4 TOYS for the HOLIDAY SEASON

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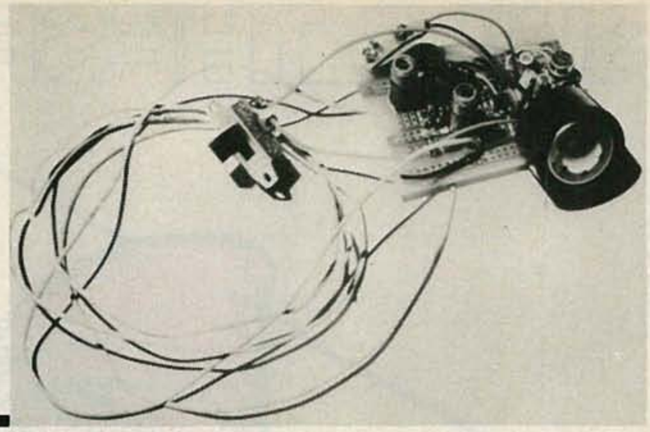
Just in time for the holiday season, here are four electronics toys that are sure to delight any young person.

WITH THE HOLIDAYS RAPIDLY APPROACHING, MOST PARENTS (as well as grandparents, aunts and uncles, etc.) are in the midst of their annual search for a present that their child will enjoy. Your local toy store, however, is not the only place to look for such a present. Often, a simple electronic toy that you build for your child, or help your child to build for himself or herself, will be far more appreciated and enjoyed than most. The toys described in this article were designed for their ease of assembly, the availability of parts, and, I hope, to appeal to a child's curiosity. In addition, they are fun to build. The theory of operation of each is fully explained, making them educational for the builder, as well as entertaining for the child. Those toys also make good "science fair" projects for children up to junior high-school age.

You can build any of the toys with just a handful of new or junk-box parts. The siren requires only two easy-to-obtain transistors, a few resistors and capacitors, a pushbutton switch, and a battery. The bird-chirper requires only four standard transistors in addition to the resistors, capacitors, and the like. The AM wireless microphone requires two transistors, a common op-amp IC, and a couple of tuning coils; incidentally, projects similar to that have long been favorites with young people. The electronic "chug-chug" simulates the sound of a steam locomotive with variable speed, and uses a design that doesn't need a special noise diode, selected transistors, or Zeners. While the chug-chug is the most complicated of the projects, it still should not take more than a weekend to finish, depending on the builder's experience.

Before we get into each project in detail, let's go over a few points about selecting parts. While you should have no trouble finding most of the parts, you may run into a situation where a particular listed part is not available locally. In that case you have two alternatives: order it by mail (the advertisers in the back of this issue are a good source), or find a suitable substitute. There are a couple of choices listed for many of the critical components, and while those are the ones that will work the best in a particular circuit, in most cases (the exceptions are noted in the text) there are others that will work. For instance, IC1 in the "chug-chug" toy is listed as a CA3240. Actually, that IC is a dual CA3140 (that is one possible substitute). Acceptable substitutes include a TL062, a TL072, or a TL082 IC, although those IC's have a lower noise-output. In fact, almost any dual MOSFET-input op-amp can be used if you know its pin-out.

One note about the capacitors: While ceramic discs can be used with good results in most situations (except where electrolytic or tantalum types are specifically called for), if you are buying new parts, you may want to consider Mylar or mica capacitors instead. While those are more expensive, they are precision units and, depending on the application, they may provide better results.



1. WIRELESS AM MICROPHONE

The schematic for the wireless AM microphone is shown in Fig. 1. Transistor Q1 and its associated components comprise a tuneable RF oscillator. This oscillator generates an RF signal in the AM broadcast band. The output frequency of the oscillator is tuned by coil L1 to an unused frequency between 800 and 1200 kHz. The RF signal is fed to transistor Q2, which serves as the modulator. Operational amplifier IC1 increases the level of the audio signal from the microphone, and applies it through resistor R4 to the base of Q2. The amplified audio signal varies the bias current of Q2. The non-linear characteric of Q2 results in an amplitude-modulated RF signal that is taken from the emitter of Q2, and connected to the antenna via a matching network consisting of C6, L2, and R6. The antenna itself is a 7- to 10-foot length of insulated, stranded hookup-wire.

The audio sensitivity is determined by the output level of the microphone used, and by the value of R10. The value shown for that resistor will give you adequate sensitivity when using a 600-ohm or higher impedance dynamic-type microphone, similar to the inexpensive ones (generally less than five dollars) sold for use with audio cassette recorders.

Construction details

You can build the wireless microphone using any one of a number of construction techniques. However, the easiest method to use for this project would be wire-wrap. First mount the components on perfboard using wire-wrap posts. Use a wire-wrap IC socket for IC1. Then, following the schematic, connect the posts using a wire-wrap tool. As with any other RF circuit, keep the wiring short and neat, and avoid locating the antenna, L2, C6, R6, L1, C5, or C3 near pins 2 or 3 of op-amp IC1. Also, keep L1 away from L2 so that no interaction occurs. When connecting the microphone, be sure to use shielded cable to prevent hum pickup.

After construction is completed, turn on an AM radio and tune it to an unused frequency betwen 800 to 1600 kHz. Then turn on the wireless microphone and place it next to the radio. Tune L1 until you hear a change in the audio level coming from the radio. Whistling into the microphone while you tune L1 will help you recognize when L1 is tuned correctly.

Use an RF probe and a VTVM to monitor the output voltage from the antenna, and peak it by adjusting L2. (Alternatively, the "S" meter of a general-coverage receiver tuned to the correct frequency can be used.) If L1 is disturbed, it may be necessary to readjust L2 for peak performance. Depending on the impedance of the microphone you chose, the audio sensitivity (gain) can be increased by decreasing the value of R10, and vice-versa.

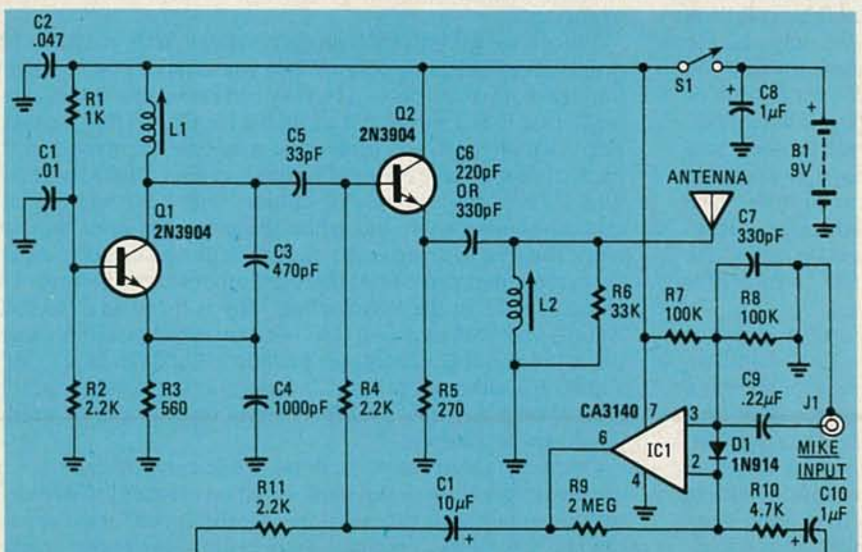


FIG. 1—A GOOD INTRODUCTION to the principles of radio, AM wireless microphones have long been a favorite with young people.

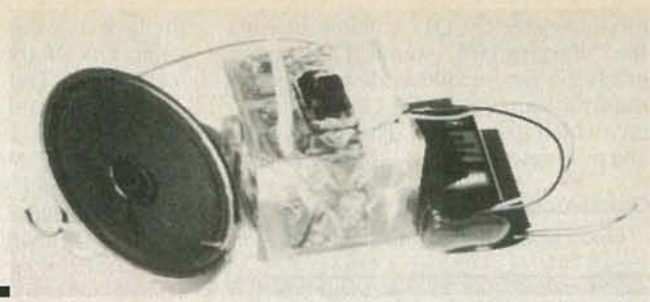
PARTS LIST—AM WIRELESS MICRPHONE

Resistors ¼ watt, 5%, unless otherwise noted
R1—1000 ohms
R2, R4, R11—2200 ohms
R3—560 ohms
R5—270 ohms
R6—33,000 ohms
R7, R8—100,000 ohms
R9—2 megohms
R10—4700 ohms (nominal, see text)

Capacitors
C1—.01 µF, ceramic disc
C2—.047 µF, Mylar or ceramic disc
C3—470 pF, mica or ceramic disc
C4—1000 pF, Mylar or ceramic disc
C5—33 pF, mica or ceramic disc
C6—220 pF, mica or ceramic disc
C7—330 pF, mica or ceramic disc
C8, C10—1 µF, 10 volts or higher, electrolytic
C9—0.22 µF, mica or ceramic disc
C11—10 µF, 6 volts or higher, electrolytic

Semiconductors
D1—1N914
IC1—CA3140 op-amp
Q1, Q2—2N3904, 2N2222, or equivalent general purpose NPN transistor
L1, L2—68-180 µH "loopstick" AM-radio oscillator coil (Miller 9055, Miller 9018, or equivalent)
B1—9-volt battery, transistor-radio type
J1—phono jack
S1—SPST switch

Miscellaneous: wire, solder, stranded hook-up wire (for antenna, see text), etc.



2. ELECTRONIC SIREN

The schematic diagram of the siren is shown in Fig. 2. The "wailing" sound of the siren is generated by a variable-frequency oscillator consisting of Q1 and Q2. Capacitor C2 provides the feedback for the oscillator. The frequency of the oscillator is varied by the voltage applied to the base of Q1 through R3. When switch S1 is closed, capacitor C1 charges, thus increasing the oscillator frequency. When S1 is released (opened), capacitor C1 discharges and the oscillator frequency decreases. Capacitor C3 limits the maximum oscillator frequency. The average battery current drain is about 15 milliamps.

Construction

You can build the siren using any construction method you choose; there is nothing critical about the layout. Be sure to use only the transistors listed for Q2. You have a little more flexibility in choosing Q1, as long as it is equivalent to the ones listed. Use a miniature pushbutton-switch for S1. When S1 is closed, the siren will begin its upward wail; a slow, downward wail will begin as soon as S1 is released.

The loudspeaker should be a miniature 8-ohm transistor-radio type. You can change the overall pitch of the siren by changing the value of R3. If you decrease the value of R3, the overall pitch of the siren will increase. Too small a value of resistor R3, however, could make the oscillations stop prematurely, provided that switch S1 is held down long enough.

PARTS LIST—SIREN

Resistors, ¼ watt, 5%, unless otherwise noted
R1, R4—7500 ohms
R2—33,000 ohms
R3—270 ohms
R5—4.7-10 ohms
Capacitors
C1—100 μF, 10 volts or higher, electrolytic
C2—.0068 μF, Mylar or ceramic disc
C3—1 μF, 10 volts or higher, tantalum or electrolytic
Semiconductors
Q1—2N3904, 2N2222, or equivalent NPN transistor
Q2—MJE370 or 2N4919 PNP transistor
B1—9-volt battery, transistor-radio type
S1—SPST momentary pushbutton-switch, normally open
Miscellaneous: wire, solder, 8-ohm speaker, etc.

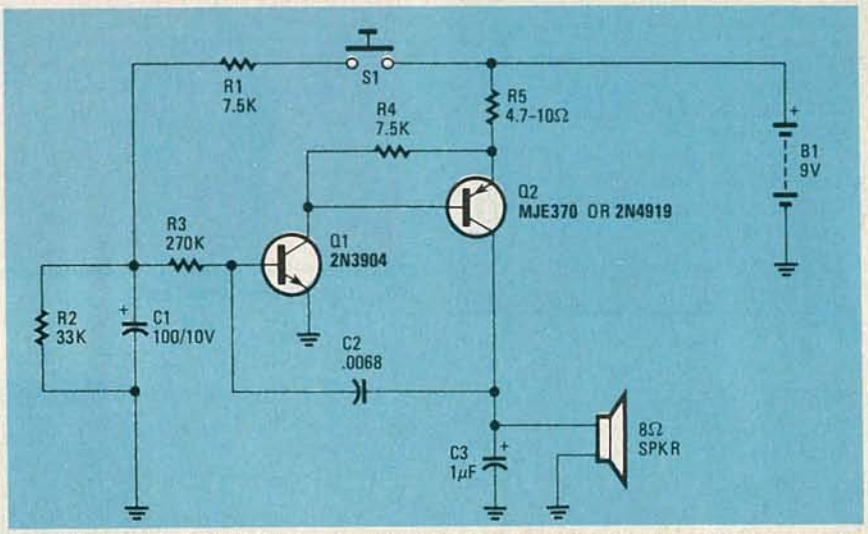
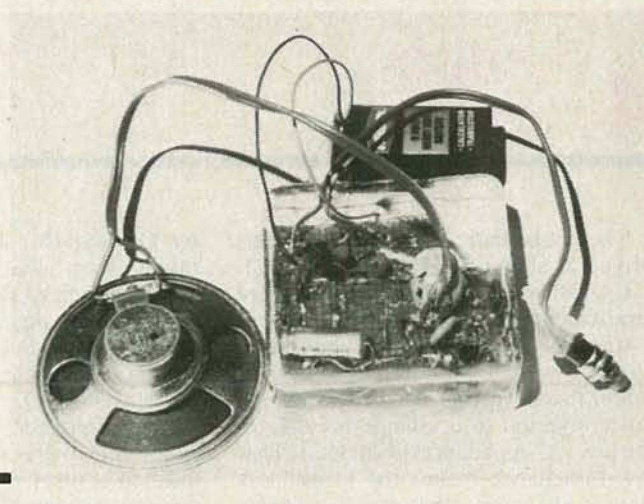


FIG. 2—EASE OF CONSTRUCTION makes this electronic siren a great first-time project for your child. Be sure to use only the transistors listed for Q2.



3. ELECTRONIC BIRD CHIRPER

The schematic of the electronic bird chirper is shown in Fig. 3. Transistors Q1 and Q2 form the two halves of a free-running multivibrator whose frequency is determined by the voltage across C8. That capacitor is charged and discharged by closing and opening switch S1.

Transistors Q3 and Q4 make up a variable-frequency oscillator similar to the one used in the siren. The output of the free-running multivibrator frequency modulates the Q3-Q4 oscillator, causing the "chirping bird" sound. The number of chirps per second is determined by the frequency of the Q1-Q2 multivibrator, which also varies. The pitch of the chirps is determined by C5 and C6.

Construction

Once again, there is nothing critical in the layout of this project; it can be built using any of the popular construction techniques. The chirping is controlled by opening and closing switch S1, a normally open, momentary SPST pushbutton switch. When you finish the circuit, if the pitch of the chirps is too low and not bird-like, you can omit C5; but monitor the battery current if you do so. (If you can, substitute a current-limited power supply for the battery while you are testing the circuitry; doing that will prevent the battery from draining. If the current drain exceeds 50 milliamperes when S1 is closed for a second or so, you should raise the value of C6. Be sure to use the listed transistor for Q4.

PARTS LIST—BIRD CHIRPER

Resistors, ¼ watt, 5%, unless otherwise noted
R1, R8—20,000 ohms
R2, R4—4700 ohms
R3—12,000-18,000 ohms
R5—180 ohms
R6—5600 ohms
R7—120,000 ohms

Capacitors
C1, C3—10 μF, 6 volts or higher, electrolytic
C2—3300 μF, 10 volts or higher, electrolytic
C4—.0047 μF, Mylar or ceramic disc
C5—0.1 μF, Mylar or ceramic disc
C6—.02 μF, Mylar or ceramic disc
C7—200 μF, 10 volts or higher, electrolytic
C8—100 μF, 10 volts or higher, electrolytic

Semiconductors
D1—1N914
Q1-Q3—2N3904, 2N2222, or equivalent NPN transistor
Q4—MJE370 or 2N4919 PNP transistor
B1—9-volt battery, transistor-radio type
S1—SPST momentary pushbutton switch, normally open

Miscellaneous: wire, solder, miniature 8-ohm speaker, etc.

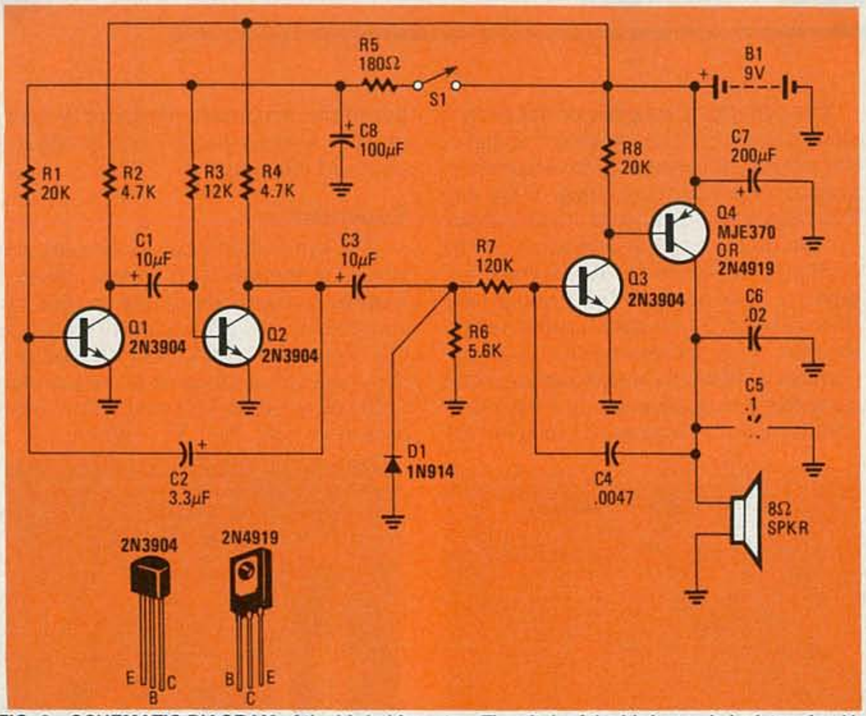
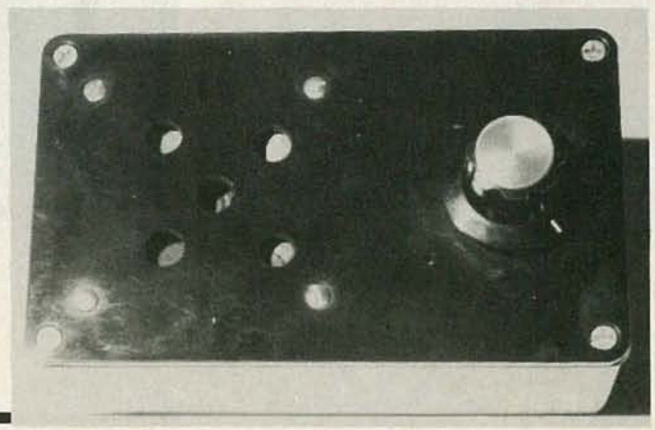


FIG. 3—SCHEMATIC DIAGRAM of the bird-chirper toy. The pitch of the bird sounds is determined by capacitors C5 and C6 (see text).



4. CHUG-CHUG

The schematic diagram for this project is shown in Fig. 4. Op-amp IC1, a CA3240 dual MOSFET-input device (equivalent to two CA3140's), is used as a white-noise source. The white noise appears on pin 7 of IC1 as a current rather than a voltage signal. The noise is not converted to a voltage because of the low AC impedance around IC1. That low impedance makes the layout less critical than for other types of noise sources, and eliminates the need for shielding to prevent hum pickup.

Op-amp IC2 is used as a driver stage for the push-pull output stage formed by Q5 and Q6. Negative feedback is taken from that output stage and brought back to pin 2 of IC2. Resistors R6 and R8 determine the minimum amount of negative feedback, and hence the maximum gain.

Transistors Q2, Q3, and Q4 form a variable-frequency multivibrator; resistor R11 is the SPEED control, and is used to control the multivibrator's frequency. The output from the multivibrator is differentiated by C8, and is then applied to modulator transistor Q1 through D1 and R7. Transistor Q1 modulates the gain of the output-amplifier stage by changing the impedance to ground seen by R6 and C4. That creates chopped white-noise; there is also residual low-level noise from IC2 when Q1 is not conducting. When the multivibrator's frequency is reduced using R11, C8 discharges slowly, creating a sound similar to escaping steam from a stopped locomotive. As the multivibrator's frequency is increased, the toy generates a sound like an accelerating locomotive.

Construction details

The only thing to keep in mind when

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laying-out the circuit is not to route the output of IC1 near the input to that IC. If possible, use a 100-mA current-limited power-supply in place of battery B2 while adjusting the circuit; doing that will protect transistors Q5 and Q6, and prevent draining the battery.

The first thing you'll need to do is to find the proper value for R3. Start by shorting Q1's collector to ground. Then, increase the value of R3 until the current drain from the power supply is less than 60 milliamperes. When that is done, remove the short from Q1.

To see if the device is operating properly, close switch S1 and reduce the resistance of R11. Wait 10 seconds, then rotate R11 slowly, and you should hear a sound similar to that of a steam locomotive picking up speed.

There you have it—four simple toys that any child would enjoy. We have built several of each and submitted them to some very tough "critics"—several children that we know! The results were very positive! **R-E**

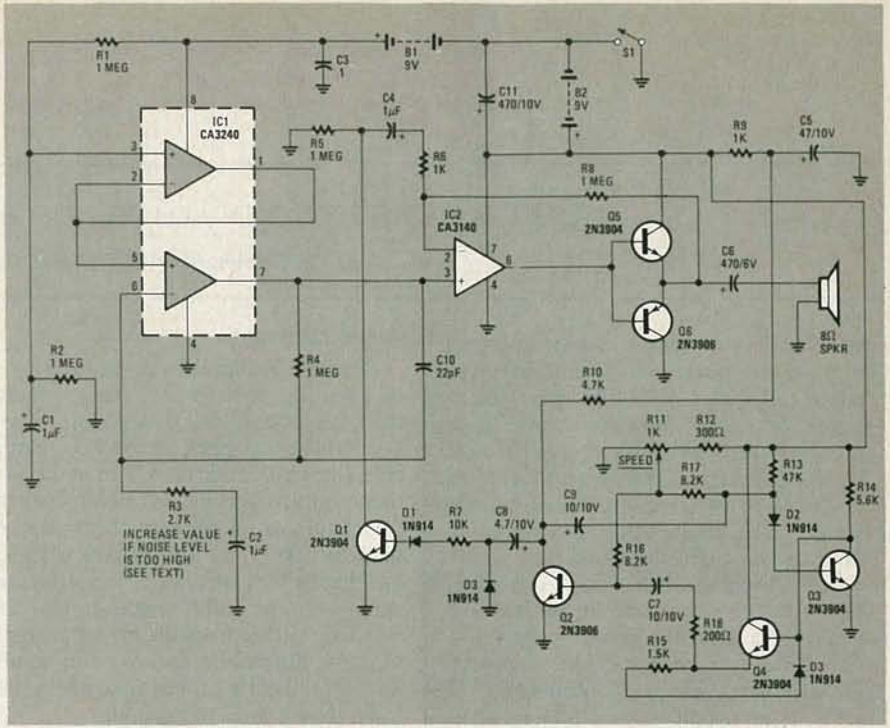

FIG. 4—THE CHUG-CHUG TOY simulates the sound of a steam locomotive. A dual MOSFET-input op-amp, IC1, is used as a white noise generator in this circuit.

PARTS LIST—CHUG-CHUG

Resistors, ¼ watt, 5%, unless otherwise noted
R1, R2, R5, R8—1 megohm
R3—2700 ohms
R6, R9—1000 ohms
R7—10,000 ohms
R10—4700 ohms
R11—1000 ohms, potentiometer, linear taper
R12—300 ohms
R13—47,000 ohms
R14—5600 ohms
R15—1500 ohms
R16, R17—8200 ohms
R18—200 ohms

Capacitors
C1, C2, C4—1 µF, 10 volts or higher, electrolytic
C3—0.1 µF, Mylar or ceramic disc
C5—47 µF, 10 volts or higher, electrolytic
C6—470 µF, 6 volts or higher, electrolytic
C7, C9—10 µF, 10 volts or higher, electrolytic
C8—4.7 µF, 10 volts or higher, electrolytic
C10—22 pF, mica or ceramic disc
C11—470 µF, 6 volts or higher, electrolytic

Semiconductors
D1-D3—1N914 or equivalent silicon diode
IC1—CA3240 (RCA) or equivalent dual op-amp
IC2—CA3140 (RCA) or equivalent op-amp
Q1-Q5—2N3904, 2N2222, or equivalent NPN transistor
Q6—2N3906 or equivalent PNP transistor
B1, B2—9-volt battery, transistor-radio type
S1—SPST switch
Miscellaneous: Wire, solder, miniature 8-ohm speaker, etc.