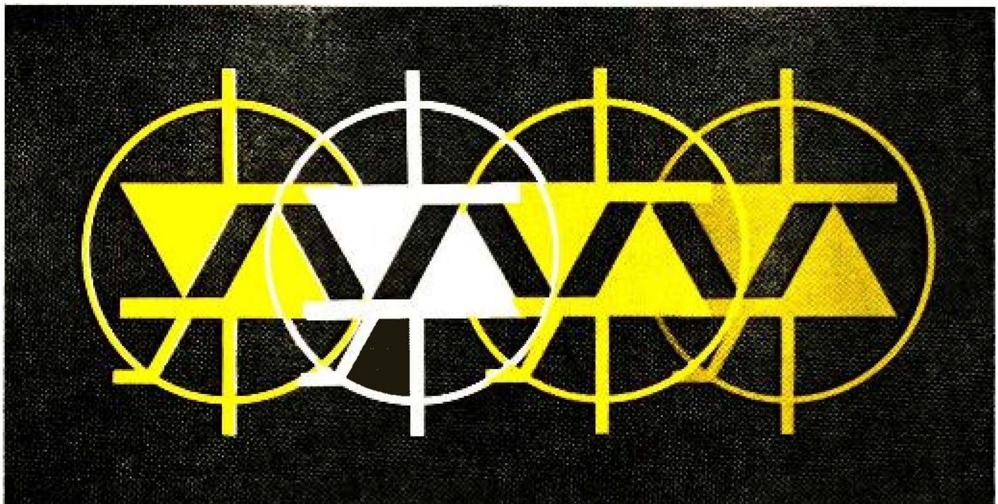


THE DYMWATT

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, photofloods, 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!

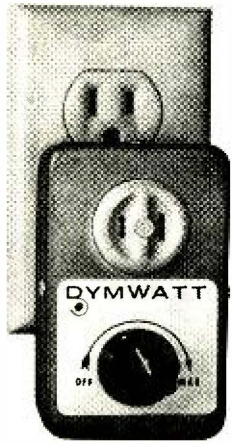
Two of the Triac's three leads (*T1* and *T2*) are connected in series with the load. The third connection is the gate lead (*G*). (The designations *T1* and *T2* simply mean terminal 1 and terminal 2. Designations of anode and cathode, unfortunately, cannot apply in this case. An equivalent set of components 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 thyratron, 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 *R1* (see Fig. 1) charges capacitor *C1* up to 30 volts, which is the breakdown voltage of the special pulse diode (*D1*). 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 *R1*, *C1* circuit. Diode *D1* keeps conducting until *C1* 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 *R1* is, the longer it takes to charge *C1* and the longer it takes to turn on the Triac. The fact that the Triac shuts off at the end of each ½ 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 *R1* controls the r.m.s. voltage. See Fig. 2.

If *R1* is nearly zero in value, *C1* charges very rapidly, and nearly full power reaches the load. If *R1* is very large in value, *C1* never reaches 30 volts within the 60-cycle swing. With each alternation of voltage, *C1* starts to charge in the other direction. Under this condition, gate pulses cannot be



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.

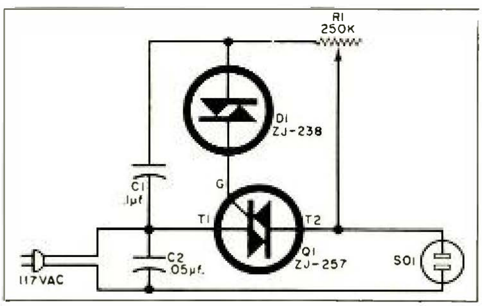
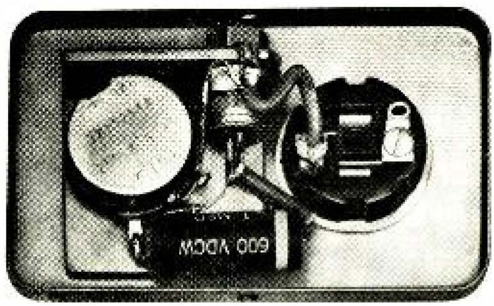


Fig. 1. The Triac (Q1) will conduct in either direction. A positive or negative gate pulse can trigger conduction and control r.m.s. output voltage.



The heat sink on the inside of the case and the dial plate on the outside are held in place by a rivet (hidden by the capacitor) and the potentiometer nut.

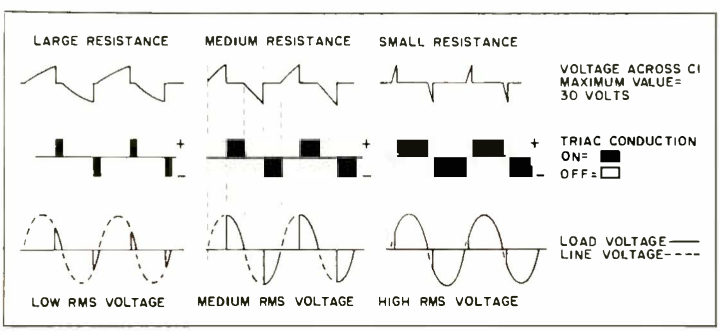


Fig. 2. When C1 reaches 30 volts, D1 conducts and triggers Q1. The sooner the gate pulse is developed with respect to the 60-cycle line voltage, the higher the effective output voltage. With little or no resistance in the circuit, the output is maximum. As the resistance increases, the output decreases. If the resistance is made high enough, the output is 0.

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 1/8"-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

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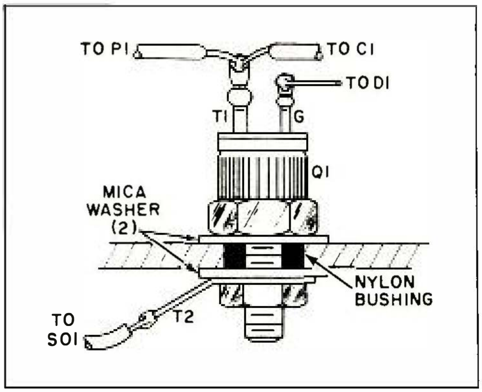

Fig. 3. Silicone grease, two mica washers, and a nylon bushing are used to mount Triac on heat sink to get thermal conduction without electrical contact.

PARTS LIST

C1—0.1-µf., 600-volt capacitor
C2—0.05-µf., 600-volt capacitor
D1—General Electric ZJ-238 diode, 30-volt avalanche trigger (or Transitron ER-900, or Texas Instruments TI-43)
P1—A.c. plug (Amphenol 61-M or equivalent)
Q1—General Electric ZJ-257 Triac
R1—250,000-ohm carbon potentiometer, linear taper
SO1—A.c. socket (Amphenol 61-F or equivalent)
1—2 1/4"x2 1/4"x4" case, and cover
Misc.—Silicone grease, knob, 1/8" "Pop" rivets, spaghetti, solder, wire, nameplate, and 1/4" solderless terminal, 2 1/4" x 1 7/8" x 1/8" piece of aluminum, etc.

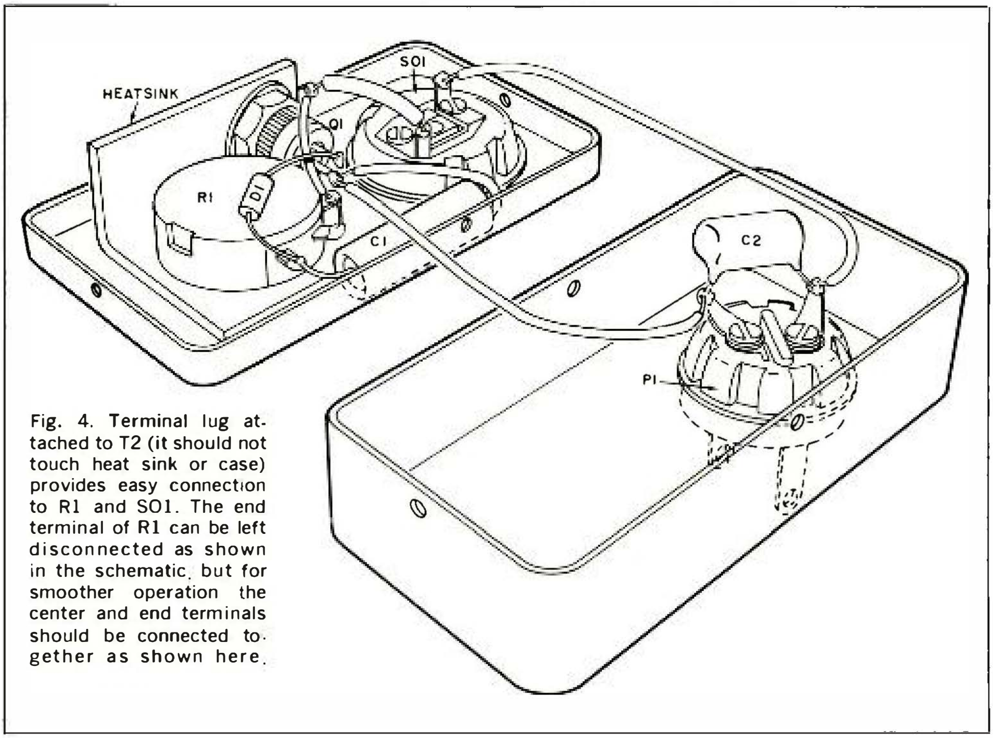

Fig. 4. Terminal lug attached to T2 (it should not touch heat sink or case) provides easy connection to R1 and SO1. The end terminal of R1 can be left disconnected as shown in the schematic, but for smoother operation the center and end terminals should be connected together as shown here.

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. —30—

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. —30—