Private telephone:

simple two-station intercom

Got a couple of extra unused telephones around the house? Build this easy one-night project and make your own private intercom system. Your kids will love it. And you will too.

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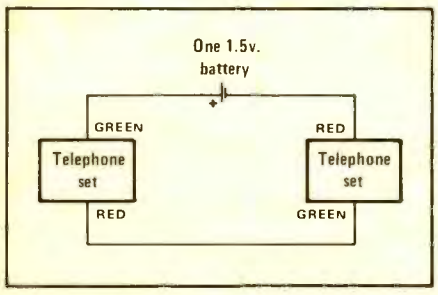
BY PETE STARK

Even though it's only been legal for a few months to connect your own extension phone to your telephone line, subject to some stringent rules, extra telephones have been sold by many electronics and department stores for years. If, like many people, you have an extra phone or two just gathering dust, why not use it for a *private* telephone system of your own?

A two-phone telephone system is just like an intercom, except that regular telephone sets are used at each end instead of speaker-type "squawk boxes." You can use it between parts of your house, or even between adjacent houses. Better yet, your kids will just love having their own telephones which they can use to their heart's content.



The simplest form of telephone intercom consists of two phones in series with a battery. When both phones are off the hook, the circuit is powered. When both or either one of the phones is on the hook, the circuit is dead.

The telephone system described here is a two-station hook-up. It uses just one talking circuit to connect the two phones. A separate signaling circuit shares the same two connecting wires with the talking path. Signaling the other party to answer the phone is automatic. Just pick up the phone, and a small tone generator at the other end of the connection goes *beep beep beep*. When the phone is answered the beeping stops.

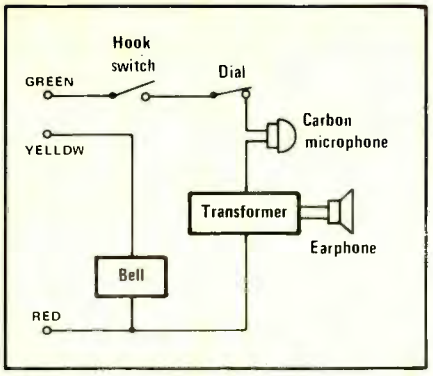
Easy to build

Most modern telephones use three wires. The internal bell is connected to the yellow and red leads. The rest of the phone is connected between the green and red leads.

Although there are many parts to a telephone set, in a simplified circuit there are four components in series: the hook switch, which opens the circuit when the handset is placed in the cradle; the dial; a carbon microphone in the handset; and a complex transformer circuit feeding the earphone. In a rotary dial telephone, the dial switch is normally closed and completes the circuit. Pushbutton phones have a slightly different connection for the dial, but the rest is quite similar.

Since the microphone is a carbon type, a source of direct current is needed for its operation. In the regular telephone system a 48-volt supply is used, but even a 1.5-volt dry cell can provide enough power for talking. If the dry cell battery is connected between the red and green leads, current will flow through the microphone and transformer, with the result that sounds picked up by the mike will be heard in the earphone. The simplest telephone intercom consists of just two telephone sets and one battery, all connected in series.

In a series connection, a small current flows from the battery and through the two phones, so that both phones carry the same current. Each earphone will then reproduce the sound picked up by both microphones, and two persons can talk to each other. No extra on-off switch is needed by the circuit, since hanging up either telephone breaks the series circuit as the hook switch opens. A tiny



The typical modern telephone has four major components connected in series. The hook switch, which is open when the phone is on the hook, the dial mechanism, microphone and earphone. The bell is independent of the voice circuit.

current flows only when both phones are off the hook, and so a single C or D cell can last a year or more.

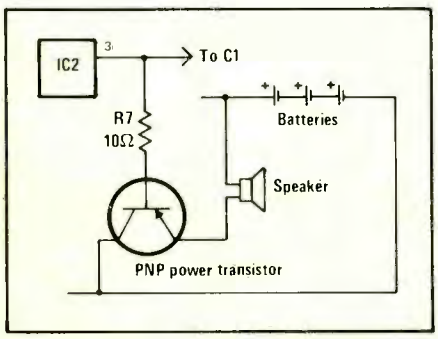
Answer the phone

Although this system can provide useful conversation for two or more persons, there is no easy way of ringing the built-in bells in each phone. The normal bell in the telephone won't work on direct current. It requires a voltage of about 100 volts at 20 Hertz for its operation. Generating such a high voltage at 20 Hz is difficult and expensive.

If the bell worked at 60 Hz, some kind of transformer could be used to provide the bell voltage. But, it might not be very safe to do so!

A simple alternative is to provide a separate bell or buzzer with a pushbutton at each end of the system. It involves adding either a third wire to connect the two telephones, or an elaborate switching circuit to share the same two wires for both talking and ringing.

By using a few transistors and integrated circuits, you can build a completely automatic tone "beeper" which replaces the bell. Two beepers are needed, one at each end of the circuit, connected directly across the telephone



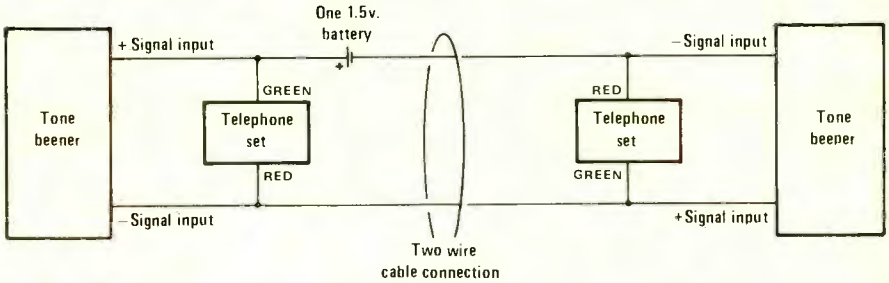
The volume level of the beeper can be increased by adding a PNP power transistor between the output of IC2 and the speaker. Although battery life will be shortened, they should still provide months of service in normal use.

set. But you'll still need only two wires to make the complete circuit path between the two phones.

Almost any kind of inexpensive wire can be used—line cord, bell wire, speaker wire, even tv antenna wire. Over short distances, a radiator pipe or water pipe can be used instead of one wire. If speaker wire or similar two-conductor wire is used, the two telephones can be separated by thousands of feet and still work.

tant. The easist, of course, is to use the printed circuit boards available, or make some from the layouts shown. But, any other type of construction will work.

The addition of one transistor can boost the volume by several times, as shown in the diagram. An inexpensive PNP power transistor is simply connected between IC2 and the speaker, as shown. Although the modified circuit requires substantially more current during beeping, the batteries will still last



Automatic signaling is provided by a pair of beepers connected across the two telephones. Lifting one of the phones off its hook causes the beeper on the other phone to signal the presence of an incoming call.

The beepers are completely automatic, and require no switches or pushbuttons. Each beeper has a simple circuit which monitors the telephone line and activates the tone generator which drives a small speaker. When both telephones are hung up, or both are picked up, the beepers are silent. But whenever only one telephone is picked up, the other beeper goes *beep beep beep*. So to place a call, all you need do is pick up your telephone handset and wait.

Its easy to build

The circuit is noncritical and the parts layout can be changed to fit whatever you have on hand. The capacitor and resistor values can be twice as large or half as large, and the circuit will still work. But, it may sound a bit different. Still, one *beep* is a good as another.

The electrolytic capacitors can have any rating from 6 volts to 35 or more, and either ½-watt or ¼-watt resistors can be used. The most critical parts are diode D1 and transistor Q1. D1 should be a silicon diode, not germanium, and should be of fairly good quality. A signal diode such as a 1N914 or 1N4148 is best. Transistor Q1 should be a silicon NPN signal transistor, not a power transistor, and should have fairly good gain.

Parts are easily obtainable at electronics or tv supply stores. The parts list gives Radio Shack parts numbers as well. If D1 or Q1 are marginal, the beeps may sound rather sick, if the gain of Q1 is low, or the speaker may beep or click even when both phones are hung up.

As shown in the photographs the tone beepers can be built in various ways. The exact style of construction is not important. The easist, of course, is to use the printed circuit boards available, or make some from the layouts shown. But, any other type of construction will work.

The addition of one transistor can boost the volume by several times, as shown in the diagram. An inexpensive PNP power transistor is simply connected between IC2 and the speaker, as shown. Although the modified circuit requires substantially more current during beeping, the batteries will still last many months in normal use.

Another modification may be needed if you live close to a commercial radio transmitter or a high-powered CB radio operator. In the presence of strong radio frequency signals, some interference may be picked up by the telephone wires between the two phones. In mild cases, this will simply be heard on the telephone while speaking. In severe cases, it may trigger the beepers when they should be silent, or may even be heard through the speakers. Installing two or three 0.01 uf or 0.1 uf disk capacitors directly across the signal leads at the tone beepers, or directly across the red

Parts list

Part number	Description	Radio Shack number
C1	.001 mfd disk ceramic	272-126
C2, C5	0.1 mfd disk ceramic	272-135
C3, C4	25 mfd electrolytic	272-1026
D1	1N914 or 1N4148 diode	276-1122
IC1, IC2	555 timer IC	276-1723
Q1	2N2222A or equivalent	276-2014
R1	100 ohm	*
R2	100K ohm	*
R3, R4	27K ohm	*
R5, R6	4.7K ohm	*
R7	10 ohm	*
Spkr	8-ohm to 45-ohm speaker	40-262

Notes: All resistors can be ¼-watt composition type such as Radio Shack's 271-1300. series. Printed circuit boards can be made from template shown in the article. Etched, plated and drilled boards are available from Star-Kits, P.O. Box 209, Mt. Kisco, NY 10549 for $7 a pair.

Include self-addressed stamped envelope, and if a New York State resident, the appropriate sales tax. Any enclosure, batteries and battery holders and hardware can be used to complete the project.

How it works

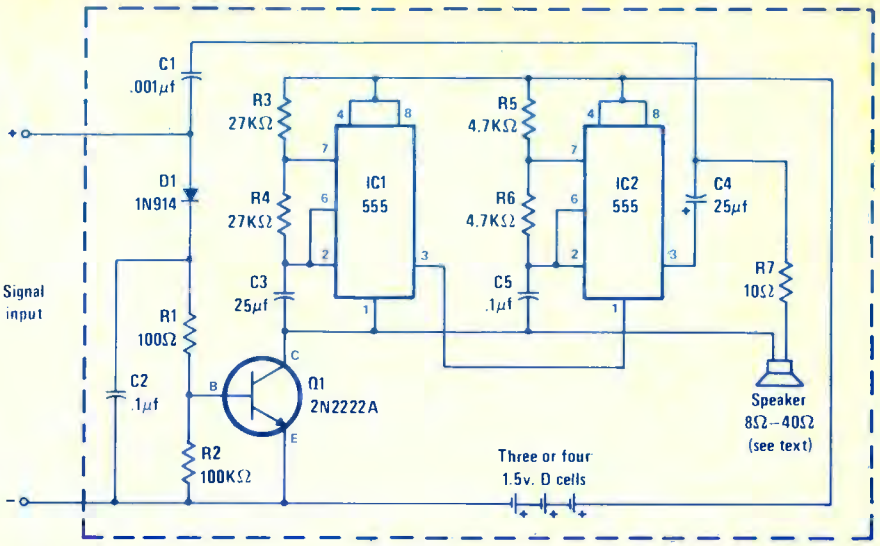
As the schematic diagram shows, each beeper consists of a transistor, Q1, two integrated circuits, IC1 and IC2, and a handful of small parts. The entire circuit is powered by three or four 1.5-volt dry cells, which provide between 4 and 6 volts dc power and should last many months in normal use. Both integrated circuits are 555 timers which are connected so as to oscillate. IC2, when operating, oscillates at about 1000 Hz, and its output drives a small speaker through capacitor C4 and resistor R7. When oscillating, it sends a constant *beeeeep* to the speaker at a moderate volume. But it does not oscillate continuously, because it is controlled by IC1.

IC1 is also an oscillator, but in this case it only operates about once every three seconds. The output from pin 3 of IC1 drives pin 1 of IC2, so that IC2 generates a *beep* for about one second, and is turned off for about two seconds. Thus the two IC's together generate a series of beep-beep-beep sounds, which drive the speaker. The sounds are also coupled back into the telephone line to let the caller know that the other phone is "ringing." This coupling is done by capacitor C1.

IC1 and IC2 are not connected directly across the battery supply. The only way they can obtain power for operation is if transistor Q1 is energized. This connects pin 1 of IC1 to the negative side of the battery through the transistor. Hence, the transistor acts as a switch to turn the beeper on and off.

To turn Q1 on, you must supply a voltage of about 1 volt or more between + and – signal input leads. When both phones are hung up, the 1.5 volts supplied by the single battery in series with the two phones splits up, with about 0.75 volts across each phone and its beeper. Likewise, when both phones are picked up and being used, the 1.5 volts splits up with 0.75 volts across each beeper. Either way, each beeper sees less than 1 volt, and hence transistor Q1 is turned off and the beeper is silent.

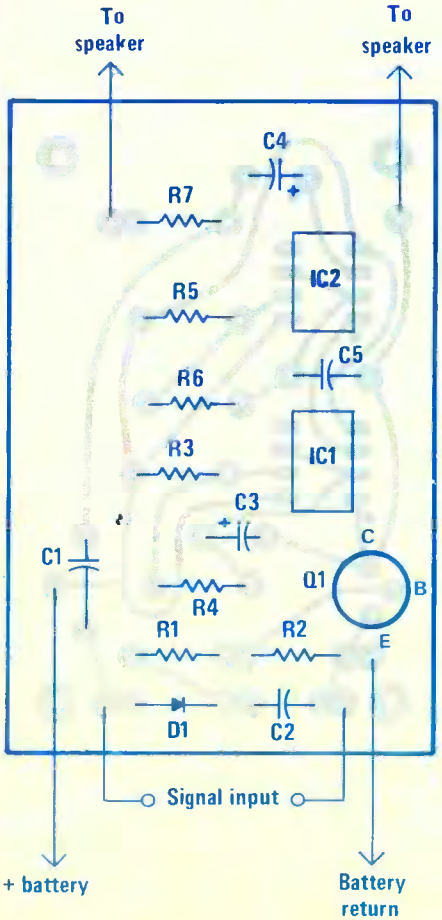
On the other hand, if one phone is picked up while the other remains hung up, the voltage splits unevenly. The phone which is hung up has a high resistance since its hook switch is open. The other phone has a low resistance. As a result, the beeper which is connected across the phone which has been picked up sees a very low voltage. The other beeper, however, sees close to 1.5 volts and beeps. In this way, when you pick up one phone you automatically cause the other to "ring." The beeping stops when the other party answers, or you hang up.

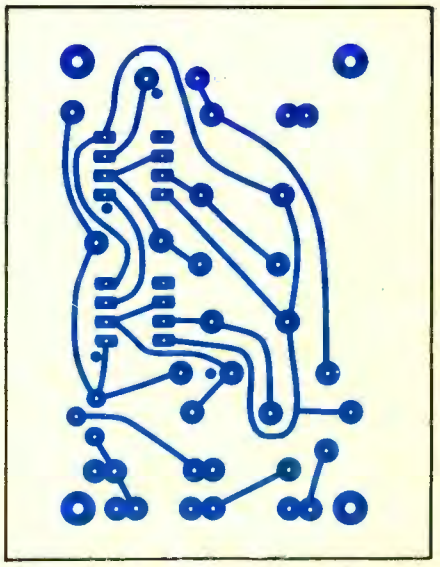


Each signal beeper consists of just two ICs, a transistor, and a handful of small parts, most of which you probably have in your junk box. The values shown are not critical. You substitute values up to twice as large, or half as large without affecting performance beyond changing the sound of the signal beeping.

and green telephone leads, should eliminate the interference. In very severe cases it may be necessary to experiment with exact placement of the capacitors.

An extension telephone can be connected in parallel with one of the existing phones, but one of the beepers may sound whenever all three telephones are picked up at once. If an extension beeper is needed, additional 8-ohm speakers can be connected in series with the speakers shown and placed in another room. As many as three or four speakers can be used with each beeper circuit without reducing the overall volume. Somewhat greater volume will be obtained if 20- or 30-ohm speakers are used.





Using a printed circuit board will simplify construction. You use this layout to make your own boards, or purchase boards from Star-Kits. For details, refer to the parts list.

This circuit works best when two identical telephones or very similar ones are used. However, if a very new phone is used with a very old one, one of the two beepers may beep, or at least click, even though both phones are picked up. If you have a voltmeter, you can diagnose this problem by measuring the voltage across the two phones. There should be close to .7 volts across each. If one has substantially more voltage across it than the other, add a resistor in series with the phone having the lower voltage. Adjust the resistance so that the two voltages even out.