SINGLE-ELEMENT TRANSDUCERS (LONGITUDINAL MODE TRANSDUCERS)

Single-element transducers The transducers that we consider here are those connected with NDT of structural materials and medical ultrasound. In many ways the transducers used in these fields are quite similar, and there has been an explosion in their variety and availability in the last decade.

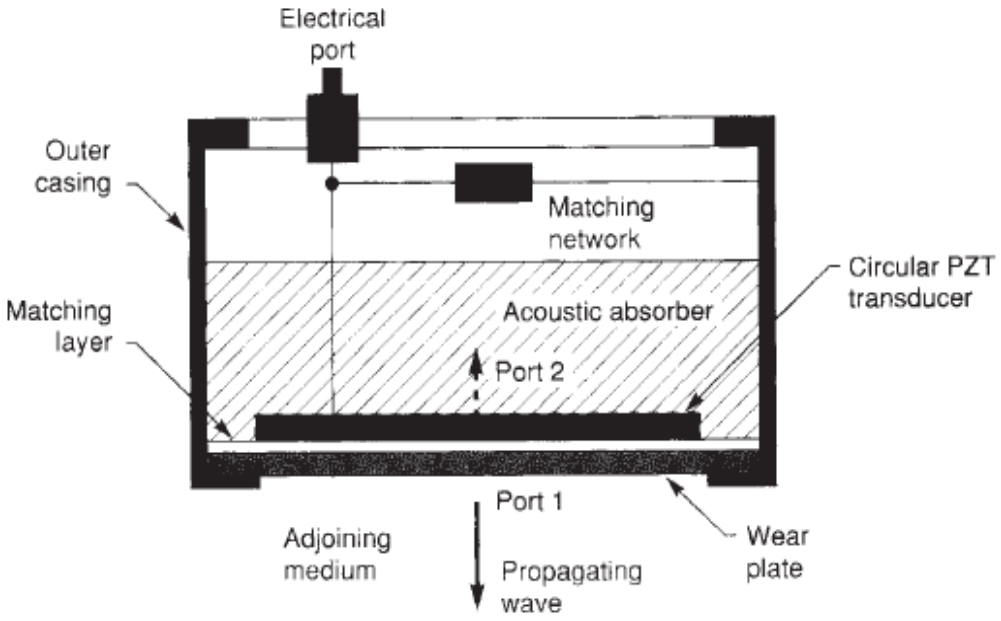

Fig 5.20 A single-element longitudinal mode transducer.

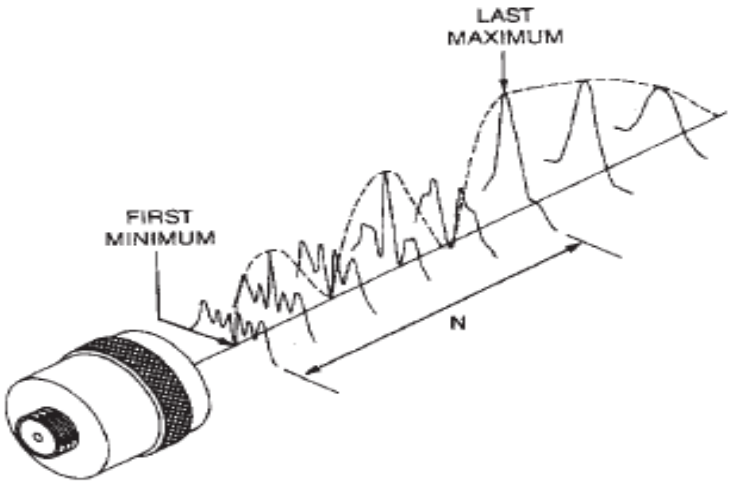

Fig 5.21 The on-axis acoustic pressure field of a single-element transducer

The frequencies employed in NDT and medical ultrasound cover the range from 100 kHz to 50 MHz. A single-element transducer is shown in Fig. 5.20. The active element, a piezoelectric ceramic, is poled in the thickness direction. The backing has an impedance ZB, and absorbs some or all of the energy from one face. The wear plate sometimes includes a quarter-wave matching layer to optimize the energy transfer of the propagating wave into the adjoining medium. Figure 5.21 shows the on-axis (dashed line) and the transverse ultrasonic fields of a circular piston transducer. The on-axis acoustic pressure field is divided into two regions, the near field, or Fresnel region and the far field, or Fraunhofer region. The extent of the Fresnel region is indicated by N. In this region the field goes through a series of maxima and minima and ends with a last maximum, which is considered as the effective focus of the transducer, 44.

The distance N is given by

$$N = \left(\frac{D^2}{4\lambda} - \frac{\lambda}{4}\right) \tag{5.19}$$

with D=diameter of transducer element
λ=wavelength in propagation medium ($=V_M/f_0$)

where f_0=excitation frequency
V_M=propagation velocity in the medium

In the transverse direction, the acoustic beam spreads as one moves away from the transducer face and its intensity drops. Focusing decreases the beam diameter and increases the intensity of the beam. Focusing can be achieved by bonding an acoustic lens to the PZT transducer or by using a spherically shaped PZT transducer. This increase augments the sensitivity of the transducer to locate small targets. In the pulse-echo mode, the –6-dB beam diameter at the effective focus is

$$\text{Beam diameter} = \frac{1.028FV_M}{f_0 D} \tag{5.20}$$

Where F is the effective focal length in the medium.

Single-element rectangular transducers can be assembled as a linear phased array transducer. In this configuration, the acoustic beam can be deflected in a sector scan format and focused by using delayed excitation signals.

Source: http://mediatoget.blogspot.in/2012/06/single-element-transducers-longitudinal.html