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AUTONOMOUS INSTITUTION
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VII Semester

AU3008 Sensors and Actuators

UNIT – 4 - AUTOMOTIVE ACTUATORS

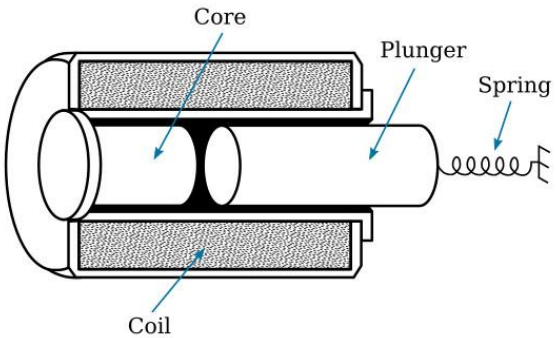
4.5 Working principles, construction and location of Solenoid Actuator

A **solenoid actuator** is an electromechanical device that converts electrical energy into linear mechanical motion. It consists of a coil of wire (solenoid) and a movable core, often called a plunger. Solenoid actuators are widely used for tasks that require a linear push or pull motion, such as in locking mechanisms, valves, and automotive systems.

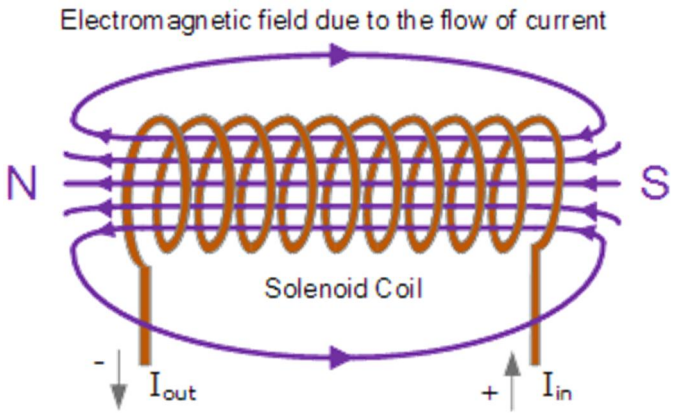
Structure and Components

A typical solenoid actuator consists of the following key components:

1. **Coil:** This is a coil of wire wound around a core. When an electric current pass through the coil, it generates a magnetic field.
2. **Core:** The core is a ferromagnetic material, usually iron or steel, that concentrates the magnetic field produced by the coil.
3. **Plunger:** A movable piece of ferromagnetic material that is attracted to the core when the coil is energized.
4. **Housing:** A protective casing that encloses the coil and plunger.
5. **Spring (Optional):** In many designs, a spring is used to return the plunger to its original position when the coil is de-energized.



Magnetic Field Produced by a Solenoid Coil



- When an electrical current is passed through the coils windings, it behaves like an electromagnet and the plunger, which is located inside the coil, is attracted towards the centre of the coil by the magnetic flux setup within the coils body, which in turn compresses a small spring attached to one end of the plunger.
- The force and speed of the plunger's movement is determined by the strength of the magnetic flux generated within the coil.
- When the supply current is turned "OFF" (de-energised) the electromagnetic field generated previously by the coil collapses and the energy stored in the compressed spring forces the plunger back out to its original rest position.
- This back and forth movement of the plunger is known as the solenoids "Stroke", in other words the maximum distance the plunger can travel in either an "IN" or an "OUT" direction, for example, 0 – 30mm.

Working of Solenoid Actuators:

- When current flows through the conductor, it produces a magnetic field.
- The magnetic flux produced by the coil results in establishing north and south poles in both the core and the plunger.
- The plunger is attracted along the lines of force to a position at the center of the coil.

- ❒ The deenergized position of the plunger is partially out of the coil due to the action of the spring.
- ❒ When voltage is applied, the current through the coil produces a magnetic field. This magnetic field draws the plunger within the coil, resulting in mechanical motion. When the coil is deenergized, the plunger returns to its normal position because of spring action.
- ❒ The effective strength of the magnetic field on the plunger varies according to the distance between the plunger and the core. For short distances, the strength of the field is strong; and as distances increase, the strength of the field drops off quite rapidly.
- ❒ While a solenoid is a control device, the solenoid itself is energized by some other control device such as a switch or a relay.
- ❒ One of the distinct advantages in the use of solenoids is that a mechanical movement can be accomplished at a considerable distance from the control device. The only link necessary between the control device and the solenoid is the electrical wiring for the coil current.
- ❒ The solenoid can have large contacts for the control of high current. Therefore, the solenoid also provides a means of controlling high current with a low current switch.

Types of Solenoid Actuators:

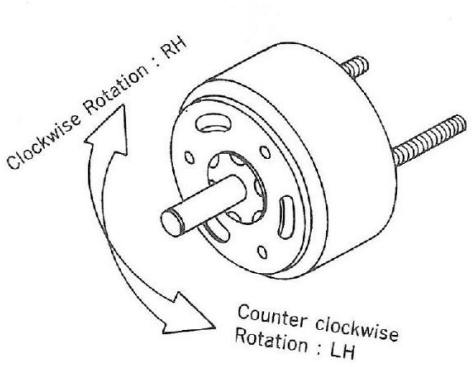
Solenoid actuators are electromechanical devices that use electromagnetic fields to generate linear or rotary motion. There are several types of solenoid actuators, classified based on their motion, structure, and application. Here are some key types:

1. Linear Solenoids

- **Pull-type:** These solenoids pull in a metal plunger when activated and are commonly used in applications where pulling motion is required, such as door locks.
- **Push-type:** The coil pushes the plunger outward when energized, often used in dispensing systems or ejector mechanisms.
- **Push-pull type:** Capable of both pushing and pulling motions, offering flexibility in applications that require reversible movement.

2. Rotary Solenoids

- Designed to convert electromagnetic force into rotary motion, these solenoids rotate a specified number of degrees (typically 25–90°) upon activation. They're often used in positioning devices, switches, and mechanisms that require a rotational movement.



- ❖ **Coil:** The coil is the electromagnet that generates the magnetic field when energized.
- ❖ **Plunger:** The plunger is a movable part that is attracted to the magnetic field generated by the coil.
- ❖ **Spring:** The spring provides restoring force to return the plunger to its original position when the power is removed.

3. Tubular Solenoids

- Cylindrical in shape, tubular solenoids have a high power-to-size ratio, making them suitable for applications requiring powerful linear motion in compact spaces. Common in automotive and industrial equipment, these solenoids are highly efficient due to their design.

4. Other Types of Solenoid Actuators:

- ❒ C-Frame Solenoids
- ❒ D-Frame Solenoids
- ❒ Open-Frame Solenoids
- ❒ Latching Solenoids
- ❒ Proportional Solenoids
- ❒ Holding Solenoids

Applications of Solenoid Actuators:

Solenoid actuators are used widely in industries and applications that require precise control of motion, either linear or rotary. some common applications of solenoid actuators:

- ❖ Starter Motors
- ❖ Fuel Injection Systems:
- ❖ Door Locks
- ❖ Valves for Fluid and Gas Control
- ❖ Robotics
- ❖ Washing Machines and Dishwashers

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