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Design and Development of Hydraulically Operated Torx Key Manufacturing Machine

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Abstract: ***The scant documentation available indicates that the idea of a hex socket screw drive was probably conceived from the 1860s to the 1890s, but there were no such screw manufacturers till 1910. This Torx key is used to drive bolts and screws with hexagonal sockets in their heads. Torx is a type of screw drive characterized by a 6-point star-shaped pattern, developed in 196 by Camcar Textron. A popular name that is generic, for the drive is a star, as in star screwdriver or star bits. Torx key is used generally to unlock the Torx screws. This paper shows the Manufacturing of Torx key machine using a hydraulic system, its circuit design, and 3D modeling of the machine using Autocad Fusion 360.***
Keywords: Torx key, Mini Press, Hydraulic Press, Embossing dies.

I. INTRODUCTION

Torx screws are used in automobiles, motorcycles, bicycle brake systems (disc brakes), hard disk drives, computer systems, and consumer electronics commonly. In the beginning, they were used in applications requiring tamper resistance in some ways, but since the drive systems and screwdrivers were not available widely; as drivers became more common, tamper-resistant variants, as described below, were developed. Torx screws are also becoming popular dynamically in many industries.

Torx is a trademark for a type of screw drive characterized by a 6-point star-shaped pattern, developed in 196 by Camcar Textron. A popular name that is generic for the drive is a star, as in star screwdriver or star bits. The official generic name which is standardized by the International Organization for Standardization as ISO 10664, is hexalobular internal. Sometimes, this is compacted in databases and catalogs as 6 lobes (starting with the numeral 6, not the capital letter G). Torx Plus, Torx Paralobe, and Torx tap are improved head profiles.



Fig. 1 Torx key (Product)

A. Problem Statement

Laxmi Tool Corporation is a Nashik based tool manufacturing company who supply various type of tools for CNC, VMC machines, tool holders, spare machine parts, and customized machines. While providing tools holders to the customer they need to supply an extra torx key with each tool holder they supply to the customer. They have to buy this torx key, which causes extra cost, reducing profitability etc., they want to manufacture torx key in house.

B. Objective

This project will have following objectives to achieve while designing the torx key manufacturing machine:

1) Cost reduction through in house manufacturing of torx keys.
2) Designing industry friendly machine systems.
3) Selecting machine components through market survey.
4) Optimum performance of Machine Elements.
5) Connecting theoretical knowledge with practical one.

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C. Methodology

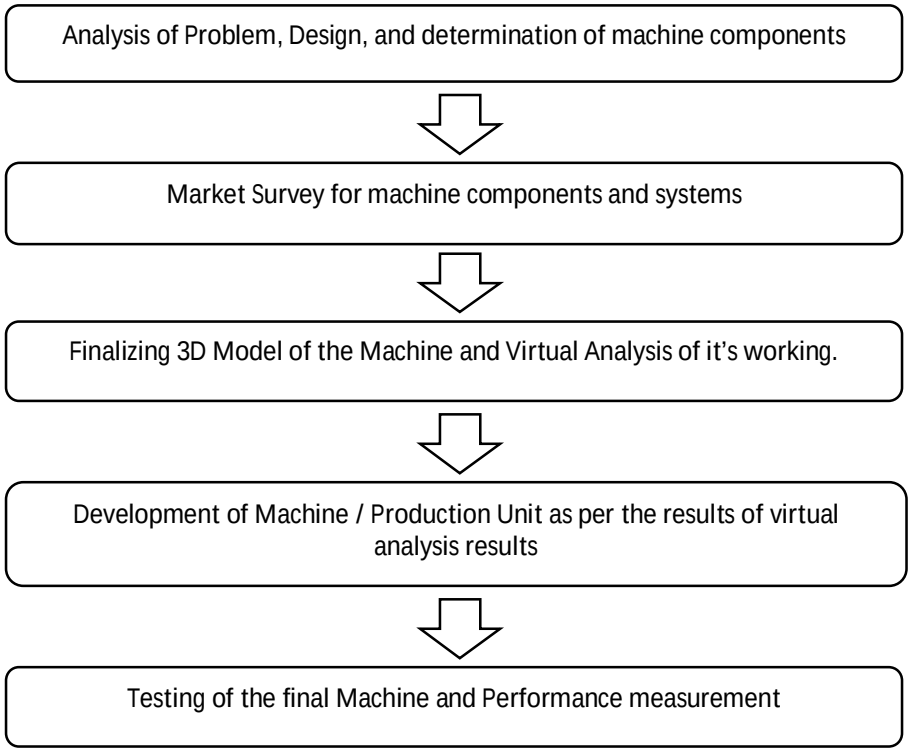


Fig. 2. Methodology

The methodology of the project is as shown in fig. 2. We had analized the problem. Then we started to decide that what should be design Considerations? Which components need to be select to manufacture this machine? The market survey has to be done accordingly.That is why we did Market survey in the last couple of weeks and we Finalize the components from market Survey. By using these components we had design 3D model. The yellow color shows that we have completed these stages in our project. We are going to do Force analysis. Once we final our design then we will do it's virtual analysis. analyze the results from it and start the development of the machine. Finally we will conduct the testing of the Machine and it's performance.

II. LITERATURE REVIEW

Under this project, we will use the currently available research on mini hydraulic press and Torx key manufacturing unit. This available research has a research gap that we are going to overcome through designing and manufacturing the Torx key manufacturing unit.

A. Hydraulic Press

A paper on "Design, Characterization, and Testing of Hand operated Hydraulic Press by Mr. Piyush T. Patel, Mr. Sachin Patel, Mr Hiren shah gives us a simplified and practical Design Approach & Manufacturing Process for the Mini hydraulic press [1]. This machine was tested to ensure trustworthiness to design objectives and usability by them. By performing, an experiment for sheets of different thicknesses, it remains concluded that molding operation is performed up to 20 mm. It was a machine that is multi-functional as it can be used for performing different tasks.

If we changed the die then different operations like bending, blanking, etc. can be performed on this hydraulic press machine. The design has focused on reducing operator fatigue and increasing safety, improving flexibility and making operations more convenient, and achieving dimensional and positional accuracy. Components of the press are designed in such a way that they can keep away from bending failure due to applied load. Mild steel is selected as a material based on its properties such as high bending & tensile strength, its compatibility with operations like machining, welding, finishing, cutting, etc., and cost as an economic factor. [1]

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Another paper on "Design and Development of Hydraulic Press with Die" by Tejas Patel, Vikas Panchal, Saurin Sheth, Purvi Chauhan allows us to understand the Ease of operation to manufacture the smaller parts in bulk. Here a press is developed by using a hydraulic system. This press will be useful for the scale manufacturing of Washers. It will increase productivity and increase the accuracy of production. Even the press can be completely atomized by using the concept of electro-hydraulics. Direction control valve (DCV) can be a solenoid actuated so that it will make the system close-loop which may lead to higher rates of production [2].
Conventional hydraulic power units, it requires oversized pumps and motors to make sure performance during a system's highest duty cycle demands. In today's eco-conscious and globally competitive economic environment, a transition to systems in which power should be precisely modulated where requirements of specific tasks within highly complex hydraulic systems are essential. This is where drive-controlled pump (DCP) technology can provide a solution to address the challenges of more demanding applications, rising energy costs, and greater environmental requirements. [3]

B. Product Study

Various types of keys are used for locking and unlocking of screws on the tool holders as shown in fig.3. Hexagon, Allen keys, most Torx keys are small enough which can be easily carried in pockets and this enables the user to decide the appropriate fasteners without a separate screwdriver or power tool. [4] You may also come across a type that has an additional pin in the middle of the star. These are called Security Torx screws and require an appropriate security Torx key or screwdriver bit in order to drive them. [5] The Use of Simulation Methods in the Analysis of the Manufacturing Process of Hex Allen Bolts Irena NOWOTYŃSKA, Stanisław KUT, Mirosław OSETEK – Preference for product details [6]. Steps in the design of key - Though these five design process steps are all necessary, the way in which you apply them should be flexible. [7]You may have multiple stages running parallel to one another and you certainly will jump back and forth between the stages based on your continuous user research. But this order is a good place to start. [8]
The various design process will be performing user research, defining the problem, generation of the ideas, creating virtual prototypes for virtual analysis using 3d model software and physical prototype to be designed at the second stage of the project, conducting user testing in the industry environment. [9]



Fig. 3: Torx Key and Phillip Key Comparison

C. Research Gap

After studying the available research, we found that there is research available in a hydraulic press for small components as well as in Allen Key Manufacturing but there is a lack of research in manufacturing Torx Key using a hydraulic press. We are trying to bridge the research gap by designing a cost-effective Torx key manufacturing unit using a mini-press.

III.HYDRAULIC CIRCUIT

Hydraulic Circuit for the Torx key as shown in fig. 4, consists of hydraulic pump, piston and cylinder arrangement, control valves, and impression dies. The actuator is a device or machine that helps it to achieve physical movements by converting electrical, air, or hydraulic energy into mechanical force.
Simply it is the component in any machine that enables movement. Adjustment of the force on a hydraulic piston rod or the torque on a hydraulic motor shaft. Pressure relief valves are generally used to set the maximum pressure in the circuit and protect it from overloading. Pressure-reducing valves maintain the output pressure at the set value while protecting the appliance from overloading in the system. Unloading valves are designed for economic pressure control in accumulator-operated circuits that serve as a power source device for emergency control.

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A hydraulic pump is a device of power that converts mechanical power into hydraulic energy. It generates a flow with enough power to overcome pressure induced by the load at the outlet of the pump. When a hydraulic pump creates a vacuum at the pump inlet, forcing liquid from the reservoir into the inlet line to the pump, and by mechanical action, it delivers this liquid to the pump outlet. It then forces oil into the hydraulic system. Direction control valves will usually consist of a spool inside a cylinder that is mechanically or electrically actuated.

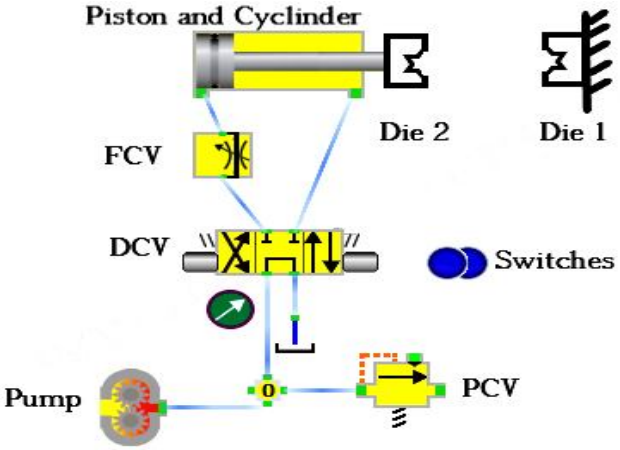


Fig. 4 Hydraulic Circuit of Torx key unit

IV. DESIGN OF TORX KEY

Torx screws are used in automobiles, motorcycles, bicycle brake systems (disc brakes), hard disk drives, computer systems, and consumer electronics commonly. In the beginning, they were used in applications requiring tamper resistance in some ways, but since the drive systems and screwdrivers were not available widely; as drivers became more common, tamper-resistant variants, as described below, were developed. Torx screws are also becoming popular dynamically in many industries.

Following are design considerations and calculations for Torx key

The little consideration will show that the key fails either in shearing or crushing

Tensile Strength-530 MPa (from material properties)

Yield Strength-385 MPa (From material properties)

Using, Yield strength of Material for T7 key i.e. Diameter=7mm

Therefore, P=14.81 KN …….. (YS/Area)

Using, Tensile strength of Material for T7 key i.e. Diameter=7mm

Therefore, P=20.96 KN …….. (TS/Area)

V. 3D MODEL

3D Model for Torx key Manufacturing unit as shown in Fig 5 using 3D modeling software is as follows which shows the actual virtual prototype of the unit. Various systems in the unit consist of:

1) Hydraulic System
2) Control System
3) Embossing Dies

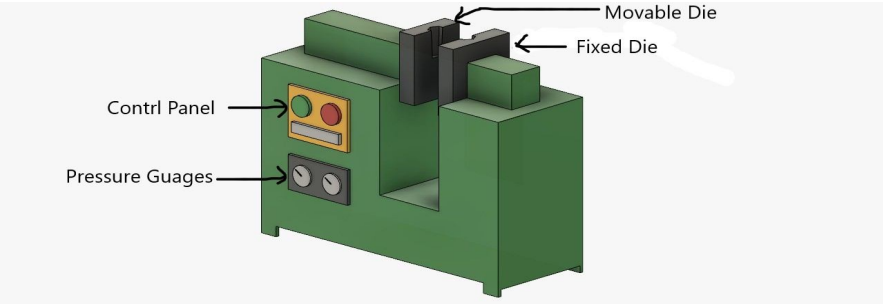


Fig. 5. 3D Model of Torx Key Unit

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Hydraulic system is consist of gear pumps, filters, control valves, actuators, and pressure gauges. The work done by hydraulic oil SAE68 will provide motion in dies which in turn will apply pressure on the Torx key blank by embossing replica shape as that of the die and giving the actual shape of the Torx key. The side view and front view are shown in Fig. 6 and Fig 7.

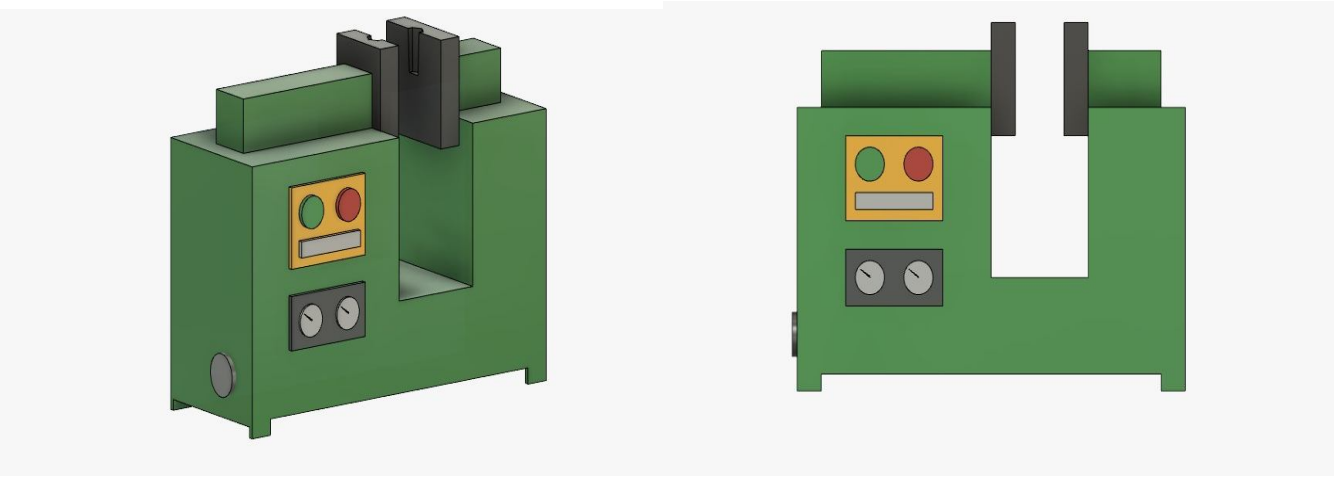


Fig. 6. Side View of 3D Model

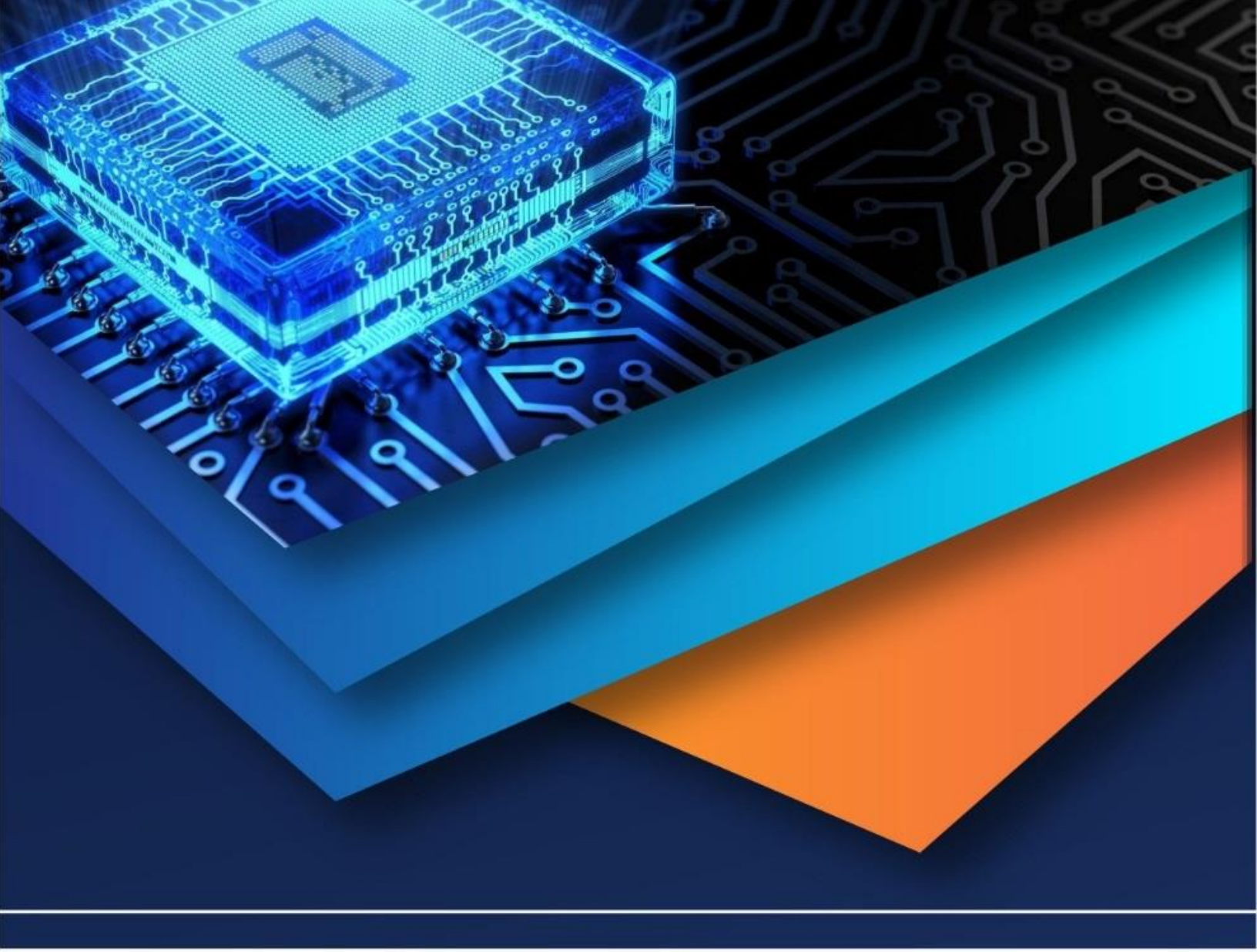
Fig.7. Front View of 3D Model

VI. CONCLUSION

The Design and development of the Torx key manufacturing unit will help reduce the product cost thus increasing the profitability for manufacturers and cost reduction for customers. Some of the conclusions that we are drawing from this Project are as follows: - Properly designed, fabricated, and operated tool enables us to provide high-quality products at a sufficiently high volume of production, low cost. Developing Torx key manufacturing unit will require designing special dies which will make impression on the key, the hydraulic pressure will be created by a small hydraulic press and impressions will be marked. Under this project we will use the currently available research on a mini hydraulic press and Allen key manufacturing unit. Available research has a research gap that we are going to overcome through designing and manufacturing the Torx key manufacturing unit. Thus, we can reduce the research gap there in the Torx key manufacturing and the special unit for Torx key manufacturing at Laxmi Tools Corporation will increase the profitability of the company up to 60% reducing the input cost which has to be bearded by the manufacturer itself.

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