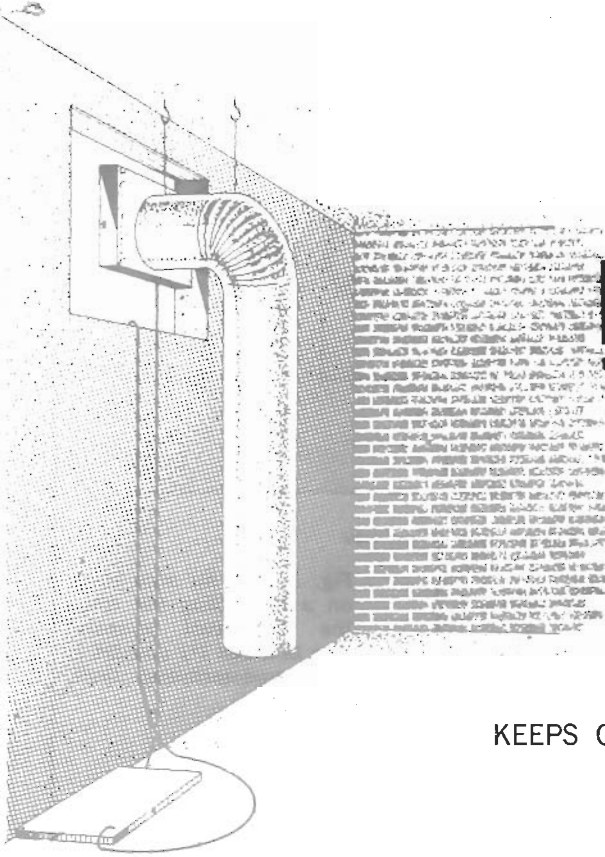

DIFFERENTIAL-TEMPERATURE BASEMENT VENTILATOR

KEEPS OUT MILDEW AND MOLD

BY JIM ASHE

FORTUNATE indeed is the home owner who can say that his cellar stays completely dry year round. When the weather is hot and humid outside and relatively cool and humid in the basement, moisture, mold, and mildew usually start to collect. The situation can be greatly improved by equalizing the temperature differences.

The project described here consists of a ventilating system to draw the cool, damp air from the floor of the basement and replace it with warmer air from outside. The system includes an electronic differential circuit which senses the temperature difference between inside and outside and turns on the ventilating fan when necessary.

A typical small axial fan, mounted in a 6″ diameter stove pipe can move about 100 cubic feet of air per minute. Assuming a 50′ x 20′ x 7′ basement, it will take the fan about 70 minutes to change the air. Of course, using a larger fan or having a smaller basement will change the time. For maximum benefit, the ventilator should be run every day.

How It Works. The circuit used to detect the temperature difference is shown in Fig. 1. Essentially it consists of an operational amplifier (*IC1*) whose output state is determined by the voltage drop across a pair of germanium temperature-sensing diodes, *D1* and *D4*. This voltage drop is dependent not only on the current flowing through the diodes but also on the ambient temperatures surrounding them. The integrated circuit is connected as a differential amplifier whose output is coupled to a Schmitt trigger consisting of *Q1* and *Q2*. The trigger circuit converts the relatively slow action of the output of the op amp (due to the slow rate of change of current through the diodes) to a fast-acting switch. The trigger, though it is a form of multivibrator, does not change the frequency of operation. Since such a circuit is regenerative, its action is fast; and slow input signals become sharp, decisive outputs.

Although it is possible to conne motor control relay to the collecto of the Schmitt trigger (*Q2*), som working margin is included by

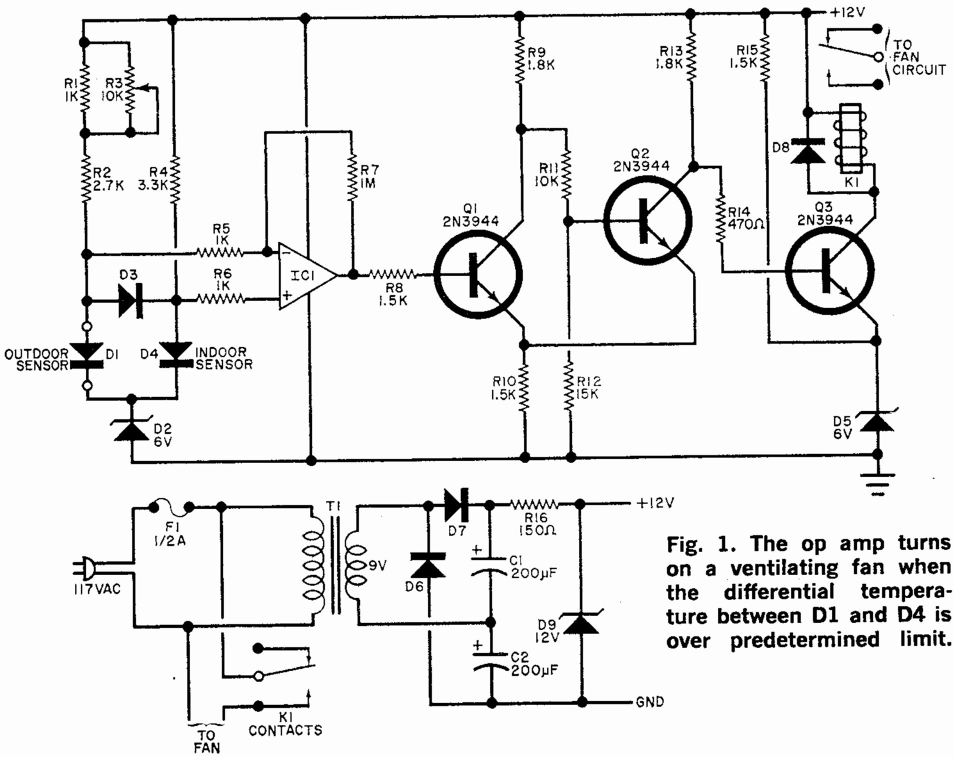

Fig. 1. The op amp turns on a ventilating fan when the differential temperature between D1 and D4 is over predetermined limit.

PARTS LIST

C1,C2—200-μF, 15-volt electrolytic capacitor
D1,D4,D8—Germanium signal diodes (HEP 134. D1 and D4 matched. See text.)
D2,D5—HEPZ0214 6-volt, 400-mW zener diode
D3,D6,D7—Silicon diode (HEP 154 or equiv.)
D9—HEP105 12-volt, 1-W zener diode
F1—½A fuse and holder
IC1—Operational amplifier (741 or similar)
K1—500-ohm, low-current dc relay
Q1-Q3—2N3944 transistor
R1,R5,R6—1000-ohm, ½-watt resistor
R2—2700-ohm, ½-watt resistor
R3—10,000-ohm, potentiometer
R4—3300-ohm, ½-watt resistor
R7—1-megohm, ½-watt resistor
R8,R10,R15—1500-ohm, ½-watt resistor
R9,R13—1800-ohm, ½-watt resistor
R11—10,000-ohm, ½-watt resistor
R12—15,000-ohm, ½-watt resistor
R14—470-ohm, ½-watt resistor
R16—150-ohm, 1-watt resistor
T1—Filament transformer; secondary: 9V at 100mA
Misc.—Length of two-conductor cable, chassis, stovepipe and elbow, 117-volt axial fan, socket for IC1 (optional), mounting hardware.

trigger to drive a biased power stage, *Q3*, which has the relay in its collector circuit. The emitter of *Q3* is biased by *R15* and zener diode *D5*, so that *Q3* is either on or off with no indecision. When the positive-going signal from *Q2* occurs on the base of *Q3*, it turns on very fast, energizing the relay.

Diodes *D1* and *D4* are connected in a bridge with balance provided by trimmer potentiometer *R3*. Diode *D3* acts as a safety diode if the circuit happens to have power applied when *D1* is not in the circuit. This is necessary to protect the op amp. Feedback register *R7*, in conjunction with the 1000-ohm input resistor produces a stage gain of 1000 in the op amp. To reduce temperature sensitivity, *R7* can be replaced by a smaller resistor to reduce circuit gain.

Zener diode *D2* clamps the input circuit at 6 volts, since the op amp cannot accept signals near ground or close to 12 volts. Most operational amplifiers do not have this problem as they are operated by either a positive or a negative supply.

Diodes *D1* and *D4* should be as alike as possible and should be checked by measuring their forward voltage drop. This is done by connecting a resistor in series with the diode and power source and measuring the

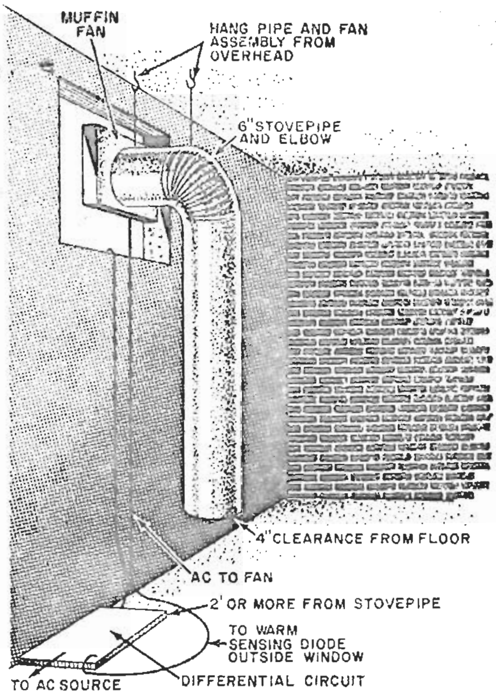

Fig. 2. Diagram shows how to install the fan (in stovepipe) in a basement window, to draw out cool, damp air.

diode drop very carefully. Final adjustment of the bridge will be made by *R3*. Reducing the value of *R3* raises the *D1* current simulating a falling temperature outdoors or a rising temperature indoors.

Construction. The circuit can be constructed on perf board or a printed circuit board. There is nothing particularly critical about the circuit. Diode *D4* is mounted on the circuit board in such a way that air can circulate around it. Diode *D1* is mounted outside the basement window and connected by a length of ordinary two-conductor cable. Do not place *D1* where it will get direct sunlight, since the excessive heating will produce false results.

The mechanical arrangement is shown in Fig. 2. A suitable length of 6" stovepipe with an elbow is the main element. The axial fan is mounted to the end of the elbow as shown and the entire assembly is suspended so that the fan is in the window (remember it exhausts the basement air) and the bottom of the stovepipe is about 4" from the floor. Keep the electronic circuit, especially *D4*, at least two feet away from the bottom of the stovepipe so that the moving air will not cool the diode and produce a false indication in the differential circuit.

Calibration With *D1* and *D4* close to each other, allow them to stabilize for an hour or so. Then set *R3* a little bit beyond where the relay opens. The two diodes are now temperature matched. If a large fan is required, and the current demand is more than the *K1* contacts can tolerate, use *K1* to drive a power relay or a simple SCR or triac controller. ◈

The electronic circuit for differential temperature sensing can be easily assembled on a breadboard as shown here. It should be positioned two feet from pipe.