## UNIT-5

## NON DESTRUCTIVE TESTING

Non-destructive testing is the use of physical methods which will test materials,
components and assemblies for flaws in their structure without damaging their future usefulness. NDT is concerned with revealing flaws in the structure of a product. It, however, cannot predict where flaws will develop due to the design itself.

**All NDT methods have the following common characteristics:**

- The application of a testing medium to the product to be tested.
- The changes in the testing medium due to the defects in the structure of the product.
- A means by which it detects these changes.
- Interpretation of these changes to obtain information about the flaws in the structure of the product.

### EDDY CURRENT TESTING (ET)

This method is widely used to detect surface flaws, to sort materials, to measure thin walls from one surface only, to measure thin coatings and in some applications to measure case depth.

This method is applicable to electrically conductive materials only. In the method eddy currents are produced in the product by bringing it close to an alternating current carrying coil. The alternating magnetic field of the coil is modified by the magnetic fields of the eddy currents. This modification, which depends on the condition of the part near to the coil, is then shown as a meter reading or cathode ray tube presentation. Figure 1.5 gives the basic principles of eddy current testing.

There are three types of probes Figure 1.6 used in eddy current testing. Internal probes are usually used for the in-service testing of heat exchanger tubes. Encircling probes are commonly used for the testing of rods and tubes during manufacturing. The uses of surface probes include the location of cracks, sorting of materials, measurement of wall and coating thickness, and case depth measurement.

**This method may be used for:**

- For the detection of defects in tubing.
- For sorting materials.
- For measurement of thin wall thicknesses from one surface only.
- For measuring thin coatings.
- For measuring case depth.

**Some of the advantages of eddy current testing include:**

- Does not require couplant.
- It gives instantaneous response.
- Has uncomplicated steps during set-up.
- Is extremely sensitive to flaws.
- Is very repeatable.
- High scanning speeds can be used.
- Is very accurate for dimensional analysis of flaws or coating thickness

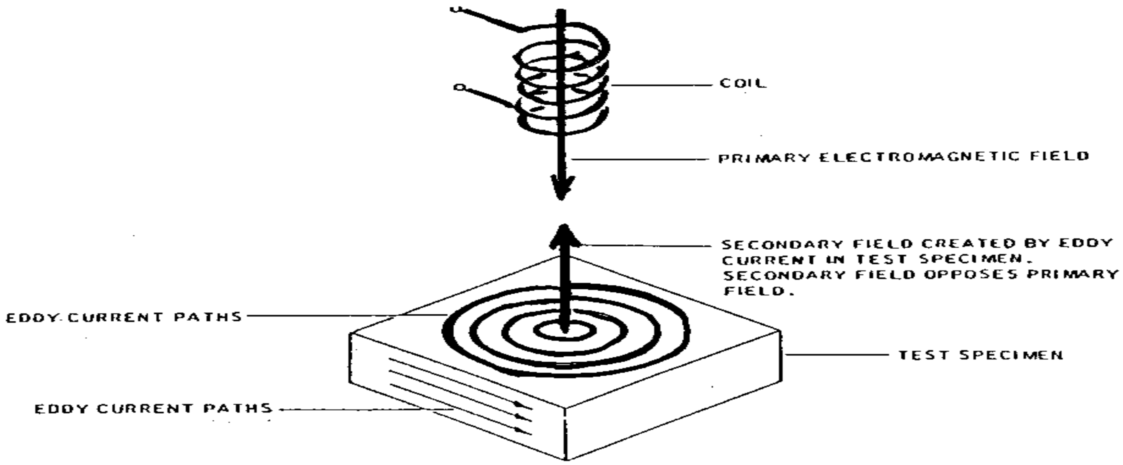



***Figure 1.5: (a) Generation of eddy currents in the test specimen.***

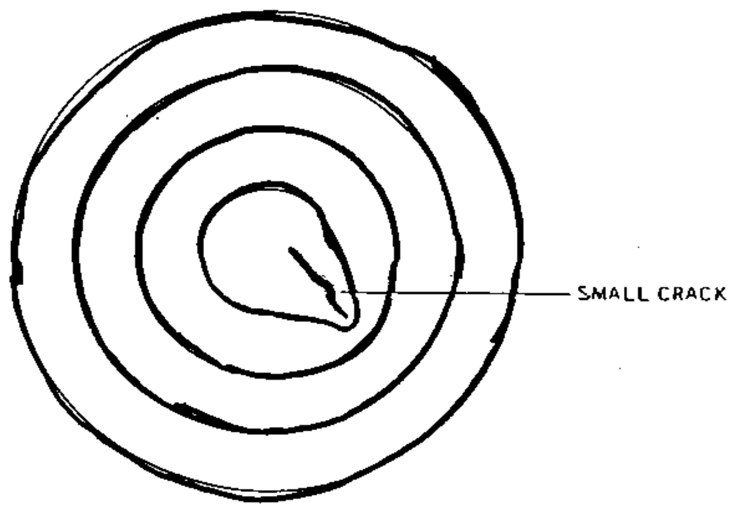
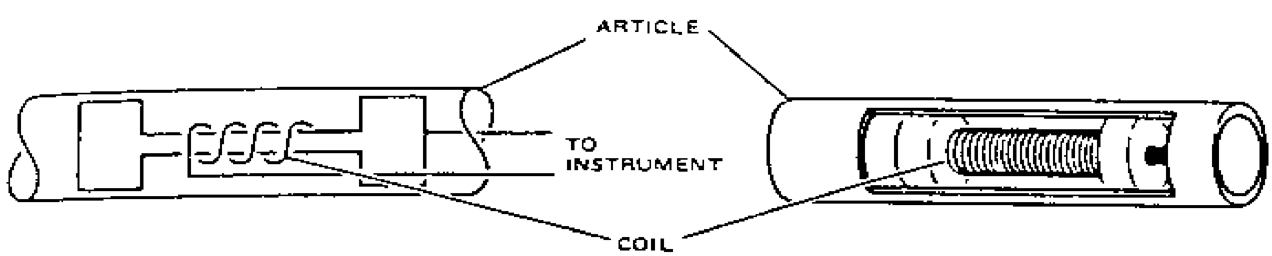
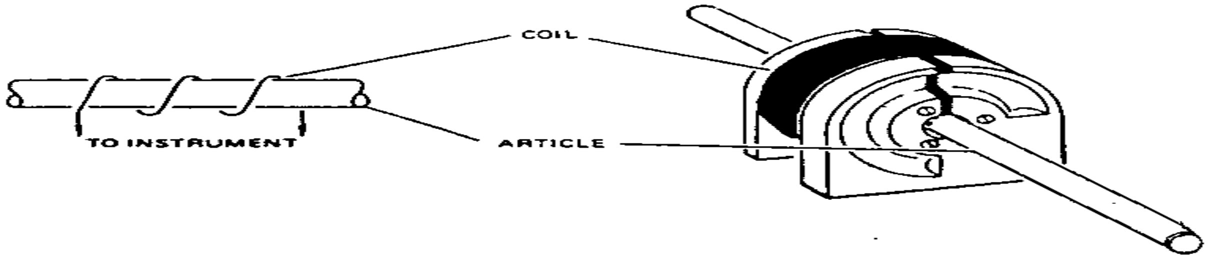


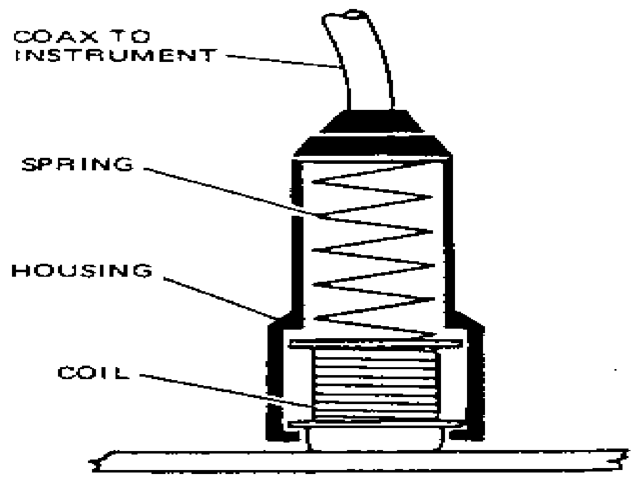

***Figure 1.5: (b) Distortion of eddy currents due to defect.***




Internal coil




*(a) Encircling Coil*

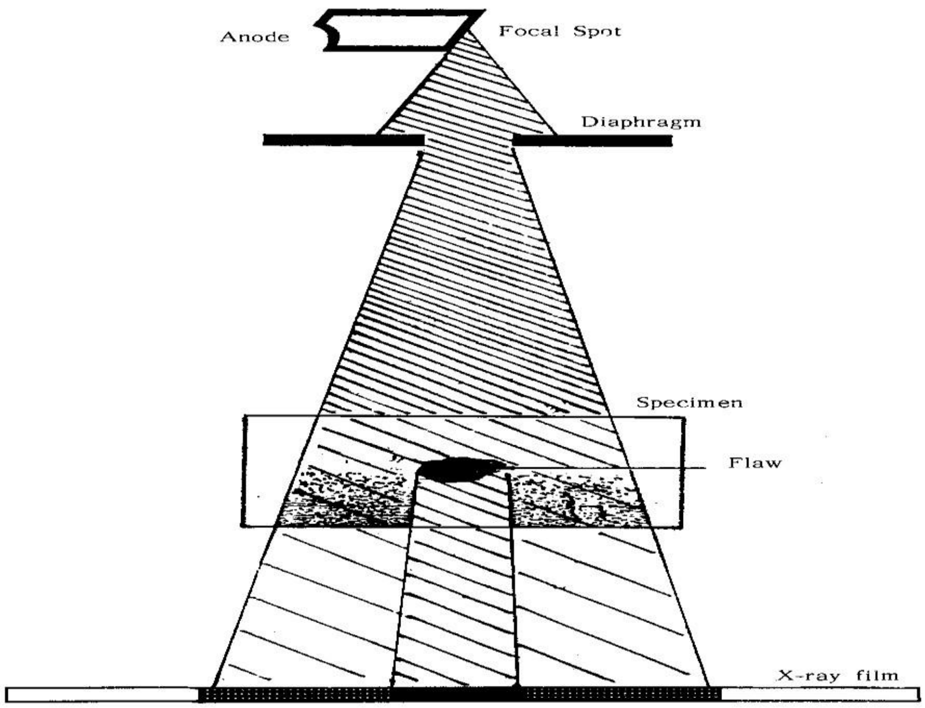



***Surface Probe***

**Some of the limitations of eddy current testing include the following**

- The theory requires a good academic background in electrical principles and in mathematics.
- Extremely sensitive to surface variations and therefore requires a good surface.
- It is applicable to conductor materials only.
- Can be used on non-magnetic and magnetic material but is not reliable on carbon steel for the detection of subsurface flaws.
- Its depth of penetration is limited.
- Crack tightness and orientation of eddy current flow to a crack or linear discontinuity will affect detectability.

RADIOGRAPHIC TESTING METHOD (RT)




The radiographic testing method is used for the detection of internal flaws in many different materials and configurations. An appropriate radiographic film is placed behind the test specimen and is exposed by passing either X rays or gamma rays (Co-60 & Ir-192 radioisotopes) through it. The intensity of the X rays or gamma rays while passing through the product is modified according to the internal structure of the specimen and thus the exposed film, after processing, reveals the shadow picture, known as a radiograph, of the product. It is then interpreted to obtain data about the flaws present in the specimen. This method is used on wide variety of products such as forgings, castings and weldments. Some of the advantages of radiographic testing include:

- It can be used to inspect large areas at one time.
- It is useful on wide variety of materials.
- It can be used for checking internal mal-structure, miss-assembly or misalignment.
- It provides permanent record.
- No calibration needed on the job site.
- Devices for checking the quality of radiograph are available.

**Some of the limitations of this method are:**

- X rays and gamma rays are hazardous to human health.
- It cannot detect planar defects readily.
- Access to both sides of the specimen is required.

- Thickness range that can be inspected is limited.
- It is more costly.
- It cannot be easily automated.
- It requires considerable skill for the interpretation of the radiographs.
- Depth of discontinuity not indicated.

## ULTRASONIC TESTING (UT)

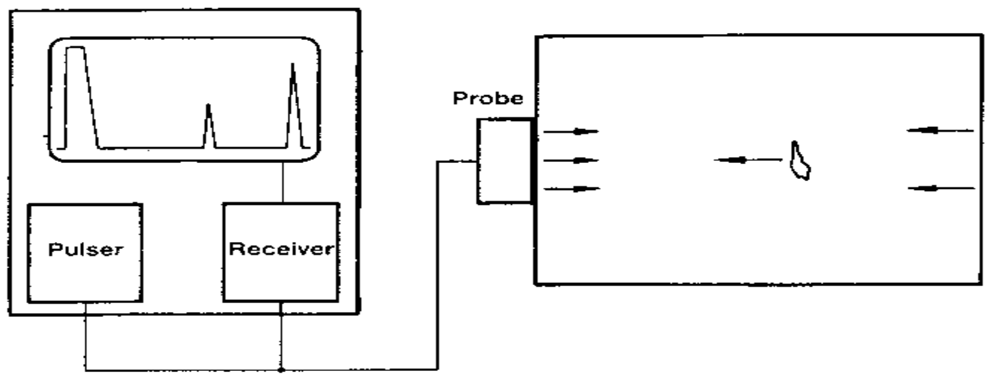
Ultrasonic inspection is a non-destructive method in which high frequency sound waves are introduced into the material being inspected. Most ultrasonic inspection is done at frequencies between 0.5 and 20 MHz, well above the range of human hearing which is about 20 Hz to 20 kHz. The sound waves travel through the material with some loss of energy (attenuation) due to material characteristics. The intensity of sound waves is either measured, after reflection (pulse echo) at interfaces (or flaw) or is measured at the opposite surface of the specimen (pulse transmission). The reflected beam is detected and analyzed to define the presence and location of flaws. The degree of reflection depends largely on the physical state of matter on the opposite side of the interface, and to a lesser extent on specific physical properties of that matter, for instance, sound waves are almost completely reflected at metal-gas interfaces. Partial reflection occurs at metal-liquid or metal-solid interfaces. Ultrasonic testing has a superior penetrating power than radiography and can detect flaws deep in the test specimen (say up to about 6 to 7 meter of steel). It is quite sensitive to small flaws and allows the precise determination of the location and size of the flaws. The basic principle of ultrasonic testing is illustrated in Figure 1.8.

Ultrasonic testing method is:

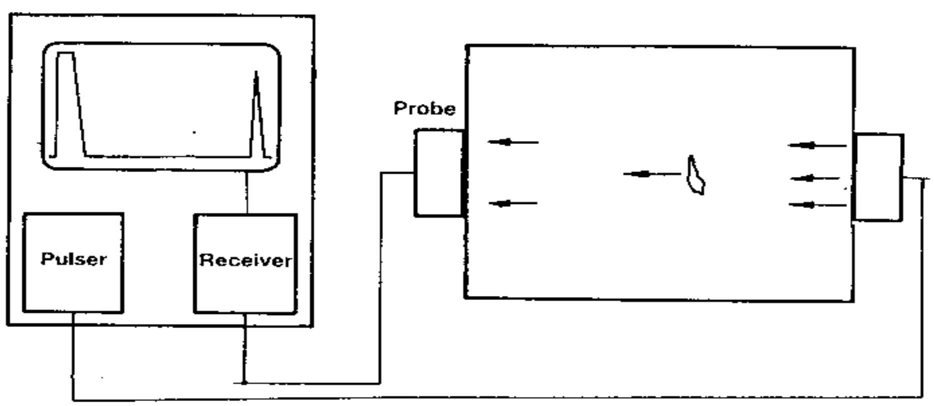
- Mostly used for detection of flaws in materials.
- Widely used for thickness measurement.
- Used for the determination of mechanical properties and grain structure of materials.
- Used for the evaluation of processing variables on materials.

**Some of the advantages of ultrasonic testing are:**

- It has high sensitivity which permits detection of minute defects.
- It has high penetrating power (of the order of 6 to 7 metres in steel) which allows examination of extremely thick sections.
- It has a high accuracy of measurement of flaw position and size.
- It has fast response which permits rapid and automatic inspection.
- It needs access to only one surf ace of the specimen.




*Pulse echo method.*




*(a) Through transmission method.*

*Figure 1.8: Basic components of an ultrasonic flaw detection system*

**Some of the limitations of this method are:**

- Un-favorable geometry of the test specimen causes problems during inspection.
- Inspection of materials having undesirable internal structure is difficult.
- It requires the use of a couplant.
- The probe must be properly coupled during scanning.
- Defect orientation affects defect detectability.
- Equipment is quite expensive