



Design and Development of Semi-Automatic Punching Machine with Feed Mechanism

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Abstract:

Now world requires speed on each and every field. Hence quick work is most important New machine and Techniques are being developed continuously to manufacture various product at cheaper rates and high quality. This project is mainly carried out for production-based industries. Industries are basically meaning for production cost, machinery cost and low inventory cost. Today in this world every task has been made quicker and fast due to technology advancement but this advancement also demands huge investment and expenditure, every industry desire to make high productivity rate maintaining the quality and standard of the product at low average cost, but still we are using a separate machine for separate operations. This is a time and power consuming process; it need maintenance as well as more space. Our project is to overcome above listed problems. In our project two operations are built as a one machine tool i.e. punching and feeding of work materials. This project we are designing and fabricating the prototype of “DESIGN AND DEVELOPMENT OF SEMI-AUTOMATIC PUNCHING MACHINE WITH FEED MECHANISM”. This project is specially designed for automatic punching in metal sheet. This project is to introduce automation in industries.

Keywords:

Semi-automatic feed, Punching mechanism, Gear train arrangement

Introduction:

Punching machine is one of the principle machines in paper cutting industry and sheet metal industry. It is mainly used as the name indicated to cut strips. So, we are going to make it multipurpose and should be used to cut the card board, asbestos sheets, papers, foam, thin plastic sheets.

Now, world requires speed on each and every field. Hence rapidness and quick working is the most important in all field. New machine and techniques are being developed continuously and manufacture various products at cheaper rates, high quality and less human efforts. In the convectional punching machine, the time taken for job setting, feeding, punching operation is more. Labor cost is also more. With CAM based punching machine this time taken for job setting, feeding, punching and reduce the labor cost, production cost and also maintenance cost. In this project we are designing and fabricating of “Design and Development of Semi-Automatic Punching Machine with Feed Mechanism”.

This project is specially designed for automatic punching in metal sheet. This project is to introduce automation in industries using mechanically arrangement. It is suitable for making mass production of the sheet metal punching industry.

Aim:

In conventional punching machine, the time consumption for job setting, holding, marking, punching operation is more. Labor cost and production cost are also more. Also, skilled worker required for the operation. So, holding, feeding and injecting are operation of the sheet metal in punching machine are included in to 'Auto Feeding System' by operate Cam driven. This project is specially designed for automatic punching in metal sheet. This project is to introduce automation in industries using mechanically arrangement. It is suitable for making mass production of the sheet metal punching industry.





Literature Review:

Every research is incomplete without suggestions from previous research work, so as with us we also referred to the research paper and patent related to our work, along with punching machines available in our market of our segment. Starting from PLC Based Pneumatic Punching Machine (Sudeep and Sridhar 2015) explained about PLC controlled sheet metal punching machine with can replace existing manual feed punching machine. After that, we came along Pneumatic Auto Feed Punching and Riveting Machine (A.S. Aditya and K. Sri. Varsha 2012) explained about different type of punch dies can be used to attain wide range of products and also, according to work material operating pressure can be varied. Design and development idea of the punching machine was infused by Design and Development of Pneumatic Punching Machine (Viraj N. Suryawanshi, Nilesh V. Wakade, Prof. Prashant A. Narwade 2019), from this research paper we got to know that pneumatic punching machine is way to better to hydraulic punching machine in economical purposes. In addition to that, pneumatic punching machine using compressed air generate high pressure to be applied on piston. For the automation purpose we took insights from Design of Automatic Pneumatic Hole Punching Machine (Utkarsh Sharma 2015). Maintenance cost of hydraulic machines are higher than pneumatic ones. On the contrary, the production cost of pneumatics is cheaper than hydraulic. For the semi-automatic feed, we were having numerous options like, chain drive, rollers, cam arrangement and many more however, using rollers was the input taken from Design and Fabrication of Auto Roll Punching Machine (Kundan Kumar 2016), rollers were the cheapest and easiest mean to use for the punching machine. The rollers in synchronization with cam arrangement were the punch is held. Calculation for the fourth requirement on punch tool and its modification were exemplified from Review on Pneumatic Punching Machine and Modification in Punch Tool to Reduce Punching Force Requirement (P. Goyal, G. Srivastava, R. Singh, N. Singh 2015). Solid-works software was used for the simulation of the punching machine also, helped us to design 3D view of our machine. For the smooth working of roller and its automation we helped out ourselves through Autoroll Punching Machine (S.M. Kadu, A.P. Hingane, V.V. Dhon, R.B. Bahekar, Y.S. Chaware 2016). For the costing and components, we reviewed Automatic Punching Machine: A Low-Cost Approach (Arun S, Sree Rajendra, Vijayavithal Bongale 2014). This research paper provided valuable insights on the components and its costing. From this we also got to know the minimum number of components should be use i.e. optimality should be attained. We also referred to the various punching machine available in our surrounding and also hand zoned the same. We deduced flaws and advantages of the machines, used them for our machine. We got ourselves helped from the book Design of Machine Elements (V.B. Bhandari) and also used Theory of Machine by (R.S. Khurmi , J.K. Gupta).


Component Details:

Table-1: Components

Sr. No.	Part Name	Quantity	Description	Figure
1	Gear Box	1	<p>It is used for speed reduction to get sufficient output. 1:60 is the gear speed ratio.</p> <p>It is attached with the motor with help of star coupling.</p>	 <p style="text-align: center;">Figure-1: Gear Box</p>
2	Closed Joint Chain	3	<p>Closed joint chain is connected to the sprocket wheel to transmit the power between the rollers.</p>	 <p style="text-align: center;">Figure-2: Closed Joint Chain</p>
3	Star Coupling	1	<p>The primary purpose of coupling is to join two pieces of rotating equipment. It is used to connect motor and gear box shaft.</p>	 <p style="text-align: center;">Figure-3: Star Coupling</p>

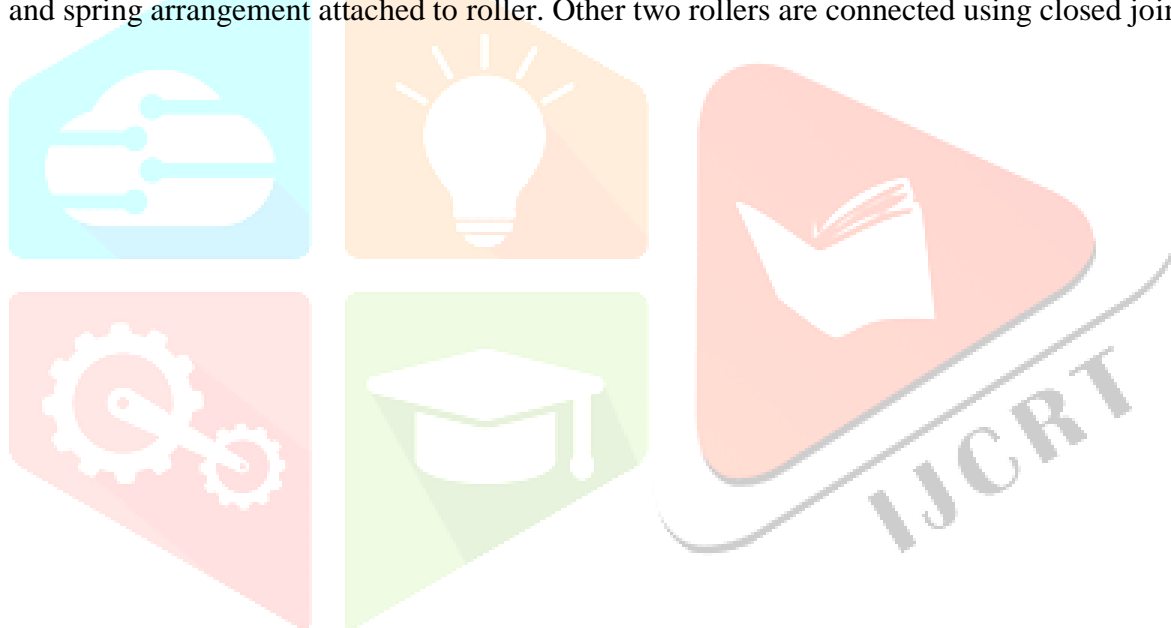
4	Sprocket	4	Sprocket is used as the power transmitting medium. The sprocket wheel is placed at the roller end to connect the closed joint chain.	 <p>Figure-4: Sprocket</p>
5	Free Wheel	1	Free wheel is used to provide the particular angle rotary motion. It is attached with the spring and rotating wheel arrangement.	 <p>Figure-5: Free Wheel</p>
6	Main Shaft Bearing	1	Main shaft bearing is used to provide the rotary motion in main shaft.	 <p>Figure-6: Main Shaft Bearing</p>
7	CAM	1	Cam is placed at the main shaft. It is used to convert the rotary motion into intermediate motion.	 <p>Figure-7: CAM</p>

8	Feed Rollers	4	<p>Roller is made of mild steel and shaft is covered with rubber coating. The roller is used to feed the workpiece.</p>	 <p>Figure-8: Feed Rollers</p>
9	Bearing	8	<p>Roller ball bearing is used to produce the smooth rotary motion on the shaft. The bearing is placed at the rollers end to provide rotary motion without friction.</p>	 <p>Figure-9: Bearing</p>
10	Step Up Mechanism	1	<p>It is used to maintain the punching hole distance. We have 4 variety of distance in this wheel. It is attached with main shaft. It is connected with the freewheel and spring arrangement using closed joint chain.</p>	 <p>Figure-10: Step Up Mechanism</p>

11	Motor	1	In this machine we used single phase AC motor having 1440rpm with 0.5hp. The motor is main power supply source	 <p>Figure-11: Motor</p>
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Assembly:

First the base plate was fitted with the supports under it. Then motor and shaft assembly separately were fixed to the base plate. Motor and Gearbox is connected using start coupling. Cam drive fixed on main shaft and attached with punching machine. Feed roller is fixed on frame with bearings. Auto feed is provided using Free wheel and spring arrangement attached to roller. Other two rollers are connected using closed joint chain.



Design Assembly:

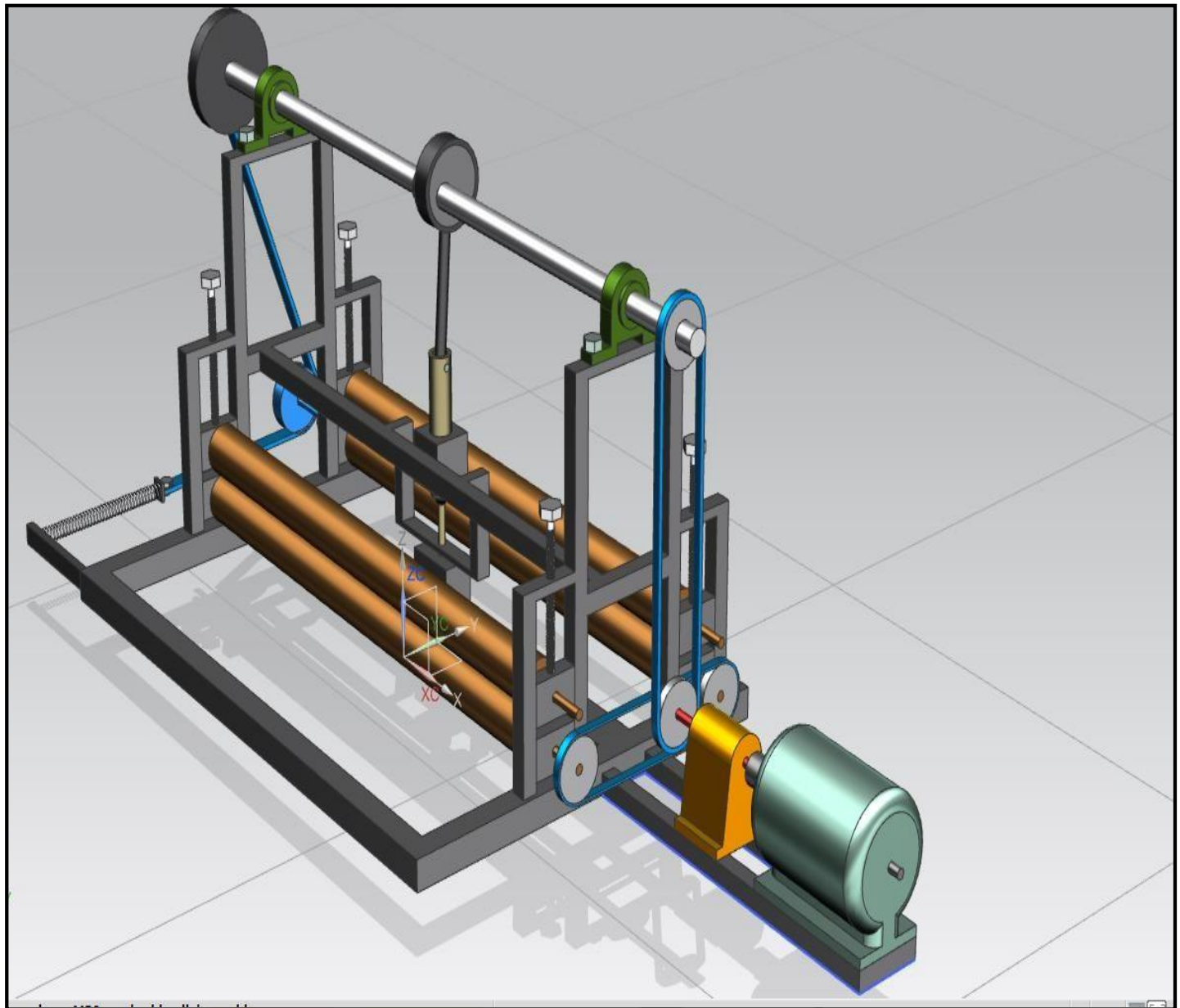


Figure-12: Assembly of Components

Top View:

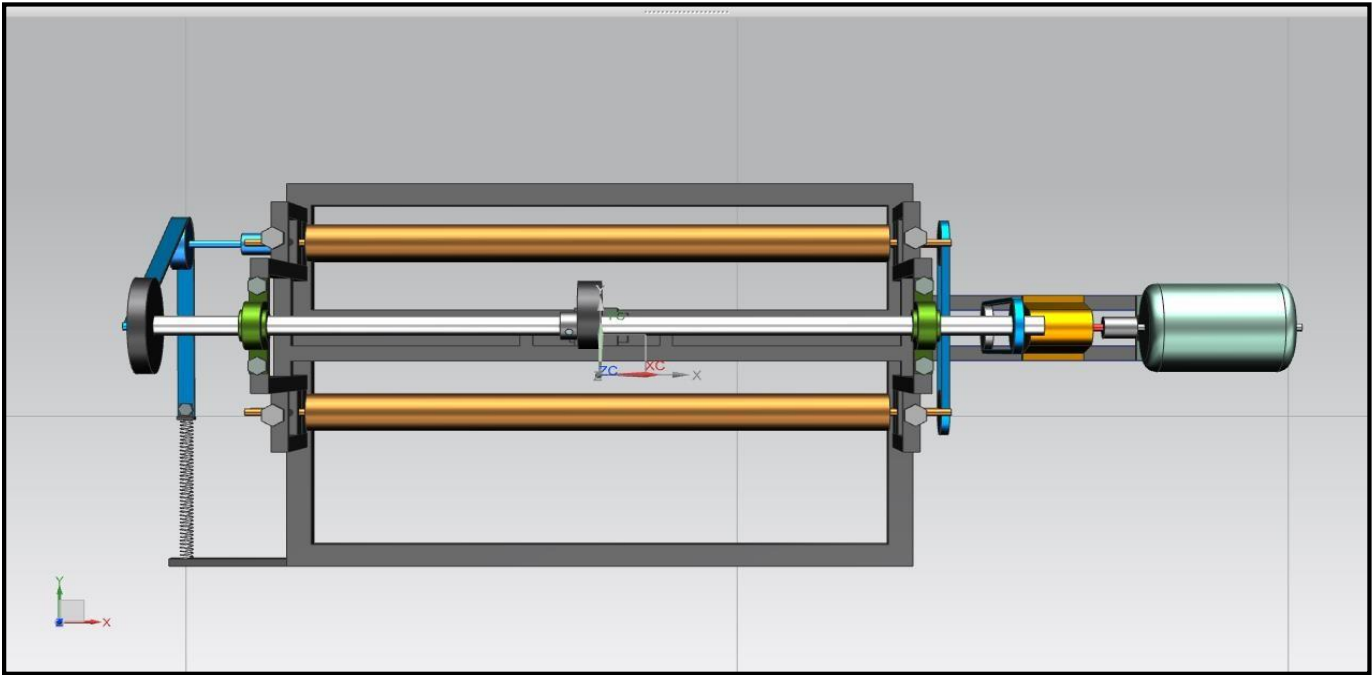


Figure-13: Top View of Assembly

Left Hand Side View:

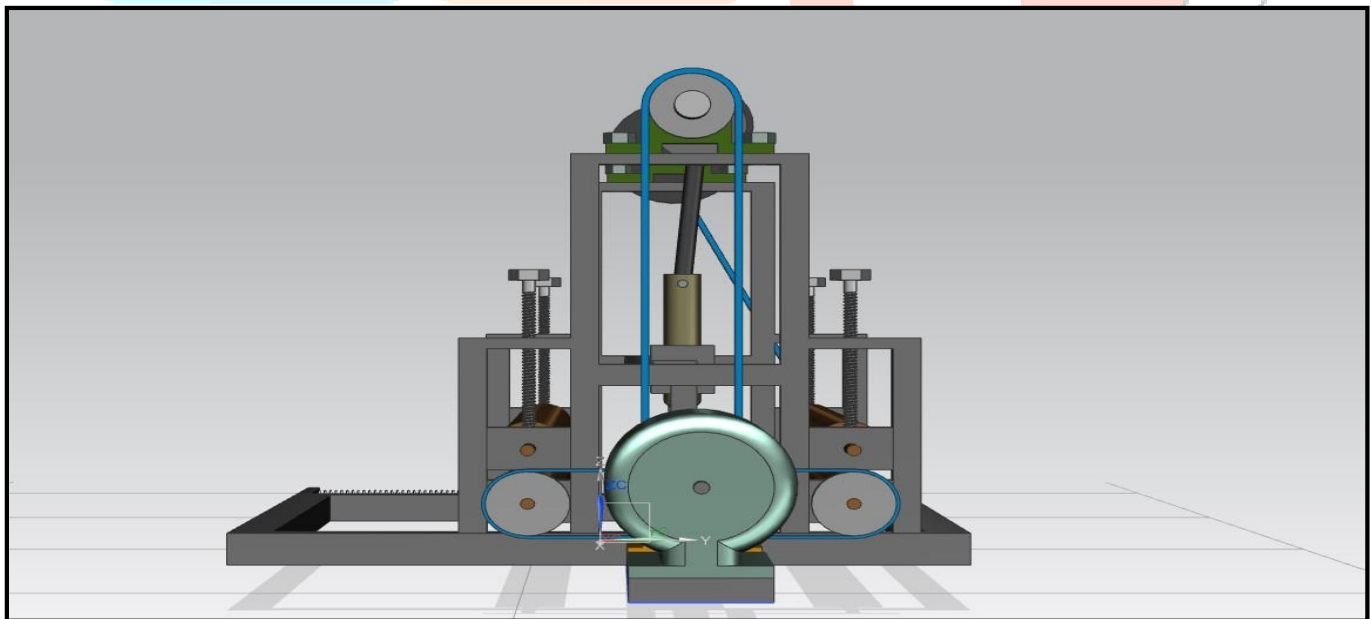


Figure-14: Left hand side view of assembly

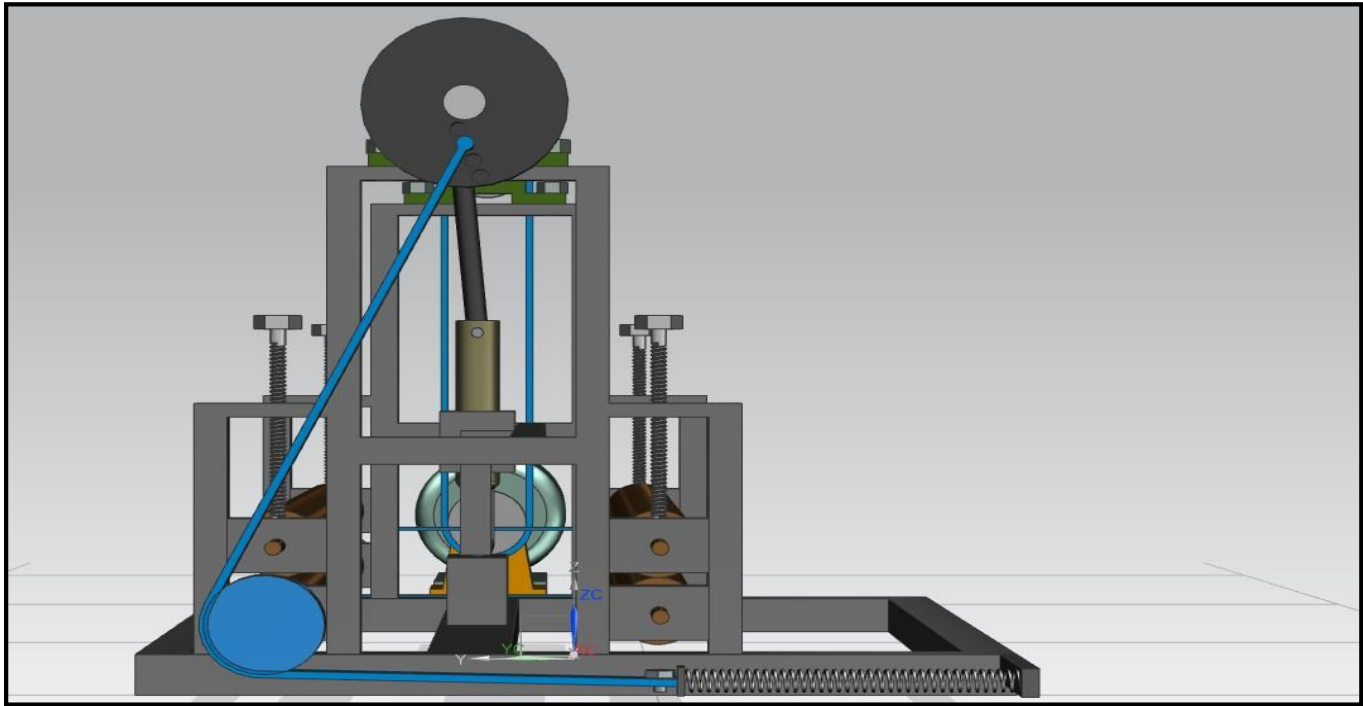
Right Hand Side View:

Figure-15: Right hand side view of assembly

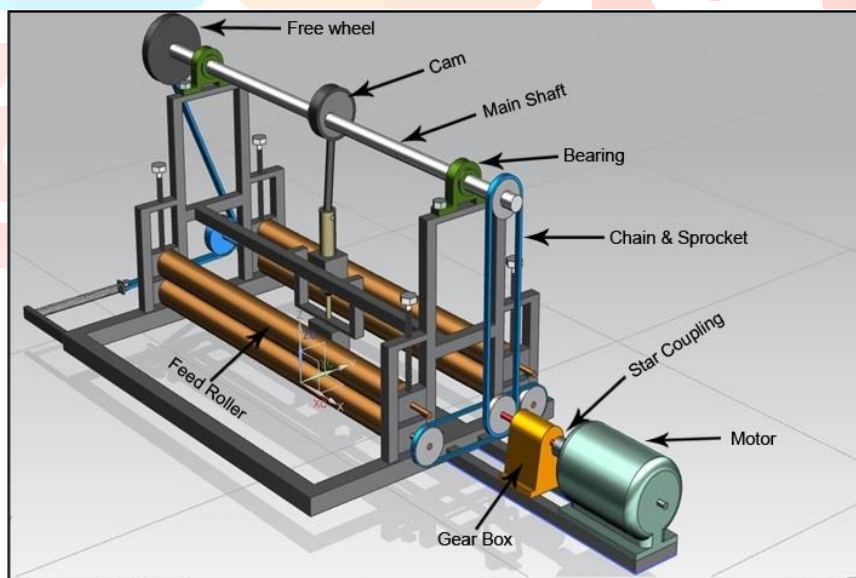
3D Model of Assembly:

Figure-16: 3D Model of Assembly

Methodology:

This project consists by the designed with using Cam drive mechanism moving arrangement and punching mechanism. Punching machine is designed with mechanical arrangement in which movements are controlled by using Cam mechanism.

Auto roll punching machine consists of two sections. One section is Auto Feeding System and the second section is conversion of rotary motion into linear reciprocating motion of punching tool. The first section consists of Cam drive keyed to main shaft on the center it has attached punching tool with it. The end of main shaft is connected with chain sprocket wheel. Sprocket will transfer the power from the gearbox and motor

to main shaft. Main shaft will rotate with the Cam mechanism and the other end is connected with mechanism which is providing the auto feed by the free wheel and the spring and the spring is connected with main shaft through closed joint chain and it is going through free wheel. The free wheel is rotating which is attached with the main roller arrangement and roller start rotating with these and another chain is attached at the other end two rollers will rotate with that arrangement. using this the auto feed will be provided to the rollers.

The second section consists of electrically operated DC motor, cam with a gear box and closed joint chain is attached at the main shaft by using sprocket wheel. The second section is used to convert the rotary motion of the cam into reciprocating motion of punching tool. The rotating shaft is keyed to the cam at the center and the other end is connected to DC motor and gear box arrangement by chain's sprockets. The punch tool slide is reciprocated by the connecting the cam through the main shaft. The sheet is fed automatically by the rotation of Cam. Punching operation will generate by the arrangement of cam and punching tool arrangement.

In this project, we can modify the heights of rollers by just adjusting screw arrangement over the rollers. The punching operation can be done by using the Cam arrangement on the main shaft. The punching tool use being guided by the guide block on the center of the frame. This guide will provide the proper direction to the punching tool and punching will done properly.

Advantages:

- **Reduction in production Time:** Having a machine that definitely speeds up the production time seen no thinking is needed by the machine, there is better repeatability and less human error.
- **Less human error:** No one is perfect, and we are all prone to making mistakes. Which is why a machine that performs repeated task is less likely to make mistakes than employees.
- **Less employee cost:** By adding automated machines to an operation, means less employees are needed to get the job done. It also indicates less safety issues, which leads to financial saving.
- **Increased safety:** Having automated machines means having less employees who perform task that can be dangerous and prone to injury, which can make the work environment safer.
- **Higher volume production:** Investing in automated equipment creates a valuable resource for large production volume, which in turn, will increase profitability.
- **Increase the accuracy and repeatability:** When an automated machine is programmed to perform task over and over again, the accuracy and repeatability compared to an employee far greater.

Disadvantages:

- **Less versatility:** by having a machine that can perform a certain task limits to the flexibility and variety of tasks that an employee could do.
- **Increase in unemployment:** by increasing the amount of automation, there are less employees required causing high unemployment rates.
- **Unpredictable costs:** there can be several unpredictable costs that may exceed the actual cost saved by the automation itself. Some cost of the design and fabrication of precise sized gears.

Comparison with Conventional Machine:

Radius of hole punched (r) = 5mm

Thickness of sheet (t) = 2mm

Following table shows reading for punching 5 holes in series

Table-2: Comparison Between Convectional and Auto feed Punching Machine

Sr No.	Distance between two consecutive punches (millimeter)	Time required for Convectional Punching machine (Second)	Time required for Auto feed Punching machine (Second)	Time saved in Auto feed punching machine (Second)
1	15	12	10	2
		13	10	3
		13	11	2
2	20	18	15	3
		19	15	4
		18	15	3
3	20	30	25	5
		29	25	4
		29	25	4
4	25	25	21	4
		26	20	6
		26	20	6
5	30	27	23	4
		28	25	3
		27	24	4

Conclusion:

The project carried out by us is used to make punching on G.I. Sheet with more prescribed than a conventional punching machine. As conventional punching machine takes more time for Job setting, Holding, Marking, Punching operation. Labor cost and production cost are also more. With this Cam based Auto Feed Punching machine the time taken for all this process can be reduced and production time also reduced and production rate will be high. No extra skill is required for operating this system. Operation is very smooth and, in this system, we can get more output by applying less effort. It is more suitable for the mass production in industry. It is very much useful for making series of holes of same diameter and constant pitch. Thus, it can be useful for punching application.

Future Scope:

- In this project, we had modified the regular manual punching machine into the Auto Feed Punching machine and we had used Cam mechanism to provide the timing and accuracy of the punching operation.
- It can provide good work efficiency with less timing of job settling.
- Using for Higher production in Industries.
- Operation being fully automatic using less skilled employees and less labor cost.
- We can do punching operation in mass production by increasing power, more punching tool and cam arrangement.
- Much useful for making series of holes of same diameter with constant pitch.
- We can also do blanking operation with this punching machine and we can increase it into mass production.

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