Vertical Lifting System – Scissor Lift: A Review

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Abstract :
The paper focuses on the available vertical lifting system for material handling in industries i.e Scissor lift. Scissor-type systems are frequently used as lifting systems in the industry. These systems are mainly preferred to do maintenance, repair, and clean. A scissor lift provides most economic, dependable and versatile methods of lifting loads as it has few moving parts which may only require lubrication. Scissor lift is used in various combination as hydraulic, pneumatic and mechanical. It is used because of its ergonomics as compared to other heavy lifting devices available in the market. As per the problem discussed in the paper the design presented in the same is targeted to solve the problem faced by the industry.

Index Terms -
Hydraulic Scissor Lift, Hydraulic Cylinder, Scissor Arm, Top Platform. Base Support Frame

I. INTRODUCTION

From manufacturing and construction to shipping and logistics, material handling plays a critical role in almost all industries. Globalization, along with rapid rise of online shipping, has further fueled the demand for efficient and cost-effective material handling solution. In fact the growth of globalized supply chains and highly efficient material handling goes hand in hand. The industrial lifting process, however is a complex and challenging task. If you the wrong set of equipment or a lifting crew that lacks the necessary skills, you are more likely to end up with potentially fatal injuries or damaged goods. Telecommunication towers are used for communication purposes among people. All the wireless communication, mobile networking, radio broadcasting and television antennas are connected via these towers. A special form of the radio tower is the telescopic mast. The most common type of aerial device are known in the AWP industry as **Knuckle Boom Lifts** or **Articulated Boom Lifts**, due to their distinctive shape, providing easy access to awkward high reach positions. Another type of aerial device is a **Straight Boom Lift** or **Telescopic Boom Lift,** which as the name suggests has a boom that extends straight out for direct diagonal or vertical reach by the use of telescoping sections, letting you take full advantage of the boom length range.

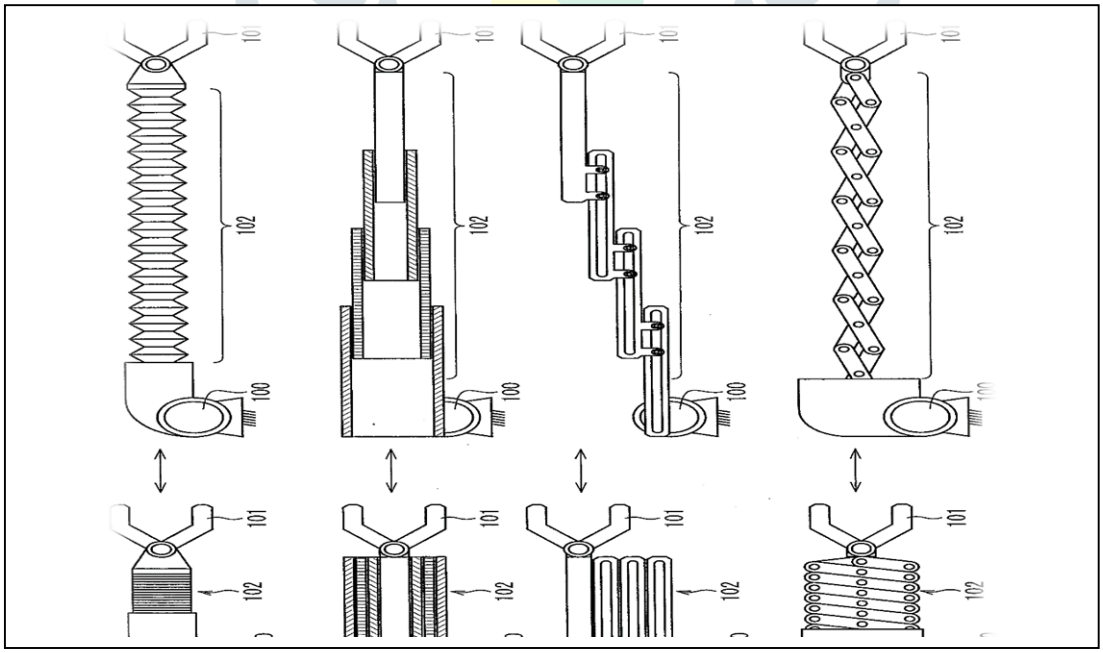

Fig 1: Different Lifting Mechanisms

Some AWP are classified as **Spider Lifts** due to the appearance of their legs as they unfold, extend and stabilize, providing a wide supportive base to operate safely. These legs can be manual or hydraulic (usually depending upon the size and price of the machine). AWP are widely used for maintenance and construction of all types, including extensively in the power and telecommunications industries to service overhead lines, and in arboriculture to provide an independent work platform difficult or dangerous trees. A

specialist type of the articulated lift is the type of fire apparatus used by firefighters worldwide as a vehicle to provide high level or difficult access. These types of platform often have additional features such as a piped water supply and water cannon to aid firefighters in their task.

II. LITERATURE REVIEW

Author	Research Work	Remark/Conclusion
Georgy Olenin (2016)	Design of hydraulic scissors lifting platform.	Aerial Working Platform is designed for the purpose of heavy loads.
Gaffar G Momin (2014)	Design, Analysis, Manufacturing of Hydraulic Scissor Lift.	Uniform Scissor arm length is used. Motive drive is provided manually instead of electrical power
Sabde Abhijit Manoharrao, Prof. Jamgekar R.S. (2017)	Design and Analysis of Hydraulic Scissor Lift By Finite Element Analysis.	Vibrations were studied during the lifting of tower by using modal analysis.
Robert W. Lucky Jon Eisenberg (2006)	Renewing US Telecommunication system.	Development of temporary radar and network system to create a zone that receives strong network signals.

III. SCISSOR LIFT

A Scissor Lift is a type of platform that can usually only move vertically. The mechanism to achieve this is the use of linked, folding supports in a crisscross "X" pattern, known as a pantograph (or scissor mechanism). The upward motion is achieved by the application of pressure to the outside of the lowest set if supports, elongating the crossing pattern, and propelling the work platform vertically. The platform may also have an extending deck to allow closer access to the work area, because of the inherent limits of Vertical-only movement. The contraction of the scissor action can be hydraulic, pneumatic or mechanical (via lead screw or rack and pinion system). Diesel Scissor Lifts have larger rough terrain tires with high ground clearance for uneven outdoor surface conditions. Many machines contain outriggers that can be deployed to stabilize the machine for operation. A new scissor lift named *Athena bi-levelling scissor lift* is an outdoor lift with tracks (instead of tires) that extends and contracts and self-levels the machines while in operation, allowing the machine to operate on steep slopes.

Scissor lifts are types of equipment designed for lifting objects or individuals according to one's preferences. Unlike other platforms, these lifts move only vertically to transport materials, people or equipment. Scissor lifts are widely used in construction and manufacturing industry where it is a need for workers to do job in hard to reach heights and spaces. A scissor lift relies upon the elongation of a collapsible mechanism to provide vertical elevation in ratio to a rotational or linear input. The body of the scissor lift that is holding the platform used to carry materials or people has foldable support that looks like a crisscrossed pattern linked together [5]. The body is known as the Pantograph which is lifting the mechanism. Scissors lifts owe their mechanical capability to the pantograph. A pantograph is a series of linked parallelograms with hinged intersections that allow the operator to elongate the mechanism while maintaining the integrity of the geometric figure. Pantograph functions like a spring wherein the elevation or upward motion takes place due to application of pressure. Its length and size is defined by the expansion and contraction of the body of the scissor lift(5). The structural components of the pantograph serve as opposing line segments within adjacent parallelograms; geometric changes are therefore uniform across the mechanism. True vertical lift is accomplished by using components of equal length.

As 'L' (length of the base) increases, the pantograph contracts, and X^0 deceases while Y^0 increases. As L decreases, the pantograph extends, and X^0 increases in contrast to Y^0. When two pantographs are arranged so as to actuate from a single drive they extend correspondingly and loads can be balanced between them. A calculator exists for computing the linear input force required according to where the drive supplies power to the scissor mechanism, be it upon the base or a center pin.

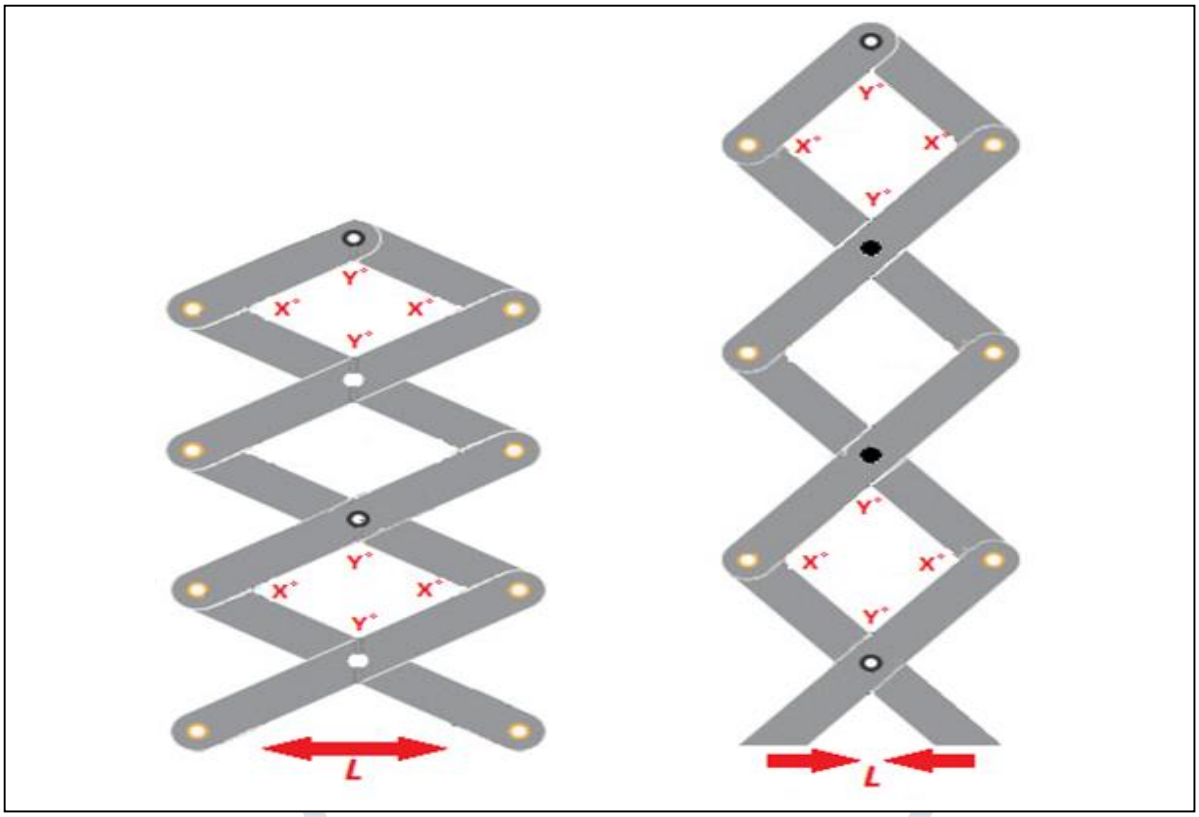

Fig 2 : Scissor Lift Specifications

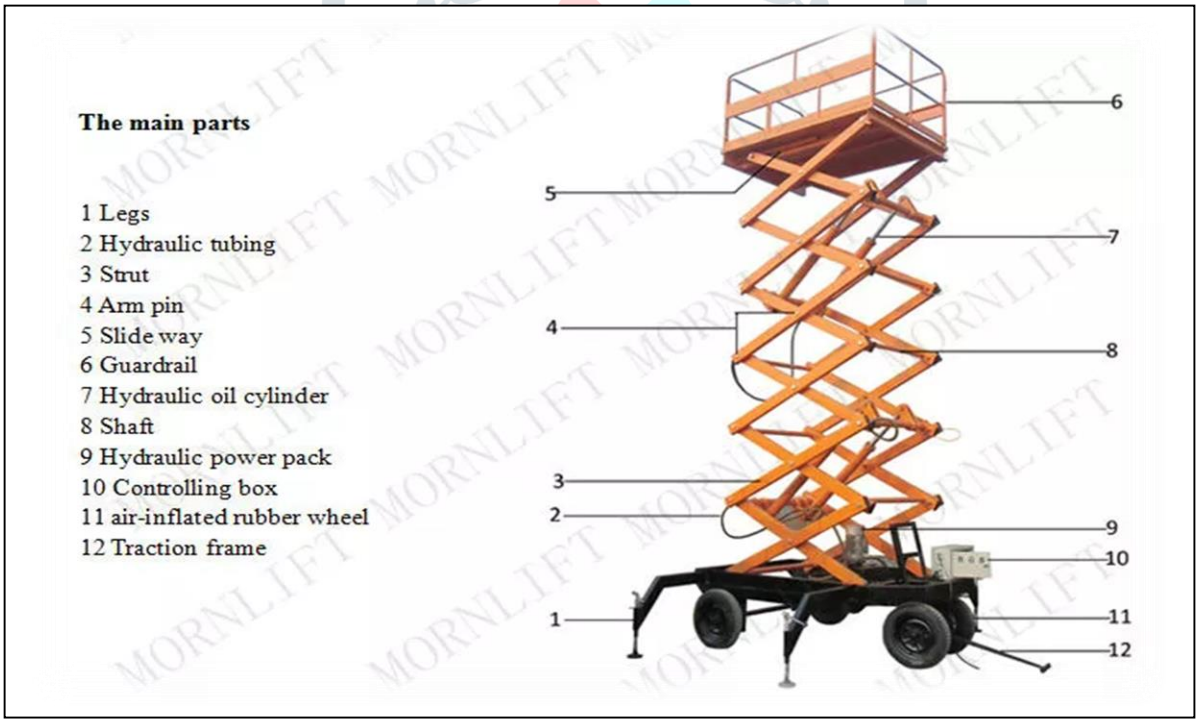

Fig 3 : Components of Scissor Lift

3.1 COMPONENTS:

The components of scissor lifts are as follows:

1. Aerial Working Platform

It's a flat surface providing work area for carrying out different operations like material handling, rescue operations during firefighting, street lights repairing, etc.

2. Base-frame

This is the foundation on which the machinery/system setup rests. Depending on the application the dimensions and design of base frame varies. The static end of the scissor lift rests at one end of this frame and the dynamic end is given with the area to slide to and fro.

3. Pantograph

A pantograph is a series of linked parallelograms with hinged intersections that allow the operator to elongate the mechanism while maintaining the integrity of the geometric figure. The bottom end of this rests on the base frame consisting of one static end and other dynamic end.

4. Motive

The lift can be driven by various motive mechanism such as hydraulic, pneumatic, manual, electrically with the help of motor.

3.2 MOBILITY

Motor-driven propulsion is a valuable attribute in many situations requiring scissor lifts. This allows workers to position the lift on an as-needed basis which is particularly useful in maintenance and construction applications. 'Slab' lifts are restricted to paved, smooth surfaces; rough terrain lifts rely on robust tires and four-wheel drive to traverse off-road conditions. To improve lift agility, manufacturer rely on a sharp turning radius and a short wheelbase. Parking brakes ensure lift location, and tires and casters come in non-making, off-road, anti-slip, press-on and urethane varieties. Economical and legal reasons prohibit scissor lifts from road travel; they are hauled or towed between job sites.

A major difference among scissor lifts is between those that are made for indoor use and those that are made for outdoor use. Indoor scissor lifts (lift A below), or "slab" lifts, are made by their manufacturers to be used on smooth and level ground only. Outdoor scissor lifts (lifts B and C below), or "rough terrain lifts," are meant for use on slightly sloped and rough ground. Rough terrain scissor lifts come equipped with additional stabilizers (B below) or outriggers (C below) which allow them to be placed on sloped or rough ground while the platform is elevated.

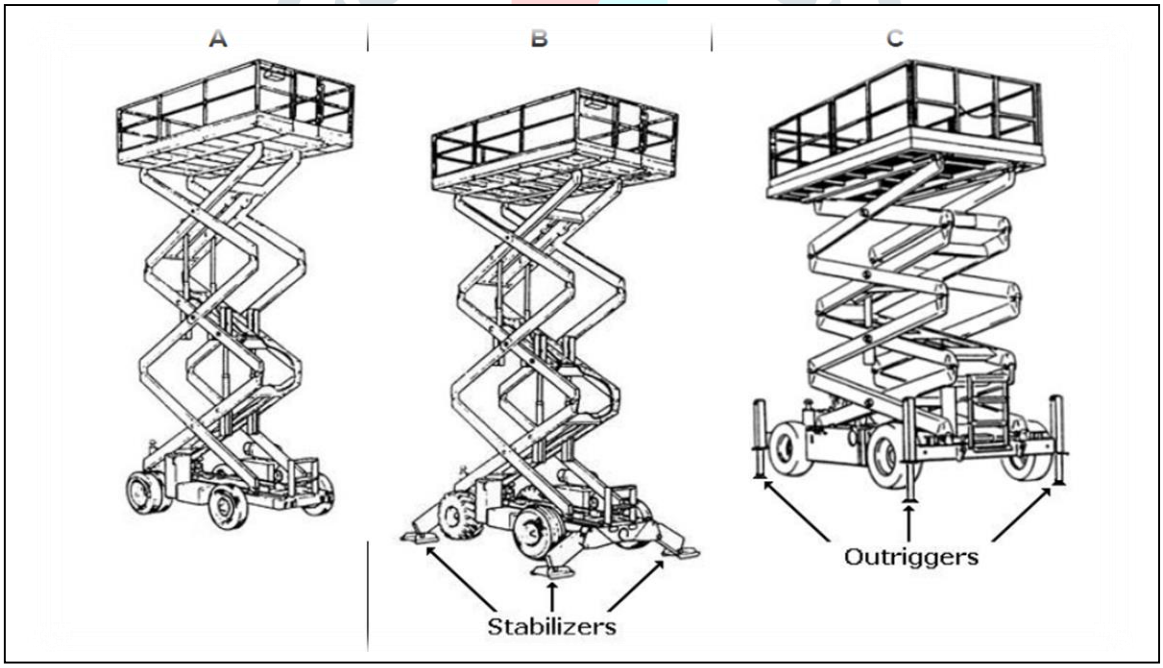

Fig 4 : Stability Variants for Lift

3.3 POWER SUPPLY

Stationary scissor lifts are almost always fed by an AC electrical supply. Mobilized scissor lifts are most commonly powered by variable speed DC motors. They typically utilize 6V batteries that are stored in a maintenance panel along with a recharging cord that connects to AC power supplies. An emergency shut-off prevents operators from accidentally removing the lift during the recharge. Electric scissor lifts are quiet and emission free, making their preferred workspace indoors [7].

Gas/diesel/propane engine scissor lifts have higher load capacity with better traction control making them ideal for outdoor worksites. Some may include a hybrid drive for when working in enclosed spaces. These lifts also typically have a higher extension range and are favored in construction applications.

3.4 SPECIFICATIONS

While the control, maneuverability and power source of a scissor lift is critical to its utility, other characteristics better describe the vertical capabilities of the lift.

1. **Stroke:** this is the range of height safely attained by use of scissor lift. This is directly correlated with the number of scissors intersections and the lengths of the components used in the pantograph.
2. **Size:** this is the dimensions of the work platform elevated by the lift. Many lifts feature an extendable platform to increase the area's square volume.
3. **Capacity:** the maximum burden that the lift is designed to safely support, be it personnel or freight.

3.5 SAFETY

Components should be regularly integrated in scissor lifts to prevent mechanical catastrophe. Such measures may include: bellows on short-stroke scissor lifts to prevent materials from interfering with the mechanism; descent guards, which sense items in the lift's path on its descent; release locks to prevent unconstrained descent; and a fall arrest anchor so workers can use a fall arrest system, if needed.

3.6 STANDARDS

- MHI MH29.1: Safety requirements for industrial scissor lifts
- ASME PASE: Safety standards for portable automotive service equipment
- BS EN 1570-1: Safety requirement for lifting tables part 1: lifting tables serving up to two fixed landings.

IV. DISCUSSION

The scissor lifts used nowadays in industries for material handling are to made heavy in nature so that they lift can handle the load of 700kg to 1000kg. The aerial working platform provides the space for loading the material and stacking it. In some lifts this platform provides the space for human mobility. The lift can be operated hydraulically, by using servomotor, or manually. Depending upon its area of application the specification of the scissor lift are varied. The major parameters deciding the manufacturing of scissor lift are the operating height, the weight to be lifted. For light weight application the existing scissor lift can be modified. The aerial working platform can be designed as per the requirement. The arm length of each stage in scissor lift can be reduced, this will help in reducing the overall weight of the system. Next major area which can be worked on is the material of the arms of the lift. Currently uniform material is used throughout the arms of the lift. If the weight application on the lift is less the material of each stage arm can be varied and selected depending upon the load acting on each stage. A good combination of light weight and high strength material can be used which will enhance the strength of the lift as well as help in reducing the weight of lift. Following is the proposed system for light weight applications. The system shown in the following figure depicts the use of portable scissor lift for mounting antenna or any other accessories such as optical sensor for surveillance of sensitive area. A 360 degree rotatable antenna or PTZ camera can be mounted on the auto alignment mast. This system will be light in weight as the arm length is gradually decreasing.

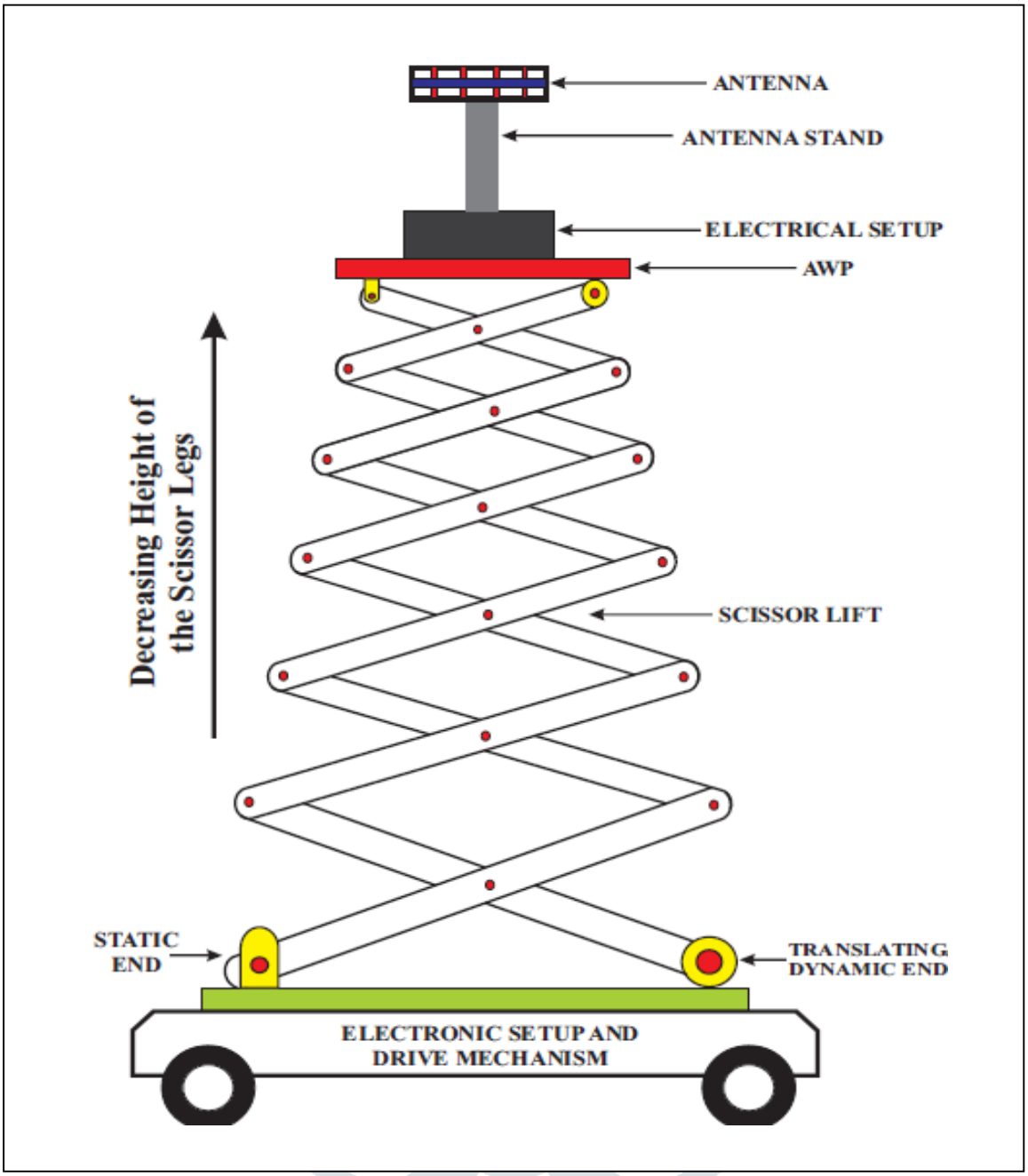

Fig 5 : Proposed Portable Scissor Lift

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