INDICATING SCHEMES FOR FAILED CELL DETECTION ON SILICON SEMITRON RECTIFIER POWER SUPPLIES

INTRODUCTION

Figures 1A and 1B illustrate two commonly used rectifier circuits. In these circuits, each rectifier leg will consist of a group of silicon Semitron rectifier cells. This group of cells will contain one or more cells in series and several series "strings" of cells in parallel. The number of cells in series is determined by the repetitive inverse voltage applied to the string, the inverse voltage rating of the individual cells, and the "peak inverse voltage ratio". This ratio is the ratio of the cell rated peak inverse voltage and the repetitive applied peak inverse voltage and is generally of the order of 2.5 to 1. The number of "strings of cells" in parallel is determined by the current rating of the individual cells and the required total current rating of the rectifier.

Figure 2 shows typical pictures of the forward current and inverse voltage of each rectifier cell. During each cycle of the supply voltage, a cell must carry a forward current. This is known as the conduction period. Immediately after the end of conduction, a cell must withstand the circuit inverse voltage. This is known as the blocking period.

When a cell fails, it will lose its ability to support inverse voltage and become shorted. It is desirable to have an indication of this condition so that the failed cell can be removed and replaced with a new cell as soon as possible.

This leaflet will describe failed cell schemes for circuits with one, two, or three cells in series.

INDICATING SCHEME FOR CIRCUITS WITH ONE CELL IN SERIES

In circuits with only a single cell in series in each leg, a cell failure constitutes a short circuit of the transformer. This short circuit will result in a current flow in the reverse direction through the failed cell. In series with each cell is a current-limiting type fuse. When this reverse fault current starts flowing, the current-limiting fuse will melt open and clear the circuit, limiting the magnitude of this fault current and removing the shorted cell from the circuit.

Now the voltage which had previously appeared across the cell will appear across the blown fuse. Figures 3A and 3B illustrate how this is used to obtain failed cell indication.

In Figure 3A, the indication is obtained by a lamp across the fuse. In low voltage circuits this lamp will be an incandesent type. In higher voltage circuits, this lamp will be a neon type bulb.

In some cases, the wide voltage range of the rectifier will make it impractical to use a lamp for indication. For these cases, a trigger or indicating fuse can generally be used as shown in Figure 3B. The trigger fuse is merely a small fuse which is placed in parallel with the main fuse. When the main fuse begins opening, some of the current transfers to the trigger fuse, causing the trigger fuse to open. When the trigger fuse opens, a plunger is released and the plunger then protrudes from the end of the fuse. This plunger provides a visual indication of the main fuse operation. The plunger can also be used to provide other indication or relaying functions.

INDICATING SCHEME FOR CIRCUITS WITH TWO CELLS IN SERIES

In circuits with two cells in series, some means must be provided to insure equal voltage division between the two cells. This is the function of the voltage dividing resistors shown in Figure 4. As long as the inverse voltage is balanced between the two cells, points A and B are at the same potential and no current will flow in the bulb shown in Figure 4. It can happen, however, that just one of the two cells in series will fail. This will not necessarily cause the fuse to blow since the other cell can support the voltage. It will, however, cause a current to flow in the indicating lamp shown in Figure 4.

This circuit will then indicate the failure of either cell. If both cells fail, the fuse will open. This will also cause a current to flow in the bulb, giving an indication.

This circuit then will provide indication for either one or both cells failing.

INDICATING SCHEME FOR CIRCUITS WITH THREE CELLS IN SERIES

A scheme for three cells in series is shown in Figure 5. Resistors R1 assure an equal normal voltage division among the three cells. Resistors R2 and R3 are chosen such that points A and B are at the same potential as long as the inverse voltage is equally divided among the three cells in series. R2 and R3 are high resistance, low wattage resistors as required for operation with neon bulbs. If any one of the three cells fails, point A will shift in potential with respect to point B, causing the neon bulb L_1 to light. If all three cells fail, the fuse will blow. This will cause neon bulb L_2 to light. R_4 is a current limiting resistor for the neon bulb.

This scheme then gives a warning light if any one of the three cells fails. The cells should be checked and the failed cells replaced as soon as possible. It also gives an indication if all three cells fail causing the fuse to blow. The failed cells should be replaced as soon as possible.

CAUTION

Always make sure that any replacement bulbs or sockets are exactly the same type as originally supplied. The sockets for use with neon bulbs generally have a built-in resistor. The sockets for use with incandescent bulbs have no built-in resistor. Failure to use the right bulb and socket will result in bulb burnouts or failure to indicate.

TESTING INDICATING BULBS

It is recommended that all indicating bulbs be checked at least once a year. Neon bulb receptacles are available with built-in resistors for testing directly across 110 volts a-c. Incandescent bulbs should be tested in a receptacle with the proper battery voltage applied. Any bulbs which fail to light or indicate poorly should be replaced.

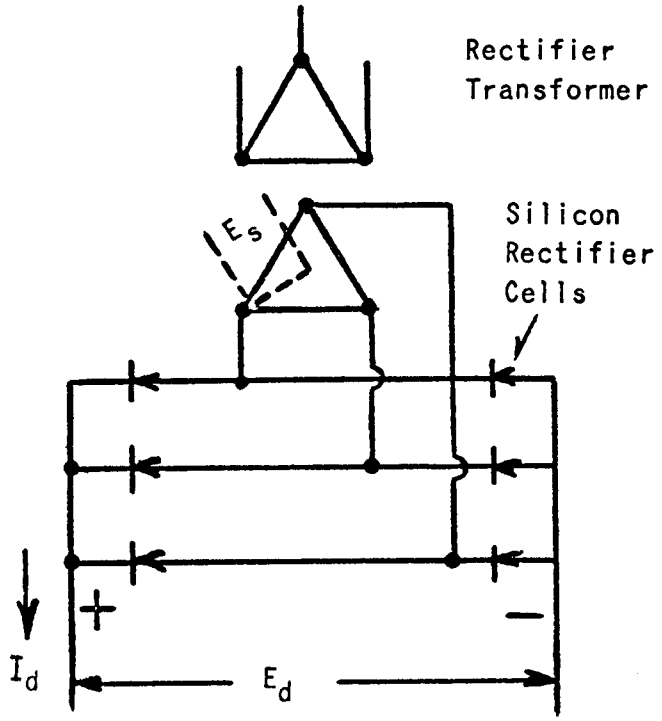

Figure 1A - Delta, Six Phase Delta Double Wye Circuit

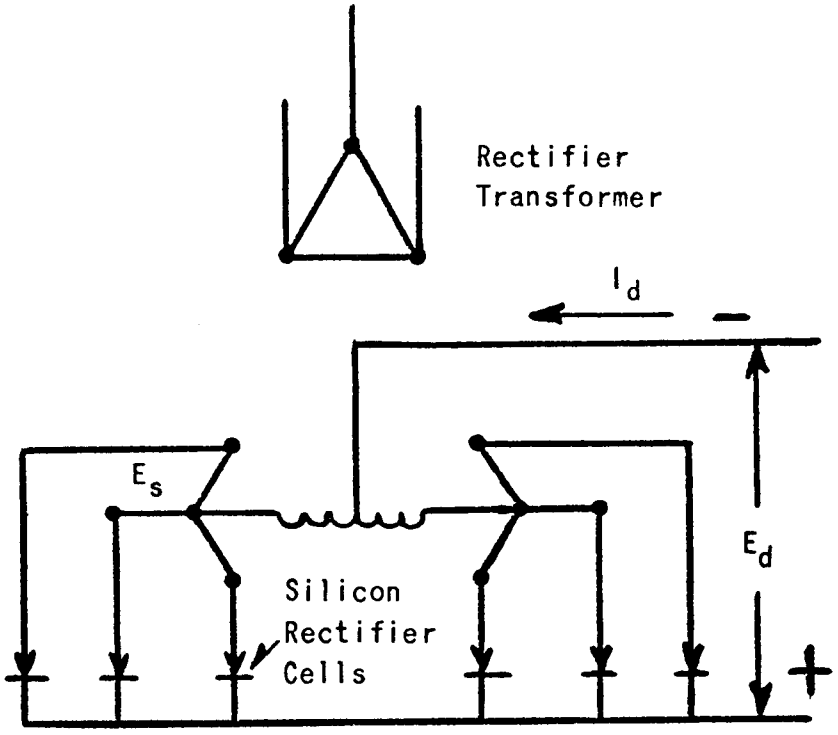

Figure 1B - Delta, Six Phase Double Wye Circuit

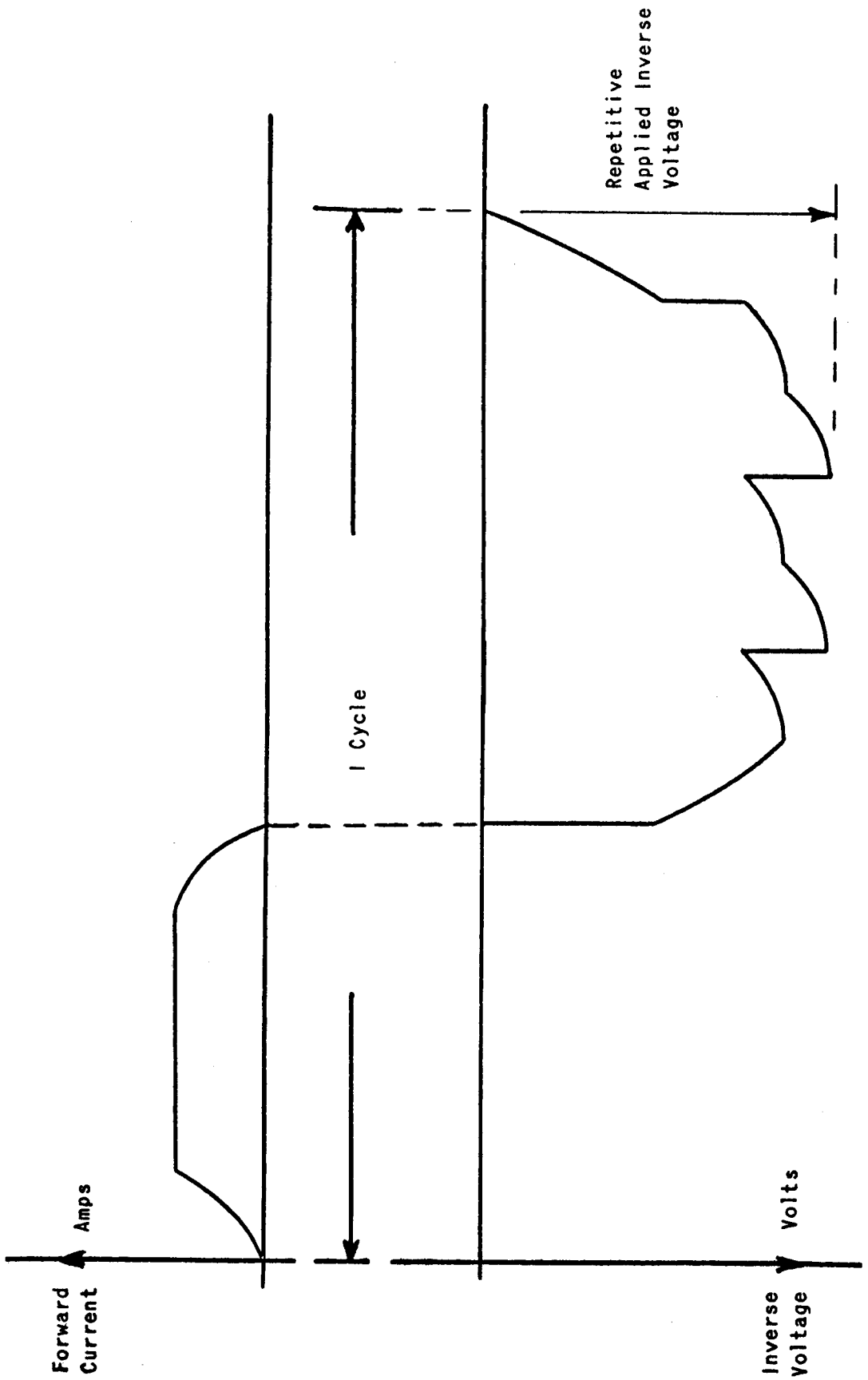

Figure 2 - Typical Forward Current and Inverse Voltage of Each Rectifier Cell

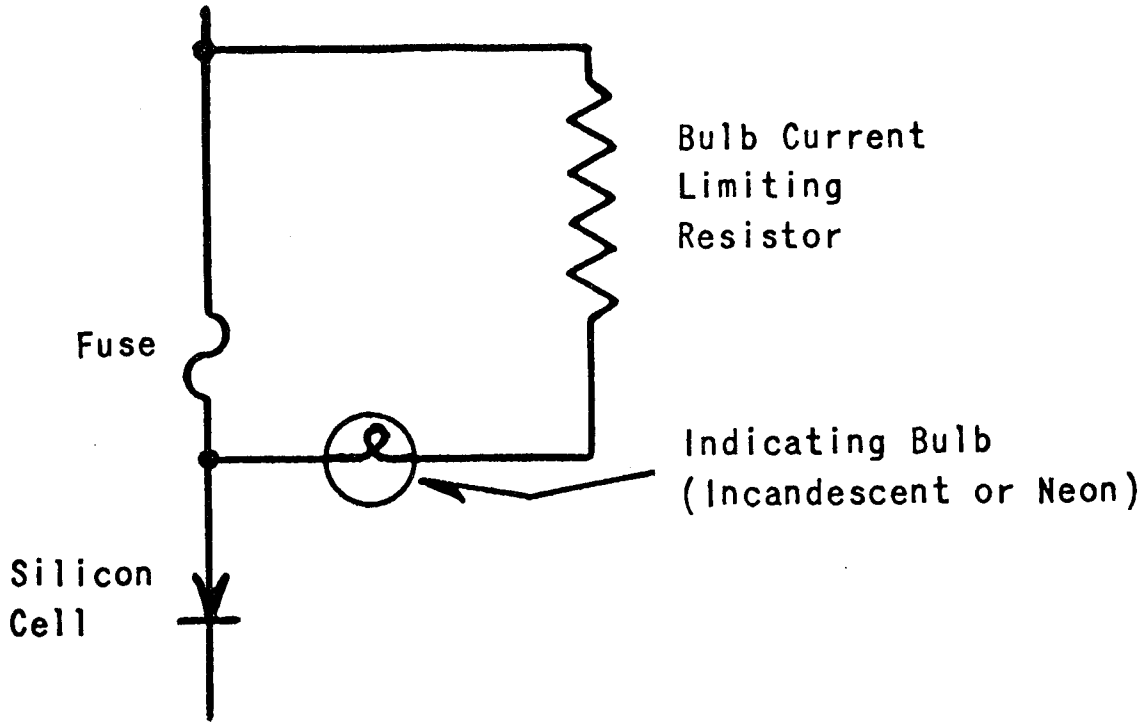

Figure 3A - Failed Cell Indicating Scheme - One Cell in Series

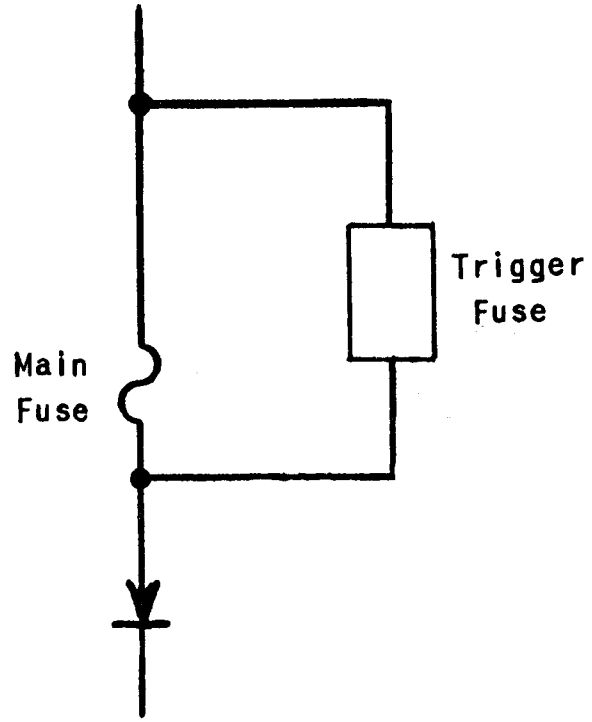

Figure 3B - Trigger or Indicating Fuse

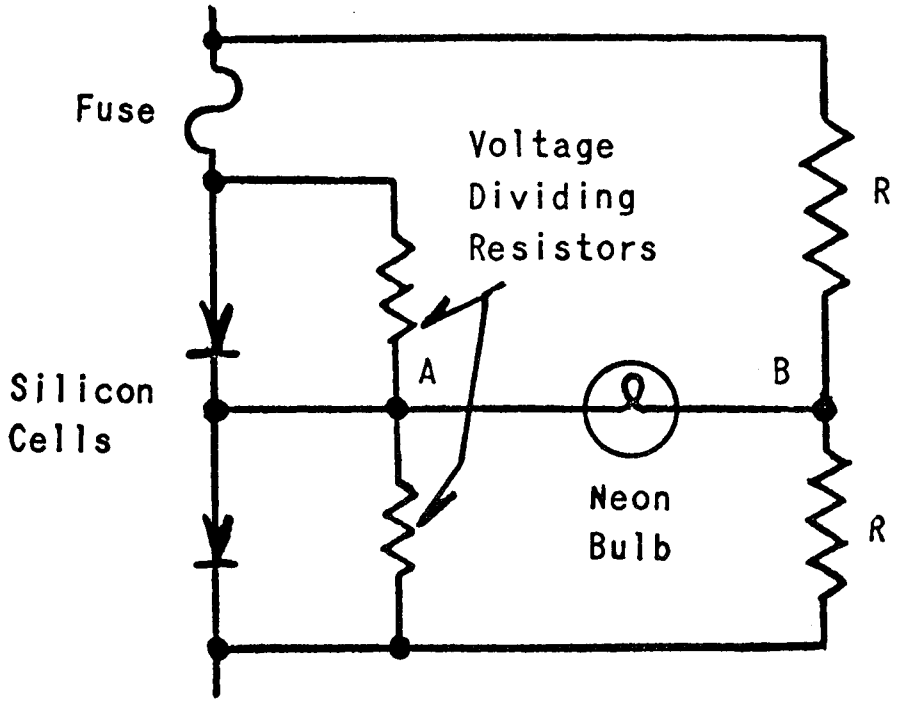

Figure 4 - Failed Cell Indicating
Scheme - Two Cells
In Series

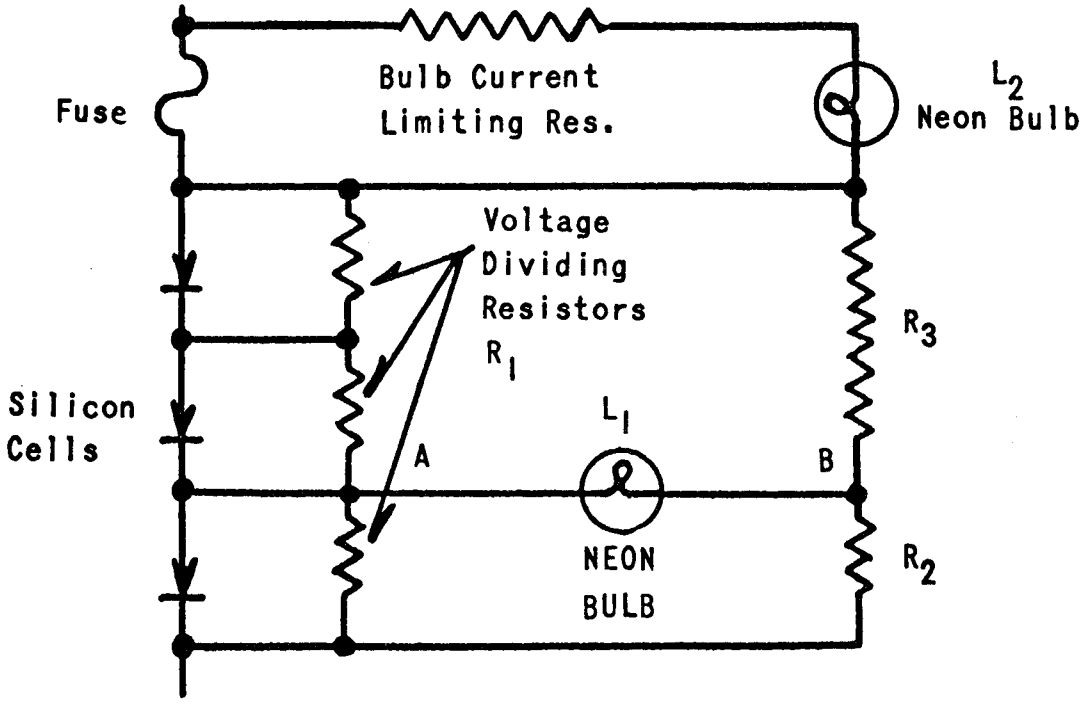

Figure 5 - Failed Cell Indicating
Scheme - Three Cells
In Series