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# Pneumatic Lifting Table

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## ABSTRACT

This project is developed for the users to lift any weight using air pressure. High pressure air is stored in a tank. A cylinder with piston arrangement is connected with a zig-zag pattern. Two pipes connected with ball valves connect the air tank with the cylinder. When one valve is opened, the air rushes out into the cylinder. Therefore the piston moves in one direction. The rod connected with the piston pushes the zig-zag frame so that the lift moves up. When the other ball valve is opened, the air inside the cylinder is released. Therefore the lift comes down.

***Keywords:-*** 5/2 DCV, hydraulic piston, pneumatic cylinder

## I. INTRODUCTION

Nowadays, on heavy traffic roads or highways, if there is any technical problem in a car there are traffic issues. To avoid traffic problems, we need a mechanism that can lift the car at a particular height and move it aside on the road. So our purpose is to create a mechanism which is operated mechanically by using manual power. Nowadays there are hydraulic and pneumatic lift but in accidental cases or any technical problem it is difficult to carry these systems as they are bulky and also need lot of maintenance but this mechanism is portable and requires less maintenance as compared to pneumatic and hydraulic systems.

Now days as every mechanism are getting optimized related to space and portability our aim is to optimize and make a portable lift which is easily accessible and easy to use. The aim is to lift a certain car with a portable mechanically operated lift to do certain work like oil change, under body jobs, car wash etc. Our aim in this project is to design equipment that would replace or can be an alternate for conventional lifts used to lift cars. To use the mechanical power for lifting car to a certain height. This will help reducing the traffic problems on heavy traffic roads and as we are using mechanical power this will lead to reduce cost of end product as compared to hydraulic and pneumatic based lifts.

The main benefit of this model is to reduce the unnecessary cost, reduce the over design, the design will be up to the mark. This model will give new approach to product design. Such as in case of large volume, the cost reduction is more and it will increase the demand of product in market itself. In case of the manufacturing of the scissor jack we can reduce the material of the product by converting the manufacturing process, e.g., Casting into sheet metal, in which the strength of the product remains as it is and the cost of the material will be automatically reduces. Even part reduction by assembly process and no welding joints will give less deflection and the large accuracy. A scissor lift, or commonly called as a table lift, is mainly used to lift people upwards with its crisscrossing foundation supporting beneath the platform. As the platform pulls itself together, it moves upright in the vertical direction and push the platform in accordance with the height and weight.

These lifts can be controlled through hydraulic, pneumatic or mechanical power for height extension. Originally delivered in numerous sizes and shapes, it is designed and manufactured as an industrial lift, and has been customized for commercial and comprehensive purposes. Scissor lifts typically operate in two axes of movement and are designed for applications where people and material need only up and down travel (stationary lift), where the lift needs to be moved around to perform work (manually positioned lift), or to access work along a fixed area of travel (rail guided lift).

## II. PNEUMATICS

Pneumatics is a branch of engineering that makes use of gas or pressurized air. Pneumatic systems used in industry are commonly powered by compressed air or compressed inert gases. A centrally located and electrically powered compressor powers cylinders, air motors, and other pneumatic devices. A pneumatic system controlled through manual or automatic solenoid valves is selected when it provides a lower cost, more flexible, or safer alternativeto electric motors and actuators. Pneumatic systems in fixed installations, such as factories, use compressed air because a sustainable supply can be made by compressing atmospheric air. The air usually has moisture removed, and a small quantity of oil is added at the compressor to prevent corrosion and lubricate mechanical components. Factory-plumbed pneumatic-power users need not worry about poisonous leakage, as the gas is usually just air. Smaller or stand-alone systems can use other compressed gases that present an asphyxiation hazard, such as nitrogen—often referred to as OFN (oxygen-free nitrogen) when supplied in cylinders. Any compressed gas other than air is an asphyxiation hazard—including nitrogen, which makes up 78% of air. Compressed oxygen (approx. 21% of air) would not asphyxiate, but is not used in pneumatically-powered devices because it is a fire hazard, more expensive, and offers no performance advantage over air.

## III. OBJECTIVE

To design a machine that can achieve high accuracy in lifting using smooth and efficient fluid power. To eliminate the use of hydraulic pump in hydraulic systems. Controlled lifting of load. To minimize initial cost, operating cost and maintenance cost.

## IV. LITERATURE REVIEW

No matter how grand the scale, sophisticated the design or intricate the planning, all great undertakings are born from diminutive origins--a core concept or ideal from which all subsequent ideas and actions radiate. Whether it is a solution to a commonly encountered problem, an easier way to complete a task or even a challenge to what is considered possible by current technology, a concept is born simple. Ideas aspire to be great. They are useless on their own but given the right environment and support, ideas can help foster immense possibilities. Once a concept is founded the possibilities of how to proceed abound. From a stream of ideas and theories, a natural progression of events and list of necessities will become apparent to the inventor.

These will become steps along the way that must be completed before the final goal may be attained. Think of the great minds of the past, sitting on the earth, gazing at the heavens, longing to touch the stars. Astrophysics and space shuttles where certainly not created overnight but guided by the list of necessities along the way, scientists put these great contributions into existence and thus made the distance separating man from his skyward endeavor that much shorter. Of course few goals are as lofty as space travel but the central idea of invention, from concept through completion is no different and the elation felt after a project is complete is no less great. While no astronauts were created in the undertaking of this project, I pushed many boundaries and explored new areas of understanding. In keeping with the previously mentioned structure of invention, this projects concept was created with only one goal in mind. The project, which even in its infancy was referred to simply as "the lift", was called to life in response to a single question from my mentor Loren Schreiber (Faculty Professor and Director of Technology at San Diego State University's Department of Theatre), "Why don't we make our own [lift system] and rent it out?" Little did I know at the time how large an impact such a simple proposition would have on my graduate school career.

For better understanding of the projects creation, it is necessary to pause and give context to the Department of Theatre at San Diego State University and their use of technology in a theatre environment. While the department boasts a large scenic construction shop, with access to an impressive amount of tools and advanced equipment, it is what is hiding in the basement that truly defines its level of technical sophistication. Managed by Loren Schreiber, The San Diego Theatre Arts Research Laboratory, or S.T.A.R. Lab, is housed in the lower level of the Don Powell Theatre Building. It is here that technical theatre magic happens. The lab is a facility dedicated to the creation and refinement of machinery and effects, specialized for use in not only the schools theatrical productions, but professional theatres across the country. Often aligned under the single category of "automation," technology used by students in the lab includes, but is certainly not limited to, the areas of pneumatics, hydraulics, programmable logic controllers, radio controlled electronics, and motorized winch systems.

Add in the access to fully operational wood and metalworking shops, also housed in the theatre, and students can produce almost anything the mind can envision. While, when left in disarray, the lab can resemble a mad scientists workshop, this is a space where amazing inventions in theatre technology come into being; a place where students are limited only by their own imaginations and desire to learn. It is in this breeding ground for creativity that I spent the majority of my time as a graduate student. Whether working as an assistant building an effect system for a show or going to class, the STAR Lab quickly became my home away from home. Given the nature of the lab, it should be no surprise that this is where the idea of the lift project first came about. It was during an informal conversation between Schreiber and me that he revealed the San Diego Opera was in need of a lift system for their production of Faust in the coming season and they were inquiring around town for possible rental of such a system. This is when Schreiber posed what seemed at that time, to be a simple proposition, “Why don’t we make our own [lift system] and rent it out?” What followed was a series of back and forth discussion of hypothetical scenarios and systems, which could be manufactured in the Departments metal shop, rented to the San Diego Opera and then returned for the Departments own use.

## V. METHODOLOGY

Fluid power technology actually began in 1950 with the discovery of Pascal's law: Pressure is transmitted undiminished in a confined body of fluid. Pascal found that when he rammed a cork down into a jug completely full of wine, the bottom of the jug broke and fell out. Pascal's law indicated that the pressures were equal at the top and bottom of the jug. However, the jug has small opening area at the top and a large area at the bottom. Thus, the bottom absorbs a greater force due to its larger area. Combination of pneumatics coupled with hydraulics is used to lift large amount of load with more precision and accuracy.

The combination system eliminates the limitations of individual systems of hydraulics and pneumatics like costly hydraulic pumps and hydraulic direction control valves in addition to reduction in operating and maintenance costs. Pressurized air of 3 bars from the compressor hits the piston (60 mm diameter) of the single acting pneumatic cylinder from the blank end side via three ports and two positions (3/2) push button operated directional control valve. As a result, the piston of the pneumatic cylinder extends. This in turn pressurizes (12 bar) the enclosed oil in the hydraulic line, as per Pascal’s law. This could be due to the extension of the rod (30 mm diameter) of the piston of the pneumatic cylinder, and surprisingly, the rod acts as piston to the hydraulic line. The pressurized fluid of 12 bar will act on the blank end of the piston (100 mm diameter) of the single acting hydraulic cylinder. A large amount of load carrying capacity of approximately 9400 kg would be delivered by the hydraulic cylinder rod. This could be achieved by connecting metallic plate (or pan) to the rod of the hydraulic cylinder by means of nuts and bolts. This arrangement can be used for lifting the loads as well as to clamp the work piece on the table during machining. As the push button of 3/2 DCV is depressurized, trapped pressurized air from the pneumatic cylinder is vented to the atmosphere freely. Consequently, the oil from the hydraulic cylinder reverts back to the reservoir (hydraulic line). The cylinder will be retracted and load is released.

## VI. DESIGN

While concepts typically remain fixed, the tactics employed in to fulfil them are often in flux early in the life of a project. These initial steps in the design process are exciting but can also become frustrating as large amounts of work and planning can go into a design scheme, only to have it shot down because any number of logistical or technical conflicts makes it impossible. This is a prime example of how artistic and mechanical designs differ.In artistic design, your work can be allowed to evolve and become whatever you wish to allow. In the mechanical realm however, constraints are plentiful and your design may be forced to fit within a very precise set of parameters to be even considered feasible. It is vital to outline your design process in broad strokes with requirements in mind and not make any assumptions on what will or will not work. Instead of seeing these constraints as a limitation to one’s artistic vision, one should look to them as guidelines--markers that will push one’s work in the appropriate direction when one may not know where to go next.

The establishment of the parameters for my system was the first step in the design process. During this phase I generated as many questions as I could pertaining to the lift’s necessary attributes. How and where will it be used specifically? How large does it need to be? How much weight must it carry? How fast is it required to move? Are all of these specifications possible to combine and be fulfilled safely? Basic questions such as these shaped my initial understanding of the systems require capabilities. Only after having the answers to these queries would I then be free to let my imagination wander and begin putting possible components together in my mind. Once I determined the general outline of how the lift must perform, it was time to move on to the far more specific challenges of how to meet and/or exceed all the requirements. Armed with a barrage of questions that would shape the future of my mechanical design, I was now ready to have a meeting with the technical director of the San Diego Opera, John David Peters, the man who would be renting our lift, once completed. Schreiber had made an appointment with Peters so that we would be able to talk specifics with him as well as tour the San Diego Civic Theatre where the lift was to be installed. This allowed us to take much needed measurements of the theatre as well as discuss with Peters the specific uses of the system in their upcoming production of Faust. We did not have much time with Peters since he was in the midst of overseeing a union crew loading out a large scale set, but he took the time to answer our questions. Peters' responses along with the help of a camera, tape measure and a finely calibrated laser distance meter, gave me much of the information I would need for planning the lift. All in all, it was a very successful first meeting. During our meeting, Peters explained to us that the lift would function in the opera as a gateway to hell. One of the principal characters in the tragedy is a devil named Mephistopheles who appears multiple times to the title character, Faust.

For the purposes of this production, the set design called for Mephistopheles to enter the stage from the basement through a trap door in the floor. The missing panel in the floor would be concealed by a set piece designed to look like a well. Mephistopheles would rise from below in a cloud of sulphur, as if arriving from Hell. Peters' insisted that the system must be absolutely safe for the actors and technicians working around it. And it needed to be very quite so it would not be heard by the audience or disrupt the orchestra musicians who would be in very close proximity. And finally, it needed to be consistent. It simply had to work every time without fail or the whole show could come to a screeching halt. Failure is not an acceptable scenario in the professional theatre business. With Peters' parameters in mind, the measurements that I paid the closest attention to, and made sure to triple check, were those pertaining to the stage trap door and the basement area under and around it. Using a laser distance meter I verified measurements down to one thirty-second of an inch from multiple spots on the floor of the basement up to the structural beams of the stage and steel bracing of the trap door sections. Additionally, since I knew it would be difficult to return for measurements again in the future, I used a tape measure to plot nearby obstructions and important elements of the space. These included walkways, structural pillars, air ducting, and access to electrical panels. Finally, I documented our tour of the space with a small handheld video camera, taking note of the dimensions of entryways and elevators so that I could decide how to get such a large contraption into the basement. The video also served well as a review in cases where any of the notes that I took during my time there were unclear when I returned to them for vital information.

Having collected multiple pages of notes and measurements pertaining to the venue, I began drafting the space into AutoCAD. Entering all of these essential figures into one base drawing file would provide me with a scaled, visual representation of the theatre that could be referenced in the future and would be much easier to decipher than pages of seemingly random numbers. I took the time to generate separate section views from the sides and front as well as a plan view from above which included all nearby obstructions.Having multiple views and sections of the area the lift would occupy allowed me to project a three dimensional view of the theatres basement and the lift's spatial constraints.

The drawing of the Civic Theatres trap room would serve as the foundation for all the systems design drawings to follow. It was at some point during this free exchange of ideas that the project began to become more concrete. The possibilities seemed limitless and our conversations were exciting. Over the course of the following weeks, meetings between Schreiber and me became more detailed, focusing on specific components and operations of the theoretical lift system. Ideas were proposed, dismissed, tweaked and then dismissed again. This pattern continued until the day that Schreiber approached me in theatre's metal working area with word that he had corresponded with the Opera's Technical Director John David Peters regarding the lift. Not only was Peters interested in our lift idea, he had already approved payment of half of the agreed upon rental fee up front to get our proposed contraption out of the concept phase and into design and fabrication. This was the day that my lift ceased to be an idea and became a project. The following months would prove to be very productive, yet challenging, times.

## VII. CONSTRUCTION

A cylinder with piston arrangement is connected with a zig-zag pattern. Two pipes connected with ball valves connect the air tank with the cylinder. When one valve is opened, the air rushes out into the cylinder. Therefore the piston moves in one direction. The rod connected with the piston pushes the zig-zag flame so that the lift moves up. When the other ball valve is opened, the air inside the cylinder is released. Therefore the lift comes down. The main objective of Zig-Zag Pneumatic Lift project is developing a lift system for lifting any weight using air pressure. In this project, we stored high pressure air in a tank. A zig-zag pattern is connected with a cylinder with piston arrangement. The cylinder and the air tank are connected by the two pipes with ball valves. When one ball valve is opened, the high pressure air will enter into the cylinder. Hence, the piston will move in one direction. The rod connected with the piston pushes the zig -zag frame so that the lift moves up. When we open the other ball valve, the air inside the cylinder is released. So, the lift comes down.

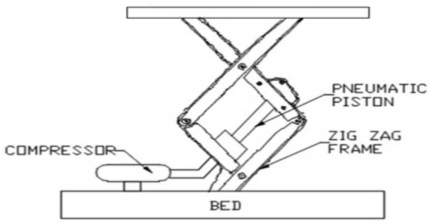


Fig: pneumatic lifting table

## VIII. WORKING

The complete fabricated model picture of pneumatic lifting table is shown below. The upper base is mounted on the linkage as shown in the diagram and is connected to the piston of the pneumatic cylinder. The both sides of the piston are connected to the single stage reciprocating air compressor through the solenoid valve.

Air from a single stage air compressor enters the push button direction control valve and is directed to the pneumatic actuator. The pneumatic actuator is a double acting cylinder and the compressed air extends the piston. The piston rod acts as piston in the hydraulic line and pressurizes the hydraulic fluid. Thus the hydraulic fluid enters the delivery

pipe through a filter arrangement. The pressurized fluid is made to act on a hydraulic cylinder placed on a table arrangement. The hydraulic fluid then extends the hydraulic piston. The end of the piston rod is connected to a load pan. Thus the pan extends along with the piston rod and lifts the load.

Pressurized air at 3bar from the compressor hits the piston of the double acting pneumatic cylinder from the blank end side via five ports and two positions (5/2) push button operated directional control valve. As a result, the piston of the pneumatic cylinder extends.

This in turn pressurizes the enclosed oil in the hydraulic line, as per Pascal's law. This is due to the extension of the piston rod of the pneumatic cylinder and the rod acts as piston to the pneumatic line. The pressurized fluid at 69bar will act on the blank end of the piston of the single acting pneumatic cylinder. A large amount of load carrying capacity of approximately 1300Kg would be delivered by the pneumatic cylinder rod. This could be achieved by connecting metallic plate (or pan) to the rod of the hydraulic cylinder by means of nuts and bolts. This arrangement can be used for lifting the loads as well as to clamp the work piece on the table during machining. By operating push button of the 5/2 DCV, air from the compressor enters into the pneumatic cylinder through the rod end side.

This makes the piston to retract and the oil from the reservoir is drawn into booster portion of the pneumatic cylinder. By depressurizing the push button of 5/2 DCV, the spool of the DCV assumes its initial position. As a result, air pressure on the blank end side of the cylinder pushes the rod of the piston into the booster area. High force delivered by the piston creates an increase in the pressure of the fluid, which in turn enters into the blank end region of the single acting pneumatic cylinder. This causes rising of the load via the cylinder, which depends on the cross sectional area of the piston. In order to lower the load cylinder, needle valve connected to the main hydraulic line is operated, which causes the draining of the oil from the hydraulic cylinder to the reservoir.

## IX. CONCLUSION

Instead of using hydraulic lift we have used mechanically operated pneumatic lift which is more cost efficient and portable. We have designed scissor lift in such a way that it has reduced design complexities. All the design calculations are performed taking into consideration the dimensions of car and all the safety issues. Modifications can be done by providing rollers to the lower base so it could be portable. Also by providing upper magnetic base ferrous material can be held easily.

## REFERENCES


[1] Balkeshwar Singh, Anil Kumar Mishra, “Analysis and Fabrication of Remote Control Lifting Jack”. International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-3, June 2015 ISSN: 2395-3470.

[2] Dr. Ramachandra C G, Krishna Pavana, Shivraj Shet and Venugopal Reddy, “Design and fabrication of automotive hydraulic jack system for vehicles”.International Journal of Advances in Engineering Research (IJAER) 2013, Vol. No. 6, Issue No. VI, Dec.

[3] M.M.Noor, K. Kadirgama, M.M. Rahman, M.S.M. Sani, M.R.M. Rejab, “Development of Auto Car Jack Using Internal Car Power”. Malaysian Science and Technology Congress,MSTC08, 16~17 Dec, KLCC, Malaysia, 2008.

[4] Helmi Rashid and et.al, “Design Review of Scissors Lifts Structure for Commercial Aircraft Ground Support Equipment using Finite Element Analysis”. International Symposium on Robotics and Intelligent Sensors 2012 (IRIS 2012).

[5] Bharath Kumar K, Gowtham S., Paul James Thadhani,Deepak Kumar.Bibin George Thomas, Kiron Antony Rebeiro “Fabrication of zig zag pneumatic lift” published by international journal of scientific engineering and applied science (IJSEAS) - Volume-1, Issue-3, June 2015 ISSN: 2395-3470.

[6] Jaydeep M. Bhatt, Milan J. Pandya, “Design And analysis of an aerial scissor lift” Journal of information knowledge and research in Mechanical Engineering, Volume – 02, Issue – 02, P.N.452-455, Nov 12 To Oct 13.

[7] Ivan Sunit Rout, Dipti Ranjan Patra, Sidhartha Sankar Padhi, Jitendra Narayan Biswal, Tushar Kanti Panda” Design and fabrication of motorized automated object lifting jack” IOSR journal of engineering (IOSRJEN) ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 04, Issue 05 (may. 2014), ||V5|| pp 06-12.

[8] Rahul J.Kolekar, S.S. Gawade “Design and development of lift for an automatic car parking system” published by India.

[9] Gaffar G. Momin, Rohan Hatti, Karan Dalvi, Faisal Bargi, Rohit Devare “Design, manufacturing & analysis of hydraulic scissor lift”International Journal of Engineering Research And General Science Volume 3, Issue 2, Part 2, March-April, 2015 ISSN 2091-2730733.

[10] P.S. Rana, P.H. Belge1, N.A. Nagrare, C.A. Padwad1, P.R. Daga1, K.B. Deshbhratar N.K. Mandavgade “Integrated automated jacks for 4-wheelers”

[11] Scholars Research Library European Journal of Applied Engineering And Scientific Research, 2012, 1 (4):167-172.