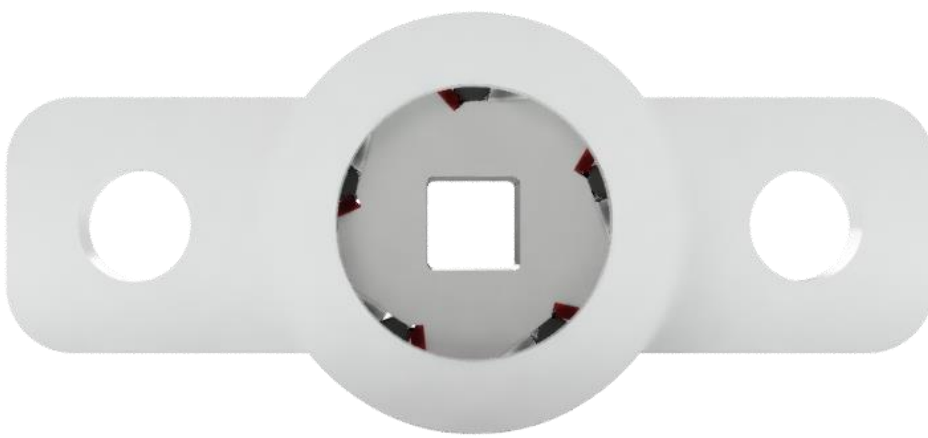
TRAPPED ROLLER CLUTCH

By Yasada De Silva



Introduction

Ratchets are a commonly used mechanism in VEX Robotics. They allow a shaft to freely rotate in one direction, while preventing rotation in the opposite direction. This makes them useful for many applications, from allowing a flywheel to overrun its driveshaft, to enabling a single motor to deliver torque to multiple systems. To effectively fulfill these functions, a ratchet must have minimal backlash, to prevent undesired movement. It is also desirable that the ratchet be small, so it can fit in confined spaces. Lastly, the ratchet must be easy to use, so that relatively inexperienced teams can take advantage of the mechanism in their designs. The current VEX ratchet systems, however, fail to meet these goals. Note, for example, the Ratchet and Pawl, shown below in ***Figure 1***.

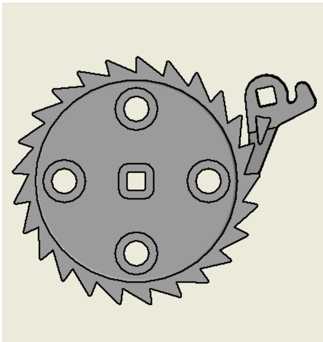


Figure 1

This design uses a gear with asymmetric teeth to produce a ratchet-like motion. Note that the design of this device means that the pawl can only stop backwards motion at discrete points on the gear, which can result in a lot of backlash in the system. Also, note the placement of the pawl. Improper mounting of this pawl will result in an ineffective ratchet, as the pawl will not properly “catch” on the gear teeth. This dependence on perfect mounting makes the ratchet difficult to mount in confined spaces and discourages its use by inexperienced teams.

It should be noted that, in response to the ineffectiveness of the VEX Ratchet and Pawl, many teams have designed custom ratchets for use in their robots. While these designs usually do not suffer from problems of backlash, they often use large components, such as VEX 84 tooth High Strength Gears. Custom ratchets also often rely on a complex assembly of screws, standoffs, and rubber bands, which can be quite daunting for any inexperienced robot-builder to handle. Thus, though custom ratchets are an improvement over the VEX Ratchet and Pawl, there is still a great need for a ratchet-like device that meets the design goals outlined above.

My Solution

The need for an effective ratchet can be met with the Trapped Roller Clutch, a part of my own creation, shown below in ***Figures 2*** and ***3***. This design consists of an Outer Ring (in which is an Outer Race), an Inner Ring, 10 Springs, and 5 Rollers. Each of these parts is labelled in ***Figure 3***. A driveshaft can simply be placed through the bore in the Inner Ring. This shaft can freely rotate in the clockwise direction, and the Clutch's Springs will ensure that it can smoothly do so by keeping the Rollers in constant contact with the Outer Race. If the shaft spins in the counterclockwise direction, however, the device's ratcheting mechanism comes into effect, as shown in ***Figure 4***.

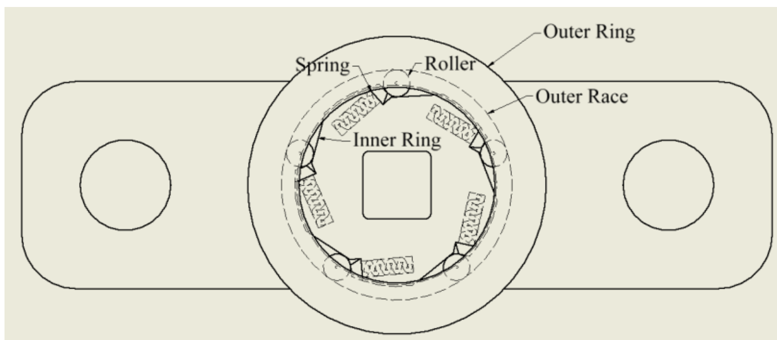


Figure 2

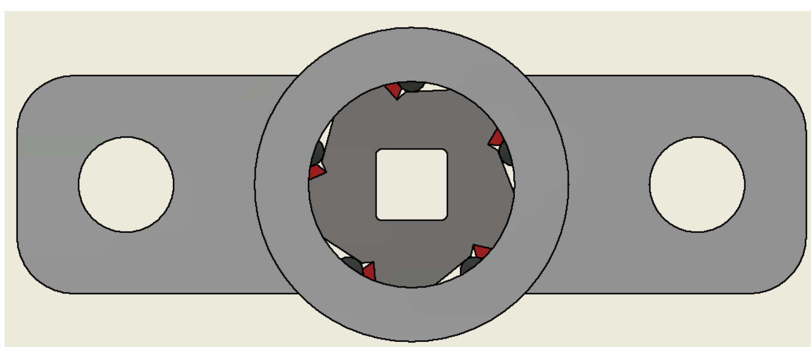


Figure 3

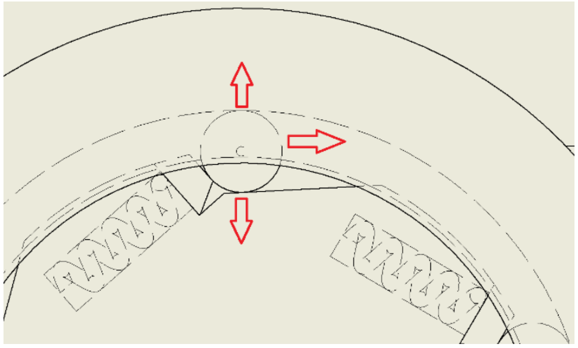


Figure 4

As the shaft spins in the counterclockwise direction, the Roller is forced in the clockwise direction and up the ramp formed by the Inner Ring. This jams the Roller against the Outer Race, which prevents any relative motion between the Inner and Outer Rings and instead causes them to rotate counterclockwise together.

Therefore, the Trapped Roller Clutch can fulfill the basic functions of a ratchet. Unlike the VEX Ratchet and Pawl or custom Ratchets, however, the Clutch meets all the design goals outlined in the Introduction. For example, since the Clutch's ratcheting mechanism does not rely on discrete points along the Outer Ring there is very little backlash in the system. In addition, the Clutch is compact and easy to use in confined spaces. Lastly, note the flange on the Outer Ring. The spacing of the holes on this element is the same as in a VEX C-Channel, High Strength Sprocket, or High Strength Gear. This means that integrating the Clutch in an assembly is as simple as screwing it onto a given part. The Clutch's ease of assembly, compact size, and minimal backlash make it the ideal alternative to current ratchets used in VEX.

Design Process

Autodesk Inventor Professional 2020 was used to design the Trapped Roller Clutch. The Inner Ring, Outer Ring, Rollers, and Springs were all designed in separate Part files. Each part was first properly dimensioned using parametric sketches, then made into a 3D model using functions such as Extrude, Revolve, and Coil. Those parts were then precisely assembled in an Assembly file using various Constraints and Joint functions. The use of properly dimensioned sketches and a precise assembly process ensured that the various parts of the Clutch perfectly fit together and that the design would work. The Inventor Presentation environment was then used to visualize the Clutch's ratcheting mechanism, while the CAM environment was used to design a possible manufacturing toolpath for the Inner Ring.

Conclusion

This project was my first time using the CAM and Presentation environments in Inventor. These environments are quite different from the 3D Modelling and Assembly environments I am used to, and the process of using them has taught me both how to effectively troubleshoot problems in an unfamiliar environment, and how to actually use the environments themselves. Both the CAM and Presentation environments are incredibly useful to both robot-builders, and those in my desired future career of engineering. For both those in competitive robotics teams and in the engineering field, the CAM environment provides an easy way to determine the manufacturability of a part. This ensures that both robot-builders and engineers do not lose sight of practical considerations such as tool size, material cost, and manufacturing cycle time when producing parts. The Presentation environment is also quite useful to robot-builders and engineers, as it provides an effective way to communicate ideas visually to team members, judges, and clients. CAD software is therefore very important to engineers and robot-builders who wish to create designs for production and to share these designs with others. For these reasons, I hope to continue to use CAD software both within my robotics team and as part of a future engineering career.