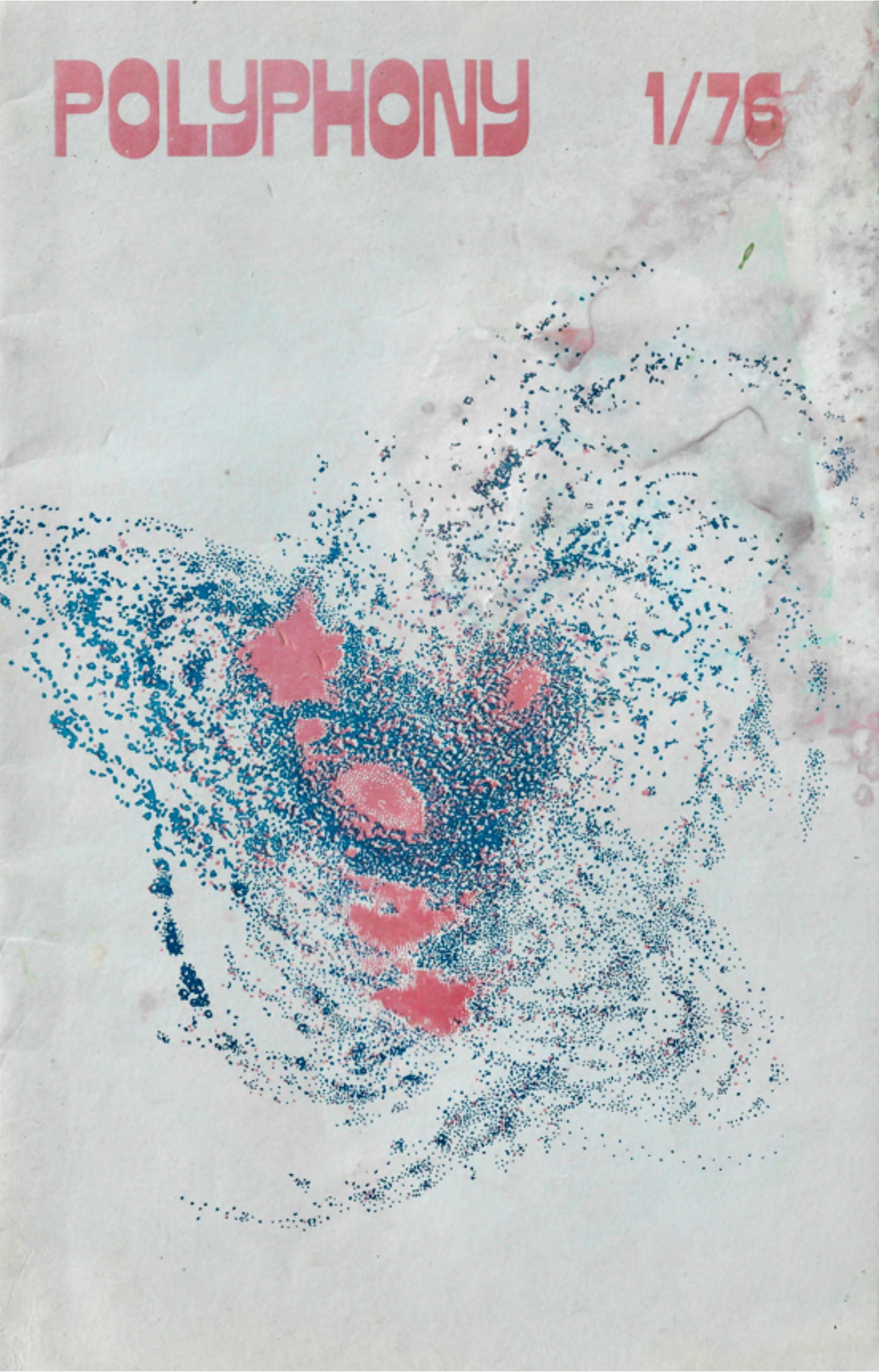
POLYPHONY 1/76



Editorial

During the course of answering my daily mail, I've noticed an expressed concern with obsolescence by owners of older synthesizer modules as new designs are released. For instance, those who were excited about the development of the 2720-2A are disappointed that they didn't know about the new 4720 super VCO; traveling musicians who own 2720-8 cases and now want to transfer to the 4761/4762 Road Cases. Now, wait a minute! Let's take a closer look, is there really a problem?

Foremost in our minds when designing new kits are (1) Providing advanced, state-of-the-art circuitry to do more things better for less and (2) makingsure that the resulting new products are compatible with ALL that has gone before so that our previous customers aren't left behind. Number two is what we are directly concerned with in this discussion. Most of you are aware of the things we do to insure compatibility. For example; standard module size insuring interchangeability and using the same power supply lines for all modules. It seems silly to us, but there are some companies who purposely design products that are incompatible with previous models. This supposedly promotes sales of new products, but we feel that this type of policy alienates the consumer.

Even though we are constantly developing newer, more elaborate things we take special steps to insure that PAIA's older products don't become obsolete. One of the first retro-fits that we made available was the 2720-9 Glide. We could have incorporated this modification in the 2720-8 Sample/Hold circuit, called it "The new, improved 2720-8A" and anyone who wanted Glide would have had to buy whole new keyboard electronics. But we didn't. We made a retro-fit available at minimal cost. A more recent example of this philosophy is the availability of a retro-fit model of the Road Cases.

As for the circuitry, the older, simpler modules do not become obsolete. In creating a near infinite number of voices using one instrument (which is what synthesis is all about) these less complicated circuits are well suited to the less complex nature of the sounds most often generated. As an example, oscillators are most often used in the audio mid-range. Sure, bass is used, but an orchestra of bass sounds muddy, heavy and overbearing. In the upper octaves of audibility (above 10 kHz.) the harmonic content of various waveforms is lost due to the limits of human hearing. Waveshaping cannot be heard and a concentration of voices in the upper octaves would sound like an orchestra of piccolos. Ouch! It hurts my ears to think of it! The point is that VCO's are primarily used in the audio mid-range and the time tested, less expensive 2720-2A VCO performs admirably in this area, serving 75% of the VCO applications of even the most advanced synthesizer. Don't get me wrong, the 4720 is good for those special super low and super high voicings, but there is no reason to replace all '-2A's with 4720's. In even the most bizarre, free form, purely electronic compositions and recordings most voicings are, by themselves, rather plain with more complex sounds added for frills, special effects or texture.

Now that we've bared our souls and shown you where our heads are at, I hope you understand that we see where your head is at! Many of us were customers before joining PAIA and moreover, many of us are musicians as well as technicians, designers, printers or whatever. We think that helps a lot and hope you do too.

On a closing note (E flat, I think) the response to the premier issue of POLYPHONY was outstanding, but don't slack off! There's always the next issue just waiting for neat goodies to be published. Don't sit around thinking that someone has already discovered your favorite patch or modification. Anything you have to say is welcomed here at PAIA, ANYTHING!

- Marvin Jones -

contents

FEATURES

COLUMNS

Marvin Jones Editor Linda Brumfield Editorial Assistant

John S. Simonton, Jr., CONTRIBUTING EDITOR

COVER GRAPHIC by: Ramona L. French

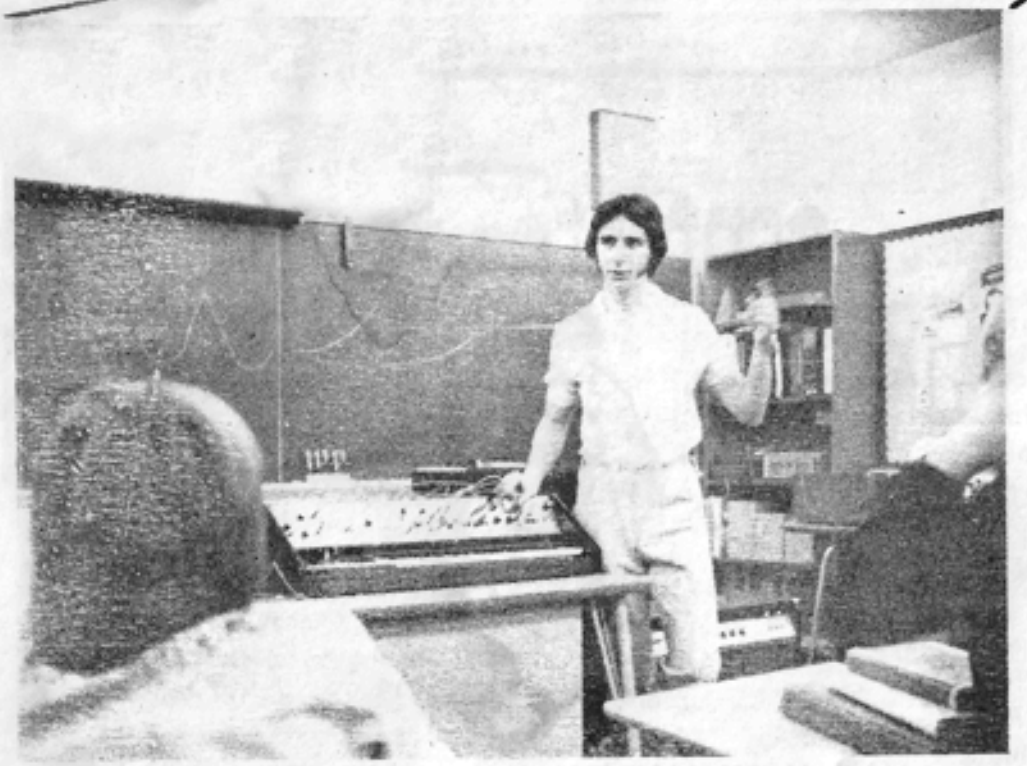
Subscriptions

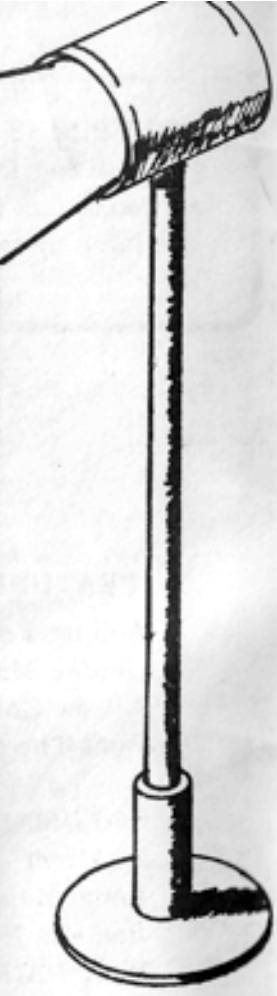
Subscriptions are for the entire calendar year. If you wish to continue receiving this publication, enclose $2.00 payment for 1976 issues and return the mailing label indicating any changes necessary to the name and address.

Published quarterly by PAIA Electronics, Inc., 1020 W. Wilshire Blvd. Oklahoma City, OK 73116.

Spotlight

FIRST IN A SERIES OF ARTICLES
ABOUT PEOPLE USING
PAIA EQUIPMENT





PITT STUDENT SHOWS SYNTHESIZER

Using Synthesizer as an educational tool in teaching the relationship of waveforms to sound has become more prevalent in recent years with its usage extending from primary grade levels to University music lab applications.

Brian Wechtenhiser is a Music and Electrical Engineering student at the University of Pittsburgh in Johnstown, PA. One of Brian's recent projects was to deliver lecture demonstrations on electronic music principles to the students at Johnstown's Richland Junior High School.

As a demonstration instrument, Brian used his PAIA 2720/R Synthesizer. With the help of an oscilloscope he showed how the processing elements of the synthesizer produced and altered waveshapes and how these changes effected the final sound. Illustration voices ranged from conventional musical instruments to chain saws. Sounds most requested by the students, however, were those from popular recordings.

Brian's musical involvement began with percussion instruments when he was in elementary school. "I play the drums" he says, " but I'm really into synthesizers a lot more, and appreciate PAIA's price, innovation and willingness to listen to the public." His current musical interests include Emerson, Lake and Palmer (for both Emerson's synthesis and Palmer's drumming) and Isao Tomito and his Pictures at an Exhibition album. Upon completion of his degree, Brian hopes to realize a career utilizing both his musical and electronics training.

(ed note:)
Let us hear how you are using PAIA equipment. Send us as many details of the application as possible and include Black & White glossy photo's for publication.

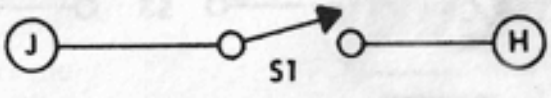
Adding Footswitch Control for Glide

A modification which might prove useful (especially for the performing musician) is adding a jack to the 2720-9 Glide circuitry to allow footswitch control.

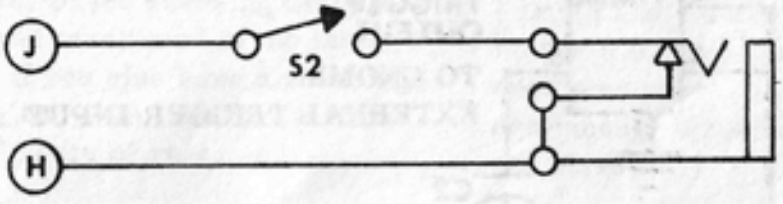
The footswitch jack is placed in series with the switch on the glide potentiometer to allow a master on-off capability. The jack selected is a switching type (Switchcraft # 12-A or similar) providing for normal operation of the circuit when the footswitch is disconnected.

Note that the shaft connection (mounting bushing) of the footswitch jack must be insulated from ground. This is accomplished in 2720-8 and 4762 cases by mounting the jack in a hole drilled in the wooden case to the left of the Glide face plate.

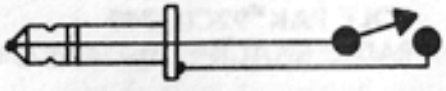
Wire the jack into the circuitry before mounting in position to the left of the Glide face plate. Circuit modifications are shown in the drawing below.



PART OF R4 STOCK —9



SWITCH CRAFT 12AOR SIM
MODIFIED —9



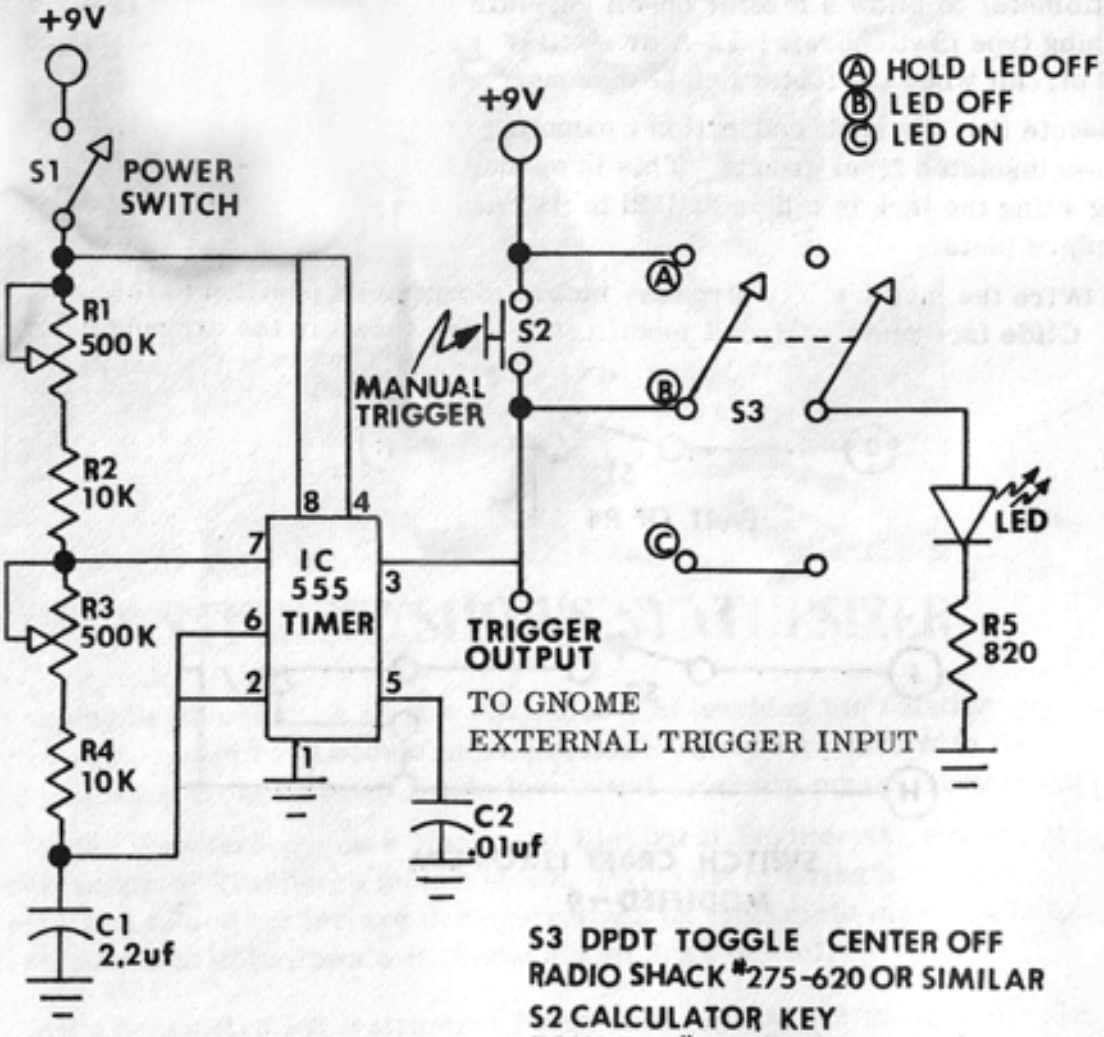
FOOTSWITCH WIRING

PAIA's funky 'Foot Switch" or any Foot Switch intended for use with guitar amps are suitable. There are two different types of switches which can be used, each providing different control capabilities. The "Standard" footswitch, employing a push-on, push-off switch, enables you to tap the switch once to have Glide and again to turn it off. A Momentary-Contact, Normally open type switch will allow the glide effect to remain off until the switch is pressed. When released the glide effect ceases. This allows the addition of glide to selected notes or passages making them musically more interesting.

GNOME MULTI-TRIGGER

by Russell A. Grokett, Jr.

Here's a versatile "Multi-Trigger" generator with variable pulse, manual trigger and continuous trigger outputs. It also has an LED to monitor the output state of the generator. I have used this very successfully with the GNOME and it should work with the 2720. Also I have found that calculator keys available from Radio Shack and Poly Paks make very good external triggers for the Gnome.



R1 AND R3 PULSE RATE AND WIDTH CONTROLS

S3 DPDT TOGGLE CENTER OFF
RADIO SHACK #275-620 OR SIMILAR
S2 CALCULATOR KEY
POLY PAK #92CU1749
RADIO SHACK #275-1420 OR SIMILAR

This circuit is basic and can be hardwired on a small piece of perf board. The 555 timers are available as surplus from many of the Mail-Order firms advertising in trade magazines such as Popular Electronics, Radio-Electronics, Audio Amateur, etc. The 556 is a dual 555, and can be used to build up a dual trigger generator.

Using this circuit as a repeating trigger unit, strumming or repeating envelopes can be produced. Or, by hanging a pot on the output, the circuit can be used as a pulse wave control oscillator for VCO trilling and other specialized applications.

If you haven't read much about the 555 type timer circuits, I strongly recommend the articles in February and March 1976 issues of Radio-Electronics, or the spec sheet/applications notes available from the manufacturers of these circuits. There are a number of interesting things that these circuits can do and many of them apply to electronic music.

Local Happenings

If you live near any of these people, contact them. They are anxious to talk with other synthesists, organize ensembles and exchange information.

Dave Biddle
1132 Valleyview S.W.
Canton, OH 44710

Earl Keyser
208 N. Green St.
Keota, IA 52248

Peter Bailey, Music Teacher
Kodiak Island Borough School Dist.
P. O. Box 886
Kodiak, AK 99615
(Particularly interested in contacting other K-12 music instructors using PAIA equipment)

Sammy Greene
Box 366
Jay, FL 32565
(as you may recall, Sammy is the owner of the sneezing Gnome which was mentioned in the last issue. If you also have a sneezing Gnome, tell it to take two aspirin and get plenty of rest. -ed.-)

Ron Di Iulio
871 Capt. Shreve Dr.
Shreveport, LA 71105
(318) 865-0908

Jerry Von Loh
230 Deleglise
Antigo, WI 54409

Bruce Wojac
11100 W. Forestwood
Willow Springs, IL 60480
(312) 839-8094

Brian Wechtenhiser
600 Linden Ave.
Johnstown, PA 15902
(412) 535-4916
(Brian also plays drums)

David Harper
5414 Beverly Hill #32
Houston, TX 77027
629-5823
(David has pointed out that he has a four channel tape deck and quite a bit of test equipment, including an oscilloscope.)

If YOU would like other PAIA user's to contact you, drop us a line giving permission to publish your name and address. Should anything come of these meetings such as Jam sessions, Lecture/demonstrations, rap sessions, etc., be sure to fill us in on the details. A little publicity couldn't hurt, could it?

FIRM ANNOUNCES NEW COMPONENT

Oklahoma City, April 1, 1976 ---- PAIA Electronics, Inc., the Oklahoma City kit manufacturing firm long known for their unusual product line, today announced that they intend marketing a new line of voltage to current - current to voltage converters (V/I I/V C pronounced Vi'-ivc).

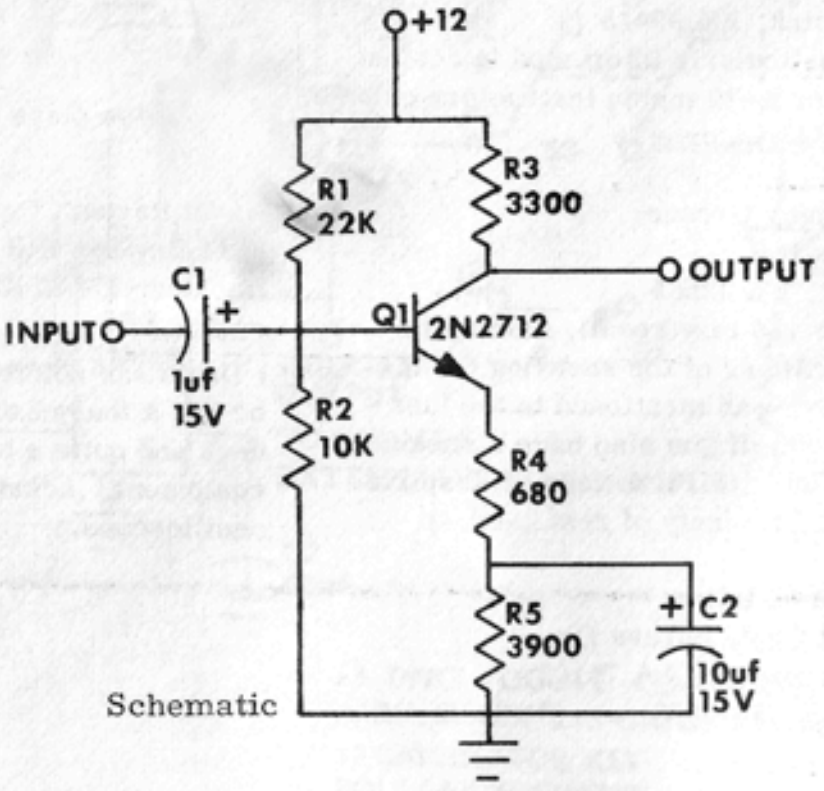
A spokesman for the firm stated "We have decided to call this new element an ecantsiser in honor of that great British Physicist Sir Thomas William Ecant

.....continued on page 23

A LOW COST AUDIO BUILDING BLOCK

Late 1975 saw the release of PAIA's audio amp - the Pygmy. The Pygmy has a gain of around 50, and high (line) level signals can easily drive the Pygmy into natural distortion. Doing more work with the Pygmy, we found that some guitars and other signal sources had low enough output to prohibit driving the Pygmy fully into distortion. Many of the guitars whose pickups use reverse winding techniques to achieve humbucking action will have this problem.

To overcome low input levels, PAIA has released the #1710 preamp kit. The circuit, as shown in figure a, is a single transistor amp with a gain of 5. This circuit was designed to mount inside the Pygmy and use its supply, but the preamp is much more versatile when considered as a basic audio building block.



Schematic

As musicians look for more ways to express themselves, they eventually try some signal processing devices such as distortion boxes, wa-wa's, and so on. If a musician accumulates a large assortment of "black boxes", he is likely to run into signal losses, higher noise, etc. One way to solve a lot of these problems is a preamp. That's where the 1710 shows its versatility.

The preamp is constructed on a small (1.5" X 2.5") circuit board which can easily be mounted in most any existing piece of equipment -- inside your amp, a foot pedal, or even inside your guitar. Although the schematic (fig. a) lists a power supply of 12 volts, any supply from 9 to 18 volts can be used without affecting operation. This makes a 9 volt transistor battery ideal, especially since most foot units also use this type of power. Also, the gain of the preamp can be changed by varying the value of R4. If you need more gain, decrease R4 to 330 ohms. This will give a gain of 10.

The AC input impedance of the preamp is around 7K ohms. The output is approximately 500 ohms. No output capacitor is used on the 1710 since the Pygmy amp input is AC coupled. For experimentation in other applications, an output capacitance of at leats .1 mfd. should be used.

If this unit looks interesting to you as an experimental building block, or as a functional item to be added to your present equipment, the complete kit including circuit board, parts and instructions is available from PAIA by ordering kit #1710 for $1.50 postpaid.

Happy experimenting!

BEAT THE SEQUENCER or QUICK DRAW SEQUENCER

Hank Jones
Mesquite, TX

And now for something completely different - how about a little game of chance using the 4780 Sequencer!

Prepare the sequencer by sliding the CLOCK switch fully up into the "run" position and setting the "rate" control fully CCW. Also connect one end of a medium length (8 - 12 ") control voltage patch cord to the "load" input jack. Now, notice that touching the probe on the free end of the patch cord to the pulse (⅃‾) trigger output jack causes the sequencer to begin counting and that it will go through only a single cycle before stopping.

The object of the game is to start the sequencer as above and then move the probe to the last stage output in the SEQUENCE box quickly enough to cause the count to cycle rather than end. Now try it again, this time shooting for the 11th stage rather than the 12th. And again going for the 10th, 9th, 8th and so on.

As your skill increases you can increase the clock rate for a greater challenge and a bit of audio theatrics may be added by connecting the control voltage output to a VCO.

Who know's - maybe the PAIA 4780 will start showing up in Las Vegas!

- Marvin Jones -

Marvin got to jack #6 on his first try before the clock caught him.

- Linda Brumfield -

Random Noise

A sharing of miscellaneous hints which might prove helpful in an electronic music studio but are not directly concerned with the Synthesis equipment.

REMOVING SOLDER FLUX

Many circuits used in a synthesizer are fairly critical and can be "Thrown off" by high impedance sources of leakage. Such circuits include Sample/Hold and Voltage Controlled Oscillators.

The rosin flux which is deposited when soldering can bridge the circuit board paths and induce high impedance leakage between conductors. This will cause Sample/Hold circuits to drift and VCO's to be non-linear. To eliminate rosin build ups, acetone (a solvent available at most drug stores) can be wiped or brushed across the conductor side of the circuit board to dissolve the rosin and leave the circuit board free from high impedance leakage paths.

Mike Metz of Wichita, KS says that "P.C. Laquer Solvent" (used in etching circuit boards) will also do the trick.

Be careful not to get acetone on any plastic parts, i.e.: keyboards, knobs etc. Acetone loves to eat plastic.

RECORD SPRAY CLEANS GNOME CONTROLLER

John Blacet of Santa Rosa, CA passes along a nifty trick he discovered while working with his Gnome.

"I discovered that an application of a silicone record spray cleaner (I used Radio Shack # 42-2500) after a lighter fluid cleaning of the control strip solved my noise problems. The noise had refused to be erradicated by the lighter fluid cleanings, and had persisted long after the indicated break-in period. In any case, wiping the strip with lighter fluid and wiping it off is followed by the silicone spray, allowing it to sit for a minute and wiping it off with a soft cloth.

This solves noise problems as well as making the strip slicker. I prefer this as it eases playing. I hope you have the opportunity to pass this on to other Gnome owners". "Thanks, John", ed.

PATCH CHART ORGANIZATION

Jay Machado of Cherry Hill, NJ says that he uses recipe cards to draw his patch charts on. The patch can be drawn on the blank side of the card, while control settings and special comments are listed on the ruled side. Index cards are available with plastic tabs for dividing the patches into sections such as: Percussion, string, horns, electronic-tonal, electronic-non-tonal, etc. The whole system can be stored in a small easily handled recipe card box.

TP TUBES HELP ORGANIZE PATCH CORDS

If you are one of the country's typical performing musicians, you undoubtedly have plenty of cords to take care of: Audio cords used to connect instruments to foot pedals to amplifiers, speaker cords to hook amp heads to umpteen speaker cabinets, extension cords to get to AC power to your amp and on and on! If you tend to throw all of your cords in a box between

..... continued on page 22

Dear PAIA,

A column devoted to answering your questions about PAIA, electronic music or any other area which might be of interest to our readers.

DEAR PAIA,

I would like to know how to make the sound of the falling rain and the sound of thunder. Dale Naylor

Dear Dale; The quality of sound is very subjective; everyone thinks of something different. Most thunder and rain sounds are based on noise in one way or another. For rain, try putting noise through a low pass filter. This produces a constant (steady rain) sound because the volume is not changed significantly. Thunder is a little more complicated because of dynamics changes. You'll want to construct a Percussion type sound so begin with the Function generator and a VCA, and because higher frequency sound travels faster than lower frequency sound some sort of filtering will be helpful.

We hope that this aims you in the right direction. As always, experiment with different combinations until you have something that sounds most like thunder and rain to you.

DEAR PAIA,

I have a Sony 630 deck, which is a nice machine, but, my tastes are grandiose. A lot of my favorite classics involve from 8 to 16 voices. I'm sure that there are some more inventive individuals than I who, working within the limitations of a home stereo system, have designed and built supplementary equipment to expand on their own capabilities. Has anyone come up with a modification or technique to get 16 clean and separate voices together using a three-head stereo deck? Mark Meyering

Dear Mark,

Tape recorders and their use and modification is an important part of synthesis. You'll be seeing more on this subject in future issues of Polyphony. Meanwhile, some helpful information is contained in the "Handbook of Multi-Channel Recording" by F. Alton Everest, available from TAB books, (#781 - $10.95, hard cover) Blue Ridge Summit, PA 17241.

DEAR PAIA,

Is there any way that I can convert my 2720-5 Control Oscillator to provide a pulse wave output? John Finney

Dear John, Until a 4700 series Control Oscillator is released, the easiest way to obtain a 5 volt pulse wave is to run the variable output of your -5 into the trigger input of the 2720-4 Function Generator. Set the Function Generator attack and decay controls at minimum, and switch the expand control to off.

As the output level of the control oscillator is increased, the Function Generator will start to fire and produce narrow pulses. As the Control Oscillator output is increased further, the width of the pulses will increase to a maximum of around 60% duty cycle due to a continually larger portion of the '-5 output being above the trigger level of the function generator.

If the envelope generator is already being used in the patch, an a alternative is to feed the control oscillator variable output into the Envelope Follower input. The step output of the Envelope Follower will then be the source of a 5 volt pulse wave.

NEW NEW NEW

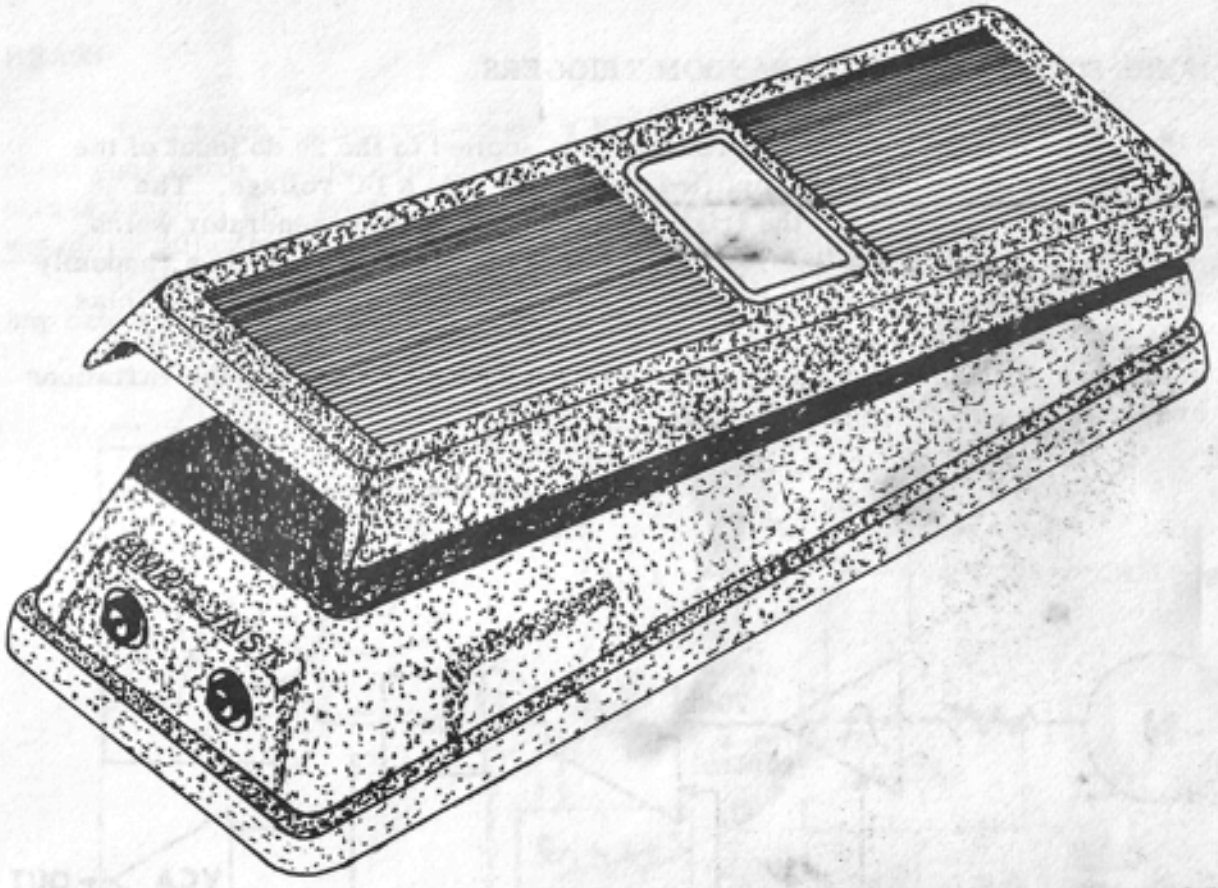
INTRODUCING OUR NEW SUPER SYNTHESIZER PACKAGE

Here's the first 4700 series package, a system configured by John for his own use. It's module complement is selected to provide the capabilities of two synthesizers in a single case. The left hand cabinet is intended to be used primarily with the keyboard controller and features two 4720 VCO's, a 4730 VCF, 4711 Quad Stereo Mixer, 4740 Envelope Generator and 4710 Balanced Modulator/VCA. The right hand cabinet can be thought of as a Sequencer based synthesizer system and includes a 4780 twelve event Sequencer, VCO, VCF, Envelope Generator, Balanced Modulator/VCA as well as a 4712 Reverb Module and Control Oscillator/Noise Source. The system includes three of the 4770 Watt Blocks.

If all of the modules, cases, keyboard, etc. were purchased separately, the ticket would come to about $575.00 but as a system we can offer it at the price listed below.

4700/S	Synthesizer	$499.00	40 lbs.

NEW NEW NEW



PAIA/De Armond Pedal Volume Control

We've made special arrangements with Rowe/De Armond to sell their model 1600 as a PAIA/De Armond foot pedal. If you're familiar with this pedal you know that it's one of the toughest made and is an industry standard. We will be offering some special effects goodies in this cast housing before too long, but for now we're making it available in a volume control/expression pedal configuration for use with synthesizers, guitars, or whatever you've got. De Armond's recommended list price is $54.00 but to Polyphony subscribers we're able to sell it for $29.95.

PAIA/De Armond Foot Control #*1600 $29.95 plus $1.50 postage & handling

---

SUPER INEXPENSIVE PRE AMP

Fully described in "How to" article on page 8. If you're not up to rounding up the parts yourself or wiring them together, send us $1.50 and we'll send you a complete kit with circuit board, parts and a step-by-step instruction sheet.

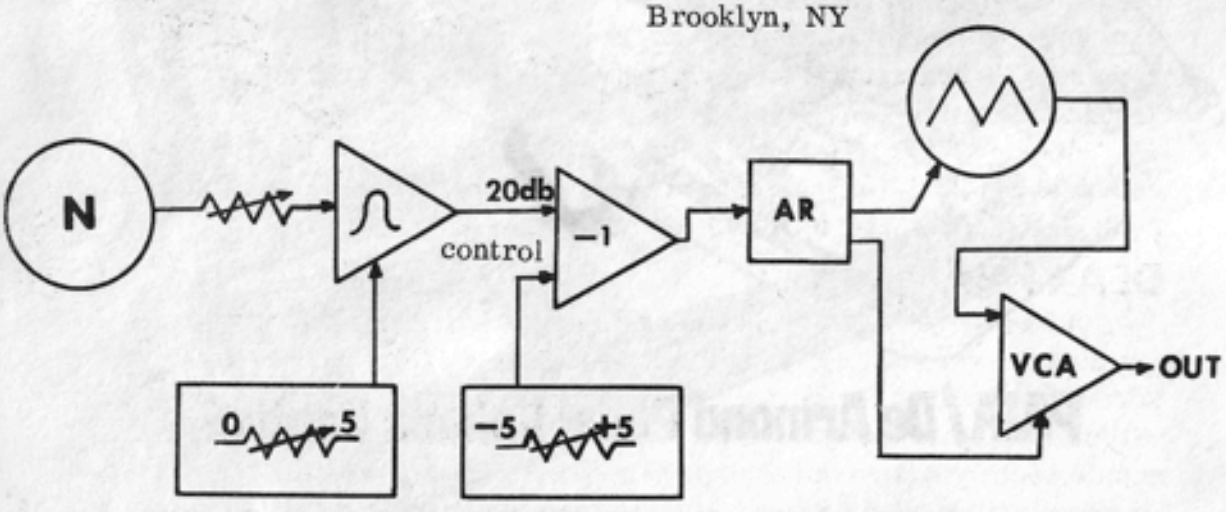
#1710 Preamp kit $1.50 postpaid.

PATCHES

NOISE SOURCE PROVIDES RANDOM TRIGGERS

The noise source is filtered and then applied to the 20 db input of the inverter/buffer where it is amplified and mixed with a DC voltage. The control output then goes to the trigger input of the function generator which drives both the VCO and VCA. Since the noise generator produces a randomly varying voltage, the function generator triggers randomly. The -5, +5 bias control is adjusted to raise the function generator to trigger as often or as seldom as you like. You can have a lot of fun with this patch and the variations are endless.

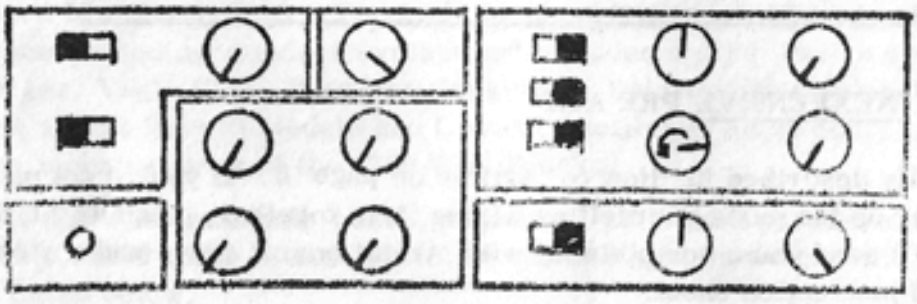
Robert Matarazzo
Brooklyn, NY



WOW! Try this one, you'll really like it, but beware, you could wind up playing with this one all day synthesizing popping strings of firecrackers, percolators, popcorn popping, space wars etc.

Here's a patch diagram for a GNOME Train Effect.
Comments: Hit trigger and slowly rotate VCF attack knob counter-clockwise.

Mike Weiblen
W. Hyattsville, MD



Mike has had a rubber stamp made of the GNOME graphics for quick and easy recording of patches. The patch diagram above was reproduced directly from Mike's rubber stamp impression. - ed. -

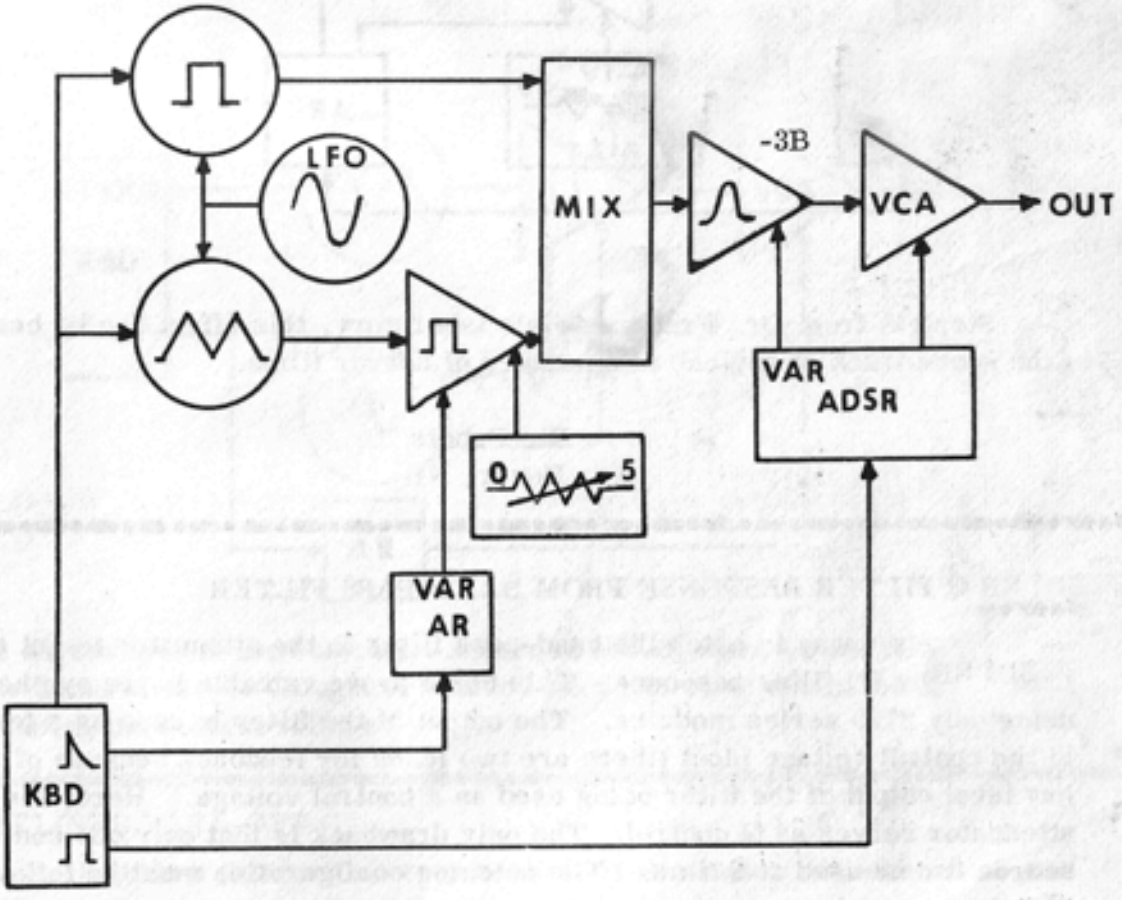
more...

patches

BRASS

This patch configuration uses a jillion patch cords, so get ready to count your cords before attempting this one. It sounds best played in the mid-octave range of the keyboard and requires some knob twidling and filter and waveform adjustments. The 4730 filter would probably give a crisper sound.

Playing in different ranges with different settings can give you most any brass sound from trumpets to trombones. -ed.-



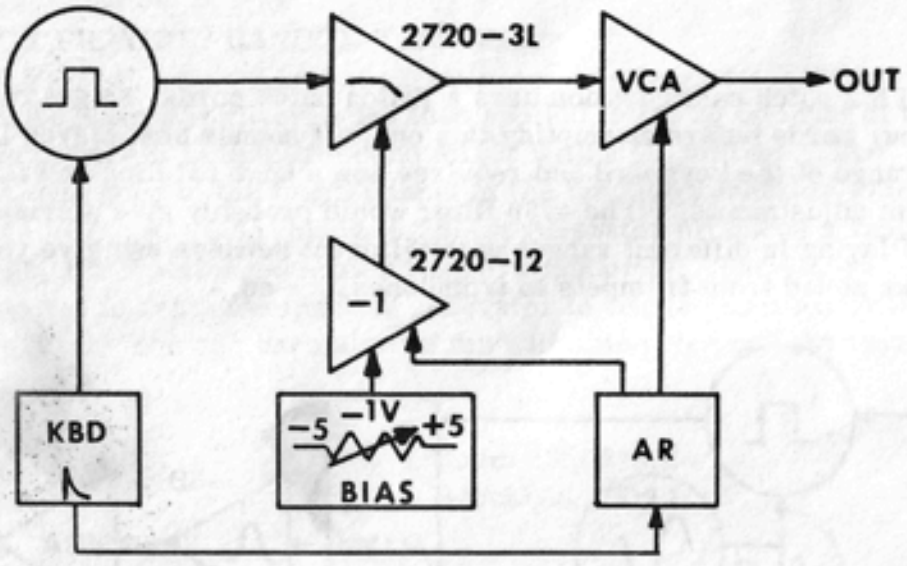
Track two VCO's C below Mid C to 2nd C above Mid C

1. (a) PWM bias to full 50% tone
   (b) Var. AR out to PWM to narrowest pulse.
2. ADSR VCA envelope A - 10%, D - 20%, S - 60%, R - 20%.
3. Adjust AR curve to ADSR A & D to eliminate phase difference.
4. Add narrow pulse (20% duty cycle), or ramp for softer tone.
5. BPF "Q" - 90% and ADSR var. to desired tone (around 30%).
6. Add approximately 4 Hz. control to VCO's for vibrato.

Mark Schweter
Parma, OH

patches

TESLA COIL SOUND



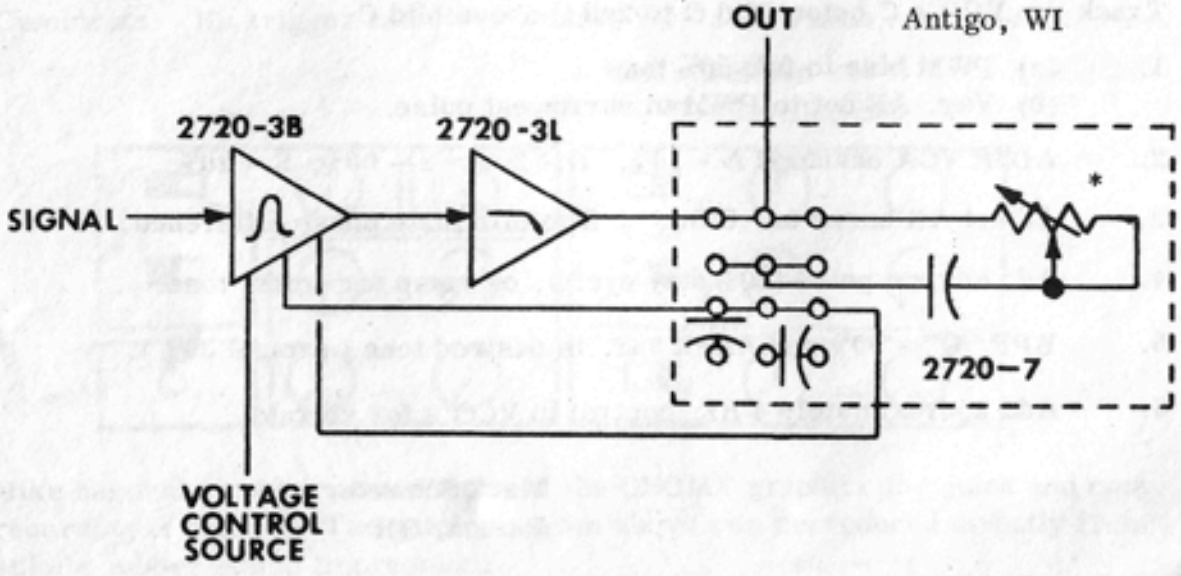
Straight from Dr. Frankenstein's laboratory, this effect can be heard in the sound track of any one of a number of horror films.

W. Dubois
Dover, NH

SUPER Q FILTER RESPONSE FROM BAND-PASS FILTER

Here's a way to patch the band-pass filter to the attenuator to get a truly "super Q" filter response. This could prove valuable to the synthesist using only 2720 series modules. The output of the filter is used as a feedback in the control voltage input (there are two leads for feedback because of the low level output of the filter being used as a control voltage.) Here, the attenuator serves as Q control. The only drawback is that only one control source can be used at a time. The patching configuration must be followed exactly.

Jerry Van Loh
Antigo, WI



* VCA may be used in place of attenuator for a voltage controlled Q.

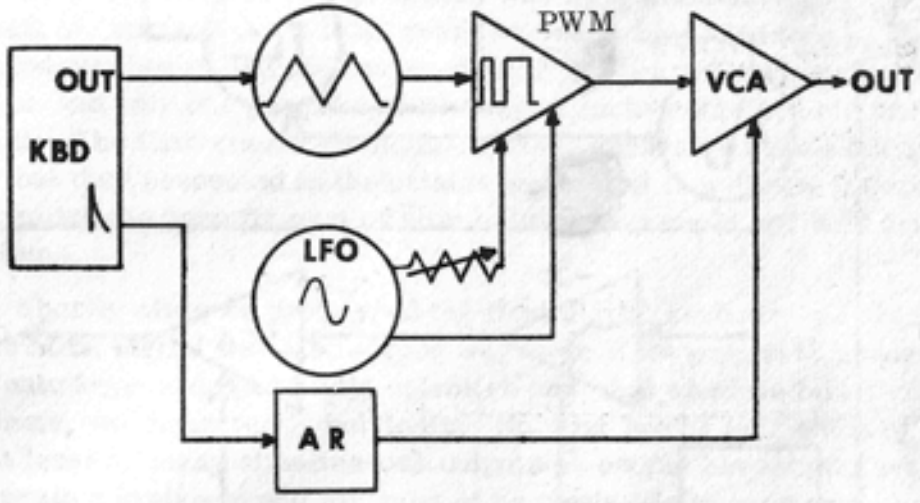
more...

patches

HONKY-TONK

This patch sounds much like a honky-tonk piano if the oscillator is kept at the top of its range. Sounds even better if the keyboard output is doubled by way of the patch panel. Using both control oscillator outputs sounds as though the PWM frequency were doubled. Admittedly, this doesn't sound much like a piano a low frequencies, but it's still a funky sound!

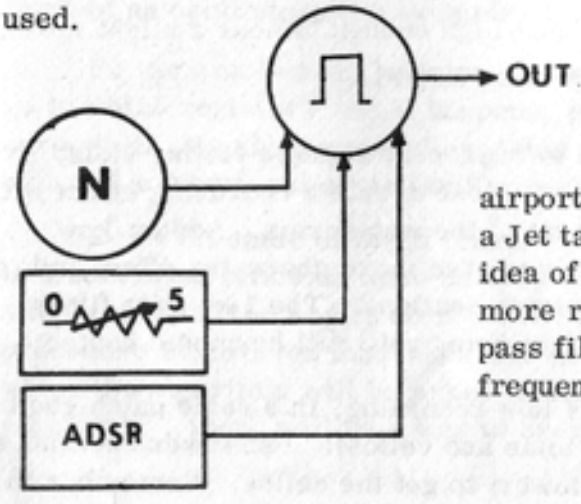
Gary Bannister
Indianapolia, IN



As an example of the subjective nature of sound; when we set this one up in our demo studio we thought it sounded a lot like steel drums before doubling the control voltage.

JETLINER TAKE-OFF

Here's a patch which very realisticly duplicates the take-off of a Jetliner at an airport. Even though patching is simple, adjustments need to be made to arrive at the final sound. Adjust the bias so the pitch doesn't get low enough to sound unrealistic. Adjustments of the ADSR can be changed to give different effects. Other options are putting the output through some filtering or using multiple oscillators. A 2700 series oscillator was used.



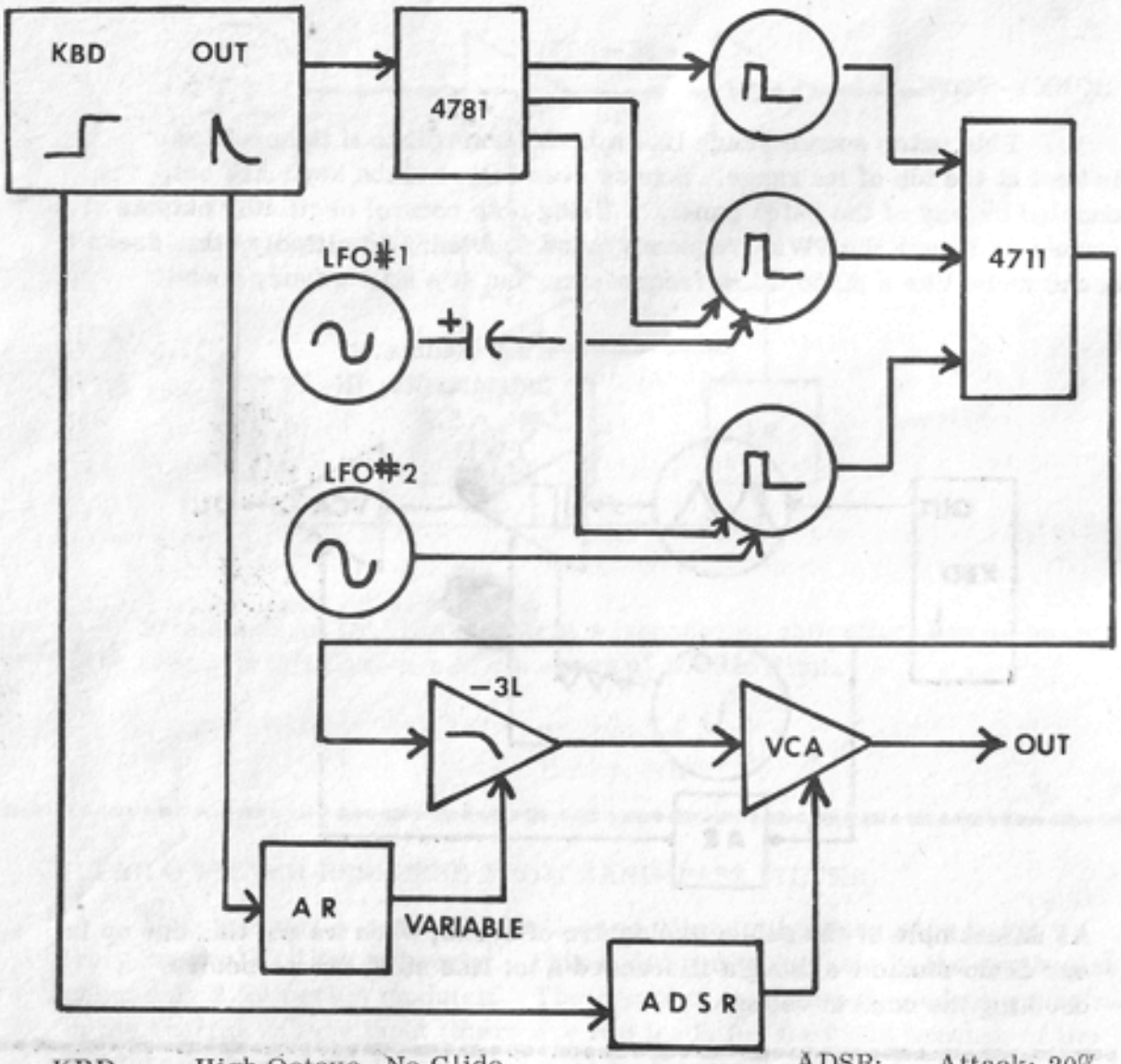
Eric Hanson
Seabrook, TX

If, by chance, you don't live near an airport, and have a strange yearning to hear a Jet take-off, this patch will give you some idea of what they sound like in action. Sounds more realistic when passed through a low-pass filter at a fixed bias to pass only low frequencies.

-ed.-

patches

STRINGS



KBD: High Octave, No Glide.

AR: Expand: off
Attack : 20%
Decay: 40%
Variable Output: 50%

ADSR: Attack: 20%
Decay: 30%
Sustain: 60%
Release: 50%

4781 Manual Transposer: All VCO's tuned in unison

VCO's: All VCO's using pulse output. Pulse width set to 10% to 20% duty cycle.

LFO#1: * Hz. Variable output set just high enough to hear a slight vibrato.

LFO#2: 10 Hz. Variable output set as in LFO#1.

MIXER: All signals mixed equally.

All VCO's are tuned in unison to represent a single violin, viola, or cello section. The multiple oscillators alone create a chorusing effect with random cancellation and reinforcement of the waveforms. Adding Low Frequency FM to two of the VCO's gives even more chorusing effect and the vibrato usually associated with string sections. The Low pass filter adds the "Bowing" effect giving a slight delay until full harmonic content is achieved.

When building up string tracks in a recording, this same patch can be used for all high strings (violins, violas and cellos). Use lower sections of the keyboard (or tune the keyboard lower) to get the cellos. Remember to re-adjust the LFO frequency and depth to better approximate the vibrato on the lower strings. - Marvin Jones -

MORE NEXT ISSUE .....

JOHN SAYS.....

This is the month that we said that we were going to talk about digital keyboards for synthesizers - so let's begin with a little history.

Despite what you may think, digital concepts are not new to PAIA. My first love was digital electronics but that was back in "them days" before integrated circuits were low enough in cost to be used by the average experimenter. I got into audio - and the company with me - because it was about the only place that kits could be produced at low enough cost to be of interest to the "casual" experimenter.

But, my interest in digital stuff was still smouldering only slightly beneath the surface and a little over two years ago it led to the first designs for what we then called the "quasi-digital" keyboard. Originally, these designs had only one purpose; to produce a rock-stable sample and hold circuit. The first ones were night-marish, expensive beasts but since the data that they presented to the outside world was in a digital format it did accomplish the specific goal of eliminating any sample and hold drift problems.

Shortly after we prototyped the first digital keyboard we began to realize that digital was also a good way to go if we wanted to produce a polytonic keyboard. And let's establish now that when we talk about polytonic, we mean really polytonic. Not just two or four notes at a time but at least as many simultaneous outputs as people have digits available to operate a keyboard and for most of us that's 10, give or take a couple.

In principle, a digital polytonic keyboard is simplicity itself; a digital circuit of some sort scans the keyboard - looking at it one note at a time. When the scanning circuitry discovers that a key is down (or changed in any way from the last scan) additional logic circuits determine what to do about it.

In most cases what they want to do is store it someplace - most likely in an output "register". In digital circuitry a register is very roughly the equivalent of analog S/H circuits; data goes in and is held. If the register is strapped to a Digital to Analog (D/A) converter then the stored binary number is converted to a control voltage which is then used in the same way that we use any other control voltage. To set the pitch of an oscillator, for example.

So the problem is; how does the machine determine which note is to go to which register? As it happens, there are lots of ways, but for the purpose of this abbreviated discussion we'll consider the simplest which we will call a "temporal algorithm".

Don't let some of these terms snow you - they're only words. Algorithm is a somewhat officious term used by mathematician and computer types which simply means "the way to do it". The term implies that a rigorous, formal procedure is involved that takes into account all conceivable situations with which the algorithm will be asked to deal. Temporal means time. A "temporal algorithm", then, will be a way to assign notes to registers based on the time

sequence in which they are recognized by the machine as being called for.

Assuming that the registers are numbered 1 through N, the first key down will be assigned to the first register, the second key to the second register and so on through the Nth key being assigned to the Nth register.

But, what happens when keys are released? Does the circuitry still "hold" that note and continue to ignore the register when subsequent keys go down? Does it mark (or un-mark) the register some way so that the next key to be activated can be stored there? Does it go up in flames? Well, it can do any of these things (though hopefully not the last) or it can do other things that we haven't thought of yet. And now we have not only a note assignment algorithm, but rising from it a group of potentially useful reassignment algorithms. Each algorithm having it's own advantages and disadvantages, each suited to a specific purpose.

That leads us to the first real problem that we ran into. We found ourselves very busy generating obsolete prototypes. No sooner would a working model of something be built than we would have thought of other neat things to do, which would require re-design and prototyping by which time we had thought of other neat things - ad infinitum.

What kinds of neat things are we talking about? For example:

MEMORY - once you have a digital keyboard, the hard part of large digital sequencers that can be "programmed" from an organ type keyboard is done. 1024 note digital sequencer expansion modules shouldn't cost over $40 - but of course a new algorithm is required to handle the memory.

STRUM - since the keyboard is being scanned, we can introduce a time delay between the instant when a key is found to be activated and the time when the controller goes looking for the next key. The effect is similar to strumming a guitar - except that since this is a synthesizer we can just as easily "strum" a bassoon or piccolo.

JCH - this is our own mnemonic (memory aid) for Jam Chord High. We arbitrarily said earlier that there would be at least 10 registers but in fact the most basic keyboard that we envision at this point has the capability of addressing 16 registers so that there are 6 "extra" registers that we won't ordinarily get to, using only ten fingers. On push-button command a chord that the musician is holding down can be "jammed" into these extra registers and held there - even after the keys are released. It's pretty slick to jam a chord (and this can be any chord, not just majors or 7ths) and still have ten fingers available for melody.

There are a bunch of other features that are potentially available and the list is growing constantly (problem 1 again). You the customer, don't want to get involved in our problem 1 because for you it will translate into constantly buying obsolete equipment (or worse for us, not buying, waiting for the ultimate that never materializes). And that leads us to where we are today; the application of micro-computers to electronic music.

Micro-processors have a lot going for them (other than their formidable "buzz-word" advertising value). They are potentially very inexpensive general purpose machines that can serve a number of different purposes

simply by changing their programming. If you have a digital controller system that is processor based you don't have to re-design and re-build the entire system every time a new feature comes to mind, you just re-program. Most of you won't be interested in generating your own programs at first but that's not a problem - we will provide this "soft-ware" in the form of an integrated circuit Read Only Memory (ROM). Changing the whole personality of the machine will simply be a matter of un-plugging the old ROM and plugging in a new one that has programs for the new features. (See, we will use sockets when they serve a useful purpose)

Not only does this concept go a long way toward making your investment obsolescence-proof, it also opens up what is essentially a whole new field of artistic expression; writing not only unique musical scores using unique voices but also writing the controller software to enable elaborate musical scores to be performed in real-time by a single performer.

Does my enthusiasm come through? It should, this is the slickest thing I've ever worked on and the best part is that even when the units are in production as a stock item we still will have only just begun.

I hadn't planned on spending so much time on basic principles because there's another point that needs to be covered. It's aggravating because it's a matter of going back to clear waters muddied by those of the "exponential" persuasion; but, it's important.

If you read somewhere that exponential VCO's require only 6 bits of binary code to represent 5 octaves of equally tempered pitch while linear oscillators will take 12 or more, remember this:

BUNK!

The currently most popular type of D/A is known as an "R-2R ladder" converter and its chief characteristic is that as the digital data input "counts" the output voltage changes by equal increments. This is the same principle as a keyboard that has been designed to operate with exponential oscillators generating equal voltage changes - ordinarily 1/12 volt increments.

If this were the only kind of D/A there was, then the statement about word length would be true; but it's not (true or the only type of D/A, take your pick). There's also a thing known as a "Multiplying D/A"

While the R-2R ladder converters can be thought of as summing a series of weightings corresponding to bit significance, the MD/A multiplies the weightings and then multiplies the resulting constant by a reference voltage. While that may possibly sound more complicated than the operation of a "normal" D/A, it's really not. The two circuits (the way we do it) are of roughly comparable complexity.

If the weightings of the bits is selected properly, the output of the D/A will be a series of exponentially incrementing voltage steps that exactly meet the requirements for producing equally tempered musical scales from a linear oscillator.

One of the nice things is that since the D/A is multiplying a reference

voltage by this equally tempered series of constants, transposing the whole thing into a new key signature is simply a matter of changing the reference (which, by the way, can itself be a summation of several voltages).

Now, this is important: THE COMBINATION THAT I HAVE JUST DESCRIBED BEHAVES IN EVERY WAY THE SAME AS IF THERE WERE AN EXPONENTIAL CONVERTER HANGING ON THE FRONT END OF THE OSCILLATOR. Except that, of course, there isn't - and notice that we have eliminated this touchy exponential circuitry from each and every oscillator and filter in the entire system. And when you're working with polytonic systems you are conceivably talking about 20 to 30 oscillators/filters. That's a lot of somewhat critical and expensive parts that we're talking about not using.

John S. Simonton, Jr., President, PAIA Electronics, Inc.

Random Noise

continued from page ..

jobs, you probably end up spending an hour untangling them before the next job. This tip is for you! Save the small cardboard tubes that toilet paper is wound on. As you are putting away each cord, fold it neatly until it is a small bundle about 6 to 8 inches long and slip it into a TP tube. Voila! No more tangled cords.

Cover with fancy cloth or contact paper to "sturdy up" the tube and camouflage its identity. Everyone will wonder where you found the "Far Out" storage tubes!

Next Issue!

In the next issue of POLYPHONY you can look for:

* A Polytonic front end for the GNOME Micro-Synthesizer.
* Craig Anderton telling how to interface guitar to the GNOME and a review of Craig's new book , "ELECTRONIC PROJECTS FOR MUSICIANS".
* More neat patches.
* More circuits.
* Some sort of digital stuff.

Firm Announces ..... continued from page 7.

who passed away recently after contracting a terminal case of athletes foot from a PAIA Foot-Switch."

"The 'siser - as we here at PAIA call it - has the most amazing properties", continued the smokesman, " It's a three terminal device which when activated by a measured current into any two terminals will cause a voltage that is exactly proportional to the current to appear at the third terminal. Yet this same incredible unit, when excited by a voltage across any two terminals will produce an exactly proportional current flow from the third."

Since PAIA has expended almost dozens of dollars on the research leading to the discovery of this device the first units to be produced will necessarily be expensive. $10,000 a piece in single unit quantities "the spokesman stated, "but we fully expect to have that price down to 10 or 12¢ within the next few hours as yields increase".

Even at the current high price, there have been rumbles around the industry about a 100 unit purchase to be split between the Pentagon's JTEB (Joint Thingie Evaluation Board) and FOBS (Federal Office of Bizarre Stuff).

When asked about delivery dates the spokesman replied " It shouldn't be but a couple of weeks now!"

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