Portable Frequency Standard

A SMALL, compact frequency standard that requires only periodic connection to a commercial power line has been developed at the Boulder Laboratories of the Bureau. The standard was devised by A. H. Morgan of the NBS radio standards laboratory under the sponsorship of the U. S. Army Signal Corps.

Adapted for use in this unit is the principle of the latent-heat stabilization method for controlling enclosed-space temperature, developed by Robert Alvarez of the NBS Chemistry Division.[1] Using diphenyl at its double-point (about 70° C); i. e., at a temperature where it exists as a mixture of solid and liquid, a temperature stability of a few hundredths of a degree centigrade was obtained. The oscillator stability was ± 1 part in 10^7 over a period of several hours.

bottom of bellows located in the inner compartment. This movement of the bellows closes the microswitch and opens the heater circuit. The heater can be adjusted to operate at varying degrees of temperature by a shaft that controls the height of the upper contact point of the microswitch. Heat losses from the oven are reduced by a heat radiation shield and a vacuum insulation space.

After the oven temperature has been stabilized at the double-point temperature of the diphenyl, the unit may be disconnected from the power source that supplied the initial heat, and operated for several hours on temperature without external power connections.

External controls are provided on the developmental model to adjust the oscillator frequency (coarse and

The portable frequency standard (left) is shown partially disassembled at right. The upper unit is the compartment containing the oscillator and buffer-amplifier. Note heat fins and bellows. The lower can contains the diphenyl. The various nested compartments are shown in exploded view at center.

The instrument is expected to prove valuable for airborne use and in other cases where a stable but portable frequency source is required. Until now, all frequency standards of this precision have been large and bulky and have required continuous connection to a commercial power line.

The apparatus consists of a transistor crystal-controlled oscillator and a two-stage transistor buffer-amplifier which are operated continuously from four small mercury cells contained in the bottom compartment of the standard. All components of the circuit are enclosed in the diphenyl oven which maintains them at a constant temperature.

Surrounding the diphenyl is an electric heating coil controlled by a microswitch. When the diphenyl is heated it increases in volume and presses against the

fine frequency controls): the oscillator tank capacitor for best output voltage; and the oven temperature. An inexpensive, commercial, 1-Mc quartz crystal is used to control the frequency of the oscillator. The output voltage is about 400 mv into a 600-ohm load.

Silicon junction transistors were chosen for the oscillator and amplifier because of their ability to operate at high temperature (up to 150°), whereas germanium transistors cease operation around 80° C. The over-all efficiency of the oscillator and amplifier is around 78 percent (input power from mercury cells is 7 mw and matched load output power is 5.4 mw).

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[1] Constant-temperature oven for quartz crystal oscillator, *NBS Tech. News Bul.* **40**, 59 (*April 1956*).