AEC-NASA TECH BRIEF

Induction Probe Determines Levels of Liquid Metals

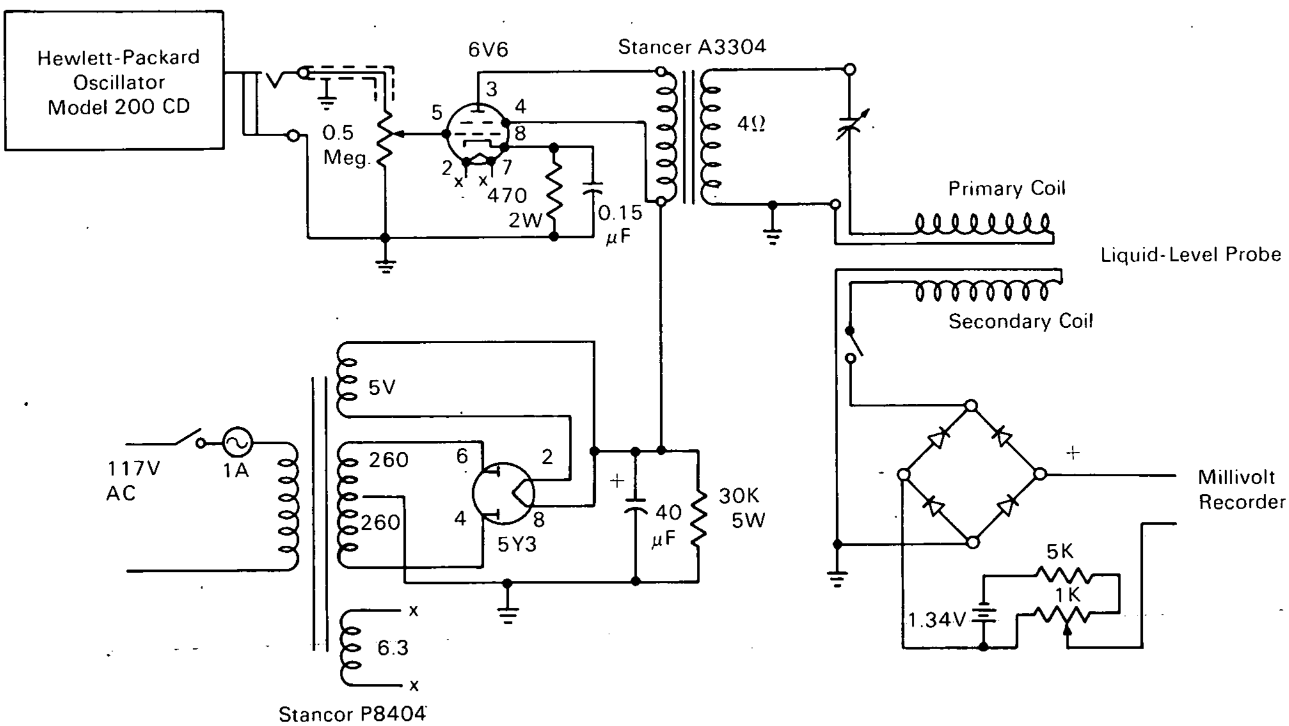

Fig. 1. Circuit diagram of the electronic equipment

The problem:

To develop a liquid-level probe for use in pyrochemical processes for the recovery of spent reactor fuel. In these processes, liquid metals and molten salts serve as the solvents for the fuel materials.

The solution:

An instrument, employing a mutual-inductance coil, that accurately and reliably measures liquid levels in a variety of liquid metals at elevated temperatures. This mutual-inductance probe locates the interfaces between gas and liquid metal and liquid salt and liquid metal.

The probe is a bifilar coil of nichrome wire on an alumina form contained in a well of type-304 stainless steel or ceramic. A high-frequency voltage supplied to one winding induces a voltage in the second winding that is inversely relaxed to the depth of liquid surrounding the coil. Probes, about 5 and 14 inches long,

(continued overleaf)

were calibrated in liquid cadmium, bismuth, and sodium at temperatures between 200° and 700°C. The output signal was affected only slightly by the metal's resistivity, but it was influenced by the temperature.

The device has several advantages over other means of measuring liquid levels of corrosive fluids at high temperatures. It is compact, rugged, reliable, and reasonably accurate. For a calibrated probe, the average deviation in measured liquid level is about 3% of the length of the windings. The instrument is well adapted to operations in remotely operated facilities because it has no moving parts and can be easily replaced.

How it's done:

The probe consists of two coils of 20-gage nichrome wire wound in the grooves of an alumina form that is contained in a protective well. The grooves hold the wires stationary and are deep enough to allow for thermal expansion of the wire without the wire contacting the containment well. The lead wires terminating at the bottom of the probe are drawn through two holes in the center of the alumina form and are protected from contact with the bottom of the well by a protrusion from the form. The four wires leading from the top of the form are protected by a four-hole alumina tube extending to the top of the well.

The fluctuating magnetic field, created by the alternating current in the primary coil of the probe, induces eddy currents in any nearby conductor, including the secondary coil, the well, and the liquid surrounding the well. The presence of electrically conducting material near the coils decreases the mutual inductance between the coils, and thus decreases the voltage induced in the secondary coil.

The high-frequency signal is generated by an audio oscillator with output frequencies ranging from 5 to 600,000 Hz and a maximum signal output of 10 v root-mean-square (Fig. 1). The oscillator output is amplified by a class-A power amplifier and fed to the primary winding of the coil. The signal induced in the secondary winding is rectified and then measured by a millivolt recorder.

Changes in the mutual conductance of the coil, caused by variations of the eddy-current strength in the surroundings of the coil, are detected as change in the voltage induced in the secondary winding. The output signal is sensitive to the voltage supplied to the primary winding, and to changes in the electrical resistance of the coil and lead wires. The instrument is zeroed at a standard liquid level and temperature, and liquid depths are then determined by changes in the output signal from this standard. Because of the stability of the circuitry the zero needed setting only once with a single probe during an experiment lasting 1,000 hours.

Reference:

For more detail see T. R. Johnson, F. G. Teats, and R. D. Pierce, in *ANL-7153* (Argonne National Laboratory, May 1967) (available from CFSTI, Springfield, Va. 22151, at $3.00—microfiche, $0.65); *Nuclear Applic.* **4**, 47 (Jan. 1968).

Notes:

1. This information may interest persons and organizations concerned with processing of liquid metals.
2. Inquiries may be directed to:

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Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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