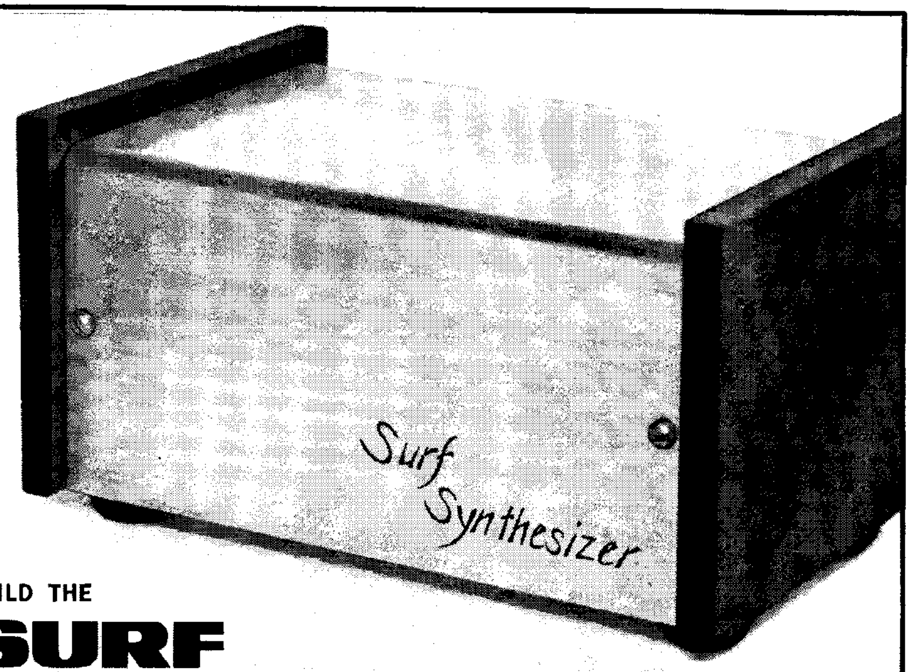


BUILD THE

SURF SYNTHESIZER

REPRODUCE THE SOUND OF BREAKERS AGAINST THE SHORE

BY JOHN S. SIMONTON, JR.

ONE of the most relaxing sounds imaginable is the roar of the surf. From Presidents on down, anyone who is close enough, and has the time, heads for the seashore when he wants to unwind. But what is really nice is to have the sound of the surf always available at the flick of a switch—and now you can. With a "Surf Synthesizer," you can turn your home into an apartment at Malibu Beach.

The Surf Synthesizer is actually a special-purpose electronic music synthesis system which operates through your hi-fi amplifier. White noise is generated by an inexpensive silicon transistor and voiced by a voltage-controlled, low-pass filter and attenuator under the control of a random voltage generator.

Design Analysis. A complete schematic of the Surf Synthesizer is shown in Fig. 1, but it is convenient to break the unit down into blocks as shown in Fig. 2. There are a noise source; voltage-controlled, low pass filter (VCF); voltage-controlled attenuator (VCA); and random voltage generator.

The noise source (*Q7*) is built around a reverse biased pn junction operating above its breakdown potential. The shot noise resulting from the avalanche breakdown mechanism is amplified by *Q8*.

Control voltages for the VCF and VCA originate in the random voltage generator which consists of three astable multi-vibrators (*Q1*-*Q6*) running at different rates and with different duty factors. The three outputs are summed and appear across *R18*. While the voltage across *R18* is to a certain extent random, it is weighted by the different periods and duty factors of the astables and the different values of the summing resistor to approximate the "roll" of the ocean.

If there is a secret to the Surf Synthesizer, it is in the VCF (*D1*). When the VCA is disabled and only the VCF is operating, the sound is close to that of the surf

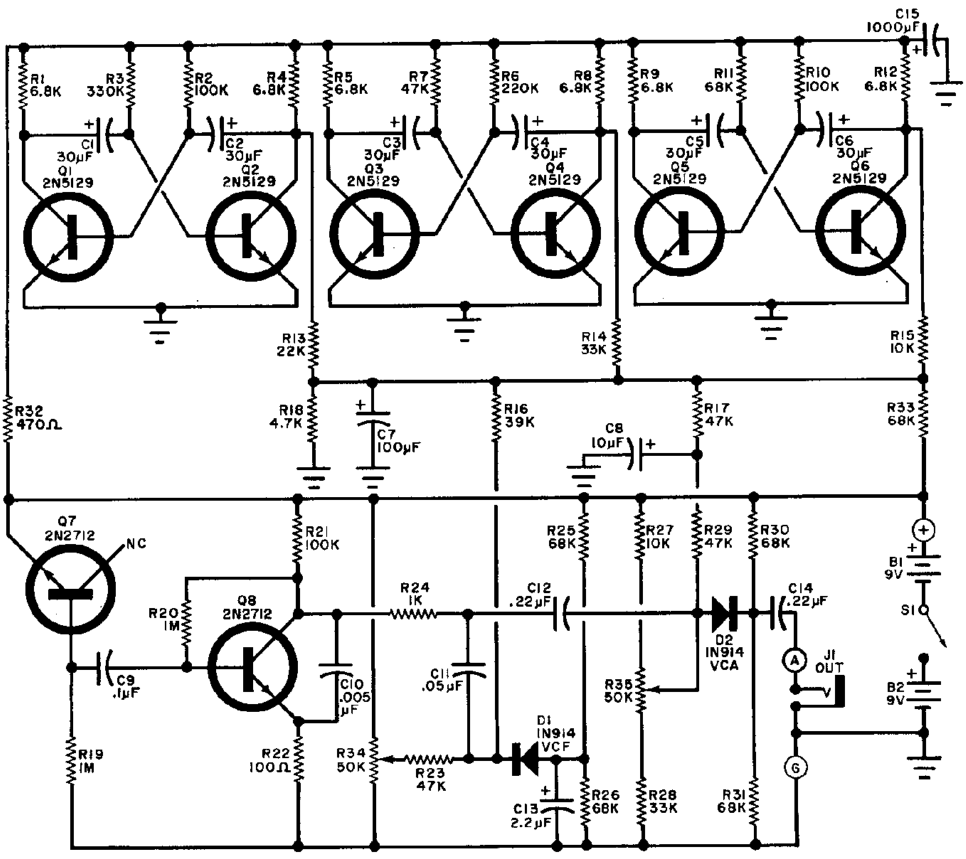


Fig. 1. The three astable multivibrators develop a composite voltage that controls both the voltage-controlled filter (VCF) and the voltage-controlled attenuator (VCA) to form the sound of the surf.

PARTS LIST

B1,B2—9-volt battery
C1-C6—30-μF, 10-volt electrolytic capacitor
C7—100-μF, 16-volt electrolyic capacitor
C8—10-μF, 10-volt electrolytic capacitor
C9—0.1-μF disc capacitor
C10—0.005-μF disc capacitor
C11—0.05-μF disc capacitor
C12,C14—0.22-μF Mylar capacitor
C13—2.2μF, 16-volt electrolytic capacitor
C15—1000-μF, 10-volt electrolytic capacitor
D1,D2—1N94 diode (or similar)
Q1-Q6—2N5129 transistor
Q7,Q8—2N2712 transistor
R1,R4,R5,R8,R9,R12—6800-ohm, ½-watt resistor
R2,R10,R21—100,000-ohm, ½-watt resistor
*R3—330,000-ohm, ½-watt resistor**
R6—220,000-ohm, ½-watt resistor
R7,R17,R23,R29—47,000-ohm, ½-watt resistor
R11,R25,R26,R30,R31,R33—68,000-ohm, ½-watt resistor
R13—22,000-ohm, ½-watt resistor
*R14,R28—33,000-ohm, ½-watt resistor**
*R15,R27—10,000-ohm, ½-watt resistor**
R16—39,000-ohm, ½-watt resistor
R18—4700-ohm, ½-watt resistor
R19,R20—1-megohm, ½-watt resistor
R22—100-ohm, ½-watt resistor
R-24—1000-ohm, ½-watt resistor
R32—470-ohm, ½-watt resistor
R34,R35—50,000-ohm trimmer potentiometer
S1—Spst switch
Misc.—Case, battery connectors, battery clamps, output jack, wire, solder, hardware, etc.
Note—The following are available from PAIA Electronics, P.O. Box 14359, Oklahoma City, OK 73116: etched circuit board #3711pc at $3.00 postpaid; kit of parts with circuit board and selected transistor for Q7, but less batteries and case #3711K at $10.95 plus postage for 1 lb; case #3711C at $2.50 with kit order.

**If the surf sound is not natural enough, try changing R3 to 270,000 ohms, R14 to 22,000 and R15 to 15,000.*

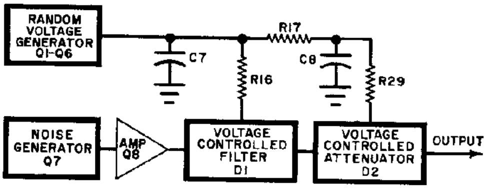
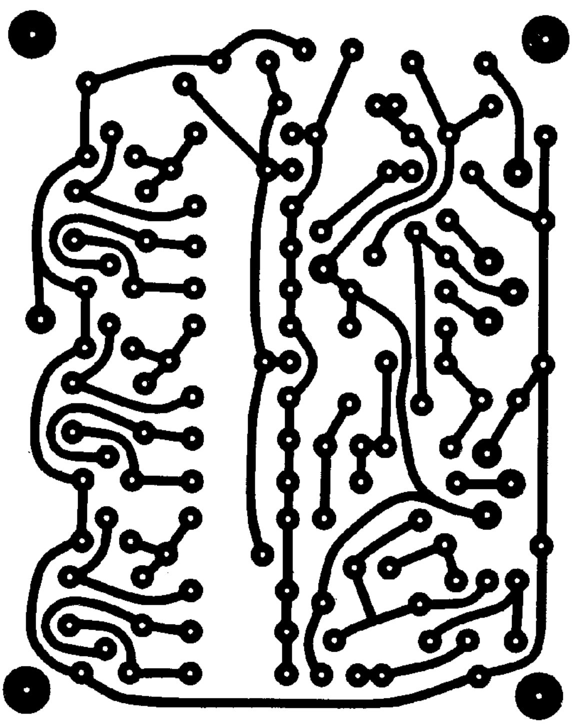


Fig. 2. Block diagram shows how random signal is filtered and level controlled by integrated random voltages from three sets of multivibrators.

even though there is no amplitude change. If, on the other hand, the VCA is working alone, the result only sounds like interstation radio static fading in and out.

The VCF uses the nonlinear V-I characteristic of a conventional silicon diode as a voltage-controlled resistor. By proper adjustment of *R34*, diode *D1* is ordinarily forward biased, resulting in a loss of high frequencies through *C11*, *D1*, and *C13*. As the control voltage of the VCF increases, it reverse biases *D1* and allows less high-frequency loss to ground. The high frequencies not shunted to ground naturally become part of the output signal.

The operation of the VCA is similar to that of the VCF. Diode *D2* is in series with the signal and is slightly reverse biased by *R35*. As the control voltage applied to the anode of *D2* increases, its effective resistance becomes less, allowing more signal to pass. Capacitor *C12* blocks dc from the VCF and does not noticeably contribute to the overall frequency response.

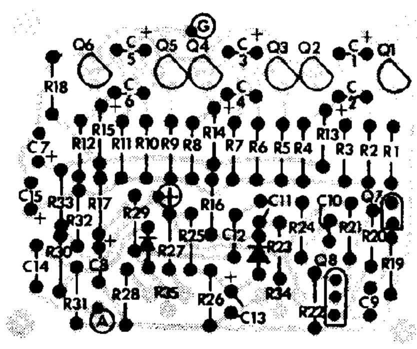


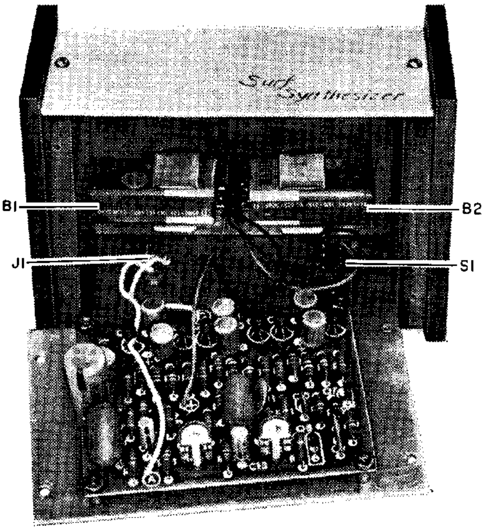
Construction. Since there are no very high frequencies involved and parts placement is not critical, any method of construction may be used. An etched circuit board will make the job easier, however. If you decide to use a board, the foil pattern is given in Fig. 3. Component layout is also shown in Fig. 3. Leave transistors *Q7* and *Q8* till the last; their selection and installation are explained later. Be sure to get polarized components properly installed and use a heat sink on the semiconductor leads when soldering. In fact, it is good practice to save the installation of all semiconductors for last so that the heat from soldering adjacent components does not damage them.

When all of the components except *Q7* and *Q8* have been installed, connect the positive lead of one of the battery connectors to the circuit board point marked "+" and the negative lead of the other to point "G". Solder the remaining lead from each connector to either side of switch *S1*. Also connect the output jack to points "A" and "G" with wires that will be long enough to reach from the location of the jack to the circuit board when it is installed in the case.

To select *Q7* and *Q8*, remember that not every 2N2712 breaks down when its base-emitter junction is reverse biased with 18 volts. However a piece-by-piece survey of over 5000 transistors indicated that approx-

Fig. 3. Actual size foil pattern and component layout. Take care when installing semiconductors, diodes, etc. See text before installing Q7 and Q8.





Interior view of author's prototype shows method of mounting boards and location of both of the batteries.

imately 80% of them were suitable for use as a noise source. Since two of these transistors are used in the synthesizer, there's a good chance that one can be used for *Q7*. Arbitrarily select *Q7* and *Q8* and lightly solder them in place. Note that the collector of *Q7* is not connected to any point in the circuit. Rotate *R34* and *R35* fully clockwise as viewed from the nearest edge of the board. Run a jumper from the output jack to the low-level input of a hi-fi or instrument amplifier and adjust the amplifier's gain about midway. Install two 9-volt batteries in the Synthesizer and turn on *S1*. You should hear a rushing sound from the amplifier. If you don't, unsolder *Q7* and *Q8* (being careful to avoid overheating) and interchange them. When you are sure that *Q7* has been properly selected, solder it and *Q8* permanently in place.

This is a good time to check the voltages at the collectors of *Q2*, *Q4*, and *Q6* to make sure that all three astables are operating. Use any VTVM set to a 20-to-25-volt scale. The voltage on the collector should go from about ½ to 17 volts and have a period of several seconds.

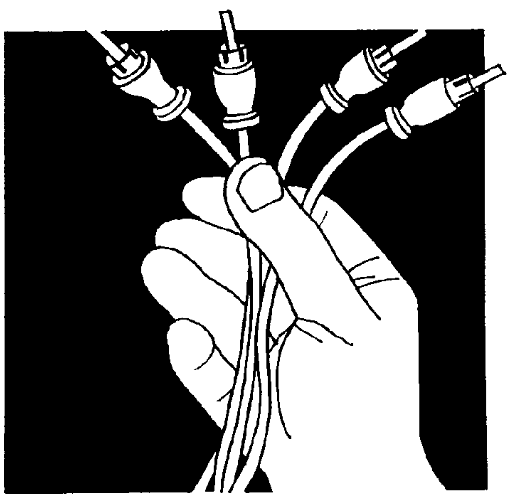
The Surf Synthesizer may be housed in any convenient case. In the prototype, the case was made of sheet aluminum folded into a U measuring about 5" x 2½" x 3¼". The ends of the U were sealed with walnut blocks having a rabbet cut around each edge. The ends are held in place by #4 wood screws through the aluminum. Holes were cut in the back of the case to provide clearance for the output jack and the power switch. The battery clips were glued to the top of the channel.

The circuit board was fastened to the aluminum bottom plate with 4-40 hardware and ¾" standoffs. The bottom plate was fastened to the wooden ends with #4 screws.

Setup and Operation. The only adjustments to be made on the Surf Synthesizer are the settings of *R34* and *R35*. While these settings are largely a matter of personal preference, a couple of tips will get you started.

Connect the Synthesizer to an amplifier and turn both on. With *R35* set fully clockwise, adjust *R34* for the widest and most natural sounding tone changes. When you are satisfied with the adjustment of the tone control, you can set *R35* for volume changes. You will probably find that the most natural sound results when the Synthesizer is completely muted for short periods of time. There is little electrical interaction between *R35* and *R34*, but it will probably take some twiddling before you are completely satisfied with their adjustments.

Bear in mind that the quality of the amplifier used with the Synthesizer will greatly affect the final sound. Use an amplifier with the best bass response available so that the "roar" of the surf can be heard as well as the crescendo-like crash as the waves break. It will probably be necessary to advance the bass boost of the amplifier to achieve a really natural sound. ◈



Getting "Surf" From Synthesizer

After assembling the Surf Synthesizer (Feb 1972), I ventured to the Pacific Ocean along the Mexican coast to listen. Guess what? The real ocean (at least there) doesn't sound like the synthesized ocean. The real ocean's cycles are longer and, as the foam breaks on the beach, the hiss has a different roar/rumble characteristic. The PAIA circuit also produces a "pop" every two minutes or so as the flip-flops get synchronized at their switching points.

To eliminate the pop, lengthen the cycles and produce higher hiss tones from my Synthesizer, I made the following changes: I reversed D1 first. Then I substituted 270 k, 33 k, 160 k, 22 k, 560, and 22 k values in place of those called for in the Parts List for R3, R13, R7, R14, R11, and R15, respectively. Finally I changed the value of C3 from 30 μF to 8 μF. Now, the sound from the Synthesizer sounds more like the real thing .

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