PNEUMATIC OPERATED VICE AND JACK

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ABSTRACT

The main objective of our project is to perform various machining operations. In the manufacturing area this paper need one device for work and tool holding. For work holding this paper need vice to keep the work piece stationary while machining. Here the vice is adjusted by using the pneumatically operated jack. From the compressor the air is supplied to the jack. Due this pneumatic force the jack is adjusted (vertically or horizontally) correspondingly the vice is adjusted. Work holding and releasing is the most essential act to carry out using "auto feed mechanisms" in work holding device with the of help of pneumatic system . This project using two mechanisms one mechanisms is used to hold work piece and another one is to feed the work piece into holding device in automatically. A pneumatic machine can be thought of as a large flexible mechanical structure that is moved by some sort of control system. The control system takes its input from a human operator and translates this command into the motion of actuators, which move the mechanical structure. The high performance and highly powerful, pneumatic machine vice together with the capacity for high volumes are suited for holding heavy objects. Generally, pneumatic cylinder operations are based on pneumatic pump operation. Air is pumping to the pneumatic cylinder by using pneumatic pump system.

***Key words**: Fabrication, Automatic Vice, Feed, Pneumatic Linear Actuators.*

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1. INTRODUCTION

Pneumatics is that branch of technology, which deals with the study and application of use of pressurized air to affect mechanical motion. "Pneumos" means "Air" and "Tics" means "Technology Pneumatics is using air to push/pull things or suck them up. The pistons and tubing are light and powerful, lighter than equivalent motors; however, the compressor is itself a motor and is heavy. Once the big decision to add the compressor is made, adding extra pistons is much easier and lighter than adding extra motors (and gearing). The air compressor keeps air storage tanks filled and the storage tanks provide the reserve air to quickly fill the actuators or pistons. Storage tanks are at least twice the pressure of the actuators so one tank of storage air will quickly fill an actuator the same size, but after that the air compressor cannot replenish the used air very quickly. It adds roughly half a cubic foot of air per minute depending on the pressure already in the system that it's striving to shove more air into. Less air is moved near full pressure (.24cfm) and more at zero (.79cfm) pressure, so in an entire 2 minute match expect the air compressor to add ~.8 cubic feet of air. Plan on doing a test while watching the main high-pressure gauge to see how low it gets during what you expect to be normal operation.

A vise or vice (see American and British English spelling differences) is a mechanical screw apparatus used for holding or calming a work piece to allow work to be performed on it with tools such as saws, planes, drills, mills, screwdrivers, sandpaper, etc. Vises usually have one fixed jaw and another, parallel, jaw is moved to work holding device. There are two main types: a wood working vise and engineer's vise. The woodwork vise is working processer the hand, engineering vice is used worked the small places. To understand how compressed air is able to do things, let's think of a ball. If we blow up the ball so that it is full, it will contain a lot of compressed air. If we bounce the ball, it will bounce very high. However, if the ball is burst then the compressed air will escape and the ball will not bounce as high. Quite simply, the ball bounces because it is using the energy stored in the compressed air.

Work holding and releasing is the most essential act to carry out machining to hold the job in proper position. To release the job quickly and hold the job rigidly. To prevent the vibrations of the job while the machining is carried-out. We are using mechanical work holding devices. In this project we are dealing with pneumatic vice used in drilling machine. In pneumatic type vice one end of piston rod is connected to the movable jaw and the piston slides in the cylinder. Here the air actuates the movement of piston; this in turn actuates the movable jaw. Here the principle movement is only a reciprocating movement.

A vice is a mechanical screw apparatus used for holding or clamping a work piece to allow work to be performed on it with tools such as saws, planes, drills, mills, screwdrivers, sandpaper, etc. Vices usually have one fixed jaw and another parallel jaw which is moved towards or away from the fixed jaw by the screw. Vice is used to drill a wood, metal, etc. by holding your work piece tightly, it gives you all stability you need so you can make precise cuts. Even it is used for sawing a job with constant force applied by hand, or automatically, in order to cut desired shapes. A pneumatic system is controlled through manual or automatic process. In this Automatic pneumatic vice project for metal working is provided with widely and quick movable clamping jaw and fixed jaw where the vertical clamping surface of the fixed jaw and the horizontal surface of the fastening plane for the working piece confirm an accurate and unchangeable. Using automatically operated pneumatic vice will help you to get the work down easily and save energy.

There are three major types of work holding devices which are:

- Mechanical type
- Hydraulic type
- Pneumatic type

In mechanical type, the screw rod is actuating the movable jaw. One end is connected to the movable jaw and it passes through a fixed type nut. When we rotate one end of the screw rod it will rotate in the nut and in turn moves the movable jaw. Here the rotary motion is converted into reciprocating motion.

In Hydraulic type's one end of the piston rod is connected to the movable jaw and the piston slides in the cylinder. Here the hydraulic fluid actuates the movement of the piston; this in turn actuates the movable jaw. Here the principle movement is only a reciprocating movement.

Pneumatic type is same as the hydraulic type. Here instead of hydraulic fluid, air is used.

An incredible range of manufacturing systems use the force and power of fluids such as water, oil and air. Powered clamps open and close with the force of pressurized air or oil, large presses shape and form metal with hydraulic pressure, and assembly torque tools fasten components with pressurized air. In each example, fluid power provides the energy necessary to exert significant mechanical forces. Systems that use air are called pneumatic systems while systems that use liquids like oil or water are called hydraulic system. The pneumatic systems will be the subject of the first three sessions in the course starting from this session.

Pneumatics is all about using compressed air to make a process happens. Compressed air is simply the air we breathe squeezed into a small space under pressure. You might remember that air under pressure possesses potential energy which can be released to do useful work.

Their principle of operation is similar to that of the hydraulic power systems. An air compressor converts the mechanical energy of the prime mover into, mainly, pressure energy of the compressed air. This transformation facilitates the transmission, storage, and control of energy. After compression, the compressed air should be prepared for use.

A pneumatic system consists of a group of pneumatic components connected together so that a signal (compressed air) is passed through the system to make something happen at the output. These groups of components can be divided into five categories according to their function in the pneumatic circuit as follows:

1. Supply elements: these elements are the sources of power that drives the system which are the compressors.
2. Input elements: these elements are used to send signals to the final control elements and come in two forms; either as components that is actuated by the operator like push buttons or sensors that determine the status of the power elements such as limit switches and proximity sensors.
3. Processing elements: these elements may perform operations on the input signals before sending the signal to the final control elements such as non-return valves, directional control valves and presser control valves.
4. Final control elements: to control the motion of actuators such as directional control valves.

5. Power elements (actuators): these are the outputs of the pneumatic system which use the stored potential energy to perform a certain task such as pneumatic cylinders and motors.

A pneumatic machine can be thought of as a large flexible mechanical structure that is moved by some sort of control system. The control system takes its input from a human operator and translates this command into the motion of actuators, which move the mechanical structure. The high performance and highly powerful, Pneumatic machine vice together with the capacity for high volumes are suited for Holding Heavy Objects.

The automatic pneumatic jack for light vehicle garages has been developed to cater the needs of small and medium automobile garages. In most of the garages the vehicles are lifted by using screw jack. This needs high man power and skilled labors.

In order to avoid all such disadvantages, this automatic pneumatic jack has been designed in such a way that it can be used to lift the vehicle very smoothly without any impact force. The operation is made simple so that even a layman person can handle it by just pressing the button.

1.1 Features

- Working Efficiency Is Good.
- Maintenance Cost is Low.
- Less noisy in operation.

1.2 Problem Statement

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc of these sources, pneumatics form an attractive medium for low cost automation. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production. Nowadays almost all the manufacturing processes are being made automatic in order to deliver the products at a faster rate. The following reasons affirms the benefits of automation,

- To achieve mass production
- To reduce man power
- To increase the efficiency of the plant
- To reduce the work load
- To reduce the production cost
- To reduce the production time
- To reduce the material handling
- To reduce the fatigue of workers
- To achieve good product quality

- **1.3 Objectives**

  The main objective of project is to improve version of a mini pneumatic jack. This will be more efficient for the user. This machine is pneumatic powered which has low co-efficient of friction. A pneumatic cylinder erected provides power to lift up the Jacky. This is a pneumatic powered machine and requires no other means of power to operate. The advantage of a mechanical jack is the ratio of the load applied to the effort applied. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor.

1.4 Scope

- The developed pneumatic vice and jack must be operated on a flat surface.
- The developed jack is only a prototype and not readily functioning as commercial product. The developed automatic jack can only withstand below.
- The design is based on current pneumatic jack & cars in the market.

2. Literature Survey

Mechanical jacks were very common for jeeps and trucks. For example, the World War II jeeps (Willys MB and Ford GPW) were issued the "Jack, Automobile, Screw type, Capacity 1 1/2 ton", Ordnance part number 41-J-66. This jacks and similar jacks for trucks were activated by using the lug wrench as a handle for the jack's ratchet action to of the jack. The 41-J-66 jack was carried in the jeep's tool compartment. Screw type mechanical jack's continued in use for small capacity requirements due to low cost of production raise or lower it. A control tab is marked up/down and its position determines the direction of movement and almost no maintenance. Thomas J. Prather (2009): In this, there was an introduction about vehicle lift system. A drive assembly was mechanically coupled to the piston. The drive assembly was operated in first direction to raise an upper end of the piston with respect to the housing. The drive assembly was operated in a second direction to lower the upper end of the piston with respect to the housing. The drive assembly was coupled to the power supply port which is removable to supply electrical power to the drive assembly.

Lokhande Tarachand (2012): This paper referred to optimize the efficiency of square threaded mechanical screw jack by varying different helix angle.

Manoj Patil (2014): In this general article, screw jack is developed to overcome the human effort. It is actually difficult job to operate for pregnant women and old person. Changing the tyre is not a pleasant experience. Especially women can't apply more force to operate. For that, electric operated car jack is introduced.

With the industrial revolution of the late 18th and 19th centuries came the first use of screws in machine tools, via English inventors such as John Wilkinson and Henry Maudsley The most notable inventor in mechanical engineering from the early 1800s was undoubtedly the mechanical genius Joseph Whitworth, who recognized the need for precision had become as important in industry as the provision of power.

In Alleghany County near Pittsburgh in 1883, an enterprising Mississippi river boat captain named Josiah Barrett had an idea for a ratchet jack that would pull barges together to form a „tow". The idea was based on the familiar lever and fulcrum principle and he needed someone to manufacture it. That person was Samuel Duff, proprietor of a local machine shop, together, they created the Duff Manufacturing Company, which by 1890 had developed new applications for the original "Barrett Jack" and extended the product line to seven models in varying capacities. The company had offered manually operated screw jacks but the first new product manufactured under the joint venture was the air motor-operated power jack that appeared in 1929. With the aid of the relatively new portable compressor technology, users now could move and position loads without manual effort. The jack, used predominantly in the railway industry, incorporated an air motor manufactured by The Chicago Pneumatic Tool Company.

There was clearly potential for using this technology for other applications and only 10 years later, in 1940, the first worm gear screw jack, that is instantly recognizable today, was offered by Duff-Norton, for adjusting the heights of truck loading platforms and mill tables. With the ability to be used individually or linked mechanically and driven by either air or electric motors or even manually, the first model had lifting capacity of 10 tons with raises of 2"or 4" Since then the product has evolved to push, pull, lift, lower and position loads of anything from a few kilos to hundreds of tonnes. One of the biggest single screw jacks made to date is a special Power Jacks E-Series unit that is rated for 350 tonnes even in earthquake conditions for the nuclear industry. A mechanical jack that has a built-in motor is now referred to as a linear actuator but is essentially still a screw jack.

Today, mechanical jacks can be linked mechanically or electronically and with the advances in motion-control, loads can be positioned to within microns. Improvements in gear technology together with the addition of precision ball screws and roller screws mean the applications for screw jacks today are endless and a real alternative to hydraulics in terms of duty cycles and speed at a time when industry demands cleaner, quieter and more reliable solutions.

Screws Application is used in the elevation of vehicles or objects. The operation of the mechanical jack is such that it comprises a handle for driving a bolt element (Lead Screw) manually so as to adjust the height of the Jack to elevate a vehicle or the object. The operation of the jack manually makes it difficult for most women and the elderly to operate since much effort is needed to drive the screw jack which results in low linear speed and time consuming. These presently available jacks further require the operator to remain in prolonged bent or squatting position to operate the jack. Doing work in a bent or squatting position for a period of time is not ergonomic to human body. It will give back ache problem in due of time. Suppose car jacks must be easy to use by women or whoever had problem with the tyres along the road. The objective of this paper is therefore to modify the existing design of car jack by incorporating an electric motor into the existing screw jack to make the operation easier, safer faster and more reliable

3. Methodology

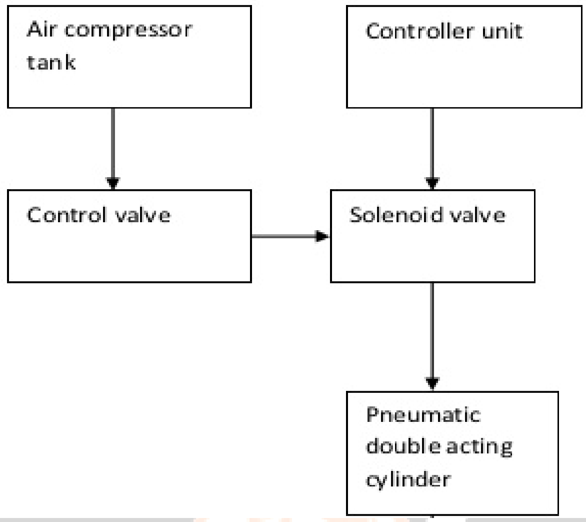

Fig 3.1: Block Diagram

A vice is a mechanical screw apparatus used for holding or clamping a work piece to allow work to be performed on it with tools such as saws, planes, drills, mills, screwdrivers, sandpaper, etc. Vices usually have one fixed jaw and another parallel jaw which is moved towards or away from the fixed jaw by the screw. Vice is used to drill a wood, metal, etc. by holding your work piece tightly, it gives you all stability you need so you can make precise cuts. Even it is used for sawing a job with constant force applied by hand, or automatically, in order to cut desired shapes. A pneumatic system is controlled through manual or automatic process. In this Automatic pneumatic vice project for metal working is provided with widely and quick movable clamping jaw and fixed jaw where the vertical clamping surface of the fixed jaw and the horizontal surface of the fastening plane for the working piece confirm an accurate and unchangeable. Using automatically operated pneumatic vice will help you to get the work down easily and save energy.

4. Design Calculation

4.1 Design of System

- **Force**

The fluid pushes against the face of the piston and produces a force. The force produce is given by the formula.
F = PA
P is the pressure in N/m2 and A is the area the pressure acts on in m2.
This assumes that the pressure on the other side of the piston is negligible. The diagram shows a double acting cylinder. In this case the pressure on the other side is usually atmospheric so if p is a gauge pressure we need not worry about the atmospheric pressure.
Let A be the full area of the piston and a be the cross sectional area of the rod. If the pressure is acting on the rod side, then the area on which the pressure acts is (A-a).
F= P A on the full area of piston.
F= P (A-a) on the rod side.
This force acting on the load is often less because of friction between the seals and both the piston and piston rod.

- **Speed**

The speed of the piston and rod depends upon the flow rate of fluid. The volume per second entering the cylinder inside. It follows then that.
Q m3/ s =Area * distance moved per second
Q m3/s=A*velocity (full side)

Q m3/s= (A-a)* velocity (rod side)
Note in calculus form velocity is given by v= A dx/dt this is useful in control applications.
In this case of air cylinders, it must be remembered that Q is the volume of the volume of compressed air and this changes with pressure so any variation in pressure will cause a variation in the velocity.

- **Power**

Mechanical power is defined as force * velocity.
This makes it easy to calculate the power of a cylinder. The fluid power supplied is more than the mechanical power output because of friction between the sliding parts.

4.2 Design Of Vice
Type of material: ms steel
Type of fabrication: welding

4.2.1 Welding
Arc welding is a type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is usually protected by some type of shielding gas, vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the late part of the 19th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles.
Electrode Arc welding is used for joining of the MS steel plates. The electrode will act as both electrode and filler material for the fabrication purpose.

4.3 Working:
The apparatus is fixed. Make sure that the all the joints are air leak proof start the compressor for the running condition after the pressure reached between the 2 & 3 kgf/cm2 release the compressor valve slowly to maximum position.
After that release the regulating valve of the pneumatic cylinder the high pressured compressed air will enters into the cylinder moving the piston to lock the work piece.
When the machining operation is completed the hose pipe is removed and the valves are opened to the atmosphere then the work piece will be removed.

Fig 3.2 :cutting

Fig 3.2: Welding

Fig 3.3: Cutting Of Rods

Fig 3.4: Grinding

Fig 3.4: Actual Photo

4.4 Calculation

Perimeter of the Cylinder = $2*\pi*R=23cm$

$R=23/(2*\pi)$

R=3.66cm

Diameter of the cylinder D=2R

D=2*3.66

D=7.32

Connecting rod Perimeter = $2*\pi*r = 2.5cm$

$r = 2.5/(2*\pi)$

r = 0.3978 cm

Diameter of the connecting rod = d= 2r

d =2*0.3978

d = 0.7956

Total stroke length of the cylinder = 15.5 cm

Effective stroke length = 6cm

F =Force exerted on work piece

F = P*A

F = (Pcomp – Patm) * A

F= (Pcomp – Patm) * $\pi/4(D^2 - d^2)$

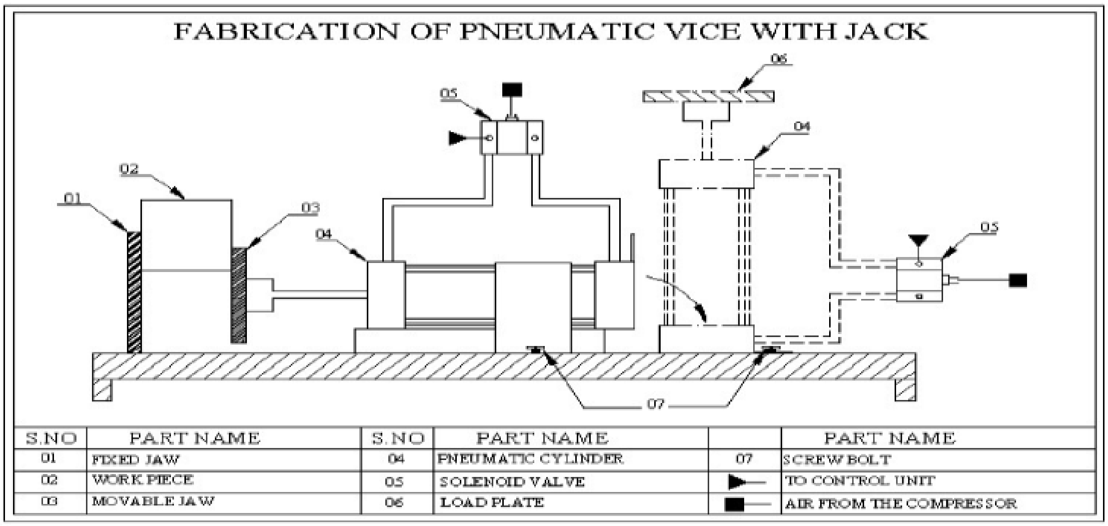

Fig 3.5: 2D CAD Drawing of Pneumatic Vice and Jack

4.6 Battery Charger Calculation

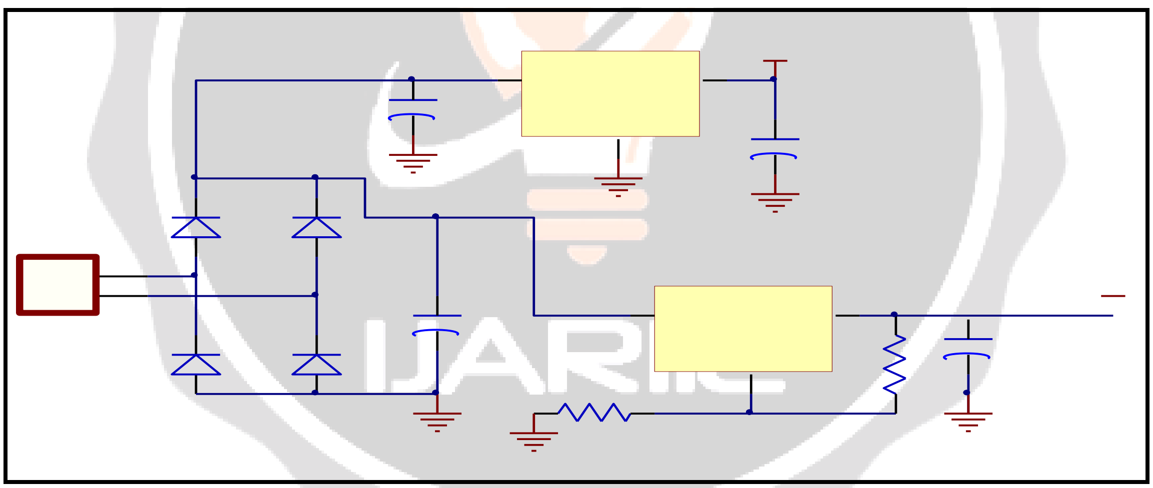

Fig 3.6: Power Supply Design

Designing of power supply:-

A) The following information must be available to the designer of the transformer.

1) Power output.
2) Operating voltage.
3) Frequency range.
4) Efficiency and regulation.

Size of core is one of the first considerations in regard of weight and volume of a transformer. This depends on type of core and winding configuration used. Generally following formula is used to find Area or Size of the Core.

$$A_i = \sqrt{W_p} / 0.87$$

Where Ai = Area of cross section in square cm.

Wp = Primary Wattage.

For our project we require +12V output, so transformer secondary winding rating is 12V, 1A.
So secondary power wattage is,

P2 = 12 * 1A
= 1 Watt

So,
Ai = √ 1 / 0.87 = 1.149
Generally 10% of area should be added to the core.
So,

Ai = 1.149

a) Turns per volt:- Turns per volt of transformer are given by relation.

Turns per volt = 100000 / 4.44 f * Bm * Ai

Where,

F = Frequency in Hz.
Bm = Density in Wb / Square meter.
Ai = Net area of the cross section.

Following table gives the value of turns per volt for 50 Hz frequency.

Flux density 0.76 Wb /sq m	1.14	1.01	0.91	0.83
Turns per Volt 45 / Ai	40 / Ai	45 / Ai	50 / Ai	55 / Ai

Generally lower the flux density better the quality of transformer. For our project we have taken the turns per volt is 0.91 Wb / sq.m from above table.

Turns per volt = 50 / Ai
= 50 / 1.149
= 43.52

Thus the turns for the primary winding is,

230 * 43.52 = 10009.6

And for secondary winding,

12 * 43.52 =510.36

b) Wire size: - As stated above the size is depends upon the current to be carried out by winding which depends upon current density. For our transformer one tie can safely use current density of 3.1 Amp / sq.mm.
for less copper loss 1.6Amp/sq.mm or 2.4sq.mm may be used generally even size gauge of wire are used.
R.M.S secondary voltage at secondary to transformer is 12V. So maximum voltage Vm(Vp) across secondary is
VP= Vrms x√2
Vrms=VP / √2

= 12 / 1.141
= 10.52

D.C output voltage Vm across secondary is,

Vdc = 2 * 10.52/pi
= 2 * 10.52/3.14
= 6.70 V

P.I.V rating of each diode is

PIV = 2Vdc
= 2 * 6.70
= 13.4 V

Maximum forward current, which flow from each diode is 500 mA. So from above parameter, we select diode 1N4007 from the diode selection manual.

B) **Design of filter capacitor:-**

Formula for calculating filter capacitor is

C = ¼ √3 r * F * R1

Where,

r = ripple present at output of rectifier, which is maximum 0.1 for full wave rectifier.

F = frequency of AC main.

R1 = input impedance of voltage regulator IC

C = 1/(4 *(√3 * 0.1 * 50 * 28)

= 1030 µf

= 1000 uF

Voltage rating of filter capacitor should be greater than the i/p Vdc i.e. rectifier output which is 5.02 V so we choose 1000µf / 25V filter capacitor

C) **Specification of voltage regulator IC:-**

Parameter	**Rating**
Available output DC voltage.	+12V
Line regulation.	0.03
Load regulation.	0.5
Vin maximum.	16.16 V
Ripple rejection.	60-80db

1. Design of CPVC Pipe
   a) Internal Pressure acting inside the pipe,

$$S = \frac{P \times (D - 1)}{2 \times t}$$

Where, S = circumference stress (in psi)

P = Internal pressure (in psi)

T = wall thickness (in inches)

D = outer diameter

Let Circumference stress be = 35 psi

t = 0.157 inches

D = 1.338 inches

$$\text{Hence,}\quad 35 = \frac{P \times (1.338 - 1)}{2 \times 0.157}$$

P= 32.514psi

b) Design stress

$$L = \sqrt{\frac{3E \times D\,(\Delta L)}{2 \times S}}$$

Where, L = loop length (in inches)

E = Modulas of elasticity (in psi)

D= Outer diameter of pipe (in inches)

S= Working Stress (in psi)

Δ L = change in length (in inches)

Hence $\sqrt{\frac{3\times 0.118 \times 1.338 \times 0.059}{2 \times 0.393}}$

S = 0.188psi

5. Cost List

COST LIST

Sr. No.	**Component Name**	Specifications	Cost
1.	Pneumatic Cylinder	ϕ25x 100mm	1500
2.	Lever	3x2	850
3.	Battery	12V 2.5Amp	550
4.	Compressor	12V DC	1850
5.	Frame	6”x12”	1250
6.	Hings		60
7.	Jaw System	4”x6”	500
8.	Welding System		2000
9.	Charger	12V 2Amp	500
10.	lugs	metallic	50
11.	Fabrication Charges		2000
	Total		11110/-

6. Conclusion

Safety rules help to keep us safe. They highlight dangers and this helps to prevent accidents. When we are using pneumatics, we must follow these rules.

1. Never blow compressed air at anyone, not even yourself.
2. Never let compressed air come into contact with your skin, as this can be very dangerous.
3. Always wear safety goggles when you are connecting and operating circuits.
4. Check that all airlines are connected before turning on the main air supply.
5. Always turn off the main air supply before changing a circuit.
6. Keep your hands away from moving parts.
7. Avoid having airlines trailing across the floor or where someone could trip or become entangled.

Modifications

Pneumatic pump comprises of pressure valve for the checking pressure .So the valve will only send compressed air, but will not oppose (pass through it in opposite direction).So we need to open the cylinder and the pressure valve will be removed. Then the cylinder will be assembled. All the fittings must be air tight. Thread lockers are used for the air tightness of the cylinder.

Advantages

1. Idle time of the machine is reduced.
2. When compared with the mechanical vices, it consumes less time for clamping and unclamping the job.
3. It reduces the manual labour
4. Hence, production rate is higher
5. In this mechanism there is no backlash.

Diasadvantages

1. Initial higher cost.
2. May be a choice of air leakage
3. Cylinder stroke length is constant

Applications:

1. To hold the job rigidly while machining.
2. For quick clamping and unclamping of the job

7 . Aknowledgement

One of the rewards in doing this project report such that it provides an opportunity for discussing and testing ideas with both colleagues and teachers. We express a deep sense of gratitude toward the member of our staff who helped us to make this project successfully. We welcome this opportunity to express deep gratitude and sincere. Thanks to Project guide **Prof.R.D.Sonar** from our department for their inspiration, invaluable suggestions and encouragement in all phases of project. We are thankful to HOD of Mechanical Engineering **Prof. J. R. Wadile** and also, we would like to thank to our principal **Prof. Prashant. N. Patil for** their valuable guidance. Last but not least we would like to thank all those directly or indirectly involved in making project successfully. Every work is an outcome of full proof planning, continuous and organized efforts. This work is combination of all to put together sincerely

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