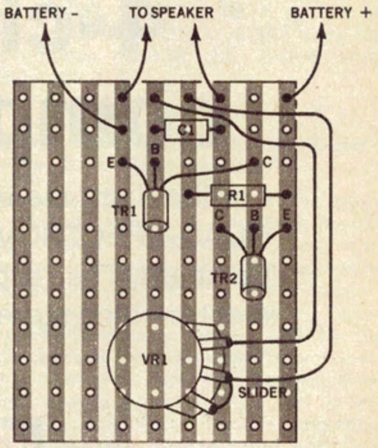
TAKE 20 COMPONENTS...

A group of simple transistor projects, each using less than 20 low-cost components.

by JULIAN ANDERSON



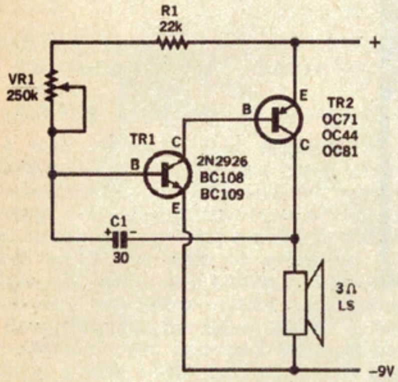
The component layout of the mini metronome using Veroboard.

A Mini Metronome

Here is a really simple project — a unit that simulates beautifully the sound of a time bomb ticking away! For those more attracted to gentler pastimes it may also serve as a metronome, that is it gives a loud click at regular intervals, the actual interval being varied by a potentiometer in the circuit. It's very simplicity also makes it highly suitable for use as an audio warning device, inserting the alarm switch in the supply line.

The actual working of the circuit is fairly simple; on applying a voltage across R1, VR1, C1 and the loudspeaker, the capacitor C1 charges up till a point is reached when Tr1 switches on, this in turn switches Tr2 to a conducting state — meaning that a voltage is applied across the loudspeaker causing it to "plop".

The base current of Tr1 neutralises the charge on C1 and soon the voltage on the base reaches the stage where the transistor



The circuit of the mini metronome.

is turned off; thus the cycle starts all over again. The rate at which C1 charges depends upon VR1 and thus by altering this the interval between each cycle can be varied.

The actual transistors used are unimportant, I have tried a large variety and all have worked successfully. One of the transistors is a PNP, the other NPN. The germanium one is similar to the OC71, OC44 etc, and the silicon one is like the BC108, BC109, 2N2926 etc.

The components are mounted on a small piece of Veroboard. One end is drilled to take the potentiometer (⅜in spindles are virtually standard) and the other components are mounted and soldered at the other end. The project is so simple that very little can go wrong and immediately you switch on regular "plops" will be heard. By altering VR1 a wide range of intervals should be covered but if you want slower ones — that is with several seconds' interval, increase the value of C1. If you want faster ones lower its value.

The circuit described is certainly the cheapest method of getting a sound from a loudspeaker and thus it makes an ideal warning device. The plops themselves are loud and the unit could be used as a burglar alarm by arranging the supply voltage to be switched on when a window is opened etc. Even if the plopping isn't heard by anyone you can bet it'll get your unwelcome visitor worried.

The time intervals are regular and the unit will serve well for its intended use as a metronome providing the beat for music lessons etc.

Metronome Parts List

R1 22k, 10⅜, ¼W
C1 30uF 12V
VR1 250k lin pot
Tr1 2N2926, see text
Tr2 OC81, see text
Loudspeaker any 3-ohm or 8-ohm type
Veroboard 1¾ x 1⅜in, 0.15in matrix
9V battery

A One-Transistor Radio

Ever since I first started playing about with transistors, I wanted to build a one-transistor radio, operating a loudspeaker without an external aerial. This was not possible in those early days as there were no transistors on the market with sufficient gain. A few months ago I had a crack at this again using the very high gain silicon transistors now available quite cheaply. The result is published here.

I don't want to mislead anyone, the volume is low but it is sufficient for a child's or bedside radio.

With the prices of nearly all components falling — and transistors falling most rapidly, many readers will think that it would be cheaper and easier to use two transistors and do away with some of the other parts. They are perfectly correct, but until there are laws forbidding slavery in transistors there is a lot of satisfaction in getting the last ounce of work out of them.

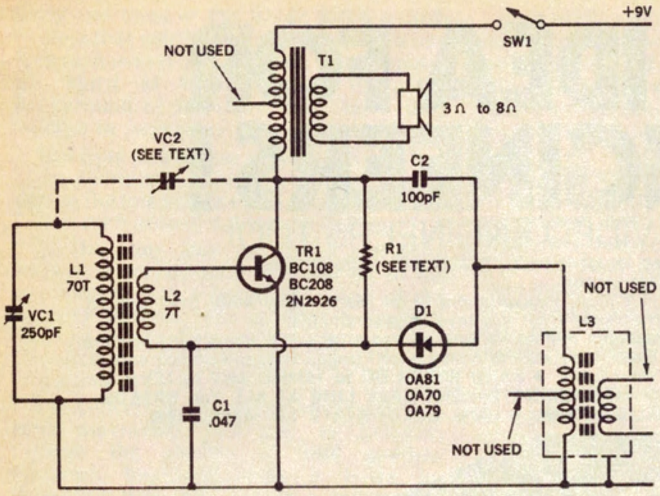
The signal is picked up on the aerial winding L1 on the ferrite rod and tuned by VC1. L2 transforms the signal and feeds it to the base of the transistor, C1 acting as a DC blocking capacitor. The amplified RF signal appears at the collector and finding its path blocked by the inductance of T1, passes through C2. Now C2 and L3 are chosen so that they form a tuned circuit, which is slightly damped by the other parts of the circuit, and it encourages the RF through it. The diode D1 detects this signal and after being smoothed by C1 passes to the base of Tr1.

The amplified AF signal appears at the collector and T1 acts as the load, transforms it and feeds it to the speaker. C2 is too low in value to pass much AF but any that does is taken straight to the earthy side of the circuit by L3. R1 provides the bias for the transistor and will vary with the one chosen; it is best found by experiment but will probably lie between 47k and 1M.

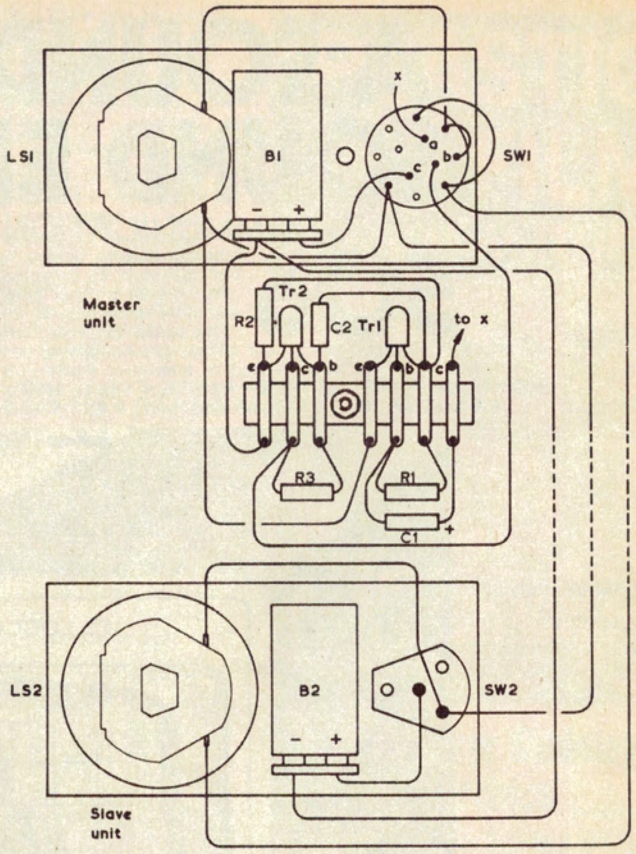
Almost any broadcast-band ferrite rod aerial may be used but the larger the better. If you want to wind your own, the aerial winding should consist of about 70 turns and the secondary, wound either beside or on top, of about 7 turns. Any transistor output transformer will suffice for T1, most of these are centre tapped but this should be ignored. L3 is the primary of an IF tansformer; take off the can protecting this and cut off the small capacitor if one is fitted; in this case the centre tap and secondary are ignored.

The larger the loudspeaker the better and although sufficient volume is obtained with a 2in speaker, the larger ones are far better. A volume control, if needed, is best fitted across the secondary of the output transformer — a 10-ohm pot should do. If this were fitted into any other part of the circuit it would affect the working conditions.

Care must be taken in the layout. Owing



(Above) The circuit of the simple one transistor radio.



(Right) Component layout and wiring details of the simple intercom.

to the very high gain it is easy for the circuit to break into oscillation and L3 must be kept well away from L1. Similarly L2 and the collector of Tr1 must be away from the aerial coil. This explains VC2; regeneration can be applied by feeding a tiny part of the signal back to the aerial coil, but the value of such a capacitor will be in the order of 0.5pF and its value is critical. It is best to keep the two apart as much as possible and then with a wire fixed to Tr1 collector to lay this near the winding. If the radio fails to oscillate reverse the connections of L2. If Veroboard is used even the capacitance between the strips may send it into uncontrolled oscillation.

After switching on, adjust the core in L3 for best results over the section of the band you will normally be using.

The current consumption is between 4mA and 15mA and a battery should last a fair while under these conditions.

Parts for One-Transistor Radio

R1 — see text
C1 0.047uF
C2 100pF
VC1 250pF variable
VC2 — see text
Tr1 2N2926 or similar
D1 OA70, OA79, OA81 etc
T1 Transistor output transformer
L3 IF transformer
Ferrite rod with MW winding
9V battery,
Loudspeaker
Paxolin board

Simple Intercom

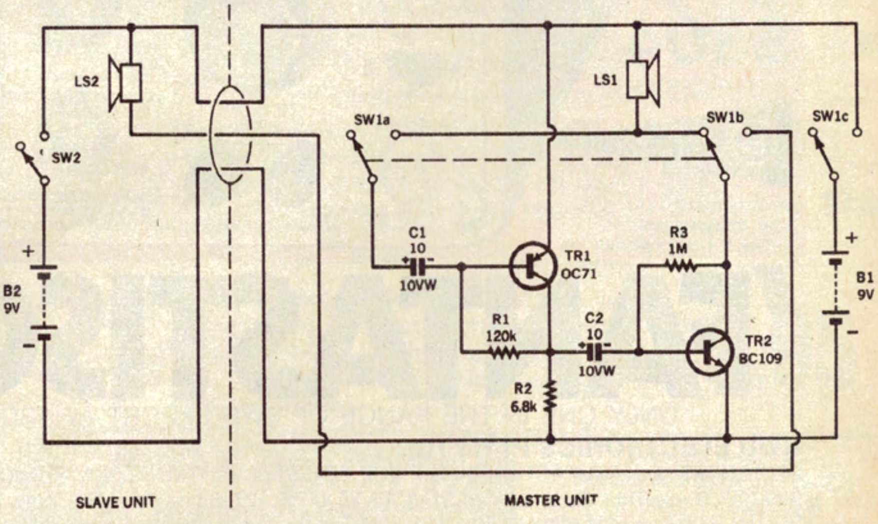
There are on the market several types of intercom, and there is no doubt that many readers could find a use for one, but doubt whether the expenditure would be justified. The unit described here is a relatively low-cost project. It can easily be used as a baby alarm — it is certainly sensitive enough — merely by switching one of the units on permanently.

Most of the commercially available units are arranged so that first a signal button is pressed and the unit is then switched on and the volume level set. Also nearly all of them can be used for "spying", that is, switching on by the master activates the slave microphone so that the master can eavesdrop.

The unit described here is not fitted with a buzzer as calling over the unit is usually enough to draw the attention of the distant party. It cannot be used for eavesdropping (an undesirable, "Big Brother" type feature) and thus its installation can cause no offence. Since no volume control is fitted (this is really unnecessary for this type of equipment) only one switch is operated by either end to activate the unit.

The basis of the intercom is a simple amplifier which boosts the "microphone" output to feed a speaker. To make the project simpler and cheaper we use balanced armature earpieces which, by being switched, serve both functions as microphone and loudspeaker. These balanced armature earpieces are really marvellous pieces of design. They are extremely sensitive, have a perfect impedance for transformerless transistor work and are very cheap. Some are still available from various sources, but this will not help those who can't obtain them. Eight-ohm loudspeakers can be used in their place, even if a little more expensive.

The amplifier is slightly unusual and is a very simple Lo-Fi (I imagine that's the



The circuit diagram of the simple intercom.

Parts for Simple Intercom

R1 120k ¼W miniature
R2 6.8k ¼W miniature
R3 1M ¼W miniature
C1, C2 10uF 10V
Tr1 OC71 or similar
Tr2 BC109C or similar
SW1 three-pole, two-way
SW2 one-pole, two-way
LS1, LS2 balanced armature earpieces
Miscellaneous:
Paxolin boards, tagstrip battery clips.

opposite of Hi-Fi!) sensitive AF amplifier. It uses a PNP and an NPN transistor and is RC coupled. The switching is straightforward; two batteries are used, one each in the master and slave section. This is done purely to enable a three-wire rather than a four-wire connector to be used.

In the normal position (as shown in the circuit diagram) no current is drawn and the switch on the master is set to receive calls from the slave. The only thing the slave has to do is apply battery voltage to the master by making SW2.

When the master makes a call the output from the amplifier is fed to the slave loudspeaker, its own loudspeaker is switched to the input, becoming the microphone and the slave's microphone becomes the loudspeaker switched to the output of the amplifier. The master unit will, of course, override the slave.

Both the sections are built on Paxolin panels about 4¼ x 2½in and all the components, including the battery, are mounted on this; the layout is by no means critical and the drawing is self-explanatory.

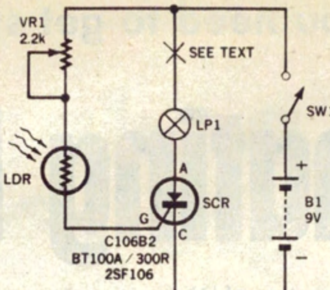
Although it may be better if press button switches were used, these are not readily available and are rather dear compared with the rotary switches used here. Also, using rotary switches enables either of these units to be switched on permanently for use as a baby alarm.

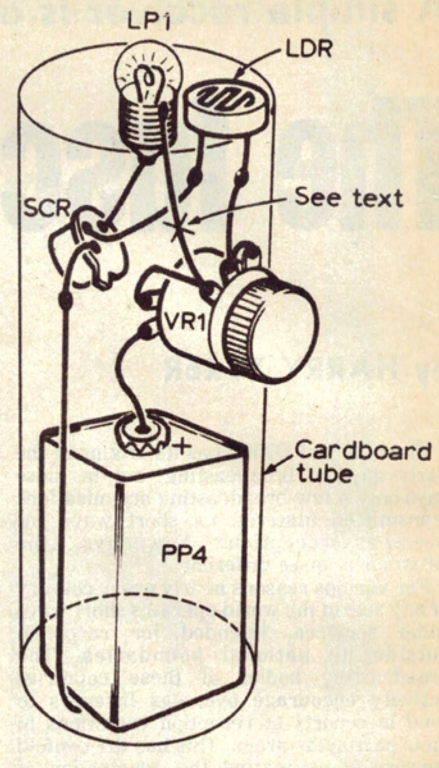
Magic Candle

Part of the fun of electronics is in being able to "amaze and mystify" members of the family and friends with little tricks. Those unfamiliar with the mysteries of electronics invariably assume that anyone who has tackled even the simplest crystal set is a true genius and, even when they see how few parts are employed, refuse to believe that "that's all there is to it". When they can't see the components that make an item tick they are even more impressed — let us not shatter their illusions, let us allow the uninitiated to marvel at our unquestionable brilliance!

This project is purely for fun; to my knowledge it has no practical use whatsoever but it should amuse and it is relatively inexpensive. Using the constructional layout shown none of the component leads need be cut short and this will allow the components to be employed later for some more practical purpose.

The title of magic candle is self explanatory: the wick and flame are replaced by a small light bulb; when a lighted match or cigarette lighter is moved near it the bulb lights up and remains alight until "snuffed" by turning it off.





The circuit of the magic candle (above). The components are mounted inside a cardboard tube (right), painted to look like a candle.

Apart from the battery, only four components are used: a light dependent resistor (LDR), a silicon-controlled rectifier (SCR), a potentiometer (VR1) and the bulb itself.

At normal light levels the resistance of the LDR will be several hundred ohms (though this varies enormously with the specimen and the actual light level) and with VR1 at maximum setting there will not be sufficient current flowing in the gate circuit to trigger the SCR. However, if VR1 is reduced in value and the light level on the LDR increases there will be an increase in current, the SCR will turn on and apply the battery volts across the bulb. Because of the action of an SCR even when the triggering current falls away completely, current will still be passed in the anode-cathode circuit.

VR1 acts as the sensitivity control; when it is set to minimum resistance and with a sensitive LDR, even quite low light levels will trigger the circuit. At maximum resistance the bulb will probably not light at all.

Ideally one would use both a battery and a bulb of the same voltage but SCRs don't seem to work well at voltages much below 9V and 9V bulbs with low current consumption are not widely available. If one can be obtained (note that the current should be no higher than 60mA) the circuit is exactly as shown. However 6V, 40mA bulbs are available and cheap but to avoid blowing it a 68-ohm resistor should be wired in series with the bulb at the point marked both in the circuit and the layout.

Magic Candle Parts List

VR1 2.2k lin. pot with switch
LDR Light dependent resistor
SCR C106 B2 or similar thyristor (50V, 1A)
LP1 6V, 40mA bulb, see text

The circuit is best built to look something like a wax candle. A cardboard tube, such as aluminium foil is supplied on, is suitable. The battery sits on the bottom to give stability with VR1 just above this. For ease of wiring it is best to wire up VR1 first with three long leads, two to come out of the top and one that goes down to the battery and then to fit it into a hole cut out of the side.

A stout card disc, cut to go over the top, can then be fitted with the bulb and the LDR which should be lightly glued under a small hole about ¼in in diameter. This should be as near to the bulb as possible. The SCR can be either left floating as shown or it can be glued to the top cardboard disc. A long wire should be fitted to the cathode which is fed down the tube to the battery negative terminal. Once working the tube and top may be painted white to give the appearance of a candle.