3204C PNEUMATIC COMPRESSOR

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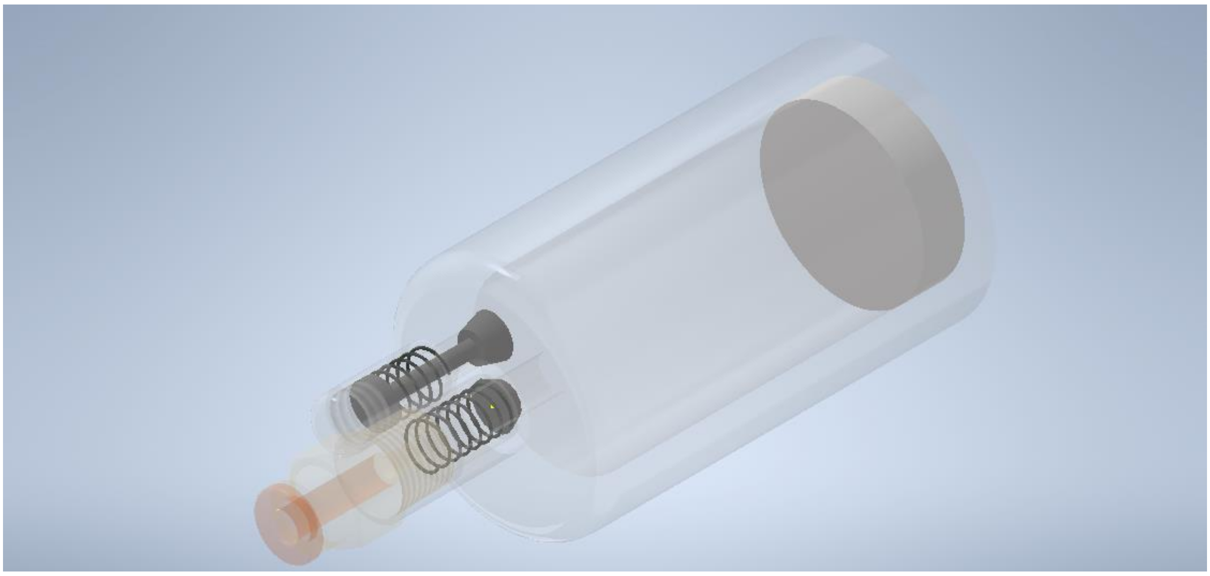
The VEX pneumatic system has always been rather limited in practicality due to its limited air capacity. This has resulted in teams often being forced to use much more bulky and impractical solutions for linear motion that would have otherwise been perfectly suited to be used with pneumatics. We set out to solve this problem by designing an air compressor that is small enough to be mounted on a VRC robot as well as being able to interface with the rest of the VEX Pneumatic system.

To design this, we used Autodesk Inventor Professional 2023 as it runs much faster than Fusion 360 and doesn't have the same limitations as TinkerCAD. However, we actually started off on paper where we sketched out and developed possible purely mechanical mechanisms to compress the air to the 100 psi requirement. We initially wanted to use a cylinder that somehow drew air in on one stroke and exhausted it into the system in the other. This initial concept was slowly refined and evolved until we finally settled on the abstract design of a one-way valve that would serve as the intake for the compression cylinder, and another one-way valve that would prevent the compressed air from the rest of the system from rushing back into the compressor.

We then decided on the target size of our compressor. We wanted it to be small enough to be able to be easily incorporated into a typical VRC robot, yet large enough to be able to compress two pneumatic reservoirs to 100 psi in under 2 minutes. We eventually decided that we wanted our compression cylinder to have an inner diameter of 1.5 inches, as we believed this was a very good compromise.

Another concern we had was how we would make it interface with the V5 brain. Fortunately, we quickly realized that we could use a standard V5 motor to power it. This prevented teams from gaining a significant unfair advantage with our compressor, as well as greatly simplifying the design process as we did not have to worry about working with electronics.

We then started to design the cylinder. Below, we have attached an x-ray view of our intake/air release mechanism to demonstrate how it works.



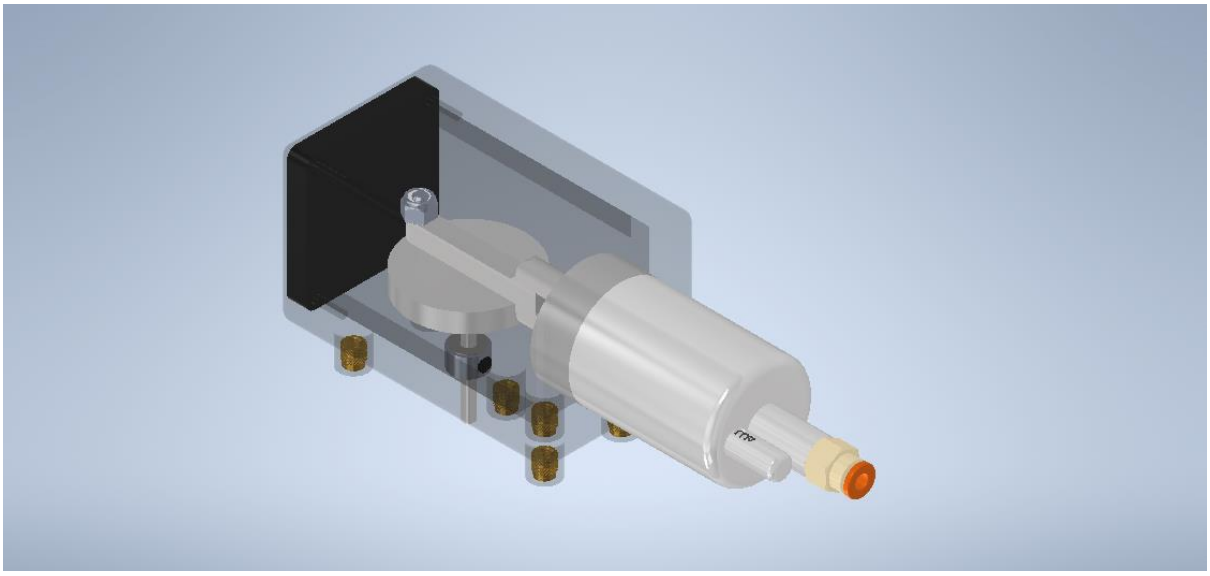
From here, we needed to figure out how to convert the rotational motion of our power source (V5 Motor) into the linear motion required by the piston. The most commonly used mechanism we found was the cam mechanism. In our case, we used a wheel attached to the input shaft as well as a rod connecting the outer portion of the wheel to the piston.

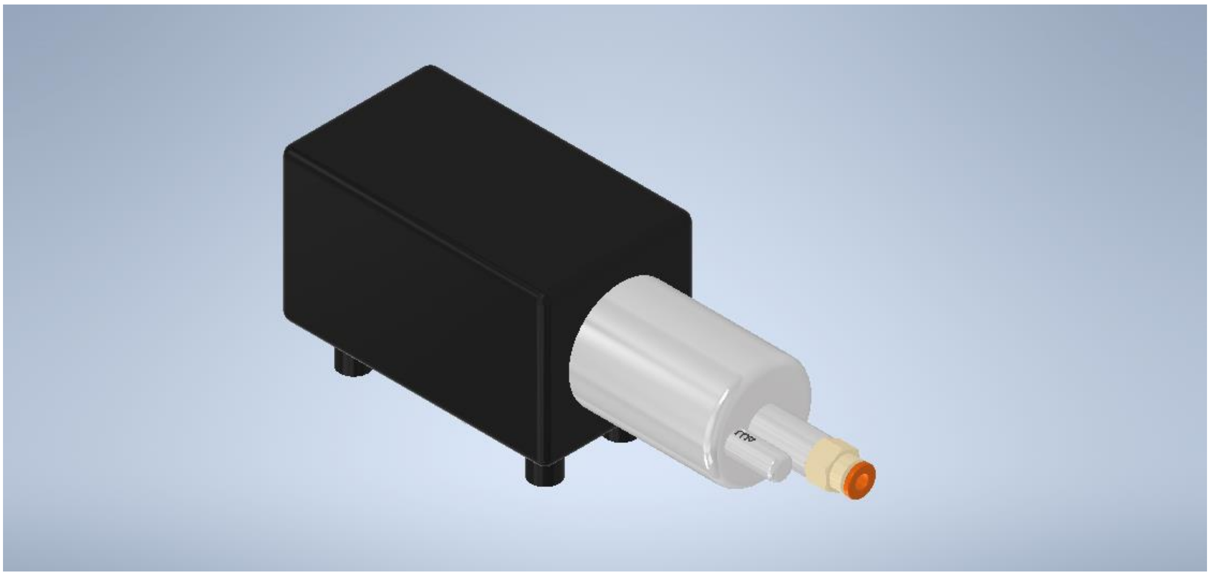
We initially planned to support the shaft from two points, one at each end of the casing of the linear motion conversion mechanism. Unfortunately, we soon realized that our connecting rod would hit the shaft if it continued through both sides of the wheel. Fortunately, this could have been overcome by simply rotating the shaft 180 degrees clockwise and counterclockwise to achieve the same linear motion as completing a full 360 degree turn. Unfortunately, if this were to become a real product, many teams would likely not realize that this would be the case and stall their motors by trying to do a full rotation. The solution we eventually decided on was to only support the axle from one side of the mechanical casing, but extending it’s contact area as far as possible to spread out the pressure over a larger area.

We also added mounting points to allow teams to mount their compressors either directly to a motor or to the structure of their robot. These use standard vex screws and spacing to simplify mounting.

Finally, we wanted to ensure that it was actually possible to manufacture this using standard methods. This is why the intake has a screw-on cap, and there are no impossible to tool locations. The only exception to this is the mounting post for the axle, which has a shape that makes the outer shell impossible to injection mould using a two part mould. However, we made sure to leave space for this to be easily changed to extend the protrusion so that it can be made using a simple mould. The reason we kept it as it is is because it prevents wasted material on prototype 3d prints, which would need to be manufactured in order to test the real-world feasibility of this design.

This is what the final product looks like:





From this project, we learnt one very important lesson to keep in mind for future CAD projects: the importance of scale. Our air intake is very small and may result in additional strain on the motor while drawing in air. Additionally, there is likely not enough material to support the pneumatic hosing connector, particularly at the high pressures we are dealing with. However, this is an issue that can be solved by moving the air exit away from the intake. Unfortunately, we ran out of time to do this so we have had to submit it in this almost-complete state. For the future, this lesson will be very important to ensure that we don't make the same mistake again in a more high-risk setting.