ELECTRONIC ENGINEERING EXPERTISE AND ARTISTIC TALENT TEAM UP TO GIVE MUSIC AN EXCITING NEW DIMENSION

THE ART AND TECHNOLOGY

MOST people associate the word "synthetic" with "fake" and conjure up ideas of inferior versions of the genuine article. Perhaps it is only natural, then, that many people do not consider music synthesizers and their electronically produced sounds a legitimate part of real music. Electronic music has, admittedly, undergone rather gimmicky stages of development, but that is all over now. Today's sophisticated music synthesizers leave their gimmicky predecessors behind and take an important place in the evolution of legitimate music.

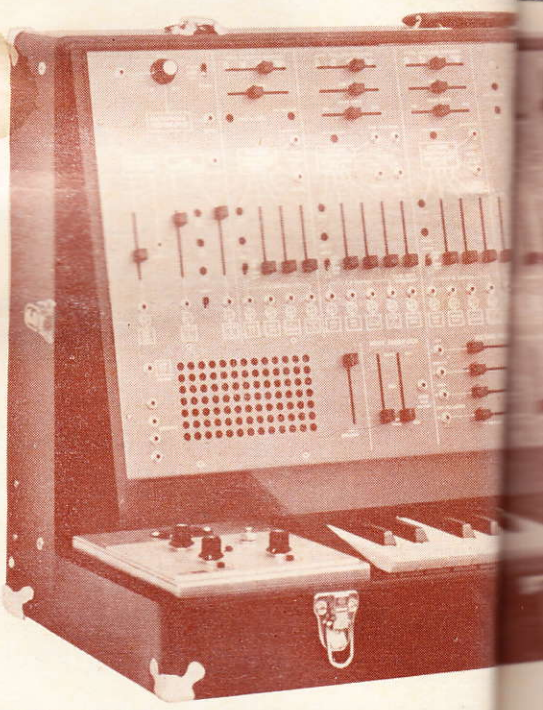
Music synthesizers are especially noted for the variety of sounds they can assemble or synthesize. A skilled performer can mix together a handful of basic tones to make the instrument mimic familiar sounds, including those of other musical instruments. Some of the sounds may not be very musical in the usual sense. But just how "unmusical" they sound depends upon the performer's artistic talent and the listener's personal tastes.

A good performer can make a synthesizer sound like a cathedral organ one moment; and then by changing some plugs and dials, he can make it sound like someone walking across a gymnasium floor in wet sneakers. Then, of course, there are the unlimited number of unfamiliar sounds—too strange to describe—that are possible with the music synthesizer.

An Awesome Experience. The neophyte who sits down at a synthesizer console for the first time, is in for an awesome experience. Seeing all those dials, switches, wires, and plugs can make him feel inadequate. The tendency when approaching a synthesizer is to equate it with familiar musical instruments. And it is this attitude that can defeat a beginner at the outset.

With a piano, the musician has a choice of one out of 88 notes to play. He can start anywhere and, with one finger, fumble out a tune. But it is different when he is sitting at a music synthesizer console where the choices of things to do first are virtually infinite in number. What is more, while the piano is ready to play immediately, the synthesizer must first be prepared to play. The proper combination of switches must be thrown, dials have to be turned, and patch cords have to be plugged in. Only then will the synthesizer condescend to utter a peep.

Playing a music synthesizer probably will not always be as difficult as it is now. This



new art/technology wedding is still new. Hence, it is constantly being improved. But even if the mechanical and electrical bugs are ironed out tomorrow, there will remain a major obstacle: How does one write a musical score for an instrument that does not fit the mold of traditional musical instruments? The little black notes that have served musicians fairly well for centuries cannot begin to manage the task of com-

BY DAVID L. HEISERMAN

municating an electronic sound no one has ever heard before.

From a performer's viewpoint, present-day music synthesizers have two technical drawbacks. First, most can produce only one particular note at a time. And, second, they can produce only one particular tonal quality at a time. Unlike a piano player who can play up to ten notes simultaneously, and run through an entire composition without stopping, a synthetic music performer can generally play only "one-finger" music and, whenever he wants to change the tonal quality of the notes, he must stop the music and reprogram the instrument.

Portable synthesizer made by ARP Instruments (Div. of Tonus Inc.)

Because of this stopping and starting, a tape recorder is a vital part of the synthetic music studio. The performer records a segment of his composition, stops the recorder, patches a new sound into the synthesizer, then records the next segment. After completing the recording session, playing the tape straight through gives the impression that the sequences of sounds flow smoothly from one to the next. At this point, though, the music still sounds like a shallow one-finger melody.

Just as the tape recorder can take care of pauses for reprogramming the sound, so, too, can it make one synthesizer sound like four instruments. By using a four-channel tape recorder, the performer records his basic one-finger melody on the first track. After that, he fills in the other three tracks, one at a time, with the desired background, harmony, and rhythm. It is the same old trick that can make one singer sound like a quartet.

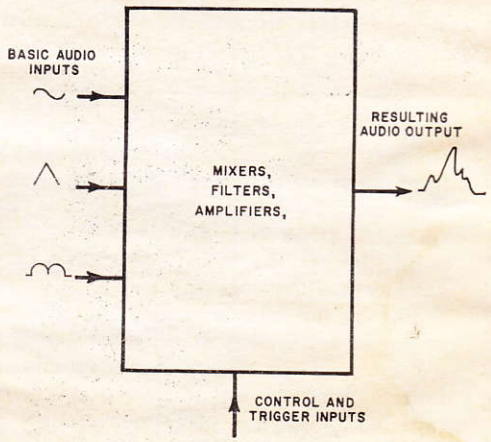
So, the serious composer and solo performer finds that a four-channel tape recorder is just as important as the synthesizer itself. Several groups of accomplished performers, however, have been touring the country with live synthesizer concerts. By using three or four performers and synthesizers on stage, one or two of them can be playing while the others reprogram and tune their synthesizers to pick up the music when the others come to the end of a certain sound segment.

From an economic point of view, music synthesizers are very expensive. Professional instruments bear price tags starting at about $2000. By adding desirable extras and a good tape recorder, the cost of setting up a decent studio quickly runs over the $8000 mark. This, combined with the fact that few people have the expertise to handle the synthesizer properly, keeps the systems out of the hands of the general public.

In spite of the drawbacks inherent in present-day synthesizers, they are exerting a powerful influence on the evolution of modern music. As the art and technology of synthetic music progresses, music synthesizers promise to become as popular as the piano.

How Synthesizers Work. It is the har-

OF ELECTRONIC MUSIC



Basic synthesizer scheme shows audio inputs combined into complex output. Performer controls the final outcome.

monic structure of the sound from a violin that makes it distinctively recognizable from the sound of a clarinet. In the music synthesizer, all sounds that emerge begin from a number of basic tones. By running these tones through electronic mixers, filters, and amplifiers, a performer can juggle the harmonic structure of an electrical waveform to make it produce just about any kind of sound he chooses.

Music synthesizers generate three different kinds of electrical signals: audio signals, control signals, and trigger signals. The audio signals eventually emerge from the system as sounds. Control signals vary the audio signals to make them change loudness, pitch or quality. The performer can do these things manually, but it is easier and more convenient to let control voltages do the job. The trigger signals begin and end control sequences according to a preset program. Again, the performer could perform the trigger operations manually, but an electronic trigger circuit does the job better.

Most synthesizers get their basic audio tones from a set of tone oscillators and a noise generator. Each of the tone oscillators produces one note at a time, while the noise generator produces a wide range of frequencies at once, the result sounds like pure static.

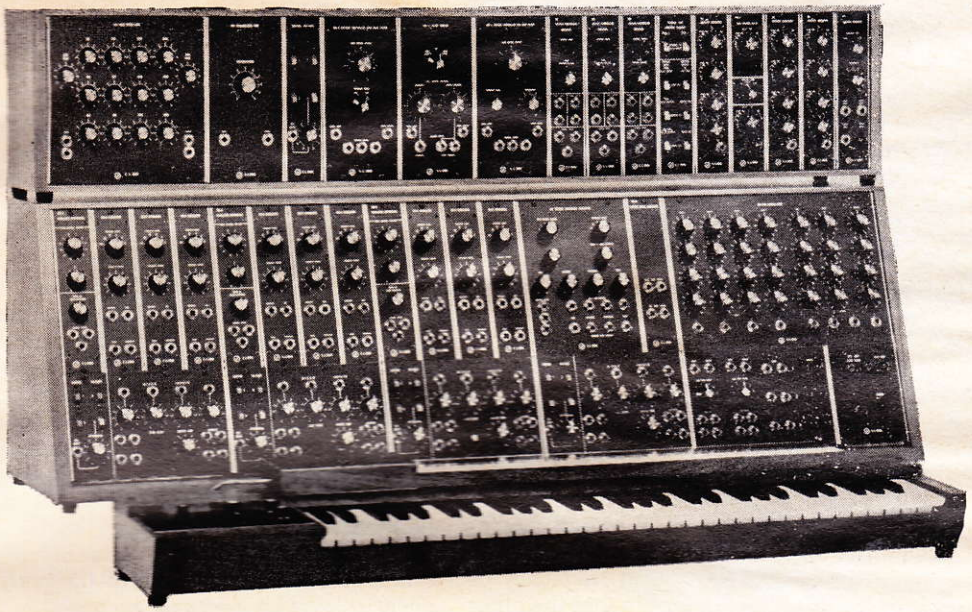
Larger music synthesizers have four or more identical tone oscillator modules in them. Each oscillator has a manual control that can be used to adjust the output frequency. These oscillators also have voltage control inputs to accommodate output frequency control by means of a voltage from some external source. Typical frequency ranges for the audio tone oscillators run between 2 and 30,000 Hz.

These oscillators have separate output jacks or selector switches for sinusoidal, rectangular, sawtooth, and triangular waveforms. The different outputs give the operator a choice of four basic tonal qualities from each oscillator. The sinusoidal waveform produces a pure sound much like that from a tuning fork. Rectangular waveforms produce one basic tone, too; but it sounds rather raspy because the sharp rising and falling edges contain a large number of high frequency harmonics. The sawtooth waveforms have a lot of raspy-sounding harmonics only on one edge. Finally, the triangular waveform produces basic notes that have a quality somewhere between that of a sine wave and a rectangular pulse.

A performer can change frequency from an audio tone oscillator without stopping the flow of music. Whenever a change is desired in the basic waveform, however, the operation must be stopped long enough to patch in a different waveform or to turn a selector switch.

The noise generator produces mixed-up frequencies that cover the entire audio spectrum. This "white noise" has a hissing quality. By means of filter circuits, all but one narrow section of the spectrum can be wiped out, producing a "pink noise." Pink noise sounds like static, too; but it has a dominant frequency that slices through. It sounds something like wind whistling through tree branches. The operator has complete control

Ionic Industries' "Putney" model has a joy stick to let the performer control two different kinds of functions at once. Keyboard is also available.



The Model IIIc synthesizer, made by R. A. Moog, is perhaps the most versatile, sophisticated, and well-known system that is on the markey today.

over the loudness and dominant frequency of the pink noise.

While it is possible to vary the frequency and output level of the audio tone signal sources manually, it is far more convenient to let control signals do most of the work. The various kinds of control signal sources produce voltages that can change the operating frequencies of a tone oscillator. And, by feeding the control voltages to special voltage-controlled amplifiers, it is also possible to vary the loudness of the audio signals.

Devices that generate the control signals include a 4-octave keyboard, ribbon controller, envelope generator circuit, foot pedal, and joy stick. Most synthesizers come equipped with at least one built-in envelope generator module, and performers generally use at least one keyboard and a ribbon controller.

The musical keyboard of a synthesizer looks like a short piano keyboard. But the similarity stops at looks. Each key operates a switch connected to a long resistive voltage divider network. Operating one of the keys picks off a voltage from the divider and sends it to a keyboard output jack. The keyboard can be set up so that playing up the scale makes the keyboard generate stepwise increases in output voltage.

This keyboard output voltage can be patched into any of the voltage-controlled circuits in the system. After plugging the output into one of the V-C audio tone oscillators, for example, playing up the scale on the keyboard makes the synthesizer produce scale-like tones. Depressing the middle-C key on the keyboard, however, does not necessarily make the synthesizer produce a familiar middle-C note.

By adjusting a manual control on the oscillator module, any key on the keyboard can be made to produce just about any note desired. If desired, the performer can even patch the system so that playing up the scale on the keyboard makes the synthesizer produce a downward-going scale.

What is more, the frequency difference between two adjacent white keys need not be the familiar one-note difference. A control on the keyboard lets the performer adjust the frequency differences between keys.

The output of the keyboard can be connected to circuits other than the audio tone oscillators. By patching the keyboard to a mixer or filter module, it is possible to use the keyboard to change the harmonic structure of waveforms generated by other circuits. Or, the keyboard can be used as a stepwise volume control by patching it to one of the voltage-controlled amplifiers.

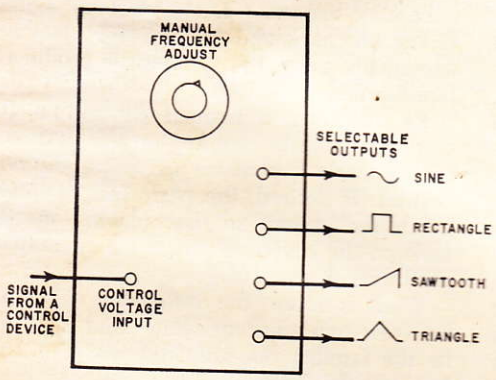
Thus, the keyboard for a music synthe-

sizer can perform many different functions. Perhaps it is a case of sentimentalism on the part of musically inclined engineers that a synthesizer's keyboard looks like an ordinary musical keyboard. There is actually no real reason why it should not look like a typewriter keyboard--and, in fact, it might be more useful if it did.

Another common control device, the ribbon controller, does about the same kinds of jobs as a keyboard. Instead of producing stepwise voltage changes, however, it produces continuous changes in output voltage. A ribbon controller works something like a potentiometer, and, by patching its output to a tone oscillator, it can be used to produce sweeping, theremin-like tones.

Optional control devices such as foot pedals and joy sticks work about the same way as a ribbon controller. A joy stick has the added advantage of being a two-dimensional controller. Moving the handle in one direction can vary the output frequency of a tone oscillator, while moving it in the other direction changes overall tonal quality. Moving it obliquely, it can produce degrees of both changes simultaneously.

Most of the control devices also generate a brief trigger signal whenever changes are made in the control voltage output. Every time a key is depressed, the keyboard circuits generate both a control voltage and a brief trigger voltage.



In audio tone oscillator, frequency of the output is adjusted by control knob or by use of an external signal.

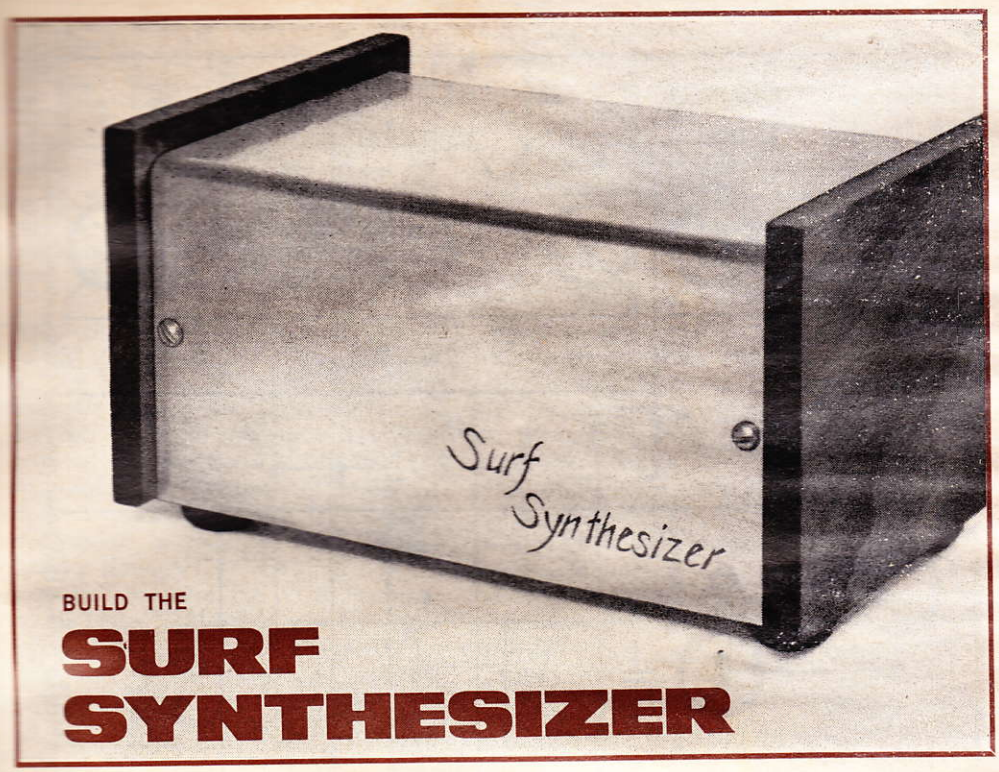
These trigger voltages can initiate other control operations, such as those performed by an envelope generator module. The envelope generator is capable of producing various control waveforms that can be used to adjust the attack, decay, and sustain level of a note. Instead of having every new note come on at full volume, for example, a patch cord, run between the envelop generator and one of the V-C amplifiers, can make the note sweep up in volume. Likewise, a note can be made to decay away slowly instead of decaying rapidly. By adjusting the contour setting on the envelope generator, a note can be made to sustain even after the player takes his hands off the keyboard.

Electronic mixers, audio amplifiers, and high-quality headphones and loudspeakers also play important roles in a music synthesizing system. A performer can make his instrument about as complex as his finances will allow. In general, the more add-ons he buys, the more versatile his instrument becomes. In the long run, though, it is actually the technical and artistic competence of the performer—not the complexity of the system—that determines the versatility of the synthesizer and the quality of the performance.

Synthesizers Vs. Composers. A performer at the console of a professional music synthesizer has complete control over every sound that comes from the system. In principle at least, he "plays" the system much the same way one plays an organ or piano. There is a growing number of electronic music "composers" appearing as construction projects and finished items in a few stores. These devices, costing about $50 for parts and about $300 for the finished item, are close relatives of the synthesizer.

Electronic music composers, however, do not synthesize different harmonic structures. Instead, they assemble different tonal patterns to produce strange sounding and sometimes pleasing melodies. By adjusting dials or switches, they can be made to produce an almost limitless number of different melodies that can run for years without repeating. In a sense, an electronic music composer works something like a player piano. Once the user sets the program, the instrument takes over all the work of producing the melodies.

Composers occupy an important place in modern elementary music classes, and they are fun to build and use. But an electronic music enthusiast should be aware of the fact that the versatility of an electronic music composer cannot even begin to approach that of its big brother, the professional music synthesizer. ◈



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

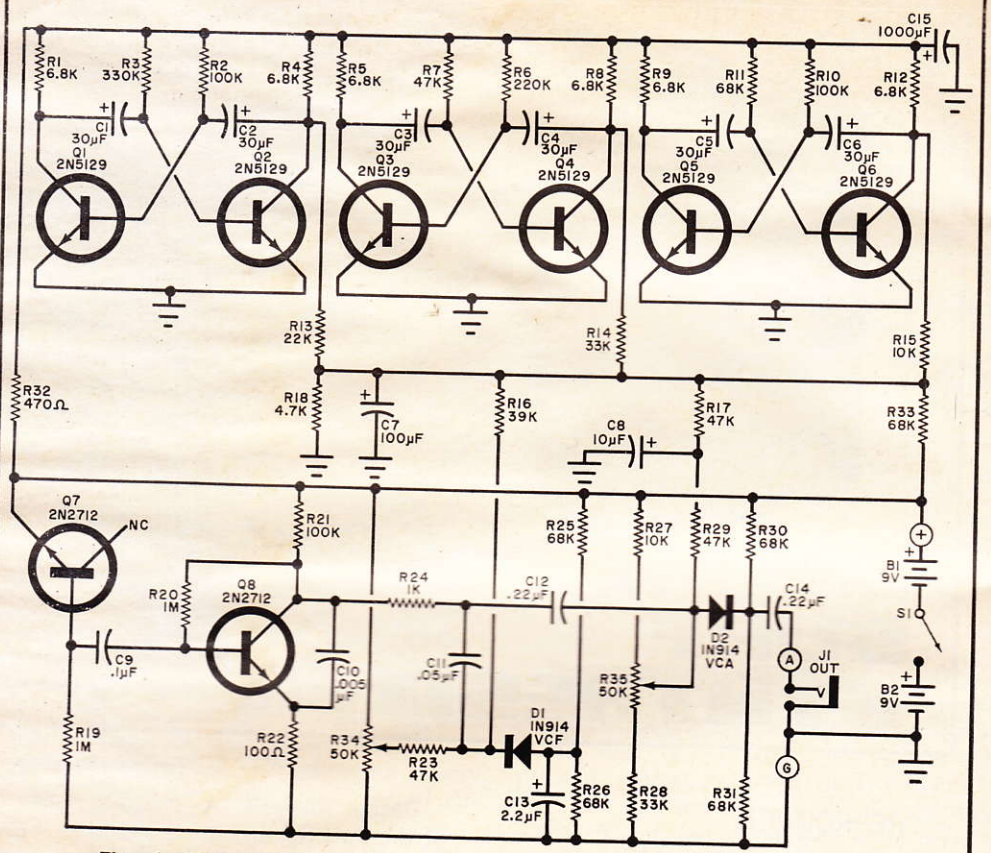


Fig. 1. The three astable multivibrators develop a composite voltage that controls both the voltage-controlled filter (VCF) and the voltage-controlled attenuator (VCA) to form the sound of the surf.

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.*