MATH'S NOTES

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WHAT'S NEW AND HOW TO USE IT

A Power Supply "Crowbar" Protection Circuit

One of the most common circuits built by experimenters is the power supply. Virtually every project requires power of some sort, and many derive this operating power from the AC line or some other similar uncontrolled source. If the dropping element or regulator of such a supply fails by shorting, the effect to the rest of the circuit can often be disastrous. The fuse that everyone includes (you do, don't you?) may not blow quickly enough to protect delicate op-amps or similar devices, and in some cases such failure can be quite expensive. There is a circuit that commercial power supplies use, however, that is fast enough to react to an over-voltage condition (in a microsecond or so), and that is the topic for this month.

The circuit I am describing is shown in fig. 1. It functions by immediately shorting the output of a power supply when the input exceeds a particular value. It then either causes a safety fuse to blow or trips a circuit breaker, effectively disconnecting anything that is connected to the supply. Such a circuit is commonly called a "crowbar" circuit because (as the inventors obviously felt) it is the electronic equivalent of throwing a crowbar across the line!

In the circuit shown, Q1 is a sensitive gate SCR with a maximum current rating that is at least five to ten times the maximum short current of the power supply. The fuse, or circuit breaker, is chosen so that its trip current is about twice the maximum current drawn from the power supply during normal operation. The zener, CR1, is a 400 milliwatt to 1/2 watt device with a voltage equal to the voltage at which you want the circuit to trip.

In normal operation the zener does not conduct, as it is biased below its conducting voltage. This results in zero volts at the gate of the SCR, which keeps it cut off and out of the circuit. The instant the output rises above the zener voltage, however, CR1 conducts, fires the SCR which immediately shorts the line (protecting the circuit), and then blows the fuse or trips the breaker. Although you might now need a new fuse, the $50 worth of components you were powering will live to see another day. As a practical example, fig. 2 is a circuit that will trigger at 6 volts, making it ideal for protecting TTL circuitry.

If zeners are not available for the exact voltage you need, the circuit can easily be modified as shown in fig. 3. Here the zener has been replaced by a voltage divider con-

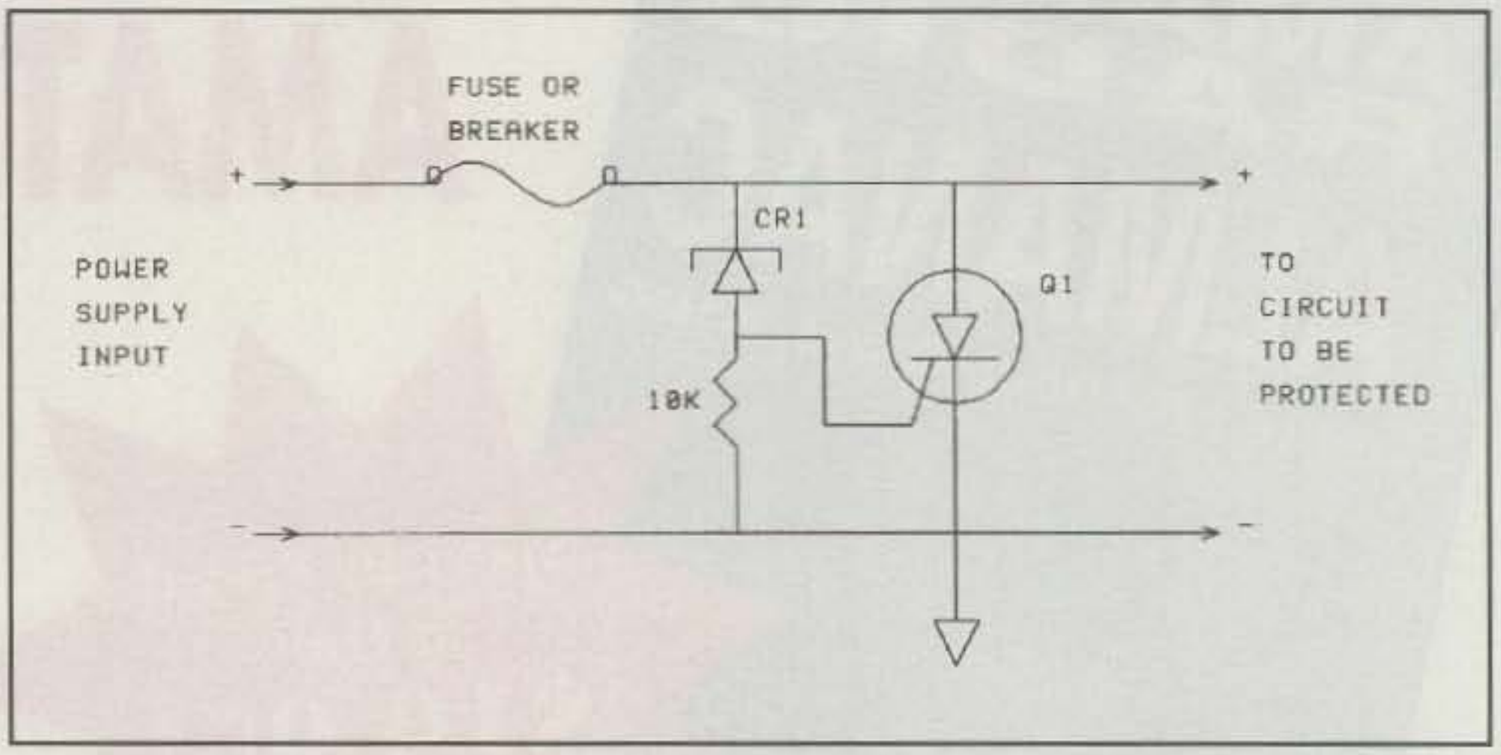

Fig. 1– Circuit of the electronic "crowbar."

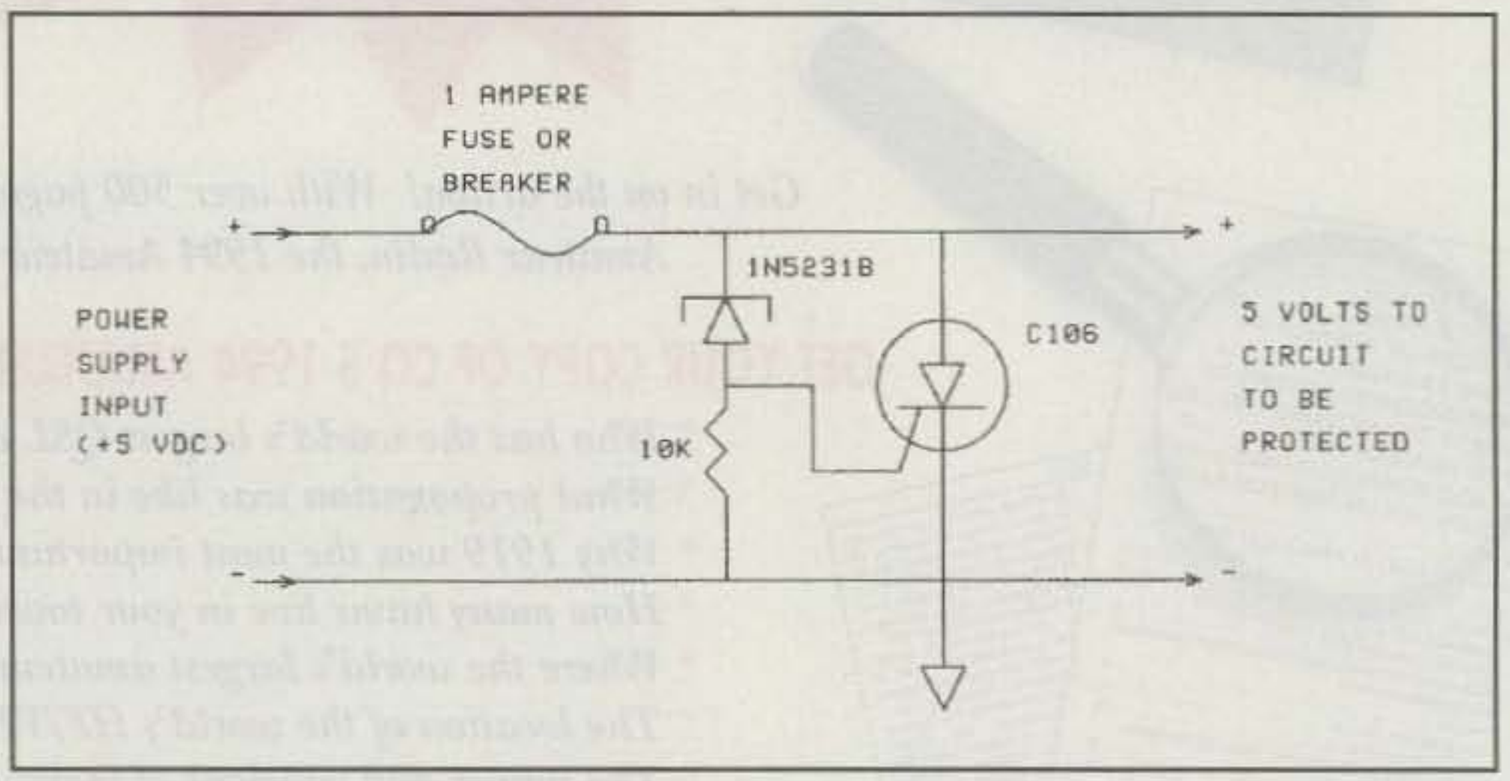

Fig. 2– TTL crowbar circuit (trips at 6 volts).

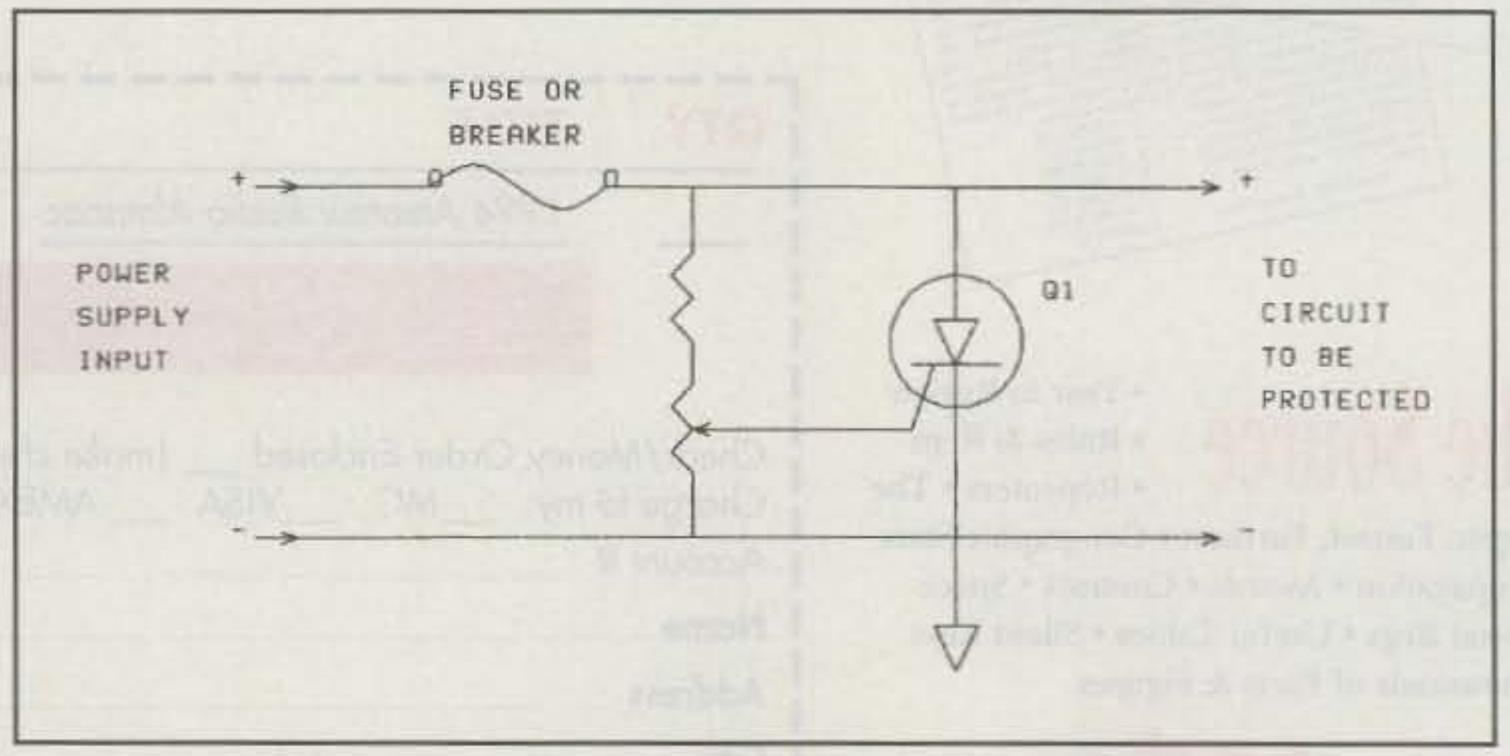

Fig. 3– Variable crowbar circuit.

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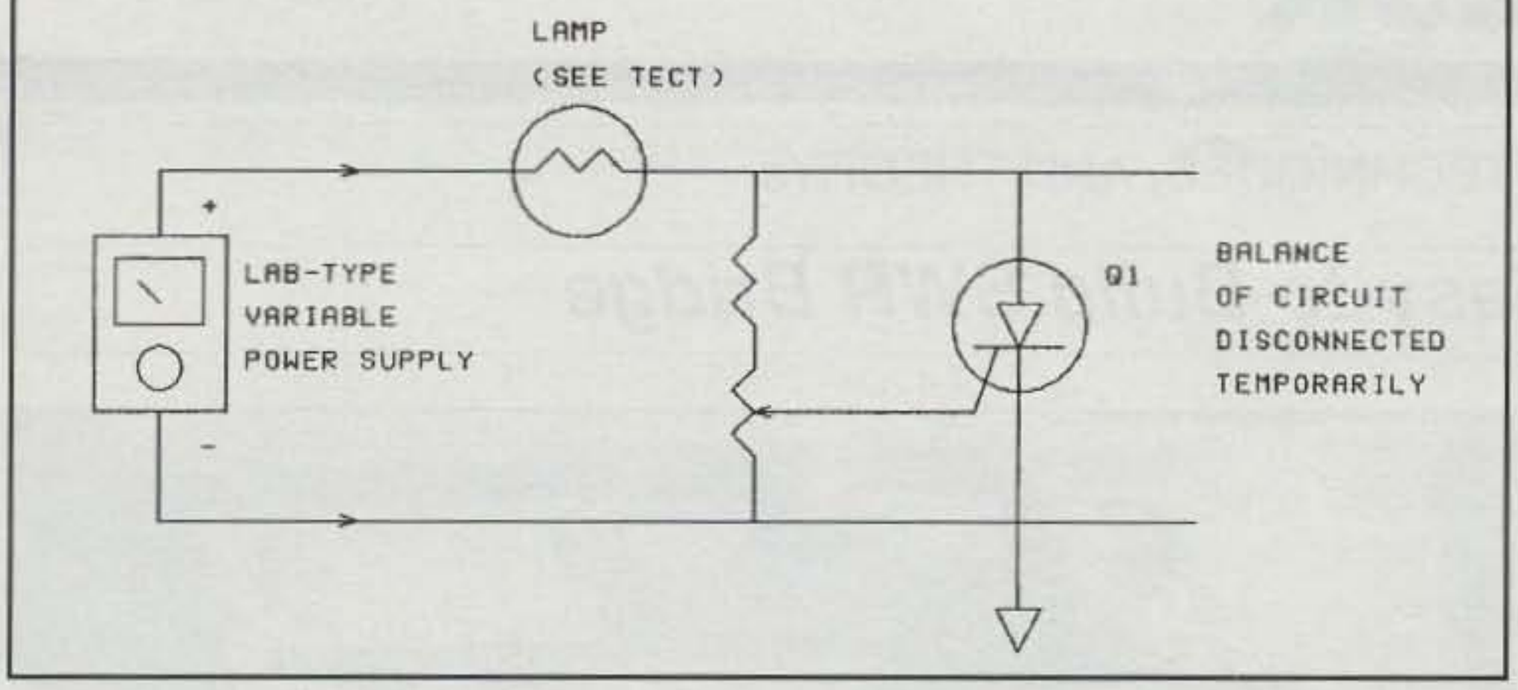

Fig. 4– Test setup for calibrating the crowbar circuit.

sisting of a potentiometer and fixed resistor. Operation, however, is still the same. When the voltage at the arm of the potentiometer reaches the triggering point of the SCR, it fires and protects the circuit in the same manner as the zener version. Varying the set point of the potentiometer varies the point at which the circuit will trigger.

To calibrate the circuit of fig. 3, you must first set the potentiometer to zero (the point at which the arm connects to ground). Referring to fig. 4, temporarily disconnect the circuit to be protected and replace the fuse or circuit breaker with a lamp that is rated at about 1.5 times the voltage at which you wish the crowbar to trigger. Connect a variable lab-type power supply, set to the exact input voltage at which you want the crowbar to trigger, to the input of the circuit as also shown in fig. 4. Now slowly turn the potentiometer until the lamp just comes on. If you need to repeat this procedure, turn the power supply off (to reset the SCR), return the potentiometer to zero, and start again. When you are satisfied with the triggering point, reconnect the fuse or circuit breaker and the rest of the circuit, and you are in business.

The first time the crowbar protects a delicate, expensive experimental circuit from going up in smoke, you will truly appreciate the extra few minutes involved in building it.

73, Irwin, WA2NDM