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AN INTEGRATED CIRCUIT CONTROL SYSTEM FOR THE PEWEE REACTOR

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ABSTRACT

A control system utilizing digital and linear integrated circuits was developed for low power testing of the Rover reactor, PEWEE. The control rod actuator employs electric stepping motors which are geared down to provide 0.01° resolution to the reactor rotary control rods. The system was designed to provide precision positioning capability for the control rods and features operating ease and versatility which minimizes the time and effort required to execute experiments.

SUMMARY

The Pewee nuclear reactor is similar to a Rover propulsion reactor but reduced in size. Pewee evolved as a more practical reactor size for fuel element development testing. Its physical configuration is similar to the Rover Propulsion Kiwi reactors and the more recent Phoebus reactors. The Pewee reactor consists of a cylindrical core surrounded by the reflector assembly which contains nine rotary control rods. The rotary rods have an operating span of 180°. Rotation of the neutron absorbing material on the rods toward or away from the core provides control of the reactor power.

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The Pewee reactors are assembled at the Los Alamos Scientific Laboratory and tested at low power levels prior to shipping them to Nuclear Reactor Development Site at Jackass Flats, Nevada, for full power testing. This paper describes the control system used for the low power testing of the Pewee reactors.

The Pewee control system design was based on the characteristics of an electric stepping motor. The motor produces a shaft rotation of 1.80° for each input electrical pulse. Each step is accurate to $\pm 5\%$ and the error is non-cumulative. Control rod position information is obtained by counting algebraically the number of electrical pulses which step the motor.

In order to provide versatility and safety, two types of actuators are used to position the nine control rods. The first type, the "slow rod actuator," is used to position seven of the control rods in a deliberately slow fashion for safety reasons. Steps of 0.01° are produced by means of a 180:1 gear reduction, and the rate is limited to $0.70^\circ/\text{sec}$. The second type, the "fast rod actuator," is used to make rapid changes in reactivity as required during fast period measurements. The two fast rod-actuators are geared to produce 0.1° steps and are limited to $20^\circ/\text{sec}$.

A fail-safe scram system is provided in the form of an electrically-operated clutch, which decouples the control rod from the gear train and allows a spring to scram the rod. Figure 1 shows one of the slow rod-actuators.

The digital logic for the control system is performed with DTL integrated circuits. Wyle series M logic modules were used where possible and supplemented with in-house designed and fabricated cards as required.

Each of the nine control rod circuits contains a pulse generator, a synchronized gating, stepping motor logic, a motor-driver and a bi-directional counter with zero detection and equal comparator. Details of these circuits will be included in the final paper.

The Pewee control console is shown in Fig. 2. The three top chassis contain the electronics for controlling the nine actuators. They also contain the bi-directional counters used for obtaining accurate digital rod position information as well as the analog rod position meters. The meters provide reliable rod position information from a potentiometer geared to the control rod shaft. Shown below the digital counter readout are the digital thumb switches. They provide a set-point which the rod can be rotated to. When the counter equals the thumb switch setting, the control rod will stop. The two push buttons on each side of the thumb switch are the individual pulse rate (slow and fast) buttons used to position that particular control rod.

The bottom chassis contain the common demand controls and counter. It is used for group positioning the control rods. The left portion of the chassis contains the power control circuitry which features a novel divider circuit. The divider is used to maintain a constant loop gain over a wide range of low power operation. The bottom row of lamps are

indicators for the power supply monitor circuit. If any power supply output becomes too low or too high the rods will be scrambled and an indicator lamp will light.

Figure 3 shows the bottom chassis pulled out to illustrate the drawer construction. Each drawer contains logic cards, 5 volt power supply for the logic cards and a 170 volt power supply for the nixie tubes.

FIGURE 1

FIGURE 2

FIGURE 3