Continuous Rope Climb
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Abstract

The purpose of this project is to design and build a continuous rope climbing device for cross-training gyms that can be used regardless of having limited ceiling height. This is accomplished by employing a continuous loop of rope, a rope pulley with gear reduction, and an eddy current braking system, which regulates the climbing speed. Our design is compact, easy-to-use, does not require external power supply, and weighs less than 70 pounds. The device is compliant with a range of rope diameters from 1.25” to 1.75”, which can be replaced without disassembly, and is easily maintained. The climber runs quietly, can be installed in most gyms, and may be used for both a continuous vertical climb and horizontal pull. The braking system creates variable resistance on the continuous loop of rope, allowing for the ability to simulate a constant climb, even with low ceilings or limited space.

Problem

Our team took on the task of engineering a design which simulates a continuous rope climb, and would compete in the areas of safe, function, and cost with similar products currently available on the market.

Solution Benefits to Sponsor

Bill and Becky Strahan wanted climbing solutions that are fully and require little space to use for their customers. The dimensions of our design are 12” x 12.43” x 28”, making it compact and easy to install in most gyms and easy to transport from location to location.

Function: our product on the market today range in price from $1,700.00 and upwards of $9,000.00. By incorporating interned custom parts, nearly all the small components, our finished product can be marketed in a cost range of $500.00 - $1,000.00 per unit.

Eddy Current Resistance

Our machine uses neodymium magnets placed on either side of a non-ferrous aluminum disk, which creates eddy currents. These currents resist the spinning motion of the disk and allow the climber to effectively climb. The faster the disk velocity, the greater the resistance. Using this relationship, the arm holding the magnets can be repositioned to allow for varying resistances proportional to the climber’s strength.

Specifications

• Support 300 – 100 lb. spike weight
• Less than 70 pounds
• Fit into three stacked shoe boxes
• 100% mechanical
• Use non-linear braking system
• Use 1.5 +/- .25 inch rope diameter
• Easy to replace looped rope
• Rope is out of climber’s way
• Off the shelf items
• Market range cost in hundreds

Design Features

The design uses a unique eddy current braking and tensioning system to provide necessary rope slack, which simulates an actual climbing experience. The device uses a unique current braking and tensioning system to provide necessary rope slack, which simulates an actual climbing experience.

Design Validation

During the first climbing test, the tensioner pulley was found to be too small, causing the rope to bind. This prevented the rope from traveling through the device to allow for a continuous climb. By increasing the pulley diameter and lengthening the arm that held it, the rope was able to smoothly slide through the system.

Results and Conclusions

Our design accomplished all the objectives for our project, but the first prototype proves there is room for improvement. In the compact frame design there are places where the rope rubs on other components, producing undesired friction. This could be prevented by adding a sleeve to the overall length of the frame. Also, with all the moving parts in the climber, we recommend enclosing the device with some form of a shell or protective shield.

Project Background and Design

Project Background and Overview

Our client is a CrossFit Trainer, and has experience in exercise machine design. He came to us with the idea of making the rope climb exercise available to anyone, regardless of the ceiling height in their facility.

Objectives and Goals

• Create a device that would accommodate a loop of rope
• Provide enough resistance to allow the rope to be continually climbed
• Keep the design as compact and safe as possible

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Analyses & Results

Analyses

• Calculations and analyses used to design project
• The plot depicts the analysis of an N42 NIB magnet of dimension 2” x 5” x 125” used to select appropriate dimensions in our design.
• The Von Mises graph depicts the stresses on the axle with the rope pulley while the device is loaded with an active climber.

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Summary

Over the course of two semesters, our team worked closely with our client Armored Fitness to design a state-of-the-art continuous rope climbing machine that will not only deliver a continuous rope climbing experience, but also come in an affordable, transportable, and competitive alternative to products on the market today.

From left to right: Danielle Hickerson, Alyssa Kolviz, Benjamin Hetrick, Roy Jacobs, Tristan Loteryman, and Bill Strahan.

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