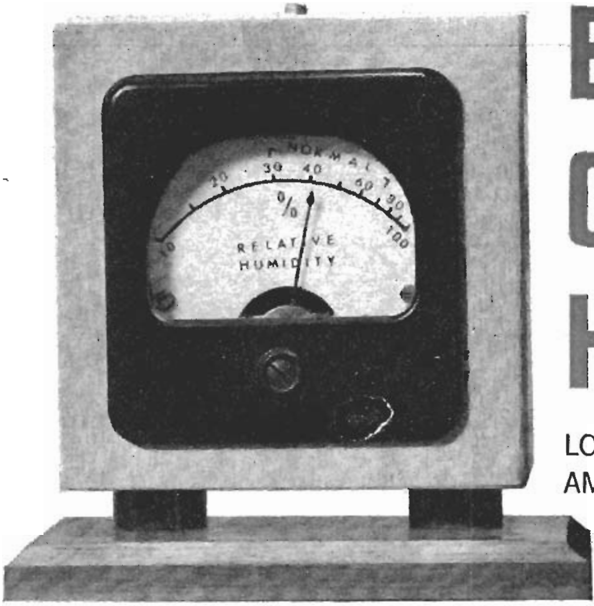


Electro-Chemical Hygrometer

LOW-COST UNIT MEASURES AMBIENT RELATIVE HUMIDITY

BY JOSEPH GIANNELLI

WHEN IT comes to determining how the current weather will affect us, the relative humidity is almost as important as the temperature. (Isn't that why the weather bureau gives us the temperature-humidity index every day?) There are many sophisticated ways of measuring the relative humidity; but if you would like to have your own hygrometer, here's a good direct-reading, fast-responding unit that can be built easily and cheaply.

Many salts, such as common table salt (sodium chloride), are hygroscopic in nature. That is, if the ambient atmosphere has a higher water vapor content (high humidity) than the salt, the salt absorbs the moisture until the vapor pressure of the salt equals the vapor pressure of the atmosphere. At that point the absorption stops, and the salt has some definite ohmic resistance. When the ambient atmosphere drops in humidity, the salt gives up its moisture, and has a higher ohmic resistance.

This change in resistance with humidity can be used in a standard bridge circuit with a meter that is calibrated in percent humidity. However, since salts exhibit some form of polarization to dc current, manifested by a continual resistance change as long as the dc is applied, it is necessary to use ac current in the circuit (see Fig. 1).

Circuit Operation. Transistor *Q1* and its associated components are arranged in a twin-T oscillator configuration. With the values shown in Fig. 1, the frequency is about 400 Hz. The output of the emitter of *Q1* provides the ac signal to the bridge. Power is supplied to the meter during the positive half cycles. The two variable controls (*R5* and *R6*) are used to set the two ends of the meter scale.

Construction. The circuit can be assembled on a small PC board using the foil pattern shown in Fig. 2. The board is mounted directly on the meter terminals through the two holes on top of the board. Large solder lugs are used to make the electrical connections to the meter terminals.

Construction of the sensor is shown in Fig. 3. A ½"-wide strip of fiberglass cloth (about the same weight as a handkerchief) is mounted as shown. After clamping both ends in the brass plates, the weave threads are removed from the cloth to improve the response time. The completed sensor is dipped into a solution of lithium chloride (a mound of the salt about the size of a dime dissolved in a tablespoon of water). After soaking the sensor, shake off the excess solution and allow the sensor to dry.

Calibration and Test. When assembly is complete and the sensor is dry, attach about 8 inches of insulated wire to each end of the sensor, connect it to the circuit, and suspend the sensor in an 8-ounce jar contain-

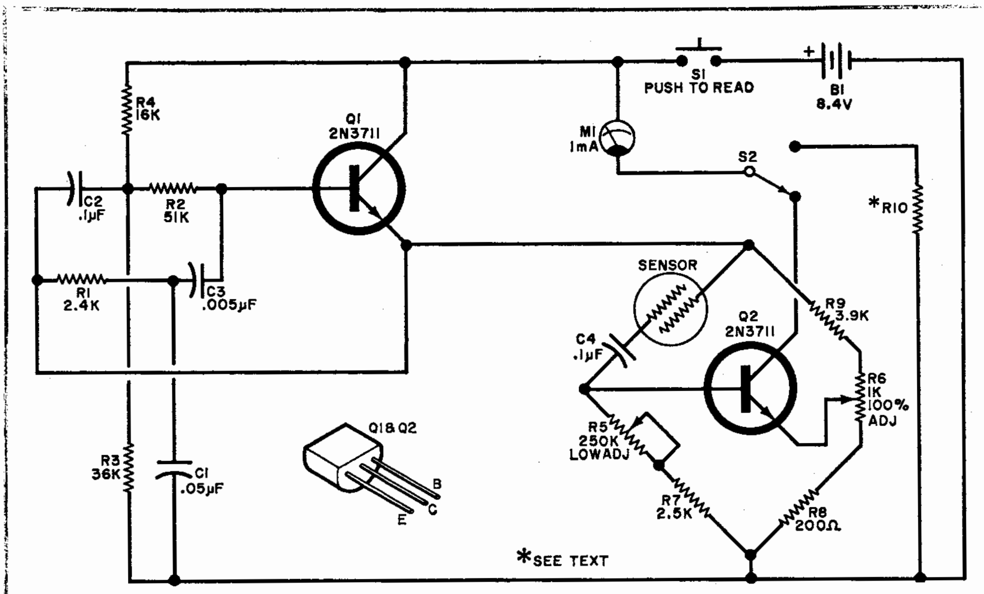


Fig. 1. Twin-T oscillator circuit (Q1) provides the depolarization current for the humidity sensor which is one leg of a bridge circuit, with meter driver Q2.

PARTS LIST

B1—4.2-volt mercury battery (2 required) (Mallory TR133 or similar)
C1—0.05-µF Mylar capacitor
C2, C4—0.1-µF Mylar capacitor
C3—0.005-µF Mylar capacitor
M1—1-mA (or less) meter
Q1, Q2—2N3711 or 2N3392 transistor
R1—2400-ohm resistor
R2—51,000-ohm resistor
R3—36,000-ohm resistor
R4—16,000-ohm resistor
R5—250,000-ohm, PC-type potentiometer
R6—1000-ohm, PC-type potentiometer
R7—2500-ohm resistor
R8—200-ohm resistor
R9—3900-ohm resistor
R10—(see text)
S1—Normally open pushbutton switch
S2—Spdt slide switch
Misc.—Battery holder, 25,000-ohm potentiometer for 100% check, suitable chassis, fiberglass cloth (handkerchief weight), lithium chloride (1 oz, available at chemical supply houses or Conso-Lab Supply Co., 7 Endo Blvd., Garden City, NY 11533), hardware for sensor, mounting hardware, etc.

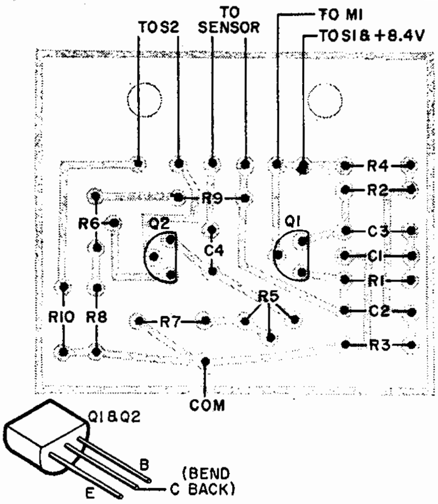
ing a wad of water-soaked tissue. Do not allow the sensor to touch the wet tissue. The sensor leads can be brought out under the jar lid. After a few minutes, place S2 in the bridge position, depress pushbutton *S1*, and adjust *R6* to obtain a 100% indication on the meter scale. When you are satisfied that the reading repeats after a few more minutes, remove the sensor from the jar, disconnect it from the circuit, and substitute a 25,000-ohm potentiometer for the sensor. Adjust this potentiometer to obtain a 100% indication on the meter. Dry the sensor by placing it in the air stream from a fan.

Without disturbing the setting of the 25,000-ohm 100% humidity potentiometer, remove it from the circuit (for use in later checks), and re-connect the dried sensor.

To determine the local ambient humidity, use a conventional bulb thermometer to record the temperature. Then wrap the bulb with water-soaked tissue and place it in the

PSYCHROMETRY TABLE

Percent Humidity	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb
10	75	50	70	47	65	44
20		53		50		47
30		56.5		53		48.5
40		60		56		52
50		62.5		58		54
60		65		61		56.5
70		68		63		59
80		70		65.5		61
90		72.5		68		63



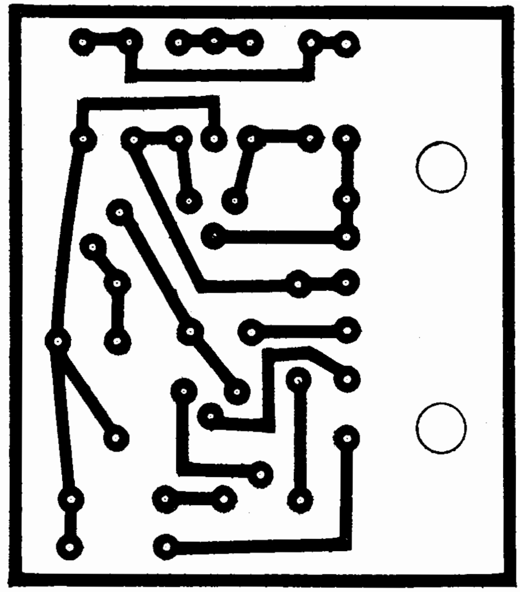


Fig 2. Foil pattern (right) and component layout (above). The board is mounted right on the meter terminals.

air stream from a fan. Record the lower temperature. The accompanying table is a greatly simplified psychrometric table that relates dry-bulb temperatures to wet-bulb temperatures and converts the two readings to percent humidity. A more detailed psychrometric chart can be found in almost any book on air conditioning in your local library.

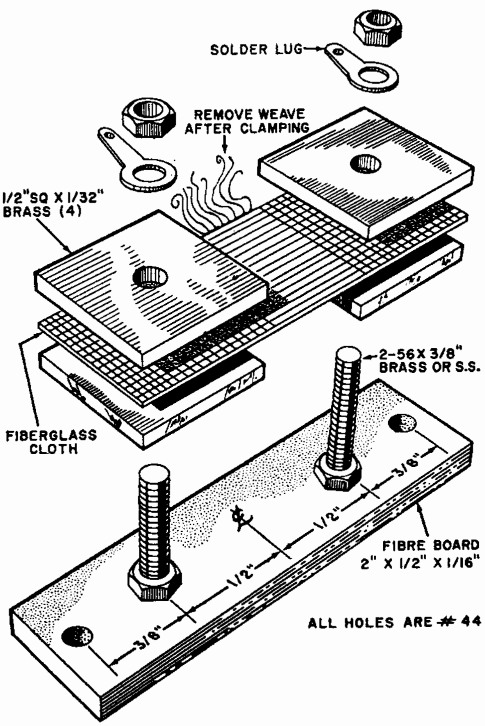


Fig. 3. Sensor is a small piece of ½" fiberglass with some weave removed.

After a short period of time, the sensor will have taken on the local humidity and potentiometer *R5* can be adjusted so that the meter reads the same as the humidity determined from the dry and wet thermometer readings. Using the previously set 25,000-ohm potentiometer in place of the sensor, recheck the 100% point and adjust *R6* if necessary. Recheck the local humidity and adjust *R5* again if necessary. The two potentiometers (*R5* and *R6*) are set to obtain the best compromise. The two calibrated points will repeat accurately at room temperatures between 68° and 78°F, but will be off by about 10% at other temperatures. If you require better accuracy, many wet/dry-bulb readings may be made at different times, with required corrections noted. Then a new meter scale can be fabricated.

An increase in humidity will require about ½ to 1 second to register, but a decrease will require about 3 minutes to register.

Resistor *R10* is used to keep tabs on the battery. Use a value that will produce about a ¾-scale indication on the meter, with a new battery and *S2* in the battery test position. Mark this point on the meter scale. Typical values for *R10* are 11,000 ohms for a 1-mA meter movement and 22,000 ohms for a 0.5-mA meter. ◈