Electrical Protection

Electricity at Work Regulations 1989

Regulation 11: Means for protecting from excess of current.

Efficient means, suitably located, shall be provided for protection from excess current in every part of a ***system*** *as may be necessary to prevent danger.*

Types of protective devices

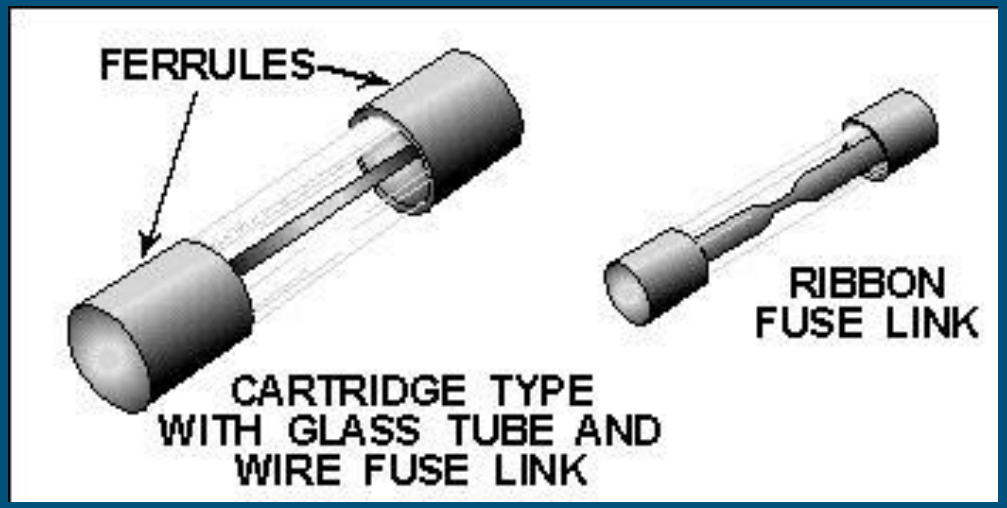
Fuses

- BS3036 (Rewireable Domestic)
- BS1361 (Domestic Consumer Units)
- BS1362 (Domestic Plugs/Outlets)
- BS88-1,2,3 (Industrial)

Fuse

A device that contains a fuse element (wire or strip conductor) which is designed to break (rupture) by melting of the fuse element over a specific period of time, when the current drawn by the circuit exceeds the normal current carrying capacity protecting the circuit to which its connected. (See BS7671 Part 2)

Construction



Casing: Ceramic, glass, composite

Terminals: Lugs, end caps, ferrules, blades

Elements: Zinc, copper, silver, aluminum or alloys

Arc diffuser: Sand, silica, quartz, air or non-conducting liquids

BS1362 Cartridge Fuse

BS 1362 cartridge fuses are available in 7 ratings

1, 2, 5, 7, 10	Amp	Coloured Black	1, 2, 5, 7 and 10 Amp provided commercially
3	Amp	Coloured Red	3 and 13 Amp available in high street stores
13	Amp	Coloured Brown	

BS88 HRC/HBC Fuses

High Rupturing Capacity or High Breaking Capacity (80kA)

Low Voltage ≤ 1000VAC

Designed and constructed to break large fault currents rapidly without damage to the fuse enclosure or surroundings

Construction: Ceramic body, end caps, fusing element, quartz or silica sand

Nominal Current Rating

A fuse has a ***nominal current rating,*** which is the current, which it can carry continuously without overheating or deteriorating and without altering its characteristics.

BS88 Fuses are supplied in the standard ratings:

5A, 6A, 10A, 16A, 20A, 25A, 32A, 40A, 50A, 63A, 80A, 100A, 125A, 160A, 200A

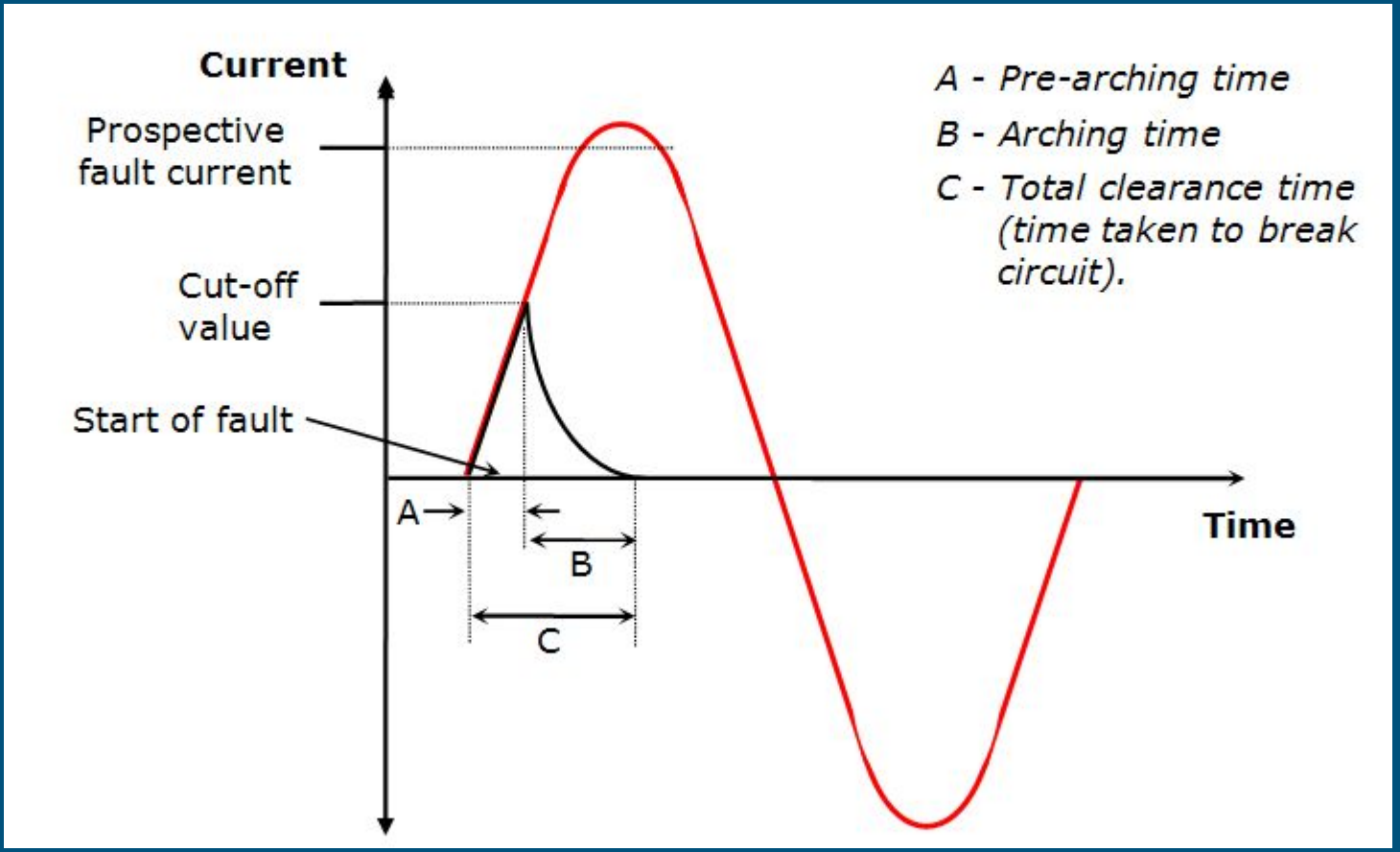
BS7671 IET Regulations, Tables 41.2 & 41.4

Operating Characteristics

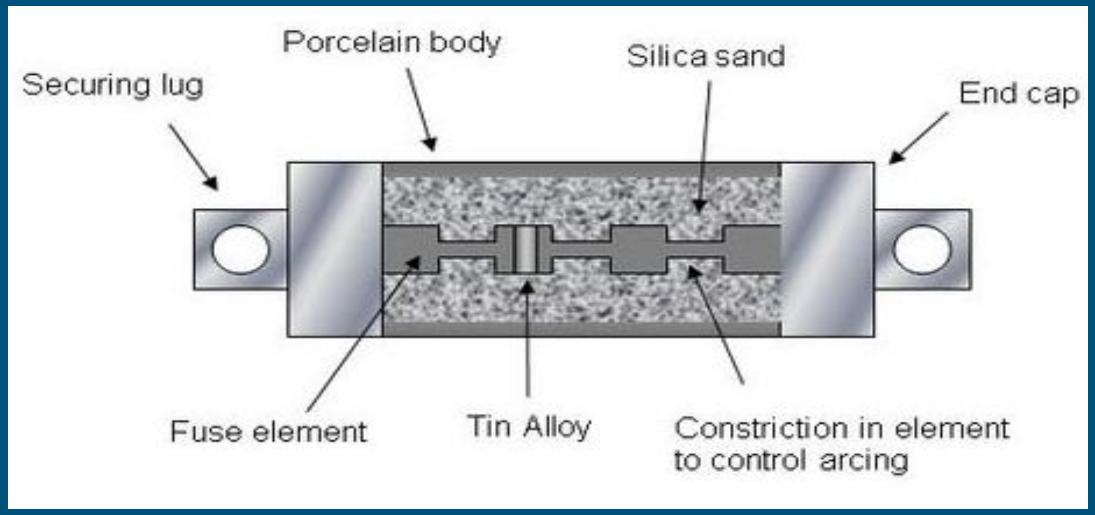
In order to protect the consumer and the circuit, HRC fuses must act rapidly. This is achieved by designing and constructing each fuse with prospective fault current "cut-off" value.

This means that the short circuit current is interrupted before it can reach it's full value in the first half cycle of short circuit.

Energy Let Through I^2t



HRC Structure



Fusing element – Specially shaped elements are used. The shaping of the elements allows for controlled operation of the element during melting by one or more of the constricted (narrow) sections melting and fusing with powder to form globules of high-resistance in the path of the arc, resulting in it being extinguished and insulating the end caps.

HRC Fuse Types & Categories

There are three main types of HRC fuses.
These are:-

S.S. These are mainly used in lighting circuits.

N.I.T. Used in lighting circuits and power circuits.

T.I.A. This the general purpose fuse, they are used in most circuits.

Letters are related to construction size, fitting and lug type of manufacturer

Categories

HRC fuses are categorised in the following way:

aG aM gG gM

a – Partial break capacity interrupts short circuit currents only

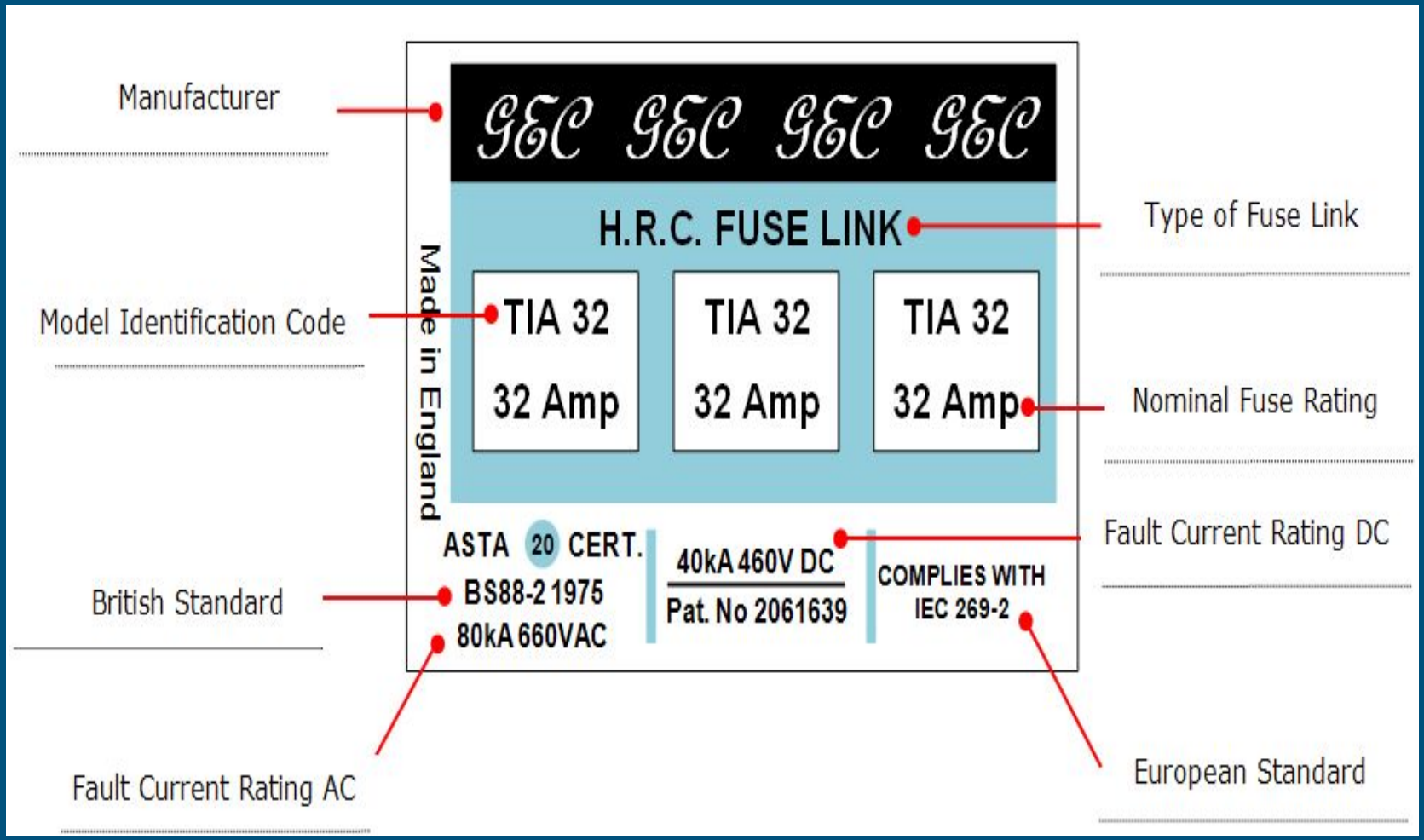
g – Full range breaking capacity – interrupts short circuit and overload currents safely,

G – Fuse link for general application including protection of small motor circuits

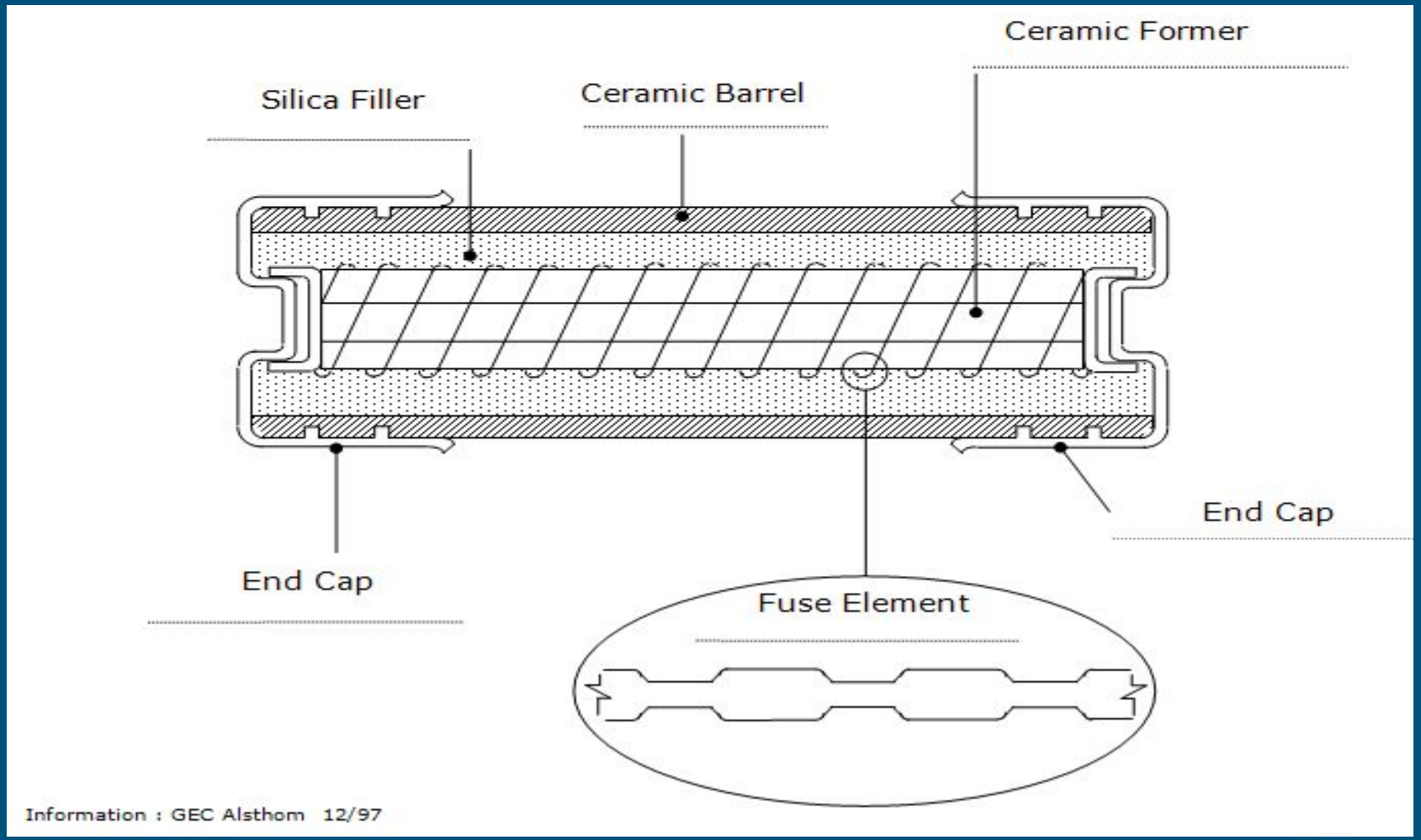
M – Fuse link protection of motor circuits

The commonly used fuse links are classified as either gG or gM

Labelling


Manufacturer
GEC GEC GEC GEC
H.R.C. FUSE LINK
Type of Fuse Link
Model Identification Code
Made in England
TIA 32
32 Amp
TIA 32
32 Amp
TIA 32
32 Amp
Nominal Fuse Rating
Fault Current Rating DC
ASTA 20 CERT.
40kA 460V DC
Pat. No 2061639
COMPLIES WITH
IEC 269-2
British Standard
BS88-2 1975
80kA 660VAC
Fault Current Rating AC
European Standard

HV HRC Fuses


Ceramic Former
Silica Filler
Ceramic Barrel
End Cap
End Cap
Fuse Element
Information : GEC Alsthom 12/97

HV HRC Fuses cont'd

These types tend to be longer in length due to the higher voltages involved, therefore the insulating gap created by the fusion of silica with the molten arc of the element is much larger.

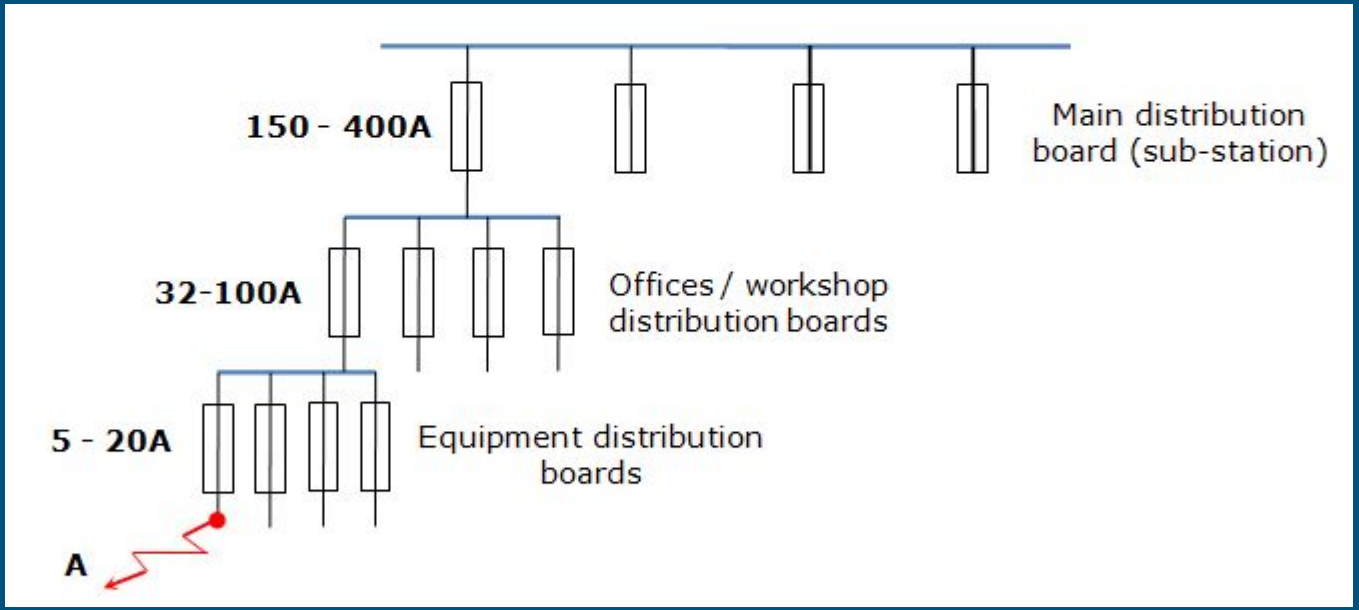
In 1931 Professor A.W. Metcalf introduced a system of doping where conditions of small overloads are controlled by the use of a special alloy melted onto the elements. These are known as the .M.effect After his research

Discrimination

In any distribution system it is important to ensure that, in the presence of an electrical fault, the lower rated fuses operates before the higher rated fuses.

Each fuse rating would be selected according to the prospective load of the circuit that it is protecting.

Discrimination Cont'd



In the event of a fault at point "A" the protection device immediately up-stream of the fault should operate only and isolate the faulty circuit, hence leaving the healthy circuits unaffected. This is known as discrimination.

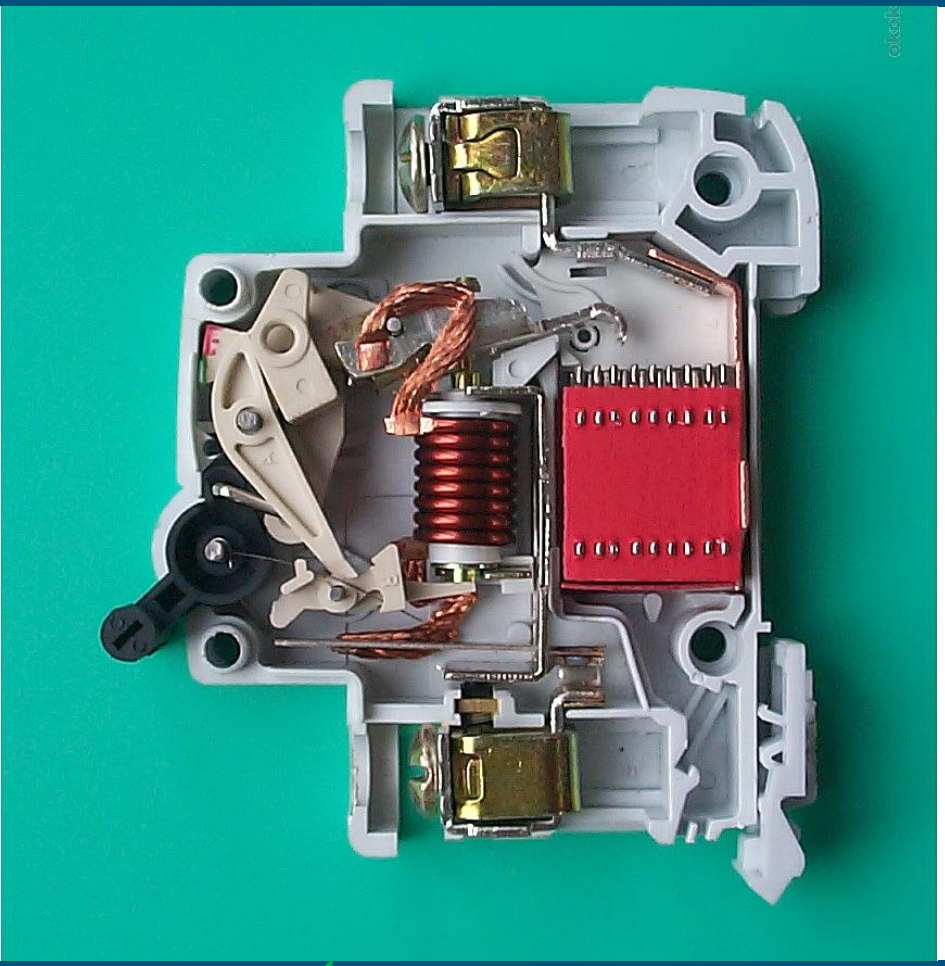
Types of protective devices

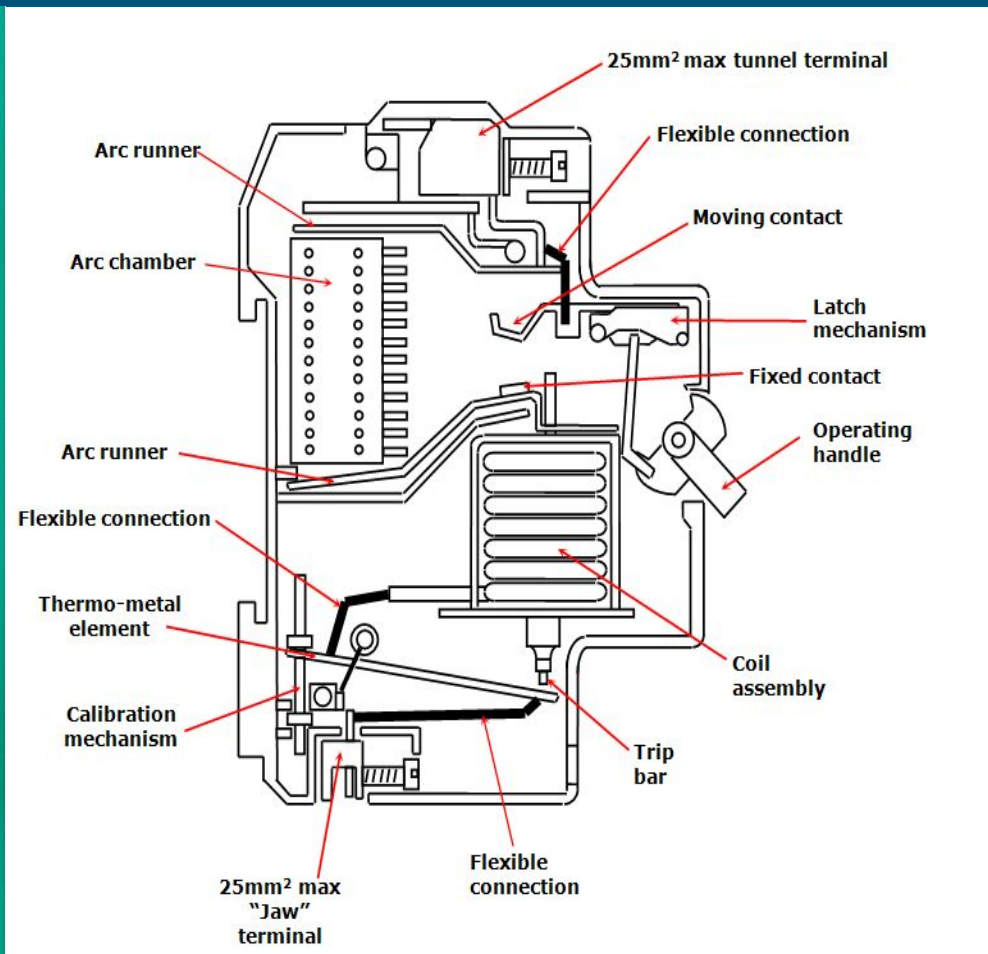
Miniature Circuit Breakers (MCB's)

BS60898 (Domestic/Commercial)

BS60947-2 (Industrial)

Inside an MCB





See the Animation on Lisa

Miniature Circuit Breaker (MCB)

How does it works?

Miniature Circuit Breaker (MBC) Types

Type B MCB

This type of MCB trips between 3 and 5 times full load current.

Type B devices are mainly used in residential applications or light commercial applications where connected loads are primarily lighting fixtures, domestic appliances with mainly resistive elements.

MCB Types Continued

Type C MCB

This type of MCB trips between 5 and 10 times full load current. This is used in a commercial or industrial types of applications where there could be chances of higher values of short circuit currents in the circuit. Loads are mainly inductive (e.g inductive motors)

Type D MCB

This type of MCB trips between 10 and 20 times full load current. These MCBs are used in specialty industrial/commercial uses where current inrush can be very high. Examples include transformers or large winding motors etc, where high levels of inrush current are expected.

Types of protective devices

Residual Current Circuit Breakers (RCCB's)
Residual Current Devices (RCD's)
BS EN 61008-1

Residual Current Breakers with Overload (RCBO's)
BS EN 61009-1

Note
For 3 Phase Motors

When calculating the current for a 3 phase motor and protection size use the following formula

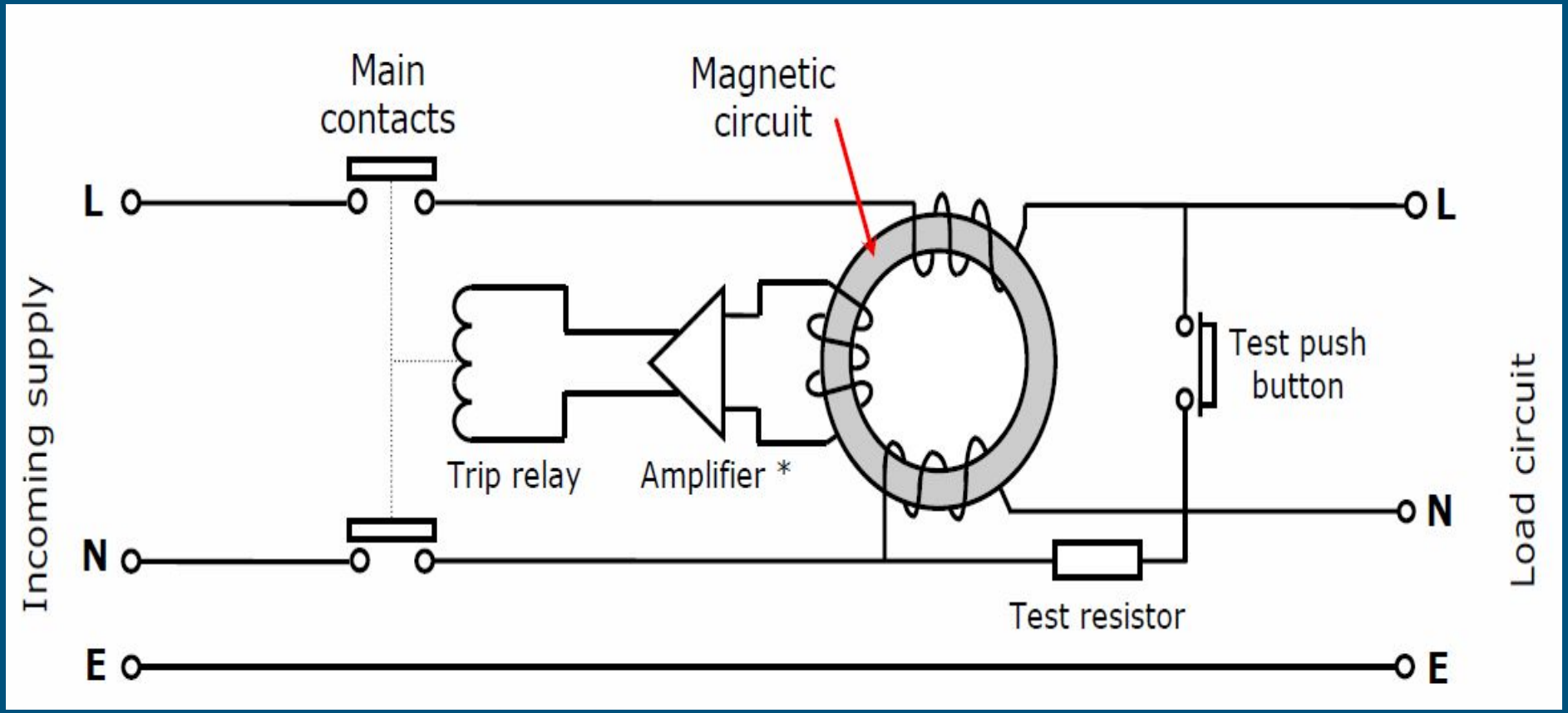
IL = Power / $\sqrt{3}$ x VL x Cos$\varnothing$

There for a 5KW motor having a Voltage of 400 and a Cos$\varnothing$ factor of 0.80

IL = 5000 / 1.732 x 400 x 0.80

IL = 9.02 Amps

RCD Operation



Protective devices
Conclusion

Fuses

These look for overload current (excess current above the fuse rating)

MCB

As the fuse above looking for overload current (excess current above the MCB rating)

RCD

Looking for an unbalanced current in the circuit.
For domestic use this is 30mA

RCBO

Is a combination of the MCB and RCD. Looking for unbalanced current of the circuit and or an overload current in excess of the RCBO rating