QUARTZ RESONATOR PRESSURE TRANSDUCER FOR GEOTHERMAL WELL LOGGING*

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Sandia Laboratories is developing a quartz resonator pressure transducer for geothermal well logging applications.[1] The resulting pressure tool (Figure 1) will be designed for use in wells at up to 275°C (527°F) and pressure up to 52 MPa (7500 psi).

The transducer element consists of a rotated X-cut quartz resonator disc[2] which controls the frequency of an oscillator circuit (see Figure 2). As stress is applied around the circumference of the disc, the mechanical resonant frequency is lowered. The end caps isolate the resonator surface from the pressure coupling fluid. The crystallographic orientation of the quartz transducer is optimized for specific applications to minimize the effect of small temperature changes about the operating temperature. This is done by operating at the turning point where the slope of the frequency vs. temperature curve is zero (see Figure 3). Multiple curves are shown for different crystallographic orientations. By selecting the appropriate orientation, the transducer can be optimized for operation at any specific temperature. For optimum resolution and accuracy the transducer can be isolated from the environmental temperature and maintained at the turning point temperature by an oven.

An identical transducer with a slightly higher resonant frequency is isolated from the pressure. It is used as a reference and is thermally coupled to the pressure transducer to provide tracking over small temperature changes. The two oscillator outputs are mixed and the resulting difference frequency is transmitted up the cable for pressure readout. A block diagram of the electronics is shown in Figure 4.

REFERENCES

1. EerNisse, E.P., "Quartz Resonator Pressure Gauge: Design and Fabrication Technology", SAND 78-2264, Sandia Laboratories, January 1974.

2. EerNisse, E.P., "Rotated X-Cut Quartz Resonators for High Temperature Applications", Proc. 32nd Annual Symposium on Frequency Control, 1978.

DISCLAIMER

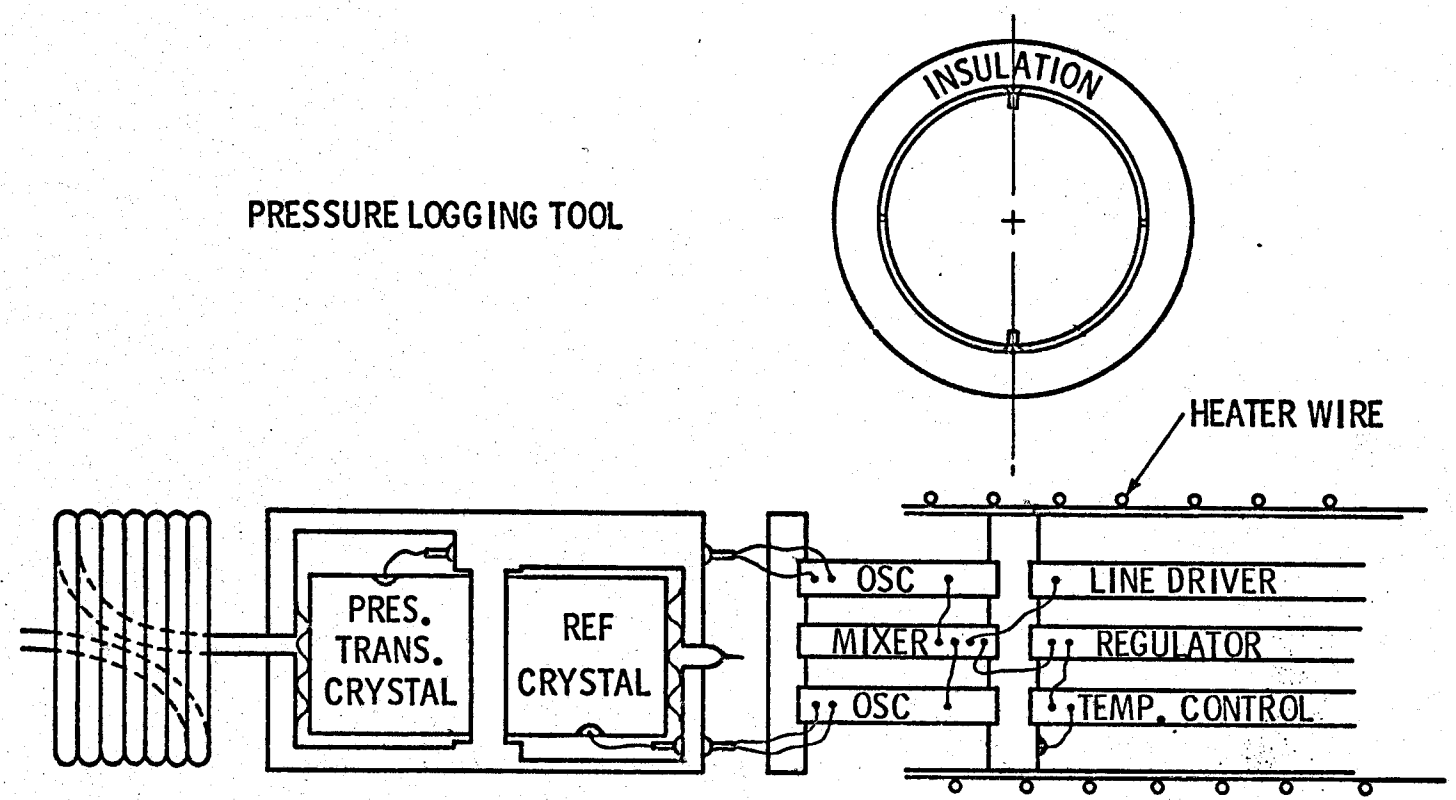
PRESSURE LOGGING TOOL
INSULATION
HEATER WIRE
PRES.
TRANS.
CRYSTAL
REF
CRYSTAL
OSC
MIXER
OSC
LINE DRIVER
REGULATOR
TEMP. CONTROL

Figure 1.

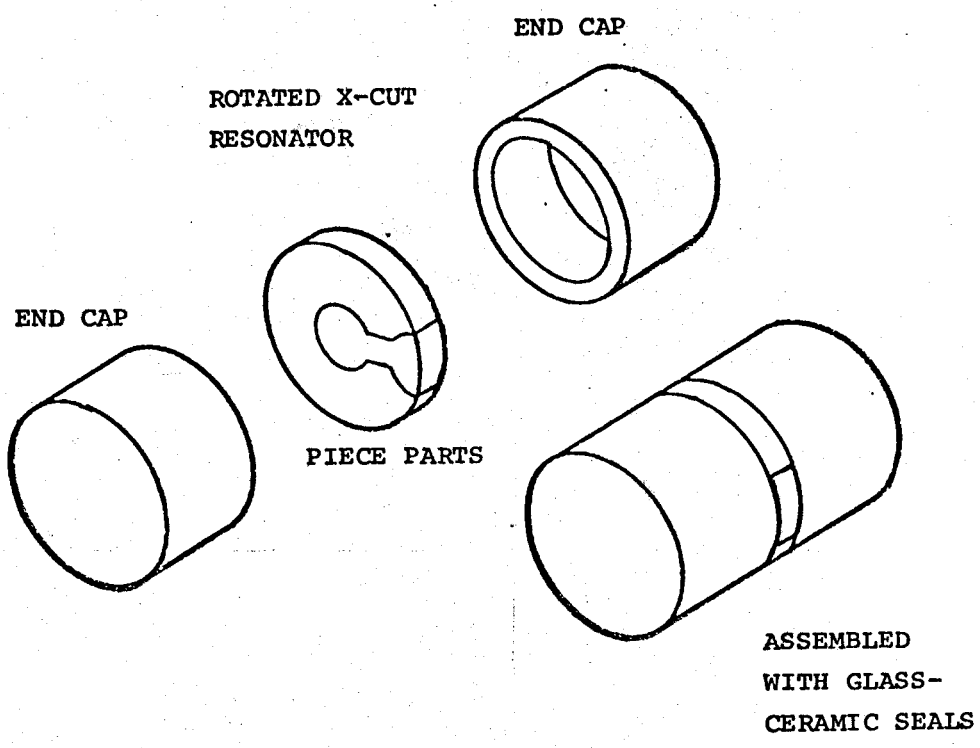

Figure 2. QUARTZ RESONATOR PRESSURE GAUGE
For Geothermal Well Logging

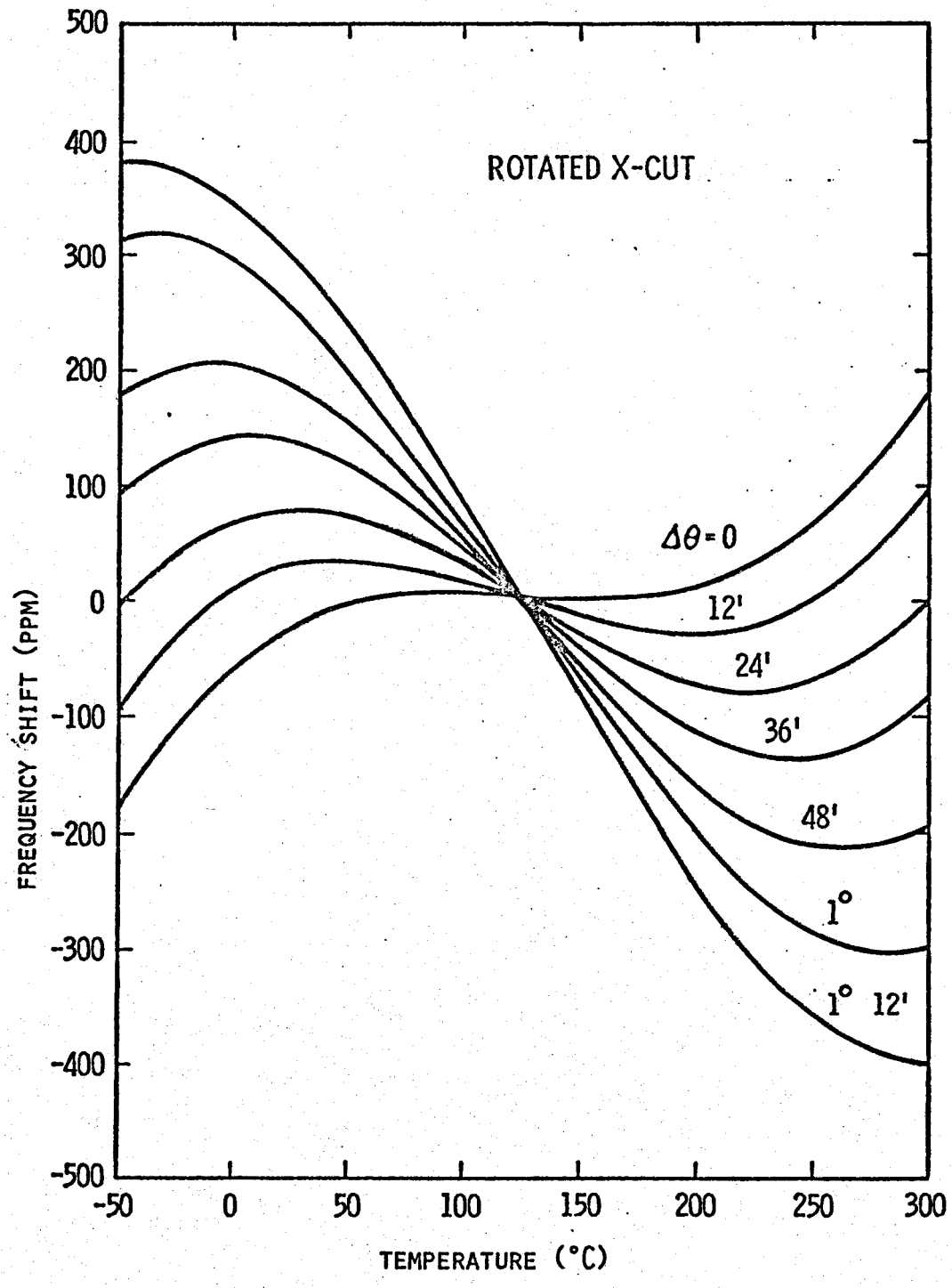

Figure 3. Temperature vs. Frequency θ

SHEAR MODE PRESSURE TRANSDUCER

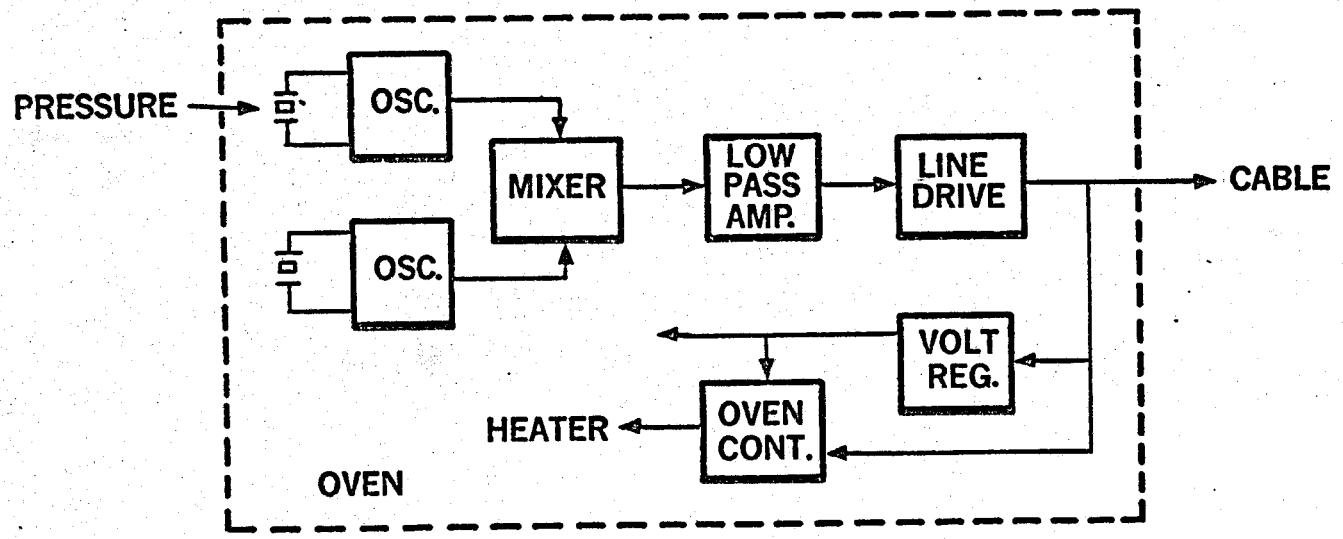

Figure 4.