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INCREASING THE STABILITY OF SERIES AVALANCHE TRANSISTOR CIRCUITS*

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ABSTRACT

The operation of avalanche transistors in a strong RFI environment, has been made very reliable by subjecting them to a large bias. The scheme presented here still permits the connection of the individual transistors into a Marx generator circuit.

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In the design of spark gap pulse generators, there is a need for high voltage trigger amplifiers, in order to fire the gap from a low voltage logic pulse. Some power triodes (ML 8533) have been found satisfactory for this purpose; their input impedance is of the order of 100 ohms, and their cut-off bias is approximately 150 volts. Then the problem consists in generating a 150-volt pulse into 100 ohms, with a very short delay, and series avalanche transistors have been favored because of their fast rise time, quick response, and power capabilities.[1,2,3]

Yet there is a price to pay for fast response and short pulse propagation delay, and that is the extreme sensitivity the circuit exhibits. In a noisy environment, and in the vicinity of spark chambers or firing gaps, the shielding of avalanche transistors is hardly sufficient for their reliable operation. It was found that small transients on power supply lines or ground planes, were susceptible to trigger the transistors, even when the base series resistance was very low. The solution adopted in general consists in returning the base to some negative voltage. However this palliation does not lend itself to a Marx generator circuit, (consider Fig. 1 with the diodes shorted out), since it requires, during the avalanche process, that the emitter and base voltages of the n^{th} stage assume a peak level of $\frac{nV}{N}$, where V is the output pulse voltage, and N the total number of stages.

A circuit was devised which permits to return the base of each stage to a negative bias, without impairing the series operation of the avalanche transistors, (see Fig. 1). A Zener diode having a voltage just less than the transistor BV_{EBO}, is inserted in series with each emitter and provides the negative voltage required by the individual stages. During the discharge, some of the avalanche current flows through the diode and this amount is limited by a series resistor.

This arrangement offers the advantage of an increased stability and retains the possibility of using a low base to emitter series resistance. The total delay for three stages was found to be 5 nanoseconds (Fig. 2), and is essentially the same as before. Nevertheless the input trigger level must be larger, and the additional circuitry usually costs a supplementary delay of 3 nanoseconds.

The resistance of the shielded pulse generator to electromagnetic interference, was evaluated by placing it in the vicinity of a spark gap discharging a 5-nanofarad capacitor charged to 15 kilovolts, into a 50-ohm load. The radiated power did not trigger the avalanche transistors.

REFERENCES

1. T. H. O'Dell, "Series operation of avalanche transistors," Elec. Letters 5, 94 (1969).
2. W. B. Mitchell, "Avalanche transistors give fast pulses," Elec. Design 6, 202 (March 14, 1968).
3. Louis Lavoie, Sherwood Parker, Charles Rey, and Daniel M. Schwartz, "Spark chamber pulsing system," Rev. Sci. Instr. 35, 1567 (1964).

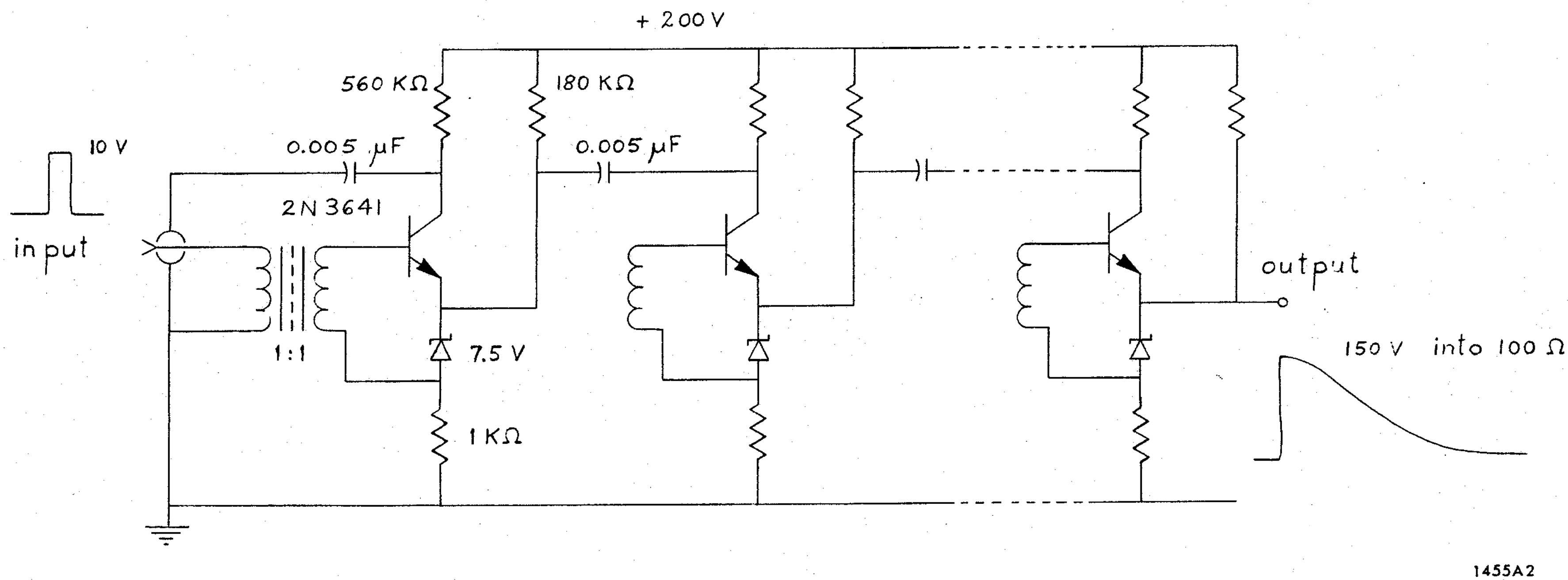

Fig. 1

Circuit diagram of modified Marx generator.

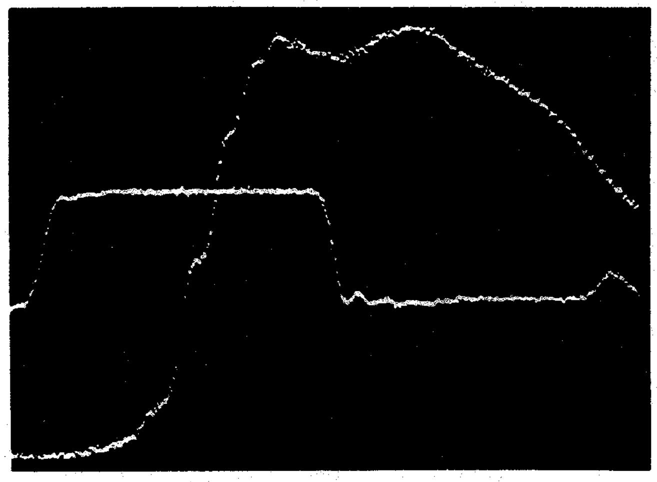

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Fig. 2

Input-output waveforms of Marx generator:

Trigger: 5 V/cm

Output pulse: 25 V/cm

Time scale: 2 nsec/cm.