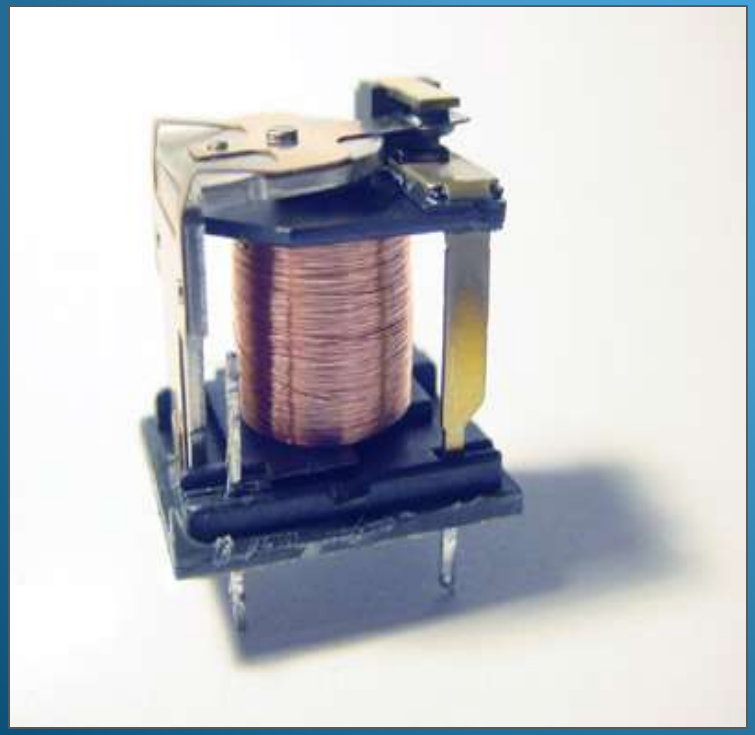
GOVERNMENT COLLEGE OF ENGG., CHANDRAPUR

PROTECTIVE RELAY



- Flexible AC Transmission System (FACTS) have been evolving to a mature technology with high power rating.
- This technology has wide spread application, became a top rate, most reliable one, based on power electronics. The main purpose of these systems is to supply the network as quickly as possible with inductive or capacitive reactive power that is adapted to its particular requirements, while also improving transmission quality and the efficiency of the power transmission system.
- With the progression and development in power electronics application not only improved the performance of AC systems but also make it feasible for long distance.

Agenda

- Introduction
- What is relay ?
- Fundamental of relay
- Operating principle
- Single line diagram
- Types of relay
- Importance
- Why a system needs protection ?
- Advantages and disadvantages
- Conclusion

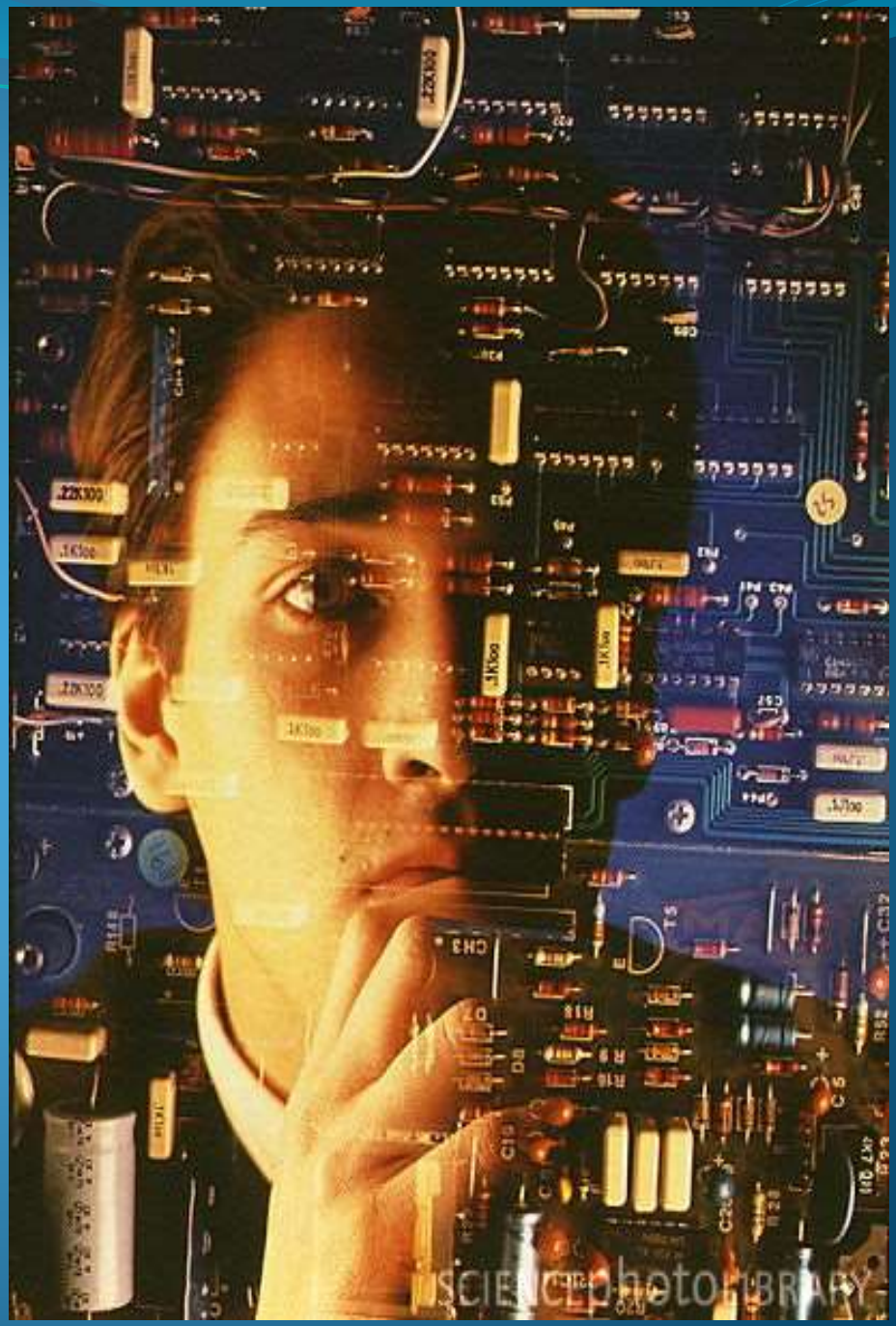
INTRODUCTION

- Protective relay is a device designed to trip a circuit breaker when fault is detected
- Protective relay were electromagnetic device
- It is operating on moving parts to provide detection of abnormal condition

- Electromechanical protective relay use at hydroelectrical plant.
- The relay are in round glass cases.
- The need to act quickly to protect circuit to protect equipment and trip a breaker with in a few thousands of seconds.

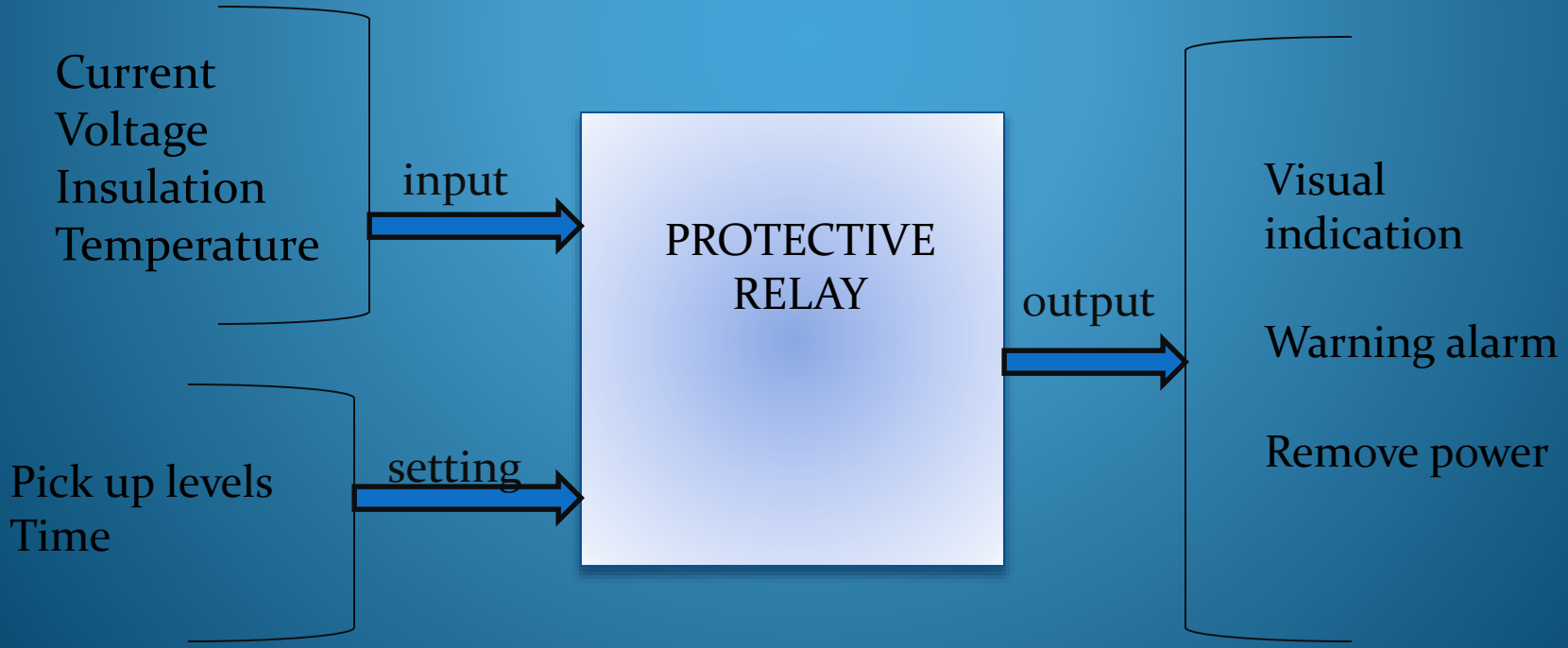
What is relay?

A relay is a automatic device which senses an abnormal condition of electric circuit and closes its contacts



Relay

A protection relay is a smart device that receive inputs, compares them to set points, and provide outputs .
Inputs can be current ,voltage ,resistance or temperature.
Outputs can include visual feedback in the form of indicator lights.
A diagram is shown below.



INPUT:- A relay needs information from the system to make decision.

SETTING:- The user programs setting that allow relay to make decision.

PROCESS:- Once input are connected and setting are program, the relay compares there and make decision.

OUTPUT:- The relay will operate a switch to indicate that the input has surpassed a setting. Or the relay can provide notification through visual feedback such as a meter or LED.

Functional Characteritics of a protective relay

Reliability:- It must operate when it is required. Inherent reliability is a matter of design based on experience.

This can be achieved partly by

1. Simplicity and robustness in construction
2. High contact pressure
3. Dust free enclosures
4. Good contact material
5. Good workmanship
6. Careful maintenance

Selectivity:- it should be possible to select which part of the system is faulty and which is not and should isolate the faulty part of the system.It is achieved by two ways:

1. Unit system of protection
2. Non unit system of protection

Speed:- A protective relay must operate at required speed.It should neither be too slow nor too fast may result in undesired operation during transient fault.

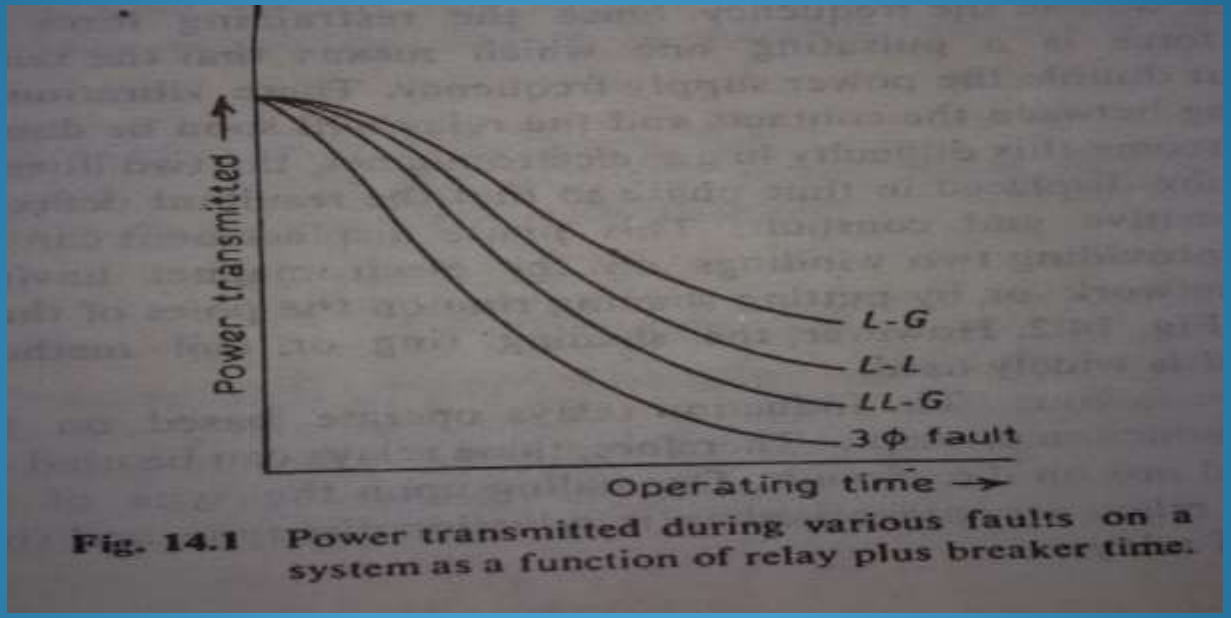


Fig. 14.1 Power transmitted during various faults on a system as a function of relay plus breaker time.

Sensitivity:- A relay should be sufficiently sensitive so that it operates reliably when require under the actual condition in the system which produce the least tendency for operation.

Terms related to protective relay

Pick up level of actuating signal:-The value of actuating quantity (voltage or current) which on threshold above which the relay initiates to be operated.

Reset level:- The value of electric current or voltage below which a relay open its contacts and comes in original position.

Operating time of relay:-The time which elapses between the instant when actuating quantity exceeds the pick up value to the instant when the relay contacts close.

Reset time:-The time which elapses between the instant when the actuating quantity becomes less than the reset value to the instant when relay contacts return to its normal position.

Primary relay:-The relay which are connected directly in the circuit to be protected.

Secondary relays:- The relay which are connected in the circuit to be protected through current and potential transformer.

Auxiliary Relays:- The relay which operate in response to opening or closing of its operating circuit to assist another relay in the performance of its function.

Reach:- A distance relay operates whenever the impedance seen by the relay is less than a pre specified value.

Under reached value:- The tendency of relay to restrain at the set value of impedance or impedance lower than the set value is known as under reached.

Over reached:- The tendency of the relay to operate at impedances larger than its setting.

OPERATING PRINCIPLE

- There are really only two fundamentally different operating principles,
  1. Electromagnetic attraction
  2. Electromagnetic induction
- Electromagnetic attraction relays operate by virtue of a plunger being drawn into a solenoid.
- Electromagnetic induction relays use the principle of the induction motor whereby torque is developed by induction in a rotor.

Fundamental of protective relay

•The two fundamental relay operations are to isolate faulted sections of the power system while maintaining the power delivery capability in the rest of the power system.

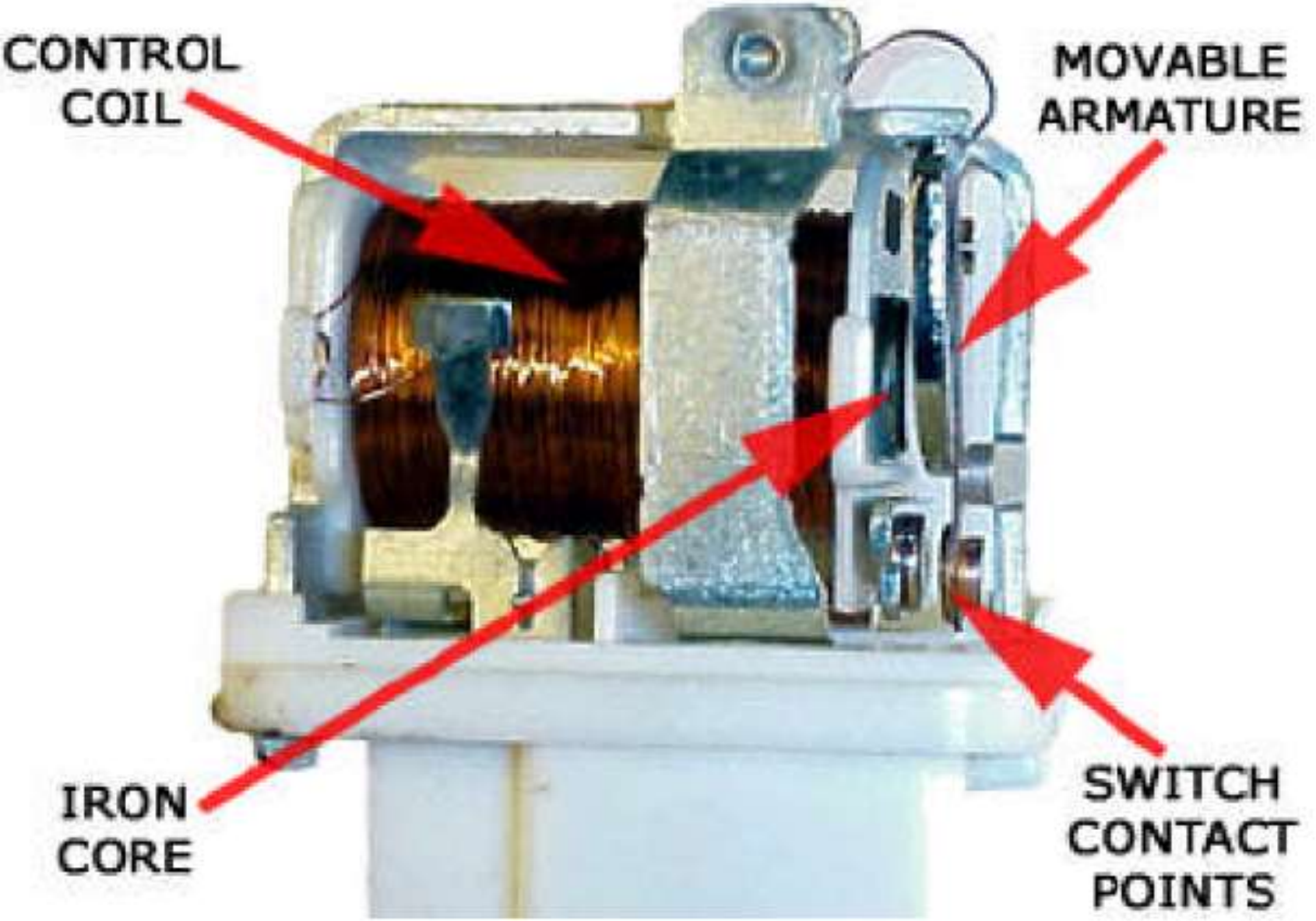
•Relays can have numerous inputs on which to determine if a trip signal is required.

• DC power is needed to supply relay power as well as to provide trip coil power for the power circuit breaker.

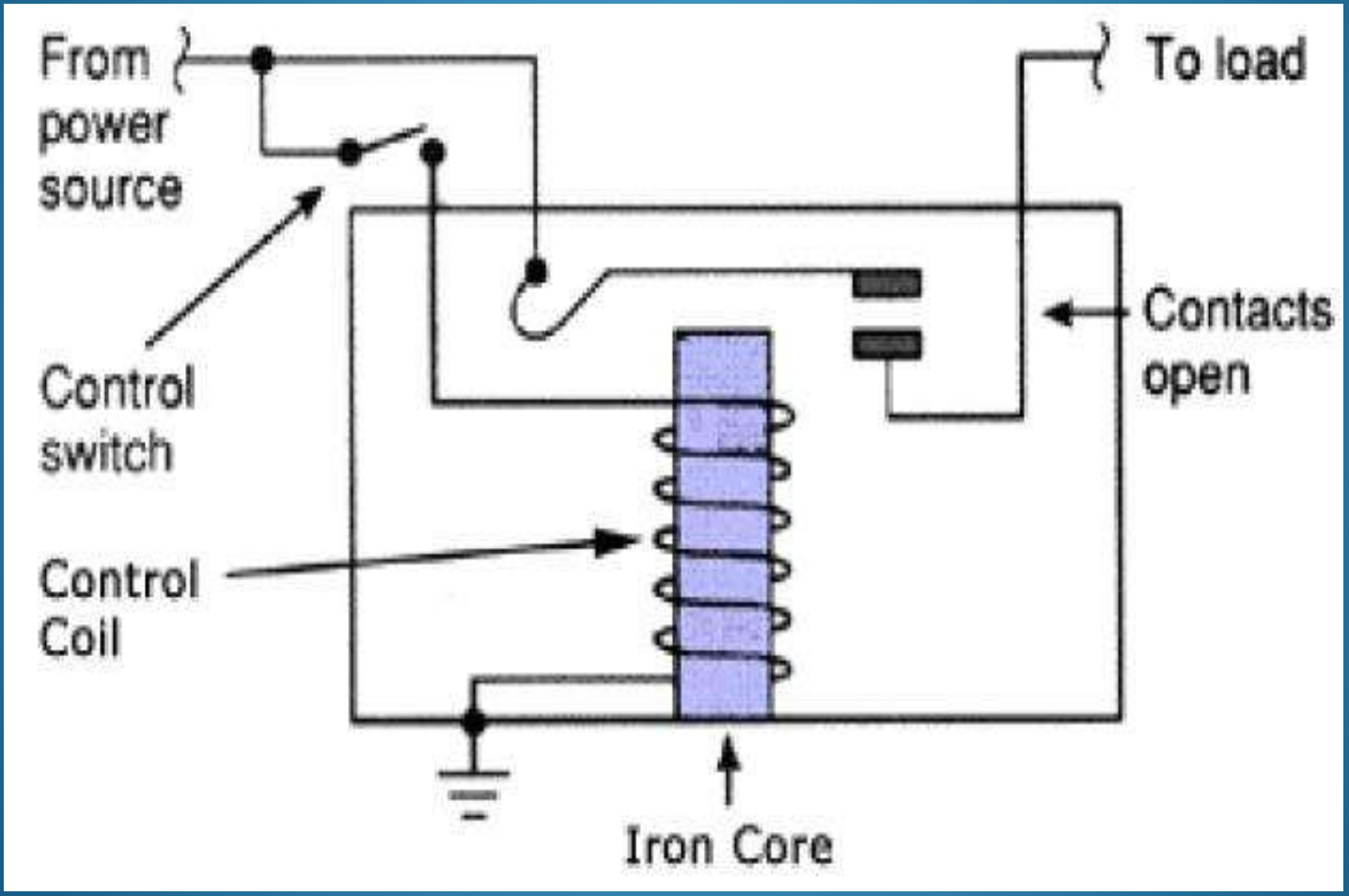
•Other inputs can modify relay behavior to speed up or inhibit operations.

• Relay communications also allows remote control and event retrieval.

How relay look



How a Relay Works



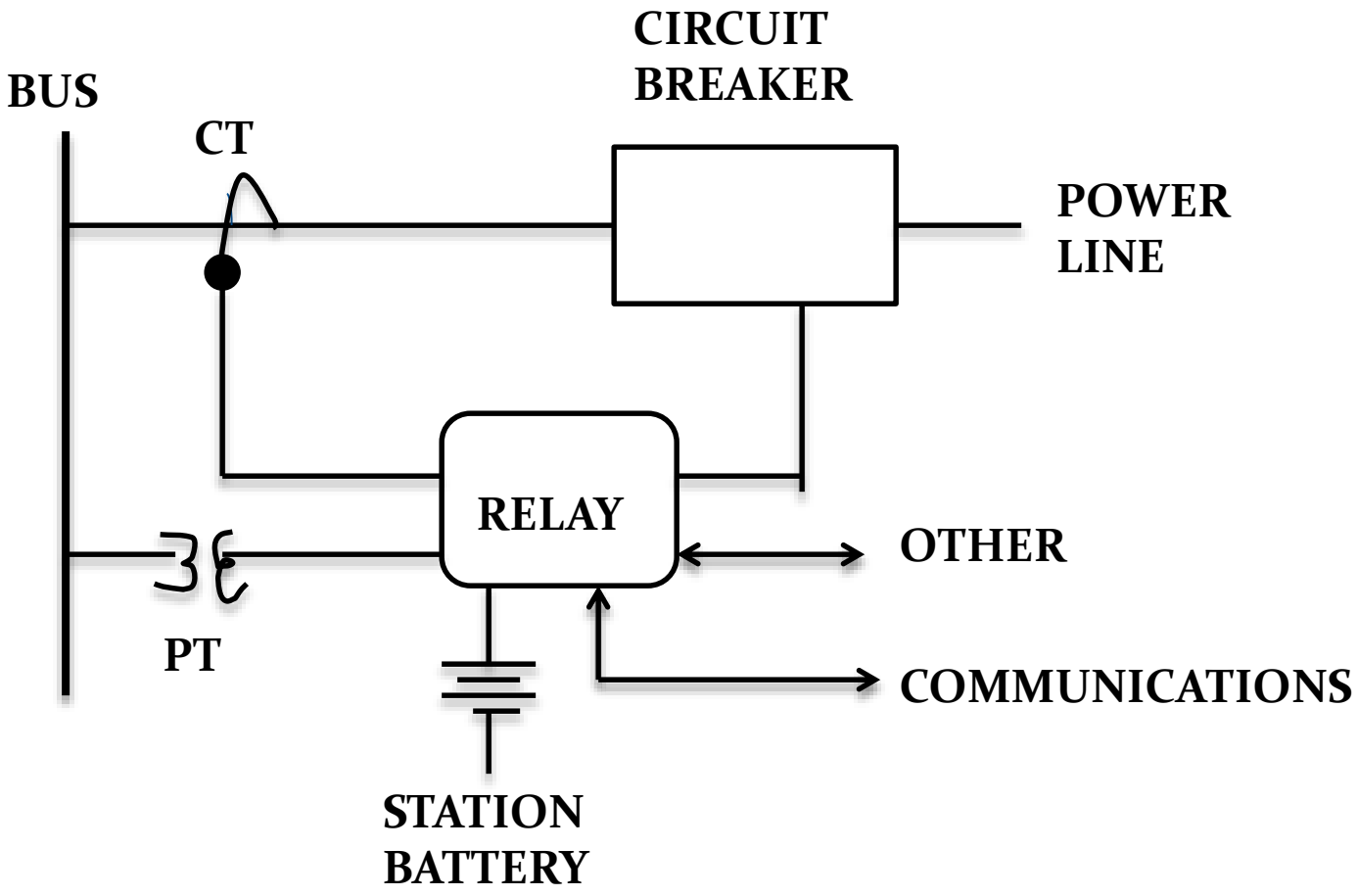
Stage 1:

When conductors with good insulation are exposed to fault initiators such as moisture, dust, chemicals, persistent overloading, vibration or just normal deterioration, the insulation will start to slowly deteriorate. Such small changes will not be immediately obvious until the damage is severe enough to cause an electrical fault. Protective relays can detect that a problem is developing by identifying slight deviations in current, voltage, resistance, or temperature. Due to the small magnitude in change, only a sophisticated device such as a sensitive protection relay or a monitor can detect these conditions and indicate that a problem may be developing, before any further damage has occurred.

Stage 2:
As the problem becomes more severe, further changes take place such as insulation breakdown, overheating, or overvoltage. Since the change from normal to abnormal is great, traditional devices can be used to interrupt power. A protection relay can also be used to provide additional protection by detecting the fault contributors (overheating, overvoltage, etc.) not possible with fuses and circuit breakers.

Stage 3: At this point, the problem has occurred and caused damage. Different types of protective relays and monitors can reduce or eliminate damage because they detect problems in advance of traditional devices.

Single Line diagram of relay



Relay Purpose

- Isolate controlling circuit from controlled circuit.
- Control high voltage system with low voltage.
- Control high current system with low current.
- Logic Functions

TYPES OF RELAY

Types of protection relays are mainly based on their characteristics ,logic, on actuating parameter & operation mechanism.

- **Based on operation of mechanism**
  1. Electromagnetic relay
  2. Static relay
  3. Mechanical relay

- **Based on actuating parameter**
  1. Current relay
  2. voltage relay
  3. Frequency relay
  4. Power relay

- Based on characteristics
  1. Definite time relay
  2. Inverse time relay with definite minimum
  3. Instantaneous relays
  4. IDMT with Instrument
  5. Stepped characteristics
  6. Programmed switches
  7. Voltage restraint over electric current relay

- Based on application
  1. Primary relay
  2. Back up relay

- Based on logic

1. Differential
2. Unbalance
3. Neutral displacement
4. Direction
5. Restricted earth fault
6. Over fluxing
7. Distance scheme
8. Bus bar protection
9. Reserve power relay
10. Loss of excitation
11. Negative phase sequence relay

Importance of relay

- Inadequate protection can lead to a major fault that would have been avoided.

- By adequate protection the damage can be eliminated or minimized.

- If the faulty part is disconnected quickly the damage caused by fault is minimum.

- The protective relaying helps in improving service continuity and its importance to self evident.

Why A System Needs Protection?

- There is no ‘fault free’ system.
- It is neither practical nor economical to build a ‘fault free’ system.
- Electrical system shall tolerate certain degree of faults.
- Usually faults are caused by breakdown of insulation due to various reasons: system aging, lighting, etc.

Operating principles

- A protective relay may respond to the magnitude of a quantity such as voltage or current. Induction types of relay can respond to the product of two quantities in two fields

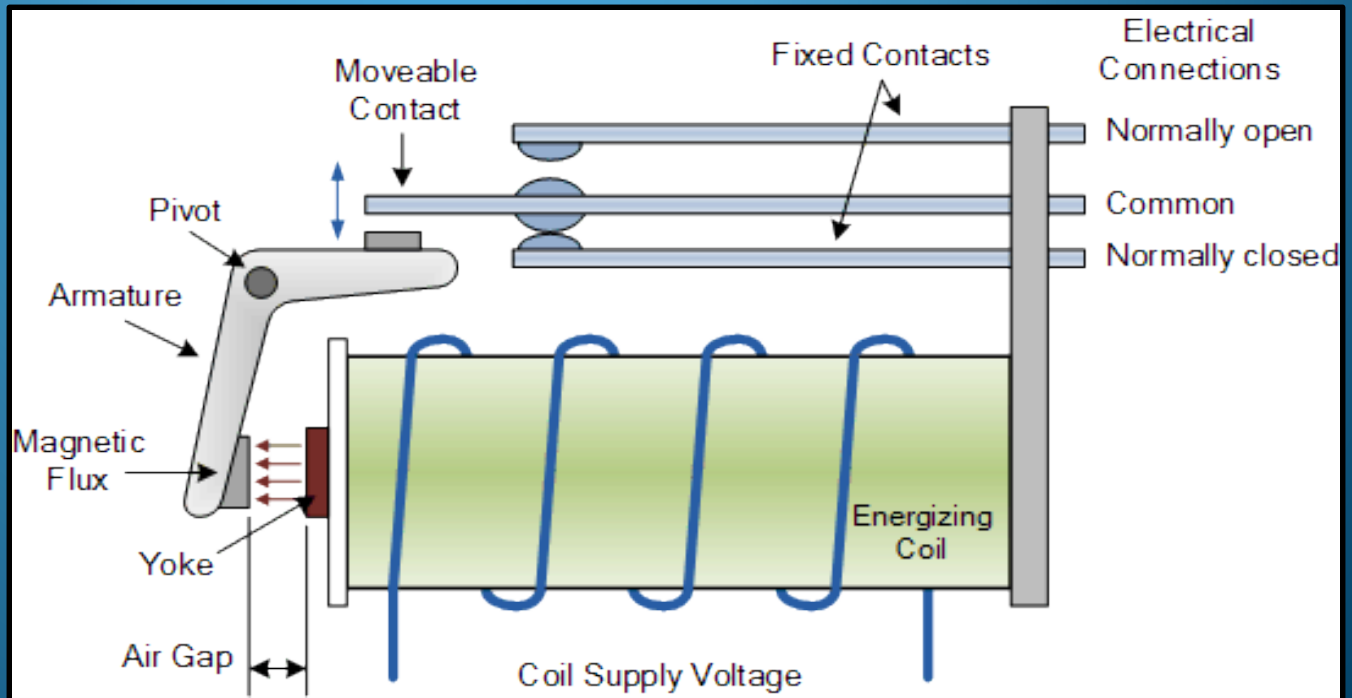
- Several operating coils can be used to provide "bias" to the relay, allowing the sensitivity of response in one circuit to be controlled by another.

- By use of a permanent magnet in the magnetic circuit, a relay can be made to respond to current in one direction differently from in another.

- . For AC circuits, the principle is extended with a polarizing winding connected to a reference voltage source.

ELECTROMECHANICAL RELAY

In our simple relay above, we have two sets of electrically conductive contacts. Relays may be "Normally Open", or "Normally Closed". One pair of contacts are classed as **Normally Open**, An example of this arrangement is given below.

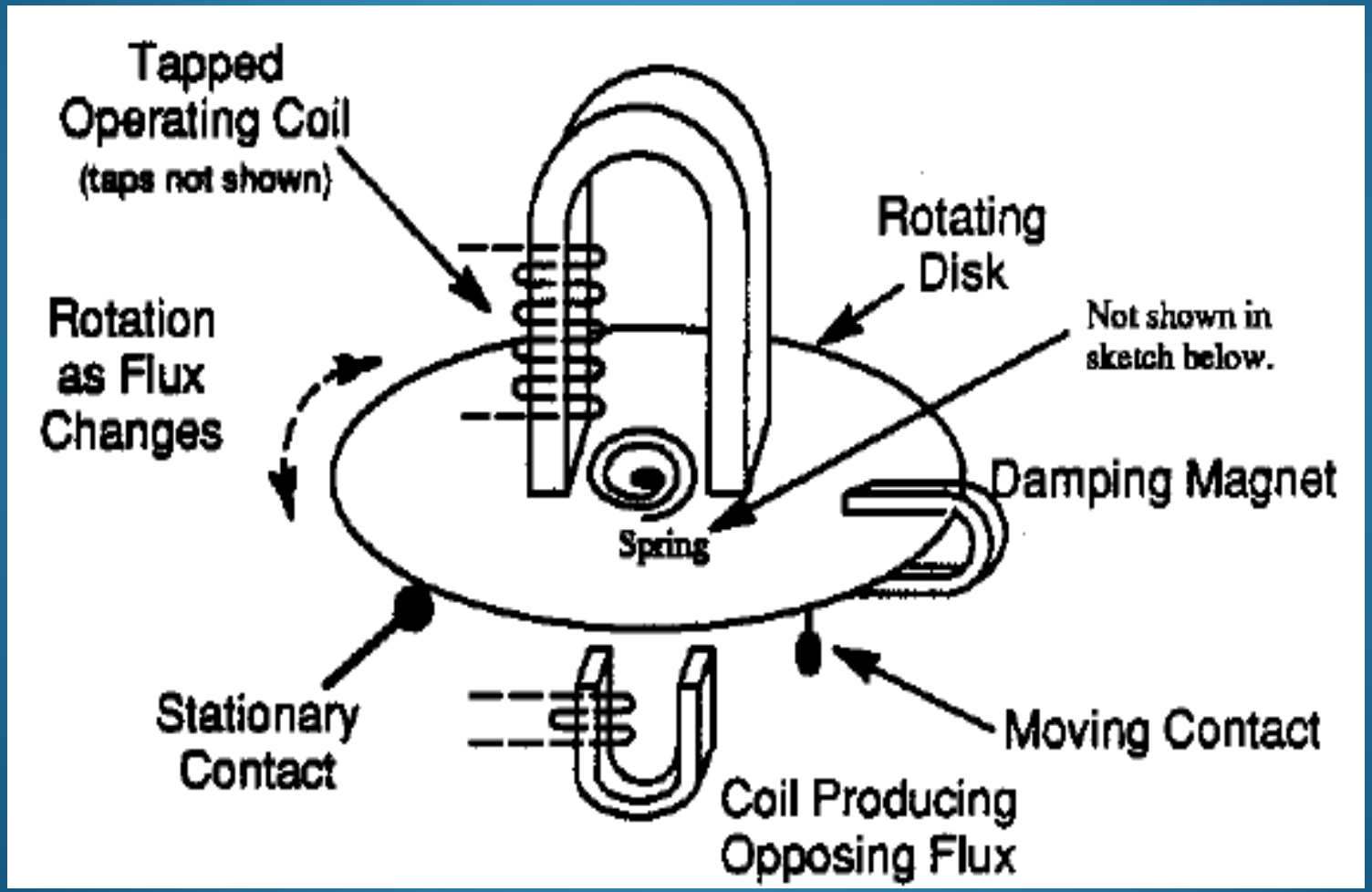


- Relays may be “Normally Open”, or “Normally Closed”. One pair of contacts are classed as **Normally Open, (NO)** or make contacts and another set which are classed as **Normally Closed, (NC)** or break contacts .
- In the normally open position, the contacts are closed only when the field current is “ON” and the switch contacts are pulled towards the inductive coil.

- In the normally closed position, the contacts are permanently closed when the field current is “OFF” as the switch contacts return to their normal position.

- These terms *Normally Open, Normally Closed* or *Make and Break Contacts* refer to the state of the electrical contacts when the relay coil is “de-energized”, i.e, no supply voltage connected to the inductive coil.

INDUCTION TYPE RELAY



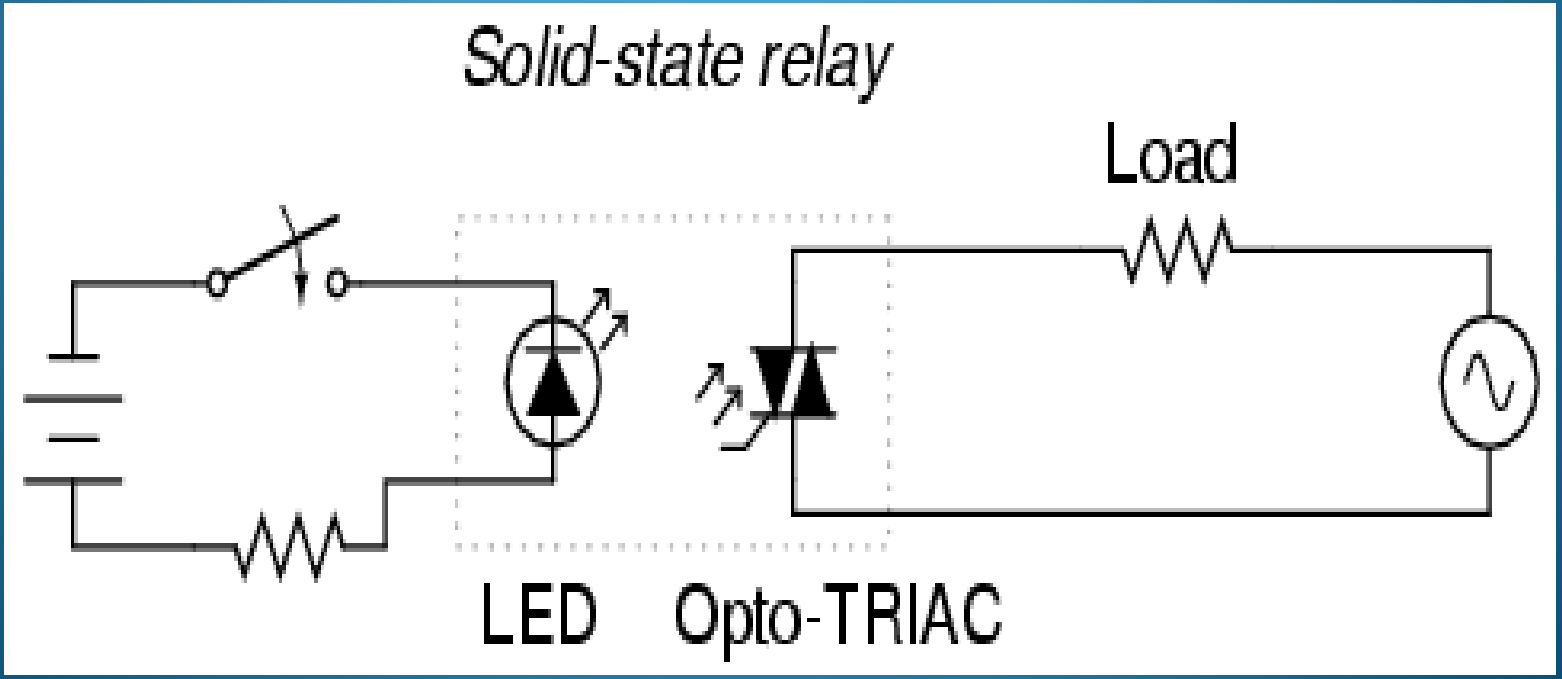
- An induction relay works only with the alternating current.

- It consist of an electromagnetic system which operates on moving conductors generally in the form of disc or cup function through the interaction of electromagnetic flux.

- These two fluxes which are mutually displaced both in angle and in position.

Solid-state Relays (SSRs)

SSRs use semiconductor output instead of mechanical contacts to switch the circuit.
The output device is optically-coupled to an LED light source inside the relay.
The relay is turned on by energizing this LED, usually with low-voltage



Numerical Motor Protection Relay

FEATURES

- Locked Rotor Protection based on impedance measurement
- Three phase o/c relay with selectable IDMT /definite time characteristics
- Earth fault relay with selectable IDMT / definite time characteristics
- Negative sequence relay
- Thermal Overload protection
- Wide setting range
- Suitable for medium and large motors

AUTORECLOSER RELAY

PROTECTION FUNCTIONS

- THREE PHASE O/C WITH SELECTABLE IDMT/DEFINITE TIME CHARACTERISTICS
- EARTH FAULT WITH SELECTABLE IDMT / DEFINITE TIME CHARACTERISTICS
- COLD LOAD PICKUP LOGIC
- CIRCUIT BREAKER FAILURE
- BROKEN CONDUCTOR

CONTROL FUNCTIONS

- MULTI-SHOT (4) AUTORECLOSER
- EACH SHOT IS INDEPENDENTLY PROGRAMABLE
- CIRCUIT BREAKER CONTROL TWO SETTING GROUPS

- A microprocessor-based digital protection relay can replace the functions of many discrete electromechanical instruments

- These convert voltage and currents to digital form and process the resulting measurements using a microprocessor.

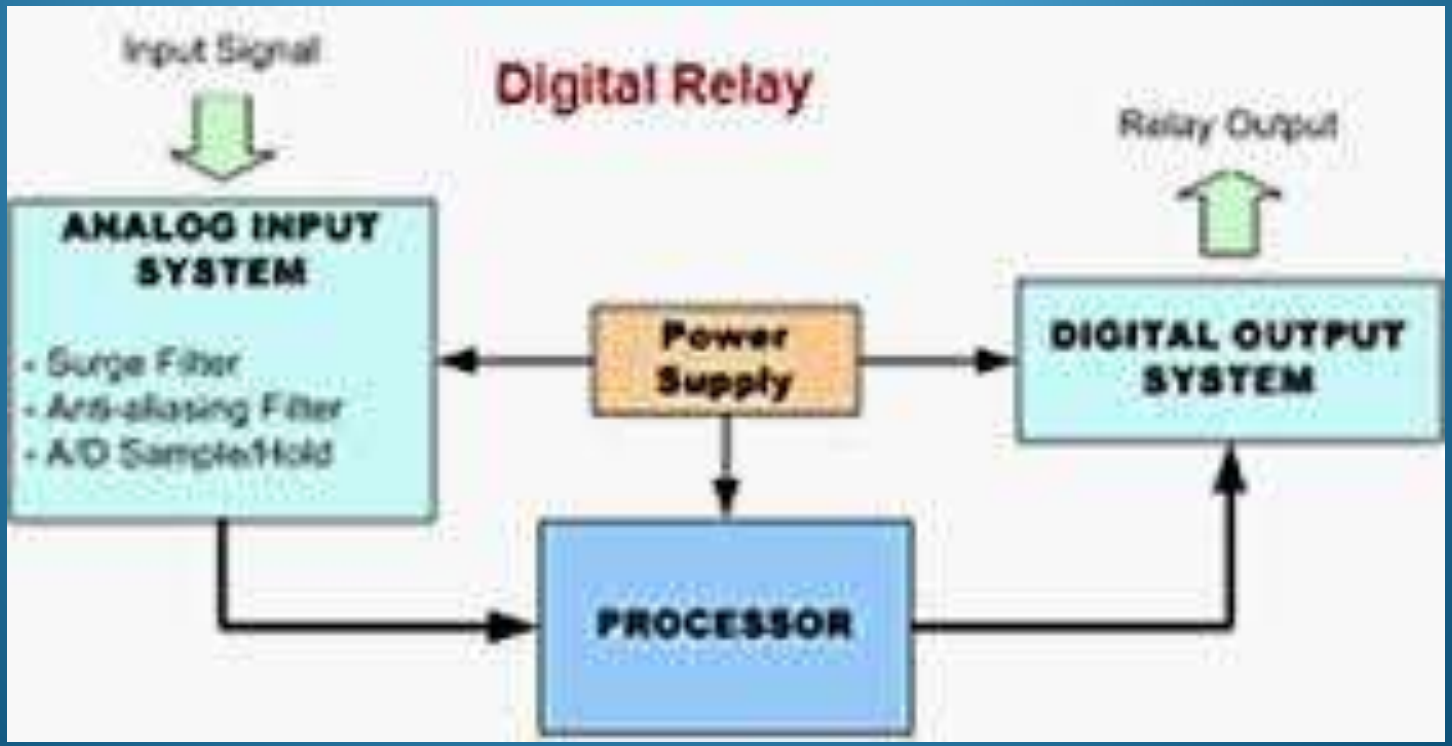
- The digital relay can emulate functions of many discrete electromechanical relays in one device, simplifying protection design and maintenance.

- Each digital relay can run self-test routines to confirm its readiness and alarm if a fault is detected.
- Numeric relays can also provide functions such as communications (SCADA) interface, monitoring of contact inputs, metering, waveform analysis, and other useful features.

Digital Relay

The functions of electromechanical protection systems are now being replaced by microprocessor-based digital protective relays, sometimes called "numeric relays".

- A microprocessor-based digital protection relay can replace the functions of many discrete electromechanical instruments

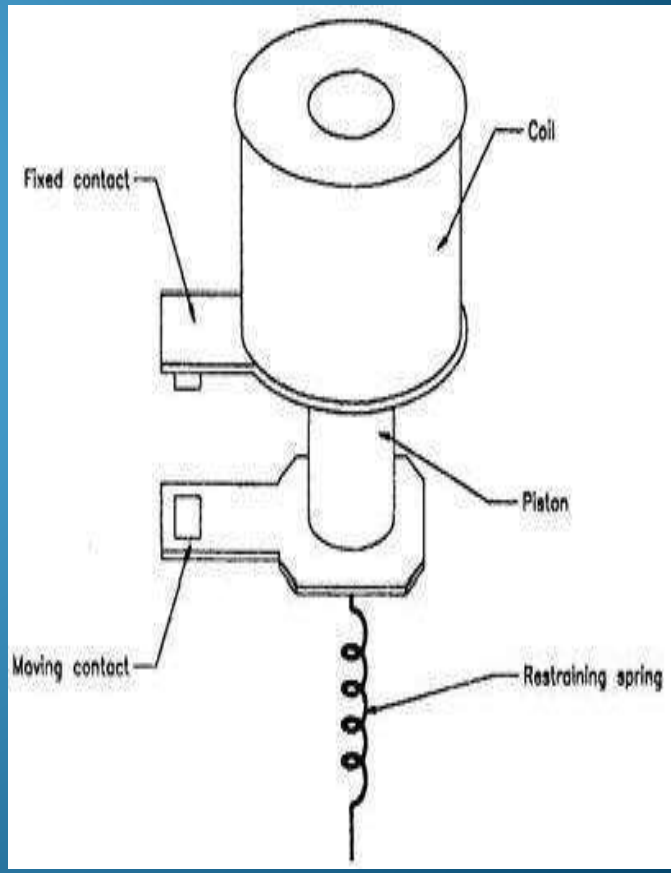


Relays with moveable coils

This type of relay consists of a rotating movement with a small coil suspended or pivoted with the freedom to rotate between the poles of a permanent magnet. The coil is restrained by two springs which also serve as connections to carry the current to the coil.

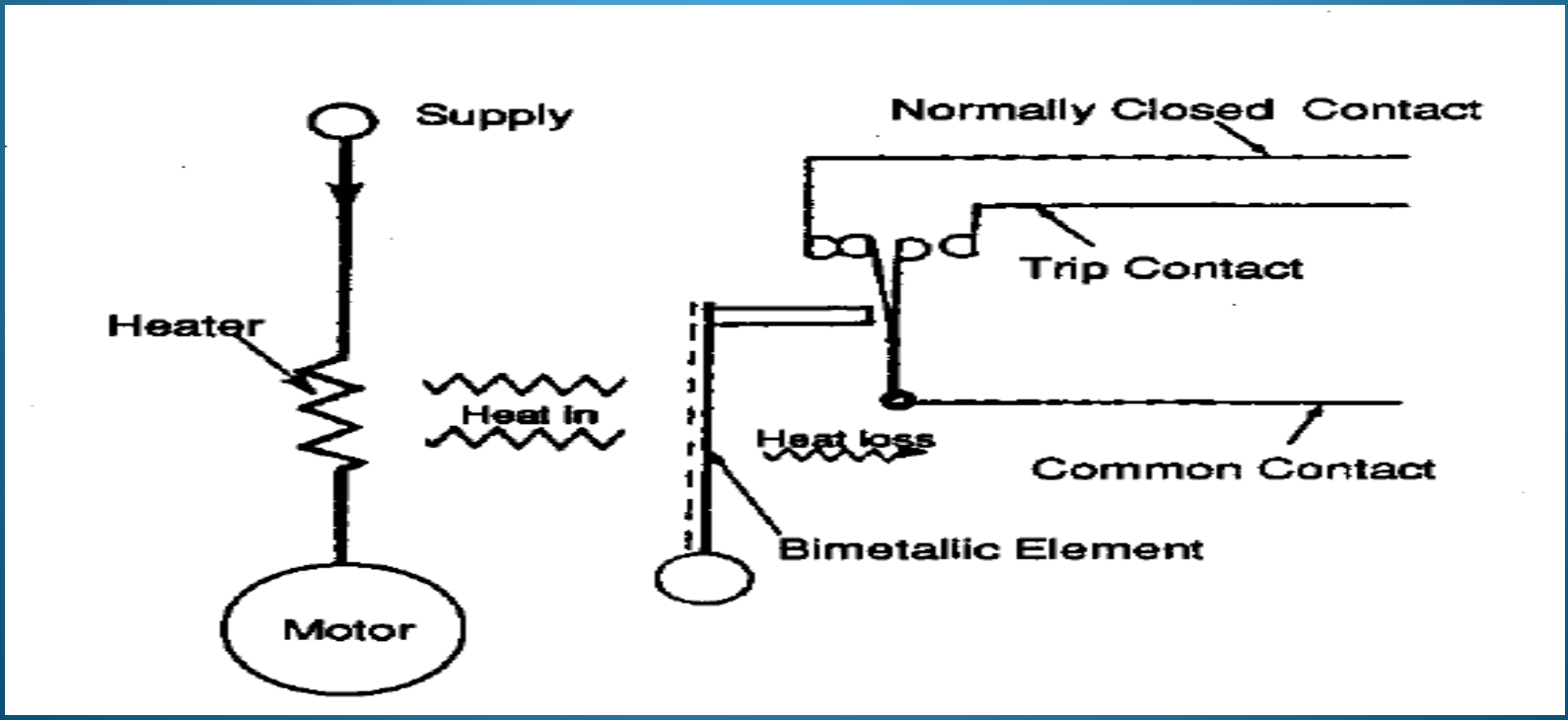
The torque produced in the coil is given by:
$T = B.l.a.N.i$

Where:
T= torque
B = flux density
L =length of the coil
a = diameter of the coil
N = number of turns on the coil
i = current flowing through the coil



Thermal Protection Relay

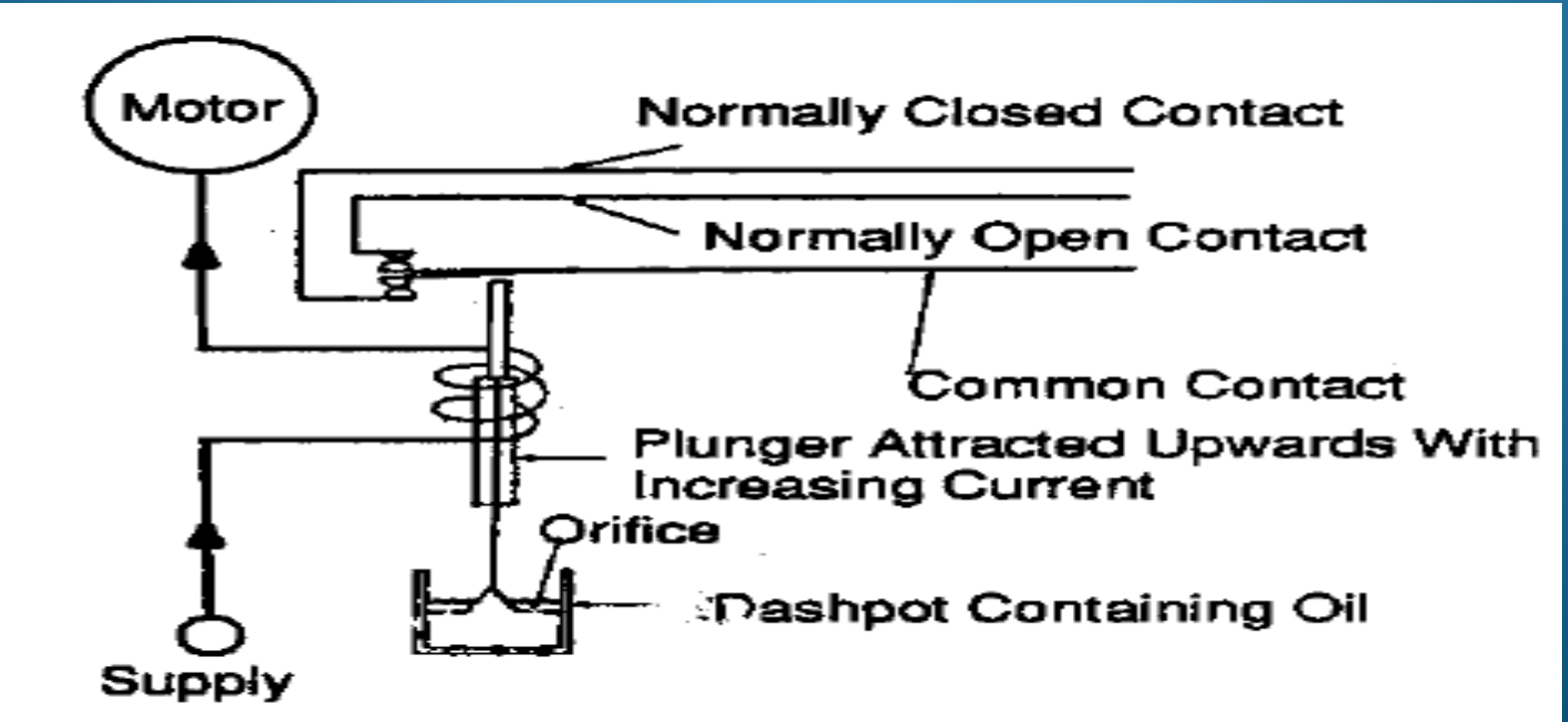
- Use bimetallic strips to open/close relay contacts when temperature exceeds/drops to certain level
- Require certain reaction time
- Inverse time/current relationship



Plunger-type Relays

- Fast reaction time
- Use timer for time delay
- Such as oil dash pot.
- Inverse time/current relationship

It is a four pole structure.This has operating, polarising and restraining coils.



Reactance relay

In this relay the operating torque is obtained by current and restraining torque due to current –voltage directional element.

For the operation of the relay the reactance seen by the relay should be smaller than the reactance for which the relay has been designed.

The characteristic will be as shown in fig:

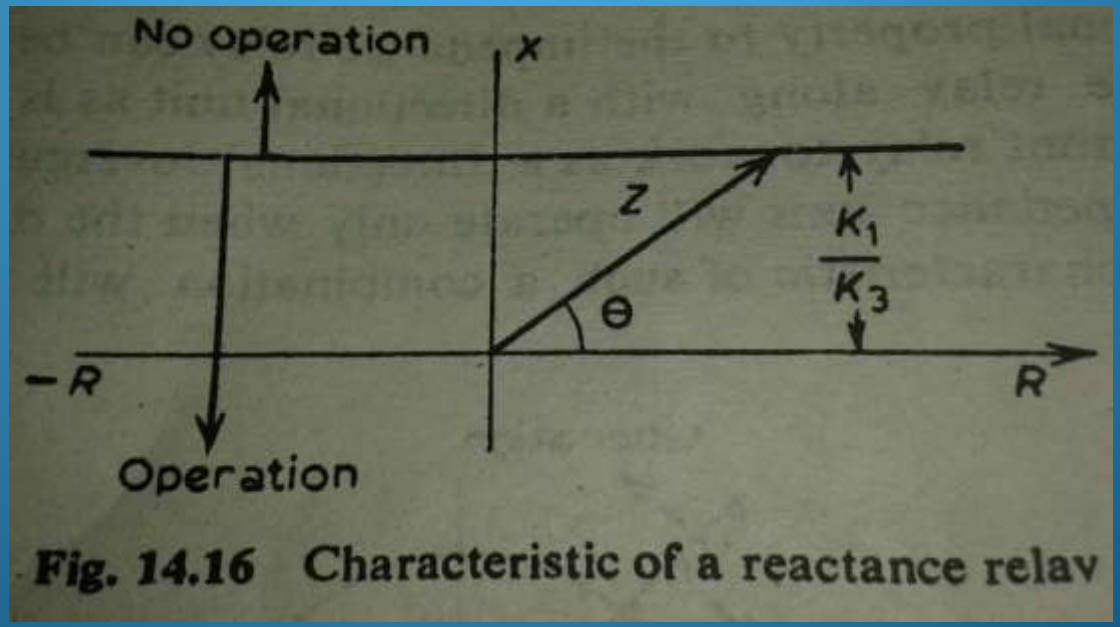


Fig. 14.16 Characteristic of a reactance relay

A typical reactance relay using induction cup structure is shown in fig below:

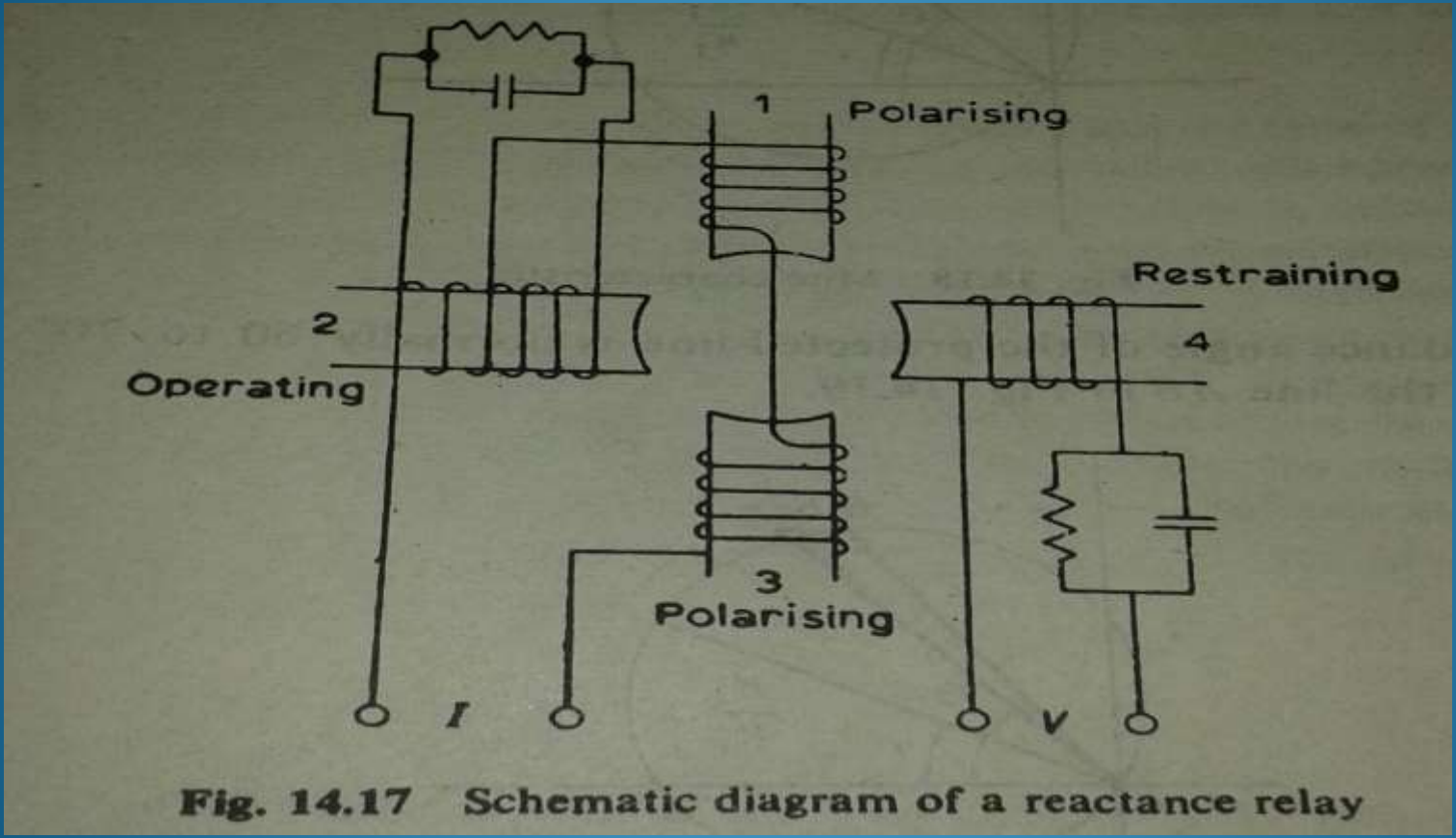


Fig. 14.17 Schematic diagram of a reactance relay

It is a four pole structure.This has operating, polarising and restraining coils.

Advantages for Using Protective Relays

- Detect system failures when they occur and isolate the faulted section from the remaining of the system.

- Mitigating the effects of failures after they occur. Minimize risk of fire, danger to personal and other high voltage systems.

Transformer Protection

- Gas Monitoring Relays:

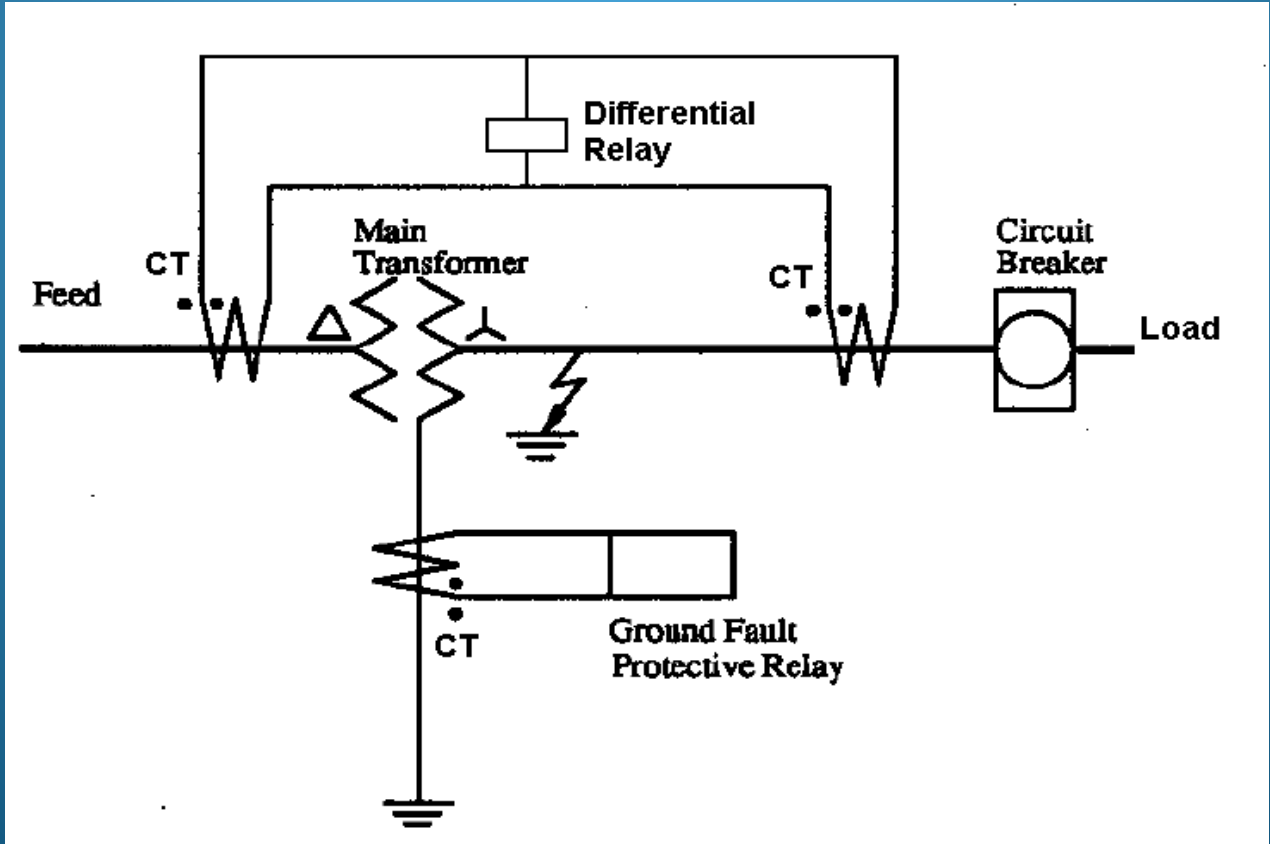
These relays will sense any amount of gas inside the transformer. A tiny little amount of gas will cause transformer explosion.

- Temperature Monitoring Relays:

These relays are used to monitor the winding temperature of the transformer and prevent overheating.

Transformer Protection
Ground Fault and Differential Relay

For a wave connection, ground fault can be detected from the grounded neutral wire.



Advantages/Disadvantages

- Electromagnetic Relays (EMRs)
  - Simplicity
  - Not expensive
  - Mechanical Wear
- Solid-state Relays (SSRs)
  - No Mechanical movements
  - Faster than EMR
  - No sparking between contacts
- Microprocessor-based Relay
  - Much higher precision and more reliable and durable.
  - Improve the reliability and power quality of electrical power systems before, during and after faults occur.
  - Capable of both digital and analog I/O.

  Higher cost


Incoming Subtransmission Lines
Electric power path through substation
34 KV in
Lightning Arresters
Air-break Switches
Outgoing Distribution Lines
Step-down Transformer
Distribution Bus
7.2 KV out
Cutout Switches
Oil Circuit Breakers
Voltage Regulators
Metal-clad Switchgear
Control House

Conclusion

- Relays control output circuits of a much higher power.
- Safety is increased
- Protective relays are essential for keeping faults in the system isolated and keep equipment from being damaged.

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THANK YOU!!!