Control Components

Introduction to Control Systems

- Every activity in our day to day life is influenced by some sort of control system. Control systems are now integral parts of modern industrialization, industrial processes and home appliances. Hence the control systems and its components plays very important role in our daily life. In this lecture we will study the various control components.

Introduction to Control Systems

- A control system consisting of interconnected components is designed to achieve a desired purpose. To understand the purpose of a control system, it is useful to examine examples of control systems through the course of history. These early systems incorporated many of the same ideas of feedback that are in use today.

- Modern control engineering practice includes the use of control design strategies for improving manufacturing processes, the efficiency of energy use, advanced automobile control, including rapid transit, among others.

- We also discuss the notion of a design gap. The gap exists between the complex physical system under investigation and the model used in the control system synthesis.

- The iterative nature of design allows us to handle the design gap effectively while accomplishing necessary tradeoffs in complexity, performance, and cost in order to meet the design specifications.

Control Components

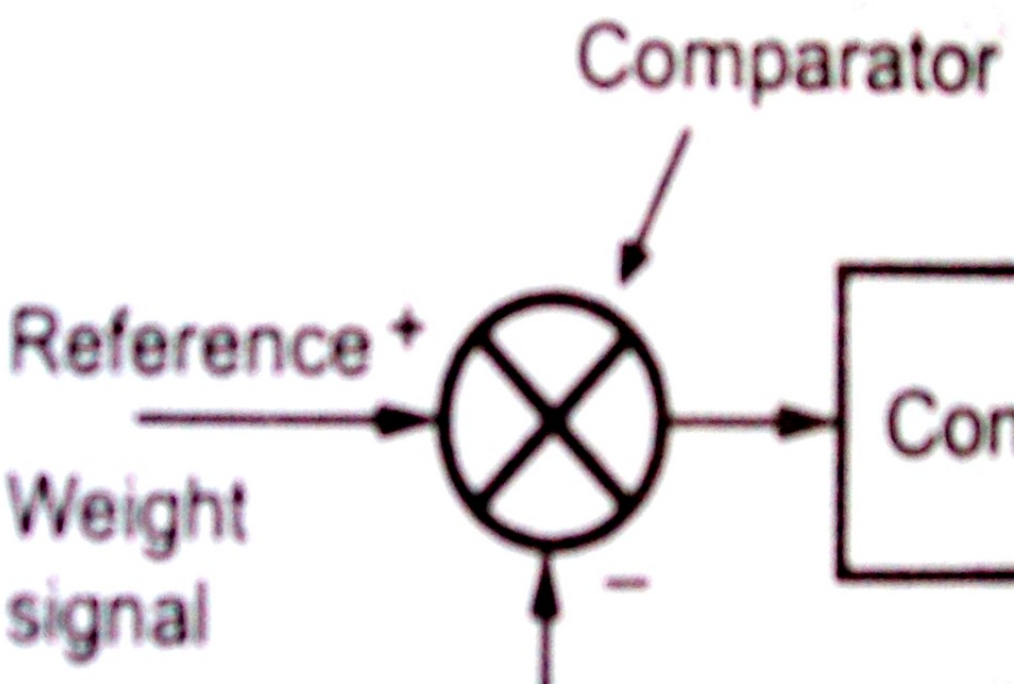
- There are various types of control components

1. Error Detectors
2. Potentiometers
3. Synchros
4. AC & DC Techogenerators
5. AC & DC Servomotors
6. Stepper Motors
7. Magnetic Amplifiers

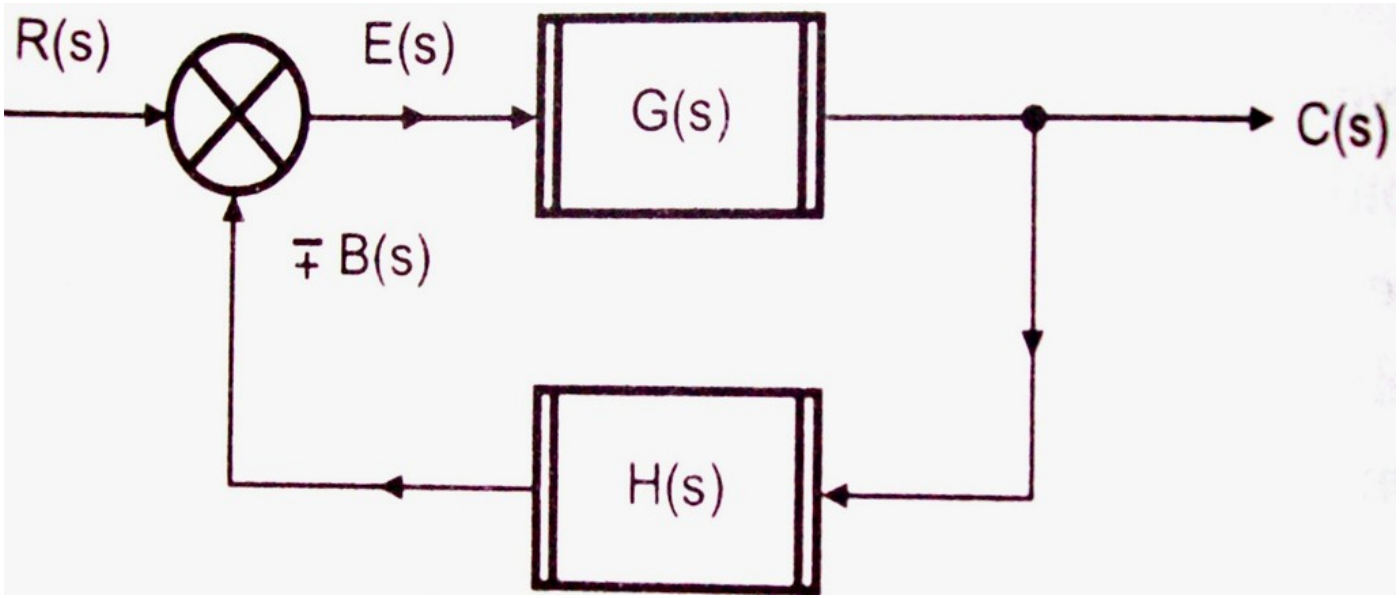
Error Detectors

- All feedback control systems operate from the error signal which is generated by a comparison of the reference and the output. Error detectors perform the crucial task of comparing the reference and output signals. In a purely electrical system where the reference and output are voltages, the error detector is a simple comparator.

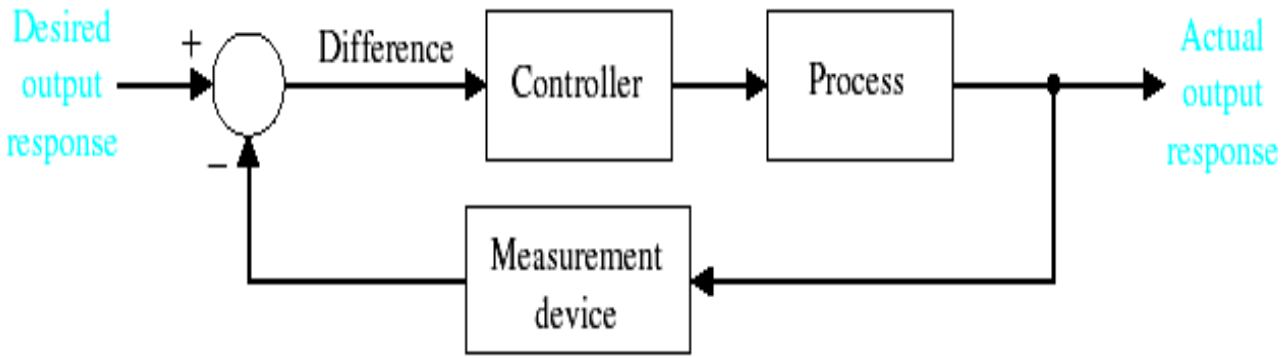
Error Detectors



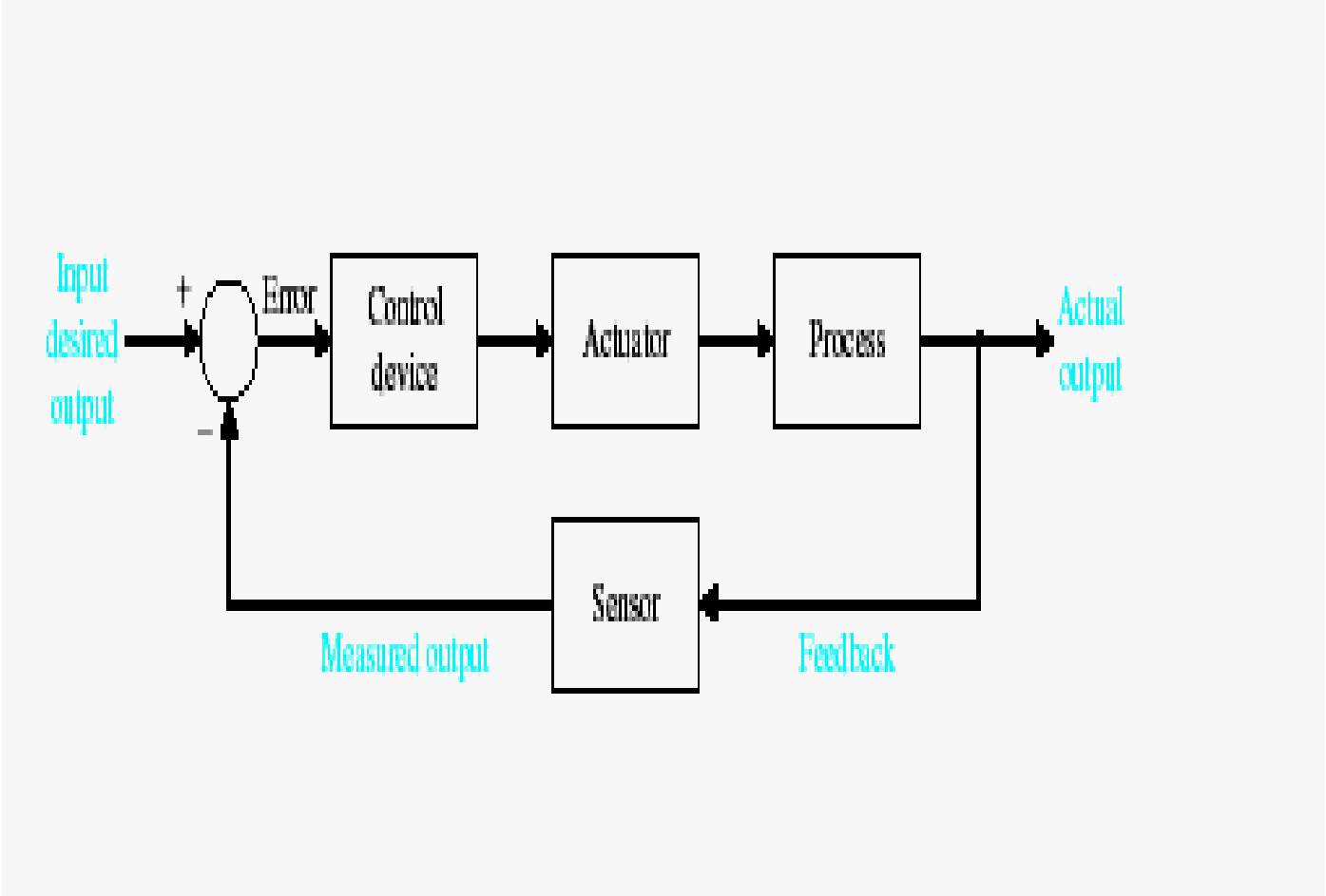
Error Detectors



Error Detectors



Error Detectors



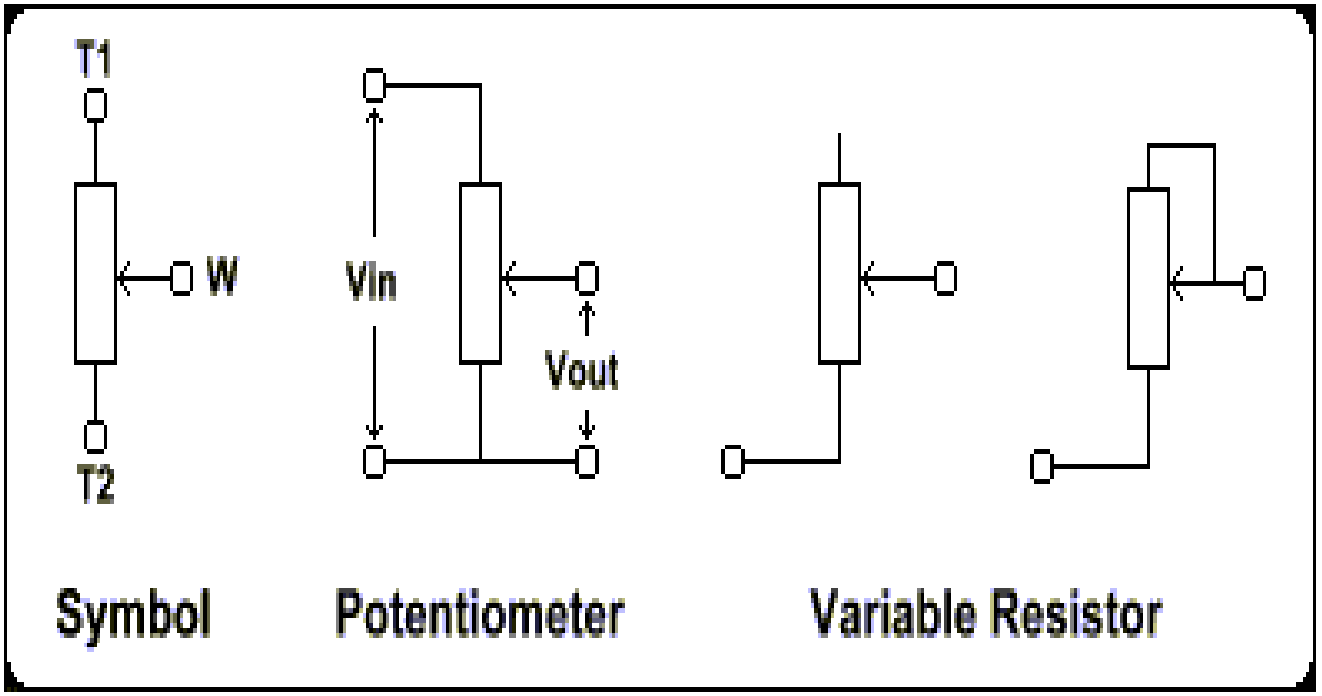
Potentiometer

- A **potentiometer**, informally a **pot**, is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a ***variable resistor*** or ***rheostat***.
- A potentiometer measuring instrument is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.

Potentiometer

- Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load

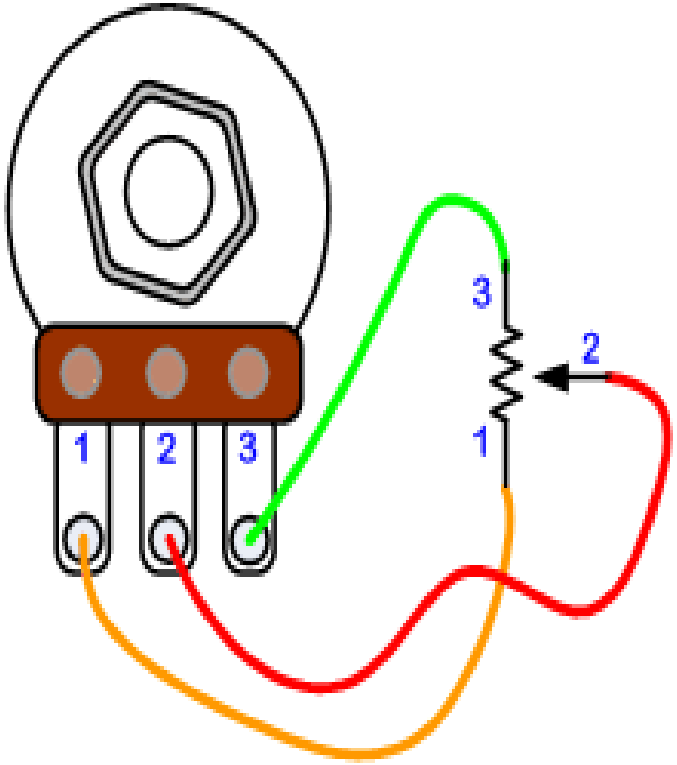
Potentiometer Symbol

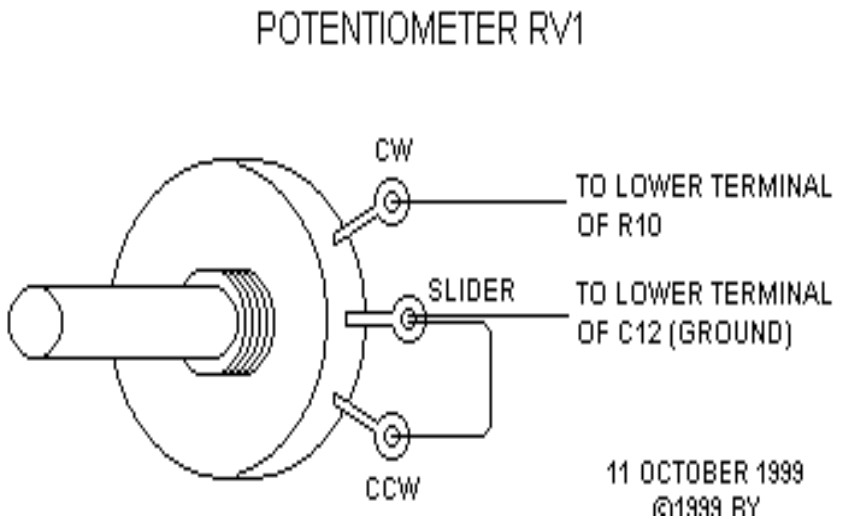


Potentiometer Construction

- Potentiometers comprise a resistive element, a sliding contact (wiper) that moves along the element, making good electrical contact with one part of it, electrical terminals at each end of the element, a mechanism that moves the wiper from one end to the other, and a housing containing the element and wiper.

Potentiometer Construction

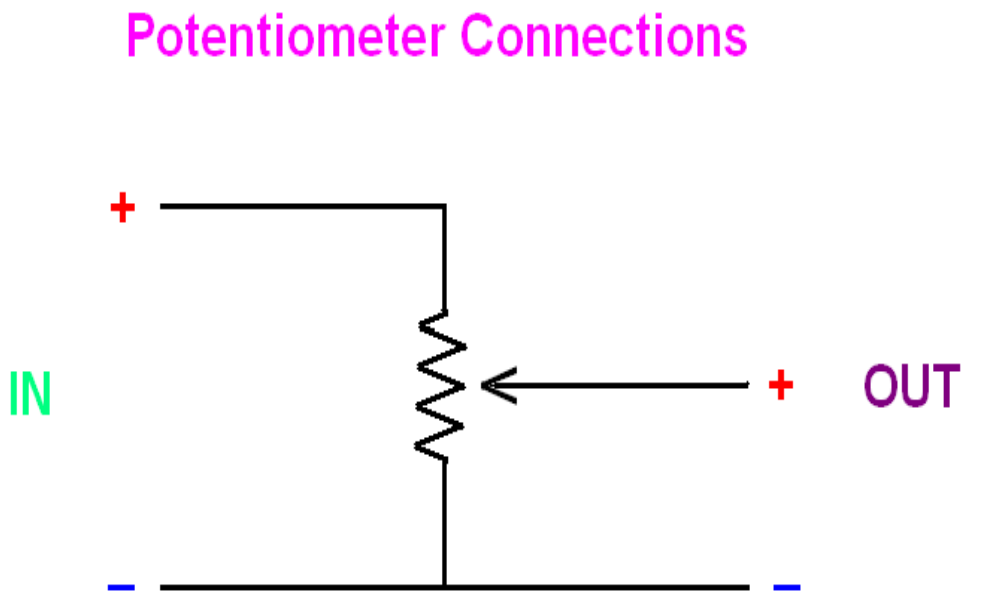


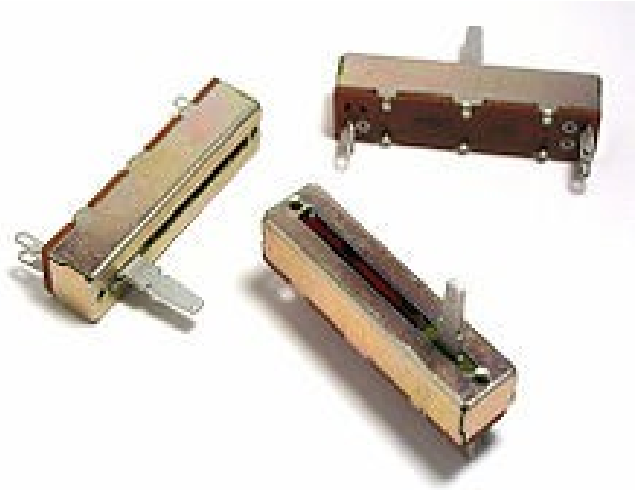


Potentiometer Construction

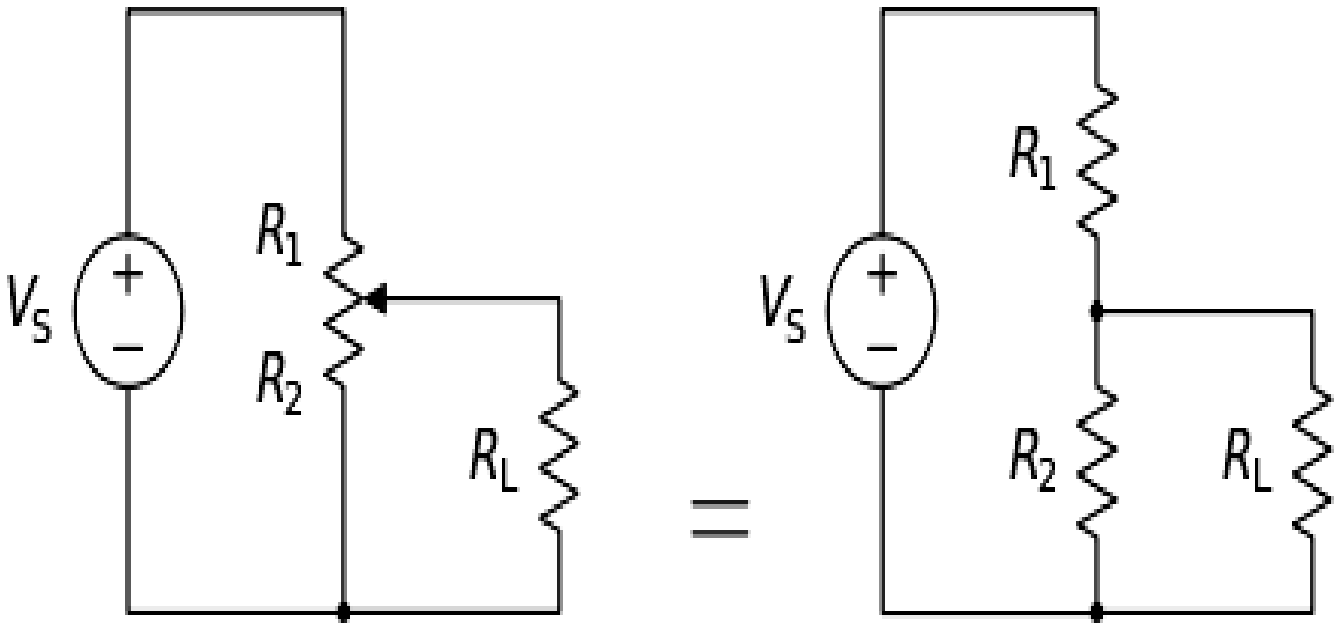
- Another type is the linear slider potentiometer, which has a wiper which slides along a linear element instead of rotating. Contamination can potentially enter anywhere along the slot the slider moves in, making effective sealing more difficult and compromising long-term reliability. An advantage of the slider potentiometer is that the slider position gives a visual indication of its setting. While the setting of a rotary potentiometer can be seen by the position of a marking on the knob, an array of sliders can give a visual impression of the effect of a multi-channel equalizer

Potentiometer Construction





Theory of operation

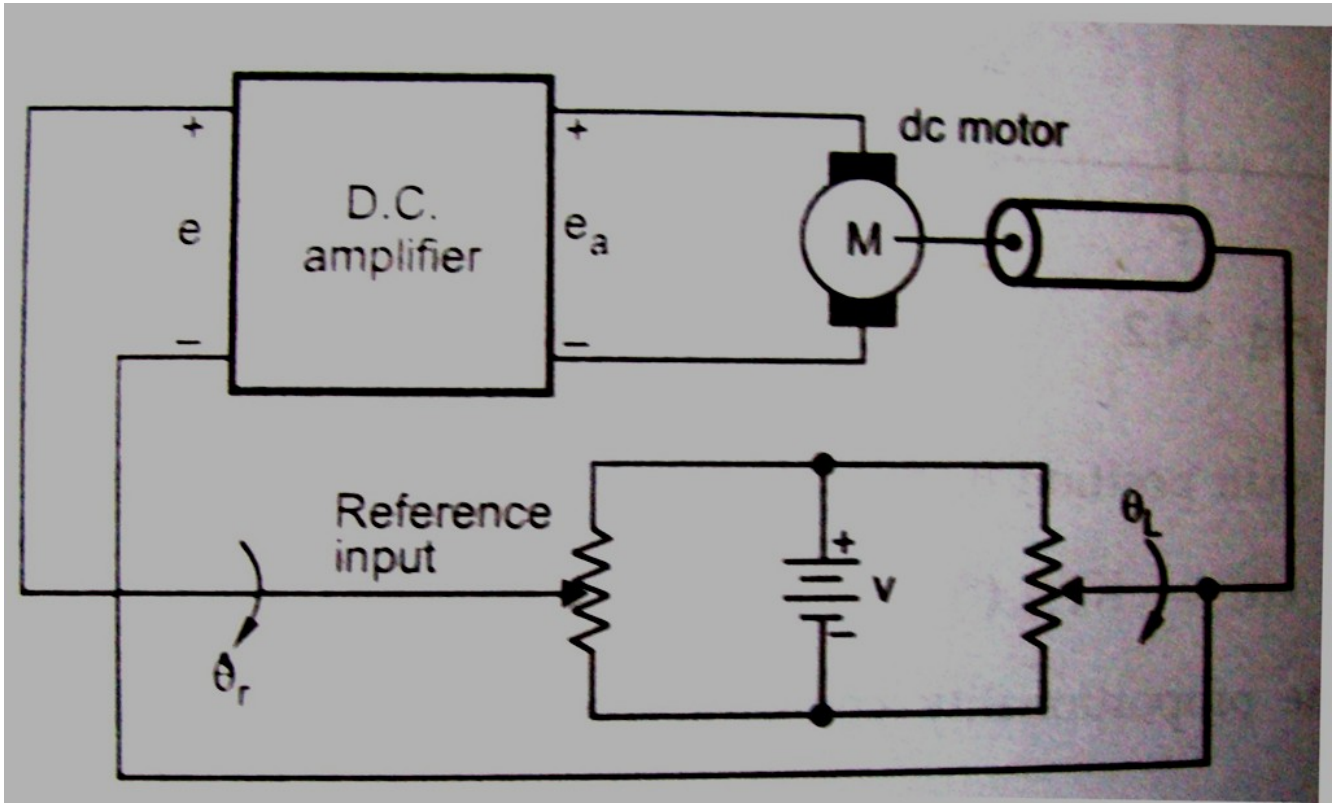


Theory of operation

- The potentiometer can be used as a voltage divider to obtain a manually adjustable output voltage at the slider (wiper) from a fixed input voltage applied across the two ends of the potentiometer. This is their most common use.
- The voltage across can be calculated by:

$$V_{\mathrm{L}} = \frac{R_2 R_{\mathrm{L}}}{R_1 R_{\mathrm{L}} + R_2 R_{\mathrm{L}} + R_1 R_2} \cdot V_s.$$

Potentiometer as an Error Detector



Potentiometer as an Error Detector

- DC Motor control systems potentiometers can be used as position feedback as shown in the previous slide. The reference position of shaft is compared by a pair of two pots and reference input is fed to DC Amplifier, which is further amplifying the armature current of the DC Motor.

Potentiometer as an Error Detector

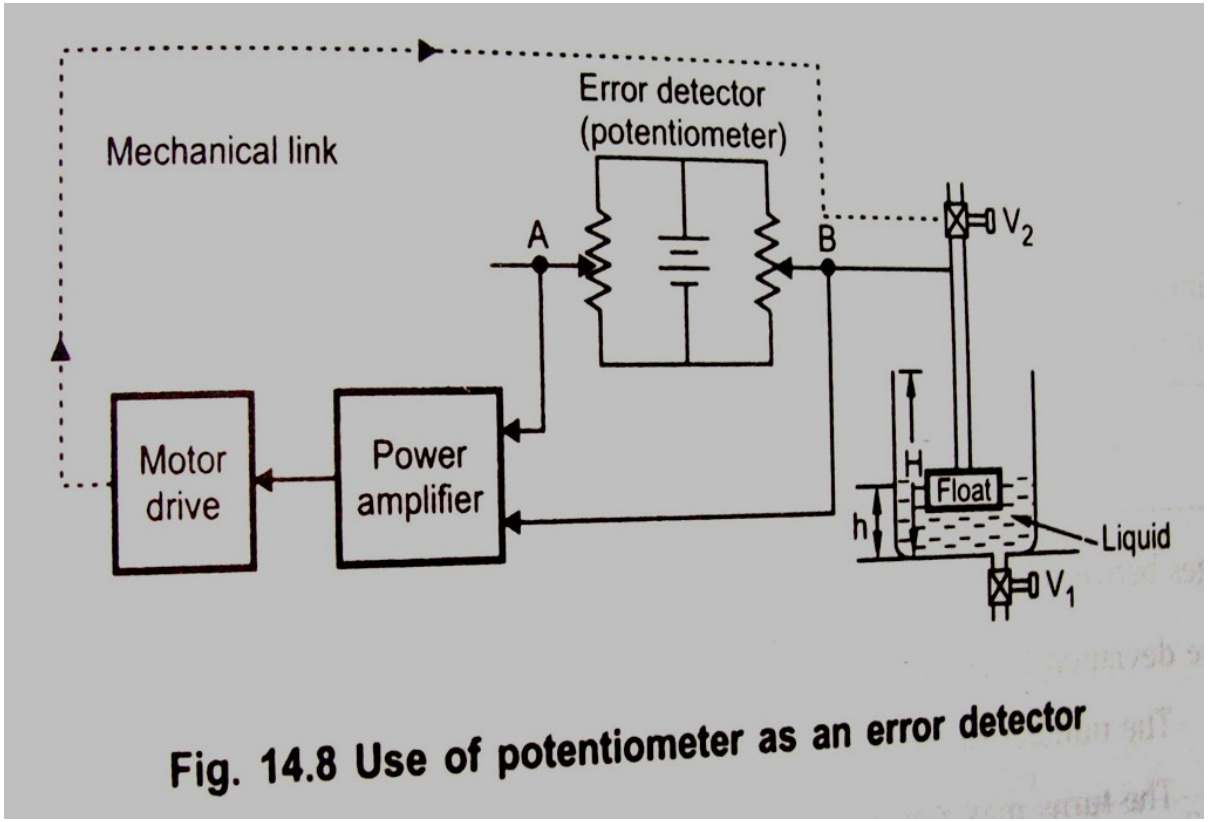
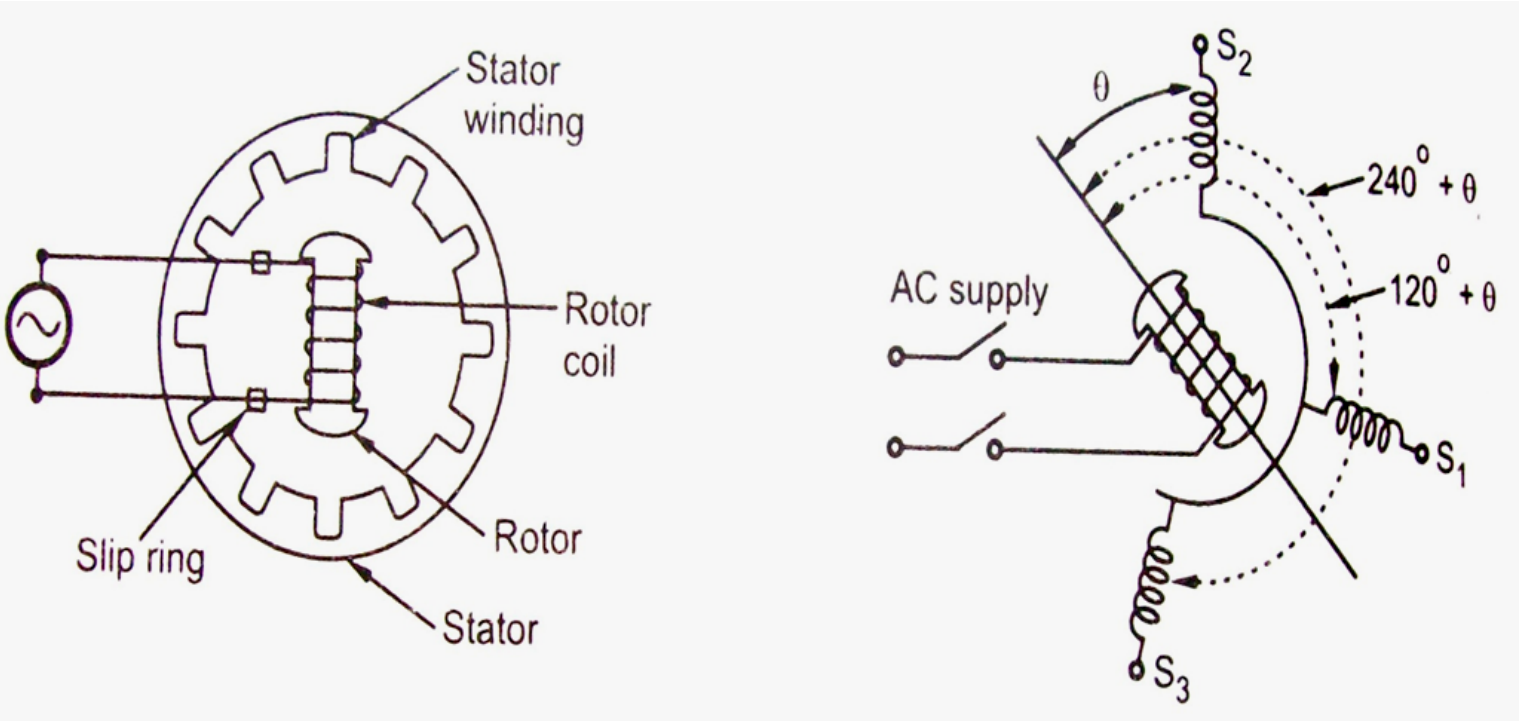


Fig. 14.8 Use of potentiometer as an error detector

Synchros

- A **synchro** is a type of rotary electrical transformer that is used for measuring the angle of a rotating machine such as an antenna platform. In its general physical construction, it is much like an electric motor. The primary winding of the transformer, fixed to the rotor, is excited by an alternating current, which by electromagnetic induction, causes currents to flow in three star-connected secondary windings fixed at 120 degrees to each other on the stator. The relative magnitudes of secondary currents are measured and used to determine the angle of the rotor relative to the stator, or the currents can be used to directly drive a receiver synchro that will rotate in unison with the synchro transmitter

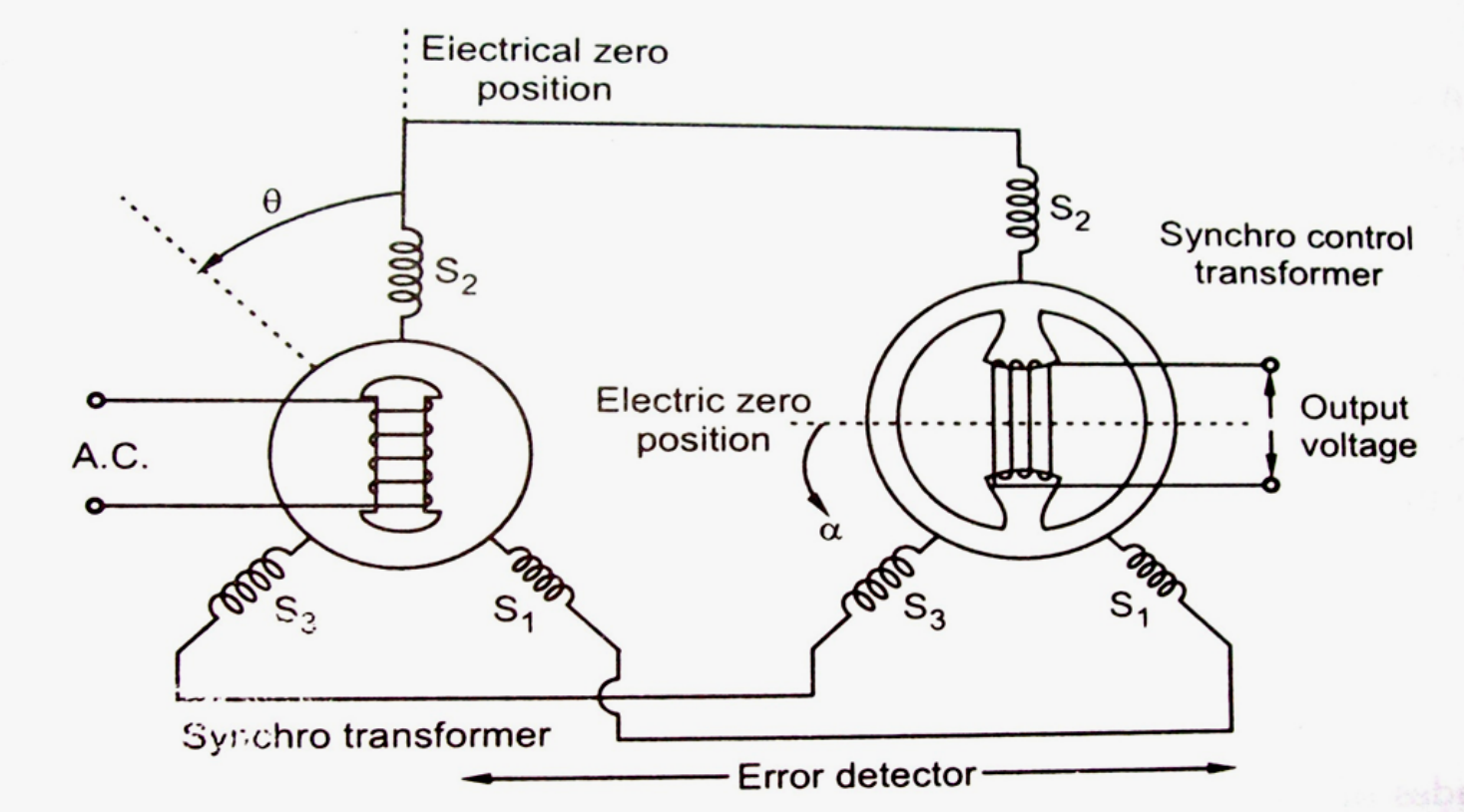
Synchros


Stator winding
Rotor coil
Slip ring
Rotor
Stator
θ
S2
240° + θ
120° + θ
AC supply
S1
S3

Synchro Operation

- On a practical level, Synchros resemble motors, in that there is a rotor, stator, and a shaft. Ordinarily, slip rings and brushes connect the rotor to external power. A synchro transmitter's shaft is rotated by the mechanism that sends information, while the synchro receiver's shaft rotates a dial, or operates a light mechanical load. Single and three-phase units are common in use, and will follow the other's rotation when connected properly. One transmitter can turn several receivers; if torque is a factor, the transmitter must be physically larger to source the additional current.

Synchro as Error Detector



Uses of Synchros

- Synchro systems were first used in the control system of the Panama Canal in the early 1900s to transmit lock gate and valve stem positions and water levels to the control desks
- Fire-control system designs developed during World War II used synchros extensively, to transmit angular information from guns and sights to an analog fire control computer, and to transmit the desired gun position back to the gun location.

Uses of Synchros

- Smaller synchros are still used to remotely drive indicator gauges and as rotary position sensors for aircraft control surfaces, where the reliability of these rugged devices is needed. Digital devices such as the rotary encoder have replaced synchros in most other applications.
- Selsyn motors were widely used in motion picture equipment to synchronize movie cameras and sound recording equipment.
- Large synchros were used on naval warships, such as destroyers, to operate the steering gear from the wheel on the bridge.

Tachogenerators (Tachometers)

- Tachometer is an electromechanical unit which generates an electrical output proportional to the speed of the shaft. In automatic control system tachometer performs two main functions:
- Stabilization of system
- Computation of closed loops in a control system

THANKS