The Basics of the **Electric Linear Actuator**

What is an electric linear actuator?

- *An electric linear actuator is a device that converts the rotational motion of an electric motor into linear motion (push or pull movement).*
- *It can be used anywhere a machine pushes or pulls a load, raises or lowers a load, roughly positions a load, or rotates a load.*

By Jon Mueller, Tyler Pocock, and Samantha Rosenfeld - TiMOTION

There are many components and options to an actuator. We will discuss a new subject in each section related to the basics of an electric linear actuator and the factors to consider when purchasing. In this section of the article we will discuss the common styles and configurations, and review the internal and external components of a linear actuator. Then, we will cover the safety related options that can be added and explain the various load and speed characteristics to consider and how it can be adjusted to meet your applications' needs. We will follow that with the various levels of IP ratings an actuator can have for liquid and dust protection as well as lubrication used, as well as consider the certifications and standards that are needed to meet certain market and country requirements. Lastly, we will discuss the importance of feedback sensors in electric linear actuators.

Common Styles of Actuators

There are various styles of linear actuators that are all interchangeably customizable to fit a customer's application needs. Some common styles of electric or electromechanical linear actuators include:

A. Parallel Drive Actuator - The motor is directly parallel to the drive spindle. Typically, these types of electric linear actuators are spur gear or belt driven with more gear ratio options. Parallel drive actuators allow for a wider range of loads and speeds; however, they can operate louder than worm gear driven actuators.

B. Right-Angle or "L" Drive Actuator - The motor is set perpendicular to the drive spindle. These types of electric linear actuators are typically worm gear driven. These motors have fewer gear ratio options, however because of that they are more efficient than spur gear driven motors and operate with low noise. In addition, one of the key benefits of a worm gear driven, right angle electric linear actuator is increased self-locking ability.

C. Inline Actuators - An inline actuator has a longer retracted length, but is designed specifically to fit into smaller or compact spaces. The inline actuator is typically made up of a motor, planetary gear assembly and drive spindle. These usually operate at a higher noise level.

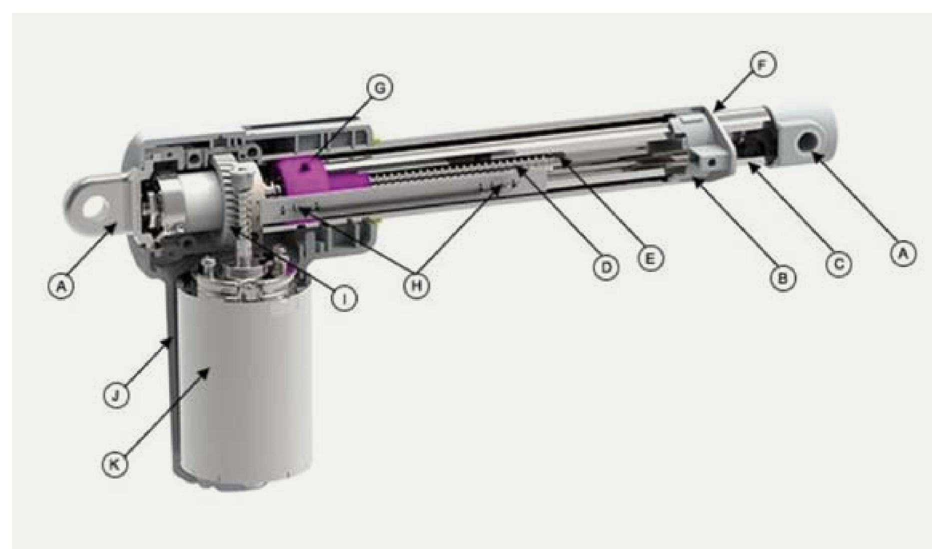
D. Gear Motors - Gear motors allow for economical and flexible designs, when matching them with various external spindle assemblies. The compact design is typically worm gear driven and an excellent choice for mechanical synchronization.

E. Safety Stop - Located on the end of the spindle, its function is to prevent the inner tube from overextension.

F. Linear Slide Actuator - This actuator style creates a linear movement without the use of an outer tube. It utilizes a plastic slide mechanism which travels across the actuator, attached to the frame of common household furniture, such as power recliners and couches. A slide actuator can even be used in some medical furniture because of its 60601 certification.

G. Electric Lifting Column - Lifting columns can cater to the industrial, medical, and ergonomic markets. The primary advantage of a column is its ability to vertically lift high loads while retaining a high degree of stability. Our industrial and medical grade columns are designed for applications such as medical and bariatric beds and height-adjustable industrial work stations, where worker and patient safety is essential. Our office ergonomic columns come in various colors, shapes, orientations, as well as 2 or 3 stages for BIFMA compatibility depending on user preference.

Components of an Electric Linear Actuator



Components of an Electric Linear Actuator

A. Front / Rear Clevis - Attachments on the front and rear of the actuator that allow it to be mounted to the application. Types of attachment styles include round, U-shaped (or slotted) or with a punched hole. Clevises can be customized to best fit the application they are being used on.

B. Outer Tube - Also known as the cover tube. This extruded aluminum or steel tube protects the outside of the linear actuator and houses all of the inner components of the actuator.

C. Inner Tube - Also known as the extension tube, drive tube, translating tube or piston. This tube is usually made out of aluminum or steel. While retracted, the inner tube is where the spindle is located. It is attached to the threaded drive nut and extends and retracts when the nut moves along the rotating spindle.

D. Spindle - Also known as the lead screw, rotating screw or lifting screw. This part of the linear actuator rotates, extending or retracting the nut/inner tube, which creates a linear motion. Our steel spindle ensures durability and strength. The spindle can be threaded in different ways for various load and speed capabilities. Additional details of this will be covered in another section.

E. Safety Stop - Located on the end of the spindle, its function is to prevent the inner tube from overextension.

F. Wiper - A sealing component attached to the end of the outer tube which prevents contaminants like dust and liquids from entering the spindle area of the actuator. It also ensures a proper seal between the inner and outer tubes which influences the IP rating of the linear actuator.

G. Drive Nut -The nut, which can be acme or ball, is attached to the inner tube and travels along the spindle. The nut is the component that allows extension or retraction of the inner tube. It can be made of metal or plastic and is sometimes keyed to prevent inner tube rotation.

H. Limit Switches - Limit switches control the fully extended and retracted position of the inner tube by electrically cutting current to the motor. These switches prevent the actuator from over extending or over retracting. In addition to cutting current, limit switches can also be used as a signal sending device.

I. Gear - A gear is made of steel or plastic and mates with other gears to alter the relation between the speed of a driving mechanism (such as the engine of a vehicle) and the speed of the driven parts (the vehicle's wheels). The gear connected to a power source, such as the motor, is called the "drive gear".

J. Motor Housing - The motor housing contains all the internal parts to the gear motor without leaving anything exposed for external damage. Many motor housings are typically made of high quality plastic.

K. DC Motor - The DC (Direct Current) motor is where all the power is generated for the electric linear actuator. There are several types of DC motors, including brushed DC motors which are composed of:

1. Stator: The stationary, outside portion of the motor made up of the motor housing, two permanent magnets, and motor caps. The stator generates a stationary magnetic field that surrounds the rotor.

2. Rotor: Also known as the armature is the inner part of the motor which rotates. The rotor is mainly made up of silicon steel laminate, motor shaft, commutator, and copper windings.

3. Commutator: The commutator is a pair of plates attached to the motor shaft. These plates provide two connections for the coil of the electromagnet. The commutator is used to reverse polarity of current in the motor and essentially keep the motor rotating without losing torque.

4. Carbon Brushes: Carbon brushes use sliding friction to transmit electrical current from the stator to the rotor in the motor.

5. Motor Shaft: The motor shaft connects the gear motor to the bottom of the stator on the DC motor.

6. Output / Feedback Sensors: Output (or feedback) sensors are used to communicate the actuator's stroke position. The feedback that it gives is sent to the control box MCU (micro control unit). Linear actuators with position feedback are typically required when an application requires high level functions such as synchronization and memory positioning. Additional details of this will be covered in another section.

Optional Safety Features

Depending on the environment and duress that the actuator will be operating in and undergoing, it is wise to reinforce the stability and strength of the actuator. Some safety feature options to consider are:

A. Overload Clutch -The overload clutch is a built-in device that slips when the electric actuator reaches a pre-set load limit. The overload clutch connects and disconnects the motor from the lead screw. This slippage prevents the linear actuator from incurring possible damage.

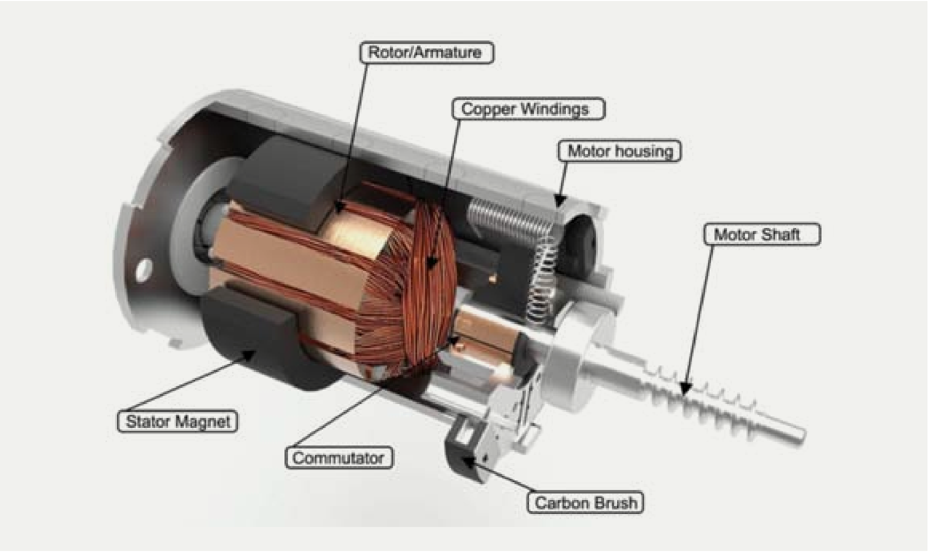
B. PTC Thermistor - A PTC Thermistor essentially acts as a fuse which cuts the power to the motor, protecting the motor from overheating and burning out. Our electric motors have a UL certification option that includes a PTC Thermistor installed inside.

C. Safety Nut - A safety nut is essentially a metal reinforced acme drive nut used to help the linear actuator support a higher load. A safety nut is recommended for loads of 6,000N or more. Many electric actuators also have the option to add this feature to ensure the strength and integrity of the product.

D. Push-Only Nut - A standard drive nut will have threads to screw into the extension tube whereas a "push only" nut won't have threads. This prevents obstructions (animals, people, other furniture, etc.) from being damaged by a retracting linear actuator system. This can be helpful for example in a recliner, where if the foot of the recliner is going from an extended to retracted position and there is an object below the feet of the chair. The foot of the chair will not continue to push force on the object it comes into contact with.

E. Quick Release – A handle or cable which allows the actuator to be quickly back driven when it is released. The quick release is designed mainly for medical bed applications for when the back rest of a medical bed needs to be quickly laid flat (in case of emergency CPR). Our medically certified linear actuators can come with this option, depending on the application needs.

Direct Current Motor Components



F. Manual Release - The manual release is designed primarily for a medical patient hoist system. The manual release allows the extension tube (inner tube) to release from the front attachment (clevis) and spin freely. This allows the linear actuator to back-drive freely and for a patient to be manually lowered from the patient hoist system.

G. Manual Crank - The manual crank is a safety feature designed mainly for the medical industry. It allows a medical practitioner to manually operate the bed position in case of emergency or power outages.

H. Spring Coil Brake - A spring coil brake is installed and wrapped around the worm gear. It is a unidirectional no-back type brake that is activated automatically by pinion winding and then released when the motor turns.

I. Motor Brake - The motor brake is installed either on the top or bottom of the

motor shaft depending on whether the application will be pushing or pulling the load. The motor brake gives the electric actuator the added durability that ensures longevity of the actuator.

J. Electromechanical Brake -The electromechanical brake slows or stops the motor using electromagnetic force to apply mechanical resistance to the spindle. The electromechanical brake is also installed on the bottom of the motor shaft.

K. Mechanical Brake - A mechanical brake can be added to reinforce stability of the actuator when back drive can possibly be a factor with high weight loads.

For Part Two of this article please check out the March issue of Valve World Americas journal.

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