By DON LANCASTER

Build a full-wave motor speed control and light dimmer with new Triac semiconductor and four other components

MEET the "Dymwatt." It's a no-nonsense light dimmer and power-tool speed control that provides up to 600 watts of 117-volt a.c. with a symmetrical waveform and full-range, variable power output. The circuit uses only five electronic parts and fits in the palm of your hand.

With the Dymwatt, you can get precise control of incandescent lights, photo-floods, soldering guns and irons, and electric drills. It will also control any motor rated up to 1/2 horsepower and equipped with brushes—including most, but not all, sanders, fans, and electric mixers. The only things this control can't handle are fluorescent lights and induction motors—but neither can most of the ordinary power controls.

The two special parts in the circuit, Q1 and D1, price out at $6.98 and $2.25 respectively. This puts the Dymwatt's cost at less than $10 if you've got a volume control, a box, and two stock capacitors.

The "Triac." Older control designs call for SCR's. A single SCR provides a half-range type of control, as between half and full brightness, or between zero and half brightness. To provide full-wave, full-range control, you have to add parts—usually a second SCR, a single mechanically switched diode, or a full-wave bridge rectifier.

The "Triac" is a new semiconductor which makes possible full-wave control without the need for all the extra components. The electrical equivalent of SCR's back to back, it operates equally well in both current directions, and with either a positive or negative gate pulse!

Two of the Triac's three leads (T1 and T2) are connected in series with the load. The third connection is the gate lead (G). (The designations T1 and T2 simply mean terminal 1 and terminal 2. Designations of anode and cathode, unfortunately, cannot apply in this case. An equivalent set of components for the Triac would contain seven transistors and several resistors.)

A small signal pulse can trigger the Triac so that it will fire just like a thyatron, and switch on full or partial
power to the load. Conduction stops when the current through the load circuit drops to zero. This happens every time the a.c. voltage goes through zero. It also happens when the load is removed, or the circuit is opened.

**How It Works.** Current through potentiometer $R_I$ (see Fig. 1) charges capacitor $C_1$ up to 30 volts, which is the breakdown voltage of the special pulse diode ($D_I$). At 30 volts, the pulse diode "snaps" on and delivers a pulse to the Triac gate. The Triac then turns on, allows full current flow through the load, and shorts out the $R_I, C_1$ circuit. Diode $D_I$ keeps conducting until $C_1$ is discharged, and then turns off. The Triac continues to conduct until the a.c. line voltage alternates and goes through a zero.

The larger $R_I$ is, the longer it takes to charge $C_1$ and the longer it takes to turn on the Triac. The fact that the Triac shuts off at the end of each $1/2$ cycle of line voltage, plus the delayed start of conduction, reduces the conduction time and the effective voltage (r.m.s.) accordingly. Thus, it becomes apparent that increasing or decreasing the value of $R_I$ controls the r.m.s. voltage. See Fig. 2.

If $R_I$ is nearly zero in value, $C_1$ charges very rapidly, and nearly full power reaches the load. If $R_I$ is very large in value, $C_1$ never reaches 30 volts within the 60-cycle swing. With each alternation of voltage, $C_1$ starts to charge in the other direction. Under this condition, gate pulses cannot be

![Fig. 1. The Triac (Q1) will conduct in either direction. A positive or negative gate pulse can trigger conduction and control r.m.s. output voltage.](image1)

![Fig. 2. When $C_1$ reaches 30 volts, $D_I$ conducts and triggers Q1. The sooner the gate pulse is developed with respect to the 60-cycle line voltage, the higher the effective output voltage. With little or no resistance in the circuit, the output is maximum. As the resistance increases, the output decreases. If the resistance is made high enough, the output is 0.](image2)

Finished Dymwatt can be plugged into one opening of a duplex receptacle without obstructing the other. You have a choice of using the controlled or noncontrolled outlet. Cost of this full-wave unit is less than that of commercially available half-wave controllers.
produced and the Triac remains cut off. By making \( R1 \) variable, it is possible to adjust for maximum or minimum power output.

Capacitor \( C2 \) is directly across the line to prevent any high-frequency pulse, which might be set up by the fast switching action of the Triac, from radiating down the power line and becoming a source of radio interference.

Construction. The Triac should be mounted on an aluminum heat sink. A \( \frac{3}{8}'' \)-thick piece of aluminum will do the trick. Bend it in a vise or small brake and then drill the holes. Use insulated mounting hardware and silicone grease to mount the Triac, as shown in Fig. 3. The Triac must be electrically insulated from the heat sink. Test the setup with (Continued on page 95)

![Diagram of heat sink and Triac assembly](image)

**PARTS LIST**

- \( C1 \): 0.1-µf, 600-volt capacitor
- \( C2 \): 0.03-µf, 600-volt capacitor
- \( D1 \): General Electric Z1-238 diode, 30-volt avalanche trigger (or Transistor ER-900, or Texas Instruments T1-43)
- \( P1 \): A.c. plug (Amphenol 61-M or equivalent)
- \( Q1 \): General Electric Z1-257 Triac
- \( R1 \): 250,000-ohm carbon potentiometer, linear taper
- \( S1 \): A.c. socket (Amphenol 61-F or equivalent)
- Misc.: Silicone grease, knob, \( \frac{3}{8}'' \) "Pop" rivets, spaghetti, solder, case, nameplate, and \( \frac{3}{8}'' \) soderless terminal, \( 2\frac{3}{8}'' \times 1\frac{3}{8}'' \times \frac{3}{8}'' \) piece of aluminum, etc.
axial cable as the down lead. Coax is completely unaffected by its surroundings. The only thing you must not do to coax is to crush it. Crushing changes the spacing between the conductors, thus changing impedance.

In order to use coax, however, you must match it to 300-ohm antennas and TV sets. Both an outdoor matching transformer, used to match the antenna to 75 ohm coax, and an indoor unit mounted on a TV set are illustrated in this article. Some TV antennas are already matched to 75 ohms, and eliminate the need for an outdoor matching transformer.

Coax is very easy to run. You can tape it to the mast or run it through a metal conduit. If you have any left over, you can coil it and hang it up behind the TV set (don’t try this with twin lead, incidentally).

Although it does cost more than twin lead initially, coax lasts much longer. It is impervious to changing weather conditions, won’t pick up interference, and can deliver good color pictures.

The Dymwatt

(Continued from page 73)

an ohmmeter to be sure there is no electrical connection.

An aluminum case will help the heat sink do its work. Do not use a smaller box than the one specified—it might get too hot to touch and could damage the Triac. The case used by the author remains relatively cool for all but the heaviest power loads; above 400 watts it becomes noticeably warm.

See Fig. 4 for parts layout. The heat sink on the inside and a dial plate on the outside of the case are held in place with a “Pop” rivet and the mounting nut of the potentiometer. Avoid overheating either Q1 or D1 when you are soldering. If you wish, a NE-83 neon lamp can be substituted for D1 to reduce cost, but it will also reduce the control range.

As long as the Dymwatt is used within its ratings and only for its intended types of loads, it is capable of long life and trouble-free service.