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A CROWBAR CIRCUIT WITH OVERVOLTAGE ACTIVATION INDICATION

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THE INVENTION AND ITS ADVANTAGES

This invention is helpful to servicing personnel, manufacturing personnel or R&D personnel who are trying to find the root cause of a system shutdown when traced to a particular power supply with a blown fuse or a tripped circuit breaker, the cause of which could have been (1) an output load overcurrent condition or (2) an input overvoltage input condition that activated the internal crowbar circuit which shorted the input or output to protect the load, and this invention solves the ambiguity with an added LED and associated circuitry to indicate that it was the crowbar activation that caused to fault when the LED is lit. The LED will stay lit until manually serviced by replacing or resetting a separate fusing device, so the problem may be found and acknowledged. A software or firmware action would probably never be expected to reset the memorised overvoltage indication but a digital port might monitor the state of the LED for software diagnostic schemes.

Hence the invention offers an advantageous solution which (1) immediately solves for the ambiguity of what type of fault had blown or tripped a fusing device and (2) requires manual servicing so that the problem will be acknowledged.

CIRCUIT FUNCTION DESCRIPTION

The circuit is shown in Figure 1, below, which shows the addition of two key components, DS1 LED and F2, a very low current fusing device. The intent of this invention is to improve a conventional crowbar circuit with an LED indication that the crowbar circuit had been activated. In order to protect a load from high voltage, a crowbar circuit traditionally short circuits the power supply output, which is in series with a power supply fusing device whenever the input voltage reaches an overvoltage condition in order to protect the load, by activating an SCR, which creates the short circuit, and which stays latched on until the power supply's main fusing device (F1) blows or trips. With the addition of this invention, an indicator light should be turned on, and remain on after F1 blows or trips, by using a semi-permanent memory means in the form of fusing device F2. When F2 is blown or trips, this will require a manual maintenance operation, to "clear" the indicated over voltage fault by replacing or resetting F2. A conventional crowbar circuit can be realized with only some of the components shown in Figure 1, namely R1 to limit current through Zener diode D1 and the SCR gate input, R2 to pull charge off the SCR gate to reduce the chance of false triggering events. The Zener diode D1 turns on in reversed bias mode during an overvoltage condition, thereby supplying current to the gate terminal of D2 SCR, hence D2 SCR is triggered when D1 is turned on. A turned on SCR of course stays turned on and creates a very low impedance between the F1 fuse and ground and then blows or trips fusing device F1, saving the load from an overvoltage condition. In a regular SCR crowbar circuit, D3 is nonexistent, and would instead be a length of wire. Hence, the invented circuitry is the inclusion of LED DS1, fusing device F2, diode D3 and resistors R3 and R4. The circuitry turns on the normally off DS1 LED by the action of blowing or tripping F2 if an overvoltage event has happened. Of course DS1 is off while F2 is intact (not blown or tripped) because the low resistance of F2 will short out LED DS1 and it will not receive any significant amount of current through R4. In the circuit operation, during the overvoltage input fault condition the

SCR will turn on and draw high current through F2, just as it will draw high current through F1. The primary purpose of D3 is to prevent the power supply output current load from passing through through fuse F2. Diode D3 must be a power diode so that it can handle the high current through the turned-on SCR. While the SCR is turned on, it will only get its current from F1 (through D3) and F2, and the SCR will only turn off after both F1 and F2 are blown. Resistor R3 limits the LED current while the SCR is on. After F1 blows or trips, the SCR will turn off and resistor R4 provides a path to turn on LED during this situation where input power is available, the SCR is off and the F2 device is blown or tripped. Resistor values need to be properly selected to bias D1, D2 and DS1 to desired currents for normal and/or fault conditions. Surely enough, F2 acts as a permanent memory element – a write once memory. After F2 has blown or tripped due to an overvoltage condition, replacing or restoring F2 will turn off the DS1 LED. Note that the state of fuse F2 will not affect normal power supply operation once F1 has been replaced.

After repairing or restoring F1, if the event that caused F1 to blow or trip was not an overvoltage input situation, but was instead an overload current situation, then DS1 LED will not glow because the SCR in the crowbar circuit will have never been activated and fuse F2 would have remained intact, neither blown nor tripped due to D3 action, and the LED will not be lit.

For circuit implementation, F1 could be a standard exploding/melting wire fuse, a mechanical circuit breaker or an electronic fuse while F2 can be an exploding/melting wire fuse or a mechanical circuit breaker. F2 must neither be a self-resetting fuse, nor an electronic fuse, or this invention will not work.

Fusing device F2 may have a much smaller current rating and a quicker activation time (blowing or tripping) than F1 to save costs and reduce time that the SCR is turned on.

F2 could be sealed and/or potted within the power supply for purposes of a permanent record.

For digital logic detection of a blown F2 situation, DS1 LED could instead be an LED opto-isolator input with the DS1 on the LED side and the photo-transistor wired in as an active pull-up or active pull-down in a logic circuit. Another option is including an additional opto-isolator LED input wired together with the visible LED to allow both visual and digital fault detection.

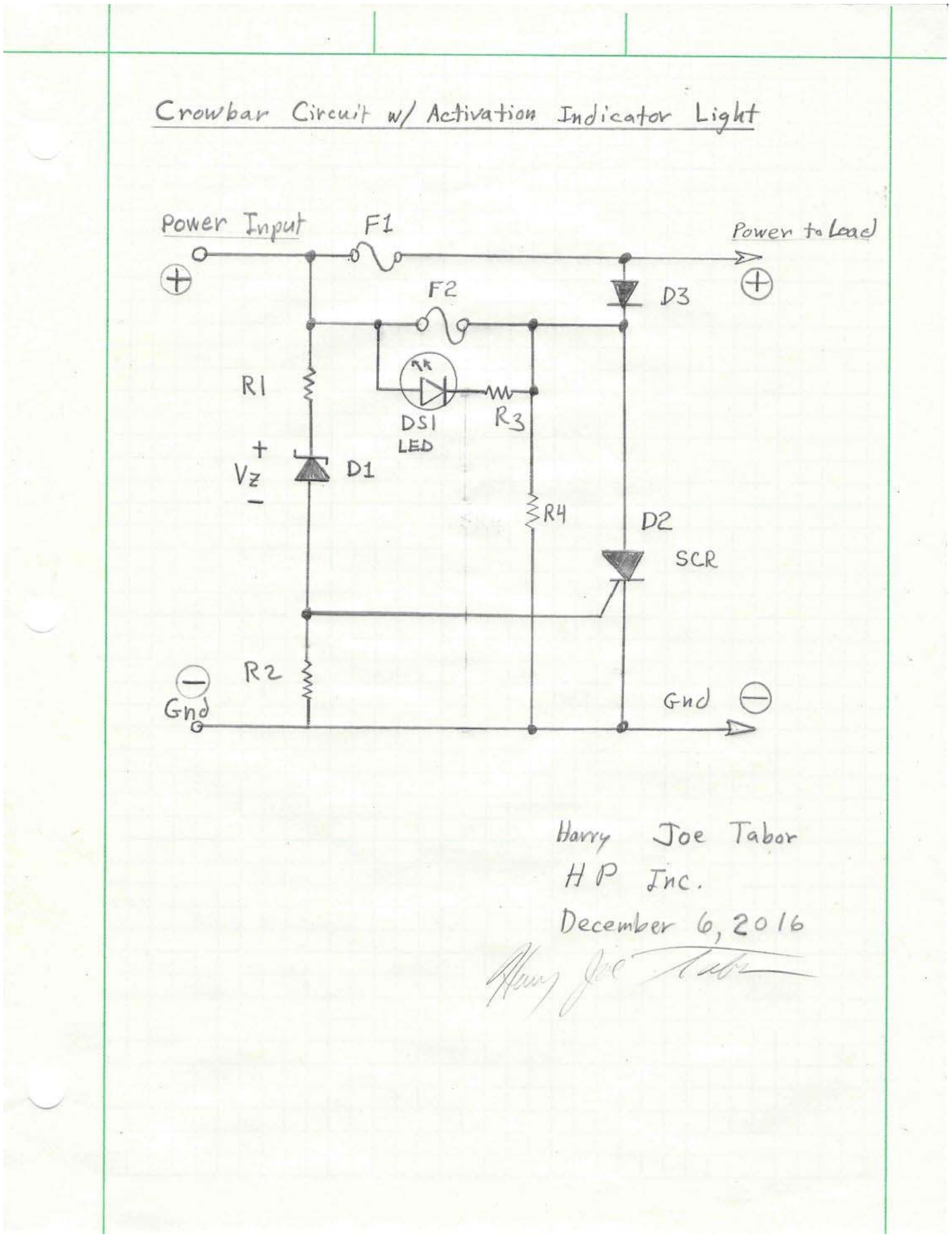

Figure 1: Crowbar Circuit with Activation Indicator Light

Disclosed by H. Joe Tabor, HP Inc.