CONSTRUCTION

THE POWER GUARD

Boosts voltage and eliminates TV picture shrinkage during summer brownouts

BY JULES H. GILDER

DURING the summer months, when power demands peak, brownouts are an all too common occurrence. As power companies cut back on the amount of voltage delivered to the ac outlets in your home, the picture on your TV receiver is likely to shrink and lose color, your lights might dim slightly, and some of your appliances may have difficulty operating on the unaccustomed low voltage. Some electrically operated appliances can even be irreparably damaged if they are operated on too low a voltage.

Most people just grit their teeth and try to bear with the inconveniences of the brownout situation. This is one way to approach the problem, but a more practical approach would be to use a device that will restore the line voltage level to normal. This is exactly what the Power Guard is designed to do. It is completely automatic. As the line voltage begins to fall below a predetermined level, the Power Guard compensates for the reduction by boosting the voltage available at its output. Then, when the power company restores normal service, the Power Guard switches itself out of the line, to remain ready to go into action again when the next brownout occurs.

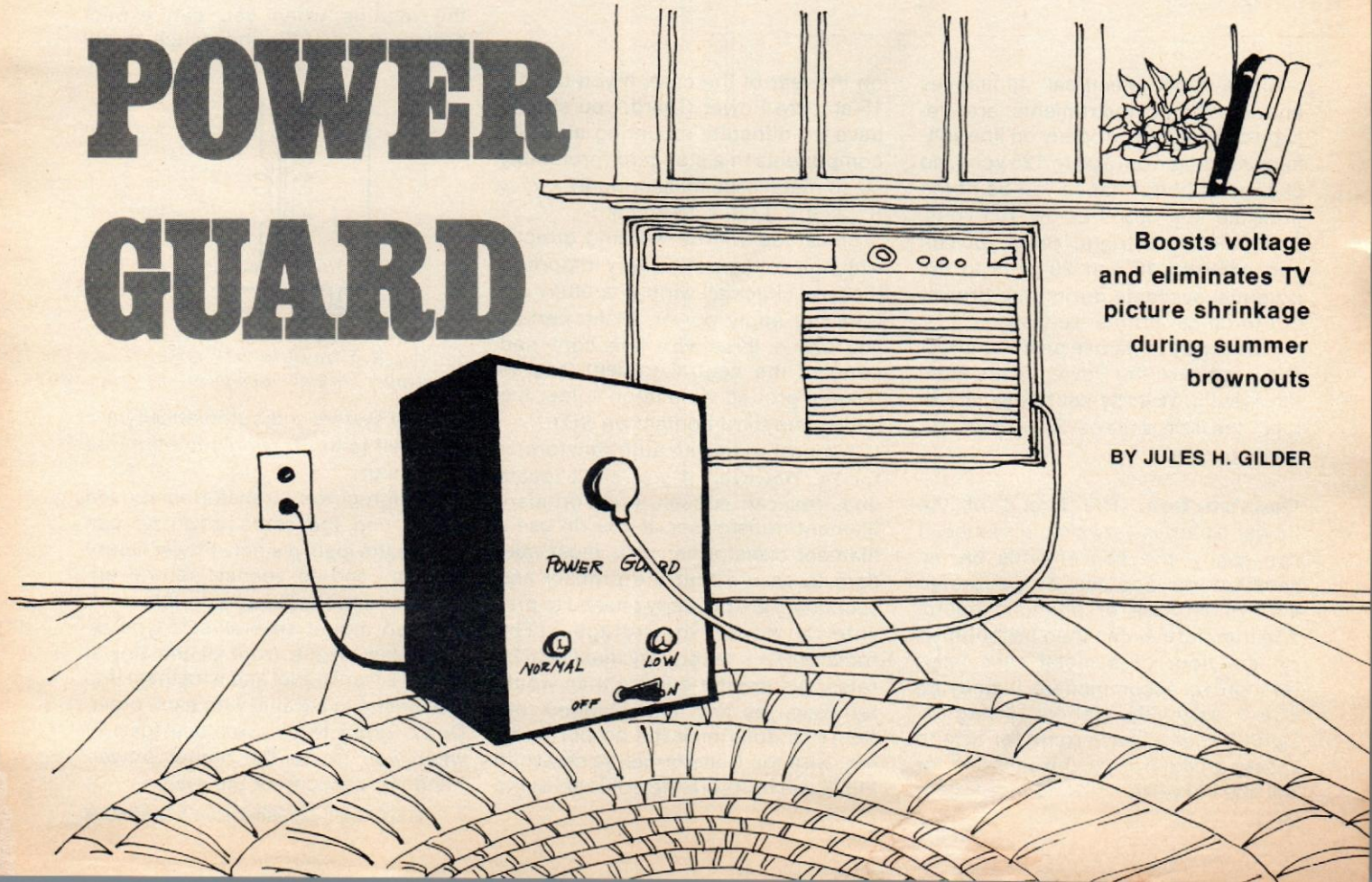
About the Circuit. A voltage-sensing circuit that operates a relay, causing it to switch a transformer in and out of the ac line is the heart of the Power Guard (see Fig. 1). The sensing circuit is made up of the voltage divider formed by *R1* and *R2*, neon lamp *I1*, and silicon controlled rectifier *SCR1*.

When switch *S1* is set to ON, line voltage is applied across the *R1*/*R2* divider network. Assuming that this potential is greater than 105 volts ac, *I1* will fire. This, in turn, indicates that the power available at the wall outlet is at a "normal" level. By adjusting *R2*, the line potential at which *I1* is triggered can be varied.

When *I1* comes on, it applies current to the gate of *SCR1*, triggering the silicon controlled rectifier into conduction and energizing relay *K1*. When this happens, the relay's lower set of contacts places output receptacle *SO1* directly across the ac line. Capacitor *C1* across the solenoid of *K1* eliminates the possibility of relay chatter that would normally be caused by the rectified voltage coming through *SCR1*.

When a brownout occurs and the line voltages drops below the value predetermined by the setting of *R2*, *I1* extinguishes and removes gate current from *SCR1*. This causes the SCR to cut off on the next zero crossing of the line voltage and deenergizes *K1*. This, in turn, switches the secondary of *T1* into the circuit, which is designed to add the primary and secondary voltages. This "boosted" voltage is then delivered to *SO1*. The magnitude of the voltage boost depends on the secondary voltage of *T1* at the reduced line voltage. The point at which the boost comes into play depends on the setting of *R2*. (Note also that, when the boost circuit is operating, *I2* comes on to provide a visual indication that line voltage is down.)

Tracking, the opening and closing of the relay's contacts caused by minor changes in line voltage, is eliminated by *I1*. The reason for this is that the neon lamp's firing voltage is higher than that required to maintain it in the ionized state. So, while the lamp requires about 110 volts to fire, it will not extinguish until the line voltage drops to 105 volts.



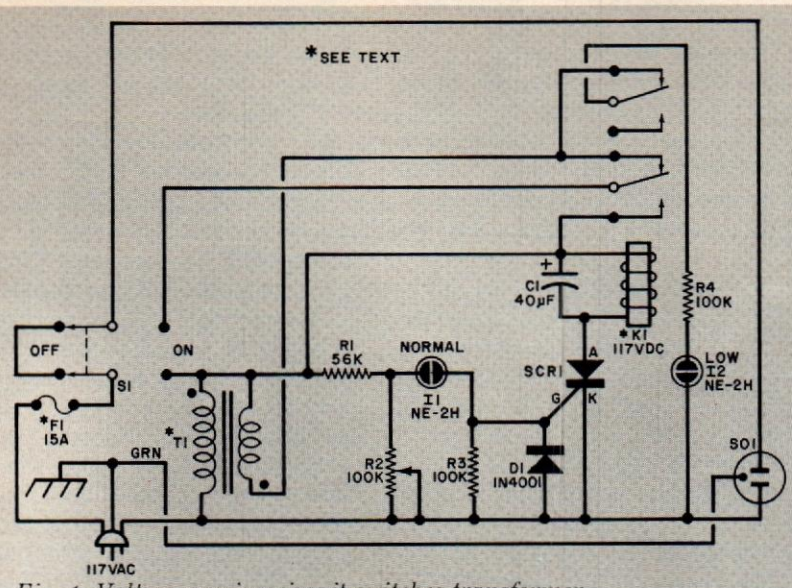


Fig. 1. Voltage-sensing circuit switches transformer in and out of circuit to keep voltage up during brownout.

PARTS LIST

C1—40-μF, 200-volt electrolytic capacitor
D1—Silicon rectifier (1N4001 or similar)
F1—15-ampere fuse (3AB, 15A)
I1, I2—NE-2H neon lamp
K1—117-volt dc relay with dpdt contacts rated at 20 amperes or more
R1—56,000-ohm, ½-watt resistor
R2—100,000-ohm trimmer potentiometer
R3, R4—100,000-ohm, ½-watt resistor
S1—Heavy-duty dpdt power switch rated at 25 amperes or more
SCR1—200-volt silicon controlled rectifier (HEP-R1211 or similar)
SO1—Three-contact chassis-mounting ac receptable
T1—Autotransformer (Allied Electronics Cat. No. 705–0144 16-ampere or 705–0104 8-ampere type) or high-current filament transformer (See text)
Misc.—Metal chassis box; heavy-duty three-wire line cord with plug attached; fuse holder for F1; perforated board and solder clips; machine hardware; hookup wire; solder; etc.

Since most electrical appliances and electronic instruments are designed to operate properly on line voltages ranging from 105 to 125 volts, no change in performance will be noted until the line drops below 105 volts. Using this as the trigger point, you can add between 10 and 20 volts to the potential available during the brownout to obtain normal service.

Placing *S1* in its OFF position effectively removes the Power Guard from the system. With *S1* set to OFF, therefore, the line voltage is coupled directly to *SO1*.

Construction. The circuit of the Power Guard is very simple. Hence, it can easily and conveniently be assembled on a piece of perforated epoxy-fiberglass or phenolic board. The transformer can then be mounted on the floor of a metal case large enough to accommodate it and the board assembly without crowding. Don't forget to leave room for *SO1* to mount on the front of the case and for the line cord exit hole and fuse holder on the rear of the case. If you build a 15-ampere Power Guard, you should have no difficulty mounting all of its components in a standard (preferably steel) metal case measuring 9″ × 7″ × 6″ (22.9 × 17.8 × 15.2 cm).

Since you will be working directly with line voltages, it is very important that you check all wiring carefully before you apply power. Make certain you use a three-wire line cord and connect the neutral (green) lead to chassis ground via a large solder lug and to the third contact on *SO1*.

It is best to use an autotransformer for *T1*. However, if you can't locate one, you can substitute an ordinary filament transformer. If you do use a filament transformer, you must take care to assure that the primary and secondary are properly phased to provide a boost in voltage. (The transformer's secondary must also be rated at a greater current than would be drawn by any load plugged into *SO1*.) To determine the proper phasing, wire the transformer as shown in Fig. 2 and measure the potential at the "output" leads. Transpose the secondary leads and again measure the output voltage. The connection scheme that yields the higher voltage is the proper phasing setup.

Setup and Use. To use the Power Guard properly, it is necessary to first adjust *R2* so that the system triggers *SCR1* at the correct voltage level. The simplest way to adjust *R2* is to plug the Power Guard into a variable transformer and decrease the potential applied to the system's power plug to 105 volts. If you don't have access to a variable transformer, a filament transformer connected as a "bucking" instead of "boosting" autotransformer can be used.

When the potential is 105 volts, adjust *R2* so that *I1* just extinguishes. At this point, the relay in the system should not be energized, and the booster winding in the Power Guard should be in the circuit. If you measure the voltage at *SO1* it should be between 110 and 120 volts ac.

Once *R2* has been adjusted for the proper triggering level, it need not be touched again. The Power Guard is ready to use.

Appliances can be permanently plugged into *SO1* and the Power Guard's switch set to OFF when no brownouts are expected. Then, during the months when you can expect brownouts, just flip the switch to ON,

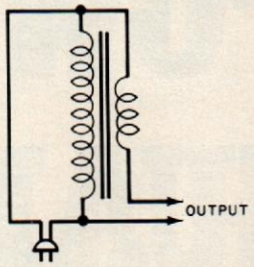


Fig. 2. Circuit to determine proper transformer phasing.

and the system will automatically adjust itself to the varying conditions as they occur.

If a high-current transformer is used for *T1* and the contacts on *K1* can handle the load, a single Power Guard can be used to service several appliances simultaneously. In this case, you can mount several *SO1*-type receptacles on the front of the Power Guard's front panel and wire them into the system in parallel with each other. Don't forget to also replace fuse *F1* when you go to the higher power-handling capacity of the system. ◈