International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

Design and Manufacturing of Hole Punching Machine with Pneumatic System for Square Drum(Paper Fibre)

Saurabh Khopade[1], Jitesh Kesarkar[2], Hrishikesh Haware[3], Sourav Khirid[4], Ajay Sontakke[5], Nandkumar. S. Vele[6]

[1,2,3,4]UG Student, Dept. of Mechanical Engineering, Pimpri Chinchwad College of Engineering and Research, Maharashtra, India
[5]Manager, HEW Precision Pvt. Ltd., Maharashtra, India
[6]Professor, Dept. of Mechanical Engineering, Pimpri Chinchwad college of Engineering and Research, Maharashtra, India

---

Abstract - *Pneumatics systems are extensively used in a wide range of industries and factories and manufacturing sector entities. Pneumatics system are noted for their simplicity, reliability, and ease of operation. Also they are suitable for fast and rapid application of force.*

The purpose of this project is to therefore design a simple, easily operated pneumatic punching machine that is sturdy and strong. The pneumatics have an advantage of working in low pressure, that is even a pressure of 6 bar is enough for operating the unit. The pressurized air passing through the tubes to the cylinder, forces the piston out whose power through the linkage is transmitted to the punch. Industries require to seal the boxes(square drum). This was carried out by drilling the holes and then using them to seal. As the traditional way of drilling or punching a hole was done manually this included a set of injuries. Even a small fatal step could cause a catastrophe. This gives an opportunity for developing and innovating a machine which would punch a hole manually eliminating the typical human errors.

Key Words: Pneumatics, Hole Punching, Square drum

1. INTRODUCTION

Industries require to seal the boxes(square drum). This was carried out by drilling the holes and then using them to seal. As the traditional way of drilling or punching a hole was done manually which included a set of injuries. Even a small fatal step could cause a catastrophe. This gives an opportunity for developing and innovating a machine which would punch a hole manually eliminating the typical human errors. So the main challenge was to have a proper consistency in punching of a box. Hence to achieve this there were many parameters to be taken into consideration. At the first place we had to select a proper pneumatic cylinder which would deliver the desired pressure. The cylinder selected was (A63-64) from the janatics catalogue. This cylinder is a compact type and it can deliver a pressure ranging from 6-10 bar. Hence eight pneumatic cylinders are used for the two machines. One of machine is for the drum/box and the other is for the lid. For the proper alignment of the cap a key is provided.

In this machine pneumatic cylinder is used as a punching equipment. The compressed air from the compressor is used as the force medium for this operation. In the first position, air enters to the top of the cylinder and pushes the piston so that the punching is done. In the next position, air enters to the bottom of the cylinder and pushes the piston back, so that the return stroke is obtained.

1.1. Punching

Punching is a metal forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. The punch often passes through the work into a die. There is a small amount of clearance between the punch and the die to prevent the punch from sticking in the die and so less force is needed to make the hole. The punch press forces the punch through a work piece, producing a hole that has a diameter equivalent to the punch, or slightly smaller after the punch is removed.

1.2. Need for Automation

Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provide human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Manufacturing company usually produce hundred thousand products a day, and most of the time they rely on automation to meet their client's expectation and deadline in able to have good profit. Thousand manpower is very effective, new technologies today have important to increase the productivity of a certain company.

2. PROBLEM STATEMENT

To design and develop seal hole punching machine with pneumatic system for square drum (paper fibre).

3. PROBLEM DEFINATION

The task is to develop a machine which can punch the hole in corrugated boxes (paper fibre 300 gsm) automatically replacing the typical manual errors. The machine which is to be developed would be capable of punching 8mm and 10mm holes more efficiently.

4. COMPANY REQUIREMENT

- To develop a mechanism for punching ø8mm and ø10mm holes as per the need.
- To have a proper consistency in hole punching.
- To provide a holder for punch guide, this can be varied according to the height of the box lid.
- Consistency in hole positioning.
- Handling safety.
- To provide a flexibility in punching operation according to variation in height of the box rather than traditional way of manual drilling.

5. OBJECTIVE

- Automation of manual drilling process.
- To develop a mechanism for punching Ø8mm and Ø10mm holes as per the need.
- To have a proper consistency in hole punching.
- To provide a holder for punch guide which can be varied according to the height of the box lid.
- To insert a key for alignment of cap during punching.

6. RESEARCH GAP

- The traditional way of drilling is with help of a skilled worker. This process was time consuming as well as it was not much accurate and consistent.
- The traditional way of drilling is to drill the holes one by one in cap as well as drum, which have 4 holes each.
- Also, the manual drill cannot be precise each time as it involves manual errors.
- Suppose, if a working requires 8 hrs to drill 100 boxes, traditionally, then this becomes a very time consuming process also the manual way is going to consume a lot of resources like electricity, wages of workers, etc.
- For eg: Consider a worker working for 8 hrs to drill 100 boxes. This will cost 8 hrs of electricity, whereas the pneumatic punching machine will save this 7 hrs cost of electricity and worker's wage by doing the same work in 1 hr.
- Above mentioned are the flaws of manual drilling. The pneumatic punching machine will counter these flaws.
- If to specifically mention, pneumatic punching machine will punch all the holes (4 each in cap and drum) simultaneously instead of one by one to reduce the time and will improve accuracy with the help of punch holder die.

7. PROPOSED WORKING PRINCIPLE

- In this project we are using the pneumatic cylinder as punching equipment.
- The compressed air from the compressor is used as the force medium for this operation.
- In one position, air enters the cylinder and pushes the piston so that the punching is done.
- In next position, air enters again to the cylinder and pushes the piston return back, so that the return stroke is obtained.

8. CALCULATIONS

- **Calculations for Selection of Pneumatic cylinder-** *Diameter of hole= 8mm & 10mm*
- **Force Calculation:**

Selecting 10 mm diameter of the hole to be punched.

L = Length of cut(Perimeter of shape) = π × Diameter of hole

= π × 10

= 31.41 mm

Total thickness of the box (t) = 3 mm

Shear Strength of corrugated square paper drum [300 gsm] (Tmax) = 0.65 Mpa [11]

Cutting force: - The force which has to act on the stock material in order to cut the blank or slug.

Stripping force: - The force developed due to the spring back (or resiliency) of the punched material that grips the punch

Total Cutting Force = Length of Cut × Thickness × Shear strength

$$= L \times t \times T_{max}$$

= 31.41×3×0.65

= 61.2495 N

Stripping Force = 15% of cutting force

$$= 61.2495 \times \frac{15}{100}$$

= 9.18 N

Press Force = Cutting force + Stripping Force

= 61.2495 + 9.18

= 70.43 N

The total force which is required to blank or peirce the corrugated paper drum is = 70.43 N

Pressure range of compressor = 6 to 12 bar

- **Selection of the cylinder :**

Selecting working pressure of compressor = 6 bar

$= 6 \times 10^5$ Pascal.

The output force = 70.43 N

We know,

$$\text{Pressure} = \frac{Force}{Area}$$

$$\text{Area} = \frac{Force}{Pressure}$$

$$A_{cyl} = \frac{70.43}{6\times10^5}$$

$A_{cyl} = 1.17 \times 10^{-4}$ mm^2

We know,

$$A_{cyl} = \frac{\pi}{4} \times D^2$$

$$D^2 = \frac{A_{cyl}\times4}{\pi}$$

$$D = \sqrt{\frac{1.17\times10^{-4}\times4}{\pi}}$$

D = 0.0122 m

D = 12.20 mm

From janatics catalogue, A 63 (magnetic) compact cylinder of 25 diameter should be selected but, considering highest factor of safety & material property changing condition, cylinder of diameter 80mm is selected which delivers 2714N force at bar pressure.

Output force (force in N : 1N = 0.1 kgf)

Cylinder bore Ø (in mm)	Rod Ø (in mm)		Working pressure in bar								
			2	3	4	5	6	7	8	9	10
25	10	Extend	88	132	176	220	264	308	352	396	440
		Retract	74	111	148	185	222	260	296	334	370
32	12	Extend	145	217	289	362	434	507	579	651	724
		Retract	124	187	249	311	373	435	498	559	622
40	12	Extend	226	339	452	565	678	792	905	1018	1130
		Retract	206	309	411	514	617	720	823	926	1029
50	16	Extend	353	530	707	883	1060	1237	1413	1590	1767
		Retract	317	476	634	793	952	1110	1269	1427	1586
63	16	Extend	561	842	1122	1403	1683	1964	2244	2525	2805
		Retract	525	787	1050	1312	1575	1837	2099	2362	2624
80	20	Extend	905	1357	1809	2262	2714	3167	3619	4071	4524
		Retract	848	1272	1696	2120	2544	2969	3393	3817	4241
100	20	Extend	1414	2120	2827	3534	4241	4948	5655	6362	7068
		Retract	1357	2036	2714	3393	4071	4750	5429	6107	6786

(Above values have been worked out taking frictional loss into consideration)

Table-1: Janatics catalogue

9. WORKING METHODOLOGY

- Compressor is a device that converts power into energy. Power conversion is done with the help of electricity.
- We have used compressor which is electrically operated.
- As the application is pneumatic, we have selected 5x2 DCV.
- The application which is to be punched is corrugated box of 3 mm thickness. But considering future scope the cylinder that we have selected can compensate the material change.
- The cylinder selection is done in such a way that it can generate power which can punch the metal box.
- The cylinder that we have selected is janatics (A63-64) compact as per ISO 21287 standards.
- The selection of the punch holder is as per the required shape of the box.
- Design of the punch is such that it can punch the given shape.
- Key is provided for the proper alignment of the cap and the box.
- The compressed air from the compressor is used as the force medium for this operation of punching.
- In one position air enters the cylinder and pushes the piston so that punching is done.
- In the next position, as the ports of the DCV opens and the air enters the cylinder the piston is pushed to its return position so that the return stroke is obtained.
- In this way the punching operation of box is done.

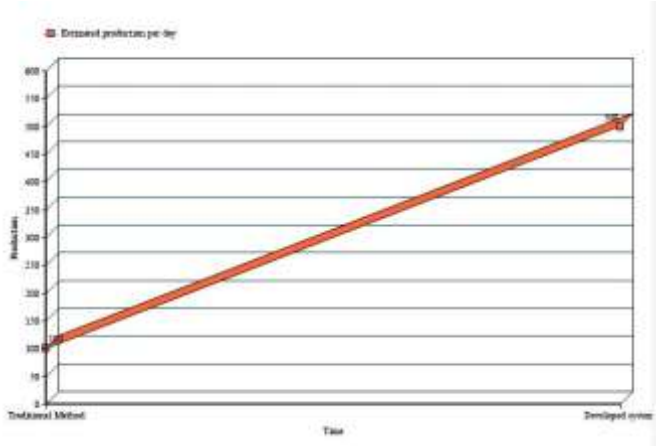

Chart-1: Comparison of Estimation of production per day(10 hrs)

10. MACHINE DESIGN

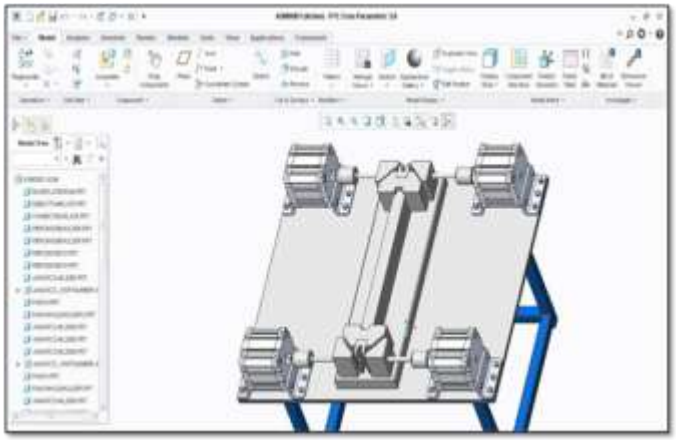

Fig-1: CAD Model for Pnuematic Punching Machine

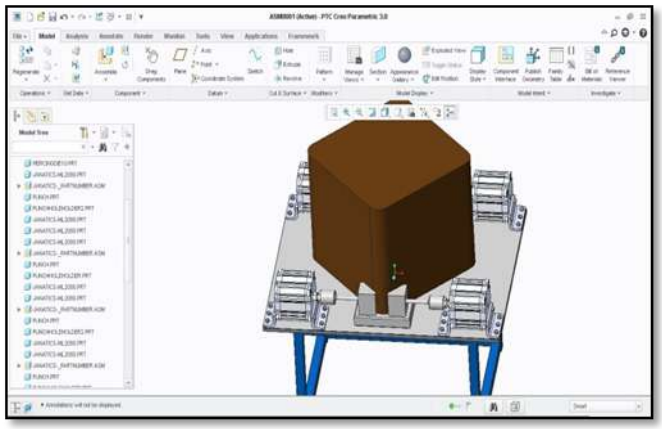

Fig-2: CAD Model for Pneumatic Punching Machine (Square Drum Mounted)

Fig-3: Square Drum (Paper Fibre 300 GSM)

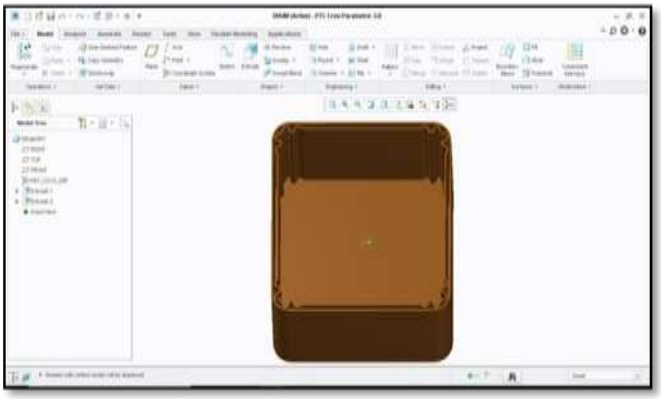

Fig-4: CAD Model for Square Drum

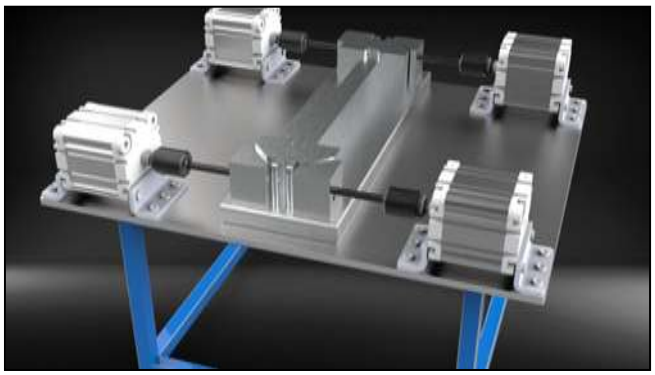

Fig-5: CAD Model realistic look (rendered)

11. ACTUAL MANUFACTURED MACHINE

Fig-6: Machine for Lid punching

Fig-7: Machine for Lid punching with lid mounted

Fig-8: Machine for box punching

Fig-9: Machine for box punching with box mounted

12. ANALYSIS

The solution of any physical problem can be obtained in three different ways via analytical, experimental and numerical methods. Analytical method is a classical approach gives 100% accurate results but applicable only for simple problems like cantilever simply supported beams. second method is the experimental method and is used for actual measurement of physical quantities such as vibration measurement by FFT, principal stresses and strains by photo elastic or strain gauge rosette method etc. Lastly, numerical method and is the mathematical representation of physical problem gives approximate solution for the complex problems.

- ANALYSIS FOR BOX (ANSYS)-

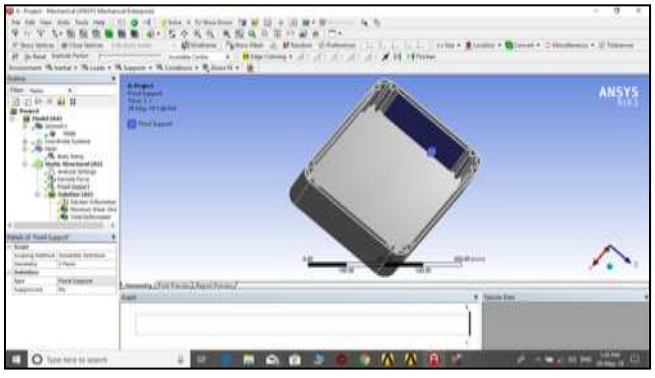

Fig-10: ANSYS fixed support assigned for drum

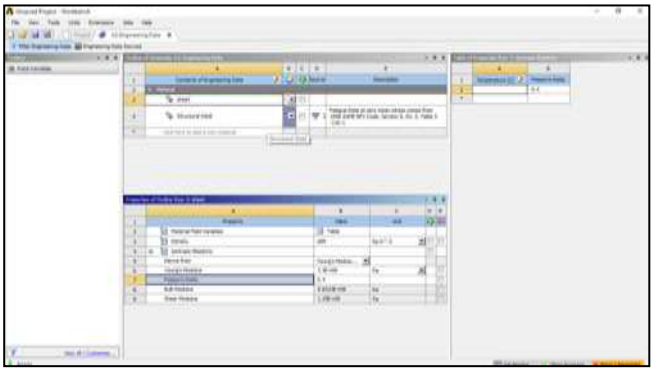

Fig-11: ANSYS fixed support assigned for drum

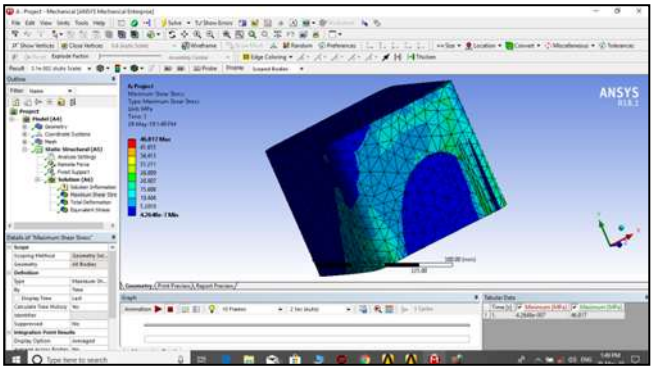

Fig-12: ANSYS fixed support assigned for drum

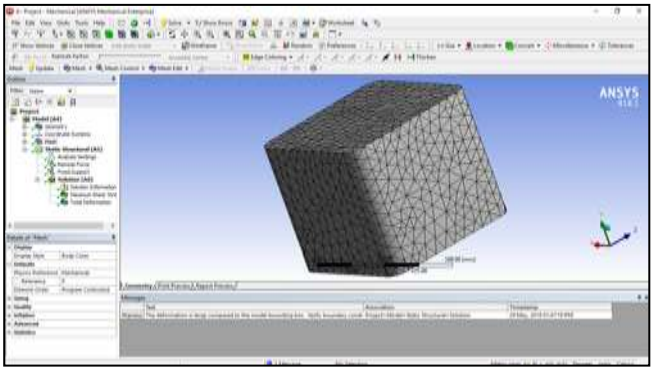

Fig-13: ANSYS fixed support assigned for drum

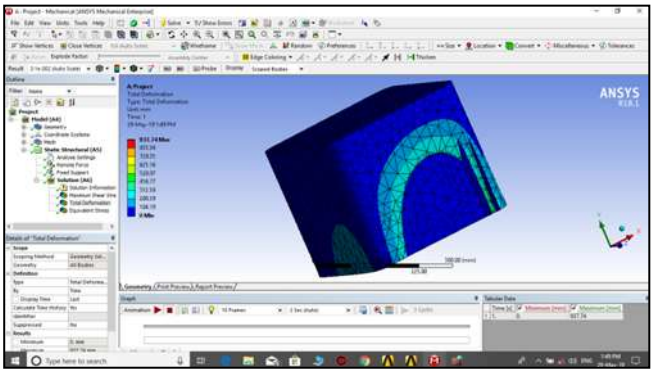

Fig-14: ANSYS deformation analysis

12. ADVANTAGES

- Improved efficiency of box punching and sealing.
- Mass sealing of boxes in less time.
- More time bound process than traditional sealing.
- More safe process than the traditional process of sealing and punching.
- Skilled operator is not required.
- Interchangeability of lids & boxes due to precise punching.
- Precise hole punching isn't affected due to lid & box size variation.

13. DISADVANTAGES

- Complicated repairing of machine due to pneumatic system.
- Air Pressure system/Pneumatic system is more prone to leakage.
- Even a bit of air/oil leakage may result in power loss.

14. FUTURE SCOPE

- As of now the machine is capable of punching corrugated boxes but in mere future if the material changes for e.g.: If the material changes from paper fibre to metal boxes this machine is also capable of punching the metal boxes.

- The design of the punch and the selection of the pneumatic is done in such a way that even if the material changes these two parameters remains the same.
- There is no need to change the punch and the cylinders.
- Selection of the compressor is done in such a way that even if there are any fluctuations in the pressure the selected compressor can deliver the same or desired output.

As in the future if the material changes the pneumatic system can be changes to hydraulic system for heavier applications.

15. CONCLUSION

The project carried out made an impressing task in the field of industries which require sealing operation. It is very useful for the workers to carry out hole punching operation at a very fast pace and ease with desired precision in a single machine. Estimated productivity in operation after use of machine for hole punching resulted to be around 500%. This project has also reduced the cost involved in the concern as compared to traditional way of sealing. Project has been designed to operate perfectly satisfying entire requirements.

ACKNOWLEDGMENT

I have great pleasure in submitting the Research paper for Industrially sponsored Project on the topic, "DESIGN AND MANUFACTURING SEAL HOLE PUNCHING MACHINE USING PNEUMATIC SYSTEM FOR SQUARE DRUM (PAPER FIBRE)".It gives me immense pleasure to record my debt of gratitude and my warmest regards to our company mentor Mr. Ajay Sontakke and project guide Prof. N.S.Vele for extensive guidance and direction we have received from him throughout the progress of the work. The various values that we tried to learn from him shall remain source of inspiration for us forever. I would like to say thank you to our Project Coordinators, Company. I am thankful to my family for their whole hearted blessings, support and encouragement towards the fulfilment of my work. I wish to record the help extended by my friends in all possible ways and active support and constant encouragement.

REFERENCES

[1] Ankit Pawar, Arjun Pawar, Lalit Sillak, Pritish Sonawane , Amay Tipayle. Electromagnetic Punching Machine. International Research Journal of Engineering and Technology. Volume: 04 Issue: 05 | May -2017.

[2]Sharma, Utkarsh. "Design of Automatic Pneumatic Hole Punching Machine." *Int Res J Eng Technol* 2.09 (2015): 2258-2260p.

[3]Sathishkumar, S., Swaminathan, R., Sena, S. M., & Dinakaran, P. T. Design and development of special purpose machine using hydropneumatic cylinders to do 4 holes and 2 holes piercing in a square tube. Volume 8, Issue 3, March 2017.

[4]Arun, S., Rajendra, S., & Bongale, V. (2014). Automatic Punching Machine: A Low Cost Approach. International Journal of Advanced Mechanical Engineering, 4(5), 509-517.

[5]Kelaginamane, S., & Sridhar, D. R. (2015). PLC Based Pneumatic Punching Machine. Journal of Mechanical Engineering and Automation, 5(3B), 76-80.

[6]Anand Kumar Singh, Mitesh L Patel. Design and Devolopment of Pneumatic Punching Machine.International Journal For Technological Research In Engineering. Volume 4, Issue 11, July-2017.

[7] Goyal, P., Srivastava, G., Singh, R., & Singh, N. (2015). Review on Pneumatic Punching Machine and Modification in Punch Tool to Reduce Punching Force Requirement. International Journal of Engineering Technology Science and Research (IJETSR), 2(2).

[8]Amit Patil**,** Divakar Sharan**,** Saurabh Kumar, Shaik Mohammad Basha, B.S.Anil Kumar. (2017). Development and Fabrication of Miniature Pneumatic Punching Machine. IDL-2017-ISSN (Online) : 2465-328.

[9] Girish Gharat, Aniket Patil, Harshal Mhatre, Sandesh Satvi (2015). Design and Fabrication of Pneumatic Punching and Bending Machine. Vol. 3, Issue 02, 2015.

[10] Madhu Kumar V, Arun Kumar N, Harsha B S, Naveen Kumar K N, Nagaraja T.K. (2016). Design and Fabrication of Pneumatic Sheet Metal Cutting and Bending Machine. Volume. 02 Issue.01, May-2016.

[11] www.paperonweb.com

[12] P.Goyal, G.Srivastava, R.Singh, N.Singh. Review on Pneumatic Punching Machine and Modification in Punch Tool to Reduce Punching Force Requirement. International Journal of Engineering Technology Science and Research. Volume 2 Issue 2 February 2015.