



# Bicycle Power Take-Off

## Introduction

Bicycle technology has been around for a little over 100 years. Throughout that time the world has taken the bicycle beyond its transportation purpose. Different approaches and alternative designs use the bicycle to power everyday devices. The design for the bicycle power take-off is currently being used at D Acres in the apple cider process for apple crushing.

## Design

The purpose of the power take-off is to provide multifunctional uses of the bicycle without removing the transportation factor. By incorporating a power take-off, the bicycle can be ridden to where it is needed and then set up to power a belt-driven device. The design is adapted and modified from Job S. Ebenezer's Dual-Purpose Bicycle. The plans for Ebenezer's design can be found at:

<http://www.technologyforthe poor.com/PedalPowerReport/PedalPowerReport.htm>

Although the bicycle used in the following document is permanently fixed to a stand made of angle iron and steel rods, the power take-off can be removed and placed on other bicycles that have a horizontal top tube. A frame is still being designed for functioning bicycles to be propped on as discussed in Ebenezer's Dual-Purpose Bicycle.

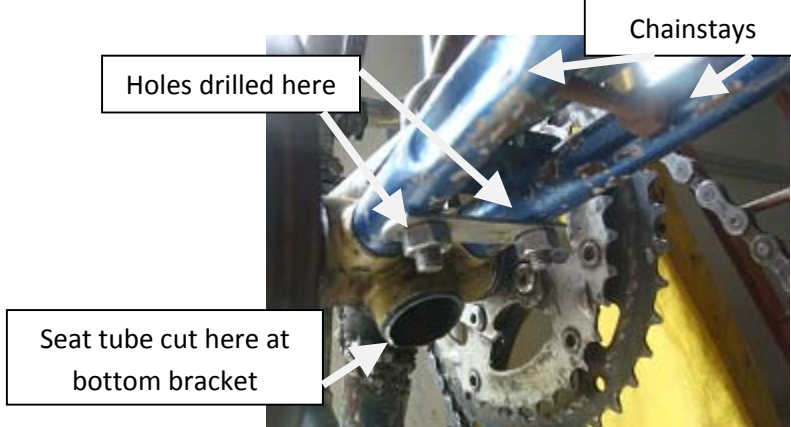
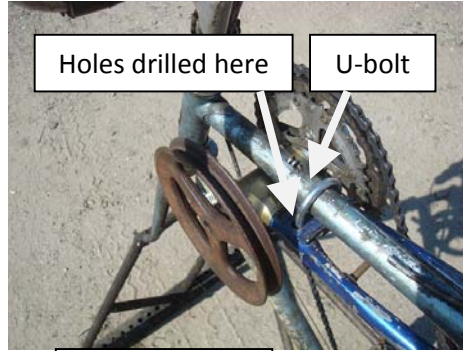
The final power take-off design is based off the availability of parts at D Acres, making the most use of old parts and reducing costs. The design continually changed throughout its construction in order to account for this factor.

## Build it!

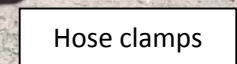
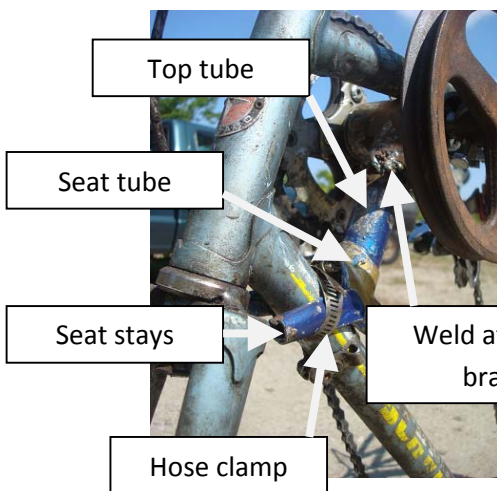
[Parts needed]:

- **Bike frame**
- **Crankset and axle**
- **U-bolt**
- **Pulley**
- **(3) Hose clamps**

The frame of the power take-off is from the chainstays of a bicycle frame that had been damaged in a crash and was no longer usable as transportation. The crankset and axle were salvaged from a mountain bike. Two holes for a u-bolt were drilled into the metal plate used for the kickstand. The u-bolt is secured to the top tube of the bicycle. The pulley is secured to the axle opposite the chainrings. The crank arm was sawn off with a hacksaw to avoid contact with the operator during the device's use. Due to the small pulley inner diameter, the salvaged mountain bike axle had to be grinded to fit.



The seat tube, with a portion of the top tube and seat stays, was used to brace the device against the down tube of the bicycle. A section of the seat tube was cut out (between the seat stays) to fit the down tube. This section is welded to the area where the down tube would connect to the bottom bracket axle. An additional hose clamp secures the section of seat stays to the bicycle. The rear drop outs are secured by two hose clamps to the bicycle. The rear hose clamp encompasses the seat tube and top tube. The other hose clamp is around the power take-off and top tube. See images below.



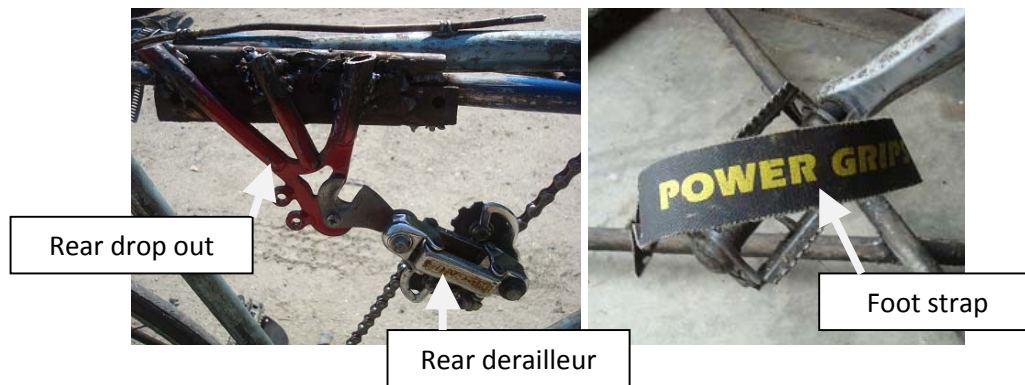
# Belt and chain tension

## [Parts needed]:

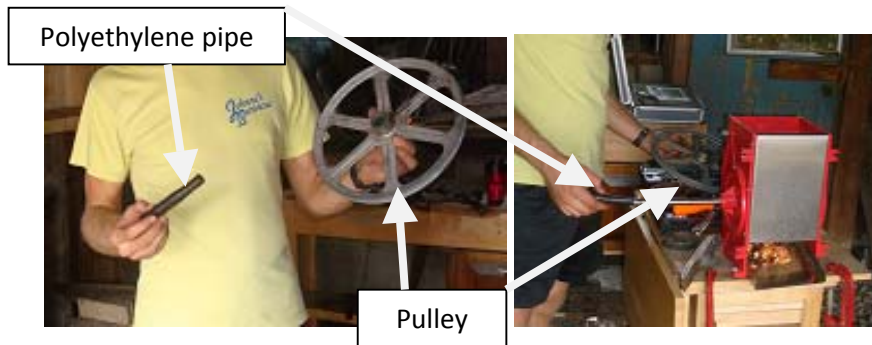
- Rear dropout
- Rear derailleur

## [Process]:

Due to tensioning challenges with the chain, a rear drop out was welded to the device. Most new users tended to rock the bike side-to-side and derail the chain. The rear derailleur provides enough tension to prevent the chain from falling off during use, while still keeping the equipment running smoothly. Metal plates were welded to the power take-off to provide numerous points of contact for the welds and additional strength. Foot straps are used to provide the operator with better leverage. The rear drop out, derailleur, and foot straps were salvaged from an old road bike frame. See images below.



The apple crusher used in the photos is modified from handle operated to belt and pulley operated. The pulley that was available was too large for the stainless steel axle. The size difference was solved using a piece of polyethylene pipe used for irrigation. The section of pipe is slid on the axle of the crusher and then the pulley is placed over it. See images below.



## Challenges

When building a fixed-gear device it can be challenging to make it user friendly, especially when users are unfamiliar with bicycles. The static frame increases the amount of vibrations during operation. The increased vibrations lead to chain derailment and misalignment in the belt.

For this design, the derailleur has significantly decreased the derailing frequency even with the most rowdy of users. On smooth floors belt tension is difficult to maintain. To keep the system in constant tension it has proven best to keep an object between the bike and flywheel (a board in this particular case). The crusher is also bolted to the table. The constant tension keeps the belt from slipping.

Gear ratio is also important to note. A small driving sprocket/pulley creates more speed when attached to a larger sprocket/pulley. Due to the large amount of force needed to crush the apples the gear ratios were closer to 1:1. For devices that require speed, such as a belt sander, the ratio would be much larger.

## Flywheel technology

To further improve the system a flywheel is added. A flywheel stores the mechanical energy produced by pedaling and keeps the crusher running smoothly. Without the flywheel, the pedaling becomes choppy and uncomfortable. The inertia of the flywheel tears through the apples with ease and provides a smooth and comfortable ride. The flywheel pictured below is a combination of pulleys and two pillow block bearings.



## Application

The power take-off can be used to run numerous devices that are belt driven. Currently, the power take-off photographed has been used to power a stone grinder, an apple crusher, and a washing machine. The gear ratios can be adjusted by substituting different pulley sizes depending on the task. Two v-belts are required to run the flywheel and crusher. See image below.

