Most penetrants are organic compounds that may cause dermatitis Skin contact should be avoided and personal hygiene strictly followed

Ultraviolet equipment should be effectively shielded or filter lenses of the correct shade should be worn (see Chapter 36, "Personal Protective Equipment")

Ultrasonics

Ultrasonic waves (above the audible range of 20,000 c (cycles per second) are created by an electronic generator which supplies high-frequency voltage to a piezoelectric crystal

Three basic ultrasonic methods have been developed the reflection method, the through-transmission method, and the resonant-frequency method

In the *reflection method*, that portion of the ultrasonic beam which strikes a flaw or discontinuity in the material is reflected, the rest of the beam goes on The piezoelectric crystal transducer radiates these waves through a coupling medium into the material and also acts as a receiver to detect reflections, which are then picked up by an electronic amplifier and applied to a cathode ray oscilloscope on which the time intervals between the outgoing and the incoming waves can be measured

In the *through-transmission method*, a beam or wave is directed through a piece of material If a flaw or discontinuity is encountered, the energy is absorbed, and the beam or wave does not get through Since fluids such as water, oil, and glycerin give better coupling than air, they are generally used as the coupling medium between the transmitter, material, and receiver In some applications, however, air or other gases can be used

The *resonant-frequency method* is used primarily to measure the thickness of material The equipment consists of an electronic oscillator which supplies voltage of ultrasonic frequencies to a piezoelectric transducer The transducer is pressed into contact with the part to be tested and induces longitudinal vibrations in the test piece under the area of contact One type of resonance instrument displays the thickness reading on a cathode ray tube as a pip on a calibrated scale.

Equipment should be disconnected from the power supply and the condensers discharged whenever a cathode ray tube must be adjusted or removed

Triboelectric method

The triboelectric method is used to detect minute quantities of current generated when two metallurgically or chemically unlike conductors are moved into frictional contact If the conductors are alike, no current will be generated

The equipment consists of a control unit and a portable sorting head connected by means of a cable The sorting head contains all the main controls for actuating the test and is designed for one-handed operation This method is designed to sort and identify metal parts of not more than four alloy types

Electromagnetic methods

Two types of electromagnetic tests are currently being used in industry magneto-inductive and eddy current A third type, employing radar frequency, is also being used, but only to a limited extent

The *magneto-inductive method* utilizes variations in the permeability of magnetic materials to create variations in a pickup coil or probe

The second type of electromagnetic testing utilizes AC in a coil or probe to induce *eddy current* into the part being tested Defects and variations in properties or geometry cause changes in the strength and distribution of the eddy current. Readout is presented on a cathode ray tube, on a meter, by audible or visible alarm, or by a combination of these methods

Radar frequency methods use high-frequency radar waves to measure the electromagnetic properties of thin coatings and surface layers of material To make such tests, a wave guide or cavity oscillator is coupled to the test object, high-frequency waves are then reflected from the object, providing an indication of the surface electrical resistance and of the thickness of the nonconducting coatings

In some radar-frequency testing installations, operators have been burned internally when they passed between the object being tested and the testing device Special regulations should be formulated and enforced, and barriers should be set up to prevent operators and other workers from entering