ELECTRONIC STEAM WHISTLE

GREAT FOR MODEL TRAIN BUFFS— OR MAKING WILD AUTO HORNS

BY JOHN S. SIMONTON, JR.

IF MODEL railroading is one of your hobbies, you probably have at least one problem in common with every other railroad buff—finding a steam whistle sound for your layout. Since you may not be inclined to invest the money necessary to install boilers and pipes for a real whistle, this design for an $8.00 electronic substitute could be just what you need.

If you're adventurous, you might also want to try the steam whistle as a really different auto horn. (*Or how about a chromatic scale of whistles to make a steam calliope?*—Ed.)

Theory of Circuit Design. A whistle is basically nothing more than a resonant chamber which produces a tone when excited by the steam flowing over a turbulence producing orifice. However, there are other factors involved. There is the sound of the steam which can be heard as a faint hiss as the whistle is blown. Also, like other "musical" instruments, a whistle has its own peculiar attack and decay characteristics. That is, it takes a short time for the sound to build up to a maximum and the vibrations persist for some short time after the exciting force (steam) is removed. Finally, there is a slight lowering of pitch as the vibrating medium in the cavity changes from air to a denser air/water combination.

In this electronic whistle, whose schematic is shown in Fig. 1, there are three essentially independent sections which produce the necessary effects to make it sound like a real steam whistle. They are a tone oscillator, a noise source, and a gating amplifier.

The oscillator is a conventional phase shift circuit with *Q1* in a common-emitter configuration for gain and also to provide 180° of the required 360° of phase shift. The remaining 180° is provided by the frequency determining components, *C1*, *C2*, *C3*, *R1*, *R2*, and *R3*.

The steam sound is provided by a white noise generator, *Q2*, which has its base-emitter junction biased above the breakdown potential. The noise of the resulting avalanche breakdown mechanism appears across *R8* and is used to simulate the sound of steam.

The outputs of the oscillator and the noise source are mixed by resistors *R7* and

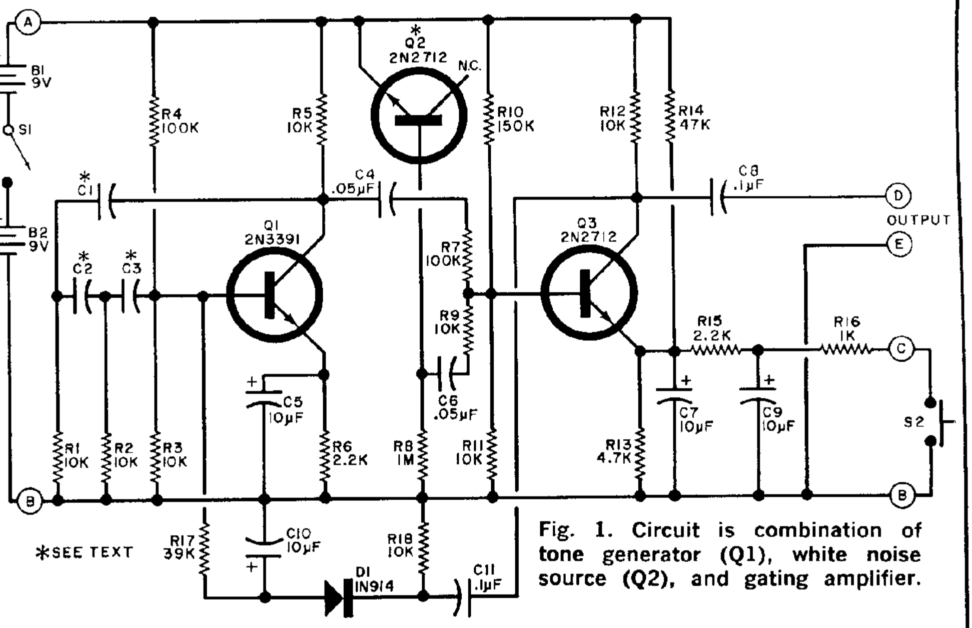
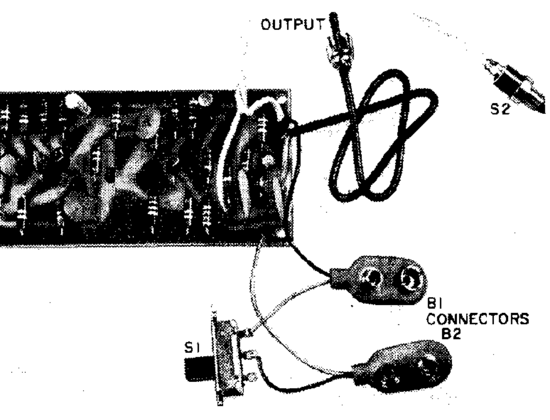


Fig. 1. Circuit is combination of tone generator (Q1), white noise source (Q2), and gating amplifier.

PARTS LIST

B1,B2—9-volt battery
C1-C3—0.005 to 0.05-µF disc capacitor (see text)
C4,C6—0.05-µF disc capacitor
C5,C7,C9,C10—10-µF, 6-volt electrolytic capacitor
C8,C11—0.1-µF disc capacitor
D1—Diode (1N914 or similar)
Q1—2N3391 transistor
Q2,Q3—2N2712 transistor (see text)
R1-R3,R5,R9,R11,R12,R18—10,000-ohm, ½W, 10% resistor
R4,R7—100,000-ohm, ½W, 10% resistor
R6,R15—2200-ohm, ½W, 10% resistor
R8—1-megohm, ½W, 10% resistor
R10—150,000-ohm, ½W, 10% resistor
R13—4700-ohm, ½W, 10% resistor
R14—47,000-ohm, ½W, 10% resistor
R16—1000-ohm, ½W, 10% resistor
R17—39,000-ohm, ½W, 10% resistor
S1—Spst slide or toggle switch
S2—Spst, normally open, pushbutton switch
Misc.—Battery clips, coax, phono plug, wire, solder, etc.
Note—The following are available from PAIA Electronics, Inc., Box 14359, Oklahoma City, OK 73114: etched and drilled PC board #6710 at $2.00, postpaid in U.S.; complete kit of all parts including PC board and selected Q2 and two sets of C1, C2, and C3, but less batteries, at $7.95, postpaid in U.S.

Note how components are connected to board with S1 between the batteries.

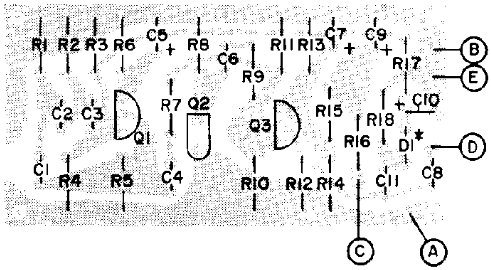


R9 and applied to the common emitter gain stage, *Q3*. When pushbutton *S2* is open, *Q3* cannot pass audio because its emitter is held at a slightly higher voltage than its base by the voltage divider *R14* and *R13*. When *S2* is closed, the voltage at *Q3*'s emitter begins to drop as *C9* discharges through *R16*.

As *Q3*'s emitter voltage drops, its base-emitter junction becomes more and more forward biased and thereby increases the gain of *Q3*. When *S2* is opened, a reverse action occurs as *C9* charges up through *R15*. These two time constants are chosen to simulate the attack and decay characteristics of the steam whistle.

Part of the output signal is tapped off of *Q3*'s collector and rectified and filtered

Fig. 2. The actual size foil pattern and component layout. Observe the polarities carefully during assembly.



by *D1* and *C10*. The resulting dc voltage is applied to *Q1's* base, where it gradually lowers the pitch of the oscillator slightly as the whistle is blown.

Construction. As with any project, an etched circuit board provides ruggedness and contributes to the appearance; but since there are no high frequencies involved here, the PC board is not essential. A foil pattern and component placement diagram are shown in Fig. 2.

Solder in place the resistors and disc capacitors first; then the electrolytics and semiconductors, being sure to observe the polarities. Use heat sinks on the semiconductor leads while soldering.

Selecting a transistor for *Q2* may present a problem, but the prospect is unlikely. Samples of test lots of 2N2712 transistors indicate that only a small percentage will not function properly as a noise source when driven from an 18-volt supply. Since two 2N2712's are required for the unit, the chances that neither will work for the noise source are remote. If you wish, check the performance of the noise source by putting a high-impedance crystal earphone directly across resistor *R8* and listen for the hiss. The volume of the noise at this point in the circuit is very low but you should be able to hear it.

Complete the assembly by soldering in place the positive lead from one battery connector and the negative lead from the other, the wires to the pushbutton and the audio output lead. Note that one of the pushbutton leads and the negative battery connector lead share a circuit board connection point and that a short length of small coax (RG-174/U) is used for the audio output. The remaining battery connector leads are used as a switch leg and soldered to power switch S1.

Operation. There are no adjustments which must be made to the whistle to make it operate, but there are some component values you may want to trim to get the sound the way you want it.

The values of *C1*, *C2*, and *C3* determine the pitch. Using 0.005 microfarads for all three of these capacitors produces the high-pitched screech of European trains, while 0.05-microfarad units give the throaty roar of American freight trains. The three capacitors need not be of equal value to sustain oscillation; and pitches between the two extremes can be obtained by changing individual capacitors.

The amount of "steam" can be varied by altering the value of *R9*. For more noise, decrease the resistance; for less hiss, increase the resistance.

Operation of the whistle is simply a matter of snapping two 9-volt batteries in place and plugging the output into a suitable amplifier. The type of amplifier used is not important, but the better it is (in terms of fidelity), the better will be the sound. ◈