BUILD A

SOLAR CONTROLLER

Electronic temperature comparator

for solar energy systems or attic fans

BY JERALD M. COGSWELL

THE SEARCH for new energy sources has encouraged amateurs as well as professional engineers to experiment with solar energy hardware as used in space heating. A typical solar heating system consists of three functional parts: solar energy collection, heat storage, and heat distribution. Automatic controls are required to operate the fans, blowers, pumps, etc. and coordinate operation of the overall system.

Because the backyard (or rooftop) experimenter may be discouraged by the high cost or unavailability of suitable controls, the Solar Controller described here should come in very handy. It can be built for about $35 and can be easily adapted to turn on attic fans when needed. It thus reduces the cooling load and prevents costly over-running of fans.

The Solar Controller is a temperature comparator that turns on a blower or pump when the air or fluid in the solar collector is at a sufficiently high temperature to justify a transfer to the storage medium. In the fan application, control is by the temperature difference between the attic and outside air (or between ceiling and floor of a large room).

Circuit Operation. The basic controller circuit is shown in Fig. 1. In *IC1*, a voltage comparator, the resistances of two temperature-dependent resistors (*TDR1* and *TDR2*) are compared, with *TDR1* placed in the storage medium and *TDR2* in the solar collector. When *TDR1* is warmer than *TDR2*, its resistance is higher and the higher voltage at the inverterting (-) input to *IC1* keeps its out-

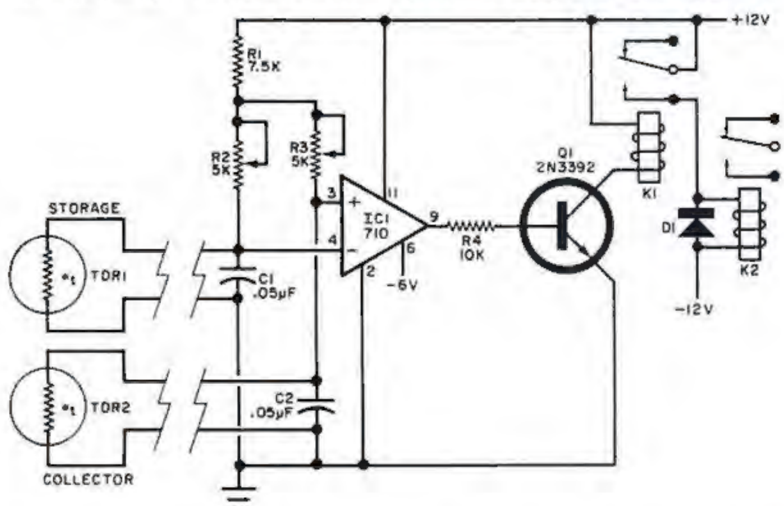

Fig. 1. Comparator IC1 turns on or off depending on resistances of TDR1 and TDR2. When IC1 is on, Q1 and the relays are energized.

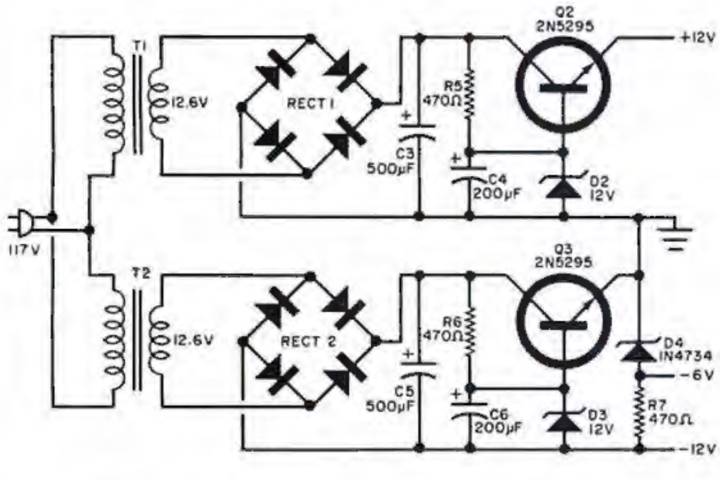

Fig. 2. The power supply for the solar controller is standard design and provides regulated positive and negative outputs.

PARTS LIST

C1,C2—0.05-μF, ceramic disc capacitor
C3,C5—500-μF, 25-V electrolytic capacitor
C4,C6—200-μF, 25-V electrolytic capacitor
D1—General-purpose silicon rectifier diode
D2,D3—12-V, 1-W zener diode (1N4742, or similar)
D4—6-V, 1-W zener diode (1N4734 or similar)
IC1—710 voltage comparator
K1—12-V, 600-ohm coil relay
K2—24-V, 10-ampere contacts relay
Q1—2N3392 transistor
Q2,Q3—2N5295 transistor (or similar)
R1—7500-ohm, ½-W resistor
R2,R3—5000-ohm multi-turn trimmer potentiometer
R4—10,000-ohm, ½-W resistor
R5,R6,R7—470-ohm, ½-W resistor
T1,T2—12.6-V, 300-mA transformer (Radio Shack 273-1385 or similar)
TDR1,TDR2—TG-1/8, 100-ohm, ±5% Sensitor
Misc.—Suitable enclosure, perforated or pc board, socket for IC1, twin lead cable for sensors, heat sinks(2), power cord, mounting hardware.
Note: The Sensitors are available from Texas Instruments semiconductor dealers, or from Texas Instruments, 2916 Holmes St., Kansas City, MO 64109 at $2.40 each.

put in the low state. When *TDR2* gets warmer, the voltage across it gets higher and, when it is about 5 millivolts higher than the voltage across *TDR1*, the output of *IC1* goes high.

When this happens, transistor *Q1* is turned on and activates low-power relay *K1*. The latter, in turn, activates a 24-volt heavy-duty relay, *K2*, which handles the power requirements of the system.

Capacitors *C1* and *C2* prevent transients from affecting the inputs of *IC1*. Trimmer potentiometers *R2* and *R3* are used to preset the voltages on *IC1*. Diode *D1* is a general-purpose silicon rectifier used to protect the contact of *K1*. If desired, *Q1* can be replaced by a power transistor (such as RCA 40594) and one of the relays can be eliminated.

The power supply for the Solar Controller is shown in Fig. 2.

Construction. All components except the power transformer and relays can be mounted on a 3" x 6" piece of perforated board or pc board. Use small solder clips for connections to *TDR1*, *TDR2* and the relay. The entire system can be mounted in any type of enclosure. Use a heat sink for *Q2* and *Q3*.

The temperature sensors can be mounted at a distance from the rest of the circuit provided the resistance of the interconnecting leads does not exceed a few ohms. Use #14 wire or conventional slender twin leads. Solder the leads to the sensors carefully (and quickly) and anchor the soldered ends in silicone or epoxy. Be sure the bodies of the resistors are exposed to insure fast thermal response to temperature changes.

Adjustment. Set trimmer potentiometer *R2* at about its 3/4-resistance point. Then place the body of *TDR1* in a bowl of water that has been heated to the average temperature you expect in the storage medium. Place *TDR2* in another bowl of water that is between 5° and 10°F hotter than the first bowl. You will have to determine the exact temperature difference you want the circuit to detect.

Once both temperature sensitive devices are in their water bowls, and the water temperature difference is what you want, adjust trimmer *R3* until relay *K1* activates. The circuit can be made as sensitive as your needs demand. Note also that although the device appears passive when both probes are at room temperature, a gust of warm breath, or the touch of a finger on *TDR2*; or a drop of cool water on *TDR1*, will cause *K1* to be energized. ◇