

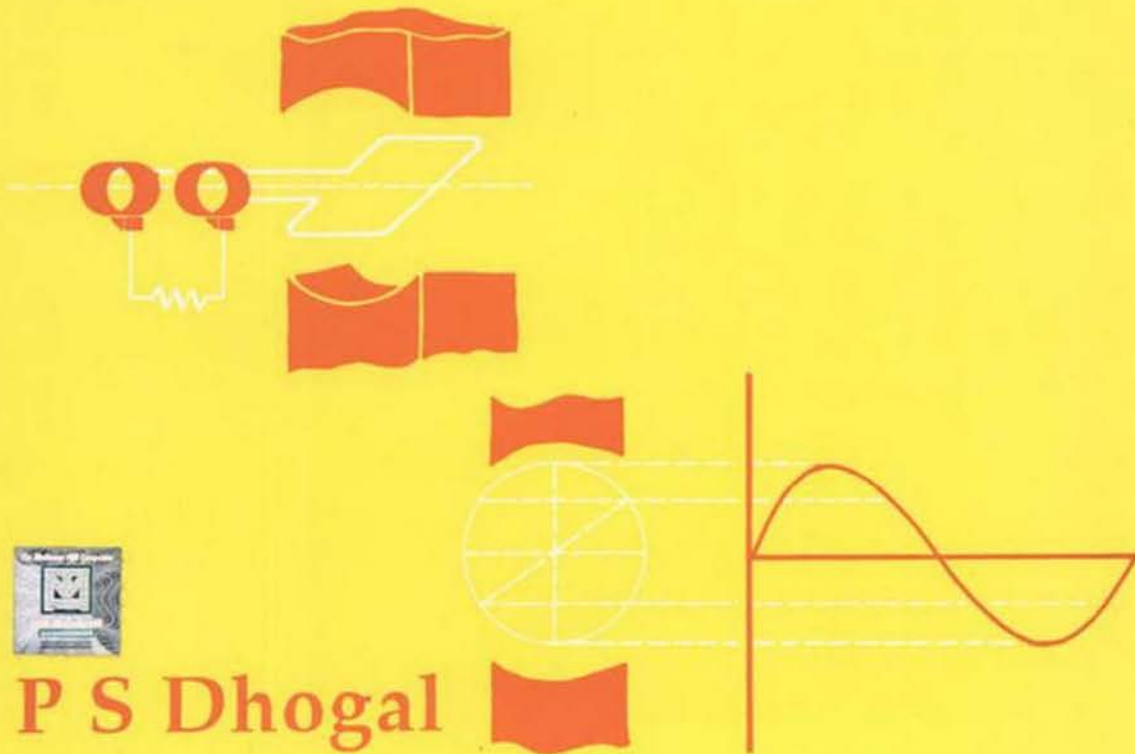


Technical Education Series

# BASIC ELECTRICAL ENGINEERING

With Numerical Problems

VOLUME I



P S Dhogal

# Basic Electrical Engineering

With Numerical Problems

Volume I

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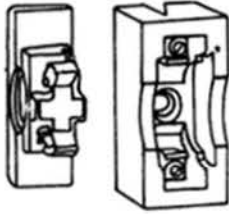


Fig. 2.20 Fuse kit-kat

are connected the incoming and outgoing cables of the live wire. The carrier is also made of porcelain and carries the fuse element. The following are the main advantages of this design.

- (i) It facilitates easy renewal of the fuse wire and does not involve any danger of coming in contact with it.
- (ii) It is very cheap to replace the fuse wire.
- (iii) It does not involve any possibilities of coming in contact with the metallic covering.

It, however, suffers from unreliable operation owing to the use of an incorrect size of the fuse wire and owing to oxidation. These fuses are meant for low rupturing capacity and are not employed for the power circuit.

**Iron-Clad Cut-out** The general practice is not to use semi-enclosed fuse holders unless they are provided with an iron cover. These fuse holders are known as iron-clad cut-outs (Fig. 2.21).



Fig. 2.21 Iron-clad cut-out

### 2.23 INSULATOR

A substance which (at a particular voltage) does not allow the flow of electrons (current) through them is called an *insulator*. For example, some of the good insulators are mica, porcelain, glass, rubber, Bakelite, etc.

In insulators the electrons are closely and strongly bound to the nucleus. There are

very few free electrons in them and the interchange between atoms is little. Therefore, insulators do not conduct any electric current or conduct very little if a very high potential difference is applied across them.

### 2.24 QUALITIES OF INSULATING MATERIALS

The following are the main qualities of good insulating materials which should be considered while selecting a particular one for use :

- (i) It should be flexible.
- (ii) It should have good mechanical strength.
- (iii) It should be nonabsorptive of moisture.
- (iv) It should be easily moulded to any shape.
- (v) It should be noninflammable.
- (vi) It should not be affected by acids or alkalis.
- (vii) It should have high specific resistance to reduce the possibilities of leakage current. It should be capable of working at high temperature because insulators lose their insulating properties as the temperature increases.
- (viii) It should have high dielectric strength, i.e. the value of the voltage at which the breakdown takes place in a plate of insulator 1 mm thick should be high. Dielectric strength of an insulator is measured in kilovolts per millimetre thickness.

The majority of insulating materials available for use in the construction of electrical machines and apparatus have only a few of the above mentioned properties. It is, therefore, the work of the designer to select a particular insulation for the purpose for which it is required.

### 2.25 COMMON INSULATING MATERIALS—THEIR PROPERTIES AND USES

The following are the common insulators which are extensively used in electrical and electronic industries.

**Mica** It is a very good insulator and is widely used as an insulating material in electrical and electronic industries. It has very high specific resistance and dielectric strength. It is fireproof and does not absorb moisture.

Mica is obtained from mines in big solid sheets. Thin sheets can be obtained of thick-



ness 0.0005 in. On account of it being available in thin sheets, it can be rolled and used where the space is limited. Mica starts softening at 1200°C. However, at 600°C it is very stable. Therefore, it can be used as an insulating material where the temperature is not to increase beyond 600°C. In between 600° and 1200°C mica starts disassociating. Therefore, it cannot be used as an insulator beyond 600°C. For temperatures above 600°C it is mixed with shellac or a resin adhesive known as micanite, which can withstand higher temperature. A mixture of mica and adhesive pasted on paper or cloth is known as micanite paper or micanite cloth. Micanite can be bent into any shape when it is heated. Mica is used as an insulator in electric irons, between commutator segments, slot linings for high voltage machines, condensers and for many other electrical and electronics work.

**Rubber** Rubber in the pure form is very soft and to make it tough and hard, 5% sulphur and other mineral materials, such as zinc oxide, red lead and some colour are added to it. It is then known as vulcanized rubber. It does not absorb moisture up to a certain limit and serves as a good insulation and protective covering for conductors for low and medium voltages. It melts easily and can be moulded into any shape. It is flexible, resistant to abrasion, chemicals and the affects of oxygen. It is inflammable but has low conductivity. Therefore, it is used as an insulating material in various electrical appliances, insulation on wires, rubber gloves, hard rubber battery containers, etc.

**Polyvinyl Chloride (P.V.C.)** It is a synthetic chemical substance which is used as a sheathing on insulated cables or flexible cords to form an outer protective covering. This protective covering makes the cable reasonably resistant to decay, mechanical abrasion, acid alkalis and other corrosive materials. It has very good insulating properties and has now superseded the cab-type insulation of the cable. It can be moulded into any shape. It is available in many colours. It does not absorb moisture and is unaffected by oil, grease and acid. P.V.C. has very good insulating properties and nowadays it is replacing rubber for cable insulation.

**Tropodure** It is a hard, tough and excellent insulation like P.V.C. and is not affected by the atmosphere. It does not easily get damaged by mechanical injury. It is used on cables which are subjected to work at damp places, chemical plants and oil factories. Tropodure is the trade mark for the thermoplastic compound on a polyvinyl chloride. This insulation is also employed on submarine cables.

**Ebonite or Vulcanite** It is a good insulator and can be moulded into any shape. It is manufactured by mixing 30 to 50% sulphur with vulcanized rubber and then heating it 3 to 4 h at about 150°C. It is a hard substance and becomes soft at 70°C. It is used for making covers for resistance boxes, containers of lead acid batteries, panel frames, etc.

**Bakelite** It is a synthetic material of brown colour. It can be moulded to make rods, tubes, sheets and to any shape to suit a particular purpose. Its working temperature is higher than ebonite and is not affected by moisture, oil and acid. It is a very good insulating material and is used for making electrical accessories, such as switches, wall sockets, ceiling roses, holders, etc.

**Asbestos** It is a white fibrous material and is incombustible. It is a good conductor of heat. It is manufactured into ropes, tapes, sheets and sleeves. It is used in the form of sheets for lining in ovens, electric irons, kettles, arc shields in circuit breakers, etc.

**Glass** It is a transparent insulator and is not affected by chemical fumes. It can also be moulded into any shape and is brittle. It is nonhygroscopic and can withstand high temperatures. It is used in making the glass bulb of electric lamps, tubes, mercury arc rectifiers, overhead line insulators, etc. It is also used in making glass tapes, sleeves for armature winding, etc.

**Porcelain** It is made from china clay and quartz stone and can be moulded into any shape. It is white or brown in colour and is not as brittle as glass. It is not affected by chemical fumes and the atmosphere. Porcelain is glazed to make it nonabsorptive of moisture. It is used for making low, medium-

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