

Thermo Electric Generation Kit for Mobile Phone Charging using the Waste Heat from Motorcycle Exhaust

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Abstract - The purpose of the project is to build a TEG(Thermo Electric Generator) kit which can charge the mobile phone using the waste heat from motorcycle exhaust. Till now in India there is no any bike available in which provision for mobile phone charging is available with the help of waste heat. our device works on the principle of Seeback effect. According to seeback effect when one side of the TEG plate is hot and the other is cold, the temperature difference results in the conversion of voltage difference. This project focuses on using the waste heat of motorcycle exhasust and converting the heat energy into electrical energy with the help of TEG(Thermo Electric Generator). The kit comprises of TEG modules which are made up of semiconductors. Bismuth telluride(Bi_2Te_3), lead telluride(PbTe), and silicon germanium(SiGe) are commonly used semiconductors. This kit takes the heat energy from the exhaust pipe of motorcycle and the cooling is done by the free convection with the help of fin attached on the other side of the TEG module. This temperature difference is converted into voltage difference by TEG module. This voltage difference is further regulated by voltage regulator and finally can be used for mobile phone charging. It is best option for mobile phone charging as it uses the waste heat and also not affect the environment as it is not causing any type of pollution. This project is overall cost saving and environment friendly.

Keywords: Waste Heat Utilization, Thermo Electric Generation, Energy Harvesting, Two Wheeler Waste Heat Utilization, Waste Energy Utilization From Automobile.

1. INTRODUCTION

Energy has a great impact in the development of our world mainly in economic growth because of increasing population. We mainly depend on fossil fuel. Approximately increase in demand of fossil fuel for electricity generation is 77% from 2007 to 2030 [1]. When we use fossil fuel there are many issues arises with that like various type of pollution and heat waves etc. In a study performed on IC engine for getting the distribution of energy, we get to know that only 25% energy we used for shaft power, 40% energy get wasted from exhaust system. If we convert 10% of this waste heat we will get 20% decrease in fuel consumption[2].

In two wheeler there is large part of waste heat which is exhausted by exhaust pipe. We can use Thermo Electric Generator to convert the heat energy into electrical energy. The device made by TEG is for conversion is practical, eco friendly, easily installable and does not require any cost of operating and maintenance[3]

So this type of kit has great impact both on economy and environment.

2. LITERATURE REVIEW

Shrutika Karpe [4] studies to meet the global warming and the alternative method of these cause. Thermoelectric generation kit is one the best method to do so .It use TEG plate to play this role. TEG direct converts heat energy into electrical power. The application of this technology can also improve the overall efficiency the of energy conversion systems feasible electricity generation is possible due to waste heat emitted from the automobile [4]

this method involve the methods like seeback effect and thermoelectric effect. According to Seeback effect if you generate a temperature gradient across the junctions of two dissimilar conductors, electrical current would flow.

Thermoelectric effect: phenomenon in which an inter-conversion of heat and electrical energy takes place known as thermoelectric effect[4]

M Akif Kunt [5] studies about the TEG module structure TEG module in exhaust system. In his study, thermoelectric generator which was aircooled was designed to recycle waste heat energy of exhaust systems of IC engines and its performance was tested. The results obtained results were compared with the results of analyses and experiments. Maximum voltage value at $R_L = 450$ load resistance was obtained as 11.03 V (experiment) and 11.22 V (analysis), and maximum current value at $R_L = 50$ load resistance as 0.42 A (experiment) at $T_h = 250$ C, $\Delta T = 40$

Mohd. Quasim Khan , S Malarmannan , G Manikandaraja [6] focused their study on heat exhaust from the car engine, how much we can use or how much energy we lost in the atmosphere in the form of global warming and all but our project is mainly focused on the two wheelers and there exhaust system and heat used but the concept is aproxmatily same . . The IC engines which are used in cars have maximum .25 to 0.30 efficiency and rest of the heat energy which is burned in combustion chamber transferred to the exhaust and then to the atmosphere. The installation position and thermoelectric materials also has a vital role in improving the efficiency

Wayan Nata Septiadi, Gemilang Ayu Iswari, Muhammad Ainur Rofiq , Bobby Gitawan , Jeplind Morico Gugundo and Chris Ave Duga Purba [7], there cluster study tells U.S.A. concerning the dimension , style and experimental setup of the appliances. Recycle energy mistreatment seeback concept[1] on a motorbike is completed as a result of the bike has the energy potency of \pm thirty five – forty take a while the remainder were drop unceremoniously within the type of heat that's issued through the exhaust. TEGs with four electricity modules asynchronous were ready to manufacture higher output voltage and current compared to TEGs with a pair of electricity modules with output voltage reaching 15.7 volts 7.7 volts . The TEGs circuit with four electricity modules produces 62.6% larger power than TEGs with a pair of electricity modules.[7]

Thermoelectric generators (TEGs) are designed with the help of four electricity modules TECI-12706B kind SP1848-27145 reserves dimensions fifty x fifty millimeter with four millimeter thickness asynchronous in pairs between atomic number 13 plate one hundred twenty x one hundred twenty mm[7]

Mohamed Amine Zoui, Said Bentouba, John G. Stocholm and Mahmoud Bourouis [8] presents there Review on electricity Generators. Their application like wherever the can use and wherever they perform the most effective work . They got maximum output from vehicle.

Yuchao Wang a,b , Chuanshan Dai a,b , Shixue Wang[9] ,they give the theoretical and mathematical analysis of electricity generation kits . The model shows the impact of relevant factors, and exhaust mass rate, temp. and mass rate of various types of cooling fluid, convection heat transfer constant, height of PN couple, the magnitude relation of external resistance to internal resistance of the circuit on the output power and efficiency.

3. RESEARCH GAP

For extracting energy from waste heat various type of work has been done by making various type of equipment. These equipments are like Economizer, Air preheater, Recuperators, Regenerators, Plate heat exchanger, Heat

recovery steam generator. But there is no significant work in field of direct energy conversion from heat energy into electrical energy with the help Thermo Electric Generator.

4. PROBLEM STATEMENT

If we consider the present scenario, we found that almost whole the shopping is done in online mode and items are home delivered. These items are delivered by delivery boys. These delivery boys use bikes for home delivery and uses mobile phone for taking orders and finding the routes. So for this purpose they have to use mobile phone continuously. So most of the time their mobile phone get discharged. But the problem is that there is not any provision available for mobile phone Charging in bikes which is cost effective and eco friendly also. We are going to solve this problem.

Moreover tourists in hilly areas also find difficulty to charge their mobile phones as they have to move continuously and there is no proper place and time to stay to get mobile charge. There is need of a device or system which can be used to charge the mobile phone during travel. Our focus is not only solving the problem but also solve it in cost effective and eco friendly manner because this is the need of the hour. There can be two methods to solve this problem 1. by developing the highly efficient processes and technologies to reduce the wastage of energy.2. by utilizing the waste energy. Our device is based on second method because it is easy to take energy from waste heat of an existing system than developing the totally new efficient processes and technologies. And according to the study conducted on two wheelers, it is found that more than 50% of the energy get wasted from the exhaust. we are using this waste energy in our device.

So by considering all these limitations, we are introducing TEG kit for mobile phone charging using the waste heat from motorcycle exhaust to solve this problem.

5. OBJECTIVE

- a) To make a Portable TEG Kit for the Conversion of Waste Heat from Two Wheeler Exhaust into Electricity, to Utilize for Mobile Phone Charging.
- b) Kit should be cost effective and eco friendly.

6. METHODOLOGY

- a) In this we are going to make a kit[Fig-4] that charge the battery of the mobile phone through exhaust pipe of the bike.
- b) For the kit first of all we will make an aluminium channel that is going to fixed on exhaust pipe of bike.
- c) On this channel we will fixed a thermal tape on open face of the aluminium channel and TEG plates are attached on the thermal tape.
- d) After this setup Aluminum Fins are attached on the open face of the TEG plates for cooling the other side of the TEG plate.
- e) TEG plates are connected in series and voltage regulator is connected with this connection to regulate the voltage.Three dimensional view of kit is shown in [Fig-2]. Two dimensional view of kit can be seen in [Fig-3]
- f) A pin is connected to voltage regulator which is used for connecting the mobile phone with device.
- g) When the bike exhaust is heated then the heat of exhaust is going to flow in TEG plates and upper part is cooled by fin that makes potential difference or electric energy that makes the phone charge. The installed view of kit can be seen in [Fig-5]
- h) The whole arrangement of kit is shown in block diagram [Fig-1]

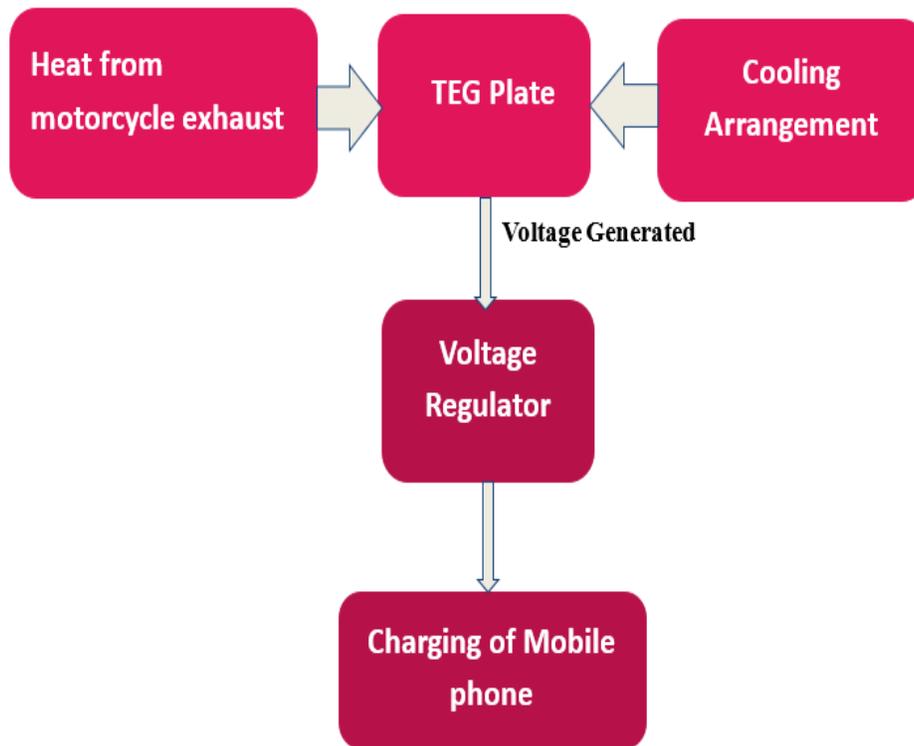


Fig-1: Block diagram

7. COMPONENTS/ HARDWARES

Various components which are used in our kit is listed below-

- a) TEG PLATES
- b) ALUMINIUM FINS
- c) Thermal Double Sided Adhesive Tape
- d) VOLTAGE REGULATOR
- e) ALUMINIUM CHANNEL
- f) CHARGING PIN
- g) CONNECTING WIRES

8. SELECTION OF VARIOUS PARTS USED IN THIS PROJECT

The detailed description and specification of various components which are used in making of the device is illustrated below-

8.1 TEG PLATES:-

Thermoelectric Generator converts heat flux into power. They are compact in size. They need semiconductors with low thermal conduction and high power issue. Very rare components that build them terribly costly compound. TEGs will work upto a temperature distinction of 300 C. Colding face posts with the words Heating face is empty. Red wire to positive, black wire to the negative, it generate electricity once the temperature distinction happened.

Specification:

Model: SP1848-27145

Size: 40MM x 40MM x 3.4MM

Temperature distinction vs voltage vs current:

20 degree temperature difference: open-circuit voltage zero. 97V, generated current: 225mA

40 degree temperature difference: circuit voltage one. 8V, generated current: 368mA

60 degree temperature difference: circuit voltage a pair of. 4V, generated current: 469mA

80 degree temperature difference: the circuit voltage three. 6V, generated current: 558mA

100 degree temperature difference: circuit voltage four. 8V, generated current: 669mA

8.2 ALUMINIUM FINS:-

Aluminium fins are usually employed in cooling IC and electronic element. The fins increase the surface area of the plate and therefore give for larger heat transfer. These fins are made up of Aluminium, which gives quick heat transfer and long service life. It reduces danger of hardware failure due to heating.

8.3 THERMAL DOUBLE SIDED ADHESIVE TAPE:-

We used thermal tape for attaching fin on the plate. Thermal tape heat conduction is high and stable, its life is longer than the usually used heat-dissipating double-sided sticker, and it will work for a minimum of five years at traditional temperature (80-120°C).

8.4 VOLTAGE REGULATOR:-

A voltage regulator maintains a fixed output voltage, irrespective of any changes to the input voltage or load variation. Voltage regulators keep the voltages from a power supply in a range which is suited with the other electrical elements.

Specification:

Low ultra wide range of input voltage 3 v - 32 v

Low ultra wide range of output voltage 5 v - 35 v

8.5 ALUMINIUM CHANNEL:-

This channel is created of Aluminium that provides base for whole device and additionally act as a thermal conductor between lamb plate and piping. This channel has clamping system also.

8.6 CHARGING PIN:-

Charging pin is employed to attach voltage regulator to mobile port.

8.7 CONNECTING WIRES:-

Wire is employed for connecting TEG plates in series and making various connections.

9. DESIGN AND CALCULATIONS

Various designs and calculation based on the performance is done which is illustrated below-

9.1 Mathematical Algorithms for charging time (in hour)

Table 1 Variation with Temperature

Temperature (in Celsius)	Voltage (in Volt)	Current (Milliampere)
20	.97	225
40	1.8	368
60	2.4	469
80	3.6	558
100	4.8	669

6 TEG plate generates 900mA current .

For the charging, considering 2000 mAh battery

$$T=AH/A$$

Where,

T= Time in hour

AH= Ampere rating of the battery

A= Current in Ampere

From the experiment all the values is in Current (mA) and Battery (mAh)

$$T=2000/900$$

$$T=2.22 \text{ Approx. 2 hour 13 minute (Theoretically)}$$

40% of the battery losses during the charging

$$\text{Loss} = 2000 * 40 / 100$$

$$= 800 \text{ mAh}$$

Now, Total charging= 2000+800= 2800 mAh

$$T=2800/900$$

$$T= 3.1 \text{ Approx. 3 hour 6 minute}$$

The charging starts after the 5 minutes of the motorcycle continuous in motion so, the total time of charging is 3 hour 11 minutes.

9.2 Calculation for Impact of our Idea if Implemented:

If a two wheeler used for 300 days a year and used for 1hr of mobile charging each day by using TEG kit then

$$W=V*I*T = 5*1*1 = 5J/Sec = 5W = 0.005kW$$

Per day utilization from single two wheeler in 1hr of use = 0.005kWh

Total units sell in last 5 years in India = 85020600

Then energy utilization for 85020600 units of two wheelers when used for 300 days (an hour a day)

$$= 85020600*0.005*300 = 127530900 KWH$$

Reduction in carbon foot print

To produce 127530900 kWh of energy through power plant, the carbon footprint is :

$$127530900 kWh \times 0.85 = 108401265 \text{ kg of } CO_2$$

10. GRAPHS:

There are various parameters which vary according to the various condition. The variation of voltage with current can be seen in [Chart-1]. The variation of voltage with temperature difference is shown in [Chart-2]. The variation of current with temperature difference is shown in [Chart-3].

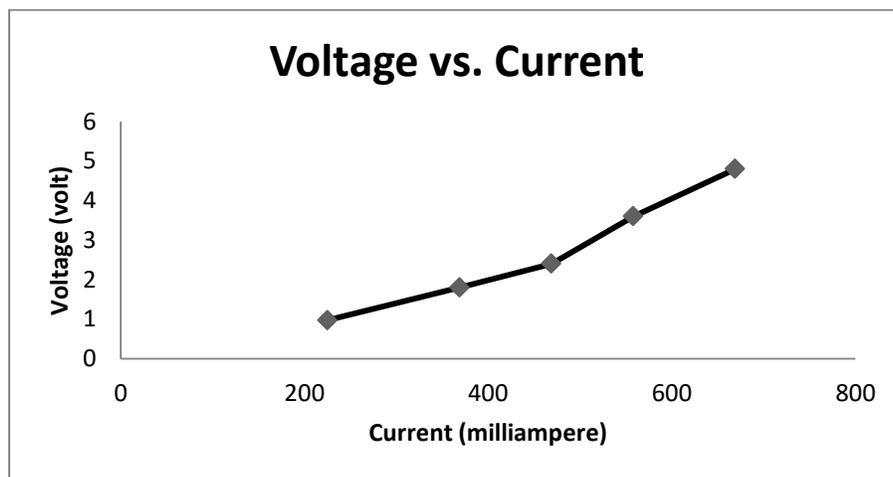


Chart-1: Voltage vs. Current

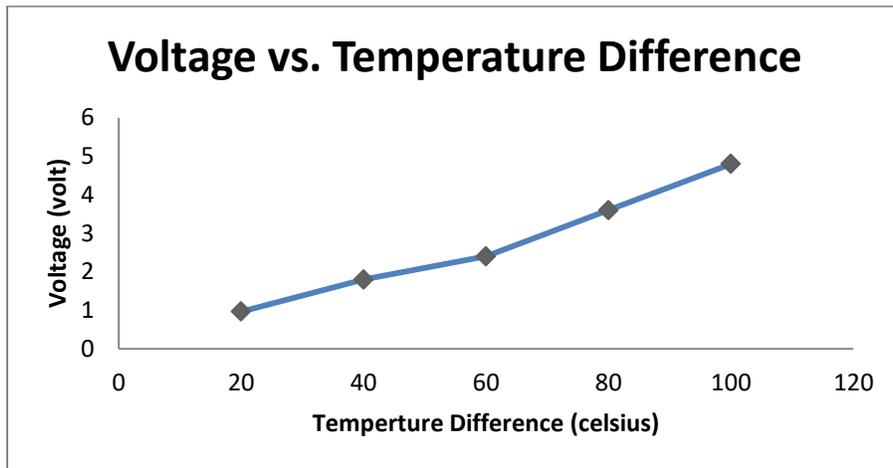


Chart-2: Voltage vs. Temperature Difference

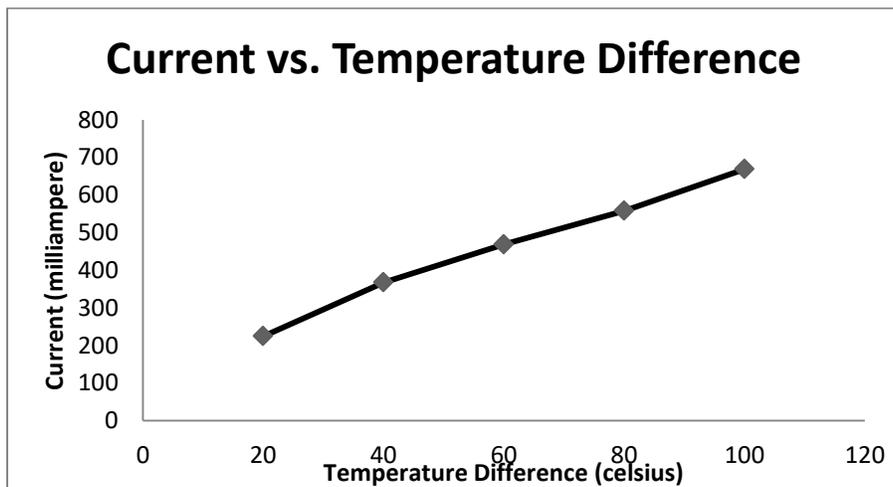


Chart-3: Current vs. Temperature Difference

11. DRAWING

Various types of drawing are shown below-

11.1 3D diagram of the device

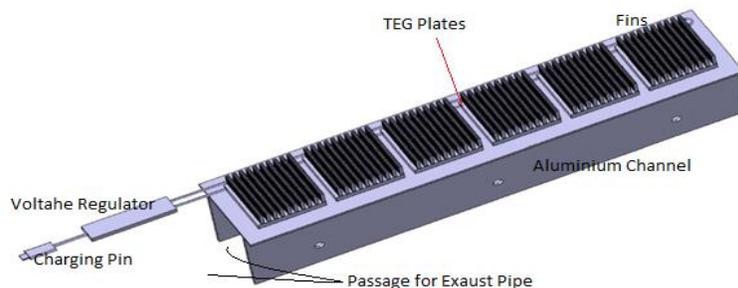


Fig-2: 3D Drawing of the KIT

11.2 2D diagram of the device

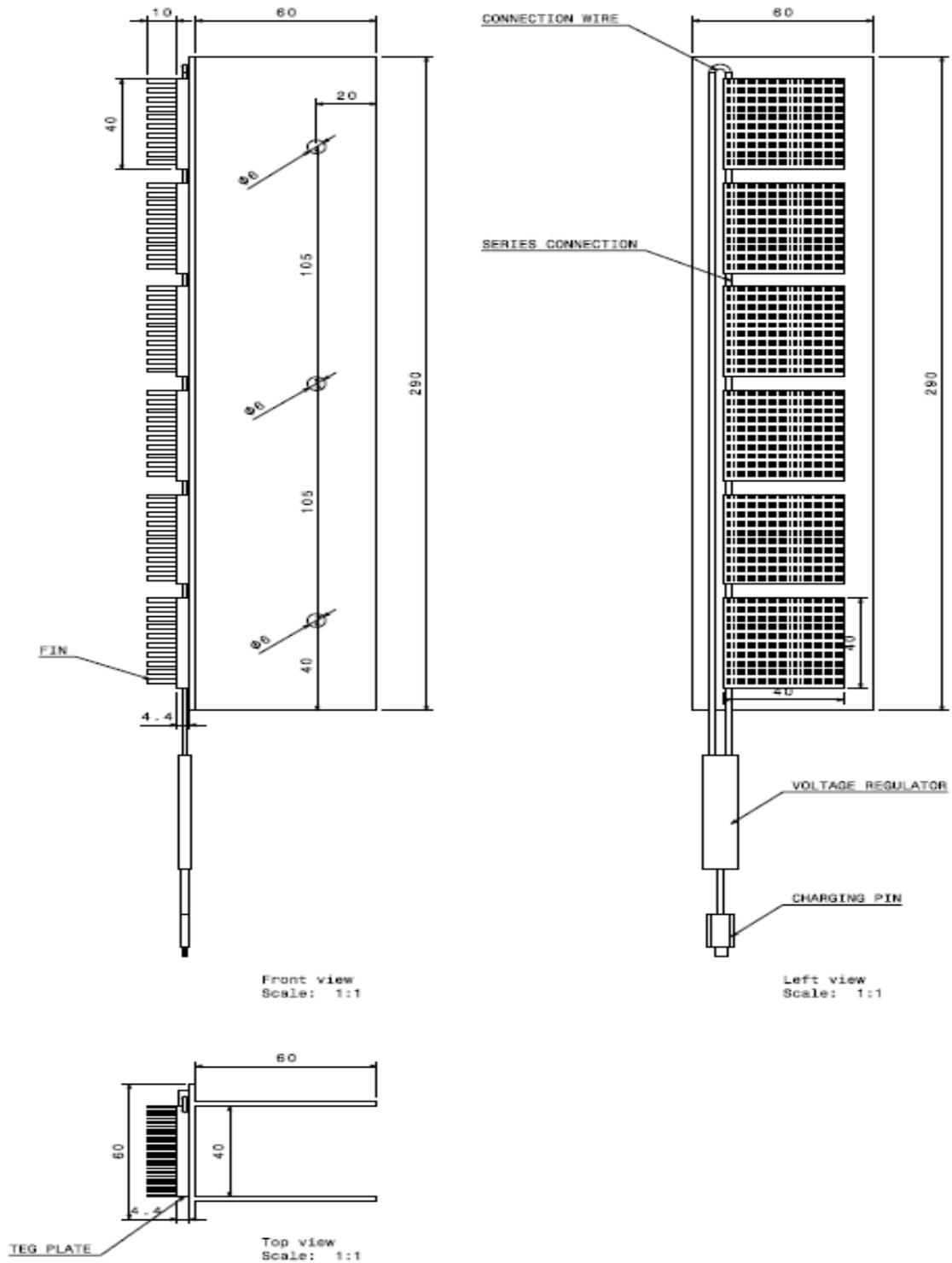


Fig-3: 2D Drawing of the Kit

11.3 Kit and its installation

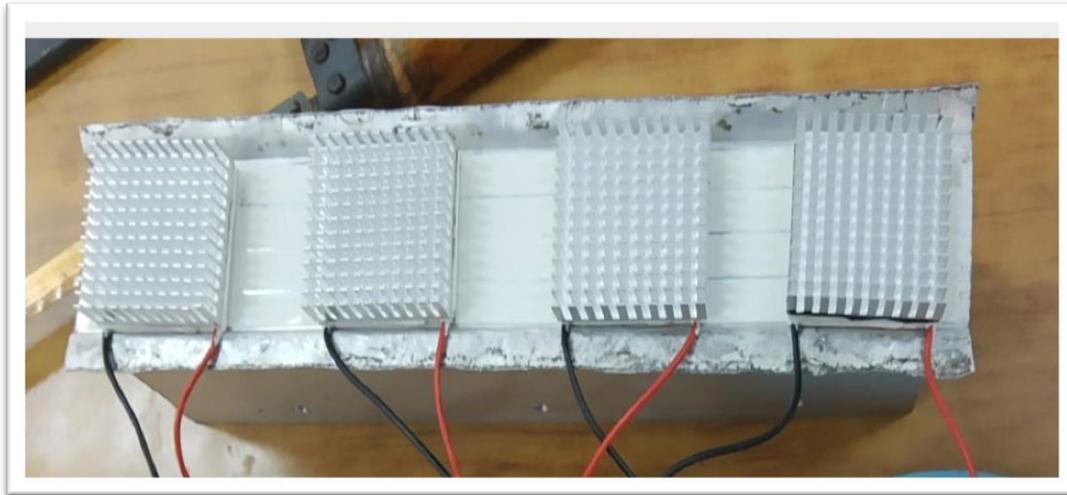


Fig-4: Kit

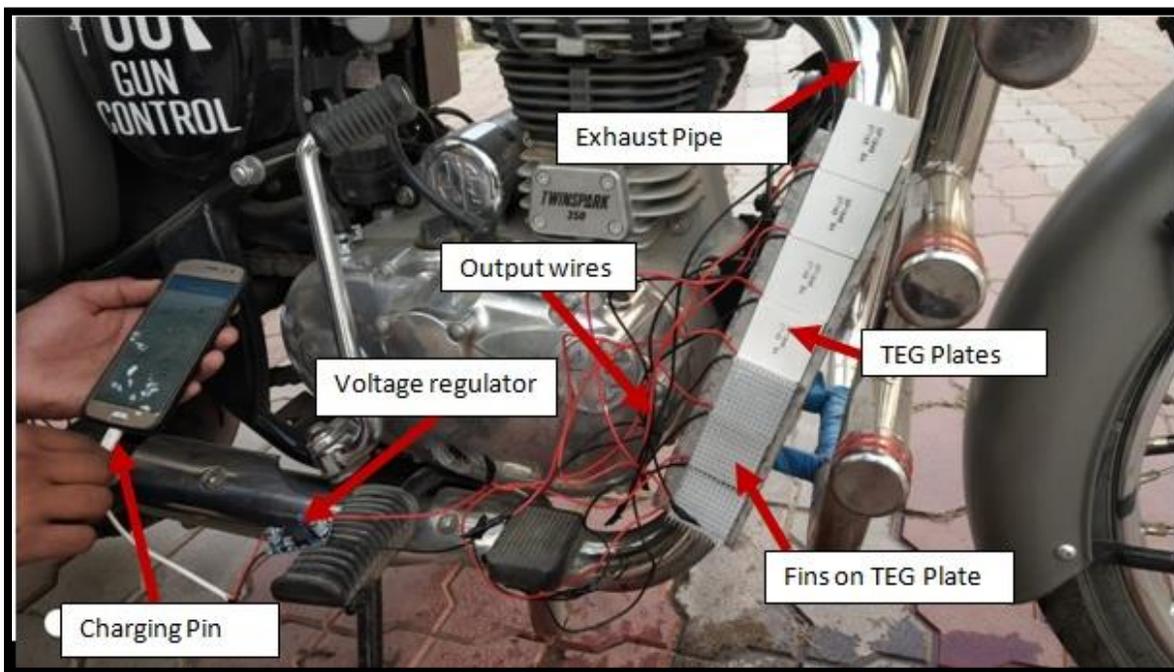


Fig-5: Installed kit during testing

12. CONCLUSIONS

- This project gives a possible way to recover the waste heat from the exhaust of I.C. engine and to design and fabricate one such system to serve the aim.

- Experimentally it is found that when six thermoelectric generators are connected in series. The generated power either directly used to run some auxiliary devices of an automobile or may be stored in the battery and used later.
- These auxiliary loads can be served from battery to this system , so it reduces load on alternator.
- The engine performance is unaffected by the designed system because heat extracted from the surface of the bend-pipe of the exhaust manifold which does not affected the working of engine.
- If higher temperature range is needed then TEG module must be changed to higher temperature range (200°C). So, the above stated system may be successfully implemented in different automobile engines, with few changes.

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