

50% of the resistors used in electronic industry are carbon resistors.

Types of resistor leads

Resistors are available with different types of lead attachment as shown in Fig 4. This make it easy for the user to mount the resistors in different ways on lug boards, PCBs and other types of circuit boards.

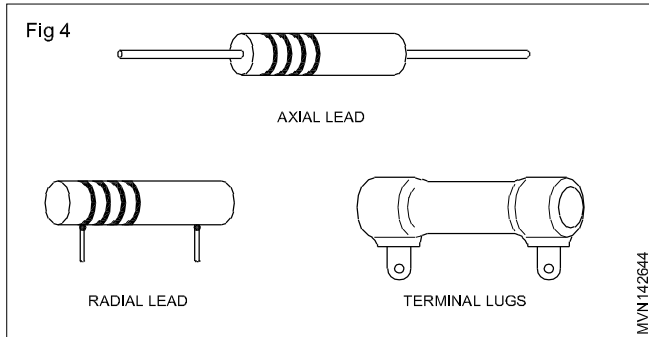


TABLE 1

Resistor Colour Code

Colour	Significant figures	Multiplier	Tolerance
Silver	-	10^{-2}	$\pm 10\%$
Gold	-	10^{-1}	$\pm 5\%$
Black	0	1	-
Brown	1	10	$\pm 1\%$
Red	2	10^2	$\pm 2\%$
Orange	3	10^3	$\pm 3\%$
Yellow	4	10^4	$\pm 4\%$
Green	5	10^5	$\pm 0.5\%$
Blue	6	10^6	-
Violet	7	-	-
Grey	8	-	-
White	9	-	-
(None)	-	-	$\pm 20\%$

1, 2 and 3: 1st, 2nd and 3rd significant figures ;

M : Multiplier ; T : Tolerance ; T_c : Temperature co-efficient

Fuse

Objectives: At the end of this lesson you shall be able to

- state the need of a fuse in the circuit
- explain the construction of a fuse
- list out the types of fuses
- explain the working of fuses
- explain the circuit with and without a fuse
- explain circuit breakers.

Introduction

A fuse is a protective device. It is a weakest portion in the electrical circuit.

An electric current heats the wire when the current passes through it. The amount of heat depends upon the current and resistance in the wire.

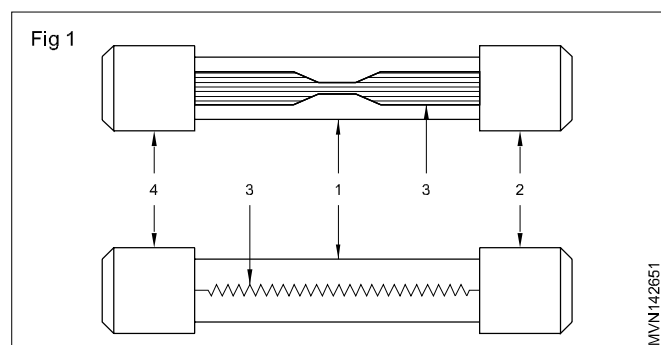
In automobiles, this heating effect is utilized in heaters, bulbs and gauges etc.

The heating effect in the circuit is limited by the fuse. If this limit is not controlled, the circuit an accessories will be overloaded causing severe damage to them.

Purpose of fuse (Fig 1)

A fuse opens the circuit by blowing out when current (overload) flows in the circuit to prevent severe damage to the accessories.

The flow of excess current in a circuit may be caused by a short circuit.



Construction

Fuse elements are of lead-tin or tin-copper alloy wire in strip of correct amperage for each circuit.

The fuse is assembled in a fuse carrier of glass or ceramic material.

Nowadays fuse elements assembled in glass tubes, called cartridges, are widely used in automobiles.

It consists of a glass tube (1) with metal end caps (2) & (4).

A soft fine wire or strip (3) carries the current from one cap to another (4).

The conductor (3) is designed to carry a specific maximum current.

Working

The current flows through the conductor (3) between two metal caps (2) & (4) and then to the equipment.

If the current value exceeds the limit prescribed on the fuse, the fuse element (3) melts and opens the circuit and prevents the equipment from damage.

Identification of blown fuse

If you look at the burnt fuse and if the element is broken the fuse is burnt due to overloading.

The glass is foggy white or black the fuse is blown out due to short circuit.

Circuits protected with fuse

- Headlight circuit
- Tail - light circuit
- Number -plate circuit
- Panel lamp circuit
- Interior lamp circuit
- Side indicator circuit
- Horn circuit
- Wiper circuit
- Dashboard / panel instruments circuit
- Heater and air conditioner
- Charging circuit
- Radio
- Cigarette lighter
- Reverselamp

Circuits without fuse

- Starting circuit
- Ignition circuit

Capacitors

Objectives: At the end of this lesson you shall be able to

- describe a capacitor
- brief construction and function of a capacitor
- brief how does a capacitor store energy
- state the units of capacitance
- state parallel and serial capacitors.

Capacitors

A device designed to possess capacitance is called a capacitor.

- Fuel pump
- Stop - light circuit
- Oil pressure lamp circuit
- Ignition warning lamp circuit.

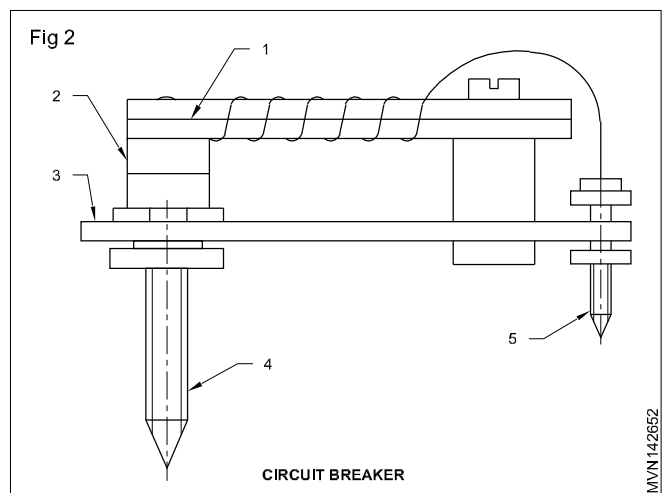
Fuse rating and colour

Rating	Colour
3 Amp	Violet
5 Amp	Tan
10 Amp	Red
20 Amp	Yellow
25 Amp	White
30 Amp	Light green

Circuit Breaker

Circuit Breaker (Fig.2): These units are regarded as a non-replaceable type of fuses. Generally fitted in the headlight circuit, it consists of a bimetallic strip (1) with moving contact (2). A fixed contact (3) is provided with the terminals (4) & (5). The strip (1) bends as soon as the current exceeds the maximum permissible value for the electrical component concerned. This way it opens the points to break the circuit. When this type of device is used in the lighting circuit, the lamp will light and then go out. Thus giving an indication of a faulty circuit. The circuit breakers are made in ratings up to 50 amps.

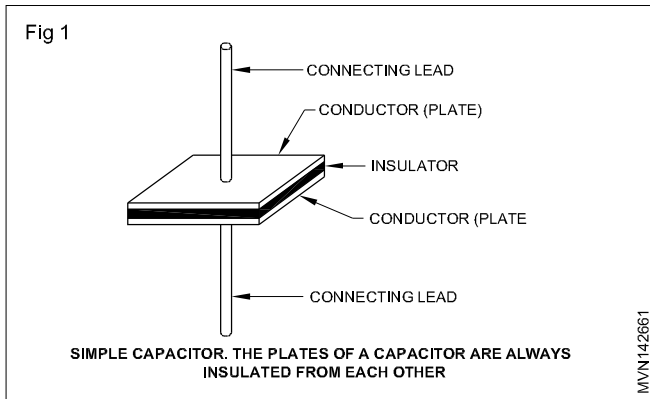
Rectifiers are provided inside the meter to convert AC to DC in the AC measurement circuit.



Construction

A capacitor is an electrical device consisting of two parallel conductive plates, separated by an insulating material

called the dielectric. Connecting leads are attached to the parallel plates. (Fig 1)



Function

In a capacitor the electric charge is stored in the form of an electrostatic field between the two conductors or plates, due to the ability of dielectric material to distort and store energy while it is charged and keep that charge for a long period or till it is discharged through a resistor or wire. The unit of charge is coulomb and it is denoted by the letter 'C'.

Capacitance

The ability to store energy in the form of electric charge is called capacitance. The symbol used to represent capacitance is C.

Unit of capacitance

The base unit of capacitance is farad. The abbreviation for farad is F. One farad is that amount of capacitance which stores 1 coulomb of charge when the capacitor is charged to 1 V. In other words, a farad is a coulomb per volt (C/V).

A farad is the unit of capacitance (C), and a coulomb is the unit of charge (Q), and a volt is the unit of voltage (V).

Capacitors are widely used as parts of electrical circuits in many common electrical devices. Ex. Ignition circuit.

Parallel Capacitors

Capacitors connected in parallel will **add** their capacitance together.

$$C_{\text{total}} = C_1 + C_2 + \dots + C_n$$

Tracing of auto electrical components in a circuit

Objectives: At the end of this lesson you shall be able to

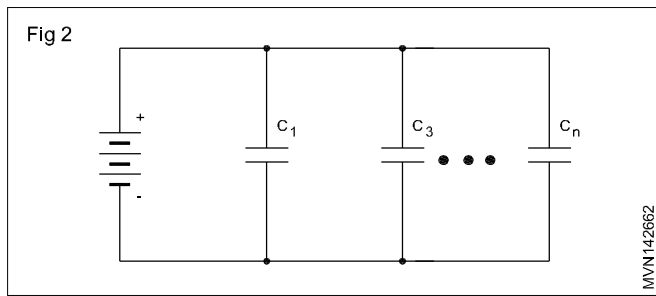
- describe automobile cables
- state the colour coding in wiring
- state the purpose of colour coding.

Description of automobile cables

The cable consists of multi - strand copper conductor covered with good quality PVC insulation.

The current to the various electrical accessories is carried through cables.

The various cables used in wiring are :



A parallel circuit is the most convenient way to increase the total storage of electric charge.

The total voltage rating does not change. Every capacitor will 'see' the same voltage. They all must be rated for at least the voltage of your power supply. Conversely, you must not apply more voltage than the lowest voltage rating among the parallel capacitors.

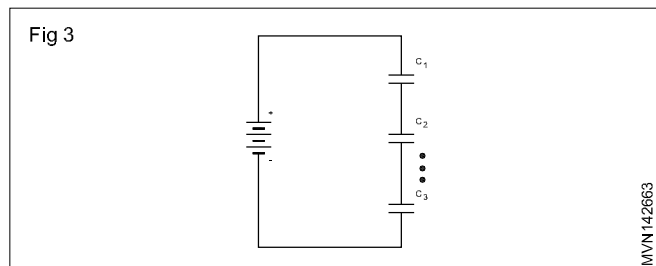
Series Capacitors

Capacitors connected in series will have a lower total capacitance than any single one in the circuit.

$$C_{\text{total}} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \dots + \frac{1}{C_n}}$$

This series circuit offers a higher total voltage rating. The voltage drop across each capacitor adds up to the total applied voltage.

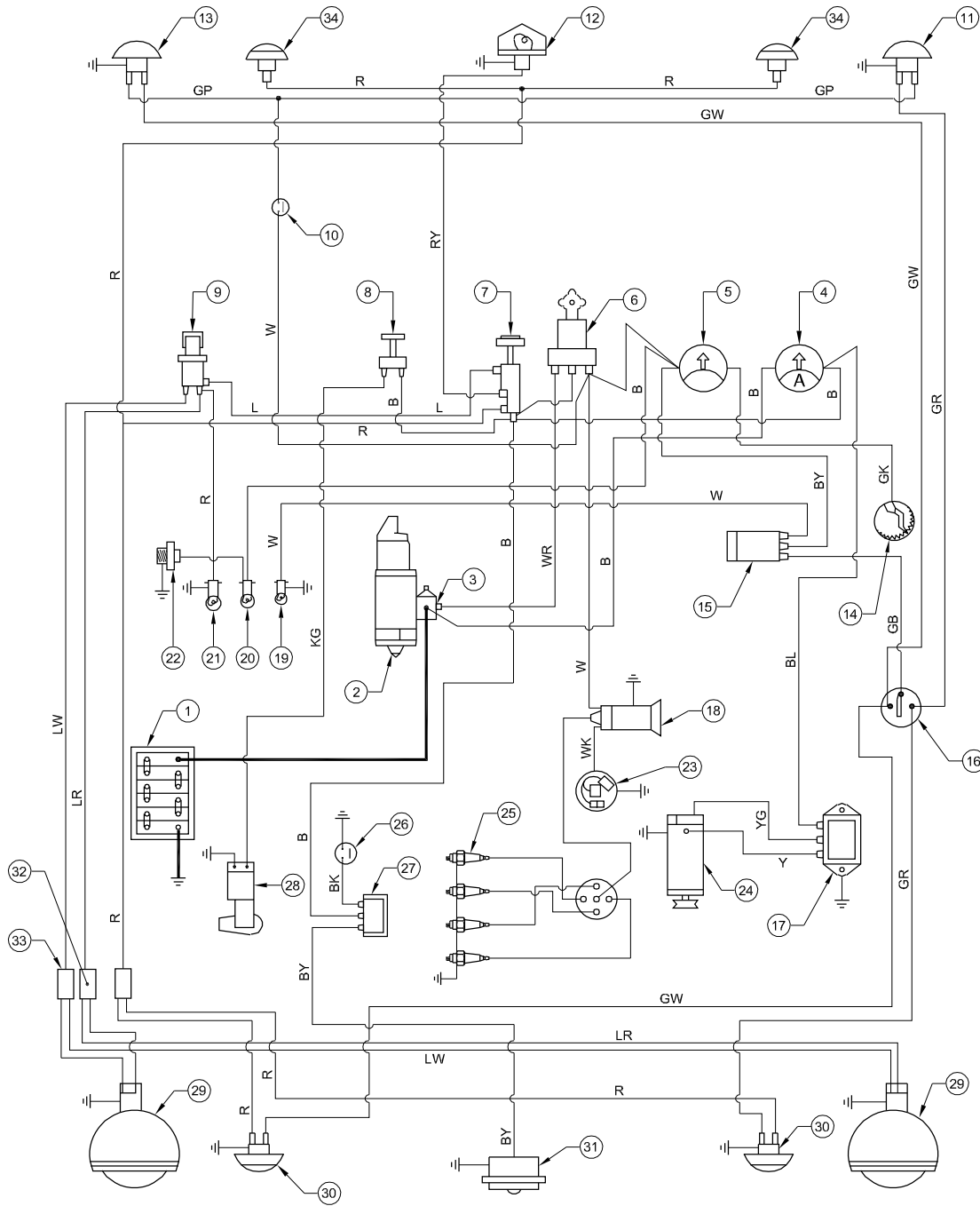
Series capacitors are generally avoided in power circuits.



- Starting system cable
- General purpose cable
- High tension cable

The specification of the cable refers to the number of strands and diameter of each strand. Eg. 25/012 indicates, the cable consists of 25 strands of 0.012" gauge diameter of each strand.

Fig 1



MVN142681

The size of the cable depends upon the current rating of the accessories connected in that circuit. A thick cable can carry more current and is used in the starting system.

Colour code in cables and wirings

In automobiles a number of electric circuits are connected to the battery which is quite complicated.

The large number of cables are braided into a single harness assembly.

The automobile manufactures use cables of different colours and usually follow the Lucas colour code system. It consists of basic colours (main colours) and combination of colours to identity individual circuits. (Refer of Fig 1).

The distinction between wires in a group is done by the use of a coloured bracer on the main colours of the insulator of each wire.

Colour coding

The colour coding for electrical system provides easy identification each circuit vehicles conform to the colour coding standard when used in conjunction with the wiring diagram. The colour coding may vary from model to model. But the colour coding adopted for a particular model is clearly given on the makers wiring diagram.

Standard colour coding

Standard colour coding should be adopted for motor vehicle wiring. In every electrical unit, three wires or con-