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Design and Development of Treadmill to Generate Electricity by Using Mechanical Energy

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Abstract - *In this paper, a method for the generation of electricity is proposed by using Mechanical Energy which is generated due to the workout carried on Treadmill Machine. The Treadmill is driven by human being. The developed treadmill is based on a manual flatbed treadmill using a brushless PMDC generator coupled to a front end of belt. A rechargeable battery is used to store the generated energy and additional components to measure the generated power, speed by using Tachometer, distance, calories burnt are included. All these parameters are displayed on LCD screen which is interfaced with microcontroller. The electric energy generated while carrying out exercise may be used for charging a battery or for any other work. The design of this Treadmill is presented in this paper*.

Key Words: **Generator, Treadmill, Battery, Tachometer.**

1.INTRODUCTION

Everybody knows that exercise is good for health. No one can ignore the health benefits of regular exercise and physical activity regardless of age, sex or physical ability. There are many advantages of exercise. Most of the people do exercise worldwide. Different types of machines are used for exercise. These machines have handy operations. In manual exercise machines muscle power goes waste during exercise. Anyways this power which otherwise goes waste during exercise may be used by converting it into any other form of energy. With the technological advancement across the globe, the demand for energy is drastically increasing. The power generation is also increasing and most of the energy generation plants are using fossil fuels which bring up many adverse effects. Hence there is a need of alternative methods of power generation. Inventions are going on worldwide for generating power through alternative methods. A treadmill manufacturing company wood way manufactured a treadmill which generates power for display and can even be used for charging a phone or MP3 player.

2. DESIGN

Load analysis of the selected material: -
Maximum applied load = 150kg = 1471.5 N.

Design of Shaft: -
Maximum allowable load = 150 kg = 1471.5 N
Length of Shaft= 600 mm.
Uniform distributed load= 2.45 N/mm.
Consider simply supported load.

Material: -
Designation - C45.
Condition - Tubes, cold drawn and tempered.
Yield strength (syt) - 600 N/mm2.
Ultimate tensile strength (Sut) - 700 N/mm2.
Tp = 0.3 Syt = 0.3*600 = 180 N/mm2.
Tp = 0.18 Sut = 0.18*700 = 126 N/mm2.
Select whichever is smaller value – Tp = 126 N/mm2.
Assume kb =1.5 and kt =1.
P(KW) = 2πNT 60∗1061.5=2πT∗1500 60∗106.
T = 9549.29 N-mm.
Mmax = (2.45*600) *300 = 441450 N-mm.
As per ASME code,
$\pi d3$Tp16= $\sqrt{}$ $(kb * M)2 + (kt * T)2$.
$\pi d3 * 126\ 16 = \sqrt{}\ (1.5 * 441450)2 + (1 * 9549.29)2$.
$\pi d3 * 126\ 16 = 662243.852$.
$d3 = 26768.097$.
d = 29.91.
d ≃ 30 mm.
Step 6: - Bearing selection and design
P = X*V*Fr + Y*Fa

Where,
P = equivalent dynamic load (N),
Fr = Radial load (N),
Fa = Axial or thrust load (N),
V = Race rotation factor
$Fr = 200 * 9.81\ 4 = 490.5$ N

Hence, the bearing is subjected to Pure bearing load.
The value of V is 1.2 when the outer race rotates w.r.t.

Load while the inner race remains stationary.
P = V*Fr = 1.2* 490.5 = 588.6 N.
Bearing life (L10)
We take L10h = 16000
L10 =60n$L10h$ 106

Where,
n = Speed of rotation (rpm)
$L10h$ = rated bearing life (hours)
$L10$= bearing life (mill. revln)
=60∗1500∗16000 106
= 1440 milli revln

Then, we find Dynamic load capacity (C)
C = P (L10h)1/3= 588.6 (1440)1/3
C = 6645.725 N.
We select bearing 16006.
Belt selection and design
P=1.5 KW
Load correction factor= 1.2
Maximum power= 1.2*1.5= 1.8 KW
αs = 180 −2sin−1$(D - d)$ 2C
αs = 180 −2sin−1(67 − 50) 2 ∗ 1520
αs = 179.359
$\alpha s \simeq$ 180.

Hence, arc of contact factor Fd =1
Power corrected= (KW)max * Fd =1.8*1= 1.8 KW
Power corrected= 1.8 KW.
Assume n = 120 rpm not 1500 rpm as human being run on the belt to measure velocity.

Belt velocity is given by,
v =$\pi * d * n$ 60 ∗ 103
v =π ∗ 67 ∗ 120 60 ∗ 103
v = 0.4209 m/s.

Corrected KW rating =0.118 ∗ v 5.08
Corrected KW rating =0.118 ∗ 0.4209 5.08
Corrected KW rating = 9.778 ∗ 10−4 KW.
width ∗ plies =$corrected\ power\ corrected\ belt\ rating$
width ∗ plies =1.8 9.778 ∗ 10−4
width ∗ plies = 1840

for 4 plies,
width =18404
width = 460 mm
width = 46 cm.

For standardization we assume width = 50 cm.
Length of Belt is given by,
L = 2C +$\pi(D + d)$ 2+$(D - d)$2 4C
L = 2 ∗ 1520 +π(67 + 50) 2+(67 − 50)2 4 ∗ 1520
L = 3223.83 mm
L ≃ 325 cm.

3. FIGURE

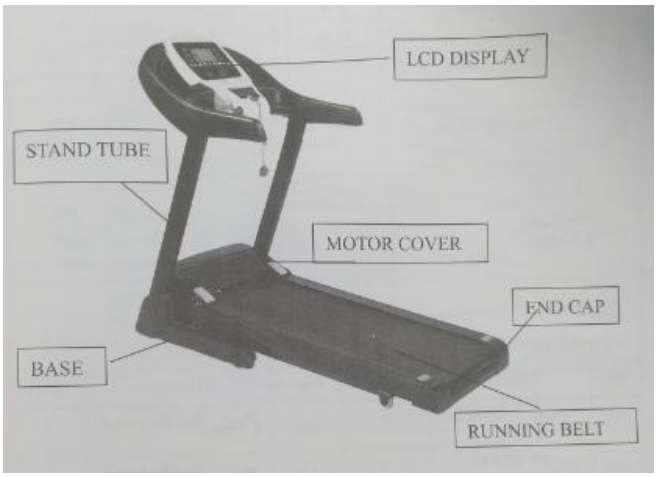
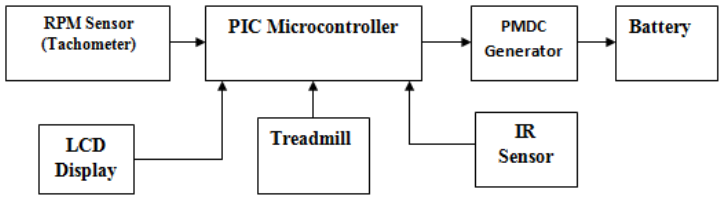


Fig-1: Treadmill

4. BLOCK DIAGRAM



Proposed Method:
The RPM (Revolution per Minute) Sensor, LCD (Liquid Crystal Display) and IR (Infrared) Sensor are interfaced with PIC Microcontroller. The PIC microcontroller is connected to Treadmill from which energy is generated and stored into the battery using PMDC generator.

RPM Sensor

A tachometer is an instrument measuring the rotation speed of a shaft, as in a motor or other machine. The device usually displays the Revolutions Per Minute (RPM) on a precised analog panel, but digital displays have a great demand..

PIC Microcontroller

A microcontroller is a small computer on a single integrated circuit. In modern terminology, it is a System On Chip or SoC. A microcontroller contains one or more CPU's (Central Processing Units) along with memory and programmable input/output peripherals.

LCD

A liquid-crystal display (LCD) is a flat-panel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly.

IR Sensor
A infrared sensor (IR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view.

PMDC Generator
A Permanent Magnet Direct Current synchronous generator is the one in which the excitation field is provided by a permanent magnet instead of a coil. The term synchronous refers here to the fact that the rotor and magnetic field will move in circular fashion with the same speed, because the magnetic field is produced through a shaft mounted permanent magnet mechanism and current is induced into the stationary armature.

Battery
An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices. When a battery is supplying power, its positive terminal is the cathode while its negative terminal is the anode.

5. COMPONENET SPECIFICATION

By Proposed Method
In this project we are going to display various parameters like speed of treadmill, distance covered, time, date, calories burnt and heart rate. Along with this there would be USB port connection along with MP3 point connection on the panel supported for LCD.

Speed:
For displaying speed use of tachometer is selected.
Speed Range:1000-1500 rpm

PMDC Generator:
0.5 HP
1500 rpm

Photo Diode:
The photo diode will be used to measure the distance covered by running on treadmill. In this technique a point could be marked on belt, every time when the diode will crossover the mark on belt, a certain distance would be covered. So certainly the overall distance covered by running on Treadmill can be measured.

Time and Date:
RTC is used for displaying Current Time and Date by connecting Microcontroller.

Heart Rate:
By using IR Sensor, the corresponding Heart rate of a person can be known.
USB Port: USB, short for Universal Serial Bus, USB was designed to standardize the connection of computer peripherals

Calories Burnt:
By using the below formulae we can calculate the calories burnt during work out.
1. 0.75 *(your weight in pounds) *(distance run in miles)

USB 3.0
outside pins provide a 5-volt
five pins
USB 3.0, it moves up to 900mA (0.9A).
charging ports provide up to 1,500mA (1.5A)

LCD:
Display: 20 × 4 character
Outline: 146.0 x 55.0 x 13.5
VA: 123.5 x 43.0
Driver: 1/16
LCD: STN Yellow Green
Backlight: Yellow Green LED
Also Available LCD: STN Blue Negative, Backlight: White LED

Battery:
6V
50 ah

PIC Microcontroller:
Program Memory Type-Flash
Program Memory (KB)-32
CPU Speed (MIPS)-12
RAM Bytes-2,048
Data EEPROM (bytes)-256
Digital Communication Peripherals-1-UART, 1-SPI, 1-I2C1-MSSP(SPI/I2C)
Capture/Compare/PWM Peripherals-1 CCP, 1 ECCP-
Timers-1 x 8-bit, 3 x 16-bit
ADC-13 ch, 10-bit
Comparators-2
USB (ch, speed, compliance)-1, FS Device
Temperature Range (C)- -40 to 85
Operating Voltage Range (V)-2 to 5.5

3. CONCLUSIONS

In conclusion, a treadmill based human power generator was developed using an PMDC generator coupled to a manual treadmill. The final circuit delivering power to a heavy duty battery was found to be able to deliver 6V peak for a short period of time. Regression equations were obtained to relate the power generated to the belt speed.

Exercise

Treadmill bicycle helps in maintaining proper health. Physical fitness is of important in day to day life.People often get bored while exercising in a closed room such as gym. By using this portable treadmill one can work outdoors in fresh air.

Energy saving

People often require electric power. This causes unnecessary wastage of energy. Due to use of treadmill a certain amount of electricity is produced. Thus, we can use it for some the domestic applications and also it can be stored.

Eco- friendly

Treadmill does not require any fuel. Therefore, it does not emit any pollutants. So it is an eco-friendly equipment.

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