Correspondence

A Junction Transistor for Kilowatt Pulses*

While it has long been recognized that the transistor is a very useful device for the fast switching of currents, applications have usually been at relatively low current levels. It is the purpose of this note to describe a transistor which has been developed to switch currents of 40 amperes in times of the order of a microsecond. Since the transistor can operate on voltages up to 30 volts, pulses with powers in the kilowatt range can be produced.

The theory of large signal switching behavior of transistors has been developed by Ebers, Moll, and Miller.1-3 For our purposes the design requirements may be summarized: 1) high α at the operating current; 2) low extrinsic base resistance, and 3) high α cutoff frequency.

These objectives have been achieved using the design theory proposed by the present author,4 in which the emitter is in the form of a thin bar, flanked by parallel bars making ohmic base connection. In the present transistor the configuration has been distorted to annular shape, sin-e for this particular size, this allows a more economical use of germanium. The transistor element is shown in Fig. 1.

To increase emitter efficiency an alloy of 0.5 per cent gallium in indium was used for the emitter.6 Traditional alloying methods were used, but a special effort was made to achieve a uniform thin base layer over the large area involved. This was done by reducing the thickness of the germanium and indium to about 0.005 inch and using very carefully machined graphite alloying jigs.

Relatively few transistors have been made, but the results reported below indicate what can reasonably be attained with this design. Collector currents as high as 45 a have been obtained with as little as 3-A base current, though average transistors require rather more drive than this. Rise times are fastest when a constant current pulse is applied to the emitter in a grounded base configuration.

Rise time for a collector current of 40 a is as little as ½ microsecond for some transistors, even without collector “bottoming,” and overdrive could reduce this somewhat without appreciable storage. Rise times for other pulsing arrangements are much longer (several microseconds typically) but greater power gains can be realized and overdrive is more economical. Extrinsic base resistances are less than 1 ohm so that input impedances are very low and power gain is quite high.

The mechanical structure of the transistor is shown in Fig. 2. The collector junction has a low thermal resistance path to the chassis and the unit can dissipate considerable power, though it was designed principally for low duty cycle pulsing systems where dissipations of only a few watts are involved.

The author is specially indebted to H. Flood of this laboratory who made the alloying jigs and other fittings as well as the transistors themselves.

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