TELEPHONE ACCESSORY

Turn-On Appliances Via Long Distance

An add-on device that enables you to turn on and off appliances or sequently turn on multiple appliances by ringing your telephone

JAMES GUILDER

THE TELEPHONE IS PROBABLY ONE OF THE most important of all those appliances that can have a bearing on our daily lives; yet it is the one most often taken for granted. We usually think of it as merely a means of communication but in this article we will see how the telephone can become a "Magic Genie" that can control many simple household tasks while we are away from home.

The project described in this article is designed to operate with the ordinary house telephone. To better understand how it works, we must first look at the basic phone instrument and see how it operates.

One of the more common telephones in use today is the *model 500* used in the Bell Telephone System. It is the model that will be considered. A typical schematic of the 500-type telephone is illustrated in Fig. 1.

Sound is picked up by the telephone transmitter (microphone) as variations in pressure caused by a vibrating diaphragm. Sound is reproduced in the telephone receiver. It contains an electromagnetic earphone.

It's possible to make a telephone with just the receiver, transmitter and some additional switches. But such an instrument would be difficult to use because your voice would be loud in your receiver and low in the receiver of the party you were talking to. The same thing would be true on the other end. To eliminate this, telephone engineers have included varistors in the telephone instrument. (Varistors are voltage variable resistors in which the resistance varies inversely with the voltage.) So if the voltage across a varistor increases, the resistance decreases and vice versa. This means that the average voltage across the receiver in the phone remains relatively constant. The voltage produced in your receiver by your microphone is reduced to the same level as the voltage coming from the distant microphone.

In Fig. 1 varistor RV1 suppresses dial pulse clicks in the receiver. The balancing network, composed of varistor RV2, resistor R2, and capacitors C2 and C3 with the windings of the induction coil, forms a hybrid arrangement that provides simultaneous two-way operation over a two-wire circuit. Capacitor C1 and resistor R1 make up a dial pulse filter to suppress high-frequency interference to nearby radio receivers. Varistors RV2 and RV3 with R1 also reduce the efficiency of the transmitter on short loops from the central office to maintain satisfactory transmission volume. All of the components marked with an asterisk (*) are located within the network block

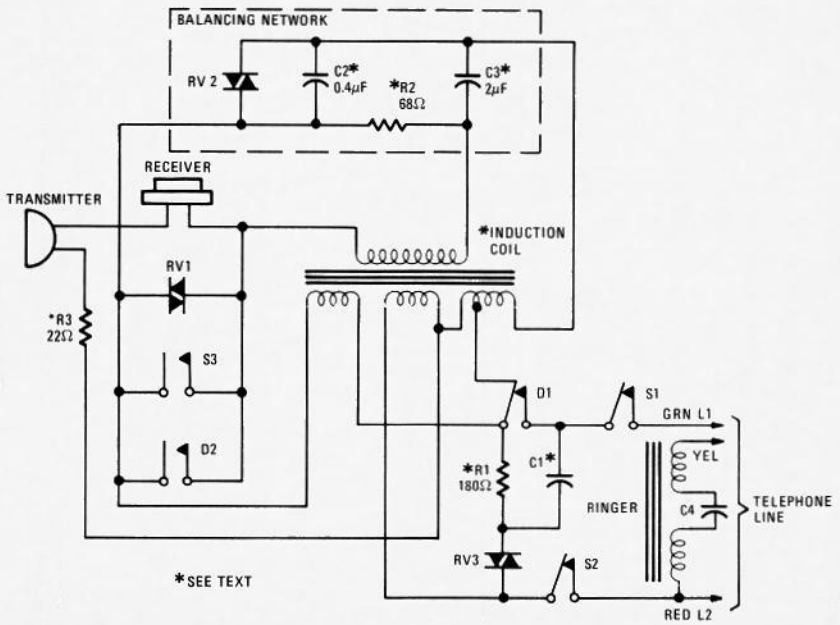

FIG. 1—500-TYPE TELEPHONE contains transmitter, receiver and network for balancing the signal level between the two.

located inside Western Electric and ITT telephones. In phones produced by Automatic Electric, these components are on a printed circuit board in the phone.

While most telephones have three wires coming out of them—green (L1), red (L2) and yellow—the green and yellow wires are often connected together. The yellow and red wires are used to make the telephone ring. To do this, between 60 and 90 volts at 20 Hz is applied to the ringer, which consists of two coils in series with a capacitor. The ringing coils of the bell and capacitor C4 are designed so that once the bell starts to ring, the ringing signal is reinforced and even a small electrical current will cause the bell to continue to ring.

The ringer assembly is connected to the telephone line at all times because it is connected before the hook switch that disables the rest of the telephone until the receiver is lifted off the hook. If the telephone company wants to determine how many phones are connected to a line, it either measures the capacitance of the line or the current drawn during ringing.

When the receiver is lifted off the hook, switches S1 and S2 close, while switch S3 opens. When S1 and S2 close, the phone resistance, that normally varies between 600 and 900 ohms, is placed across the line. The 48 volts across the line when the phone is on the hook drops to about 5 volts.

To dial a phone number, the line must be interrupted (opened and closed) at a repetition rate of 10 pulses per second. This is done by contact D1, located on the back of the telephone dial. If, for example, the number 7 is dialed, D1 (normally closed) opens and closes 7 times. While this is happening, D2 stays closed. The moment the dial is moved from its normal resting position, contact D2 closes and stays closed until the dial returns to its resting position. This short circuits the receiver to prevent the dial clicks from being heard.

Build the Teleswitch

How would you like to be able to call your house after an evening out, turn the electric coffee pot on, and have a fresh pot of hot coffee waiting for you when you get home? Or maybe you'd like to turn the lights on and off in your house while you are away on vacation so potential burglars won't realize that you are not home.

You can do these things and more with Teleswitch. If you want to, you can turn on a whole series of devices in sequence, just by making one phone call every time a device is to be turned on. And the best part of the whole thing is that you do not get charged for a phone call, even if it is long distance. The reason for this is that Teleswitch does not answer the phone. It simply uses the ring signal to activate whatever devices are connected to it.

Do not worry about anyone else turning things on accidentally. Teleswitch is designed so that unless the phone rings *exactly once*, and *only once*, nothing will happen.

There are two versions of Teleswitch: sequential, multiple-device and on/off switching. The sequential type will turn on a series of electrically operated appliances one after the other. This is good if you have several things to control remotely such as an electric coffee pot, warming tray, lights, etc. The disadvantage of this device is that to turn something off, it requires a sepa-

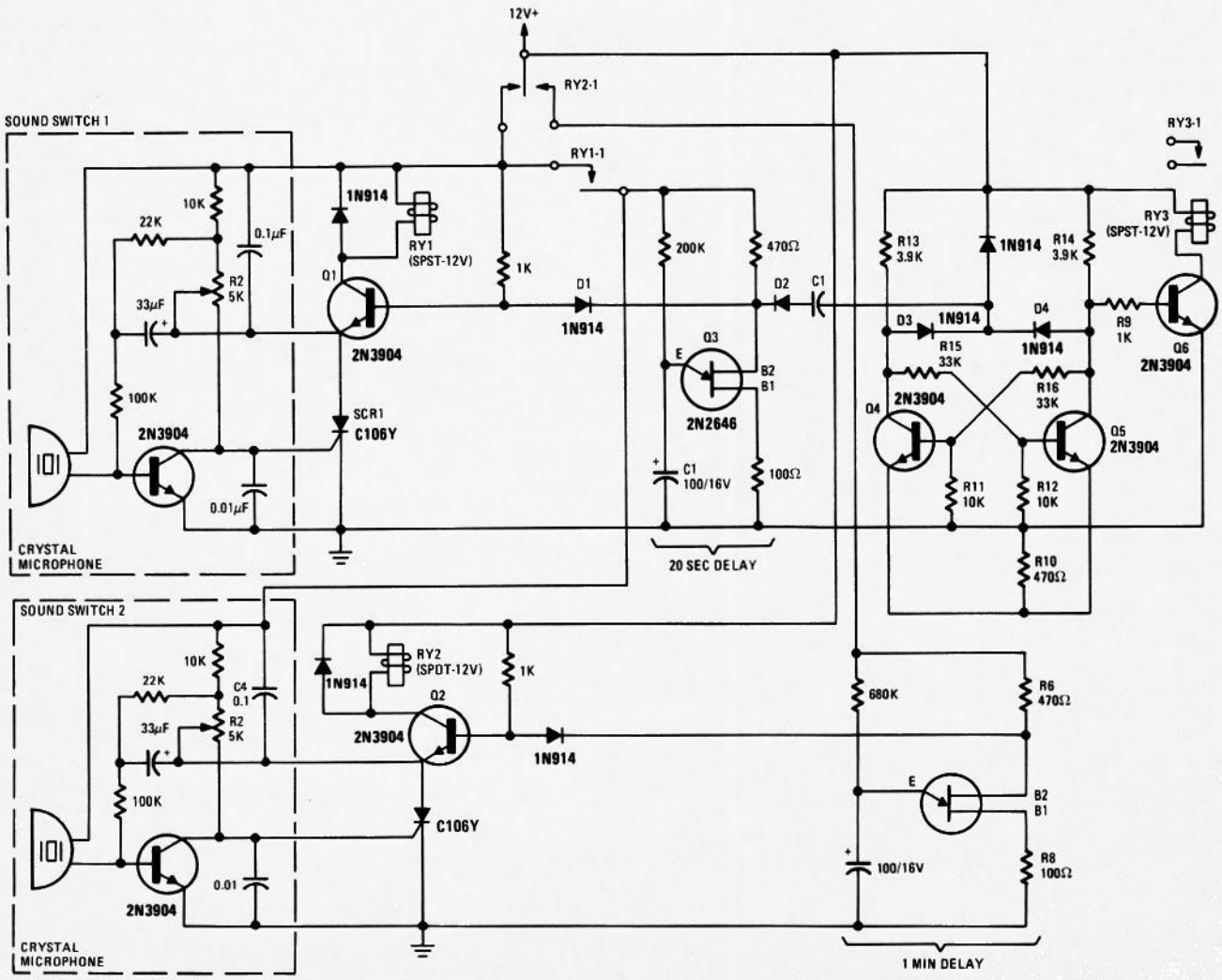

FIG. 2—ON/OFF-TYPE TELESWITCH responds only to single telephone ring.

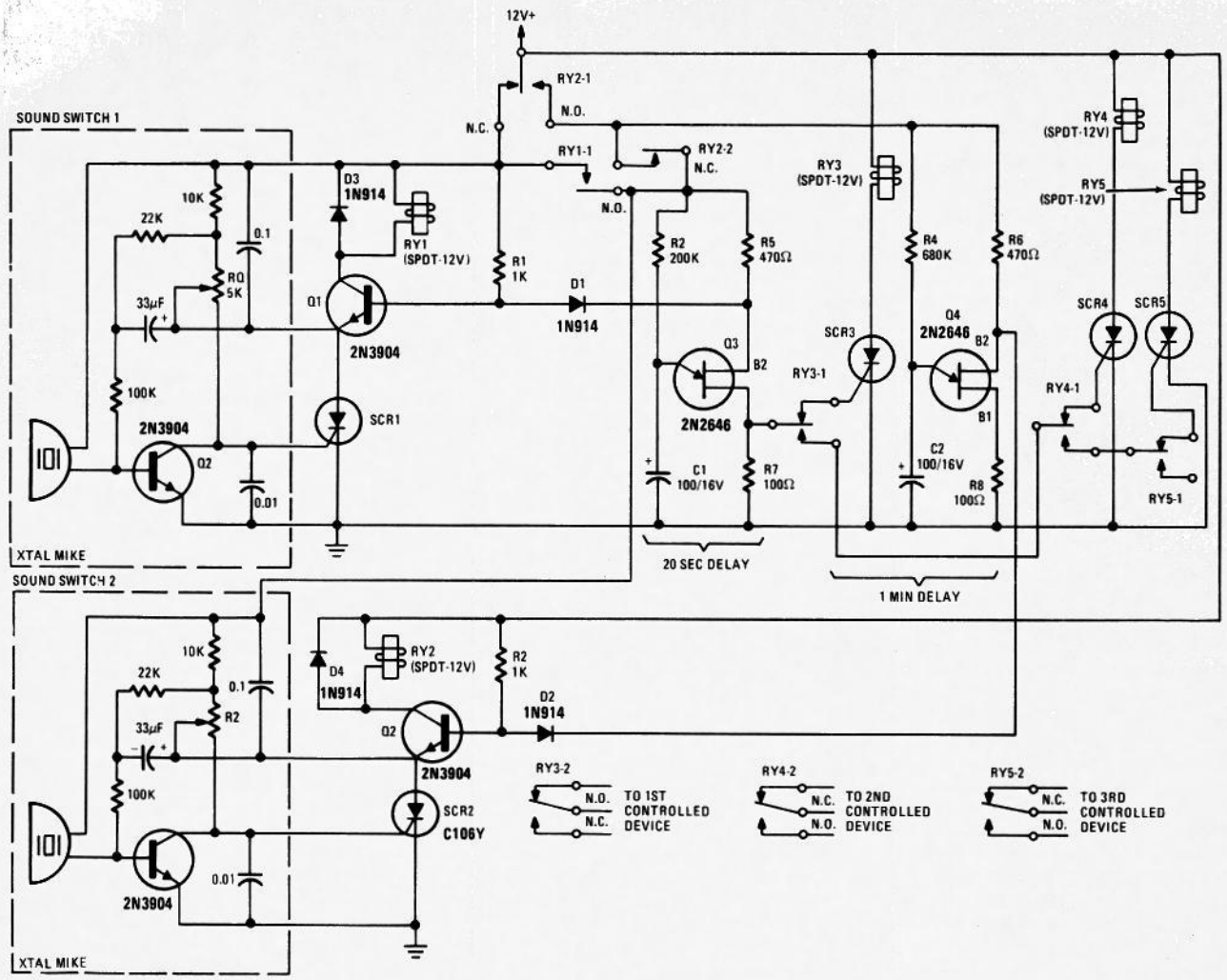

FIG. 3—SEQUENTIAL-TYPE TELESWITCH sequentially turns on multiple appliances.

rate relay in the sequence chain.

This turn-off problem can be eliminated if you are only interested in turning one device or group of devices on and off together. This configuration uses a flip-flop circuit to control a relay that turns whatever is connected to it on and off. The first time you dial, it turns the device on. The next time, it turns it off.

About the circuit

This device uses two sound switches. When the telephone rings the crystal microphone picks up the sound of the bell and triggers SCR1 which closes relay RY1 (Fig. 2). Transistor Q1 is held on by resistor R1 and is used to reset the sound switch by applying a negative pulse to its base.

When RY1 closes, its contacts apply voltage to the second sound switch and to a 20/second unijunction timer circuit.

If the telephone rings only once, which is what happens if you place a call to turn something on, capacitor C1 has enough time to charge and trigger unijunction transistor Q3. The time required for C1 to charge is determined by the R3—C1 combination. The values shown give a delay of about 20 seconds.

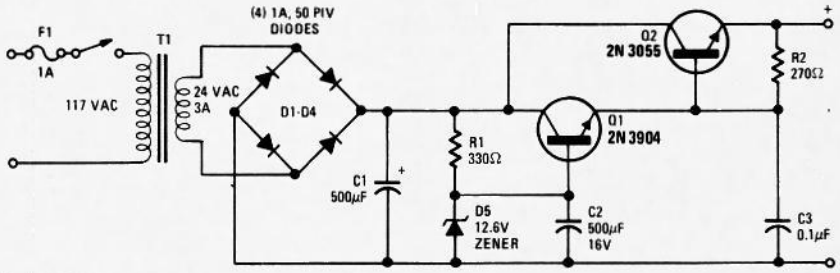

FIG. 4—POWER SUPPLY FOR TELESWITCH. Output voltage is determined by Zener diode. Power is taken from 117 VAC line.

When Q3 is triggered, it produces a pulse that is used to turn SCR3 on and Q1 off. SCR3 latches relay RY3 on. One set of contacts on RY3 is used to prepare the circuit to trigger SCR4 on the next signal. This is done by transferring the gating pulse from SCR3 to the gate of SCR4 or SCR5, etc. The other set of contacts of RY3 are used to control the first item to be turned on.

While all this is happening capacitor C2 is building up a charge. When the charge on C2 reaches the triggering voltage for unijunction Q4, a reset pulse is generated that resets the sound switches by turning off Q2 and SCR2 and de-energizing RY2 if the call was not a legitimate control signal. The components used produce a delay of about 1 minute from the time the phone first rings until the reset pulse is generated.

What this means is that sequential devices cannot be activated unless there is an interval of at least 1 minute. This delay helps prevent accidental activation by random phone calls.

On-off switching

For on/off switching, the second version of Teleswitch, shown in Fig. 3, should be used. It is similar to the sequential type in that it uses two sound switches and two unijunction transistor

Ma Bell, the FCC and You

There is a gray area of regulatory conditions surrounding the use of privately-owned telephone equipment on telephone company lines. The famous 1968 "Carterfone Decision," that permitted attachment of privately owned *"foreign"* equipment to the telephone lines, was not a Federal Court decision as most people believe. The Federal Court referred the case to the Federal Communications Commission because of its technical nature. Thus the decision was only an FCC opinion, and not a court ruling.

That decision was against the restrictive practices of the telephone company and said, essentially, that the attachment of customer-owned *"foreign"* equipment, that increases the utility of the phone to the user, should be permitted providing that such attachment does not pose a hazard to the telecommunications network, telephone company equipment, its employees, or the public.

As a result of the Carterfone Decision, telephone companies modified their tariffs, permitting such connections, but with wording inserted that requires a "voice connecting arrangement."

The FCC has since entered into hearings with the telephone companies, the state Public Utilities Commissions, and telephone equipment manufacturers to finally implement the intent of the 1968 decision. While moving slowly, progress has been made; and in most cases, the agreements reached and the tariff changes have all been in the direction of allowing private equipment to be connected to the line. AT&T itself has changed its tariffs recently to allow certain equipment, that contains a telephone company-approved connecting device, to be connected to the line.

But these telephone company-approved devices increase the cost of the equipment sold and many people feel they are unnecessary. Experts in the field find it illogical and unreasonable for AT&T to use foreign attachments without the "voice connecting arrangement," but to require it when the identical device is purchased directly by the telephone user.

An Electronics Industry Association staff vice-president for communications and industrial electronics has reported that more than 1800 phone companies nationwide already use independently made attachments without the so-called protective devices for interconnect.

The FCC has indicated to AT&T that the Bell System should not require connecting arangements for equipment when the same type of equipment provided by the telephone companies themselves is not connected through these voice-connecting arrangements. The Bell System, for example, offers a telephone answering machine on a rental basis and does not connect that unit through the connecting arrangement they want to require others to use.

Many experts believe that it is now perfectly legal and permissible to connect telephone accessories to the regular phone line providing that these devices do not interfere with normal telephone operations, deprive the phone company of its lawful revenue, or create a hazard to its equipment or personnel.

The FCC's position regarding interconnect is quite clear and has been expressed many times. Even where a potential for harm exists, the FCC is determined to investigate the facts and to assure that only minimum restriction and regulations will be allowed as are absolutely required to prevent such harm.

Many believe that it is only a matter of time before the restrictive interconnecting arrangements will no longer be required. For the time being, would-be users of telephone accessories have three choices:

1. Use only equipment that is inductively or acoustically connected to the telephone line.
2. Pay to have the telephone company install a connecting arrangement and pay a monthly service charge.
3. Ignore the tariffs and connect your telephone accessories directly to the telephone line. (This, of course, would be illegal.)

timing circuits. The difference between the two is that the output of Q3 triggers a flip-flop (Q4 and Q5) instead of an SCR. The negative going pulse from Q3's B2 terminal does two things. First it goes via isolating diode D1 to the base of Q1 and turns off SCR1 and its associated relay. The negative pulse is also applied via isolating diode D2 to the triggering circuit of the bistable flip-flop. Capacitor C4 blocks any DC levels while diodes D3 and D4 serve as steering diodes which cause pulses to change the flip-flop from one state to another, forming the on/off switching action.

The output from one side of the flip-flop is fed to Q6, which acts as a relay driver and closes the relay on every other pulse.

As with the first version of Teleswitch, this one requires exactly one ring of the telephone to activate. More than one ring will trigger sound switch 2 and disable the entire system for one minute.

Construction

Teleswitch is best built on a chassis that measures at least 5 × 9 × 2 inches. Depending on how many sequential devices you are going to control, you may want to use a larger chassis, with enough room to mount all of the controlled outlets.

Mount both sound switches next to each other in the middle and towards the rear of the chassis.

Drill two $\frac{1}{8}$-inch holes at the spot where the crystal microphones will be mounted so that the ring signal can be picked up more easily. The controlled outlet(s) are mounted next, after you have first drilled a $1\frac{5}{16}$-inch hole to accommodate the outlet. This outlet is similar to the ones commonly found in homes except that it does not have two receptacles, only one. It can be purchased in any electrical supply store. After drilling the main hole for the outlet, make the two small holes for the retaining screws. Remember to select a chassis large enough to mount the number of controlled outlets you are going to have.

Layout of components requires no special attention. Perforated phenolic circuit boards can be used, and any convenient arrangement will do. A 12-volt power supply should be used. If a large number of high-current relays are needed, make sure the supply can handle all the current required; otherwise a higher current transformer and power transistor will be needed.

The schematic of a suitable power supply is shown in Fig. 4. The AC voltage is stepped down by the transformer to 24 volts and then rectified by the bridge rectifier. The rectified voltage is then fed to a resistor/Zener-diode circuit, where a reference voltage is produced, and fed to the collectors of Q1 and Q2. The Zener reference voltage, which determines the output voltage of the supply, is applied to the base of Q2 which is connected in a Darlington configuration with Q1. Output is taken across the series combination of the 270-ohm resistor and the 0.1-μF capacitor.

The components for the supply are not critical. Just about any NPN power transistor can be used instead of the 2N3055 specified, and any low-frequency small-signal NPN can be used for Q2. The output voltage of the supply equals the Zener voltage minus the voltage drop across the two transistors, or $V_z - 1.2$. To change the output voltage of the supply, simply change the Zener diode.

If a large amount of current is required, the transistor will become very hot and it may be necessary to mount it on a heat sink. As long as you can hold a finger on the transistor for a minute while it is operating, you're okay. If you have to pull your finger away immediately, use a heat sink. But be careful, don't burn yourself.

Installation and operation

To use the Teleswitch it is only necessary to place the telephone on top of the chassis and plug in the devices to be controlled. You must adjust the thresh-

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old level of each sound switch so it triggers on the telephone ring. This is done by adjusting the value of the potentiometer on each sound switch so that the SCR will latch after the first ring.

If the sequential Teleswitch is used and you want to turn things off remotely, remember that you have to connect that device to the power line through a normally closed relay so that the relay contacts can be opened when the relay is activated.

To test the unit, have someone telephone you, but do not answer the phone. Let it ring a few times and then have the caller wait 1 minute and call back.

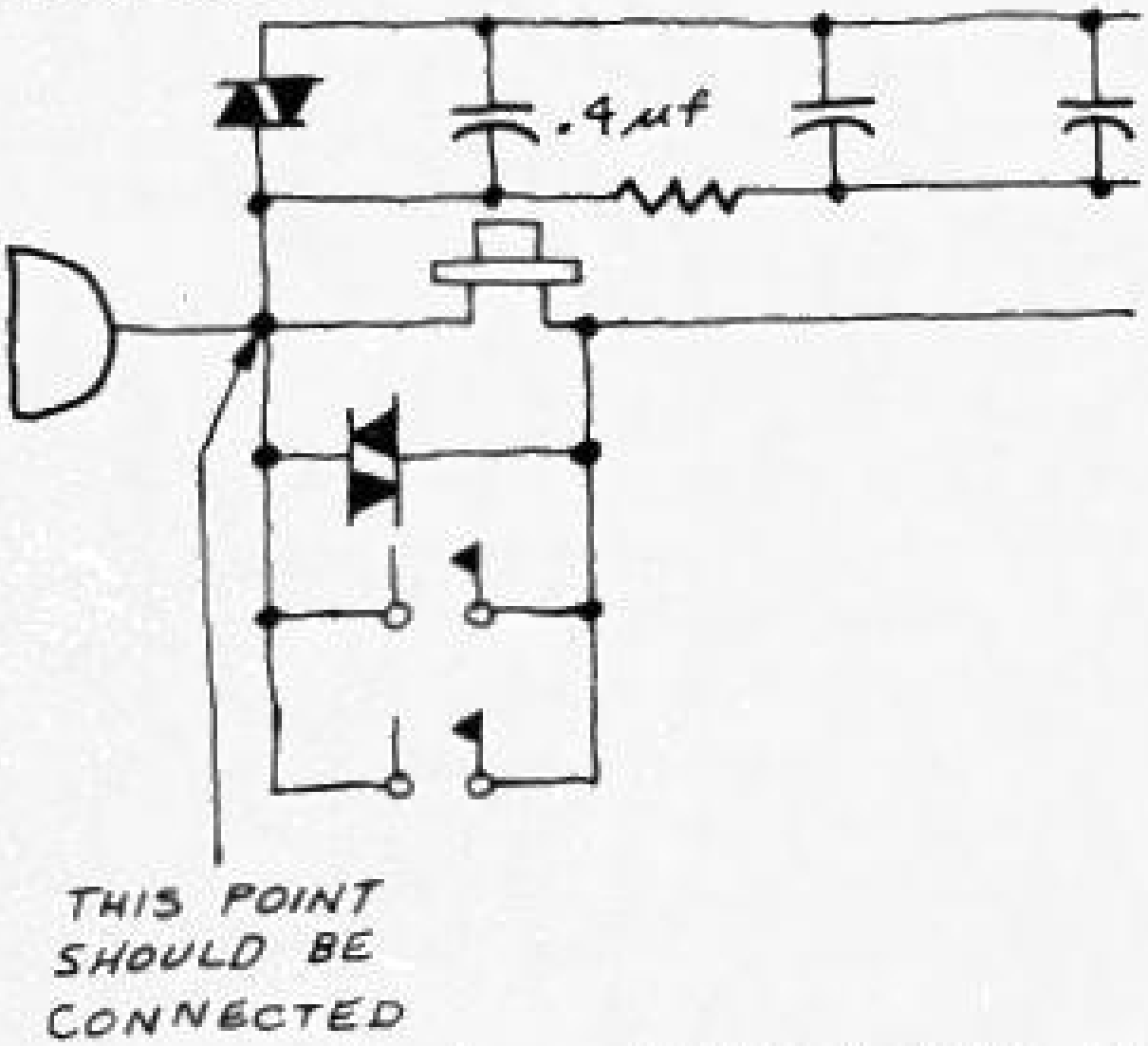
If the unit is operating properly, a relay click should be heard after the first ring and another relay click after the second ring. If so, the controlled device should remain off. After a total of 1 minute from the first ring, the sound of a relay opening should be heard. This is RY2 disconnecting power from the reset timer. Now the teleswitch is rTady to accept a new ring signal.

Have your friend call again, this time allowing the telephone to ring only once. Twenty seconds after that ring, the device connected to the controlled outlet should turn on.

For the sequential version of the circuit, the next single ring should turn on the second outlet. In the on/off version, the next single ring of the telephone will turn the controlled outlet that is now on, to off. **R-E**

ERROR IN DIAGRAM

There is an error in Fig. 1 of the article entitled "Turn-On Appliances Via Long Distance," in the April 1977 issue of **Radio-Electronics.**



The error is shown in the diagram. The indicated point should be connected.

GAINES M. CROOK, P.E.
Chatsworth, CA

RINGBACK

Your article telling how to build a teleswitch for your home (April 1977 issue) didn't mention one important misconception about phone company equipment.

Ringback, the intermittent sound you hear in the earpiece after dialing, has no correlation with the number of rings occurring at the other end. The signal you hear is generated by equipment in your local phone company switching office. Even if the call were made within the same switching office, the ringback is sent out to you, the caller, only for your benefit so as to create a false sense of security that indeed the call has gone through.

A situation could come up where you think you've allowed your phone to ring once only, but it may have rung as many as three times, or not at all, depending on the equipment, or, I should say, on its availability at the moment it generates ring and ringback.

JONAS R. BIELKEVICIUS
Greenbelt, MD 20770

TELESWITCH SURPRISE

Readers who construct James Gilder's Teleswitch (April 1977, Radio-Electronics) may be in for an unpleasant surprise when they discover that the ringback signal and the ringing signal are not necessarily synchronized, depending upon the equipment at the central office.

The ringback signal—that which lets the caller know that the called phone is ringing—may be produced by a separate ringing generator, or may be switched by a different cam on the same generator.

Callers who "let the phone ring just once" may, in fact, be ringing it once, twice—or not at all! In my (General Telephone) area, I often have confused callers by picking up after the first ring—they hadn't heard the ringback yet.

I would suggest that prospective Teleswitch builders perform a simple experiment: Call another phone nearby, and compare your ringback signal with the other phone's ringing. If the phones are in different exchanges, a pair of handie-talkies makes it easy, but you will need a helper.

There is another "confusion factor": to equalize the load on the ringing generator, the central office connectors draw their ringing current from different angles of the ringing cycle; the synchronism of the ringing/ringback tones, or lack thereof, may vary depending upon the numbers of the calling and called parties.

ERIC G. LEMMON
Lompoc, CA

R-E