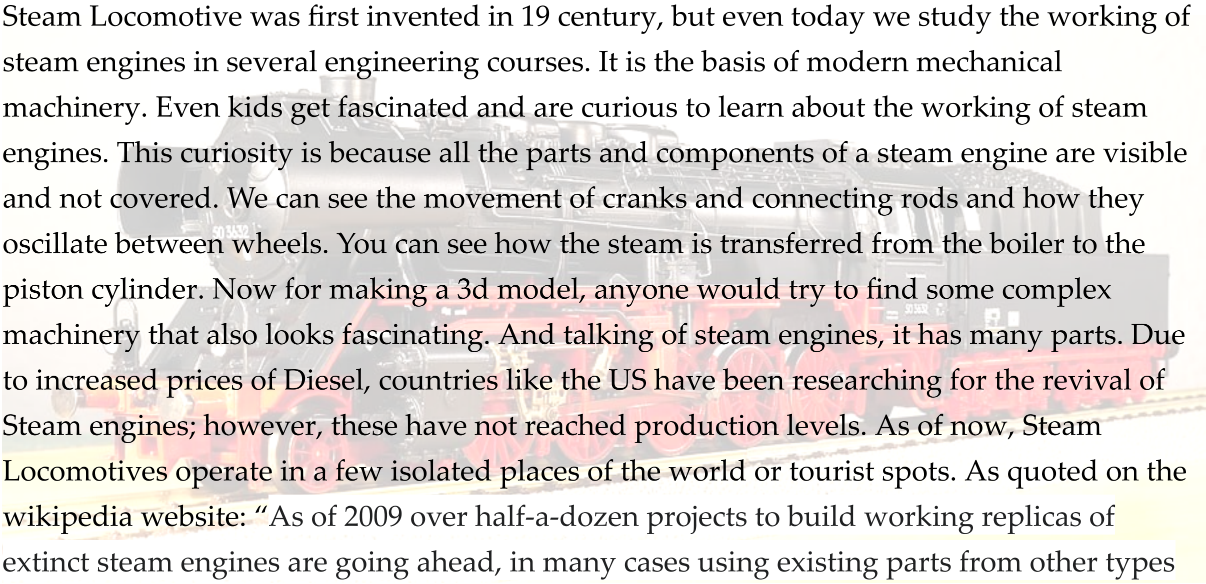
STEAM LOCOMOTIVE

Introduction

We live in a world of super-fast bullet trains and metros which can take you from one place to another in the blink of an eye. The metros have had such an immense effect on our lives that we have started to measure the distance between two far-off places in minutes. But before these high-speed, cool-looking machines came into existence there was the very hefty-looking machine which would make a lot of sound while in motion but yet was an engineering masterpiece, whose introduction changed the books of transport and travel. This was the steam locomotive. Our group through this activity aims to reimagine all the major components involved in this classic yet magnificent piece of art.

Motivation



Steam Locomotive was first invented in 19 century, but even today we study the working of steam engines in several engineering courses. It is the basis of modern mechanical machinery. Even kids get fascinated and are curious to learn about the working of steam engines. This curiosity is because all the parts and components of a steam engine are visible and not covered. We can see the movement of cranks and connecting rods and how they oscillate between wheels. You can see how the steam is transferred from the boiler to the piston cylinder. Now for making a 3d model, anyone would try to find some complex machinery that also looks fascinating. And talking of steam engines, it has many parts. Due to increased prices of Diesel, countries like the US have been researching for the revival of Steam engines; however, these have not reached production levels. As of now, Steam Locomotives operate in a few isolated places of the world or tourist spots. As quoted on the wikipedia website: “As of 2009 over half-a-dozen projects to build working replicas of extinct steam engines are going ahead, in many cases using existing parts from other types to build them. Examples include BR 72010 *Hengist*, Brighton Atlantic *Beachy Head*, the LMS 5551 *The Unknown Warrior* project, 2999 *Lady of Legend*, 1014 *County of Glamorgan* and 6880 *Betton Grange* projects. ”

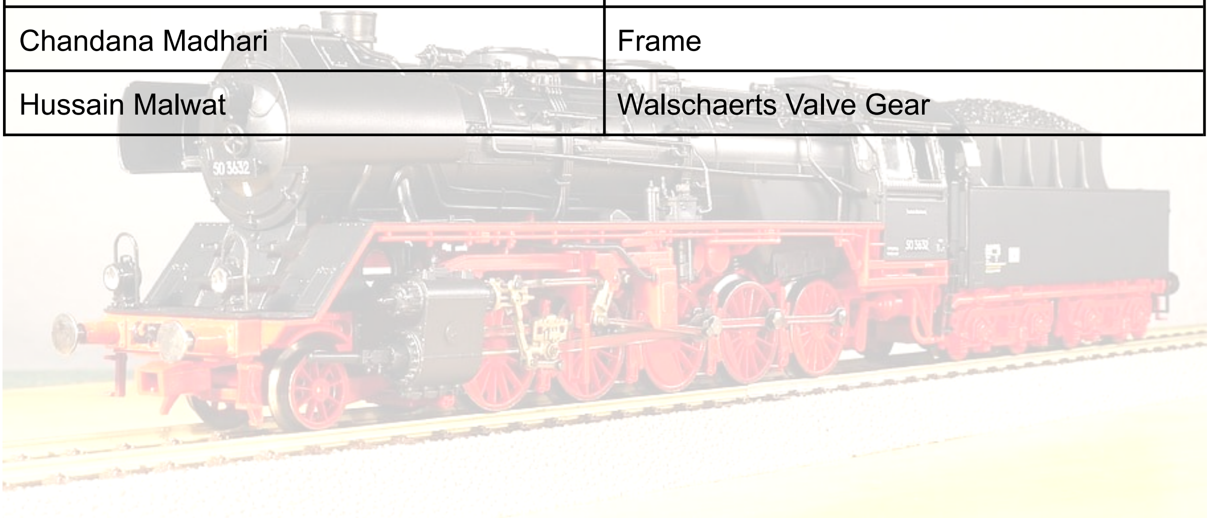
History

Steam locomotives made the transport of goods and people much easier and gave humans the ability to create new industries. Steam locomotive was first made by Richard Trevithick in the United Kingdom in the early nineteenth century. After Trevithick's success many people started to work on steam locomotives. The first commercial steam engine was made by George Stephenson. Steam locomotives allowed people to travel in comfort and luxury over long distances in a short amount of time as before steam locomotives, people used to travel only on a horse or by sea. The United States built a network of railways that connected towns so they could expand westwards. Steam locomotives changed the way people lived.

It had a huge impact on the industrial revolution as businesses were connected to the ports through the railways. Farmers used to set up their fields near railways so they could sell their food which could be exported. Residents could sell goods they made much easier. Residents no longer had to live near workplaces but could travel from small towns towards cities for working and gave citizens much more opportunities. Companies could also hire skilled workers from different cities which benefited the revenue of the companies.

Though they are engineering marvels, they were phased out during the 1960s but still many of them have been well preserved.

Name	**Part**
Abhishek Mandlik	Boiler
Akshith Goud	Pilot
Charan maloth Tej	Air Pump
Lokesh Khandelwal	Tender
Manas Agrawal	Turbo Generator
Manav Parmar	Leaf Springs,Wheels
Manas Kawal	Cabin
Divya Madineni	Steam Box Steam door
Chandana Madhari	Frame
Hussain Malwat	Walschaerts Valve Gear



Modeling Project Title

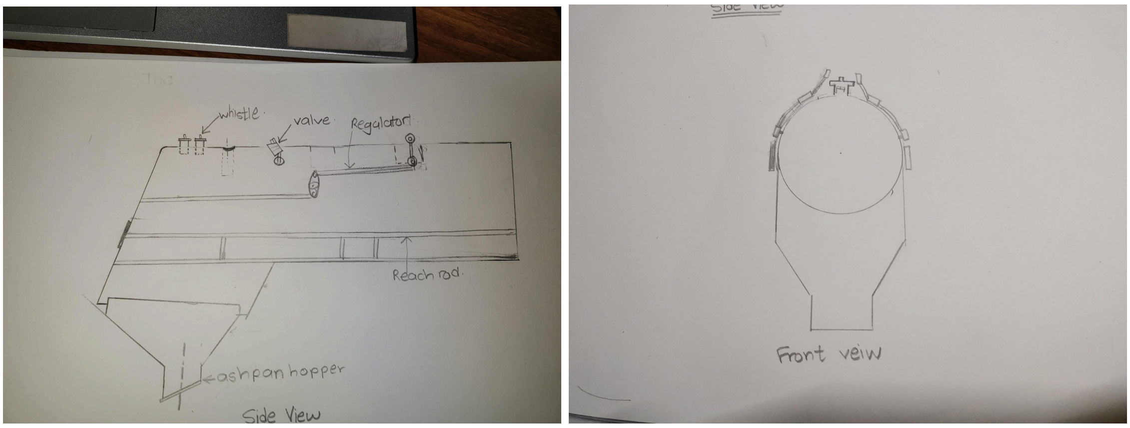
Term: Spring 2022

Group #

Submission date:

Si. No.	Student name	Signature
1	Abhishek Mandlik	[illegible]
2	Akshith Goud	[illegible]
3	Maloth charan tej	[illegible]
4	Lokesh Khandelwal	[illegible]
5	Manas Agrawal	[illegible]
6	Manav Parmar	[illegible]
7	Manas Kawal	ManasKawal.
8	Madineni Divya	M.Divya
9	Madhari Chandana	M.Chandana
10	HUSAIN MALWAT	Husain

BOILER



This is an image of boiler

Overview

I will write about the boiler that stores the steam for the engine. The boiler is where heat energy is converted to mechanical power to run the locomotive. Boilers are being made from the 17th century, but they were first used in trains in the 19th century by Richard Trevithick in the United Kingdom. A fire-tube boiler was commonly used in steam locomotives. But other types of boilers were evaluated but were not widely used, except for some locomotives in Hungary, which used the water-tube boiler known as broton boilers.[1]

Body structure and working

The boiler is a closed cylindrical vessel behind the smokebox and ahead of the cabin and has a whistle, steam box, and electric generator on top and wheels at the bottom. The boiler is used for heating water converted into steam to run in the engine, or water is just heated for cooking, water heating, and sanitation or produce electricity for usage in trains and passenger car heating systems.
The boiler contains a firebox that sucks air from underneath the train. The solid fuel sits on grates through which dead ash can fall into the ashpan, which is located below the grates. The firebox allows the air and smoke to escape through the pipes, which run along the entire length of the boiler and connect it to the steam box. The steam box is kept at lower pressure for air to move from the boiler to there. The water inside the boiler surrounds the firebox. It is heated and converted to steam which is then used to power the train through the piston.

The water level must be kept in between lines marked on the sight glass. If the water level is more or low, it affects the engine's efficiency. If the steam exceeds the pressure limit, which is set according to the boiler, the safety valve at the top opens so that the excess steam is removed from the boiler and pressure is maintained.

Steam is used to power the engine. Water was heated by coal or oil; Coal was initially the only fuel. Switzerland used electricity to power steam locomotives in world war two because of the coal shortage and abundance of hydroelectricity. Light diesel-type oil was used by Switzerland, Argentina, and Australia for tourist locomotives and heritage locomotives. Coal was stored in the Engine's tender, which was hand shoveled by a fireman into the firebox. Coal was used as it has a very high energy density. In North America, wood was used; even if it had less energy density than coal, it was much more economical. We are going to make a coal powered locomotive. Water was also stored in tender and passed to the locomotive through an injector which was then heated to convert into steam to power the train. Water was supplied to specific areas from a source connected to gantries as less water on trains would mean less efficiency.

The boiler is made of steel or alloy steel, or wrought iron during earlier stages of a steam locomotive. Stainless steel was not used in wet parts of the boiler, but ferritic stainless steel was used in the superheater section, which was not exposed to boiling water. Copper or Brass was used in fireboxes because it has high thermal conductivity, but as copper got expensive stainless steel was used instead as they are much cheaper than copper. Large amounts of heat are wasted if a boiler is not insulated. The first two steam locomotives used wooden lagging to insulate their boilers. Improved insulating methods were applying a thick paste of a porous mineral-like kieselguhr or attaching curved blocks with similar structures to insulating compounds like that of magnesia blocks.[2]

Challenges

The challenge that I think I might face while making a 3d project of the boiler is that there is a lot of detailing on the boiler and the ash collector, which is located at the bottom, and the steam wires that pass from the sides of the boiler.

[1] - https://en.wikipedia.org/wiki/Steam_locomotive#Boiler

[2] - https://en.wikipedia.org/wiki/Boiler

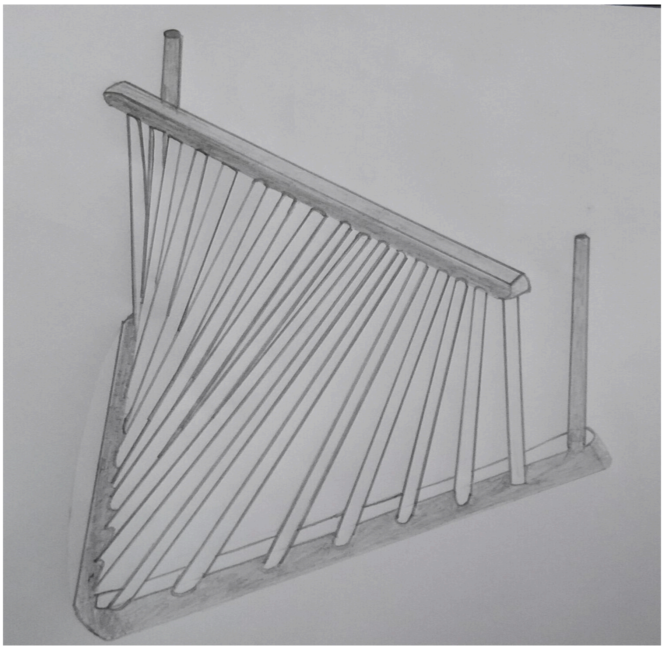
Overview

In rail tracks, a device called a pilot(also termed as cowcatcher) is positioned in front of a locomotive to deflect obstructions on the path that may otherwise cause severe damages.

This was invented by the great scientist Charles Babbage who was an English polymath, a philosopher, a mathematician, an inventor and a mechanical engineer in the nineteenth century. When he was working for the Liverpool and Manchester Railway, he got stuck with the idea of creating this part. However, Babbage's innovation was not constructed, and it was unclear if following manufacturers were aware of his concept.

Body structure and working

The design principle of this cowcatcher is to push the object sidewards and upwards out of the way and not to shift the locomotive on impact. On the main track of the locomotive, the cowcatcher has to fully deflect the obstacle hit at speed. The shape of this cowcatcher was of prior importance for many scientists in those times. The typical shape of a cowcatcher was a blunt wedge with a shallow 'V' shape in plan. This had made the scientists amused. In the later steam locomotives, the front coupler was designed to swing out of the way too, so it could not get caught up, this was referred to as "Drop coupler pilot". Many new designs were introduced after this which were very helpful. In early times, pilots were normally fabricated with bars mounted on the frame of the locomotive. But in later times, sheet metal pilots came into existence as they were used for additional smoothness. Also some cast steel pilots were employed for mass and smooth shape. Early diesel locomotives followed this principle of plan. The first cowcatcher models were constructed of a series of metal bars on a frame, but sheet metal and cast steel models became more popular, as they worked more smoothly and effectively.

This is a sketch of cow catcher

Cowcatchers on early shunting locomotives in the United States typically included stairs (referred to as "footboard pilots") that allowed yard workers to ride alongside the engine. Footboard pilots are prohibited in several nations for safety concerns and have been phased out. Workers can ride on front and rear platforms with safety rails or steeply recessed stairs on modern locomotives. Small metal bars known as life-guards or rail guards are installed immediately in front of the wheels in the United Kingdom. Their job is to remove tiny impediments that are immediately on the railhead's operating surface. Historically, fenced-off railway systems in Europe depended only on those devices, with no need for pilots, but in current systems, pilots have mostly replaced them, which was viewed as a significant return. With the passage of time, most modern European rail locomotives are required to include snowplow pilots and rail guards. The system must have a strength of 30kN in the middle of the track and 50kN near the rails. Because a diesel locomotive's cab is towards the front, the crew is subject to impediments pushed up by the pilot, modern US diesel locomotives have flatter, less wedge-shaped pilots.

The cowcatcher was frequently reinforced with a drop coupler as steam-powered locomotives became more widespread. The front coupler, which connects train carriages, was designed to hinge up and out of the way to avoid snagging on objects.

A new method called Anti-climbers, where it was to secure the passengers and crew. Most modern locomotives have a horizontally grooved steel beam known as an anti-climber fixed at the front, above the coupler. Its task is to avoid colliding locomotives from riding up and rushing over the locomotive frame through the cab.

One may definitely wonder whether the modern trains have cowcatchers?

Cowcatchers in these modern times also work to clear small obstacles/obstructions from the rail tracks. This part of the steam locomotive has been used for many years. A device called a front coupler is used to join railroad cars to each other and also it was fashioned to hinge up and out of the way in order to avoid it's catching on obstructions.

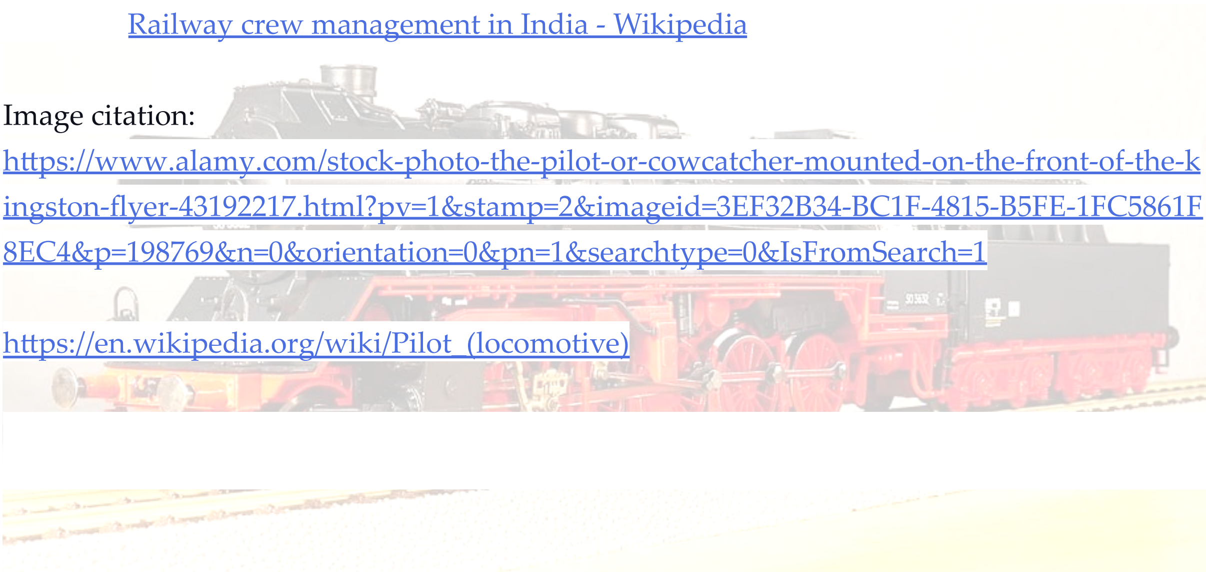
Challenges

The challenges that might be faced while doing this project includes the design of the cow catcher on Autodesk inventor. As this is the main part of the locomotive, the complete knowledge regarding this part is necessary, which should be sourced from credible sites. As modern times are also using cow catcher in the modern locomotives, it is very important to know the working system of the part. It might become very difficult to exhibit the 3D model of a cowcatcher as its design varies. Being an essential part of a steam locomotive, the challenge to make it better increases its efficiency. The outcome of modern locomotives such as metro rails may ensure to find different designs to look better and smooth, which may lead to a new revolution.

Citations: https://www.infobloom.com/what-is-a-cow-catcher.htm
Railway crew management in India - Wikipedia

Image citation:
https://www.alamy.com/stock-photo-the-pilot-or-cowcatcher-mounted-on-the-front-of-the-kingston-flyer-43192217.html?pv=1&stamp=2&imageid=3EF32B34-BC1F-4815-B5FE-1FC5861F8EC4&p=198769&n=0&orientation=0&pn=1&searchtype=0&IsFromSearch=1

https://en.wikipedia.org/wiki/Pilot_(locomotive)



Air compressor of steam locomotive.

Air pumps are the brake valves which apply the pressure between the wheels and operating system to stop the train . The air pump contains the air compressor cylinder which rubs the surface of the train wheels . When the brakes are applied the cylinders apply the pressure to stop the trains or the steam engine valve controls the supply of the stream to the cylinders. The valve gear is connected to the driving wheel. It ensures that steam is delivered to the piston with precision. The types of valves are slide valves, piston valves or poppet valves. Valves chamber next to the cylinder containing passengers to distribute steam to the cylinder .

Straight air brake

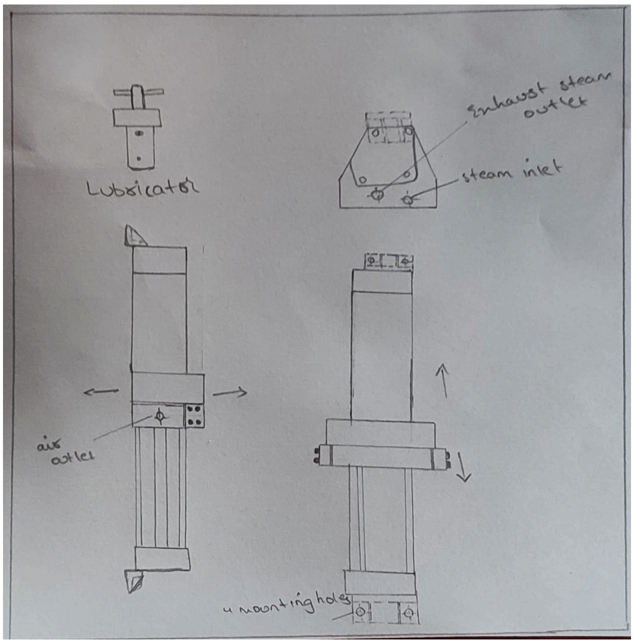
Air pump is a railway power braking system with compressed air as the operating medium . Straight air brakes :Straight air brake system is the simplest form of air brake's system . The piston is connected through the mechanical linkage to brake shoes that can rub on the train wheels. So that the train can slow down due to resulting friction . The main problem with the straight air is the loss of air pressure due to the separation between the hoses and pipes while applying the brakes.

Westinghouse air brake

It's the straight air braking system without any shortcomings of the straight air system. The Westinghouse air brake was invented by Westinghouse . He invented this system wherein each piece of railroad stock was equipped with an air reserver and had a triple valve.The triple valve performs three functions at a time. So,it is named as the triple valve.To apply the brakes it allows air into an air tank ready to be used and releases them. It maintains or holds the application and it permits the exhaust of brake cylinder pressure and the recharging of the reservoir during the release. Whestinghouse refers to his triple valve device in the patent application, because of the three components valvular parts comprising it .

The brake exhaust portal is closed and air from the car's reservoir is fed into the brake cylinder if the pressure in the train line is lower than that of the reservoir. While applying brakes pressure increases in the cylinder and decreases in the reservoir. This process will continue until the equilibrium is achieved between the brake pipe pressure and the Reservoir pressure.
The triple valve connects the train line to the reservoir feed , causing the air pressure in the reservoir to increase when the pressure in the train line is higher than that of the reservoir. The triple valve also exhausts the brake cylinder to the atmosphere, releasing the brakes . The air in the reservoir is sealed in, and the brake cylinder is not pressurized. when the pressure in the train line and reservoir is equalised.

air compressor



Sketch of air compressor of steam locomotive.

Modern systems

The train line vents are controlled and the train line pressure is reduced when the brakes are applied and in turn the triggering the triple valve on each car to feed air into its brake cylinder. The locomotive brake valve portal to the atmosphere is closed when the train operator releases the brake. It allows the train line to be recharged by the compressor of the locomotives. The train operator makes a "service application" of a "service rate reduction", when the train brakes are applied during normal operation. It takes several seconds to reduce the brake pipe pressure throughout the train. The pressure of the brake pipe is reduced at a controlled rate

Automatic breaks:

The automatic brake control the brake pipe and provide the service of emergency braking control for the entire train.

Independent brake:

The secondary system which has the locomotive at the head of the train is called the independent brake .the independent brake is a "straight air" system that has the application on the head of the train locomotive consists independent of the automatic brake, which provide more nuanced train control. The automatic brake system and independent brake system may interact differently as a matter of preference by the locomotive builder or the railroad

Working pressures

The locomotive air compressor charges the main reservoir with air at 120-140 psi(8.6bar,860-970kPa). The train brakes are released through the automatic brake valve and regulate the main reservoir air pressure to the brake pipe. The brake pipe pressure is reduced when the automatic brake handle is moved to service position. The smallest reduction that will cause a satisfactory brake response is used to conserve brake pipe pressure. The sudden pressure is produced when the automatic brake valve is moved to the emergency position. This is also known as emergency brake application. The pressure in the brake pipe is never reduced to zero during normal service. The brake must be applied after recharging. A large brake pipe reduction is required in order to achieve the desired amount of– braking effect. [1]

CHALLENGES:

1. I have faced some challenges while designing the 3d model in the autodesk. I have only basic knowledge about the autodesk inventor software. The parts of the steam locomotive are complex and more numerous. It was hard to make the design in the autodesk and due to more parts.

2. It's hard to find the dimensions of the steam locomotive. And all the dimensions of my design should coordinate with my team members' design .

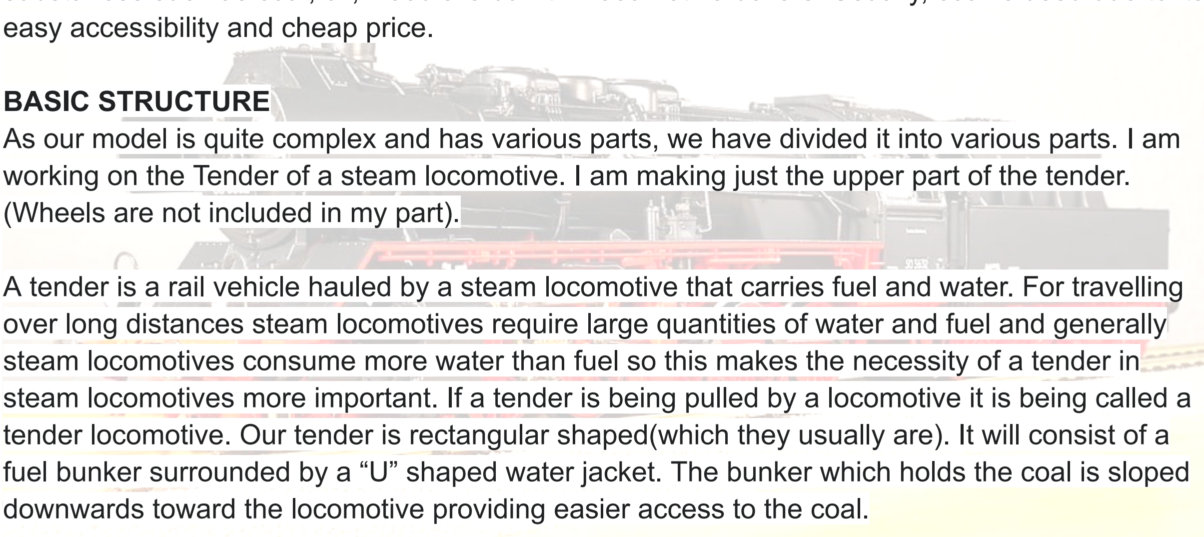
3 We did not learn more about joining various parts in the autodesk. Coming classes may be helpful in learning joining parts.

(https://en.wikipedia.org/wiki/Railway_air_brake#Westinghouse_air_brake.)

Lokesh Khandelwal- Tender

OVERVIEW

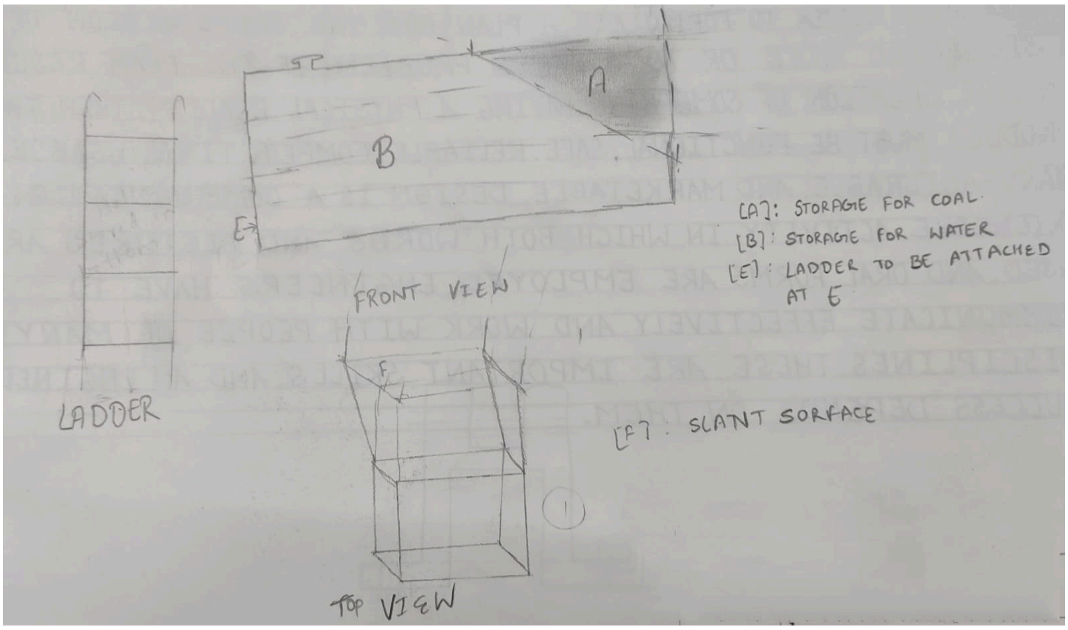
We have decided to make a 3D model of a steam locomotive. A steam locomotive is a rail vehicle that uses the expansion of steam to create the force to move itself and other vehicles. It can be considered as a steam engine on wheels. For fuelling it, combustible substances such as coal, oil, wood are burnt in locomotive boilers. Usually, coal is used due to its easy accessibility and cheap price.



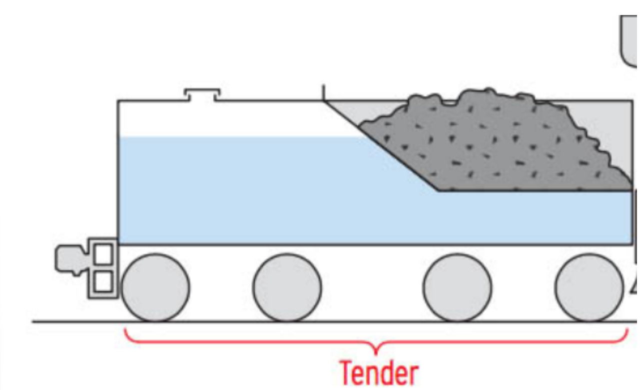
BASIC STRUCTURE

As our model is quite complex and has various parts, we have divided it into various parts. I am working on the Tender of a steam locomotive. I am making just the upper part of the tender. (Wheels are not included in my part).

A tender is a rail vehicle hauled by a steam locomotive that carries fuel and water. For travelling over long distances steam locomotives require large quantities of water and fuel and generally steam locomotives consume more water than fuel so this makes the necessity of a tender in steam locomotives more important. If a tender is being pulled by a locomotive it is being called a tender locomotive. Our tender is rectangular shaped(which they usually are). It will consist of a fuel bunker surrounded by a “U” shaped water jacket. The bunker which holds the coal is sloped downwards toward the locomotive providing easier access to the coal.



This is the image of tender.



[1]

It will have a sloppy side inside the rectangular bunker that will contain the fuel(coal). Underneath will be left empty for the water to be stored. A ladder has to be attached at the back of the tender that will have nearly 5-6 steps and a curvy end upward at both of the handles. And a small chimney needs to be added at the top of the tender as can be seen in the image above.

SCIENCE BEHIND IT

Our model basically works on the principle of the burning of the combustible substance such as coal which provides energy to heat the water till it gets converted to a gaseous state. Basically fuelling the steam engine so that it can run. And to run over long distances more fuel that is more water and coal are required and tender is used to carry the fuel in large quantities making it possible for the steam engines to run over long distances.

FUNCTIONS

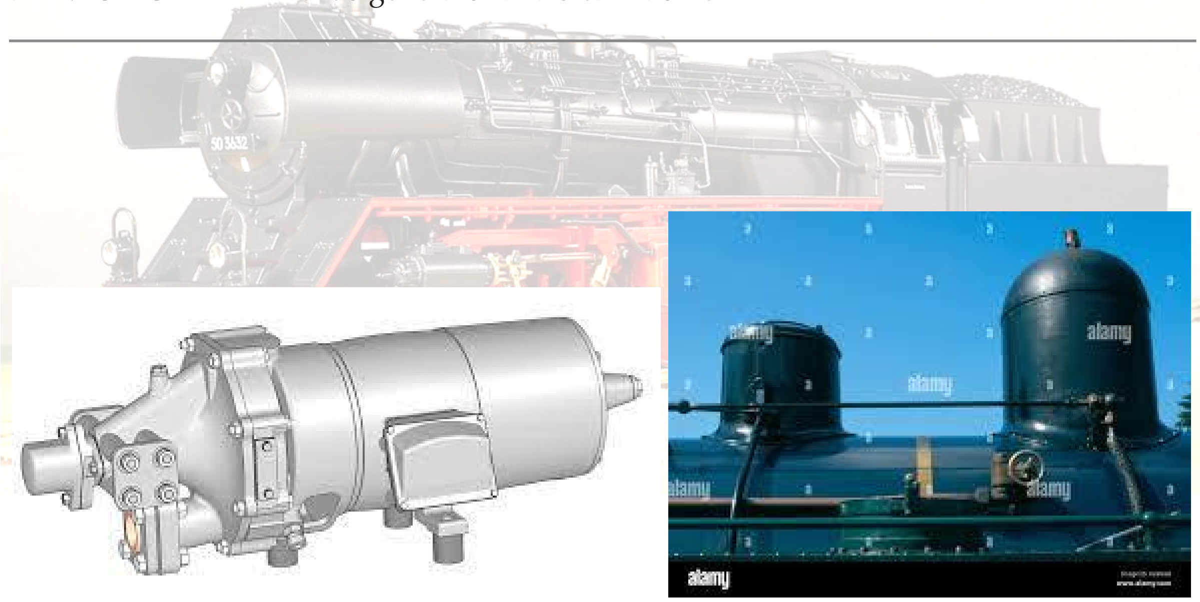
Mainly it is used for fuel and water supply, for the steam engine to run. It is an essential part of the locomotive. Steam locomotives use a lot of water compared to how much fuel they use, thus tenders are required to keep them operating over long distances.

POSSIBLE CHALLENGES THAT CAN BE FACED

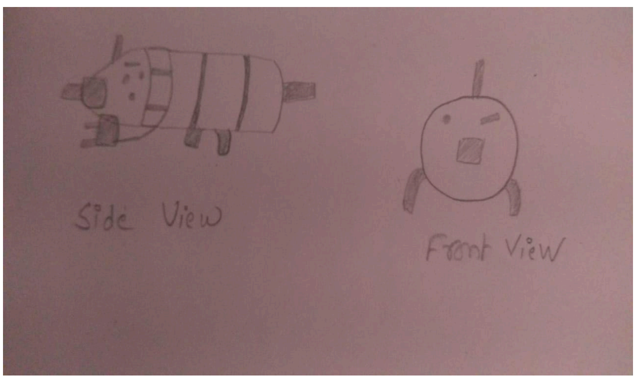
I have attended just two tutorial sessions as of now, so I cannot claim the challenges but some possible challenges can be the inner part of the tender. The inner part has quite minute details that have to be visible so need to keep the dimensions accordingly. And attaching the stairs at the back and extruding it correctly might cause a problem I guess. The small chimney and other details of the top need to be designed carefully as they have small dimensions and can overlap or might require a different plane which I am not very good at so need to keep more attention while working on the upper part of the tender.

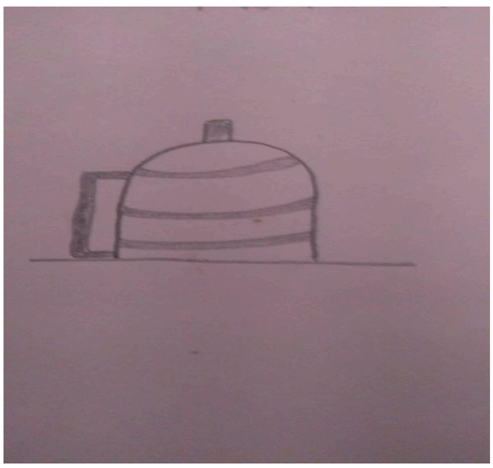
[1]: Google Images
Source: https://en.wikipedia.org/wiki/Tender_(rail)

MANAS AGRAWAL-Turbo generator and steam dome



Left- electric generator, right- steam dome

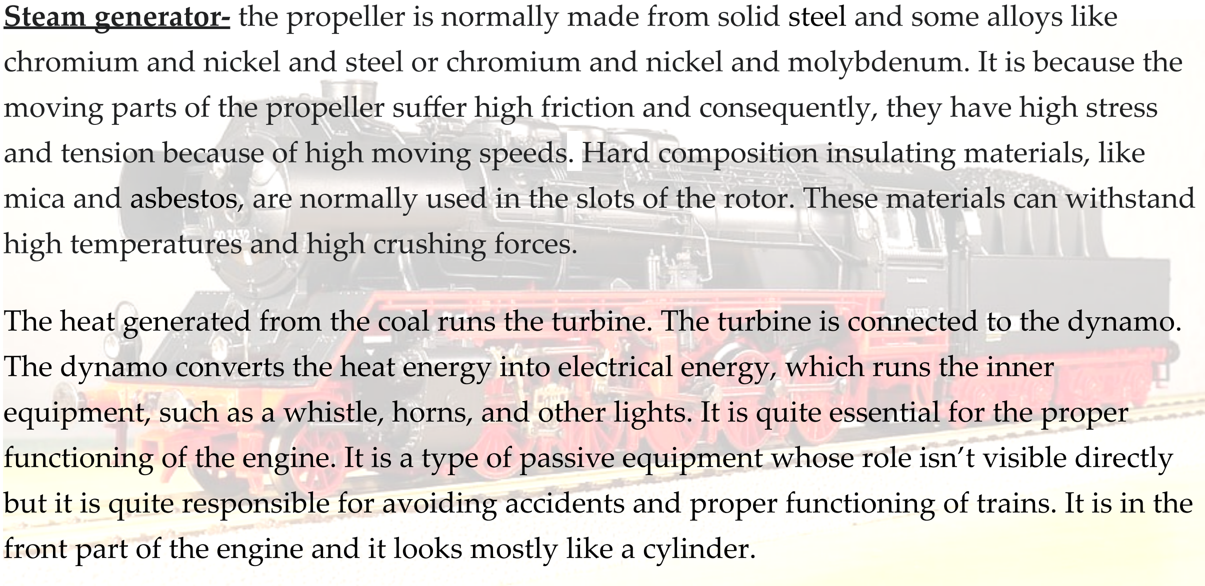




Overview - Electric generators are the most important part of a steam engine. It basically converts heat energy into electric energy. It works on the principle of a turbine. The heat generated from the coal runs the turbine. The turbine is connected to the dynamo. The dynamo converts the heat energy into electrical energy, which runs the inner equipment, such as a whistle, horns, and other lights.

A steam dome is also one of the important parts of a steam locomotive. It acts as a chimney in steam locomotives. It connects to the main opening of the steam boiler and maintains the opening of the steam valve so that a hydraulic choke doesn't occur. It also maintains a smooth flow of steam inside and outside. It checks that the water level in the boiler remains stable and doesn't overflow

Body and working –



Steam generator- the propeller is normally made from solid steel and some alloys like chromium and nickel and steel or chromium and nickel and molybdenum. It is because the moving parts of the propeller suffer high friction and consequently, they have high stress and tension because of high moving speeds. Hard composition insulating materials, like mica and asbestos, are normally used in the slots of the rotor. These materials can withstand high temperatures and high crushing forces.

The heat generated from the coal runs the turbine. The turbine is connected to the dynamo. The dynamo converts the heat energy into electrical energy, which runs the inner equipment, such as a whistle, horns, and other lights. It is quite essential for the proper functioning of the engine. It is a type of passive equipment whose role isn't visible directly but it is quite responsible for avoiding accidents and proper functioning of trains. It is in the front part of the engine and it looks mostly like a cylinder.

Turbo generators were initially used for running for high-speed rotations of big shafts. Initially, they were for steam and gas turbines. The general velocity of the turbo generator is 1500 to 3000 RPM with four or many times two poles at 50 Hz.

There are some heavy nonmetal wedges on the upper part of slots that protects windings against centrifugal forces.

Steam dome- Its shape is the same as that of a cylinder and it was usually made of rolled iron and later with steel sheets. But these sheets were not big enough, so 2-3 sheets were required at a time to make a single dome

"The first locomotive with a deliberate dome added to the boiler barrel was 'Stephenson's rocket' although this was so small as to have little effect against priming. Many other locomotives built shortly after this date instead used either the 'Haycock Boiler."

It is very clear about the work and function of the steam dome. [1]

Challenges- The major challenge while designing this part on autodesk is about the dimensions, since we were in experience of making designs with provided dimensions. It would be a bit hard to find dimensions and coordinate with proportion with other parts as well. Also, the turbo generator is cylindrical, with numerous sub parts embedded while we were in the habit of designing proper cut to cut parts, i mean kind of linear parts. so , that part is going to be quite challenging.

The thing that I would like to highlight is that **don't confuse a steam dome with a sand dome.** These are two different things. A sand dome is a sand container that lays out the sand in front of the wheels at the railway tracks to avoid slipping during winters at icy or ultra-smooth rails while the steam dome has to do nothing with the movement of the engine. It just ensures that the water and the steam movement continue normally. Also, there is no water choke

Some points are paraphrased from the internet (wikipedia)

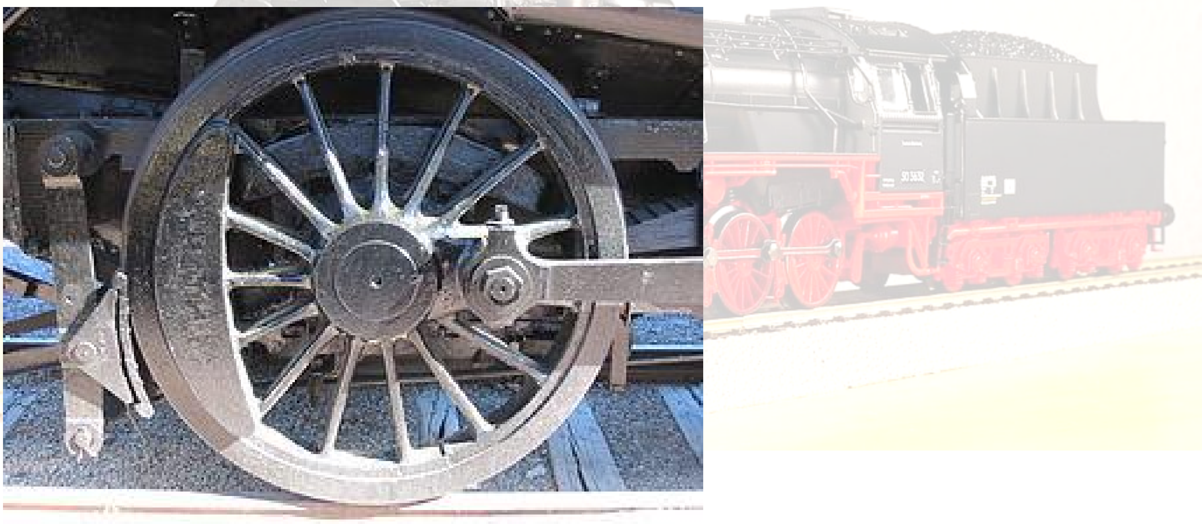
https://en.wikipedia.org/wiki/Steam_dome

[1]https://en.wikipedia.org/wiki/Steam_locomotive_components

These above are the sources from where some of the points were cited.

Manav Parmar- Wheels and leaf springs

Wheels-



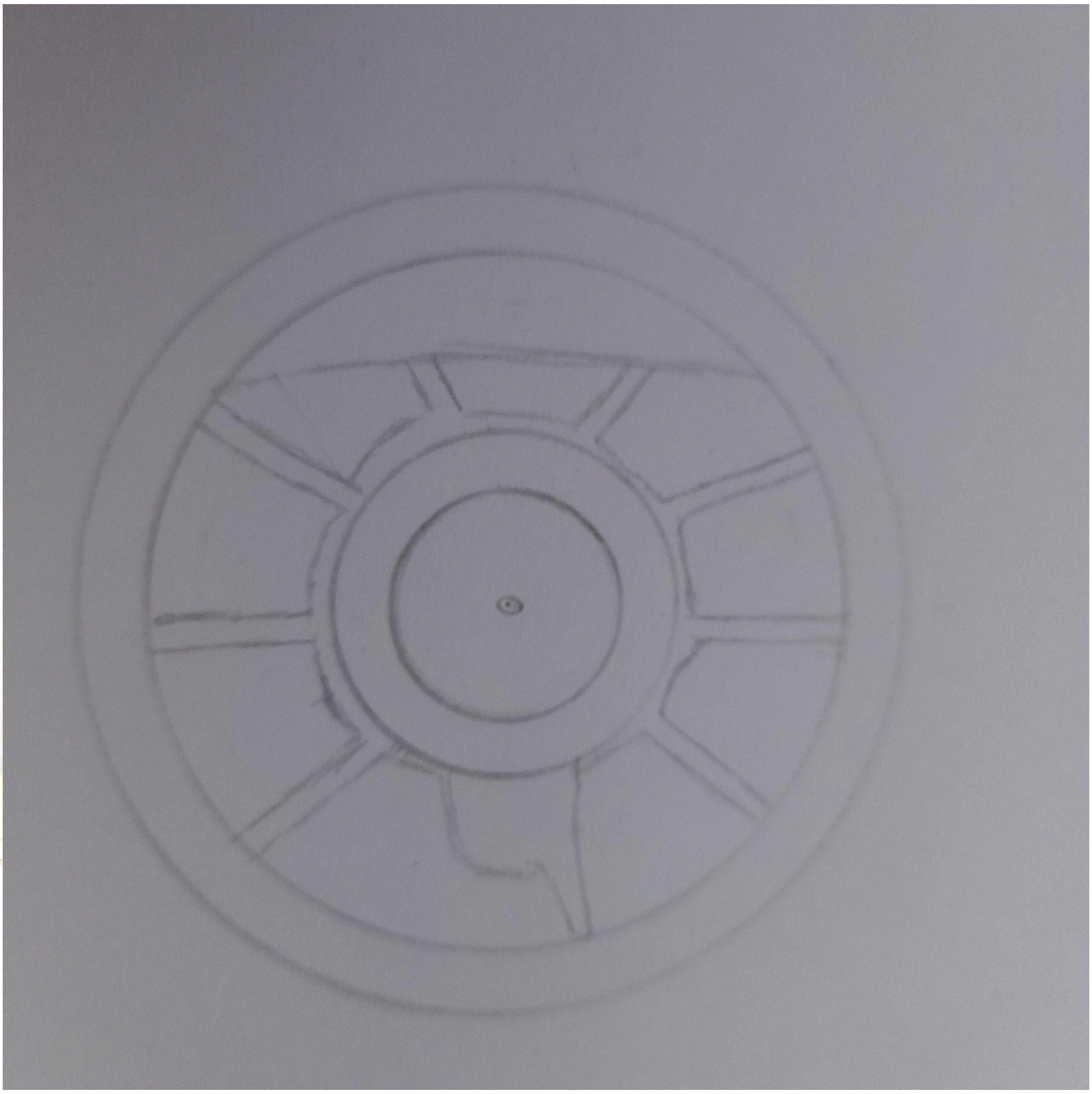
Overview

The driving wheel as the name suggests is the wheel that is under the cab of the locomotive. Its function is to convert the linear force of the piston to the rotational force which is applied on the rails. Furthermore, it also helps to transfer weight. On the face of it, it may seem to be a simple part but it has its own complications. For example, the radius of the wheel can determine the pulling capacity and the top speed of the entire locomotive. Also to offset the weight of the side rods the driver wheels must include appropriate counterbalancing[1]

.

Basic structure

There are usually three sets of wheels associated with the driving wheel. They are viewed in 2d, circular-shaped structures with long rectangular rods in them. The tricky part is their connections with the other wheels and their connections with the motor. In three dimensions it will have two sorts of hollow cylinders with some width and long cylindrical rods which can be connected to the inner part of the central circular part and the inner part of the outer cylindrical part. The wheels on each side are connected through a metal rod called an axle.[2]



Science behind it

The normal construction of a wheel having a cylindrical structure would work very well for straight tracks but the problem arises when the train has to travel in a curved path To help the train stay on track the wheels are slightly slanted as when the slanted set of wheels turns, The outer part of the wheel is moved towards the outside of a cone, and conversely, the inner part moves towards the inner part of the cone. This happens due to the application of centrifugal force. So effectively on a running locomotive, there are effectively two wheels.

Due to the larger radius of the outer wheel, it effectively travels a larger distance than the inner wheel.[1]
On how the wheels get power-it is provided through traction motors. Each motor will power a small gear which in turn will power the larger gear on the axle shaft. Also, various torque converters are used which transfers power from the engine to the local wheels.[4]

Possible difficulties

Since I have not had a lot of experience with Autodesk, I do not have a clear picture of difficult to do parts. But on the surface of it, the connections with the axle and the motor are going to be tough. The making of the semicircular part present in the left of the shared image also looks like a challenging task. Another challenge will be to convert the actual dimensions to dimensions on AutoDesk. As I won't be including all the parts, the dimensions of the ones I have included would be done considering the visibility and appearance and hence would complicate the structure.

Sources-

1.https://www.scientificamerican.com/article/train-wheel-science/#:~:text=When%20a%20train%20with%20slanted,are%20effectively%20two%20different%20sizes. ,
2.https://www.steamlocomotive.com/types/drivers/
3.https://en.wikipedia.org/wiki/Driving_wheel#:~:text=On%20a%20dream%20locomotive%2C%20a,of%20a%20dream%20turbine%20locomotive).
4.https://www.quora.com/How-do-diesel-locomotives-get-power-to-its-wheels

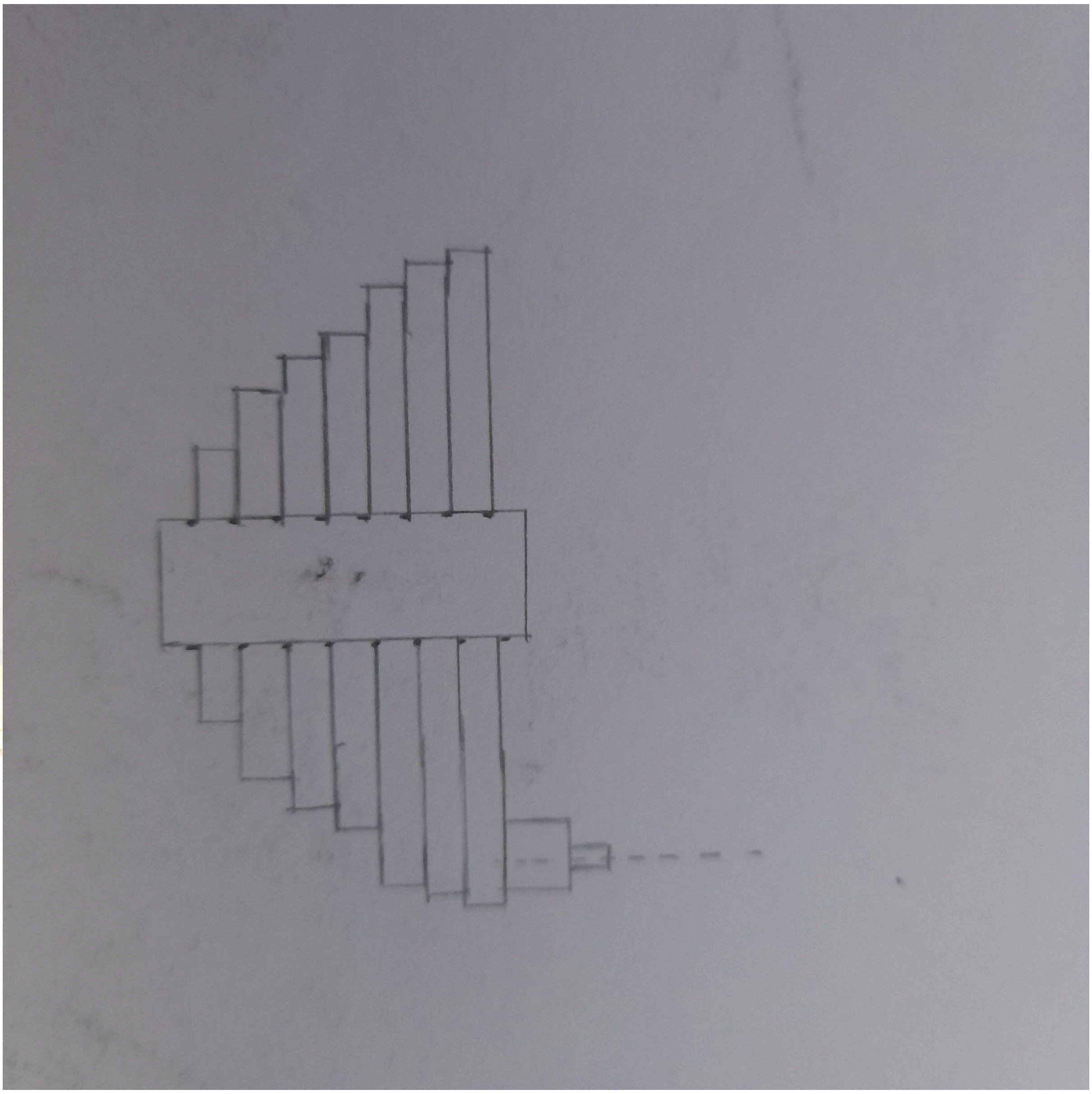
Leaf Springs-

Overview

Leaf spring is a basic tool used for suspension in wheeled vehicles. Originally called a carriage spring it first appeared in France in the mid 17th century. The basic function of the leaf spring is to provide some degree of comfort against the vertical movement which can be caused due to the non-uniformity of the road. The spring should have a low modulus of elasticity in the longitudinal direction for better functioning.It must also have good resistance towards high fatigue as changing it every now and then might become a hectic task.[1]

Basic structure

It has a number of layers joined together that increase in size as we move from top to bottom. They are directly attached to the frame either from one side or from both sides. When viewed from the front in 2d it will look like multiple arcs of increasing radius joined together. It will have multiple springs attached to it. It forms a semi-elliptical shape



Science behind it

It functions just like a normal suspensor. When spring is damned it produces an opposing force which reduces the acceleration and hence ensures that the passengers or the goods inside do not have to face a lot of vertical movements due to uneven tracks. Springs also function to support the weight. They are always accompanied by dammers which ensure that the springs do not vibrate uncontrollably.[2]

Possible difficulties

Since the modal is of a nonroutine geometrical shape difficulties can be expected from the 2d figures. The leaf springs not being perfectly planar will also cause some trouble. As I have not used a lot of Autodesk, the above mentioned are just some of my estimations

Sources-

1.https://www.sciencedirect.com/topics/engineering/leaf-springs

2.https://en.wikipedia.org/wiki/Leaf_spring

OVERVIEW

The interior of the cabin mainly includes:

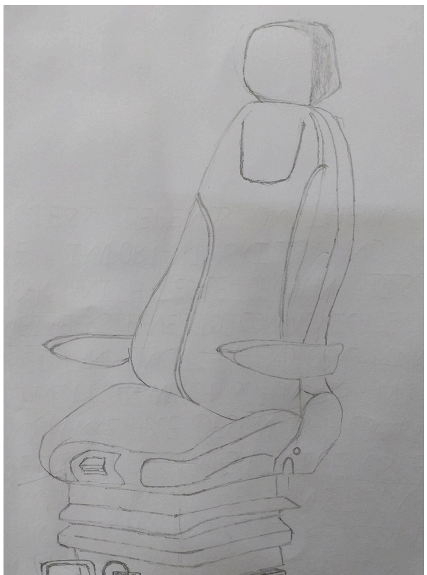
- Dashboard
- Driver's seat
- Some additional sitting
- Some storage space.

A dashboard, otherwise known as an instrument panel is a control panel for all vehicle operations. It has control over the whole vehicle and all its operations, all the information related to the vehicle can also be found here. It comprises many small meters, buttons, and levers, to have complete control over the vehicle. All the steam pipes also pass through the dashboard so that the driver is aware of any mishaps. It is located directly in front of the driver's seat, which is a basic sitting arrangement for the driver. The Driver's seat must be comfortable so the driver does not feel tired or have any undue pressure on the body and can work efficiently.

BASIC STRUCTURE

A dashboard has considerably evolved, in shape, design, and technology. Different vehicles have dashboards of different shapes and sizes with varying technologies. In a train, the dashboard is quite complex. The structure of a dashboard is sort of a table top at an angle for the better viewing angle of the driver. Also the sides are curved and are placed at an angle to make every corner of the dashboard reachable. Generally made of a very strong material like metal to withstand trains movement over long distances. Ideally, it should cover one side of the cabin and touch both sides so that it can have support for a stable structure.

The structure of the seat is such that there is a metal frame covered with cushions to make them comfortable. The metallic frame has a square base and a back support which is at an angle to the base and under the base is a shock absorbing mechanism with springs which is crucial considering the nature of train journeys. The cushions are covered with leather as it is durable and comfortable. The seat also has two arm rests and an adjustable head support.



SCIENCE BEHIND IT

All the working of the dashboard is behind the basic outer structure we see. All the meters, buttons, and levers have long wires attached which connect them to the part they are supposed to connect. Like a switch for light connects the power supply to all the light bulbs and a switch to turn the lights on and off on purpose, the brakes liver is connected to the brakes, etc. The shock absorption mechanism basically has a spring under the base of the seat, which compresses and releases based on the type of the track. Everytime the train goes over a bump the spring compresses from the lower part and keeps the upper part, where the driver is sitting, stationary so that the ride can be smooth and comfortable for the driver.

POSSIBLE CHALLENGES

With just two classes into the course, I'm Expecting to face a lot of challenges some of which I can mention are the curved shape of the seat cushion, as it is not any definite shape and is kind of like a wave, I might have a hard time drawing it, also, the spring mechanism can be a possible challenge as we haven't drawn any structure like that yet. Also we haven't learned how to join parts yet, so it will be tough to make the whole structure in one piece. Making the structure of the dashboard will be a challenge as to place it in the cabin like its positioning and all the dimensions. While assembling the pipe I suppose it will be difficult to position them under the dashboards as they will be made at an angle. Also, the structure of the steering wheel will be a challenge, and assembling it and making it movable on the dashboard will be tough.

Overview:

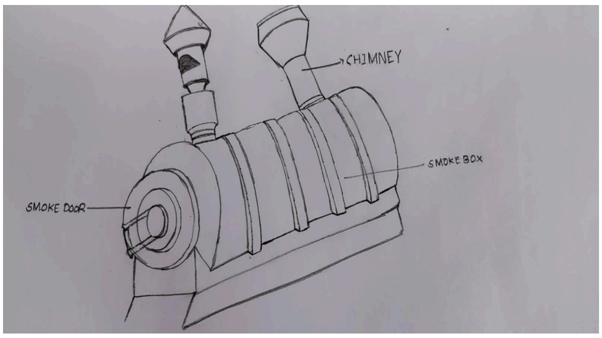
Smoke Box plays an important role in the working of steam engines. Smokebox helps prevent the burnt air in the tubes to the firebox so that fresh air can enter into the combustion box. Even researchers tried for the long chimney instead of the smokebox but it did not work because the smoke and hot gases in tubes are going back to the firebox and the char from cylinders are getting stuck to the walls so the passage of air into the atmosphere is difficult. The smokebox has a blast pipe which is a vertical pipe located below the chimney. The smoke door is kept so that if the dust from smoke remains it sticks to the walls of the door so that it can be easily cleaned at the end of the working day.

Basic Structure:

SmokeBox consists of Blast pipe, Chimney, Petticoat pipe/Apron, Blower, Superheater.

Smoke Box

Smoke door



Smoke boxes are usually made of steel welded plate and to protect the steel from hot char and acid or rainwater attack the floor is lined with the concrete.
Smokebox doors are hinged circular doors to allow service access to the smokebox.
Smoke doors have handles that should be fixed tightly so that no air leaks. Some smoke doors have a single handle and some have the type of clock doors.
It consists of appropriated nozzles of pipes so that gasses are drawn effectively.
A blower is a vertical pipe located below the chimney petticoat pipe, with the holes to blow steam upwards

Working:

The smokebox consists of a blast pipe through which the used steam is passed and the heat from boiler tubes gets into the box and enters into the atmosphere through the chimney. The use of this blasted pipe draws effective heat so that the heat cannot escape to the firebox back. The steam which is coming from the regulating valve enters the cylinder which consists of a piston and used steam into the blast pipe. If the smokebox is not present then the heat in the tubes gets into the firebox and decreases the steam to enter into the cylinder. The smokebox lets the fresh air into the firebox so that heat is converted to mechanical energy. A smoke door is present so that the remains of any ashes are stuck to the walls of the door and this can be easily removed at the end of the working day. A blower is a pipe ending in a ring containing a pin-sized hole, which creates a ring of steam jets. This will draw the gasses from fireboxes and burn effectively. Blast pipe makes a sound like chuff when steam is passing into it. Even a spark arrest is involved within the smokebox. This is of cylindrical mesh from the blast pipe to the chimney...Even there is some disadvantage of spark arrests as they have a thermodynamic effect, which opposes the draw of air over the fire. So there may be a reduction in the output. So the use of these spark arresters may be contentious. The benefit of this superheating in superheater is that the steam has greater expansive properties when entering cylinders, so more power can be gained from the small amount of water and fuel. Hence, for the working of steam engine smokebox plays a crucial role in heating water in the boiler tubes and thus the steam is converted into mechanical energy.

Science Behind It:

The science behind this smoke box is that the smoke in the cylinder passes through a blast pipe. The piston in the cylinder moves so that heat energy is converted into mechanical energy, that is this movement of the piston drives the wheels which are connected to the cylinders through different rods. There is not much science behind the smokebox door as this keeps the dust that remained in the smokebox come to a point so that the dust in the can be cleaned easily at the end of working day by opening this smokebox door. Many inventors tried to avoid smoke boxes and can be placed with the long chimney but did not work because of these important functions of smokebox that passes all the steam into the air so that fresh air can enter into combustion.[1]

Challenges to be faced:

Since this is the first time introducing an inventor desk I may face a problem in making up the chimney at the top since it has a funnel shape and may have trouble with this. Coming to the smoke door I may face a problem in making the handle of the door as there are very small dimensions, to sketch it in the autodesk I will face a problem in showing dimensions along the smoke box.To extrude the dimensions properly in the smoke door also I may face a problem.

Reference:

[1] https://en.m.wikipedia.org/wiki/Locomotive_frame#:~:text=A%20 locomotive%20 frame%20is%20the,frame%20structure%20of%20some%20kind.

Frame or Locomotive Frame of Steam Engine

Locomotive frame is one of the parts of a steam engine and it plays a major role in the processes of a working steam engine. It is also called the backbone structure of the steam engine and the locomotive frame gives strength and support to some superstructure elements that are present near the locomotive frame such as cab, boiler, or bodywork. In locomotives, the massive structure is a frame structure.

The frame is directly connected to the wheels of a steam engine. The bodies are mounted on a locomotive frame and every bogie has their locomotive frame.

Without the locomotive frame, there is no motion in the entire steam engine.

There are three types of frames in a steam engine they are plate frames, bar frames, and cast steel beds, these are the fundamental types of frames on a steam locomotive and they are distinguished based on the working process and place situated but these all types of frame are situated above the railway track or below the bogie. These three types of frames play a major role in the working of the steam engine without the presence of any type of frame the steam engine may not work or may not move further.

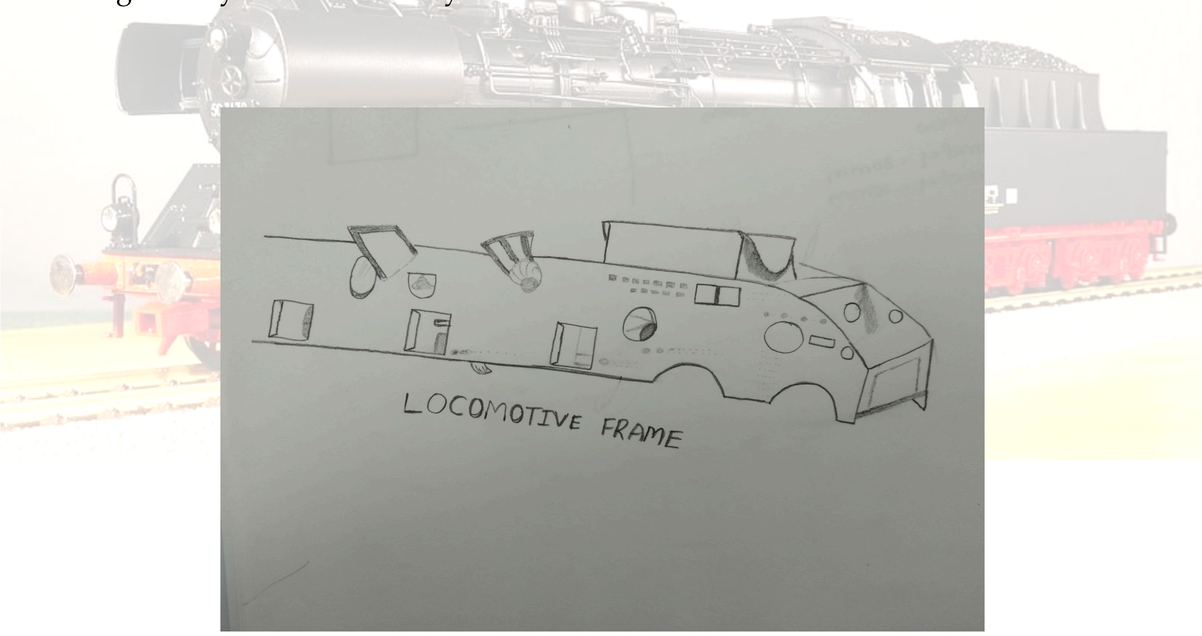


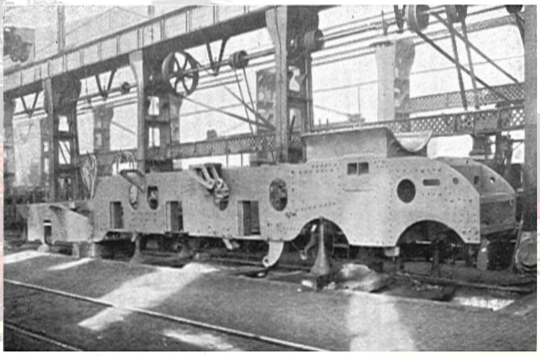
Plate frames

The plate frames are made up of steel material and the thickness of the plate frame is one to two inches or 25.4-50.8 millimeters. Sometimes the plate frames are used in some parts of India but it is mostly in England and some places of continental Europe. Most of the plate frames are situated between the wheels which are locomotive driving wheels. In early times instead of using the plate frames, our ancestors used outside frames constructed with diesel shunters. There are different types of designs in the frames of the steam engine, in early times the design of the frame of the steam engine is double framed design, the double-framed design is the old design which consists of both inside and outside as plates within the driving wheels, there are some frames called sandwich frames, these are also an old design and they are constructed with wood sandwiched and the metal plates and they constructed with a sandwich wood in between the two metal plates but this design is very big and to construct frames metals plays a vital role because metals are very hard and strong.

Bar Frames

Most of the bar frames are made up of steel and sometimes it also made up of iron bars, the thickness of the bar frames is four to seven inches or 100-180 millimeters, and the bar frames also play a major role in the movement of the steam engine and the bar frames are openwork pillars built with iron bars and steel. In the past few days instead of using bar frames, they have bury bar frame locomotives. In the 1830s and nineteenth centuries the bar frames were widely used in America and most parts of England also and these are also used for export to other countries like Australia and New zealand.

The bury bar frame locomotive is one of the early types of steam locomotives and mostly it is developed at Liverpool it was invented by Edward bury in 1842 and is developed by Robert Stephenson, Timothy Hackworth, and Edward Bury.



[2]

The cast steel beds are made up of steel material. Cast beds are designed in the United States of America and they are also exported to Britain and some parts of Australia from the United States of America.[1]

Challenges Faced

I encountered some challenges while designing the frame of the steam engine as I had only basic knowledge about Autodesk software. As the part on which the wheels are attached and the engines are mounted, the frame of the train requires to be designed with utmost care in terms of the proper dimensions. Dimensions are to be made by the width of the track through which the train is to travel. The design of the frame should go in hand with the dimensional design of the parts that are to be attached to it.
The material of the frame must be chosen in such a way as to support the associated parts and stay durable as it is the supporting skeletal structure on which the entire machinery rests. These are made of steel or iron bars. So I should make it give importance to the role it plays in holding together the steam engine.

Most train accidents occur due to the improper arrangements of frames and in correction in connections of frames and wheels. The locomotive frame supports all the moving parts in a steam engine and also it holds all parts in proper positions.

Citation:
[1] https://en.m.wikipedia.org/wiki/Locomotive_frame#:~:text=A%20 locomotive%20 frame%20is%20the,frame%20structure%20of%20some%20kind.

Image citation:

[2]https://images.app.goo.gl/9TdvvAjDEVpx1D5S9
https://images.app.goo.gl/QT3ngpwXpDyjRvuC6

Malwat Mohammed Hussain

Walschaerts Valve Gear

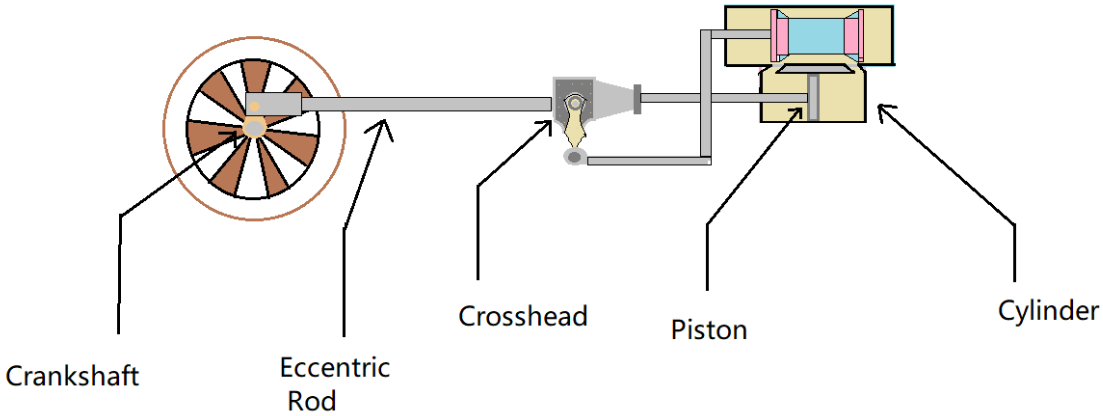
Overview:

The Walschaerts Valve Gear includes complex rods and links that control the power of the steam injection and exhaust from the cylinder. Earlier to the invention of steam locomotives by Egide Walschaerts valve mechanisms were very inefficient in managing the steam resources as they worked in timing scheme.

Working:

The sliding valve is driven back and forth conducting high-pressure steam from the center of the chamber into alternating end ports of the working cylinder below it and simultaneously the valve sends steam to one end of the cylinder while the other end is exhausted through the opposite end of the valve chamber in this case you can see that the valve remains open for nearly the entire stroke of the piston this timing scheme results in the maximum power here's how it works the valve spool motion is the result of two linkage trains resolved by the combination rod while the lower linkage moves synchronously with the piston the upper linkage is 90 degrees out of phase. Due to its connection to a second eccentric on the primary drive wheel the eccentric is linked to a special expansion link which transmits motion to the radius rod and the radius rod in turn links to the combination rod just above the valve stem connection as the upper linkage is 90 degrees out of phase with the lower it subtracts motion at one end of the piston stroke and adds it at the other thereby keeping the injection towards open for the maximum duration now once the train has reached running speed full power is no longer required to conserve high-pressure steam then the valve timing can be adjusted to reduce the injection period with respect to the piston stroke the expansion link gives the engineer the ability to do this by controlling how much secondary motion is transmitted to the combination link as the radius rod pivot is adjusted to the center slot position in the expansion link dialog the motion contributed by the secondary eccentric linkage is effectively canceled consequently the travel of the valve stem is greatly reduced and thus the steam injection period is shortened to just a fraction of the piston stroke the engine can be continually adjusted between high power and high efficiency as the situation finally by adjusting the radius rod to pivot above the expansion link pivot the eccentric motion is effectively applied 90 degrees out of phase in the opposite direction thereby reversing the engine

Parts:
(5 Parts)



1)Piston Rod

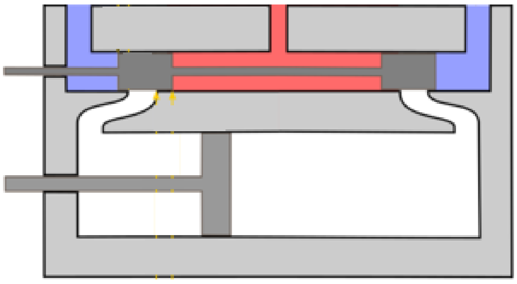
It joins the piston to the crosshead thus joining the Eccentric Rod to drive the crankshaft. It needs to be smoothened and accurately cylindrical.

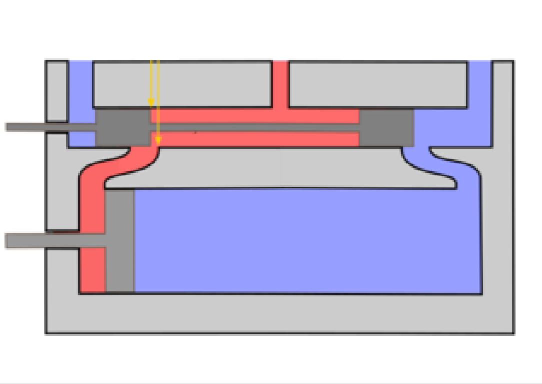
2)Piston:

It is driven backward and forward in the cylinder due to expansion of steam thus producing motion for the locomotive. In steam engines particularly steam is entered front front and back of piston hence its called double acting

3) Cylinder :

The main component providing power in steam locomotives is the cylinder. It is made air-tight to maintain steam pressure with valves to distribute steam along the ends.Valves are used to control the admission and exhausting of steam in the cylinder such that the locomotive moves with maximum power possible.





3)Crosshead

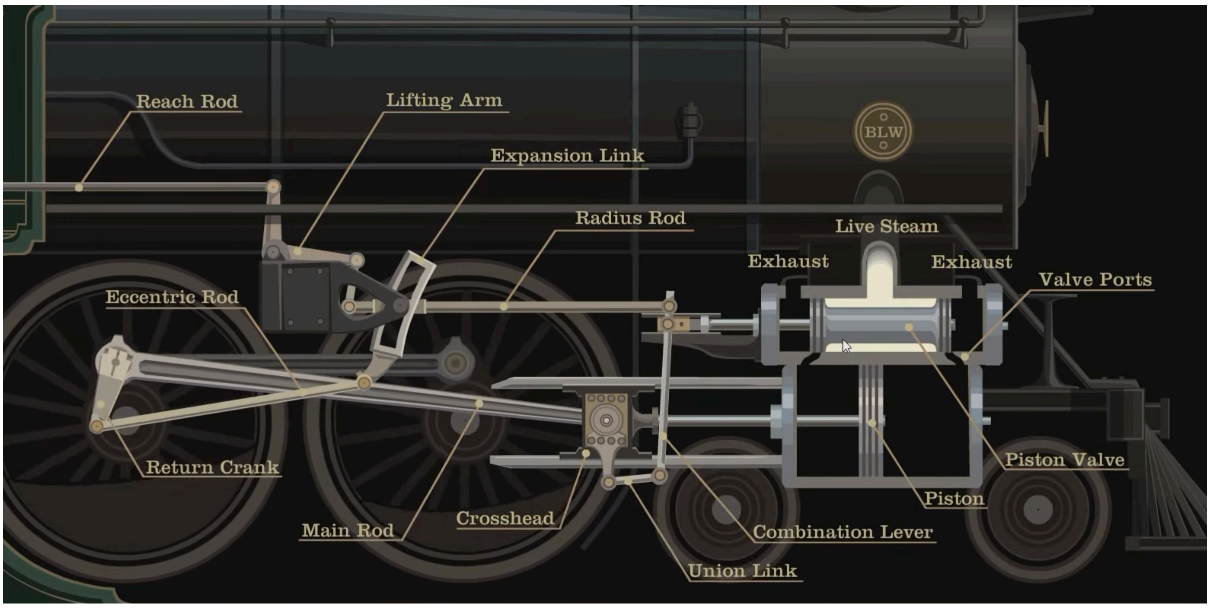
A crosshead is a mechanism used to reduce the sideways pressure on piston. It helps the eccentric rod to freely move outside the cylinder.

4)Eccentric Rod

Steel rod that converts oscillatory motion of piston into rotary motion of wheels.It is connected to piston and main ro in a crosshead fashion, which slides on a bar.

5)Crankshaft:

It is attached to the Eccentric rod to convert the oscillatory motion into rotary motion. The crank is of a length such that the pin attachment to the eccentric rod is 90 degrees out of phase with the lead motion.



Challenges :

1. As the parts of locomotives are complex and more in number, their dimensions need to be coordinated well with the group members.
   (As of now we have only image of steam engine and no dimensions are available for parts)
2. In 3d some parts are visible from outside while the majority of parts get hidden behind. I don't know any technique to present those parts.

Sources:

1. https://en.wikipedia.org/wiki/Steam_locomotive_components
2. https://www.youtube.com/watch?v=8yRVMnPJmdQ
3. https://www.youtube.com/watch?v=YuPtJ3kkd0w

50 3632