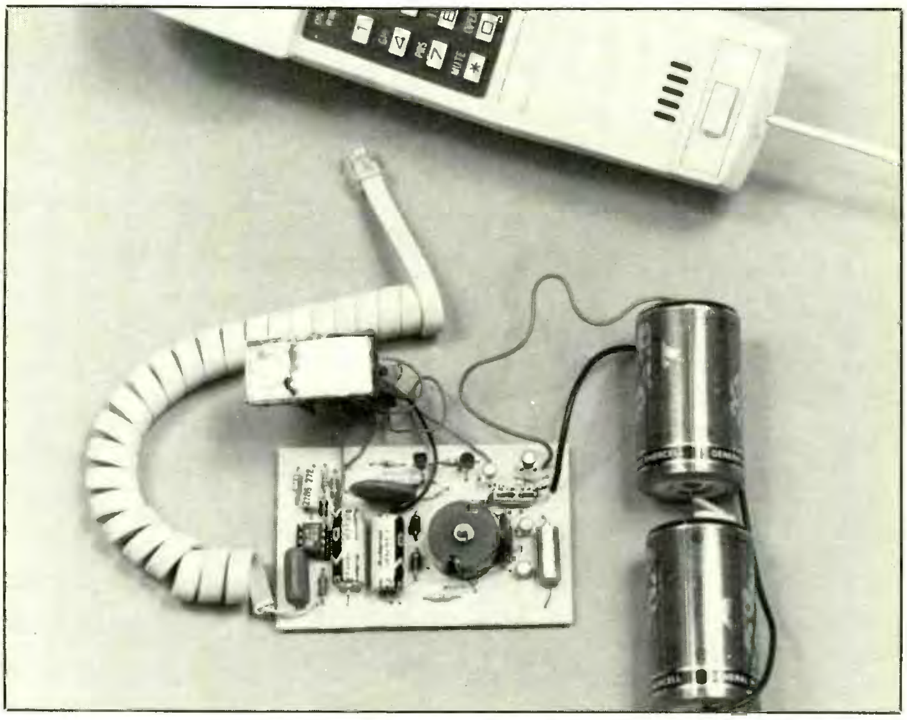
Automatic Telephone Flasher

Add-on accessory gives you visual indication of an incoming telephone call

By Anthony J. Caristi



Have you ever missed an important call because you didn't hear your telephone ring? Perhaps you were listening to music at high volume through headphones, or you or a member of your household is hearing impaired. For situations like these, a visible alerter like the Automatic Telephone Flasher to be described provides a practical solution. The Flasher can be used in conjunction with your instrument's "bell" or alone simply by switching off the latter.

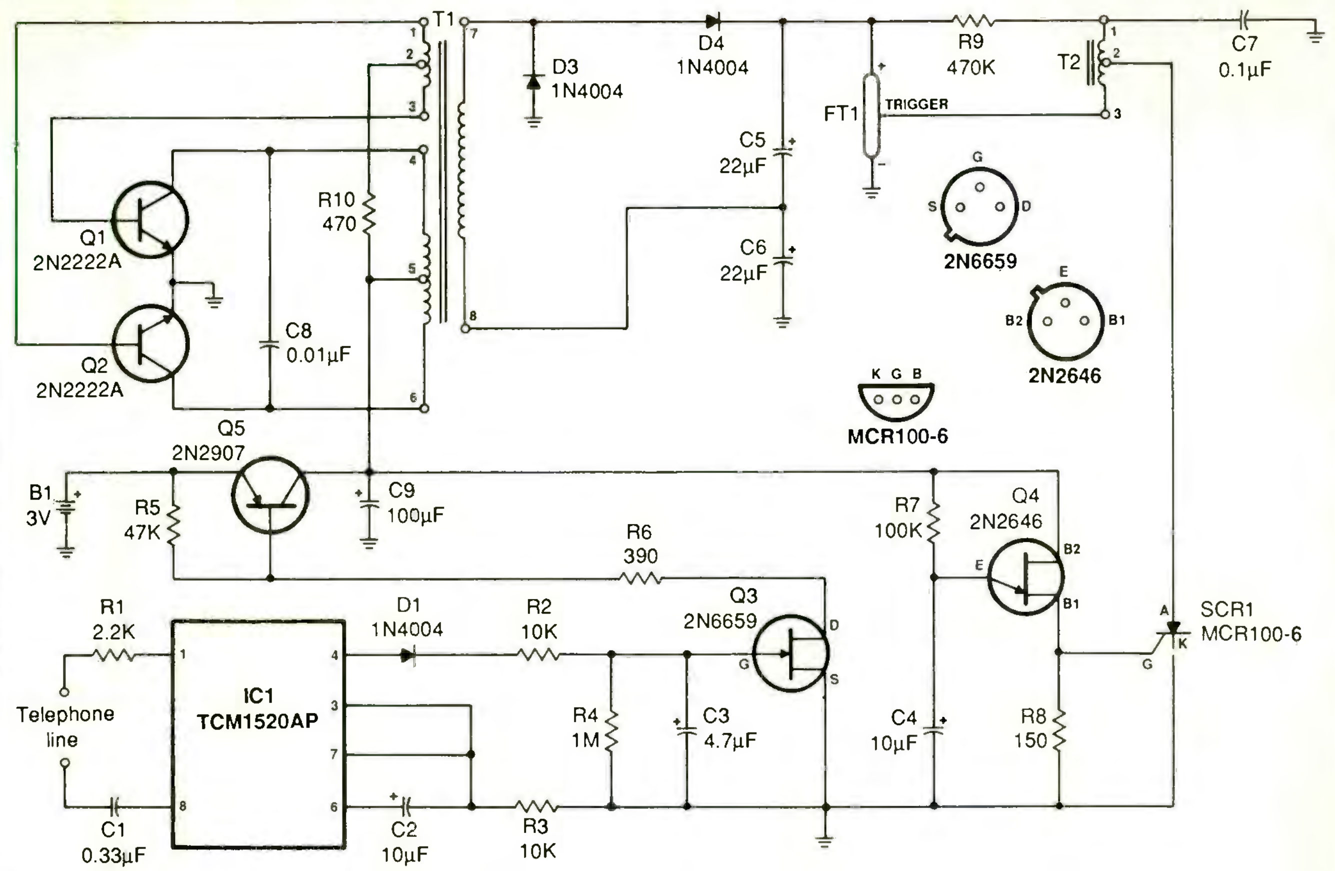
Completely self-contained in its own enclosure, the Automatic Telephone Flasher uses a pulsed photoflash unit as the alerting device. The project connects to the telephone line only to sense the ring signal generated by an incoming call. Because the ring signal has very little energy, two standard D cells power the project's flashtube circuitry and are called on to deliver power to the circuit only when the ring signal is present on the line. Hence, battery life is extremely long—up to a year or more, depending on the number of calls you receive in a year.

About the Circuit

As shown in the complete schematic diagram of the project in Fig. 1, the telephone flasher consists of two major sections—a telephone ring-signal detector and a dc-to-dc converter power supply that generates a high voltage required to trigger a xenon flashtube. These two sections are coupled to each other by an electronic switch made up of n-channel enhancement-mode field-effect transistor *Q3* and silicon bipolar transistor *Q6*.

Telephone ring detector *IC1* and its associated components are used to detect the ring signal when it appears on the telephone line from the phone company when a caller attempts to get through. Included in *IC1* is a bridge rectifier, 5-volt regulator and transient suppression circuitry that prevents damage to the integrated circuit and false operation that might otherwise occur if a large transient voltage appears across the telephone line.

Drive for *IC1* is provided directly from the 90-volt, 20-Hz ring signal that appears across the line to announce an incoming call. During standby, *IC1* presents a very high impedance to the telephone line. Also, this chip in no way affects incoming and outgoing calls. Its only purpose is to generate a regulated output voltage at pin 4 in response to the ring signal. Capacitor *C2* stores the energy of the signal to power the regulator circuit so that it produces a 5-volt dc output between pins 4 and 7 of the integrated circuit.



PARTS LIST

Semiconductors

D1,D2,D3—1N4004 or equivalent 400 PIV silicon diode
IC1—TCM1520AP telephone ring detector (Texas Instruments)
Q1,Q2—2N2222A or similar npn silicon transistor
Q3—2N6659 or equivalent n-channel enhancement-mode field-effect transistor
Q4—2N2646 unijunction transistor
Q5—2N2907 pnp silicon transistor
SCR1—MCR 100-6 silicon-controlled rectifier (Motorola)

Capacitors

C1—0.33-µF, 250-volt Mylar
C2,C4—10-µF, 50-volt electrolytic
C3—4.7-µF, 25-volt electrolytic
C5,C6—22-µF, 150-volt electrolytic
C7—0.1-µF, 500-volt ceramic disc
C8—0.01-µF, 250-volt ceramic disc
C9—100-µF, 10-volt electrolytic

Resistors (¼-watt, 10% tolerance)

R1—2,200 ohms
R2,R3—10,000 ohms
R4—1 megohm
R5—47,000 ohms
R6—390 ohms
R7—100,000 ohms
R8—150 ohms
R9—470,000 ohms
R10—470 ohms

Miscellaneous

B1—Two 1.5-volt high-energy or alkaline D cells in series (see text)
FT1—250-volt Xenon flashtube (Radio Shack Cat. No. 272-1145 or similar —see text)
T1—Hand-wound transformer (requires TDK pot core and bobbin No. H5AP2213Z52H or similar and Nos. 30 and 36 enameled wire—see text)
T2—Trigger transformer with 300-volt primary and 6,000-volt secondary (Triad No. PL-10 or similar)
Printed-circuit or perforated board with holes on 0.1″ centers and suitable solder or Wire Wrap hardware (see text); socket for IC1; double D-cell holder for B1; standard telephone cord with modular connector at one end; thin tape; suitable enclosure (see text); machine hardware; hookup wire; solder; etc.

Note: The following items are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: Pc board, $7.75; pot core and bobbin, $8.75; 2N2222A, 2N6659 and MCR 100-6, $2.25 each; 2N2646 and 2N2907, $3.00 each; and TCM1520AP, $3.95. Add $1 P&H. New Jersey residents, please add state sales tax.

Fig. 1. Complete schematic diagram of automatic telephone flasher.

Since its gate-to-source voltage is zero, *Q3* remains in cutoff during standby. The resistance between the drain and source is virtually infinite, which prevents any base current from flowing in *Q5*. As a result, *Q5* is also in cutoff, meaning that no current can flow from battery *B1* to the rest of the circuit.

When a ring signal appears across the telephone line, the 5-volt dc output from *IC1* biases *Q3* into conduction. The resulting low resistance now between *Q3*'s drain and source causes *Q5* to switch on at full saturation. This powers the circuit and allows the dc-to-dc converter to oscillate and trigger xenon flashtube *FT1*.

Since the time constant of *Q3*'s gate circuit, controlled by the values of *R4* and *C3*, is about 5 seconds, the forward bias on *Q3* is sustained during the 4-second interval between telephone ring pulses so that *FT1* continues to flash.

When the ring signal ceases, the bias on *Q3* decays to zero, which cuts off both this transistor and *Q5*. When this occurs, *FT1* extinguishes.

About 250 volts is needed to trigger the flashtube. This high voltage is provided by the dc-to-dc converter power supply composed of bipolar transistors *Q1* and *Q2*, transformer *T1* and the associated components. These components make up an oscillator circuit that operates at a frequency of 3 to 4 kHz. The collectors of the two transistors are connected in push-pull fashion to alternately drive each half of *T1*'s primary with the battery voltage.

The bases of *Q1* and *Q2* are driven by the feedback winding to assure that the dc-to-dc converter will oscillate as it should. Each transistor alternately conducts and is cut off, causing the transformer's primary to be driven by a 10-volt peak-to-peak square wave. The step-up turns ratio of the secondary winding produces a high ac voltage at pins 7 and 8 of *T1* that is used to drive a full-wave voltage doubler. The doubler charges *C5* and *C6* to about 125 volts each. Since these capacitors are connected in series with each other, the sum of the voltages—about 250 volts—is used to trigger the gas inside the flashtube to ionize and, in so doing, emit a bright flash of light.

Although *FT1* is connected across the output of the power supply, it does not conduct current and flash until it is triggered by a very-high-voltage pulse fed to its trigger electrode. This electrode is simply a wire that wraps around the flashtube near its middle.

To generate the very-high-voltage spike (it is almost 6,000 volts) needed to trigger the flashtube into operation, a second, trigger, transformer (*T2* in Fig. 1) is used. This circuit is very much like that used in the typical capacitive-discharge (CD) electronic ignition system used in motor vehicles.

Unijunction transistor *Q4* and its associated components make up a relaxation oscillator that operates at a frequency of about 1 Hz. Timing capacitor *C4* is charged by current through *R7*. When the charge reaches about 1.5 volts, *Q4* suddenly conducts and dumps the charge stored in *C4* into emitter resistor *R8*. When this occurs, the voltage produced across *R8* is sufficient to trigger silicon-controlled rectifier *SCR1* into conduction.

During the time *C4* charges to 1.5 volts, *C7* is charged to about 250 volts through *R9* and the high-voltage supply. When *SCR1* is suddenly triggered into conduction, the energy stored in *C7* flows into the primary of *T2*. Step-up action causes the approximately 6,000-volt output at the secondary of *T2* to be be presented to *FT1*'s trigger electrode, causing the flashtube to conduct and the energy stored in *C5* and *C6* to be converted into heat and light.

Although the energy in a single flash of *FT1* is dissipated in about

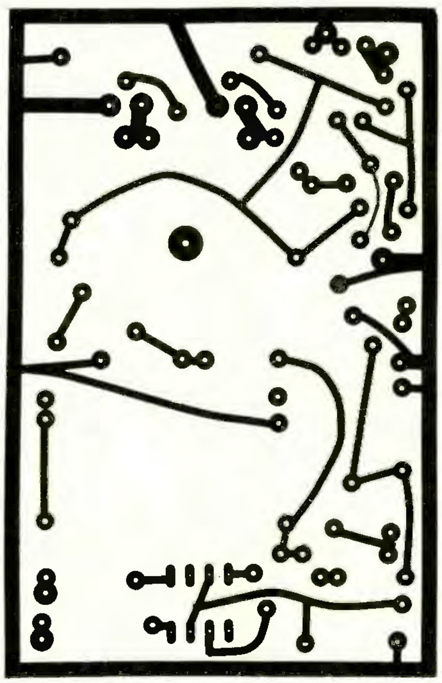


Fig. 2. Actual-size etching-and-drilling guide for project's printed-circuit board.

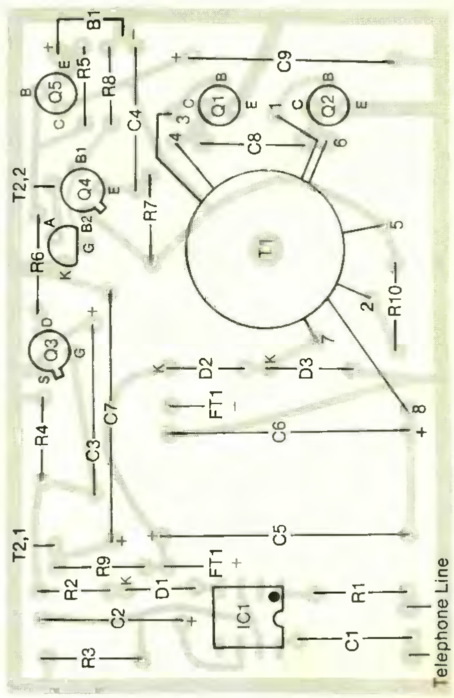


Fig. 3. Wiring guide for pc board. Use this as rough layout guide if you wire project on perforated board.

0.001 second, the flash produces enough light—similar to that of a photoflash used with cameras—to be easily seen. As *FT1* flashes, *C5*, *C6* and *C7* quickly recharge to await the next pulse from *C4*. The cycle repeats as long as the ring signal is present on the telephone line.

Although trigger transformer *T2* produces an output of about 6,000 volts, no potential shock hazard exists because there is no power (current) behind this very-high voltage. However, it is always a good idea to respect any high voltage, whether from *T1* or *T2*, since you will get an electrical shock if you place any part of your body in contact with the circuitry.

Construction

As shown in the lead photo, the entire circuit, with the exception of the battery and flashtube, can be wired on a small single-sided printed-circuit board that measures only 3.5 × 2.25 inches. Since there is nothing critical about either wiring or component location, you can assemble the circuit on a similar-size perforated board that has holes on 0.1-inch centers and use suitable soldering or Wire Wrap hardware to make wiring interconnections. Just be sure that the secondary of *T1* and the primary of *T2* do not cross over the low-voltage circuits of the transistors and related components. If you do not heed this advice, the circuit can fail should a voltage breakdown occur between the high-voltage supply and the sensitive low-voltage components. The advantage of using a printed-circuit board is that it precludes such a breakdown.

You can fabricate your own pc board using the actual-size etching-and-drilling guide shown in Fig. 2, or you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List. Once the board is ready, refer to Fig. 3 and mount and solder into place a socket in the *IC1* location. Do *not* install *IC1* in its socket until after preliminary checks have been made.

Install and solder into place the resistors, diodes and capacitors. Then do the same for the transistors (except *Q3* and *Q5*, which will also be installed after preliminary checks have been made) and *SCR1*. Observe polarity with the diodes and electrolytic capacitors and basing for the transistors and silicon-controlled rectifier. (Note: If you wire the project on perforated board, use the layout shown in Fig. 3 as a rough guide to component placement and orientation.)

The flashtube and trigger transformer *T2* can be obtained from the sources given in the Parts List. Alternatively, you can salvage these items from an old camera photoflash unit. Wire these components to the circuit board as indicated in Figs. 1 and 3; observe polarity for the flashtube.

Since this project contains voltages that are not normally encountered in modern solid-state circuits, be sure to follow the voltage ratings of the components indicated in the Parts List when selecting them. Do *not* use components with voltage ratings less than those indicated. If you do, one or more of the components is likely to break down. If this occurs, the circuit will not operate and other components are likely to be damaged.

Use a standard telephone cord that is terminated in a modular plug to make connection to the telephone line. This is both an FCC requirement for telephone accessories and a convenience that will let you move the project to another telephone if you desire to do so. Since the circuit is ac coupled to the telephone line through *C1*, you need not be concerned with polarity. Connections are made to the red and green conductors of the telephone line; the black and yellow conductors are not used and can be disregarded.

Switching transformer *T1* must be hand wound by you. This is not as difficult a task as you might imagine. In addition to the pot core/bobbin assembly specified in the Parts List, you will need a small quantity of No. 30 and 36 enameled (so-called "magnet") wire and some thin insulating tape. Mylar tape will do nicely. It is mandatory that you perform the winding procedure exactly as follows to ensure proper phasing of the primary and feedback windings.

Start with the feedback winding, identified by terminals 1, 2 and 3 in Fig. 1. Use No. 30 enameled wire for this winding. Wind a total of 10 turns of this wire on the bobbin, making a center tap at the fifth turn. Starting with a 36-inch length of wire, wind five turns around the bobbin, leaving a 4-inch-long "leader." Bring the wire out of the bobbin, at one of the openings provided, fold the wire over into a 4-inch U shape wind five more turns on the bobbin in the *same* direction as you wound the first five turns. Secure the feedback winding in place on the bobbin with a single layer of tape to insulate it from the next winding. Allowing about a 4-inch leader at the end of the wire, clip off any excess. Use masking tape to label the start, center tap and end of this winding with the numbers 1, 2 and 3, respectively.

Next, wind the transformer's primary turns in bifilar fashion to achieve the tightest possible coupling between the two halves of the winding to minimize voltage spikes that will appear at the collectors of *Q1* and *Q2*. Use two 30-inch lengths of No. 30 enameled wire for this winding. Label the same ends of these two wires 4 and 5. Place these two ends together and, leaving a 4-inch leader in both cases, wind nine turns around the bobbin in the *same* direction as the feedback winding was wound. Secure this winding with a layer of tape. Clip all but 4 inches from what remains of these wires.

Use an ohmmeter set to a low-ohms range or a continuity tester to identify the unmarked ends of the primary. Label the wire that gives continuity with the end labeled 4 with a 5. The other wire then gets a label with a 6 on it.

The secondary winding of the transformer simply consists of 250 turns of No. 36 enameled wire wound in either direction. When you have finished winding the wire onto the bobbin, secure it in place with a couple of layers of tape. Then trim the leads to about 4 inches in length and label them with the numbers 7 and 8.

Assemble the bobbin inside the pot core halves, being careful to avoid getting any dirt or other foreign debris on the polished surfaces of the core. Use tape to secure the two halves of the pot core together. Then carefully scrape away about ¼ inch of enamel insulation from the ends of all transformer leads, including the center of the U loop on the center tap of the feedback coil, after first clipping open the center of the U. Tin each lead end with a thin layer of solder.

Mount the transformer on the circuit-board assembly in the location shown in Fig. 3. Use a No. 6 machine screw and nut and a plastic or fiber washer if you have one. Be very careful to avoid over-tightening the hardware or you will crack the very brittle ferrite pot core, rendering it useless.

Plug the transformer's leads into the appropriate holes in the pc board and solder into place. Remember that there will be *two* leads that go into holes 2 and 5. Be very careful to connect the transformer's leads into the circuit properly; a wiring error at this stage will result in an inoperative circuit.

You can install the entire project in a suitable plastic or metal enclosure. Mount the flashtube so that it will be readily seen when it flashes. If you use a clear plastic enclosure, you can locate the flashtube inside it.

Since power for the circuit is provided by two 1.5-volt D cells in series with each other to provide 3 volts, it is best to use heavy-duty or alkaline cells for longest operating life. This battery is called upon to deliver current only when the telephone rings; hence, its service life can approach that of its shelf life. Just keep in mind that the circuit is designed to give a flash rate of about once per second. When you notice that the frequency of flashes is much less than this, it is time to replace the cells with fresh ones.

Checkout & Use

It is best to check operation of the dc-to-dc converter section first. Make sure that *IC1*, *Q3* and *Q5* are *not* installed on the circuit-board assembly. Use a bench-type dc power supply set to deliver 2.5 volts or two C or D cells in series as a power source. Current drawn from the source will be in the 100- to 300-mA range.

Use a dc voltmeter or a multimeter set to dc volts to measure the output voltage from the dc-to-dc converter circuit. The meter must have an input resistance of 1 megohm or more and be set to measure at least 300 volts. Be very careful not to touch any of the wiring during and after the test because high voltage will be present in the circuit.

Before powering the circuit, connect the meter's "hot" probe to the positive (+) side of *C6* and common probe to the negative (−) side of *C6*. Then connect the dc power source across *C9*, again observing polarity. You may now hear a faint 3- or 4-kHz tone as the circuit oscillates, and the voltmeter's reading should slowly rise toward 250 volts. As the flashtube fires, the indicated voltage should suddenly drop toward zero and begin to rise toward 250 volts. This charge/discharge cycle should continue to repeat about once each second for as long as power is applied to the circuit.

Once you obtain the proper indications, disconnect the power source from the circuit and use a low-value, say, 1,000-ohm, resistor to carefully discharge *C5* and *C6* by temporarily bridging each capacitor's leads. Be careful to avoid touching the resistor's leads!

If you do not obtain a dc voltage reading on the meter, the circuit is probably not oscillating as it should. Disconnect the power source from the circuit and check the basings of *Q1* and *Q2* and the orientations of *D3*, *C5* and *C6* against Fig. 3. If all seems to be okay, the 1 and 3 feedback leads of *T1* may be incorrectly phased. Transpose these two leads and try again. If this does not work, return the leads to their original holes, and carefully review the transformer winding instructions to ascertain that you have properly performed the procedure.

If you obtain 250 volts or more but the flashtube fails to fire, *Q4* may not be oscillating. In this case, check the orientation of *C4* and basing of *Q4*. Connect the voltmeter across *C4* and ascertain that the reading indicated slowly rises to about 1.5 volts, then suddenly drops to near zero and repeats about once per second.

If *Q4* is oscillating, check the wiring of *T2* and *SCR1*. If possible, try using another flashtube. Do not proceed to final assembly until you have cleared up any problems encountered during checkout.

When you are finished with checkout, disconnect the power source from the project and once again carefully discharge *C5* and *C6* with the bridging resistor. Then plug *IC1* into its socket, making sure to properly orient it as shown in Fig. 3 and that no pins overhang the socket or fold under between socket and IC. Install and solder into place *Q3* and *Q4*, checking for proper basing before soldering the leads of these transistors to the copper pads on the bottom of the board.

Place two D-size cells in a two-cell holder and wire them in series with each other. Then wire this "battery" into the circuit as shown in Figs. 1

and 3. With the cells connected into the circuit as shown, there should be no project activity.

For your final test, plug the modular connector at the end of the project's cord into a telephone jack (use a duplex adapter if only one jack is present at the telephone box) along with your existing telephone instrument. Have a friend place a call to your number. When the telephone rings, the flashtube should fire at a rate of about once per second, even during the 4-second interval between rings. When you pick up your phone's handset to answer the call, flashing should continue a few more times and then cease.

You can now proceed to final installation. Simply leave the project plugged into the telephone line but locate the automatic telephone flasher where its flashing light will easily be seen from anywhere in the room. ME