

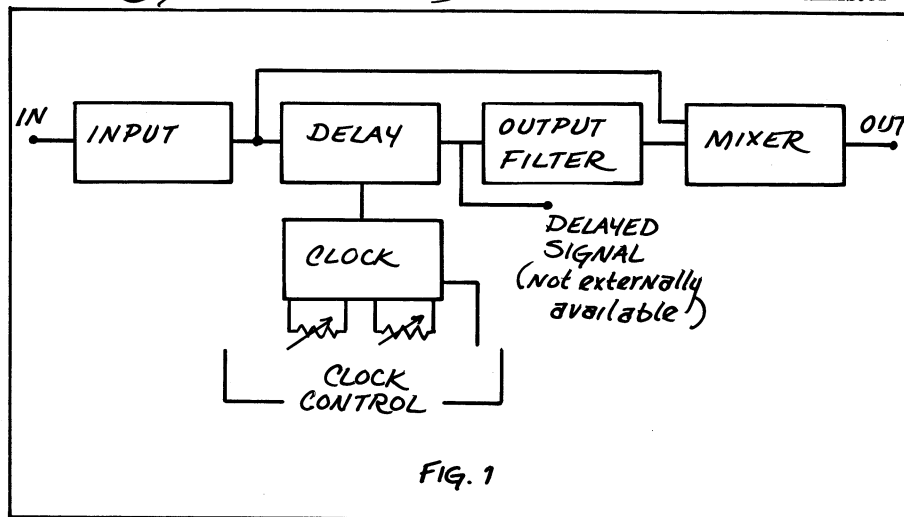
TO PHASE OR TO FLANGE OR TO EACH HIS OWN

By
Gary
Bannister

The Age of IC's has been here a long time, and with each new chip a previous impossibility has become reality.

And so it is with the SAD 1024. This unit is of the Charge Coupled Device class, which also include solid state image sensors (a TV camera with no tubes - Remember Yule Brenner's eyes in "WestWorld"?). However, the exact workings of such devices is not important here. For those interested, a block diagram is included of the PAIA #1500 Phlanger. A more complete explanation may be found in the #1500 User's Manual.

What is important is the question, "Is this enough?" If you purchase a Phlanger (I prefer Flanger for spelling. Phlanger will be used to indicate the PAIA unit. - GB) You have everything



you need to become another Isao Tomita right? Well, maybe. Let's see just what you get.

The purpose of any flanger is to produce a true TIME delay of a signal (phase delay will be covered later). Ideally there should be no degrading of the waveform, although this is a necessity as PAIA so carefully explains in the Phlanger manual.

If the above rules are adhered to, we would have the following available. (See figure 2)

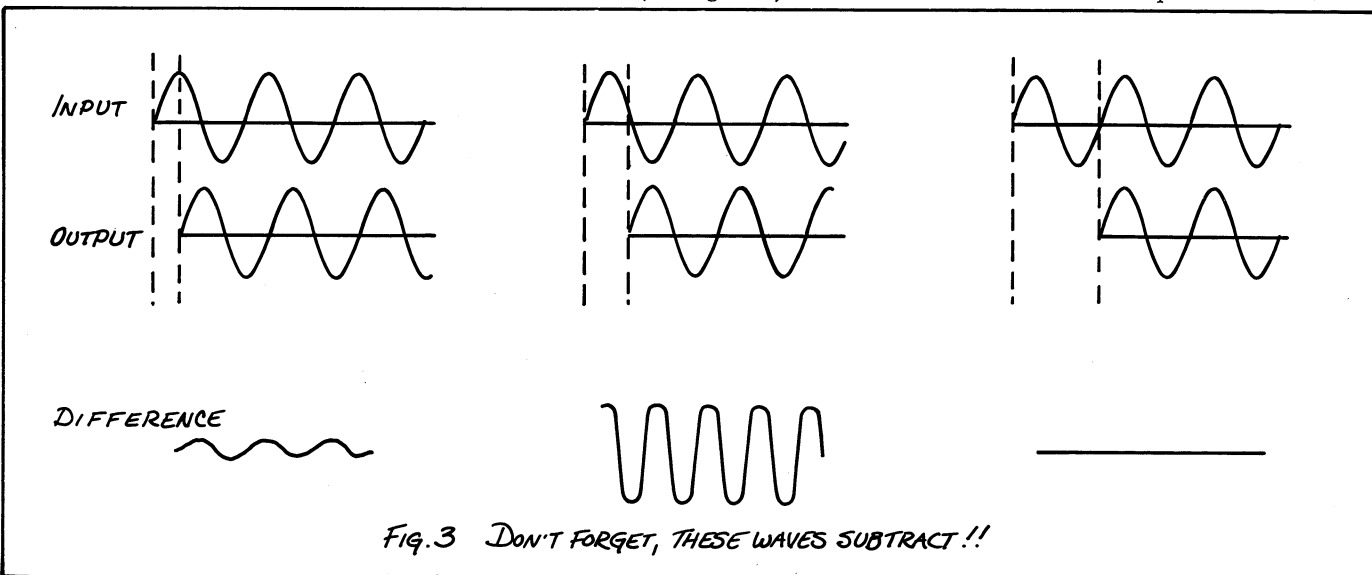
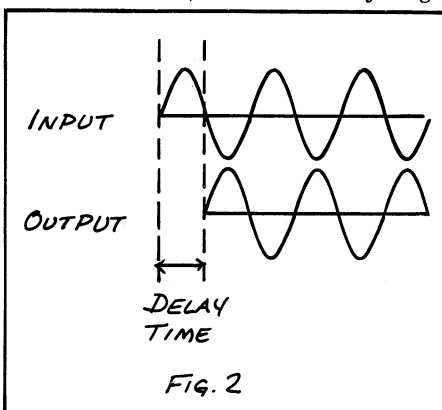
Due to the characteristics of the Phlanger these two signals are subtracted from each other. Depending on the amount of delay this produces various results. (See figure 3)

Note that with the proper delay a sine wave can be made to totally cancel or to boost to a higher output. These boost and cut actions occur at different frequencies over the audio range.

The amount of delay necessary to boost or cut a frequency is a function of the PERIOD of the frequency. The period is the amount of time necessary for the waveform to complete ONE CYCLE. This is found by dividing one second by the number of cycles per second. (See figure 4)

For any given time delay, the boost and cut action will produce a series of "peaks and valleys" which look like figure 5.

The actual frequencies at which



IE: $1\text{KHz PERIOD} = \frac{1\text{SEC.}}{1000\text{CPS}} = .001\text{SEC.} = 1\text{MILLISECOND} = 1\text{MSEC.}$

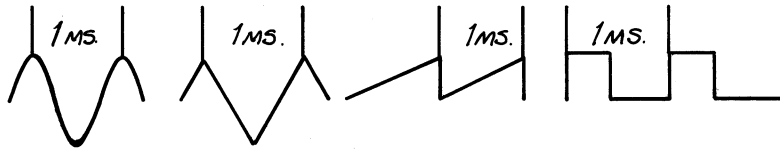


FIG. 4 ALL OF THESE ARE 1KHZ SIGNALS.

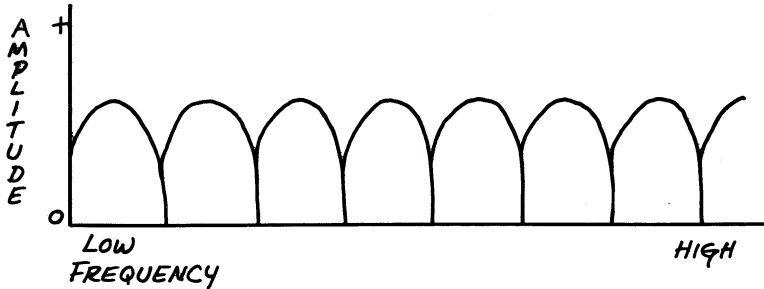


FIG. 5

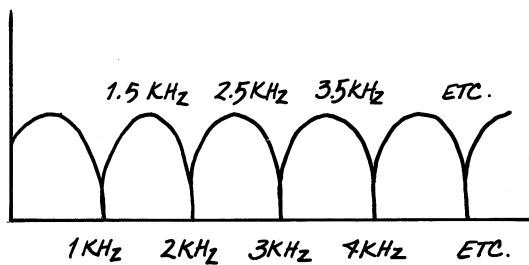


FIG. 6

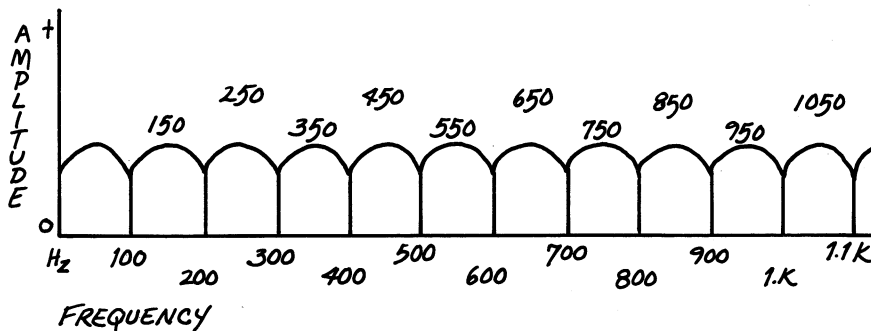


FIG. 7

these peaks and valleys occur is a function of the delay time. The delay time is, of course, dependent on the number of stages in the delay chip (512 per side of the SAD 1024) and the clock frequency (usually from 30KHz to 500Hz).

For specifics, let's introduce a hypothetical example:

The SUPERDUPER QMOP
1000 delay chip (500 stages per side)
A clock of 500KHz
This will give us a delay of .001 sec or 1 msec.

(In practice, the exact formula for finding delay time with any of the popular delay line chips is: $T_d = N/(2F_c)$. In this equation, N represents the number of stages in the delay line, and F_c is the frequency of the clock. The halving factor in the denominator is present due to the fact that the 'charge packets' in the delay line are actually transferred on each clock transition, thus two stages are passed per clock cycle. In the example, the delay time would be .5 msec., making the notches shown below at 2KHz intervals. However, the overall frequency response pattern would be as shown. Marvin)

A delay time of 1 msec. corresponds to a frequency of 1KHz. This means that any frequency that is a multiple of 1KHz (1KHz, 2KHz, 3KHz, 4KHz, etc.) will receive a cut and frequencies between them (500Hz, 1.5Hz, 2.5KHz, etc.) will be boosted. (See figure 6) Note that these are all evenly spaced.

Now, if the delay time is increased by a factor of 10 to 10 msec. the response becomes: (figure 7). Note that there are now MANY more humps and dips, and that they are closer together.

From the above examples it can be seen that as the delay time is increased the number of peaks and valleys increases, and vice versa. The change in response is what gives the flangers their characteristic 'smooth' sound.

Now let us consider the true phaser. The difference is more than just semantics. While the flangers depend on TIME delay, the phaser depends on PHASE delay.

The actual effect of phase delay is quite similar to time delay. However, we must look at each in a different light. With a flanger we can make any given time delay that will affect ALL frequencies that pass through. With a phaser we can affect only one frequency with a given response. Restated, a flanger affects ALL frequencies

EQUALLY, while a phaser produces a given effect at only ONE frequency.

Figure 8 shows one simple phase-control circuit. This uses FETs and a variable potentiometer. The same thing can be done with modern op-amps. (See figure 9) This uses less parts to do the same as figure 8, but neither one is quite sufficient for our purposes. These two examples only produce 90° of phase shift (at only ONE frequency - remember), and for a true cancellation we need 180° of shift. So let's connect two such units in series. (Figure 10) This circuit gives us the following response. (See figure 11) The exact frequency at which the notch occurs is a function of the values of the fixed resistors and the capacitors, and the setting of the two pots.

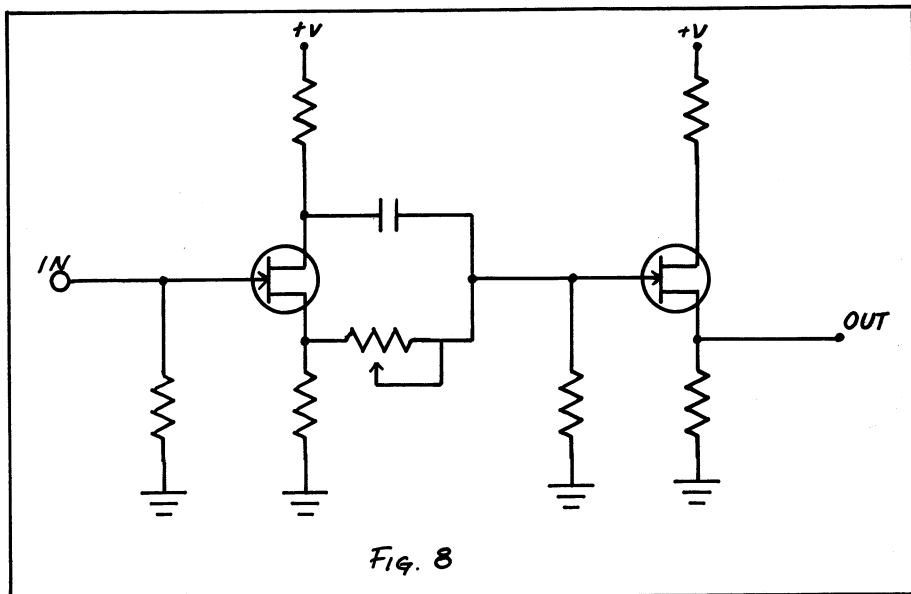


FIG. 8

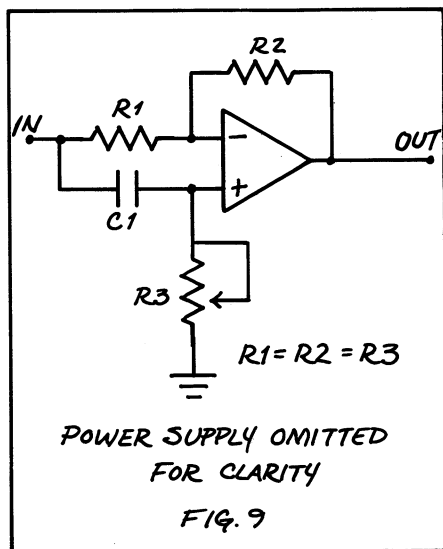


FIG. 9

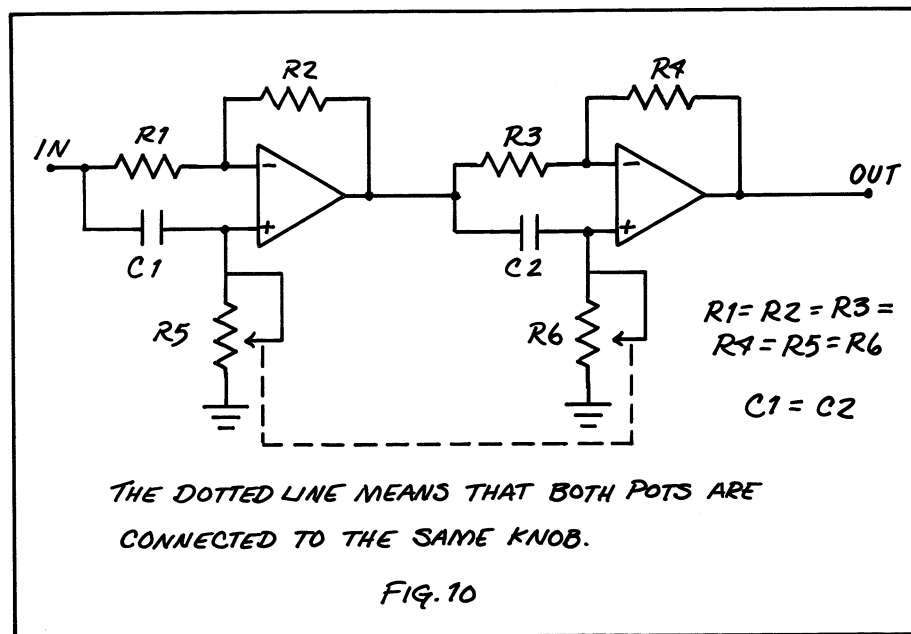


FIG. 10

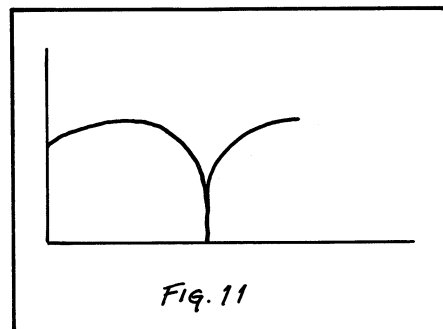


FIG. 11

It would be rather difficult to turn these pots by hand fast enough all the time (as it is with all synthesizer modules). Also, if we use more than two of these phase shift stages, multiple pots are not practical at all. So let's use FETs as voltage controlled resistors. (See figure 12)

Actually, even two of these stages are not enough. The minimum to produce a one-hump-two-notch response is four. Indeed, this is what is in

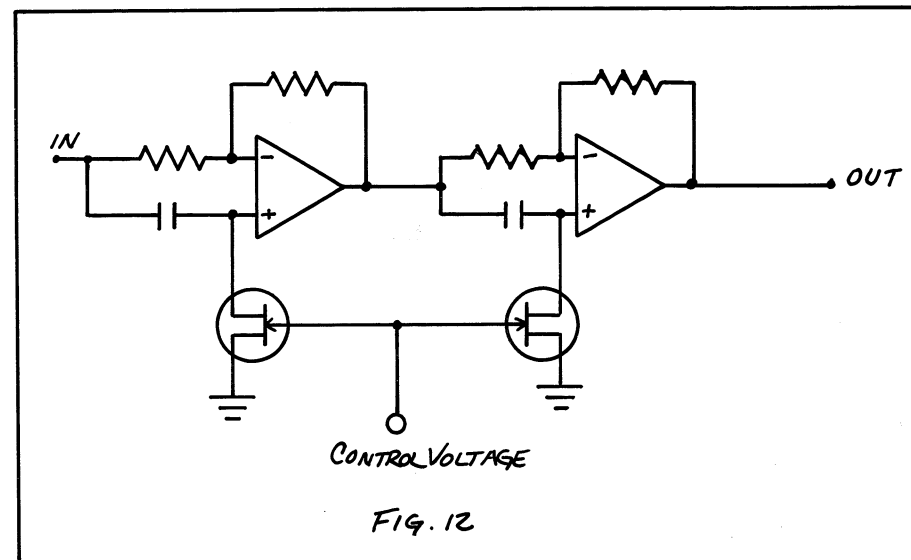
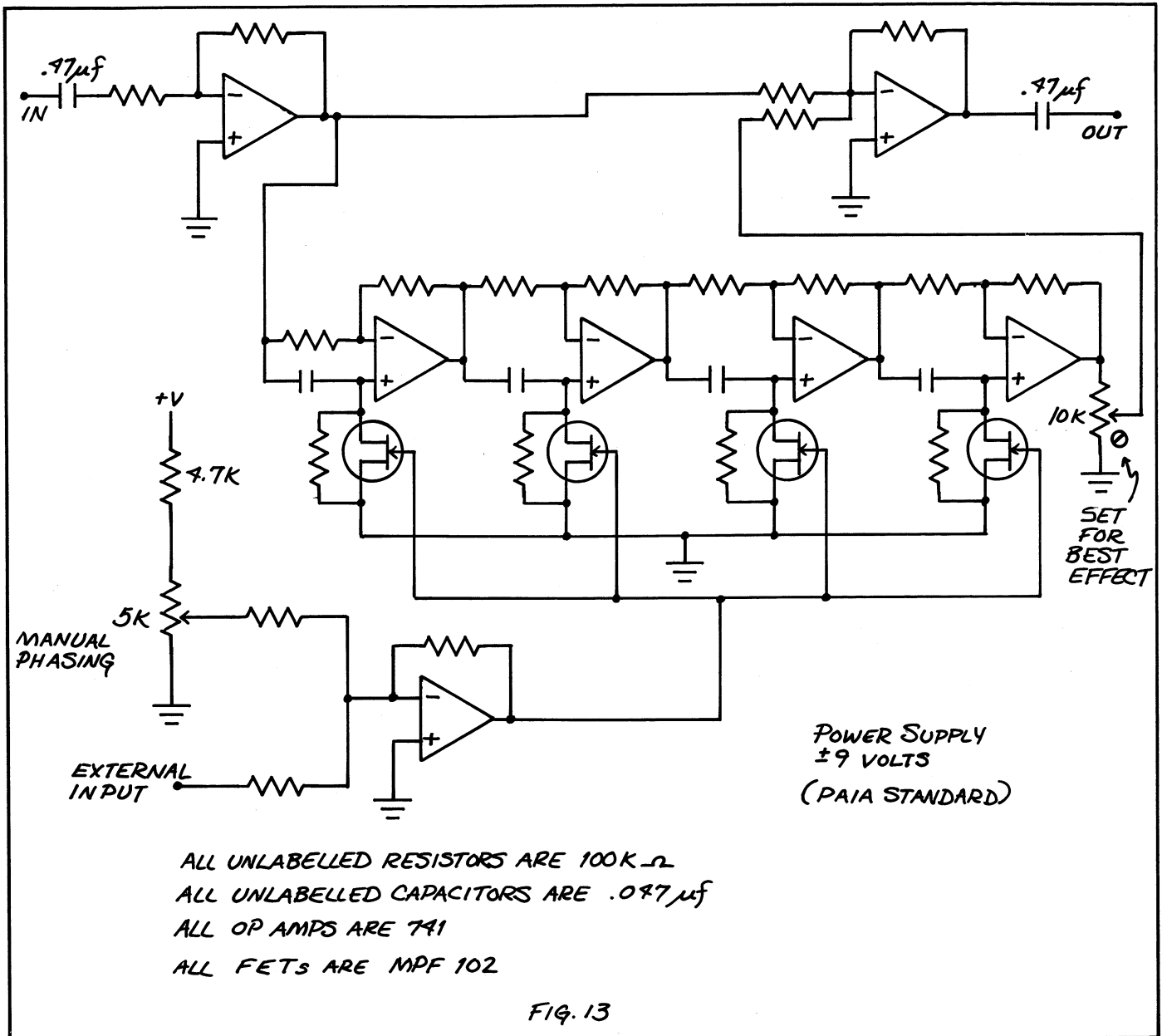


FIG. 12



many of the popular 'pedal phasers'. Many larger units use 6, 8, even up to 12 such stages. In general, two stages produce a notch, and three are necessary for a hump.

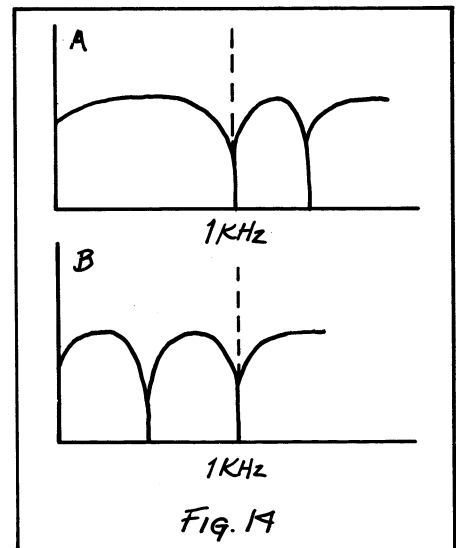
Taking a quantum jump from theory to design, figure 13 is a workable schematic of a 4-stage phase shifter. This works as is, but lacks an internal sweep, resonance controls, and variable mix. It may also need some part value optimization for best operation. In addition, this basic unit may be easily expanded to 6, 8, or even 12 stages.

Simple, huh? There is nothing really critical about the operation. Assembly is easy and can be done on perfboard, wire wrap, or PC. Some sources claim that the FETs must be

matched, but actual operation proves this to be necessary in only the most critical applications. Well regulated supplies are not necessary, either, but some extra filtering on the board won't hurt.

Before we look close, let's look at the response that is produced by this phaser. (Figure 14) Figure 14A is the response with no control voltage input. Note that there is one hump and two notches. For comparison we will assume that the first notch occurs at 1KHz, although it may be anywhere due to slightly different component values. In figure 14B we have applied 5 volts of control. Note that the response is now shifted DOWN, but otherwise remains the same.

continued on page 29...



...continued from page 15

Compare these two responses with those for the flanger in figures 6 and 7 and the true difference will become quickly apparent.

And now for a snappy summary that may serve to answer the original question, Is a Phlanger enough? Let's list some comparisons between the two units:

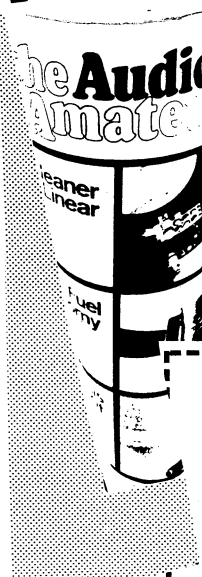
- I) A flanger depends on time manipulation, while the phaser depends on PHASE manipulation.
- II) The flanger affects ALL frequencies EQUALLY, while the phaser affects EACH frequency DIFFERENTLY.
- III) The flanger is very smooth sounded, while the phaser has noticable bumps or resonances. The phaser may be made smoother by adding more stages.
- IV) The flanger is presently more expensive than a phaser.
- V) The flanger is more critical in its operation, than a phaser, and catastrophic failure of a flanger is more difficult and expensive to repair.
- VI) Both units can be built with voltage control, variable resonance, internal clocks, and variable mix.

As an opinated answer to the question, I don't think that either a flanger OR a phaser alone is the total way to go. As can be seen, each has an entirely different sound, although both operate in similar manners. If you're really into synthesis I don't think you can afford to own only a Phlanger, just as you can't pass up PAIA's deal to own a great piece of equipment at such a low price as the #1500 Phlanger.

References (and strongly suggested reading if you want the full story):
 AUDIO HANDBOOK National Semiconductor Corp.; 2900 Semiconductor Dr.; Santa Clara, CA 95051.
 FET PRINCIPLES, EXPERIMENTS, AND PROJECTS Edward M. Noll; Howard W. Sams & Co.; Indianapolis, Indiana 46268.
 APPLICATIONS OF OPERATIONAL AMPLIFIERS Jerald Graeme; McGraw-Hill Book Co.; New York, New York.
 ACTIVE FILTER COOKBOOK Don Lancaster; Howard W. Sams & Co.; Indianapolis, Indiana 46268.
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