Build THE SURFER

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Psycho-acoustic device simulates sound of surf, gentle rain, or white noise to provide tranquil background for sleep, study or concentration.

IT IS WELL known that certain naturally occurring sounds can help us to relax, to study, and to concentrate. Among the more familiar of these are the sounds of the surf, rain, and white noise (as when you cup a seashell or a drinking glass to your ear). The "Surfer" is a simple electronic device that can generate all three of these pleasant, tranquil sounds at the flip of a switch. You can use the Surfer to set just the right mood for falling off to sleep, studying, or concentrating simply by setting the selector switch to the appropriate sound position.

About the Circuit. Transistor *Q1* in Fig. 1 serves as a white-noise source by virtue of its being operated in the reverse-bias breakdown mode. The "white-noise" signal is generated across *R2* and is amplified by *Q2*, whose high-frequency rolloff is determined by *C3* (and *C5* when *S1* is in the SURF position). With *S1* set to SURF, *Q3* has two inputs. One is the white-noise signal from *Q2* and the other is determined by the light intensity from *I1* falling on photocell *PC1*. As the intensity of light from *I1* varies, the bias on *Q3* is shifted which, in effect, amplitude modulates the white-noise signal. Trimmer potentiometer *R9* can be adjusted to prevent the white noise from being cut off.

When *S1* is set to RAIN, *PC1* is out of the *Q3* input circuit. This causes *Q3* to function as a conventional emitter-follower stage. The white noise at the emitter of *Q3* is passed through *R11* and VOLUME control *R12* for amplification by *IC1*. The circuit and its operation remain the same when *S1* is set to NOISE, except that, in this mode, limiting resistor *R11* is bypassed.

Photocell *PC2*, which is also illuminated by *I1*, and capacitors *C8*, *C9*, and *C10* form a nonlinear high-cut tone control circuit whose high-frequency attenuation is proportional to the light intensity that illuminates *PC2*.

The period of relaxation oscillator *Q6* is determined by the values of *C16* and the preset value of potentiometer *R20*. The interval controlled by *R20* can be adjusted between 7 and 35 seconds.

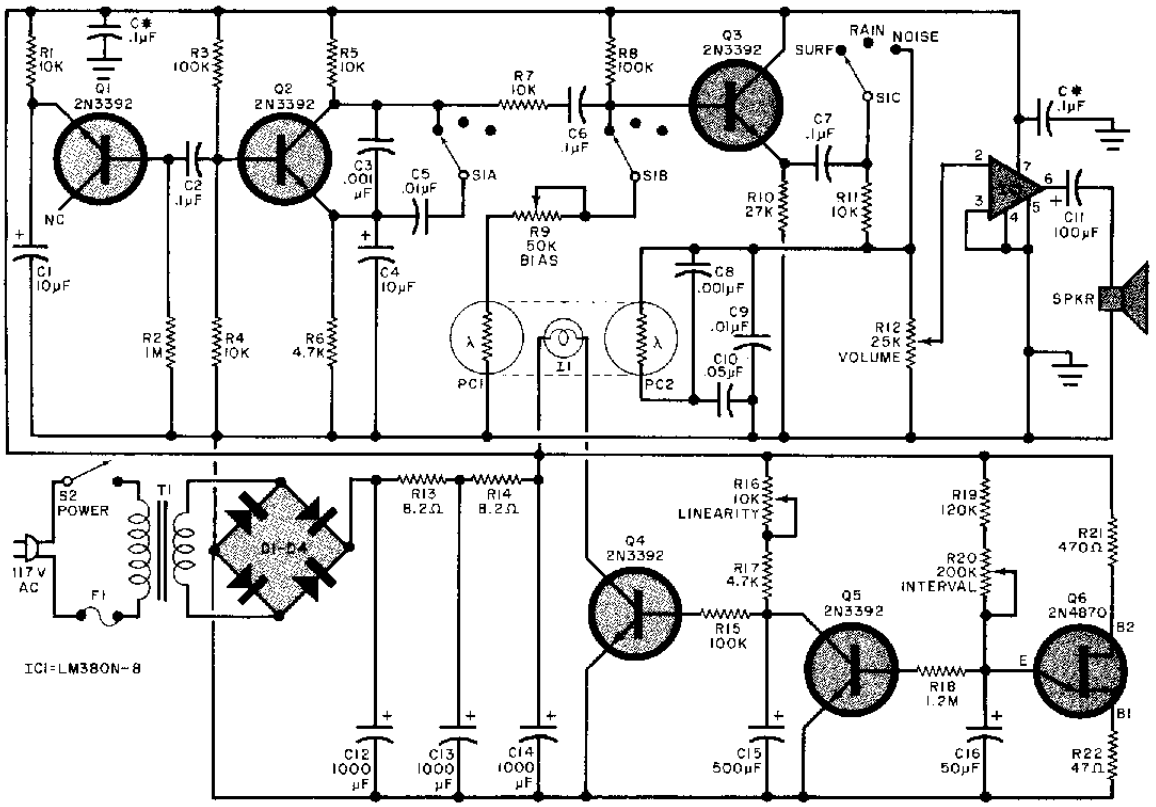


Fig. 1. White noise generated in Q1 is amplitude-modulated and filtered to produce different sounds.

PARTS LIST FOR FIG. 1

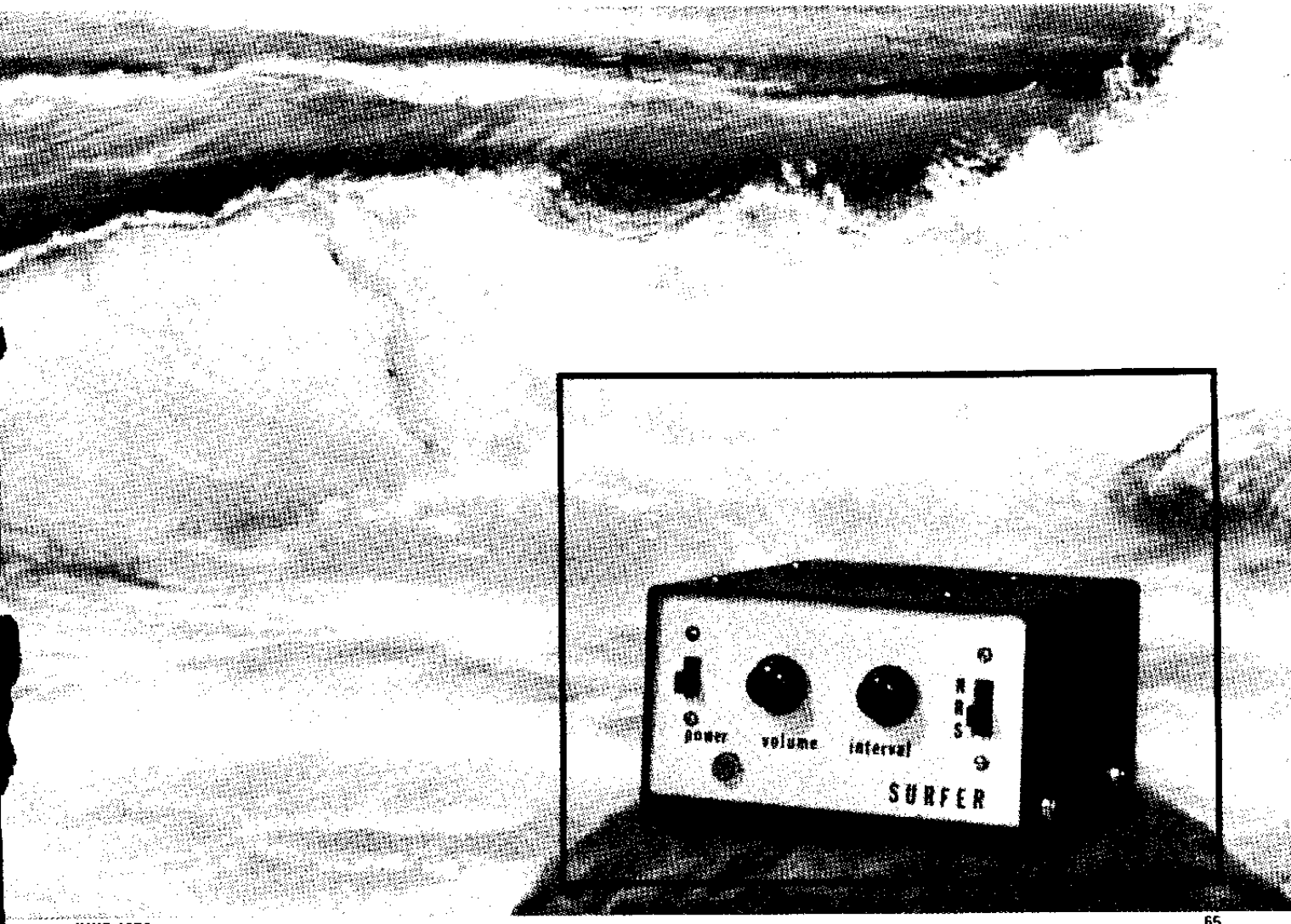
C1,C4—10-μF, 25-volt electrolytic
C2,C6,C7—0.1-μF disc capacitor
C3,C8—0.001-μF disc capacitor
C5,C9—0.01-μF disc capacitor
C10—0.05-μF disc capacitor
C11—100-μF, 25-volt electrolytic
C12,C13,C14—1000-μF, 25-V electrolytic
C15—500-μF, 25-V electrolytic
C16—50-μF, 25-V electrolytic
C*—0.1-μF capacitor (see text)
D1 through D4—1N4001 rectifier diode
F1—¼-ampere fuse and holder
I1—#1869 miniature lamp (10 V, 0.014 A, with wire leads)
IC1—LM380CN (National) or similar audio amplifier
PC1,PC2—Photoresistive cell with 5-megohm dark and 15,000-ohm light resistances (Clairex No. CL702L or Vactec No. VT322L)
Q1 through Q5—2N3392 transistor
Q6—2N4870 unijunction transistor
The following resistors are ¼-watt, 10%:
R1,R4,R5,R7,R11—10,000 ohms
R2—1 megohm
R3,R8,R15—100,000 ohms
R6,R17—4700 ohms
R10—27,000 ohms
R13,R14—8.2 ohms
R18—1.2 megohms
R19—120,000 ohms
R21—470 ohms
R22—47 ohms
R9—50,000-ohm trimmer potentiometer
R12—25,000-ohm audio-taper potentiometer
R16—10,000-ohm trimmer potentiometer
R20—200,000-ohm linear-taper potentiometer
S1—3-pole, 3-position nonshorting slide or rotary switch
S2—Spst switch
SPKR—8- or 16-ohm loudspeaker (see text)
T1—12.6-volt, 300-mA transformer
Misc.—Metal chassis box; line cord; materials for light shield (see text); rubber grommet; spacers; machine hardware; hookup wire; solder; etc.

The waveform present at the emitter of *Q6* is directly coupled to buffer/amplifier *Q5*, whose *C15/R16/R17* output circuit linearizes the signal before it is applied to lamp driver *Q4*.

Typical waveforms for the circuit are shown in Fig. 2. The upper waveform is present at the emitter of *Q6* when *R20* is set for a period of 17 seconds. The next waveform down illustrates the voltage at the collector of *Q4* after waveshaping by the *Q5* buffer stage. The inverse of this waveform is the voltage across *I1*. The third and fourth traces illustrate the outputs of the *Q1* white-noise source and *IC1*, respectively. Note that the output of *Q1* is a constant 10 mV, while the output of *IC1* varies between 100 and 400 mV. This amplitude variation is the result of the varying bias on *Q3* caused by the *I1/PC1* system.

Construction. There is nothing critical about circuit layout and you can use any wiring scheme you prefer. If you want printed-circuit board construction, you can make your own pc board using the etching-and-drilling guide shown in Fig. 3, which also contains component-installation instructions.

Lamp *I1* and photocells *PC1* and *PC2* must be mounted close together and shielded from outside light. Mount *I1* vertically with *PC1* and *PC2* on opposite sides of it so that they receive equal illumination. (Once the circuit is adjusted,



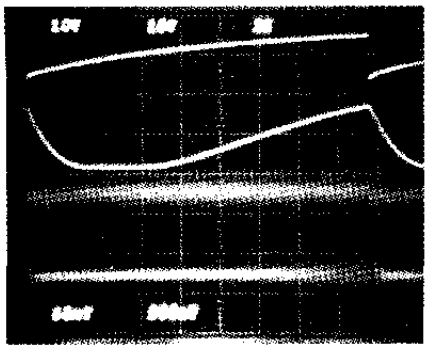
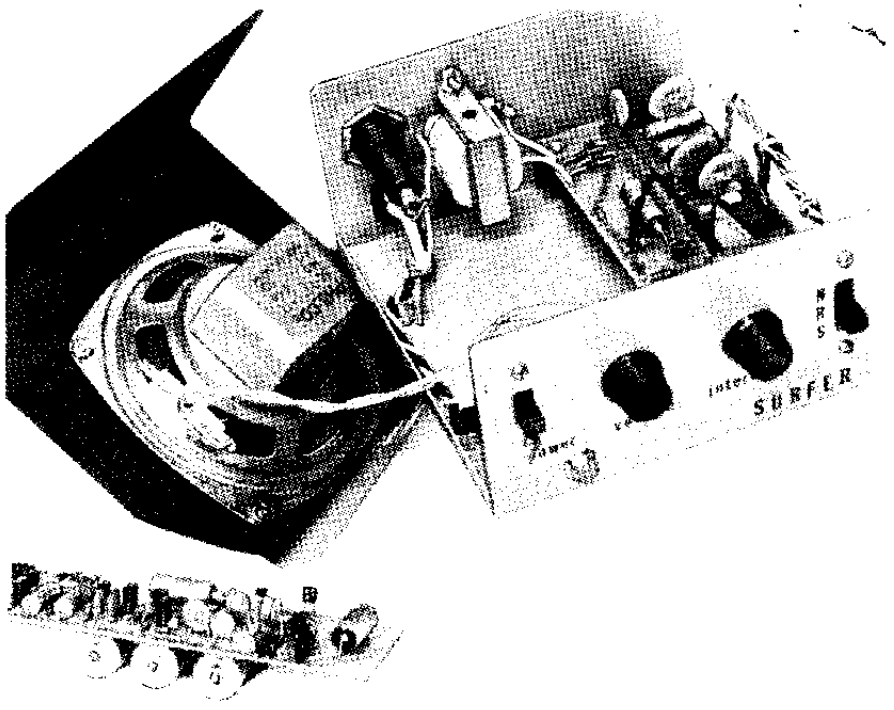
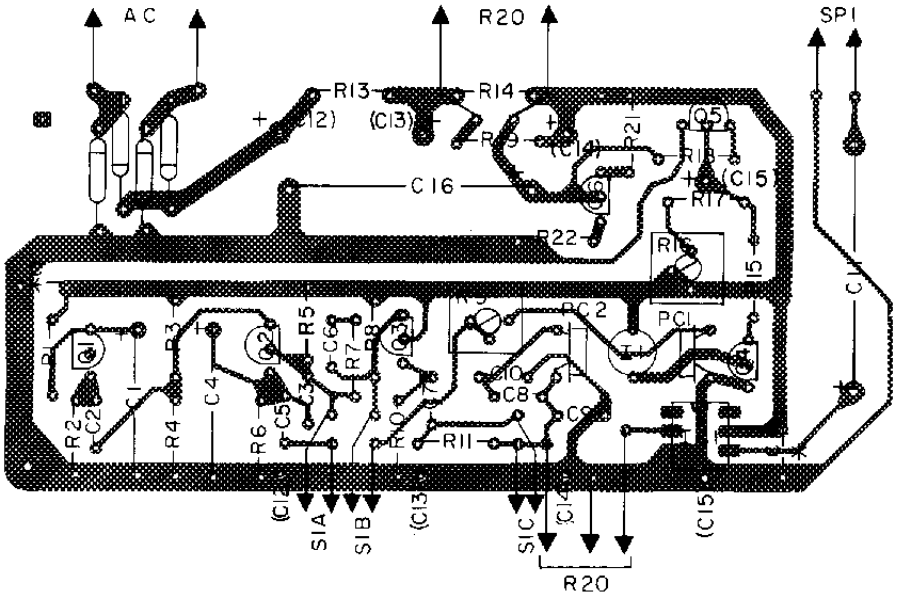


Fig. 2. Circuit waveforms show, at top, output of UJT; and, below that, collector of Q4 after waveshaping. Next two traces are white noise. One from Q1 at 10 mV and, at bottom, final audio output, with swing from 100 to 400 millivolts.



Printed circuit board is mounted on spacers in metal enclosure with T1, fuseholder and line cord on rear apron.



opaque tape or cardboard tubing can be used to make a light shield to exclude external light.

Note that there are two capacitors identified by asterisks (*). One of these decoupling capacitors must be mounted as close as possible to pin 7 of *IC1*, while the other should be mounted as close as possible to the positive end of *R1*. If you use the pc board pattern shown in Fig. 3, *C12*, *C13*, *C14*, and *C15* go on the *foil* side of the board and should be the last components installed.

The quality of the loudspeaker used in the circuit is a significant factor in performance. The maximum output power from *IC1* is about 0.5 watt into 8 ohms. Needless to say, do not use a 4-ohm speaker because it can damage *IC1*. A

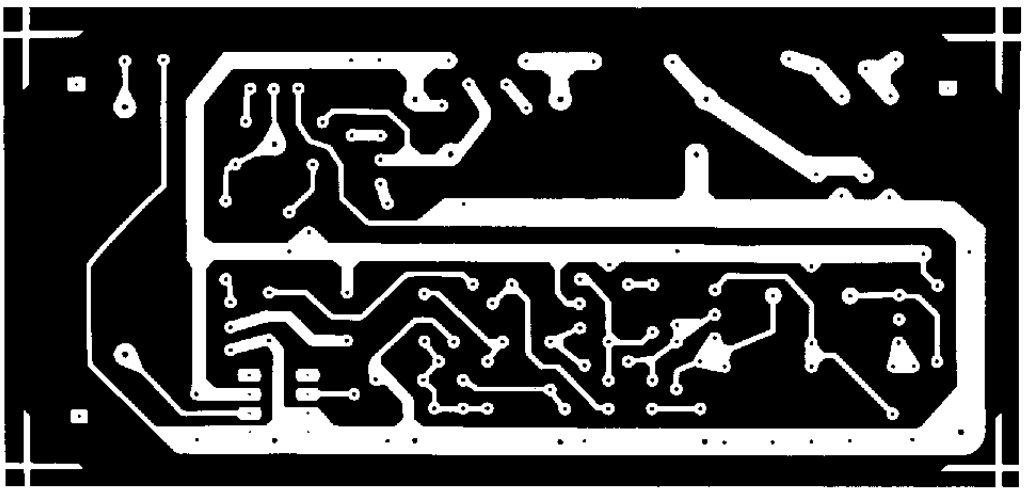


Fig. 3. Actual-size foil pattern is at left, with component placement above. Capacitors C12, C13, C14 and C15 are mounted on foil side.

good choice is a 4" to 6" (10.2 to 15.2 cm) high-compliance, high-fidelity quality loudspeaker with an 8- or 16-ohm impedance.

With *Q1* operated in the manner shown, it is susceptible to detecting r-f. Hence, the circuit should be housed in a metal box and the common bus on the pc board electrically connected to the box. The pc board assembly mounts in place with spacers and machine hardware. POWER switch *S2*, VOLUME control *R12*, INTERVAL control *R20*, and SELECTOR switch *S1* mount on the front panel. Transformer *T1* and the holder for fuse *F1* can be mounted on the rear of the box. Also, the line cord for the project should enter the box through a grommet-lined hole in the rear panel.

Adjustment and Operation. Two simple adjustments are required to get the Surfer into proper operating order. Set trimmer pots *R9* and *R16* to their centers of rotation, set the VOLUME control fully clockwise (maximum volume), and set *S1* to the SURF position. Now, apply power and set the INTERVAL control for a period of about 25 seconds. Adjust *R16* so that *I1* extinguishes about a second before the end of the cycle. Wait several cycles and then check *R16* again and readjust it if necessary. Once *R16* is adjusted, place the shield over the lamp/photocell assembly.

Set the VOLUME control to its center of rotation. Then adjust trimmer pot *R9* until the sound is just barely audible at the beginning of the cycle. This completes adjustments.

During operation, when *S1* is set to SURF, *C5* (see Fig. 1) produces the maximum high-frequency rolloff and *PC1* is connected to the base of *Q3*. This produces a roaring sound that changes in intensity and tone. In the RAIN position of *S1*, maximum high-frequency attenuation occurs with no amplitude modulation. This creates a constant-volume "hiss" whose tone varies. When *S1* is in the NOISE position, *R11* is shorted out, which causes the tone control to lose its effectiveness. In general, a long interval is best for the SURF function, while a short interval is best for RAIN.

The Surfer is not intended to be used as a sound-effects generator to which one consciously listens. Rather, it is meant to provide a nondistracting background of sounds. Best effects are created when the Surfer is positioned 6' (1.8 m) or more from the listener with the VOLUME adjusted so that the sound is barely audible. ◇