A Report

On

Dynamics of machine Project

Submitted By

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Prepared in the partial fulfilment of the

DOM PROJECT

In

Mechanical Engineering

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SUBMITTED TO: -

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&

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BML MUNJAL UNIVERSITY™

FROM HERE TO THE WORLD

SCHOOL OF ENGINEERING AND TECHNOLOGY

BML MUNJAL UNIVERSITY GURGAON

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INTRODUCTION

A Stirling Engine is an extremely efficient device at extracting energy from heat differences (i.e., one side hot and one side cold) and it can be run from any fuel or energy source from the sun, to a candle, or from burning wood to the heat from your hand. Best of all, it is surprisingly simple to make a working model Stirling engine from readily accessible free or cheaply available parts and without expensive tools.

It is device that converts heat energy to mechanical power by alternately compressing and expanding a fixed quantity of working fluid at different temperatures.

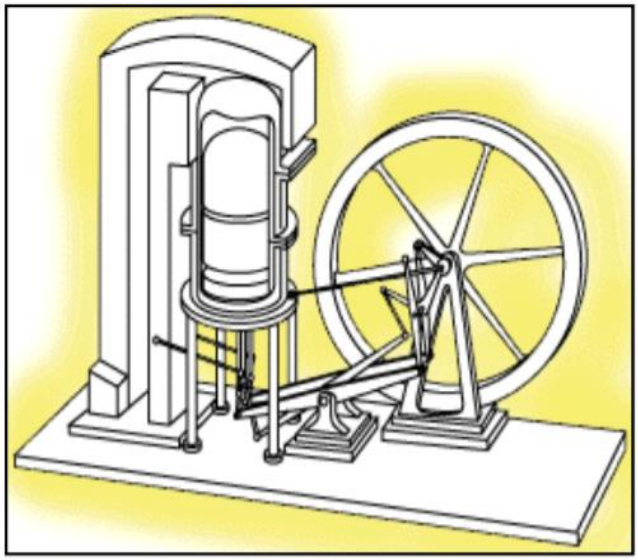
Regeneration as alternative.

Stirling engines are sometimes called **hot-air engines**. If we seal this air in a closed pipe, so the same air moves back and forth repeatedly, picking up energy from the fire and releasing it in the cylinder, we solve the problem of the engine needing a constant supply of water. Finally, why not add some sort of heat exchanger so that as the hot air passes back and forth, it's energy is retained inside the machine and recycled to improve the overall efficiency.

These are the essential ways in which a Stirling engine improves on a steam engine. You'll sometimes see Stirling engines described as "closed-cycle, regenerative heat engines," which is a very terse way of saying what we just said: closed-cycle means they use a sealed volume of gas to move heat back and forth, over and over again, through a series of endlessly repeated steps; regenerative simply means that they use heat exchangers to retain some of the heat that would otherwise be lost on each cycle.

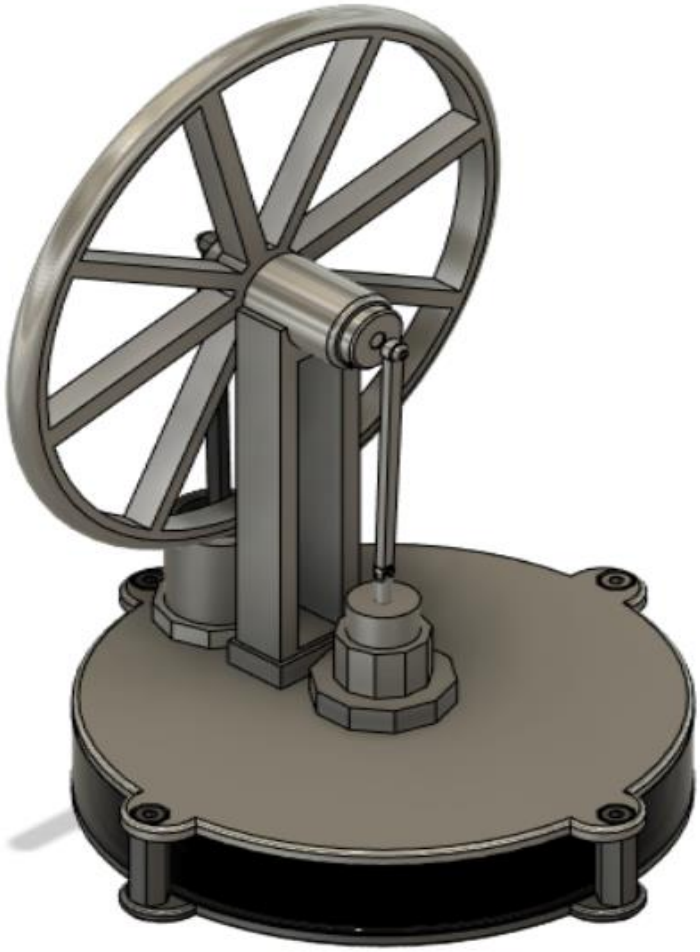
HISTORY

he Stirling Engine is one of the hot air engines. It was invented by Robert Stirling (1790-1878) and his brother James. His father was interesting in engine and he inherited it. He became a minister of the church at Scotland in 1816. At this period, he found the steam engines are dangerous for the workers. He decided to improve the design of an existing air engine. He hope it wound be safer alternative. After one year, he invented a regenerator. He called the "Economiser" and the engine improves the efficiency. This is the earliest Stirling Engine. It is put out 100 W to 4 kW. But the internal combustion engine substituted for it quickly. The Ericsson invented the solar energy in 1864 and did some improvements for after several years. Robert's brother, James Stirling, also played an important role in the development of Stirling engines.

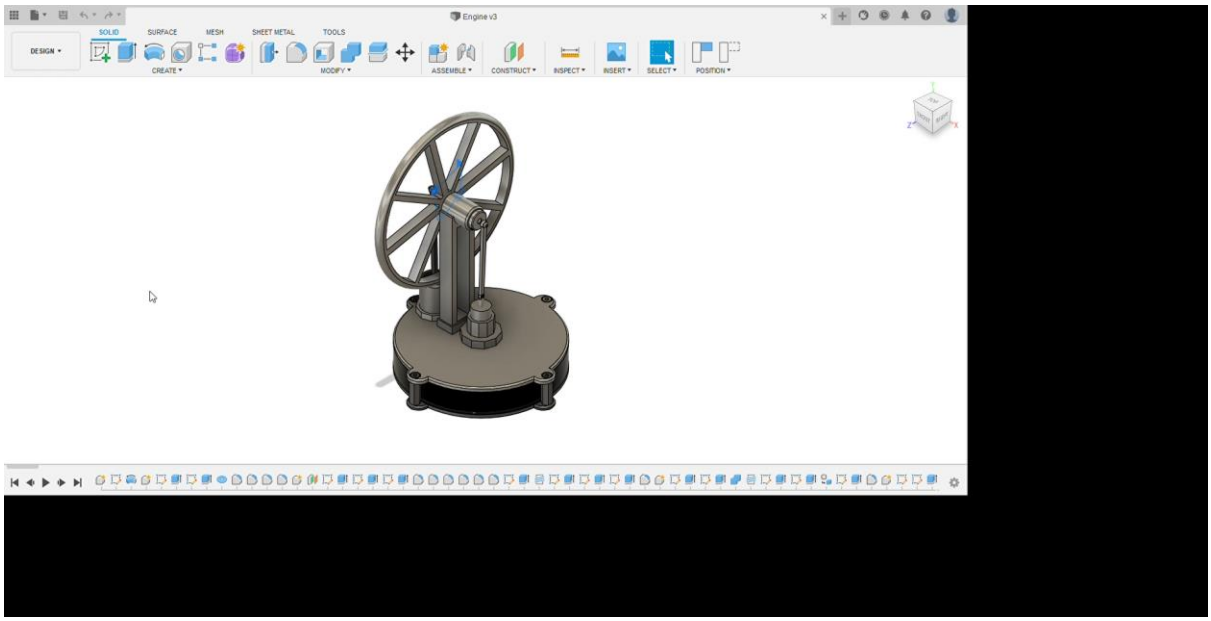


Robert Stirling gets a patent for the economizer with an air engine incorporating it in 1817. Since the Stirling engine worked at a lower pressure, and could not cause steam burns, the danger to explode is impossible. In 1818 he built the first practical exponent of his engine, used to pump water from a quarry. The inventors sought to create a safer engine instead of steam engines at that time, whose boilers often exploded as a result of high pressure of the steam and the inadequate materials.

3D MODEL



ANIMATION



Parts

1. Cylinders

There are 1 or 2 cylinders used in stirling engine depending on its type i.e. alpha stirling engine or the beta stirling engine.

In alpha stirling engine 2 cylinders are used that are-

1. **A cold wall cylinder-** It is the cylinder that provides cooling of the gas by some external means like cooling system, in order to reuse the gas for another cycle.
2. **A hot wall cylinder-** It is the cylinder through which the external heat source is connected that provides heat to the gas inside this cylinder to expand the gas.

2. Pistons

It is the rigid cylindrical piston which is used inside the cylinder and is responsible for the final power output of the engine **.**

Depending upon the type of Stirling engine i.e., alpha or beta, 1 or 2 pistons are used, (for alpha stirling engine 2 piston and for beta stirling engine single piston is used).

3. Gas

A gas which is the working fluid for the stirling engine is used inside the cylinder in such a way that the compression and expansion of this gas inside the cylinder causes to and fro movement in the pistons.

4. External Heat Source

A external heat source (renewable or non-renewable) is used for heating the wall of the hot cylinder (Alpha S E) or the hot end of the cylinder (Beta S E) which in turn expands the gas i.e. increases potential energy of the molecules of the gas, in order to cause movement in the piston.

5. Cooling System

A effective cooling system that can be water cooled or air cooled is used to cool the wall of the cold cylinder (Alpha SE) or the cold end (Beta cylinder) which in turn cools the gas inside the cylinder for re-use.

6. Crankshaft

It is the shaft through which the mechanical work is transferred from the piston to the flywheel.

The reciprocating motion of the piston is converted into rotational motion which is the final output obtained from the flywheel.

In alpha Stirling engine both the pistons from the cold cylinder and from the hot cylinder are interlinked with the crankshaft through the crank pins.

7. Flywheel

Same as the IC engine a flywheel is used at the outer part of the crankshaft to store the engine's output for further transmission.

Working Principle

The basic principle on which the Stirling engine works is as follows-

- The gases enclosed inside a closed lid or area, when heated by any external mean expands and applies pressure (due to the kinetic energy attained by the gas molecules) to the walls of the enclosed area which can be used to obtain any mechanical work.
- Stirling engine uses 2 closed chambers (one with the heat source and other with the cooling source) inside which the gas is enclosed, the compression and expansion of the interlinked pistons of both the cylinder is caused by these cold and hot gases which in turn provide mechanical output through the connected crankshaft.

Types

Depending upon the number of cylinders used, Stirling engines are of 2 types-

1. Alpha Stirling Engine

It is the type of stirling engine in which 2 cylinders are used out of which one is the expansion cylinder or hot cylinder which is equipped with the heat source and another is the compression cylinder or cold cylinder, which is having cooling device at its outer wall, these 2 cylinders are connected with a common passage through which the exchange of cold gas from the cold cylinder to the hot cylinder and hot gas from the hot cylinder to the cold cylinder takes place.

- Alpha stirling engine is the low power engine and is used for light load applications.

2. Beta Stirling Engine

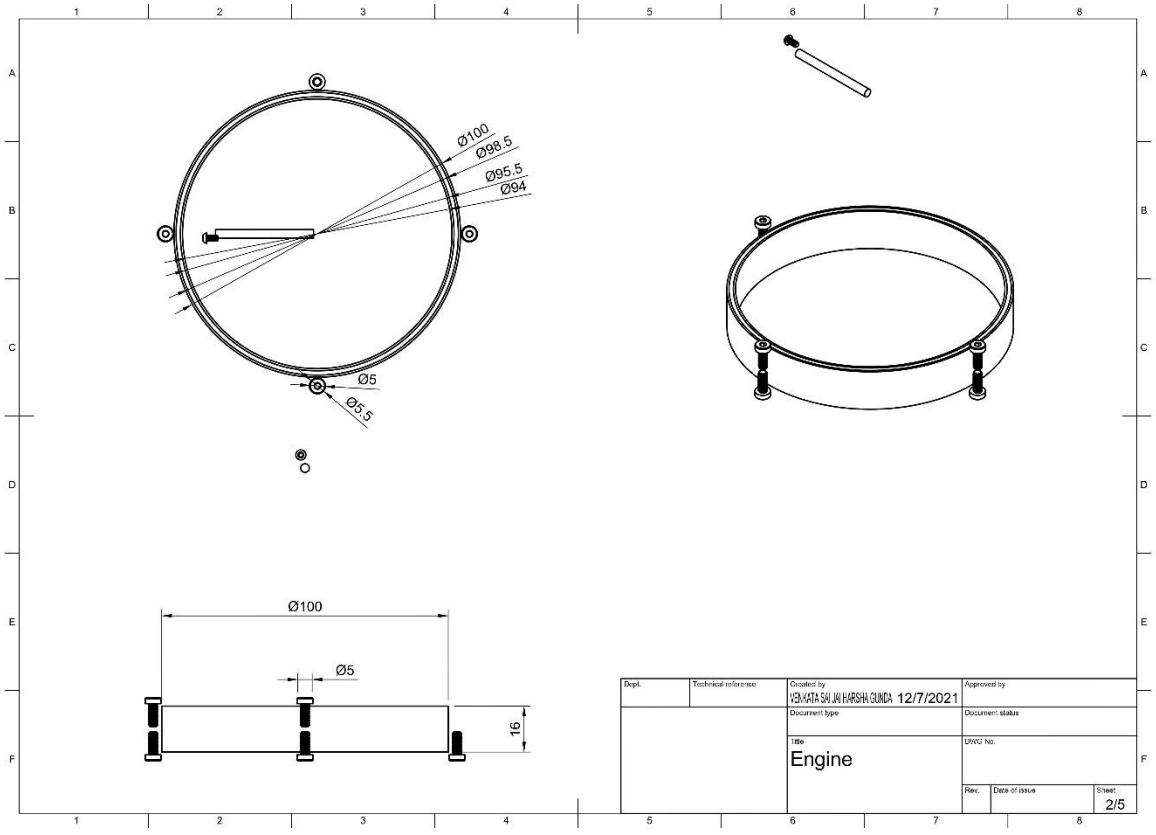
It is the type of stirling engine in which a single cylinder is used which is equipped with the heat source at the one end and a cooling device at another end.

The exchange of hot and cold gas from hot end to the cold end and from cold end to the hot end is provided by the loosely fitted displacer, this displacer is connected to the crankshaft or the flywheel that controls its motion inside the cylinder.

A power piston which is connected to the flywheel moves in between the hot and cold end inside the cylinder which is responsible for the power output of the engine.

- Beta stirling engine is the high-power engine and is used for high load applications.

2D Sketches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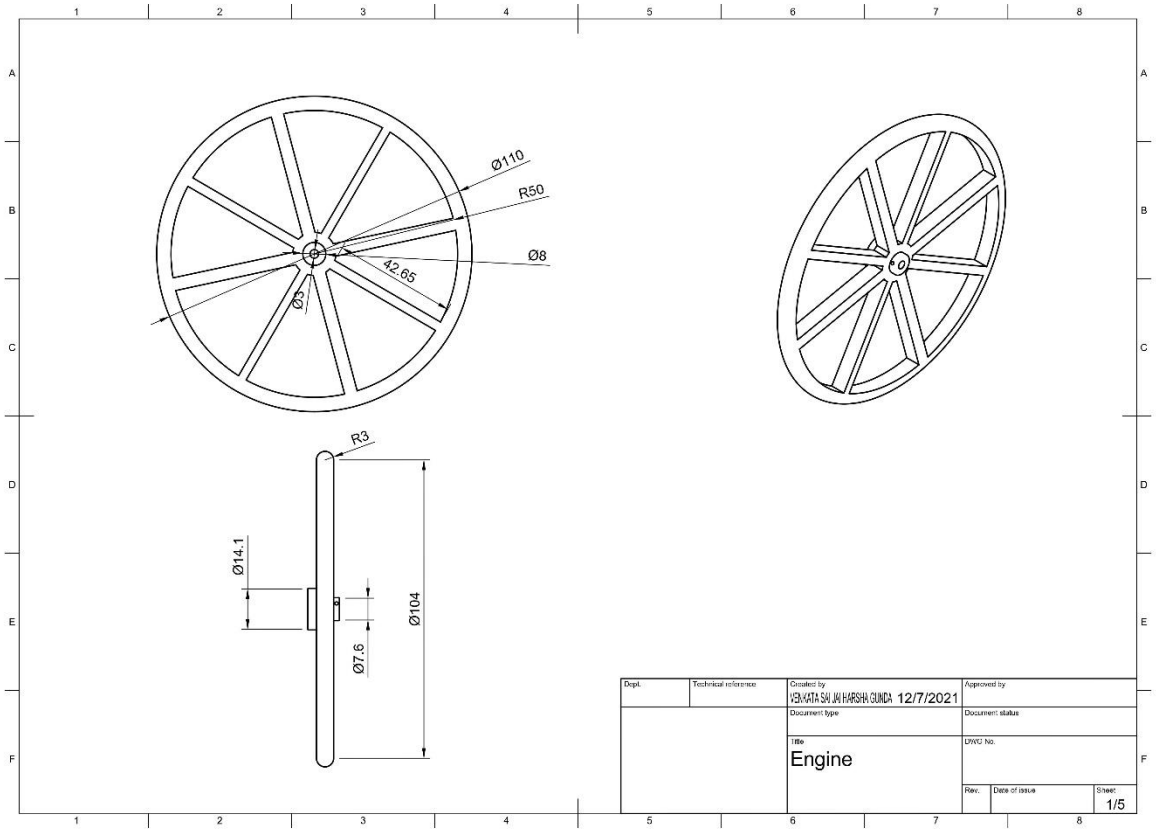
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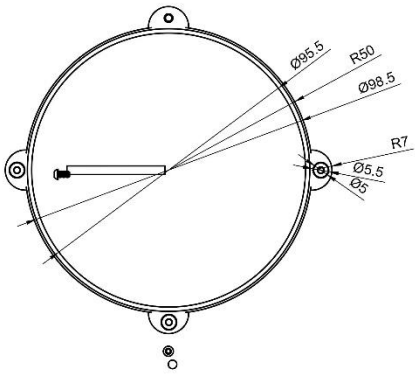

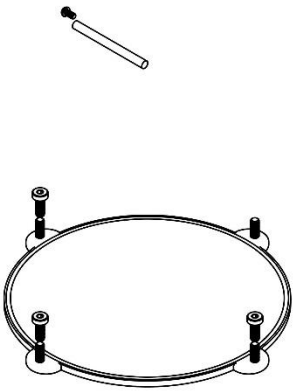

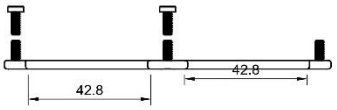

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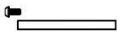

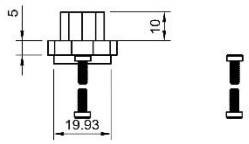

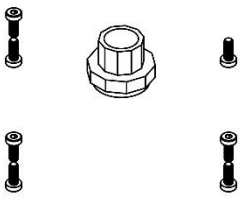

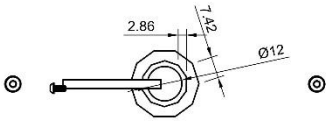

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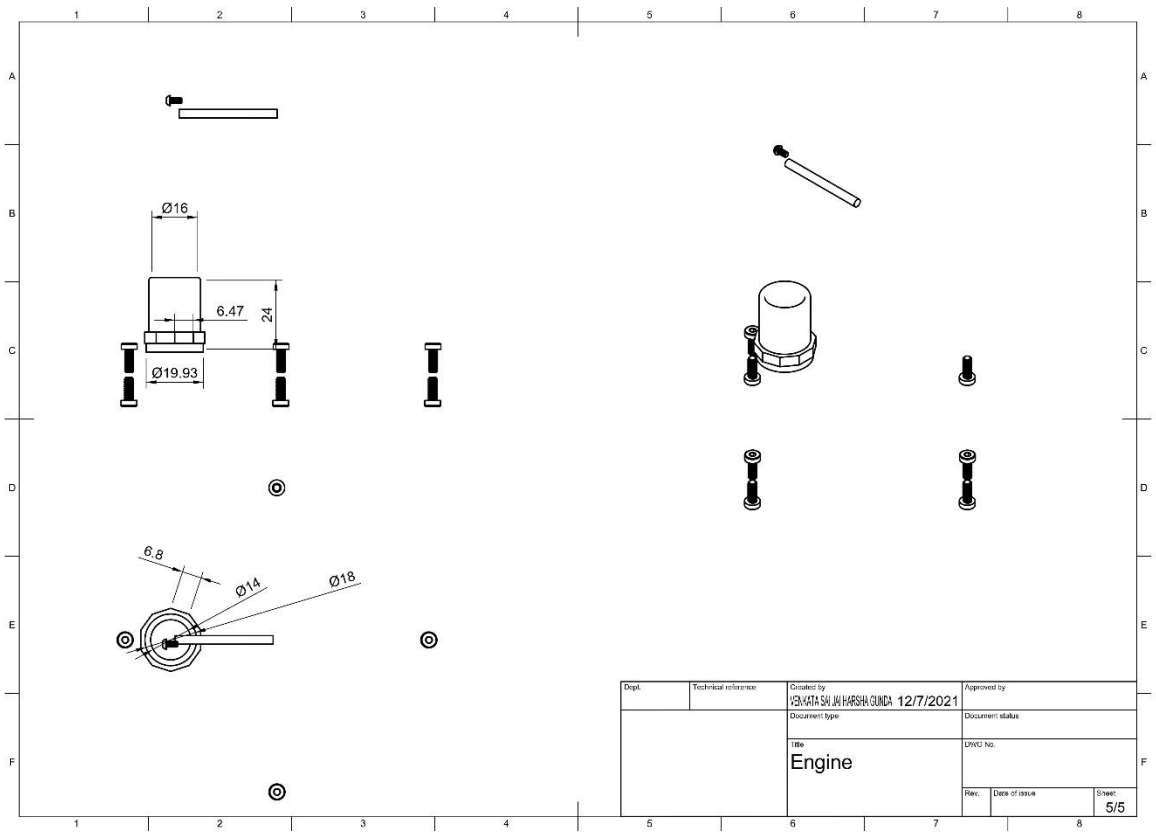

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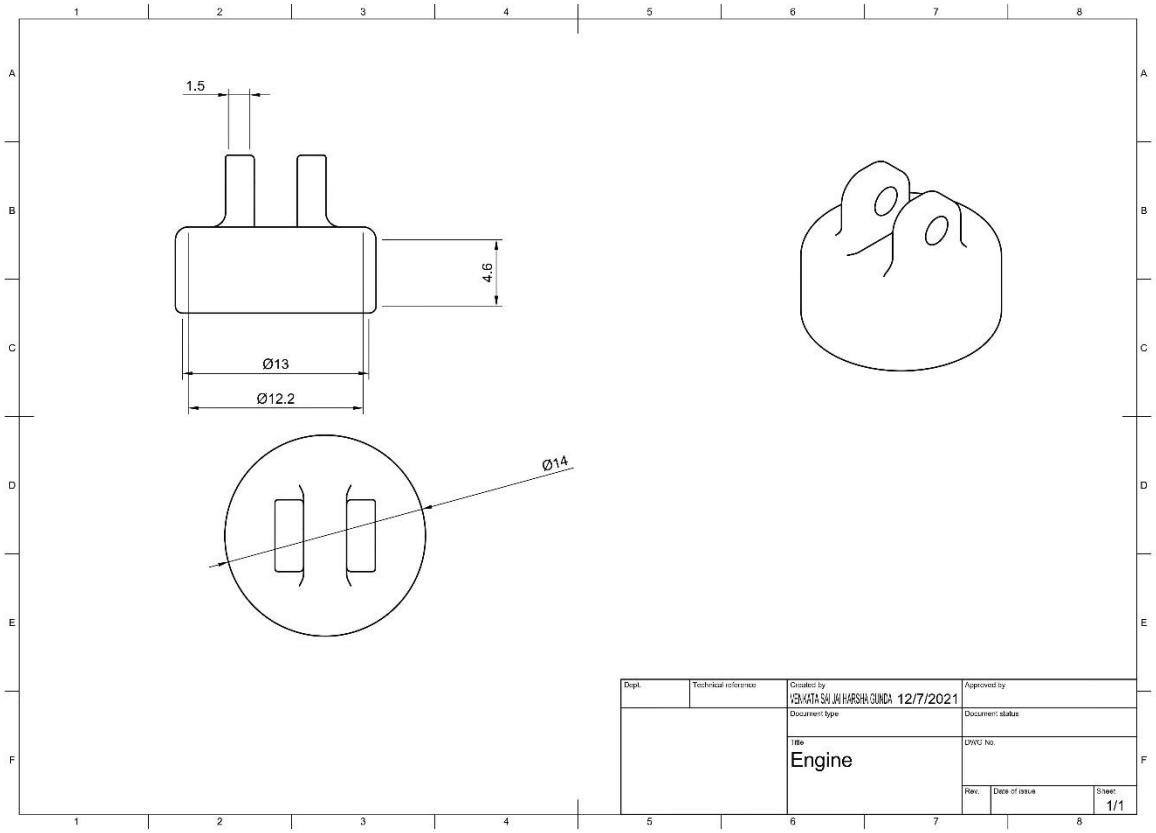

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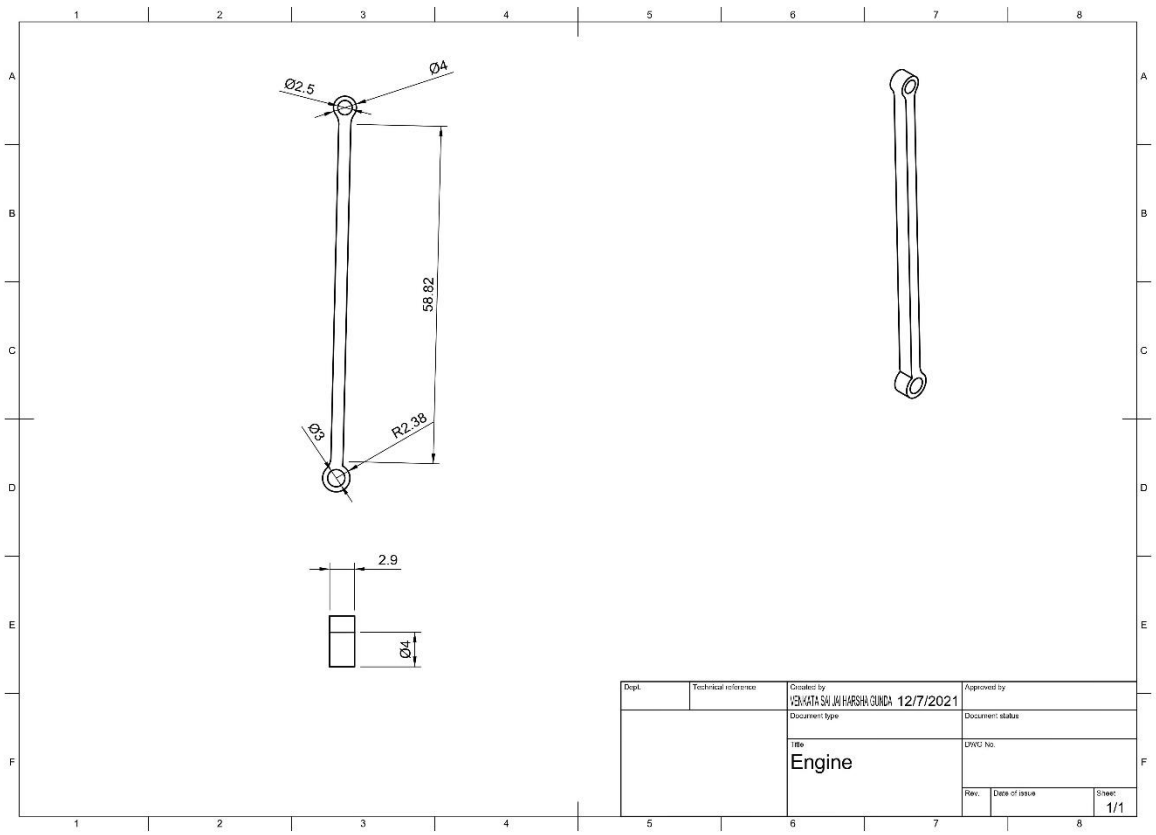

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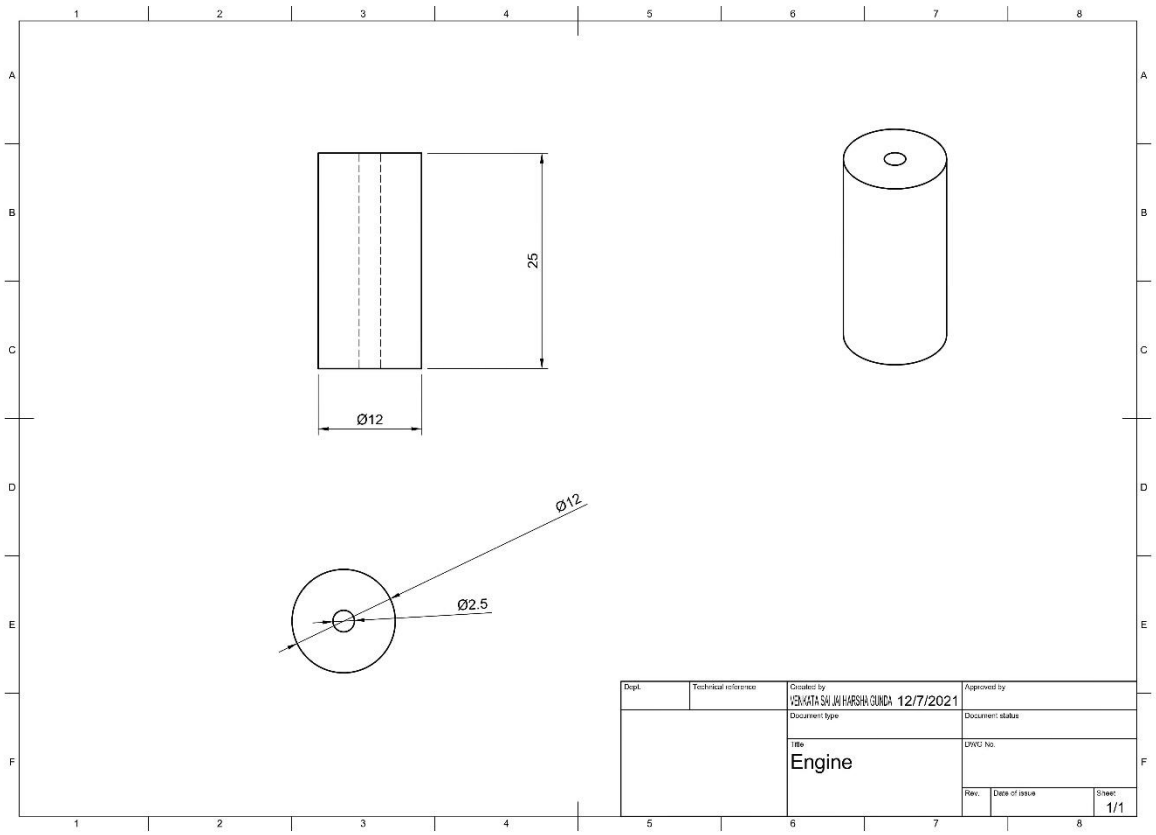

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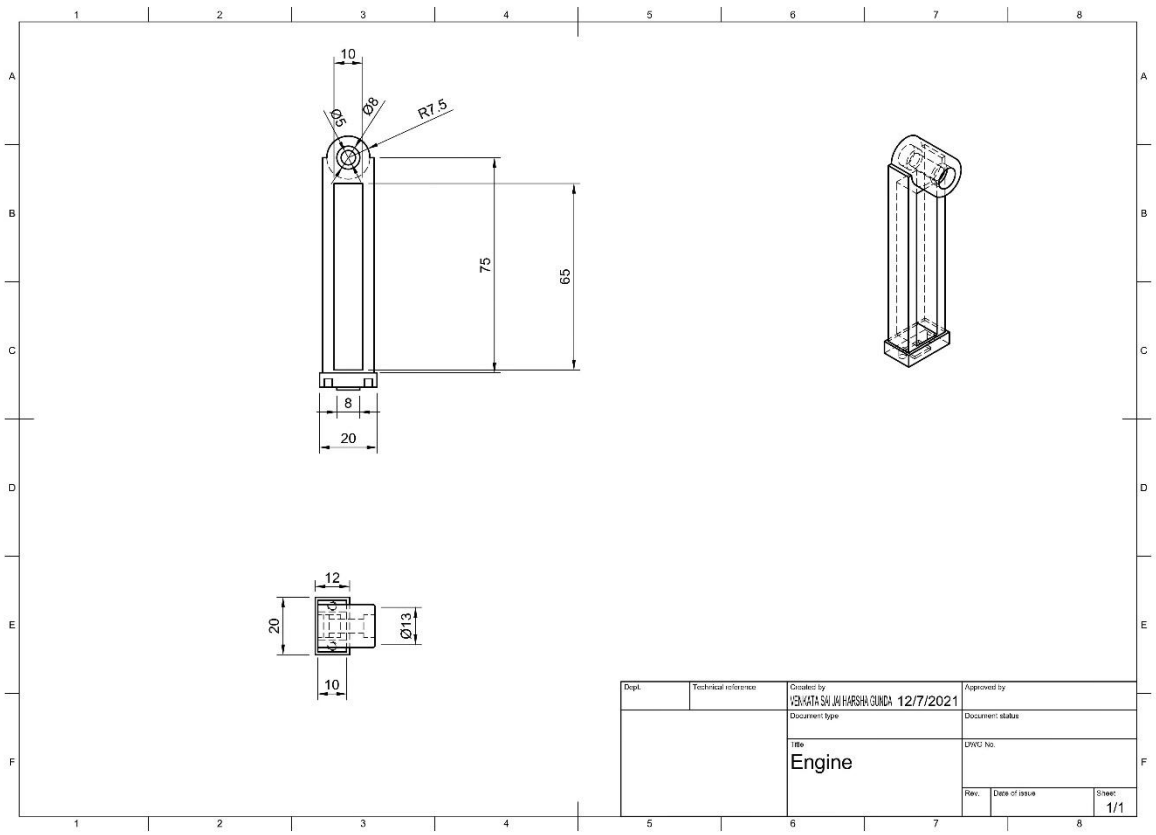


Bill of materials.

s.no	Part name	Material	volume mm^3	Density	Mass g	Rate /g	Quanity	Total
1	Big Tube	Acrylic	14088.749	0.001	16.766	0.2	1	3.3532
2	plate	Copper	23891.15	0.009	213.587	0.45	1	96.11415
3	Plate 2	copper	22380.727	0.009	199.92	0.45	1	89.964
4	Displacer piston	Brass	2896.79	0.008	24.594	0.3	1	7.3782
5	power piston	steel	3168.998	0.008	11.182	0.19	1	2.12458
6	Fly wheel tower	Aluminium	10221.025	0.003	27.597	0.25	1	6.89925
7	Flywheel	Steel	17981.97	0.008	152.664	0.19	1	29.00616
8	Displacer bushing	Steel	2704.7	0.008	21.232	0.19	1	4.03408
9	Bearing 1	steel	162.947	0.008	1.279	0.19	2	0.48602
10	power piston	steel	1125.211	0.008	6.652	0.19	1	1.26388
11	Lower rubber	steel	538.51	0.008	4.227	0.19	2	1.60626
12	spacers	steel	1627.48	0.008	12.776	0.19	4	9.70976
13	Connecting rod	laminate	246.083	0.001	0.34	0.11	2	0.0748
							Total cost	252.0143

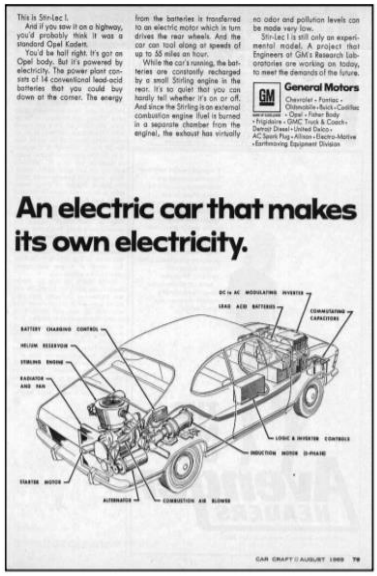
APPLICATIONS

1 Cars

In the ages of 1970s and 1980s several automobile companies like “General Motors” or “Ford” were researching about Stirling Engine.

This device is good for a constant power setting, but it is a challenge for the stop and go of the automobile. A good car can change the power quickly. One possibility to obtain this important characteristic is design a power control mechanism that will turn up or down the burner. This is a slow method of changing power levels because is not enough to accelerate crossing an intersection.

The best solution despite these difficulties in automobiles is hybrid electric cars where Stirling Engine could give enough power to make long trips where could get burn gasoline or diesel, depending on which fuel was cheaper. The batteries could give the instant acceleration that drivers are used to. This invention makes the car silent and clean running.



2 Submarine

This high-technology is named air-independent propulsion (AIP). There are four submarines equipment with Stirling AIP. The models are HMS Näcken, which was launch in 1978 and after ten years 1988 became the first submarine equipped with AIP system, by means of a cut and lengthened by an intersection of a Stirling AIP section, which before the installation is equipped by two

Stirling units, liquid oxygen (LOX) tanks and electrical equipment. Successful demonstration of AIP system during many routine patrols of HMS Näcken made that Gotland, another type of submarine, was the first submarine designed from the beginning to operate with AIP system. The other four submarines that operates with this technology are two Söderman class were upgraded by 2004.

Figure 21 : Stirling engine in Näcken

3 Heat and power System

This device replaces traditional boilers in houses. It is an innovative system developed to provide central heating, water heating and electricity. Usually this device is called “Micro Combined Heat and Power (CHP)” and produces much less carbon dioxide than other ways of providing heat and power. In fact, if the level of CHP was increased to the Government's target of 10,000 MW, the UK could be one third of the way to meeting its international commitments to reduce carbon dioxide emissions

4 Cryocooler

If It is applied mechanical energy instead of cold and heat sources by means of external engine, It is possible reach temperatures like 10 K (-263°C) in machines of high technology. The first Stirling-cycle cryocooler was developed at Philips in the 1950s and commercialized in such places as liquid nitrogen production plants. This company is still active in the development and manufacturing Stirling cryocoolers and cryogenic cooling systems. A wide variety of smaller size Stirling cryocoolers are commercially available for tasks such as the cooling of sensors.

5 Nuclear power

Steam turbines of a nuclear plan can be replaced by Stirling engine thus reduce the radioactive by-products and be more efficient. Steam plants use liquid sodium as Stirling Engine 25 coolant in breeder reactors, water/sodium exchanger are required, which in some cases that temperature increase so much this coolant could reacts violently with water.

Innovativeness & Usefulness:

- The Stirling engine is an efficient engine that requires outside heat to operate. Because of this, the effect of pollution is eliminated.
- Stirling engines can operate on different types of fuel, including natural gas, propane, gasoline, diesel, biofuels, and sunlight.
- One of the best features is the extra-quiet operation of the machine, along with the capability of burning slowly.
- Many engines can be used as a heat pump when driven by a motor or another Stirling engine, which allows them to be used for space conditioning, refrigeration, and cryo-cooling.

Conclusion

- The Stirling engine is noted for its high efficiency compared to steam engines, quiet operation, and the ease with which it can use almost any heat source.
- Stirling Engines are very flexible. There are a lot of different types of engines. They can be very small and run with only a small temperature difference, they are very quiet, for example to use them in submarines or they can be used as a CHP plant.
- Another good point is that they can be constructed in a way that they produce no emissions. That means, in combination with solar or geothermal heat, they can be used as a renewable energy source to produce electricity.