

Power Generation using Gym Equipment

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Abstract: This paper holds the detail methodology about of the project. The world is facing energy crisis with the difference in demand and supply and limited number of natural resources. So there is a need for saving energy and requirement an alternate energy source which is cheap and feasible. This project attempt to concentrate on how electrical energy can be generated from gym equipment/ exercise equipment. In urban areas people are very much health conscious and spend average one hours time in gym for his physical fitness. This project harnessed the mechanical energy of the machine and converted it to electrical energy using a generator based system which gives dual benefit where people can gain body fitness as well as electrical power is generated.

Keywords: Dynamo, Reinforced wire, Rectifier, Dead weight, CAD model

I. INTRODUCTION

The field of energy conservation is becoming an increasingly notable subject of research among the scientific community today. As the increase in the population people are facing problem of energy crisis. We need to think in such a way that how the energy demand of the world can be fulfilled. Which encourage us to build something that can generate the renewable source of energy from day to day activities.

The intention of this project is to build a straight forward human powered generator from gym and to use it to power light bulbs, cell phones, and other small appliances also with can be saved in the battery for further application. This project will help one to develop engineering skills while learning about a clean way of generating electricity. These systems need to be improved and designed for maximum power output, cost-efficiency, and marketability. Engineered to be used for retrofitting an existing exercise machine, this project includes an efficient yet controllable power storage. The exercise equipment will be attached to the dynamo motor which means that the dynamo will be attached on the rotating shaft, which will be rotating the dynamo there by converting the kinetic energy into electrical energy. Thus, produced electrical energy is used in powering a piece of equipment such as lamp while exercising.

1. Energy Harvesting Using Gym Machines

In any gym there are people on treadmills, stationary bikes, elliptical or rowing machines producing power in order to burn calories. The power being produced is dissipated primarily as heat. Human energy, if captured and used as an alternative to fossil fuel could supply a gym with clean sustainable energy that would be good for the environment and save the gym money. The process of capturing, converting and storing this energy is known as Energy Harvesting (EH).

There are various method of peoducing electrical energy using gym equipment. Various gym machines which helps in generating the electrical powers are

- Bicycle machine
- Treadmill
- Pull up machine

Stationary Bicycle

Stationary bikes are widely used in gym for doing cardio exercises for both male and female. It provides good health results and highly beneficial for heart. Stationary bikes coupled with electrical generator are used in the modern gym. which is also called as eco bikes.

This type of bikes generates electricity by pedaling the pedal which rotates the wheel attached to it and that wheel is coupled to a electrical generator. This electrical generator produces electricity which is of low

power that can be boosted up by using step up transformer. This type of bikes are widely used now days in green gym or modern gym. Fig. 1 shows the stationary bikes used in the gym.



Fig. 1 Stationary Bike

Tread Mills

Tread mills are another type of exercise equipment which can be used in gym as well as in home. People are supposed to run in the tread mill which consist of path like structure which shift and rotate so that a person can walk and run like in outdoor. Electrical power can be generated by using this kind machine also and it is already being used widely in many gym center and home. A tread mill can produce upto 100 watts of power in average which can certainly be used in various applications.

Fig. 2 shows the eco tread mill used in a eco gym which can generate the electrical power.



Fig. 2 Tread Mill Used in Eco Gym

Pull up Machine

Pull up machines are heavy machines where people lift load in order to perform exercise. Power generation using pull up machine is not so widely used because the amount of power generation is comparatively less than other but although it can get some amount of energy instead of nothing. Power generation using gym pull up comprised of addition of the electrical generation which can be operated by lifting of the load. The electricity can be generated by trasfering motion using rack and pinion mechanism or chain sprocket. Fig. 3 shows the gym pull up machine used in gym.



Fig. 3 Pull up Machine

2. Energy Generating Gymnasium Machines (EGGM)

Lat Pull Down Machine

The word “Lat” is short form for Latissimus Dorsi which is the name of the muscle. Late pull down machine is constructed for the development of latissimus dorsi muscle. Pull down machine simply consist of pulleys and metallic cable rolled over pulleys. One end of cable is attached with adjustable weight and on other end force is applied by user to lift the weight. Cable may be pulled up or down depending on the nature of exercise. Working principle of Lat pull down machine is expressed in Fig. 1.6 and Fig. 1.7, which is a multipurpose machine used to exercise for multi joints, biceps, triceps, shoulder and legs. Weights are selected by adjusting the nail into the specific holes (A, B, C, and D) if metallic rod. For example, if nail is entered into the “B” hole then 3 upper weights will be selected to lift them up for exercise. This machine can be made as energy generating machine by installing a generator in it directly. Lat pull down machine may be connected with a generator by 2 methods.

Method 1: The shaft of generator will be attached with the axle of pulley in first method represented in Fig. 4. This combination will give result of transformation of torque from pulley to the armature of the generator. Rotation of armature will produce electrical energy. The electrical voltage and current will be the alternating as the direction of rotation of pulley will change in clock wise and anti-clock wise direction. A rectifier will be necessary in order to charge the D.C batteries.

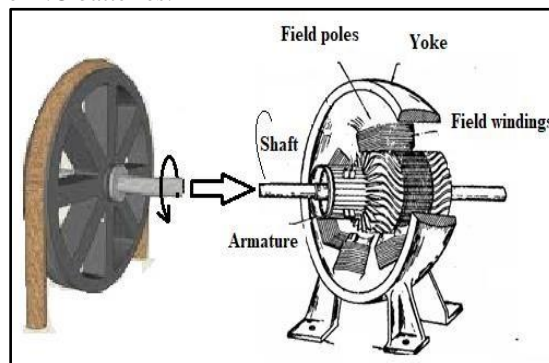


Fig. 4 Pulley and Generator are Combined to Generate Energy

Method 2: The second way of installing the generator will be so that the generator will be placed in the basement of machine. when the cable is pulled downward the armature of generator will rotate and electrical power will be produced through the generator, this process is explained by Fig. 5 and Fig. 6.

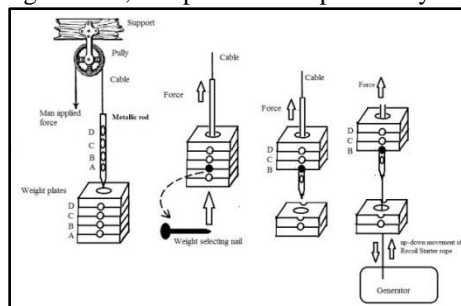


Fig. 5 Working Principle and Installation of Generator in Lat Pull Down Machine

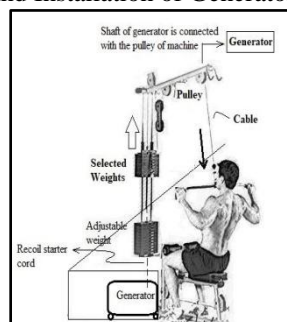


Fig. 6 Lat Pull Down Machine as a Energy Generating Machine

II. LITERATURE SURVEY

M. Musharraf et al. [1], A theoretical model of Energy Generating Gymnasiums System (EGGS) is proposed in this paper which will contribute its share in renewable energy sector. People of modern society are conscious about their health and adopt gymnasium exercises in order to achieve their desired fitness level. Gymnasium is a place where people physically operate many machines by applying force on the machines. The idea behind smart EGGS is that the human expended energy on machines in a gymnasium should be converted into electrical energy. Electrical energy harvested by using smart EGGS will be clean, renewable and sustainable. Research proposed for smart EGGS suggest that human being is also a source of renewable energy and chemical energy possessed by humans can be converted into electrical energy. EGGS will be very beneficial for the countries that are facing severe energy crises. Total output of all the gymnasium machines will give a sufficient amount of electrical energy needed by the gymnasium electrical appliances. The excessive electrical energy can be sold back to utility.

Roshan ojha et al. [2], the use of human-power in more efficient manner for generation has been possible due to modern technology. Pull up pull down power is an excellent source of energy, 95 percentage of the exertion put into pull up pull down power converted into energy. Pull up pull down power is the transfer of energy from a human source through the use of rack and pinion system. This technology is most commonly used for gym center. Whenever the person is allowed to pass over the gym pull up pull down. As the spring are attached to gym equipment, they get compressed and the rack, which is attached to, the bottom of the rod moves down reciprocating motion of rack in to rotary with certain RPM these shafts are connected through a chain drive to the dynamos, which converts the mechanical energy into electrical energy. Pull up pull down power is the transfer of energy from a human source through the use of rack and pinion system. This technology is most commonly used for gym centre or house less commonly gym power is used to power agricultural and hand tools and even to generated electricity.

Sourabh Borchate [3], In day to day life human being suffering from the health problems and stress. Another problem faced by the world is difference between energy generation and energy consumption. We can examine some aspects in our observation to save energy. Like to run on treadmill power supply is given for ease of running and for showing the parameters. But what about our human power, that is going to waste. To store that energy into electric energy the mechanism of treadmill will be develop such that the rotary motion of roller transforms energy to the generator by coupled it with belt. By this type of arrangement the health problems and energy problems can be solved. The stored energy can be used for various purpose and we not only save the energy required for treadmill but also generates the energy from using treadmill. A treadmill is a device basically used for running and to loss calories. Now a day because of business of human being in their day to day work, they feel tired to go for run. But health problems occurred due to stressful life and obesity occurs in many of them. For ease of running and to know the how much calories burn and for running at same place treadmill was developed. Treadmill provides a moving platform with a wide conveyor belt (track), driven by an electric motor. The belt moves to the roller, requiring the user to walk or run at a speed matching that of the belt. The rate at which the belt moves is the rate of walking or running. Thus, the speed of running may be controlled and measured by using controller and sensors provided. The more expensive, heavy duty versions are motor-driven(usually driven by an electric motor). And manual treadmills without motor are less expensive but require more human efforts for moving the belt on roller. In most of the gym premises expensive and motor driven treadmill used.

Mandhup Kumar and Mundada [4],investigated and worked onenergy harvesting on gym equipment due to the increase in demand of energy in the world and need of renewable source of energy and its development. The concept is “The average human generates around 100 watts in an average day. Depending on the person's activity, weight, and metabolism, a person's power can be slightly higher or lower. A typical American consumes about 2500 kilocalories of energy in a day. Assuming no weight gain or loss, this also means that 2500 kilo calories are used by the body in a day. With 2500 kilocalories of energy, the body is able to function properly. This allows to do everyday activities such as reading, jogging, sleeping, etc.”

III. OBJECTIVES

The objectives of the current project work are enlisted below:

- To create renewable form of energy (electrical energy) by the gym equipment by attaching the dynamo in the gym pull up system.
- To make the project flexible enough so that multiple exercises can be performed in single setup.
- To change the traditional way of doing gym and losing the human energy at no cost.
- To construct the new gym pull up setup in very simple and effective way.
- To provide electrical energy to the each and every area possible in order to reduce energy crisis.

IV. METHODOLOGY

The project aims to construct and manufacture an entirely unique electric generation system that fuses both form and function into a cost-effective and convenient solution. The methodology of the project is as follows:

- At first the frame of the setup is build which is also called as the body of the setup which consists of all the major components of the model. The frame is taken from old gym pull up machine and modified as per convenience.
- Pulleys are mounted on the shaft of proper dimension and the shaft is inserted inside the bearing which then is supported in the frame. Pulleys are added in between of frame in order to reduce the human effort.
- Driver pulley of 100mm is also mounted on the same shaft. Driver pulley is attached on the shaft and smaller pulley (driven) is attached in the dynamo.
- A metal reinforced plastic wire is used which one end is attached with the handle other end is attached to dead weight through pulley connections.
- Dynamo along with pulley is supported on the frame is connected to the driver pulley via rope.
- All the electrical connection are attached through the dynamo via electrical wires.
- The output from the dynamo is being tested in various loading conditions and average power is calculated.
- The AC output from the dynamo need to be converted to the suitable DC output, which is done by using rectifier circuit. The
- The output from the circuit is extended by using extention circuit and connected to 12V battery.
- The output from the battery is gained by output circuit at 12v.
- While performing the exercise the weight is lifted by handle thereby rotating the main shaft which is then connected to the dynamo in order to produce the electrical current which can be used immediately or can be stored in the battery

V. WORKING PRINCIPLE

The working of the project similar to that of the traditional gym pull up machine, which are being used in the most of the gym center. It is an electro-mechanical project, which consist of mechanical system combined with electrical system. An AC dynamo will be mounted on the body, which is connected to the main shaft via pulley setup. All the operation acting on the model is similar to traditional gym pull up machine along with generation of electrical generation with help of dynamo.

Fig. 7 shows the working principle of the working model in 3D model.

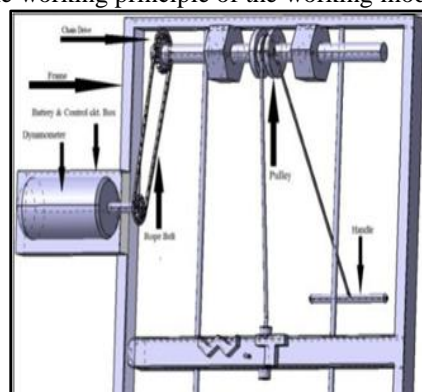


Fig. 7 Working Principle of the Model (Front View)

The electrical energy generated depends on faraday day of electro-magnetic induction and the type of current depends on the type of dynamo used. If the dynamo is of AC type the then AC current is produced and vice-versa. If AC dynamo is used the thus produced AC current can be used directly but if it is needed to be stored in battery then rectifier circuit need to be added in order to convert the AC into DC current. The current produce either AC or DC may not have sufficient voltage and also may be of fluctuating type hence step-up circuit is used in order to get the required amount of out. The electric current produced can be used for various purpose directly or can be stored in battery and can be used whenever needed.

However the generation of electrical energy is based on principle of faraday law of electromagnetic induction. faraday's laws of electromagnetic induction explains the relationship between electric circuit and

magnetic field. This law is the basic working principle of the most of the electrical motors, generators, transformers, inductors etc

Faraday's First Law states that whenever a conductor is placed in a varying magnetic field an EMF gets induced across the conductor (called as induced emf), and if the conductor is a closed circuit then induced current flows through it.

Magnetic field can be varied by various methods

- By moving magnet
- By moving the coil
- By rotating the coil relative to magnetic field

Fig. 8 shows the principle of faraday law of electromagnetic induction

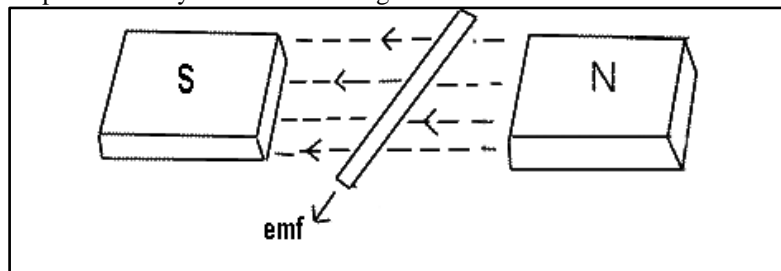


Fig. 8 Principle of Faraday Law of Electromagnetic Induction

Faraday's second law of electromagnetic induction states that, the magnitude of induced emf is equal to the rate of change of flux linkages with the coil. The flux linkages is the product of number of turns and the flux associated with the coil.

VI. COMPONENTS USED

A Fabrication of the project includes the work needed in order to make the project in working condition like welding, clamping, nut and bolt arrangements etc. to fix the all components. The major components are listed below:

- Frame
- Handle
- Reinforced Wires
- Shaft
- Bearing
- Pulleys
- Driver and driven pulley
- Dynamo
- Electrical circuit
- Battery
- Dead weights



Fig. 9 Final Model of the Project

VII. CALCULATION AND RESULTS

The average power generated by the machine at normal loading conditions is about 3.2 watts. Average a man can produce a power of approx 100 watt in a day from a single exercise equipment. 1 day =100 watt, 30 days = 30×100 watt = 3 Kilo Watt With the amount of 3-Kilowatt power 03 Ceiling Fan can run approx 08 hours in a day for whole Month.

If the charge for electricity is ₹ 4/- per unit then the monthly electricity bill of 03 ceiling fan will be
 $2.4 \times 30 = 72$ unit/day &
 $72 \times 4 = 288$ Rupees

So, power generation by a single human on a single exercises machine is saving 288 rupees per month. Also, the generated power can be used to glow lights, charge the phones in gym as well as can run many electrical appliances in home.

VIII. ADVANTAGES,DISADVANTAGESANDAPPLICATIONS

Advantages

- It is clean and eco-friendly energy.
- Dual benefit system.
- Maintenance is not complicated.
- It does not require any fossil fuel.
- It does not produce harmful effect on environment.
- Human health benefit.
- Electrical energy can be stored in battery.

Disadvantages

- Comparatively Less amount of power will be generated. Tread mills and stationary bicycle can produce at higher rate.
- Mechanical moving parts are more so, chances of mechanical loss is more.
- Weight of the model is very high so difficult to transport.
- Initial investment is high.

Applications

- Power generation using gym pulling can be used in most of places such as home, Colleges, School and Gym centre.
- It is can be used for glowing plenty of lights, charging electrical devices and can also be stored in battery which can be used for multiple purpose.
- It can be used in public parks.

IX. CONCLUSIONS AND SCOPE FOR FUTURE WORK

Conclusions

- This design and implement an innovative exercise equipment to generate electrical power for the house appliances.
- Energy storage is very necessary and important within renewable energy systems to ensure stability of the system. These models vary in complexity and accuracy and therefore the model chosen must match the application for which it is needed.
- This type of model can be used in many places and if it is operated throughout the day by many people it can create sufficient amount of energy.
- It will be very helpful for the rural areas. In this day where the world is challenged to be more responsible in its sourcing of electrical power, the method of human power generation could be a solution that also helps mitigate the issue of obesity and overweight.
- If additional design and study of this concept proves it effective in energy use reduction, localized energy delivery and sustainability education, it could efficiently answer the three great challenge; source of electrical power, reducing the emission of CO₂ to the atmosphere and the issue of obesity.

Scope for Future Work

- Only one dynamo was used in the project so power generated was less, to order to get more power multiple dynamo can be made.
- The load in the current model is not detachable, hence it is very difficult to transport or move the machine. So the load used for lifting can be made detachable so that it will be easy to transport.

- The energy generation from gym equipment can be also enhanced as now a day most of the population are health conscious and they are spending time for exercise in gym or another suitable place. If energy generation is large in amount then it can be also used for commercial purpose also.
- In order to increase the speed of the shaft variable gear ratio can be applied.
- In future, if the flywheel speed control device and voltage protection devices can be added with large generation process, it would be a model all over the world.

REFERENCES

- [1] M. Musharraf, Ifrah Saleem, Farhat Iqbal, Energy Generating Gymnasiums Machines for Renewable, Sustainable and Green Energy, International Research Journal of Engineering and Technology, Vol. 5(12), 2018, Pp. 153-160.
- [2] Roshan Ojha, Rahul Raj, Shaaravan Kumar, T.Hari prasadh, Naveen Kumar, KS Badarinarayan, Power generation by gym pull up, International Research Journal of Engineering and Technology, Vol. 5(6), 2016, Pp. 1297-1299.
- [3] Sourabh Borchate, Amit Gaikwad, Ajay Jadhav, Prasad Dhage, Design of Treadmill to Generate Electricity by using Mechanical Energy, International Conference on Ideas, Impact and Innovation in Mechanical Engineering, Vol. 5(6), 2017, Pp. 498-505.
- [4] Madhup Kumar, G S Mundada, Energy Harvesting from Gym Equipments, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol. 5(7), 2017, Pp. 127-131.