USN

Internal Assessment Test 2 – June 2021

Sub:	INDUSTRIAL SAFETY					Sub Code:	17ME662	Branch:	MECHANICAL
Date:	24/06/2021	Duration:	90 min's	Max Marks:	50	Sem/Sec:	6th Sem B		OBE

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1.	What is electric shock? Explain effect of electric current on human body.	[10]	CO2	L2
2.	Explain the prevention of electrical accidents.	[10]	CO3	L2
3.	What is primary and secondary shock? Explain AC and DC current Shock.	[10]	CO3	L2
4.	What is fire? What are the types of fire? Explain fire tetrahedron.	[10]	CO5	L2
5.	Explain different types of portable fire extinguisher.	[10]	CO5	L2
6.	Briefly explain any 5 fire detectors used in fire detection system.	[10]	CO4	L2

1. Electric shock is a sudden stimulation of the nervous system of human body by the flow of electric current through a part of the body.

The effects of electric shock on the human body depend on several factors. The major factors are:
1. Current and Voltage
2. Resistance
3. Path through body
4. Duration of shock

The muscular structure of the body is also a factor in that people having less musculature and more fat typically show similar effects at lesser current values.

CURRENT AND VOLTAGE

Although high voltage often produces massive destruction of tissue at contact locations, it is generally believed that the detrimental effects of electric shock are due to the *current* actually flowing through the body. Even though Ohm's law (I=E/R) applies, it is often difficult to correlate voltage with damage to the body because of the large variations in contact resistance usually present in accidents. Any electrical device used on a house wiring circuit can, under certain conditions, transmit a fatal current. Although currents greater than 10 mA are capable of producing painful to severe shock, currents between 100 and 200 mA can be lethal. With increasing alternating current, the sensations of tingling give way to contractions of the muscles. The muscular contractions and accompanying sensations of heat increase as the current is increased. Sensations of pain develop, and voluntary control of the muscles that lie in the current pathway becomes increasingly difficult. As current approaches 15 mA, the victim cannot let go of the conductive surface being grasped. At this point, the individual is said to "freeze" to the circuit. This is frequently referred to as the "let-go" threshold. As current approaches 100 mA, ventricular fibrillation of the heart occurs. Ventricular fibrillation is defined as "very rapid uncoordinated contractions of the ventricles of the heart resulting in loss of synchronization between heartbeat and pulse beat." Once ventricular fibrillation occurs, it will continue and death will ensue within a few minutes. Use of a special device called a de-fibrillator is required to save the victim. Heavy current flow can result in severe burns and heart paralysis. If shock is of short duration, the heart stops during current passage and usually re-starts normally on current interruption, improving the victim's chances for survival.

RESISTANCE

Studies have shown that the electrical resistance of the human body varies with the amount of moisture on the skin, the pressure applied to the contact point, and the contact area. The outer layer of skin, the epidermis, has very high resistance when dry. Wet conditions, a cut or other break in the skin will drastically reduce resistance. Shock severity increases with an increase in pressure of contact. Also, the larger the contact area, the lower the resistance. Whatever protection is offered by skin resistance decreases rapidly with increase in voltage. Higher voltages have the capability of "breaking down" the outer layers of the skin, thereby reducing the resistance. If skin resistance is high, much energy may be dissipated at the surface as current passes through the skin, and large surface burns can result at the entry and exit points.

PATH THROUGH BODY The path the current takes through the body affects the degree of injury. A small current that passes from one extremity through the heart to the other extremity is capable of causing severe injury or electrocution. There have been many cases where an arm or leg was almost burned off when the extremity came in contact with electrical current and the current only flowed through a portion of the limb before it went out into the other conductor without going through the trunk of the body. Had the current gone through the trunk of the body, the person would almost surely have been electrocuted. A large number of serious electrical accidents in industry involve current flow from hands to feet. Since such a path involves both the heart and the lungs, results can be fatal.

DURATION OF SHOCK

The duration of the shock has a great bearing on the final outcome. If the shock is of short duration, it may only be a painful experience for the person. If the level of current flow reaches the approximate ventricular fibrillation threshold of 100 mA, a shock duration of a few seconds could be fatal. This is not much current when you consider that a small light duty portable electric drill draws about 30 times as much. At relatively high currents, death is inevitable if the shock is of appreciable duration; however, if the shock is of short duration, and if the heart has not been damaged, interruption of the current may be followed by a spontaneous resumption of its normal rhythmic contractions

2. Prevention of electrical accidents

a. **Have only licensed electricians install, repair and dismantle jobsite wiring.** That way, everything will be completed according to electrical safety codes, ensuring greater protection for the workers who will be using the wiring to power tools and equipment.

Bringing in a professional electrician also prevents the injuries that result when less-qualified individuals attempt electrical jobs that they aren't properly trained to do.

b. **Always plug into a GFCI.** Ground Fault Circuit Interrupter protection is required at every plug-in point associated with your jobsite's temporary electrical supply - right down to extension cords. Make sure that only GFCI receptacles are installed, and that portable GFCIs are kept on hand in case additional grounding needs arise.

c. **Check each extension cord before use.** Ensure that insulation is completely intact (free from cracks, tears, or abrasion) and that power extension cables haven't been knotted, which can cause conductor damage and increase the risko fire

d. **Do a thorough check for electrical wiring before cutting through any wall, floor or ceiling.** Any time that a tool inadvertently makes contact with an unseen electrical line, the person holding that tool is likely to be shocked or electrocuted. Always size up the situation before you get started to reduce your risk of injury.

e. **Inspect power tools on a regular basis.** Look over the tools' power cords and plugs for any sign of damage to the insulation, blades, or grounding pin. If you find signs of excessive wear and tear, take tools out of commission until they've been properly repaired. Maintain awareness during electrical tool use as well; if a tool starts to overheat, smoke, give off a burning smell, or shock you on contact, discontinue use immediately.

f. **Check insulated tools for damage before each use.** Once the insulation layer of an insulated hand tool becomes nicked, cracked or cut, the tool is no longer effectively insulated - it actually becomes more of an electrical conductor, and can increase your risk of injury. If a tool has damaged insulation, it is no longer safe to use - destroy and replace it right away.

g. **Never modify electrical plugs.** Under no circumstances should you ever file down the blades, remove the ground pin, or otherwise modify an electrical plug so that it will fit into a socket - doing so only increases the likelihood of shock, electrocution, and fire. Either have a certified electrician change the device's plug, or replace outdated two-prong receptacles with grounded outlets that can accommodate a ground pin.

h. **Keep extension cords in a safe place where they won't be stepped on or driven over.** The force of a vehicle - or even repeated treading by pedestrians - can cause an extension cord's conductor to become misshapen or break, a problems that can lead to electrical fires. Because it occurs in the core of the cable, conductor damage isn't always obvious to the eye, so play it safe from the start by guarding jobsite extension cords with heavy-duty cord covers.

(3).

Primary: Injury or death can occur whenever electric current flows through the human body. Currents of less than 30 mA can result in death. A thorough coverage of the effects of electricity on the human body is contained in the section of this module entitled Effects

Secondary: Although the electric current through the human body may be well below the values required to cause noticeable injury, human reaction can result in falls from ladders or scaffolds, or movement into operating machinery. Such reaction can result in serious injury or death.

The three basic factors that determine what kind of shock you experience are the amplitude of the current, the duration of the current passing through the body, and the frequency. Direct Currents actually have zero frequency, as the current is constant. However, there are physiological effects during electrocution no matter what type of current. The factor deciding the effects of the AC and DC current is the path the current takes through the body. If it is from the hand to the foot, it does not pass through the heart, and then the effects are not so lethal. However DC current will make a single continuous contraction of the muscles compared to AC current, which will make a series of contractions depending on the frequency it is supplied at. In terms of fatalities, both kill but more milliamps are required of DC current than AC current at the same voltage.

3. Fire is a rapid chemical reaction of oxidant with fuel accompanied by the release of energy, indicated by incandescence or flame

- Class A Fires involving solid combustible materials of organic nature such as wood, paper, rubber and plastics where the cooling effect of water is essential.
- Class B Fires involving flammable liquids or liquefiable solids or the like where a blanketing effect is essential.
- Class C Fires involving flammable gases under pressure including liquefied gases, where it is necessary to inhibit the burning gas at fast rate with an inert gas, powder or vaporising liquid.
- Class D Fires involving combustible metals like magnesium, aluminium, zinc, sodium, and potassium where the burning metals are reactive to water containing agents and in certain cases carbon dioxide, halogenated hydrocarbons and ordinary dry powders. These fires require special media and techniques to extinguish.
- Class E Fire risks involving electrical apparatus/equipment.
- Class F/K Fires involving cooking oils, trans-fats or fats in cooking appliances. These typically occur in restaurant and cafeteria kitchens

The fire triangle is a model for conveying the components of a fire. The fire triangle’s three sides illustrate the three elements of fire, which are heat, fuel and oxidization The three elements must be combined in the right proportions for a fire to occur. If any of the three elements are removed, the fire is extinguished. The first element in the fire triangle is heat, which is perhaps the most essential of fire elements. A fire cannot ignite unless it has a certain amount of heat, and it cannot grow without heat either. One of the first things firefighters do to extinguish a fire is to apply a cooling agenT usually water. Another cooling agent is a chemical fire retardant, such as the ones used in fire extinguishers.

Another method of diffusing heat from a fire is to scrape the embers from the firesource, such as wood embers on a burning building. Firefighters will also turn off the electricity in a burning building to remove a source of heat. The second element in the fire triangle is fuel. A fire needs a fuel source in order to burn. The fuel source can be anything that is flammable, such as wood, paper, fabric, or chemicals. Once the fuel element of the fire triangle is removed, the fire will go out. If a fire is allowed to burn without any attempt to extinguish it, as in the case of a controlled burn conducted by the Forest Service, it will extinguish on its own when it is consumed all of the fuel. The final element of the fire triangle is oxygen, which is also an essential component of fire. A fire needs oxygen to start and continue. That is why one recommendation for extinguishing a small fire is to smother it with a non- flammable blanket, sand or dirt. A decrease in the concentration of oxygen retards the combustion process. In large fires where firefighters are called in, decreasing the amount of oxygen is not usually an option because there os no effective way to make that happen in an extended area.

An alternative to the fire triangle model is the fire tetrahedron. The fire tetrahedron adds another element to the fire, which is chemical reaction. Fires involving metals such as titanium, lithium and magnesium have a chemical reaction that requires a different approach for firefighters. This is called a class D fire and the application of water will exacerbate the combustion. Because of the chain reaction caused by the metals in class D fires firefighters must use a different approach involving the introduction of inert agents like sand to smother it.

4.

Heat Safe guards

- Ensure employees are aware of their responsibility to report dangers
- Control sources of ignition
- Have chimneys inspected and cleaned regularly
- Treat independent building uses, such as an office over a shop as separate purpose groups and therefore compartmentalize from each other
- Ensure cooking food is always attended
- Use the Electricity Supply Board's Safety webpage
- Have regard to relevant Authority Safety Alerts, e.g. Mobile Phone Filling LPG Cylinders

Smoking

- Provide no-smoking signs at appropriate locations
- Ensure smoking area(s) are away from flammable materials
- Arrange for cigarettes and matches to be disposed of safely and away from other combustible rubbish

Plant and Equipment

- Ensure all work equipment protects against catching fire or overheating
- Ensure proper housekeeping, such as preventing ventilation points on machinery becoming clogged with dust or other materials – causing overheating
- Have electrical equipment serviced regularly by a competent person to prevent sparks and fires
- Properly clean and maintain heat producing equipment such as burners, heatexchangers, boilers (inspected and tested yearly), ovens, stoves, and fryers.
- Require storage of flammables away from this equipment.

Portable Heaters

- Do not use portable heaters unnecessarily.

- They should have emergency tip-over switches, and thermostatic limiting controls.
- Turn them off if people leave the room or are going to sleep
- Ensure they are 1M away from anything that can burn
- Do not use them to dry clothes

Hot work often arises from construction and/ or maintenance activities. Hot work is work that might generate sufficient heat, sparks or flame to cause a fire. Hot work includes welding, flame cutting, soldering, brazing, grinding and other equipment incorporating a flame, e.g. tar boilers, etc.

  - Identify all hot work
  - Only allow hot work if no satisfactory alternative
  - Ensure relevant contractors are aware of hot work procedures and controls
  - Use a hot work permit system including
  - leave workplace clean and safe

Electrical safety

- All electrical equipment and installations designed, constructed, installed, maintained, protected, and used to prevent danger

- Get a qualified electrical contractor to carry out installation and repairs to electrical equipment and fittings
- Check electrical equipment and remove defective equipment
- Ensure electrical cords are in good condition
- Plug appliances and lights into separate electrical outlets

Arson

Deliberately started fires pose very significant risks to all types of workplace. He majority of deliberately started fires occur in areas with a known history of vandalism (Action involving deliberate destruction of or damage to public or private property.)or fire-setting. Typically, local youths light the fires outside the premises as an act of vandalism, using materials found nearby. Appropriate security measures, including the protection of stored materials and the efficient and prompt removal of rubbish, can therefore do much to alleviate this particular problem.

Oxygen Safeguards

- Prevent oxygen enrichment by ensuring that equipment is leak-tight and in good working order

- follow safety advice from the supplier
- follow the safeguards on the safety data sheet
- Check that ventilation is adequate
- Always use oxygen cylinders and equipment carefully and correctly
- Always open oxygen cylinder valves slowly
- Do not smoke where oxygen is being used

- Never use replacement parts which have not been specifically approved for oxygen service

Fuel

- Workplaces in which large amounts of flammable materials are displayed, stored or used can present a greater hazard than those where the amount kept is small.

Fuel Safeguards

- Follow the Authority's advice on LPG
- Follow the Authority's advice on explosive atmospheres and use the Guide to the Safety, Health and Welfare at Work
- Where there is a possibility of the presence of flammable gas/ vapour, conduct a full risk assessment and consider the need for gas detection equipment

Flammable materials

- Identify all flammable materials so that proper controls can be put in place
- Identify use of substances with flammable vapors (e.g. some adhesives)
- Reduce quantities of flammable materials to the smallest amount necessary for running the business and keep away from escape routes
- Replace highly flammable materials with less flammable ones

- Store remaining stocks of highly flammable materials properly outside, in a separate building, or separated from the main workplace

Flammable liquids

- The quantity of flammable liquids in workrooms should be kept to a minimum, normally no more than a half-day's or half a shifts supply
- Flammable liquids, including empty or part-used containers, should be stored safely. Small quantities (Tens of Litres) of flammable liquids can be stored in the workroom if in closed containers in a fire-resisting (e.g. metal), bin or cabinet fitted with means to contain any leaks
- Container lids should always be replaced after use, and no container should ever be opened in such a way that it cannot be safely resealed

Cleanliness and housekeeping

- Avoid accumulations of combustible rubbish and waste and remove at least daily an store away from the building
- Never store flammable or combustible rubbish, even temporarily, in escape routes, or where it can contact potential sources of heat

5.

13.28. WATER TYPE FIRE EXTINGUISHERS

Water expelling fire extinguishers has water as an extinguishing agent which is released in the form of a jet by means of gas pressure in the upper part of the container. The gas pressure may be induced by chemical reaction or by mechanical means.

Water expelling fire extinguishers are used mainly in Class "A" fires (IS : 2190-1979) involving ordinary combustible materials like wood, paper, textiles, etc. which are put out by the cooling action of water. Besides, water when applied to burning material is converted to steam which reduces the percentage of available oxygen.

Water expelling type extinguishers should not be used on fire as involving electrical equipment without de-energising them.

The various types of water expelling extinguishers are :

1. Soda acid type IS : 934-1976
2. Gas Pressure actuated type IS : 940-1976
3. Constant Air Pressure Type IS : 6234-1971

The soda acid type is the most commonly used. We shall discuss about it in detail and briefly touch upon the constructional and operational part of the other two types.

13.29. SODA ACID TYPE-WATER EXTINGUISHERS

Construction : The various parts and contents of a soda acid extinguishers are shown in the Fig. 13.4.

The total liquid capacity of the body (or the solution containers) when filled to the specified level, should be 9 litres.

During manufacture, the body is required to be tested to an internal hydraulic pressure of 25 kgf/cm^2 for 5 minutes.

Method of operation : The operational instructions given on the body of the extinguishers should be read carefully. It should be confirmed whether soda acid extinguishers are of **up-right type** or **turn-over type** depending on their method of working. The type of the extinguishers provided at a given place must be known and method of operation must be practiced well in advance during training.

Principle of Operation. When the plunger is struck the acid phial (bottle) ruptures. The sulphuric acid and sodium bicarbonate solution react together to release carbondioxide (CO_2) gas.

The CO_2 generated creates internal pressure which forces the **water out of the extinguishers**.

Note. The CO_2 gas acts only as a propellant and the water extinguishers the **fire by cooling effect.** Such extinguishers are recommended only for class A fires.

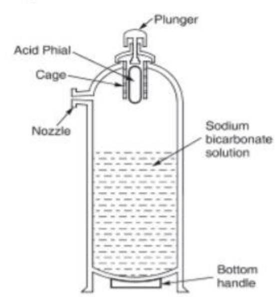

Fig. 13.4. Water-soda Acid type Portable Extinguisher.

13.30. GAS PRESSURE TYPE WATER EXTINGUISHER

The gas pressure type essentially has an outer container similar to that of the soda acid type. There is a gas cartridge filled with CO_2 under pressure which forms the inner compartment. When the cartridge is pierced open, CO_2 under pressure is released into the body of extinguishers driving water out through the discharge tube.

13.31. CONSTANT AIR PRESSURE TYPE WATER EXTINGUISHER

The constant air pressure extinguishers is filled with water and dry air is **introduced from air lines till** the desired pressure is build up.

When air lines are removed, the container is hermetically sealed. While actuating, safety pin is withdrawn and value level is depressed resulting in a jet of water through the hose under internal air pressure.

13.32. FOAM FIRE EXTINGUISHERS

Portable extinguishers expelling foam are recommended for class B fires involving flammable liquids like oils, solvents, petroleum products, varnishes, paints, etc. The foam expelled by actuating the extinguishers forms a blanket over the surface.

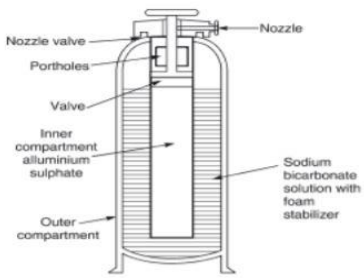

Fig. 13.5. Foam type Fire Extinguisher.

13.33. DRY POWDER FIRE EXTINGUISHERS

Dry Powder Fire Extinguishers are suitable for tackling petroleum fires, gas fires, fires in electrical equipments and for controlling surface fires in textile fibres. These extinguishers are noted for the speed with which they put out fires.

The chemical powders employed are usually sodium based and when applied to a fire, undergo chemical reaction. The free radicals which are responsible for sustaining any fire are out of action by the dry chemical powders and because of this, the fire dies out very fast.

Special dry powders containing sodium, potassium and barium compounds have been found useful in extinguishing fires in metals such as sodium and magnesium. The dry powders used should conform to IS : 4308-1982 specification.

13.34. GAS CARTRIDGE TYPE EXTINGUISHERS

There are two types of ordinary dry powder extinguishers available *viz.* (1) Gas Cartridge type and (2) Stored Pressure type. The first type being the most common. These extinguishers are available in 1, 2, 5 and 10 kg capacities.

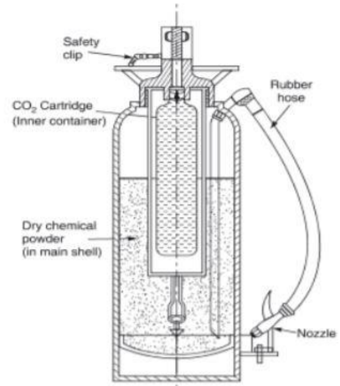

Fig. 13.6. Dry chemical powder type extinguisher (for Class C, Class B, Class E fires).

13.35. CONSTRUCTION OF STORED PRESSURE TYPE EXTINGUISHER

The construction of this type of fire extinguisher is shown in the figure. The chemical powder is contained in the main shell of the extinguisher and CO_2 gas is held under high pressure in a sealed cartridge. When the extinguisher is operated, the cartridge is broken allowing the CO_2 gas to escape to the main shell and push out the powder in the form of fog.

METHOD OF OPERATION

Carry the extinguisher to the place of fire and keep it upright. Remove the safety clip and strike the knob located in the cap to actuate the piercing mechanism which in turn breaks the sealing disk of the cartridge. Direct the stream of escaping powder at the base of the flame. For effective result stand about 2 to 3 m away and direct the stream near the seat of the fire. Progress forward, moving the nozzle rapidly with a side sweeping motion.

When using on outdoor fires always operate the extinguisher from the upwind side of the fire to extend the effective range of the spray.

13.36. CARBON DIOXIDE FIRE EXTINGUISHERS

Carbon Dioxide (CO_2) is effective extinguishing agent primarily it reduces the oxygen content of air to a point where combustion cannot continue. CO_2 is non combustible and does not react with most substances. Being a gas it can penetrate and spread to all areas affected by fire.

Carbon Dioxide fire extinguishers are used for putting out fires in oils, petroleum products, gaseous substances under pressure, and also on electronic apparatus.

Carbon Dioxide extinguishers are **not** to be used in :

(*i*) Fires involving chemicals that contain their own oxygen supply (such as cellulose nitrate).

(*ii*) Fires involving reactive metals such as sodium, potassium and magnesium.

The common type of portable carbon dioxide extinguisher covered by IS : 2878-1976 is discussed here.

Construction. The principal parts of extinguishers are, as shown in Fig. 13.6 figure above. Carbon Dioxide is retained in the cylinder as liquid under pressure. The cylinder is filled with the charge to about two-thirds by weight of its total water capacity.

Method of Operation. Take extinguisher to the place of fire. Remove the safety pin operate the discharge device or unscrew the valve depending on the design. Carbon dioxide is delivered by means of discharge horn through a high pressure flexible hose.

Project the hose to the base of the fire, starting at one edge and sweeping across the surface of the burning material. When used in open air, the operator should stand on the up-wind side of the fire. On fires in electrical equipment first switch off the current. Then direct the jet or horn straight at the fire.

The gas at the time of discharge makes considerable noise. The user should therefore be well conversant with its operation to prevent the jet from being misdirected during the first few vital seconds.

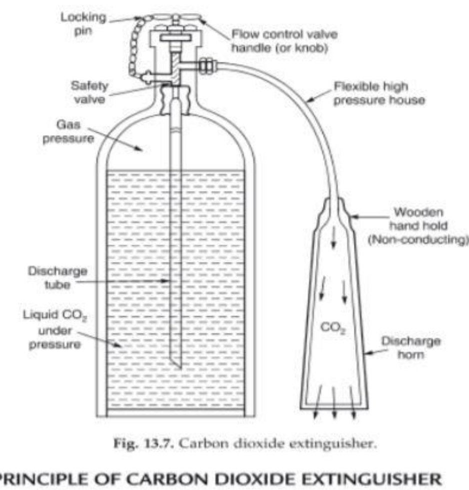

Fig. 13.7. Carbon dioxide extinguisher.

PRINCIPLE OF CARBON DIOXIDE EXTINGUISHER

When the extinguisher is actuated carbon dioxide from the cylinder comes out at a considerable velocity into the atmosphere and forms a layer of gas which is about one and a half times heavier than air. The vapour blanket puts out fire and reducing the oxygen supply needed to continue combustion.

6. .

(1) *Fusible Bulb (FB) Detector*. Five different temperature ratings covering the 60°C to 140°C range are used. When subjected to a specific temperature, the bulb shatters to release either compressed air (detector) or high pressure water (sprinkler).

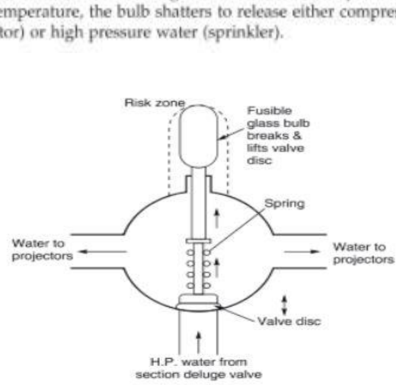

Fig. 13.8. Fusible heat detector combined with water-valve.

(2) *Rate of Temperature Rise Detector*. ROTR is a mercury switch which operates an alarm and/or initiates release of compressed air. Halon gas or high pressure water dependent upon the system. Two interconnected inert-gas-filled bulbs, one shielded from direct heat, contain a flow restricting orifice or a column or mercury. In the event of a fire, the heat creates a differential pressure between the two bulbs, which transfers the mercury column to change the state of the mercury switch.

(3) *Heat Sensitive Cables* are suspended along cable trays, as shown by Fig. 13.9 to detect an increase in surrounding temperature. The detector cable has conducting cores insulated from each other by a heat-sensitive negative temperature coefficient dielectric whose insulation resistance reduces rapidly with increasing temperature. The outer sheath is usually made from a distinctively-coloured-high temperature PVC compound to safely withstand localised fire. One type of cable exhibits a response to temperature according to the percentage of its total length exposed to heat. Typically the temperature rise, above a specified minimum ambient temperature of 40°C, to initiate an alarm condition ranges form 25°C over the entire length of the cable to 75°C over only a one meter length. Thus, it is not normally practicable to extend or shorten standard lengths of cable, since each is matched to its monitoring unit. As a general rule, cable heat detection schemes are used to initiate alarms only. Indication is displayed at fire control panel.

(4) *Smoke and heat detectors*. These are located on ceilings of risk areas, they have neon indicators to identify which device has operated. Smoke detectors may be of either the ionisation type (Fig. 13.10) or the photo-electric cell type, through thermistor and electrical fusible link types are in general use. Generally, such detectors initiate

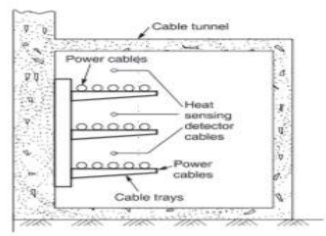

Fig. 13.9. Heat sensitive detector cable.

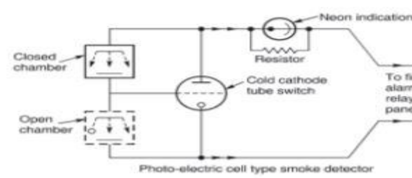

Fig. 13.10. A type of smoke detector circuit based on ionisation chamber.

only alarms. In some cases, they may initiate a discharge of Halon gas in computer rooms. Mechanical fusible links are often employed to close fire dampers in ventilation ducting.

(5) Heat-sensitive *fire detection canopies*, mounted over selected coal conveyors, detect rate-of-rise in temperature ; Any fire will activate the sprinkler fire protection system, and stop the conveyor. Optical methods of detecting conveyor fires are prone to suprious operation caused by clouds of coal dust created when dry coal is being handled. In one design of heat canopy, a group of compensated electrical detectors, incorporating exposed and shielded elements, is used. The shielded element is covered by a silicone compound, which has a larger thermal mass than the exposed element. In the event of fire, the hot gases trapped under the canopy, together with the radiated heat, warm each exposed element to create a small voltage difference between the shielded and exposed element. Since group of elements are connected in series, the resultant voltage is used to actuate the detection system.