

Design and Development of Pneumatic Cutting Machine

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Abstract – The pipe cutting process is a main part of all industries. Normally the pipe cutting machine is manually hand operated one for medium and small scale industries. Automation in the modern world is inevitable. Any automatic machine aims at the economical use of man, machine, and material worth the most. In our project a solenoid valve and control timing unit is used for automation. The pipe cutting machine works with the help of pneumatic double acting single cylinder. The piston is connected to the moving cutting tool. It is used to cut the small size of the pipe. The machine is portable in size, so easy transportable. A compressed air from compressor is used as force medium for this operation. There are pneumatic double acting cylinders, solenoid valve, flow control valve and timer unit is used. The air from the compressor enters to the flow of control valve. The control air from the flow control valve enters to the solenoid valve. The function of solenoid valves is all of air correct time interval. The 5/2 solenoid valve is used. In one position air enters to the cylinder and pushes the piston so that the cutting stroke is obtained. The next position air enters to the other side of cylinder and pushes the piston return back, so that the remaining stroke is obtained. The speed of cutting releasing stroke is varying by the timer control unit circuit.

IndexTerms – Automation, Compressor, Solenoid valve, Pneumatic.

I. INTRODUCTION

Our project deals with simple type of pneumatics assembly called as “Design and development of Pneumatic Cutting Machine”. In machine we arrange number of pneumatic components in such a manner to form reciprocating motion finalized into cutting action.

Today, the working of pipe cutting is done manually or by hydraulics power hacksaw whenever the application needed. But, it is done manually the lot of time efforts are being increased and also there is no possibility of accuracy and it has been expensive if it is done by hydraulically. By using this machine the cutting can be done at any place and any quantity. There are fewer efforts required for user hence mental balance of user is not disturbed and proper work can be performed. This is mainly used for cutting metal.

The hacksaw is the metal cutting machine tool designed to cut metal by applying pneumatic pressure. The machine exclusively intended for mass production and they represent faster and more efficient way to cut a metal.

Hacksaws are used to cut thin and soft metals the operation of the unit is simplified to a few simple operations involving a cylinder block and piston arrangement. There are numerous systems in hacksaw machine. The main function of pneumatic hacksaw is to cut thin and soft metals by pneumatic power.

Now a day in industries especially in automobile and other industries the automatic cutting machines are widely used. Earlier the cutting machines were operated manually. So the output of machine was very less. Because it takes too much time for cutting action and less accuracy.

The main aim of this project is to cut the various types of pipe material by using the complete pneumatic devices, sensors and feeding system etc. by which the manually operated any machine can be converted into a semi or fully automatic unit.

II. LITERATURE REVIEW

The main purpose of this literature review is to get information about the project from the reference books, magazines, journals, technical papers and website. We examined various research papers related to the subject. There have been significant research and development on design of fabrication of pneumatic operated cutting machine for general and industrial use. Feeding system is relatively new concept.

Pneumatic systems use pressurized gases to transmit and control power. As the name implies, pneumatic system typically use air (rather than some other gas) as the fluid medium because air is safe, low cost and readily available fluid. It is particularly safe in environments where an electrical spark could ignite leaks from system components (Majumdar, 1995).

P. J. Bird, Development in the design and control of pneumatic linear actuators, European Conference on Electrics versus Hydraulics versus Pneumatics, Inst. of Mechanical Engineers, London, In Mechanical Engineering. Research paper extensively elaborates the design and fabrication procedures.

Iman Hajizadeh Chi-Ghun Lee (1992) studied ‘alternative configuration for cutting machine in a tube cutting mill’. In this paper stock material exists as a continuous stream. They formulated and solved the new type of cutting stock problem and demonstrate

that significant saving is expected when the new configuration is employed. The paper conclude that by opening the end of the cutting machine they have shown numerically that the production time could be decreased by up to 44% such improvement would help production managers in tube mills reduce costs such as finished product inventory, labor cost and so forth.

Oscar Amiet, and La Chaux de founds investigated 'collect feed mechanism for cutting machine'. In this paper the present invention refers to an automatic operation cutting machine, of the type of which is the axis, and other at holder carrying at least one cutting tool is mount right angle to the axis of the base these resolvable around the axis of the bar to be to pins cooperate with a contacting screw cut.

III. METHODS AND MATERIAL

This circuit uses compressed air as a working medium. Air compressor can be driven by IC engine or electric motor, sucks an air from atmosphere & compresses it to higher atmospheric pressure. The compressed air is then supplied through pipe to the piston cylinder via filter, regulator, and lubricator.

In F.R.L. unit, the air entering from compressor is first filtered and the contaminated elements are sorted off from the air. Then the filtered air is regulated by regulator operating valve. After then, the air is passed through lubricator where the lubricator form a mist of lubricant oil on the filtered high pressure air for providing lubrication to mating components of valve, piston and cylinder.

This filtered, regulated and lubricated compressed air is ready for further process. Then, this air is supplied to 5/2 port air operated DC valve & timer delay valve by splitting its way through manifold. The working of our project goes on in two major steps which are as follows.

Movement of piston in Forward direction

The compressed air from F.R.L. Unit enters into the inlet port of DC Valve and get discharged from position 'A', i.e. left side of DV valve & then provided in cylinder. This process result into forward motion of piston; after doing work on piston the cutting is done with the help of hacksaw, air is discharged to atmosphere through exhaust port.

Movement of piston in Reverse direction

The compressed air from F.R.L. unit enters into the inlet port of DC valve & gets discharged from position 'B', i.e. right side of DC valve & then provided in cylinder. This process results into reverse motion of piston; after doing work on piston the cutting action is done with the help of hacksaw same as above air is discharged to atmosphere. We can attach hacksaw to the piston with same line of action as that of position. It is position accurately with reference to stroke length of piston rod. Here the action of rod is like cutting action.



Figure 1 Pneumatic cutting machine

IV. COMPONENTS OF MACHINE

Air Cylinder

The forces exerted by the compressed air moves the piston in two directions in a double acting cylinder. They are used particularly when the piston is required to perform work not only on the advanced movement but also on the return. In principle, the stroke length is unlimited, although buckling and bending must be considered before we select a particular size of piston diameter, rod length and stroke length.

The construction of double acting single cylinder is quite simple and varies according to the use and application of the cylinder. The materials used for the various parts will differ for different types of cylinder depending on application.

F.R.L. Unit

The FRL Unit refers to the filter, Regulator and lubricator set as manufactured and available in commercial market. These subunits are also available as modules so that a filter and a regulator can be offered as one set-that is, any one unit can be enjoined with the other unit.

Solenoid Valve

This type of valve consists of five-port which ensures easy exhausting of air from the valve. It consists of five-port, two-position D.C valve. The spool slides inside the valve body. According to spool position, the port get connected or disconnected.

Hacksaw

A hacksaw is a fine-teethed saw, originally and principally for cutting metal. They can also cut various other materials, such as plastic and wood for example, plumber and electrician often cut plastic pipes and plastic conduit with them. There are hand saw version and power saw versions. Most hacksaws are hand saw with a C-shape frame that holds the blade under tension.

Such hacksaw has a handle, usually a pistol grip with pins for attaching narrow disposable blades. The frames may be adjustable to accommodate blades of different sizes. A screw or other mechanism is used to pun the thin blade under tension. These saws are no longer commonly available, but hacksaw blades holders enables. Standard hacksaw blades to use similarly to a keyhole saw or pad saw.

Polyurethane Tubes

A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross-section, used mainly to convey substances which can flow liquids and gases (fluids), slurries, powders, masses of small solids. It can also be used for structural applications; hollow pipe is far stiffer per unit weight than solid members. In common usage the words pipe and tube are usually interchangeable, but in industry and engineering, the terms are uniquely defined.

Depending on the applicable standard to which it is manufactured, pipe is generally specified by a nominal diameter with a constant outside diameter (OD) and a schedule that defines the thickness.

Printed Circuit Board (PCB)

A printed circuit board (PCB) is a plastic board made for connecting electronic components together. These are used in almost all computers and electronics today. The “card” is made of a material that does not conduct electricity, like fiberglass or plastic. Usually copper is etched (set in thin lines) inside the board between the layers of plastic, or on the surface of the board. [1] This makes the electricity go only where it is wanted. Electronic components are then attached to this board using a metal to conduct electricity. The metal etched into the board allows electricity to travel from one component to another in electrical circuits.

Microcontroller

A microcontroller is a small computer single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip as well as a typically small amount of RAM. Microcontroller used in personal computers or other general purpose application consisting of various discrete chips.

Microcontroller are used in automatically controlled products and devices, such as automobile engine control system, implantable medical devices, remote controls, office machines, appliances, power tool, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separates microprocessor, memory, and input/output devices, microcontroller are common, integrating analog component needed to control non-digital electronics system.

DC Motor

10 RPM side shaft 37 mm diameter compact DC gear motor is suitable for us small robots / automation system. It has sturdy construction with gear box built to handle stall torque produced by the motor. Drive shaft is supported from both sides with a metal bush .Motor runs smoothly from 4volt to 12volt.

Features of 10 RPM DC Motor

1. It is 10 RPM 12 V DC motor with gearbox.
2. It having 6 mm shaft diameter with internal hole.
3. Same size motors are available in various rpm.
4. The torque is 12 kg-cm and No-load current is 60 mA(Max) and load current is 300 mA (Max).

Rack And Pinion

A rack and pinion is a type of linear actuator that comprises is a pair of gear this converts rotational motion into linear motion. A circular gear called “the pinion” engages teeth on a linear “gear” bar called “the rack”; rotational motion applied to the pinion causes the rack to move relative to the pinion, Thereby translating rotational motion of the pinion into linear motion. For example, in a rack railway, the rotation of pinion mounted on a locomotive or a railcar engages a rack between the rail and force a train ups a steep slope.

A rack and pinion is a pair of gears which convert rotational motion into linear motion. The circular pinion engages teeth on a flat bar - the rack. Rotational motion applied to the pinion will cause the rack to move to the side, up to the limit of its travel. The pinion is in mesh with a rack. The circular motion of the pinion is transferred into the linear rack movement.

Transformer

Transformers are one of the most basic yet practical devices used today. No matter where you are there is always a transformer nearby. They are used throughout alternating-current (ac) systems from generating plants to the doorbell at your home. Power companies use transformers to increase the voltage for their long distance power lines, the voltage is than reduced by other transformers before the power enters your house.

The method of transferring electrical energy by a transformer is done indirectly. Electrical energy is first converted into magnetic energy, then reconverted back into electrical energy at a different voltage and ampacity. Because of this conversion process, the transformer can perform duties which have made it invaluable in the field of electricity.

V. SAMPLE DESIGN CALCULATION

Stroke length= 200 mm = d = 0.2m

Time= t= 1 sec.

Speed= s= d/t = 0.2/1 = 0.2 m/sec.

For pressure 7 bar & bore diameter =50 mm

$$F = P \times A$$

$$= (7 \times 10^5) \times \pi/4 \times (0.05)^2$$

$$F = 1374.44 \text{ N.}$$

Work done = Force \times displacement

$$= 1374.44 \times 0.2$$

$$= 274.88 \text{ N-m or Joule.}$$

Power = Work done/Time

For 1 second,

$$= 274.88/1 = \text{N-m/sec or joule/sec.}$$

$$P = 274.88 \text{ Watt.}$$

$$P = 0.274 \text{ KW}$$

VI. RESULTS AND DISCUSSION

TABLE 1 Cutted By Manually

Material	Size diameter (mm)	Time
G.I.	20 mm	120 sec
	30 mm	150 sec
PVC	20 mm	60 sec
	30 mm	90 sec
Aluminum	20 mm	90 sec
	30 mm	120 sec

TABLE 2 Cutted By Pneumatic Cutting Machine

Material	Size diameter (mm)	Time
G.I.	20 mm	25 sec
	30 mm	30 sec
PVC	20 mm	7 sec
	30 mm	10 sec
Aluminum	20 mm	15 sec
	30 mm	20 sec

From above observation it is found that the cutting time of PVC, GI and Alluminium pipe by using pneumatic pipe cutting machine is less than manually cutting operation. And also the accuracy obtained by pneumatic cutting machine is more than manually cutting operation.

VII. CONCLUSION

We comes the following conclusion:-

1. The time required for pipe cut by pneumatic cutting machine is less as compare to manually operated hacksaw.
2. In this machine we use the automatic bar feeding mechanism for avoiding contact & injury.
3. Minimal human intervention only limited to replacing the pipe stock on to the machine.
4. To reality new machine and technique are being developed continuously to manufacture various product at the cheaper rate and high quality.
5. It is pneumatic operated hence easy and affordable in performance.
 6. It can be effect as well as time minimizing machine.
 7. It is easy to assembled and disassemble.
 8. It is easy to for handling.
 9. It is more reliable because of standard component are used.

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