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DESIGN AND DEVELEOPMENT OF SOLAR OPERATED HYDRAULIC JACK

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ABSTRACT
This project investigates the development and implementation of a solar-powered hydraulic jack, designed to offer an environmentally friendly and efficient lifting solution. Hydraulic jacks are commonly used in automotive and industrial settings for lifting heavy loads. Traditionally, these jacks depend on manual effort or electrical power, which can be labor-intensive or reliant on non-renewable energy sources. The proposed system utilizes solar energy as a sustainable alternative to power the hydraulic mechanism.
The solar-powered hydraulic jack consists of several key components: solar panels, a battery storage system, a DC motor, a hydraulic pump, and the hydraulic jack itself. The solar panels convert sunlight into electrical energy, which is stored in the battery. This stored energy powers a DC motor that drives the hydraulic pump, generating hydraulic pressure to lift the load.
The design aims to optimize energy efficiency and reliability. By utilizing renewable solar energy, the system reduces the carbon footprint and operational costs associated with traditional hydraulic jacks. The project also addresses the challenge of intermittent solar power by incorporating a battery storage system, ensuring continuous operation even during low sunlight conditions.
Experimental results demonstrate that the solar-powered hydraulic jack performs comparably to conventional models, with the added benefits of sustainability and reduced dependency on external power sources. This innovation has the potential to revolutionize the lifting equipment industry, providing a green alternative that aligns with global efforts to combat climate change and promote renewable energy technologies.

Keywords: Solar energy, hydraulic jack, renewable energy, sustainability, battery storage, DC motor, hydraulic pump.

INTRODUCTION

General Introduction

Our survey among vehicle users revealed that lifting vehicles for reconditioning often involves difficult methods. This project focuses on addressing this challenge by developing a solar-powered hydraulic jack that can lift vehicles from the ground without applying impact force. Designed to cater to the needs of small and medium automobile garages, which typically rely on manual labor with minimal skill, this jack aims to simplify the lifting process. In most garages, vehicles are lifted using

screw jacks, which require significant manpower and skilled labor. To overcome these disadvantages, our built-in jack is designed for smooth operation, allowing even unskilled labor to use it with ease. As the automobile market grows, advanced concepts are continually being implemented to enhance the versatility and comfort of vehicles. One such concept is variable height adjustment, which allows for the adjustment of a vehicle's ground clearance, making it adaptable to various road conditions.

A hydraulic jack operates on the principle of using liquid to push against a piston, based on Pascal's Principle. This principle states that pressure in a closed container is uniform at all points. In a system with two connected cylinders, applying force to the smaller cylinder generates the same pressure in the larger cylinder. Due to the larger area of the second cylinder, the resulting force is greater. Therefore, an increase in area leads to an increase in force, and the greater the difference in cylinder size, the greater the force generated. This two-cylinder system is fundamental to the operation of a hydraulic jack.

Hydraulic Jack:-

A mechanical lifting device incorporates an external lever, which, when force is applied, causes a small internal piston to pressurize fluid—usually oil—in a chamber. The generated pressure exerts force on a larger piston, causing it to move vertically upward and raise the bearing plate above it. A hydraulic jack uses an incompressible liquid, typically oil, which is forced into a cylinder by a pump plunger. Oil is preferred because it is self-lubricating and stable. When the plunger pulls back, it draws oil from the reservoir through a suction check valve into the pump chamber. When the plunger moves forward, it pushes the oil through a discharge check valve into the cylinder. The suction valve ball inside the chamber opens with each draw of the plunger, while the discharge valve ball outside the chamber opens when oil is pushed into the cylinder. At this stage, the suction ball within the chamber is forced shut, allowing oil pressure to build in the cylinder.

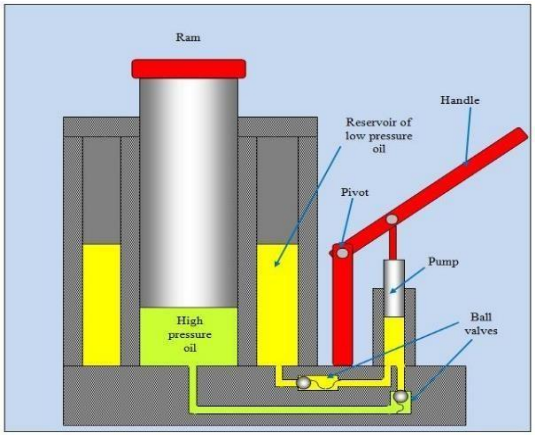


Fig 1. Hydraulic Jack.

LITERATURESURVEY

Early Development Of The Jack

Evidence of screw usage dates back to Ancient Rome, but it was Leonardo da Vinci in the late 1400s who first demonstrated the use of a screw jack for lifting loads.

Leonardo's Design

Leonardo's design employed a threaded worm gear, supported on bearings, rotated by a worm shaft to drive a lifting screw and move the load. This principle is instantly recognizable and still used in modern screw jacks.

Further Improvements

The history of hydraulic jacks traces back to the 17th century when French mathematician and philosopher Blaise Pascal illustrated the principle of the hydraulic jack. In 1795, British engineer Joseph Bramah obtained a patent for a new method of producing and applying power to machinery, which led to the development of the first hydraulic press.

On July 8, 1851, Richard Dudgeon, the founder of Richard Dudgeon, Inc., was awarded a patent for "portable hydraulic presses" in New York. These early jacks were operated by water or other fluids like whiskey and whale oil. The fluid reservoir was located in the head of the device, leading to the nickname "Whiskey Jack" because whiskey was often used as the working fluid due to its resistance to freezing and thickening in winter.

Dudgeon’s initial hydraulic jack had some drawbacks, such as being top-heavy due to the reservoir's placement. He addressed this issue 14 years later by relocating the fluid reservoir to the base of the jack, resulting in a more balanced and improved model. The 1851 design proved more powerful, portable, and easier to operate compared to screw jacks, which required significant effort to lift heavy loads. Dudgeon's hydraulic jacks found extensive use in railroad shops and the shipbuilding industry due to their high performance and functionality.

Evolution and Modern Applications

Since then, hydraulic jacks have evolved to push, pull, lift, lower, and position loads ranging from a few kilograms to hundreds of tonnes. One of the largest single screw jacks made to date is a special Power Jacks E-Series unit, rated for 350 tonnes. This evolution underscores the jack's versatility and continual improvement in design and functionality.

PROBLEM IDEFINITION

Common Issues with Scissor Jacks

One of the most common problems with scissor jacks is their instability, especially when jerks are applied to loosen wheel nuts. Additionally, the small base of these jacks often fails to provide proper support on uneven surfaces, such as off-road terrains, and they cannot tolerate any inclination.

Current Mechanism of Hydraulic Jack Operation

****Hydraulic Jacks:****

- Hydraulic jacks are typically used for shop work rather than as emergency jacks carried with vehicles.
- These jacks operate by using a handle, which acts as a lever to compress fluid and route it to an actuating cylinder, resulting in lift.
- Hydraulic jacks are commonly used for various lifting applications due to their efficiency and power.

Objective

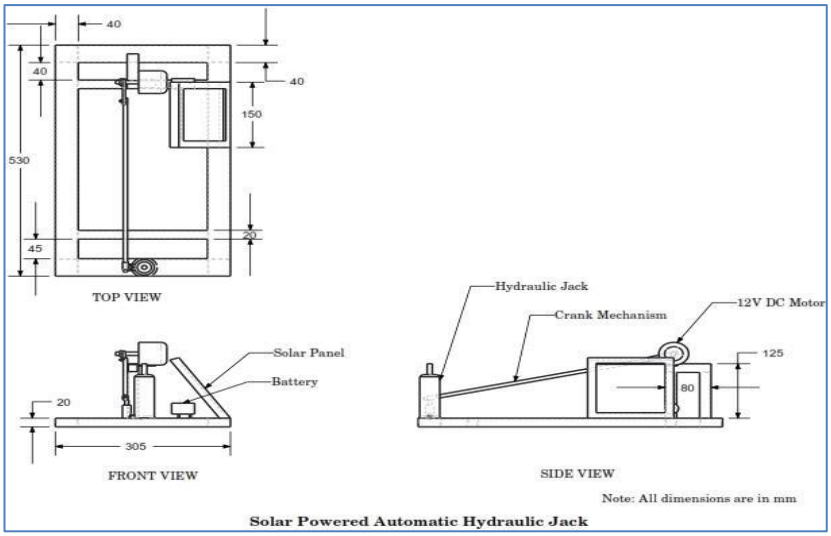
The project focuses on designing a simple solar-powered automatic hydraulic jack and analyzing its structural improvements to ensure stability and load capacity on uneven surfaces, allowing for some inclination.

The goals of the project include:

- Designing a hydraulic jack that is very stable and capable of handling enough load on uneven surfaces.
- Allowing for some degree of inclination in the jack design.
- Conducting stress analysis, efficiency evaluation, and estimating the expected lifespan of the jack.
- Developing a cost-effective hydraulic jack with a long life that can withstand rough handling.

By addressing these objectives, the project aims to create a more reliable and versatile hydraulic jack suitable for a variety of environments and conditions.

METHODOLOGY



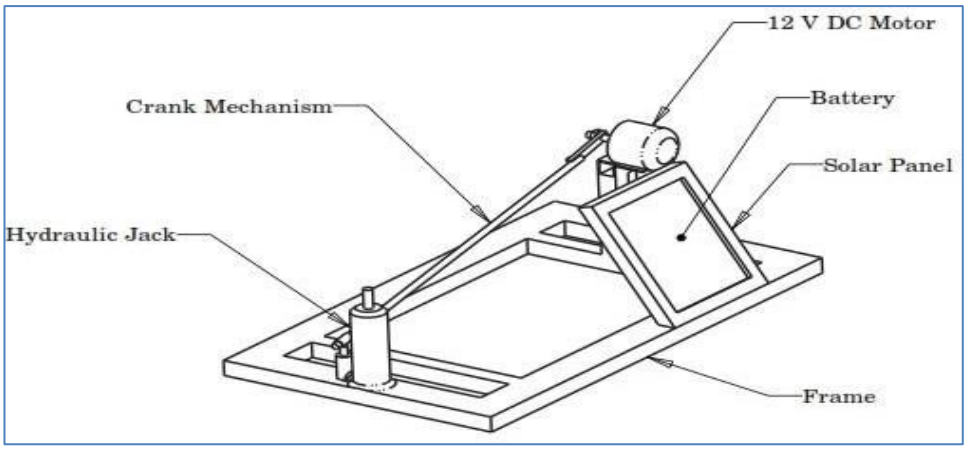


Fig 2. 3d Models

WORKINGPRINCIPLE:

A hydraulic mechanical jack employs a hydraulic power system to lift heavy equipment. The most common forms are car jacks, floor jacks, or garage jacks, used to lift vehicles or trucks for maintenance. Hydraulic jacks are rated based on their maximum lifting capacity, such as 1.5 tons, 3

tons, 20 tons, or 30 tons.

Hydraulic jacks use an incompressible fluid, typically hydraulic oil, which is forced into a cylinder by a pump plunger. The oil is self-lubricating and stable, making it ideal for this application. The operation involves the following steps:

1. **Plunger Movement**: When the plunger pulls back, it draws oil from the reservoir through a suction check valve into the pump chamber.
2. **Oil Compression**: When the plunger moves forward, it pushes the oil through a discharge check valve into the cylinder.
3. **Valve Mechanism**: The suction valve ball within the chamber opens with each draw of the plunger, while the discharge valve ball outside the chamber opens when oil is pushed into the cylinder. At this point, the suction ball within the chamber is forced shut, building oil pressure in the cylinder.

In some hydraulic jacks, horizontal pistons push on the short end of a bell crank, with the long arm providing vertical motion to a lifting pad, kept horizontal by a horizontal linkage. Castors and wheels compensate for the arc taken by the lifting pad, allowing a low profile when collapsed and considerable extension for lifting.

Components and Operation

Components used in this project:

- Solar panel
- Battery
- DC motor
- Hydraulic jack
- Frame
- Crank mechanism

Operation:

- The solar panel charges the battery.
- The battery powers the DC motor, which rotates.
- The DC motor drive is transmitted to the hydraulic jack unit through the crank mechanism.
- The rotary motion of the motor is converted into the reciprocating motion of the jack.
- The vehicle is lifted up and down by pressing a switch on the panel board.
- A 12V DC supply is provided by the 12V DC motor, allowing the vehicle to be lifted slowly without any jerks.

The incorporation of a DC motor with a hydraulic jack, controlled by a solar-charged battery, results in a smooth and efficient lifting mechanism, suitable for various environments and capable of handling uneven surfaces and inclinations

COSTING

MATERIAL COST

TableNo1.Material Costs

Bill of Materials

Sr	COMPONENTS	COST(Rs)	QUANTITY
1.	Solar Plate	1200	1
2.	Frame	350	5
6.	Motor	2400	2
7.	Hydraulic Jack	1800	1
8.	Pipe	200	3
9.	Battery	1450	1
10.	Rivets	240	3 meter
	TOTAL	7640Rs.	

ADVANTAGES, DISADVANTAGES, APPLICATIONS

ADVANTAGES

Advantages of the Solar-Powered Hydraulic Jack

1. **Single-Person Operation**: Can be operated efficiently by one person to remove the tire.
2. **Easy and Efficient Handling**: Allows for easy and efficient handling of the liner puller without causing damage to the vehicle or other parts.
3. **Increased Puller Life**: Enhances the lifespan of the puller.
4. **Low Maintenance**: Requires minimal maintenance.
5. **No Dedicated Workspace Needed**: Does not require a separate workplace.
6. **On-Site Usability**: Can be used directly at the work spot.
7. **Load Lifting Suitability**: Well-suited for lifting loads.
8. **No Conventional Electricity Needed**: Does not require conventional grid electricity.
9. **Long Operating Life**: Designed for long operating life.
10. **Highly Reliable and Durable**: Offers high reliability and durability.
11. **Ease of Use**: Simple to operate and maintain.
12. **Eco-Friendly**: Environmentally friendly.
13. **No Environmental Pollution**: Does not cause environmental pollution like fossil fuels or nuclear power.
14. **Long-Lasting Solar Cells**: Solar cells have a long lifespan and low running costs.
15. **Low Power Consumption**: Consumes low power.
16. **Energy Conservation**: Promotes energy conservation.
17. **Utilizes Free Solar Energy**: Makes use of the freely available solar energy.
18. **Energy Storage**: Stores energy in a rechargeable battery.
19. **Stored Energy for Lifting**: Uses stored energy to lift the car.

These advantages highlight the efficiency, reliability, and environmental benefits of the solar-powered hydraulic jack, making it a superior choice for lifting applications.

Disadvantages

1. **Battery Maintenance**: Requires careful maintenance of batteries.
2. **Oil Leakage**: Oil leakage is not repairable.

3. **Availability of Spare Parts**: Spare parts for the hydraulic jack are not readily available.
4. **Reduces Drudgery**: Manual power is not required, reducing physical effort during maintenance operations.
5. **Timeliness and Efficiency**: Increases timeliness and efficiency in maintenance operations.
6. **Safety**: Reduces the risk of injury in case of malfunctioning of the device.
7. **High Load Capacity**: Hydraulic systems have a large load-carrying capacity.
8. **High Efficiency**: High efficiency with minimal friction loss keeps the cost of power transmission low.
9. **Smooth and Quiet Operation**: Hydraulic systems operate smoothly and quietly, with minimal vibration.
10. **Easy Control**: Handling and controlling a wide range of speeds and forces is easy.
11. **Repair and Replacement**: Repairing and replacing parts is straightforward.

Applications

1. **Metal Press Work**: Used for pressing sheet metal into any required shape.
2. **Drawing and Pushing Rods**: Effective for drawing and pushing rods.
3. **Bending and Straightening**: Suitable for bending and straightening metal pieces.
4. **Packing Press**: Used in packing press operations.
5. **Dismantling Old Tanks**: Useful for dismantling old tanks.
6. **Tank Foundation Repair**: Applied in repairing tank foundations.
7. **Field-Erected Storage Tanks**: Utilized in the building of field-erected storage tanks.
8. **Tank Bottom Plate Repair/Replacement**: Effective for repairing or replacing tank bottom plates.
9. **Increasing Tank Capacity**: Used for increasing tank capacity by adding shell rings or courses.
10. **Erecting Circular Structures**: Employed in the erection of circular structures such as reactor shields in nuclear power stations, etc.

These disadvantages and applications provide a comprehensive understanding of the limitations and versatile uses of the solar-powered hydraulic jack.

CONCLUSION

Solar-powered hydraulic jacks offer an efficient solution for pushing, pulling, lifting, lowering, and positioning loads using solar energy. The demand for an improved portable jack for automotive vehicles has long been evident. It is essential for such a jack to be operable from inside the vehicle or from a safe location off the road where the vehicle is situated.

The ideal jack should be lightweight, compact enough for storage in an automobile trunk, and easily carried to its point of use by most adults. Additionally, it should have the capability to lift a wheel of a heavy vehicle off the ground while ensuring stability and ease of control through a switch operation for safety. Furthermore, it should be easily maneuverable to position underneath the vehicle axle or another reinforced support surface designed for jack engagement.

The development of this motorized automated object lifting jack takes into account all these requirements. This particular design will prove beneficial for lifting and lowering heavy loads safely and efficiently. With its innovative features and reliance on solar power, it represents a significant advancement in the field of automotive maintenance and lifting equipment.

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