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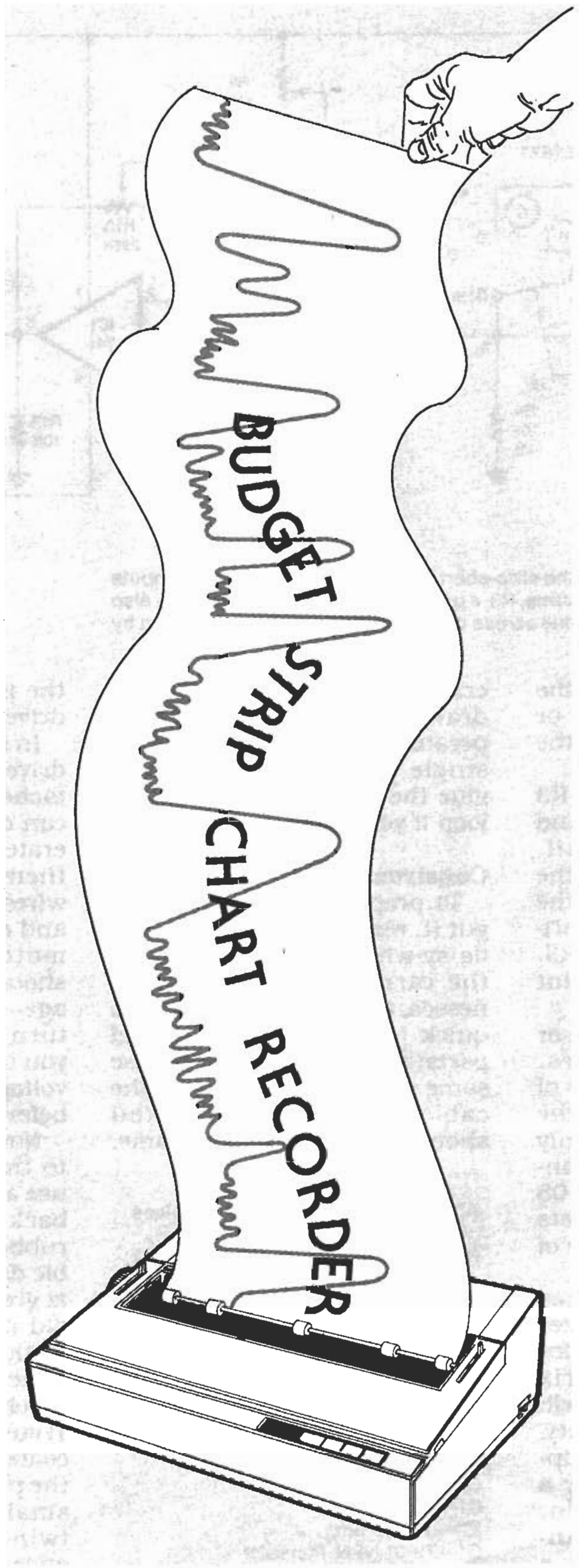
CONVERTING AN OBSOLETE computer printer into a strip-chart recorder is both easy and inexpensive. With about $40 in parts, construction of a simple circuit, and some minor mechanical fabrication, you can have a functioning chart recorder. We built the prototype as a weather station to record air temperature, but it could be used for any number of things ranging from seismography to radio astronomy.

The chart recorder works by comparing the voltage on a potentiometer to the voltage on a temperature-sensing thermistor. The potentiometer is mechanically connected to the printer carriage. A marking pen is also connected to the printer carriage. Any difference in the voltages on the potentiometer and the temperature sensor causes an op-amp to attempt to bring the voltages back in balance. In so doing, the print-head carriage moves left or right, thereby causing a mark on the paper. We drive the platen (i.e., pull the paper through the device) using a standard household timer.



Convert that old computer printer into a strip-chart recorder

How it works

Figure 1 shows the complete circuit. We use a standard 741 op-amp as a comparator. The comparator monitors the voltages at the junctions, marked TP1 and TP2 in Fig. 1, of two voltage-divider networks. The op-amp compares the voltages from the two networks at its inputs (pins 2 and 3). When the voltages are identical, the op-amp's output (pin 6) is zero, so neither driver transistor (Q1 and Q2) turns on, and therefore the motor does not turn.

But if thermistor R2's resistance changes because of a change in air temperature, a new voltage occurs at the op-amp's inverting input (pin 2). For example, assume the value of R2 decreases. The pin-2 voltage then increases, so the op-amp's output swings negative, thereby biasing Q2 on. That in turn starts the motor, which moves the carriage left or right.

Potentiometer R5 is also coupled to the carriage, so, as the carriage moves, R5's wiper moves, thereby varying the voltage on the non-inverting input of IC1. When the op-amp's input voltages become equal, the output goes to zero, both transistors turn off, and so does the motor. Now the circuit remains quiescent until the temperature changes again.

The potentiometer is a precision, 10-turn type with a value of 20K. A 50K device would provide a wider range, but with reduced resolution. You should be able to buy a surplus 10-turn unit from an electronics supplier for $1–5.

For temperature sensing, we used a common thermistor available from Radio Shack. (Internally, each device actually consists of two separate thermistors.) A thermistor is a device whose resistance changes with temperature. The thermistor is not linear; its resistance increases disproportionately fast at cooler temperatures. That nonlinearity restricts the range of the recorder. Also, the resistance range of your probe, be it a thermistor or some-

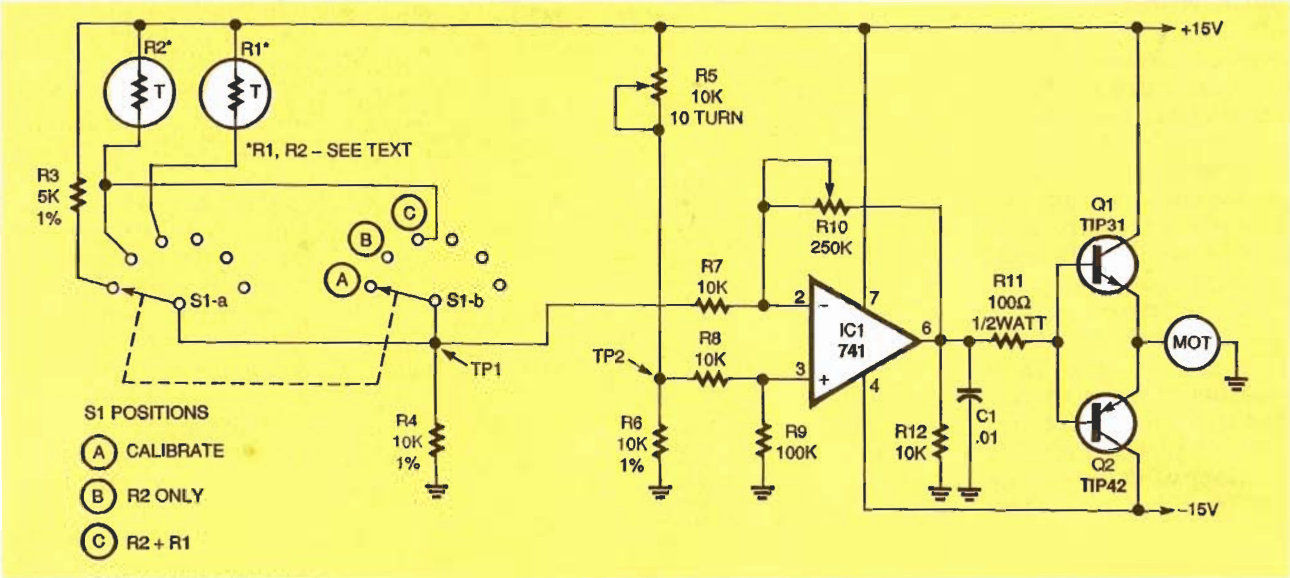


FIG. 1—COMPLETE SCHEMATIC of the strip-chart recorder. When the op-amp inputs differ, the motor turns. As the motor turns, R5, a precision ten-turn potentiometer, also turns. When R5's value equals the value across the temperature sensor (as chosen by S1), the motor stops.

thing else, must not exceed the range of the potentiometer, or the pen will try to run off the side of the chart.

We use precision resistor R3 in conjunction with S1-a and S1-b to calibrate the circuit. When R3 is in the circuit, the carriage will move to where the value of R5, the 10-turn potentiometer, equals the value of R3. That provides a reference point for the chart printouts.

By switching in either one or two temperature sensors, switch S1 allows the choice of two ranges. Position 1 of the switch is for calibration; only R3 is connected. Position 2 connects R2, for a range of 20–108 °F; and Position 3 connects both R1 and R2, for a range of −6–76 °F.

For the prototype, we picked up a derelict daisy-wheel printer at a local second-hand store for $5. Note that a dot-matrix printer would work just as well. If you live near a university, check whether it has an equipment-disposal unit, typically a warehouse with old, broken, and outdated equipment. Another potential source is a printer repair shop.

For marking the chart paper, we simply installed a pencil, using a rubber band to maintain tension against the platen, as shown in Fig. 2. We used several different colors of soft lead drawing pencils to track temperatures for several days on a single chart. You could even glue the chart into a multi-day loop if you wish.

Construction

To prepare the printer, first gut it, removing PC boards, the daisy-wheel mechanism from the carriage, the wiring harnesses, the fan, etc. Don't be too quick to dispose of the gutted parts; you may be able to use some of them, particularly the cables and connectors. You should end up with the frame, the platen, and a carriage and drive mechanism.

In most printers the carriage-drive motor has several wires attached. By trial and error you can determine which wires operate the motor. In our case, there were two red and black wires. We merely tried one red and one black wire and got the motor to turn. The motor should operate on a low DC voltage—the prototype begins to turn at about 2–3 volts—but you may want to determine low-voltage DC operation for certain before you buy.

Now affix the potentiometer to the carriage. Some printers use a cable to move the carriage back and forth; others use a rubber belt. Our unit used a cable drive, but because the cable is greasy and hard to get at, we did not attach to the cable directly. Instead, as shown in Fig. 3, we fixed the potentiometer securely to the carriage and then strung a length of strong, coated twine from one side of the printer frame to the other. A small coil spring keeps the twine taut. The twine wraps once around a spindle attached to the potentiometer shaft. The diameter of the spindle should be such that the potentiometer turns ten rotations (or a little less than ten) over the length of the carriage movement.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.

R1, R2—Thermistors, Radio Shack 271-110 or equiv.
R3—5000-ohms, 1%
R4, R6—10,000 ohms, 1%
R5—20,000 ohms, potentiometer,10-turn
R7, R8, R12—10,000 ohms
R9—100,000 ohms
R10—250,000 ohms, potentiometer
R11—100 ohms, ½ watt, 5%

Other components

C1—0.01 µF
IC1—741 op-amp
Q1—TIP31 NPN Transistor
Q2—TIP42 PNP Transistor
S1—Rotary switch, 2 pole, 6 position

ORDERING INFORMATION

Precision 10-turn potentiometers are available from Ra-elco, Inc., 2780 South Main St., Salt Lake City, Utah 84115, 801-487-7749.

To calculate the diameter of the spindle, simply measure the total distance the carriage moves from left to right, and divide that value by ($\pi \times 10$). Anything that size or slightly larger will do. The spindle material is not critical; we used two hard rubber spacers bracketed by a couple of large washers, and brushed with paint to increase friction. You could also use a wooden spool, a small diameter pipe, or a stack of washers. Incidentally, the spindle must be wide enough to allow the string to worm its way across without jamming into the bracketing washers.

To drive the platen, we used a plug-in appliance timer, available at most hardware and variety stores. We glued the timer dial directly to the platen knob, giving a chart speed of about ⅙-inch per hour, which is satisfactory for temperature recording.

That type of timer is not intended to drive anything, so you should keep a close eye on it until you are certain it can do the job without overheating. We tried three different brands, old and new, and they all worked. Be sure to minimize the drag on your platen by removing all drive gears, stepper motors, etc. Also, because of mechanical slack in the system, it may take up to an hour for the timer to begin turning the platen. If you desire a faster chart speed, other drive arrangements can be constructed, possibly using the built-in mechanics.

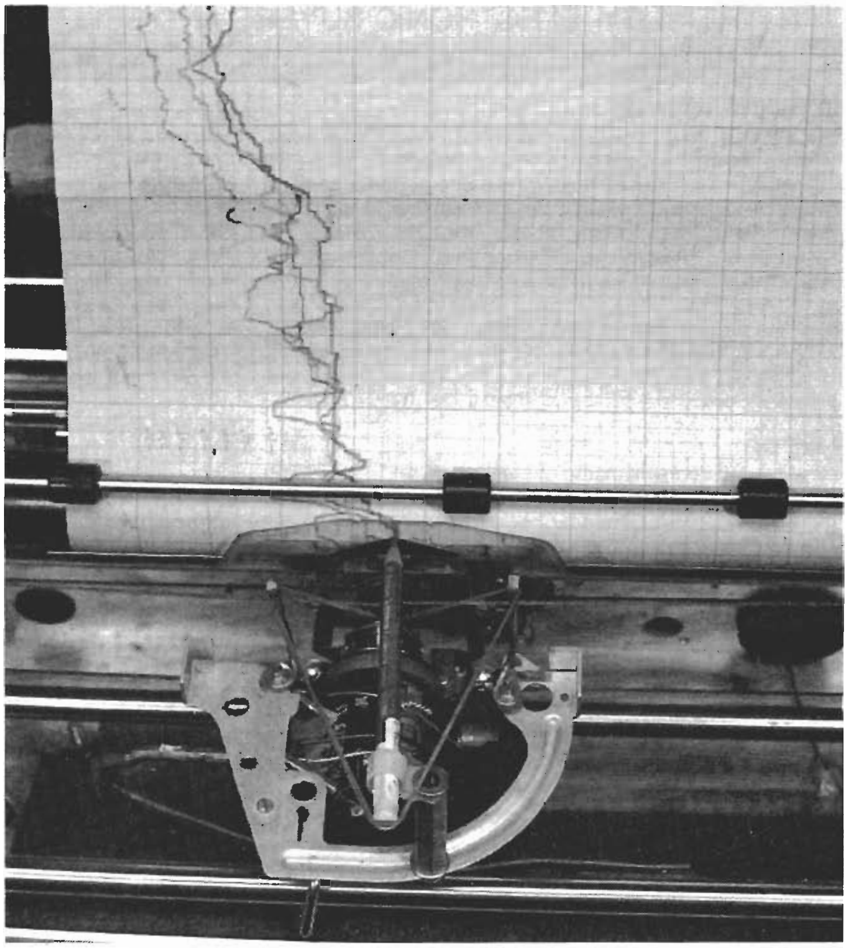


FIG. 3—STRIP-CHART RECORDER IN ACTION. Note how the rubber band holds the pencil against the chart. Chart speed here was about 17 mm/hr.

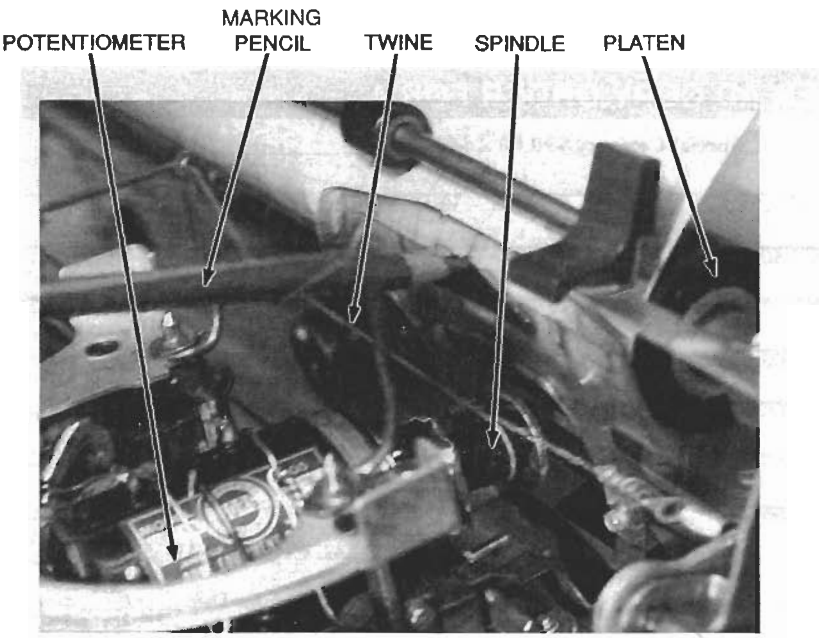


FIG. 2—MECHANICAL ARRANGEMENT of the strip-chart recorder. Note twine wrapped once around the spindle attached to the shaft of the potentiometer.

Your printer may have operable DC power supplies. Ours didn't, so we bought two wall-mount DC adapters. Anything in the range of 12–15 volts DC at 500 mA should work, but check the current draw of your carriage drive motor to be safe.

Calibration and testing

Switch R3 into the circuit, let the carriage settle down, and then mark that point as a reference. You may want to slip the twine to move the carriage assembly to a convenient location.

The simplest way to calibrate

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STRIP CHART RECORDER

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the recorder is to place a thermometer beside the temperature probe and mark pen positions and thermometer readings at various temperatures. Glue the marked-up calibration strip to a ruler or strip of plastic. You can then scale your charts by aligning the reference point on your ruler with the reference point on your chart.

Test the circuit by turning op-amp gain (R10) all the way up and setting S1 to Calibrate. The pen should move to the reference position and stop. If the carriage moves all the way to one side or the other, try reversing the wires going to the motor

If the carriage oscillates (hunts), gain is too high. so turn R10 down. When you get the drive working properly, switch to the thermistor, making certain that ambient temperature puts it within range of your chart recorder. Now verify the thermistor's resistance at different temperatures.

In addition to temperature, the author has recorded wind direction using a modified 10K potentiometer as a sensor. One planned experiment involves putting a probe in the ground and charting the relationship between soil temperature and tomato taste. If you come up with a novel project using an obsolete printer for a new purpose, let us know about it. A possible application idea is placing a signature on a check. There are other possibilities using otherwise obsolete computer components. Ω