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Development of Forearm Machine for Electric generation

Rushikesh Suryawanshi[1], Jadhav Akash Pratap [2], Prathamesh Koshti[3], Abhimanyu Patil[4], Patil Vrushabh[5]

Student at KES Rajarambapu Institute of Technology, Sakharale. Affiliated to Shivaji University, Kolhapu, INDIA[1-5]

Abstract: New technologies are needed as alternatives to traditional power generation systems, alleviating the strain on existing methods. This paper explores forearm machine power generation, a technology harnessing human effort expended during exercise to produce electricity, which can then be used to illuminate a room. The experimental setup showcased the generation of electrical energy from physical exertion. Scaling up such equipment could significantly contribute to electricity generation, potentially fulfilling the energy needs of small households or appliances. This project forms part of the final year capstone work undertaken by students, presenting an exciting opportunity to explore alternative sources of electricity.

Keywords*:* Electricity generation, Forearm Machine, alternative energy source..

I. INTRODUCTION

There are many alternative resources that could be unveiled as an alternative to electricity generation methods used. The conventional methods those may not balance the demand and supply. So, there by become a necessity to find alternative for electricity generation.

We hereby make use of an energy harvester system that moves in response to movement of the motion of a forearms exercise machine for converting kinetic energy of the forearms exercise equipment into electrical power. Our system makes use of the gripping rod connected to spring based motorized mechanism having rack pinion arrangement and multiple motors to power the system and generate power. The system aims to provide resistance to forearms movement while generating power from the same thus serving dual purpose. The machine makes use of 2 motor arrangements to provide 2 levels of generation capability. The machine aims to generate electricity through horizontal motion created while working our forearms. The spring-based mechanism allows for efficient resistance settings in the machine as needed. Increased resistance leads to increased power generation in the machine.

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 or houseless commonly gym power is used to power agricultural and hand tools and even to generate electricity

Some application includes battery charge home appliance. The articles on this page are about the many wonderful applications for power generation by gym pulley technology. Whenever the person is allowed to pass over the gym pull up pull down. As the spring are attached to gym equipment's, 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 which converts the mechanical energy into electrical energy.

An energy crisis is any great bottleneck (or price rise) in the supply of energy resources to an economy. Energy crisis can develop due to Overconsumption, Overpopulation, Delay in Commissioning of Power Plants, Wastage of Energy. Sometimes bottlenecks at oil refineries and port facilities restrict fuel supply. An energy crisis can arise due to over use of the resources and wastage of energy generated. This project addresses both the issues of energy saving as well as energy generation using simple mechanism from gym equipment. "Energy changes from one form to the other". When people work out in gym then there are lot of energies involved in the process. Energy due to spinning of pulley, rolling/ up-down movement of exercise equipment, heat etc. is lost in the environment. The idea is to utilize and convert the mechanical energy to electrical energy. A mechanical shaft with the dynamo is attached to the pulley of exercise equipment. When people work out on exercise equipment, pulley rotates due to up-down movement of equipment, the pulley rotates which in turn moves shaft of the dynamo. When the shaft rotates it generates the voltage based on Faraday's law. This voltage can in turn be stored in a battery which can be further used to light the street bulbs. 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.

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A typical American consumes about 2500 kilocalories of energy in a day. Assuming no weight gain or loss, this also means that 2500 kilocalories are used by the body in a day. With 2500 kilocalories of energy, the body is able to function properly. This allows you to do everyday activities such as reading, jogging, sleeping, etc." Objective of the study of forearm machine power generation is, to understand what is Energy Harvesting and the need for it: also, the sources of energy harvesting. To study the Human Power Energy Harvesting. To Design and fabricate forearm power generation machine. To Analyze the concept of Green Gym and survey on the existing equipment which harness the Human Power into useful electrical energy.

II. LITERATURE REVIEW

The idea of first sustainable gyms was conceived by Italian inventor Lucien Gambarota. He partnered with entrepreneur Doug Woodring and Hong Kong-based company California Fitness (now known as the Motorwave Group) to open the world's first such gym in 2008. California Fitness's president at the time, Steve Clinefelter, explained the concept's advantages by giving the example of a treadmill modified to generate electricity. Other Sustainable Gyms also open in 2008 was "The Green Gym" by fitness instructor Adam Boesel in Portland, Oregon. Boesel's goal is complete sustainability, but in the meantime, his gym has been able to reduce its carbon emissions by 60%.

Treadmill:
A treadmill is not a self-powered machine; therefore, it needs to be plugged in all the time even if no one is using it. This suggests that treadmills account for a large consumption compared to other gym equipment. According to [1], the treadmill was the third in terms of the overall energy consumption. For example, the power consumption for a treadmill with a speed of 5 mph is 480W and by increasing the speed to 9W increases the consumption to 1083W [2]. However, during standby, it consumes around 3 Watts.

A treadmill can be used to generate up to 100W of electricity per hour [3]. This number can vary according to the speed choice, resistance choice and the time. The higher any of these elements, the larger the power that can be harnessed.

Human powered treadmill is a device that converts human kinetic energy into electric potential energy. The energy exerted to turn a belt on the treadmill is transferred via a generator into a simple circuit that charges a small battery. The battery can be used to charge small electrical devices like laptops, mobiles etc. In order to build a human powered treadmill, a manual treadmill is used. The manual treadmill has two flywheels as a part of its front axle. Because it is a manual machine, no external power source is required to operate it. All power going into the system is from human power. The power coming out of the system is then collected in a 12V rechargeable battery. One flywheel of the treadmill's front axle is connected to the pulley, attached to the shaft of the dynamo, using belt drive system. Hence, the mechanical power produced by the treadmill's motion is converted to electrical energy with the help of DC electromagnetic dynamo.

2) Elliptical machines: Elliptical machines consist of machines like cross-trainers and stair steppers which simulate stair climbing and walking or running. These are self-powered and the energy that is not used to power the machine or the monitors can be harvested.

Depending on the speed and the resistance set by the user, the elliptical trainers offer a cardio-vascular workout ranging from minimal impacts to intensive ones. An hour exercise on average produce 100 Watts while an advanced exerciser can generate up to 150 Watts [4].

The kinetic energy from the workout can be converted to DC (direct current) when users use the elliptical machines. ReRev™ technology helps retrofit cardio equipment so that the DC can be converted to AC (alternating current). Each retrofit consists of a controller box which helps feed the current into a central-grid tied inverter that is connected to the building's electrical system [5]. A typical 30-minute workout will produce 50 Watt-hours of electric energy [6].

3) Stationary bike: A stationary bike is exercise equipment that consists of pedals, a saddle and handlebar, representing a bicycle but does not move from place to place. Some of the models have handlebars that are connected to the pedals so that besides the lower body, the upper body can also exercise at the same pace. The amount of energy generated from these devices varies according to user experience, user pace, and speed. Several estimates exist for the human generated power: 60-120W, 50W, 75-100W [7] and 150W [8].

Design architect of Forearm Machine.

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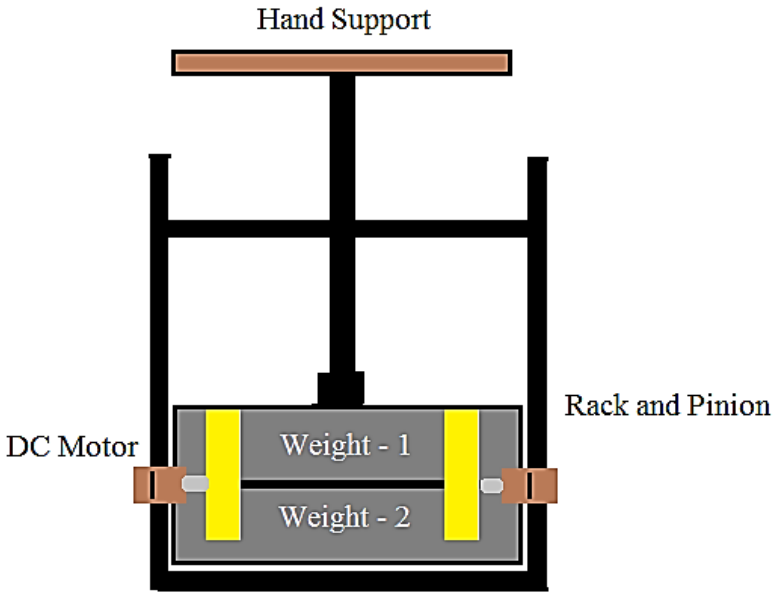

Fig 1: Forearm Machine Power Generation

III. PROPOSED WORK

Energy demand graph is ascending day by day and scientists are exploring the new ideas and resources to get any form of energy. In this paper we will discuss a method in order to harness energy from human. In proposed method human is considered a device or machine for converting biomass energy into electrical energy. The device which converts one form of energy into another form of energy is called a transducer. Man takes calories from food and performs work, however excess of calories due to unbalanced diet will store in adipose tissues giving a fatty appearance. People join gymnasium in order to maintain healthy look and fitness where they perform different types of exercises, like running, weight lifting, muscles building. There are specified machines for exercise of specific portion of human body, e.g., cable preacher curl, close grip bar curl, barbell curl, and dumbbells lifting are some exercises for biceps.

Exercises for chest are barbell bench press, flat bench dumbbell press, low inclined barbell bench press, seated machine bench press, etc. Some of the cardiovascular machines in gymnasium equipment are made of cables and pulleys. These machines are main focus of this research since these machines can contribute to harvest energy. As the demand of energy is increasing day by day so it is necessary to invent new ways and techniques to produce energy within a small area which may be a home or a gymnasium building.

During exercise in gymnasium people apply force on machines and expend energy to do some work. In this proposed work the authors suggest a theoretical technique which will make it possible to harvest energy from some gymnasium machines. The basic idea behind the research is to harness energy from the moving parts of gymnasium machines in electrical form. For this purpose, low RPM (revolution per minute) generators can be installed in the gymnasium machinery.

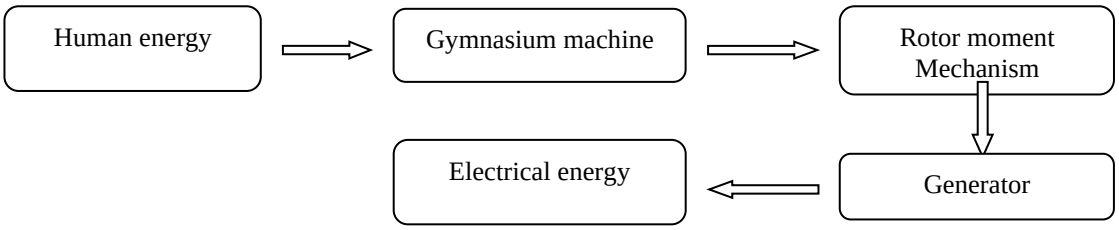

Fig 2: Human energy converts to electrical energy

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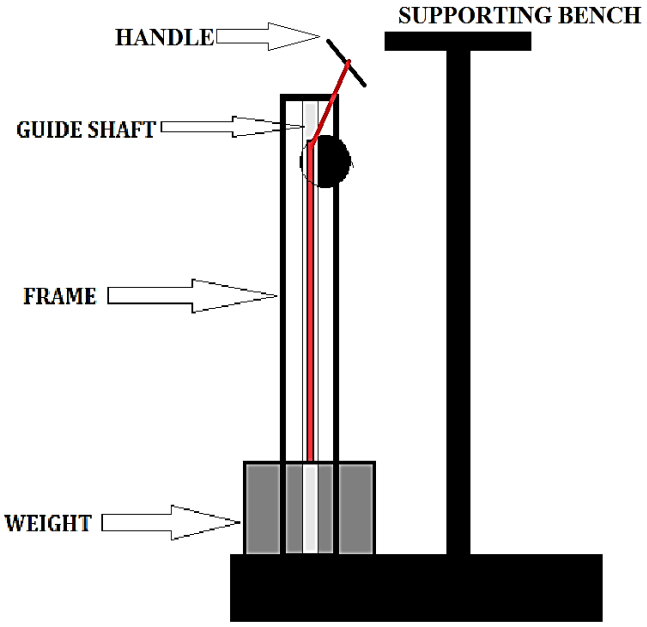

Fig 3: Block diagram of forearm machine

Fig 2 and 3 are the flow diagram showing process of energy conversion. They way in which human energy is used to get electric energy. And block diagram of machine.

IV. USED COMPONENTS DESIGN AND CALCULATIONS

Power Calculation

1 Day = Working = 2 hr

= 2 × 60 = 120 min = 2 × 120 = 240 sec

1 turn hand up &down

= 2.30 sec

Turn hand in 2 hr = 240 / 2.30

= 313.304 Sec

1 turn hand up &down = Watt = ?

Watt = Ampere × voltage

W = A × V

W = 0.1 × 9 = 0.9 Watt per 1 hand turn

Total watt = turn hand up& down × 1 hand turn watt

= 313.304 × 0.9

Total watt = 272.736W per Day

Average a man can produce a power of approx. 272.723W in a day from single exercise equipment. 1Day = 272Watt 30 day = 30 × 272 Watt = 8.16 KW With the amount of power for whole month.

Design of angles: -

Here, the maximum load due to all factors = 200 kg (including friction)

F= 200kg = 200 x 9.81 = 1962 N.

We know that the load on each link,

F1 = 1962/4 = 490.5 N.

Assuming a factor of safety as 3, the links must be designed for a buckling load of

Wcr = 490.5 x 3 = 1471.5 N

Let t1= Thickness of the link

b1= width of the link

So, cross sectional area of the link = A = t1x b1

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Assuming the width of the link is three times the thickness of the link, i.e. b1= 3 x t1
Therefore
A= t1x 3 t1 = 3 t12
And moment of inertia of the cross section of the link,
I = 1/12 t1b13
= 2.25 t14
we know that, I = AK2, where k = radius of gyration.
K2 = I/A = 2.25 t14 / 3 t12 = 0.75 t12
Since for the buckling of the link in the vertical plane, the ends are considered as hinged,
Therefore, the equivalent length of the link
L = l = 600 mm.
And Rankin's constant, a = 1/ 7500
Now using the relation,

Wcr=(f x A)/(1+a (L/K)2)
Wcr = 1 + a (L / K)2 with usual notation,
Here, f = 100 N / mm2
3310.9 =(100x3x(t1)2)/(1 + (1 / 7500) (6002/0.75t12))

300 t14 – 3310.9 t12 –64 x 3310.9 = 0
t12= 41.2
t1 = 6.418 mm
b1= 3 x t1 = 3 x 6.418 = 19.25 mm.
But the standard angle available of 35x 35 x 3
Hence, for safer side we have,
This can bear the impact loading. Hence our design is safe.

V. CONCLUSION

The "Forearm Power Generation" project has been successfully designed and demonstrated, with a well-fabricated setup capable of converting human mechanical energy into electrical energy. Based on calculations and experimental trials, the estimated daily electrical output is 272 watts per day. Future Prospects, Further advancements in energy generation from gym equipment hold promise, especially considering the current trend of heightened health consciousness leading to increased time spent exercising. If energy generation can be scaled up significantly, it could potentially be utilized for commercial purposes as well. Additionally, incorporating flywheel speed control and voltage protection devices into the large-scale generation process could establish it as a model for widespread adoption worldwide.

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