Title

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We have found that selected Motorola transistors of the MM-486, MM-487, and MM-488 type are quite useful for avalanche-mode operation. Figure 1 shows a circuit used in conjunction with a traveling-wave oscilloscope for selecting avalanche units. The output of the line-type pulse generator is 40 to 60 volts (either polarity of output is available), and the rise time is less than 0.5 nsec. Figure 2 shows a plot of the static V-I characteristics of the collector-to-emitter junction for various units, avalanching and nonavalanching. Both avalanching and nonavalanching transistors of this type exhibit similar static characteristics, which thus offers little help in the selection of avalanche units. However, for avalanching units, negative-resistance regions (as shown in Fig. 2) should be avoided if time and amplitude jitter of the output pulse are to be minimized. In addition, it is significant that if a transistor avalanches at all, it will do so anywhere in the flat portion of the curves of Fig. 2, i.e., the standing current is not critical. The wide operating range is desirable, but has not been found in avalanche units previously used by the authors. At the higher end of the current range, some units free-run and are useful as high-rep-rate pulse generators.

One can expect that 10 to 30% of the transistors will avalanche. There is some indication that those of the low-beta type (MM-486) give the best yield.

There is a time delay of a few nanoseconds between application of a trigger pulse and the rise of the main avalanche current. Figures 3 and 4 show this delay, measured between the 50% point of the trigger-voltage waveform and the 50% point of the avalanche output waveform, as a function of trigger-voltage amplitude (Fig. 3) and static-collector current (Fig. 4).

A temperature change from 70 to 150 $^{\circ}$F has negligible effect on time delay, but raises the breakdown knee (Fig. 2) to higher current (e.g., from 2×10^{-3} to 8×10^{-3} μA).

*This work was done under the auspices of the U. S. Atomic Energy Commission.

FIGURE LEGENDS

Fig. 1. Avalanche test circuit. The circuit is triggered by a positive 2-nsec pulse from the mercury-switch pulser. Transformer T_1 is a 2:2 winding on a Ferroxcube 208 F125-3C core. A low-capacitance vacuum-tube voltmeter is used to measure the collector-to-emitter voltage V_{CE}, and is removed before the pulse test.

Fig. 2. Direct-current V-I characteristics. Breakdown of nonavalanching and avalanching transistors is compared for a zero base-to-emitter junction at 25°C.

Fig. 3. Avalanche firing delay time as a function of the base-to-emitter trigger voltage at 25°C. The unit ceases to fire below 0.96 volts for $I_c = 10\mu A$, and below 0.8 V for $I_c = 200\mu A$.

Fig. 4. Avalanche firing delay time as a function of the dc collector current (for a typical avalanche unit) at 25°C. The unit was turned on with a base drive voltage of 2.5-v amplitude and 4-nsec pulse width.

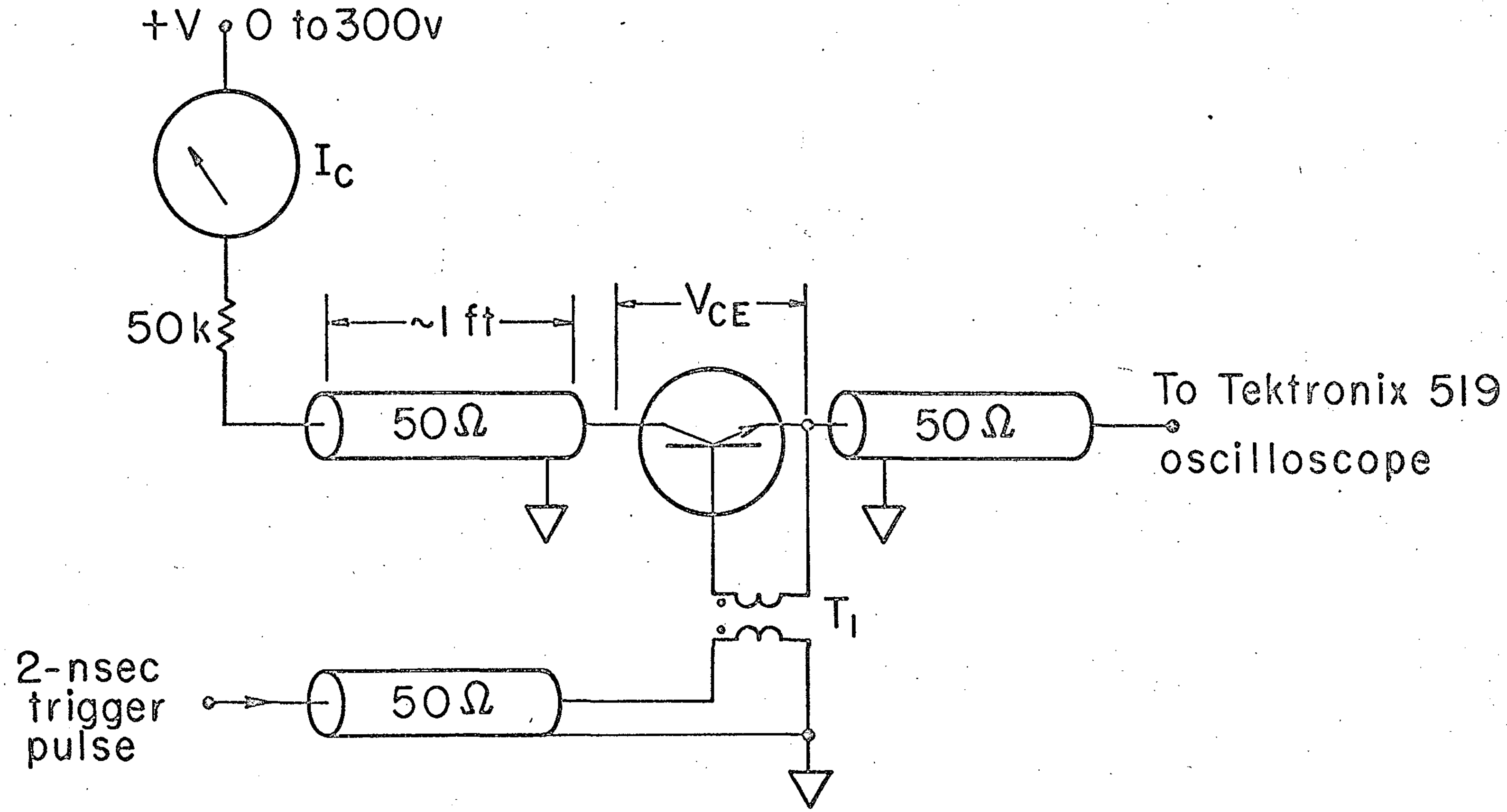

Fig. 1.

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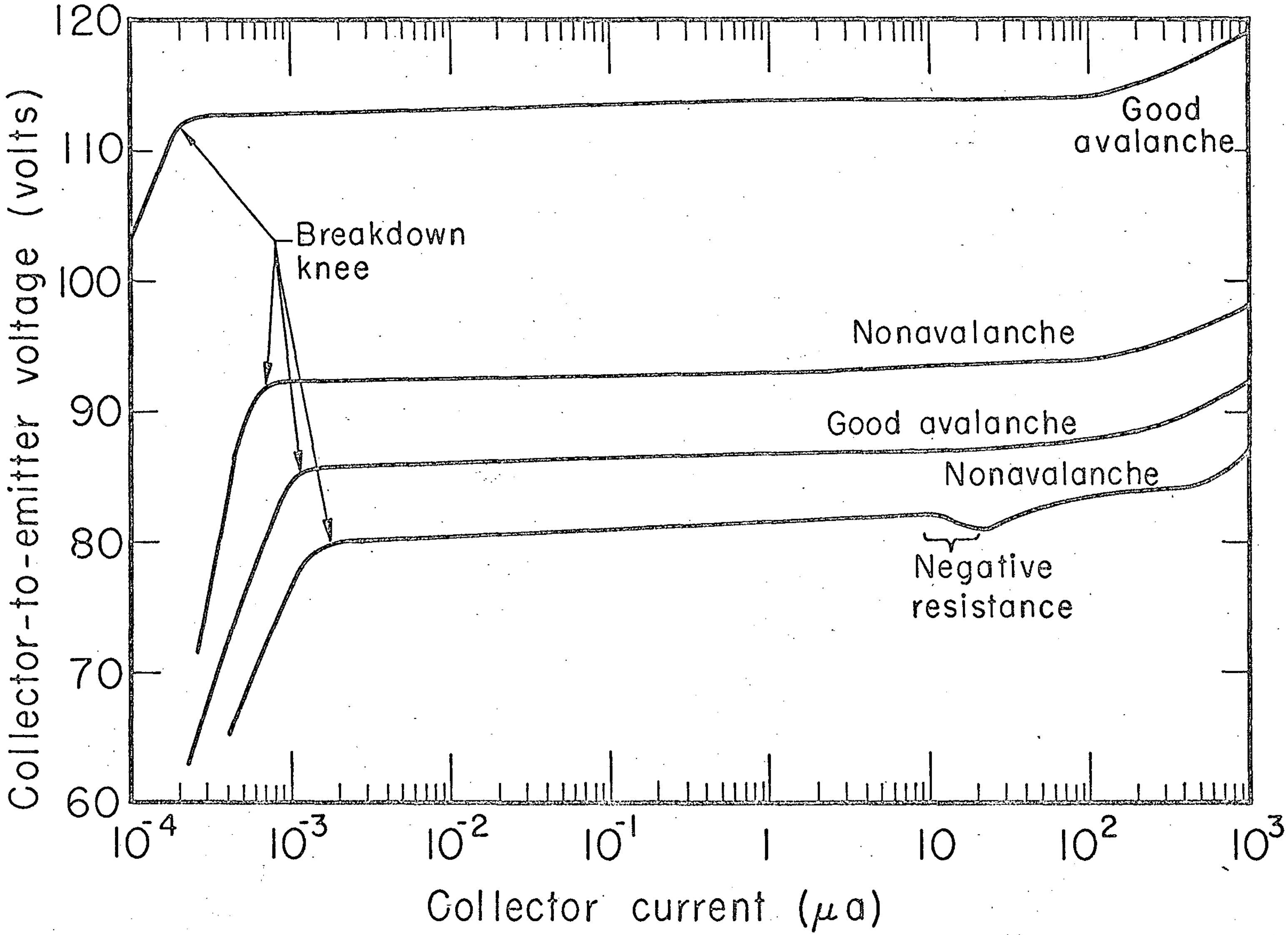

Fig. 2.

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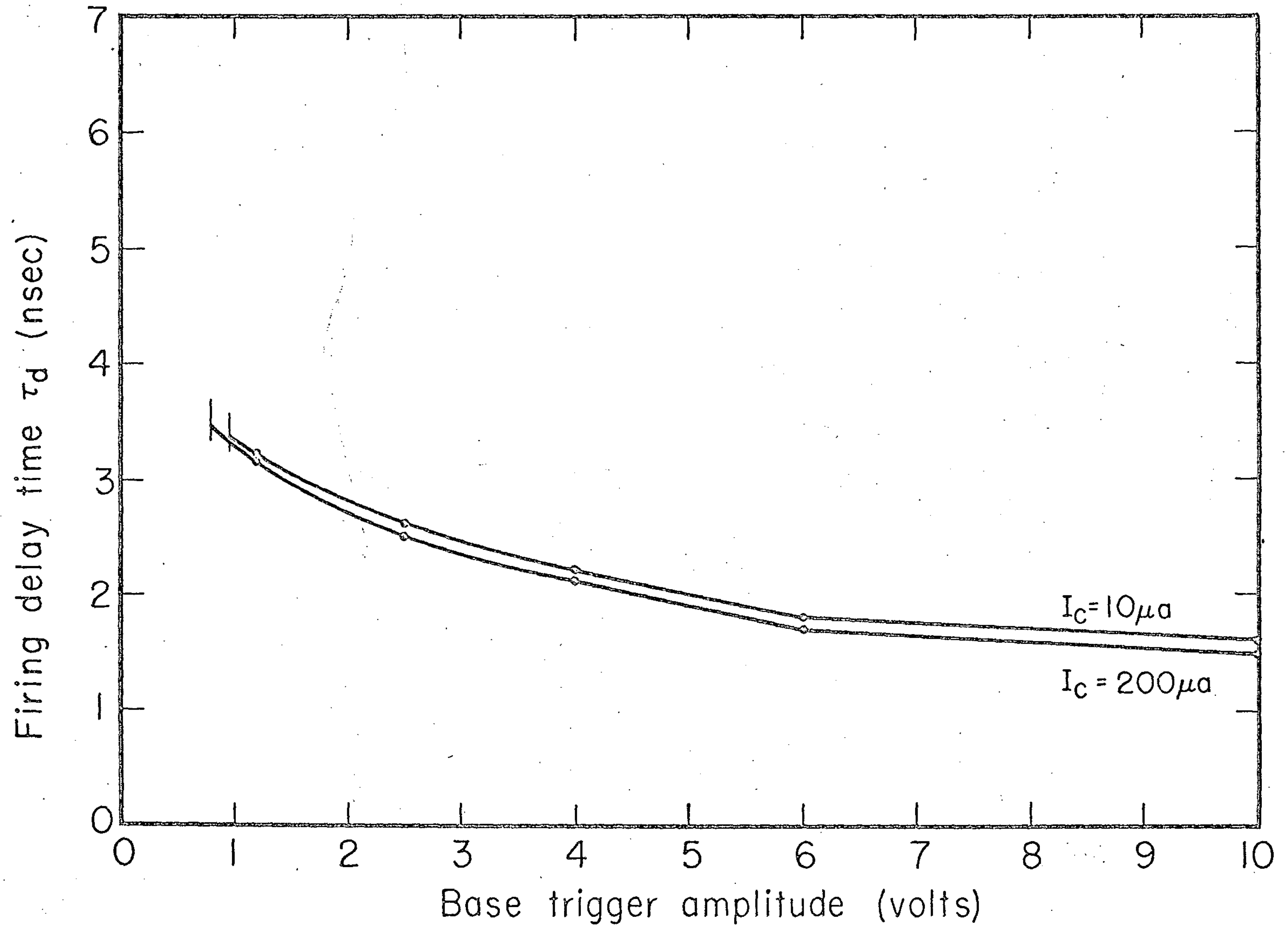
Firing delay time τd (nsec)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8
9
10
Base trigger amplitude (volts)
IC=10μa
IC = 200μa
MU-26298

Fig. 3.

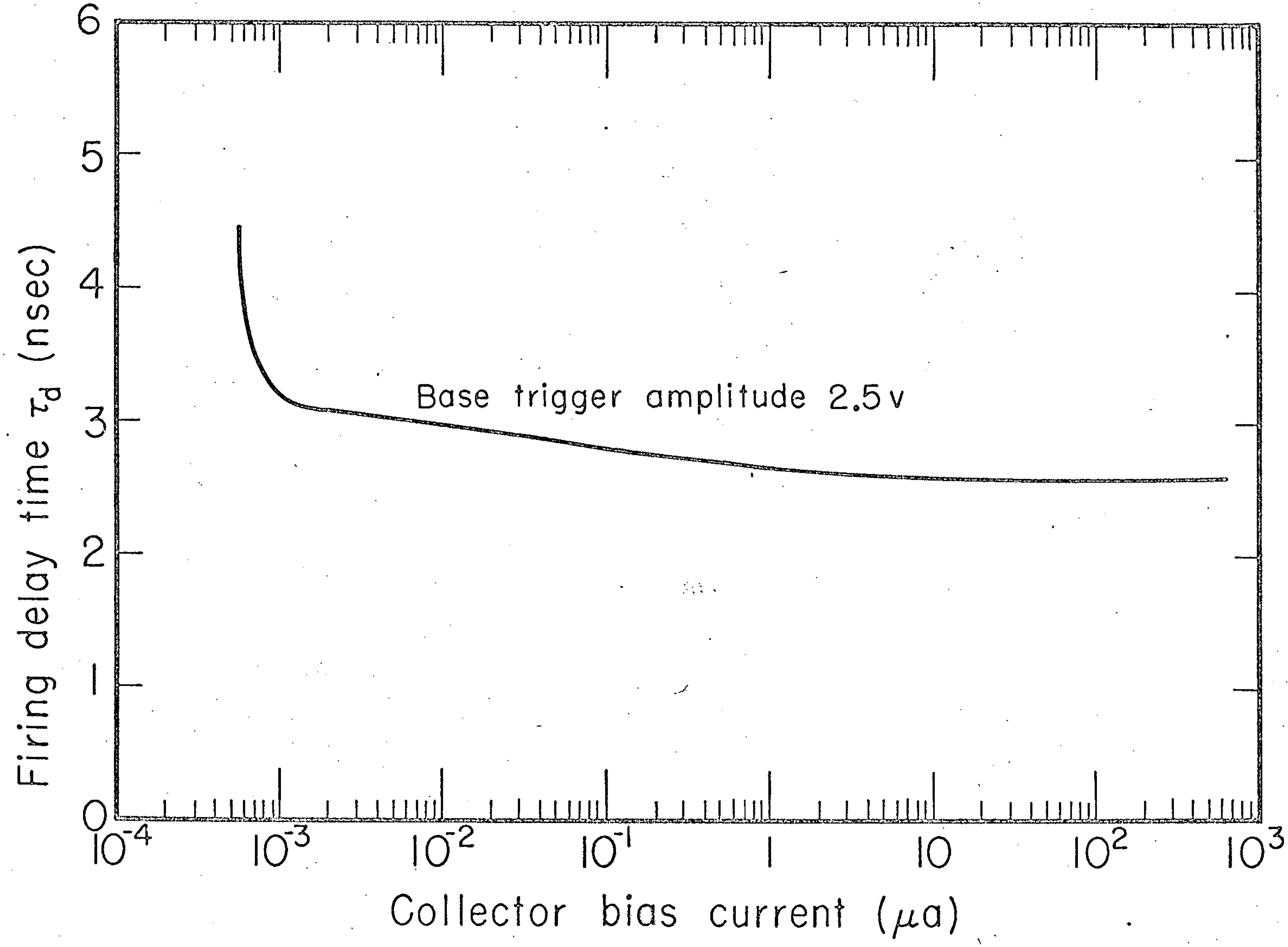

Fig. 4.

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