Design and manufacturing of a archery release aid

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Abstract

The design of a product that shall endure all weather conditions, no maintenance, rough treatment and look nice while doing it, is always a challenging task. In this paper a discussion on the base principals of a trigger mechanism, ergonomics and looks, durability and manufacturing of a archery release aid. And in the end have a product that can be marketed as a top of the line release aid for professionals to novice archers.

I. Introduction

Within archery there are several bow types, the main two types are Recurve bows, which are the ones allowed to use in the Olympics and then there is compound bows, these are have a cam on each of the limbs that the string rides in to create a special draw cycle. On compound bows it is also normal to use a release aid. On the string there is a small loop called a d-loop witch the release aid is mounted to. This allows the release to be rotated somewhat without moving the string to much and effecting accuracy.

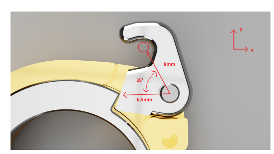
(a) A compund bow

(b) A D-loop mounted on a bowstring

II. Release mechanism

A release mechanism is used in many fields. The objective of a release mechanism is to hold a large force and be able to release this without using much force. This mechanism is an unbalanced mechanism when left to its own devices would release the large force, but it can be balanced with a small force, keeping this mechanism in balance will make it be able to hold the large force. This sort of mechanism has very much in common with regular gears and regular gears can be made to create such a mechanism.

(a) Overview of the release mechanism



(b) The hook part of the mechanism

In the picture above we can see the hook design with measurement. The origin is in the axle centre. The contact point of the hook against the ring is assumed to be on the Y axis and length for the axle to the contact point on the hook is 4,5mm in the y direction and -6,5mm in the X direction.

Contact point D-loop = β
Contact point ring = γ
Angle between β and γ = α

$$F_\gamma = \frac{L_\beta}{L_\gamma} * F_\beta * sin(\alpha) \quad (1)$$

The forces seen on on gamma is 0,71 of beta.

Lets assume we add 600N to beta, this will represent about 125% over the maximum allowed force on a target archery bow. The forces seen on gamma is 426N.

The tangential force on the hook will say how much the mechanism is unbalanced. Having a very unbalanced setup generates more stress in the balancing mechanism, but in our application this tangential force also moves the hook out of the way, and therefore ensures a reliable operations. The user of this device can hold their release in several ways, this will affect where the contact point alpha is and witch way this force vector is pointed. Therefore, a quite high tangential force may prove useful.

III. Feel of the product

An archery release is always held by the archers in several thousand hours of training, when aiming on the ten to win a championship or waiting to go on the line for a world championship. This means that it needs to be able to take a lot of wear, it needs to be comfortable and inspire the confidence in the archer using. The first two points go hand in hand. If the release wears then it also wears on the users hand, and it is probably not comfortable. A design consideration to make his that a release should not too comfortable when it is stationary in the hand, the trigger needs to be moved for the mechanism to be activated. Usually this movement is done by rotating the whole hand and having the thumb staying sill. And by this we need to create a release that is comfortable and feels natural when it is rotating in the hand [10]. This is also a point in generating confidence in the archer, another point is that the device has to look pretty and feel like a well thought out and quality product. So the archer always has the confidence that they are using the best release available and they can rely on it.

The obvious points is that all edges needs to be rounded, and the different length of fingers sp that the groves for each the fingers need to be inn different size and the whole handle need to have a curve and be slimmed down when getting to the smaller fingers. The backside of the release is also important, this gives the release a nice looking silhouette and a good feeling in the hand when handled around. The back side should follow some of the same traits as front side, not equal amounts of curving on all of the edges, and by using not linearly curved lines also creates a organic design.

IV. Durability

The outside of the release is subject to quite harsh conditions as the release is usually in a salt rich environment, which promotes corrosion. But this is usually removed by use and after a while creating a patina. The inside of the release needs to tackle some stress and need to be in contact with the handle. There should be a heavy grease between these surfaces, but having materials that do not cause galvanic corrosion is the right way to go. When considering the handle material we need to consider dermatological effects as this product will be held in the hands of the user many hours every day.

One way to make a release feel better and inspire confidence in the archer is to have a heavy release, it feels like a quality product and their nervous twitches want be transmitted as easy to the release and making for a better controlled release process. Therefore a material with high density would be beneficial.

Gold could also be a suitable material, but is quite soft and the price makes it off-limits even for this product.

Lead is poisonous and soft, and therefore no need for further consideration.

Silver prices are also quite high and it has problems with reacting with salt and becoming poisonous.

Copper is material not yet used in any other release and would defiantly create a unique release aid. Some testing needs to be done on the

Metal	Density (lb/in³)	Specific Gravity
Magnesium	.064	1.77
Aluminum	.098	2.70
Titanium	.161	4.51
Chromium	.250	6.92
Zinc	.258	7.14
Tin	.264	7.30
Stainless Steel (Type 410)	.278	7.70
Iron/Steel	.284	7.87
Stainless Steel (Type 304)	.285	7.90
Muntz Metal	.303	8.39
Cartridge Brass	.308	8.53
Commercial Bronze	.318	8.80
Monel	.319	8.83
Nickel	.321	8.90
Nickel Silver	.323	8.95
Copper	.323	8.96
Silver	.379	10.49
Lead	.409	11.34
Gold	.687	19.32

corrosions while using this material. It would definitive be unique, but will the oxidation wear of easy and thusly wearing out the faces to much and leaving a deposit of corrosion on the users hand.

Nickel is quite pricey but is within the scope of this project. Nickel would also produce a unique product. But the machinability is quite low, it work hardens and has high shear strength, requiring strong machines and dulls the tools quite quick [**?**] [**?**]. It would defiantly be unique, but some people react to the material [5]. And creating a product that some people might get a rash from using is not ideal.

Bronze is quite though to machine [9] and somewhat expensive, but otherwise a fine choice.

Brass is the second most used material for releases after aluminium. It is a good compromise of looks, corrosion resistance, machinability and price.

Stainless steel could also be a suitable material, but it is hard to machine and it is lighter than brass. This makes brass the obvious choice.

Both brass and copper comes out as good candidates, and they are both quite resistant to galvanic corrosion [6]

For the inner moving parts, we need to consider that galvanic corrosion and harder materials will create lower deflection and a better trigger feel, but also a low coefficient of friction is desired. If we compare some hardness list and coefficient of friction list there are a few solutions and candidates that would be desired [7] [8]. Steel is an obvious choice, but leaves something to be desired in steel against steel friction. This could be amended by for example producing the ring in some sort plastic or phosphor bronze. Phosphor bronze is fine candidate for all the moving parts, its quite hard and have an excellent coefficient of friction. It is quite tough to machine, but for these smaller parts it should do fine [9]. If bronze is to hard to come by, stainless steel can be used, but this does not have as good coefficient of friction.

Cavities are made for the storage of grease and dust build-up. The design also tries to keep the mechanism as closed as possible to ensure minimal dust build-up.

The solution for the handle parts to mount to each other is with 3 screws and 2 axles. This design focuses on having the lid only being machined on one side, and keeping the other flat. But this will probably have to be edited. And creating blind holds and grease cavities on both sides of the inner mechanism. This would also allow for novels way of fastening the two halves together. And some effort will be laid into creating a design that doesn't show any fasteners. Like using a variant of the pushing type automotive interior fasteners, but this may prove to be week. And by opening the device may cause the spring to go into low earth orbit.

V. Manufacture

A lot of effort in this design has gone into creating parts that require few setups and parts not requiring a lot of metal removal. All the inner parts are 4mm thick to make it suitable to be cut out from a plate. And the hook even fits inside the ring, to lessen the extent of leftover material. Also creating easy to manufacture parts will also give the end product a higher chance of a high surface finish and better fitting parts.

In going with the earlier points on ergonomics it is important to have as few as possible parts to create a good design, but our hand is sensitive and imperfection and weaknesses are easily felt. And even though we want to keep it simple and slim, we have to keep deflections to a minimum.

VI. Prototypes and way forward

Many design iteration has been done on the handle form with another mechanism, and the handle design was on iteration 16 when this project started. During this process there where four iterations in the internal mechanism and two handle variations. All off these have been printed out to check for fitment issues, and get the feel of the design. The latest internals are halfway produced in aluminium on a Pocket NC mill, some troubles in setting up the a axis and the flimsy vise mounted on it [2]. But all of this will be corrected with a manual mill.

This project should produced some more prototypes now that the design is fairly nailed down. One for destructive testing and two for long term testing with professional archers. Some experimentations will be done with using the pocket NC mill, but larger mills are probably needed as the pocket NC probably lack the power and stiffness to machine anything harder than aluminium [**?**].

For some reason some of the cites end up as question marks... haven't figured out yet why this happens.

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