form of ultrasonic pulses. Cracks and areas of corrosion in the stressed airframe structure emit sound waves that are registered by the sensors. These acoustic emission bursts can be used to locate flaws and to evaluate their rate of growth as a function of applied stress. Acoustic emission testing has an advantage over other NDI methods in that it can detect and locate all of the activated flaws in a structure in one test. Because of the complexity of aircraft structures, application of acoustic emission testing to aircraft has required a new level of sophistication in testing technique and data interpretation.

## Magnetic Particle Inspection

Magnetic particle inspection is a method of detecting invisible cracks and other defects in ferromagnetic materials, such as iron and steel. It is not applicable to nonmagnetic materials. In rapidly rotating, reciprocating, vibrating, and other highly-stressed aircraft parts, small defects often develop to the point that they cause complete failure of the part. Magnetic particle inspection has proven extremely reliable for the rapid detection of such defects located on or near the surface. With this method of inspection, the location of the defect is indicated and the approximate size and shape are outlined.

The inspection process consists of magnetizing the part and then applying ferromagnetic particles to the surface area to be inspected. The ferromagnetic particles (indicating medium) may be held in suspension in a liquid that is flushed over the part; the part may be immersed in the suspension liquid; or the particles, in dry powder form, may be dusted over the surface of the part. The wet process is more commonly used in the inspection of aircraft parts.

If a discontinuity is present, the magnetic lines of force are disturbed and opposite poles exist on either side of the discontinuity. The magnetized particles thus form a pattern in the magnetic field between the opposite poles. This pattern, known as an "indication," assumes the approximate shape of the surface projection of the discontinuity. A discontinuity may be defined as an interruption in the normal physical structure or configuration of a part, such as a crack, forging lap, seam, inclusion, porosity, and the like. A discontinuity may or may not affect the usefulness of a part.

### *Development of Indications*

When a discontinuity in a magnetized material is open to the surface and a magnetic substance (indicating medium) is available on the surface, the flux leakage at the discontinuity tends to form the indicating medium into a path of higher permeability. (Permeability is a term used to refer to the ease that a magnetic flux can be established in a given magnetic circuit.) Because of the magnetism in the part and the adherence of the magnetic particles to each other, the indication remains on the surface of the part in the form of an approximate outline of the discontinuity that is immediately below it. The same action takes place when the discontinuity is not open to the surface, but since the amount of flux leakage is less, fewer particles are held in place and a fainter and less sharply defined indication is obtained.

If the discontinuity is very far below the surface, there may be no flux leakage and no indication on the surface. The flux leakage at a transverse discontinuity is shown in *Figure 10-26*. The flux leakage at a longitudinal discontinuity is shown in *Figure 10-27*.

### *Types of Discontinuities Disclosed*

The following types of discontinuities are normally detected by the magnetic particle test: cracks, laps, seams, cold shuts, inclusions, splits, tears, pipes, and voids. All of these may affect the reliability of parts in service.

Cracks, splits, bursts, tears, seams, voids, and pipes are formed by an actual parting or rupture of the solid metal. Cold shuts and laps are folds that have been formed in the metal, interrupting its continuity.

Inclusions are foreign material formed by impurities in the metal during the metal processing stages. They may consist, for example, of bits of furnace lining picked up during the melting of the basic metal or of other foreign constituents.

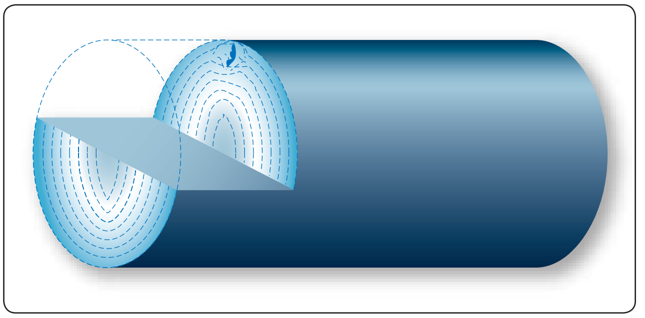

**Figure 10-26.** *Flux leakage at transverse discontinuity.*

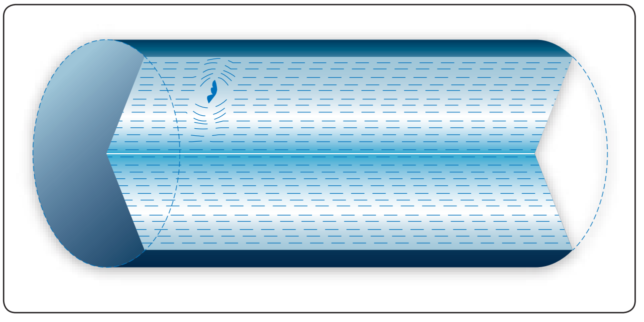

**Figure 10-27.** *Flux leakage at longitudinal discontinuity.*