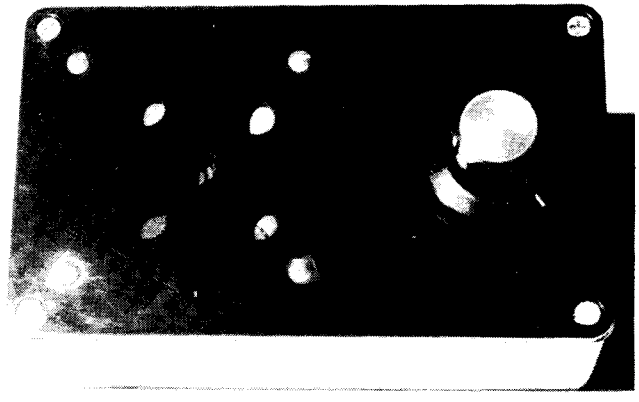
4. CHUG-CHUG



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**

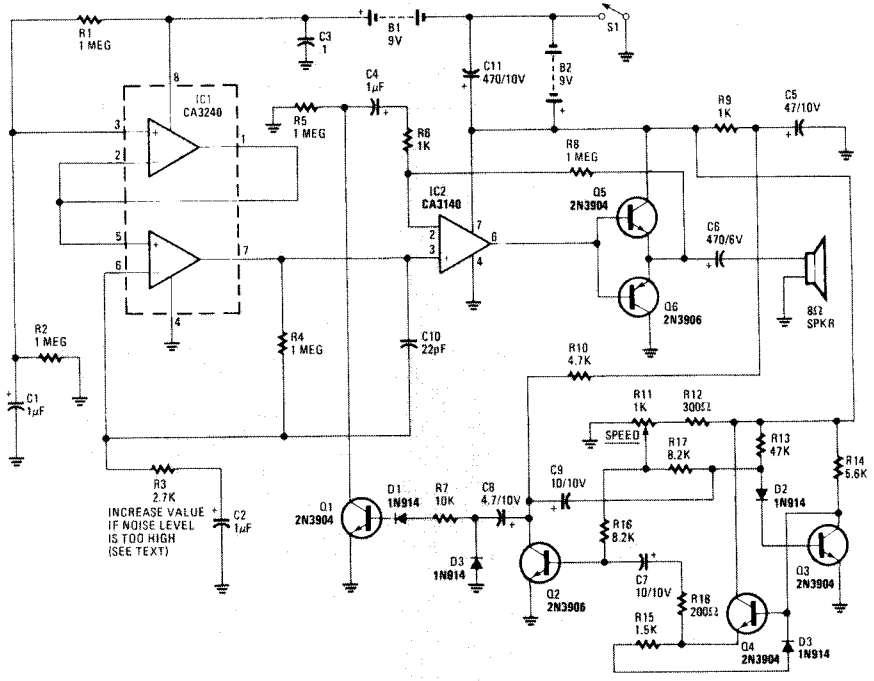

FIG. 4—THE CHUG-CHUG TOY simulates the sound of a steam locomotive. A dual MOSFET-input op-amp, IC1, is used as a white noise generator in this circuit.

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.