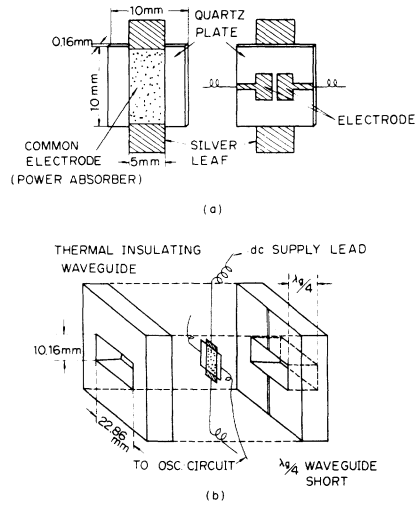

Fig. 1. (a) Quartz thermosensor. (b) Microwave power mount.

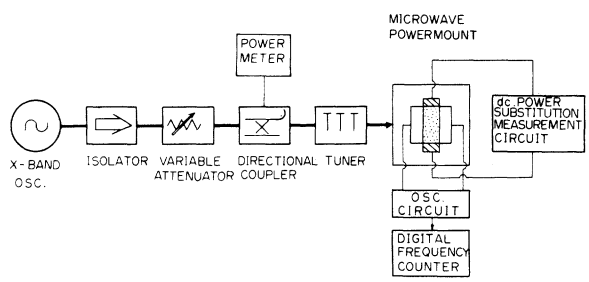

Fig. 2. Arrangement of experimental circuit.

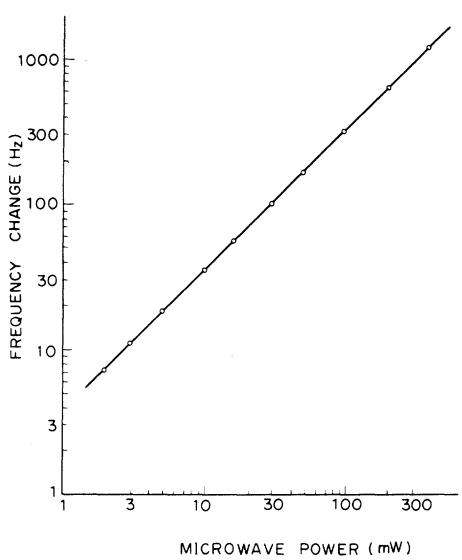

Fig. 3. Frequency change versus microwave input power at 10 GHz.

heat flow coming in and out the $\lambda_g/4$ waveguide short including the crystal.

Fig. 2 shows experimental arrangement of the microwave-power measurement using the quartz-crystal power mount. The VSWR of this mount is 1.2–1.3 over 9–11 GHz. The microwave power fed to the mount is adjusted by a variable attenuator, and is calibrated by using a 30-dB directional coupler and a microwave powermeter (Boonton Electronics 42AD). The oscillating electrodes of the quartz resonator are connected to an ordinary transistorized Colpits oscillation circuit, and the oscillation frequency is measured by a frequency counter with the resolution of 0.1 Hz.

The experimental result at 10 GHz is shown in Fig. 3. The oscillation frequency of the quartz crystal increases linearly with input power, and the sensitivity of the power detector is 34 Hz/mW (3.4 ppm/mW). The stability and the linearity stand within the resolution of the counter, which corresponds to about 3μW in input power.

The sensitivity and resolution of the mount could be increased much more than the present results by using other cut crystal which has larger temperature sensitivity and wider range linearity than AC-cut crystal, further, by using smaller size crystal with small heat capacity and overtone techniques.

Supplying dc power through the leads of silver leaves to the common electrode, we know the mount efficiency; the value of which is about 90 percent.

ACKNOWLEDGMENT

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Directional-Coupler Technique for Triggering a Tunnel Diode

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***Abstract*—Present tunnel diode (TD) pulse generators have distortions in the pulse baseline and topline due to feedthrough of the triggering signal. This paper presents a new technique for reducing the trigger-induced distortions. A directional coupler is used to couple the trigger signal to the TD.**

INTRODUCTION

The tunnel diode (TD) is one of the fastest switching electronic devices known. It is capable of generating voltage transitions with a 10–90-percent transition time of the order of 15 ps. As such the TD is widely used in fractional nanosecond time-domain pulse measurements and applications to produce a steplike waveform.

Many problems arise when using a TD due to the fact that it is a two terminal device without input/output isolation. In the shunt connection, whatever input voltage is present also appears on the output. In the series connection the input and output currents are equal. In pulse generator applications, it is thus difficult to isolate the input trigger signal from the desired step-like output waveform. Failure to do so superimpos-

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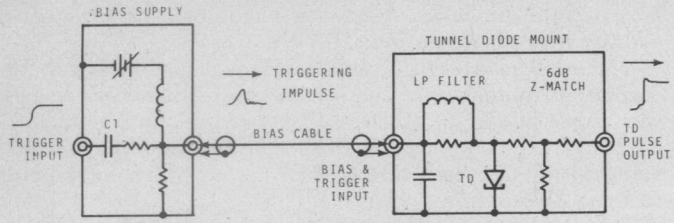

Fig. 1. Typical bias supply and TD mount.

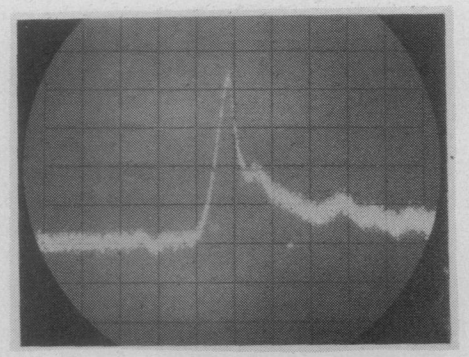

Fig. 2. Triggering impulse after passing through the TD mount. Bias set just below triggering level. Vertical: 5 mV/div. Horizontal: 1 ns/div.

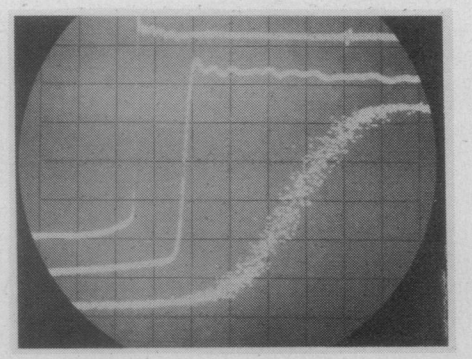

Fig. 3. Normal pulse output of commercial TD pulse generator. Bias set for minimum jitter. Vertical: 50 mV/div. Horizontal: top to bottom—500 ps/div, 100 ps/div, and 10 ps/div.

es the input trigger signal upon the output waveform. The presence of the trigger pulse causes distortions in the flatness of the pulse baseline and topline immediately before and after the fast pulse transition. This paper presents a new technique for triggering a TD pulse generator using a directional coupler to avoid trigger pulse distortion in the output waveform.

PREVIOUS COMMERCIAL TD PULSE GENERATORS

Fig. 1 is the circuit diagram of a typical commercial TD pulse generator presently used for transition time transfer standards (t_r ~20 ps) between NBS and other calibration laboratories. This circuit is also typical of most TD pulse generator circuit designs. In its quiescent state the TD is biased slightly below its peak current point. The input trigger pulse is sharpened by the differentiation action of C_1 into a trigger impulse which is added onto the dc bias. The dc bias and trigger impulse are sent through a cable to the TD mount. The trigger impulse is passed through a low-pass filter to the TD causing it to rapidly switch to its high voltage state. The TD mount includes a 6-dB impedance matching pad. The impedance seen looking left into the output connector is nominally 50 Ω.

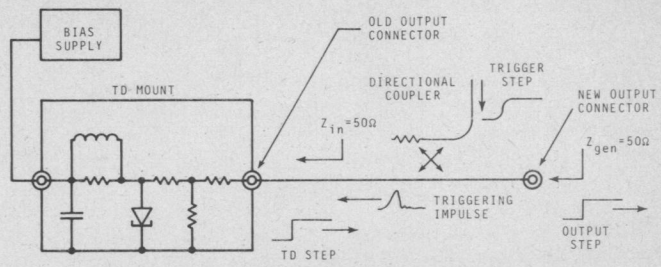

Fig. 4. New TD triggering technique using a directional coupler.

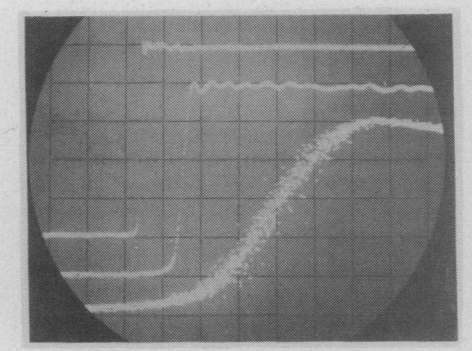

Fig. 5. TD pulse generator output using directional coupler triggering. Vertical: 50 mV/div. Horizontal: top to bottom—500 ps/div, 100 ps/div, and 10 ps/div.

The triggering impulse propagates to the right on the bias cable, strikes the TD, and then continues on to the right on the output line. The baseline/topline problem is induced at this point. When the TD switches, it generates a step transition that propagates to the right and the left. The output signal propagating to the right consists of the algebraic sum of the desired TD step transition and the undesired triggering impulse. Fig. 2 shows the triggering impulse after passing through the TD mount with the bias set low enough to prevent TD triggering. Fig. 3 is the typical output signal showing the composite TD step tnsition and the feedthrough triggering impulse. The TD bias was adjusted to give the minimum time jitter to the output transition waveform.

To date, only one commercial tunnel diode pulse generator has virtually eliminated the baseline/topline distortion due to the trigger pulse. It uses a balanced differential capacitance probe arrangement for triggering [1]. Its transition time is 70 ps which is rather slow for some fractional nanosecond-pulse applications.

From the standpoint of precision 10–90-percent transition time measurements, the perturbed baseline and topline are very objectionable. To precisely determine the 10 and 90-percent points it is first necessary to determine the 0 and 100-percent levels. Practically all other pulse parameters are also referenced to the 0 and 100-percent levels. In the past, for NBS transition time calibrations, considerable human judgment (always subject to error) has been required to extrapolate the 0 and 100-percent levels from results such as Fig. 3.

NEW TRIGGERING TECHNIQUE FOR A TD[1]

A new technique for triggering a TD is shown in Fig. 4. The same power supply [2] and TD mount as previously discussed are used. The trigger signal is coupled onto the output line via a directional coupler. When the trigger step is passed through the directional coupler, it is formed into a triggering impulse that propagates to the left. If the coupler is perfect (infinite directivity), none of the triggering impulse will propagate to the right to the new output connector. The dc bias is applied to the TD in the usual manner. The triggering impulse now

[1] Patent applied for.

enters the TD mount through its old output connector, first encountering the 6-dB impedance matching network and then the TD. The triggering impulse is completely absorbed within the TD mount due to its 50-Ω input impedance. Thus none of the triggering impulse is reflected to appear at the new output connector. When the TD is triggered, it generates its fast step transition as before. This fast step propagates to the right and out the new output connector. The generator impedance as seen at the new output connector is still 50 Ω. The use of a directional coupler as a directional pulse coupling device and the directional properties of electromagnetic waves in transmission lines are the important concepts in this technique.

Fig. 5 shows the results obtained using this technique. A 10 dB 7–18-GHz directional coupler having 25-dB directivity was used. The trigger step was a 0.4-V 70-ps transition time pulse from a snapoff diode pulse generator. A comparison of Fig. 5 with Fig. 3 demonstrates that the baseline/topline perturbations have been markedly reduced.

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Suitability of a Resonant Sonic System for Decay Detection in Softwood Poles

A. DOUGLAS SHAW

***Abstract*—A resonant sonic system has been established as satisfactory for the detection of serious internal decay for both treated and untreated hardwood (eucalyptus) poles used for electricity distribution purposes [1]. This paper summarizes the results of an investigation of the Resotest method conducted in New Zealand on a variety of softwood poles used for electricity distribution and communications purposes and concludes that the method is also valid for softwoods.**

I. INTRODUCTION

The resonant sonic (Resotest®) system is becoming established as a satisfactory means of detecting internal decay in Australian hardwood power poles, where the comparative nature of the test can be ensured, i.e., when a sound datum position some 2 ft 6 in above ground can be assumed.

Since softwood poles such as Douglas fir, radiata pine, and similar species are also frequently used for power distribution and similar purposes, it is of importance to determine if there are limits to the applicability of the Resotest system.

Because of the variability of the physical properties of wood, no detailed theory can be developed to enable assessment by other than empirical means. Indeed, the Resotest system itself has been derived in this manner.

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® Resotest is a registered trade name.

TABLE I
Summary of Comparisons of Relative Effectiveness between Conventional Testing Method and Resotest System for Softwoods

Total poles	92
Poles assessed as being unsound after boring	10
[a]Poles rejected by conventional means	25
[b]Poles rejected by conventional means and sound	15
Poles rejected by conventional means and unsound	10
Poles cleared by conventional means and unsound	0
Poles rejected by Resotest system	10
Poles rejected by Resotest system and sound	0
Poles rejected by Resotest and unsound	10
Poles cleared by Resotest and unsound	0

[a] Includes poles where conventional means were insufficient to establish whether or not a pole was seriously reduced in strength and where pole inspectors would be likely to err on the side of safety.
[b] Several of these poles contained traces of early decay.

II. FIELD TRIALS ON NEW ZEALAND SOFTWOOD POLES

In Australia, relatively little use has been made of softwood poles. The nearest source of such poles to Australia is New Zealand, where radiata pine is used in abundance and also use is made of other softwood species.

With the assistance of the New Zealand Forest Research Institute, a small ground survey of both sound and suspect poles was conducted in November 1974, and March 1975. The poles investigated were either pressure-impregnated with C.C.A. waterborne salt or creosote, or hot and cold bath creosote treated and ranged in diameter generally between 6 and 11 in. A range of species was included in the trial. This included radiata pine (pinus radiata) Douglas fir (pseudotsuga taxifolia), and larch (larix decidua) many of which had been installed for about 30 years.

Poles were located in areas of greatly differing climates, from around Rotorua in the North Island to Balmoral and Gore, two widely separated districts of the South Island. Most defective poles were located in the Balmoral and Rotorua areas. In the far South at Gore there was very little evidence of poles deteriorated by decay.

III. RESULTS OF FIELD TRIALS

Table I indicates the relative effectiveness of the resonant sonic method compared with conventional methods of pole inspection, based on similar criteria to Australian poles; viz., that a reject Resotest result indicated a condition of strength loss of 25–30 percent.

IV. CONCLUSION

A. Performance of Equipment on Softwood Poles

There was no significant difference between the performance of the equipment on hardwood poles and softwood poles of the species tested, although one might have expected a somewhat lower power input because of the lower density of timber and also the smaller diameters of many of the softwood poles.

B. Application of "Tourniquet"

As with hardwoods, some of the softwoods had severe radial splits extending over long lengths and the application of a "tourniquet" was necessary at such times to ensure a correct determination of pole condition.

C. Method of Attachment of Transmitter and Receiver

As the preservative envelope of some of softwood poles was very thin, a modification of the single nail support for the