Fuse:

Fuse is the simplest current interrupting device for protection against excessive currents.

ADVANTAGES

❑ It is the cheapest form of protection available.

❑ It needs no maintenance.

❑ It interrupts enormous short circuit currents without noise , flame , gas or smoke.

❑ The minimum time of operation can be made much smaller than that with the circuit breakers.

❑ Its inverse time-current characteristics enables its use for overload protection.

DISADVANTAGES

❑ Considerable time is lost in rewiring or replacing a fuse after operation.

❑ The current-time characteristics of a fuse cannot always be correlated with that of

Miniature Circuit Breaker

Nowadays we use more commonly **miniature circuit breaker** or **MCB** in low voltage electrical network instead of fuse.

The **MCB** has some advantages compared to fuse.

1. It automatically switches off the electrical circuit during abnormal condition of the network means in over load condition as well as faulty condition. The fuse does not sense but **miniature circuit breaker** does it in more

reliable way. MCB is much more sensitive to over current than fuse.

2. Another advantage is, as the switch operating knob comes at its off position during tripping, the faulty zone of the electrical circuit can easily be identified. But in case of fuse, fuse wire should be checked by opening fuse grip or cutout from fuse base, for confirming the blow of fuse wire.
3. Quick restoration of supply cannot be possible in case of fuse as because fuses have to be rewirable or replaced for restoring the supply. But in the case of MCB, quick restoration is possible by just switching on operation.
4. Handling MCB is more electrically safe than fuse. Because of too many advantages of MCB over fuse units, in modern low voltage electrical network, miniature circuit breaker is mostly used instead of backdated fuse unit. Only one disadvantage of MCB over fuse is that this system is more costly than fuse unit system.

Working Principle Miniature Circuit Breaker

There are two arrangement of **operation of miniature circuit breaker.** One due to thermal effect of over current and other due to electromagnetic effect of over current. The thermal **operation of miniature circuit breaker** is achieved with a bimetallic strip whenever continuous over current flows through MCB; the bimetallic strip is heated and deflects by bending. This deflection of bimetallic strip releases mechanical latch. As this mechanical latch is attached with operating mechanism, it causes to open the miniature circuit breaker contacts.

But during short circuit condition, sudden rising of current, causes electromechanical displacement of plunger associated with tripping coil or solenoid of MCB. The plunger strikes the trip lever causing immediate release of latch mechanism consequently open the **circuit breaker** contacts. This was a simple explanation of **miniature circuit breaker working principle.**

Miniature Circuit Breaker Construction

Miniature circuit breaker construction is very simple, robust and maintenance free. Generally a MCB is not repaired or maintained, it just replaced by new one when required. A miniature circuit breaker has normally three main constructional parts. These are:

Frame of Miniature Circuit Breaker

The frame of miniature circuit breaker is a molded case. This is a rigid, strong, insulated housing in which the other components are mounted.

Operating Mechanism of Miniature Circuit Breaker

The operating mechanism of miniature circuit breaker provides the means of manual opening and closing operation of miniature circuit breaker. It has three-positions "ON," "OFF," and "TRIPPED". The external switching latch can be in the "TRIPPED" position, if the MCB is tripped due to over-current. When manually switch off the MCB, the switching latch will be in "OFF" position. In close condition of MCB,

the switch is positioned at "ON". By observing the positions of the switching latch one can determine the condition of MCB whether it is closed, tripped or manually switched off.

Trip Unit of Miniature Circuit Breaker

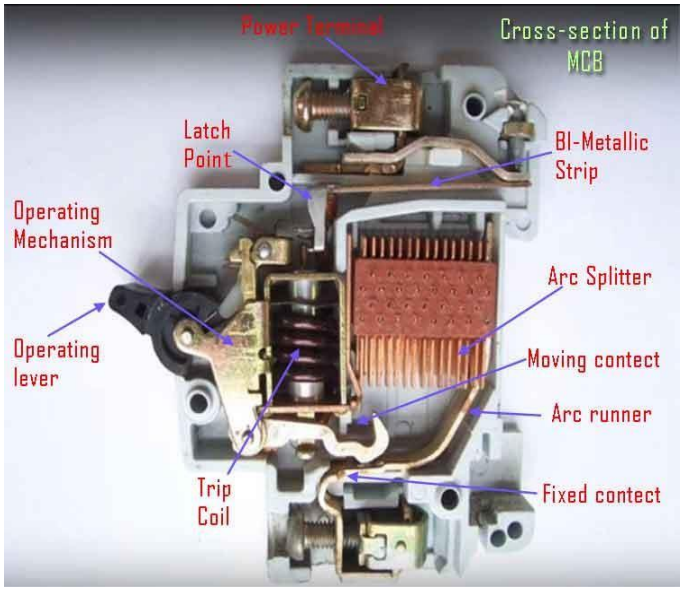
The trip unit is the main part, responsible for proper **working of miniature circuit breaker.** Two main types of trip mechanism are provided in MCB. A bimetal provides protection against over load current and an electromagnet provides protection against short-circuit current.

Operation of Miniature Circuit Breaker

There are three mechanisms provided in a single miniature circuit breaker to make it switched off. If we carefully observe the picture beside, we will find there are mainly one bi - metallic strip, one trip coil and one hand operated on-off lever. Electric current carrying path of a miniature circuit breaker shown in the picture is like follows. First left hand side power terminal - then bimetallic strip - then current coil or trip coil - then moving contact - then fixed contact and - lastly right had side power terminal. All are arranged in series.

If circuit is overloaded for long time, the bi - metallic strip becomes over heated and deformed. This deformation of bi metallic strip causes displacement of latch point. The moving contact of the MCB is so arranged by means of spring pressure, with this latch point, that a little displacement of latch causes, release of spring and makes the moving contact to move for opening the MCB. The current coil or trip coil is placed such a manner that during short circuit fault the mmf of that coil causes its plunger to hit the same latch point and make the latch to be displaced. Hence the MCB will open in same manner. Again when operating lever of the **miniature circuit breaker** is operated by hand, that means when we make the MCB at off position manually, the same latch point is displaced as a result moving contact separated from fixed contact in same manner. So, whatever may be the operating mechanism, that means, may be due to deformation of bi - metallic strip, due to increased mmf of trip coil or may due to manual operation, actually the same latch point is displaced and same deformed

spring is released, which ultimately responsible for movement of the moving contact. When the moving contact separated from fixed contact, there may be a high chance of arc. This arc then goes up through the arc runner and enters into arc splitters and is finally quenched. When we switch on an MCB, we actually reset the displaced operating latch to its previous on position and make the MCB ready for another switch off or trip operation.



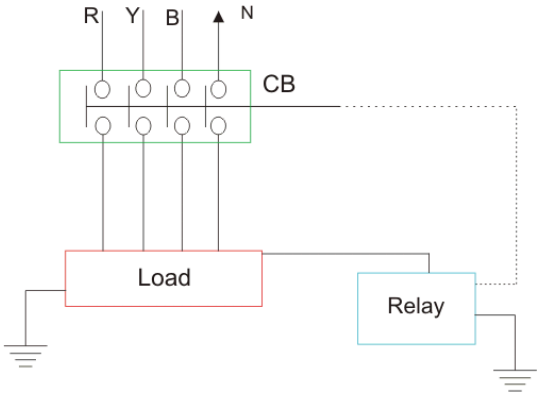
Earth Leakage Circuit Breaker or ELCB

If any current leaks from any electrical installation, there must-be any insulation failure in the electrical circuit, it must be properly detected and prevented otherwise there may be a high chance of electrical shock if-anyone touches the installation. An **earth leakage circuit breaker** does it efficiently. Means it detects the earth leakage current and makes the power supply off by opening the associated circuit breaker. There are two types of **earth leakage circuit breaker**, one is **voltage ELCB** and other is **current ELCB**.

Voltage Earth Leakage Circuit Breaker

The **working principle of** voltage **ELCB** is quite simple. One terminal of the relay coil is connected to the metal body of the equipment to be protected against **earth leakage** and other terminal is connected to the earth directly.

If any insulation failure occurs or live phase wire touches the metal body, of the equipment, there must be a voltage difference appears across the terminal of the coil



connected to the equipment body and earth. This voltage difference produces a current to flow the relay coil.

If the voltage difference crosses, a predetermined limit, the current through the relay becomes sufficient to actuate the relay for tripping the associated circuit breaker to disconnect the power supply to the equipment. The typicality of this device is, it can detect and protect only that equipment or installation with which it is attached. It cannot detect any leakage of insulation in other installation of the system.

Current ELCB or RCCB or Residual Current Circuit Breaker

The **working principle of current earth leakage circuit breaker** or **RCCB** is also very simple as voltage operated ELCB but the theory is entirely different and **residual current circuit breaker** is more sensitive than ELCB.

Actually, ELCBs are of two kinds, but it is general practice to refer voltage based ELCB as simple ELCB. And current based ELCB is referred as RCD or RCCB.

RCCB (Residual Current Circuit Breaker)

It falls under the category of wide range of circuit breakers. As we know there are several types of miniature circuit breakers like MCCB which works on different

operational principle and has different safety purpose.

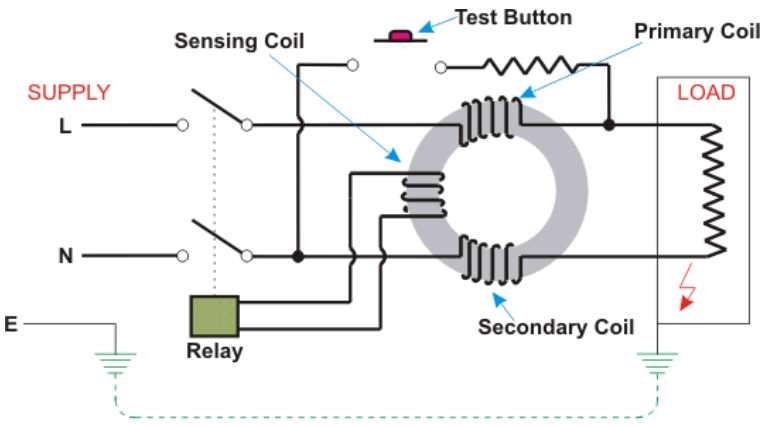
Function: Residual Current Circuit Breaker is essentially a device which senses current and disconnects any low voltage (unbalanced current) circuit whenever there is any fault occurs.

Purpose: Residual Current Circuit Breaker basically is installed to prevent human from shocks or death caused by shocks. It prevents accidents by disconnecting the main circuit within fraction of seconds.

How Residual Current Circuit Breaker Works?

It has very simple working based on Kirchhoff's Current Law i.e. the incoming current in a circuit must be equal to the outgoing current from that circuit. This circuit breaker is made such that whenever a fault occur the current balance of line and neutral did not matches (imbalance occurs, as the fault current finds another earthing path of current). Its circuit is made such that an every instance it compares the value of incoming and outgoing circuit current. Whenever it is not equal, the residual current which is basically the difference between the two currents actuates the circuit to trip/switch off.

Working Principle of Residual Current Circuit Breaker



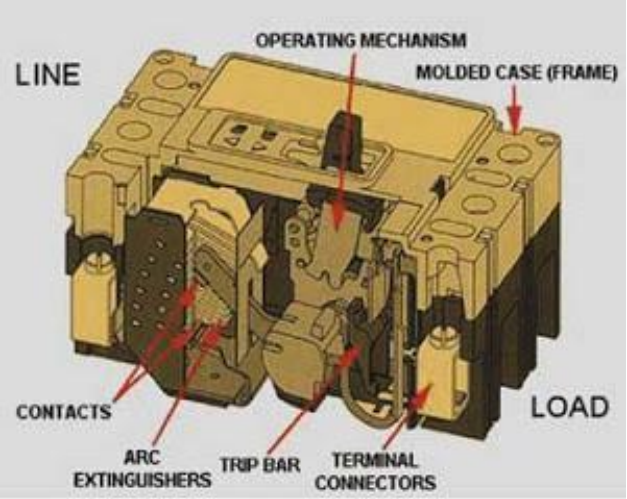
Working Principle of Residual Current Circuit Breaker

The basic operating principle lies in the Toroidal Transformer shown in the diagram containing three coils. There are two coils say Primary (containing line current) and Secondary (containing neutral current) which produces equal and opposite fluxes if both currents are equal. Whenever in the case there is a fault and both the currents changes, it creates out of balance flux, which in-turn produces the differential current which flows through the third coil (sensing coil shown in the figure) which is connected to relay.

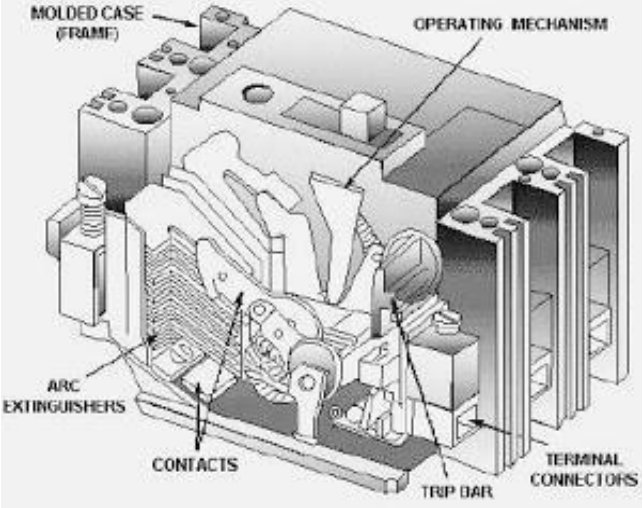
The Toroidal transformer, sensing coil and relay together is known as RCD - Residual Current Device. **Test Circuit:** The test circuit is always included with the RCD which basically connects between the line conductor on the load side and the supply neutral. It helps to test the circuit when it is on or off the live supply. Whenever the test button is pushed current starts flowing through the test circuit depending upon the resistance provided in this circuit. This current passes through the RCD line side coil along with load current. But as this circuit bypasses neutral side coil of RCD, there will be an unbalance between the line side and neutral side coil of the device and consequently, the RCCB trips to disconnect the supply even in normal condition. This is how the test circuit tests the reliability of **RCCB**.

MCCB

Moulded Case Circuit Breakers are electromechanical devices which protect a circuit from Over current and Short Circuit. They provide Over current and Short Circuit Protection for circuits ranging from 63 Amps up to 1000 Amps.



Their primary functions are to provide a means to manually open a circuit and automatically open a circuit under overload or short circuit conditions. The over current, in an electrical circuit, may result from short circuit, overload or faulty design.



MCCB is an alternative to a fuse since it does not require replacement once an overload is detected. Unlike fuse, a **MCCB** can be easily reset after a fault and offers improved operational safety and convenience without incurring operating cost.

Moulded case circuit breakers generally have a

- Thermal element for over current and
- Magnetic element for short circuit release which has to operate faster.

MCCBs are manufactured such that end user will not have access to internal workings of the over-current protection device. Generally constructed of two pieces of heavy- duty electrically insulated plastic, these two halves are riveted together to form the whole. Inside the plastic shell is a series of thermal elements and a Spring-loaded trigger. When the thermal element gets too warm, from an over current situation, the spring trips, which in turn will shut off the electrical circuit.

Summary

MCB (Miniature Circuit Breaker)

Characteristics

Rated current not more than 100 A.

Trip characteristics normally not adjustable.

Thermal or thermal-magnetic operation.

MCCB (Moulded Case Circuit Breaker)

Characteristics

Rated current up to 1000 A.

Trip current may be adjustable.

Thermal or thermal-magnetic operation.

RCD (Residual Current Device / RCCB (Residual Current Circuit Breaker)

Characteristics

Phase (line) and Neutral both wires connected through RCD. It trips the circuit when there is earth fault current. The amount of current flows through the phase (line) should return through neutral. It detects by RCD any mismatch between two currents flowing through phase and neutral detect by RCD and trip the circuit within 30Miliseconed. RCDs are an extremely effective form of shock protection the most widely used are 30 mA (milliamp) and 100 mA devices. A current flow of 30 mA (or 0.03 amps) is

sufficiently small that it makes it very difficult to receive a dangerous shock. Even 100 mA is a relatively small figure when compared to the current that may flow in an earth fault without such protection (hundred of amps)

ELCB (Earth Leakage Circuit Breaker)

Characteristics

Phase (line), Neutral and Earth wire connected through ELCB.

ELCB is working based on Earth leakage current.

Operating Time of ELCB:

The safest limit of Current which Human Body can withstand is 30ma sec.

Suppose Human Body Resistance is 500Ω and Voltage to ground is 230 Volt.

The Body current will be 500/230=460mA.

Hence ELCB must be operated in 30maSec/460mA = 0.65msec

Difference between ELCB and RCCB

ELCB is the old name and often refers to voltage operated devices that are no longer available and it is advised you replace them if you find one.

RCCB or RCD is the new name that specifies current operated (hence the new name to distinguish from voltage operated). The new RCCB is best because it will detect any earth fault. The voltage type only detects earth faults that flow back through the main earth wire so this is why they stopped being used. The easy way to tell an old voltage operated trip is to look for the main earth wire connected through it. RCCB will only have the line and neutral connections.

ELCB is working based on Earth leakage current. But RCCB is not having sensing or connectivity of Earth, because fundamentally Phase current is equal to the neutral current in single phase. That's why RCCB can trip when the both currents are deferent and it withstand up to both the currents are same. Both the neutral and phase currents are different that means current is flowing through the Earth. Finally both are working for same, but the thing is connectivity is difference. RCD does not necessarily require an earth connection itself (it monitors only the live and neutral).In addition it detects current flows to earth even in equipment without an earth of its own. This means that an RCD will continue to give shock protection in equipment that has a faulty earth. It

is these properties that have made the RCD more popular than its rivals. For example, earth-leakage circuit breakers (ELCBs) were widely used about ten years ago. These devices measured the voltage on the earth conductor; if this voltage was not zero this indicated a current leakage to earth. The problem is that ELCBs need a sound earth connection, as does the equipment it protects. As a result, the use of ELCBs is no longer recommended.