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CARR'S CORNER

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Using the NE-602 IC in Ham Circuits

The Signetics NE-602 integrated circuit is one of those few devices that strike the imagination because it is well conceived and behaves like it's supposed to. That latter attribute means that it will work well when amateurs design and build circuits without the aid of SPICE tools or an engineering degree. One of the other chips I place in that category is also a Signetics product: the venerable 555 IC timer.

The NE-602N is an active double-balanced mixer (DBM) based on a transistor circuit called a "transconductance cell." It also contains internal power supply regulation and an oscillator transistor. The DBM works to 500 MHz, while the local oscillator works to 200 MHz.

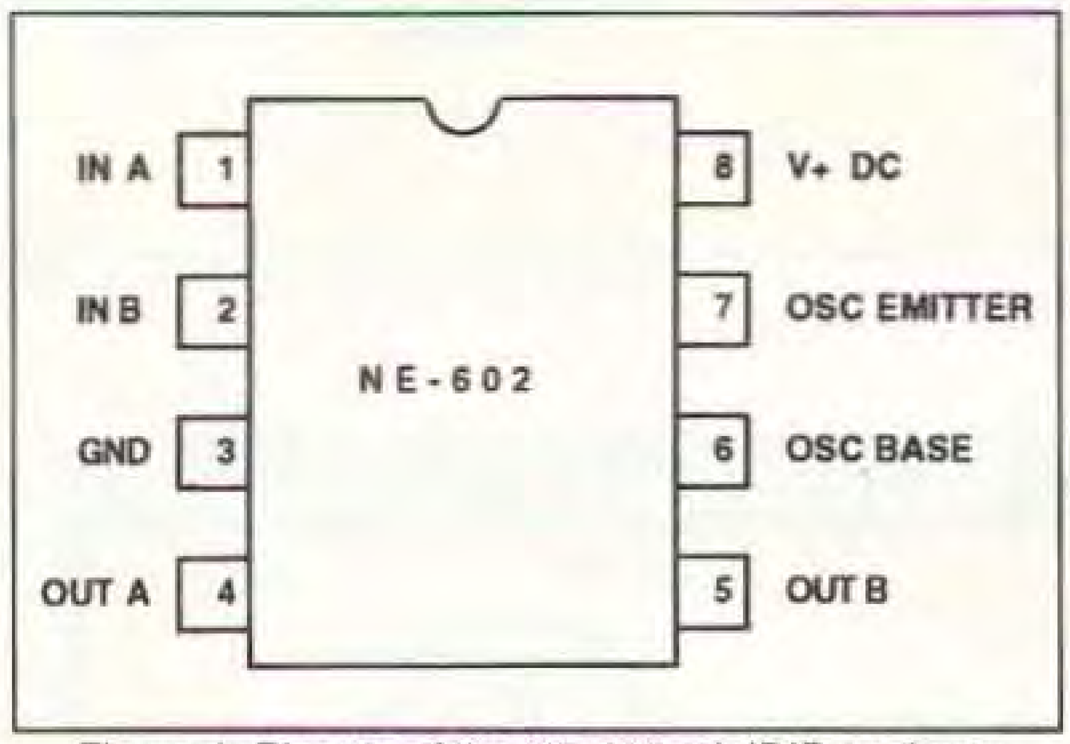

Figure 1. Pinouts of the NE-602 miniDIP package.

Figure 1 shows the pinouts of the NE-602 8-pin miniDIP device. Pins 1 and 2 form inputs "A" and "B," respectively. In single-ended circuits, input "A" is typically used, while input "B" is decoupled to ground through 0.05 µF or 0.1 µF. In differential or push-pull input circuits, both input "A" and input "B" are used. The push-pull outputs are pins 4 and 5. Again, both single-ended and push-pull configurations are accommodated. The local oscillator transistor base and emitter are brought to the outside world via pins 6 and 7, respectively. The DC power connections are pin no. 3 for signal and DC ground, and pin no. 8 for +V DC. The DC power supply should be less than +7 volts, or regulation provided.

Figure 2 shows the DC power configuration for the NE-602. In this circuit it is assumed that a higher voltage (e.g. +12 volts) is being used, so a voltage regulator is provided to reduce it to a stable +5 VDC. The regulator can be one of those little 78L05 100-mA IC devices because the NE-602 is not exactly a current hog. A 100-ohm series resistor is used to limit current and improve decoupling. At the power terminal of the NE-602 (pin no. 8), there are two decoupling capacitors: a 100 µF unit for low frequencies and a 0.1 µF unit for higher frequencies. I've used just the 0.1 µF unit with no problems, but I note that most articles on the NE-602 tend to include both capacitors.

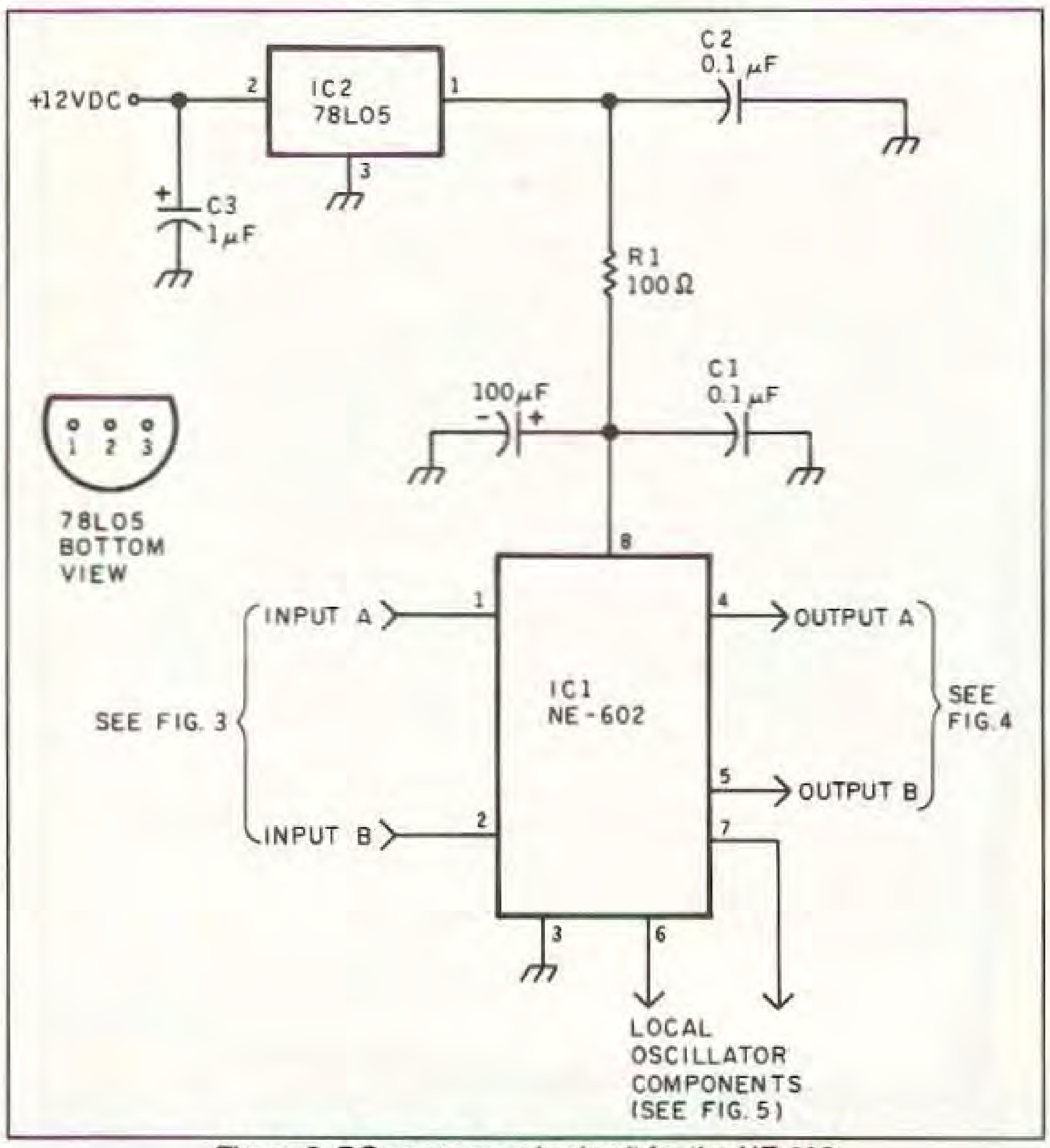

Figure 2. DC power supply circuit for the NE-602.

You can use a +9 volt DC power supply if a 1,000-ohm resistor is used for R1. The goal is to keep pin no. 8's voltage less than +7 VDC when about 15 mA is drawn. Even so, I recommend that the 78L05 device be used instead of depending on a voltage-dropping resistor.

Input Circuits

Figure 3 shows several input configurations. These circuits are quite varied, and which to use depends somewhat on application and somewhat on preference and convenience. For untuned or high impedance applications, use the direct input circuit shown in Figure 3A. This circuit capacitor couples signal to pin no. 1, and decouples pin no. 5 through a capacitor. The signal level applied to pin no. 1 should be less than 200 mV peak-to-peak.

An untuned differential circuit is shown in Figure 3B. This circuit uses an RF transformer that is not tuned for the input signal coupling. I've used two forms of transformer. First, I've salvaged or adapted, as you prefer, 10.7 MHz IF transformers intended for FM IF amplifier service in transistor radios. The tuning capacitor on the secondary of such transformers can be easily removed in most cases. It is located external to the base of the transformer, in a small recess in the bottom. A small screwdriver or sharp pointed tool will allow access where the capacitor can be crushed into oblivion. The other approach is to wind a toroidal core. I've used the Amidon T-50-2 and T-50-6 cores in 75/80, 40 and 20 meter NE-602 receiver applications with good success. Each core was wound with about 20 turns of #26 AWG enameled wire on the secondary, and about four turns of the same wire on the primary.

The same sort of transformer can be used for the tuned variant shown in Figure 3C. In this particular instance the tuning capacitor floats across the secondary of the transformer. This method works when the capacitor is a trimmer type, or can be insulated from ground. But most variable tuning capacitors are designed to be grounded when mounted to the chassis, so a circuit similar to Figure 3D must be used. In this case, the

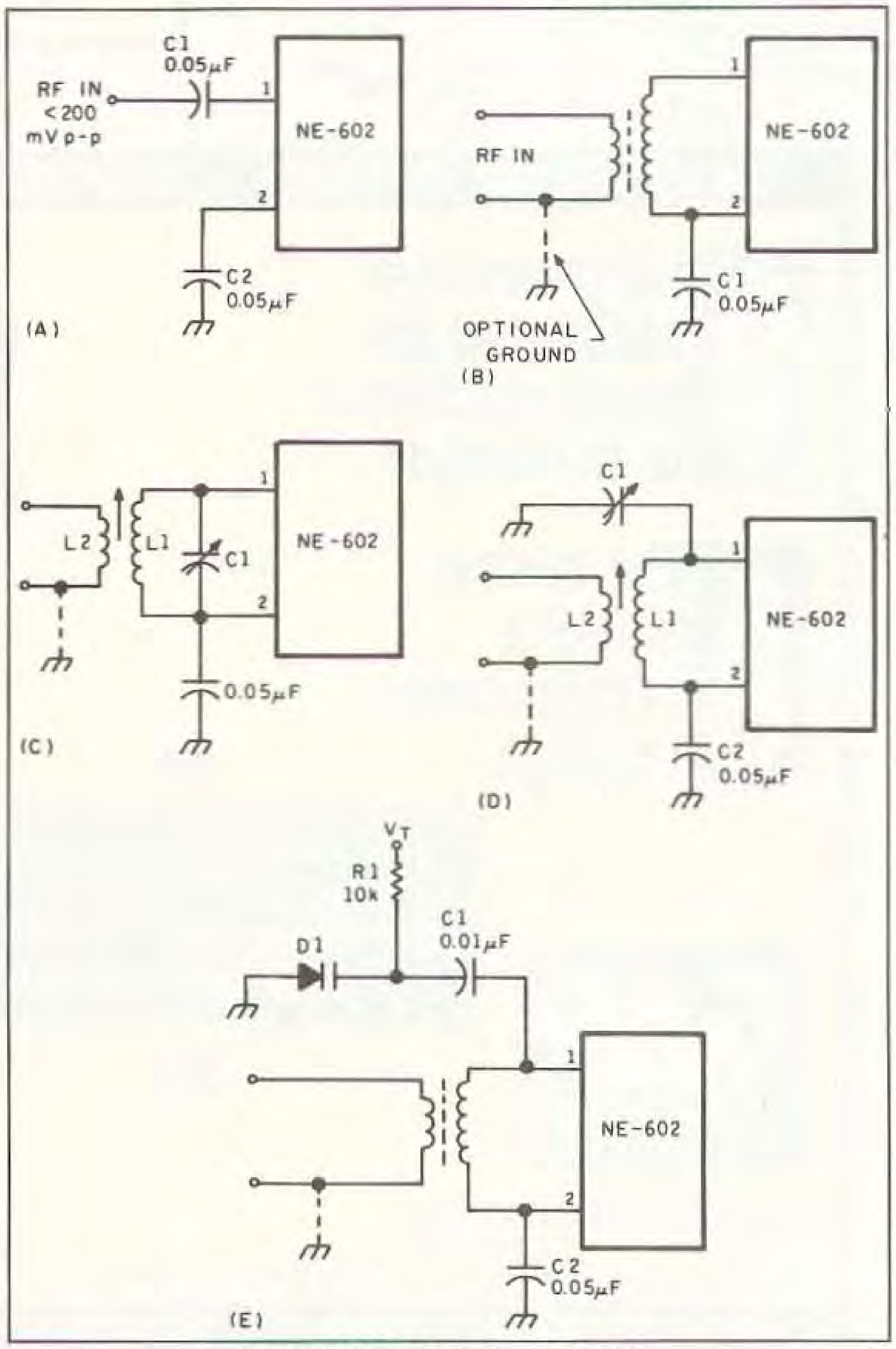

Figure 3. Input circuits for the NE-602.

tuning capacitor is connected from pin no. 1 of the NE-602 to ground. As long as C2 has a value that is considerably larger than the value of C1, the circuit will tune very much like that of Figure 3C.

Finally, given that air dielectric capacitors are hard to find, and often quite costly when available, a varactor-tuned variant is shown in Figure 3E. This circuit uses a voltage-variable capacitance diode to tune the transformer. A tuning voltage Vt from a potentiometer will set the resonant frequency of the circuit.

Output Circuits

Figure 4 shows typical output circuits. Again, several variations are shown. In Figure 4A, the untuned single-ended output circuit is shown. This circuit capacitor couples the signal from either pin no. 4 or pin no. 5 (it rarely makes any difference which) to the rest of the circuit. A balanced output transformer version is shown in Figure 4B. This circuit can use an ordinary IF transformer that matches the 1,500-ohm output impedance, or be specially wound for other applications. A single-ended tuned circuit is shown in Figure 4C. This circuit uses a parallel-tuned resonant tank circuit connected with one end to either pin no. 4 or pin no. 5 of the NE-602, and the other end to V+. Although the output signal is taken from a link winding (L2) on the tuning inductor (L1), it is also possible to capacitor-couple the output with the tank circuit in place. In either event, the output frequency selected will be that of the resonant tank circuit.

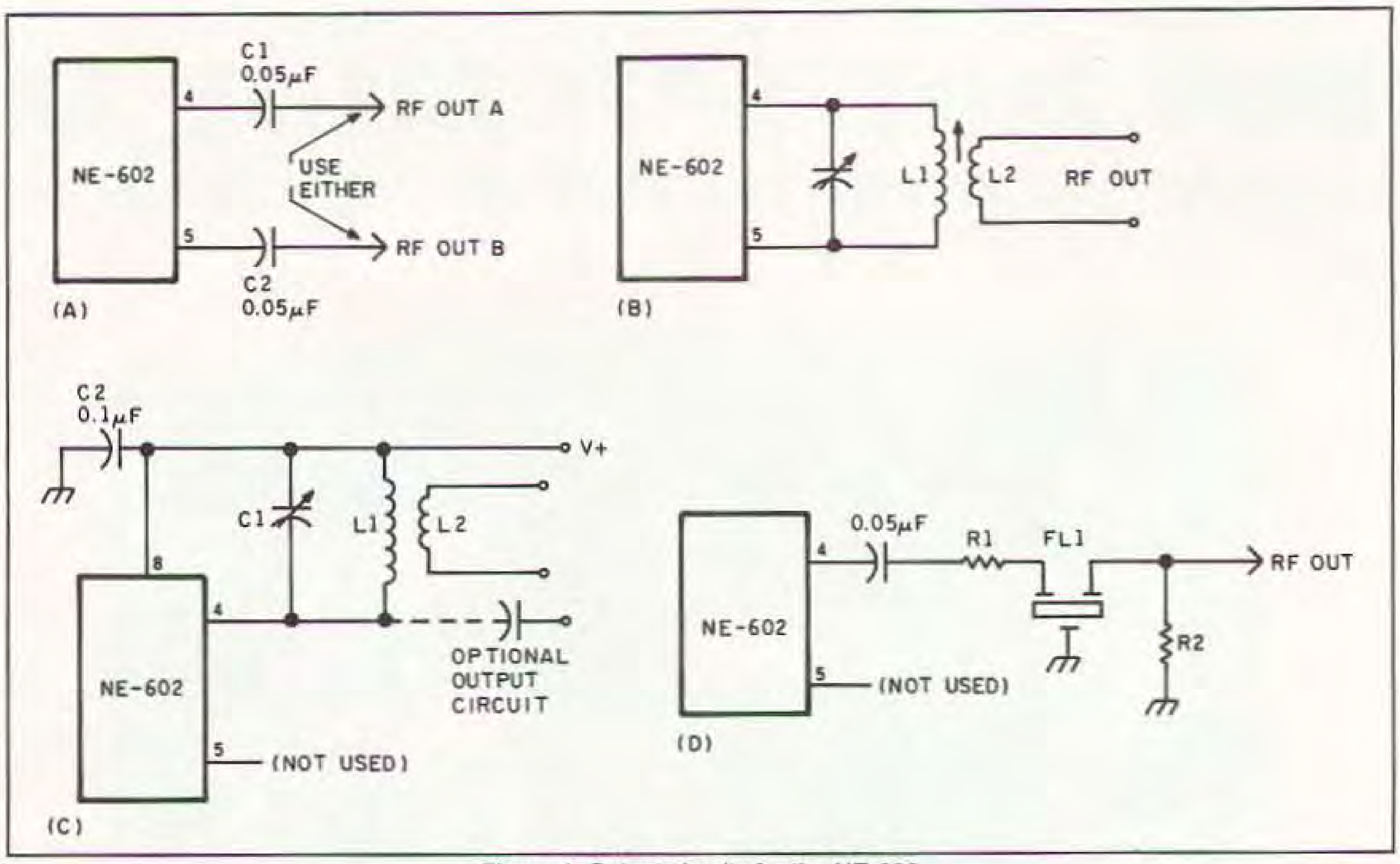

Figure 4. Output circuits for the NE-602.

> ***"The NE-602 is one of those well-designed little chips that has a lot of amateur radio uses."***

In most modern receivers a ceramic, crystal or mechanical filter is used for the IF resonator. Connection of these types of filters is shown in Figure 4D. Resistors R1 and R2 are set to match the impedance of the filter.

The internal local oscillator can be used in either VFO or XTAL configurations. Figure 5 shows several variations on the theme. The circuit in Figure 5A is a crystal-controlled Colpitts oscillator. The two capacitors are semi-critical. The values of these capacitors should be on the order of:

$$C1 = \frac{100}{\sqrt{F_{MHz}}} \text{ pF} \quad [1]$$

and,

$$C2 = \frac{1{,}000}{F_{MHz}} \text{ pF} \quad [2]$$

Although these equations give the impression of a fair degree of precision in the matter of capacitor values, I've found that they are only semicritical. In one NE-602 oscillator that I built I found that changing the crystal frequency more than an octave (i.e. 2:1) did not overly disturb the operation. Those capacitors should be some sort of low tempco type, however, such as polystyrene, silvered mica or NPO ceramic (these same capacitors can be used for any of the oscillators shown here).

The rest of the circuits in Figure 5 are variable frequency oscillators (VFOs). The circuit of Figure 5B is a parallel resonant Colpitts design. Note that the parallel resonant tank circuit (L1/C1) is tied on the "cold" end to either V+ or ground (and it doesn't seem to matter which). The other capacitors in the circuit are selected similarly to those of the crystal oscillator, except that C2 is a 0.01 µF unit.

A Hartley variant is shown in Figure 5C. This circuit uses a tapped inductor for feedback. The capacitors in the circuit (C2 and C3) are 0.05 µF disk ceramic or polystyrene devices. The tuning capacitor is an air variable with a grounded frame.

Another VFO circuit is shown in Figure 5D. This circuit has worked well from 80 meters up through 20 meters. It is based on the use of a varactor ("voltage variable capacitance diode") capacitor. The capacitance of this diode is set by the level of tuning voltage Vt applied to the reverse biased junction of D1.

The NE-602 is one of those well-designed little chips that has a lot of amateur radio uses. Space does not allow us to go further in depth on the device. I am currently writing a book for TAB called *Mastering RF Circuits* (the actual published title may be a little different, but the "Mastering" part will remain because it is part of a series). It will deal in depth with the NE-602 and certain related chips. In the meantime, I would be interested in hearing from readers who have used the chip. Please relate your experiences and any novel uses for it. You might see your name in print if the application is interesting to a broad spectrum of readers.

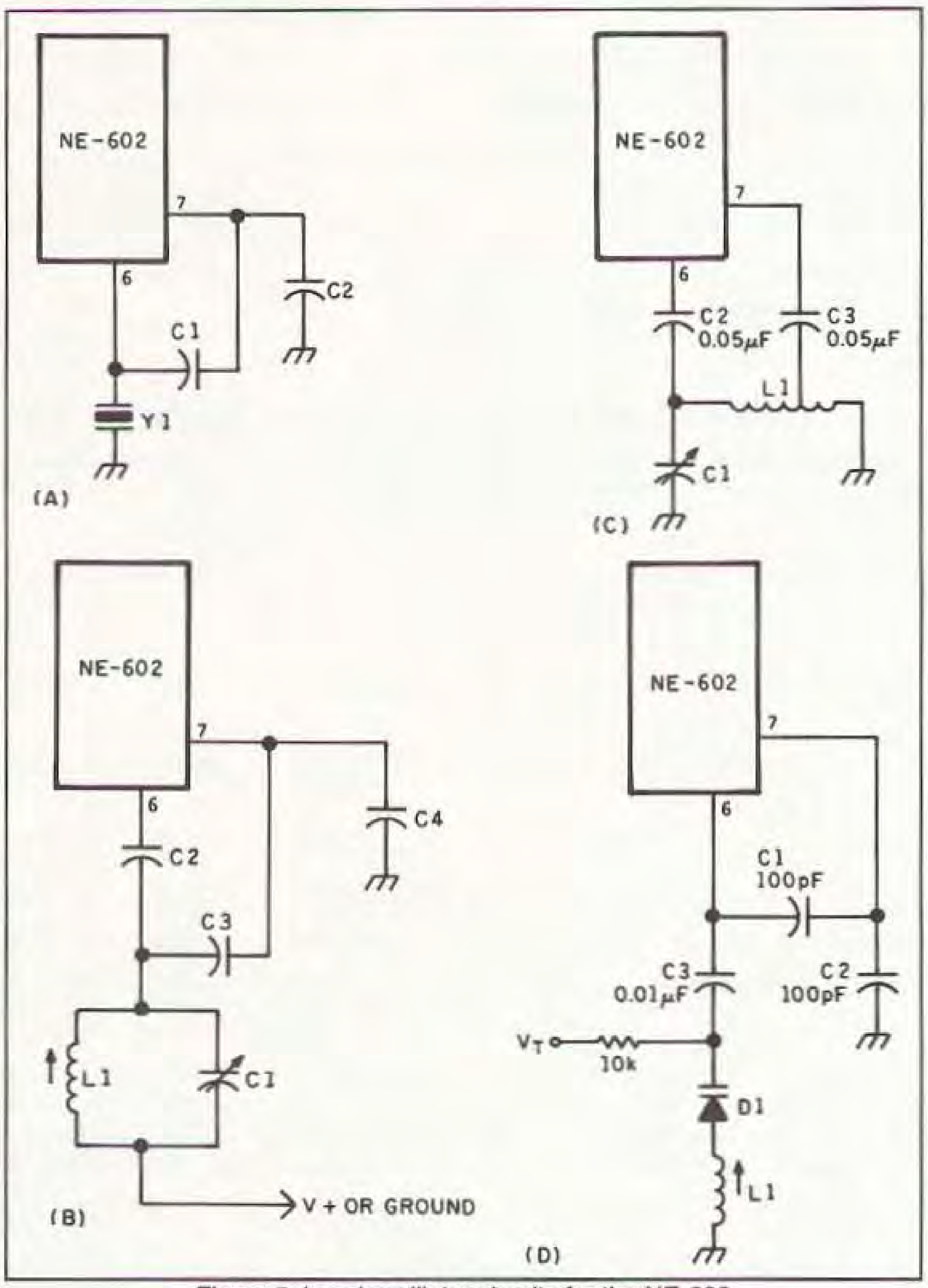

Figure 5. Local oscillator circuits for the NE-602.