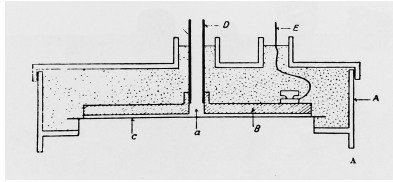


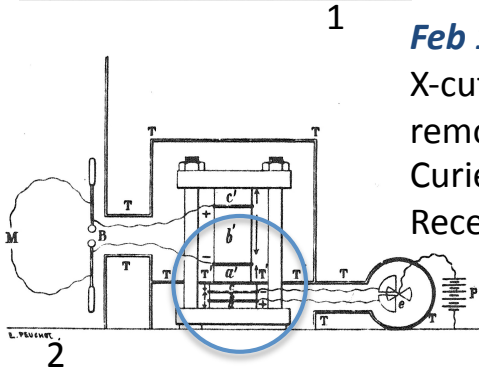
Discovery, design, development and delivery of Langevin's quartz sandwich transducer

Francis Duck bathduckf@gmail.com

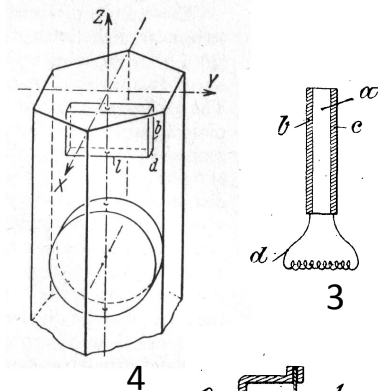
This poster illustrates the design sequence used by Paul Langevin (1872-1946), between February 1917 and February 1918, to develop the first ultrasonic pulse-echo transducer.



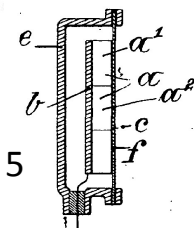
Feb 1917: Mica capacitor transmitter operating at **100 kHz**



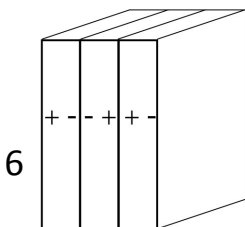
Feb 1917: 25x25mm X-cut quartz slice removed from the Curies' apparatus. Receives at **100 kHz**



Mar 1917: 15 mm thick X-cut quartz slice, 10x10cm, cut from large crystal. Electrically tuned receiver at **100 kHz**

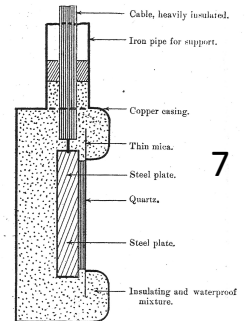


May 1917: The same crystal exhibits piezoelectric resonance at about **180 kHz** for transmission and reception

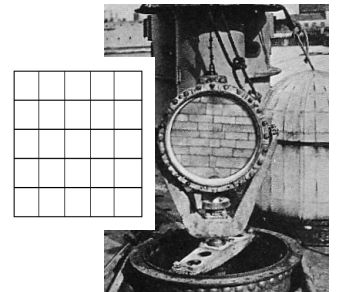


June 1917: 3 quartz slices bonded together resonate at **60kHz**

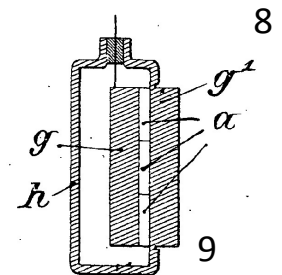
July 1917: Single $\lambda/4$ quartz slice bonded to $\lambda/4$ steel retains resonance. This design was used for subsequent UK asdics



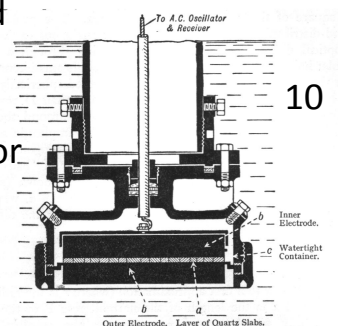
Sept 1917: Mosaic of square or rectangular elements permit the construction of larger, lower-frequency transducers



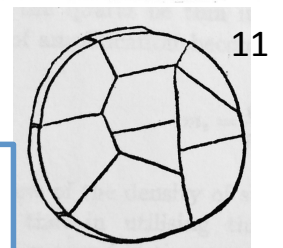
Dec 1917: Mosaic of thin quartz slices mounted between $\lambda/4$ steel plates. Resonant at **40 kHz**



Feb 1918: Air-backed 20x20cm square quartz sandwich successfully tested for submarine detection at **40 kHz**



Early 1920s: Circular 'crazy-paving' mosaic minimises diffraction effects



Picture credits

Curie J&P. J Phys 1889 [2]
Langevin P. BIR Report 1917 [1]
Langevin P. Patent 1918 [3,5,9]
Boyle R. BIR Report 1917 [7]
Hackmann W. HMSO 1984 [8,10]
Langevin P. Hydr Rev 1924 [11]
Heidemann E. Ultraschall 1939 [4]

Langevin proposed the use of ultrasound for medical applications in 1918. All initial therapeutic and diagnostic uses of MHz ultrasonics used quartz, until the introduction of ferroelectric ceramic materials from about 1950.