SINE WAVE GENERATOR - ADAPTED FROM HEATH IG-18

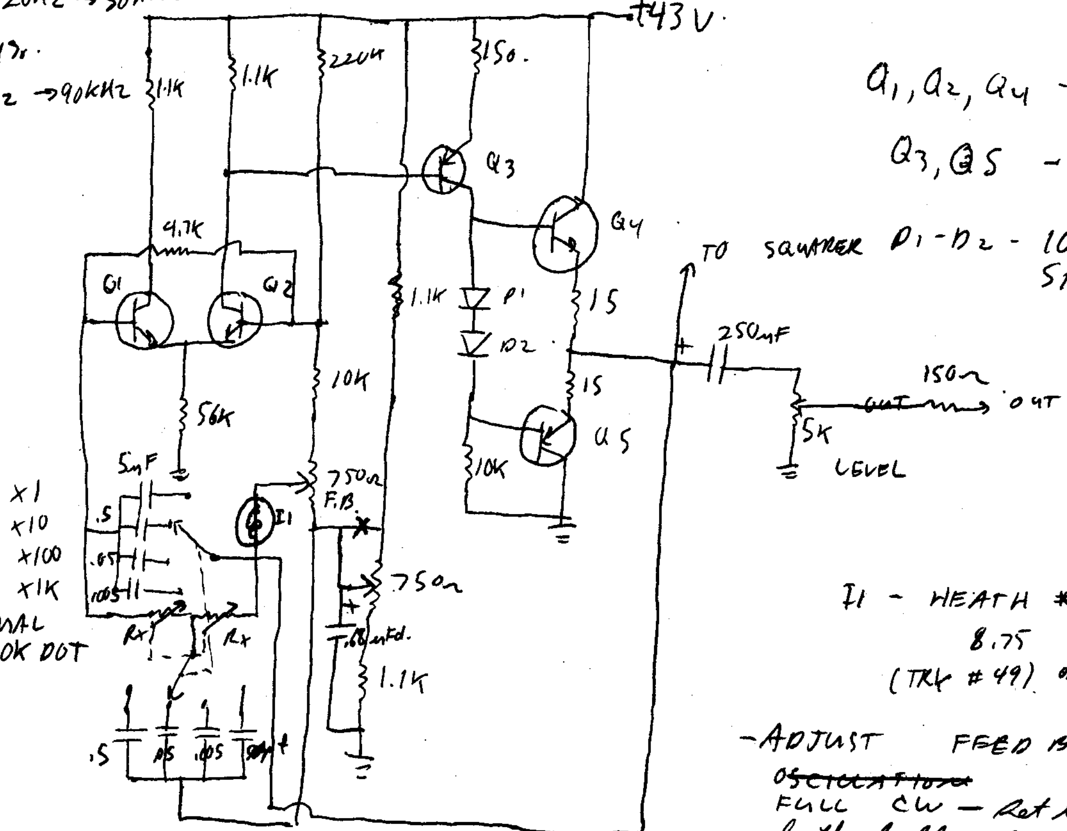
< .06% DISTORTION 20Hz → 50kHz

< .1% 8Hz → 90kHz

Q_1, Q_2, Q_4 - 2N3416

Q_3, Q_5 - 2N2306

$D_1 - D_2$ - 100PIV 100mA SILICON.



I1 - HEATH # 412-66
8.75
(TRK # 49) or 117V 3W LAMP.

- ADJUST FEED BACK TO ~~FOR OSCILLATION~~ FULL CW - set bias so both halfs of waves are symmetrically clipped - Reset F.B. for ~~not~~ no clipping at any ~~point~~ freq, but for max output also

DUAL 10K POT GIVES 10:1 ranging - 10Hz to 100Hz.

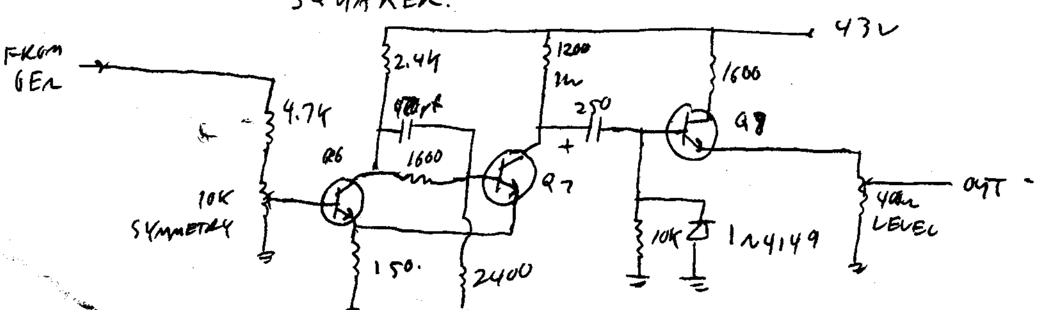
DUAL 100K POT GIVES 100:1 range. - 1.0Hz to 100Hz

on X1 Rx = 100K FOR 1Hz
50K FOR 2Hz
33.3K FOR 3Hz
25K FOR 4Hz.
20K FOR 5Hz
16.7K FOR 6Hz
14.3K FOR 7Hz
12.5K FOR 8Hz
11.1K FOR 9Hz.
10K FOR 10Hz.

$$F = \frac{1}{2\pi R_x \sqrt{C_1 C_2}}$$

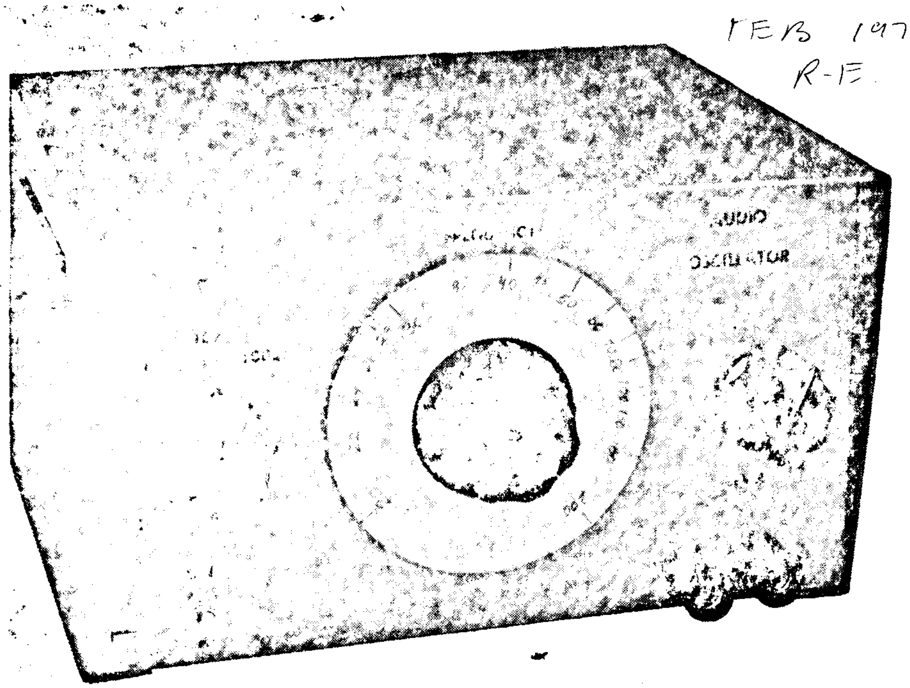
C1 always 10 times C2.

SQUARER.



Q6, Q7, Q8 - 2N2369.

FEB 1971
R-E



Build One-IC Audio Generator

High-quality low-cost generator covers 20 Hz to 20 kHz in three bands. It's easy to build and very handy to have around the shop.

by R. D. CRAWFORD

LINEAR INTEGRATED CIRCUITS ARE coming into style in a big way, and for good reasons. The present generation of operational amplifiers, for instance, has features that lend themselves to the design of audio equipment. These features include:

1. Well controlled gain and phase characteristics,
2. Short-circuit proof,
3. High gain,
4. High input impedance,
5. Reasonable price.

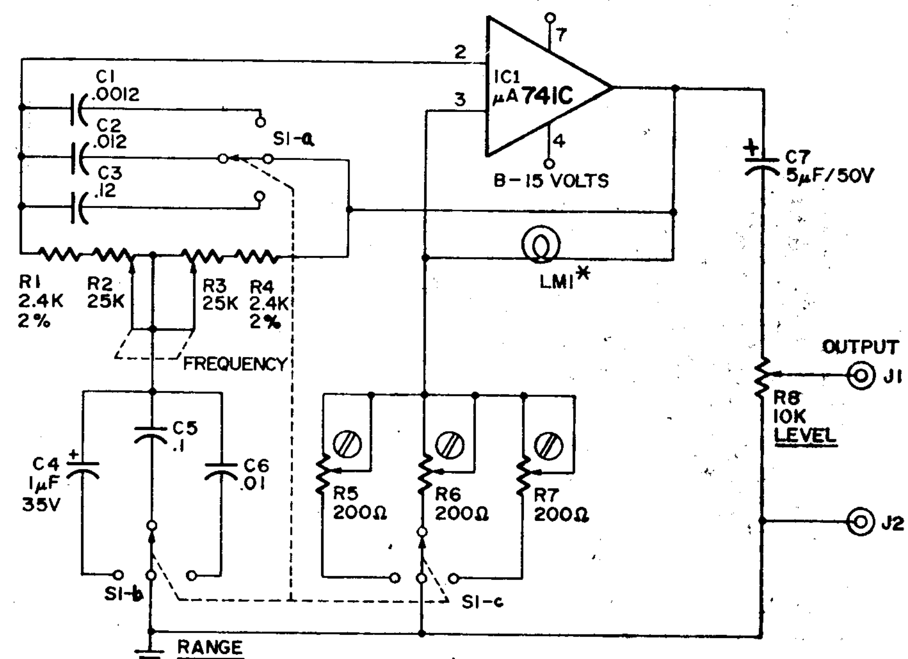
An excellent application for these IC's is the audio oscillator described here. It covers the audio range from 20 Hz to 20 kHz with less than 1% distortion and is very simple.

The circuit (see Fig. 1) is derived

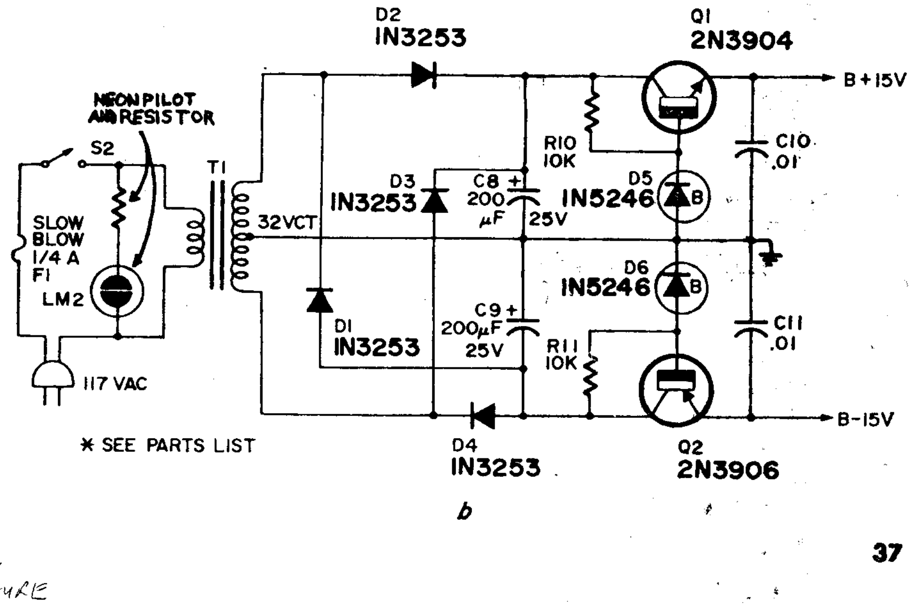
continued

PARTS LIST

R1, R4—2400 ohms, 2%, ¼ watt
R2, R3—ganged pot, 25,000 ohms each section, linear taper
R5, R6, R7—pot, 200 ohms, ¼ watt
R8—pot, 10,000 ohms, audio taper
R10, R11—10,000 ohms, 10%, ½ watt
C1—.0012 μF, 200 V, Mylar, 10%
C2—.012 μF, 200 V, Mylar, 10%
C3—0.12 μF, 200 V, Mylar, 10%
C4—1.0 μF, 35 V, tantalum, 20%
C5—0.1 μF, 200 V, Mylar, 10%
C6—.01 μF, 200 V, Mylar, 10%
C7—5 μF, 50 V, electrolytic
C8, C9—200 μF, 25 V, electrolytic
C10, C11—.01 μF, 100 V
D1, D2, D3, D4—1N3253 (500 mA, 200 prv, silicon)
D5, D6—1N5246 (16 V Zener) 10%
IC1—μA741C or equivalent (Fairchild)
Q1—2N3053
Q2—2N4037
F1—¼A slow blow
S1—3-pole 3-position shorting (Centralab 1008 or equiv)
S2—spst, 3A
T1—117V pri; 32V ct sec. (Triad F-90X or equal)
LM1—10V, 14 mA (344, 1869, 914) or 10V, 10mA (913,367)
LM2—Neon panel lamp and resistor assembly



a



b

FIG. 1—HERE'S THE CIRCUIT of the generator (a) and its power supply (b).

APPROX $13.00 IN QUANTITY TO MANUFACTURE

10mA lamp give lower distortion ~~below~~ above 100Hz
but higher below 100Hz

RESPONSE IS WITHIN 1db IS A REASONABLY GOOD QUALITY POT IS USED

2nd harmonic: H.D = .04% at 1KHz with 4VRMS OUTPUT .02% at 20Hz 1% at 20KHz.
below .1% from 30Hz to 3KHz.

3rd harmonic = .01% at 1KHz .14% at 20Hz .4% at 20KHz.
below .1% from 30Hz to 14KHz.

~~[illegible]~~
IC draws 20mA with a low Z load ∴ power supply limits current to 20mA
∴ a very small transformer may be used.

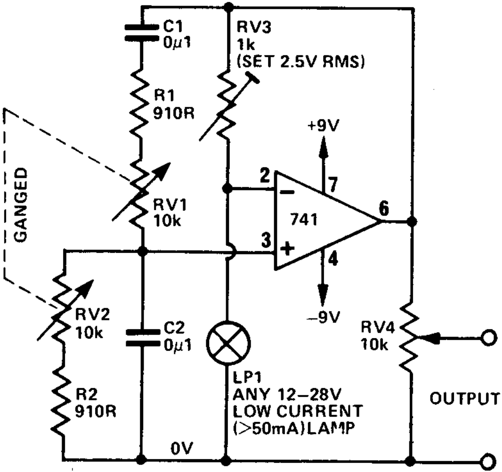
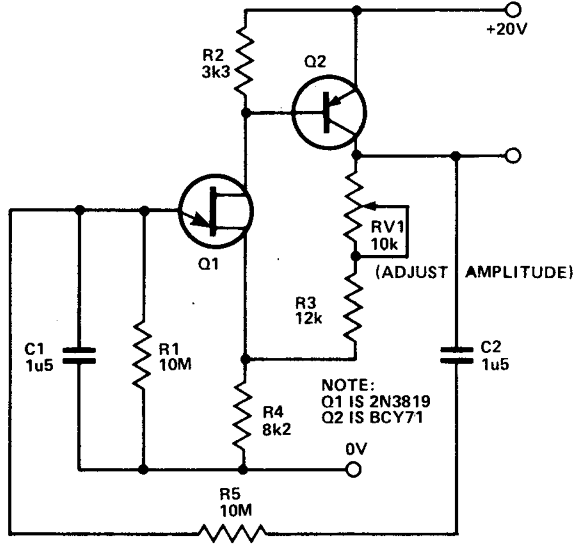


Fig. 32 150Hz - 1.5kHz Wien-bridge oscillator.

VLF Sine Generator

G. Loveday

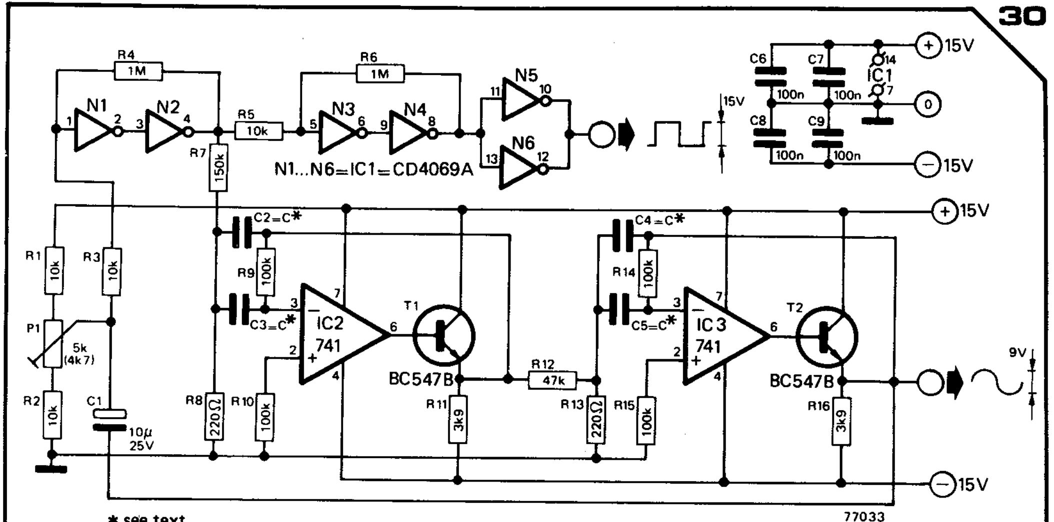
Generating very low frequency sine waves (i.e. less than 0.1 Hz) presents several problems. Timing capacitors usually have to be large valve electrolytics, any amplifier used must be D.C. coupled, and the amplifier's input impedance must be very high. One standard method is to first generate low frequency square waves, and then to shape these into an approximation of a sine wave by the use of several non linear devices, such as diodes. The circuit shown in Fig. 1 is a relatively simple approach based on the familiar wien bridge. An n-channel FET and a pnp transistor are arranged in a DC coupled circuit and the voltage gain is determined by the negative feedback R3 and R4. The gain need only be about three, thus if the bias required by the FET is 3V the output level will be approximately half the supply voltage.



Since R1 can be a high value resistor the value of the capacitor is only 1u5 for sine wave outputs of 0.01 Hz. This capacitor is available in polycarbonate. The amplitude of the output can be adjusted by RV1 to give low harmonic distortion and to be about 10V peak to peak. As expected, with this wien bridge circuit, frequency stability is good with changes in both supply voltage and temperature.

25

spot-frequency sinewave generator



This circuit employs an unusual method of producing a sinewave signal and, unlike most sinewave generators, requires no amplitude stabilising components such as thermistors or FETs. N1 and N2 are connected as a Schmitt trigger at whose output appears a squarewave (how this happens will become apparent). The squarewave signal is fed into two cascaded selective filters consisting of IC2/T1, IC3/T2 and their associated components. The filters remove the harmonic content of the squarewave leaving only the sinusoidal fundamental. This signal is fed back via C1 to the input of the Schmitt trigger. At each zero-crossing of the sinewave the Schmitt trigger changes state, thus producing the original squarewave that is fed to the input of IC2. P1 adjusts the trigger point of the Schmitt trigger, which varies the duty-cycle of the squarewave and hence the sinewave purity. By suitable adjustment of P1 distortion levels of 0.15% to 0.2% can be achieved. With the ICs used lower figures are not possible due to the distortion introduced by IC3 and T2.

N3 and N4 also function as a Schmitt trigger, which further speeds up the leading and trailing edges of the squarewave from N2. A squarewave signal with short rise and fall times, synchronised to the sinewave signal, is available at the outputs of N5 and N6. The value of C for a particular frequency f_0 is given by $C\ (\mu F) = \dfrac{0.34}{f_0\ (Hz)}$.

Build a Low-Distortion Low-Cost Audio Generator

Generates sine waves with less than 0.02% distortion, or acts as a gyrator.

BY DAVID R. LANG

MOST function generators use operational amplifiers to generate the basic square and triangle waveforms. The sine waveform is not generated directly; instead, a passive or active shaping network is generally used to "soften up" the triangle wave to produce an approximation of the sine wave, which means that the distortion level leaves much to be desired.

The least expensive way to generate precision sine waves, at only 0.02% distortion, is to use a "gyrator." Using the gyrator, only a single potentiometer is required to cover a 15:1 frequency range. A pair of switch-selectable capacitors can then be used to establish the desired frequency range.

In addition to serving as a precision low-distortion oscillator, the gyrator circuit can also be used as a high-quality variable inductance and as a narrow-band audio pass/reject filter. The schematic is shown on the following page.

About the Circuit. As shown in the schematic diagram, the generator's circuit is arranged as a gyrator, one side of which is referenced to the common or ground point of the split power supply. Operation of the circuit is best understood by observing that *IC3* has a gain of $1/(R4C1\omega)$ and that *IC3* is followed by a current generator made up of *Q1* and *Q2*, which has a transfer function of $1/Rk$. Integrated circuit *IC1* is used as a voltage follower whose gain is unity and input impedance is very high. Integrated circuit *IC2* is operated as a unity-gain inverter, where *R1* and *R2* have similar resistance values.

An input voltage, *E1*, to *IC1* generates a current specified by the formula $I1 = 1/(R4RkC1\omega)$, which can be written as $E1/L = I1$, since dimensionally $L = R^2C$. The statement $1/Rk$ is simply the ratio of the input voltage (from *IC3*) to the total collector current changes referenced to the common point of the power supply. Ignoring the input resistance to the transistors and assuming $\alpha = 1.00$, $Rk = [R7(R6+R5)]/2R5$ and $L = R4RkC1$.

When the circuit is operated as an oscillator, *C2* performs as a low-pass parallel-resonant *LC* network that is driven by *IC5* through *R11*, where the feedback level is determined by the setting of *R9*. Switch *S1* is used to disconnect *IC5* from the inductance to disable the oscillator when only an inductance or an *LC* network is desired. The inductance is linear as long as the peak-to-peak voltage at the junction of the collectors of *Q1* and *Q2* does not exceed about 6 volts for the 18-volt supply illustrated.

With *S2* open, *IC5* serves as a comparator that clips the sine wave to produce a square-wave output from the system. Potentiometer *R3* is used to adjust the square wave's duty cycle.

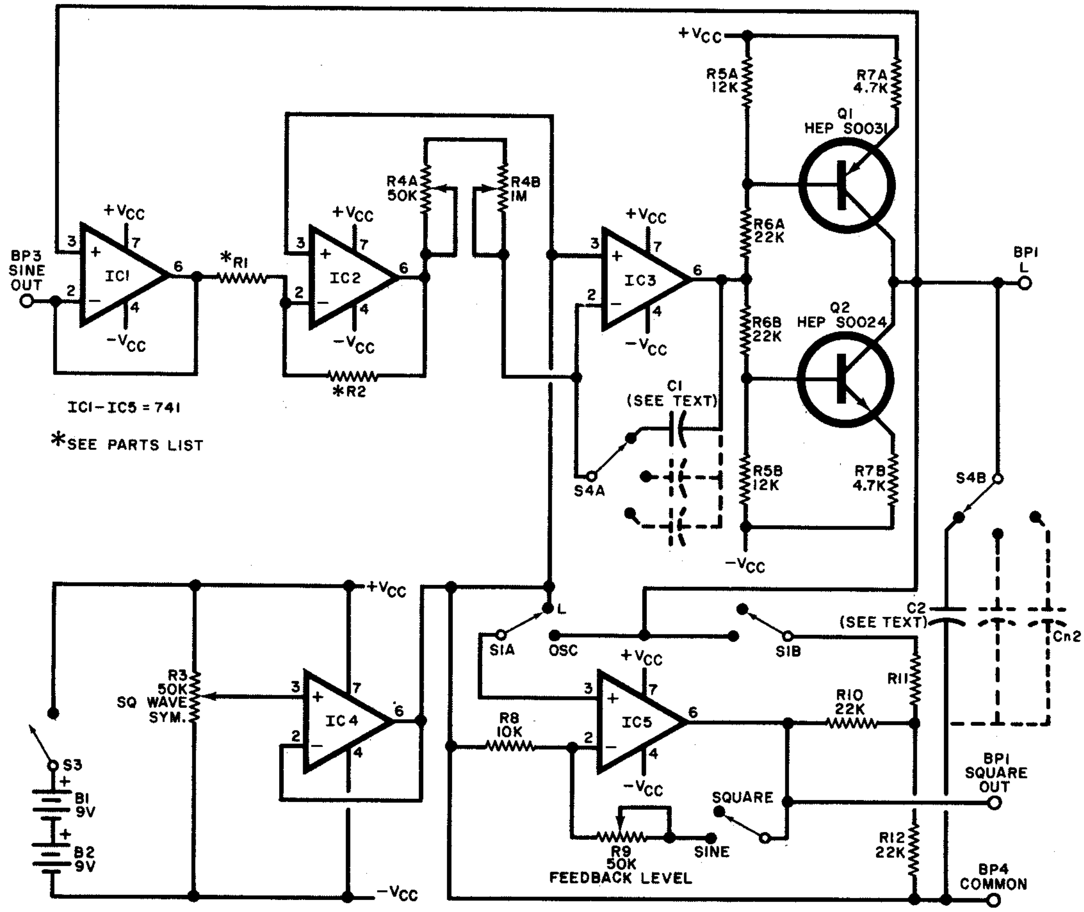
Construction. The circuit can be assembled on perforated board with sockets for the IC's and transistors or on a printed circuit board of your own design. Be sure to note that the pin designation numbers for the IC's in the schematic diagram are for an eight-pin DIP device. You can use any other package style of 741 op amp, but be sure to observe proper pin designations.

For best temperature stability, all fixed resistors should be of metal-film or wire-wound construction, and polystyrene, mica, or Mylar capacitors should be used for *C1, C2,* and any other range-determining capacitors. For *Q1* and *Q2*, any reasonable low-leakage, high-gain silicon transistors can be used.

Complementary sine-wave outputs are available from *IC1* and *IC2*, since the 741 op amp is not designed to deliver substantial output power, a buffer should be used if a load impedance of less than 1000 ohms is anticipated.

Range capacitors *C1* and *C2* should be mounted on a multi-position two-deck rotary switch (*S4*), along with any other range capacitors you might decide to use. RANGE switch *S4*, POWER switch *S3*, FEEDBACK control *R9*, FREQUENCY control *R4B*, L/OSC switch *S1*, SINE/SQUARE switch *S2*, and output binding posts *BP1* through *BP4* should all mount on the front panel of the box in which the circuit is to be housed. Mount a piece of heavy white paper or stiff cardboard behind the hex nut that holds *R4B* in place; it will become a scale for the FREQUENCY control. Slip over the shaft of this control a knob with a pointer. Then label all controls and switch positions according to function and/or range.

Setting It Up. For best results, a frequency counter should be used to set trimmer potentiometer *R4A* to provide



Sine-wave generator also serves as a-f filter or simulates inductor from 1 to 1000 H.

PARTS LIST

B1, B2—9-volt battery
BP1 through BP4—Four-way binding post
C1, C2—0.15-µF Mylar capacitor (for 13-to-130-Hz range); 0.015-µF capacitor (for 130-to-1300-Hz range); 0.0015-µF capacitor (for 1300-to-13,000-Hz range)
IC1 through IC5—741 operational amplifier
Q1—HEP S0031 (Motorola) or similar pnp silicon transistor
Q2—HEP S0024 (Motorola) or similar npn silicon transistor
R1, R2—6800-to-8200-ohm, 1% tolerance film resistor (value not critical)
R3, R4A—50,000-ohm trimmer potentiometer
R5A, R5B—12,000-ohm, 1% tolerance film resistor
R6A, R6B—22,000-ohm, 1% tolerance film resistor
R7A, R7B—4700-ohm, 1% tolerance film resistor
R8—10,000-ohm, 5% tolerance resistor
R9—50,000-ohm potentiometer
R10, R12—22,000-ohm, 5% tolerance resistor
R11—470,000-to-600,000-ohm film resistor (Stability more important than absolute value)
S1—Dpdt switch
S2, S3—Spst switch
S4—Two-pole, three-position nonshorting rotary switch.
Misc.—Battery connectors (2); suitable case; perforated board (or pc board); IC sockets (5); transistor sockets (2); control knobs (two round one pointer type); heavy white paper or cardboard; dry-transfer lettering kit; machine hardware; hookup wire; solder; etc.

an exact 10:1 frequency spread over *R4B*'s range, which corresponds to an inductance range of 100:1 (*R4A* = *R4B*/99). Starting at the highest frequency, where the scale is compressed, use the frequency counter to establish convenient frequency intervals on the FREQUENCY control's dial. A different color ink can be used to label the inductance values in accordance with the relationship $L = 1/\omega^2 C$. With the component values specified, the inductance range is from 1 to 1000 H.

When *R4B* is a 1-megohm potentiometer, the values of 0.0015, 0.015, and 0.15 µF for the *C1* and *C2* components provide ranges of 1300 to 13,000 Hz, 130 to 1300 Hz, and 13 to 130 Hz, respectively. If these sets of capacitors are accurately related by powers of 10, switching between ranges should yield frequencies within a few percentage points of the expected values. The frequencies at the scale endpoints can be changed for all ranges simultaneously by trimming the value of *R2*.

FEEDBACK control *R9* should be set to just beyond the point where oscillation begins, at the lowest-frequency setting. The oscillations will rapidly increase in amplitude until *IC5* goes into clipping, establishing an operating point. The value of resistor *R11* must be large to suppress harmonic distortion by minimizing the parallel resistive shunt across *L/C2*, thereby increasing its Q. When the circuit is operating properly, the dc potential at *BP1* is within a few millivolts of COMMON binding post *BP4*, and the current demand on the power supply will be approximately 8 mA.

The least distortion occurs when the FEEDBACK control is adjusted to the point where it just barely sustains oscillation. If *R9* were a fixed value to enable operation on all ranges and at all frequencies, the maximum distortion would be about 0.1%. Stray capacitance limits the oscillations to about 40,000 Hz if *R4A* is unchanged from its low-frequency value. ◇