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DESIGN AND FABRICATION OF TREADMILL WALKING CYCLE

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Abstract - This paper deals with conversion of a conventional tricycle into treadmill bicycle. In this tricycle the frame of the bicycle is completely modified and the treadmill is placed in between the two wheels, on which user will walk. As the user walks or runs on the treadmill the belt moves to the rear. The mechanism used in this walking cycle is versatile of its kind in which, the cycling pedals are replaced with a treadmill belt. This treadmill belt drives the cycle forward by introducing free wheels and shafts mechanism. The prototype design requires a treadmill belt, shafts, the frame of treadmill, the free wheels, gears, chain-drive and gear-chain .The platform on which the treadmill belt is placed is fabricated. All the links are made up of normal MS (mild steel) including the head which has a direct contact with the treadmill belt.

II. INTRODUCTION

One of the most popular types of home exercise equipment is the treadmill, which provides a straight forward, efficient aerobic workout. For many, treadmills are a good choice to begin a new exercise routine because walking is well tolerated by most individuals regardless of fitness level and for most back conditions. As strength and endurance are developed, the treadmill can be used for jogging and/or for interval training. Treadmill cycle is a tread mill commuting vehicle. Treadmill cycle is a three-wheeled transportation device. It is used similarly to a bicycle and is just as easy to ride. And it is a global product, addressing the need for compact personal transportation for all markets around the world. The walking cycle has a simple mechanism, operated with free wheels, gear, chain, bearing shaft and links arrangement. As by the linear walking motion is converted into rotary motion which indeed done by the gear chain and free wheel mechanism of the linkages, which takes very simple movement. The rotary motion is again converted in to linear motion of the cycle through mechanical linkages (gear-chain and free wheels) arrangement. The walking bicycle is the one, which combines walking and cycling into one activity. The walking bicycle combines the two activities into a linear motion, allowing you to propel yourself forward at desired speed, simply by walking on the belt provided. Usually, the operation of the walking cycle machine is controlled by the user itself by simply walking on the treadmill belt and also balancing the cycle. The operating speed of the walking cycle differs on the amount of force applied by the user. This project work modifying a treadmill to better fit the needs of users. Treadmill bike is design for those persons who love to run outside. Treadmill fitted on bicycle frame and constructs a big innovation named 'TREADMILL CYCLE'. This bicycle runs entirely on human momentum. As the rider walks on the treadmill, the belt butts up against the rear wheel propelling the bike forward.

III. PROBLEM DEFINITION

While working out in the gym people use treadmill for the purpose of jogging and running. The main drawback of treadmill is that, it is stationary. That becomes boring for user to run in a still surrounding with natural exposure to environment. Similarly cycling in the conventional way is common and not possible for all age groups as old people prefer walking. Even for travelling short distance people prefer vehicles that cause pollution and wastage of energy in terms of fuel. So, we came up with the concept of walking tricycle.

IV. METHODOLOGY

The working of the treadmill cycle is majorly based on the principle of conversion of the linear motion applied by the human being on the treadmill into the rotary motion of the wheels with the help of gear system and motor mechanism. In addition to the liner motion applied by the human being. The main chassis of the treadmill consist of square pipes welded together to for the outer portion of the chassis. The big rollers are present at the front and rear part of the chassis provide a tightening effect on the belt due to which a proper grip is maintained between the belt and the rollers.

As the human being moves straight ahead on the treadmill it causes the belt to move in the anticlockwise direction when seen form the left. The rollers will also move in the same direction as the belt. The big end roller also consists of gear mechanism at its either ends. On the shaft of the big end roller are mounted the small gears on the either side of the roller. Bearing present on the inner of the small gear makes the rotation of the same smooth and frictionless. With the help of the pedestal bearings on the either side of the chassis near the end roller causes a smooth and easy mounting of the big gear mounted on the shaft above it. With proper measurement the big gear can be kept in mesh with the smaller gear for the smooth operation of the gear system. Since the gear system are in mesh it causes the big gear to rotate in the anti-clockwise direction, which is the desired motion required for the cycle to move ahead. There is also a small chassis extending from the main chassis to the wheels. This chassis also consists of the sub assembly for mounting of the pedestal bearings, and similarly on this bearings is mounted a hollow shaft which is connected to the hub of the two rear wheels.

The rotation of the hollow shaft causes the wheel to move in the direction of motion. To this shaft is mounted the sprockets as well at the center of the shaft, these sprockets are also grub screwed to the shaft and, also welded to the shaft so that the position of the sprockets do not change on the shaft and remain at the same place. Also these sprockets are connected with the sprockets on the shaft of the big gear with the help of chains. This mechanism is called as the chain sprocket mechanism. Hence as the big gear shaft rotate in the anticlockwise direction, it causes the sprockets too to rotate in the same direction, and with help of the chain drive mechanism it causes the sprockets on the hollow shaft also to rotate in the same direction and hence causes the wheels to move ahead in the desired direction of the motion.

V. COMPONENTS

5.1 Tyre (Front And Rear)

A **tire** (American English) or **tyre** (British English; see spelling differences) is a ring-the wheel to the ground and to provide traction on the surface traveled over. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint that is designed to match the weight of the vehicle with the bearing strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively.

5.2 Wheel Support

There are two aspects to how pneumatic tires support the rim of the wheel on which they are mounted. First, tension in the cords pull on the bead uniformly around the wheel, except where it is reduced above the contact patch. Second, the bead transfers that net force to the rim. Thus the bead must have high tensile strength.

5.3 Cords

The cords, which form the ply and bead and provide the tensile strength necessary to contain the inflation pressure, can be composed of steel, natural fibers such as cotton or silk, or synthetic fibers such as nylon or kevlar.

5.4 Rolling Resistance

Optimizing rolling resistance in the elastomer material is a key challenge for reducing fuel consumption in the transportation sector. It is estimated that passenger vehicles consume approximately 5~15% of its fuel to overcome rolling resistance, while the estimate is understood to be higher for heavy trucks. However, there is a trade-off between rolling resistance and wet traction and grip, while low rolling resistance can be achieved by reducing the viscoelastic properties of the rubber compound (low tangent (δ)), it comes at the cost of wet traction and grip, which requires hysteresis and energy dissipation (high tangent (δ)). A low tangent (δ) value at 60 °C is used as an indicator of low rolling resistance, while a high tangent (δ) value at 0 °C is used as an indicator of high wet traction.

5.5 Wheel

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel and flywheel.

VI CONSTRUCTION

6.1.1Rim

The rim is the "outer edge of a wheel, holding the tire. It makes up the outer circular design of the wheel on which the inside edge of the tire is mounted on vehicles such as automobiles. For example, on a bicycle wheel the rim is a large hoop attached to the outer ends of the spokes of the wheel that holds the tire and tube.

6.1.2 Hub

The hub is the center of the wheel, and typically houses a bearing, and is where the spokes meet.

A hub less wheel (also known as a rim-rider or center less wheel) is a type of wheel with no center hub. More specifically, the hub is actually almost as big as the wheel itself. The axle is hollow, following the wheel at very close tolerances.

6.1.3 Spokes

A spoke is one of some number of rods radiating from the center of a wheel (the hub where the axle connects), connecting the hub with the round traction surface. The term originally referred to portions of a log which had been split lengthwise into four or six sections. The radial members of a wagon wheel were made by carving a spoke (from a log) into their finished shape. A spoke shave is a tool originally developed for this purpose.

6.2 BELT

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel.

In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts).

6.2.1 Power Transmission

Belts are the cheapest utility for power transmission between shafts that may not be axially aligned. Power transmission is achieved by specially designed belts and pulleys. The demands on a belt-drive transmission system are huge, and this has led to many variations on the theme. They run smoothly and with little noise, and cushion motor and bearings against load changes. However, improvements in belt engineering allow use of belts in systems that only formerly allowed chains or gears.

6.2.2 Flat Belts

Flat belts were widely used in the 19th and early 20th centuries in line shafting to transmit power in factories. They were also used in farming, mining, and logging applications such as, sawmills, threshers, blowers, conveyors for filling corn cribs or haylofts, balers, water pumps, and electrical generators. Flat belts are still used today, although not nearly as much as in the line-shaft era. The flat belt is a simple system of power transmission that was well suited for its day. It can deliver high power at high speeds (500 hp at 10,000 ft/min, or 373 kW at 51 m/s), in cases of wide belts and large pulleys.

But these wide-belt-large-pulley drives are bulky, consuming lots of space while requiring high tension, leading to high loads, and are poorly suited to close-centers applications, Flat belts were traditionally made of leather or fabric. Today most are made of rubber or synthetic polymers.

6.2.3 Belt Selection Criteria

Belt drives are built under the following required conditions: speeds of and power transmitted between drive and driven unit; suitable distance between shafts; and appropriate operating conditions. The equation for power is

power [kW] = (torque [N·m]) × (rotational speed [rev/min]) × (2π radians) / (60 s × 1000 W).

Minimum pulley diameters are limited by the elongation of the belt's outer fibers as the belt wraps around the pulleys. Small pulleys increase this elongation, greatly reducing belt life. Minimal pulley diameters are often listed with each cross-section and speed, or listed separately by belt cross-section. In large speed ratios or small central distances, the angle of contact between the belt and pulley may be less than 180°. This is because power capacities are based on the standard of a 180° contact angle. Smaller contact angles mean less area for the belt to obtain traction, and thus the belt carries less power.

6.2.4 Belt Friction

Belt drives depend on friction to operate, but excessive friction wastes energy and rapidly wears the belt. Factors that affect belt friction include belt tension, contact angle, and the materials used to make the belt and pulleys.

6.2.5 Belt Tension

Power transmission is a function of belt tension. However, also increasing with tension is stress (load) on the belt and bearings. Belt tensions should also be adjusted to belt type, size, speed, and pulley diameters. Belt tension is determined by measuring the force to deflect the belt a given distance per inch of pulley. Timing belts need only adequate tension to keep the belt in contact with the pulley.

6.2.6 Belt Wear

Fatigue, more so than abrasion, is the culprit for most belt problems. This wear is caused by stress from rolling around the pulleys. High belt tension; excessive slippage; adverse environmental conditions; and belt overloads caused by shock, vibration, or belt slapping all contribute to belt fatigue.

6.2.7 Belt Vibration

Vibration signatures are widely used for studying belt drive malfunctions. Some of the common malfunctions or faults include the effects of belt tension, speed, sheave eccentricity and misalignment conditions. The effect of sheave Eccentricity on vibration signatures of the belt drive is quite significant. Although, vibration magnitude is not necessarily increased by this it will create strong amplitude modulation. When the top section of a belt is in resonance, the vibrations of the machine is increased. However, an increase in the machine vibration is not significant when only the bottom section of the belt is in resonance. The vibration spectrum has the tendency to move to higher frequencies as the tension force of the belt is increased.

6.2.8 Specifications

To specify a belt, the material, length, and cross- section size and shape are required. The length of the belt is the sum of the central length of the system on both sides, half the circumference of both pulleys, and the square of the sum (if crossed) or the difference (if open) of the radii. When the wider the small drive increases, the belt length is higher.

6.3 Chain Drive

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. The power is output by simply rotating the chain, which can be used to lift or drive the objects with its mechanism. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered to its speed range. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution.

6.4 Sprocket

A sprocket or sprocket-wheel is a profiled wheel with teeth, or cogs, that mesh with a chain, track by radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.

By various designs, a maximum of efficiency being claimed for each. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed.

6.4.1 Transportation

For multi-speed in bicycle, can provided by two or three different-sized driving sprockets and up to 11 different- sized driven sprockets, allows up to 33 different gear ratios. The resulting lower gear ratios make the bike easier to pedal up hills while the higher gear ratios make the bike more powerful to pedal on flats and down hills. In a similar way, manually changing the sprockets on a motorcycle can change the characteristics of acceleration and top speed by modifying the final drive gear ratio.

6.5 BRAKE

A brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction.

6.5.1 Characteristics of Brakes

Brakes are often described according to several characteristics including:

- Peak force – The peak force is the maximum decelerating effect that can be obtained. The peak force is often greater than the traction limit of the tires, in which case the brake can cause a wheel skid.
- Continuous power dissipation – Brakes typically get hot in use, and fail when the temperature gets too high. The greatest amount of power that can be dissipated through the brake without failure is the continuous power dissipation.
- Smoothness – A brake that is grabby, pulses, has chatter, or otherwise exerts varying brake force may lead to skids.
- Power – Brakes are often described as "powerful" when a small human application force leads to a braking force that is higher than typical for other brakes in the same class.
- Durability – Friction brakes have wear surfaces that must be renewed periodically. Wear surfaces include the brake shoes or pads, and also the brake disc or drum.
- Weight – Brakes are often "added weight" in that they serve no other function. Further, brakes are often mounted on wheels, and unsprang can significantly hurt traction in some circumstances.

6.6 Brakes

6.6.1 Rim brakes

In Rim brakes, braking force is applied by friction pads to the rim of the rotating wheel, thus slowing it and the bicycle. Brake pads can be made of leather, rubber or cork and are often mounted in metal "shoes". Rim brakes are typically actuated by a lever mounted on the handle bar.

➢ Brake pads

Brake pads are available with numerous shapes and materials. Many consist of a replaceable rubber pad held on a mounting, or brake shoe, with a post or bolt on the back to attach to the brake. Many pad designs have a rectangular shape; others are longer and curved to match the radius of the rim.

6.6.2 Disc Brakes

A disc brake consists of a metal disc, or "rotor", attached to the wheel hub that rotates with the wheel. Disc brakes may be actuated mechanically by cable, or hydraulically.

Many hydraulic disc brakes have a self-adjusting mechanism so as the brake pad wears, the pistons keep the distance from the pad to the disc consistent to maintain the same brake lever throw.

6.6.3 Actuation Mechanism

The actuation mechanism is that part of the brake system that transmits force from the rider to that part of the system that does the actual braking. Brake system actuation mechanisms are either mechanical or hydraulic.

 Mechanical brakes

The primary modern mechanical actuation mechanism uses brake levers coupled to Bowden cables to move brake arms, thus forcing pads against a braking surface. Cable mechanisms are usually less expensive, but may require some maintenance related to exposed areas of the cable.

 Hydraulic brakes

Hydraulic brakes also use brake levers to push fluid through a hose to move pistons in a caliper, thus forcing pads against a braking surface. While hydraulic rim brakes exist, today the hydraulic actuation mechanism is identified mostly with disc brakes. Two types of brake fluid are used today: mineral oil and DOT fluid. Mineral oil is generally inert, while DOT is corrosive to frame paint but has a higher boiling point.

 Brake levers

Brake levers are usually mounted on the handlebars within easy reach of the rider's hands. They may be distinct from or integrated into the shifting mechanism. The brake lever transmits the force applied by the rider through either a mechanical or hydraulic mechanism.

Bicycles with drop handlebars may have more than one brake lever for each brake to facilitate braking from multiple hand positions. Modern top-mounted brake levers, called interrupt brake levers, use an entirely different method of actuation and are considered safer.

The mechanical advantage of the brake lever must be matched to the brake it is connected to in order for the rider to have sufficient leverage and travel to actuate the brake.

Mechanical (cable) brake levers come in two varieties based on the length of brake cable pulled for a given amount of lever movement:

- Standard pull levers work with most brake designs, including caliper brakes, traditional cantilever brakes, and mechanically actuated disc brakes branded for "Road".

- Long pull levers work with "direct-pull" cantilever brakes, such as Shimano "V-Brakes", and mechanically actuated disc brakes branded for "Mountain".

- BRAKING TECHNIQUE

The motion dynamics of a bicycle, if too much power is applied to the front brake, momentum may cause the rider and bike to flip over - a type of crash sometimes called an "endo". The skidding of the rear wheel can serve as a signal to reduce force on the front brake.

On tandem bicycles and other long-wheel-base bicycles the lower relative center of mass makes it virtually impossible for Heavy front braking to flip the bicycle; the front wheel would skid first.

- Rollers

Bicycle rollers are a type of bicycle trainer that make it feasible to ride a bicycle indoors without moving forward. However, dissimilar to other types of bicycle trainers, rollers do not confine to the bicycle frame, and the rider must balance him or herself on the rollers while training.

6.7 Free Wheel

In mechanical or automotive engineering, a freewheel or overrunning clutch is a device in a transmission that disengages the driveshaft from the driven shaft when the driven shaft rotates faster than the driveshaft. An overdrive is sometimes mistakenly called a free wheel, but is otherwise unrelated.

Rotating in one direction, the saw teeth of the drive disc lock with the teeth of the driven disc, making it rotate at the same speed.

The Saab freewheel can be engaged or disengaged by the driver by respectively pushing or pulling a lever. This will lock or unlock the main shaft with the freewheel hub.

A freewheel also produces slightly better fuel economy on carbureted engines and less wear on the manual clutch, but leads to more wear on the brakes as there is no longer any ability to perform engine braking.

6.8 Shafts

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various members such as pulleys and gears are mounted on it.

6.8.1 Types

They are mainly classified into two types.

- Transmission shafts are used to transmit power between the source and the machine absorbing power; e.g. counter shafts and line shafts.

- Machine shafts are the integral part of the machine itself; e.g. crankshaft.

6.8.2 Materials

- The material used for ordinary shafts is mild steel.

When high strength is required, an alloy steel such as nickel, nickel-chromium or chromium-vanadium steel is used.

Shafts are generally formed by hot rolling and finished to size by cold drawing or turning and grinding.

- STANDARD SIZES

- Machine shafts

Up to 25 mm steps of 0.5 mm

- Transmission shafts

o 25 mm to 60 mm with 5 mm steps
o 60 mm to 110 mm with 10 mm steps
o 110 mm to 140 mm with 15 mm steps
o 140 mm to 500 mm with 20 mm steps

The standard lengths of the shafts are 5 m, 6 m and

7 m.

6.9 Stresses

The following stresses are induced in the shafts.

- Shear stresses due to the transmission of torque (due to torsional load).

- Bending stresses (tensile or compressive) due to the forces acting upon the machine elements like gears and pulleys as well as the self-weight of the shaft.

- Stresses due to combined torsional and bending loads.

6.9.1 Design Stresses

reduces friction between moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

The term "bearing" is derived from the verb "to bear"; a bearing being a machine element that allows one part to bear (i.e., to support) another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface. Other bearings are separate devices installed into a machine or machine part.

- Rolling-element bearing, in which rolling elements placed between the turning and stationary races prevent sliding friction. There are two main types

- Ball bearing in which the rolling elements are spherical balls

- Roller bearing, in which the rolling elements are cylindrical rollers

6.10.1 Motions

Common motions permitted by bearings are:

- axial rotation e.g. shaft rotation
- linear motion e.g. drawer
- spherical rotation e.g. ball and socket joint
- hinge motion e.g. door, elbow, knee

6.10.2 Friction

Reducing friction in bearings is often important for efficiency, to reduce wear and to facilitate extended use at high speeds and to avoid overheating and premature failure of the bearing. Essentially, a bearing can reduce friction by virtue of its shape, by its material, or by introducing and containing a fluid between surfaces or by separating the surfaces with an electromagnetic field.

The maximum permissible (design) stresses in bending By shape, gains advantage usually by using spheres (tension or compression) may be taken as:

- 112 N/mm2 for shafts with allowance for keyways.
- 84 N/mm2 for shafts without allowance for keyways. The maximum permissible (design) shear stresses may be taken as:
- 56 N/mm2 for shafts with allowance for keyways.
- 42 N/mm2 for shafts without allowance for keyways.

6.10 Bearings

A bearing is a machine element that constrains relative motion to only the desired motion, and
or rollers, or by forming flexure bearings.

- By fields, exploits electromagnetic fields, such as magnetic fields, to keep solid parts from touching.

- Air pressure exploits air pressure to keep solid parts from touching.

6.10.3 Maintenance And Lubrication

Many bearings require periodic maintenance to prevent premature failure, but many others require little maintenance. The latter include various kinds of fluid and magnetic bearings, as well as rolling-element bearings. They work successfully in many applications, providing maintenance-free operation.

Bearing life is often much better when the bearing is kept clean and well lubricated. However, many applications make good maintenance difficult. The frequent lubrication, by its nature, provides a limited kind of cleaning action, by displacing older oil or grease with a fresh charge, which itself collects grit before being displaced by the next cycle.

6.11 Frame

A frame is the main component of any kind of cycle, onto which wheels and other components are fitted. The modern and most common frame design for an upright cycle is based on the safety cycle, and consists a rectangular frame, Frames are required to be strong, stiff and light, which they do by combining different materials and shapes.

A frameset consists of the frame and front fork of a cycle and sometimes includes the headset and seat post. Frame builders will often produce the frame and fork together as a paired set.

VII CYCLING CONSUMES MORE POWER THAN WALKING

A study published in The Lancet confirms that cycling is one of the best forms of exercise for losing weight or keeping trim. Researchers from the London School of Hygiene and Tropical Medicine, UK, investigated the relationship between commuters' chosen means of transport and obesity risk. They studied 72,999 men and 83,667 women aged between 40 and 60. Comparing the daily modes of transport of 150,000 participants revealed that cycling was one of the most effective forms of exercise for keeping trim and even for losing weight. Commuters who favoured cycling had the lowest BMIs. For the average man in the sample (age 53 years, height 176.7cm, weight 85.9kg), cycling to work was associated with a weight difference of 5kg compared with driving or taking public transport.

The results revealed that BMI was 1.71kg/sq m lower among male cyclists and 1.65kg/sq m lower among female cyclists, compared with commuters using "passive" modes of transport. Similar results were seen with body fat measurements, which were 2.75 per cent lower for male cyclists and 3.26 per cent lower for female cyclists.

Other active modes of transport, such as walking, were also associated with significantly reduced BMI and body fat, albeit to a lesser extent. The scientists remind commuters that it's important to use every opportunity to fit physical exercise into the working day, especially for those with sedentary lifestyles.

VIII WORKING PRINCIPLE

The treadmill cycle is driven manually, more or less the same effort is required to drive the bike as the effort required in treadmill, consisting of various gear arrangements and two

shafts provided to change the motion. The treadmill cycle will be the best in its segment.

The treadmill is used for walking on it, the motion id transferred by the belt as we walk on it, moreover the motion is also transferred by the shaft. The gears reversing the motion and transferring to countershaft, hence the rear wheel moves as simple as moves in bicycle. A chain is a series of connected links which are typically made of metal. A chain may consist of two or more links. Hence as the big gear shaft rotate in the anticlockwise direction, it causes the sprockets too to rotate in the same direction, and with help of the chain drive mechanism it causes the sprockets on the hollow shaft also to rotate in the same direction and hence causes the wheels to move ahead in the desired direction of the motion.

IX CALCULATIONS

9.1 Power Calculation

Torque = Force Radius of wheel
Human force required for sliding rollers = 225 N
Radius of cycle wheel ro = 325mm, ri = 265mm

Torque = Force Radius of wheel = 225 325 = 73125 N – mm

Without considering the rolling resistance and air drag

Average velocity of bicycle = 15.5 km/hour
Velocity = angular velocity Radius of wheel
= 4.30556 = Speed N = 127 rpm
Power required to drive a cycle =
P = = 972.076 Nm/s = 0.972 Kw

9.2 Calculation For Belt

Design power = Rated power(P) Service factor(KS) Arc of contact factor(Ka)
Rated power (P) = 0.972 KW
Service factor (KS) = 1.2 [Steady load] PSG 7.53
Arc of contact = 1800 – 600
Diameter of belt roller (D) = 40 mm
Diameter of belt roller (d) = 40 mm
Center distance (C) = 1000 mm
Arc of contact = 1800 – (0) = 1800
Correction factor (Ka) = 1.00 [PSG 7.54]
Design power = 0.972 1.2 1.00 = 1.1664 KW
Dunlop FORT 949g fabric belt is selected

Belt speed (V) = V = = 0.2659 m/s
No of ply 5 is selected
Belt load rating = Load rating at 10 m/s
Load rating at 10 m/s = 0.0289 Kw /mm/ply
= 0.0289 = 7.6845 Kw/mm/ply
Width of belt = 303.5 mm
Standard width of Dunlop FORT 949 g is 305 mm PSG 7.52
Length of belt (L) = 2C + (D+d) + = 2 + (80) + (0) = 2125.66 mm
Initial tension to be provided = 0.5% of Length of belt [PSG 7.53] = 2125.66 = 10.62 mm

Length after standard deduction for initial tension = 2125.66 – 10.62 = 2115.04 mm

Roller width for 305 mm width belt = 305 + 38 = 343 mm

Therefore the Belt length and width are calculated, design is safe.

9.3 Calculation For Chain

Transmission ratio = 1

Selection of teeth (Z1& Z2)

For same diameter of sprocket Z1 = Z2 = 27 teeth, assume

Selection of standard pitch a = 30 to 50 p [PSG 7.74] Centre distance (a) = 300 mm, a = 30 p

Pitch = 10 mm, standard pitch (p) =12.7 mm [PSG 7.71] Simplex chain R 1252 is selected
Roller diameter = 7.95 mm Breaking load = 1410 kgf Weight/meter = 0.69 kgf Bearing area = 44 m2
Calculation of total load on the driving side of the chain [PSG 7.78]

Tangential force Pt = (N in Kw)

V = 0.725 m/s

Pt = = 136.82 kgf = 1368 N Centrifugal tension Pc w = 0.69 kgf , k= 6 (horizontal)

Pc = = 0.03697 kgf

Tension due to sagging = k.w.a

PS = 6 0.69 0.35 = 1.449 kgf = 14.49 N

= 1368 N + 14.49 N + 0.3697 N = 1382.85 N
Service factor KS = K1 K 2 K3 K4 K5 K6
K1 = 1.25 (Variable load with mild shocks)
K2 = 1.25 (Fixed centre distance)
K3 = 1 (a = 30 to 50 p)
K4 = 1 (Inclination upto 600) K5 = 1 (Drop lubrication)
K6 = 1 (Single shift of 8 hours day)
KS = 1.25 1.25 1 1 1 1 = 1.5625

Calculation of design loads

Design load = Total load Service factor = 138.2 = 216.07 kgf
Factor of safety = 6.525
Induced actual bearing stress = 4.858 kgf/mm2
Length of chain LP = 2a p + Centre distance ap = 23.6
Lp = (2) + 27 + 0 = 74 mm
Length of chain (L) = Lp P = 74 = 942.9 mm

Exact center distance [PSG 7.75]
a = p
Z1 = Z2 = 27, m = = 0, e = Lp - = 74-27 = 47 mm
a = 12.7 = 298.45 mm
Decrement in the center distance for initial sag 0.5 f, f = 0.02 a = 2.9845 mm a = a - = 298.45 – 2.9845 = 295.46 mm (Exact center distance)

Sprocket diameter d1 = 34 mm d2 = 34 mm
Therefore the required Chain length is calculated, design is safe.

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