An Ion Sniffer

This hand-held unit detects relative amounts of free ions in the air

By Robert Iannini

The Ion Sniffer is a compact, sensitive instrument that detects the relative amount of free ions in the air. It can be used to indicate the output from ion generators, locate high-voltage leakage points and conductors of static electricity, check electric field gradients, and for any other application where the presence of ions or a measurement of their relative flux density is required.

About the size of a pack of king-size cigarettes, the hand-held Ion Sniffer features a sensitivity control and a separate meter and light-emitting diode that indicate relative ion flux density. It offers a choice of two grounding arrangements—one by hand contact and a much better one by hard wiring to earth ground through an optional jack. The project is low in cost, easy to build and simple to operate.

About the Circuit

The Ion Sniffer consists of basically two sections: an ion "collector" and an amplifier/display. The collector is nothing more than an ordinary telescoping whip or stiff wire antenna, which plugs into *J1* in Fig. 1. Ions collected by the antenna cause a minute current to flow into the base of *Q1*. This minute current is amplified by the Darlington circuit made up of *Q1* and *Q2* to bias on *Q3*.

When *Q3* conducts, base-to-emitter current passes through potentiometer *R3* and resistor *R2*. The setting of *R3* and the magnitude of the current flowing through *Q3*'s collector circuit, determine how far up-scale the pointer of meter *M1* will deflect when *Q3* is conducting. Hence, *R3* serves as a sensitivity control.

The meter serves as a visual indicator of the *relative* amount of ionization present in the air. It is not an absolute indicator. Light-emitting diode *LED1* in the emitter circuit of *Q3* flashes when the project is used to measure strong ion fields.

Capacitor *C1* and resistor *R1* make up an RC network whose time constant eliminates any rapid fluctuations in the ion-field intensity from causing rapid meter pointer swings. Diodes *D1* and *D2* clamp transients to prevent excessive voltage from destroying *Q1*.

Power for the Ion Sniffer is supplied by common 9-volt battery *B1*. The battery is switched on and off with *S1*, which is ganged with *R3*.

Some sort of ground is required for the Ion Sniffer to operate properly. Metallic tape around the plastic case in which the project is housed provides a convenient means by which grounding can be accomplished. Holding the tape-wrapped Ion Sniffer in your hand partially grounds it to the earth through your body. If the project is not to be held in a hand, it should be earth grounded to a water pipe or

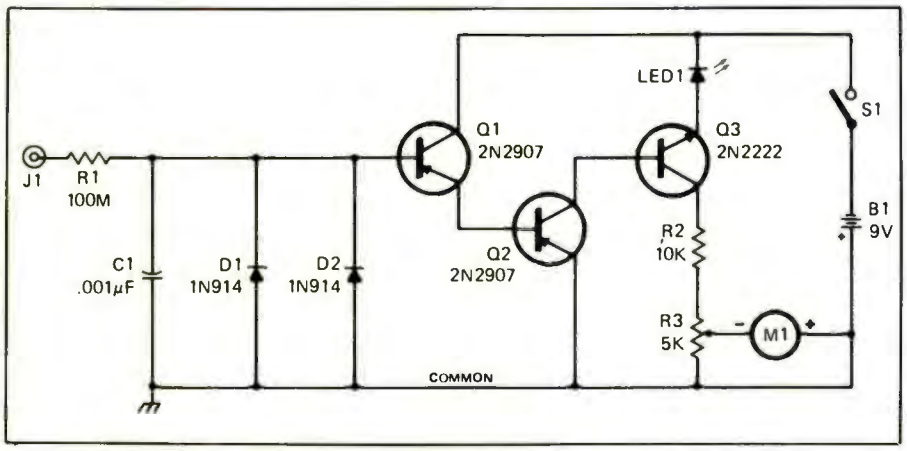

Fig. 1. The complete diagram of the Ion Sniffer.

PARTS LIST

B1—9-volt battery
C1—0.001-μF, 25-volt disc capacitor
D1,D2—1N914 diode
J1—Phono jack (eliminate if telescoping whip antenna is used)
LED1—Light-emitting diode
M1—Miniature 100-mA panel meter movement
Q1,Q2—2N2907 transistor
Q3—2N2222 transistor
R1—100-megohm, ½-watt resistor
R2—10,000-ohm, ¼-watt, 10% tolerance resistor
R3—5,000-ohm, linear-taper potentiometer with spst switch (see S1)
S1—Spst switch (part of R3)
Misc.—Suitable plastic enclosure (see text); perforated board (see text); snap connector for B1; small control knob for R3/S1; telescoping antenna or 12" stiff wire for antenna; 10" × ½" foil tape; busing or grommet for LED1; double-sided foam tape; machine hardware; hookup wire, solder; etc.

Note: A complete kit of all parts, less battery and optional pin jack, is available as kit No. IOD1K from Information Unlimited, P.O. Box 716, Amherst, NH 03031.

other object that gives good grounding.

Construction

Because the Ion Sniffer's circuit is so simple, it can easily be wired together on a 2" × 1" piece of perforated board without having to use soldering hardware. Of course, if you are ambitious, you can design and fabricate your own printed-circuit board and use this instead of the perforated board. In either case, trim away the upper corners of the board as shown in Fig. 2.

All conductors and component leads on the top of the board in Fig. 2 are indicated by solid lines, while those on the bottom of the board are shown as broken lines. With the flat of the transistor cases facing you and the leads pointing downward, the leads are emitter, base and collector from left to right. If you orient the transistors exactly as shown, you should

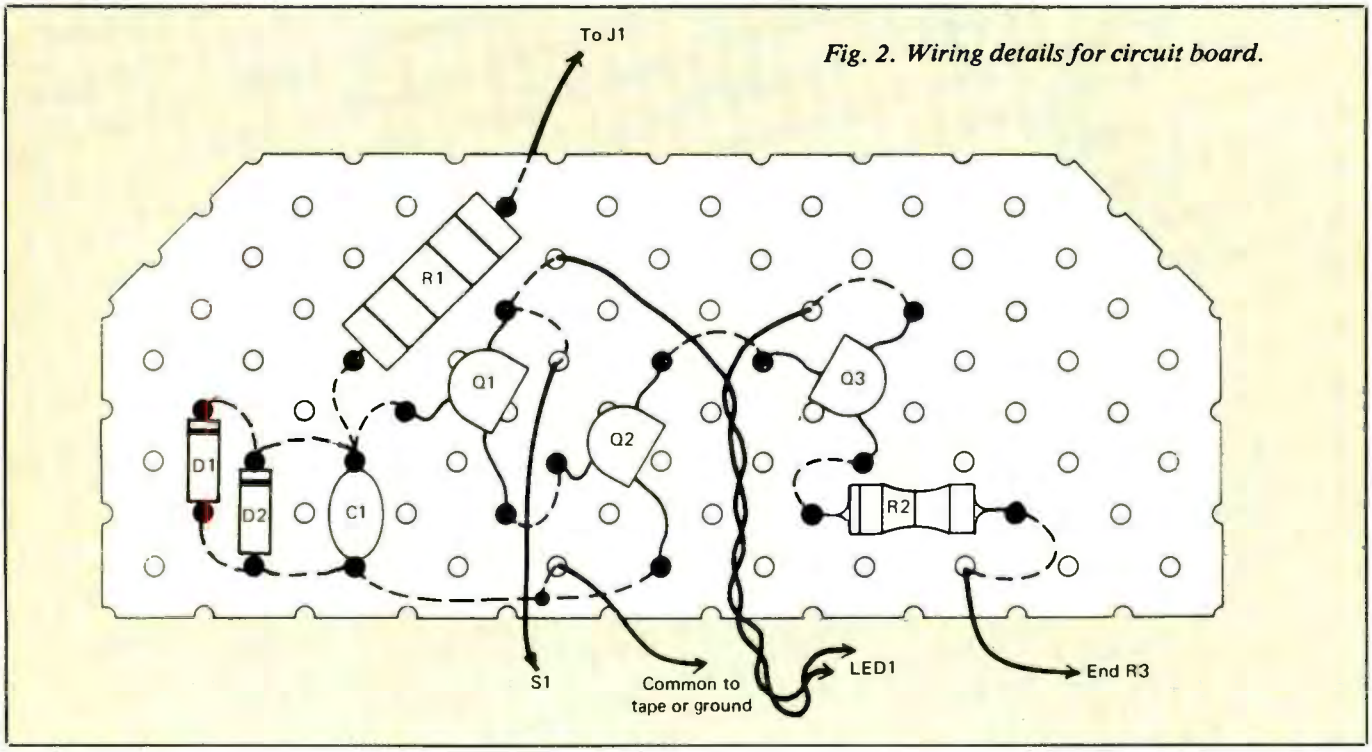

Fig. 2. Wiring details for circuit board.

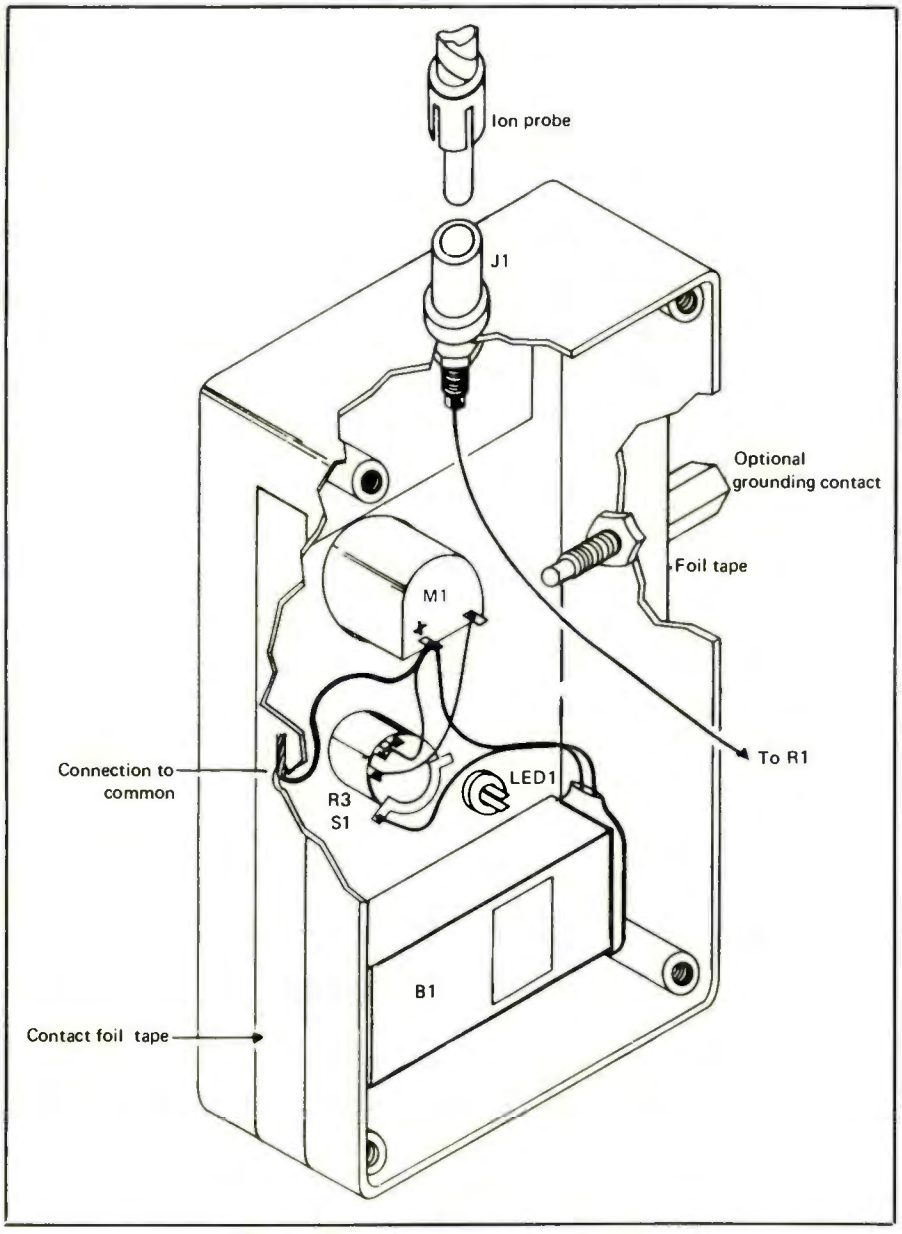

Fig. 3. Component mounting details.

have no difficulty identifying which lead is which when interconnecting the components.

Wire the circuit exactly as shown in Fig. 2. Use enough solder on all connections to assure good electrical and mechanical joints. Then solder 4" lengths of hookup wire to the points in the circuit to which off-the-board components connect. Label each of these wires as shown. Label the LED1 wires coming from the collector of *Q1* and emitter of *Q2* as CATHODE and ANODE, respectively.

A 4½" × 1½" × 1" plastic utility box is ideal for housing the project. It has ample room inside for all components, its front panel is large enough to accommodate the meter movement and sensitivity control/power switch (*R3/S1*) without crowding, and the box itself is sized for comfortable hand-held operation.

Prepare the front panel of the box as follows. Draw a light pencil line down the center of the box. Measure 1" down from the top of the box and strike a line across the first line at this point. Drill or cut a 1"-diameter hole here for the meter movement. Measure down 1" from the meter hole and drill a hole large enough to accommodate the mounting bushing of *R3/S1*. Off to the left and in line with the control hole or below it, drill a mounting hole for the LED, sizing it as necessary for a panel-mount bushing or small rubber grommet into which the LED can be plugged.

Drill a ¼" hole through the top of the box for the phone jack or telescoping antenna (if you use the latter, drill a smaller hole through the bottom of the box, directly in line with that in the top, for the antenna's anchoring screw). Drill holes on opposite sides of the box for the common wire and a pin jack (the latter is optional) that contact the grounding tape. Mount the phono jack (if used).

Next, run a 10" length of ½"-wide foil tape around the left, bottom and right outer walls of the case, centering it between the front and back edges so that it covers the holes drilled for the circuit ground (common) lead and the optional pin jack. With a punch or awl, perforate the tape through the centers of the holes.

Mount the circuit board at the top of the box, using double-sided foam tape between it and the box. The beveled corners fit between the mounting posts for the back of the box. Mount the meter movement, *R3/S1* and LED bushing or grommet in their respective holes. Plug the LED into the bushing or grommet. Assembly details are shown in Fig. 3.

Referring back to Fig. 1, finish wiring the circuit. Pass the free end of the circuit grounding wire through the hole in the box and foil tape and tack solder it to the latter. Then after making sure the circuit is dry, you might want to coat the entire circuit board assembly with varnish or urethane to

seal it against moisture that can decrease sensitivity due to leakage. Finally, with *S1* set to off, install the battery and assemble the case.

Turn on the Ion Sniffer and rotate sensitivity control *R3* fully clockwise and note that the meter's pointer deflects slightly up-scale. This indication is due to transistor leakage; it should not be considered an indication of ions. (Note: If the meter's pointer deflects down-scale, turn off the power and transpose the connections to the outer lugs on *R3*.)

Plug the collector probe into the phono jack on the top of the project (or extend the telescoping whip antenna if you are using that instead). Again turn on power and rotate the sensitivity control knob to the fully clockwise position.

Holding the Ion Sniffer with your hand in contact with the foil tape, run a plastic comb through your hair a few times and bring it close to the ion collector (or antenna). Note that the meter's pointer deflects up-scale and the LED flashes on. The amount of meter pointer deflection and brilliance of the LED's light depend on the setting of the sensitivity control and the relative humidity of the air. The indications will be stronger under low-humidity conditions than under high-humidity conditions. If you obtain the proper results, the project is ready to be put into service.

In Conclusion

For best results, the Ion Sniffer should be hard-wired to earth ground, via the pin jack if you have included it in your project. The project will not be as sensitive or stable when used as a hand-held portable instrument but will nevertheless provide indication of moderate to strong ion fields.

Whichever way you choose to use the project, always adjust the setting of the sensitivity control to keep the pointer somewhere on the meter's scale. **ME**