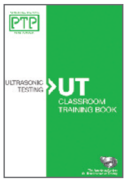

Ultrasonic Testing Classroom Training Book second edition

Errata – second printing 04/16

The following text correction pertains to the second edition of the *Ultrasonic Testing Classroom Training Book*. Subsequent printings of the document will incorporate the corrections into the published text.

The attached corrected page applies to the second printing 04/16. In order to verify the print run of your book, refer to the copyright page. Ebooks are updated as corrections are found.

Page	**Correction**
61	The figure 14 caption “Spatial resolution” should be “Near surface resolution.”
127–128	At the bottom of page 127 and top of 128, the two instances of “sound velocity” should be “acoustic impedance.”

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Even transducers of the same size, frequency, and material by the same manufacturer do not always produce identical indications on a given display screen. A transducer's sensitivity is rated by its ability to detect a given size flat-bottom hole at a specific depth in a standard reference block.

Resolution

The *resolution* or *resolving power* of a transducer refers to its ability to separate the echoes from two reflectors close together in time; for example, the front-surface echo and an echo from a small discontinuity just beneath the surface. The time required for the transducer to stop *ringing* or vibrating after having been supplied with a long voltage pulse is a measure of its near-surface resolving power. Long tails or wave trains of sound energy from a ringing transducer cause a wide, high amplitude echo from all reflectors in the sound path, including the entry surface.

As illustrated in Figure 14(a), a small discontinuity just beneath the surface is easily masked by the ringing signal of the initial pulse. Figure 14, in general, shows that even reflectors at a greater distance are not displayed distinctly due to the same issue of too long a pulse length applied to the transducer. Figure 15 displays additional examples of poor versus good resolution in the far field.

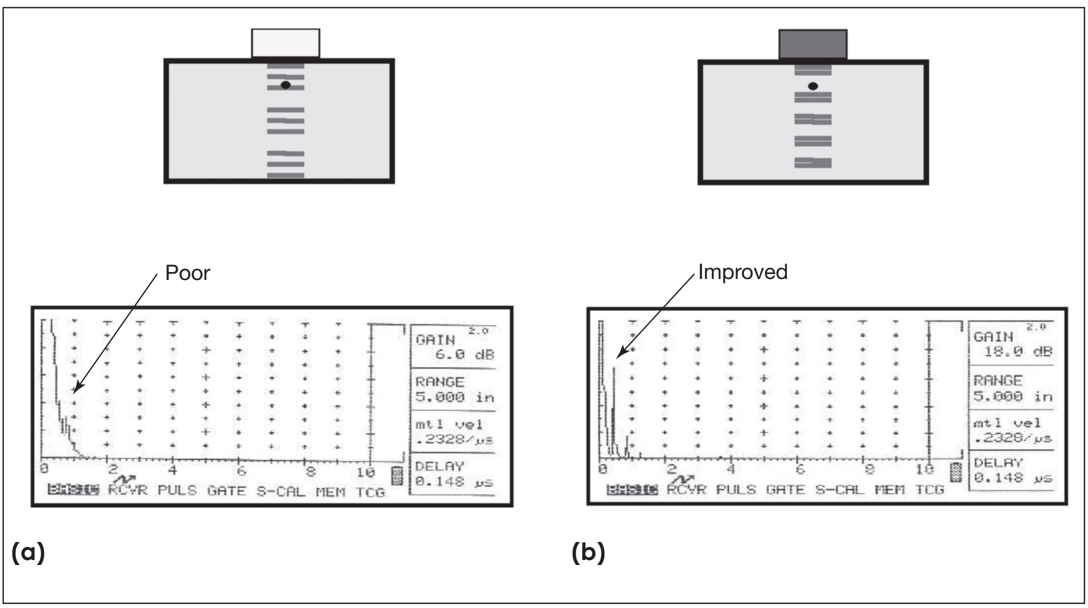

Figure 14: Near surface resolution: (a) poor resolution; (b) improved signal.

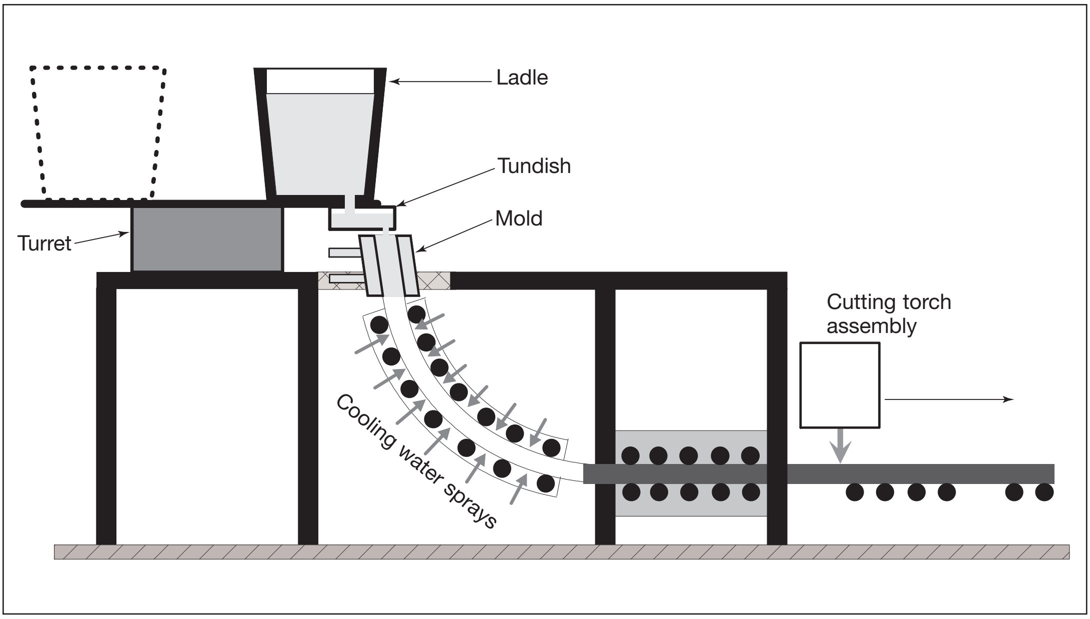

Figure 2: Continuous caster.

through the curved series of rollers, as shown. After the dummy bar passes through the final set of rollers, it is removed, leaving a continuous length of new steel extending from the mold to the cutting area beyond the last set of rollers.

During the entire casting process, the steel is sprayed with water to control the *solidification process*. As with ingots, the solidification process occurs from the outside inward, so the steel starting down the caster has a solid outer shell with a molten core. As the process continues, the steel solidifies completely and is rolled to the desired thickness as it passes through the final set of rollers. Once the steel exits the final rollers, a cutting torch system clamps to the new slab, cutting it to the desired length.

Discontinuities in Steel

Inherent discontinuities in the ingot-casting and continuous-casting processes are similar to those of other castings and include segregation, nonmetallic inclusions, shrinkage voids, cracks, and pipe.

Segregation occurs when individual elements either are not fully mixed in the heat or separate during the cooling process. Segregated elements do not have the same sound velocity as the parent metal, but unless the areas of segregation are relatively large, they cannot be easily detected ultrasonically. *Nonmetallic inclusions*, such as slag and other contaminants, are generally larger in size than segregations and can be more easily detected using ultrasonic testing.

Shrinkage voids and *cracks* are both good reflectors of sound and can be detected ultrasonically much more readily than segregation due to the sharp edges of the resulting voids and the large change in acoustic impedance between the void and the metal. Because the entrapped gas tends to form rounded tubes with smoother sides, *pipe* does not result in as sharp a reflector as *shrinkage* and *shrink cracks*. But because of the change in acoustic impedance between the gas and the metal, it too can be easily found ultrasonically.

Slabs and Billets

Because of their size, *slabs* and *billets* must be processed to reduce them to a manageable thickness. This is done in hot-rolling mills where the heated slab or billet is repeatedly passed through correspondingly tighter rollers. As the slab or billet is rolled, it increases in length, resulting in a longer, thinner shape. During this process, the metal grains in the steel are elongated in the direction of rolling, as are most discontinuities. Depending on the intended use of the steel, the product may be cut to length between rolling passes to make handling more manageable.

Plate and Sheet

The rolling process permits slabs and billets to be reduced in thickness into plates, and, if the process is continued, the plates can be rolled into *sheets*. Since the thinning process continually elongates the product form, rolling sheet steel results in a very long product. To reduce the physical size of the forming area and to make handling easier, the sheet is often formed into a coil. These coils can then be transported, stored for additional forming processes, or sent back through the same rollers set at closer tolerances to further reduce the thickness of the sheet. During the rolling operation, several types of process discontinuities can occur, as shown in Figure 3.

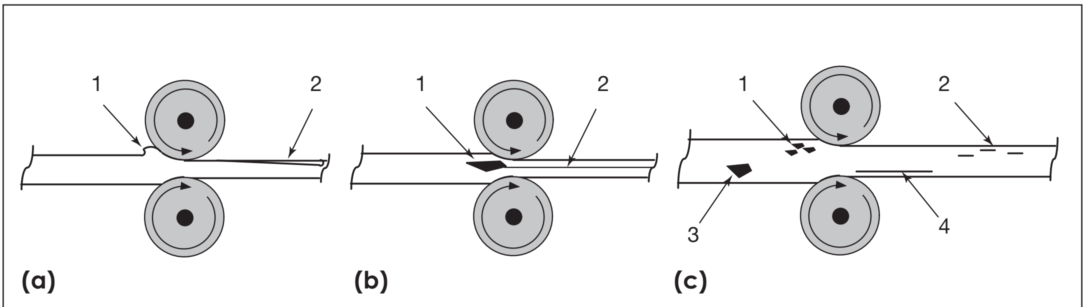

Figure 3: Rolling discontinuities: (a) rolling lap; (b) centerline delamination; (c) segregation and inclusion laminations.

Discontinuities in Plate and Sheet

One such discontinuity is a *rolling* or *surface lap*, shown in Figure 3(a). This occurs when some of the metal humps up in front of one of the rolls (1) and then is folded back over the unrolled sheet and pulled through the rollers. This results in an elongated sliver of steel that has been pressed back into the surface of the plate (2). The lap may be