TREADMILL PORTER

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ABSTRACT

This project deals with the design and fabrication of the treadmill vehicle. The treadmills are not used to harness power, but as exercise machines for running or walking in one place, we are utilizing same principle for travelling shorter distances. The motion of the machine is achieved by transferring the human's energy to the machine through the concept of treadmill. This machine can be helpful for travelling to short distances as well as used for exercise to the peoples. Using this machine, allotting a separate time for their exercise is not needed. The same action performed on the treadmill is used in this machine for the movement of the machine. As we (the operator), walk forward, the machine moves forward.

Keyword :- *Bearings, Rollers, Gears, Shaft, Belt, Material Selection, Designing, Treadmill Cycle*

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1. OBJECTIVE

To work on modifying a treadmill to better fit the needs of elderly users and meet increasing productivity demands of Industry 4.0. This subject includes an MQP to identify the needs and modify a stock treadmill to better meet them. Based on a survey of local senior citizens, it has been determined that a treadmill would be the best machine to modify. The attempt to soften the impact force users to be experienced. To construct handrails for added support and safety. To alter the motor control circuit to allow it to run at lower speeds and a gear transmission to change speeds as and when required. To make a product beneficial for the society. To be able to meet the requirements of people in all walks of life. To have a fuel free, simple vehicle.

2. INTRODUCTION

A Treadmill is a device designed for walking or running while staying in the same place. The machine provides a moving platform with a wide conveyor belt driven by an electric motor or a flywheel or mechanical work. The belt moves to the rear end, making 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. The simpler, lighter, and less expensive versions passively resist the motion, moving only when walkers push behind the belt with their feet, with the latter known as manual treadmills. The conveyor belt is coupled to the wheels of the treadmill vehicle by a suitable arrangement so that when the user walks, the machine is moved forward and vice versa.

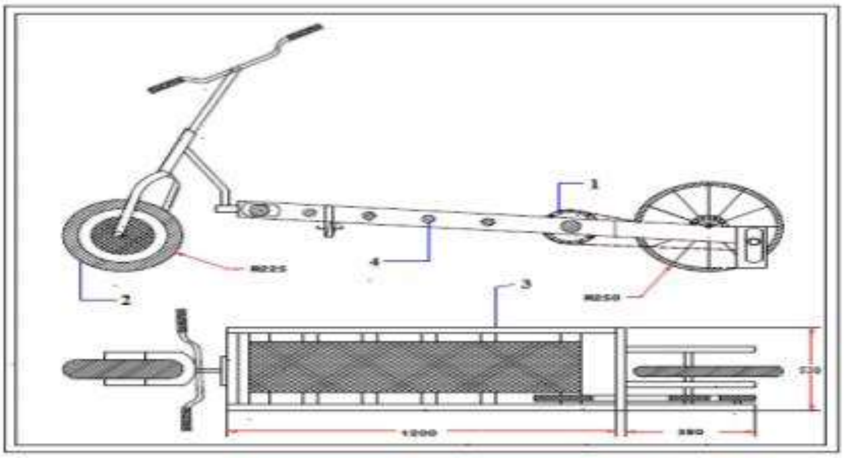


FIG. SCHEMATIC LAYOUT OF TREADMILL CYCLE

The user interface still needs a significant amount of work to become what we originally designed it to be. The mechanical speed reducer, while it was the best solution we could develop, is not an optimal solution. It would be significantly simpler to have someone with knowledge of electronics. A new control circuit would allow the treadmill motor to run at further lower speeds.

The porter consists of two modes :

a) Normal or Exercise mode

b) e – vehicle mode

3. LITERATURE SURVEY

3.1 ANCIENT TREADMILLS(V. R. Gandhewar, Priyanka H. Kakade, Himani. S. Lonkar)

In an ancient days concept of treadmill was invented for generating mechanical energy with the help of animals such as horse, dogs etc. First treadmill was introduced by Roman Empire for heavy loading like conveyer belt which we use in industries. Some of those invention required electric power for initial torque. After study the history of treadmill bicycle we get idea to develop new concept of treadmill which will manually operated so that no external energy source is required to run treadmill bicycle. Our main objective while developing this concept is ‘A Treadmill with more outputs in less time along with surface cleaning’.

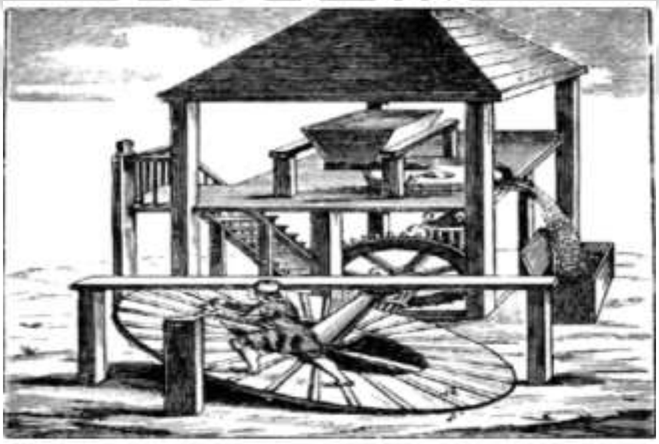


Fig . Human Powered Grinding Machine

3.2 DOG & HORSE POWER TREADMILL

Nicholas Potter- He invented “Dog Power Treadmill” to tackle domestic work and produce rotary and reciprocating motion for use with light machinery. To run the treadmill animals like horses and dogs energy are used. Nicholas Potter, of Troy PA noted as the father of the first dog treadmill this machine is then marketed as a practical devise for dogs. The first patent issued in 1871 and the final patent in 1881.

Fig . Dog Power Treadmill

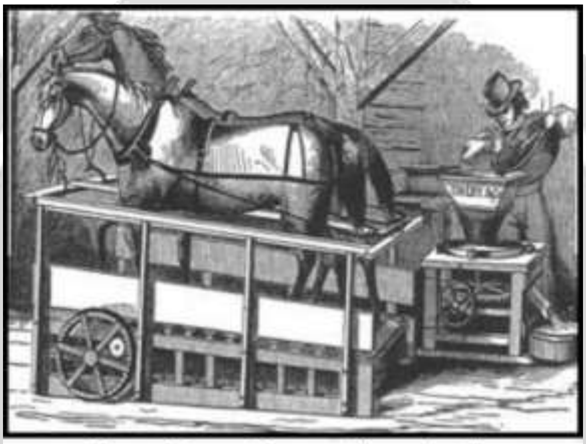


Fig . Horse Power Treadmill

3.3 WILLIAM CUBITT(1818)

He invented prison treadmill for punishment. The prisoner would simply work the wheel to produce power to grinding and pump water. The main motto behind this invention want to punish the prisoner.

3.4 WILLIAM STAUB(1968)

Mechanical Engineer William Staub and Dr. Kenneth H. Cooper brought the first household exercise treadmill to market. He called his first treadmill "The PaceMaster 600" at his plant in Clifton, New Jersey.

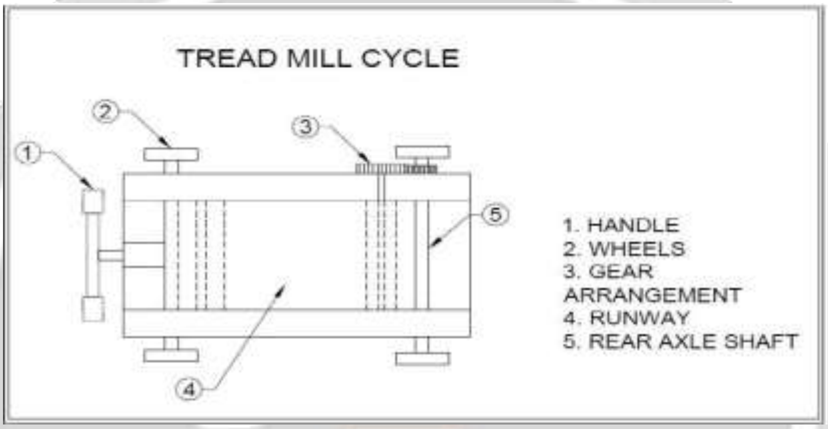
Fig 5. The Pacemaster 600

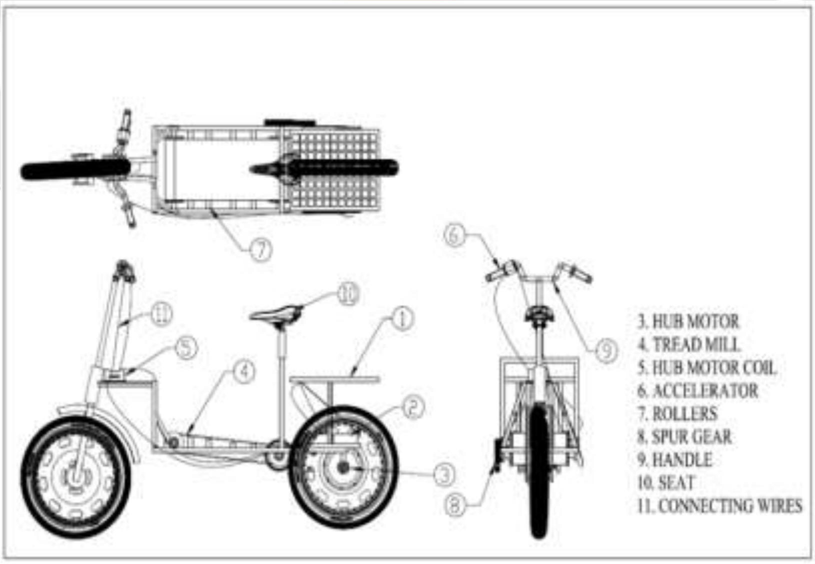
4. FINDINGS IN LITERATURE STUDIES

The treadmills are heavy in weight and static at the gym so people get bored while running on it. Treadmill is no longer a way to mobilize farm operation, but an effective exercise alternative. It helps people to challenge weather, hectic schedule and physical limitation, busy streets and crowed areas. In our day to day life, people mostly use cars, bikes, etc. which causes pollution. So, it prevents environment pollution and fuel abuse. People who travel below 5-7 Kms a day can use Treadmill Porter. Treadmill Porter perform multi operation in minimum time. Treadmill Porter is completely manual operated and can also converted to an e-vehicle. Treadmill Porter does not used any organic fuels so it is eco-friendly. Treadmill Porter does not promote any type of pollution. Treadmill Porter provide more exercise with travelling.

5. WORKING PRINCIPLE

The fabrication of the treadmill traveller is very advantageous because of its simple construction and easy working principle. To say in a one line, this machine follows the action of the user. That is, when the driver walks forward, the machine moves forward and when he walks backward, the machine moves backward. A treadmill setup is made so that the operator can walk on the belt. A handle is placed in the front for the controlling of the vehicle. The rollers above which the conveyor belt (treadmill belt), held in tension are coupled to the wheels of the machine, usually rear wheels. The rollers are connected by a suitable arrangement for efficient transmission of motion thus having minimal losses during the transmission of motion. The frame of the machine is designed in such a way that it is balanced and the operator doesn't put any effort in balancing the machine. Now when the operator walks forward, the conveyor belt moves in one direction which makes the wheels of the machine to rotate so that the machine moves front. When he walks backwards, the motion direction of the belt is reversed and thus the vehicle moves backwards.





Treadmill cycle is also exercise device which is used at the time off morning for walking or running purpose, at morning time we have need of juice so we can arrange juice mixture from the wheel arrangement by using gear. We can make juice at any time when we use bicycle. Mobile is important device which any time in our pockets. So there is need of battery charging for mobile so arrange the charging kit with bicycle which operated on treadmill cycle wheel.

5.1 METHODOLOGY

The research described in this thesis will attempt to solve the problems detailed in the previous points. To meet these ends, the following goals have been set:

- Identification of the problem
- Analysing the Causes/Effects
- Material Selection for Parts of treadmill
- Design of Parts &Selection of bearings
- Fabrication process
- To select the length & diameter of the shaft, forces applied on the components of the cycle which are moving and stationary.
- Assembly of unit
- Finalizing the project.
- Process parameters: Metal cutting, Turning, Facing, Chamfering, Boring, Welding, Drilling.

6. LIST OF PARTS

1) Square Plates (for frame)

2) Wheels

3) Belt

4) Rollers

5) Bolts and Nuts

6) Chain Sprocket

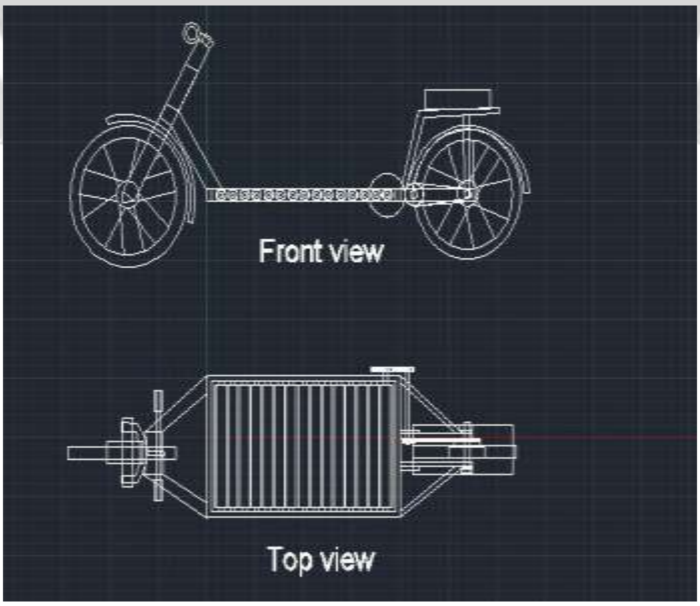
7) Bearings

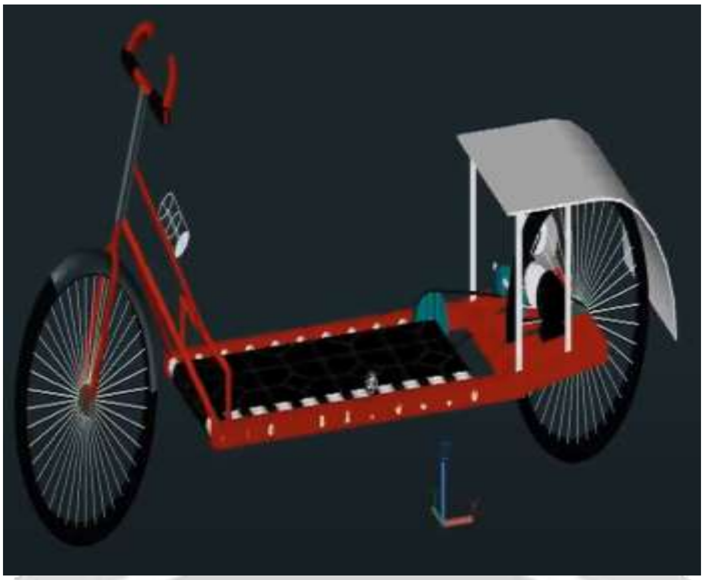
8) Spur Gear Pair (Gear Box Arrangement)

9) Handle Bar

10) Brake (Wire & Shoe set)

7. ASSEMBLY DRAWING & MODELING





8. DESIGN CALCULATION

Spur Gears : **[Referring to PSGDDB Edition 2013]**

Let

- Length of last roller be 'l' m
- Force applied to last roller be 'F' N
- No. of teeth of the gear attached to output(sprocket) shaft be 'Z_1' and speed of that gear be 'N_1' rpm
- No. of teeth of the gear attached to input shaft 'Z_2' and speed of that gear be 'N_2' rpm

Now, we take length of last roller to be

$$l = 45 \text{ cm}$$

$$\therefore \mathbf{l = 0.45\ m}$$

Here,

$$\mathbf{Z_1 = 20\ teeth}$$

$$\mathbf{Z_2 = 36\ teeth}$$

We take **F = 76.67 N**

So, Torque $M_t = F \times l = 76.67 \times 0.45$

$$\therefore \mathbf{M_t = 34.5\ Nm}$$

Now, we take $N_2 = 40$ rpm

Also, by formula for gear ratio, we know that

$$\frac{Z_1}{Z_2} = \frac{N_2}{N_1}$$

$$\therefore \frac{20}{36} = \frac{40}{N_1}$$

$$\mathbf{N_1 = 72\ rpm}$$

① Speed Ratio

$$i = \frac{N_1}{N_2} = \frac{Z_2}{Z_1} = \frac{36}{20}$$

$$\therefore \mathbf{i = 1.8}$$

②Selection of Material

- Here, gears are made of mild steel.
- So, 'C-45' steel is selected for both pinion & wheel.
- Also, we consider module till 6 mm

[From PSGDDB, Pg. 8.5]

Maximum bending stress $[\sigma_b]$ **= 1400 kgf/cm²** → $[\sigma_b] = 1400\ \text{kgf/cm}^2$

Maximum contact compressive stress $[\sigma_c] = 5000\ \text{kgf/cm}^2$

Equivalent Young's Modulus $E_{eq} = 2.15 \times 10^6\ \text{kgf/cm}^2$

OR

$[\sigma_b] = 137.34$ **MPa**

$[\sigma_c] = 490.5$ **MPa**

$E_{eq} = 210915$ **MPa**

③Gear Life

Here, we take gear life T = 12000 hours

Now, we know that

$$n = 60 \times N \times T \text{ (in cycles)}$$

Here ,

$$N = 72\text{rpm}$$

$$\therefore n = 60 \times 72 \times 12000$$

$$\therefore n = 5.184 \times 10^7 \text{ cycles}$$

④ Design Torque $[M_t]$ / Power Transmitted P

[From PSGDDB Pg. 8.15]

We know that

$$[M_t] = M_t \times K_d K$$

$$= 34.5 \times 1.3 \qquad (\text{Taking } K_d K = 1.3)$$

$$\therefore [M_t] = 44.85 \text{ Nm}$$

Also, Power Transmitted

$$P = \frac{2\pi N M_t}{60}$$

$$= \frac{2 \times \pi \times 72 \times 34.5}{60}$$

$$\therefore P = 260.12 \text{ W}$$

⑤Calculate E_{eq}, $[\sigma_b]$, $[\sigma_c]$

[From PSGDDB Pg. 8.14]

For steel,

$$\mathbf{E_{eq} = 2.15 \times 10^6\ kgf/cm^2}$$

$$\therefore \quad \textbf{Equivalent Young's Modulus } \mathbf{E_{eq} = 210915 \times 10^6\ N/m^2}$$

[From PSGDDB Pg. 8.5]

Maximum bending stress $[\sigma_b]$ = 1400 kgf/cm^2

Maximum contact compressive stress $[\sigma_c]$ = 5000 kgf/cm^2

OR

E_{eq} = 210915 MPa

$[\sigma_b]$ = 137.34 MPa

$[\sigma_c]$ = 490.5 MPa

⑥Centre Distance , a

[From PSGDDB Pg. 8.13]

We know that Centre Distance

$$a \geq (i \pm 1)\sqrt[3]{\left(\frac{0.74}{[\sigma_c]}\right)^2 \frac{E\,[M_t]}{i\varphi}} \quad (m)$$

[From PSGDDB Pg. 8.14]

$$\varphi = \frac{b}{a}$$

And we take φ = 0.3

$$a \geq (1.8+1)\sqrt[3]{\left(\frac{0.74}{[490.5 \times 10^6]}\right)^2 \frac{210915 \times 10^6\,[44.85]}{1.8 \times 0.3}}$$

$$\therefore \quad a \geq 0.095 \text{ m}$$

OR

a = 95 mm

⑦Number of teeth Z_1 and Z_2

Here,

$$Z_1 = 20$$

$$Z_2 = 36$$

Also,

$$Z_2 = iZ_1$$

$$\therefore \quad i = 36/20 = 1.8$$

⑧Module m

[From PSGDDB Pg. 8.13A]

For spur gear,

$$m \geq 1.26\sqrt[3]{\frac{[M_t]}{y\,[\sigma_b]\varphi_m z_1}} \quad (m)$$

[From PSGDDB Pg. 8.18]

Form factor y = 0.389 (Since $z_1 = 20$)

[From PSGDDB Pg. 8.14]

$$\varphi_m = 10$$

By substituting the corresponding values, we get

$$m \geq 0.002 \text{ m}$$

$$\therefore \text{ m = 2 mm}$$

⑨Revised Centre Distance a and Number of Teeth

[From PSGDDB Pg. 8.22,Table 26]

$$a = \frac{m(z_1 + z_2)}{2} \text{ (mm)}$$

That implies $95 = \frac{2(z_1+(1.8)z_1)}{2}$ (Since $z_2 = iz_1$)

$$\therefore \quad z_1 = 33.92 \approx 34 \text{ teeth}$$

$$\therefore \ z_2 = 1.8 \times 34 = 61.2 \approx 62 \text{ teeth}$$

Now, $a = \frac{2(34+62)}{2}$

$$\therefore \quad a = 96 \text{ mm}$$

⑩Face width b, Pitch circle diameter d_1, Pitch line velocity v

[From PSGDDB Pg. 8.1]

$$b = \varphi a$$

$$= 0.3 \times 96$$

$$\therefore b = 28.8 \text{ mm}$$

[From PSGDDB Pg. 8.4]

b = 10 × module = 10 × 2 = 20 mm

Now , taking higher value

$$\therefore \quad b = 28.8 \text{ mm}$$

[From PSGDDB Pg. 8.22]

Pitch Diameter

$$d_1 = mz_1 = 2 \times 34$$

$$\therefore d_1 = 68 \text{ mm}$$

$$d_2 = mz_2 = 2 \times 62$$

$$\therefore d_2 = 124 \ mm$$

Pitch Line Velocity

$$v = \frac{\pi d_1 N_1}{60} = \frac{\pi d_2 N_2}{60}$$

$$= \frac{\pi \times 68 \times 72}{60 \times 1000}$$

$$\therefore v = 0.256 \text{ m/s}$$

⑪Quality of Gears

[From PSGDDB Pg. 8.3, Table 2]

For v = 0.256 m/s,

IS Quality **10, 12** is selected.

⑫Revision of Design Torque [M_t]

[From PSGDDB Pg. 8.15, Table 14]

$$\varphi_p = b/d_1 = 28.8/68$$

$$\therefore \quad \varphi_p = 0.4235$$

For φ_p= 0.4, **Load Concentration Factor K = 1**

[From PSGDDB Pg. 8.16, Table 15]

For IS Quality 10, 12 and v = 0.256 m/s

Dynamic Load Factor K_d = 1.1

Also,

$$[M_t] = M_t \times K_d K$$

$$= 44.85 \times 1 \times 1.1$$

$$\therefore \quad [M_t] = 49.335 \text{ Nm}$$

$\therefore$ **Design is safe**

⑬Checking for maximum induced bending stress

[From PSGDDB Pg. 8.13A]

We know that

$$\sigma_b = \frac{i \pm 1}{a\, m\, b\, y}[M_t] \le [\sigma_b]$$

[From PSGDDB Pg. 8.18]

For $Z_1 = 34$, **y = 0.4496**

Here, a = 96 mm, m = 2 mm, b = 28.8 mm, $[M_t] = 49.335$ Nm, i = 1.8, y =0.4496

By substituting the corresponding values, we get

$$\sigma_b = 55.56\ MPa$$

And, $[\sigma_b] = 137.34\ MPa$

$\therefore$ **Design is safe**

⑭Checking for maximum induced contact compressive stress

[From PSGDDB Pg. 8.13, Table 8]

$$\sigma_c = 0.74\left(\frac{i \pm 1}{a}\right)\sqrt{\frac{i \pm 1}{ib} E_{eq}[M_t]} \le [\sigma_c]$$

By substituting the corresponding values, we get

$$\sigma_c = 485.13\ MPa$$

And, $[\sigma_c] = 490.5\ MPa$

∴ Design is safe

⑮Basic Dimensions
[From PSGDDB Pg. 8.22]
Pinion :

Pitch Circle Diameter $\boldsymbol{d_1 = mz_1}$

$= 2 \times 34$

$\therefore\ \boldsymbol{d_1 = 68\ mm}$

Height factor $\boldsymbol{f_0 = 1}$

Tip diameter $\boldsymbol{d_c = (z_1 + 2f_0)m}$

$= (34+2(1))2$

$\therefore \boldsymbol{d_c = 72\ mm}$

Root Diameter $\boldsymbol{d_f = (z_1 - 2f_0)m\ - 2c}$

$= (34 - 2(1))2 - (2 \times 0.25 \times 2)$ [Since c = 0.25 × m]

$\therefore \boldsymbol{d_f = 63\ mm}$

Wheel :

Pitch Circle Diameter $\boldsymbol{d_2 = mz_2}$

$= 2 \times 62$

$\therefore\ \boldsymbol{d_2 = 124\ mm}$

Height factor $\boldsymbol{f_0 = 1}$

Tip diameter $\boldsymbol{d_c = (z_2 + 2f_0)m}$

$= (62+2(1))2$

$\therefore \boldsymbol{d_c = 128\ mm}$

Root diameter $\boldsymbol{d_f = (z_2 - 2f_0)m\ - 2c}$

$= (62 - 2(1))2 - (2 \times 0.25 \times 2)$ [Since c = 0.25 × m]

$\therefore\ \boldsymbol{d_f = 119\ mm}$

9. MERITS, DEMERITS & APPLICATION

9.1 MERITS

- Simple in construction.
- Easy to fabricate.
- The components used for the fabrication are simple and easily available.
- The cost of the system is less.
- No need of separate time for exercising.
- No need of skilled operators to operate this machine.
- Less maintenance is needed.
- Compact in size.
- Less weight.
- Easily portable.

9.2 DEMERITS

- Not suitable for travelling longer distances.
- Not as efficient as motor driven vehicles.
- More human effort is required in order to drive the vehicle.

9.3 APPLICATIONS

- Fitness and gym,
- Those who are interested in evening walks.
- Automobile application.
- Two wheeler Application.
- Light vehicles

10. PHOTOGRAPHS








11. CONCLUSION

Treadmill bicycle perform multi operation in minimum time. Treadmill bicycle is completely manual operated. Treadmill bicycle provide more exercise for human. Treadmill bicycle does not used any organic fuels so it is ecofriendly.Treadmill bicycle does not promote any type of pollution. In this we have made a shear modification of treadmill and cycle running through power assisted energy, which is an output of non-conventional or the renewable sources of energy.

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