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Learning Objectives

Electric heating is a process in which electrical energy is converted into heat energy. It is essential for the students to know, how the electrical energy is being utilized in heating appliances. The main objective of this chapter is to make students, to understand the working of various heating appliances through the types of conductive methods.

Furthermore, this lesson also aims to aid the students, to gain practical experience about defects, their reasons and its corrective measures of the heating appliances.

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3.1 Introduction

Electricity plays major role in our everyday life. One of the main applications of electricity is to produce heat from heating elements. In this chapter, we shall learn about the types of heaters and its working procedure such as

- i. Electric iron box
- ii. Induction stove
- iii. Bread toaster
- iv. Coffee percolator and
- v. Electric water geyser.

3.2 Electric iron box

An Electric iron box is an appliance used to remove the wrinkles in the clothes when heated. It is of three types.

- i) Non-automatic or Ordinary type iron box
- ii) Automatic iron box
- iii) Steam automatic iron box

a) Clothes and its temperature

The operating temperature of the iron box for different types of cloths is tabulated below

Nylon	- 70°C -90° C
Rayon	- 100°C - 120°C
Silk	- 130°C - 150°C
Wool	- 160°C - 180°C
Cotton	- 200°C - 220°C
Linen	- 230°C - 260°C

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- 3.5 Coffee percolator
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According to the range of heat required to clothes, the thermostat can be fixed and the wrinkles were removed from the washed clothes.



b) Power chord

The electric conductor that permits electric supply to an electric appliance will contain three terminals such as Phase (Red color), Neutral (Black color) and Earth (Green). The electrical conductors coiled with cotton threads are the most commonly used power chords.

3.2.1 Non-automatic or ordinary type iron box

As shown in figure 3.1 the nonautomatic or ordinary type iron box is an appliance, where we control the heat of the appliance by simply putting the switch 'ON' and 'OFF' only according to the types of cloths used.



Fig. 3.1 Non-automatic iron box

The main parts of the iron box are listed below

a) Handle

Handle is made up of bakelite a hard type of plastic in the iron box. Bakelite is having resistive power of heat and nonconductor of electricity. A rubber tube is provided at the top of the handle, to avoid the damage of power chord while in use.

b) Top cover

Top cover is at the top of the appliance and it covers all the inner parts of the appliance. It is made of metal which is chromium plated to look attractive.

c) Stand

Stand is made up of strong iron to make the appliance to keep stand when not in use.

d) Pressure plate

Pressure plate is made up of hard cast iron and it gives weight to the appliance. Due to this, the wrinkles in the clothes are removed.

e) Mica sheet

Mica is an insulator of electricity. It is kept in top and bottom of the heating element for safety purpose. Mica is also good to resist the heat.

f) Heating element

The heating element of the iron box is made from mixed alloy of Nichrome. Usually in all the heating appliances, it is used as heating element. The heating element here used is of ribbon type.

Heating element is of two types.

- 1. Coiled type and
- 2. Ribbon type.

g) Sole plate

Sole plate is plated with chromium and made up of cast iron. The bottom of the sole plate is surface grained for smoothness.

Working principle

The power chord of the iron box is connected to the main supply. The electric energy is converted into heat due to this heating element. The heating element is having the property of high resistivity. According to the law of conservation of energy the heat energy produced is proportional to the square of current without any loss. This heat energy makes the sole plate to hot and with that the wrinkles in the cloth are removed. In this type of iron box, according to the type of cloth, the heat can be controlled manually, by connecting or disconnecting the supply through switch.

3.2.5 Automatic iron box

In an automatic iron box, the temperature of the cloths can be selected to the required quantity of heat. The temperature is controlled by the thermostat in the appliance automatically. Hence this appliance is called as Automatic Iron Box.



Fig. 3.2 Electric automatic iron box

a) Construction

As shown in figure 3.2, the construction and operation of automatic iron box is similar to that of an Ordinary iron box. In an automatic iron box, the temperature is controlled with the help of thermostat. The thermostat is a bi-metallic strip. In addition to this, an indicating lamp is connected in series with the heating element.

b) Indicating lamp

In the iron box LED lamp is used as an indicating lamp. Indicating lamp is provided to know whether the supply is going into the appliance or not. During the time of supply, the indicating lamp glows. After attaining the fixed level in the regulating knob (or) Selector knob the indicating lamp turns off automatically. This shows the availability of supply in the appliance.

c) Thermostat

Thermostat is a bi-metallic strip made up of two different metals. Generally, due to heat, the metals get expanded. After setting the required value in the regulating knob, the heat increases gradually and gets saturated. Then the bi-metallic strip will bend automatically and to stop the supply to the heating element. This can be viewed in the figure 3.3.

After the heat gets reduced in the sole plate, the bi-metallic strip, again contacts with electric supply and makes the appliance to get heated as shown in figure 3.4. The expansion of the strip will vary, according to the strip which the bi-metal was made.

d) Working principle of automatic iron box

The electric input is given to the iron box by putting the switch in ON position. The current goes to the heating element of the iron box through power chord. The heating element gets heated up due to its heat production property. The heat was absorbed by the sole plate and gets heated gradually. This heat removes the wrinkles in the clothes.

3.2.6 Steam iron box

The construction and working principle of a steam iron box is similar to



Fig. 3.3 Thermostat in closed position



Fig. 3.4 Thermostat in open position

that of automatic iron box. The internal construction is shown in figure 3.5.

A steam iron is an electric iron that produces steam from water. The steam removes the wrinkles in the clothes. It is fitted with thermostat with wattage of around 1000 to 1600 watts. Steam ironing is one of the easiest methods to iron clothes. For the removal of the wrinkles from the clothes and ironing is in better way.



Fig. 3.5 Steam iron box

The steam iron requires more duration to get heated when compared to the other types of iron the clothes.

In this, a small water container is kept above heating element and it supplies water to sole plate through the holes provided in it. The water steam flow is controlled by a press valve kept near the handle. The valve control is provided in handle in order to control the water flow easily. The valve will not allow the water or steam to back side. The water in the tank comes through holes in sole plate in the form of steam. Once the valve gets opened, the steam reaches the cloth and the wrinkles in the cloth will be cleared. The flow of steam upon the position of the knob is kept in it. Any defects in the heating element may cause the unit to be replaced by a new one.

a) Maintenance

- 1. In steam iron box, distilled water should only be used.
- 2. After the use of iron box, the water in the container should be removed completely with the help of steam control valve.
- The salt deposits inside the iron box should be cleaned with the help of vinegar. The vinegar is mixed with water and is rinsed inside two or three times to clear the salt depositions in it.

Sl. No.	Defects	Reasons	Remedies
1. Iı h	Iron box not gets heated.	1. No electric supply.	 Correct the electric supply.
		Heating element is not connected with supply.	 Connect the supply to the heating element properly.
		 Loose connection in heating element. 	3. Heating element should be connected properly.
2.	Heat produced in	1. Voltage drop.	1. Correct the voltage.
tl a	the iron box is not adequate.	2. Thermostat knob not fitted properly.	 Proper fitting of thermostat knob should be done.
		3. Loose connection in thermostat.	3. Thermostat connection should be done properly
3.	Heat produced is exceeding the	1. Short circuit in thermostat.	1. Short circuit in thermostat is corrected.
	setting point kept.		2. Emery sheet should be used for cleaning the terminal ends to avoid short circuit.

3.2.6 Trouble shoot chart

Sl. No.	Defects	Reasons	Remedies
4.	Clothes are sticking in the sole plate while ironing.	 Abnormal heat produced. Due to that thermostat terminals contact with one another. 	1. Terminals of thermostat should be connected correctly.
		2. Bottom of the sole plate is corroded.	2. The corrosion in the sole plate should be cleaned by applying non corrosion things.
5.	Iron box is getting electric shock.	 Supply wire may contact with body of the iron box. 	 Connect the supply wire without touching the metal parts of the iron box. Earth connections should be properly checked.



Fig. 3.6 Induction stove

Induction stove is widely used in places where there is no LPG gas connection facility. Induction stove is commonly used in hospitals and temporary exhibitions. The construction is shown in the figure 3.6. In this type of stove no smokes and flames will be produced. The utensils kept over the induction will not get much heated. Only the things kept inside the utensil alone gets heated. Now-a-days, these types of stoves are widely used in Asia, Europe and America.

Induction heating is the process of heating an element or appliance electrically by the principle of electromagnetic induction. The heat generated in this type of stove by means of the eddy currents produced in the induction coils.

According to the types of the Induction stoves are classified as

- a) Single type
- b) Dual type and
- c) Four type

3.3.1 Construction

Induction stove is made up of noncorrosive stainless steel. Heating element is fixed on the top of the stove, in which utensils were kept. Three pin plugs are used as supply terminal in this stove. Rubber bush is kept at the bottom of the stove for grip. In this, various facilities like child lock safety, timer, temperature indicator and cooking options were included.

3.3.2 Working principle

An alternating supply is made to flow through the resonant coil, which leads to the generation of oscillating magnetic field. The magnetic field induces an electric current inside the cookware. The induction cook top works with cookware made of certain materials which have specific properties. The Induction stove transfers electrical energy by induction from a coil of wire into a metal vessel that must be ferromagnetic. The coil is mounted under the cooking surface, and a high frequency of alternating current is passed through it. The current in the coil creates a dynamic magnetic field. The magnetic field induces whirling electrical eddy currents inside the pan, turning into a heater. Heat from the pan flows directly into the food or water kept inside the container, by conduction method of heat.

High production of heat is the specialty of this stove. No heat losses will occur. This type of stove can be used in all climatic condition.

3.3.3 Uses

- i. Function is faster than other types of stoves.
- ii. Easy to clean.
- iii. Stains produced in this can be easily cleaned with cloth.

- iv. Cost is less.
- v. No noise occurs while functioning.
- vi. Burns or wounds will not be caused when touched.

3.3.4 Difference between regular stove tops and induction cook tops

Regular stove tops heat pots and pans through contact, flames or electrical heating elements. Regular stovetops generate heat, and the heat is transferred through the contact from the burner to the base of the pot. This process is known as thermal conduction.

On the other hand, the Induction cook tops do not generate heat. Induction burners have a coiled wire just below the ceramic surface, which generates an oscillating magnetic field. The key to induction cooks tops is that the pots and pans used must be made of magnetic material to work with this system.

The induction cook top will induce the electrons in a magnetic material to move around, creating an electric current. This current generates heat in the pot. If you place your hand, or a glass pot on an induction cook top, neither will heat up because they are not magnetic and therefore not affected by the alternating magnetic field of the induction burner.

3.4 Bread toaster

A Bread toaster, or a toast maker, is an electric small appliance designed to toast sliced breads by exposing it to radiant heat, thus converting it into toast. It is a portable device.

3.4.1 Types

The most common household toaster is classified as

- i. Ordinary type bread toaster, and
- ii. Automatic type.

Ordinary type of bread toaster is not used in now-a-days.

3.4.2 Automatic bread toaster

a) Construction

Electric bread toaster looks like a rectangular box and is used for toasting the bread slices as shown in figure 3.7. In this, two gaps are provided, in which two bread slices are put for toasting. The gap is adequate for bread slices to go inside. Bread toaster contains three heating elements and they are in front, middle and back side of the toaster. The centre heating element is the main element for toasting. A resting thick sheet is kept inside the toaster and is attached with a lever. A Thermostat, the heat control device is connected in series with heating element and to the supply. Three pin power chords are used as supply wire for the appliance. Handle is made of hard plastics which insulates the heat and electric supply. A

tray is kept below the toaster, in order to collect the waste particles of bread.



Fig. 3.7 Bread toaster

b) Working principle

The bread slices are kept in the place of bread resting container, and put the lever down to make the bread slices to get in. Then close the top of the toaster with lid, and allow the supply to get toasted. After the bread slices gets toasted, the thermostat which is connected in series with electric supply disconnect the supply and pushes the lever up. Now the toasted slices came out with golden colour.

The use of Thermostat is to allow and disconnect the power supply when the toaster is in use.

Sl. No. Defects Remedies Reasons Supply is 1. There may be open 1. Open circuit or Short circuit 1. in the power chord should be circuit or short circuit given, but the in the power chord. checked before giving the supply. toaster not 2. The supply terminals functioning 2. Connect the terminals of the not connected with heating element correctly. heating element.

3.4.3 Defects, reasons and remedies of electric bread toaster

Sl. No.	Defects	Reasons	Remedies
2.	Getting	Electric supply terminal	The contact of supply terminal on
	electric shock	is contacting with metal	the metal part should be properly
	while using	parts of the toaster.	insulated.
	the toaster		
3.	When switch	Short circuit in the	Short circuit should be identified
	is 'ON', the	toaster.	and gets rectified.
	fuse gets		
	melted		

3.4.4 Timer switch

Timer switch is a safety switch for the bread toaster. It limits the electric supply and saves electric energy.

3.5 Coffee percolator

Water is heated through electric supply, and that hot water is mixed with coffee powder, coffee water is prepared. This appliance is called coffee percolator.

3.5.1 Parts

The main parts of coffee percolator are listed below

- 1. Heating element
- 2. Cylindrical shape body
- 3. Water container
- 4. Vertical tube or Percolating tube
- 5. Coffee basket
- 6. Top cover
- 7. Container for coffee water
- 8. Outlet for coffee water
- 9. Handle

3.5.2 Construction

Coffee percolator is portable device as shown in figure 3.8. In this, the coil is

made up of nichrome and is used as heating element. Because of its high resistance in the coil, the electrical energy is converted into heat energy. The appliance is cylindrical in shape and is made up of iron coated with lead. Water is poured into the container. A coffee basket is kept above the vertical tube. In some appliances, the lid is made up of glass. In certain type of coffee percolator, the chamber for hot water and coffee water are seprated. Handle is made up of nonconductive materials like bakelite, which resists heat produced in it.



Fig. 3.8 Coffee percolator

3.5.3 Working principle

First the percolator lid is opened, and water is poured inside, through the percolating tube. Coffee powder was poured to the required quantity in the coffee basket and the lid was closed. If the supply is given, the water in the container gets heated and the steam of the water goes towards percolating tube, and soaks the coffee powder in the basket. Now the essence of coffee water is collected from the bottom of the container through a tap. Any leakage or holes in the tube, this percolator will not function.

3.5.4 Defects, reasons and remedies of coffee percolator

Sl. No.	Defects	Reasons	Remedies
1	Supply is given, coffee	1. There may be open	1. Open circuit or Short
	percolator is not	circuit or short circuit	circuit in the power
	functioning	in the power chord.	chord should be
			checked before giving
			the supply.
		2. The supply terminals	2. Connect the terminals
		not connected with	of the heating element
		heating element.	correctly.
2	Getting shock while	Electric supply terminal	The contact of supply
	using the coffee	is contacting with metal	terminal on the metal
	percolator	parts of the coffee	part should be properly
		percolator.	insulated.
3	When we switch 'ON'	Short circuit in the coffee	Short circuit should
	the supply, the fuse	percolator.	be identified and gets
	gets melted		rectified.

3.6 Geyser

A geyser is a heating appliance which is used in the places where hot water is required. Normally tubular type of heating element is used in this appliance. Nichrome is the heating element used in all heating appliances. Due to the high resistance in the heating element, the electrical energy is converted into heat energy, and the water gets heated. Thermostat, in the appliance regulates the heat produced in it. The geyser is available in various rating of 15, 25, 35 and 50 litres and is also available from 1000 to 5000 watts.

Construction

1. Container

Geyser is an appliance used for getting huge quantity of hot water for domestic purposes. It is cylindrical in shape and contains two containers such as

- 1. Inner container
- 2. Outer container.

Inner container is made up of brass and is coated with lead to avoid

corrosion. Outer container is made of steel coated with paint. In between the inner and outer container a glass wool is used to protect the hot water from the outer atmosphere and moisture. Also, it prevents the hotness from inner container to outer container.

2. Water inlet pipe

The inlet pipe is provided to allow the water to go inside the inner container. A valve is fixed to regulate the flow of water into it.

3. Water outlet pipe

Outlet pipe is the pipe used for collecting the hot water from the geyser. The outlet pipe is bent on the top, in order to collect hot water uniformly.

4. Heating element

Tubular type of heating element is used as a heating element. Nichrome, the mixed alloy, is used as a heating element in all heating appliances.

5. Thermostat

Thermostat is a bi-metallic strip used to control the heat and is connected in series with the heating element to get the determined value of heat fixed in the setting position.

6. Vent pipe

When we want to shift the geyser or replace the heating element, the water in the geyser is to be removed completely. During that time, this vent pipe is used to drain the water inside the container.

7. Pressure release valve

In order to release the pressure inside the geyser from explosion, pressure,

release valve is used. Also, it maintains the level of water inside the container.

8. Positive plate

The positive rod itself accepts the corrosion produced and preserves the steel container from corrosion.

Geyser is of two types. They are

- i. Non pressure type geyser and
- ii. Pressure type geyser

3.6.3 Non pressure type geyser

Non pressure type geyser is used in places where small quantity of hot water is required.





Working principle

When an electric supply is given to the geyser, the electrical energy makes the heating element gets heated gradually. The conversion of electrical energy into heat energy is due to nichrome, which is having a very high resistance value. Now the heat conducts water and makes it hot. The setting position of thermostat automatically stops the electrical input in the appliance. After the heat gets reduced, the thermostat immediately connects with electric supply and makes the water again to get heated. The density of hot water is lesser than cold water. Hence the hot water is on the top and cold water in the bottom of the geyser.

3.6.4 Pressure type geyser

For requirement of large quantity of hot water, in a multi-storied building, pressure type of geyser is used. It is shown in figure 3.10. The water in the appliance is controlled by float valve.



Fig. 3.10 Pressure type geyser

Working principle

The working principle of this type is similar to that of non-pressure type geyser. In this water pressure is controlled by a floating valve. Being the outlet pressure is high, this type of geyser is used in multi-storied building for getting hot water. This type of geyser is fixed in one place and hot water can be collected in various rooms.

3.6.5 Defects, reasons and remedies of electric geyser

Sl. No.	Defects	Reasons	Remedies
1	Supply is given. But the geyser is not functioning	There may be open circuit in conductor, plug or power chord.	The power chord and plug should be properly connected.
2	Fuse gets melted when the supply is put 'ON'.	Short circuit between the terminals.	Phase and neutral wire should be properly insulated.
3	Gets electric shock while touching it.	Supply wire may contact with metal parts of the appliance.	The contact terminal part should be properly insulated.

Evaluation



Choose the correct answer

- 1. Which is not connected with heating appliances?
 - a. Electric stove
 - b. Electric iron box
 - c. Room heater
 - d. Electric fan
- 2. In which appliance, a small water tank is kept over the heating element.
 - a. Pressure type geyser
 - b. Steam iron box
 - c. Coffee percolator
 - d. Electric soldering iron
- 3. The use of control valve in an electric steam iron box is
 - a. prevents water and steam not to go top
 - b. control water alone.
 - c. control steam alone
 - d. control heat alone.
- 4. What type of water can be used in steam iron box?
 - a. Ordinary water
 - b. Hot water
 - c. Cold water
 - d. Pure distilled water
- 5. Mica sheet is a
 - a. non-conductive material.
 - b. non-resistive to heat.

- c. conductive material.
- d. easily combustible.
- 6. Which metal, the heating element is made up of?
 - a. Brass
 - b. Nichrome
 - c. Aluminium
 - d. Copper
- 7. Due to -----, the electric energy is converted into heat energy.
 - a. low electric supply
 - b. low resistance
 - c. high resistance
 - d. high electric supply
- 8. The ratio of heat in heating appliances is
 - a. I^2Rt b. I^2R^2t c. IR^2t d. IRt^2
- 9. Under which law, the heating appliances will function?
 - a. Ohms law
 - b. Law of conservation of energy
 - c. Current law
 - d. Voltage law
- 10. ----- is used in indicating lamp.
 - a. Incandescent lamp
 - b. Light emitting diode lamp

(1 Marks)

- c. Tube light
- d. Compact fluorescent lamp
- 11. The appliance which induces hot waves from electromagnetic field is
 - a. Electric iron box
 - b. Hair drier
 - c. Induction stove
 - d. Electric kettle
- 12. According to ----- rule, induction stove will function.
 - a. Law of conservation of energy
 - b. Ohms law
 - c. Flemings rule
 - d. Faraday's law
- 13. How many Bread slices are toasted in a Bread toaster simultaneously?
 - a. 2
 - b. 3
 - c. 4
 - d. 5
- 14. In heating appliances, thermostat is connected in ----
 - a. Series
 - b. Parallel
 - c. Series parallel
 - d. Earth

- 15. Use of percolating tube in coffee percolator is
 - a. to get coffee water
 - b. outlet for steam
 - c. to get hot water
 - d. to store coffee powder.
- To avoid corrosion in an inner container of geyser ----coating is used.
 - a. Lead
 - b. Chromium
 - c. Nickel
 - d. Copper
- 17. Use of glass wool in geyser is ----
 - a. to retain the water hotness as it is.
 - b. to retain the water chillness as it is
 - c. to get more heat
 - d. to get less heat.
- 18. The use of fusible plug in geyser is to
 - a. increase pressure
 - b. release pressure
 - c. get more heat
 - d. get less heat

Answer the questions in brief

- 1. State the types of electric iron boxes.
- 2. What is the use of small water tank in steam electric iron box?
- 3. What is the use of control valve in steam electric iron box?
- 4. State the maintenance tips of steam electric iron box.
- 5. What is the use of pressure plate in electric iron box?

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PART-B

(3 Marks)

8. What is called induction stove?9. What are the uses of induction stove?

electric iron box?

7. State indicating lamp.

- 10. Define bread toaster.
- 11. What is the use percolating tube in coffee percolator?

6. What is the use of sole plate in

- 12. Define coffee percolator.
- 13. State geyser.
- 14. Write down the types of geyser?
- 15. What is the use of fusible plug in geyser?
- 16. What is the insulation value of the geyser? In which instrument it is measured?

PART-C

Answer the questions in one page

1. Explain the functions of thermostat in an electric steam iron box?

- 2. Draw and explain the construction diagram of automatic iron box?
- 3. State the defects and rectification of the faults happening in induction stove?
- 4. Tabulate the troubles, reasons and remedial measures of an electric bread toaster?

(5 Marks)

(10 Marks)

- 5. Explain the pressure type geyser?
- 6. Draw and explain the construction of coffee percolator?

PART-D

Answer the questions in two page

Draw and explain the construction and working principle of an electric steam iron box.

- 2. Tabulate the defects, reasons and remedial measures of an electric steam iron box.
- Explain the construction and working principle of an electric induction stove with suitable sketch.
- 4. Explain the construction and working principle of an electric bread toaster with sketch.

- 5. Explain the construction and working principle of an electric coffee percolator with sketch.
- 6. Explain the construction and working principle of pressure type geyser with neat diagram.
- Explain the construction and working principle of nonpressure type geyser with neat diagram.



1. A text book of 'Electrical Technology' volume III B.L. Theraja and A.K. Theraja.



- 1. http://www.wikipedia.org
- 2. http://www.electricl4u.com