Designing a Hydraulic Scissor Lift

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Hydraulics are a very powerful tool for applying a ton of force (no pun intended) where you want, when you want it. This tech note discusses the principles behind the design of a hydraulically powered scissor lift.

The first issue to consider is when we would want a scissor lift. The main advantage of a scissor lift over other mechanisms is that you pack a lot of travel in to a small space. Any scissor platform, when retracted, occupies a fraction of its height when extended.

Additionally, because of the physics behind it, scissor lifts extend out extremely quickly. However, depending on the design of the lift, there is a good chance that the lift will not move at constant velocity. Many scissor lifts move slowly when they are near full extension or contraction, and much more quickly in between these extremes.

When we're working with hydraulics, scissor lifts have another big advantage. As we will see, they multiply the travel distance of the piston rod. This is a big deal, as piston travel is usually one of the limitations of hydraulic systems (if you're working with high pressure hydraulics).

Now that we know when to use scissor lifts, we can look at the requirements for safely building one. You can see the general schematic from the exploded diagram in the attached document. This is a scissor lift with one 'tier.' If built well, you can build a scissor lift with

several tiers. Keep in mind that the bottom tier must be strong enough to hold up the entire scissor lift, plus any weight on the platform. Also consider that there is a rational limit as to the height-to-width ratio of any raised platform — don't make the scissor platform too narrow when extended, or it will fall over.

Due to the physics involved, each arm in the scissor lift must hold roughly 1/4 the weight of the platform (of course). However, each beam must suffer a shear stress that is the equivalent of supporting half the weight in the middle of the beam, with support at each end. As such, you must design beams that are strong enough to handle this.

The most common form of power used in scissor lifts, as noted above, is hydraulics. This is not the only option — a regular motor will work too — but hydraulics can push a lot of force quickly and accurately, so these systems are favored. In general, the hydraulics are attached as shown in the attached picture.

The pistons are attached to one end of the base, and the piston rods are attached to a point *slightly off center* from the middle of the opposite rod. The exact point of attachment is important because it affects the amount of force you need to exert in order to begin to raise the lift. Notice that with this arrangement, it requires much more force to raise the lift the first few degrees, and much less force after that.

To determine how much force you need, simply look at the angle of the pistons when the lift is collapsed. the force needed will be equal to the weight of the lift (plus whatever weight you want to raise, if you want to raise weight on it) times the sin of the piston angle. This point is why the positioning of the attachment point is so important. Keep that in mind

when designing your lift.