

Pneumatic Base Robotic Arm

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Abstract —Pneumatic robot arm are essential for material handling for heat treatment or in chemical industries where electrical or hydraulic are unsustainable due to short circuit and fire hazard.

The study was carried out mainly to replace the robotic arms that utilize electric or hydraulic drive and to design a pneumatic base robotic arm which would be highly effective and low cost with the approach with the aim works individual component optimisation. According to NFIRS/NFPA national statistical database, about 16% of the structural fires in the US are caused by electrical current from electrical and electronic equipment.

Keywords- Pneumatic Cylinder, Wiper Motor, Bevel Gear, Operator Switch, Mounting Fabrication, Holding Gripper.

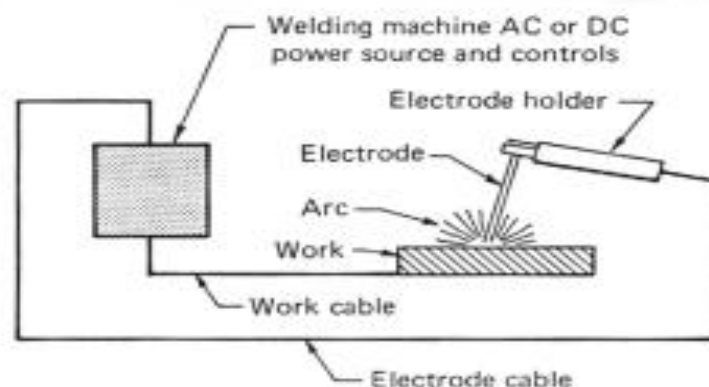
1. INTRODUCTION

The handling of abstract materials and mechanisms to pick and place are widely found in factory mechanization and industrial manufacturing. There are different mechanical electrical grippers which are based on unlike motor technologies have been designed and working in numerous applications. The robotic gripper in this paper is a two jaw actuated gripper which is different from the conventional cam and follower gripper in the way that skilful movement of the jaws is done with the help of pneumatic cylinders using air as a working medium. The force developed in the cylinder is very gentle and is directly transported to the jaws in a compact way. The design, analysis and fabrication of the gripper model are explained in details along with the thorough list of all existing pneumatic grippers. The force and load capacity for the gripper have been calculated for different set of conditions. The working of this system is checked for different pressure. Pneumatic grippers are very easy to handle and are generally cost-effective because air as a working medium, valves and other pneumatic and observation for pay load is recorded at various pressures model can be easily set at intermediate positions by regulating the devices are easy to maintain.

2. PROJECT WORKING

Frame Welding

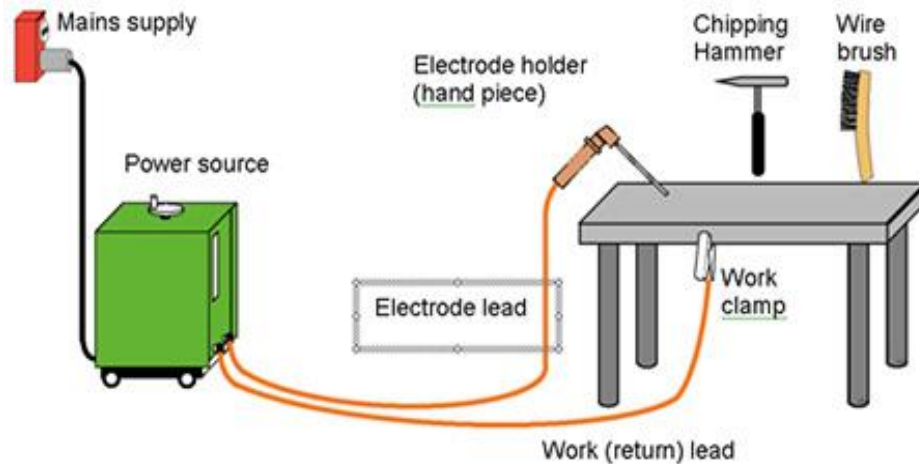
Arc welding is one of several fusion processes for joining metals. By applying intense heat, metal at the joint between two parts is melted and caused to intermix - directly, or more commonly, with an intermediate molten filler metal. Upon cooling and solidification, a metallurgical bond is created. Since the joining is an intermixture of metals, the final element potentially has the same strength properties as the metal of the parts. This is in sharp contrast to non-fusion processes of joining (i.e. soldering, brazing etc.) in which the mechanical and physical properties of the base materials cannot be duplicated at the joint.



In arc welding, the intense heat needed to melt metal is produced by an electric arc. The arc is formed between the actual work and an electrode (stick or wire) that is manually or mechanically guided along the joint. The electrode can either be a rod with the purpose of simply carrying the current between the tip and the work. Or, it may be a specially systematized rod or wire that not only conducts the current but also melts and supplies filler metal to the joint. Most welding in the manufacture of steel products uses the second type of electrode.

Equipment

The equipment for the shielded metal arc welding process consists of a power source, welding leads, electrode holder, and work clamp or attachment. A diagram of the equipment is shown below.

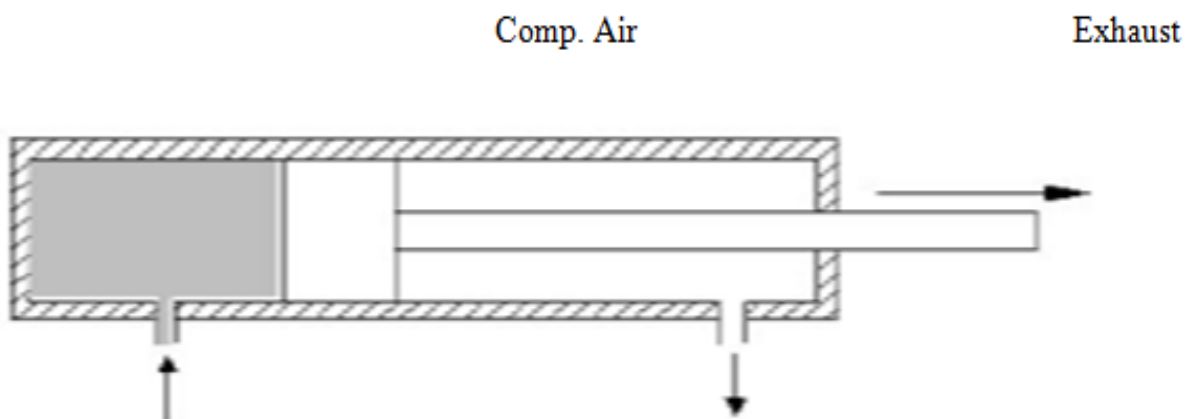


Pneumatic Systems

1. Pneumatic systems are designed to move loads by controlling pressurized.
2. Air in distribution lines and pistons with mechanical or electronic valves.
3. Air under pressure possesses energy which can be released to do useful Work.
4. Examples of pneumatic systems: dentist's drill, pneumatic road drill, automated production systems.

Cylinder is the actuator in the pneumatic system. When compressed air flows into a cylinder, energy stored in the air will release, transferring into kinetic

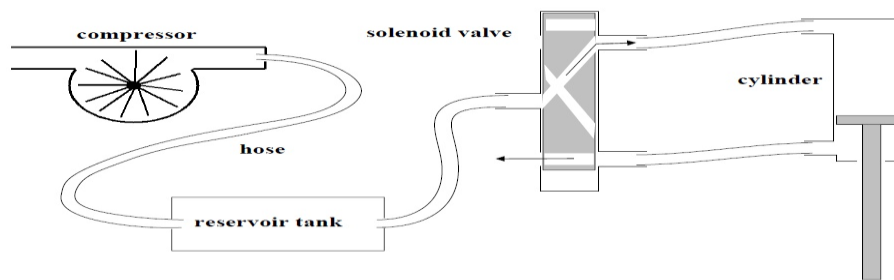
1. Energy to do work.



The input air pressure is 0.5 MPa, which means the air would exert a force of 0.5N on each square millimeters. If the area of the piston is 300mm², then the total force produced by the cylinder will be:

$$\begin{aligned}\text{force} &= \text{pressure} \times \text{piston area} \\ &= 0.5 \text{ N/mm}^2 \times 300\text{mm}^2 \\ &= 150 \text{ N}\end{aligned}$$

3.PNEUMATIC PRINCIPLES



Why Use Pneumatics?

- Weight
 - Much lighter than motors (as long as several used)
- Simple
 - Much easier to mount than motors
 - Much simpler and more durable than rack and pinion
- More rugged
 - Cylinders can be stalled indefinitely without damage
 - Resistant to impacts
- Disadvantage: All the way in or all the way out

Cylinders

Force = Pressure \times Area

- 2" diameter piston
- Area = $3.14 \times 12 = 3.14 \text{ in}^2$
- Pressure = 60 psi
- $3.14 \text{ in}^2 \times 60 \text{ psi} = 188 \text{ lbs}$
- Force while extending greater than while retracting

Main decisions: Length and diameter

- Diameter based on required force
- Larger diameter: more force, but more air

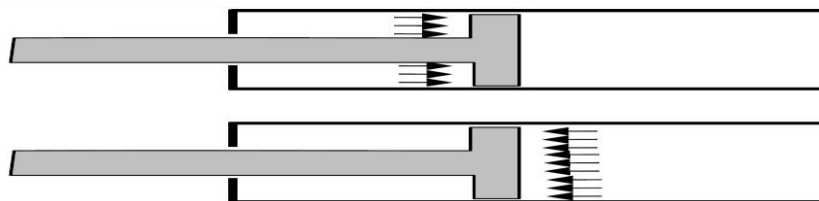


Fig. 4.6

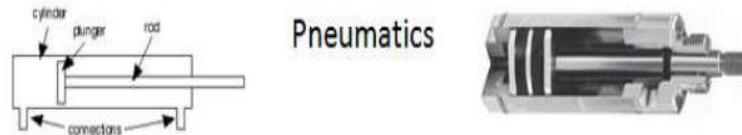
Flow Controls

- Regulate flow of air into and out of a cylinder
- Used to control speed of a pneumatic cylinder
- if used, attach directly to cylinder (only one end needed)
- seems to regulate air flowing in both directions, but one direction restricted a little more



Fittings

- Put Teflon tape on all threads to ensure a good seal
 - Do not put tape on first two threads, as it may come loose and clog up a valve
- Tubing attached simply by pushing it into connector
 - If you have a leak, try cutting off the last couple centimeters of tubing; if it is damaged, it will not seal properly
 - To detect leaks, put soapy water on suspect connections and watch for bubbling



4.CALCULATION OF CYLINDER FORCES – METRIC BASED PRODUCTS

General Formula

The cylinder output forces are derived from the following formula:

$$F = \frac{P \times A}{10}$$

Where F = Force in N

P = Pressure at the cylinder in Bar

A = Effective area of cylinder piston in square mm.

Prior to selecting the cylinder bore size, properly size the piston rod for tension (pull) or compression (push) loading. (See the Piston Rod Selection Chart)

If the piston rod is in compression, use the ‘Push Force’ table below, as follows:

1. Identify the operating pressure closest to that required.
2. In the same column, identify the force required to move the load (always round up).
3. In the same row, look over to the cylinder bore required.

If the cylinder envelope dimensions are too large for the application, increase the operating pressure, if possible, & repeat the exercise.

If the piston rod is in tension, use the ‘Deduction for Pull Force’ table. The procedure is the same but due to the reduced area caused by the piston rod, the force available on the ‘pull’ stroke will be smaller. To determine the pull force:

1. Follow the procedure for ‘push’ force as described previously.
2. Using the ‘Deduction for Pull Force’ table, identify the force indicated according to the rod & pressure selected.
3. Deduct this from the original ‘push’ force. The resultant is the net force available to move the load.

If this force is not large enough, repeat the process & increase the system operating pressure or cylinder diameter if possible. For assistance, contact your JMC representative.

Formula

The teeth on gears are designed so that the gears can roll on each other smoothly (without slipping or jamming). In order for two gears to roll on each other smoothly, they must be designed so that the velocity at the point of contact of the two pitch circles (represented by v) is the same for each gear.

Mathematically, if the input gear G_A has the radius r_A and angular velocity ω_A , and meshes with output gear G_B of radius r_B and angular velocity ω_B , then

$$v = r_A \omega_A = r_B \omega_B,$$

The number of teeth on a gear is proportional to the radius of its pitch circle, which means that the ratios of the gears’ angular velocities, radii, and number of teeth are equal. Where N_A is the number of teeth on the input gear and N_B is the number of teeth on the output gear, the following equation is formed:

$$\frac{\omega_A}{\omega_B} = \frac{r_B}{r_A} = \frac{N_B}{N_A}.$$

This shows that a simple gear train with two gears has the gear ratio R given by

$$R = \frac{\omega_A}{\omega_B} = \frac{N_B}{N_A}.$$

This equation shows that if the number of teeth on the output gear G_B is larger than the number of teeth on the input gear G_A , then the input gear G_A must rotate faster than the output gear G_B .

Speed ratio

Gear teeth are distributed along the circumference of the pitch circle so that the thickness t of each tooth and the space between neighboring teeth are the same. The pitch p of a gear, which is the distance between equivalent points on neighboring teeth along the pitch circle, is equal to twice the thickness of a tooth,

$$p = 2t.$$

The pitch of a gear G_A can be computed from the number of teeth N_A and the radius r_A of its pitch circle

$$p = \frac{2\pi r_A}{N_A}.$$

In order to mesh smoothly two gears G_A and G_B must have the same sized teeth and therefore they must have the same pitch p , which means

$$p = \frac{2\pi r_A}{N_A} = \frac{2\pi r_B}{N_B}.$$

This equation shows that the ratio of the circumference, the diameters and the radii of two meshing gears is equal to the ratio of their number of teeth,

$$\frac{r_B}{r_A} = \frac{N_B}{N_A}.$$

The speed ratio of two gears rolling without slipping on their pitch circles is given by,

$$R = \frac{\omega_A}{\omega_B} = \frac{N_B}{N_A}.$$

In other words, the gear ratio, or speed ratio, is inversely proportional to the radius of the pitch circle and the number of teeth of the input gear.

Torque ratio

A gear train can be analyzed using the principle of virtual work to show that its torque ratio, which is the ratio of its output torque to its input torque, is equal to the gear ratio, or speed ratio, of the gear train. This means that the input torque T_A applied to the input gear G_A and the output torque T_B on the output gear G_B are related by the ratio

$$R = \frac{T_B}{T_A},$$

Where R is the gear ratio of the gear train.

The torque ratio of a gear train is also known as its mechanical advantage

$$MA = \frac{T_B}{T_A}.$$

5.PROJECT DESIGN

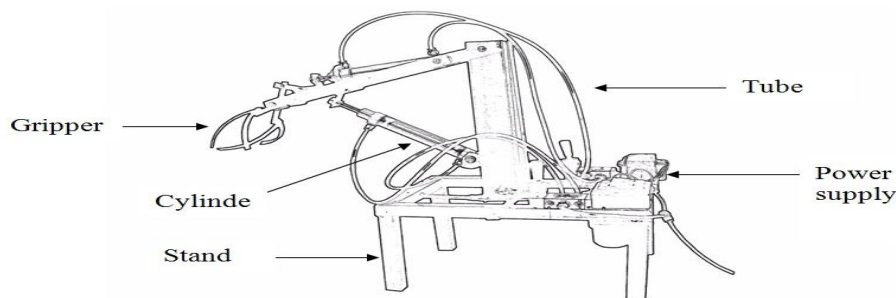


Diagram of pneumatic gripper project

6.Advantages

1. The machine has very low error.
2. The size of project made by is more suitable for material handling system.
3. The cost of machine is less.
4. It has low maintenance.

7.Disadvantages

- 1 Being semiautomatic we cannot neglect at least one operator.
- 2 Air compressor is most important for Pneumatic cylinder operated.

9.Conclusion

- 1.The proper guidance of project head and the sincere efforts of our group have lead to the successfully accomplishment of our concerned projects.
- 2.The project based on pneumatic base arm was interesting to work on and was also gained in this project work..
- 3.This knowledge of project will definitely be helpful in our future. So we must maintain that this 4.final year project was an essential part of our engineering education enhancing our technical knowledge and practical skill.

10.Referances

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