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General Description

1.1. Principle of Heating Appliances

The appliances which work on the generation of heat for their operation are called heating appliances. The electrical appliances like electrical irons ; electrical kettles ; electrical stove (Heater) ; electric water heater ; electric hot plate ; electric soldering iron ; electric toaster ; electric cooking ranges and other similar equipments are grouped in this category. All these appliances are based on this principle that when an electric current is passed through the wire, the electrical energy is transferred into heat energy due to electron collisions into the wire and the wire is heated up to a certain temperature and radiates the bright orange red coloured heat.

In most of the above heating appliances, the heating element or heating unit is replacable. The appliance is manufactured in such a way that the heating element can be replaced easily by dismantling the appliance.

The wire used for the heating elements in the heating appliances is generally made by the combination of nickel, chromium and iron in the ratio of 65 : 15 : 20 and the ratio may vary according to the rating of resistance wire or the combination of 80% nickel and 20% chromium preparing the nichrome wire. Two or more metals are melted to make an alloy in the form of resistance wire which provides a high resistance in the flow of electric current and gives red heat without burning or melting. The shape of the element may be round or flat according to the manufacturing of the appliance. The element may work on any desirable temperature if it is designed suitably with proper length, diameter and shape.

It is very clear that the material used for heat producing element must be of high resistance or of high specific resistance so that a small length or wire may be used. The wire must have the following properties in addition to the above one :

(*i*) It should have high melting point to exist the high temperature.

(*ii*) It should not be oxidized with high temperature.

(*iii*) It should have small temperature co-efficient so that it may not be temperature co-efficient so that it may not be affected by increased temperature.

The element for any heating appliance can be designed after having the following type of data :

(*a*) *Wattage.* The rating in watts for the resistance wire of a particular size.

(*b*) *Resistance.* The total resistance of the element in ohms or resistance per foot or per cm.

(*c*) *Amperes.* Current capacity of the element in amperes.

(*d*) *Wire size.* The specific gauge of wire for the element.

(*e*) *Wire length.* The approximate total length of wire in foot or cm for the element.

The data of resistance wire (Nichrome wire) for 230 V are given below :

Wire size in B.W.G. and S.W.G.	*Length in feet*	*Total resistance in ohms*	*Total current in amps*	*Total wattage in watts*
33	38.3	494	0.435	100
32	24.4	247	0.87	200
31	16.9	160.37	1.3	300
29	24.2	123.52	1.73	400
27	30.6	98.82	2.17	500
26	32.0	82.35	2.6	600
25	34.8	70.58	3.04	700
25	30.7	61.77	3.48	800
24	34.2	54.90	3.9	900
23	38.6	52.91	4.35	1000
23	35.0	44.92	4.8	1100
22	38.0	41.17	5.52	1200
21	47.5	38.00	5.65	1300
20	55.7	35.30	6.10	1400
19	66.0	32.94	6.54	1500

Suppose we have to design an element for an electric stove of 1000 watts which is to work on 230 volts mains, then solution can be done like this.

Power to be consumed by electric stove = 1000 W

Total voltage of the supply = 230 V

$\therefore$ Resistance of the element $= R = \frac{E^2}{W}$

$$= \frac{230 \times 230}{1000} = 52.9 \text{ ohms}$$

Total current for the element $= \frac{230}{52.9} = 4.35$ amps

Total length of resistance wire $= \frac{\text{Total } R}{\text{ohms/foot}}$

In this way we will have to choose a suitable size of wire for carrying the current of 4.35 amps and having a resistance of 52.9 ohms. Referring to the table, it will be seen that No. 23 wire will meet these all requirements and the element can be prepared by taking the total length *i.e.* equal to 38.6 ft. or 10 m approx.

1.2. Principle of Motorized Appliances

Those appliances which work with an electric motor for their operation are called motorized appliances. The washing machine, the electric mixer and the vacuum cleaner etc. are considered in this category. The appliances under this category contain a variety of moving parts which create problems at all times. The motors of such appliances may be designed to work on A.C., D.C., and A.C./D.C. The appliance motor consists of two main parts *i.e.* one fixed and other rotating. In D.C. and universal motors, the fixed part is 'field coils' and the rotating part is 'Armature'. But in A.C. motors, the fixed part is 'Stator' and the moving part is known as 'Rotor'.

In such appliances, mostly two types of defects may occur *i.e.* electrical defects and mechanical defects. The electrical defects may be like this—*Open circuit* in the plug, in the connector, at the terminals, in the field coils, in the armature, in the switch. *Short circuit* in the wire of the switch, terminals of motor, in the armature winding, in the field coils, in the appliance, loose contact of the brushes, dirty commutator, sparking at the brushes etc. *Earth or Leakage fault i.e.* insulation of winding becomes old or damaged and the winding may touch the metallic part of the appliance inside or the current leaks through the insulation to the metal body of the appliance. Then open, short, earth or leakage fault can be removed by testing with test lamp. Commutator can be turned on the lathe machine, brushes can be replaced and armature can be tested on growler for short circuit.

The mechanical defects may be like this—bearing or brushes defects ; shaft may be bent, loose fitting of the motor ; any loose part etc. The bearing defect can be rectified by lubricating. The loose parts can be fitted well. The shaft can be straightened by hammer.

1.3. Principle of Appliances depending upon the Luminous Effect

The appliances which work on the principle of luminous effect are known as Luminous appliances *i.e.*

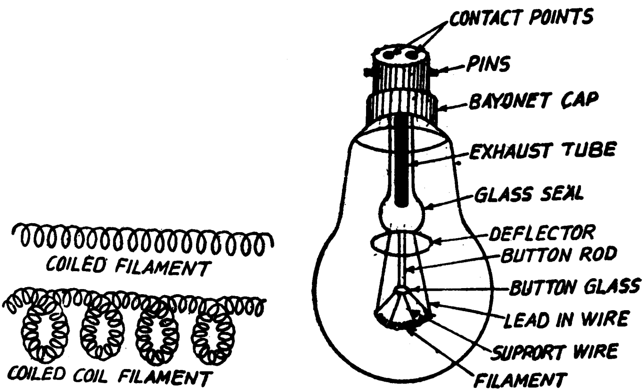
(*i*) When current passes through a filament enclosed in a glass bulb, it becomes red hot giving the white-yellowish coloured light at a certain temperature as in incandescent lamps.

(*ii*) When current passes through a metallic vapour or gas enclosed in a glass tube or glass bulb, discharge of gas takes place between the electrons and ions of gas at a certain temperature, producing a visible light of whitish, bluish, greenish, redish colour etc. depending upon the different chemicals and gases used inside the glass tube as in the neon tube, mercury vapour lamp and fluorescent lamp etc.

Structure of filament lamps

In these lamps, a metal of high melting point and less susceptible to vaporisation for the filament of lamps is used. These lamps work on the principle of heating the filament by passage of an electric current to a certain temperature at which it emits light. Greater the temperature, brighter will be the glow. The filament used in these lamps is of tungsten. Various parts of the filament lamps are as under :

1. Glass bulb filled with a mixture of nitrogen and Argon gas.
2. Metallic base or cap with contact points.
3. Glass seal.
4. Exhaust tube.
5. Deflector.
6. Button rod.
7. Button glass.
8. Lead-in-wire or support wire.
9. Filament wire made of tungsten in the form of coiled wire or coiled coil wire.



Glass Bulb filled with gas.

Fig. 1.1 Showing different parts of a filament lamp.

The filament lamps are rated according to power consumption in watts. These lamps are suitable for operation on both a.c. and d.c. supply. They are very much susceptible to voltage changes. Life and efficiency of these lamps is low as compared to that of fluorescent lamp. Even then, their low initial cost, convenience and simplicity to install and to maintain and instantaneous start enable it be preferred by common people for a light source. The frequency of starts and stops has no appreciable effect on the life of filament lamps.

Structure of Fluorescent lamp

This is one of the types of the gas discharged lamps. It consists of glass tube with filament type electrodes sealed into each of its ends. The electrodes are of tungsten wire, coated with a material having ability to emit electrons. The phospher material *i.e.* fluorescent powder is coated inside the tube. Most of the air is removed from the tube during the manufacturing the lamp and a small amount of argon gas and drops of mercury are filled inside it. The lamp circuit can be studied from the circuit diagram given fig. 1.2.

The electrodes come in series with a choke and across the supply through a thermal starting switch (starter). When the supply is switched to the lamp, the current passes through the circuit and heats the filaments. The heat vaporises the mercury causing electrons to be emitted from the material with which the filaments are coated. The starter contacts are also heated which are opened after a few seconds.

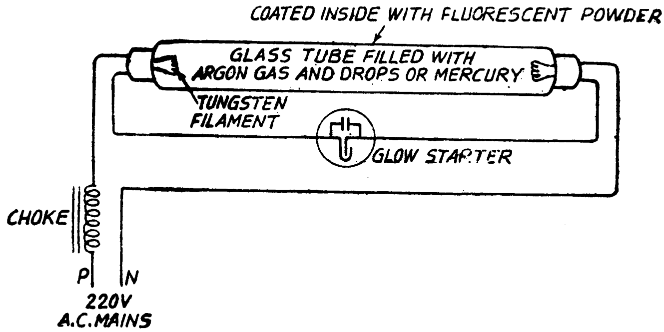


Fig. 1.2. Shows Connection diagram of Fluorescent tube.

The sudden stop of current through the choke produces voltage of several thousands volts across it because of self inductance of the coil. The high voltage starts the flow of electrons from one filament to the other through the gas filled inside the tube. The electrons passing through the argon gas collide with mercury atoms and produces invisible ultra violet rays. When these ultra violet rays fall on the coated fluorescent powder inside the tube, they glow brightly and produce visible rays which we see in the form of whitish light.