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Remote Phase Control of Radio Station WWVL

THE standard very-low-frequency 20-kc. emission from the National Bureau of Standards radio station *WWVL* at Sunset, Colorado, has been synchronized with the frequency of a working atomic standard located at the National Bureau of Standards Laboratories in Boulder, Colorado, eleven miles from the transmitter site. The phase-lock loop for this purpose uses a servosystem similar to that described by Looney[1], with the system elements necessarily divided between the two locations. At Boulder Laboratories is located a 20-kc./s. receiver, phase detector, atomic standard and a 50 Mc./s. F.M. auxiliary transmitter for returning error and reference phase signals, by means of duplexing, to a 400 c.p.s. two-phase servomotor with gear reduction which drives a resolver at the transmitter site. The resolver, which is located electrically between the local crystal oscillator and transmitter input, thus corrects the transmitter input phase so as to maintain the transmitted output phase, as received at Boulder Laboratories, in synchronism with the phase of the controlling atomic oscillator. This system therefore corrects for frequency drift of the transmitter control oscillator as well as for changes in phase which in general are known to occur in the transmitter and antenna system (ref. 2 and Watt, A. D., private communication). Comparisons made on a very-low-frequency monitor between the phase of the received 20-kc./s. signal at Boulder Laboratories and that derived from the working atomic standard oscillator show that any uncorrected random phase variations may amount to no more than 0·05 μsec. phase shift so that transmitted phase stability is essentially that of the working atomic oscillator.

From the results of daily comparisons of the controlling atomic oscillator with that of the United States frequency standard[3], daily variations of the frequency of the working atomic standard are of the order of 1 or 2 in 10^{-11}.

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