DESIGN AND FABRICATION OF BIO-MECHANICAL ENERGY HARVESTER

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled "**DESIGN AND FABRICATION OF BIO-MECHANICAL ENERGY HARVESTER**" is the bonafide work of

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Branch : MECHANICAL ENGINEERING

Semester : SIXTH SEMESTER

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The report of project work submitted by the above students in partial fulfillment for the award of Bachelor of Engineering degree in Mechanical Engineering of Anna University and confirmed to be the report of the work done by the above students.

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ABSTRACT

Ages before the case was "no man, no electricity". But in present scenario it has changed to "no electricity, no man" Electricity is one of the basic needs of mankind. It has become a major part of our life. We use it in almost every work we do. Right from the start of our day till the end of it , electricity is part of our daily life. But still the world is facing a huge shortage of power. Thus project focuses on generating electric power when a human walks.

To solve this problem to an extent by generating power out of human walk. Gear train and a generator are used to produce power. The power produced can be used for charging cell phone batteries, ipods and so on.

The basic idea used in this project is speed increasing gear trains which is then coupled to the generator. The drive to the gear is obtained from the movement of our hand when we walk.

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1.INTRODUCTION:

1.1AIM:

The aim of this project is to generate enough electricity from walking to operate a portable GPS locator, a cell phone and many other devices. This bio mechanical energy harvester may be a boon to many soldiers and common man.

1.2 APPLICATION

Exercise may soon do more for you than tighten up your sagging muscles. Advances in bio-mechanical engineering could use energy generated while walking, hiking or running to power any device requiring portable power, including night-vision goggles and other battery-operated devices used by soldiers as well as robotic prosthetic limbs, cell phones and computers in remote locations where no other energy sources are available.

Volunteers, wearing a brace strapped on each hand, generated about five watts of electricity per person during a recent experiment, enough power, researchers say, to run 10 cell phones concurrently and twice that needed to keep a computer running (something useful in developing regions of Africa where electricity is scarce). They report that one brace-wearing subject generated 54 watts of power by running in place.The best area to place a device for harnessing human energy is near a joint, because this is where the muscles—the body's power source—work hardest, There's a long history of human power generation using hand cranks and bikes, but these require your dedicated attention, so you don't do it for very long." The key to energy harvesting is extracting the energy from the body's natural movement and, aside from breathing; very few unconscious muscle movements are more automatic than the action of walking.

2.MECHANISM:

Following are the three major parts in the bio mechanical energy harvester.

1.**Gear trains** : the purpose of gear train is to increase the speed of the alternator

2.**Twine** :the purpose is to convert the reciprocating motion of the hand in to the rotary motion of the gears

3.**Alternator** : to produce power.

Mechanisms of these three major parts are as follows.

2.1GEAR TRAINS:

To create large gear ratios, gears are often connected together in **gear trains.**

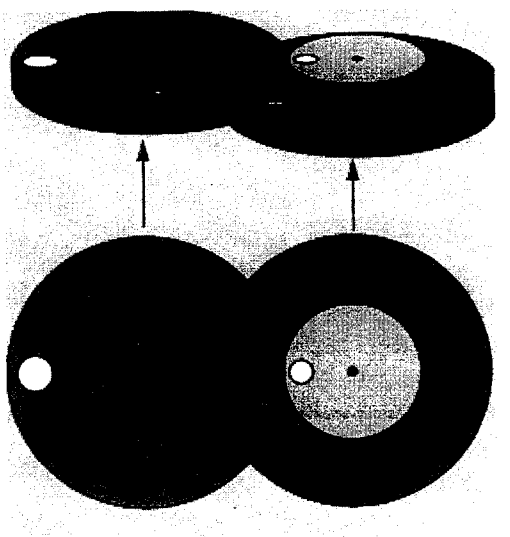

Fig 1: Gear train

The right-hand gear in the train is actually made in two parts, as shown. A small gear and a larger gear are connected together, one on top of the other. Gear trains often consist of multiple gears in the train.

This is the basic gear train. But we can't attain higher speeds using this type of gear trains. So to attain higher gear speed ratios gear trains with more number of gears are used.

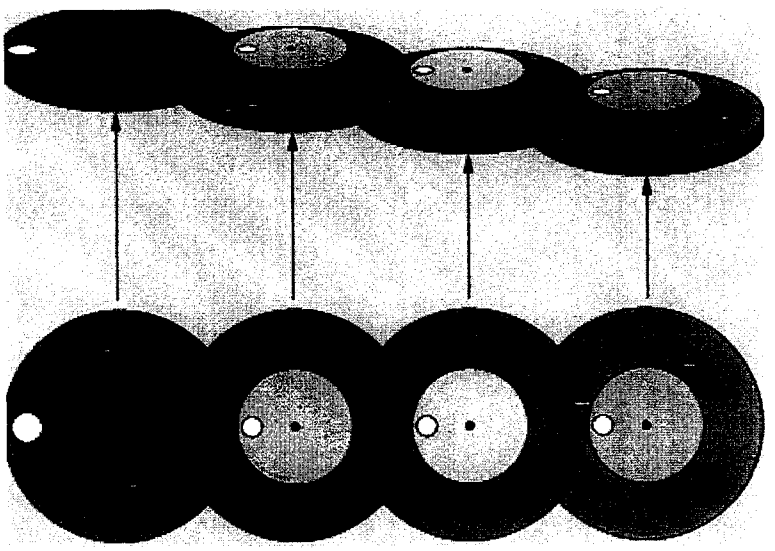

Fig 2: Gear trains

In this train, the smaller gears are one-fifth the size of the larger gears. That means that if you connect the gear to a motor spinning

at 100 rpm (revolutions per minute), the gear will turn at a rate of 500 rpm and the gear will turn at a rate of 2,500 rpm. In the same way, you could attach a 2,500 rpm motor to the gear to get 100 rpm on the gear. If you can see inside your power meter and it is of the older style with five mechanical dials, you will see that the five dials are connected to one another through a gear train like this, with the gears having a ratio of 10:1. Because the dials are directly connected to one another, they spin in opposite directions.

2.2ALTERNATOR:

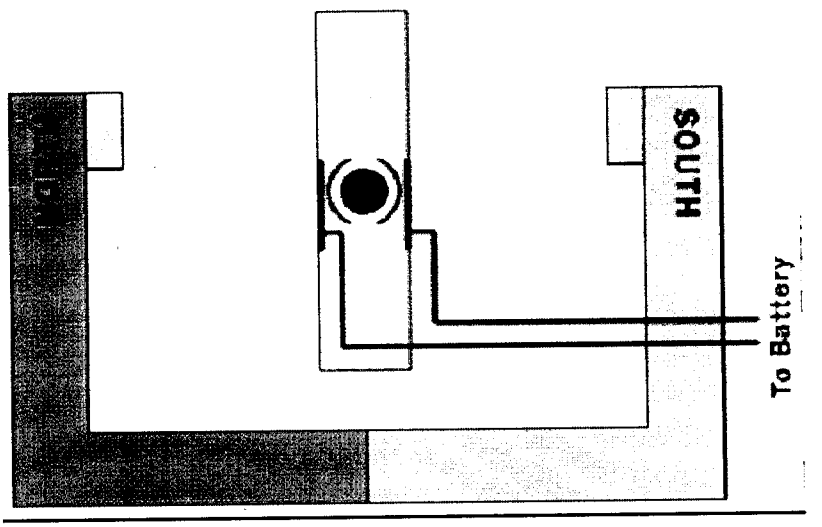

Fig 3 : Alternator

The generator is also known as alternator. All generators work on the principle of dynamically induced emf. This principle is nothing but the faraday's law of electromagnetic induction. It states that " whenever the number of magnetic lines of force that is flux linking with the conductor or a coil changes, an electro motive force is set up in the conductor or coil."

The change in flux associated with the conductor can exist only when there exist a relative motion between the conductor and the flux. The relative motion can be achieved by rotating the conductor with respect to flux or by rotating flux with respect to conductor. So a voltage gets generated in a conductor, as long as there exist a relative motion between the conductor and the flux. Such an induced emf is called dynamically induced emf.

The major parts of alternator are:

Armature winding: To have a large voltage as output, the number of conductors are connected together in sa specific manner

to form a winding. This winding is called armature winding. The part on which this armature winding is kept is called armature.

Poles:

In armature, both north and south poles are placed opposite to each other in the yoke so that there will be magnetic flux lines passing between them through the armature coils.

WORKING:

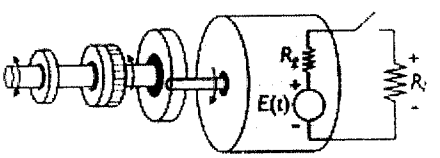

Fig 4: Schematic diagram of the bio mechanical energy harvester

The above figure shows the schematic diagram of the bio mechanical energy harvester. The left most part of the above diagram is where the twine will be tied to our hands. The right most part is the alternator. The twine is connected to the shoulder.

So when we walk normally, the reciprocating motion of our hands is converted to rotary motion. This is because the twine which is tied to our hand, is pulled and hence it causes the rotation of the gear.

The gear train is used to convert the low velocity high torque to high velocity low torque. The alternator is connected to the end of the gear train. thus the armature of the alternator spins with the high velocity. Thus the flux are being cut and the power is being generated.

The fig.5 shows actual figure of the bio mechanical energy harvester

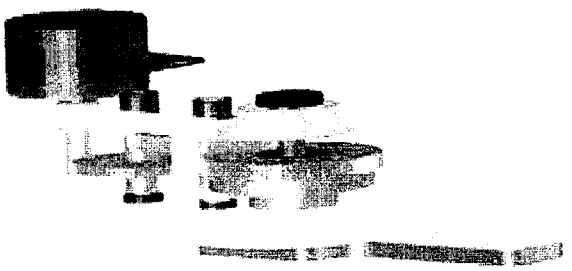

Fig.5 : Actual figure of the bio mechanical energy harvester

3.DESIGN OF GEARS:

Input power to the gears from the knee joints, P= 6.7 kw

Speed of the gear, $N_1 = 150$ rpm

Speed of the pinion, $N_2 = 1000$ rpm

Speed ratio, $i = N_2 / N_1$

$= 1000 / 150$

$= 6.67$

Material selected: Nylon

Tensile strength, $\sigma_u = 82$ N/mm^2

Compressive stress, $\sigma_c = 35$ N/mm^2

Torque, $M_t = (P * 60) / 2\pi N1$

$= (6.7 * 103 * 60) / 2\pi * 150$

$= 426.53$ N-m

Design torque, $[M_t] = M_t * k * k_d$

$= 426.53 * 1.3$ (assume $k * k_d = 1.3$)

$= 554.5$ N-m

Young's modulus, $E = 0.24\ N / mm^2$

$\Psi = 0.3$ (assumed value)

Center distance,

$$a = (i+1) * [(0.74/\sigma_c)2 * (E * [M_t]) / (i * \Psi)]^{(1/3)}$$

$$= (6.67+1) * [(0.74/35)2 * (0.24 * 554.5 * 1000) / (6.67 * 0.3)]^{(1/3)}$$

$$= 23.7 \text{ mm}$$

Bending stress, $[\sigma_b] = \sigma_u / n$ (n is the factor of safety)

$$= 82 / 2.5$$

$$= 32.8\ N / mm^2$$

Module, $m = 1.26 * [[M_t] / (y * [\sigma b] * \Psi * Z1)]^{(1/3)}$

(Initially assume Z1 = 20)

$$= 0.5 \text{ mm}$$

Calculation of no. of teeth:

No. of teeth on the pinion, $Z2 = (2 * a) / (m * (i + 1))$

$$= (2 * 23.7) / (0.5 * (6.67 + 1))$$

$$= 12 \text{ teeth}$$

No. of teeth on the gear, Z1 = i* Z2
= 6.67 * 12
= 80 teeth

Pitch circle diameter of the pinion, d2 = m * Z2
= 0.5 * 12
= 6 mm

Pitch circle diameter of the gear, d1 = m * Z1
= 0.5 * 80
= 40 mm

Face width, b = Ψ * a
= 0.3 * 23.7
= 7.11 mm

Velocity of the gear, V = (π * d2 * N2) / 60
= (π * .006 * 1000) / 60
= 0.314 m/s

Recalculation of [M_t] :

[M_t] = M_t * k * k_d
= 426.53 * 1.06 * 1.35
= 610.36 N-m
(from the design data book k=1.06
k_d=1.35)

$$\sigma_c = 0.74 * [(i+1) / a] * [(i+1) * (E * [M_t]) / (i*b)]^{(1/2)}$$
$$= 1.16 \text{ N / mm}^2 < [\sigma_c]$$

Since the designed value of compressive stress is greater than its working condition, **the design is safe**.

Bending stress

$$\sigma_b = (i+1) * [M_t] / (a * m * b * y)$$
$$= 18 \text{ N/mm}^2$$

Since the designed value of bending stress is greater than its working stress, **the design is safe**.

4.FABRICATION:

The following are the components used in bio-mechanical energy harvester.

1.Alternator:

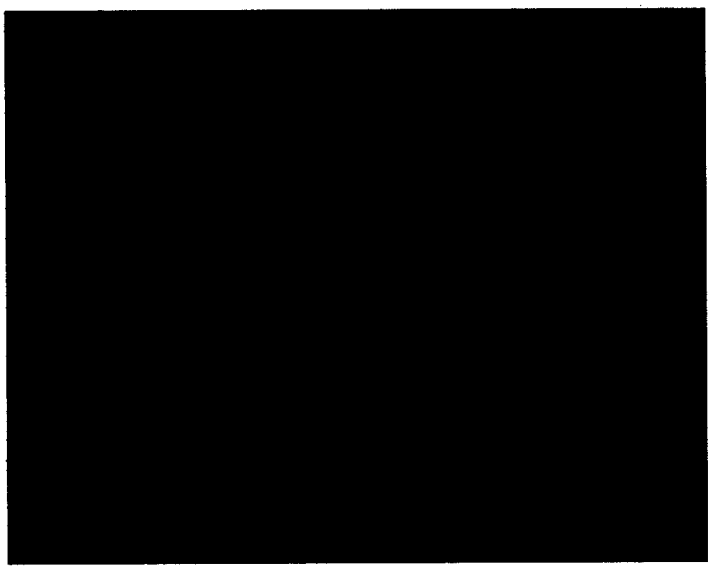

Fig.6:Alternator used in harvester

Fig.6 showing the alternator used in the harvester. It was purchased from SVS electricals in oppanakara street. The generator produces a voltage of 1 volt and a current of 3mA. This is enough to light low power bulbs.

2. Gears :

Fig.7:Gears used in harvester

Fig.7 showing the gears used in the harvester. The gears were bought from china bazaar. The gears are connected in gear train in such a way that it increases the final speed of the gear which is coupled to the alternator.

Diameter of the bigger gear, d_1=40mm
Diameter of the smaller gear, d_2=6mm

3.Twine:

Fig.8: Twine used in harvester

Fig.8 showing the twine used in the harvester. The twine is used to convert the reciprocating motion of hand to the reciprocatory motion of the gear.

The gears are then made to mesh with each other.

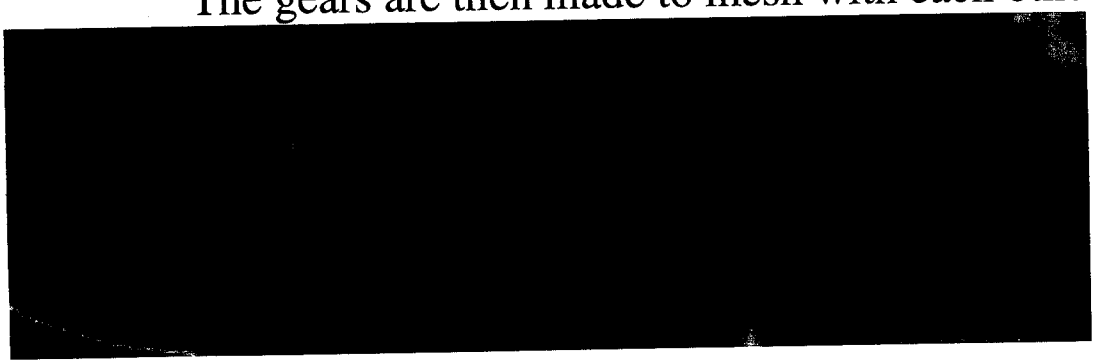

Fig. 9:Gears meshing with each other

Fig. 9 showing two gears meshing with each other. The centre distance between them is calculated using

Centre distance, a=(d1+d2)/2

=(40+6)/2

=23mm

Thus the gears are kept 23mm apart.

The alternator is then connected to the gear train.

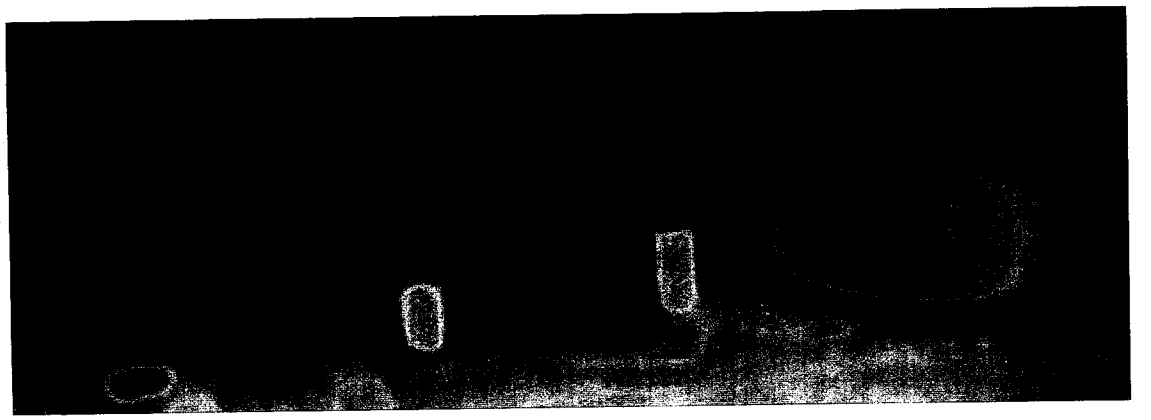

Fig. 10:Alternator connected to gear train

Fig.10 showing alternator connected to the gear train. The center distance calculated as before and it is 23mm.

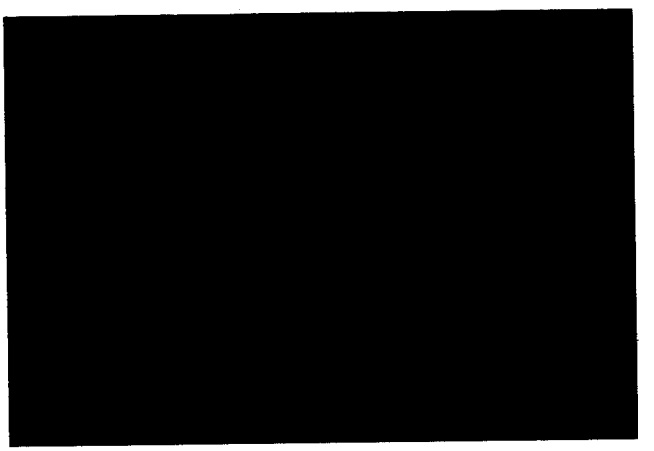

Fig. 11:Twine connected to gear train

Fig.11 showing twine connected to the gear train. the twine is used to get the initial drive to the gear.

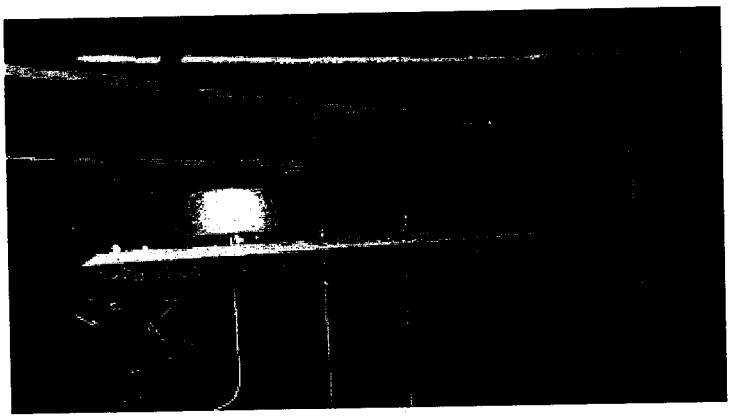

Fig.12 Bio-Mechanical Energy Harvester

Fig.12 showing the final picture of the harvester. We use plastic cardboard and nuts and bolts to support the gear train and the alternator.

Fig.13 Harvester mounted on the hand

Fig.13 showing the harvester mounted on the shoulder.

5.APPLICATIONS:

5.1. IN ARMY:

Fig.14 Armed forces

To the armed forces(as shown in fig 8), equipment for communication and navigation is as critical as food and water. But it comes at a steep price: On a 24-hour mission, a soldier will carry as much as 13 kilograms (30 pounds) of batteries to power this equipment - significantly limiting his or her range and speed of travel. Due to logistics, delivering portable power is expensive with estimates as high as Rs 20 lakhs/- per soldier per year for the cost of batteries alone. The Biomechanical Energy Harvester can dramatically improve performance, reduce weight, and cut overall

costs by slashing the size and quantity of batteries required to complete a given mission. It could also make rechargeable batteries a feasible option for the vast majority of applications currently powered by disposables.

5.2. MEDICAL FIELD:

Fig.15 Medical field

People around the world rely on battery-powered devices that either assist a partly paralyzed limb or replace its function altogether. To this community, quality of life is a direct function of battery weight and charge duration. Our technology can extend the range and confidence of those who rely on such outhouses and prostheses - or on other innovations such as drug pumps and neuro-electric stimulators(as shown in fig 9),. Future versions of the Biomechanical Energy Harvester could potentially be fully

integrated into these products, or it could even be implanted subcutaneously, creating a seamless interface between power and product.

5.3. CONSUMERS:

Fig.16 Consumers

Hikers, road warriors, mobile field workers(as shown in fig 10),. Bionic Power solutions could benefit anyone who relies on portable electronics for work or play. Our present technology could extend the operating time of mobile phones, GPS, MP3 players, digital cameras, headlamps and similar devices. Since such products are typically designed around their power sources, next-generation Bionic Power solutions could possibly pave the way for a new and exciting era of consumer applications and form factors.

6.CONCLUSIONS

Through this project, we intend to create power out of walking with a little extra effort. The output voltage generated in harvester is 1V and the current is 3mA. This is enough to run low power bulbs. The power produced can be increased by using more gear trains. Since electricity is a major part in human life, producing it out of virtually nothing will prove as a major boon to the human community.

7.References

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