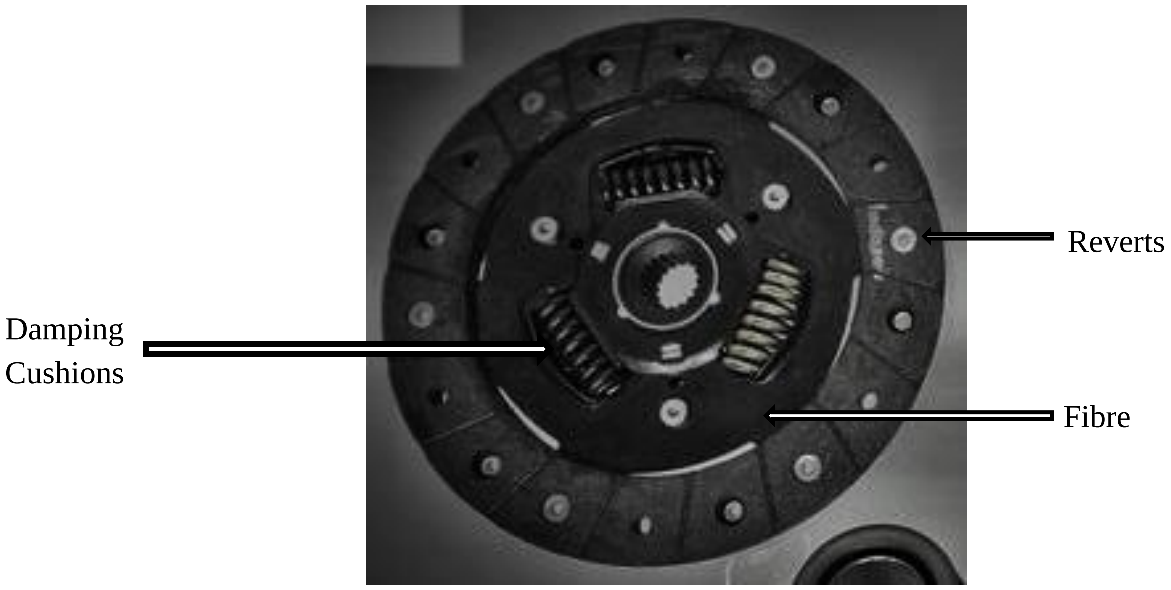


Figure 2.30 Clutch Plate


Figure 2.31 Pressure Plate

## 2.5 MILLWRIGHT WORKSHOP (WORKSHOP 32)

### 2.5.1 Introduction to Millwright Workshop

The main task of workshop 32 is to undertake the repairs of the machines, which are used to repair locomotive components. It did not have any specific type of components, but has a huge variety. From foot bicycles to internal components of milling machines are repaired, since the workshop has several sections in it.

### 2.5.2 Tools Used in the Workshop

Figure 2.32 Workshop Crane

A turning machine is used to cut a metal piece, which was moulded in the foundry to make a crane wheel. Cranes are the ones those are used in almost every workshop to carry heavy components within the workshop area (see figure 2.32). They have the ability of lifting a whole engine at a time.

A socket is used to fix the cutting tool to the machine. It is a taper cut, shown in figure 2.33, which is used to change the drill bits of a drill. It helps to fix the tool rigidly and conveniently and at same time makes it easy to remove it. A hammer is used to separate the tool from the socket.

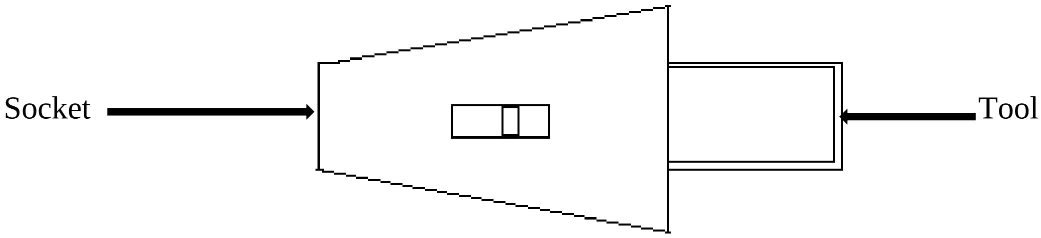


Figure 2.33 Taper Cut

A helical gear wheel set from a boring machine (see figure 2.34), which is at workshop 41 was found trouble in functioning due to some damages happened. Some parts of the teeth of the gear wheel was gone missing and had had to be filled with metal pieces and some parts were appropriately cut out. If the only option is replacing them, they can be manufactured within the workshops alone

Figure 2.34 Damaged Gear Wheel Set

The ticket machine, which is used in every railway station in Sri Lanka is still same as the one, which was used fifty years ago. The machine is manufactured by casting its parts in the railway workshops. But there is still some work left with cutting threads. That operation was done by taps in the workshop 32. As shown in figure 2.35 taps have different types.

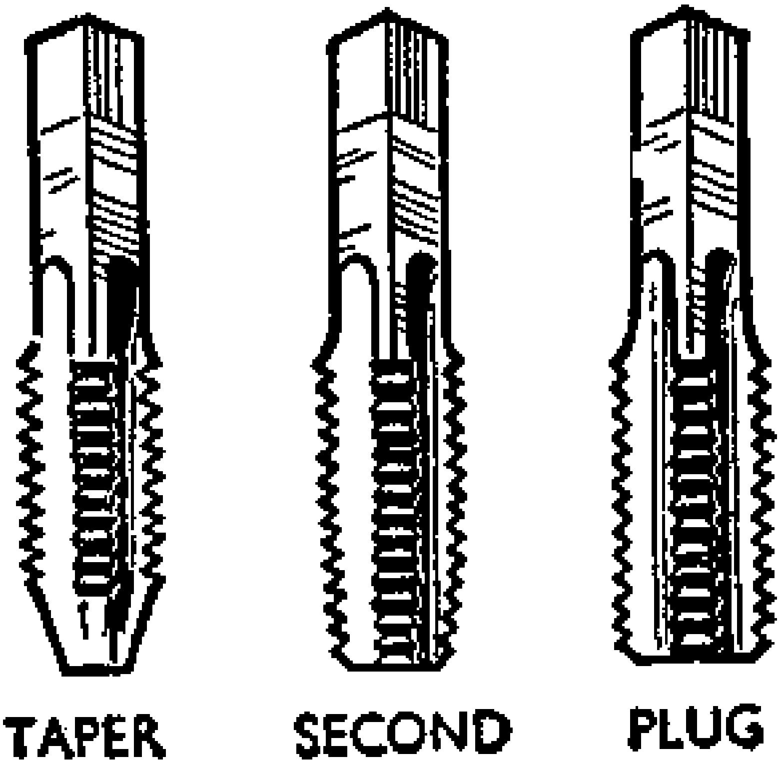


Figure 2.35 Different Types of Taps

Bevel protractor (see figure 2.36) was used in workshop 32 to measure the taper angle of the crane wheels, which are made by the lathe machine. The bevel protractor used in workshop 32 was more than fifty years old and it was not a very precise way of measuring angles.

Figure 2.36 Bevel Protractor

## 2.6 DIESEL ENGINE AUXILIARIES (WORKSHOP 10)

In the workshop 10, the repairs of all types of diesel engine auxiliaries are undertaken. Some of the main auxiliaries we got to familiarized are air compressors, radiators, water pumps, engine pipes, exhausters and expressers.

Radiator is a main components of engine cooling system. Radiators are used for cooling the water that circulating through the engine and other components. Radiators surface area had to be maximized to transfer the heat to the atmosphere. Locomotives have 6-8 radiators for cooling huge amount of water. As shown in figure 2.37, water, which comes from a tank is pressurized and sent into the tank on the other side of the radiator.

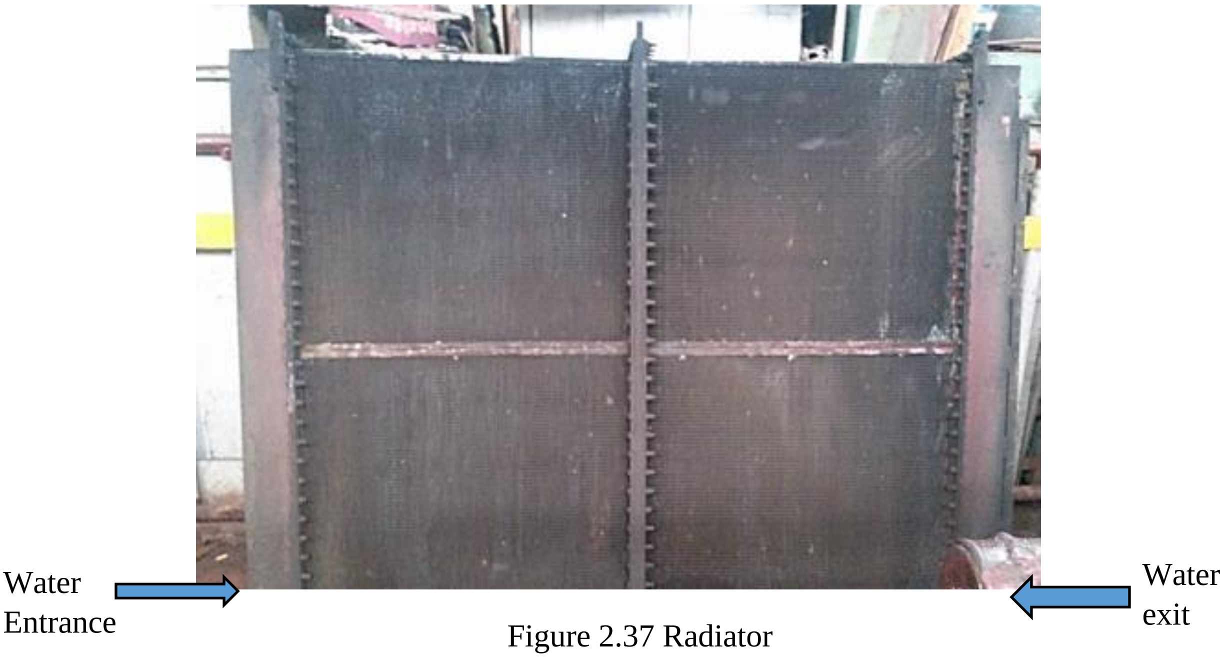


Figure 2.37 Radiator

Cleaning of radiator pipes (see figure 2.38) is done by merging them in a special tank, where there is an air supply at the bottom of the tank. The tank is filled with NaOH. In order to clean the blocked lines, compressors have to be turned on.

Figure 2.38 Cleaning Radiator Pipes

In air compressors (see figure 2.39 & 2.40) of locomotives, there are two stage compressors and single stage compressors. The two stages in two stage compressors are the law pressure compressor and the high-pressure compressor. There are few advantages of two stage compressor over single stage compressor.

- Gas can be compressed to sufficient high pressure
- Pressure ratio of each stage lower. So, air leakage is lower
- Low pressure ratio in cylinder improve the volumetric efficiency

The valves of the air compressors are designed such that they only allow the air to flow in one direction. If air tries to flow in the other direction, air path gets closed with the help of a mechanism, driven by two disks, which are placed adjacent to each other.to make sure the perfect seal the plates are polished by silicon carbide dust.

Figure 2.39 Air Compressor

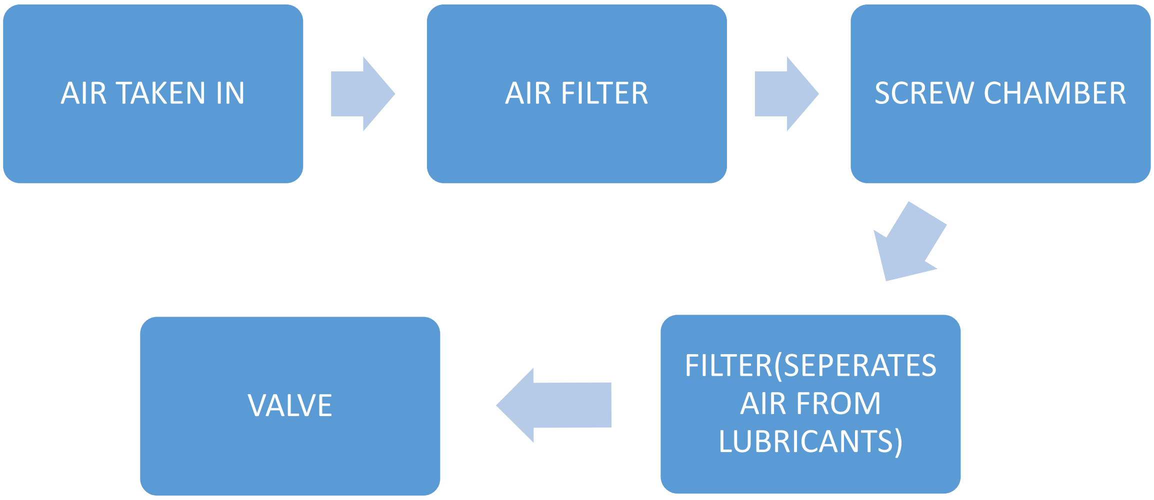


Figure 2.40 Schematic Diagram of a Screw Type Compressor

Expresser, shown in figure 2.41 is a device that combination of air compressor and exhauster. This used for air brakes of engine and vacuum brake of rail carriage. Exhauster is the inverse process of the air compressor. It is making a vacuum. It is used for vacuum brakes.

Figure 2.41 Expresser

Turbocharger, shown in figure 2.42 is used for four stroke engines to breathe more air into the combustion chamber using exhaust power. Turbochargers contain two main parts. Impeller (see figure

2.43) and turbine. With the use of the exhaust gas, the turbine is rotated initially and as it has coupled to the impeller, the impeller will rotate and pressurize the air, which flows into the engine.

Figure 2.42 Turbocharger

Figure 2.43 Impeller of the Turbocharger

The pressurized air, which comes out of the turbocharger has some amount of heat carrying and the engine after coolers (see figure 2.44 & 2.45) are used to take out the heat from that gas and cool them down. Those will ensure the minimum vapour quantity in the gas. Air coolers are made by attaching metal pieces to the pipes, in order to enlarge the heat transfer area and enhance the heat transfer rate for a better cooling process. These air coolers are fully designed and manufactured in the workshop 10, itself.

Figure 2.44 Air Coolers -Original

Figure 2.45 Air Coolers-Made in the Workshop 10

In the workshop 10, mainly gas welding could be observed as a process of joining.it is used when arc welding could cause metal surfaces to crack or when the material of the welding electrode is unavailable.

In the gas welding process, the components that needed to be weld are heated and the rod used to weld is dipped in sif-flux to remove the surface impurities and improve weld performance.

Figure 2.46 Bearing Fitting Process

At the workshop we had the chance to see the process of fixing a roller type tapered bearing to a shaft of a compressor, as shown in figure 2.46. Bearings are fitted to the shaft without using any means of holding them together other than fitting them tightly. In order to succeed this, the bearing is first placed in a hot oil bath, so that its’ hole expands and can be easily fitted to the shaft and once it cooled down it will tightly fit to the shaft. Hydraulic pressure is used to remove the bearing, if needed.

## 2.7 HEALTH AND SAFETY IN INDUSTRIAL ENVIRONMENT

- Precautions like wearing helmets and gloves were barely taken by the technicians and the labours, even though they were instructed in advance.
- There are notices indicating high voltage danger signs.
- There were dengue prevention programmes conducted, since some of the workers reported, infected.
- There is a medical centre, which is open for all the employees.

# CONCLUSION

As a second year undergraduate, who did not have any experience in the industry before, it was a great opportunity for me to work as a trainee Mechanical Engineer at Sri Lanka Railways Chief Mechanical Engineering Workshops. The knowledge gained was unique since it was about locomotive technology, but sometimes universally applicable, which made the training experience a useful one.

We were appointed to six workshops and three of them were engine workshops, which mainly focus on locomotive engine repairing and maintaining. The difference in three workshops depend on the engine types that is undertaken into the repairing process.

The Millwright workshop is the place, where the machines used to repair locomotive components are being repaired. At that workshop a bore machine’s gear repairing and replacement procedure was observed mainly. A cutting procedure using a turning machine, working principle of workshop cranes were observed and studied about types of taps used in metal drilling operations.

But when it comes to interacting with the employees, it was bit difficult for us to reach and learn from them since some of them were not friendly and were not willing to teach us. But majority of the workshop foremen, technicians, labours were friendly and kind enough to share whatever they know and their experience the industry. Even though we started our training at 7.30 am daily, we had to wait for several hours to study or observe something, since the technicians and labours do not start their work at the time they are supposed to. My suggestion is to change the time period a trainee engineer should start their work, because throughout the training period we were not assign to any responsibility, but had to learn each and everything from the technicians and supervisors. But it is also not convenient to give a trainee engineer a responsibility or a duty in a workshop either. Assigning a project would be a better idea from my point of view.

The things that were taught in the second-year mechanical programme were so much useful in understanding the principles and technologies used in the workshops. At the engine workshops we could get hands on experience on governors, which was taught under ME 211, Mechanics of Machines.

The knowledge on power transmission systems and gears, gained under the course ME 205 Tribology and Power Transmission Elements were widely used in many applications in many workshops as well. In Applied Thermodynamics I, the internal combustion engines were a special part that we learnt and it was much easier for us to understand the practical situations when comes to locomotive engines.

The fundamentals of cooling systems in a locomotive engine system could be observed and studied when we were at the workshops and they were taught furthermore in detail in the fifth semester under Applied Thermodynamics II. It was at the sixth semester that we were supposed to study about whirling of shafts under the course ME 301 Vibrations. But we were able to learn about whirling and the reducing solutions in advance at the workshop 28.