TUTCO
HEATING SOLUTIONS GROUP

TUTCONNECT

FARNAM | SUREHEAT | CONDUCTIVE | WATTCO | NOVEMBER 2024

Building Custom Solutions

TUTCO Farnam excels at creating custom products for our customer's unique applications

At TUTCO Farnam, we specialize in the design and engineering of custom heating solutions that are tailored to meet the unique demands of each customer. While many people assume that "custom" automatically means "expensive," custom heating solutions are not always more costly, especially when you factor in the overall savings they can offer in performance, reliability, and integration with your system.

When considering whether a custom heater is the right choice, we typically begin by looking at the total cost and overall needs. For most projects, we recommend a minimum annual spend of around $15,000 before we begin to explore custom options. It is important to understand that almost all heaters at TUTCO Farnam are customizable. Even our standard heaters can be tailored to meet specific requirements such as wattage, voltage, inlet and exhaust temperatures, and more. That said, the majority of our products, approximately 80%, are fully custom-made to suit customer's exact specifications.

One of the key aspects of custom heating solutions is understanding the true cost of a project. While adapting to someone else's heater might seem like the more economical choice upfront, it can actually cost more in the long run. Having to adapt to a heater that doesn't fully meet your needs could result in performance issues, inefficiencies, and costly modifications to your system. Rather than just providing "a solution", a custom heater is designed to be "your solution".

The process of customizing a heater begins with a conversation about your specific needs. We start by reviewing the physical space where the heater will be installed—its size and configuration—and understanding the temperature range you need to achieve. From there, we discuss any additional requirements, such as the need for thermostats or temperature sensors. We also look at how the heater will integrate into your existing system, which may involve custom lead lengths, connectors, or enclosures that allow for easier installation and operation.

At TUTCO Farnam, our engineers are committed to understanding every aspect of your project. We take the time to listen to your needs and apply our expertise to provide the best design for your application. Whether it's retrofitting existing equipment or designing something entirely new, we work closely with you to ensure the final product meets all of your technical requirements.

Once we have a clear understanding of the project, we follow a structured process to deliver the custom solution. First, our team creates preliminary drawings based on your specifications. After you approve the design, we move on to building a prototype, which allows us to test and refine the heater to ensure it meets the required performance standards. We then move to production where we have the capabilities to quickly ramp up to meet your production schedule.

With over 2,000 custom heater designs in our portfolio, we've likely already created a solution similar to what you need. And with manufacturing facilities in the U.S., Canada, Mexico, and China, we can support production needs wherever your final assembly is located.

At TUTCO Farnam, our commitment is to provide more than just a product—we offer the very best in design and engineering to deliver a custom heating solution designed specifically for your unique needs.

LEARN ABOUT OUR CUSTOM SOLUTIONS PROCESS

Heaters in Series and Parallel

by Ian Renwick

Electric Heating elements can be connected to a voltage source in a variety of different ways. Making sure things are done correctly is important so that you get the performance expected and, most importantly, to make sure it's done safely.

If you have a 240V power supply but only 120V heaters available, are you able to use them? Why do people prefer heaters connected in series while others prefer them connected in parallel? What's the difference? Are any special considerations required?
We'll cover those topics and more in this article.

When connecting electric heaters in series, they are all placed end-to-end along a single path, electrically, meaning the same current flows through each heater; whereas, in parallel, the heaters are connected with each heater across the voltage source so that the current splits and passes through the heaters separately, with each component experiencing the same voltage.

Key differences

Current flow:

In a series circuit, the current is the same through every heater, while in a parallel circuit, the current is divided among the different heaters.

Voltage distribution:

In a series circuit, the voltage is divided across each heater depending on their individual resistance, while in a parallel circuit, the voltage is the same across all heaters regardless of their individual resistance.

Put another way...

In series, the current through each heater is the same. The voltage drop across each one depends on its resistance.
In parallel, the voltage drop across each heater is the same. The current through each one depends on its resistance.

Circuit failure:

If one heater in a series circuit fails, the entire circuit stops working, whereas in a parallel circuit, the remaining unfailed heaters continue to operate.

Now, some more details...

When heaters are connected in series, they are connected such that the current that flows through one heater flows through every heater that is connected in series with it. If you think of electrical flow as water in a pipe, the heaters, when connected end to end (like piping) have whatever water flows through one of them, flow through all of them. In this type of connection, if the resistance of each heater is the same, then the voltage drop across each heater is the same. If the resistances are different, the voltage drops are different.

The resistance of heaters connected in series is the sum of the individual heater resistances.

Example:

10Ω, 20Ω and 40Ω heaters connected in series have a total resistance of 10Ω + 20Ω + 40Ω = 70Ω.

Two heaters in Series

```
 --------VVVVVVVV--------VVVVVVVV--------
|                                        |
 -------  + Voltage Source -  -----------
```

Three heaters in Series

```
 --------VVVVVVVV--------VVVVVVVV--------VVVVVVVV--------
|                                                        |
 ----------------  + Voltage Source -  -------------------
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In these diagrams, "VVVVVVVV" is used to represent the resistance of each individual heater.

Here are a few additional examples.

For simple one: Let's say you have 4 heaters connected in series, all rated at 100 watts when 120 volts is applied. If you apply 480 volts across those 4 heaters, the voltage drop across each one is 120 volts (480V / 4) and each one produces 100 watts. You've just made use of 4 heaters rated for 120 volts in a 480 volt power system. The drawback to that scenario is that you've got to make sure all the heaters can handle a 480V potential between the circuit and sheath; make sure the heaters' dielectric strength is sufficient. Even though each heater 'acts' as if they only 'see' 120 volts, the entire system, heaters and all, must withstand the 480V force trying to break through the internal insulating material of the heater. If you had 3/16" diameter cartridge heaters it would not be recommend doing this in a 480V scenario due the heater's small size and low dielectric strength. If you had 3/4" diameter heaters you would probably be fine.

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Heaters in Series and Parallel Continued

For a more difficult example, if you had one 100W/120V heater and two 100W/240V heaters in that scenario things would behave quite differently. First you would need to calculate the resistance for each heater and determine the wattage produced by each of those heaters knowing that the current passing through each one is the same. In this case you would have $120^2/100\Omega$, $240^2/100\Omega$ and $240^2/100\Omega$ of resistance in series or 144Ω, 576Ω and 576Ω. That's a total of 1296Ω. 480V is being applied, so the total power output of the system will be $480^2/1296$ or 177.77 watts. With 177.77 watts of power being produced at 480V, that means there's 177.77/480 or 0.37037 amps of current passing through all the heaters. Power is calculated as I^2R so the power for each heater (in order) is $0.37037^2 \times 144$, $0.37037^2 \times 576$, and $0.37037^2 \times 576$. That gives the wattages of 19.75 watts, 79.01 watts and 79.01 watts, or a grand total of 177.77 watts. That's good because it matches the overall number that was calculated earlier. For the voltage drop across each heater, and being that we know a lot about the condition of the situation, it can be calculated using RxI or P/I or $\sqrt{(PxR)}$. For the first heater RxI = 144 x 0.37037 = 53.3V and P/I = 19.75 / 0.37037 = 53.3V and $\sqrt{(19.75 \times 144)}$ = 53.3V. It's left to the reader to show that the voltage drop across the other two heaters is 213.3V each.

As stated earlier, if one of the heaters fails then the circuit is broken and all the heaters stop working. This is sometimes desirable because then you can tell if a single heater has failed and the system isn't limping along with fewer heaters than intended.

If you're into this sort of thing, here's is the formula for determining the total resistance of a system of heaters that are connected in series. If you have n heaters connected in series, their total resistance, regardless of if they're the same or not is:

$$\Omega_{Total(S)} = \sum_{i=1}^{n} \Omega_i$$

where:

ΩTotal(S) is the total resistance of heaters (n heaters) connected in series.

Σ is the capital Greek letter Sigma, meaning that everything to the right of it is summed

Ωi is the resistance of each individual heater, numbered 1 through n.

n is the number of heaters.

i is the counter used in the summation process, adding the resistances of heater Ω1 + Ω2 + Ω3 + …. + Ωi.

When connected in parallel, the current that enters the system of heaters is split between all the heaters and shared amongst them, though not necessarily evenly.

How the current is split depends on the resistance of each heater. If the heater resistances are identical then the current is split evenly between all the heaters. Think of the water pipe analogy as the heater with higher resistance have more constricted flow, so less current goes through those heaters.

When heaters have the same resistance it's straight-forward to determine the current passing through each one; divide the total current by the number of heaters.

In all cases of heaters connected in parallel, be there equal resistances between heaters or different resistances, the voltage across each heater will be the same.

Example:

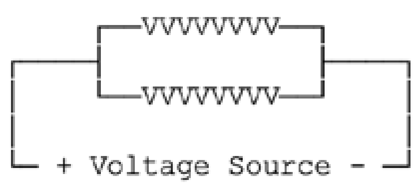
If there are two heaters connected in parallel, each having 10Ω of resistance, then the resistance over the set of heaters is 10Ω/2 or 5Ω. If there are 16 heaters connected in parallel, each having 320Ω of resistance, then the resistance over the set of heaters is 320Ω/16 or 20Ω.

The calculation required to determine the resistance of different heater resistances connected in parallel is a bit trickier. This is where each heater offers different constricted flow in that water pipe model. It is calculated as the inverse of the sum of the inverses of the individual heater resistances.

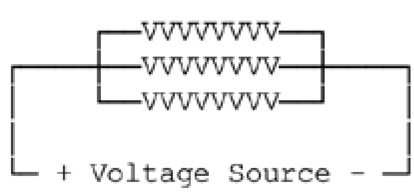
Example:

10Ω, 20Ω and 40Ω in parallel is $1 / (1/10 + 1/20 + 1/40) = 1 / (0.1 + 0.05 + 0.025) = 1 / (0.175) \approx 5.7\Omega$

Two heaters in Parallel



Three heaters in Parallel



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Heaters in Series and Parallel Continued

Again, if you're into this sort of thing, here are two formulas for determining the total resistance of a system of heaters that are connected in parallel.

If the resistances of each heater (n heaters) are the same, the total resistance of all of them connected in parallel is:

$$\Omega_{Total(P)} = \frac{\Omega_i}{n}$$

where:

ΩTotal(P) is the total resistance of heaters (n heaters) connected in parallel.
n is the number of heaters.
Ωi is the resistance of an individual heater. Since they're all the same, it can be the resistance of any one of the heaters.

If the resistances of at least one of a group of heaters (n heaters) is different, the total resistance of all of them connected in parallel is:

$$\Omega_{Total(P)} = \frac{1}{\sum_{i=1}^{n} \frac{1}{\Omega_i}}$$

This is more work because you must calculate the sum of the inverses of each individual heater's resistance, and then take the inverse of that when you're done adding the inverses together.

In this formula Ωi is the resistance of the individual heaters, numbered 1 through n, like in earlier formula. You could actually use the second formula in a scenario with all the heaters having the same resistance and you would get the same result as the first formula. It's just a lot easier to use the first one when the resistances are all the same.

Why connect heaters in parallel? If you have a system where you can achieve the necessary process temperature without all the heaters being energized, you can operate in this fashion. If a heater fails then the remaining working heaters would have to work harder with a longer duty cycle to make up for the missing heater, but it can be done. Not all situations are good for this scenario, like if you need to heat in a very specific location or the remaining heaters just can't pull off the work required. You would be able to see if a heater has stopped worked by either a change in the temperature profile of your system, an increase in duty cycle of the remaining heaters, or a reduction in total current drawn by the system. For some applications this works fine, for others not so much.

In conclusion, the choice between series and parallel connections depends on the specific application, required reliability, and safety considerations. While series connections ensure uniform current flow and easier fault detection, parallel setups provide greater system redundancy. Understanding the fundamental differences enables informed decisions for optimal heater performance.

READ MORE ASK IANS

Feature Product

Farnam's Axial Fan Heaters

Axial Fan Heaters are compact, efficient, and versatile heating solutions that meet a wide range of temperature and airflow needs. Designed to integrate seamlessly with axial fans, these heaters feature blades ranging from 2.36 inches to 4.72 inches and efficiently warm air as it passes through durable heating coils. TUTCO Farnam specializes in high-quality axial fan heaters, offering standard options in 4.72-inch (120mm), 3.15-inch (80mm), and even a smaller 2.36-inch (60mm) size. Whether you need to heat a space, cure materials, or dehumidify an environment, these heaters deliver reliable performance.

The AF-20 series Axial Fan Heaters are designed for easy installation, mounting directly onto square axial fans using the same holes and doubling as protective guards for the fan and heating element. With a broad range of wattages and custom features available, TUTCO Farnam's heaters can be tailored to meet any requirements. Customers can choose from standalone heating coils or complete assemblies that include optional mounting brackets and finger guards.

All models are UL-recognized components, ensuring safety and compliance with industry standards.

At TUTCO Farnam, we pride ourselves on being more than just a supplier. We're your partner in creating customized heating solutions. Our in-house engineering team collaborates with you to understand your unique needs, offering prototypes for testing and proof of concept. Our heating coils are manufactured under strict quality control to ensure exceptional performance and durability.

LEARN MORE

Feature Video

TUTCO SureHeat Max and Threaded Inline Heaters

Choosing the right industrial air heater is critical for optimizing efficiency and meeting the demands of your specific application. Two popular options from TUTCO SureHeat—the Max Air Heater and the Threaded Inline Heater—offer reliable performance but are suited to different needs. In this video, we compare these two heating solutions to better understand their differences.

The Max Air Heater is a dependable and compact option for industrial applications requiring moderate pressure. The Threaded Inline Heater is used in demanding, high-pressure applications and processes requiring higher inlet temperatures. Ultimately, choosing between a Max Heater and a Threaded Inline Heater comes down to the specific requirements of your application. If you're working with moderate pressures and lower inlet temperatures, the Max Air Heater is a reliable, compact solution. It's user-friendly, with easy wiring and installation, and provides excellent performance for standard industrial processes. If your project involves high pressures or extreme inlet temperatures, the Threaded Inline Heater's durability and versatility make it the better option. Its ability to handle extreme conditions, combined with customization possibilities, ensures it can meet even the most demanding environments.

Both heaters are competitively priced, so the decision will likely be determined by your system's pressure and temperature requirements. Whether you opt for the simplicity of the Max or the high-performance capabilities of the Threaded Inline, TUTCO SureHeat delivers quality solutions that deliver a high level of performance.

For guidance on selecting the right heater or exploring customization options, reach out to TUTCO SureHeat's experts or visit tutcosureheat.com to learn more.

WATCH THE VIDEO

Ask and You Shall Receive

Half a century ago, a major fast-food chain introduced the slogan "Have it your way," which has remained a cornerstone of their branding ever since. This slogan was a direct challenge to the largest fast-food chain at the time, offering customers an alternative to the "cookie-cutter" options that dominated the industry. It sent a clear message: customers didn't have to settle for a standardized offering—they could have exactly what they wanted.

This philosophy mirrors the approach we take in the heating market. While the TUTCO Heating Solutions Group offers a range of standard options, we go beyond that by customizing those options or even creating entirely new, one-of-a-kind designs. We understand that off-the-shelf solutions don't always fit the unique requirements of every application. That's why we work closely with our customers to ensure they get exactly what they need, tailored to their specifications.

At TUTCO, we pride ourselves on thinking outside the box. Whether it's developing an innovative new solution or simply pointing customers toward an option they weren't aware of, we are committed to finding the right answer. This philosophy is rooted in the age-old principle: the customer knows best when it comes to their needs.

In conclusion, we're not limited to just our standard offerings. With the combined expertise of our commercial and industrial divisions, we can address many special requests and provide tailored solutions. Backed by decades of experience in research, development, engineering, and manufacturing, we are ready to make your projects a success. No matter how simple or complex your heating needs may be, TUTCO is here to help. Because at TUTCO, we want you to have it your way.

MORE THINKING OUTSIDE THE BOX