Here Comes the Sun

Part 2: Geomagnetic monitoring.

Thomas M. Miller WA8YKN
314 South 9th Street
Richmond IN 47374
[thomil@bioelectrifier.com]

Even though it's possible to get geomagnetic data from the *GOES 8* and *GOES 9* satellites via the Internet, it's a lot of fun to monitor the effects of solar activity with your own equipment. While the changes in the magnetic field are much smaller on the surface than at an altitude of 23,000 miles, they still can be measured. Also, since it's impractical to monitor the Internet 24 hours a day, it would be handy to have a device to sound an alert whenever a strong geomagnetic event is detected.

One of the easiest effects to measure is "Earth Currents." Whenever the geomagnetic field changes, electricity is induced in all conductors within it, and this includes the Earth itself. By driving a pair of long copper rods into the ground 100 feet or more apart, a voltage differential can be measured between them when the field shifts. Connect each rod to the meter with shielded cable, and ground the shield at one end only. The meter must be a zero-center type, since the polarity depends on the direction of the magnetic shift. A sensitive zero-center microammeter with several switchable series resistors could be used to set different ranges. You could also use an auto-polarity digital multimeter set to the mV scale.

A second method of monitoring geomagnetic shifts is to use a compass. Since it's no fun to sit staring at the little blue arrow all day, we can build a circuit that will do this for us. The easiest way is to drill a small hole, 1/16-inch or less, through the compass disk near the rim, at the EAST position. Drill a matching hole at the WEST position so that the disk will still balance on the needle.

By shining light from an infrared LED through one of these holes and receiving it with a phototransistor below the disk, we can tell if the compass disk rotates even slightly. The circuit shown in **Fig. 1** can be used to activate a small piezo alarm when the light is cut off. You don't need the entire compass—just the disk and needle. I mounted mine on a small piece of pine board which I could then rotate slowly until the hole in the disk matched the position of the LED and phototransistor.

This device, though simple to the extreme, is actually quite sensitive, as you can prove by waving a small magnet around the room. You will need to put a box over the whole thing to prevent air currents from disturbing the compass.

An even more sensitive device is the magnetometer. Originally designed as a "UFO Detector," this device has an iron rod that serves the same function for the magnetic field as an antenna does for radio waves. The lines of flux from the geomagnetic field are concentrated in the iron, and a coil consisting of many turns of fine wire is wound around the rod. Changes in the magnetic flux induce a voltage in the coil, which can then be amplified and used to trigger an alarm.

Iron rods are not commonly found around the house, but for our purposes, milled steel will work just fine. (It is, after all, more than 90% iron.) For portable devices, a #10-32 bolt passed through the center of a coil from a small relay will make a good sensor that will fit inside the enclosure used for the electronics.

Increasing the size of the rod and the number of turns will make the device far more sensitive. The best one I've built consisted of an entire one-quarter-pound spool of #36 magnet wire. I

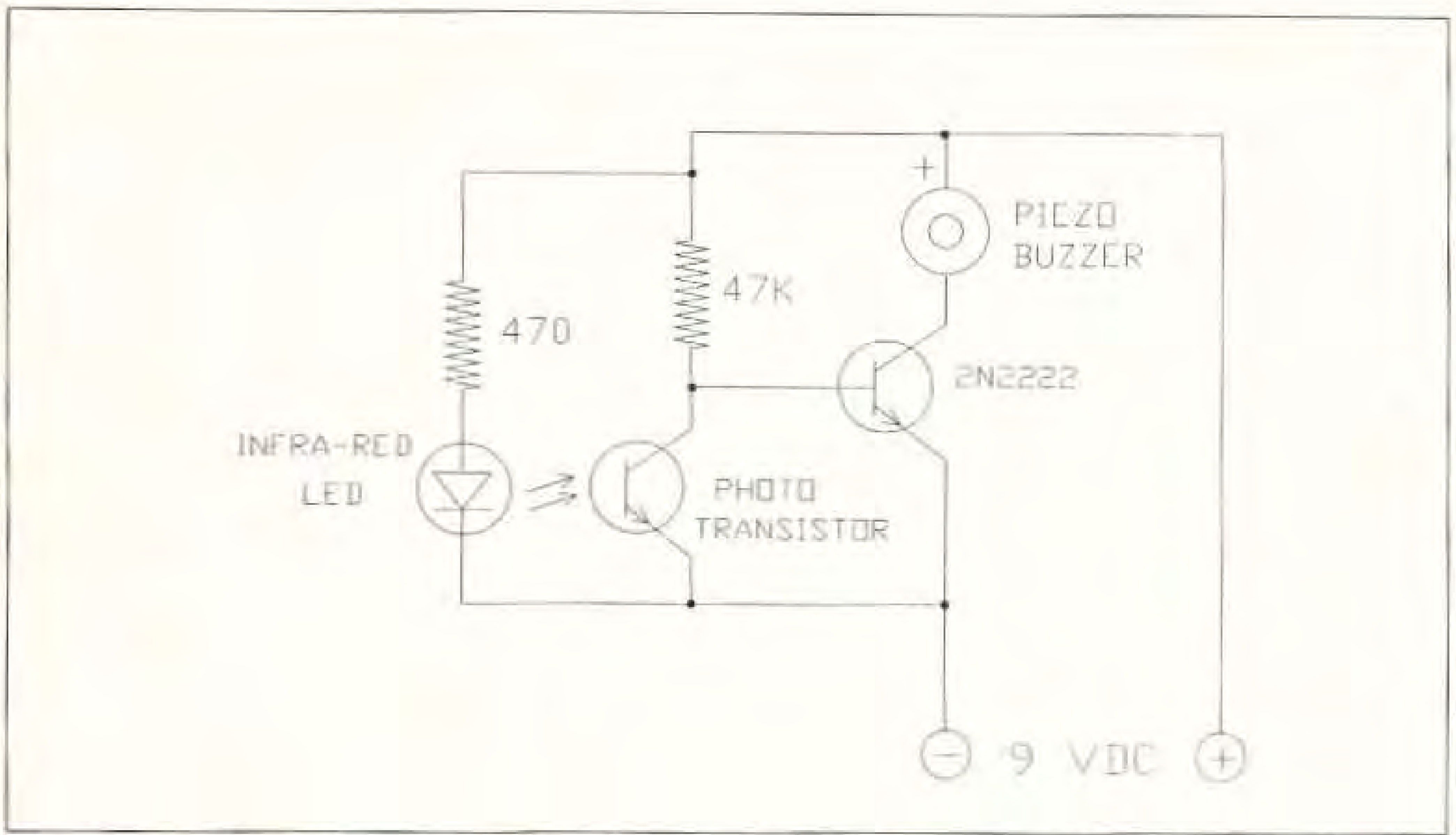

Fig. 1. The "Dark Detector." By positioning the LED above a hole in the compass disk and the phototransistor below, the alarm will sound when small magnetic fluctuations cause the compass to rotate.

didn't *wind* the coil—I just fished out the inner end of the wire and used the whole spool as it was. The plastic spool had a one-inch diameter hole through it, so I used a piece of one-inch round steel bar stock 18 inches long, passed through the center of the spool. Coated with urethane varnish and mounted inside a piece of plastic PVC pipe, it made a very sensitive sensor when mounted on the roof, away from stray magnetic fields.

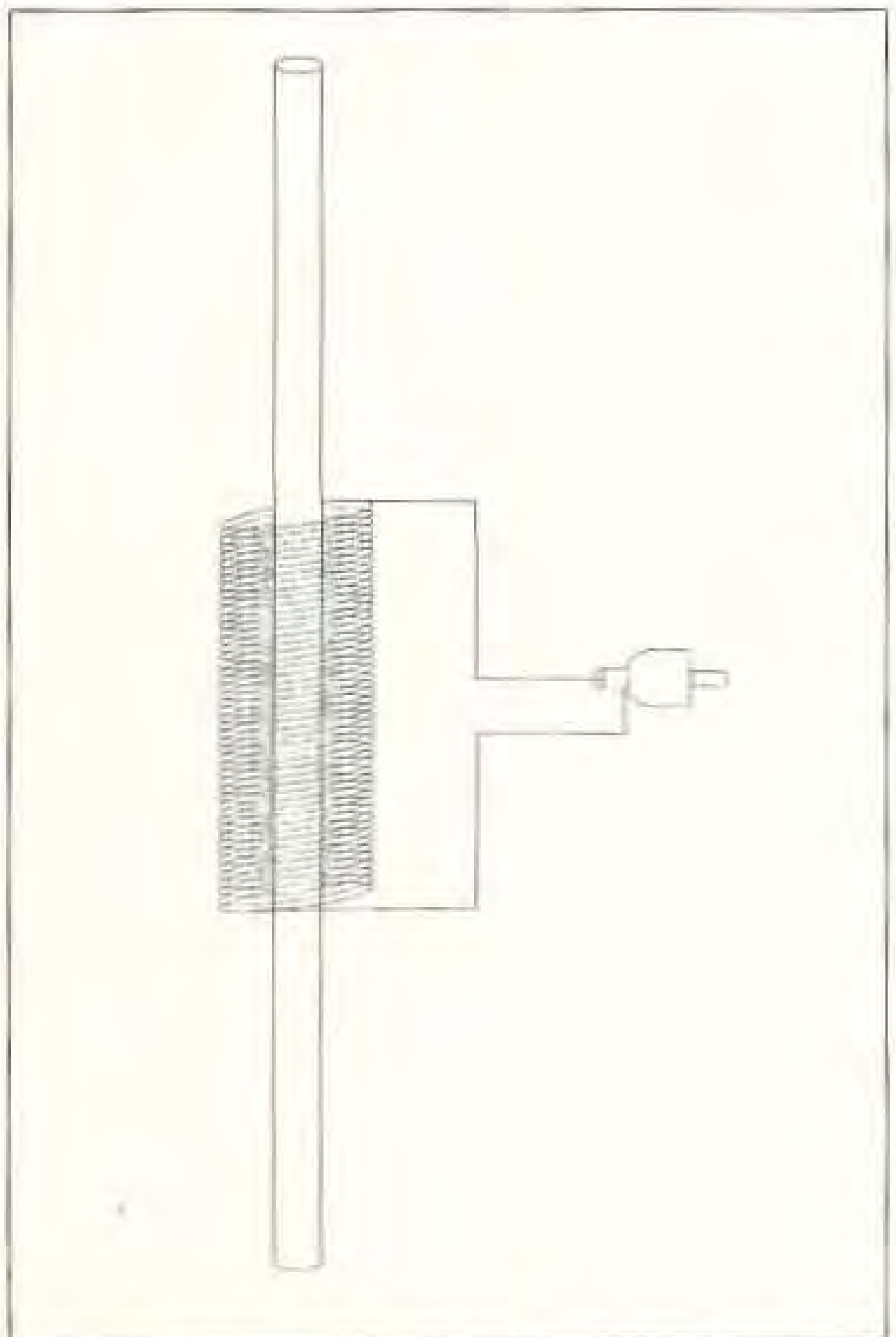

Fig. 2. A very large coil of fine wire wound around a bar of iron or steel will detect very small fluctuations in the geomagnetic field.

Fig. 3 shows the circuit diagram of the magnetometer. One stage of a dual op amp amplifies the signal from the sensor, which is then fed to a window comparator using an LM339. The output from the comparator triggers a 555 timer connected as a one-shot, which turns on the piezo alarm for several seconds. The gain of the amplifier stage is set with a one-megohm pot, which is adjusted just below the point at which the alarm sounds.

The second section of the dual op amp is used as an audio amplifier. The 2.2-μF capacitor couples any audio frequencies detected by the sensor to the op amp, which can then be heard via headphones or connected to an external amplifier and speaker. Some very strange sounds can occasionally be heard from this device, especially before a thunderstorm. (Of course, if you're using an outside-mounted sensor and AC line power, *do not* use this device *during* a thunderstorm ... especially when using headphones!)

The switch in series with the piezo alarm lets you turn the alarm off. This is handy for adjusting the gain, and also so that you can advance the gain to maximum and listen to the audio without being driven insane by the constant beeping.

Fig. 4 shows the printed circuit board pattern for the magnetometer, and **Fig. 5** shows the parts layout. Be sure to orient the integrated circuits,

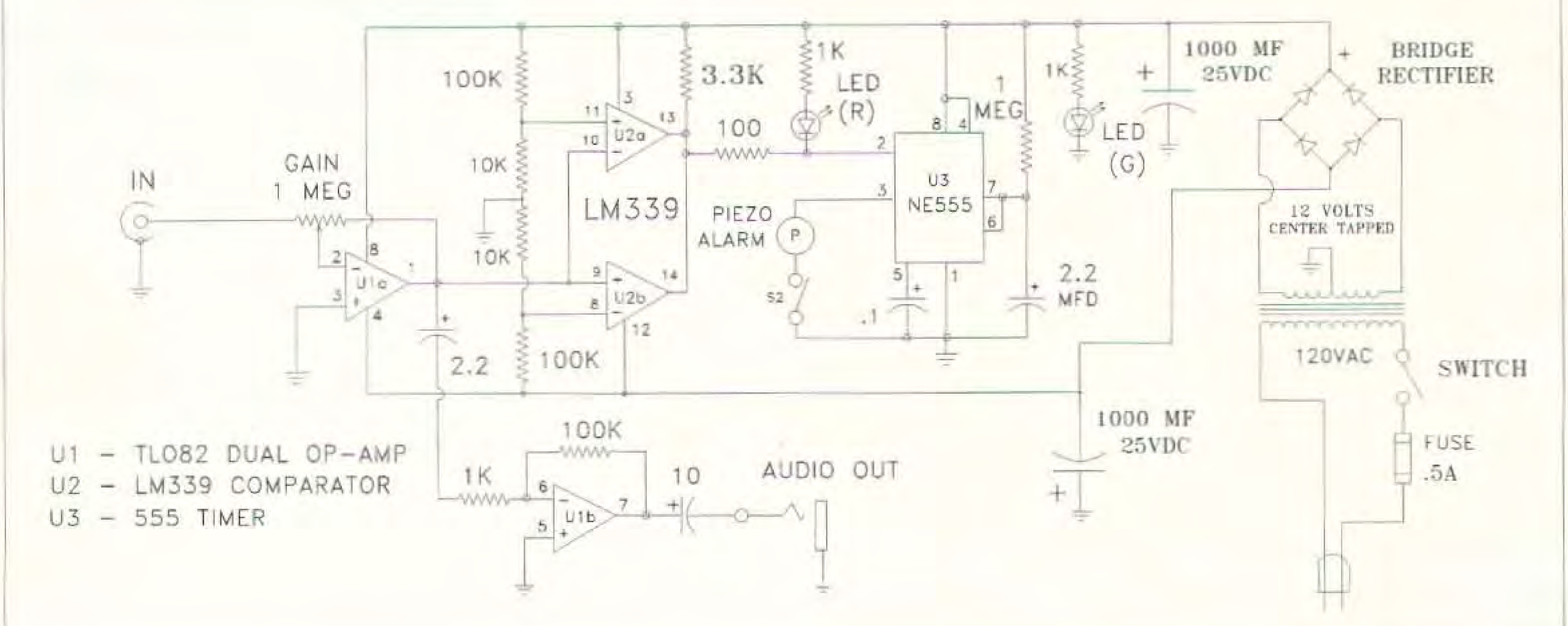

Fig. 3. The schematic diagram of the "UFO Detector" magnetometer. This circuit will amplify the signal from the sensor and trigger an alarm.

rectifier, capacitors, and piezo alarm as shown, since they will be damaged if reversed.

The circuit shown is AC line-powered, but you will probably need to use one or more AC line filters ahead of the device to prevent stray line noise from triggering the alarm. Even so, it may react to the occasional light switch or a motor starting up somewhere in the house. Using battery power (a pair of nine-volt batteries) eliminates the noise, but this makes long-term monitoring a problem, since the batteries will only last a few days. I've found that AC power works best for continuous monitoring, and I've also built several battery-powered devices which are great for portable use.

The magnetometer, used with an external sensor, is very sensitive to changes in the geomagnetic field. Besides solar-induced effects, it will also respond to large, moving ferrous objects, such as nearby cars and trucks. It will alert you to an approaching

Continued on page 54

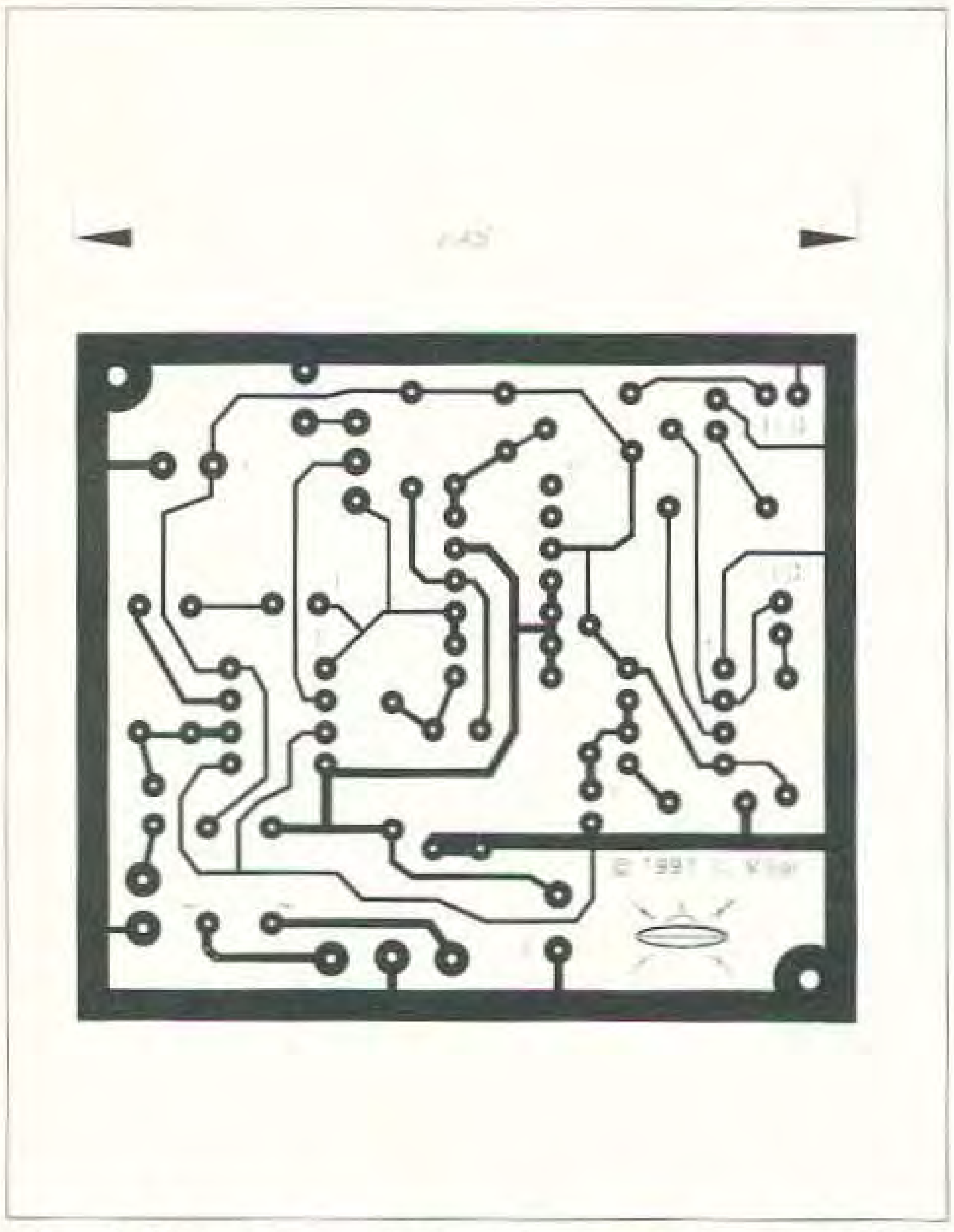

Fig. 4. Printed circuit board pattern for the "UFO Detector" magnetometer.

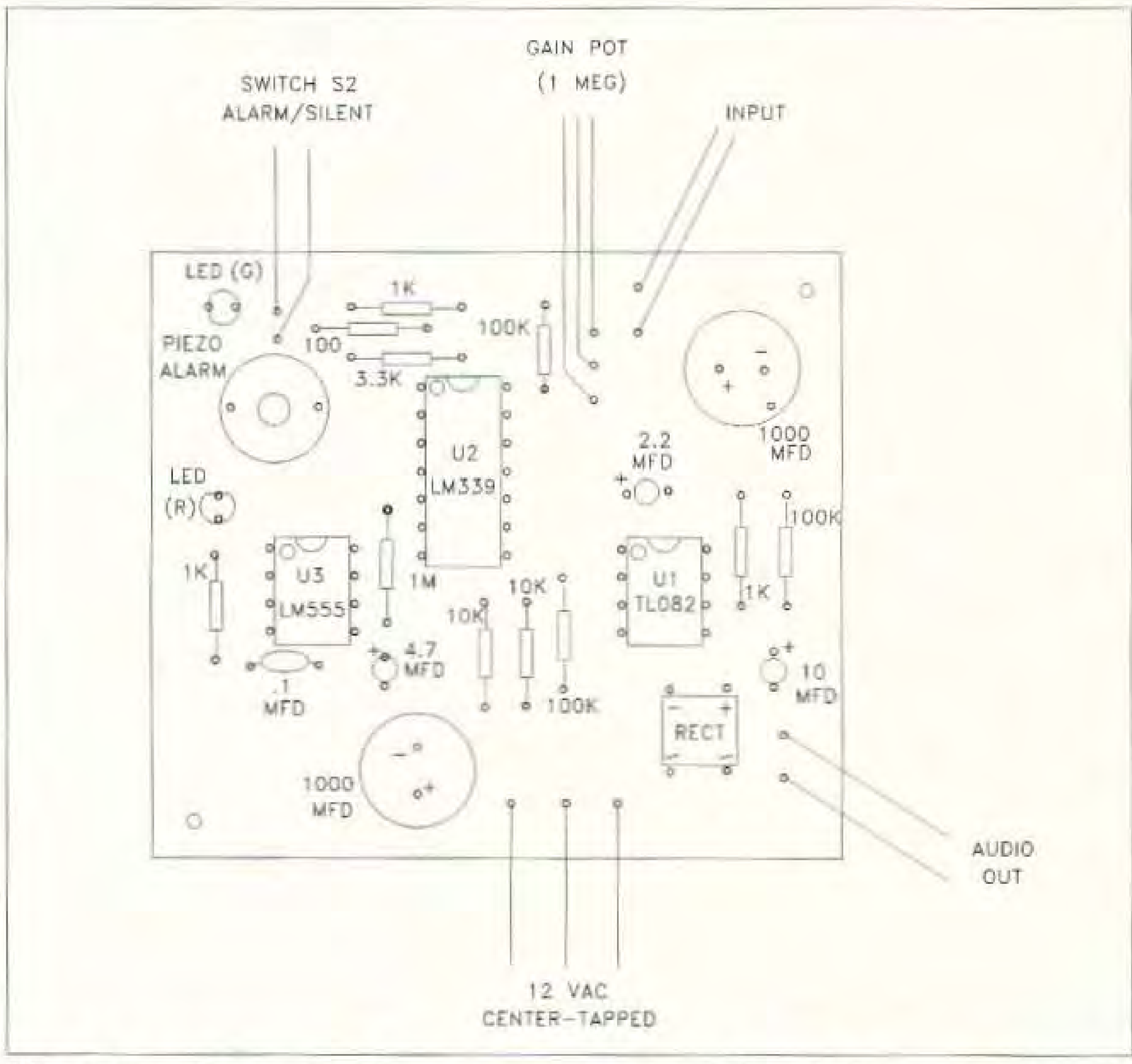

Fig. 5. Parts layout for the magnetometer circuit board. Be sure to orient the components as shown.

Here Comes the Sun

continued from page 36

thunderstorm many miles away. A number of these devices are in use as "UFO Detectors," and the portable devices might even be useful in investigating strange phenomena such as crop circles or poltergeist activity.

More information on these and other devices can be found on the Internet by going to my site at [http://www.bioelectrifier.com] and clicking on the SOLAR link. You can also reach me via E-mail at the address at top or by clicking on the "hot key" on my Web site. 73