ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Sheet Metal Cutting Machine Using Pneumatic Energy

G.Prem Chand
B.Tech (Mechanical Engineering), Hyderabad Institute of Technology and Management y, Hyderabad, Telangana, India.

G.Venkata Kiran
B.Tech (Mechanical Engineering), Hyderabad Institute of Technology and Management y, Hyderabad, Telangana, India.

P.Sudhakar Reddy
Associate Professor, Department of Mechanical Engineering, Hyderabad Institute of Technology and Management y, Hyderabad, Telangana, India.

Abstract:
It is a manual method so that sheet metals are to be wasted sometime because of mistakes happened such as wrong dimensions etc., and also even a simple cutting may take long time. Hydraulic machines are also available for sheet metal cutting. But this method is used for only heavy metal cutting and its cost is very high. Using a pneumatic system for sheet metal cutting in a easy way. It is operated by a pneumatic hand lever of two way control valve. Control valve is operated by a compressor.

I. INTRODUCTION:

The formation of any business begins with someone producing the initial idea for the project. The continued success of an established business depends upon the number and quality of the ideas fed into it. Without a continual flow of new ideas, a business cannot function profitably or expand successfully and must, therefore eventually fade into total obscurity.

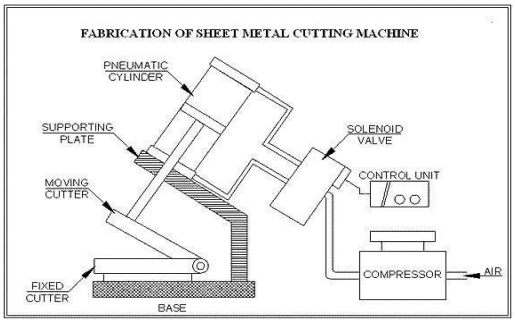

Figure 1: Concept Image for Project

Ideas for a new business project, a new product, a means of reducing manufacturing costs or for solving industrial labor problems, begin in the human mind. Most people conceive their ideas unconsciously, and because they are unaware of the mental mechanics that caused the 'idea' to be produced, they cannot repeat the ideation process to produce further profitable ideas at will.Fortunately, there are available established creative techniques which, when used correctly, do enable a person to produce a large number of first-class ideas at will. One such creative technique, and probably the most widely used in American industry, is 'brainstorming'.

II. LITERATURE SURVEY:

In shearing or cutting operation as or blade descends upon the metal, the pressure exerted by the blade first cause the plastic deformation of the metal. Since the clearance between the two blades is very small, the plastic deformation takes place in a localized area and the metal adjacent to the cutting edges of the blade edges becomes highly stressed, which causes the fracture to start on both sides of the sheet as the deformation progresses and the sheet is sheared. In dentistry applications, pneumatic drills are lighter, faster and simpler than an electric drill of the same power rating, because the prime mover, the compressor, is separate from the drill and pumped air is capable of rotating the drill bit at extremely high

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rpm. Pneumatic transfer systems are employed in many industries to move powders and pellets.

III. SHEET METAL:

Sheet metal is simply a metal formed into thin and flat pieces. It is one of the fundamental forms used in metal working and can be cut and bent into a variety of different shapes. Countless everyday objects are constructed of the material. Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate.Sheet metal is available in flat pieces or as a coiled strip. The coils are formed by running a continuous sheet of metal through a roll slitter.The thickness of the sheet metal is called its gauge. Commonly used steel sheet metal ranges from 30 gauges to about 8 gauge. The larger the gauge number, the thinner the metal. Gauge is measured in ferrous (iron based) metals while nonferrous metals such as aluminum or copper are designated differently; i.e., Copper is measured in thickness by Ounce.

There are many different metals that can be made into sheet metal, such as aluminum, brass, and copper, steel, tin, nickel and titanium. For decorative uses, important sheet metals include silver, gold and platinum (platinum sheet metal is also utilized as a catalyst.) Sheet metal also has applications in car bodies, airplane wings, medical tables, roofs for buildings (Architectural) and many other things. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines. Historically, an important use of sheet metal was in plate armor worn by cavalry, and sheet metal continues to have many decorative uses, including in horse tack. Sheet metal workers are also known as "Tin Bashers",("Tin Knockers") which is derived from the hammering of panel seams when installing tin roofs.
There are three primary procedures in Layout

1. Parallel
2. Radial
3. Triangulation

Sheet Metal Cutting:

Cutting processes are those in which a piece of sheet metal is separated by applying a great enough force to cause the material to fail. The most common cutting processes are performed by applying a shear force, and are therefore sometimes referred to as shearing processes. When a great enough shearing force is applied, the shear stress in the material will exceed the ultimate shear strength and the material will fail and separate at the cut location. This shearing force is applied by two tools, one above and one below the sheet. Whether these tools are a punch and die or upper and lower blades, the tool above the sheet delivers a quick downward blow to the sheet metal that rests over the lower tool.

A small clearance is present between the edges of the upper and lower tools, which facilitates the fracture of the material. The size of this clearance is typically 2-10% of the material thickness and depends upon several factors, such as the specific shearing process, material, and sheet thickness.The effects of shearing on the material change as the cut progresses and are visible on the edge of the sheared material. When the punch or blade impacts the sheet, the clearance between the tools allows the sheet to plastically deform and “rollover” the edge. As the tool penetrates the sheet further, the shearing results in a vertical burnished zone of material, finally, the shear stress is too great and the material fractures at an angle with a small burr formed at the edge. The height of these portions of the cut depends on several factors, including the sharpness of the tools and the clearance between the tools.

IV. CONSTRUCTION:

Raw Material Used:

1. Mild Steel bars for base frame.
2. 35C8 material for shearing blades.
3. Cylinder fittings like fork end, base plates, support links.
4. Angle section for blade fitting.

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5. Connecting link.
6. Blade link.

Ready Items Used-
1. Pneumatic double acting cylinder.
2. Direction & flow control valves.
3. Pneumatic pipe & pipe fittings.
4. Bolts & nuts.
5. Antirust coat & paint.

Machines & Tools Used-
1. Cutting Machine.
2. Hacksaw Cutting Machine.
3. Sensitive Drilling Machine.
4. Horizontal Milling Machine.
5. Electric Arc Welding Machine.
6. Table Grinder.
7. Hand Grinder.
8. Surface Grinding Machine.
9. Tap & Tap Holder.

Specifications
1. Pneumatic Cylinder-
Quantity: 1
Total Length: 375mm
Bore: 40mm
Stroke: 200mm
Piston Rod Diameter: 20mm
Max Working Pressure: 8 bar
Weight: 3kg

2. DC Valve-
Quantity: 1
Operation: Manual
Type: Hand Lever, Detent Type
Number of Ports: 5
Number of Positions: 3
Construction: Sliding spool type

3. Pneumatic Pipe-
Quantity: 3000mm
Diameter: 8mm
Thickness: 1mm

4. Fork End Nut-
Quantity: 2
Length: 16mm
Size: M16

5. Cylinder Base Plate Bolts-
Quantity: 4
Length: 32mm
Size: M6

6. Blade Fixing Bolts-
Quantity: 3
Length: 25mm
Size: M10

V. PARTS OF MACHINE

1. Pneumatic Cylinder:

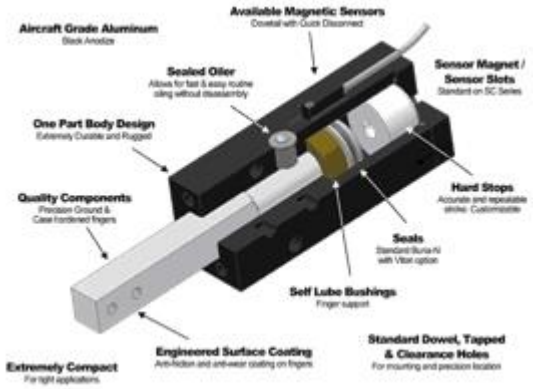

Fig 2: Schematic diagram of Pneumatic Cylinder

Key points:
- Pneumatic cylinders come in many basic versions.
- All cylinders can be tweaked to better fit an application.
- Custom designs can perform better and save money when standard cylinders don't fit the job.

Resources:

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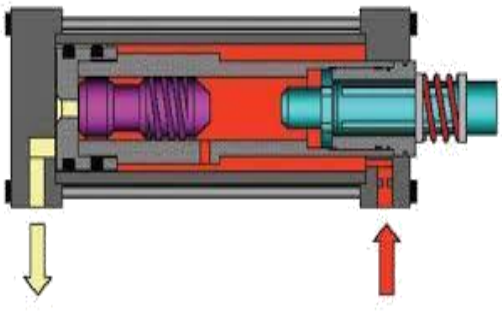

Fig 3: cross sectional view of Pneumatic Cylinder

Pneumatic cylinders are widely used to generate force and motion on a vast range of OEM equipment. They can move products directly or indirectly by pushing, pulling, lifting, lowering, or rotating, and can keep them from moving by clamping them in place.Wide acceptance comes in large part because cylinders are simple, economical, durable, and easy to install. They can produce thousands of pounds of force over a broad range of velocities; cycle at high speeds without overheating; and stall without internal damage. And they readily tolerate tough conditions such as high humidity, dusty environments, and repetitive high-pressure wash downs.Pneumatic actuators come in literally thousands of styles, sizes, and configurations. This variety makes more innovative-equipment possible, but sorting out the best cylinder for an application can be a bit overwhelming. Here are some key considerations.

Cylinder design:

The basic, rod-style industrial cylinder consists of a tube sealed by end caps. A rod attached to an internal piston extends through a sealed opening in one of the ends. A port at one end of the cylinder supplies compressed air to one side of the piston, causing it (and the piston rod) to move. The port at the other end lets air on the opposite side of the piston escape — usually to atmosphere. Reversing the roles of the two ports makes the piston and rod stroke in the opposite direction. Rod-style cylinders function in two ways:
Double-acting cylinders use compressed air to power both the extend and retract strokes, moving the rod back and forth. This arrangement makes them ideal for pushing and pulling loads. Controlling the rate at which air exhausts determines rod speed. *Single-acting cylinders* have compressed air supplied to only one side of thepiston; the other side vents to atmosphere. Depending on whether air is routed to the cap or rod end determines whether the rod extends or retracts.

Rod-style cylinders come in various designs:

Repairable cylinders can be disassembled to replace seals and other internal components. This extends a cylinder's life. These durable cylinders are generally used in rugged, heavy-duty applications.Sealed-for-life or "disposable" cylinders have end caps mechanically crimped to the tube. Internal components are preluded prior to assembly. Although they are less expensive to manufacture than comparable repairable cylinders, they cannot be taken apart to repair without destroying the housing. These cylinders are usually used in lighter-duty applications and must be replaced when they fail. Compact Cylinders fit into smaller spaces where only a short stroke is required. They are used in lighter-duty applications due to the small bearing surface on which the rod slides.

They mainly come in single-acting versions, but double-acting styles also are available. Guided Cylinders have guide rods and guide blocks mounted parallel to the piston rod, or dual piston rods. They prevent the piston from rotating and provide precise, controlled linear motion — especially when the unit is subject to high side loads. In such cases, the guides reduce rod and piston bending and uneven seal wear. They are recommended in applications with sizeable offset loads or require that the load be guided, for example, down a conveyor.

Rack-and-pinion:

Units convert a cylinder's linear motion to angular rotation that can exceed 360°. The rotary actuators — with the rack mounted on the rod — are often used in process industries to operate quarter-turn valves.In addition to rod-type cylinders, other designs included.
Bellows Are durable, single-acting actuators with

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
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flexible, reinforced-elastomeric walls and metal end plates, they extend when inflated and can generate high forces, thanks to their large diameters. A cylindrical shape lets them bend in any direction, making them useful where load direction might curve. Note that external restraints should be used to limit maximum extension and compression. Unrestrained extension can blow off the end plate, and exhaust without restraint can let the load crush the sidewalls.

Rod-less cylinders, as the name implies, have no rod extending through the end caps, instead, an external carriage slides back and forth on the tube. The load mounts on this carriage. In many designs, an internal piston is mechanically connected to the carriage through a sealed longitudinal slot in the cylinder wall. Long sealing strips inside and outside the cylinder tube prevents air leaks and dust and dirt ingression. Other variations include cable-and-pulley arrangements and magnetically coupled pistons and carriages.

Compressor:

Fig 4: compressor

According to the design and principle of operation:-

1. Rotary screw compressor
2. Turbo compressor

Positive displacement:

Positive-displacement compressors work by forcing air into a chamber whose volume is decreased to compress the air. Common types of positive displacement compressors arePiston-type air compressors use this principle by pumping air into an air chamber through the use of the constant motion of pistons.

They use one-way valves to guide air into a cylinder chamber, where the air is compressed. Rotary screw compressors use positive-displacement compression by matching two helical screws that, when turned, guide air into a chamber, whose volume is decreased as the screws turn. Vane compressors use a slotted rotor with varied blade placement to guide air into a chamber and compress the volume. Negative-displacement air compressors include centrifugal compressors. These use centrifugal force generated by a spinning impeller to accelerate and then decelerate captured air, which pressurizes it.

Cooling:

Due to adiabatic heating, air compressors require some method of disposing of waste heat. Generally this is some form of air- or water-cooling, although some (particularly rotary type) compressors may be cooled by oil (that is then in turn air- or water-cooled)[3] and the atmospheric changes also considered during cooling of compressors.

Applications:

•To supply high-pressure clean air to fill gas cylinders

• To supply moderate-pressure clean air to a submerged surface supplied diver

• To supply moderate-pressure clean air for driving some office and school building pneumatic HVAC control system valves

• To supply a large amount of moderate-pressure air to power pneumatic tools, such as jackhammers

• For filling tires

• To produce large volumes of moderate-pressure air for large-scale industrial processes (such as oxidation for petroleum coking or cement plant bag house purge systems).

3. Direction Control Valve:

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Fig 5: control valve

Directional control valve:

Directional control valvesare one of the most fundamental parts inhydraulicmachinery as well and pneumatic machinery. They allow fluid flow into different paths from one or more sources. They usually consist of a spool inside a cylinder which is mechanically or electrically controlled. The movement of the spool restricts or permits the flow, thus it controls the fluid flow.

Nomenclature

The spool (sliding type) consists of lands and grooves. The lands block oil flow through the valve body. The grooves allow oil or gas to flow around the spool and through the valve body. There are two fundamental positions of directional control valve namely normal position where valve returns on removal of actuating force and other is working position which is position of a valve when actuating force is applied. There is another class of valves with 3 or more position that can be spring centered with 2 working position and a normal position.

Classification:

Directional control valves can be classified according to-

- number of ports
- number of positions
- actuating methods
- Type of spool.

Example: A 5/2 directional control valve would have five ports and two spool positions.

Number of Ports:

According to total number of entries or exits connected to the valve through which fluid can enter the valve or leave the valve there are types like two way, three-way, and four way valves.

Number of Positions:

Including the normal and working positions which a valve spool can take there are types like two position, three position and proportional valves.

Pressure Gauge:

Fig 6: Pressure Gauge

Wheneverpossible,gaugesshouldbelocatedtominimizet heeffectsofvibration, extreme ambient temperatures and moisture. Dry locations way from very high thermal sources (ovens, boilers etc.) are preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

Air Supply Pipe:

Fig 7: Air pipe

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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. Tube is most often specified by the OD and wall thickness, but may be specified by any two of OD, inside diameter (ID), and wall thickness. Pipe is generally manufactured to one of several international and national industrial standards.

While similar standards exist for specific industry application tubing, tube is often made to custom sizes and a broader range of diameters and tolerances. Many industrial and government standards exist for the production of pipe and tubing. The term "tube" is also commonly applied to non-cylindrical sections, i.e., square or rectangular tubing. In general, "pipe" is the more common term in most of the world, whereas "tube" is more widely used in the United States.

V. PNEUMATIC CYLINDER WORKING:

The following figure shows general layout for the machine.

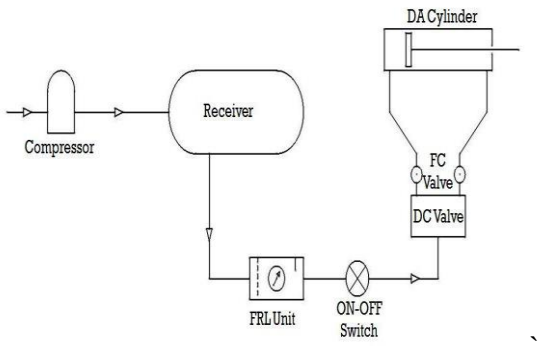

Fig 8: General Layout

From the manifold a separate supply for the machine is taken out and given to initially the air-compressor is started and allowed the receiver tank air pressure to reach up to 8 bar. The supply air is then passed to the manifold ON-OFF switch; so as to operate the machine at will without interrupting the running of compressor. Then the pipe carries compressed air first to machine's Direction Control Valve. At position 'A' shows the non-actuated circuits diagram. At this position the piston is steady and locked. All ports are in closed condition.

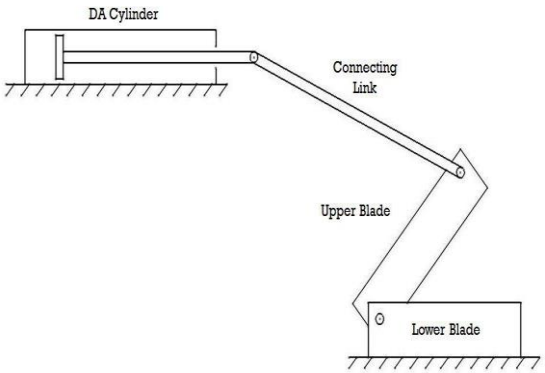

Fig 9: Position 'A'

At position 'B', the DC valve is at left hand position as shown in figure. The cap end port & pressure port get connected to each other and the rod end port gets connected to the exhaust port. The compressed air comes in the cap end of the cylinder and pushes the pistons outwards. The air already present in the rod end side is pushed out of the cylinder. When the piston moves outwards, the force is transmitted through the connecting link and the upper blade moves downwards.

Before the actuating DC valve the sheet is inserted in between the upper & lower blades. As upper blade moves downwards, the stress is generated in the sheet metal and goes beyond ultimate shear stress of sheet metal. And thus the shearing action takes place. Now the DC valve is operated to come at position 'C', as shown in figure. The rod end port & pressure port get connected to each other and the cap end port gets connected to the exhaust port.

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The compressed air comes in the rod end of the cylinder and pushes the pistons inwards. The air already present in the cap end side is pushed out of the cylinder. The sheet metal is either again inserted for further cutting in case of large pieces; the small cut pieces are removed and the next sheet is inserted to cut

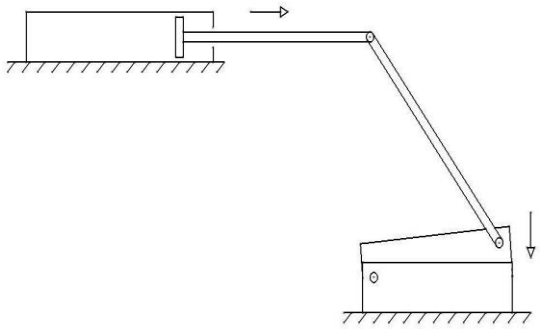

Fig 10: Position 'B'

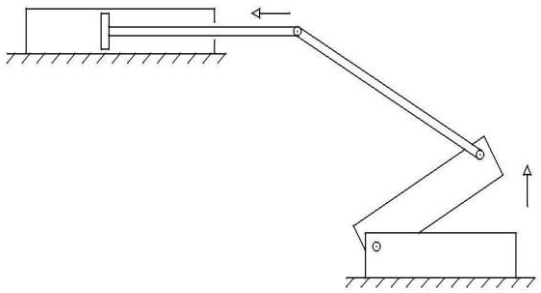

Fig 11: Position 'C'

Stainless steel:

The three most common stainless steel grades available in sheet metal are 304, 316, and 410.Grade 304 is the most common of the three grades. It offers good corrosion resistance while maintaining formability and weld ability. Available finishes are #2B, #3, and #4. Note that grade 303 is not available in sheet form. Grade 316 offers more corrosion resistance and strength at elevated temperatures than 304. It is commonly used for pumps, valves, chemical equipment, and marine applications. Available finishes are #2B, #3, and #4. Grade 410 is a heat treatable stainless steel, but does not offer as good corrosion resistance. It is commonly used in cutlery. The only available finish is dull.

Working:

The pneumatic machine includes a table with support arms to hold the sheet, stops or guides to secure the sheet, upper and lower straight - edge blades, a gauging device to precisely position the sheet. The table also includes the two way directional valve. The two way directional valve is connected to the compressor. The compressor has a piston for a movable member. The piston is connected to a crankshaft, which is in turn connected to a prime mover (electric motor, internal combustion engine).

At inlet and outlet ports, valves allow air to enter and exit the chamber. When the compressor is switched ON, the compressed air is flow to inlet of the pneumatic cylinder. The sheet is placed between the upper and the lower blade. The lower blade remains stationary while the upper blade is forced downward. The upper blade is slightly offset from the lower blade, approximately 5 – 10% of the sheet thickness. Also the upper blade is usually angled so that the cut progresses from one end to the other, thus reducing the required force.

Fig 12: prototype of sheet metal cutting machine

When the pneumatic hand operated lever is moved forward, the piston starts moving in the forward direction. When the pneumatic hand operated lever is moved backward, the upper blade will come to the original position (i.e., the upper blade will move upwards).After the material is cut, adjust the pneumatic hand lever to the mid position (i.e., normal position) and then the compressor is switched OFF.

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VI. MERITS & DEMERITS

Merits:

1. Hydraulics present certain advantages over pneumatics, but in a given application, pneumatic powered equipment is more suitable, particularly in industries where the factory units are plumbed for compressed air.
2. Moreover, to avoid corrosive actions, oil or lubricants are added so that friction effects can be reduced.
3. Compressed air is used in most of the machines and in some cases compressed carbon dioxide, whereas cutting process is become easy.
4. Fast cutting action is carried out.
5. Cutting without bending is achieved.

Demerits:

1. Sheet more than 2 mm thickness cannot cut easily.
2. Compressed air is must.
3. Foundation is required also safety major must be taken

APPLICATIONS

Sheet metals are used in

- Car bodies
- Airplane wings
- Medical tables
- Roofs for buildings (Architectural) and many other things
- Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines.
- Historically, an important use of sheet metal was in plate armor worn by cavalry, and sheet metal continues to have many decorative uses, including in horse tack.

ADVANTAGES

- Low cost
- Less consumption of time
- Easy to handle
- Skilled labor is not required
- Less maintenance
- High accuracy
- Good surface finish
- Less floor space

Future Scope

Since old age man is always trying to gain more and more luxurious. Man is always trying to develop more and more modified technique with increasing the aesthetic look and economic consideration. Hence there is always more and more scope. But being the Diploma Engineers and having the ability to think and plan. But due to some time constraints, and also due to lack of funds, we only have thought and put in the report the following future modifications.

1. It can be made hydraulically power operated by installing the gear oil pump at the place of air compressor and pneumatic cylinder arrangement.

2. It can be made rack and pinion operated or spring and lever operated, by replacing the pneumatic circuit by rack and the pinion arrangement by the square threaded screw and nut arrangement.

3. The place where there is scarcity of the electricity the electric motor operate compressor is replaced by an I.C. Engine installed compressor.

Thus in future there are so many modifications, which we can make to survive the huge global world of competition.

VII. CONCLUSION:

Now we know that Pneumatic Shearing machine is very cheap as compared to hydraulic shearing machine. The range of the cutting thickness can be increased by arranging a high pressure compressor and installing more hardened blades. This machine is advantageous to small sheet metal cutting industries as they cannot afford the expensive hydraulic shearing machine.

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