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TURBO DIESEL REGISTER

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ISSUE 65 AUG/SEPT/OCT 2009

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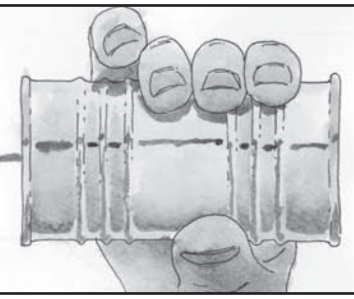

I think you will agree with me when I categorize Turbo Diesel owners as independent people who are not afraid to try something new. You are an ingenious membership who reinvents and improves a product to make it better serve your needs. You show a strong willingness to share your shadetree solutions. With your input each quarter, we publish the "Member2Member" exchange to give you a forum to tell other members how you solved a problem.

THEORY AND APPLICATION OF THE AUTOMOTIVE RELAY

by Ryan Battelle

In this article we'll explore, in simple terms, what relays are, and why you should be using them in your wiring projects.

What is a relay?

A relay is a switch. It's as simple as that. Just like the switches in your house, or your headlight switch, a relay is meant to do exactly one thing: control the flow of electricity. And just like a switch, relays are either "on" or "off" at any given moment.

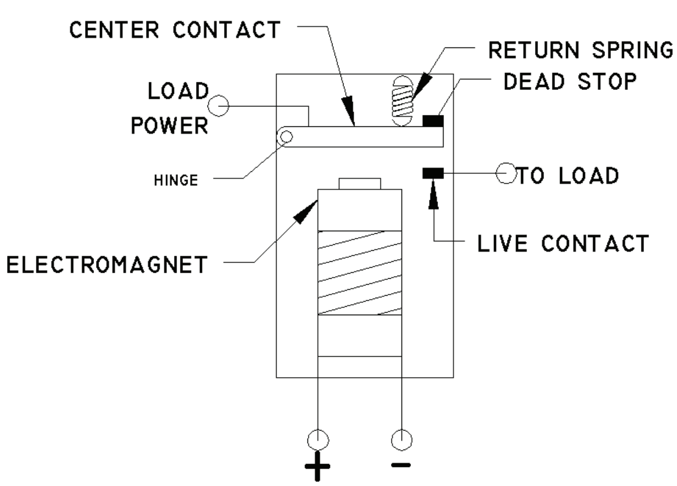

Figure 1: a single-pole, single-throw relay (SPST).

Relays have two fundamental parts: an electromagnet and a set of contacts (see figure 1). As the name implies, an electromagnet produces a magnetic field when a current passes through a wire coiled around a piece of iron. The center contact (as labeled) is made of steel and hinged at one end. When a current is applied to the + and - terminals in figure 1, a magnetic field forms, which draws the center contact down to the live contact.

The center contact is connected to a power source (labeled "Load Power" in figure 1). Since the center contact is conductive, when it is applied to the live contact, power flows through the center contact and out to whatever you've got connected to the live contact.

When current is removed from the + and - terminals, magnetism dissipates, and the center contact is drawn back up to the dead stop by the return spring.

Figure 1 depicts a single-pole, single-throw relay (commonly specified as SPST). That means it has exactly one center contact, and exactly one live contact. SPST relays are used, obviously, to switch a circuit on or off, just like a toggle switch.

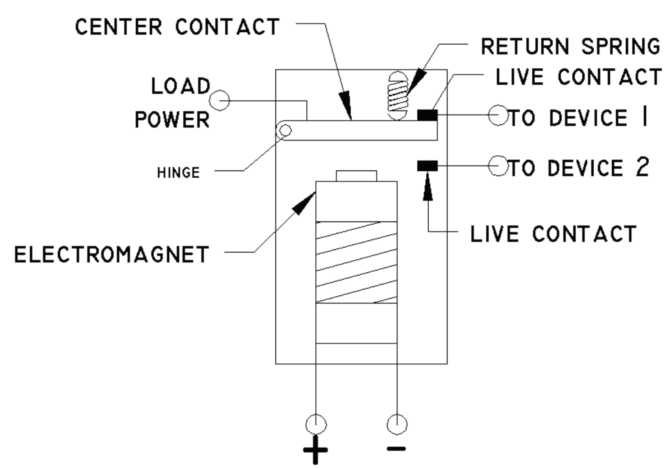

Figure 2: a single-pole, double-throw relay (SPDT).

Figure 2 depicts a single-pole, double-throw relay (SPDT). As shown, such a relay has a single center contact like an SPST, but two live contacts. The upper contact in the figure is live when the electromagnet is off, whereas the lower contact is live when the electromagnet is on. These are useful in applications where you need two different devices to be activated depending on the position of a single switch. For example, let's say you wanted to be able to monitor both front and rear axle fluid temperature from a single gauge in the cab. You could wire each temperature sensor to its own live contact in figure 2, and then use a toggle switch to select between the two.

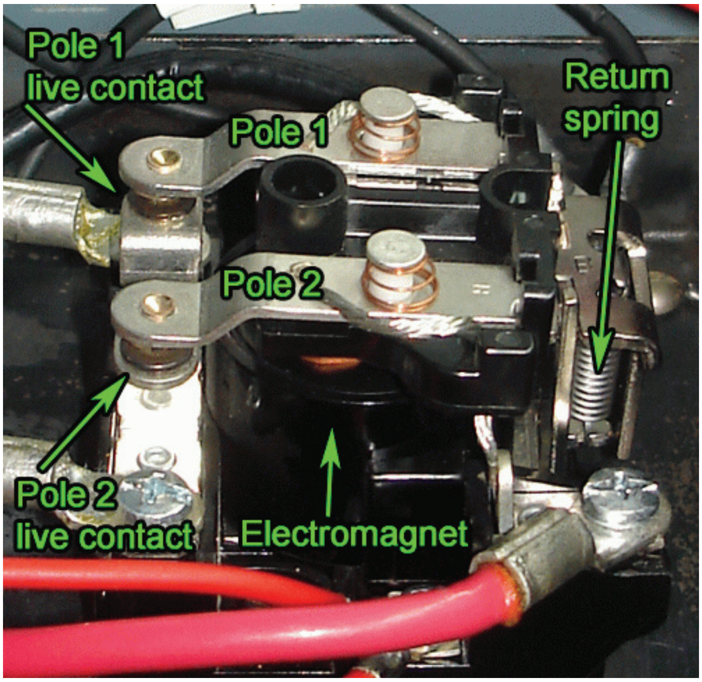

Figure 3: a double-pole, single-throw relay (DPST).

The next-most-complex relay type is the double-pole, single-throw (DPST) type. This relay has two separate center contacts, both of which are actuated by a single electromagnet (see figure 3). The center contacts (labeled "Pole 1" and "Pole 2" in the figure) are electrically isolated from each other. This type of relay is useful when you have two circuits that must each have its own independent connection to a source. (You could certainly achieve the same effect using two separate SPST relays, but the DPST relay would have fewer moving parts and, therefore, be slightly more reliable and easier to wire.)

We can continue building more complex relays by adding more poles. The DPDT (double-pole, double-throw) type would be an evolution of the DPST relay in figure 3. With such a relay, there would be an additional set of live contacts sitting above the two depicted that would be active when the electromagnet is off.

Why should I use a relay?

At this point it should be apparent that it's possible to completely ignore relays and simply use the manual switch to activate/deactivate your circuits. So why would anyone want to go to the trouble of wiring a relay instead? The main reason is that relays permit a very small current device to control a very large current device.

Take your starter motor for example. On a cold startup, that motor can draw 1000 amps (or more). A manual switch capable of handling that much current would be quite impractical in the cab of your truck. Instead, your ignition switch (which isn't capable of handling more than a few amps of current) merely signals the starter relay when you turn the key to START. At that point the starter relay connects the batteries to the starter motor, and all the current travels through the relay's live contact rather than your ignition switch.

But what about more typical home-shop mechanic's circuits, like aftermarket fog lamps? Moderately-sized fog lamps might only draw around 10 amps and there are certainly small toggle switches capable of handling that much current. Why use a relay in this case?

I can think of two reasons. The first is that the use of a relay allows you maximum flexibility in choosing any switch you want. Since the electromagnet in a relay draws very little current, you can use very small switches to operate it.

Second, it's a matter of safety.

Best electrical design practice states that wherever possible, the length of wires carrying high currents should be minimized. A relay mounted close to your fog lights (for example) allows for a very short run of high-current wire, with a long run of low-current wire traveling into the cab to your switch. That way, if your high-current wires short out, you're less likely to cause a fire. Additionally, longer wires have more resistance which means more heat. Conversely, short wires have low resistance and generate less heat.

How do I wire a relay?

SPST (single-pole, single-throw) relays are very simple to wire. Your manual switch is wired to the electromagnet, and the device you're trying to power is wired to the live contact.

Typically, you ground one side of the electromagnet (the - in figure 4), and wire positive power from the switch to the other side of the electromagnet (the + in figure 4).

On the device side, you ground the negative lead on your device, and connect the positive lead to the live contact on the relay. Connect the center contact to your power source (usually a fused battery-positive).

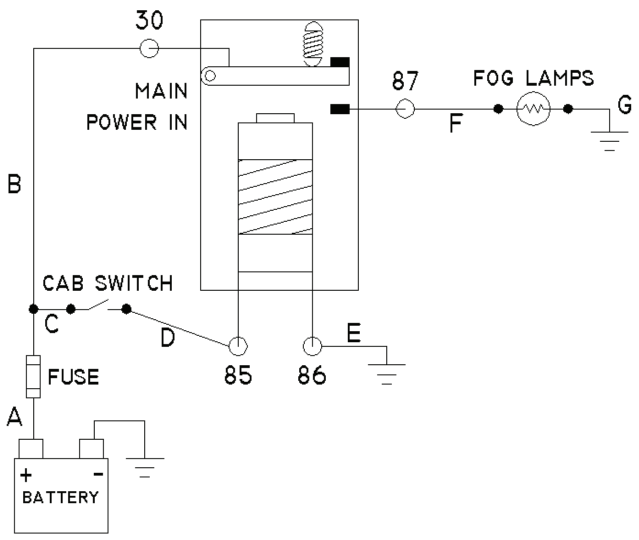

Figure 4: a SPDT relay wired for fog lamps.

Figure 4 shows the complete wiring diagram for a fuse-protected SPST relay that operates fog lamps via an in-cab manual toggle switch. The numbers (85, 86, 87, 30) correspond to the standard contact numbers printed on most automotive-style relays. This is how it's wired:

1. Connect wire A to one side of a fuse. An inline fuse can be used here if that's convenient for you.

2. Connect wire B from the other side of the fuse (step 1) to the center contact terminal of your relay. For standard relays, this is terminal number 30.

3. Tap into wire B using wire C, which you connect to one of the terminals on your in-cab switch. Note: this layout allows the fog lights to be on at any time. Connecting wire C to a "key on" or "parking light on" circuit would ensure that you never leave the fog lights on accidentally.

4. Connect wire D from the other terminal on your in-cab switch (the one you didn't use in step 3) to one of the electromagnet terminals on your relay. On a standard relay, the electromagnet terminals are numbered 85 and 86. It doesn't matter which of these you decide will be the connection to your switch.

5. Connect the other electromagnet terminal (the one you didn't use in step 4) to a good ground (wire E in the diagram).

6. Connect the positive lead for your fog lamps to the load contact on your relay (wire F in the diagram). For standard relays, this is terminal number 87.

7. Connect the negative lead for your fog lamps to ground (wire G in the diagram).

Ryan Battelle
Centerville, OH