KREP

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KARNATAKA RADIOLOGY EDUCATION PROGRAM

TRANSDUSER

An ultrasound transducer converts electrical energy into mechanical (sound) energy and back again, based on the piezoelectric effect. It is the hand-held part of the ultrasound machine that is responsible for the production and detection of ultrasound waves.

A transducer consists of five main components:

1. **Crystal/Ceramic Element With Piezoelectric Properties Usually Lead Zirconate Titanate (Pbzt)**
   - **May Consist Of A Single Element Or Be A Broadband Transducer With Multiple Elements**
   - **Piezoelectric Polyvinylidene Fluoride (PVDF) Is Useful In Those High Frequency, High Bandwidth Transducer That Needs Focusing To A Certain Region .**
   - **PVDF Also Has Low Acoustic Impedance Similar To Water, Thus Is Useful In Making Ultrasound Pulses With Good Temporal Resolution .**
   - **Element Thickness Is Determined By What Resonance Frequency Is Desired Equal To Half The Wavelength**
   - **A Thicker Element Produces A Lower Frequency Oscillation While A Thinner Element Produces A Higher Frequency Oscillation**

2. **Positive And Ground Electrodes On The Faces Of The Element This Allows For Electrical Connection**
   - **Positive Electrode Is In The Back Of The Element**
   - **Ground Electrode Is On The Front Of The Element3**

3. **Damping (Backing) Block**
   - **Adhered To The Back Of The Crystal (Behind The Positive Electrode)**
   - **Absorbs Ultrasound Energy Directed Backward And Attenuates Stray Ultrasound Signals From The Housing 1**
   - **Dampens The Resonant Vibrations In The Element Which Creates A Shorter Spatial Pulse Length; This Allows For Better Axial Resolution For Imaging Of Organs And High Bandwidth To Receive Reflected Echoes**

4. **Matching layer**

Interface between the transducer element and the tissue allows close to 100% transmission of the ultrasound from the element into the tissues by minimizing reflection due to traversing different mediums (acoustic impedance) achieves this by consisting of layers of material with acoustic impedances that are between soft tissue and transducer material may consist of one or multiple layers each layer is one-quarter wavelength thick

5. **Housing**
    - **Electrical Insulation And Protection Of The Element**
- **Includes A Plastic Case, Metal Shield And Acoustic Insulator**

Ultrasound beam production

Ultrasound transducers typically consist of 128-512 piezoelectric elements arranged in linear or curvilinear arrays. Each element is individually insulated.

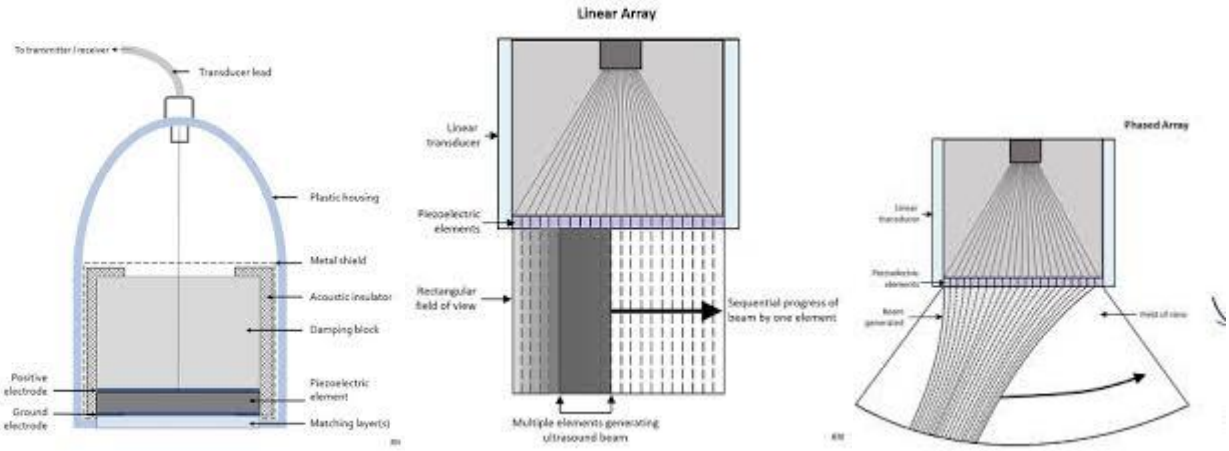
Transducers can produce an ultrasound beam by mechanical or electronic means. In mechanical transducers, either oscillating or rotating wheels is used. In electronic transducers, there are two ways to generate ultrasound beam3:
linear array (also called sequential array)
phased array

Ultrasound transducers that produce images via linear array typically contain 256-512 elements, making them the largest assembly. Each element produces a scan line that makes up the ultrasound image.
Multiple adjacent elements combine to produce an ultrasound beam that is emitted at 90 degrees to the transducer head. Multiple elements (5 to 20) work as an individual unit in order to achieve a wider aperture and more useful beam shape. The ultrasound beam produced moves sequentially along the transducer one element at a time to obtain the image. Received ultrasound echoes are interpreted as corresponding to the center element of the beam.
Linear transducers produce a rectangular field of view with uniform beam density throughout. They are useful for imaging shallow structures and small parts.

A phased array ultrasound transducer is typically 2-3 cm long, consisting of 64-128 elements. It is a smaller assembly than a sequential array and can be either linear or curvilinear.
A sector field of view is produced by all elements firing to create a single waveform. Small delays in element firing allow for electronic field steering and focusing without moving the ultrasound probe. All elements will be fired multiple times with different degrees of steering to create an image. Echoes are detected by all elements and entered into an algorithm to form the image.

Line density decreases at the bottom of the image. The sensitivity of the image reduces at extremes of steering and lateral resolution is best in the center of the field of view due to a larger effective aperture.

The benefits of a phased array include; a small faced transducer allowing for imaging in small spaces and being able to change the focus of the ultrasound beam.



Compiled by: Dr Pravin G U Principal,Prof.RadioDiagnosis .

Sri Chamundeshwari Medical college Hospital & Research Institute,Channapatna,Karnataka.

REF : Christensen's Physics of Diagnostic Radiology,Radiopedia.

Christensen's physics of diagnostic radiology