DESIGN AND PERFORMANCE ANALYSIS OF MOTORIZED SCREW JACK

A Project

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DESIGN AND PERFORMANCE ANALYSIS OF MOTORIZED SCREW JACK

We thus certify that the undergraduate thesis work described in this thesis was completed by us under the guidance of Md. Faruque Hossain, Lecturer, Sonargaon University (SU) Department of Mechanical Engineering, and that this report has not been submitted in whole or in part to any other university for another degree, award, or other reason. We hereby certify that Sonargaon University's (SU) Department of Mechanical Engineering is the sole owner of all copyrights to this practicum report. It is strictly forbidden to reproduce or use in any way without Sonargaon University's (SU) explicit approval.

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ABSTRACT

A screw jack is a mechanical device used for lifting the heavy-duty vehicles. Screw jack is employed by the screw threads for lifting purpose. To operate the screw the handle is used and when the handle is operated clockwise then it lifts the work similarly when the handle is operated in anti-clockwise then it lowers the work. In case of tire flat or changing the tire, the screw jack is very important and useful device. The screw jack is operated manually and when the ancient people when they want to change the tire it is not so easy. So, to overcome the situation it can be employed automatically so that the time is reduced and they can conveniently replace the tire. The motorized screw jack features user-friendly controls, robust safety systems like automatic locks and emergency shut-off functions, and is constructed from durable materials to ensure long-term reliability. It operates via a 12V power supply, typically sourced from a vehicle's cigarette lighter socket. The project demonstrates that the motorized screw jack can lift a vehicle safely and efficiently, making it a valuable tool for both professional mechanics and everyday vehicle owners. The prototype's performance in load tests confirms its capability to handle substantial weights with improved lifting speed and minimal manual effort.

CHAPTER 1
INTRODUCTION

1.1 Introduction

This paper deals with the design and fabrication of motorized screw jack which is used for lifting heavy automobiles, using the power from a dc motor. The project helps in reducing the effort as well as time taken to lift the load in comparison to the ordinary screw jack. It consists of a D.C motor, battery, worm gear arrangement and a screw jack arrangement. A screw jack's compressive force is obtained through the tension force applied by its lead screw. A square thread is most often used, as this thread is very strong and can resist the large loads imposed. These types are self-locking, which makes them more intrinsically safe than other jack technologies. This type of screw jack will be helpful for women and adolescents during the puncture to lift the vehicle when they have no means to serve. Electrical actuation is chosen here because the power obtained through this is comparatively high. The direction of the rotation of the motor is obtained by the pulse modulation from the control relay. Thus it is considered to be the most efficient and easy method to actuate. A scissor lift (jack) or mechanism is a device used to extend or position a plate formed by mechanical means. The term "scissor" is used since the folding supports are in criss cross "X" pattern. The extension or displacement motion is achieved by applying force to one of the supports and thus the elongation of the crossed pattern occurs. The force applied to extend the scissor mechanism may be hydraulic, pneumatic or mechanical means. Our objective is to actuate through electric mean.[1]

1.2 Design And Architecture

This is an era of automation where it is broadly defined as the replacement of manual effort by mechanical power in all degrees of automation. The Remote Operated Screw Jack is designed with a focus on simplicity, reliability, and efficiency. It comprises the following main components:

I. Lead Screw: The screw is a threaded shaft that moves linearly when rotated. It is the primary component responsible for lifting or lowering the load.

II. Universal Joint: It is used to connect the motor to the lead screw, allowing for angular misalignment and flexibility in the mounting arrangement.

III. DC Motor: A DC motor is used to provide the rotational force required to

drive the screw. The motor is controlled remotely, allowing for convenient operation.

IV. Remote Control System: The remote-control system enables the remote operation of the screw jack. It allows the user to control the movement of the screw and the lifting or lowering of the load from a distance.

V. 12V Battery: Powers the motor and can be sourced from the car's own battery for added convenience.

1.3 Objectives of the Study

- To design and construct motorized screw jack.
- To analyze the performance of motorized screw jack.

1.4 Proposed Methodology

The proposed system focuses on designing and fabricating a motorized screw jack to simplify the vehicle lifting process during maintenance and tire replacement. Traditional manual jacks require significant human effort and time, often posing safety risks. The motorized screw jack integrates an electric motor, lead screw mechanism, and control switch to automate the lifting and lowering operations. This system ensures efficient, safe, and reliable vehicle elevation with minimal manual input. Designed for automotive applications, the proposed model enhances portability, reduces operation time, and provides a user-friendly solution adaptable for both light and medium duty vehicles.

1.5 Organization of book

Chapter 1: Introduction - Provides an overview of motorized screw jack design and project objectives.

Chapter 2: Literature Review - Reviews existing research and advancements related to motorized design, performance, and optimization techniques.

Chapter 3: Components and Materials - Details the selection and specifications of materials, components, and the construction of motorized screw jack.

Chapter 4: Methodology - Describes the design process, construction and calculations, used in the project.

Chapter 5: Results and Discussion - Presents the findings, performance evaluation, comparison with industry standards, and application of motorized screw jack.

Chapter 6: Conclusion - Summarizes the project's findings, contributions, limitations.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

A jack, screw jack or jackscrew is a mechanical device used as a lifting device to lift heavy loads or to apply great forces. A mechanical jack employs a screw thread for lifting heavy equipment. A hydraulic jack uses hydraulic power. The most common form is a car jack, floor jack or garage jack, which lifts vehicles so that maintenance can be performed. Jacks are usually rated for a maximum lifting capacity (for example, 1.5 tons or 3 tons). Industrial jacks can be rated for many tons of load. A hydraulic jack operates on this two-cylinder system (Muchnik, 2007). Many trends (screw or hydraulics) have gone down around the lifting applications in the automobile workshops. Increasing the mechanical advantage of doing work remains the objective of these developments (Muchnik, 2007)[1].

2.2 Literature Review

Screw type mechanical jacks were very common for jeeps and trucks of World War II vintage. For example, the World War II jeeps (Willys MB and Ford GPW) were issued the "Jack, Automobile, Screw type. This jacks and similar jacks for trucks were activated by using the lug wrench as a handle for the jack's ratchet action to the jack. Screw type jack's continued in use for small capacity requirements due to low cost of production and ease of mobility. The virtues of using a screw as a machine, essentially an inclined plane wound round a cylinder, was first demonstrated by Archimedes in 200BC with his device used for pumping water.[2] There is evidence of the use of screws in the Ancient Roman world but it was the great Leonardo da Vinci, in the late 1400s, who first demonstrated the use of a screw jack for lifting loads Leonardo’s design used a threaded worm gear, supported on bearings, that rotated by the turning of a worm shaft to drive a lifting screw to move the load - instantly recognizable as the principle we use today. During the early 1880s in Coaticook, a small town near Quebec, a 24-year-old inventor named Frank Henry Sleeper designed a lifting jack. Like Da Vince’s jack, it was a technological innovation because it was based on the principle of

the ball bearing for supporting a load and transferred rotary motion, through gearing and a screw, into linear motion for moving the load. The device was efficient, reliable and easy to operate. It was used in the construction of bridges, but mostly by the railroad industry, where it was able to lift locomotives and railway cars. With the ability to be used individually or linked mechanically and driven by either air or electric motors or even manually, the first model had a lifting capacity of 10 tons with raises of 2 or 4 inches. More recent developments have concentrated on improved efficiency and durability, resulting in changes in both lead screw and gearbox design options for screw jacks [3]

2.3 Motorized System

The motor that is used for this project is a 12V DC Car Wiper Motor. The motor is powered by the internal car battery power connected through the car cigarette socket inside the car. The DPDT switch is used as the two-way circuit for the motor. It controls the rotation of the motor. Generally, DPDT has six terminals, whereas DC motor has two terminals. DPDT switch is used to make a two-way circuit in order to allow the motor to rotate clockwise and counter-clockwise. Figure 1shows the circuit diagram for the motorized system of the automatic scissor jack. The circuit diagram was constructed by using Circuit Diagram Web Editor. When the DPDT switch 'O' button is pressed, current will flow and enter the motor from the positive pole and exit from the negative pole. This will make the motor shaft rotate clockwise, thus lifting the car. However, when the DPDT switch '-'button is pressed, the current will flow and enter the motor from the negative pole and exit from the positive pole.[4] This will trigger the motor to rotate its shaft to opposite direction which is counter clockwise and will lower the car. This explains the two-way circuit by using the DPDT switch.

2.4 The Main Components Are As Follows

1) Hydraulic Jack: A Hydraulic jack consists of a cylinder and piston mechanism. The movement of piston rod is used to raise or lower the load. And secondly Mechanical jacks. They are either hand operated or power driven. They have further components like ram, plunger

2) Motor: The motor is DC type of motor with 12 volts power which gives 45rpm speed, which is efficient to lift the vehicles from ground.

3) Crank: It can be used to convert circular motion into reciprocating motion, or vice versa. The arm may be a bent portion of the shaft, or a separate arm or disk attached to it.

4) Connecting Rod: When crank combined with a connecting rod, it can be used to convert circular motion into reciprocating Motion, or vice versa.

5) Battery: Acid lead battery with capacity 35A provides nominal Voltage of 12V

6) Switch: To operate the operation in one press switch is used to closed and open the circuit from battery with motor hence Jack will be stop.

7) LED Strip: For Better visualization and handling the operation during night time

8) Base Frame: All of the above components are assembled with this base to achieve the goal [5].

2.5 Working Of Motorized Jack

The lead-acid battery is used to drive the D.C motor. The D.C motor shaft is connected to the spur gear. Spur gear is messed with main gear which is in-turn messed with lead screw of jack. When the power is given to the D.C motor, it drives the spur gear which in-turn rotates the lead screw via main gear in messing with it. The lead screw moves upward, so that the vehicle lifts or object lifts from ground. The vehicle/object is lifted by using the lifting platform at the top of the lead screw. Lifting and lowering of jack is controlled using a remote-control circuit also as a secondary controlling unit toggle switch is incorporated[6].

Under ideal conditions, the jack can lift a vehicle body when it interacts with the upper plate, which is created by the revolution of force screw through the electric power taken from the car battery (12V) by means of cigarette lighter repository connected to auto. Firstly, mechanized jack will be put under car body with some freedom space between top plate and skeleton. The cigarette lighter repository associated with jack will be connected to the port, consequently interfacing specifically with car battery. At the point when a course of development will be given by joystick, the power will be taken and Motor begins turning. The motor will exchange its shaft velocity to the pinion equip coinciding with a greater apparatus which is associated with screw jack and it will turn [7]. On surrendering course, the screw jack will pivot inside strung cubical bore in far-reaching heading, which will make joints move along strong segment towards each other in load raising procedure and the other way around. Amid stacking process, jack

will take out the freedom space amongst itself and frame by ascending. At the point when the case will interact with jack, the heaviness of auto will step by step exchange to jack. These created strengths will be disseminated among connections and cubical bore. The drive transmitted to cube shape will be exchanged to screw strings.

2.6 Summary

A motorized screw jack is an advanced, automated version of the traditional mechanical jack, designed to lift heavy loads with minimal physical effort. It functions by integrating an electric motor—typically powered by a 12V vehicle battery or a portable power source—to drive the internal gear and screw mechanism. This system converts the motor's rotational energy into linear motion, allowing the jack to raise or lower weights through a simple switch or remote control. By replacing manual cranking with electrical power, these jacks significantly reduce the time and labour required for tasks like roadside tire changes or industrial equipment positioning.

Beyond convenience, motorized screw jacks offer enhanced safety and precision compared to manual models. Most designs incorporate self-locking Acme threads or specialized braking systems, ensuring the load remains securely in place even if the power is disconnected. In industrial settings, multiple motorized jacks can be synchronized electronically to lift large, unbalanced platforms with perfect balance. Because of their portability, ease of use, and reliable performance, motorized screw jacks have become essential tools for both professional mechanics and modern industrial applications, providing a safer and more efficient alternative to traditional lifting methods[7].

CHAPTER 3
REQUIRED MATERIALS

3.1 Required Components

Table 3.1: Required Components

S/L	Component	Quantity
1	D.C Motor	1
2	Lead screw	1
3	Battery	1
4	Spur gear	1
5	Control Switch	1

3.2 D.C Motor

The wiper motor and bracket is the electric wiper motor forms the central part of the windshield wiper system. The motor is mounted on a fabricated mild steel bracket which is polyester powder coated to prevent corrosion. The motor is connected electrically by means of a multi-pin connector The drive lever is secured to the wiper motor shaft and connected through a tie bar, to the spindle lever assembly.

These components transfer the motor shaft rotation to the wiper arm assemblies. The drive mechanism provided transfers the rotary output from the motor; to a reciprocating motion of the spindles, this mechanism is zinc plated and is sized to give the correct angle of arc for the windscreen wiper arm being driven[8]. The Spindles that drive the wiper arms pass through the bulkhead, connecting the drive mechanism to the wiper arm; these are manufactured from stainless steel, to prevent corrosion.

The spindles are driven from the main drive crank by connecting tie bars which distributes the load evenly between the shafts of the wiper arm thus reduces the load on the individual interfaces between the wiper arm and the spindles.

Figure 3.1: D.C Motor

3.3 Lead Screw

The lead screw used as a linkage in a machine to turning motion into linear motion. The size and shape (i.e. short, tall, fat & thin) of lead screw depend on the load under they work and space in which they need to fit. Due to sliding contact of the lead screw, a large amount of heat is generated. To overcome such problem and to increase efficiency it should be work under ambient condition or lubricant must be applied.

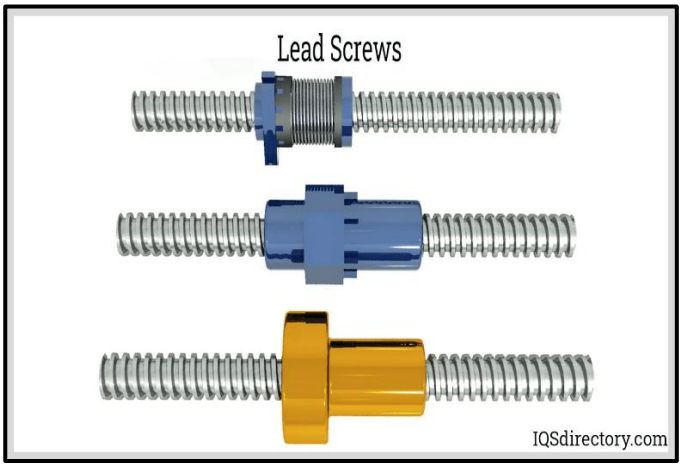

Figure 3.2: Lead Screw

3.4 Battery

Battery supplies current to operate the starting motor and the ignition system when the engine is being started. It also acts as a voltage stabilizer by supplying current for the lights, radio, and other electrical accessories 'when the alternator is not handling the load. The battery is an electrochemical device. This means it uses chemicals to produce electricity

Figure 3.3: Battery

The amount of electricity it can produce is limited. As the chemicals in the battery are "used up" the battery runs down, or is discharged. It can be recharged by supplying with electric current from a battery charger, or a vehicle alternator can recharge it. The "used up" chemicals are then returned to their original condition, so the battery becomes recharged[9].

3.5 Control Switch

Smart high-side switches reliably drive off-board loads. These switches contain highly-adjustable and selectable current limits that enable a system to be optimally designed for specific loads. By connecting an external resistor to set the current-limit threshold, the switch protects the load and power supply from overstressing during short-circuits to GND events or power-up conditions.

This enables more reliable designs by minimizing transient currents and supply droops

Figure 3.4: Control Switch

The CS pin does not need to be calibrated, and can serve as a diagnostics report pin. Whenever an open load or short happens, the voltage on the CS pin falls to 0 V. Whenever a current limit, thermal event, or an open load or short in the off state occurs, the voltage is pulled up to its maximum threshold. High-accuracy current monitoring and adjustable current limit are ideal for industrial applications like programmable logic controllers, motor valves, servo drives, and control units. Another functionality of smart high-side switches is load-dump compatibility, which allows these devices to connect directly to a 12-V battery without concerns about typical voltage and current transients' Additional protection includes mitigation of large inrush current events that would otherwise damage downstream components.

CHAPTER 4
METHODOLOGY

4.1 Methodology

This section considers the materials and method utilized in the actualization of the work, design analysis of the motorized toggle jack, principle of operation of the system and required system assembly. Operational Principle Under ideal conditions, the jack is put under car body with some freedom space between top plate and skeleton. The cigarette lighter repository associated with jack will be connected to the port, consequently interfacing specifically with car battery. The car battery is used to drive the D.C motor. The D.C motor shaft is connected to the screw through coupling. If the power is driven to the D.C motor, it will run so that the screw also runs and converts rotary to translator motion. The arms of the jack move upwards, so that the vehicle lifts from the ground. The vehicle is lifted by using the lifting platform at the top of the jack. The motor draws the power from the battery. After pressing the switch, power from the battery is connected to the screw. When taping the switch to the positive pole, positive voltage is supplied to the D.C. motor in clockwise direction and the lead screw moves in downward direction. Similarly, when tapping the switch to the negative pole, negative voltage is supplied to the D.C. motor which moves in anticlockwise direction and the lead screw moves in upward direction. In this way the directions can be controlled which in turn regulates the lift load direction either upward or downward[10].

4.2 Block Diagram

The general definition of automation in this era is the substitution of mechanical power, in all its forms, for human labour. The Remote Operated Screw Jack was created with simplicity, dependability, and efficiency in mind.

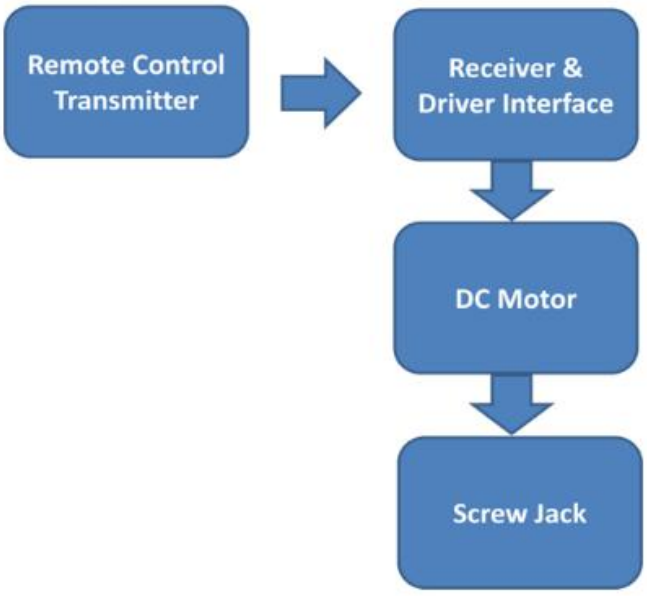

Figure 4.1: Block Diagram

4.3 Complete Project Prototype Image:

Figure 4.2: Complete Project Picture

4.4 Working Principle of Motorized Screw Jack

A) Scissor Jack:

The scissor jack is used to lift the vehicle where the action is carried it out by mechanical, hydraulic or pneumatic means. Such a jack is a standard accessory with many cars. It consists of a diamond shaped frame having a nut on one side and a sleeve on the other. A screw is supported in the nut and the sleeve. Rotating the screw the nut moves towards or away from the sleeve depending upon the direction of the rotation, so that the vehicle supported on the jack is lifted or moved down. The jack is so designed that there is always sufficient friction in the screw to hold the jack from moving down under load. But we are using the motor to rotate the screw for lifting the vehicle.

Figure 4.3 : Scissor Jack

B) Screw Jack Mechanism:

We have used ON/OFF switch in this project; the ON/OFF switch keys are interface with control circuit with battery. And we are connecting the DC motor with the mechanical model for the up and down movement. When we switch ON, it will send a high pulse to control circuit then the control circuit activates the corresponding relay to rotate the DC motor in forward direction, so that the jack will move up. When we switch OFF, it will also send a low pulse to the control circuits its activating relay to rotate the DC motor in reverse direction so the jack will move down. Using this we can lift the load using power jack without human effort[11].

CHAPTER 5
RESULT AND DISCUSSION

5.1 Design & Calculation

Load Calculation:

$$W = \frac{2\pi T\eta}{P}$$

$$= \frac{2\pi \; x \; 9 \; x \; 0.3}{0.002}$$

$$= 8482 \text{ N}$$

P= Pitch = 2mm= 0.002 m

$$\eta = 30\% = 0.3$$

T (torque) = 9 N-m

We know,

$$1 \text{ kg} \approx 9.8 \; Newton$$

$$\frac{8482}{9.8} = 865 \text{ kg}$$

5.2 Result

The jack which is designed has an efficiency of 29% whereas the normal jacks have efficiency of around 15% to 20%.

5.3 Advantage

Our initiative undoubtedly has many benefits, some of the most significant of which are listed below:

- The loaded light vehicles can be easily lifted.
- Checking and cleaning are easy, because the main parts are screwed
- Handling is easy
- No Manual power required
- Easy to Repair.
- Replacement of parts is easy

5.4 Disadvantage

- Cost of the equipment is high when compared to ordinary hand jack.
- Care must be taken for the handling the equipment such as proper wiring connection, battery charging check-up, etc.

5.5 Application

- It is useful in auto-garages.
- This motorized screw jack is used for lifting the vehicles. Thus, it can be useful for the following types of vehicles in future Maruthi, Ambassador, Fiat, Mahindra.

5.6 Limitation

- Cost of the equipment is high when compared to ordinary hand jack.
- Since it involves electric circuitry device should be handled with care.
- Care must be taken for the handling the equipment such as proper wiring connection, battery charging and checkup. Space constraints in compact designs may hinder flow optimization.

5.7 Discussion

A motorized screw jack is a very effective mechanical tool that uses an electric motor's rotational energy to provide linear motion in order to raise, lower, or place large loads. A high-torque electric motor, a gear reduction device (often a worm or spur gear), and a threaded lead screw make up the standard setup. The load moves vertically with considerable mechanical advantage when the motor is turned, which also rotates the screw. The "self-locking" feature of machine screw versions, which guarantees the load stays firmly in place even when power is cut off, makes this design very valuable. Due to its accuracy and simplicity of usage, motorized screw jacks have become more and more popular in contemporary engineering and automotive contexts for 2026. In the automotive industry, 12V DC-powered models enable drivers to easily raise cars during emergency tire changes by just plugging the gadget into the battery or cigarette lighter. These jacks are frequently used into automated systems with sensors and remote controls in industrial settings to control heavy machines or alter the height of assembly lines. Because they don't run the risk of oil leaks, motorized screw jacks are a better option for precision-driven and environmentally conscious applications than hydraulic jacks.

CHAPTER 6
CONCLUSION

6.1 Conclusion

In conclusion, the mechanical screw jack stands as a versatile and indispensable device vital for lifting, lowering, or holding heavy loads across diverse applications. Its core mechanism comprises a threaded screw that converts rotary motion into linear motion, offering mechanical advantage to lift loads with minimal exertion.

Throughout our exploration, we delved into the working principles, components, and design considerations of the mechanical screw jack. We examined crucial features such as the screw thread profile, load capacity, lifting speed, and safety mechanisms. Additionally, we explored various types of screw jacks, including worm gear screw jacks and ball screw jacks, each with distinct advantages and limitations. Furthermore, we emphasized the significance of proper maintenance and lubrication to ensure the smooth operation and longevity of screw jacks. Regular inspection, cleaning, and lubrication are imperative to prevent issues such as wear, corrosion, or jamming. Safety precautions associated with screw jack usage were also discussed, stressing the importance of accurate load calculations, stability, and the implementation of additional safety measures like limit switches, overload protection, and emergency stop mechanisms. In summary, the mechanical screw jack stands as a reliable and efficient tool indispensable in industries such as automotive, construction, and manufacturing. Its straightforward yet robust design, coupled with diligent maintenance and safety measures, enables efficient load handling while ensuring a secure working environment.

6.2 Future Scope

The mechanical screw jack has long served as a reliable tool for lifting and lowering heavy loads across various applications. Despite the emergence of alternative lifting methods driven by technological advancements, mechanical screw jacks still hold potential for future applications and enhancements. Here are several areas where they could continue to excel:

- Industrial Machinery: Mechanical screw jacks remain valuable in industrial settings where precise vertical positioning is essential. They find utility in assembly lines, manufacturing processes, and other industrial applications requiring controlled lifting and lowering of heavy equipment.
- Construction and Infrastructure: Screw jacks can contribute to construction projects by providing temporary support, leveling, and adjustment of structures. They are beneficial for aligning precast concrete elements, adjusting formwork, and facilitating temporary lifting during construction activities.
- Maintenance and Repair: Screw jacks offer practical solutions for maintenance and repair tasks, particularly when hydraulic or electric alternatives are impractical. They assist in lifting heavy machinery or equipment for inspection, repair, or component replacement.
- Automotive Industry: In the automotive sector, screw jacks serve various purposes such as vehicle repairs, tire changing, and lifting heavy vehicle parts during assembly or disassembly. They provide stability and controlled lifting in diverse automotive applications.
- Customized Applications: Mechanical screw jacks can be tailored to meet specific requirements in niche industries or specialized applications. They can be integrated into unique equipment or machinery setups, addressing challenges like space constraints, environmental conditions, or specific load demands.

While mechanical screw jacks offer distinct advantages, it's essential to acknowledge that other lifting technologies, such as hydraulic, pneumatic, or electric systems, may outperform them in terms of speed, efficiency, and automation. Consequently, the future scope of mechanical screw jacks might be somewhat constrained compared to these alternatives. Nonetheless, they retain relevance in specific scenarios where their unique features and characteristics are advantageous.

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