Case Study #177: What Happens When Two Heaters With Different Wattage and Voltage Are Wired In Series

A customer phoned in one day about an issue with two heaters. The two heaters were wired in series on a barrel. One of the heaters, however, was getting red hot and the other was not. He did not know why. Our first thoughts were that maybe the heaters were accidentally wired in parallel rather than in series. After checking with the customer, we found that the heaters were wired correctly. But, why was one of them getting so hot?

One heater was 610 W at 230 V. The other was 1260 W at 230 V. The customer applied 460 V across these two heaters when they were wired in series.

Hint: to successfully wire two heaters in series, they must be equal wattage AND equal voltage, i.e., they must have equal resistance.

Now to see what happens when we calculate the resistance of each heater:

$$R_1 = \frac{E^2}{W} = \frac{230^2}{610} = 87\ \Omega$$

$$R_2 = \frac{E^2}{W} = \frac{230^2}{1260} = 42\ \Omega$$

Now when we apply 460 V across these two heaters that are wired in series the circuit looks like this:

Total Ω = 87 Ω + 42 Ω = 129 Ω
I = E /R = 460 V /129 Ω = 3.57 A
Voltage across the 87 Ω heater = (3.57 A)(87 Ω) = 310 V
Voltage across the 42 Ω heater = (3.57 A)(42 Ω) = 150 V

Wattage Heater 1 = E x I = (310 V) (3.57 A) = 1,107 W
Wattage Heater 2 = E x I = (150 V) (3.57 A) = 536 W

	Stamped Wattage	Actual Wattage
R_1	610 W	**1,107 W**
R_2	1,260 W	535 W

This is the heater that got red hot