A Fan-Delay Timer For Air Conditioning

Saves on cooling costs by purging cool air trapped in an air-conditioning system when the compressor stops
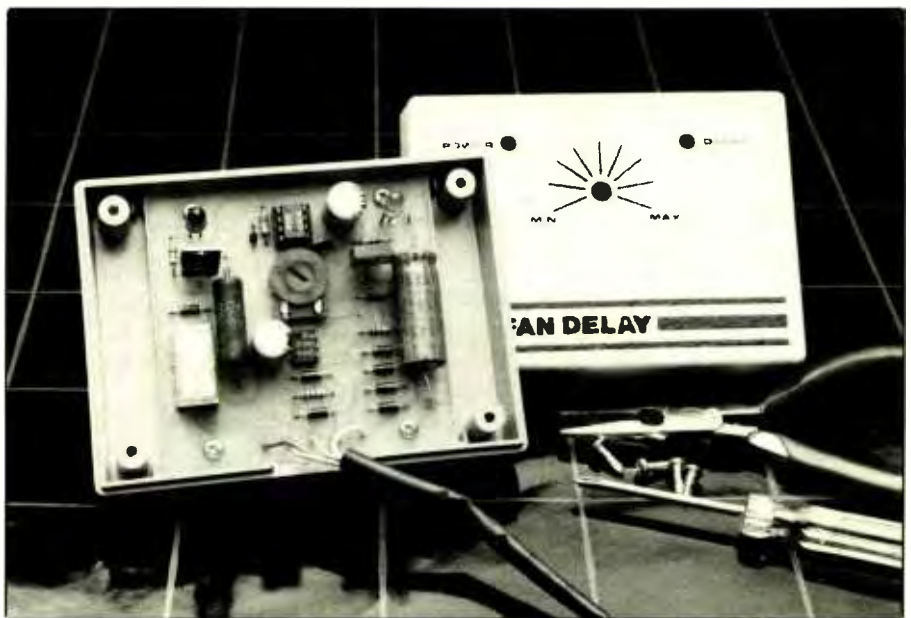
By Bill & Kathy Owen

Residential central air conditioners are usually controlled by a bimetallic thermostat whose basic design is more than 100 years old. Simple in design and virtually fail-safe in operation, this type of thermostat simultaneously switches on and off the air conditioner's compressor and fan. This causes cool air inside the system's ductwork and around the cooling coils to remain where it is. As a result, the air does not get into the areas you want to cool.

If the fan could be made to remain on for several minutes after compressor shutdown, however, the cool air could be forced into the rooms to keep them cooler for a longer period of time. Moreover, the compressor would cycle less frequently, resulting in better operating economy and less equipment wear and tear. The Fan-Delay Timer to be described here can be added to your present bimetallic thermostat to do this inexpensively.

The timer can be set so that your air-conditioning system's fan runs on for a precise period of time to maximize cooling without adversely affecting economy.

How it Works

To understand the operation of the Fan Delay Timer, let's examine how a thermostat operates. In the modern thermostat, 24 volts ac is provided by a step-down transformer inside the air-conditioning unit. Only one side of the transformer (the secondary red or return wire) is brought to the thermostat.

In the typical air-conditioning system, three other wires are brought to the thermostat. These come from the heat, compressor and fan contactors. When the thermostat connects any of these lines to the RETURN line, that part of the system is activated. Only low-power 24 volts ac is switched by the thermostat, not the full 117 volts at high power needed to power the cooling, heating and fan loads.

When the system is operated in the automatic mode, many thermostats switch on and off the fan and compressor in parallel. Hence, fan and compressor are always simultaneously switched on and off. The Fan Delay Timer keeps the fan on when the compressor cuts out, without otherwise affecting system operation.

In Fig. 1 is shown the complete schematic diagram of the Fan Delay Timer circuit. Note the routing of the Y IN and Y OUT conductors through the normally closed contacts of the relay. When relay *RY1* is energized, these normally closed contacts open, breaking the Y IN and Y OUT connection.

Power for the project is obtained from the RETURN and HEATING contactor conductors, where 24 volts ac is always present when heat is not being used. The 24 volts ac is rectified by *CR1* through *CR4* and filtered by *C1*, after which it is regulated by *VR1* to provide the 12 volts dc required to power the rest of the circuit. Red light-emitting diode *LED1* serves as a power-on indicator.

Time delay is provided by 555 timer *U1*, configured here as a monostable multivibrator whose timing cycle is determined by the time constant of *R4*, *R9* and *C1*. Because *R9* is a potentiometer, time delays ranging from less than 1 minute to about 10 minutes allow the system to be optimized for changing conditions.

During the time-delay period, pin 3 of *U1* is high, causing *Q1* to conduct and energize *RY1*. Current through *RY1*'s coil is limited by *R10*, and green or yellow *LED2* lights to tell you when the relay is energized and the fan delay countdown is in progress.

Every time the cooling circuit is broken and *U1* is triggered, the LED inside optocoupler *U2* senses this event. When the compressor is energized, the Y and RETURN circuits are at the same potential and no current flows through *U2*'s LED. As soon as the compressor contactor is broken, 24 volts ac is present and is rectified by
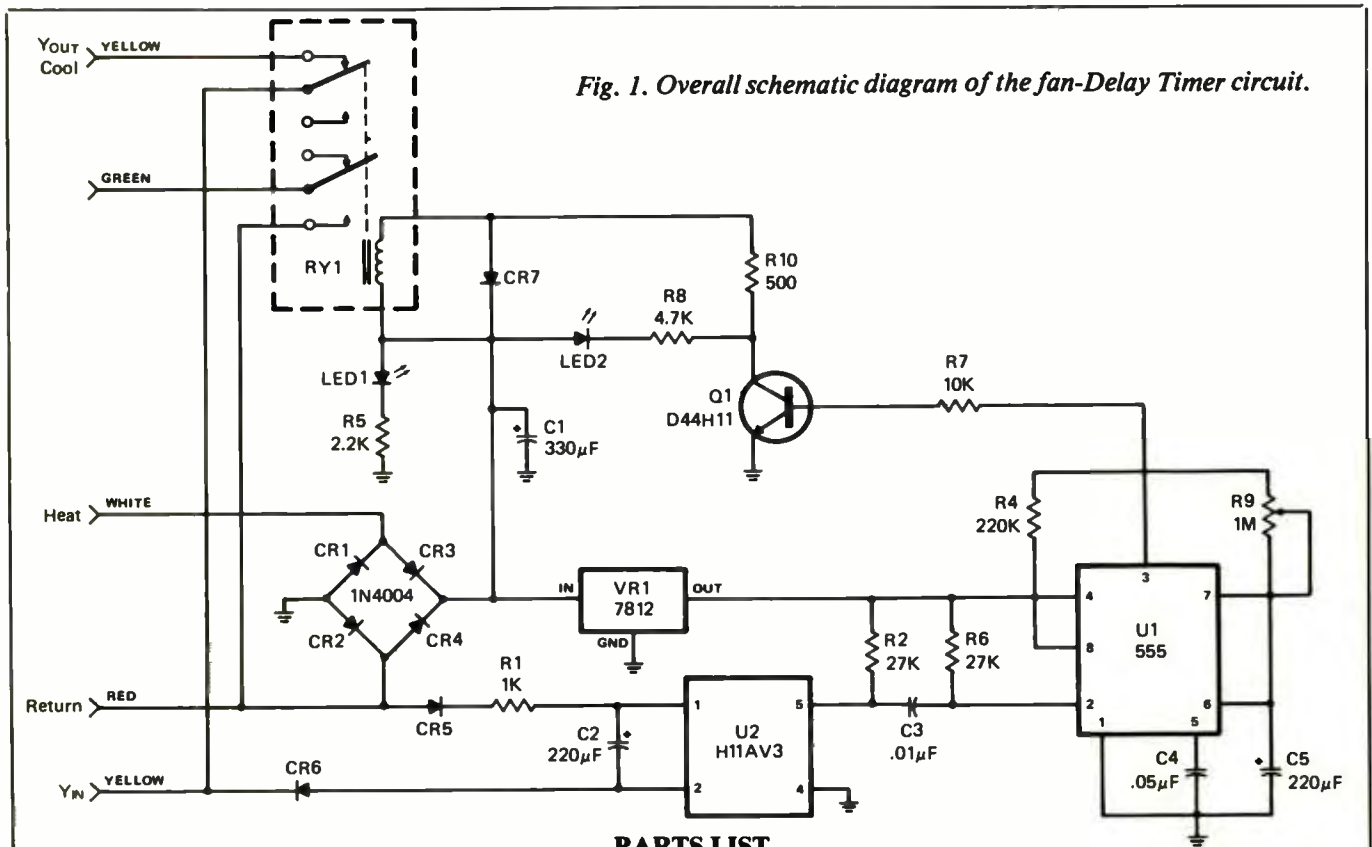

Fig. 1. Overall schematic diagram of the fan-Delay Timer circuit.

PARTS LIST

Semiconductors
CR1 thru CR7—1N4004 rectifier diode
LED1,LED2—Light-emitting diode (one red, one green)
Q1—D44H11 transistor
U1—555 timer
U2—H11AV3 optocoupler
VR1—7812 12-volt regulator

Capacitors
C1—330-μF, 40-volt electrolytic
C2,C5—220-μF, 16-volt electrolytic
C3—0.01-μF disc
C4—0.05-μF disc

Resistors (¼-watt, 5% tolerance)
R1—1,000 ohms
R2,R6—27,000 ohms
R3—Not used
R4—220,000 ohms
R5—2,200 ohms
R7—10,000 ohms
R8—4,700 ohms
R10—500 ohms, 2 watts
R9—1-Megohm flat-mount pc-type trimmer potentiometer

Miscellaneous
RY1—24-volt, dpdt pc-type miniature relay

Printed-circuit board; socket for U1; Molex Soldercons for U2 (optional; see text); suitable case; color-coded stranded hookup wire (see text); solder; etc.

Note: The following are available from NRG Electronics, P.O. Box 24138, Ft. Lauderdale, FL 33307: Etched and drilled pc board for $9.95; complete kit of all parts except cabinet for $17.95; drilled and silk-screened plastic cabinet for $7.95. Please add $2.75 P&H for each order. Florida residents, add 5% sales tax.

CR5 and CR6 and filtered by C2. When U2's LED lights, the optocoupler's internal phototransitor conducts and sends a negative pulse through C3 to start U1's timing cycle. The collector of U2's internal phototransistor, at pin 5 of U2, remains low as long as the compressor contactor is open, but C3 prevents U1 from triggering.

Construction

To make the Fan-Delay Timer as compact as possible, printed-circuit board construction is recommended. You can fabricate your own pc board, using the actual-size etching-and-drilling guide shown in Fig. 2, or purchase one ready for wiring from the source given in the Parts List.

Wiring of the board is simple and straightforward, as shown in the drawing in Fig. 3. Saving the IC for last, wire the components to the board exactly as shown. Make sure that the solid-state devices and electrolytic capacitors are properly oriented before soldering. Also, use a socket for U1. A socket is also recommended for U2, but since this is a 6-pin device, you must make a "socket" using

Some Possible Thermostat Wiring Schemes					
Fan-Delay Board	**R**	**W**	**Y OUT**	**G**	**Y IN**
Wire Color	red	white	yellow	green	yellow
Some possible	R5	4	Y6	G	
thermostat	R	W	Y	G	
terminal board	RH	W	Y	G	
markings	4	W	Y	G	
	M	H	C	F	
	RETURN	HEAT	COOL	FAN	

Molex Soldercons if you cannot locate a supplier of 6-pin sockets. If you wish, however, you can simply solder U2 directly into place. Mount the red POWER LED1 and green or yellow DELAY LED2 so that the bottoms of their cases are 1″ above the surface of the board.

When all components have been mounted on the board, plug in U1 and U2. Then remove ¼″ of insulation from both ends of 12″ lengths of stranded hookup wire (two yellow and one each red, white and green). Twist together the fine conductors at each end and lightly tin with solder. Then plug one end of each wire into the appropriate holes at the bottom of the board and solder into place. Follow the color-coding scheme detailed in

Fig. 1 (G = green; Y IN and Y OUT = yellow; R = red; W = white).

You can house the project inside any enclosure large enough to accommodate it. The prototype shown in the lead photo was built into a 4¾″ × 3¼″ × ½″ plastic box. The 1½″ depth of the this box provides enough clearance for the components on the board and is shallow enough to permit the domes of the LEDs to fit into holes in the top of the box to provide easy viewing from almost any angle.

Prepare the box by drilling two ¼″ holes for the LEDs and a ³⁄₁₆″ or ¼″ hole for access to R9, and cut or file a slot where the two halves of the box meet to provide a means for the five

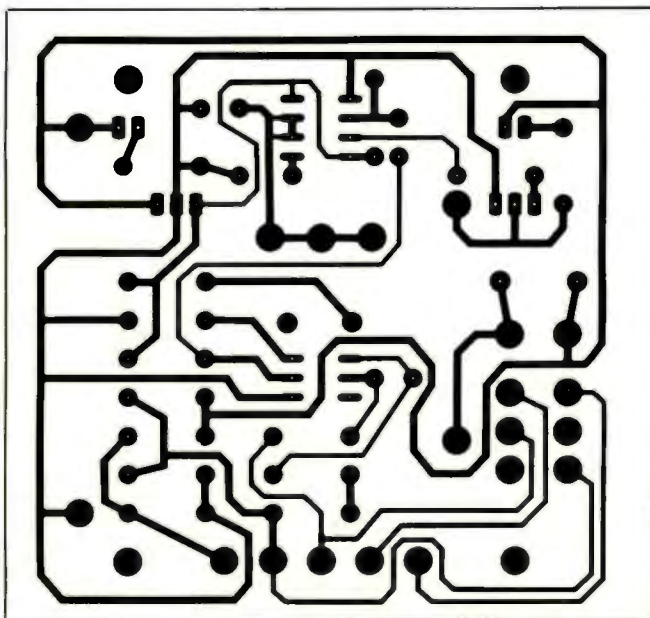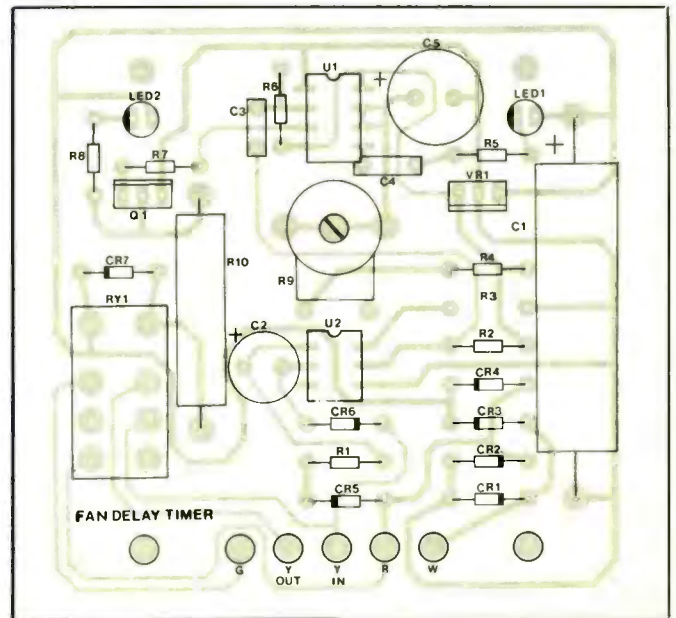Fig. 2. Actual-size etching-and-drilling guide.
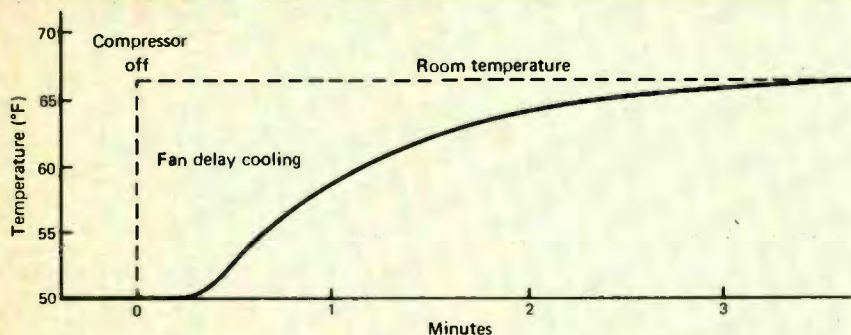

Fig. 3. The components-placement diagram.

Cost Analysis

Shown in the graph is a plot of the rise in air temperature measured at an air-conditioning vent during and after compressor operation. Note that it takes more than 3 minutes for the temperature inside the air conditioner to equalize with room temperature. This 3 minutes roughly equates to 1 minute of compressor on-time. Consider now that a typical air-conditioning system might cycle on and off three times per hour, or 72 times per day. Assuming a typical month to contain 30 days, during this period, the system would cycle 2160 times. If the system were run for six 30-day months, it would cycle 12,960 times.

For a medium-sized house, the cost of running an air-conditioning system is about 60 cents per hour, or 1 cent per minute. From this, you can calculate the saving if you were to use the Fan-Delay Timer described in the main article. If the compressor ran only 1 minute in each cycle, at the end of 12,960 cycles, the cost would be $129.60 (about $130). the cost of operating only the fan would be $15 over the same period of time, resulting in a savings of $130 − $15 = $115.

Now consider that you can build the Fan Delay Timer at a cost of only about $25. This being the case, your net saving over the six-month period would be $115 − $25 = $90. Hence, the project would pay for itself shortly after it's put into service.

Your actual savings would depend on the type of air-conditioning system with which you use the project. Though the above cost analysis is fairly typical, results can vary widely.

be helpful. Therefore, always follow the labeling on the thermostat.

When you are sure which wire is which, disconnect the compressor wire (usually yellow) from the thermostat, and splice it to the yellow Y IN wire from the project. Connect the project's yellow Y OUT wire to the thermostat mounting base terminal. Leave all other wiring from the air-conditioning system to the thermostat as is. Add the Fan-Delay Timer wires to the appropriate contacts on the thermostat's terminal board.

Mount the project on the wall near the thermostat and return power to the air-conditioning system. At this point, the red POWER indicator LED should be on.

Cycle the compressor and adjust *R9* for the desired fan-delay period. Do not set this period to have the fan run beyond the point at which the air entering the room is no longer colder than that in the room. If you do, this may cause more moisture than necessary to enter the room, resulting in a lowering of the comfort index. As the outside temperature changes, you may find it necessary to reset the Fan-Delay Timer's control to maintain maximum efficiency. **ME**

wires that go to the thermostat to exit. If you are using a metal box, however, route the wires through a rubber-grommet-lined hole. Then use a dry-transfer lettering kit to label the LEDs and *R9*'s access hole as shown in the lead photo.

Installation & Adjustment

Before attempting to install the Fan Delay Timer, disconnect power from your air-conditioning system at the circuit breaker panel or at the unit itself. If you do not know how to do this, get help from someone who does.

Remove the cover from the thermostat and then the thermostat itself from its mounting base to gain access to the points where the wiring connects to it. Keep in mind that wire insulation color coding may not always

EDITORIAL . . . *(from page 4)*

pulled a 40% share! Fourteen percent of respondents noted that they plan to buy a hard-disk drive, while 15% indicated they already own one.

In response to a question on "Computer Applications Mostly Used," 46.8% of respondents indicated that it was for Professional or Business purposes, 61.5% for Hobby, 43.0% for Education, and 26.2% for Entertainment. (The total exceeds 100% due to multiple uses, of course.)

Toting up all the plan-to-buy responses, MODERN ELECTRONICS readers are expected to spend more than $34-million in the next 12 months on computer hardware!

In line with the large electronics/computer professional readership we have, 59.5% indicate they specify/influence/authorize company purchases of electronic and/or computer equipment. Your in-

fluence on purchases of electronics and computer equipment extends beyond this, too, to personal advice given to friends, neighbors and others who, as you know, seek out your counsel when they learn that you're an "expert." Thirty-six percent of respondents not surprisingly indicated they gave buying advice to ten or more people in the past 12 months, for example.

As you can see from this brief overview of our 1986 Study, you are certainly very special people with enormous talent and energy, contributing actively to our technologically advanced life. And having fun doing it.

Art Salsberg